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1. STRUCTURE

This service 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 repairs and make judgements. Make sure you understand the contents of this manual and use it to full effect at every opportunity.
This service manual mainly contains the necessary technical information for operations performed in a service workshop.
For ease of understanding, the manual is divided into the following sections.

SECTION 1 GENERAL
This section explains the safety hints and gives the specification of the machine and major components.

SECTION 2 STRUCTURE 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.

SECTION 3 HYDRAULIC SYSTEM
This section explains the hydraulic circuit, single and combined operation.

SECTION 4 ELECTRICAL SYSTEM
This section explains the electrical circuit, monitoring system and each component. It serves not only to give an understanding electrical system, but also serves as reference material for trouble shooting.

SECTION 5 TROUBLESHOOTING
This section explains the troubleshooting charts correlating **problems** to **causes**.

SECTION 6 MAINTENANCE STANDARD
This section gives the judgement standards when inspecting disassembled parts.

SECTION 7 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.

2. HOW TO READ THE SERVICE MANUAL

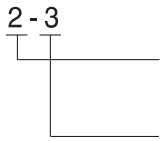
Distribution and updating

Any additions, amendments or other changes will be sent to HYUNDAI distributors.

Get the most up-to-date information before you start any work.

Filing method

1. See the page number on the bottom of the page.
   File the pages in correct order.
2. Following examples shows how to read the page number.
   Example 1



   Item number (2. Structure and Function)
   Consecutive page number for each item.
3. Additional pages : Additional pages are indicated by a hyphen(-) and number after the page number. File as in the example.

   10 - 4
   10 - 4 - 1 ┐
   10 - 4 - 2 ┘ Added pages
   10 - 5

Revised edition mark (①②③…)

When a manual is revised, an edition mark is recorded on the bottom outside corner of the pages.

Revisions

Revised pages are shown at the list of revised pages on the between the contents page and section 1 page.

Symbols

So that the shop manual can be of ample practical use, important places for safety and quality are marked with the following symbols.

Symbol	Item	Remarks
	Safety	Special safety precautions are necessary when performing the work.
		Extra special safety precautions are necessary when performing the work because it is under internal pressure.
	Caution	Special technical precautions or other precautions for preserving standards are necessary when performing the work.

3. CONVERSION TABLE

Method of using the Conversion Table

The Conversion Table in this section is provided to enable simple conversion of figures. For details of the method of using the Conversion Table, see the example given below.

Example

1. **Method of using the Conversion Table to convert from millimeters to inches**

   Convert 55mm into inches.

   (1) Locate the number 50in the vertical column at the left side, take this as ⓐ, then draw a horizontal line from ⓐ.

   (2) Locate the number 5 in the row across the top, take this as ⓑ, then draw a perpendicular line down from ⓑ.

   (3) Take the point where the two lines cross as ⓒ. This point ⓒ gives the value when converting from millimeters to inches. Therefore, 55 mm = 2.165 inches.

2. Convert 550mm into inches.

   (1) The number 550 does not appear in the table, so divide by 10(Move the decimal point one place to the left) to convert it to 55 mm.

   (2) Carry out the same procedure as above to convert 55 mm to 2.165 inches.

   (3) The original value (550 mm) was divided by 10, so multiply 2.165 inches by 10 (Move the decimal point one place to the right) to return to the original value.
   This gives 550 mm = 21.65 inches.

Millimeters to inches

1 mm = 0.03937 in

	0	1	2	3	4	5 ⓑ	6	7	8	9
0		0.039	0.079	0.118	0.157	0.197	0.236	0.276	0.315	0.354
10	0.394	0.433	0.472	0.512	0.551	0.591	0.630	0.669	0.709	0.748
20	0.787	0.827	0.866	0.906	0.945	0.984	1.024	1.063	1.102	1.142
30	1.181	1.220	1.260	1.299	1.339	1.378	1.417	1.457	1.496	1.536
40	1.575	1.614	1.654	1.693	1.732	1.772	1.811	1.850	1.890	1.929
ⓐ 50	1.969	2.008	2.047	2.087	2.126	ⓒ 2.165	2.205	2.244	2.283	2.323
60	2.362	2.402	2.441	2.480	2.520	2.559	2.598	2.638	2.677	2.717
70	2.756	2.795	2.835	2.874	2.913	2.953	2.992	3.032	3.071	3.110
80	3.150	3.189	3.228	3.268	3.307	3.346	3.386	3.425	3.465	3.504
90	3.543	3.583	3.622	3.661	3.701	3.740	3.780	3.819	3.858	3.898

Millimeters to inches

1 mm = 0.03937 in

	0	1	2	3	4	5	6	7	8	9
0		0.039	0.079	0.118	0.157	0.197	0.236	0.276	0.315	0.354
10	0.394	0.433	0.472	0.512	0.551	0.591	0.630	0.669	0.709	0.748
20	0.787	0.827	0.866	0.906	0.945	0.984	1.024	1.063	1.102	1.142
30	1.181	1.220	1.260	1.299	1.339	1.378	1.417	1.457	1.496	1.536
40	1.575	1.614	1.654	1.693	1.732	1.772	1.811	1.850	1.890	1.929
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80	3.150	3.189	3.228	3.268	3.307	3.346	3.386	3.425	3.465	3.504
90	3.543	3.583	3.622	3.661	3.701	3.740	3.780	3.819	3.858	3.898

Kilogram to Pound

1 kg = 2.2046 lb

	0	1	2	3	4	5	6	7	8	9
0		2.20	4.41	6.61	8.82	11.02	13.23	15.43	17.64	19.84
10	22.05	24.25	26.46	28.66	30.86	33.07	35.27	37.48	39.68	41.89
20	44.09	46.30	48.50	50.71	51.91	55.12	57.32	59.5.	61.73	63.93
30	66.14	68.34	70.55	72.75	74.96	77.16	79.37	81.57	83.78	85.98
40	88.18	90.39	92.59	94.80	97.00	99.21	101.41	103.62	105.82	108.03
50	110.23	112.44	114.64	116.85	119.05	121.25	123.46	125.66	127.87	130.07
60	132.28	134.48	136.69	138.89	141.10	143.30	145.51	147.71	149.91	152.12
70	154.32	156.53	158.73	160.94	163.14	165.35	167.55	169.76	171.96	174.17
80	176.37	178.57	180.78	182.98	185.19	187.39	189.60	191.80	194.01	196.21
90	198.42	200.62	202.83	205.03	207.24	209.44	211.64	213.85	216.05	218.26

Liter to U.S. Gallon

1ℓ = 0.2642 U.S.Gal

	0	1	2	3	4	5	6	7	8	9
0		0.264	0.528	0.793	1.057	1.321	1.585	1.849	2.113	2.378
10	2.642	2.906	3.170	3.434	3.698	3.963	4.227	4.491	4.755	5.019
20	5.283	5.548	5.812	6.6076	6.340	6.604	6.869	7.133	7.397	7.661
30	7.925	8.189	8.454	8.718	8.982	9.246	9.510	9.774	10.039	10.303
40	10.567	10.831	11.095	11.359	11.624	11.888	12.152	12.416	12.680	12.944
50	13.209	13.473	13.737	14.001	14.265	14.529	14.795	15.058	15.322	15.586
60	15.850	16.115	16.379	16.643	16.907	17.171	17.435	17.700	17.964	18.228
70	18.492	18.756	19.020	19.285	19.549	19.813	20.077	20.341	20.605	20.870
80	21.134	21.398	21.662	21.926	22.190	22.455	22.719	22.983	23.247	23.511
90	23.775	24.040	24.304	24.568	24.832	25.096	25.631	25.625	25.889	26.153

Liter to U.K. Gallon

1ℓ = 0.21997 U.K.Gal

	0	1	2	3	4	5	6	7	8	9
0		0.220	0.440	0.660	0.880	1.100	1.320	1.540	1.760	1.980
10	2.200	2.420	2.640	2.860	3.080	3.300	3.520	3.740	3.950	4.179
20	4.399	4.619	4.839	5.059	5.279	5.499	5.719	5.939	6.159	6.379
30	6.599	6.819	7.039	7.259	7.479	7.969	7.919	8.139	8.359	8.579
40	8.799	9.019	9.239	9.459	9.679	9.899	10.119	10.339	10.559	10.778
50	10.998	11.281	11.438	11.658	11.878	12.098	12.318	12.528	12.758	12.978
60	13.198	13.418	13.638	13.858	14.078	14.298	14.518	14.738	14.958	15.178
70	15.398	15.618	15.838	16.058	16.278	16.498	16.718	16.938	17.158	17.378
80	17.598	17.818	18.037	18.257	18.477	18.697	18.917	19.137	19.357	19.577
90	19.797	20.017	20.237	20.457	20.677	20.897	21.117	21.337	21.557	21.777

kgf·m to lbf·ft

1 kgf·m = 7.233 lbf·ft

	0	1	2	3	4	5	6	7	8	9
		7.2	14.5	21.7	28.9	36.2	43.4	50.6	57.9	65.1
10	72.3	79.6	86.8	94.0	101.3	108.5	115.7	123.0	130.2	137.4
20	144.7	151.9	159.1	166.4	173.6	180.8	188.1	195.3	202.5	209.8
30	217.0	224.2	231.5	238.7	245.9	253.2	260.4	267.6	274.9	282.1
40	289.3	396.6	303.8	311.0	318.3	325.5	332.7	340.0	347.2	354.4
50	361.7	368.9	376.1	383.4	390.6	397.8	405.1	412.3	419.5	426.8
60	434.0	441.2	448.5	455.7	462.9	470.2	477.4	484.6	491.8	499.1
70	506.3	513.5	520.8	528.0	535.2	542.5	549.7	556.9	564.2	571.4
80	578.6	585.9	593.1	600.3	607.6	614.8	622.0	629.3	636.5	643.7
90	651.0	658.2	665.4	672.7	679.9	687.1	694.4	701.6	708.8	716.1
100	723.3	730.5	737.8	745.0	752.2	759.5	766.7	773.9	781.2	788.4
110	795.6	802.9	810.1	817.3	824.6	831.8	839.0	846.3	853.5	860.7
120	868.0	875.2	882.4	889.7	896.9	904.1	911.4	918.6	925.8	933.1
130	940.3	947.5	954.8	962.0	969.2	976.5	983.7	990.9	998.2	10005.4
140	1012.6	1019.9	1027.1	1034.3	1041.5	1048.8	1056.0	1063.2	1070.5	1077.7
150	1084.9	1092.2	1099.4	1106.6	1113.9	1121.1	1128.3	1135.6	1142.8	1150.0
160	1157.3	1164.5	1171.7	1179.0	1186.2	1193.4	1200.7	1207.9	1215.1	1222.4
170	1129.6	1236.8	1244.1	1251.3	1258.5	1265.8	1273.0	1280.1	1287.5	1294.7
180	1301.9	1309.2	1316.4	1323.6	1330.9	1338.1	1345.3	1352.6	1359.8	1367.0
190	1374.3	1381.5	1388.7	1396.0	1403.2	1410.4	1417.7	1424.9	1432.1	1439.4

kgf/cm² to lbf/in²

1 kgf / cm² = 14.2233 lbf / in²

	0	1	2	3	4	5	6	7	8	9
		14.2	28.4	42.7	56.9	71.1	85.3	99.6	113.8	128.0
10	142.2	156.5	170.7	184.9	199.1	213.4	227.6	241.8	256.0	270.2
20	284.5	298.7	312.9	327.1	341.4	355.6	369.8	384.0	398.3	412.5
30	426.7	440.9	455.1	469.4	483.6	497.8	512.0	526.3	540.5	554.7
40	568.9	583.2	597.4	611.6	625.8	640.1	654.3	668.5	682.7	696.9
50	711.2	725.4	739.6	753.8	768.1	782.3	796.5	810.7	825.0	839.2
60	853.4	867.6	881.8	896.1	910.3	924.5	938.7	953.0	967.2	981.4
70	995.6	1010	1024	1038	1053	1067	1081	1095	1109	1124
80	1138	1152	1166	1181	1195	1209	1223	1237	1252	1266
90	1280	1294	1309	1323	1337	1351	1365	1380	1394	1408
100	1422	1437	1451	1465	1479	1493	1508	1522	1536	1550
110	1565	1579	1593	1607	1621	1636	1650	1664	1678	1693
120	1707	1721	1735	1749	1764	1778	1792	1806	1821	1835
130	1849	2863	1877	1892	1906	1920	1934	1949	1963	1977
140	1991	2005	2020	2034	2048	2062	2077	2091	2105	2119
150	2134	2148	2162	2176	2190	2205	2219	2233	2247	2262
160	2276	2290	2304	2318	2333	2347	2361	2375	2389	2404
170	2418	2432	2446	2460	2475	2489	2503	2518	2532	2546
180	2560	2574	2589	5603	2617	2631	2646	2660	2674	2688
200	2845	2859	2873	2887	2901	2916	2930	2944	2958	2973
210	2987	3001	3015	3030	3044	3058	3072	3086	3101	3115
220	3129	3143	3158	3172	3186	3200	3214	3229	3243	3257
230	3271	3286	3300	3314	3328	3343	3357	3371	3385	3399
240	3414	3428	3442	3456	3470	3485	3499	3513	3527	3542

TEMPERATURE

Fahrenheit-Centigrade Conversion.

A simple way to convert a fahrenheit temperature reading into a centigrade temperature reading or vice verse is to enter the accompanying table in the center or boldface column of figures.

These figures refer to the temperature in either Fahrenheit or Centigrade degrees.

If it is desired to convert from Fahrenheit to Centigrade degrees, consider the center column as a table of Fahrenheit temperatures and read the corresponding Centigrade temperature in the column at the left.

If it is desired to convert from Centigrade to Fahrenheit degrees, consider the center column as a table of Centigrade values, and read the corresponding Fahrenheit temperature on the right.

˚C		˚F	˚C		˚F	˚C		˚F	˚C		˚F
-40.4	-40	-40.0	-11.7	11	51.8	7.8	46	114.8	27.2	81	117.8
-37.2	-35	-31.0	-11.1	12	53.6	8.3	47	116.6	27.8	82	179.6
-34.4	-30	-22.0	-10.6	13	55.4	8.9	48	118.4	28.3	83	181.4
-31.7	-25	-13.0	-10.0	14	57.2	9.4	49	120.2	28.9	84	183.2
-28.9	-20	-4.0	-9.4	15	59.0	10.0	50	122.0	29.4	85	185.0
-28.3	-19	-2.2	-8.9	16	60.8	10.6	51	123.8	30.0	86	186.8
-27.8	-18	-0.4	-8.3	17	62.6	11.1	52	125.6	30.6	87	188.6
-27.2	-17	1.4	-7.8	18	64.4	11.7	53	127.4	31.1	88	190.4
-26.7	-16	3.2	-6.7	20	68.0	12.8	55	131.0	32.2	90	194.0
-26.1	-15	5.0	-6.7	20	68.0	12.8	55	131.0	32.2	90	194.0
-25.6	-14	6.8	-6.1	21	69.8	13.3	56	132.8	32.8	91	195.8
-25.0	-13	8.6	-5.6	22	71.6	13.9	57	134.6	33.3	92	197.6
-24.4	-12	10.4	-5.0	23	73.4	14.4	58	136.4	33.9	93	199.4
-23.9	-11	12.2	-4.4	24	75.2	15.0	59	138.2	34.4	94	201.2
-23.3	-10	14.0	-3.9	25	77.0	15.6	60	140.0	35.0	95	203.0
-22.8	-9	15.8	-3.3	26	78.8	16.1	61	141.8	35.6	96	204.8
-22.2	-8	17.6	-2.8	27	80.6	16.7	62	143.6	36.1	97	206.6
-21.7	-7	19.4	-2.2	28	82.4	17.2	63	145.4	36.7	98	208.4
-21.1	-6	21.2	-1.7	29	84.2	17.8	64	147.2	37.2	99	210.2
-20.6	-5	23.0	-1.1	35	95.0	21.1	70	158.0	51.7	125	257.0
-20.0	-4	24.8	-0.6	31	87.8	18.9	66	150.8	40.6	105	221.0
-19.4	-3	26.6	0	32	89.6	19.4	67	152.6	43.3	110	230.0
-18.9	-2	28.4	0.6	33	91.4	20.0	68	154.4	46.1	115	239.0
-18.3	-1	30.2	1.1	34	93.2	20.6	69	156.2	48.9	120	248.0
-17.8	0	32.0	1.7	35	95.0	21.1	70	158.0	51.7	125	257.0
-17.2	1	33.8	2.2	36	96.8	21.7	71	159.8	54.4	130	266.0
-16.7	2	35.6	2.8	37	98.6	22.2	72	161.6	57.2	135	275.0
-16.1	3	37.4	3.3	38	100.4	22.8	73	163.4	60.0	140	284.0
-15.6	4	39.2	3.9	39	102.2	23.3	74	165.2	62.7	145	293.0
-15.0	5	41.0	4.4	40	104.0	23.9	75	167.0	65.6	150	302.0
-14.4	6	42.8	5.0	41	105.8	24.4	76	168.8	68.3	155	311.0
-13.9	7	44.6	5.6	42	107.6	25.0	77	170.6	71.1	160	320.0
-13.3	8	46.4	6.1	43	109.4	25.6	78	172.4	73.9	165	329.0
-12.8	9	48.2	6.7	44	111.2	26.1	79	174.2	76.7	170	338.0
-12.2	10	50.0	7.2	45	113.0	26.7	80	176.0	79.4	172	347.0

SECTION 1 GENERAL

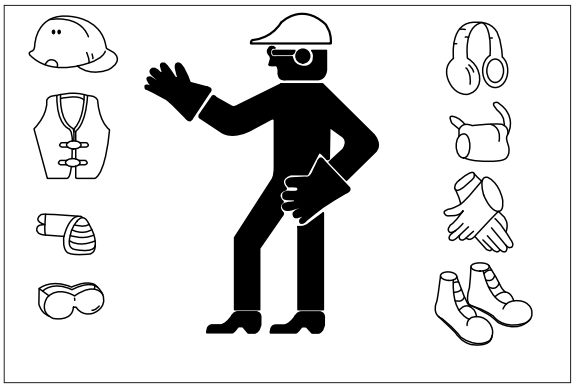
GROUP 1 SAFETY

FOLLOW SAFE PROCEDURE

Unsafe work practices are dangerous. Understand service procedure before doing work; do not attempt shortcuts.

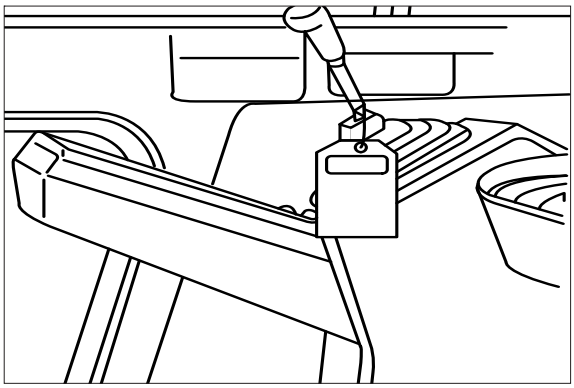
WEAR PROTECTIVE CLOTHING

Wear close fitting clothing and safety equipment appropriate to the job.



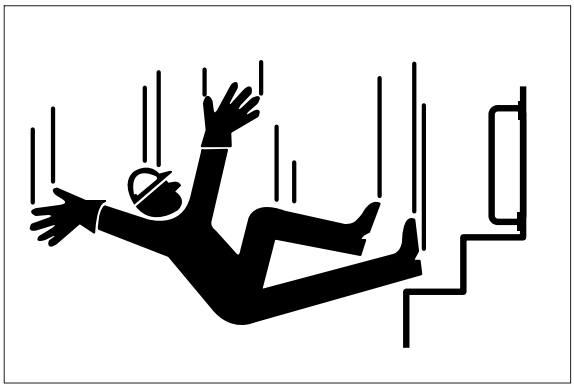
WARN OTHERS OF SERVICE WORK

Unexpected machine movement can cause serious injury.
Before performing any work on the excavator, attach a 「**Do Not Operate**」 tag on the right side control lever.



USE HANDHOLDS AND STEPS

Falling is one of the major causes of personal injury.
When you get on and off the machine, always maintain a three point contact with the steps and handrails and face the machine. Do not use any controls as handholds.
Never jump on or off the machine. Never mount or dismount a moving machine.
Be careful of slippery conditions on platforms, steps, and handrails when leaving the machine.

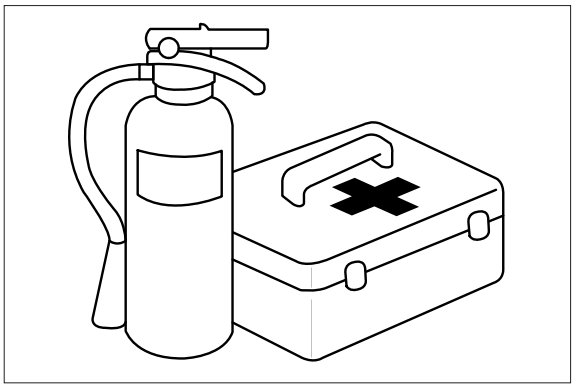


PREPARE FOR EMERGENCIES

Be prepared if a fire starts.

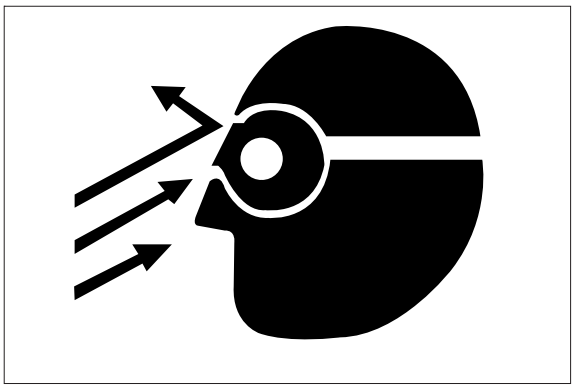
Keep a first aid kit and fire extinguisher handy.

Keep emergency numbers for doctors, ambulance service, hospital, and fire department near your telephone.



PROTECT AGAINST FLYING DEBRIS

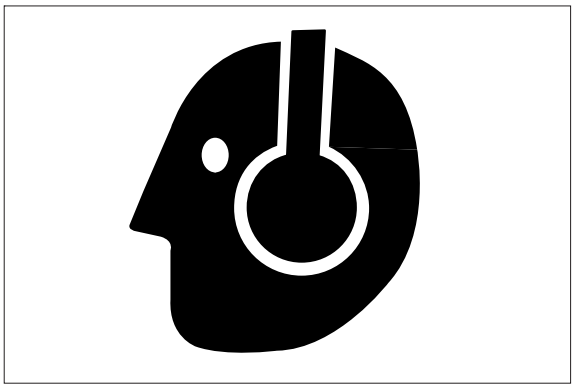
Guard against injury from flying pieces of metal or debris; wear goggles or safety glasses.



PROTECT AGAINST NOISE

Prolonged exposure to loud noise can cause impairment or loss of hearing.

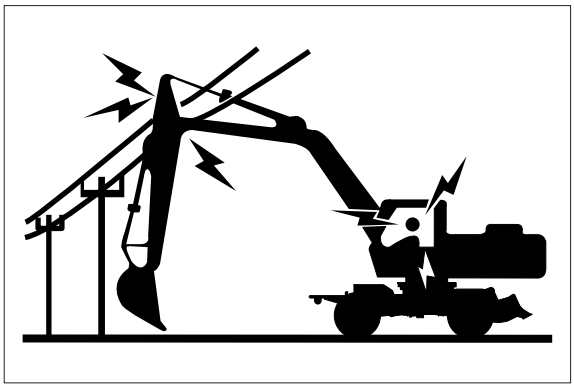
Wear a suitable hearing protective device such as ear-
muffs or earplugs to protect against objectionable or uncomfortable loud noises.



AVOID POWER LINES

Serious injury or death can result from contact with electric lines.

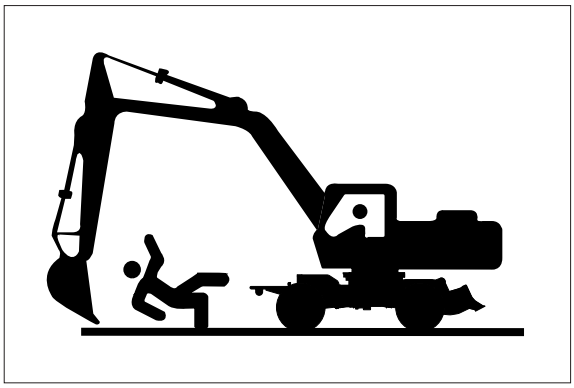
Never move any part of the machine or load closer to electric line than 3 m (10 ft) plus twice the line insulator length.



KEEP RIDERS OFF EXCAVATOR

Only allow the operator on the excavator. Keep riders off.

Riders on excavator are subject to injury such as being struck by foreign objects and being thrown off the excavator. Riders also obstruct the operator's view resulting in the excavator being operated in an unsafe manner.

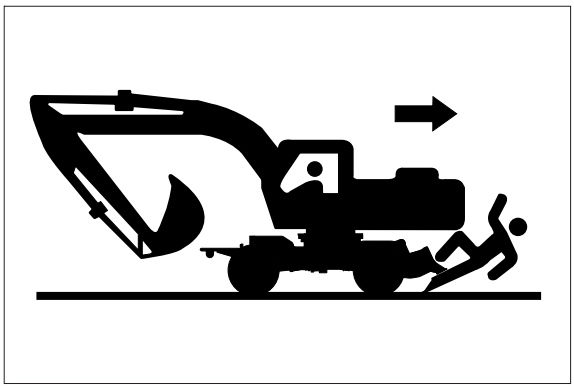


MOVE AND OPERATE MACHINE SAFELY

Bystanders can be run over. Know the location of bystanders before moving, swinging, or operating the machine.

Always keep the travel alarm in working condition. It warns people when the excavator starts to move.

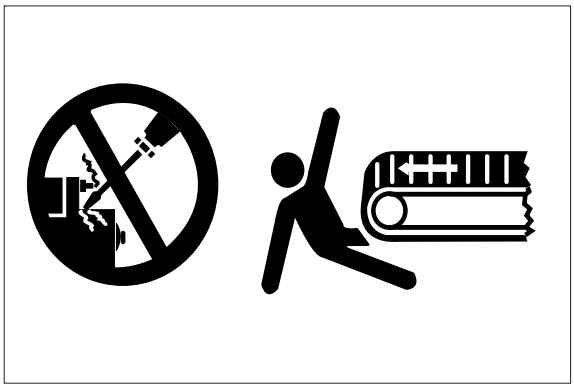
Use a signal person when moving, swinging, or operating the machine in congested areas. Coordinate hand signals before starting the excavator.



OPERATE ONLY FORM OPERATOR'S SEAT

Avoid possible injury machine damage. Do not start engine by shorting across starter terminals.

NEVER start engine while standing on ground. Start engine only from operator's seat.



PARK MACHINE SAFELY

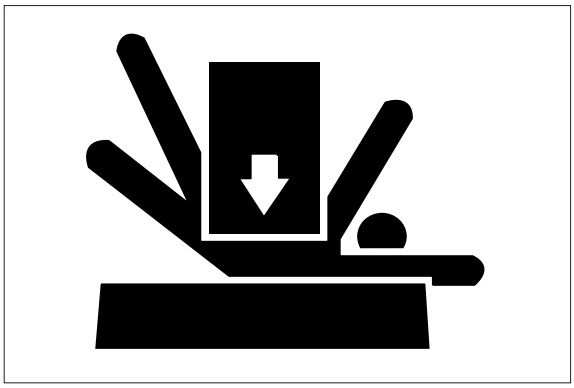
Before working on the machine:

- Park machine on a level surface.
- Lower bucket to the ground.
- Turn auto idle switch off.
- Run engine at 1/2 speed without load for 2 minutes.
- Turn key switch to OFF to stop engine.
  Remove key from switch.
- Move pilot control shutoff lever to locked position.
- Allow engine to cool.

SUPPORT MACHINE PROPERLY

Always lower the attachment or implement to the ground before you work on the machine. If you must work on a lifted machine or attachment, securely support the machine or attachment.

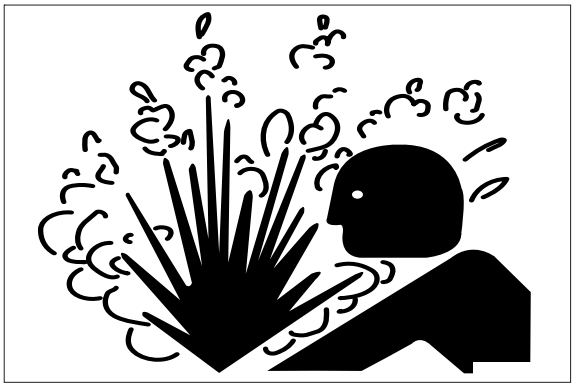
Do not support the machine on cinder blocks, hollow tiles, or props that may crumble under continuous load.
Do not work under a machine that is supported solely by a jack. Follow recommended procedures in this manual.



SERVICE COOLING SYSTEM SAFELY

Explosive release of fluids from pressurized cooling system can cause serious burns.

Shut off engine. Only remove filler cap when cool enough to touch with bare hands.



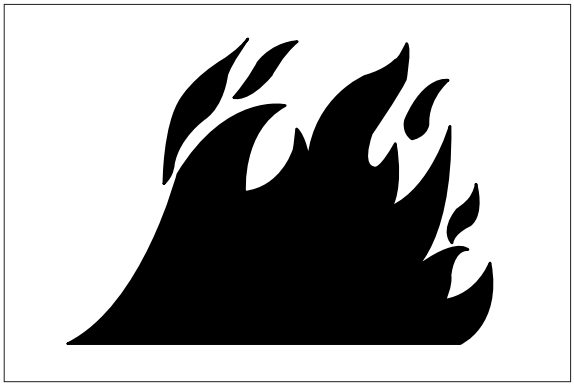
HANDLE FLUIDS SAFELY-AVOID FIRES

Handle fuel with care; it is highly flammable. Do not refuel the machine while smoking or when near open flame or sparks. Always stop engine before refueling machine.
Fill fuel tank outdoors.

Store flammable fluids away from fire hazards. Do not incinerate or puncture pressurized containers.

Make sure machine is clean of trash, grease, and debris.

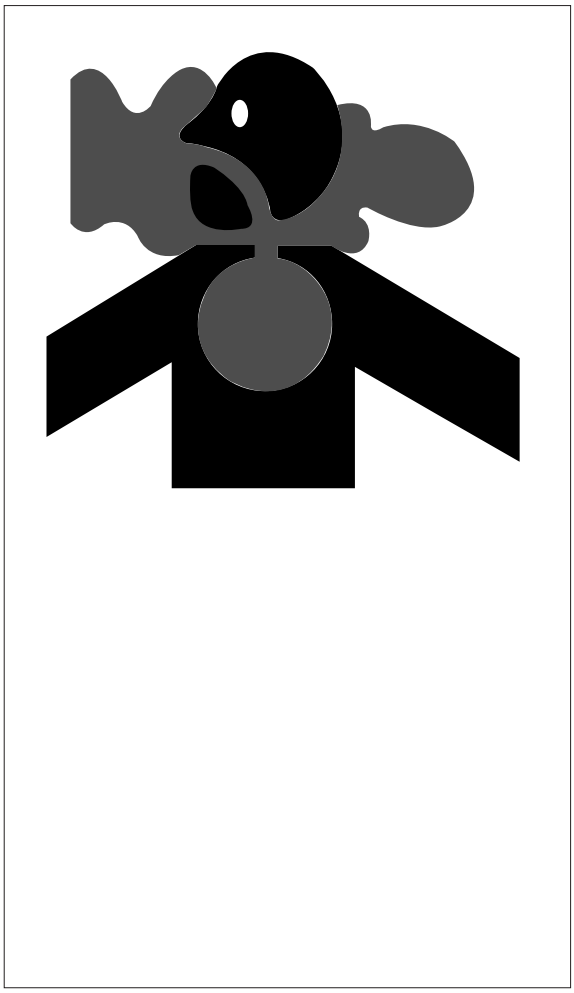
Do not store oily rags ; they can ignite and burn spontaneously.



BEWARE OF EXHAUST FUMES

Prevent asphyxiation. Engine exhaust fumes can cause sickness or death.

If you must operate in a building, be positive there is adequate ventilation. Either use an exhaust pipe extension to remove the exhaust fumes or open doors and windows to bring enough outside air into the area.



REMOVE PAINT BEFORE WELDING OR HEATING

Avoid potentially toxic fumes and dust.

Hazardous fumes can be generated when paint is heated by welding, soldering, or using a torch.

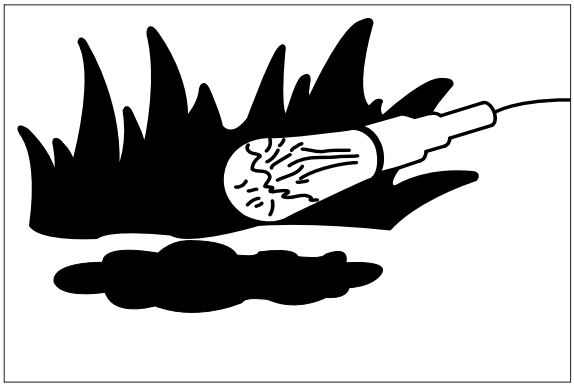
Do all work outside or in a well ventilated area. Dispose of paint and solvent properly.

Remove paint before welding or heating:

- If you sand or grind paint, avoid breathing the dust. Wear an approved respirator.
- If you use solvent or paint stripper, remove stripper with soap and water before welding. Remove solvent or paint stripper containers and other flammable material from area. Allow fumes to disperse at least 15 minutes before welding or heating.

ILLUMINATE WORK AREA SAFELY

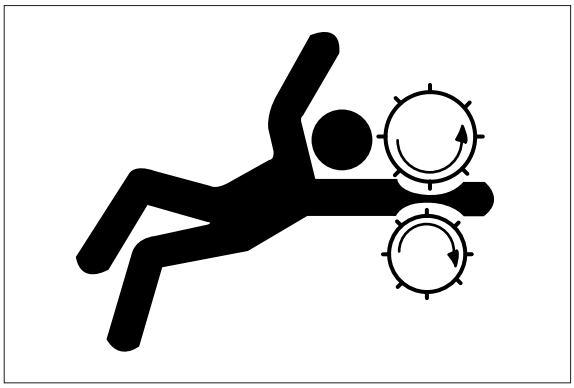
Illuminate your work area adequately but safely. Use a portable safety light for working inside or under the machine. Make sure the bulb is enclosed by a wire cage. The hot filament of an accidentally broken bulb can ignite spilled fuel or oil.



SERVICE MACHINE SAFELY

Tie long hair behind your head. Do not wear a necktie, scarf, loose clothing or necklace when you work near machine tools or moving parts. If these items were to get caught, severe injury could result.

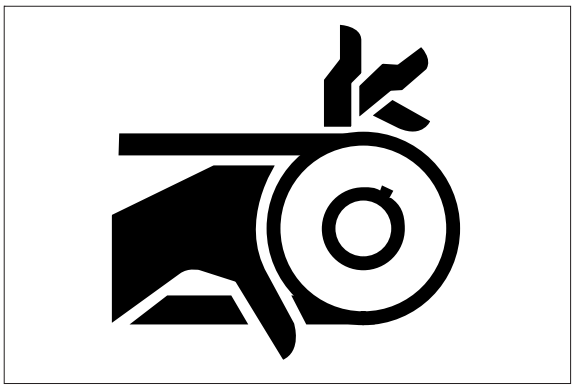
Remove rings and other jewelry to prevent electrical shorts and entanglement in moving parts.



STAY CLEAR OF MOVING PARTS

Entanglements in moving parts can cause serious injury.

To prevent accidents, use care when working around rotating parts.



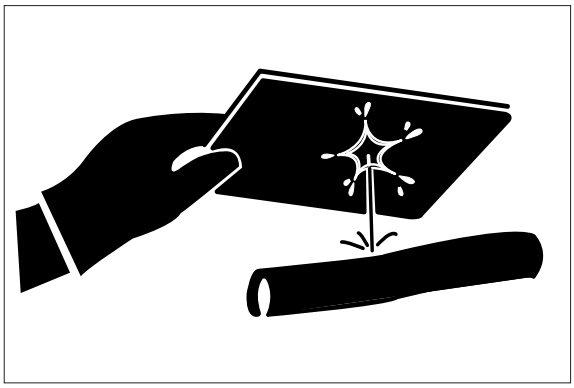
AVOID HIGH PRESSURE FLUIDS

Escaping fluid under pressure can penetrate the skin causing serious injury.

Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure.

Search for leaks with a piece of cardboard. Protect hands and body from high pressure fluids.

If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result.



AVOID HEATING NEAR PRESSURIZED FLUID LINES

Flammable spray can be generated by heating near pressurized fluid lines, resulting in severe burns to yourself and bystanders. Do not heat by welding, soldering, or using a torch near pressurized fluid lines or other flammable materials.

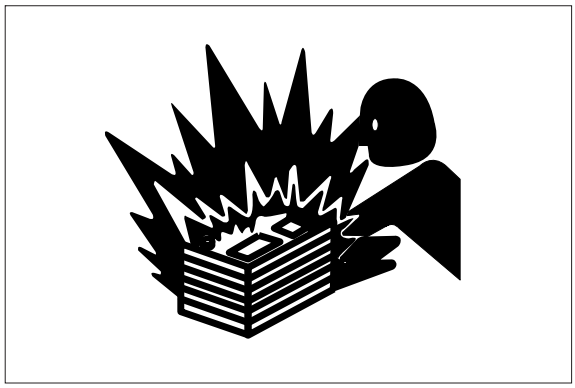
Pressurized lines can be accidentally cut when heat goes beyond the immediate flame area. Install fire resisting guards to protect hoses or other materials.

PREVENT BATTERY EXPLOSIONS

Keep sparks, lighted matches, and flame away from the top of battery. Battery gas can explode.

Never check battery charge by placing a metal object across the posts. Use a volt-meter or hydrometer.

Do not charge a frozen battery; it may explode. Warm battery to 16˚C (60˚F).



PREVENT ACID BURNS

Sulfuric acid in battery electrolyte is poisonous. It is strong enough to burn skin, eat holes in clothing, and cause blindness if splashed into eyes.

Avoid the hazard by:

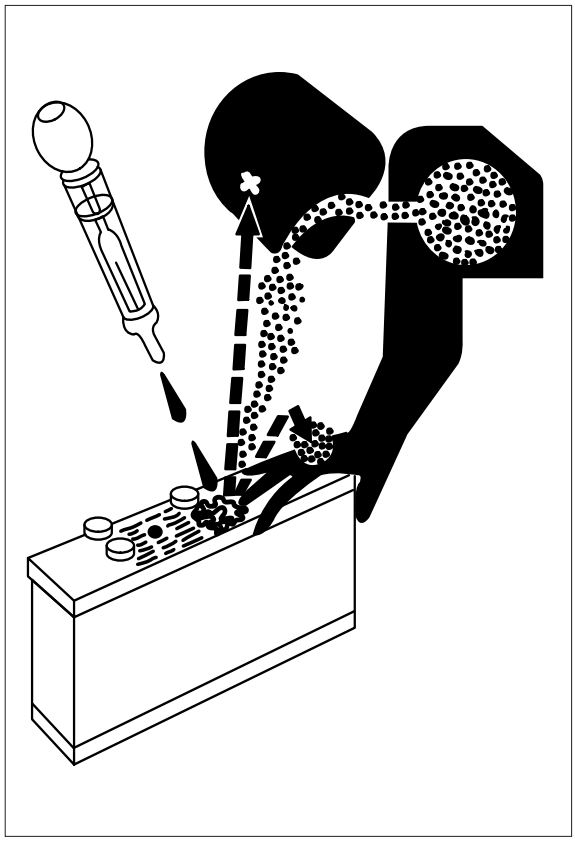
1. Filling batteries in a well-ventilated area.
2. Wearing eye protection and rubber gloves.
3. Avoiding breathing fumes when electrolyte is added.
4. Avoiding spilling of dripping electrolyte.
5. Use proper jump start procedure.

If you spill acid on yourself:

1. Flush your skin with water.
2. Apply baking soda or lime to help neutralize the acid.
3. Flush your eyes with water for 10-15 minutes. Get medical attention immediately.

If acid is swallowed:

1. Drink large amounts of water or milk.
2. Then drink milk of magnesia, beaten eggs, or vegetable oil.
3. Get medical attention immediately.



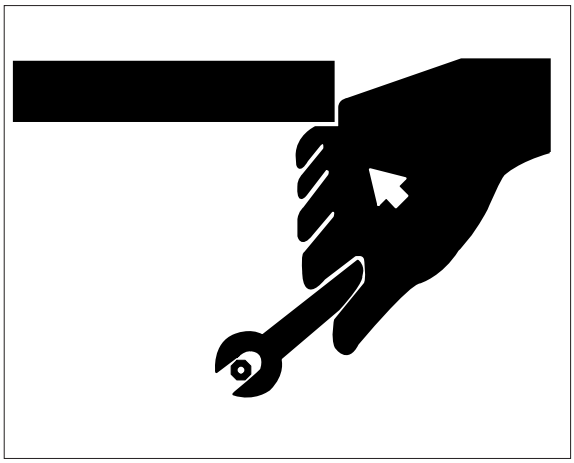
USE TOOLS PROPERLY

Use tools appropriate to the work. Makeshift tools, parts, and procedures can create safety hazards.

Use power tools only to loosen threaded tools and fasteners.

For loosening and tightening hardware, use the correct size tools. DO NOT use U.S. measurement tools on metric fasteners. Avoid bodily injury caused by slipping wrenches.

Use only recommended replacement parts.(See Parts manual.)

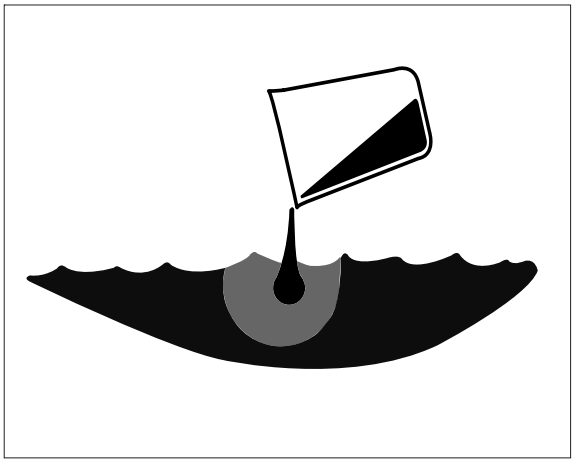


DISPOSE OF FLUIDS PROPERLY

Improperly disposing of fluids can harm the environment and ecology. Before draining any fluids, find out the proper way to dispose of waste from your local environmental agency.

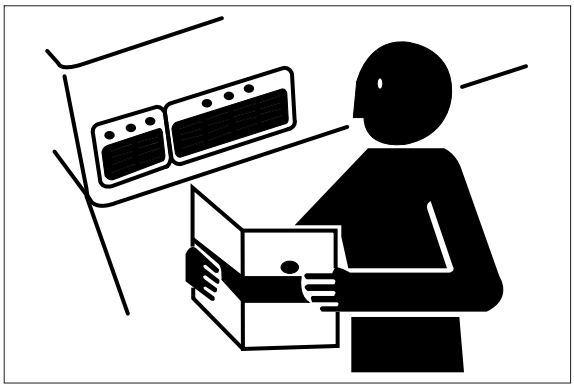
Use proper containers when draining fluids. Do not use food or beverage containers that may mislead someone into drinking from them.

DO NOT pour oil into the ground, down a drain, or into a stream, pond, or lake. Observe relevant environmental protection regulations when disposing of oil, fuel, coolant, brake fluid, filters, batteries, and other harmful waste.



REPLACE SAFETY SIGNS

Replace missing or damaged safety signs. See the machine operator's manual for correct safety sign placement.

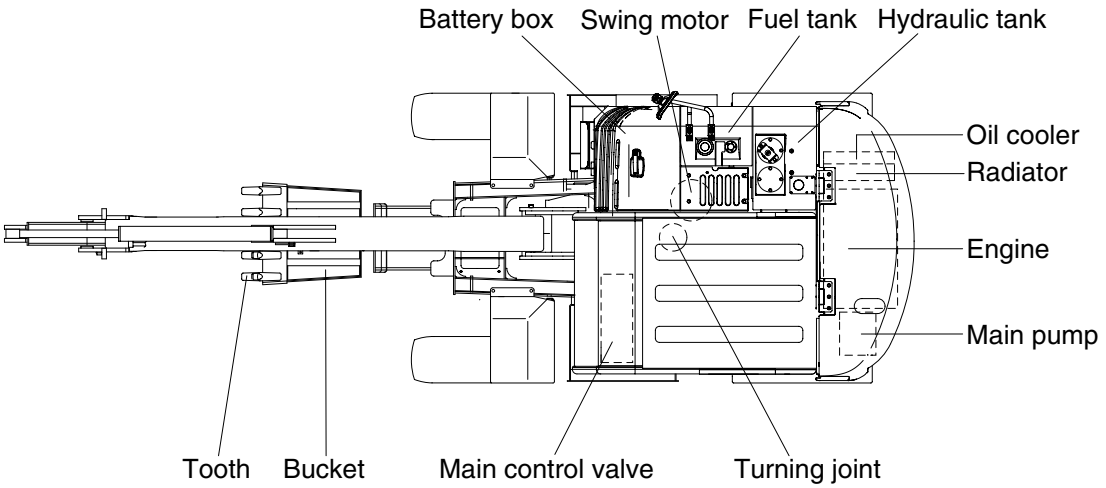


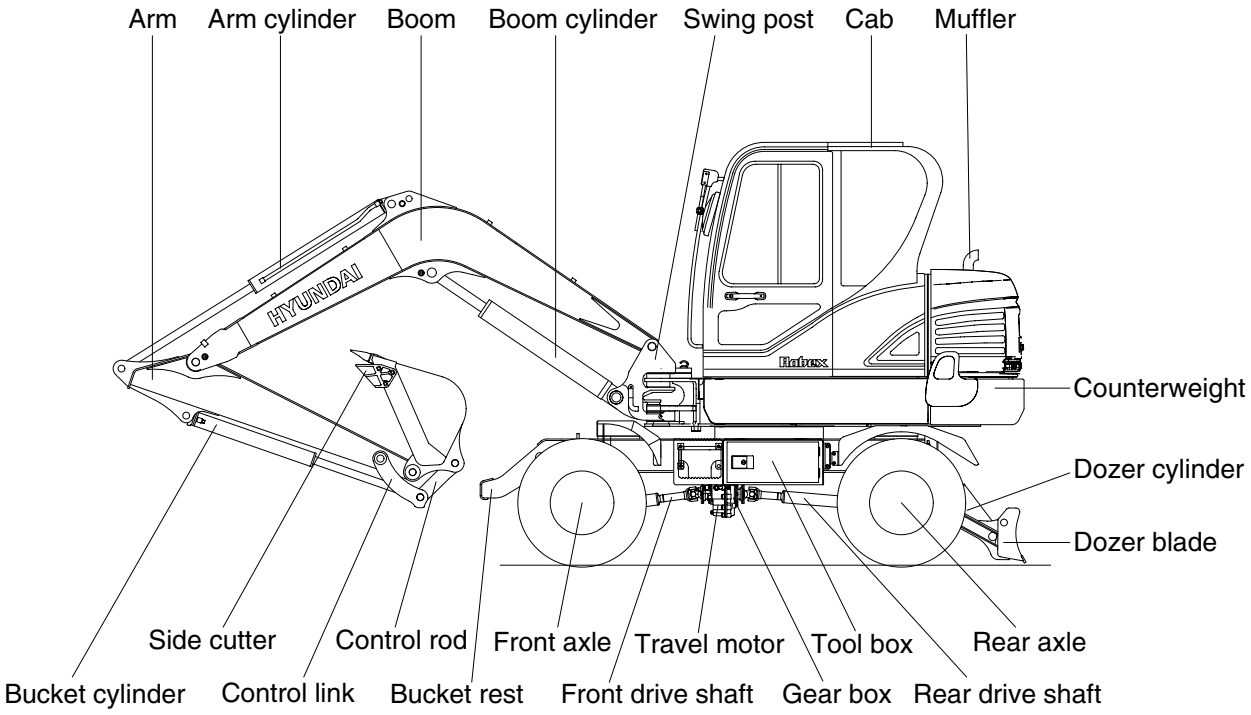
LIVE WITH SAFETY

Before returning machine to customer, make sure machine is functioning properly, especially the safety systems. Install all guards and shields.

GROUP 2 SPECIFICATIONS

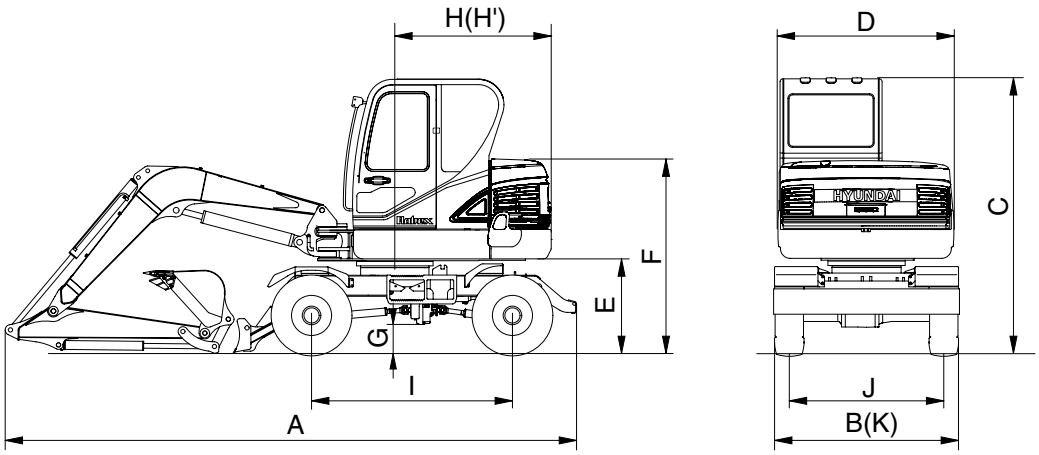
1. MAJOR COMPONENT





2. SPECIFICATIONS

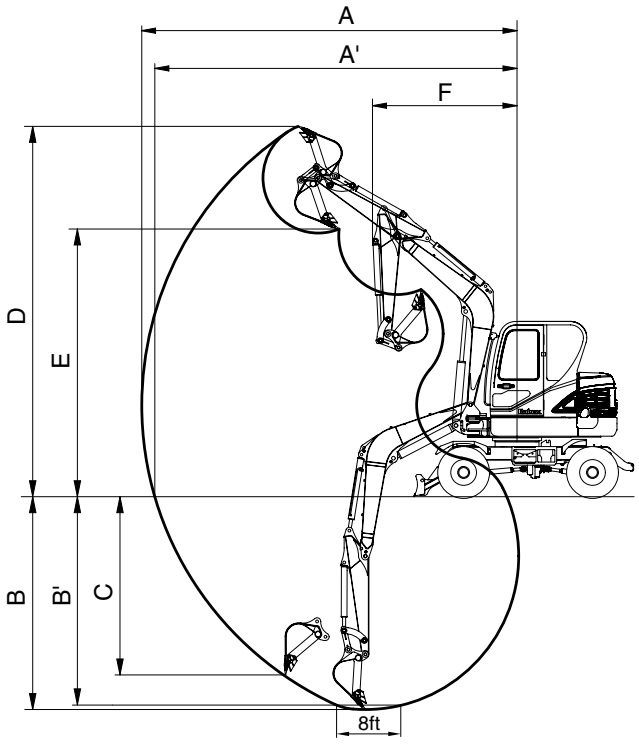
1) 3.0 m (9'10") MONO BOOM, 1.6 m (5' 3") ARM WITH BOOM SWING SYSTEM



Description		Unit	Specification
Operating weight		kg (lb)	5720 (12610)
Bucket capacity(SAE heaped), standard		m^3 (yd^3)	0.21 (0.28)
Overall length	A	mm (ft-in)	6100 (20' 0")
Overall width	B		1925 (6' 4")
Overall height	C		2850 (9' 4")
Upperstructure width	D		1850 (6' 1")
Ground clearance of counterweight	E		986 (3' 3")
Engine cover height	F		1980 (6' 6")
Minimum ground clearance	G		290 (11.4")
Rear-end distance	H		1650 (5' 5")
Rear-end swing radius	H'		1650 (5' 5")
Wheel base	I		2100 (6'11")
Tread	J		1600 (5' 3")
Dozer blade width	K		1925 (6' 4")
Travel speed	Low	km/hr (mph)	10 (6.25)
	High		31 (19.4)
Swing speed		rpm	10
Gradeability		Degree (%)	35 (70)
Max traction force		kg (lb)	3600 (7937)

3. WORKING RANGE

1) 3.0 m (9'10") MONO BOOM WITH BOOM SWING SYSTEM



Description		1.6 m (5' 3") Arm
Max digging reach	A	6150 mm (20' 2")
Max digging reach on ground	A'	5980 mm (19' 7")
Max digging depth	B	3500 mm (11' 6")
Max digging depth (8 ft level)	B'	3100 mm (10' 2")
Max vertical wall digging depth	C	2960 mm (9' 9")
Max digging height	D	6070 mm (19' 11")
Max dumping height	E	4340 mm (14' 3")
Min swing radius	F	2350 mm (7' 9")
Boom swing radius (left/right)		80˚/50˚
Bucket digging force	SAE	46.7 kN
		4762 kgf
		10499 lbf
	ISO	52.5 kN
		5356 kgf
		11810 lbf
Arm crowd force	SAE	27.5 kN
		2808 kgf
		6186 lbf
	ISO	30.9 kN
		3154 kgf
		6948 lbf

4. WEIGHT

Item	R60WVS PRO	
	kg	lb
Upperstructure assembly	2753	6071
Main frame weld assembly	651	1432
Engine assembly	280	620
Main pump assembly	31	72
Main control valve assembly	34	76
Swing motor assembly	77	173
Hydraulic oil tank assembly	90	200
Fuel tank assembly	60	130
Boom swing post	110	240
Counterweight	210	460
Cab assembly	300	660
Lower chassis assembly	2087	4605
Lower frame weld assembly	550	1210
Swing bearing	90	200
Travel motor assembly	50	110
Turning joint	30	70
Gear box	63	140
Front axle assembly	280	617
Rear axle assembly	200	440
Dozer blade assembly	207	455
Front attachment assembly (3.0 m boom, 1.6 m arm, 0.21 m^3 SAE heaped bucket)	792	1744
3.0 m boom assembly	253	559
1.6 m arm assembly	125	279
0.21 m^3 SAE heaped bucket assembly	167	363
Boom cylinder assembly	72	159
Arm cylinder assembly	54	117
Bucket cylinder assembly	36	82
Bucket control link assembly	40	90
Boom swing cylinder assembly	40	90
Blade cylinder assembly	33	77

5. LIFTING CAPACITIES

1) 3.0 m (9'10") boom, 1.6 m(5' 3") arm equipped with 0.21m³(SAE heaped) bucket and the dozer blade down.

·  : Rating over-front ·  : Rating over-side or 360 degree

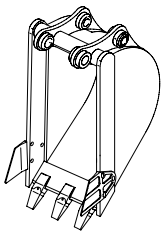
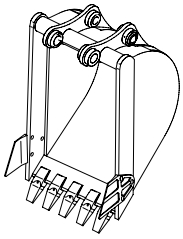
Load point height		Load radius								At max. reach		
		2.0m (6.6ft)		3.0m (9.8ft)		4.0m (13.1ft)		5.0m (16.4ft)		Capacity		Reach
												m(ft)
5.0m 16.4ft	kg lb											
4.0m 13.1ft	kg lb					*1110 *2450	1090 2400			*1100 *2430	870 1920	4.54 (14.9)
3.0m 9.8ft	kg lb					*1250 *2760	1060 2340	*1220 *2690	720 1590	*1090 *2400	700 1540	5.05 (16.6)
2.0m 6.6ft	kg lb			*2100 *4630	1580 3480	*1550 *3420	1000 2200	1260 2780	700 1540	1150 2540	630 1390	5.28 (17.3)
1.0m 3.3ft	kg lb			*2770 *6110	1460 3220	1760 3880	950 2090	1240 2730	670 1480	1130 2490	610 1340	5.28 (17.3)
0.0m 0.0ft	kg lb	*2490 *5490	*2490 *5490	2790 6150	1400 3090	1720 3790	910 2010	1220 2690	650 1430	1200 2650	640 1410	5.05 (16.6)
-1.0m -3.3ft	kg lb	*3950 *8710	2740 6040	2780 6130	1400 3090	1710 3770	910 2010			1400 3090	750 1650	4.55 (14.9)
-2.0m -6.6ft	kg lb	*3830 *8440	2810 6190	*2350 *5180	1430 3150					*1760 *3880	1070 2360	3.65 (12.0)

2) 3.0 m (9'10") boom, 1.6 m (5' 3") arm equipped with 0.21m³(SAE heaped) bucket and the dozer blade up.

Load point height		Load radius								At max. reach		
		2.0m (6.6ft)		3.0m (9.8ft)		4.0m (13.1ft)		5.0m (16.4ft)		Capacity		Reach
												m(ft)
5.0m 16.4ft	kg lb									*1460 *3220	1410 3110	3.54 (11.6)
4.0m 13.1ft	kg lb					*1350 *2980	1180 2600			*1410 *3110	980 2160	4.48 (14.7)
3.0m 9.8ft	kg lb			*1670 *3680	*1670 *3680	*1480 *3260	1160 2560			*1360 *3000	820 1810	4.99 (16.4)
2.0m 6.6ft	kg lb			*2430 *5360	1680 3700	*1770 *3900	1110 2450	1370 3020	800 1760	1280 2820	750 1650	5.22 (17.1)
1.0m 3.3ft	kg lb			2980 6570	1580 3480	1880 4140	1070 2360	1340 2950	780 1720	1260 2780	730 1610	5.22 (17.1)
0.0m 0.0ft	kg lb	*2070 *4560	*2070 *4560	2930 6460	1540 3400	1850 4080	1040 2290			1340 2950	770 1700	4.99 (16.4)
-1.0m -3.3ft	kg lb	*4030 *8880	2940 6480	2930 6460	1550 3420	1840 4060	1040 2290			1560 3440	890 1960	4.49 (14.7)
-2.0m -6.6ft	kg lb	*3590 *7910	3010 6640	*2280 *5030	1580 3480					*1720 *3790	1250 2760	3.56 (11.7)

Note 1. Lifting capacity are based on SAE J1097 and ISO 10567.
2. Lifting capacity of the ROBEX series does not exceed 75% of tipping load with the machine on firm, level ground or 87% of full hydraulic capacity.
3. The load point is a hook located on the back of the bucket.
4. *indicates load limited by hydraulic capacity.

6. BUCKET SELECTION GUIDE

	
0.07m³ SAE heaped bucket	0.21 m³ SAE heaped bucket

Capacity		Width		Weight	Recommendation
					3.0 m (9' 10") boom
SAE heaped	CECE heaped	Without side cutter	With side cutter		1.6 m (5' 3") arm
0.07 m³ (0.09 yd³)	0.06 m³ (0.08 yd³)	315 mm (12.4")	360 mm (14.2")	115 kg (255 lb)	Applicable for materials with density of 1600 kgf/m³ (2700 lb/yd³) or less
0.21 m³ (0.28 yd³)	0.18 m³ (0.24 yd³)	705 mm (27.8")	770 mm (30.3")	137 kg (375 lb)	

7. SPECIFICATIONS FOR MAJOR COMPONENTS

1) ENGINE

Item	Specification
Model	Yanmar 4TNV98-EPHYBU
Type	4-cycle diesel engine, low emission
Cooling method	Water cooling
Number of cylinders and arrangement	4 cylinders, in-line
Firing order	1-3-4-2
Combustion chamber type	Direct injection type
Cylinder bore × stroke	98 × 110 mm (3.85" × 4.33")
Piston displacement	3319 cc (203 cu in)
Compression ratio	18.5 : 1
Rated gross horse power(SAE J1995)	58.2 Hp at 2400 rpm (42.5 kW at 2400 rpm)
Maximum torque at 1550rpm	20.5 kgf · m (148 lbf · ft)
Engine oil quantity	11.6 ℓ (3.1 U.S. gal)
Dry weight	270 kg (595 lb)
High idling speed	2200 + 50 rpm
Low idling speed	1050 ± 100 rpm
Rated fuel consumption	176 g/Hp · hr at 2400 rpm
Starting motor	12V-3.0 kW
Alternator	12V-100 A
Battery	1 × 12V × 100Ah

2) MAIN PUMP

Item	Specification
Type	Variable displacement tandem axis piston pumps
Capacity	63 cc/rev
Maximum pressure	240 kgf/cm^2 (3480 psi)
Rated oil flow	151.2 ℓ /min
Rated speed	2400 rpm

3) GEAR PUMP

Item	Specification
Type	Fixed displacement gear pump single stage
Capacity	8 cc/rev
Maximum pressure	204 kgf/cm^2 (2958 psi)
Rated oil flow	19.2 ℓ /min

4) MAIN CONTROL VALVE

Item	Specification
Type	8 spools sectional block
Operating method	LUDV
Main relief valve pressure	240 kgf/cm^2(3480 psi)
Overload relief valve pressure	265 kgf/cm^2(3842 psi)

5) SWING MOTOR

Item	Specification
Type	Two fixed displacement axial piston motor
Capacity	28.9 cc/rev
Relief pressure	230 kgf/cm^2 (3335 psi)
Braking system	Automatic, spring applied hydraulic released
Braking torque	14 kgf · m (101 lbf · ft)
Brake release pressure	20~40 kgf/cm^2 (284~570 psi)
Reduction gear type	2 - stage planetary

6) TRAVEL MOTOR

Item	Specification
Type	Bent axis design variable displacement axial piston motor
Relief pressure	230 kgf/cm^2 (3335 psi)
Counterbalance valve	Applied
Capacity	80 cc

7) POWER TRAIN

Item	Description		Specification
Gear box	Type		2 speed hydrostatic
	Gear ratio	1st	4.06
		2nd	1.31
Parking brake	Type		Multi disc brake integrated in rear axle
	Maximum braking power		945 kgf · m (6835 lbf · ft)
Axle	Type		4 wheel drive with differential
	Gear ratio		13.65
	Brake		Multi disc brake

8) CYLINDER

Item		Specification
Boom cylinder	Bore dia × Rod dia × Stroke	ø 110 × ø 65 × 715mm
	Cushion	Extend only
Arm cylinder	Bore dia × Rod dia × Stroke	ø 90 × ø 55 × 850mm
	Cushion	Extend and retract
Bucket cylinder	Bore dia × Rod dia × Stroke	ø 80 × ø 50 × 660mm
	Cushion	Extend only
Dozer cylinder	Bore dia × Rod dia × Stroke	ø 105 × ø 55 × 189mm
	Cushion	-

※ **Discoloration of cylinder rod can occur when the friction reduction additive of lubrication oil spreads on the rod surface.**

※ **Discoloration does not cause any harmful effect on the cylinder performance.**

9) BUCKET

Item		Capacity		Tooth quantity	Width	
		SAE heaped	CECE heaped		Without side cutter	With side cutter
R60WVS PRO	STD	0.21 m^3 (0.28 yd^3)	0.18 m^3 (0.24 yd^3)	5	705 mm (27.8")	770 mm (30.3")
	OPT	0.07 m^3 (0.09 yd^3)	0.06 m^3 (0.08 yd^3)	3	315 mm (12.4")	360 mm (14.2")

8. RECOMMENDED LUBRICANTS

Use only oils listed below or equivalent.

Do not mix different brand oil.

Service point	Kind of fluid	Capacity ℓ (U.S. gal)	Ambient temperature ˚C(˚F) -50 (-58) -30 (-22) -20 (-4) -10 (14) 0 (32) 10 (50) 20 (68) 30 (86) 40 (104)
Engine oil pan	Engine oil	12 (3.1)	★SAE 5W-40 SAE 30 SAE 10W SAE 10W-30 SAE 15W-40
Swing drive	Grease	0.2 (0.1)	★NLGI NO.1 NLGI NO.2
	Gear oil	1.5 (0.4)	★SAE 75W-90 SAE 85W-140
Gear box case	Gear oil	1.8 (0.5)	SAE 85W-90 LSD(GL-5)
Front axle		Center : 4.5 (1.19) Hub : 0.4×2 (0.11×2)	
Rear axle		Center : 4.5 (1.19) Hub : 0.4×2 (0.11×2)	
Hydraulic tank	Hydraulic oil	Tank; 70 (18.5) System; 120 (31.7)	★ISO VG 15 ISO VG 32 ISO VG 46, HBHO VG 46★3 ISO VG 68
Fuel tank	Diesel fuel★1	120 (31.7)	★ASTM D975 NO.1 ASTM D975 NO.2
Fitting (grease nipple)	Grease	As required	★NLGI NO.1 NLGI NO.2
Radiator (reservoir tank)	Mixture of antifreeze and water 50 : 50★2	10 (2.5)	Ethylene glycol base permanent type ★Ethylene glycol base permanent type (60 : 40)

SAE : Society of Automotive Engineers
API : American Petroleum Institute
ISO : International Organization for Standardization
NLGI : National Lubricating Grease Institute
ASTM : American Society of Testing and Material
UTTO : Universal Tractor Transmission Oil

★ : Cold region
Russia, CIS, Mongolia

★1 : Ultra low sulfur diesel
- sulfur content ≤ 15 ppm

★2 : Soft water
City water or distilled water

★3 : Hyundai Bio Hydraulic Oil
- For more information, contact HYUNDAI dealers.

※ Using any lubricating oils other than HYUNDAI genuine products may lead to a deterioration of performance and cause damage to major components.

※ Do not mix HYUNDAI genuine oil with any other lubricating oil as it may result in damage to the systems of major components.

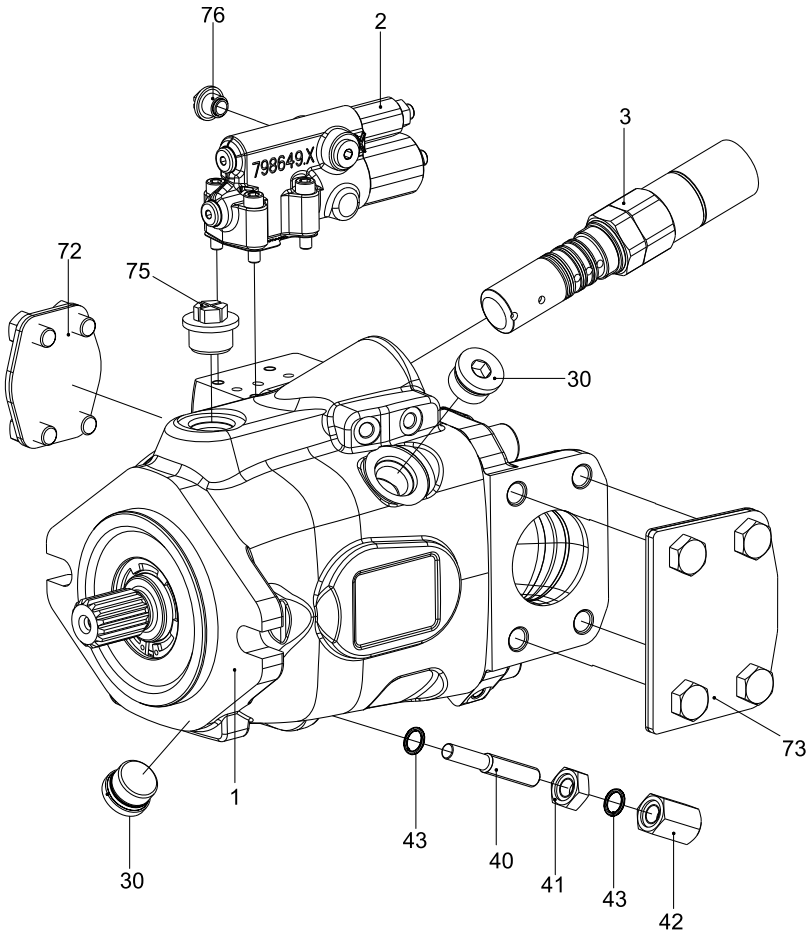
※ For HYUNDAI genuine lubricating oils and grease for use in regions with extremely low temperatures, please contact HYUNDAI dealers.

SECTION 2 STRUCTURE AND FUNCTION

SECTION 2 STRUCTURE AND FUNCTION

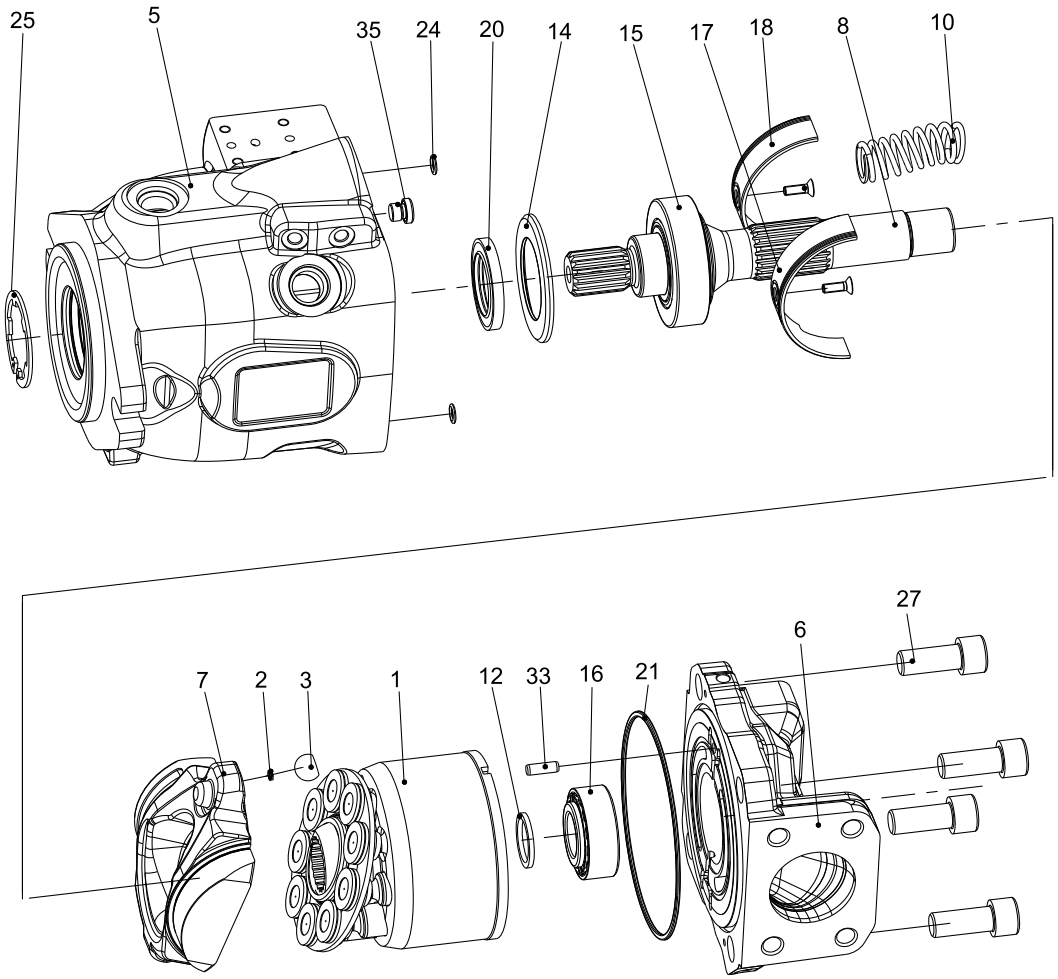
GROUP 1 HYDRAULIC PUMP

1. STRUCTURE (1/2)



1	Main pump	43	O-ring
2	Control valve	72	Cover
3	Control valve	73	Cover
30	Locking screw	75	Screw
40	Stop screw	76	Screw
41	Nut		
42	Cap		

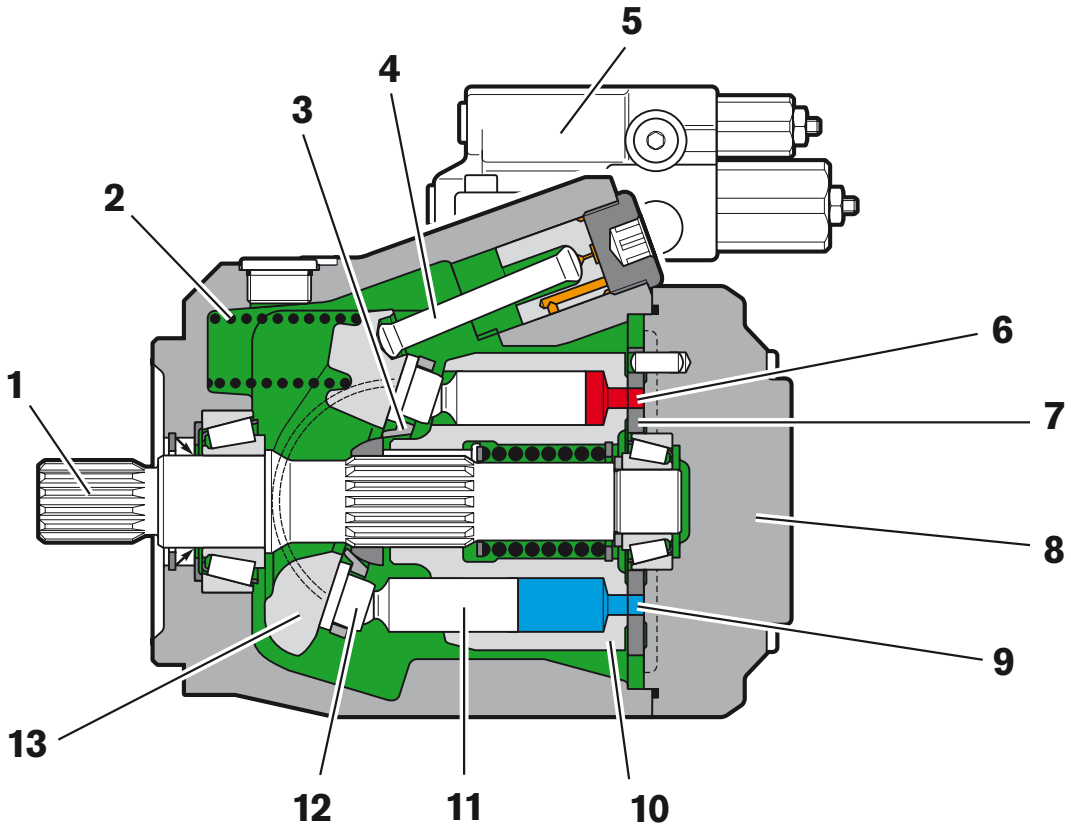
STRUCTURE (2/2)



1	Rotary Assy	16	Taper roller bearing
2	Spring	17	Liner bearing
3	Stopper	18	Liner bearing
5	Pump housing	20	Seal ring
6	Port plate	21	O-ring
7	Swash plate	24	Seal ring
8	Drive shaft	25	Retainer ring
10	Spring	27	Socket screw
12	Adjust shim	33	Cylinder pin
14	Stop ring	35	Screw
15	Taper roller bearing		

2. PRINCIPAL COMPONENTS AND FUNCTIONS

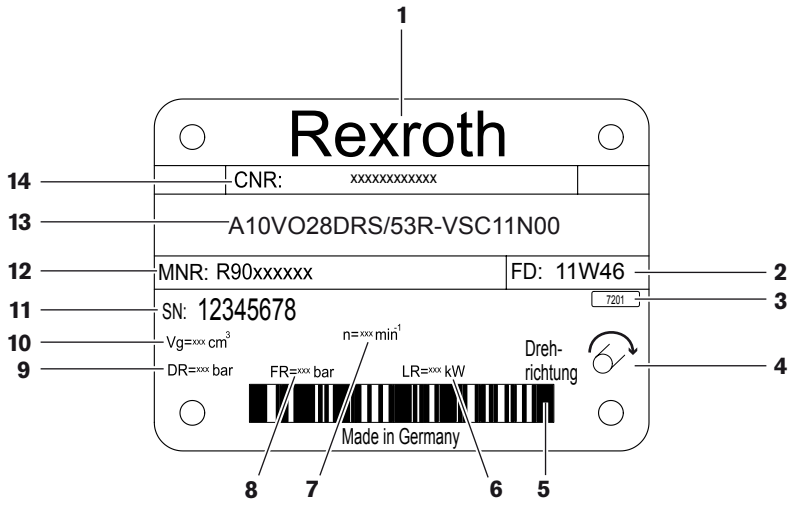
The A10VO, A10VSO, A10VNO, A10VSNO are variable pumps with axial piston rotary group in swashplate design for hydrostatic drive in an open circuit. Flow is proportional to drive speed and displacement. The flow can be steplessly changed by controlling the swashplate (13). For axial piston units with swashplate design, the pistons (11) are arranged axially with respect to the drive shaft (1).



1	Drive shaft	**6**	High-pressure side	**11**	Piston
2	Spring	**7**	Control plate	**12**	Slipper pad
3	Retaining plate	**8**	Port plate	**13**	Swashplate
4	Stroke piston	**9**	Suction side		
5	Control valve	**10**	Cylinder		

3. PRODUCT IDENTIFICATION

The axial piston unit can be identified from the name plate. The following example shows an A10VO name plate:

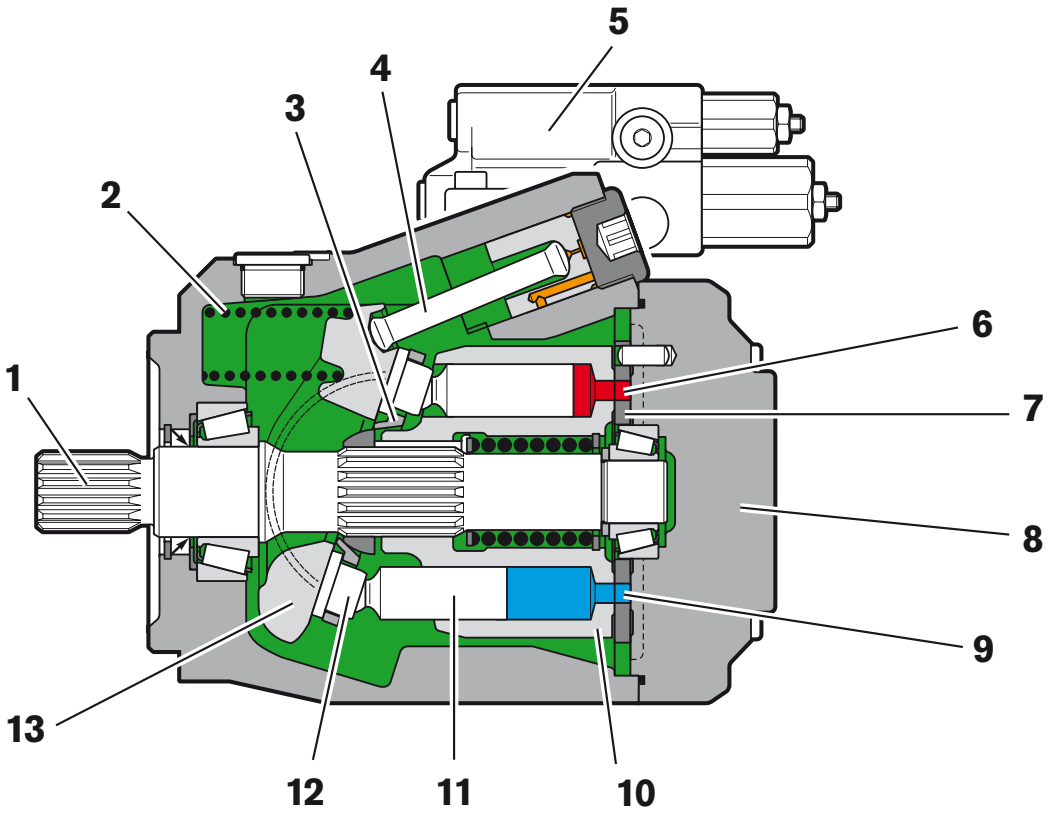


1 Manufacturer
2 Production date
3 Internal plant designation
4 Direction of rotation (viewed on drive shaft) – here: clockwise
5 Bar code
6 Power setting (optional)
7 Speed
8 Flow setting (optional)
9 Pressure controller setting (optional)
10 Minimum displacement
11 Serial number
12 Material number of theaxialpistonunit
13 Ordering code
14 Customer material number

4. Function of pump

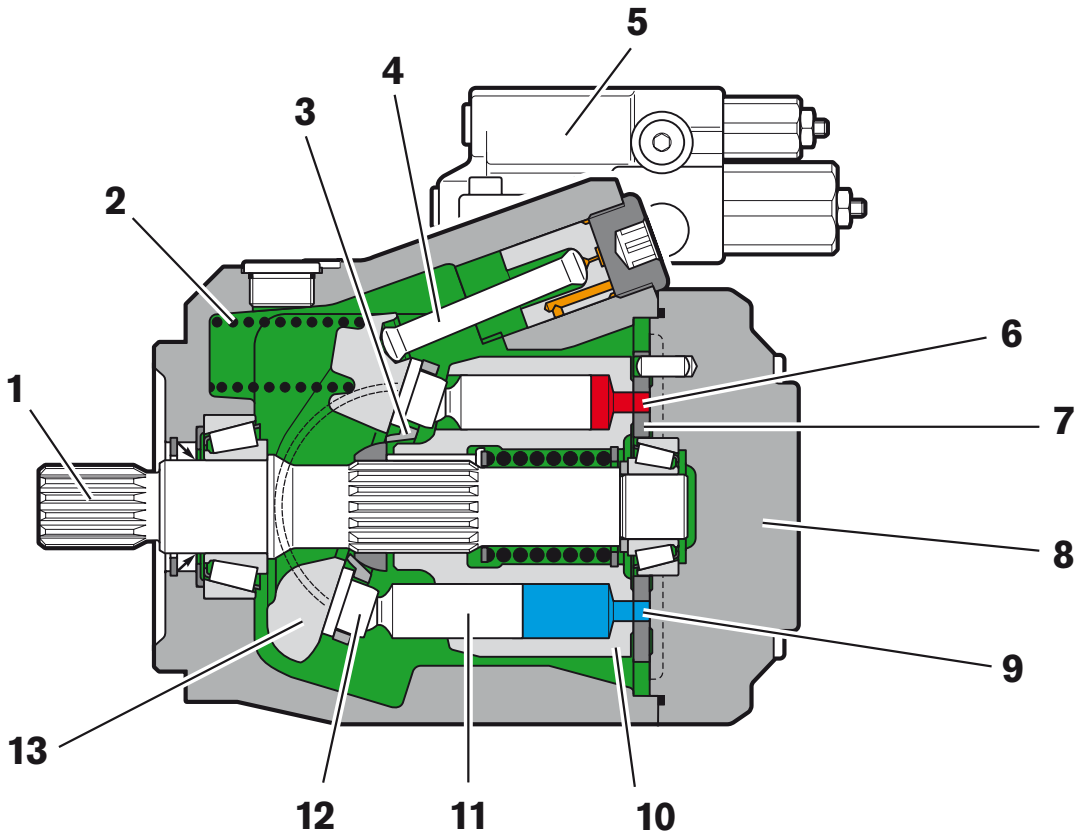
1) Pump

Torque and rotational speed are applied to the drive shaft (**1**) by an engine. The drive shaft is connected by splines to the cylinder (**10**) to set this in motion. With every revolution, the pistons (**11**) in the cylinder bores execute one stroke whose magnitude depends on the setting of the swashplate (**13**). The pistons hold the slipper pads (**12**) onto the glide surface of the swashplate with the retaining plate (**3**) and guide them along. The swashplate setting during a rotation causes each piston to move over the bottom and top dead centers and back to its initial position. Here, hydraulic fluid is fed in and drained out through the two control slots in the control plate (**7**) according to the stroke displacement. On the suction side (**9**) hydraulic fluid flows into the piston chamber as the piston recedes. At the same time, on the high-pressure side (**6**) the fluid is pushed out of the cylinder chamber into the hydraulic system by the pistons.



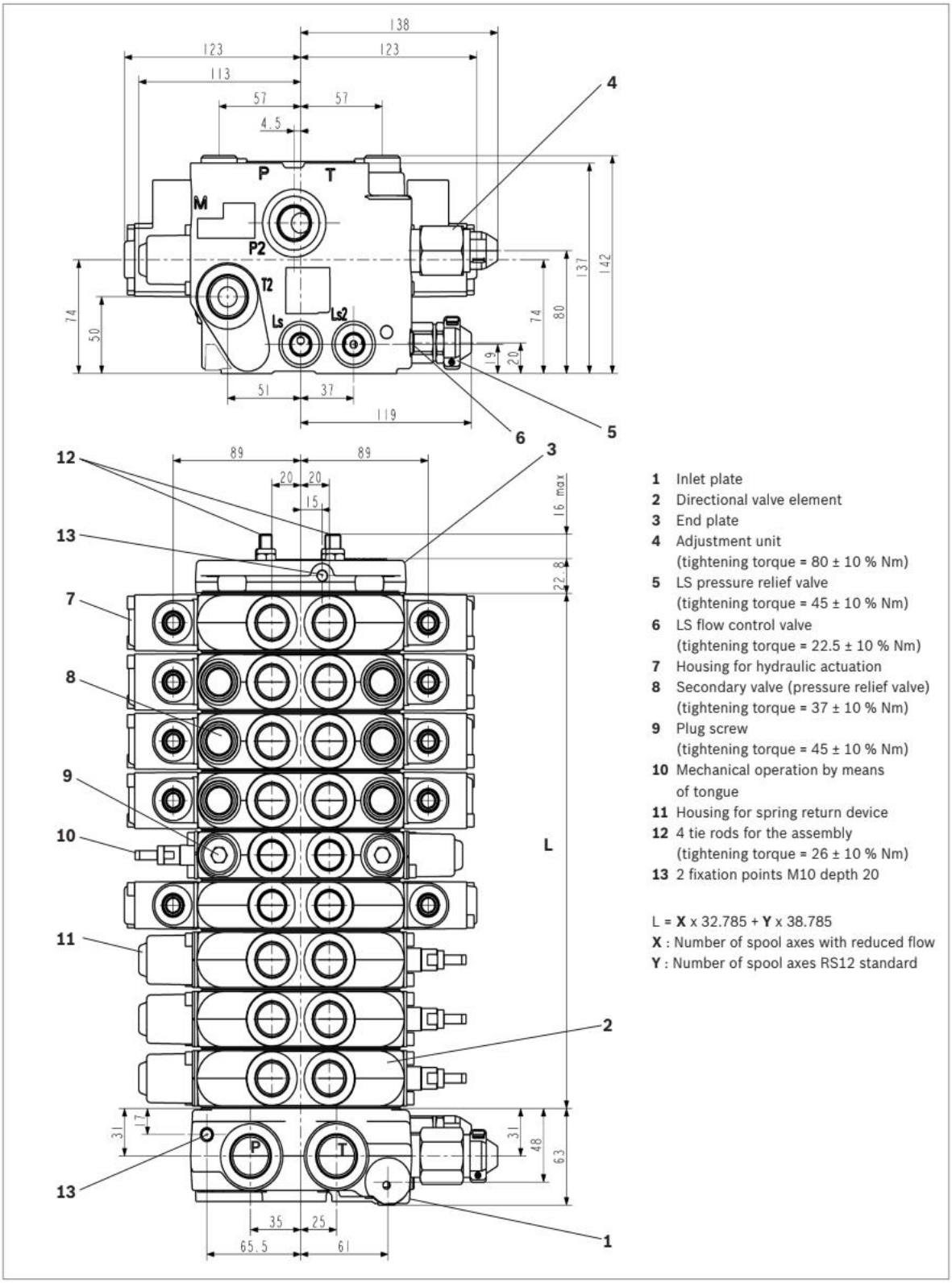
2) CONTROL FUNCTIONS

The swivel angle of the swashplate (**13**) is steplessly variable. Controlling the swivel angle of the swashplate changes the piston stroke and therefore the displacement. The swivel angle is changed hydraulically by means of the stroke piston. The swashplate is mounted in swivel bearings for easy motion and it is kept in balance by a spring (**2**). Increasing the swivel angle increases the displacement; reducing the angle results in a corresponding reduction in displacement.



GROUP 2 MAIN CONTROL VALVE

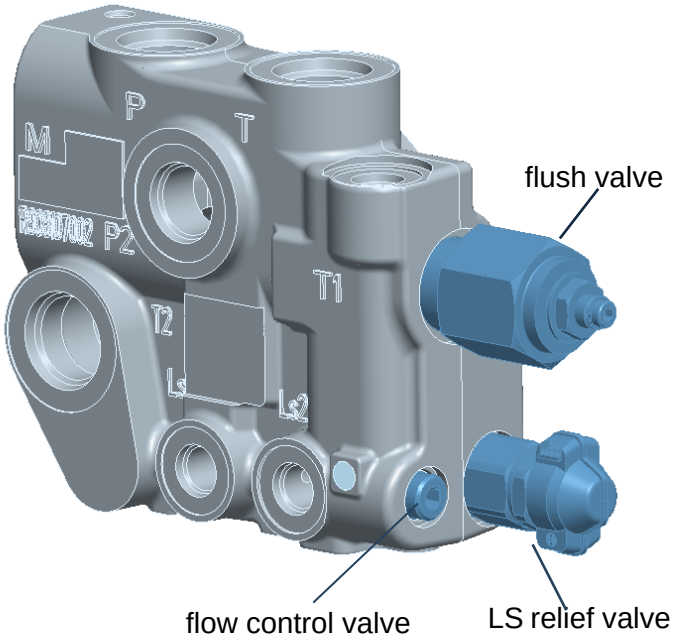
1. OUTLINE(REXRORH RS12)

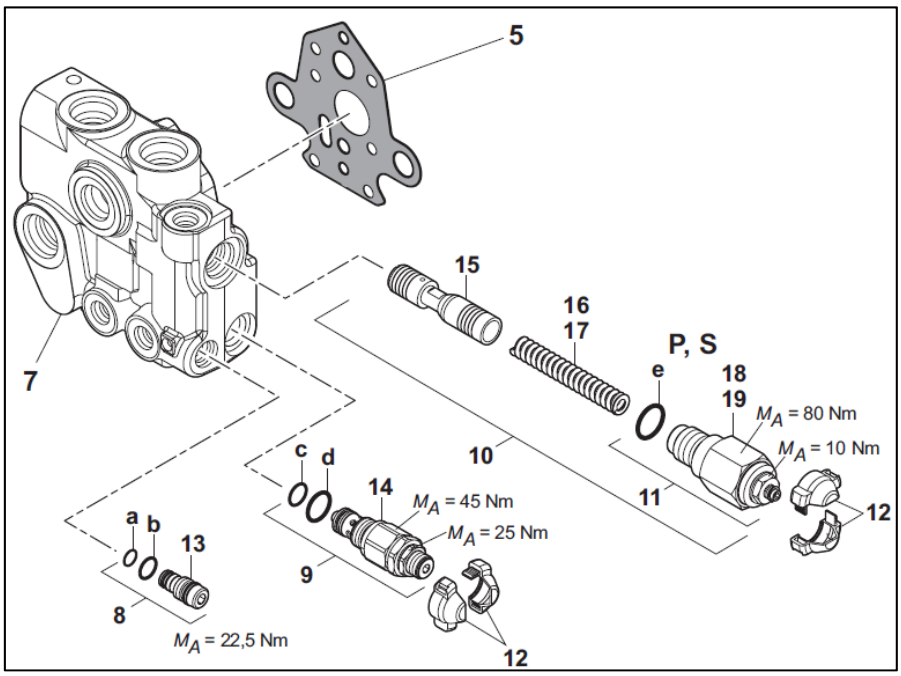


1 Inlet plate
2 Directional valve element
3 End plate
4 Adjustment unit
(tightening torque = 80 ± 10 % Nm)
5 LS pressure relief valve
(tightening torque = 45 ± 10 % Nm)
6 LS flow control valve
(tightening torque = 22.5 ± 10 % Nm)
7 Housing for hydraulic actuation
8 Secondary valve (pressure relief valve)
(tightening torque = 37 ± 10 % Nm)
9 Plug screw
(tightening torque = 45 ± 10 % Nm)
10 Mechanical operation by means of tongue
11 Housing for spring return device
12 4 tie rods for the assembly
(tightening torque = 26 ± 10 % Nm)
13 2 fixation points M10 depth 20

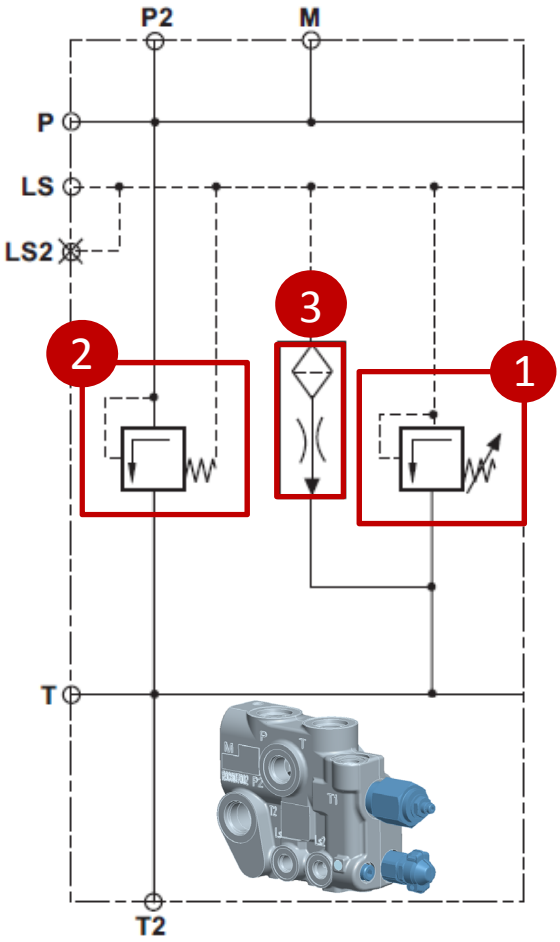
L = **X** x 32.785 + **Y** x 38.785
X : Number of spool axes with reduced flow
Y : Number of spool axes RS12 standard

2.FEED GROUP (REXRORH RS12) 1/2





2.FEED GROUP (REXRORH RS12) 2/2

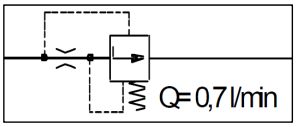


1. LS relief valve: overflow LS oil line working pressure

2. Flush valve:

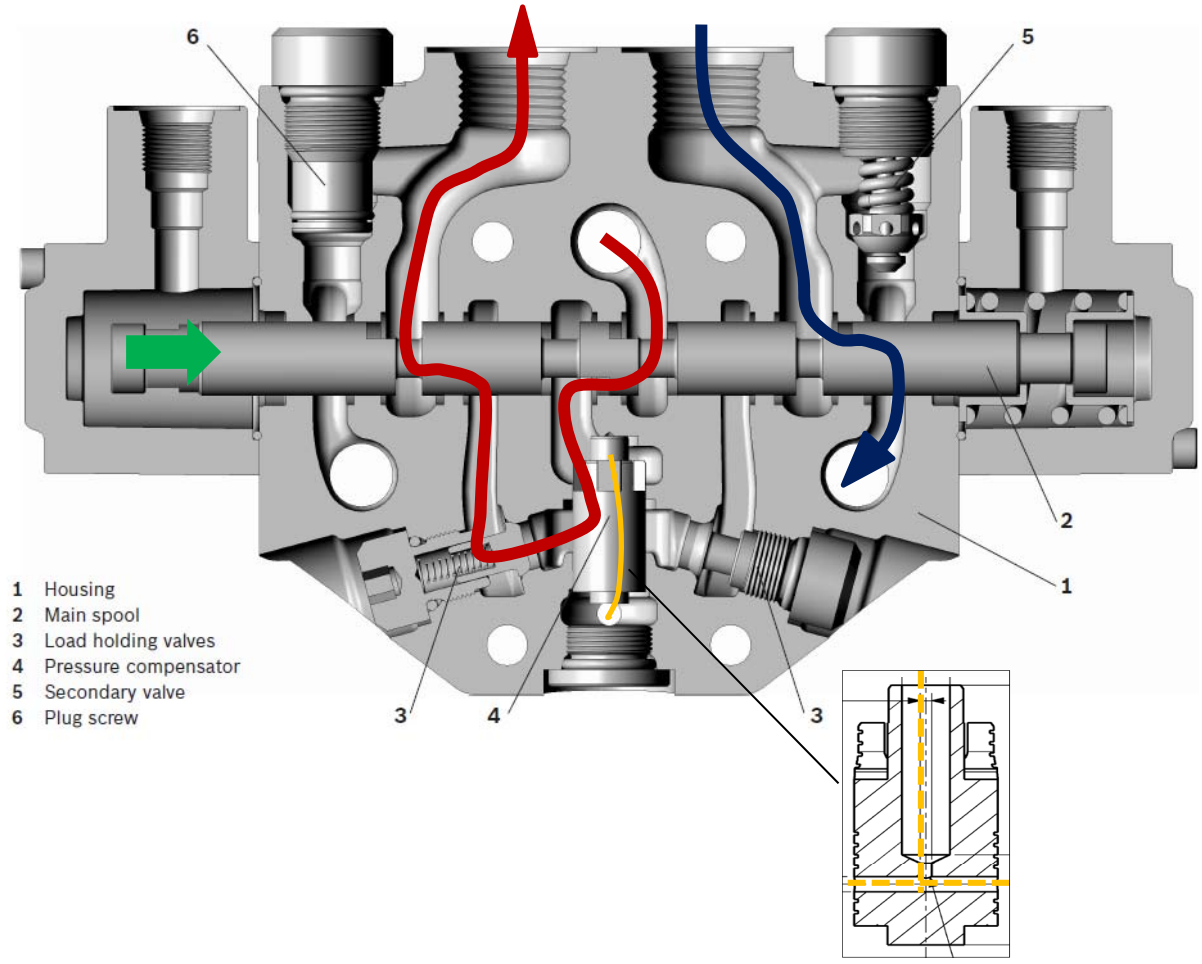
- Medium standby pressure: fast response and accumulator pressure loss to ensure machine action
- The median flushing
- Combined with LS relief valve, it acts as the main relief valve of the system

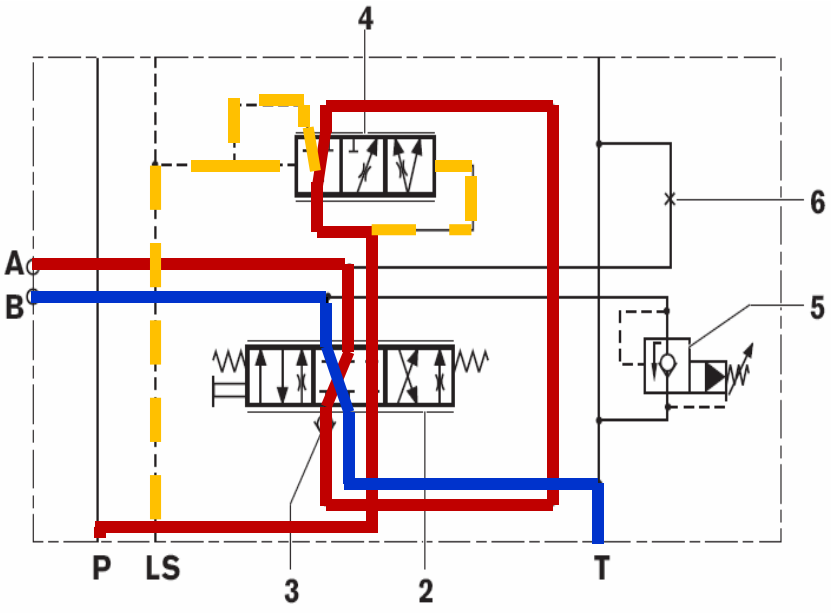
3. Flow control valve: release LS oil pressure



4. System pressure: LS overflow pressure + flushing valve pressure

3. WORKING GROUP (REXRORH RS12)





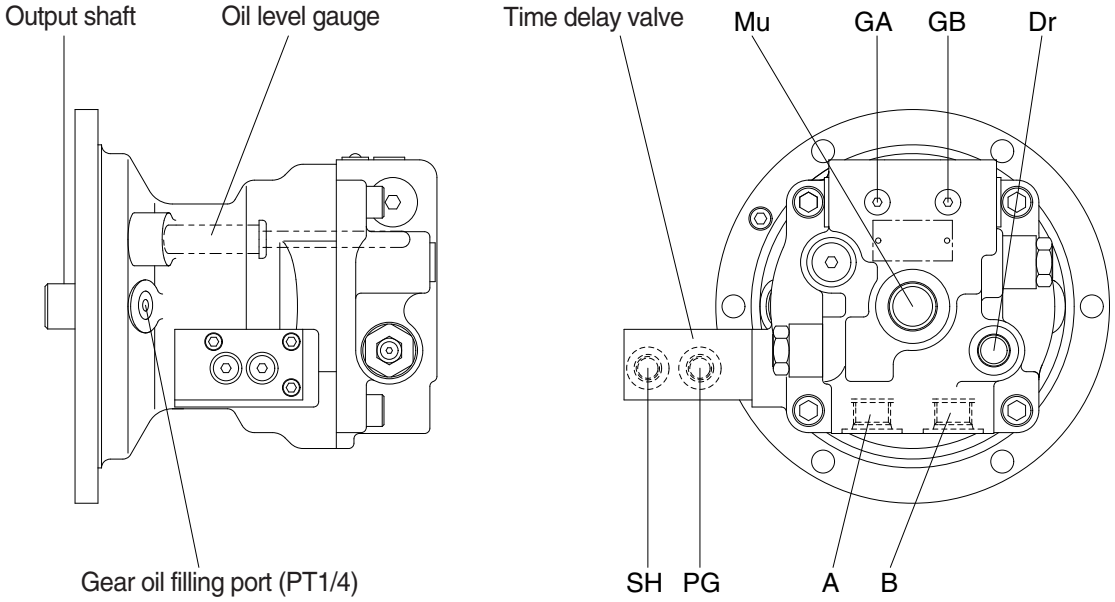
GROUP 3 SWING DEVICE

1. STRUCTURE

Swing device consists swing motor, swing reduction gear.

1) SWING MOTOR

Swing motor include mechanical parking valve, relief valve, make up valve and time delay valve.



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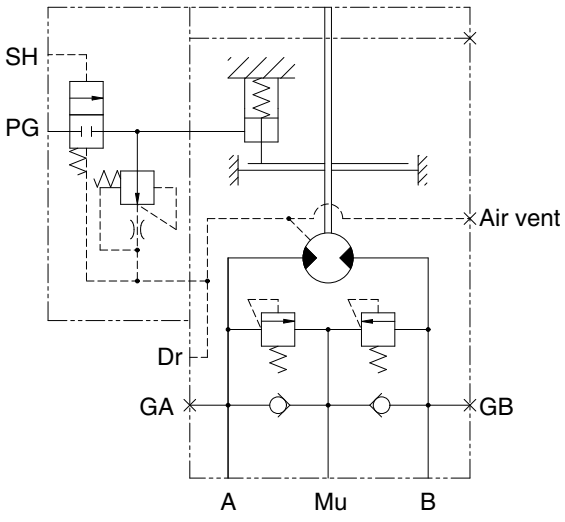
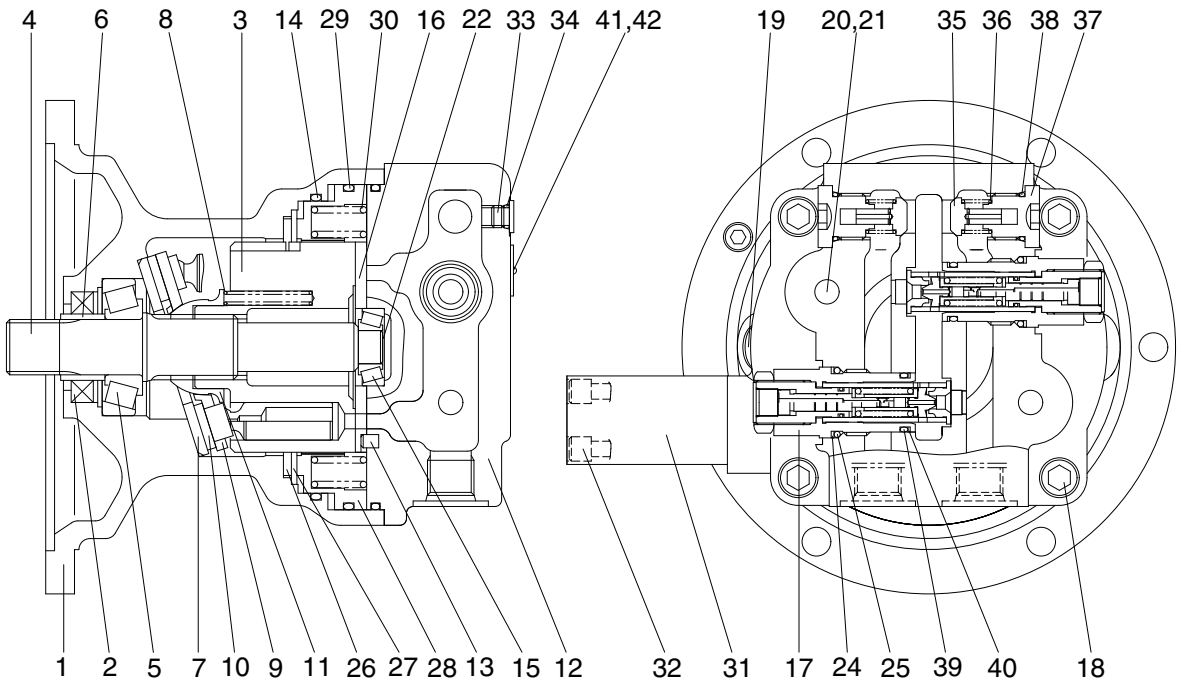


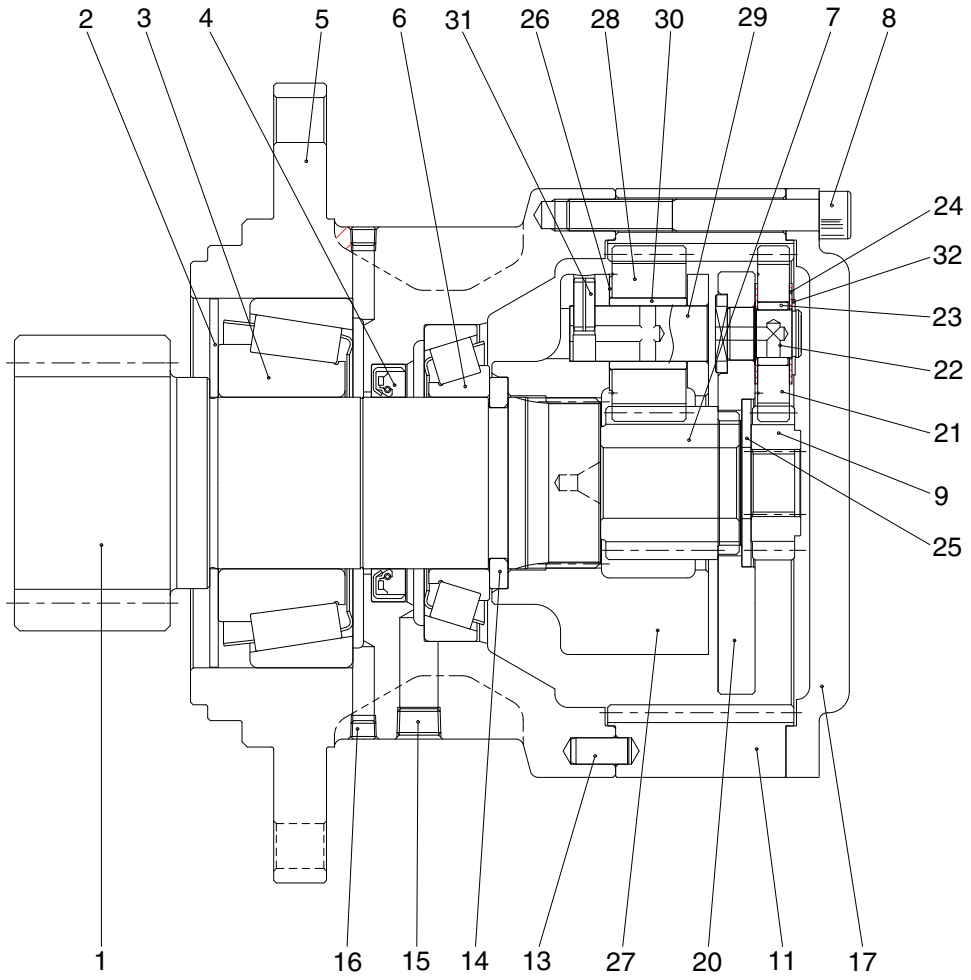
Hydraulic circuit

Port	Port name	Port size
A	Main port	SAE PF 1/2
B	Main port	SAE PF 1/2
Dr	Drain port	PF 3/8
Mu	Make up port	PF 3/4
PG	Brake release stand by port	PF 1/4
SH	Brake release pilot port	PF 1/4
GA,GB	Gauge port	PF 1/4



1	Body	15	Taper bearing	30	Spring
2	Oil seal	16	Valve plate	31	Time delay valve
3	Cylinder block	17	Relief valve assy	32	Socket bolt
4	Shaft	18	Socket bolt	33	Plug
5	Taper bearing	19	Plug	34	O-ring
6	Bushing	20	Plug	35	Valve
7	Shoe plate	21	O-ring	36	Spring
8	Spring	22	Shim	37	Plug
9	Set plate	24	Back up ring	38	O-ring
10	Piston shoe assy	25	O-ring	39	O-ring
11	Ball guide	26	Friction plate	40	Back up ring
12	Rear cover	27	Plate	41	Name plate
13	Pin	28	Parking piston	42	Rivet
14	O-ring	29	O-ring		

2) REDUCTION GEAR



1	Shaft	12	Carrier assy 2	23	Bushing 1
2	Bearing cover	13	Dowel pin	24	Thrust washer 1
3	Taper roller bearing	14	Collar	25	Thrust washer 3
4	Case	15	Plug	26	Thrust washer 2
5	Oil seal	16	Plug	27	Carrier assy 2
6	Taper roller bearing	17	Cover	28	Planet gear 2
7	Sun gear 2	18	Pipe	29	Pin 2
8	Socket bolt	19	Level gauge	30	Bushing 2
9	Sun gear 1	20	Carrier assy 1	31	Spring pin
10	Carrier assy 1	21	Planet gear 1	32	Snap ring
11	Ring gear	22	Pin 1	33	Thrust washer 4

2. FUNCTION

1) ROTARY PART

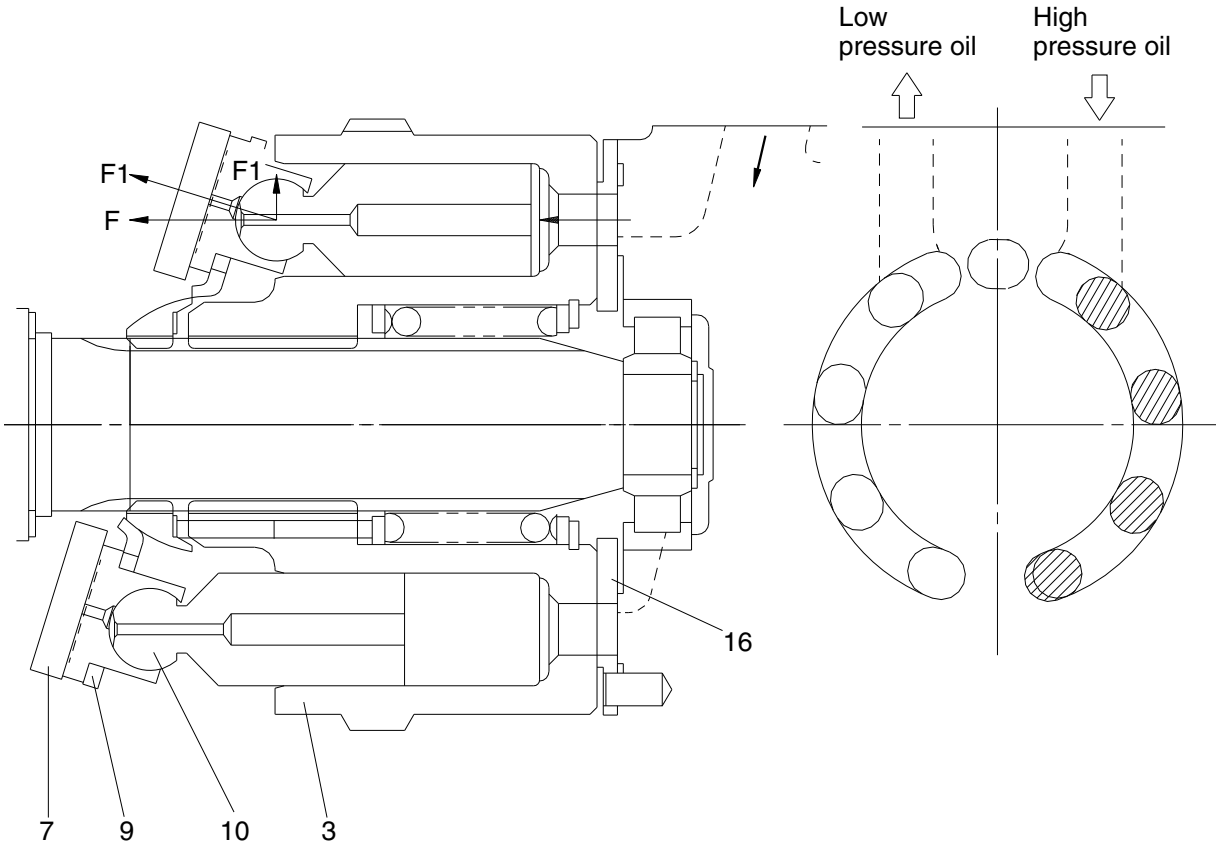
When high pressurized oil enters a cylinder through port(a), which is the inlet of balance plate(16), hydraulic pressure acting on the piston causes axial force F. The pressure force F works via the piston(10) upon the return plate(9) which acts upon the swash plate(7) via an hydrostatic bearing. Force F1 perpendicular to swash plate(7) and force F2 perpendicular to cylinder center.

Being transferred to the cylinder block(3) through piston, force F2 causes rotational moment at surroundings of cylinder.

Since cylinder block has 9 equidistantly arrayed pistons, rotational torque is transmitted to cylinder shaft in order by several pistons connected to the inlet port of high pressurized oil. When the direction of oil flow is reversed, rotational direction of cylinder is also reversed. Output torque is given by the equation.

$$T = \frac{p \times q}{2\pi},\ q = Z \cdot A \cdot PCD \cdot \tan\theta,\ F1 = \frac{F}{\cos\theta},\ F_2 = F\tan\theta,\ S = PCD \times \tan\theta$$

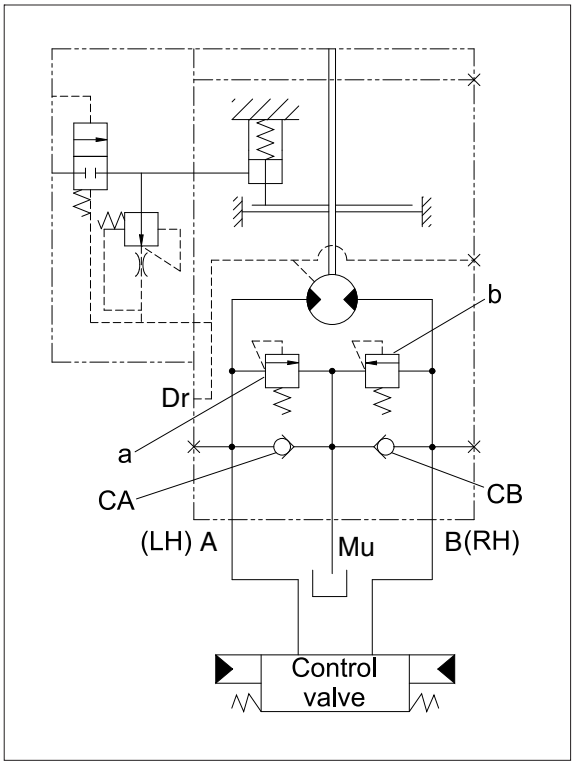
Where p : Effective difference of pressure (kgf/cm^2)
q : Displacement (cc/rev)
T : Output torque ($kgf \cdot cm$)
Z : Piston number (9EA)
A : Piston area (cm^2)
θ: Tilting angle of swash plate (degree)
S : Piston stroke (cm)



2) MAKE UP VALVE

(1) Outline

The safety valve portion consists of a check valve and safety valve.



(2) Function

When the swing is stopped, the output circuit of the motor continues to rotate because of inertia. For this reason, the pressure at the output side of the motor becomes abnormality high, and this will damage the motor. To prevent this, the oil causing the abnormal hydraulic pressure is allowed to escape from the outlet port (high-pressure side) of the motor to port Mu, thereby preventing damage to the motor.

Compared with a counterbalance valve, there is no closed-in pressure generated at the outlet port side when slowing down the swing speed. This means that there is no vibration when slowing down, so the ease of swing control is improved.

(3) Operation

① When starting swing

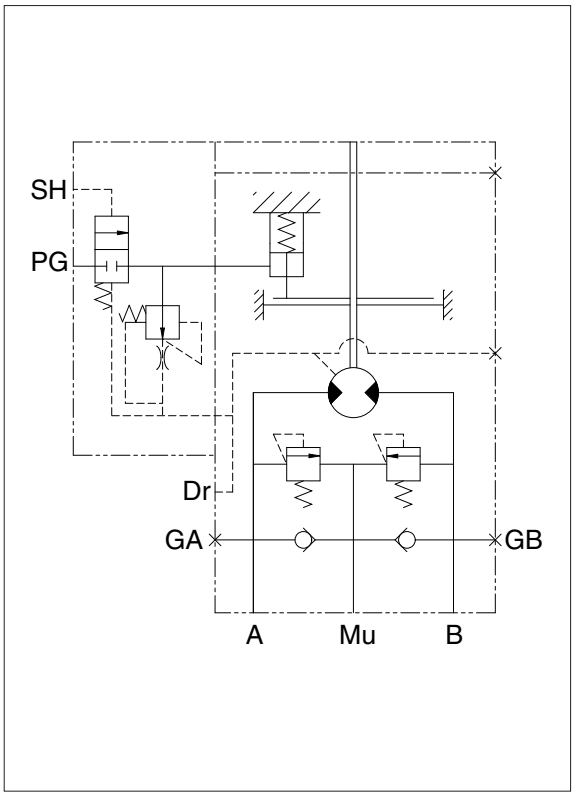
When the swing control lever is operated to left swing, the pressurized oil from the pump passes through the control valves and is supplied to port B. Because of this, the pressure at port B rises, staring torque is generated in the motor, and the motor starts to rotate. The oil from the outlet port of the motor passes from port A through the control valve and returns to the tank.

② When stopping swing

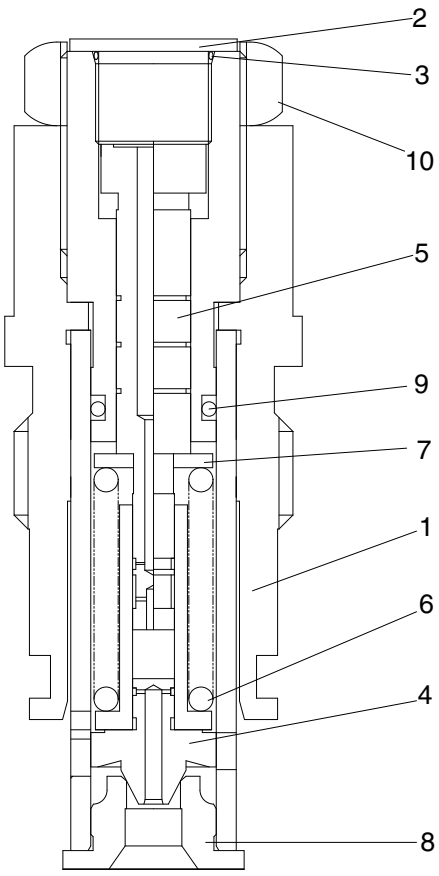
· When the swing control lever is returned to neutral, no pressurized oil is supplied from the pump to port B.
  The return circuit to the tank is closed by the control valve. So the oil from the outlet port of the motor increases in pressure at port A. Resistance to the rotation of the motor is created, and the brake starts to act.

· The pressure at port A rises to the set pressure of make up valve a, and in this way, a high brake torque acts on the motor, and the motor stops.

· When make up valve a is being actuated, the relief oil from make up valve a and the oil from port Mu pass through check valve CB and are supplied to port B. This prevents cavitation from forming at port B.



3) RELIEF VALVE



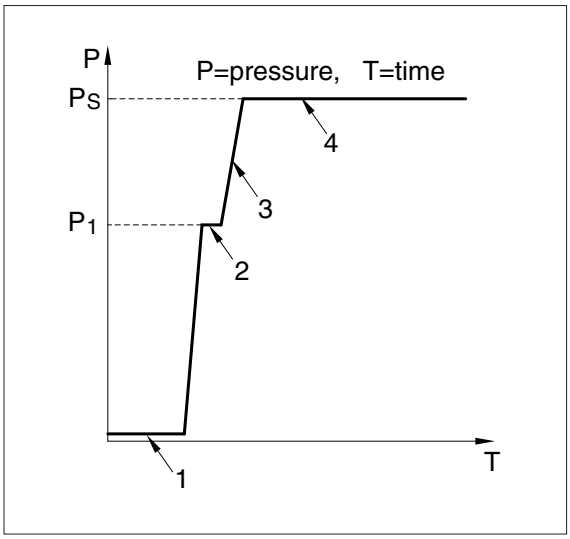
1 Body
2 Plug
3 O-ring
4 Plunger
5 Piston
6 Spring
7 Spring seat
8 Seat
9 O-ring
10 Nut

(1) Construction of relief valve

The valve casing contains two cartridge type relief valves that stop the regular and reverse rotations of the hydraulic motor. The relief valves relieve high pressure at start or at stop of swing motion and can control the relief pressure in two steps, high and low, in order to insure smooth operation.

(2) Function of relief valve

Figure illustrates how the pressure acting on the relief valve is related to its rising process. Here is given the function, referring to the figure following page.

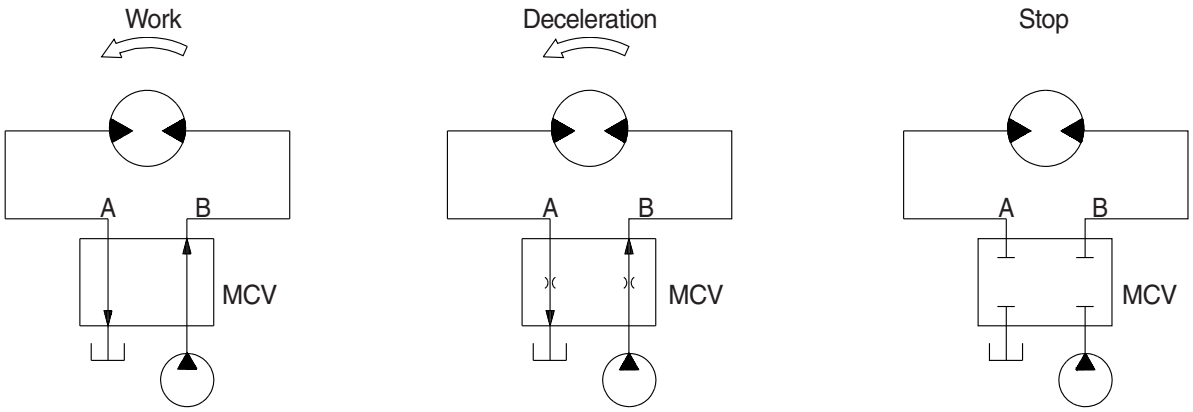


4) BRAKE SYSTEM

(1) Control valve swing brake system

This is the brake system to stop the swing motion of the excavator during operation.

In this system, the hydraulic circuit is throttled by the swing control valve, and the resistance created by this throttling works as a brake force to slow down the swing motion.



MCV A, B opened　　MCV A, B throttled　　MCV A, B closed

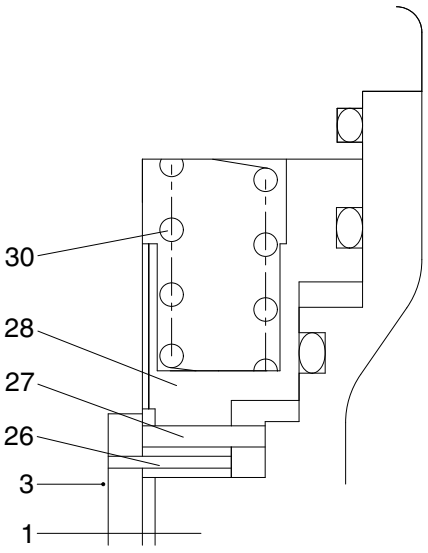
(2) Mechanical swing parking brake system

The mechanical swing parking brake system is installed to prevent the upper structure from swinging downhill because of its own weight when the excavator is parked on a slope since it completely eliminates the hydraulic drift of swing motion while the excavator is on a slop, work can be done more easily and safely.

① Brake assembly

Circumferential rotation of separate plate (27) is constrained by the groove located at casing (1). When housing is pressed down by brake spring (30) through friction plate (26), separate plate (27) and brake piston (28), friction force occurs there.

Cylinder (3) is constrained by this friction force and brake acts, while brake releases when hydraulic force exceeds spring force.

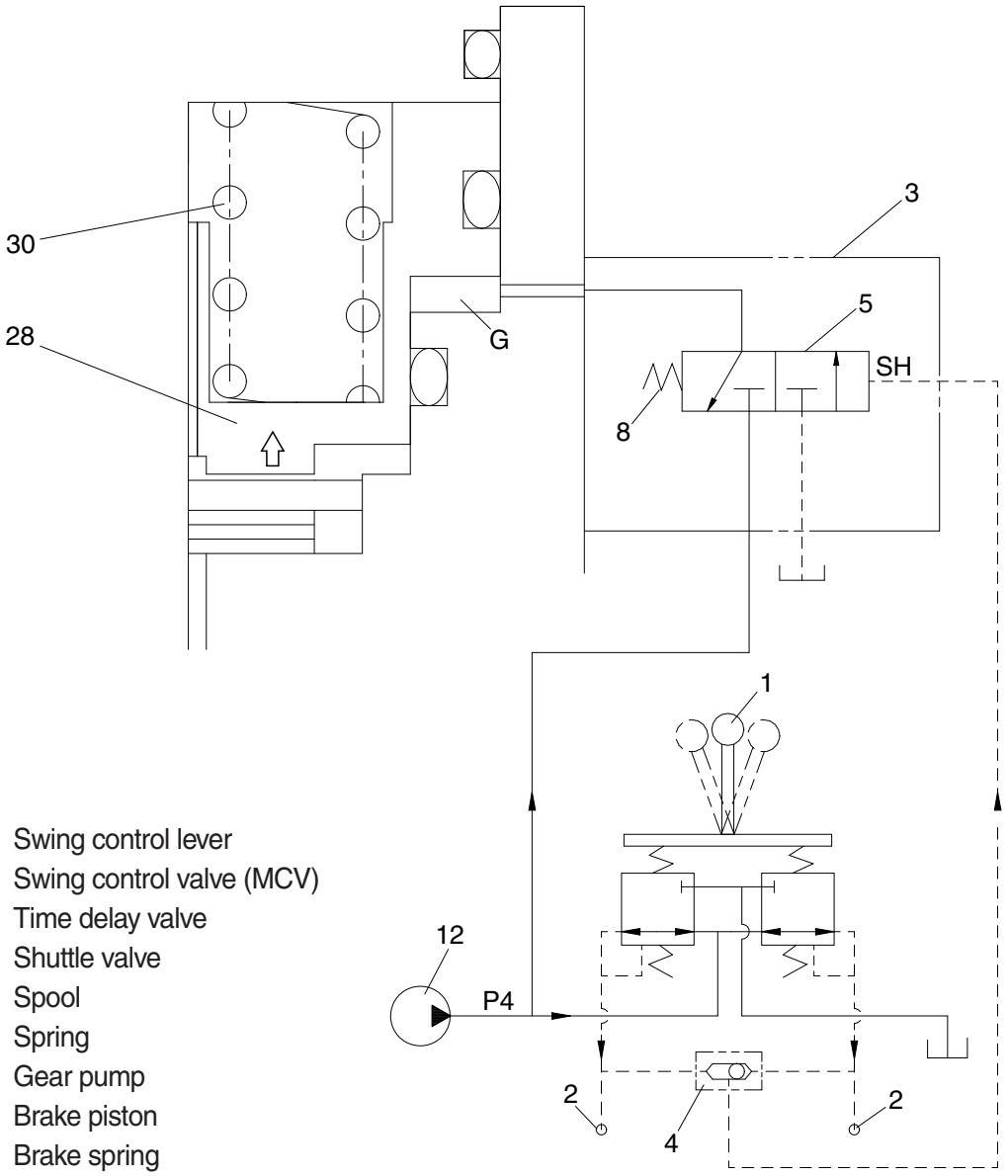


1	Casing	27	Separate plate
3	Cylinder	28	Brake piston
26	Friction plate	30	Brake spring

② Operating principle

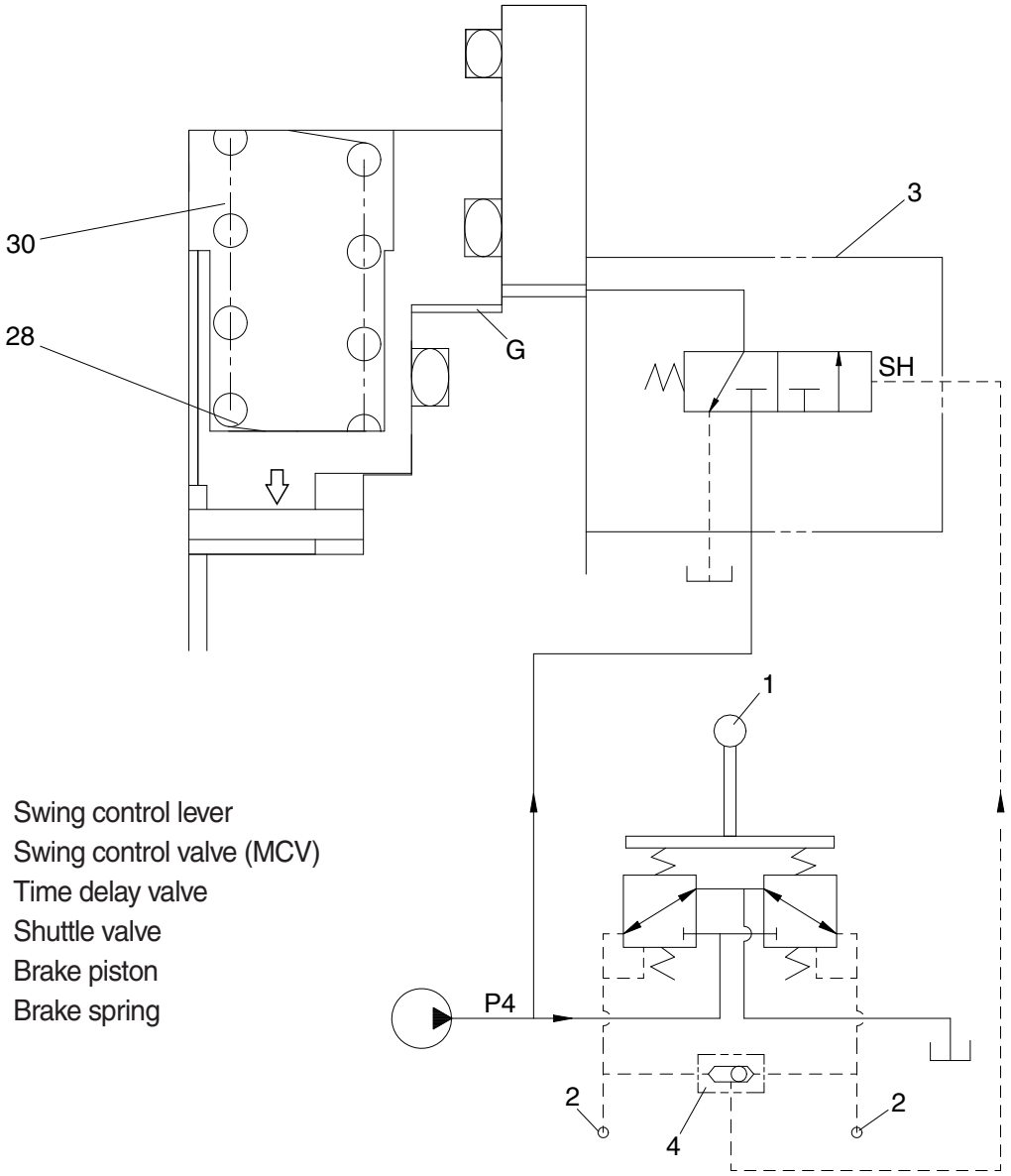
a. When the swing control lever (1) is set to the swing position, the pilot oil go to the swing control valve (2) and to SH of the time delay valve (3) via the shuttle valve (4), this pressure move spool (5) to the leftward against the force of the spring (8), so pilot pump charged oil (P4) goes to the chamber G.

This pressure is applied to move the piston (28) to the upward against the force of the spring (30). Thus, it releases the brake force.



1 Swing control lever
2 Swing control valve (MCV)
3 Time delay valve
4 Shuttle valve
5 Spool
8 Spring
12 Gear pump
28 Brake piston
30 Brake spring

b. When the swing control lever (1) is set the neutral position, the time delay valve (3) shifts the neutral position and the pilot oil blocked chamber G.
Then, the piston (28) is moved lower by spring (30) force and the return oil from the chamber G is drain.

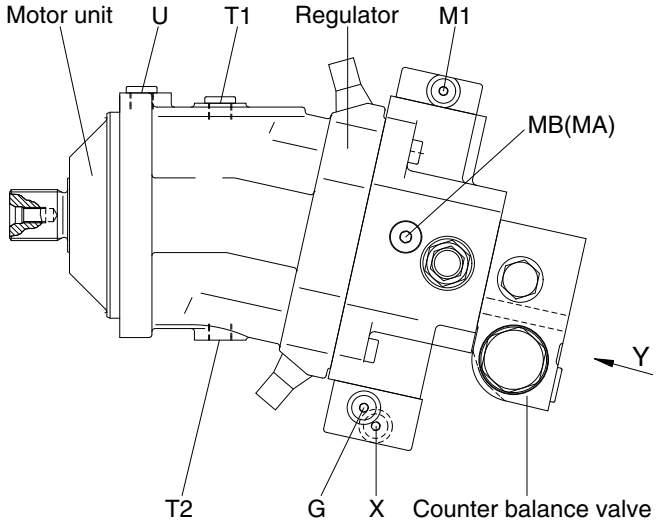


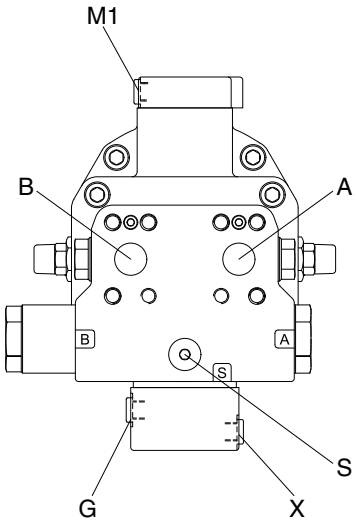
1 Swing control lever
2 Swing control valve (MCV)
3 Time delay valve
4 Shuttle valve
28 Brake piston
30 Brake spring

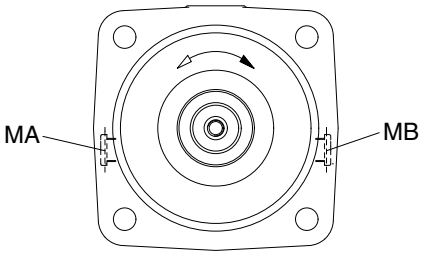
GROUP 4 TRAVEL DEVICE

1. CONSTRUCTION

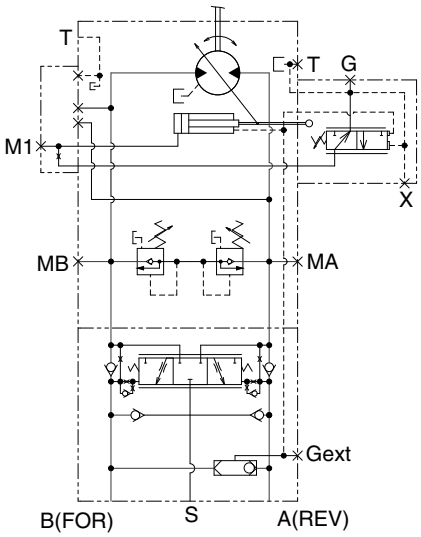
Travel motor consists motor unit, regulator and counter balance valve.







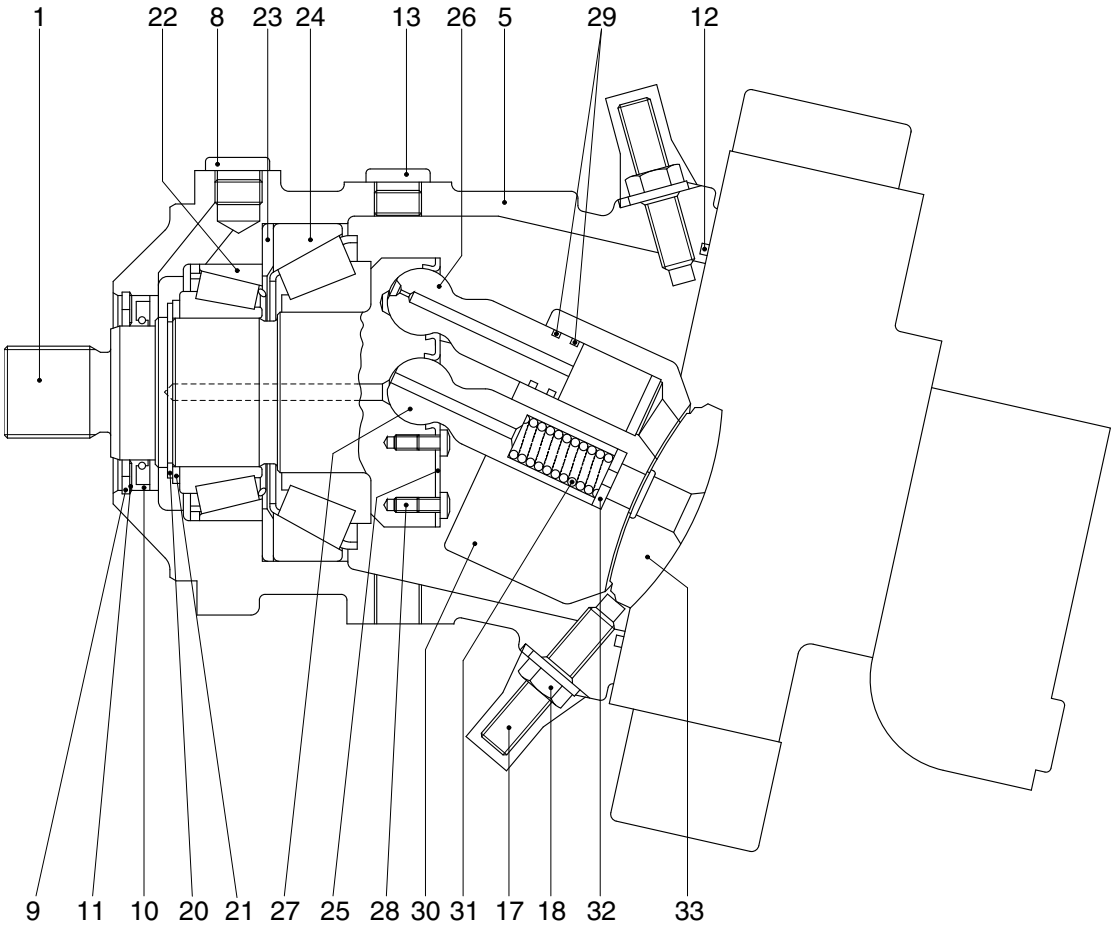
VIEW Y



Hydraulic circuit

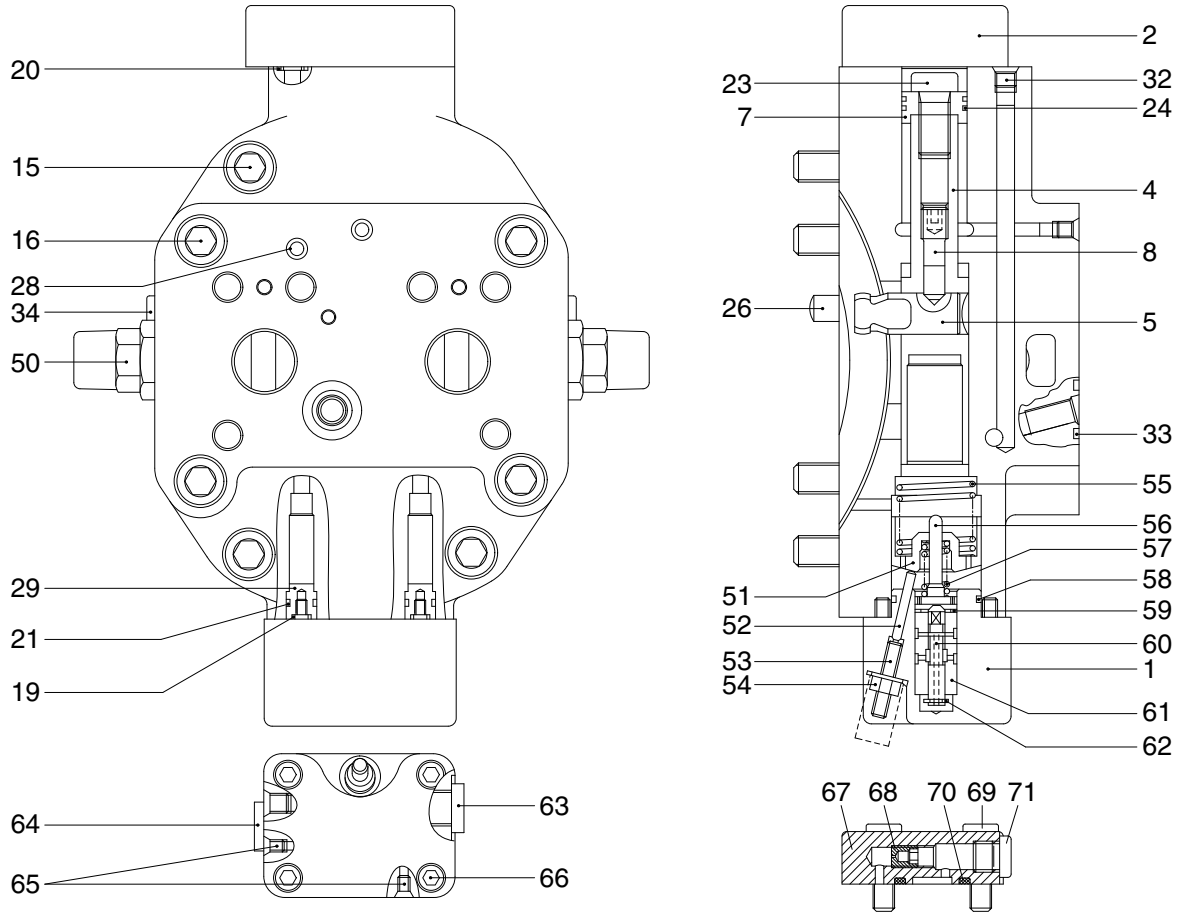
Port	Port name	Port size
A, B	Main port	SAE 6000psi 1
G	Gauge port	M14×1.5
M1	Gauge port	M14×1.5
X	Pilot pressure port	M14×1.5
T2	Drain port	M18×1.5
U	Flushing port	M18×1.5
S	Make up port	M22×1.5
MA,MB	Gauge port	M18×1.5

1) MOTOR UNIT



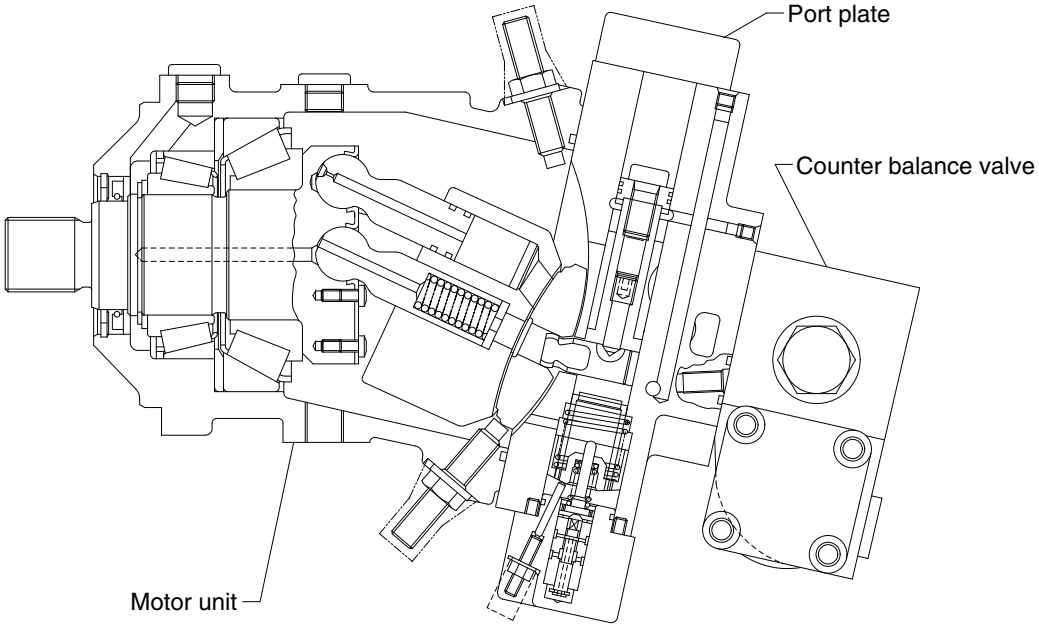
1	Drive shaft	17	Threaded pin	26	Piston
5	Housing	18	Seal lock nut	27	Center pin
8	Locking screw	20	Retaining ring	28	Pan head screw
9	Retaining ring	21	Back up plate	29	Steel sealing ring
10	Shaft seal ring	22	Taper roller bearing	30	Cylinder block
11	Back up plate	23	Shim	31	Pressure spring
12	O-ring	24	Taper roller bearing	32	Adjustment shim
13	Locking screw	25	Retaining plate	33	Control lens

2) REGULATOR



1	Control housing	28	Double break off pin	59	Retaining ring
2	Cover	29	Plug	60	Control piston
4	Positioning piston	32	Double break off pin	61	Control bushing
5	Positioning trunnion	33	O-ring	62	Retaining disc
7	Piston	34	Locking screw	63	Locking screw
8	Threaded pin	50	Relief valve	64	Locking screw
15	Socket head screw	51	Adjusting bushing	65	Double break off pin
16	Socket head screw	52	Cylinder pin	66	Socket head screw
19	O-ring	53	Threaded pin	67	Cover
20	O-ring	54	Seal lock nut	68	Throttle screw
21	O-ring	55	Pressure spring	69	Socket head screw
23	Socket head screw	56	Spring collar	70	O-ring
24	Square ring	57	Pressure spring	71	Locking screw
26	Cylinder pin	58	O-ring		

2. FUNCTION



1) **VARIABLE DISPLACEMENT MOTOR** (with integrated counterbalance valve)

The variable displacement motor has a rotary group in bent axis design.
The torque is generated directly at the drive shaft.
The cylinder barrel is driven by a tapered piston arrangement.
The change of displacement is generated by the control lens via positioning piston. The control lens slides on a circular shaped surface.

In case of constant pump flow volume and high pressure
- The output speed is increased at smaller swivel angle, the torque is reduced
- The torque rises at swivel angle increase, the output speed is decreased

The max swivel angle is 25˚, the min swivel angle is 0˚.

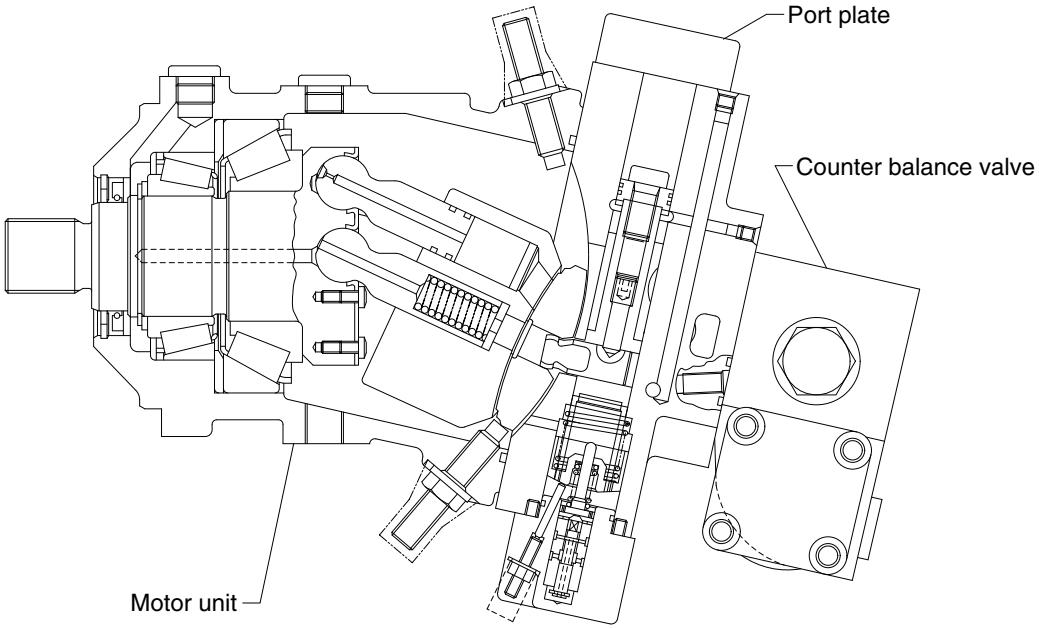
The variable displacement motor with integrated counterbalance valve is designed to be operated in open loop.

Min and max displacement are limited by a stop screw. Stepless adjustment to various higher values is possible.

※ Reduction to smaller displacement may result in overspeeding the motor.

2) **PORT PLATE**

With high pressure dependent control HA1, mounted counterbalance valve, integrated secondary pressure relief valves, plugged gauge and boosting ports, service ports to the rear.



3) HIGH PRESSURE DEPENDENT CONTROL

The displacement is-dependent on operating pressure - automatically adjusted. Upon reaching the operating pressure set at the control valve - internally measured at A or B - the motor swivels from V_{gmin} to V_{gmax} until output torque = load torque. For values lower than the adjusted one the motor keeps min swivel angle. The necessary positioning energy is taken from the respective high pressure side via shuttle valve.

Swivelling results in a change of the displacement.
Swivel time is controlled by an orifice installed in the cover of the large positioning piston side.

4) COUNTERBALANCE VALVE

Mounted at the rear of the port plate.
Incase of downhill traveling or deceleration of the machine a counterbalance valve avoids overspeeding and cavitation of hydraulic motor.

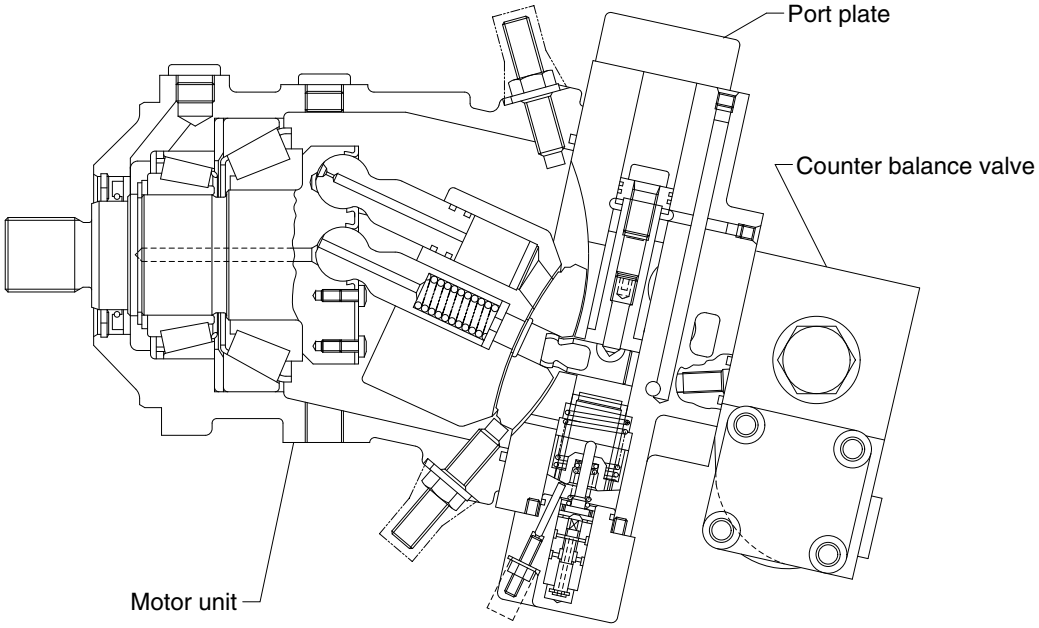
5) FUNCTION AS TO CIRCUIT DIAGRAM

Check valves in the inlet line A and B for by passing of the counterbalance valve.
At traveling forward the return oil flow is controlled by a counterbalance spool. At drop in inlet pressure the counterbalance spool throttles the return oil flow. The motor is locked. The oil behind the spool is led to the low pressure side via an additional check valve. Same function for traveling forward and backward.

Braking means for the motor that
- At reduced or zero inlet flow the counterbalance spool reaches a modulating position or a neutral position caused by spring force
- The high pressure oil (at outlet side of the motor) is returned to the low pressure side(At inlet side) of the motor via crossover relief valves.

As the control pressure for regulation of the HA control via the integrated shuttle valve is no longer available, the motor with HA control and counterbalance valve will swivel to its minimum displacement during deceleration.
In addition, an external boost flow/pressure can be applied at port S for preventing cavitation.

※ Counterbalance valves do not replace the service and parking brake.



6) INSTALLATION

The housing must be filled entirely with oil and shall also not run empty at rotary group standstill.

7) FILTRATION

According to purity class 9 as to NAS 1638, 6 as to SAE, ASTM, AIA and 18/15 as to ISO/DIS 4406.

8) PRESSURE

Ports A or B : Normal 400bar, peak pressure 450 bar
Port A + B : Pressure summation below 700 bar
Max permissible intermittent case pressure : 6 bar

9) DIRECTION OF ROTATION/ DIRECTION OF FLOW

With view on the drive shaft - clockwise/ A to B; Counter-clockwise/ B to A

10) LEAKAGE OIL TEMPERATURE

In the bearing area max permitted -25˚C to +80˚C; Short time operation -40˚C to +115˚C

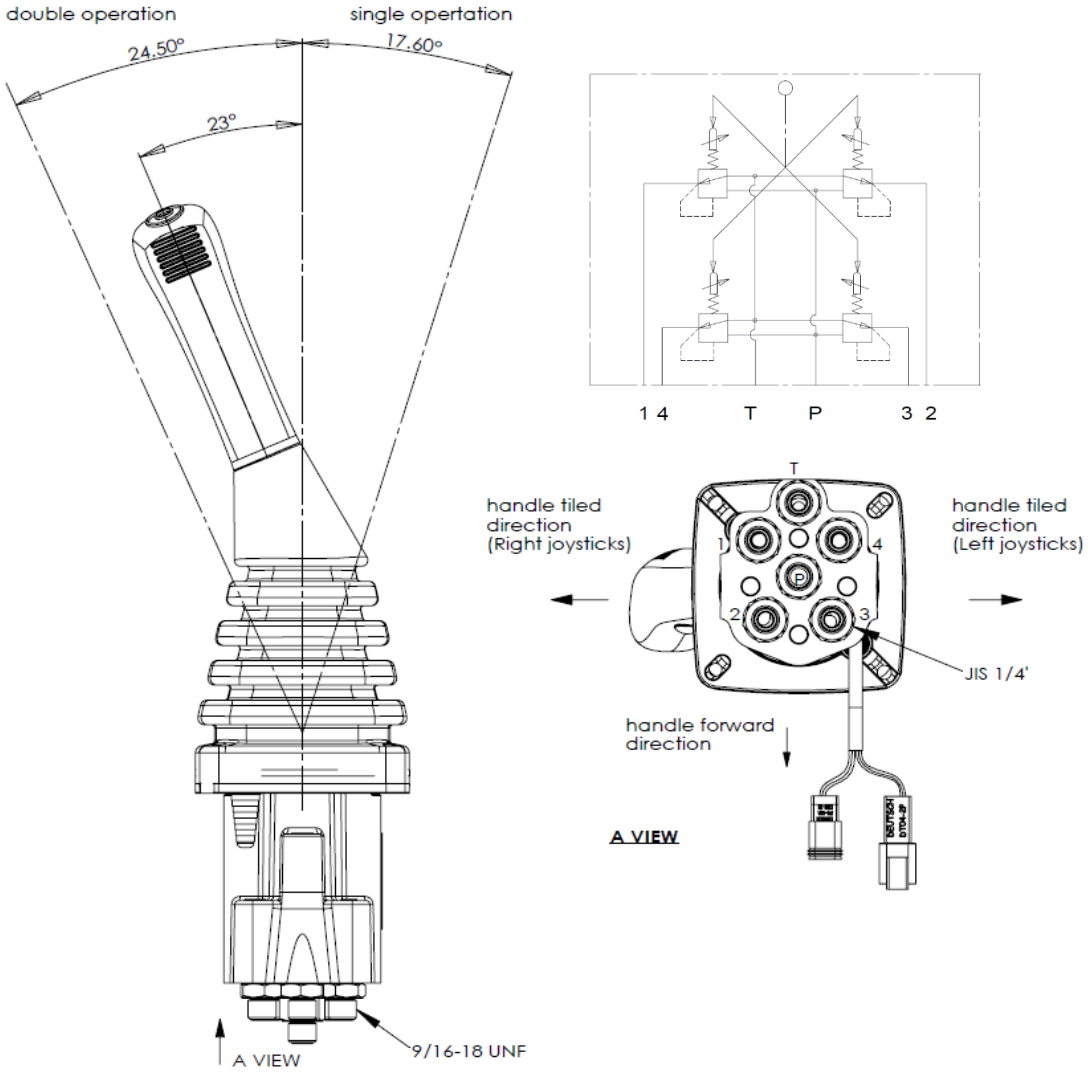
11) COMMISSIONING

Fill the housing entirely with oil through highest located T port. Also connect the leakage oil pipe at this port. After commissioning check sealing and make visual control of the complete installation.

GROUP 5 RCV LEVER

1. STRUCTURE

- **STRUCTURE:**
  SVM980 joysticks with Anti-dampening design to built a advantage low lever effort, it have a whole cast iron body that can work at more higher flow capacity and life. And Compatible with Walvoil levers and rubber boots.

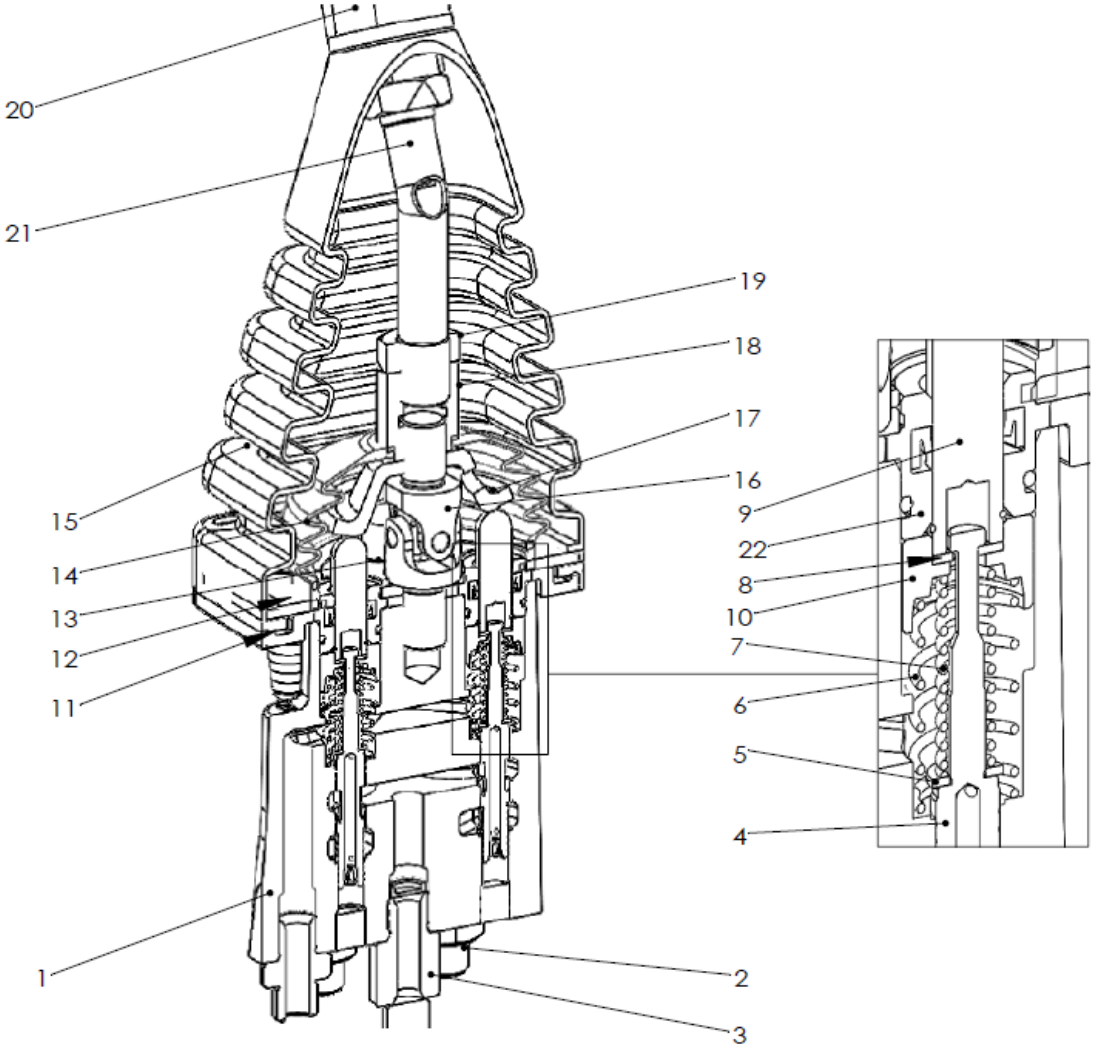


Port	Left joysticks	Right joysticks	Port size
P	Pilot oil inlet port	Pilot oil inlet port	JIS 1/4'
T	Pilot oil return port	Pilot oil return port	With adaptor
1	Left swing port	Bucket out port	9/16-18 UNF
2	Arm in port	Boom down port	
3	Right swing port	Bucket in port	
4	Arm out port	Boom up port	

- **CROSS SECTION:**

The construction of this pilot valve is showing the whole internal components which to built the pilot curve and how to work.

pressure reducing section is composed of spool (4), spring seat (5), reducing spring (7), The return spring (6), lock washer (8), guider ring (10), bullet (9), piston (22), the reducing spring (7) to create the pilot pressure 8~28bar during his whole stroke in the setting, the spool (4) is pushed against to the normal position by return spring (6).



Port P with adaptor '3', Port 1,2,3,4,T with adaptor '2'.

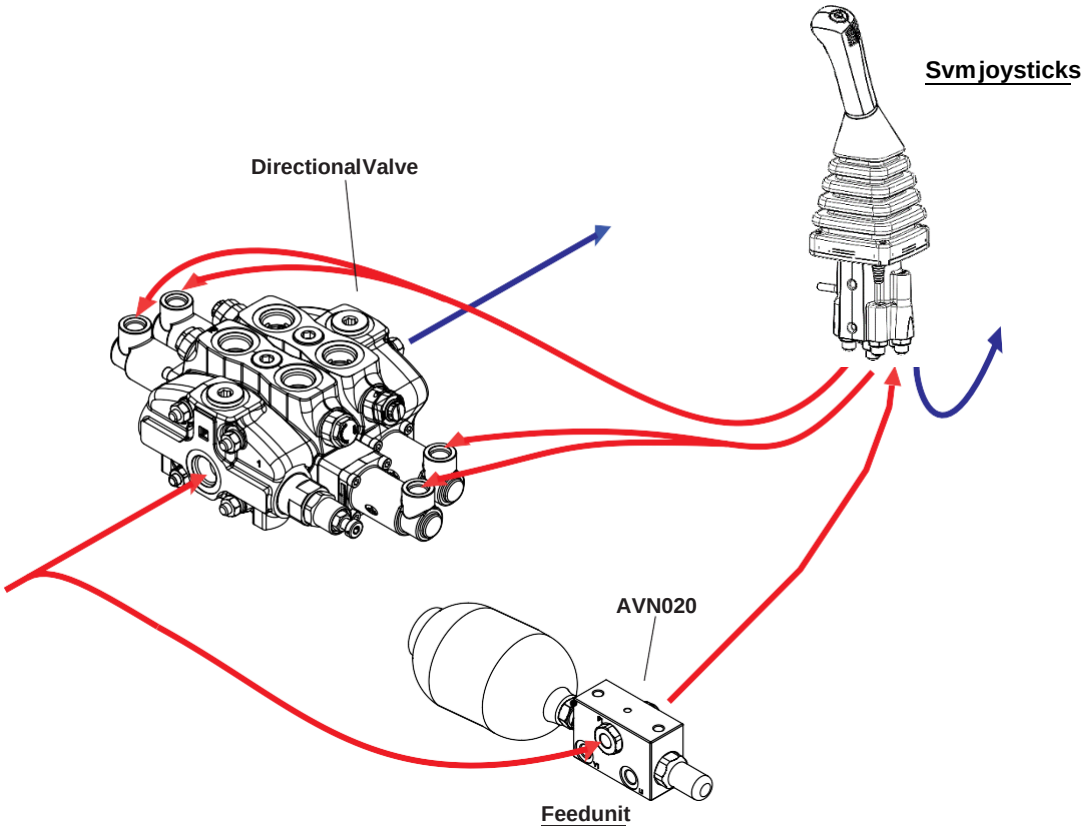
1 Body	2 Short adaptor	3 Long adaptor	4 Spool
5 Spring seat	6 Return spring	7 Reduce spring	8 Lock Washer
9 Bullet	10 Guider ring	11 Fixing flange	12 Press flange
13 Circle flange	14 In rubber bellow	15 Rubber bellow	16 Cardon Joint
17 Selector	18 Link nut	19 Lock nut	20 Handle
21 Bent joint	22 Piston		

- **FUNCTION:**

This is an ideal hydraulic proportional remote control system when max. movement precision and long-lasting reliability are required.

The system needs a secondary circuit with low pressure pilotage, fed separately by a dedicated pump and in derivation to the primary one. In this last case, it is necessary to include a feeding unit with eventual accumulator for emergency interventions into the circuit.

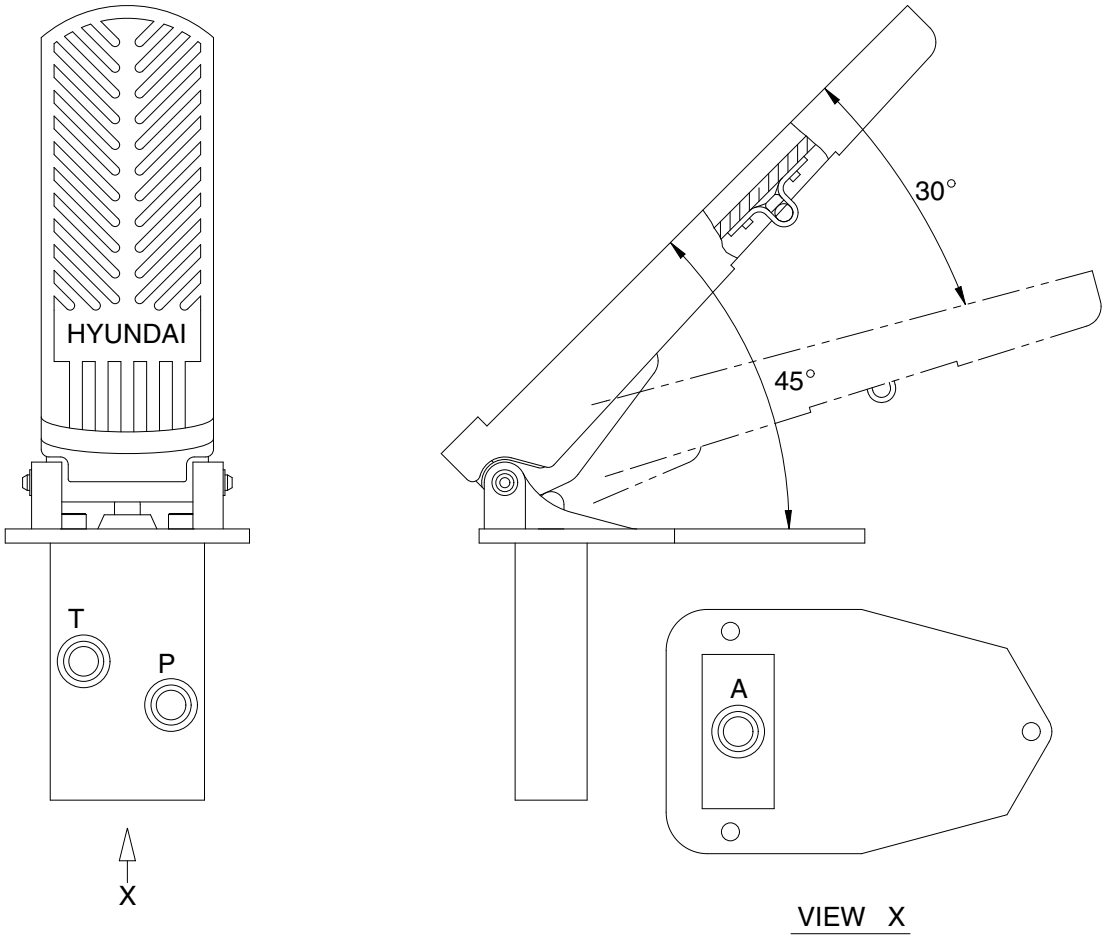
1) Inlet port(P) where oil be fed from pilot pump or Feed unit.
2) Out port (1,2,3,4) be supplied oil from inlet port and send to main valve control kits,
3) T port connect to oil tank.

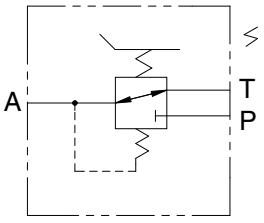


GROUP 6 ACCELERATOR PEDAL

1. STRUCTURE

The casing has the oil inlet port P (primary pressure), and the oil return port T (tank). In addition the secondary pressure is taken out through port A.



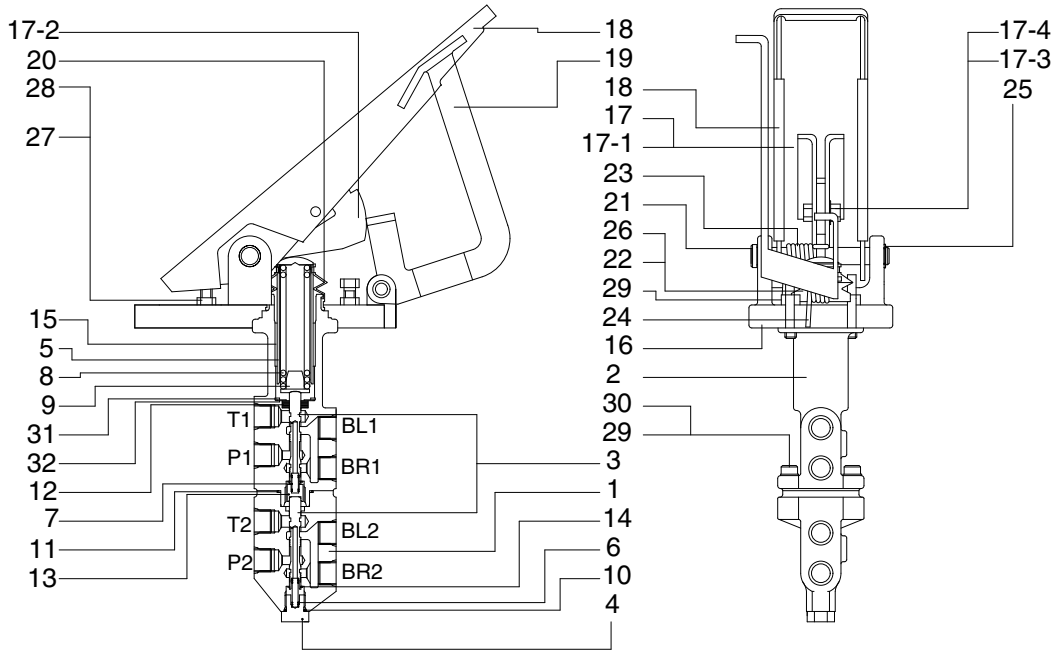


Port	Port name	Port size
P	Pilot oil inlet port	PF 1/4
T	Pilot oil return port	
A	Pilot oil output port	

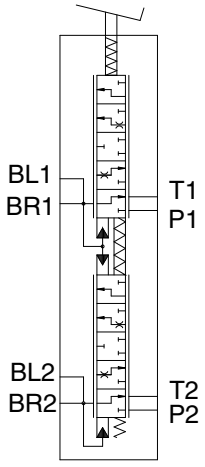
GROUP 7 BRAKE PEDAL (VALVE)

1. STRUCTURE

The casing (spacer) has the oil inlet port A(Primary pressure), and the oil outlet port T (tank). In addition the secondary pressure is taken out through ports 1,2,3 and 4 provided at the bottom face.



1	Lower body	13	Spring guide	21	Lock pin 1
2	Upper body	14	Stop ring-C	22	Lock pin 2
3	Spool	15	DU bushing	23	Torsion spring 1
4	Plug	16	Pedal plate	24	Torsion spring 2
5	Holder	17	Pedal assy	25	Stop ring-C
6	Lower spring	17-1	Pedal	26	E-ring
7	Upper spring	17-2	Lock plate	27	Hex bolt
8	Main spring	17-3	Hex bolt	28	Hex nut
9	Spring retainer	17-4	Plat washer	29	Socket head bolt
10	O-ring	18	Pedal rubber	30	Spring washer
11	O-ring	19	Latch	31	Plat washer
12	Oil seal	20	Rubber cover	32	Stop ring-C



Port	Port name	Port size
P1	Port	PF 3/8
P2	Port	PF 3/8
BR1	Brake cylinder port	PF 3/8
BR2	Brake cylinder port	PF 3/8
BL1	Pluging	PF 3/8
BL2	Pluging	PF 3/8
T1	Drain port	PF 3/8
T2	Drain port	PF 3/8

2. FUNCTION

1) PURPOSE

The purpose of the brake valve is to sensitively increase and decrease the braking pressure when the brake pedal is actuated.

2) READY POSITION

When the braking system is ready for operation, its accumulator pressure acts directly on port P1/P2 of the brake valve. A connection is established between ports BR1/BR2 and port T1/T2 so that the wheel brakes ports BR1/BR2 are pressureless via the returns ports T1/T2.

3) PARTIAL BRAKING

When the brake valve is actuated, an amount of hydraulic pressure is output as a ratio of the foot force applied.

The spring assembly (8) beneath pedal plate (16) is designed in such a way that the braking pressure changes depending on the angle. In the lower braking pressure range, the machine can be slowed sensitively.

When the braking process is commenced, the upper spool (3) is mechanically actuated via spring assembly (8), and the lower spool (3) is actuated hydraulically by spool (3). As spools (3) move downward, they will first close returns T1/T2 via the control edges, thus establishing a connection between accumulator port P1/P2 and ports BR1/BR2 for the wheel brake cylinders. The foot force applied now determines the output braking pressure. The control spools (3) are held in the control position by the force applied (spring assembly) above the spools and the hydraulic pressure below the spool (balance of forces).

After output of the braking pressure, spools (3) are in a partial braking position, causing ports P1/P2 and T1/T2 to close and holding the pressure in ports BR1/BR2.

4) FULL BRAKING POSITION

When pedal (17) is fully actuated, an end position of the brakes is reached and a connection established between accumulator ports P1/P2 and brake cylinder ports BR1/BR2. Returns T1/T2 are closed at this point.

When the braking process ended, a connection is once again established between brake cylinder ports BR1/BR2 and return ports T1/T2, closing accumulator ports P1/P2.

The arrangement of spools in the valve ensures that even if one braking circuit fails the other remains fully operational. This is achieved by means of the mechanical actuation of both spools and requires slightly more pedal travel.

5) LIMITING THE BRAKING PRESSURE

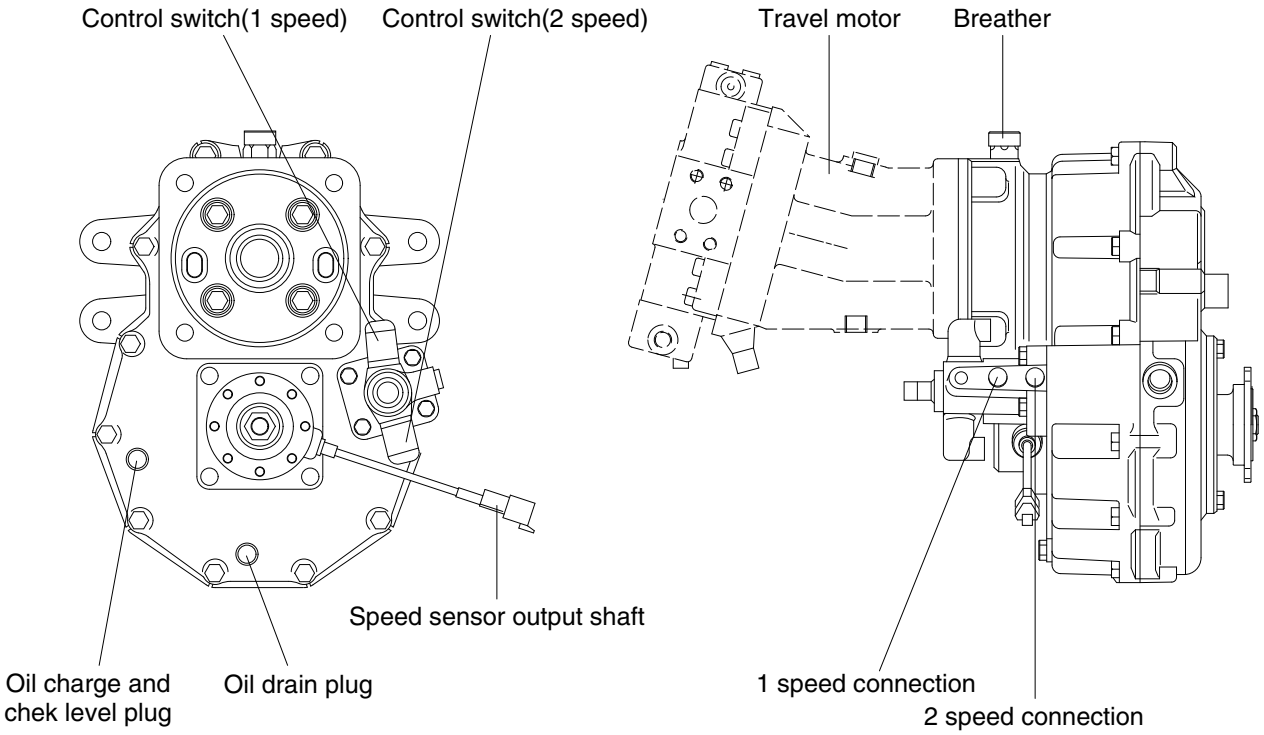
Pedal restriction screw (29) on pedal plate (16) below pedal (17) is used to limit the braking pressure.

6) FAILURE OF A CIRCUIT

In the event of the lower circuit failing, the upper circuit will remain operational. Spring assembly (8) will mechanically actuate spool (3). In the event of the upper circuit failing, the lower circuit will remain operational since the lower spool (3) is mechanically actuated by spring assembly (8) and spool (3).

GROUP 8 GEAR BOX

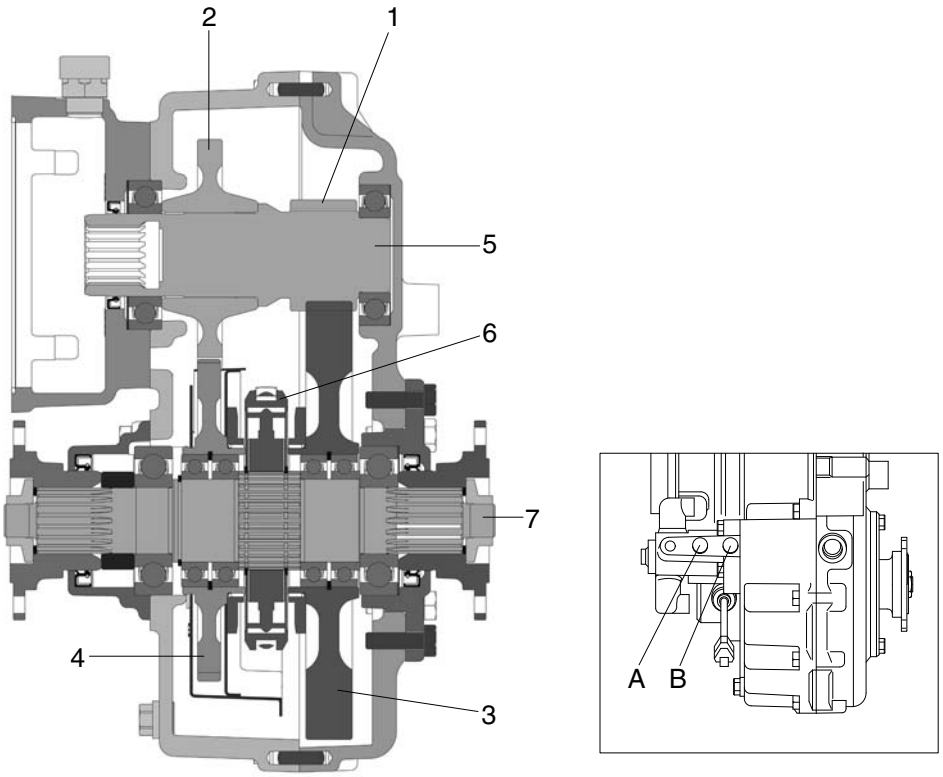
1. STRUCTURE



2. GEAR BOX FUNCTION

It explains mechanism, function operation principle and caution in the operation of transfer gear box applied to for this equipment.

1) GEAR BOX MECHANISM



1	Input shaft gear 1	4	Output shaft gear 2	7	Output shaft
2	Input shaft gear 2	5	Input shaft		
3	Output shaft gear 1	6	Change selector		

2) FUNCTION

Transfer gear box applied to R60W-9S is a hydraulic system having 1, 2 speed gear and its system is dog clutch type.

Once pushing 1 speed button for speed change, exhausted hydraulic power flow from the pump supplied to port "A" by operating 1, 2 speed solenoid valve and change selector (6) pushed by selector shift goes in gear with output shaft gear 1 (3).

The power gear box is moved to input gear shaft 1 (1), output shaft gear 1 (3), change selector (6), output shaft (7) and this procedure lead to 1 speed operation status.

Meanwhile, once pushing 2 speed button in the equipment stop condition, hydraulic power flow from the pump supplied to port "B" and change selector (6) pushed by selector shaft goes in gear with output shaft gear 2 (4).

The power gear box is moved to input shaft gear 2 (2), output shaft gear 2 (4), change selector (6), output shaft (7) and this procedure lead to 2 speed operation status.

3. TECHNICAL DATA

1) GENERAL DATA

(1) Max. input power : 70 kW

(2) Max. input torque : 71.4 kgf·m

(3) Max. input speed : 4500 rpm

(4) Hydraulic motor : 80 cc/rev

(5) Gear ration
- ·1st speed : 4.06 : 1
- ·2nd speed : 1.31 : 1

(6) Output flange
- ·Bolt for propshaft connection : M10×1.25
- ·Gear box weight : 75 kg (165 lb)

2) GEAR BOX CONTROL

(1) Control pressure

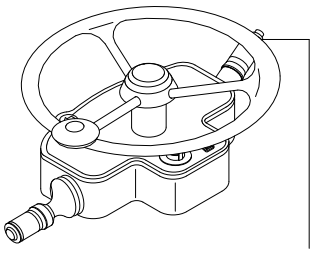
① At connection P1 and P2 at Low/High speed : 26~32 kgf/cm^2

② Definition of lubricants : SAE 80W-90 API GL-4

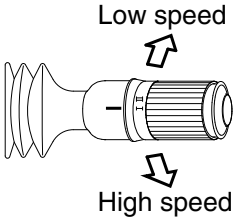
3) HOW TO CHANGE THE TRAVEL SPEED

If you want to change the speed, be sure to operate according to the following procedure. Otherwise, unreasonable operation may cause fatal impact and failure to the transfer box (gear box).

- In case of changing the travel speed, be sure to stop the machine completely.
- Keep the machine on the stationary state and stepping the brake pedal to full stroke. Thereafter, select the speed switch to the desired position.
  When operating the travel speed switch without stepping brake pedal and stopping the machine completely, the operation of gear box can not be worked actually even though the position of speed switch is left to the desired position.
- When turning the key switch to "OFF" position to stop the machine, be sure to transfer the travel speed switch to the low speed position.
  Because the position of solenoid valve for travel is automatically transferred to the low speed position when turning the key switch to "OFF"position.

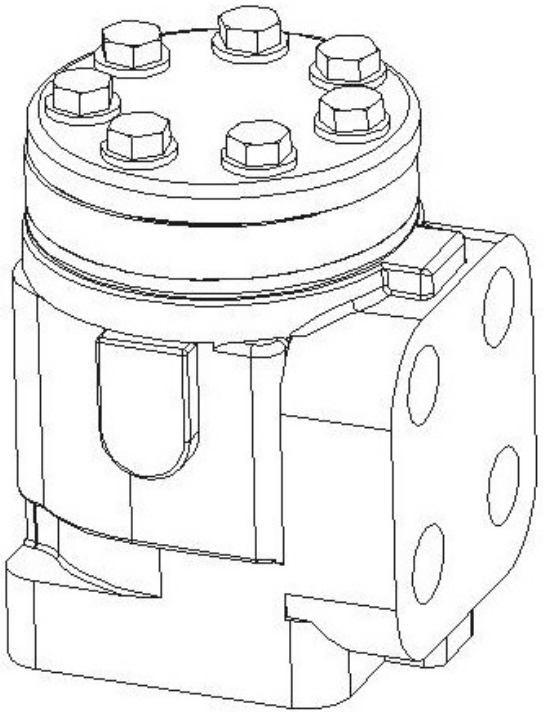


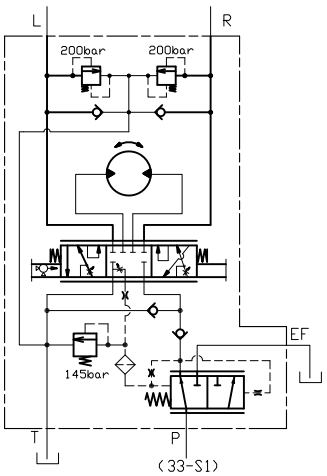
Travel speed switch



GROUP 9 STEERING VALVE

1. STRUCTURE

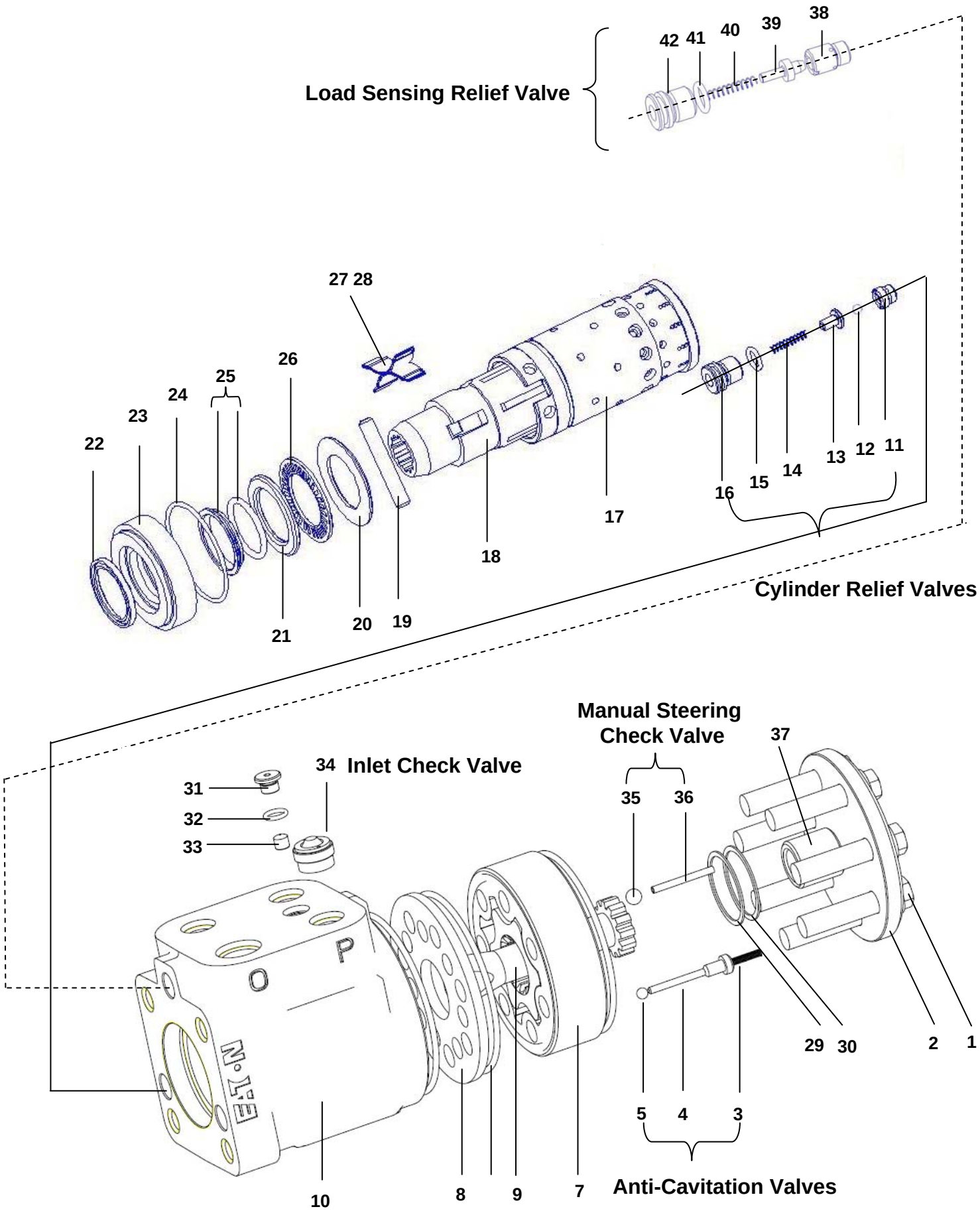




Hydraulic circuit

55W7A2ST01

Port	Port name	Port size
L	Left port	PF 3/8
R	Right port	PF 3/8
P	Pump port	PF 1/2
T	Tank port	PF 3/8
EF	Auxiliary port	PF 1/2


Load Sensing Relief Valve
42
41
40
39
38
27 28
26
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23
22
21
20
19
18
17
16
15
14
13
12
11
Cylinder Relief Valves
Manual Steering
Check Valve
37
34
Inlet Check Valve
31
32
33
35
36
O
P
29
30
2
1
5
4
3
Anti-Cavitation Valves
10
8
9
7

1. Cap Screw (M10)
2. End Cap
3. Spring
4. Plug
5. Ball 4mm
6. Seal, O-ring 77.5mm ID*
7. Gerotor
8. Spacer Plate
9. Drive
10. Housing
11. Valve Seat
12. Ball 5mm
13. Ball Holder
14. O-ring 7.6454mmID*
15. Spring
16. Plug
17. Sleeve
18. Spool
19. Pin
20. Bearing Race
21. Bearing Race
22. Dust Seal*
23. Gland Bushing
24. O-ring 43.2mm ID
25. Shaft Seal Kit*
26. Needle Thrust Bearing
27. Spring
28. Spacer
29. Back-up Washer*
30. Ring, Seal*
31. Plug
32. O-ring 6.07mm ID*
33. Screw, Set
34. Inlet Check Valve
35. Ball 7mm
36. Roll Pin
37. Spacer
38. Valve Set
39. Poppet
40. Spring
41. O-ring 7.6454mmID*
42. Plug

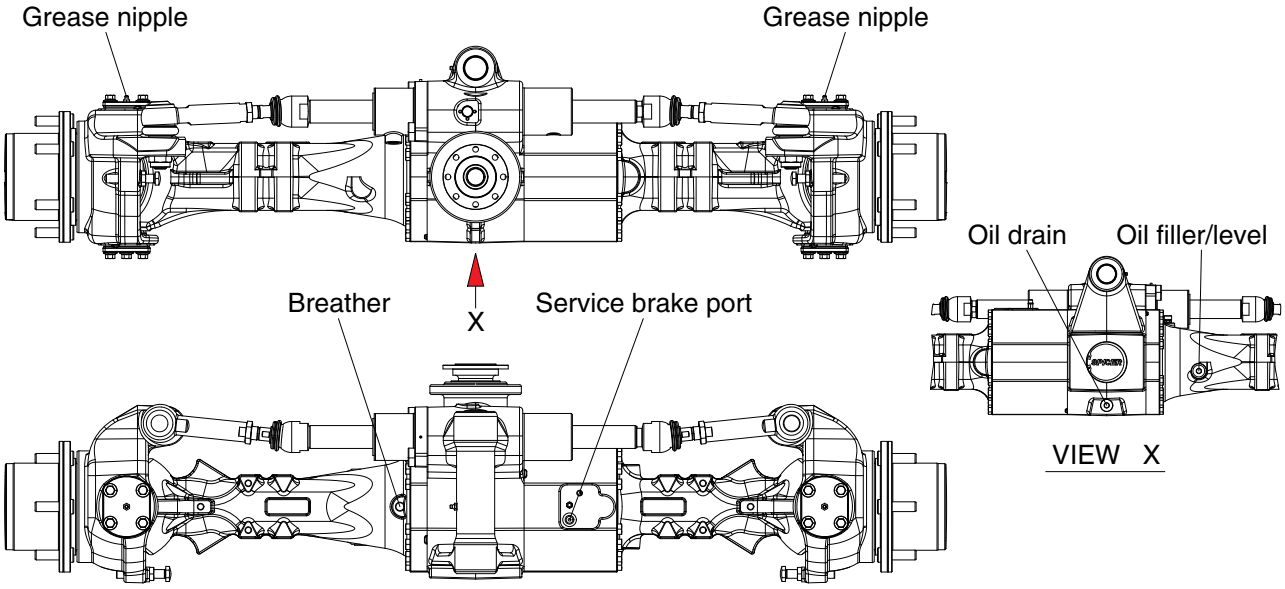
GROUP 10 AXLE

1. OPERATION

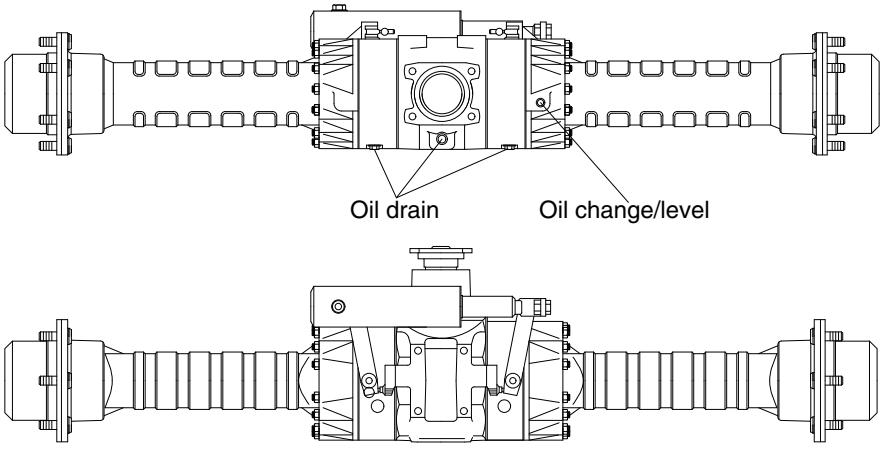
·The power from the engine passes through main pump, travel motor and transmission and drive shafts, and is then sent to the front and rear axles.

·Inside the axles, the power passes from the bevel pinion to the bevel gear and is sent at right angles. At the same time, the speed is reduced and passes through the both differentials to the axle shafts. The power of the axle shafts is further reduced by planetary-gear-type final drives and is sent to the wheels.

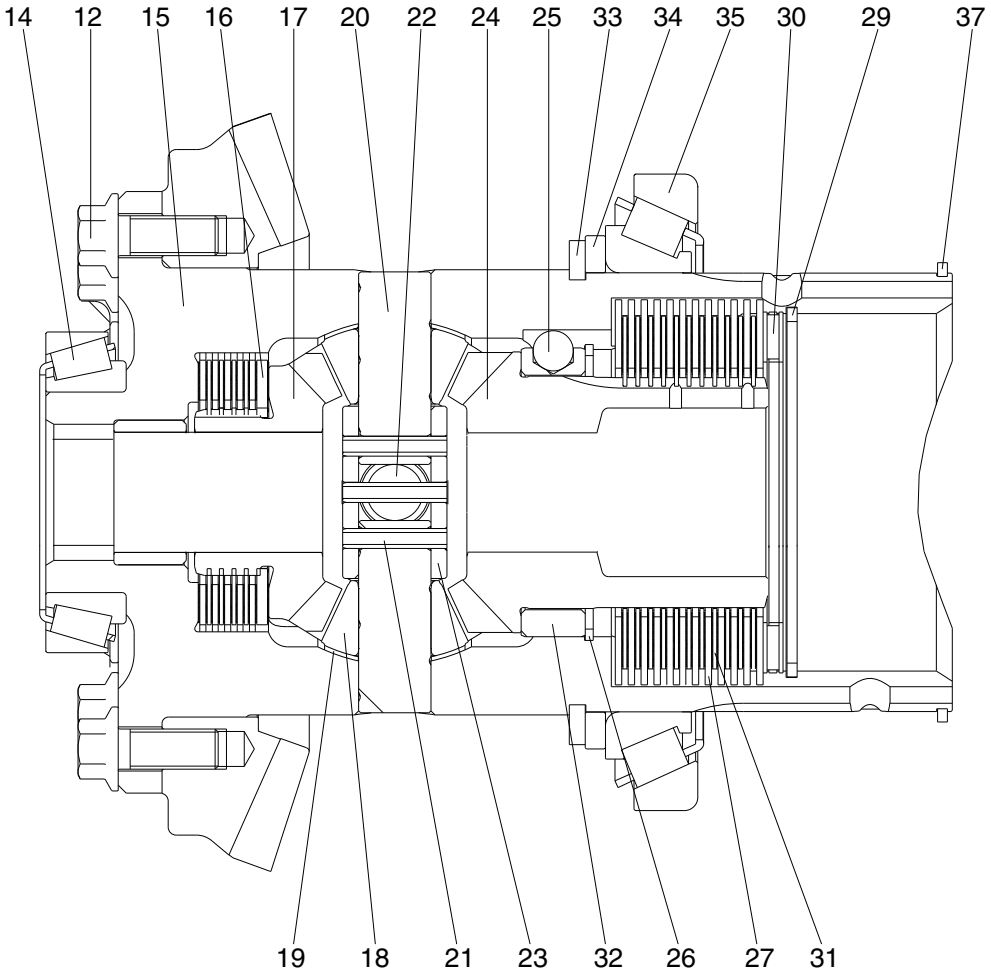
1) FRONT AXLE



2) REAR AXLE

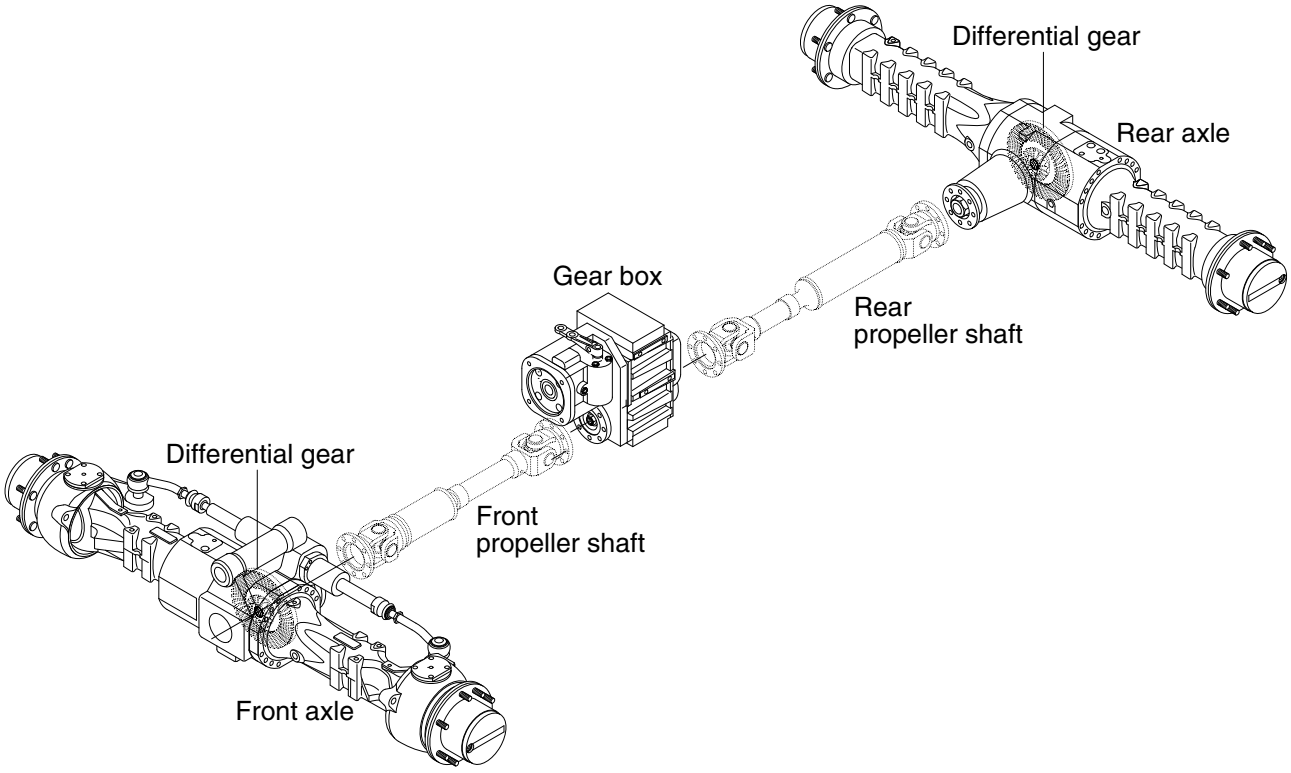


2. SECTION OF DIFFERENTIAL



11	Bevel gear set
12	Bolt
14	Taper roller bearing
15	Differential carrier
16	Friction washer
17	Differential side gear
18	Differential pinion
19	Friction gear
20	Pin
21	Dowel
22	Pin
23	Shaft retainer
24	Differential side gear
25	Detend ball
26	Circlip
27	Clutch disc
29	Circlip
30	Bearing
31	Clutch disc
32	Bushing
33	Circlip
34	Spacer
35	Bearing
37	Circlip

3. DIFFERENTIAL



The differential is installed on the front and rear axle to transfer the driving torque from the axle to the wheels. The differential transfers half of the output torque of the transmission via the universal drive shaft to the planetary gear of the wheel hubs and transfers the rpm and torque from the gear via the pinion and the ring.

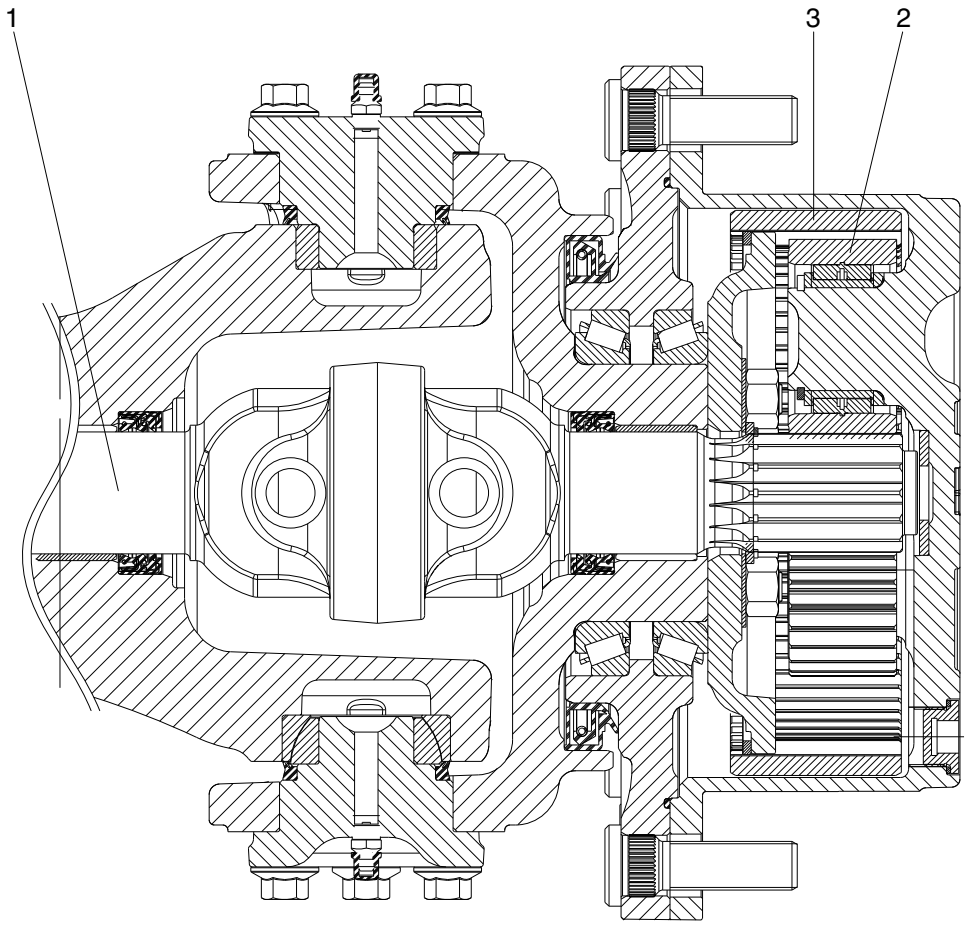
In addition, the differential also servers as an equalizer when going around curves. If the mechanical connection from the transmission to the universal drive shaft, differential, shaft, and planetary gears to the wheels would be rigid, every steering movement would strain the axle construction and would result in increased tire wear.

The equalizing function comes from the special construction of the differential. The power input from the input flange to the pinion shaft, ring and differential housing to the equalizing axle in the differential housing meshes the four equalizing tapered gears with the axle gears, which are located in the equalizing axles. This changes the relative direction of rotation between the shafts meshed with the side gears. This means that one shaft turns clockwise and the other counterclockwise, and one shaft turns faster than the other.

This balancing movement has the disadvantage that when traveling off road, traction is reduced on uneven ground, on loose ground or on snow or ice only wheel per axle is engaged. This disadvantage can be corrected in part by installing a self locking differential.

4. FINAL DRIVE

1) FRONT AXLE

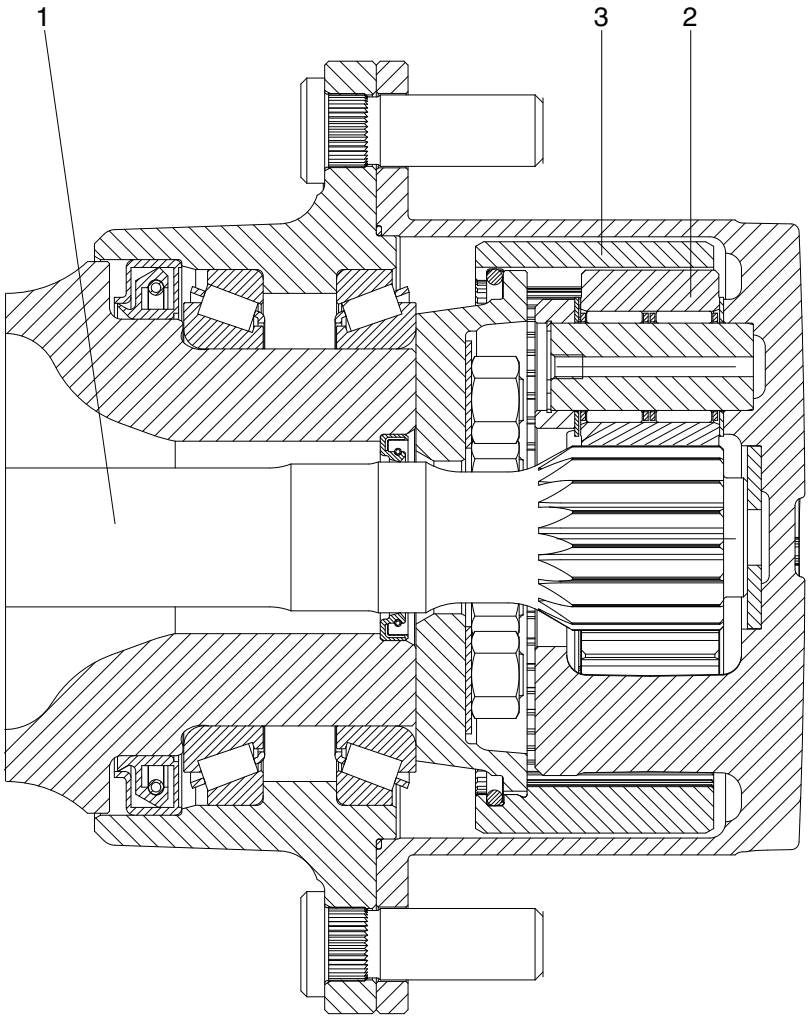


1 Universal joint 2 Pinion gear 3 Ring gear

(1) To gain a large drive force, the final drive uses a planetary gear system to reduce the speed and send drive force to the tires.

(2) The power transmitted from the differential through universal joint (1) to pinion gear (2).
The pinion gear rotates around the inside of a fixed ring gear (3) and in this way transmits rotation at a reduced speed to the planetary carrier.
This power is then sent to the wheels which are installed to the planetary carriers.

2) REAR AXLE

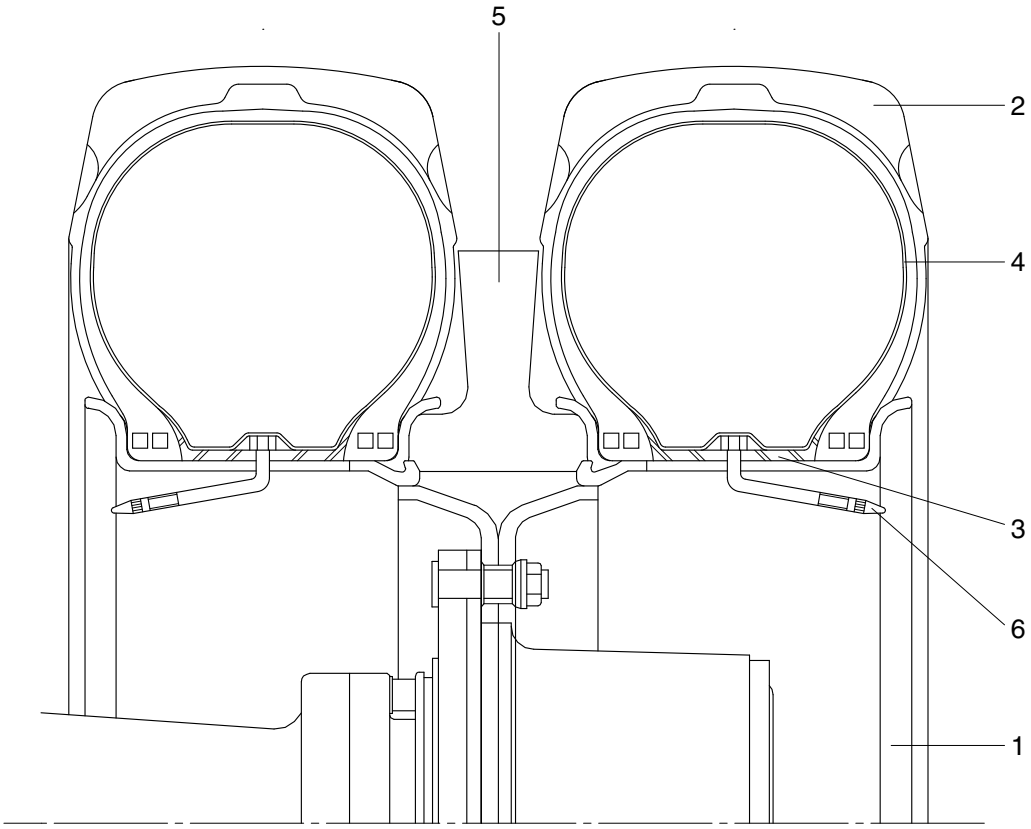


1 Axle half shaft 2 Pinion gear 3 Ring gear

(1) To gain a large drive force, the final drive uses a planetary gear system to reduce the speed and send drive force to the tires.

(2) The power transmitted from the differential through axle half shaft (1) to pinion gear (2). The pinion gear rotates around the inside of a fixed ring gear (3) and in this way transmits rotation at a reduced speed to the planetary carrier.
This power is then sent to the wheels which are installed to the planetary carriers.

5. TIRE AND WHEEL



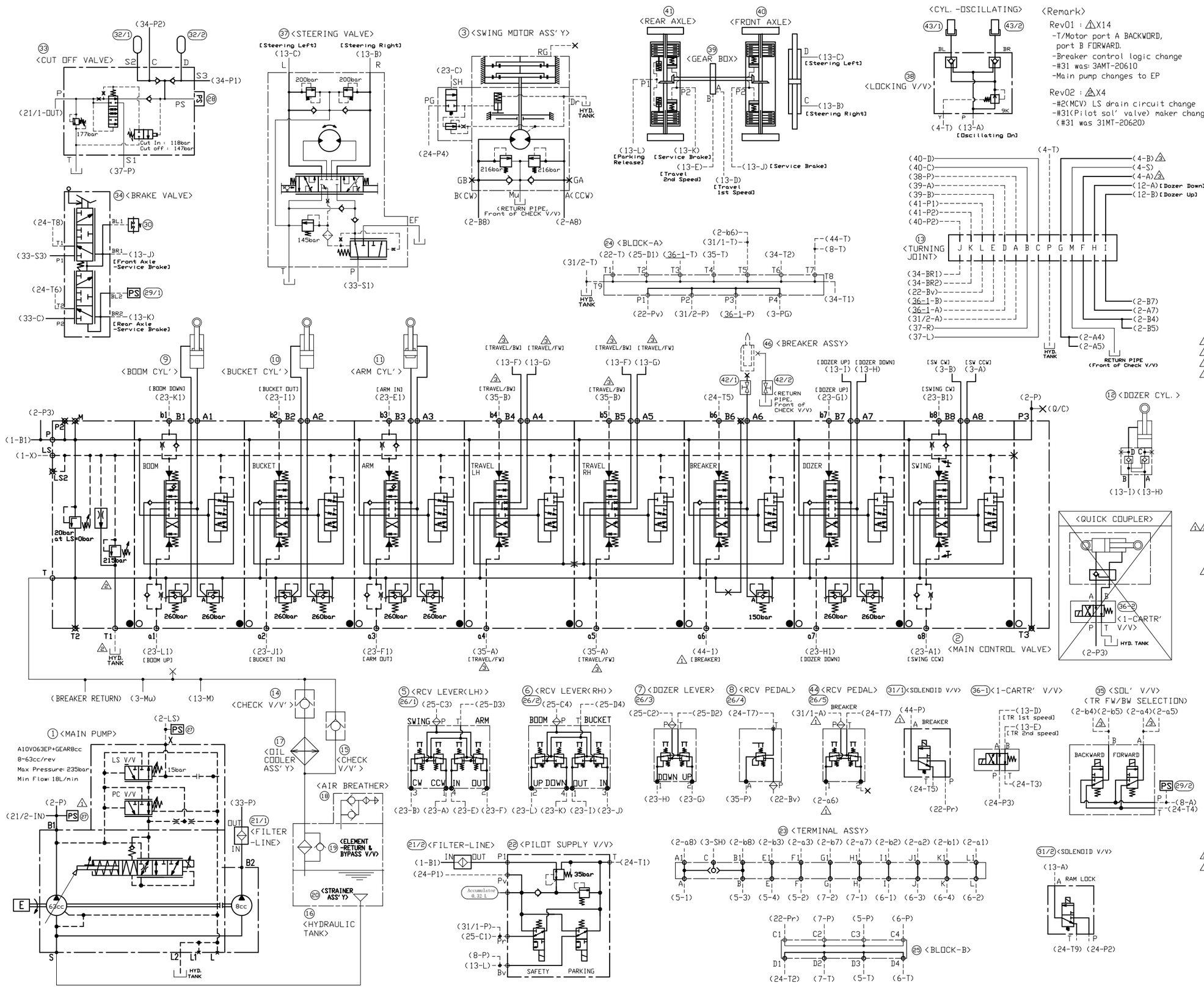
1	Wheel rim	3	Flap	5	Stone resister ring
2	Tire	4	Tube	6	Valve assembly

1) The tire acts to absorb the shock from the ground surface to the machine, and at the same time they must rotate in contact with the ground to gain the power which drives the machine.

2) Various types of tires are available to suit the purpose. Therefore it is very important to select the correct tires for the type of work and bucket capacity.

SECTION 3 HYDRAULIC SYSTEM

GROUP 1 HYDRAULIC CIRCUIT (1/2)

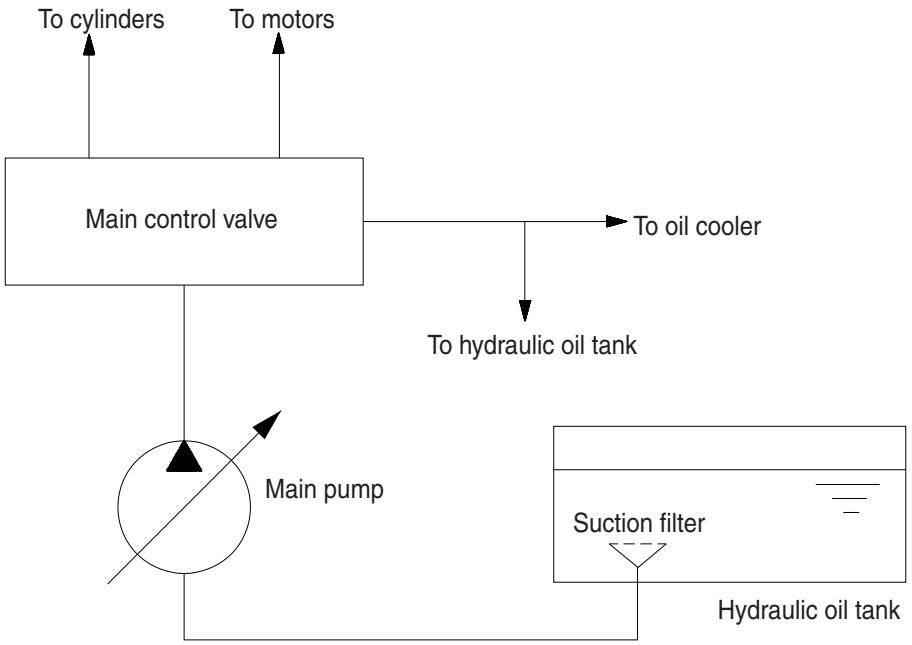


ITEM	PART NO	PART NAME	QTY	
△1	47	3BM9-91210	QUICK COUPLER ASSY	1	(OPTION)
△1	46	3BM9-91310	BREAKER ASSY	1	(OPTION)
△1	~~36-2~~	~~31M9-20060~~	~~1-CARTR' V/V~~	~~1~~	(OPTION)
△1	~~45~~	~~3196-20180~~	~~TEE-SHUTTLE~~	~~1~~	
	44	31MT-20050	RCV PEDAL	1	
	43	31M6-00162GG	CYL.-OSCILLATING	2	
	42	31M5-65383	STOP V/V	2	
	41	81M0-40120	REAR AXLE	1	
	40	81M9-40110	FRONT AXLE		
	39	81M9-40130	GEAR BOX	1	
	38	31M9-43612	LOCKING V/V	1	
	37	3BM9-21320	STEERING V/V	1	(New)
	36-1	31M9-20060	1-CARTR' V/V	1	
	35	31M8-25050	2-CARTR' V/V	1	
	34	31EE-30112	BRAKE V/V	1	
	33	3BM9-31160	CUT-OFF V/V	1	(New)
	32	31AC-10100	ACCUMULATOR	2	
△2 △3	31	3BM9-21150	SOLENOID VALVE	2	
	30	31Q4-40840	PRESSURE SWITCH	1	0-100 bar
	29	31Q4-40820	PRESSURE SENSOR	2	100 bar
	28	31Q4-40810	PRESSURE SENSOR	1	200 bar
△1	27	31Q4-40800	PRESSURE SENSOR	2	500 bar
	26	31N6-25060	FILTER-LAST GUARD	5	
	25	31MH-20112	BLOCK-B	1	
	24	31M8-15411	BLOCK-A	1	
	23	3BM9-21210	TERMINAL ASSY	1	
	22	3BM7-26160	PILOT SUPPLY VALVE	1	
	21	3BM7-26150	FILTER-LINE	2	
	20	31M8-01210	STRAINER ASS'Y	1	
	19	31RF-10200	ELEMENT-RETURN	1	
		31M5-00240	VALVE-BYPASS	1	
	18	31EE-02100	AIR BREATHER	1	
	17	1BM9-40010	OIL COOLER ASS'Y	1	(New)
	16	3BM9-01110	HYD' TANK WA	1	(New)
	15	31EE-10510	CHECK V/V-RETURN	1	4.41 bar
	14	31M5-52111	CHECK V/V-RETURN	1	2.94 bar
	13	31M9-40251	TURNING JOINT	1	
	12	3BM9-41120	DOZER CYLINDER	1	with D.P.C. V/V
	11	3BM7-56130	ARM CYLINDER	1	
	10	3BM7-56120	BUCKET CYLINDER	1	
	9	3BM7-56110	BOOM CYLINDER	1	
	8	3BM9-21330	RCV_TRAVEL PEDAL	1	(New)
	7	31M8-21100	RCV_REVER(DOZER)	1	
	6	31M8-21120	RCV_REVER (RH)	1	
	5	31M8-21110	RCV_REVER (LH)	1	
	4	31M5-00033	TRAVEL MOTOR ASS'Y	1	Rexroth(New)
	3	3BM7-11110	SWING MOTOR ASS'Y	1	
△2	2	3BM9-11611	MAIN CONTROL VALVE	1	(New, 8*RS12Q)
△1	1	3BM9-11020	MAIN PUMP	1	A10VD63+8

GROUP 2 MAIN CIRCUIT

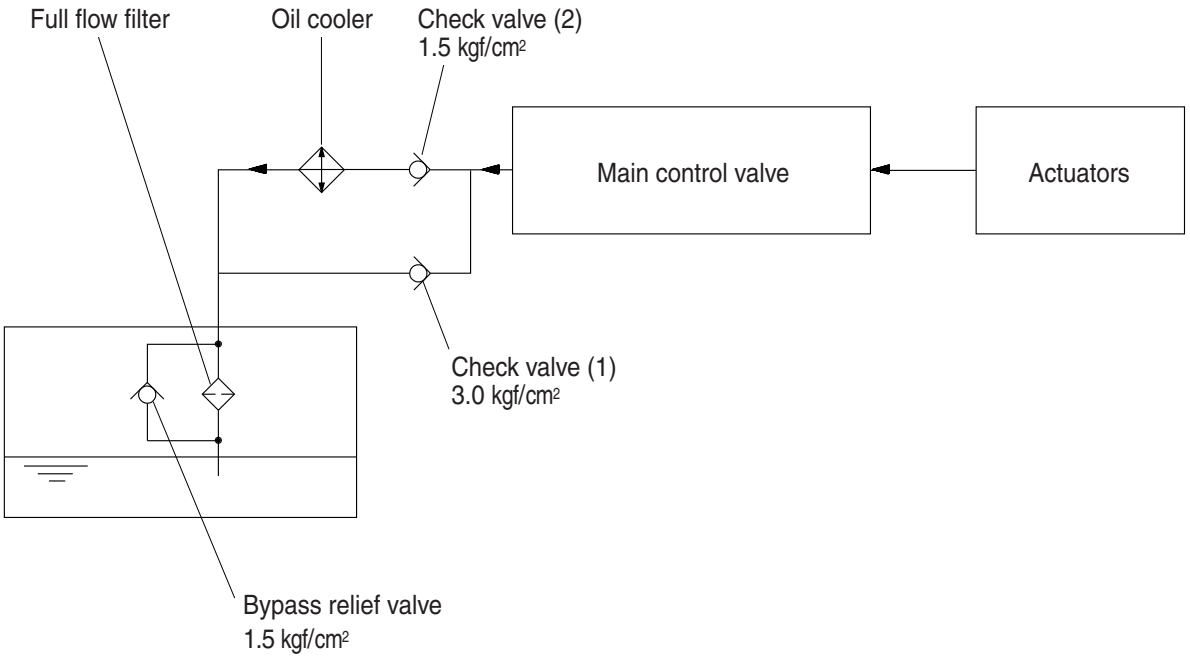
The main hydraulic circuit consists of suction circuit, delivery circuit, return circuit and drain circuit.
The hydraulic system consists of one main pump, one control valve, one swing motor, four cylinders and two travel motors.
The swash plate type variable displacement axial piston pump is used as the main pump and is driven by the engine at ratio 1.0 of engine speed.

1. SUCTION AND DELIVERY CIRCUIT



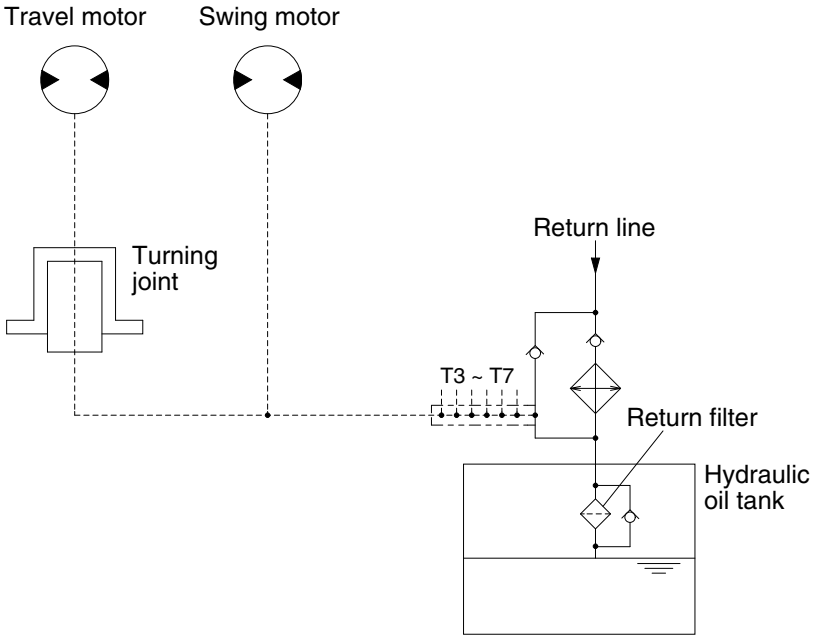
The pumps receive oil from the hydraulic tank through a suction filter. The discharged oil from the pump flows into the control valve and goes out the tank ports.
The oil discharged from the main pump flows to the actuators through the control valve.
The control valve controls the hydraulic functions.
The return oil from the actuators flows to the hydraulic tank through the control valve and the oil cooler.

2. RETURN CIRCUIT



All oil returned from each actuator returns to the hydraulic tank through the control valve.
The bypass check valves are provided in the return circuit.
The setting pressure of bypass check valves are 1.5 kgf/cm2 (21 psi) and 3.0 kgf/cm2 (43 psi). Usually, oil returns to the hydraulic tank from the left side of control valve through oil cooler.
When oil temperature is low, viscosity becomes higher and flow resistance increases when passing through the oil cooler. When the oil pressure exceeds 3.0 kgf/cm2 (43 psi), the oil returns directly to the hydraulic tank, resulting in the oil temperature being raised quickly at an appropriate level.
When the oil cooler is clogged, the oil returns directly to the hydraulic tank through bypass check valve (1).
The full-flow filter and bypass relief valve are provided in the hydraulic tank.
The oil returned from right and left side of control valve is combined and filtered by the full-flow filter. A bypass relief valve is provided in the full-flow filter.
When the filter element is clogged, the bypass relief valve opens at 1.5 kgf/cm2 (21 psi) differential pressure.

3. DRAIN CIRCUIT



Besides internal leaks from the motors and main pump, the oil for lubrication circulates.

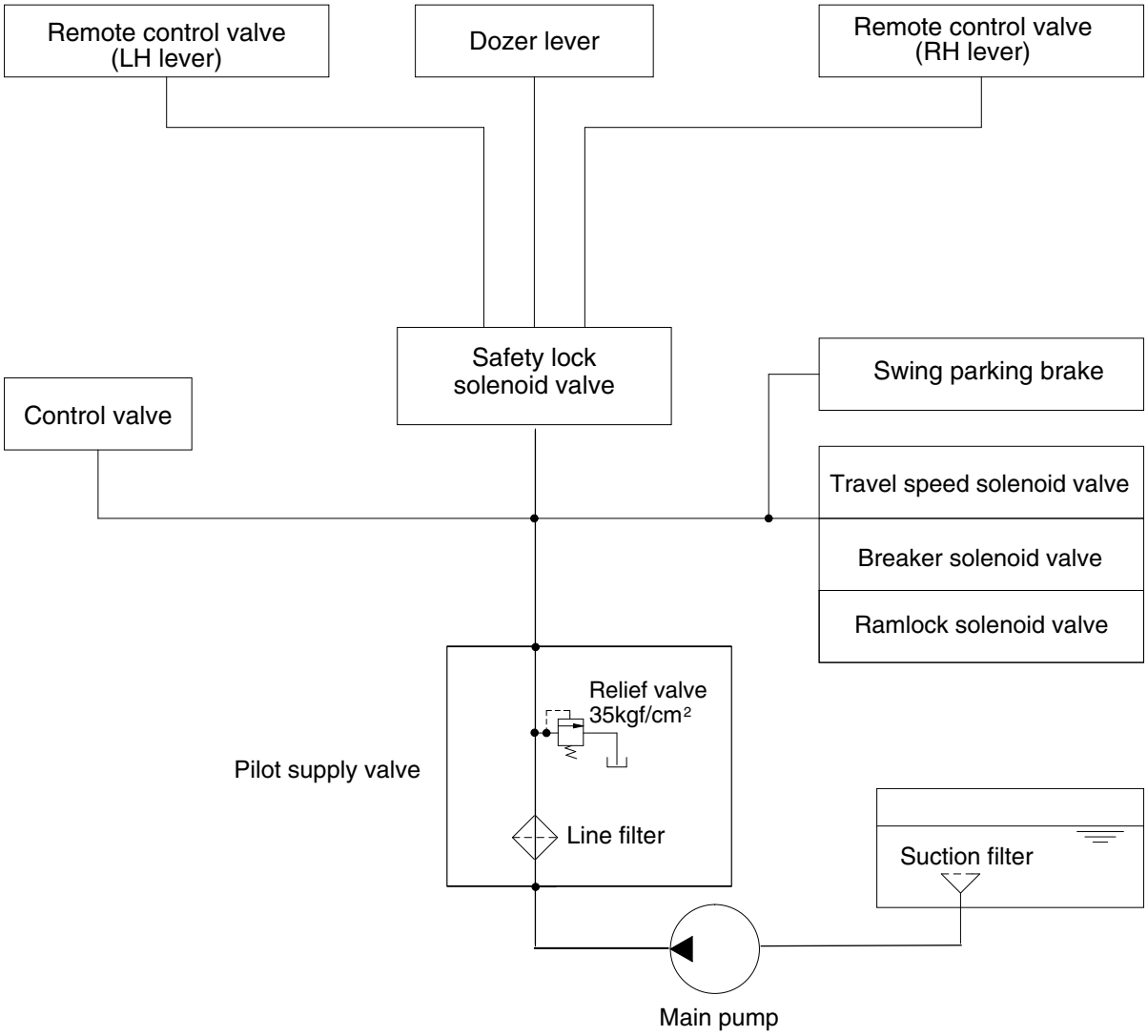
1) TRAVEL MOTOR DRAIN CIRCUIT

Oil leaked from the right and left travel motors comes out of the drain ports provided in the respective motor casing and join with each other. These oils pass through the turning joint and return to the hydraulic tank after being filtered by return filter.

2) SWING MOTOR DRAIN CIRCUIT

Oil leaked from the swing motor returns to the hydraulic tank passing through a return filter with oil drained from the travel circuit.

GROUP 3 PILOT CIRCUIT



The pilot circuit consists of suction circuit, delivery circuit and return circuit.

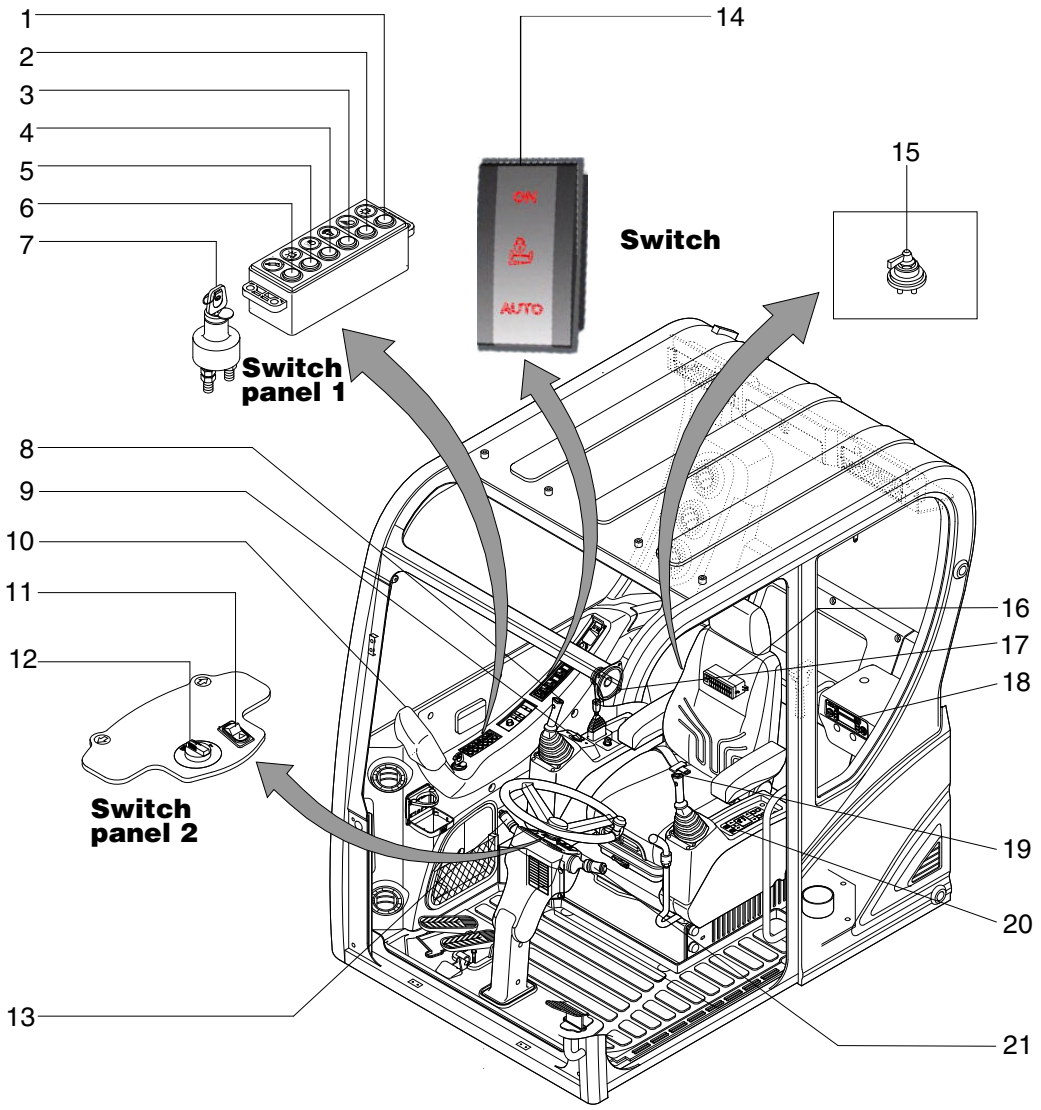
The pilot pump is provided with relief valve, receives the oil from the hydraulic tank through the suction filter.

The discharged oil from the pilot pump flows to the remote control valve through line filter, solenoid valve assemblies, swing parking brake, main control valve and safety lock solenoid valve.

SECTION 4 ELECTRICAL SYSTEM

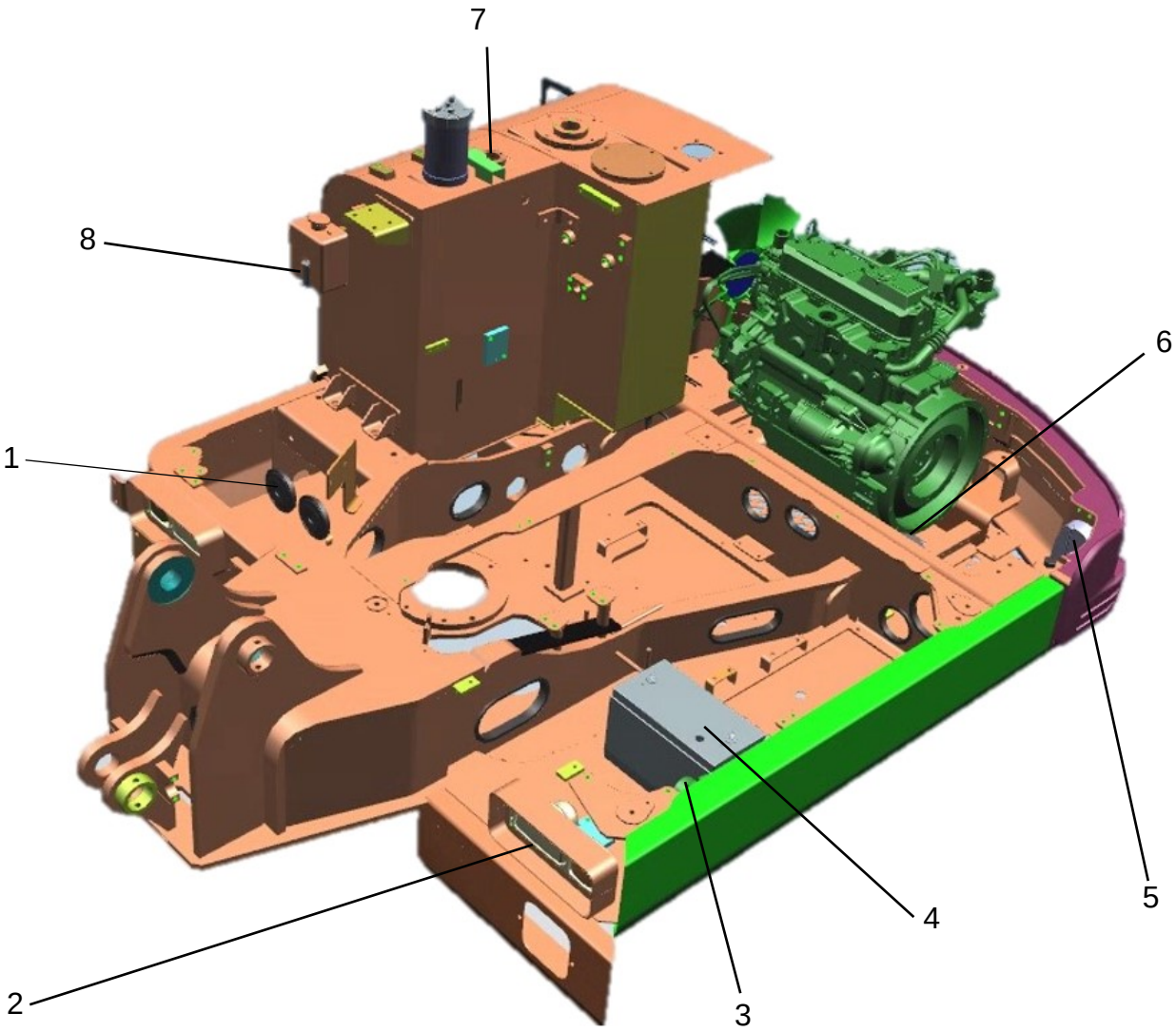
GROUP 1 COMPONENT LOCATION

1. LOCATION 1



1	Head light switch	10	Cluster	19	Horn switch
2	Work light switch	11	Hazard switch	20	Aircon and heater switch
3	Travel alarm switch	12	Select switch	21	Multifunction switch (LH)
4	Cab light switch	13	Multifunction switch (RH)		
5	Beacon switch	14	Auto Ram Lock switch		
6	Breaker selection switch	15	Master switch		
7	Start switch	16	Fuse box		
8	Breaker operation switch	17	Speaker		
9	Accel dial switch	18	Radio & USB player		

2. LOCATION 2



1	Horn	4	Battery	7	Fuel sender
2	Head lamp	5	Combination lamp	8	Washer pump
3	Battery relay	6	Travel alarm buzzer		

GROUP 2 MONITORING SYSTEM

1. OUTLINE

Monitoring system consists of the monitor part and switch part.

The monitor part gives warnings when any abnormality occurs in the machine and informs the condition of the machine.

Various select switches are built into the monitor panel, which act as the control portion of the machine control system.

2. CLUSTER

1) MONITOR PANEL

3. CLUSTER FUNCTION

1) GAUGES AND DISPLAYS

(1) Operation screen

When you first turn starting switch ON, the operation screen will appear.

Default (A type)

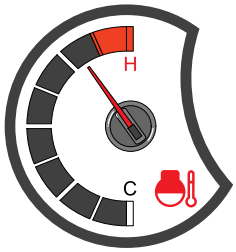
Option (B type)

Option (C type)

1	Engine coolant temp gauge	3	Fuel level gauge	5	Accel dial
2	Hydraulic oil temp gauge	4	Engine rpm		

※ **Operation screen type can be set by the screen type menu of the display.**
Refer to page 4-22 for details.

(2) Engine coolant temperature gauge

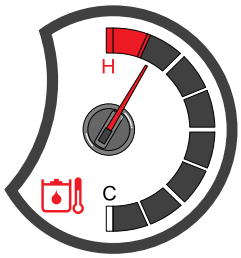


① This gauge indicates the temperature of coolant.
- Black range : 40-115˚C (104-239˚F)
- Red range : Above 115˚C (239˚F)

② If the indicator is in the red range or lamp lights ON in red, turn OFF the engine and check the engine cooling system.

※ **If the gauge indicates the red range or lamp lights ON in red even though the machine is on the normal condition, check the electric device as that can be caused by the poor connection of electricity or sensor.**

(3) Hydraulic oil temperature gauge

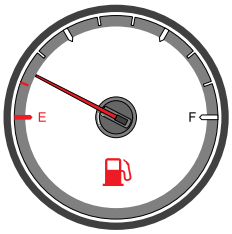


① This gauge indicates the temperature of hydraulic oil.
- Black range : 40-105˚C (104-221˚F)
- Red range : Above 105˚C (221˚F)

② If the indicator is in the red range or lamp lights ON in red, reduce the load on the system. If the gauge stays in the red range, stop the machine and check the cause of the problem.

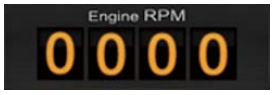
※ **If the gauge indicates the red range or lamp lights ON in red even though the machine is on the normal condition, check the electric device as that can be caused by the poor connection of electricity or sensor.**

(4) Fuel level gauge



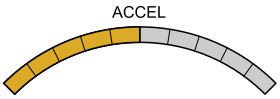
① This gauge indicates the amount of fuel in the fuel tank.
② Fill the fuel when the red range, or lamp lights ON in red.
※ **If the gauge indicates the red range or lamp lights ON in red even though the machine is on the normal condition, check the electric device as that can be caused by the poor connection of electricity or sensor.**

(5) Engine rpm display



① This displays the engine speed.

(6) Accel dial display



① This displays acceleration dial level from 0 to 10 step.

3) COMMUNICATION ERROR AND LOW VOLTAGE WARNING POP-UP

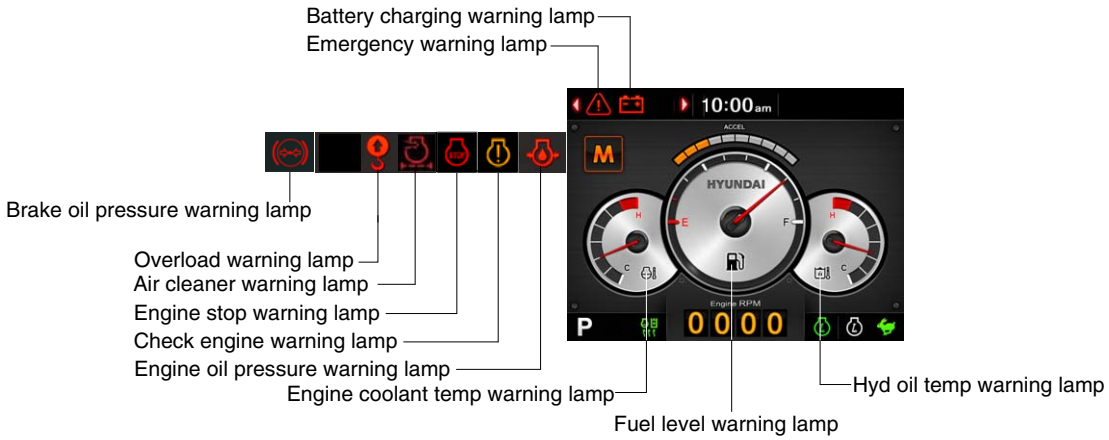
(1) Communication error pop-up

① Cluster displays this communication error pop-up when it has communication error with MCU.
② Communication error pop-up displays at operation screen only. Just buzzer alarm at the other screen.
③ If communication with MCU become normal state, it will disappear automatically.

(2) Low voltage warning pop-up

① Cluster displays this low voltage warning pop-up when the battery voltage is low.
② Low voltage warning pop-up displays at operation screen only. Just buzzer alarm at the other screen.
③ This pop-up will disappear with using touch screen or buzzer stop switch. While the battery voltage is low, buzzer sounds every minute.
④ When the battery voltage is higher than 11.5 V, the pop-up off.

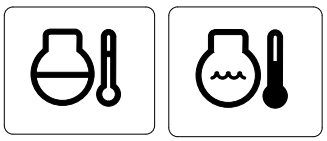
4) WARNING LAMPS



※ **Each warning lamp on the left-top of the LCD pops up on the center of LCD and the buzzer sounds when the each warning is happened. The pop-up warning lamp moves to the original position and lights ON when the buzzer stop switch is pushed or the pop-up is touched. And the buzzer stops. Refer to page 4-14 for the switch.**

※ **When the warning lamps light ON more than 4, you can check all lamps with next page button (◀ , ▶) near the warning lamps.**

(1) Engine coolant temperature warning lamp

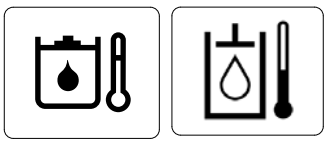


① The ⚠ lamp pops up on the center of LCD and the buzzer sounds when the engine coolant temperature is over 115˚C.

② The pop-up ⚠ lamp moves to the original position and lights ON when the buzzer stop switch is pushed or pop-up is touched. Also, the buzzer stops and lamp keeps ON.

③ Check the cooling system when the lamp keeps ON.

(2) Hydraulic oil temperature warning lamp

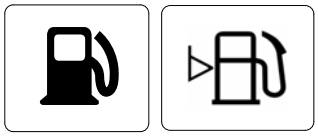


① The ⚠ lamp pops up on the center of LCD and the buzzer sounds when the hydraulic oil temperature is over 105˚C.

② The pop-up ⚠ lamp moves to the original position and lights ON when the buzzer stop switch is pushed or pop-up is touched. Also, the buzzer stops and lamp keeps ON.

③ Check the hydraulic oil level and hydraulic oil cooling system.

(3) Fuel level warning lamp



① This warning lamp lights ON and the buzzer sounds when the level of fuel is below 10%.

② Fill the fuel immediately when the lamp is ON.

(4) Emergency warning lamp

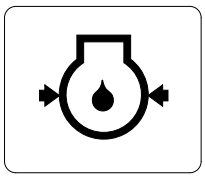
21093CD30

① This lamp pops up and the buzzer sounds when each of the below warnings are happened.
- Engine coolant overheating (over 115˚C)
- Hydraulic oil overheating (over 105˚C)
- MCU input voltage abnormal
- Accel dial circuit abnormal or open

※ The pop-up warning lamp moves to the original position and lights ON when the buzzer stop switch is pushed or pop-up is touched. Also the buzzer stops.
This is same as following warning lamps.

② When this warning lamp lights ON, machine must be checked and serviced immediately.

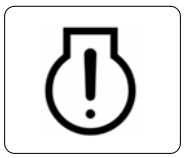
(5) Engine oil pressure warning lamp



21093CD32

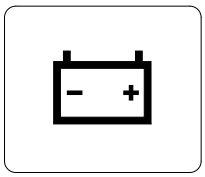
① This lamp lights ON when the engine oil pressure is low.
② If the lamp lights ON, shut OFF the engine immediately. Check oil level.

(6) Check engine warning lamp



① This lamp lights ON when the communication between MCU and engine ECM on the engine is abnormal, or if the cluster received any fault code from engine ECM.
② Check the communication line between them.
If the communication line is OK, then check the fault codes on the cluster.

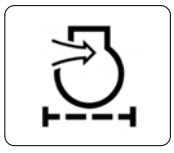
(7) Battery charging warning lamp



21093CD34

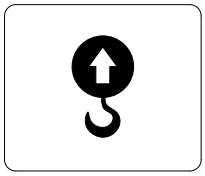
① This lamp lights ON when the battery charging voltage is low.
② Check the battery charging circuit when this lamp is ON.

(8) Air cleaner warning lamp



① This lamp lights ON when the filter of air cleaner is clogged.
② Check the filter and clean or replace it.

(9) Overload warning lamp (opt)

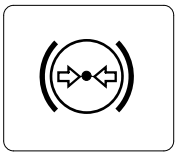


① When the machine is overload, the overload warning lamp lights ON during the overload switch is ON. (if equipped)
② Reduce the machine load.
Initiate a manual regeneration

(10) Stop engine warning lamp

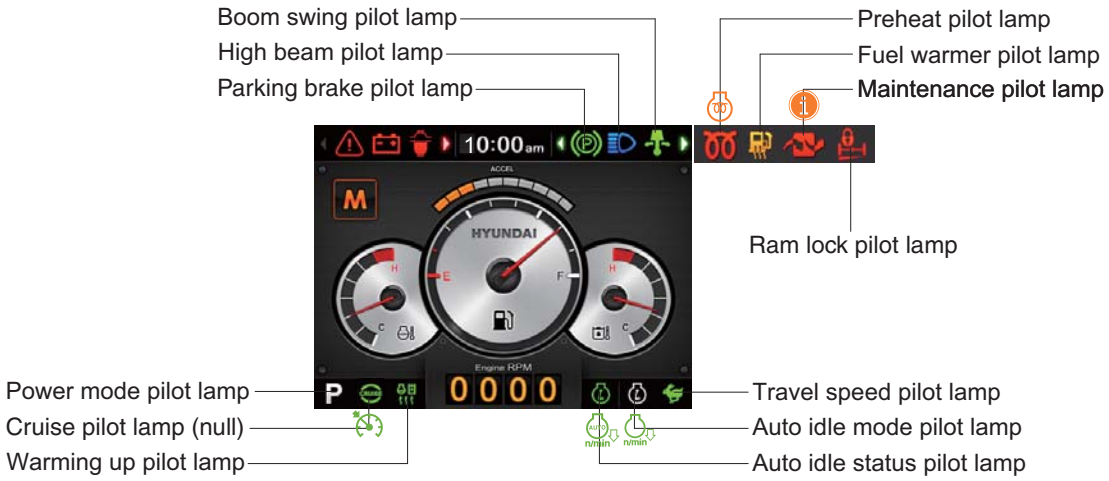
① If the lamp lights ON, stop the engine immediately and check the engine.
② Check the fault codes on the monitor.
※ **Please contact your Hyundai service center or local dealer.**

(11) Brake oil pressure warning lamp



① The lamp lights ON when the oil pressure of service brake drops below the normal range.
② When the lamp is ON, stop the engine and check for its cause.
※ **Do not operate until any problems are corrected.**

5) PILOT LAMPS

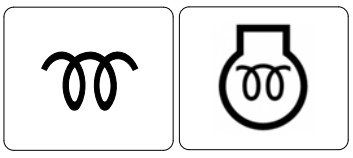


※ **When the pilot lamps light ON more than 3, you can check all lamps with next page button (,).**

(1) Mode pilot lamps

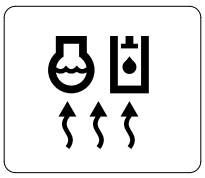
No	Mode	Pilot lamp	Selected mode
1	Power mode	P	Heavy duty power work mode
		S	Standard power mode
2	Travel mode		Low speed traveling
			High speed traveling
3	Auto idle mode		Auto idle status
			Auto idle mode

(2) Preheat pilot lamp



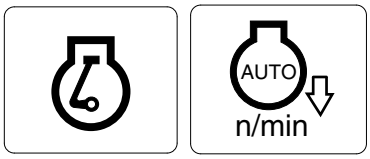
① Turning the start key switch ON position starts preheating in cold weather.
② Start the engine after this lamp is OFF.

(3) Warming up pilot lamp



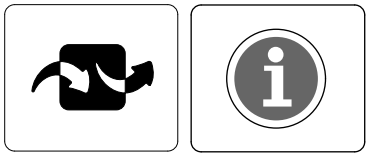
① This lamp is turned ON when the coolant temperature is below 30˚C(86˚F).
② The automatic warming up is cancelled when the engine coolant temperature is above 30˚C, or when 10 minutes have passed since starting the engine.

(4) Auto idle status/ mode pilot lamp



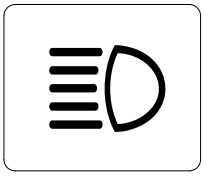
① The auto idle pilot lamp will be ON when the idle mode is selected.
② The auto idle status pilot lamp will be ON when all levers and pedals are at neutral position, and the auto idle mode is selected.

(5) Maintenance pilot lamp



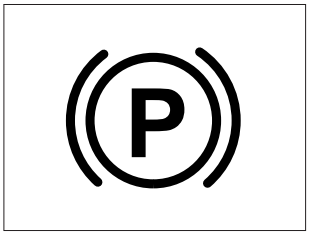
① This lamp will be ON when the consuming parts are needed to change or replace. It means that the change or replacement interval of the consuming parts remains below 30 hours.
② Check the message in maintenance information of main menu. Also, this lamp lights ON for 3 minutes when the start switch is ON position.
※ **Refer to the page 4-20.**

(6) High beam pilot lamp



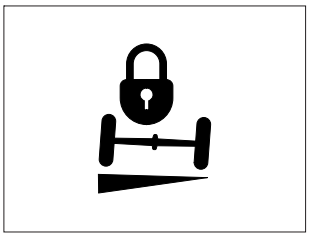
① This lamp works when the illuminating direction is upward.
② This lamp comes ON when the dimmer switch is operated, e.g, when passing another vehicle.

(7) Parking brake pilot lamp



① When the parking brake is actuated, the lamp lights ON.
※ **Check the lamp is OFF before driving.**

(8) Ram lock pilot lamp

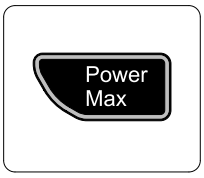


① This pilot lamp lights ON when ram lock switch is rear position.
② Also, the pilot lamp lights ON when the parking switch is ON or service brake is applied.

6) SWITCHES

※ **When the switches are selected, the pilot lamps are displayed on the LCD. Refer to the page 4-11 for details.**

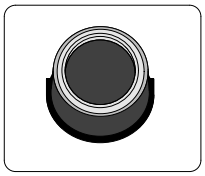
(1) Power mode switch



① This switch is to select the machine power mode and selected power mode pilot lamp is displayed on the pilot lamp position.
- P : Heavy duty power work.
- S : Standard power work.

② The pilot lamp changes S → P → S in order.

(2) Select switch



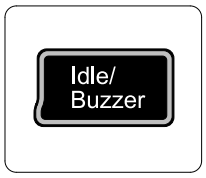
① This switch is used to select or change the menu and input value.

② Knob push
- Long (over 2 sec) : Return to the operation screen
- Medium (0.5~2 sec) : Return to the previous screen
- Short (below 0.5 sec) : Select menu

③ Knob rotation

This knob changes menu and input value.
- Right turning : Down direction / Increase input value
- Left turning : Up direction / Decreased input value

(3) Auto idle/ buzzer stop switch

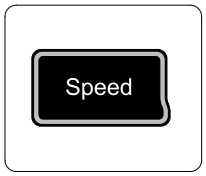


① This switch is used to activate or cancel the auto idle function.

※ **Refer to the page 4-12 for details.**

② The buzzer sounds when the machine has a problem.
In this case, push this switch and buzzer stops, but the warning lamp blinks until the problem is cleared.

(4) Travel speed control switch



① This switch is used to select the travel speed alternatively.

- : Low speed
- : High speed

(5) Escape/ Camera switch

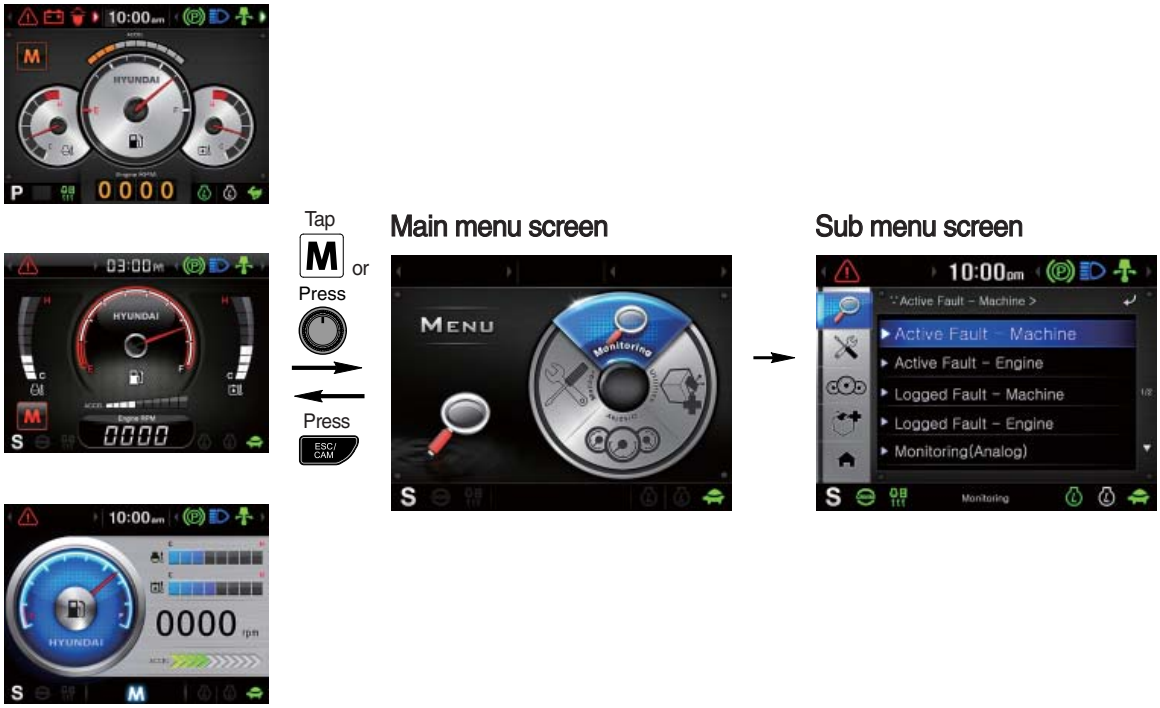
① This switch is used to return to the previous menu or parent menu.

② In the operation screen, pushing this switch will display the view of the camera on the machine (if equipped).
Please refer to page 4-24 for the camera.

③ If the camera is not installed, this switch is used only ESC function.

7) MAIN MENU

· Operation screen



※ Please refer to select switch, page 4-14 for selection and change of menu and input value.

(1) Structure

No	Main menu	Sub menu	Description
1	 Monitoring 55I3CD51A	Active fault - Machine Active fault - Engine Logged fault - Machine Logged fault - Engine Monitoring (Analog) Monitoring (Digital) - Input Monitoring (Digital) - Output	MCU ECU MCU ECU Machine information Switch status Output status
2	 Management 55I3CD51B	ESL mode setting Change password Maintenance information Machine Information A/S phone number Service menu	ESL mode setting Password change Replacement, Change interval oils and filters Cluster, MCU, Engine, Machine A/S phone number, A/S phone number change Delete logged faults, Software download, Operating hour, power shift
3	 Display 55I3CD51C	Clock Screen type Brightness setting Unit setting Language Calibration	Clock A type, B type, C type Manual, Auto Temperature, Pressure 12 language Calibrating the touch screen
4	 Utilities 55I3CD51D	Camera setting Mode Video	Number of active, Display order, Camera No. Operation mode select Play music and video file

(2) Monitoring

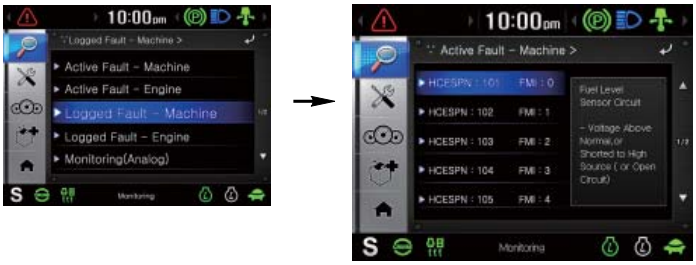
① Active fault - Machine

· The active faults of the MCU can be checked by this menu.

② Active fault - Engine

· The active faults of engine ECU can be checked by this menu.

③ Logged fault - Machine/ Engine



· The logged faults of the MCU or engine ECU can be checked by this menu.
· Only for the service person.

④ Monitoring (Analog)

· The machine status such as the engine rpm, oil temperature, voltage and pressure etc. can be checked by this menu.

⑤ **Monitoring** (Digital) - **Input**

· The switch status can be confirmed by this menu.
· The activated switchs are blue light ON.

⑥ **Monitoring** (Digital) - **Output**

· The output status can be confirmed by this menu.
· The output pilot lamps are blue light ON.

(3) Management

① ESL mode setting

· **ESL mode setting**

- ESL : Engine Starting Limit
- ESL mode is desingned to be a theft deterrent or will prevent the unauthorized operation of the machine.
- If the ESL mode was selected Enable, the password will be required when the start switch is turned ON.
- **Disable** : Not used ESL function

  Enable (always) : The password is required whenever the operator starts engine.

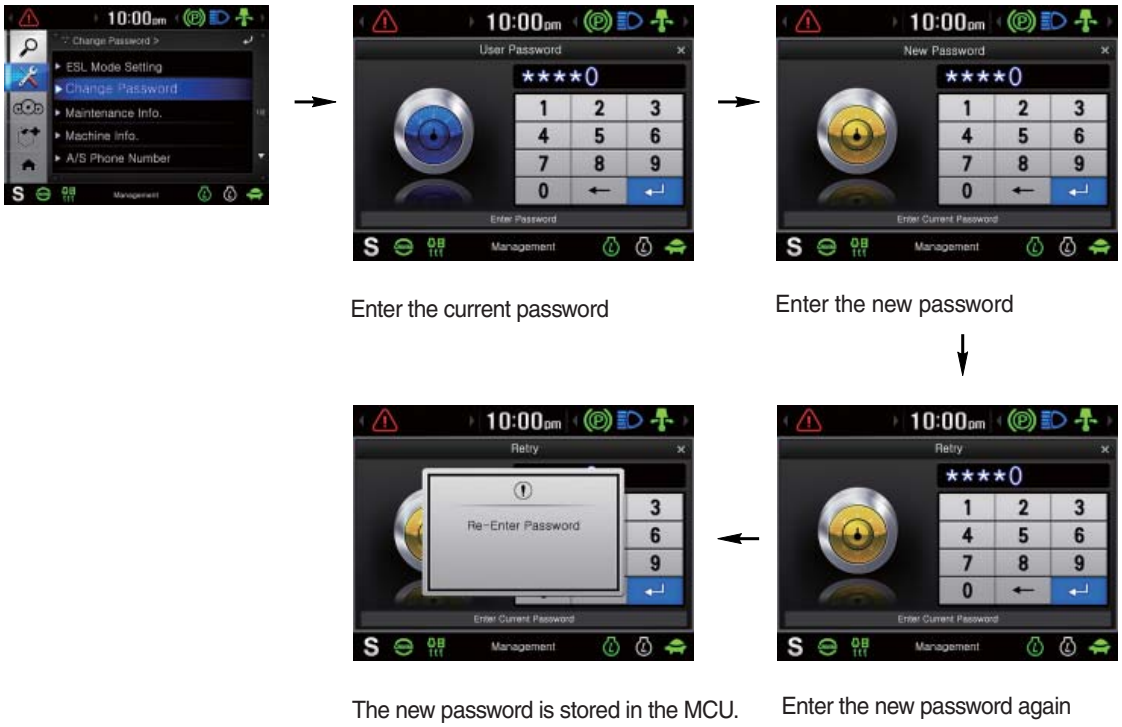
  Enable (Interval): The password is required when the operator starts engine first.
  But the operator can restart the engine within the interval time without inputting the password.
  The interval time can be set maximum 2 days.

  ※**Default password : 00000**

  ※**Password length : 5~10 digit**

② Change password

- The password is 5~10 digits.



Enter the current password

Enter the new password

The new password is stored in the MCU.

Enter the new password again

③ Maintenance information

- Elapse : Maintenance elapsed time.
- Interval : The change or replace interval can be changed in the unit of 50 hours.
- History-Hour : Maintenance replacement history.
- Replacement : The elapsed time will be reset to zero (0).
- **Change or relpace interval**

No	Item	Interval
1	Engine oil	500
2	Final gear oil	1000
3	Swing gear oil	1000
4	Hydraulic oil	2000
5	Pilot line filter	1000
6	Hydraulic oil return filter	1000
7	Engine oil filter	500
8	Fuel filter	500
9	Pre-filter	500
10	Hydraulic tank breather	1000
11	Air cleaner	500
12	Radiator coolant	2000
13	Swing gear pinion grease	1000

④ Machine Information

- This can confirm the identification of the cluster, MCU, engine and machine.

⑤ **A/S phone number**

· The A/S phone number can be checked and changed.

⑥ **Service menu**

Enter the password

· Delete logged fault : Logged faults of MCU or engine ECU can be deleted.
· S/W download : Update and display software about operating system, application, image and font.
· Operating hours : Operating hours since the machine line out can be checked.
· Power shift : Set power shift mode (standard/option)

(4) Display

① **Clock**

· The first line's three spots "****－**－**" represent Year/Month/Day each.
· The second line shows the current time. (AM, PM/0:00~12:59)

② Screen type

· The screen type (A,B,C) of the LCD can be selected by this menu.

③ Brightness setting calibration

Manual (1st~10th step)

Auto (day/night) Auto (time)

· If "Auto" is chosen, brightness for day and night can be differently set up. Also, users can define which day time interval. (Set day starting time and ending time)

④ Unit setting

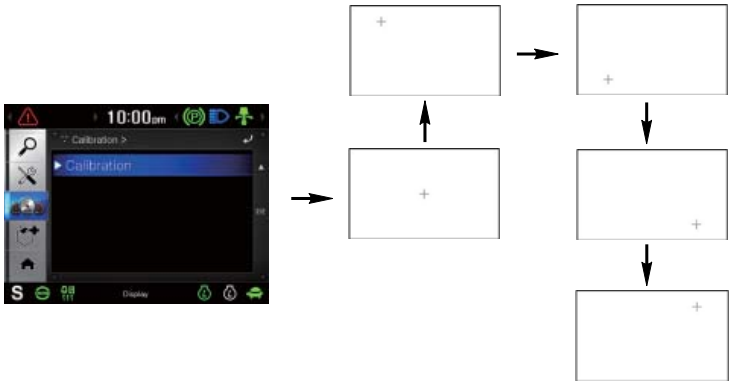
· Temperature : ˚C ↔ ˚F
· Pressure : bar ↔ MPa ↔ kgf/cm² ↔psi

⑤ Language

· User can select preferable language and all displays are changed the selected language.

⑥ Calibration

· When touch awareness goes wrong, this function use.
Fall in the next step if touches the middle point of cross with fingernail.
If touches total five points as follows, the setting is completed.



(5) Utilities

① Camera setting

- Three cameras can be installed on the machine and the display order can be set by this menu.
- If the camera was not equipped, this menu is not useful.

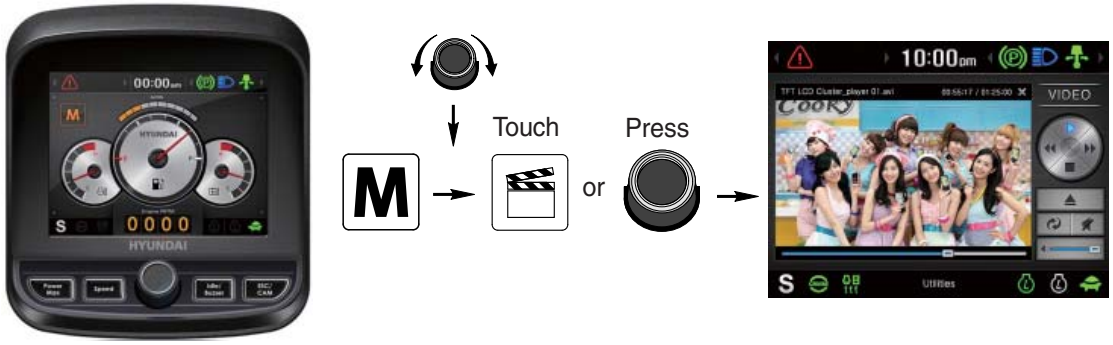
- In the operation screen, if the ESC/CAM switch is pushed, rear view camera display or stop.
- Turnning the select switch in clockwise direction, the next ordered will be shown and in counter-clockwise direction, the previously ordered will be shown. Also, you can change camera channel using touch the screen.
- Push the select switch or touch the screen, the displayed screen will be enlargement.

② Mode

- When this cluster's buttons are not work, you can control using touch screen instead of these buttons.
- You can only control in this mode screen.

③ Video

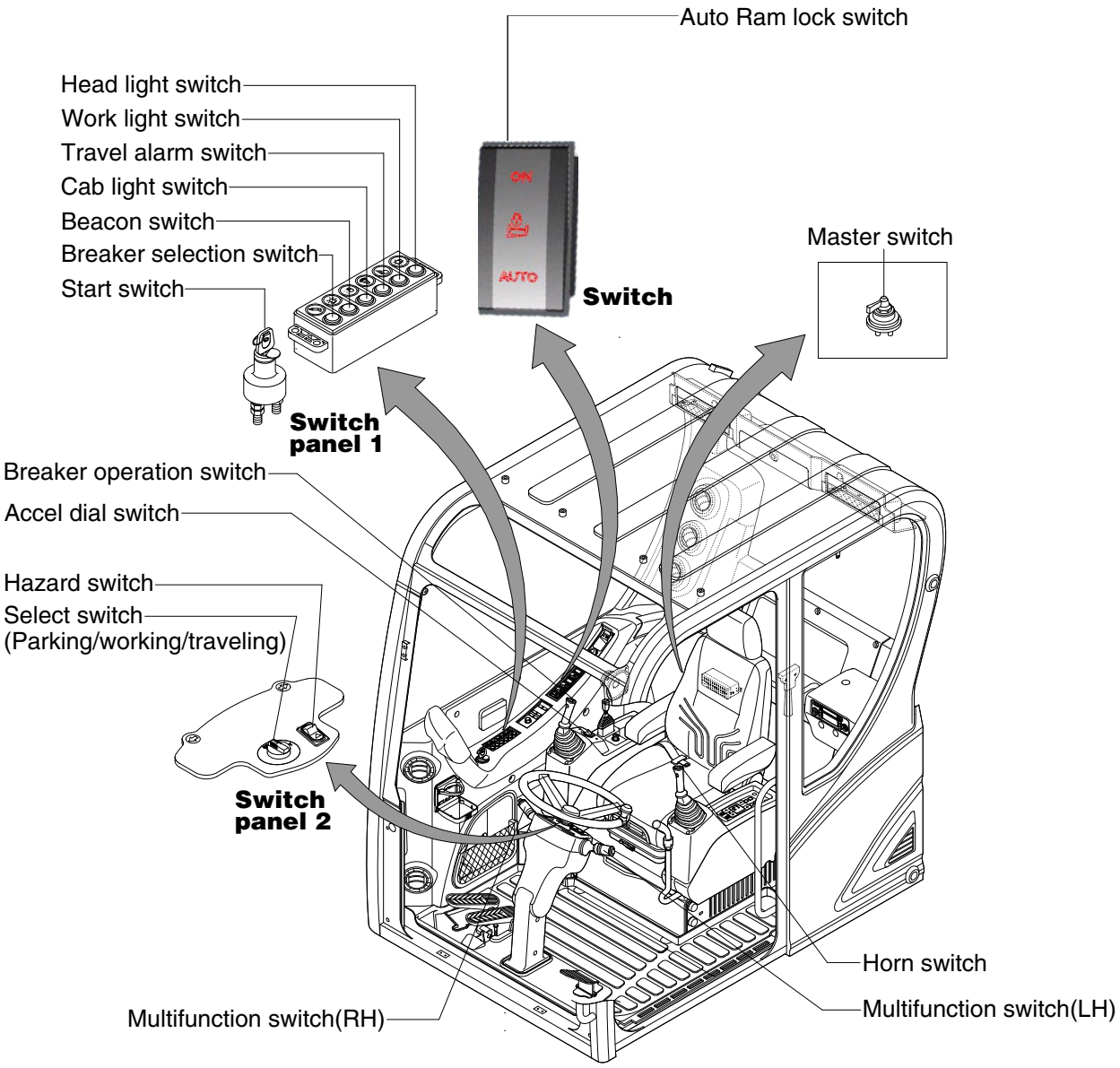
· Play MP4 or codec file of external hard disk through USB port.
· The USB port is located under the cluster.



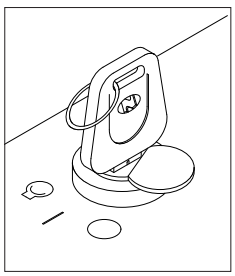
· Over 1100 engine rpm, the screen turns into the operation screen with MP4 or codec file playing for the safety.

No.	Function	Control	No.	Function	Control
1	Previous track	Power mode switch or touch	7	Sound volume	Speed switch or touch
2	Next track	Speed switch or touch	8	Stop	ESC/CAM button or touch
3	Play	Touch	9	File name	-
4	Pause	Touch	10	Current time/ Total time	-
5	Contents display	Touch	11	Current playing time	-
6	Mute	Touch	-	-	-

8. SWITCHES



1) STARTING SWITCH

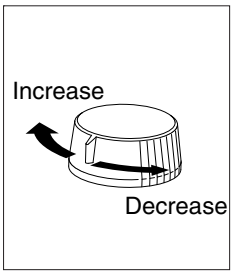


(1) There are three positions, OFF, ON and START.

- (OFF) : None of electrical circuits activate.
- (ON) : All the systems of machine operate.
- (START) : Use when starting the engine.
  Release key immediately after starting.

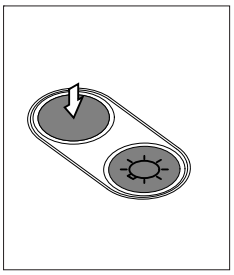
※ **Key must be in the ON position with engine running to maintain electrical and hydraulic function and prevent serious machine damage.**

2) ACCEL DIAL



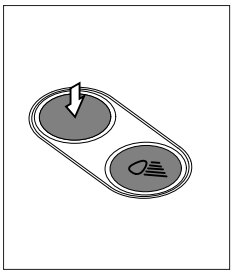
(1) There are 10 dial setting.
(2) Setting 1 is low idle and setting 10 is high idle.
- By rotating the accel dial to right : Engine speed increased.
- By rotating the accel dial to left : Engine speed decreased.

3) HEAD LIGHT SWITCH



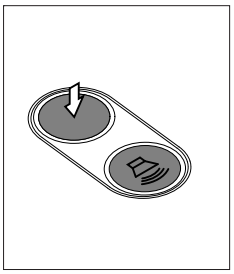
(1) This switch is used to operate the head light.
- Press the switch once, the head light comes ON and the pilot lamp ON.
- Press the switch once more, the head light and pilot lamp turn off.

4) WORK LIGHT



(1) This switch is used to operate the work light.
- Press the switch once, the work light comes ON and the pilot lamp ON.
- Press the switch once more, the work light and pilot lamp turn off.

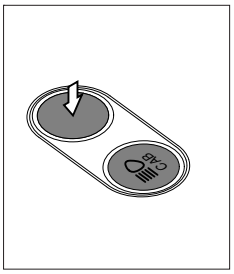
5) TRAVEL ALARM SWITCH



(1) This switch is used to alarm surroundings when the machine travels to forward and backward.

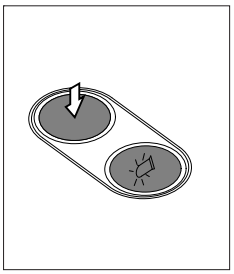
(2) On pressing this switch, the alarm operates only when the machine is traveling.

6) CAB LIGHT SWITCH



(1) This switch turns on the cab light on the cab.

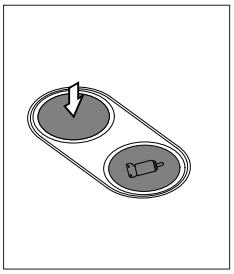
7) BEACON SWITCH (option)



(1) This switch turns ON the rotary light on the cab.

(2) The below indicator lamp is turned ON when operating this switch.

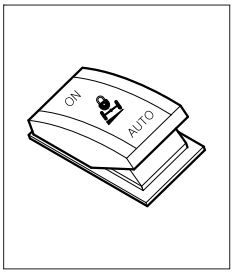
8) BREAKER SELECTION SWITCH (option)



(1) This switch is used to operate breaker.

※ **The breaker operates only when this switch is pressed.**

9) AUTO RAM LOCK SWITCH



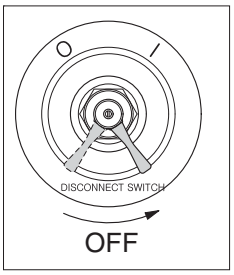
(1) This switch activate front axle oscillation cylinder to locking position for increase of stability.

· ON : Set front axle to locking position for excavation work or travels even ground. Also, the ram lock pilot lamp comes ON at the travel pilot lamp.

· AUTO : Set front axle to locking or unlocking as table.

Select switch (parking/working/ traveling)	Ram lock	Conditions
Parking (P)	Locking	· Always
Traveling (T)	Unlocking	· Always
Working (W)	Locking	· FNR lever in neutral position · Service brake pedal is depressed.
	Unlocking	· FNR lever in forward/reverse position and service brake pedal is not depressed. · 2 way pedal is equipped and service brake pedal is not depressed.

10) MASTER SWITCH

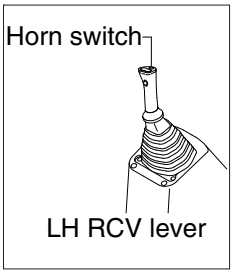


(1) This switch is used to shut off the entire electrical system.

(2) I : The battery remains connected to the electrical system.
O : The battery is disconnected to the electrical system.

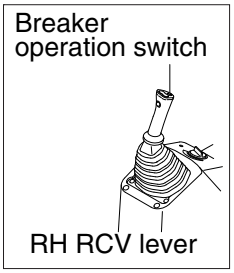
※ **Never turn the master switch to O (OFF) with the engine running. It could result in engine and electrical system damage.**

11) HORN SWITCH



(1) This switch is at the top of left side control lever.
On pressing, the horn sounds.

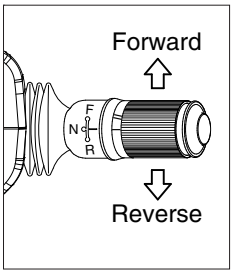
12) BREAKER OPERATION SWITCH



(1) On pressing this switch, the breaker operates only when the breaker selection switch on the switch panel is selected.

13) RH MULTI FUNCTION SWITCH

(1) FNR lever



① This lever changes travel direction of machine.
- **F** : Machine moves forward
- **N** : Neutral position
- **R** : Machine moves backward

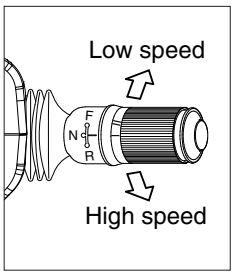
⚠ **Travel direction will be reversed if lower structure is positioned with dozer in front.**

② The warning buzzer sounds when the lever is in the reverse position.

⚠ **If this lever is not in the neutral position, engine does not started.**

⚠ **Be sure to stop the machine when changing the direction forward or backward while traveling.**

(2) Travel speed switch

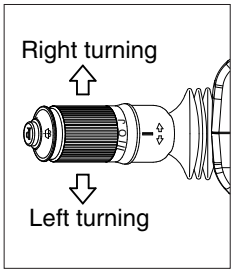


① This switch is for selecting travelling speed between high and low.
- Low speed (—) : 11.3 km/hr (7.0 mph), turtle mark
- High speed (=) : 30 km/hr (19.0 mph), rabbit mark

⚠ In case of changing the travel speed, be sure to stop the machine completely.

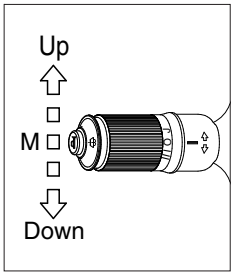
14) LH MULTI FUNCTION SWITCH

(1) Direction indication lamp switch



① This switch is used to warn or signal the turning direction of the machine to other machines or equipment.
② Push the lever to forward for turning right (⇧), pull the lever to backward for turning left (⇩).
③ The turning pilot lamp comes ON at the travel pilot lamp on the steering column.

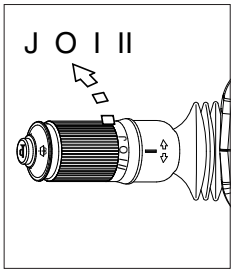
(2) Dimmer switch



① This switch is used to turn the head lights direction.
② Switch positions.
- Up ( ) : To flash for passing
- Middle ( ) : Head lights low beam ON
- Down ( ) : Head lights high beam ON

③ If you release the switch when it's in up position, the switch will return to middle.

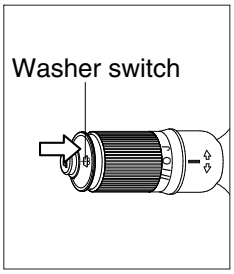
(3) WIPER SWITCH



① When the switch is in J position, the wiper moves intermittently.

② When placed in I or II position, the wiper moves continuously.

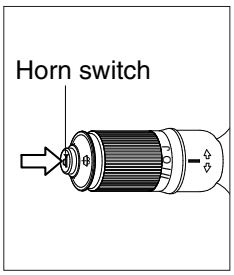
(4) WASHER SWITCH



① If you push the grip of the lever, washer liquid will be sprayed and the wiper will be activated 2-3 times.

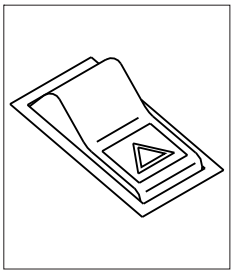
※ **Check the quantity of washer liquid in the tank. If the level of the washer liquid is LOW, add the washer liquid (in cold, winter days) or water. The capacity of tank is 1.5 liter.**

(5) HORN SWITCH



① This switch is at the end of left side multifunction switch. On pressing, the horn sounds.

15) HAZARD SWITCH

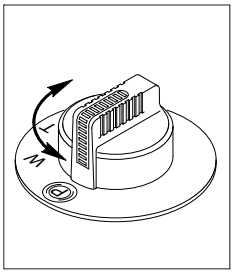


(1) Use for parking, or roading machine.

(2) LH and RH turn signal lamps come ON at the same time by this switch.

※ **If the switch is left ON for a long time, the battery may be discharged.**

16) SELECT SWITCH (parking / working / traveling)



(1) This switch is used to select the operation mode as below.

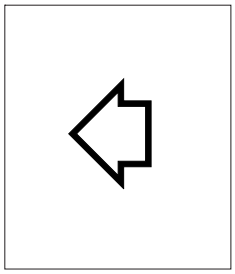
· Parking (Ⓟ) : The parking brake is applied.

· Working (W) : The machine needs to be working.

· Traveling (T) : The machine needs to be traveling.

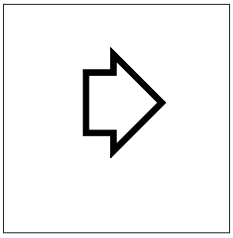
17) TURNING PILOT LAMP

(1) Left turning pilot lamp

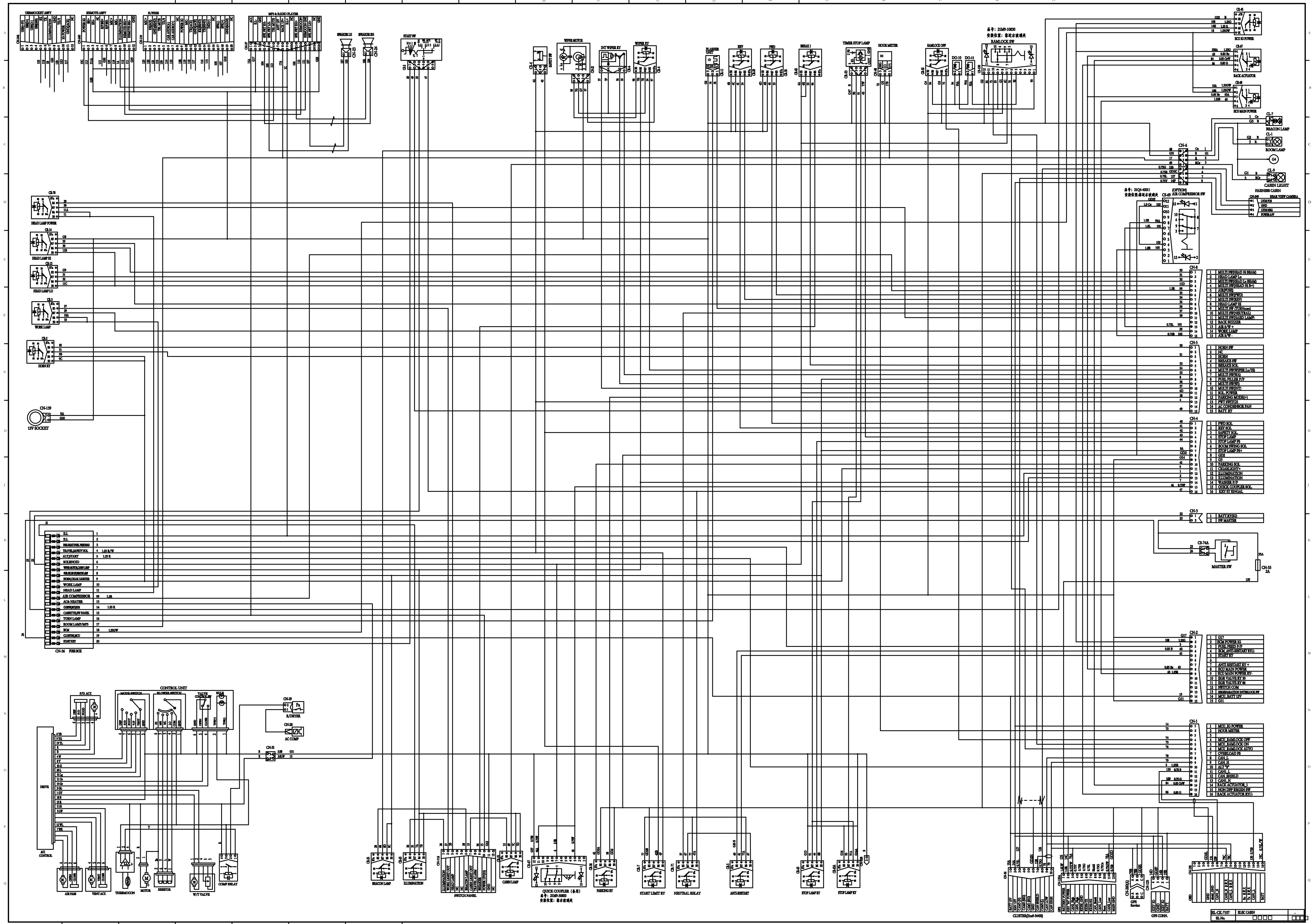


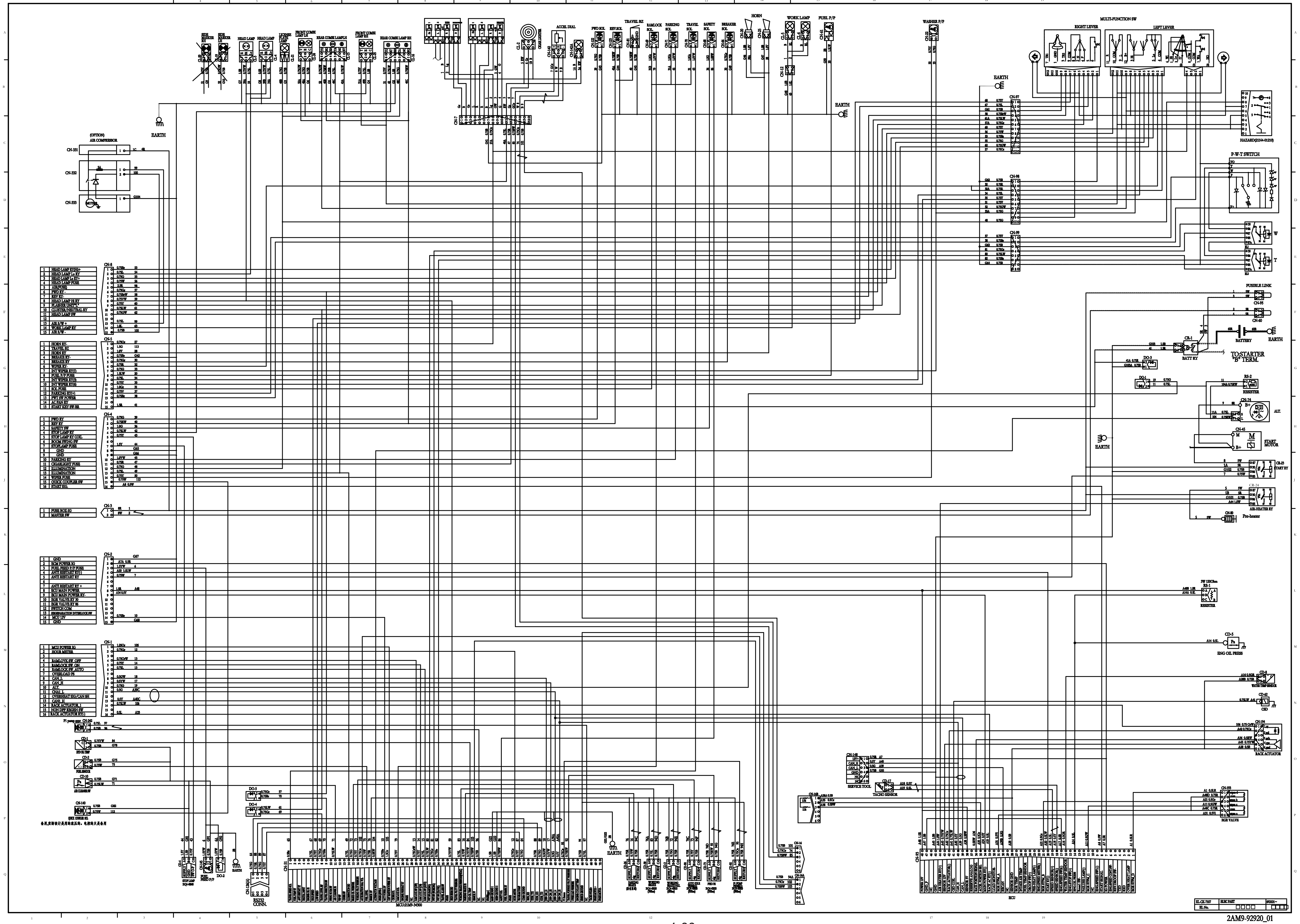
(1) This lamp flashes with sound when the LH multifunction switch is move to backward position.

(2) Right turning pilot lamp



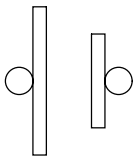
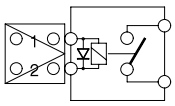
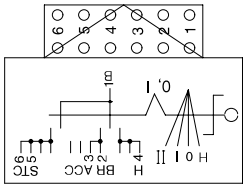
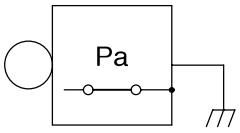
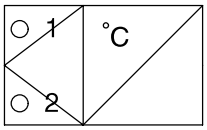
① This lamp flashes with sound when the LH multifunction switch is move to forward position.

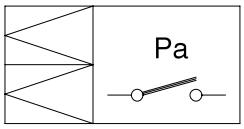
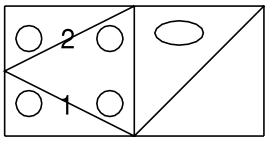
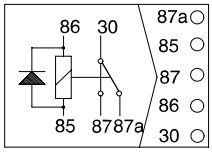
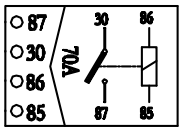
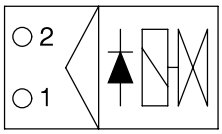
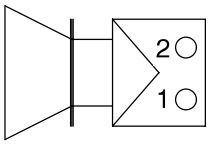

USB&SOCKET ASSY
CN-246
REMOTE ASSY
CN-245
H/FREE
CN-144
MP3 & RADIO PLAYER
CN-27
SPEAKER LH
CN-23
SPEAKER RH
CN-24
START SW
CS-2
SAFETY SW
CS-4
WIPER MOTOR
CN-21
INT WIPER RY
CR-6
WIPER RY
CR-4
FLASHER UNIT
CR-11
REV
CR-29
FWD
CR-30
BREAK 1
CR-62
TIMER STOP LAMP
CR-53
HOUR METER
CN-48
RAMLOCK OFF
CR-52
DO-10
DO-11
RAMLOCK SW
CS-100
ECU IG POWER
CR-45
RACK ACTUATOR
CR-67
ECU MAIN POWER
CR-68
BEACON LAMP
CL-7
ROOM LAMP
CL-1
CABIN LIGHT
CL-9
HARNESS CABIN
CN-249
REAR VIEW CAMERA
CN-6
(OPTION)
AIR COMPRESSOR SW
CS-69
HEAD LAMP POWER
CR-78
HEAD LAMP HI
CR-14
HEAD LAMP LO
CR-13
WORK LAMP
CR-3
HORN RY
CR-2
12V SOCKET
CN-139
CN-8
1 MULTI SW(HEAD Hi BEAM)
2 HEAD LAMP Lo
3 MULTI SW(HEAD Lo BEAM)
4 MULTI SW(HEAD Hi B+)
5 AIR(FUSE)
6 MULTI SW(FWD)
7 MULTI SW(REV)
8 HEAD LAMP HI
9 MULTI SW (TURNcom)
10 MULTI SW(NEUTRAL)
11 MULTI SW(HARD LAMP)
12 BACK BUZZER
13 AIR S/W +
14 WORK LAMP
15 AIR S/W -
CN-5
1 HORN SW
2 NC
3 HORN
4 BREAKE SW
5 BREAKE SOL
6 MULTI SW(WIPER Lo/Hi)
7 MULTI SW(WA)
8 FUEL FILLER P/P
9 MULTI SW(WI)
10 MULTI SW(INT)
11 SOL POWER
12 PARKING MODE(+)
13 PWT SWITCH
14 AC CONDENSOR FAN
15 BATT. RY
CN-4
1 FWD SOL
2 REV SOL
3 SAFETY SOL
4 STOP LAMP
5 STOP LAMP PS
6 BOOM SWING SOL
7 STOP LAMP PS+
8 GD2
9 G3
10 PARKING SOL
11 CIGARLIGHT+
12 ILLUMINATION
13 ILLUMINATION
14 WASHER P/P
15 QUICK COUPLER SOL
16 KEY ST SINGAL
CN-3
1 BATT.RY(IG)
2 SW MASTER
CS-74A
MASTER SW
CN-55
2A
CN-36 FUSE BOX
1 ILL
2 ILL
3 PRE-HEAT,FUEL FEEDING
4 TRAVEL,SAFETY SOL
5 ALT,START
6 SOLENOID
7 WIPER MOTOR,CABIN LAMP
8 FUEL FILLER P/P,BEACON LAMP
9 HORN,CIGAR LIGHTER
10 WORK LAMP
11 HEAD LAMP
99 AIR COMPRESSOR
13 AC& HEATER
14 CLUSTER,MCU,ECM
15 CASSETTE,SW PANEL
16 TURN LAMP
17 ROOM LAMP/MP3
18 ECM
19 CLUSTER,MCU
20 START KEY
CN-2
1 G17
2 ECM POWER IG
3 FUEL FEED P/P
4 ECM_ANTI-RESTART RY(-)
5 START RY
6
7 ANTI RESTART RY +
8 ECU MAIN POWER
9 ECU MAIN POWER RY-
10 EGR VALVE RY 30
11 EGR VALVE RY 86
12 SWITCH COM
13 REGENARATION INTERLOCK SW
14 MCU_BATT 12V
15 G11
CN-1
1 MCU_IG POWER
2 HOUR METER
3
4 MCU_RAMLOCK OFF
5 MCU_RAMLOCK ON
6 MCU_RAMLOCK AUTO
7 OVERLOAD PS
8 CAN_L
9 CAN_H
10 ALT "S"
11 CAN1_L
12 CAN_SHIELD
13 CAN1_H
14 RACK ACTUATOR_1
15 NON DPF REGEN SW
16 RACK ACTUATOR RY(-)
CONTROL UNIT
F/D. ACT.
MODE SWITCH
BLOWER SWITCH
VALVE CONTROL SW
BULB
CN-29
R/DRYER
CN-28
AC COMP
CN-31
DRIVE
ACT. CONTROL
AIR PASS
VENT ACT.
THERMOCON
MOTOR
RESISTOR
W/T VALVE
COMP RELAY
BEACON LAMP
CR-55
ILLUMINATION
CR-65
SWITCH PANEL
CN-116
CABIN LAMP
CR-10
QUICK COUPLER
CS-67
PARKING RY
CR-36
START LIMIT RY
CR-7
NEUTRAL RELAY
CR-71
ANTI-RESTART
CR-5
STOP LAMP RY
CR-43
STOP LAMP RY
CR-43A
CLUSTER(21m9-34400)
CN-56
GPS
CN-125A
GPS Service
CN-260(A)
GPS CONN.
CN-125
OBD
CN-130
EL-CK-7107
ELEC CABIN
EL No.
2AM9-93911_00

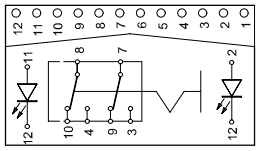
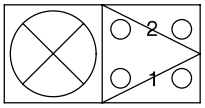
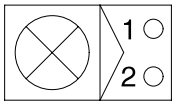
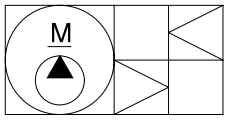
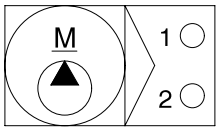
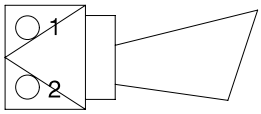


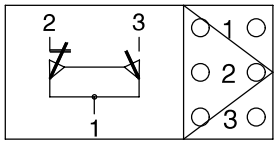
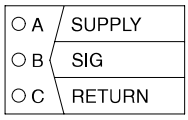
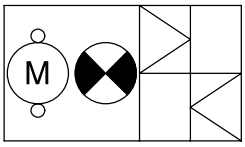
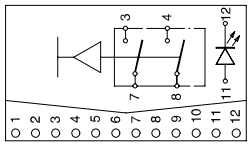
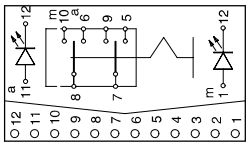
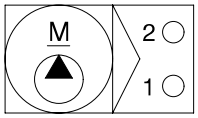
2AM9-92920_01

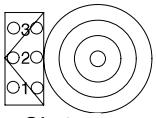
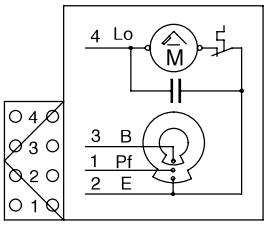
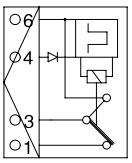
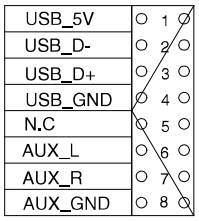
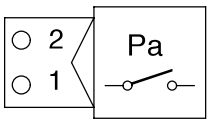
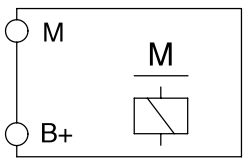
GROUP 4 ELECTRICAL COMPONENT SPECIFICATION

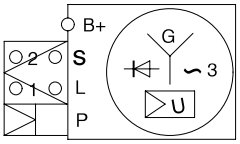
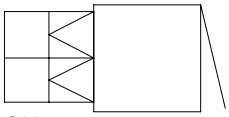
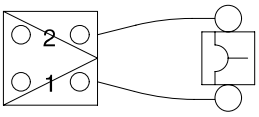
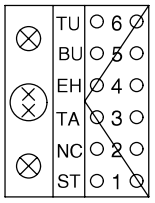
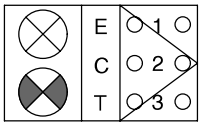
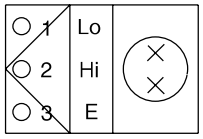
Part name	Symbol	Specification	Check
Battery		12V × 100Ah	※ Check specific gravity 1.280 over : Over charged 1.280 ~ 1.250 : Normal 1.250 below : Recharging
Battery relay	 CR-1	Rated load : 12V 100A (continuity) 1000A (30 second)	※ Check coil resistance Normal : about 12Ω ※ Check contact Normal : ∞Ω
Start key	 CS-2	12V	※Check contact OFF : ∞Ω (for each terminal) ON : 0Ω (for terminal 1-3 and 1-2) START : 0Ω (for terminal 1-5)
Pressure switch (for engine oil)	 CD- 5	0.5 kgf/cm² (N.C TYPE)	※ Check resistance Normal : 0Ω (CLOSE)
Temperature sensor	 CD-1 CD-8	-	※ Check resistance 50˚C : 804Ω 80˚C : 310Ω 100˚C : 180Ω

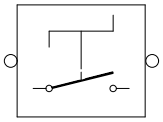
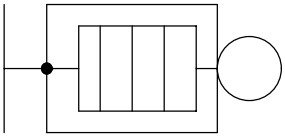
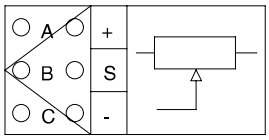
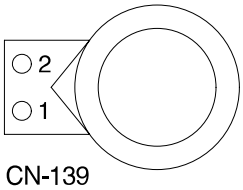
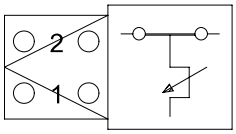
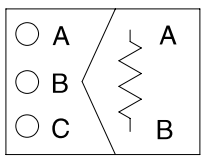
Part name	Symbol	Specification	Check
Air cleaner pressure switch	 CD-10	Pressure: 635mmH_2O (N.O TYPE)	※ Check contact Normal : ∞Ω
Fuel sender	 CD-2	-	※ Check resistance Full : 100Ω Low : 500Ω Empty warning :700Ω
Relay	 CR-2 CR-3 CR-5 CR-7 CR-13 CR-14 CR-29 CR-30 CR-45 CR-62 CR-65 CR-78	12V 20A	※ Check resistance Normal : About 200Ω (for terminal 85-86) : 0Ω(for terminal 30-87a)
Relay	 CR-23 CR-24	12V 60A	※ Rated coil current 1.2±0.3A
Solenoid valve	 CN-66 CN-68 CN-69 CN-70 CN-71 CN-121 CN-122 CN-123 CN-140	12V 1A	※ Check resistance Normal : 15~25Ω (for terminal 1-2)
Speaker	 CN-23(LH) CN-24(RH)	4Ω 20W	※Check resistance Normal : 4Ω

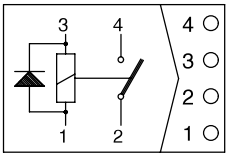
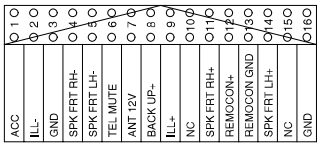
Part name	Symbol	Specification	Check
Switch (looking type)	 CS-67 CS-69	12V 16A	※ Check contact Normal OFF - ∞Ω(for terminal 1-5,2-6) - 0Ω(for terminal 5-7,6-8)
Work lamp	 CL-5 CL-6 CL-9 CL-19 CL-20	12V 55W (H3 TYPE)	※ Check disconnection Normal : 1.2Ω
Room lamp	 CL-1	12V 10W	※ Check disconnection Normal : A few Ω
Fuel filler pump	 CN-61	12V 35 ℓ/min	※Check operation Supply power(for terminal 1) : 12V
Fuel feed pump	 CN-145	12V	-
Horn	 CN-20 CN-25	12V	100±5dB

Part name	Symbol	Specification	Check
Safety switch	 CS-4	Micro	※ Check contact Normal : 0Ω (for terminal A-B) : ∞Ω (for terminal A-C) Operating : ∞Ω (for terminal A-B) : 0Ω (for terminal A-C)
Pressure sensor	 CD-3 CD-4 CD-7 CD-26 CD-31 CD-32 CD-38 CD-73 CD-92	8-30V	※ Check contact Normal : 0.1Ω
Beacon lamp	 CL-7	12V (strobe type)	※ Check disconnection Normal : A few Ω
Auto cruise switch	 CS-23	12V 16A	※ Check contact Normal : ∞Ω
Auto ram lock switch	 CS-100	12V 16A	※ Check contact Normal : 0Ω
Washer pump	 CN-22	12V 3.8A	※Check contact Normal : 3Ω (for terminal 1-2)

Part name	Symbol	Specification	Check
Cigar lighter	 CL-2	12V 10A 1.4W	※Check coil resistance Normal : About 1MΩ ※ Check contact Normal : ∞Ω Operating time : 5~15sec
Wiper motor	 CN-21	12V 3A	※Check contact Normal : 6Ω(for terminal 2-6)
Int wiper relay	 CR-6	12V 12A	–
Radio & USB player	 CN-27A	12V 3A	※ Check voltage 10 ~ 12.5V (for terminal 10-14,11-14)
Receiver dryer	 CN-29	12V	※ Check contact Normal : 0Ω
Starter	 CN-45	12V	※ Check contact Normal : 0.1Ω

Part name	Symbol	Specification	Check
Alternator	 CN-74	12V 80A	※ Check contact Normal : 0Ω (for terminal B+-1) Normal : 10 ~ 12.5V
Travel buzzer	 CN-81	12V	-
Circuit breaker manual reset	 CN-60 CN-95	12V, 30A (CN-65) 12V, 60A (CN-95)	-
Rear combination lamp-LH, RH	 CL-15 CL-16	12V 21W×2 12V 21/5W	※Normal : 4.8Ω (for terminal 1-4) Normal : 2.1Ω (for terminal 2-4, 4-5, 4-6)
Front combination lamp-LH, RH	 CL-24 CL-25	12V 21W 12V 5W	※Normal : 4.8Ω (for terminal 1-2) Normal : 2.1Ω (for terminal 2-3)
Head lamp -LH, RH	 CL-3 CL-4	12V 60/55W	※Normal : 1.0Ω (for terminal 1-3, 2-3) Normal : 1.5Ω (for terminal 1-2)

Part name	Symbol	Specification	Check
Master switch	 CS-74	12V 1000A	-
Preheater	 CN-80	12V 42A 500W	-
Accel dial	 CN-142	-	※ Check resistance Normal : about 5KΩ (for terminal A-C) ※ Check voltage Normal : about 5V (for terminal A-C) : 2-4.5V (for terminal C-B)
12V socket	 CN-139	12V 120W	
Dust sensor (switch)		1˚C OFF 4˚C ON	※Check resistance Normal : 0Ω (for terminal 1-2) The atmosphere temp : over 4˚C
Resistor	 RS-1	3W	※ Check resistance A-B : 120Ω

Part name	Symbol	Specification	Check
Relay (air con blower)		12V 20A	※ Check resistance Normal : About 200Ω (for terminal 1-3) 0 Ω (for terminal 2-4)
Radio & USB plalyer	 CN-27	12V 2A	※Check voltage 10~16V - (for terminal 1-3, 3-8)

GROUP 5 FAULT CODES

1. MACHINE FAULT CODE

Fault code		Description
HCESPN	FMI	
101	3	Hydraulic oil temperature sensor circuit - voltage above normal or shorted to high source (or open circuit)
	4	Hydraulic oil temperature sensor circuit - voltage below normal or shorted to low source
105	0	Working pressure sensor data above normal range (or open circuit)
	1	Working pressure sensor data below normal range
	2	Working pressure sensor data error
	4	Working pressure sensor circuit - voltage below normal, or shorted to low source
108	0	Travel oil pressure sensor data above normal range (or open circuit)
	1	Travel oil pressure sensor data below normal range
	2	Travel oil pressure sensor data error
	4	Travel oil pressure sensor circuit - voltage below normal or shorted to low source
122	0	Overload pressure sensor data above normal range (or open circuit)
	1	Overload pressure sensor data below normal range
	2	Overload pressure sensor data error
	3	Overload pressure sensor circuit - voltage below normal or shorted to low source
301	3	Fuel level sensor circuit - voltage above normal or shorted to high source (or open circuit)
	4	Fuel level sensor circuit - voltage below normal or shorted to low source
503	0	Brake pressure sensor data above normal range (or open circuit)
	1	Brake pressure sensor data below normal range
	2	Brake pressure sensor data error
	4	Brake pressure sensor data - voltage below normal or shorted to low source
505	0	Working brake pressure sensor data above normal range (or open circuit)
	1	Working brake pressure sensor data below normal range
	2	Working brake pressure sensor data error
	4	Working brake pressure sensor circuit - voltage below normal, or shorted to low source
530	0	Travel fwd pilot pressure sensor data above normal range (or open circuit)
	1	Travel fwd pilot pressure sensor data below normal range
	2	Travel fwd pilot pressure sensor data error
	4	Travel fwd pilot pressure sensor circuit - voltage below normal, or shorted to low source
	14	Travel fwd pilot pressure sensor circuit - special instructions
	16	Travel fwd pilot pressure sensor circuit - voltage valid but above normal operational range
701	4	Hour meter circuit - voltage below normal, or shorted to low source
705	0	MCU input voltage high
	1	MCU input voltage low
707	1	Alternator node I voltage low (or open circuit)
714	3	Acc. dial circuit - voltage above normal, or shorted to high source (or open circuit)
	4	Acc. dial circuit - voltage below normal, or shorted to low source
840	2	Cluster communication data error
841	2	ECM communication data error
IDSP		Water in fuel warning
Lo bat		Low battery warning

2. ENGINE FAULT CODE

Fault code		Description	
YANMAR SPN	FMI	Area	Status
522400	2	Crankshaft speed sensor	Crankshaft signal error
	5		No signal from crankshaft
522401	2	Camshaft speed sensor	Camshaft signal error
	5		No signal from camshaft
	7		Angle offset error
523249	5	Crankshaft speed sensor, Camshaft speed sensor	Crankshaft/camshaft, speed sensor non-input (simultaneous)
91	3	Accelerator sensor 1	Accelerator sensor 1 error (voltage high)
	4		Accelerator sensor 1 error (voltage low)
28	3	Accelerator sensor 2	Accelerator sensor 2 error (voltage high)
	4		Accelerator sensor 2 error (voltage low)
522624	7	Accelerator sensor 1 + 2	Dual accelerator sensor error (closed position)
522623	7		Dual accelerator sensor error (open position)
29	3	Accelerator sensor 3	Accelerator sensor 3 error (voltage high)
	4		Accelerator sensor 3 error (voltage low)
	8	Pulse sensor	Pulse accelerator sensor error (pulse communication)
28	0	Accelerator sensor 3	Accelerator sensor 3 error (foot pedal in open position)
	1		Accelerator sensor 3 error (foot pedal in closed position)
51	3	Intake throttle position sensor	Intake throttle position sensor error (voltage high)
	4		Intake throttle position sensor error (voltage low)
102	3	EGR low pressure side pressure sensor	ERG low pressure side pressure sensor error (excessive sensor output)
	4		ERG low pressure side pressure sensor error (insufficient sensor output)
	13		ERG low pressure side pressure sensor error (abnormal learning value)
	10		ERG low pressure side pressure sensor error (detected value error)
1209	3	EGR pressure sensor (high-pressure side)	ERG high pressure side pressure sensor error (excessive sensor output)
	4		ERG high pressure side pressure sensor error (insufficient sensor output)
	13		ERG high pressure side pressure sensor error (abnormal learning value)
	10		ERG high pressure side pressure sensor error (detected value error)
110	3	Engine coolant temperature sensor	Engine coolant temperature sensor error (excessive sensor output)
	4		Engine coolant temperature sensor error (insufficient sensor output)
	10		Engine coolant temperature sensor error (detected value error)
	0		Engine coolant temperature high (overheat)
172	3	Ambient air temperature sensor	Ambient air temperature sensor error (voltage high)
	4		Ambient air temperature sensor error (voltage low)

Fault code		Description	
YANMAR SPN	FMI	Area	Status
174	3	Fuel temperature sensor	Fuel temperature sensor error (voltage high)
	4		Fuel temperature sensor error (voltage low)
	0		Fuel temperature high
157	3	Rail pressure sensor	Rail pressure sensor error (voltage high)
	4		Rail pressure sensor error (voltage low)
3251	3	DPF differential pressure sensor	DPF differential pressure sensor error (excessive sensor output)
	4		DPF differential pressure sensor abnormal rise in differential pressure
	0		DPF differential pressure sensor error abnormal rise in differential pressure
	13		DPF differential pressure sensor error (abnormal learning value)
4795	31	DPF substrate/DPF differential pressure sensor	DPF substrate/DPF differential pressure sensor error (DPF substrate removal/DPF differential pressure sensor detected value error)
3609	3	DPF high pressure side pressure sensor	DPF high pressure side pressure sensor error (excessive sensor output)
	4		DPF high pressure side pressure sensor error (insufficient sensor output)
	10		DPF high pressure side pressure sensor error (detected value error)
3242	3	DPF intermediated temperature sensor	DPF inlet temperature sensor error (excessive sensor output)
	4		DPF inlet temperature sensor error (insufficient sensor output)
	10		DPF inlet temperature sensor error (detected value error)
	0		DPF inlet temperature sensor abnormal temperature (abnormally high)
3250	3	DPF intermediate temperature sensor	DPF intermediate temperature sensor error (excessive
	4		DPF intermediate temperature sensor error (insufficient sensor output)
	10		DPF intermediate temperature sensor error (detected value error)
	1		DPF intermediate temperature sensor abnormal temperature (abnormally low)
108	3	Atmospheric pressure sensor	Atmospheric pressure sensor error (excessive sensor output)
	4		Atmospheric pressure sensor error (insufficient sensor output)
	10		Atmospheric pressure sensor error (characteristic error)
173	3	Exhaust manifold temperature sensor	Exhaust manifold temperature sensor error (excessive sensor output)
	4		Exhaust manifold temperature sensor error (insufficient sensor output)
	10		Exhaust manifold temperature sensor error (detected value error)
1485	7	Main relay	Main relay contact sticking
	2		Main relay early opening

Fault code		Description	
YANMAR SPN	FMI	Area	Status
522243	5	Starting aid relay	Starting aid relay disconnection
	6		Starting aid relay relay GND short circuit
654	5	Injector (No.1 cylinder)	Disconnection (injector-specific)
	6		Coil short circuit
	3		Short circuit
653	5	Injector (No.2 cylinder)	Disconnection (injector-specific)
	6		Coil short circuit
	3		Short circuit
652	5	Injector (No.3 cylinder)	Disconnection (injector-specific)
	11		Coil short circuit
	3		Short circuit
651	5	Injector (No.4 cylinder)	Disconnection (injector-specific)
	6		Coil short circuit
	3		Short circuit
4257	12	All injectors	Injector drive IC error
2797	6		Injector drive circuit (Bank1) shotrt circuit (4TN: common circuit for No.1, No4 and all 3TN cylinders)
2798	6		Injector drive circuit (Bank2) short circuit (4TN: circuit for No.2 and 3 cylinders)
523462	13	Injector (correction value)	Inujector (No.1 cylinder) correction value error
523463	13		Inujector (No.2 cylinder) correction value error
523464	13		Inujector (No.3 cylinder) correction value error
522465	13		Inujector (No.4 cylinder) correction value error
522571	3	SCV (MPROP)	SCV (MPROP) L side VB short circuit
	6		SCV (MPROP) L side GND short circuit
633	3		SCV (MPROP) H side VB short circuit
	6		SCV (MPROP) H side GND short circuit
	5		SCV (MPROP) disconnection
522572	6		SCV (MPROP) drive current (high level)
	11		SCV (MPROP) pump overload error
157	0	Rail pressure error	Rail pressure too high
	18		Rail pressure deviation error (low rail pressure)
	15		Rail pressure deviation errer (high rail pressure)
	16	PLV (common rail pressure limit valve)	PLV open valve
523469	0		Rail pressure fault (The times of PLV valve opening error)
523470	0		Rail pressure fault (The time of PLV valve opening error)
523489	0		Rail pressure fault (The actual rail pressure is too high during PRV limp home)
523498	9		Rail pressure fault (contrilled rail pressure error after PLV valve opening)
523491	0	Rail pressure control	Rail pressure fault (injector B/F temperature error during PLV4 limp home)
523460	7		Rail pressure fault (operation time error during RPS limp home)

Fault code		Description	
YANMAR SPN	FMI	Area	Status
190	16	Overspeed	Overspeed
2950	5	Intake throttle drive circuit	No-load of throttle valve drive H bridge circuit
	3		Power short circuit of throttle valve drive H bridge output 1
	4		GND short circuit of throttle valve drive H bridge output 1
	6		Overload on the drive H bridge circuit of throttle valve
2951	3		VB power short circuit of throttle valve drive H bridge output 2
	4		GND short circuit of throttle valve drive H bridge output 1
2950	7		Throttle valve sticking (sticking open)
2951	7		Throttle valves sticking (sticking closed)
522596	9	CAN 2	TSC1 (SA1) reception timeout
522597	9		TSC1 (SA2) reception timeout
522599	9		Y_ECR1 reception timeout
522600	9		Y_EC reception timeout
522601	9		Y_RSS reception timeout
237	31		VI_ reception timeout
	13		VI_ reception data error
522609	9		Y_ETCP1 reception timeout
522618	9		EBC1 reception timeout
522619	9		Y_DPFIF reception timeout
522730	12		Immobilzer error (CAN communication)
1202	2		Immobilizer error (system)
522610	9	CAN 1	CAN 1 (for EGR): reception timeout from the EGR valve
522611	9		CAN 1 (for exhaust throttle): receptiom timeout
2791	0	EGR valve	EGR overvoltage error
	1		EGR low voltage error
	7		EGR feedback error
	9		EGR ECM data error
	12		Disconnection in EGR motor coils
522579	12		Short circuit in EGR motor coils
522580	12		EGR position sensor error
522581	7		EGR valve sticking error
522183	7		EGR initialization error
522184	1		EGR high temperature thermistor error
522617	1		EGR low temperature thermistor error
522746	12		EGR target value out of range
522747	12	Exhaust throttle	Exhaust throttle (voltage fault)
522748	12		Exhaust throttle (motor fault)
522749	12		Exhaust throttle (sensor system fault)
	12		Exhaust throttle (MPU fault)
522750	12		Exhaust throttle (PCB fault)
522751	19		Exhaust throttle (CAN fault)

Fault code		Description	
YANMAR SPN	FMI	Area	Status
630	12	EEPROM	EEPROM memory deletion error
522576	12		EEPROM memory reading error
522578	12		EEPROM memory writing error
522585	12	ECU internal fault	CY 146 SPI communication fault
522588	12		Excessive voltage of supply 1
522589	12		Insufficient voltage of supply 1
522590	12		Sensor supply voltage error 1
522591	12		Sensor supply voltage error 2
522592	12		Sensor supply voltage error 3
522744	4		Actuator drive circuit 1 short to ground
522994	4		Actuator drive circuit 2 short to ground
523471	6		Actuator drive circuit 3 chort to ground
523473	12		AD converter fault 1
523474	12		AD converter fault 2
523475	12		External monitoring IC and CPU fault 1
523476	12		External monitoring IC and CPU fault 2
523477	12		ROM fault
523478	12		Shutoff path fault 1
523479	12		Shutoff path fault 2
523480	12		Shutoff path fault 3
523481	12		Shutoff path fault 4
523482	12		Shutoff path fault 5
523483	12		Shutoff path fault 6
523484	12		Shutoff path fault 7
523485	12		Shutoff path fault 8
523486	12		Shutoff path fault 9
523487	12		Shutoff path fault 10
523488	0		Recognition error of engine speed
3059	5	Breather heater (optional parts for 4TNV86CT and 4TNV98CT)	Breather heater disconnection
	4		Breather heater short circuit (GND)
	3		Breather heater short circuit (VB)
522323	0	Air cleaner switch	Air cleaner clogged alarm
522329	0	Water weparator switch	Water separator alarm
167	5	Charge switch	Charge switch disconnection
	1		Charge alarm
100	4	Oil pressure switch	Oil pressure switch disconnection
	1		Low oil pressure alarm
522573	0	DPF	Excessive PM accumulation (method C)
522574	0		Excessive PM accumulation (method P)
522575	7		Regeneration falure (stationary regeneration failure)
522577	11		Regeneration failure (staonary regeneration not performed)
3250	0	DPF intermediate temperature sensor	DPF intermediate temperature sensor abnormal rise in temperature (post-injection malfunction)

Fault code		Description	
YANMAR SPN	FMI	Area	Status
3720	16	DPF OP interface	Ash cleaning request 1
	0		Ash cleaning request 2
3719	16		Stationary regeneration standby
	0		Backup mode
3695	14		Reset regeneration is inhibited
3719	9		Regeneration faulure (recovery regeneration failure)
	7		Recovery regeneration is inhibited

SECTION 5 TROUBLESHOOTING

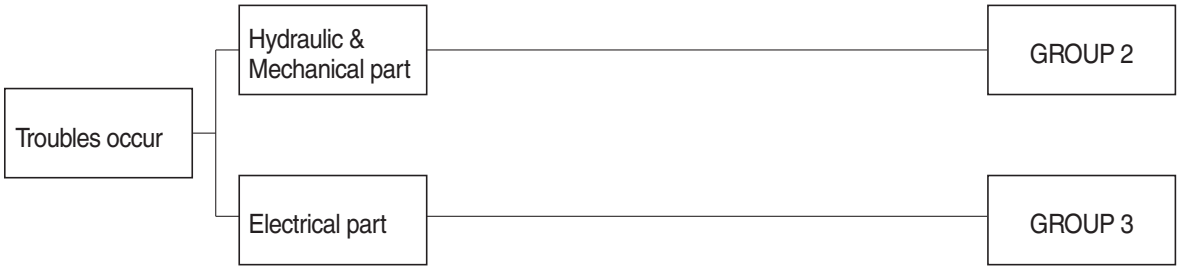
GROUP 1 BEFORE TROUBLESHOOTING

1. INTRODUCTION

When a trouble is occurred in the machine, this section will help an operator to maintain the machine with easy.

The trouble of machine is parted Hydraulic & Mechanical system and Electrical system system.

At each system part, an operator can check the machine according to the troubleshooting process diagram.

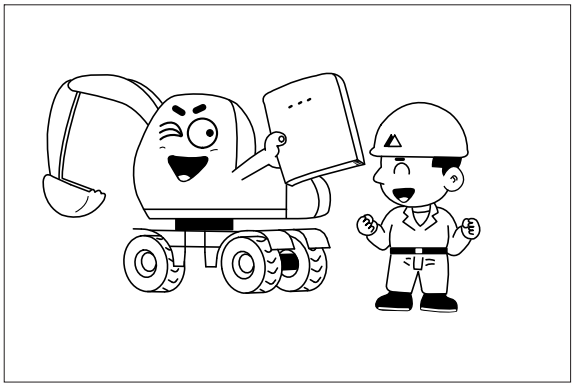


2. DIAGNOSING PROCEDURE

To carry out troubleshooting efficiently, the following steps must be observed.

STEP 1. Study the machine system

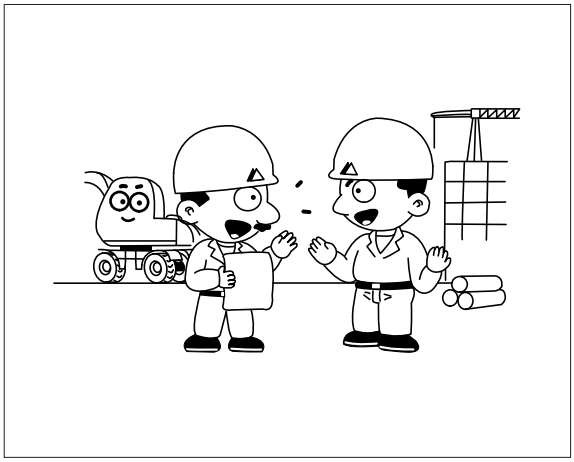
Study and know how the machine is operating, how the system is composing, what kinds of function are installed in the machine and what are specifications of the system components by the machine service manual.
Especially, deepen the knowledge for the related parts of the trouble.



STEP 2. Ask the operator

Before inspecting, get the full story of malfunctions from a witness --- the operator.

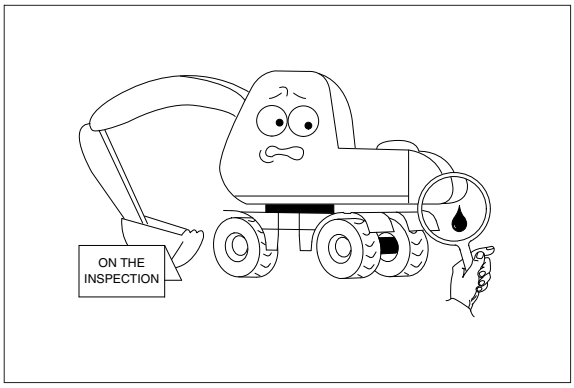
1) How the machine is used and when it is serviced?
2) When the trouble was noticed and what work the machine was doing at that time?
3) What is the phenomenon of the trouble? Was the trouble getting worse, or did it come out suddenly for the first time?
4) Did the machine have any troubles previously? If so, which parts were repaired before.



STEP 3. Inspect the machine

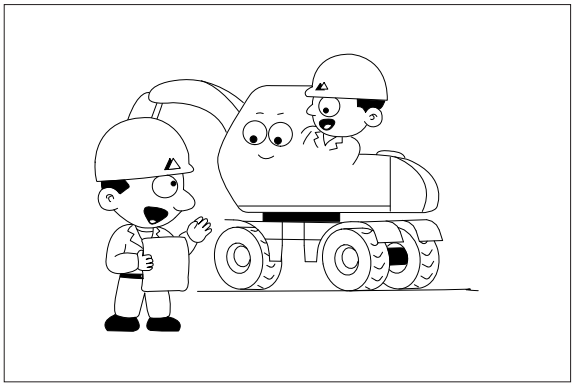
Before starting troubleshooting, check the machine for the daily maintenance points as shown in the operator's manual.

And also check the electrical system including batteries, as the troubles in the electrical system such as low battery voltage, loose connections and blown out fuses will result in malfunction of the controllers causing total operational failures of the machine.



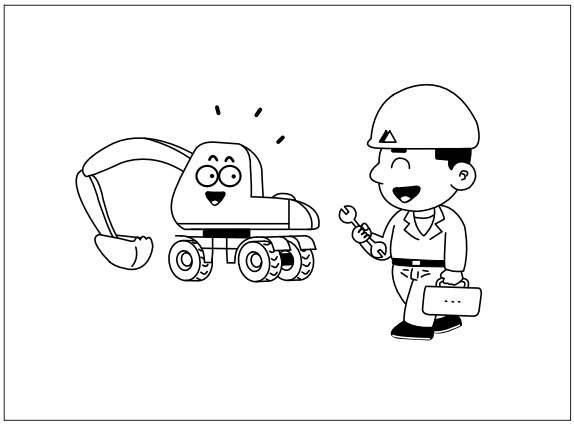
STEP 4. Inspect the trouble actually on the machine

In case that some trouble cannot be confirmed, obtain the details of the malfunction from the operator.
Also, check if there are any in complete connections of the wire harnesses are or not.



STEP 5. Perform troubleshooting

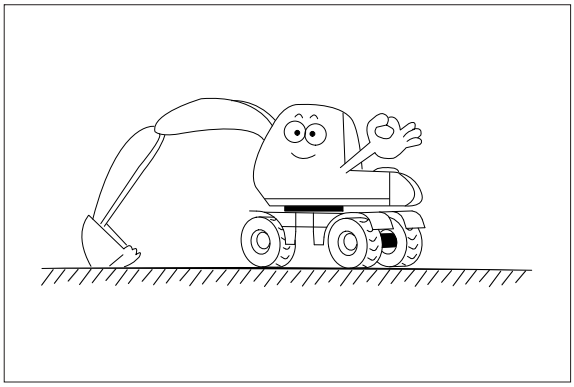
According to where the trouble parts are located, hydraulic & mechanical system part or electrical system part or mechatronics system part, perform troubleshooting the machine refer to the each system part's troubleshooting process diagram.



STEP 6. Trace a cause

Before reaching a conclusion, check the most suspectible causes again. Try to trace what the real cause of the trouble is.

Make a plan of the appropriate repairing procedure to avoid consequential malfunctions.



GROUP 2 HYDRAULIC AND MECHANICAL SYSTEM

1. INTRODUCTION

1) MACHINE IN GENERAL

(1) If even a minor fault is left intact and operation is continued, a fatal failure may be caused, entailing a large sum of expenses and long hours of restoration.
Therefore when even a small trouble occurs, do not rely on your intuition and experience, but look for the cause based on the troubleshooting principle and perform maintenance and adjustment to prevent major failure from occurring. Keep in mind that a fault results from a combination of different causes.

(2) The following lists up commonly occurring faults and possible causes with this machine. For the troubleshooting of the engine, refer to the coming troubleshooting and repair.

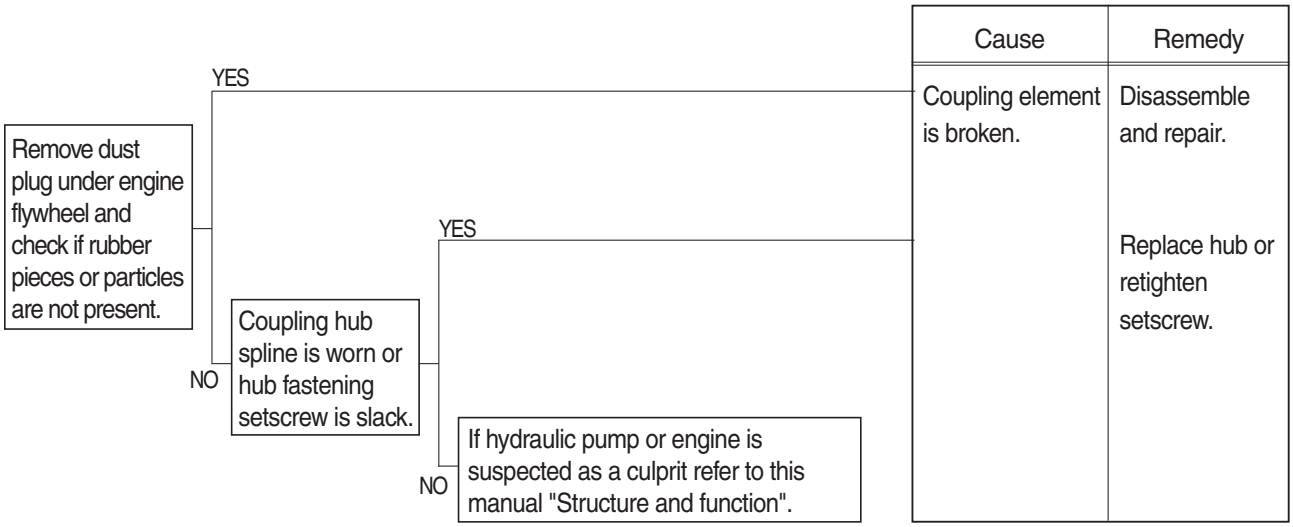
(3) When carrying out troubleshooting, do not hurry to disassemble the components.
It will become impossible to find the cause of the problem.

(4) Ask user or operator the following.
① Was there any strange thing about machine before failure occurred?
② Under what conditions did the failure occur?
③ Have any repairs been carried out before the failure?

(5) Check before troubleshooting.
① Check oil and fuel level.
② Check for any external leakage of oil from components.
③ Check for loose or damage of wiring and connections.

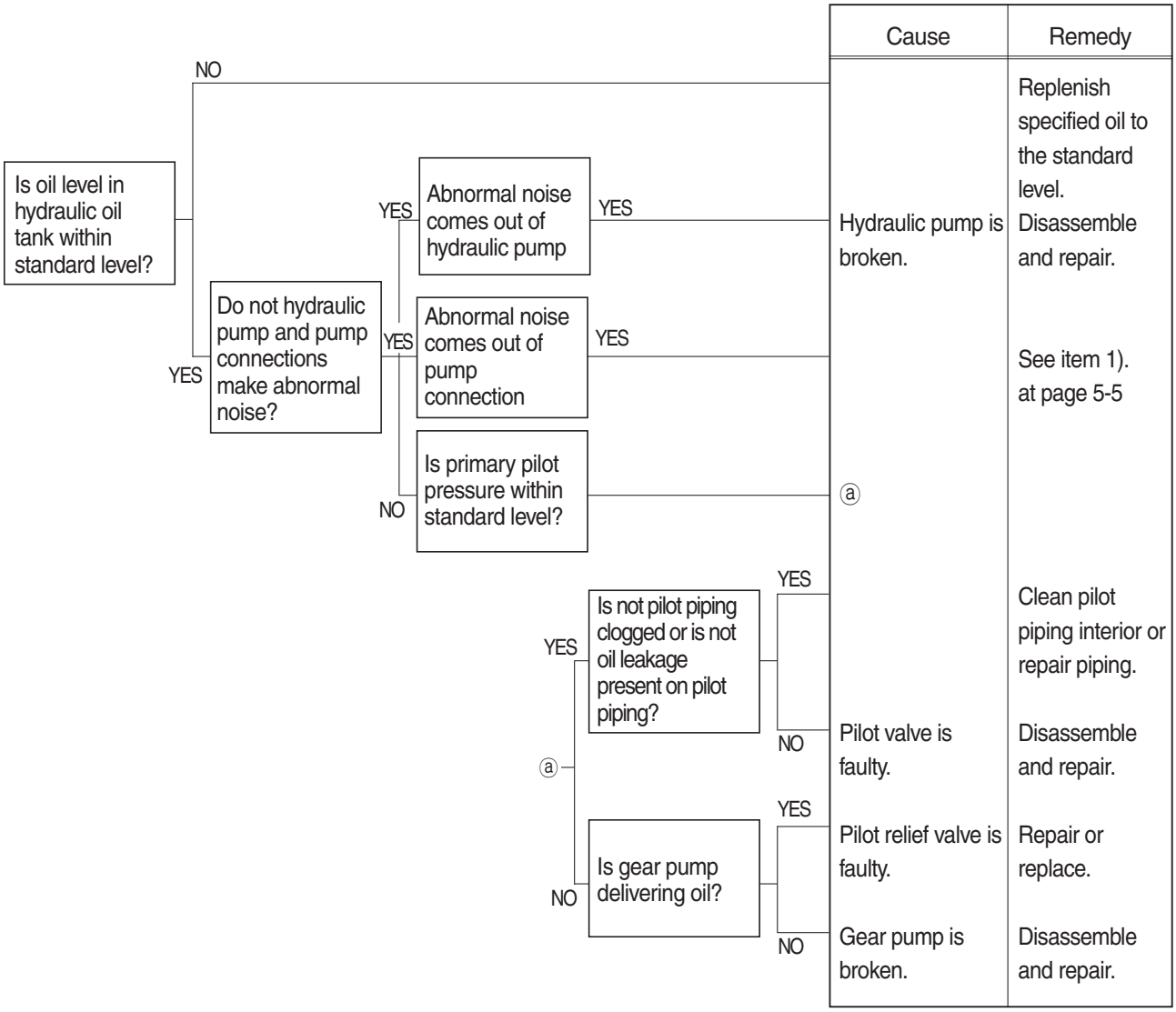
2. DRIVE SYSTEM

1) UNUSUAL NOISE COMES OUT OF PUMP CONNECTION



Cause	Remedy
Coupling element is broken.	Disassemble and repair.
	Replace hub or retighten setscrew.

2) ENGINE STARTS BUT MACHINE DOES NOT OPERATE AT ALL



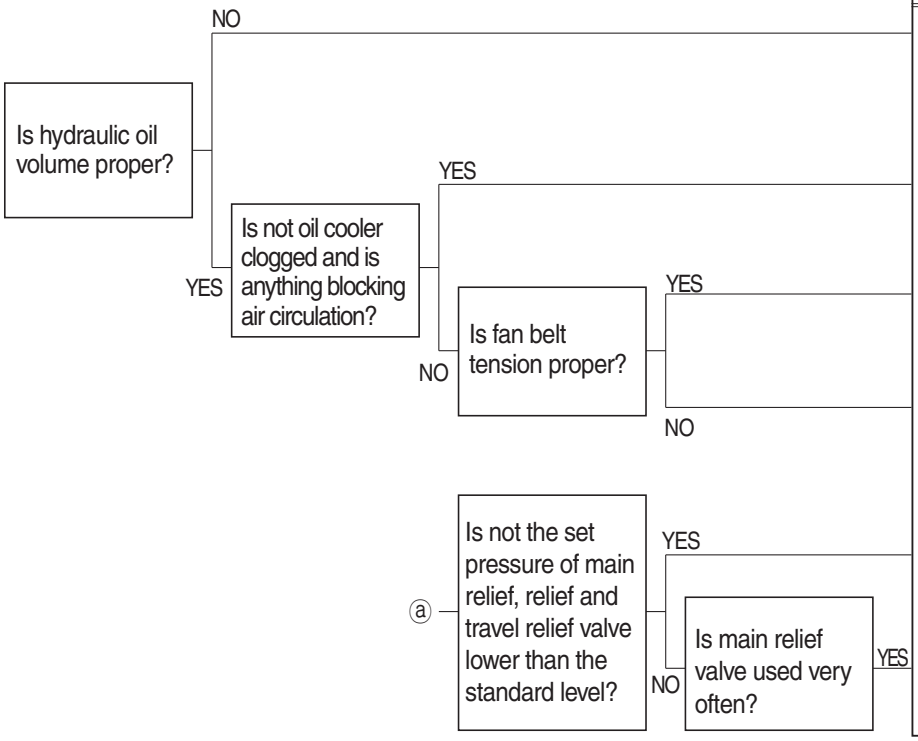
Cause	Remedy
Hydraulic pump is broken.	Disassemble and repair.
	See item 1). at page 5-5
ⓐ	
Pilot valve is faulty.	Disassemble and repair.
Pilot relief valve is faulty.	Repair or replace.
Gear pump is broken.	Disassemble and repair.
	Replenish specified oil to the standard level.
	Clean pilot piping interior or repair piping.

3. HYDRAULIC SYSTEM

1) HYDRAULIC OIL IS CLOUDY

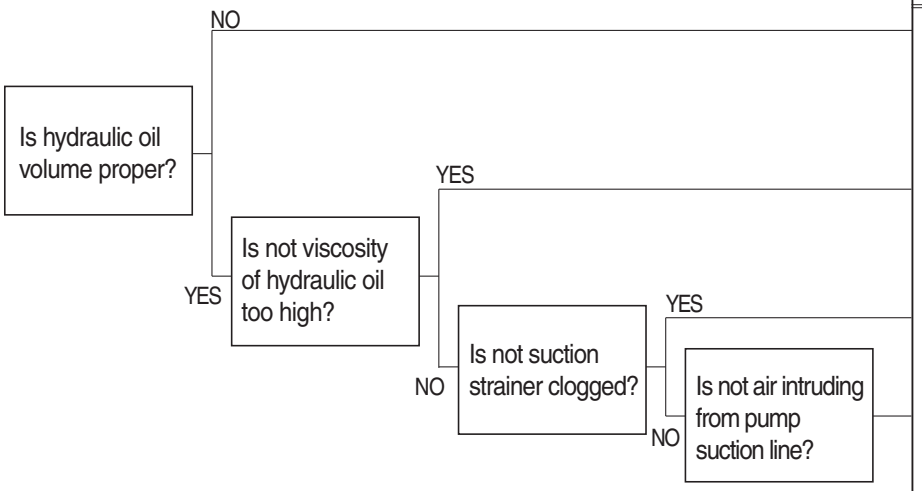
Cause	Remedy
Water is mixed.	Put hydraulic oil still, separate water and dispose it or replace hydraulic oil.
Air is intruded.	Check suction line and return line and eliminate the air intruding source.

2) HYDRAULIC OIL TEMPERATURE HAS RISEN ABNORMALLY



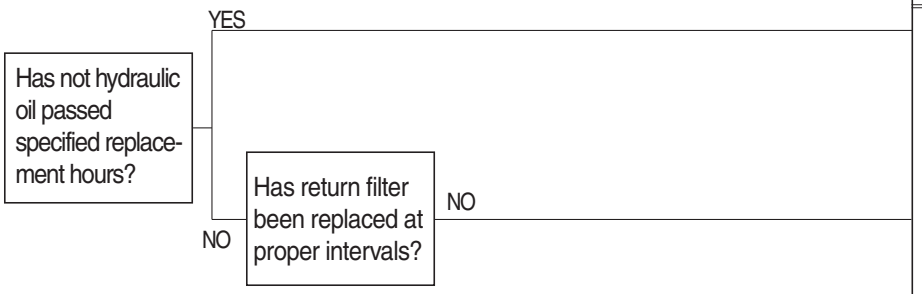
Cause	Remedy
ⓐ	Replenish specified oil to the standard level. Clean oil cooler. Secure air circulation route. Adjust belt tension or replace belt. Readjust set pressure. Reduce load.

3) CAVITATION OCCURS WITH PUMP



Cause	Remedy
	Replenish specified oil to the standard level. Replace oil with one of proper viscosity. Clean suction strainer. Check for air intrusion in suction line and retighten or replace parts.

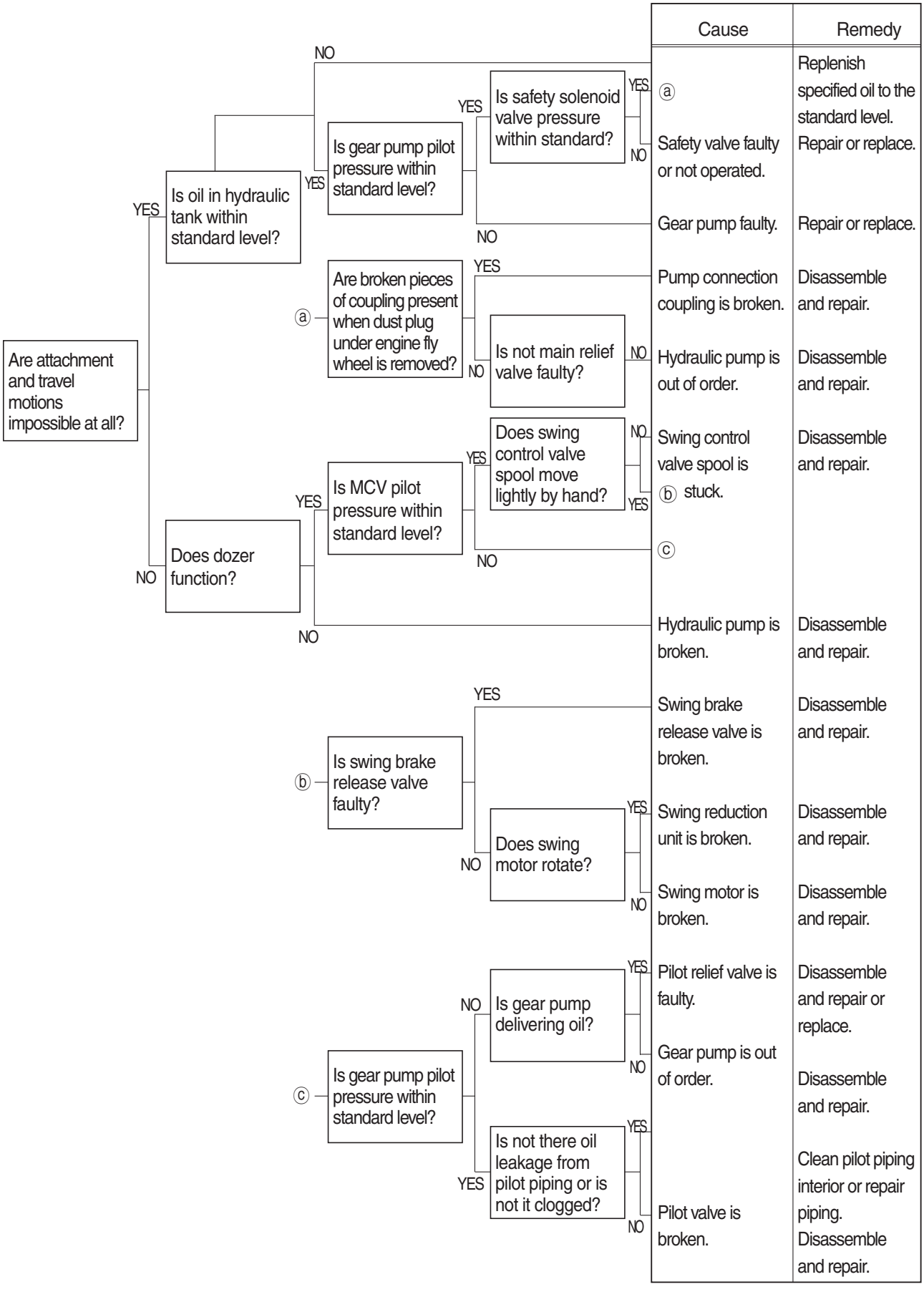
4) HYDRAULIC OIL IS CONTAMINATED



Cause	Remedy
	Replace hydraulic oil to be specified. Flush with hydraulic oil and replace return filter.

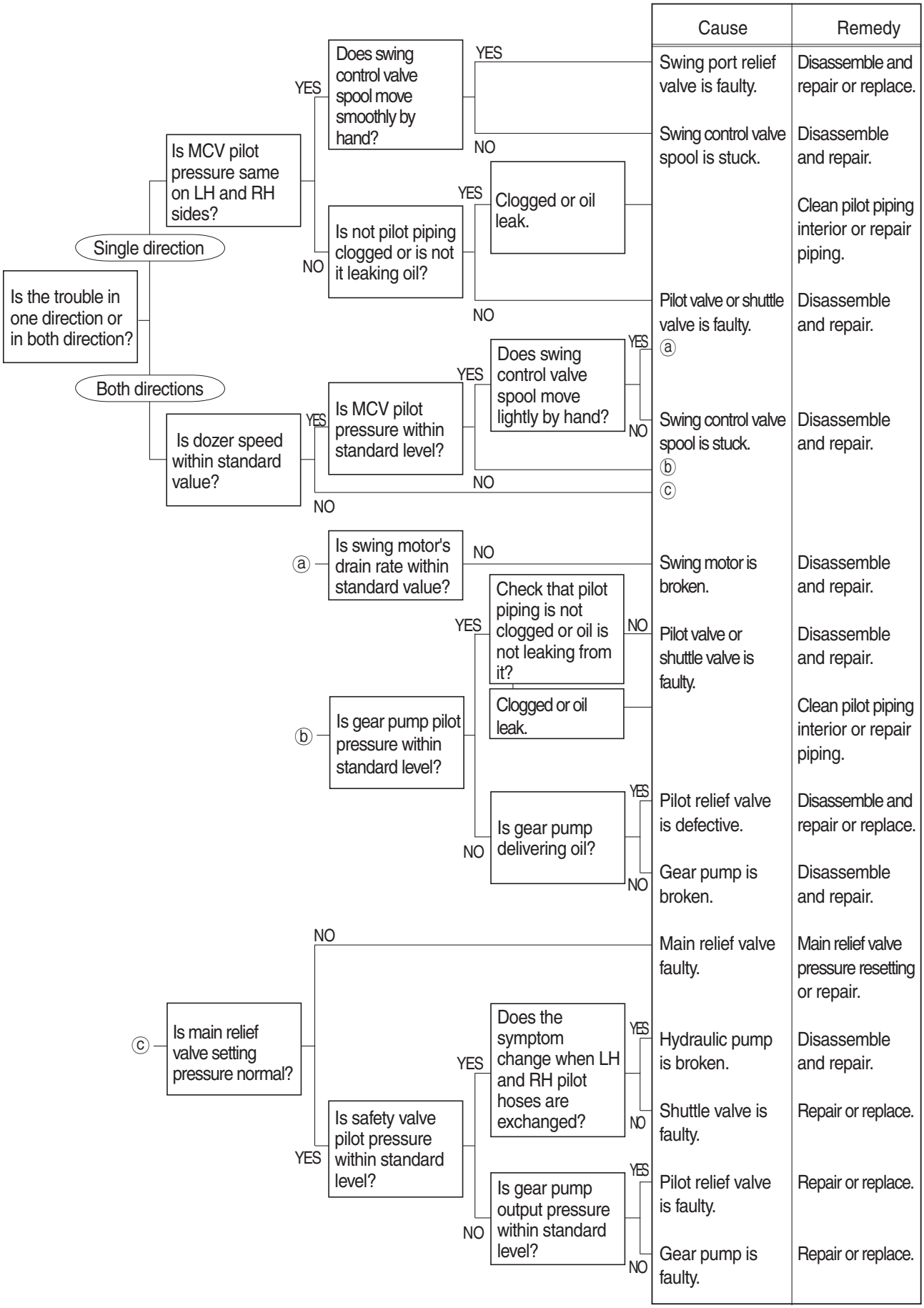
4. SWING SYSTEM

1) BOTH LH AND RH SWING ACTIONS ARE IMPOSSIBLE

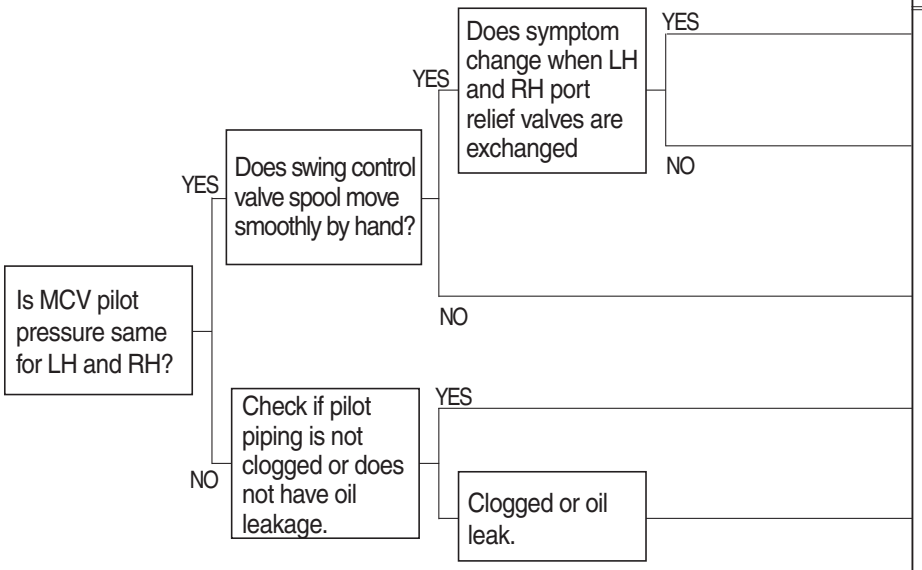


Cause	Remedy
ⓐ Safety valve faulty or not operated.	Replenish specified oil to the standard level. Repair or replace.
Gear pump faulty.	Repair or replace.
Pump connection coupling is broken.	Disassemble and repair.
Hydraulic pump is out of order.	Disassemble and repair.
Swing control valve spool is ⓑ stuck.	Disassemble and repair.
ⓒ Hydraulic pump is broken.	Disassemble and repair.
Swing brake release valve is broken.	Disassemble and repair.
Swing reduction unit is broken.	Disassemble and repair.
Swing motor is broken.	Disassemble and repair.
Pilot relief valve is faulty.	Disassemble and repair or replace.
Gear pump is out of order.	Disassemble and repair.
Pilot valve is broken.	Clean pilot piping interior or repair piping. Disassemble and repair.

2) SWING SPEED IS LOW

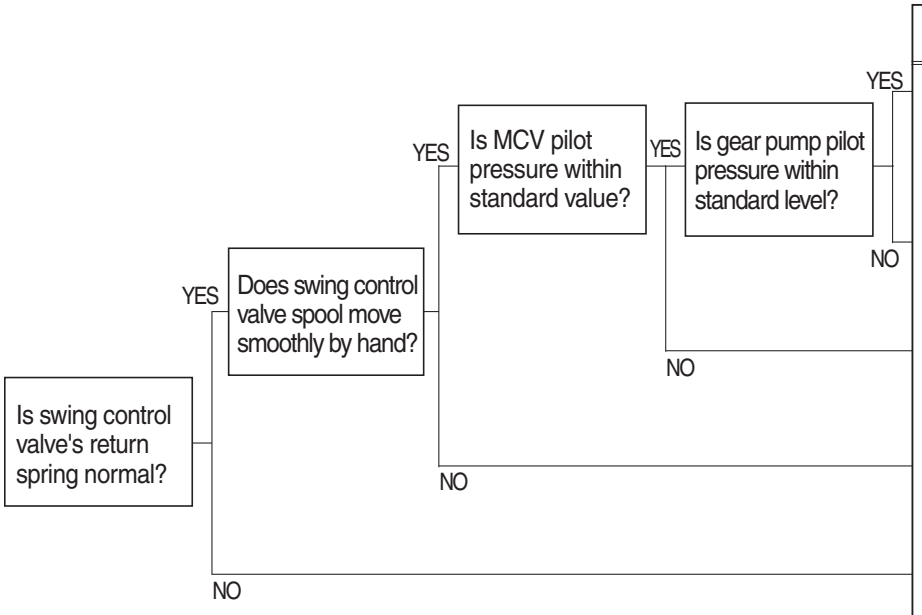


3) SWING MOTION IS IMPOSSIBLE IN ONE DIRECTION



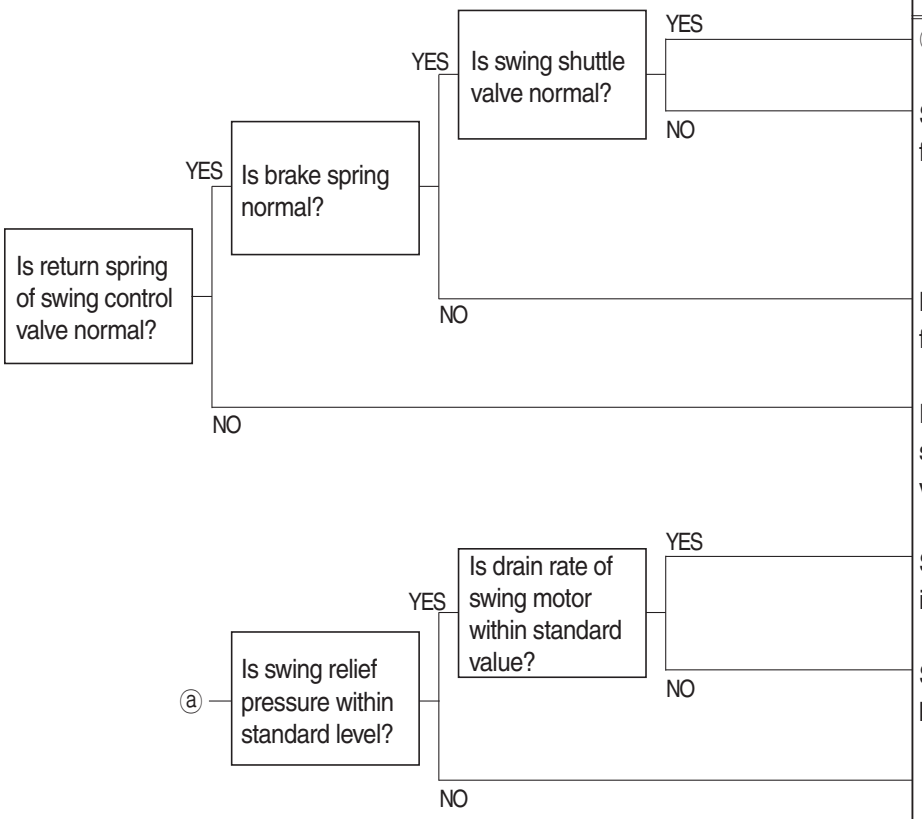
Cause	Remedy
Swing port relief valve is faulty.	Disassemble and repair.
Shuttle valve is faulty.	Disassemble and repair.
Swing control valve spool is stuck.	Disassemble and repair.
Pilot valve is faulty.	Disassemble and repair.
	Clean pilot piping interior or repair piping.

4) MACHINE SWINGS BUT DOES NOT STOP



Cause	Remedy
Pilot relief valve is faulty.	Disassemble and repair or replace.
Gear pump is broken.	Disassemble and repair.
Pilot valve is faulty.	Disassemble and repair.
Swing control valve spool is stuck.	Disassemble and repair.
Return spring is faulty.	Disassemble and replace.

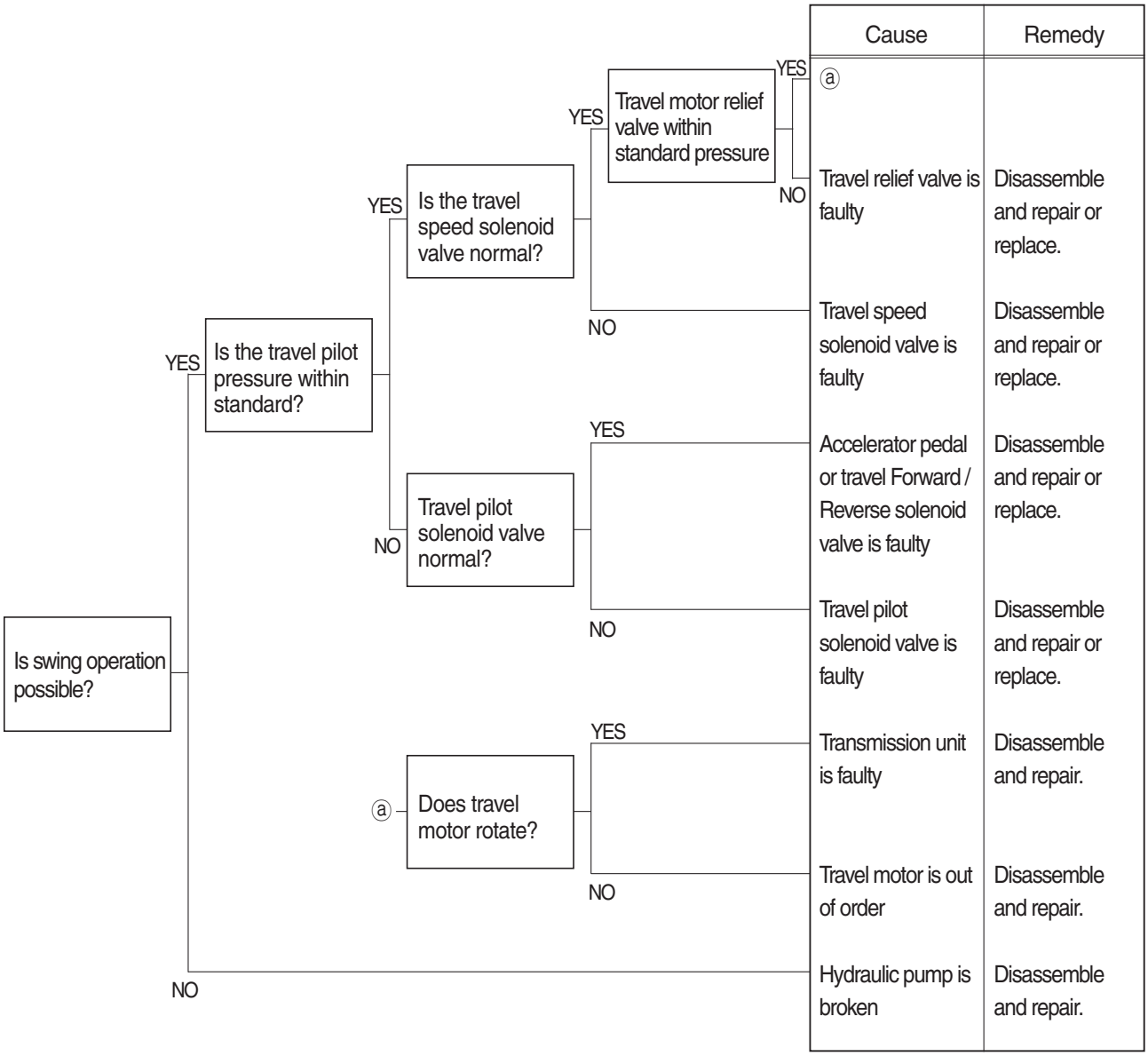
5) THE SWING UNIT DRIFTS WHEN THE MACHINE IS AT REST ON A SLOPE



Cause	Remedy
ⓐ	
Shuttle valve is faulty.	Disassemble and replace.
Brake spring is faulty.	Disassemble and replace.
Return spring of swing control valve is faulty.	Disassemble and replace.
Swing relief valve is faulty.	Disassemble and repair or replace.
Swing motor is broken.	Disassemble and repair.
	Adjust swing relief valve pressure or replace swing relief valve.

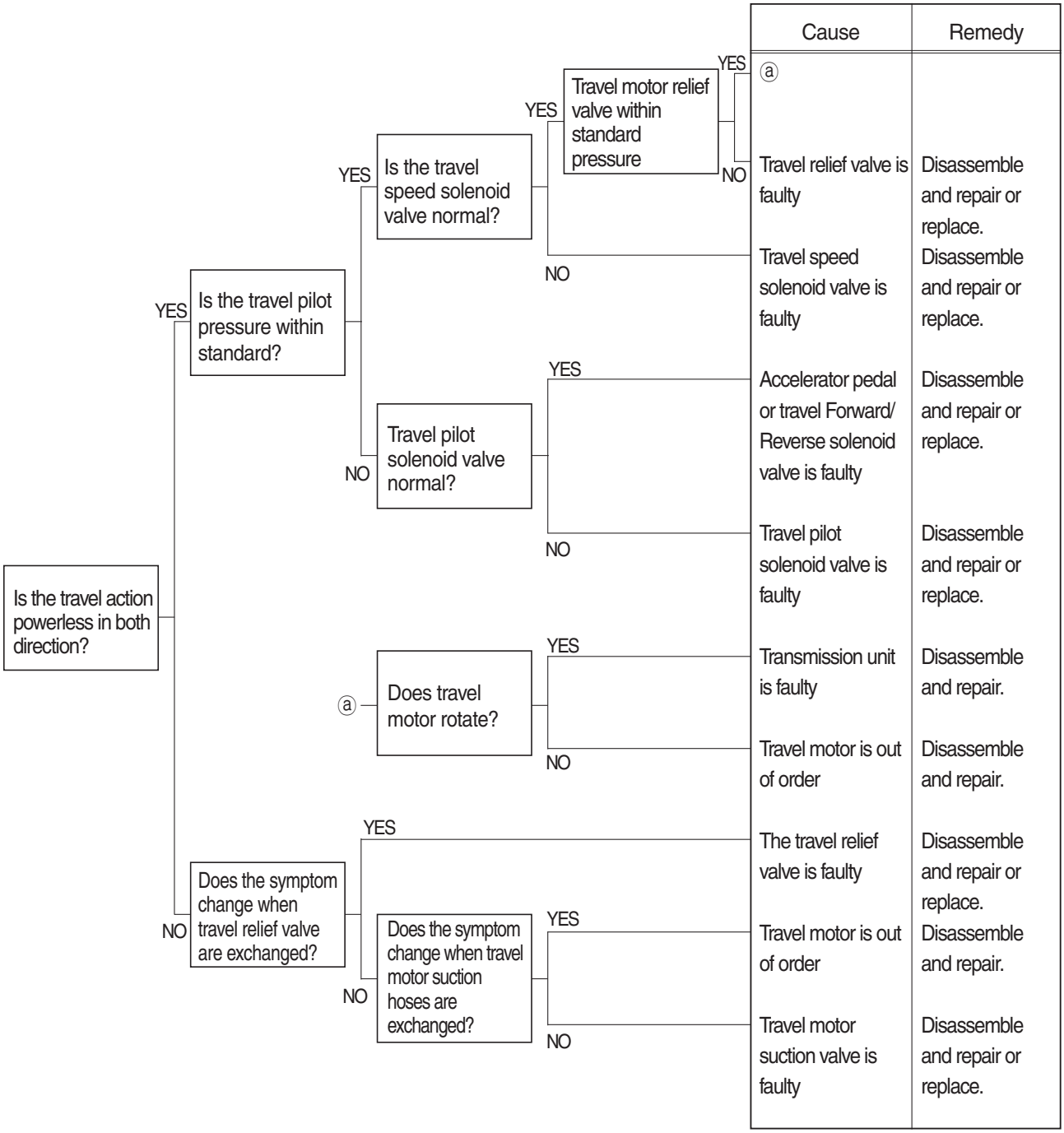
5. TRAVEL SYSTEM

1) TRAVEL DOES NOT FUNCTION



Cause	Remedy
ⓐ	
Travel relief valve is faulty	Disassemble and repair or replace.
Travel speed solenoid valve is faulty	Disassemble and repair or replace.
Accelerator pedal or travel Forward / Reverse solenoid valve is faulty	Disassemble and repair or replace.
Travel pilot solenoid valve is faulty	Disassemble and repair or replace.
Transmission unit is faulty	Disassemble and repair.
Travel motor is out of order	Disassemble and repair.
Hydraulic pump is broken	Disassemble and repair.

2) TRAVEL ACTION IS POWERLESS (travel only)



3) THE HYDRAULIC MOTOR DOSE NOT GET STARTED

The hydraulic motor does not get started

Cause	Remedy
The spool does work properly. (the spool keeps fully open)	Screw the fitting bolts one more time with correct tightening torque. If the spool turns out to be damaged, it should be repaired or the new one should be used
The anti-cavitation check valve does not work properly. (the check valve is kept open.)	Ditto

4) IT TAKES TIME TO ACCELERATE THE MOTOR

It takes time to accelerate the motor

Cause	Remedy
The spool does not work properly.	Screw the fitting bolts one more time with correct tightening torque. If the spool turns out to be damaged, it should be repaired, or the new one should be used.
The orifice for closing the counterbalance is clogged.	Remove the foreign matter by disassembling and cleaning.
Wrong setting of pressure of the relief valve.	Adjust at the correct value. If the relief valve turns out to be out of order, the new one should be used.

5) IT IS NOT POSSIBLE TO REDUCE THE MOTOR SMOOTHLY

It is not possible to reduce the motor smoothly

Cause	Remedy
The orifice for closing the counterbalance is clogged. The opening of the neutral position of the spool is clogged.	Remove the foreign matter by disassembling and cleaning.
Wrong setting of pressure of the relief valve.	Adjust at the correct value. If the relief valve turns out to be out of order, the new one should be used.

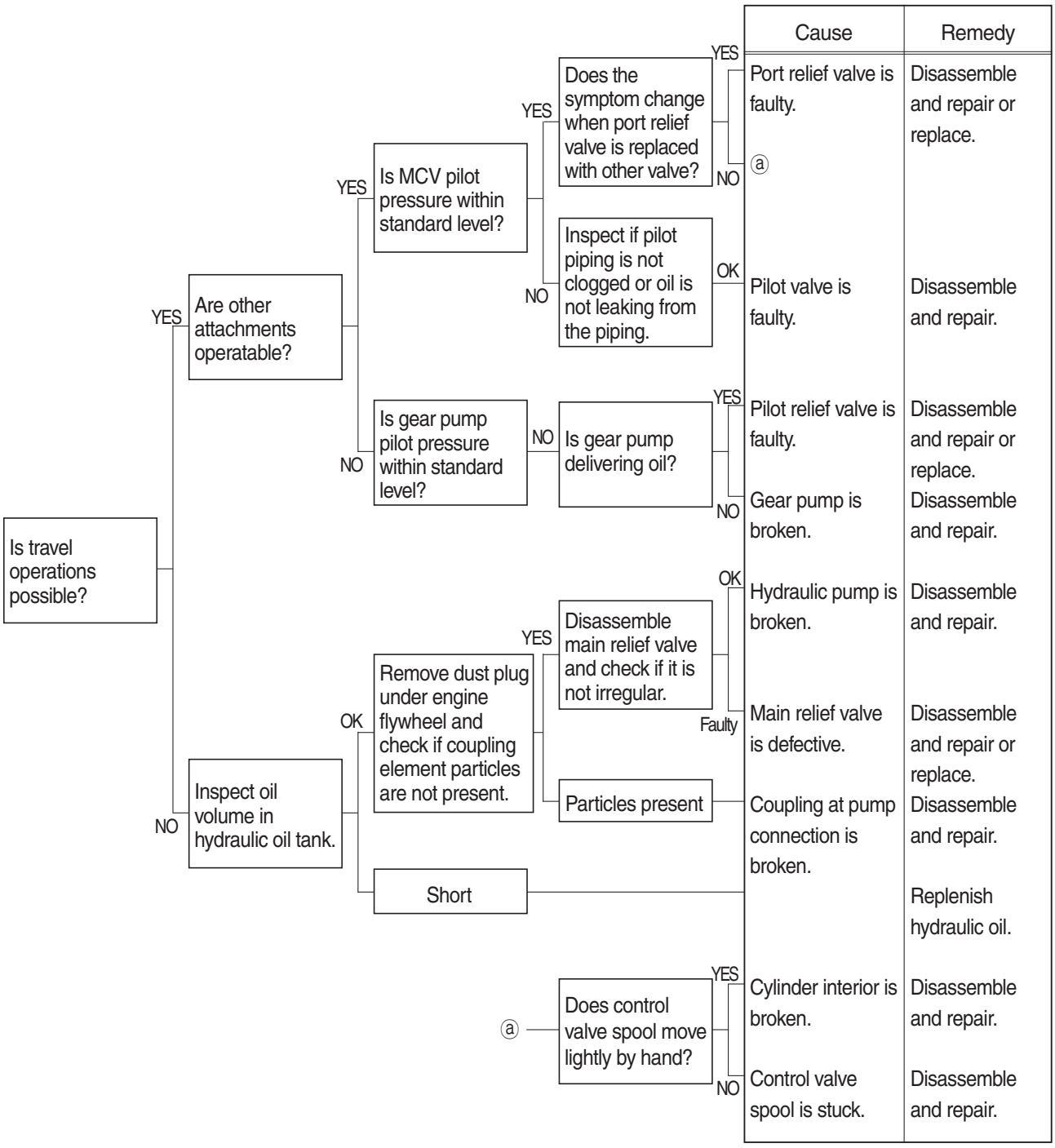
6) EXTRAORDINARY NOISE IS HEARD WHEN SUDDENLY REDUCING THE SPEED FROM THE HIGH-SPEED MODE

It takes time to accelerate the motor

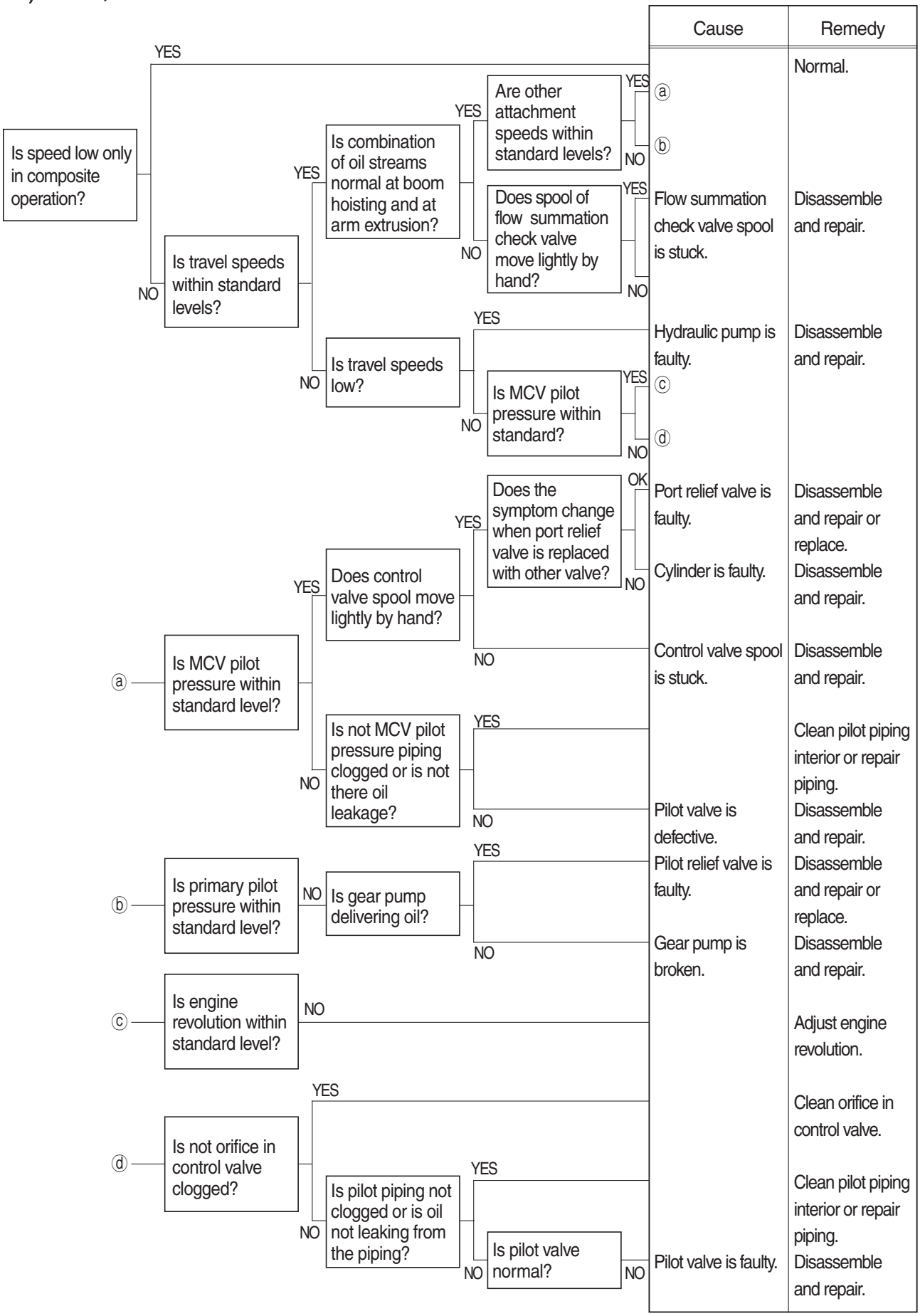
Cause	Remedy
The anti-cavitation valve does not not work properly.	Screw the fitting bolts one more time with correct tightening torque. If the valve turns out to be damaged, is should be repaired.

6. ATTACHMENT SYSTEM

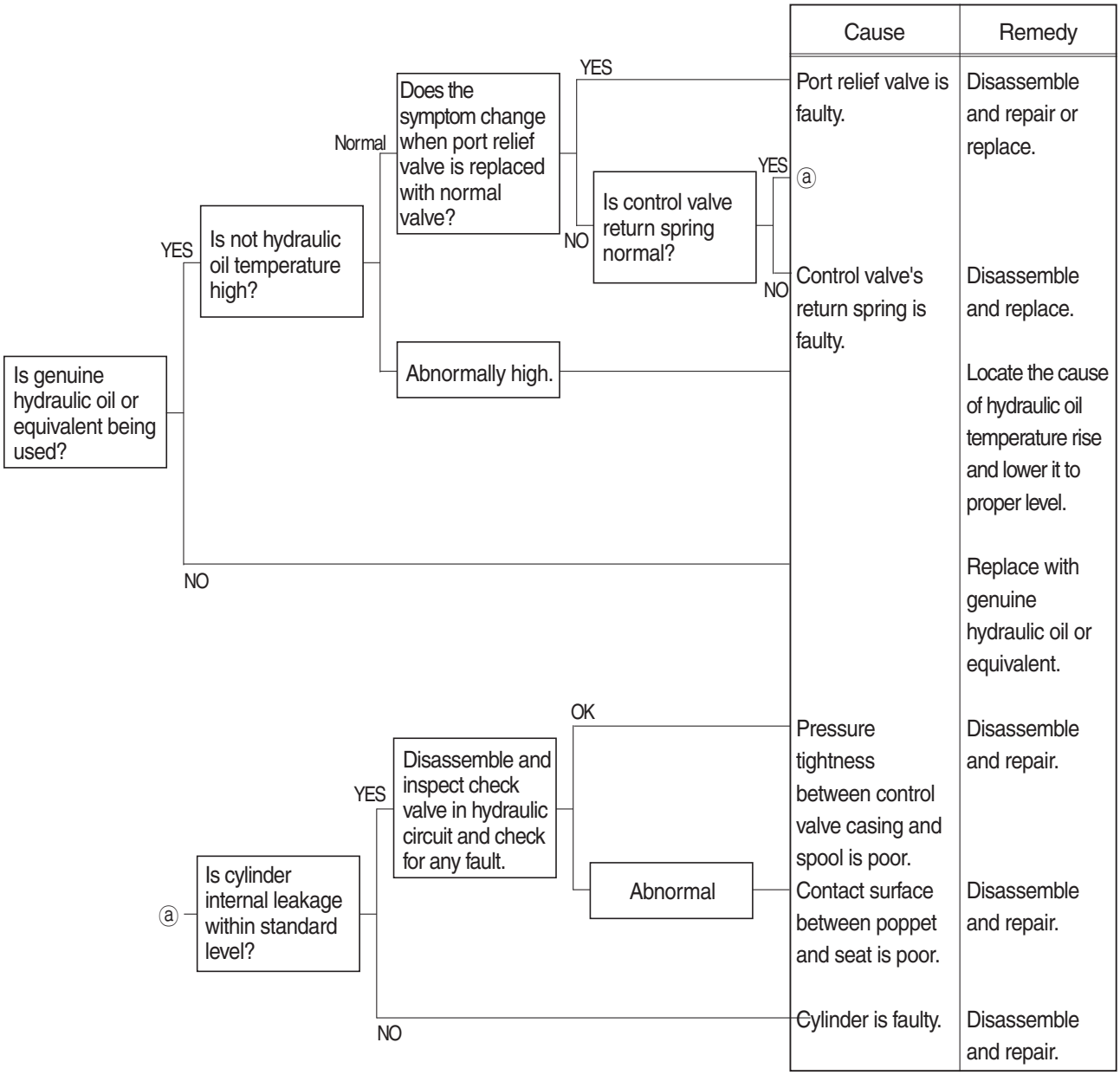
1) BOOM OR ARM ACTION IS IMPOSSIBLE AT ALL



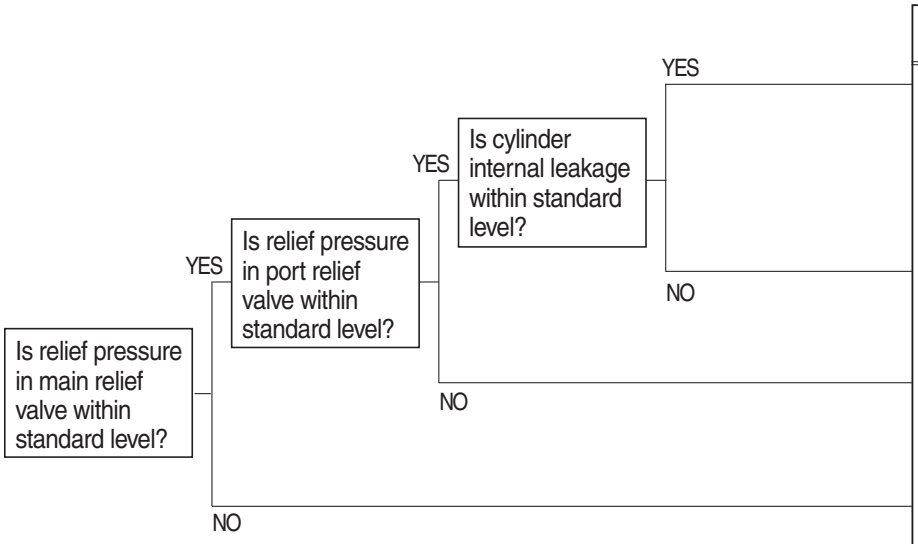
2) BOOM, ARM OR BUCKET SPEED IS LOW



3) BOOM, ARM OR BUCKET CYLINDER EXTENDS OR CONTRACTS ITSELF AND ATTACHMENT FALLS

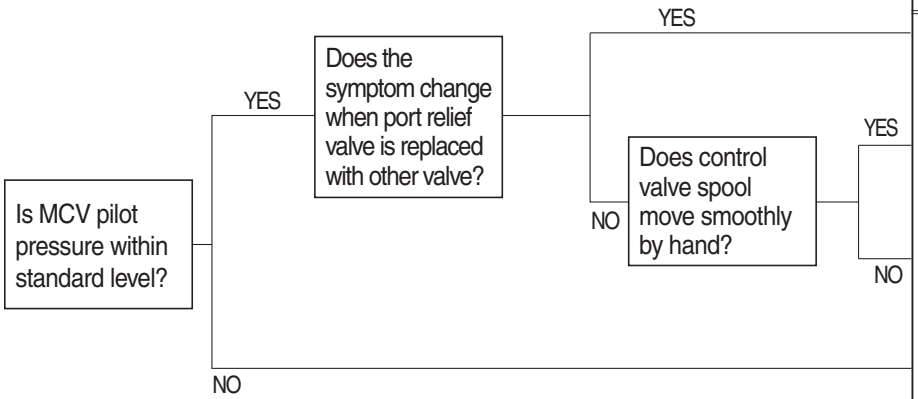


4) BOOM, ARM OR BUCKET POWER IS WEAK



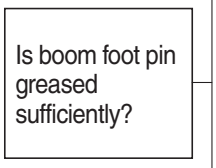
Cause	Remedy
	Check according to the procedure in Item "Speed is low".
Cylinder is faulty.	Disassemble and repair.
Port relief valve is faulty.	Adjust pressure, repair or replace.
Main relief valve is defective.	Adjust pressure, repair or replace.

5) ONLY BUCKET OPERATION IS TOTALLY IMPOSSIBLE



Cause	Remedy
Port relief valve is defective.	Disassemble and repair or replace.
Cylinder interior is broken.	Disassemble and repair.
Control valve spool is stuck.	Disassemble and repair.
Pilot valve is faulty.	Disassemble and repair.

6) BOOM MAKES A SQUARING NOISE WHEN BOOM IS OPERATED



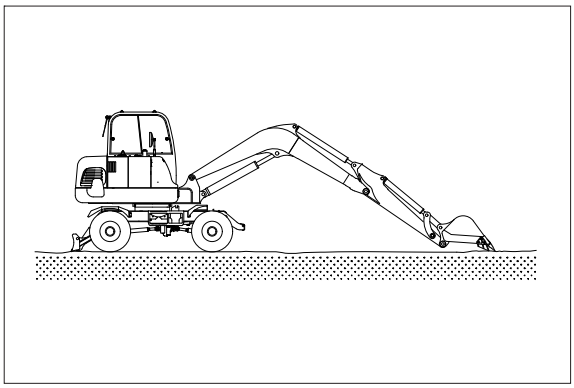
YES

NO

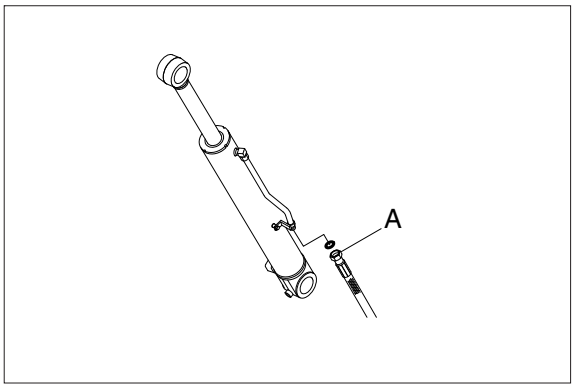
Cause	Remedy
	Frictional noise occurs between the sliding faces of boom cylinder's oil seal and boom proper. ※ Frictional noise will disappear if they are kept used.
Boom foot pin has run out of grease.	Supply grease to it. ※ If seizure is in an initial stage, supply sufficient grease. If seizure is in a grown state, correct it by paper lapping or with an oil stone.

※ HOW TO CHECK INTERNAL BOOM CYLINDER LEAKAGE

1. Lower the bucket teeth to the ground with bucket cylinder fully retracted and arm cylinder rod retracted almost in full.

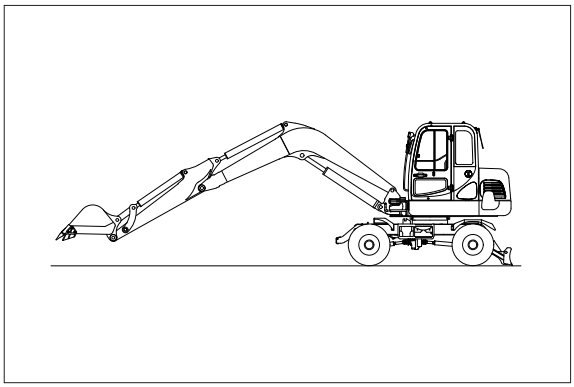


2. Disconnect hose (A) from rod side of boom cylinder and drain oil from cylinder and hose. (put cups on piping and hose ends)



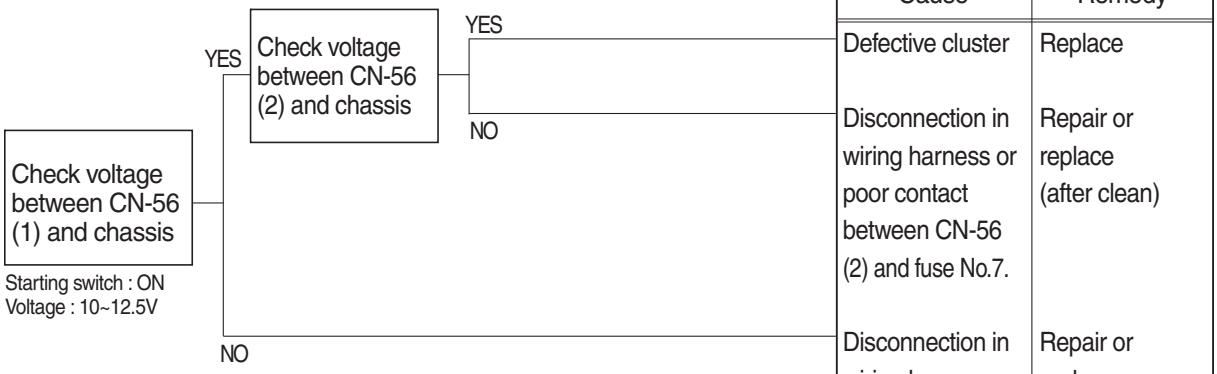
3. Raise bucket OFF the ground by retracting the arm cylinder rod.

   If oil leaks from piping side and boom cylinder rod is retracted there is an internal leak in the cylinder.
   If no oil leaks from piping side and boom cylinder rod is retracted, there is an internal leak in the control valve.



1. WHEN STARTING SWITCH IS TURNED ON, MONITOR PANEL DISPLAY DOES NOT APPEAR

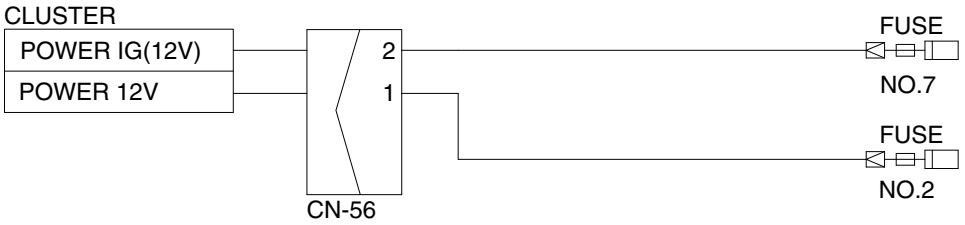
·Before disconnecting the connector, always turn the starting switch OFF.
·Before carrying out below procedure, check all the related connectors are properly inserted and short of fuse No.2 and No.7.
·After checking, insert the disconnected connectors again immediately unless otherwise specified.



Cause	Remedy
Defective cluster	Replace
Disconnection in wiring harness or poor contact between CN-56 (2) and fuse No.7.	Repair or replace (after clean)
Disconnection in wiring harness or poor contact between CN-56 (1) and fuse No.2	Repair or replace (after clean)

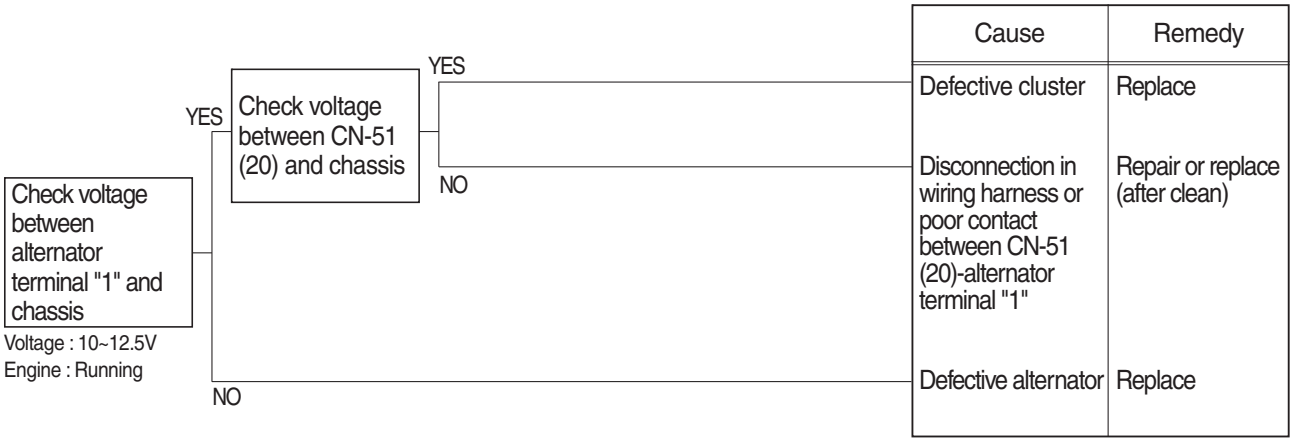
Check voltage

YES	10 ~ 12.5V
NO	0V



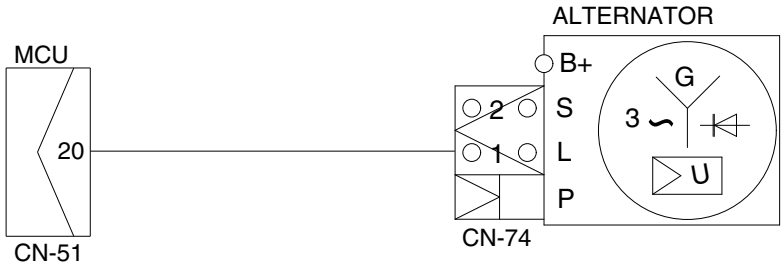
2. BATTERY CHARGING WARNING LAMP LIGHTS UP (starting switch : ON)

·Before disconnecting the connector, always turn the starting switch OFF.
·Before carrying out below procedure, check all the related connectors are properly inserted.
·After checking, insert the disconnected connectors again immediately unless otherwise specified.



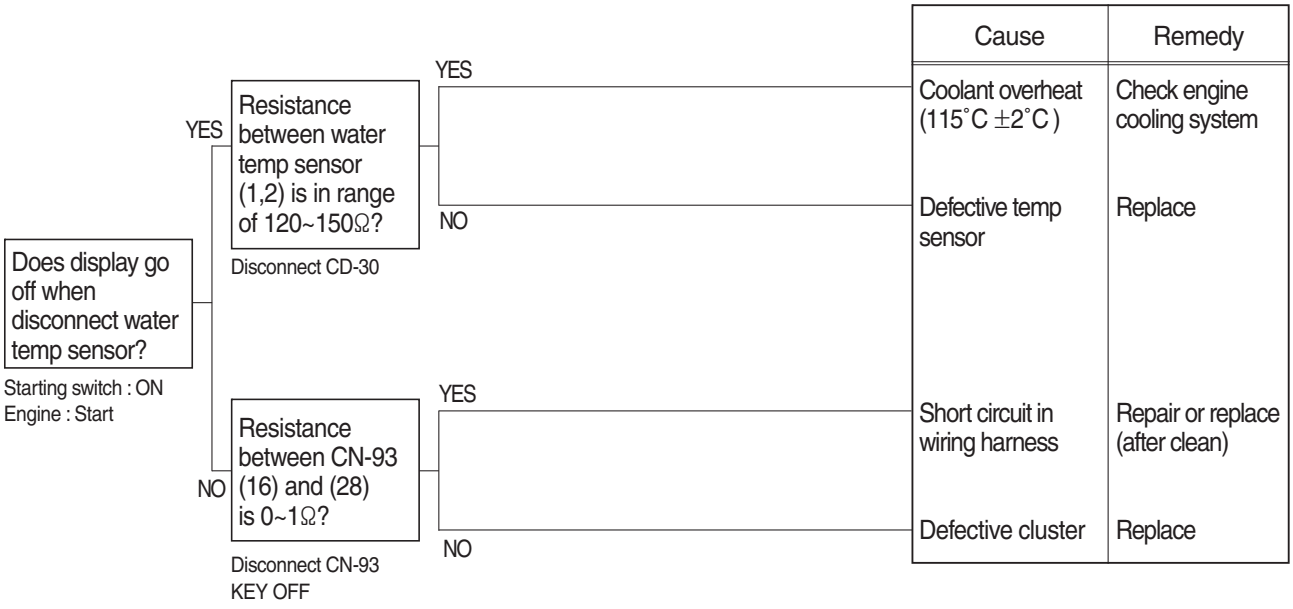
Check voltage

YES	10 ~ 12.5V
NO	0V



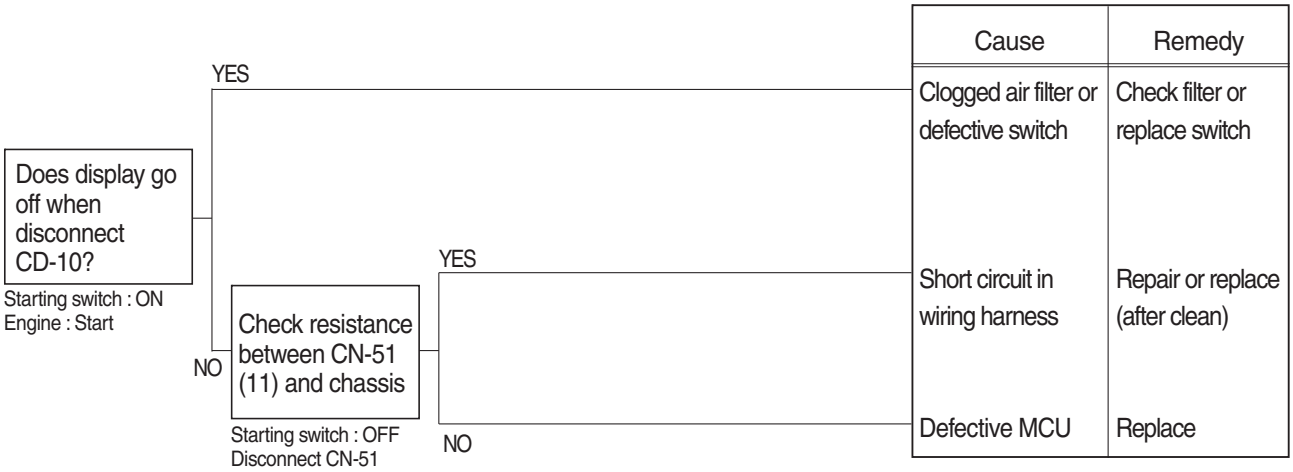
3. WHEN COOLANT OVERHEAT WARNING LAMP LIGHTS UP (engine is started)

·Before disconnecting the connector, always turn the starting switch OFF.
·Before carrying out below procedure, check all the related connectors are properly inserted.
·After checking, insert the disconnected connectors again immediately unless otherwise specified.



4. WHEN AIR CLEANER WARNING LAMP LIGHTS UP (engine is started)

·Before disconnecting the connector, always turn the starting switch OFF.
·Before carrying out below procedure, check all the related connectors are properly inserted.
·After checking, insert the disconnected connectors again immediately unless otherwise specified.

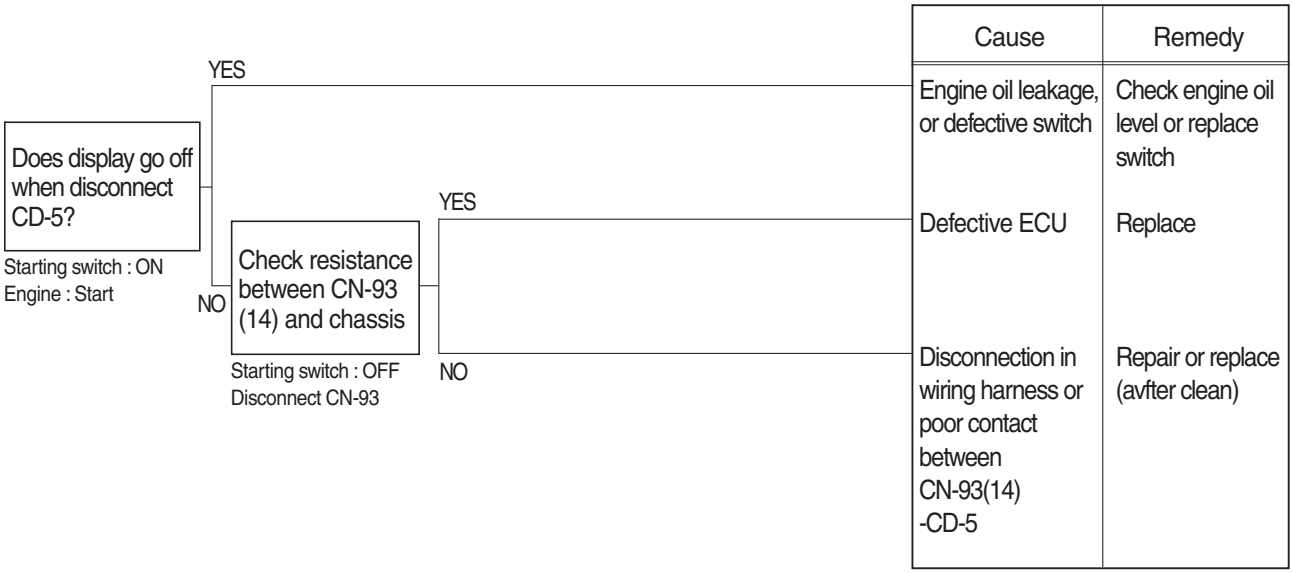


Check resistance

YES	MAX 1Ω
NO	MIN 1MΩ

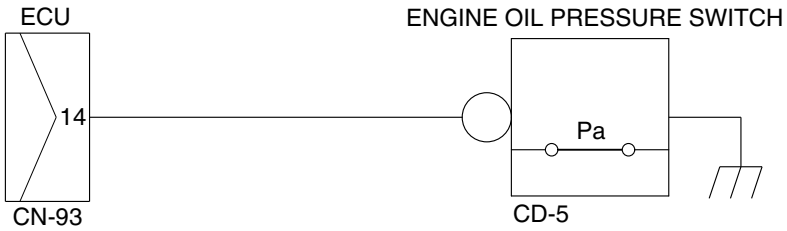
5. WHEN ENGINE OIL PRESSURE WARNING LAMP LIGHTS UP (engine is started)

·Before disconnecting the connector, always turn the starting switch OFF.
·Before carrying out below procedure, check all the related connectors are properly inserted.
·After checking, insert the disconnected connectors again immediately unless otherwise specified.



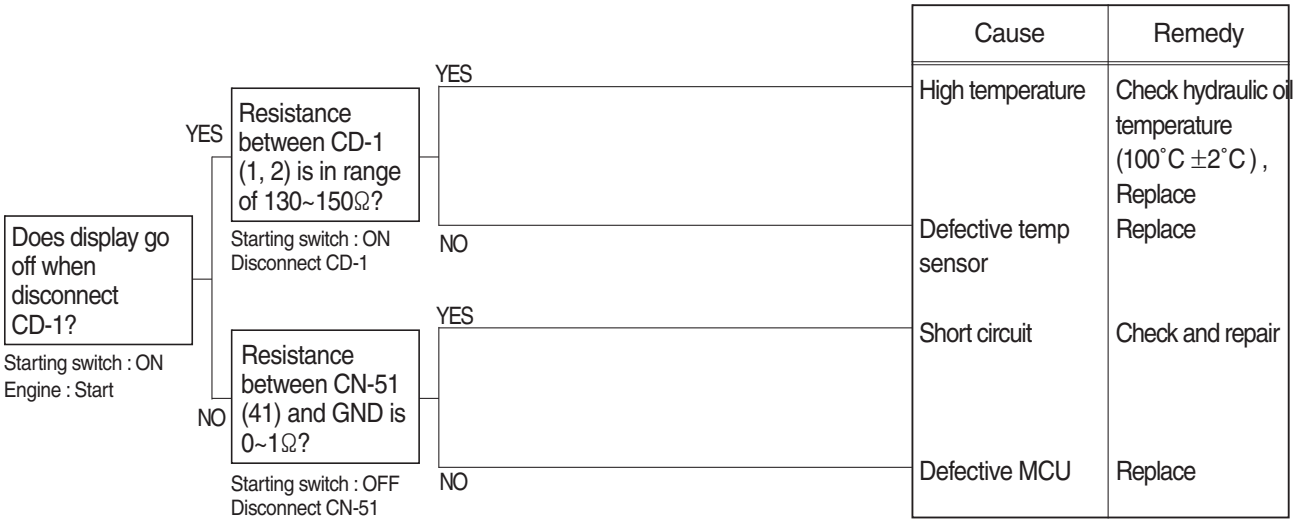
Check resistance

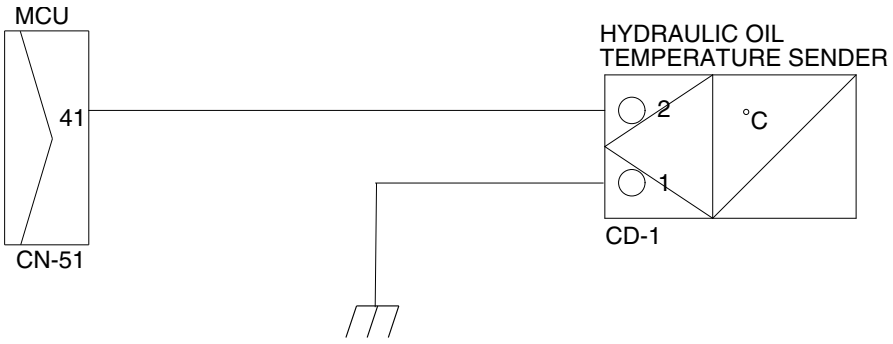
YES	MAX 1Ω
NO	MIN 1MΩ



6. WHEN HYDRAULIC OIL TEMPERATURE WARNING LAMP LIGHTS UP (engine is started)

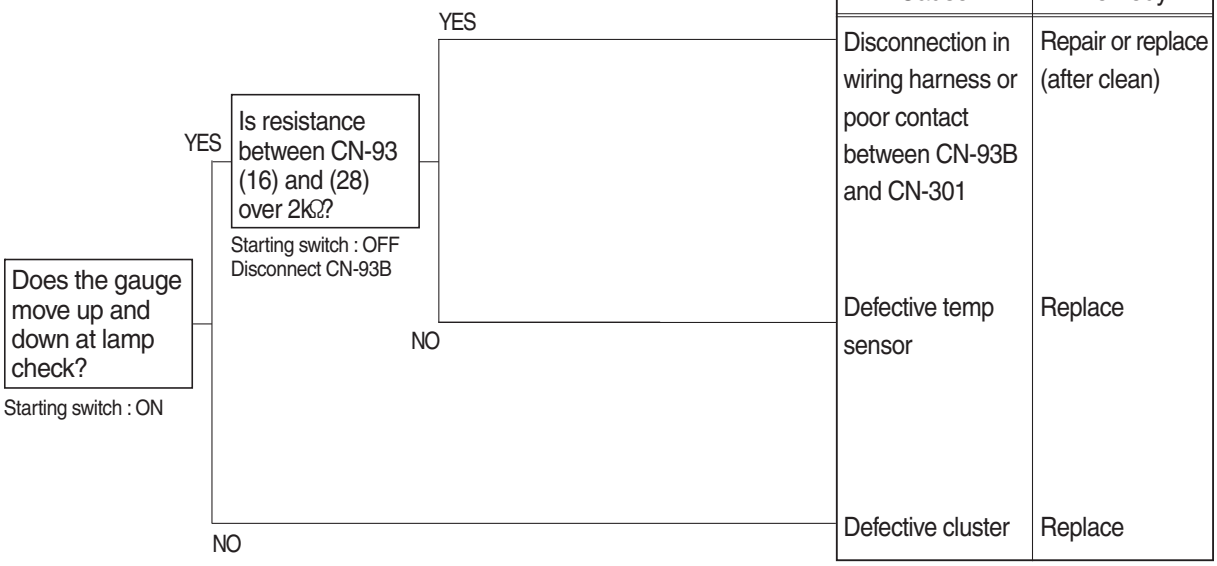
·Before disconnecting the connector, always turn the starting switch OFF.
·Before carrying out below procedure, check all the related connectors are properly inserted.
·After checking, insert the disconnected connectors again immediately unless otherwise specified.



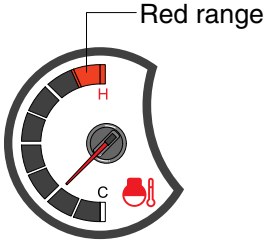


7. WHEN COOLANT TEMPERATURE GAUGE DOES NOT OPERATE

·Before disconnecting the connector, always turn the starting switch OFF.
·Before carrying out below procedure, check all the related connectors are properly inserted.
·After checking, insert the disconnected connectors again immediately unless otherwise specified.

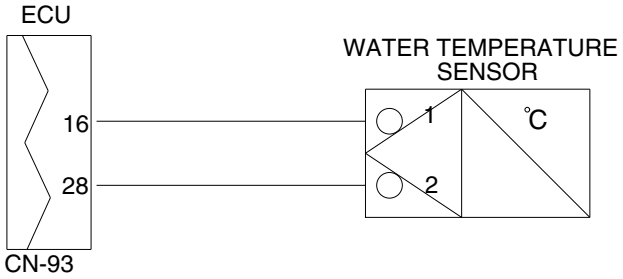


Cause	Remedy
Disconnection in wiring harness or poor contact between CN-93B and CN-301	Repair or replace (after clean)
Defective temp sensor	Replace
Defective cluster	Replace



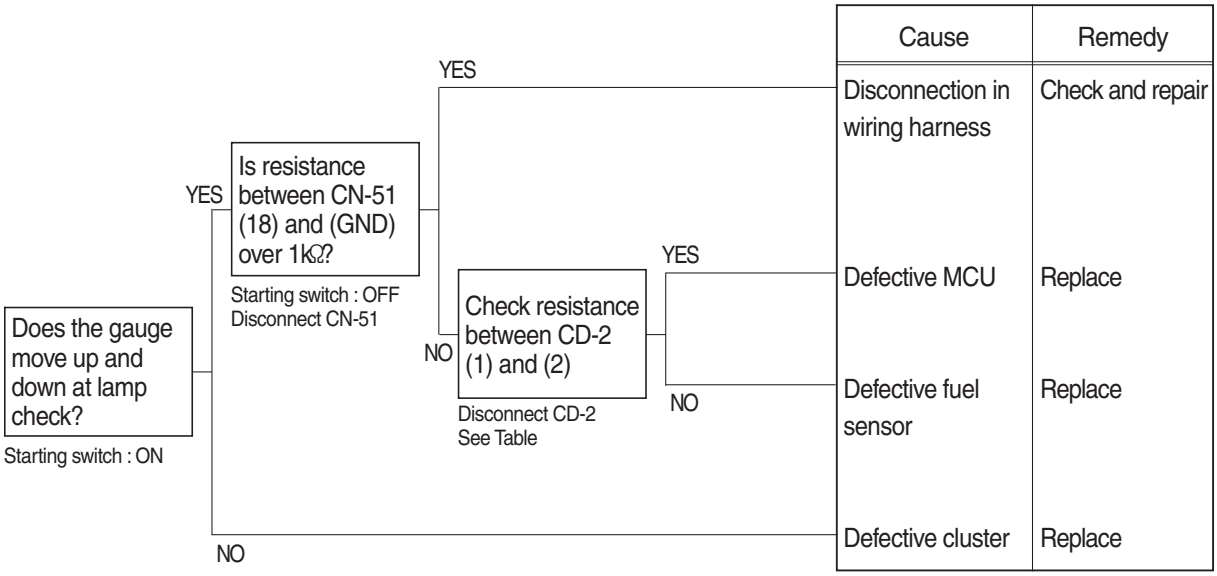
Check Table

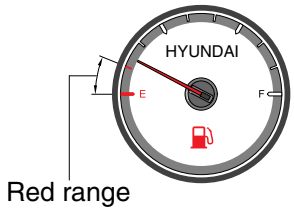
Item \ Temperature	40˚C	85~110˚C	115˚C (red range)
Unit Resistance(Ω)	1170~	270~130	~124
Tolerance(%)	±5	−8~0	±5



8. WHEN FUEL GAUGE DOES NOT OPERATE (check warning lamp ON/OFF)

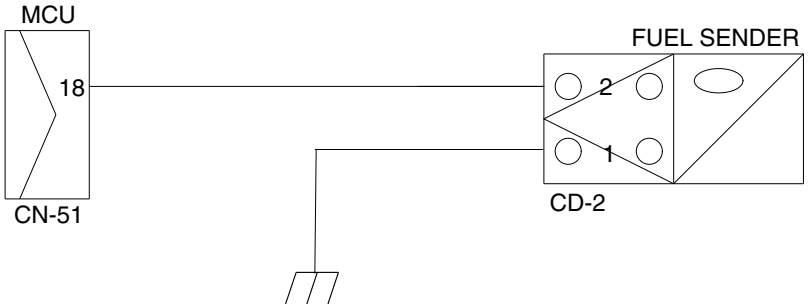
- Before disconnecting the connector, always turn the starting switch OFF.
- Before carrying out below procedure, check all the related connectors are properly inserted.
- After checking, insert the disconnected connectors again immediately unless otherwise specified.





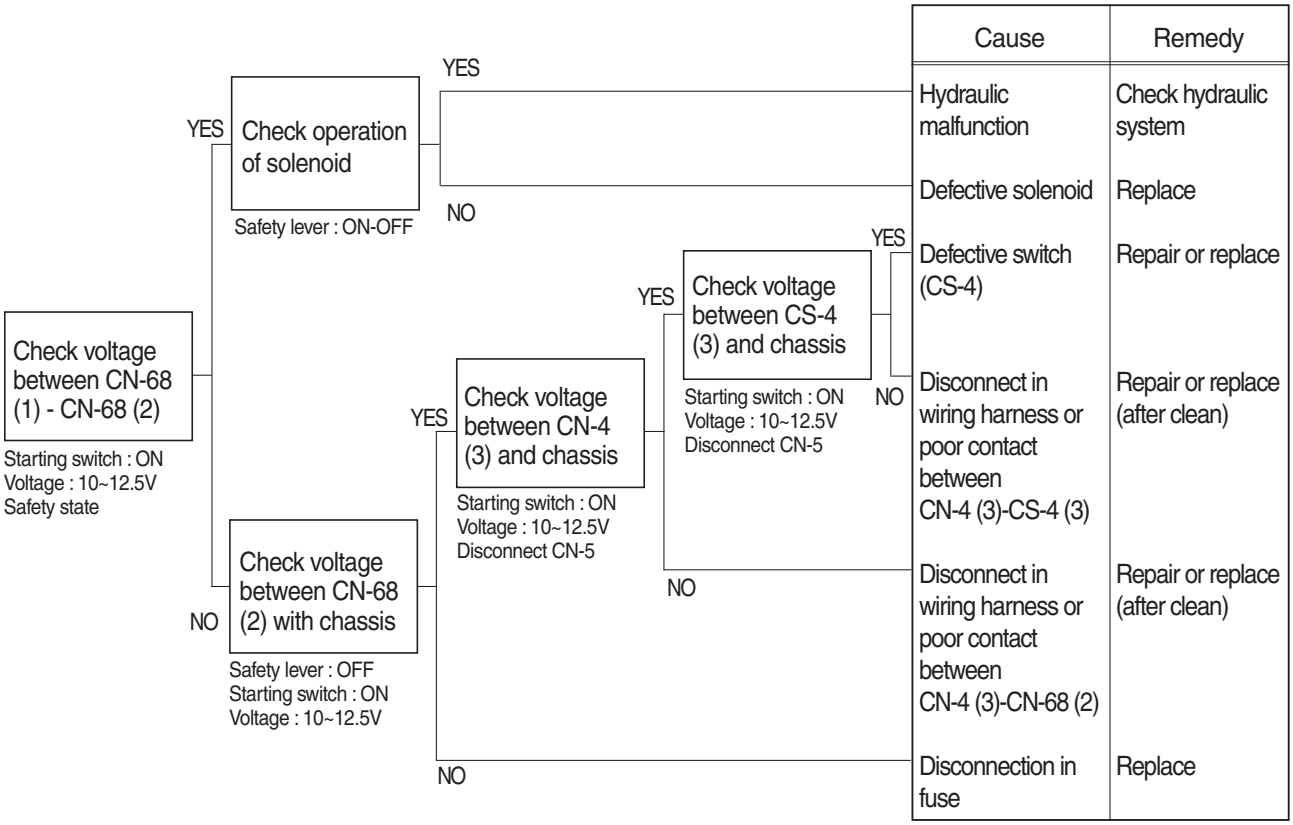
Check Table

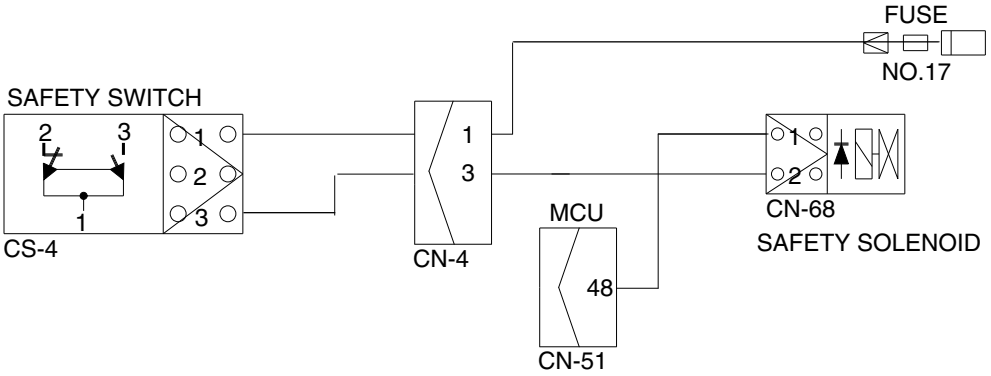
Item \ Level	Empty	1/2	Full
Unit Resistance (Ω)	700	300	~100
Tolerance (%)	±5	±8	±5



9. WHEN SAFETY SOLENOID DOES NOT OPERATE

·Before disconnecting the connector, always turn the starting switch OFF.
·Before carrying out below procedure, check all the related connectors are properly inserted and short of fuse No.17.
·After checking, insert the disconnected connectors again immediately unless otherwise specified.



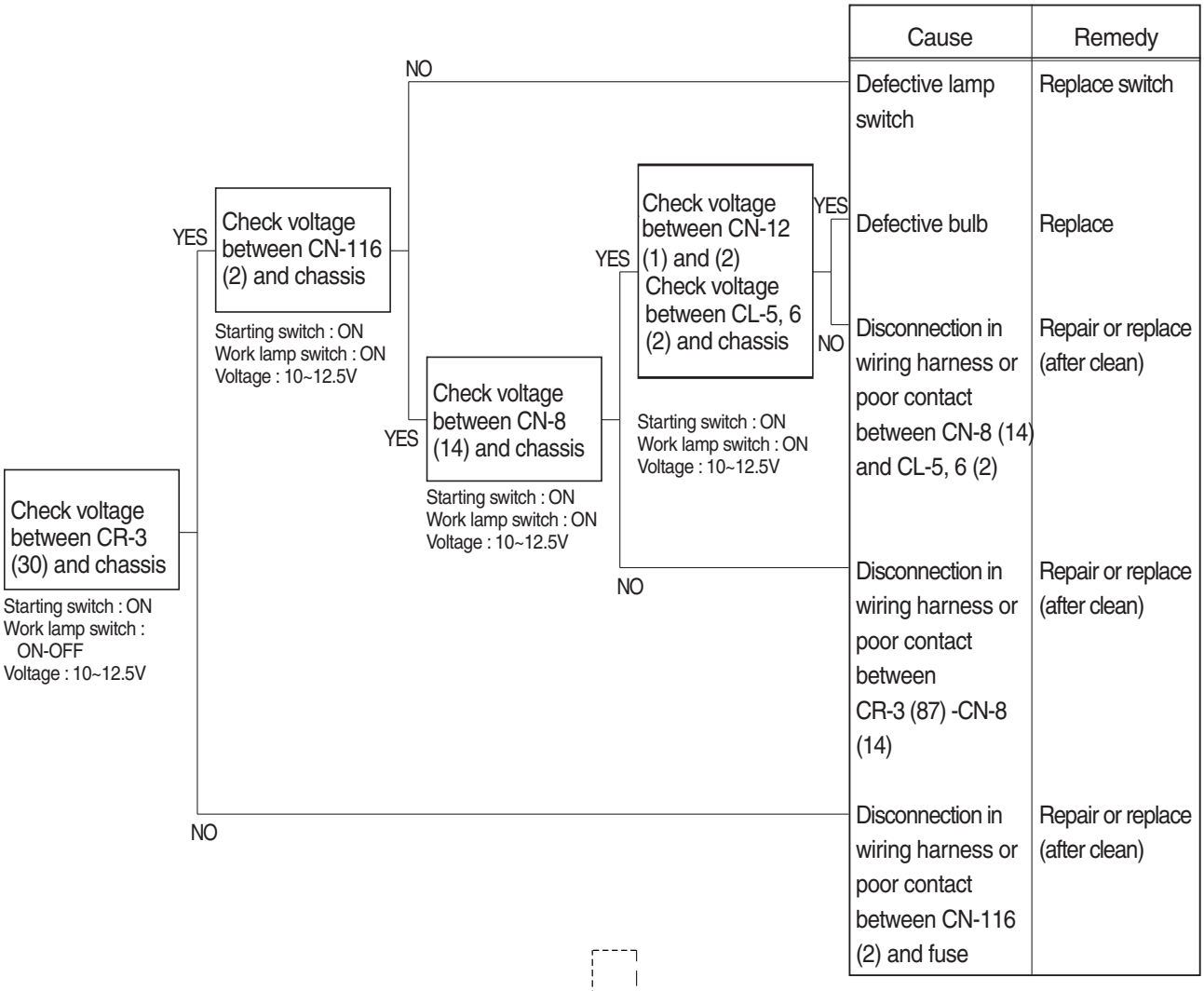


10. WHEN STARTING SWITCH IS TURNED ON, WORK LAMP DOES NOT LIGHTS UP

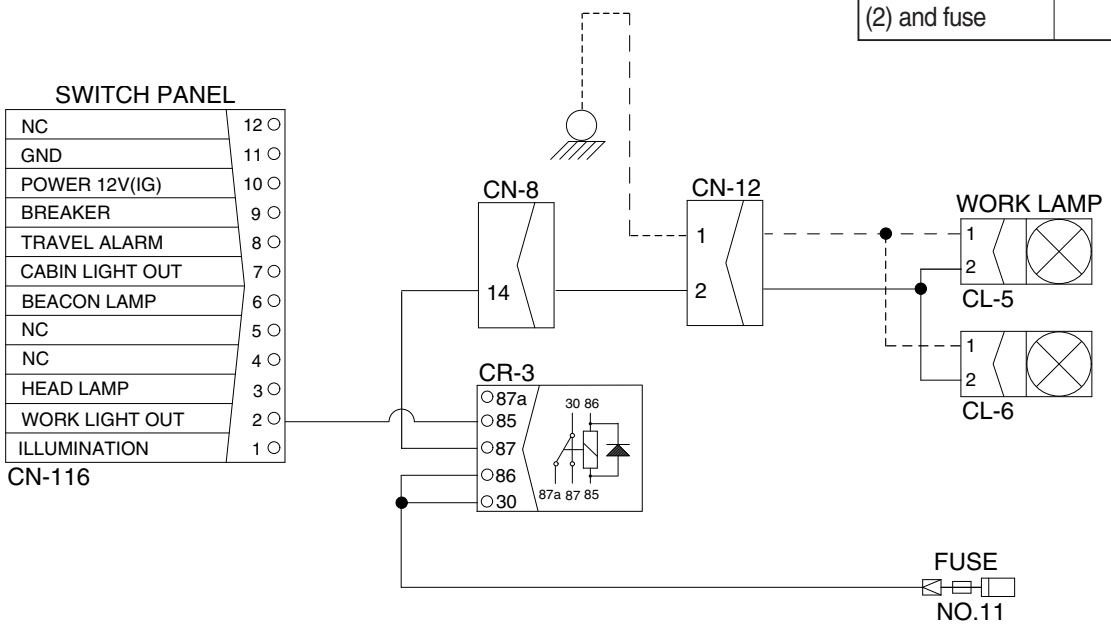
·Before disconnecting the connector, always turn the starting switch OFF.

·Before carrying out below procedure, check all the related connectors are properly inserted and short of fuse No.11.

·After checking, insert the disconnected connectors again immediately unless otherwise specified.



Cause	Remedy
Defective lamp switch	Replace switch
Defective bulb	Replace
Disconnection in wiring harness or poor contact between CN-8 (14) and CL-5, 6 (2)	Repair or replace (after clean)
Disconnection in wiring harness or poor contact between CR-3 (87) -CN-8 (14)	Repair or replace (after clean)
Disconnection in wiring harness or poor contact between CN-116 (2) and fuse	Repair or replace (after clean)



GROUP 4 AXLE

1. TROUBLE SHOOTING

Problem	Cause	Correction
Loss of brakes	1. Incorrect adjustment	Inspect disc thickness (see page 7-149) and if discs are usable readjust brakes to the specifications in the manual.
	2. Brake discs worn out	Inspect disc thickness (see page 7-149) and replace if needed
	3. Incorrect brake fluid	Replace all seals in axle and master cylinder that have made contact with the incorrect fluid and all brake hoses. If incorrect fluid leaked into axle oil, seals and O-rings in axle must be replaced.
	4. Loss of brake fluid	Inspect for and repair any leaks in outside circuit or master cylinder. If caused by incorrect brake fluid see correction No.3. If leak is to the outside replace the O-rings between the center and intermediate sections. If leak is to the inside replace above O-rings and brake piston O-rings.
	5. Overheated axle causing brake fluid to vaporize (brake return when axle cools).	See "Overhearing" problem.
Soft brake pedal	6. Air in brake fluid	Bleed brakes.
Ineffective safety brake	7. One or both overrides are engaged	Check override bolts and adjust if needed (see page 7-155).
	8. Incorrect adjustment	See correction No.1.
	9. Brake disc worn out	See correction No.2.
Overheating	10. Oil level wrong	Drain, flush and refill oil to proper level.
	11. Too small of a brake gap.	Readjust brakes to the specifications (see page 7-155)
	12. Park brake dragging.	Unlock the brake and adjust the correct gap.
	13. Incorrect brake fluid in system.	See correction No.3.
	14. No free-pedal at master cylinder.	Readjust brake pedal.
	15. Restriction in brake lines.	Inspect for and replace damage lines.
	16. Restriction in return line of brake servo system.	Inspect for and replace damaged return line. Inspect for and remove any filter, tee'd in line or any other source of back pressure from the return line.
	17. Incorrect oil	Drain, flush and refill to the proper level with oil recommended.

Problem	Cause	Correction
Diff-lock inoperative	18. If manual, loss or misadjusted linkage.	Inspect and correct linkage and readjust.
	19. If hydraulic, problems in the hydraulic or electrical circuits of the vehicle.	Refer to the Group 2 and 3 of this section.
	20. If hydraulic, problems in the hydraulic or electrical circuits of the vehicle.	Rebuilt cylinder as described on page 7-192.
	21. If with self locking differential, weared discs.	Replace discs as described on page 7-189.
Oil coming out of breather	22. Hydraulic leak in brake system.	See corrections No.2 & 3.
	23. Hydraulic leak in diff-lock activating cylinder.	See corrections No.20.
No spin indexing noise when driven straight.	24. Unequal tire pressure from one side to the other.	Inflate tires to the recommended pressure or until the rolling radius is equal.
	25. Different style, size or brand of tires from one side to the other.	Change tires to make the rolling radius equal. Vary the tire pressure within the specifications until the rolling radius is equal.
Noise during coast and under power the same	26. Wheel bearings	Replace and adjust as described on page 7-157.
Noise under power greater than during coast.	27. Low oil level	Refill oil to proper level
	28. Incorrect oil	See correction No.17.
	29. Ring and pinion worn	Inspect through rear cover. Replace and adjust as described on page 7-173.
	30. Worn ring and pinion bearings	Replace and adjust as described on page 7-173.
	31. Worn planetary gears or bearings	Replace as described on page 7-157.
Noise during coast greater than under power	32. Loose pinion nut	Inspect ring, pinion and pinion bearings. If undamaged, retighten nut as described on page 7-173.
	33. Only one pinion bearing damages.	See correction No.30.
Noise during turn (without no spin)	34. Worn spider and / or side gears	Replace as described on page 7-185.

Problem	Cause	Correction
A "Stick slip" noise when going from forward to reverse.	35. Worn or damaged U-joint on drive shaft	Inspect and replace the u-joint.
	36. Loose wheel	Inspection for wheel and wheel stud damage. Replace if needs and retorque nuts.
	37. Worn or damaged U-joint at steering knuckle	Inspect and replace as described on page 7-166.
	38. Spider pins loose in carrier.	Inspect through rear cover. Replace as described on page 7-185.
	39. Damaged or missing spider and / or side gear washers	See correction No.34.

SECTION 6 MAINTENANCE STANDARD

SECTION 6 MAINTENANCE STANDARD

GROUP 1 OPERATIONAL PERFORMANCE TEST

1. PURPOSE

Performance tests are used to check:

1) OPERATIONAL PERFORMANCE OF A NEW MACHINE

Whenever a new machine is delivered in parts and reassembled at a customer's site, it must be tested to confirm that the operational performance of the machine meets Hyundai spec.

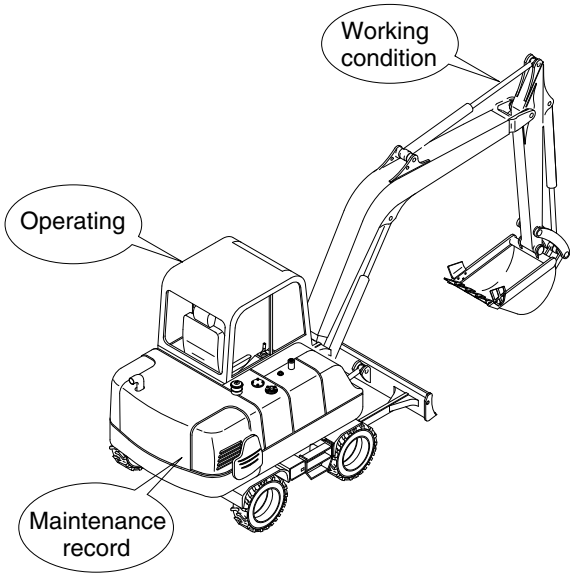
2) OPERATIONAL PERFORMANCE OF A WORKING MACHINE

With the passage of time, the machine's operational performance deteriorates, so that the machine needs to be serviced periodically to restore it to its original performance level.

Before servicing the machine, conduct performance tests to check the extent of deterioration, and to decide what kind of service needs to be done (by referring to the "Service Limits" in this manual).

3) OPERATIONAL PERFORMANCE OF A REPAIRED MACHINE

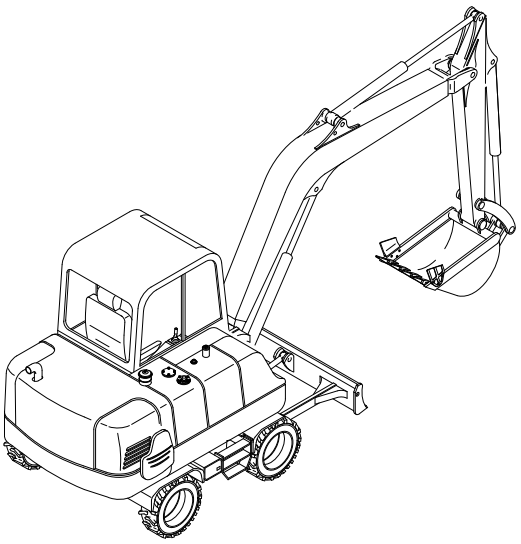
After the machine is repaired or serviced, it must be tested to confirm that its operational performance was restored by the repair and/or service work done.



2. TERMINOLOGY

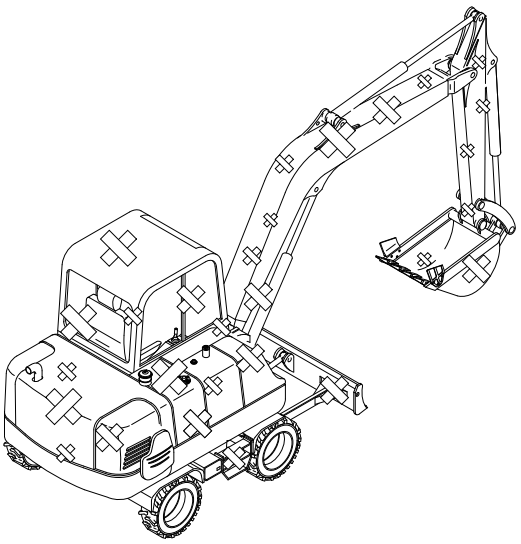
1) STANDARD

Specifications applied to the brand-new machine, components and parts.



2) SERVICE LIMIT

The lowest acceptable performance level. When the performance level of the machine falls below this level, the machine must be removed from work and repaired. Necessary parts and components must be replaced.



3. OPERATION FOR PERFORMANCE TESTS

1) Observe the following rules in order to carry out performance tests accurately and safely.

(1) The machine

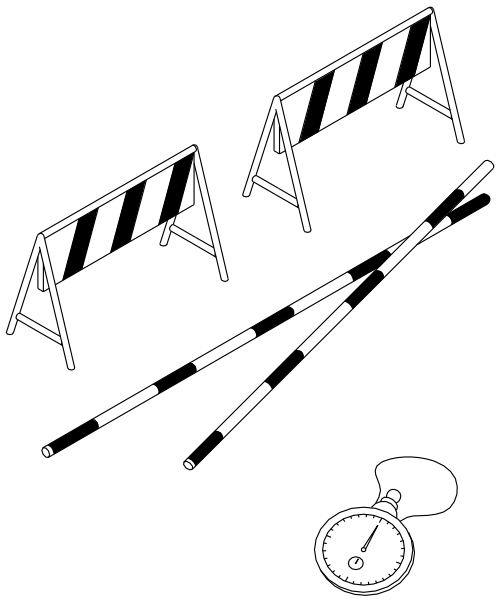
Repair any defects and damage found, such as oil or water leaks, loose bolts, cracks and so on, before starting to test.

(2) Test area

① Select a hard, flat surface.

② Secure enough space to allow the machine to run straight more than 20m, and to make a full swing with the front attachment extended.

③ If required, rope off the test area and provide signboards to keep unauthorized personnel away.



(3) Precautions

① Before starting to test, agree upon the signals to be employed for communication among coworkers. Once the test is started, be sure to communicate with each other using these signals, and to follow them without fail.

② Operate the machine carefully and always give first priority to safety.

③ While testing, always take care to avoid accidents due to landslides or contact with high voltage power lines. Always confirm that there is sufficient space for full swings.

④ Avoid polluting the machine and the ground with leaking oil. Use oil pans to catch escaping oil. Pay special attention to this when removing hydraulic pipings.

(4) Make precise measurements

① Accurately calibrate test instruments in advance to obtain correct data.

② Carry out tests under the exact test conditions prescribed for each test item.

③ Repeat the same test and confirm that the test data obtained can be procured repeatedly. Use mean values of measurements if necessary.

2) ENGINE SPEED

(1) Measure the engine speed at each power mode

※ The engine speed at each power mode must meet standard RPM; if not, all other operational performance data will be unreliable. It is essential to perform this test first.

(2) Preparation

① Warm up the machine, until the engine coolant temperature reaches 50˚C or more, and the hydraulic oil is 50±5˚C.

② Set the accel dial at 10 (Max) position.

③ Measure the engine RPM.

(3) Measurement

① Start the engine. The engine will run at start idle speed. Measure engine speed with a engine rpm display.

② Measure and record the engine speed at each mode (P, S).

③ Select the P-mode.

④ Lightly operate the bucket control lever a few times, then return the control lever to neutral; The engine will automatically enter the auto-idle speed after 4 seconds.

⑤ Measure and record the auto deceleration speed.

CLUSTER

(4) Evaluation

The measured speeds should meet the following specifications.

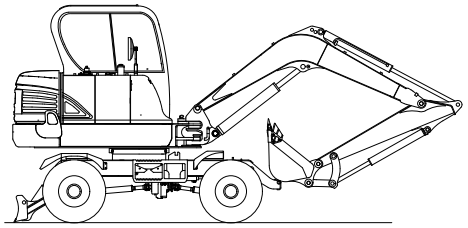
Unit : rpm

Model	Engine speed	Standard	Remark
R60WVS RRO	Start idle	1000±50	
	P mode	2000±50	
	S mode	1900±50	
	Auto decel	1100±50	

Condition : Set the accel dial at 10 (Max) position.

3) TRAVEL SPEED

(1) Measure the time required for the excavator to travel a 50m at high speed and a 20m at low speed test run.

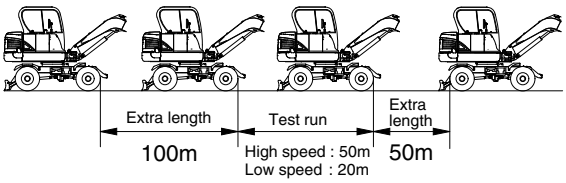


(2) Preparation

① Adjust the pressure of both tires to be equal.
② Prepare a flat and solid test track 50m in length, with extra length of 150m for machine acceleration.
③ Set the traveling position as figure.
④ Keep the hydraulic oil temperature at 50±5˚C.

(3) Measurement

① Measure both the low and high speed of the machine.
② Before starting either the low or high speed tests, adjust the RH multifunction switch to the speed to be tested.
③ Start traveling the machine in the extra length with the two speed switch at high or low speed.
④ Measure the time required to travel 50m at high speed or 20m at low speed.
⑤ After measuring the forward travel speed, turn the upperstructure 180。 and measure the reverse travel speed.
⑥ Repeat steps ④ and ⑤ three times in each direction and calculate the average values.



(4) Evaluation

The average measured time should meet the following specifications.

Unit : Seconds

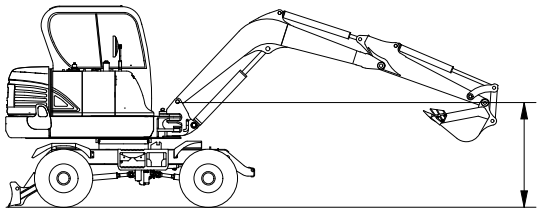
Model	Travel speed	Standard	Maximum allowable	Remarks
R60WVS RRO	Low speed	6.3±0.5	7.9	Seconds/20m
	High speed	6.0±0.5	7.5	Seconds/50m

4) SWING SPEED

(1) Measure the time required to swing three complete turns.

(2) Preparation

① Check the lubrication of the swing gear and swing bearing.
② Place the machine on flat, solid ground with ample space for swinging. Do not conduct this test on slopes.
③ Lower the dozer blade at ground.
④ With the arm rolled out and bucket rolled in, hold the bucket so that the height of the bucket pin is the same as the boom foot pin. The bucket must be empty.
⑤ Keep the hydraulic oil temperature at 50±5˚C.



(3) Measurement

① Operate swing control lever fully.
② Swing 1 turn and measure time taken to swing next 2 revolutions.
③ Repeat steps ① and ② three time and calculate the average values.

(4) Evaluation

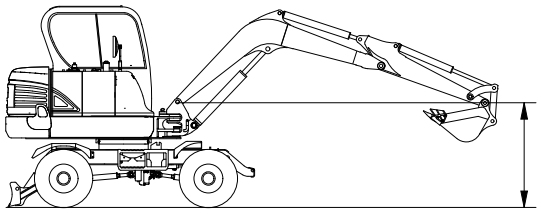
The time required for 2 swings should meet the following specifications.

Unit : Seconds / 2 revolutions

Model	Standard	Maximum allowable	Remark
R60WVS RRO	15.4 ±1.0	19.3	-

5) SWING FUNCTION DRIFT CHECK

(1) Measure the swing drift on the bearing outer circumference when stopping after a 360˚ full speed swing.

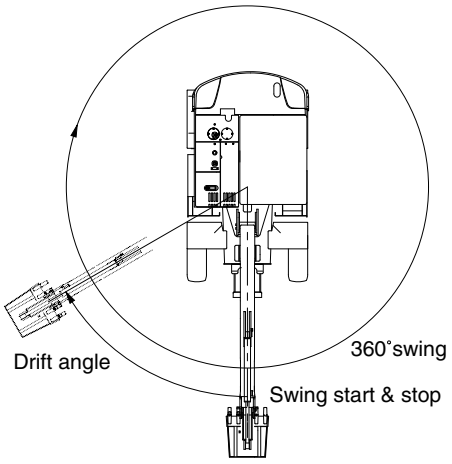


(2) Preparation

① Check the lubrication of the swing gear and swing bearing.
② Place the machine on flat, solid ground with ample space for swinging. Do not conduct this test on slopes.
③ Lower the dozer blade at ground.
④ With the arm rolled out and bucket rolled in, hold the bucket so that the height of the bucket pin is the same as the boom foot pin. The bucket must be empty.
⑤ Make two chalk marks: one on the swing
⑥ bearing and one directly below it on the track frame.
Swing the upperstructure 360˚.
⑦ Keep the hydraulic oil temperature at 50±5˚C.

(3) Measurement

① Operate the swing control lever fully and return it to the neutral position when the mark on the upperstructure aligns with that on track frame after swinging 360˚.
② Measure the distance between the two marks.
③ Align the marks again, swing 360˚, then test the opposite direction.
④ Repeat steps ② and ③ three times each and calculate the average values.



(4) Evaluation

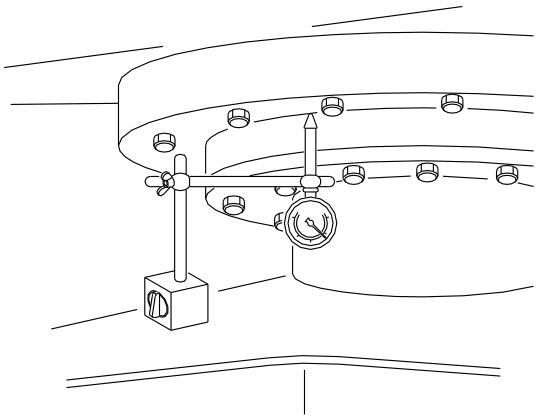
The measured drift angle should be within the following specifications.

Unit : Degree

Model	Standard	Maximum allowable	Remark
R60WVS RRO	45 below	60	-

6) SWING BEARING PLAY

(1) Measure the swing bearing play using a dial gauge to check the wear of bearing races and balls.



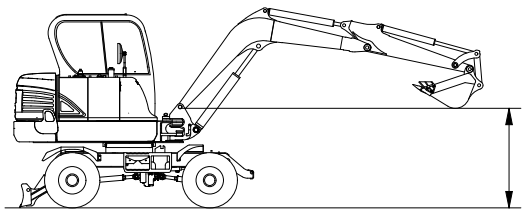
(2) Preparation

① Check swing bearing mounting cap screws for loosening.
② Check the lubrication of the swing bearing. Confirm that bearing rotation is smooth and without noise.
③ Install a dial gauge on the track frame as shown, using a magnetic base.
④ Position the upperstructure so that the boom aligns with the tracks facing towards the front axle.
⑤ Position the dial gauge so that its needle point comes into contact with the bottom face of the bearing outer race.
⑥ Bucket should be empty.

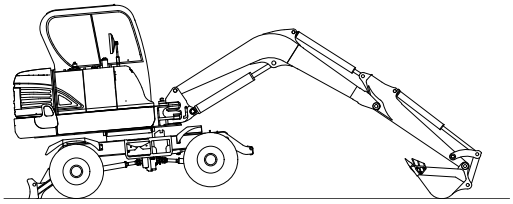
(3) Measurement

① With the arm rolled out and bucket rolled in, hold the bottom face of the bucket to the same height of the boom foot pin.
Record the dial gauge reading (h1).
② Lower the bucket to the ground and use it to raise the front axle 50 ㎝.
Record the dial gauge reading (h2).
③ Calculate bearing play (H) from this data (h1 and h2) as follows.
H=h2-h1

Measurement : h1



Measurement : h2



(4) Evaluation

The measured drift should be within the following specifications.

Unit : ㎜

Model	Standard	Maximum allowable	Remark
R60WVS RRO	0.5 ~ 1.2	2.4	

7) HYDRAULIC CYLINDER CYCLE TIME

(1) Measure the cycle time of the boom, standard arm, and standard bucket cylinders.

(2) Preparation

① To measure the cycle time of the boom cylinder.
With the arm rolled out and the empty bucket rolled out, lower the bucket to the ground, as shown.

② To measure the cycle time of the arm cylinder.
With the empty bucket rolled in, position the arm so that it is vertical to the ground. Lower the boom until the bucket is 0.5m above the ground.

③ To measure the cycle time of the bucket cylinder.
The empty bucket should be positioned at midstroke between roll-in and roll-out, so that the sideplate edges are vertical to the ground.

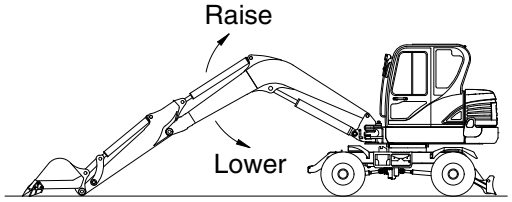
④ Keep the hydraulic oil temperature at 50±5˚C.

(3) Measurement

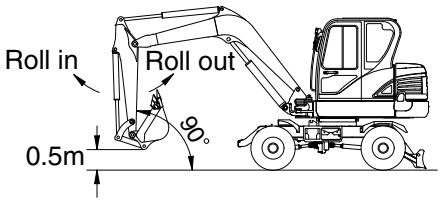
① To measure cylinder cycle times.

- Boom cylinder.
Measure the time it takes to raise the boom, and the time it takes to lower the boom. To do so, position the boom at one stroke end then move the control lever to the other stroke end as quickly as possible.
- Arm cylinder.
Measure the time it takes to roll in the arm, and the time it takes to roll out the arm. To do so, position the bucket at one stroke end, then move the control lever to the other stroke end as quickly as possible.

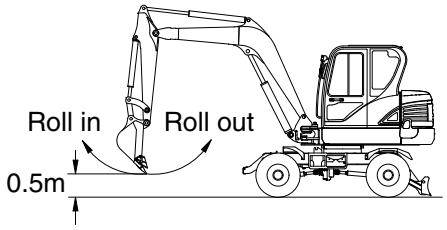
Boom cylinder



Arm cylinder



Bucket cylinder



- Bucket cylinders

  Measure the time it takes to roll in the bucket, and the time it takes to roll out the bucket. To do so, position the bucket at one stroke end, then move the control lever to the other stroke end as quickly as possible.
- Repeat each measurement 3 times and calculate the average values.

(4) Evaluation

The average measured time should meet the following specifications.

Unit : Seconds

Model	Function	Standard	Maximum allowable	Remarks
R60WVS RRO	Boom raise	2.5±0.3	3.0	
	Boom lower	2.2±0.3	3.3	
	Arm in	2.0±0.3	3.3	
	Arm out	2.2±0.3	3.2	
	Bucket load	2.2±0.3	4.7	
	Bucket dump	1.9 ±0.3	3.1	
	Boom swing (LH)	11.5 ±0.3	7.8	
	Boom swing (RH)	11.5 ±0.3	6.6	
	Dozer up (raise)	2.3±0.3	3.2	
	Dozer down (lower)	2.5±0.3	4.1	

8) DIG FUNCTION DRIFT CHECK

(1) Measure dig function drift, which can be caused by oil leakage in the control valve and boom, standard arm, and standard bucket cylinders, with the loaded bucket.
When testing the dig function drift just after cylinder replacement, slowly operate each cylinder to its stroke end to purge air.

(2) Preparation

① Load bucket fully. Instead of loading the bucket, weight (W) of the following specification can be used.

· $W=M^3 \times 1.5$

Where :

M^3 = Bucket heaped capacity (m^3)

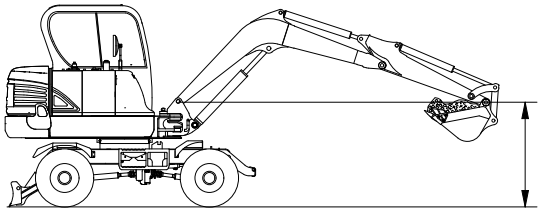
1.5 = Soil specific gravity

② Position the arm cylinder with the rod 20 to 30 mm extended from the fully retracted position.

③ Position the bucket cylinder with the rod 20 to 30 mm retracted from the fully extended position.

④ With the arm rolled out and bucket rolled in, hold the bucket so that the height of the bucket pin is the same as the boom foot pin.

⑤ Keep the hydraulic oil temperature at 50±5˚C.



(3) Measurement

① Stop the engine.

② Five minutes after the engine has been stopped, measure the changes in the positions of the boom, arm and bucket cylinders.

③ Repeat step ② three times and calculate the average values.

(4) The measured drift should be within the following specifications.

Unit : mm / 5min

Model	Drift to be measured	Standard	Maximum allowable	Remarks
R60WVS RRO	Boom cylinder	10 below	20	
	Arm cylinder	20 below	30	
	Bucket cylinder	20 below	30	

9) CONTROL LEVER OPERATING FORCE

(1) Use a spring scale to measure the maximum resistance of each control lever at the middle of the grip.

(2) Preparation

① Keep the hydraulic oil temperature at 50±5˚C.

(3) Measurement

① Start the engine.
② Operate each boom, arm, bucket and swing lever at full stroke and measure the maximum operating force for each.
③ Repeat steps ② three times and calculate the average values.

(4) Evaluation

The measured operating force should be within the following specifications.

Unit : kgf

Model	Kind of lever	Standard	Maximum allowable	Remarks
R60WVS RRO	Boom lever	1.4 or below	1.9	
	Arm lever	1.4 or below	1.9	
	Bucket lever	1.4 or below	1.9	
	Swing lever	1.4 or below	1.9	

10) CONTROL LEVER STROKE

(1) Measure each lever stroke at the lever top using a ruler.

※ When the lever has play, take a half of this value and add it to the measured stroke.

(2) Preparation

Keep the hydraulic oil temperature at 50±5˚C.

(3) Measurement

① Stop the engine.

② Measure each lever stroke at the lever top from neutral to the stroke end using a ruler.

③ Repeat step ② three times and calculate the average values.

(4) Evaluation

The measured drift should be within the following specifications.

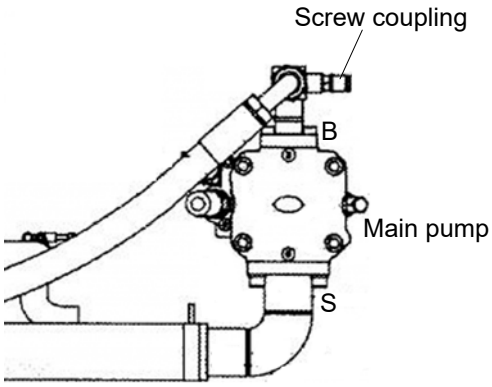
Unit : mm

Model	Kind of lever	Standard	Maximum allowable	Remarks
R60WVS RRO	Boom lever	87±10	109	
	Arm lever	87±10	109	
	Bucket lever	87±10	109	
	Swing lever	87±10	109	

11) PILOT PRIMARY PRESSURE

(1) Preparation

① Stop the engine.
② Push the pressure release button to bleed air.
③ Loosen and remove plug on the pilot pump delivery port (A4) and connect pressure gauge.
④ Start the engine and check for oil leakage from the port.
⑤ Keep the hydraulic oil temperature at 50±5˚C.



(2) Measurement

① Measure the primary pilot pressure at rated rpm.

(3) Evaluation

The average measured pressure should meet the following specifications:

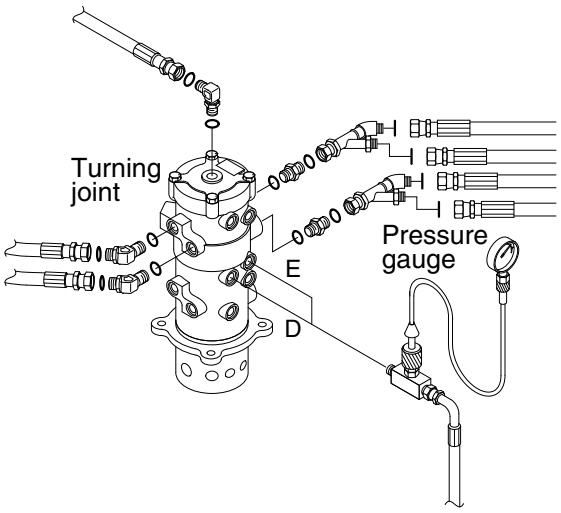
Unit : kgf / cm²

Model	Standard	Remark
R60WVS RRO	35 ±5	

12) FOR TRAVEL SPEED SELECTING PRESSURE:

(1) Preparation

① Stop the engine.
② Push the pressure release button to bleed air.
③ To measure the speed selecting pressure: Install a connector and pressure gauge assembly to turning joint D, E port as shown.
④ Start the engine and check for on leakage from the adapter.
⑤ Keep the hydraulic oil temperature at 50±5˚C.



(2) Measurement

① Lower the bucket and dozer blade to the ground to raise the tires off the ground.
② Select the following switch positions.
Parking switch : OFF
③ Measure the travel speed selecting pressure in the Hi or Lo position.
④ Operate the travel speed switch turns to the high or low position and measure the port D (high) or E (low) pressure.
⑤ Repeat steps ③ three times and calculate the average values.

(3) Evaluation

The average measured pressure should be within the following specifications.

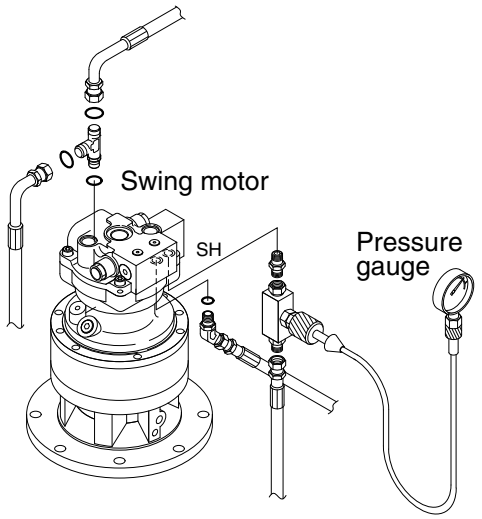
Unit : kgf / cm^2

Model	Travel speed mode	Standard		Maximum allowable	Remarks
		D port	E port		
R60WVS RRO	Low speed	-	35±5	-	
	High speed	35±5	-	-	

13) SWING PARKING BRAKE RELEASING PRESSURE

(1) Preparation

① Stop the engine.
② Push the pressure release button to bleed air.
③ Install a connector and pressure gauge assembly to swing motor SH port, as shown.
④ Start the engine and check for oil leakage from the adapter.
⑤ Keep the hydraulic oil temperature at 50±5˚C.



(2) Measurement

① Operate the swing function or arm roll in function and measure the swing brake control pressure with the brake disengaged. Release the control lever to return to neutral and measure the control pressure when the brake is applied.
② Repeat three times and calculate the average values.

(3) Evaluation

The average measured pressure should be within the following specifications.

Unit : kgf / cm²

Model	Description	Standard	Remarks
R60WVS RRO	Brake disengaged	30±10	
	Brake applied	0	

14) MAIN PUMP DELIVERY PRESSURE

(1) Preparation

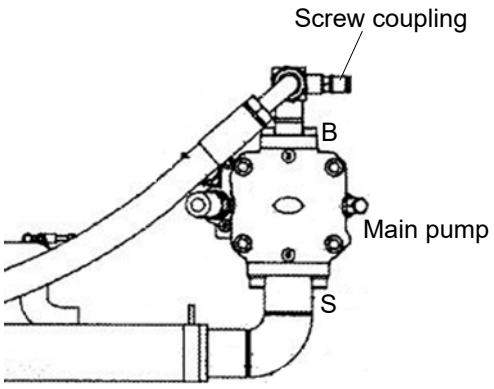
① Stop the engine.

② Push the pressure release button to bleed air.

③ To measure the main pump pressure. Install a connector and pressure gauge assembly main pump gauge port (1G, 2G) as shown.

④ Start the engine and check for oil leakage from the port.

⑤ Keep the hydraulic oil temperature at 50±5˚C.



(2) Measurement

① Measure the main pump delivery pressure at high idle.

(3) Evaluation

The average measured pressure should meet the following specifications.

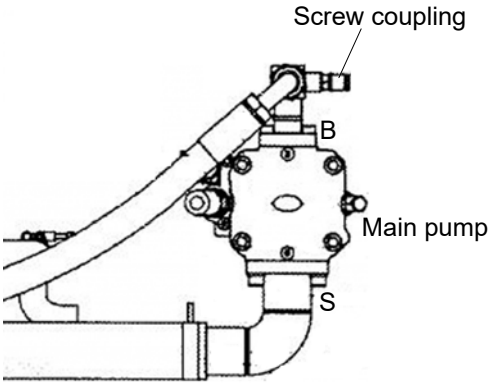
Unit : kgf / cm²

Model	Engine speed	Standard	Allowable limits	Remarks
R60WVS RRO	High ilde	20 ±5	-	

15) SYSTEM PRESSURE REGULATOR RELIEF SETTING

(1) Preparation

① Stop the engine.
② Push the pressure release button to bleed air.
③ To measure the system relief pressure. Install a connector and pressure gauge assembly main pump gauge port, as shown.
④ Start the engine and check for oil leakage from the port.
⑤ Keep the hydraulic oil temperature at 50±5˚C.



(2) Measurement

① Slowly operate each control lever of boom, arm and bucket functions at full stroke over relief and measure the pressure.
② In the swing function, place bucket against an immovable object and measure the relief pressure.
③ In the travel function, lock undercarriage with an immovable object and measure the relief pressure.

(3) Evaluation

The average measured pressure should be within the following specifications.

Unit : kgf / cm²

Model	Function to be tested	Standard
R60WVS RRO	Boom, Arm, Bucket	260±10
	Travel	230±10
	Swing	230±10

1. MAIN PUMP

Before inspection, wash the parts well and dry them completely.

Inspect the principal parts with care and replace them with new parts when any abnormal wear exceeding the allowable limit or damage considered harmful is found.

Replace the seal also when any remarkable deformation and damage are found.

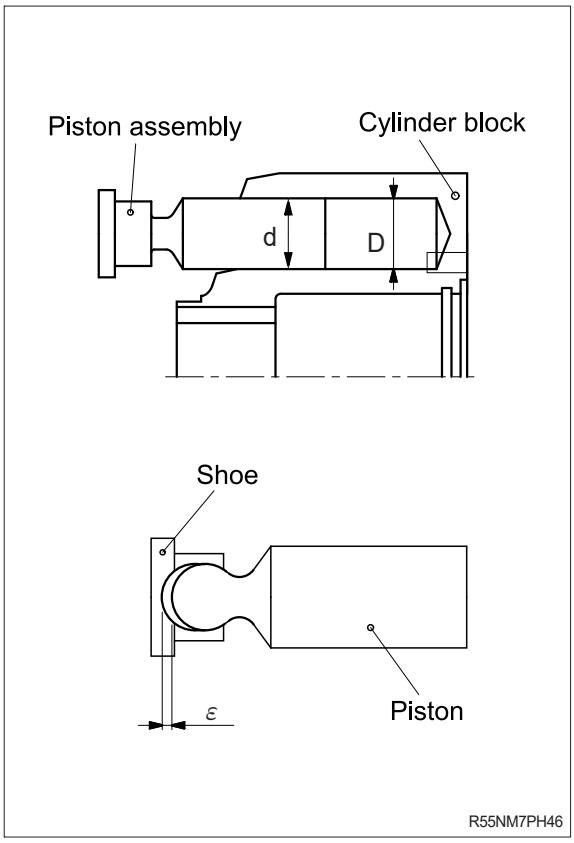
1) PISTON ASSEMBLY AND CYLINDER BLOCK

(1) Check the appearance visually.
No damage, scouring, abnormal wear (particularly, in the slide portion) should be found.

(2) Check the clearance between the piston outside dia and cylinder block inside dia.
D-d $\leq$ 0.050 mm

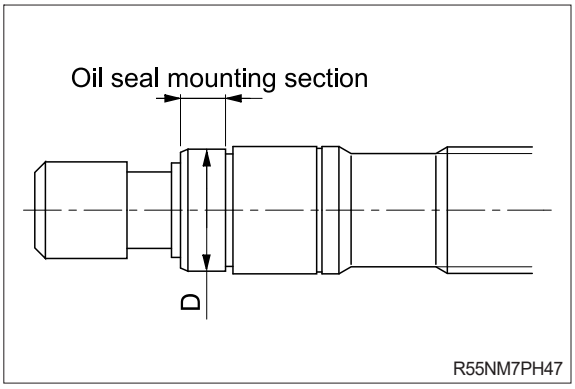
2) PISTON SHOE AND PISTON

(1) Check the axial play of the piston and piston shoe.
$\varepsilon \leq$ 0.2 mm



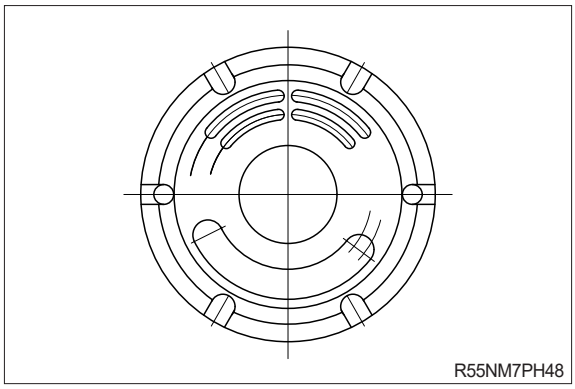
3) SHAFT

(1) Check the wear amount of the oil seal mounting section.
Wear mount $\leq$ 0.025 mm



4) CONTROL PLATE

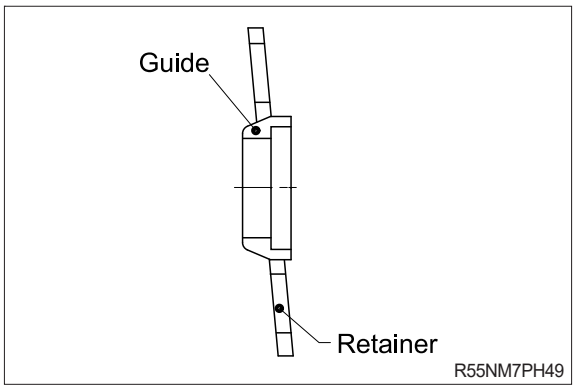
(1) Check the slide surface for any damage. When the damage is large, replace the plate with new one.



5) GUIDE AND RETAINER

(1) Check for scouring or stepped wear. If this can not be corrected, replace the guide and retainer with new full-set.

(2) Fine scouring or damage can be corrected with lapping. Carry out thorough washing after lapping.

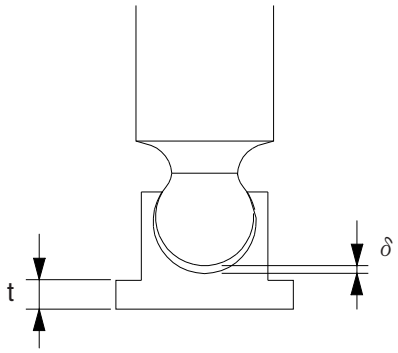
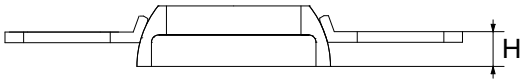


2. MAIN CONTROL VALVE

Part name	Inspection item	Criteria & measure
Block	· Existence of scratch, rusting or corrosion.	· In case of damage in following section, replace part. - Sliding sections of casing fore and spool, especially land sections applied with holded pressure. - Seal pocket section where spool is inserted. - Seal section of port where O-ring contacts. - Seal section of each relief valve for main, travel, and port. - Other damages that may damage normal functions.
Spool	· Existence of scratch, gnawing, rusting or corrosion. · O-ring seal sections at both ends. · Insert spool in casing hole, rotate and reciprocate it.	· Replacement when its outside sliding section has scratch (especially on seals-contacting section). · Replacement when its sliding section has scratch. · Correction or replacement when O-ring is damaged or when spool does not move smoothly.
Poppet	· Damage of poppet or spring · Insert poppet into casing and function it.	· Correction or replacement when sealing is incomplete. · Normal when it can function lightly without being caught.
Around spring	· Rusting, corrosion, deformation or breaking of spring, spring seat, plug or cover.	· Replacement for significant damage.
Around seal for spool	· External oil leakage. · Rusting, corrosion or deformation of seal plate.	· Correction or replacement. · Correction or replacement.
Main relief valve & port relief valve	· External rusting or damage. · Contacting face of valve seat. · Contacting face of poppet. · Abnormal spring. · O-rings, back up rings and seals.	· Replacement. · Replacement when damaged. · Replacement when damaged. · Replacement. · 100% replacement in general.

3. SWING DEVICE

1) WEARING PARTS

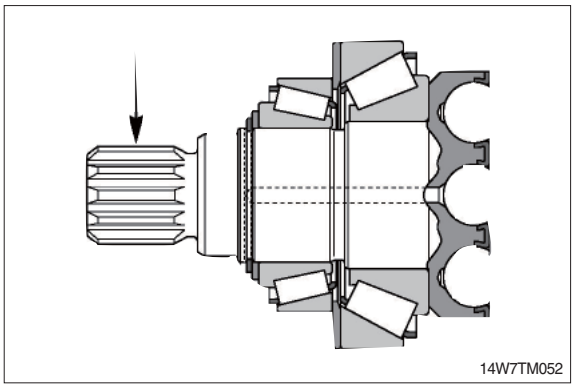
Inspection item	Standard dimension	Recommended replacement value	Counter measures
Clearance between piston and cylinder block bore	0.020	0.045	Replace piston or cylinder block
Play between piston and shoe caulking section (δ)	0	0.3	Replace assembly of piston and shoe
Thickness of shoe (t)	4	3.8	Replace assembly of piston and shoe
Combined height of set plate and guide (H)	17.4	17	Replace set of set plate and guide
Thickness of friction plate	3.6	3.2	Replace
			

2) SLIDING PARTS

Part name	Standard roughness	Remark
Shoe	0.8S	
Shoe plate	0.8S	
Cylinder	0.8S	
Valve plate	0.8S	

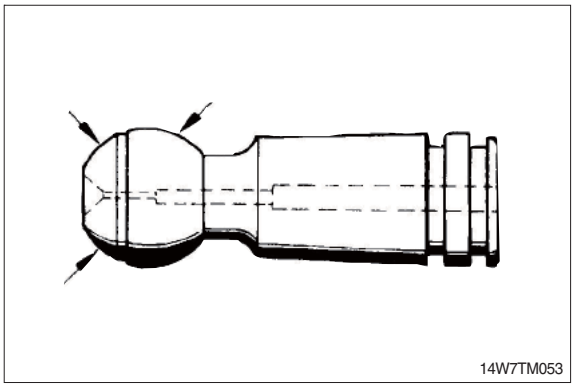
4. TRAVEL MOTOR

1) Free of corrosion, erosion or fretting; no damage to splines or keyways.



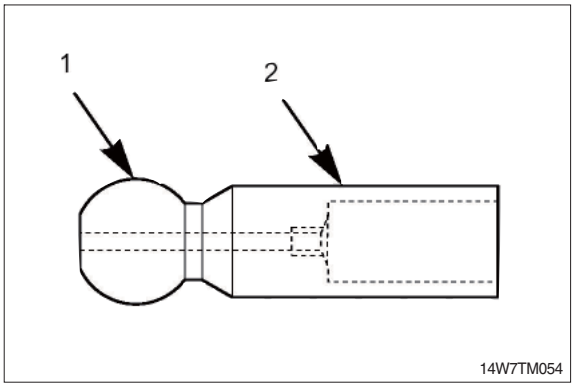
2) Pistons

No scoring and no pittings.



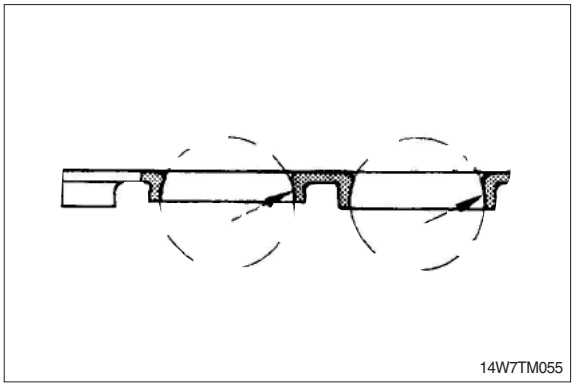
3) Center pin

No scoring and no pittings.



4) Retaining plate

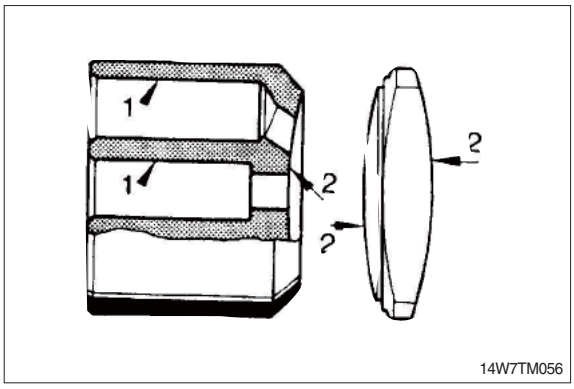
No scoring and no evidence of wear.



5) Cylinder block/control lens

① Bores free of scoring, no evidence of wear.

② Faces smooth and even, free of cracks and scoring.



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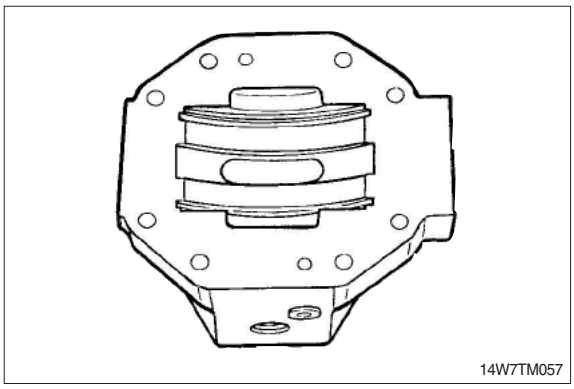
6) Control housing

Sliding surface and side guides free of scoring and no wear.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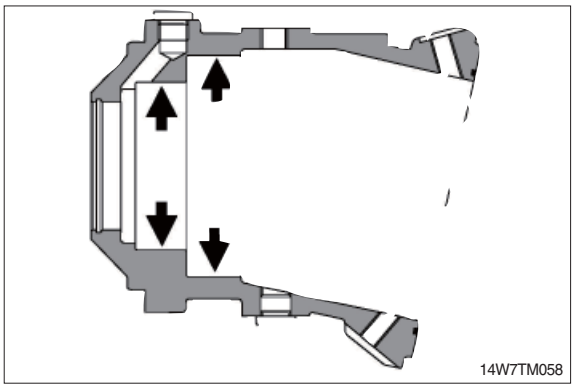
7) Visual check

Bearing areas free of scoring and no evidence of wear.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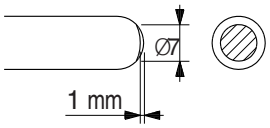
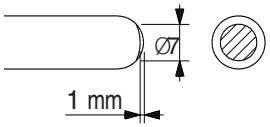
5. RCV LEVER

Maintenance check item	Criteria	Remark
Leakage	The valve is to be replaced when the leakage becomes more than 1000 cc/m at neutral handle position, or more than 2000 cc/m during operation.	Conditions : Primary pressure : 30 kgf/cm^2 Oil viscosity : 23 cSt
Spool	This is to be replaced when the sliding surface has worn more than 10 μm, compared with the non-sliding surface.	The leakage at the left condition is estimated to be nearly equal to the above leakage.
Push rod	 This is to be replaced when the top end has worn more than 1mm.	
Play at operating section	The pin, shaft, and joint of the operating section are to be replaced when their plays become more than 2 mm due to wears or so on.	When a play is due to looseness of a tightened section, adjust it.
Operation stability	When abnormal noises, hunting, primary pressure drop, etc. are generated during operation, and these cannot be remedied, referring to section 6 troubleshooting, replace the related parts.	

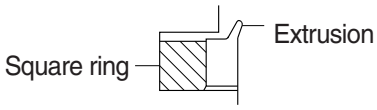
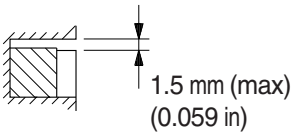
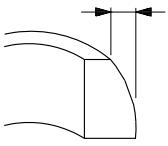
Notes 1. It is desirable to replace seal materials, such as O-rings, every disassembling. However, they may be reused, after being confirmed to be free of damage.

6. ACCELERATOR PEDAL

Maintenance check item	Criteria	Remark
Leakage	The valve is to be replaced when the leakage effect to the system. For example, the primary pressure drop.	Conditions : Primary pressure : 30 kgf/cm^2 Oil viscosity : 23 cSt
Spool	This is to be replaced when the sliding surface has worn more than 10μm, compared with the non-sliding surface.	The leakage at the left condition is estimated to be nearly equal to the above leakage.
Push rod	 This is to be replaced when th top end has worn more than 1mm.	
Play at operating section	The pin, shaft, and joint of the operating section are to be replaced when their plays become more than 2mm due to wears or so on.	When a play is due to looseness of a tightened section, adjust it.
Operation stability	When abnormal noises, hunting, primary pressure drop, etc. are generated during operation, and these cannot be remedied, referring to section 6 troubleshooting, replace the related parts.	

Notes 1. It is desirable to replace seal materials, such as O-rings, every disassembling. However, they may be reused, after being confirmed to be free of damage.

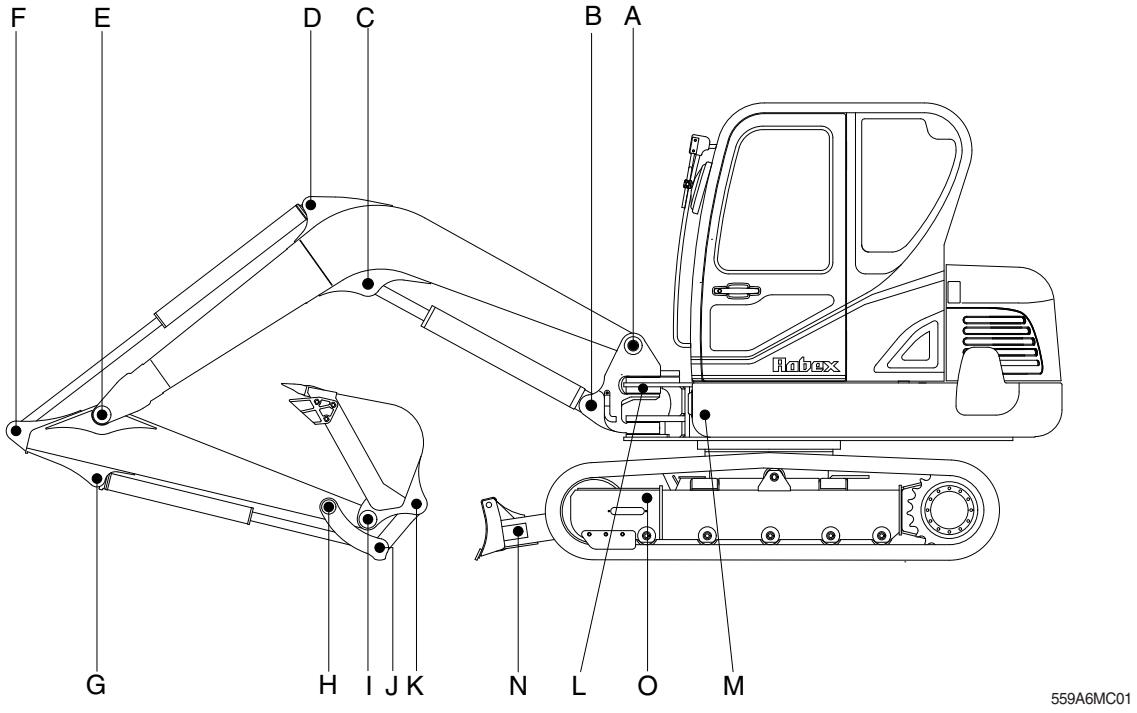
7. TURNING JOINT

Part name		Maintenance standards	Remedy
Body, Stem	Sliding surface with sealing sections	Plating worn or peeled due to seizure or contamination	Replace
	Sliding surface between body and stem other than sealing section	· Worn abnormality or damaged more than 0.1 mm (0.0039 in) in depth due to seizure contamination	Replace
		· Damaged more than 0.1 mm (0.0039 in) in depth	Smooth with oilstone
	Sliding surface with thrust plate	· Worn more than 0.5 mm (0.02 in) or abnormality	Replace
		· Worn less than 0.5 mm (0.02 in)	Smooth
		· Damage due to seizure or contamination remediable within wear limit (0.5 mm) (0.02 in)	Smooth
Cover	Sliding surface with thrust plate	· Worn more than 0.5 mm (0.02 in) or abnormality	Replace
		· Worn less than 0.5 mm (0.02 in)	Smooth
		· Damage due to seizure or contamination remediable within wear limit (0.5 mm) (0.02 in)	Replace
Seal set	-	· Extruded excessively from seal groove square ring 	Replace
	-	· Slipper ring 1.5 mm (0.059 in) narrower than seal groove, or narrower than back ring 	Replace
	-	· Worn more than 0.5 mm (0.02 in) ~ 1.5 mm (MAX) (0.059 in) 	Replace

8. CYLINDER

Part name	Inspecting section	Inspection item	Remedy
Piston rod	· Neck of rod pin	· Presence of crack	· Replace
	· Weld on rod hub	· Presence of crack	· Replace
	· Stepped part to which piston is attached	· Presence of crack	· Replace
	· Threads	· Presence of crack	· Recondition or replace
	· Plated surface	· Plating is not worn off to base metal	· Replace or replate
		Rust is not present on plating	· Replace or replate
		Scratches are not present	· Recondition, replate or replace
	· Rod	· Wear of O.D.	· Recondition, replate or replace
Cylinder tube	· Bushing at mounting part	· Wear of I.D.	· Replace
	· Weld on bottom	· Presence of crack	· Replace
	· Weld on head	· Presence of crack	· Replace
	· Weld on hub	· Presence of crack	· Replace
	· Tube interior	· Presence of faults	· Replace if oil leak is seen
	· Bushing at mounting part	· Wear on inner surface	· Replace
Gland	· Bushing	· Flaw on inner surface	· Replace if flaw is deeper than coating

9. WORK EQUIPMENT



Unit : mm

Mark	Measuring point (pin and bushing)	Normal value	Pin		Bushing		Remedy & Remark
			Recomm. service limit	Limit of use	Recomm. service limit	Limit of use	
A	Boom Rear	50	49	48.5	50.5	51	Replace
B	Boom Cylinder Head	60	59	58.5	60.5	61	〃
C	Boom Cylinder Rod	60	59	58.5	60.5	61	〃
D	Arm Cylinder Head	50	49	48.5	50.5	51	〃
E	Boom Front	50	49	48.5	50.5	51	〃
F	Arm Cylinder Rod	50	49	48.5	50.5	51	〃
G	Bucket Cylinder Head	45	44	43.5	45.5	46	〃
H	Arm Link	45	44	43.5	45.5	46	〃
I	Bucket and Arm Link	45	44	43.5	45.5	46	〃
J	Bucket Cylinder Rod	45	44	43.5	45.5	46	〃
K	Bucket Link	45	44	43.5	45.5	46	〃
L	Boom swing post	110	109	108.5	110.5	111	〃
M	Boom swing cylinder	50	49	48.5	50.5	51	〃
N	Blade cylinder	55	54	53.5	55.5	56	〃
O	Blade and frame link	35	34	33.5	35.5	36	〃

SECTION 7 DISASSEMBLY AND ASSEMBLY

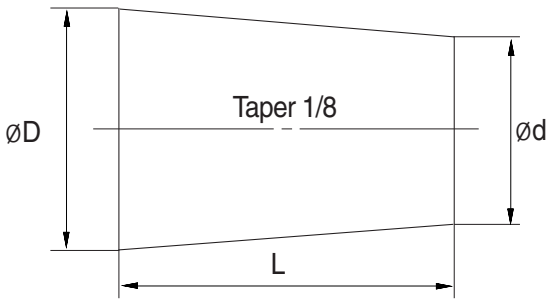
SECTION 7 DISASSEMBLY AND ASSEMBLY

GROUP 1 PRECAUTIONS

1. REMOVAL WORK

1) Lower the work equipment completely to the ground.
   If the coolant contains antifreeze, dispose of it correctly.
2) After disconnecting hoses or tubes, cover them or fit blind plugs to prevent dirt or dust from entering.
3) When draining oil, prepare a container of adequate size to catch the oil.
4) Confirm the match marks showing the installation position, and make match marks in the necessary places before removal to prevent any mistake when assembling.
5) To prevent any excessive force from being applied to the wiring, always hold the connectors when disconnecting the connectors.
6) Fit wires and hoses with tags to show their installation position to prevent any mistake when installing.
7) Check the number and thickness of the shims, and keep in a safe place.
8) When raising components, be sure to use lifting equipment of ample strength.
9) When using forcing screws to remove any components, tighten the forcing screws alternately.
10) Before removing any unit, clean the surrounding area and fit a cover to prevent any dust or dirt from entering after removal.
11) When removing hydraulic equipment, first release the remaining pressure inside the hydraulic tank and the hydraulic piping.
12) If the part is not under hydraulic pressure, the following corks can be used.

Nominal number	Dimensions		
	D	d	L
06	6	5	8
08	8	6.5	11
10	10	8.5	12
12	12	10	15
14	14	11.5	18
16	16	13.5	20
18	18	15	22
20	20	17	25
22	22	18.5	28
24	24	20	30
27	27	22.5	34



2. INSTALL WORK

1) Tighten all bolts and nuts (sleeve nuts) to the specified torque.
2) Install the hoses without twisting or interference.
3) Replace all gaskets, O-rings, cotter pins, and lock plates with new parts.
4) Bend the cotter pin or lock plate securely.
5) When coating with adhesive, clean the part and remove all oil and grease, then coat the threaded portion with 2-3 drops of adhesive.
6) When coating with gasket sealant, clean the surface and remove all oil and grease, check that there is no dirt or damage, then coat uniformly with gasket sealant.
7) Clean all parts, and correct any damage, dents, burrs, or rust.
8) Coat rotating parts and sliding parts with engine oil.
9) When press fitting parts, coat the surface with antifriction compound (LM-P).
10) After installing snap rings, check that the snap ring is fitted securely in the ring groove (check that the snap ring moves in the direction of rotation).
11) When connecting wiring connectors, clean the connector to remove all oil, dirt, or water, then connect securely.
12) When using eyebolts, check that there is no deformation or deterioration, and screw them in fully.
13) When tightening split flanges, tighten uniformly in turn to prevent excessive tightening on one side.
14) When operating the hydraulic cylinders for the first time after repairing and reassembling the hydraulic cylinders, pumps, or other hydraulic equipment or piping, always bleed the air from the hydraulic cylinders as follows:
    (1) Start the engine and run at low idling.
    (2) Operate the control lever and actuate the hydraulic cylinder 4-5 times, stopping 100 mm before the end of the stroke.
    (3) Next, operate the piston rod to the end of its stroke to relieve the circuit. (The air bleed valve is actuated to bleed the air.)
    (4) After completing this operation, raise the engine speed to the normal operating condition.

※ If the hydraulic cylinder has been replaced, carry out this procedure before assembling the rod to the work equipment.

※ Carry out the same operation on machines that have been in storage for a long time after completion of repairs.

3. COMPLETING WORK

1) If the coolant has been drained, tighten the drain valve, and add water to the specified level. Run the engine to circulate the water through the system. Then check the water level again.

2) If the hydraulic equipment has been removed and installed again, add engine oil to the specified level. Run the engine to circulate the oil through the system. Then check the oil level again.

3) If the piping or hydraulic equipment, such as hydraulic cylinders, pumps, or motors, have been removed for repair, always bleed the air from the system after reassembling the parts.

4) Add the specified amount of grease (molybdenum disulphied grease) to the work equipment related parts.

GROUP 2 TIGHTENING TORQUE

1. MAJOR COMPONENTS

No.	Descriptions		Bolt size	Torque	
				kgf·m	lbf·ft
1	Engine	Engine mounting bolt (engine-Bracket)	M10 × 1.5	6.9±1.0	50±7.2
2		Engine mounting bolt (bracket-Frame)	M16 × 2.0	25±2.5	181±18.1
3		Radiator mounting bolt, nut	M10 × 1.5	6.9±1.4	50±10.0
4		Cooling fan mounting bolt	M 8 × 1.25	1.8±0.2	13±1.4
5		Coupling mounting bolt	M10 × 1.5	6.0±1.0	43.4±7.2
6	Hydraulic system	Main pump mounting bolt	M12 × 1.75	12.3±3.0	92±22.0
7		Main control valve mounting bolt	M 8 × 1.25	2.5±0.5	18±3.6
8		Travel motor mounting bolt	M12 × 1.75	14.7±2.2	106±15.9
9		Fuel tank mounting bolt	M16 × 2.0	29.7±4.5	215±33
10		Hydraulic oil tank mounting bolt	M16 × 2.0	29.7±4.5	215±33
11		Turning joint mounting bolt, nut	M12 × 1.75	14.7±2.2	106±16.0
12	Power train system	Swing motor mounting bolt	M16 × 2.0	29.7±4.5	215±33.0
13		Swing bearing upper mounting bolt	M16 × 2.0	29.7±4.5	215±33.0
15		Swing bearing lower mounting bolt	M16 × 2.0	29.7±4.5	215±33.0
16		Front axle mounting bolt, nut	M16 × 2.0	29.7±4.5	215±33.0
17		Rear axle mounting bolt, nut	M16 × 2.0	29.7±4.5	215±33.0
18		Gear box mounting bolt	M14 × 2.0	19.6±2.9	142±21.0
19		Oscillating cylinder mounting bolt	M16 × 2.0	29.7±4.5	215±33.0
20		Oscillating cylinder support bolt	M12 × 1.75	12.8±3.0	92.6±22.0
21		Wheel nut	M18 × 1.5	46.0±3.0	333±22.0
22		Front drive shaft mounting bolt, nut	M10 × 1.25	7.4±1.5	53.5±11.0
23		Rear drive shaft mounting bolt, nut	M10 × 1.25	7.4±1.5	53.5±11.0
24	Others	Counterweight mounting bolt	M20 × 2.5	57.8±6.4	418±46.3
25		Cab mounting bolt, nut	M12 × 1.75	12.8±3.0	92±22.0
26		Operator's seat mounting bolt	M 8 × 1.25	1.17±0.1	8.5±0.7

2. TORQUE CHART

Use following table for unspecified torque.

1) BOLT AND NUT

(1) Coarse thread

Bolt size	8T		10T	
	kg·m	lb·ft	kg·m	lb·ft
M 6 × 1.0	0.85 ~ 1.25	6.15 ~ 9.04	1.14 ~ 1.74	8.2 ~ 12.6
M 8 × 1.25	2.0 ~ 3.0	14.5 ~ 21.7	2.7 ~ 4.1	19.5 ~ 29.7
M10 × 1.5	4.0 ~ 6.0	28.9 ~ 43.4	5.5 ~ 8.3	39.8 ~ 60
M12 × 1.75	7.4 ~ 11.2	53.5 ~ 81.0	9.8 ~ 15.8	70.9 ~ 114
M14 × 2.0	12.2 ~ 16.6	88.2 ~ 120	16.7 ~ 22.5	121 ~ 163
M16 × 2.0	18.6 ~ 25.2	135 ~ 182	25.2 ~ 34.2	182 ~ 247
M18 × 2.5	25.8 ~ 35.0	187 ~ 253	35.1 ~ 47.5	254 ~ 344
M20 × 2.5	36.2 ~ 49.0	262 ~ 354	49.2 ~ 66.6	356 ~ 482
M22 × 2.5	48.3 ~ 63.3	349 ~ 458	65.8 ~ 98.0	476 ~ 709
M24 × 3.0	62.5 ~ 84.5	452 ~ 611	85.0 ~ 115	615 ~ 832
M30 × 3.0	124 ~ 168	898 ~ 1214	169 ~ 229	1223 ~ 1656
M36 × 4.0	174 ~ 236	1261 ~ 1704	250 ~ 310	1808 ~ 2242

(2) Fine thread

Bolt size	8T		10T	
	kg·m	lb·ft	kg·m	lb·ft
M 8 × 1.0	2.2 ~ 3.4	15.9 ~ 24.6	3.0 ~ 4.4	21.7 ~ 31.8
M10 × 1.2	4.5 ~ 6.7	32.5 ~ 48.5	5.9 ~ 8.9	42.7 ~ 64.4
M12 × 1.25	7.8 ~ 11.6	56.4 ~ 83.9	10.6 ~ 16.0	76.7 ~ 116
M14 × 1.5	13.3 ~ 18.1	96.2 ~ 131	17.9 ~ 24.1	130 ~ 174
M16 × 1.5	19.9 ~ 26.9	144 ~ 195	26.6 ~ 36.0	192 ~ 260
M18 × 1.5	28.6 ~ 43.6	207 ~ 315	38.4 ~ 52.0	278 ~ 376
M20 × 1.5	40.0 ~ 54.0	289 ~ 391	53.4 ~ 72.2	386 ~ 522
M22 × 1.5	52.7 ~ 71.3	381 ~ 516	70.7 ~ 95.7	511 ~ 692
M24 × 2.0	67.9 ~ 91.9	491 ~ 665	90.9 ~ 123	658 ~ 890
M30 × 2.0	137 ~ 185	990 ~ 1339	182 ~ 248	1314 ~ 1796
M36 × 3.0	192 ~ 260	1390 ~ 1880	262 ~ 354	1894 ~ 2562

2) PIPE AND HOSE (FLARE type)

Thread size (PF)	Width across flat (mm)	kgf·m	lbf·ft
1/4"	19	4	28.9
3/8"	22	5	36.2
1/2"	27	9.5	68.7
3/4"	36	18	130
1"	41	21	152
1-1/4"	50	35	253

3) PIPE AND HOSE (ORFS type)

Thread size (UNF)	Width across flat (mm)	kgf·m	lbf·ft
9/16-18	19	4	28.9
11/16-16	22	5	36.2
13/16-16	27	9.5	68.7
1-3/16-12	36	18	130
1-7/16-12	41	21	152
1-11/16-12	50	35	253

4) FITTING

Thread size	Width across flat (mm)	kgf·m	lbf·ft
1/4"	19	4	28.9
3/8"	22	5	36.2
1/2"	27	9.5	68.7
3/4"	36	18	130
1"	41	21	152
1-1/4"	50	35	253

GROUP 3 SWING DEVICE

1. REMOVAL AND INSTALL OF MOTOR

1) REMOVAL

(1) Lower the work equipment to the ground and stop the engine.

(2) Operate the control levers and pedals several times to release the remaining pressure in the hydraulic piping.

(3) Loosen the breather slowly to release the pressure inside the hydraulic tank.

⚠ **Escaping fluid under pressure can penetrate the skin causing serious injury.**

※ When pipes and hoses are disconnected, the oil inside the piping will flow out, so catch it in oil pan.

(4) Disconnect hose assembly (2, 3).

(5) Disconnect pilot line hoses (4, 5, 6, 7, 8).

(6) Sling the swing motor assembly (1) and remove the swing motor mounting bolts (9).
·Motor device weight : 23 kg (51 lb)

(7) Remove the swing motor assembly.

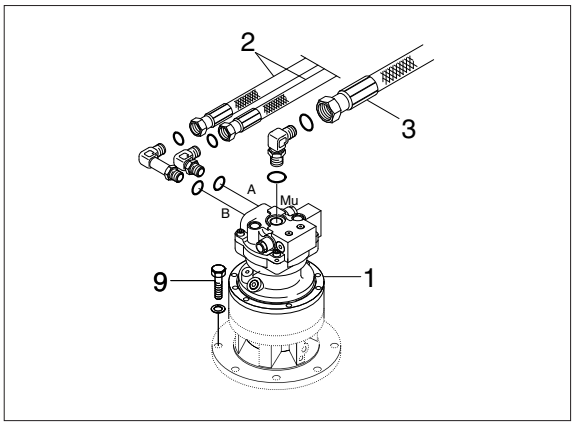
※ When removing the swing motor assembly, check that all the piping have been disconnected.

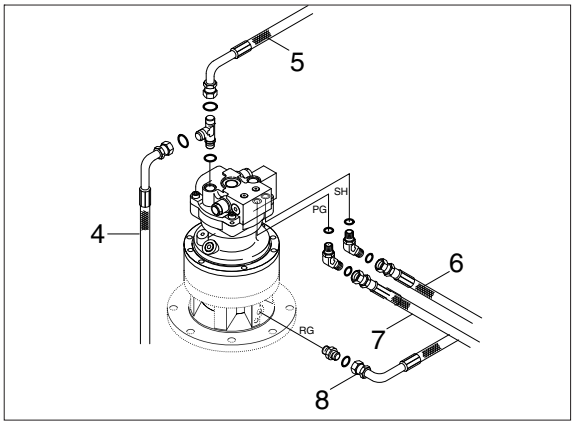
2) INSTALL

(1) Carry out installation in the reverse order to removal.

(2) Bleed the air from the swing motor.
① Remove the air vent plug.
② Pour in hydraulic oil until it overflows from the port.
③ Tighten plug lightly.
④ Start the engine, run at low idling and check oil come out from plug.
⑤ Tighten plug fully.

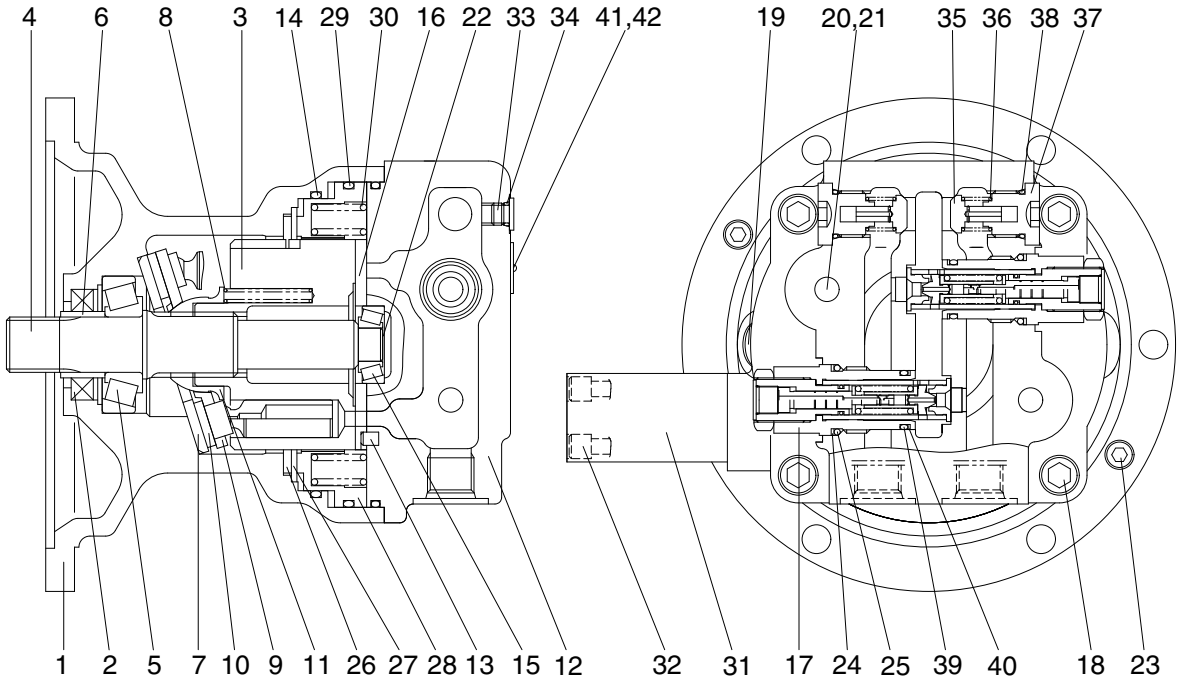
(3) Confirm the hydraulic oil level and check the hydraulic oil leak or not.





2. DISASSEMBLY AND ASSEMBLY OF SWING MOTOR

1) STRUCTURE

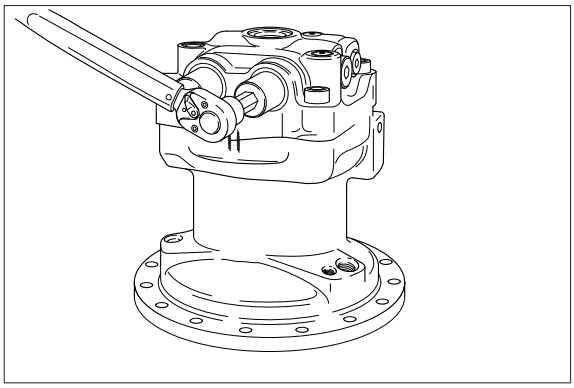


1	Body	15	Taper bearing	29	O-ring
2	Oil seal	16	Valve plate	30	Spring
3	Cylinder block	17	Relief valve assy	31	Time delay valve
4	Shaft	18	Socket bolt	32	Socket bolt
5	Taper bearing	19	Plug	33	Plug
6	Bushing	20	Plug	34	O-ring
7	Shoe plate	21	O-ring	35	Valve
8	Spring	22	Shim	36	Spring
9	Set plate	23	Plug	37	Plug
10	Piston shoe assy	24	Back up ring	38	O-ring
11	Ball guide	25	O-ring	39	O-ring
12	Rear cover	26	Friction plate	40	Back up ring
13	Pin	27	Plate	41	Name plate
14	O-ring	28	Parking piston	42	Rivet

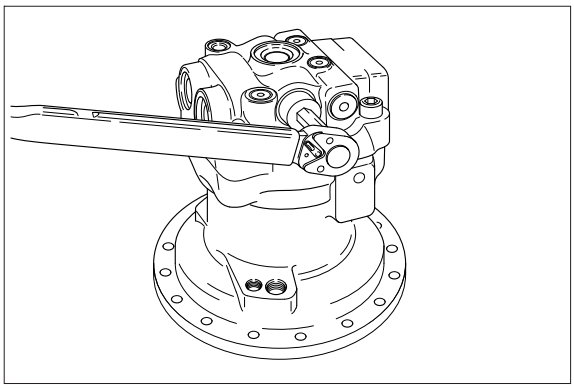
2) DISASSEMBLY

(1) Removal of relief valve assembly
Remove cap of relief valve assembly (17) with 14 ㎜ hexagonal wrench.

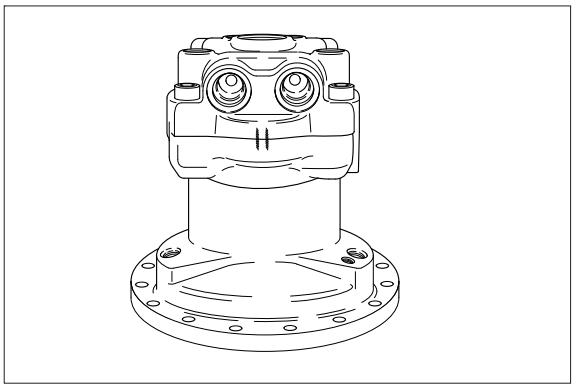
※ Assemble removed relief valve assembly (17) to original state when reassembling.



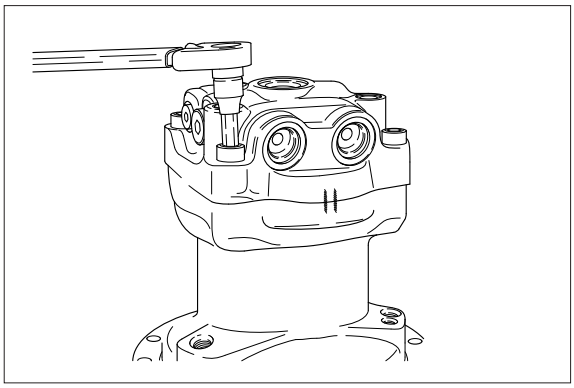
(2) Removal of make up valve and bypass valve assembly
Loosen plug (37) with 14㎜ hexagonal wrench, and remove check valve (35) and spring (36).



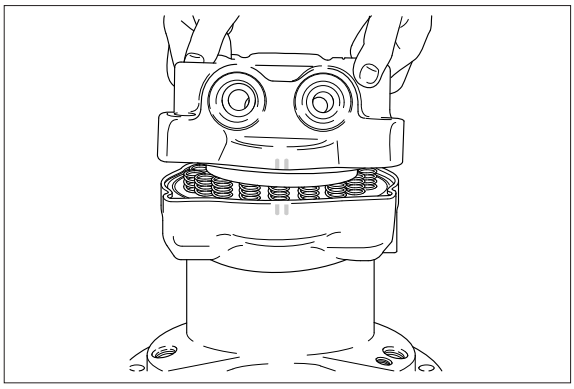
(3) Marking at swing motor
Before disassembling motor, make a matching mark between cover (12) and housing (1) for easy reassembling.



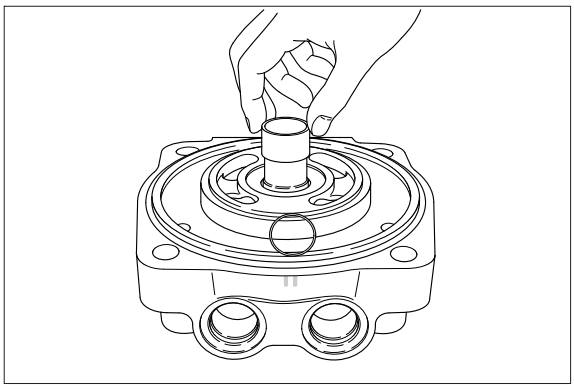
(4) Remove mounting bolts of cover
Loosen hexagon socket bolt (18) with 12 ㎜ hexagonal wrench.



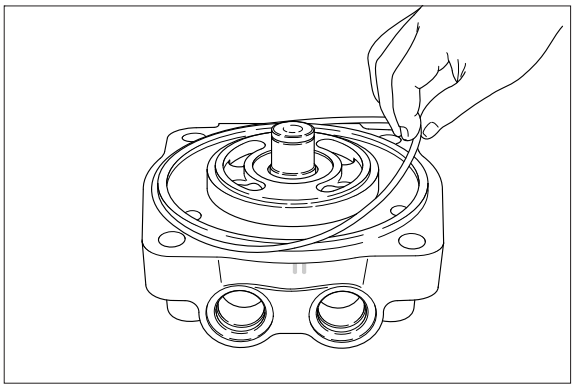
(5) Removal of cover assembly
Place shaft of motor assembly to downward and take cover (12) out.



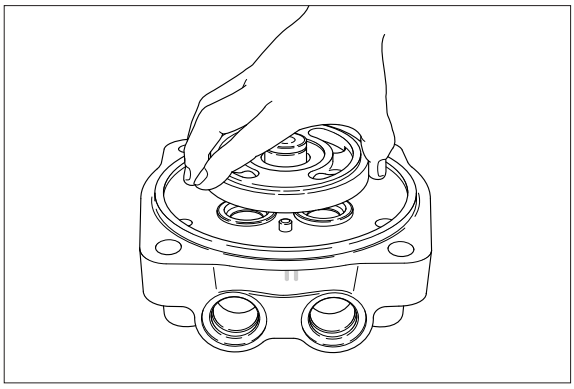
(6) Remove shim (22) remove inner race of needle bearing (15) by bearing puller.



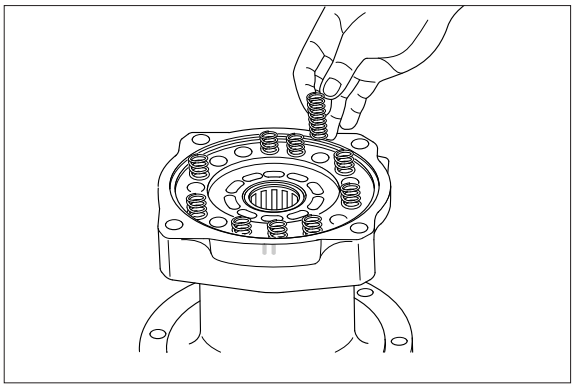
(7) Remove O-ring (29) from cover.



(8) Remove balance plate
Valve plate (16) is adhered on end surface of cylinder (3) by oil viscosity. Take off balance plate (16) with hands.
Assembling method of balance plate (16) depends on cover (12).
(band groove and round groove of high· low pressure transmission area)
Before removing, check and record location of balance plate (16) to prevent misassembling.

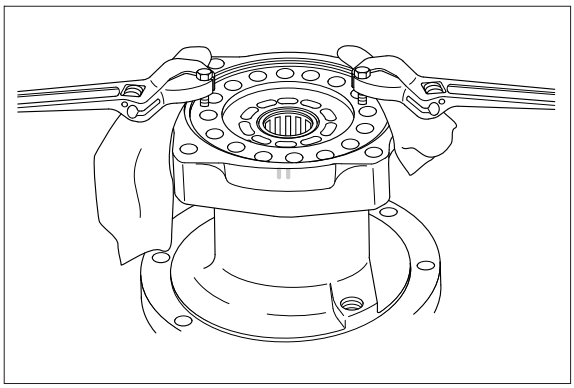


(9) Removal of spring (30, brake area)
Remove spring (30) from piston (28).
Check and record original position of each spring (30) for correct assembling.

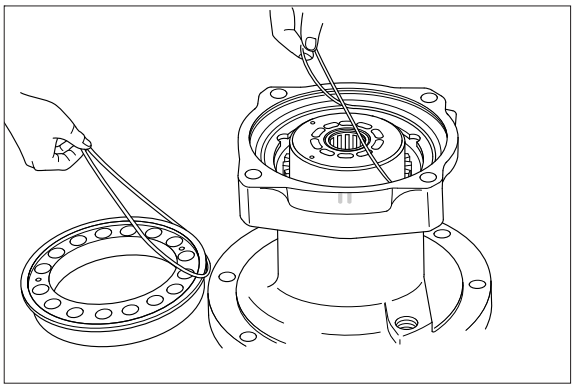


(10) Removal of brake piston

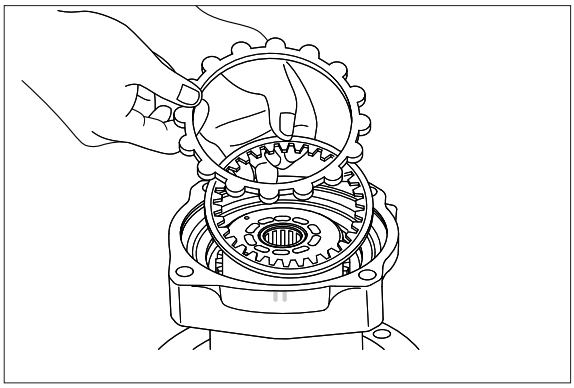
When removing piston (28) from housing (1), there is a sliding resistance against tightening of O-rings (14,29). Use tap hole on piston (28) as shown in the picture.



(11) Remove O-rings (14,29) from piston (28) and housing (1).



(12) Remove friction plate (26) and lining plate (27) from housing (1).



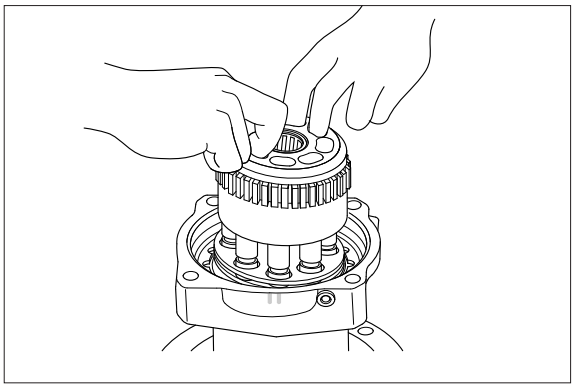
(13) Removal of cylinder assembly

Holding end of cylinder assembly (3) with hand, draw out cylinder assembly from housing.

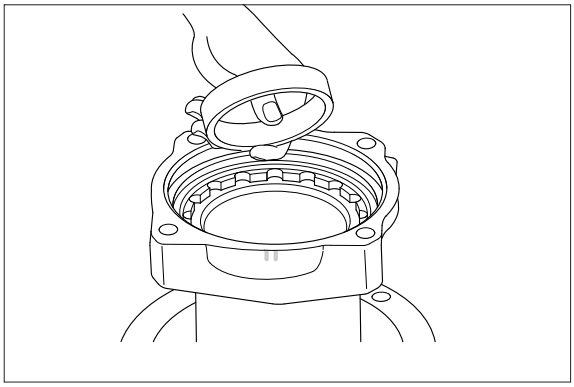
※ Oil seal (2) and outer race of taper roller bearing (15) are left inside of housing.

※ End surface of cylinder (3) is sliding face. So, protect the surface with a scrap of cloth against damage.

※ Make a matching mark on piston hole of cylinder (3) and piston assembly (10) to fit piston into the same hole when reassembling.



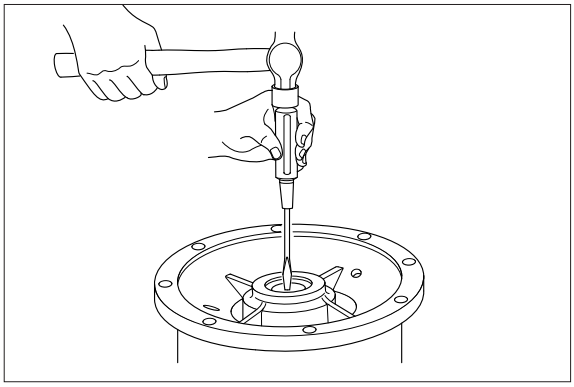
(14) Separate outer race of taper roller bearing (5) from housing.



(15) Removal of oil seal

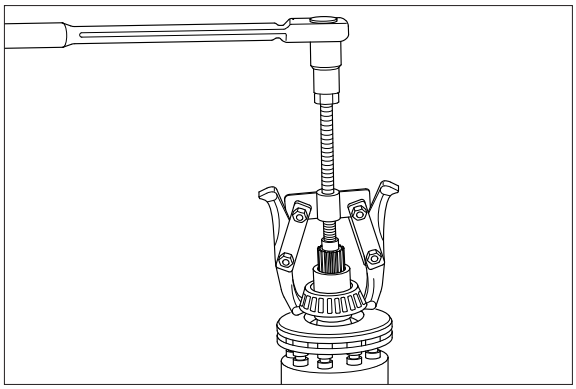
Remove oil seal (2) from housing (1) with driver and hammer.

※ Do not reuse oil seal after removal.

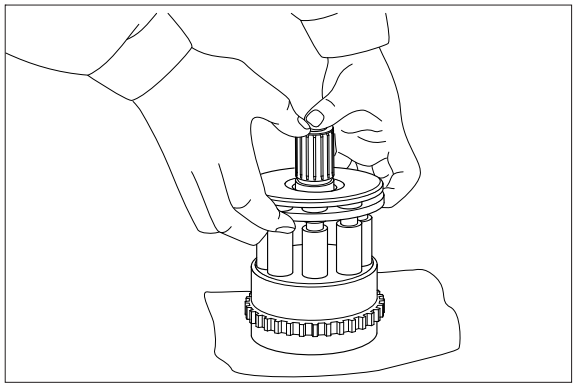


(16) Disassembly of cylinder assembly

① Removal of inner race of taper roller bearing (5).
Lift out cylinder block (3) with 2 inner race of roller bearing (5) by applying gear puller at the end of spline in the cylinder.

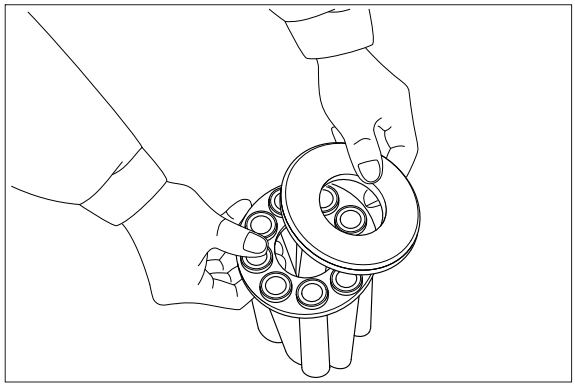


② Separate shoe plate (7), piston assembly (10), set plate (9) from cylinder block (3).

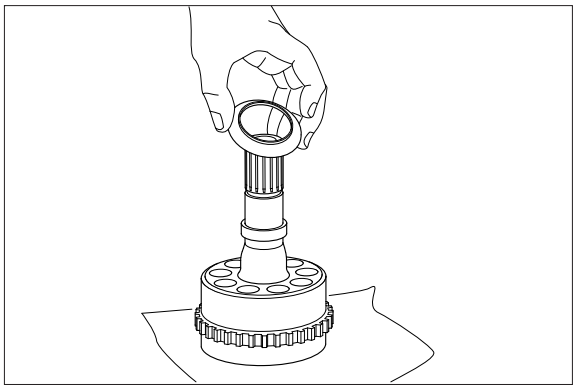


③ Get shoe plate (7) slide on sliding face of piston assembly (10) and remove it.

※ Be cautious not to damage on sliding face of cam plate.



④ Remove ball guide (11) from cylinder block (3).



This completes disassembly.

3) ASSEMBLY

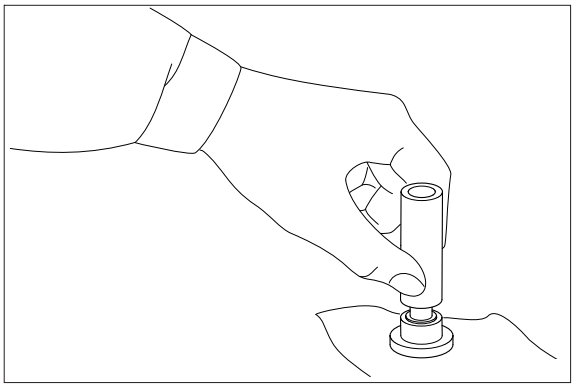
(1) Preparation

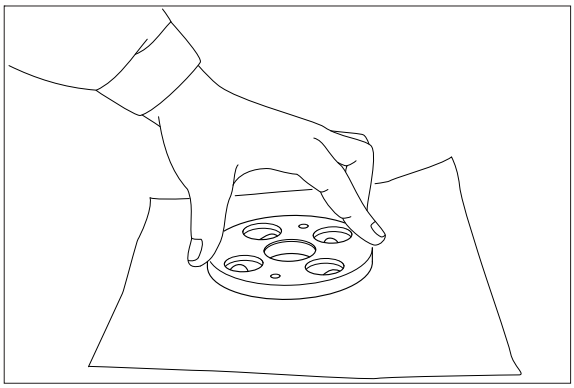
Before reassembling, perform below procedure.

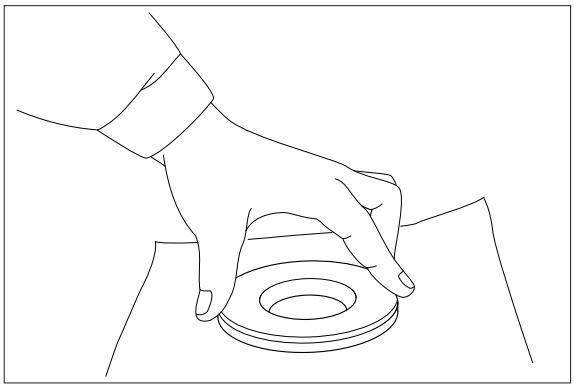
① Check each part for damage caused by using or disassembling. If damaged, eliminate damage by grinding with proper sandpaper, wash them with cleaning oil and dry with compressed air.

② Replace seal with new one.

③ Grind sliding face of piston assembly (10), balance plate (16) and shoe plate (7) with sandpaper #2000.





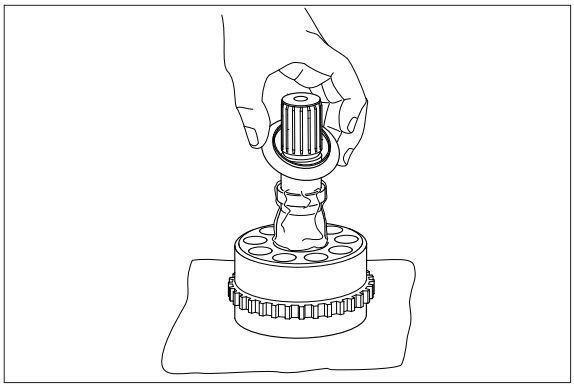


④ When assembling, lubricate with specified clean hydraulic oil.

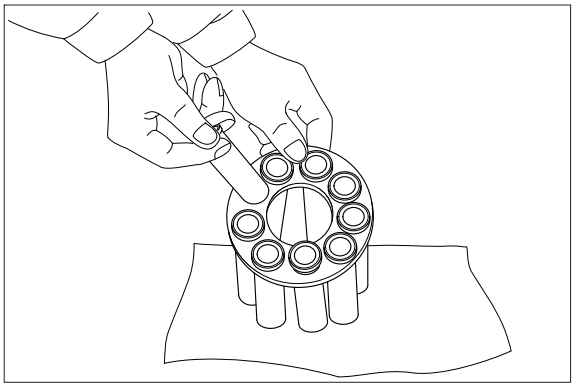
⑤ When assembling piston assembly (10) to piston hole of cylinder block (3), check matching mark between them.

(2) Cylinder assembly

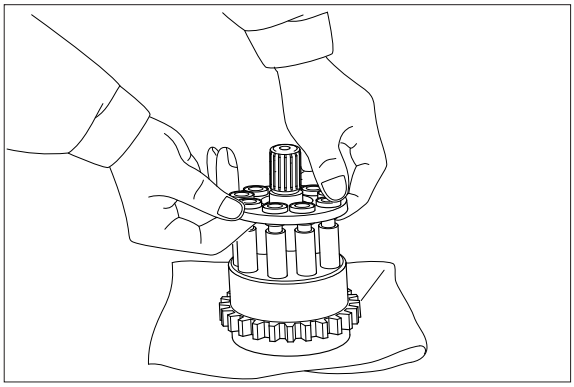
① Lubricate grease on round area (contacting area withball guide (11)) of cylinder block (3) and assemble spring (4).



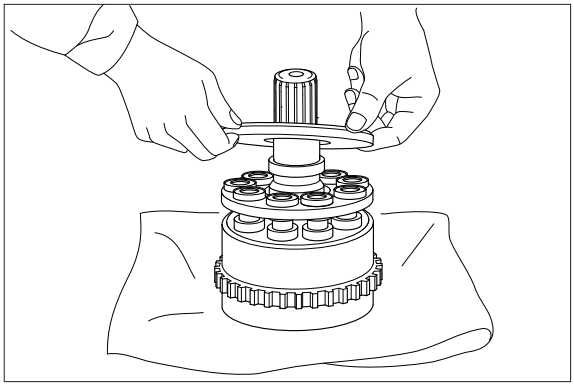
② Insert piston assembly (10) in hole of set plate (9).



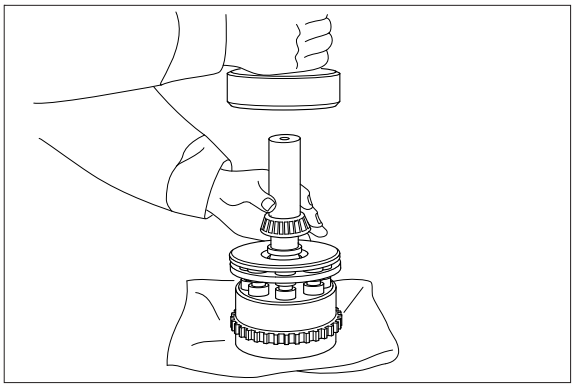
③ Assemble piston assembly (10) and set plate (9) to cylinder block (3). When assembling, check matching mark between them. Before assembling, lubricate specified hydraulic oil in piston hole of cylinder block (3).



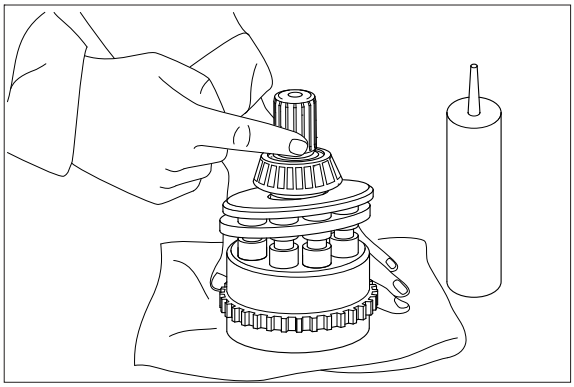
④ Lubricate specified hydraulic oil on shoe sliding face of piston assembly (10) and assemble shoe plate (7).



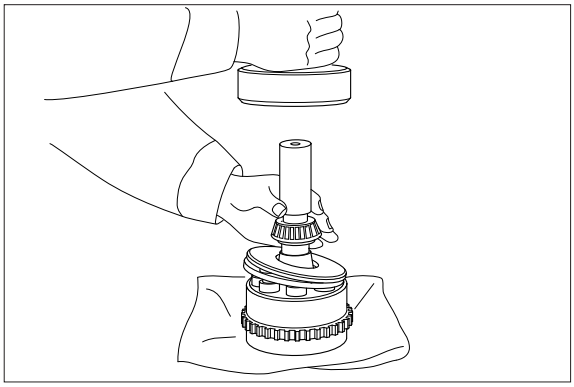
⑤ Assemble inner race of taper roller bearing (5) to cylinder block (3).



⑥ Apply loctite to bearing mounting area of inner race of cylinder block (3) lightly.



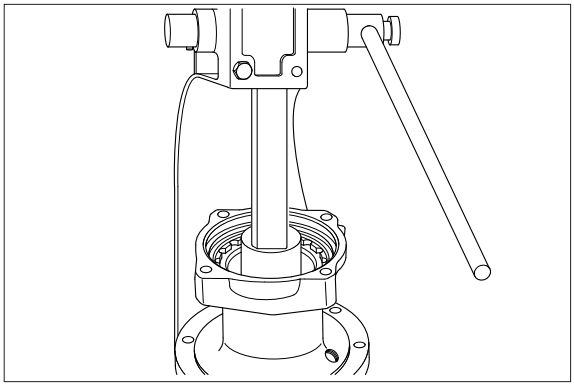
⑦ Assemble bushing (6) to cylinder block (3).



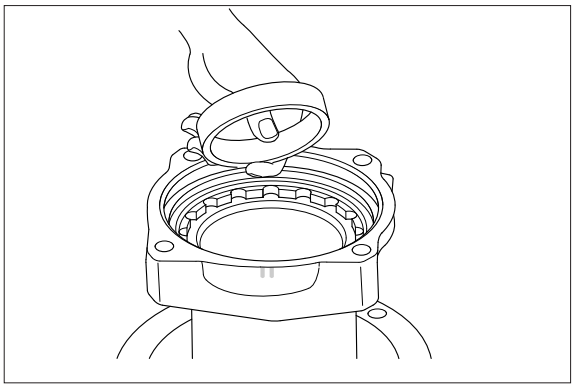
(3) Oil seal

Apply three bond of white color on outer surface of oil seal (2) and assemble and insert it.

※ Before assembling, lubricate lip of oil seal with grease.



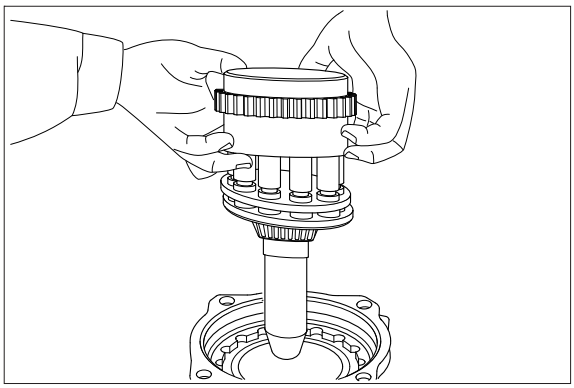
(4) Assemble outer race of taper roller bearing (5) to motor housing (1).



(5) Cylinder assembly

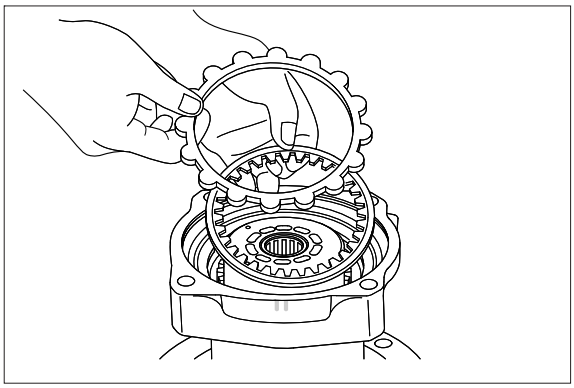
Hold end of cylinder assembly (3) with hands and assemble cylinder assembly to housing (1). Be careful to prevent damage of seal by spline of shaft.

※ When assemble cylinder assembly, spline shaft of cylinder is protruded from end of housing, therefore put pads with length 30~50 ㎜ under bottom of housing.



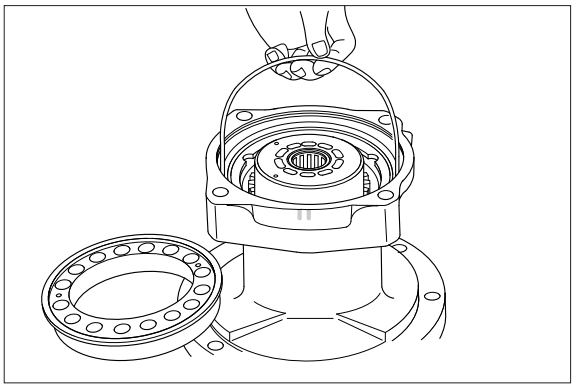
(6) Assemble friction plate (26) and lining plate (27).

※ Lubricate specified hydraulic oil on each side.



(7) Insert O-rings (14,29) into housing (1) and piston (28).

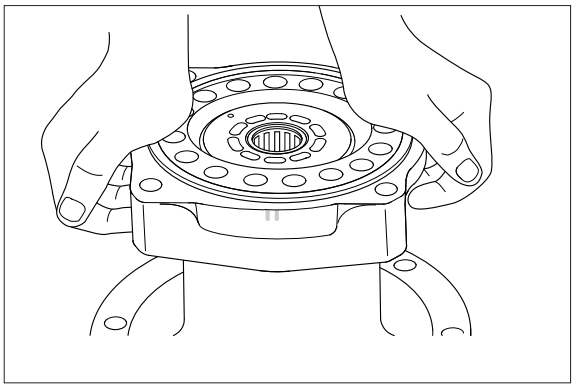
※ Lubricate O-ring with grease.



(8) Brake piston

Lubricate specified hydraulic oil on outer sliding face of piston (28) and assemble brake piston to housing (1).

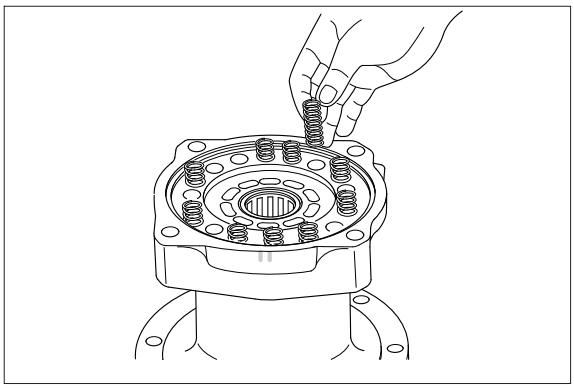
※ It is too tight to assemble piston (10) because O-rings (14,29) are fitted, therefore it is recommended to push piston (28) horizontally by hands at once.



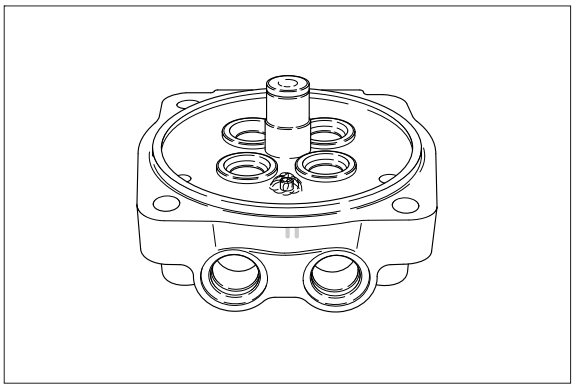
(9) Spring (30, brake unit)

Assemble spring (30) to piston (28) of brake unit.

※ Insert spring (30) into original position.



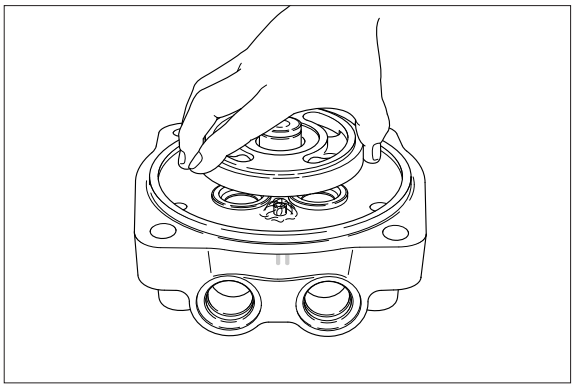
(10) Lubricate locating pin for antirotation of valve plate (16) of cover (12) with grease sufficiently and install locating pin to housing.



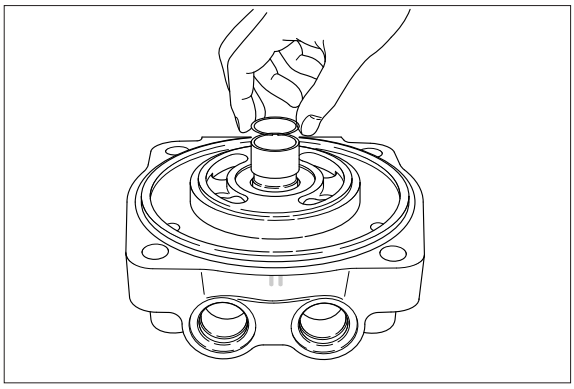
(11) Balance plate

Assemble valve plate (16) to cover (12).

※ Be cautious of assembling direction.

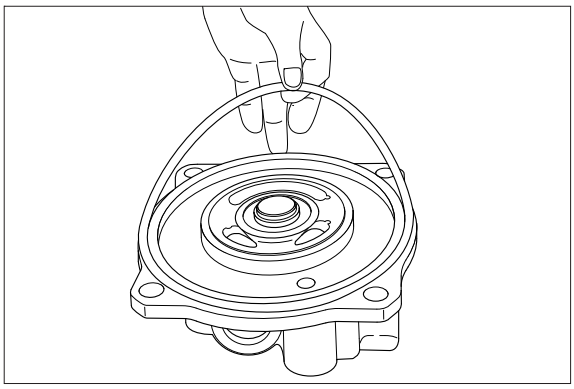


(12) Assemble inner race of needle bearing (15) and shim (22) to cover (12).

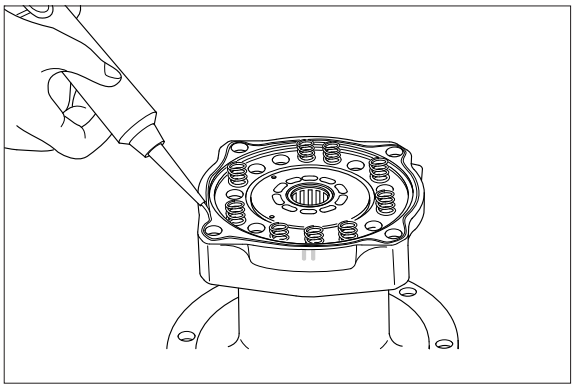


(13) Assemble O-ring (29) to cover (12).

※ Lubricate O-ring with grease.



(14) Apply three bond of white color to distinguish oil leakage from remaining oil in bolt hole of cover (12).

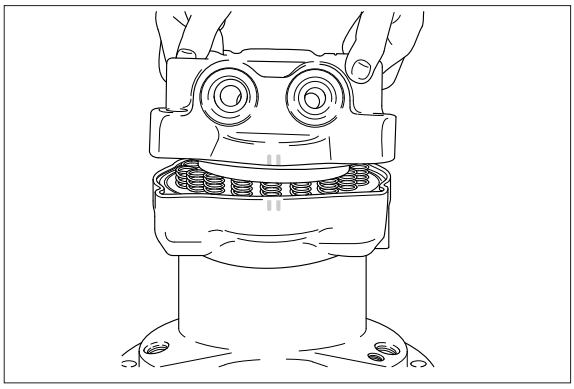


(15) Cover

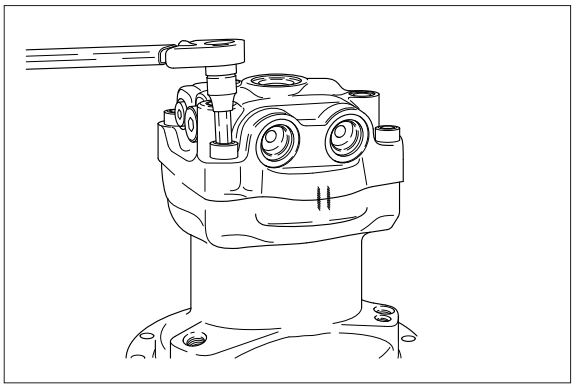
Assemble cover (12) and valve plate (16) to housing (1) lightly, holding them up with hands.

※ When assembling, be careful not to detach valve plate (16) from cover (12).

※ Fit matching marks on housing (1) and cover (12) made before disassembling.

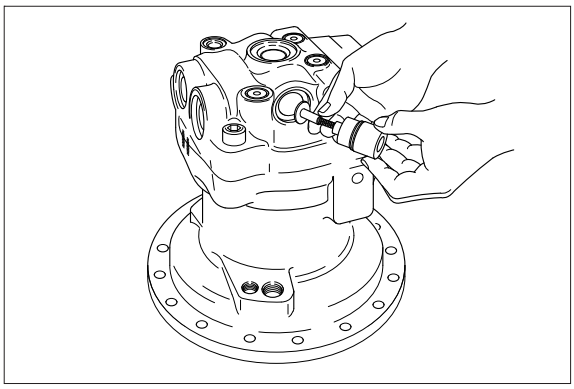


(16) Tighten cover (12) and housing (1) with 12 mm hexagonal socket bolt (18).
·Tightening torque : 16 kgf·m (116 lbf·ft)



(17) Make up valve

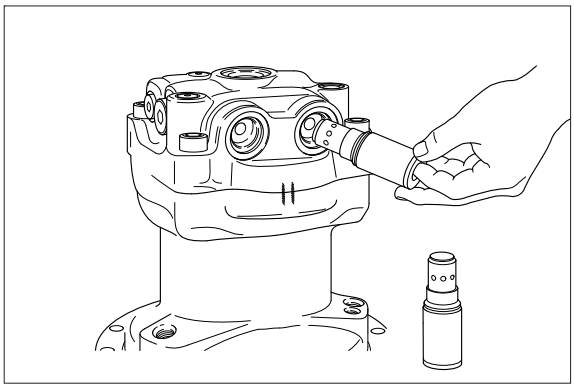
Assemble check (35) and spring (36) to cover (12) and tighten plug (37) with 14 mm hexagonal socket bolt.
·Tightening torque : 14 kgf·m (101 lbf·ft)



(18) Relief assembly

Assemble relief valve assembly (17) to cover (12) with 14 mm hexagonal socket bolt.
·Tightening torque : 8 kgf·m (58 lbf·ft)

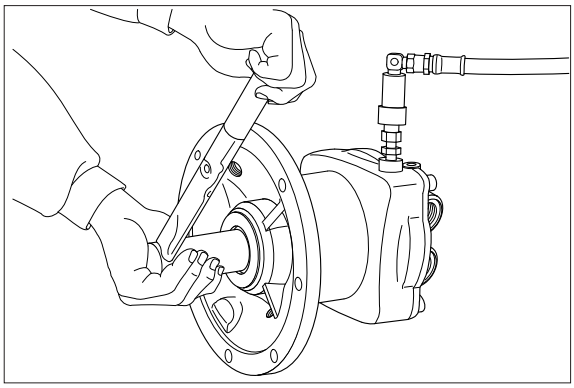
※ Be cautious of assembling method.



(19) Check of assembly

Load pilot pressure of 20 kgf/cm^2 to brake release port after opening inlet and outlet port.
Check if output shaft is rotated smoothly around torque of 0.5~1 kgf·m.
If not rotated, disassemble and check.

This completes assembly.



3. REMOVAL AND INSTALL OF REDUCTION GEAR

1) REMOVAL

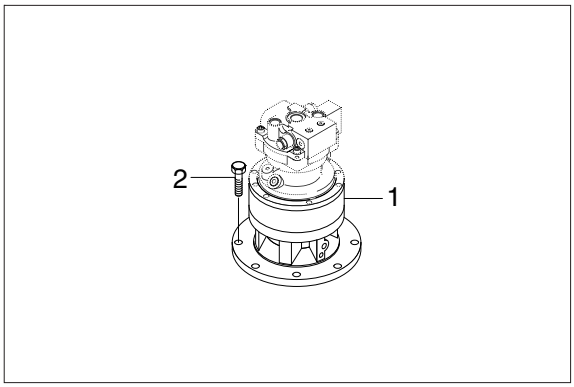
(1) Remove the swing motor assembly.
For details, see removal of swing motor assembly.

(2) Sling reduction gear assembly (1) and remove mounting bolts (2).

(3) Remove the reduction gear assembly.
·Reduction gear device weight : 45 kg
(99 lb)

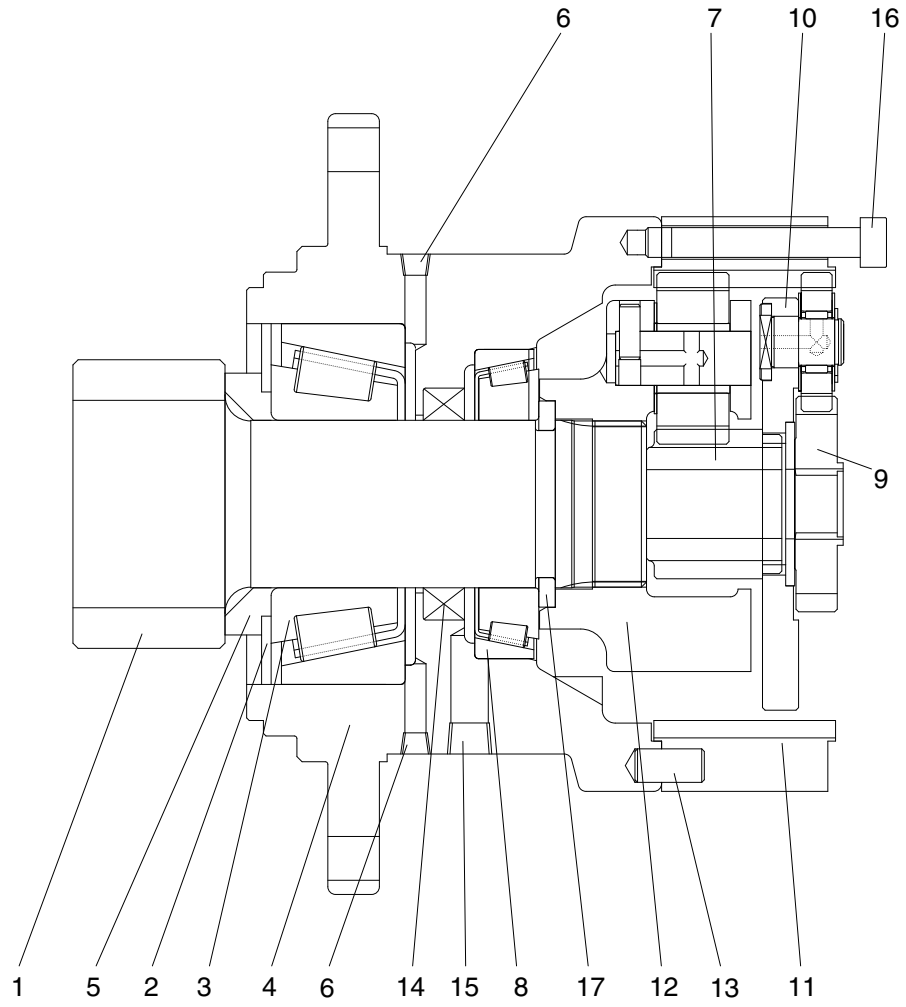
2) INSTALL

(1) Carry out installation in the reverse order to removal.
·Tightening torque : 10.5 kgf·m
(76 lbf·ft)



4. DISASSEMBLY AND ASSEMBLY OF REDUCTION GEAR

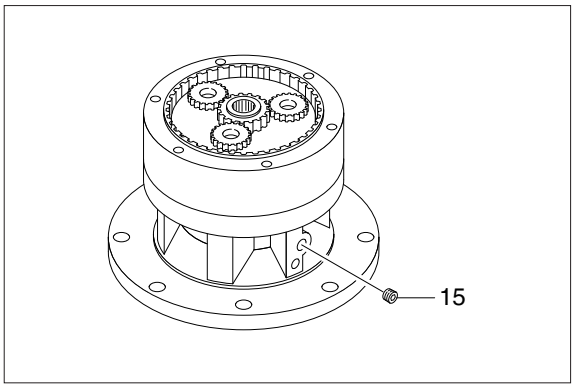
1) STRUCTURE



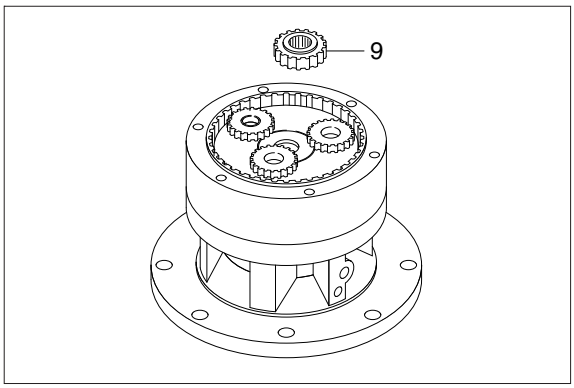
1	Pinion shaft	7	Sun gear No.2	13	Pin
2	Plate	8	Taper bearing	14	Oil seal
3	Taper bearing	9	Sun gear No.1	15	Plug
4	Case	10	Carrier assy No.1	16	Socket bolt
5	Collar No.1	11	Ring gear	17	Collar No.2
6	Plug	12	Carrier assy No.2		

2) DISASSEMBLY

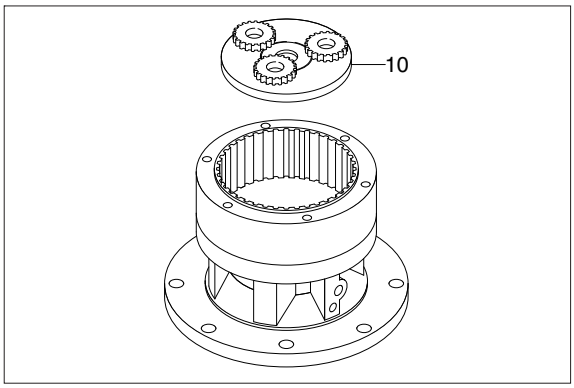
(1) Remove the plug (15) and drain out gear oil.



(2) Remove the No.1 sun gear (9).

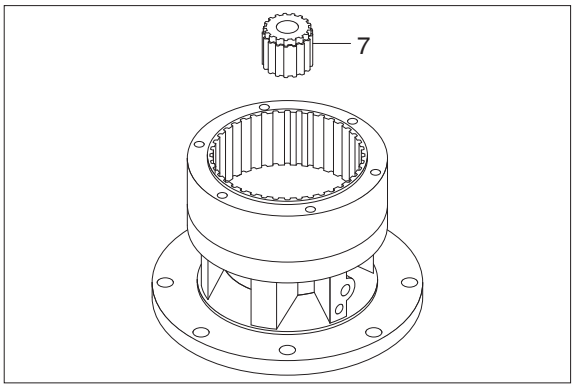


(3) Remove the No.1 carrier sub-assembly (10) using the jig.

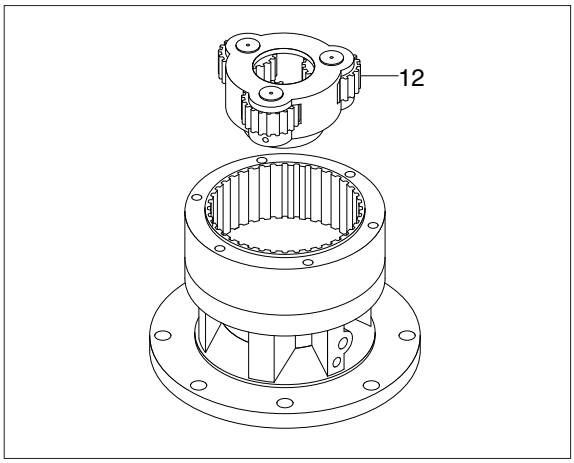


(4) Remove the No.2 sun gear (7).

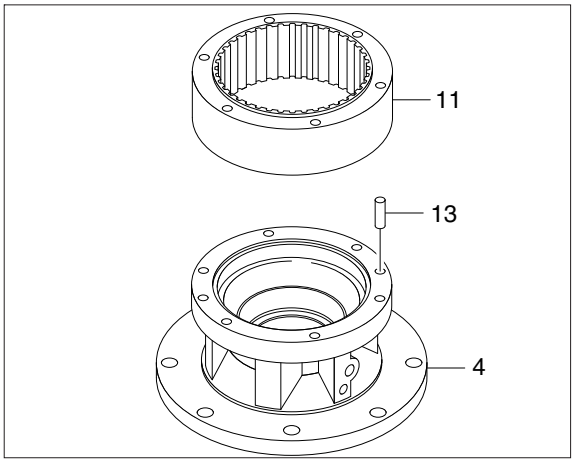
※ Pay attention to ensure the gear is not damaged during disassembling.



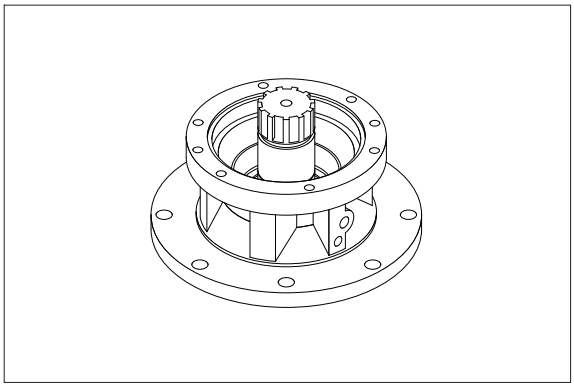
(5) Remove the No.2 carrier sub assembly (12).



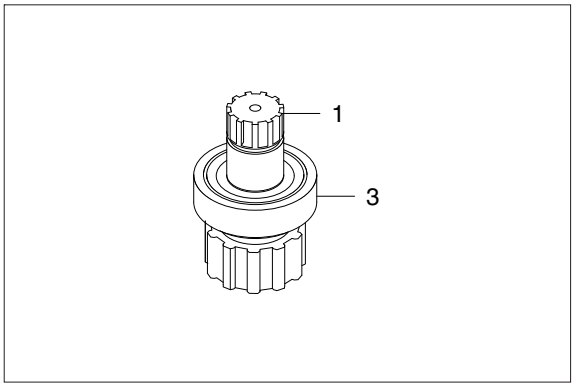
(6) Remove the ring gear by the removal groove between the ring gear (11) and casing (4) by using jig.
Full out the knock pin (13).
Do not need to remove the knock pin (13) if it is not worn or damaged.



(7) Put it on the working table with the drive shaft up.

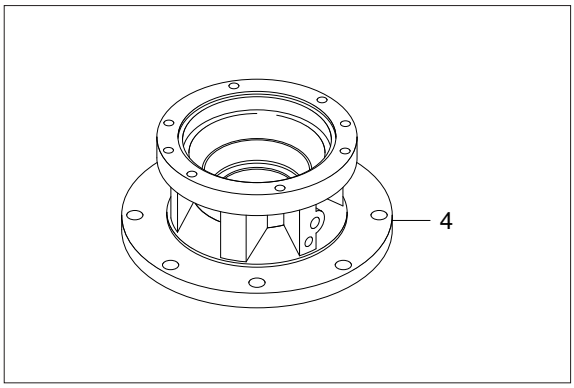


(8) Disassemble the drive shaft (1) with bearing (3) by using jig.



3) ASSEMBLING SWING REDUCTION GEAR

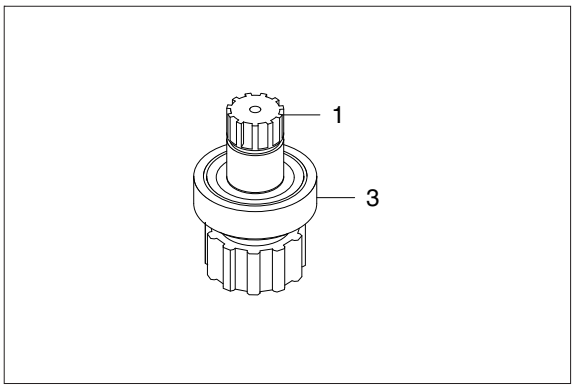
(1) Place the case (4) on the reversing machine having the flange side of the case up.



(2) Install shaft assembly (1) into case (4).

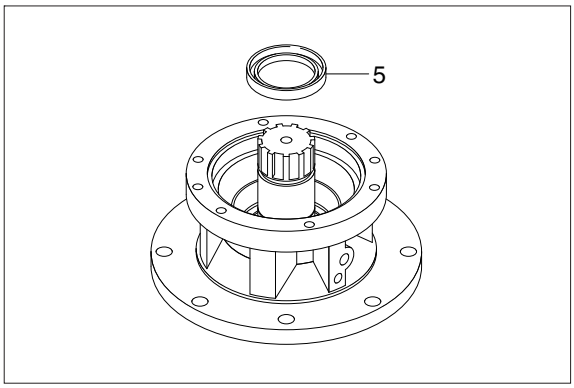
※ Be sure to clean the case before install, using washing machine with the temperature of 80˚C

※ Do not install shaft assembly by force.

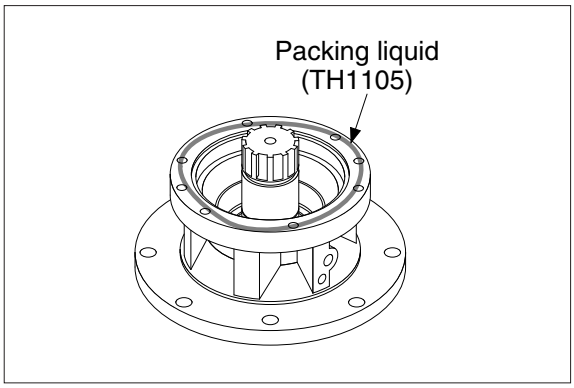


(3) Reverse case and press to insert oil seal (5) by using pressing jig after spreading grease oil around the outside ring of the seal and bearing.
Coat grease oil slightly on the lip surface to prevent any scratch when installing.

※ Be sure to check by eye that the oil seal is seated completely after being installed.



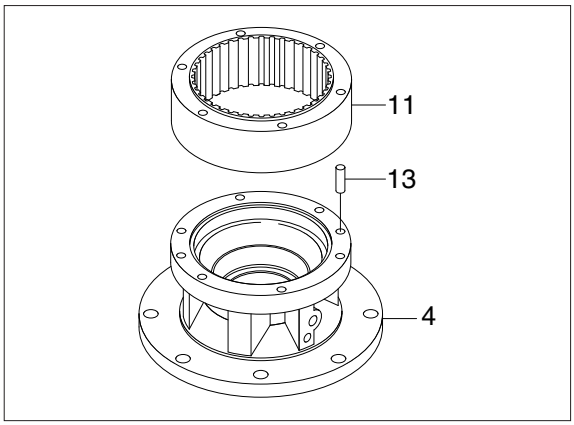
(4) Clean the assembling surface of case and spread packing liquid (TH1105) as shown in figure.



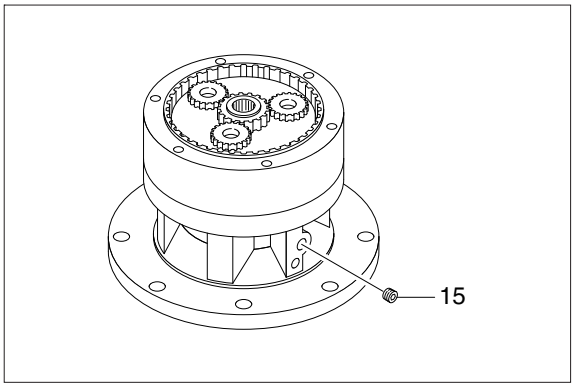
(5) Place ring gear on the case by matching it with knock pin hole.

(6) Insert 2 knock pins by using jig.

※ Be sure to check the hole location of oil gage before inserting.

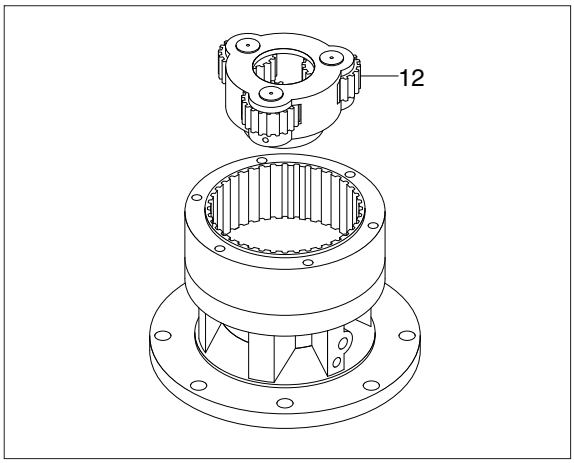


(7) Screw drain plug into drain plug (15) after winding sealing tape.



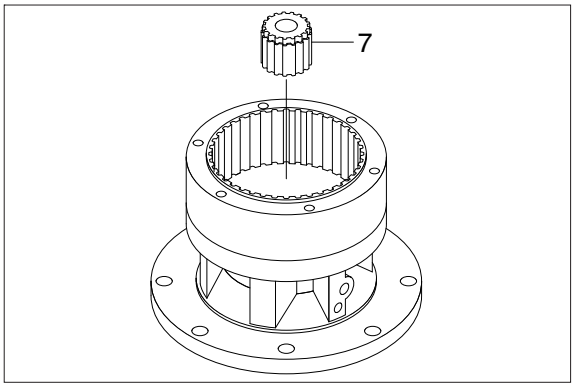
(8) Mount No.2 carrier assembly (12) in the case sub assembly and install bolts into 2 TAP holes (M6) as shown in figure.

※ Turn the carrier slowly by hand to adjust the matching holes when assembling.



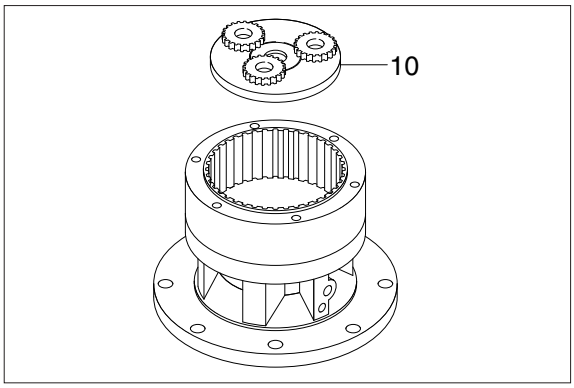
(9) Install No.2 sun gear (7).

※ Be sure to check the direction of sun gear (7) when assembling.

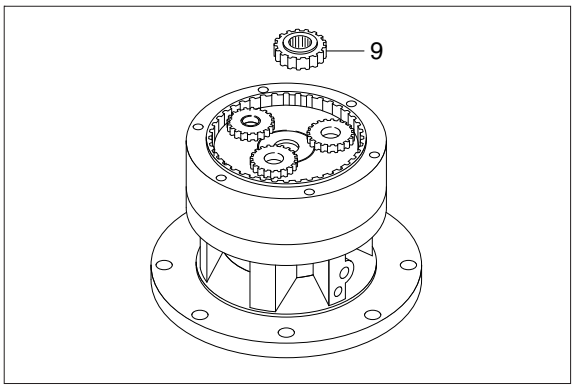


(10) Mount No.1 carrier assembly (10) in the case sub assembly and install bolts into 2 TAP holes (M6) as shown in figure.

※ Turn the carrier slowly by hand to adjust the matching holes when assembling.



(11) Assemble No.1 sun gear (9).



GROUP 4 TRAVEL MOTOR

1. REMOVAL AND INSTALL

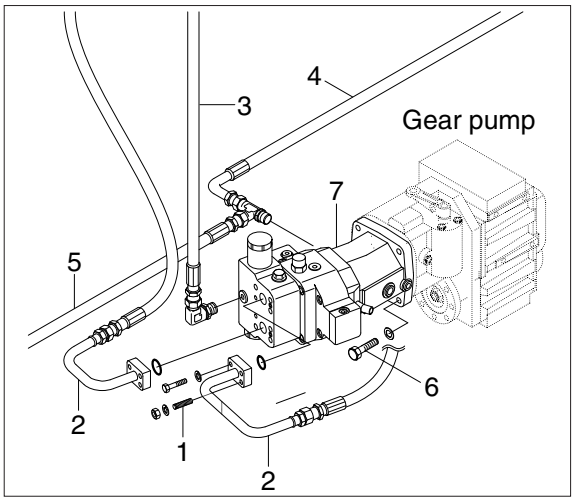
1) REMOVAL

(1) Lower the work equipment to the ground and stop the engine.

(2) Operate the control levers and pedals several times to release the remaining pressure in the hydraulic piping.

(3) Loosen the breather slowly to release the pressure inside the hydraulic tank.

⚠ **Escaping fluid under pressure can penetrate the skin causing serious injury.**



(4) Loosen the socket stud (1) and remove the pipe assy (2).

(5) Disconnect hoses (3,4,5).

(6) Loosen the hex bolt (6) and remove travel motor (7).
·Weight : 80 kg (180 lb)

※ When removing the travel motor assembly, check that all the hoses have been disconnected.

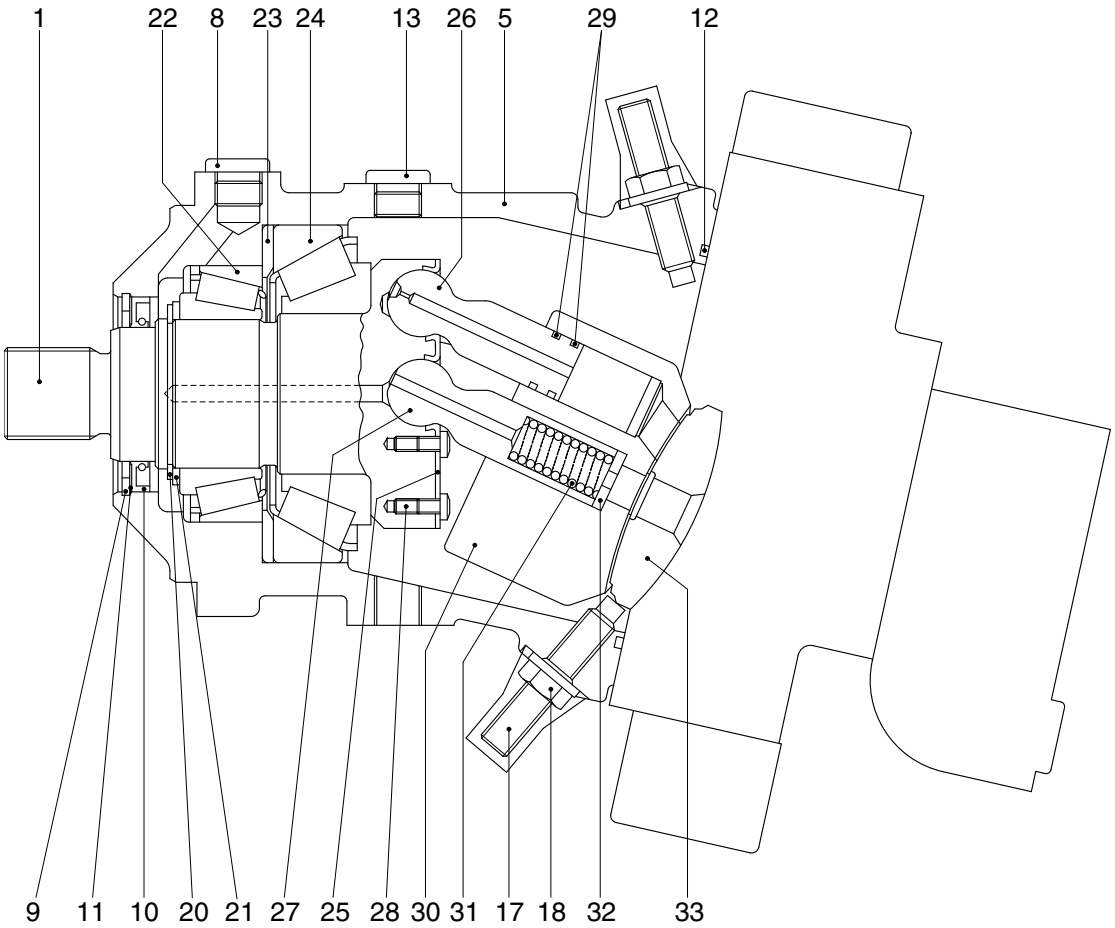
2) INSTALL

(1) Carry out installation in the reverse order to removal.

(2) Confirm the hydraulic oil level and check the hydraulic oil leak or not.

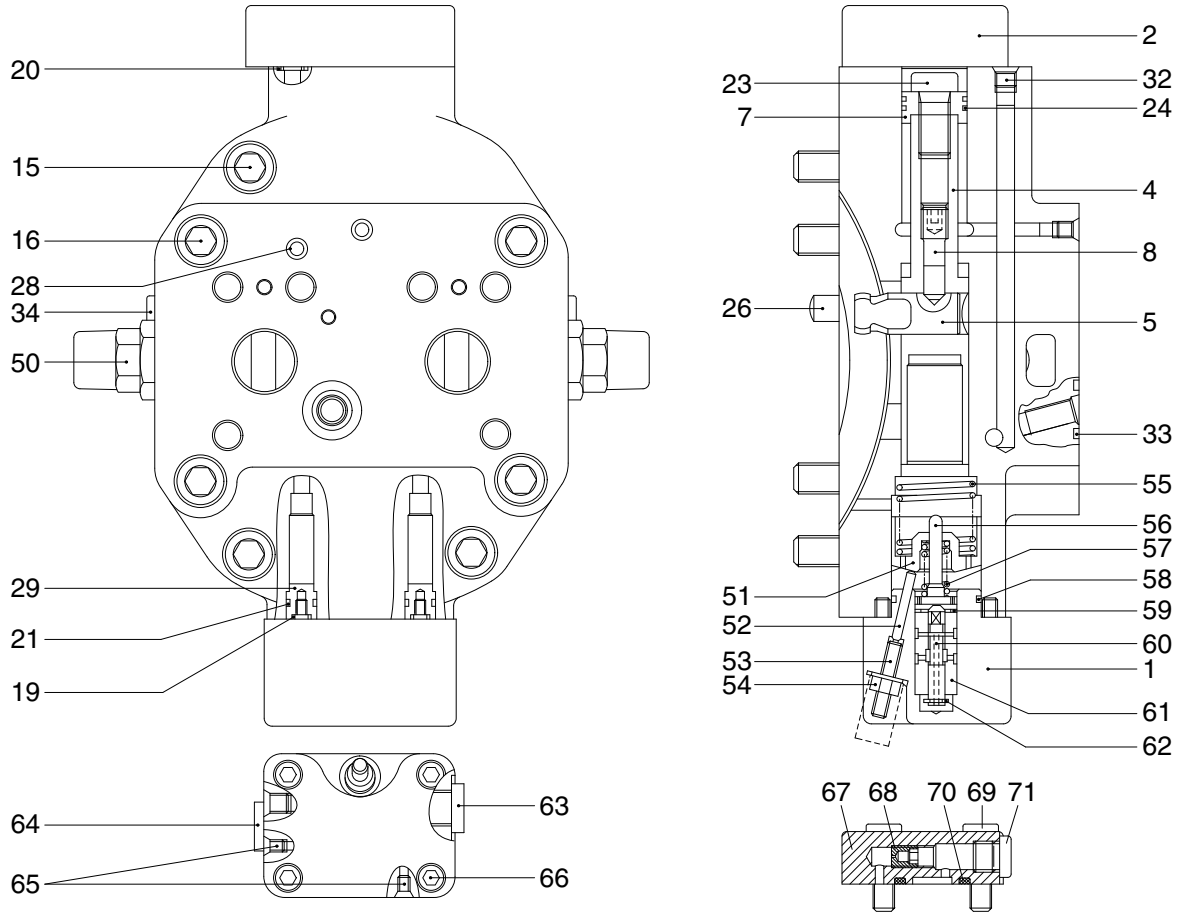
2. STRUCTURE

1) MOTOR UNIT



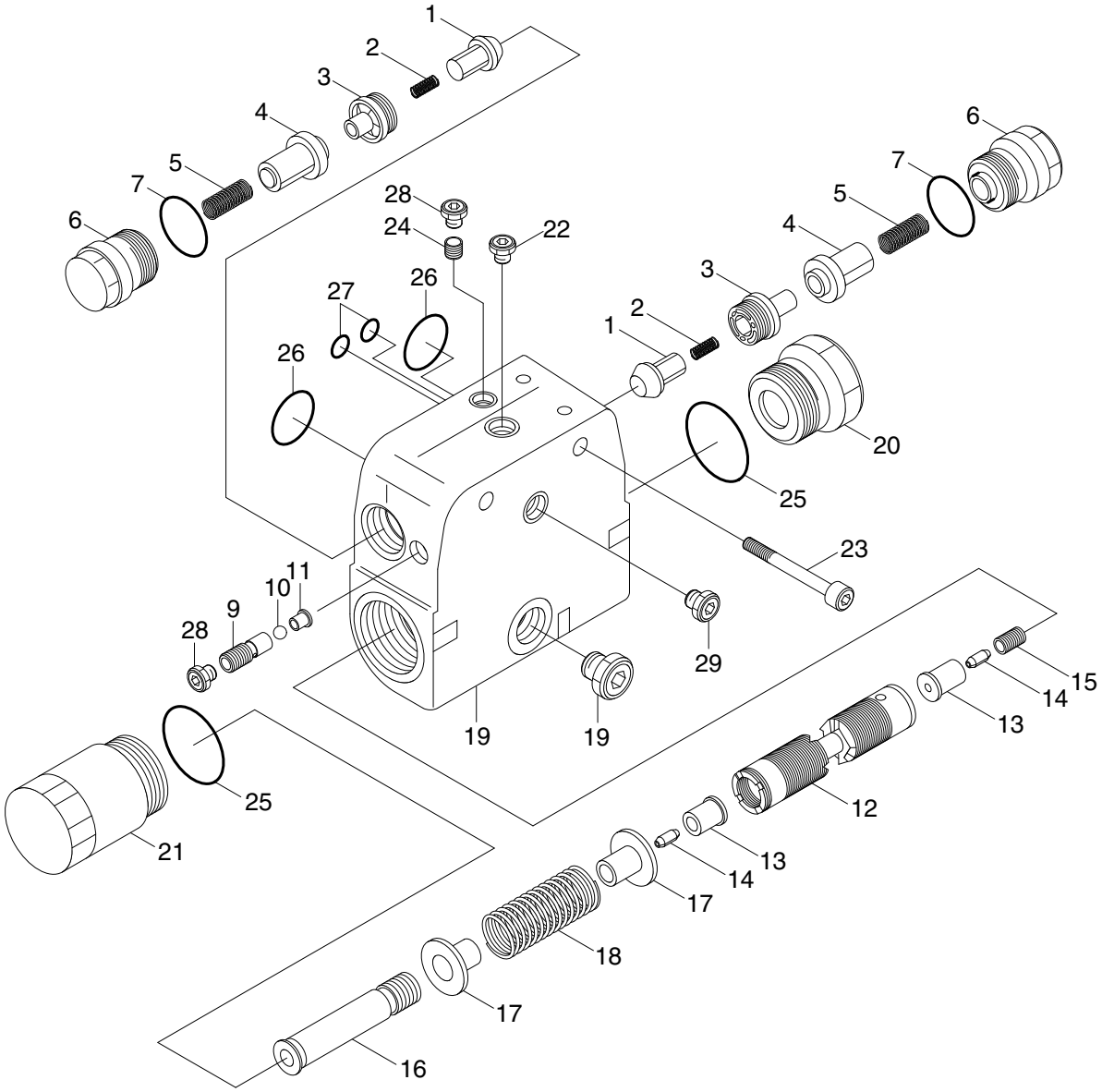
1	Drive shaft	17	Threaded pin	26	Piston
5	Housing	18	Seal lock nut	27	Center pin
8	Locking screw	20	Retaining ring	28	Pan head screw
9	Retaining ring	21	Back up plate	29	Steel sealing ring
10	Shaft seal ring	22	Taper roller bearing	30	Cylinder block
11	Back up plate	23	Shim	31	Pressure spring
12	O-ring	24	Taper roller bearing	32	Adjustment shim
13	Locking screw	25	Retaining plate	33	Control lens

2) CONTROL UNIT



1	Control housing	28	Double break off pin	59	Retaining ring
2	Cover	29	Plug	60	Control piston
4	Positioning piston	32	Double break off pin	61	Control bushing
5	Positioning trunnion	33	O-ring	62	Retaining disc
7	Piston	34	Locking screw	63	Locking screw
8	Threaded pin	50	Relief valve	64	Locking screw
15	Socket head screw	51	Adjusting bushing	65	Double break off pin
16	Socket head screw	52	Cylinder pin	66	Socket head screw
19	O-ring	53	Threaded pin	67	Cover
20	O-ring	54	Seal lock nut	68	Throttle screw
21	O-ring	55	Pressure spring	69	Socket head screw
23	Socket head screw	56	Spring collar	70	O-ring
24	Square ring	57	Pressure spring	71	Locking screw
26	Cylinder pin	58	O-ring		

3) COUNTER-BALANCE VALVE



1	Valve poppet	12	Brake piston	21	Locking screw
2	Pressure spring	13	Valve bushing	22	Locking screw
3	Poppet seat	14	Throttle pin	23	Socket screw
4	Valve poppet	15	Valve screw	24	Plug
5	Pressure spring	16	Bolt	25	O-ring
6	Locking screw	17	Spring collar	26	O-ring
7	O-ring	18	Pressure spring	27	O-ring
9	Valve screw	19	Housing	28	Locking screw
10	Ball	20	Locking screw	29	D/Break OFF pin
11	Bushing				

3. TIGHTENING TORQUE

The torques given are standard figures. Any figures specifically described in the procedure has priority.

Page	Item	Size	kgf·m	lbf·ft
8-75	8	M22 × 1.5	6.1	44
	13	M26 × 1.5	7.1	51
	18	M12	7.0	50.9
	28	M 6 × 20	1.4	10.3
8-76	15	M16 × 45	21.4	155
	23	M14 × 25	13.8	99.5
	34	M18 × 1.5	4.0	29
	53	M 6 × 30	1.4	10.3
	54	M6	1.0	7.4
	63	M14 × 1.5	3.0	22
	66	M 8 × 40	2.5	18.4
	69	M12 × 35	12.2	88.4
	71	M14 × 1.5	3.0	22

4. DISASSEMBLY AND ASSEMBLY

1) GENERAL PRECAUTIONS

(1) Disassembly

① Before disassembling the motor, check the items to be inspected and, for remedy against trouble, closely examine the nature of the trouble, so that the motor can be disassembled effectively.

② To disassemble the motor, use the disassembling procedures described in section 2) and select a clean place.

③ Place a rubber or vinyl sheet or other such protective materials on your working bench to protect the surface of the motor to be serviced.

④ During disassembly, give a match mark to the mating surfaces of each part.

⑤ Arrange removed parts in order so that they will not become damaged or missing during disassembly.

⑥ Once seals have been disassembled, they should be replaced even if damage is not observed. Have replacement seals ready on hand before starting your disassembling job.

(2) Assembly

① Reassemble in a work area that is clean and free from dust and grit.

② Handle parts with bare hands to keep them free of linty contaminants.

③ Repair or replace the damaged parts.
Each parts must be free of burrs its corners.

④ Do not reuse O-ring oil seal and floating seal that were removed in disassembly.
Provide the new parts.

⑤ Wash all parts thoroughly in a suitable solvent.
Dry thoroughly with compressed air.
Do not use the cloths.

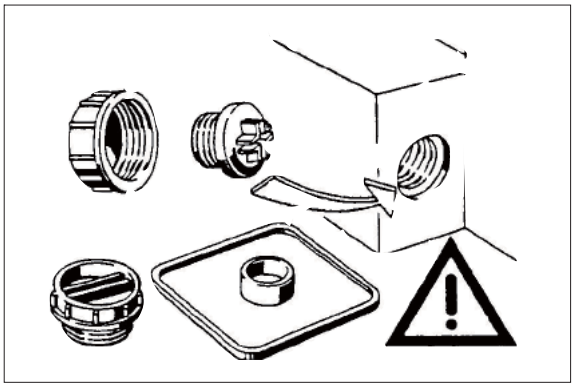
⑥ When reassembling oil motor components of motor, be sure to coat the sliding parts of the motor and valve with fresh hydraulic oil. (NAS class 9 or above)

⑦ Use a torque wrench to tighten bolts and plugs, to the torque specified as follows.

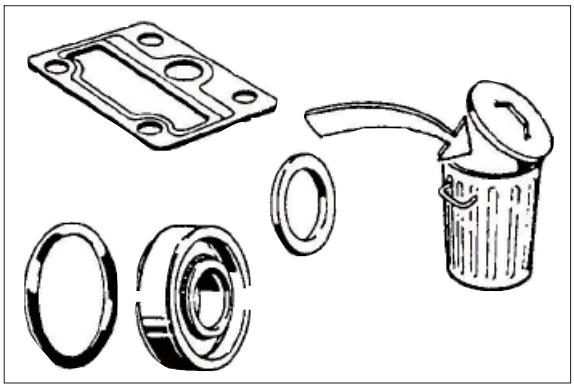
2) SEAL KITS AND COMPONENT GROUPS

Observe the following notices when carrying out repair work at hydraulic aggregates.

(1) Close all ports of the hydraulic aggregates.

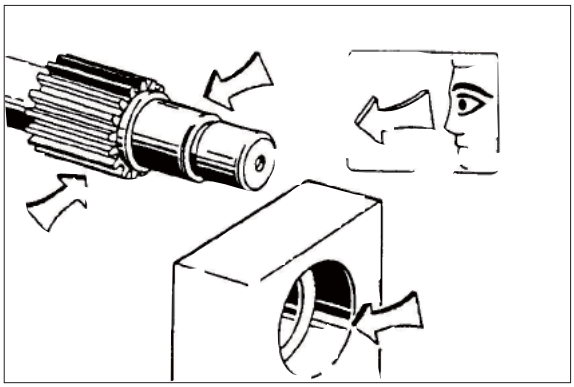


(2) Replace all seals.
Use only original hydromatik spare parts.

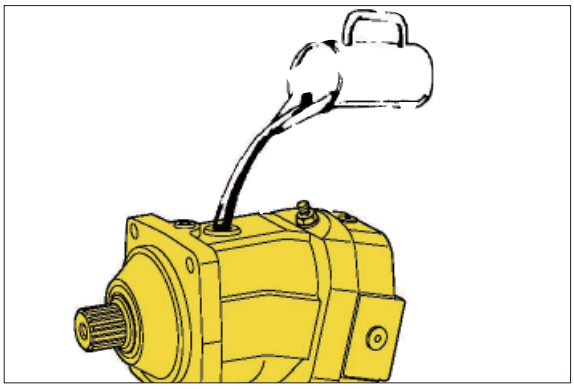


(3) Check all seal and sliding surfaces for wear.

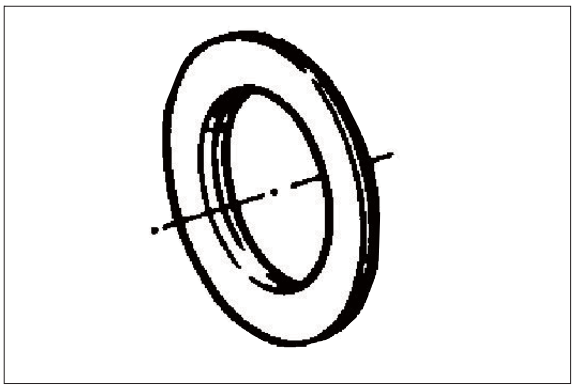
※ Rework of sealing area f.ex. with abrasive paper can damage surface.



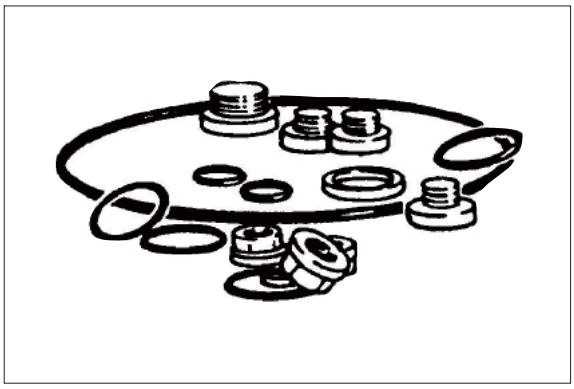
(4) Fill up hydraulic aggregates with hydraulic oil before start up.



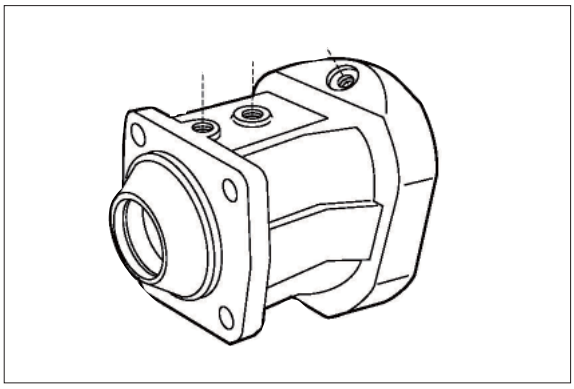
(5) Seal kit for drive shaft



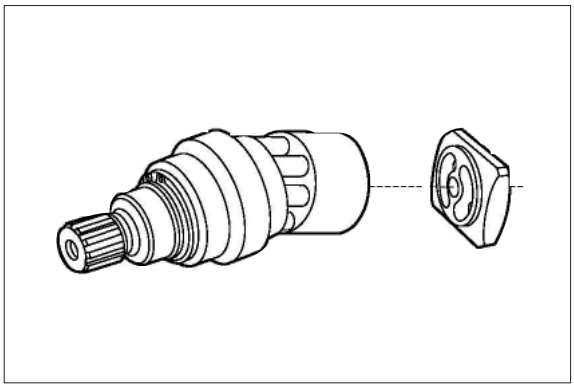
(6) External seal kit.



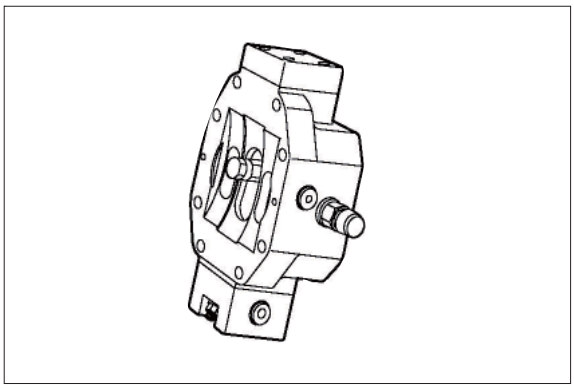
(7) Housing.



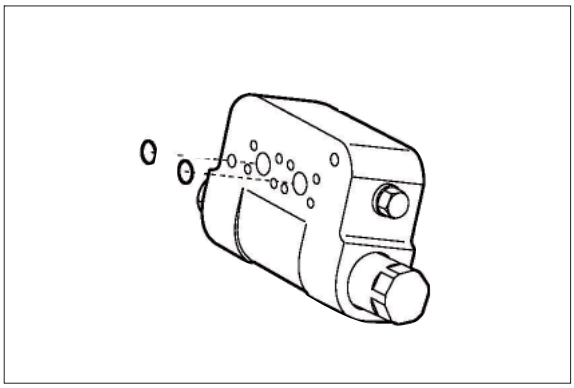
(8) Complete rotary group.



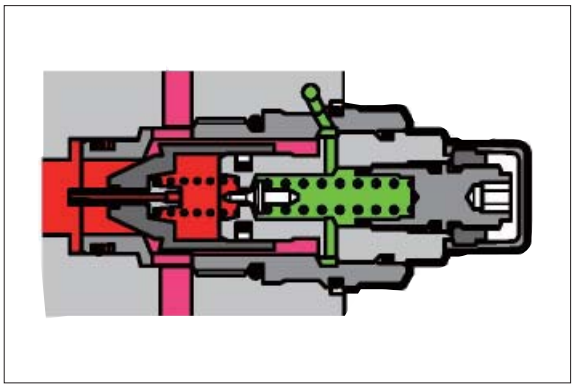
(9) Port plate with control piston.



(10) Counter balance valve.

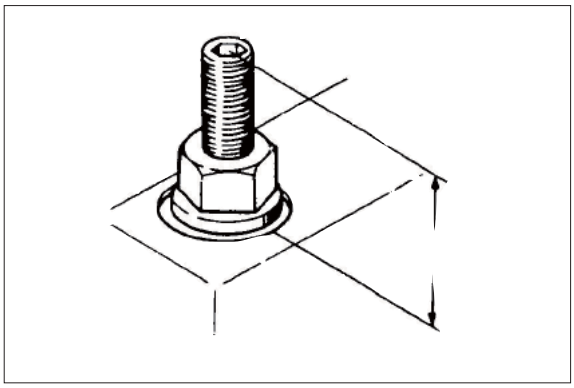


(11) Relief valve / Make up check valve.

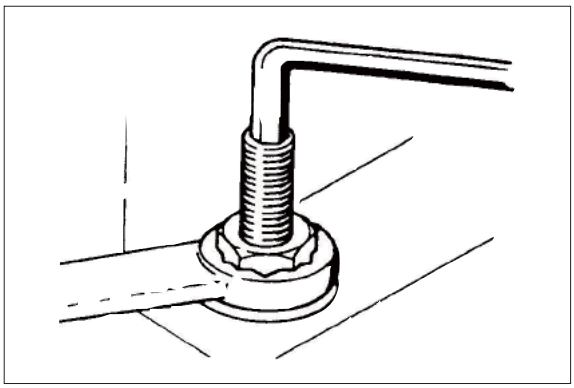


3) SEAL NUT

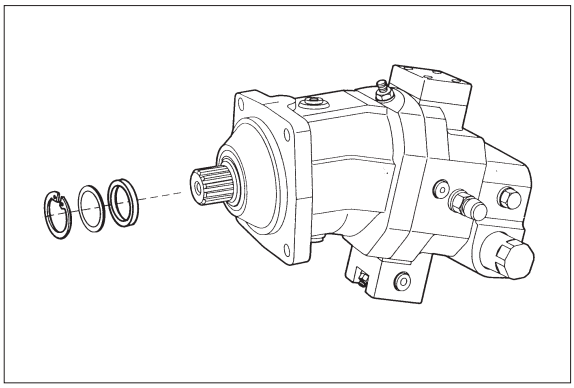
(1) Replace seal nut.
First measure and record setting height.



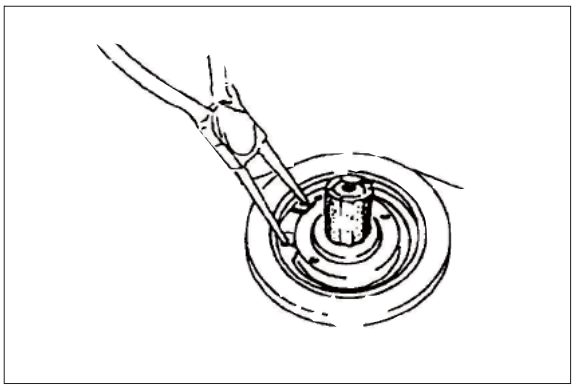
(2) When tightening, counterhold setting screw, then check setting height.



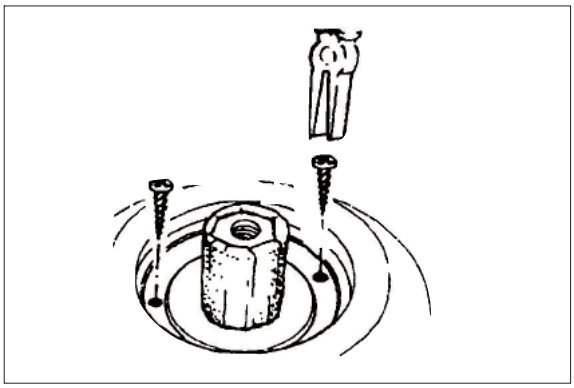
4) SEALING THE DRIVE SHAFT



(1) Protecting the drive shaft.
Remove retaining ring and shim.



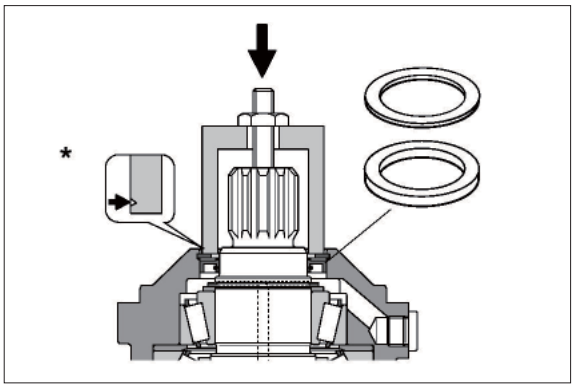
(2) Screw in sheet metal screw into the holes fitted with rubber.
Pull out seal with pliers.



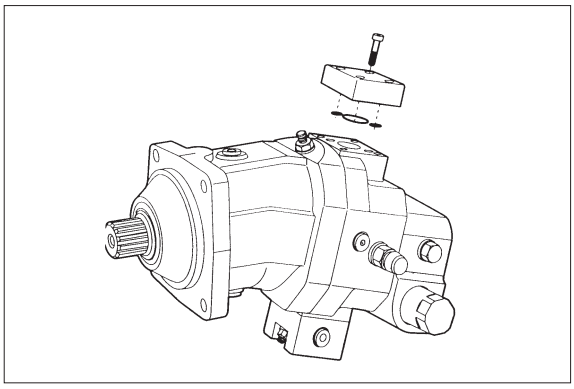
(3) Press in shaft seal and shim with bush to stop.

⚠ **Pay attention to pressing depth.**

* Mark for pressing depth.
Assemble retaining ring.

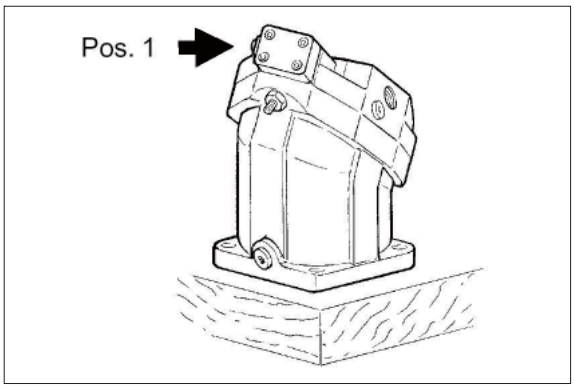


5) SEALING OF THE CONTROL PARTS



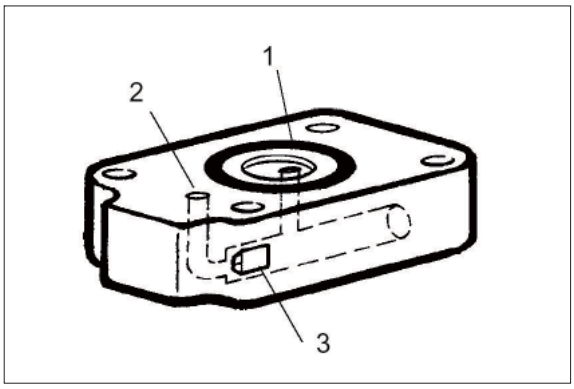
(1) Disassembly position

Remove cover 1.

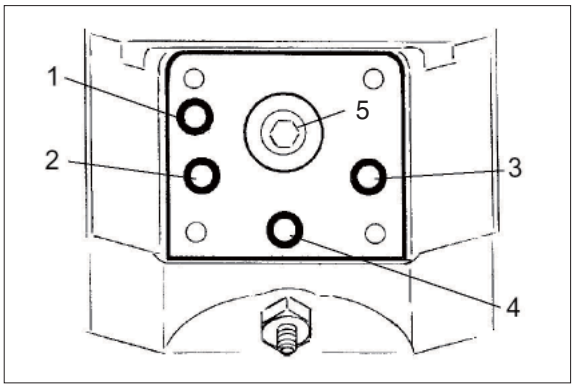


1 O-ring
2 Input flow of oil control
3 Throttle pin

※ Installation position differs according to the control components.

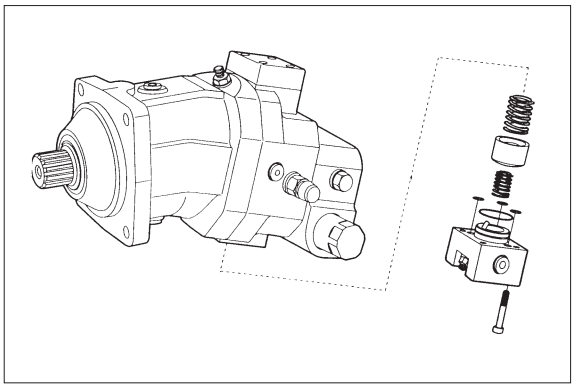


1 Input flow of oil control
2 High pressure / Low pressure
3 High pressure / Low pressure
4 Leakage oil
5 Control piston

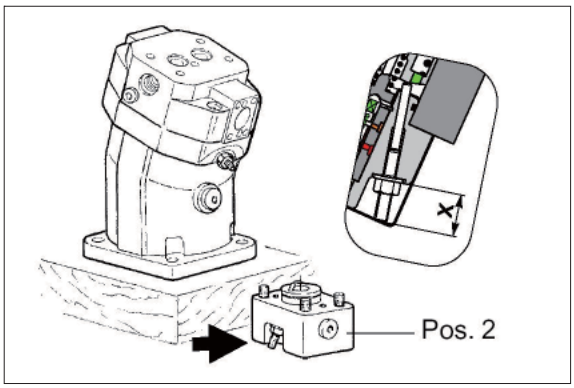


(2) Disassembly position : Remove cover 2.

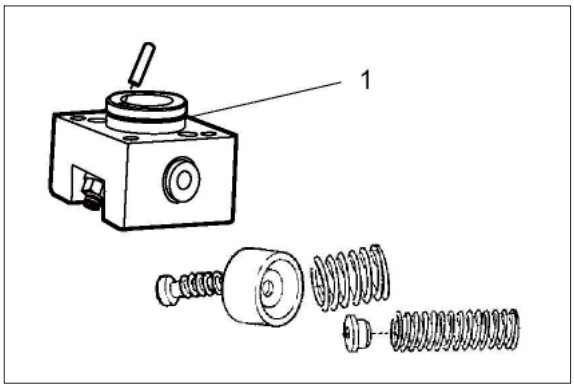
※ Attention spring load.



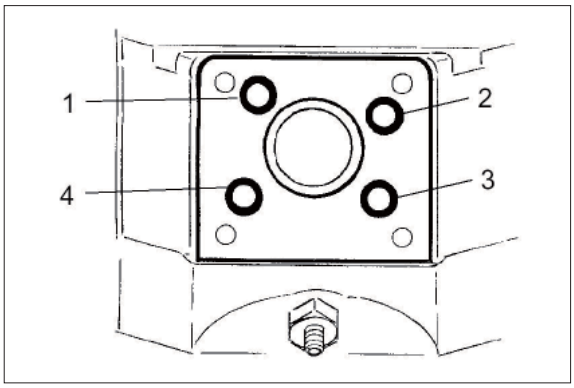
※ Dimension X : Note dimension (begin of regulation)



1 Check of O-ring

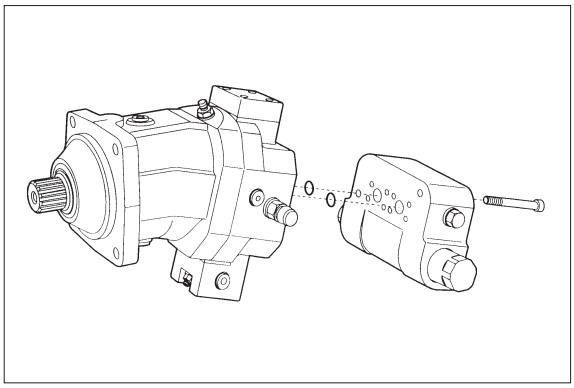


1 O-ring / High pressure-small control position side
2 O-ring / Control pressure
3 O-ring / High pressure-check valve
4 O-ring / High pressure-check valve

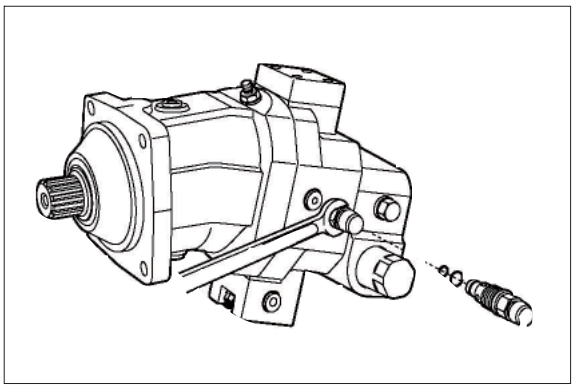


6) SEALING OF THE RELIEF VALVE / COUNTER BALANCE VALVE

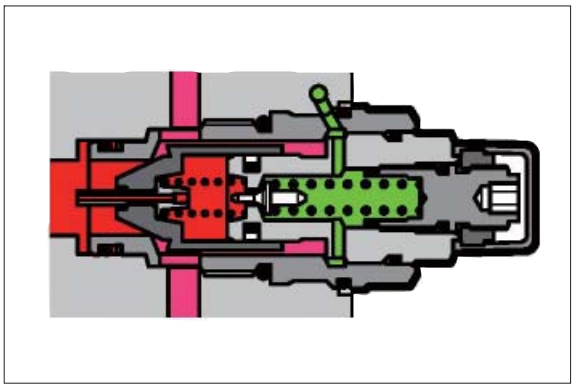
·Remove counter balance valve
·Inspect
·O-ring



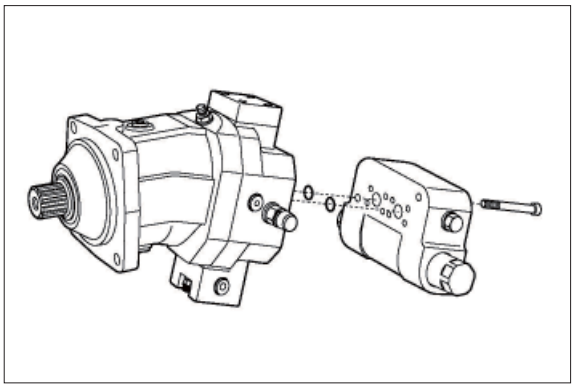
(1) Remove relief valve



(2) Inspect
O-ring



(3) Remove counter-balance valve.
Inspect
O-ring

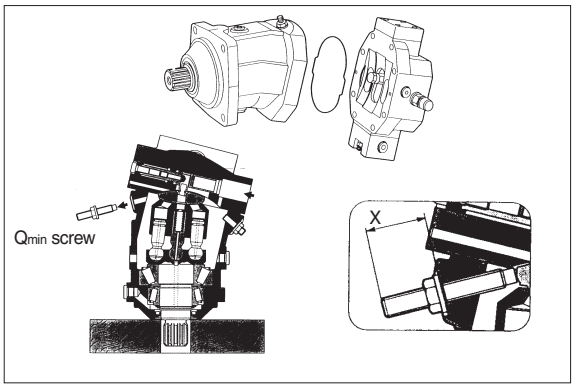


7) DISASSEMBLY OF THE PORT PLATE

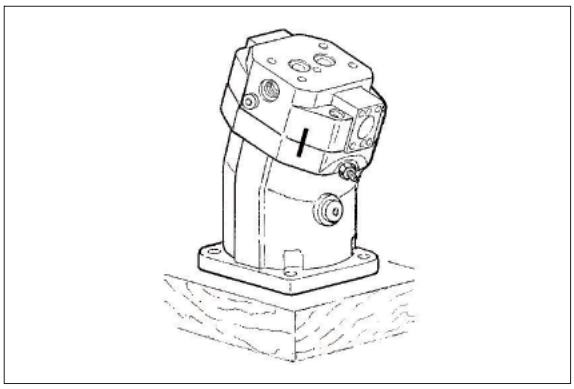
·Note dimension X

·Remove Q_{min} screw

·Swivel rotary group to zero P

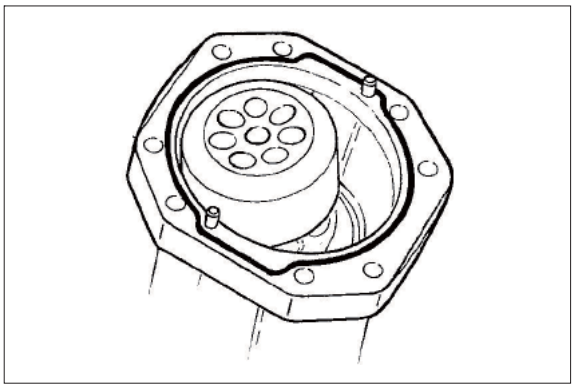


(1) Port plate.
Mark position. Loosen screws.
Removal.

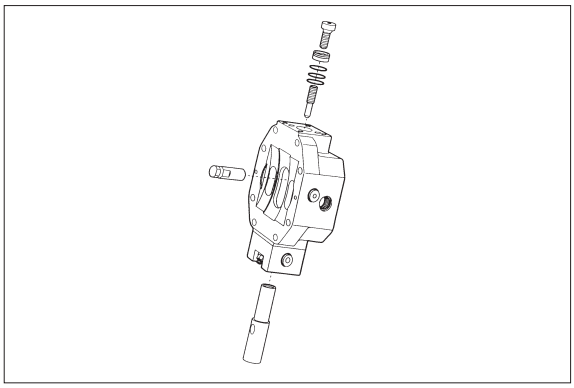


(2) Check O-ring.

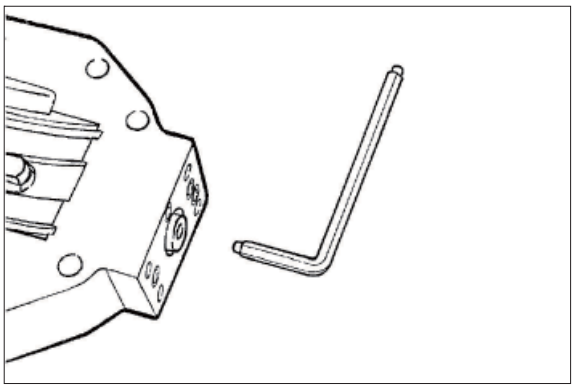
※ Stick new O-ring with some grease.
Do not swivel rotary group.
Piston rings to hang out from the cylinder boring.



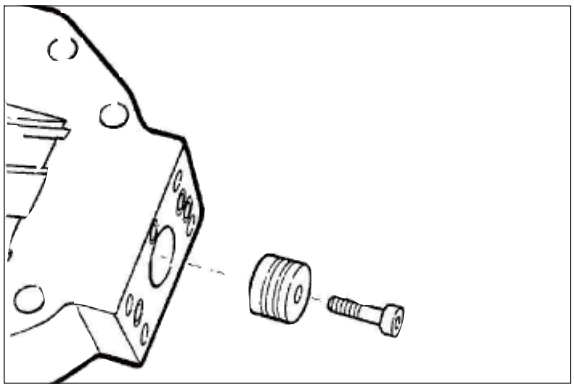
8) REMOVE OF THE POSITIONING PISTON



(1) Loosen fixing screw.
Use only socket wrench.

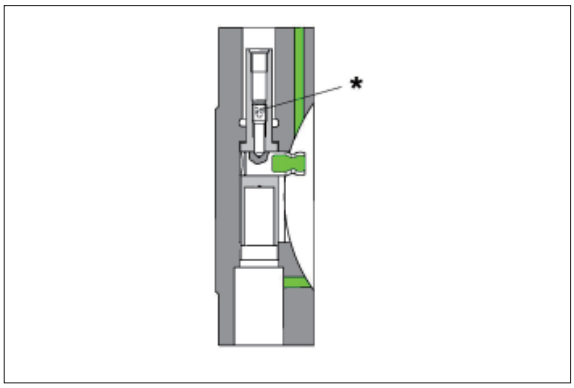


(2) Remove piston with piston ring.



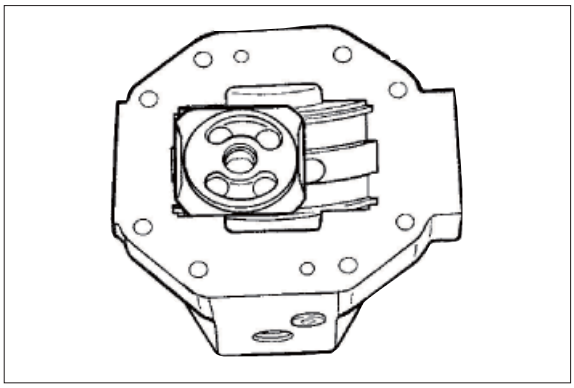
(3) Warm up fixation screw *for positioning plug via boring (screw glued-to turn out).

※ Use new screw.
Precode coating.
Note tightening torque.

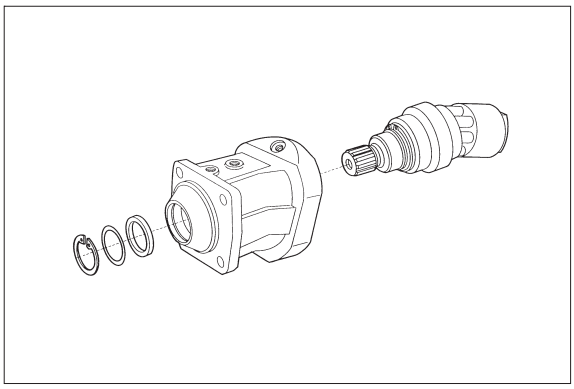


※ Stick control lens in sliding surface with grease. Assembly in reversal order. Mount port plate.

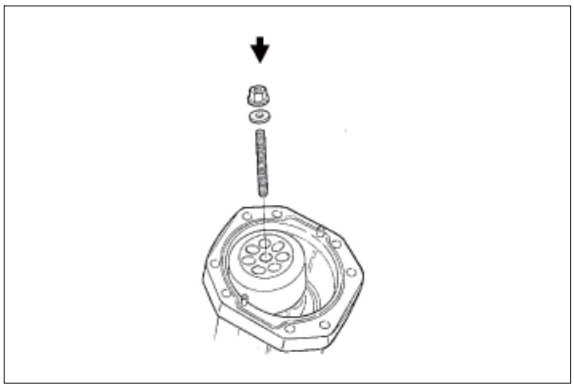
※ Rotary group vertical.



9) REMOVE ROTARY GROUP

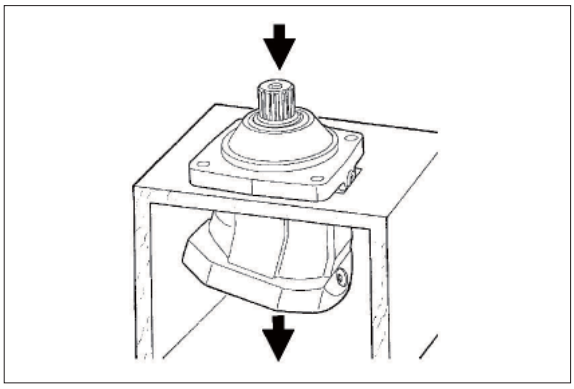


(1) Screw in threaded pin into center pin. Fix the cylinder with disc and locknut. M8×105ℓ



(2) Press out rotary group.

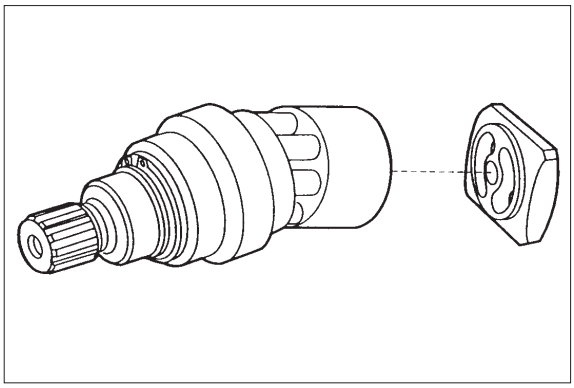
※ If the bearings are used again do not hit on the drive shaft.



10) EXCHANGING OF THE ROTARY GROUP

Complete rotary group

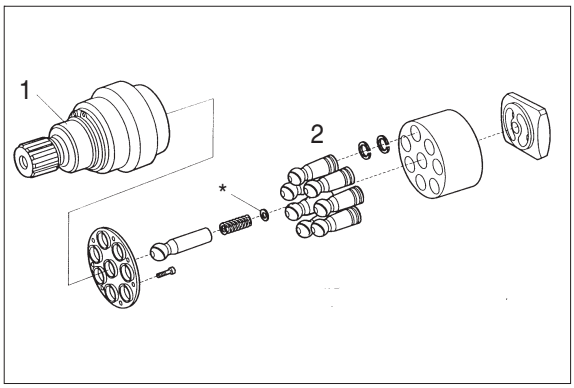
※ Setting of hydraulic part necessary.



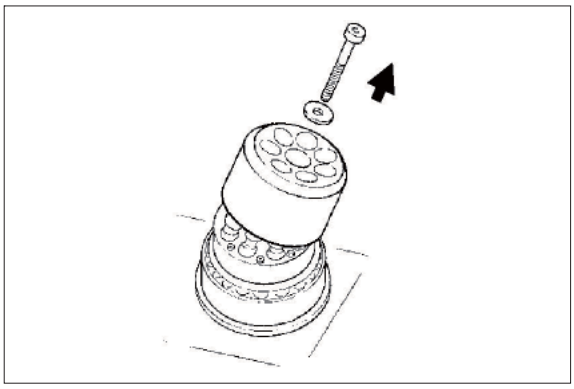
Rotary group

1 Mechanical part : Adjust drive shaft with bearing

2 Hydraulic part : Adjustment necessary

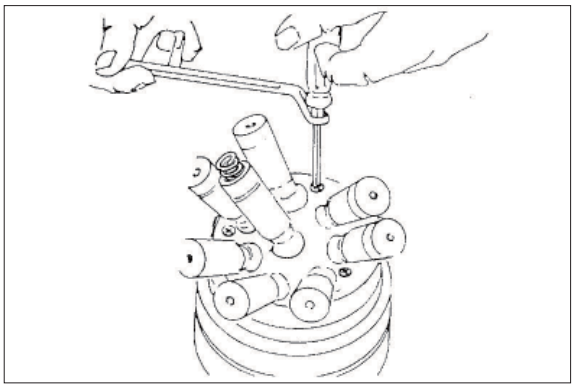


(1) Remove fixing screw (cylinder).
Remove cylinder.



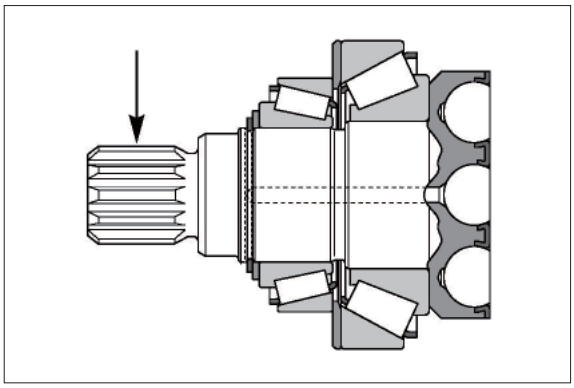
(2) Disassemble retaining plate.

※ Screws are glued.
Use Torx tools.



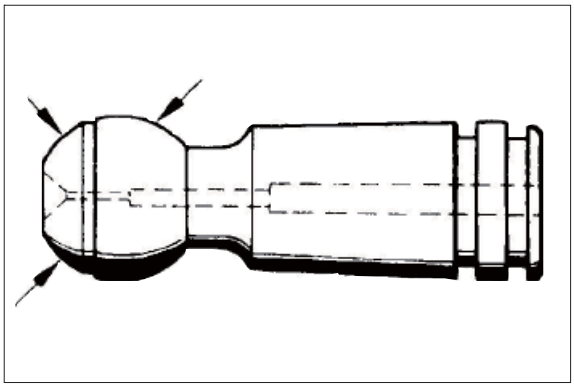
11) INSPECTION INSTRUCTIONS

(1) Free of corrosion, erosion or fretting; No damage to splines or keyways.



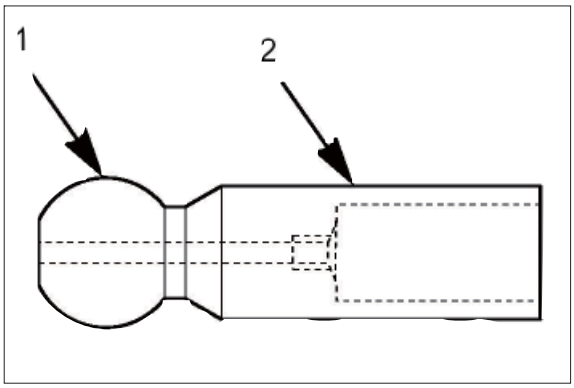
(2) Pistons

No scoring and no pittings.



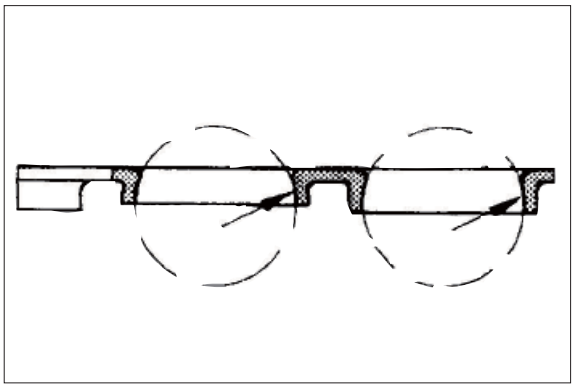
(3) Center pin

No scoring and no pittings.



(4) Retaining plate

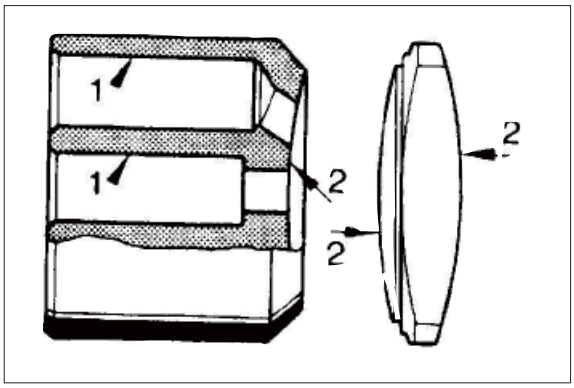
No scoring and no evidence of wear.



(5) Cylinder block / Control lens

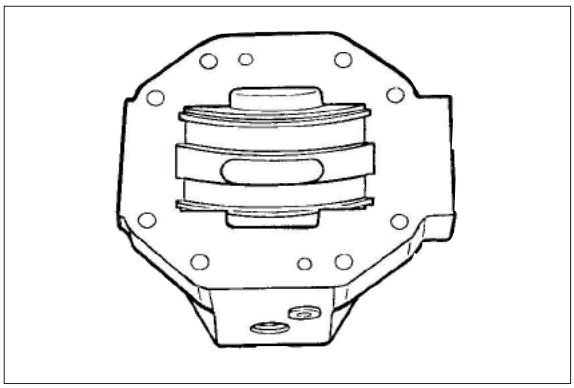
1 Bores free of scoring, no evidence of wear

2 Faces smooth and even, free of cracks and scoring



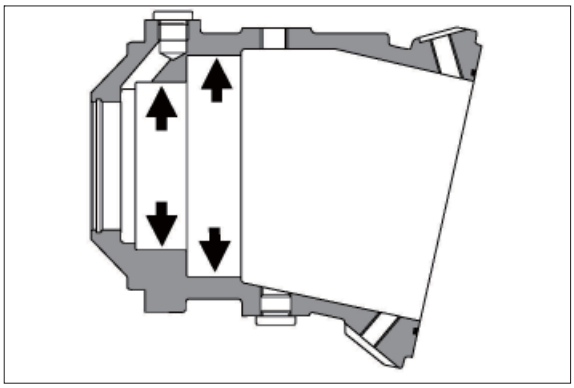
(6) Control housing

Sliding surface and side guides free of scoring and no wear.



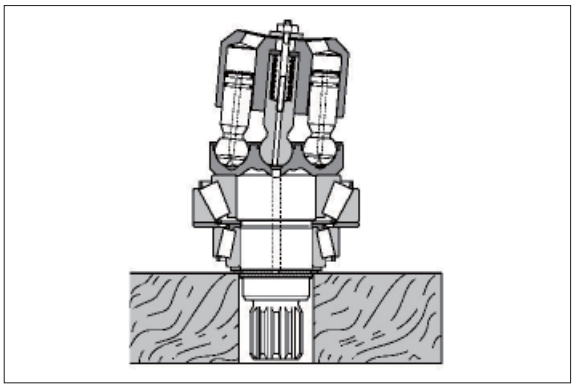
(7) Visual check

Bearing areas free of scoring and no evidence of wear.

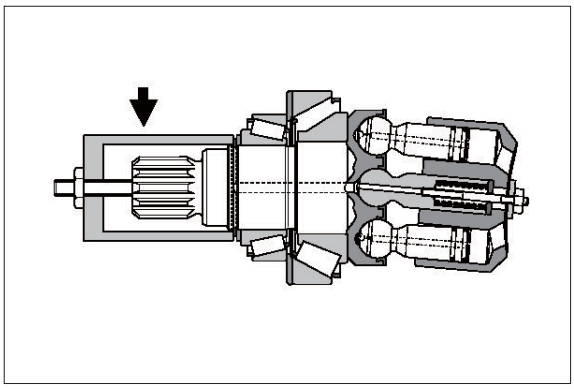


12) ROTARY GROUP ASSEMBLY

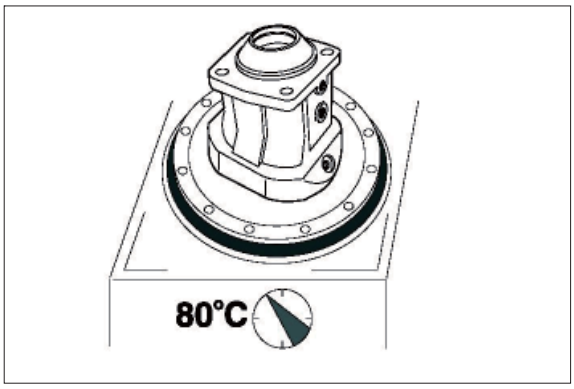
(1) Rotary group completely assembled ready for assembly.



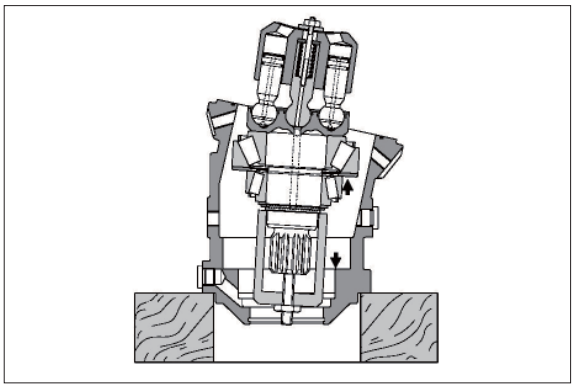
(2) Place assembly sleeve.



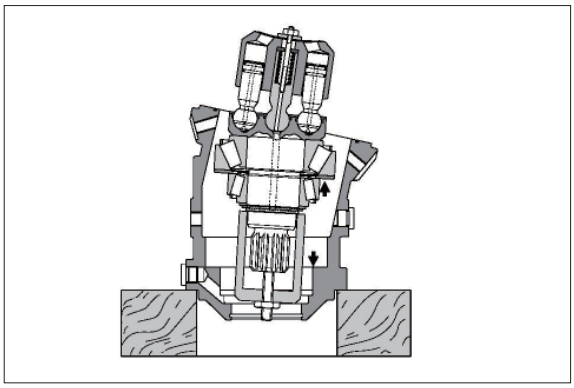
(3) Warm up housing to 80˚C.



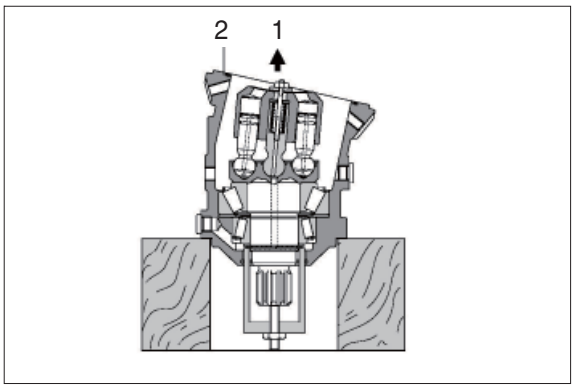
(4) Insert rotary group into housing to seat position.



(5) Insert rotary group into housing to seat position.

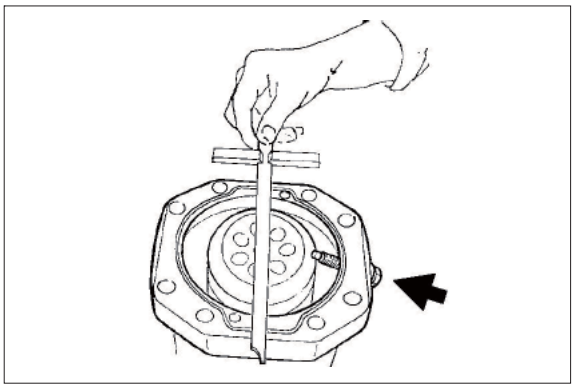


(6) Fix zero position of cylinder with Q_{max} screw.
1 Disassemble cylinder fixing screw
2 Insert O-ring

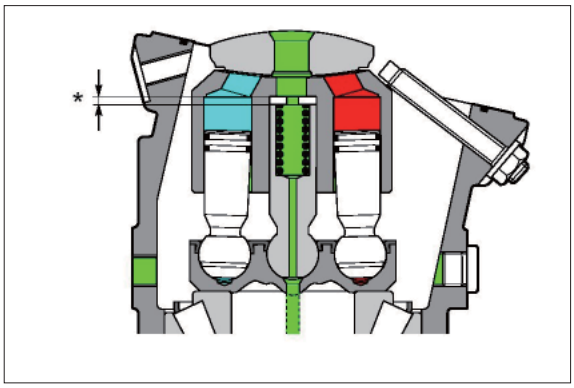


13) ROTARY GROUP ADJUSTMENT

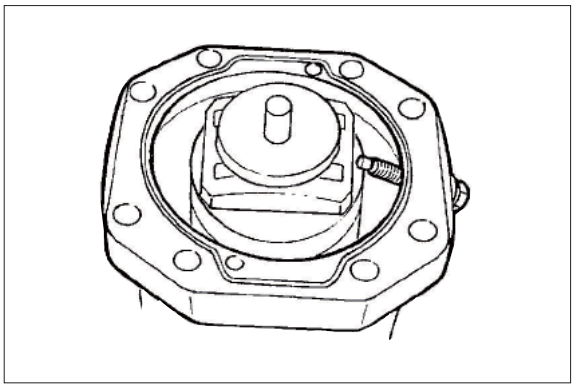
(1) Determine cylinder swivel range to max angle with screw.



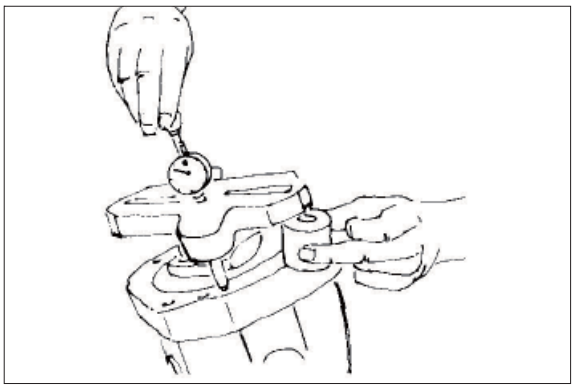
(2) * Disc



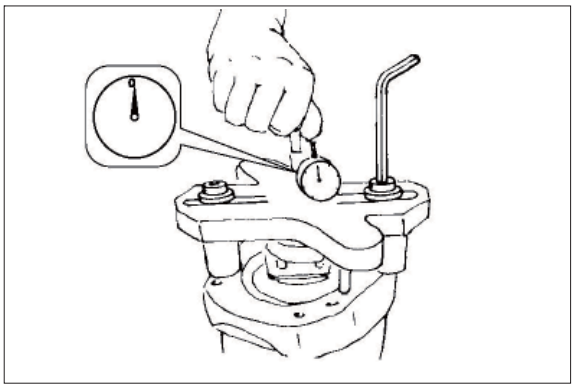
(3) Place centering disc.



(4) Mount measuring device.



(5) Check dimension X.



14) ASSEMBLY OF THE PORT PLATE

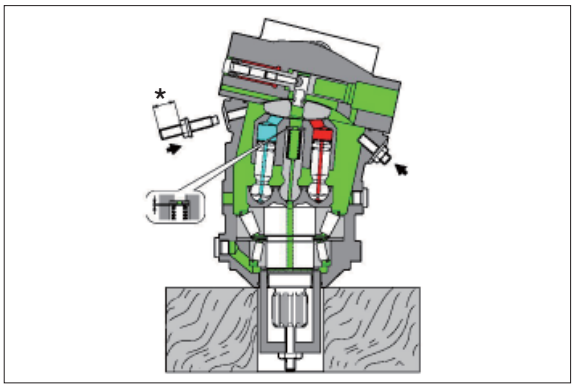
(1) Assemble port plate.

※ Take care of assembly design.
Tighten fixing screws with torque.

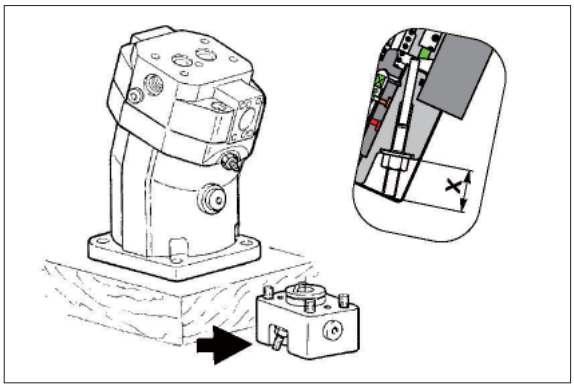
(2) Set Q_{min} screw to dimension (*).

(3) Assemble plug.

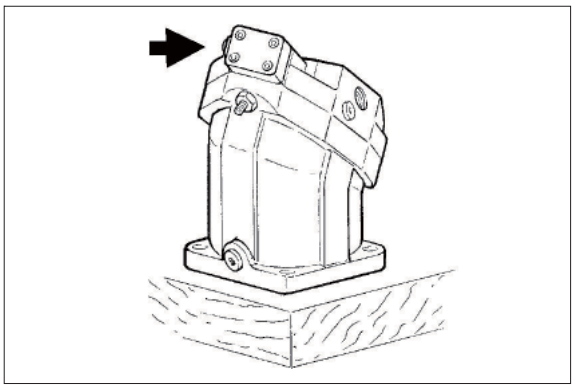
(4) Remove assembly sleeve.



(5) Assemble control components.

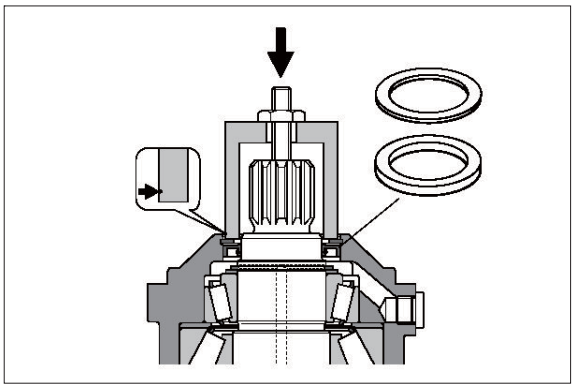


(6) Assemble cover.

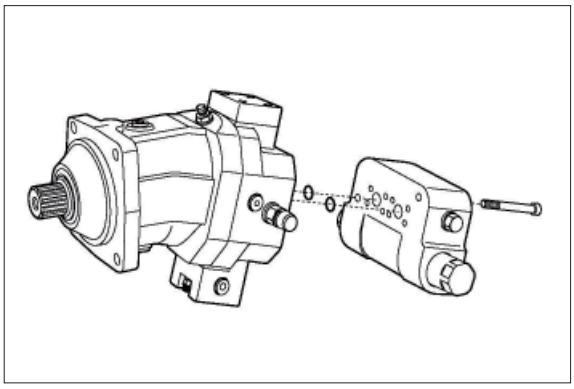


(7) Assemble shaft seal, disc and safety ring.
Press in with assembly sleeve.

※ Take care of press in depth.



(8) Assemble counter balance valve.



GROUP 5 GEAR BOX

1. REMOVAL AND INSTALL

1) REMOVAL

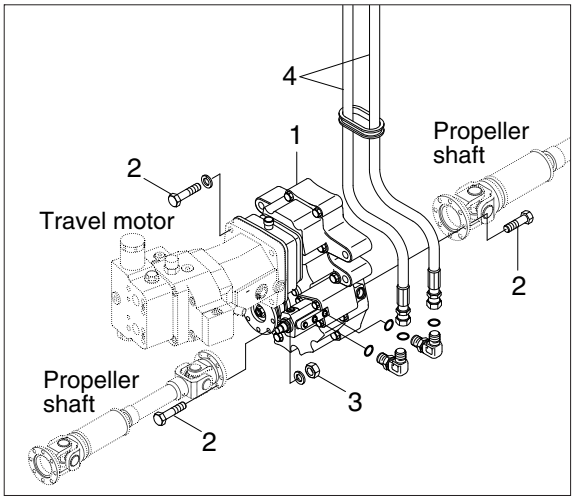
(1) Swing the work equipment 90° and lower it completely to the ground.

(2) Operate the control levers and pedals several times to release the remaining pressure in the hydraulic piping.

(3) Loosen the breather slowly to release the pressure inside the hydraulic tank.

⚠ Escaping fluid under pressure can penetrate the skin causing serious injury.

※ When pipes and hoses are disconnected, the oil inside the piping will flow out, so catch it in oil pan.



(4) Remove the propeller shaft mounting nuts (3).
- Tightening torque : 7.4±1.5 kgf · m (53.5±10.8 lbf · ft)

(5) Remove the travel motor mounting bolts (2).
- Tightening torque : 14.7±2.2 kgf · m (53.5±10.8 lbf · ft)

(6) Remove the hoses (4).

※ Fit blind plugs to the disconnected hoses.

(7) Remove the mounting bolts (2), then remove the gear box (1) device assembly.
- Weight : 63 kg (140 lb)
- Tightening torque : 19.6±2.9 kgf · m (142±21 lbf · ft)

2) INSTALL

(1) Carry out installation in the reverse order to removal.

(2) Bleed the air from the gear box.
① Remove the air vent plug.
② Pour in hydraulic oil until it overflows from the port.
③ Tighten plug lightly.
④ Start the engine, run at low idling, and check oil come out from plug.
⑤ Tighten plug fully.

(3) Confirm the hydraulic oil level and check the hydraulic oil leak or not.

2. INSTRUCTIONS

The efficiency and continued operation of mechanical units depend on constant and correct maintenance and also on efficient repair work, should there be a break-down or malfunction. The instructions in this manual have been based on a complete overhaul of the unit. However, the mechanic must decide whether or not it is necessary to dismantle the individual components when only partial repair work is needed. The manual provides a quick and sure guide which, with the use of photographs and diagrams illustrating the various phases of the operations, allows to perform accurate work to take place.

Therefore all the information needed for correct disassembly, the relative check and assembly of each individual component, has been written down.

In order to remove the different unit from the vehicle, the manuals provided by the vehicle manufacturer should be consulted. In describing the following operations it is presumed that the unit has already been removed from the vehicle.

1) IMPORTANT

Throughout the phases of repair or maintenance work it is advisable to use proper equipment such as : Trestles or supporting benches, plastic or copper hammers, appropriate levers, extractor and specific spanners or wrenches. So that the work is facilitated and the working surfaces and the operators themselves are protected. Before going on to disassemble the parts itis beat to thoroughly clean the unit, removing any encrusted or accumulated greases and then drain the oil through the oil-draining plug.

2) INTRODUCTORY REMARKS

All the disassembled mechanical units should be thoroughly cleaned with appropriate products and then restored or replaced if damage, wear, cracking or seizing have occurred.

In particular, thoroughly check the state of all moving parts (bearings, gear, crown wheel and pinion, shaft) and sealing parts (O-ring, oil shield) which are subject to major stress and wear. In any case it is a disable to replace the seals every time a component is overhauled or repaired. During assembly the sealing rings must be lubricated on the sealing edge. In the case of the crown wheel and pinion, replacement of one component requires the replacement of the other one.

During assembly the prescribed pre-loading and backlash of the parts must be maintained.

3) MAINTENANCE AND REPAIR

We have compiled these instructions for maintenance and repair in order to facilitate any such work on the DANA components differential units and change units. The drawings of any special tools required for maintenance and repair work can be bought directly from us. Spare parts can be ordered either through the vehicle manufacturer or to us directly.

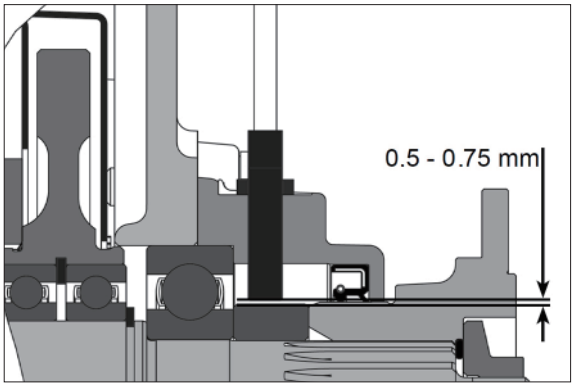
4) LUBRICANT SPECIFICATIONS

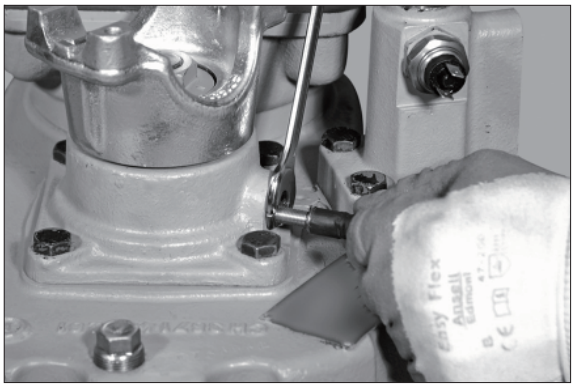
SAE 85W-90 (API GL-5)

3. COUNTER - REVOLUTION SENSOR

1) REPLACING

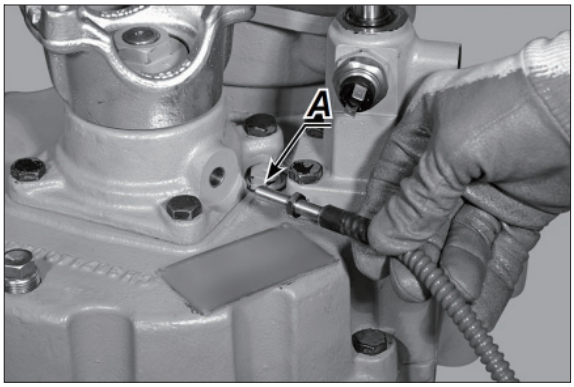
(1) Undo the sensor adjuster screw lock nut and the counter-revolution sensor.



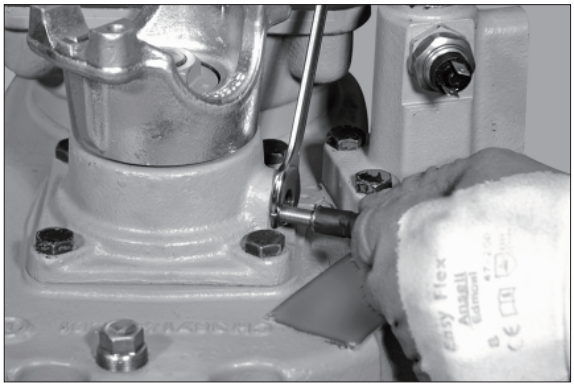


(2) Replace the counter-revolution sensor if damaged.

※ Clean the sensor reading zone “A” every oil change and every malfunctioning.

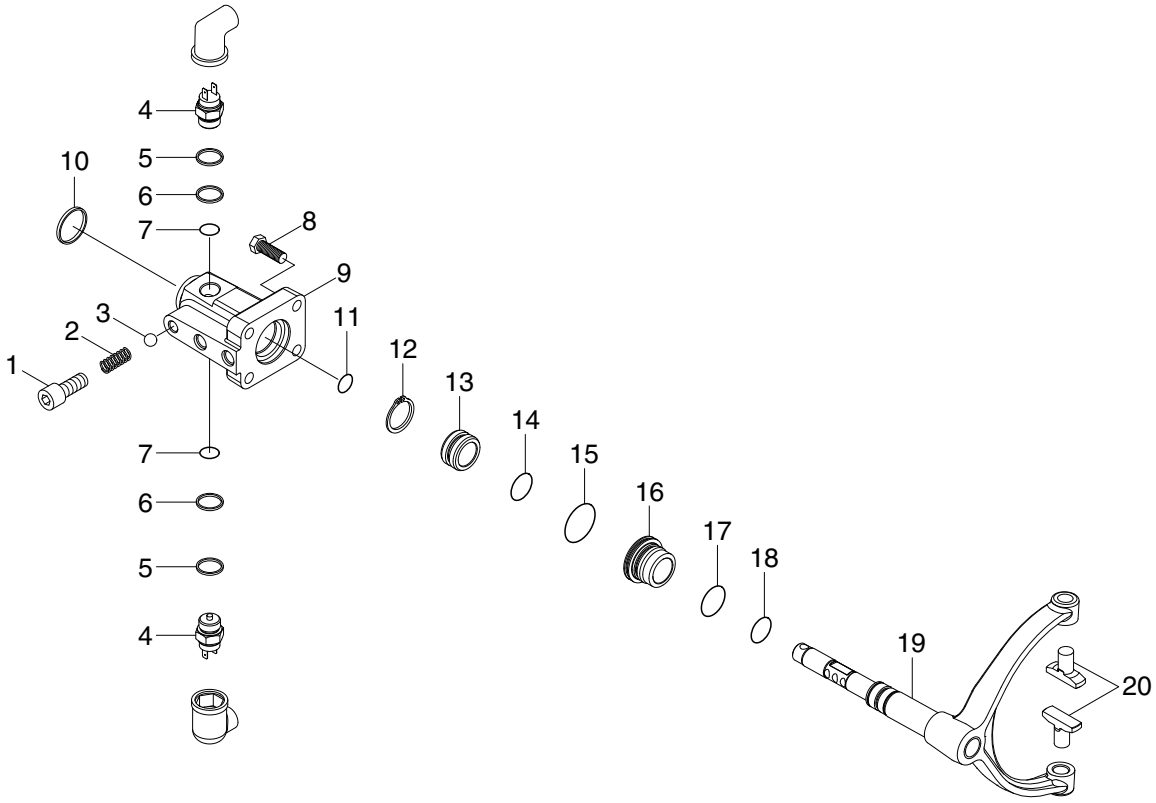


(3) Screw the counter-revolution sensor untill to the contact with the phonic end disk, then unloose the sensor 1/2 ~ 3/4 turn. Tighten the lock nuts completely.

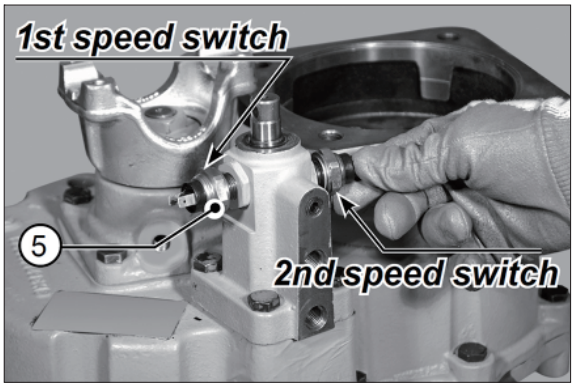


4. HYDRAULIC GEAR CONTROL

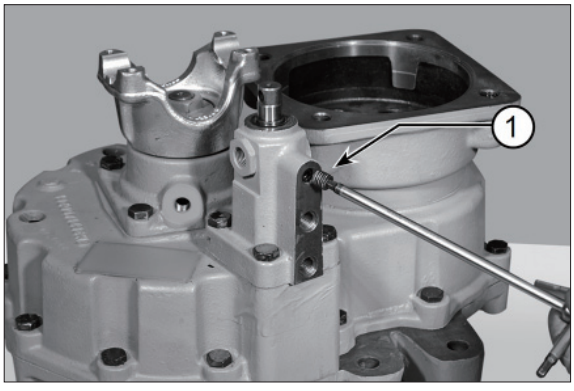
1) DISASSEMBLY



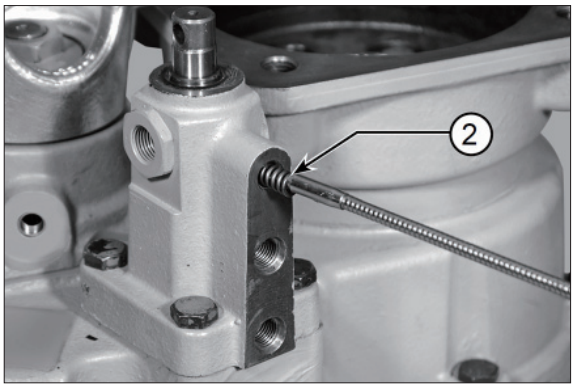
(1) Remove gear-in position switch (4), O-ring (5) and (7) and washer (7).



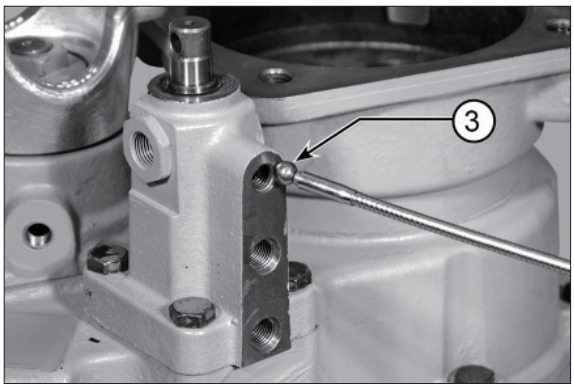
(2) Remove the cap (1) from the gear selector.



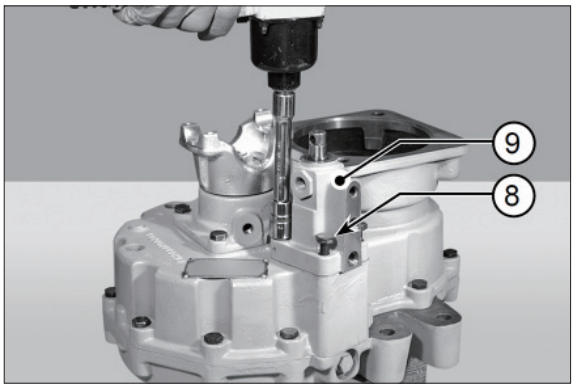
(3) Use a magnet to remove the spring (2) from the gear selector.



(4) Remove the gear selector balls (3).

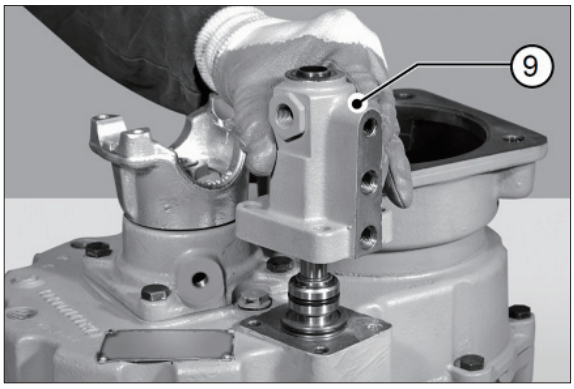


(5) Remove screws (8) on the gear control cylinder (9).

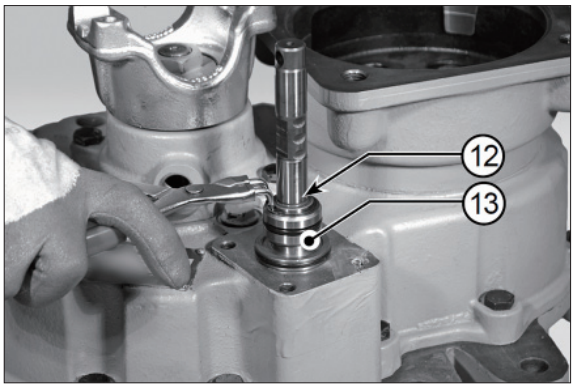


(6) Remove the gear control cylinder (9).

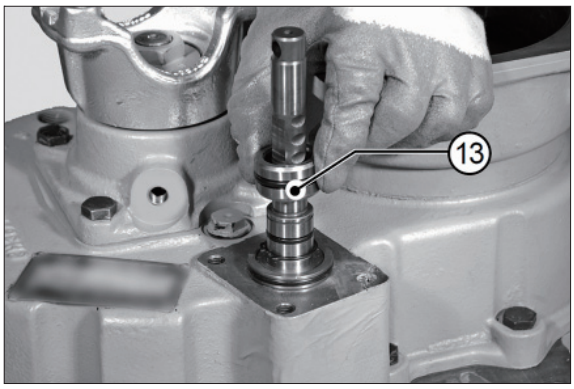
※ Carefully remove all residue of loctite from the surfaces.



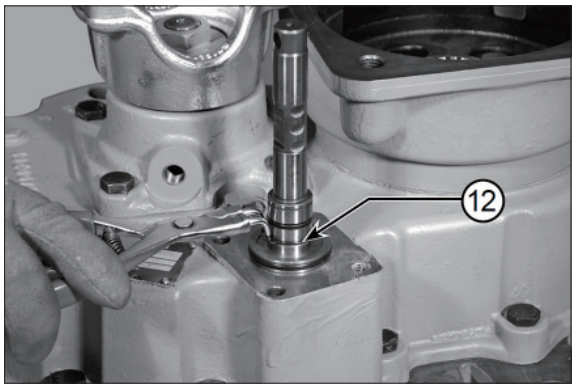
(7) Remove the snap ring (12) securing the piston (13).



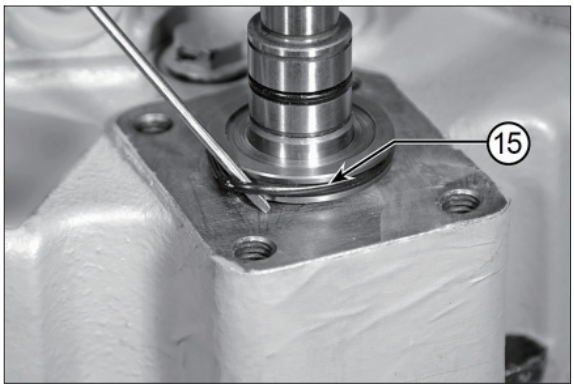
(8) Remove the piston (13), complete with seals.



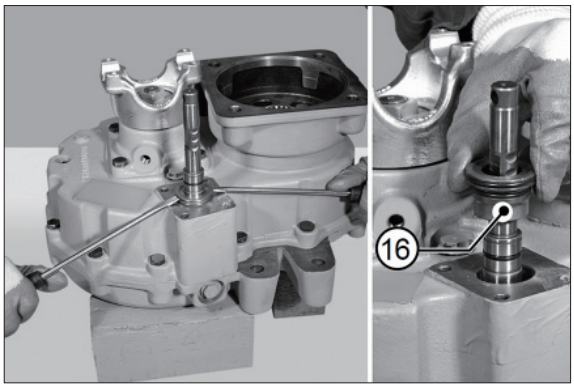
(9) Remove the snap ring (12) securing the piston (13).



(10) Remove the O-ring (15).

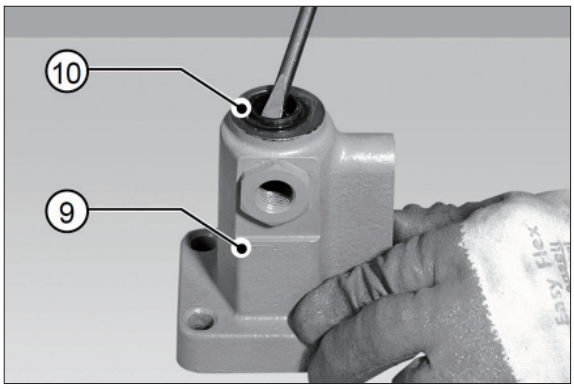


(11) Use two levers to remove the bushing (16).

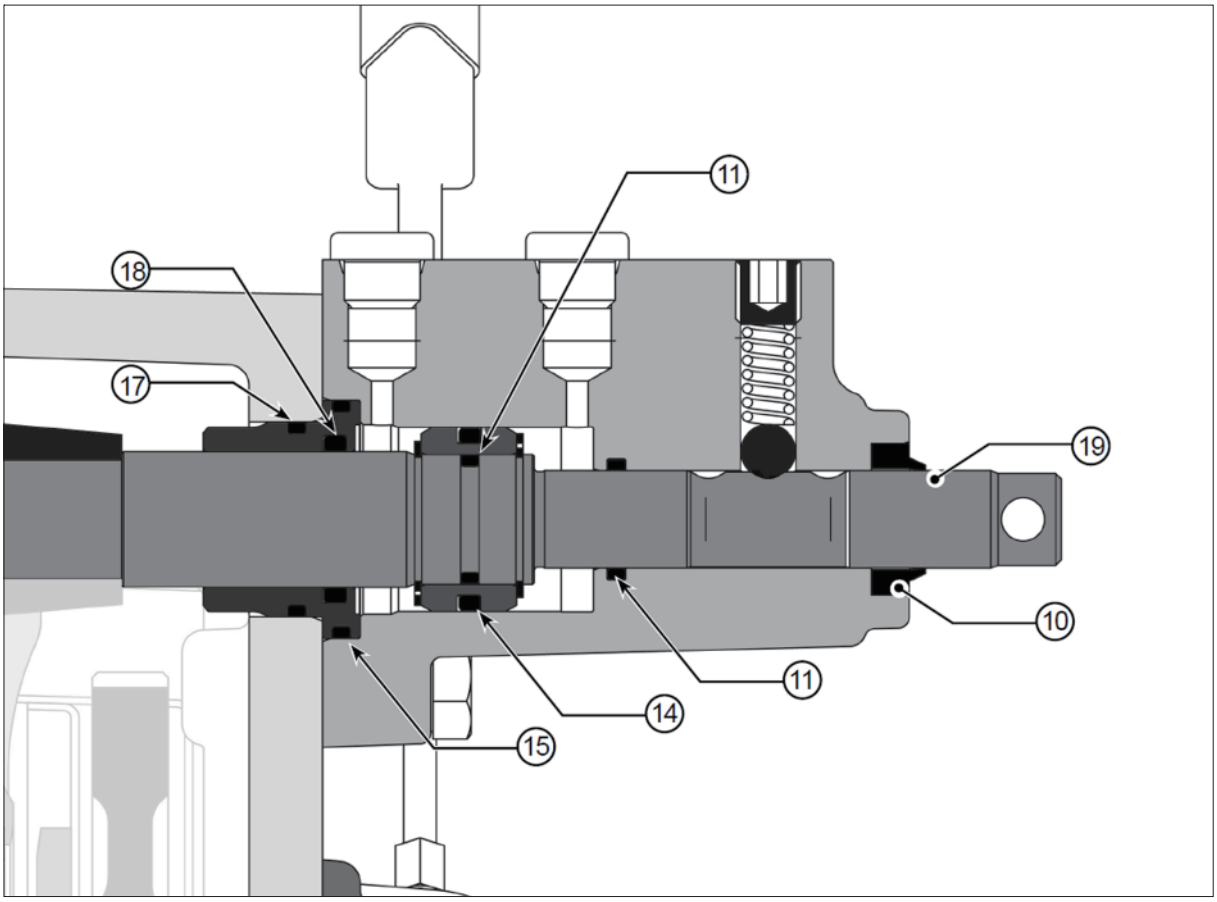


(12) Remove the dust scraper ring (10) and the rod's O-ring (11) from the gearshift cylinder (9).

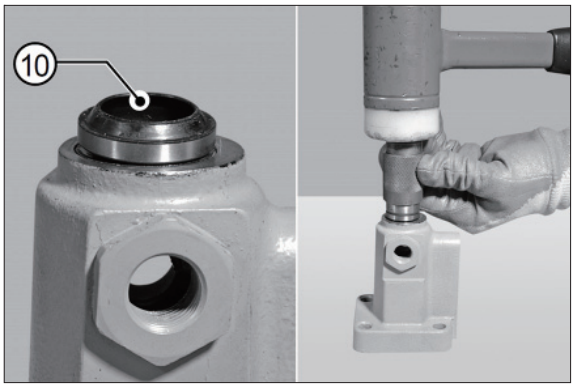
※ The O-rings and the dust scraper ring must be replaced every time the unit is disassembled.



2) ASSEMBLY

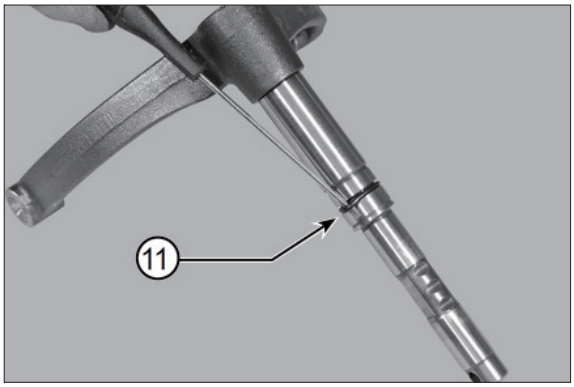


(1) Fit the rod's O-ring (11) and the dust scraper ring (10) into the cylinder.

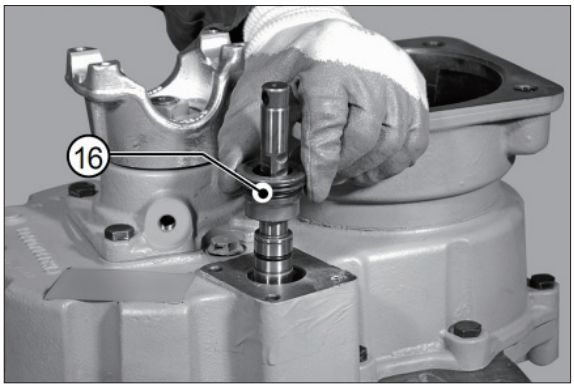


(2) Fit the new O-ring (11) on the gear selector rod (19).

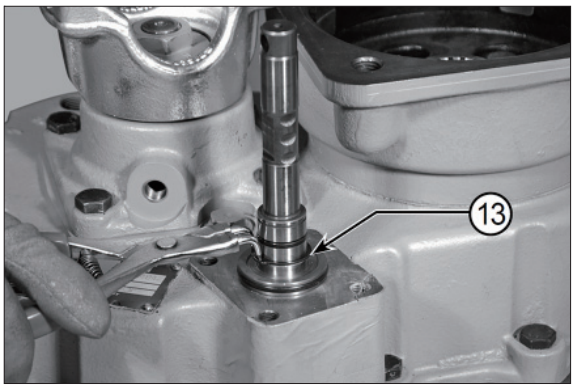
※ Lubricate before installing.



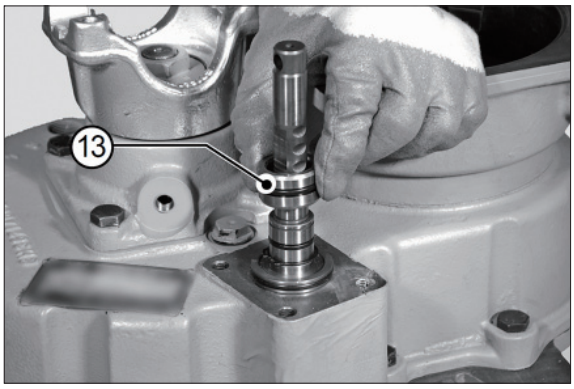
(3) Fit the O-rings (15), (17), (18) on the guide bush (16) and lubricate rings.
Fit the bush (16) onto the gear selector rod (19).



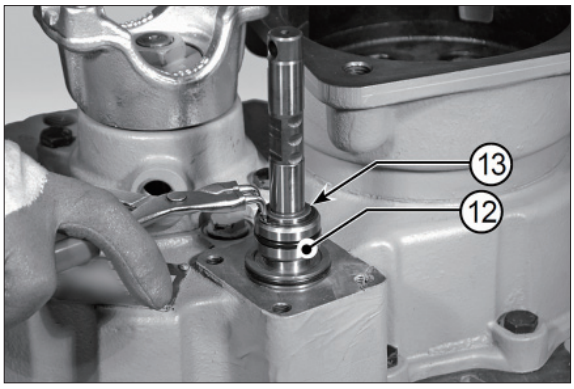
(4) Insert the snap ring (12).



(5) Fit the O-rings (11), (14) onto the piston (13) and lubricate rings.
Fit the complete piston (15) onto the gear selector rod (20) and engage it by means of the snap ring (12).

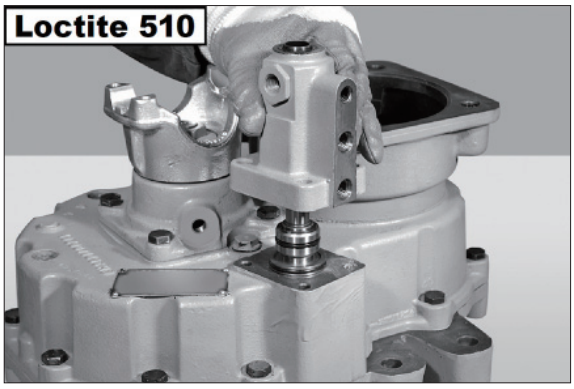


(6) Secure the piston (13) in position with the snap ring (12).

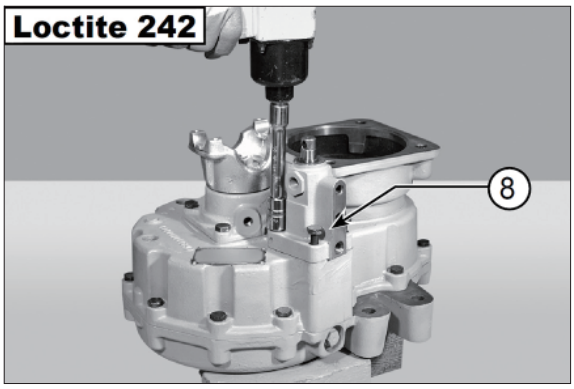


(7) Coat the coupling surface of the gearshift cylinder (9) with loctite 510; fit the cylinder on the gear selector rod (19).

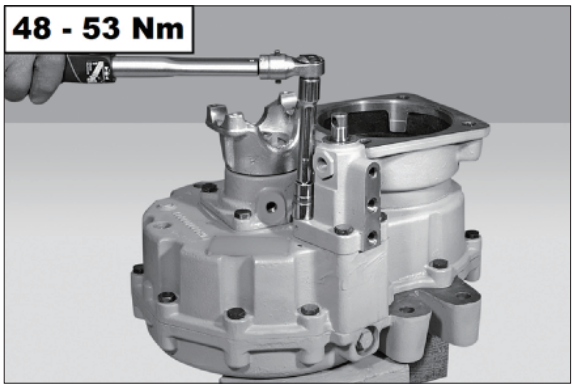
※ Make sure that the sealant forms a continuous film around the locking holes.



(8) Assembly the screws (8), spreading loctite 242 on screws.

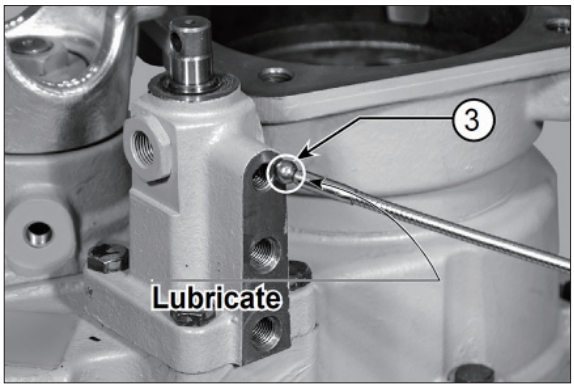


(9) Tighten screws (8) using a torque wrench setting of 4.89~5.4 kgf · m (35.4~39.1 lbf · ft).



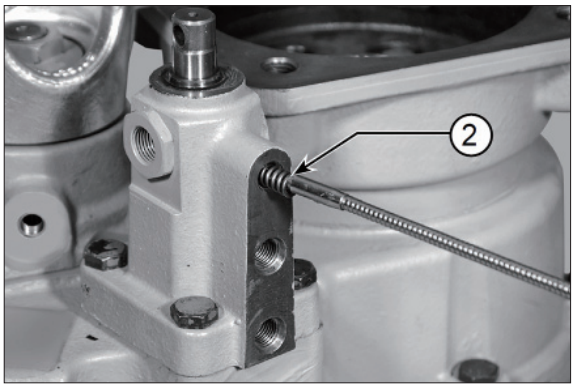
(10) Fit the gear selector balls (3).

※ Lubricate before installing.

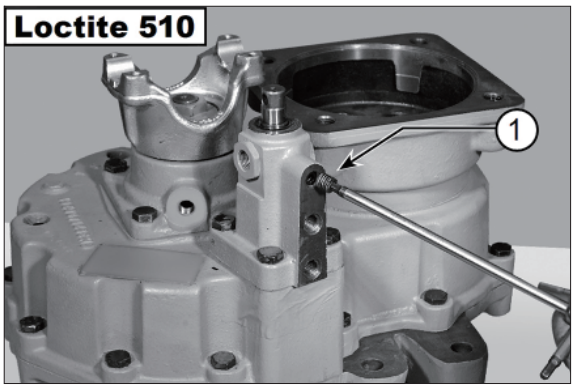


(11) Fit the gear selector springs.

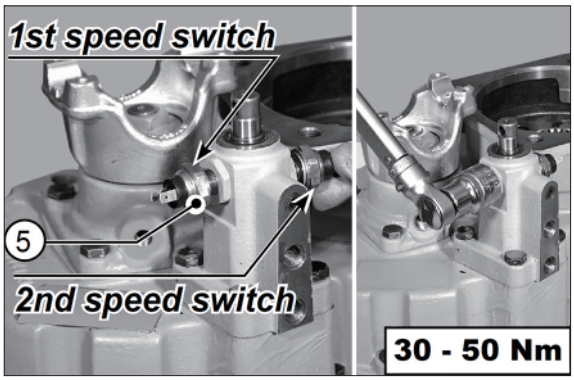
※ Replace the springs (14) if they are weakened or bent.



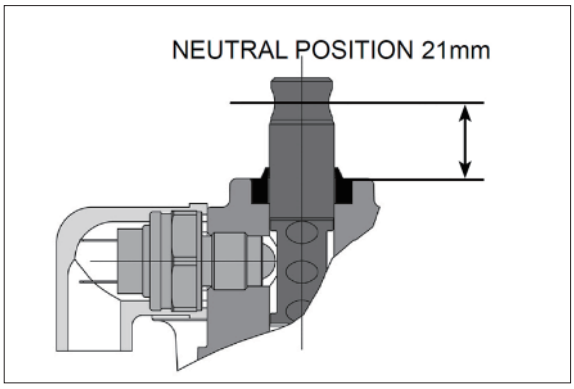
(12) Coat the dowel (1) with loctite 510 and screw it until it is level with the cylinder.



(13) Fix the gear-in position switch (4) with washer (7) and O-ring (5), (6).
Tighten with torque wrench setting of 3.57~5.09 kgf · m (25.8~36.9 lbf · ft).

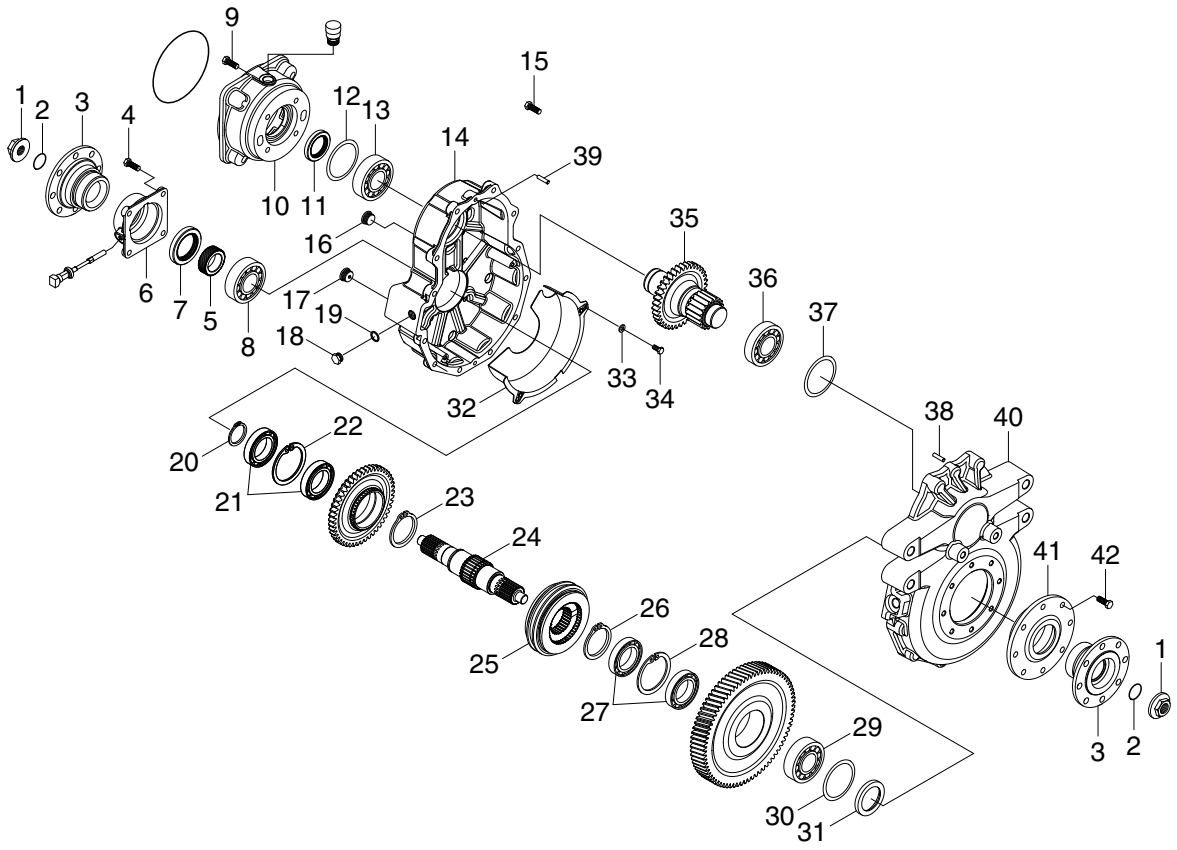


(14) Engage the 1st speed and verify with a control device (tester) that the switch 1st speed gives signal and that the switch 2nd speed is disabled.
Repeat the operation on the switch 2nd speed.

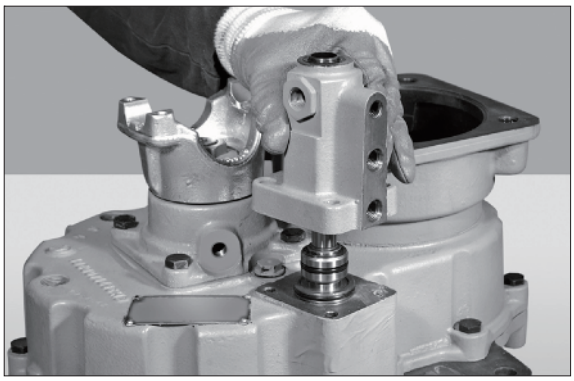


5. INTEGRATED REDUCTION GEAR

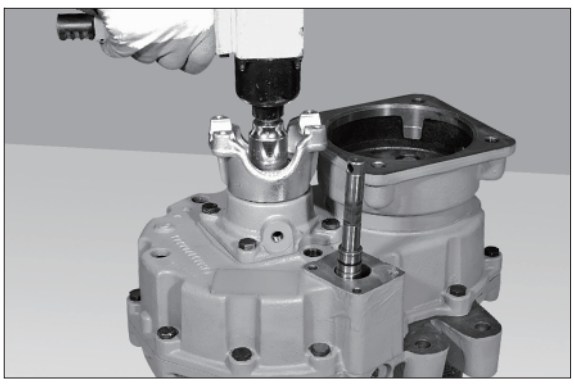
1) DISASSEMBLY



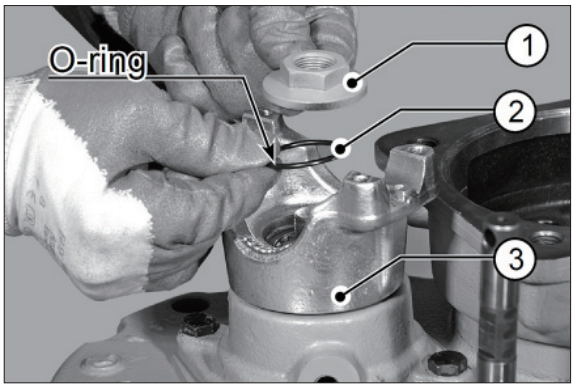
(1) Remove the gear control cylinder.
For more details, see : REMOVAL OF HYDRAULIC GEAR CONTROL



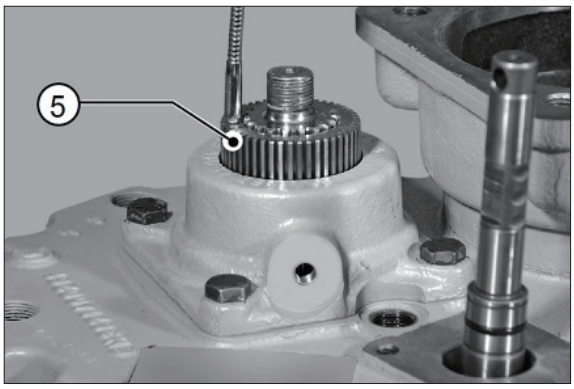
(2) Unloose the nut (1) from the flange (3).



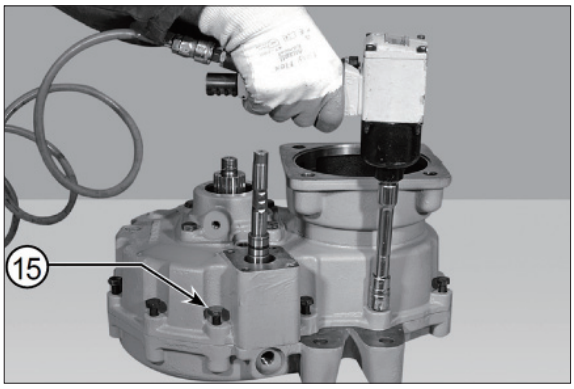
(3) Remove the nut (1) and O-ring (2) and pull out the flange (3).



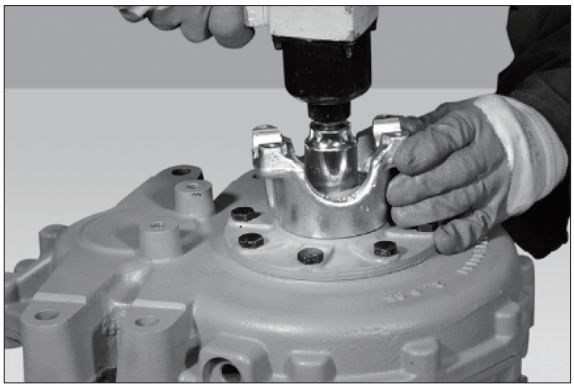
(4) Remove the phonic end disk (5).



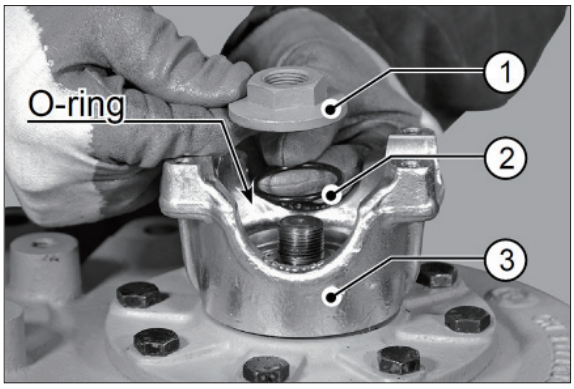
(5) Remove screws (15) of the cover (40).



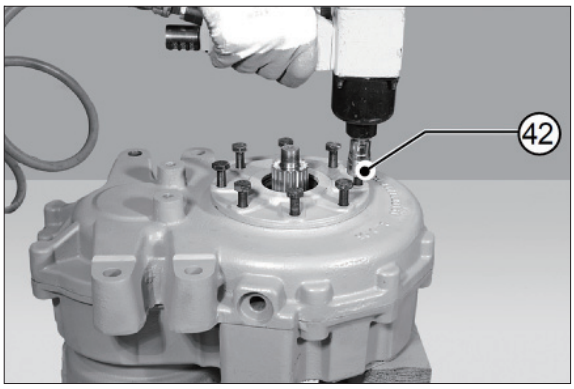
(6) Unloose the nut (10) from the flange (12).



(7) Remove the nut (1) and O-ring (2) and pull out the flange (3).

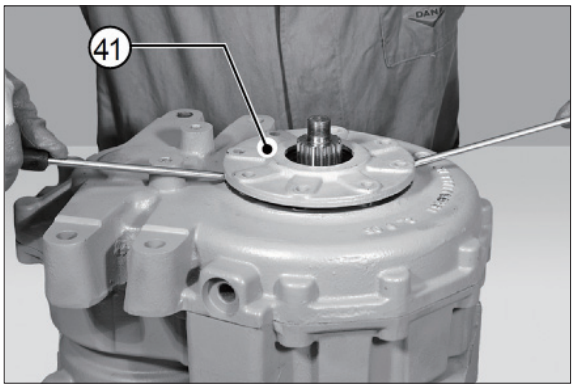


(8) Loosen and remove the check screws (42) of the cover (41).



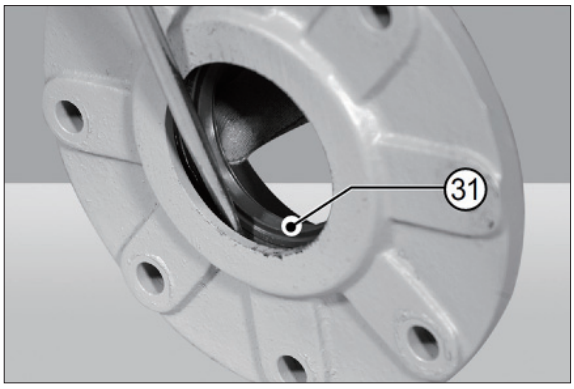
(9) Disjoin and remove the cover (41).

※ Carefully remove all residue of loctite from the surfaces.



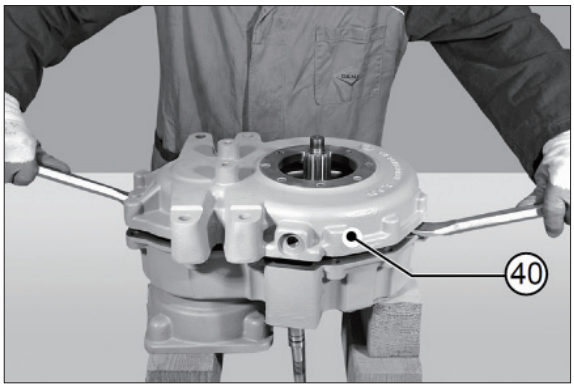
(10) Remove seal ring (31).

※ Note down direction of installation.

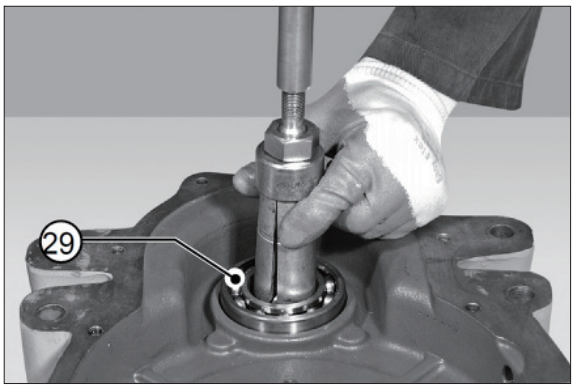


(11) Disjoin and remove the cover (40).

※ Carefully remove all residue of loctite from the surfaces.

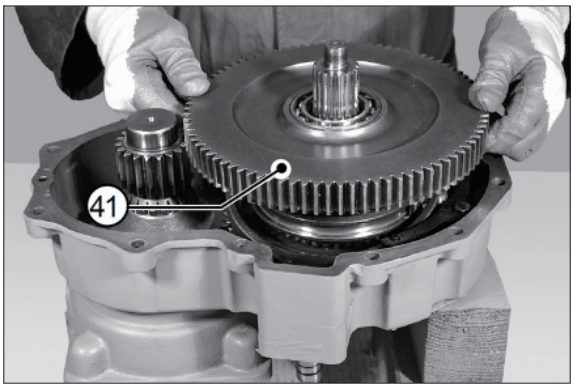


(12) Using an internal extractor, remove the bearing (29).

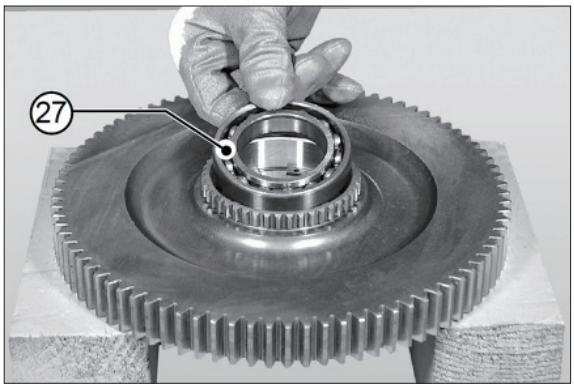


(13) Remove gear (41).

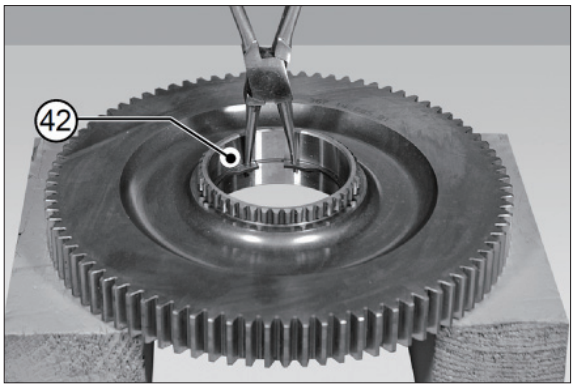
※ Note the correct mounting direction.



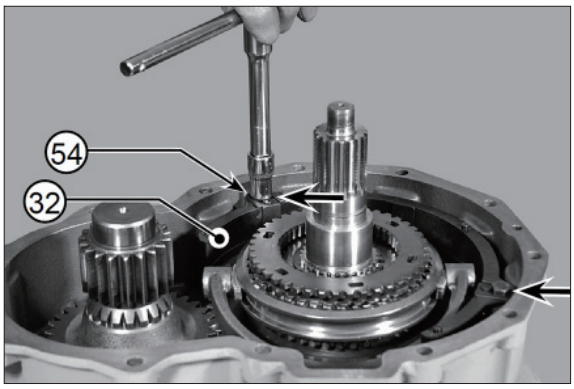
(14) Remove the bearing (27) from the gear (41).



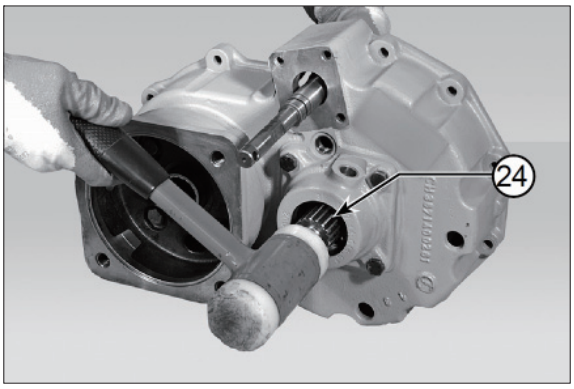
(15) Remove the snap ring (42).



(16) Remove the baffle plate (32) and retainer screws (54).

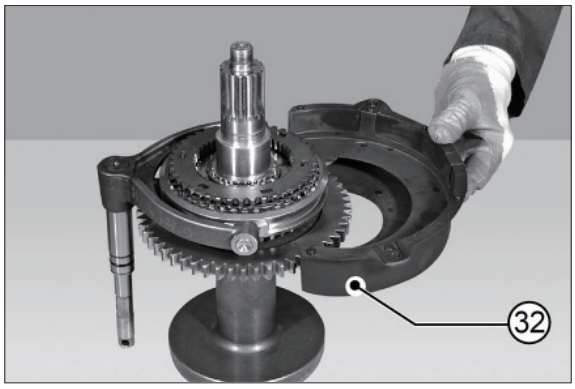


(17) Remove the lower shaft (24).



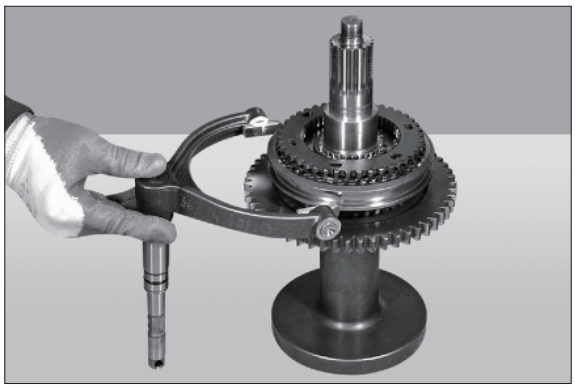
(18) Secure the lower shaft assembly to a hoist.
Remove the lower shaft assembly, complete with yoke and gearbox control rod.

(19) Remove the internal baffle plate (32).



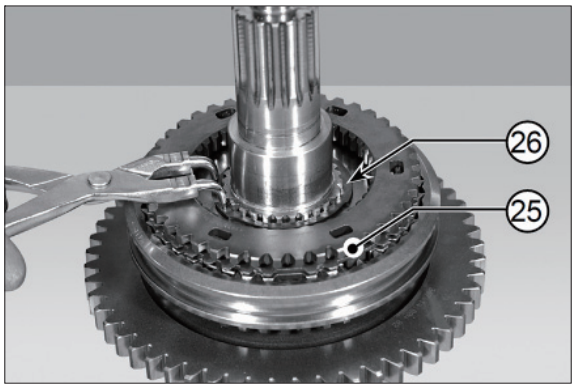
(20) Remove yoke and gearbox control rod.
Check the yoke pads for wear.

※ Replace if worn.



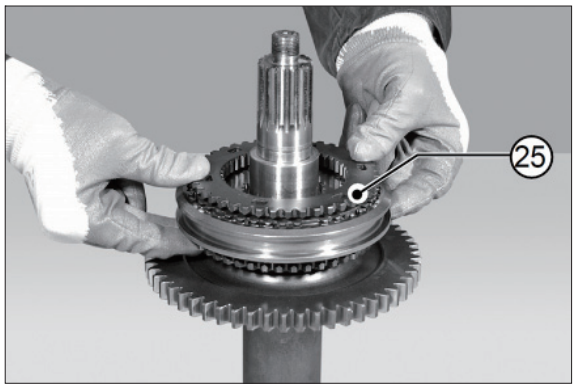
(21) Remove the snap ring (26) securing the synchroniser (25).

※ Take care not to bend the snap ring (26).



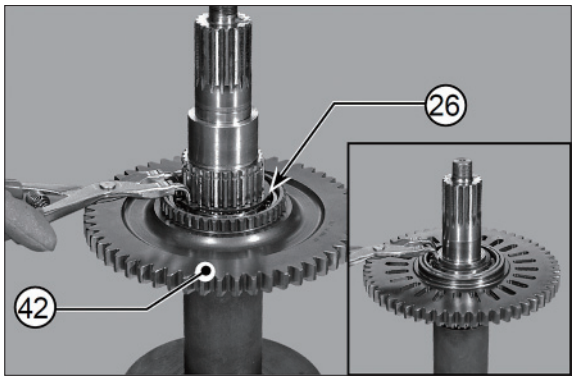
(22) Remove the complete synchroniser (25).

※ Note the correct mounting direction.



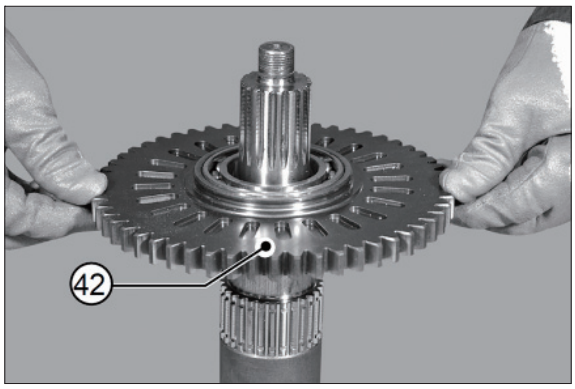
(23) Repeat the operation on both sides.
Remove the snap ring (23) securing the gear (42).

※ Take care not to bend the snap ring (23).

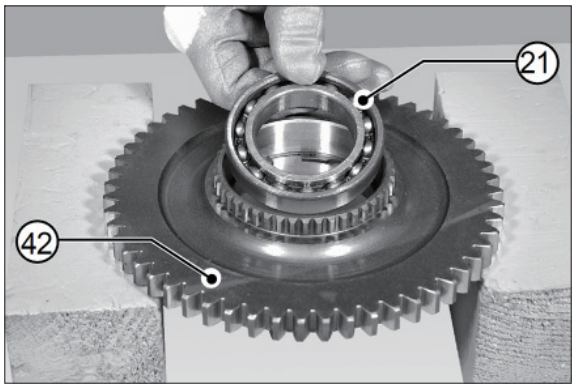


(24) Remove gear (42).

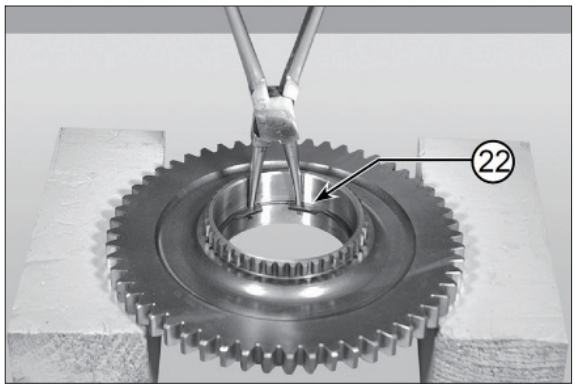
※ Note the correct mounting direction.



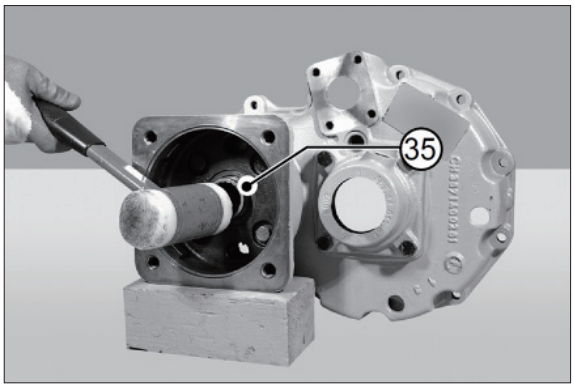
(25) Remove the bearings (21) from the gear (42).



(26) Remove the snap ring (22).

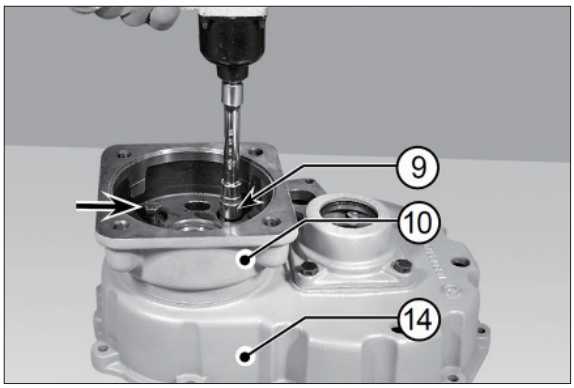


(27) Remove the upper shaft (35).



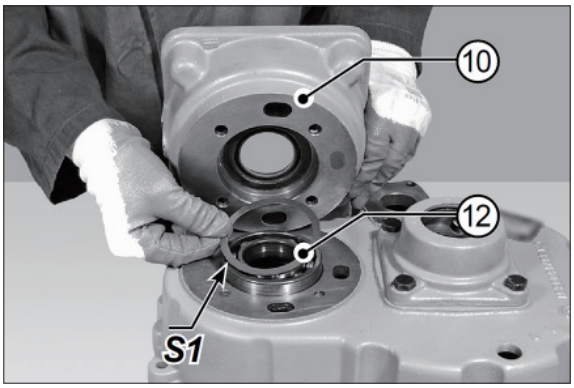
(28) Input shaft

Mark the position between the motion entrace cover (10) and reduction gear cover (14); remove screws (9) from the motion entrace cover (10).



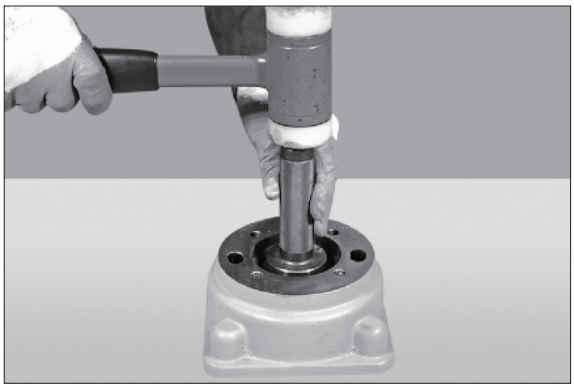
(29) Remove the cover by fixing the distance washers (12) onto the cover (10) itself.

※ Carefully remove all residue of loctite from the surfaces.

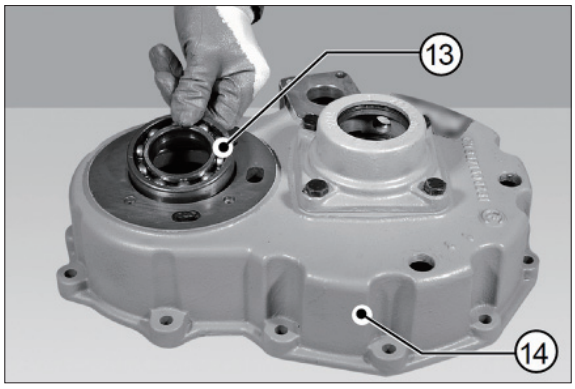


(30) Remove seal ring (11).

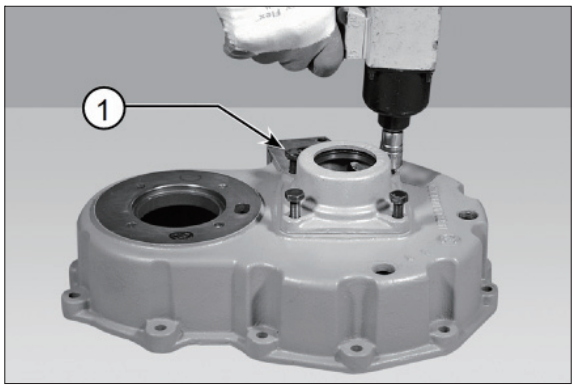
※ Note down direction of installation.



(31) Remove the bearing (13) from the cover (14).

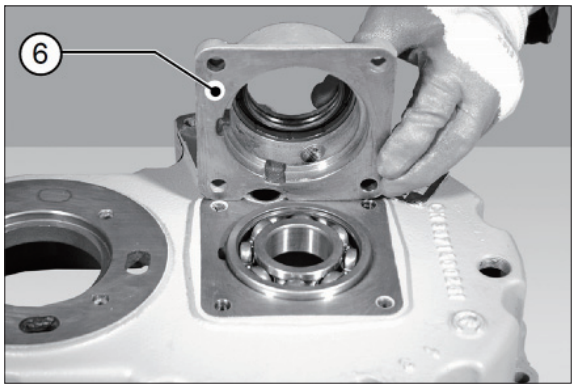


(32) Loosen and remove the check screws (4) of the cover (6).

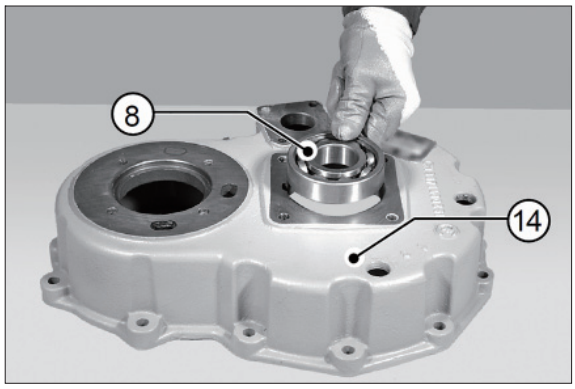


(33) Disjoin and remove the cover (6).

※ Carefully remove all residue of loctite from the surfaces.

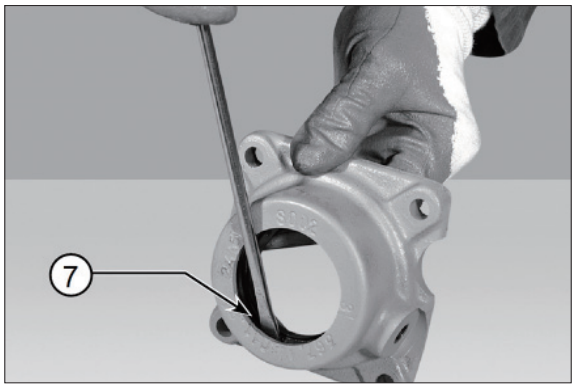


(34) Remove the bearing (8) from the cover (14).

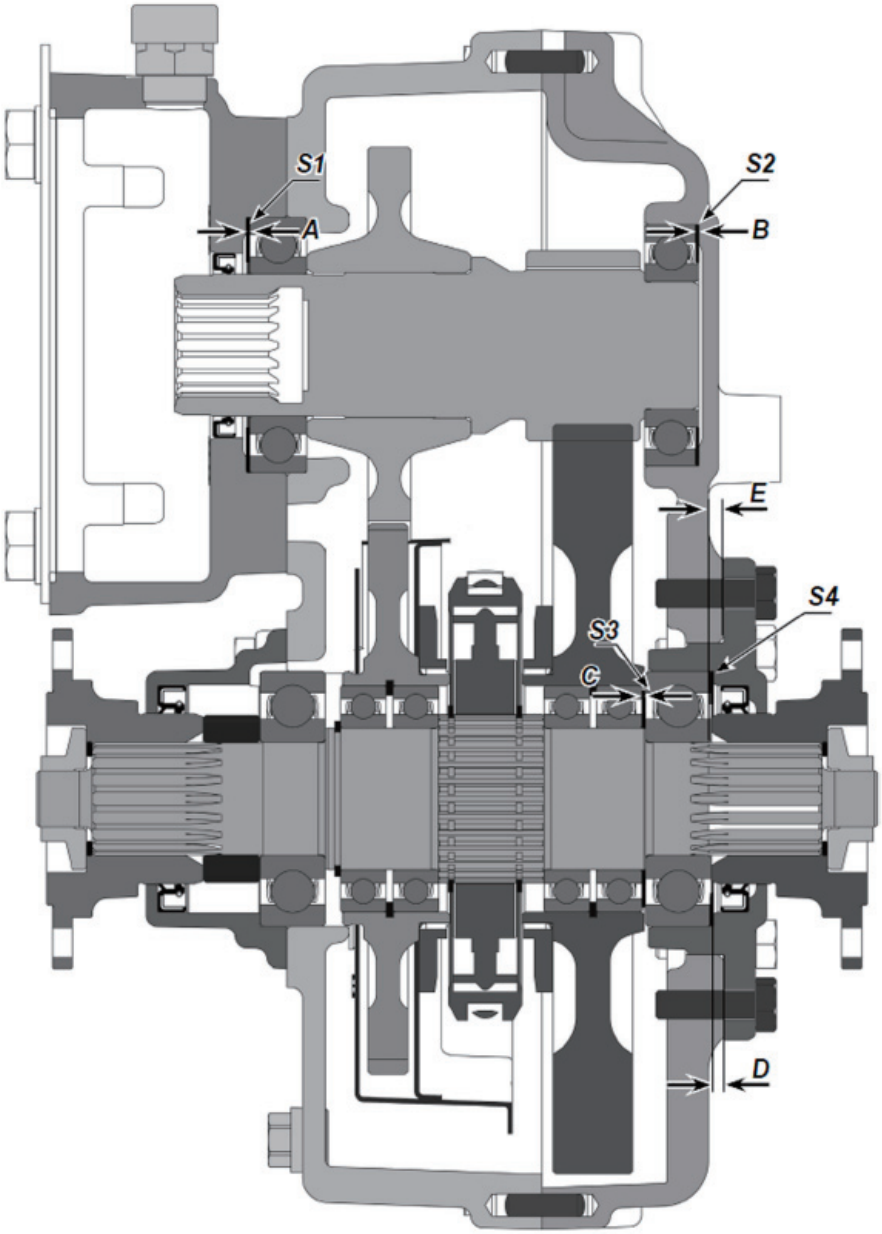


(35) Remove seal ring (7).

※ Note down direction of installation.



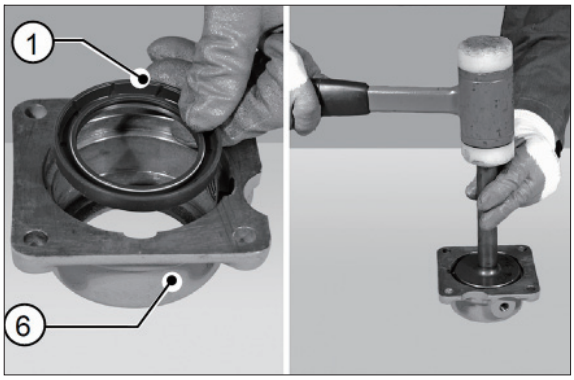
2) ASSEMBLY



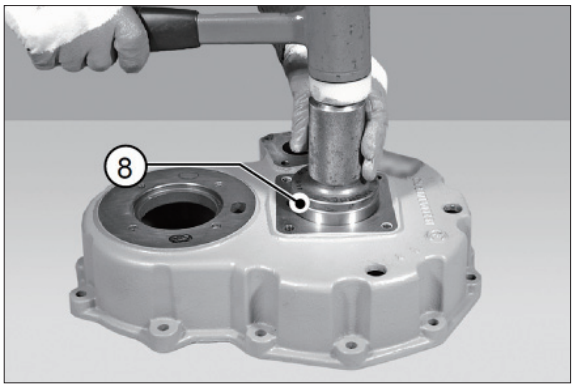
(1) Re-insert the new sealing ring (7) in the output cover (6).

※ Pay particular attention to the direction of assembly of the rings (7).

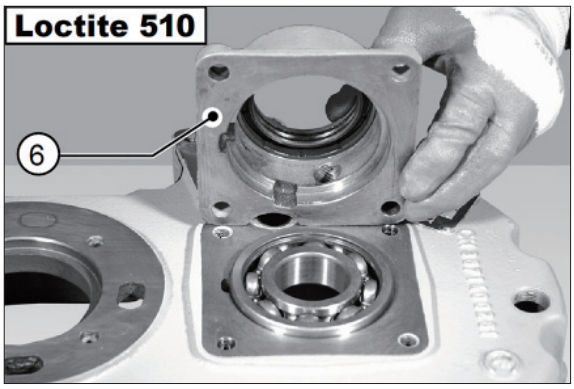
Lubricate the lip of the sealing ring with grease.



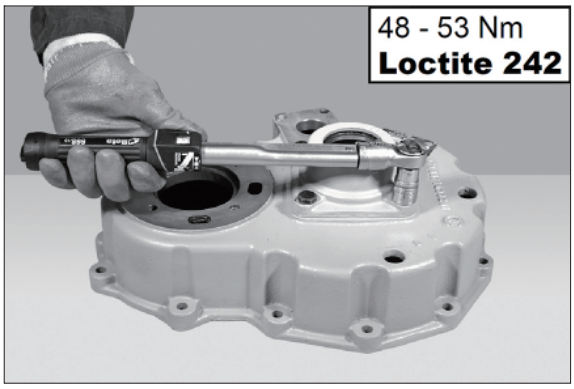
(2) Using a normal tool insert the bearing (8).



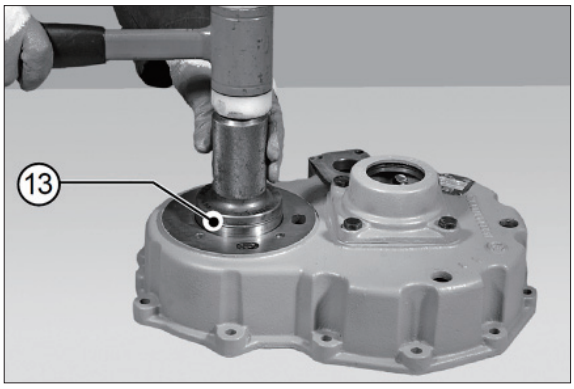
(3) Assembly the cover (16) spreading loctite 510 on planes.



(4) Assembly the screws (4) spreading loctite 242.
Tighten screws (4) using a torque wrench setting of 4.89~5.4 kgf · m (35.4~39.1 lbf · ft).



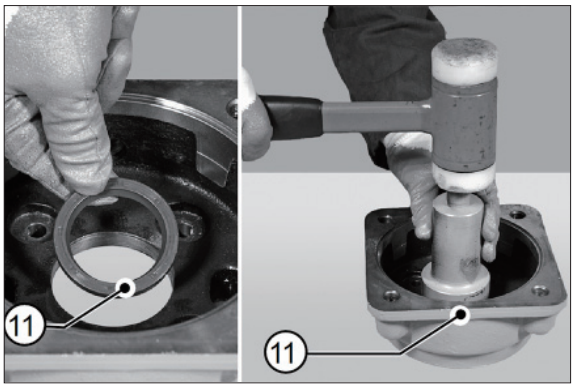
(5) Using a normal tool insert the bearing (13).



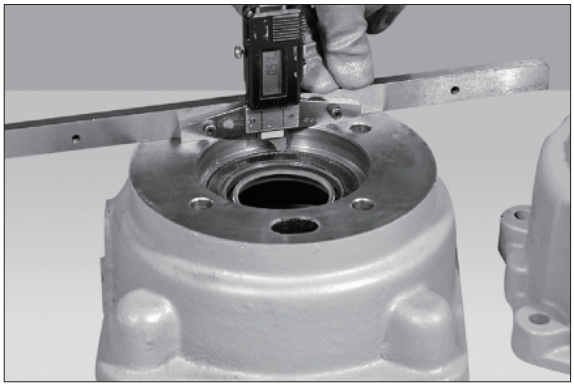
(6) Re-insert the new sealing ring (11) in the motion input cover (10).

※ Pay particular attention to the direction of assembly of the rings (11).

Lubricate the lip of the sealing ring with grease.

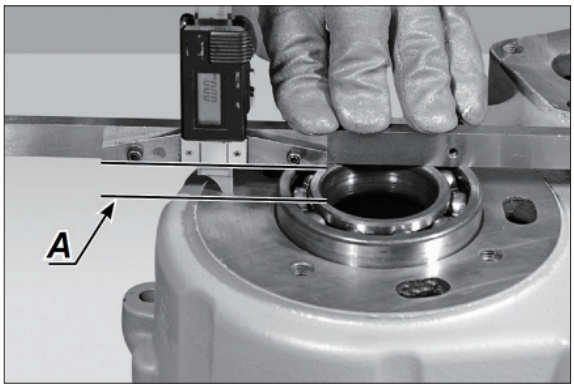


(7) Zero the depth gauge between the cover surface and bearing contact surface.



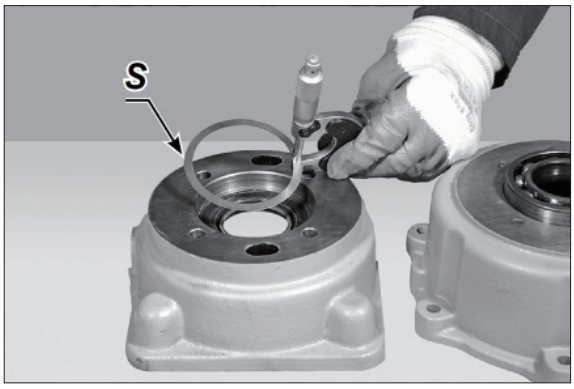
(8) Measure distance “A” between the surface and thrust block.

· Example : A = 0.50

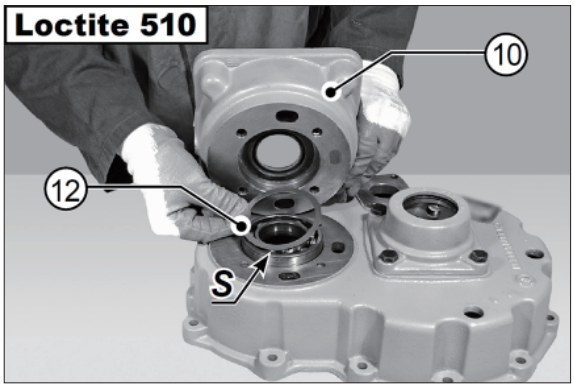


(9) Calculate thickness “S” of the shims by using this formula :
S = A - Y = S, where Y is the predefined axial backlash.
Y = backlash = 0.15 ± 0.35 mm
Example : S=A-Y=0.50-0.25=0.25 mm=S

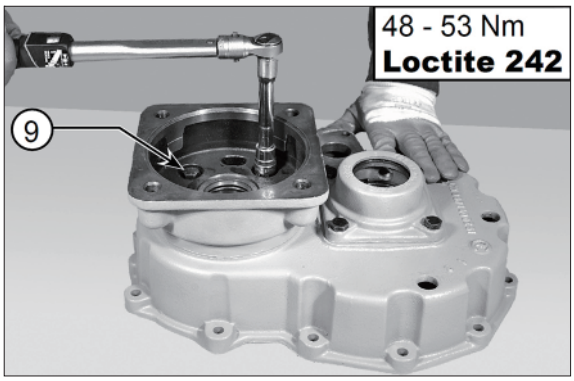
Make up the appropriate pack of shims.



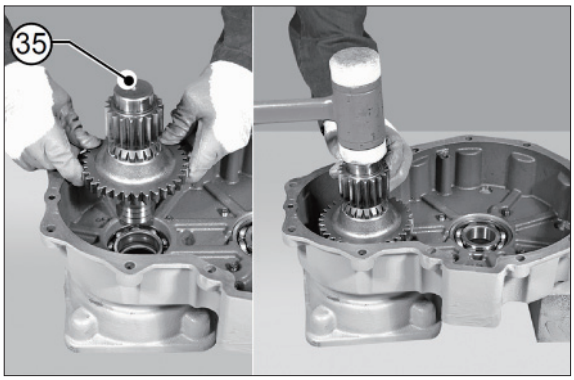
(10) Apply loctite 510 to the machined surfaces.
Assembly the cover (10) and shims (12).



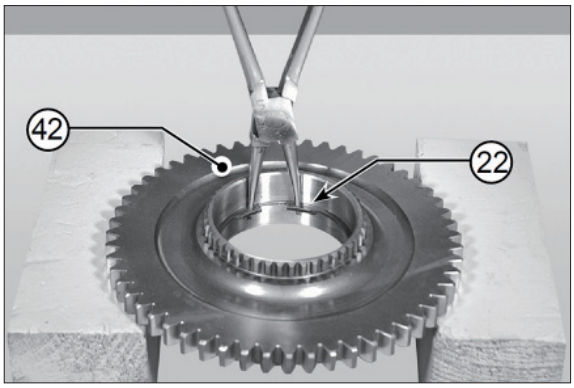
(11) Assembly the screws (9) spreading loctite 242.
Tighten screws (9) using a torque wrench setting of 4.89~5.4 kgf · m (35.4~39.1 lbf · ft).



(12) Install the drive side shaft (35) with a plastic hammer.

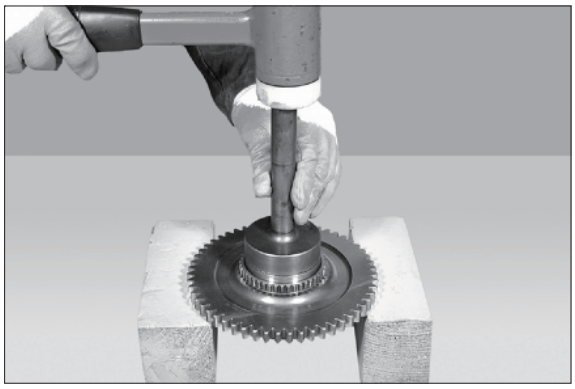


(13) Fit the snap ring (22) in the gear (42).



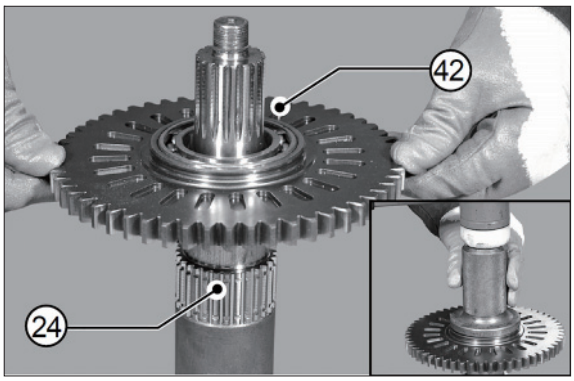
(14) Using a pusher of suitable diameter, fit the bearings (21).

※ Ensure that the bearing is seated securely.

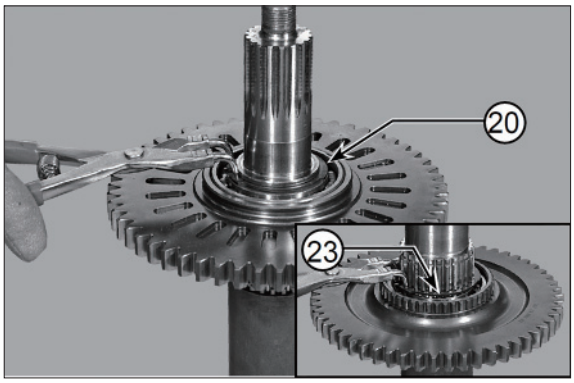


(15) Fit gear (42) onto the shaft (24).

※ Fit as originally mounted, using the markings made previously as reference.

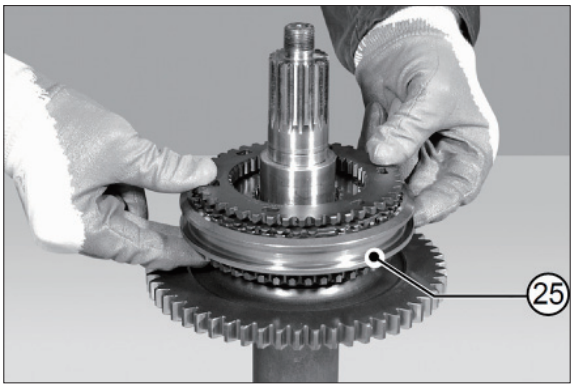


(16) Repeat the operation on both sides. Secure the gear (42) in position with the snap ring (20), (23).



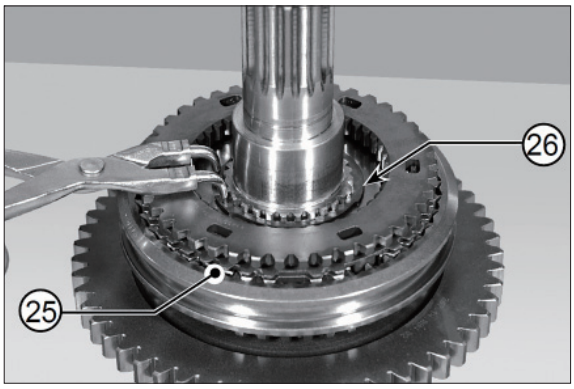
(17) Fit the complete synchroniser (25).

※ Fit as originally mounted, using the markings made previously as reference.

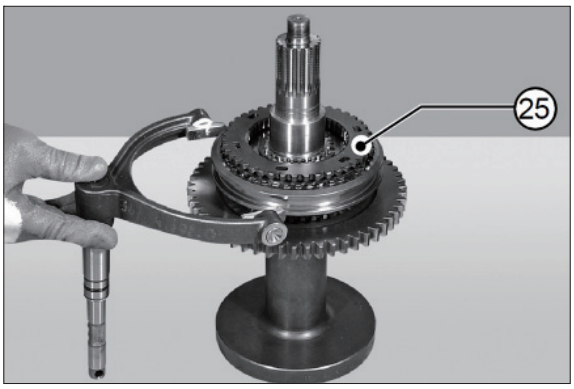


(18) Secure the synchroniser (25) in position with the snap ring (26).

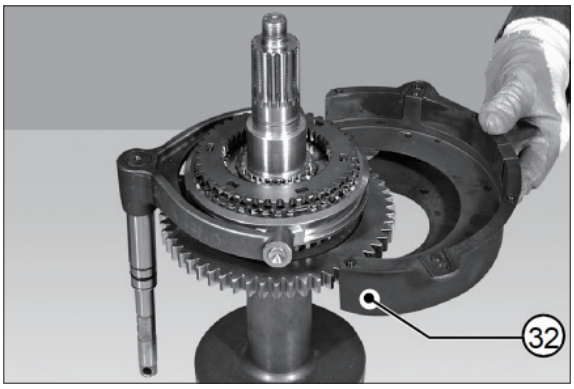
※ Check that the snap ring is seated correctly.



(19) Fit the gear selector yoke in the synchroniser (25).

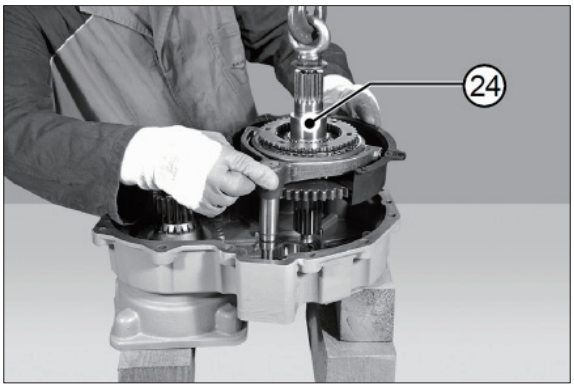


(20) Fit the internal baffle plate (32) in position.

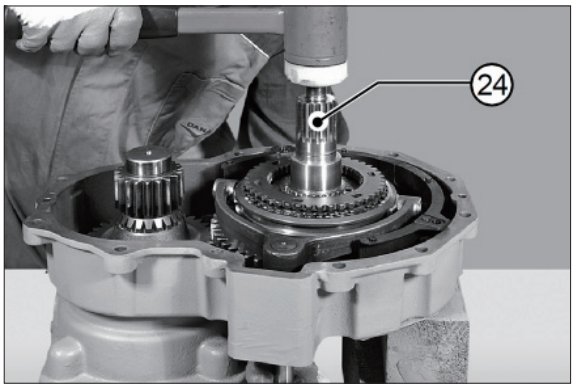


(21) Secure the lower shaft assembly (24) to a hoist.

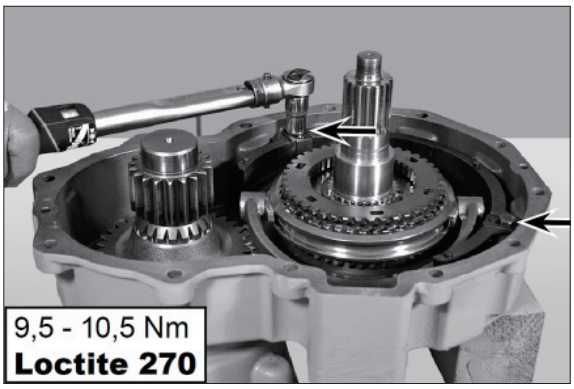
Install the lower shaft assembly (24), complete with yoke and gearbox control rod.



(22) Using a plastic hammer, install the lower shaft (24).

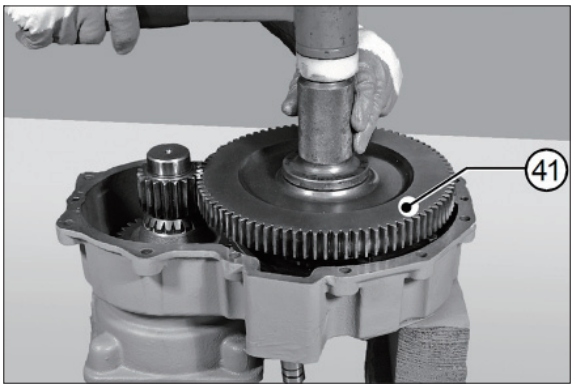


(23) Spread loctite 270 on the screws and tighten to a torque of 0.97~1.07 kgf · m (7.02~7.74 lbf · ft).

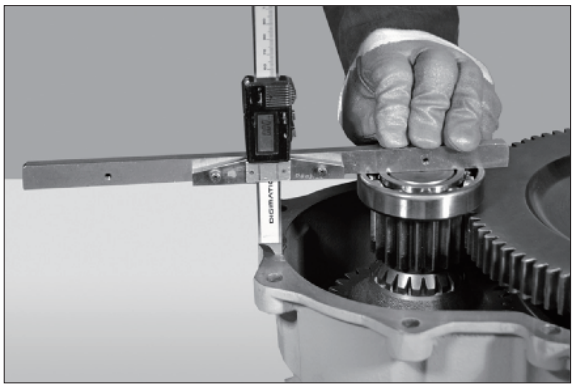


(24) Using a pusher of suitable diameter, fit gear (41) onto the shaft (24).

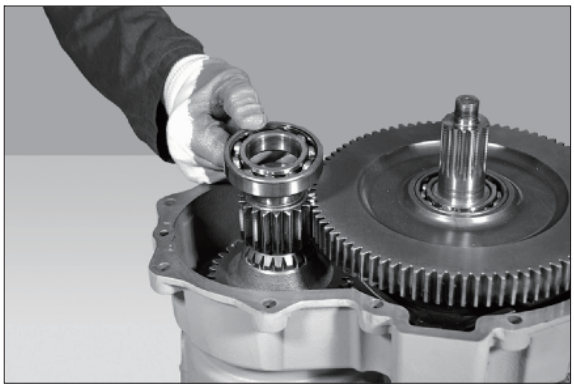
※ Fit as originally mounted, using the markings made previously as reference.



(25) By hand install the bearing on the input shaft.
Reset a digital depth gauge between cover surface and bearing.

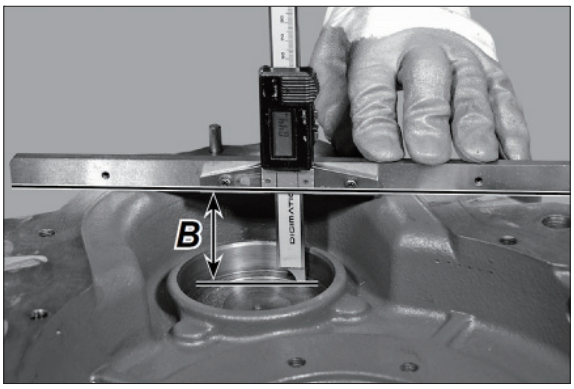


(26) Remove the bearing (75) from the input shaft (73).

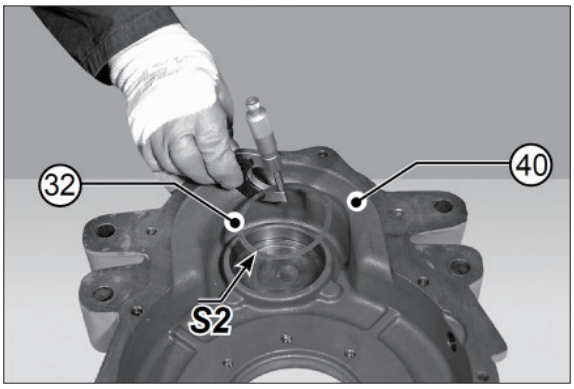


(27) Measure distance “B” between the cover surface and bearing contact surface.

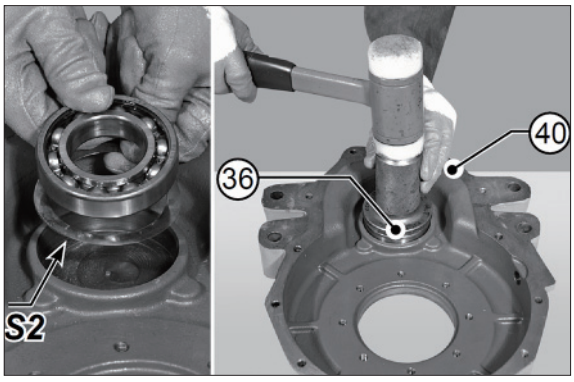
· Example : B = 0.45



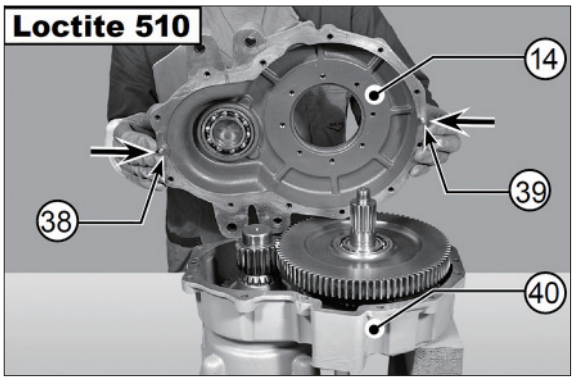
(28) Calculate thickness “S2” of the shims by using this formula :
S2 = B - Y = S2, where Y is the predefined axial backlash.
Y = backlash = 0.15 ± 0.35 mm
Example :
S2 = B-Y = 0.45 - 0.25 = 0.20 mm = S2
Make up the appropriate pack of shims.



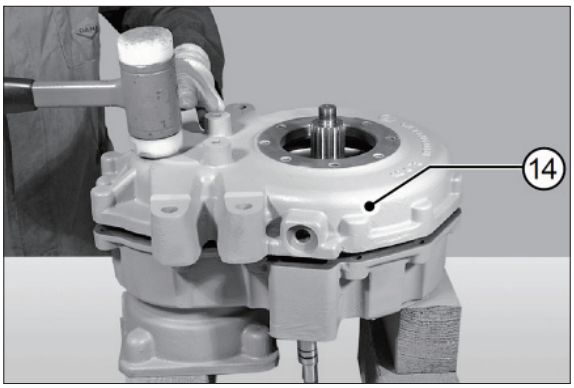
(29) Using a normal tool, push the bearing (36) and shims into its seat in the cover (40).



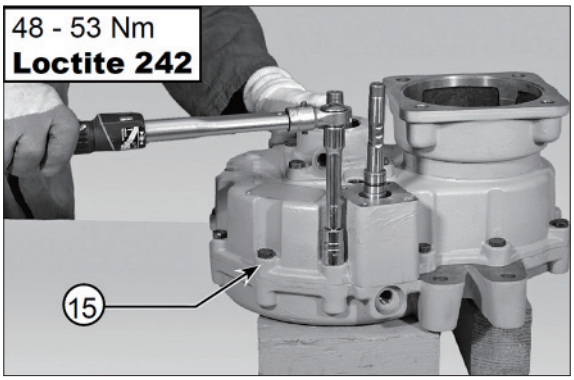
(30) Insert guide bushings (38), (39) .
Apply loctite 510 to the machined surfaces, Fit the cover (14) onto the casing (40) and align the pins (38), (39).



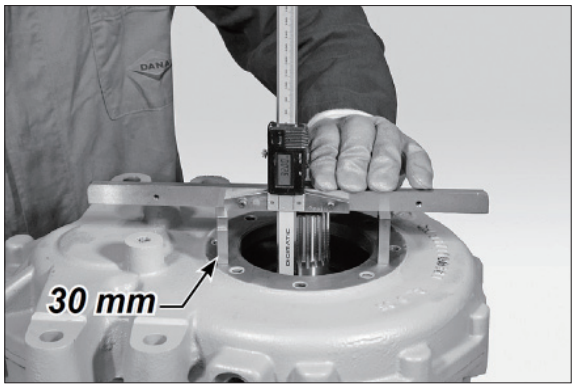
(31) Tap the cover (14) gently with a mallet to seat correctly.

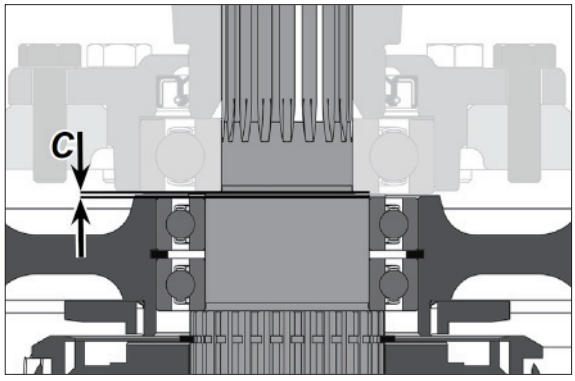


(32) Spread loctite 242 on the screws (15).
Secure in position with the screws (15), tightening to a torque of 4.89~5.4 kgf · m (35.4~39.1 lbf · ft).



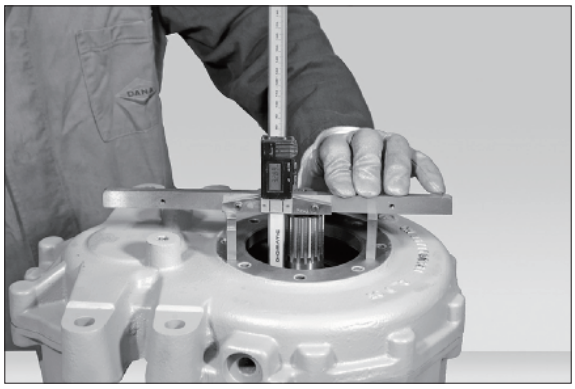
(33) Reset a centesimal digital depth gauge between calibrated blocks (whose known thickness is 30 mm) and output shaft.





(34) Measure distance “C” between the output shaft and bearing thrust block.

· Example : C = 0.45



(35) Calculate thickness “S3” of the shims by using this formula :

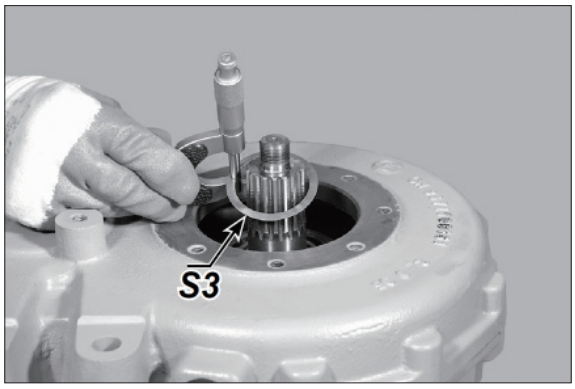
S3 = C - X = S3, where X is the predefined axial backlash.

X = backlash = 0.15 ± 0.35 mm

Example :

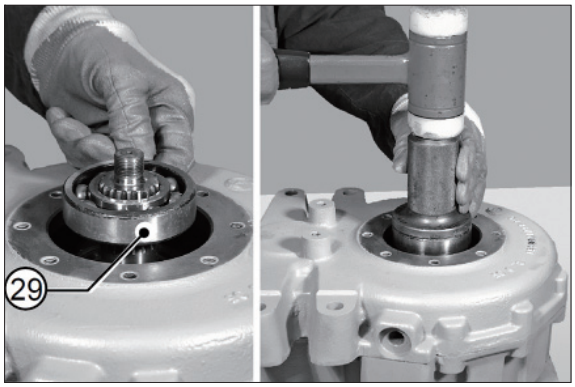
S3 = C-X = 0.45 - 0.25 = 0.20 mm = S3

Make up the appropriate pack of shims.



(36) Using a pusher of suitable diameter, fit the bearing (29) into output shaft (24).

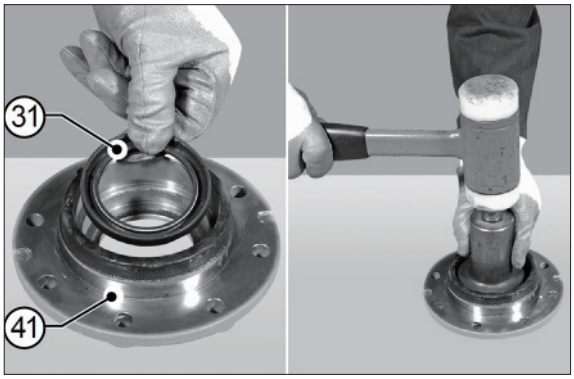
※ Ensure that the bearing is seated securely.



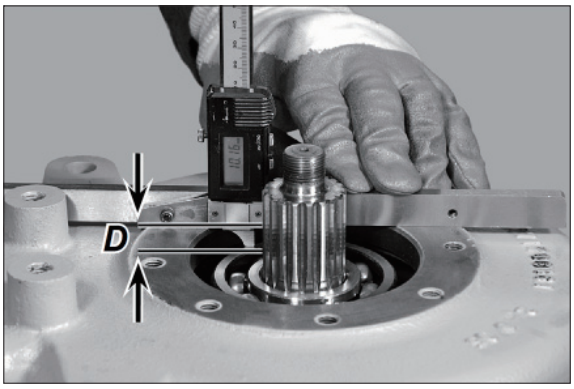
(37) Re-insert the new sealing ring (31) in the motion output cover (41).

※ Pay particular attention to the direction of assembly of the rings (31).

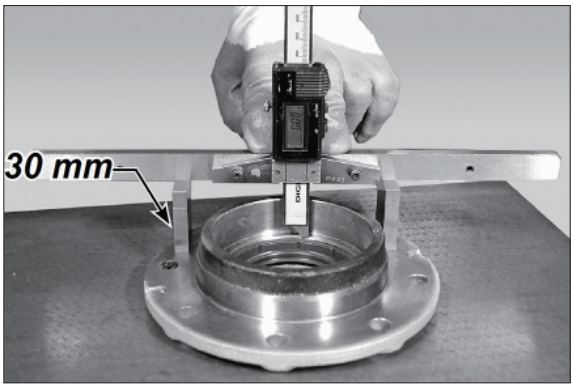
Lubricate the lip of the sealing ring with grease.



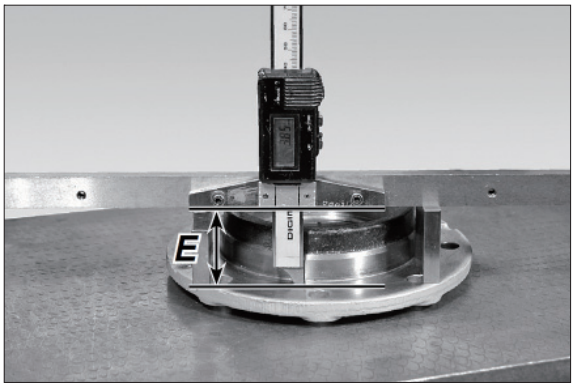
(38) Measure distance “D” between cover surface and bearing.



(39) Zero the depth gauge between calibrated blocks (whose known thickness is 30 mm) and bearing seat.

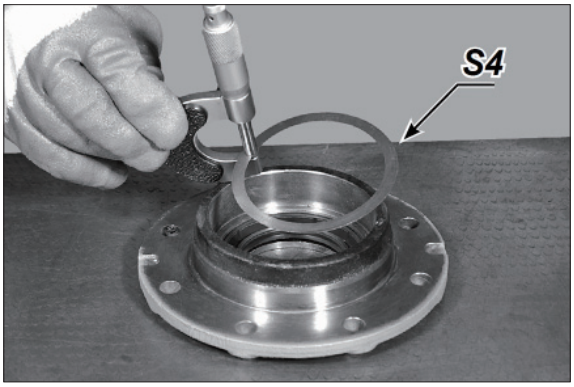


(40) Measure dimension “E” on the cover.



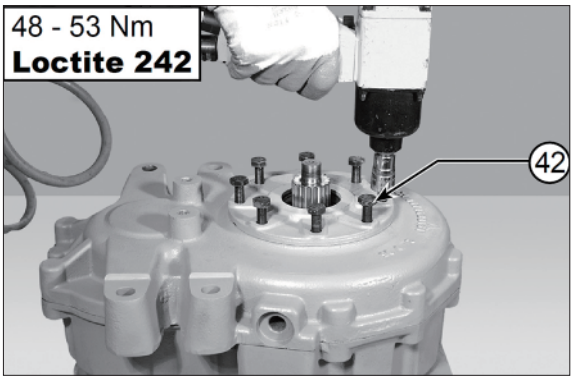
(41) Calculate thickness “S4” of the shims by using this formula :
S4 = (Dimension E - Dimension D) - X = S4, where X is the predefined axial backlash.
X = backlash = 0.15 ± 0.25 mm
Example : S4 = (E-D)-X = (3.85-3.40)-0.20 = 0.25 mm =S4

Make up the appropriate pack of shims.

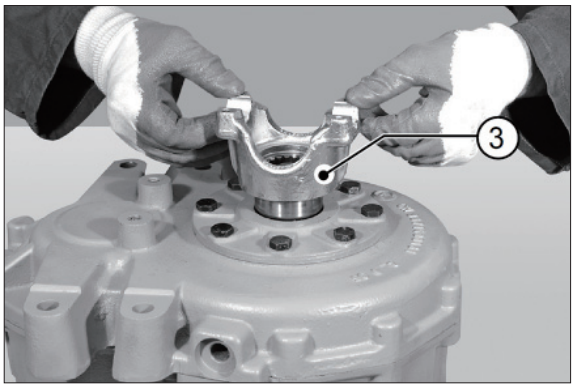


(42) Assembly the cover (41) spreading loctite 510 on planes.

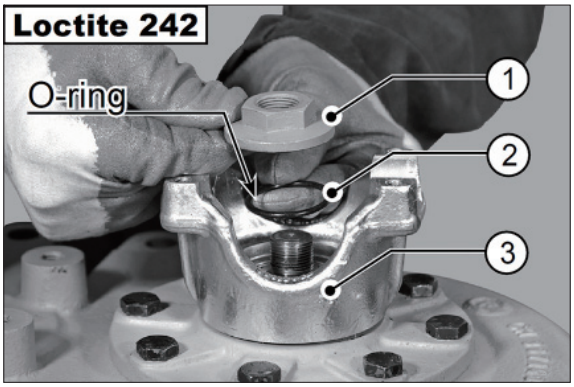
(43) Assembly the screws (42) spreading loctite 242.
Tighten screws (42) using a torque wrench setting of 4.89~5.4 kgf · m (35.4~39.1 lbf · ft).



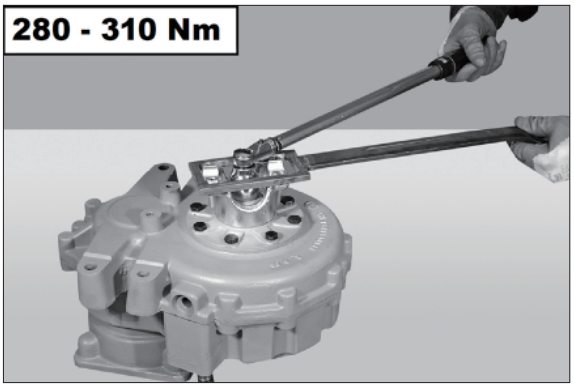
(44) Fit the flange (3) on the shaft (24), seating completely.



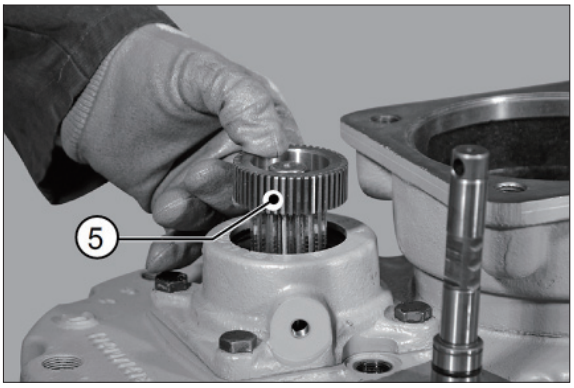
(45) Lubricate the O-ring (2) with grease and fit in the flange (3) seating.
Spread with loctite 242 the lock nut (1) and fit.



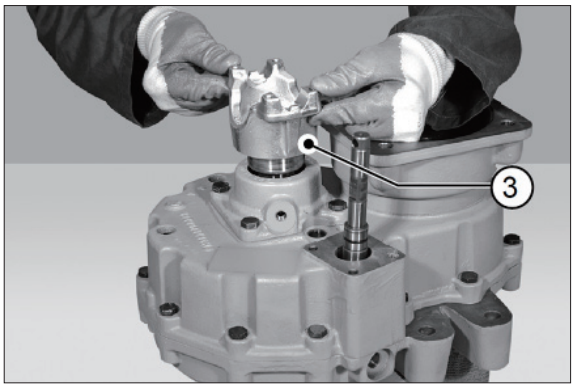
(46) Tighten the lock nut (1) to a torque of 28.6~31.6 kgf · m (207~229 lbf · ft).



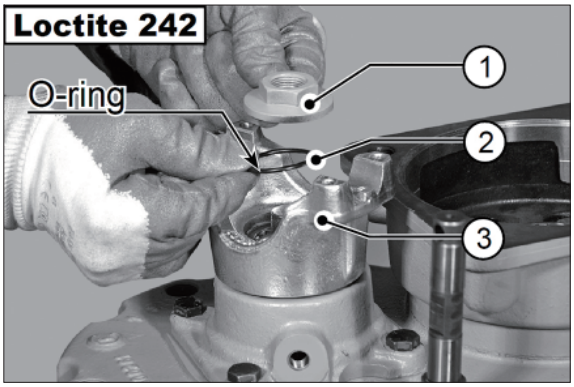
(47) Insert the phonic end disk (5).



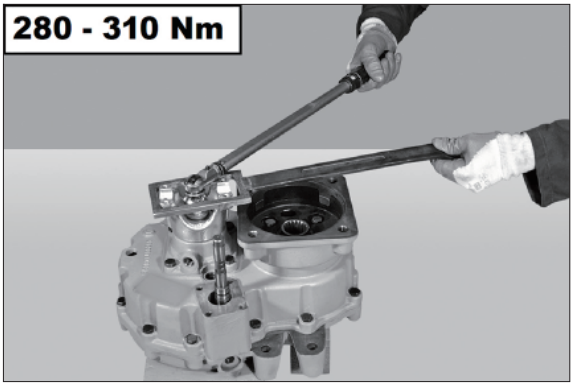
(48) Fit the flange (3) on the shaft (24), seating completely.



(49) Lubricate the O-ring (2) with grease and fit in the flange (3) seating.
Spread with loctite 242 the lock nut (1) and fit.

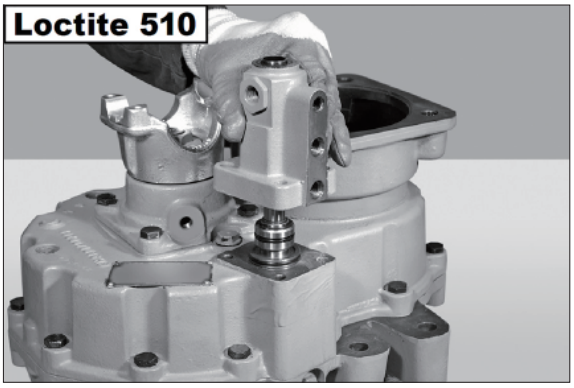


(50) Tighten the lock nut (1) to a torque of 28.6~31.6 kgf · m (207~229 lbf · ft).



(51) Coat the coupling surface of the gearshift cylinder with loctite 510 ; fit the cylinder on the gear selector rod.

※ Make sure that the sealant forms a continuous film around the locking holes.
For more details, see : INSTALLATION OF HYDRAULIC GEAR CONTROL



GROUP 6 STEERING VALVE

1. REMOVAL AND INSTALL

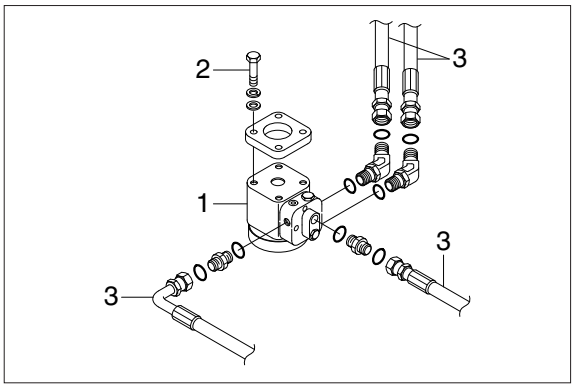
1) REMOVAL

(1) Lower the work equipment to the ground and stop the engine.

(2) Operate the control levers and pedals several times to release the remaining pressure in the hydraulic piping.

(3) Loosen the breather slowly to release the pressure inside the hydraulic tank.

⚠ Escaping fluid under pressure can penetrate the skin causing serious injury.



(4) Disconnect steering line hoses (3).

(5) Loosen the hexagon bolt (2) and remove the steering valve assembly (1).

· Tightening torque : 4.8 ± 0.3 kgf · m
(34.7 ± 2.2 lbf · ft)

2) INSTALL

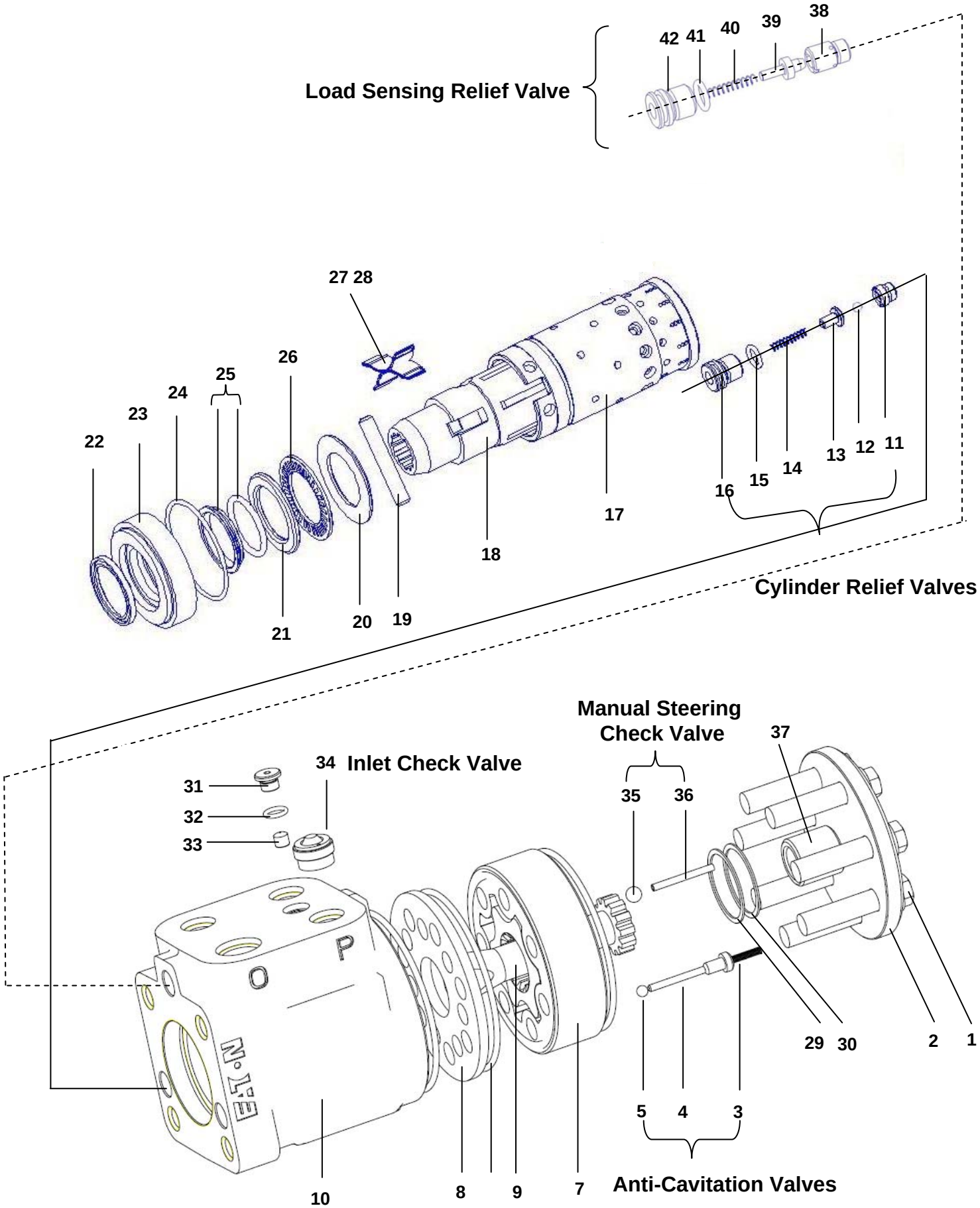
(1) Carry out installation in the reverse order to removal.

(2) Confirm the hydraulic oil level and check the hydraulic oil leak or not.

※ When removing the steering valve assembly, check that all the hoses have been disconnected.

2. STEERING VALVE

1) STRUCTURE



1. Cap Screw (M10)
2. End Cap
3. Spring
4. Plug
5. Ball 4mm
6. Seal, O-ring 77.5mm ID*
7. Gerotor
8. Spacer Plate
9. Drive
10. Housing
11. Valve Seat
12. Ball 5mm
13. Ball Holder
14. O-ring 7.6454mmID*
15. Spring
16. Plug
17. Sleeve
18. Spool
19. Pin
20. Bearing Race
21. Bearing Race
22. Dust Seal*
23. Gland Bushing
24. O-ring 43.2mm ID
25. Shaft Seal Kit*
26. Needle Thrust Bearing
27. Spring
28. Spacer
29. Back-up Washer*
30. Ring, Seal*
31. Plug
32. O-ring 6.07mm ID*
33. Screw, Set
34. Inlet Check Valve
35. Ball 7mm
36. Roll Pin
37. Spacer
38. Valve Set
39. Poppet
40. Spring
41. O-ring 7.6454mmID*
42. Plug

Disassembly

Cleanliness is extremely important when repairing a steering cont rol unit. Work in a clean area. Before disc onnecting lines, clean port area of unit thoroughly. Use a wire brushto remove foreign material and debris from around external joints of the unit.

Note

Although not all drawings show the unit in a vice, we recommend that you keep the unit in vice during disassembly. Follow the clamping procedures explained throughout the manual.

Meter (Gerotor) End

1. Clamp unit in vice, Gerotor end up.
   Clamp lightly on edges of port face sides (see figure). Use protective material on vice jaws. Housing distortion can result if jaws are over- tightened.
2. Remove M10 cap screws.
3. Remove end cap.
4. Remove drive Spacer(If included)
5. Remove seal from Gerotor.

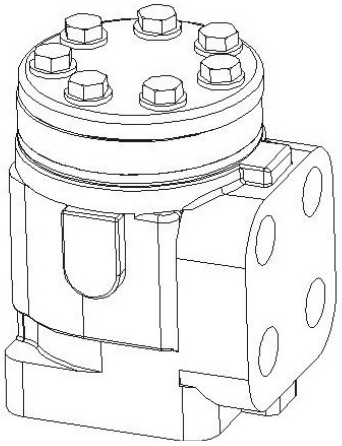


Figure 1

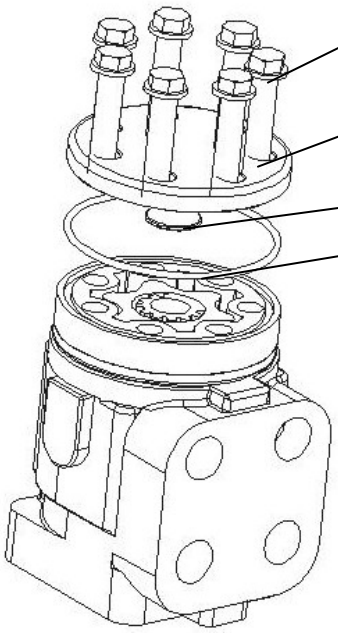


Figure 2

Disassembly

6. Remove Gerotor Set. Be careful not to drop star.
7. Remove seal .

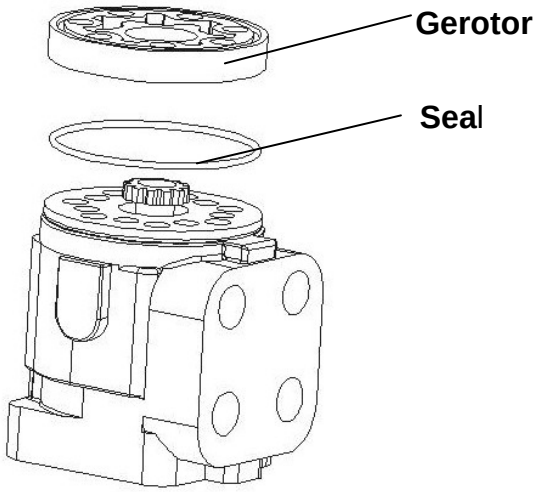


Figure 3

8. Remove drive.
9. Remove spacer plate .
10. Remove seal from housing.
11. Remove housing from vice.

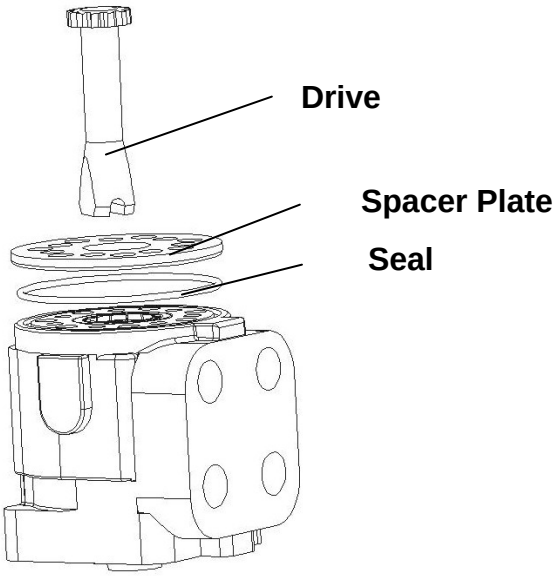


Figure 4

Disassembly

12. Carefully remove anti-cavitation check valves and manual steering check valve(roll pin and ball) from bolts holes, by tipping.

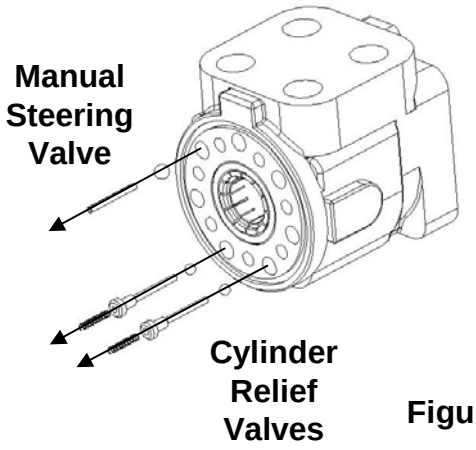


Figure 5

Note:Do not remove any valves other than manual steering check valve and anti-cavitation check valves. All other valves are factory preset and are non-serviceable

13. Carefully remove the spool-sleeve assembly from housing in upright position

Note: Do not cock spool- sleeve assembly in housing Rotate spool- sleeve assembly slowly when removing it from housing

14. Push pin from spool-sleeve assembly.

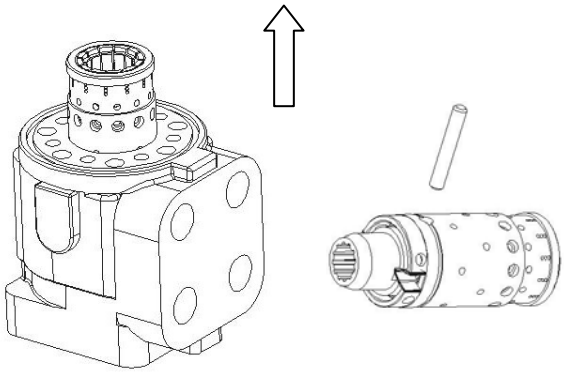


Figure 6

15. Remove the bearing race, needle thrust bearing and bearing race, step by step from the housing.

16. Remove Shaft seals from seal gland bushing.

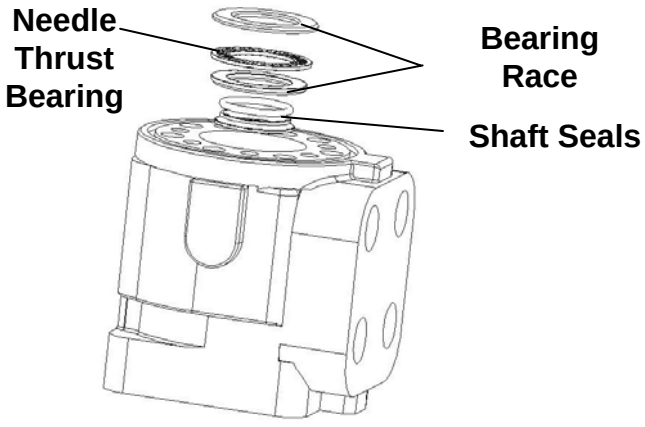


Figure 7

Disassembly

17. Push spool partially from control end of sleeve, then carefully remove centering springs from spool by hand (see figure). Low input torque unit use four centering springs and two spacers. Standard input torque unit use six centering springs.

    Make matching mark on spool and sleeve.

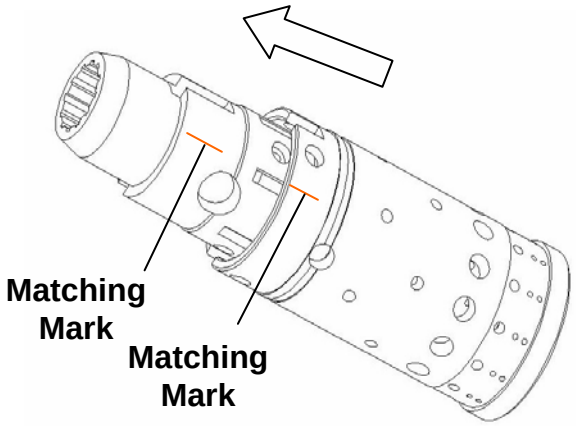


Figure 8

Note : There are different kinds of spool and sleeve set

Low torque Spring 370-000(4) and 21626-000(2)

Standard spring370-000(6)

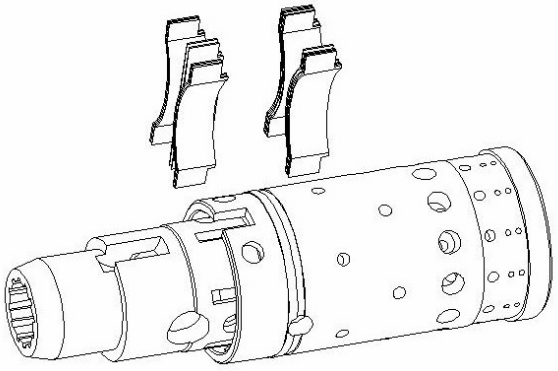


Figure 9

Reassembly

Check all mating surfaces, Replace any parts that have scratches or burrs that can cause leakage. Clean all metal parts in clean solvent. Blow dry with air. Do not wipe dry with cloth or paper to wel because lint or other matter can get into the hydraulic system and cause damage. Do not use grit paper or file or grind these parts.

Note: Lubricate all seals with clean petroleum jelly (Vaseline). A good service policy is to replace all old seals with new seals. Do not use excessive lubricant on seals for Gerotor section.

1. Assemble spool and sleeve carefully so that spring slots line up at the same end. Rotate spool while sliding parts together.

Test for free rotation. Spool should rotate smoothly in sleeve with finger tip force applied at splined end. Align spool and sleeve by matching marks, if present. Otherwise, align spring slots in spool and sleeve and stand parts on bench

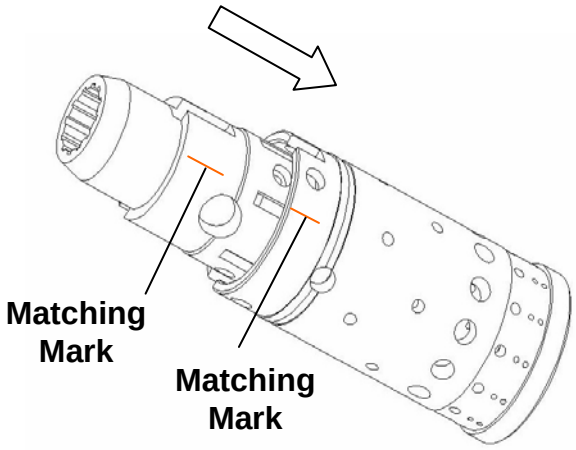


Figure 10

Reassembly

2. Centering springs for low input torque units have four arched springs with two flat spacers in the center as shown in figure.

   Centering springs for standard input torque units have six arched springs.

   Position centering springs so that the notches line up, and arched center sections are nested together. Next, with spring notches facing sleeve, insert one end of entire spring set into spring installation tool.

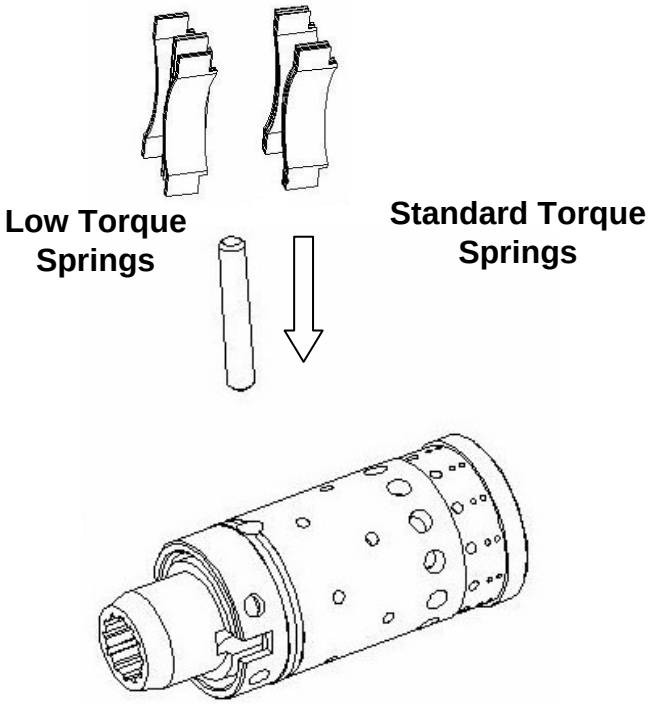


Figure 11

3. Compress extended end of spring set and push into spool-sleeve assembly. Keep pressure on spring ends while withdrawing installation tool and pushing forward on springs at same time.
4. Center spring set in spring slots. Seat springs down evenly and flush with upper surface of spool and sleeve
5. Insert pin through spool-sleeve assembly until pin is within the outside diameter of sleeve.

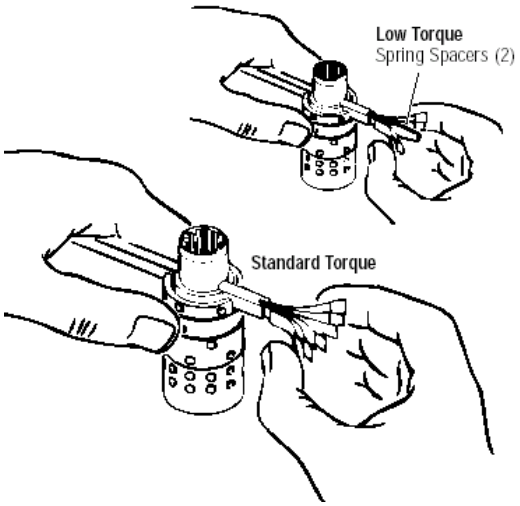


Figure 12

Reassembly

6. Lubricate seal (see parts list) before installation in seal gland bushing in housing. Use proper seal-installation tool, to make sure seal enters seal gland bushing without being cut or nicked.

   Do not use any seal that falls freely into counter-bore of seal gland bushing.

7. Install two bearing races and needle thrust bearing as shown in figure.

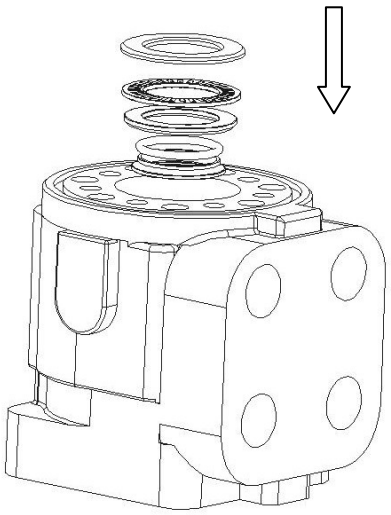


Figure 13

8. Position spool-sleeve assembly so that splined end of spool enters open end of housing first.

   Caution : While inserting spool-sleeve assembly into housing, make sure parts do not tilt out of position. Push assembly gently into place with slight rotating action, keeping pin from moving out and getting stuck in the internal groove.

   Bring spool-sleeve assembly entirely within housing bore. With spool-sleeve assembly in this flush position, check for free rotation within housing by turning assembly with fingertip force at splined end.

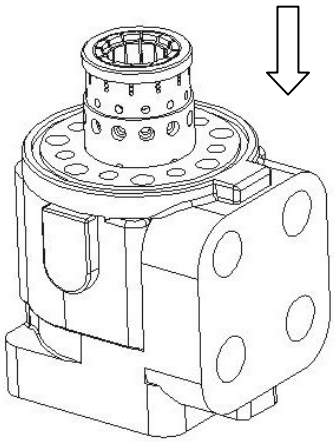


Figure 14

Reassembly

9. Clamp housing in vice, as shown in figure. Clamp lightly on edges of mounting area; do not over-tighten jaws.

   Note : Check to insure that spool and sleeve are flush or slightly below 14-hole surface of housing.

   Clean upper surface of housing by wiping with palm of clean hand. Clean each of the flat surfaces of parts in Gerotor section in a similar way just before reassembly. Do not use cloth or paper to clean surfaces.

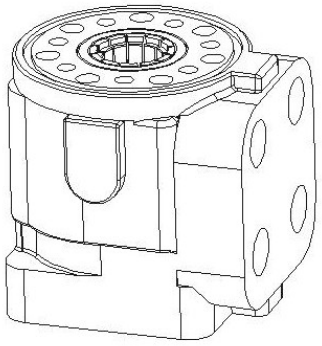


Figure 15

10. Install 77.5 ID seal in housing.
11. Install Anti-Cavitation check valves and manual steering check valve in holes, as shown in figure.
12. Install spacer plate. Align bolt holes in spacer plate with tapped holes in housing.

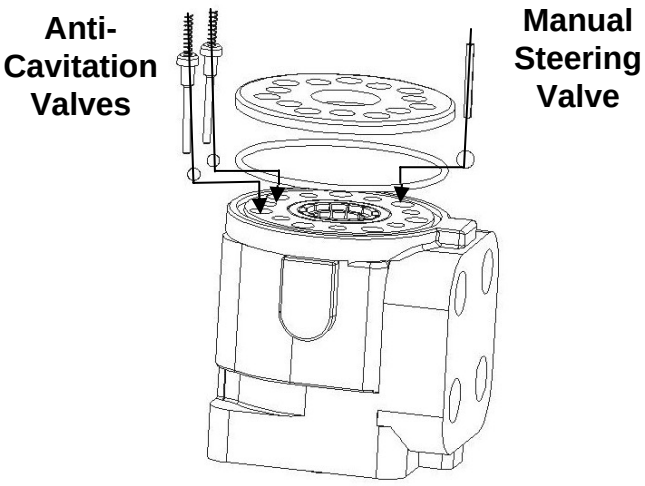


Figure 16

Reassembly

13. Rotate spool and sleeve assembly until pin is parallel with port face. Install drive, making sure drive is engaged with pin. To assure proper alignment, mark drive as shown in figure, When marking drive, note relationship of slotted end of drive to splined end of drive.
14. Lubricate and install 77.5 ID seal in Gerotor ring. The lubrication will hold seal in place.
15. Align star valleys with pin. Note parallel relationship of reference lines A,B,C and D in figure. Align bolts holes without disengaging Gerotor star from drive.

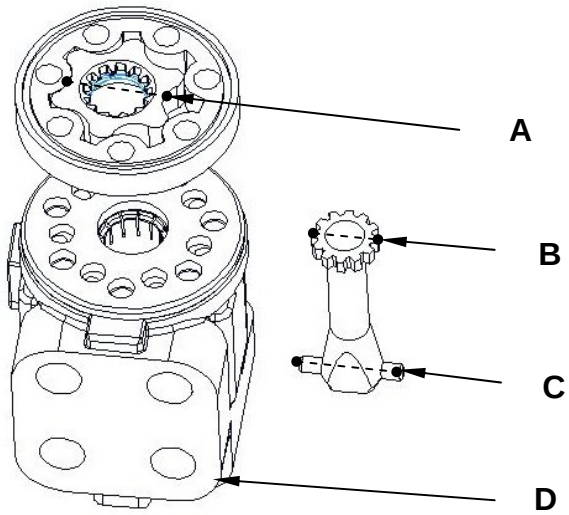


Figure 17

16. When used, install drive spacer in Gerotor star.
17. Lubricate and install 77.5 ID seal in Gerotor ring.
18. Install end cap on gerotor , aligning holes.
19. Install 7 dry cap screws in end cap. Pre-tighten screws to 17Nm, then torque screws to 35~40Nm in sequence show in figure.
20. Check for proper timing by turning the spool clockwise and feeling pressure in the “R” port.
21. Check the manual torque, the steering should turn freely.

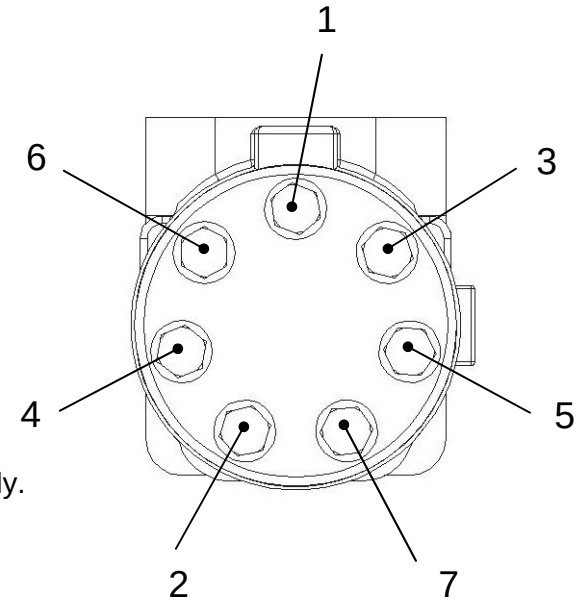


Figure 18

1. REMOVAL AXLE

1) FRONT

(1) Propeller shaft mounting nut (2, M10)
· Tightening torque : 6.9±1.4 kgf · m
(49.9±10.1 lbf · ft)

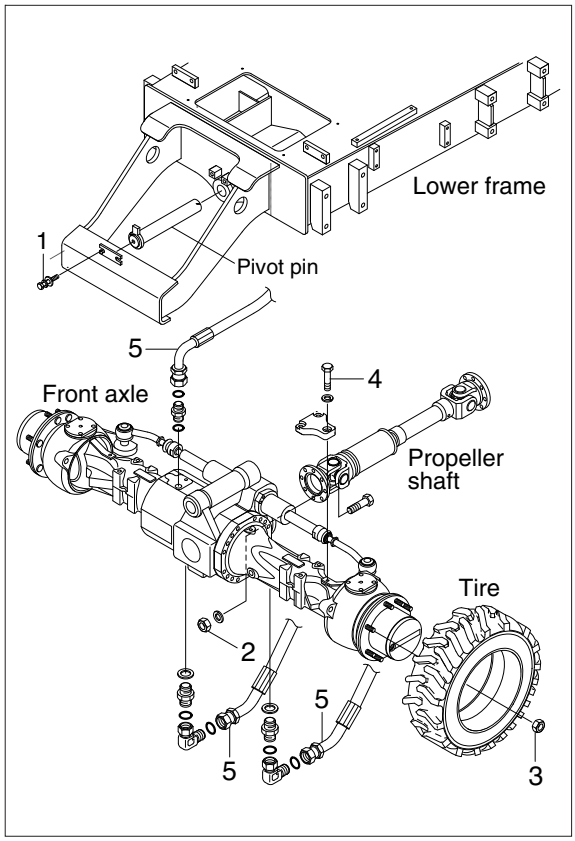
(2) Wheel nut (3, M18)
· Tightening torque : 46±3.0 kgf · m
(333±21.7 lbf · ft)

(3) Oscillating cylinder supporting mounting bolt (4, M12)
· Tightening torque : 12.8±3.0 kgf · m
(92.6±21.7 lbf · ft)

(4) Front axle mounting pin lock bolt (1, M10)
· Tightening torque : 6.9±1.4 kgf · m
(49.9±10.1 lbf · ft)

(5) Hose assy (5)

(4) Front axle weight : 280 kg (610 lb)



2) REAR

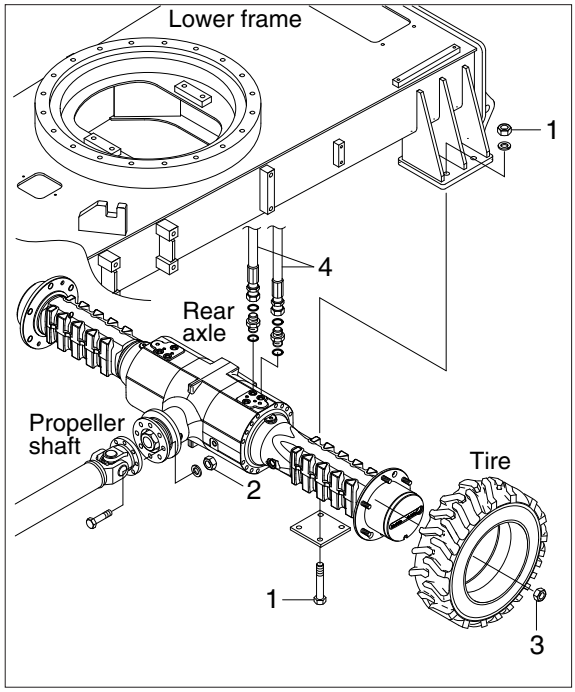
(1) Rear axle mounting bolt and nut (1, M16)
· Tightening torque : 6.9±1.4 kgf · m
(49.9±10.1 lbf · ft)

(2) Propeller shaft mounting nut (2, M10)
· Tightening torque : 7.4±1.5 kgf · m
(53.5±10.8 lbf · ft)

(3) Wheel nut (3)
· Tightening torque : 46±3 kgf · m
(333±21.7 lbf · ft)

(4) Hose assy (4)

(5) Rear axle weight : 200 kg (440 lb)



2. GENERAL INTRODUCTIONS

1) Introduction

The efficiency and continued operation of mechanical units depends on constant and correct maintenance and also on efficient repair work should there be a break-down or malfunction.

The instructions in this manual have been made based on a complete overhaul of the unit. However the mechanic must decide whether or not it is necessary to dismantle the individual components when only partial repair work is needed.

The manual provided a quick and sure guide which, with the use of photographs and diagrams illustrating the various phases of the operations, allows accurate work to take place. Therefore all the information needed for correct disassembly, the relative checks and assembly of each individual component, has been written down.

In order to remove the differential unit from the vehicle, the manuals provided by the vehicle manufacturer should be consulted. In describing the following operations it is presumed that the unit has already been removed from the vehicle.

※ Throughout the phases of repair or maintenance work it is advisable to use proper equipment such as : trestles, or supporting benches, plastic or copper hammers, appropriate levers, extractors and specific spanners or wrenches. So that the work is facilitated and the working surfaces and the operators themselves are protected.

Before going on to disassemble the parts it is best to thoroughly clean the unit, removing any encrusted or accumulated greases and then drain the oil through the oil-draining plugs.

2) Introductory statement

All the disassembled mechanical units should be thoroughly cleaned with appropriate products and then restored or replaced if damage, wear, cracking or seizing have occurred. In particular, thoroughly check the state of all moving parts (bearing, gears, crown wheel and pinion, shafts) and sealing parts (O-ring, oil shield) which are subject to major stress and wear. In any case it is advisable to replace the seals every time a component is overhauled or repaired. During assembly the sealing rings must be lubricated on the sealing edge. In the case of the crown wheel and pinion, replacement of one requires the replacement of the other. During assembly the prescribed pre-loading and backlash of the parts must be maintained.

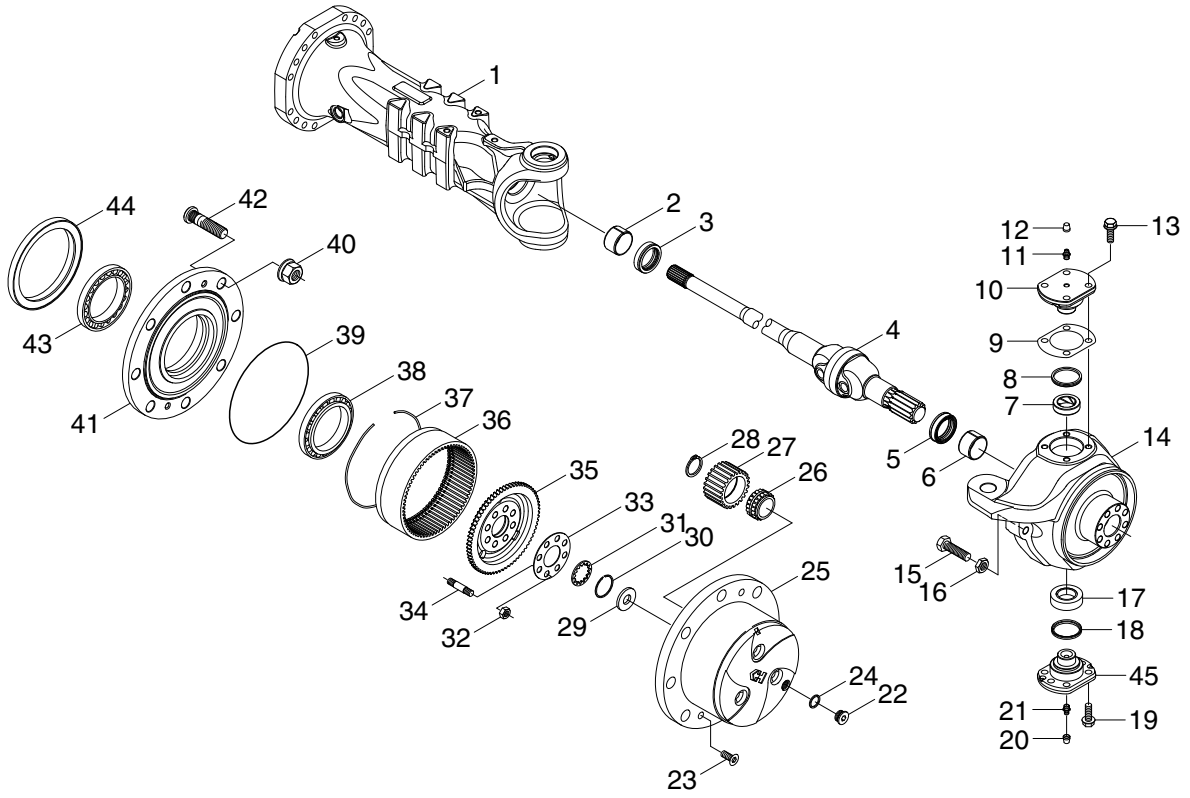
3) Maintenance and repair

We have compiled these instructions for maintenance and repair in order to facilitate any such work on the CLARK-HURTH Components differential units and gear change unit.

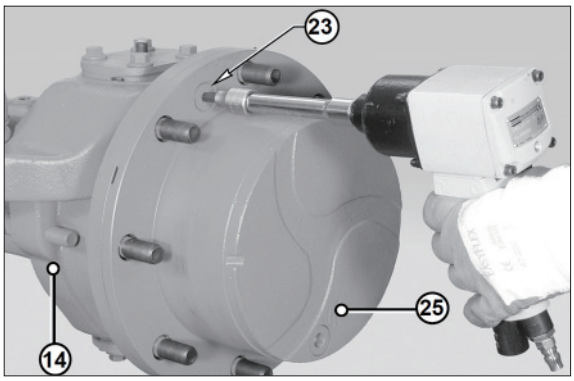
3. FRONT AXLE

1) THE PLANETARY REDUCTION AND THE COMPLETE STEERING CASE

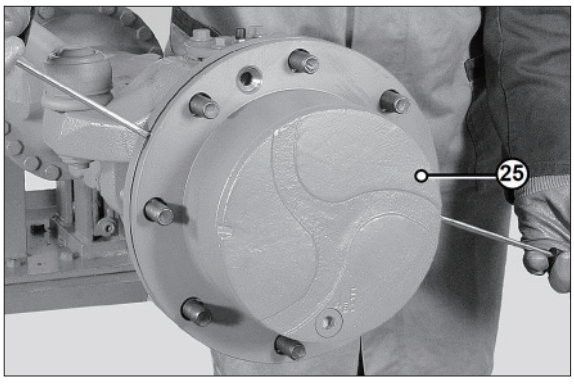
(1) Disassembly



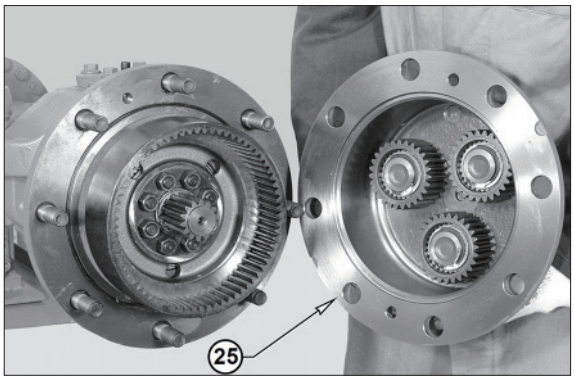
① Remove the securing screws (23) from the planetary carrier cover (25).
Disconnect the steering bars from the steering case (14).



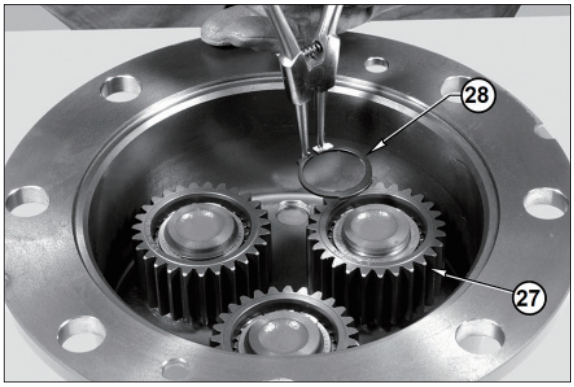
② Disjoint the planetary carrier cover (25) from the steering case by alternatively forcing a screwdriver into the appropriate slots.



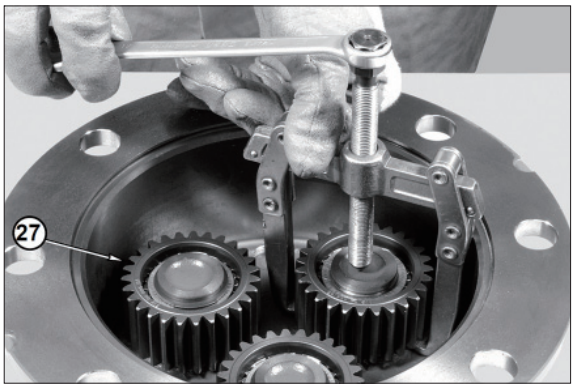
③ Remove the complete planetary carrier cover (25).



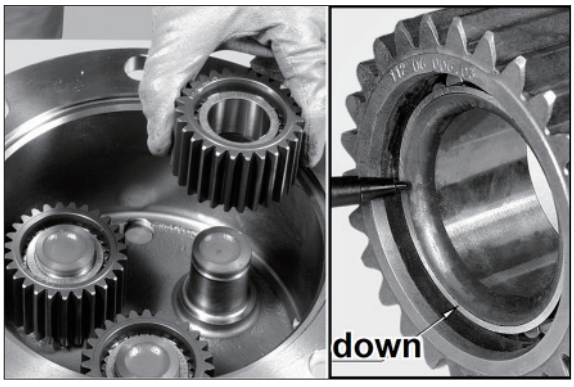
④ Remove the safety spring rings (28) of the planetary gears (27).



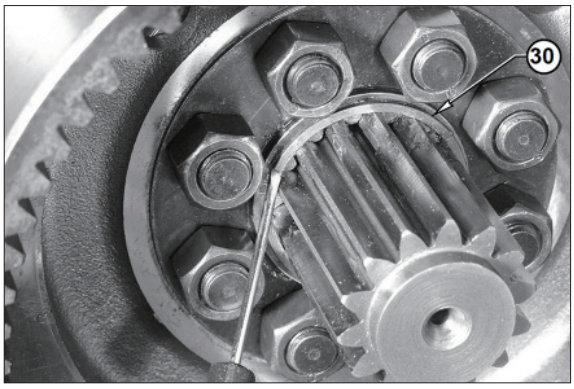
⑤ Remove the planetary gears (27).



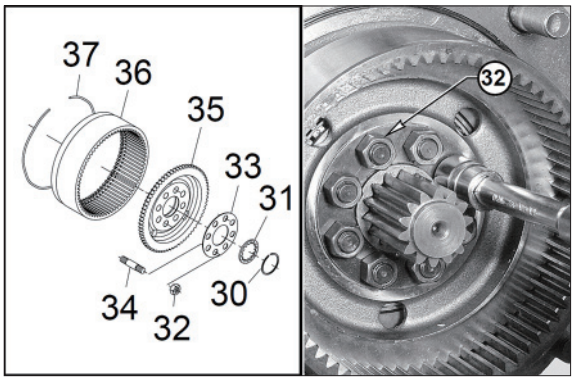
※ Note down direction of assembly of planetary gears.



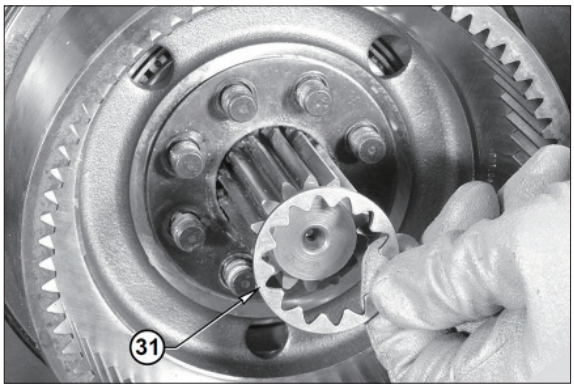
⑥ Remove the snap ring (30).



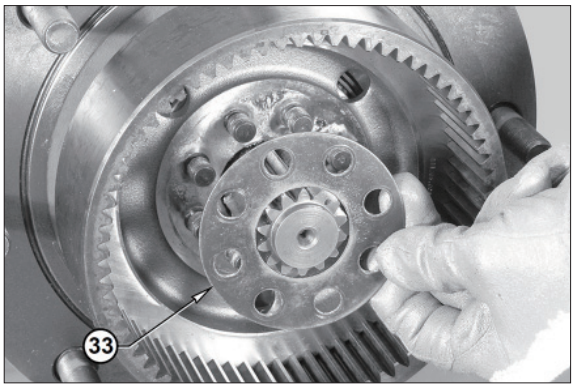
⑦ Unloose and remove the tightening nuts (32) from the crown flange (35).



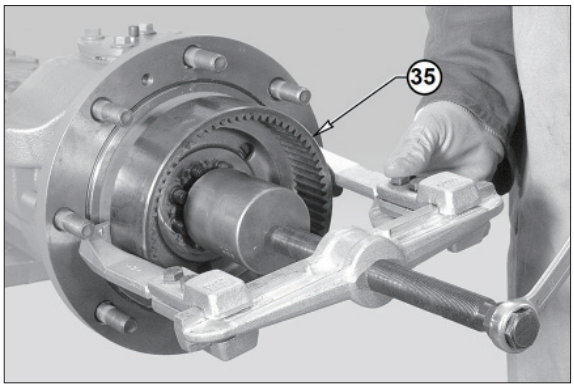
⑧ Remove the shim washer (31).

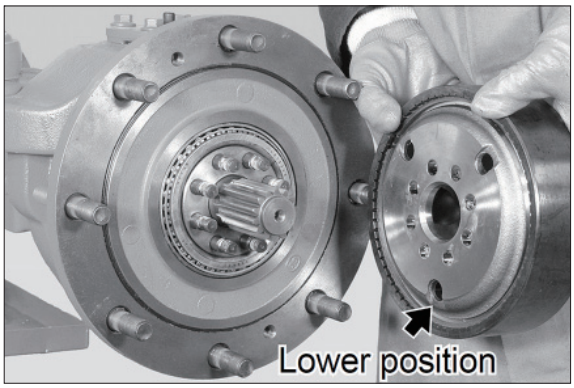


⑨ Remove the safety flange (33).



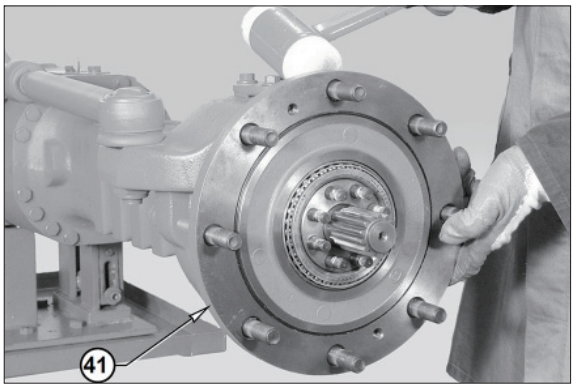
⑩ Using a puller, remove the complete crown flange (35) by acting on the stud bolts.



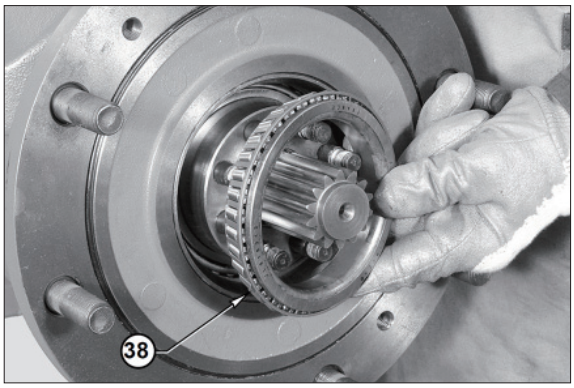


⑪ Partially extract the hub (41) using a plastic hammer.

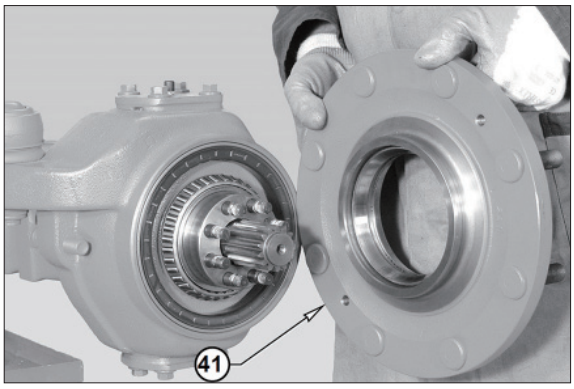
※ Alternately hammer on several equidistant points.



⑫ Remove the external bearing (38).

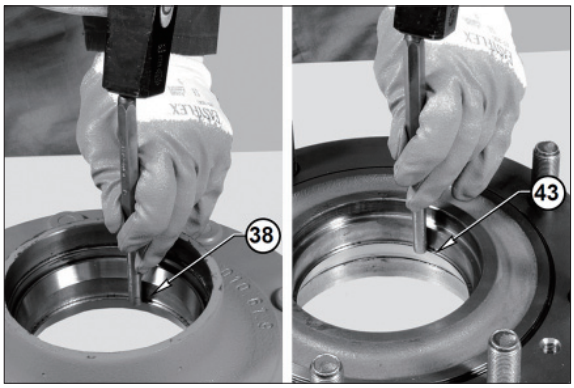


⑬ By hand remove the complete hub (41).



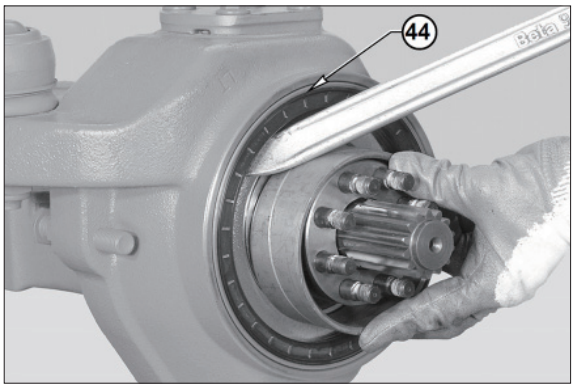
⑭ Remove the external thrust blocks of bearings, using a pindriver.

※ Hammer in an alternate sequence to prevent crawling and deformation of the thrust blocks.

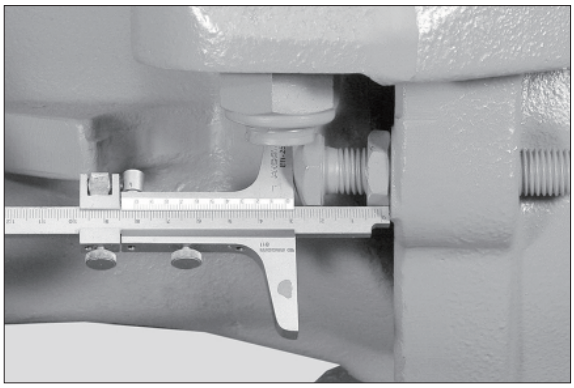


⑮ Remove the sealing ring from the steering case (44).

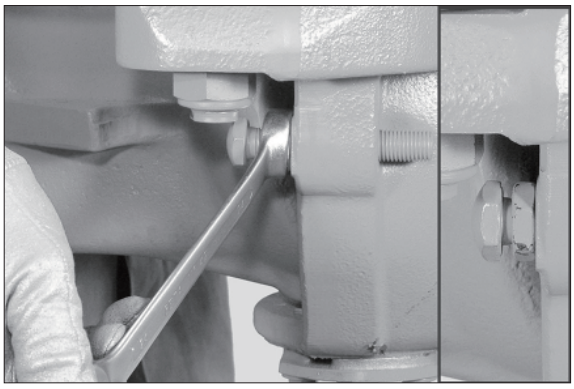
※ Pay due attention not to damage the seat of bearing.



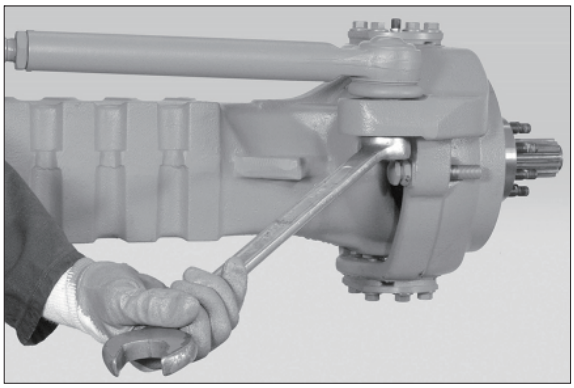
⑯ Note the measure of the screw of lock steering case.



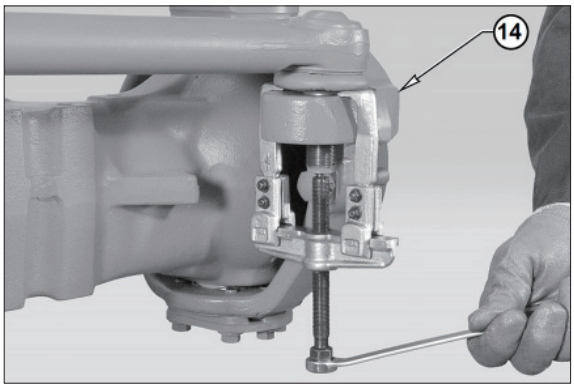
⑰ Loose the lockscrew and insert it to allow the passage of tool.



⑱ Remove the nuts that lock the articulation pins.

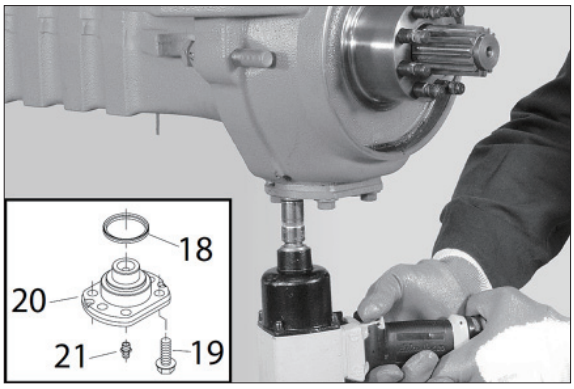


⑲ Disconnect the tapered pins of the articulation from the steering case (14) by means of a puller.

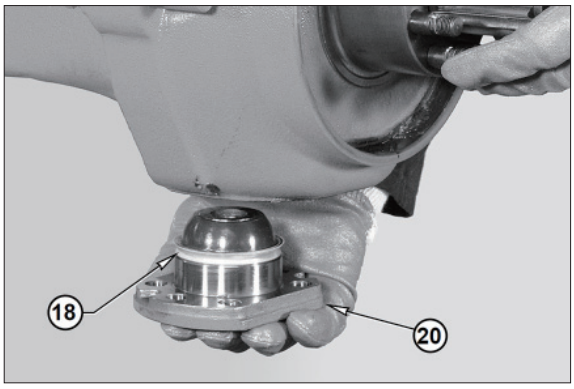


⑳ Unloose and remove the fitting screws (19) from the bottom articulation pin (20).

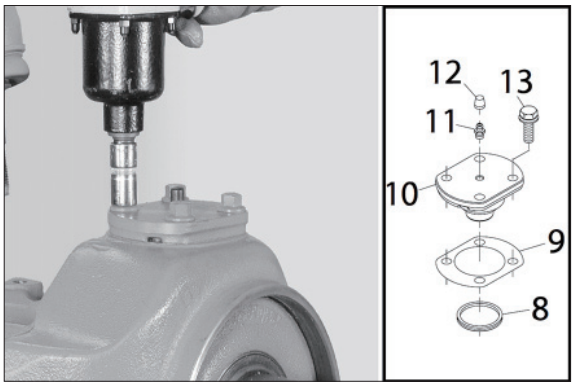
※ Screws cannot be reused.



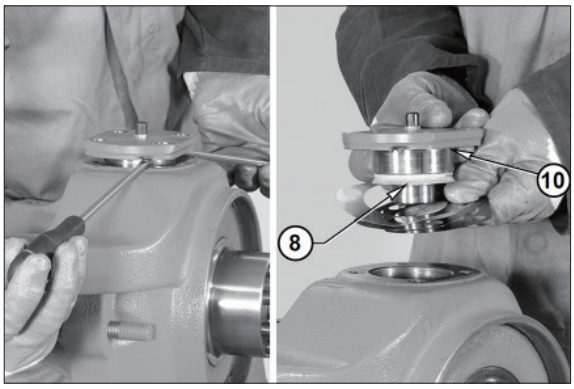
㉑ Remove the bottom articulation pin (18) complete with front sealing ring (20).



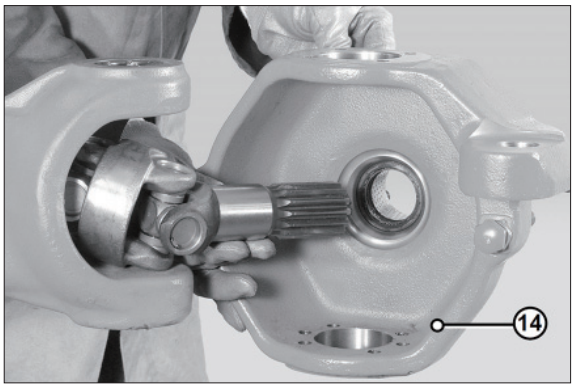
㉒ Unloose and remove the fitting screws (13) from the top articulation pin (10).



㉓ Using two levers, remove the top articulation pin (10) complete with front seal (8).
Pay attention not to damage the surfaces.

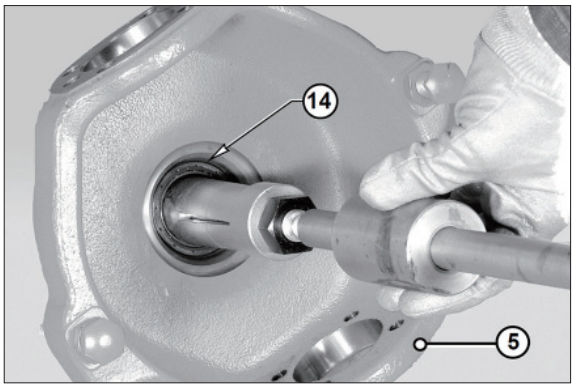


㉔ Remove the complete steering case (14).



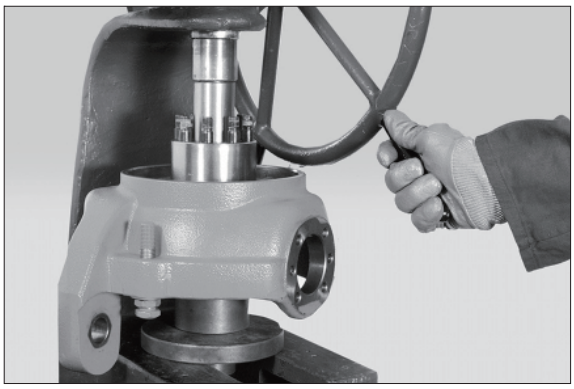
㉕ Use a puller to remove the sealing ring from the steering case (14).

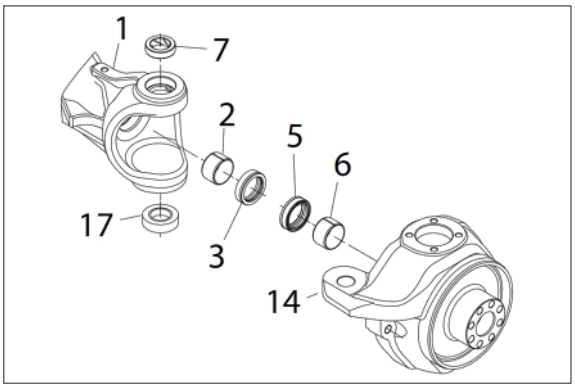
※ Note down the orientation of sealing ring (5).



㉖ Remove the bushing (6) from the steering case (14).

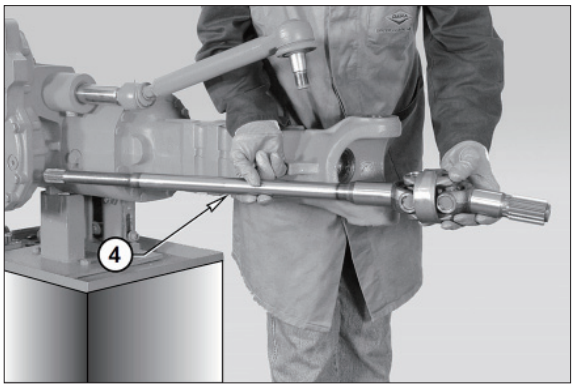
※ Note down the orientation of bushing.



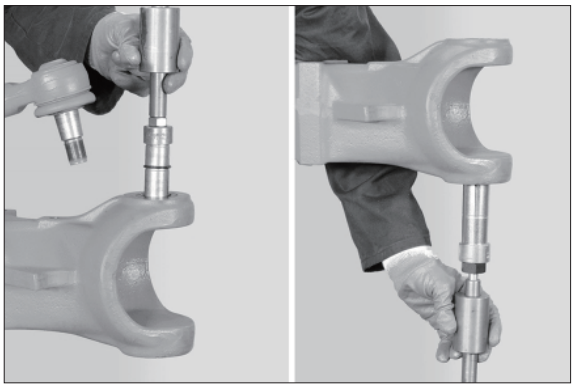


㉗ Remove the u-joint (4).

※ To remove the u-joint use, if necessary, a plastic hammer or a lever.

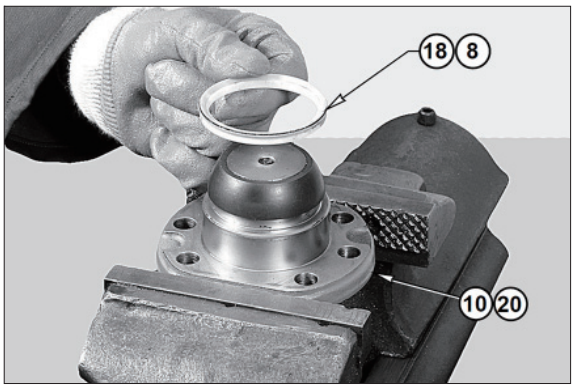


㉘ Using a puller for inner parts, remove the top bush (7) and the bottom ball-bush (17).

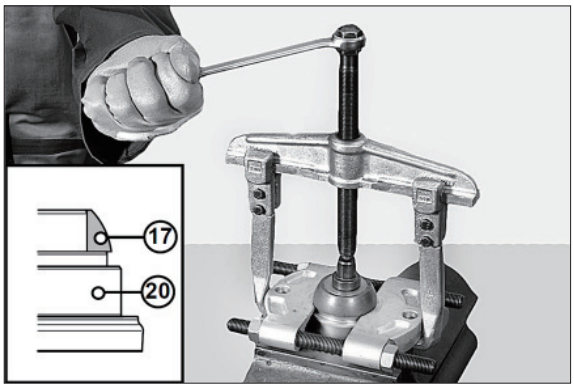


㉙ Remove the articulation pins (10) (20) and the front sealing rings (8) (18).

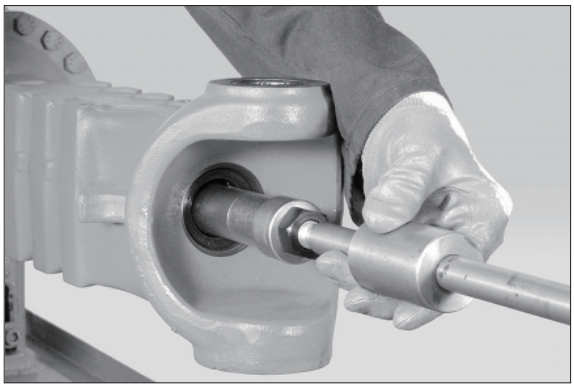
※ Note down the side for assembly.

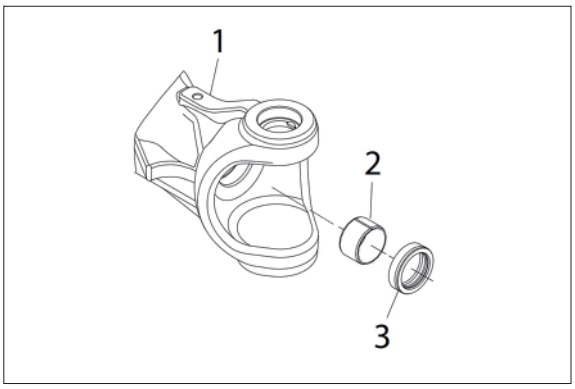


㉚ If the ball cover (17) needs replacing, remove it from the bottom articulation pin (20).

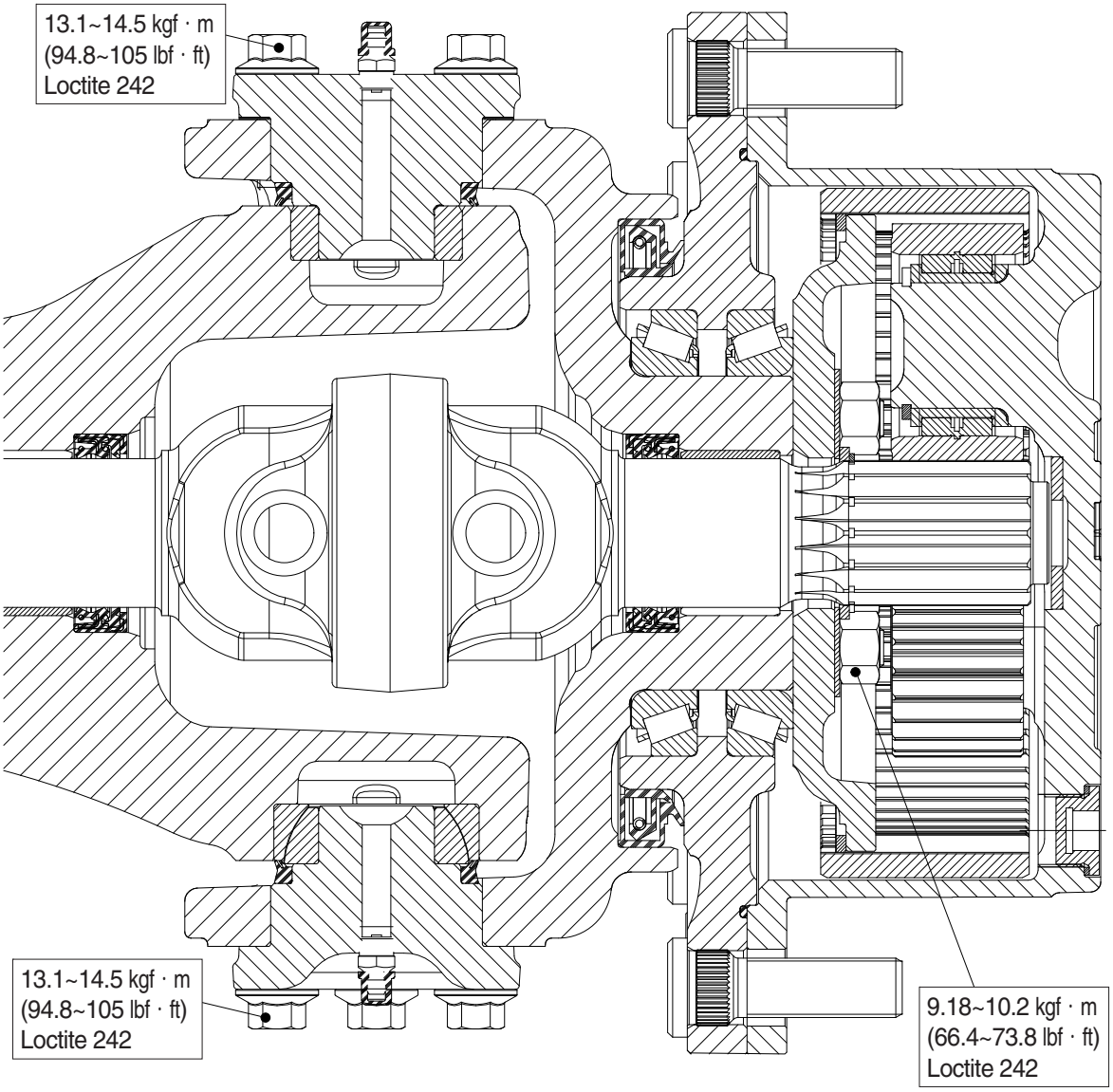


㉛ Remove seal ring (3) and the bushing (2) from the arm (1).



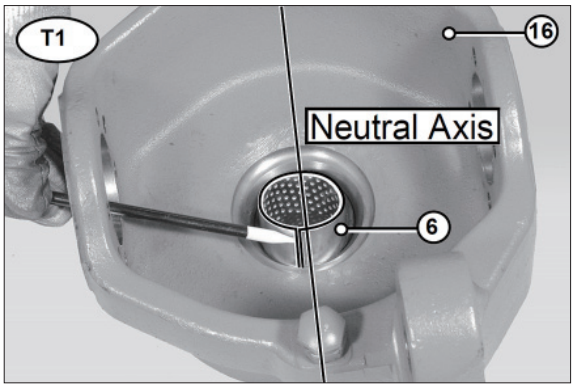


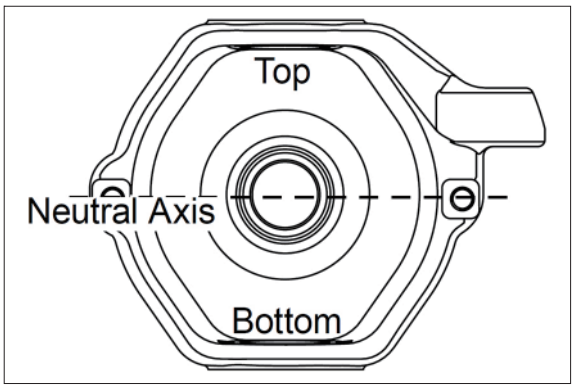
(2) Assembly



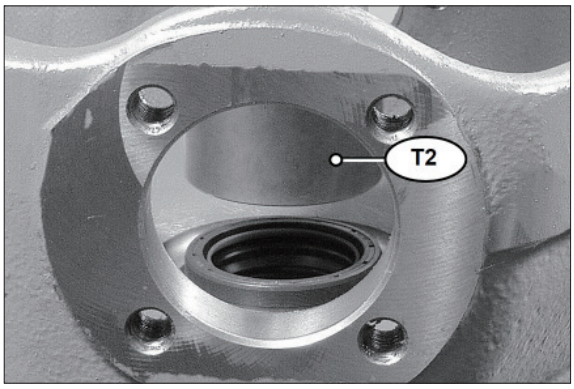
· **Continuos rolling torque** without planetary gear cover 0.71~2.04 kgf · m (5.14~14.8 lbf · ft)
· **Preload steering case** 4.08~8.16 kgf · m (29.5~59.0 lbf · ft)

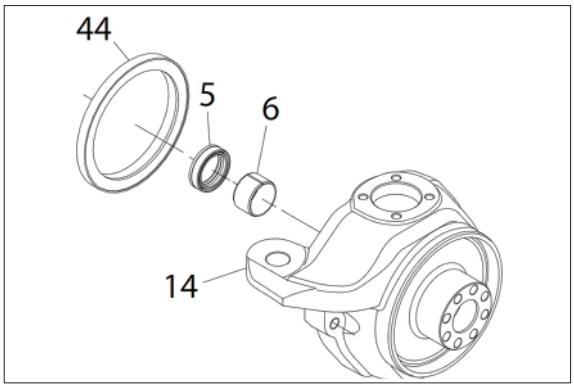
① Lubricate the bushing (6) and the seat of the steering case (14).
Install the bushing (6), using tool T1.





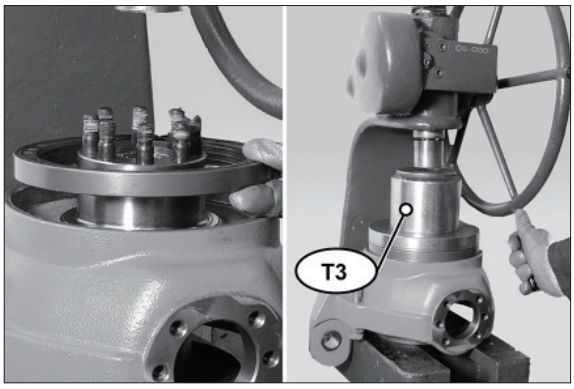
② Lubricate the outer surface of the sealing ring (5); fit them into their seat using tool T2.



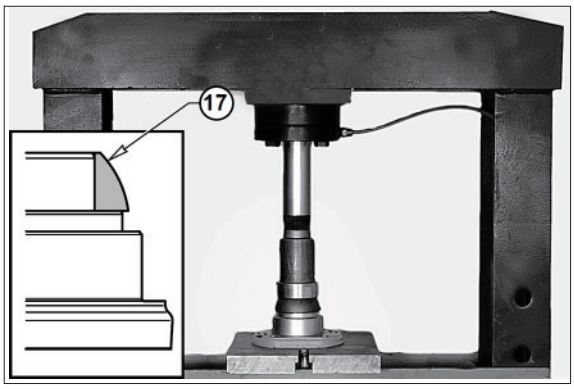


③ Using special tool T3 apply a repositionable jointing compound for seals to the outer surface of the sealing ring (44). Position the sealing ring (44) in the steering case (14).

※ Check that the ring (44) is correctly oriented.

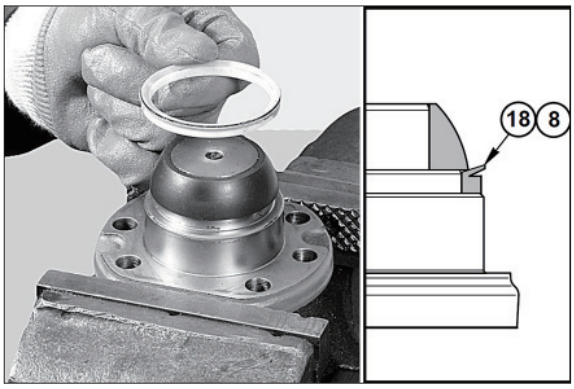


④ If the bottom articulation pin (17) has been extracted, position the pin under a press and fit the ball cover (20).

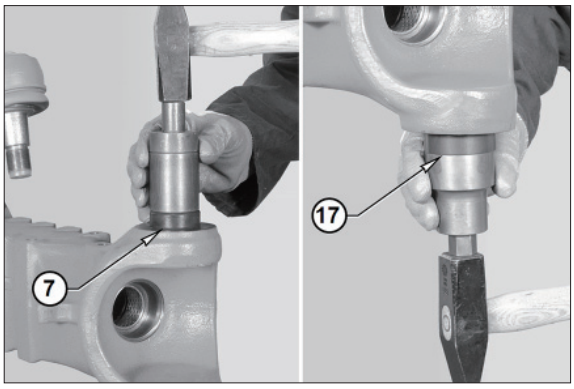


⑤ Fit the front sealing rings (18) (8) onto the articulation pins (4) and (6).

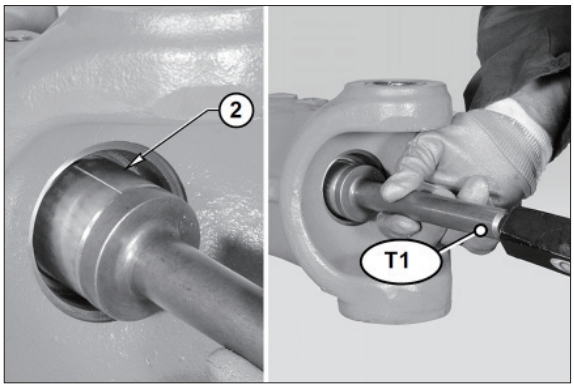
※ Carefully check that the rings are properly oriented (18) (8).



⑥ Lubricate the top bush (7) or the bottom ball bush (17) and fit them into the fulcrum holes of the arm.

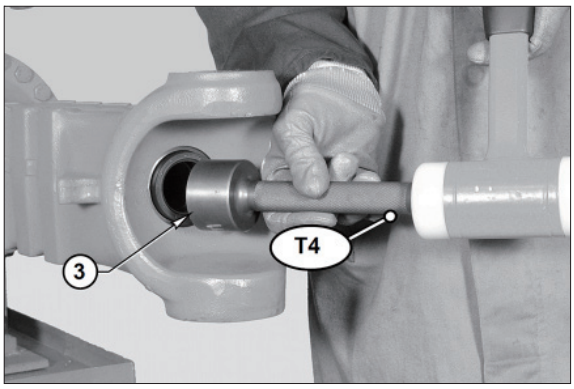


⑦ Lubricate the bushing (2) and the seat of the steering case (1).
Install the bushing (2), using tool T1.

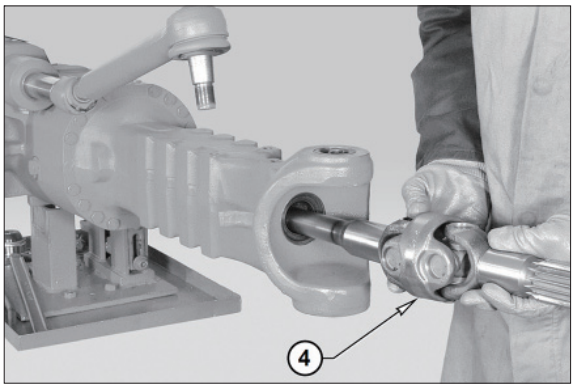


⑧ Lubricate and fit the sealing ring (3) onto tool T4 ; install the rings into the arm.

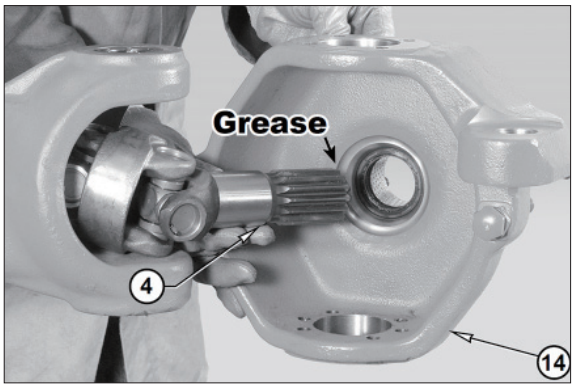
※ Pay particular attention to the direction of assembly of the rings.



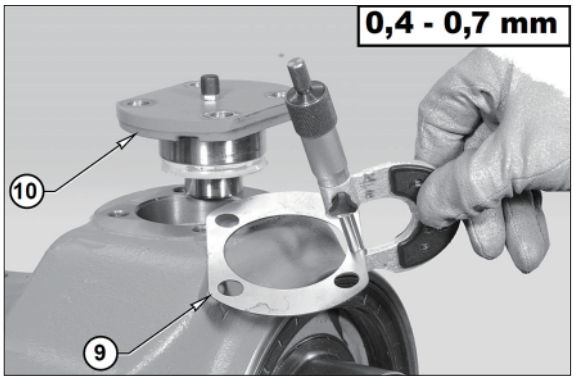
⑨ Insert the u-joint (4).



⑩ Lubricate the terminal of the u-joint (4) and install the steering case (14).
Pay due attention not to damage the dust cover rings and the sealing rings.

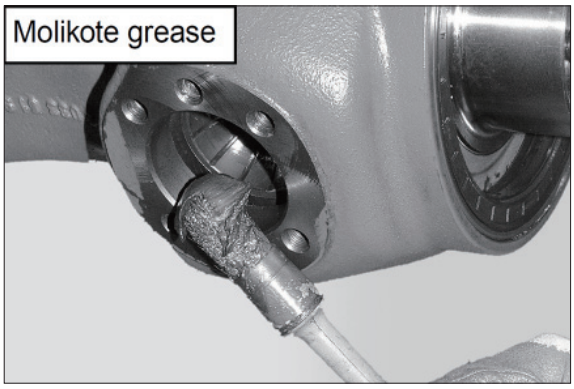


⑪ Prepare a series of shims (9) of 0.4 up to 0.7 mm.
To be assembled under the upper pin (10).

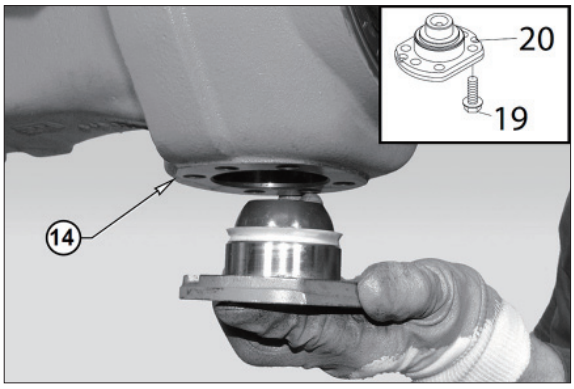


⑫ Lubricate and install the unit in the steering case.

⑬ Lubricate the steering case.

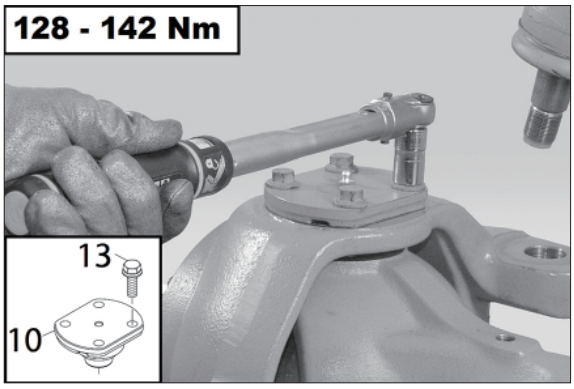


⑭ Fit the unit (20) in the steering case (14). Position the screws (19) and tightly tighten.



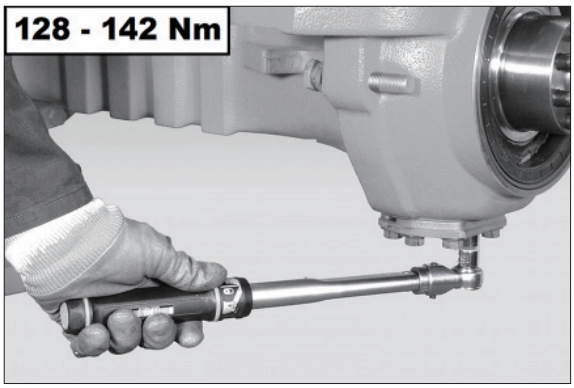
⑮ Tighten the new fitting screws (13) of top articulation pins in sequence using the cross tightening method.

· Torque wrench setting :
13.1~14.5 kgf · m (94.8~105 lbf · ft)

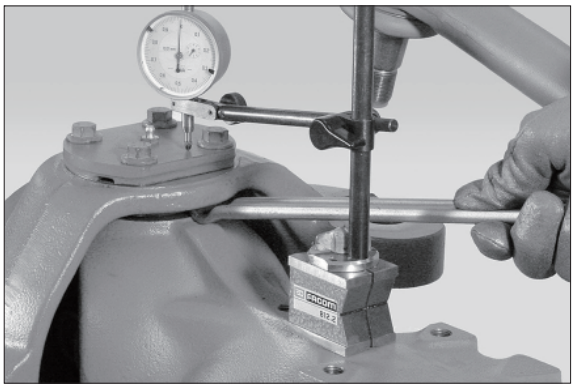


⑯ Tighten the new fitting screws (19) of bottom articulation pins in sequence using the cross tightening method.

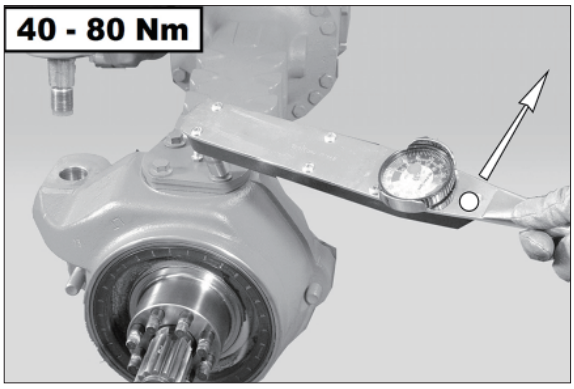
· Torque wrench setting :
13.1~14.5 kgf · m (94.8~105 lbf · ft)



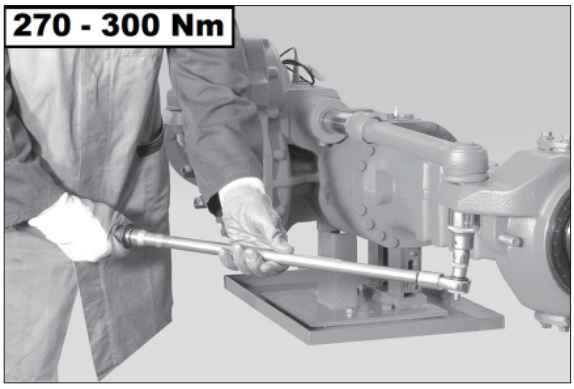
⑰ Check by means of a lever that there is no vertical gap.
In case there is any gap, determine the width and reduce it by removing shims.



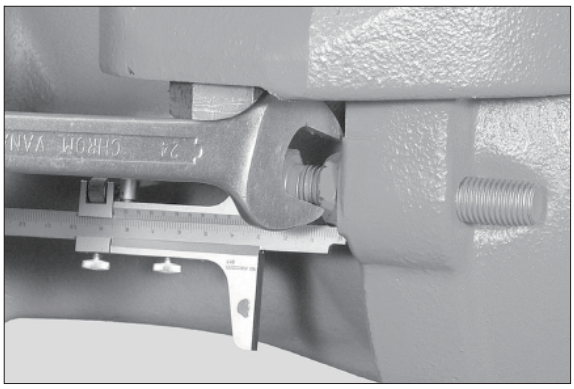
⑱ Check the torque of the pins, which has to be between 4.08 and 8.16 kgf · m.
If the preliminary measured value is too high, the shims have to be increased.



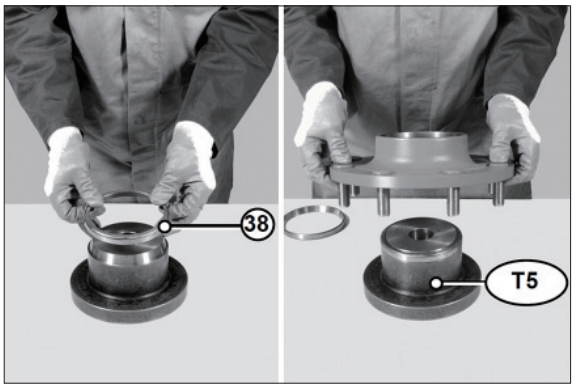
⑲ Look for the position of the notch regarding the safety cotter pin hole when the nut is finaly locked max 30.6 kgf · m (221 lbf · ft).



⑳ Bring the lockscrew to the quote at the measure previously survey.

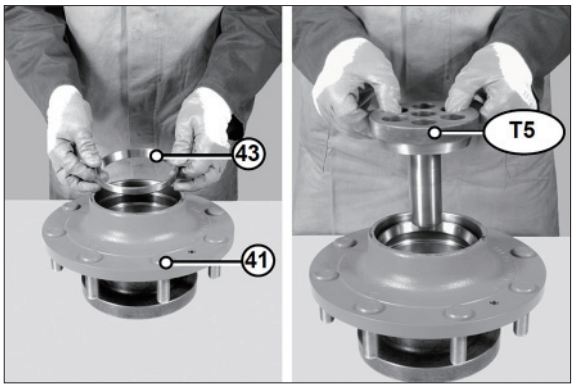


㉑ Position the lower part of tool T5 and the thrust block of the external bearing (38).



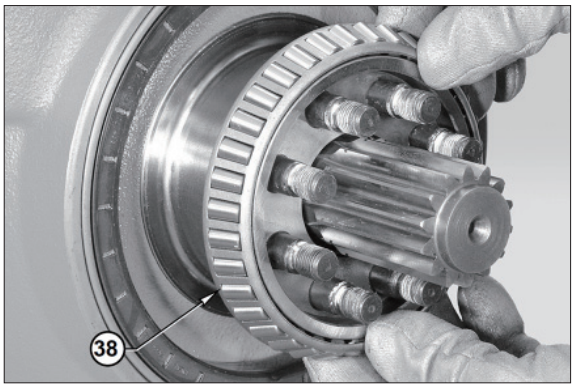
㉒ Lubricate the seats of the bearings and position the hub (41) on tool T5 ; position the thrust block of the internal bearing (43).

※ Check that the thrust block is correctly oriented.

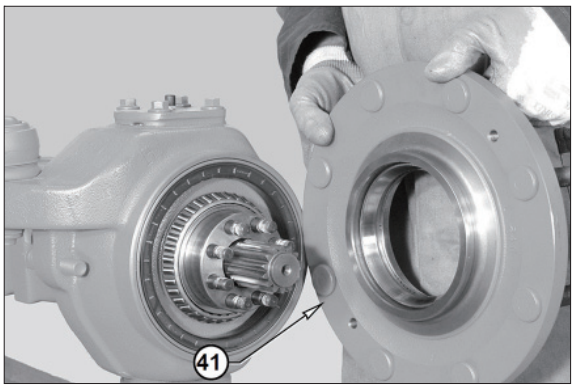


㉓ Install the external bearing (38).

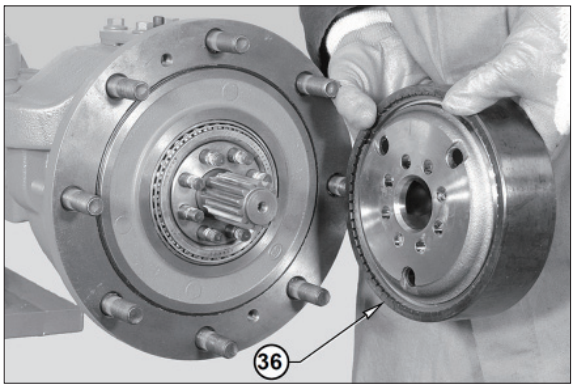
※ Move the bearing to the limit stop by hammering lightly all around the edge.



㉔ Install the wheel hub (41).

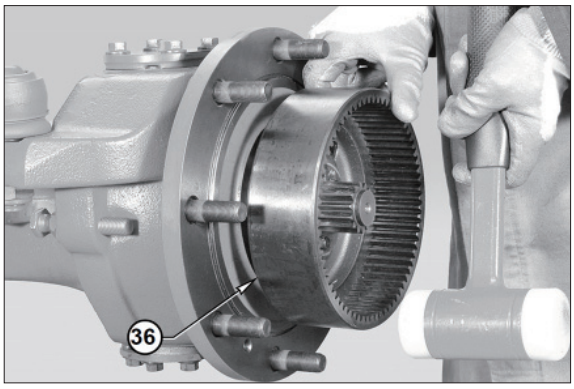


㉕ Install the crown wheel (36).

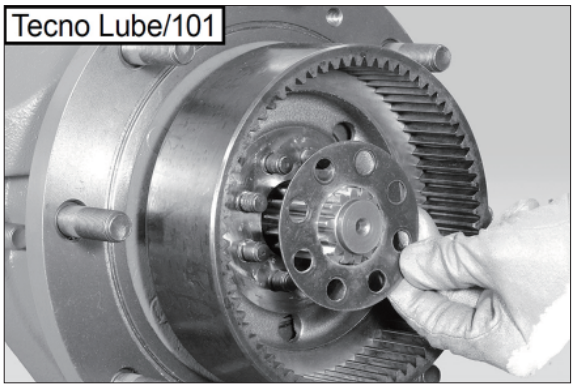


㉖ Fit the complete crown flange (36).

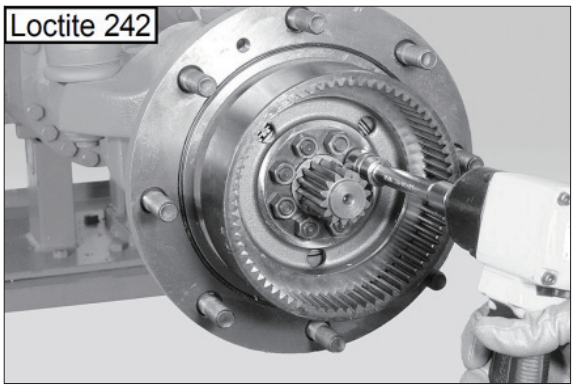
※ In order to fasten the flange (36), use a plastic hammer and alternately hammer on several equidistant points.



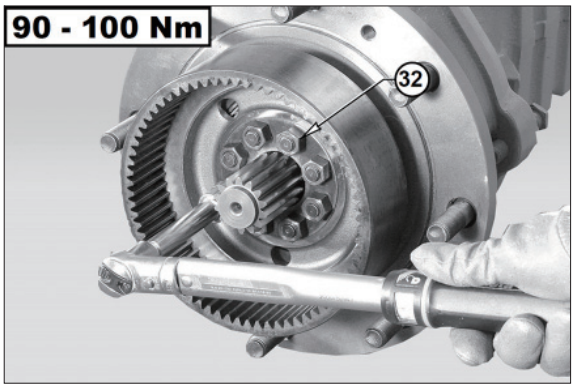
㉗ Install the security flange (33).
Grease the surface of the safety flange (33) that touches the crown wheel.



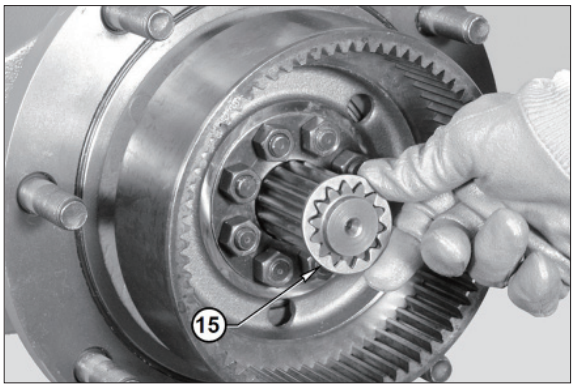
㉘ Coat the nuts (23) with loctite 242 and screw them.



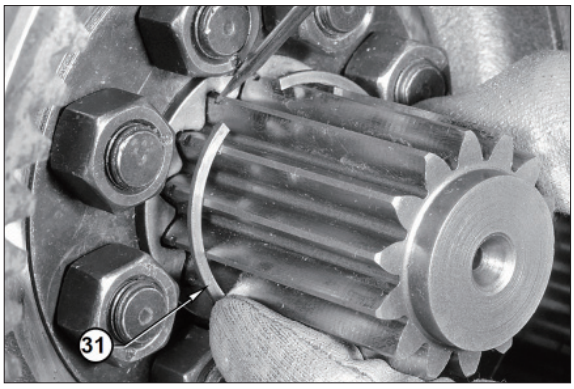
㉙ Tighten nuts (32) in two stages, using the criss-cross method.
· Initial torque wrench setting :
9.18 kgf · m (66.4 lbf · ft)
· Final torque wrench setting :
10.2 kgf · m (73.8 lbf · ft)



㉚ Install the distance piece (31).

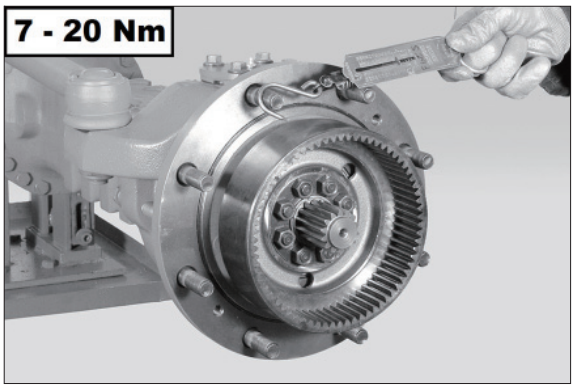


㉛ Install the snap ring (31).

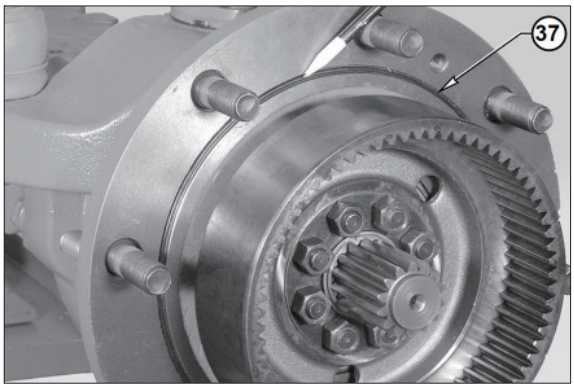


㉜ Check the continuous rolling torque on the hub.

· Torque : 0.71~2.04 kgf · m
(5.14~14.8 lbf · ft)

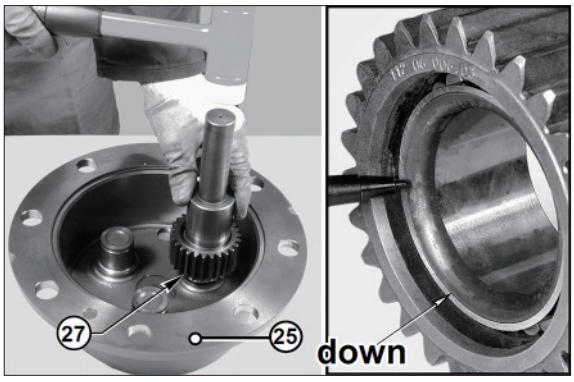


※ Check the condition and position of the O-ring (37).

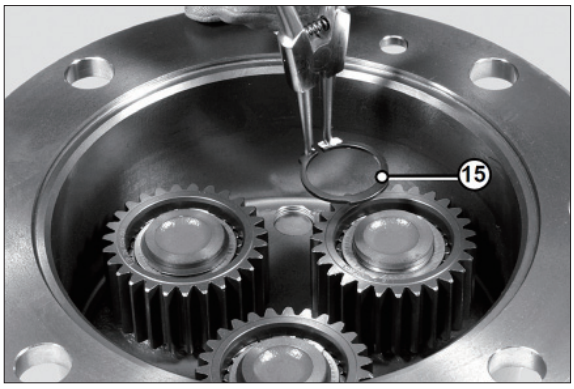


㉝ Fit the planetary gear (27) onto the planetary gear cover (25).

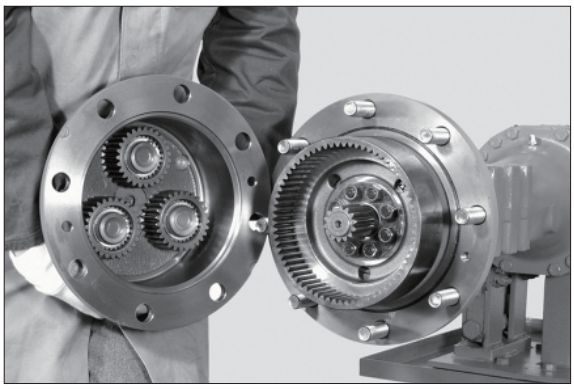
※ The jointed portion of the internal ring of the bearings must face the bottom of the pin.



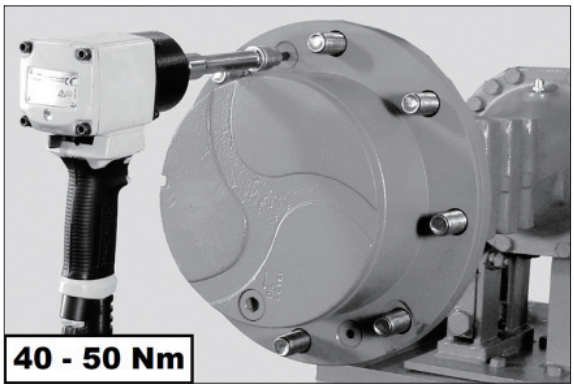
㉞ Lock into position the planetary gears (16) with the snap rings (15).



㉟ Fit the planetary gear cover (18) onto the wheel hub (4).

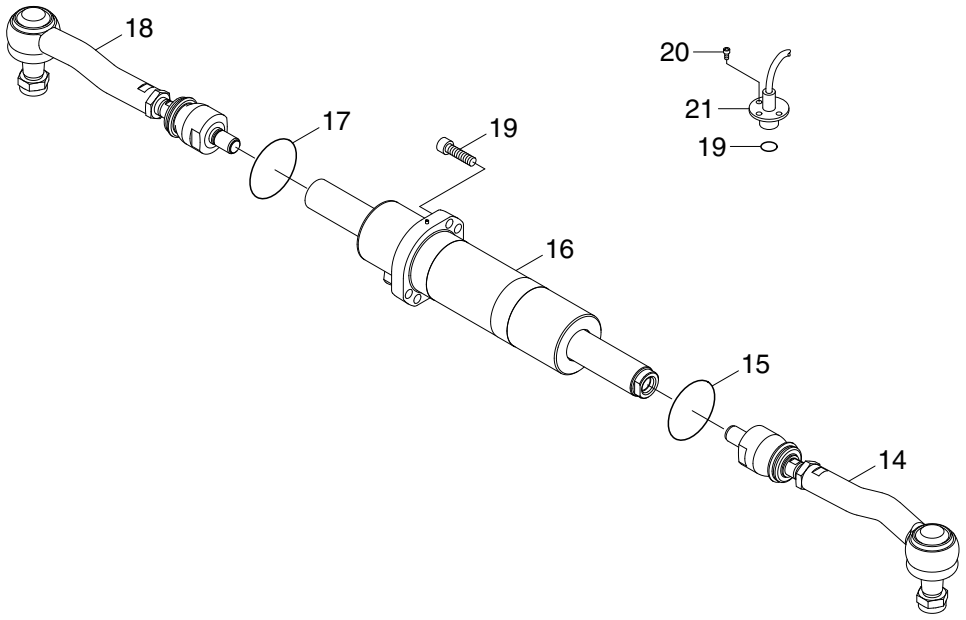


㊱ Torque wrench : 4.08~5.1 kgf · m
(29.5~36.9 lbf · ft)

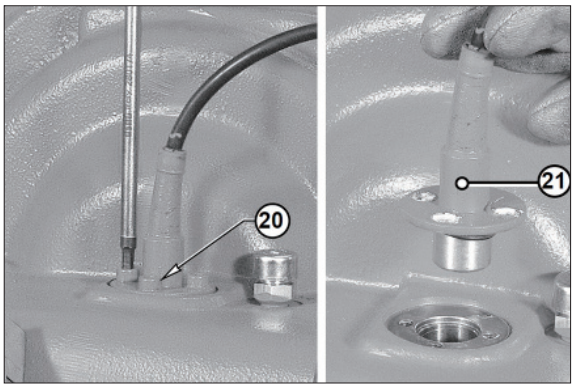


2) STEERING CYLINDER

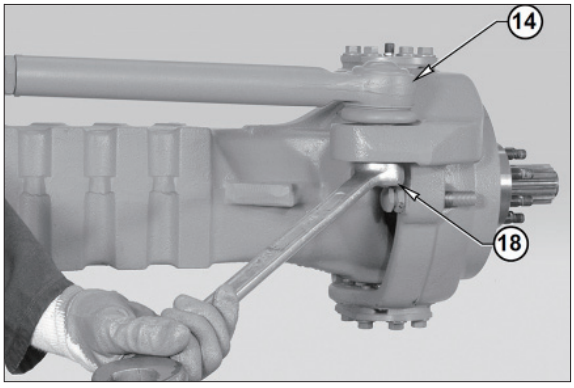
(1) Disassembly



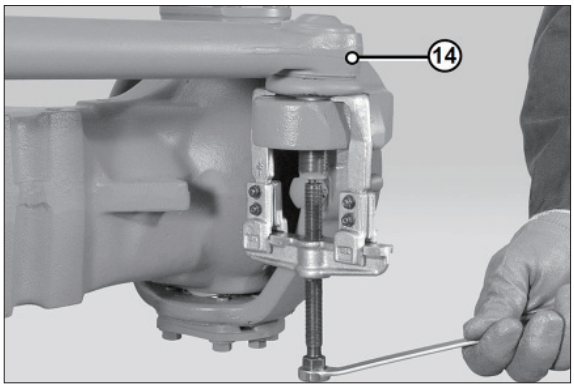
① Remove the centring sensor (21) of the steering piston.



② Remove the nuts (18) that lock the articulation pins (14).

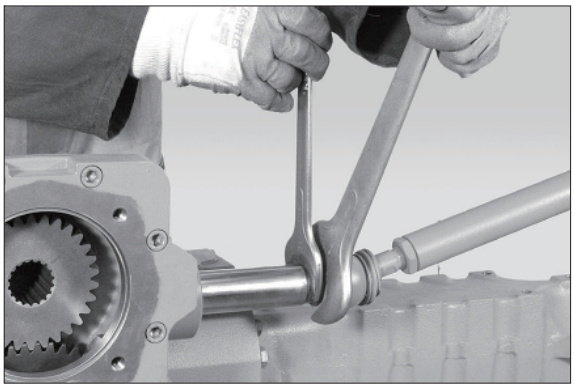


③ Disconnect the tapered pins of the articulation (14) from the steering case by means of a puller.

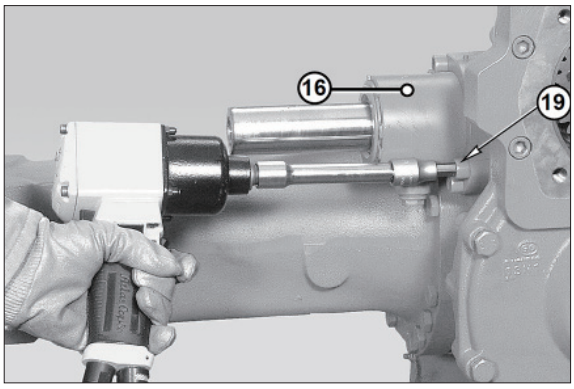


④ If the connection of the steering bars includes a safety collar, raise the border.

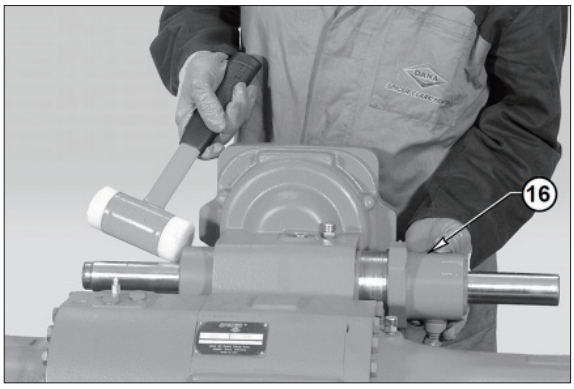
⑤ Disconnect left and right steering bars from the piston.

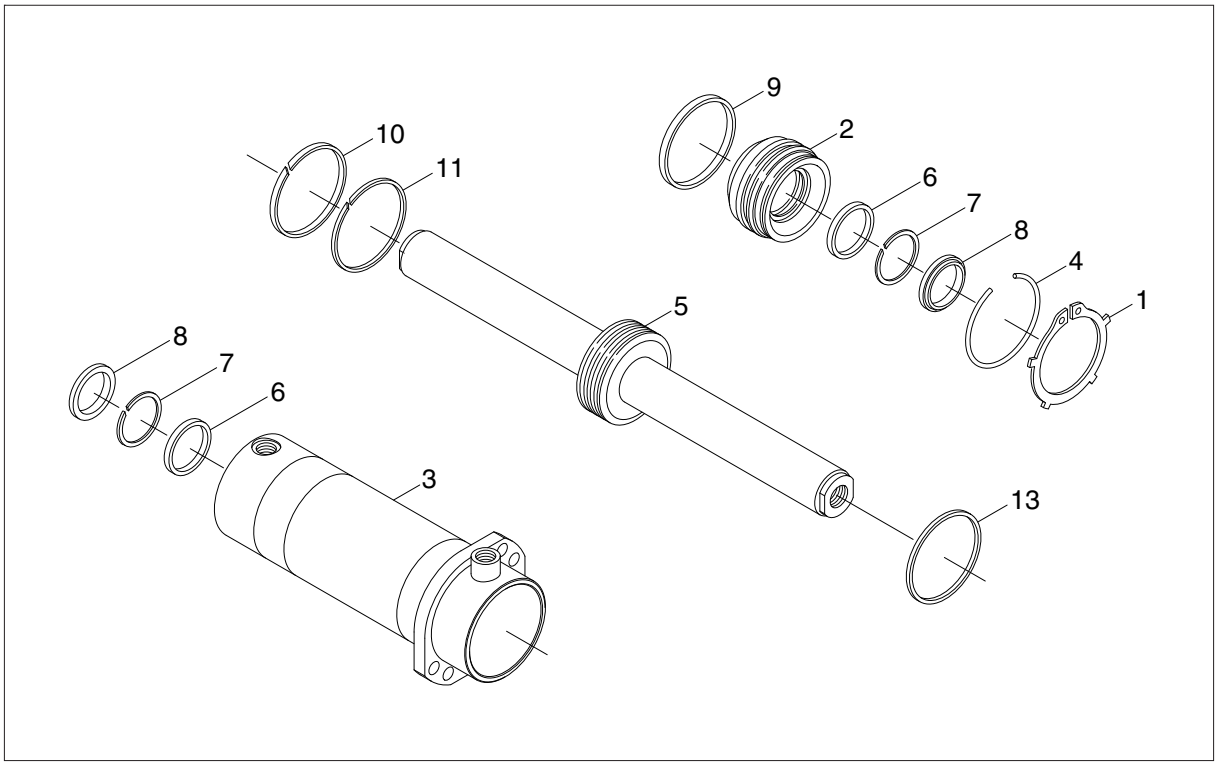


⑥ Remove the securing screws (19) from the steering cylinder (16).

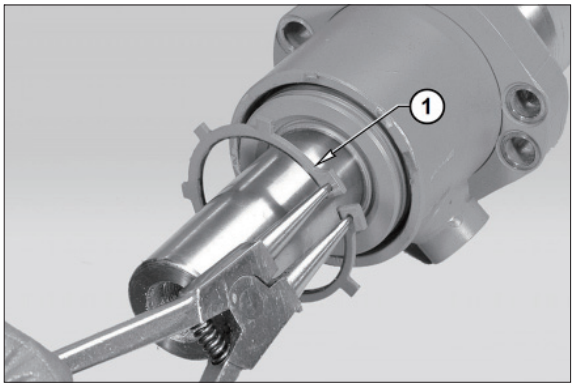


⑦ Extract the cylinder (16) using a plastic hammer.



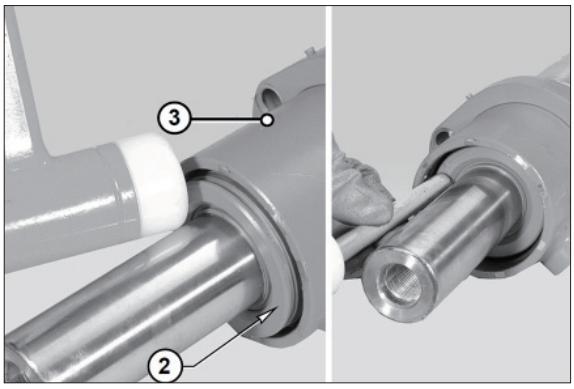


※ Before attempting to disassemble the unit, drain the oil in the cylinder chambers completely.
Using a screwdriver, remove the snap ring (1) of the cylinder head.

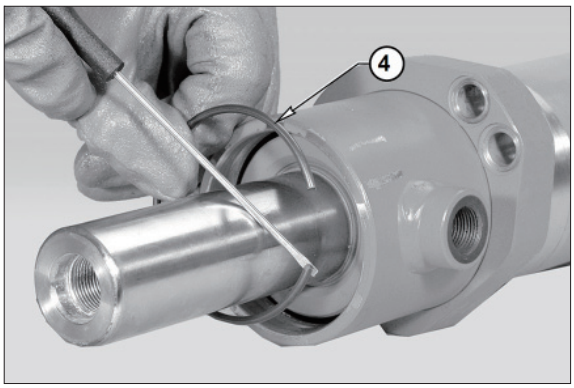


⑧ Lightly tap the cylinder head (2) with a plastic hammer so as to push it inside the cylinder (3).

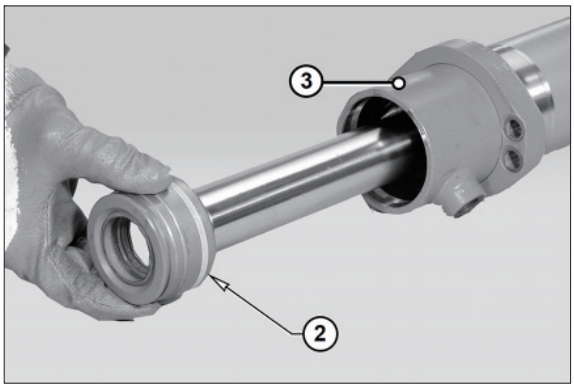
※ Insert the cylinder head so it is flush with the cylinder.



⑨ Using a punch, force the stop ring (4) located inside the cylinder (3) and extract ring using a screwdriver.



⑩ Take the cylinder unit a part by extracting the head first, followed by the piston.



※ Note down direction of installation of piston whose seal ring is oriented towards cylinder head.

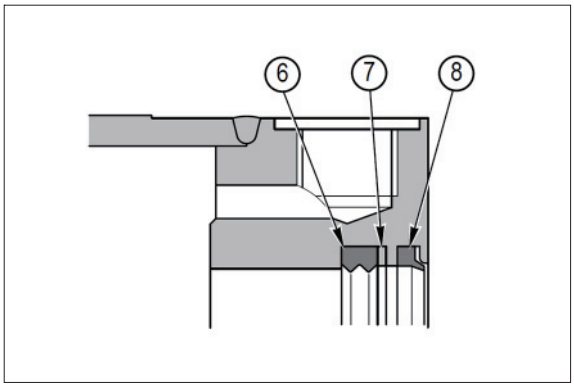
⑪ Remove all seals, anti-extrusion rings and scraper rings from head (2), cylinder (3) and piston (5).

※ All seals must be replaced every time the unit is disassembled.

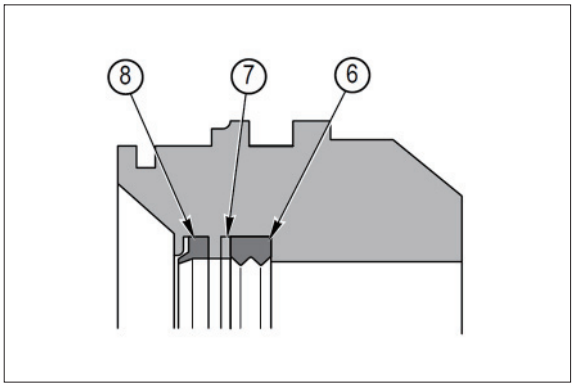
※ Particular attention must be paid not to damage the seats of both seals and piston slide.

(2) Assembly

① Grease and install the piston rod seal ring (6), rod wiper (8) and back up washer (7) into cylinder (3).



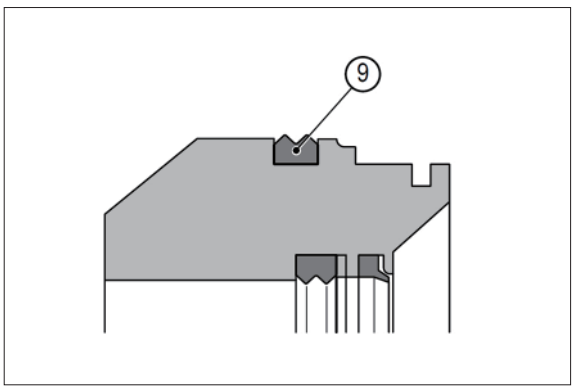
② Grease and install the piston rod seal ring (6), rod wiper (8) and anti-extrusion ring (7) into the head (2).



③ Fit seal (9) on the outside of the head (2).

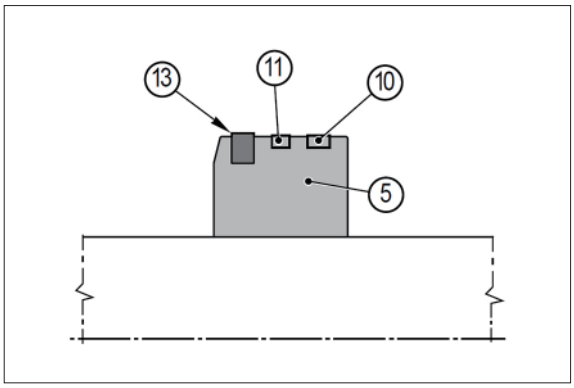
※ To ease installation, grease the outer surface of the piston

※ Do not roll the seal (9).



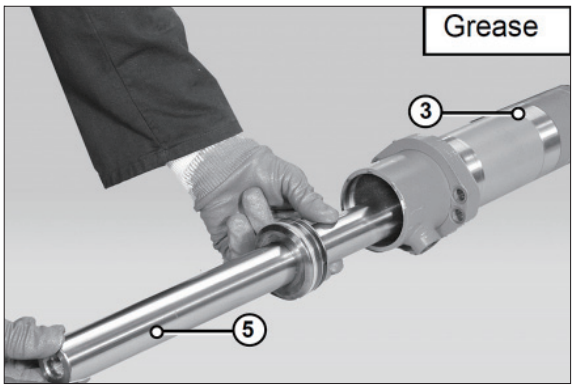
④ Prepare piston (5) by fitting it with magnetic ring (11), anti-extrusion ring (10) and piston seal (13).

※ To ease installation, lubricate with grease.

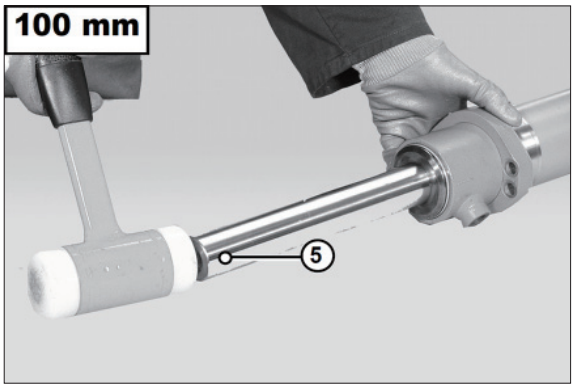


⑤ Center the shaft on the cylinder (3) so that it fits into the piston (5).

※ Apply a little grease to seals and cylinder.

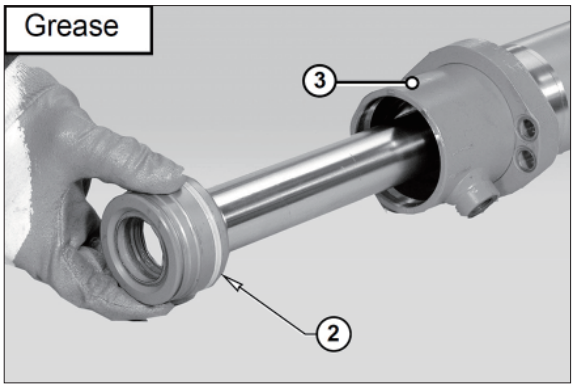


⑥ Push the piston (5) into the cylinder for 100 mm using a plastic hammer.

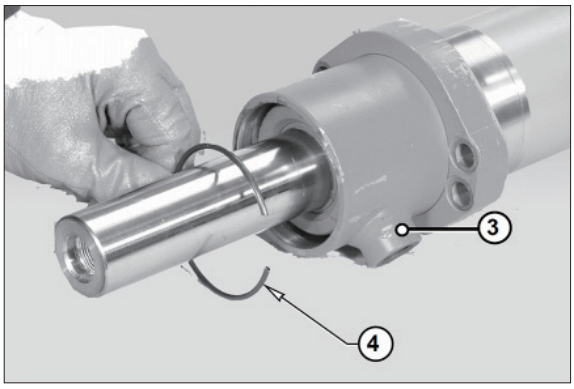


⑦ Apply grease to head (5) seals, fit the head onto the piston and push it into the cylinder (3) using a plastic hammer.

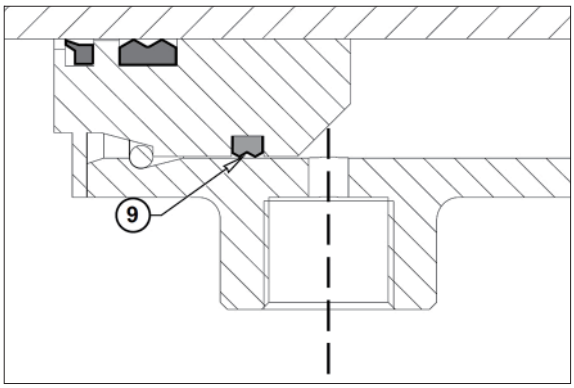
※ Insert the head as to line it up with the edge of the cylinder.



⑧ Introduce the stop ring (4) and ensure that it sets in the seat of cylinder (3).

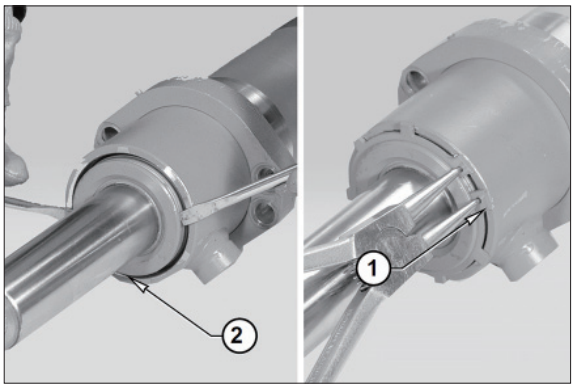


※ To insert the heading not to go beyond with the ring of gasket the hole of feeding because it could be cut.

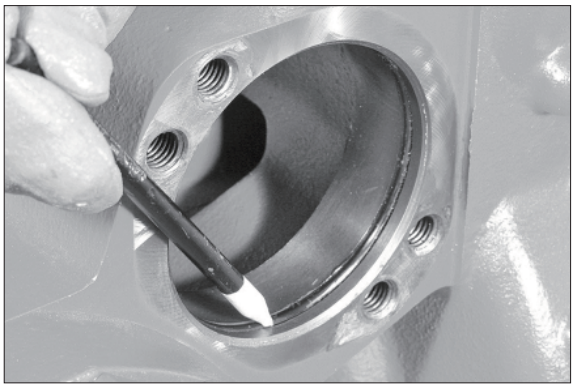


⑨ Using two screwdrivers or levers, force the head until it is seated against the stop ring (4).
Fit the snap ring (1) on the head (2).

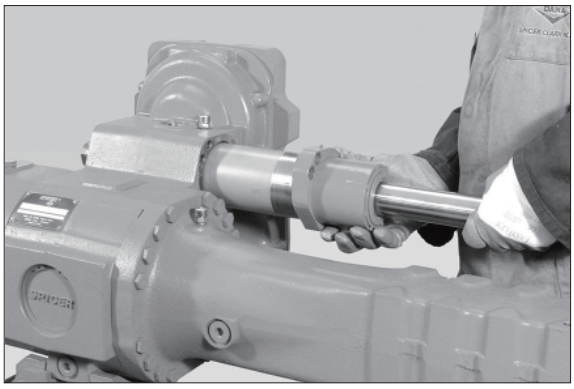
※ Make sure that the snap ring (1) is securely fastened in its seat.
If necessary, force it into its seat using a drift and a hammer.



⑩ Renew at each reassembly.

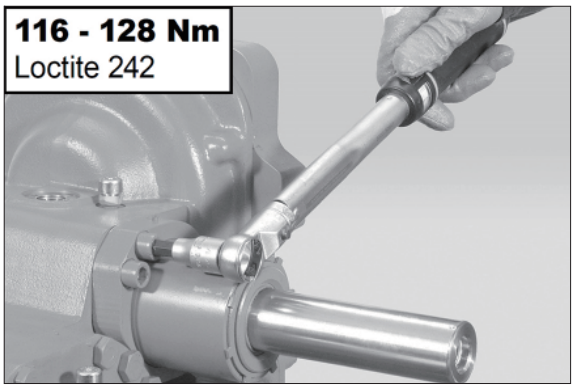


⑪ Check that the O-rings (17) (15) of the axle unit are in good condition ;
lubricate the seats of the seals and fit the steering cylinder (3).



⑫ Lock the cylinder by cross- tightening the screws (3).

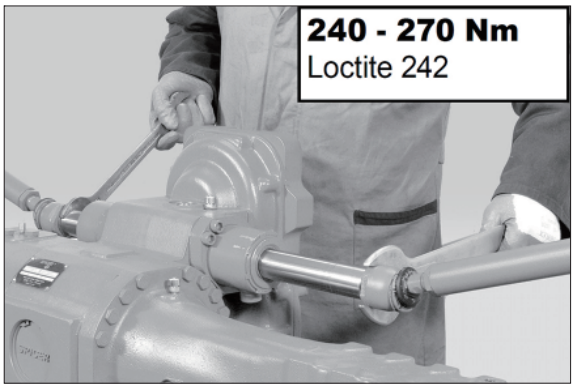
· Torque wrench setting :
11.8~13.1 kgf · m (85.3~94.8 lbf · ft)



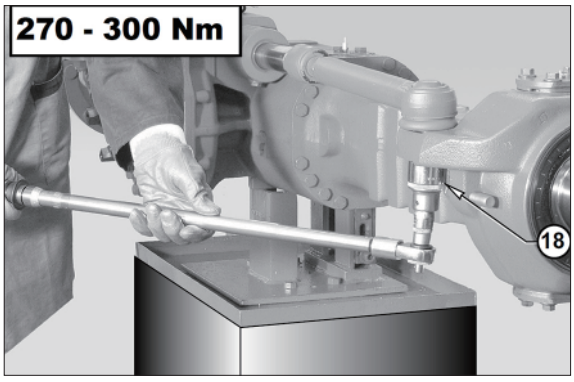
⑬ Apply loctite 242 to the thread and connect the steering bars by screwing the terminals onto the piston stem.

· Torque wrench setting :
24.5~27.5 kgf · m (177~199 lbf · ft)

※ Versions with coupling require that the rim of the articulation is riveted onto the surfaces of the piston stem.

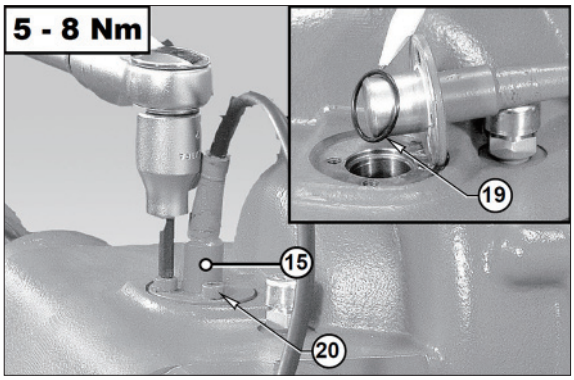


⑭ Insert the pins (18) in the steering case and lock into position using a torque wrench setting of 27.5~30.6 kgf · m (199~221 lbf · ft).



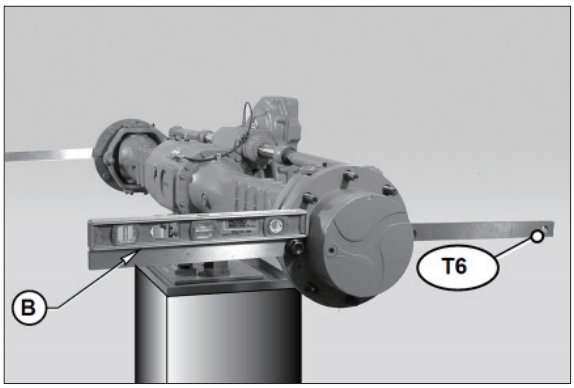
⑮ Install the proximity (21) for checking piston centring - if applicable - and tighten the screws (20).

· Torque wrench setting :
0.51~0.82 kgf · m (3.7~5.9 lbf · ft)

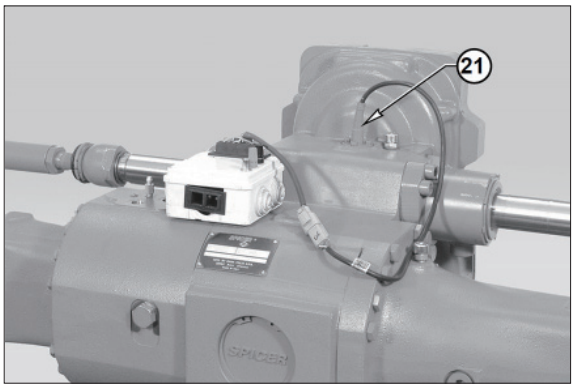


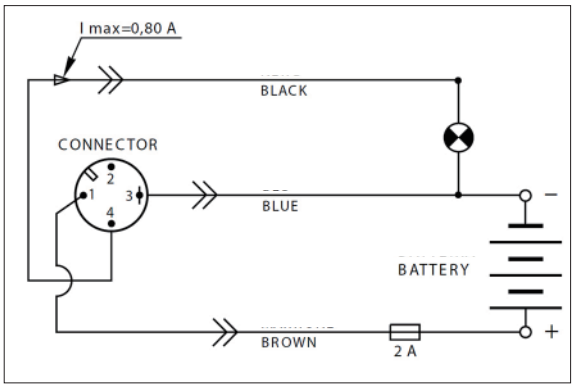
※ Eliminate the action of the negative brake, if fitted.
Apply tools T6 to the hubs and lock them.

Using a level “B”, check that tools are perfectly flat and parallel to each other.

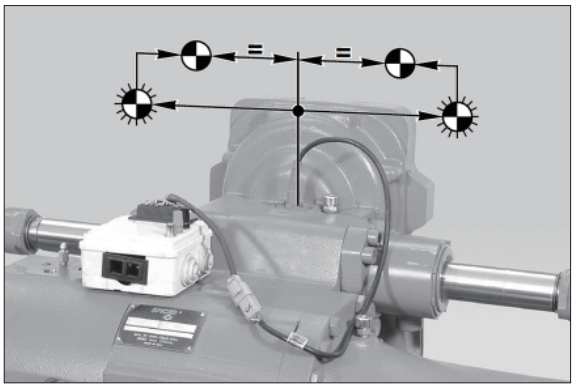


⑯ Connect the sensor (21) to the inspection device according to either diagram.



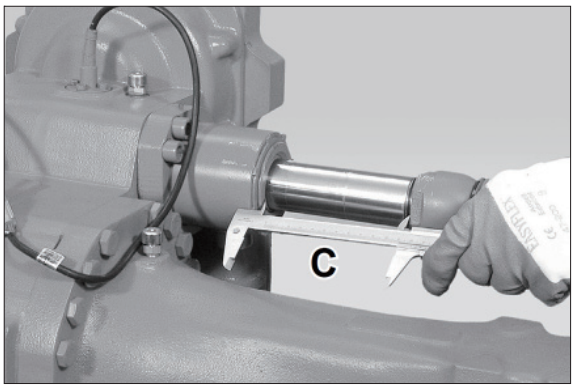


⑰ Center the piston by slowly moving it first in one direction then in the other and position it half way on the stroke, which is determined by the switching on and off of the signal lamp of the inspection device in the reversal stage.



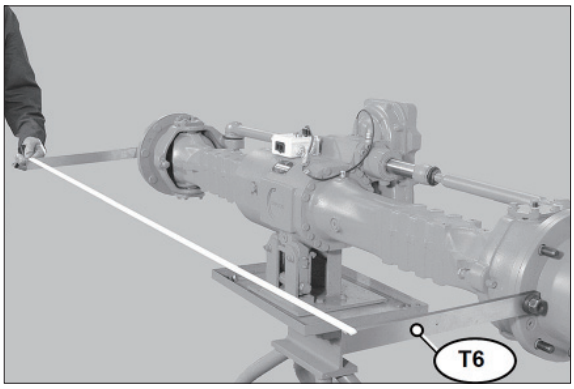
⑱ Inspect jut “C” on one side of the piston and note down the size for checking later adjustments.

※ If cylinders come without a sensor, the centering of the piston must be carried out on the basis of the maximum stroke.



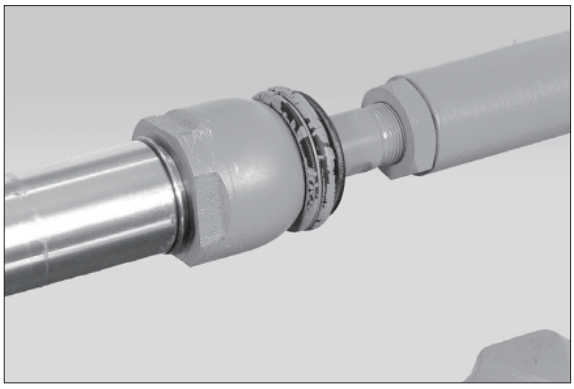
⑲ Without moving the piston, check front and rear size at the edge of tools T6.
Max. difference : 0.6-0.7 ㎜

※ In order to check the rear size, rotate the bevel pinion and check that tools T6 are flat.

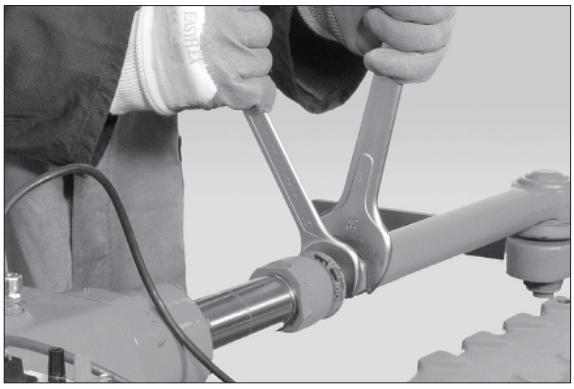


⑳ If necessary, adjust convergency without moving the centering of the piston and adjust the length of the steering bars (14).

※ With a half turn of screw, the front size is reduced by about 3 ㎜, whereas the rear one is increased by about 3 ㎜.

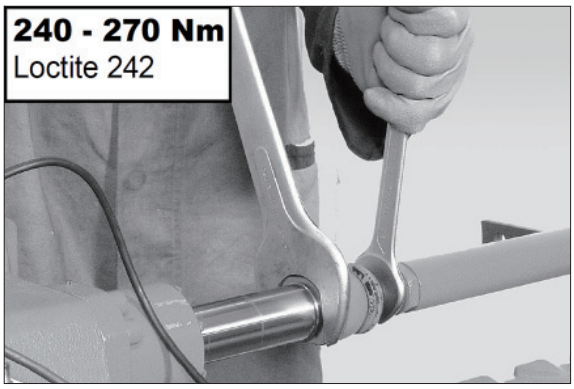


㉑ Unloose the nuts and screw them onto the ball-and-socket joints.



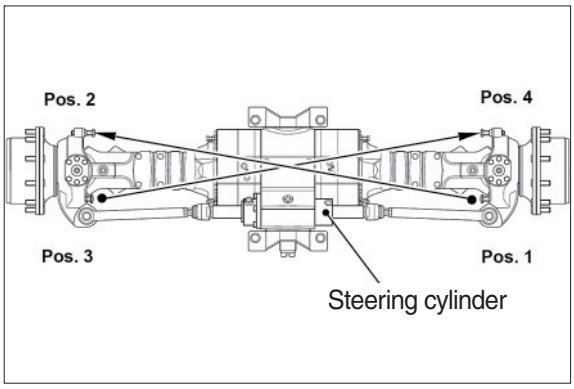
㉒ Hold the articulations still and rotate the ball-and-socket joints.
Once the convergency has been adjusted, lock the nuts.

· Torque wrench setting for nuts :
24.5~27.5 kgf · m (177~199 lbf · ft)

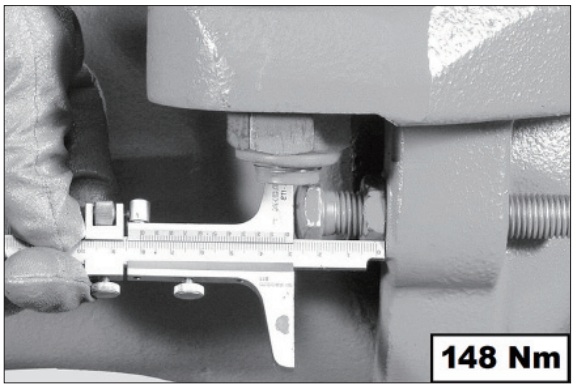


ADJUSTING THE STEERING ANGLE

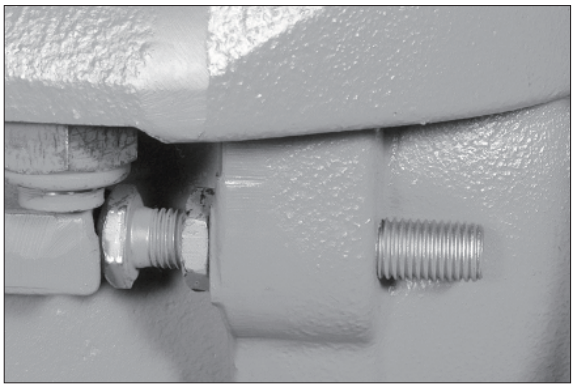
※ Perform the same operations on both sides (see diagram).
Loosen the nut of one of the adjusting screws on cylinder side.



㉓ Adjust the jutting portion of the screw according to data shown in the table (see the next page).
Lock into the position with nut tightened to max 15.1 kgf · m (109 lbf · ft).

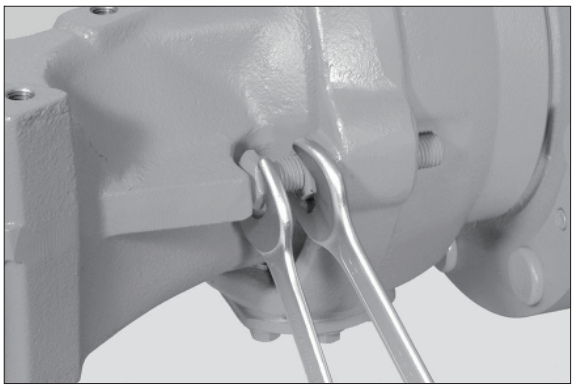


㉔ Perform one full steering operation until the adjusted screw leans against the arm stop.



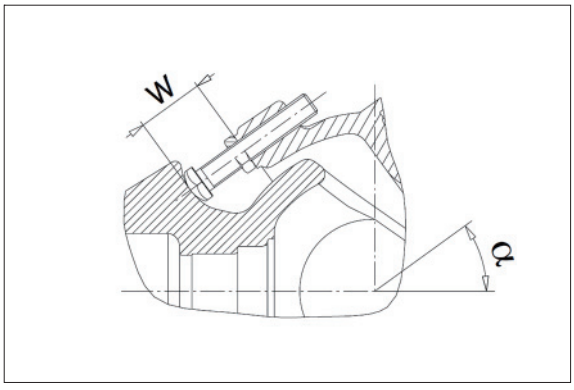
㉕ As you hold the adjusted screw in position against the arm stop, adjust the screw opposite, on non-cylinder side, until it leans against the arm stop.

※ The screws must lean against the respective arm stops all at the same time.



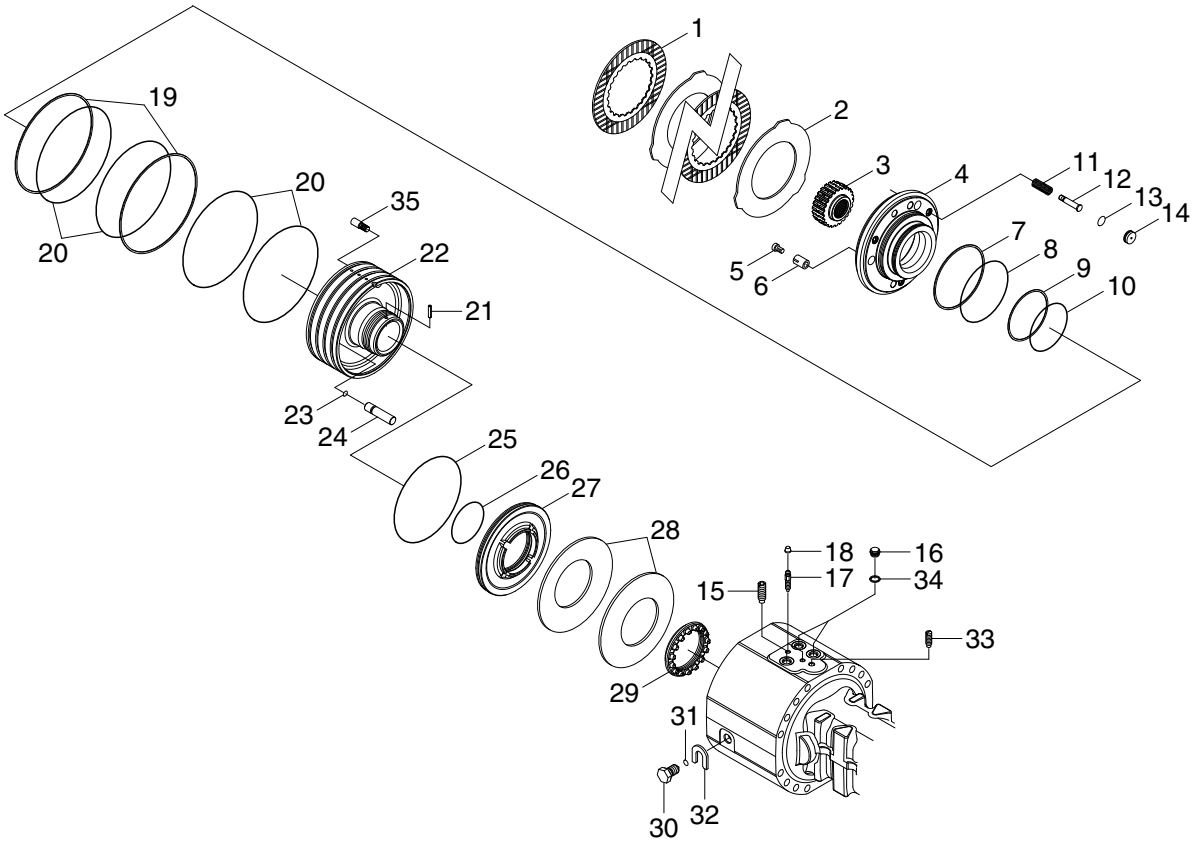
Requested steering angle : value α	25˚	27˚	30˚	32˚	35˚	36˚	40˚	42˚	45˚
Steering cases versions based on max. steering angle	Value W = Adjustment of the steering stop screw, steering cylinder side [mm]								
35˚ max angle	55.1	51.2	45.4	41.4	35.0				
45˚ max angle			57.4		47.0	44.7	35.8	31.2	24.6

※ The screws must lean against the respective arm stops all at the same time.



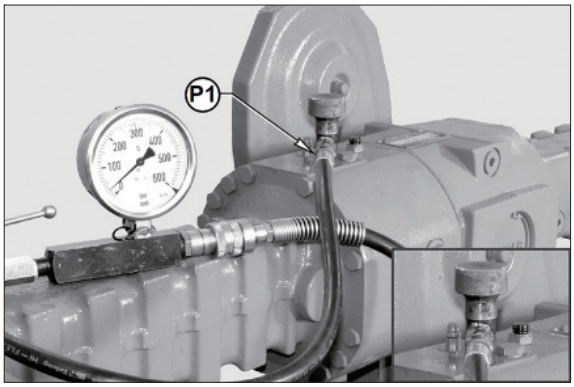
3) BRAKE : SERVICE BRAKE, NEGATIVE BRAKE

(1) Disassembly

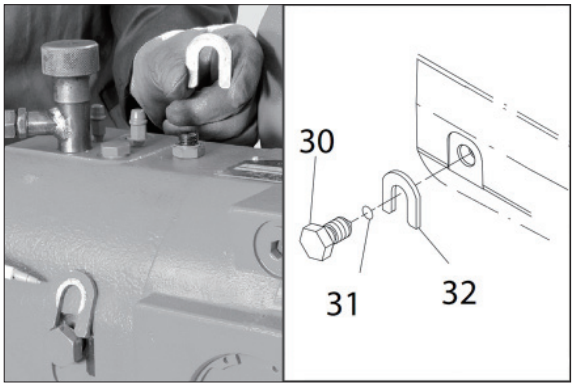


① Connect an external pump to the union piece “P1” of the negative brake and introduce a pressure of 15±30 bar to eliminate the pressure of the belleville washers.

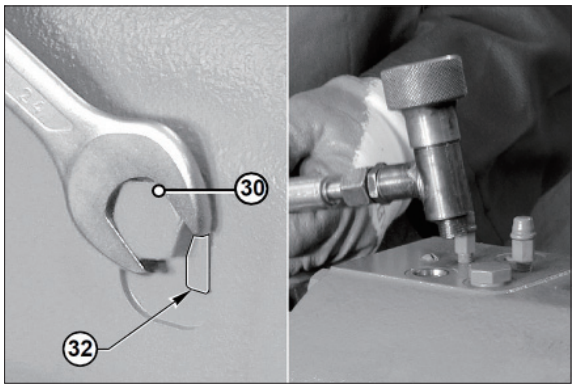
※ Perform all operations on both arms.



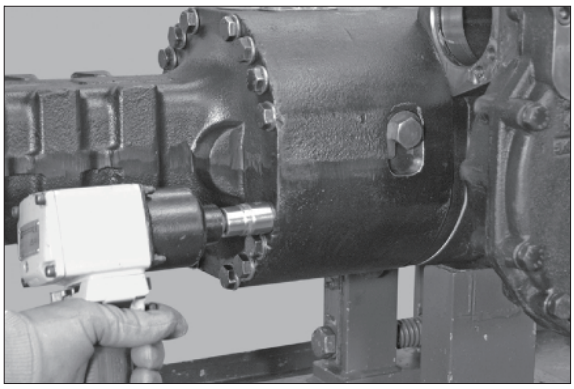
② Loosen the unlocking screws (30) and remove both stop washers (32).



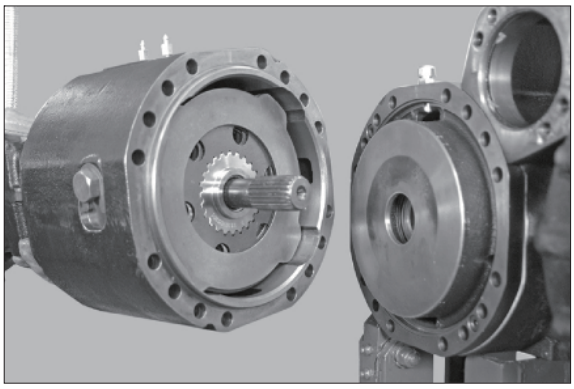
③ Insert block screws to end stroke and release pression.



④ Sling the arm to be removed and connect it to a hoist, remove screws.

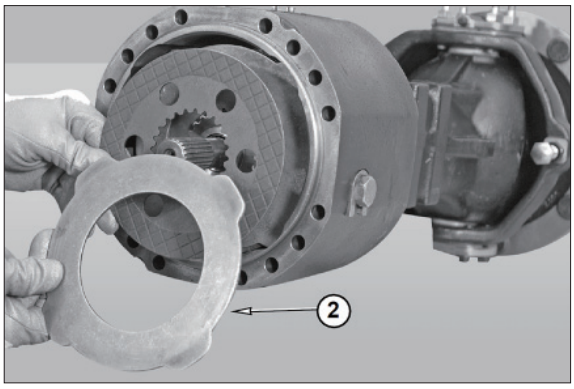


⑤ Take off the arm and lay it down vertically.

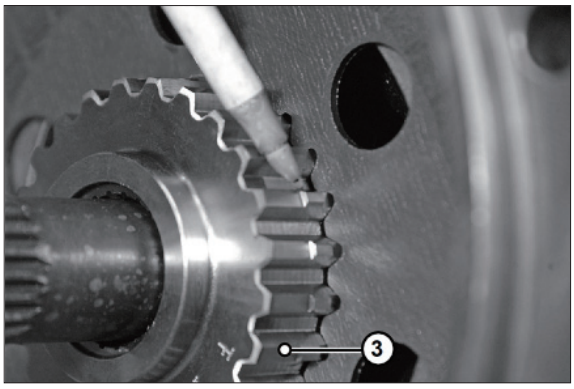


⑥ Remove the brake discs one after the other (2).

※ If they are not to be substituted, do not mix up the sequence.

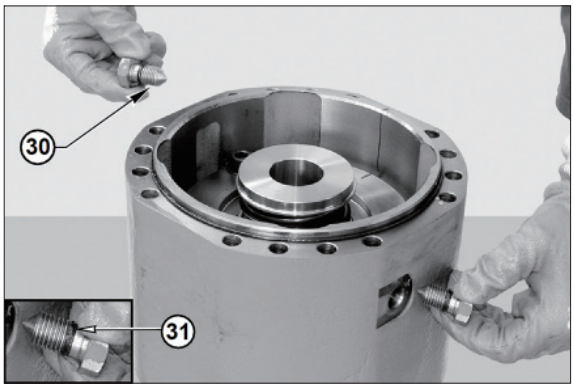


⑦ Remove the flange (3) complete with the discs.



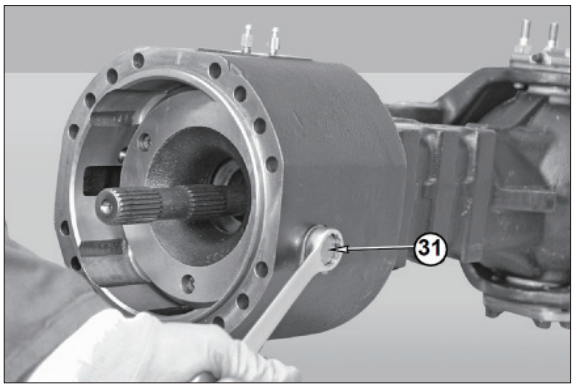
⑧ In order to keep the disc springs of the negative brake preloaded, screw down the screws with washers to the end stop.

⑨ Remove the negative brake locking screws (30).
Always exchange the O-ring (31).

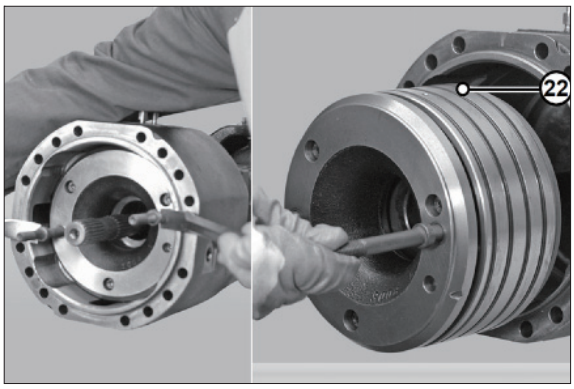


⑩ Loosen the before installed provisional screws in the same sequence and same measure.

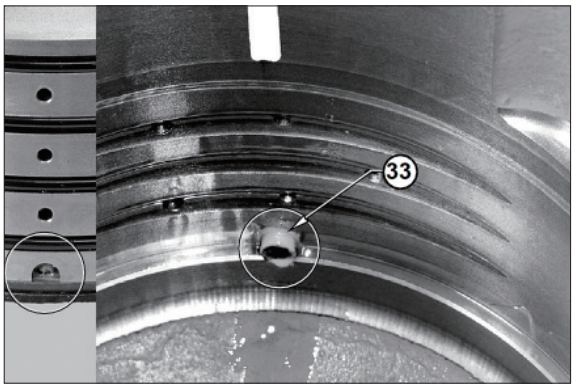
⑪ Remove the negative brake locking screws (30).
Always exchange the O-ring (31).



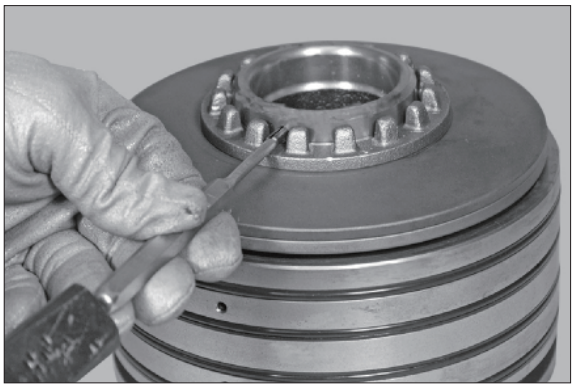
⑫ Pull out brake piston assembly module (22).



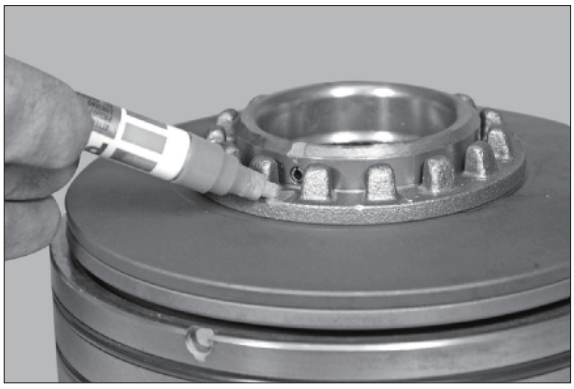
※ Check locking screw (33) of the brake piston module.



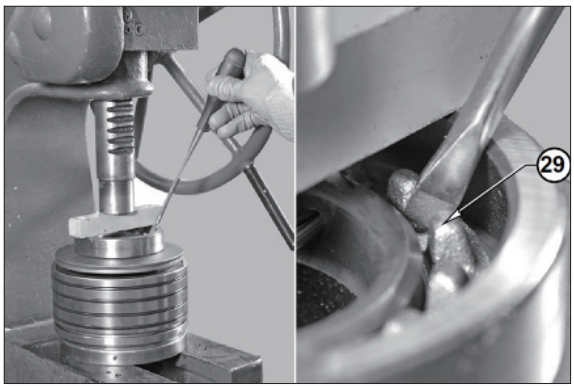
⑬ Turn upside down the brake module and with a pin driver remove the locking pin of the slotted nut.



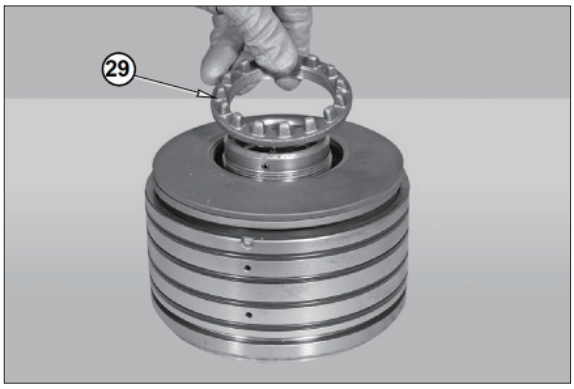
⑭ Sign the position of the slotted nut.



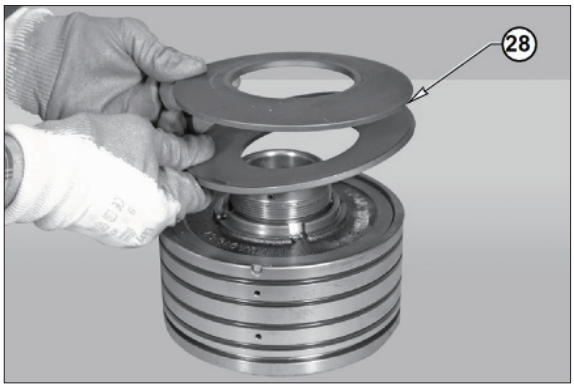
⑮ Bring the piston group below a press, compress the cup springs and loosen the metal ring.



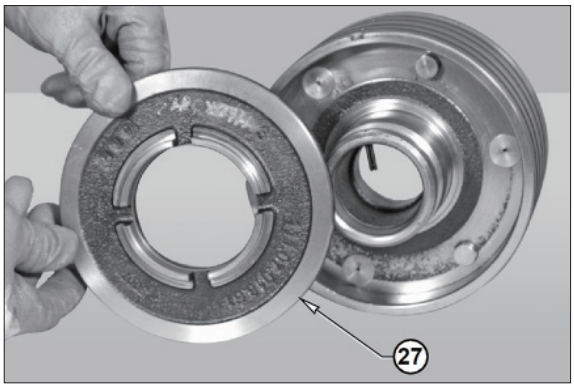
⑯ Remove nut (29).



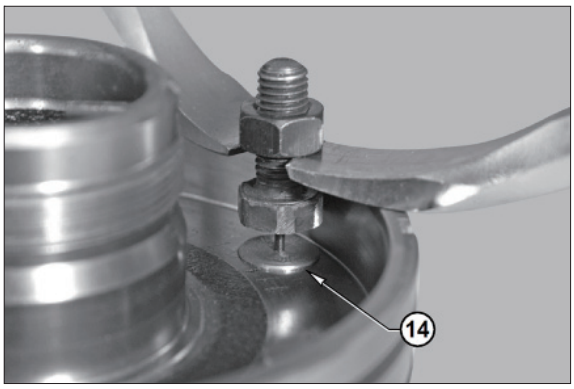
⑰ Remove the disc springs (28).



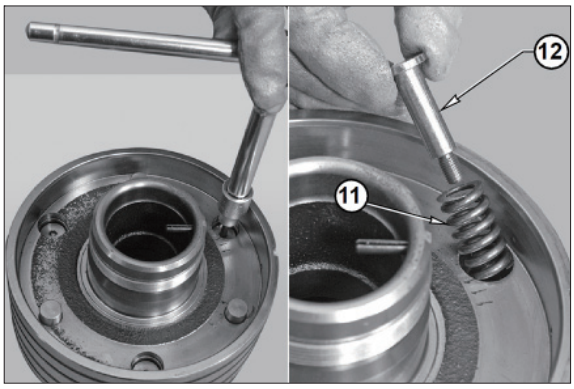
⑱ Applying air pressure, remove the piston (27) of the negative brake.



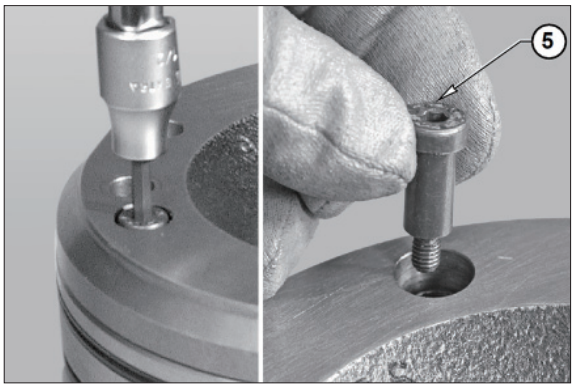
⑲ Using a new screw remove the pressure seal caps.



⑳ Remove the reversal springs (11).

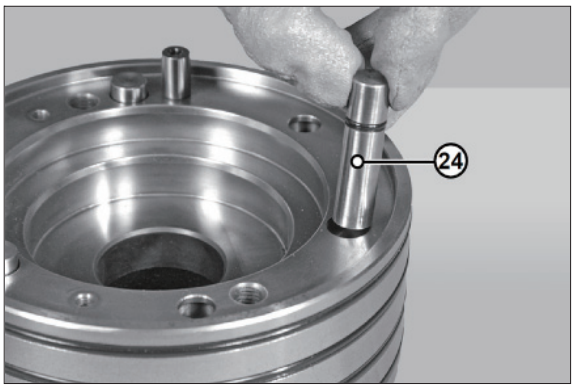


㉑ Remove the adjusting screws (5).

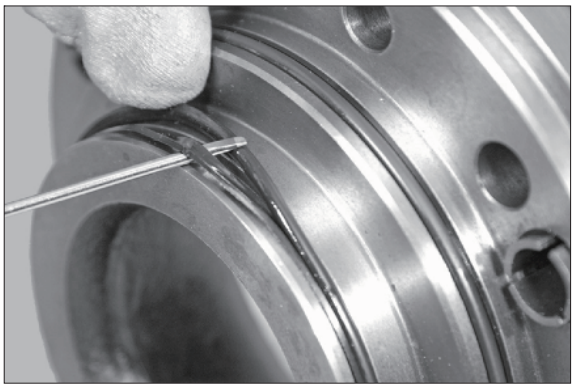


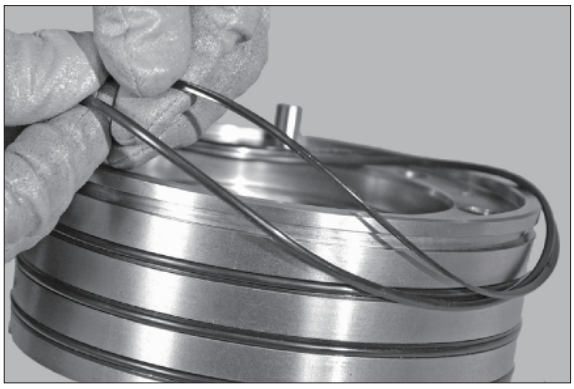
㉒ Remove the service brake piston (4).

㉓ Remove the three bolts (24).

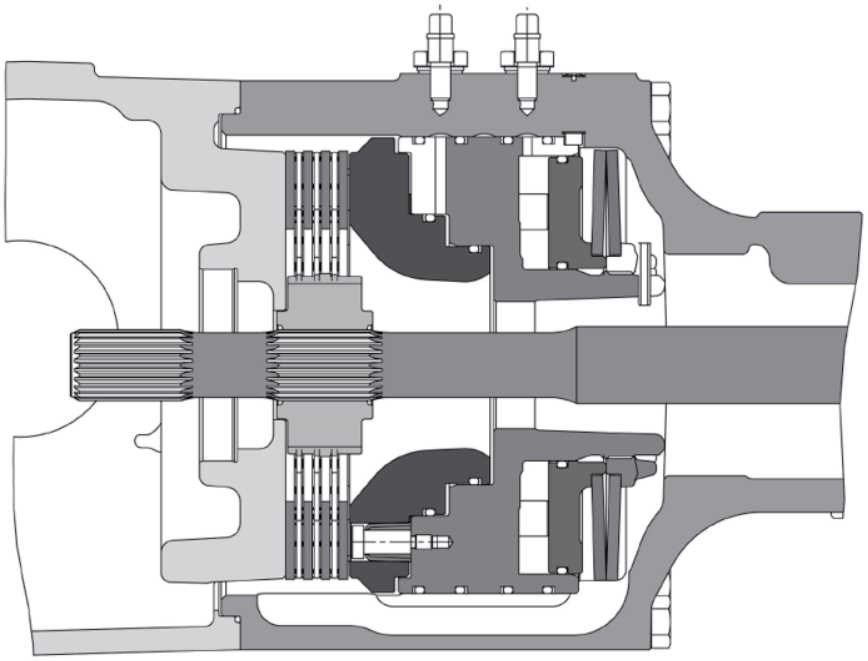


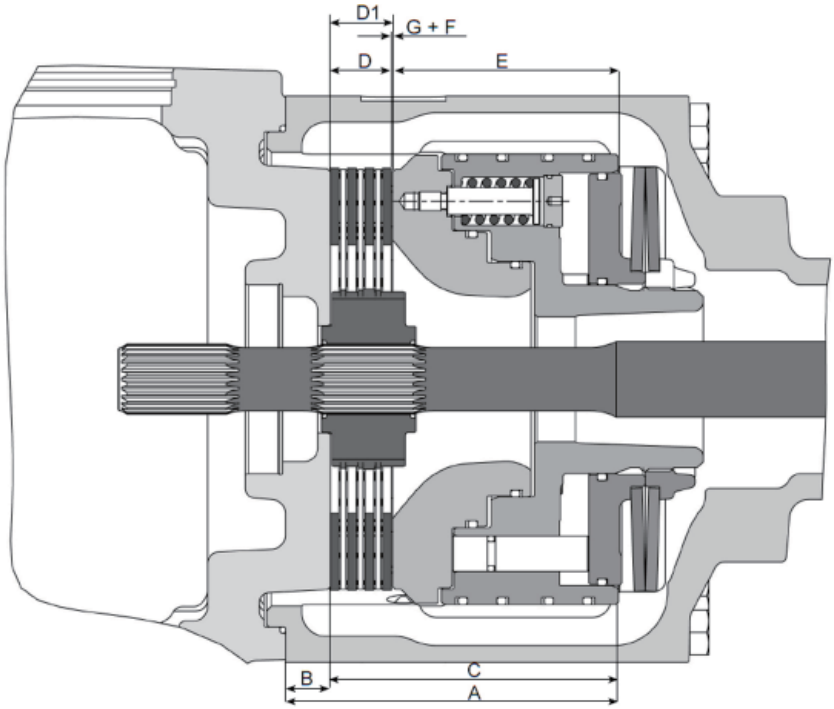
㉔ Remove the O-rings and the anti-extrusions rings from the service brake, the negative brake piston and from the piston.





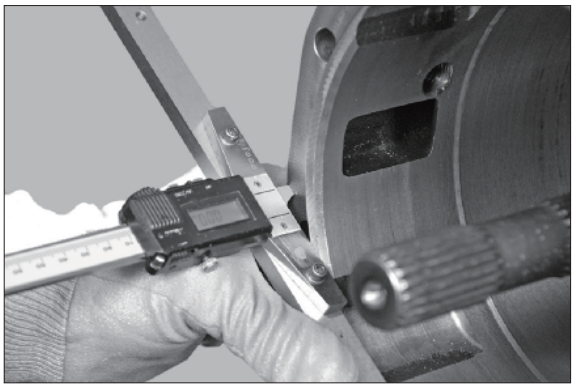
(2) Assembly



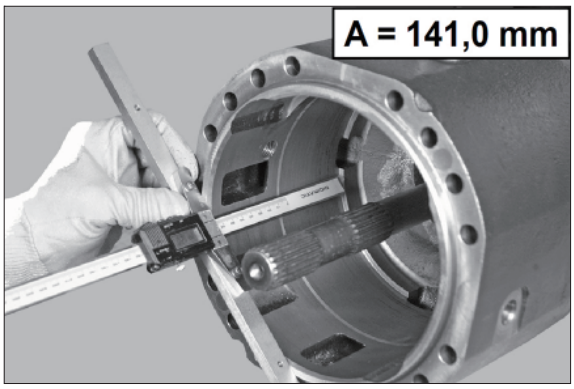


C = A - B
141.0 - 19.0 = 122 mm
C = arm quote
D1 = D + G + F
26.0 + 0.75 + 0.2 = 26.95 mm
D = tickness of discs pack
G = brake discs gap
F = fix quote
E = C - D1
122 - 26.95 = 95.05 mm
E = piston pack quote

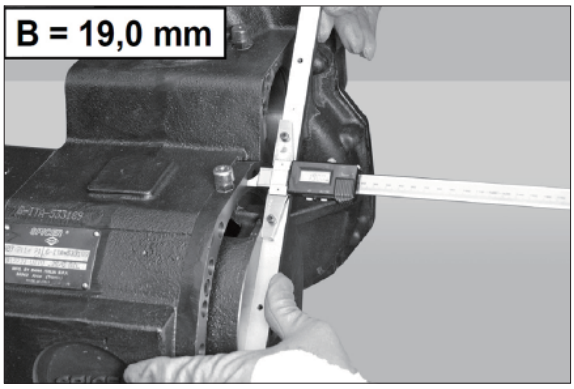
① Zero the centesimal calibre between the support plane and the centering arm.



② Then measure the distance between the arm support plane and the piston pack stop.

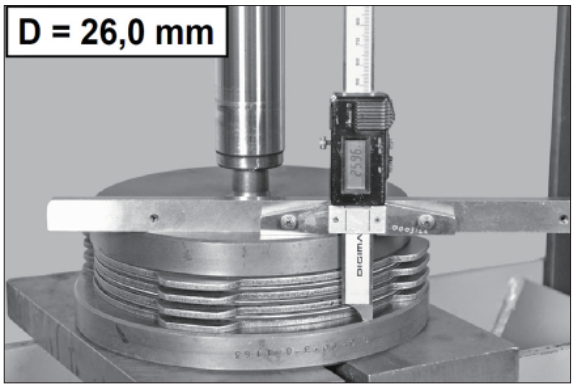


③ Measure the distance between the disk support plane and the arm support plane.
Subtract the value B from the value A to obtain the effective dimension of the arm containing the brake disks and the piston pack.



④ Bring the disk pack beneath a press, load with 1000 kg, then measure the dimension D.
Add the play G and the fixed value F (equal to 0.2 mm) to the value D.

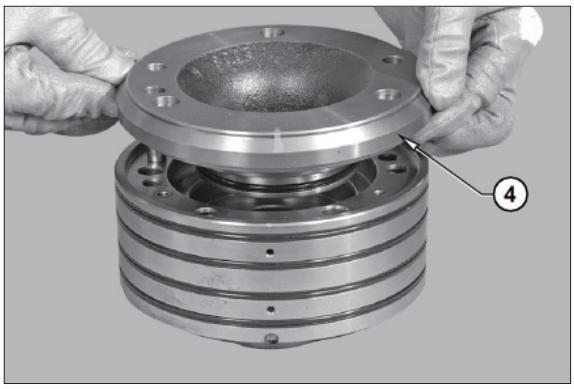
※ Do not take into account the thickness between the press piston and the disks.



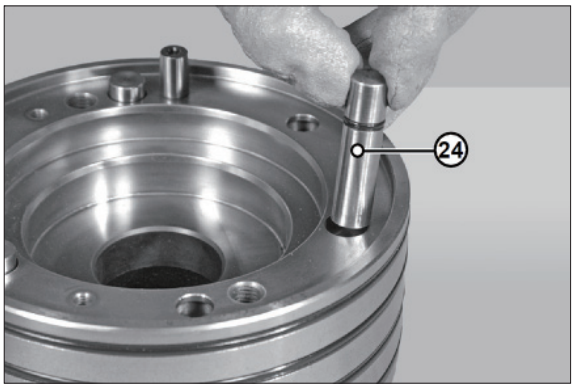
⑤ To determine the value of the piston pack, subtract value C from value D1.

C = A - B
141,0 - 19,0 = 122 mm
C= arm quote
D1 = D + G + F
26,0 + 0,75 + 0,2 = 26,95 mm
D= tickness of discs pack
G= brake discs gap
F= fix quote
E = C - D1
122 - 26,95 = 95,05 mm
E = piston pack quote

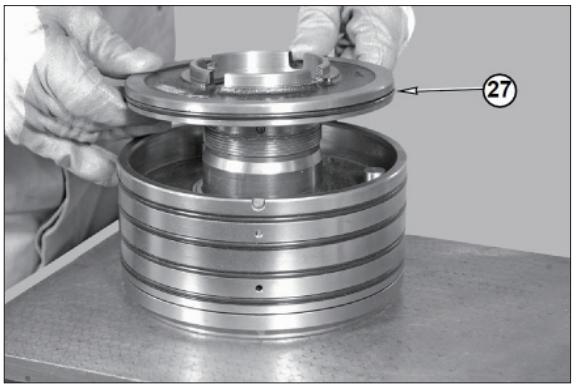
⑥ Insert the service brake piston (4) hammering alternately with a plastic hammer.



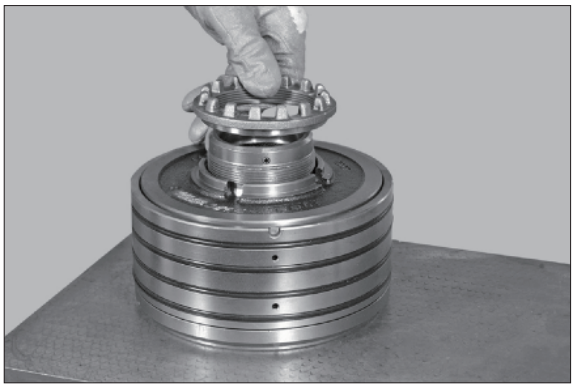
⑦ Insert the bolts (24).



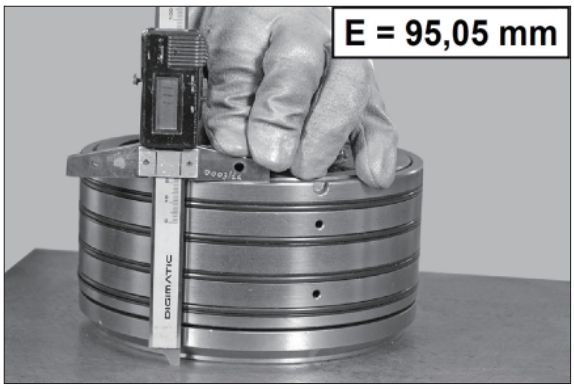
⑧ Turn upside down and insert the negative brake piston (27).



※ To determin the level “E” the slotted nut has to be operated without spring mounted.

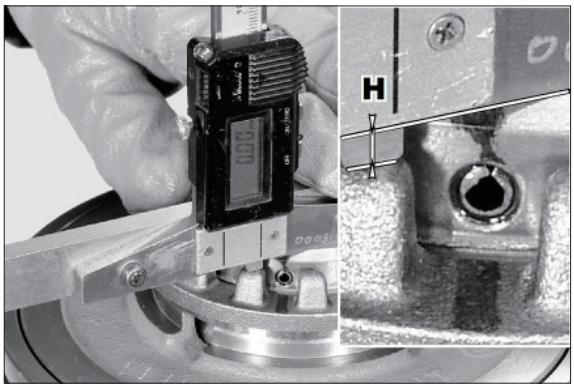


※ To define the level “E” adjust the slotted nut always to the smaller value by driving to the closer notch.

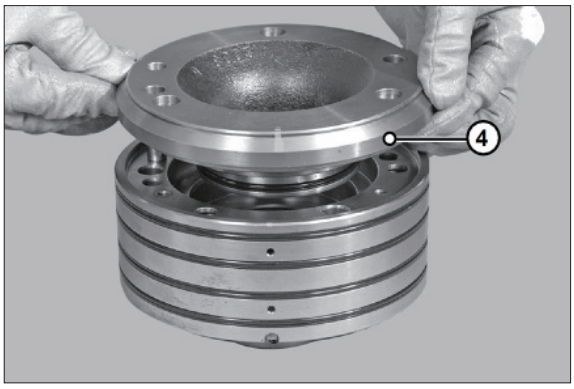


⑨ Before removing the slotted nut in order to insert the springs, note down the distance “H” from the plane to the tooth near the pin.

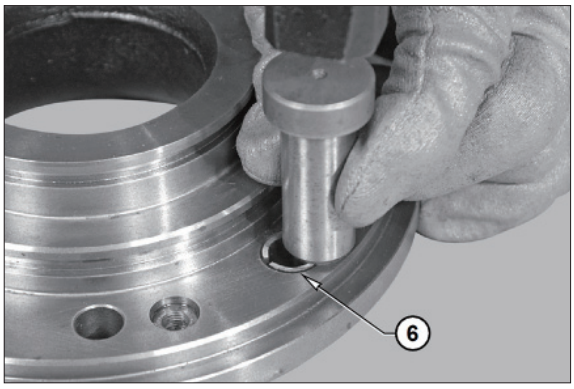
※ Sign.



⑩ Remove the service brake piston (4).

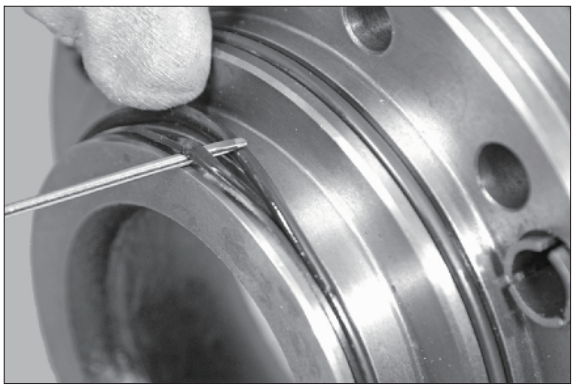


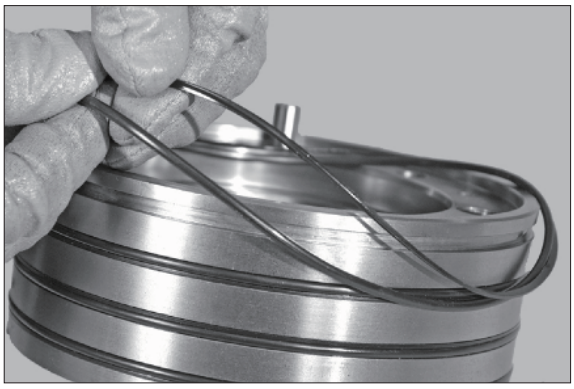
⑪ Insert the stroke automatic regulation springs (6); place them in line with the piston (4).



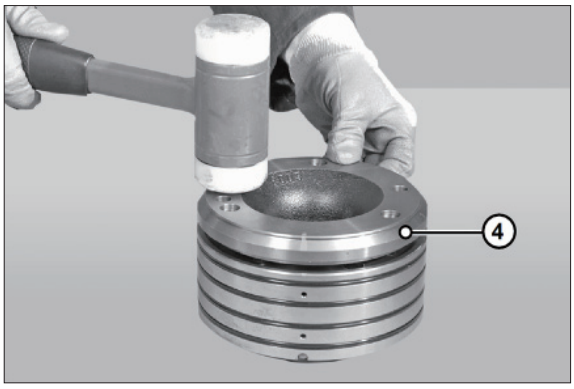
⑫ Complete the O-rings and anti-extrusion rings on all pistons.

※ The O-rings always have to be assembled from the pressure facing side.

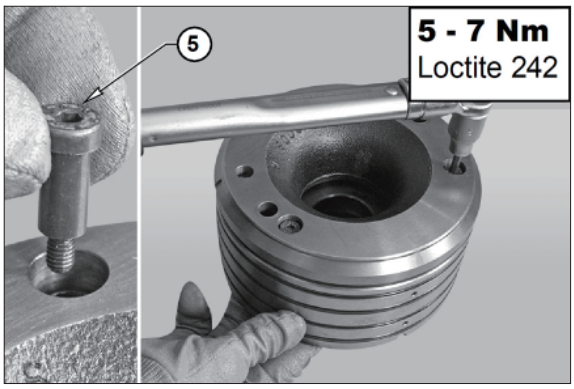




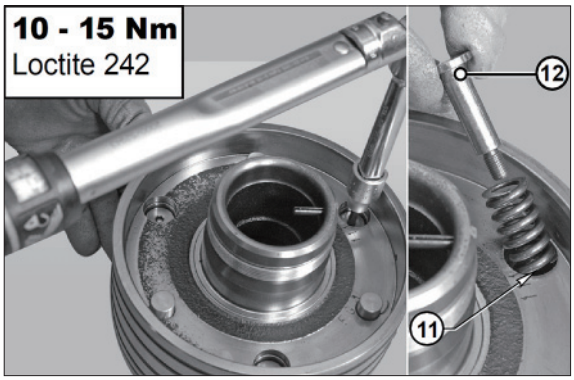
⑬ Insert the service brake piston (4) hammering alternately with a plastic hammer.



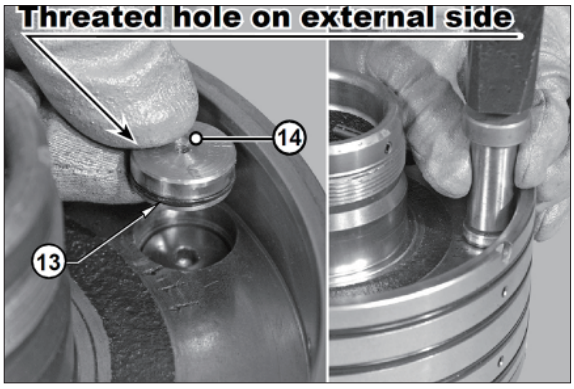
⑭ Fit the adjusting screws (5).
Apply loctite 242 to the thread.
· Torque wrench setting :
0.51~0.71 kgf · m (3.69~5.16 lbf · ft)



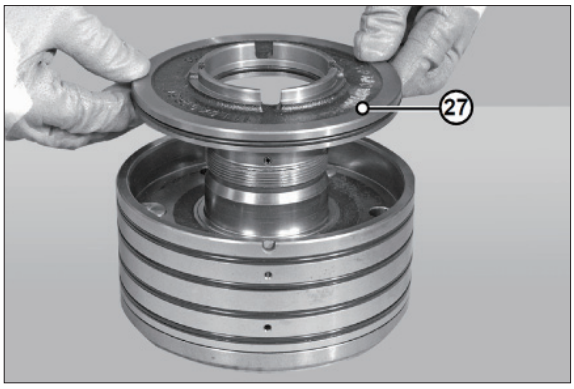
⑮ Fit the reversal springs (11) on the piston (4).
Apply loctite 242 to the thread of the adjustment screw.
Tighten with torque wrench setting of 1.02~1.53 kgf · m (7.38~11.1 lbf · ft).



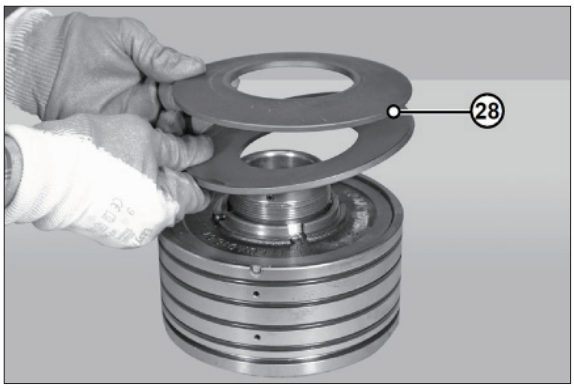
⑯ Insert the stroke end seal caps.



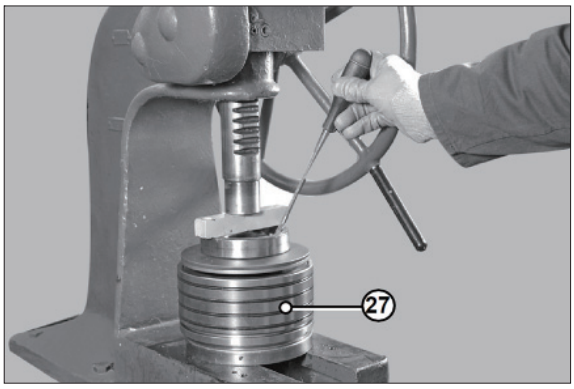
⑰ Insert the negative brake piston (27).



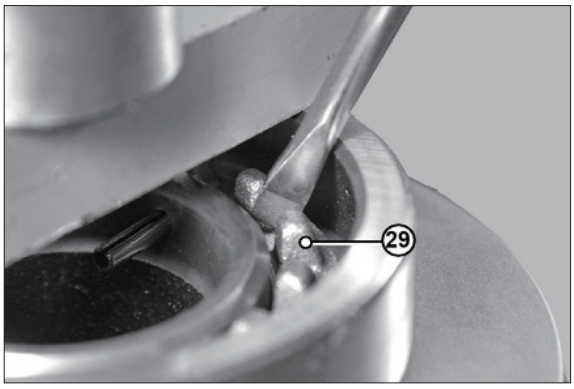
⑱ Insert the disc springs in the right position (28).



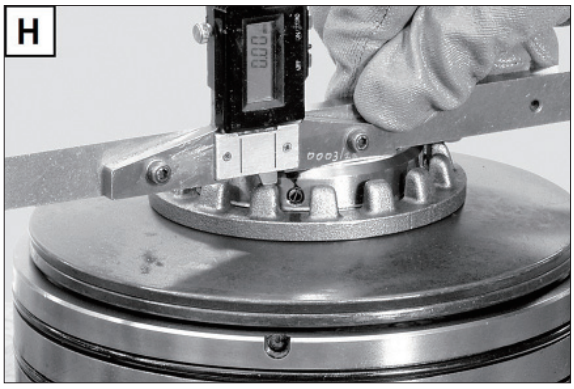
⑲ Insert at the bottom the piston of the negative brake (27) and screw up the slotted nut (29).



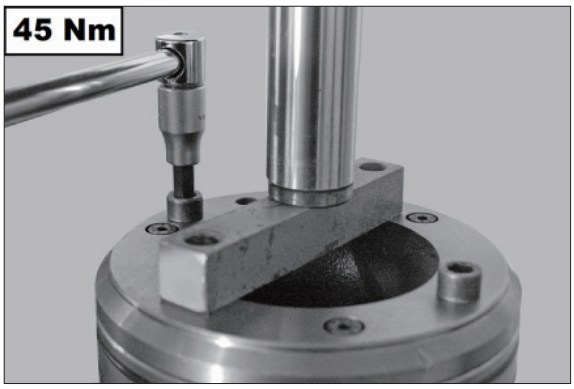
⑳ Screw down the slotted nut to the earlier determined position.



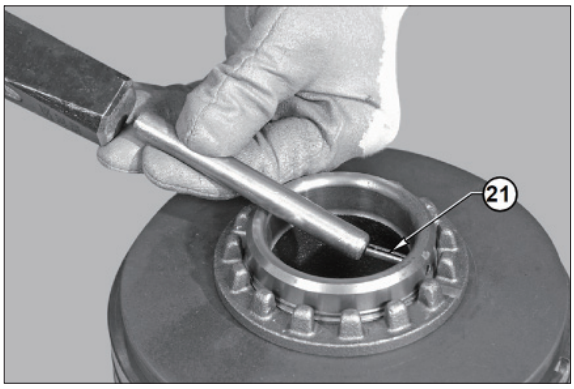
㉑ Check the earlier measured distance “H” from the plane to the tooth next to the pin.



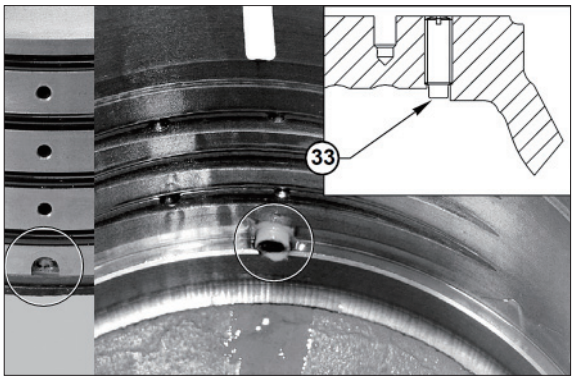
㉒ Alternately tighten with a torque wrench setting of maximum 4.59 kgf · m (33.2 lbf · ft).



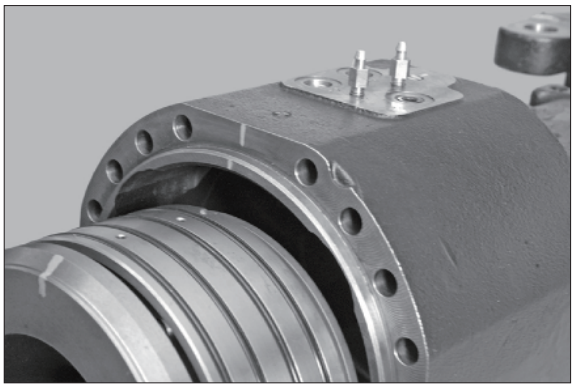
㉓ Put the pin in locking (21) position.



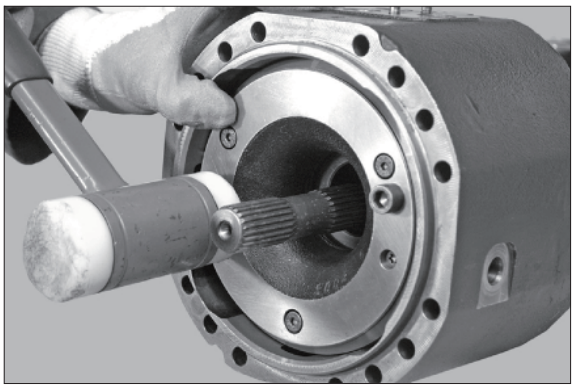
※ Check locking screw (33) of the brake piston module.



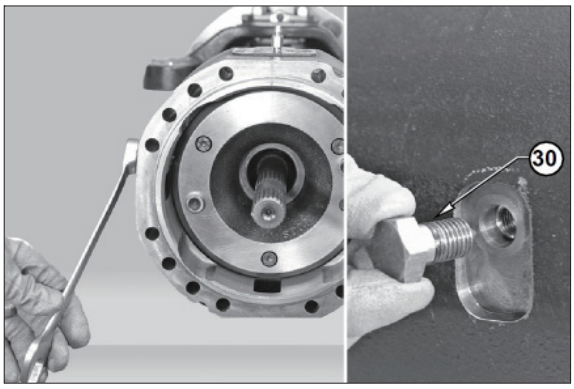
㉔ Insert the brake module facing the input holes to the top.



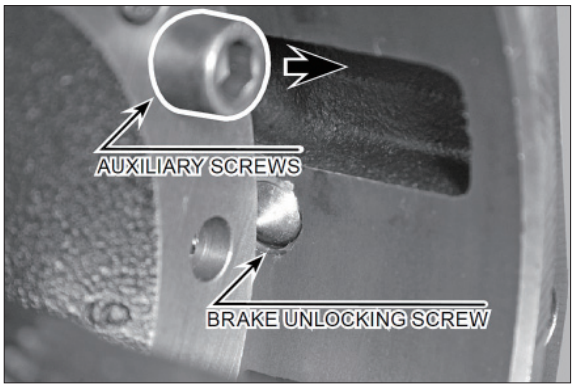
㉕ Insert the piston to the end stop by alternating light strokes and remove the screws.



㉖ Insert the negative brake unlocking screw (30) up to the end stop.

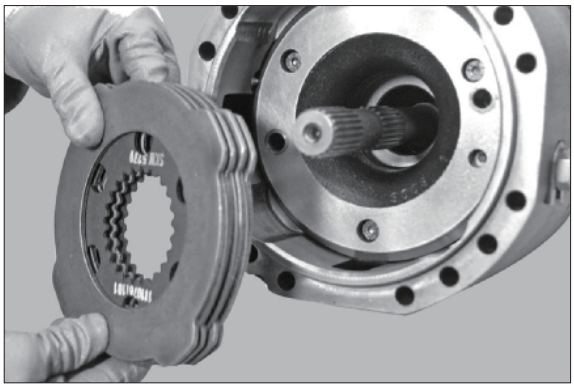


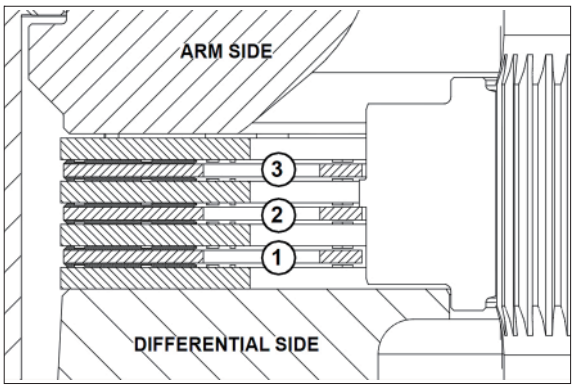
㉗ Remove the two auxiliary screws.



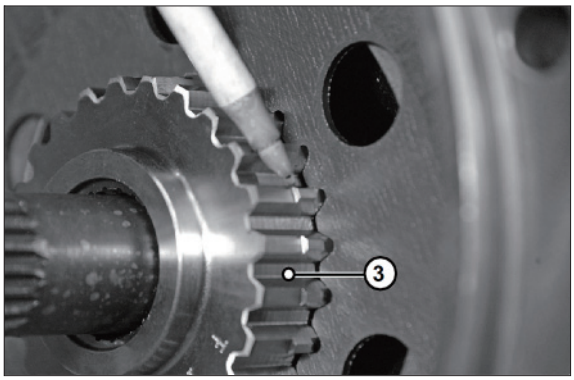
㉘ Insert the brake discs (1) (2) in the right sequence.

※ The first brake disc to be inserted must be of friction material.



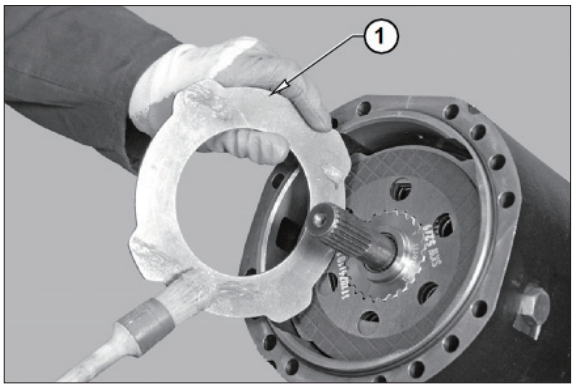


㉙ Install the flange (3) on the arm.

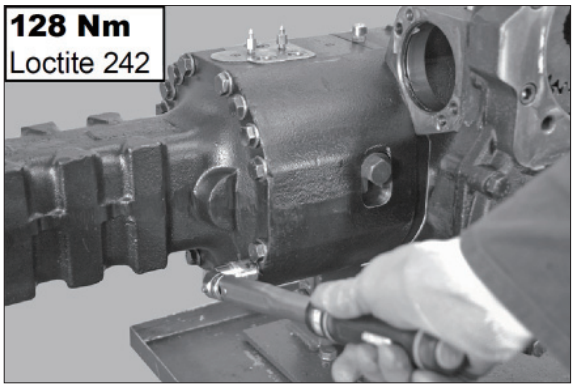


㉚ Insert the brake discs (1) (2) in the right sequence.

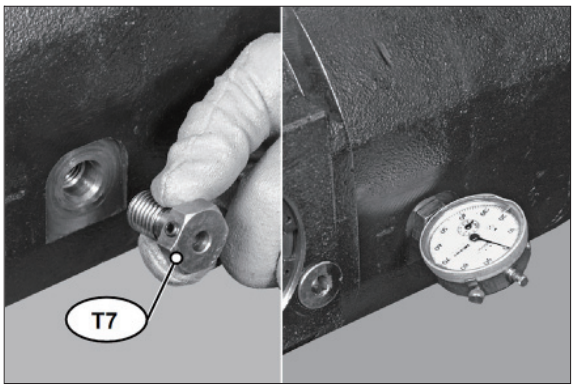
※ The last brake disc to be inserted must be of metal material.



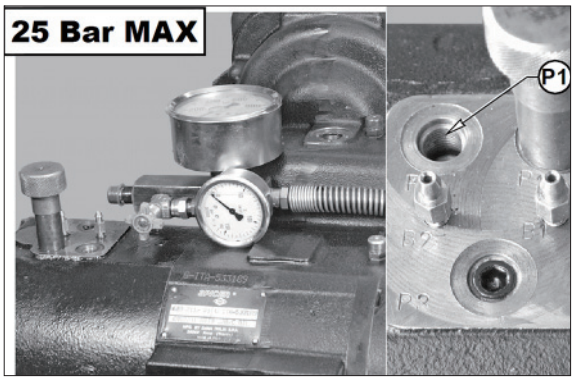
㉛ Insert the screws and tighten them alternately.



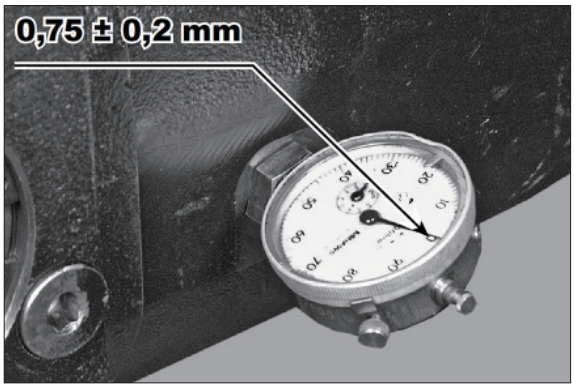
㉜ Remove the negative brake locking screws (30).
Fit the special tool T7 into the seat of the manual release of the screws, insert a comparator and pre-load it with 1 mm.



㉝ Introduce a pressure of maximum 25 bar.

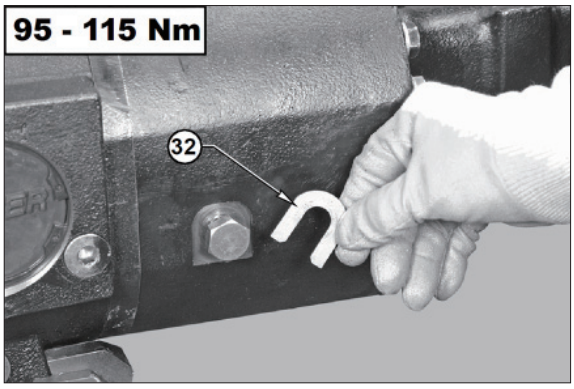


㉞ Once the pressure is inserted into the circuit the comparator must give a measurement equal to play X (0.75 mm).

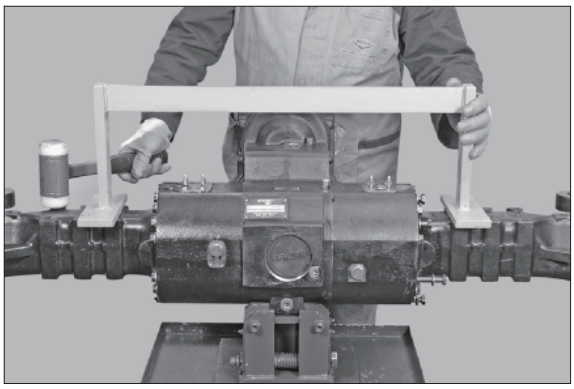


㉟ Insert the two “U”-shaped shims and tighten the screws with a torque wrench setting of 9.69~11.7 kgf · m (70.1~84.8 lbf · ft).

※ The position of the negative brake is unlocked.

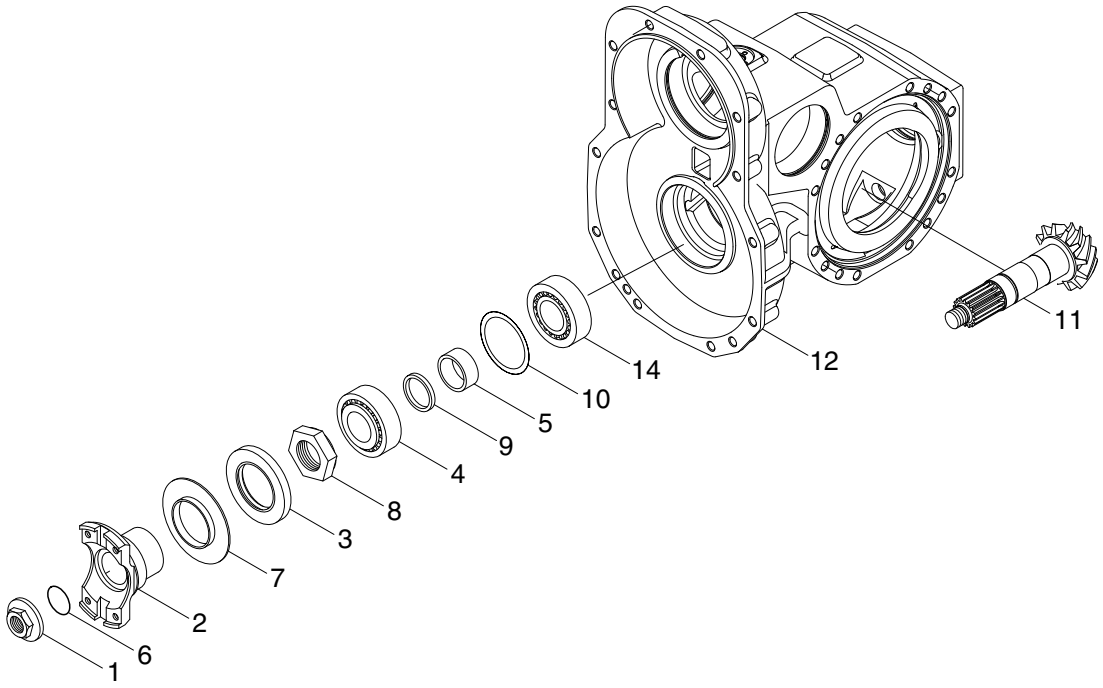


㊱ Check the flatness of the arms and finally lock the arms with the screws (4) and the washer (5) using the crosstightening method.

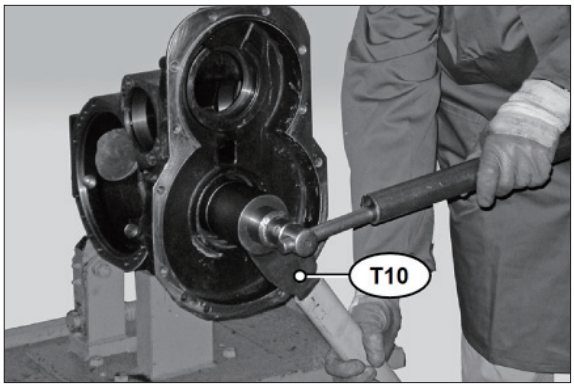


4) BEVEL PINION

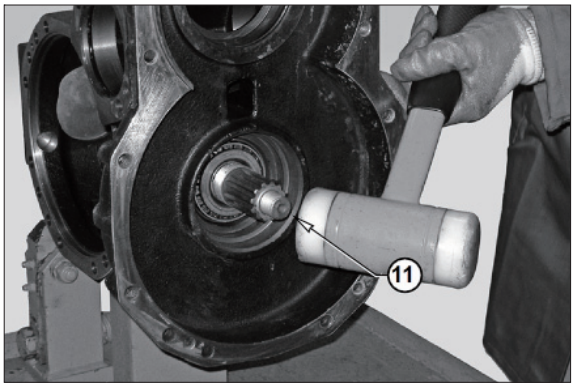
(1) Disassembly



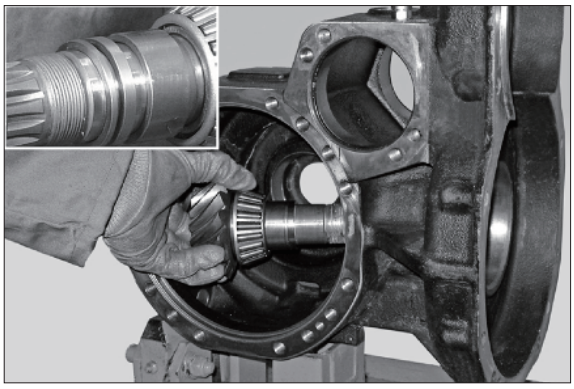
① Position tool T10, so as to avoid pinion rotation.
Unloose and remove the nut (1); also remove the O-ring (6).



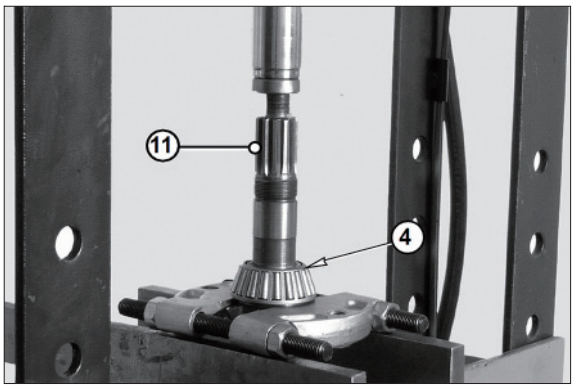
② Remove the pinion (11), shims and distance piece.



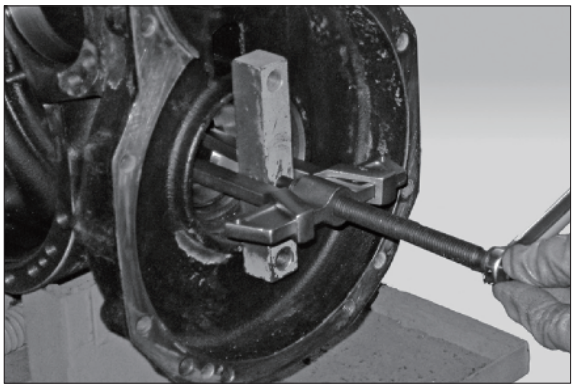
③ Refer and keep to the positions marked during disassembly.



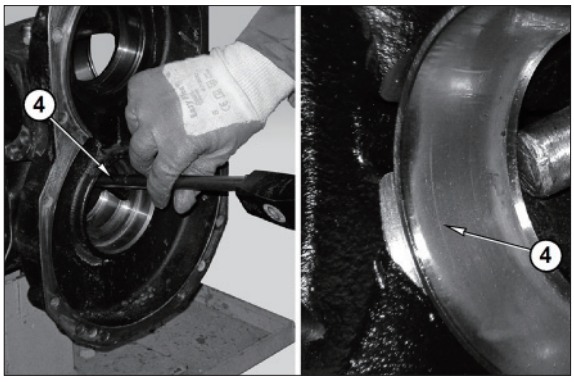
④ Using a puller and a press, remove the inner bearing (4) from the pinion (11).



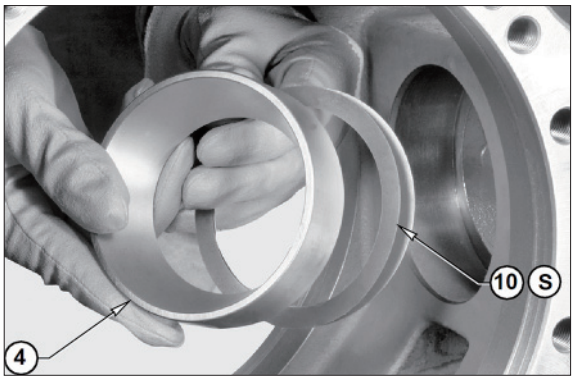
⑤ Remove the thrust block of the external bearing (14).



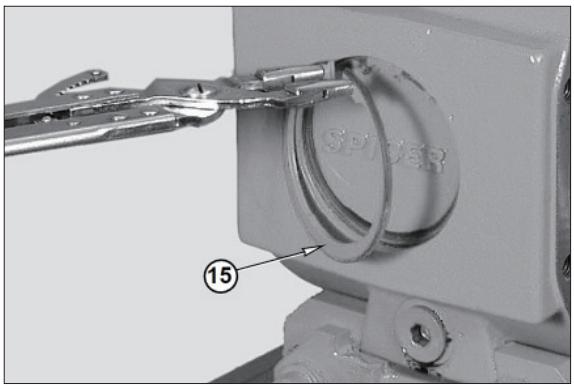
⑥ Insert a drift in the appropriate holes.



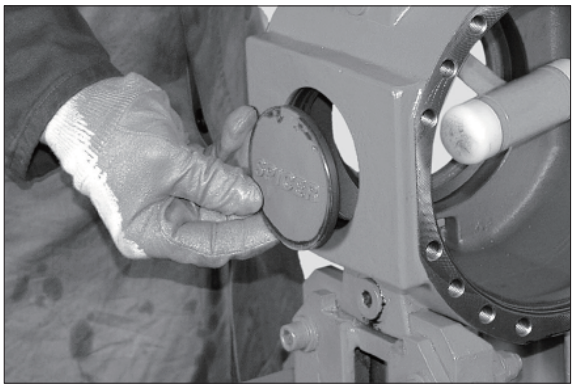
⑦ Remove the thrust block of the internal bearing (4) as well as the shim washers (10) (S).



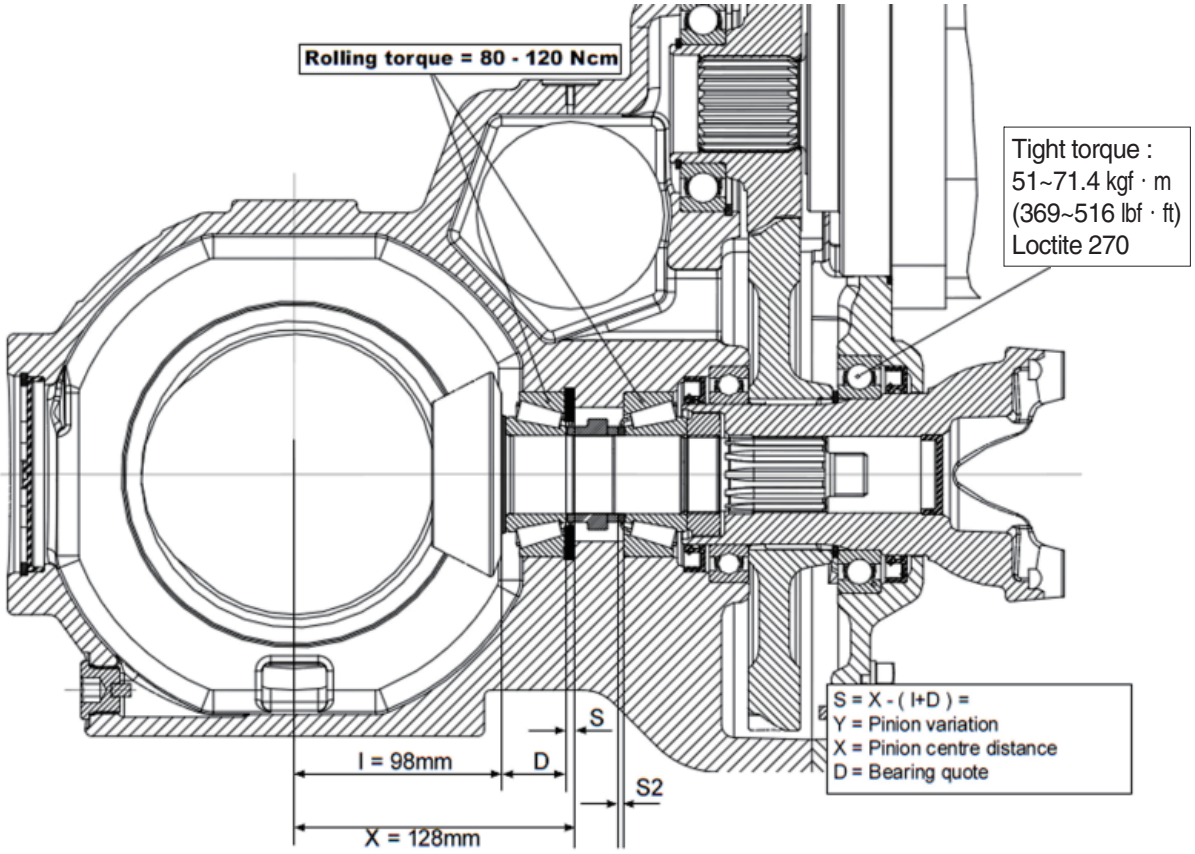
⑧ Remove the snap ring (15).



⑨ Remove the cap (14).

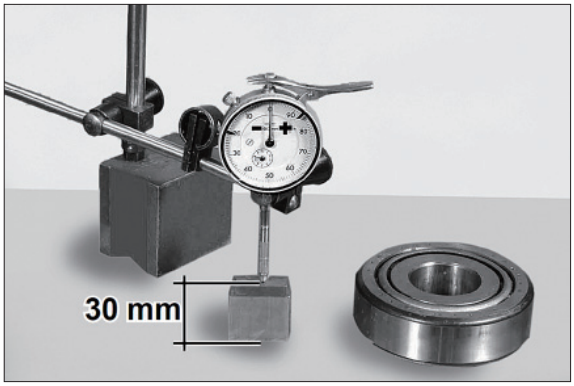


(2) Assembly



Calculating pinion center distance

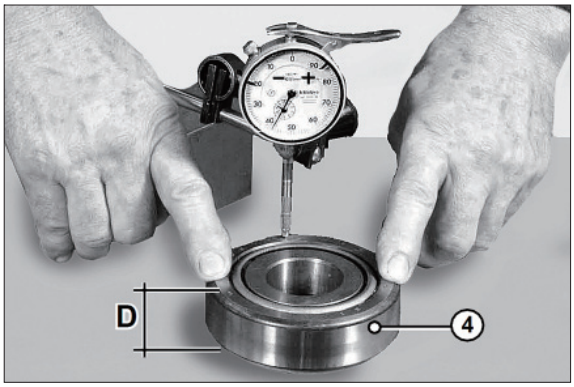
① Using a faceplate, reset a centesimal comparator “DG” on a calibrated block (whose known thickness is 30 ㎜). Preload the comparator by about 3 ㎜.



② Bring inner bearing (4), complete with thrust block, under comparator “DG”.

※ Press the thrust block centrally and carry out several measurements by rotating the thrust block.

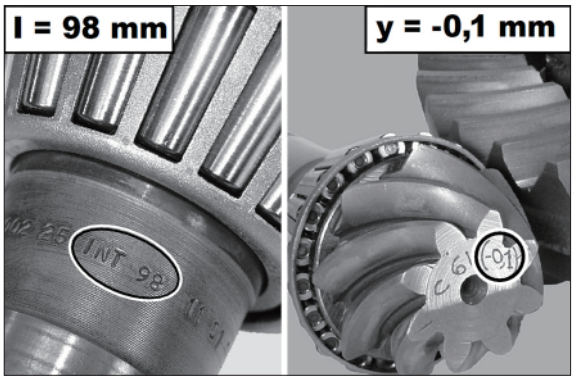
Example : 30 - 0.55 = 29.45 = “D”.



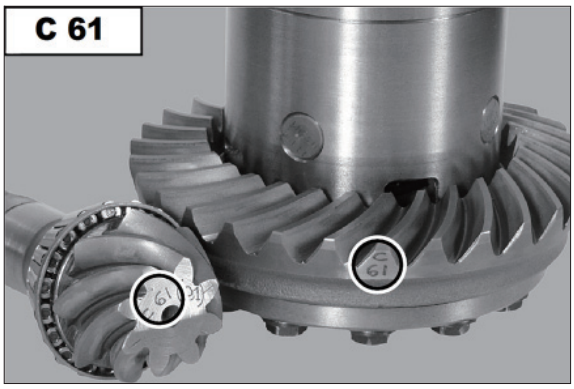
③ Check nominal dimension “I” as marked on the pinion. Add up to or subtract from “I” the variation indicated as “Y” to obtain the actual centre distance “I”.

Example : I=INT±Y=98 - 0.1=97.9 ㎜

※ C61 = Match part number

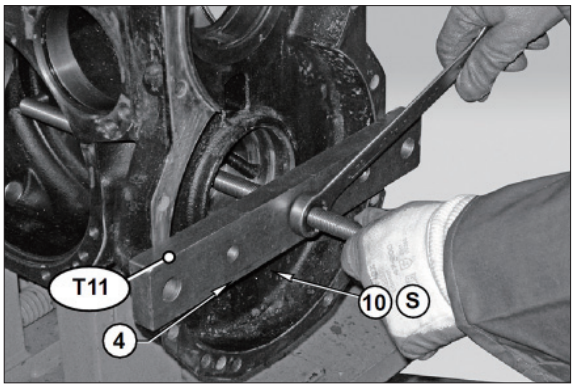


④ C61=bevel gear set matching number
(-0.1)=Y variation from the theorical I =98

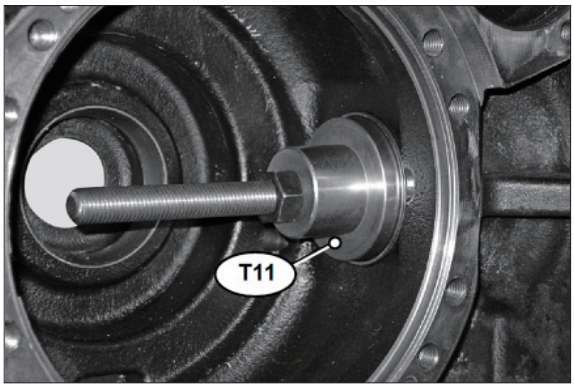


⑤ Calculate shims “S” for insertion under the thrust block of the inner bearing using the following formula :
S = X-(I+D) where : X = fixed dimension
I = actual pinion center distance
D = Total bearing thickness ;
Example :
S = 128 - (97.9+29.45) = 0.65 ㎜

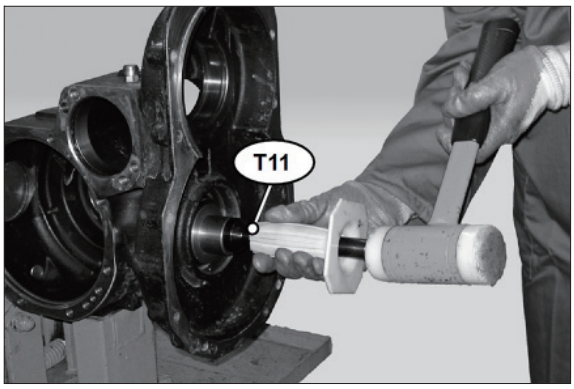
⑥ Using special tool T11.
Insert the thrust block of the bearings (4) and shims (10).



※ Before starting the next stage, make sure that the thrust block has been completely inserted into its seat.

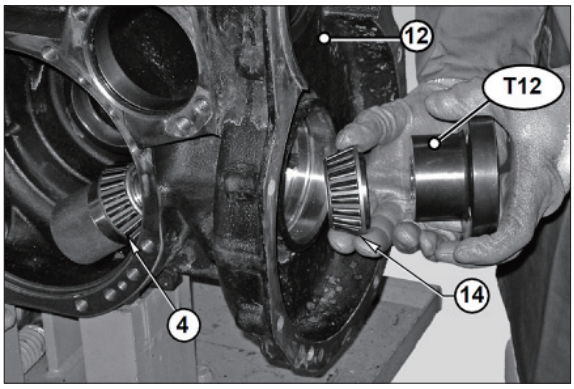


⑦ Using special tool T11.
Insert the thrust block of the bearings (4) and shims (10).

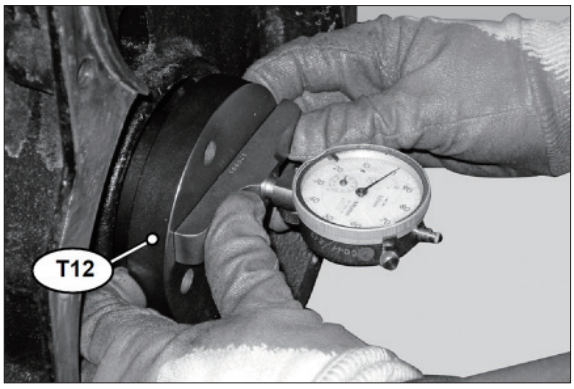


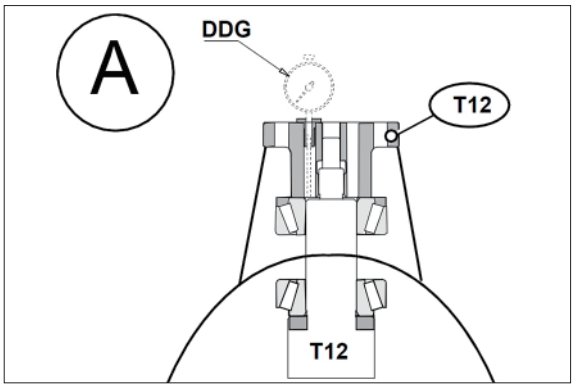
Calculating pinion bearings rolling torque

⑧ Introduce tool T12 complete with bearings (4) and (14) into the main body (12); tighten by hand until a rolling torque is definitely obtained.

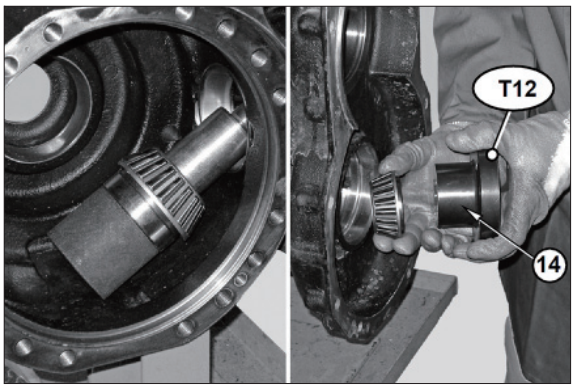


⑨ Introduce the tracer of a depth comparator “DDG” into either side hole of tool T12.
Reset the comparator with a preload of about 3 mm.



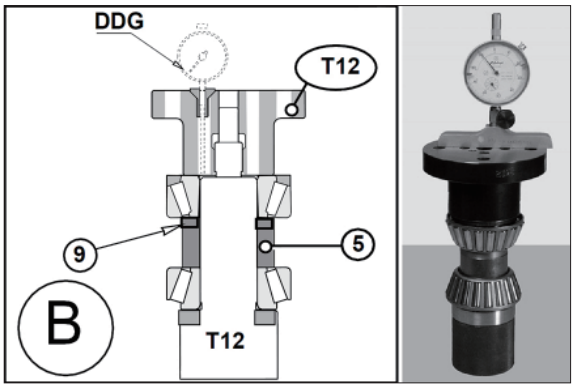


⑩ Remove the comparator and take out tool T12 and bearing kits from the main body.
Reinstall every part, also introducing a distance piece between bearings (4) and (14). Tighten the entire pack by hand.



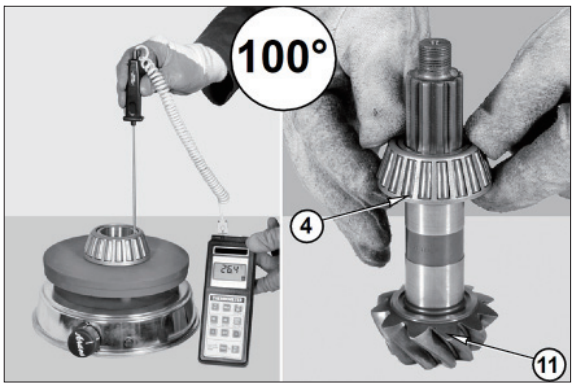
⑪ Assemble on top of the tool T12 and between the two bearings the shim (5) and the largest calibrated shim (9).

⑫ Measure the difference H using a dial gauge DDG.
・Example : H = A - B = 2.93 mm



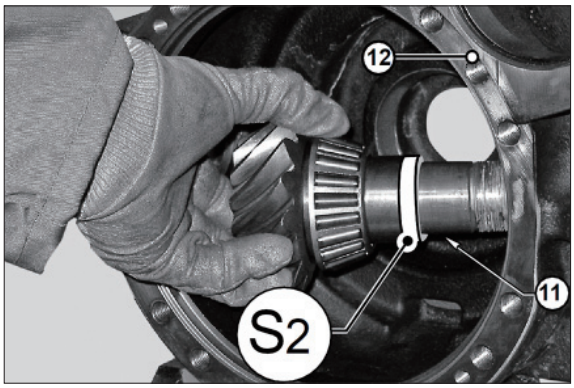
⑬ Calculate the shim S2 to be inserted.
Example : S2 = H + X1 = 3.01 ㎜
where X1 = fixed value to obtain =
0.07~0.08 ㎜

⑭ Heat the bearing to 100˚C and assemble it to the pinion shaft.



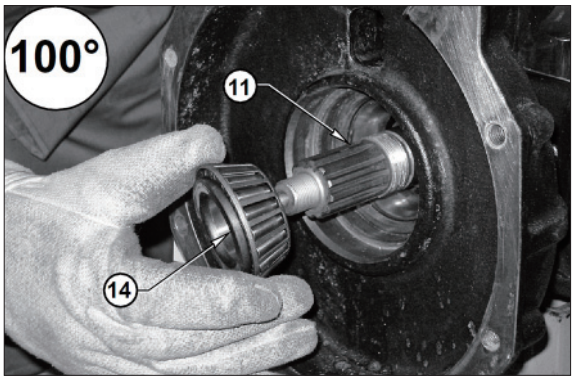
⑮ Fit the pinion (11), shim “S2” (10) and distance piece (5) (9) in the main body (12).

※ The finer shims must be placed in-between the thicker ones.

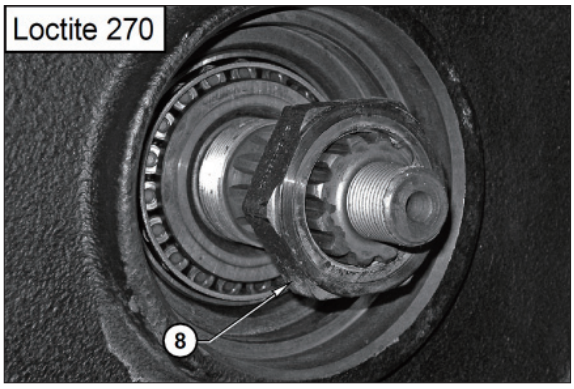


⑯ Heat the external bearing (14) to a temperature of about 100˚C and fit it on to the pinion (11) so as to complete the pack as shown in the figure.

※ Lightly lubricate bearing with SAE85W90 oil.



⑰ Apply loctite 270 to the thread of the ring nut (8) and screw the nut onto the pinion.

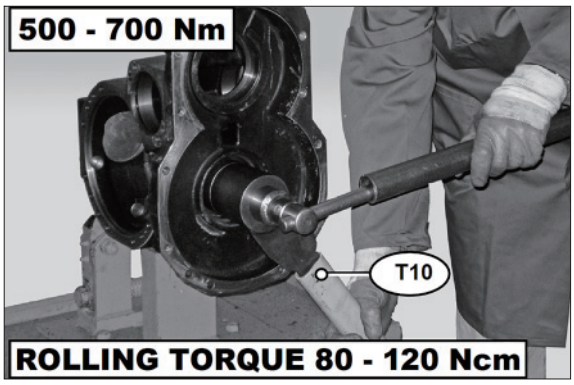


⑱ Apply onto the pinion (11) the bar-hold and with the help of a torque meter, check the torque of the pinion (11).

・Torque : 50.9~71.4 kgf · m
(368~516 lbf · ft)

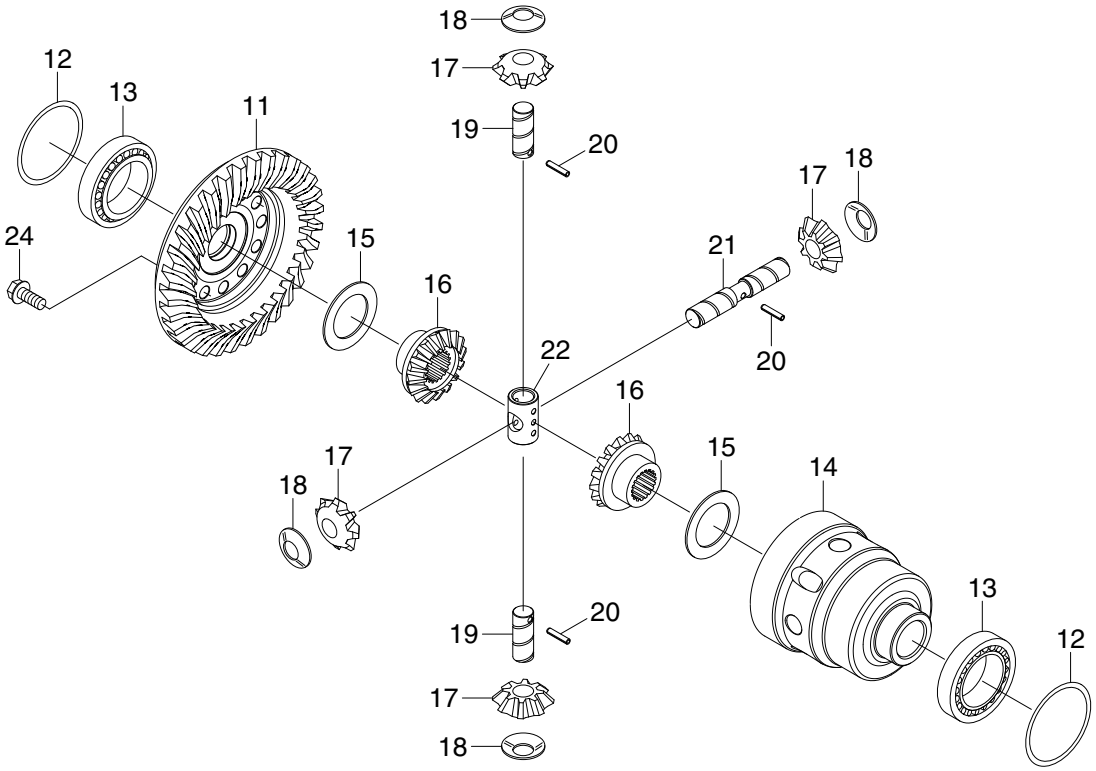
※ If torque exceeds the maximum value, then the size of shim “S1” (4) between the bearing (9) and the distance piece (3) needs to be increased. If torque does not reach the set value, increase the torque setting of the ring nut (10) in different stages to obtain a maximum value of 50.9 kgf · m (368 lbf · ft).

※ If torque does not reach the minimum value, then the size of shim “S1” (4) needs to be reduced.

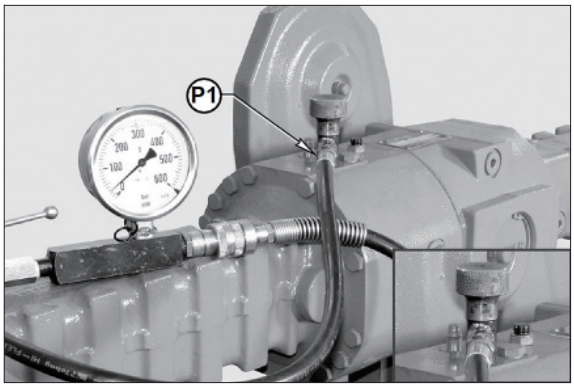


5) DIFFERENTIAL UNIT

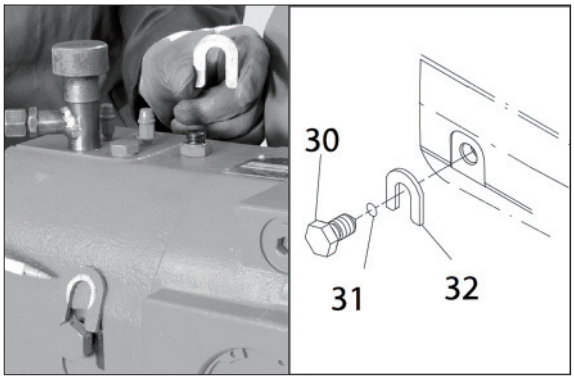
(1) Disassembly



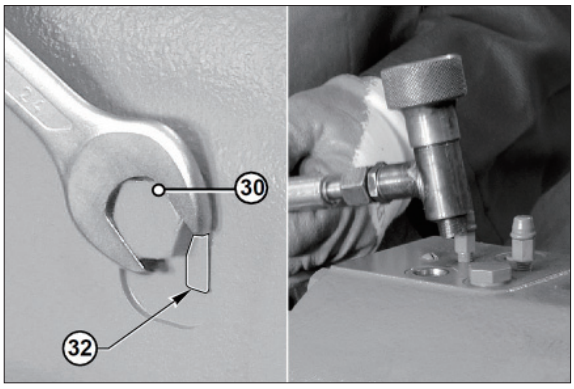
① Connect an external pump to the union piece “P1” of the negative brake and introduce a pressure of 15±30 bar to eliminate the pressure of the belleville washers.



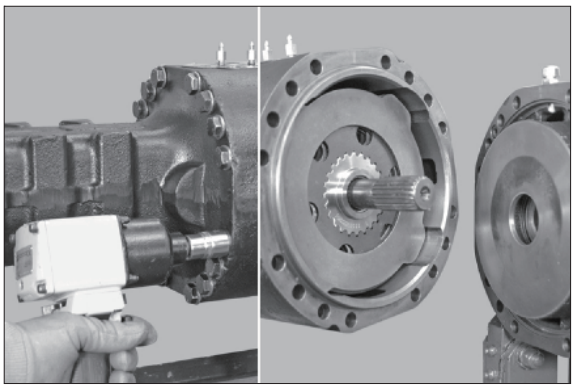
② Loosen the unlocking screws (30) and remove both stop washers (32).



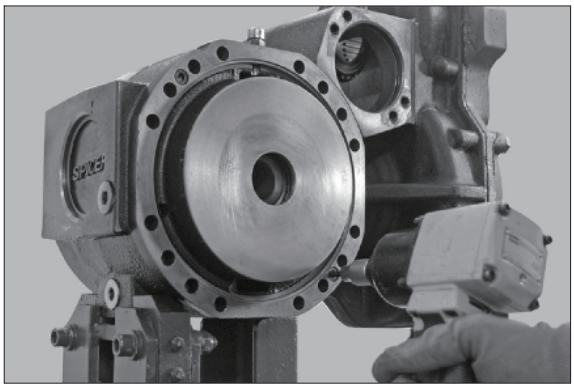
③ Insert block screws to end stroke and release pression.



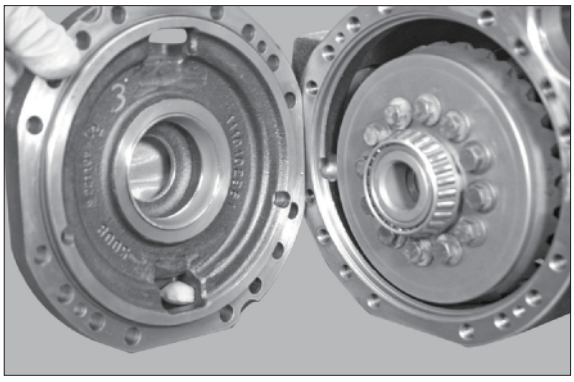
④ Remove the brake side arm and the brake discs pack.
Sling the arm to be removed and connect it to a hoist, remove screws of the crown wheel side arm.
Remove the arm together with the pack of the braking disks.
Place the arm on a bench.



⑤ Remove the fitting screws from the middle cover.

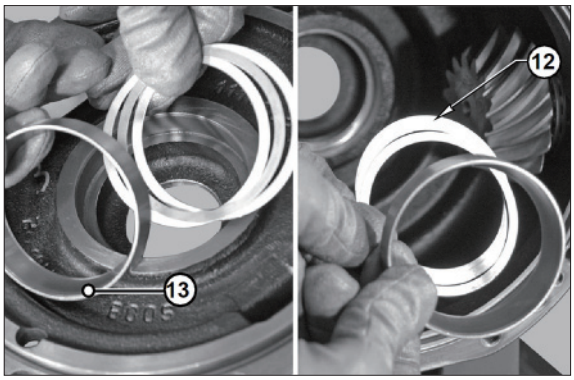


⑥ Insert a screw-driver in the opposing slots then force and remove the middle cover.

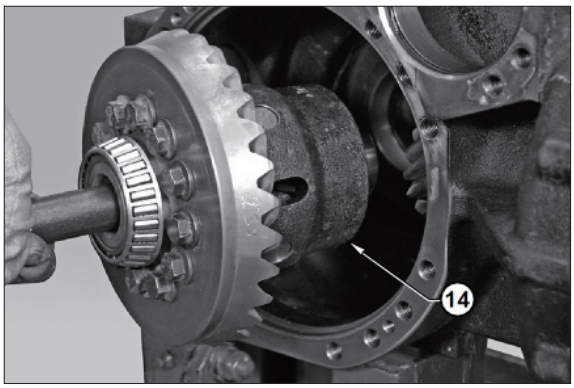


⑦ If the bearings need replacing (13), extract the external thrust blocks of the bearings (13) from middle cover and central body.

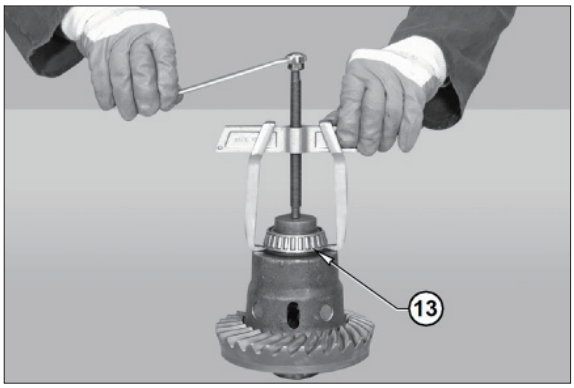
※ Accurately check the O-ring.



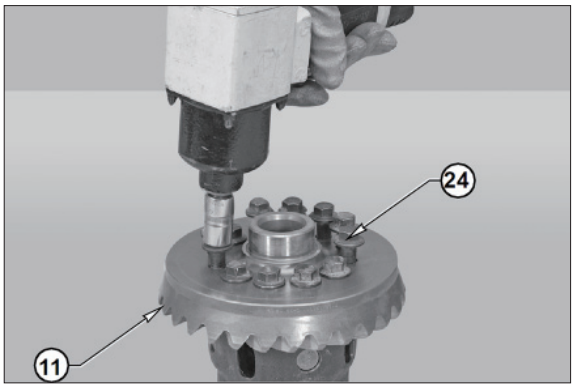
⑧ Pull out the differental (14).



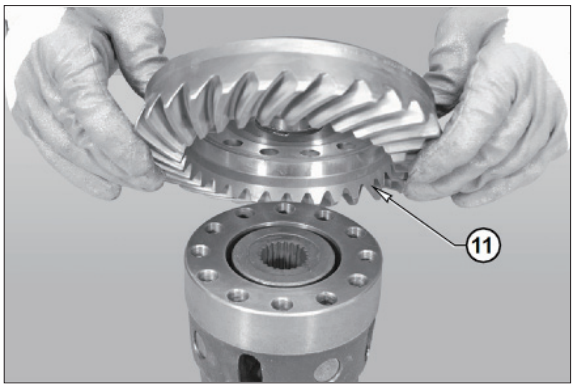
⑨ If the bearing need replacing, extract the bearing (13) from the differential carrier.



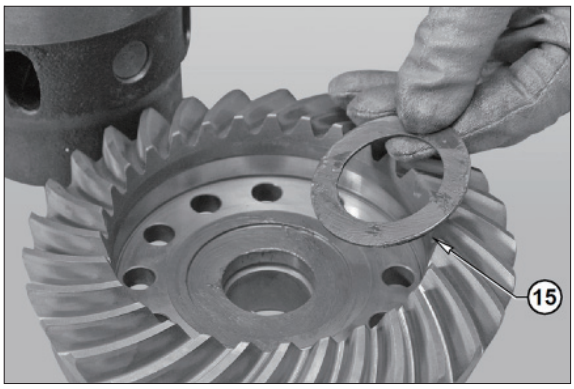
⑩ Remove fixing screws (24) of the crown wheel (11); exchange each time when removed.



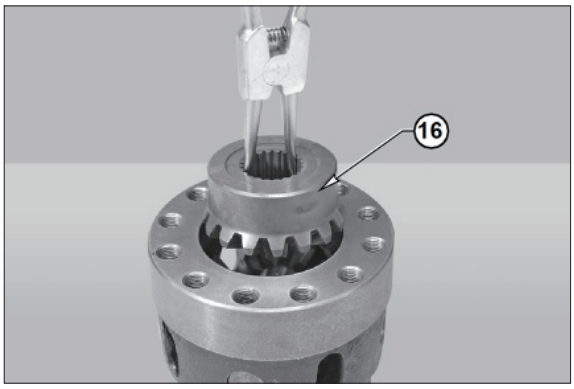
⑪ Extract the crown wheel (11).



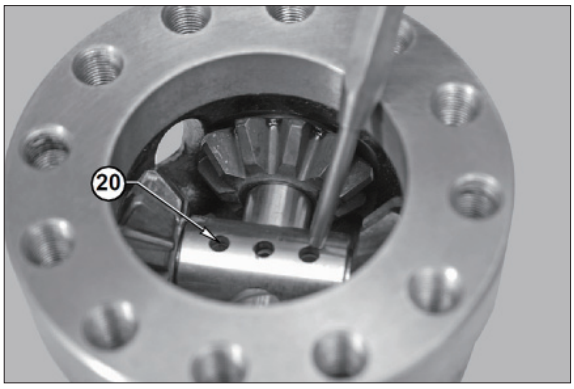
⑫ Remove the shim washer (15).



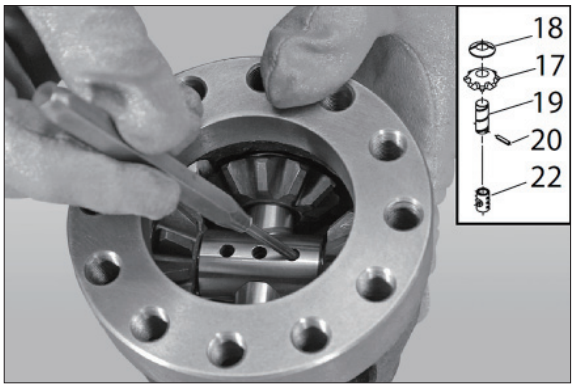
⑬ Remove the planetary gear (16).



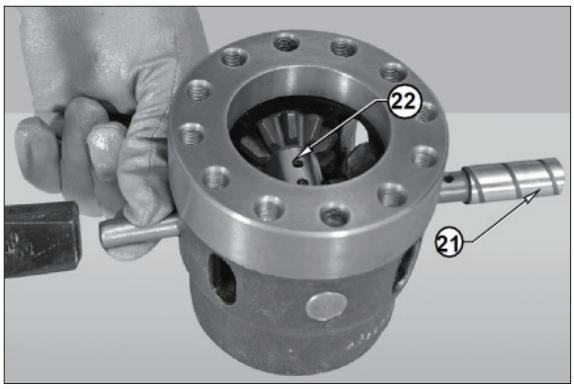
⑭ Remove the three spider blocking pins (20) by using a pin driver.



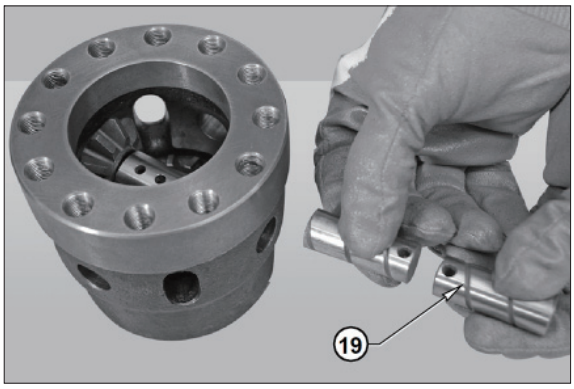
⑮ Move the two opposite mounted short bolts (19) to the outside of the box using the same pin driver.



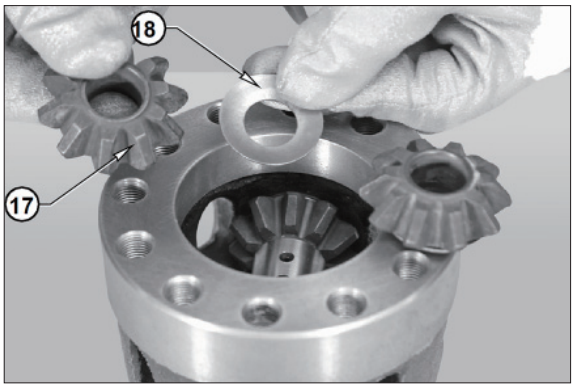
⑯ Drive out the long bolt (21) and pull out the spider (22) from the center.



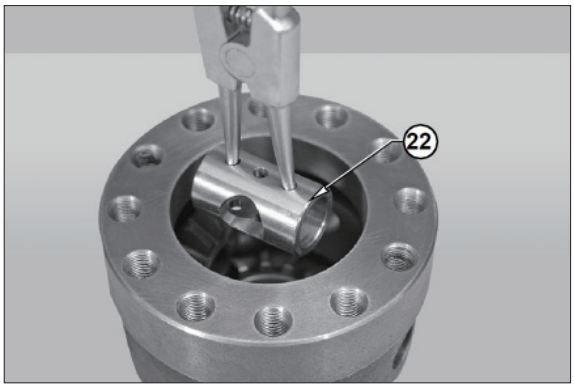
⑰ Remove the two half bolts (19), spherical washers and satellite wheels.



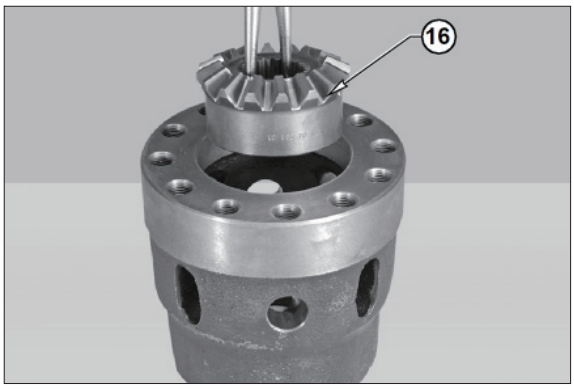
⑱ Remove long bolt, spherical washers (18) and satellite wheels (17).



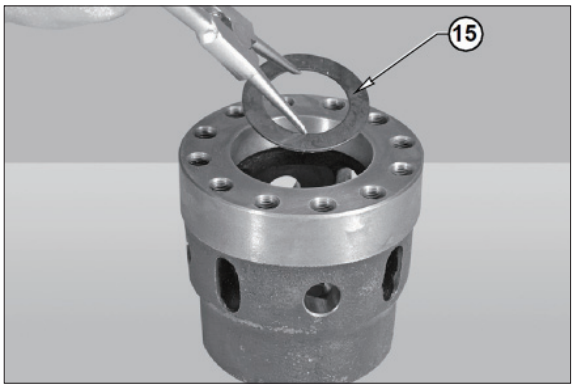
⑲ Pull out the spider (22) from the center.



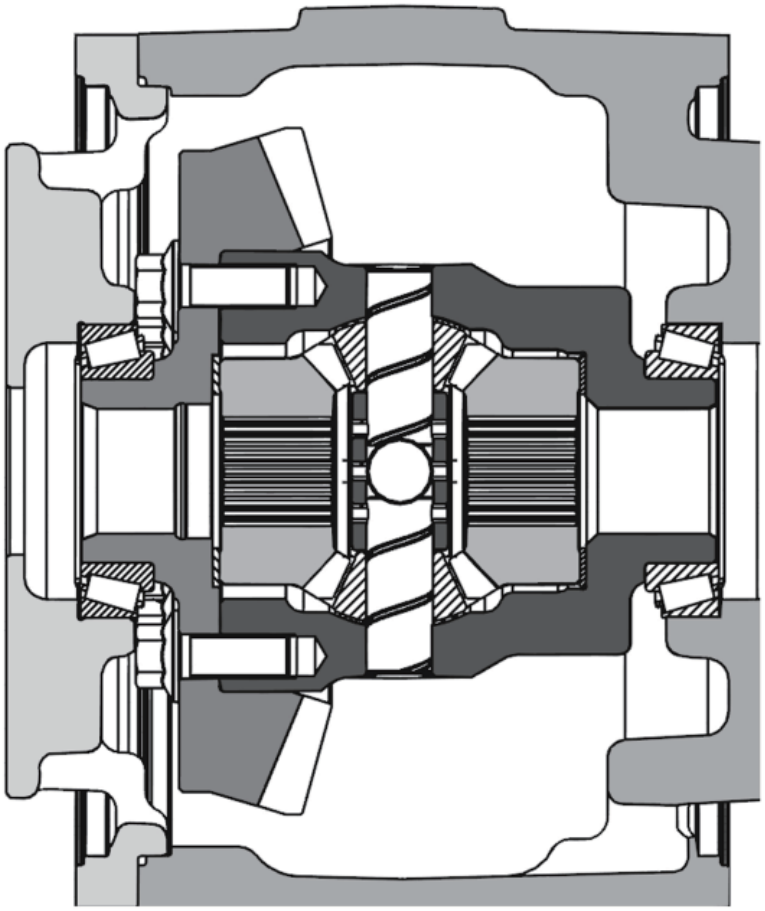
⑳ Remove the planetary gear (16).



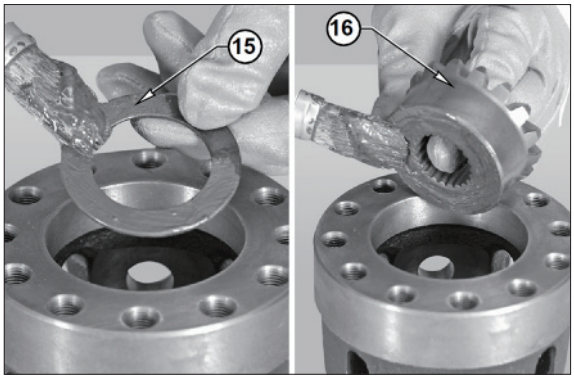
㉑ Remove the shim washer (15).

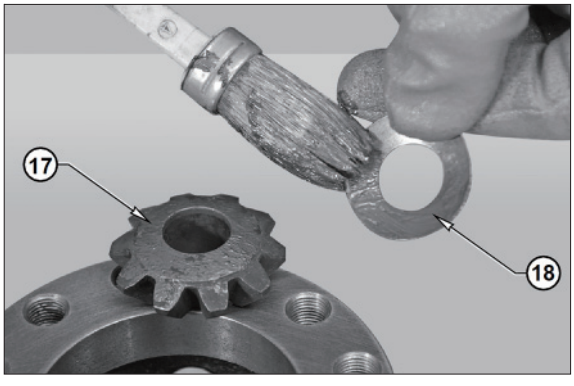


(2) Assembly

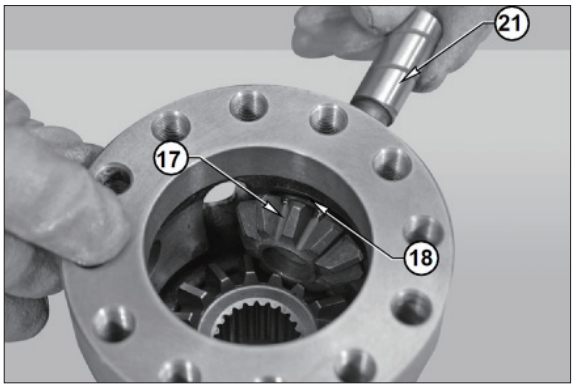


① Lubricate and insert washer (15) and plantary wheel (16).

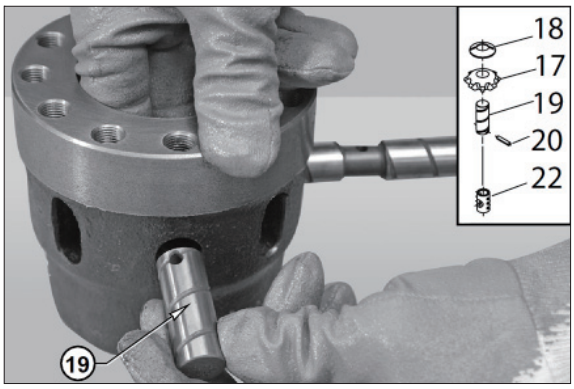




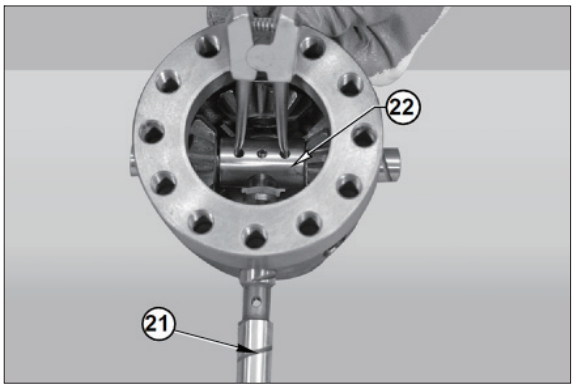
② Partially insert the long bolt (21), satellite wheels (17) and spherical washers (21).



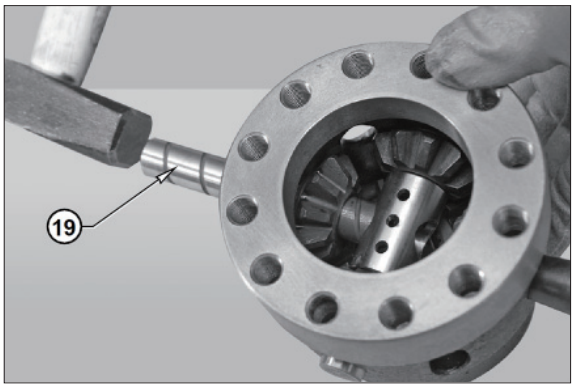
③ Insert the two half bolts (19), spherical washers (18) and satellite wheels (17).



④ Insert spider (22) and completely insert the long bolt (21).

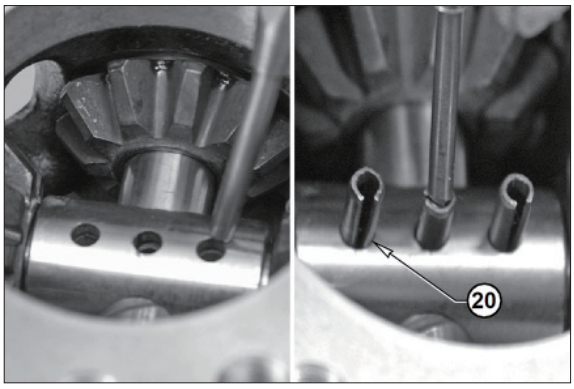


⑤ Insert completely the bolts (19).

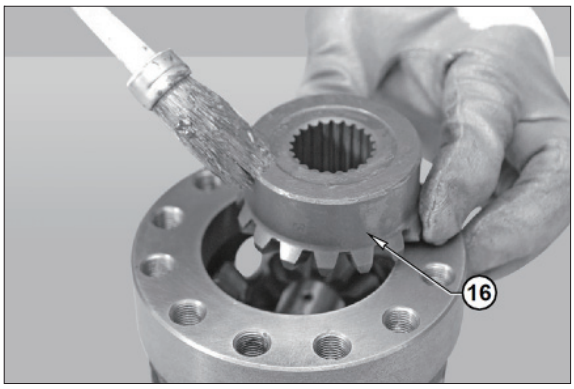


⑥ Center the pin holes and insert the 3V pins (20).

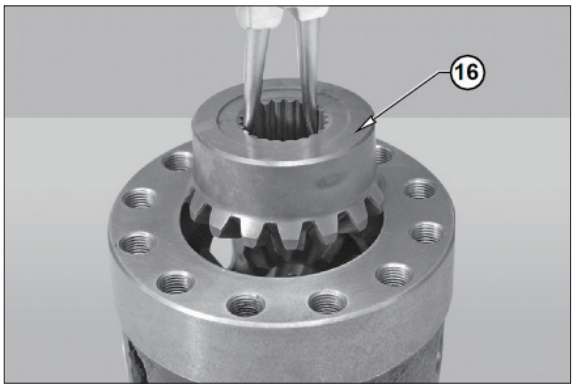
※ Check the free rotation of the satellite wheels on the bolts.



⑦ Lubricate wheel (16).

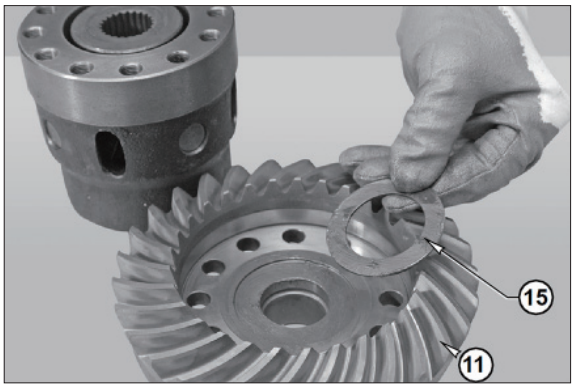


⑧ Insert planetary gear wheel (16).



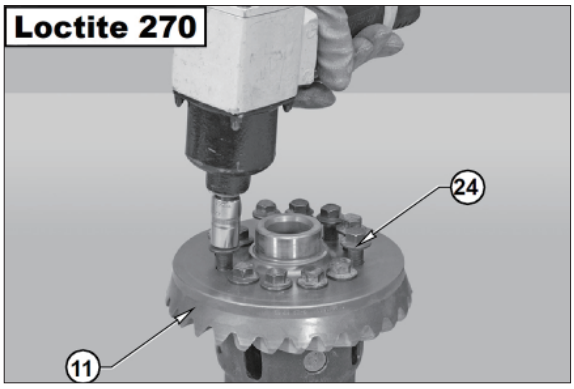
⑨ Position the shim washer (15) on the crown (11).

※ In order to hold the shim washer (15) in position, apply grease to it.



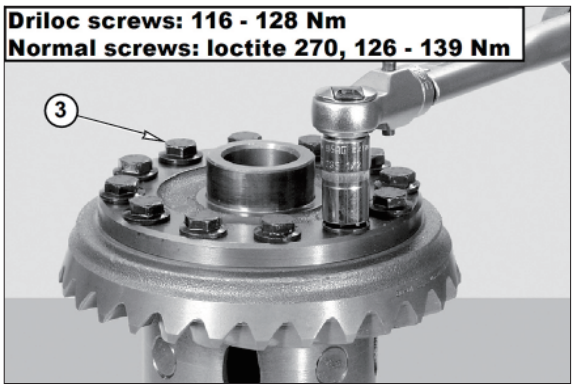
⑩ Position the crown (11) on the differential carrier and lock it with screws (24) applied with loctite 270.

※ Secure the screws using the cross-tightening method.



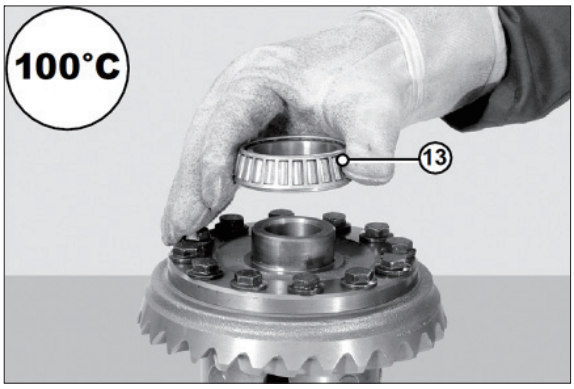
⑪ Tighten screws with a torque wrench : see table.

※ Always use new screws to fix the crown wheel. In case the screws are not thread locking pretreated, use loctite 270.



⑫ Assemble the bearing (13).

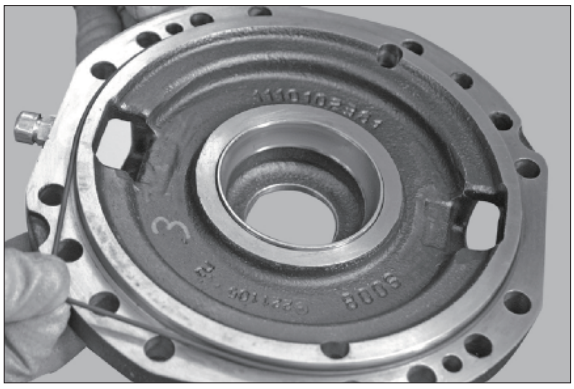
※ Heat the bearing to 100˚C before assembling.



⑬ If the bearings are replaced, insert the external thrust blocks in the middle cover and in the central body.

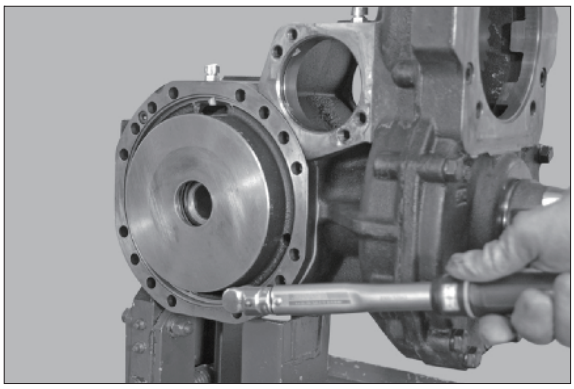
⑭ Position the differential unit in the central body with the help of a bar and fit the middle cover.

※ Thoroughly check the state of the O-ring and make sure that the cover is fitted with the oil discharge in the lower position.

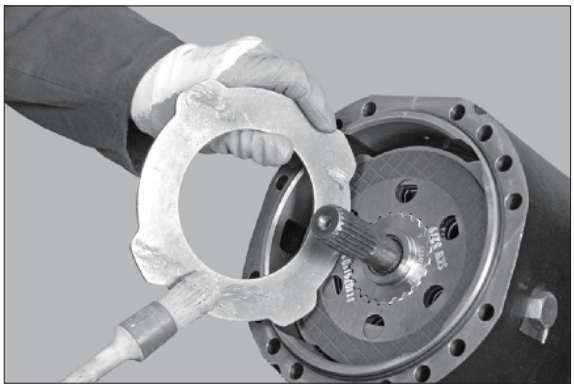


⑮ Lock the middle cover with screws.

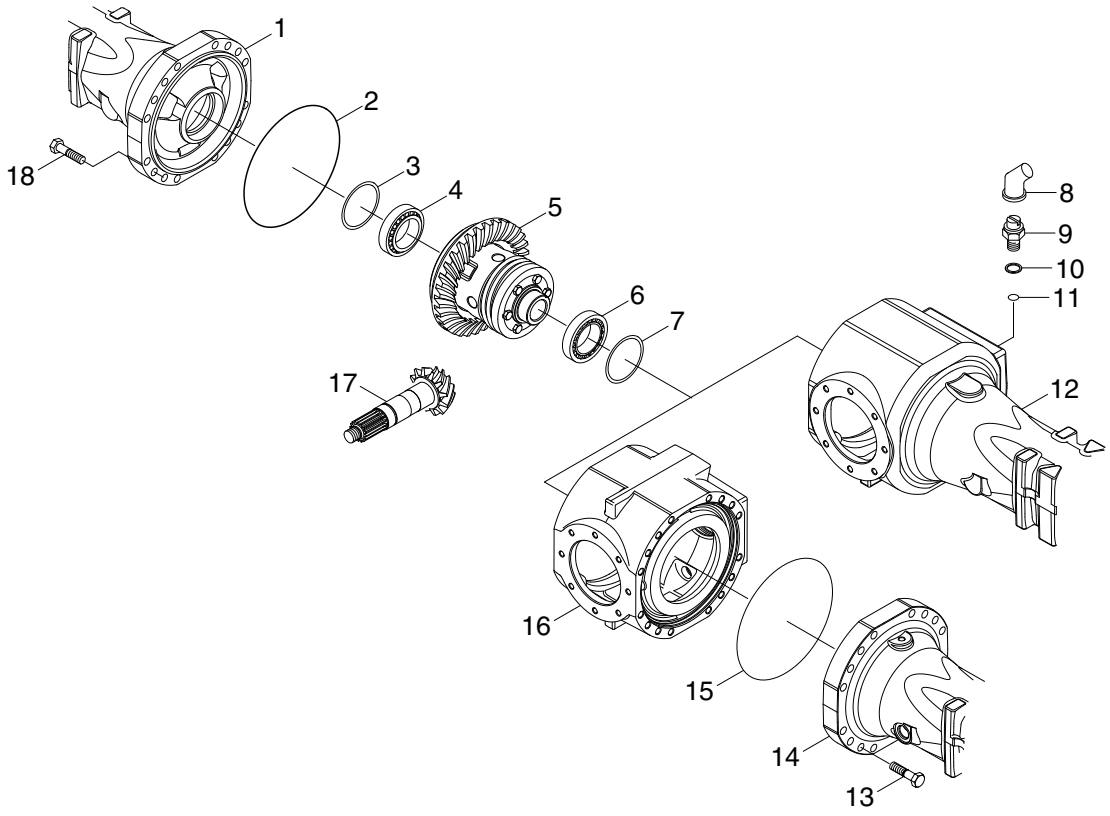
· Torque wrench setting for screw :
2.43~2.67 kgf · m (17.6~19.3 lbf · ft)



⑯ Check that the positioning of the sealing ring on the arm is intact; install the complete arm. Lock it into position using two facing screws and washers.

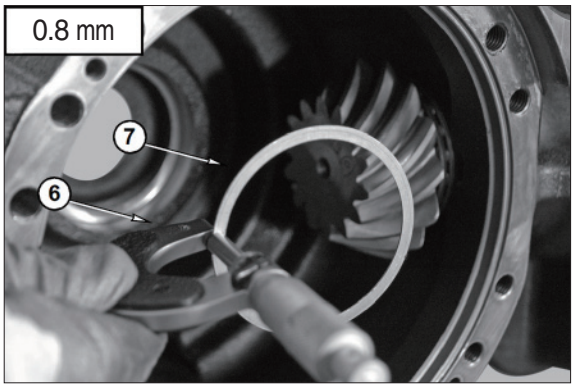


6) RING AND PINION ADJUSTING



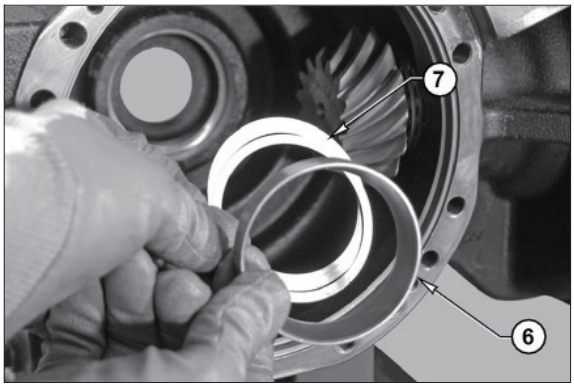
Setting of the crown wheel and pinion

(1) Insert the thrust block of the bearing (6) opposit side of the crown wheel shims (Sb) (7) of an initial thickness of about 0.8 mm.



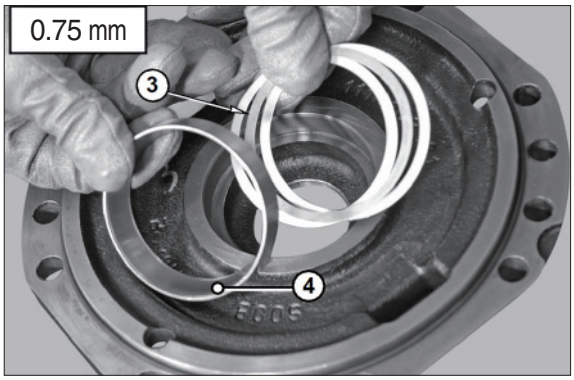
(2) Insert the thrust block (6) and the shims (Sb) (7) into the arm.

※ Check to be at end of stroke.



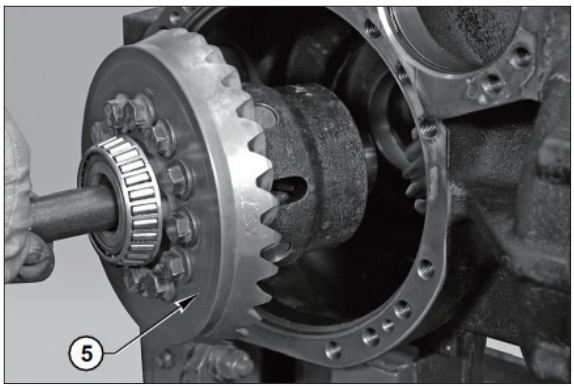
(3) Insert thrust block (4) of the bearing shims (Sc) (3) of an initial thickness of about 0.75 mm.
Insert the thrust block and the shims into the arm.

※ Check to be at end of stroke.

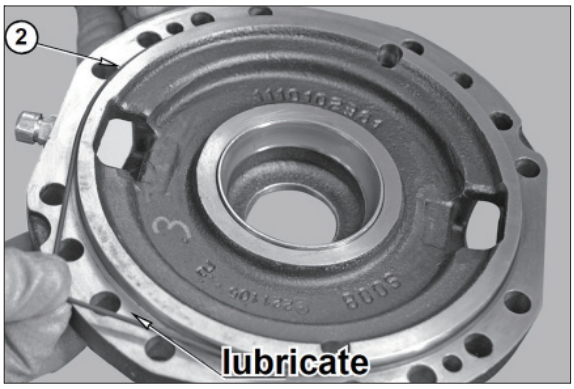


(4) Insert complete differential (5).

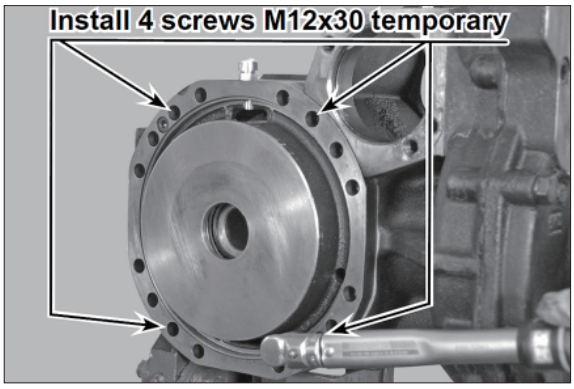
※ Do not damage the seat of the O-ring with the gearwheel.



(5) Check the O-ring (2) and grease.

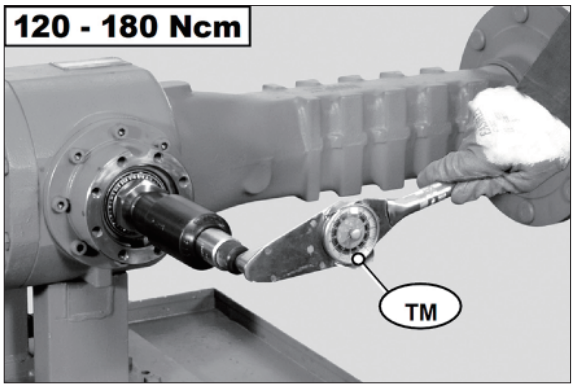


(6) Lock the middle cover (5) with screws (4).
· Torque wrench setting for screw :
2.43~2.67 kgf · m (17.6~19.3 lbf · ft)



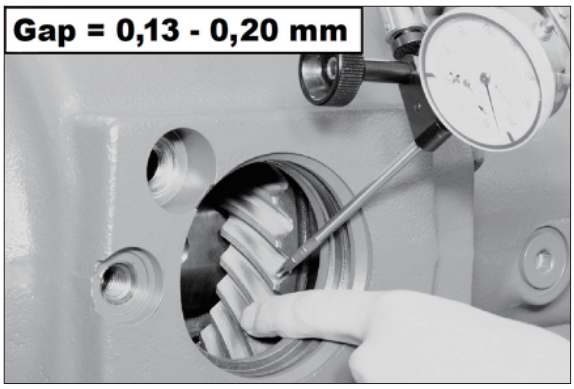
(7) Apply torque meter TM to pinion nut and check that torque will increase by 0.04~0.06 kgf · m (0.29~0.43 lbf · ft) as a result of differential bearing preload.

Example : pinion torque :
0.08~0.12 kgf · m (0.59~0.87 lbf · ft)
Pinion + differential torque :
0.12~0.18 kgf · m (0.87~1.3 lbf · ft)

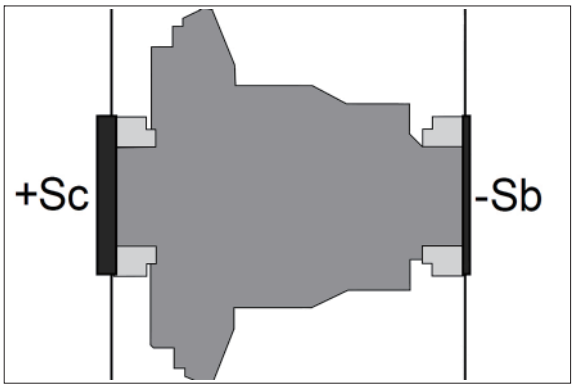


(8) Position comparator on the center of one of the crown teeth, preset it to 1 mm and reset it to zero.
Manually move the crown in both directions to check the existing clearance between pinion and crown.

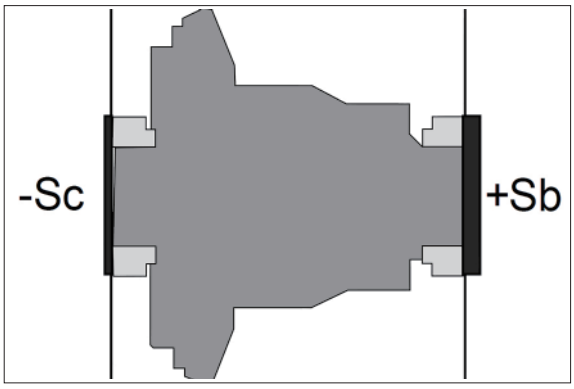
Gap = 0.13~0.20 mm



(9) + Sc (3) - Sb (7) = reduction gap ring and pinion

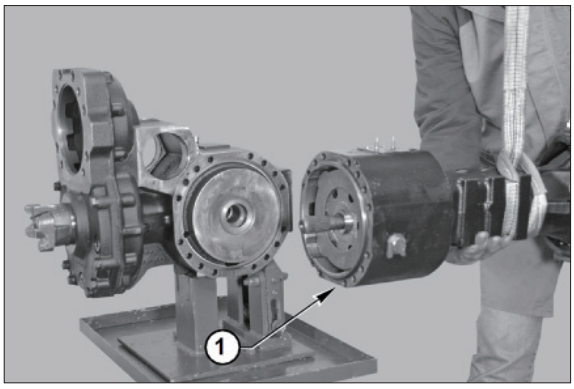


(10) - Sc (3) + Sb (7) = increase gap ring and pinion

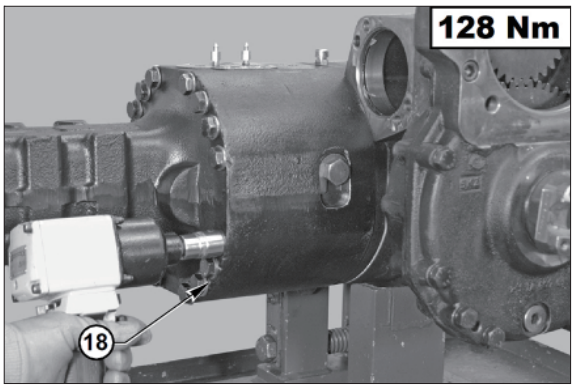


(11) Install the crown wheel side arm (1) without half-axle.

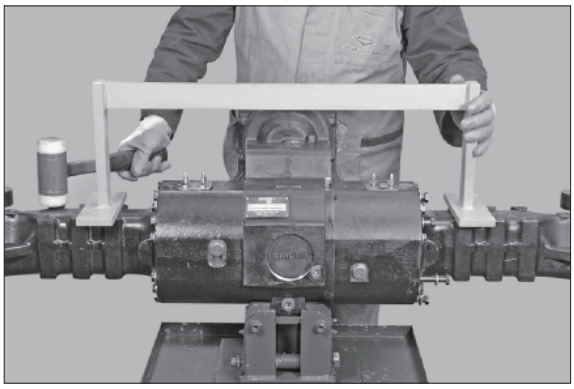
※ To check the torque of the differential, neither of both half-axles must be installed.



(12) Temporarily insert all screws of the arm (18).



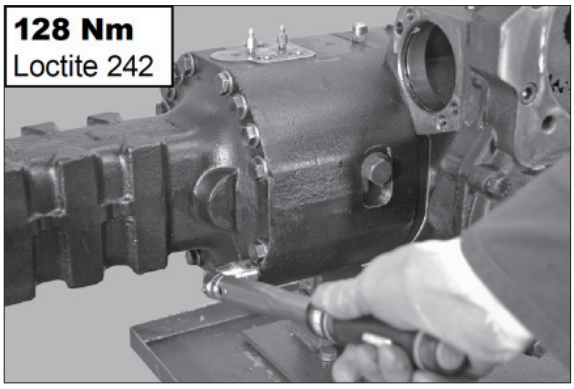
(13) Check the flatness of the arms; then lock the arms into their final position,using screws adequately coated with loctite 242.



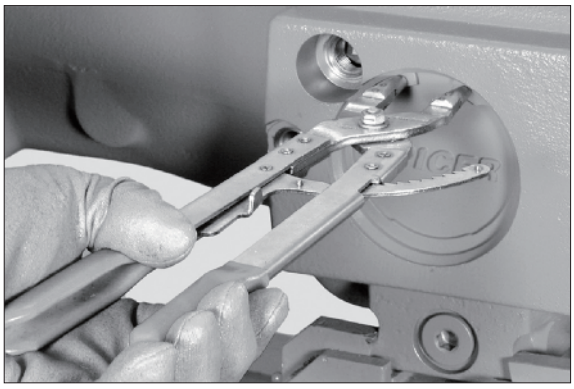
(14) Torque wrench setting :

13.1 kgf · m (94.4 lbf · ft)

※ Tighten using the criss-cross method.

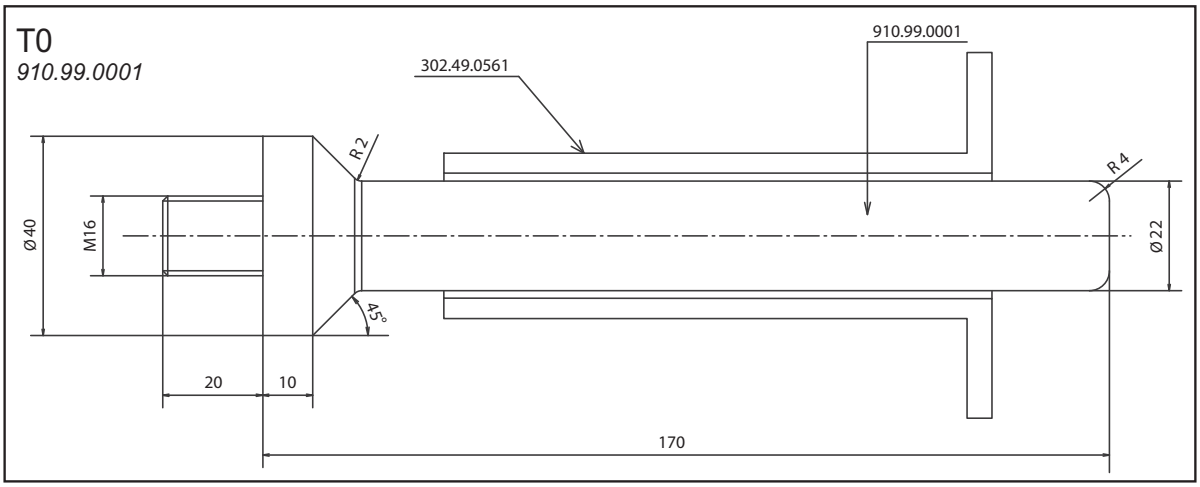


(15) Using a driver, fit the cap and position it in its seat with the snap ring.



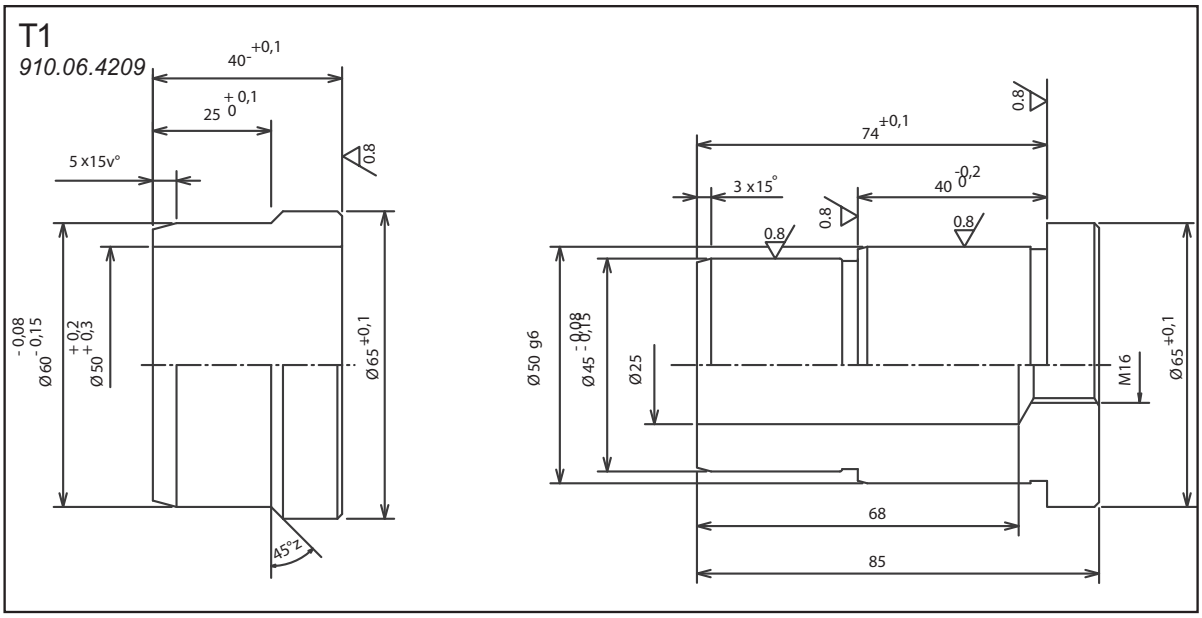
7) SPECIAL TOOLS

T0
910.99.0001

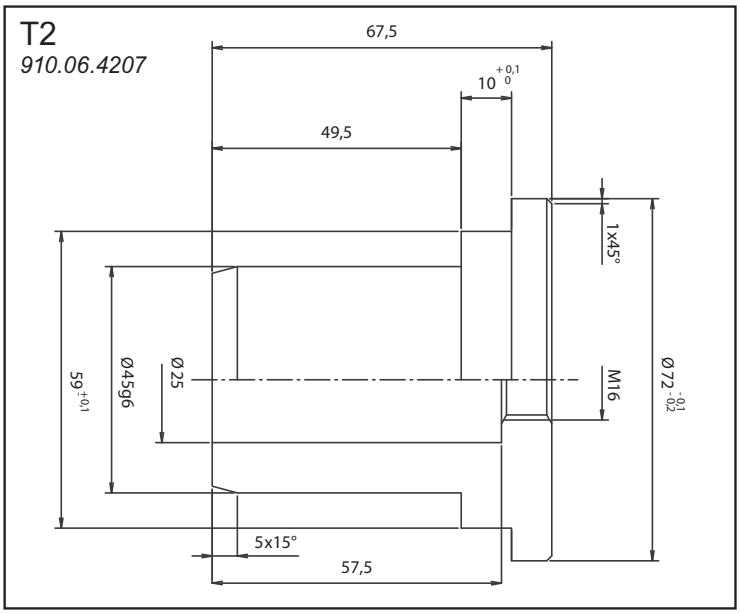


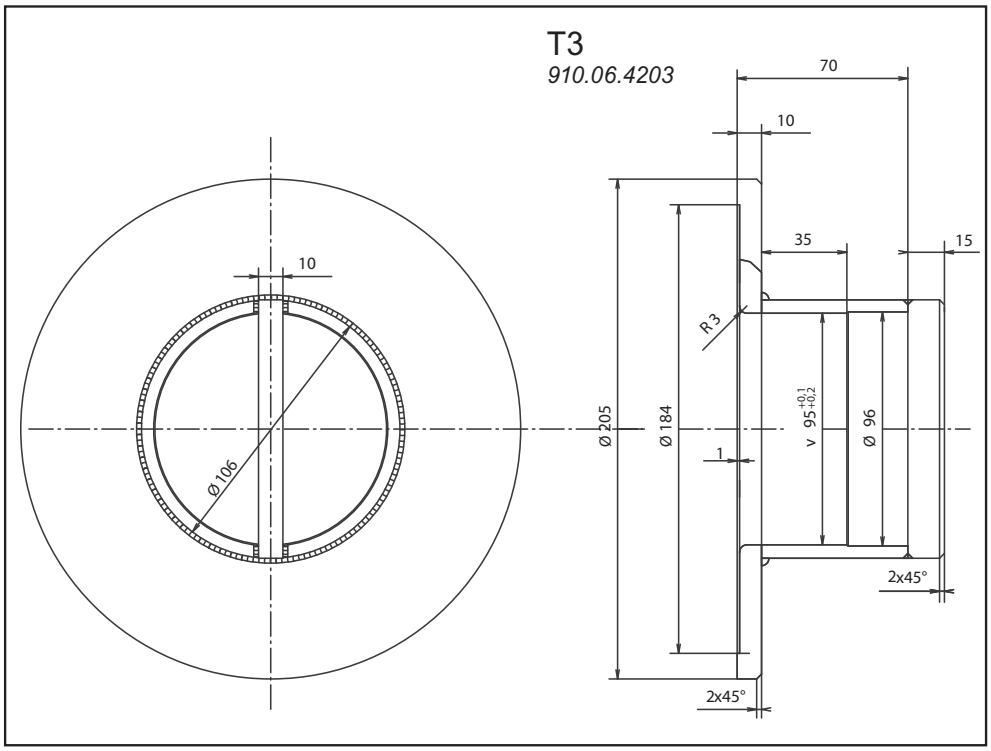
55W9NAX311-1

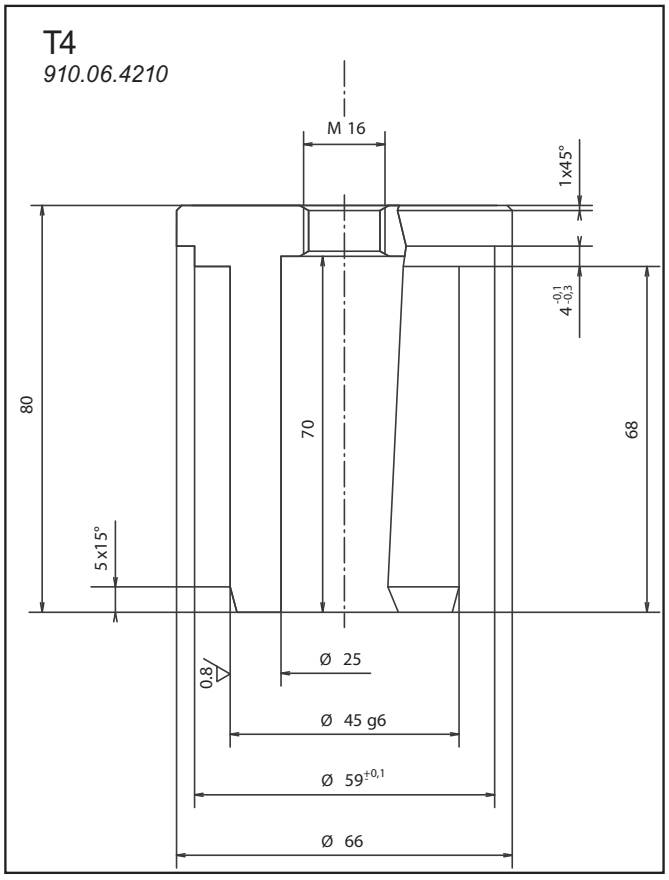
T1
910.06.4209

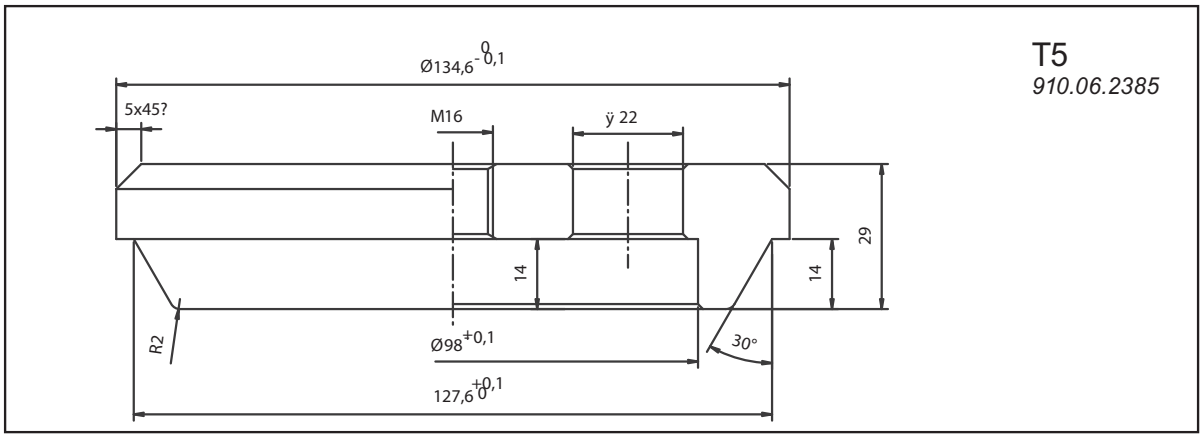


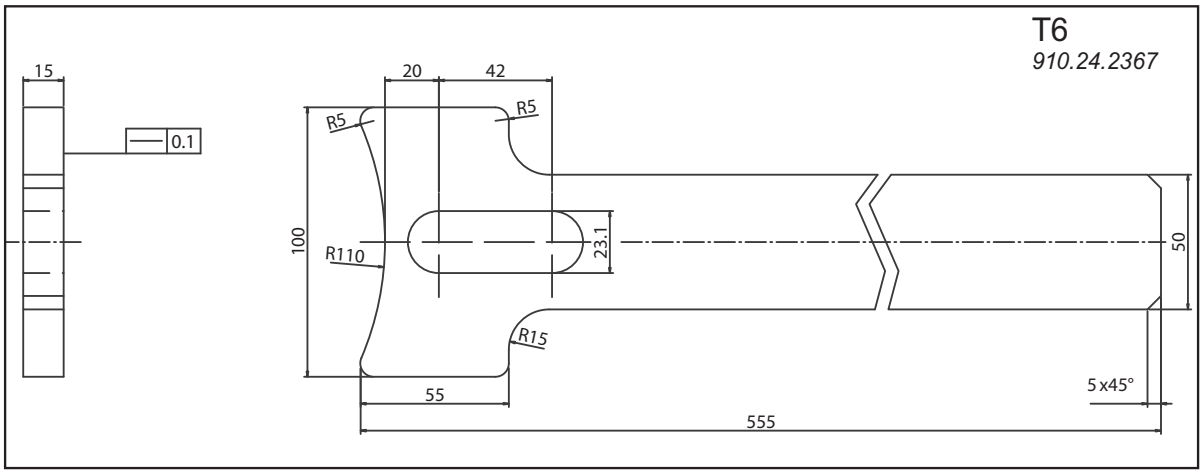
T2
910.06.4207

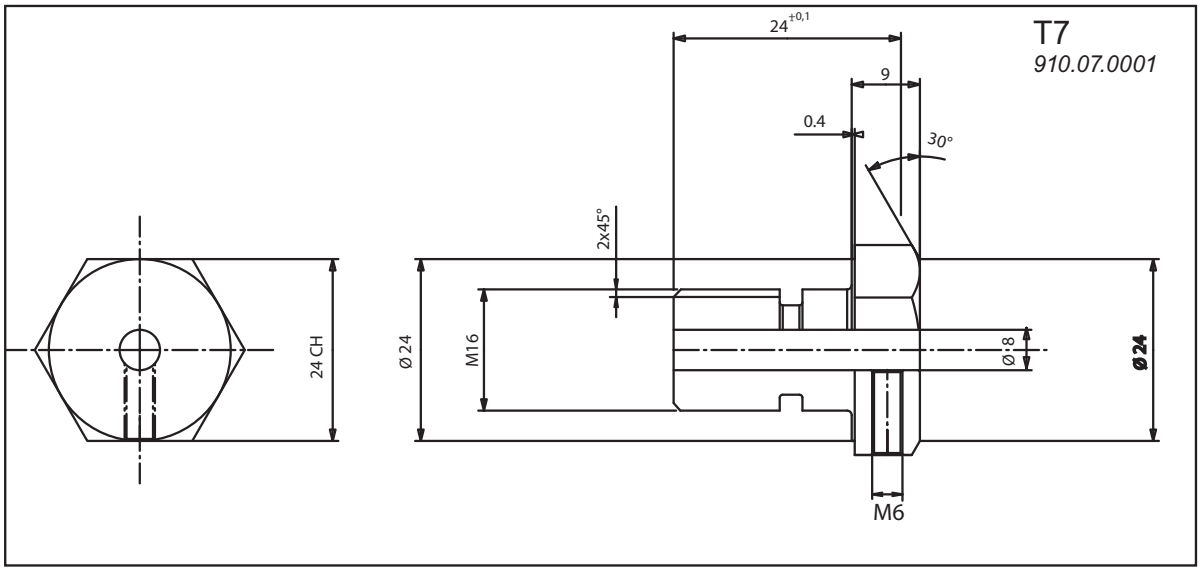


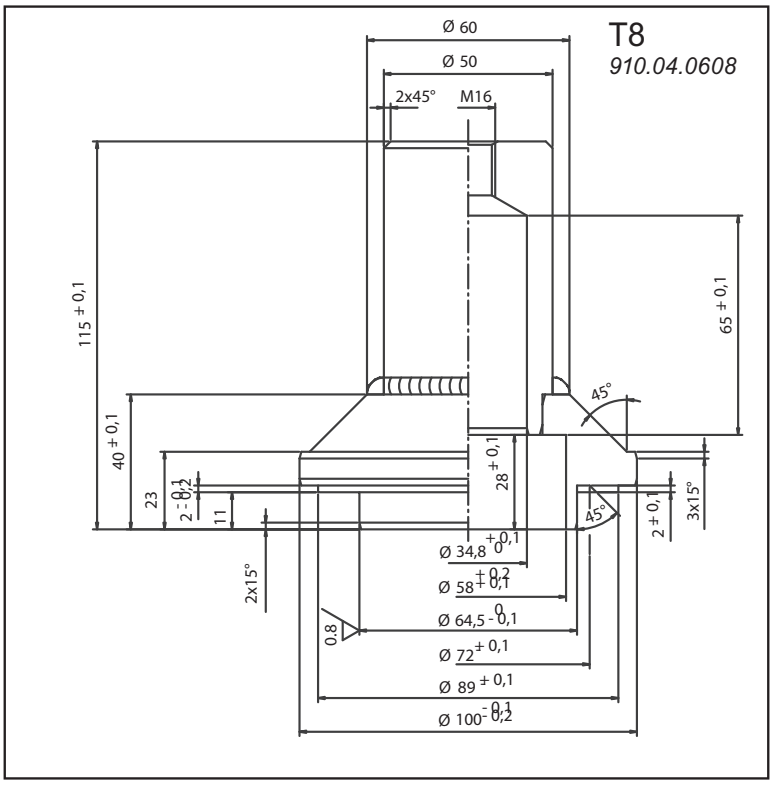

T3
910.06.4203
70
10
35
15
10
R3
Ø 205
Ø 184
v 95 +0,1 +0,2
Ø 96
1
Ø106
2x45°
2x45°

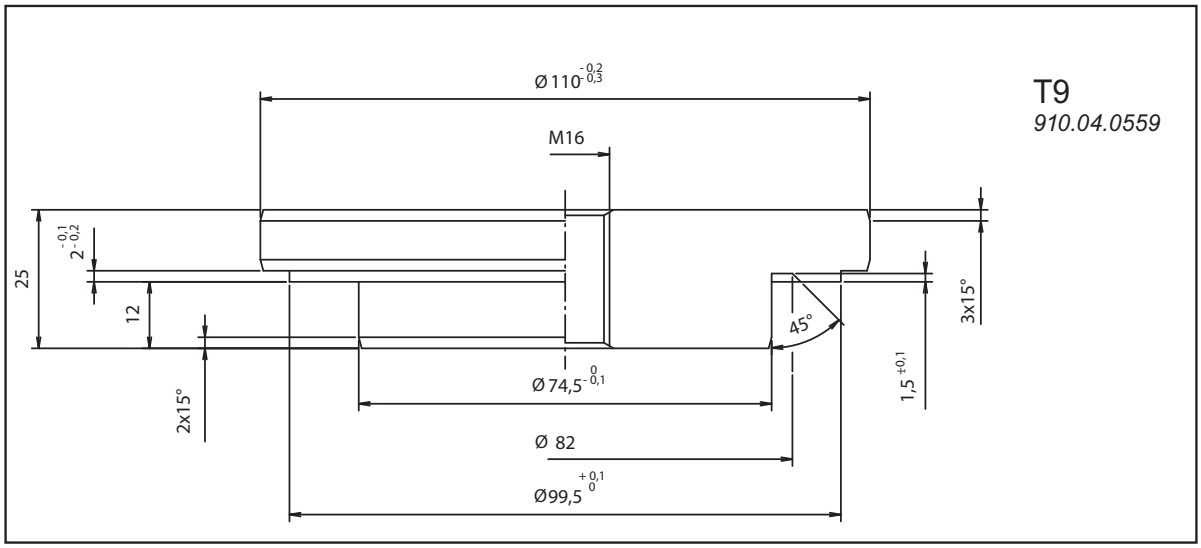

T4
910.06.4210
M 16
1x45°
4 -0,1 -0,3
80
70
68
5x15°
0.8
Ø 25
Ø 45 g6
Ø 59 ±0,1
Ø 66


T5
910.06.2385
Ø134,6 0 -0,1
5x45?
M16
ÿ 22
29
14
14
R2
Ø98 +0,1
30°
127,6 +0,1 0


T6
910.24.2367
15
0.1
20
42
R5
R5
100
R110
23.1
50
R15
55
5 x45°
555

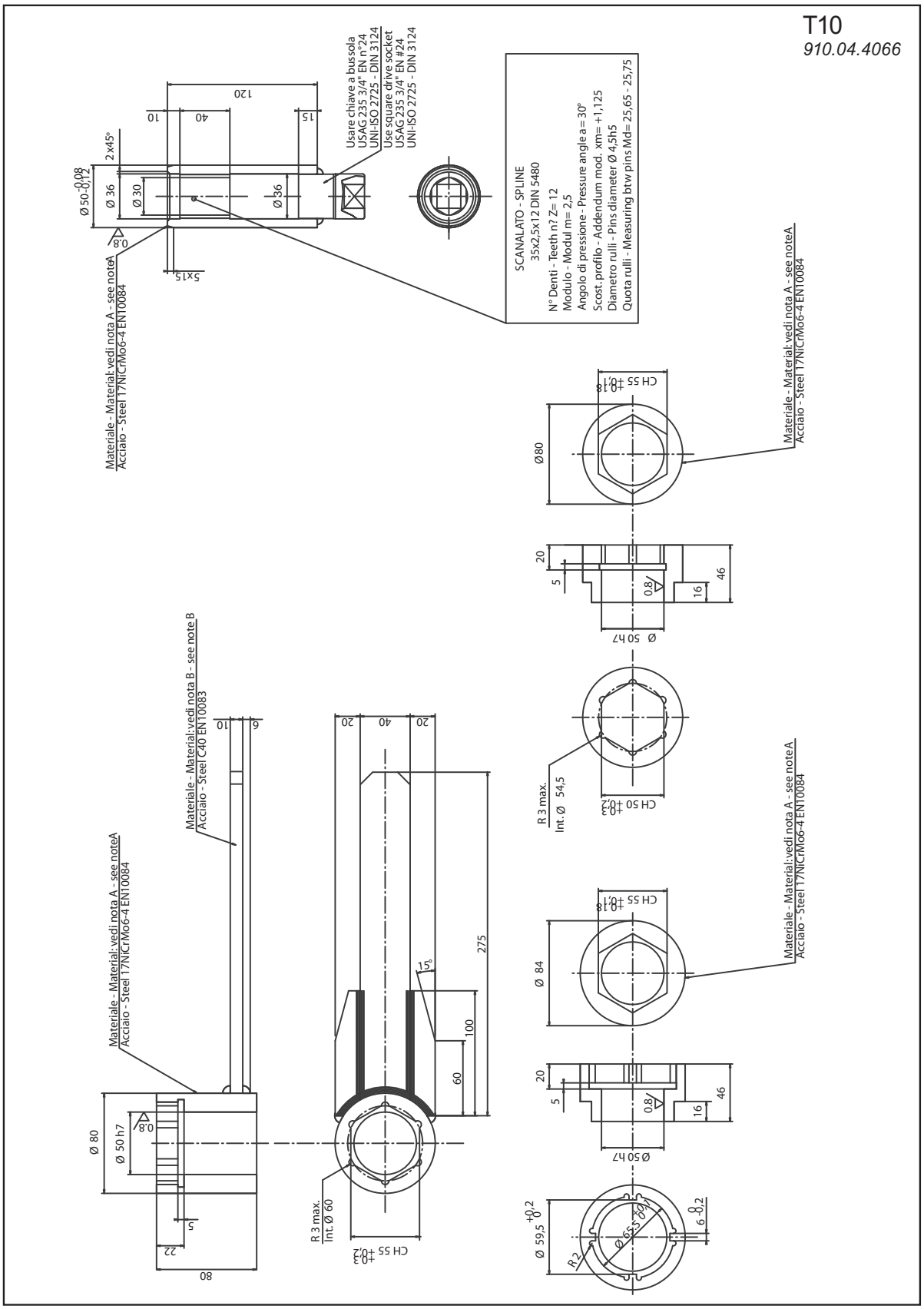

T7
910.07.0001
24 +0,1
9
0.4
30°
2x45°
24 CH
Ø 24
M16
Ø 18
Ø 24
M6


T8
910.04.0608
Ø 60
Ø 50
2x45°
M16
115 ± 0,1
65 ± 0,1
40 ± 0,1
23
2 -0,1 -0,2
11
28 ± 0,1
45°
45°
3x15°
2 ± 0,1
2x15°
Ø 34,8 +0,1 0
Ø 58 ± 0,2
Ø 64,5 ± 0,1
0.8
Ø 72 ± 0,1
Ø 89 ± 0,1
Ø 100 -0,1 -0,2


T9
910.04.0559
Ø 110 -0,2 -0,3
M16
25
2 -0,1 -0,2
12
2x15°
45°
3x15°
1,5 ±0,1
Ø 74,5 0 -0,1
Ø 82
Ø99,5 +0,1 0

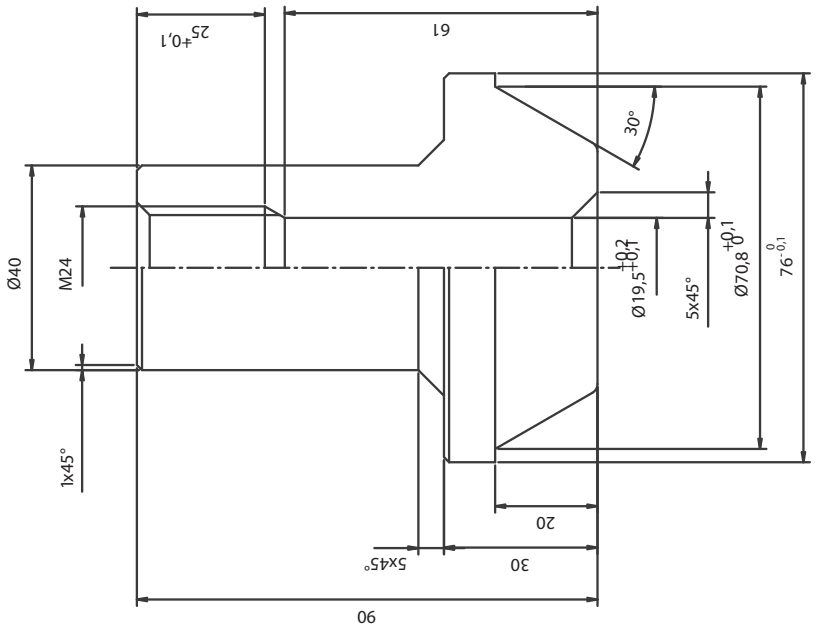
T10

910.04.4066



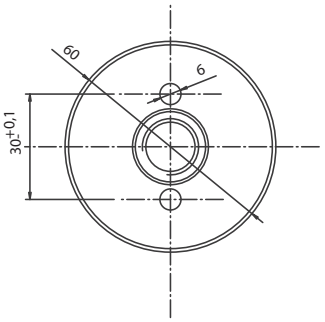
T11

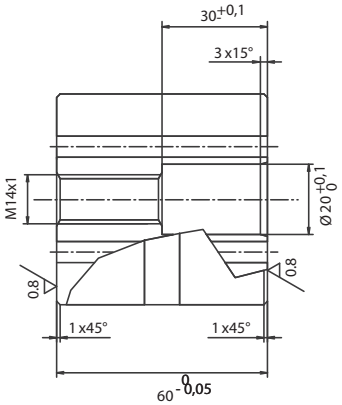
910.06.4069

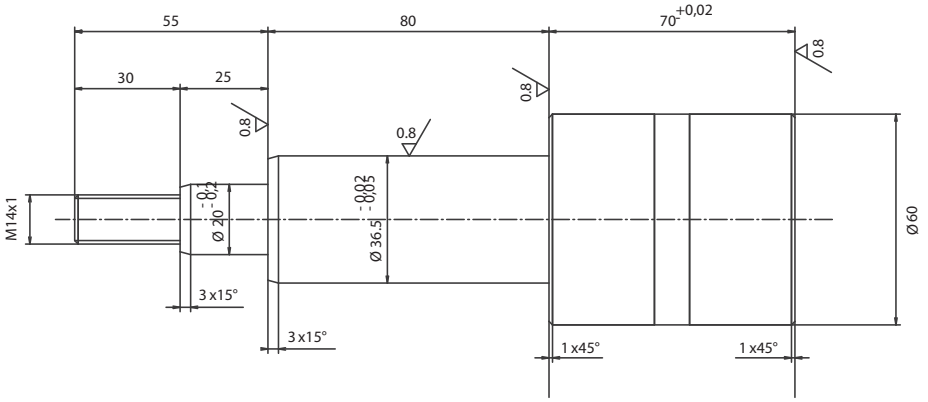


T12

910.04.2389



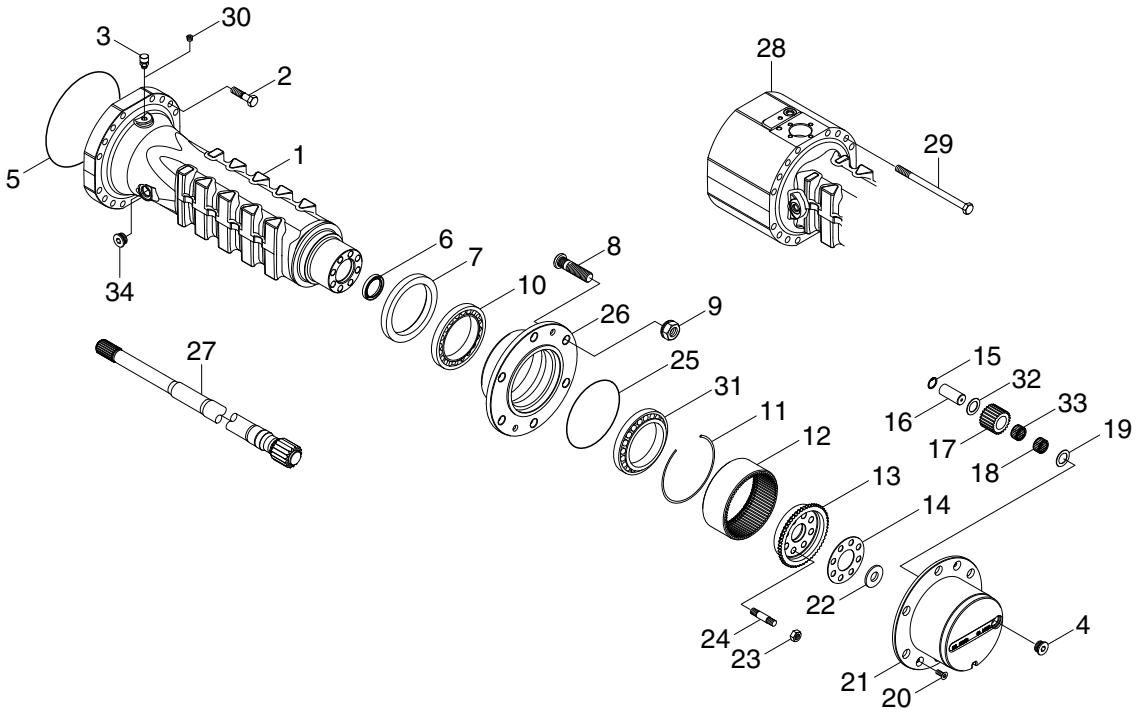




4. REAR AXLE

1) PLANETARY REDUCTION GEAR

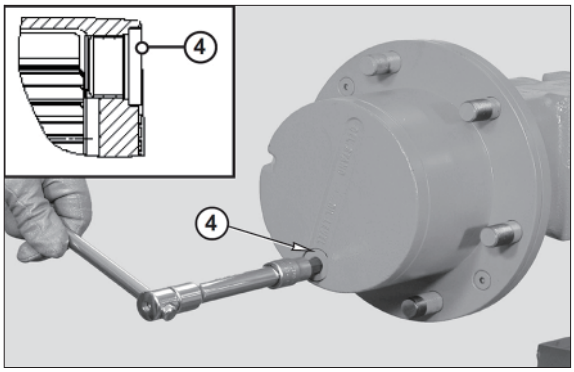
(1) Assembly diagram



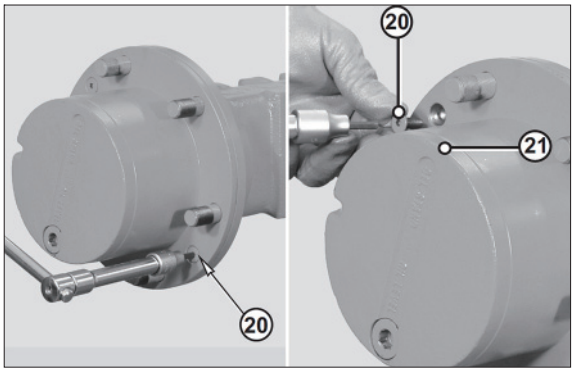
(2) Disassembly

※ Perform all operations on both arms.

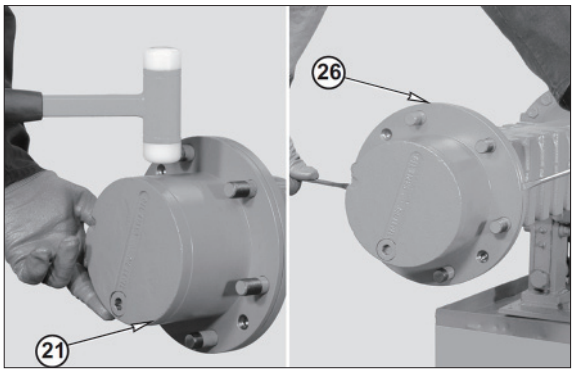
① Remove the oil level plug (4).



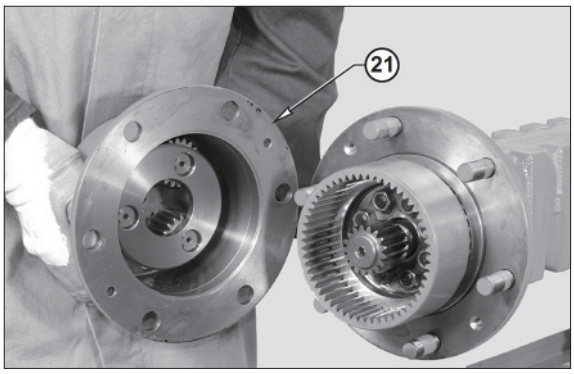
② Remove the securing screws (20) from the spider cover (21).



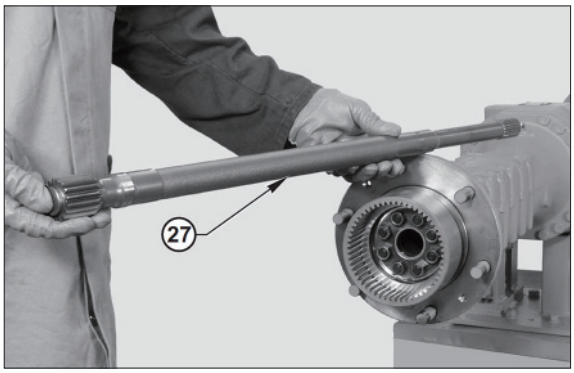
③ Disjoin the spider cover (21) from the hub (26) by alternatively forcing a screwdriver into the appropriate slots.



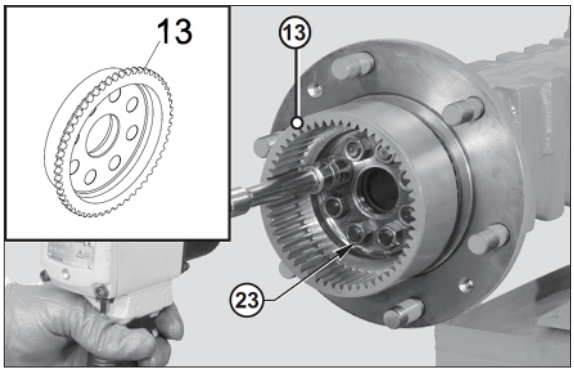
④ Remove the complete planetary carrier cover (21).



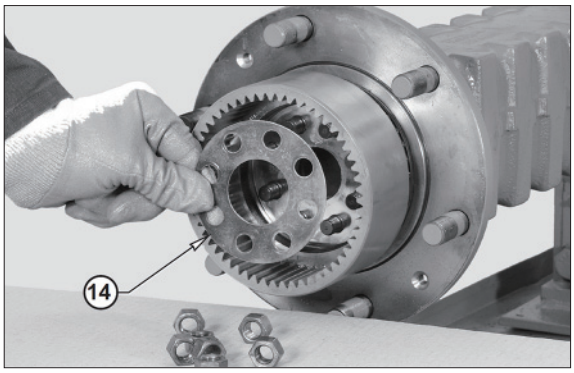
⑤ Remove the complete axle-shaft (27).



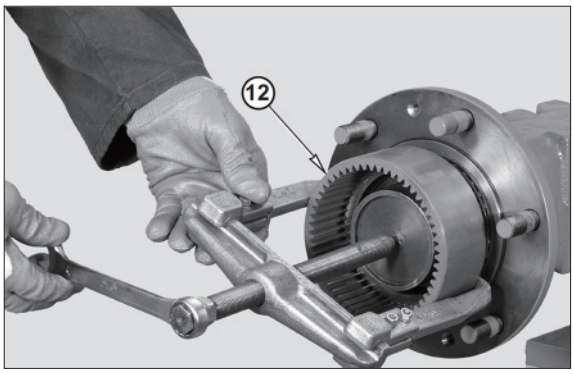
⑥ Unloose and remove the tightening nuts (23) from the crown flange (13).



⑦ Remove the safety flange (14).

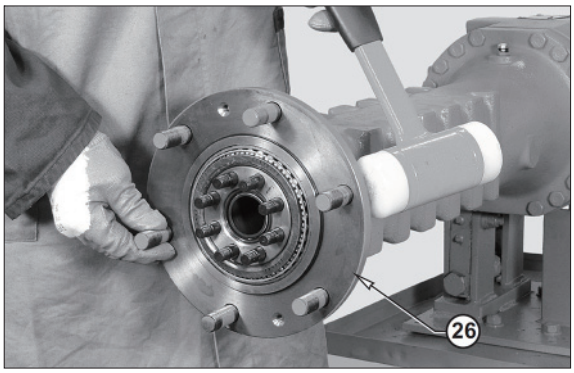


⑧ Remove the crown (12).

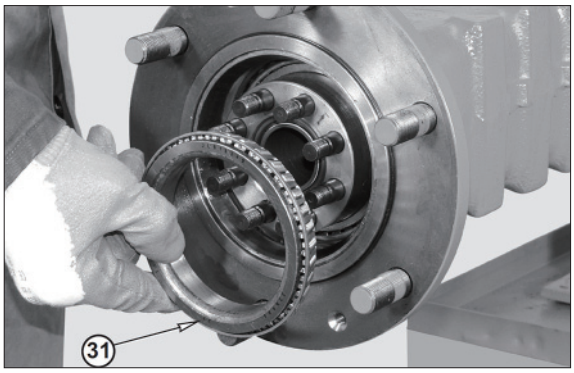


⑨ Partially extract the hub (26) using a plastic hammer.

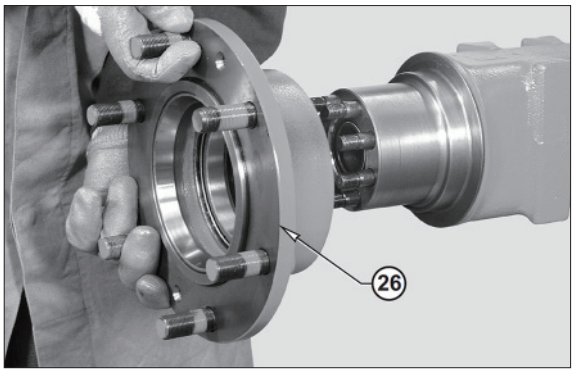
※ Alternately hammer on several equidistant points.



⑩ Remove the external bearing (31).

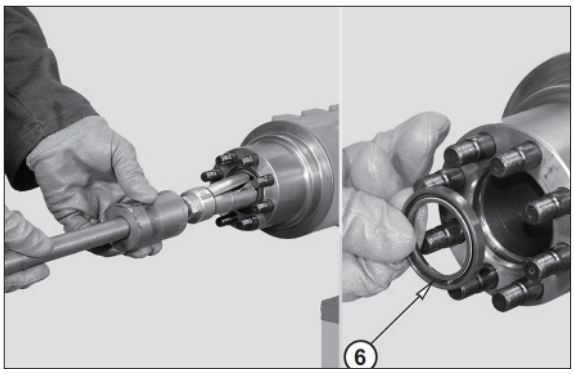


⑪ By hand remove complete hub (26).

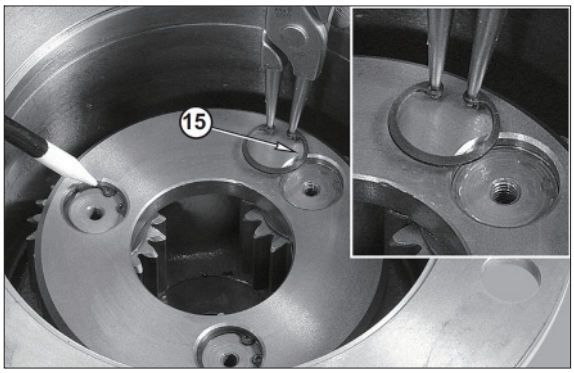


⑫ Using an extractor, remove the seal ring (6).

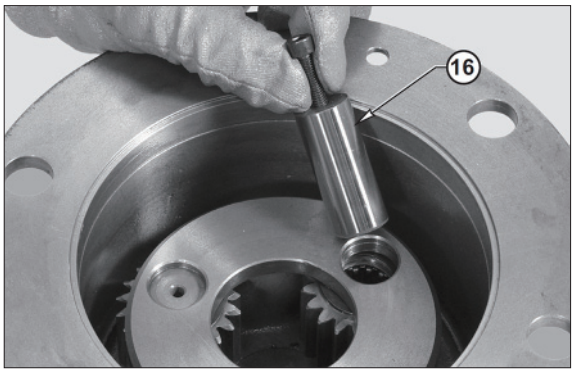
※ Note down the direction of assembly of snap ring.



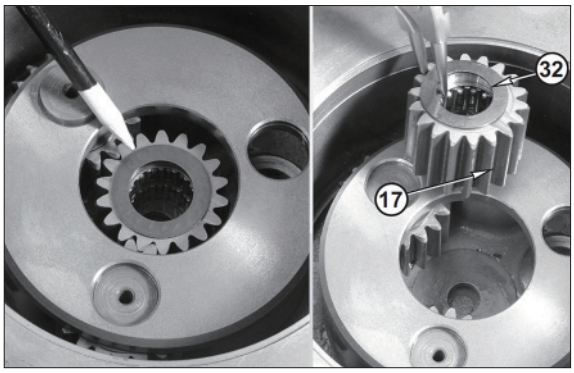
⑬ Remove snap ring (15).



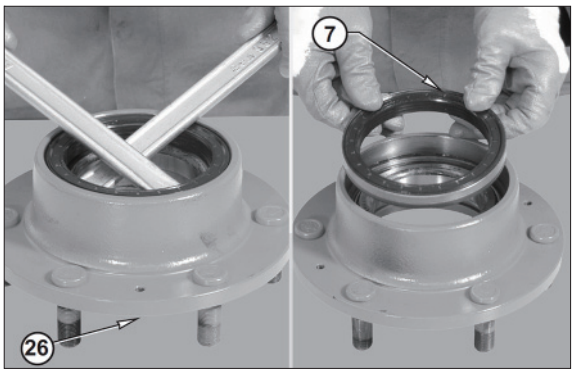
⑭ Using a screw M6 remove all bolts (16).



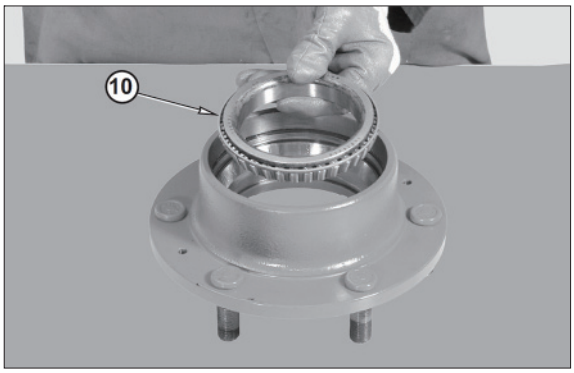
⑮ Positioning the planet wheel gear (17) in center of the spider cover and remove.



⑯ Remove the sealing ring (7) from the hub (26).

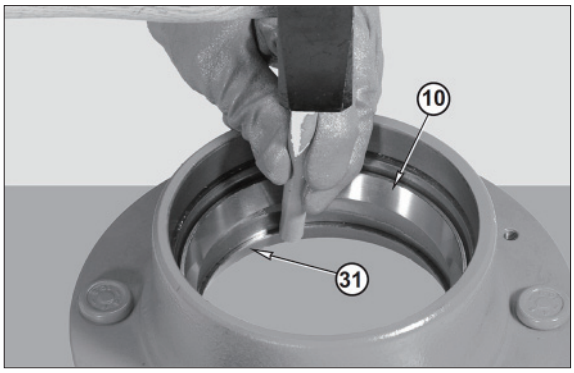


⑰ Remove the internal bearing (10).

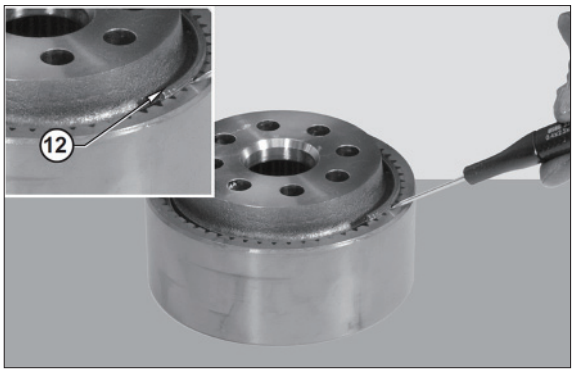


⑱ Remove the thrust blocks (10) (31) from the bearings and forcing a pin-driver into the appropriate slots on the hub.

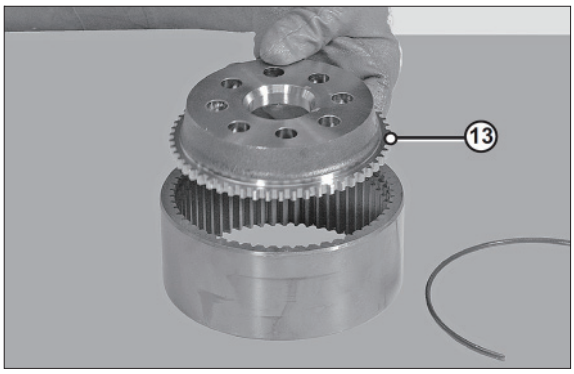
※ Hammer in an alternate way so as to avoid crawling or deformation of the thrust blocks.



⑲ Remove the snap ring (12) from the crown (13).

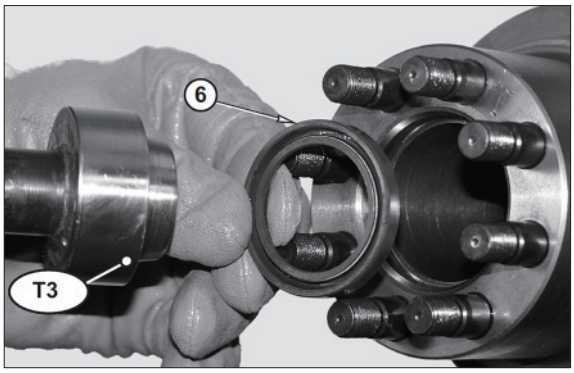


⑳ Remove the crown flange (13).

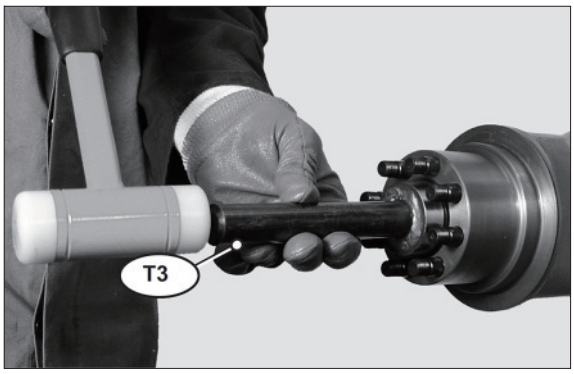


(3) ASSEMBLY

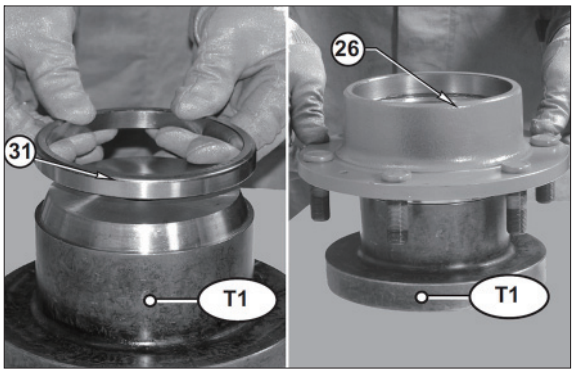
① Lubricate and fit the sealing ring (6) onto tool T3; install the rings into the arm.



※ Pay particular attention to the direction of assembly of the rings.

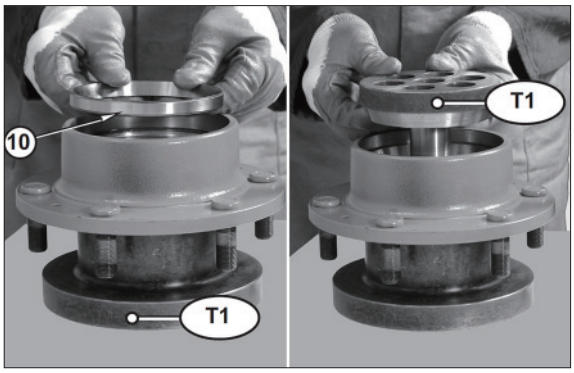


② Position the lower part of tool T1 and the thrust block of the external bearing (31).

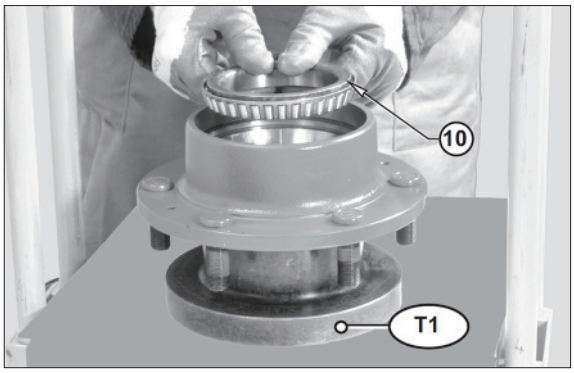


③ Lubricate the seats of the bearings and position the hub on tool T1; position the thrust block of the internal bearing (10).

Check that the thrust block is correctly oriented.

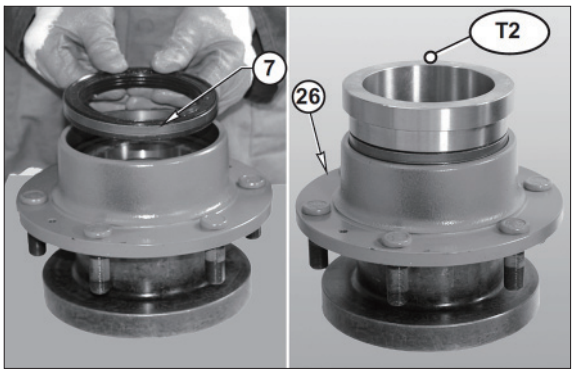


④ Fit the bearing (10) into the internal thrust block.

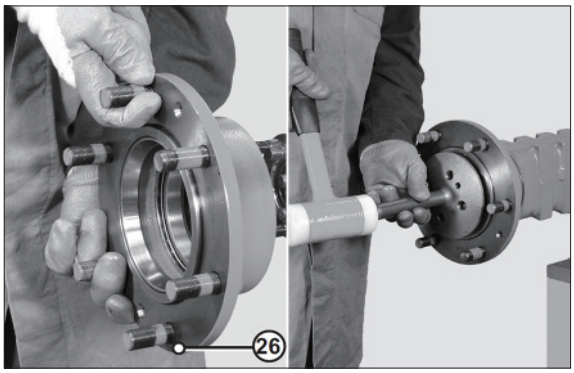


⑤ Using special tool T2 apply a repositionable jointing compound for seals to the outer surface of the sealing ring (7).
Position the sealing ring (7) in the hub (26).

※ Check that the ring (7) is correctly oriented.

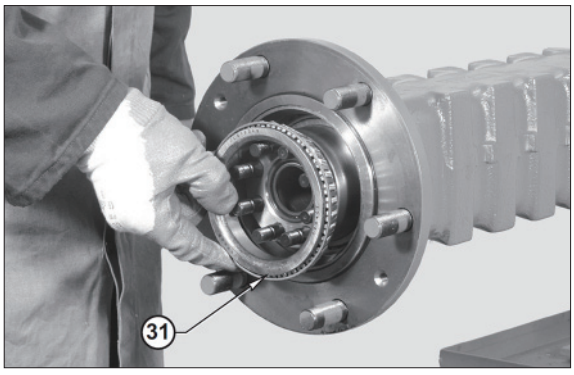


⑥ Install the wheel hub (26).



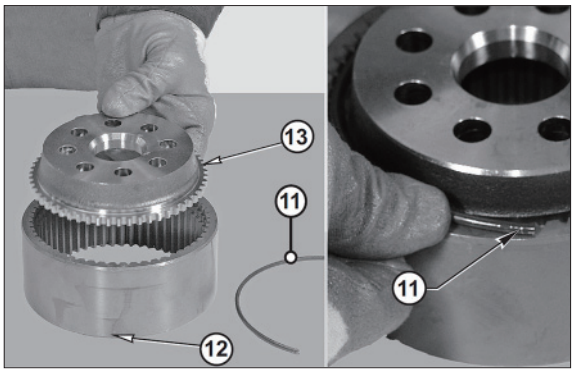
⑦ Install the external bearing (31).

※ Move the bearing to the limit stop by hammering lightly all around the edge.



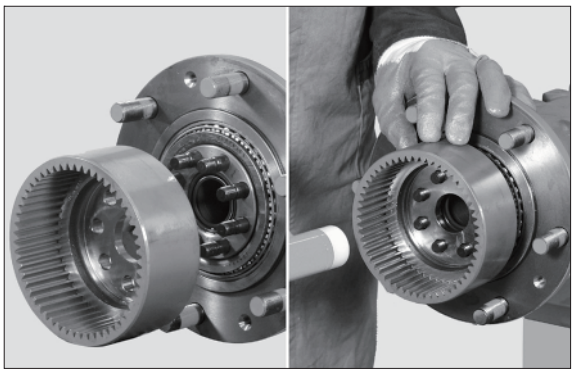
⑧ Install the crown wheel (12).
Insert the snap ring (11) in order to fix the flange (13) in the crown (12).

※ Carefully check that ring (11) is properly inserted in the slot of the crown (12).

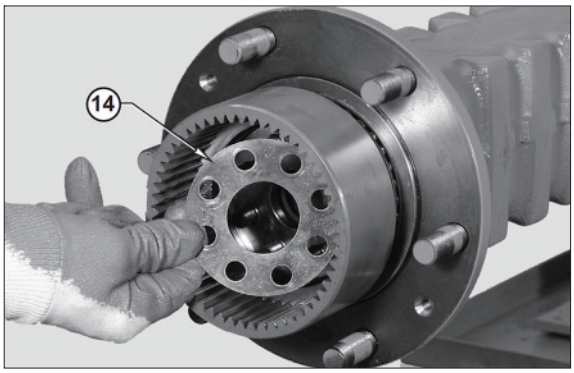


⑨ Fit the complete crown flange.

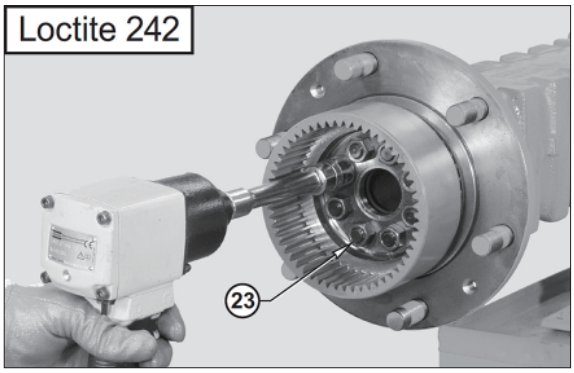
※ In order to fasten the flange, use a plastic hammer and alternately hammer on several equidistant points.



⑩ Install the security flange (14).

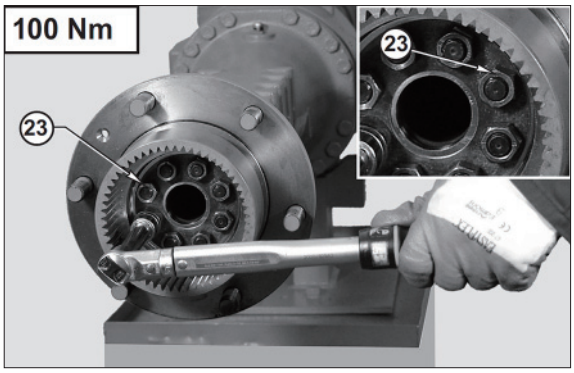


⑪ Coat the nuts (23) with loctite 242 and screw them.



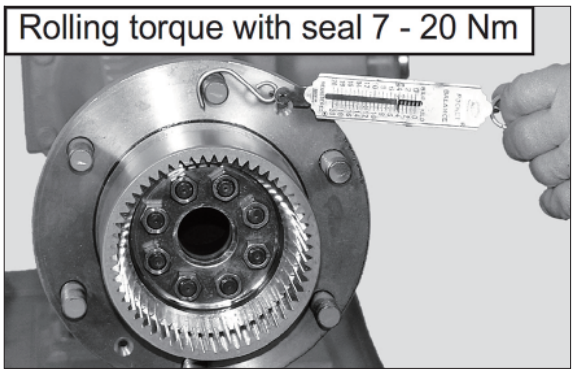
⑫ Tighten nuts (23) in two stages, using the criss-cross method.

- Initial torque wrench setting :
  9.18 kgf · m (66.4 lbf · ft)
- Final torque wrench setting :
  10.2 kgf · m (73.8 lbf · ft)

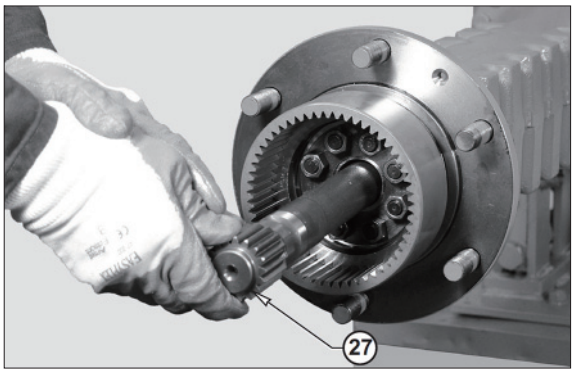


⑬ Check the continuous rolling torque on the hub.

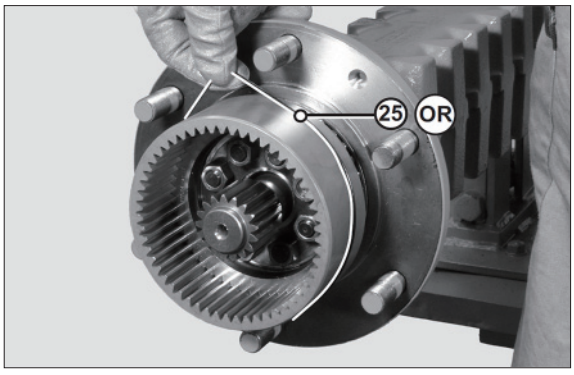
- Torque : 0.71~2.04 kgf · m
  (5.14~14.8 lbf · ft)



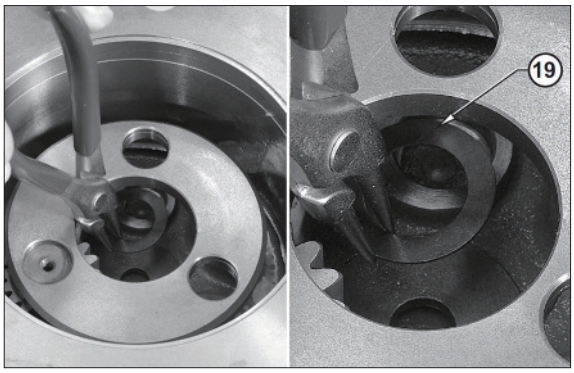
⑭ Install the axle shaft (27), making sure that it is properly inserted into braking disks and differential unit.



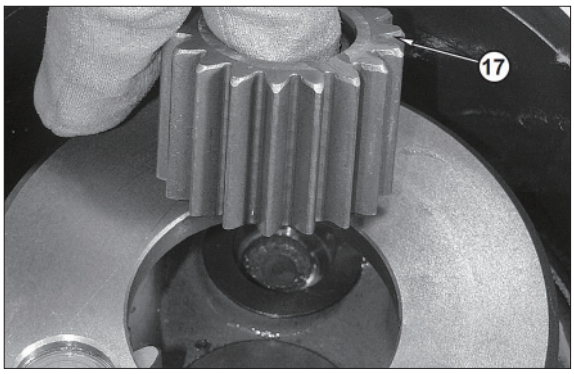
※ Check the condition and position of the O-ring (25).



⑮ Install the spherical washer (19).

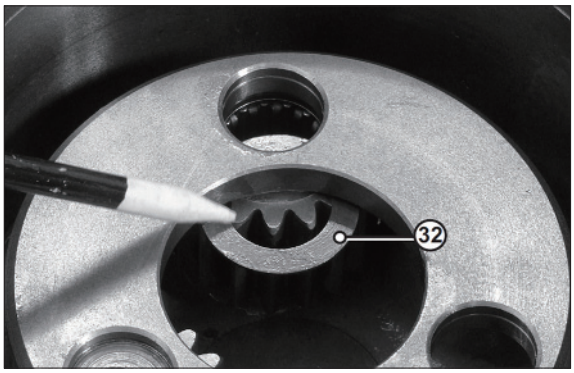


⑯ Install planetary gears complete with roller bearing (17).

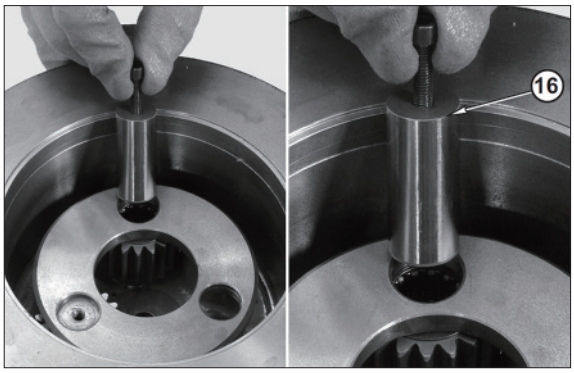


⑰ Install the others friction washers.

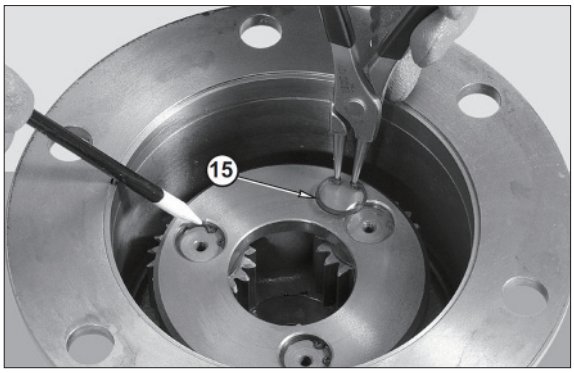
Two friction washers for every planetary gear.



⑱ Check the concentricity of the planetary gear, the seat and friction washers.
Using a screw M6 install the pin (16).

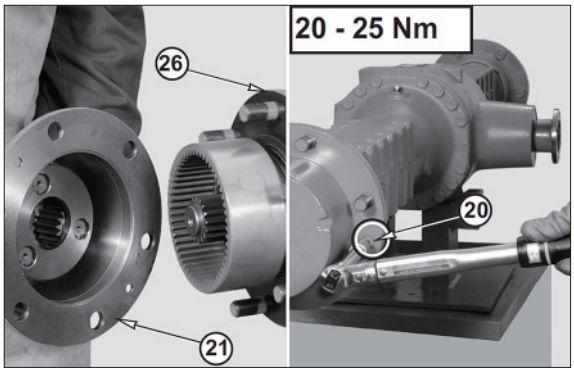


⑲ Carefully check that pin is completely inserted and install the snap rings (15).



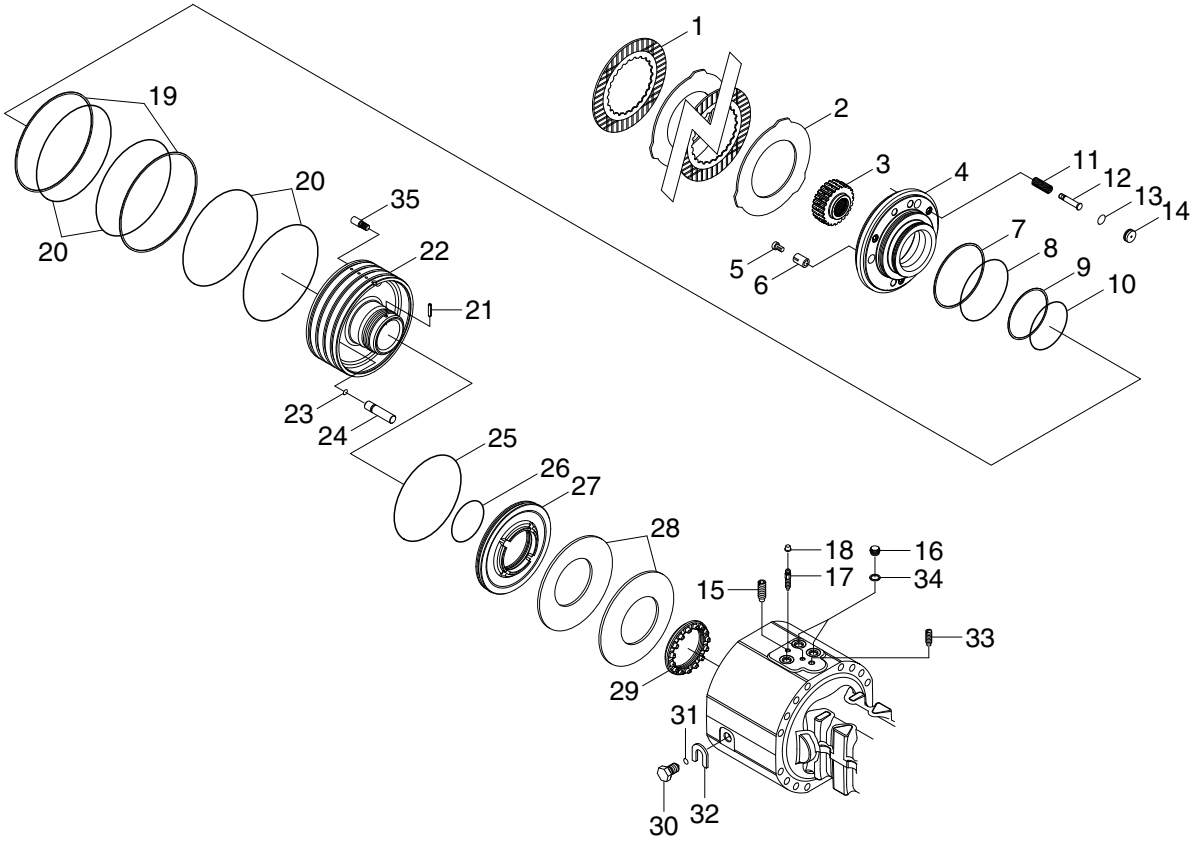
⑳ Fit the planetary gear cover (21) onto the wheel hub (26).

- Torque wrench : 2.04~2.55 kgf · m
  (14.8~18.4 lbf · ft)



2) SERVICE AND NEGATIVE BRAKE

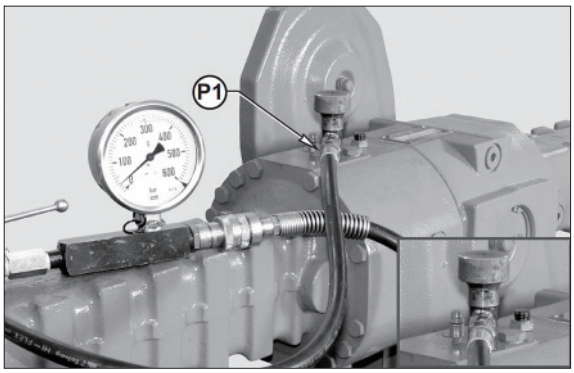
(1) Assembly diagram



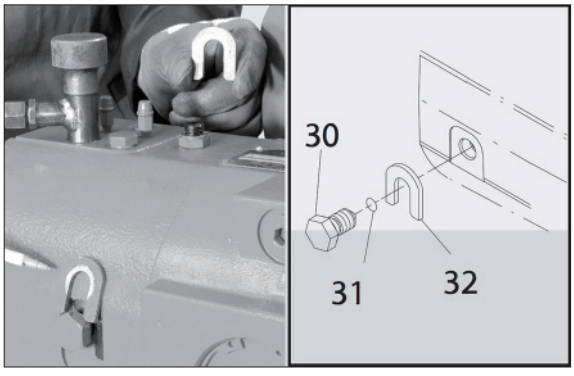
(2) Disassembly

① Connect an external pump to the union piece “P1” of the negative brake and introduce a pressure of 15~30 bar to eliminate the pressure of the belleville washers.

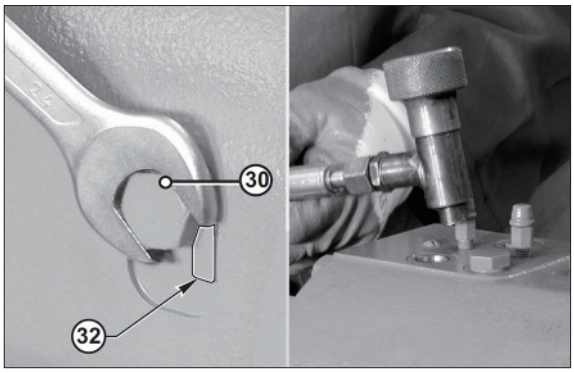
※ Perform all operations on both arms.



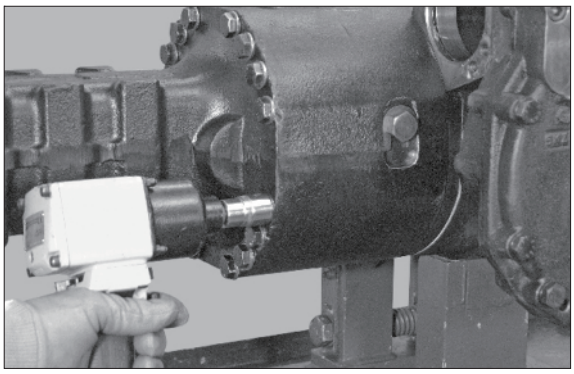
② Loosen the unlocking screws (30) and remove both stop washers (32).



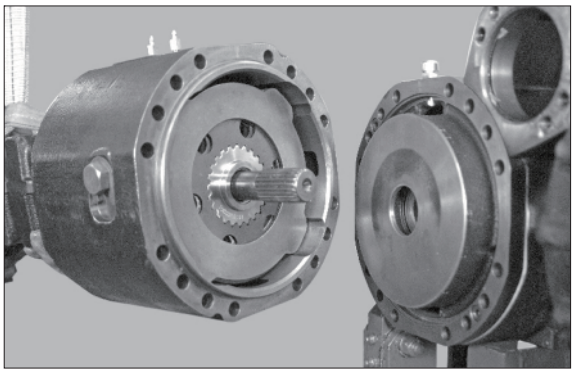
③ Insert block screws to end stroke and release pression.



④ Sling the arm to be removed and connect it to a hoist, remove screws.

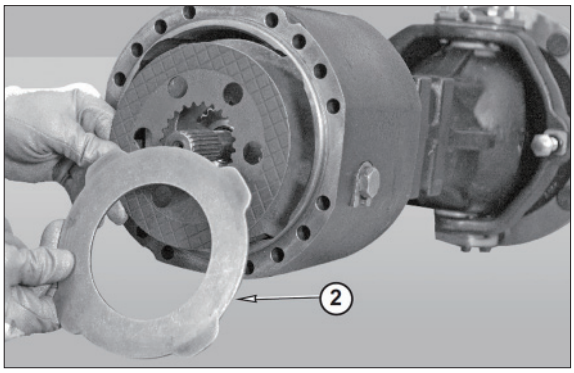


⑤ Take off the arm and lay it down vertically.

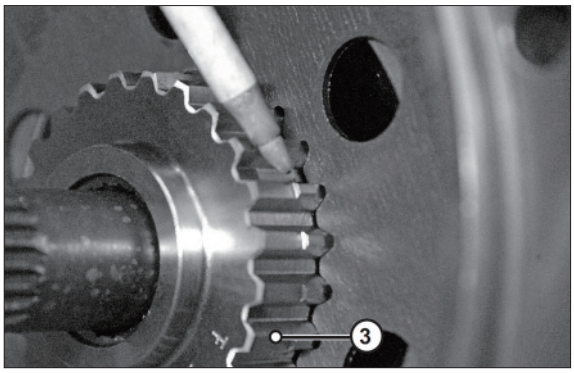


⑥ Remove the brake discs one after the other (2).

※ If they are not to be substituted, do not mix up the sequence.

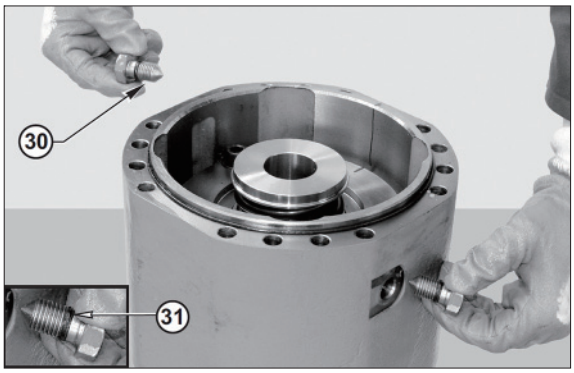


⑦ Remove the flange (3) complete with the discs.



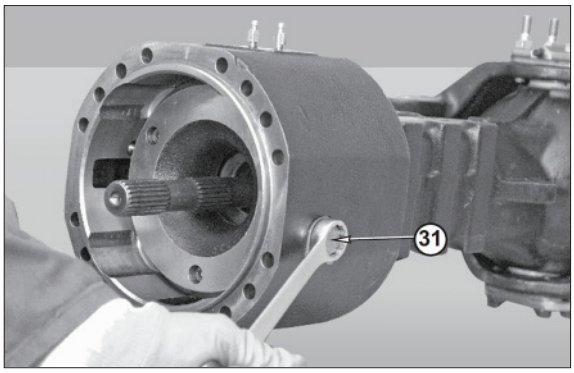
⑧ In order to keep the disc springs of the negative brake preloaded, screw down the screws with washers to the end stop.

⑨ Remove the negative brake locking screws (30).
Always exchange the O-ring (31).

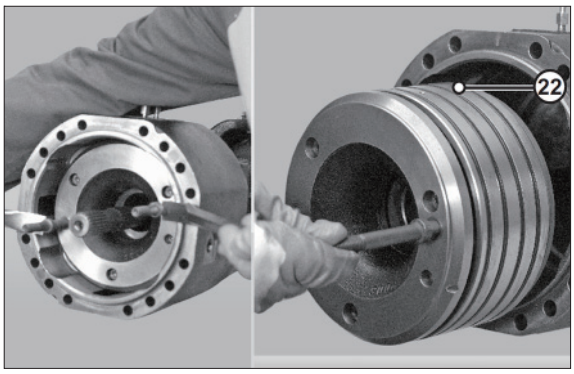


⑩ Loosen the before installed provisional screws in the same sequence and same measure.

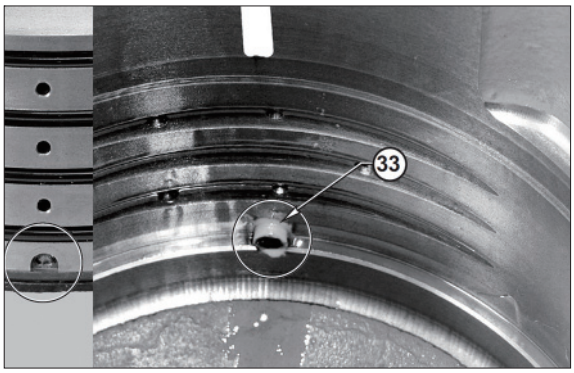
⑪ Remove the negative brake locking screws (30). Always exchange the O-ring (31).



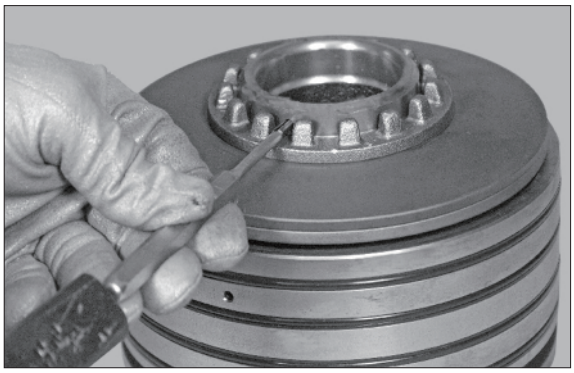
⑫ Pull out brake piston assembly module (22).



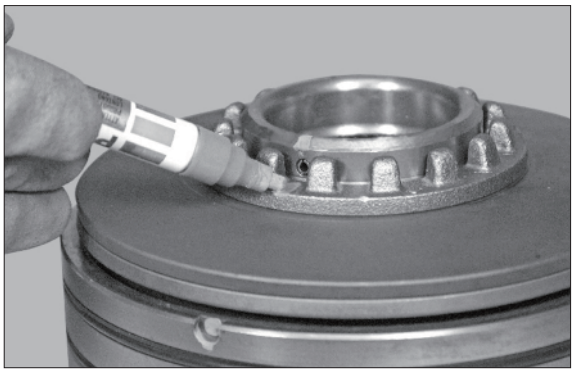
※ Check locking screw (33) of the brake piston module.



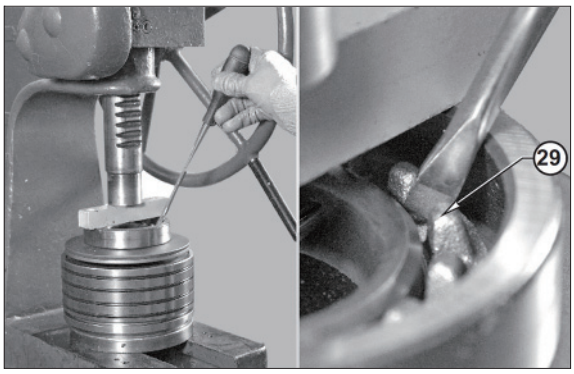
⑬ Turn upside down the brake module and with a pin driver remove the locking pin of the slotted nut.



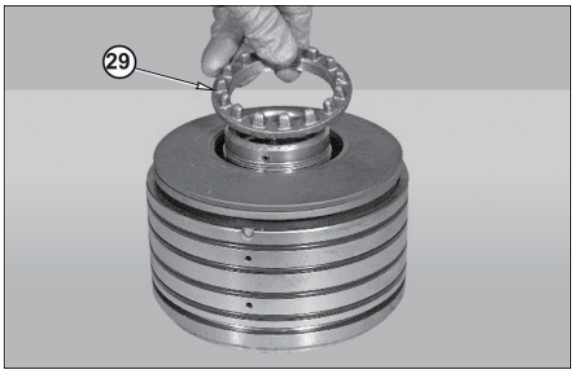
⑭ Sign the position of the slotted nut.



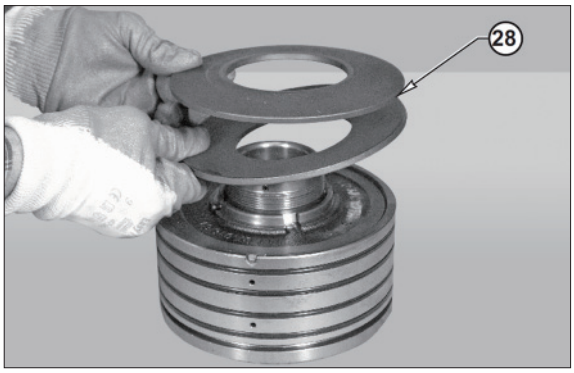
⑮ Bring the piston group below a press, compress the cup springs and loosen the metal ring.



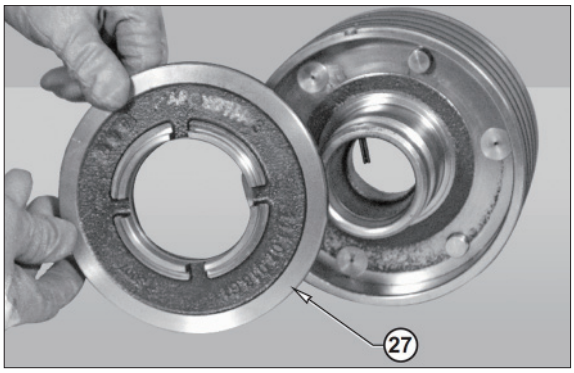
⑯ Remove nut (29).



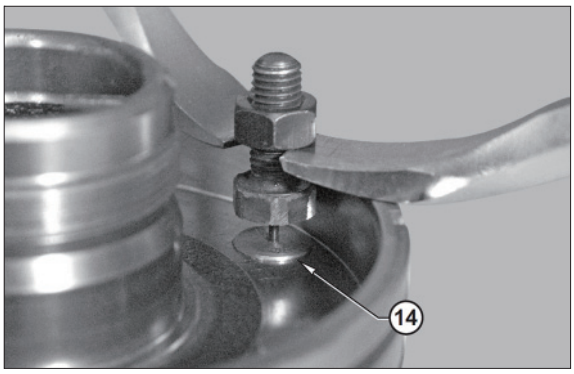
⑰ Remove the disc springs (28).



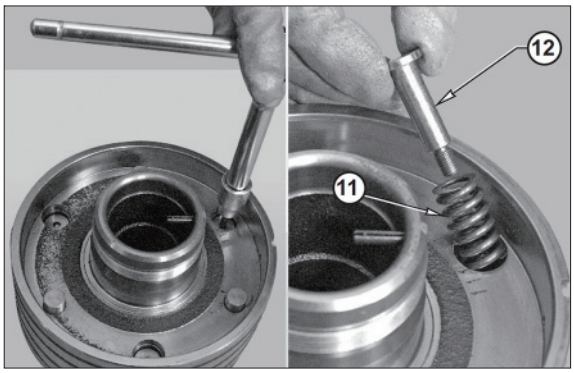
⑱ Applying air pressure, remove the piston (27) of the negative brake.



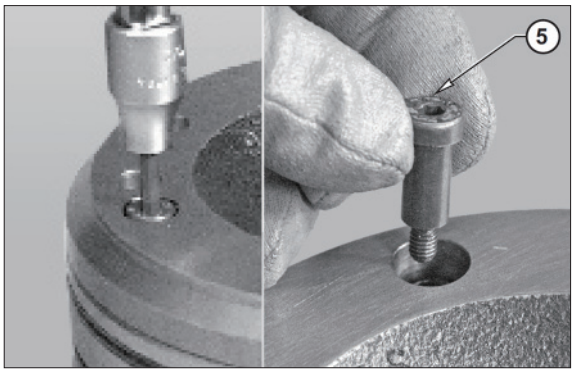
⑲ Using a new screw remove the pressure seal caps.



⑳ Remove the reversal springs (11).

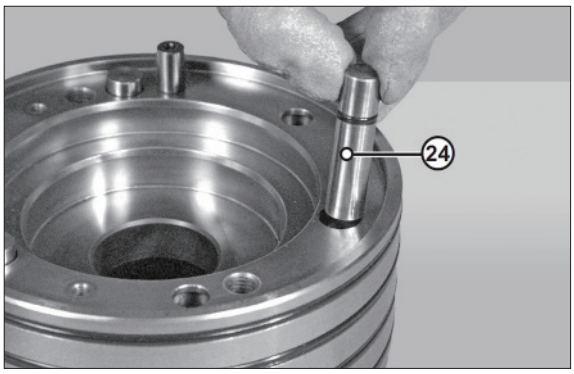


㉑ Remove the adjusting screws (5).

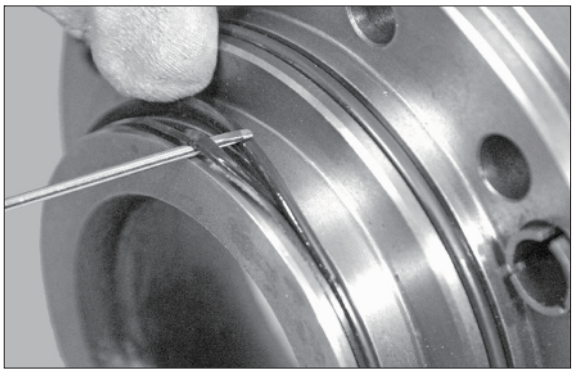


㉒ Remove the service brake piston (4).

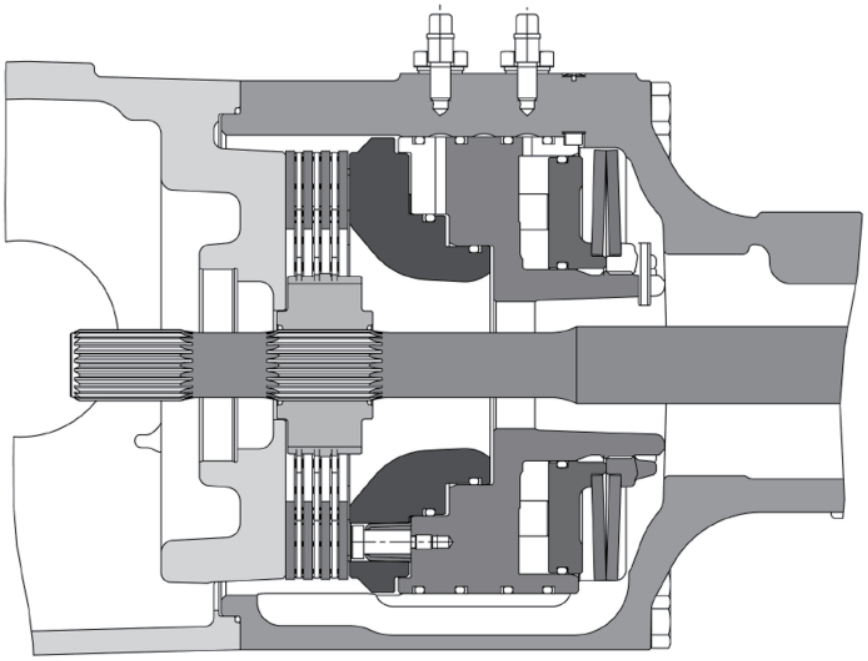
㉓ Remove the three bolts (24).

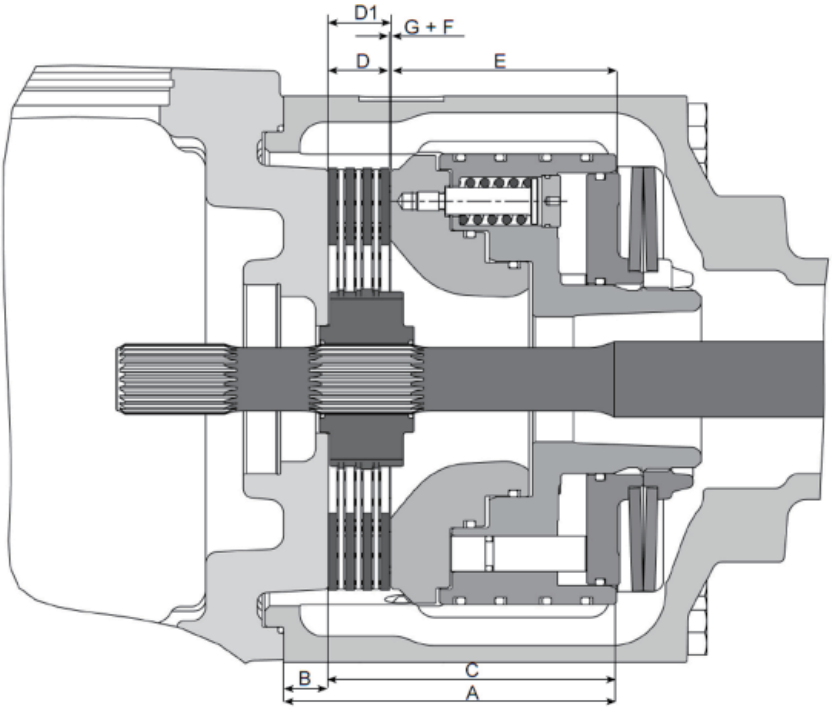


㉔ Remove the O-rings and the anti-extrusions rings from the service brake, the negative brake piston and from the piston.



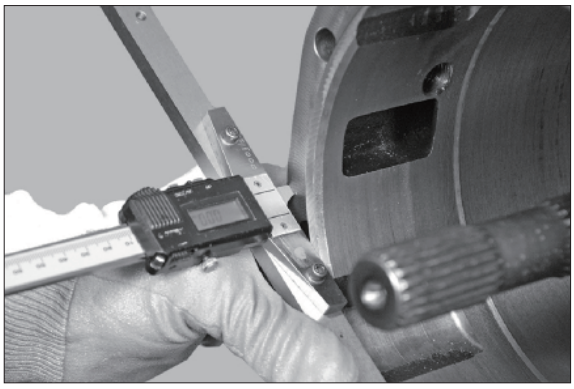
(3) Assembly



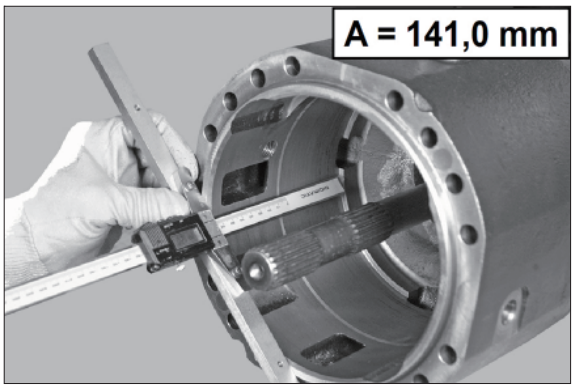


C = A - B
141.0 - 19.0 = 122 mm
C = arm quote
D1 = D + G + F
26.0 + 0.75 + 0.2 = 26.95 mm
D = tickness of discs pack
G = brake discs gap
F = fix quote
E = C - D1
122 - 26.95 = 95.05 mm
E = piston pack quote

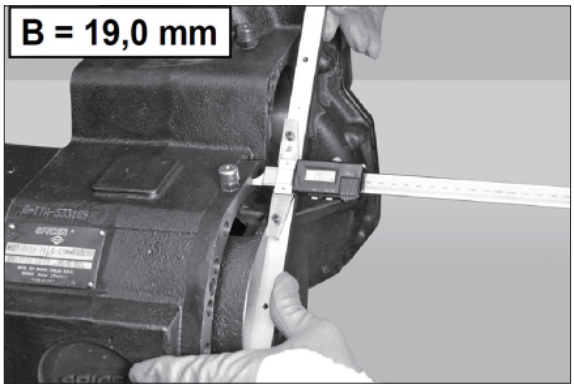
① Zero the centesimal calibre between the support plane and the centring arm.



② Then measure the distance between the arm support plane and the piston pack stop.

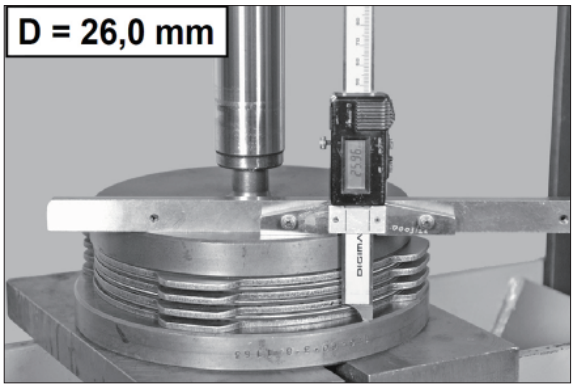


③ Measure the distance between the disk support plane and the arm support plane.
Subtract the value “B” from the value “A” to obtain the effective dimension “C” of the arm containing the brake disks and the piston pack.



④ Bring the disk pack beneath a press, load with 1000 kg, then measure the dimension “D”.
Add the play “G” and the fixed value “F” (equal to 0.2 mm) to the value “D”.

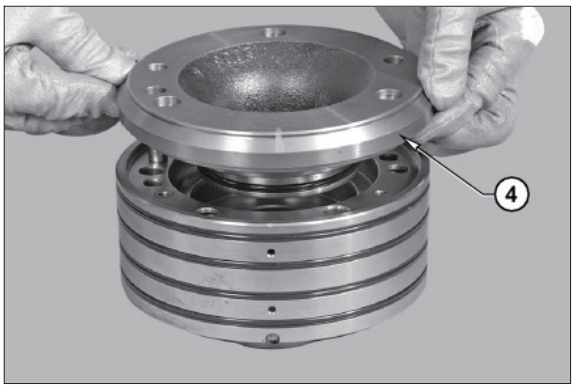
※ Do not take into account the thickness between the press piston and the disks.



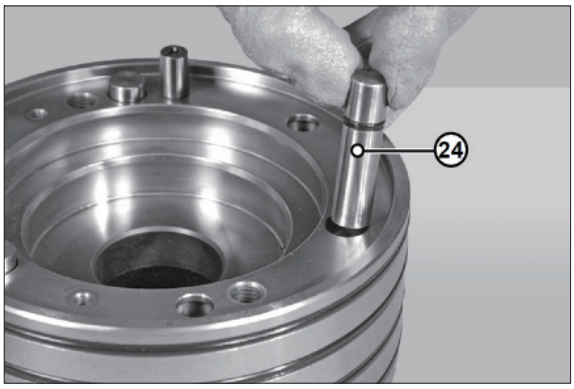
⑤ To determine the value “E” of the piston pack, subtract value “C” from value “D1”.

C = A - B
141,0 - 19,0 = 122 mm
C= arm quote
D1 = D + G + F
26,0 + 0,75 + 0,2 = 26,95 mm
D= tickness of discs pack
G= brake discs gap
F= fix quote
E = C - D1
122 - 26,95 = 95,05 mm
E = piston pack quote

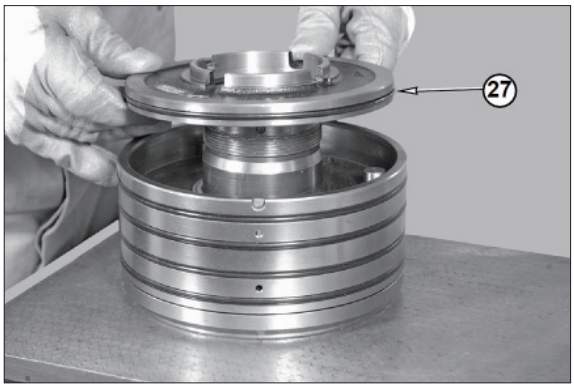
⑥ Insert the service brake piston (4) hammering alternately with a plastic hammer.



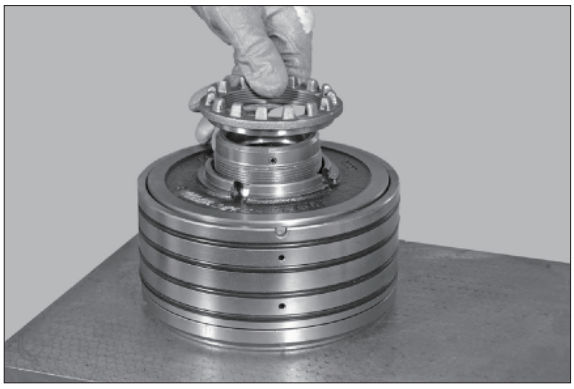
⑦ Insert the bolts (24).



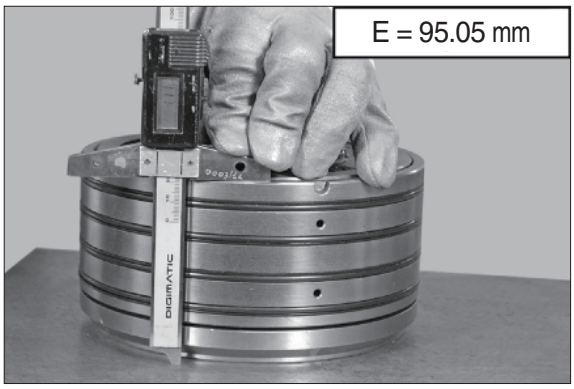
⑧ Turn upside down and insert the negative brake piston (27).



※ To determin the level “E” the slotted nut has to be operated without spring mounted.

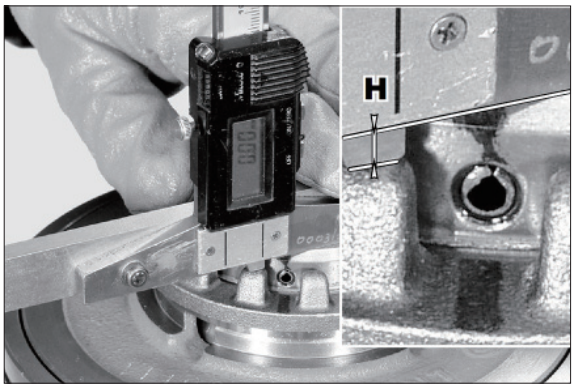


※ To define the level “E” adjust the slotted nut always to the smaller value by driving to the closer notch.

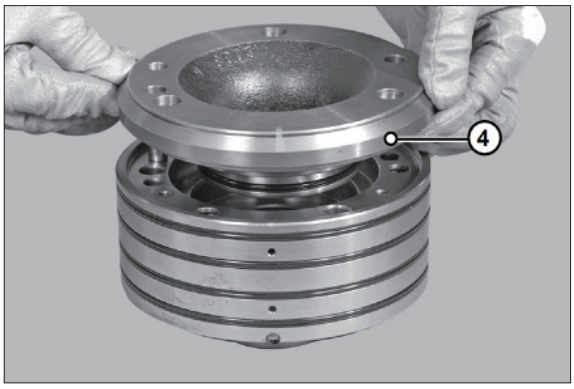


⑨ Before removing the slotted nut in order to insert the springs, note down the distance “H” from the plane to the tooth near the pin.

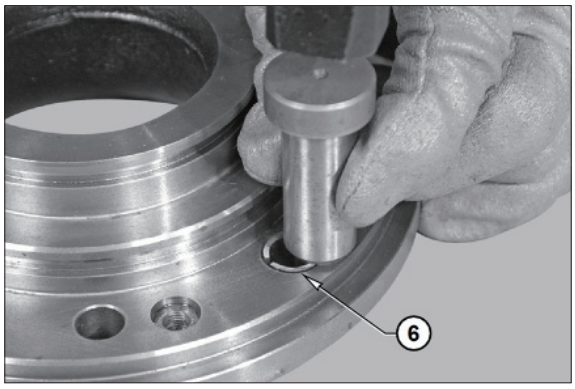
※ Sign.



⑩ Remove the service brake piston (4).

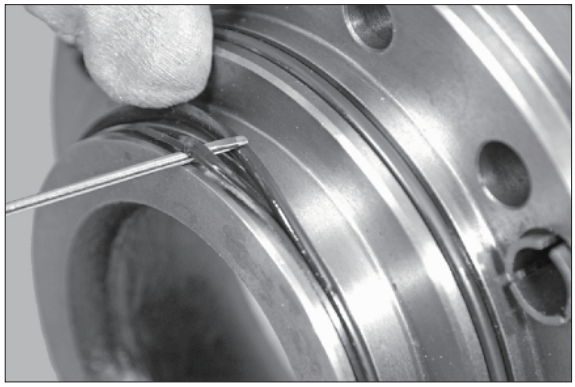


⑪ Insert the stroke automatic regulation springs (6); place them in line with the piston (4).

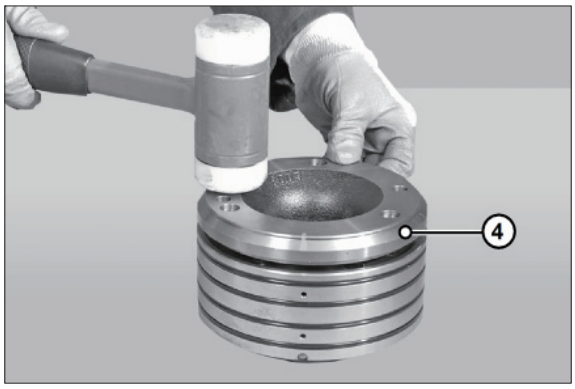


⑫ Complete the O-rings and anti-extrusion rings on all pistons.

※ The O-rings always have to be assembled from the pressure facing side.

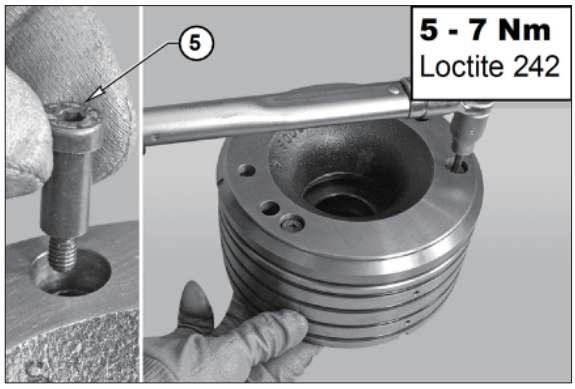


⑬ Insert the service brake piston (4) hammering alternately with a plastic hammer.

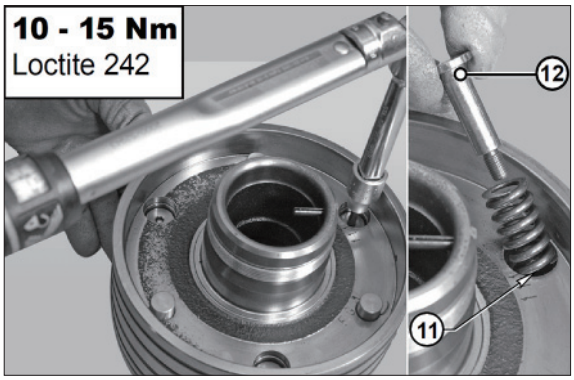


⑭ Fit the adjusting screws (5).
Apply loctite 242 to the thread.

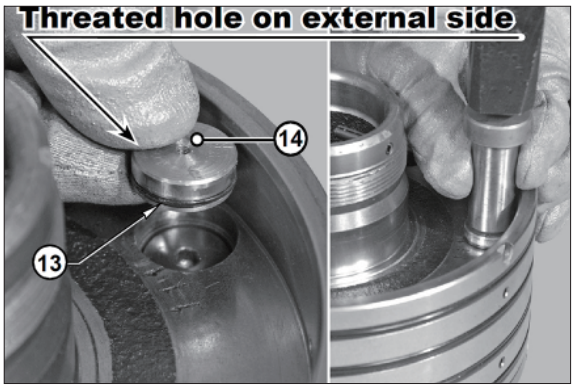
· Torque wrench setting :
0.51~0.71 kgf · m (3.69~5.16 lbf · ft)



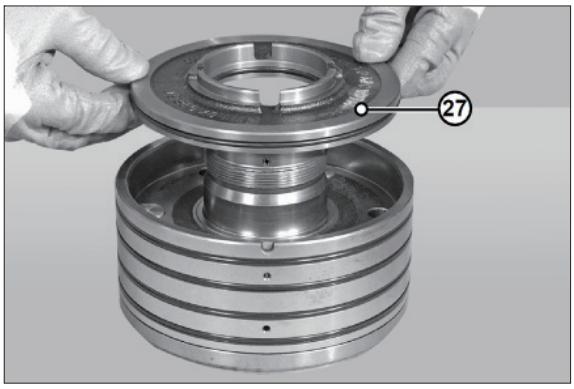
⑮ Fit the reversal springs (11) on the piston (4).
Apply loctite 242 to the thread of the adjustment screw.
Tighten with torque wrench setting of 1.02~1.53 kgf · m (7.38~11.1 lbf · ft)



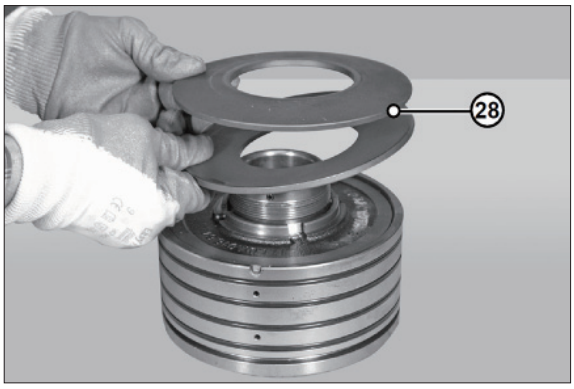
⑯ Insert the stroke end seal caps.



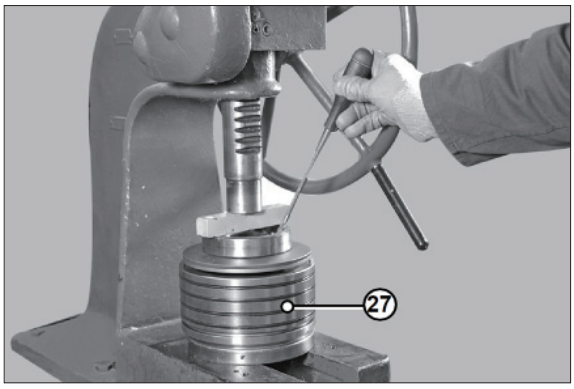
⑰ Insert the negative brake piston (27).



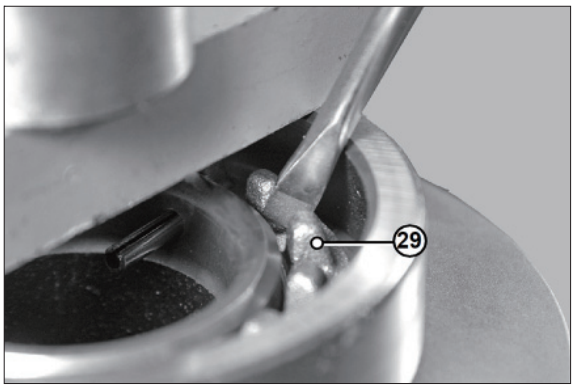
⑱ Insert the disc springs in the right position (28).



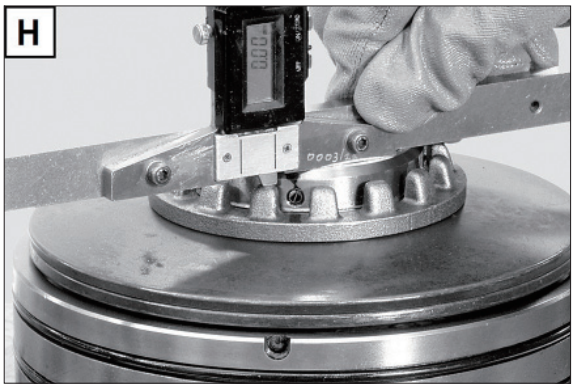
⑲ Insert at the bottom the piston of the negative brake (27) and screw up the slotted nut (29).



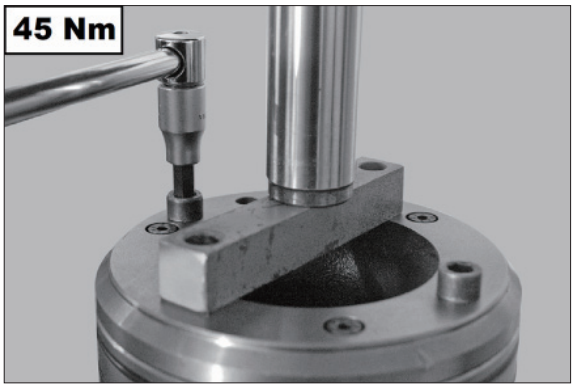
⑳ Screw down the slotted nut to the earlier determined position.



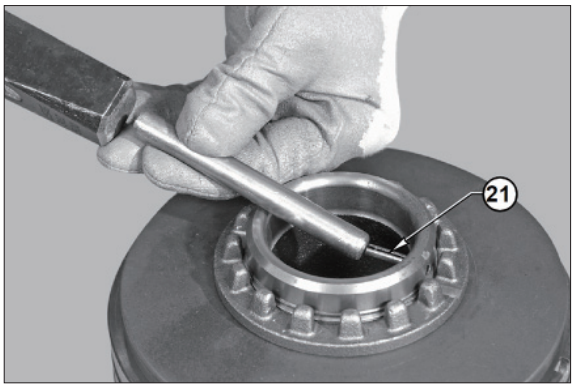
㉑ Check the earlier measured distance “H” from the plane to the tooth next to the pin.



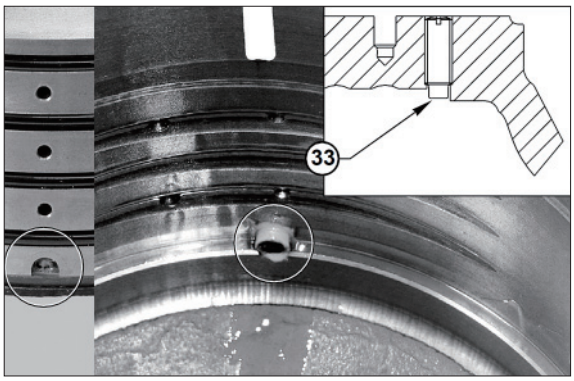
㉒ Alternately tighten with a torque wrench setting of maximum 4.59 kgf · m (33.2 lbf · ft).



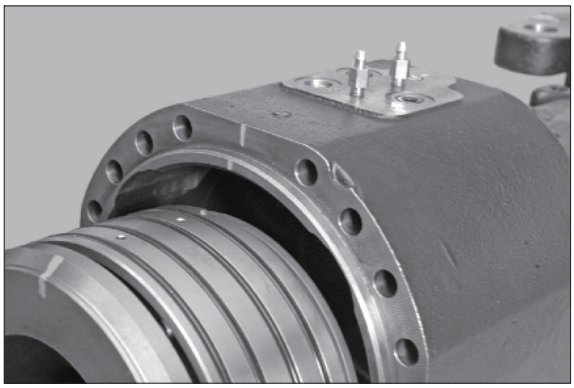
㉓ Put the pin in locking (21) position.



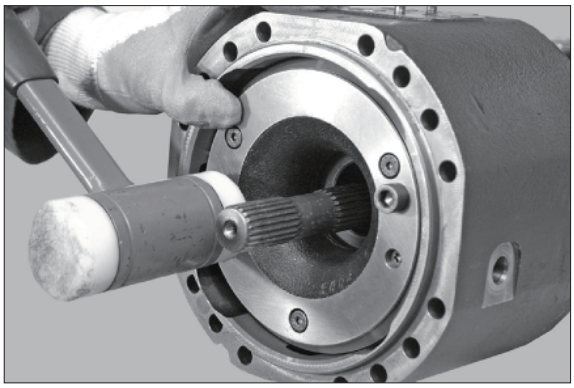
※ Check locking screw (33) of the brake piston module.



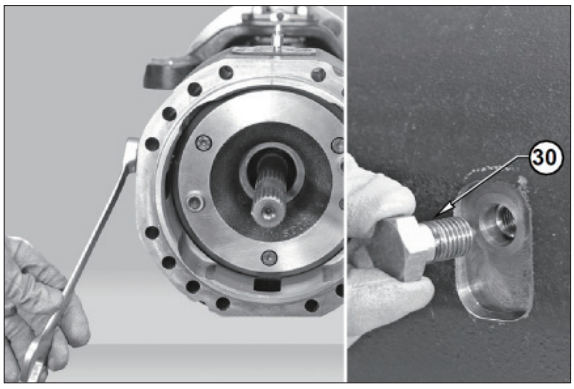
㉔ Insert the brake module facing the input holes to the top.



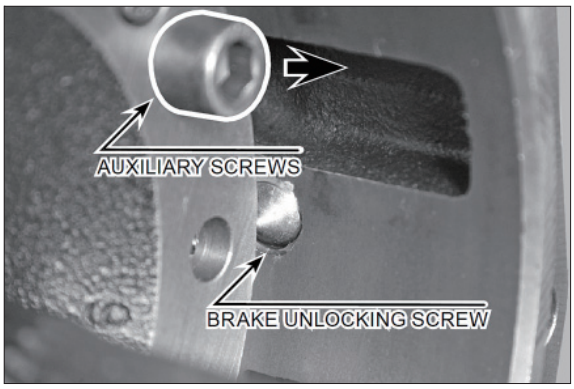
㉕ Insert the piston to the end stop by alternating light strokes and remove the screws.



㉖ Insert the negative brake unlocking screw (30) up to the end stop.

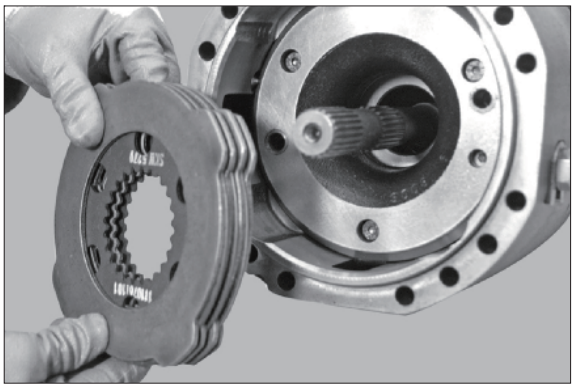


㉗ Remove the two auxiliary screws.

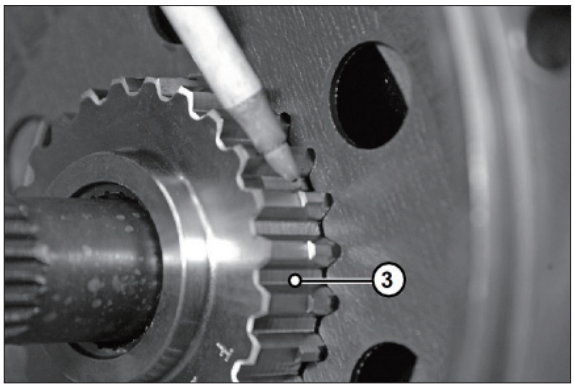


㉘ Insert the brake discs (1) (2) in the right sequence.

※ The first brake disc to be inserted must be of friction material.

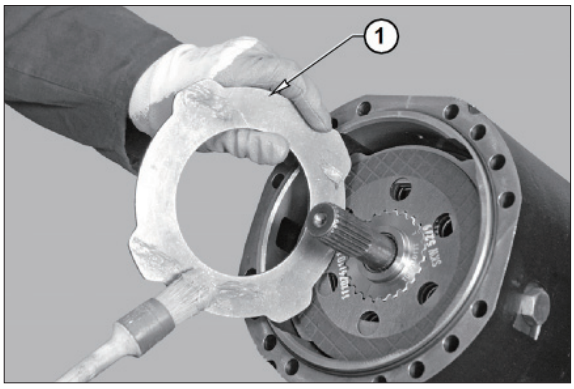


㉙ Install the flange (3) on the arm.

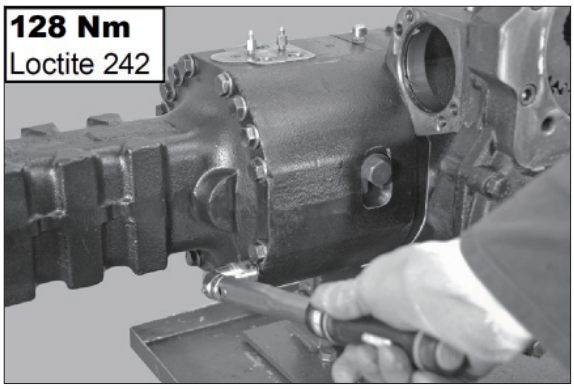


㉚ Insert the brake discs (1) (2) in the right sequence.

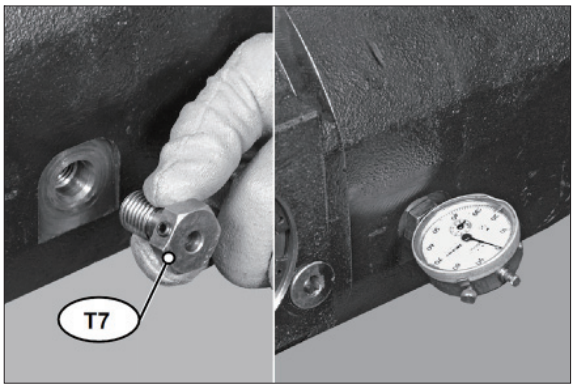
※ The last brake disc to be inserted must be of metal material.



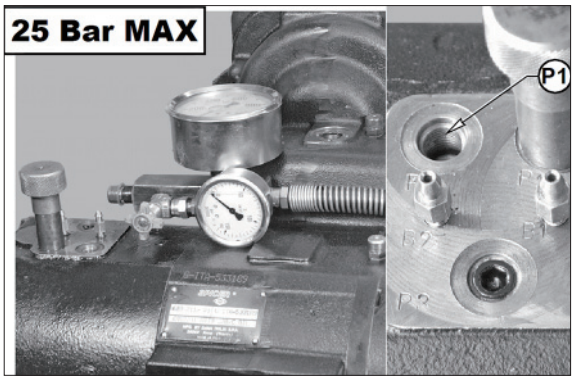
㉛ Insert the screws and tighten them alternately.



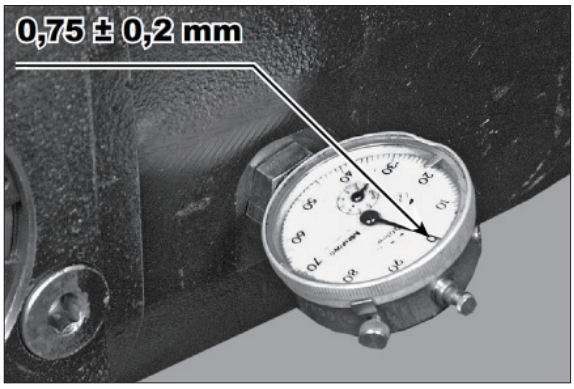
㉜ Remove the negative brake locking screws (30).
Fit the special tool T4 into the seat of the manual release of the screws, insert a comparator and pre-load it with 1 ㎜.



㉝ Introduce a pressure of maximum 25 bar.

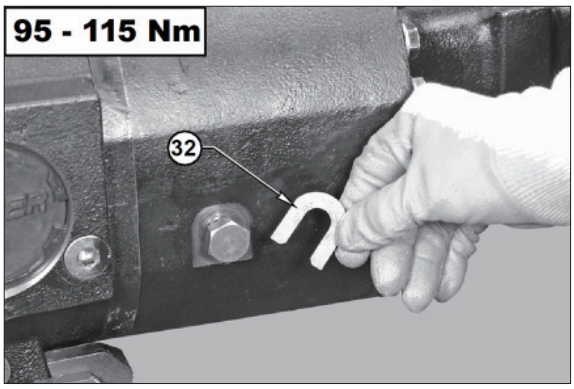


㉞ Once the pressure is inserted into the circuit the comparator must give a measurement equal to play X (0.75 ㎜).

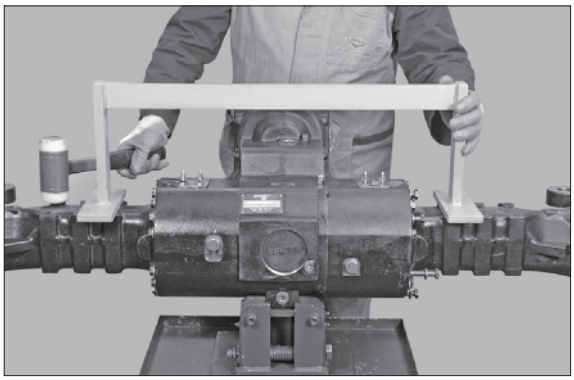


㉟ Insert the two “U”-shaped shims and tighten the screws with a torque wrench setting of 9.69~11.7 ㎏f · ㎝ (70.1~84.6 lbf · ft).

※ The position of the negative brake is unlocked.

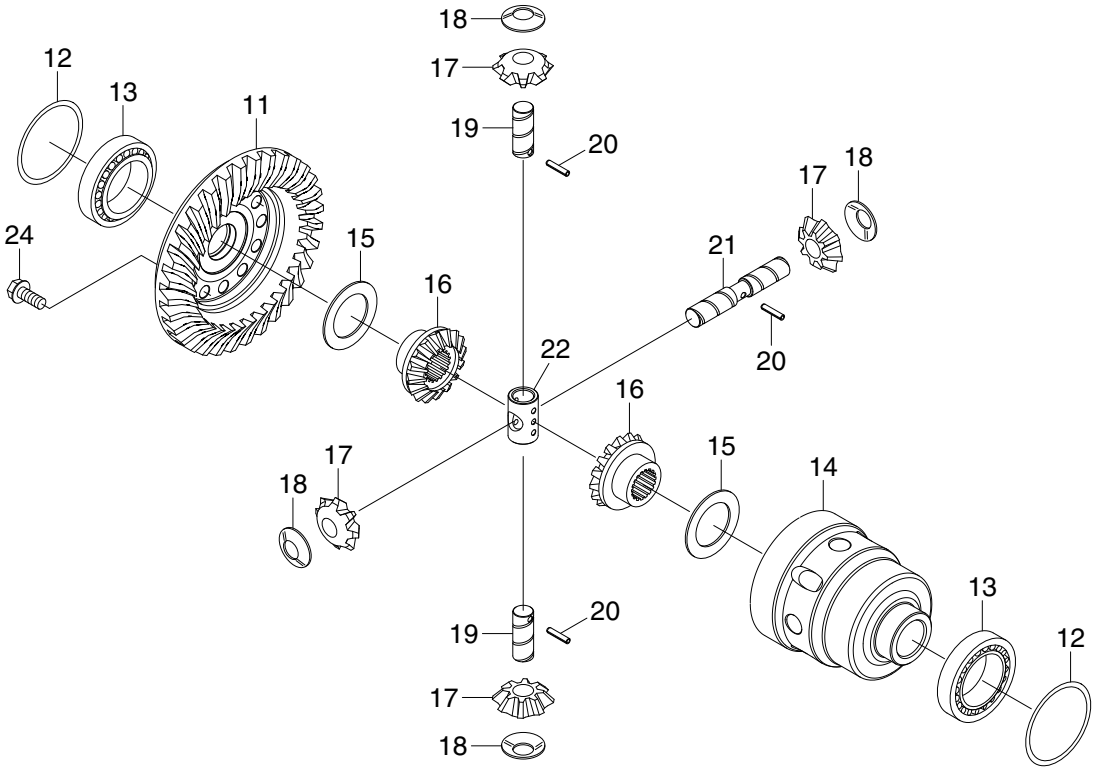


㊱ Check the flatness of the arms and finally lock the arms with the screws (4) and the washer (5) using the crosstightening method.



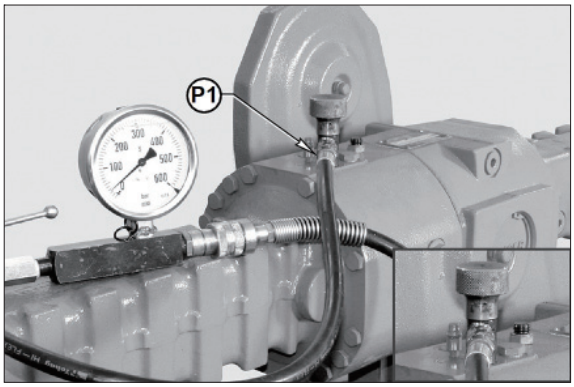
4) NORMAL DIFFERENTIAL

(1) Assembly diagram

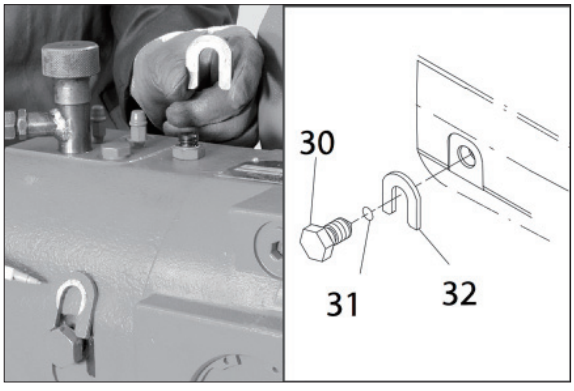


(2) DISASSEMBLY

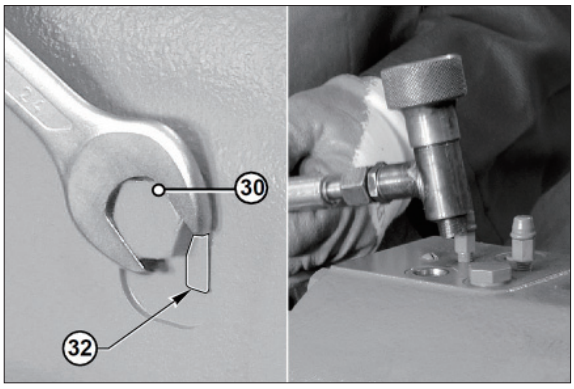
① Connect an external pump to the union piece “P1” of the negative brake and introduce a pressure of 15~30 bar to eliminate the pressure of the belleville washers.



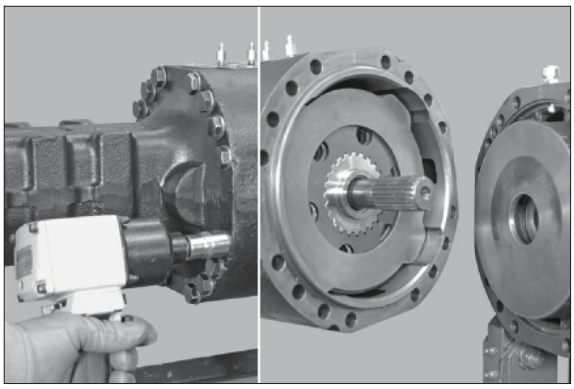
② Loosen the unlocking screws (30) and remove both stop washers (32).



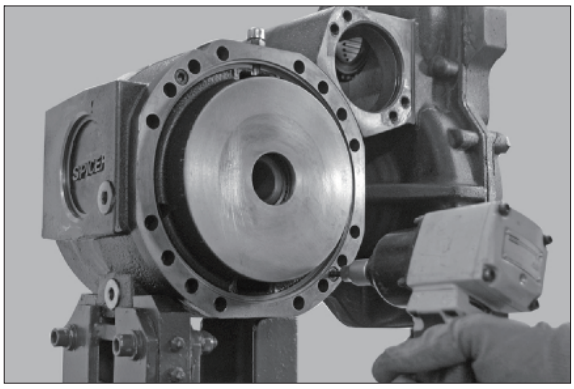
③ Insert block screws to end stroke and release pression.



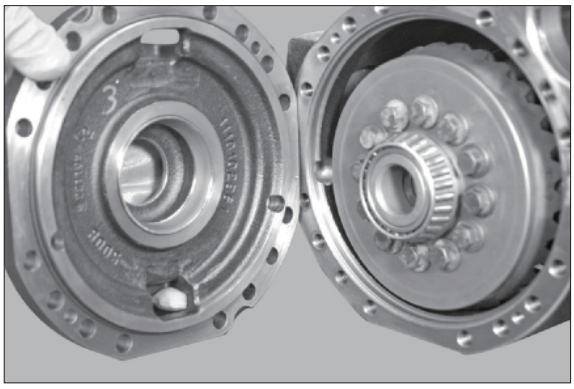
④ Remove the brake side arm and the brake discs pack.
Sling the arm to be removed and connect it to a hoist, remove screws of the crown wheel side arm.
Remove the arm together with the pack of the braking disks.
Place the arm on a bench.



⑤ Remove the fitting screws from the middle cover.

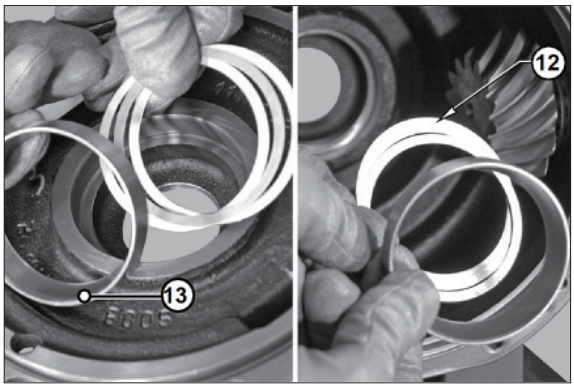


⑥ Insert a screw-driver in the opposing slots then force and remove the middle cover.

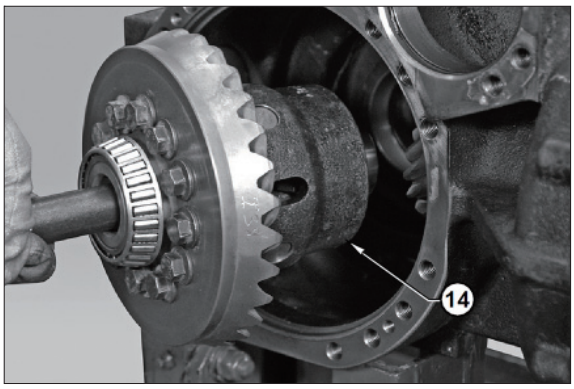


⑦ If the bearings need replacing (13), extract the external thrust blocks of the bearings (13) from middle cover and central body.

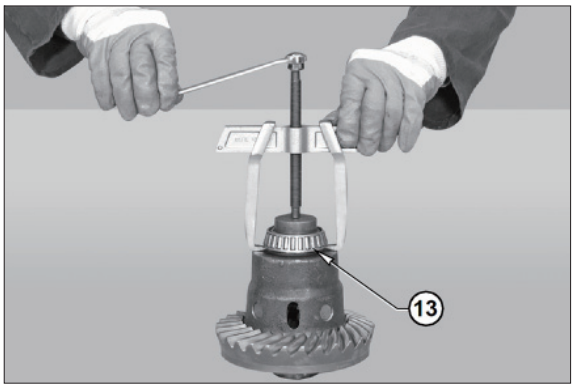
※ Accurately check the O-ring.



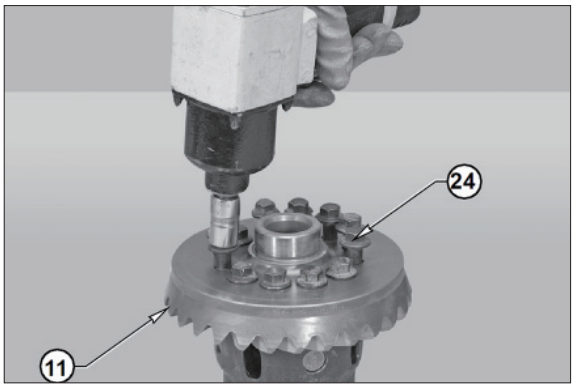
⑧ Pull out the differental (14).



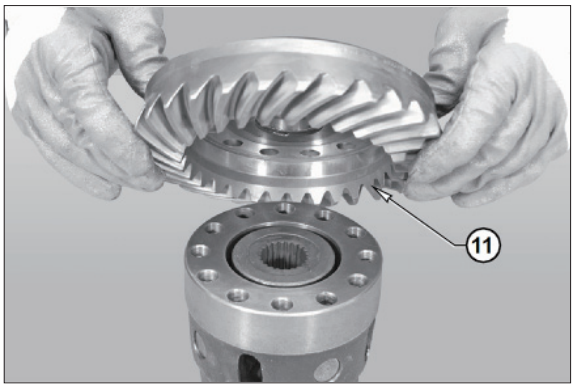
⑨ If the bearing need replacing, extract the bearing (13) from the differential carrier.



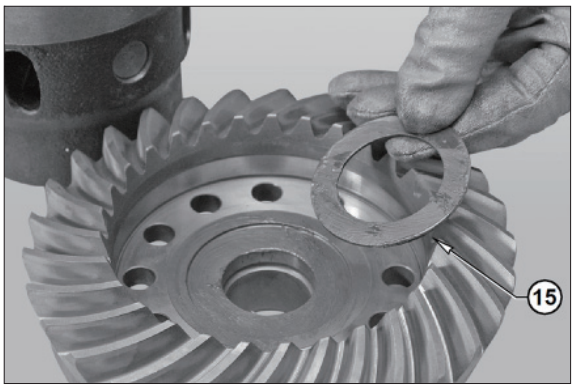
⑩ Remove fixing screws (24) of the crown wheel (11); exchange each time when removed.



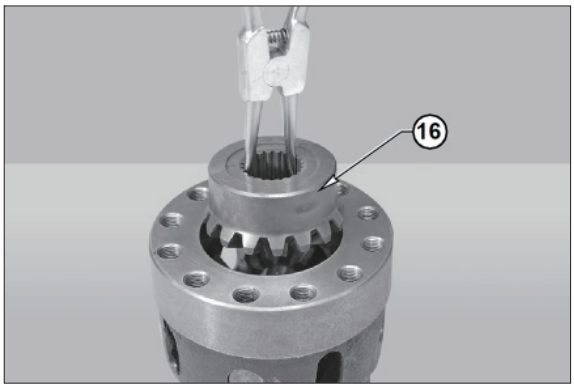
⑪ Extract the crown wheel (11).



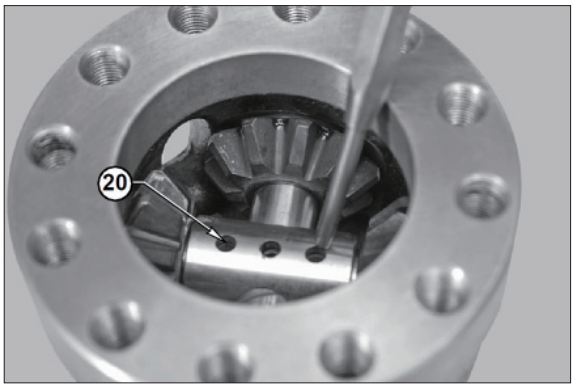
⑫ Remove the shim washer (15).



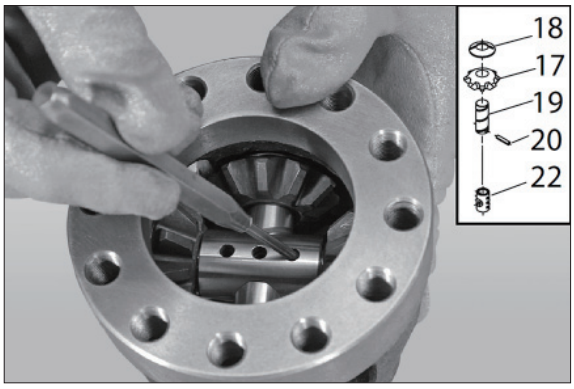
⑬ Remove the planetary gear (16).



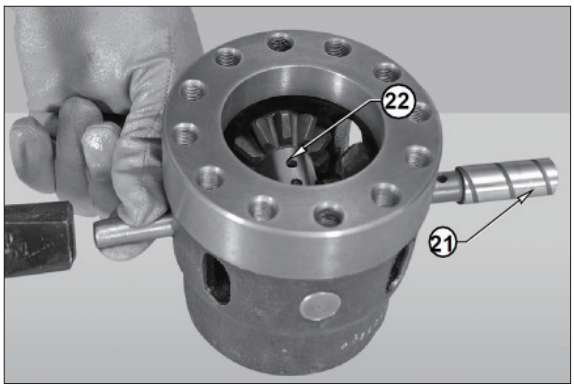
⑭ Remove the three spider blocking pins (20) by using a pin driver.



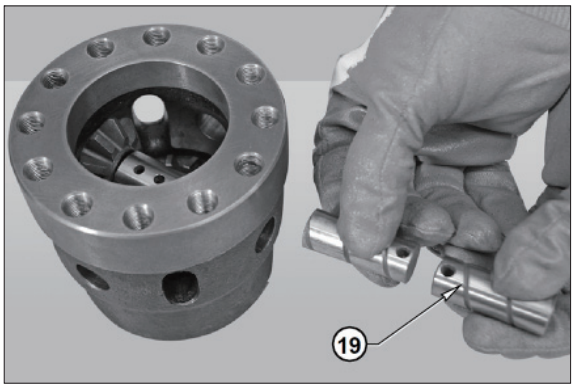
⑮ Move the two opposite mounted short bolts (19) to the outside of the box using the same pin driver.



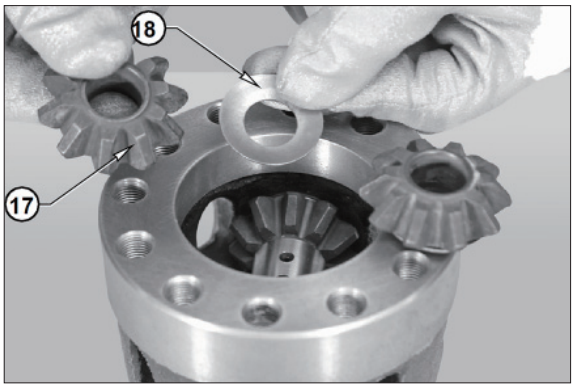
⑯ Drive out the long bolt (21) and pull out the spider (22) from the center.



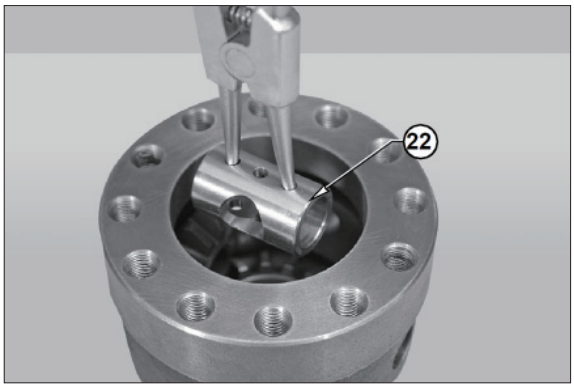
⑰ Remove the two half bolts (19), spherical washers and satellite wheels.



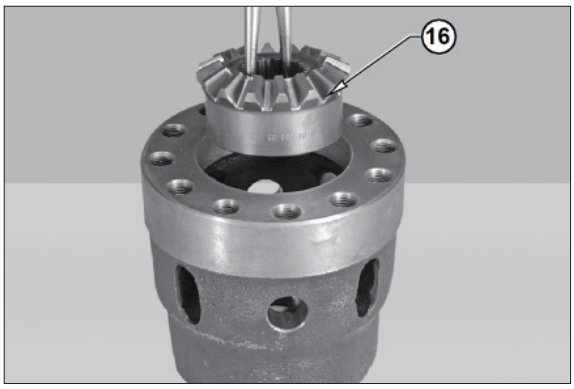
⑱ Remove long bolt, spherical washers (18) and satellite wheels (17).



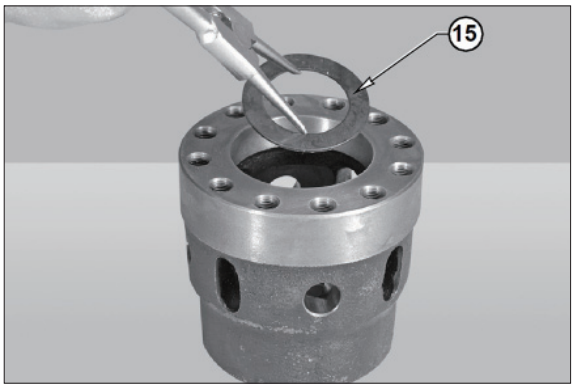
⑲ Pull out the spider (22) from the center.



⑳ Remove the planetary gear (16).

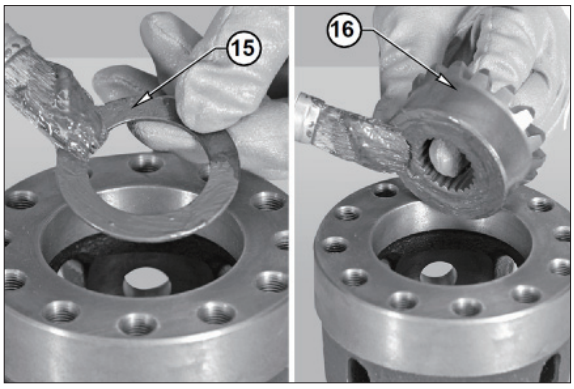


㉑ Remove the shim washer (15).

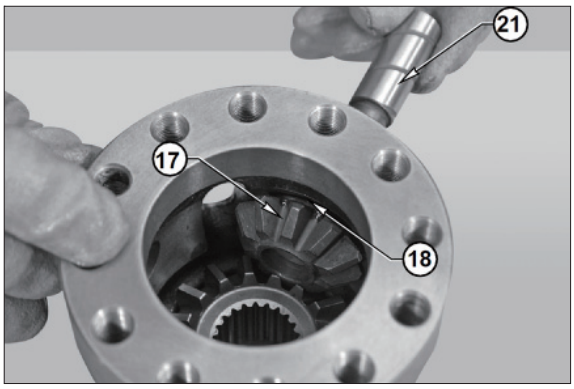


(3) ASSEMBLY

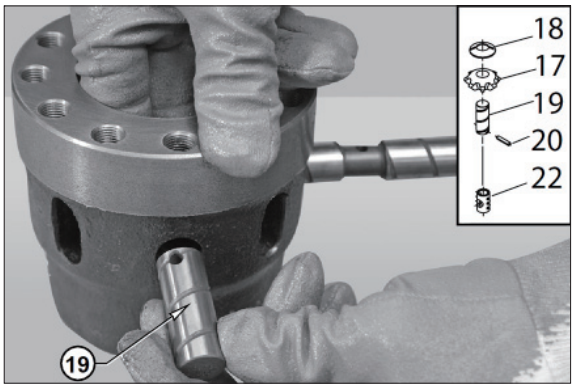
① Lubricate and insert washer (15) and plantary wheel (16).



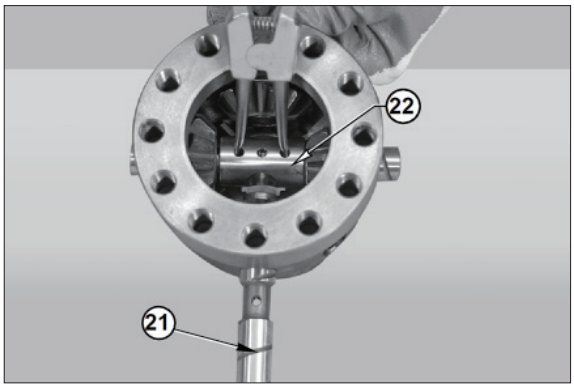
② Partially insert the long bolt (21), satellite wheels (17) and spherical washers (21).



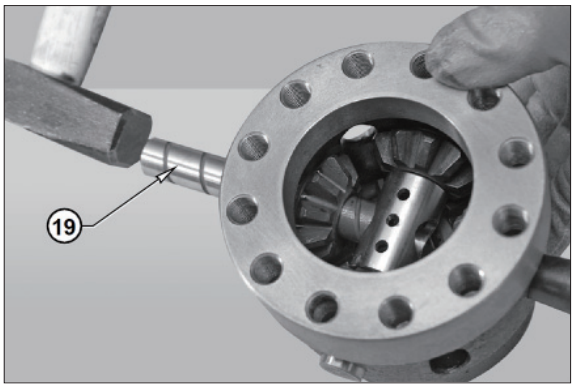
③ Insert the two half bolts (19), spherical washers (18) and satellite wheels (17).



④ Insert spider (22) and completely insert the long bolt (21).

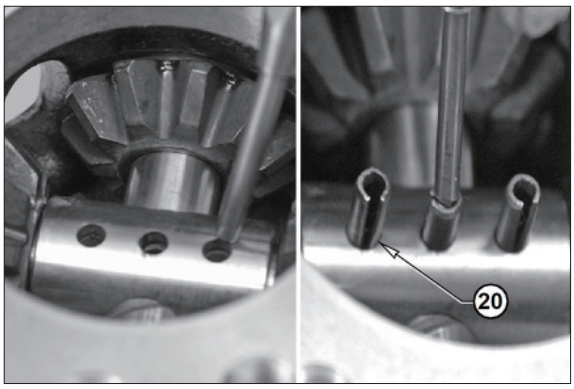


⑤ Insert completely the bolts (19).

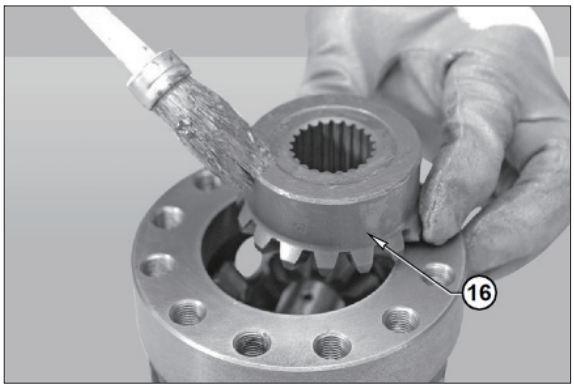


⑥ Center the pin holes and insert the 3V pins (20).

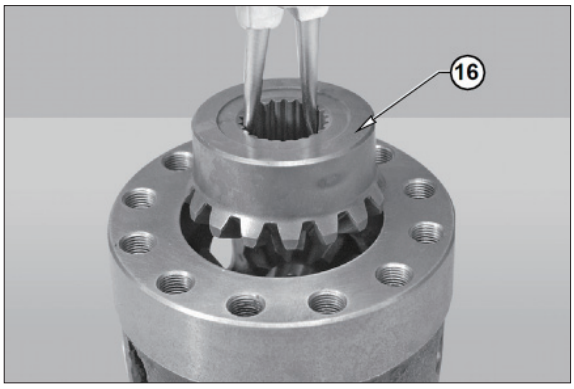
※ Check the free rotation of the satellite wheels on the bolts.



⑦ Lubricate wheel (16).

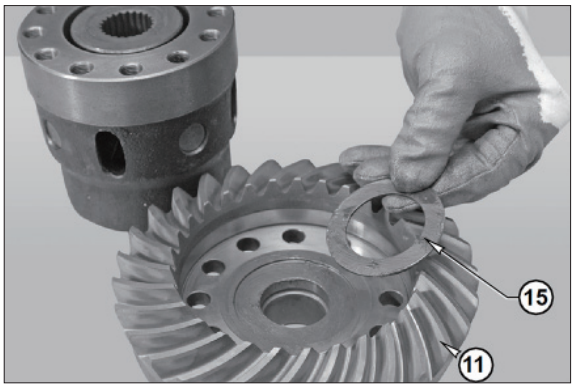


⑧ Insert planetary gear wheel (16).



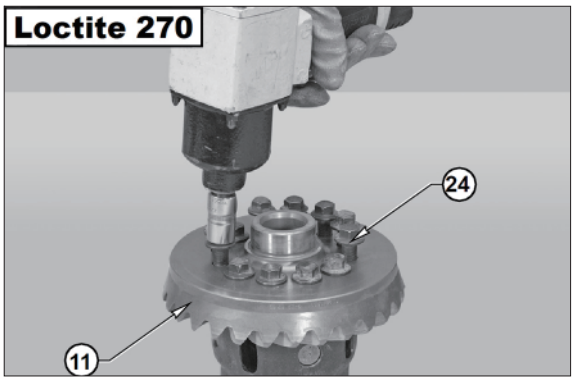
⑨ Position the shim washer (15) on the crown (11).

※ In order to hold the shim washer (15) in position, apply grease to it.



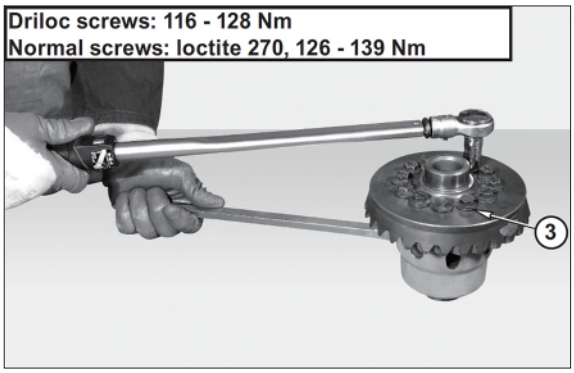
⑩ Position the crown (11) on the differential carrier and lock it with screws (24) applied with loctite 270.

※ Secure the screws using the cross-tightening method.



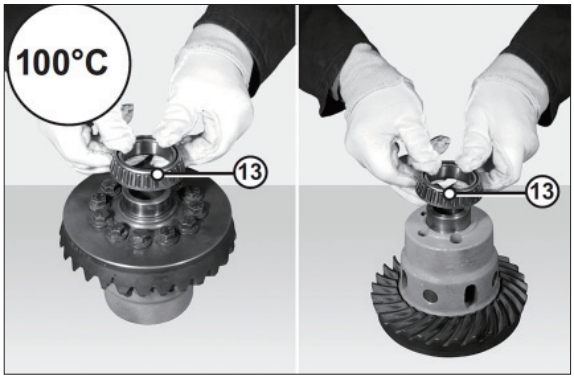
⑪ Tighten screws with a torque wrench: see table.

※ Always use new screws to fix the crown wheel. In case the screws are not thread locking pretreated, use loctite 270.



⑫ Assemble the bearing (13).

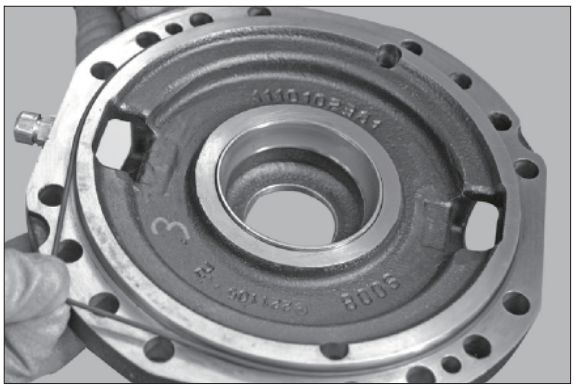
※ Heat the bearing to 100˚C before assembling.



⑬ If the bearings are replaced, insert the external thrust blocks in the middle cover and in the central body.

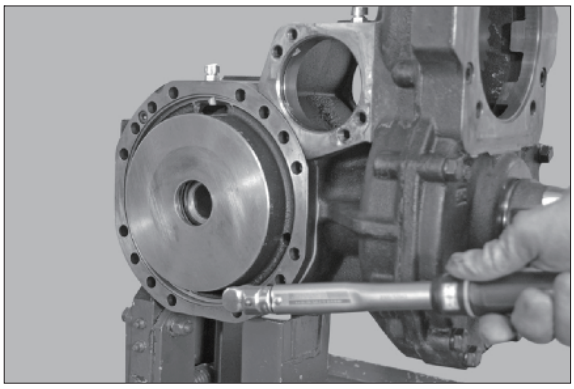
⑭ Position the differential unit in the central body with the help of a bar and fit the middle cover.

※ Thoroughly check the state of the O-ring and make sure that the cover is fitted with the oil discharge in the lower position.

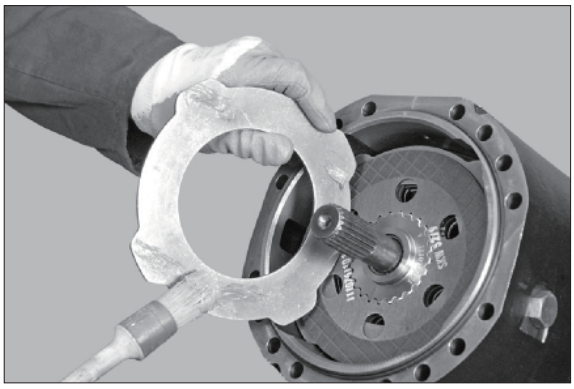


⑮ Lock the middle cover with screws.

· Torque wrench setting for screw :
2.47~2.67 kgf · m (17.9~19.3 lbf · ft)

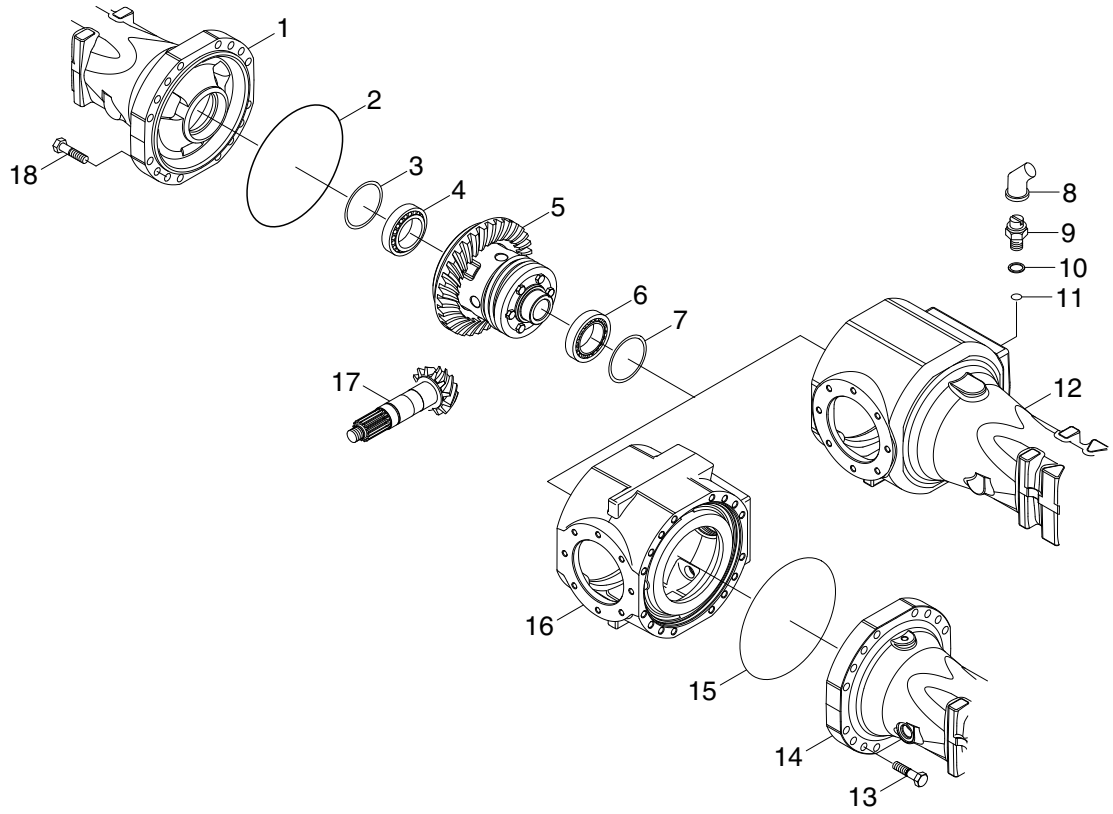


⑯ Check that the positioning of the sealing ring on the arm is intact; install the complete arm. Lock it into position using two facing screws and washers.



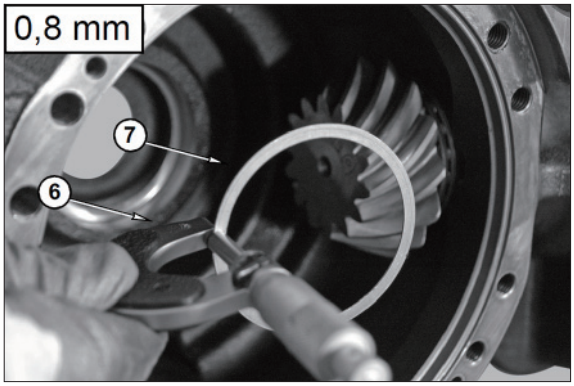
4) RING AND PINION ADJUSTING

(1) Assembly diagram



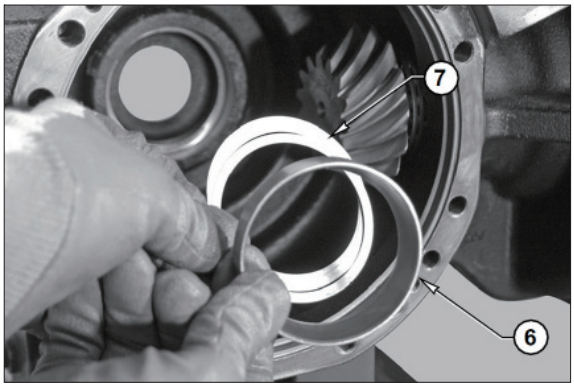
(2) Adjusting

① **Setting of the crown wheel and pinion**
Insert the thrust block of the bearing (6) opposit side of the crown wheel shims (Sb) (7) of an initial thickness of about 0.8 mm.



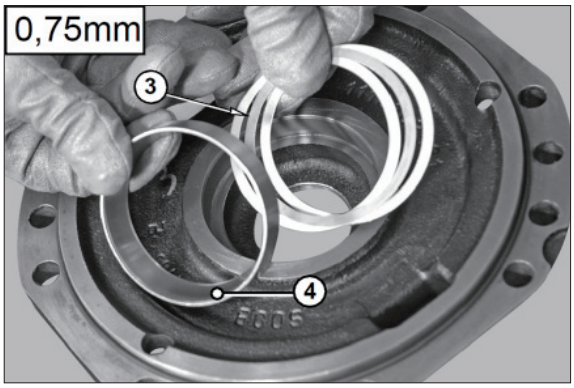
② Insert the thrust block (6) and the shims (Sb) (7) into the arm.

※ Check to be at end of stroke.



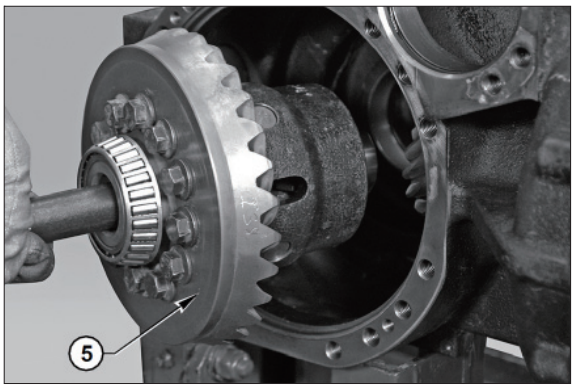
③ **Setting of the crown wheel and pinion**
Insert thrust block (4) of the bearing shims (Sc) (3) of an initial thickness of about 0.75 ㎜.
Insert the thrust block and the shims into the arm.

※ Check to be at end of stroke.

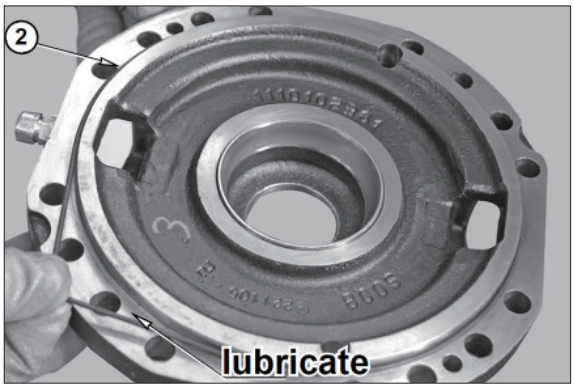


④ Insert complete differential (5).

※ Do not damage the seat of the O-ring with the gearwheel.

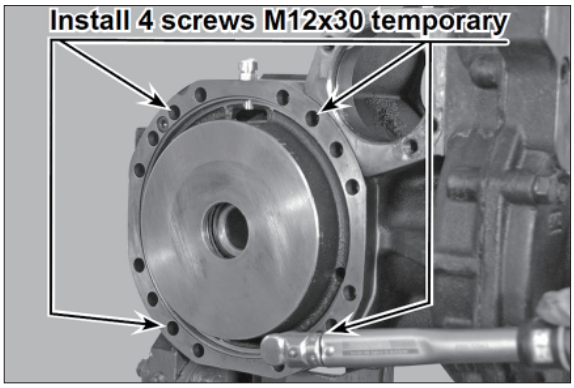


⑤ Check the O-ring (2) and grease.



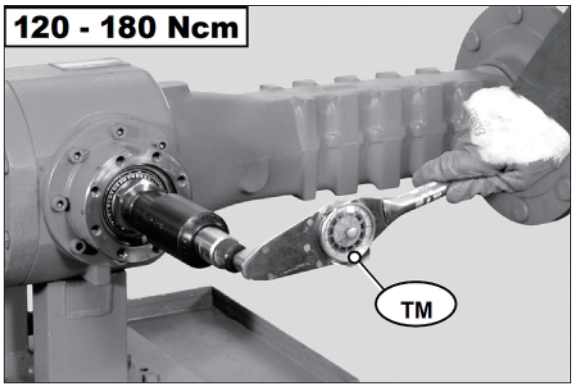
⑥ Lock the middle cover (5) with screws (4).

· Torque wrench setting for screw :
2.47~2.67 kgf · m (17.9~19.3 lbf · ft)



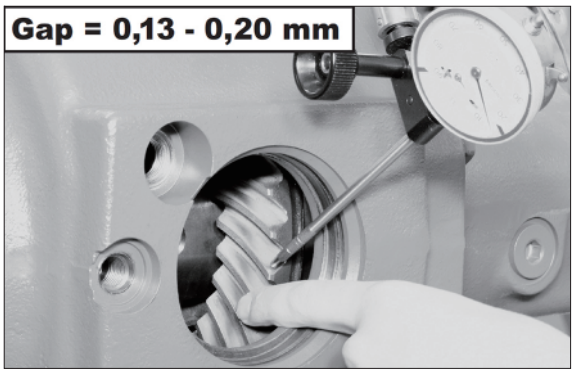
⑦ Apply torque meter TM to pinion nut and check that torque will increase by 0.04~0.06 kgf · m as a result of differential bearing preload.

· Example : pinion torque :
0.08~0.12 kgf · m (0.58~0.87 lbf · ft)
· Pinion + differential torque :
0.12~0.18 kgf · m (0.87~1.3 lbf · ft)



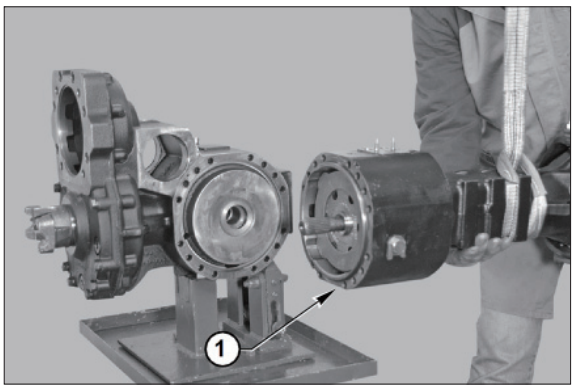
⑧ Position comparator on the center of one of the crown teeth, preset it to 1 mm and reset it to zero.
Manually move the crown in both directions to check the existing clearance between pinion and crown.

· Gap = 0.13~0.20 mm

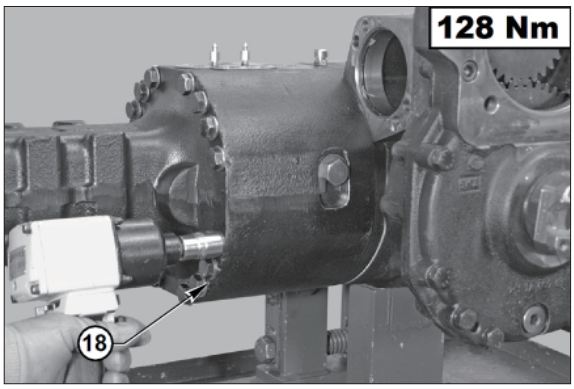


⑨ Install the crown wheel side arm (1) without half-axle.

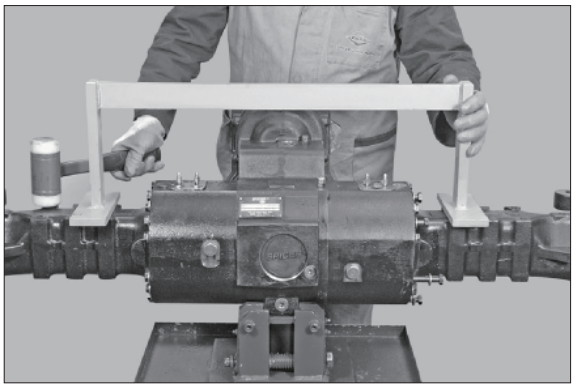
※ To check the torque of the differential, neither of both halfaxles must be installed.



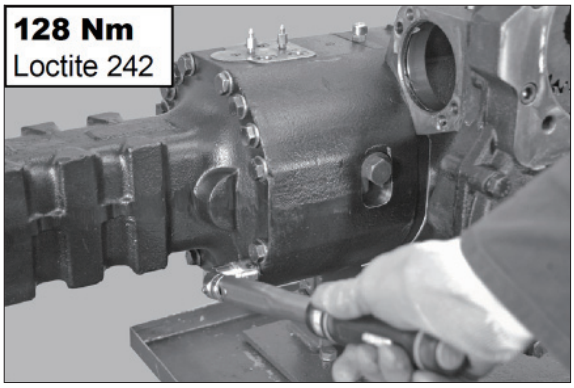
⑩ Temporarily insert all screws of the arm (18).



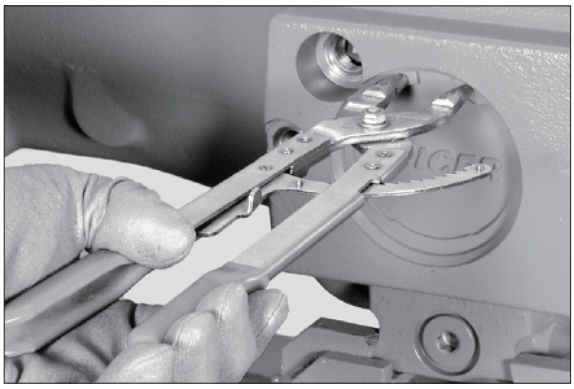
⑪ Check the flatness of the arms; then lock the arms into their final position, using screws adequately coated with loctite 242.



⑫ Torque wrench setting : 13.1 kgf · m
(94.4 lbf · ft)
Tighten using the criss-cross method.

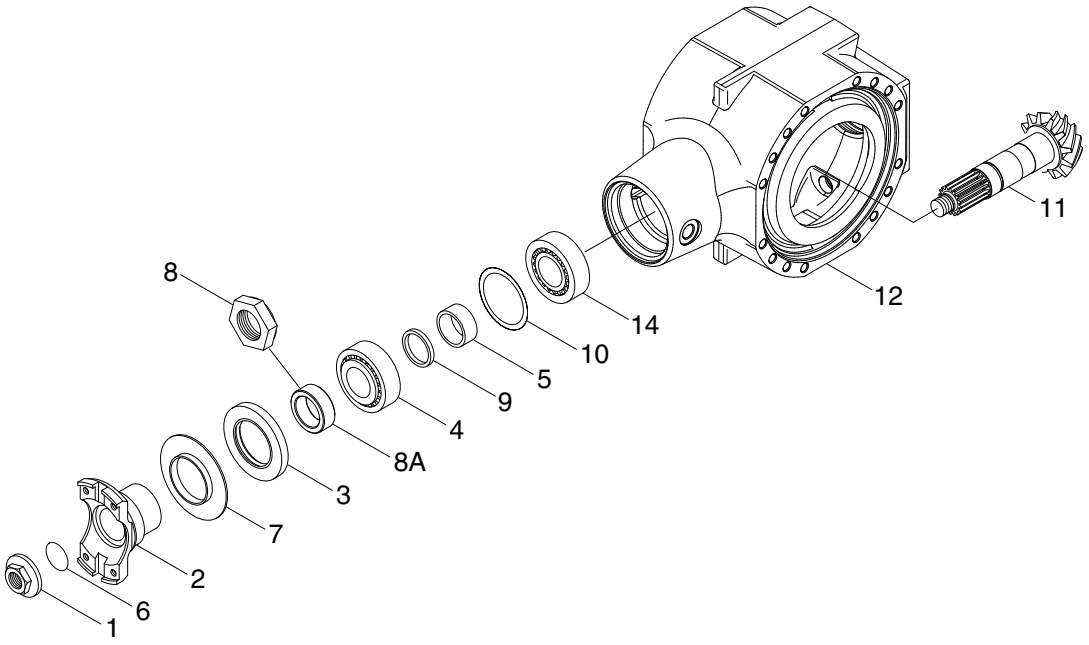


⑬ Using a driver, fit the cap and position it in its seat with the snap ring.



5) BEVEL PINION

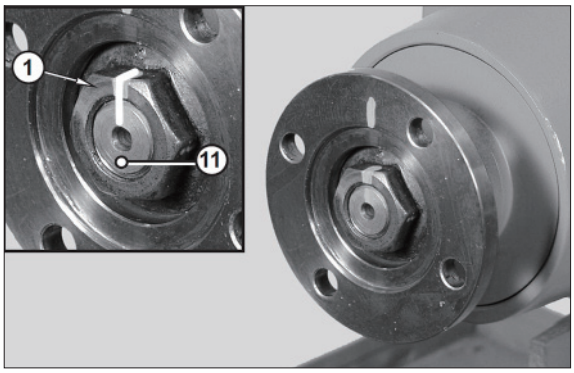
(1) Assembly diagram



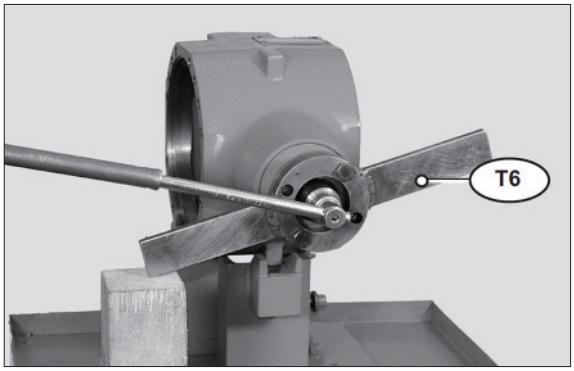
(2) Disassembly

① Make positional marks across nut (1) and pinion (11) tang; If disassembly is awkward, heat the check nut (1) of the flange (2) at 80˚C.

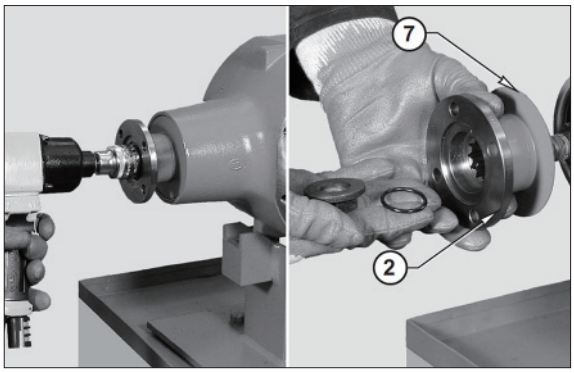
※ Heating is meant to unloose the setting of loctite on the nut (1).



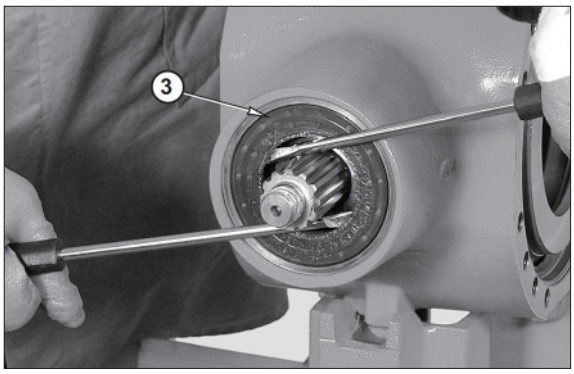
② Position tool T6, so as to avoid pinion rotation.
Unloose and remove the nut (1); also remove the O-ring (6).



③ Remove the flange (2) complete with guard (7) by means of a puller.

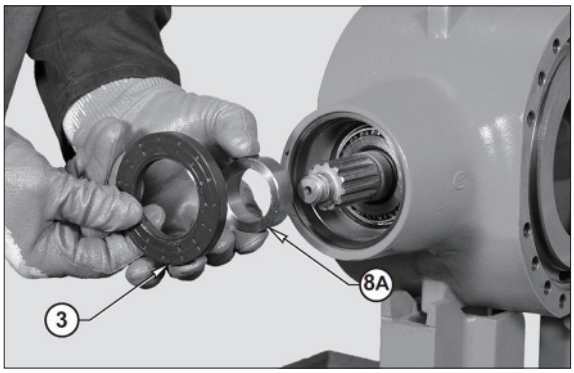


④ Remove the sealing ring (3).

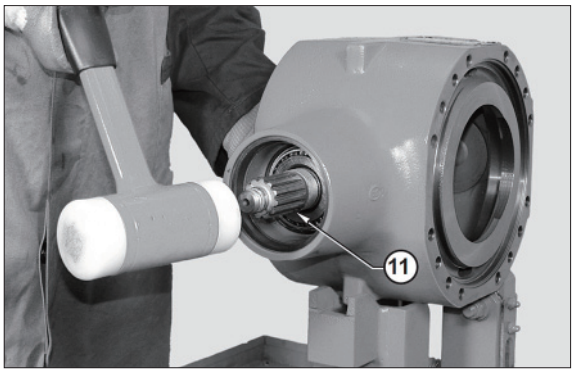


⑤ Remove the sealing ring (3) and spacer (8A).

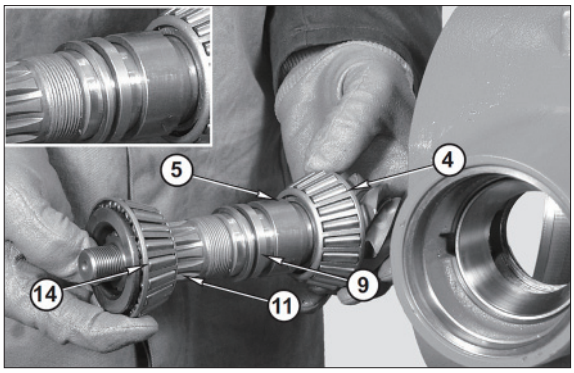
※ Sealing rings (3) must be replaced each time the unit is disassembled.



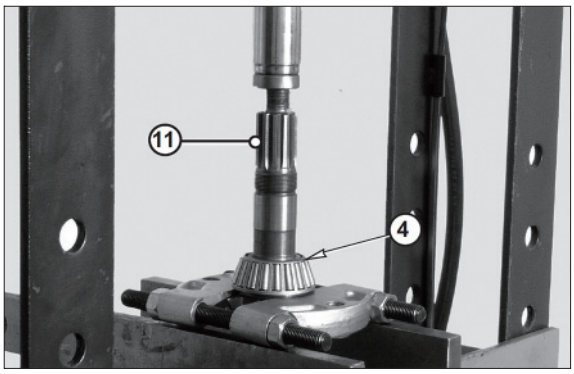
⑥ Remove the pinion (11), shims and distance piece.



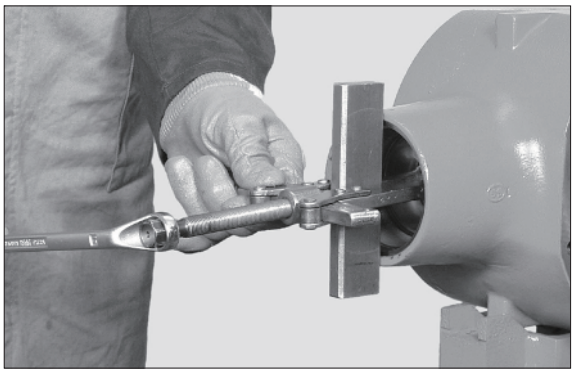
⑦ Refer and keep to the positions marked during disassembly.



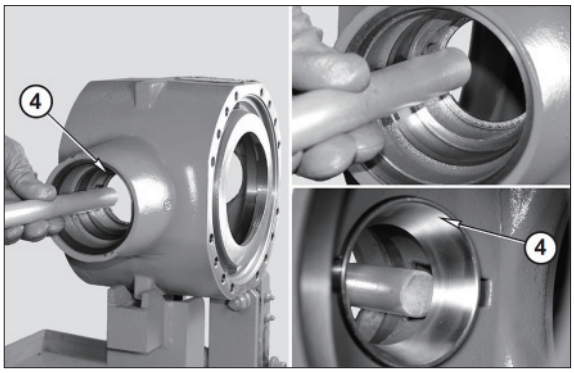
⑧ Using a puller and a press, remove the inner bearing (4) from the pinion (11).



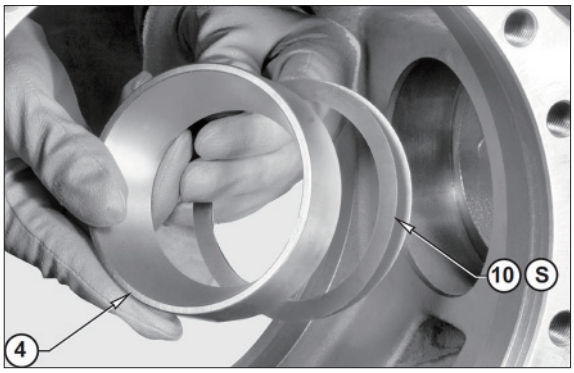
⑨ Remove the thrust block of the external bearing (14).



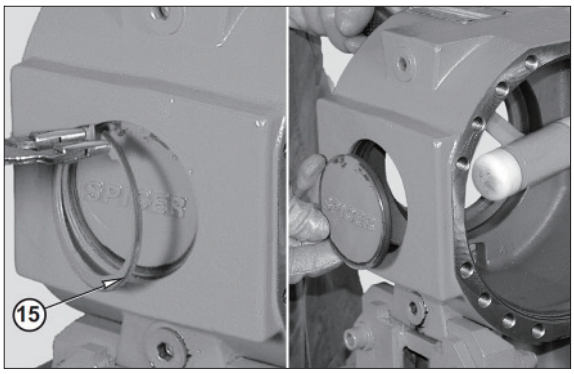
⑩ Insert a drift in the appropriate holes.



⑪ Remove the thrust block of the internal bearing (4) as well as the shim washers (10) (S).

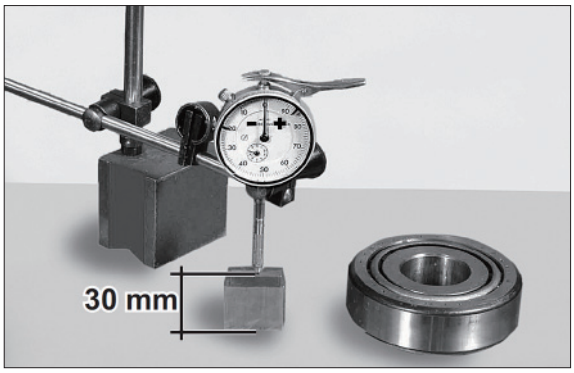


⑫ Remove the snap ring (15). Remove the cap (14).



(3) Assembly

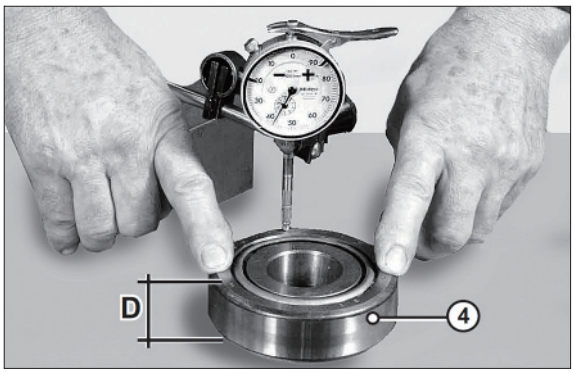
① **Calculating pinion center distance**
Using a faceplate, reset a centesimal comparator “DG” on a calibrated block (whose known thickness is 30 ㎜).
Preload the comparator by about 3 ㎜.



② Bring inner bearing (4), complete with thrust block, under comparator “DG”.

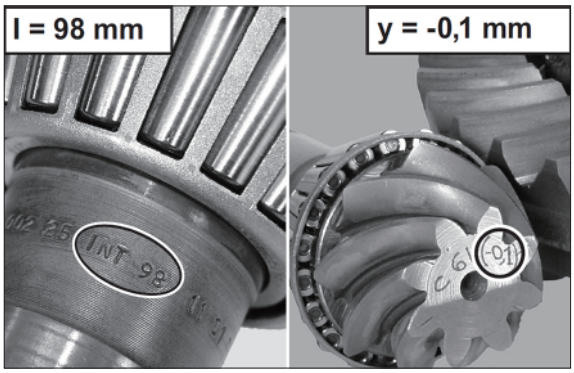
※ Press the thrust block centrally and carry out several measurements by rotating the thrust block.

· Example : 30 - 0.55 = 29.45 = “D”



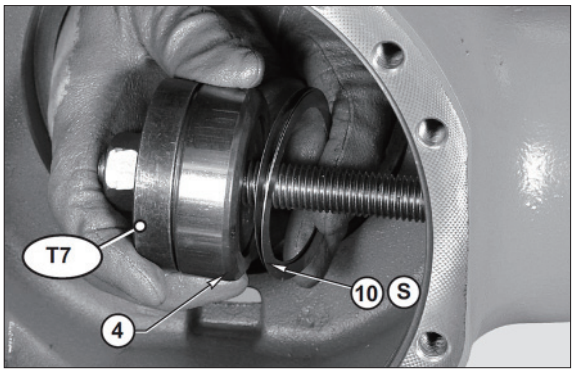
③ Check nominal dimension “I” as marked on the pinion. Add up to or subtract from “I” the variation indicated as “Y” to obtain the actual center distance “I”.

· Example : I=INT±Y=98-0.1=97.9 ㎜



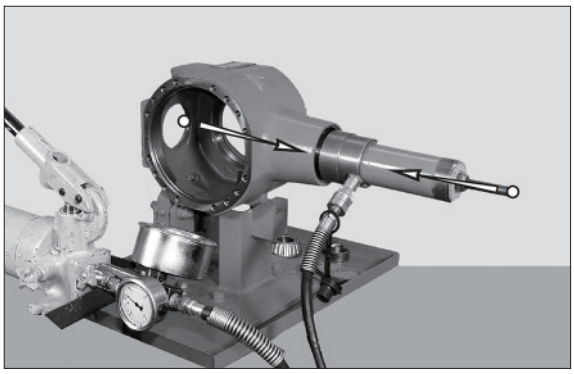
④ Calculate shims “S” for insertion under the thrust block of the inner bearing using the following formula :
S = X - (I + D) where :
X = Fixed dimension I = actual pinion center distance
D = Total bearing thickness ;
Example :
S = 128 - (97.9 + 29.45) = 0.65 ㎜

⑤ Using special tool T7.
Partially insert the thrust block of the bearings (4) and shims (10).

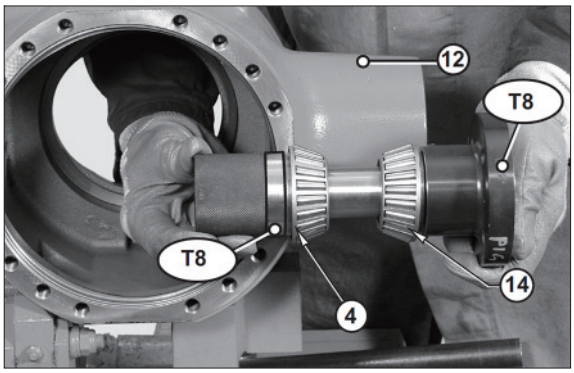


⑥ Connect the tension rod to the press and move the thrust block of bearings (4) (14) into the seats.
Disconnect the press and remove the tension rod.

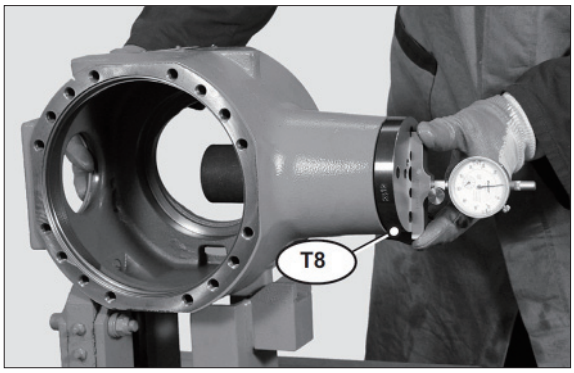
※ Before starting the next stage, make sure that the thrust block has been completely inserted into its seat.



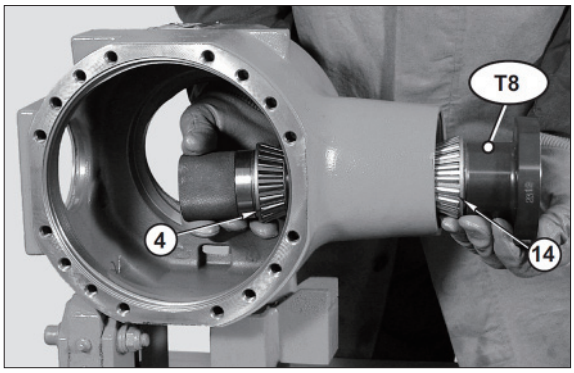
⑦ **Calculating pinion bearings rolling torque**
Introduce tool T8 complete with bearings (4) and (14) into the main body (12); tighten by hand until a rolling torque is definitely obtained.



⑧ Introduce the tracer of a depth comparator “DDG” into either side hole of tool T8.
Reset the comparator with a preload of about 3 mm.

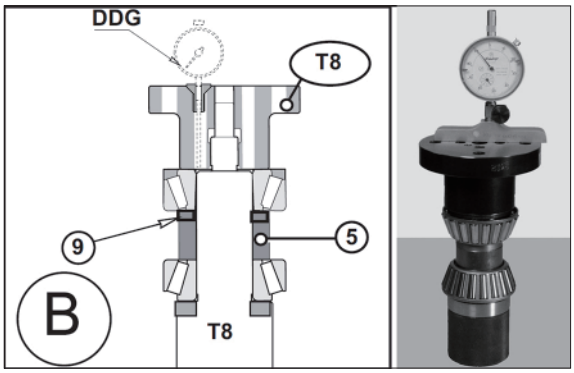


⑨ Remove the comparator and take out tool and bearing kits from the main body. Reinstall every part, also introducing a distance piece between bearings (4) and (14). Tighten the entire pack by hand.



⑩ Assemble on top of the tool T8 and between the two bearings the shim (5) and the largest calibrated shim (9).

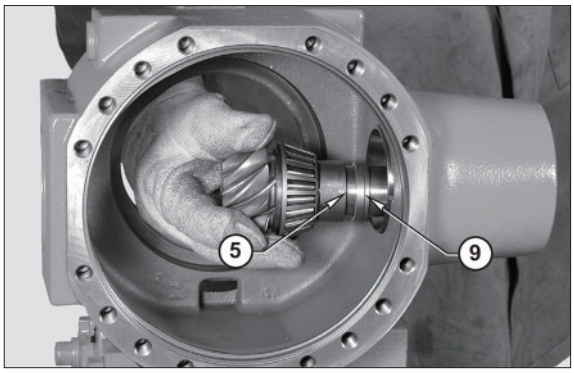
⑪ Measur the difference H using a dial gauge DDG.



⑫ Calculate the shim S2 to be inserted.
E.g. S2 = H + X = 3.01 mm where X = fixed value to obtain = 0.07~0.08 mm

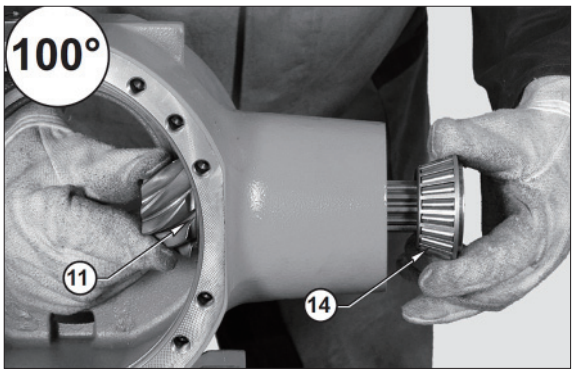
⑬ Fit the pinion (11), shim “S1” (10) and distance piece (5), (9) in the main body (12).

※ The finer shims must be placed in-between the thicker ones.



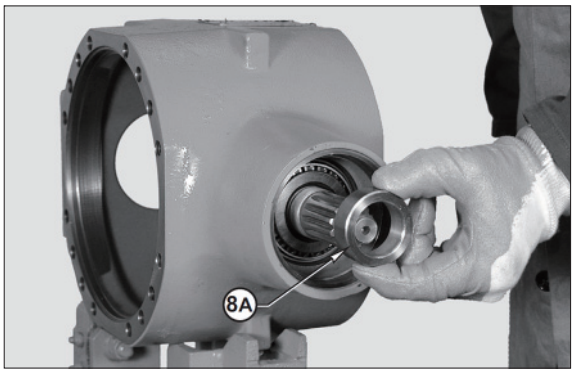
⑭ Heat the external bearing (14) to a temperature of about 100˚C and fit it on to the pinion (11) so as to complete the pack as shown in the figure.

※ Lightly lubricate bearing with SAE85W90 oil.

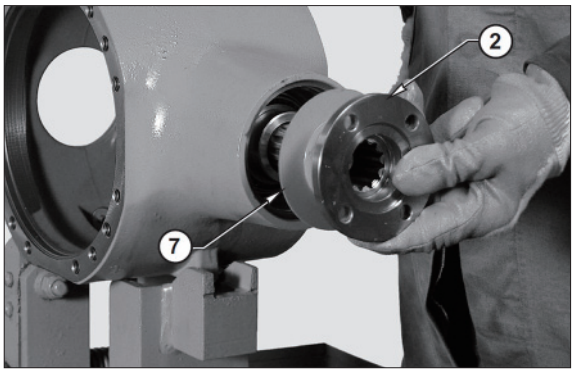


⑮ Insert the spacer (8A).

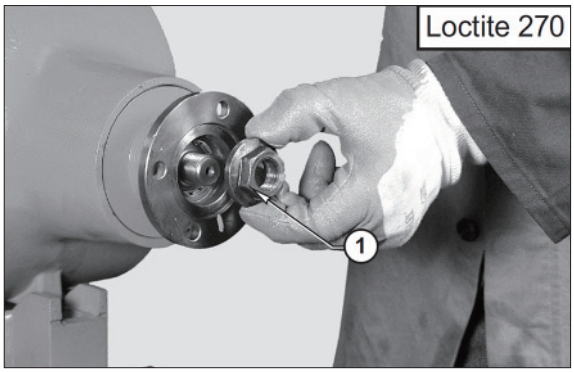
※ Check the using of the friction washers.



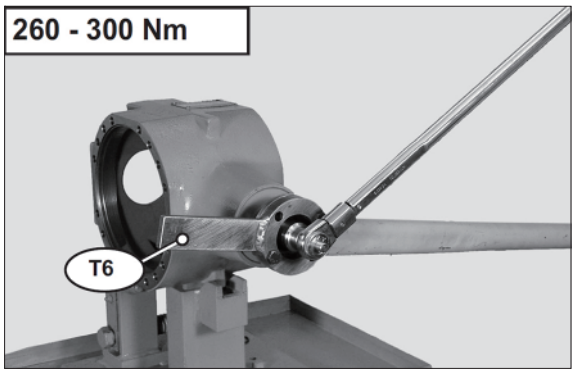
⑯ Install the flange (2) onto the pinion (11) without sealing ring.



⑰ Install the nut (1) without loctite 270.



⑱ Lock the wrench T6, rotate the pinion using a dynamometric wrench, up to a minimum required torque setting of 26.5~30.6 kgf · m (192~221 lbf · ft).

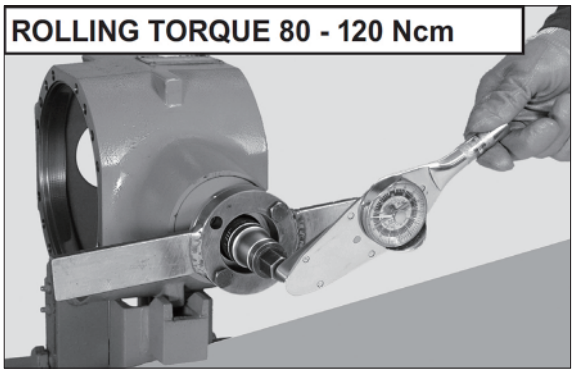


⑲ Apply onto the pinion (1) the bar-hold and with the help of a torque meter, check the torque of the pinion (1).

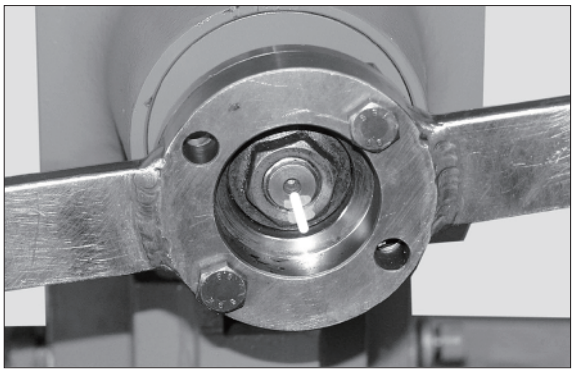
· Torque : 0.08~0.12 kgf · m
(0.58~0.87 lbf · ft)

※ If torque exceeds the maximum value, then the size of shim “S1” (4) between the bearing (9) and the distance piece (3) needs to be increased. If torque does not reach the set value, increase the torque setting of the ring nut (10) in different stages to obtain a maximum value of 51 kgf · m (369 lbf · ft).

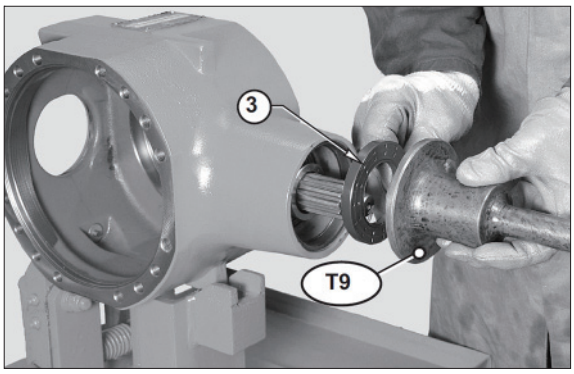
※ If torque does not reach the minimum value, then the size of shim “S1” (4) needs to be reduced. When calculating the increase or decrease in size of shim “S1”, bear in mind that a variation of shim of 0.01 mm corresponds to a variation of 0.06 kgf · m (0.44 lbf · ft) in the torque of the pinion (1).



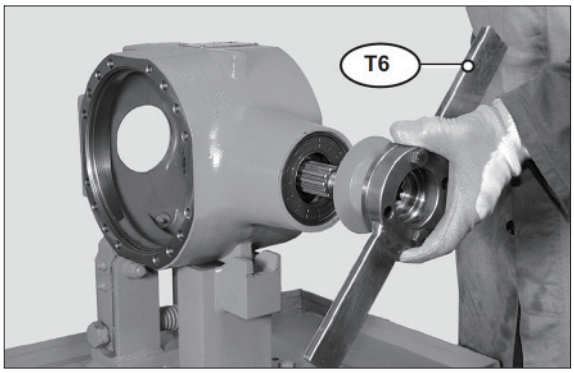
⑳ Make positional marks across nut (1) and pinion (11) tang; then remove nut and flange (2).



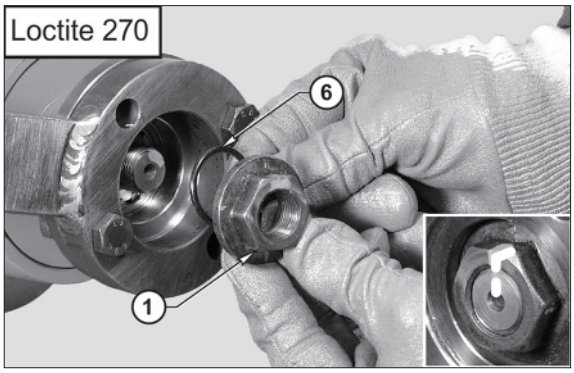
㉑ Apply Arexons rubber cement to the outer surface of the new seal ring (3) and fit ring in the main body (12) using driver T9.



㉒ Oil seal ring lips and install flange (2). Mount O-ring (6) and apply loctite 270 to pinion tang; tighten nut (1).



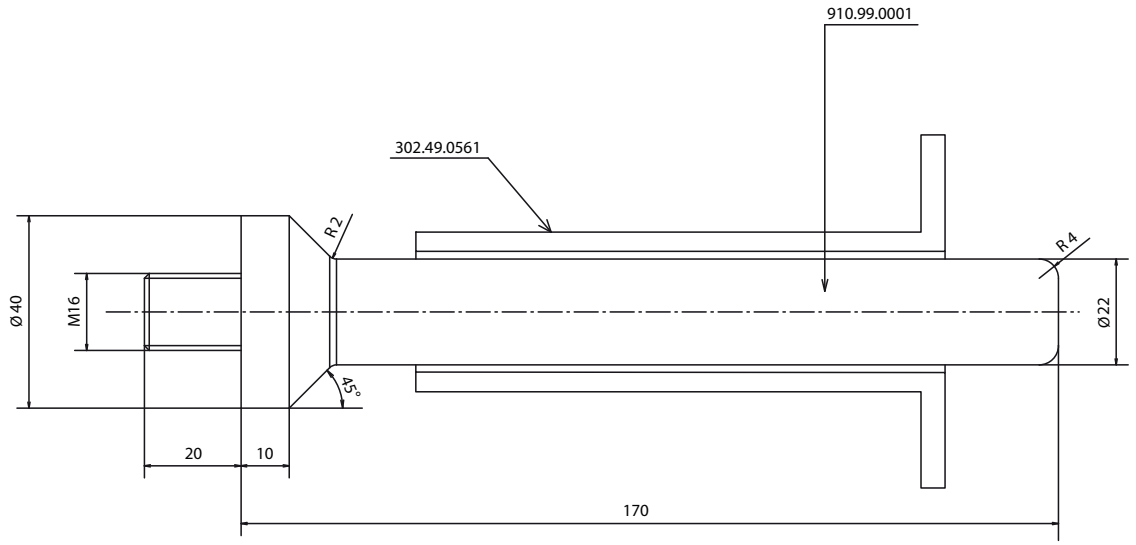
㉓ Tighten the nut until the match marks made at stage “a” line up.



6) SPECIAL TOOLS

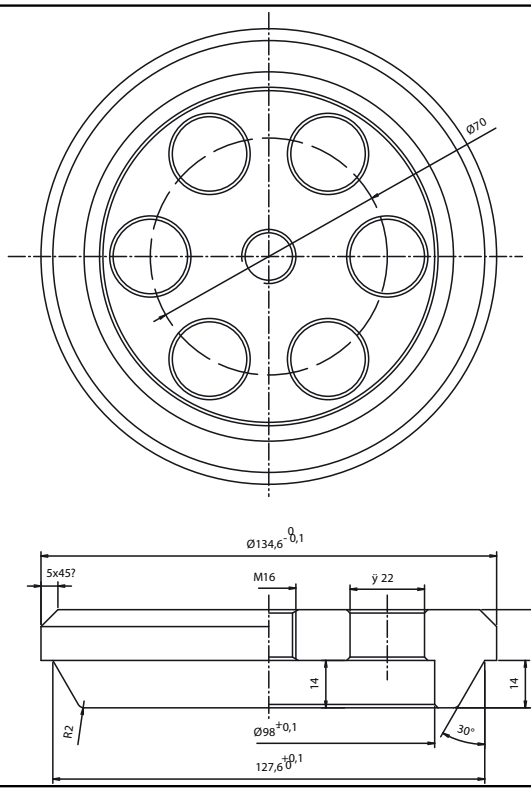
T0

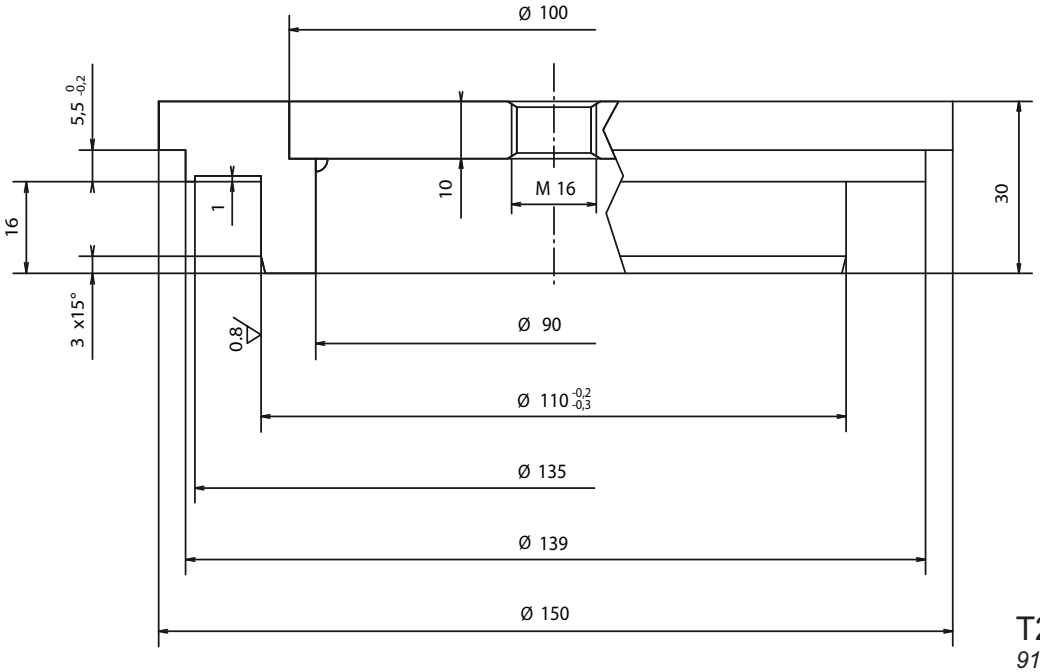
910.99.0001



T1

910.06.2385



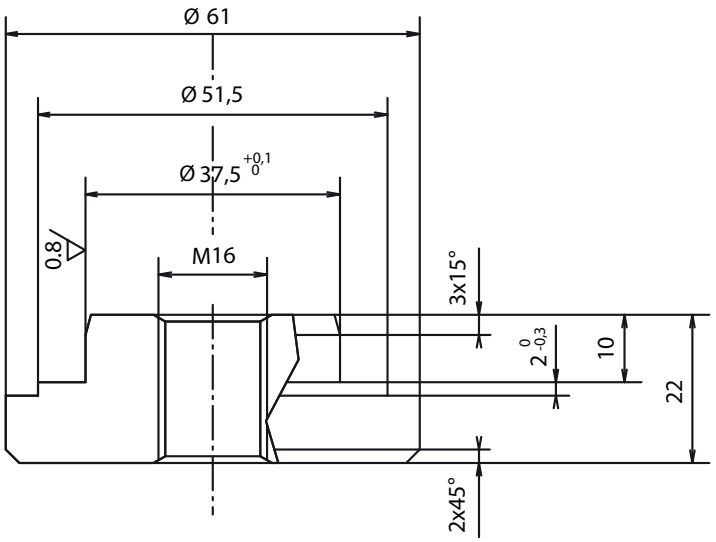


T2

910.06.0456

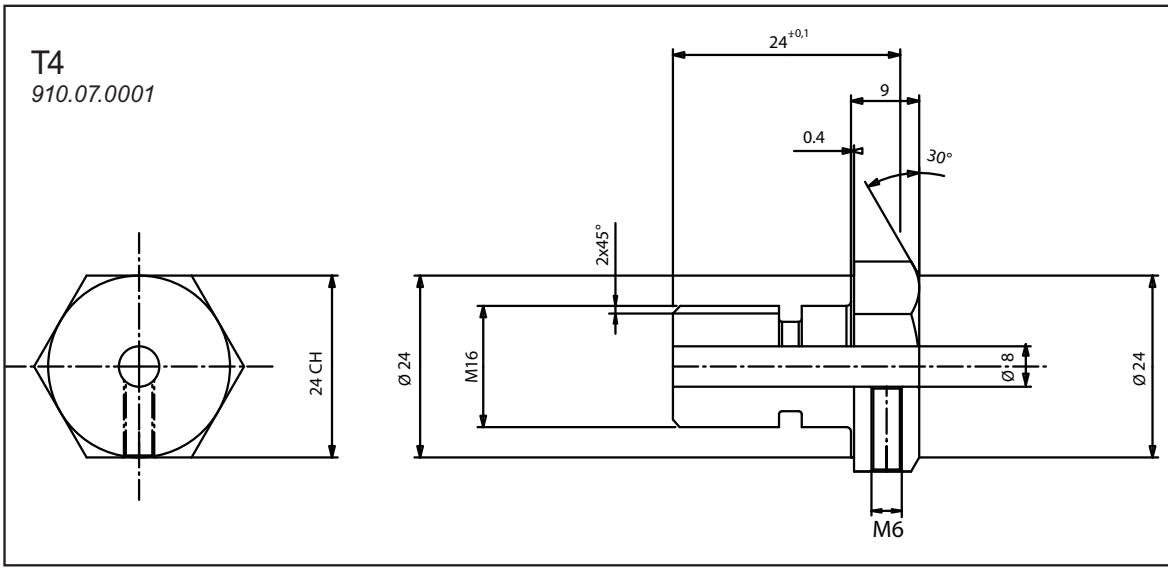
T3

910.06.4088



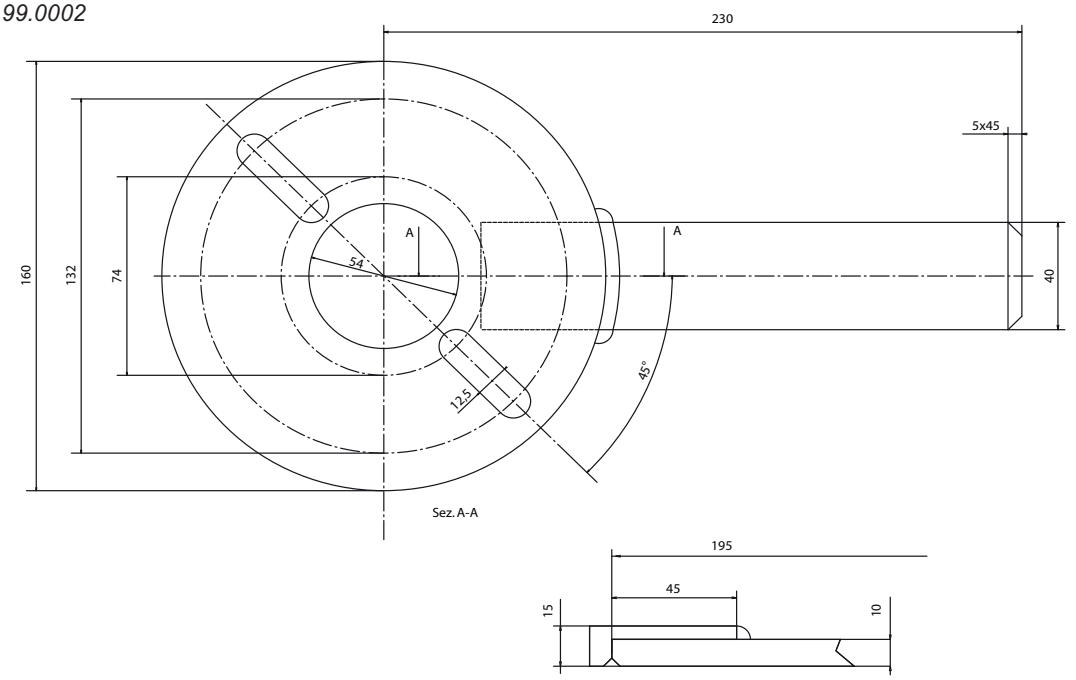
T4

910.07.0001



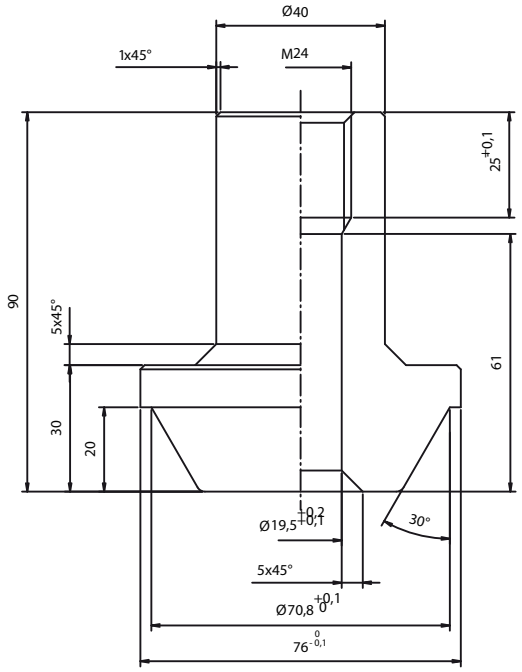
T6

910.99.0002



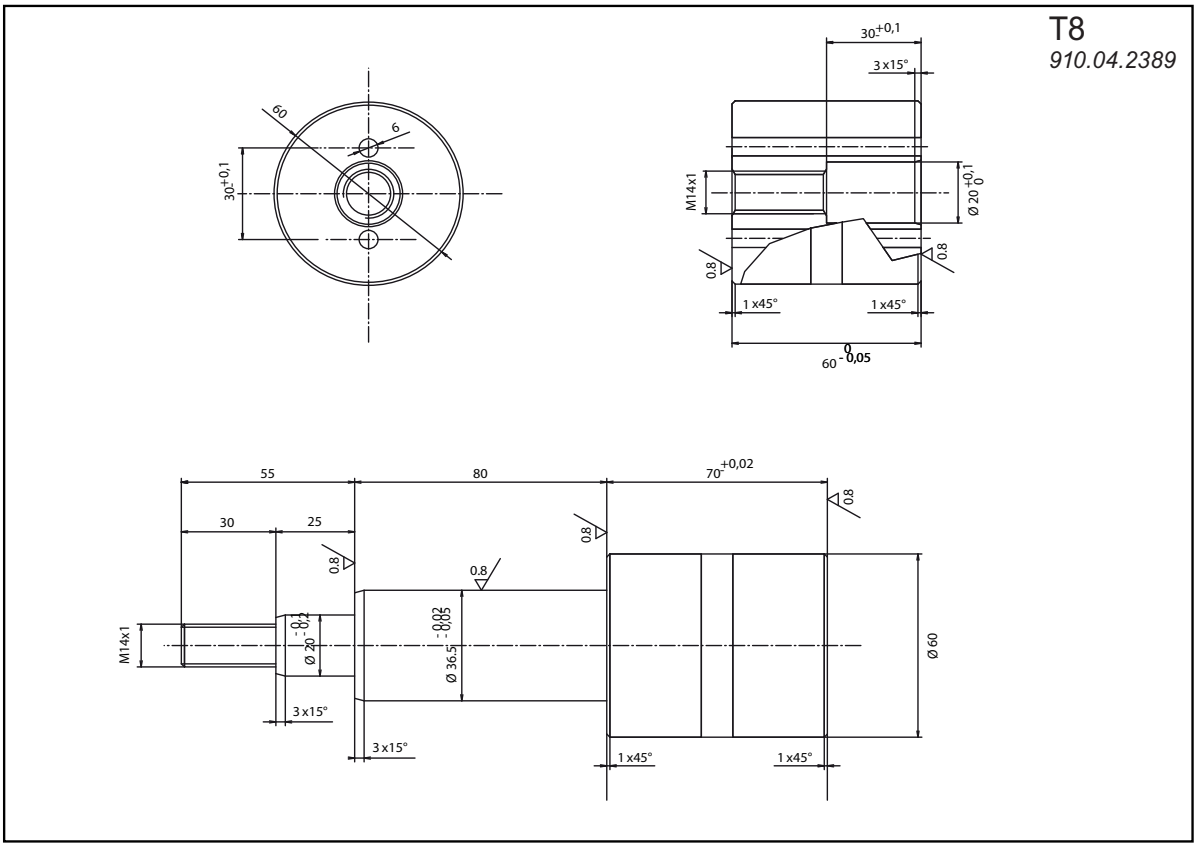
T7

910.06.4069



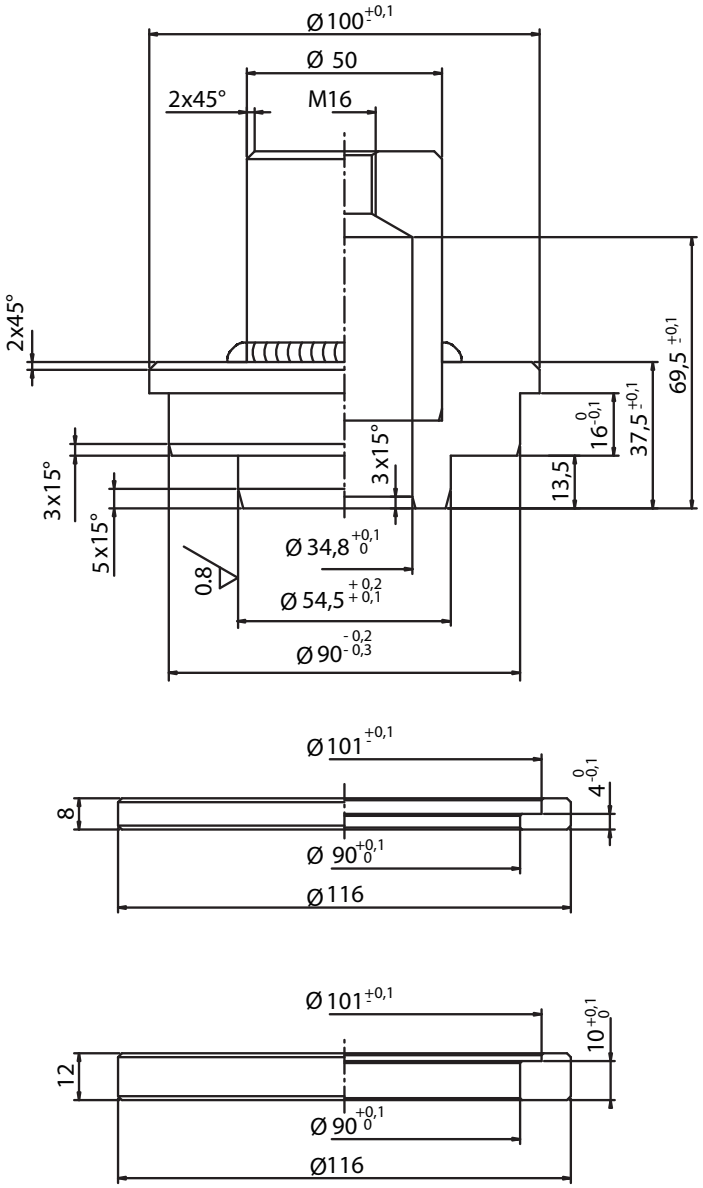
T8

910.04.2389



T9

910.04.4214

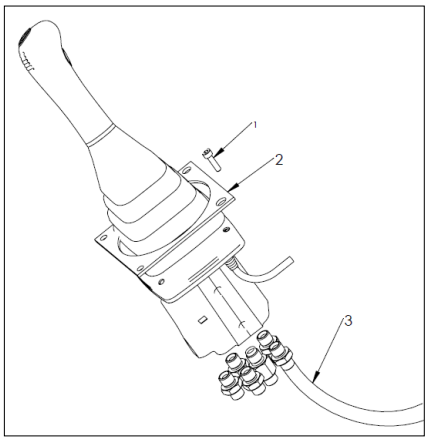


GROUP 8 RCV LEVER

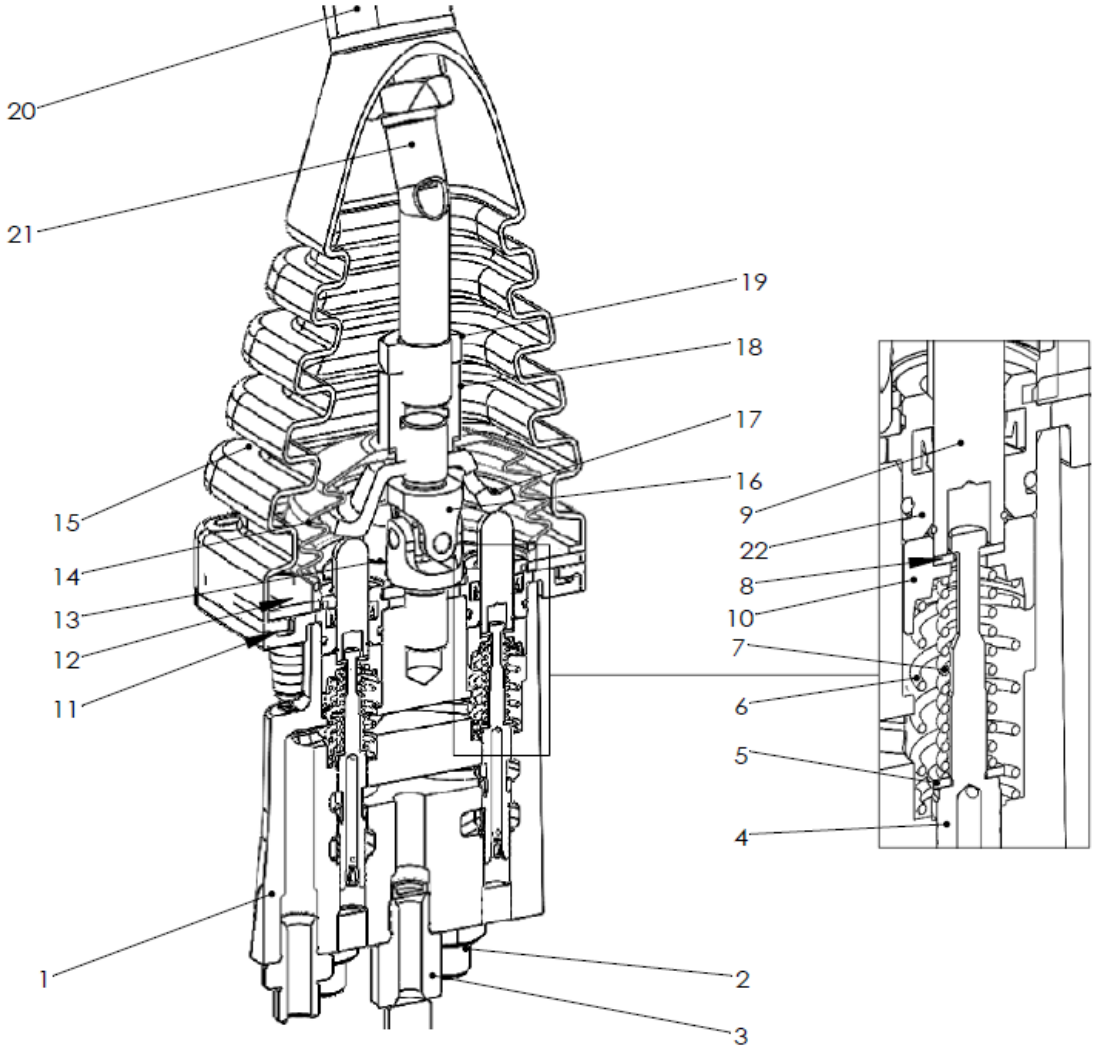
1. REMOVAL AND INSTALL

- REMOVAL
  1) Lower the work equipment to the ground and stop the engine.
  2) Operate the control levers and pedals several times to release the remaining pressure in the hydraulic piping.
  3) Loosen the breather slowly to release the pressure inside the hydraulic tank.
  4) Loosen the socket bolt(1).
  5) Remove the cover of the console box(2).
  6) Disconnect pilot line hoses(3).
  7) Remove the pilot valve assembly

- INSTALL
  1) Carry out installation in the reverse order to removal.
  2) Confirm the hydraulic oil level and check the hydraulic oil leak or not.



- **STRUCTURE**



1 Body	2 Shortadaptor	3 Long adaptor	4 Spool
5 Spring seat	6 Return spring	7 Reduce spring	8 Lock Washer
9 Bullet	10 Guider ring	11 Fixing flange	12 Press flange
13 Circle flange	14 In rubber bellow	15 Rubber bellow	16 Cardon Joint
17 Selector	18 Link nut	19 Lock nut	20 Handle
21 Bent joint	22 Piston		

- TOOLS

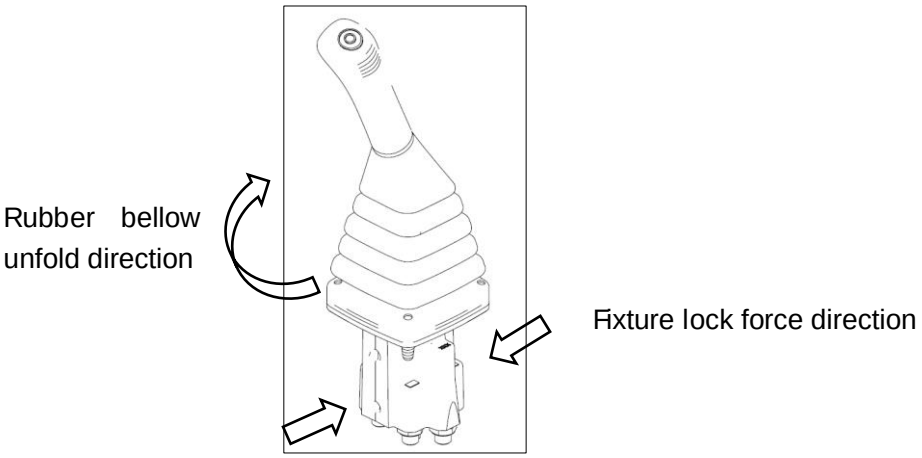
1) Allen wrench: Hex.4 mm
2) Spanner: Hex22mm; 18mm;

- TighteningTorque

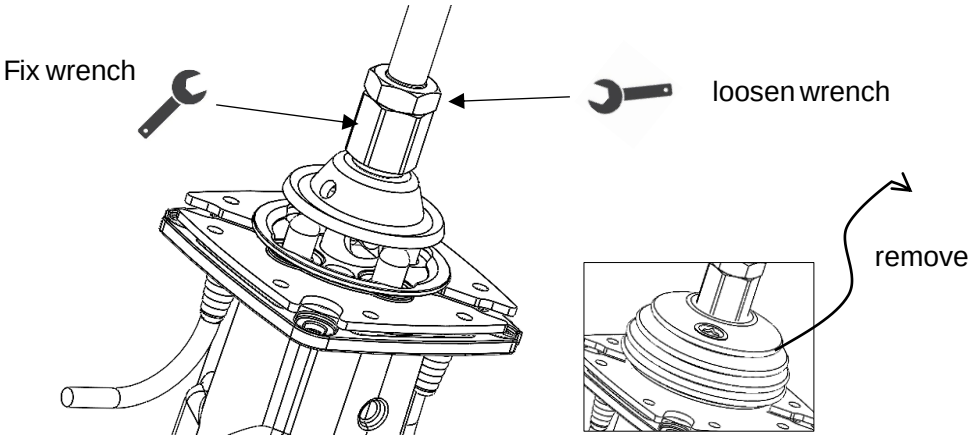
Part name	Item number	Tool size	Torque
Cardon Joint	16	18mm	24Nm
Link nut	18	22mm	24Nm
Lock nut	19	22mm	24Nm
adaptor	2, 3	19mm	24Nm

- **DISASSEMBLY**

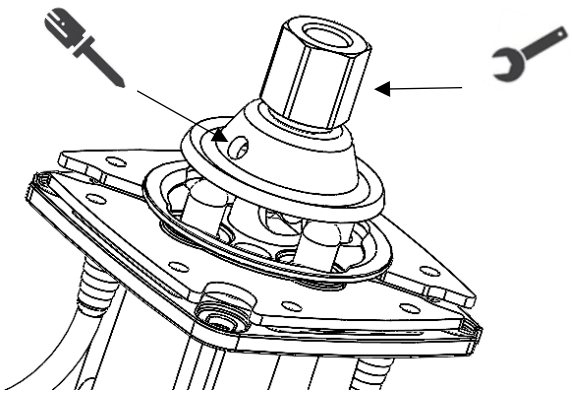
1) Fixing the joysticks on available Fixture or Bench vice Be attention to protect the body by covering closes or soft rubber
2) Loosening the rubber bellow and unfold it



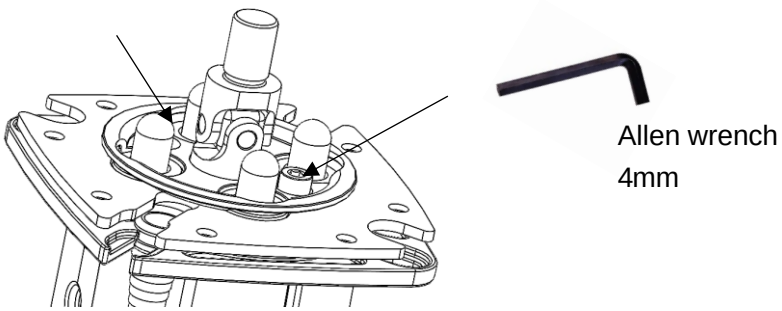
3) Remove the circle rubber bellow (14) and after to the handle kits(20), to use one wrench fix the Link nut(18), and another wrench to loosen lock nut(19)



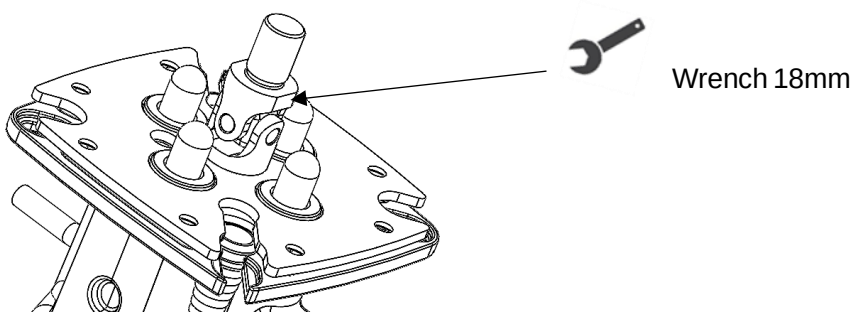
4) Remove the link nut(18), it need an auxiliary Pin or screwdriver to insert the hole on the selector(17), the loosen the link nut(18). And after to remove the Selector(17) by the screwdriver too



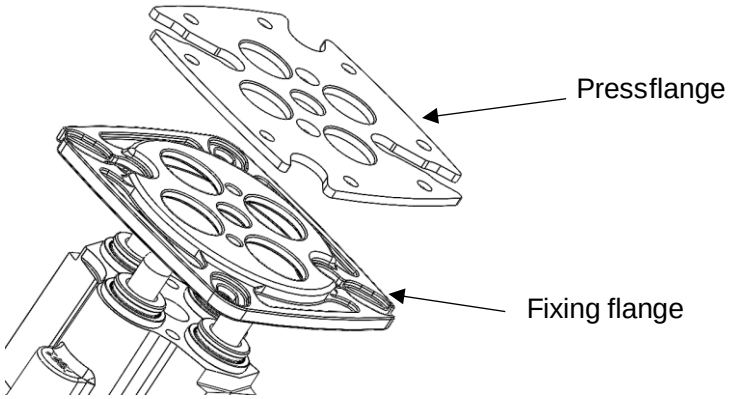
5) To disassembly the circle flange(13), to use hex 4 mm Allen wrench loosen the fix screw on this flange



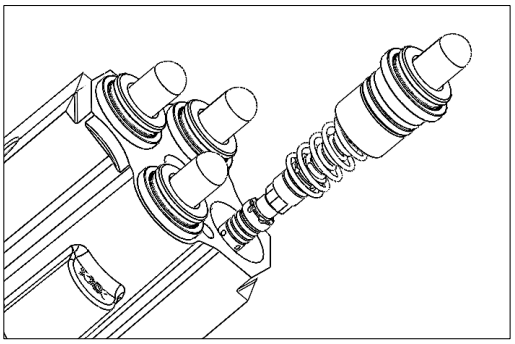
6) To disassembly Cardon Joint (16)



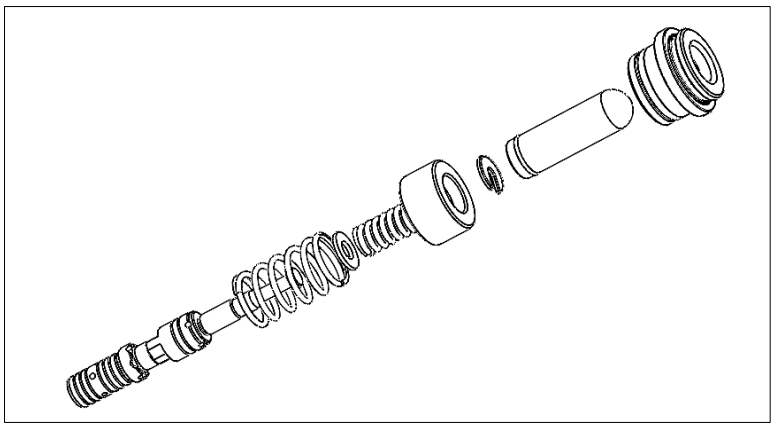
7) Remove the press flange(12) and fixing flange (11)



8) Disassembly the pilot curve kits the four kits is the same composition



9) Disassembly the curve kits, the seal will not be separated to repair, and it need to replaced with piston together as the relative parts list



10) Cleaning the internal parts

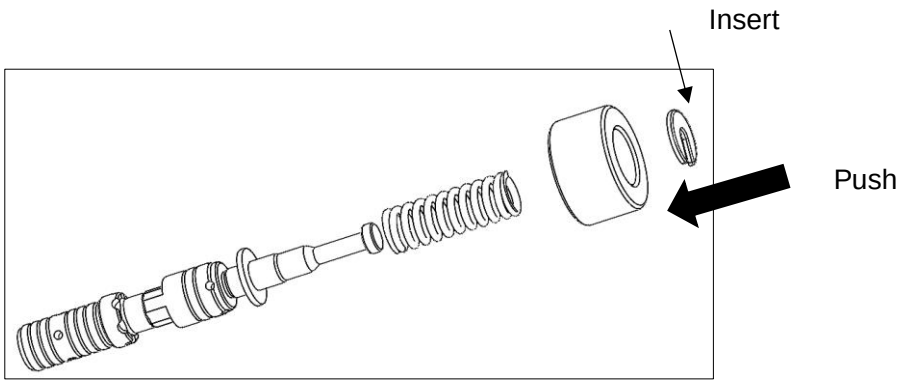
i) Put all parts in rough cleaning vessel filled with kerosene and clean them, this is a basic cleaning process

ii) Put parts in final cleaning vessel filled with kerosene, turning it slowly to clean them even to their insides, this is the best cleaning process

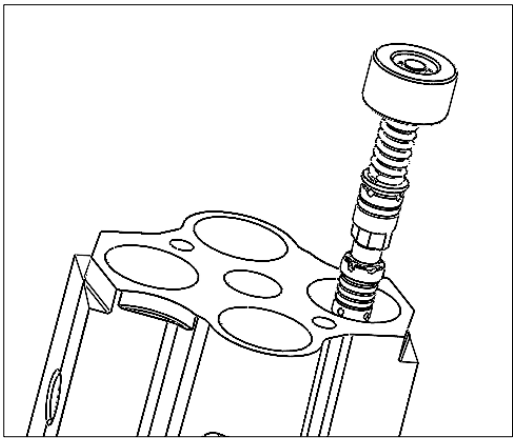
iii) It's not to recommend to remove the rusty and instead of to change new parts if it's serious

- **ASSEMBLY**

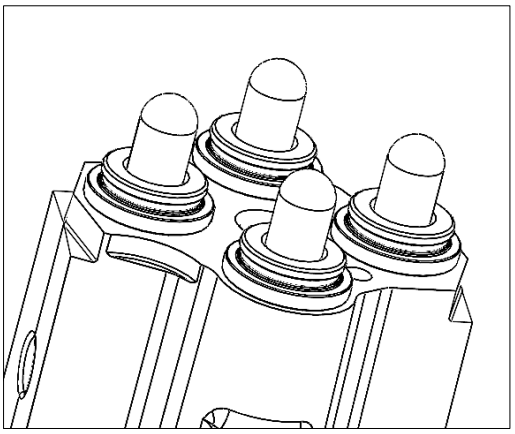
1) The curve kits assembly, to follow below view sequence to assembly these parts, and push the guider ring(10), and then inert the lock ring(8), make the curve be a whole kits



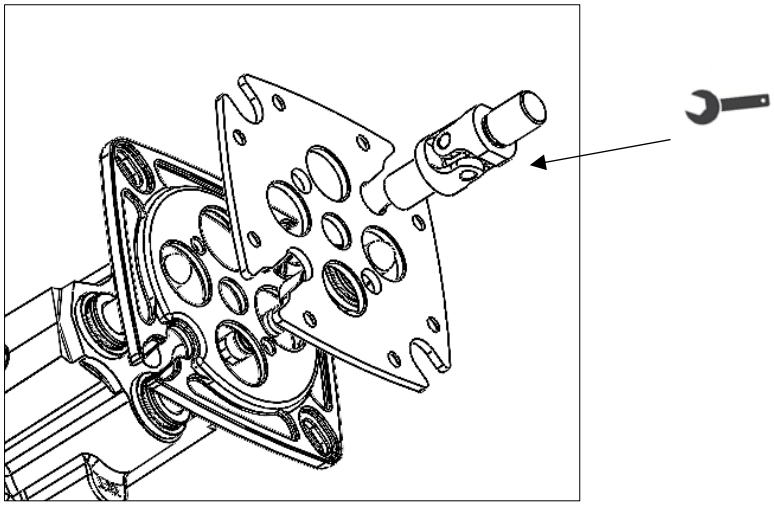
2) To put all kits in the body cavity



3) Put the piston(22) and bullet(9)



4) Put Fix flange(11) and pressflange(12), then lock it byCardon Joint(16)



5) The next assembly procedure will be a opposite operation of disassembly

6) Inject volatile rust-preventives through allports and then put blind plugs in ports.

GROUP 9 TURNING JOINT

1. REMOVAL AND INSTALL

1) REMOVAL

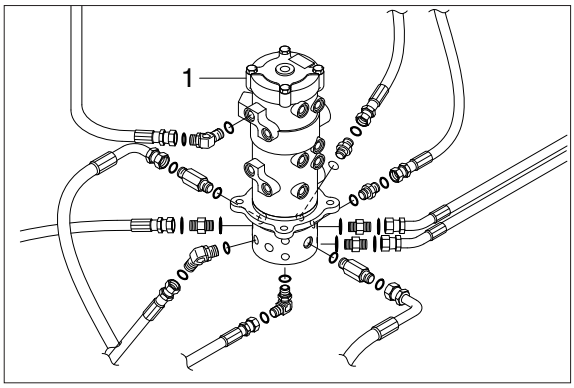
(1) Lower the work equipment to the ground and stop the engine.

(2) Operate the control levers and pedals several times to release the remaining pressure in the hydraulic piping.

(3) Loosen the breather slowly to release the pressure inside the hydraulic tank.

⚠ **Escaping fluid under pressure can penetrate the skin causing serious injury.**

※ When pipes and hoses are disconnected, the oil inside the piping will flow out, so catch it in oil pan.



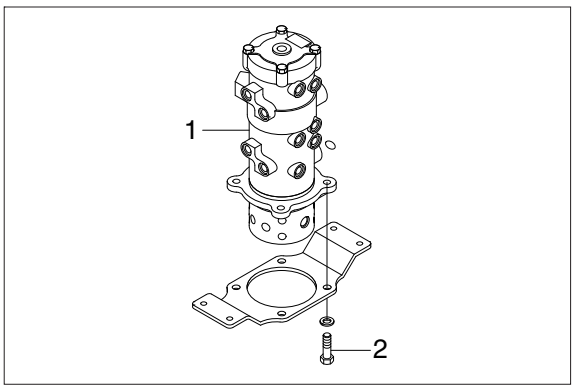
(4) Disconnect all hoses.

(5) Sling the turning joint assembly (1) and remove the mounting bolt (2).
- Weight : 30 kg (70 lb)
- Tightening torque : 14.7± 2.2 kgf · m (106± 15.9 lbf · ft)

(6) Remove the turning joint assembly.

※ When removing the turning joint, check that all the hoses have been disconnected.

2) INSTALL



(1) Carry out installation in the reverse order to removal.

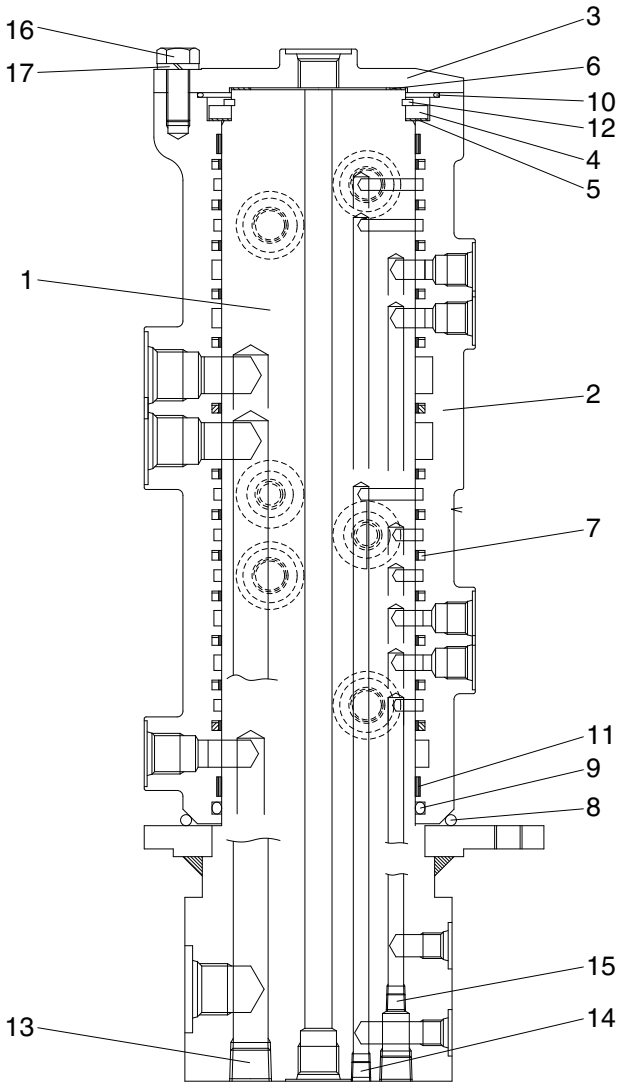
※ Take care of turning joint direction.

※ Assemble hoses to their original positions.

※ Confirm the hydraulic oil level and check the hydraulic oil leak or not.

2. DISASSEMBLY AND ASSEMBLY

1) STRUCTURE

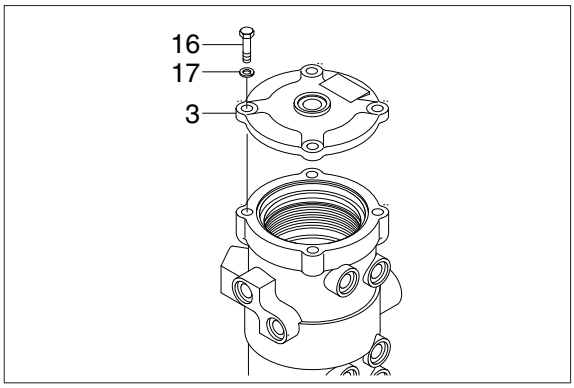


1	Shaft	7	Slipper seal	13	Plug
2	Hub	8	O-ring	14	Plug
3	Cover	9	O-ring	15	Plug
4	Spacer	10	O-ring	16	Hexagon bolt
5	Shim	11	Wear ring	17	Spring washer
6	Shim	12	Retainer ring		

2) DISASSEMBLY

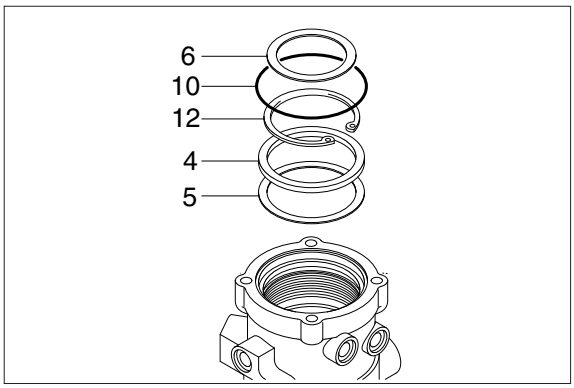
※ Before the disassembly, clean the turning joint.

(1) Loosen the bolts (16), washer (17) and remove cover (3).



(2) Remove shim (6) and O-ring (7).

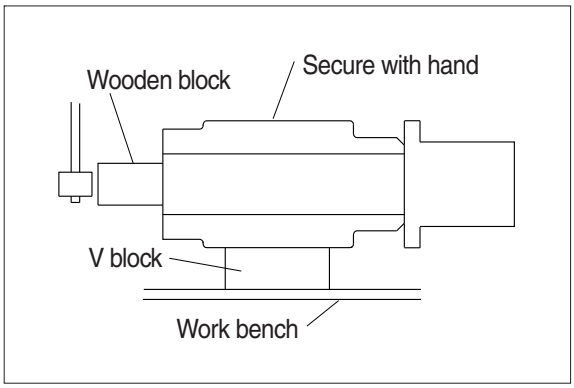
(3) Remove retainer ring (12), spacer (4) and shim (5).



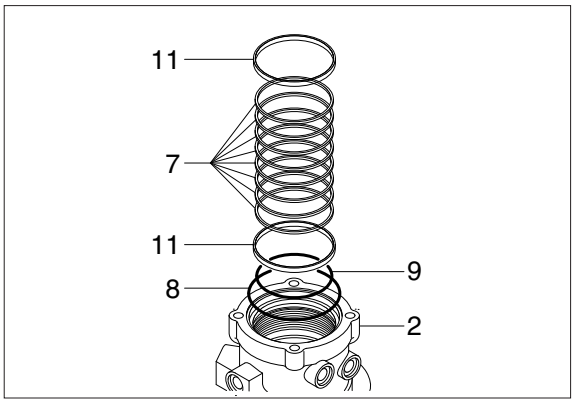
(4) Place hub (2) on a V-block and by using a wood buffer at the shaft end, hit out shaft (2) to about 1/2 from the body with a hammer.

※ Take care not to damage the shaft (1) when remove hub (2) or rest it sideway.

※ Put a fitting mark on hub (2) and shaft (1).



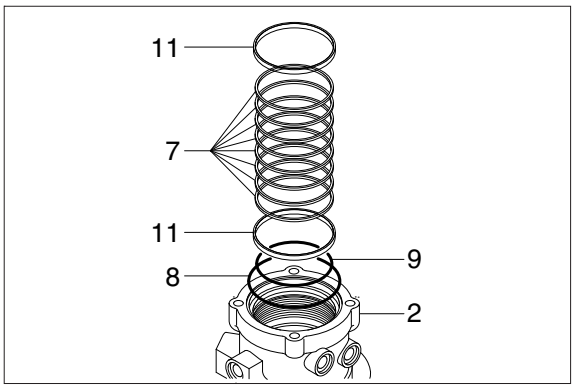
(5) Remove wear rings (11), thirteen slipper seals (7) and O-rings (8, 9) from hub (2).



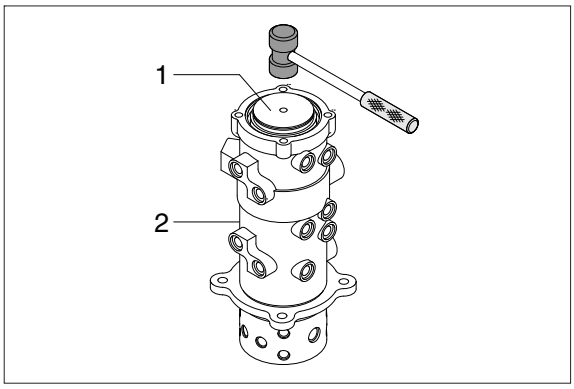
3) ASSEMBLY

※ Clean all parts.
※ As a general rule, replace oil seals and O-ring.
※ Coat the sliding surfaces of all parts with engine oil or grease before installing.

(1) Fix wear rings (11), thirteen slipper seals (7) and O-rings (8, 9) to hub (2).

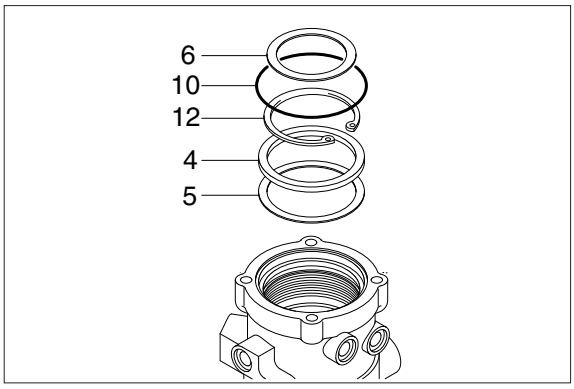


(2) Set shaft (1) on block, tap hub (2) with a plastic hammer to install.

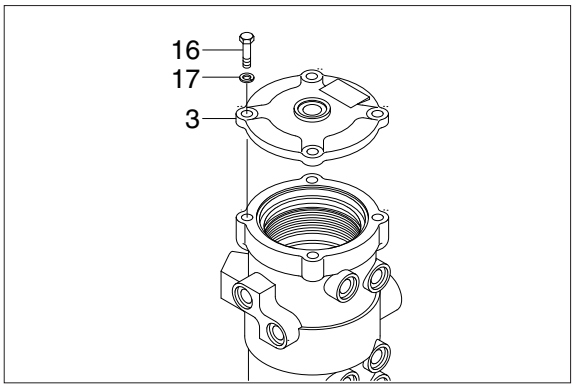


(3) Fit shim (5), spacer (4) and retainer ring (12) to shaft (11).

(4) Fit O-ring (7) to hub (2).



(5) Install cover (3) to hub (2) and tighten bolts (16) with washer (13).



1. REMOVAL AND INSTALL

1) BUCKET CYLINDER

(1) Removal

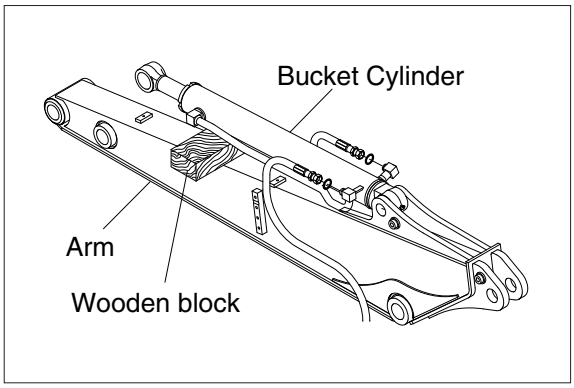
※ Expand the arm and bucket fully, lower the work equipment to the ground and stop the engine.

※ Operate the control levers and pedals several times to release the remaining pressure in the hydraulic piping.

⚠ **Loosen the breather slowly to release the pressure inside the hydraulic tank. Escaping fluid under pressure can penetrate the skin causing serious injury.**

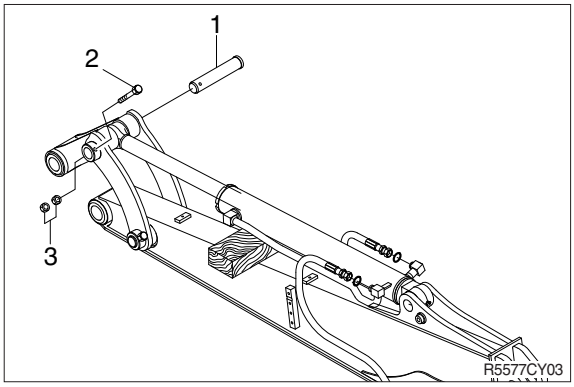
※ Fit blind plugs in the hoses after disconnecting them, to prevent dirt or dust from entering.

① Set block between bucket cylinder and arm.

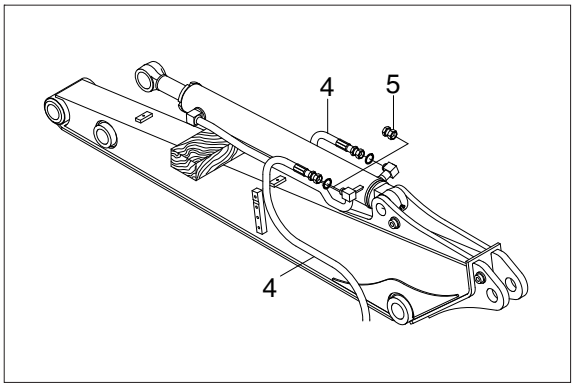


② Remove bolt (2), nut (3) and pull out pin (1).

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



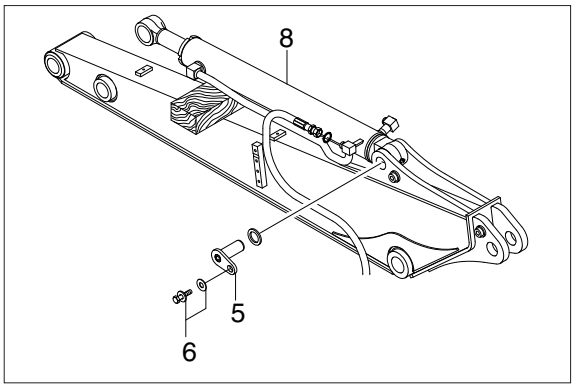
③ Disconnect bucket cylinder hoses (4) and put plugs (5) on cylinder pipe.



④ Sling bucket cylinder assembly (8) and remove bolt (6) then pull out pin (5).

⑤ Remove bucket cylinder assembly (8).

· Weight : 30 kg (70 lb)



(2) Install

① Carry out installation in the reverse order to removal.

⚠ When aligning the mounting position of the pin, do not insert your fingers in the pin hole.

※ Bleed the air from the bucket cylinder.

※ Confirm the hydraulic oil level and check the hydraulic oil leak or not.

2) ARM CYLINDER

(1) Removal

※ Expand the arm and bucket fully, lower the work equipment to the ground and stop the engine.

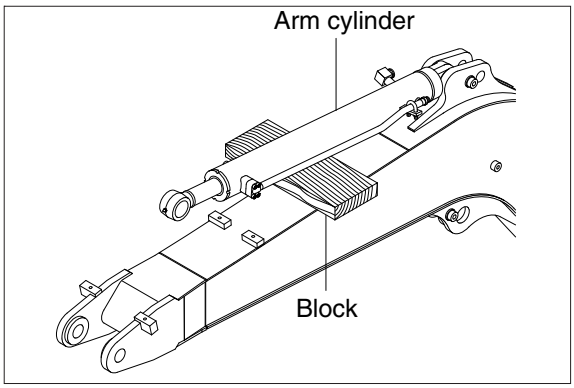
※ Operate the control levers and pedals several times to release the remaining pressure in the hydraulic piping.

⚠ Loosen the breather slowly to release the pressure inside the hydraulic tank.

⚠ Escaping fluid under pressure can penetrate the skin causing serious injury.

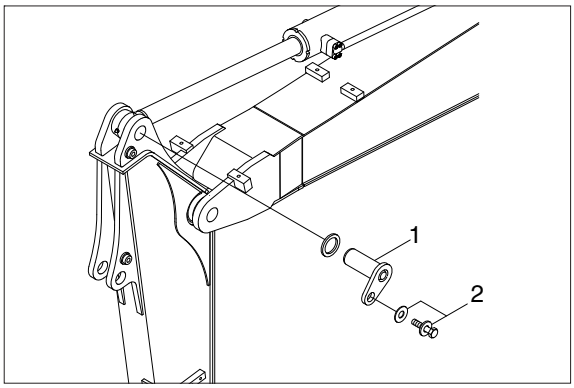
※ Fit blind plugs in the hoses after disconnecting them, to prevent dirt or dust from entering.

① Set block between arm cylinder and boom.



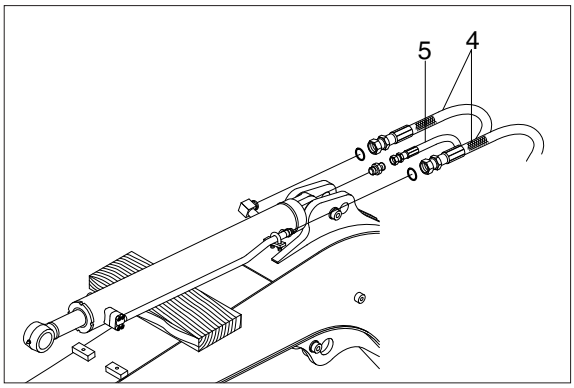
② Remove bolt (2) and pull out pin (1).

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



③ Disconnect arm cylinder hoses (4) and put plugs on cylinder pipe.

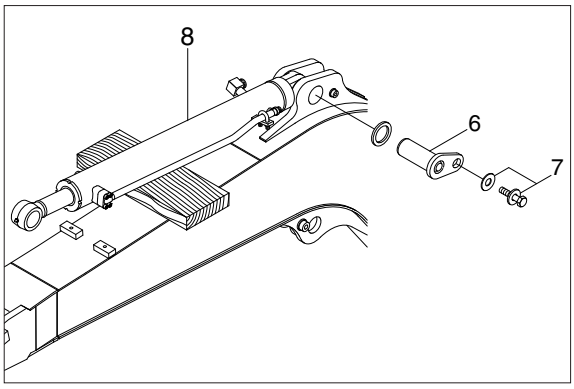
④ Disconnect greasing pipings (5).



⑤ Sling arm assembly (8) and remove bolt (7) then pull out pin (6).

⑥ Remove arm cylinder assembly (8).

・Weight : 50 kg (110 lb)



(2) Install

① Carry out installation in the reverse order to removal.

⚠ When aligning the mounting position of the pin, do not insert your fingers in the pin hole.

※ Bleed the air from the arm cylinder.

※ Confirm the hydraulic oil level and check the hydraulic oil leak or not.

3) BOOM CYLINDER

(1) Removal

※ Expand the arm and bucket fully, lower the work equipment to the ground and stop the engine.

※ Operate the control levers and pedals several times to release the remaining pressure in the hydraulic piping.

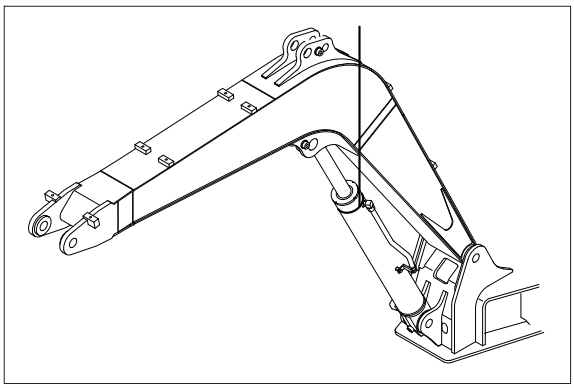
⚠ Loosen the breather slowly to release the pressure inside the hydraulic tank.

⚠ Escaping fluid under pressure can penetrate the skin causing serious injury.

※ Fit blind plugs in the hoses after disconnecting them, to prevent dirt or dust from entering.

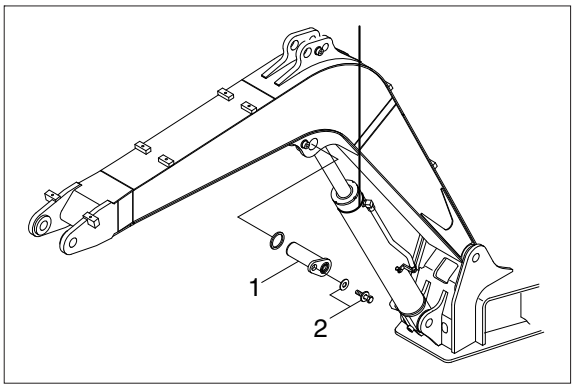
① Disconnet greasing hoses.

② Sling boom cylinder assembly.

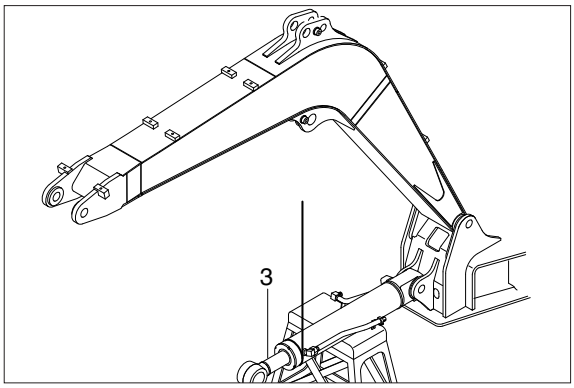


③ Remove bolt (2) and pull out pin (1).

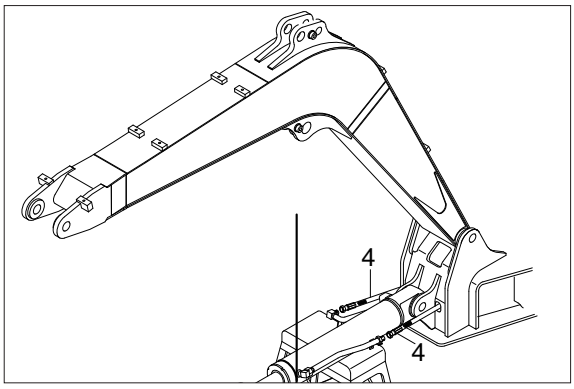
※ Tie the rod with wire to prevent it from coming out.



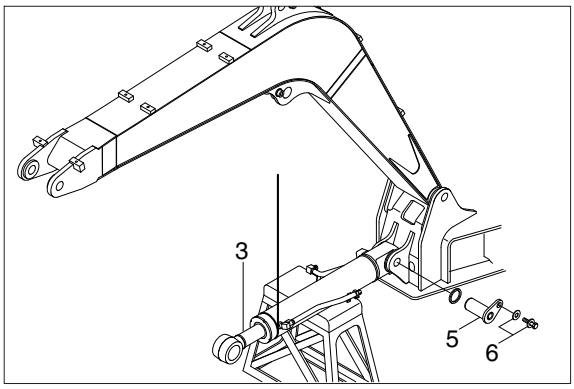
④ Lower the boom cylinder assembly (3) on a stand.



⑤ Disconnect boom cylinder hoses (4) and put plugs on cylinder pipe.



⑥ Remove bolt (6) and pull out pin (5).
⑦ Remove boom cylinder assembly (3).
· Weight : 60 kg (130 lb)



(2) Install

① Carry out installation in the reverse order to removal.

⚠ When aligning the mounting position of the pin, do not insert your fingers in the pin hole.

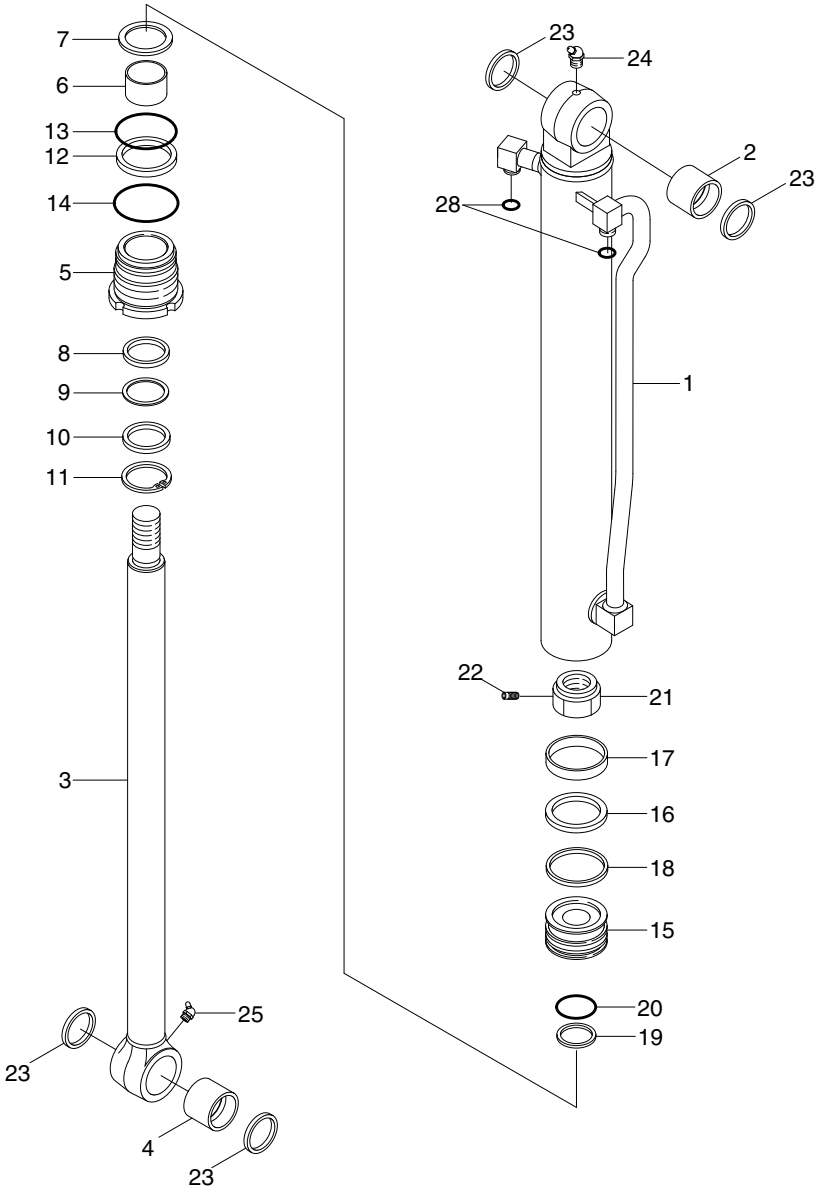
※ Bleed the air from the boom cylinder.

※ Conformed the hydraulic oil level and check the hydraulic oil leak or not.

2. DISASSEMBLY AND ASSEMBLY

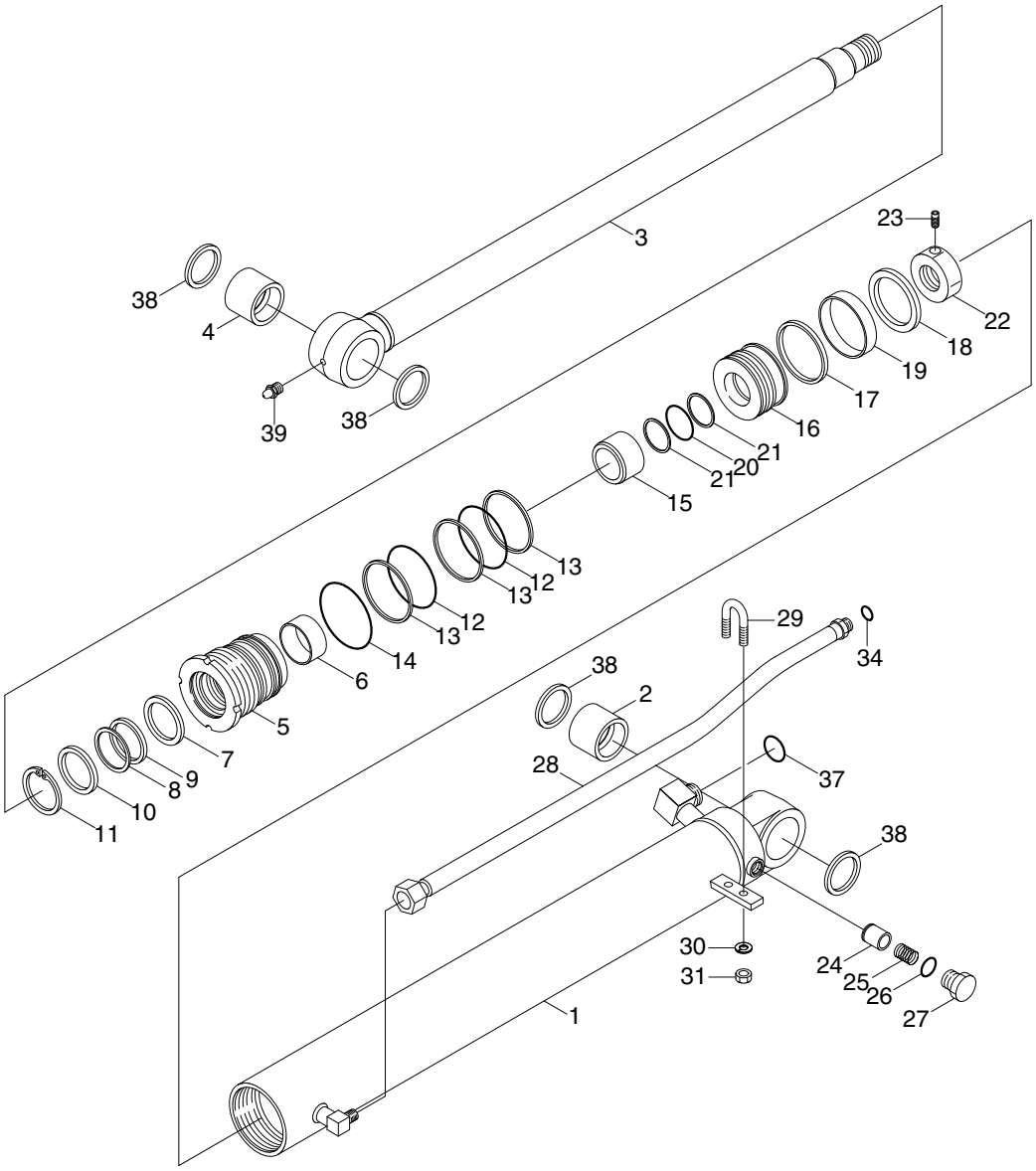
1) STRUCTURE

(1) Bucket cylinder



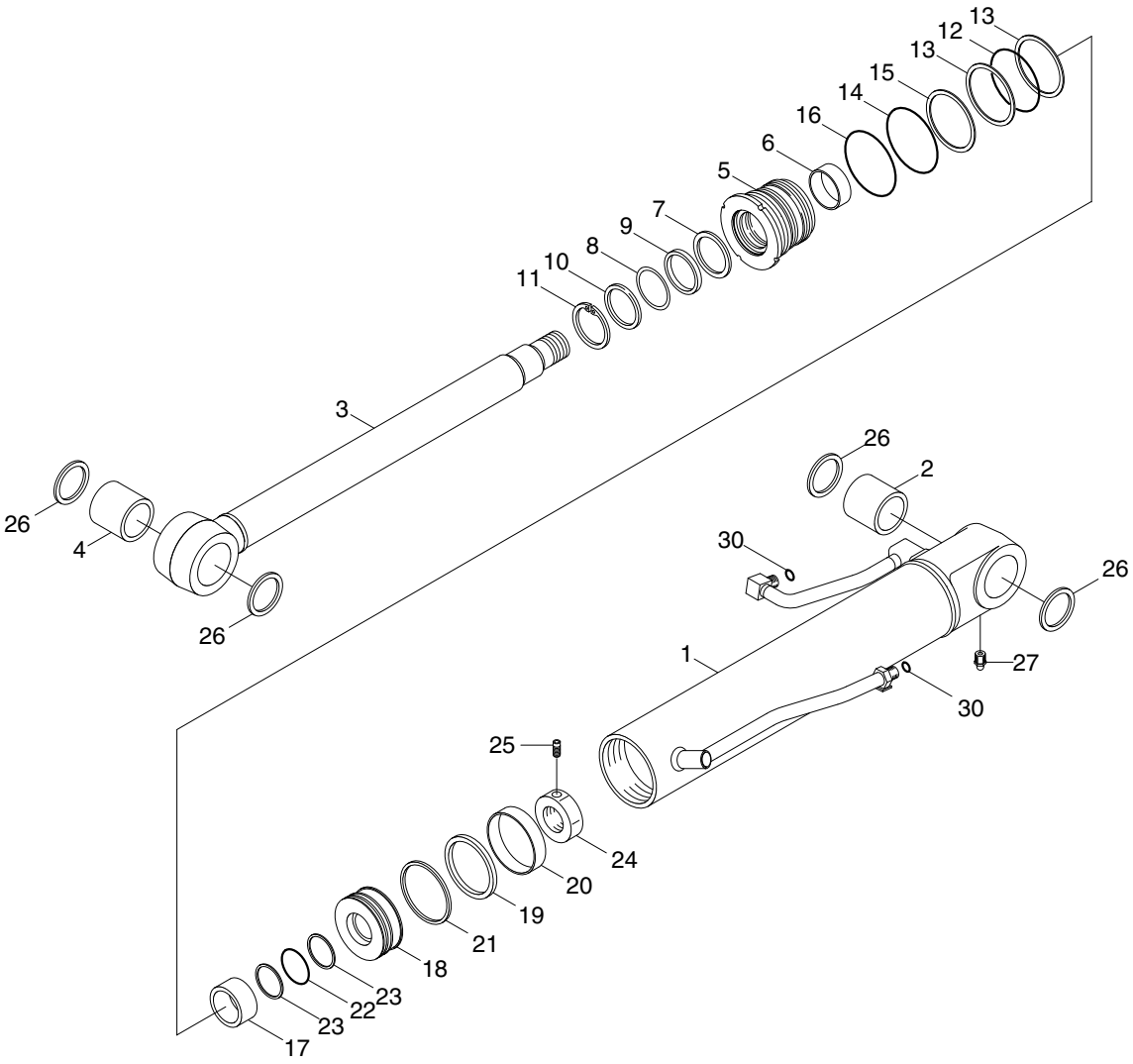
1	Tube assembly	11	Retaining ring	21	Dust ring
2	Bushing	12	O-ring	22	O-ring
3	Bushing	13	Back-up ring	23	Back-up ring
4	Du bushing	14	O-ring	24	Piston nut
5	Rod cover	15	Back-up ring	25	Set screw
6	Rod bushing	16	O-ring	26	Dust seal
7	Buffer ring	17	Cushion ring	27	Grease nipple
8	U-packing	18	Piston	30	O-ring
9	Back-up ring	19	Piston seal		
10	Dust seal	20	Wear ring		

(2) Arm cylinder



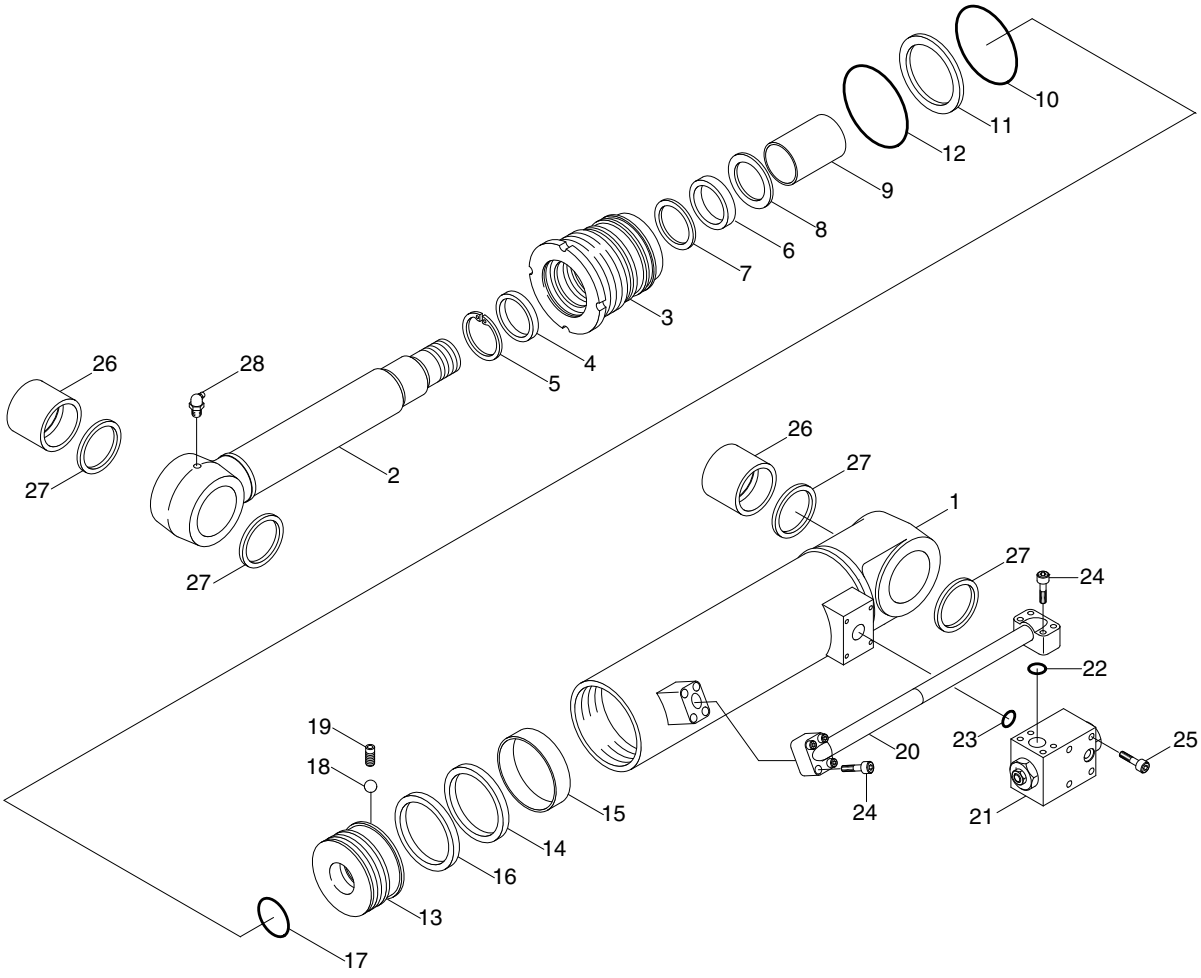
1	Tube assembly	9	DU bushing	17	O-ring
2	Rod assembly	10	O-ring	18	Back-up ring
3	Gland	11	Back-up ring	19	Steel ball
4	Dust wiper	12	O-ring	20	Set screw
5	Retaining ring	13	Piston	21	Bushing
6	Rod seal	14	Piston seal	22	Dust seal
7	Back-up ring	15	Dust ring	23	Grease nipple
8	Buffer ring	16	Wear ring	24	O-ring

(3) Boom cylinder



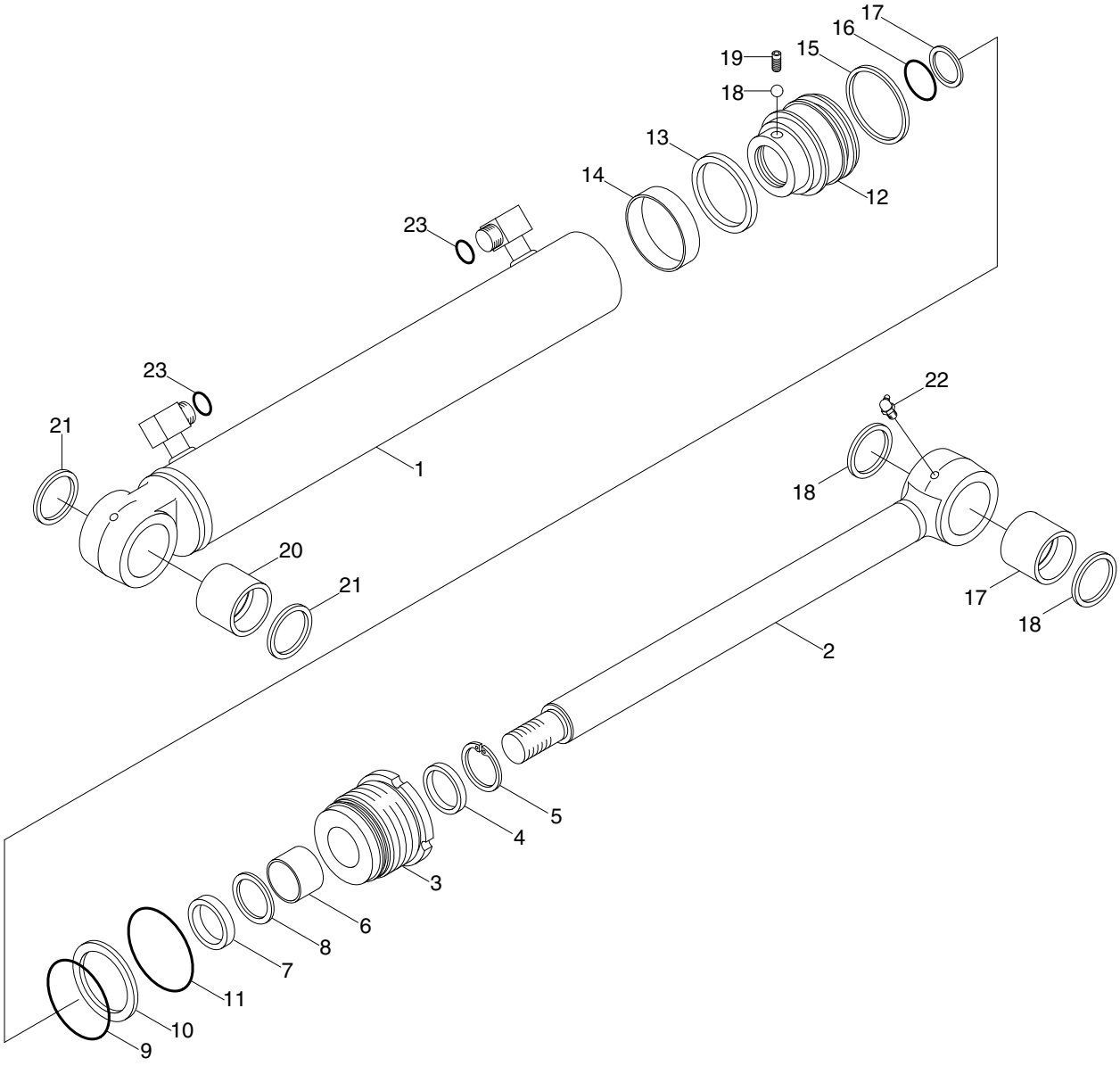
1	Tube assembly	9	O-ring	17	Back-up ring
2	Rod assembly	10	Buck-up ring	18	Steel ball
3	Gland	11	O-ring	19	Set screw
4	Dust wiper	12	Piston	20	Pin bushing
5	Retaining ring	13	Piston seal	21	Dust seal
6	DU bushing	14	Wear ring	22	Grease nipple
7	Rod seal	15	Dust ring	23	O-ring
8	Buck-up ring	16	O-ring		

(4) Dozer cylinder



1	Tube assembly	11	Buck-up ring	21	Check valve
2	Rod assembly	12	O-ring	22	O-ring
3	Gland	13	Piston	23	O-ring
5	Retaining ring	14	Piston seal	24	Socket head bolt
6	Rod seal	15	Wear ring	25	Socket head bolt
7	Buck-up ring	16	Dust ring	26	Pin bushing
4	Dust wiper	17	O-ring	27	Dust seal
8	Buffer ring	18	Steel ball	28	Grease nipple
9	DU bushing	19	Set screw		
10	O-ring	20	Pipe assembly (R)		

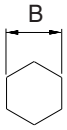
(5) Boom swing cylinder



1	Tube assembly	9	O-ring	17	Back-up ring
2	Rod assembly	10	Buck-up ring	18	Steel ball
3	Gland	11	O-ring	19	Set screw
4	Dust wiper	12	Piston	20	Pin bushing
5	Retaining ring	13	Piston seal	21	Dust seal
6	DU bushing	14	Wear ring	22	Grease nipple
7	Rod seal	15	Dust ring	23	O-ring
8	Buck-up ring	16	O-ring		

2) TOOLS AND TIGHTENING TORQUE

(1) Tools

Name	Specification	
Allen wrench	8	
	10	
Spanner	M22	
Hook spanner	Suitable size	
(-) Driver	Small and large sizes	
Torque wrench	Capable of tightening with the specified torques	

(2) Tightening torque

Part name		Item	Size	Torque	
				kgf · m	lbf · ft
Gland	Boom cylinder	5	M115	70±9.7	506±70
	Arm cylinder	5	M95	70±8.7	506±63
	Bucket cylinder	5	M85	75±7.5	540±54
	Dozer cylinder	3	M105	70±7.0	506±51
	Boom swing cylinder	3	M100	70±7.0	506±51
Lock nut	Boom cylinder	22	M45	75±7.5	540±5.4
	Arm cylinder	21	M39	75±7.5	540±5.4
	Bucket cylinder	19	M36	75±7.5	540±5.4
	Dozer cylinder	13	M39	97.5±9.8	705±71
	Boom swing cylinder	16	M39	97.5±9.8	705±71

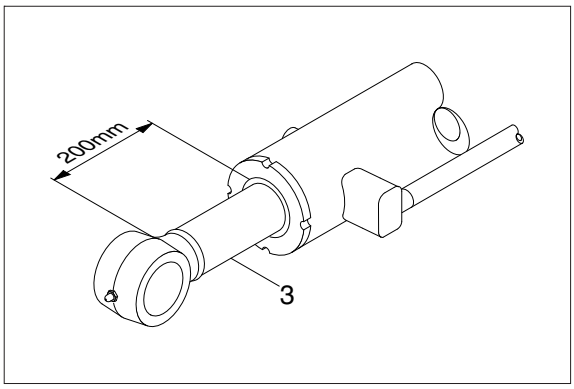
3) DISASSEMBLY

(1) Remove cylinder head and piston rod

① Hold the clevis section of the tube in a vise.

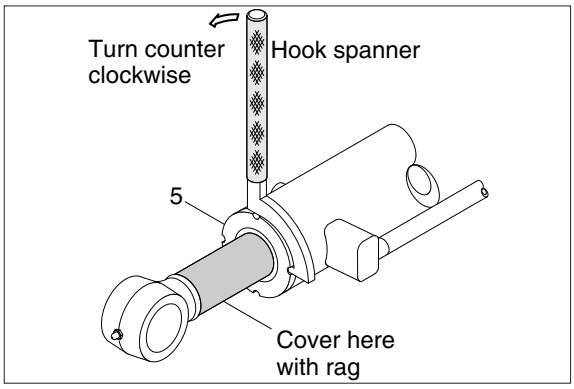
※ Use mouth pieces so as not to damage the machined surface of the cylinder tube. Do not make use of the outside piping as a locking means.

② Pull out rod assembly (3) about 200 mm (7.1 in). Because the rod assembly is rather heavy, finish extending it with air pressure after the oil draining operation.



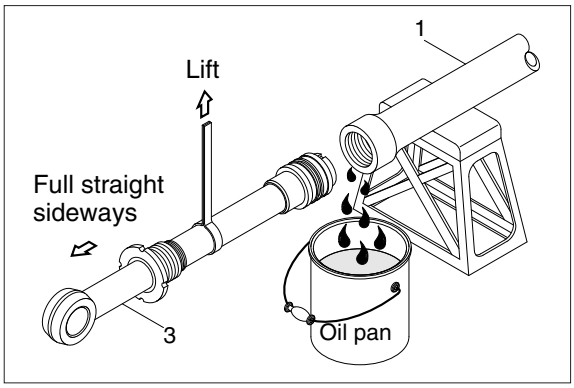
③ Remove rod cover (5) by hook spanner.

※ Cover the extracted rod assembly (3) with rag to prevent it from being accidentally damaged during operation.



④ Draw out cylinder head and rod assembly (3) together from tube assembly (1).

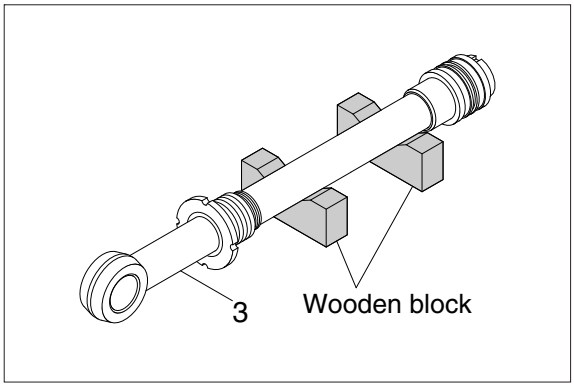
※ Since the rod assembly is heavy in this case, lift the tip of the rod assembly (3) with a crane or some means and draw it out. However, when rod assembly (3) has been drawn out to approximately two thirds of its length, lift it in its center to draw it completely.



Note that the plated surface of rod assembly (3) is to be lifted. For this reason, do not use a wire sling and others that may damage it, but use a strong cloth belt or a rope.

⑤ Place the removed rod assembly on a wooden V-block that is set level.

※ Cover a V-block with soft rag.

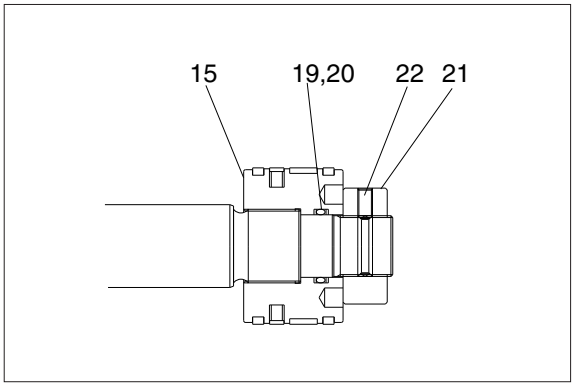


(2) Remove piston and rod cover

① Loosen set screw (22) and remove piston nut (21).

※ Since piston nut (21) is tightened to a high torque, use a hydraulic and power wrench that utilizers a hydraulic cylinder, to remove the piston nut (21).

② Remove piston assembly (15), back up ring (19), and O-ring (20).

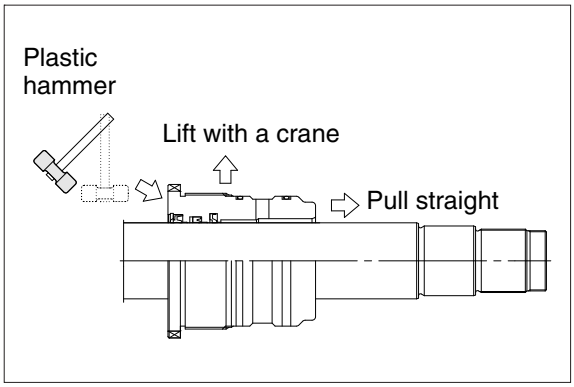


③ Remove the rod cover from rod assembly (3).

※ If it is too heavy to move, move it by striking the flanged part of gland with a plastic hammer.

※ Pull it straight with cylinder head assembly lifted with a crane.

Exercise care so as not to damage the lip of Du bushing (6) and packing (8, 9, 10, 11, 12, 13, 14) by the threads of rod assembly (3).

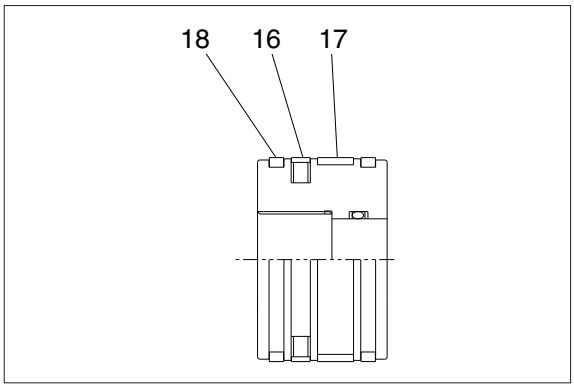


(3) Disassemble the piston assembly

① Remove wear ring (17).

② Remove dust ring (18) and piston seal (16).

※ Exercise care in this operation not to damage the grooves.



(4) Disassemble gland assembly

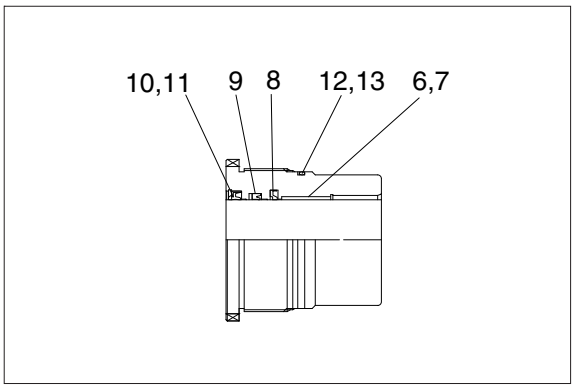
① Remove back up ring (12) and O-ring (13).

② Remove snap ring (11), dust wiper (10).

③ Remove U-packing (9) and buffer seal (8).

※ Exercise care in this operation not to damage the grooves.

※ Do not remove seal and ring, if does not damaged.

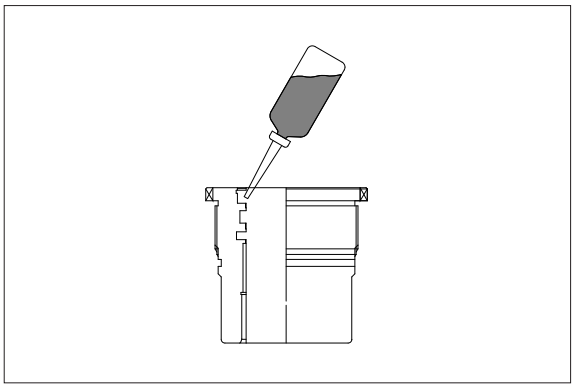


4) ASSEMBLY

(1) Assemble cylinder head assembly

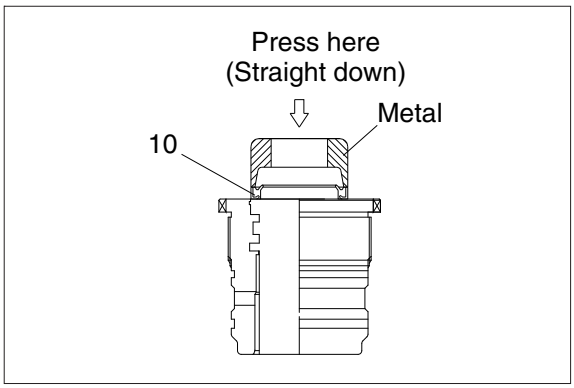
※ Check for scratches or rough surfaces if found smooth with an oil stone.

① Coat the inner face of rod cover (5) with hydraulic oil.



② Coat dust wiper (10) with grease and fit dust wiper (10) to the bottom of the hole of dust seal.
At this time, press a pad metal to the metal ring of dust seal.

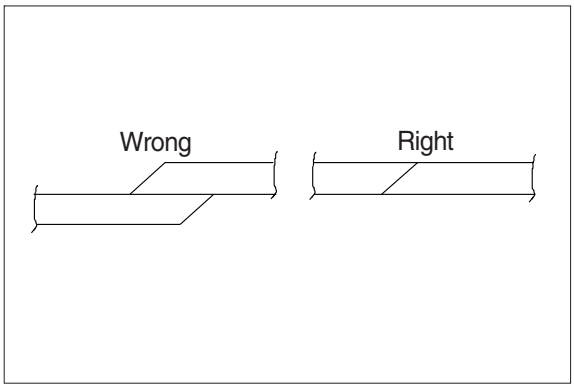
③ Fit snap ring (11) to the stop face.



④ Fit U-packing (9) and buffer seal (8) to corresponding grooves, in that order.

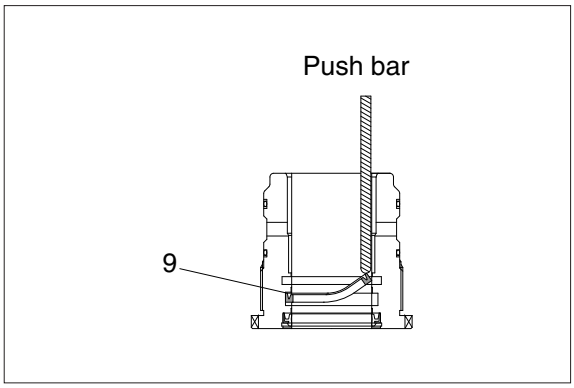
※ Coat each packing with hydraulic oil before fitting it.

※ Insert the backup ring until one side of it is inserted into groove.



※ U-packing (9) has its own fitting direction. Therefore, confirm it before fitting them.

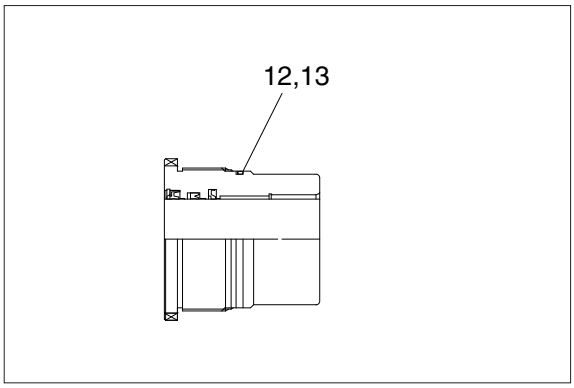
※ Fitting U-packing (9) upside down may damage its lip. Therefore check the correct direction that is shown in fig.



⑤ Fit back up ring (12) to rod cover (5).

※ Put the backup ring in the warm water of 30~50˚C .

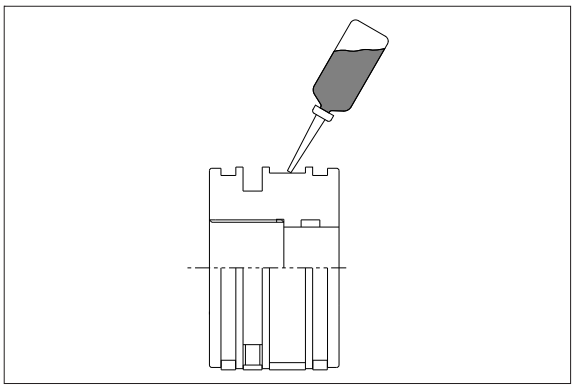
⑥ Fit O-ring (13) to rod cover (5).



(2) Assemble piston assembly

※ Check for scratches or rough surfaces. If found smooth with an oil stone.

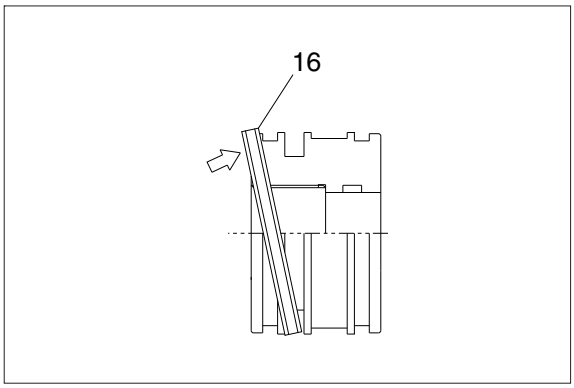
① Coat the outer face of piston (15) with hydraulic oil.



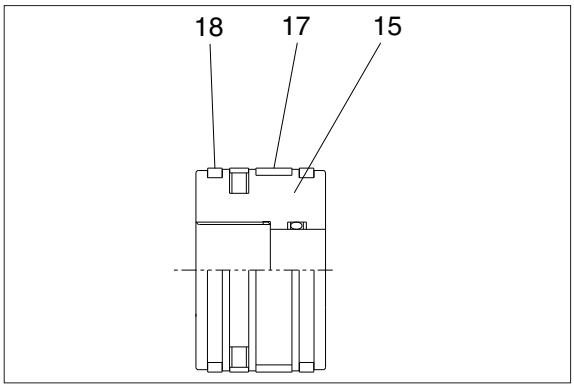
② Fit piston seal (16) to piston.

※ Put the piston seal in the warm water of 60~100˚C for more than 5 minutes.

※ After assembling the piston seal, press its outer diameter to fit in.



③ Fit wear ring (17) and dust ring (18) to piston (15).

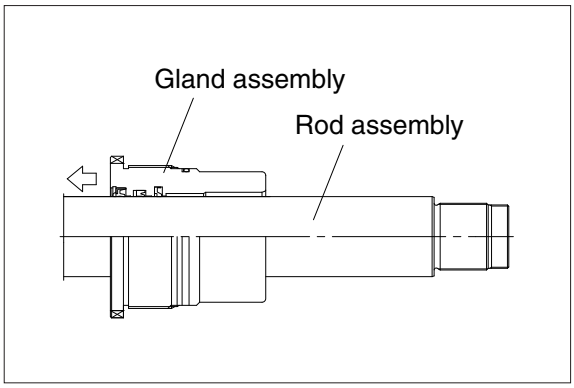


(3) Install piston and cylinder head

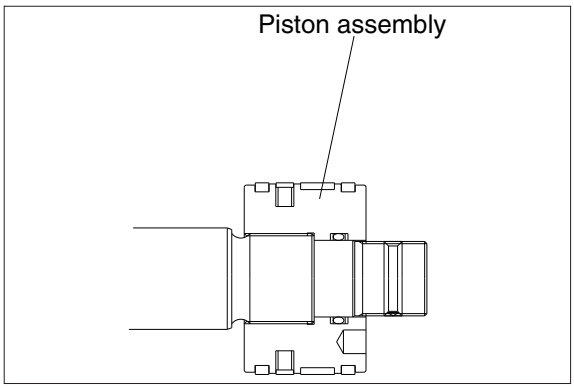
① Fix the rod assembly to the work bench.

② Apply hydraulic oil to the outer surface of rod assembly (3), the inner surface of piston and cylinder head.

③ Insert cylinder head assembly to rod assembly.



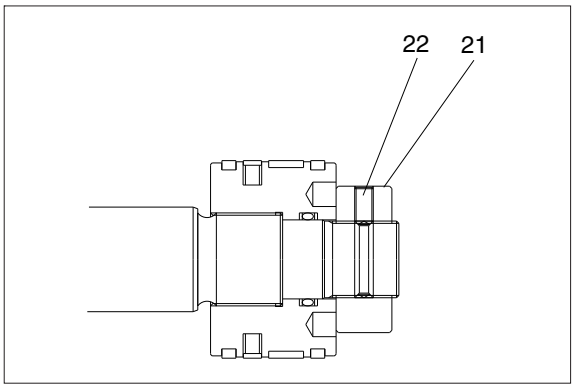
④ Fit piston assembly to rod assembly.



⑤ Fit piston nut (21) and tighten the set screw (22).

· Tightening torque :

Item		kgf · m	lbf · ft
Boom	22	75±7.5	540±54
Arm	21	75±7.5	540±54
Bucket	19	75±7.5	540±54
Dozer	16	97.5±9.8	705±71
Boom swing	16	97.5±9.8	705±71



(4) Overall assemble

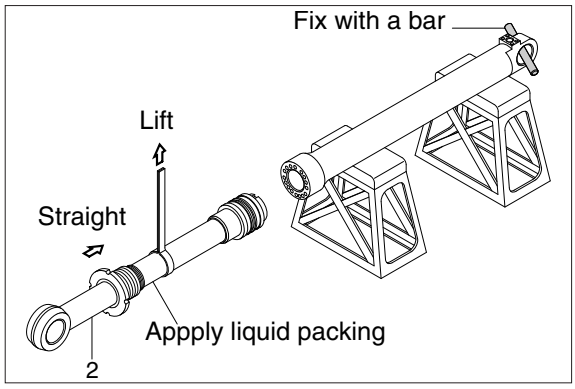
① Place a V-block on a rigid work bench. Mount the tube assembly (1) on it and fix the assembly by passing a bar through the clevis pin hole to lock the assembly.

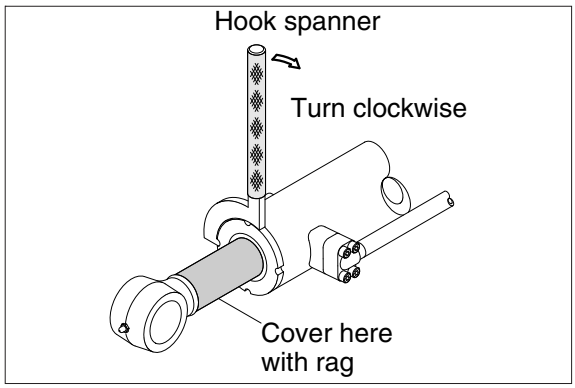
② Insert the rod assembly in to the tube assembly, while lifting and moving the rod assembly with a crane.

※ Be careful not to damage piston seal by thread of tube assembly.

③ Match the bolt holes in the cylinder head flange to the tapped holes in the tube assembly and tighten socket bolts to a specified torque.

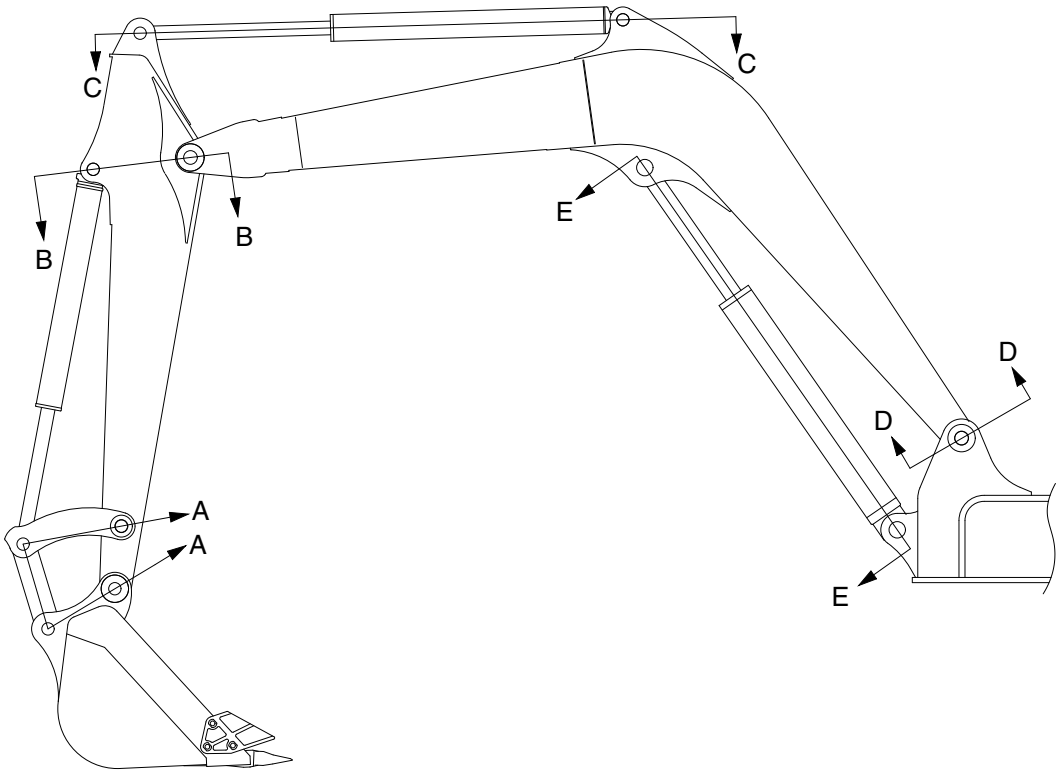
※ Refer to the table of tightening torque.

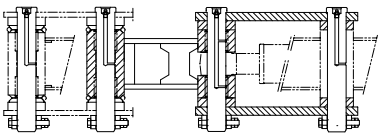




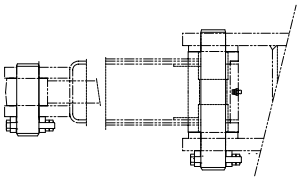
GROUP 11 WORK EQUIPMENT

1. STRUCTURE

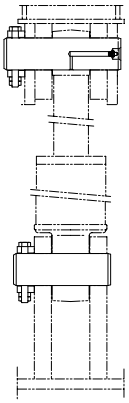




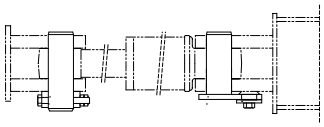
SECTION A-A



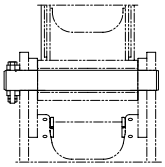
SECTION B-B



SECTION E-E



SECTION C-C



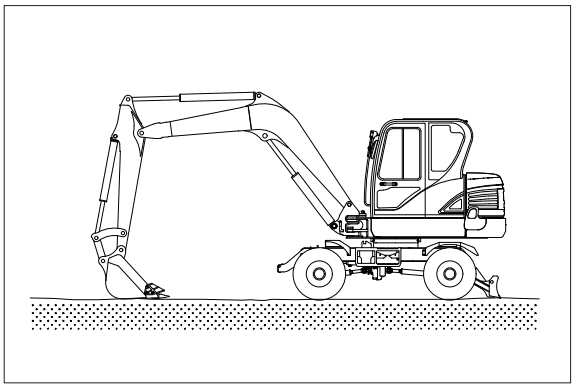
SECTION D-D

2. REMOVAL AND INSTALL

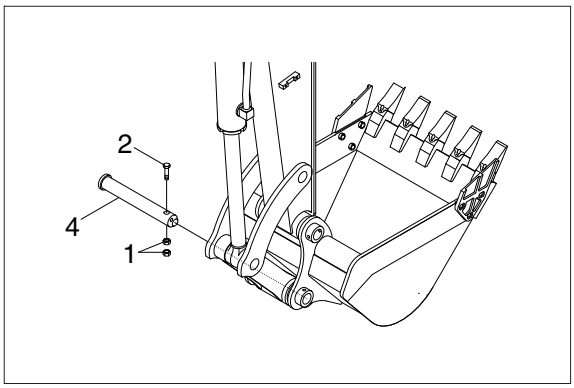
1) BUCKET ASSEMBLY

(1) Removal

① Lower the work equipment completely to ground with back of bucket facing down.

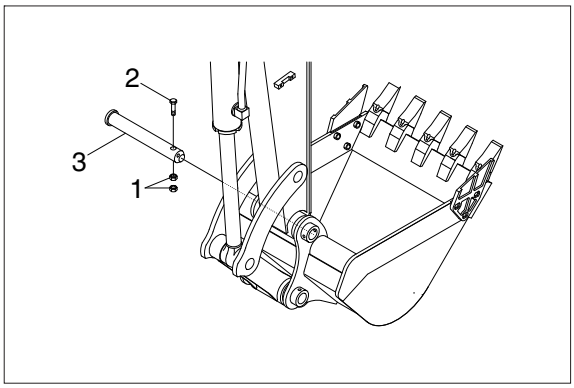


② Remove nut (1), bolt (2) and draw out the pin (4).



③ Remove nut (1), bolt (2) and draw out the pin (3) then remove the bucket assembly.

· Weight : 170 kg (370 lb)

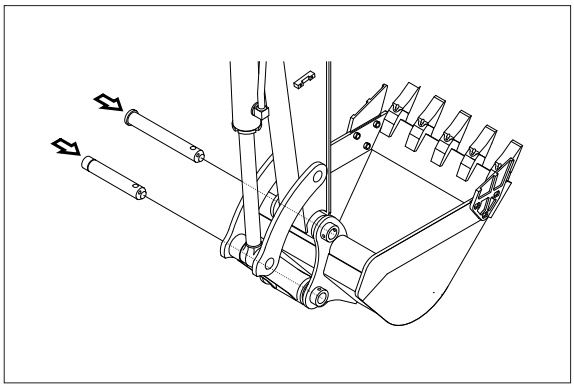


(2) Install

① Carry out installation in the reverse order to removal.

⚠ When aligning the mounting position of the pin, do not insert your fingers in the pin hole.

※ Adjust the bucket clearance.
For detail, see operation manual.



2) ARM ASSEMBLY

(1) Removal

※ Loosen the breather slowly to release the pressure inside the hydraulic tank.

⚠ Escaping fluid under pressure can penetrated the skin causing serious injury.

① Remove bucket assembly.
For details, see removal of bucket assembly.

② Disconnect bucket cylinder hose (4).

⚠ Fit blind plugs (5) in the piping at the chassis end securely to prevent oil from spurting out when the engine is started.

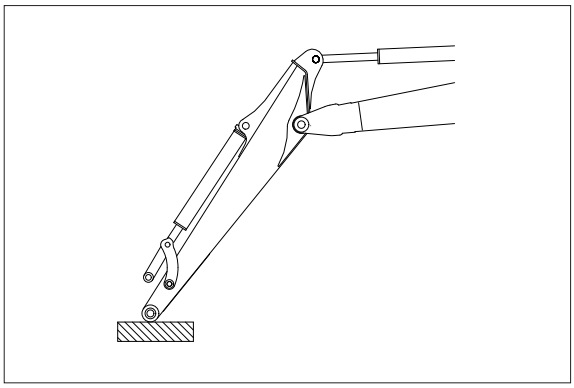
③ Sling arm cylinder assembly, remove spring, pin stopper and pull out pin.

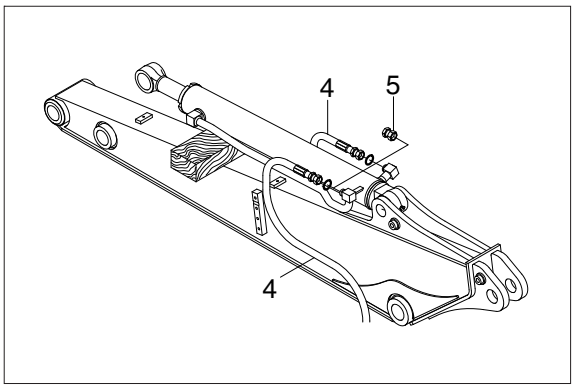
※ Tie the rod with wire to prevent it from coming out.

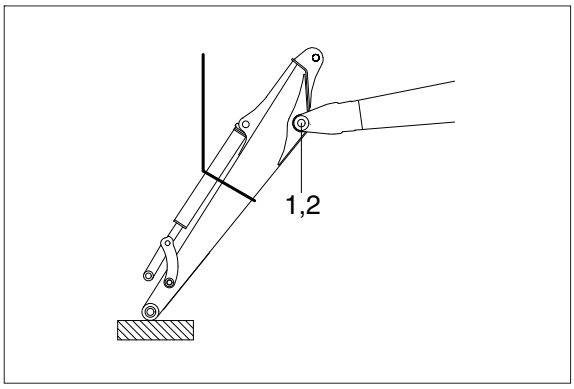
④ For details, see removal of arm cylinder assembly.
Place a wooden block under the cylinder and bring the cylinder down to it.

⑤ Remove bolt (1) and pull out the pin (2) then remove the arm assembly.
· Weight : 210 kg (470 lb)

※ When lifting the arm assembly, always lift the center of gravity.







(2) Install

① Carry out installation in the reverse order to removal.

※ When lifting the arm assembly, always lift the center of gravity.

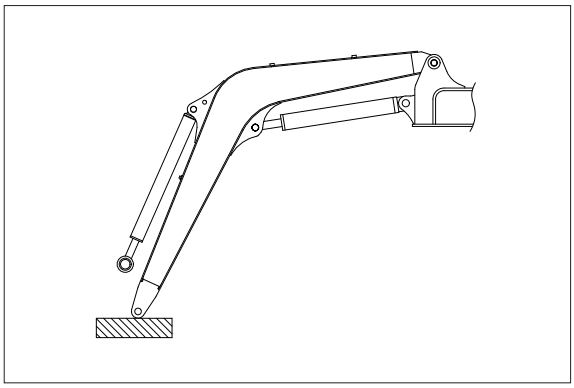
※ Bleed the air from the cylinder.

3) BOOM CYLINDER

(1) Removal

① Remove arm and bucket assembly.

② For details, see removal of arm and bucket assembly.
Remove boom cylinder assembly from boom.
For details, see removal of arm cylinder assembly.

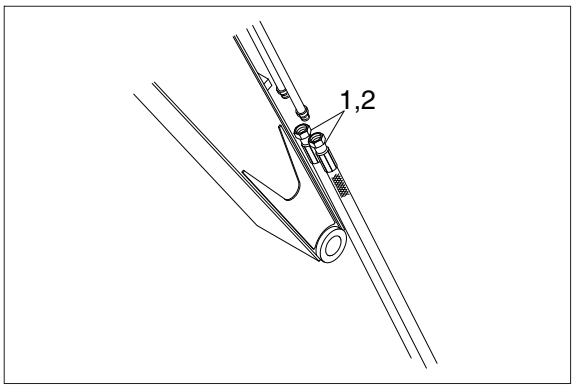


③ Disconnect head lamp wiring.

④ Disconnect bucket cylinder hose (2) and arm cylinder hose (1).

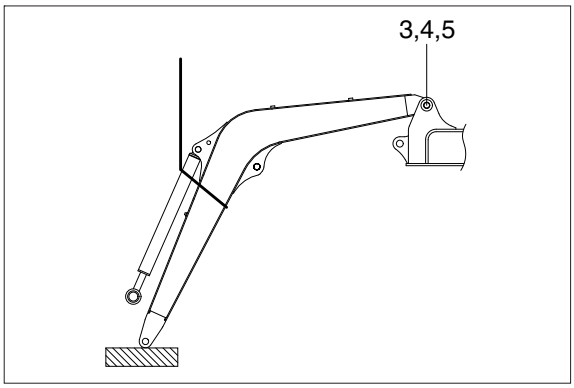
⚠ When the hose are disconnected, oil may spurt out.

⑤ Sling boom assembly (3).



⑥ Remove bolt (3), nut (4) and pull out the pin (5) then remove boom assembly.
· Weight : 310 kg (680 lb)

※ When lifting the boom assembly always lift the center of gravity.



(2) Install

① Carry out installation in the reverse order to removal.

※ When lifting the arm assembly, always lift the center of gravity.

※ Bleed the air from the cylinder.