156SHO3202

SHOP MANUAL

BE220G
BE220
BE220LC

HYDRAULIC EXCAVATOR

BEML LIMITED
INDIA

CONTENTS

01.	GENERAL	01~18
ENGINE		
02.	STRUCTURE AND FUNCTION	01~08
03.	TESTING AND ADJUSTING	01~04
04.	DISASSEMBLY AND ASSEMBLY	01~02
04a	B(S) 6D105-1 SERIES DIESEL ENGINE SHOP MANUAL	01~01
POWER TRAIN		
05.	STRUCTURE AND FUNCTION	01~14
06.	DISASSEMBLY AND ASSEMBLY	01~28
07.	MAINTENANCE STANDARD	01~10
UNDER CARRIAGE		
08.	STRUCTURE AND FUNCTION	01~08
09.	DISASSEMBLY AND ASSEMBLY	01~08
10.	MAINTENANCE STANDARD	01~10
HYDRAULIC SYSTEM		
11.	STRUCTURE AND FUNCTION	01~12
12.	DISASSEMBLY AND ASSEMBLY	01~18
13.	DISASSEMBLY AND ASSEMBLY	01~24
14.	MAINTENANCE STANDARD	01~08
PMP INSTRUCTION MANUAL		
15.	SWING DRIVE (PMT / PMTE)	01~12
16.	TRAVEL DRIVE (PMCI)	13~24
ELECTRICAL AND ELECTRONIC SYSTEM		
17.	ELECTRICAL CIRCUIT DIAGRAM	01~02

IMPORTANT SAFETY NOTICE

Proper service and repair is extremely important for the safe operation of your machine. The service and repair techniques recommended by BEML and described in this mannual are both effective and safe methods of operations. Some of these operations require the use of tools specially designed by BEML for the purpose.

To prevent injury to workers, the symbols ⚠ and ⚠ are used to mark safety precautions in this manual. The cautions accom[anying these symbols should always be followed carefully. If any dangerous situation arises or may possibly arise, first consider safety, and take the necessary action to deal with the situation.

⚠ SAFETY

GENERAL PRECAUTIONS

Mistakes in the operation are extremely dangerous. Read the operation and Maintenance Manual carefully BEFORE operating the machine.

1. Before carrying out any greasing or repairs, read all the precautions given on the decals decals which are fixed to the machine.
2. When carrying out any operation, always wear safety shoes and helmet. Do not wear loose work clothes, or clothes with buttons missing.
   - Always wear safety glasses when hitting Parts with a hammer.
   - Always wear safety glasses when grinding parts with a grinder, etc.
3. If welding repairs are needed, always have a trained, experienced welder carry out the work. When carrying out welding work, always wear welding gloves, apron, glasses, cap and other clothes suited for welding work.
4. When carrying out any operations with two or more workers, always agree on the operating procedure before starting. Always inform your fellow workers before starting any step of the operation. Before starting work, hang UNDER REPAIR signs on the controls in the operator"s compartment.
5. Keep all tools in good condition and learn the correct way to use them.
6. Decide a place in the repair workshop to keep tools and removed pats. Always keep the tools and parts in their correct places. Always keep the work area clean and make sure that there is no dirt or oil on the floor. Smoke only in the areas provided for smooking. Never smoke while working.

PREPARATIONS FOR WORK

7. Before adding oil or making any repairs, park the machine on hard, level ground, and block the wheels or tracks to prevent the machine from moving.
8. Before starting work lower blade,ripper,bucket or any other work equipment to the ground. If this is not possible, insert the safety pin or use blocks to prevent the work equipment from falling.In addition,be sure to lock all the control levers and hang warning signs on them.
9. When disassembling or assembling, support the machine with blocks, blocks, jecks or stands before starting work.
10. Remove all mud and oil from the steps or other places used to get on and off the machine. Always use the handrails, laddera or steps when getting on or off the machine. Neverjump on or off the machine, If it is impossible o use the handrails, ladders or steps, use a stand to provide safe footing.

PRECAUTIONS DURING WORK

11. When removing the oil filler cap, drain plug or hydraulic pressure measuring plugs, loosen them slowly to prevent the oil from spurting out.

    Before disconnecting or removing components of the oil, water or air circuits, first remove the pressure completely from the circuit.

12. The water and oil in the circuits are not when the engine is stopped, so be careful not to get burned.

    Wait for the oil and water to cool before carrying out any work on the oil or water circuits.

13. Before starting work, remove the leads from the battery. Always remove the lead from negative (-) terminal first.

14. When raising heavy components, use a hoist or crane.
    Check that the wire rope, chains and hooks are free from damage.
    Always use lifting equipment which has ample capacity.
    Install the lifting equipment at the coorect places. Use a hoist or crane and operate slowly to prevent the component from hitting any other part. Do not work with any part still raised by the hoist or crane.

15. When removing covers which are under internal pressure or under pressure from a spring, always leave two bolts in position on opposite sides. Slowly release the pressure then slowly loosen the bolts to remove.

16. When removing components, be careful not to break or damage the wiring. Damaged wiring may cause electrical fires.

17. When removing piping, stop the fuel or oil from spilling out. If any fuel or oil drips on to the floor, wipe it up immediately, fuel or oil on the floor can cause you to slip, or can even star fires.

18. As a general rule, do not use gasoline to wash parts. In particular, use only the minimum of gasoline when washing electrical parts.

19. Be sure to assemble all parts again in their original places.
    Replaces any damaged parts with new parts.
    - When installing hoses and wires, be sure that they will not be damaged by contact with other parts when the machine is being operated.

20. When installing high pressure hoses, make sure that they are not twisted. Damaged tubes are dangerous, so be extremely careful when installing tubes for high pressure circuits. Also, check that connecting parts are correctly installed.

21. When assembling or installing parts, always use the specified tightening torques. When installing protective parts such as guards, or parts which vibrate violently or rotate at high speed, be particularly careful to check that they are installed correctly.

22. When aligning two holes, never insert your fingers or head. Be careful not to get your fingers caught in a nole.

23. When measuring hydraulic pressure, check that the measuring tool is correctly assembled before taking any measurements.

24. Take care when removing or installing the tracks of track-type machines.
    When removing the track, the track separates suddenly, so never let anyone stand at either end of the track.

FOREWORD

This shop manual has been prepared as an aid to improve the quality of repairs by giving the serviceman an accurate understanding of the product and by showing him the correct way to perform repair and make judgements. Make sure you understand the contents of this manual and use it to full effect at every opportunity.

This shop manual mainly contains the necessary technical information for operations performed in a service workshop.

For ease of understanding,the manual is divided in to chapters for each main group of components, these chapters are further divided in to the following sections.

STUCTURE AND FUNCTION

this section explains the structure and function of each component. It serves not only to give an understanding of the structure, but also serves as reference material for troubleshooting.

TESTING AND ADJUSTING

This section explains checks to be made before and after performing repairs, as well as adjustments to be made at completion of the checks and repairs.

Troubleshooting charts correlating "Problems" to "Causes" are also indicated in this section.

DISASSEMBLY AND ASSEMBLY

This section explains the order to be followed when removing, installing, disassembling or assembling each component as well as precautions to be taken for these operations.

MAINTENANCE STANDARD

This section gives the judgement standards when inspecting disassembled parts.

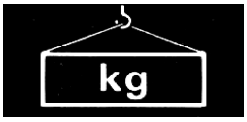
NOTE :

1. For B(S)6D105-1 engine details refer seperate engine shop manual of SE105 M 06 00 7
2. For swing machinery, final drive details refer PMP instruction manual of PMTE M001
3. For travel gear final drive details refer PMP instruction manual of PMCI M001
4. For hydraulic system details refer Rexroth instruction manual of HS-64-05-E0403-1-3

NOTICE

The specifications contained in this shop manual are subject to change at any time and without any advance notice. Contact your BEML Marketing for the latest information.

HOISTING INSTRUCTIONS



⚠ Heavy parts (25 kg or more) must be lifted with a hoist etc. In the Disassembly and Assembly section, every part weighing 25 kg or more is indicated clearly with the symbol 

1. If a part cannot be smoothly removed from the machine by hoisting, the following checks should be made:
- Check for removal of all bolts fastening the part to the relative parts.
- Check for existence of another part causing interference with the part to be removed.

2. Wire ropes

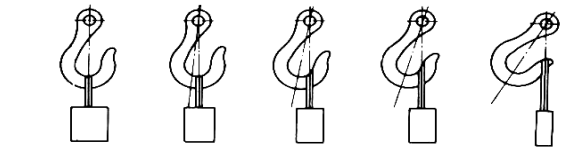
1) Use adequate ropes depending on the weight of parts to be hoisted, referring to the table below:

Wire ropes (Standard "Z" or"S" twist ropes without galvanizing)	
Rope diameter (mm)	Allowable load (tons)
10	1.0
11.2	1.4
12.5	1.6
14	2.2
16	2.8
18	3.6
20	4.4
22.4	5.6
30	10.0
40	18.0
50	28.0
60	40.0

The allowable load value is estimated to be one-sixth or one-seventh of the breaking strength of the rope used.

2) Sling wire ropes from the middle portion of the hook.
Slinging near the edge of the hook may cause the rope to slip off the hook during hoisting, and a serious accident can result.

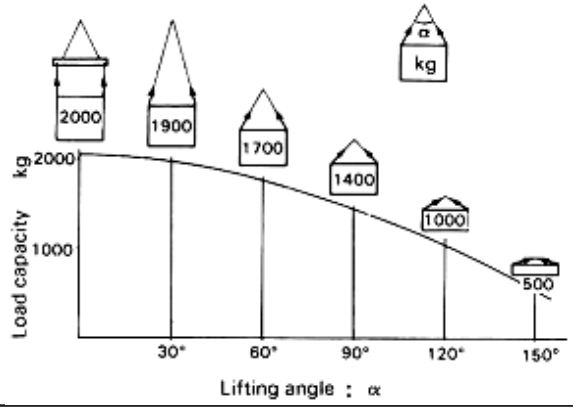
Hooks have maximum strength at the middle portion.

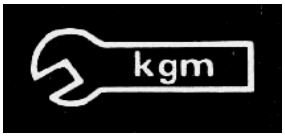


3) Do not sling a heavy load with one rope alone, but sling with two or more ropes symmetrically wound on to the load.

⚠ Slinging with one rope may cause turning of the load during hoisting, untwisting of the rope, or slipping of the rope from its original winding position on the load, which can result in a dangerous accident.

4) Do not sling a heavy load with ropes forming a wide hanging angle from the hook.
When hoisting a load with two or more ropes, the force subjected to each rope will increase with the hanging angles. The table below shows the variation of allowable load (kg) when hoisting is made with two ropes, each of which is allowed to sling up to 1000 kg vertically, at various hanging angles.
When two ropes sling a load vertically, up to 2000 kg of total weight can be suspended. This weight becomes 1000 kg when two ropes make a 120° hanging angle. On the other hand, two ropes are subjected to an excessive force as large as 4000 kg if they sling a 2000 kg load at a lifting angle of 150°.





STANDARD TIGHTENING TORQUE

1. STANDARD TIGHTENING TORQUE OF BOLTS AND NUTS

The following charts give the standard tightening torques of bolts and nuts. Exceptions are given in section of “Disassembly and Assembly

Thread diameter of bolt (mm)	width across flat (mm)		
		kgm	Nm
6	10	1.35±0.15	13.2±1.4
8	13	3.2±0.3	31.4±2.9
10	17	6.7±0.7	65.7±6.8
12	19	11.5±1.0	112±9.8
14	22	18.0±2.0	177±1.9
16	24	28.5±3	279±29
18	27	39±4	383±39
20	30	56±6	549±58
22	32	76±8	745±78
24	36	94.5±10	927±98
27	41	135±15	1320±140
30	46	175±20	1720±190
33	50	225±25	2210±240
36	55	280±30	2750±290
39	60	335±35	3280±340

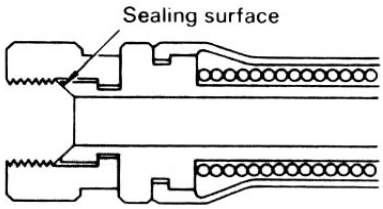
This torque table does not apply to the bolts with which nylon packings or other non-ferrous metals washers are to be used, or which require tightening to otherwise specified torque.

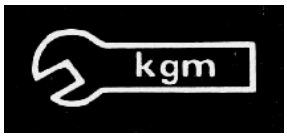
★ Nm (newton meter): 1 Nm = 0.1 kgm

2. TIGHTENING TORQUE OF SPLIT FLANGE BOLTS

Use these torques for split flange bolts.

Thread diameter of bolt (mm)	Width across flats (mm)	Tightening torque	
		kgm	Nm
10	14	6.7±0.7	65.7±6.8
12	17	11.5±1	112±9.8
16	22	28.5±3	279±29



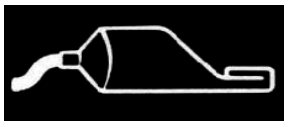


3. TIGHTENING TORQUE FOR NUTS OF FLARED

Use these torques for nut part of flared.

Thread diameter of nut part (mm)	width across flats of nut part (mm)	Tightening torque	
		kgm	Nm
14	19	2.5±0.5	24.5±4.9
18	24	5±2	49±19.6
22	27	8±2	78.5±19.6
24	32	14±3	137.3±29.4
30	36	18±3	176.5±29.4
33	41	20±5	196.1±49
36	46	25±5	245.2±49
42	55	30±5	294.2±49

COATING MATERIALS

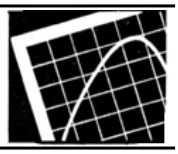


The recommended coating materials prescribed in **beml** Shop Manuals are listed below.

Nomenclature	BEML code	Applications
Adhesives	LT-1A	Used to apply rubber pads, rubber gaskets, and cork plugs
	LT-1B	Used to apply resin, rubber, metallic and non-metallic parts when a fast, strong seal is needed
	LT-2*	Preventing bolts, nuts and plugs from loosening and leaking oil.
	LT-3	Provides an airtight, electrically insulating seal. Used for aluminum surfaces.
	LT-4	Used to coat plugs (plate shaped, bowl shaped) and holes, and mating portion of shaft.
Sealant gasket	LG-1	Used with gaskets and packings to increase sealing effect.
	LG-3	Heat-resistant gasket for precombustion chambers and exhaust piping.
	LG-4	Used by itself on mounting surfaces on the final drive and transmission cases. (Thickness after tightening: 0.07 - 0.08 mm)
	LG-5	Used by itself to seal grease fittings, tapered screw fittings and tapered screw fittings in hydraulic circuits of less than 50 mm in diameter.
	LG-6	Silicon base type used in combination with LG-1 and LG-4.
	LG-7	Has a shorter curing time than LG-6, and is easier to peel off.
Antifriction compound (Lubricant including molybdenum disulfide)	LM-P	Applied to bearings and taper shafts to facilitate press-fittings and to prevent sticking, burning or rusting.
Grease (Lithium grease)	G2-L1 -	Applied to bearings, sliding parts and oil seals for lubrication, rust prevention and facilitation of assembling work.
Vaseline		Used for protecting battery electrode terminals from corrosion.

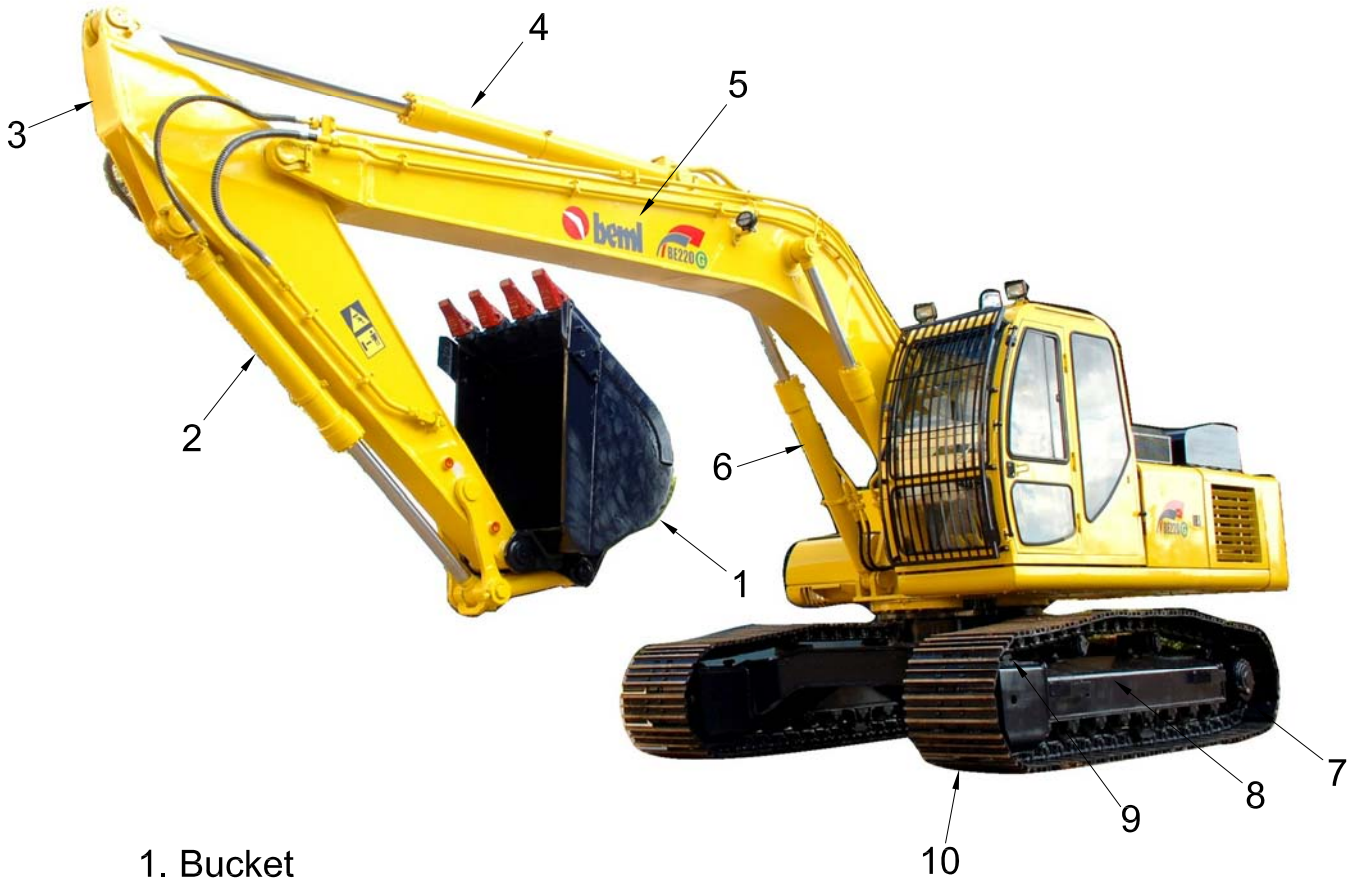
*LT-2 is also called LOCTITE in the shop manuals.

01 GENERAL



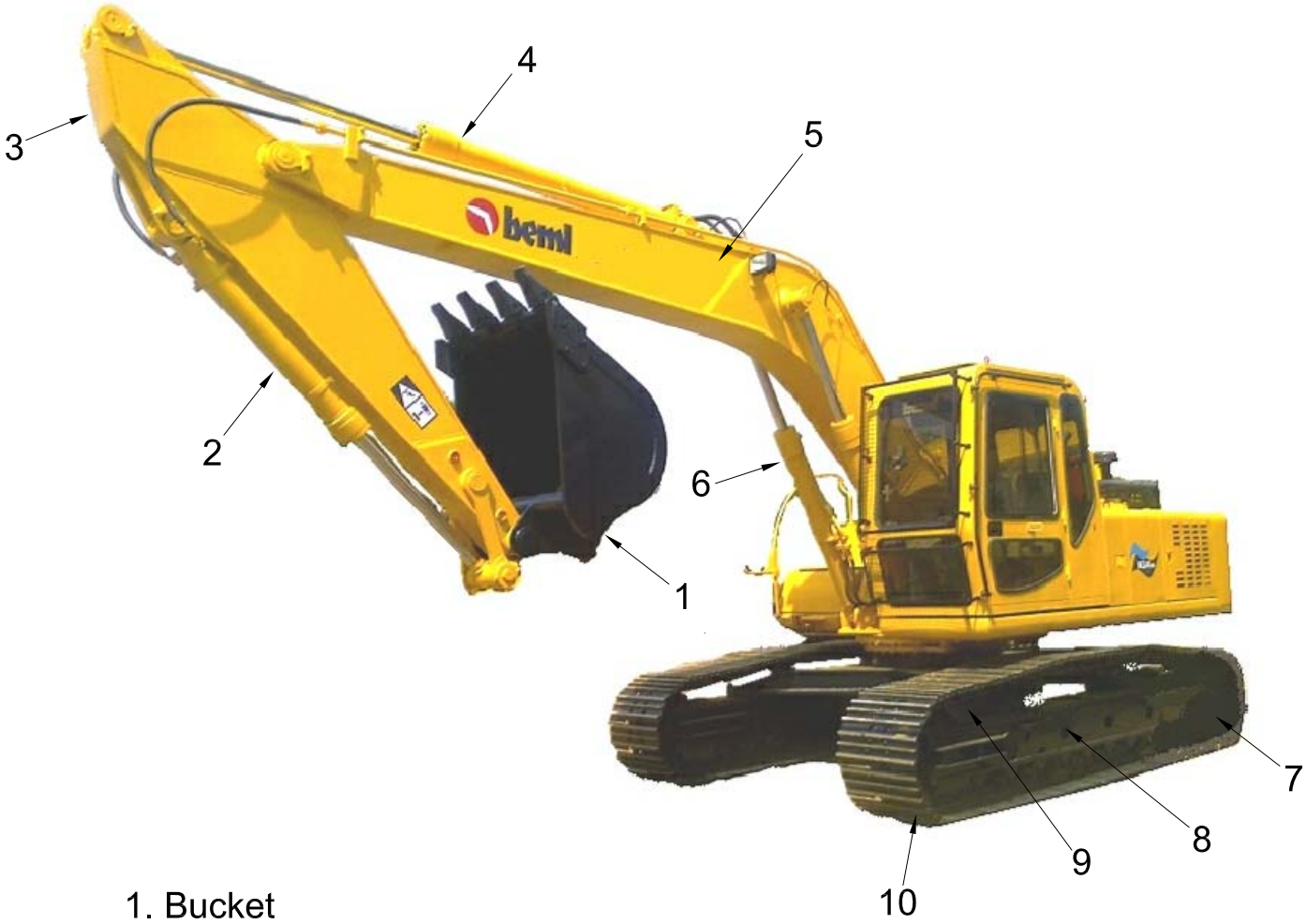
General view..... 01-10
General assembly drawing..... 01-11
Specification..... 01-13
Engine assembly drawing..... 01-14
List of weight..... 01-15
List of lubricant and water..... 01-17

GENERAL VIEW



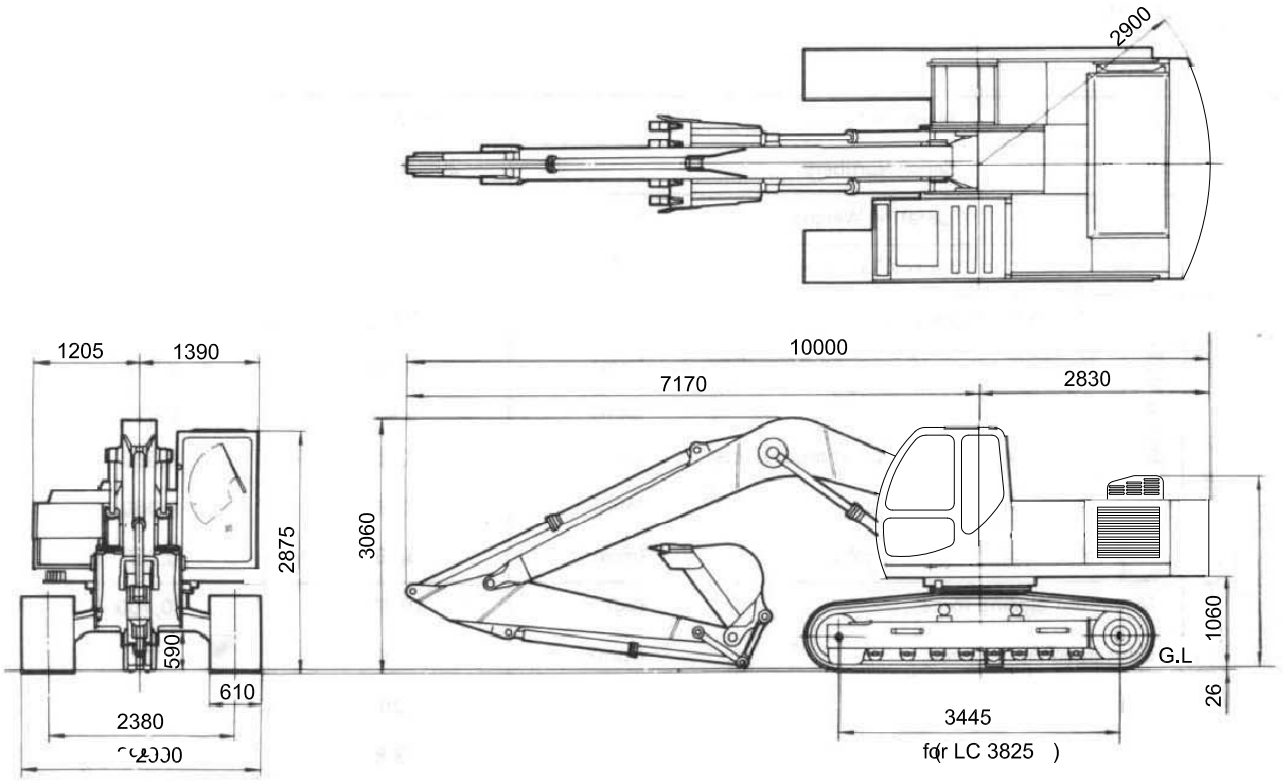
1. Bucket
2. Bucket cylinder
3. Arm
4. Arm cylinder
5. Boom
6. Boom cylinder
7. Sprocket
8. Track frame
9. Idler
10. Track shoe

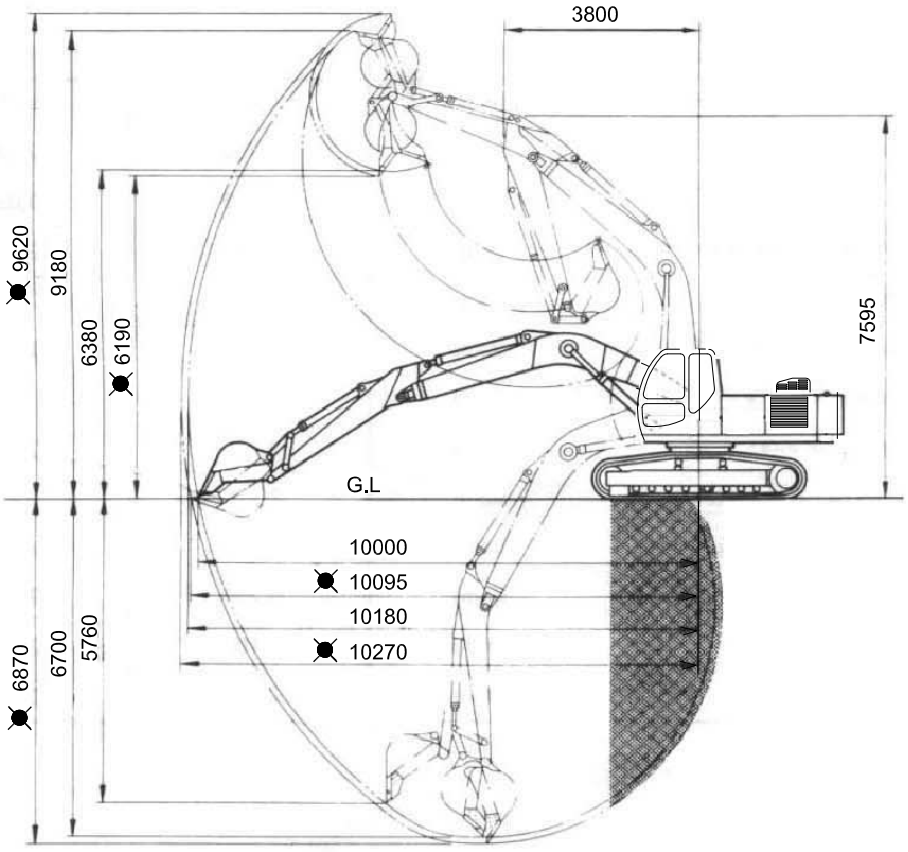
GENERAL VIEW



1. Bucket
2. Bucket cylinder
3. Arm
4. Arm cylinder
5. Boom
6. Boom cylinder
7. Sprocket
8. Track frame
9. Idler
10. Track shoe

GENERAL ASSEMBLY DRAWING



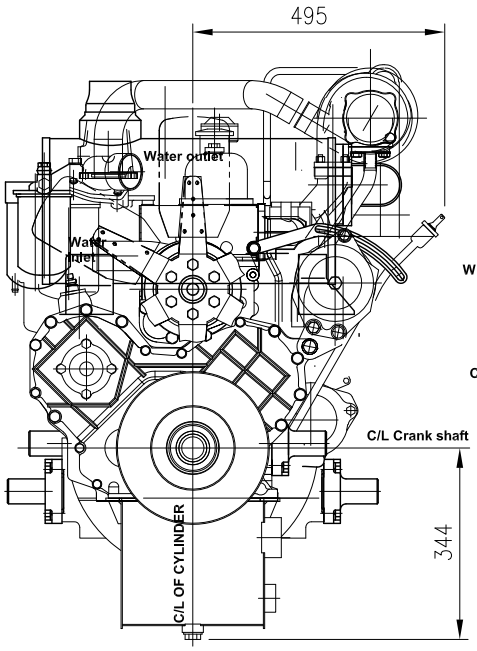


The marks ✕ indicates the dimensions for shovel operation.

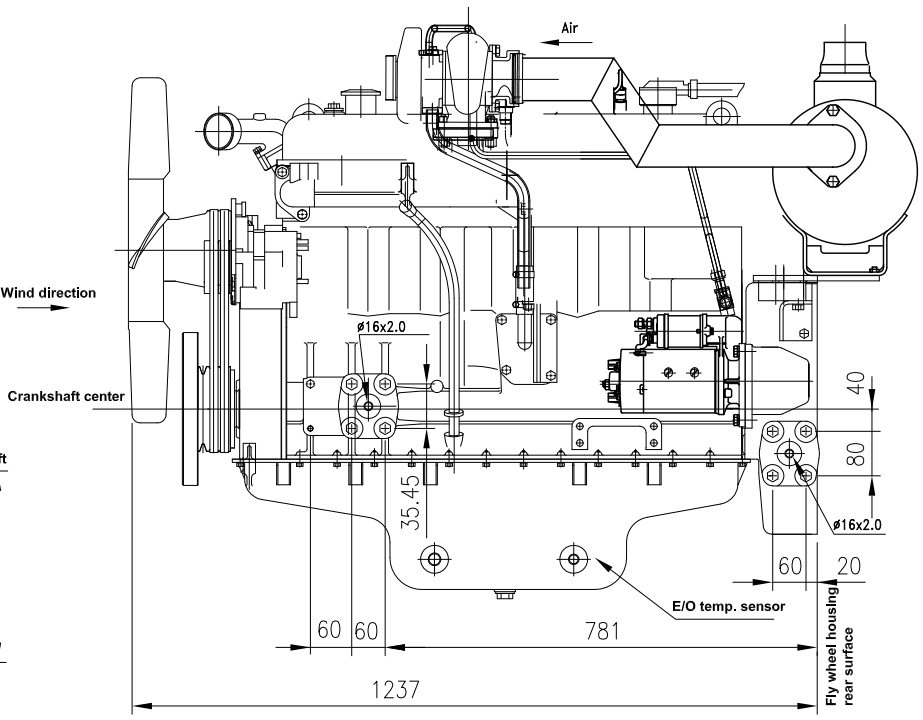
MACHINE MODEL			BE220G
SERIAL NUMBER			G16803 and up
ENGINE	Engine model		BS6D105-1
	Type		4 cycle, in-line, water cooled direct injection type diesel engine with turbo charger
	No. of cylinder - bore x stroke	(mm)	6 - 105 x 125
	Total displacement	(cc)	6,494
	Flywheel horsepower	(HP/rpm)	148 / 2,100
	Maximum torque	(kgm/rpm)	56.5 / 1,600
	High idle speed	(rpm)	2300 ± 50
	Low idle speed	(rpm)	850 ± 50
	Manimum fuel consumption ratio	(g/hpH)	155
	Starting motor		24V, 4.5 kW
	Alternator		24V, 30A
	Battery		24V (12 x 21) - 120 Ah
	Type of radiator core		Flat fin type
UNDER CARRIAGE	Carrier roller	(one side)	2
	Track roller	(one side)	8
	Track shoe		Built built-up triple growser
HYDRAULIC SYSTEM	HYDRAULIC PUMP — Type, Number		Variable displacemnt piston type x 2
			Gear type x1
	Delivery	(l per / min)	piston type : 2 x 203 (at reted engine speed)
	Set pressure	(kg / cm^2)	Gear type : 50 (at reted engine speed) Piston type : 320 Gear type : 30
	CONTROL VALVE — Type, number		7 Spool type + One optlonal spool
	Control lever operation		Pilot type, Travel control by lever with foot pedal
	HYDRAULIC MOTOR — Travel motor		Piston type
	Swing motor		Piston type
	Hydraulic cylinder		Double acting piston
	Hydraulic tank		Closed box type
	Hydraulic filter		Tank return side
	Hydraulic coller		Forced, Air cooled

ENGINE ASSEMBLY DRAWING

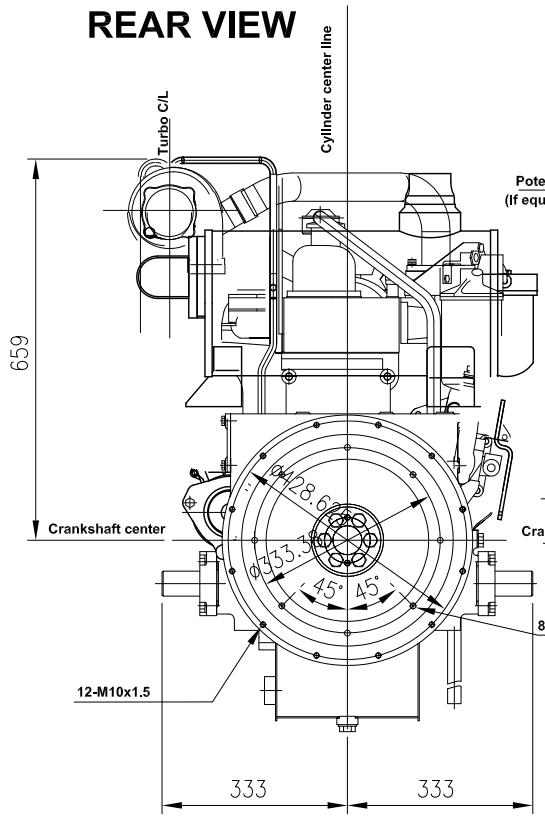
FRONT VIEW



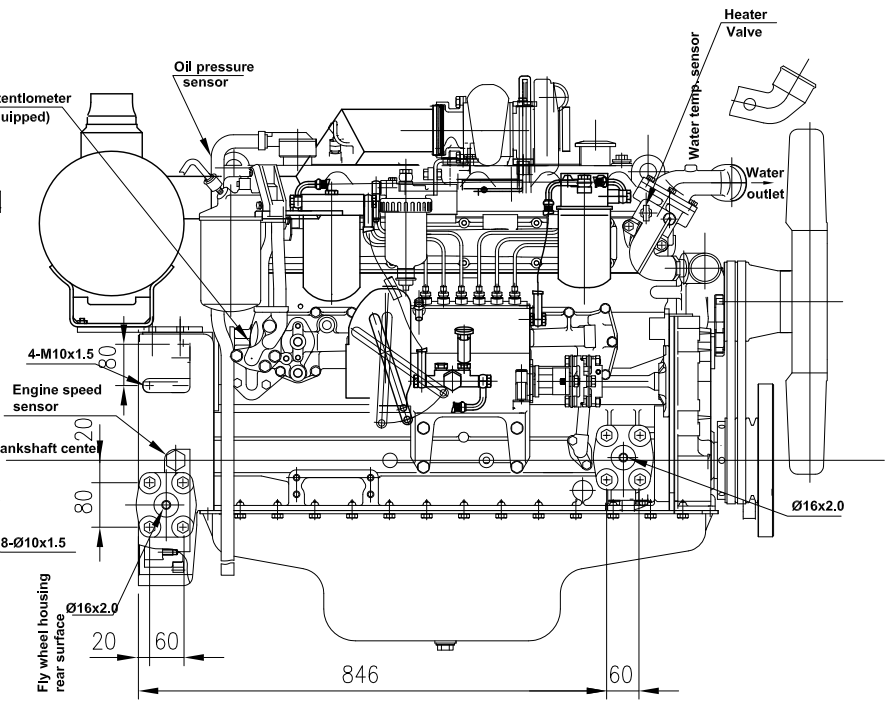
LEFT SIDE VIEW



REAR VIEW



RIGHT SIDE VIEW



BE220G / BE220, BE220LC

MACHINE MODEL	BE220G	BE220	BE220LC
Engine assembly	655	783	783
• Engine	655	655	655
• Damper	-	12	12
• Main piston pump	-	116	116
• Charging pump	-	85	85
Radiator and oil cooler assy	130	130	130
Hydraulic tank (without hydraulic oil)	196	196	196
Fuel tank (without fuel)	111	111	111
	1965	1965	1965
	395	395	395
	194	194	194
Revolving frame	1864	1853	1853
Operator's cab(including operartor's seat & heater)	395	395	395
Swing machinery	230	194	1943
Swing motor assembly	73	23	23
Travel motor assembly	-	25 x 2	25 x 2
7 - spool control valve	-	148	148
8 - spool control valve	195	-	-
Center swivel joint assembly	35	35	35
Counter Weight	3935	3935	3935
Track frame assembly	4604	4604	5100
• Track frame	3245	3245	3565
• Carrier roller assembly	22 x 4	22 x 4	22 x 4
• Track roller assembly	36 x 16	36 x 16	36 x 20
• Recoil spring assembly	135 x 2	135 x 2	135 x 2
• Idler assembly	120 x 2	120 x 2	120 x 2
• Final drive assembly	245	640	640
• Final drive assembly (with motor)	245	-	-
• Sprocket	42 x 2	42 x 2	42 x 2
• Swing circle assembly	243	243	243
Track shoe assembly	2849	2849	3146
Boom assembly	1696	1696	1696
Arm assembly	793	793	793
Bucket assembly	965	965	965

MACHINE MODEL	BE220G	BE220	BE220LC
Boom cylinder assembly	187 x 2	187 x 2	187 x 2
Arm cylinder assembly	266	266	266
Bucket cylinder assembly	167	167	167
Link (large) assembly	79	79	79
Link (small) assembly	23 x 2	23 x 2	23 x 2
Boom pin	43 + 10 x 2 + 30 + 10 + 32	43 + 10 x 2 + 30 + 10 + 32	43 + 10 x 2 + 30 + 10 + 32
Arm pin	10 x 2	10 x 2	10 x 2
Bucket pin	20 x 2	20 x 2	20 x 2
Link pin	18 x 2	18 x 2	18 x 2

⚠ **This weight table is a guide for use when transporting or handling components.**

BE220 / BE220LC

PROPER SELECTION OF FUEL, COOLANTS AND LUBRICANTS

RESERVOIR	KIND OF FLUID	BEML STD.	VISCOSITY GRADE	CAPACITY (LITERS)	
ENGINE OIL PAN	ENGINE OIL	C6002-30	CF_4 15W40	25	17.5
SWING MACHINERY CASE		C6002-03	SAE 30 CD	5	4.5
SWING BRAKE				5	4.5
FINAL DRIVE CASE				4	3.4
TRAVEL BRAKE				4	3.4
HYDRAULIC SYSTEM		C6002-03	SAE 30 CD	250	150
FUEL TANK	DIESEL	C6002-01	HSD	280	-
COOLING SYSTEM	WATER	-	-	35	26.5
GREASE	NLGI – 2 (MOLEX)	C6003-02	MOLEX GREASE	-	-

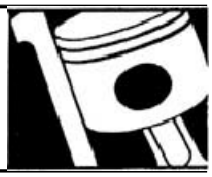
BE220G

PROPER SELECTION OF FUEL, COOLANTS AND LUBRICANTS

RESERVOIR	KIND OF FLUID	BEML STD.	VISCOSITY GRADE	CAPACITY (LITERS)	
ENGINE OIL PAN	ENGINE OIL	C6002-30	CF_4 15W40	25	17.5
SWING MACHINERY CASE	GEAR OIL	—	SAE80W90	5	4.5
SWING BRAKE				—	—
FINAL DRIVE CASE				4.5	4.0
TRAVEL BRAKE				—	—
HYDRAULIC SYSTEM		C6002-03	SAE 30 CD	250	150
FUEL TANK	DIESEL	C6002-01	HSD	280	-
COOLING SYSTEM	WATER	-	-	35	26.5
GREASE	NLGI – 2 (MOLEX)	C6003-02	MOLEX GREASE	-	-

ENGINE

02 STRUCTURE AND FUNCTION



Engine mount and engine attached parts..... 02-02

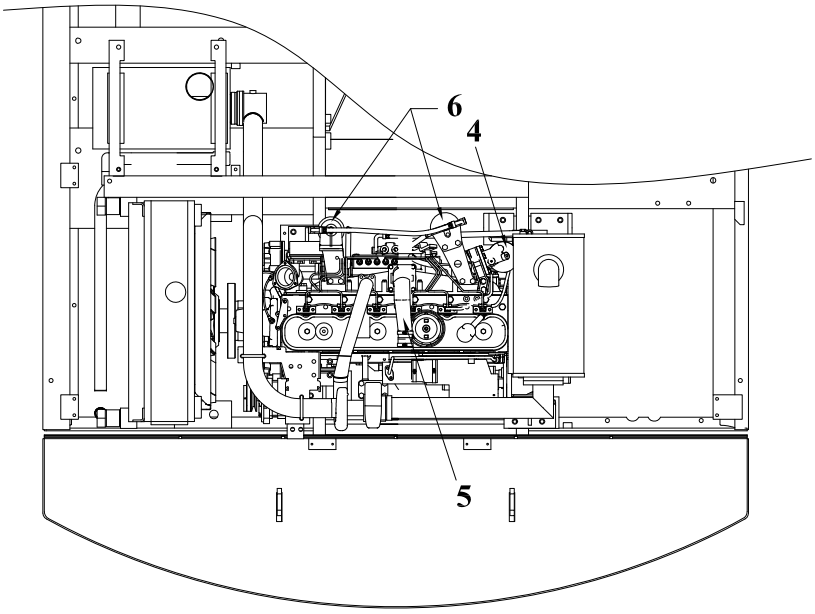
Radiator and cooler.....02-05

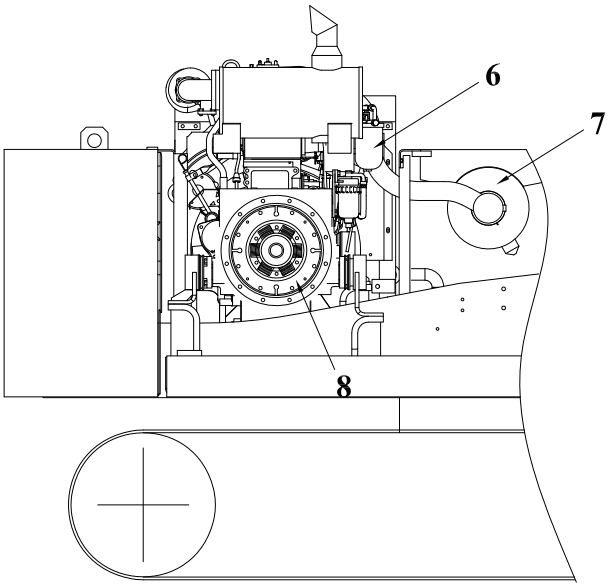
Damper..... 02-06

Fuel tank and piping.....02-08

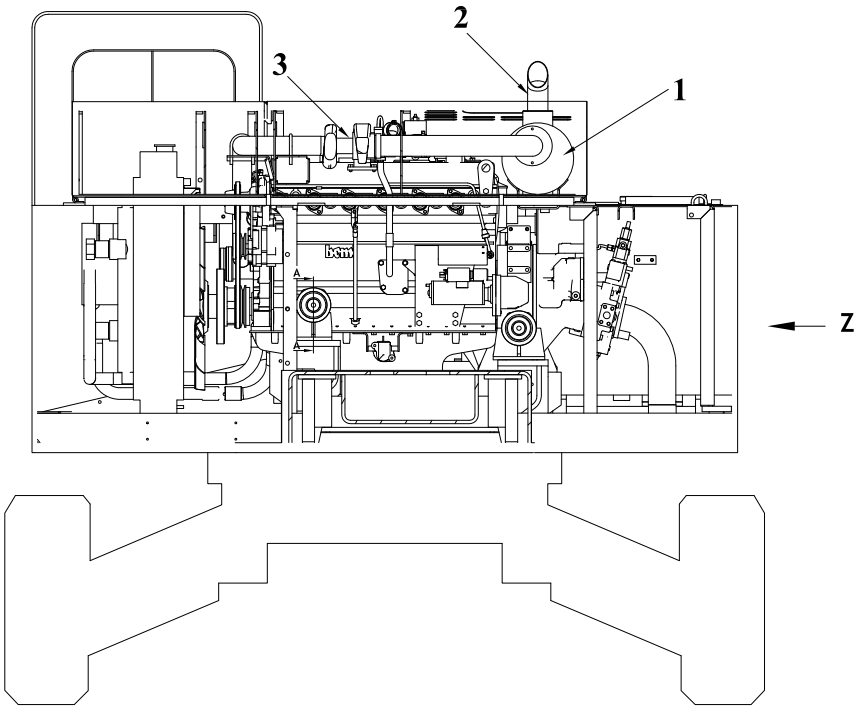
BE220G

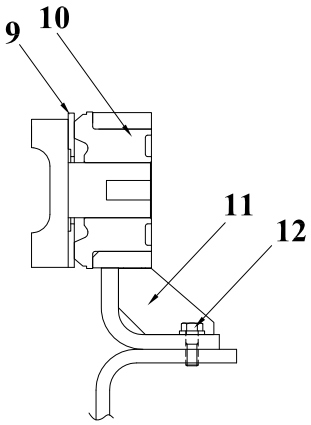
ENGINE MOUNT AND ENGINE ATTACHMENT PARTS





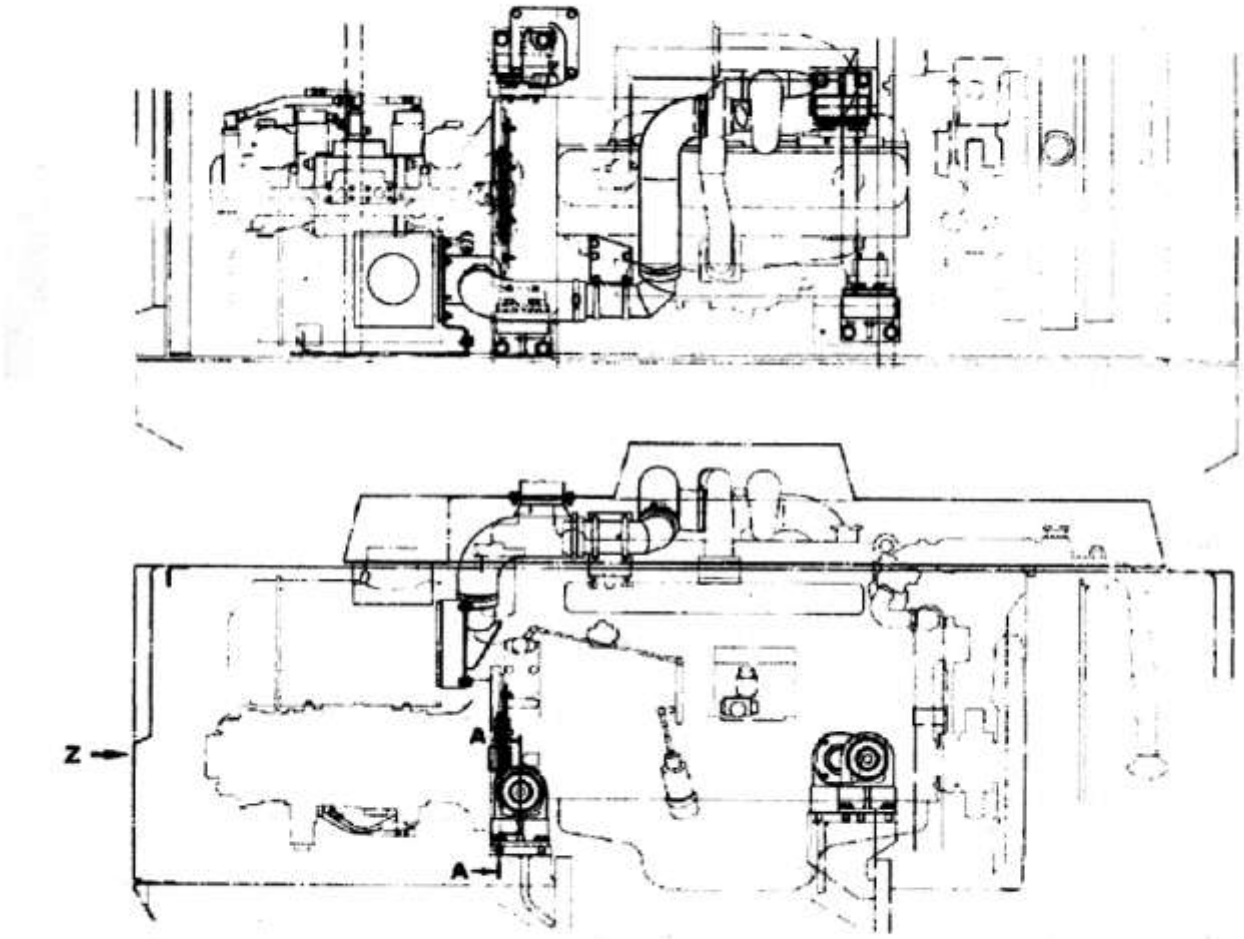
VIEW - Z

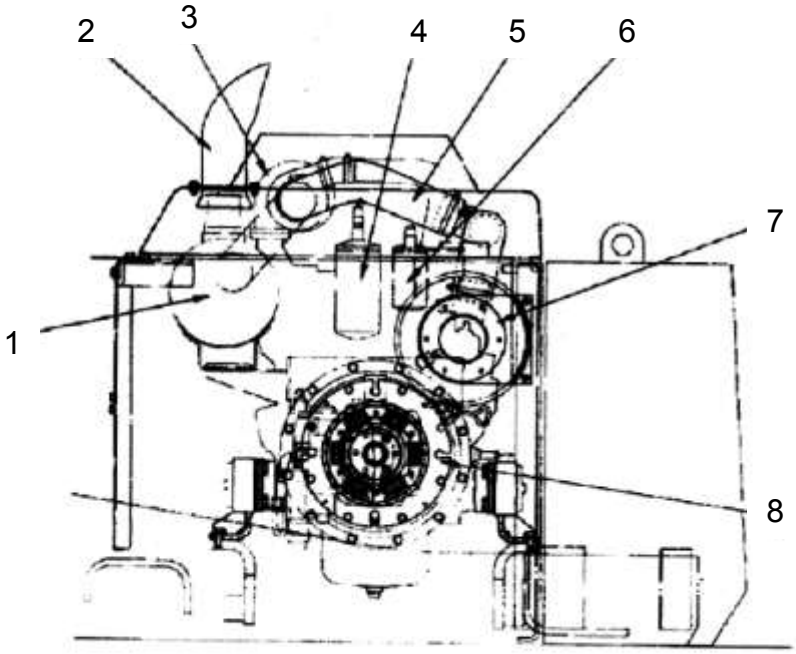




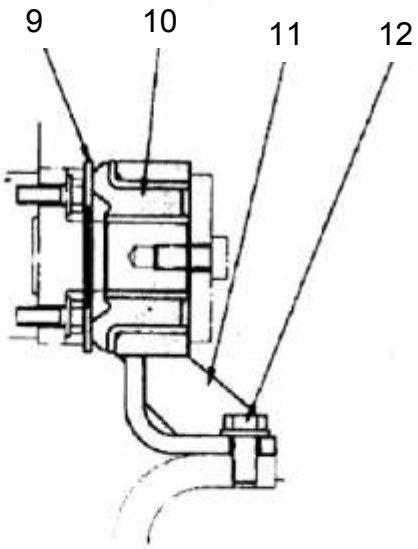
SECTION A-A

ENGINE MOUNT AND ENGINE RELATED PARTS

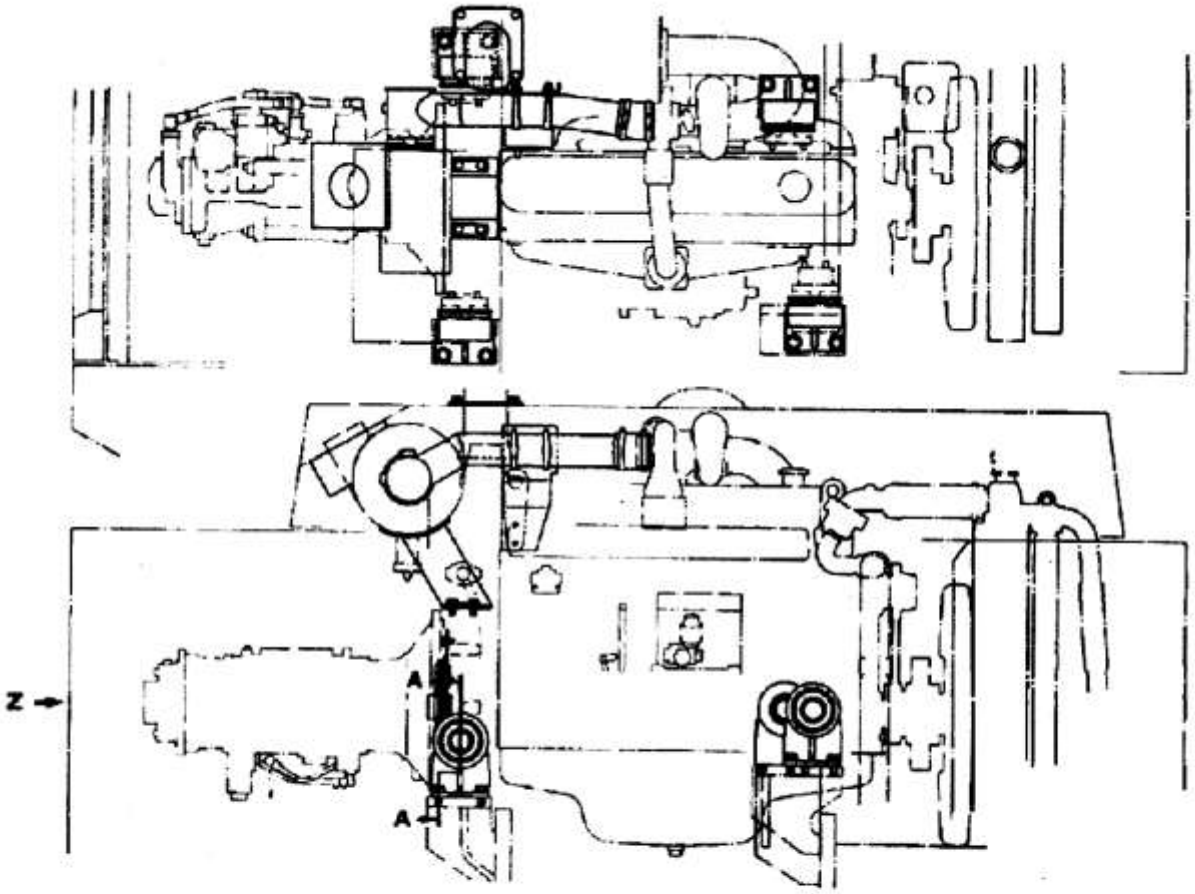


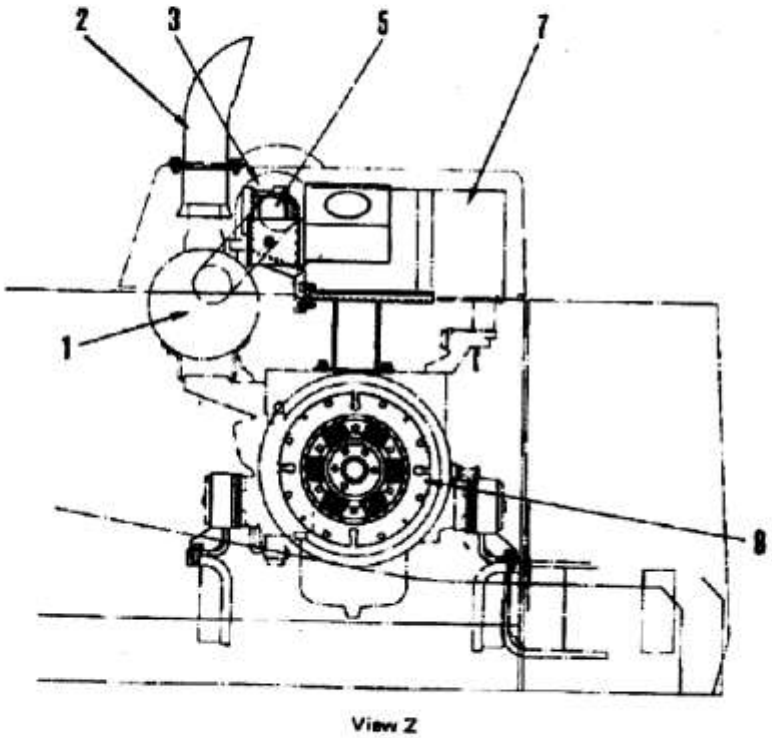


View - Z



Section – A-A





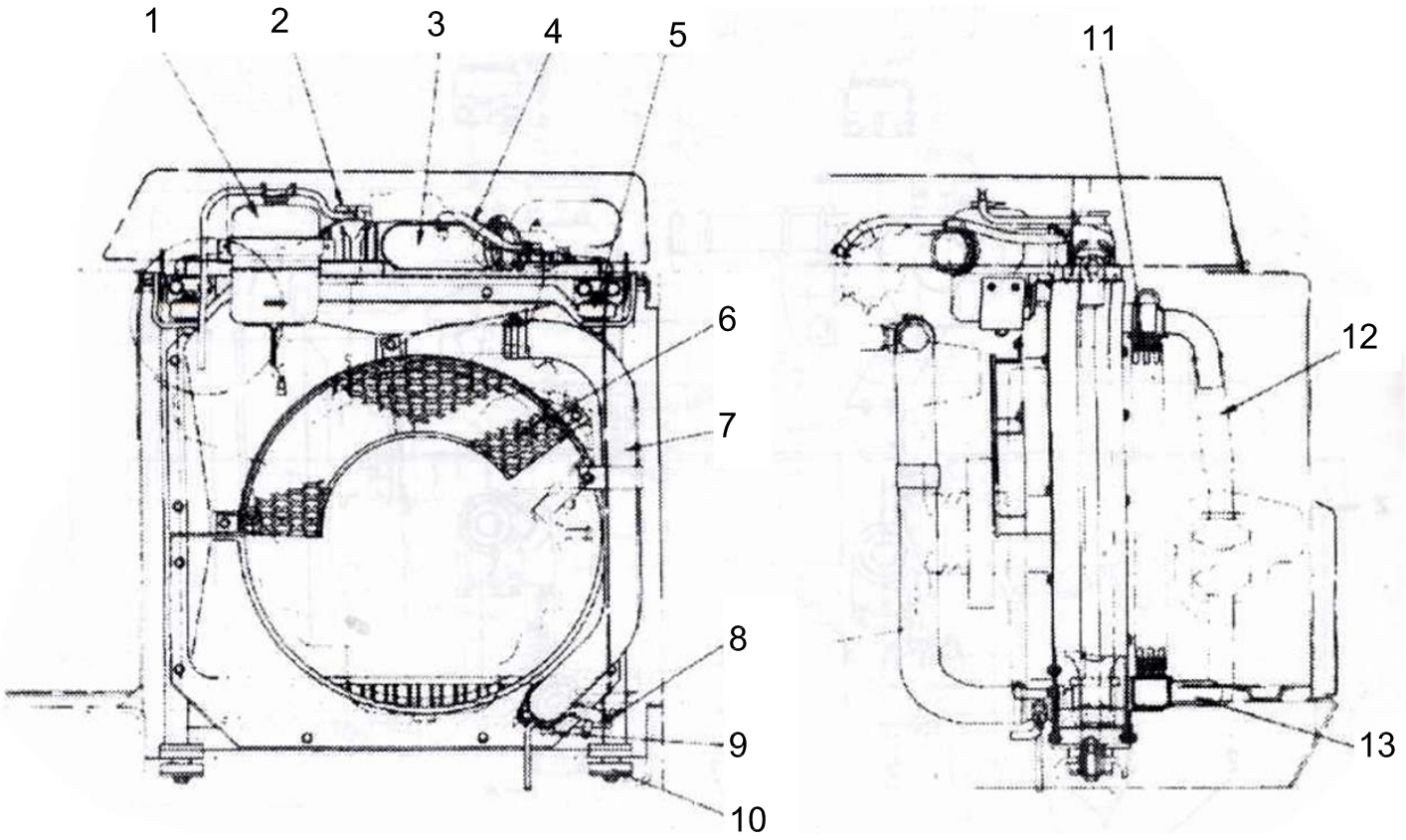
View Z

1. Muffler
2. Exhaust pipe
3. Turbocharger
4. Engine oil filter
5. Intake connector
6. Fuel Filter
7. Air cleaner
8. Damper assembly
9. Spacer
10. Engine mount cushion rubber
11. Engine mount bracket
12. Engine mount bolt

RADIATOR AND COOLER

The radiator core is a D in-line type.
Air is forced out when the fan rotates.
The hydraulic oil cooler installed to the radiator.

The radiator has sub tank (1), so to check the cooling. Water level it is only necessary to look at the sub-tank.
(there is no need to remove the radiator cap.)

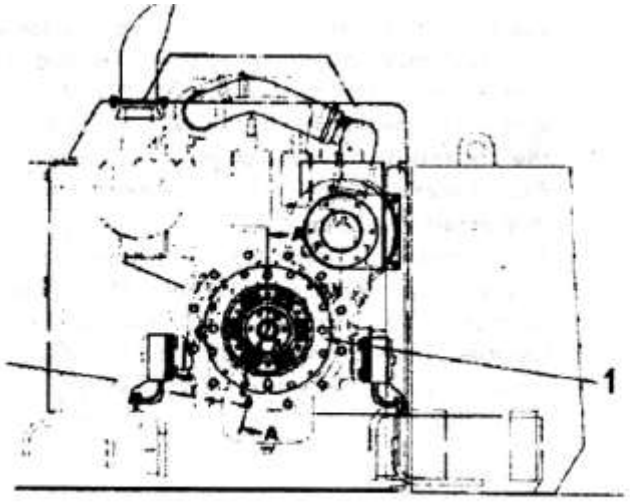


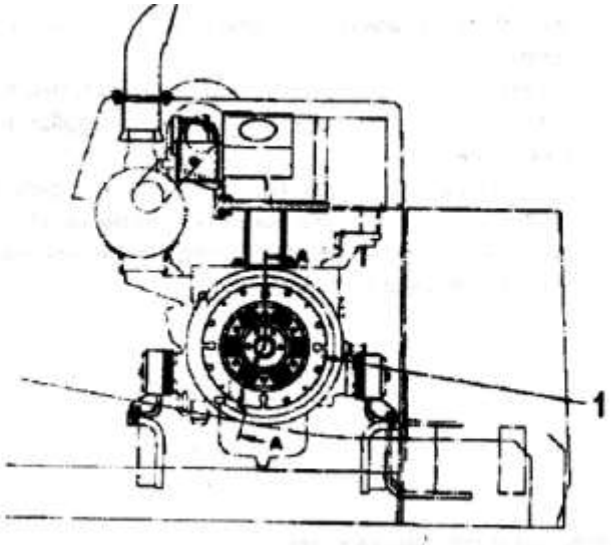
1. Sub-tank
2. Radiator cap
3. Radiator inlet hose
4. Aeration hose
5. Radiator upper mount
6. Fan guard
7. Radiator outler hose
8. Valve for heater
9. Drain valve
10. Radiator lower mount
11. Hydraulic oil cooler (air cooled)
12. Hydraulic oil cooler oil inlet hose
13. Hydraulic oil cooler oil oulet hose

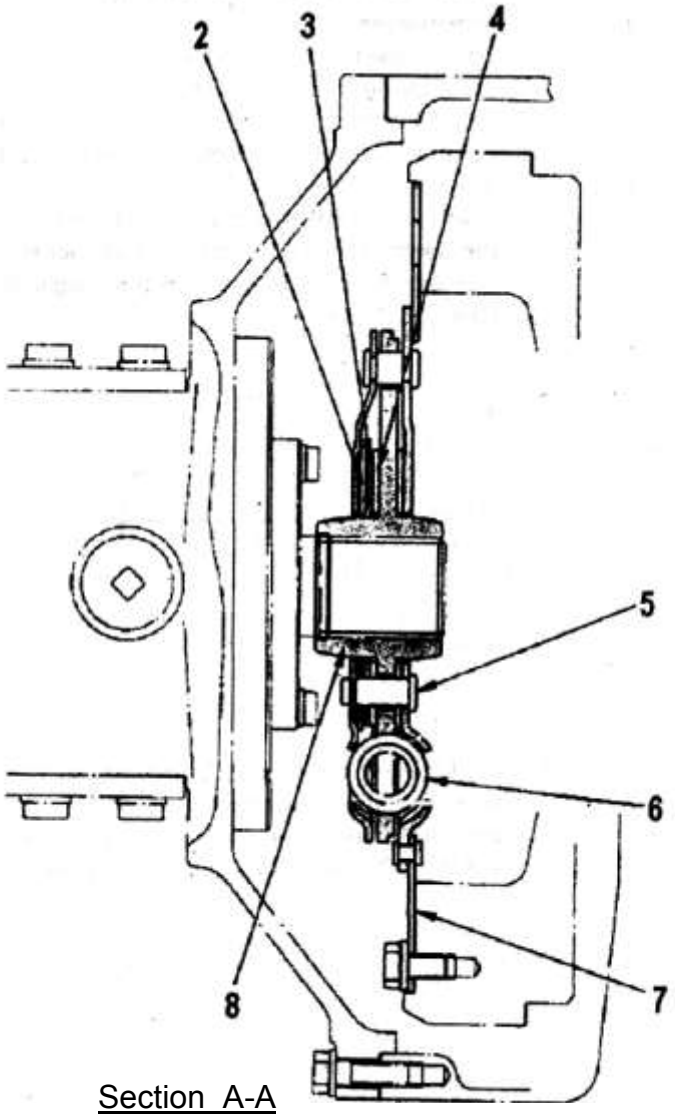
Specifications

	Core type	Overall heat radiation area	Capacity
Radiator	SF 6	55.14 m^3	36.5 ℓ
Hydraulic oil cooler (air cooled)	Fin & tube 4 rows	32.64 m^3	8.5 ℓ

DAMPER







Section A-A

1. Damper assembly
2. Friction plate
3. Cone spring
4. Friction washer
5. Stopper pin
6. Torsion spring
7. Drive plate
8. Hub

FUNCTION

- The rotating torque of the engine is not constant, and there is always a considerable amount of rotational vibration.
  To prevent this vibration from being transmitted to the gear and piston pumps, a damper is installed to absorb the vibration.
- In this way, the durability of the gear and piston pumps are increased by absorbing engine vibration and shock torque generated during sudden acceleration and heavy-duty excavtion.

STRUCTURE

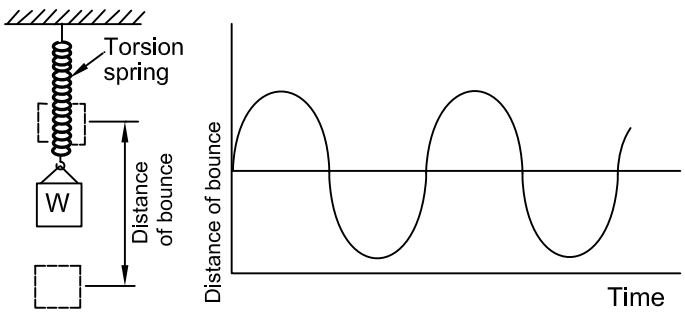
- Drive plate (7) is installed to the engine flywheel and hub (8) is fitted on shaft. There is a torsion spring (6) installed between the drive plate and hub
- Cone spring (3) pushes function plate (2) and function washer (4) against the flanged part of the hub. In this away it is stuctured to generate function torque.
- Even if friction washer (4) is worn, cone spring acts to maintain a constant torque.
- The vibration of the engine is absorbed by the torsion spring and friction washer. If any strong twisting force is brought (the transmitted torque becomes large), stopper pin (5) functions to transmit the movement of the flywheel directly to the hub.

PRINCIPLE OF OPERATION

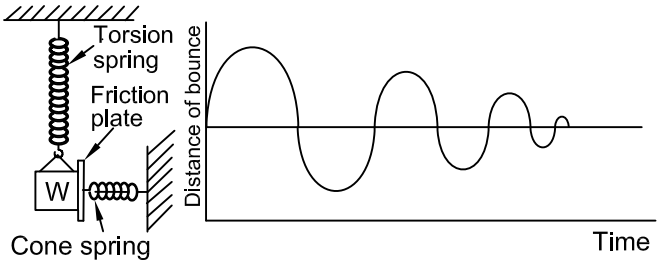
- The torsion spring of the damper acts a cushion to prevent the vibration of the engine from being transmitted directly to the gear and piston pumps. However, the vibration cannot be removed immediately just by installing a spring,becouse one spring cannot cushion the vibration completely. for this reason, a cone spring is used in addtion to the torsion spring to improve the reduction in vibration.

1. When only torsion is used

   If a weght is hung on a spring, as in the diagram below, and is then pulled down and released, it will bounce up and down freely.
   This bouncing (vibration) will not stop quickly, but will gradually become less over a period of time.

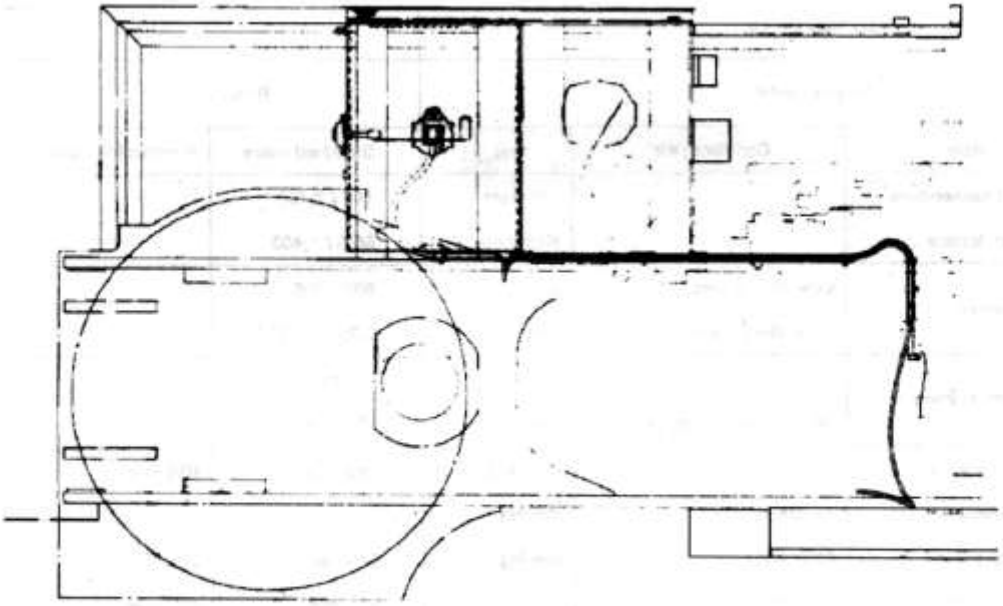


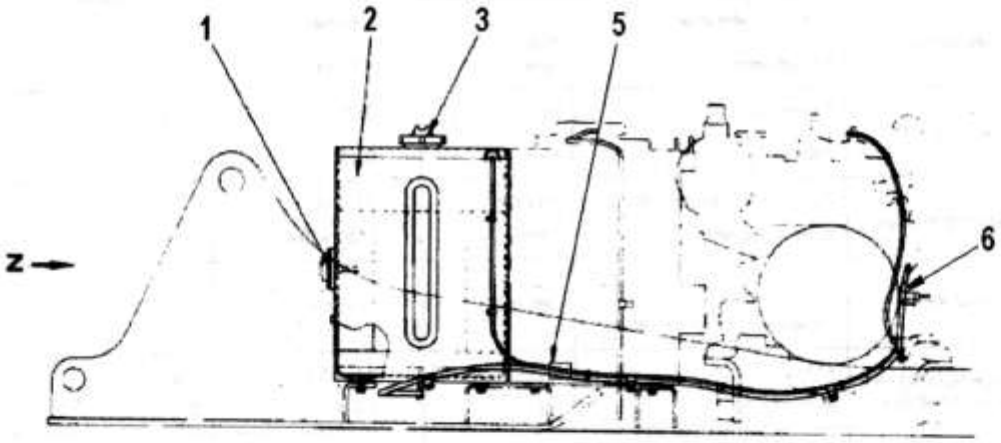
2. When torsion spring and cone spring are used in combination
   Let us now put a wall to the side of the weght, and use a spring to push a friction plate against the side of the weght.
   Friction will be generated between the weight and the friction plate.
   When this happens, the friction generated between the weght and the friction plate will act to stop the free movement (vibration) of the weght comparatively quickly.

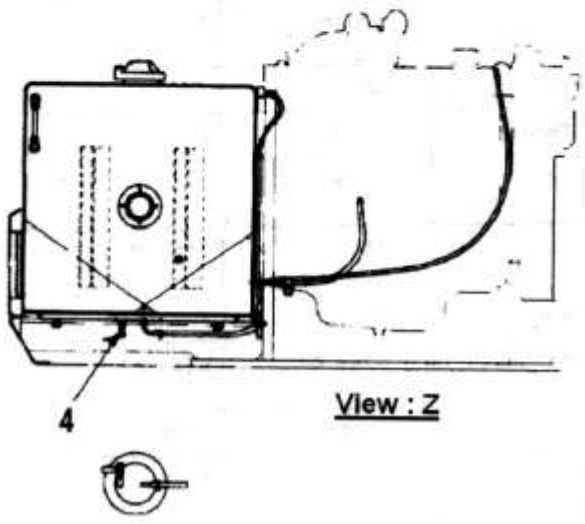


- In this way, the torsion spring acts to reduce the transmission of vibration, If a cone spring is added, the load of the spring will generate friction torque and this will further improve the vibration absorbing effect.

FUEL TANK AND PIPING







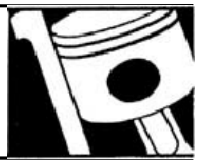
1. Fuel level gauge (sensor)
2. Fuel tank
3. Filler cap (with lock device (if equiped)
4. Drain valve
5. Fuel strainer
6. Water seperator

The fuel level sensor is installed in the fuel tank

When the fuel level monitor indicates EMPTY, there is still 40L remaining.

ENGINE

03 TESTING AND ADJUSTING



Testing and adjusting data..... 03-2
Testing and adjusting tool list..... 03-3
Adjusting valve clearance..... 03-4
Measuring compression pressure..... 03-4
Measuring blow-by pressure..... 03-4
Testing and adjusting fuel injection timing..... 03-4
Measuring exhast gas color..... 03-4
Testing and adjusting fan belt tension..... 03-4
Adjusting fuel control lever..... 03-4

Before performing inspection, adjustment or faultfinding, park the machine on level ground and check the safety pin and lock.

When performing joint work, make appropriate signals and allow only authorised personnel near the machine.

When checking the water level, allow the engine to cool down before removing the radiator cap to prevent the risk of being scalded by hot water which may spurt out if the engine is hot.

Take great care to avoid getting caught in rotating parts such as the fan, etc.

TESTING AND ADJUSTING DATA

Machine model				BE220G / BE220 / BE220LC	
Engine model				S6D105-1	
Classification	Item	Condition, etc.	Unit	Standard value	Parmissible value
Performance	Flywheel horsepower Maximum torque		HP/rpm kgm/rpm	146/2,100 56.5/1,400	
	Engine speed	Low idling speed High idling speed	rpm rpm	800 - 900 2,250 - 2,360	
	Necessary staring speed	0° C -20° C (using starting aid	rpm rpm	150 min 100 min	
Intak and exhaust system	Intake resistance Intake pressure Exhaust pressure Exhaust temperature	All speed All speed All speed All speed (intake air temperature : 20° C)	 mmHg mmHg ° C	162 max 50 max 650 max	635 max 75 650 max
	Exhaust gas colour	Low idling speed High idling speed	Boich scale	5.5 max 1.0 max	6.0 2.0
	Value clearance at 20° C	Intake value Exhaust value	mm mm	0.25 0.45	
Engine body	Comprression pressure	(Engine speed)	kg/cm^2 (rpm)	31.5 min (320 - 360)	
	Blow-by pressure	At high idling Oil temperature : min.60° C	mmH_2O	100 max	200
Lubraction system	Oil pressure (SAE30,Oil temperature 80° C min.)	At high idling At low idling	kg/cm^2 kg/cm^2	3.5 - 5.5 1.0 min.	2.5 0.8
	Oil temperature	All speed (Oil in oil pan)	° C	80 - 110	120
	Oil consumption ratio	At continuous rated out put (Ratio to fuel consumption)	%	0.5 max.	1.0
Fuel system	Fuel injection pressure	Nozzle tester	kg/cm^2	225	180
	Fuel injection time	B. T. D. C	Degree	20 ± 1	20
Cooling system	Coolant temperature	All speed (at engine outlet)	° C	70 - 80	100
	Thrmostat function	Valve cracking temperature Fuel operating temperature Fuel opening lift	° C ° C mm	74.5 - 78.5 90 10 ±0.5	74.5 - 78.5 90 10 ±0.5
	Radiator pressure valve function	All speed (at engine outlet)	kg/cm^2	0.75 ±0.1	0.75 ±0.1
	Fan speed	At high idling speed	mm	2,100	2,100
	Fan limit tension	Deflect when pushed with a force of 6 kg	mm	10	10

TESTING AND ADJUSTING TOOL LIST

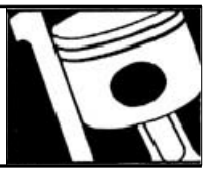
No.	Testing measuring item	Fault finding tool	Remarks
1	Engine speed	Multi-tachometer	Digital reading 60 - 2,000 rpm (L range)
2	Battery S. G.	Battery coolant tester	1.100 - 1.300
3	Freezing temperature of cooling water		-6 - -60° C
4	water temperature, oil temperature, air intake temperature	Thermistor temperature gauge	0 - 200° C
5	Exhast temperature		0 - 1,000° C
6	Lubrication oil pressure	Engine pressure measuring kit	0 - 20 kg/cm^2
7	Fuel pressure		0 - 50 kg/cm^2
8	Intake pressure, exhast pressure		0 - 1,000 mmHg
9	Blow-by pressure		0 - 500 mmH_2O
10	Intake resistance		-1,000 - 0 mmH_2O
11	Compression pressure	Compression gauge	0 - 70 kg/cm^2
12	Blow-by pressure	Blow-by checker	0 - 500 mmH_2O
13	Valve clearance	Feller guage	0.25, 0.45 mm
14	Exhaust gas colour	Handy smoke checker	Dirtiness 0 - 70% with standard lolour (Dirtiness % x 1/10=Bosch scale)
15	Water fuel content in oil	Engine oil checker	Provide with 0.1 and 0.2 water contents standard sample
16	Fuel injection pressure fuel injection nozzle spray condition	Nozzle tester	0 - 300 kg/cm^2
17	Coolant quelity	Water quelity tester	PH, nitrite ion concentration
18	Pressure valve function Leakage in cooling water system	Radiator cap tester	0 - 2 kg/cm^2
19	Radiator blockage (wind speed)	Anemometer (Air speed gauge)	0 - 40 m/s
20	Engine cranking	Cranking kit	Engine with DC24V starting motor
21	Electrical circuits	Tester	Current, Voltage, Resistance

REFER ENGINE SHOP MANUAL OF
SE105 M 06 00 07 B (S) 6D105 SERIES DIESEL ENGINE

1. ADJUSTING VALVE CLEARANCE
2. MEASURING COMPRESSION PRESSURE
3. MEASURING BLOW-BY PRESSURE
4. TESTING AND ADJUSTING FUEL INJECTION TIMING
5. MEASURING EXHAUST GAS COLOR
6. TESTING AND ADJUSTING FAL BELT TENSION
7. ADJUSTING FUEL CONTROL LEVER

ENGINE

04 DISASSEMBLY AND ASSEMBLY



STARTING MOTOR ASSEMBLY
Removel and installation..... 04-2

ALTERNATOR ASSEMBLY
Removel and installation..... 04-2

ENGINE OIL COOLER ASSEMBLY
Removel and installation..... 04-2

FUEL INJECTION PUMP ASSEMBLY
Removel..... 04-2
Installation..... 04-2

WATER PUMP ASSEMBLY
Removel and installation.....04-2

NOZZLE HOLDER ASSEMBLY
Removel and installation.....04-2

TURBOCHARGER ASSEMBLY
Removel and installation.....04-2

CYLINDER HEAD ASSEMBLY
Removel.....04-2
Installation.....04-2

RADIATOR ASSEMBLY
Removel and installation.....04-2

HYDRAULIC OIL COOLER ASSEMBLY
Removel and installation.....04-2

ENGINE MAIN PUMP ASSEMBLY
Removel.....04-2
Installation.....04-2

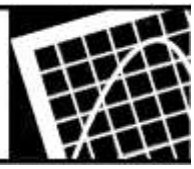
DAMPER ASSEMBLY
Removel and installation.....04-2

* When operating the hydraulic cylinders for the first time after reassembling cylinders,pumps and piping always bleed the air as follows :
1. Start engine and run at low idling.
2. Operate hydraulic cylinder 4 to 5 times,stopping 100 mm from stroke end.
3. Next,operate cylinder 3 to 4 times to stroke end.
4. After doing this,run engine at normal speed.

* After repair or long storage,follow the same procedure.

REFER ENGINE SHOP MANUAL OF
SE105 M 06 00 07 B (S) 6D105 SERIES DIESEL ENGINE

1. REMOVEL OF STARTING MOTOR ASSEMBLY
2. REMOVEL OF ALTERNATOR ASSEMBLY
3. REMOVEL OF ENGINE OIL COOLER ASSEMBLY
4. REMOVEL OF FUEL INJECTION PUMP ASSEMBLY
5. INSTALLATION OF FUEL INJECTION PUMP ASSEMBLY
6. REMOVEL OF WATER PUMP ASSEMBLY
7. REMOVEL OF NOZZLE HOLDER ASSEMBLY
8. REMOVEL OF TURBOCHARGER ASSEMBLY
9. REMOVEL OF CYLINDER HEAD ASSEMBLY
10. INSTALLATION OF CYLINDER HEAD ASSEMBLY
11. REMOVEL OF REDIATOR ASSEMBLY
12. REMOVEL OF HYDRAULIC OIL COOLER ASSEMBLY
13. REMOVEL OF ENGINE AND MAIN PUMP ASSEMBLY
14. INSTALLATION OF ENGINE AND MAIN PUMP ASSEMBLY
15. REMOVEL OF DAMPER ASSEMBLY



REFER ENGINE SHOP MANUAL OF SE 105 M 06 00 07

B(S)6D105-1 SERIES DIESEL ENGINE

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POWER TRAIN
05 STRUCTURE AND FUNCTION

Power Train 05-02

Power Train Circuit 05-03

Travel and Brake System

- Outline 05-04
- Travel Control Circuit..... 05-05
- Center Swivel Joint 05-06
- Travel Motor and Break Assembly 05-07

Final Drive System 05-08

Swing System 05-09

- Swing Control Circuit 05-10
- Swing Motor 05-11
- Swing Machinery 05-12
- Swing Circle 05-13

POWER TRAIN

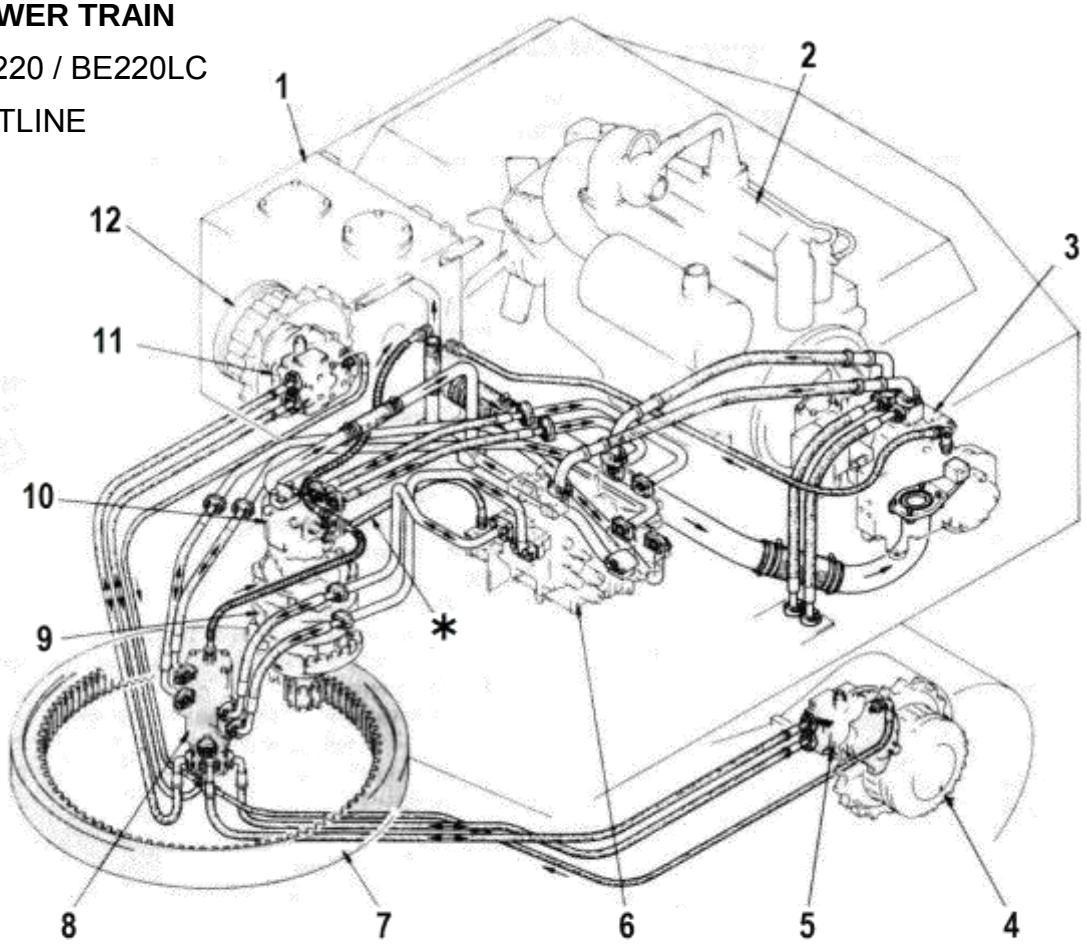
BE220G

OUTLINE Refer PMP Instruction Manual of PMCI M001

POWER TRAIN

BE220 / BE220LC

OUTLINE



* This pipe is installed only on machines with a swing mechanical brake.

1. Hydraulic tank
2. Engine
3. Main pump
4. LH Final drive
5. LH Travel motor
6. Control valve assembly
7. Swing circle
8. Center swivel joint
9. Swing machinery
10. Swing motor
11. RH Travel motor
12. RH Final drive

The mechanical power from engine (2) is converted to hydraulic power by main pump (3). The hydraulic power from main pump (3) is divided to each actuator by control valve (60. It then goes to travel motors (50 and (110, swing motor (100 and the hydraulic cylinders, and is converted back to mechanical power. This actuates the travel, swing and work equipment circuits.

POWER TRAIN CIRCUIT

BE220G

Refer PMP Instruction Manual of PMCI M001

POWER TRAIN CIRCUIT

BE220 / BE220LC

Refer Rexroth Instruction Manual of HS-64-05-E0403-1-3

TRAVEL AND BRAKE SYSTEM

BE220G

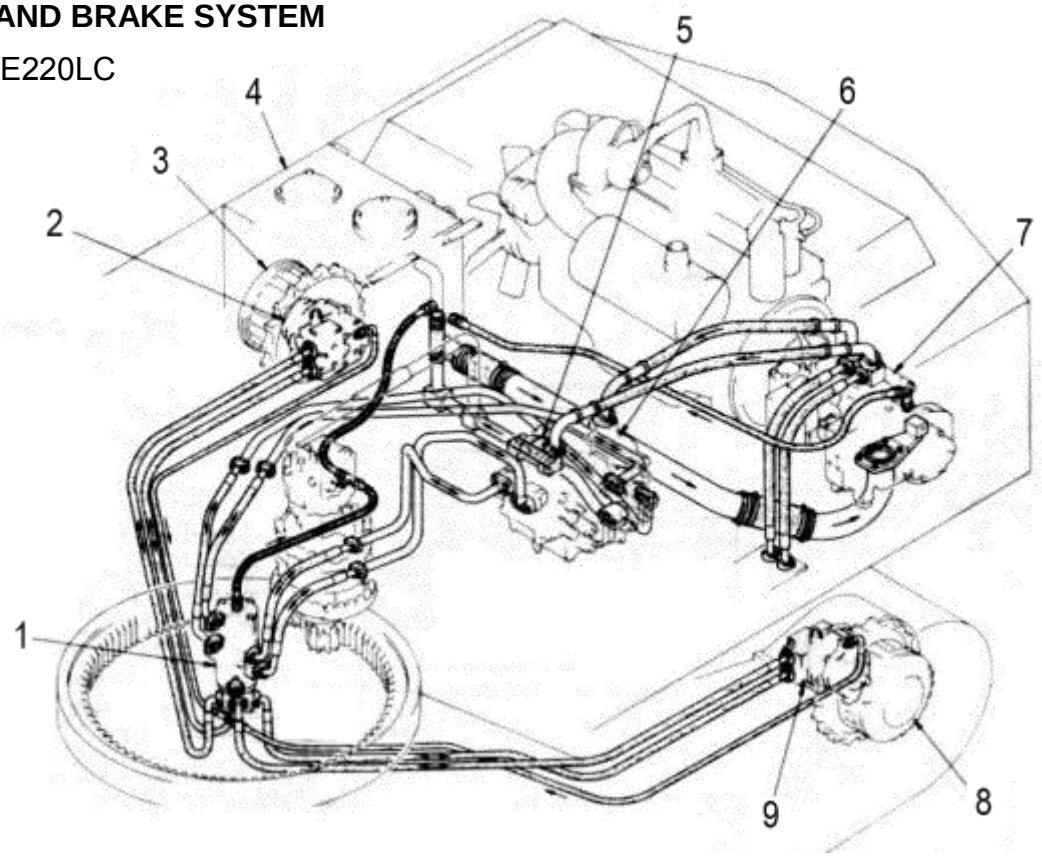
OUTLINE

Refer PMP Instruction Manual of PMCI M001

TRAVEL AND BRAKE SYSTEM

BE220 / BE220LC

OUTLINE



1. Center swivel joint
2. RH Travel motor
3. RH Final drive
4. Hydraulic tank
5. Travel shuttle valve
6. Control valve assembly
7. Main pumps
8. LH Final drive
9. LH Travel motor

- The travel control system consists of the following components.
  - Travel levers: These are used by the operator to steer the machine and to select FORWARD or REVERSE.
  - Travel Control Valve (6) (interconnected with travel levers): This regulates the direction of flow of the oil from main pumps (7).
  - The oil from travel control valve (6) flows through center swivel joint (1) to travel motors (2), (9). A parking brake is installed to the travel motor.
  - Final drives (3), (8): This reduces the travel motor speed and transmits to sprocket.
  - Straight travel valve (built-in control valve (6)): This acts to prevent the machine from deviating when the machine is traveling, and the operator uses the swing, boom, arm, or bucket circuit.
- The function of travel brake is carried out by the travel motor itself. When travel levers are moved from “TRAVEL” position to “neutral”, the inlet and outlet ports to motor are closed, so the machine stops.
- For operation of the travel control levers control levers and direction of travel, see OPERATION & MAINTENANCE MANUAL.
- For details of main pumps (7) and control valves (6), see Section 61 HYDRAULIC SYSTEM.

TRAVEL CONTROL CIRCUIT

BE220G

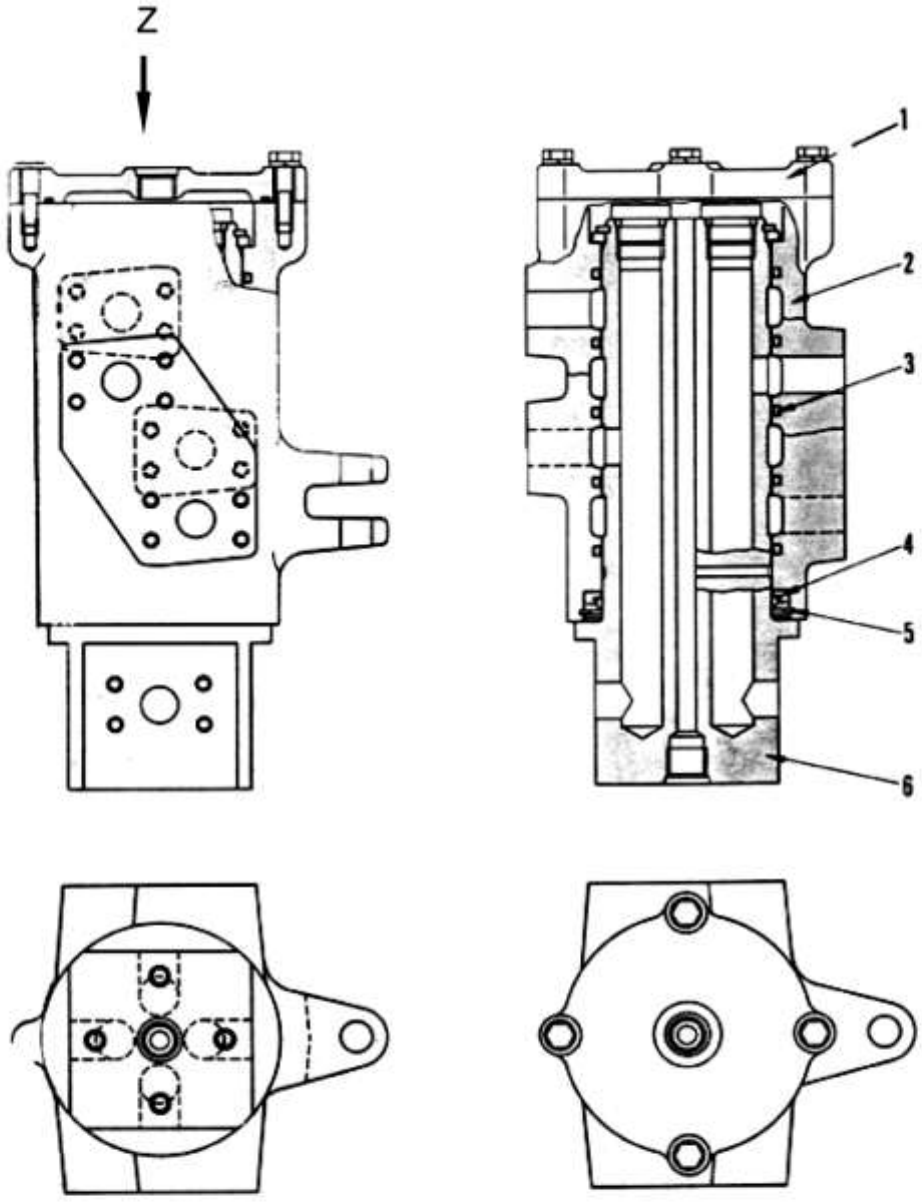
Refer PMP Instruction Manual of PMCI M001

TRAVEL CONTROL CIRCUIT

BE220 / BE220LC

Refer Rexroth Instruction Manual of HS-64-05-E0403-1-3

CENTER SWIVEL JOINT



View Z

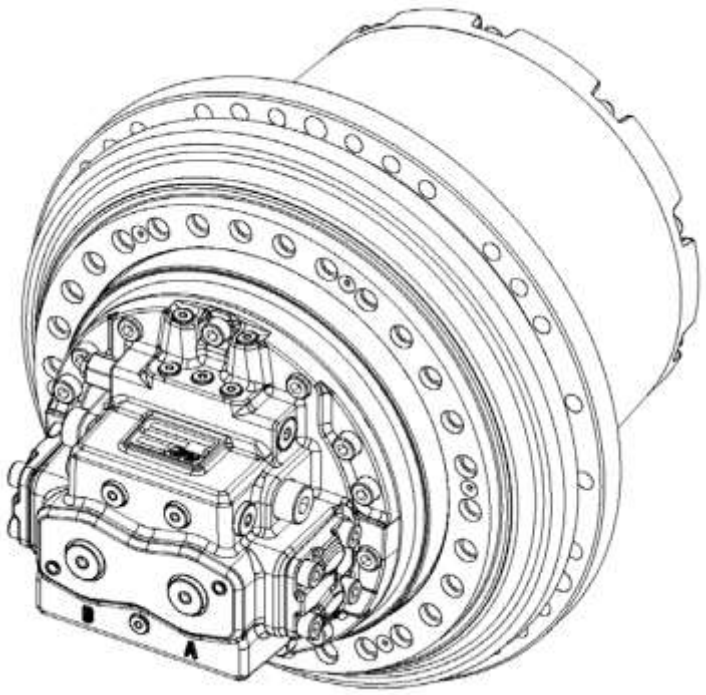
1. Cover
2. Body
3. Slipper seal
4. Oil seal
5. Snap ring
6. Shaft

- The center swivel joint is used for the piping between the upper structure (which swings) and the under-carriage (which is fixed). Oil is sent from the control valves installed in the upper structure and goes to the travel motors installed in the undercarriage.
- The oil from the travel control valve enters the hole in the port of body (2), flows through the grooves on the outside circumference of body (2) and enters the vertical holes on shaft (6). From here it is sent to the travel motor.
- Slipper seal (3) is intalled to prevent the oil from leaking outside or from flowing into the neighboring port.

TRAVEL MOTOR (WITH PARKING BRAKE) AND BRAKE ASSEMBLY

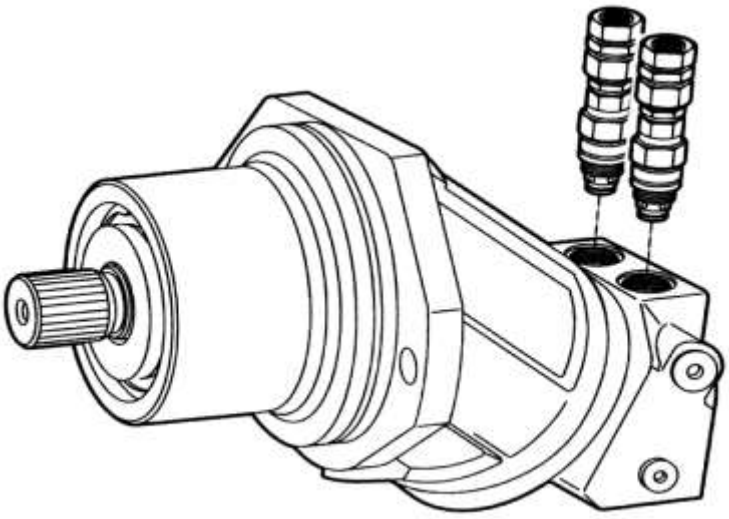
BE220G

Refer PMP Instruction Manual of PMCI M001



BE220 / BE220LC

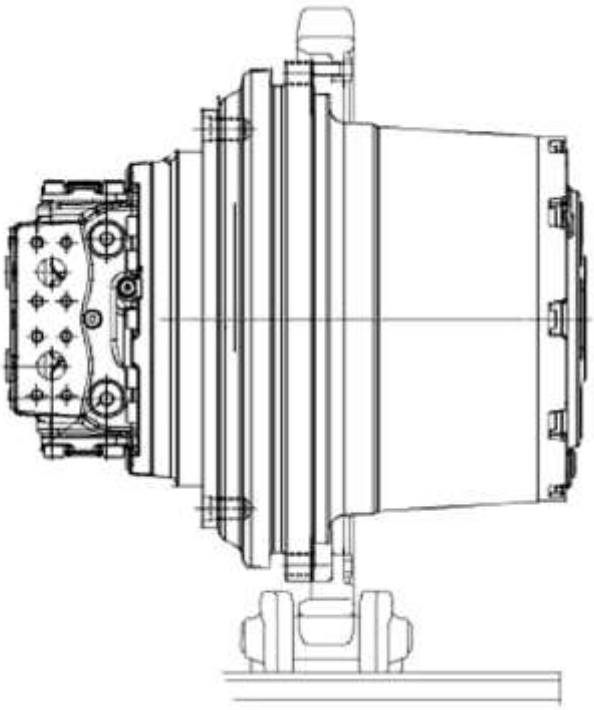
Refer Rexroth Instruction Manual of HS-64-05-E0403-1-3



FINAL DRIVE SYSTEM

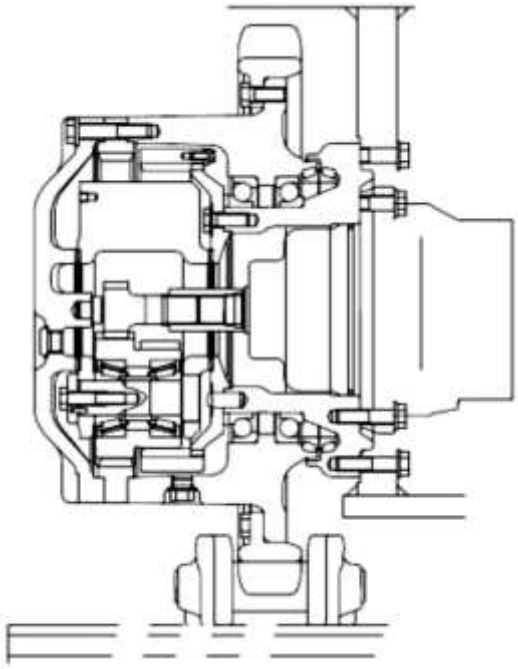
BE220G

Refer PMP Instruction Manual of PMCI M001



BE220 / BE220LC

Refer Rexroth Instruction Manual of HS-64-05-E0403-1-3



SWING SYSTEM

BE220G

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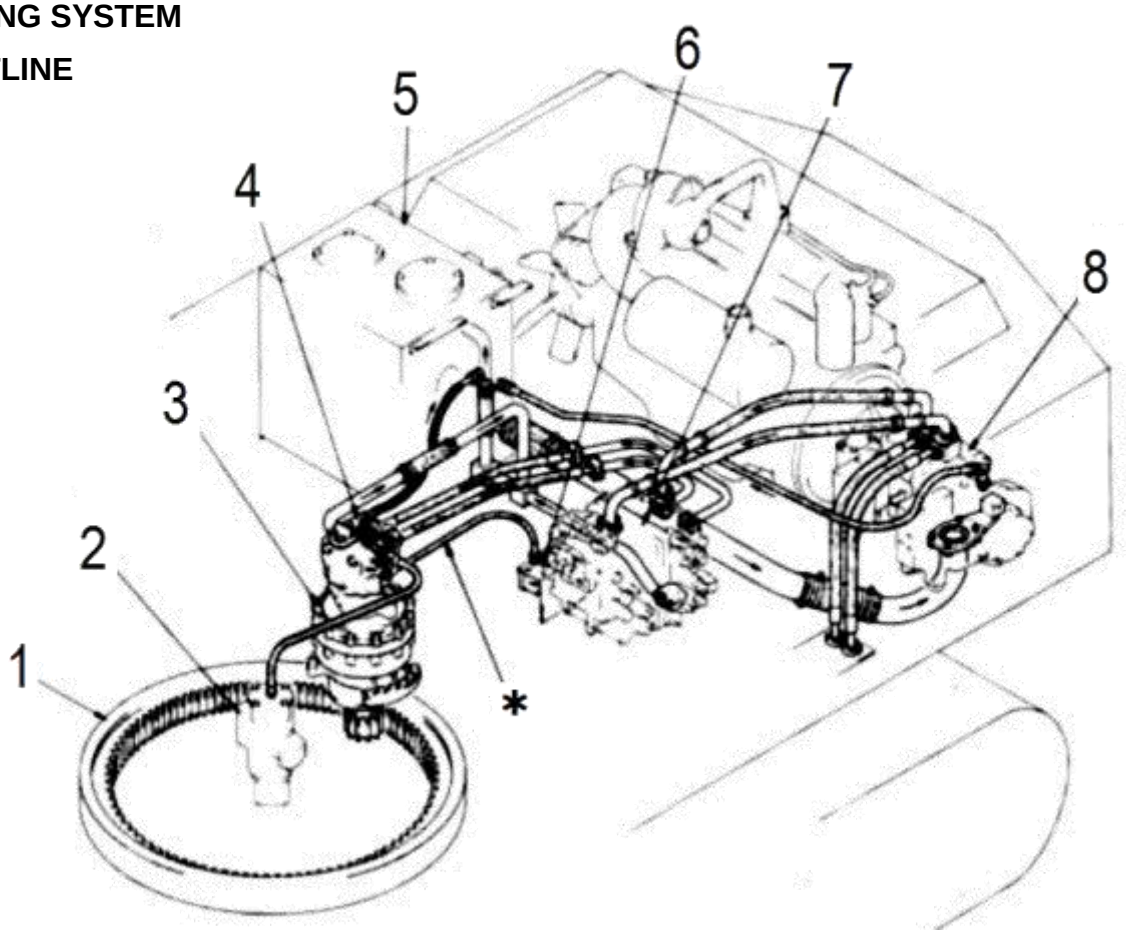
SWING SYSTEM

OUTLINE



* This pipe is installed only on machines with a swing mechanical brake.

1. Swing circle
2. Center swivel joint
3. Swing machinery
4. Swing motor
5. Hydraulic tank
6. Solenoid valve
   (for swing mechanical brake
   (if equipped)
7. Swing control valve
8. Main pumps

The hydraulic excavator has a swing mechanism which allows the work equipment to swing 360 degrees. The digging work and loading dump trucks can be done without moving the machine.

The swing mechanism consists of swing motor (4) which rotates the upper structure, reduction gears (swing machinery) (3), swing circle (10, and center swing joint (2) through which the hydraulic oil is delivered from the revolving upper structure to the undercarriage.

★ As for CENTER SWIVEL JOINT, see page 05-06.

SWING CONTROL CIRCUIT

BE220G

Refer PMP Instruction Manual of PMTE M001

SWING CONTROL CIRCUIT

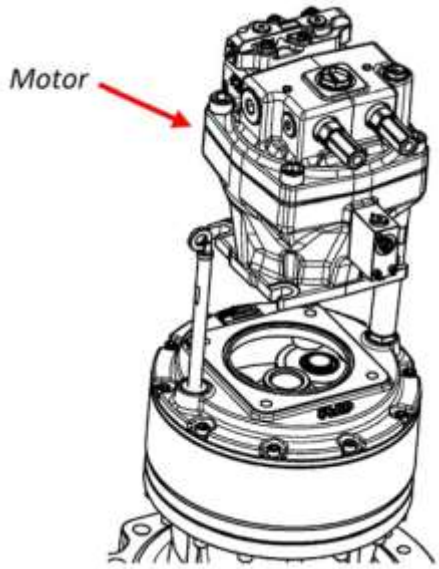
BE220 / BE220LC

Refer Rexroth Instruction Manual of HS-64-05-E0403-1-3

SWING MOTOR

BE220G

Refer PMP Instruction Manual of PMTE M001



SWING MOTOR

BE220 / BE220LC

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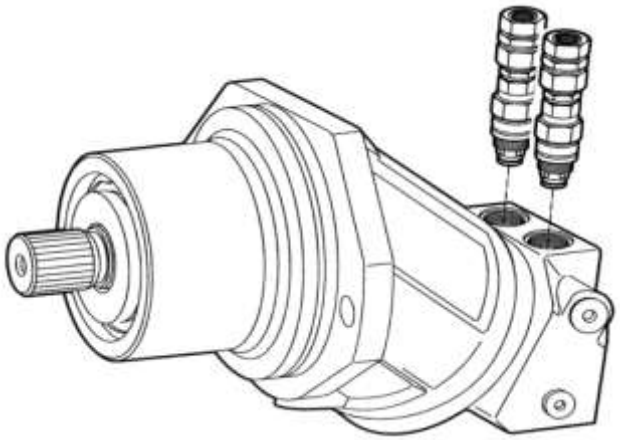

SWING MACHINERY

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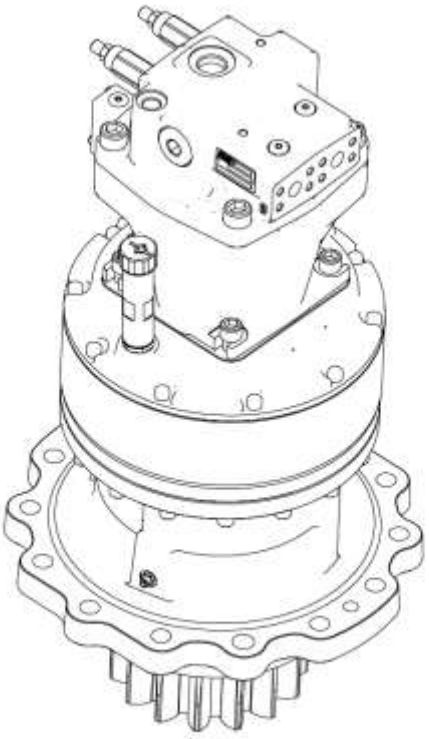
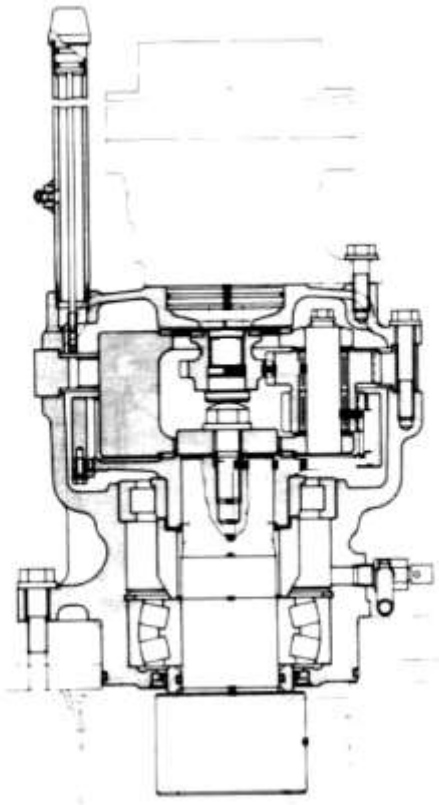
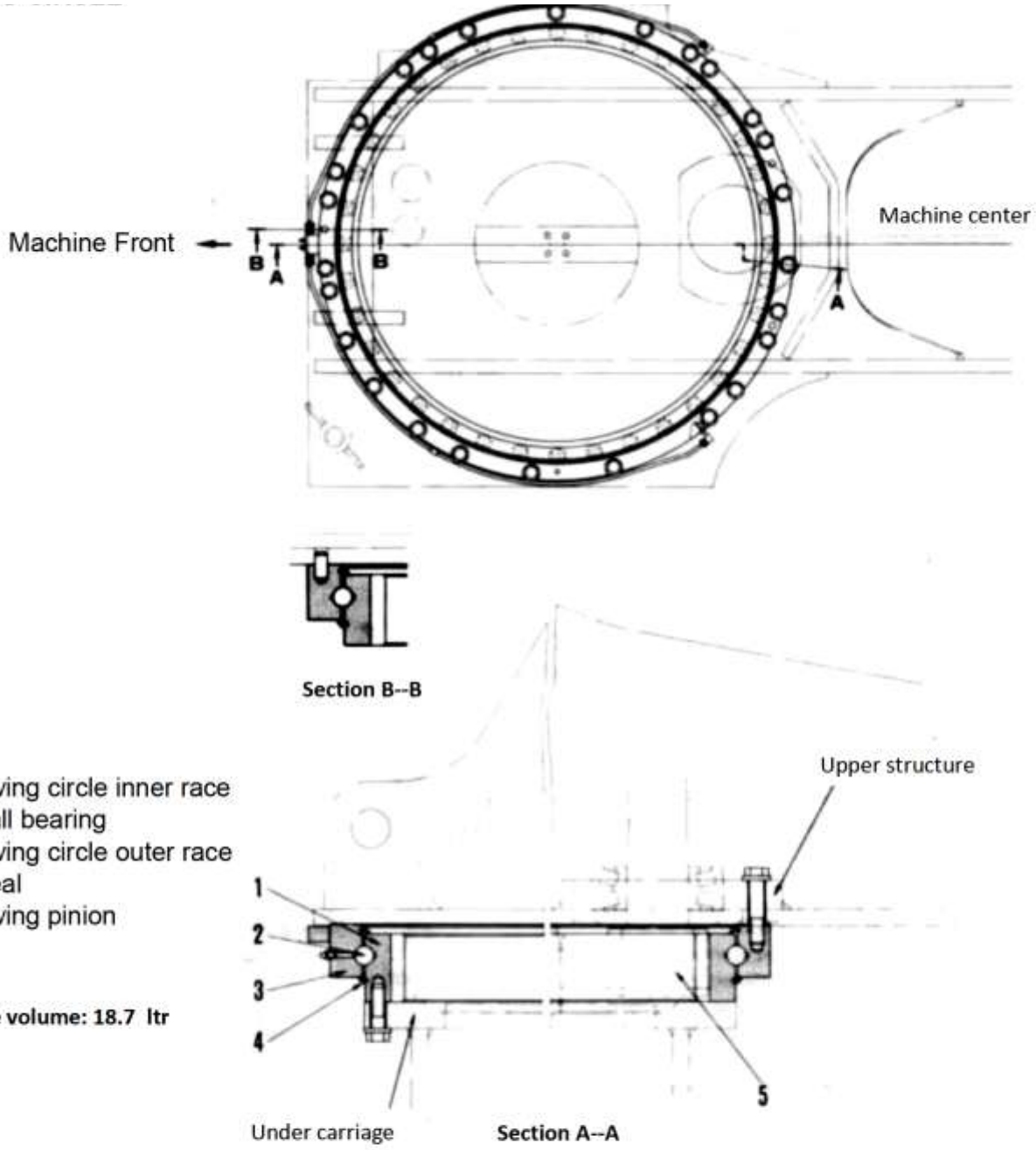


SWING MACHINERY

BE220 / BE220LC



SWING CIRCLE



1. Swing circle inner race
2. Ball bearing
3. Swing circle outer race
4. Seal
5. Swing pinion

Grease volume: 18.7 ltr

OPERATION

- The poer (revolution transmitted to swing pinion (5) via the swing machinery from the swing motor rotates on its own axis and it also revolves round the center of swing circle inner race which is bolted to the undercarriage.
- Swing circle outer race (3) is bolted to the upper structure.
- In other words, the upper structure and the under carriage can swing independently by this swing circle mechanism.

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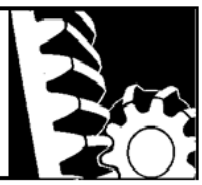
POWER TRAIN
06 DISASSEMBLY AND ASSEMBLY



CENTER SWIVEL JOINT ASSEMBLY
- Removal 06-02
- Installation 06-03
- Disassembly 06-04
- Assembly 06-05

TRAVEL MOTOR ASSEMBLY
- Removal 06-06
- Installation 06-07
- Disassembly 06-08
- Assembly 06-09

SWING MOTOR ASSEMBLY
- Removal and Installation 06-10
- Disassembly 06-11
- Assembly 06-12

SWING CIRCLE ASSEMBLY
- Removal 06-13
- Installation 06-17

SWING MACHINERY ASSEMBLY
- Removal and Installation 06-21
- Disassembly 06-22
- Assembly 06-23

SPROCKET
- Removal and Installation 06-24

TRAVEL MOTOR, FINAL DRIVE ASSEMBLY
- Removal 06-25
- Installation 06-26

FINAL DRIVE ASSEMBLY
- Disassembly 06-27
- Assembly 06-28

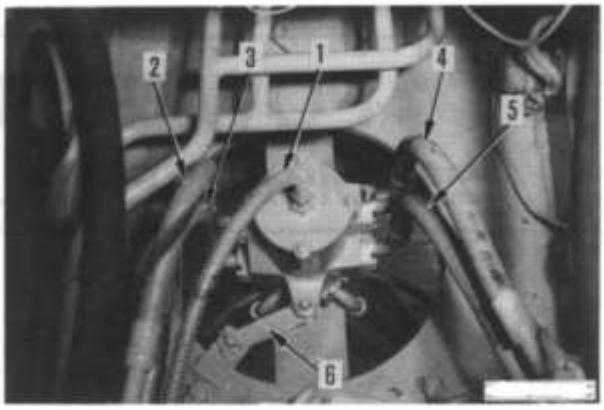
- When operating the hydraulic cylinders for the first time after reassembling cylinders, pumps and piping always bleed the air as follows:
  1. Start engine and run at low idling.
  2. Operate hydraulic cylinder 4 to 5 times, stopping 100 mm stroke end.
  3. Next, operate cylinder 3 to 4 times to stroke end.
  4. After doing this, run engine at normal speed.
  - After repair or long storage, follow the same procedure.

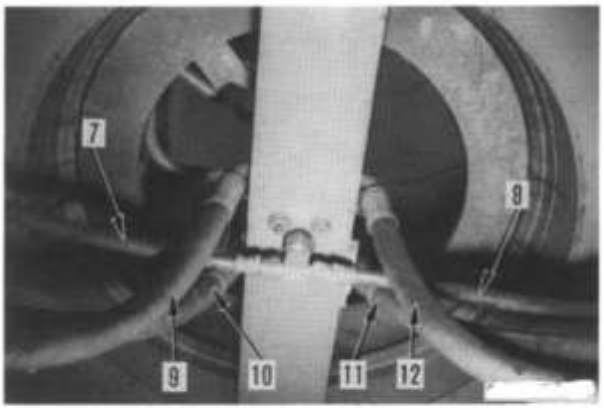
REMOVAL OF CENTER SWIVEL JOINT ASSEMBLY

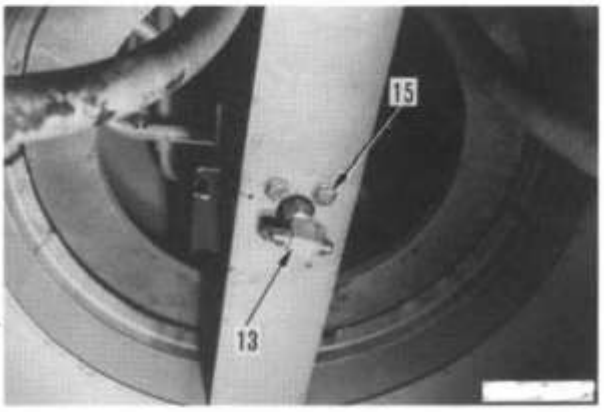
Lower the work equipment completely to the ground and stop the engine. Operate the control lever several times to release the remaining pressure in the hydraulic piping. Then loosen the oil filler cap slowly to release the pressure inside the hydraulic tank.

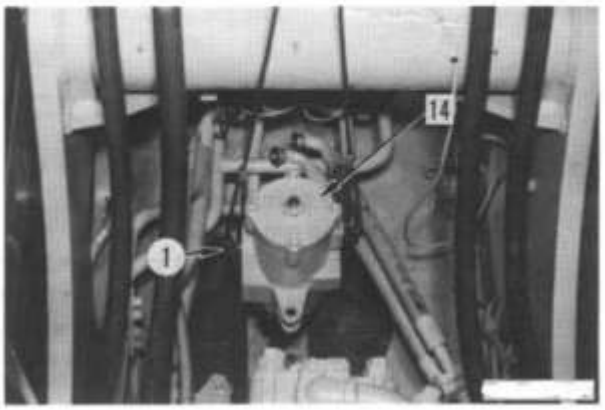
1. Disconnect upper drain hose (1) of travel motor.
   ★ Fit a blind plug in the hose.
2. Disconnect upper travel hoses (2), (3), (4) and (5).
3. Pull out pin and disconnect plate (6).
4. Disconnect lower drain hoses (7) and (8) of travel motor.
   ★ Fit a blind plug in the hose.
5. Disconnect lower travel hoses (9), (10), (11) and (12).
6. Remove tee (13) at bottom of swivel joint.
7. Using eye bolts ① (Dia. = 8 mm, Pitch = 1.25 mm), sling center swivel joint assembly (14) and remove 4 mounting bolts (15).
8. Lift off center swivel joint assembly (14).

kg Center swivel joint assembly: 30 kg









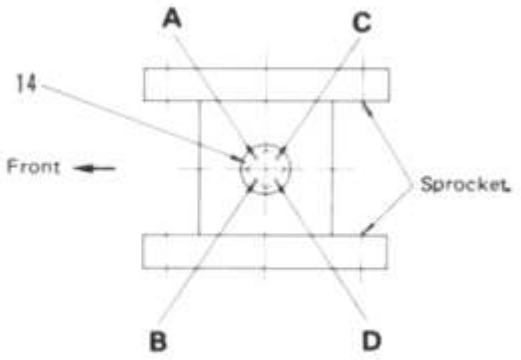
INSTALLATION OF CENTER SWIVEL JOINT ASSEMBLY

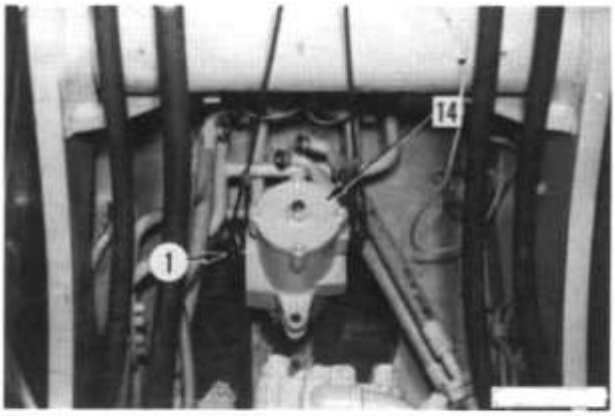
1. Using eye bolts (Dia. = 8 mm, Pitch = 1.25 mm), raise center swivel joint assembly (14). Align stamped marks **A**, **B**, **C** and **D** on port with positions shown in diagram on right, then set on frame.
2. Tighten 4 mounting bolts (15).
3. Fit O-ring and install tee (13) at bottom of swivel joint.
4. Fit O-rings and connect lower travel hoses (12), (11), (10) and (9).
   - ★ Install hose without twisting or interference.
5. Connect lower drain hoses (8) and (7) of travel motor.
   - Sleeve nut: 5 ± 2 kgm (Width across flats: 24 mm)
   - ★ Install hose without twisting or interference.
6. Install plate (6) with pin.
7. Fit O-rings and connect upper travel hoses (5), (4), (3) and (2).
8. Connect upper drain hose (1) of travel motor.
   - Sleeve nut: 5 ± 2 kgm (Width across flats: 24 mm)
   - ★ Install hose without twisting or interference.

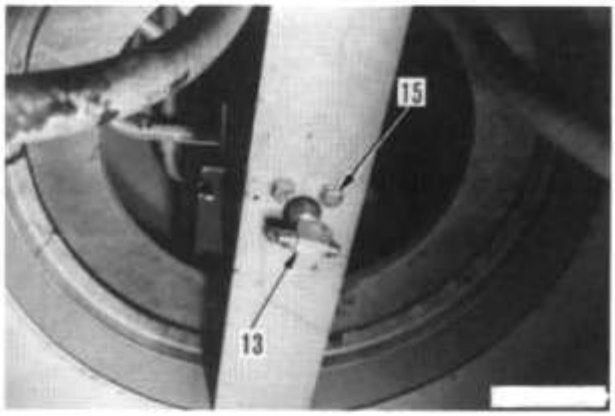
★ Start the engine and bleed the air from the travel motor.

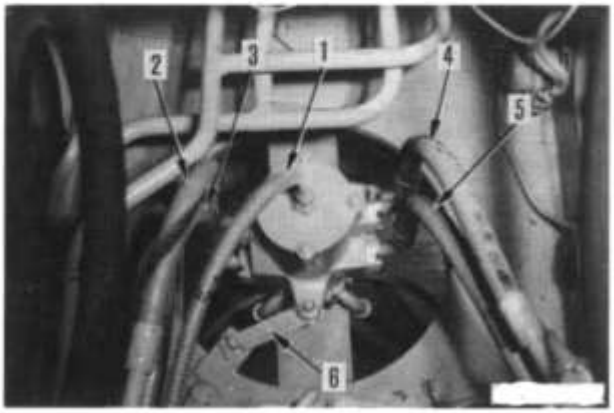
★ For details, see section 62, TESTING AND ADJUSTING, BLEEDING AIR FROM TRAVEL MOTOR.

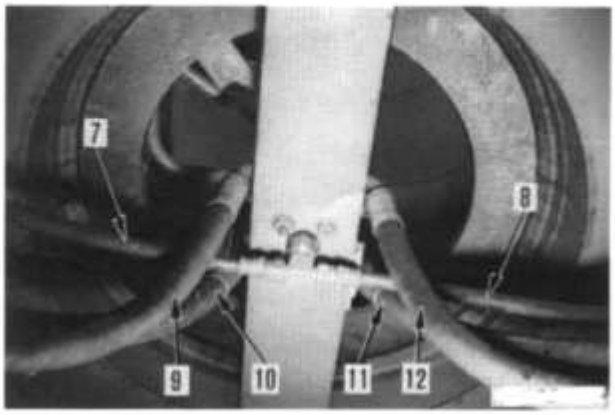
★ After bleeding the air, add oil to the hydraulic tank to the specified level.





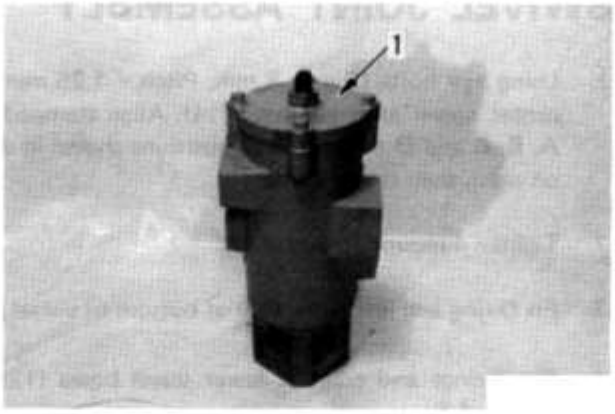


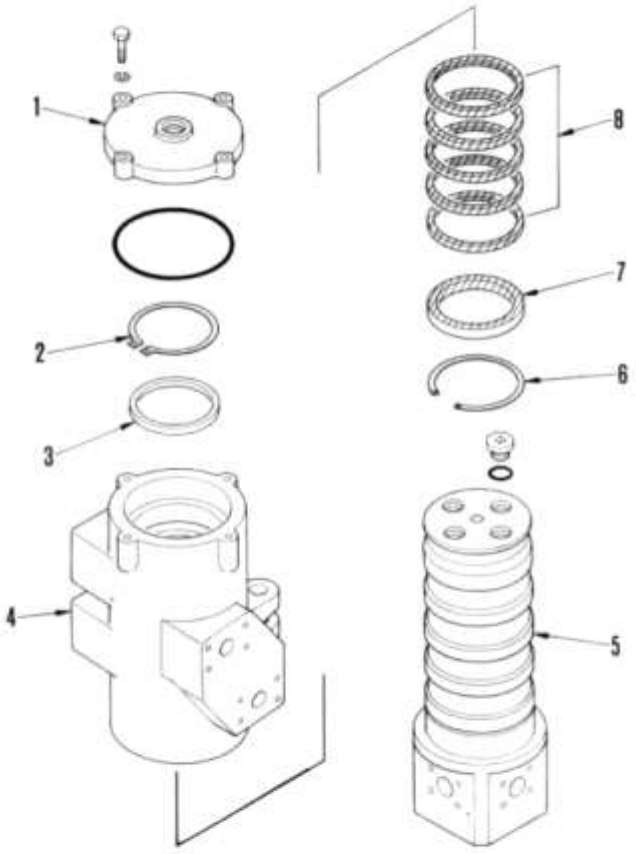


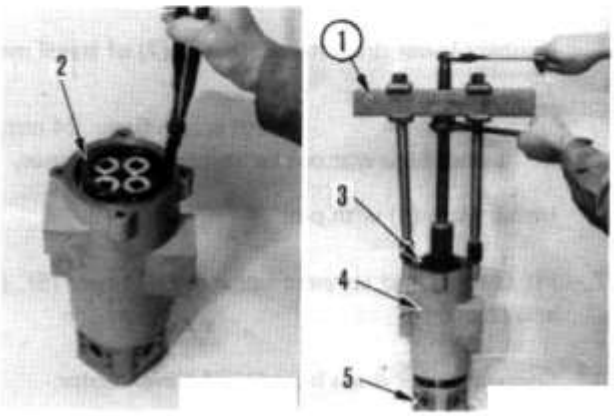


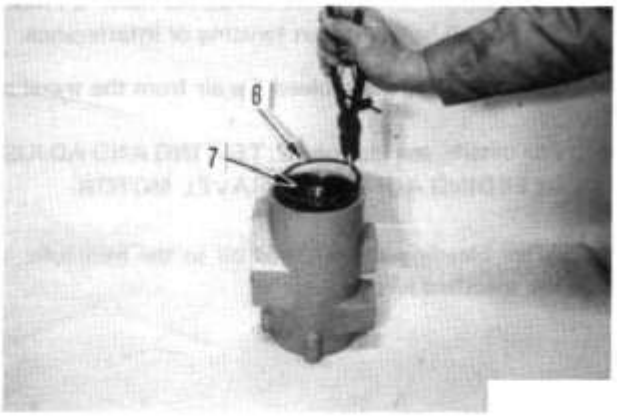
DISASSEMBLY OF CENTER SWIVEL JOINT ASSEMBLY

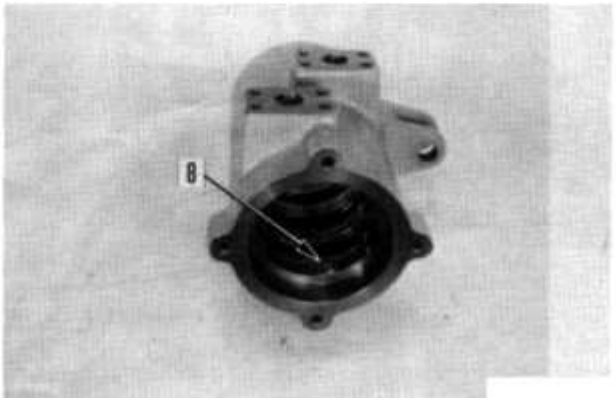
1. Remove cover (1).
2. Remove snap ring (2).
3. Using push tool ①, remove swivel rotor (4) and ring (3) from swivel shaft (5).
4. Remove snap ring (6), then remove oil seal (7) and 5 slipper seals (8).











ASSEMBLY OF CENTER SWIVEL JOINT ASSEMBLY

★ Clean all parts, and check for dirt or damage. Coat the sliding surfaces of all parts with engine oil or grease (G2-LI) before installing.

1. Assemble 5 slipper seals (8) in swivel rotor (4).

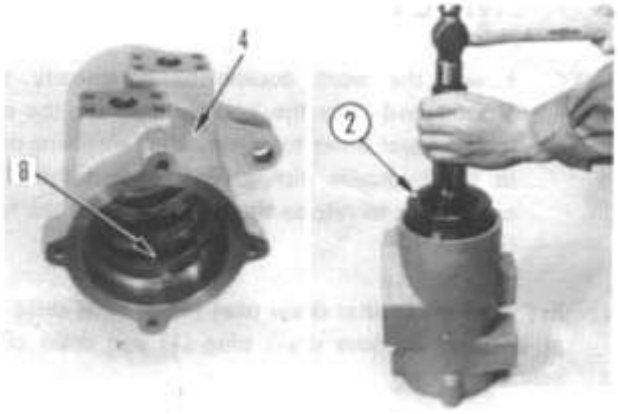
2. Using push tool ② (outside diameter: 110 mm), press fit oil seal (7) in swivel rotor (4), then install snap ring (6).

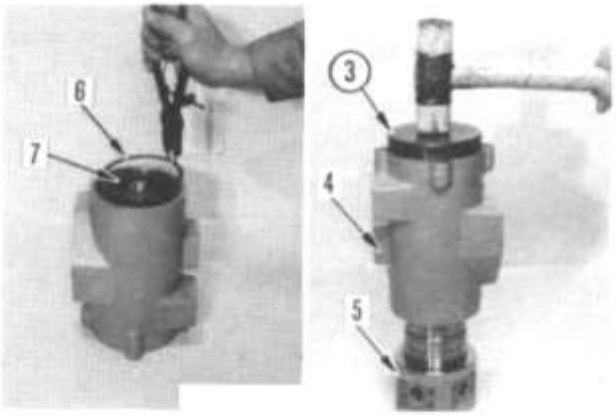
   Oil seal lip: Grease (G2-LI)

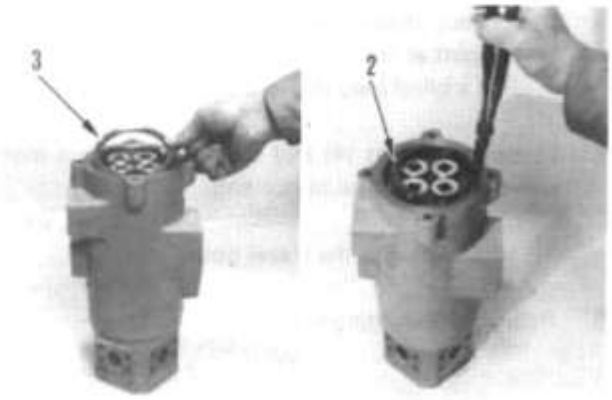
3. Set swivel shaft (5) on block, then using push tool ③ (outside diameter: 130 mm), tap swivel rotor (4) with a plastic hammer to install.
   ★ When installing the rotor, be careful not to damage the lip of the slipper seals or oil seal.

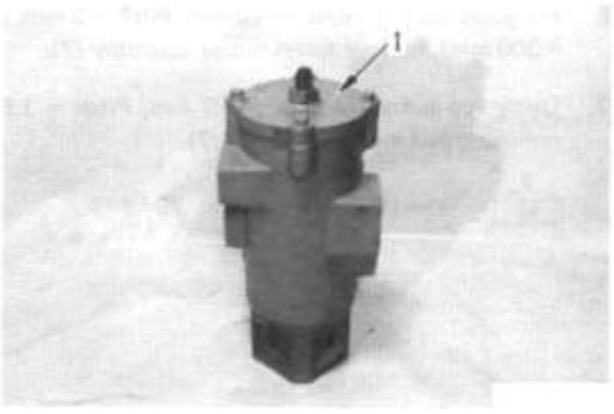
4. Install ring (3), then secure with snap ring (2).

5. Fit O-ring and install cover (1).









REMOVAL OF TRAVEL MOTOR ASSEMBLY

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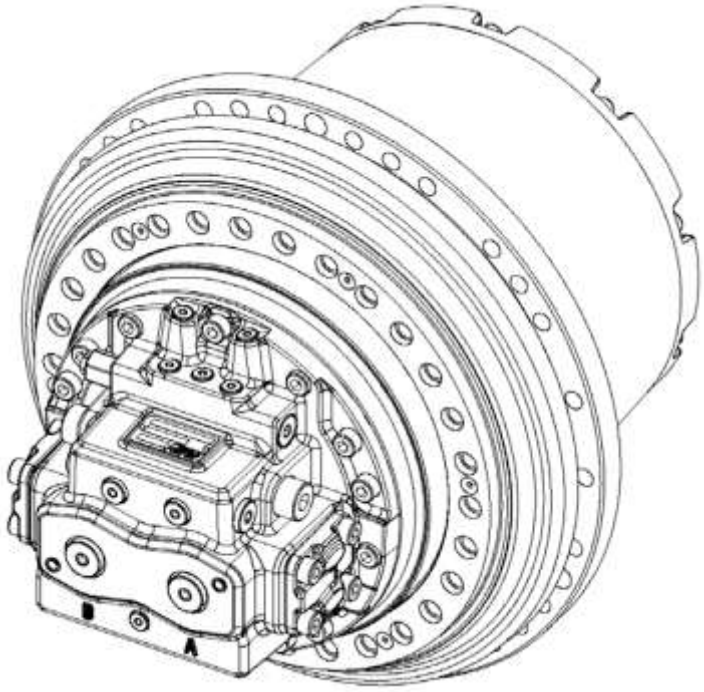

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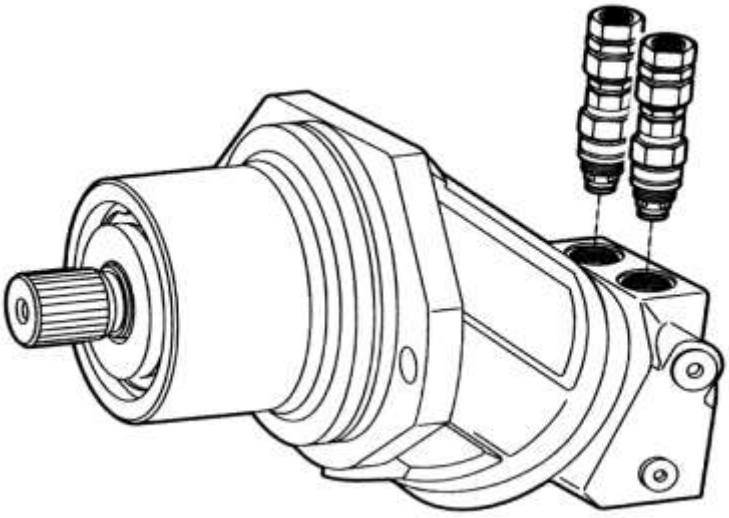

INSTALLATION OF TRAVEL MOTOR ASSEMBLY

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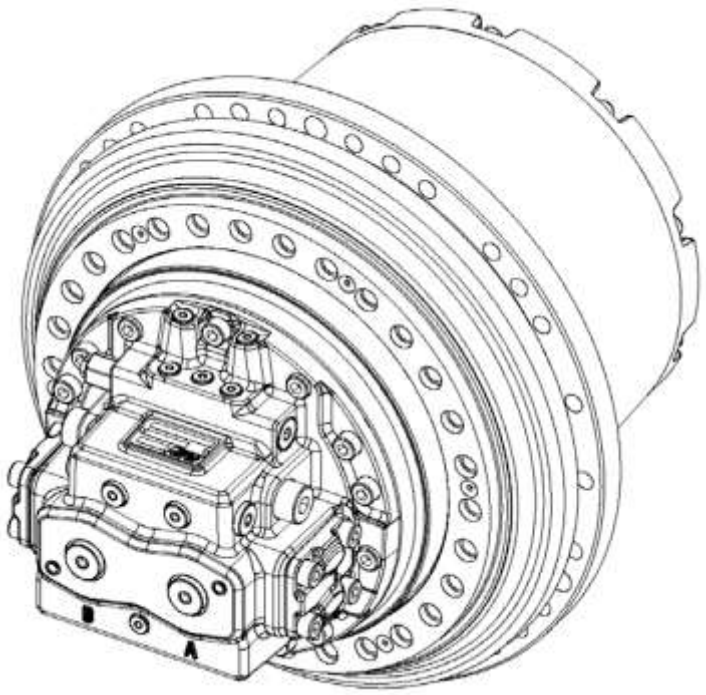
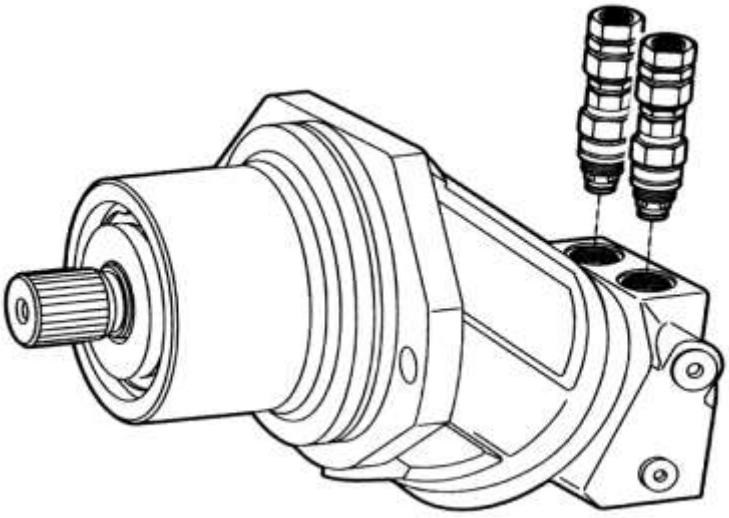


BE220 / BE220LC

Refer Rexroth Instruction Manual of HS-64-05-E0403-1-3



DISASSEMBLY OF TRAVEL MOTOR ASSEMBLY

BE220G

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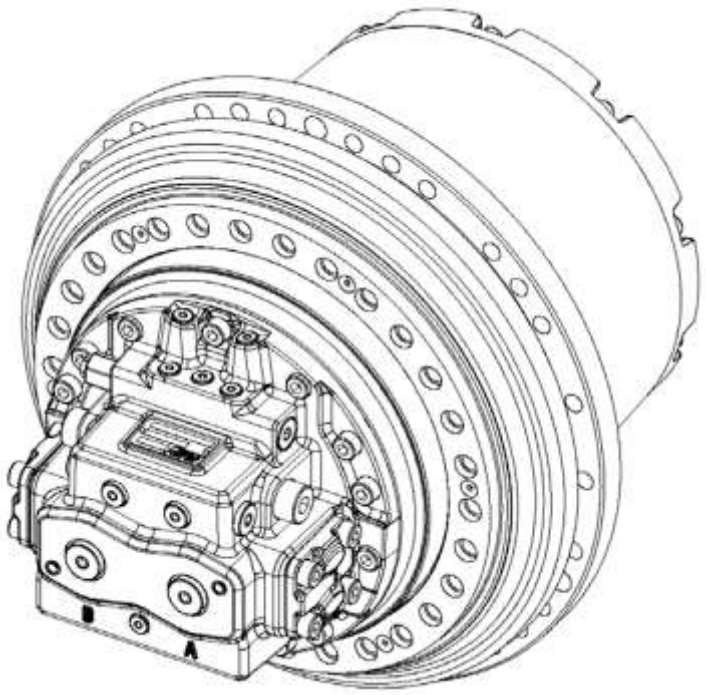

BE220 / BE220LC

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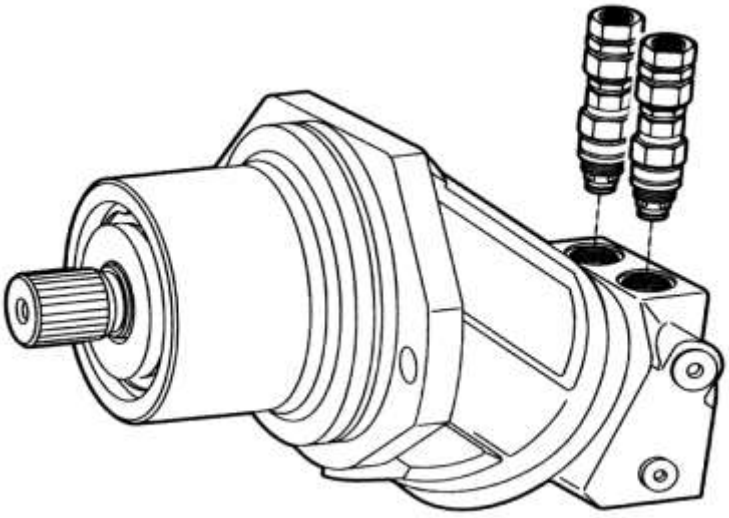

ASSEMBLY OF TRAVEL MOTOR ASSEMBLY

BE220G

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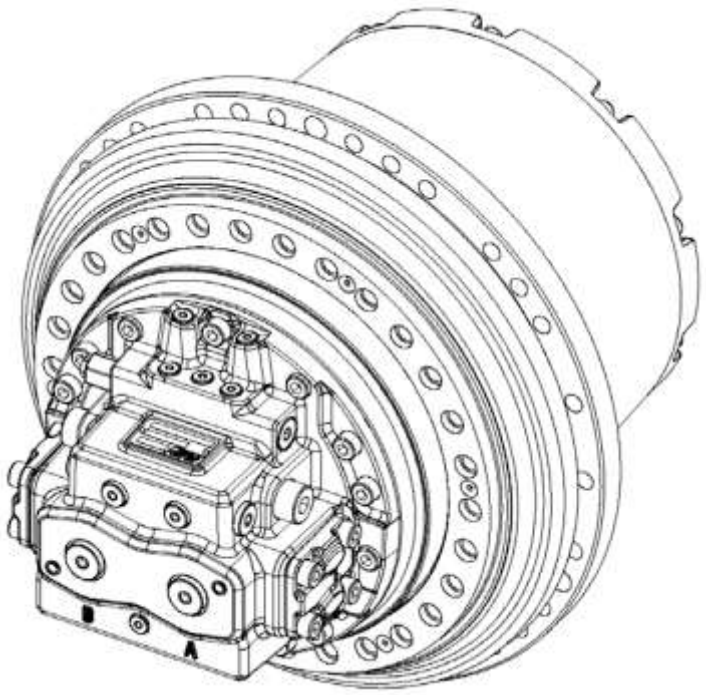

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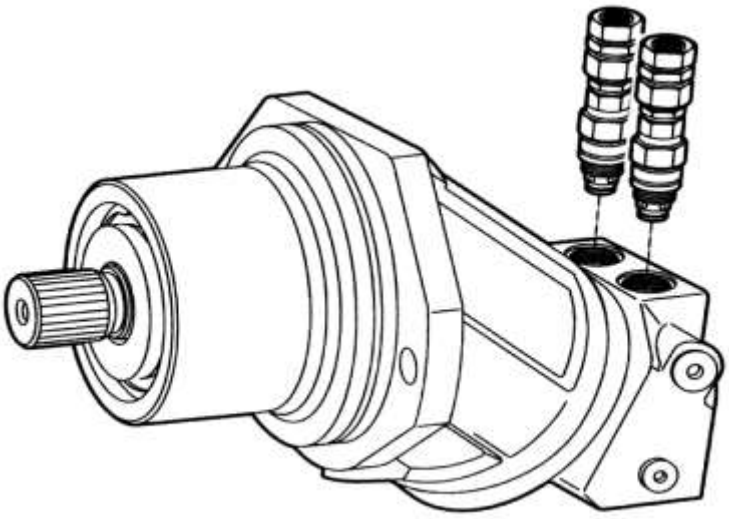
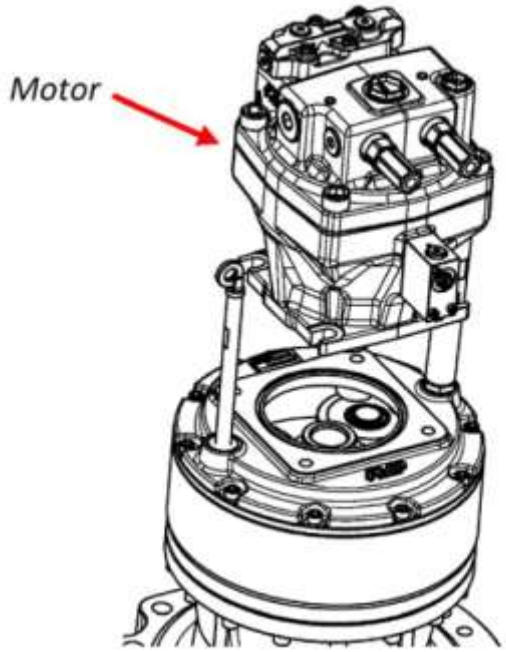


REMOVAL AND INSTALLATION OF SWING MOTOR ASSEMBLY

BE220G

Refer PMP Instruction Manual of PMTE M001



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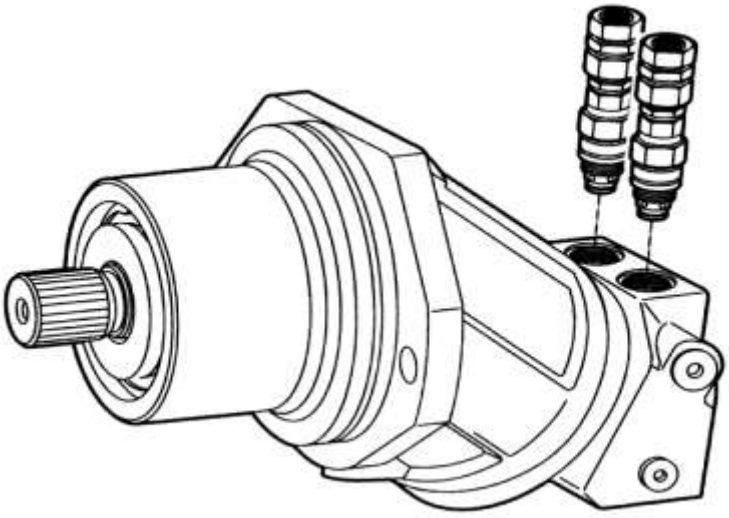

DISASSEMBLY OF SWING MOTOR ASSEMBLY

BE220G

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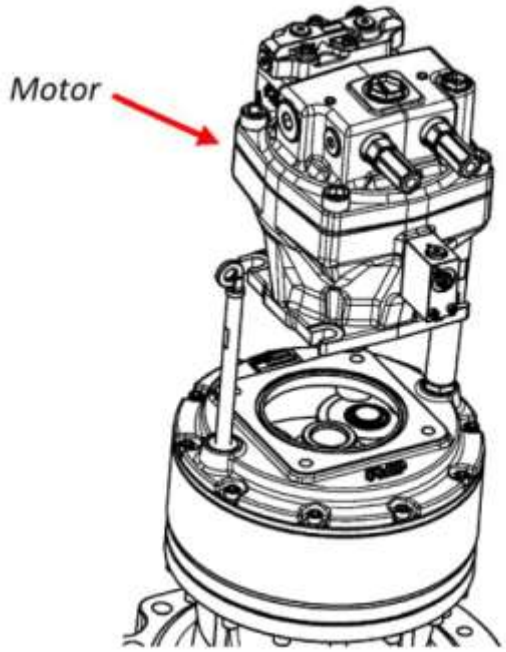
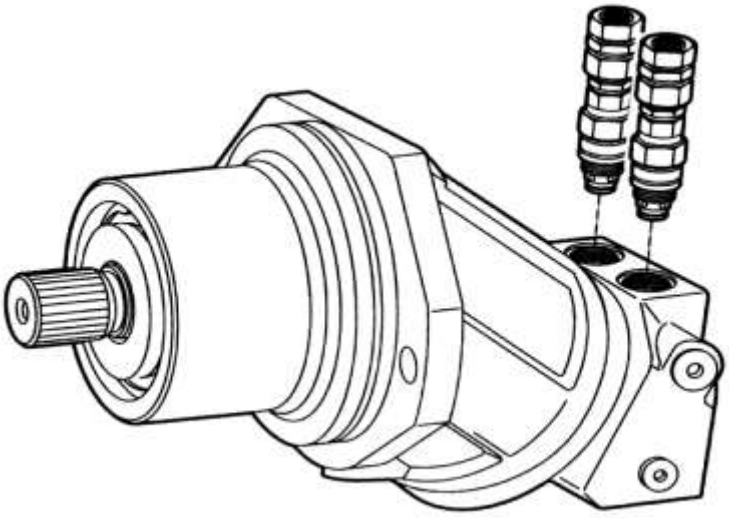


BE220 / BE220LC

Refer Rexroth Instruction Manual of HS-64-05-E0403-1-3



ASSEMBLY OF SWING MOTOR ASSEMBLY

BE220G

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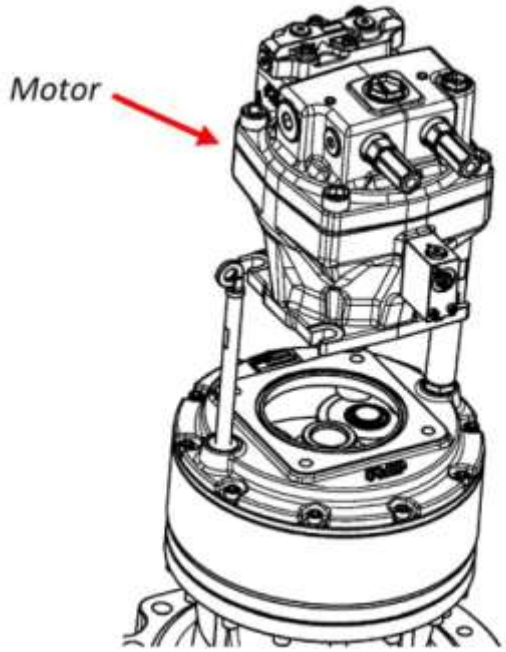
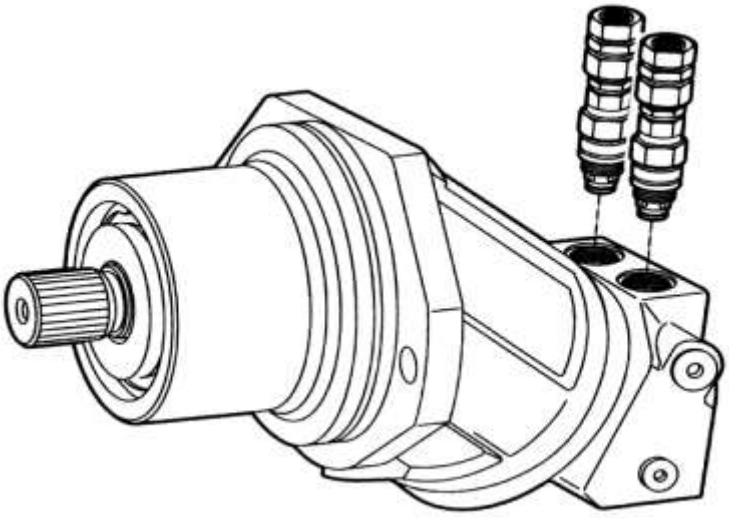
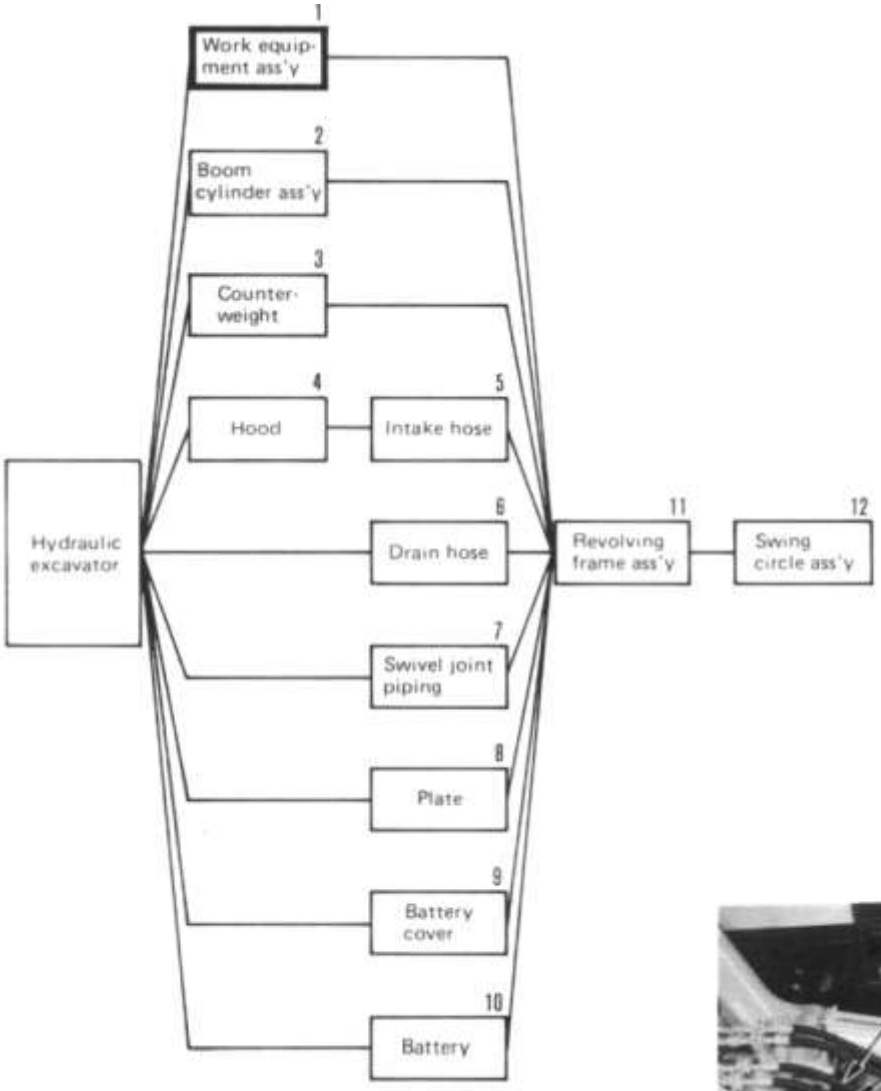


BE220 / BE220LC

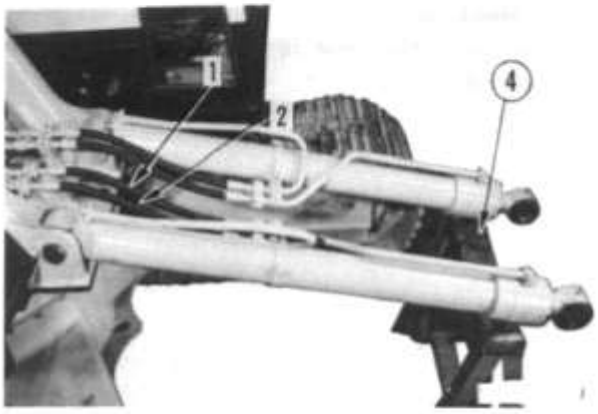
Refer Rexroth Instruction Manual of HS-64-05-E0403-1-3



REMOVAL OF SWING CIRCLE ASSEMBLY



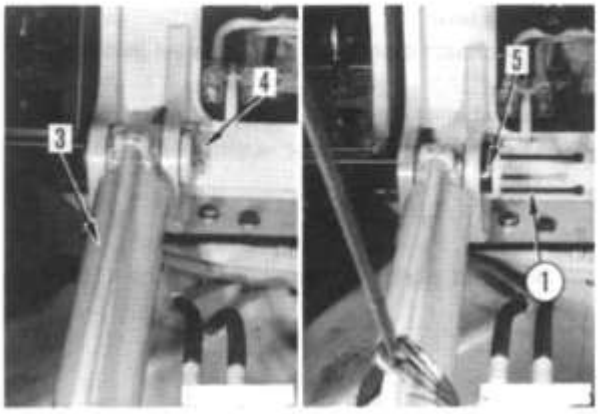
1. **Work equipment assembly**
   Remove work equipment assembly. For details, see section 63, REMOVAL OF WORK EQUIPMENT ASSEMBLY.



2. **Boom cylinder assembly**
   1) Set boom cylinder on stand ④. Disconnect boom cylinder hoses (1) and (2).
   2) Sling boom cylinder assembly (3), and remove lock plate (4). Using forcing screw ① (Dia. = 12 mm, Pitch = 1.75 mm), pull out pin (5), then remove boom cylinder assembly (3).

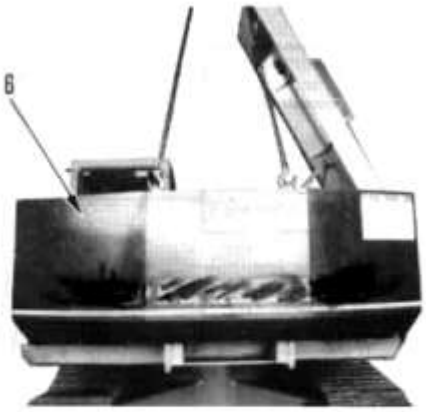
      kg Boom cylinder assembly: 185 kg

   ★ Remove the other boom cylinder assembly in the same way.



3. **Counterweight**
Sling counterweight (6), remove **4** mounting bolts, then lift off counterweight.

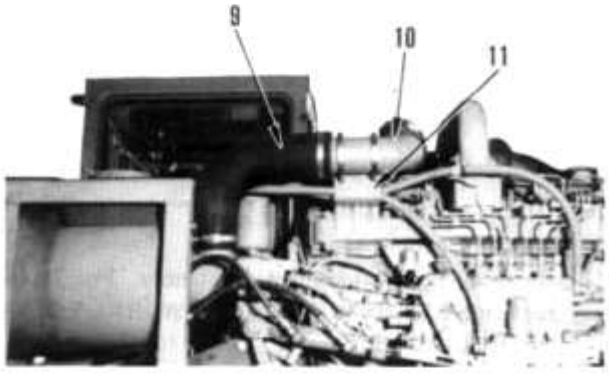
kg Counterweight: 3000 kg



4. **Hood**
1) Sling hood, pull out pin and disconnect stay (7).
2) Remove 4 mounting bolts and lift off hood (8).

kg Hood: 55 kg

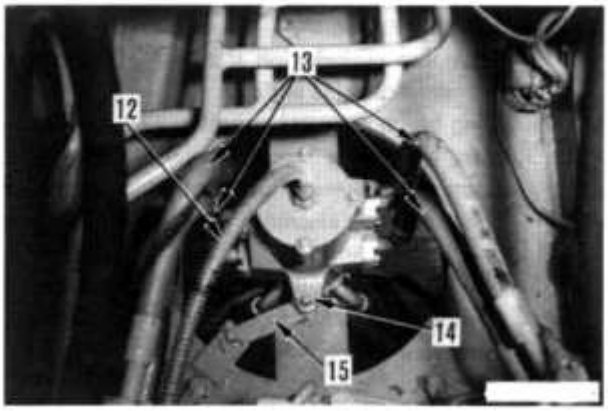
5. **Intake hose**
Remove intake hose (9) and tube (10) together with bracket (11).



6. **Drain hose**
Disconnect drain hose (12) at swivel joint end.

7. **Swivel joint piping**
Disconnect swivel joint upper hose (13) at swivel joint end.

8. **Plate**
Pull out pin (14), then remove plate (15) from swivel joint.

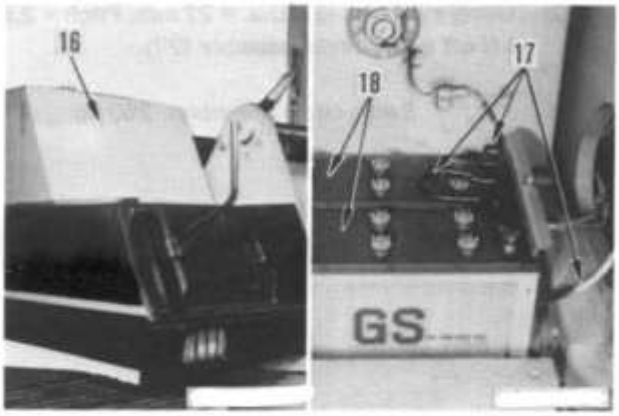


9. Battery cover

Remove battery cover (16).

10. Battery

1) Disconnect 3 battery wires (17).
   - ★ Disconnect the lead from the negative (–) terminal of the battery first.
2) Remove 2 batteries (18).

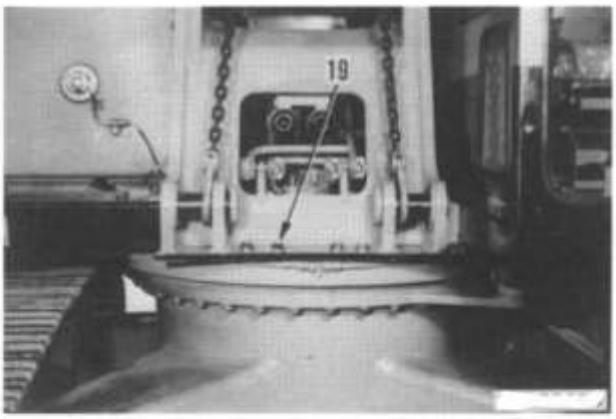


11. Revolving frame assembly

1) Remove mounting bolts (19) of revolving frame assembly, leaving 2 or 3 mounting bolts at front and rear.

2) Sling revolving frame assembly (20).
   - ★ The wire is hooked to the mounting frame of the counterweight and will contact the engine, so fit the blocks securely in position. At the front, hook the wire to the boom cylinder bottom mount.
   - ★ Use lever block ② at the front and adjust the length of the wire. This makes it easier to center the load.

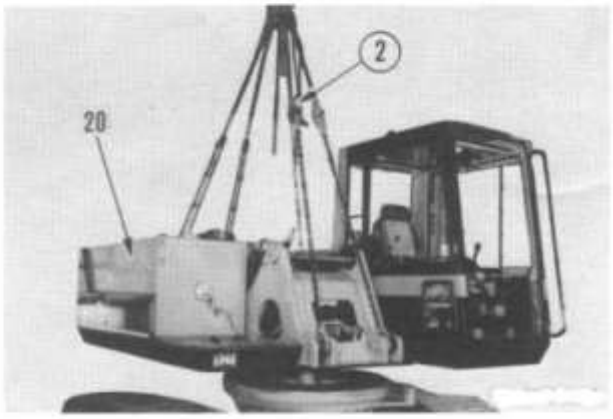
   ⚠ The load is extremely heavy, so check that the lifting tool is free from damage.



3) In this position, loosen remaining mounting bolts, then raise revolving frame assembly and check that load is center to front, rear, left and right.
   - ★ If the load is not centered, tighten the mounting bolts and adjust the length of the wire again.

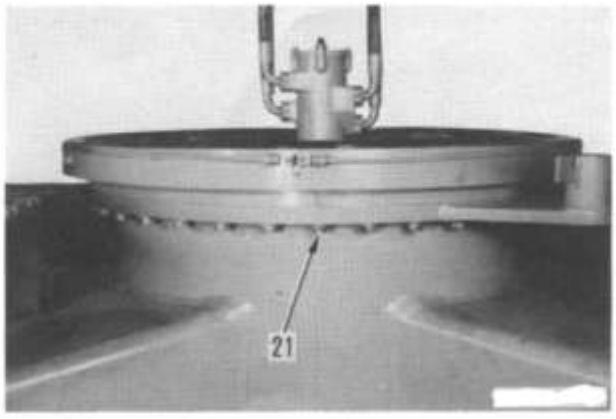
4) Repeat Step 3), and when load is centered, remove remaining mounting bolts and lift off revolving frame assembly.

   kg Revolving frame assembly: 4465 kg



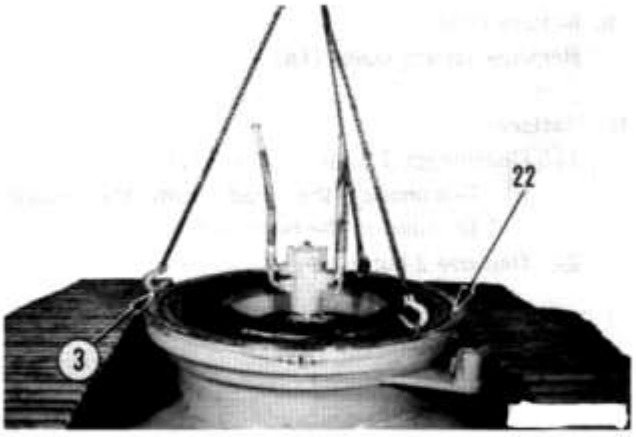
12. Swing circle assembly

1) Remove 36 mounting bolts (21).

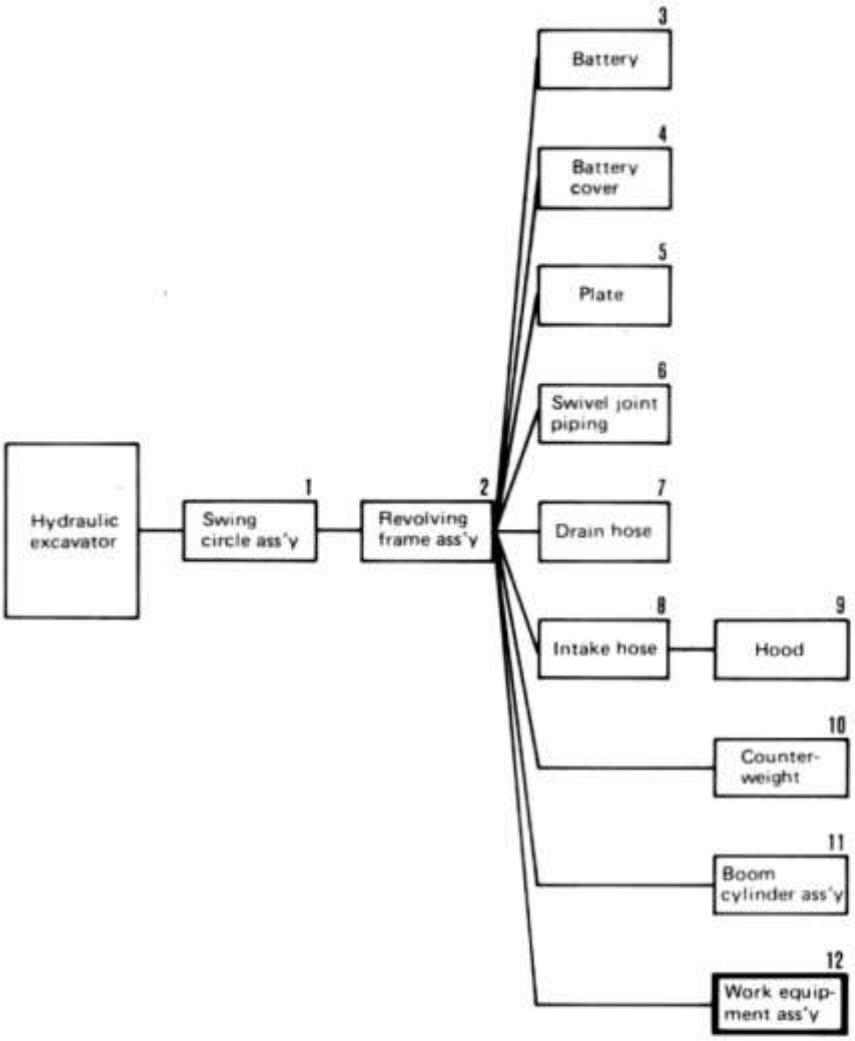


2) Using eye bolts ③ (Dia. = 22 mm, Pitch = 2.5 mm), lift off swing circle assembly (22).

kg Swing circle assembly: 260 kg

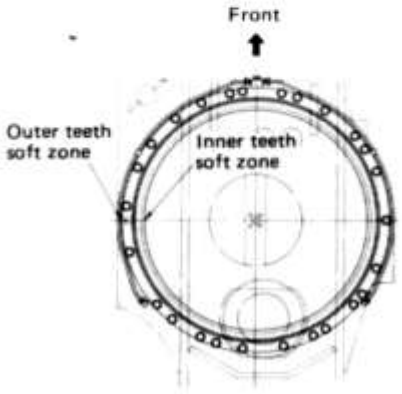


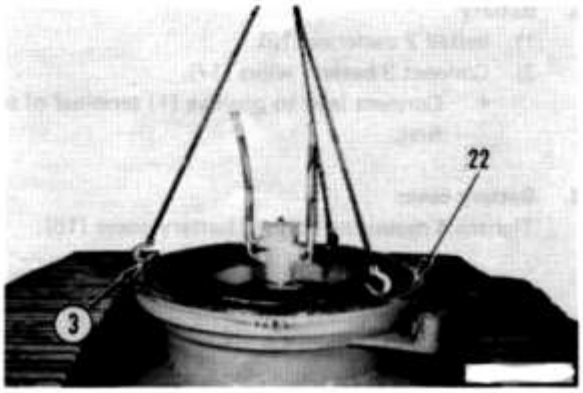
INSTALLATION OF SWING CIRCLE ASSEMBLY



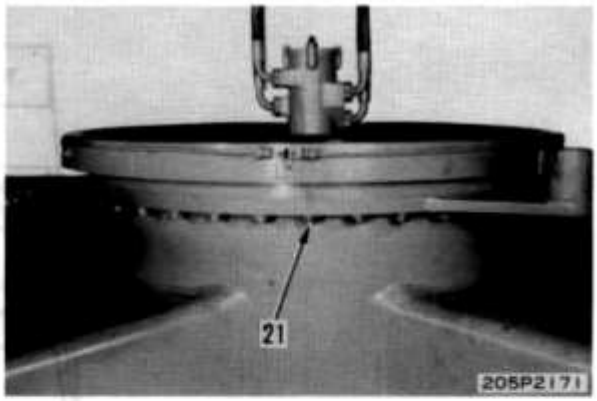
1. Swing circle assembly

1) Using eye bolts ③ (Dia. = 22 mm, Pitch = 2.5 mm), raise swing circle assembly (22). Align with inner teeth soft zone as shown in diagram, then set in position on frame.





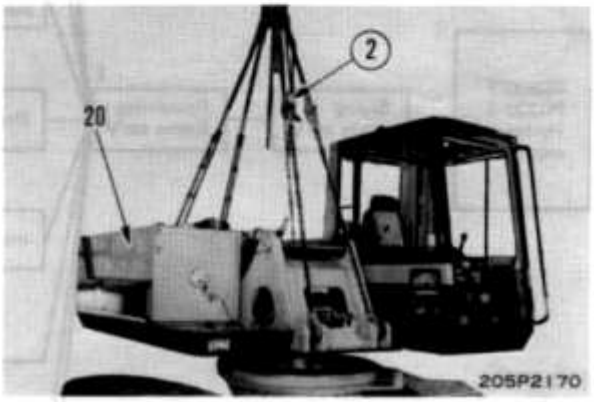
2) Tighten 36 mounting bolts (21).
   - Mounting bolts: Thread tightener (LT-2)
   - Mounting bolt: 56 ± 6 kgm
   - Inner teeth of circle: Grease (G2-LI)



2. Revolving frame assembly

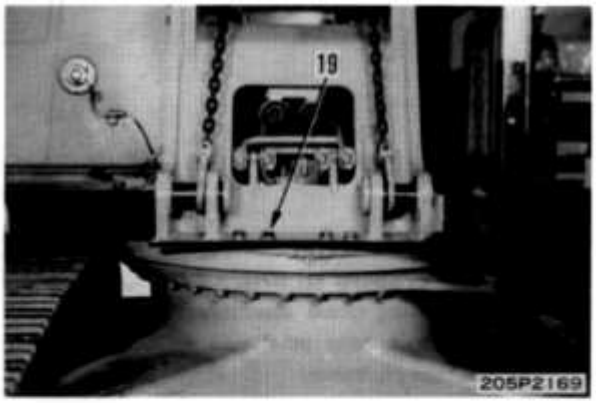
1) Raise revolving frame assembly (20) horizontally.
   - ★ The wire is hooked to the mounting frame of the counterweight and will contact the engine, so fit the blocks securely in position. At the front, hook the wire to the boom cylinder bottom mount.
   - ★ Use lever block ② at the front and adjust the length of the wire. This makes it easier to center the load.

   ⚠ The load is extremely heavy, so check that the lifting tool is free from damage.



2) Lower revolving frame assembly slowly, align swing pinion with circle gear, then align with dowel pin and set in position. Tighten 2 or 3 mounting bolts (19) at front and rear.
   - Top face of swing circle: Gasket sealant (LG-1)

3) Tighten all 26 mounting bolts (19).
   - Mounting bolt: Thread tightener (LT-2)
   - Mounting bolt: 76 ± 8.5 kgm

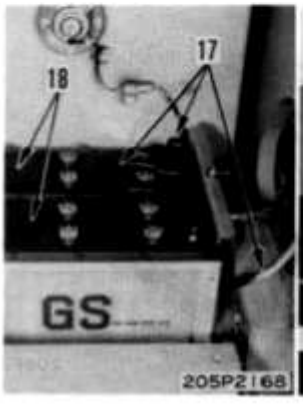


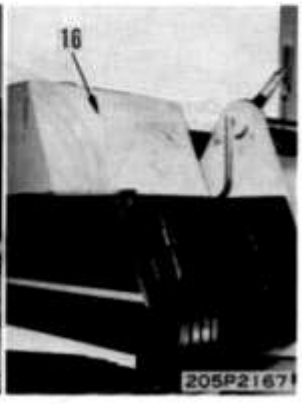
3. Battery

1) Install 2 batteries (18).
2) Connect 3 battery wires (17).
   - ★ Connect lead to positive (+) terminal of battery first.

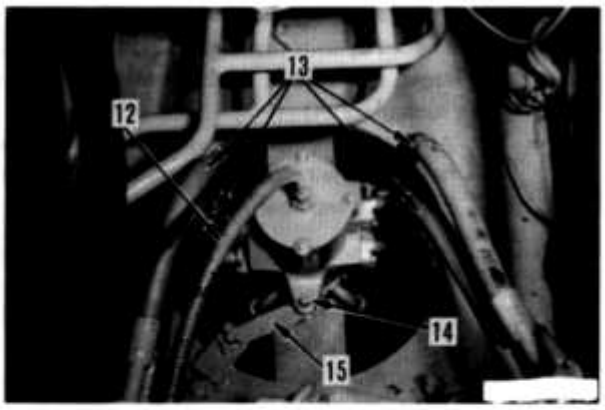
4. Battery cover

Tighten 4 mounting bolts of battery cover (16).





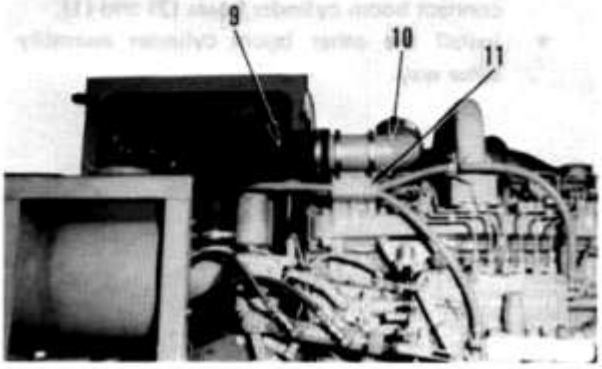
5. Plate
Set plate (15) on swivel joint, then install pin (14).



6. Swivel joint piping
Fit O-ring and connect swivel joint upper hose (13).
★ Install hose without twisting or interference.

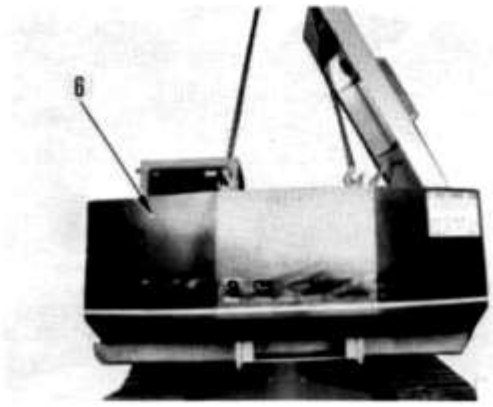
7. Drain hose
Connect drain hose (12).
Sleeve nut: 5 ± 2 kgm
(Width across flats: 24 mm)
★ Install hose without twisting or interference.

8. Intake hose
Install intake hose (9) and tube (10) together with bracket (11).



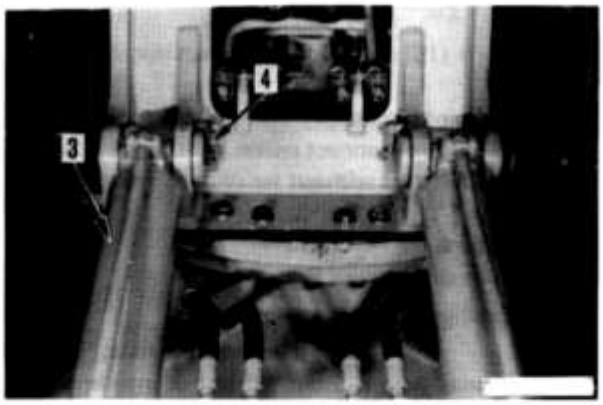
9. Hood
Raise hood (8) and set in position on frame. Tighten 4 mounting bolts, then connect stay (7).

10. Counterweight
Raise counterweight (6), set in position on frame, then tighten 4 mounting bolts.

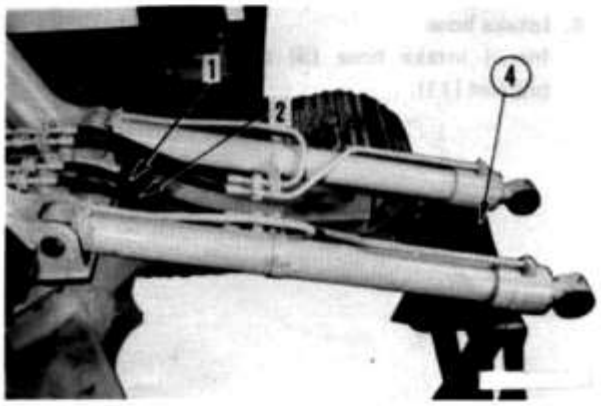


11. Boom cylinder assembly

1) Raise boom cylinder assembly (3), and set in position on frame. Knock pin at bottom end, then secure with lock plate (4).
   * Adjust with spacers so that the clearance between the revolving frame and boom cylinder bottom is less than 1 mm.



2) Set boom cylinder on stand ④. Fit O-rings and connect boom cylinder hoses (2) and (1).
* Install the other boom cylinder assembly in the same way.



12. Work equipment assembly

Install work equipment assembly. For details, see section 63, INSTALLATION OF WORK EQUIPMENT ASSEMBLY.

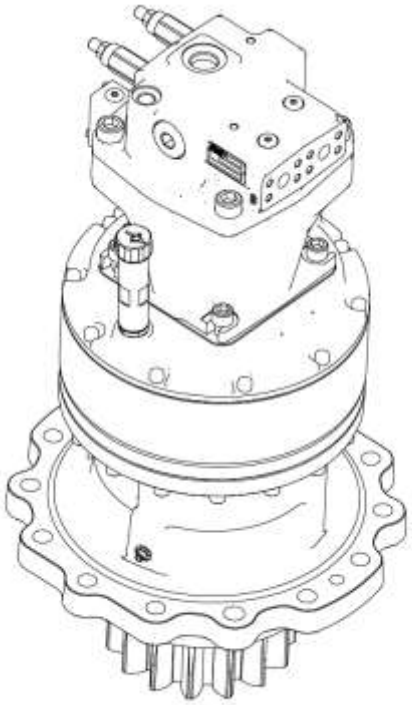
* For details, see section 62, TESTING AND ADJUSTING, BLEEDING AIR FROM TRAVEL MOTOR.

* After bleeding the air, add oil to the hydraulic tank to the specified level.

REMOVEL AND INSTALLATION OF SWING MACHINERY ASSEMBLY

BE220G

Refer PMP Instruction Manual of PMTE M001



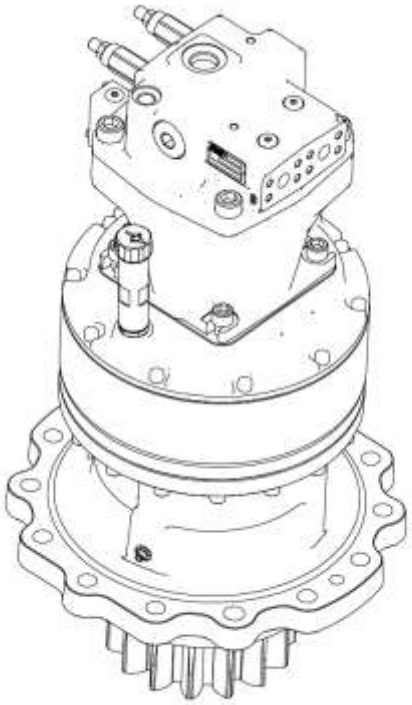
BE220 / BE220LC

Refer Rexroth Instruction Manual of HS-64-05-E0403-1-3

DISASSEMBLY OF SWING MACHINERY ASSEMBLY

BE220G

Refer PMP Instruction Manual of PMTE M001



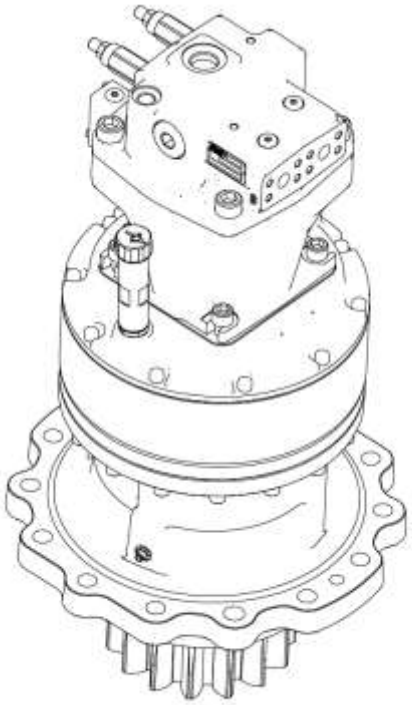
BE220 / BE220LC

Refer Rexroth Instruction Manual of HS-64-05-E0403-1-3

ASSEMBLY OF SWING MACHINERY ASSEMBLY

BE220G

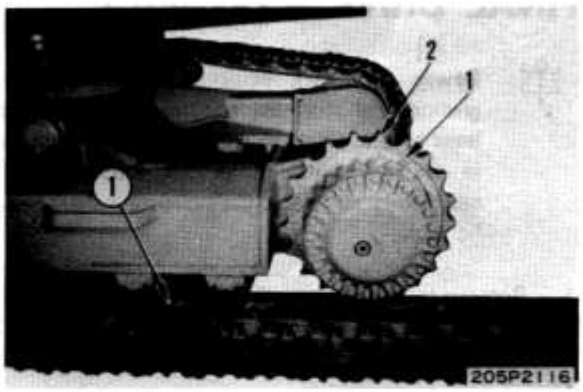
Refer PMP Instruction Manual of PMTE M001



BE220 / BE220LC

Refer Rexroth Instruction Manual of HS-64-05-E0403-1-3

REMOVAL OF SPROCKET



1. Remove track shoe assembly.
   For details, see section 33, REMOVAL OF TRACK SHOE ASSEMBLY.
2. Using hydraulic jack ① (30 t), raise track frame.
3. Remove 20 mounting bolts (1) of sprocket, then remove sprocket (2).

   kg Sprocket: 40 kg

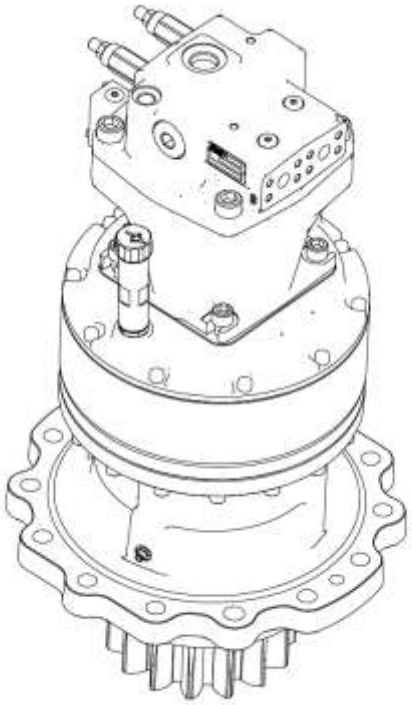
INSTALLATION OF SPROCKET

1. Set sprocket (2) in position, then tighten 20 mounting bolts (1).
2. Slowly release hydraulic jack ①, and return track frame to original position.
3. Install track shoe assembly.
   For details, see section 33, INSTALLATION OF TRACK ASSEMBLY.

REMOVEL OF TRAVEL MOTOR AND FINAL DRIVE ASSEMBLY

BE220G

Refer PMP Instruction Manual of PMCI M001



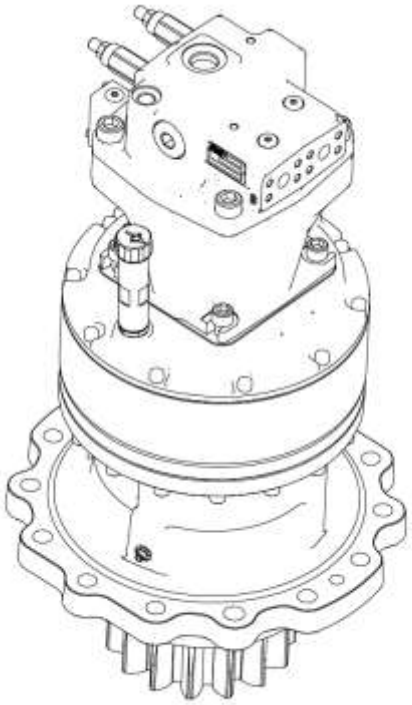
BE220 / BE220LC

Refer Rexroth Instruction Manual of HS-64-05-E0403-1-3

INSTALLATION OF TRAVEL MOTOR AND FINAL DRIVE ASSEMBLY

BE220G

Refer PMP Instruction Manual of PMCI M001



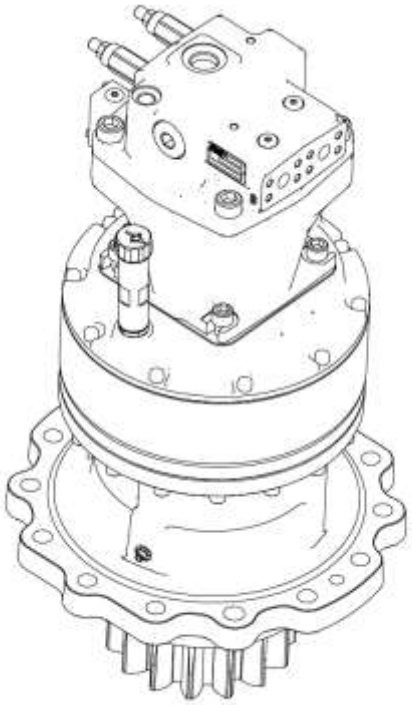
BE220 / BE220LC

Refer Rexroth Instruction Manual of HS-64-05-E0403-1-3

DISASSEMBLY OF FINAL DRIVE ASSEMBLY

BE220G

Refer PMP Instruction Manual of PMCI M001



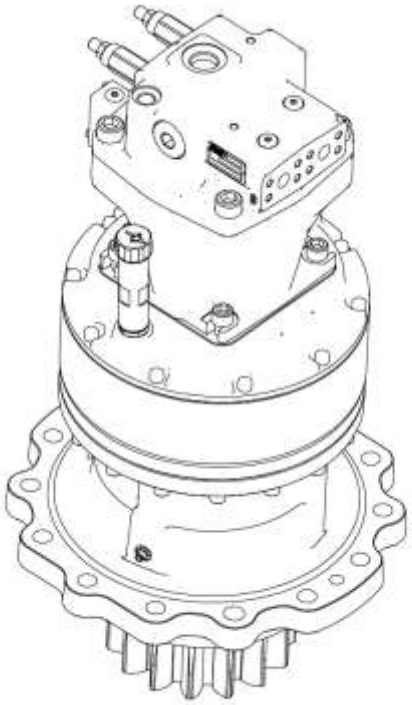
BE220 / BE220LC

Refer Rexroth Instruction Manual of HS-64-05-E0403-1-3

ASSEMBLY OF FINAL DRIVE ASSEMBLY

BE220G

Refer PMP Instruction Manual of PMCI M001

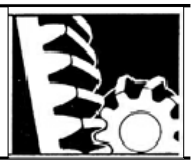


BE220 / BE220LC

Refer Rexroth Instruction Manual of HS-64-05-E0403-1-3

POWR TRAIN

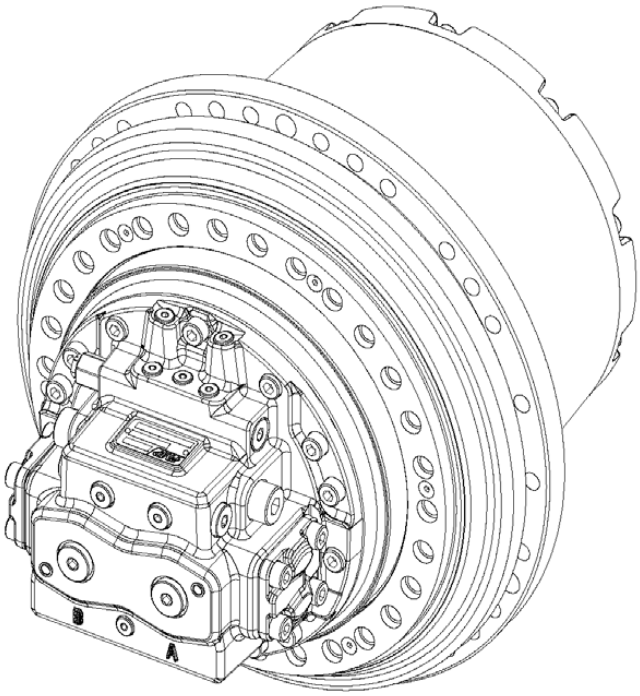
07 MAINTENANCE STANDARD



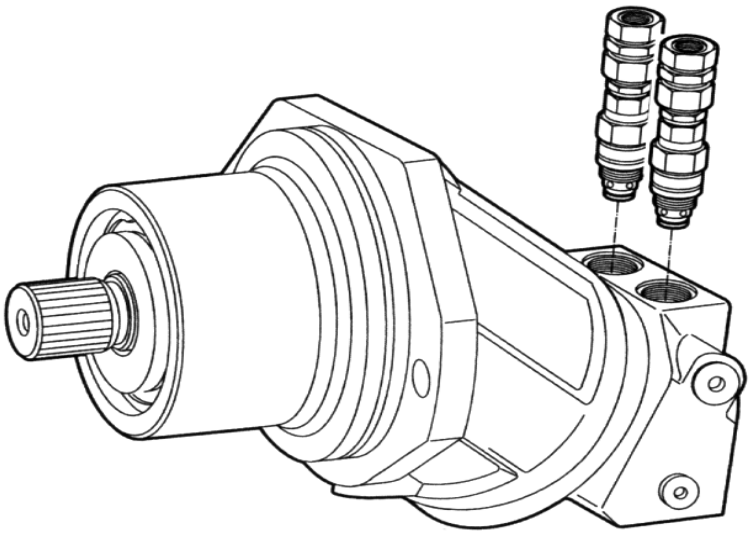
Travel motor..... 07-02
Final drive..... 07-03
Swing motor..... 07-04
Swing machinery..... 07-06
Swing circle..... 07-09

TRAVEL MOTOR

BE220G Refer PMP instruction manual of PMCI. M001

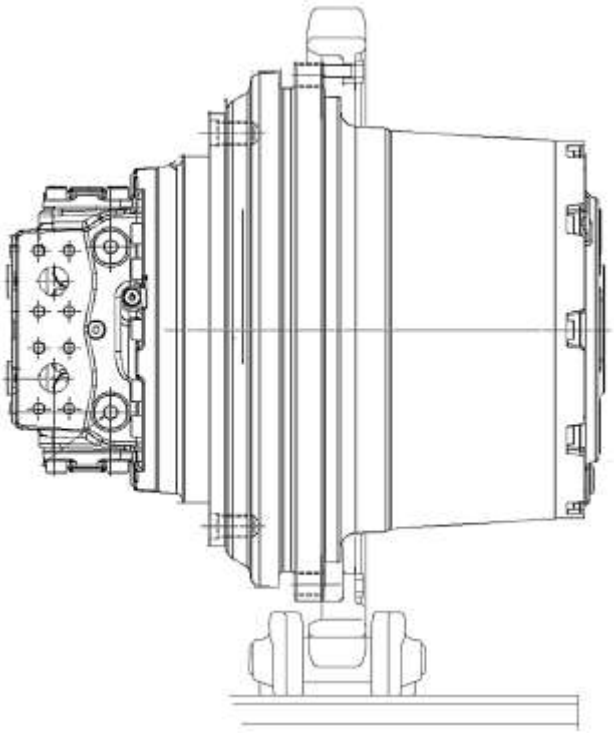


BE220 / BE220LC Refer Rexroth instruction manual of HS-64-05-E0403-1-3

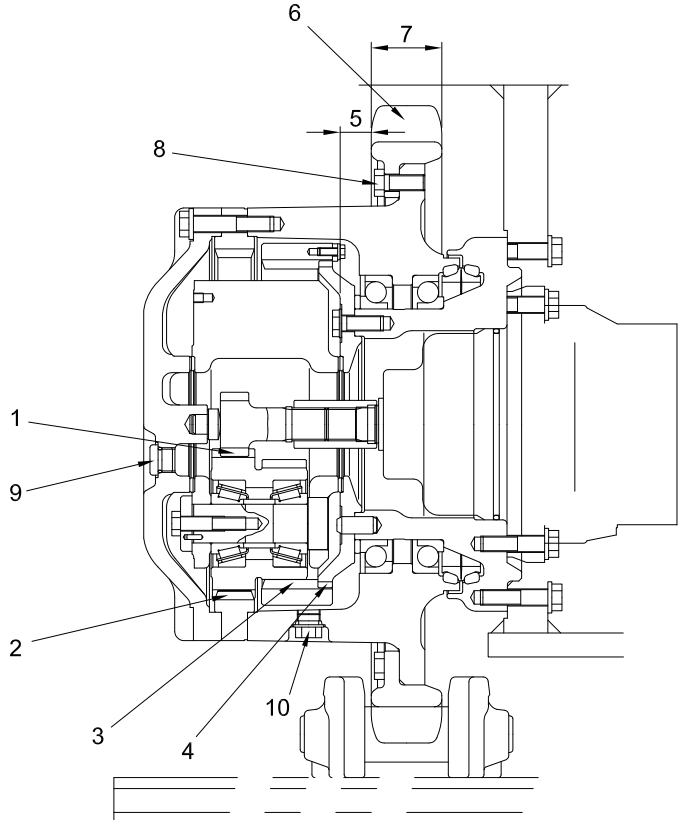


FINAL DRIVE

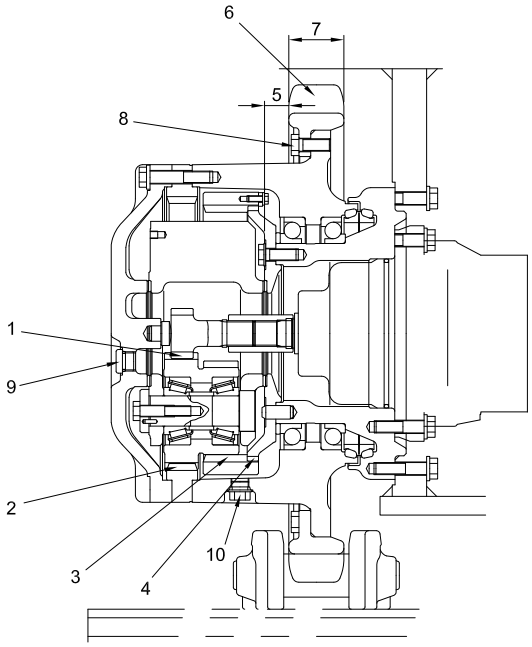
BE220G Refer PMP instruction manual of PMCI. M001



BE220 / BE220LC Refer Rexroth instruction manual of HS-64-05-E0403-1-3



FINAL DRIVE

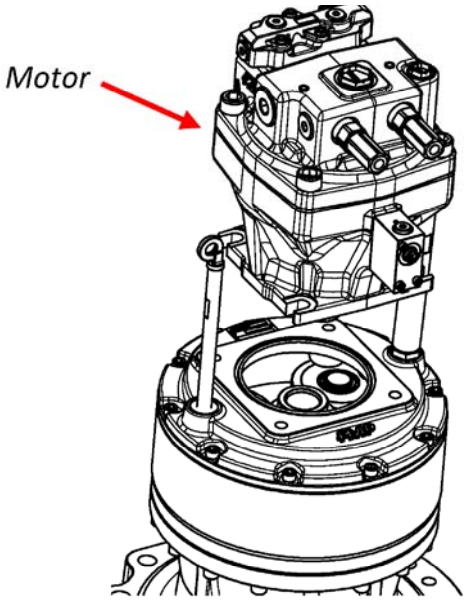


Unit : mm

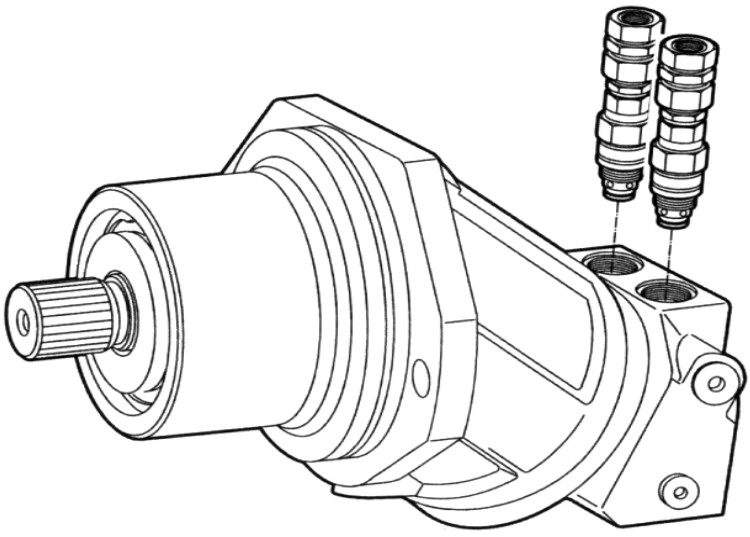
No.	Check item	Criteria		Remedy
		Standard clarance	Clearance limit	
1	Backlash between sun gear and plannet gear	0.19 - 0.51	1.00	
2	Backlash between plannet gear and No.1 ring gear	0.20 - 0.59	1.10	replace
3	Backlash between plannet gear and No.2 ring gear	0.22 - 0.60	1.10	
4	Backlash between No.2 ring gear and gear	0.22 - 0.63	1.10	
5	End play of sprocket shaft	0 - 0.1	—	
6	Amount of wear on sprocket tooth	Repair limit : 6		Repair by build up welding or replace rims
		Standard size	Repair limit	
7	Width of sprocket tooth	68	65	
8	Tightening torque of sprocket mounting bolt	25 ±6.5 kgm		Tighten
9	Tightening torque of oil filler plug	15.5 ±2.5 kgm		
10	Tightening torque of drain plug	15.5 ±2.5 kgm		

SWING MOTOR

BE220G Refer PMP instruction manual of PMTE. M001

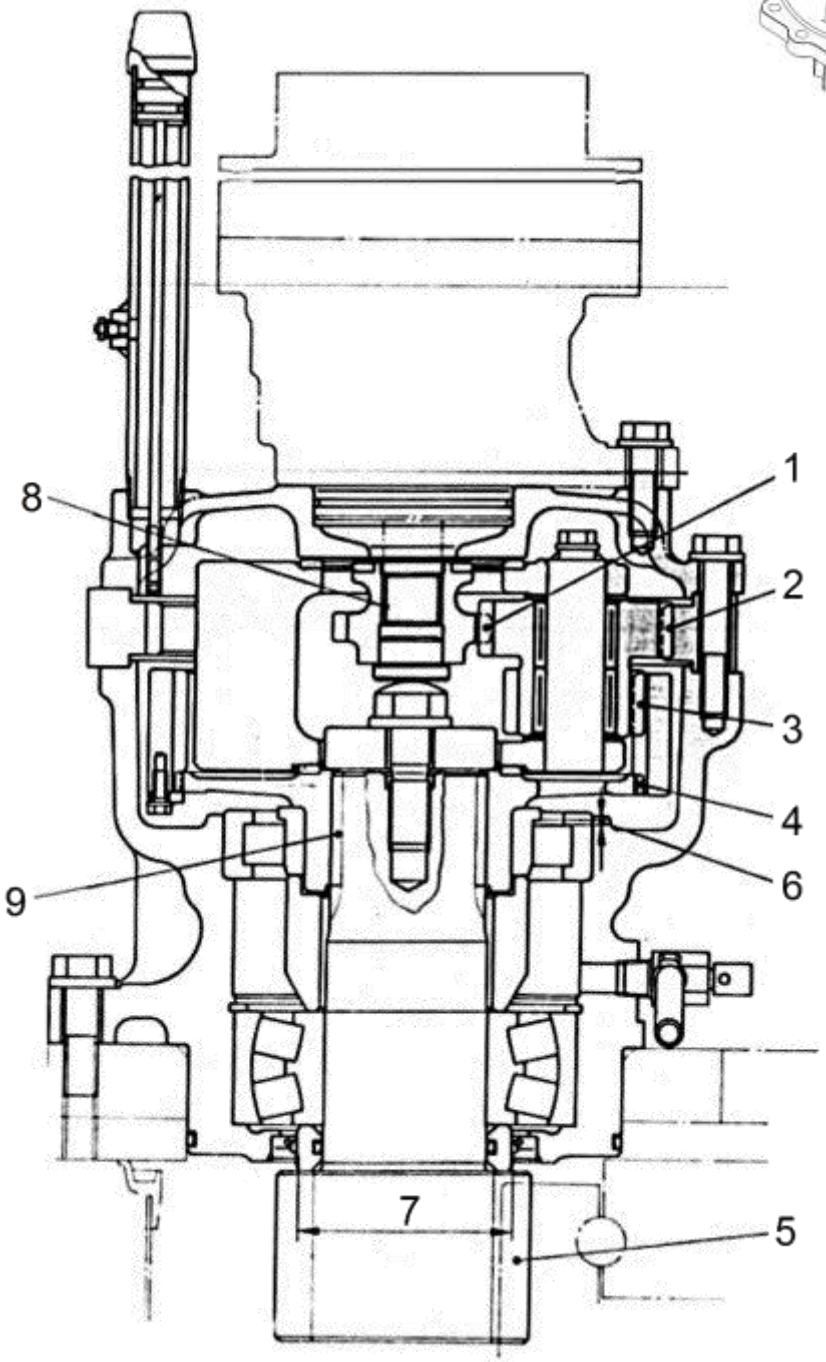


BE220 / BE220LC Refer Rexroth instruction manual of HS-64-05-E0403-1-3



SWING MACHINERY

BE220G Refer PMP Instruction of PMTE, M001



SWING MACHINERY

Unit : mm

No.	Check item	Criteria		Remedy
		Standard clarance	Clearance limit	
1	Backlash between sun gear and plannet gear	0.13 - 0.49	1.00	replace
2	Backlash between plannet gear and No.1 ring gear	0.16 - 0.58	1.10	
3	Backlash between plannet gear and No.2 ring gear	0.15 - 0.53	1.00	
4	Backlash between No.2 ring gear and gear	0.2 - 0.6	1.10	Adjust
5	Backlash between output shaft (pinoin) and swing circle	0.24 - 1.29	2.00	
6	End play of swing pinion	1.78 - 2.22	—	
		Standard size	Repair limit	Apply hard chrome plasting recondition or replace
7	Width of output shaft collar surface contacting with oil seal	Ø125 $^{0}_{-0.100}$	124.7	
		Standard clearance	Clearance limit	
8	Clearance between sun gear and swing motor output shaft spline in rotating direction.	0.06 -0.15	—	Replace
9	Clearance between output and idle gear spline in rotating direction	0.09 -0.27	—	

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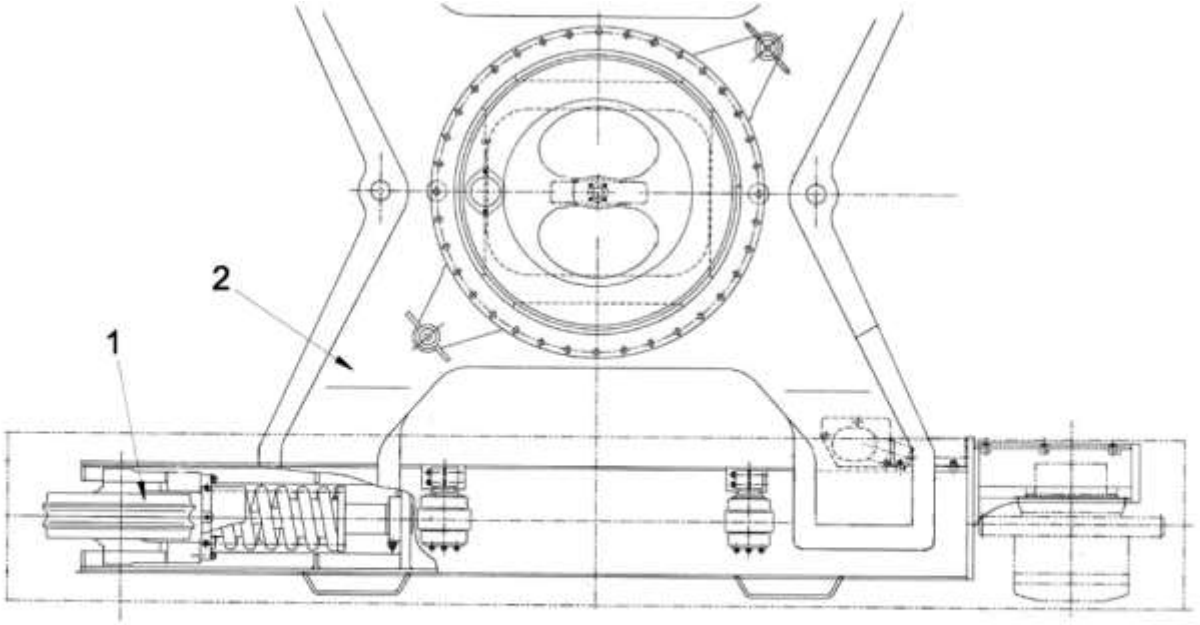
UNDERCARRIAGE

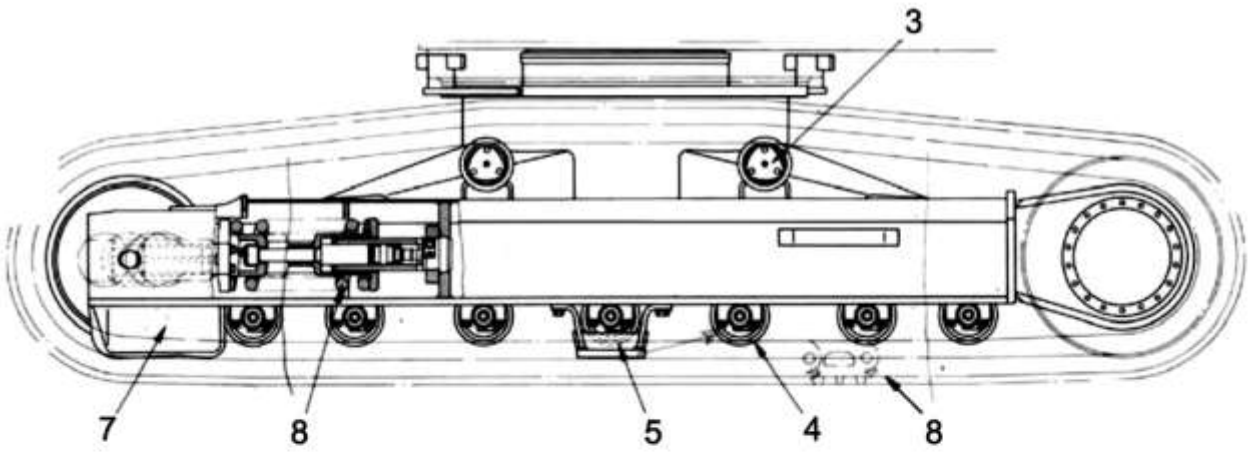
08 STRUCTURE AND FUNCTION

Track group..... 08-02
Recoil spring..... 08-04
Idler..... 08-05
Track roller..... 08-06
Carrier roller..... 08-07
Track shoe..... 08-08

TRACK GROUP

BE220G / BE220





1. Idler
2. Track frame
3. Carrier roller
4. Track roller
5. Center guard
6. Recoil spring
7. Front guard
8. Track

The tracks which bear and spread the weight of the machine on the ground convert the driving power transmitted from the sprockets into tractional force. The track group includes a pair of right and left track frames (2), front idlers (1), carrier rollers (3) and track rollers (4) are mounted. The track (8) looped around each track frame is driven by the sprocket wheel and its rolling is guided by the front idler, carrier roller and track rollers. Thetrack roller guards (4) and (7) attached on the bottom surface of each track frame prevents thetrack from slipping off due to intrusion of stones.

TRACK GROUP

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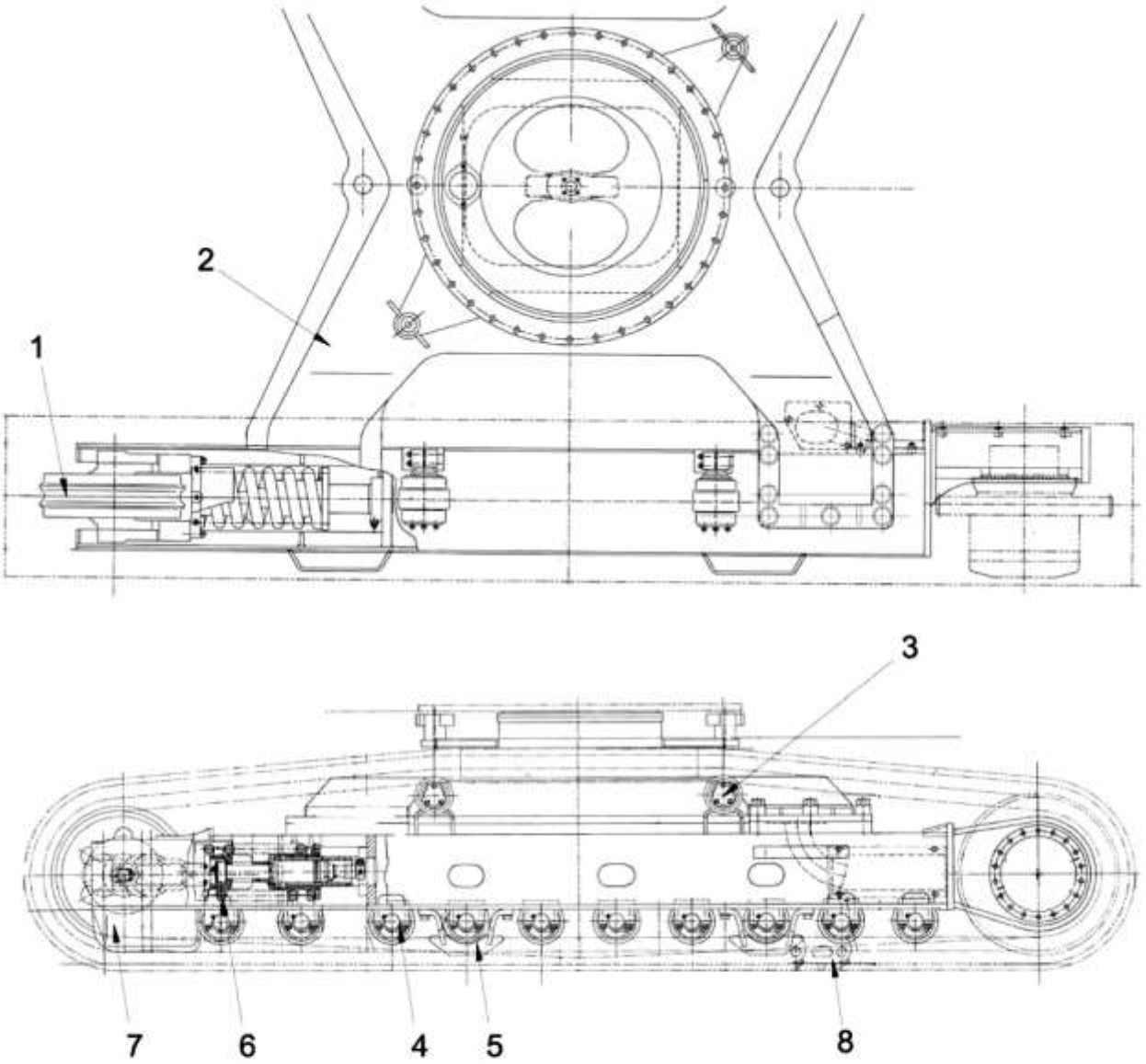
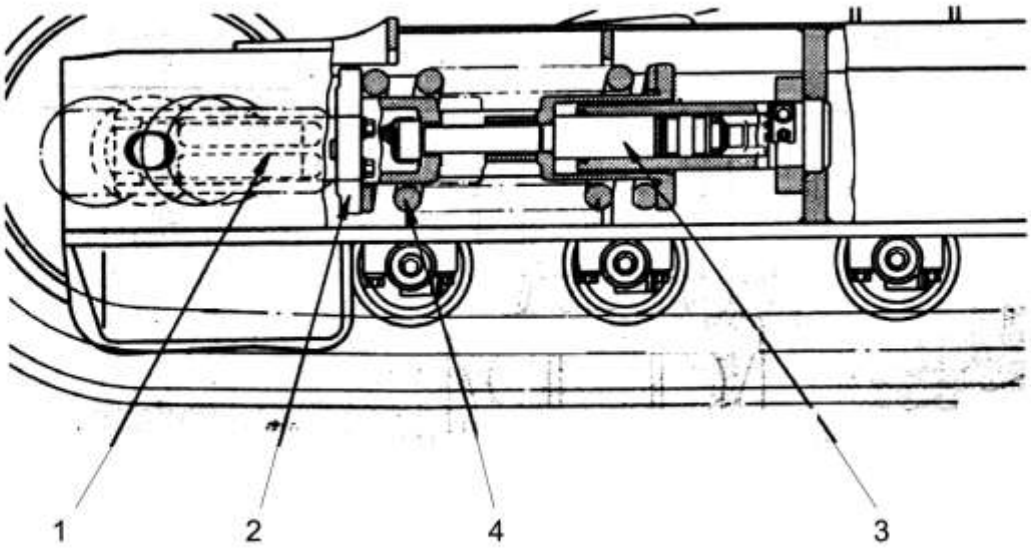


1. Idler
2. Track frame
3. Carrier roller
4. Track roller
5. Center guard
6. Recoil spring
7. Front guard
8. Track

The tracks which bear and spread the weight of the machine on the ground convert the driving power transmitted from the sprockets into tractional force.
The track group includes a pair of right and left track frames (2), front idlers (1), carrier rollers (3) and track rollers (4) are mounted. The track (8) looped around each track frame is driven by the sprocket wheel and its rolling is guided by the front idler, carrier roller and track rollers. Thetrack roller guards (4) and (7) attached on the bottom surface of each track frame prevents thetrack from slipping off due to intrusion of stones.

RECOIL SPRING



The idler cushion is mounted om the track frame between the front idler and the sprocket wheel. It performs the following functions :

1) Maintaining proper track tension
2) Absorbing shocks which the front idler is subjected to during traveling of the machine.

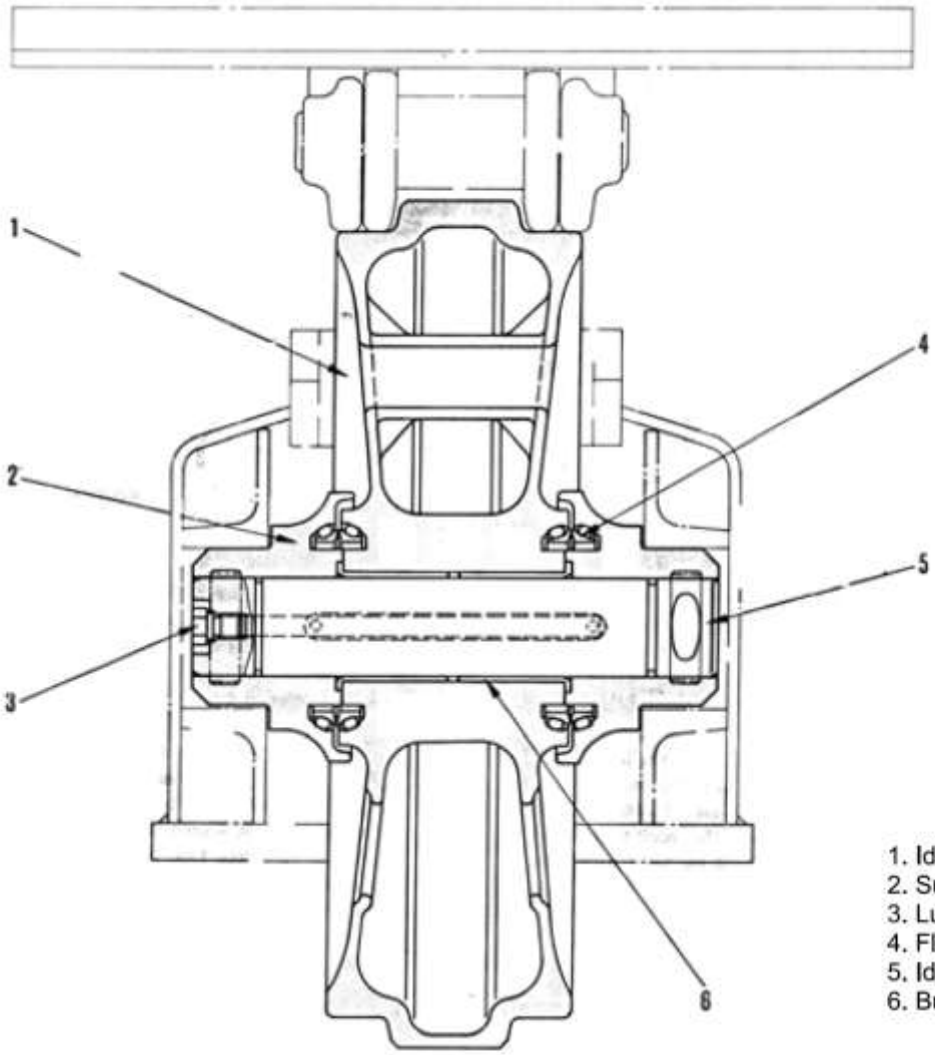
One end of the rod (1) is connected to the idler yoke and the other end to the support (2). The recoil spring support (2) and the piston (3) are always pushed toward the forward part of the machine by the recoil spring (4), and rod is also pushed forwaed by force from the piston through the grase filling the cylinder.

When the front idler, connected to the recoil spring through the adjusting cylinder, is subjected to an impact exceeding the initial preload of the recoil spring, the recoil spring will retract to absorb the shock. Also, when mud, stones or snow get lodged between the track and the sprocket wheel, the recoil spring will absorb the shock caused by a sudden increase of track tension, thus preventing damage to the track, sprocket or other roller.

The adjjusting cylinder is provided with the lubricator. Feeding grease through the lubricator causes the cylinder piston to push the other hand, track tension is decreased by loosening the lubricator to discharge the grease

To loosen track tension, loosen the lubricator by one turn. if grease does not ooze out easily, try moving the machine back and forth a short distance. Do not loosen the lubricator more than one complete turn in order to prevent dangerous spurting of grease under high pressure. Although the protector is provided to prevent the lubricator from flying out, this precaution should be kept in mind for safety.

IDLER

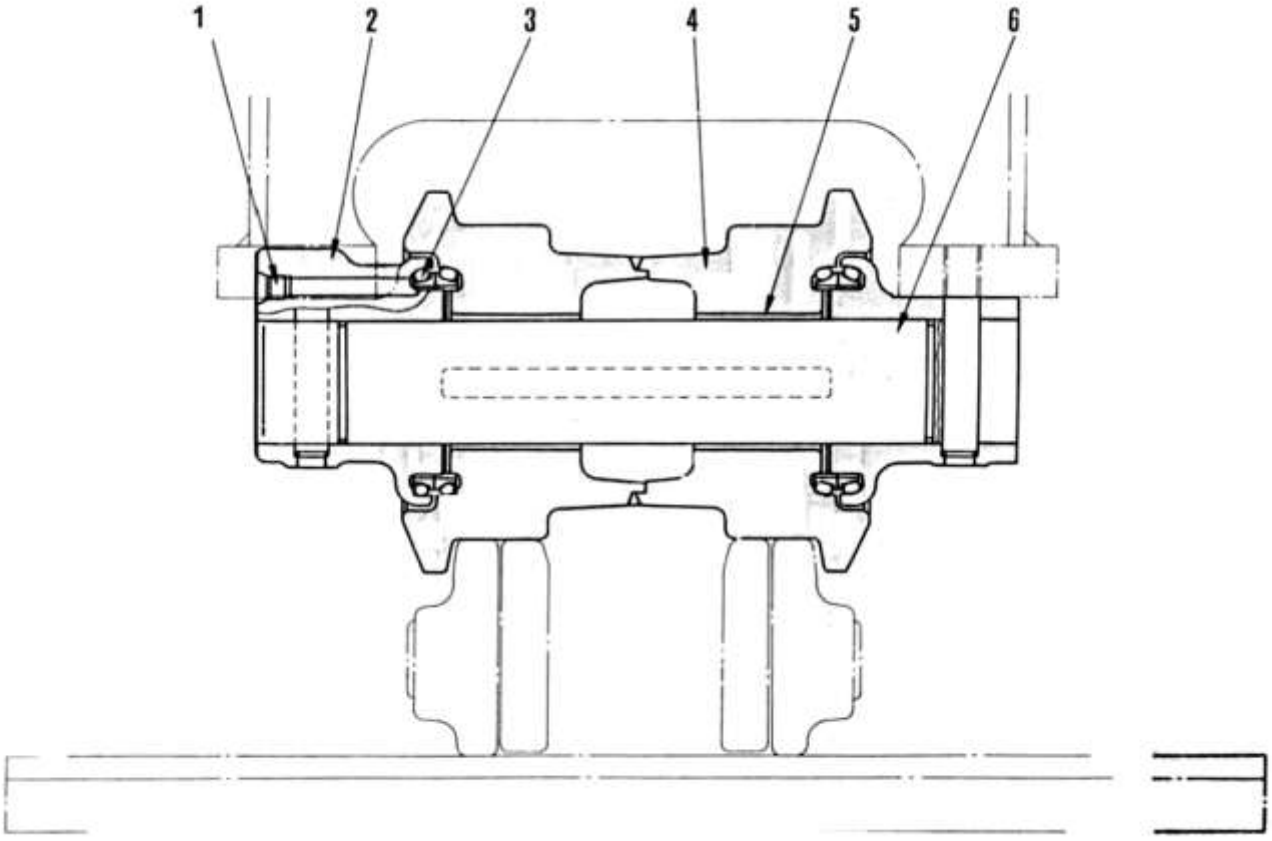


1. Idler
2. Support
3. Lubracting plug
4. Floating seal
5. Idler shaft
6. Bushing

The front idler (1) mounted at the front end of each track frame is supported on the idler shaft (5) through the guide and bushing (6).
The idler assembly including the yoke, hich is connected to the idler shaft bearings, is slidable back and forth along the track frame by the guideplates attached to the underside of the bearings and the cover so that smooth rolling of the track can always be maintained.

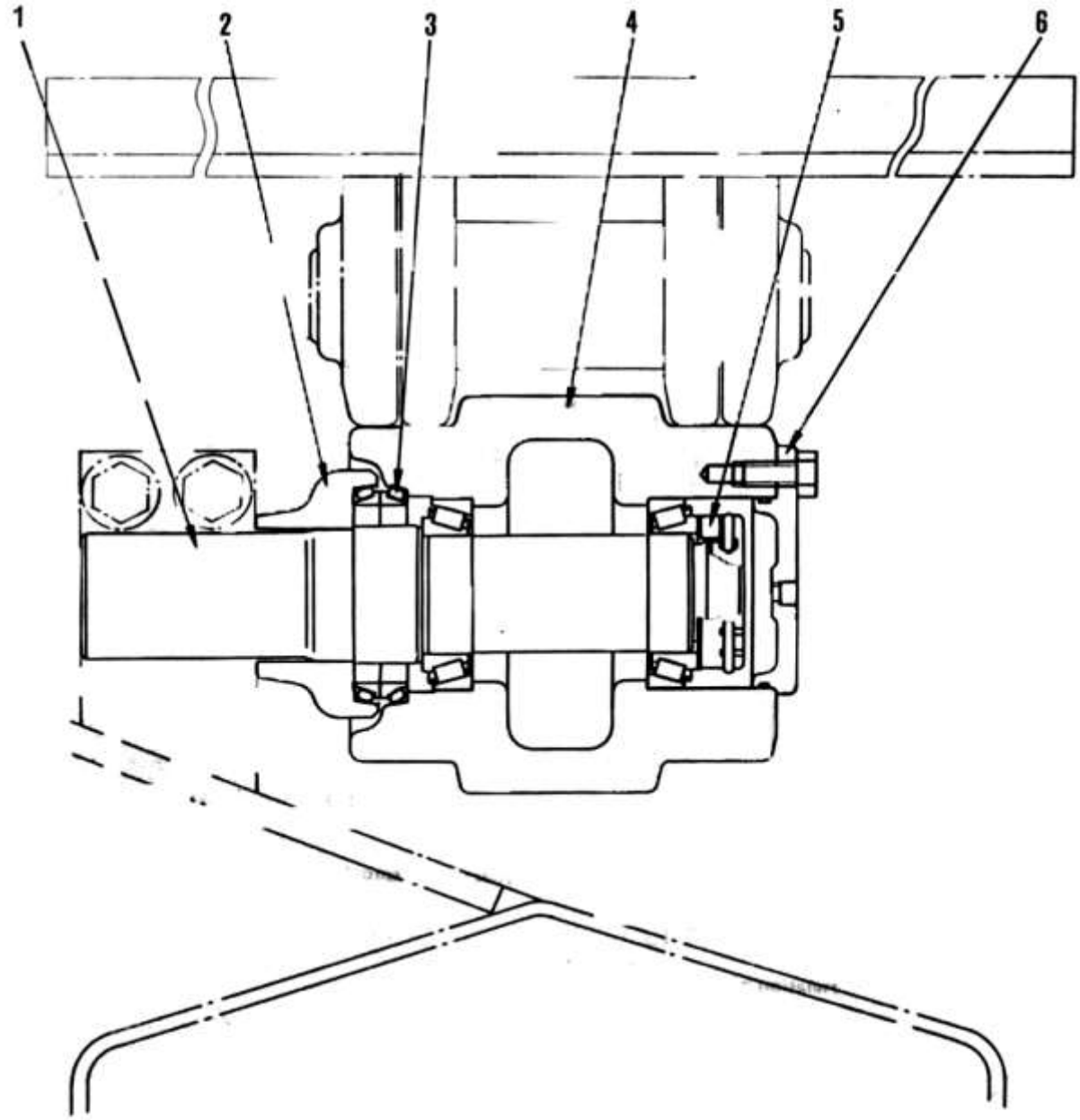
Lubrication oil (engine oil) enters the oil hole provided in the shaft to lubricate the sliding surface of the bushing. Each end of the bushing is provided with a floating seal to prevent both leakage of oil and inclusion of mud and water.
To improve its wear-resistant property, the idler is made of siliconmanganese steel casting, the tread of the idler which the track link contacts, is hardened by highfrequency hardening treatment.

TRACK ROLLER



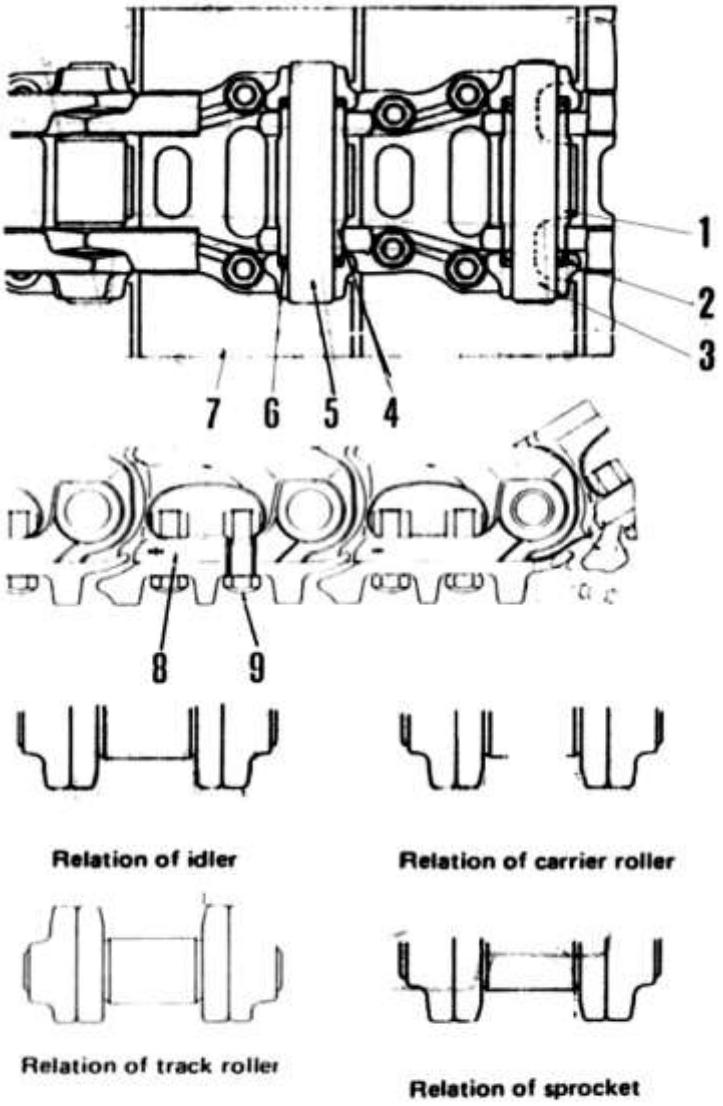
1. Lubricating plug
2. Collar
3. Floating seal
4. Track roller
5. Bushing
6. Shaft

CARRIER ROLLER



1. Shaft
2. Collar
3. Floating seal
4. Carrier roller
5. Ring
6. Cover

TRACK SHOE



1. Master bushing
2. Master dust seal
3. Master pin
4. Regular bushing
5. Regular pin
6. Regular dust seal
7. Shoe
8. Link
9. Shoe bolt

610 mm triple-shoe
Link pitch: 190 mm
Number of shoe: 102

UNDERCARRIAGE

09 DISASSEMBLY AND ASSEMBLY

IDLER RECOIL SPRING ASSEMBLY

Removel and Installation 09-02

RECOIL SPRING ASSEMBLY

Disassembly 09-03

Assembly 09-04

TRACK ROLLER ASSEMBLY

Removel and Installation 09-05

CARRIER ROLLER ASSEMBLY

Removel and Installation 09-06

TRACK SHOE ASSEMBLY

Removel and Installation 09-07

REMOVAL OF IDLER, RECOIL SPRING ASSEMBLY

1. Remove track shoe assembly.
   For details, see section 33, REMOVAL OF TRACK SHOE ASSEMBLY.

2. Using eye bolts ① (Dia. = 16 mm, Pitch = 2 mm), raise idler and recoil spring assembly (1), and pull out to front.

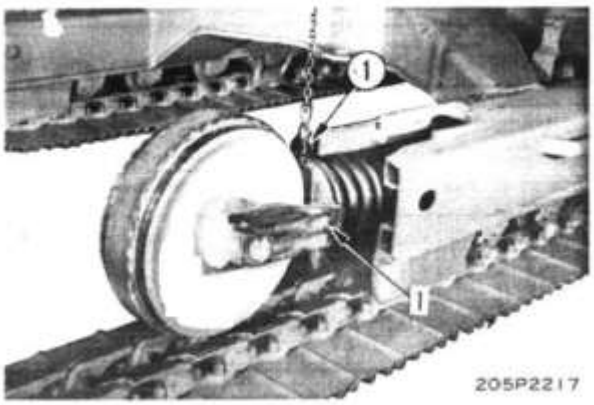
   kg Idler, recoil spring assembly: 270 kg

3. Fix recoil spring on block ②, and sling idler with crane.

4. Remove 4 mounting bolts (2), then disconnect idler assembly (3) and recoil spring assembly (4).
   ★ Make match marks on the contact faces of the idler and recoil spring before removing.

   kg Idler assembly: 130 kg

   kg Recoil spring assembly: 140 kg



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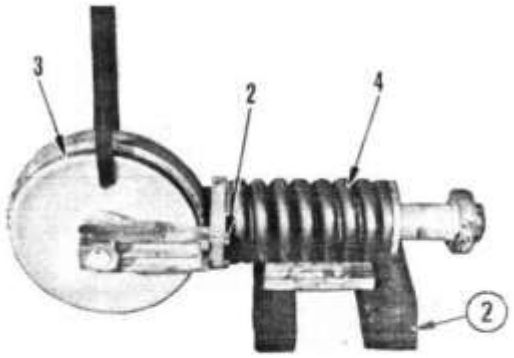

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INSTALLATION OF IDLER, RECOIL SPRING ASSEMBLY

Fix recoil spring assembly (4) on block ②, then raise idler assembly (3) with crane, and tighten 4 mounting bolts (2).

2. Raise idler and recoil spring assembly (1), and push into track frame.
   ★ Install so that the oil filler plug of the idler is on the right.

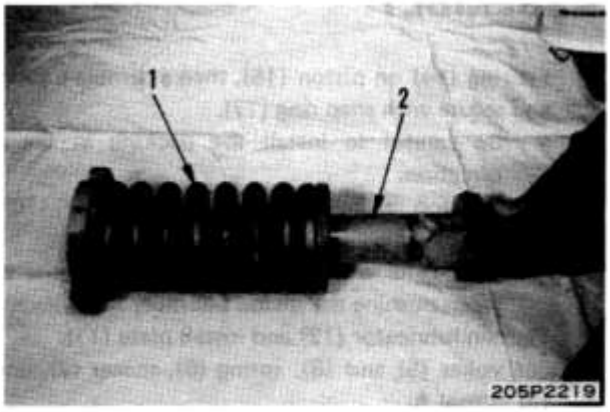
3. Install track shoe assembly.
   For details, see section 33, INSTALLATION OF TRACK SHOE ASSEMBLY.

DISASSEMBLY OF RECOIL SPRING ASSEMBLY

Special tools

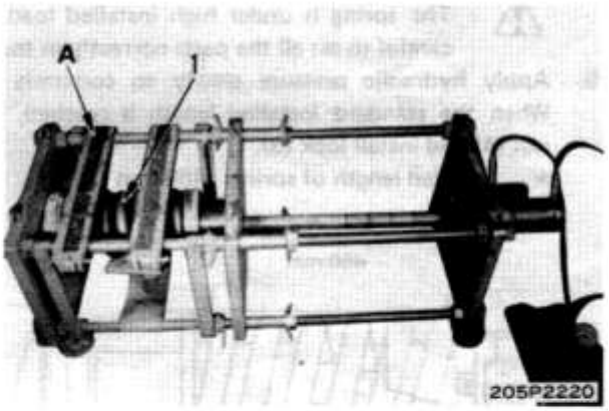
	Part No.	Part Name	Q'ty
A	791-685-8003	Compressor kit	1
A_1	790-101-1600	Cylinder ass'y (70 t)	1
A_2	790-101-1102	Pump ass'y	1

1. Divide into recoil spring assembly (1) and cylinder assembly (2).



2. Set recoil spring assembly (1) on tool **A**.

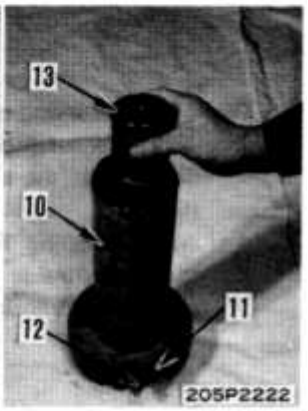
   ⚠ The spring is under high installed load, so be careful to set correctly.
   ★ Installed load of spring: 11,700 kg



3. Apply hydraulic pressure slowly to compress spring, then remove lock (3) and nut (4).
   ★ Compress the spring until the nut is loose.

4. Release hydraulic pressure slowly to remove tension of spring.
   ★ Free length of spring: 583 mm

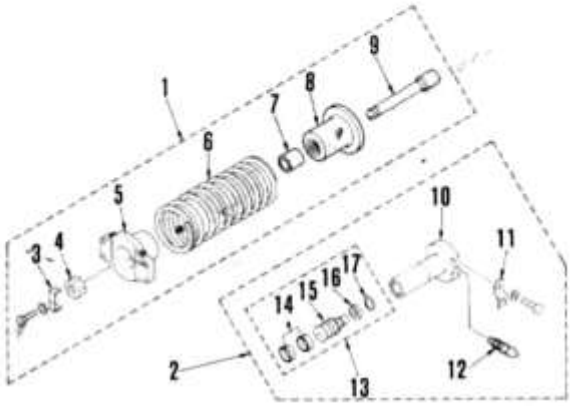
5. Disassemble into yokes (5) and (8), spring (6), spacer (7), and shaft (9).



6. Remove plate (11) from cylinder (10), then remove lubricator (12).

7. Remove O-ring, then pull out piston assembly (13).

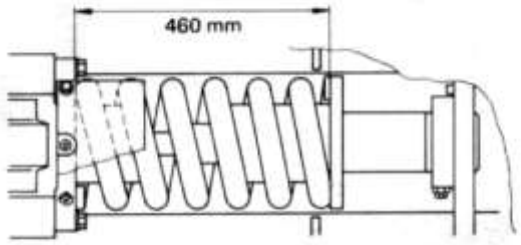
8. Remove ring (14) from piston (15), then remove snap ring (17), and packing (16).



ASSEMBLY OF RECOIL SPRING ASSEMBLY

1. Fit ring (14) on piston (15), then assemble packing (16) and secure with snap ring (17).
   - ★ Be careful to install the packing in the correct direction.
2. Push piston assembly (13) into cylinder (10), then assemble O-ring.
   - ★ Be careful not to damage the lip of the packing when pushing the piston assembly in.
3. Tighten lubricator (12) and install plate (11).
4. Set yokes (5) and (8), spring (6), spacer (7), and shaft (9) in tool **A**.

   ⚠ The spring is under high installed load, so be careful to set all the parts correctly in tool **A**.
5. Apply hydraulic pressure slowly to compress spring. When the standard installed length is reached, tighten nut (4) and install lock (3).
   - ★ Installed length of spring: 460 mm



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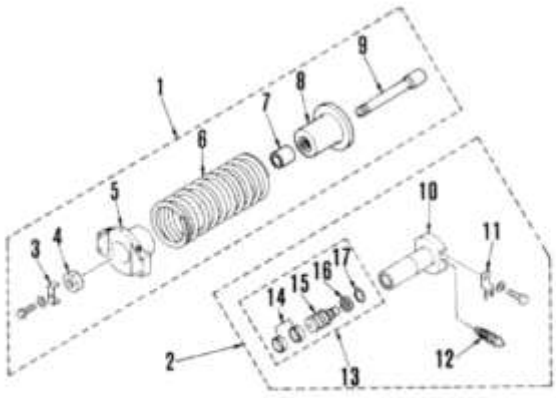
6. Remove recoil spring assembly (1) from tool **A**.
7. Install cylinder assembly (2) in recoil spring assembly (1).
   - ★ Set so that the lubricator mounting position is at the side.
   - ★ When installing the cylinder assembly, check that the piston inside the cylinder is at the outside end face of the cylinder.



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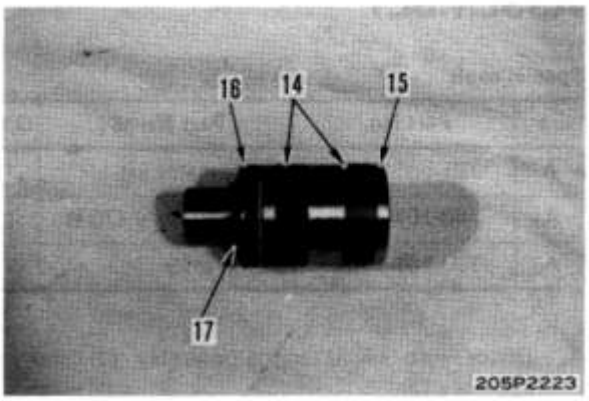

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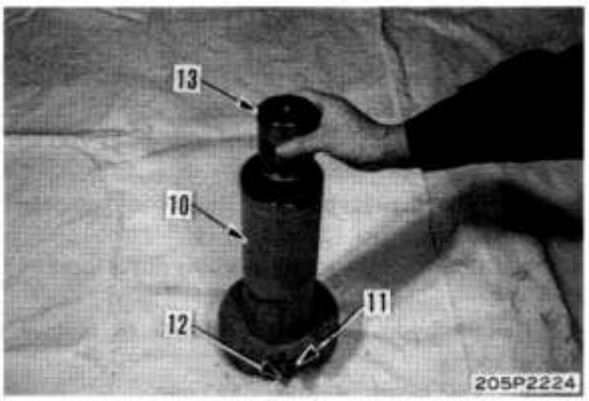

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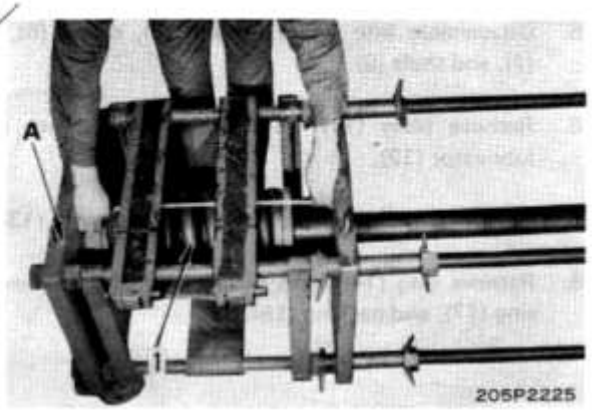

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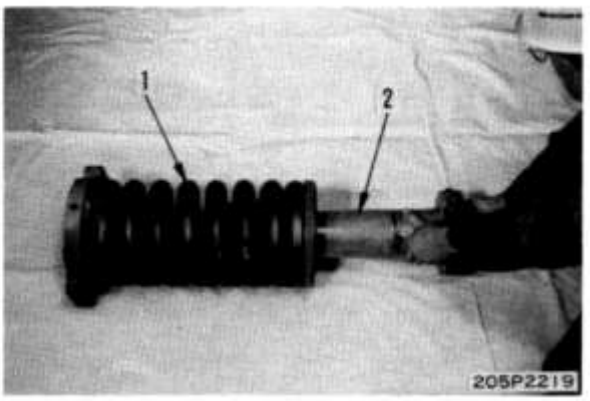

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REMOVAL OF TRACK ROLLER ASSEMBLY

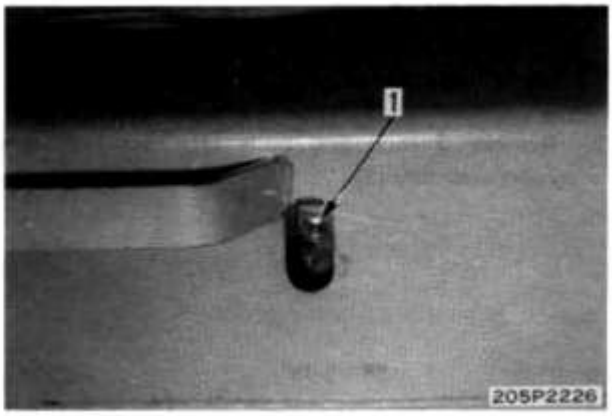
1. Lower the work equipment completely to the ground. Loosen lubricator (1) to relieve track tension.

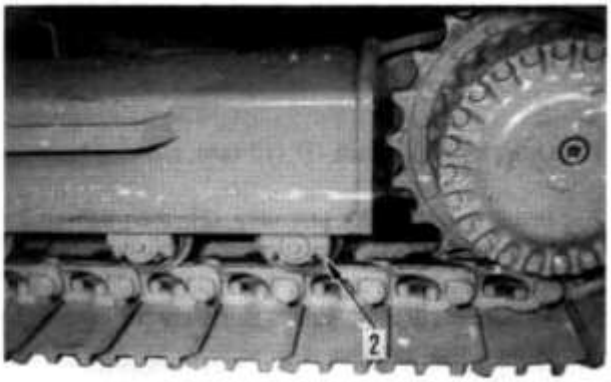
   The adjustment cylinder is under extremely high pressure. Never loosen the lubricator more than one turn. If the track tension is not relieved, move the machine backwards and forwards.

2. Remove 4 mounting bolts (2) of track roller.

3. Use work equipment to raise machine, then remove track roller assembly (3).

   kg Track roller assembly: 40 kg





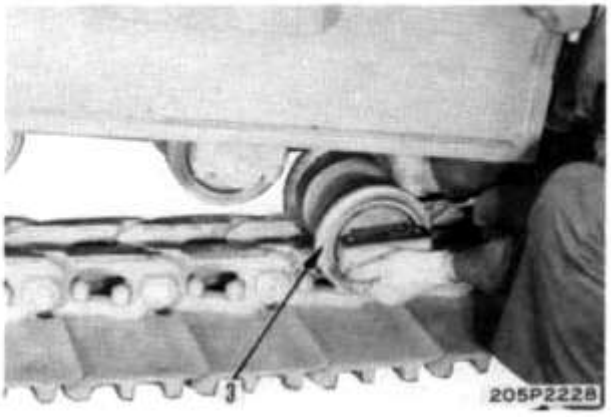
INSTALLATION OF TRACK ROLLER ASSEMBLY

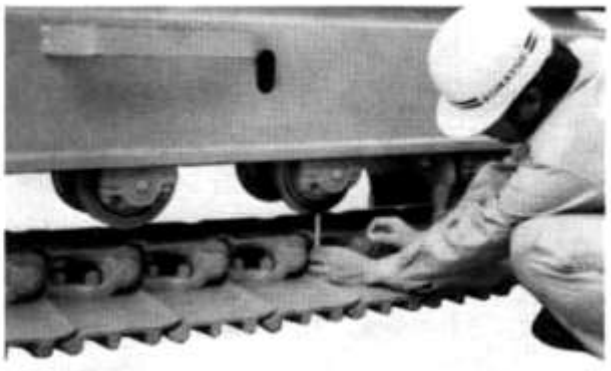
1. Set track roller assembly (3) on track link.
   * Set the track roller with the oil filler plug on the outside.

2. Use work equipment to raise boom, then partially tighten mounting bolts (2).

3. Lower machine completely to ground, then fully tighten mounting bolts (2).

4. Install lubricator (1), then pump in grease to adjust track tension.
   * Adjust the track tension to give a clearance of 60 – 100 mm between the contact surfaces of the track link and track roller at the 4th roller from the sprocket when the track is raised from the ground.

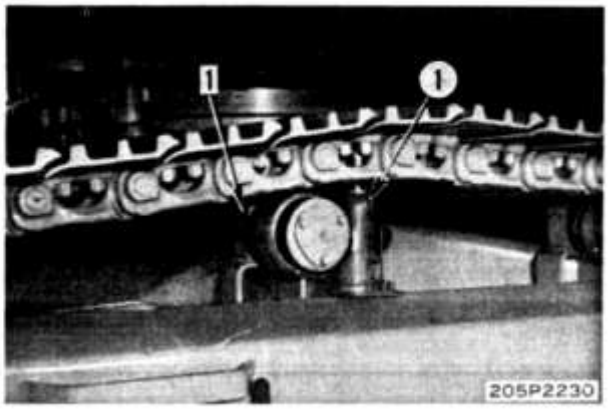




REMOVAL OF CARRIER ROLLER ASSEMBLY

1 Using hydraulic jack ① (10 ton), push up track.

2. Remove 2 mounting bolts (1), then remove carrier roller assembly (2).



INSTALLATION OF CARRIER OLLER ASSEMBLY

1. Using hydraulic jack ① (10 ton), push up track.

2. Install carrier roller assembly (2), then tighten 2 mounting bolts (1).

3. Release hydraulic jack ① slowly to return track to original position.

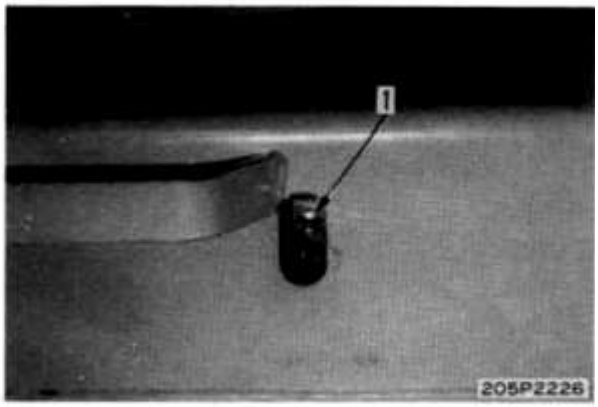
REMOVAL OF TRACK SHOE ASSEMBLY

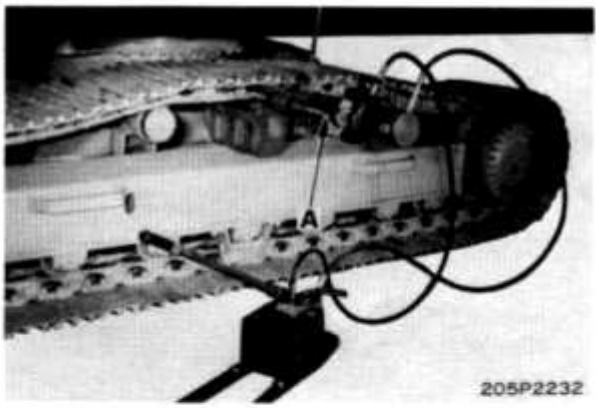
Special tools

	Part No.	Part Name	Q'ty
A	791-630-3000	Remover & installer	1
A_1	790-101-1300	Cylinder (100 ton)	1
A_2	790-101-1102	Pump	1

1. Stop machine with master pin midway between idler and carrier roller.
   - ★ Make sure that there is enough space to lay out the track shoe behind and in front of the machine.
2. Lower the work equipment completely to the gound. Loosen lubricator (1) to relieve track tension.

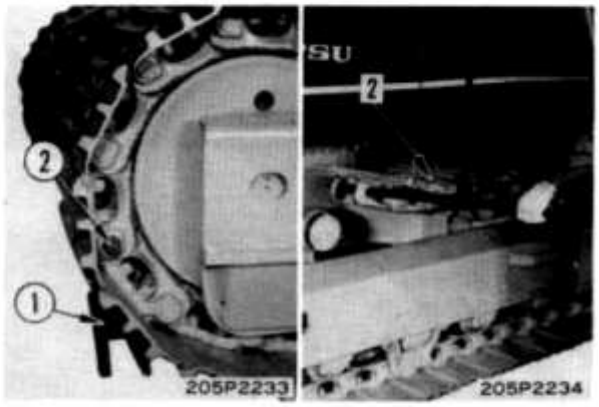
   The adjustment cylinder is under extremely high pressure. Never loosen the lubricator more than one turn. If the track tension is not relieved, move the machine backwards and forwards.
3. Using tool **A**, remove master pin.
4. Remove tool **A** and move machine forward so that temporary pin is in front of idler, then set block ① in position.
5. Remove temporary pin ② and move machine in reverse to remove track (2).





INSTALLATION OF TRACK SHOE ASSEMBLY

1. Position track under track frame, fit link bushing in sprocket, then move machine slowly forward to wind on track (2).
   - ★ Assemble the track with the link bushing at the front.
2. Set block ① in position, assemble dust seal (3) on link, then insert temporary pin ②.
3. Move machine in reverse, and stop when temporary pin is midway between idler and carrier roller.
4. Using tool **A**, press fit master pin.
5. Install lubricator (1), then pump in grease to adjust track tension.
   - ★ Adjust the track tension to give a clearance of 60 – 100 mm between the contact surfaces of the track link and track roller at the 4th roller from the sprocket when the track is raised from the ground.



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UNDERCARRIAGE

10 MAINTENANCE STANDARD

Track frame and Recoil spring …… 10-02

Idler …… …… 10-04

Track roller …… 10-06

Carrier roller ……..…… 10-07

Track shoe …… 10-08

TRACK FRAME AND RECOIL SPRING

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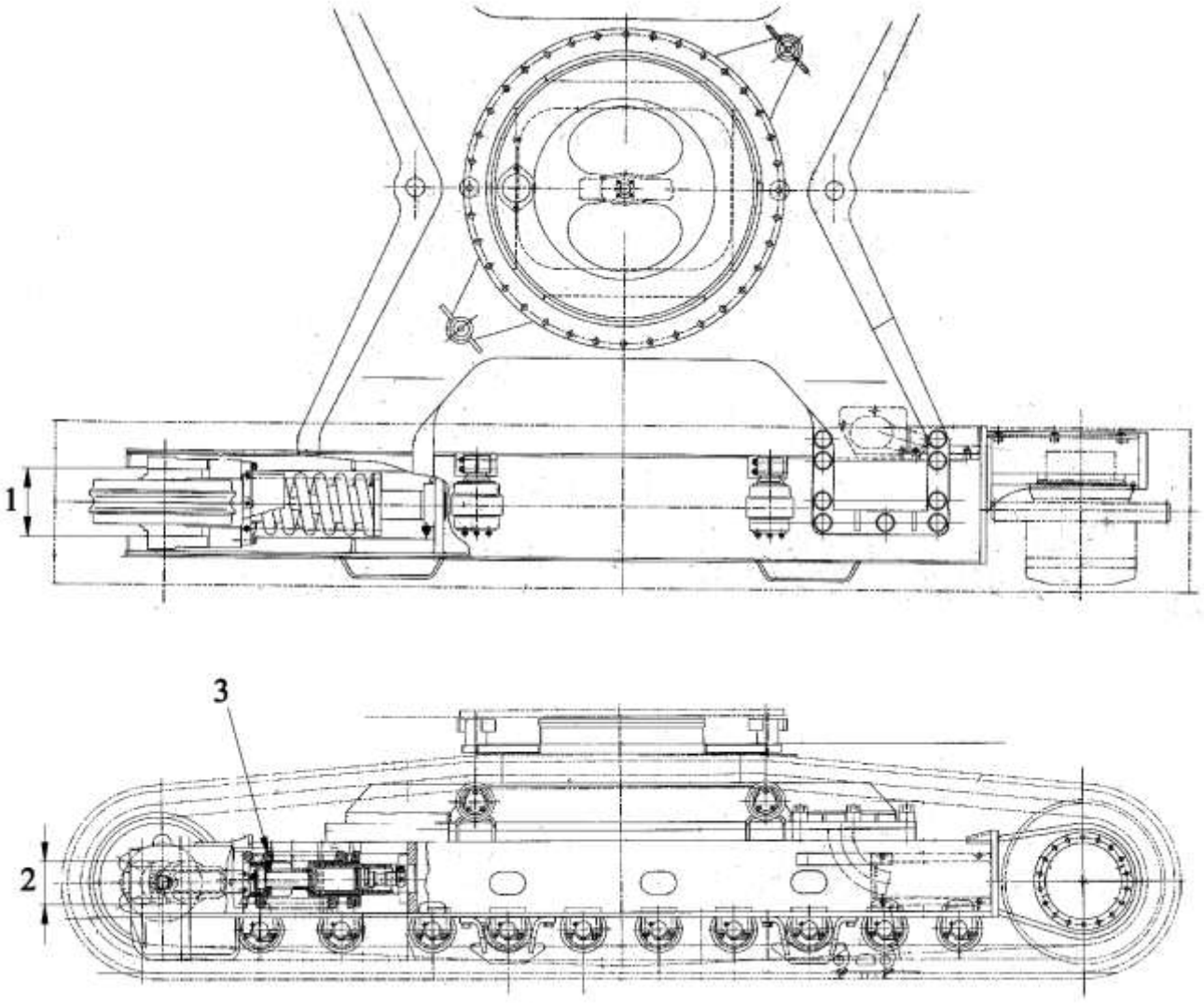
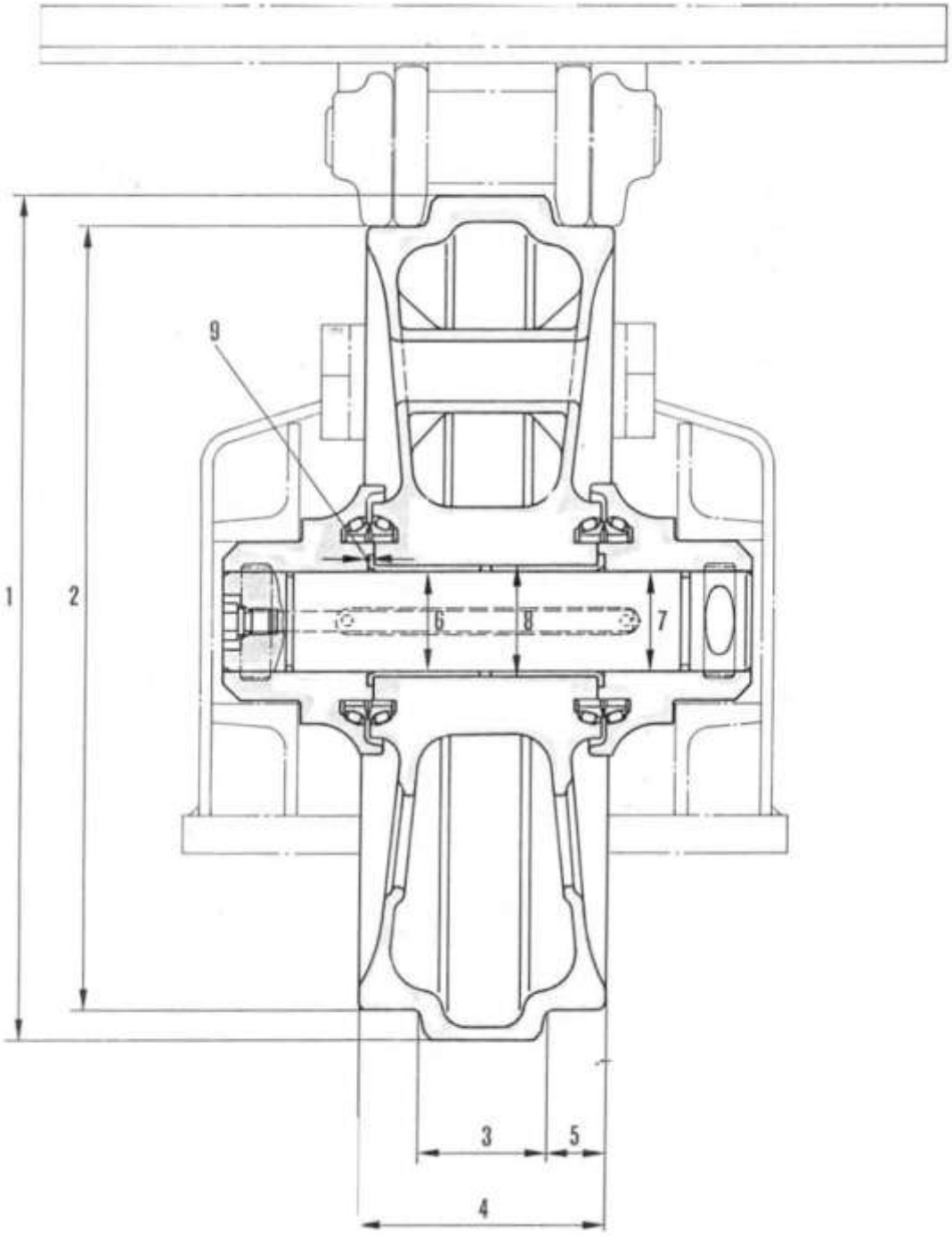


TRACK FRAME AND RECOIL SPRING

No	Check item	Criteria			Remarks
			Standard size	Repair limit	
1	Vertical	Track frame	107	111	Rebuild or replace
		Idler support	105	103	
2	Horizontal Width of idler guide	Track frame	250	255	Rebuild or replace
		Idler support	247	245	
3	Recoil spring	Free length	583	--	Replace
		Installed length	460		
		Installed load	11,700 kg	9,360 kg	

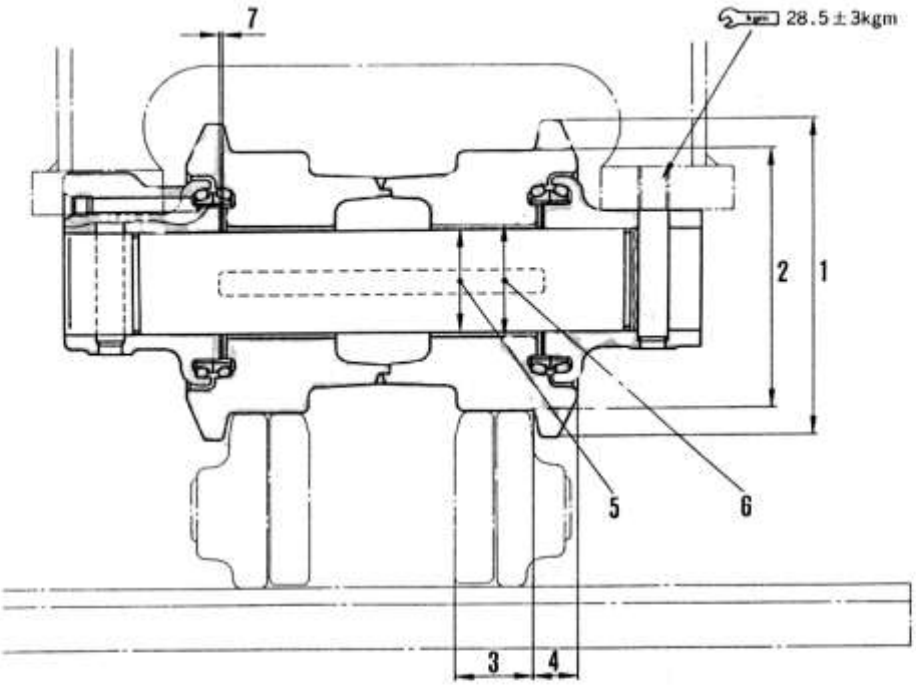
IDLER



Unit : mm

No.	Check item	Criteria					Remedy
		Standard size			Repair limit		
1	Out side diameter of protrusion	560			-		Rebuild or replace
2	Out side diameter of tread	520			508		
3	Width of protrusion	85			73		
4	Total width	164			156		
5	Total of tread	39.5			45.5		
		Standard size	Tolerance		Standard clearance	Clearance limit	Replace bushing
			shaft	hole			
6	Clearance between shaft and bushing	65	-0.250 -0.350	+0.074 - 0.036	0.214 - 0.424	1.5	
7	Clearance between shaft and support	65	-0.250 -0.290	-0.110 -0.220	0.036 - 0.180	-	Replace
		Standard size	Tolerance		Standard Interference	Interference limit	Replace bushing
			shaft	hole			
8	Interference between idler and bushing	72	-0.089 -0.059	-0.006 -0.072	0.065 - 0.161	-	
		Standard clearance			Clearance limit		
9	Side clearance of idler (each)	0.165 - 0.395			1.5		
10	Tightening torque of oil filler plug	21 ±5 kgm					Tighten

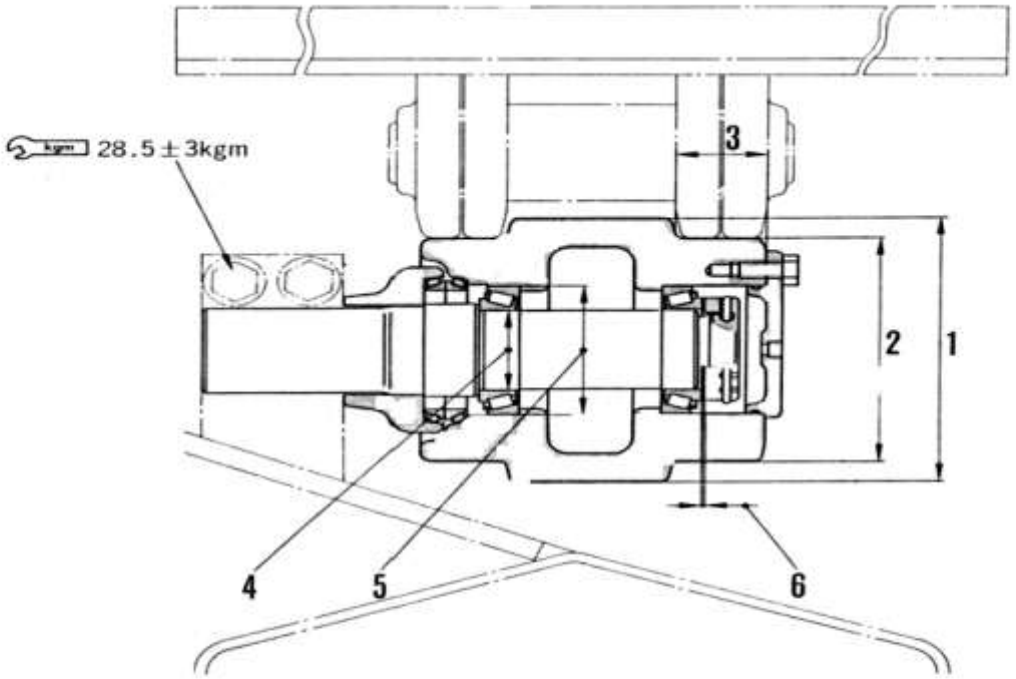
TRACK ROLLER



Unit : mm

No.	Check item	Criteria					Remedy
		Standard size			Repair limit		
1	Out side diameter of flange (out side)	188			-		
2	Out side diameter of tread	156			144		Rebuild or replace
3	Width of tread	44.5			62		
4	Width of flange	25.5			-		
		Standard size	Tolerance		Standard clearance	Clearance limit	Replace bushing
			shaft	hole			
5	Clearance between shaft and bushing	60	-0.215 -0.315	+0.196 0	0.215 - 0.510	1.5	
		Standard size	Tolerance		Standard Interference	Interference limit	Replace bushing
			shaft	hole			
6	Interference between roller and bushing	67	-0.153 -0.053	-0.030 0	0.023 - 0.153	-	
		Standard clearance			Clearance limit		Replace
7	Side clearance of roller (both)	0.41 - 0.95			1.5		

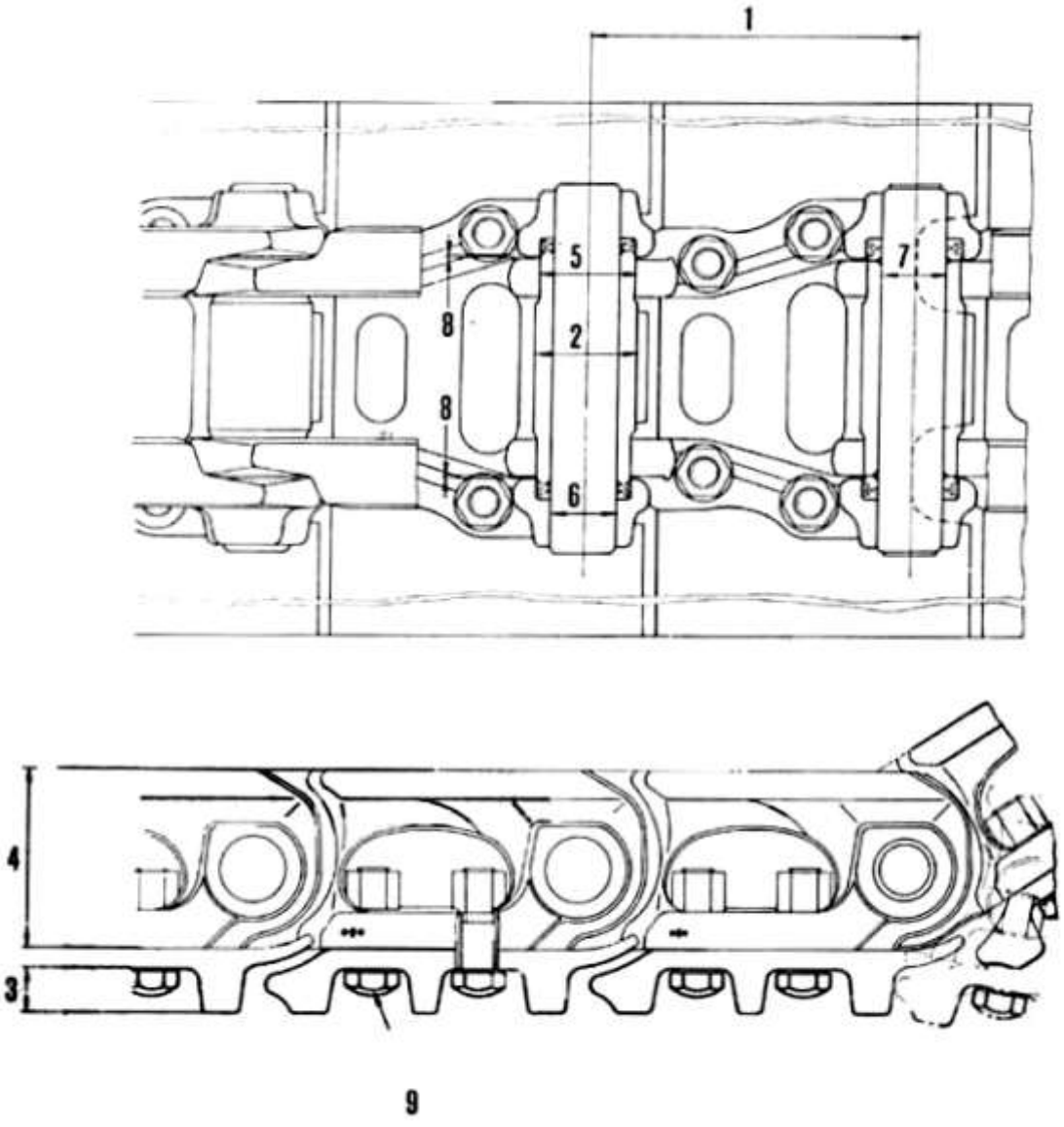
CARRIER ROLLER



Unit : mm

No.	Check item	Criteria					Remedy
		Standard size			Repair limit		
1	Out side diameter of flange (out side)	165			-		
2	Out side diameter of tread	140			128		Rebuild or replace
3	Width of tread	43			50		
		Standard size	Tolerance shaft	Tolerance hole	Standard clearance	Clearance limit	
5	Clearance between shaft and bushing	60	0 -0.016	0 -0.012	0.012 - 0.018	-	
		Standard size	Tolerance shaft	Tolerance hole	Standard Interference	Interference limit	
6	Interference between roller and bushing	80	0 -0.013	-0.021 -0.051	0.008 - 0.061	-	Replace bushing
		Standard clearance			Clearance limit		
7	Side clearance of roller	0 - 0.18			1.5		

TRACK SHOE



TRACK SHOE

Unit : mm

No.	Check item	Criteria					Remedy
		Standard size			Repair limit		
1	link pitch	190.25			193.25		Turn or replace
2	Out side diameter of bushing	59.48			56.48		
3	Height of grouser	Triple : 26			15		lug welding rebuild or replace
4	Height of link	105			97		rebuild or replace
		Standard size	Tolerance		Standard Interference	Interference limit	
			shaft	hole			
5	Interference of bushing and link	55	+0.304 +0.264	+0.074 0	0.190 - 0.304	0.1	Replace
6	Interference of pin and link	Shaft: 38 Hole : 37.8	+0.172 +0.072	+0.062 0	0.210 - 0.372	0.14	
7	Interference of master pin and link	37.8	+0.230 +0.200	+0.062 0	0.138 - 0.230	0.08	Replace with longer one
		Standard clearance (one side)		Standard clearance (both side)		Clearance limit (both side)	
8	Side clearance of bushing	0 - 0.9		0 - 1.8		—	
9	Tightening torque of shoe bolt	Initial tightening torque : 40 ±4 kgm Additional tightening angle : 120 ±10°					Tighten

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HYDRAULIC SYSTEM

11 STRUCTURE AND FUNCTION

Hydraulic Piping 11-02

Hydraulic schematics 11-03

Hydraulic circuit diagram 11-03

Hydraulic tank 11-03

Main pump 11-04

Hydraulic control valve 11-04

Accumulator 11-05

Hydraulic cylinder 11-06

Work equipment 11-09

Attachment list 11-10

HYDRAULIC PIPING

- Hydraulic pumps driven by this engine consist of two main pumps (variable displacement piston type) and one charging pump (gear pump type).
  The main pumps deliver the oil from the hydraulic tank to the control valves, while charging pump delivers the oil to the solenoid valve and to the PPC valve (or in-line servo valve).
- When the OLSS system is used, the main pumps help save energy and keepthe hydraulic pressure loss to minimum.
- The travel, steering and work equipment operations are all hydraulically controlled by operating the corresponding hydraulic motor and hydraulic cylinder, when control lever in the operators cab is operated to change the oil flow in circuit
- Each control valve has a main relief valve, a safety valve, and a suction valve.
- The main relief valve is in the circuit between the hydraulic pump and the control valve, it keeps the maximum pressure of the oil delivered from the hydraulic pump at the preset value.
- The safety valve,located in the circuit between the control valve and the actuators (hydraulic motor, hydraulic cylinder, etc.), protects the hydraulic equipment from external overloading when the control valve is in NEUTRAL, and ensures operational safety.
- The suction valve prevents the occurrence of negative pressure in the circuit.
- In addition, an oil cooler is provided in the hydraulic circuit to prevent the oil from getting too hot and to minimise the degradation of the oil.
- The oil flows in the circuit in one direction. All of the oil passes through a filter in the tank in order to protect theequipment.
- Each boom and arm circuit forms a two-pump merged circuit. When the arm and the swing operations are performed concurrently, the arm circuit from one of the pumps is restricted so that the swing circuit is given priority.
- The auto-deceleration system (if equipped) helps save energy by automatically decelerating the engine while the control levers are in neutral.

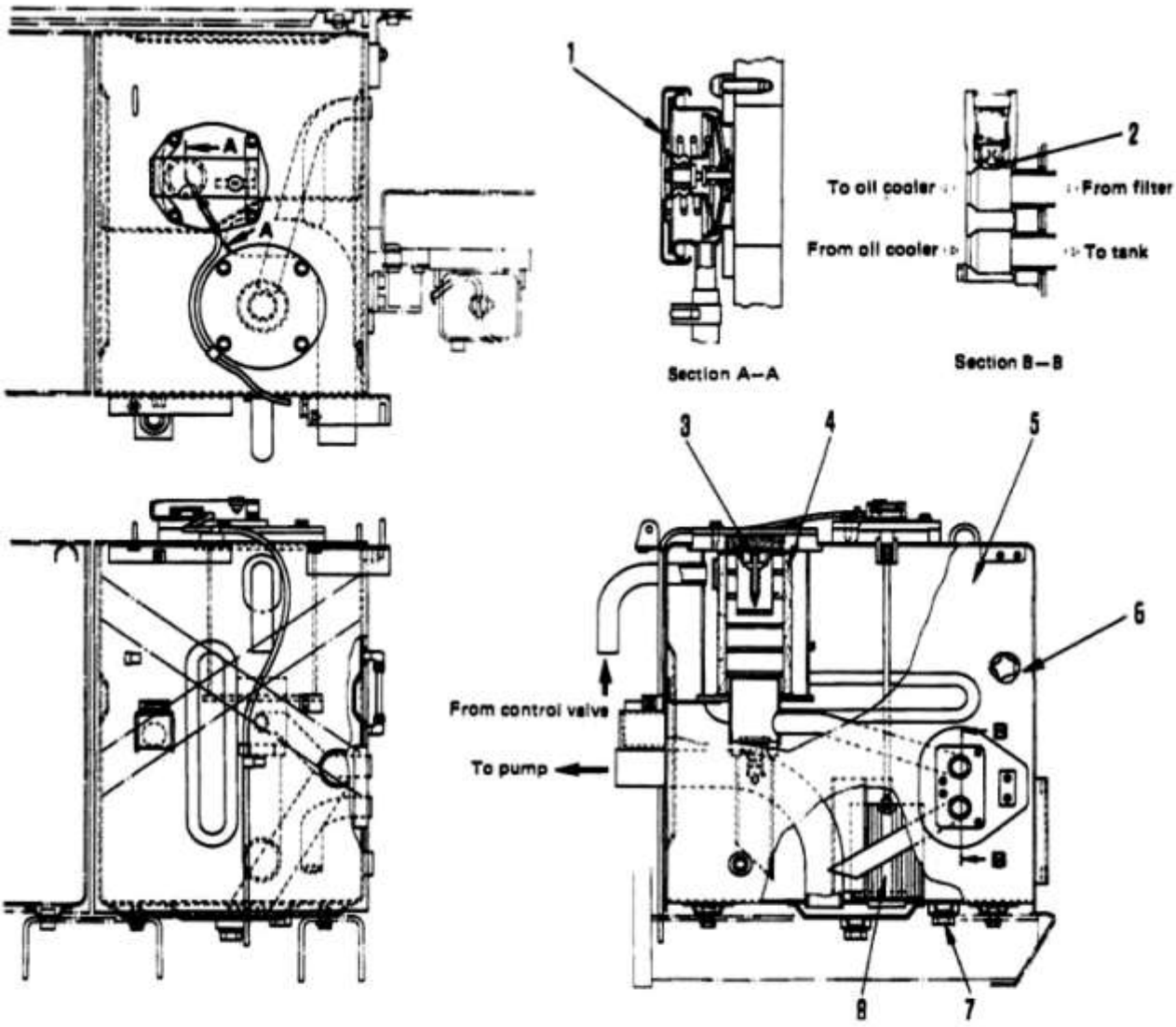
HYDRAULIC SCHEMATICS

★ Refer Rexroth Instruction Manual of HS-64-05-E0403-1-3

HYDRAULIC CIRCUIT DIAGRM

★ Refer Rexroth Instruction Manual of HS-64-05-E0403-1-3

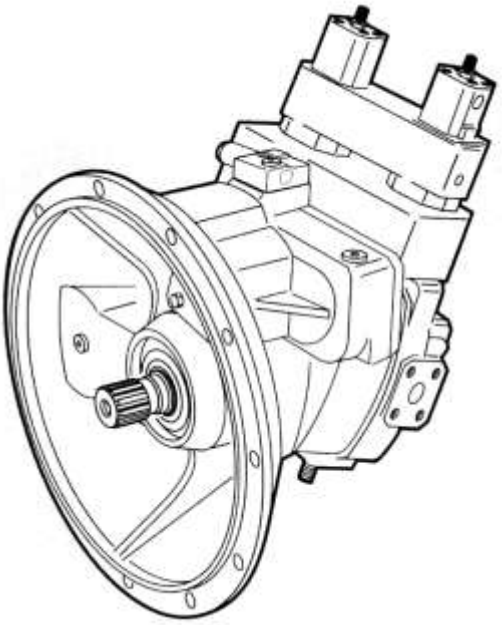
HYDRAULIC TANK



1. Filler cap (with lock device (if equipped)
2. Bypass check valve
3. Bypass valve
4. Filter element
5. Tank
6. Sight-gauge
7. Drain plug
8. Strainer

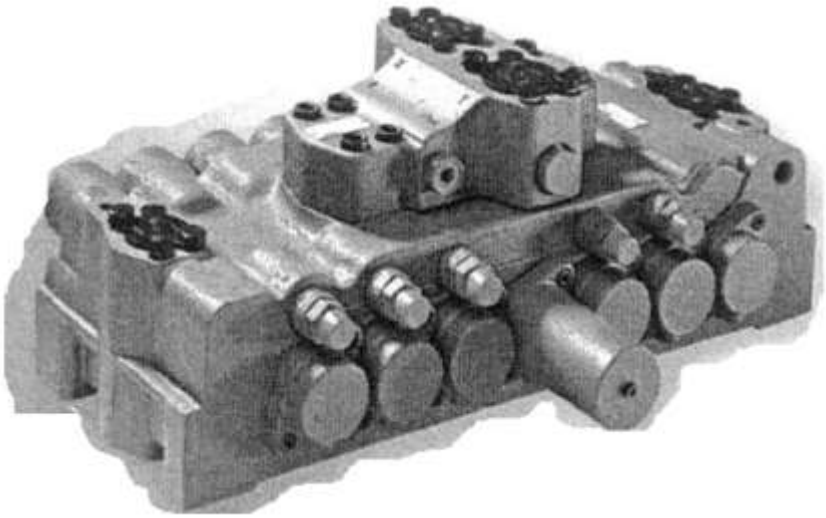
MAIN PUMP

★ Refer Rexroth Instruction Manual of HS-64-05-E0403-1-3



HYDRAULIC CONTROL VALVE

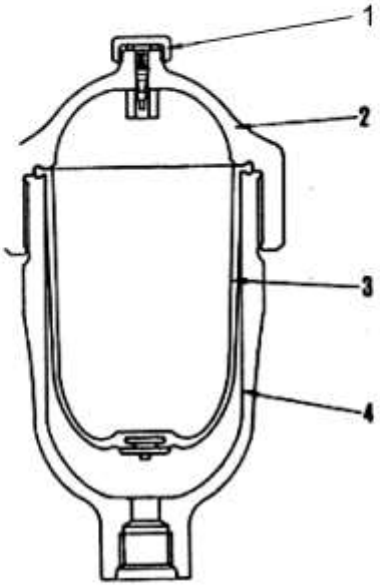
★ Refer Rexroth Instruction Manual of HS-64-05-E0403-1-3



ACCUMULATOR

FUNCTION

- The accumulator uses a flexible rubber bag (3) containing nitrogen (N_2) gas to maintain the hydraulic oil pressure.



1. Cap
2. Cover
3. Rubber bag
4. Body

OPERATION

- When the PPC valve is at neutral, the chamber A in the rubber bag (3) (nitrogen gas capacity : 480 cc) is compressed by the oil pressure in chamber B.

(Fig. 1)

- As oil pressure in chamber B lowers to 30 kg/cm^2 or below when relieving residual pressure, the rubber bag (3) expands due to the nitrogen. The working pressure is 12 to 30 kg/cm^2.

(Fig. 2)

Nitrogen is sealed in the rubber bag

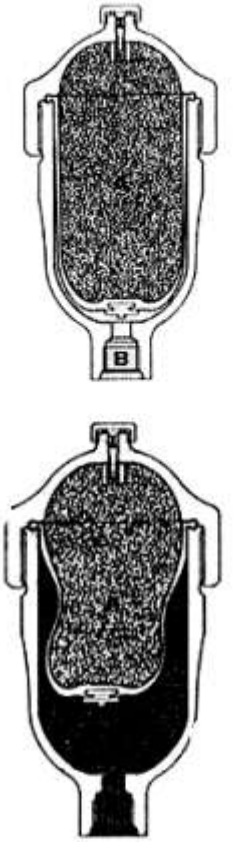


Fig. 1

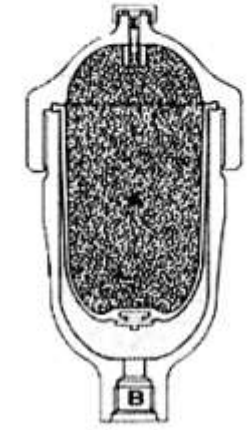
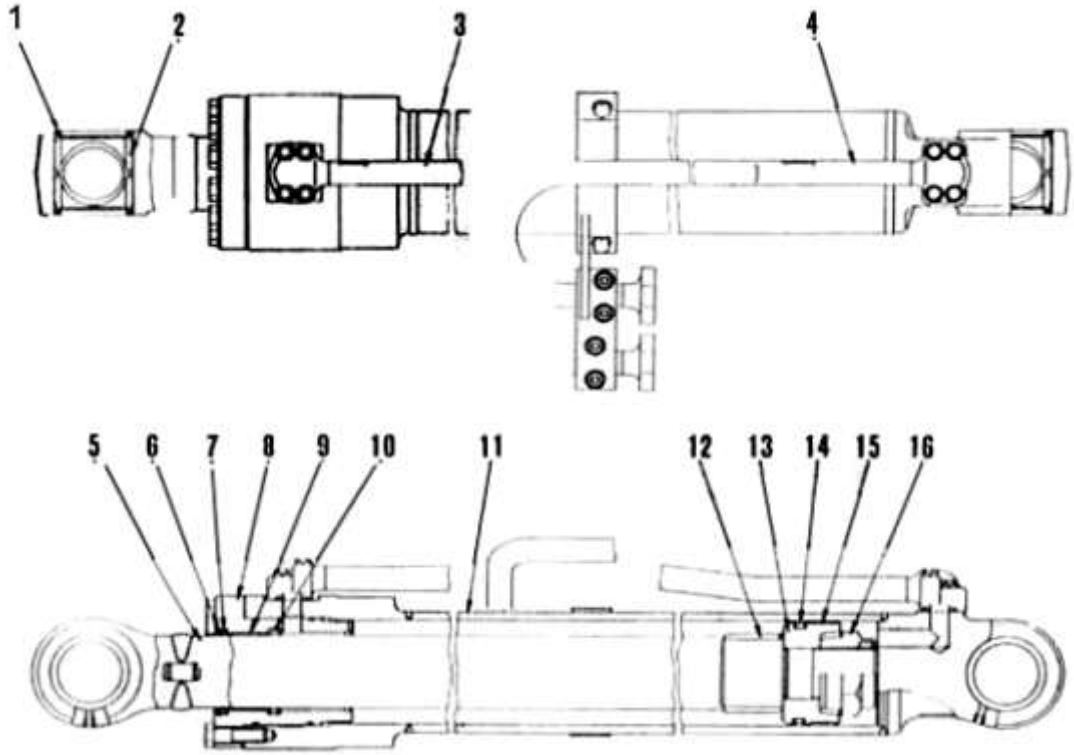


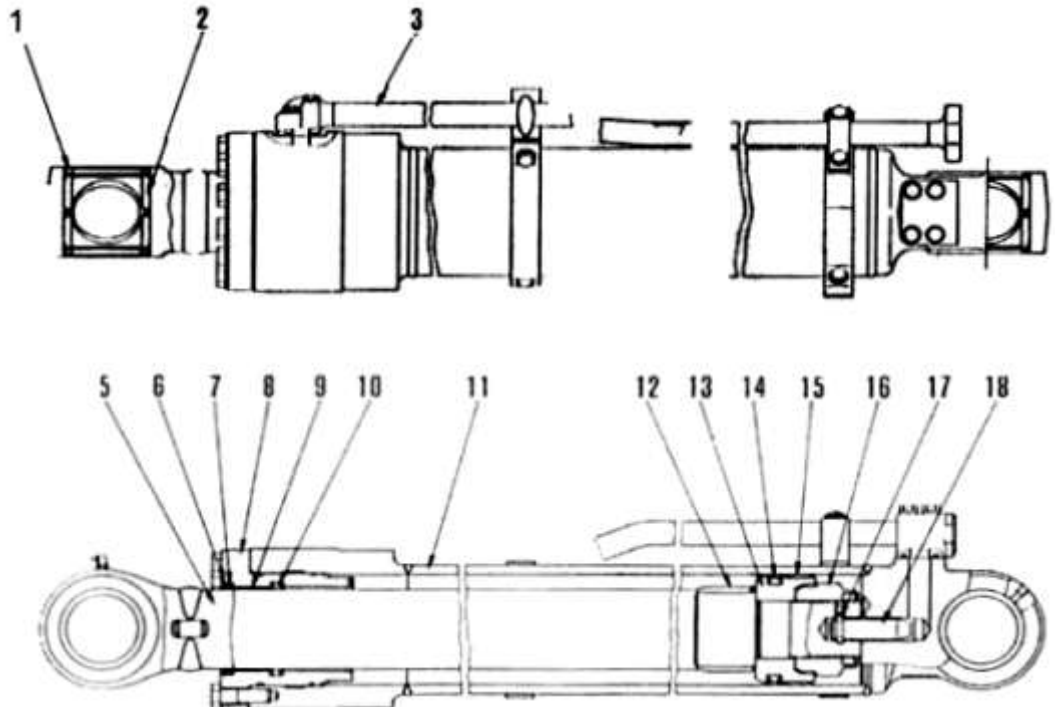
Fig. 2

HYDRAULIC CYLINDER

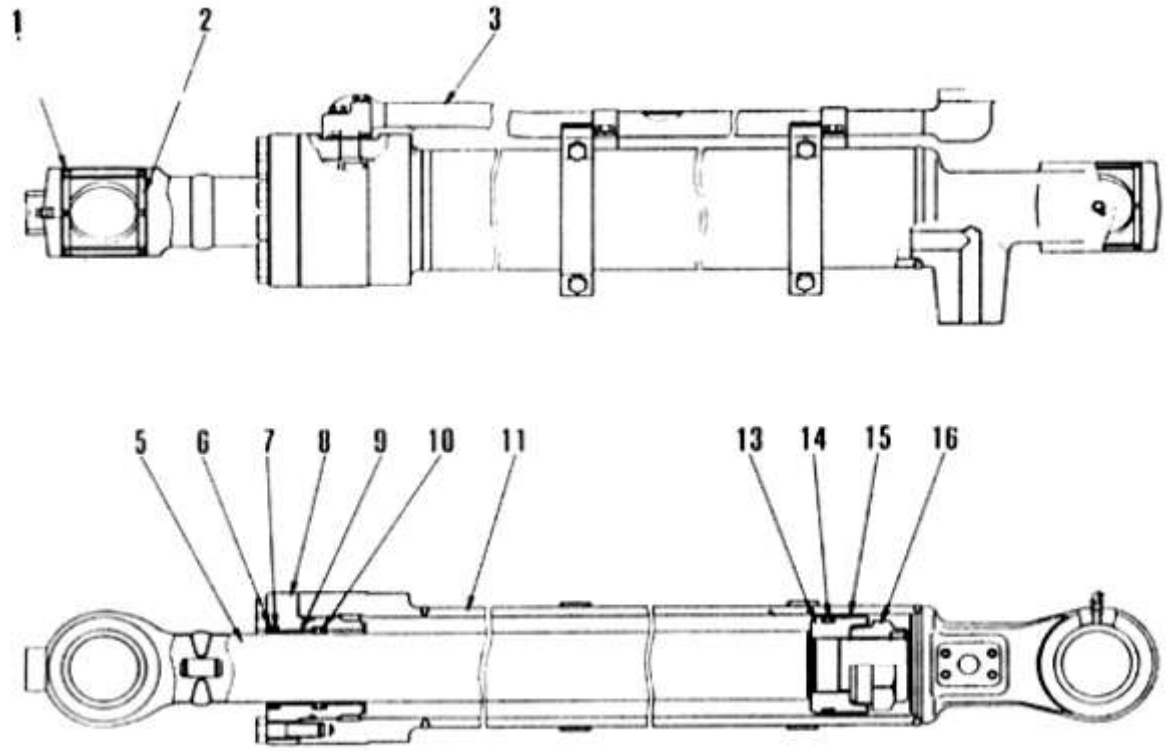
1. Boom Cylinder



2. Arm Cylinder



BUCKET CYLINDER



1. Dust seal
2. Bushing
3. Head side tube
4. Bottom side tube
5. Piston rod
6. Snap ring
7. Dust seal
8. Cylinder head
9. Bushing
10. Rod packing
11. Cylinder
12. Plunger
13. Piston
14. Slipper seal
15. Wear ring
16. Piston nut
17. Ball
18. Plunger

Unit : mm

Item	Boom	Arm	Bucket
Rod O.D	90	100	90
Cylinder I.D	130	140	130
Stroke	1234	1628	989
Max. length	3020	3825	2575
Min. length	1786	2197	1586
Piston nut width across flats	95	95	95

CUSHION CYLINDER: For Boom Cylinder Head & Arm Cylinder Head & Bottom sides

1. PURPOSE

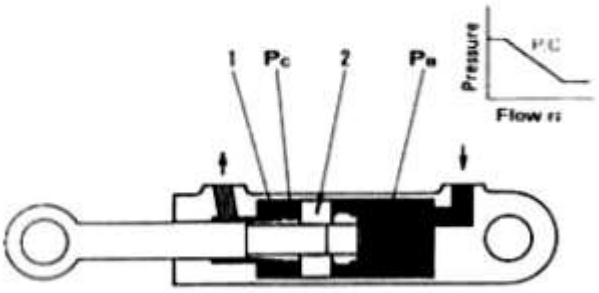
- Reducing the piston striking speed at the stroke ends alleviates the shock loads on the chassis, contributing to improved productivity and performance reliability.
- The piston striking sound is reduced.
- Durability of cylinders and their piping is improved, resulting in high operational safety and reliability.

2. FEATURES

- The construction is simple, yet a large decelerating effect is ensured.
- There is a cylinder aligning effect resulting in high durability and performance reliability of cylinders.

3. Operating principle

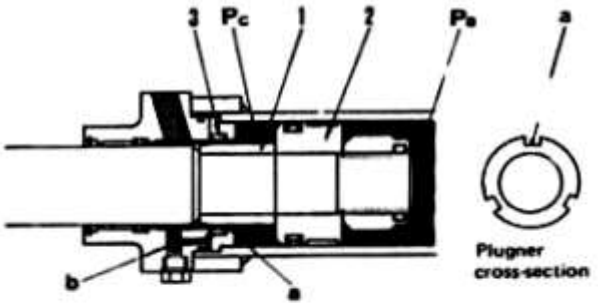
- If piston (2) approaches the stroke end, causing a cushion plunger (1) to throttle oil, the cushion pressure Pc goes up.
  Consequently, Pa also goes up. In a variable displacement pump, the flow rate is decreased along a PC curve, causing the piston speed to slow down.
  Further, if Pa continues going up, exceeding the main relief pressure setting, the cylinder speed is reduced more, resulting in a sufficient cushioning (shock absorbing) effect.



4. OPERATION

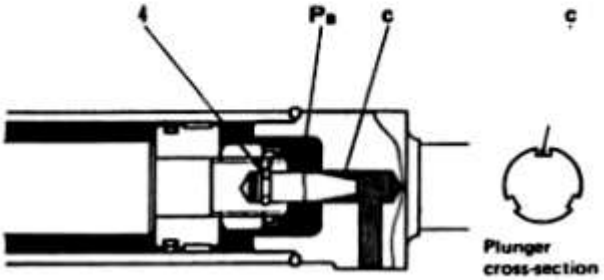
In boom cylinder head and arm cylinder head

- When the piston (2) approaches its stroke end, the plunger (1) enters the cylinder head, causing oil to be confined in chamber Pc. Then, the oil in chamber Pc flows from the cylinder head section through slits a (3 slits) around the plunger and restrictor b. This cushioning effect plus a reduced delivery from a variable displacement pump responding to the pressure variation in chamber Pa ensures a thorough shock absorbing effect for the boom cylinder.

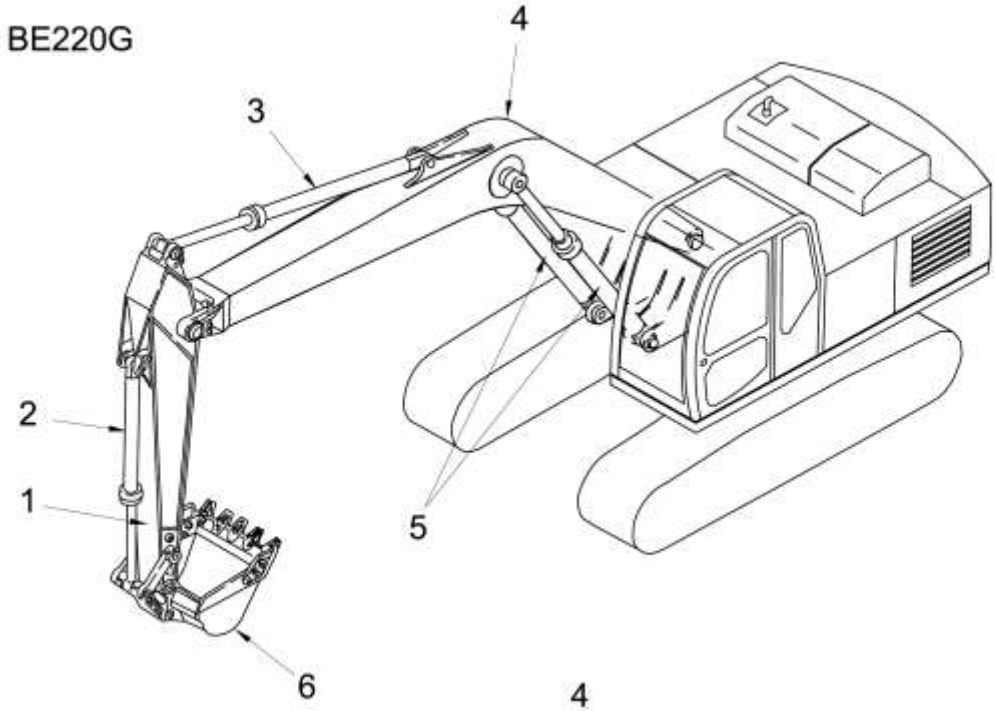


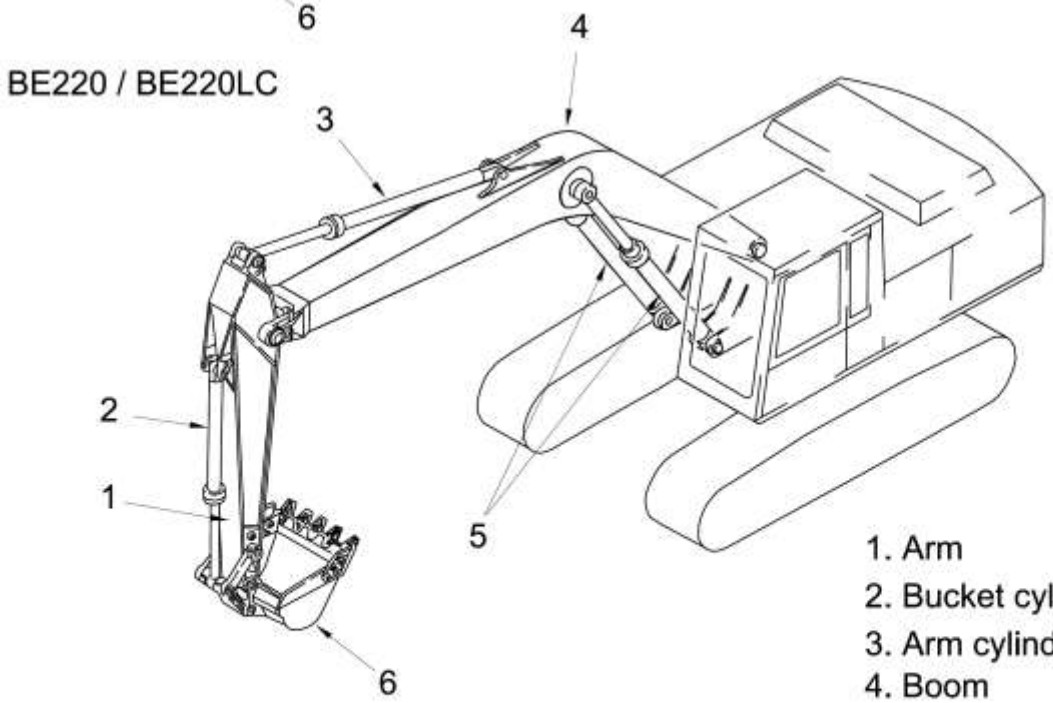
In arm cylinder bottom

- Similarly in the boom cylinder head, the oil in chamber Pa is confined and the shock absorbing effect is available through slits C (3 slits) around the plunger. Steel balls (4) aid the plunger in its self-alignment.



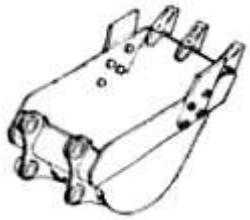
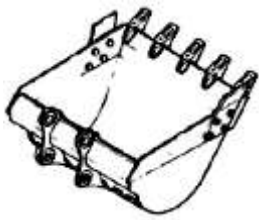
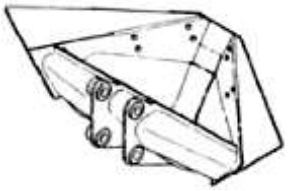
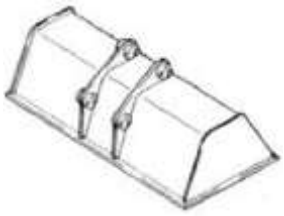
WORK EQUIPMENT



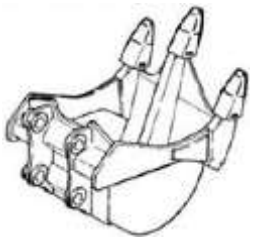
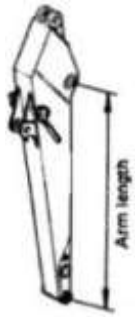


1. Arm
2. Bucket cylinder
3. Arm cylinder
4. Boom
5. Boom cylinder
6. Bucket

ATTACHMENT

Name	Style	Application	Specification	
Narrow Bucket		Used for digging narrow trenches or for digging hard ground beyond ability of standard bucket	Capacity SAE (m³)	0.72
			Bucket width (mm)	1005
			Weight (kg)	
			Reversible	Yes
Light-duty Bucket		Used for loading a large quantity of relatively light material	Capacity SAE (m³)	1.12
			Bucket width (mm)	1405
			Weight (kg)	911
			Reversible	Yes
Trapezoidal Bucket		Used for digging trapezoidal channels in farms and paddy fields	Capacity SAE (m³)	0.5
			Ditching angle (deg.)	45
			Bucket width (mm)	--
			Weight (kg)	830 (incl. side plate 220 kg)
Slope finishing Bucket		Suitable for slope forming work	Compaction area (m³)	
			Compaction width (mm)	
			Capacity (m³)	
			Weight (kg)	
Clamshell Bucket		Suitable for digging and loading work in a restricted spot such as bridge girder foundation digging work	Capacity SAE (m³)	Loading type - 0.60
			Bucket width (mm)	866
			Operating width (mm)	1,782
			Weight (kg0	1,140
			Rotation type	360° manual slide
			Opening time (sec.)	2.0
			Closing time (sec.)	1.2

ATTACHMENT

Name	Style	Application	Specification		
Ripper Bucket		Used for digging hard ground rock bed and pavements	Capacity SAE (m^3)		
			Bucket width (mm)		
			Weight (kg)	935	
			Reversible	No	
Ripper		Suitable for digging rocks and pavements and tree roots		1-shank	3-shank
			Shank width (mm)	76	53.5
			Ripper digging force (Bucket) (kg)	15,400	15,500
			Weight (kg)	363	620
Short arm		Suitable for digging on general purpose	Arm length (Overall) (mm)	2,000	
			Maximum digging depth (mm)	5670	
			Weight (kg)	671	
Long arm		Used for deep excavation work	Arm length (mm)		
			Maximum digging depth (mm)	7,160	
			Weight (kg)		

Attachment name	Standard arm 2.5m	Short arm 2.0 m	Long arm 3.05 m 3.5 m
Narrow bucket (bucket width 1005 mm)	○	○	○
Standard bucket (bucket width 1250 mm)	○	○	△
Light-duty bucket (bucket width 1405 mm)	△	△	X
Light-duty bucket (bucket width 1505 mm)	△	△	X
Slope finishing bucket	○	○	○
Trapezoidal bucket (bucket width 3370 mm)	○	○	
Ripper bucket (bucket width 950 mm)	○	○	X
Clamshell bucket (bucket width 864 mm)	○	○	○
T-shank ripper	○	○	X

○: For normal operation, △: For light-duty operation, X: Un-attachable

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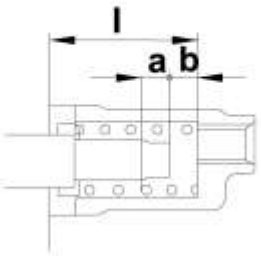
HYDRAULIC SYSTEM

12 TESTING AND ADJUSTING

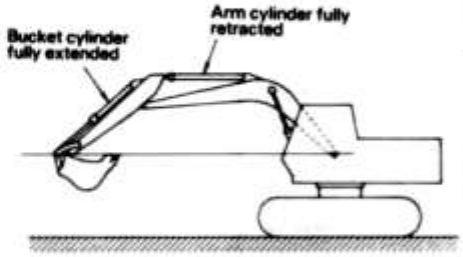
Table of judgement standard valve	12-02
Measuring hydraulic oil temperature	12-13
Air bleeding	12-14
Testing and adjusting main relief valve	12-14
Testing pressure of control circuit	12-14
Testing oil leak from swivel joint	12-15
Measuring oil leakage from swing, travel motor ..	12-17
Checking and adjusting travel motor performance	12-18

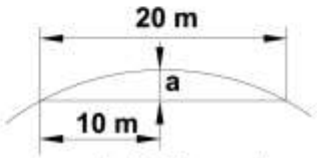
TABLE OF JUDGEMENT STANDARD VALUE

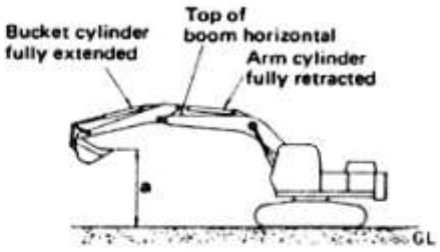
* **Standard value and permissible value in following table are the value when 2-stage mode selector switch is at S position**

Classi-fication	Item	Condition	Standard value	Permisable value
Enine speed (rpm)	Engine low idling speed	• Engine oil pressure: in correct range	730 - 830	Min. 2150
	Engine high idling speed	• Engine water temparature : in correct range	2250 - 2350	
	Engine speed when one or two main pump circuit oil is relief	• Hydraulic oil tempareture : 45 - 55°C • Engine coolant temparature : in correct range • Engine oil pressure: in correct range • At one pump relief: Bucket circuit relief • At two pump relief: Bucket and arm circuit relief	2150 - 2250	
	Engine reted speed		2100	
	Engine speed when auto deceleration acts. (If equipped)	• Fuel control lever at " FUll " • Work equipment control lever at " Neutral "	1200 ± 50	1200 ± 50
Spool travel (mm)	Boom control valve Arm control valve Bucket control valve Swing control valve L.H. Travel control valve R.H. Travel control valve Boom Hi control valve Straight travel valve Service valve		l a b: 35 9.5±05 9.5±05	l a b: 35 9.5±05
Control lever travel (mm)	Boom control lever	• At centre of lever knob: Neutral → Raise and Lower	65 ± 10	65 ± 10
	Arm control lever	• At centre of lever knob: Neutral → Arm IN and OUT	65 ± 10	65 ± 10
	Bucket control lever	• Measure at end of travel: Neutral → Curl and Dump	65 ± 10	65 ± 10
	Swing control lever	• Measure at end of travel: Neutral → RH and LH swing	65 ± 10	65 ± 10
	Travel control lever	• Do not start engine: Neutral → Forward and Reverse	130 ± 15	130 ± 15
	Travel pedal	• Do not start engine: Neutral → Forward and Reverse F	45 ± 20	45 ± 20
		• Do not start engine: Neutral → Forward and Reverse R	40 ± 5	40 ± 5
	Fuel control lever	Stop ⟷ Low idling	45 ± 20	45 ± 20
		Low idling ⟷ Full speed	175 ± 30	175 ± 30

Classi-fication	Item	Condition		Standard value	Permisable value
Control lever operating force (kg)	Boom control	• At engine full speed • Hydraulic oil temperature 45° - 55° C • Hook push-pull scale on center of lever knob measure		3.0 $^{+0.5}_{-0.8}$	3.4
	Arm control			2.5 $^{+0.5}_{-0.8}$	2.7
	Bucket control			2.5 $^{+0.5}_{-0.8}$	2.7
	Swing control			3.0 $^{+0.5}_{-0.8}$	3.4
	Travel control		Lever Forward	2.5 ±1.0	3.8
			Lever Reverse	2.5 ±1.0	3.8
			Pedal Forward	5.5 ±1.1	8.3
			Pedal Reverse	6.0 ±1.2	9
	Fuel control lever		Low idling ⟷ Stop	12.0 $^{+2.0}_{-1.0}$	10
			Low idling ⟷ Full speed	10.0 $^{+3.2}_{-2.0}$	
Hydraulic pressure (kg/cm^2)	Boom circuit	• Hydraulic oil temperature 45° - 55° C • Relief pressure at engine full speed (Be relieved oil in only measuring circuit)		320 $^{+10}_{-6}$	320 $^{+25}_{0}$
	Arm circuit				
	Bucket circuit				
	Travel circuit				
	Swing circuit			297 $^{+15}_{-10}$	275 $^{+25}_{0}$
	Charging circuit			30 $^{+5}_{0}$	
	TVC valve outlet pressure	• Hydraulic oil temperature 45° - 55° C • At engine full speed	Lower at neutral		Min 18
			At one pump relier (320 kg/cm^2) Average pressure of two pump (160-170 kg/cm^2)		16 x 1.5
	NC valve outlet pressure	• Hydraulic oil temperature 45° - 55° C • At engine full speed	Lower at neutral	Max. 7	Max. 7
			Lower at strock end Raise track on one side than rotate sprocket	Max. 18	Max. 18
	Difference pressure jet sensor	• Hydraulic oil temperature 45° - 55° C	Lower at neutral	15 ±1.0	15 ±1.0
		• At engine full speed	Lower at full stroke	Max. 2	Max. 2
	Lowered hydraulic pressure	• Hydraulic oil temperature 45° - 55° C Difference oil relief pressure between at engine full speed and at engine half speed (Measure pressure in one circuit only)		Max. 5	Max. 5

Classification	Item	Condition		Standard value	Permissible value
Air pressure	In hydraulic tank (kg/cm²)	• Hydraulic oil temperature: 45 – 55°C • Open filler cap and run engine for 5 minutes. Fix filler cap and operate work equipment. And position work equipment to measure air pressure in tank.		Max. 0.39	± 0.15
Swing system	Swing brake angle (degree)	 (Fig. 1) • Engine speed: Full speed • Work equipment in posture in Fig. 1 • Hydraulic oil temperature: 45 – 55°C • Bucket unloaded • Braking angle after swing work equipment 180° with boom horizontal, arm cylinder fully retracted and bucket empty. (angle)		85 ± 10	120
	Time taken to start swing (sec.)	• Engine speed: Full speed • Hydraulic oil temperature: 45 – 55°C • Bucket unloaded • Measure time taken for 90° and 180° swing from starting point with work equipment in posture in Fig. 1	90°	3.2 ± 0.3	3.8
			180°	4.6 ± 0.5	5.5
	Time taken to swing (sec.)	• Engine speed: Full speed • Hydraulic oil temperature: 45 – 55°C • Work equipment in posture in Fig. 1 • Measure time taken to swing for 5 turns, after swinging one turn as an approach swing		24 ± 2	30
	Hydraulic drift of swing (mm)	• Engine speed: Stopped • Hydraulic oil temperature: 45 – 55°C • Work equipment in posture in Fig. 1 • Bucket unloaded • Stop the machine on 15° slope and set boom at 90° angle across the slope • Write the mach marks on the swing circle outer race and track frame. After 5 minutes, measure the lag of match marks.		471	471
	Leakage from swing motor (ℓ/min.)	• Engine speed: Full speed • Hydraulic oil temperature: 45 – 55°C • Relieve oil in swing circuit • Measure leakage from swing motor with measuring cylinder		Max. 2.5	4

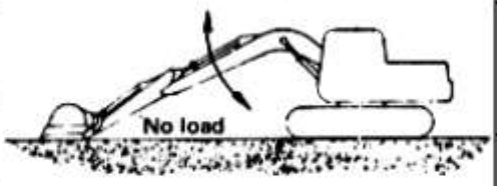
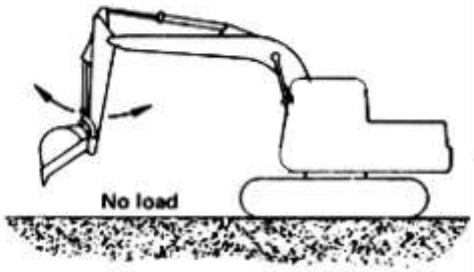
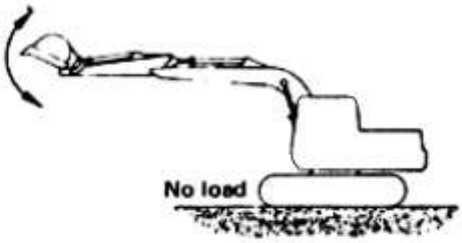
Classi-fication	Item	Condition	Permisable value	
Travel	Travel speed (1) (sec.)	• Engine speed : Full speed • Hydraulic oil tempareture : 45 - 55°C • Raise track on one side, then measure time : taken to rotate for 5 turns after rotating one turn as an approach travel • Repeat same way with track on other side	50^{+5}_{-3}	
	Travel speed (2) (sec.)	• Engine speed : Full speed • Hydraulic oil tempareture : 45 - 55°C • Machine is on level ground • measure time taken to travel for 20 m after travel 10 m as an approach travel	21^{+4}_{-2}	
	Travel deviation (mm.)	 • Engine speed : Full speed • Hydraulic oil tempareture : 45 - 55°C • Run of the machine for about 30 min on firm and level ground. • Lay out a 20 m string from a point 5 - 6 m from the start, and measure the deviation. (a) of the machine at the mid way point (10 m mark)	Max. 200	220
	Hydraulic drift of travel (mm.)	• Engine speed : Stopped • Hydraulic oil tempareture : 45 - 55°C • stop the machine on 12 ° slope with setting sprocket on uphill • Measure the distance moved by the mahine in 5 min.	0	0
	Leakage from travel motor (ℓ / min.)	• Engine speed : Full speed • Hydraulic oil tempareture : 45 - 55°C • Relieve oil in travel circuit with lock track shoe	Max. 3	4

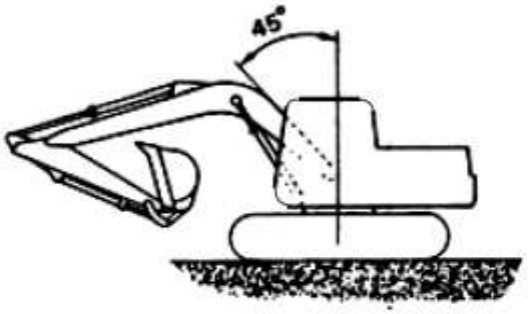
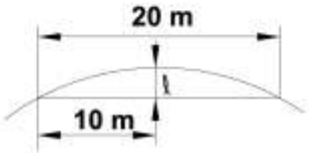
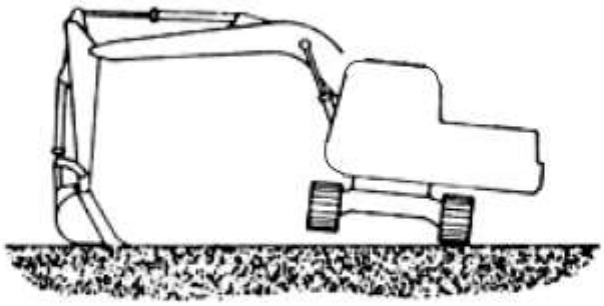
Classi-fication		Item	Condition	Standard value		Permisable value
Work equipment	Work equipment speed	Boom (sec.)	• Engine speed: Full speed • Hydraulic oil temperature 45° - 55° C • Bucket unloaded • Arm and bucket cylinder fully retracted • Measuring time taken from bucket tooth touching the ground to cylinder fully extended (RAISE) • Measuring time taken from cylinder fully extended bucket tooth touching the ground (LOWER)	RAISE		4.1
				LOWER		4.2
		Arm (sec.)	• Top of boom is in horizontal, and bucket cylinder fully retracted • Measure time taken from cylinder fuuly retracted position to cylinder fully extended position (IN) • Measure time taken cylinder fuuly extended position to cylinder fully retracted position (OUT)	IN		5.9
				OUT		3.9
		Bucket (sec.)	• Top of boom is in horizontal, and bucket cylinder fully extended • Measure time taken from cylinder fuuly retracted position to cylinder fully extended position (CURL) • Measure time taken cylinder fuuly extended position to cylinder fully retracted position (DUMP)	CURL		5.0
				DUMP		3.6
	Hydraulic drift	Total work equipment (mm)	 (Fig. 2) • Engine speed: full speed • Hydraulic oil temperature 45° - 55° C • Bucket unload • Work equipment in posture in Fig.2 • Measure amount bucket tooth moved down (distance "a") in 15 min. • Measure immediately after setting	Max. 600		Max. 960
		Boom cylinder (mm)		Max. 30		Max. 45
		Arm cylinder (mm)	• Measure amount each cylinder retracted in 15 min.	Max. 110		Max. 165
		Bucket cylinder (mm)		Max. 20		Max. 20

Classi-fication		Item	Condition	Standard value	Permisable value
Work equipment	Time lag	Boom (sec.)	• Engine speed: Low idling • Hydraulic oil temperature 45° - 55° C • Bucket unloaded • Arm and bucket cylinder fully retracted • Measuring time taken from bucket tooth touching the ground to the machine raised	0	1.2 (Time lag is 0 sec, run the engine at min 1500 rpm)
		Arm (sec.)	• Top of boom is in horizontal, bucket cylinder fully retracted • Measure time taken from arm stopped when arm came into vertical to arm moved again	0	2.8 (Time lag is 0 sec, run the engine at min 1500 rpm)
		Bucket (sec.)	• Arm is in vertical • Measure time taken from bucket stopped when bucket tooth came in bottom to bucket moved again	0	3.6 (Time lag is 0 sec, run the engine at min 1500 rpm)
Combination operation performance	Boom or arm operation and swing	Boom and swing 90°	• Engine speed: full speed • Hydraulic oil temperature 45° - 55° C • Bucket unload • Arm is in vertical and boom cylinder is extended fully • Operate at "boom raise" and in "swing" at the same time, and measure the time taken and the amount arm top pin moved up when swing for 90°	Time (sec.) 3.5 ± 0.4	3.5 ± 0.4
				Height arm top pin (mm)	Min. 3400
		Arm and swing 90°		Time (sec.)	
				Height arm top pin (mm)	
		Charging pump discharge (l/min.)	• Engine speed: 210 rpm • Hydraulic oil temperature 45° - 55° C • Fuel pressure is 30 kg/cm^2	Max. 44.5	40.5
Heat balance		Hydraulic oil temperature	• Oil level and coolant level within specifications • Convert the atmospheric temperature reading in °F to °C, using the formula $\frac{5}{9}$ (F - 32) = C. • Estimate the temperature inside the cab on the basis of the known temperature difference between the atmospheric temperature • Drain the antifreeze and use a forcibly open type thermostat • Wind velocity, maximumely bad weather Surface conditions: Flat and sandy soils with Nd Value 10-20 No: niobium • When engine running at full speed, dig a ditch whose width is about the same as the machine and whose depth is about 2/3 the max. digging depth, swing 90°, and dump. Continue until the heat balance is achieved. • AS far as possible keep the oil pressure below the set pressure of the relief valve and use simultaneous operation while digging.	Max. 100	Max. 100
		Engine coolant temperature		Max. 100	Max. 100
		Engine oil temperature		Max. 120	Max. 120
		Swing gear case oil temperature		Max. 120	Max. 120
		Final drive case oil temperature		Max. 120	Max. 120

TABLE OF L POSITION VALUE

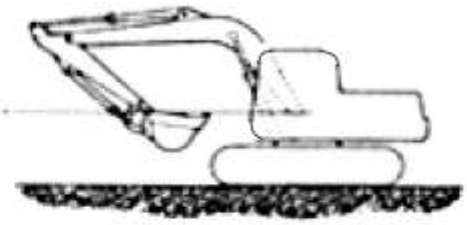
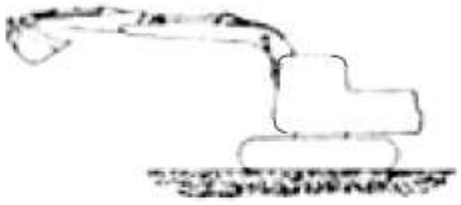
- The following table indicates the reference values for various actions when the mode selector switch is changed over from S position to L position.

Classification		Item	Condition		L position
Work equipment	Work equipment speed	Boom Bucket teeth on the ground ↕ Cylinder fully extended (sec.)	Posture of work equipment  • Engine speed High idling • Oil temp. : 45 - 55°C		BE220G/BE220
				RAISE	3.7 ±0.4
				LOWER	3.4 ±0.3
		Arm Cylinder fully retracted ↕ Cylinder fully extended (sec.)	Posture of work equipment  • Engine speed High idling • Oil temp. : 45 - 55°C	IN	5.4 ±0.5
				OUT	3.6 ±0.4
		Bucket Cylinder fully retracted ↕ Cylinder fully extended (sec.)	Posture of work equipment  • Engine speed High idling • Oil temp. : 45 - 55°C	CURL	4.2 ±0.4
				DUMP	2.7 ±0.5
	Swing	Narmal swing speed (sec.)	Posture of work equipment Max. reach  • Engine speed High idling • Oil temp. : 45 - 55°C • Measure time to swing for 2 turns, after swinging one turn as an approach swing.		9.7 ±0.5

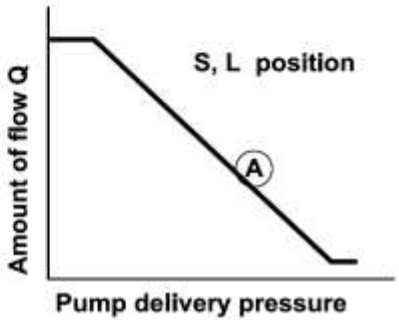
Classi-fication	Item	Condition	L position
Travel	Travel deviation (mm)	Travel posture  • Engine speed High idling • Oil temp. : 45 - 55°C • On a flat surface, make an approach run of at least 10 M, than travel another 20 m. Measure the travel deviation  • Measure dimension ℓ	BE220LC Max. 200
	Travel speed (sec.)	Machine posture with track spinning  • Engine speed High idling • Oil temp. : 45 - 55°C • Raise one track off the ground, let it spin one revolution, then measure the time required. Repeat this procedure for the other track.	22±2

FLOW CONTROL FEATURE TVC VALUE

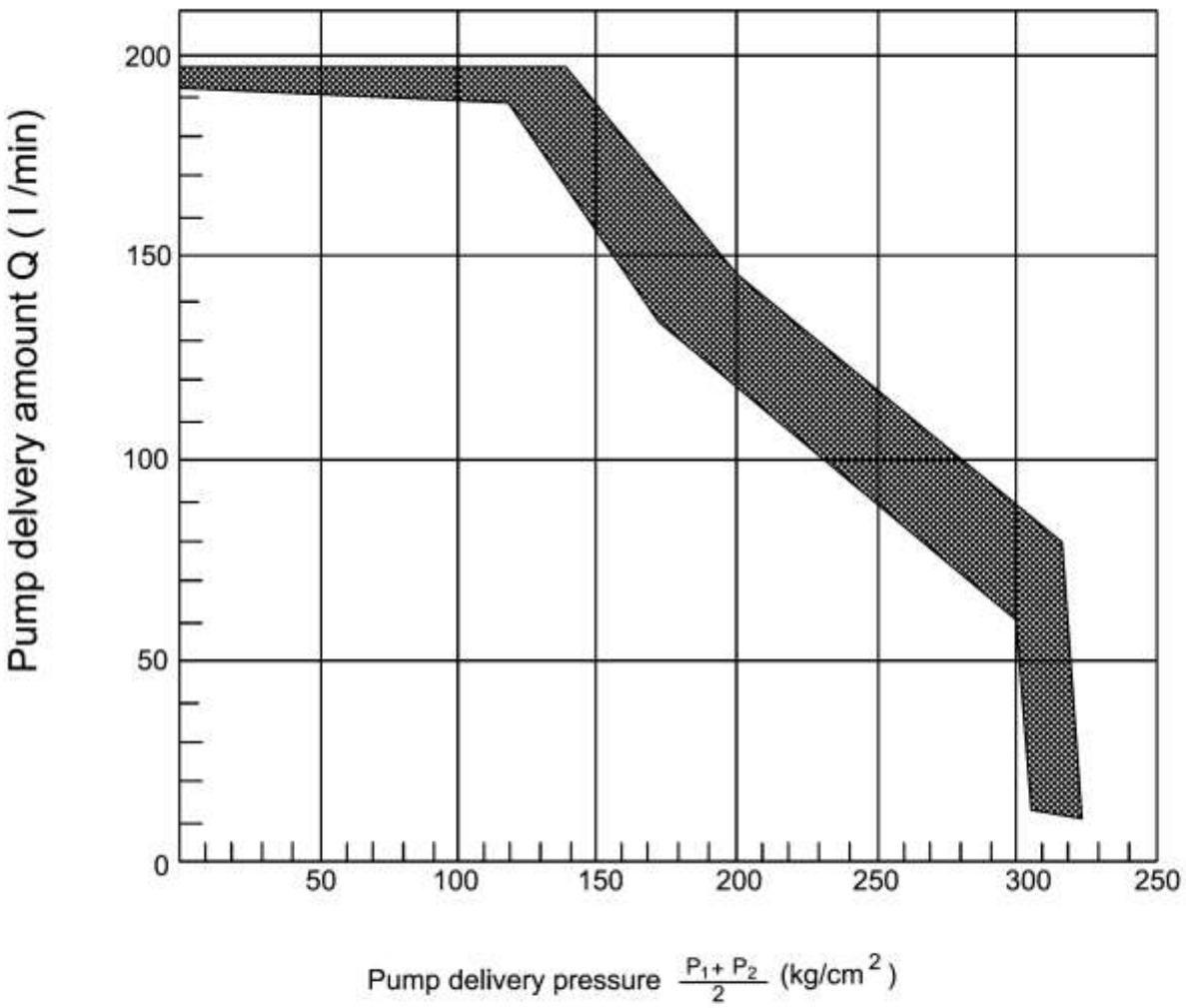
- The following table shows the reference valves for use when troubleshooting.

Classi-fication	Item	Condition	S position	L position
Combination operation performance	Boom and swing 90° (sec.)	Posture of work equipment  • Engine speed High idling • Hydraulic oil temperature : 45 - 55°C • Bucket loaded • Operate at "Boom raise" and in "Swing"at the same time,and measure the time taken when swing for 90°	3.6 ±0.4	3.8 ±0.4
Flow control feature	Minimum engine speed (rpm) at boom raise, and boom raise speed (sec.)	Posture of work equipment  • Engine speed: Full speed • Hydraulic oil temperature : 45 - 55°C • Measure time taken from bucket tooth touching the ground to cylinder full extended (RAISE)	3.5 ±0.3 (2150 ± 50)	4.0 ±0.5 (2200 ± 50)
	Note. Bucket dump speed when reliewing oil in swing circuit (sec.)	Posture of work equipment  • Engine speed: Full speed • Hydraulic oil temperature : 45 - 55°C	3.4 ±0.5	2.9 ±0.5

Note: When the control performance check of the TVC vlave, it becomes control position (approximately position A on the curve) when (swing relief pressure 297^{+15}_{-10} + bucket operation pressure) ÷2 = average pressure.



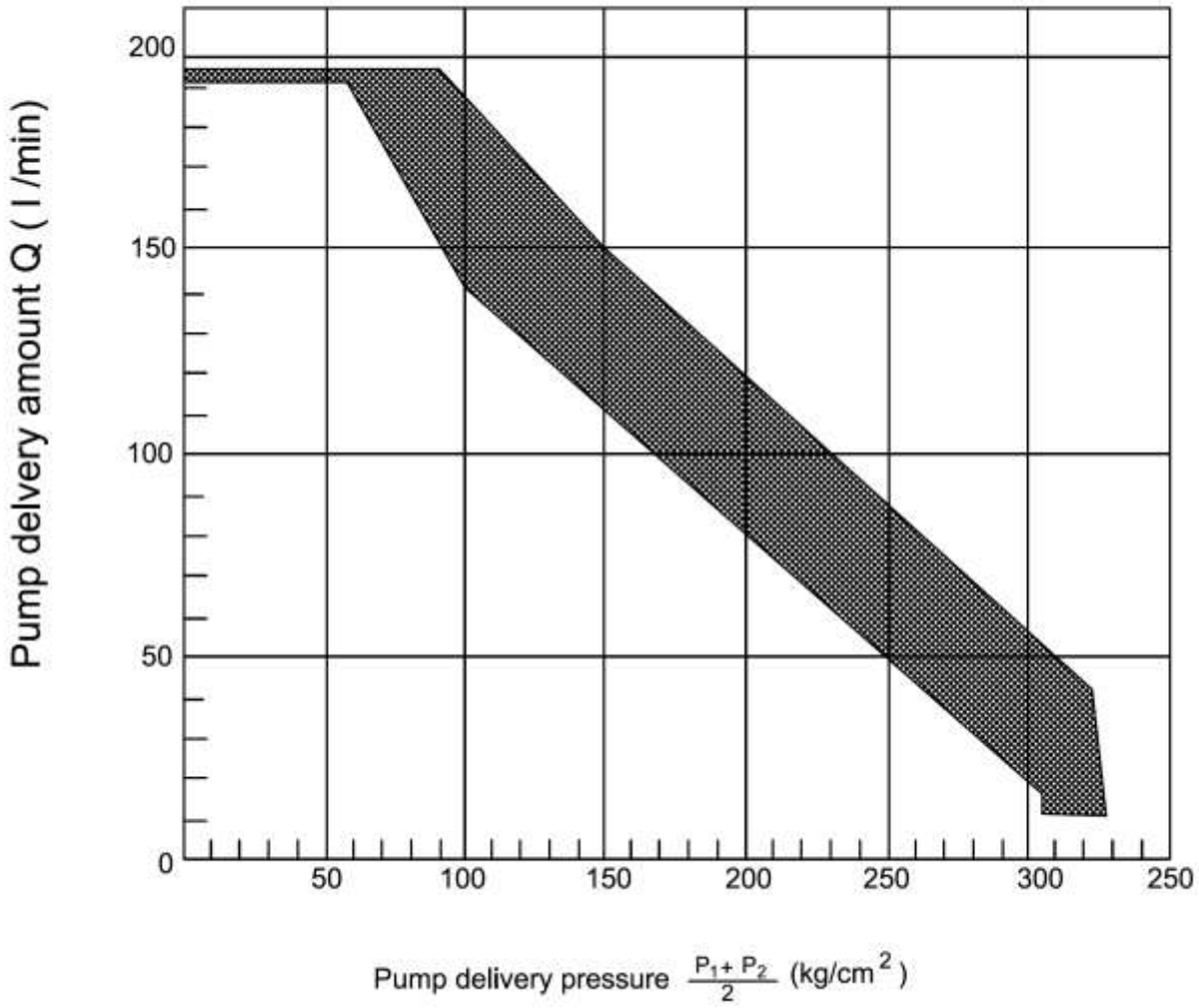
Main Piston Pump (S Mode)



Check point	Test Pump delivery pressure (kg/cm^2)	Other pump delivery pressure (kg/cm^2)	Average pressure (kg/cm^2)	Standard value for delivery Q (new machine) (l / min)	Judgement standard for delivery Q (l / min) (bottom level)
(1)	P_1	P_2	$\frac{P_1+P_2}{2}$	See graph	See graph
(2)	320	0 - 20	Note	27 ± 20	0
(3)	280	320	300	70 ± 20	50
(4)	180	320	250	100 ± 20	80
(5)	300 - 280	0 - 20	150	170 ± 20	150
(6)	0 - 20	0 - 20	0 - 20	195^{+5}_{-10}	185

Note : The CO valve is working, so the average pressure in unnecessary.

Main Piston Pump (L Mode)



Check point	Test Pump delivery pressure (kg/cm^2)	Other pump delivery pressure (kg/cm^2)	Average pressure (kg/cm^2)	Standard value for delivery Q (new machine) (l / min)	Judgement standard for delivery Q (l / min) (bottom level)
(1)	P_1	P_2	$\frac{P_1+P_2}{2}$	See graph	See graph
(2)	320	0 - 20	Note	27 ± 20	0
(3)	280	320	300	40 ± 20	20
(4)	80	320	200	100 ± 20	80
(5)	100 - 80	0 - 20	100	195^{+30}_{-20}	140
(6)	0 - 20	0 - 20	0 - 20	195^{+5}_{-10}	185

Note : The CO valve is working, so the average pressure in unnecessary.

MEASURING HYDRAULIC OIL TEMPERATURE

Special tool

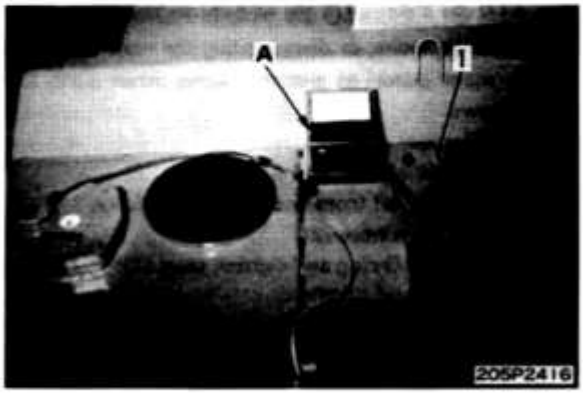
	Part No.	Part Name	Q'ty
A	790-500-1300	Thermistor temperature gauge	1

Lower the work equipment completely to the ground and stop the engine. Operate the control lever several times to release the remaining hydraulic pressure in the hydraulic piping. Then loosen the oil filler cap slowly to release the remaining oil pressure in the hydraulic tank.

- Remove cover (1), then measure the oil temperature using thermistor A.
- When hydraulic oil temperature is lower than 45°C, raise the oil temperature as follows.
- Start the engine and warm up running. Operate the arm or bucket control lever fully to relieve oil from main relief valve so that oil temperature is raised.
  - ★ Continued operation in above is within 30 seconds.

Note:

When relieving oil in boom, arm, bucket or travel circuit, CO valve acts and main pump delivery is minimum. In result, as oil flows only for hydraulic tank – main pump – main relief valve – hydraulic tank, operate boom, arm and bucket cylinders to raise the temperature of components sometimes.



AIR BLEEDING

1. AIR BLEEDING IN HYDRAULIC SYSTEM
2. AIR BLEEDING IN MAIN PUMP
3. REMAIN PRESSURE RELIVING PPC CIRCUIT
4. AIR BLEEDING IN TRAVEL MOTOR

Refer Rexroth Instruction Manual of HS-64-05-E0403-1-3

TESTING AND ADJUSTING MAIN RELIEF VALVE

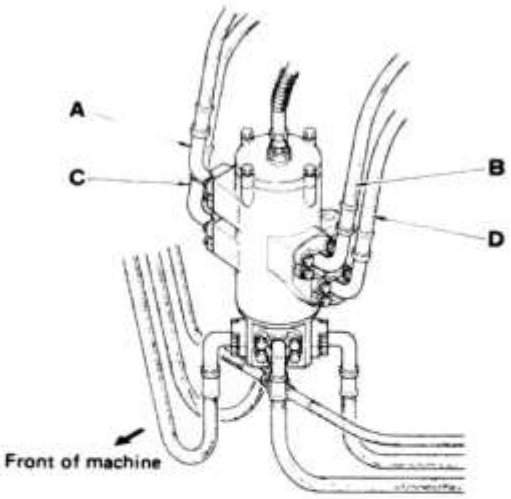
Refer Rexroth Instruction Manual of HS-64-05-E0403-1-3

TESTING PRESSURE OF CONTROL VALVE

Refer Rexroth Instruction Manual of HS-64-05-E0403-1-3

TESTING OIL LEAKAGE FROM SWIVEL JOINT

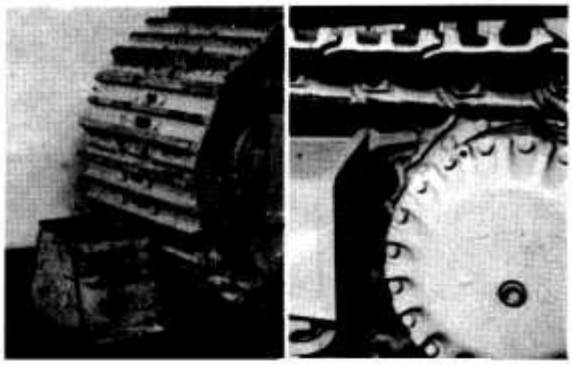
- If there is any abnormality (deviation, lack of speed, in the travel system, and there is no abnormality in the hydraulic pump, control valve, or travel motor assembly, test as follows.
  - ★ Oil temperature when measuring: 45 – 55°C

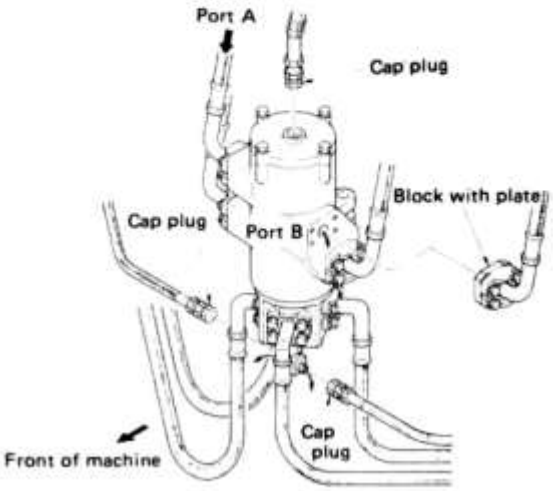


Testing for leaking from packing inside swivel joint

Inlet port of swivel joint	Direction of rotation of swing motor	Port to measure leakage inside swivel joint
A	Right REVERSE	B · Drain
B	Left FORWARD	A · C
C	Right FORWARD	B · D
D	Left REVERSE	C . Drain

1) Oil leakage from port **A (D)**
   - i) Put a block at the rear of the right track (rear of left track), move the machine slowly to put the track in contact with the block, then stop the engine.
     - Loosen the oil filler cap slowly to release pressure inside the hydraulic tank.
   - ii) Disconnect the drain hoses at the top and bottom of the swivel joint, and block both hoses with caps.
   - iii) Disconnect the hose at port **B (C)** for measuring at the top of the swivel joint, then block the hose with a plate.
   - iv) Start the engine, and run at full throttle to check.
     Relieve the circuit slowly.
   - v) Catch the oil leaking from the measuring port **B (C)** and the lower drain port in a measuring cylinder.
   - vi) Wait for one minute, then measure the leakage for the next minute.
   - ★ Use the following part as blind plug and flange hoses.
     Drain hose: Plug (CPL1150315) x 3





2) Oil leakage from port B (C)

i) Put a block at the front of the left track (front of right track), move the machine slowly to put the track in contact with the block, then stop the engine.

Loosen the oil filler cap slowly to release pressure inside the hydraulic tank.

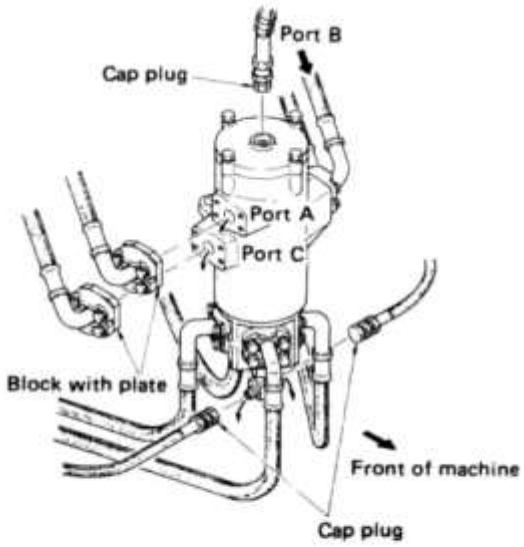
ii) Disconnect the hoses at ports **A** and **C** (**B** and **D**) for measuring at the top of the swivel joint, then block the hoses with plates.

iii) Start the engine, and run at full throttle to check.
Relieve the circuit slowly.

iv) Catch the oil leaking from the measuring ports **A** and **C** (**B** and **D**) in a measuring cylinder.

v) Wait for one minute, then measure the leakage for the next minute.

★ Use the following part as blind plug and flange hoses.
Drain hose: Plug (CPL1150315) x 3)



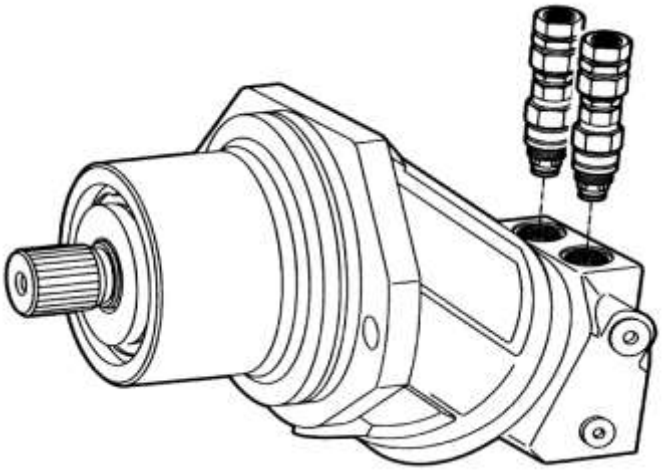
MEASURING LEAKAGE OF SWING, TRAVEL MOTOR

BE220G

Refer PMP Instruction Manuals of PMCI. M001 and PMTE M001

BE220 I BE220LC

Refer Rexroth Instruction Manual of HS-64-05-E0403-1-3



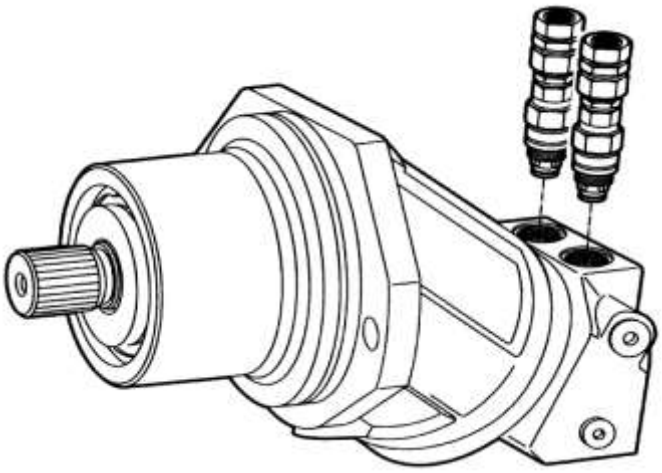
CHECKING AND ADJUSTING TRAVEL MOTOR PERFORMANCE

BE220G

Refer PMP Instruction Manuals of PMCI M001

BE220 I BE220LC

Refer Rexroth Instruction Manual of HS-64-05-E0403-1-3



HYDRAULIC SYSTEM

13 DISASSEMBLY AND ASSEMBLY

MAIN PUMP ASSEMBLY

Removel 13-02
Installation 13-02
Disassembly 13-02
Assembly 13-02
Installation 13-02

CONTROL VALVE ASSEMBLY

Removel 13-03
Installation 13-03
Disassembly 13-03
Assembly 13-03

BOOM CYLINDER ASSEMBLY

Removel and Installation 13-04

ARM CYLINDER ASSEMBLY

Removel and Installation 13-05

BUCKET CYLINDER ASSEMBLY

Removel and Installation 13-06

HYDRAULIC CYLINDER ASSEMBLY

Disassembly 13-07
Assembly 13-10

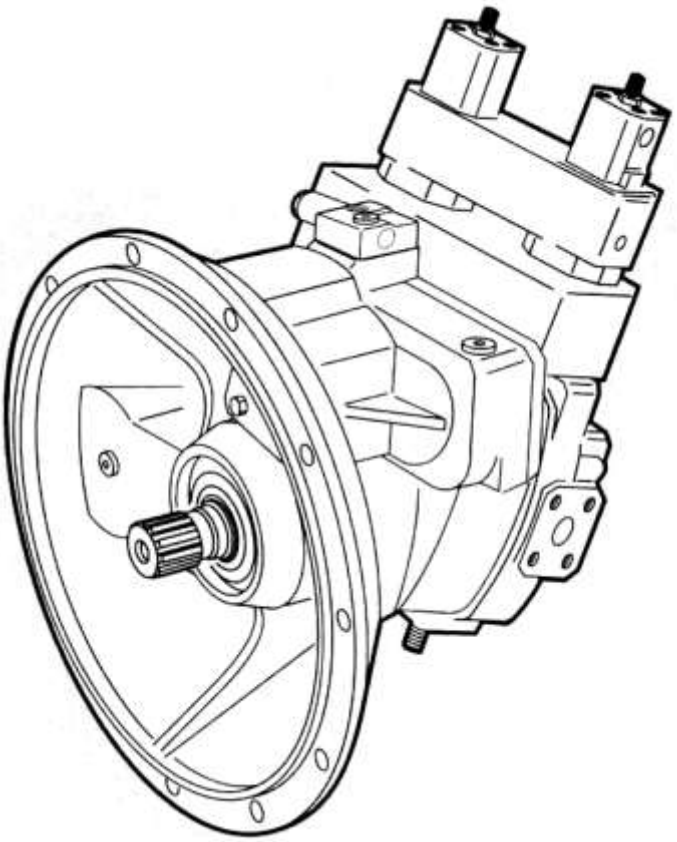
WORK EQUIPMENT ASSEMBLY

Removel 13-14
Installation 13-15
Disassembly 13-16
Assembly 13-20

- When operating the hydraulic cylinders for the first time after reassembling cylinders, pumps and piping always bleed the air as follows:
  1. Start engine and run at low idling.
  2. Operate hydraulic cylinder 4 to 5 times, stopping 100 mm stroke end.
  3. Next, operate cylinder 3 to 4 times to stroke end.
  4. After doing this, run engine at normal speed.
  - After repair or long storage, follow the same procedure.

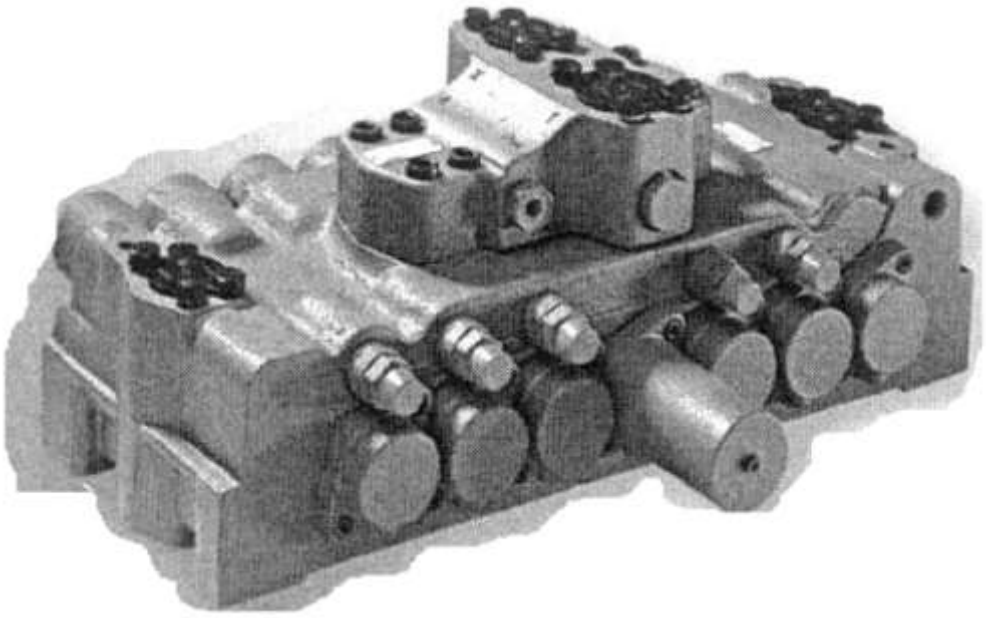
- **REMOVEL OF MAIN PUMP ASSEMBLY**
- **INSTALLATION OF MAIN PUMP ASSEMBLY**
- **DISASSEMBLY OF MAIN PUMP ASSEMBLY**
- **ASSEMBLY OF MAIN PUMP ASSEMBLY**
- **INSTALLATION OF MAIN PUMP ASSEMBLY**

Refer Rexroth Instruction Manual of HS-64-05-E0403-1-3



- **REMOVEL OF CONTROL VALVE ASSEMBLY**
- **INSTALLATION OF CONTROL VALVE ASSEMBLY**
- **DISASSEMBLY OF CONTROL VALVE ASSEMBLY**
- **ASSEMBLY OF CONTROL VALVE ASSEMBLY**

Refer Rexroth Instruction Manual of HS-64-05-E0403-1-3



REMOVAL OF BOOM CYLINDER ASSEMBLY

⚠ Extend the arm and bucket fully, lower the work equipment completely to the ground and stop the engine.

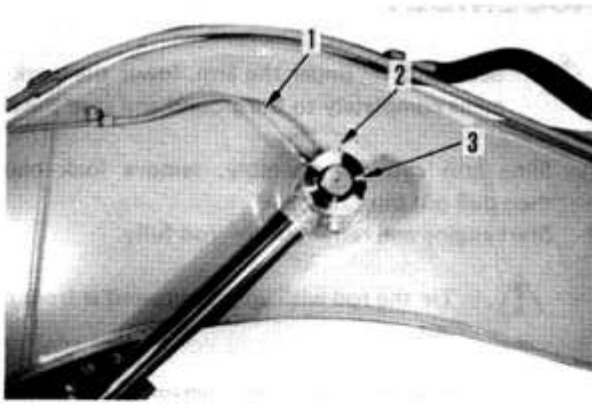
1. Disconnect greasing tube (1).
2. Remove lock bolt (2), then remove plates (3).
3. Sling boom cylinder assembly (4), push connecting pin (5) to opposite side, then remove piston rod from boom.
4. Start engine and retract piston rod fully.

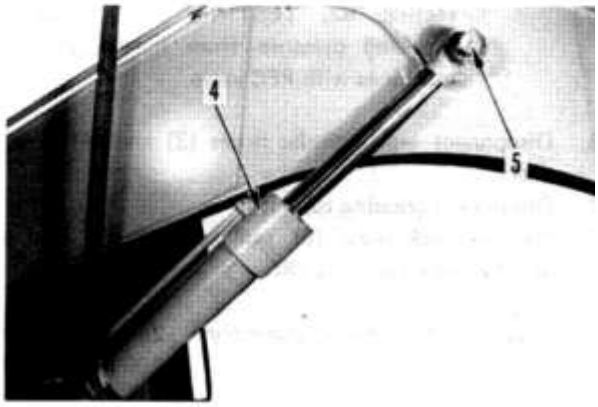
⚠ Tie the rod with wire to prevent it from coming out.

⚠ Stop the engine and release the hydraulic pressure in the hydraulic piping. For details, see section 62, TESTING AND ADJUSTING, Bleeding pressure from hydraulic circuit in machines with PPC valve.

5. Raise boom cylinder assembly (4), then set on stand ①.
6. Disconnect hoses (6) and (7).
7. Sling boom cylinder assembly (4) and remove lock plate (8). Using forcing screw ② (Dia. = 12 mm, Pitch = 1.75 mm), remove pin (9), then lift off boom cylinder assembly (4).

kg Boom cylinder assembly: 200 kg

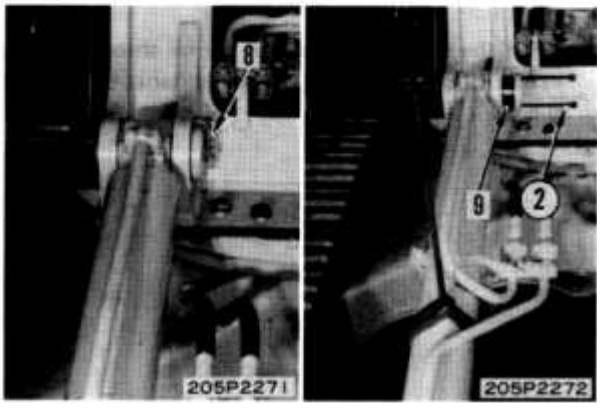




INSTALLATION OF BOOM CYLINDER ASSEMBLY

1. Raise boom cylinder assembly (4), and position bottom connecting pin hole on frame. Assemble spacer, knock in pin (9), and install lock plate (8).
   ★ Adjust with spacers so that the clearance between the revolving frame and the cylinder bottom is less than 1 mm.
2. Fit O-rings and connect hoses (7) and (6).
3. Raise boom cylinder assembly (4). Start engine, extend piston rod and align with pin hole, then knock in pin (5).
4. Fit plate (3), then secure with lock bolt (2).
5. Connect greasing tube (1).

★ Run the engine to circulate the oil through the system. Then add oil to the hydraulic tank to the specified level.



REMOVAL OF ARM CYLINDER ASSEMBLY

Set stand ① under the arm, lower the work equipment completely to the ground and stop the engine.

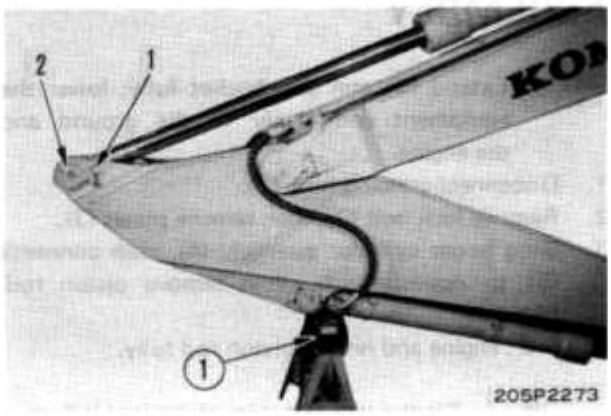
1. Sling arm cylinder assembly, remove lock plate (1), then pull out pin (2).
2. Start engine and retract piston rod fully.

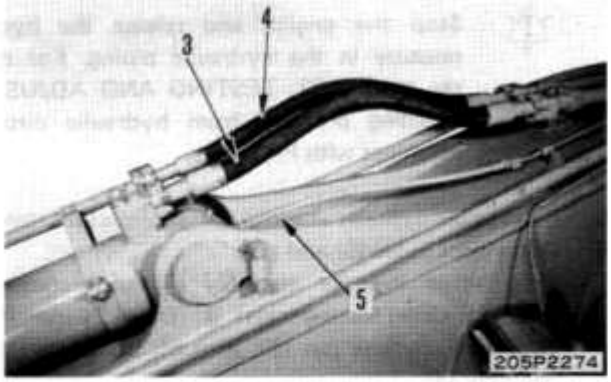
Tie the rod with wire to prevent it from coming out.

Stop the engine and release the hydraulic pressure in the hydraulic piping. For details, see section 62, TESTING AND ADJUSTING, Bleeding pressure from hydraulic circuit in machines with PPC valve.

3. Disconnect arm cylinder hoses (3) and (4) at cylinder end.
4. Disconnect greasing tube (5).
5. Remove lock plate (6), pull out pin (7), then lift off arm cylinder assembly (8).

kg Arm cylinder assembly: 280 kg



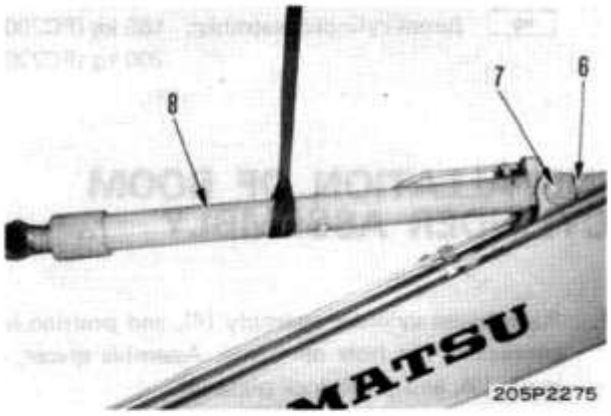


INSTALLATION OF ARM CYLINDER ASSEMBLY

1. Raise arm cylinder assembly (8) and position bottom connecting pin hole. Knock in pin (7), then secure with lock plate (6).
2. Connect greasing tube (5).
3. Fit O-rings and connect arm cylinder hoses (4) and (3).
4. Start engine, extend piston rod, knock in pin (2), then secure wth lock plate (1).

★ Adjust with spacers so that the clearance between the boom and arm cylinder bottom is less than 1 mm.

★ Run the engine to circulate the oil through the system. Then add oil to the hydraulic tank to the specified level.



REMOVAL OF BUCKET CYLINDER ASSEMBLY

⚠ Lower the work equipment completely to the ground and stop the engine.

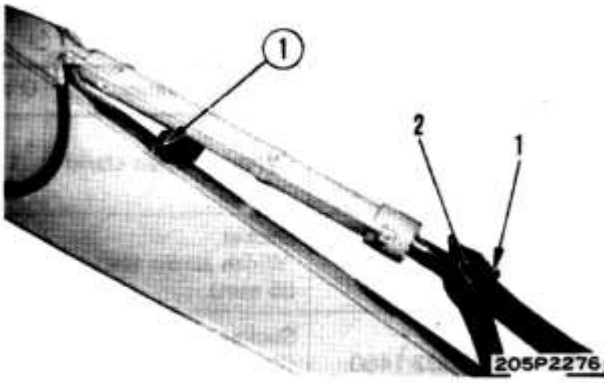
1. Remove lock bolt (1), then pull out pin (2).
   - ★ Insert block ① between the cylinder and the arm.
   - ★ Pull out pin (2) until the piston rod comes out.
2. Start engine and retract piston rod fully.

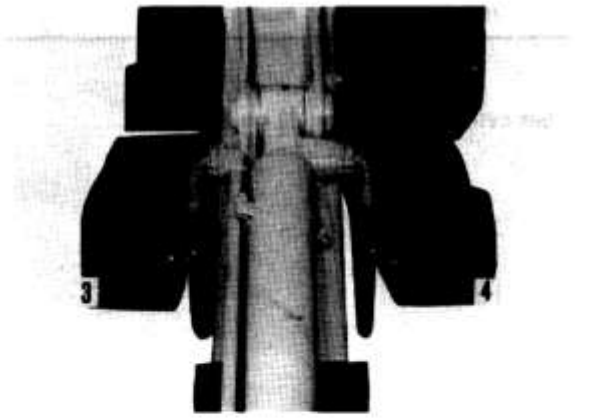
⚠ Tie the bucket cylinder rod with wire to prevent it from coming out.

⚠ Stop the engine and release the hydraulic pressure in the hydraulic piping. For details, see section 62, TESTING AND ADJUSTING, Bleeding pressure from hydraulic circuit in machines with PPC valve.

3. Disconnect bucket cylinder hoses (3) and (4) at cylinder end.
4. Sling bucket cylinder assembly (5), remove lock plate (6), then pull out pin (7).
5. Lift off bucket cylinder assembly (5).

kg Bucket cylinder assembly: 185 kg



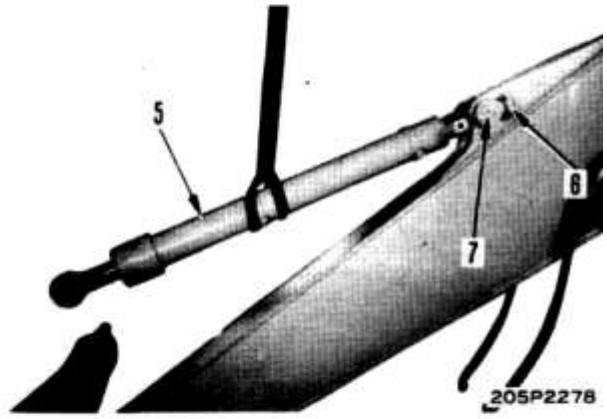


INSTALLATION OF BUCKET CYLINDER ASSEMBLY

1. Raise bucket cylinder assembly (5) and position bottom connecting pin hole. Knock in pin (7), then secure with lock plate (6).
2. Fit O-rings and connect bucket cylinder hoses (4) and (3).
   - ★ Install hose without twisting or interference.
3. Start engine, extend piston rod and align link and hole. Knock in pin (2), then install lock bolt (1).

★ Adjust with spacers so that the clearance between the arm and bucket cylinder bottom is less than 1 mm.

★ Run the engine to circulate the oil through the system. Then add oil to hydraulic tank to the specified level.

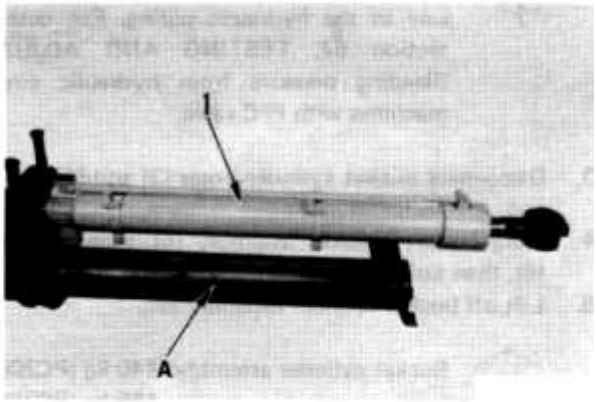


DISASSEMBLY OF HYDRAULIC CYLINDER ASSEMBLY

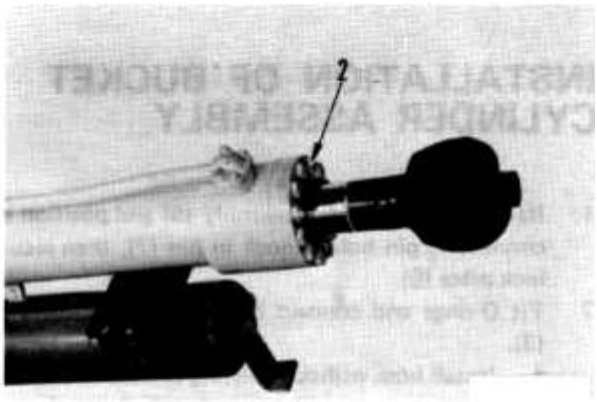
Special tool

	Part No.	Part Name	Q'ty
A	790-502-2000 or 790-502-1001	Cylinder repair stand	1
A_1	790-302-1430	Socket (Width across flats: 85 mm)	1
A_2	790-302-1450	Socket (Width across flats: 95 mm)	1
A_3	790-101-1102	Pump	1

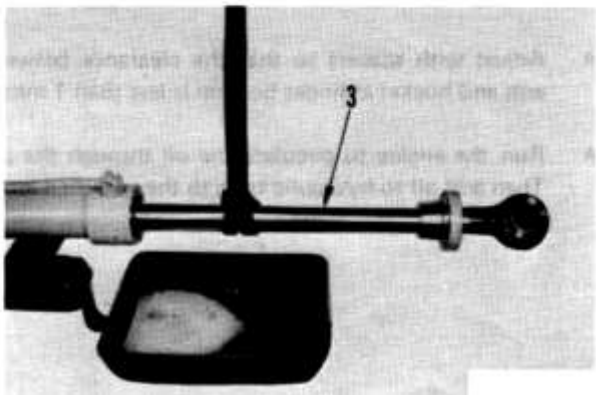
1. Set cylinder assembly (1) on tool **A**.



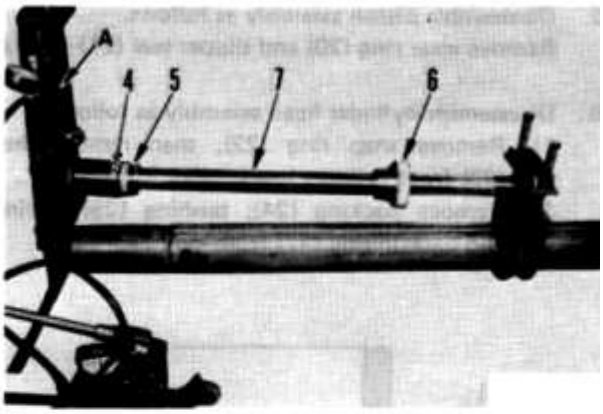
2. Remove head bolts (2).



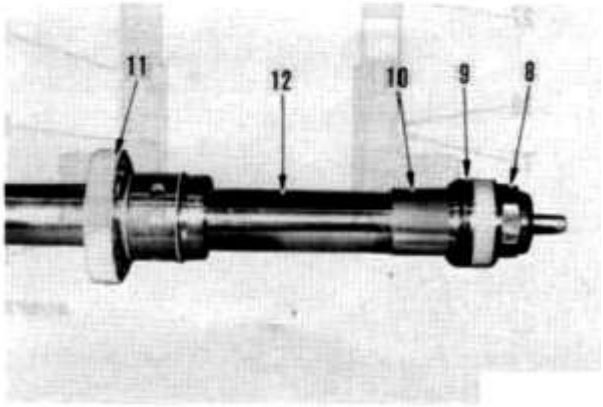
3. Pull out piston rod assembly (3) about 1 m, then lift off.
   - ★ Prepare a container to catch the oil which comes out when the piston rod assembly is removed.
   - ★ Remove the cylinder from tool **A**.



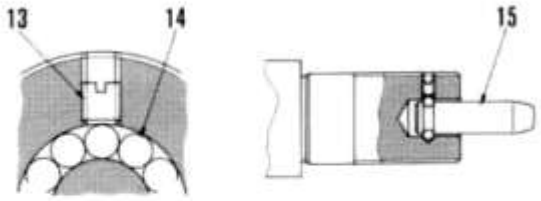
4. Disassemble piston rod assembly as follows.
   - Bucket cylinder
     1) Set piston rod assembly in tool **A**.
     2) Using tool **A**, remove nut (4).
        ★ Width across flats of nut: 95 mm
     3) Remove piston assembly (5) and cylinder head assembly (6) from piston rod (7).

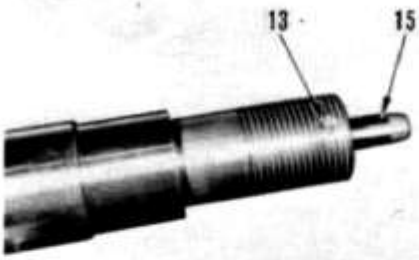


   - Arm cylinder
     1) Set piston rod assembly in tool **A**.
     2) Using tool **A**, remove nut (8).
        ★ Width across flats of nut: 95 mm
     3) Remove piston assembly (9), plunger (10) and cylinder head assembly (11) from piston rod (12).

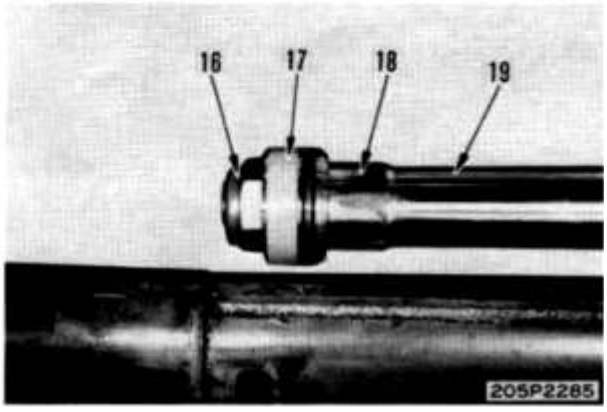


     4) Remove screw (13), take out 12 balls (14), then remove plunger (15).



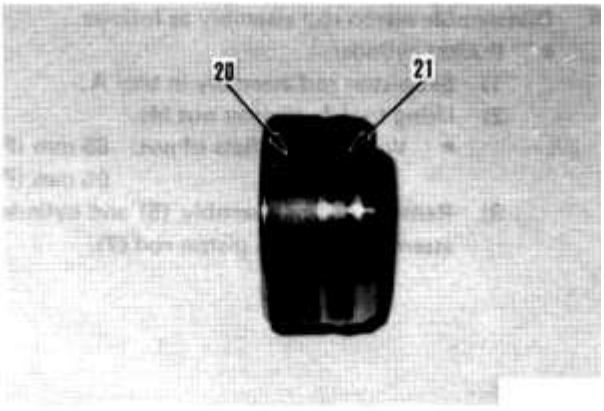


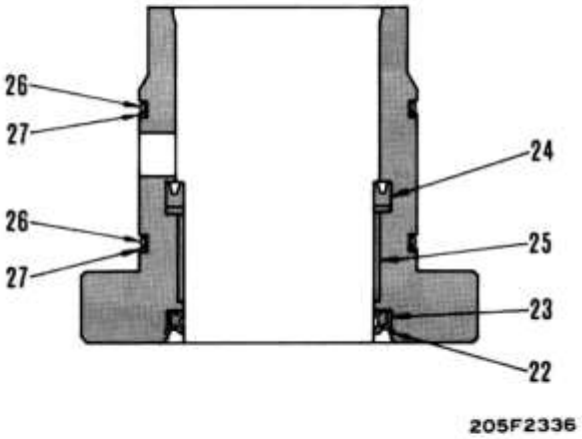
   - Boom cylinder
     1) Set piston rod assembly in tool **A**.
     2) Using tool **A**, remove nut (16).
        ★ Width across flats of nut: 95 mm
     3) Remove piston assembly (17), plunger (18) and cylinder head assembly from piston rod (19).



5. Disassemble piston assembly as follows.
   Remove wear ring (20) and slipper seal (21) from piston.

6. Disassemble cylinder head assembly as follows.
   1) Remove snap ring (22), then remove dust seal (23) from cylinder head.
   2) Remove packing (24), bushing (25), O-ring (26) and backup ring (27) from cylinder head.





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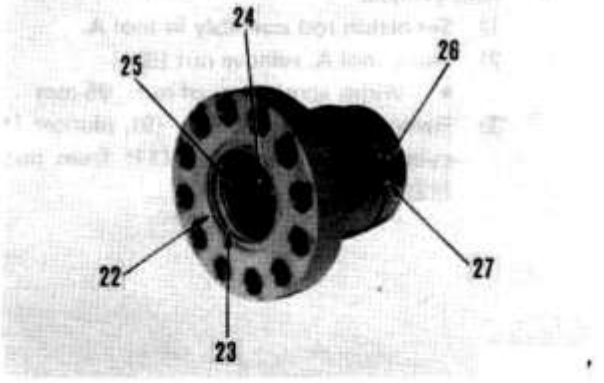


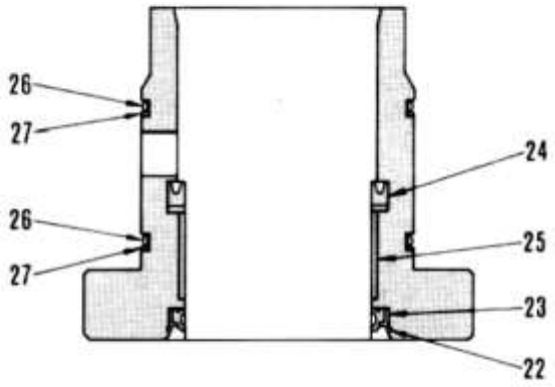
ASSEMBLY OF HYDRAULIC CYLINDER ASSEMBLY

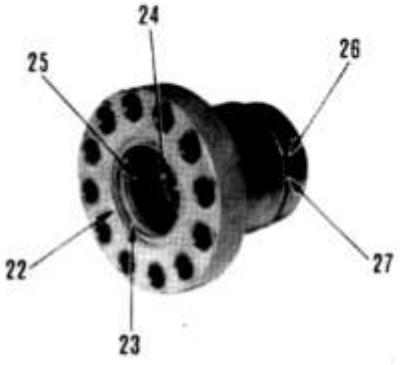
Special tool

	Part No.	Part Name	Q'ty
A	790-502-2000 or 790-502-1001	Cylinder repair stand	1
A_1	790-302-1430	Socket (Width across flats: 85 mm)	1
A_2	790-302-1450	Socket (Width across flats: 95 mm)	1
A_3	790-101-1102	Pump	1
B	790-702-1000	Expander	1

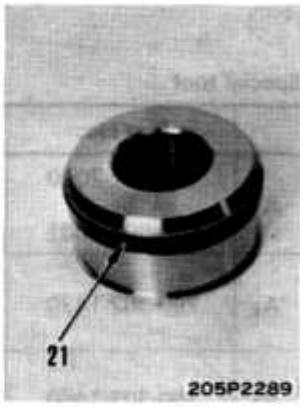
★ Clean all parts, and check for dirt or damage. Coat the sliding surfaces of all parts with engine oil before installing. Be careful not to damage packing, dust seals or O-ring when installing.

1. Assemble cylinder head assembly as follows.
   1) Using push tool, install bushing (25) on cylinder head.
      ★ Outside diameter of bushing:
      95mm (boom, bucket)
      105mm (arm)
      ★ Be careful not to deform the bushing when press fitting.
   2) Install packing (24).
      ★ Be careful to install the packing facing in the correct direction.
   3) Install backup rings (27) and O-rings (26) in turn on cylinder head.
      ★ Do not try to force the slipper seal into position. Warm it in warm water (50 – 60 °C) before fitting it.
   4) Using push tool, install dust seal (23) and secure with snap ring (22).



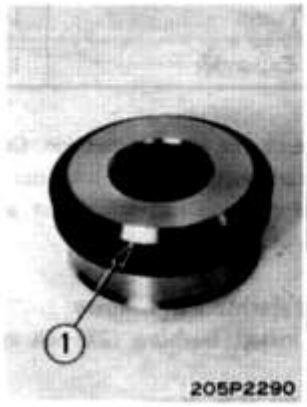


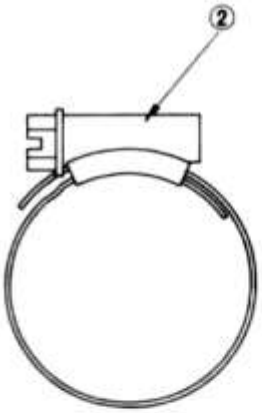
2. Assemble piston assembly as follows.
   1) Using tool B, expand slipper seal (21).
      ★ Set the slipper seal on the expander and turn the handle 8 – 10 times to expand the ring.
   2) Remove slipper seal (21) from tool, and install on piston.

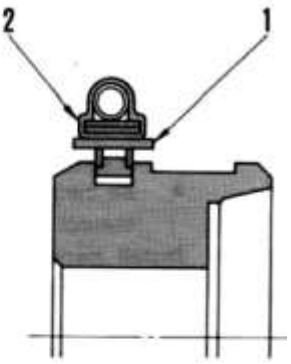


   3) Set ring ① in position, then using clamp ②, compress slipper seal (21).
      ★ Part number of ring
      796-720-1670 (bucket boom cylinder)
      796-720-1680 (arm cylinder)

      ★ Part number of clamp
      07281-01589 (bucket, boom cylinder)
      07281-01919 (arm cylinder)



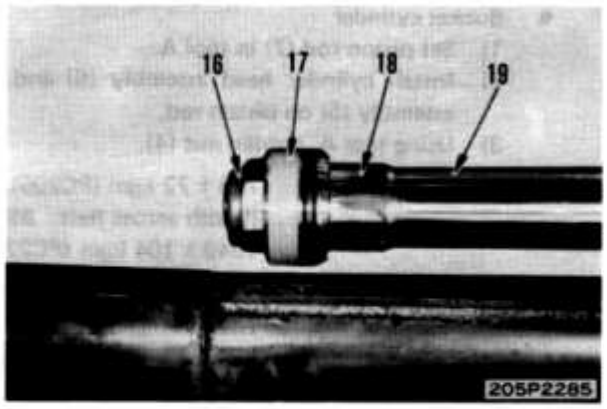




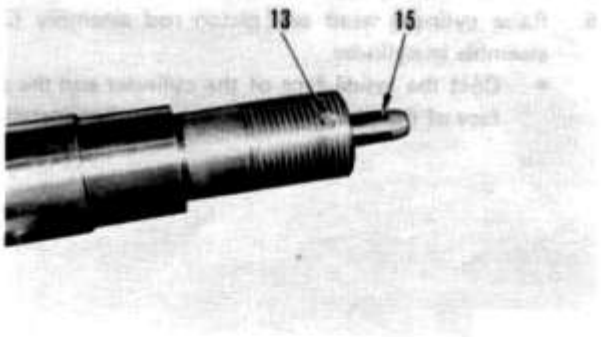
   4) Install wear ring (20) on piston.

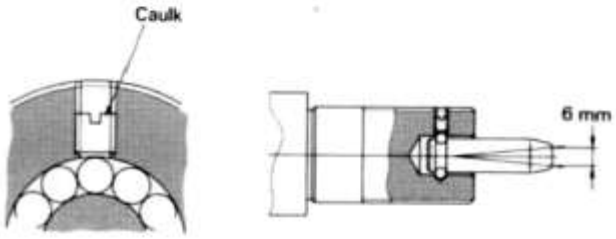
3. Assemble piston rod assembly as follows.
   - Boom cylinder
     1) Set piston rod (19) in tool **A**.
     2) Install cylinder head assembly, plunger (18) and piston assembly (17) on piston rod (19).
     3) Using tool **A**, tighten nut (16).

        kgm Nut: 1040 ± 104 kgm
        (Width across flats: 95 mm)



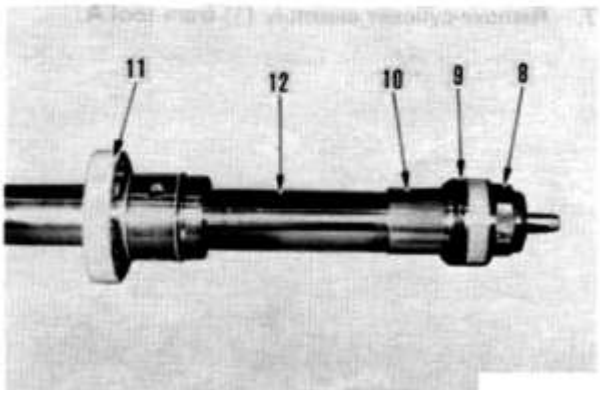
   - Arm cylinder
     1) Set piston rod (12) in tool **A**.
     2) Position plunger (15) on piston rod, then assemble 12 balls (14).
     3) Tighten screw (13) fully, then turn back about 1/2 turn. Check play at tip of plunger, then caulk.
        ★ Play at tip of plunger: Approx. 6 mm





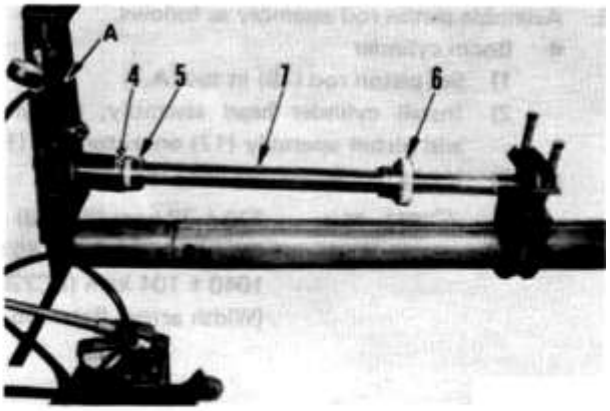
     4) Install cylinder head assembly (11), plunger (10) and piston assembly (9) on piston rod (12).
     5) Using tool **A**, tighten nut (8).

        kgm Nut: 1040 ± 104 kgm
        (Width across flats: 95 mm)



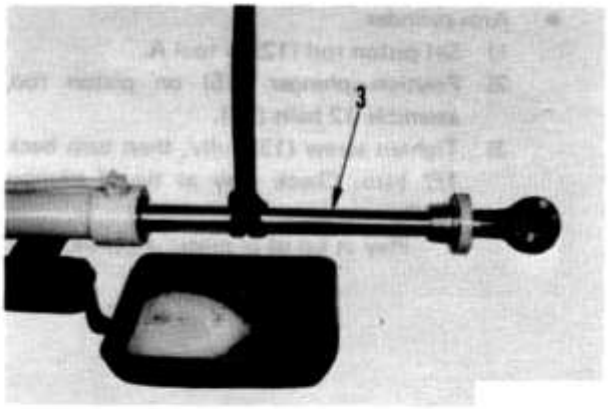
- Bucket cylinder
  1) Set piston rod (7) in tool **A**.
  2) Install cylinder head assembly (6) and piston assembly (5) on piston rod.
  3) Using tool **A**, tighten nut (4).

     Nut: 1040 ± 104 kgm
     (Width across flats: 95 mm)

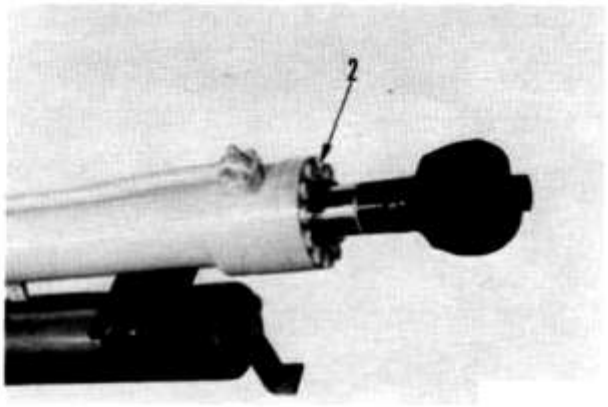


4. Set cylinder in tool **A**.

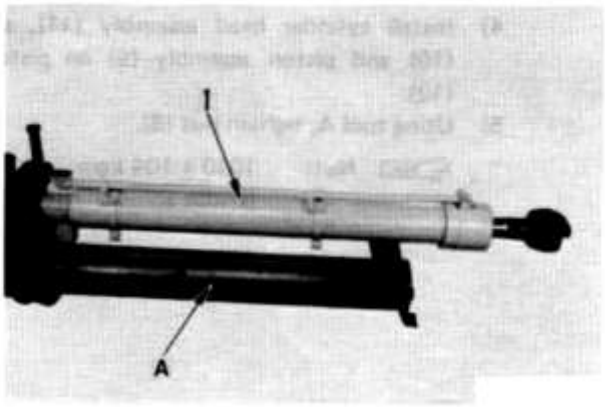
5. Raise cylinder head and piston rod assembly (3), and assemble in cylinder.
   ★ Coat the inside face of the cylinder and the outside face of the piston with engine oil when installing.



6. Assemble cylinder head assembly in cylinder, then tighten head bolts (2).
   ★ Align the punch marks and ports when assembling.
   (There is no punch mark on the bucket cylinder.)



7. Remove cylinder assembly (1) from tool **A**.



REMOVAL OF WORK EQUIPMENT ASSEMBLY

Special tool

	Part No.	Part Name	Q'ty
A	796-900-1200	Remover	1
A_1	790-101-3800	Cylinder (50 ton)	1
A_2	790-101-1102	Pump	1

⚠ Extend the arm and bucket fully, lower the work equipment completely to the ground and stop the engine.

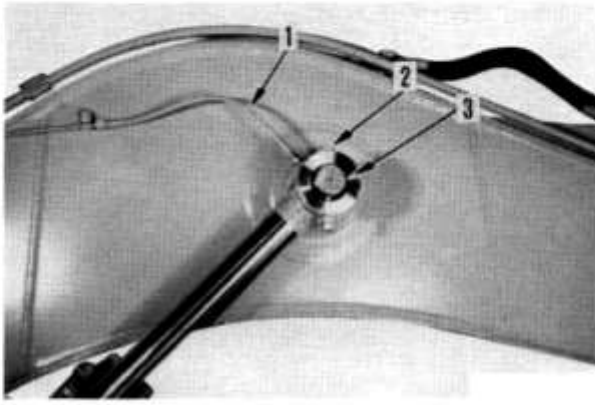
1. Disconnect greasing tube (1).
2. Remove lock bolt (2), then remove plates (3).
3. Sling boom cylinder assembly (4), push connecting pin (5) to opposite side, then remove piston rod from boom.
4. Start engine and retract piston rod fully.

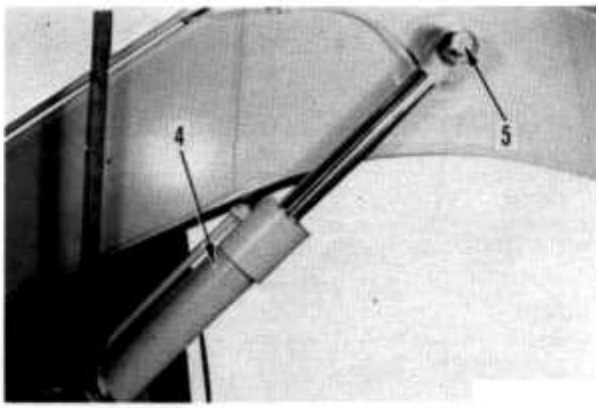
⚠ Tie the rod with wire to prevent it from coming out.

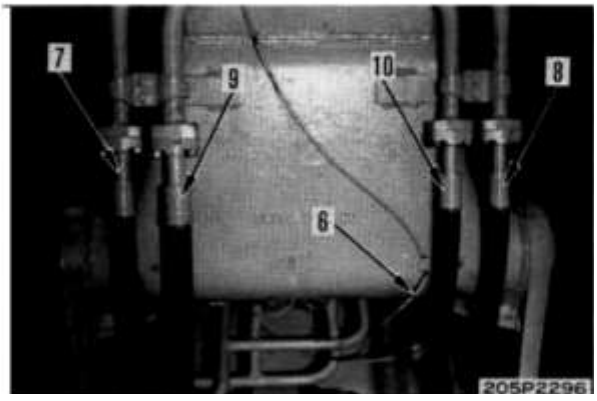
⚠ Stop the engine and release the hydraulic pressure in the hydraulic piping. For details, see section 62, TESTING AND ADJUSTING, Bleeding pressure from hydraulic circuit in machines with PPC valve.

5. Raise boom cylinder assembly (4) and lower on to stand ①.
   ★ Remove the other boom cylinder assembly in the same way, and lower on to the stand.
6. Disconnect head lamp wiring (6) at connector.
7. Disconnect bucket cylinder hoses (7) and (8), and arm cylinder hoses (9) and (10).
8. Sling work equipment assembly, and remove lock plate (11). Using tool **A**, remove pin (12).
9. Lift off work equipment assembly (13).

kg Work equipment assembly: 3700 kg







INSTALLATION OF WORK EQUIPMENT ASSEMBLY

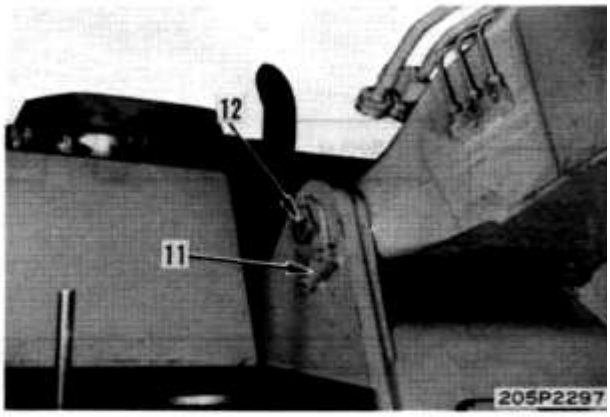
1. Raise work equipment assembly (13), and position boom foot connecting pin hole on revolving frame. Knock in pin (12), then secure with lock plate (11).
2. Fit O-rings and connect arm cylinder hoses (9) and (10) and bucket cylinder hoses (7) and (8).
   ★ Install hose without twisting or interference.
3. Connect head lamp wiring (6) at connector.
4. Raise boom cylinder assembly (4). Start engine, extend piston rod and align with pin hole, then push in pin (5).
5. Fit plate (3), then secure with lock bolt (2).
6. Connect greasing tube (1).

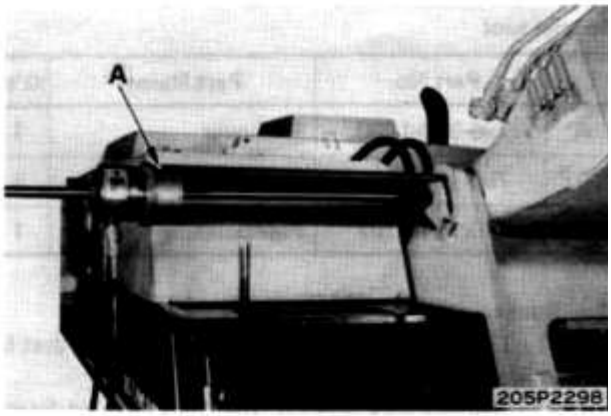
★ Install the other boom cylinder in the same way.

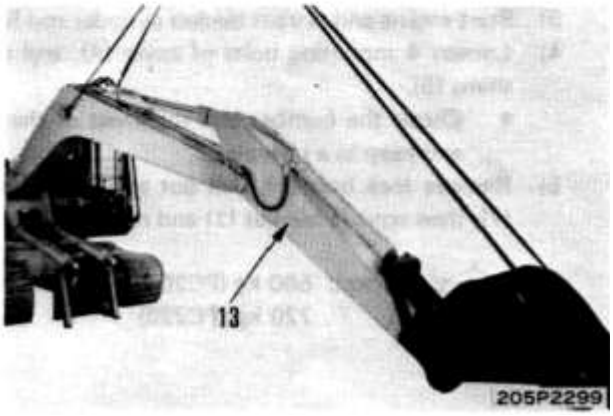
★ Adjust with spacers so that the clearance between the revolving frame and the boom foot is less than 1 mm.

★ Run the engine to circulate the oil through the system. Then add oil to the hydraulic tank to the specified level.

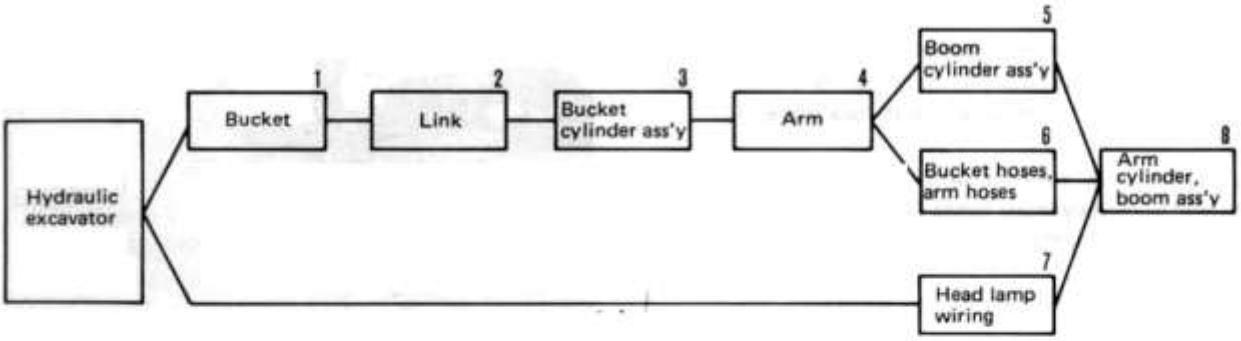
★ After installing the work equipment assembly, grease all the pins with grease (G2-LI).







DISASSEMBLY OF WORK EQUIPMENT ASSEMBLY



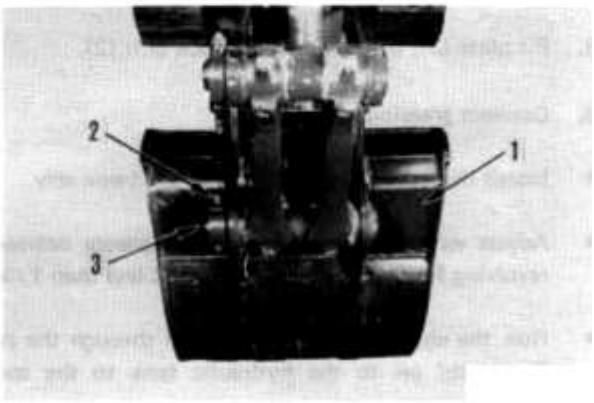
Special tool

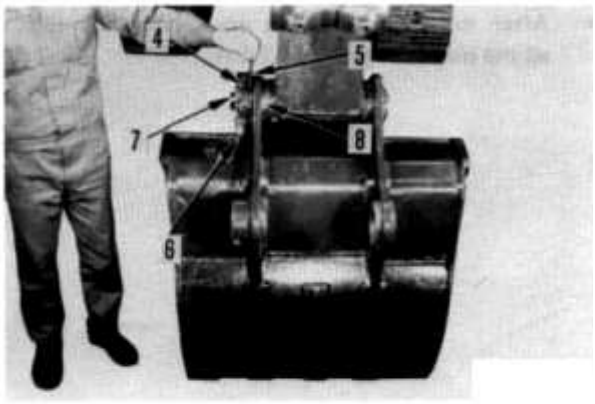
	Part No.	Part Name	Q'ty
A	796-900-1200	Remover	1
A_1	790-101-3800	Cylinder (50 ton)	1
A_2	790-101-1102	Pump	1

1. Bucket

1) Lower work equipment to ground so that bottom of bucket (1) is on ground.
2) Remove lock bolt (2), then remove cylinder connecting pin (3).
3) Start engine and retract bucket cylinder rod fully.
4) Loosen 4 mounting bolts of cover (4), and remove shims (5).
   ★ Check the number and thickness of the shims, and keep in a safe place.
5) Remove lock bolt (6), pull out arm connecting pin (7), then remove bucket (1) and retainer (8).

kg Bucket: 720 kg

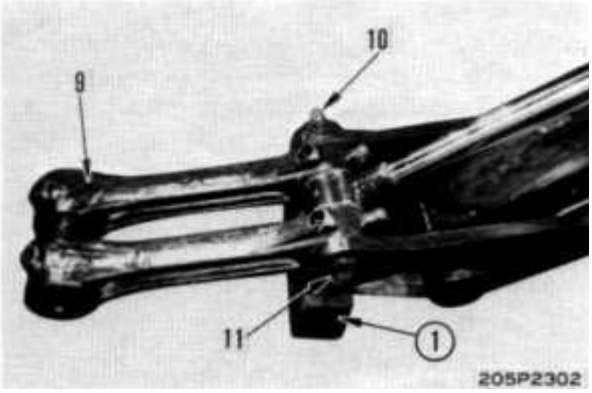




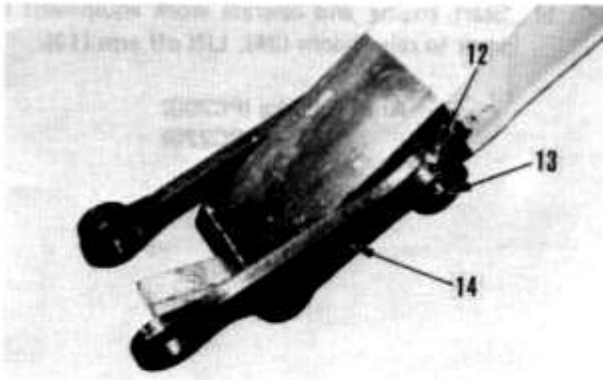
2. Link

1) Lower tip of arm to ground.
2) Set link (9) on block ①, then remove lock bolt (10). Pull out pin (11), and remove link (9).
3) Start engine and retract bucket cylinder rod fully.

⚠ Tie the bucket cylinder rod with wire to prevent it from coming out.



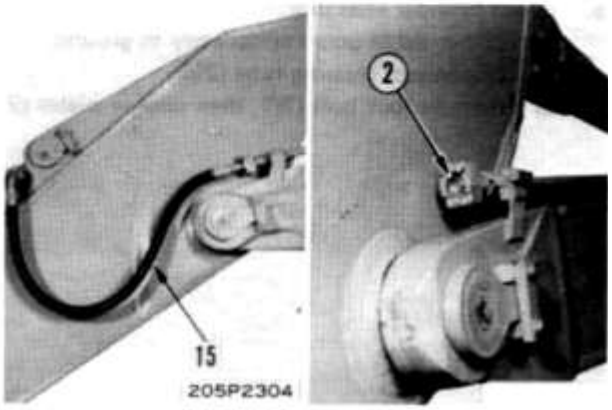
4) Remove lock bolt (12), pull out link pin (13), and remove link (14).



3. Bucket cylinder assembly

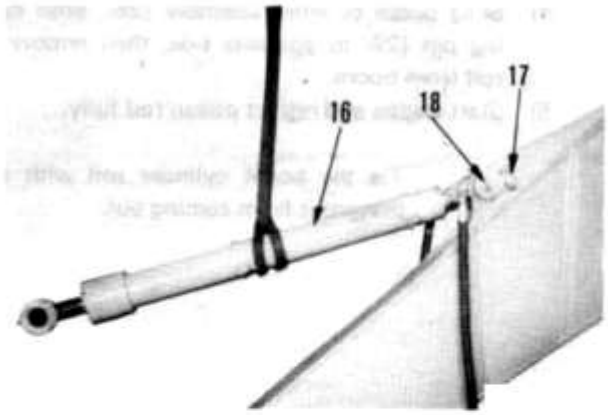
Release the hydraulic pressure in the hydraulic piping. For details, see section 62, TESTING AND ADJUSTING, Bleeding pressure from hydraulic circuit in machine with PPC valve.

1) Disconnect 2 bucket cylinder hoses (15).
   ★ After disconnecting the hoses, fit blind plug ② in the tube flange to prevent oil from coming out.



2) Sling bucket cylinder assembly (16), then remove lock plate (17). Pull out pin (18) and lift off bucket cylinder assembly (16).

kg Bucket cylinder assembly: 160 kg

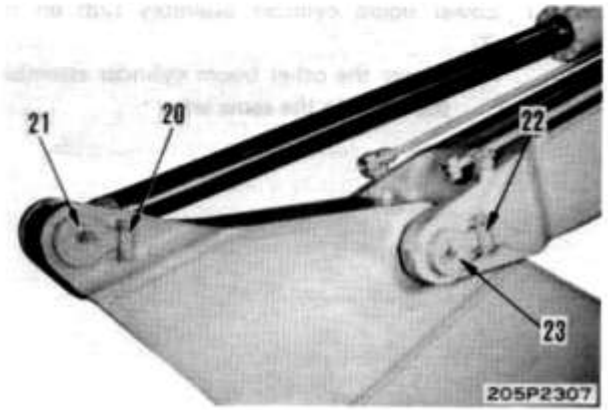


4. Arm

1) Pull in arm fully, and lower on to block (height: approx. 500 mm).
2) Remove lock plate (20), then remove pin (21).
3) Start engine and retract arm cylinder rod fully.

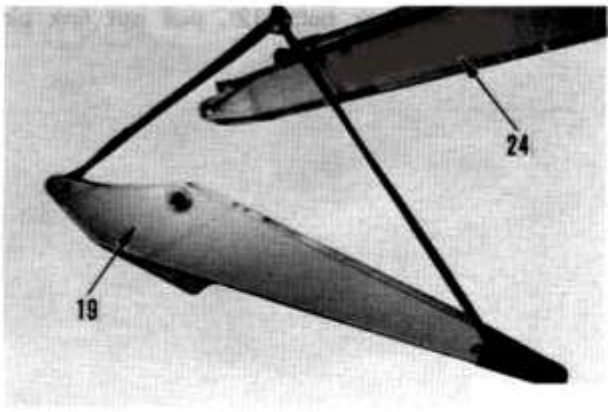
Tie the arm cylinder rod with wire to prevent it from coming out.

4) Remove lock plate (22), then remove pin (23).



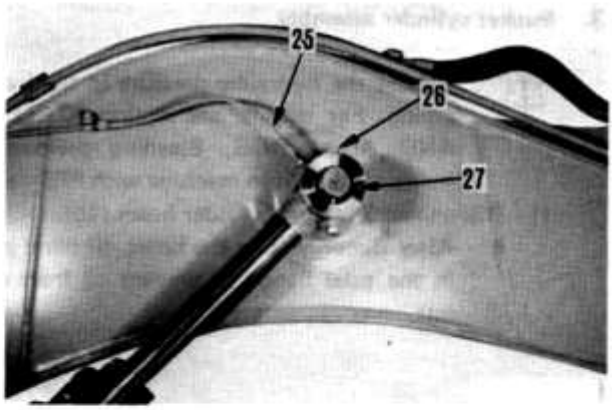
5) Start engine and operate work equipment control lever to raise boom (24). Lift off arm (19).

kg Arm: 700 kg



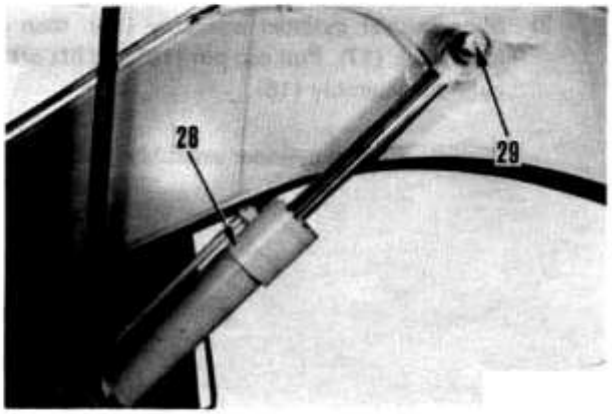
5. Boom cylinder assembly

1) Lower tip of boom completely to ground.
2) Disconnect greasing tube (25).
3) Remove lock bolt (26), then remove plates (27).



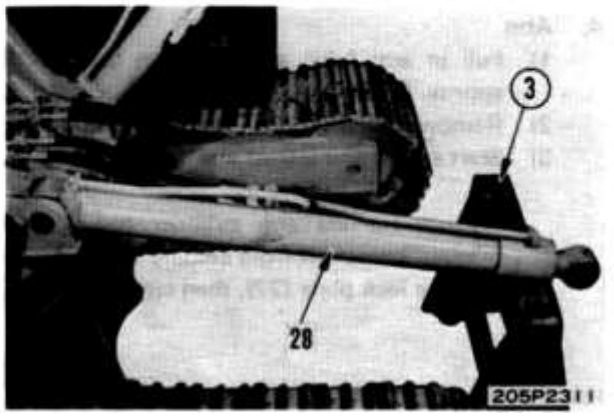
4) Sling boom cylinder assembly (28), push connecting pin (29) to opposite side, then remove piston rod from boom.
5) Start engine and retract piston rod fully.

⚠ Tie the boom cylinder rod with wire to prevent it from coming out.



6) Lower boom cylinder assembly (28) on to stand ③.

★ Lower the other boom cylinder assembly on to the stand in the same way.



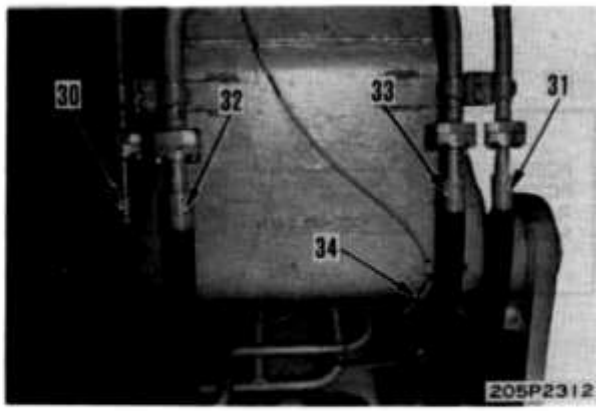
6. **Bucket hoses, arm hose**

Release the hydraulic pressure in the hydraulic piping. For details, see section 62, TESTING AND ADJUSTING, Bleeding pressure from hydraulic circuit in machines with PPC valve.

Disconnect bucket cylinder hoses (30) and (31), and arm cylinder hoses (32) and (33).

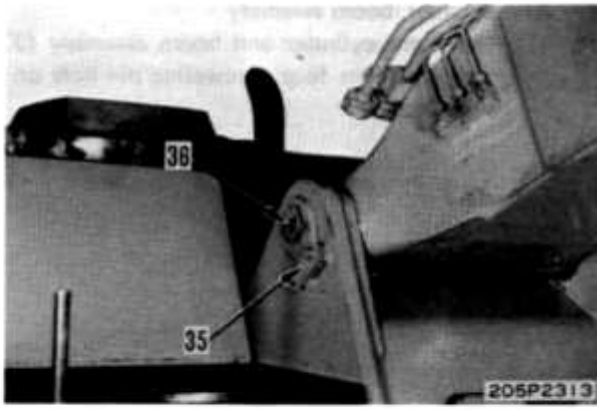
7. **Head lamp wiring**

Disconnect head lamp wiring (34) at connector.

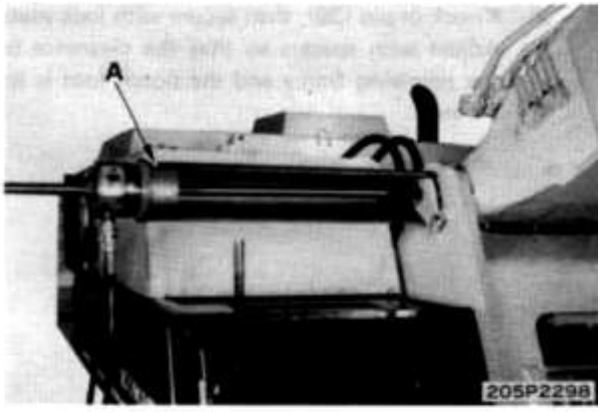


8. **Arm cylinder, boom assembly**

1) Remove lock plate (35).

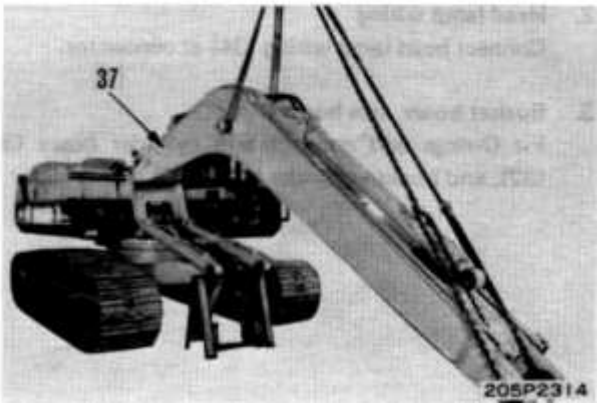


2) Sling boom, then pull out pin (36) with tool **A**.

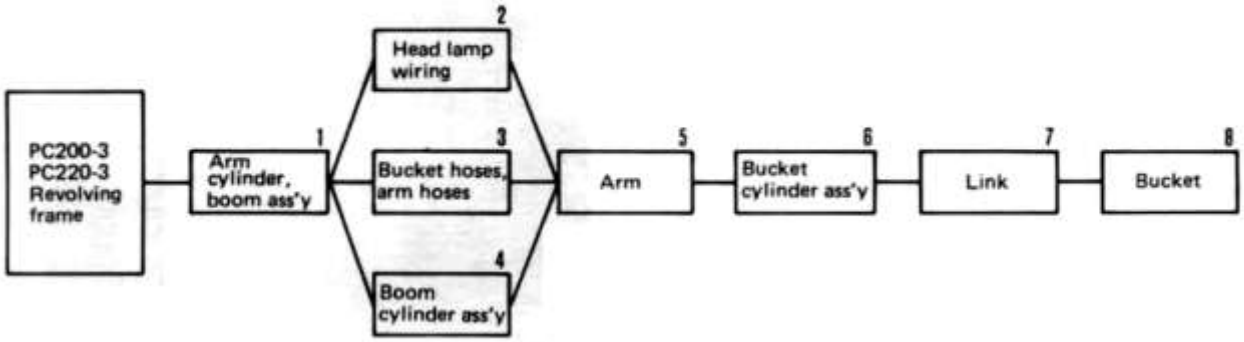


3) Raise arm cylinder and boom assembly (37), and pull out to front to remove.

kg Arm cylinder, boom assembly: **2000 kg**

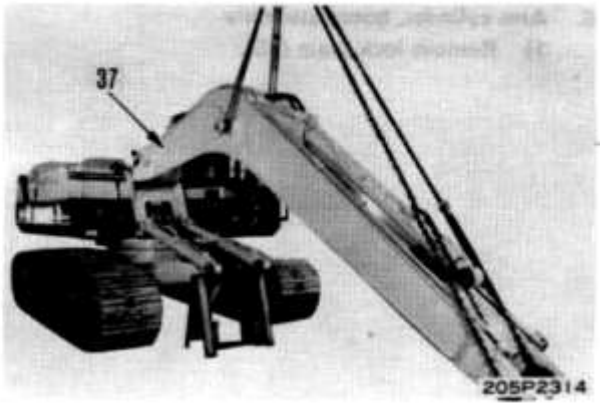


ASSEMBLY OF WORK EQUIPMENT ASSEMBLY



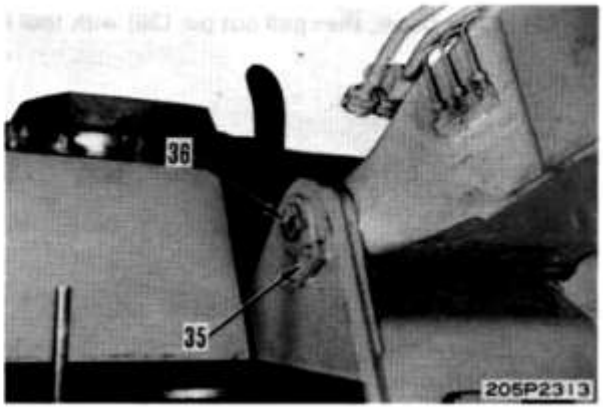
1. Arm cylinder, boom assembly

1) Raise arm cylinder and boom assembly (37), and position boom foot connecting pin hole on revolving frame.



2) Knock in pin (36), then secure with lock plate (35).

★ Adjust with spacers so that the clearance between the revolving frame and the boom foot is less than 1 mm.

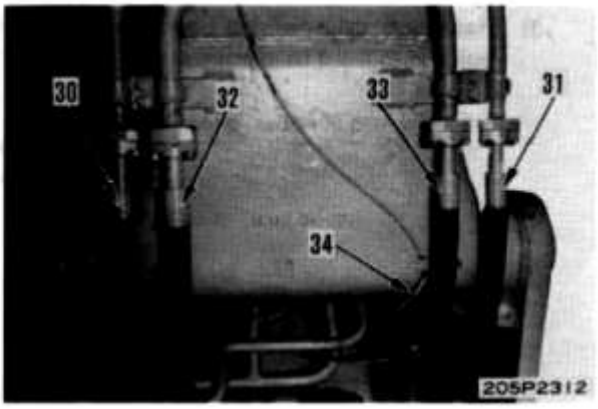


2. Head lamp wiring

Connect head lamp wiring (34) at connector.

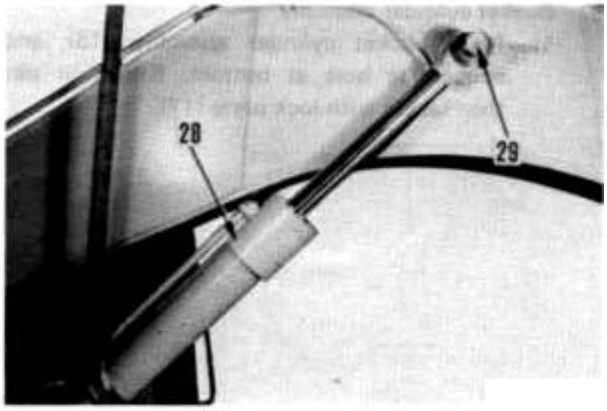
3. Bucket hoses, arm hoses

Fit O-rings and connect arm cylinder hoses (33) and (32), and bucket cylinder hoses (31) and (30).



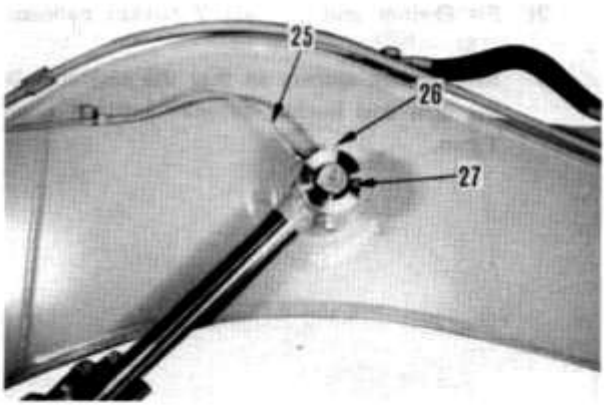
4. Boom cylinder assembly

1) Sling boom cylinder assembly (28). Start engine, extend piston rod and align with pin hole, then push in pin (29).



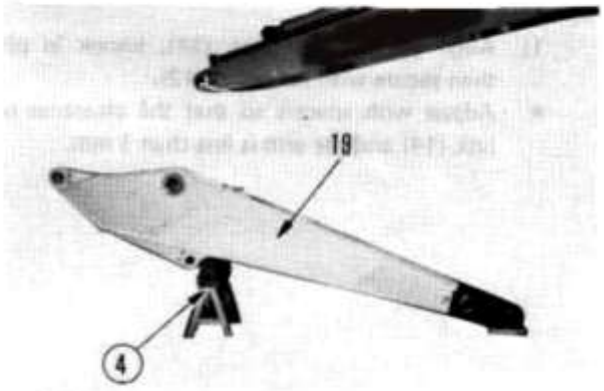
2) Fit plate (27), then secure with lock bolt (26).
3) Connect greasing tube (25).

★ Install the other boom cylinder in the same way.



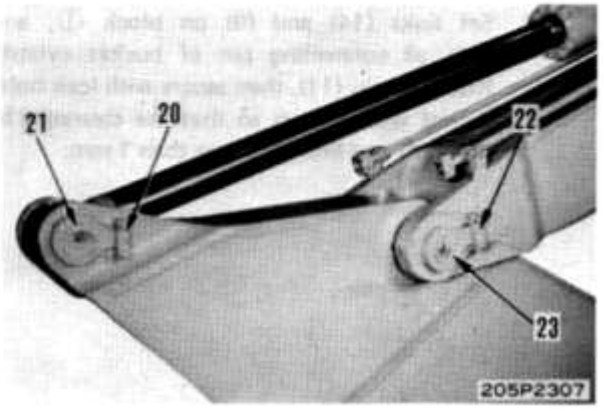
5. Arm

1) Raise arm (19), and lower on to block ④ (height: approx. 500 mm).



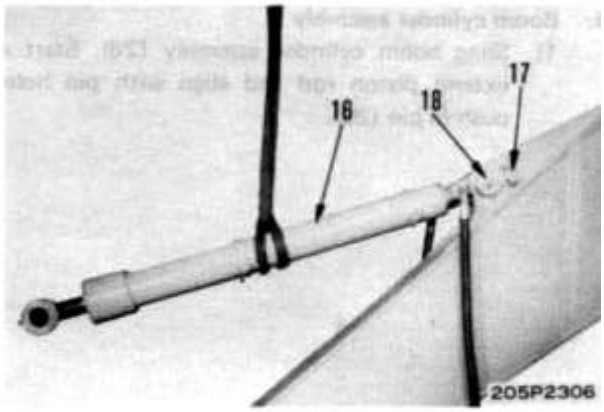
2) Operate control lever and align pin holes of boom and arm (19). Knock in connecting pin (23), then secure with lock plate (22).
3) Start engine, extend piston rod. Knock in connecting pin (21), then secure with lock plate (20).

★ Adjust with spacers so that the clearance at the joint of the arm and boom is less than 1 mm.



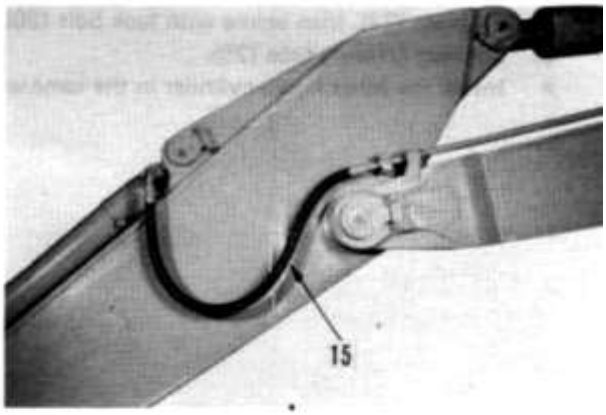
6. Bucket cylinder assembly

1) Raise bucket cylinder assembly (16), and align connecting hole at bottom. Knock in pin (18), then secure with lock plate (17).



2) Fit O-rings and connect 2 bucket cylinder hoses (15).

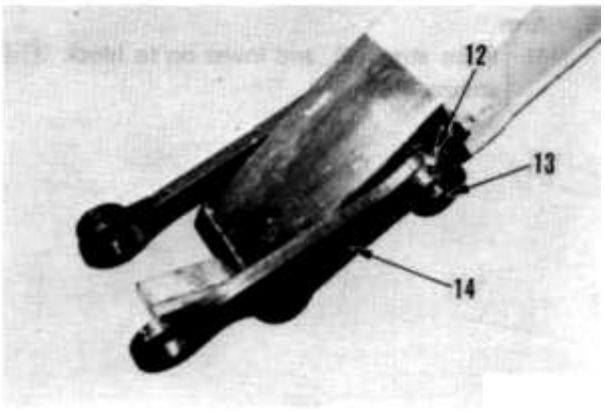
★ Adjust with spacers so that the clearance between the arm and bucket cylinder bottom is less than 1 mm.



7. Link

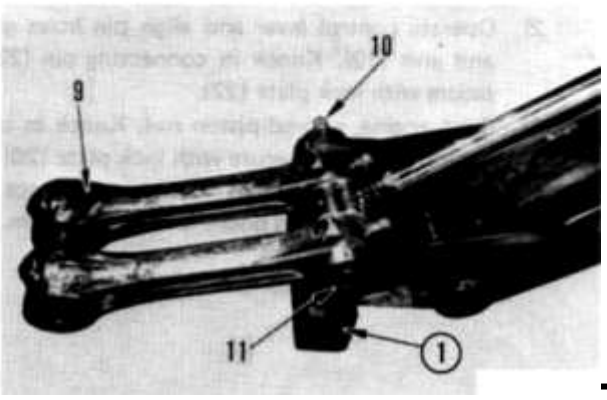
1) Align pin hole of link (14), knock in pin (13), then secure with lock bolt (12).

★ Adjust with spacers so that the clearance between link (14) and the arm is less than 1 mm.



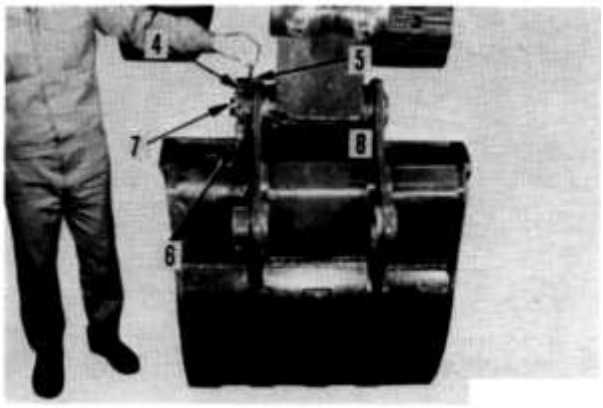
2) Set links (14) and (9) on block ①, and align hole of connecting pin of bucket cylinder rod. Knock in pin (11), then secure with lock bolt (10).

★ Adjust with spacers so that the clearance between link (14) and link (9) is less than 1 mm.

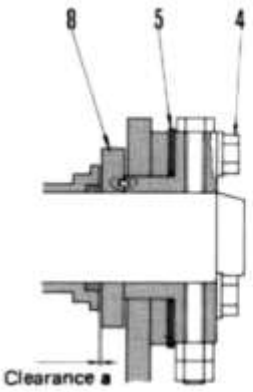


8. Bucket

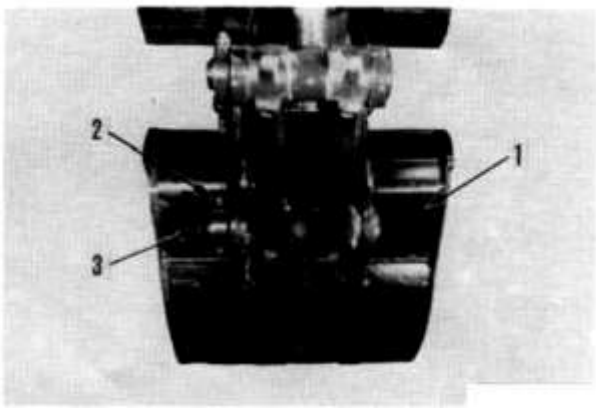
1) Set bottom of bucket (1) on ground.
2) Operate control levers, and align bucket (1) and retainer (8) with arm pin hole. Knock in arm connecting pin (7), then secure with lock bolt (6).



3) Adjust with shim (5) so that clearance "a" between arm and retainer (8) is 0.5 – 1.0 mm, then tighten 4 mounting bolts of cover (4).



4) Extend bucket cylinder rod and align pin hole. Knock in cylinder connecting pin (3), then secure with lock bolt (2).



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HYDRAULIC SYSTEM

14 MAINTENANCE AND STANDARD

Wrist control ……..…… 14-02

PPC shuttle valve …… 14-02

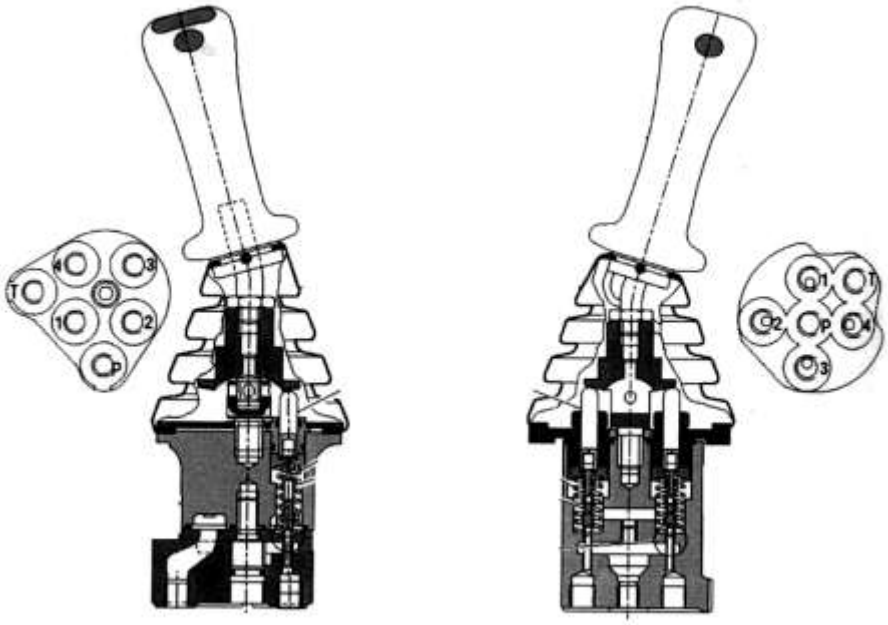
Control valve ……..…… 14-03

Hydraulic cylinder ……..…… 14-04

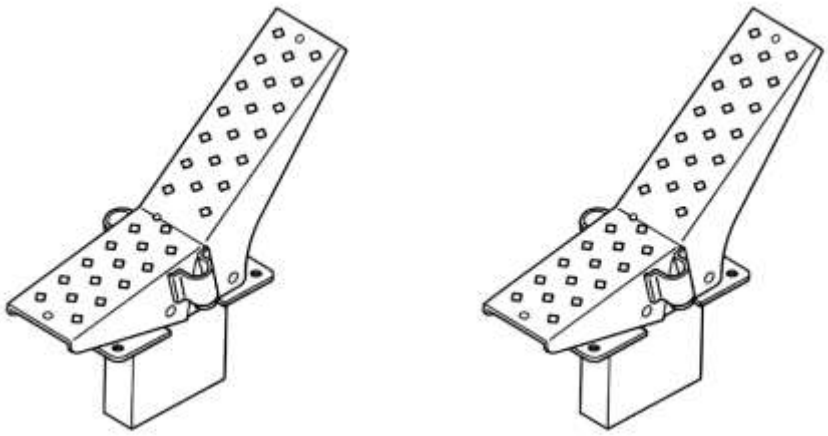
Work equipmnet …… 14-06

Refer Rexroth Insatruction Manual of HS-64-05-E0403-1-3

WRIST CONTROL

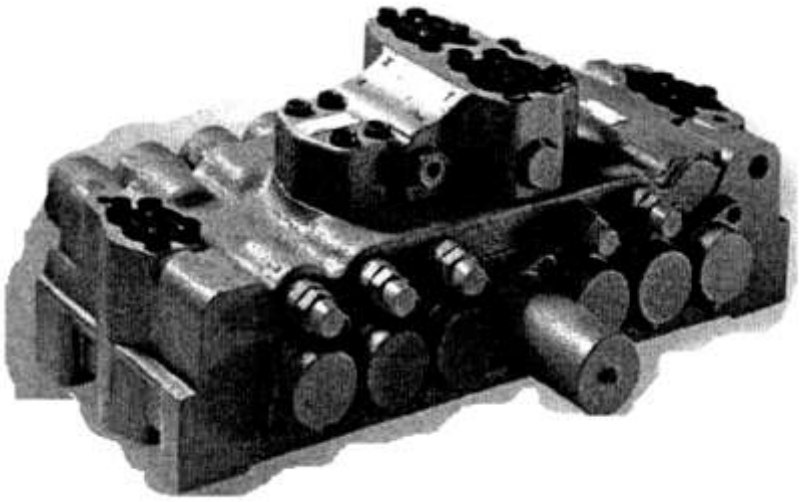


PPC SHUTTLE VALVE

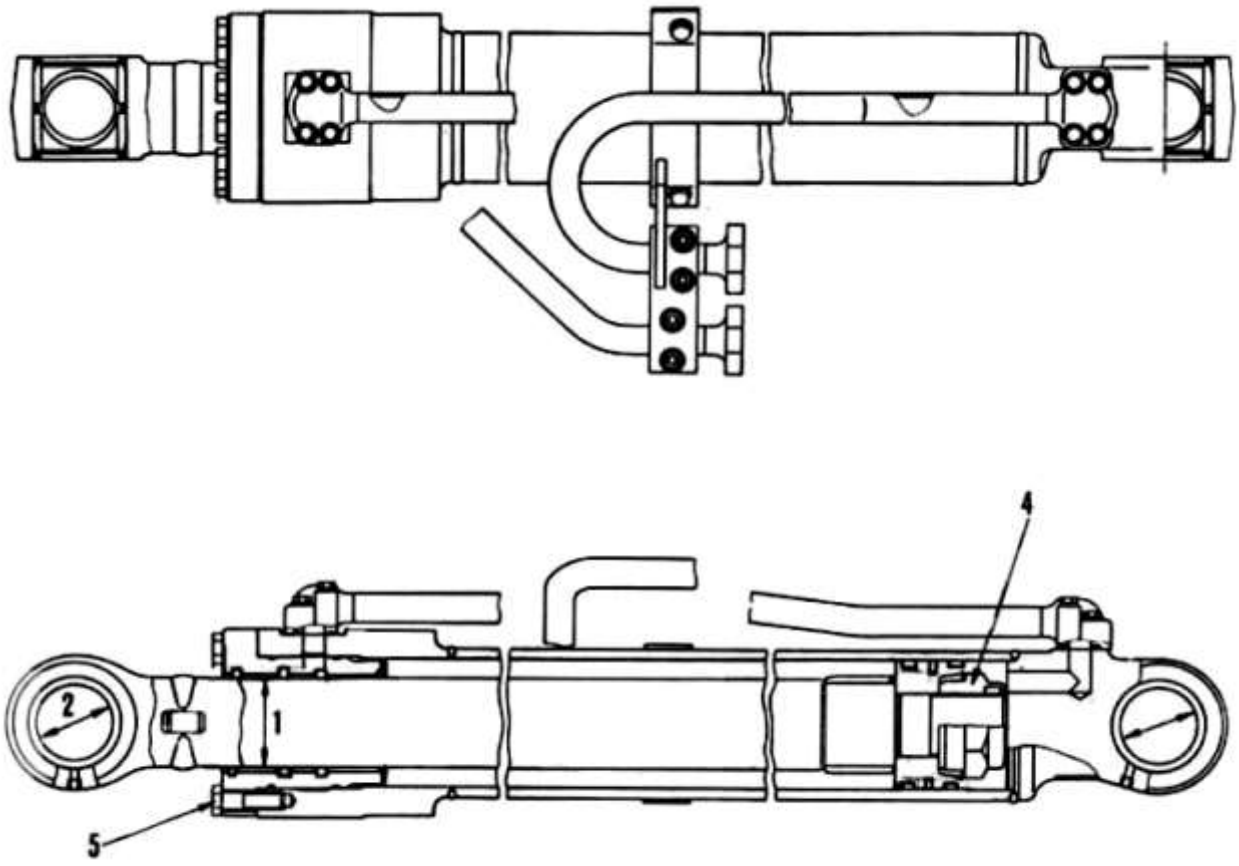


Refer Rexroth Insatruction Manual of HS-64-05-E0403-1-3

CONTROL VALVE



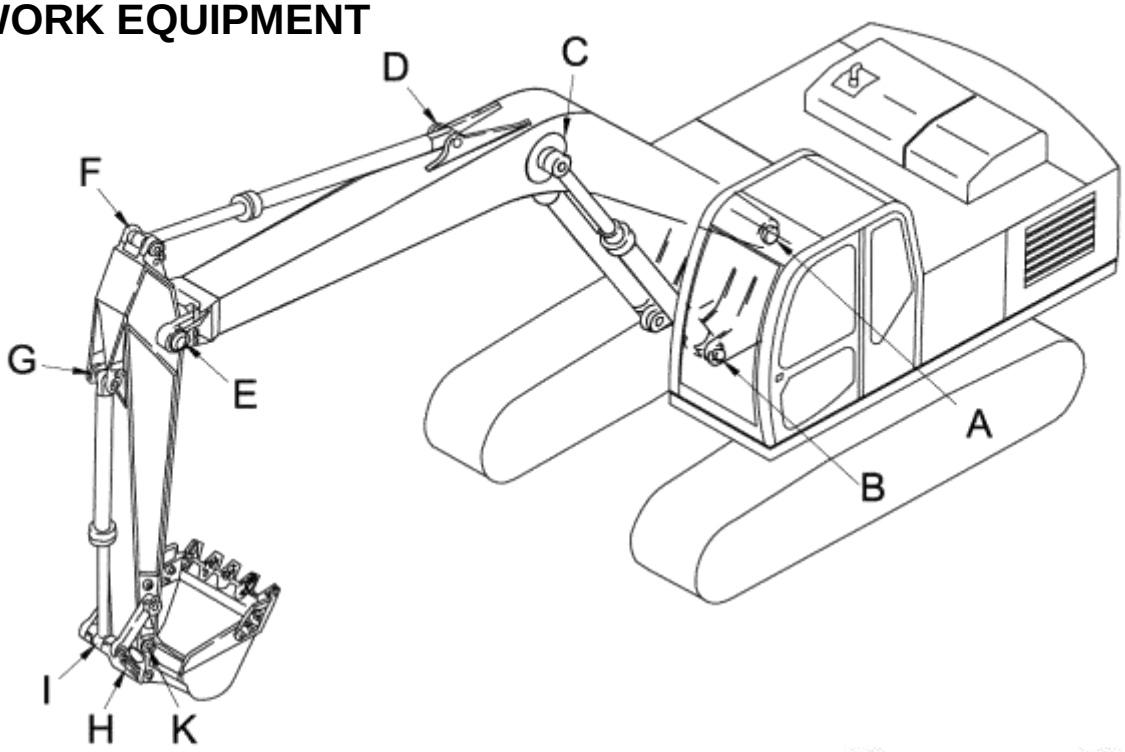
HYDRAULIC CYLINDER

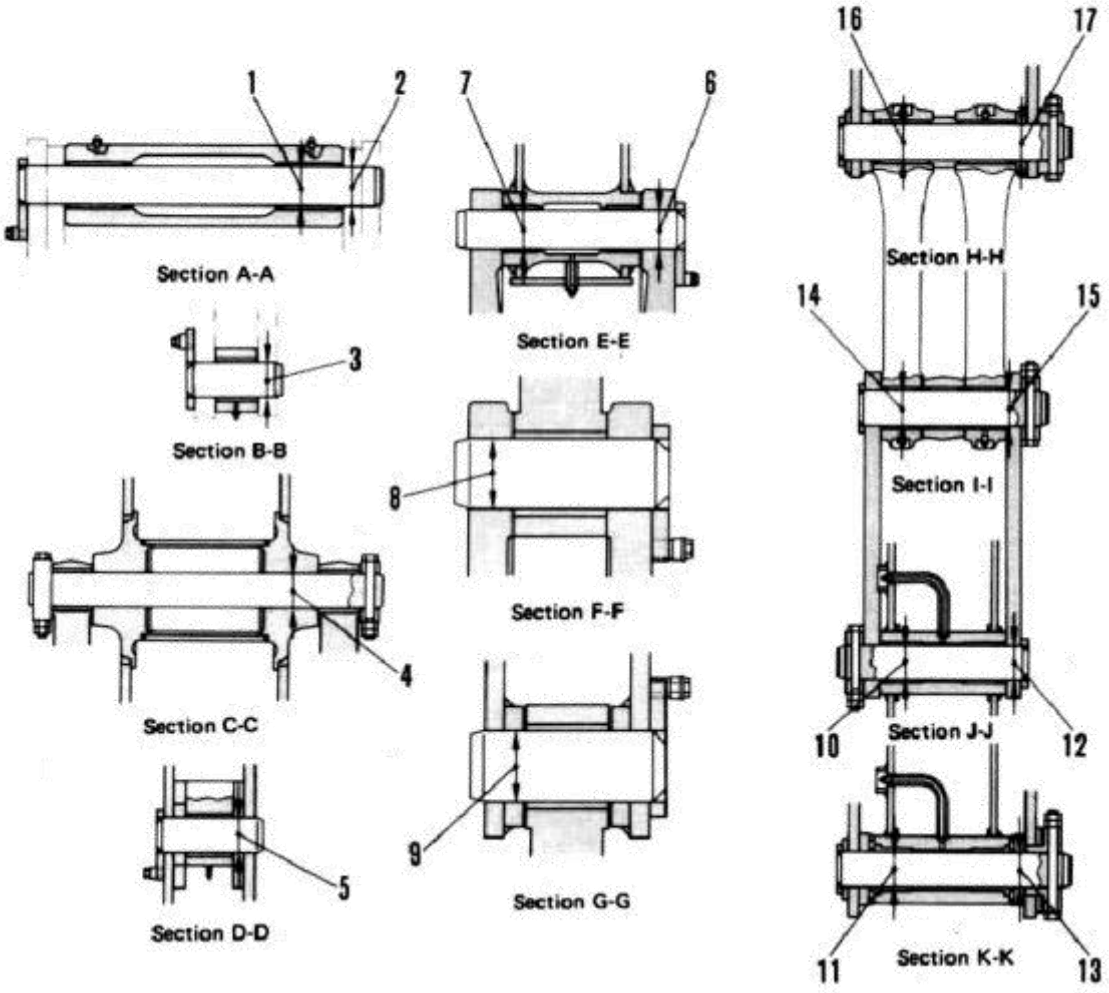


Unit : mm

No.	Check item	Criteria							Remedy
		Cylinder name	Application	Standard size	Tolerance		Standard clearance	Clearance limit	
					shaft	hole			
1	Clearance between piston rod and bushing	Boom cylinder	BE220G BE220 BE220LC	90	-0.036 -0.123	+0.257 +0.048	0.084 - 0.380	0.680	Replace bushing
		Arm cylinder	BE220G BE220 BE220LC	100	-0.036 -0.123	+0.222 +0.047	0.083 - 0.345	0.645	
		Bucket cylinder	BE220G BE220 BE220LC	90	-0.036 -0.123	+0.222 +0.047	0.083 - 0.345	0.645	
2	Clearance between piston rod support and bushing	Boom cylinder	BE220G BE220 BE220LC	80	-0.030 -0.076	+0.457 +0.370	0.400 - 0.533	1.0	Replace pin and bushing
		Arm cylinder	BE220G BE220 BE220LC	80	-0.030 -0.076	+0.457 +0.370	0.400 - 0.533	1.0	
		Bucket cylinder	BE220G BE220 BE220LC	80	-0.030 -0.076	+0.457 +0.370	0.400 - 0.533	1.0	
3	Clearance between cylinder bottom support and bushing	Boom cylinder	BE220G BE220 BE220LC	80	-0.030 -0.076	+0.457 +0.370	0.400 - 0.533	1.0	
		Arm cylinder	BE220G BE220 BE220LC	80	-0.030 -0.076	+0.457 +0.370	0.400 - 0.533	1.0	
		Bucket cylinder	BE220G BE220 BE220LC	80	-0.030 -0.076	+0.457 +0.370	0.400 - 0.533	1.0	
4	Tightening torque for piston nut	Boom cylinder	BE220G BE220 BE220LC	1,040 ±104 kgm (with across flats : 95)					
		Arm cylinder	BE220G BE220 BE220LC	1,040 ±104 kgm (with across flats : 95)					
		Bucket cylinder	BE220G BE220 BE220LC	1,040 ±104 kgm (with across flats : 95)					
5	Tightening torque for cylinder head mounting bolt	Boom cylinder	BE220G BE220 BE220LC	27.5 ±4.0 kgm					
		Arm cylinder	BE220G BE220 BE220LC	38.0 ±5.5 kgm					
		Bucket cylinder	BE220G BE220 BE220LC	27.5 ±4.0 kgm					

WORK EQUIPMENT





Unit : mm

No.	Check item	Criteria					Remedy
		Standard size	Tolerance		Standard clearance	Clearance limit	
			shaft	hole			
1	Clearance between boom-revolving frame mounting pin and bushing	90	-0.036 -0.090	+0.342 +0.269	0.305 - 0.269	1.0	
2	Clearance between boom-revolving frame mounting pin and boss hole	90	-0.036 -0.090	+0.1 0	0.036 - 0.190	1.0	
3	Clearance between boom cylinder revolving frame mounting pin and boss hole	80	-0.030 -0.076	+0.15 0	0.030 - 0.226	1.0	
4	Clearance between boom-boom cylinder rod mounting rod and boss hole	80	-0.030 -0.076	+0.17 +0.07	0.030 - 0.246	1.0	
5	Clearance between boom-arm cylinder mounting pin and boss hole	80	-0.030 -0.076	+0.1 0	0.030 - 0.176	1.0	
6	Clearance between boom-arm mounting pin and boss hole	90	-0.036 -0.090	+0.1 0	0.036 - 0.190	1.0	
7	Clearance between boom-arm mounting pin and bushing	90	-0.036 -0.090	+0.343 +0.271	0.307 - 0.433	1.0	
8	Clearance between arm-arm cylinder mounting pin and boss hole	80	-0.030 -0.076	+0.1 0	0.030 - 0.176	1.0	Replace
9	Clearance between arm-bucket cylinder mounting pin and boss hole	80	-0.030 -0.076	+0.1 0	0.030 - 0.176	1.0	
10	Clearance between arm-link mounting pin and bushing	80	-0.030 -0.076	+0.337 +0.273	0.303 - 0.413	1.0	
11	Clearance between arm-bucket mounting pin and bushing	80	-0.030 -0.076	+0.337 +0.273	0.303 - 0.413	1.0	
12	Clearance between arm-link mounting pin and link	80	-0.030 -0.076	+0.1 0	0.030 - 0.176	1.0	
13	Clearance between arm-bucket mounting pin and boss hole	80	-0.030 -0.076	+0.1 0	0.030 - 0.176	1.0	
14	Clearance between bucket cylinder-link mounting pin and bushing	80	-0.030 -0.076	+0.337 +0.273	0.303 - 0.413	1.0	
15	Clearance between bucket cylinder-link mounting pin and link	80	-0.030 -0.076	+0.1 0	0.030 - 0.176	1.0	
16	Clearance between link-bucket mounting pin and bushing	80	-0.030 -0.076	+0.331 +0.265	0.295 - 0.408	1.0	
17	Clearance between link-bucket mounting pin and boss hole	80	-0.030 -0.076	+0.1 0	0.030 - 0.176	1.0	

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SWING DRIVE
15 SERVICE MANUAL (PMT / PMTE)

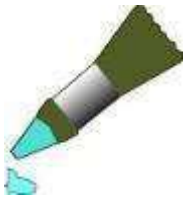
SYMBOL DESCRIPTION 04
PRODUCT IDENTIFICATION 05
GEARBOX MOUNTING..... 05
Frame mounting..... 06
Motor assembly..... 07
GEARBOX OPERATION AND MAINTENANCE… 08
General instructions..... 08
Oil filling 09
Oil draining..... 10
Lubrication of output bearing with grease..... 11

This publication supersedes and replaces any previous issue and revision.

PMP - PRO-MEC reserves the right to implement modifications without notice.

During maintenance, assembly and disassembly activities use caution and proper safety equipment, in observance to the rules provided by safety laws.

1. SYMBOLS DESCRIPTION

	COMPULSORY REQUIREMENT
	PAY ATTENTION NOT TO DAMAGE COMPONENTS
	WATCH YOUR FEET, YOUR BACK AND YOUR HANDS: THE COMPONENT IS HEAVY, MOVE IT CAREFULLY !!!
	TIGHTENING WITH DYNAMOMETRIC WRENCH !!!
	APPLICATION OF SEALING/LOCKING FLUID
	DISPOSE IN ACCORDANCE TO ENVIRONMENTAL LAWS

2. PRODUCT IDENTIFICATION

Each gearbox is supplied with an identification nameplate. (Fig. 1).

If necessary, for spare parts enquiries, information and service support, identify the model and the serial number reported on the nameplate.

The data stamped on the nameplate must always be visible and undamaged.

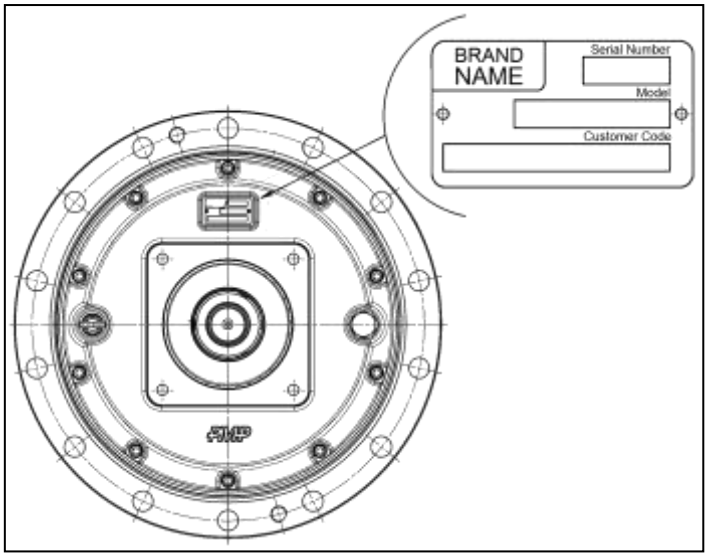


Fig. 1

3. GEARBOX MOUNTING

In the following picture there are the geometrical tolerances for assembly (Fig.2). On gearboxes with double centering surfaces, it is recommended that the dimension of hole ”L” is 0,5÷1 mm greater than the diameter of the gearbox centering surface.

For dimensions and technical data please refer to the specific drawing provided with the gearbox.

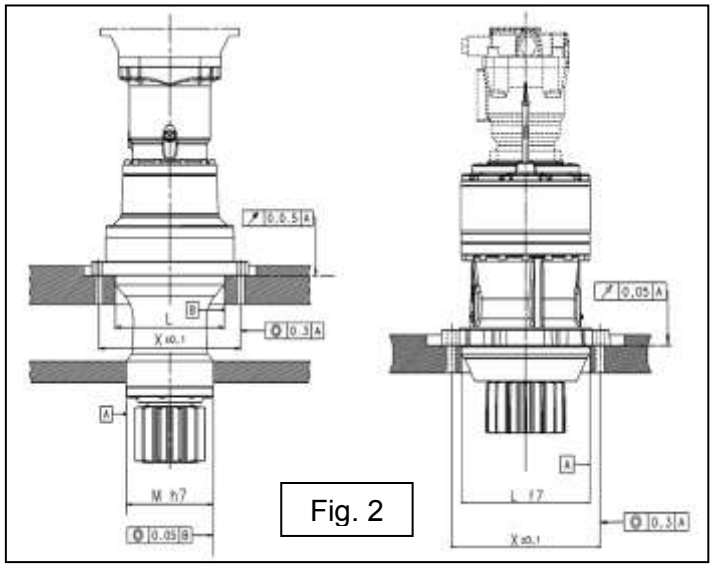


Fig. 2

3.1 FRAME MOUNTING

To ensure the correct operation of the gearbox, follow the rules below:

- The unit must be fixed to a rigid structure and the supporting surface should be thoroughly cleaned.
- The centering and the coupling surfaces of the unit must be clean and undamaged
- Lubricate all the centering diameters of the gear unit and the housing seat with grease or oil

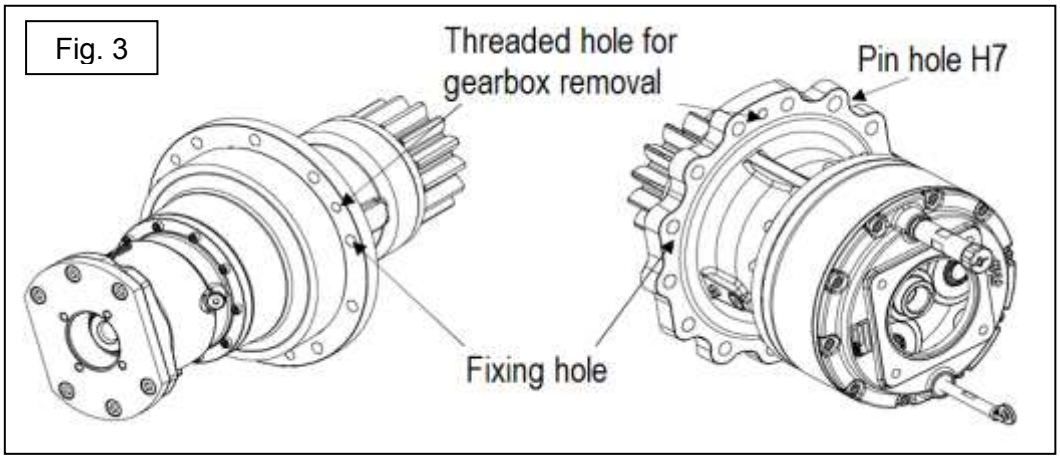
The measures described above are important for ensuring perfect meshing between gearbox pinion and the slewing ring and to prevent any damage to the structure which could cause the

Gearbox to malfunction.

PMT and PMTE gearboxes must be fixed on the frame with screws inserted in the through holes of the gearbox housing (Fig.3). Some gearboxes feature pin holes for accurate positioning.

Note: for gearbox extraction, dedicated threaded holes are available on the gearbox housing.

Fig. 3



3.2 MOTOR ASSEMBLY

Connect the motor using the 4 threaded holes on the gearbox upper flange (Fig.4).

While assembling the motor onto the gearbox, the motor shaft must be lubricated with a thin layer of grease.

Insert the motor shaft into the coupling and make sure that the motor centering diameter perfectly matches the gear unit centering diameter.

Check that the motor is properly centered, and then block it with 4 screws. Tightening torque are indicated on table 1.

ATTENTION: During the motor assembly pay attention not to damage toe O-ring.

Table 1 Tightening torque table

Thread	Torque grade 12.9
M10	70 Nm
M12	120 Nm
M14	190 Nm
M16	300 Nm
M20	680 Nm

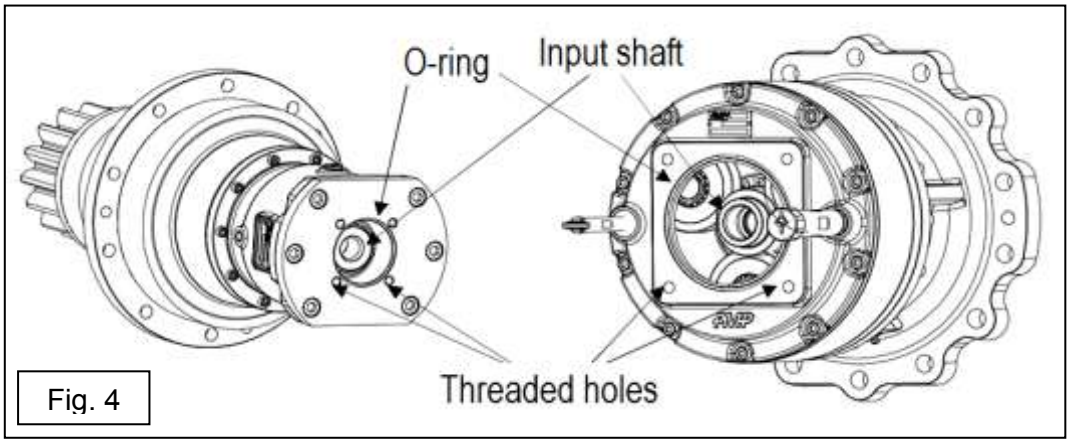


Fig. 4

4. GEARBOX OPERATION AND MAINTENANCE

4.1 GENERAL INSTRUCTIONS

Admissible oil temperature range (working conditions): -20°C / +90°C (-4°F / 194 °F)

Gearbox must be immediately stopped and cooled down if oil temperature reaches +90°C (194°F)

All maintenance activities must be in carried out under safety conditions

- The gearbox is supplied without oil
- The routine maintenance includes only the regular substitution of the oil
- At every oil change, check the magnetic plug for metallic parts with unusual dimensions
- Do not mix different types of oil
- Use the following Table 2 for maintenance intervals of the gearbox:

Table 2 Gearbox operation and maintenance

Operation	Interval
Oil level control	Every 150 operating hours of the gearbox
First oil change	After 100 operating hours of the gearbox
Regular oil change	Every 1000 operating hours or 1 year
First screw tightness control	After the first 50 operating hours
Regular screw tightness control	Every 1000 operating hours

Maintenance intervals indicated in Table 2 are based on standard working conditions. In case of intense working conditions or special environmental conditions, recommended maintenance intervals shall be discussed with PMP

4.2 OIL FILLING

ATTENTION: The gearbox is supplied without oil! Make sure to fill the gearbox with the appropriate oil quantity prior to operating it.

For the proper oil quantity refer to the specific drawing provided with the gearbox.

For correct use of the unit you are recommended to use oil type:

SAE 80W90 / API GL5

The following Table 3 shows a list of suggested lubricants (for temperate climate):

Table 3 Suggested lubricants

Manufacturers	**Oil type**
AGIP	MP
MOBIL	HD
REPSOL	EP

For oil-filling operation, follow the steps below:

Respect the environment! Dispose in accordance to environmental laws

- ***Step 1:*** Unscrew the fill plug (see Fig.:5a Page 10)
- ***Step 2:*** Check that the drain plug is tightened
- ***Step 3:*** Fill the gearbox from the fill plug.

  For PMTE the quantity of oil is sufficient when the level on the oil dipstick is within the Min and Max range (Fig.: 5b Page: 10).

  For PMTE the quantity of oil is sufficient when the level on the oil dipstick is within the oil dipstick edge and Max range (Fig.: 5b Page: 10).

  For an indication of the approximate oil quantity needed please refer to the specific drawing provided with the gearbox.
- ***Step 4:*** Put the plugs with their washers back in place.

4.3 OIL DRAINING

For oil-draining operation, follow these steps:

Respect the environment!
Dispose in accordance to environmental laws

- Step 1: In order to facilitate draining it is suggested to remove the oil filling plug
- Step 2: Remove the drain plug and allow all the oil to flow out of the gearbox
- Step 3: Refill the gearbox following the steps come described on pag.10

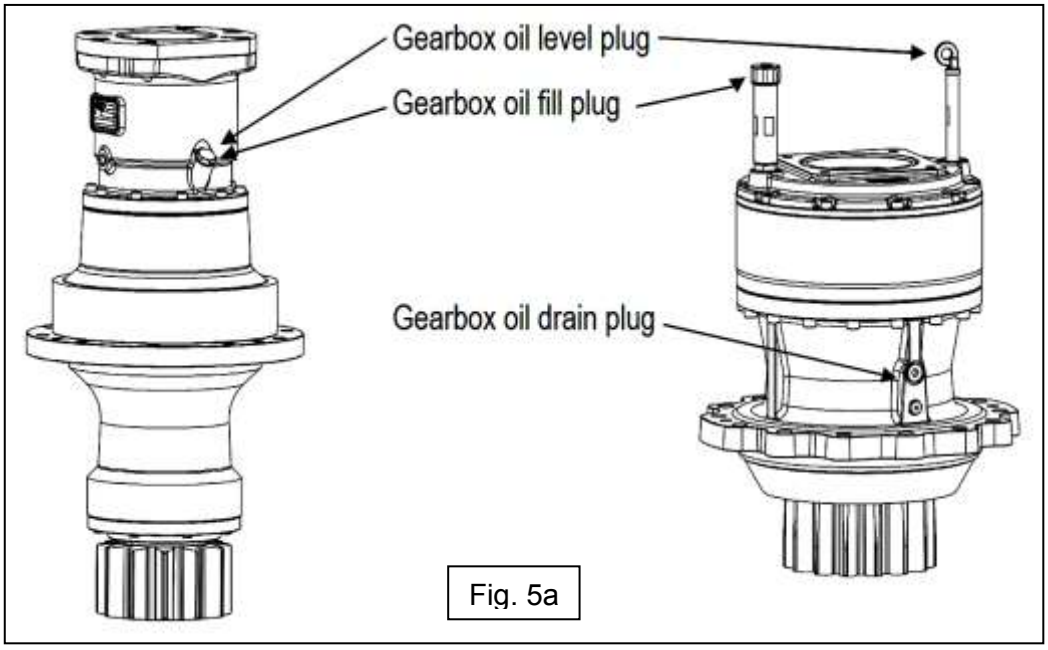


Fig. 5a

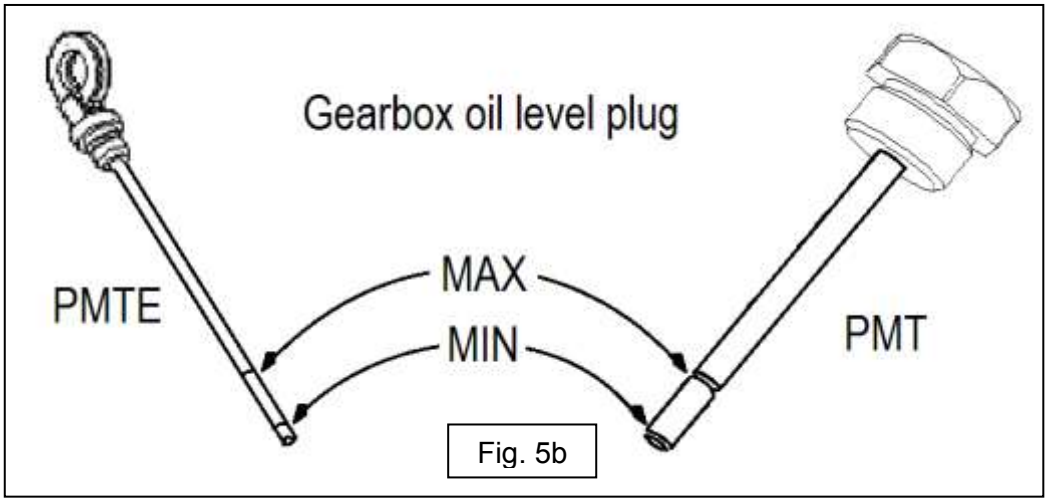


Fig. 5b

4.4 LUBRICATION OF THE OUTPUT BEARING WITH GREASE

During operation, PMTE gearboxes output bearing chamber must have the correct quantity of grease.

PMT and PMTE gearboxes are supplied with the output bearing chamber already filled with grease.

Grease level must be checked regularly every 1000 hours.

It is recommended to use Mobil grease XHP222.

Alternatively grease with the following characteristics cab be used.

Thickener type	Li-complex
Consistency	NLGI N°2
Base oil:	Mineral oil with viscosity 220 mm² / S at 40° C
Dropping point	260° C

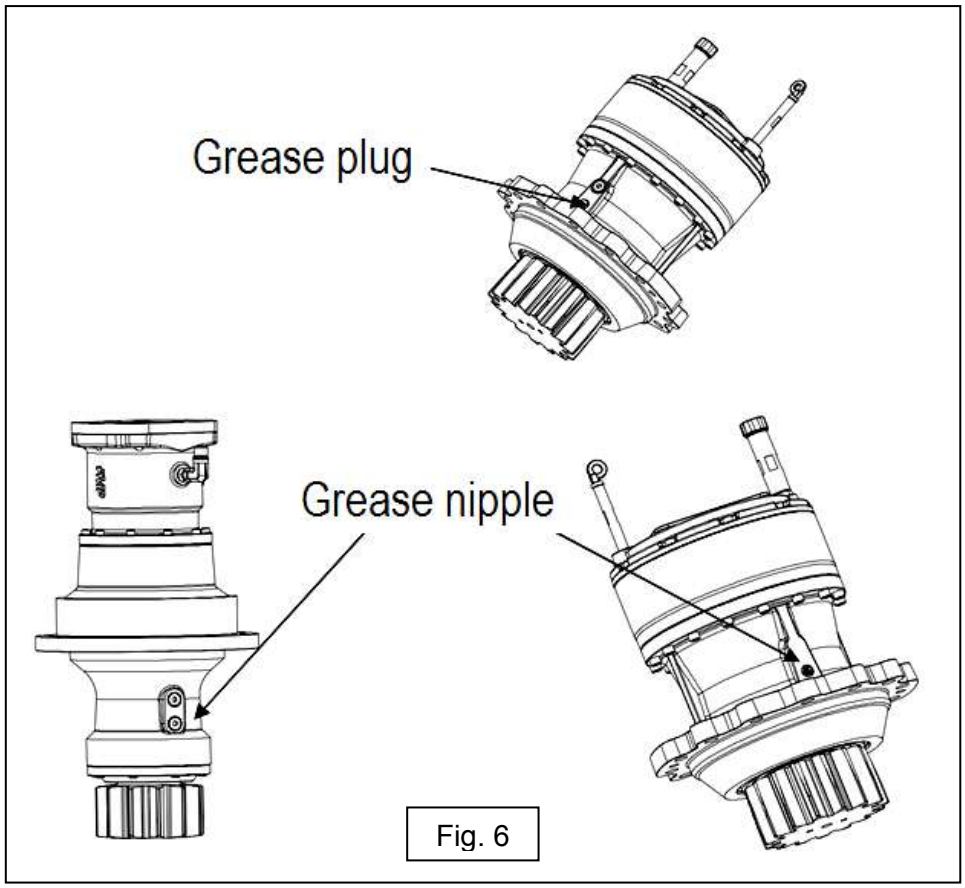


Fig. 6

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TRAVEL DRIVE
16 SERVICE MANUAL (PMCI)

1. SYMBOL DESCRIPTION 02
2. PRODUCT IDENTIFICATION 03
3. GEARBOX MOUNTING..... 03
   3.1 Frame mounting 04
   3.2 Sprocket mounting 04
4. CONNECTION TO THE HYDRAULIC SYSTEM … 05
   4.1 Hydraulic fluid ……..... 05
   4.2 Filtration 05
   4.3 Connection details 06
   4.4 Motor displacement ……..... 07
   4.5 Motor orientation ……. 07
   4.6 Connection of the brake ……. 09
5. GEARBOX OPERATION & MAINTENANCE …… 09
   5.1 General instructions …… 09
   5.2 Oil filling …… 10
   5.3 Oil draining …… 10
   5.4 Mechanical disengagement …… 11

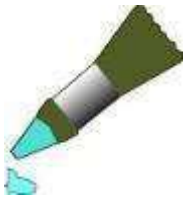
SAFETY REGULATION

This handbook provides just on overview of the gearbox and is addressed to skilled workmen properly equipped to perform maintenance.

ATTENTION!

During maintenance, assembly and disassembly activities use caution and proper safety equipment, in observance to the rules provided by safety laws.

1. SYMBOLS DESCRIPTION

	COMPULSORY REQUIREMENT
	PAY ATTENTION NOT TO DAMAGE COMPONENTS
	WATCH YOUR FEET, YOUR BACK AND YOUR HANDS: THE COMPONENT IS HEAVY, MOVE IT CAREFULLY !!!
	TIGHTENING WITH DYNAMOMETRIC WRENCH
	APPLICATION OF SEALING/LOCKING FLUID
	DISPOSE IN ACCORDANCE TO ENVIRONMENTAL LAWS

2. PRODUCT IDENTIFICATION

Each drive is supplied with one identification nameplate for the gearbox (Fig. 1a) and one for the motor (Fig. 1b).

If necessary, for spare parts enquiries, information and service support, identify the model and the serial numbers reported on the nameplates.

The data stamped on the nameplate must always be visible and undamaged.

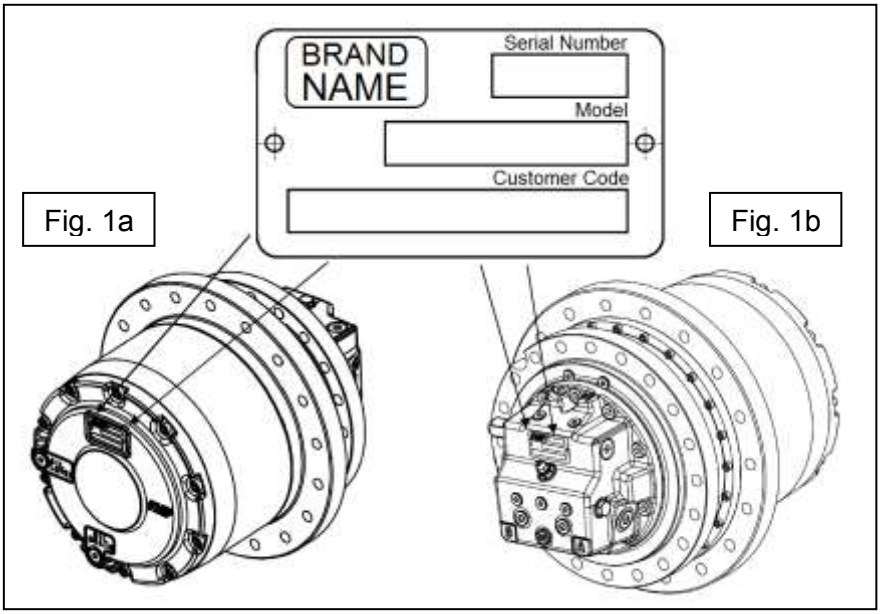


Fig. 1a

Fig. 1b

3. GEARBOX MOUNTING

The geometrical indications and tolerances for the correct mounting are shown here below (Fig. 2)

For d1 and d2 dimensions and additional technical data, refer to the specific drawing provided with the drive.

	Gearbox (mm)	Sprocket (mm)
d2	≤ 300	d2 H9
	> 300	(d2+0.2) H9

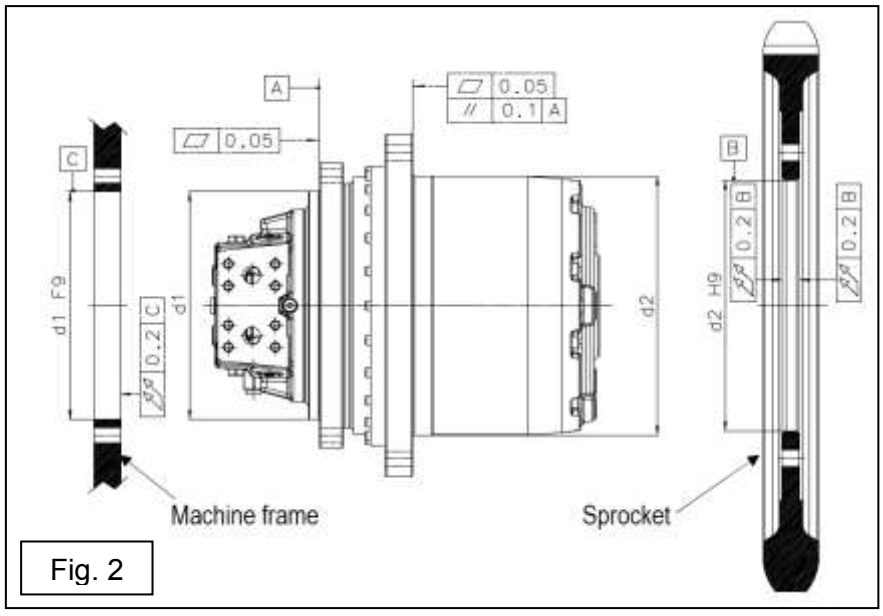


Fig. 2

3.1 FRAME MOUNTING

To ensure the correct operation of the gearbox, it is necessary to:

- Check that the structure to which the gearbox is mounted is sufficiently robust and rigid to support its weight and operating stresses.
- Check that the centering and the coupling surfaces of the drive unit are clean and undamaged, for correct and secure locking.

Apply high strength thread locker on the screw threads.

Tighten at the torque indicated on Table 1

3.2 SPROCKET MOUNTING

Clean mating surfaces and install the sprocket on the gearbox (Fig. 3)

Apply high strength thread locker on the screw threads.

Tighten at the torque indicated on Table 1

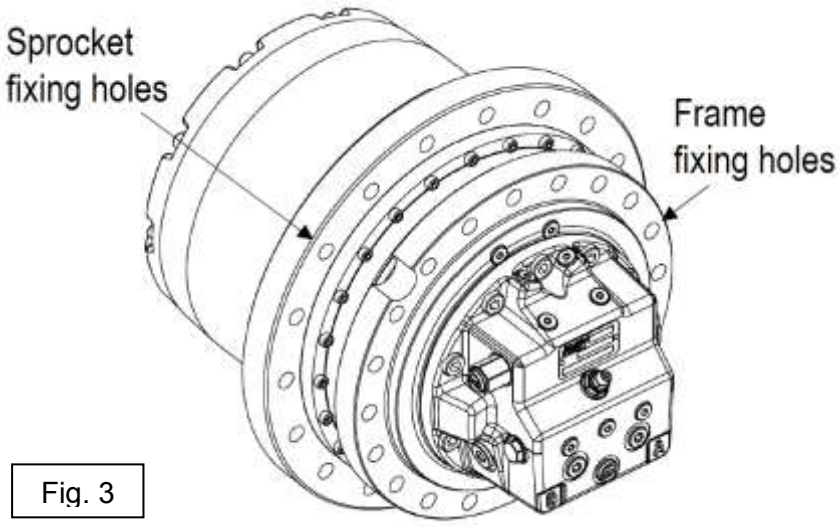


Fig. 3

Table 1 Tightening torque table

Thread	Torque Grade 12.9
M10	70 Nm
M12	120 Nm
M14	190 Nm
M16	300 Nm
M20	680 Nm
M24	1220 Nm
M30	2430 Nm

4. CONNECTION TO THE HYDRAULIC SYSTEM

PMCI drives can be used on machines equipped with open or closed loop hydraulic circuit.

For motor technical data and hydraulic schematics please refer to the specific drawing provided with the drive.

To ensure the correct operation, it is necessary to:

- Make sure that all hydraulic hoses and connections are clean and free from any internal obstruction
- Prevent that any foreign particles enter into the hoses remove the plastic caps only at the time of the connection
- Filter the oil after hoses are connected to the motor
- Not mix different kinds of oil

4.1 HYDRAULIC FLUID

The motor must be operated with high mineral oil.

The following Table 2 indicates the recommended characteristics of the hydraulic fluid:

Table 2 Hydraulic fluid viscosity range		
Hydraulic fluid	**High Viscosity Index**	
Operating viscosity range	cSt	16-36
Acceptable viscosity range for very short periods	cSt	7-1600

During operation the temperature of hydraulic fluid must be controlled and stay within the range of Table 3 below

Table 3 Hydraulic fluid temperature range		
Operating temperature range (min~max)	°C (°F)	20+90 (68 ÷194)
Maximum oil temperature	°C (°F)	90 (194)
Minimum temperature at operation start	°C (°F)	-20 (-40

4.2 FILTRATION

For efficient and durable performances it is recommended to maintain a solid particle contamination level as for Table 4:

Table 4 Hydraulic fluid viscosity range
Class 7 in accordance to NAS 1638
18/16/13 in accordance to ISO 4406

4.3 CONNECTION DETAILS

Connect the hydraulic circuit hoses to the hydraulic motor parts as per the picture 4 below. For specific dimensions and hoses size refer to the specific drawing provided with the drive.

Motor parts for open loop configuration.

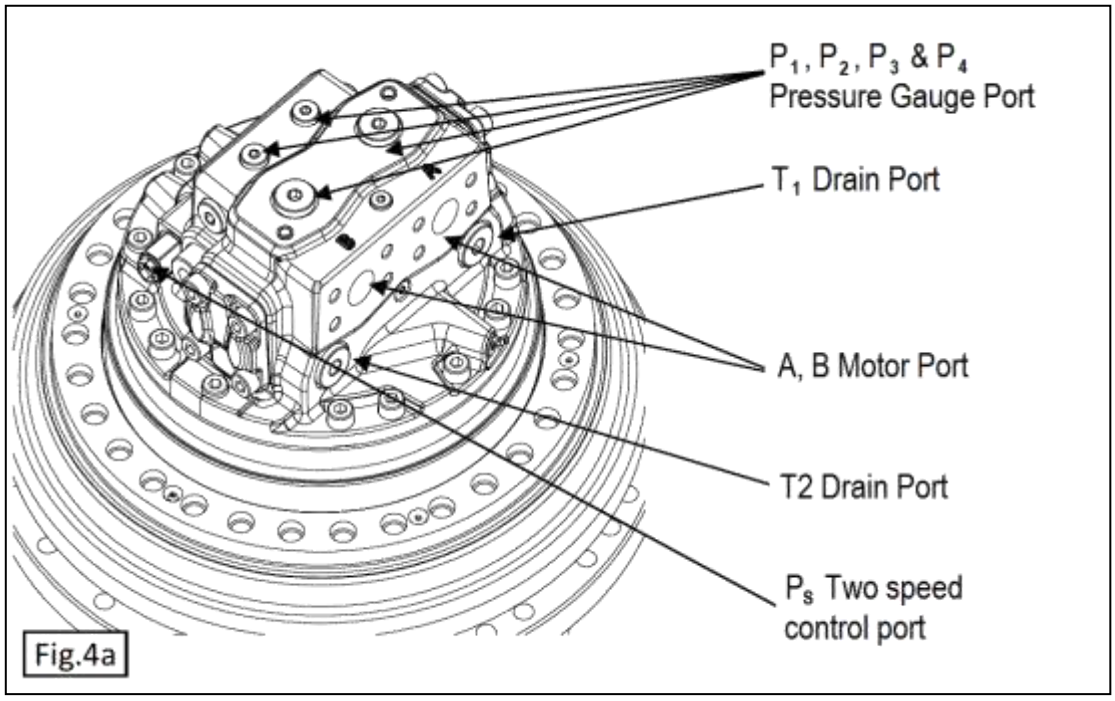


Fig.4a

Motor parts for closed loop configuration.

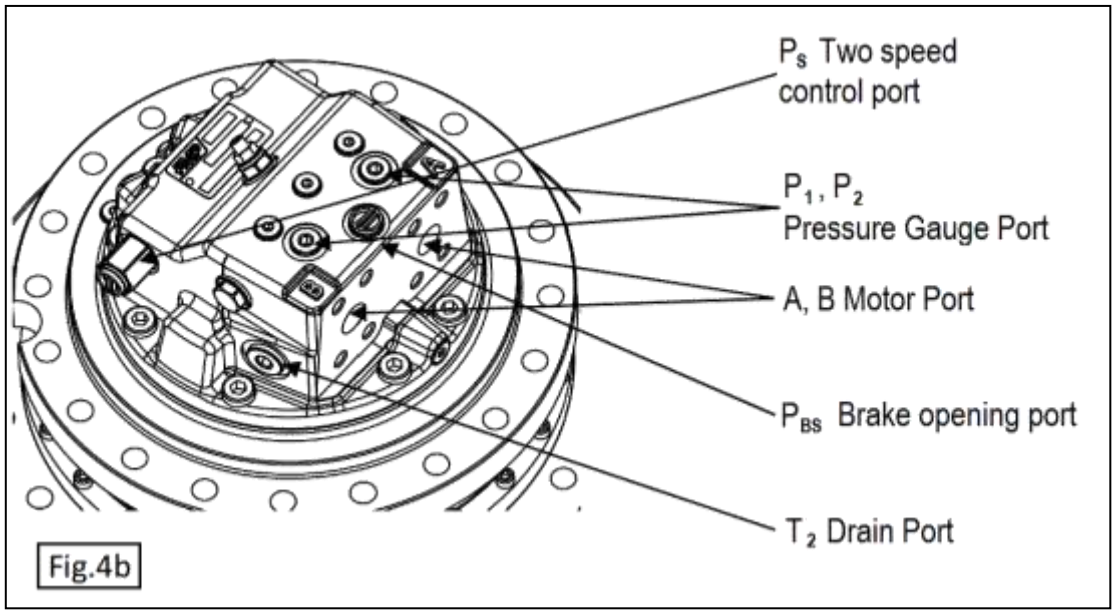


Fig.4b

4.4 MOTOR DISPLACEMENT

The standard for variable displacement motors is to operate with the motor in the high displacement (no pilot pressure Ps applied). When pilot pressure (Ps) is applied, the motor shifts to the low-displacement position.

Motors equipped with automatic auto-shift will automatically return to high displacement, despite pilot pressure Ps being applied, when A-B pressure hits a specific value.

Motors can also be supplied in the fixed displacement configuration upon request.

4.5 MOTOR ORIENTATION

Table 5 below explains the correct positioning of the motor connections.

An important condition is that the motor must be filled with pre filtered hydraulic oil.

Lack of compliance with this condition can damage the unit irreparably.

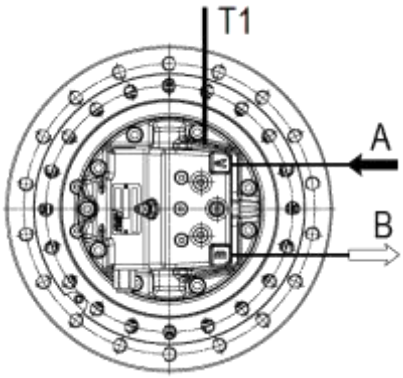
After the motor has been filled, operate the machine with no load to allow the flushing of the circuit and check for leaks in hoses or fittings.

Bleed air from every part of the hydraulic circuit; the presence of residual air in the hydraulic circuit will lead to irregular functioning of the motor as well as excessive noise

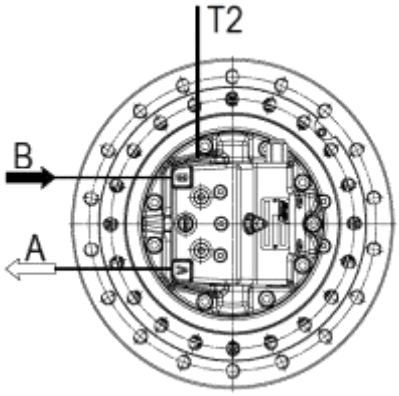
TABLE 5 MOTOR POSITIONING

NOTES:

The case drain hose must always be connected to the highest port (T_1). Plug the lower drain port with a metallic plug.

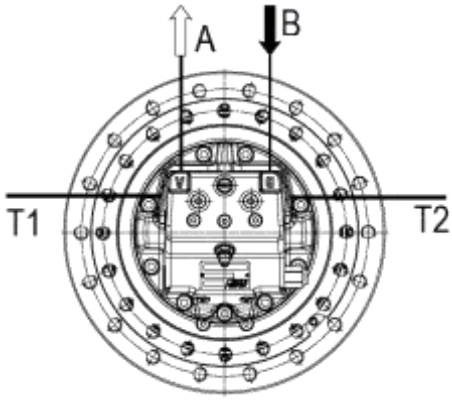


The case drain hose must always be connected to the highest port (T_2). Plug the lower drain port with a metallic plug.

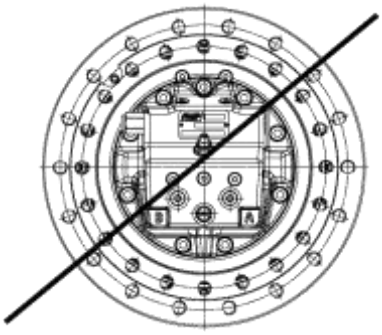


The case drain hose can be connected either to port T_1 or T_2.

Plug the remaining drain port with a metallic plug.



Not recommended connection.



4.6 CONNECTION OF THE BRAKE

PMCI drives are normally supplied with a spring applied hydraulic release parking brake, integrated into the motor.

For motor brake details please refer to the specific drawing provided with the drive.

In case of motors for open loop hydraulic circuits, brake release is automatically operated when pressure is delivered to the motor, so there is no need for external pilot pressure (fig.4a pag.18).

In case of motors for closed loop hydraulic circuits, the brake requires a dedicated external pilot pressure to be released prior to motor operation (fig.4b pag.18)

In closed loop applications, the parking brake must be fully released before motor is operated and during operations

5. GEARBOX OPERATION AND MAINTENANCE

5.1 GENERAL INSTRUCTIONS

ATTENTION!
Admissible oil temperature range (working conditions): -20°C / +90°C (-4°F / 194°F)
Gearbox must be immediately stopped and cooled down if oil temperature reaches +90°C (194°F)

All maintenance activities must be performed under safety conditions

- The gearbox is supplied without oil.
- The routine maintenance includes only the regular substitution of the oil.
- Do not mix different types of oil.
- Use the following Table 6 for maintenance intervals of the gearbox.

Table 6 Gearbox operation and maintenance

Operation	Interval
Oil level control	Every 150 operating hours of the gearbox
First oil change	After 100 operating hours of the gearbox
Regular oil change	Every 1000 operating hours or 1 year
First screw tightness control	After the first 50 operating hours
Regular screw tightness control	Every 1000 operating hours

Maintenance intervals indicated in table 6 are based on standard working conditions. In case of intense working conditions or special environmental conditions, recommended maintenance intervals shall be discussed with PMP.

5.2 OIL FILLING

ATTENTION: The gearbox is supplied without oil! Make sure to fill the gearbox with the appropriate oil quantity prior to operating it.

For correct use of the unit, it is recommended to use the following oil type:

SAE 80W90 / API GLS

The following Table 7 shows a list of suggested lubricants (for temperate climate):

Table 7 Suggested lubricants

Manufacturers	Oil type
AGIP	MP
MOBIL	HD
REPSOL	EP

For oil-filling operation, follow the steps below:

Respect the environment.
Dispose in accordance to environmental laws

- **Step 1:** Rotate the gearbox until the “OIL LEVEL” level plug, is set horizontally (see Fig.5a Page 23)
  The “OIL DRAIN” fill plug, must be above the level plug
- **Step 2:** Unscrew the fill plug and the level plug (see Fig.5a Page 23)
- **Step 3:** Fill the gearbox from “OIL DRAIN” fill plug.
  The oil quantity is sufficient when the oil reaches “OIL LEVEL” level plug.
  An indication of the approximate oil quantity needed to fill the gearbox is reported in the specific drawing provided with the drive
- **Step 4:** Put the plugs with their washers back in place
- **Step 5:** Run the unit and after few minutes check the oil level
- **Step 6:** Top up with oil if necessary.

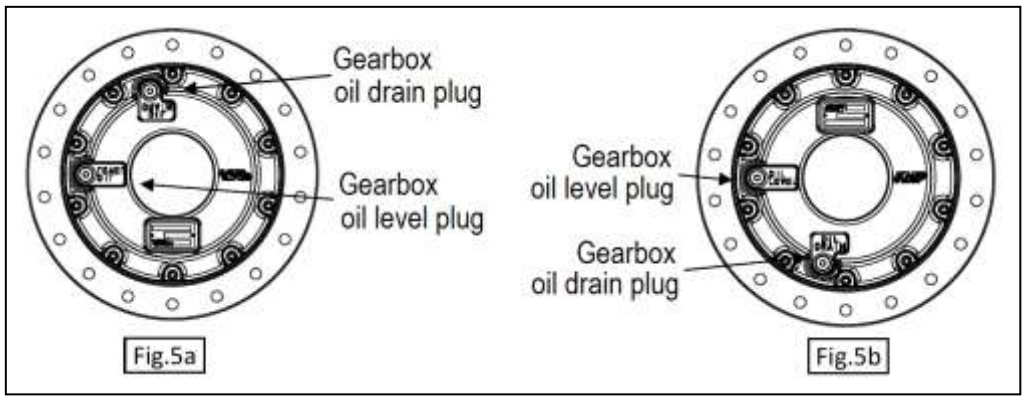
5.3 OIL DRAINING

For oil-draining operation, follow the steps below:

Respect the environment
Dispose in accordance environmental to laws

- **Step 1:** Rotate the gearbox until the plug level, identify as “OIL LEVEL” is set horizontally (see Fig.5a Page 23).
  The fill plug, identify as “OIL DRAIN”, must be on the bottom
- **Step 2:** In order to facilitate oil draining it is recommended to remove the oil level plug

- **Step 3:** Remove the drain plug and allow all the oil to flow out of the gearbox
- **Step 3:** Refill the gearbox following the steps described on Page 22.
- **Step 4:** Screw the plug on the cover and tighten it with the torque indicated in the following Table 8



5.4 MECHANICAL DISENGAGEMENT

PMCI drives can be supplied with mechanical disengagement, to allow towing the machine.

The disengagement must be connected or disconnected only when the machine is fully stopped and blocked on flat ground.

When the gearbox is mechanically disengaged, the brake and the motor are not operating on the final drive. Pay attention as the machine can move unexpectedly.

Pay attention when performing the mechanical disengagement operation: some oil will flow out when removing the cover plug.

For re-engagement operation, follow these steps.

Step 1: Unscrew the plug from the cover using the appropriate wrench.

Step 2: Tighten an M6 screw in threaded hole on the sun gear of the low torque planetary stage (Fig. 6 Page 24)

Step 3: Remove the sun gear

Step 4: screw the plug on the cover and tighten it with the torque indicated in the following Table 8.

Table 8 Tightening torque table

Plug	Key	Torque
M55	22	150 Nm
M90	22	190 Nm

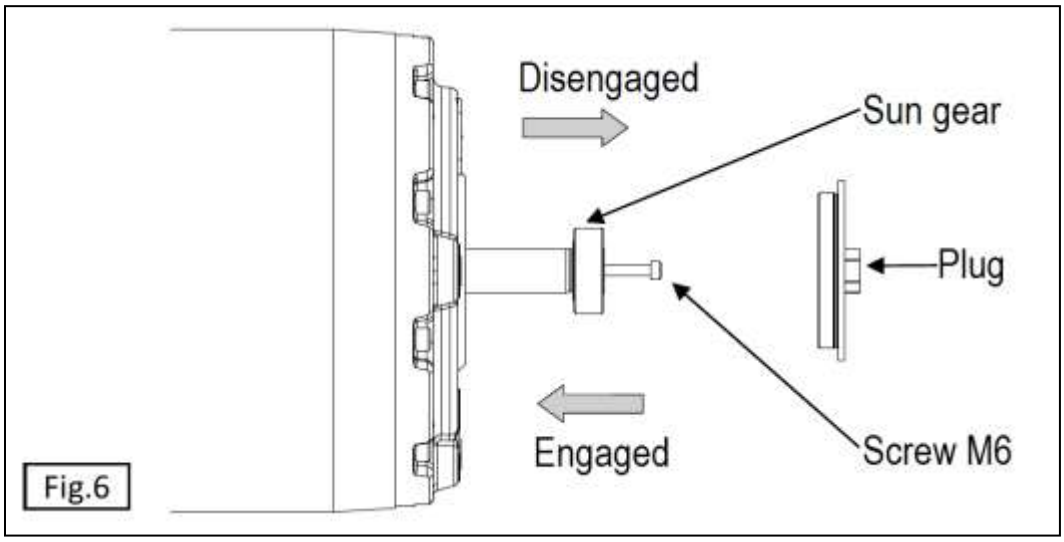


Fig.6

For re-engagement operation, follow these steps:

- Step 1: Unscrew the plug from the cover using the appropriate wrench.
- Step 2: Insert the sun gear of the low torque planetary stage back into position, aligning gear teeth.
- Step 3: Screw the plug on the cover and tighten it with the correct torque.
- Step 4: If necessary top in with lubricant.