

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 MECHATRONICS SYSTEM

This section explains the computer aided power optimization system and each component.

SECTION 6 TROUBLESHOOTING

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

SECTION 7 MAINTENANCE STANDARD

This section gives the judgement standards when inspecting disassembled parts.

SECTION 8 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.

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

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

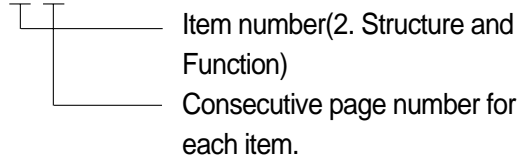
1. See the page number on the bottom of the page.

File the pages in correct order.

2. Following examples shows how to read the page number.

Example 1

2 - 3



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

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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 50 in the vertical column at the left side, take this as (a), then draw a horizontal line from (a).
- (2) Locate the number 5 in the row across the top, take this as (b), then draw a perpendicular line down from (b).
- (3) Take the point where the two lines cross as (c). This point (c) gives the value when converting from millimeters to inches. Therefore, 55mm = 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 55mm.
- (2) Carry out the same procedure as above to convert 55mm to 2.165 inches.
- (3) The original value (550mm) 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 550mm = 21.65 inches.

Millimeters to inches

(b)

1mm = 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
(a) 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

1mm = 0.03937in

	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

Kilogram to Pound

1kg = 2.2046lb

	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

1 l = 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	6.076	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	25.361	25.625	25.889	26.153

3

Liter to U.K. Gallon

1 l = 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	7.699	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

kg · m to lb · ft

1kg · m = 7.233lb · 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	296.6	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

kg/cm² to lb/in²1kg / cm² = 14.2233 lb / 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 versa 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

CRAWLER TYPE EXCAVATOR [R160LC-3]

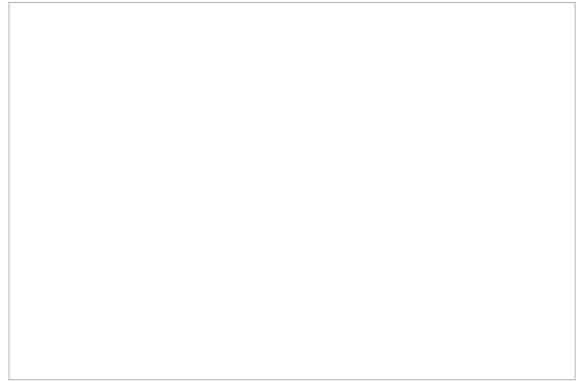
FOREWORD	Download	Group 6	Automatic Warming Up Function	Download	
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GENERAL		Group 8	Arm Half Flow System	Download	
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STRUCTURE AND FUNCTION		Group 12	EPPR(Electro Proportional Pressure Reducing) Valve	Download	
Group 1	Pump Device	Download	Group 13	Prolix Switch	Download
Group 2	Main Control Valve	Download	Group 14	Monitoring System	Download
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ELECTRICAL SYSTEM		DISASSEMBLY AND ASSEMBLY			
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Group 4	Connectors	Download	Group 4	Main Control Valve	Download
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Group 1	Outline	Download	Group 7	RCV Lever	Download
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Group 3	Automatic Deceleration System	Download	Group 9	Boom, Arm and Bucket Cylinder	Download
Group 4	Power Boost System	Download	Group 10	Undercarriage	Download
Group 5	Travel Speed Control System	Download	Group 11	Work Equipment	Download

SECTION 1 GENERAL

GROUP 1 SAFETY

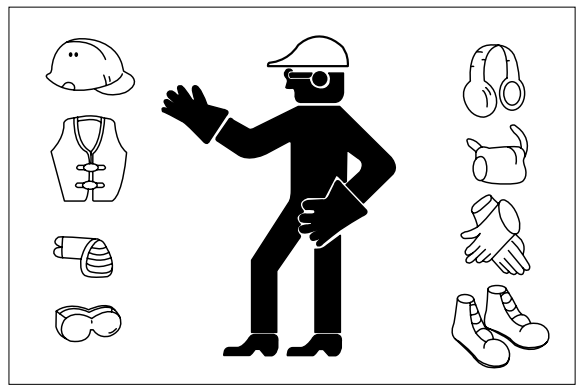
FOLLOW SAFE PROCEDURE

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



WEAR PROTECTIVE CLOTHING

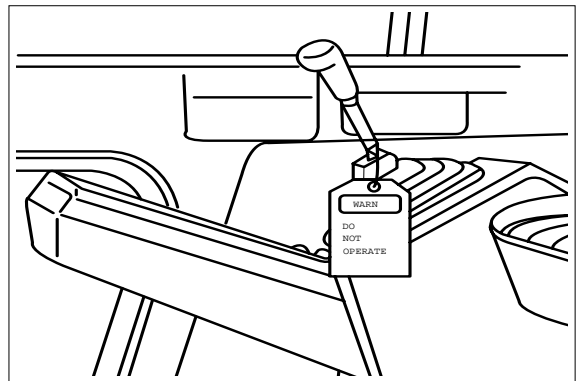
Wear close fitting clothing and safety equipment appropriate to the job.



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.

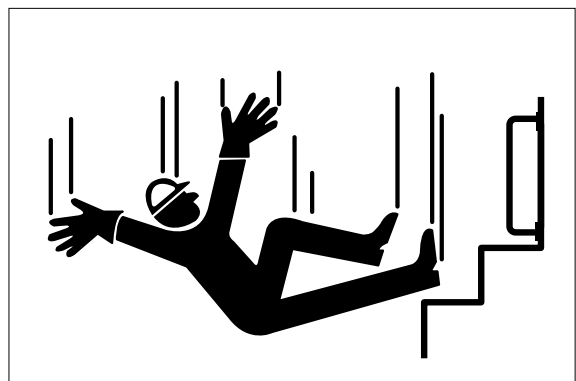


USE HANDHOLDS AND STEPS

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.

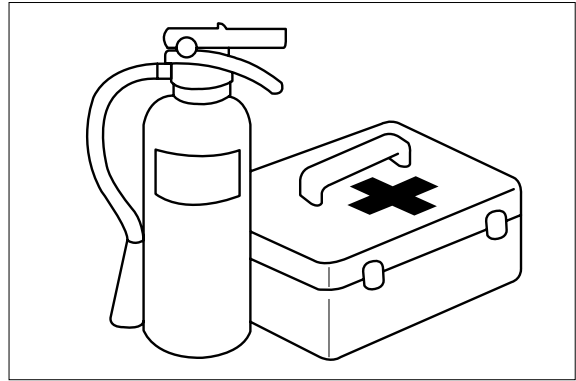


PREPARE FOR EMERGENCIES

Be prepared if a fire starts.

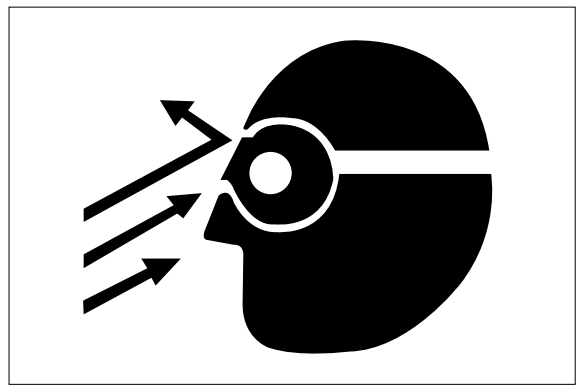
Keep a first aid kit and fire extinguisher handy.

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



PROTECT AGAINST FLYING DEBRIS

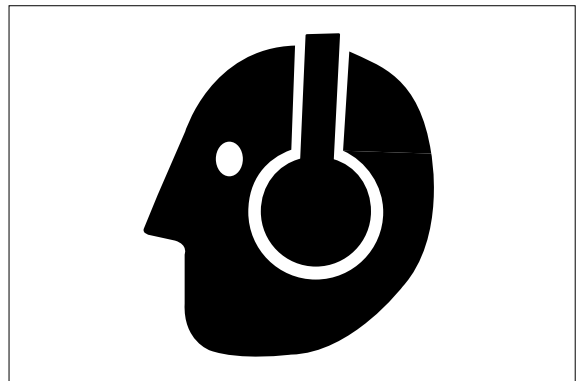
Guard against injury from flying pieces of metal or debris; Wear goggles or safety glasses.



PROTECT AGAINST NOISE

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

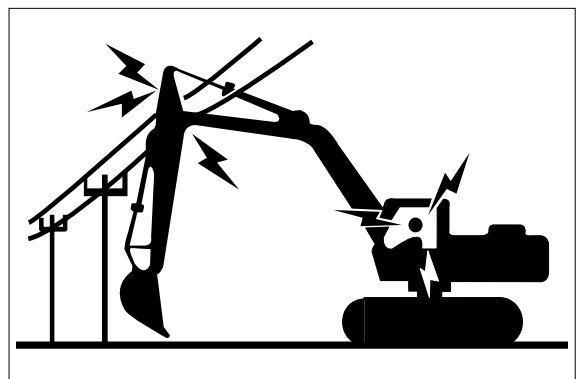
Wear a suitable hearing protective device such as earmuffs or earplugs to protect against objectionable or uncomfortable loud noises.



AVOID POWER LINES

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

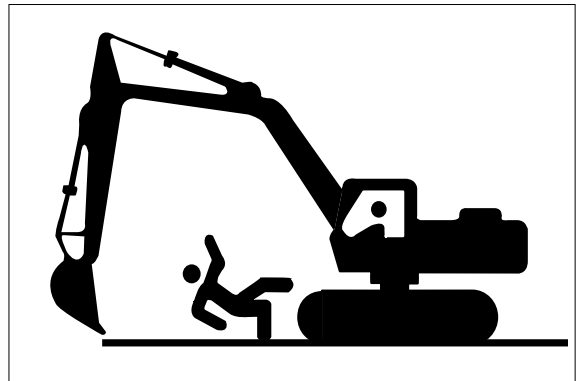
Never move any part of the machine or load closer to electric line than 3m(10ft) plus twice the line insulator length.



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.

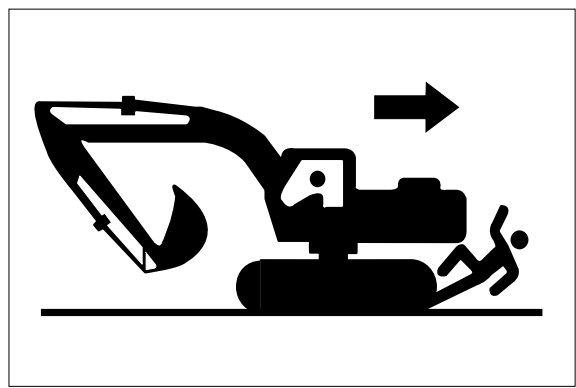


MOVE AND OPERATE MACHINE SAFELY

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 FROM 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

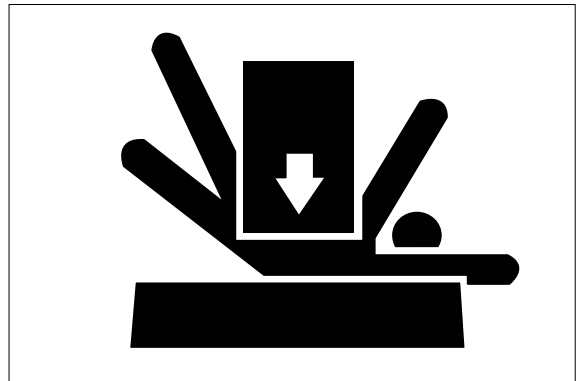
Before working on the machine:

- 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.

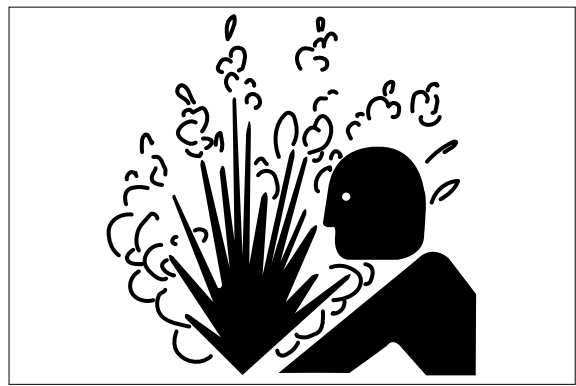
Do not support the machine on cinder blocks, hollow tiles, or props that may crumble under continuous load. Do not work under a machine that is supported solely by a jack. Follow recommended procedures in this manual.



SERVICE COOLING SYSTEM SAFELY

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

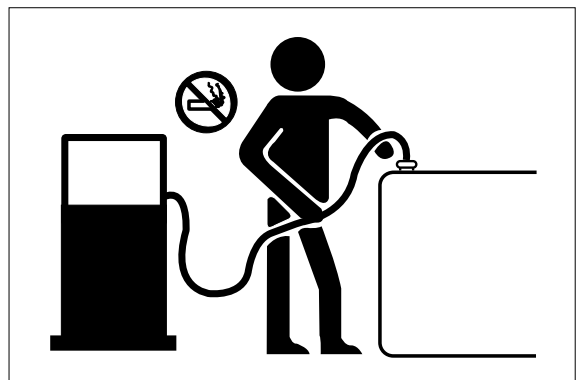
Shut off engine. Only remove filler cap when cool enough to touch with bare hands.



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.

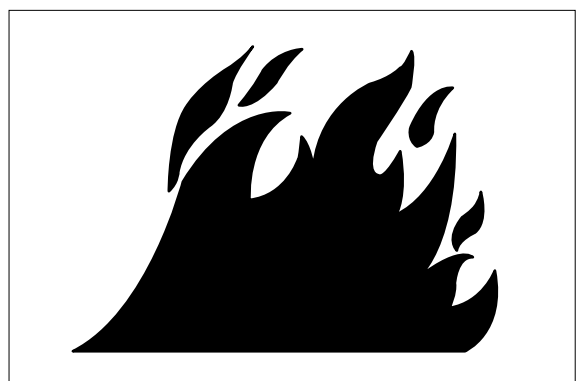
Fill fuel tank outdoors.



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

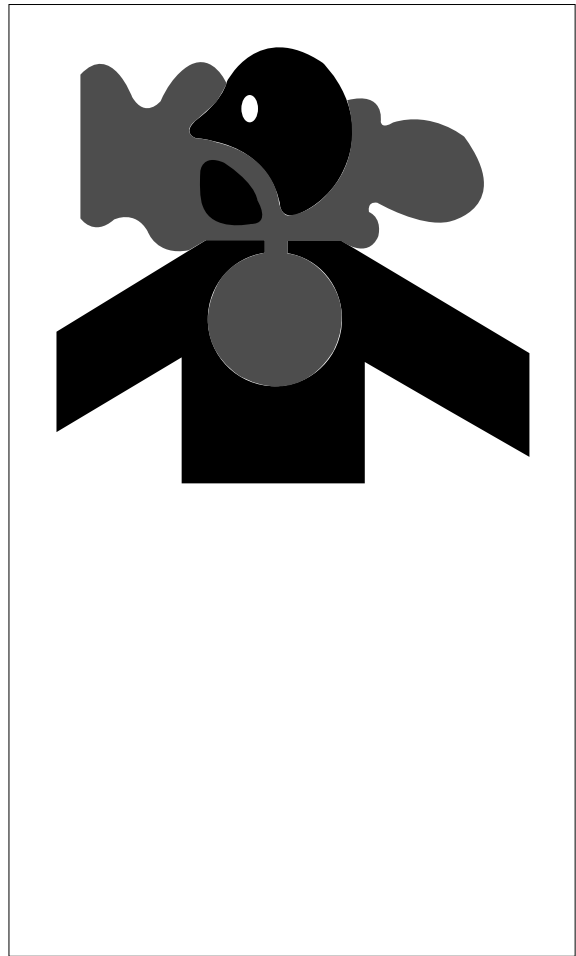
Avoid potentially toxic fumes and dust.

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.

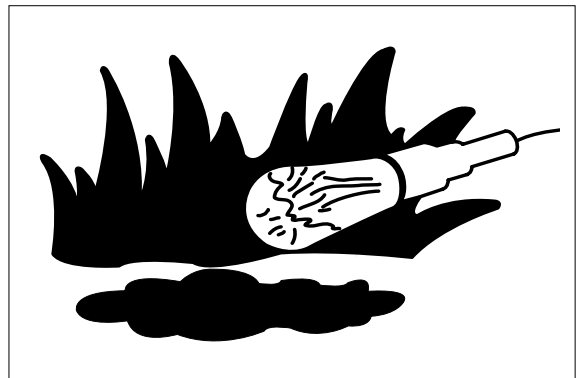
Remove paint before welding or heating:

- 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

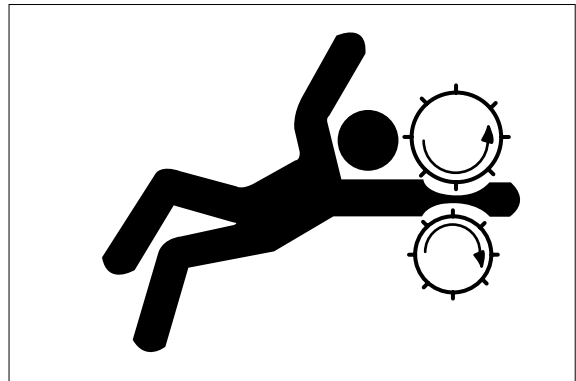
Illuminate your work area adequately but safely. Use a portable safety light for working inside or under the machine. Make sure the bulb is enclosed by a wire cage. The hot filament of an accidentally broken bulb can ignite spilled fuel or oil.



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.

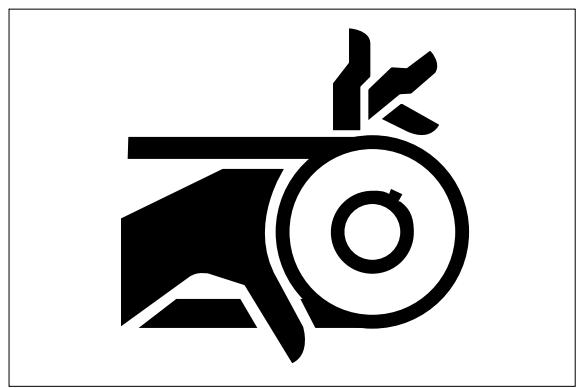
Remove rings and other jewelry to prevent electrical shorts and entanglement in moving parts.



STAY CLEAR OF MOVING PARTS

Entanglements in moving parts can cause serious injury.

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



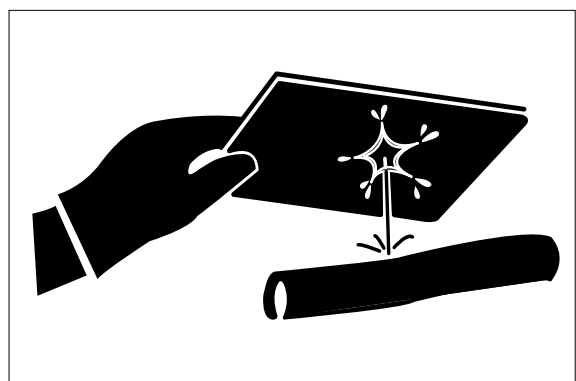
AVOID HIGH PRESSURE FLUIDS

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:

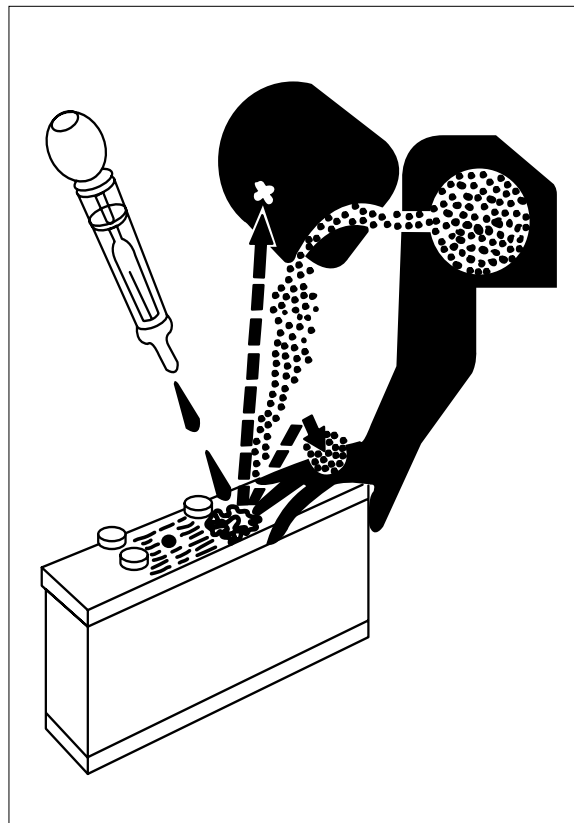
1. Filling batteries in a well-ventilated area.
2. Wearing eye protection and rubber gloves.
3. Avoiding breathing fumes when electrolyte is added.
4. Avoiding spilling or dripping electrolyte.
5. Use proper jump start procedure.

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.



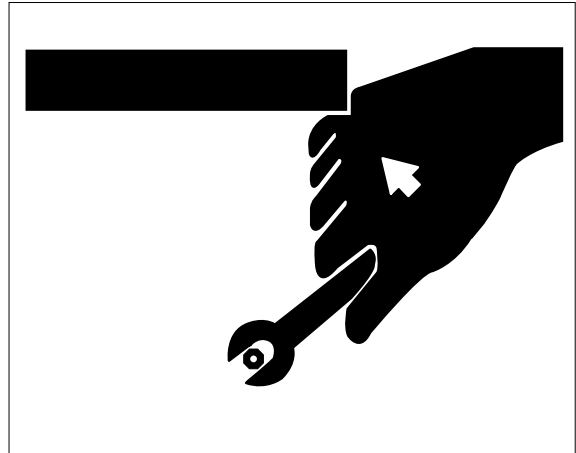
USE TOOLS PROPERLY

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 catalogue.)

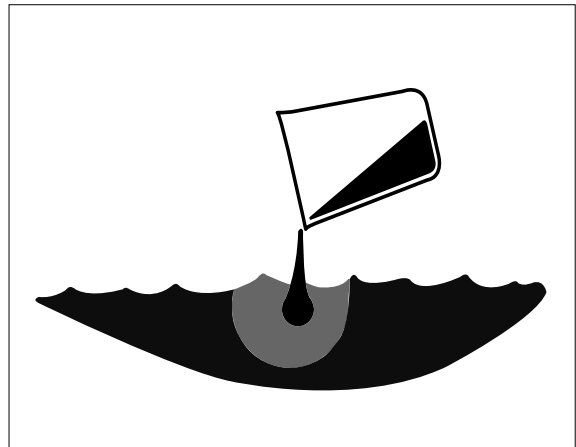


DISPOSE OF FLUIDS PROPERLY

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.

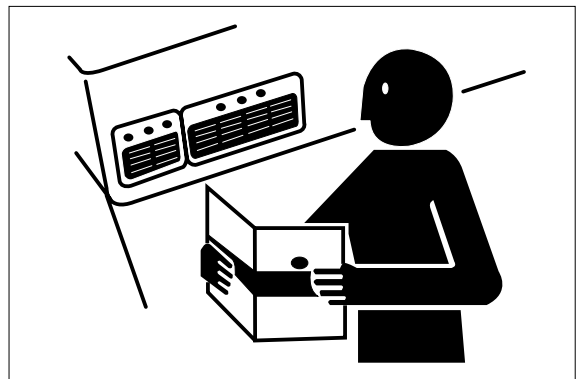
Use proper containers when draining fluids. Do not use food or beverage containers that may mislead someone into drinking from them.

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.

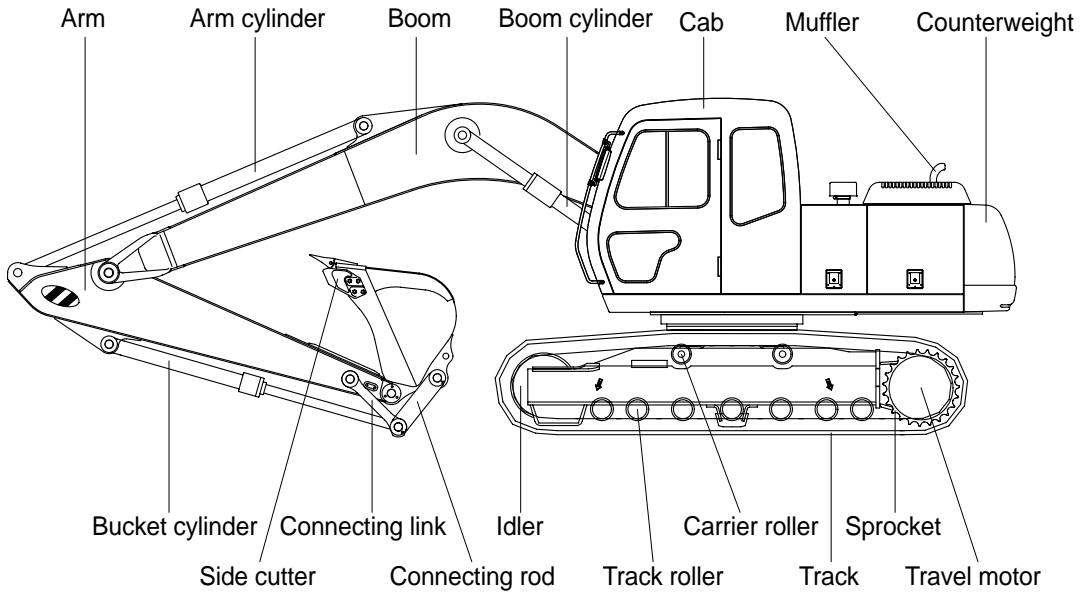
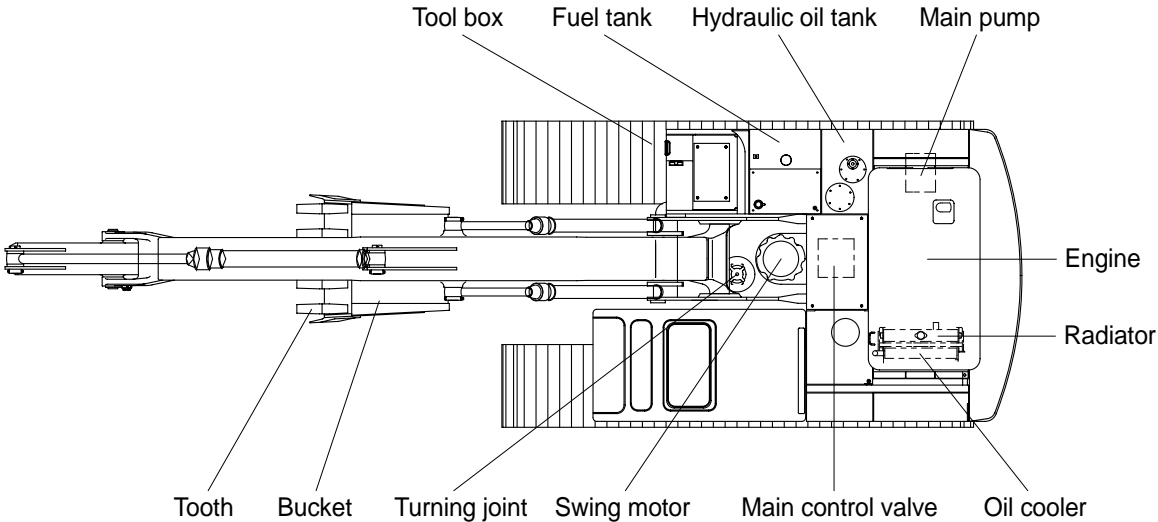


LIVE WITH SAFETY

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

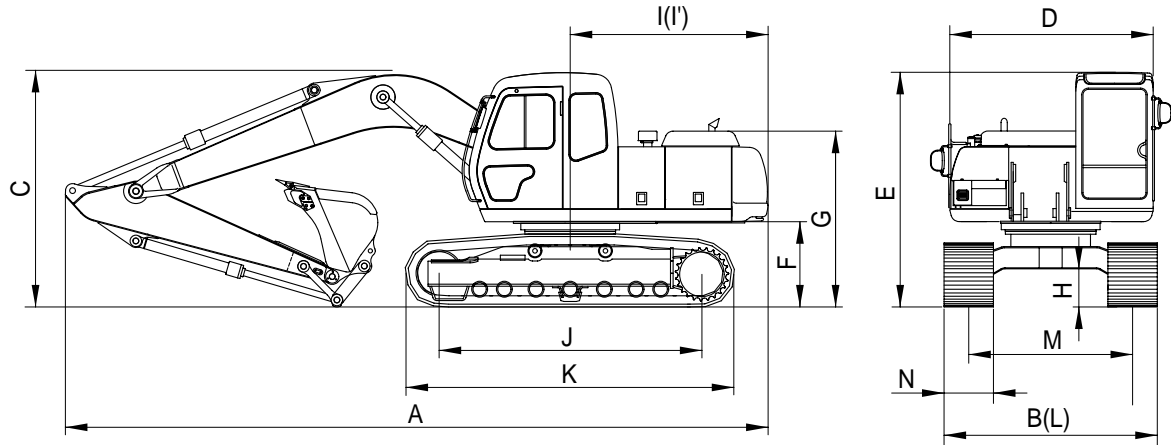
GROUP 2 SPECIFICATIONS

1. MAJOR COMPONENT



2. SPECIFICATION

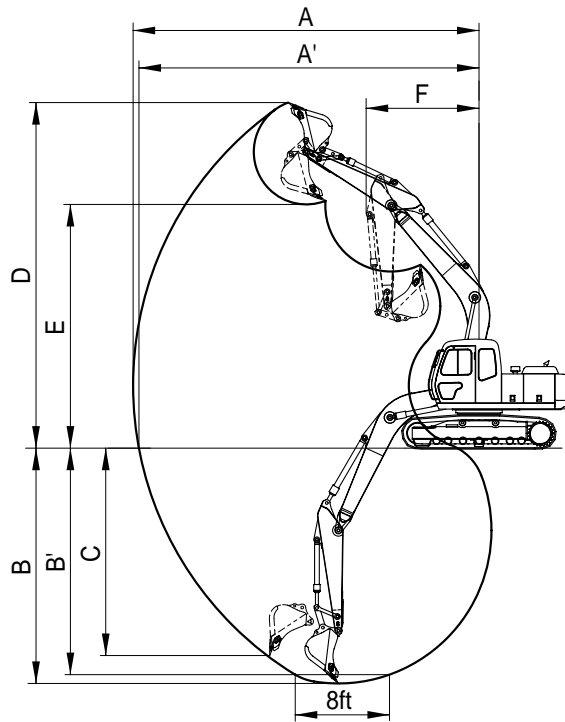
1) ROBEX 160LC-3



Description		Unit	Specification
Operating weight		kg(lb)	16600(36600)
Bucket capacity(PCSA heaped), standard		m ³ (yd ³)	0.65(0.85)
Overall length	A	mm(ft-in)	8530(28' 0")
Overall width, with 600mm shoe	B		2590(8' 6")
Overall height	C		2870(9' 5")
Superstructure width	D		2470(8' 1")
Overall height of cab	E		2850(9' 4")
Ground clearance of counterweight	F		1035(3' 5")
Engine cover height	G		2135(7' 0")
Minimum ground clearance	H		460(1' 6")
Rear-end distance	I		2400(7'10")
Rear-end swing radius	I'		2490(8' 2")
Distance between tumbler	J		3190(10' 6")
Undercarriage length	K		3980(13' 1")
Undercarriage width	L		2590(8' 6")
Track gauge	M		1990(6' 6")
Track shoe width, standard	N		600(24")
Travel speed(Low/high)		km/hr(mph)	3.5/5.5(2.2/3.4)
Swing speed		rpm	12.1
Gradeability		Degree(%)	35(70)
Ground pressure(600mm shoe)		kg/cm ² (psi)	0.40(5.69)

3. WORKING RANGE

1) 5.10m(16' 9") BOOM



Description		2.25m(7' 5") Arm	2.60m(8' 6") Arm	3.10m(10' 2") Arm
Max digging reach	A	8630mm (28' 4")	8950mm (29' 4")	9340mm (30' 8")
Max digging reach on ground	A'	8470mm (27' 9")	8800mm (28'10")	9200mm (30' 2")
Max digging depth	B	5740mm (18'10")	6090mm (20' 0')	6590mm (21' 7")
Max digging depth (8ft level)	B'	5480mm (18' 0")	5860mm (19' 3")	6360mm (20'10")
Max vertical wall digging depth	C	4930mm (16' 2")	5370mm (17' 7")	5580mm (18' 4")
Max digging height	D	8750mm (28' 8")	8940mm (29' 4")	9000mm (29' 6")
Max dumping height	E	6120mm (20' 1")	6310mm (20' 8")	6400mm (21' 0")
Min swing radius	F	2960mm (9' 9")	2920mm (9' 7")	2940mm (9' 8")
Bucket digging force	SAE	90 [99] kN	90 [99] kN	90 [99]kN
		9200 [10060] kgf	9200 [10060]kgf	9200 [10060]kgf
		20280 [22180] lbf	20280 [22180]lbf	20280 [22180]lbf
	ISO	104 [113] kN	104 [113]kN	104 [113]kN
		10570 [11560] kgf	10570 [11560]kgf	10570 [11560]kgf
		23300 [25480] lbf	23300 [25480]lbf	23300 [25480]lbf
Arm crowd force	SAE	78 [85] kN	70 [76]kN	63 [69]kN
		7920 [8660] kgf	7110 [7780]kgf	6440 [7040]kgf
		17460 [19100] lbf	15670 [17140]lbf	14200 [15530]lbf
	ISO	81 [89] kN	73 [79]kN	65 [71]kN
		8260 [9030] kgf	7390 [8080]kgf	6650 [7270]kgf
		18210 [19920] lbf	16290 [17820]lbf	14660 [16030]lbf

[] : Power boost

4. WEIGHT

1) R160LC-3













Item	R160LC-3	
	kg	lb
Upperstructure assembly	7220	15920
Main frame weld assembly	1210	2670
Engine assembly	410	904
Main pump assembly	125	276
Main control valve assembly	135	298
Swing motor assembly	218	481
Hydraulic oil tank assembly	145	320
Fuel tank assembly	110	243
Counterweight	2900	6390
Cab assembly	275	610
Lower chassis assembly	6450	14220
Track frame weld assembly	2005	4420
Swing bearing	230	507
Travel motor assembly	210	463
Turning joint	36	79
Track recoil spring and idler	137	302
Idler	160	353
Carrier roller	21	46
Track roller	38	84
Track-chain assembly(600mm standard triple grouser shoe)	1183	2610
Front attachment assembly(5.10m boom, 2.60m arm, 0.65m ³ PCSA heaped bucket)	2930	6460
5.10m boom assembly	1035	2280
2.60m arm assembly	525	1157
0.65m ³ PCSA heaped bucket	510	1124
Boom cylinder assembly	135	298
Arm cylinder assembly	183	403
Bucket cylinder assembly	125	276
Bucket control link assembly	112	247

5. LIFTING CAPACITIES

1) ROBEX 160LC-3











(1) 5.10m(16' 9") boom, 2.60m(8' 6") arm equipped with 0.65m³(PCSA heaped) bucket and 600mm (24") triple grouser shoe.

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













Load point height		Load radius										At max. reach						
		1.5m(5ft)		3.0m(10ft)		4.5m(15ft)		6.0m(20ft)		7.5m(25ft)		Capacity		Reach				
														m(ft)				
7.5m (25ft)	kg lb															*2800 *6170	*2800 *6170	6.20 (20.3)
6.0m (20ft)	kg lb							*2620 *5780	*2620 *5780						*2800 *6170	2040 4500	7.46 (24.5)	
4.5m (15ft)	kg lb							*3220 *7100	2910 6420						2810 6190	1660 3660	8.20 (26.9)	
3.0m (10ft)	kg lb			*6720 *14820	*6720 *14820	*4530 *9990	4420 9740	*3670 *8090	2760 6080	*2400 *5290	1840 4060	2550 5620	1470 3240	8.56 (28.1)				
1.5m (5ft)	kg lb			*7670 *16910	7470 16470	*5690 *12540	4050 8930	*4210 *9280	2590 5710	3060 6750	1770 3900	2480 5470	1410 3110	8.61 (28.2)				
Ground Line	kg lb			*7280 *16050	7100 15650	*6450 *14220	3800 8380	4270 9410	2450 5400	*2970 *6550	1710 3770	2570 5670	1460 3220	8.34 (27.4)				
-1.5m (-5ft)	kg lb	*6100 *13450	*6100 *13450	*9750 *21500	7060 15560	*6600 *14550	3690 8140	4190 9240	2390 5270			2900 6390	1660 3660	7.73 (25.4)				
-3.0m (-10ft)	kg lb	*9050 *19950	*9050 *19950	*9000 *19840	7170 15810	*6070 *13380	3720 8200	4220 9300	2410 5310			*3280 *7230	2160 4760	6.66 (21.9)				
-4.5m (-15ft)	kg lb			*6610 *14570	*6610 *14570	*4370 *9630	3890 8580											

- 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.

(2) 5.10m(16' 9") boom, 2.25m(7' 5") arm equipped with 0.65m³(PCSA heaped) bucket and 600mm (24") triple grouser shoe.

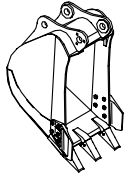
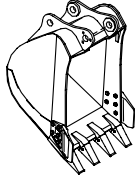
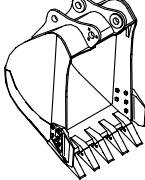
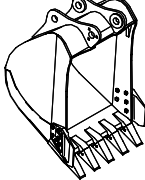
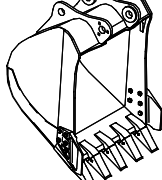
Load point height		Load radius								At max. reach			
		1.5m(5ft)		3.0m(10ft)		4.5m(15ft)		6.0m(20ft)		Capacity		Reach	
												m(ft)	
7.5m (25ft)	kg lb										*3040 *6700	*3040 *6700	5.71 (18.7)
6.0m (20ft)	kg lb										*3020 *6660	2260 4980	7.08 (23.2)
4.5m (15ft)	kg lb					*3870 *8530	*3870 *8530	*3490 *7690	2900 6390		3030 6680	1810 3990	7.86 (25.8)
3.0m (10ft)	kg lb			*7610 *16780	*7610 *16780	*4900 *10800	4390 9680	*3910 *8620	2760 6080		2740 6040	1610 3550	8.24 (27.0)
1.5m (5ft)	kg lb			*5740 *12650	*5740 *12650	*5990 *13210	4030 8880	*4410 *9720	2610 5750		2660 5860	1540 3400	8.28 (27.2)
Ground Line	kg lb			*6990 *15410	*6990 *15410	*6610 *14570	3820 8420	4300 9480	2490 5490		2780 6130	1610 3550	8.01 (26.3)
-1.5m (-5ft)	kg lb	*6620 *14590	*6620 *14590	*9920 *21870	7150 15760	*6600 *14550	3750 8270	4250 9370	2440 5380		3170 6990	1850 4080	7.37 (24.2)
-3.0m (-10ft)	kg lb	*10180 *22440	*10180 *22440	*8540 *18830	7300 16090	*5870 *12940	3800 8380				*3370 *7430	2470 5450	6.22 (20.4)
-4.5m (-15ft)	kg lb			*5730 *12630	*5730 *12630								

(3) 5.10m(16' 9") boom, 3.10m(10' 2") arm equipped with 0.65m³(PCSA heaped) bucket and 600mm (24") triple grouser shoe.

Load point height		Load radius										At max. reach				
		1.5m(5ft)		3.0m(10ft)		4.5m(15ft)		6.0m(20ft)		7.5m(25ft)		Capacity		Reach		
														m(ft)		
7.5m (25ft)	kg lb												*2480 *5470	*2480 *5470	6.76 (22.2)	
6.0m (20ft)	kg lb							*2580 *5690	*2580 *5690					*2530 *5580	1850 4080	7.92 (26.0)
4.5m (15ft)	kg lb							*2880 *6350	*2880 *6350	*1840 *4060	*1840 *4060			2590 5710	1520 3350	8.61 (28.2)
3.0m (10ft)	kg lb					*4030 *8880	*4030 *8880	*3370 *7430	2800 6170	*2750 *6060	1870 4120			2360 5200	1350 2980	8.95 (29.4)
1.5m (5ft)	kg lb			*8730 *19250	7710 17000	*5280 *11640	4120 9080	*3960 *8730	2610 5750	3070 6770	1780 3920			2290 5050	1290 2840	9.00 (29.5)
Ground Line	kg lb			*8130 *17920	7110 15670	*6200 *13670	3810 8400	4270 9410	2450 5400	2990 6590	1700 3750			2370 5220	1330 2930	8.75 (28.7)
-1.5m (-5ft)	kg lb	*5830 *12850	*5830 *12850	*9570 *21100	6970 15370	*6550 *14440	3660 8070	4160 9170	2360 5200					2620 5780	1480 3260	8.17 (26.8)
-3.0m (-10ft)	kg lb	*8220 *18120	*8220 *18120	*9510 *20970	7020 15480	*6270 *13820	3640 8020	4150 9150	2350 5180					*3230 *7120	1870 4120	7.18 (23.6)
-4.5m (-15ft)	kg lb	*11360 *25040	*11360 *25040	*7600 *16760	7240 15960	*5090 *11220	3750 8270									

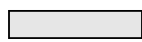
6. BUCKET SELECTION GUIDE


1) GENERAL BUCKET


				
0.39m ³ PCSA heaped bucket	0.57m ³ PCSA heaped bucket	※ 0.65m ³ PCSA heaped bucket	0.70m ³ PCSA heaped bucket	0.80m ³ PCSA heaped bucket

Capacity		Width		Weight	Recommendation		
PCSA heaped	CECE heaped	Without side cutter	With side cutter		5.10m (16' 9") boom		
					2.25m arm (7' 5")	2.60m arm (8' 6")	3.10m arm (10' 2")
0.39m ³ (0.51yd ³)	0.35m ³ (0.46yd ³)	620mm (24")	740mm (29")	410kg (900lb)			
0.57m ³ (0.75yd ³)	0.50m ³ (0.65yd ³)	840mm (33")	960mm (38")	490kg (1080lb)			
※ 0.65m ³ (0.85yd ³)	0.55m ³ (0.72yd ³)	930mm (37")	1050mm (41")	510kg (1120lb)			
0.70m ³ (0.92yd ³)	0.60m ³ (0.78yd ³)	990mm (39")	1110mm (44")	540kg (1190lb)			
0.80m ³ (1.05yd ³)	0.70m ³ (0.92yd ³)	1080mm (43")	1200mm (47")	570kg (1260lb)			

※ Standard bucket

 Applicable for materials with density of 2000kg/m³ (3370lb/yd³) or less

 Applicable for materials with density of 1600kg/m³ (2700lb/yd³) or less

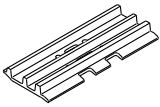
 Applicable for materials with density of 1100kg/m³ (1850lb/yd³) or less

7. UNDERCARRIAGE

1) TRACKS

X-leg type center frame is integrally welded with reinforced box-section track frames. The design includes dry tracks, lubricated rollers, idlers, sprockets, hydraulic track adjusters with shock absorbing springs and assembled track-type tractor shoes with triple grousers.

2) TYPES OF SHOES

Model	Shapes		Triple grouser			
						
R160LC-3	Shoe width	mm(in)	500(20)	600(24)	700(28)	800(32)
	Operating weight	kg(lb)	16360(36070)	16600(36600)	16970(37410)	17240(38010)
	Ground pressure	kg/cm ² (psi)	0.47(6.68)	0.40(5.69)	0.35(4.98)	0.31(4.41)
	Overall width	mm(ft-in)	2490(8' 2")	2590(8' 6")	2690(8' 10")	2790(9' 2")

3) NUMBER OF ROLLERS AND SHOES ON EACH SIDE

Item	Quantity
Carrier rollers	2EA
Track rollers	7EA
Track shoes	49EA

8. SPECIFICATIONS FOR MAJOR COMPONENTS

1) ENGINE

Item	Specification
Model	Cummins B3.9-C
Type	4-cycle turbocharged, after cooled and low emission diesel engine
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	102 × 120mm(4.02" × 4.72")
Piston displacement	3900cc(238cu in)
Compression ratio	16.5 : 1
Rated gross horse power(SAE J1349)	110Hp at 2200rpm(82kW at 2200rpm)
Maximum torque at 1500rpm	45.9kgf · m(332lbf · ft)
Engine oil quantity	11 l (2.9U.S. gal)
Dry weight	329kg(725lb)
High idling speed	2450+50rpm
Low idling speed	950 ± 100rpm
Rated fuel consumption	169.9g/Ps · hr
Starting motor	Delco Remy 28MT(24V)
Alternator	DAC(24V - 60AMP)
Battery	2 × 12V × 100Ah

2) MAIN PUMP

Item	Specification
Type	Variable displacement tandem axis piston pumps
Capacity	2 × 64cc/rev
Maximum pressure	320kgf/cm ² (4550psi)[350kgf/cm ² (4980psi)]
Rated oil flow	2 × 140 l /min (40U.S. gpm/ 30.8U.K. gpm)
Rated speed	2200rpm

[] : Power boost

3) GEAR PUMP

Item	Specification
Type	Fixed displacement gear pump single stage
Capacity	10cc/rev
Maximum pressure	40kgf/cm ² (570psi)
Rated oil flow	22 l /min(5.8U.S. gpm/4.8U.K. gpm)

4) MAIN CONTROL VALVE

Item	Specification
Type	9 spools two-block
Operating method	Hydraulic pilot system
Main relief valve pressure	320kgf/cm ² (4550psi) [350kgf/cm ² (4980psi)]
Overload relief valve pressure	380kgf/cm ² (5405psi)

[] : Power boost

5) SWING MOTOR

Item	Specification
Type	Fixed displacement axial piston motor
Capacity	99.2cc/rev
Relief pressure	260kgf/cm ² (3911psi)
Braking system	Automatic, spring applied, hydraulic released
Braking torque	42kgf · m(304lbf · ft)
Brake release pressure	4.5~20kgf/cm ² (64~284psi)
Reduction gear type	2 - stage planetary
Swing speed	12.1rpm

6) TRAVEL MOTOR

Item	Specification
Type	Variable displacement axial piston motor
Relief pressure	350kgf/cm ² (4980psi)
Capacity(max / min)	87.3/55.5cc/rev
Reduction gear type	3-stage planetary
Braking system	Automatic, spring applied, hydraulic released
Brake release pressure	11kgf/cm ² (156psi)
Braking torque	1060~1780kgf · m(7667~12874lbf · ft)

7) REMOTE CONTROL VALVE

Item		Specification
Type		Pressure reducing type
Operating pressure	Minimum	5.5kgf/cm ² (78psi)
	Maximum	19.5kgf/cm ² (277psi)
Single operation stroke	Lever	82.7mm(3.3in)
	Pedal	123mm(4.8in)

8) CYLINDER

Item		Specification
Boom cylinder	Bore dia × Rod dia × Stroke	∅ 110 × ∅ 80 × 1180mm
	Cushion	Extend only
Arm cylinder	Bore dia × Rod dia × Stroke	∅ 120 × ∅ 85 × 1320mm
	Cushion	Extend and retract
Bucket cylinder	Bore dia × Rod dia × Stroke	∅ 105 × ∅ 75 × 1005mm
	Cushion	Extend only

9) SHOE

Item	Width	Ground pressure	Link quantity	Overall width
STD	600mm(24")	0.40kgf/cm ² (5.69psi)	49	2590mm(8' 6")
OPT	500mm(20")	0.47kgf/cm ² (6.68psi)	49	2490mm(8' 2")
	700mm(28")	0.35kgf/cm ² (4.98psi)	49	2690mm(8' 10")
	800mm(32")	0.31kgf/cm ² (4.41psi)	49	2790mm(9' 2")

10) BUCKET

Item	Capacity		Tooth quantity	Width	
	PCSA heaped	CECE heaped		Without side cutter	With side cutter
STD	0.65m ³ (0.85yd ³)	0.55m ³ (0.72yd ³)	5	930mm(37")	1050mm(41")
OPT	0.39m ³ (0.51yd ³)	0.35m ³ (0.46yd ³)	3	620mm(24")	740mm(29")
	0.57m ³ (0.75yd ³)	0.50m ³ (0.65yd ³)	4	840mm(33")	960mm(38")
	0.70m ³ (0.92yd ³)	0.60m ³ (0.78yd ³)	5	990mm(39")	1110mm(44")
	0.80m ³ (1.05yd ³)	0.70m ³ (0.92yd ³)	5	1080mm(43")	1200mm(47")

9. RECOMMENDED OILS

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)								
			-20 (-4)	-10 (14)	0 (32)	10 (50)	20 (68)	30 (86)	40 (104)		
Engine oil pan	Engine oil	11(2.9)					SAE 30				
			SAE 10W								
			SAE 10W-30								
			SAE 15W-40								
Swing drive	Gear oil	3.4(0.9)	SAE 85W-140								
Final drive		4.4 × 2 (1.2 × 2)									
Hydraulic tank	Hydraulic oil	Tank; 120(31.7) System; 210(55.5)	ISO VG 32								
			ISO VG 46								
			ISO VG 68								
Fuel tank	Diesel fuel	250(66.1)	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	24(6.3)	Ethylene glycol base permanent type								

SAE : Society of Automotive Engineers

API : American Petroleum Institute

ISO : International Organization for Standardization

NLGI : National Lubricating Grease Institute

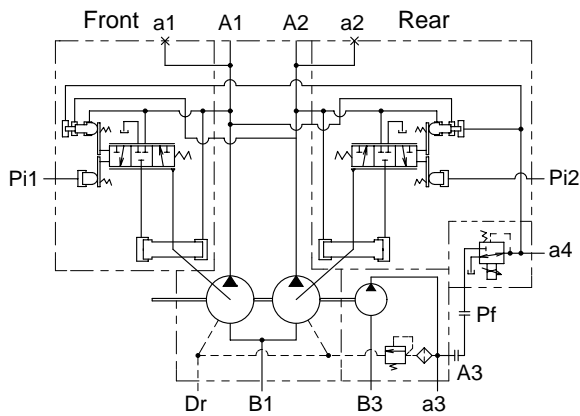
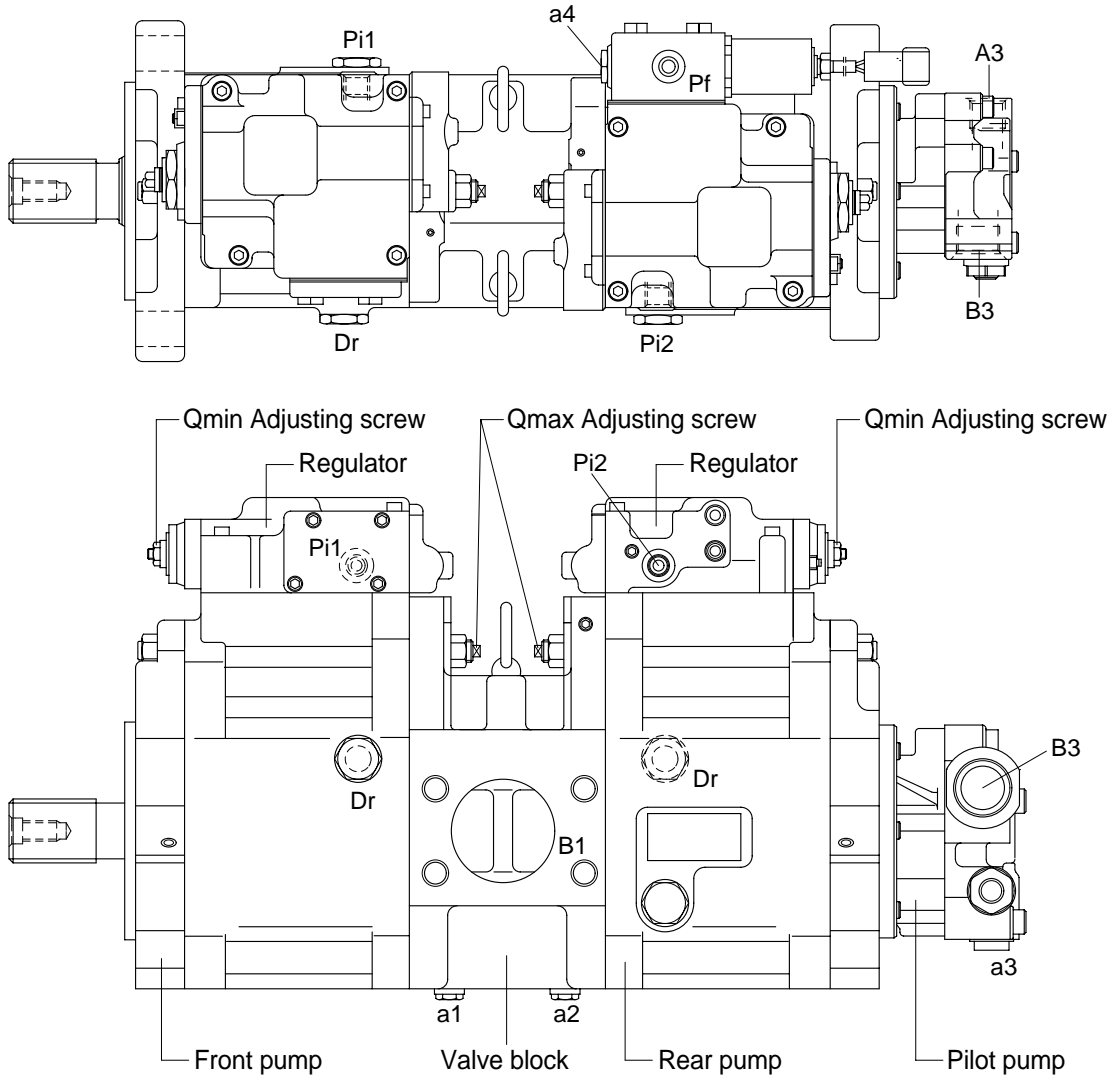
ASTM : American Society of Testing and Material

SECTION 2 STRUCTURE AND FUNCTION

GROUP 1 PUMP DEVICE

1. STRUCTURE

The pump device consists of main pump, regulator and gear pump.

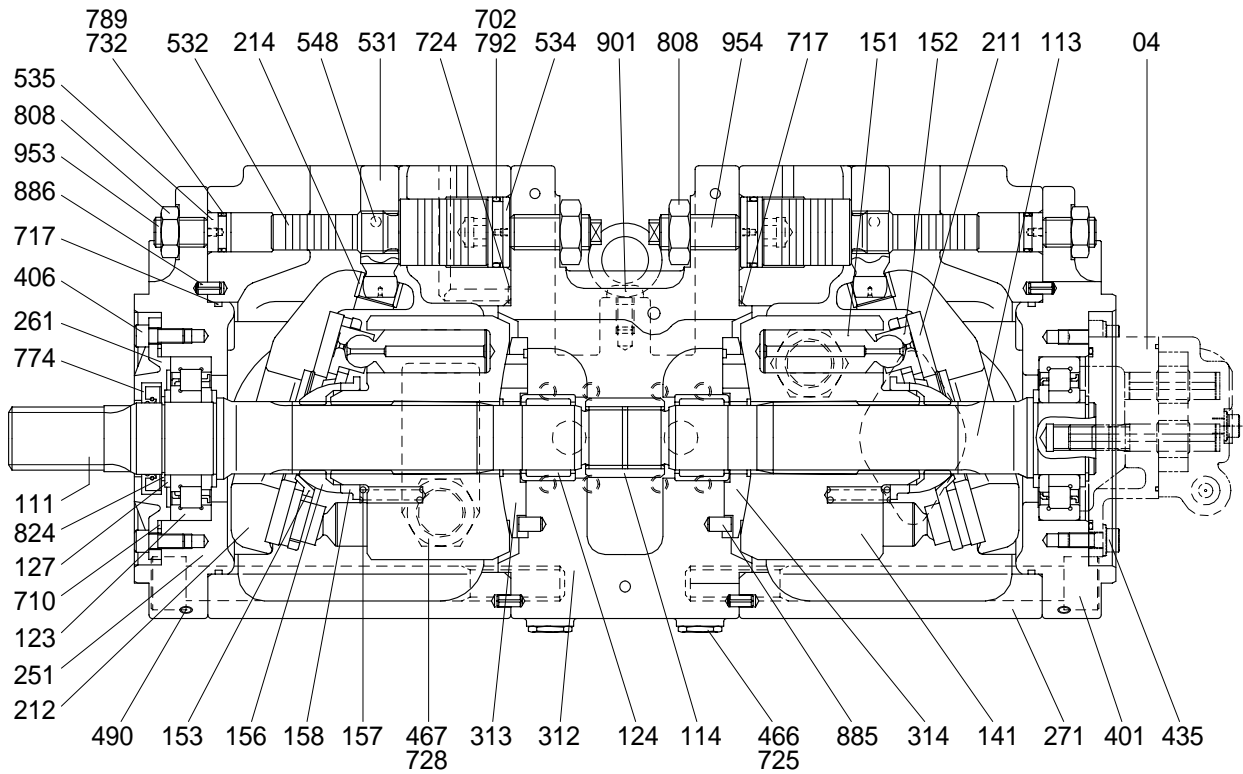


Hydraulic circuit

Port	Port name	Port size
A1,2	Delivery port	SAE6000psi 3/4"
B1	Suction port	SAE2500psi 2 1/2"
Dr	Drain port	PF 1/2 - 19
Pf	Power shift port (For decreasing)	PF 1/4 - 15
Pi1,i2	Pilot port	PF 1/4 - 15
a1,2,3,4	Gauge port	PF 1/4 - 15
A3	Gear pump delivery port	PF 1/2 - 19
B3	Gear pump suction port	PF 3/4 - 20.5

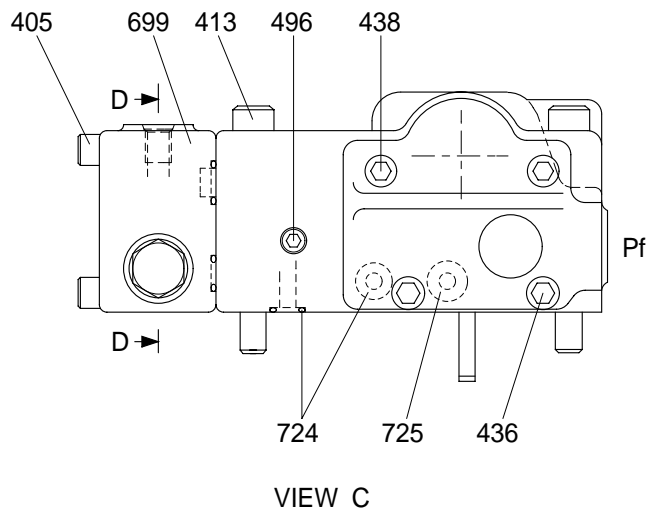
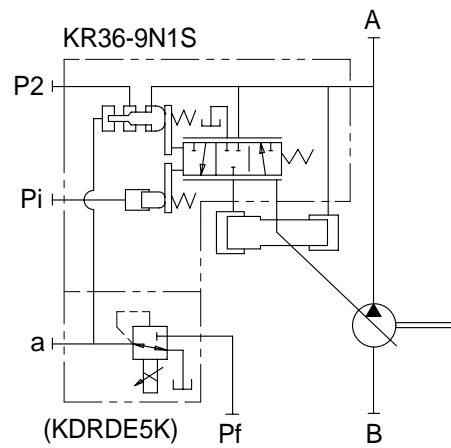
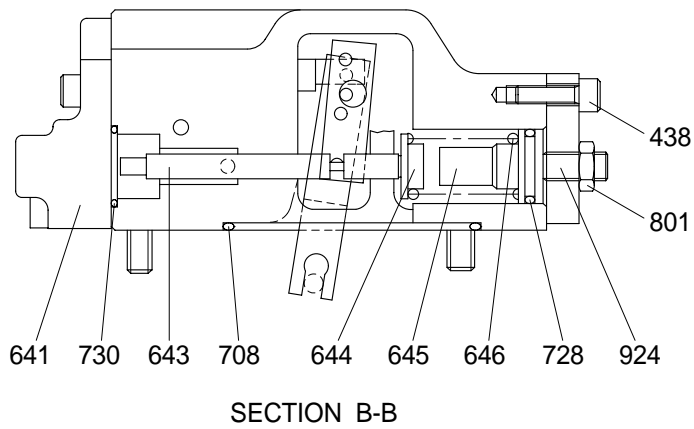
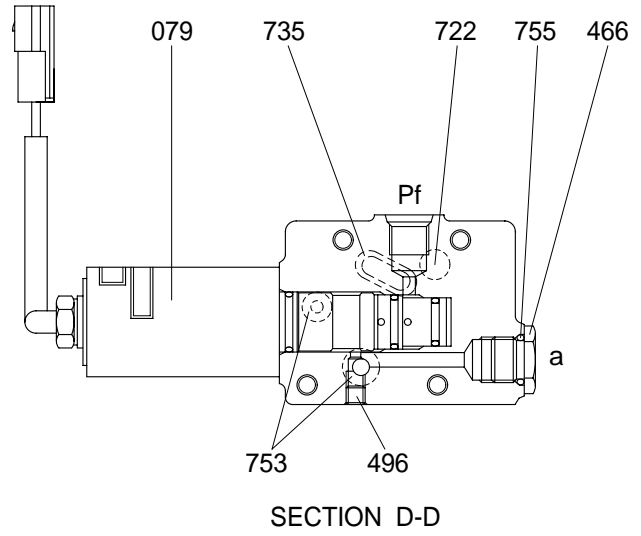
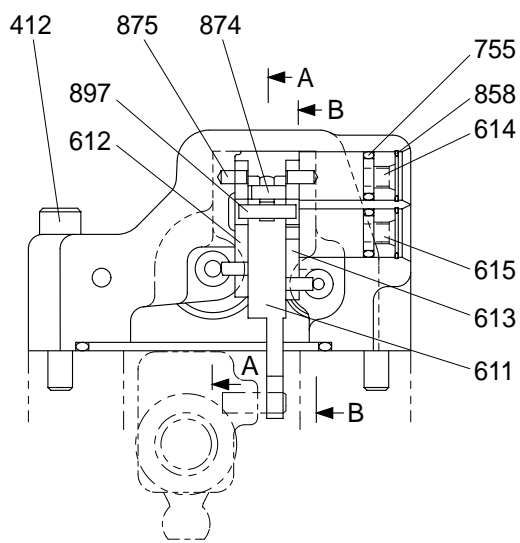
1) MAIN PUMP

The main pump consists of two piston pumps(Front & rear) and valve block.



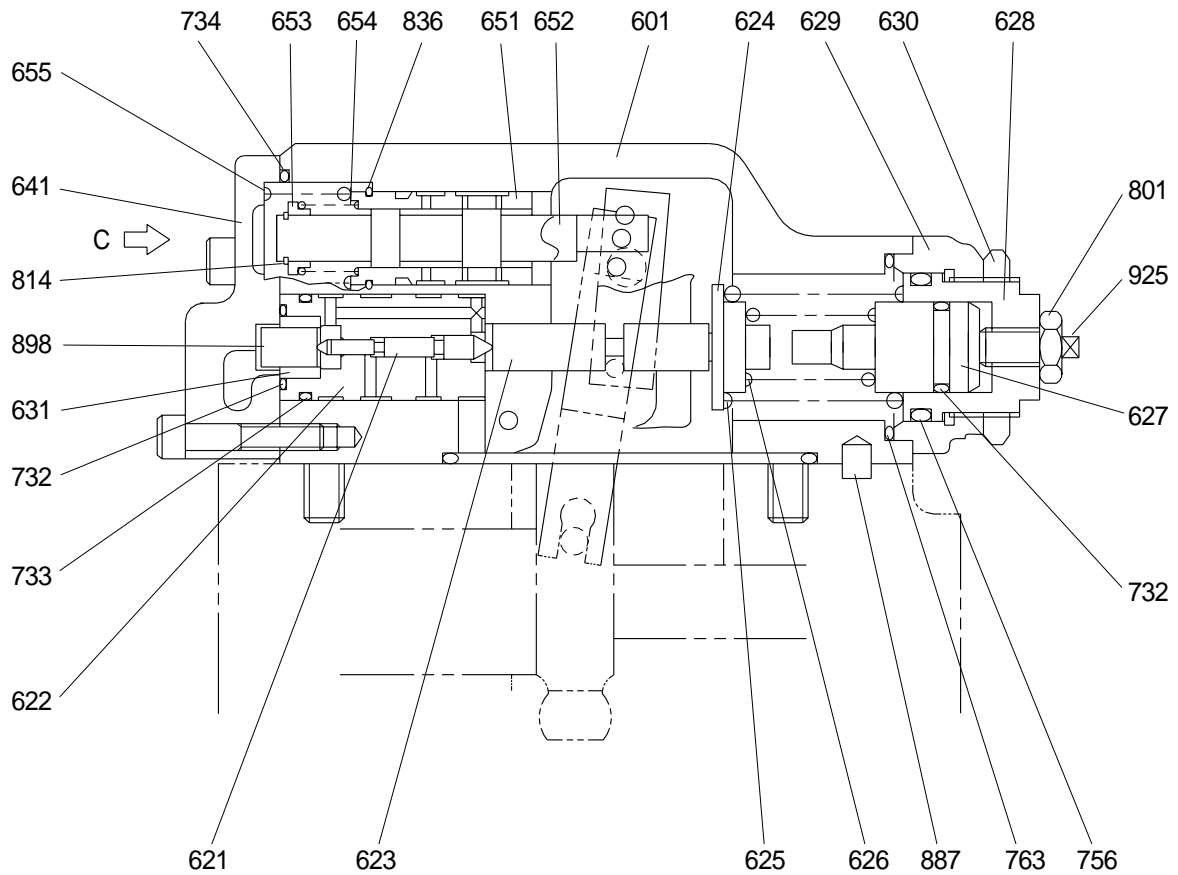
04	Gear pump	261	Seal cover(F)	717	O-ring
111	Drive shaft(F)	271	Pump casing	719	O-ring
113	Drive shaft(R)	312	Valve block	724	O-ring
114	Spline	313	Valve plate(R)	725	O-ring
123	Roller bearing	314	Valve plate(L)	728	O-ring
124	Needle bearing	401	Hexagon socket bolt	732	O-ring
127	Bearing spacer	406	Hexagon socket bolt	774	Oil seal
141	Cylinder block	435	Flange socket bolt	789	Back up ring
151	Piston	466	VP plug	792	Back up ring
152	Shoe	468	VP plug	808	Hexagon head nut
153	Push plate	490	VP plug	824	Snap ring
156	Bushing	531	Tilting pin	885	Pin
157	Cylinder spring	532	Servo piston	886	Spring pin
158	Spacer	534	Stopper(L)	901	Eye bolt
211	Shoe plate	535	Stopper(S)	953	Set screw
212	Swash plate	548	Pin	954	Set screw
214	Bushing	702	O-ring		
251	Swash plate support	710	O-ring		

2) REGULATOR(1/2)



Port	Port name	Port size
A	Delivery port	3/4"
B	Suction port	2 1/2"
Pi	Pilot port	PF 1/4-15
Pf	Powershift port	PF 1/4-15
P2	Companion delivery port	-

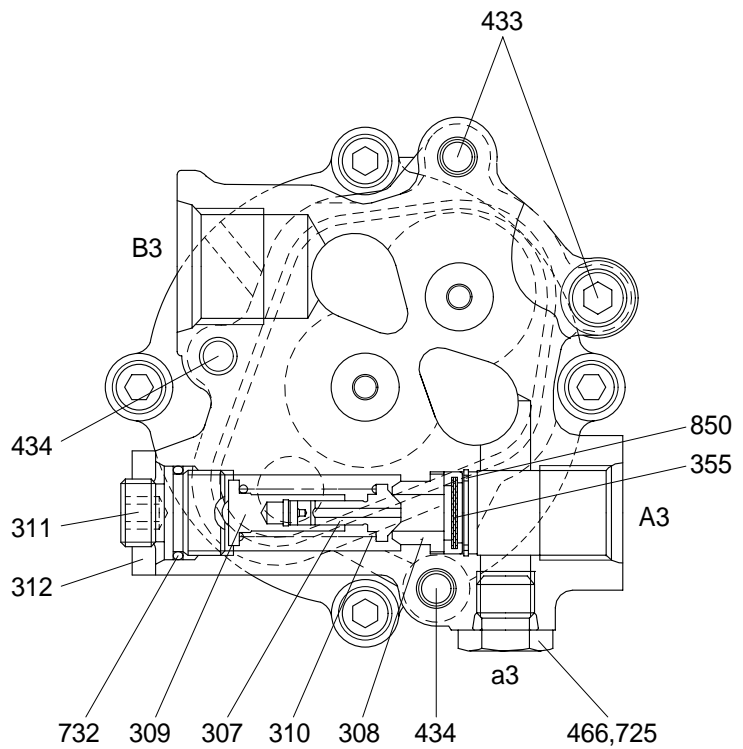
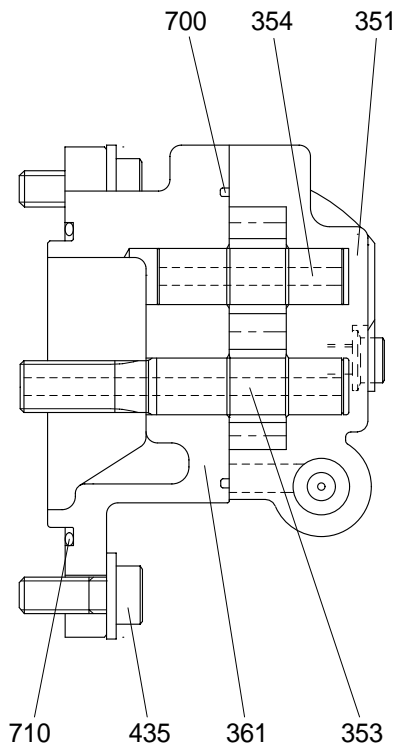
REGULATOR(2/2)



SECTION A-A

079	Hexagon socket screw	628	Adjust screw(C)		
405	Hexagon socket screw	629	Cover(C)	732	O-ring
412	Hexagon socket screw	630	Nut	733	O-ring
413	Hexagon socket screw	631	Sleeve	734	O-ring
436	Hexagon socket screw	641	Pilot cover	735	O-ring
438	Hexagon socket screw	642	Pilot cover(QMC)	753	O-ring
466	Plug	643	Pilot piston	755	O-ring
496	Plug	644	Spring seat(Q)	756	O-ring
601	Casing	645	Adjust stem(Q)	763	O-ring
611	Feedback lever	646	Pilot spring	801	Nut
612	Lever(1)	651	Sleeve	814	Snap ring
613	Lever(2)	652	Spool	836	Snap ring
614	Fulcrum plug	653	Spring seat	858	Snap ring
615	Adjust plug	654	Return spring	874	Pin
621	Piston	655	Set spring	875	Pin
622	Piston case	708	O-ring	887	Pin
623	Compensator rod	722	O-ring	897	Pin
624	Spring seat(C)	724	O-ring	898	Pin
625	Outer spring	725	O-ring	924	Set screw
626	Inner spring	728	O-ring	925	Adjust screw(Q)
627	Adjust stem(C)	730	O-ring		

3) GEAR PUMP



- 307 Poppet
- 308 Seat
- 309 Spring seat
- 310 Spring
- 311 Adjust screw
- 312 Lock nut
- 351 Gear case

- 353 Drive gear
- 354 Driven gear
- 355 Filter
- 361 Front case
- 433 Flange socket
- 434 Flange socket
- 435 Flange socket

- 466 Plug
- 700 Ring
- 710 O-ring
- 725 O-ring
- 732 O-ring
- 850 Snap ring

2. FUNCTION

1) MAIN PUMP

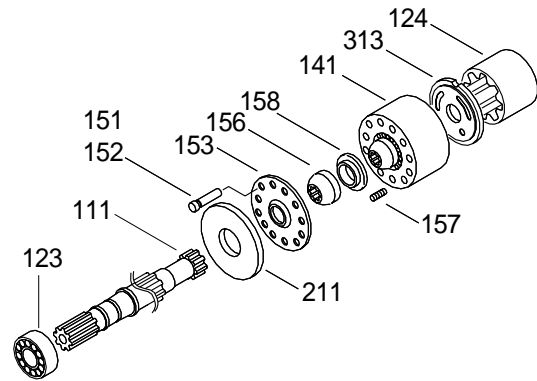
The pumps may be classified roughly into the rotary group performing a rotary motion and working as the major part of the whole pump function: The swash plate group that varies the delivery rates: And the valve cover group that changes over oil suction and discharge.

(1) Rotary group

The rotary group consists of drive shaft (F)(111), cylinder block(141), piston shoes(151,152), set plate(153), spherical bush(156), spacer(158) and cylinder spring(157). The drive shaft is supported by bearing(123,124) at its both ends.

The shoe is caulked to the piston to form a spherical coupling. It has a pocket to relieve thrust force generated by loading pressure and to take hydraulic balance so that it slides lightly over the shoe plate(211). The sub group composed by a piston and a shoe is pressed against the shoe plate by the action of the cylinder spring via a retainer and a spherical bush.

Similarly, the cylinder block is pressed against valve plate(313) by the action of the cylinder spring.

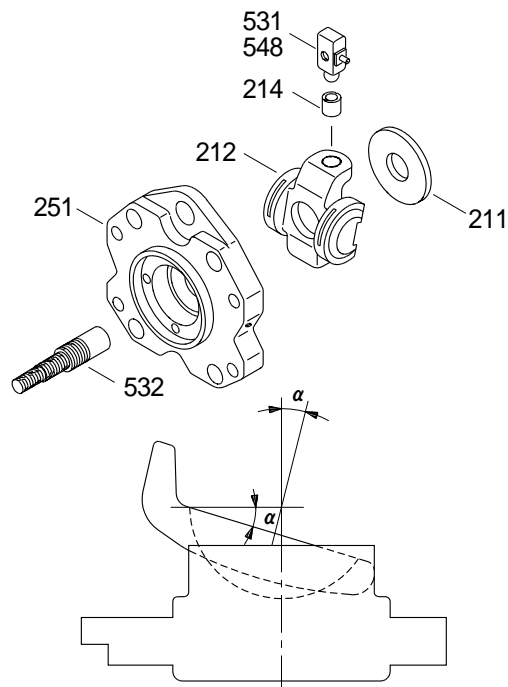


(2) Swash plate group

The swash plate group consists of swash plate(212), shoe plate(211), swash plate support(251), tilting bush(214), tilting pin(531) and servo piston(532).

The swash plate is a cylindrical part formed on the opposite side of the sliding surface of the shoe and is supported by the swash support.

If the servo piston moves to the right and left as hydraulic force controlled by the regulator is admitted to hydraulic chamber located on both sides of the servo piston, the swash plate slides over the swash plate support via the spherical part of the tilting pin to change the tilting angle(α)



(3) Valve block group

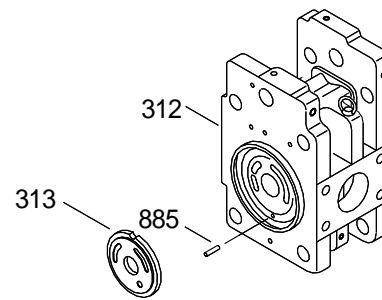
The valve block group consists of valve block(312), valve plate(313) and valve pin(885).

The valve plate having two melon-shaped ports is fixed to the valve block and feeds and collects oil to and from the cylinder block.

The oil changed over by the valve plate is connected to an external pipeline by way of the valve block.

Now, if the drive shaft is driven by a prime mover(Electric motor, engine, etc), it rotates the cylinder block via a spline linkage at the same time. If the swash plate is tilted as in Fig(Previous page) the pistons arranged in the cylinder block make a reciprocating motion with respect to the cylinder block, while they revolve with the cylinder block.

If you pay attention to a single piston, it performs a motion away from the valve plate(Oil sucking process) within 180 degrees, and makes a motion towards the valve plate(Or oil discharging process) in the rest of 180 degrees. When the swash plate has a tilting angle of zero, the piston makes no stroke and discharges no oil.



2) REGULATOR

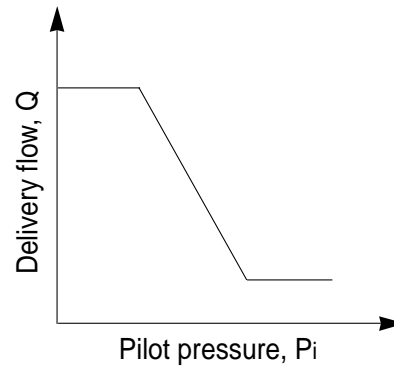
Regulator consists of the negative flow control, total horse power control and power shift control function.

(1) Negative flow control

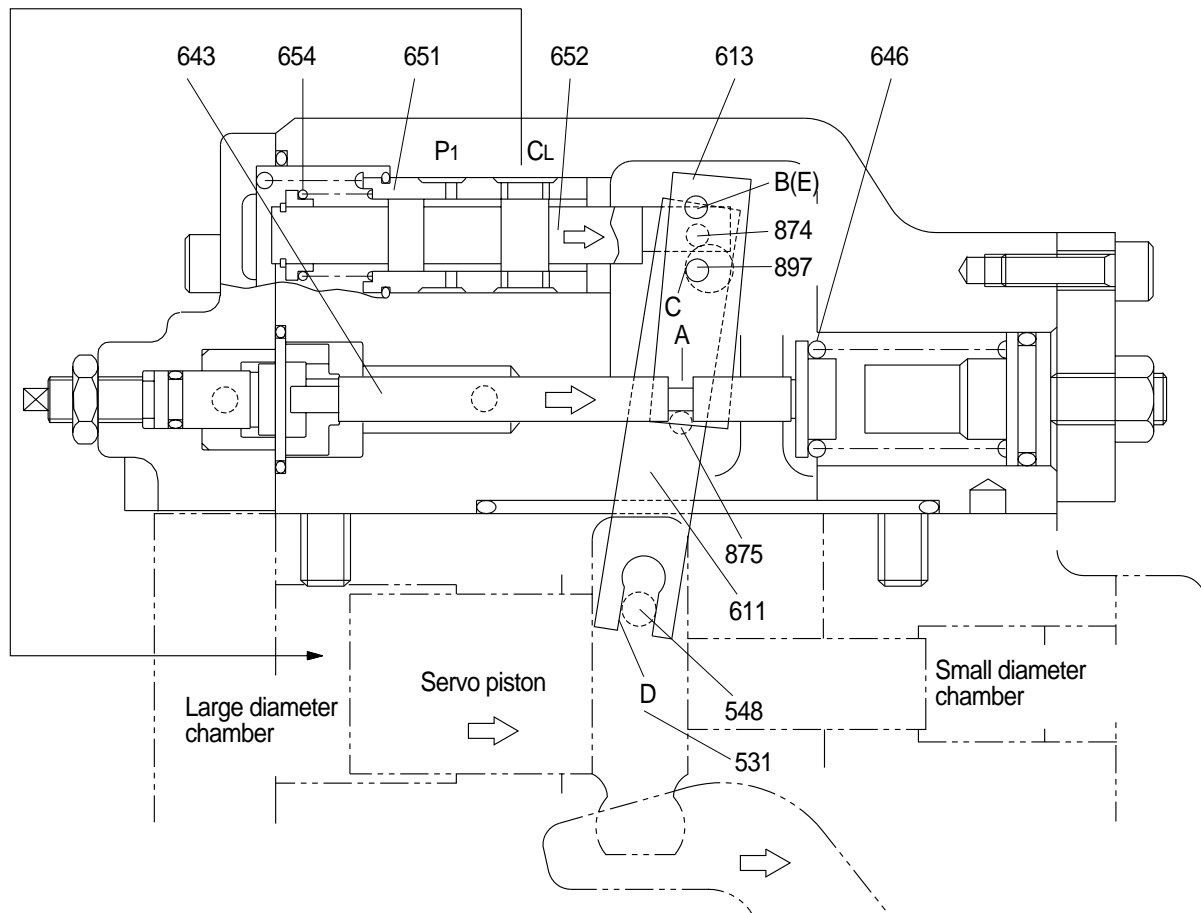
By changing the pilot pressure P_i , the pump tilting angle(Delivery flow) is regulated arbitrarily, as shown in the figure.

This regulator is of the negative flow control in which the delivery flow Q decreases as the pilot pressure P_i rises.

With this mechanism, when the pilot pressure corresponding to the flow required for the work is commanded, the pump discharges the required flow only, and so it does not consume the power uselessly.



① Flow reducing function



As the pilot pressure P_1 rises, the pilot piston(643) moves to the right to a position where the force of the pilot spring(646) balances with the hydraulic force.

The groove(A) in the pilot piston is fitted with the pin(875) that is fixed to lever 2(613). Therefore, when the pilot piston moves, lever 2 rotates around the fulcrum of point B [fixed by the fulcrum plug(614) and pin(875)]. Since the large hole section(C) of lever 2 contains a protruding pin(897) fixed to the feedback lever(611), the pin(897) moves to the right as lever 2 rotates. Since the opposing-flat section(D) of the feedback lever is fitted with the pin(548) fixed by the tilting pin(531) that swings the swash plate, the feedback lever rotates around the fulcrum of point D, as the pin(897) moves.

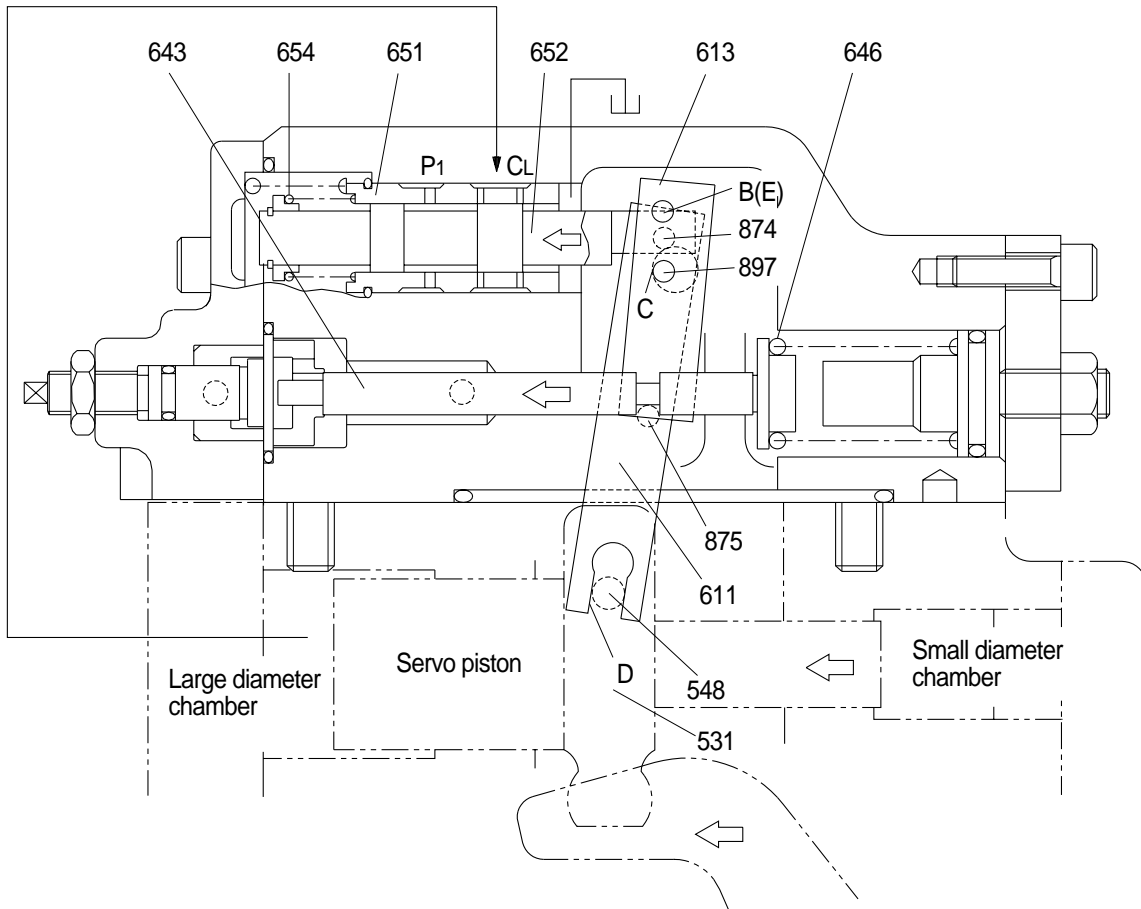
Since the feedback lever is connected with the spool(652) via the pin(874), the spool moves to the right.

The movement of the spool causes the delivery pressure P_1 to connect to port CL through the spool and to be admitted to the large diameter section of the servo piston. The delivery pressure P_1 that is constantly admitted to the small diameter section of the servo piston moves the servo piston to the right due to the area difference, resulting in decrease of the tilting angle.

When the servo piston moves to the right, point D also moves to the right. The spool is fitted with the return spring(654) and is tensioned to the left at all times, and so the pin(897) is pressed against the large hole section(C) of lever 2.

Therefore, as point D moves, the feedback lever rotates around the fulcrum of point C, and the spool is shifted to the left. This causes the opening between the sleeve(651) and spool(652) to close slowly, and the servo piston comes to a complete stop when it closes completely.

② Flow increasing function



As the pilot pressure P_i decreases, the pilot piston(643) moves to the left by the action of the pilot spring(646) and causes lever 2(613) to rotate around the fulcrum of point B. Since the pin(897) is pressed against the large hole section(C) of lever 2 by the action of the return spring(654) via the spool(652), pin(874), and feedback lever(611), the feedback lever rotates around the fulcrum of point D as lever 2 rotates, and shifts the spool to the left. Port CL opens a way to the tank port as the spool moves. This deprives the large diameter section of the servo piston of pressure, and shifts the servo piston to the left by the discharge pressure P_1 in the small diameter section, resulting in an increase in the flow rate.

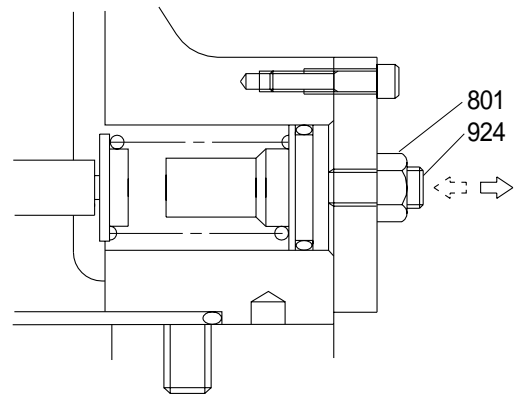
As the servo piston moves, point D also moves to the left, the feedback lever rotates around the fulcrum of point C, and the spool moves to the right till the opening between the spool and sleeve is closed.

③ Adjustment of flow control characteristic

The flow control characteristic can be adjusted with the adjusting screw.

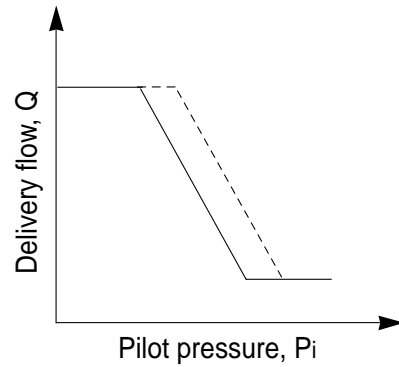
Adjust it by loosening the hexagon nut (801) and by tightening (Or loosening) the hexagonal socket head screw (924).

Tightening the screw shifts the control chart to the right as shown in the figure.



※ Adjusting values are shown in table

Speed	Adjustment of flow control characteristic		
	Tightening amount of adjusting screw (924)	Flow control starting pressure change amount	Flow change amount
(min ⁻¹)	(Turn)	(kgf/cm ²)	(l /min)
2200	+1/4	+1.5	+8



(2) Total horsepower control

The regulator decreases the pump tilting angle (Delivery flow) automatically to limit the input torque within a certain value with a rise in the delivery pressure P_1 of the self pump and the delivery pressure P_2 of the companion pump.

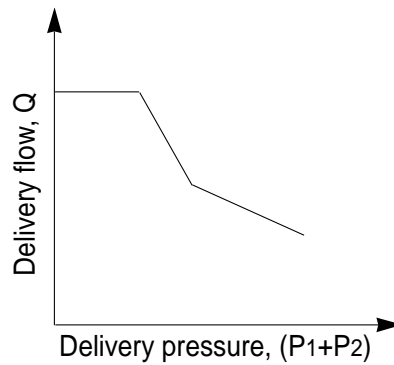
(The input horsepower is constant when the speed is constant.)

Since the regulator is of the simultaneous total horsepower type that operates by the sum of load pressures of the two pumps in the tandem double-pump system, the prime mover is automatically prevented from being overloaded, irrespective of the load condition of the two pumps, when horsepower control is under way.

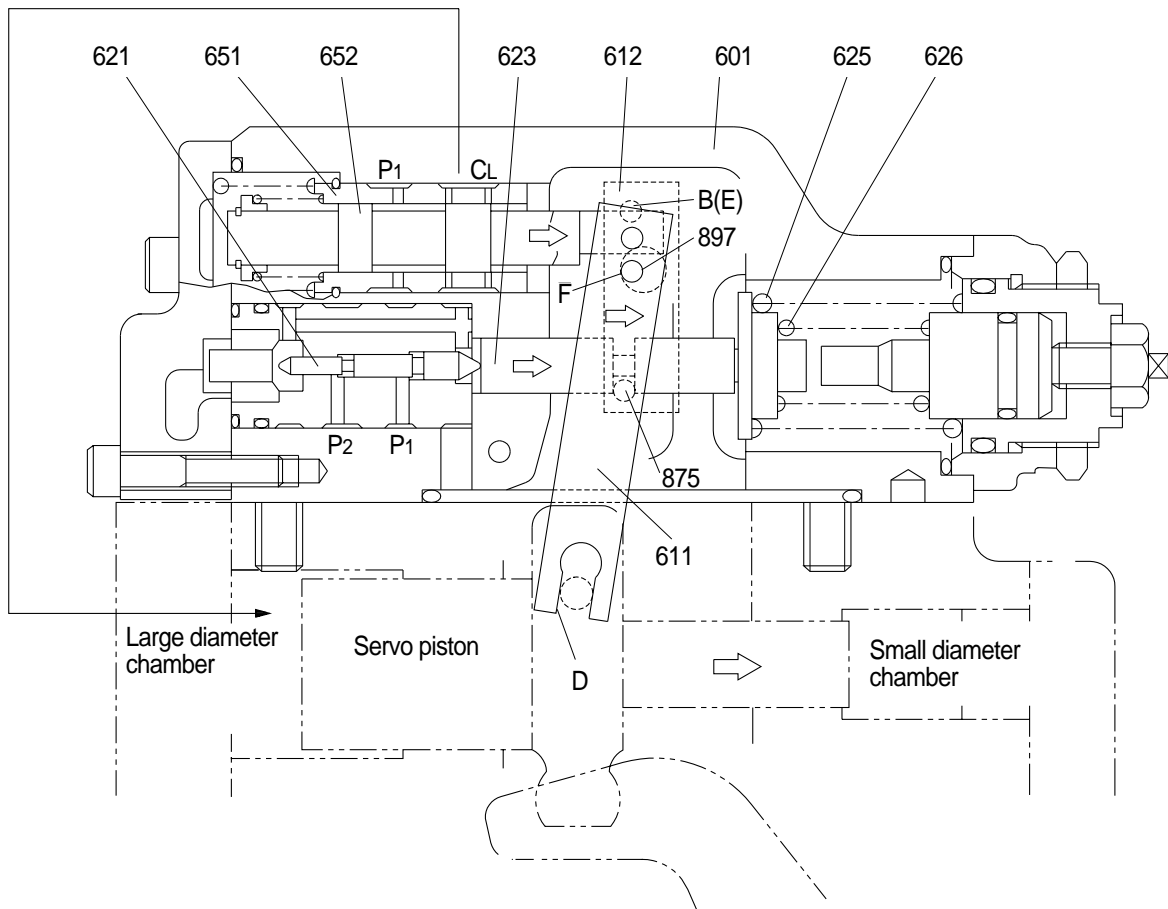
Since this regulator is of the simultaneous total horsepower type, it controls the tilting angles (Displacement volumes) of the two pumps to the same value as represented by the following equation :

$$\begin{aligned} T_{in} &= P_1 \times q/2\pi + P_2 \times q/2\pi \\ &= (P_1+P_2) \times q/2\pi \end{aligned}$$

The horsepower control function is the same as the flow control function and is summarized in the following. (For detailed behaviors of respective parts, refer to the section of flow control.)

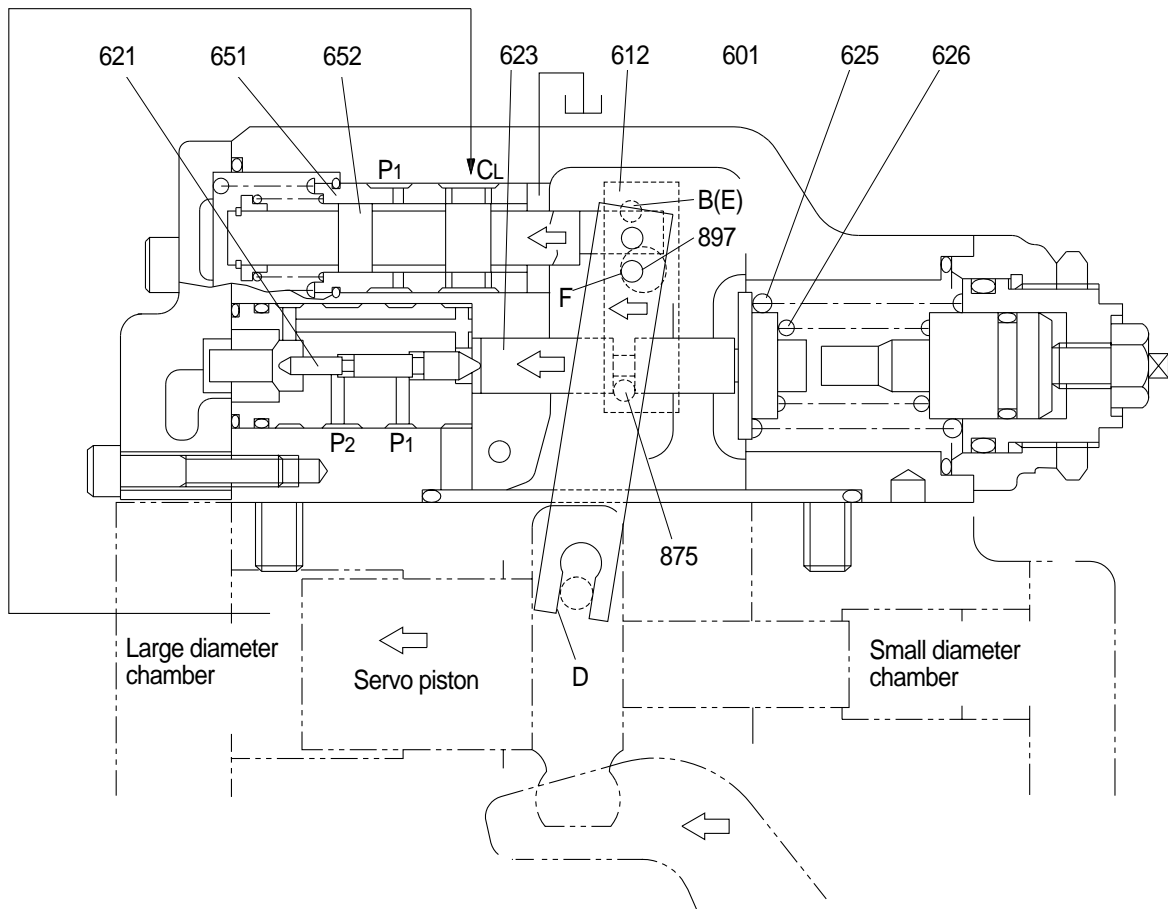


① Overload preventive function



When the self pump delivery pressure P1 or the companion pump delivery pressure P2 rises, it acts on the stepped part of the compensating piston(621). It presses the compensating rod(623) to the right till the force of the outer spring(625) and inner spring(626) balances with the hydraulic force. The movement of the compensating rod is transmitted to lever 1(612) via pin(875). Lever 1 rotates around the pin(875) (E) fixed to the casing(601). Since the large hole section(F) of lever 1 contains a protruding pin(897) fixed to the feedback lever(611), the feedback lever rotates around the fulcrum of point D as lever 1 rotates, and then the spool(652) is shifted to the right. As the spool moves, the delivery pressure P1 is admitted to the large diameter section of the servo piston via port CL, causes the servo piston move to the right, reduces the pump delivery, flow rate, and prevents the prime mover from being overloaded. The movement of the servo piston is transmitted to the feedback lever via point D. Then the feedback lever rotates around the fulcrum of point F and the spool is shifted to the left. The spool moves till the opening between the spool(652) and sleeve(651) is closed.

② Flow reset function



As the self pump delivery pressure P_1 or the companion pump delivery pressure P_2 decreases, the compensating rod (623) is pushed back by the action of the springs (625 & 626) to rotate lever 1 (612) around point E. Rotating of lever 1 causes the feedback lever (611) to rotate around the fulcrum of point D and then the spool (652) to move to the left. As a result, port CL opens a way to the tank port.

This causes the servo piston to move to the left and the pump's delivery rate to increase.

The movement of the servo piston is transmitted to the spool by the action of the feedback mechanism to move it till the opening between the spool and sleeve is closed.

③ Low tilting angle(Low flow) command preferential function

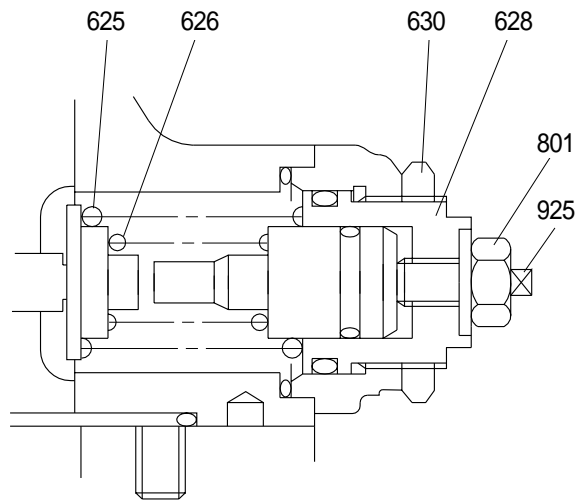
As mentioned above, flow control and horsepower control tilting angle commands are transmitted to the feedback lever and spool via the large-hole sections(C & F) of levers 1 and 2. However, since sections C and F have the pins($\varnothing 4$) protruding from the large hole($\varnothing 8$), only the lever lessening the tilting angle contacts the pin(897) ; The hole($\varnothing 8$) in the lever of a larger tilting angle command is freed without contacting the pin(897). Such a mechanical selection method permits preference of the lower tilting angle command of the flow control and horsepower control.

④ Adjustment of input horsepower

Since the regulator is of total cumulative horsepower type, adjust the adjusting screws of both the front and rear pumps, when changing the horsepower set values. The pressure change values by adjustment are based on two pumps pressurized at the same time, and the values will be doubled when only one pump is loaded.

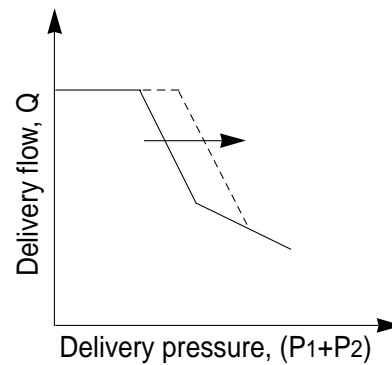
a. Adjustment of outer spring

Adjust it by loosening the hexagon nut(630) and by tightening(Or loosening) the adjusting screw C(628). Tightening the screw shifts the control chart to the right and increases the input horsepower as shown in the figure. Since turning the adjusting screw C by N turns changes the setting of the inner spring(626), return the adjusting screw QI(925) by $N \times A$ turns at first.($A=2.2$)



※ **Adjusting values are shown in table**

Speed	Adjustment of outer spring		
	Tightening amount of adjusting screw(C) (628)	Compensating control starting pressure change amount	Input torque change amount
(min ⁻¹)	(Turn)	(kgf/cm ²)	(l /min)
2200	+1/4	+19	+3

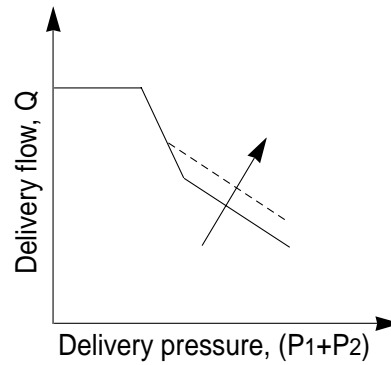
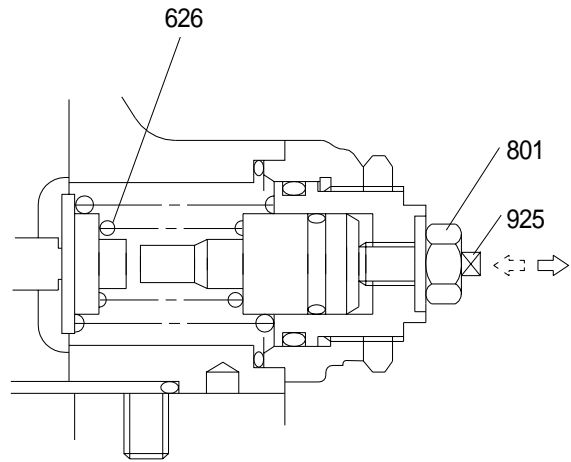


b. Adjustment of inner spring

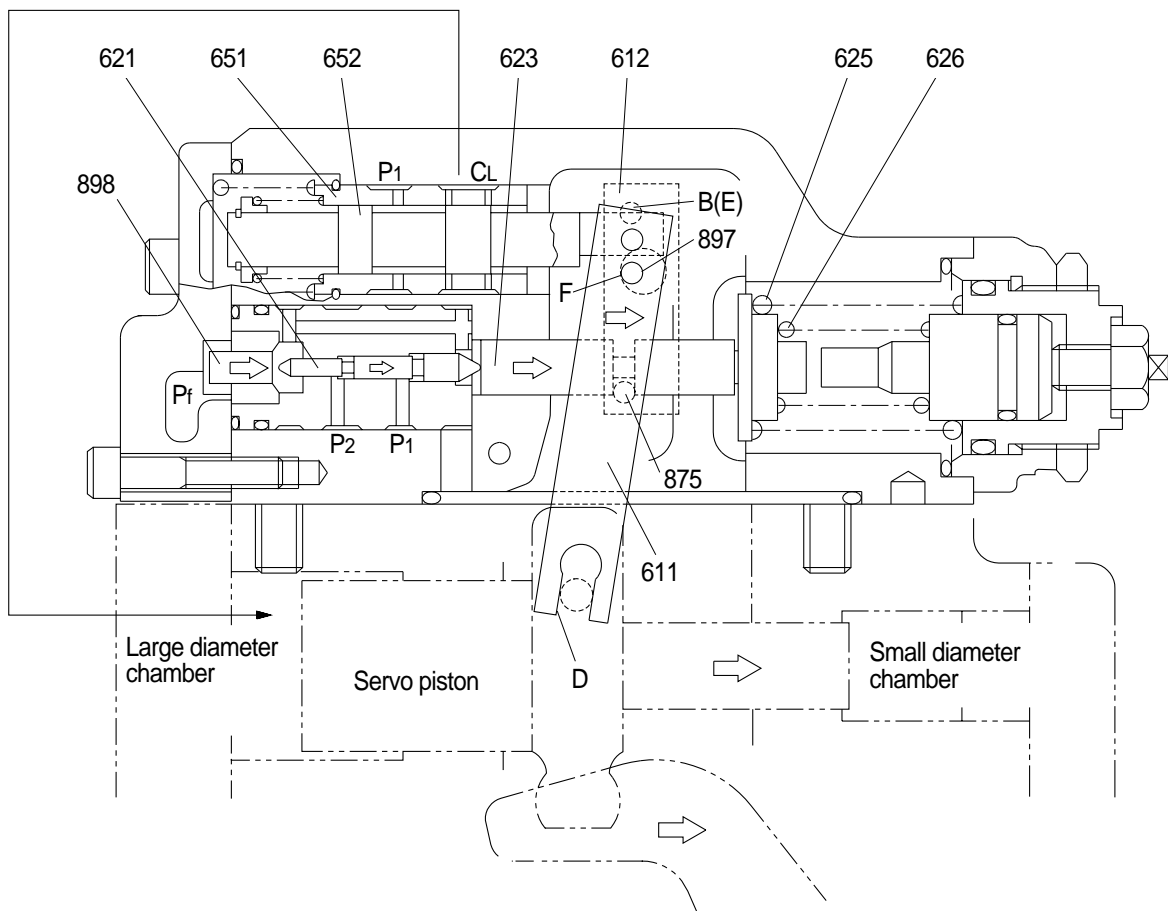
Adjust it by loosening the hexagon nut (801) and by tightening(Or loosening) the adjusting screw Q1(925). Tightening the screw increases the flow and then the input horsepower as shown in the figure.

※ Adjusting valves are shown in table

Speed	Adjustment of inner spring		
	Tightening amount of adjusting screw(Q1) (925)	Flow control starting pressure change amount	Input torque change amount
(min ⁻¹)	(Turn)	(kgf/cm ²)	(l /min)
2200	+1/4	+27	+2.5



(3) Power shift control



The set horsepower valve is shifted by varying the command current level of the proportional pressure reducing valve attached to the pump.

Only one proportional pressure reducing valve is provided.

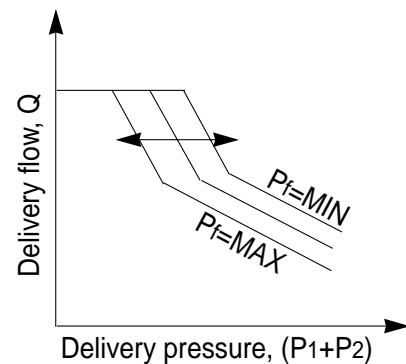
However, the secondary pressure P_f (power shift pressure) is admitted to the horsepower control section of each pump regulator through the pump's internal path to shift it to the same set horsepower level.

This function permits arbitrary setting of the pump output power, thereby providing the optimum power level according to the operating condition.

The power shift pressure P_f controls the set horsepower of the pump to a desired level, as shown in the figure.

As the power shift pressure P_f rises, the compensating rod (623) moves to the right via the pin (898) and compensating piston (621).

This decreases the pump tilting angle and then the set horsepower in the same way as explained in the overload preventive function of the horsepower control. On the contrary, the set horsepower rises as the power shift pressure P_f falls.



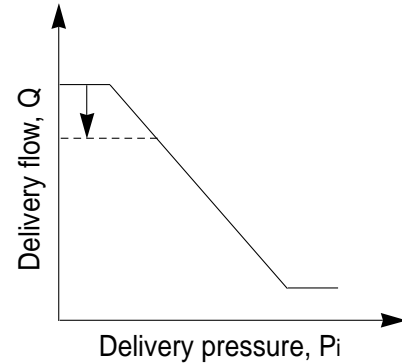
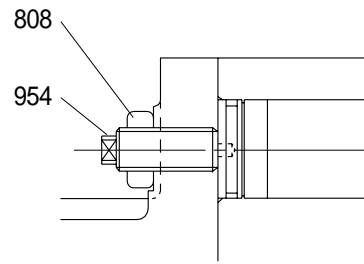
(4) Adjustment of maximum and minimum flows

① Adjustment of maximum flow

Adjust it by loosening the hexagon nut(808) and by tightening(Or loosening) the set screw(954).

The maximum flow only is adjusted without changing other control characteristics.

Speed	Adjustment of max flow	
	Tightening amount of adjusting screw (954)	Flow change amount
(min ⁻¹)	(Turn)	(l /min)
2200	+1/4	-3.5



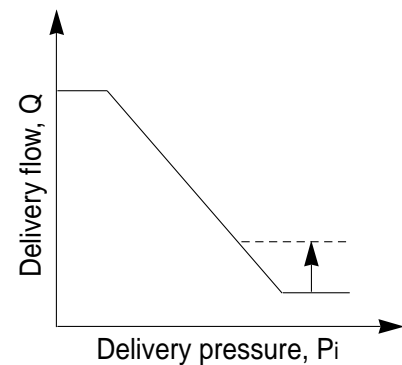
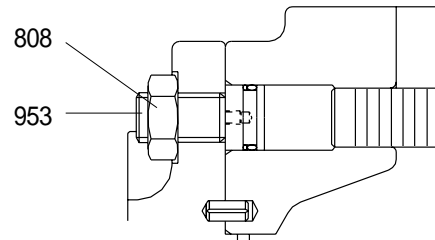
② Adjustment of minimum flow

Adjust it by loosening the hexagon nut (808) and by tightening(Or loosening) the hexagonal socket head set screw (953).

Similarly to the adjustment of the maximum flow, other characteristics are not changed.

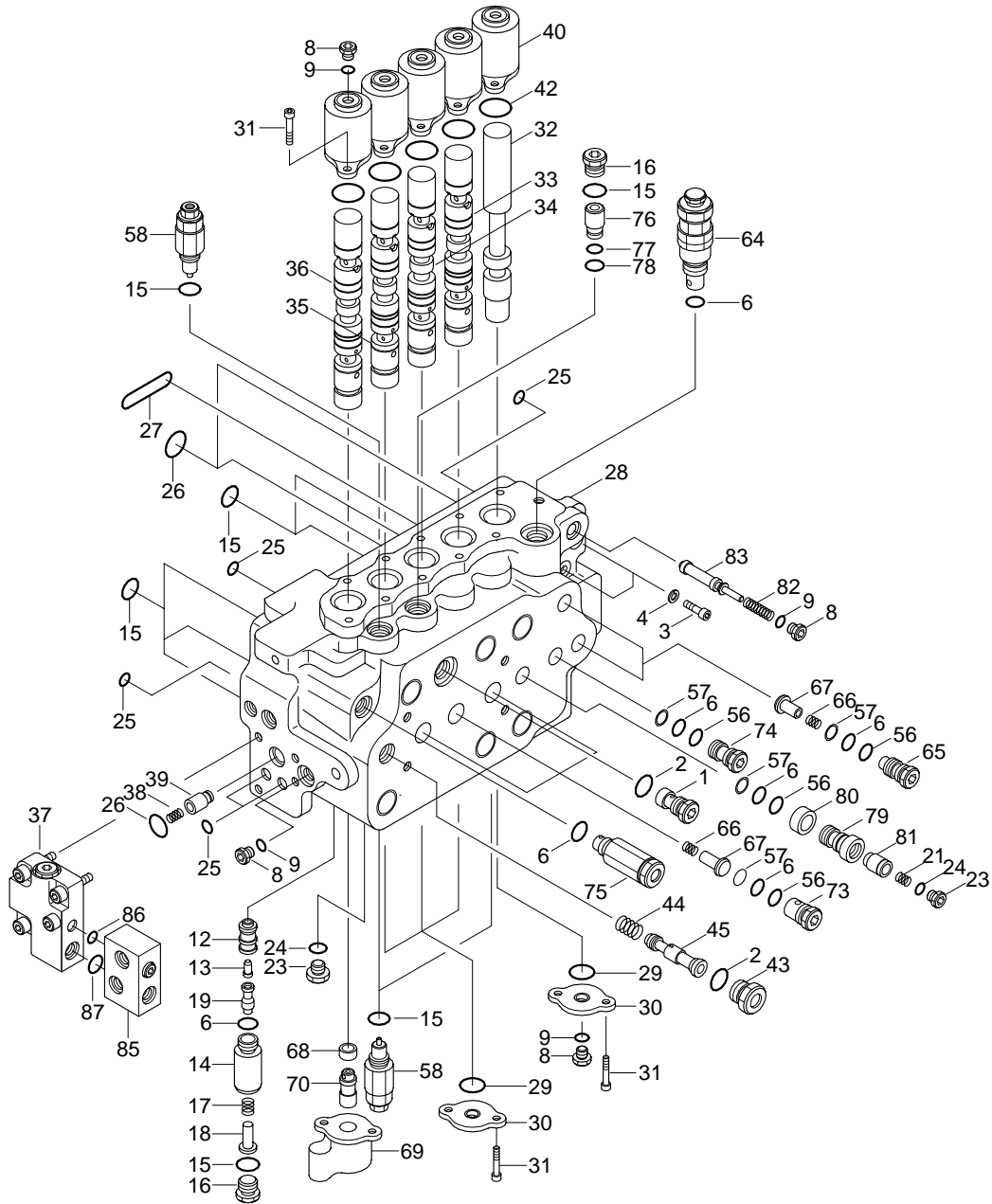
However, remember that, if tightened too much, the required horsepower during the maximum delivery pressure(Or during relieving) may increase.

Speed	Adjustment of min flow	
	Tightening amount of adjusting screw (953)	Flow change amount
(min ⁻¹)	(Turn)	(l /min)
2200	+1/4	-3.5



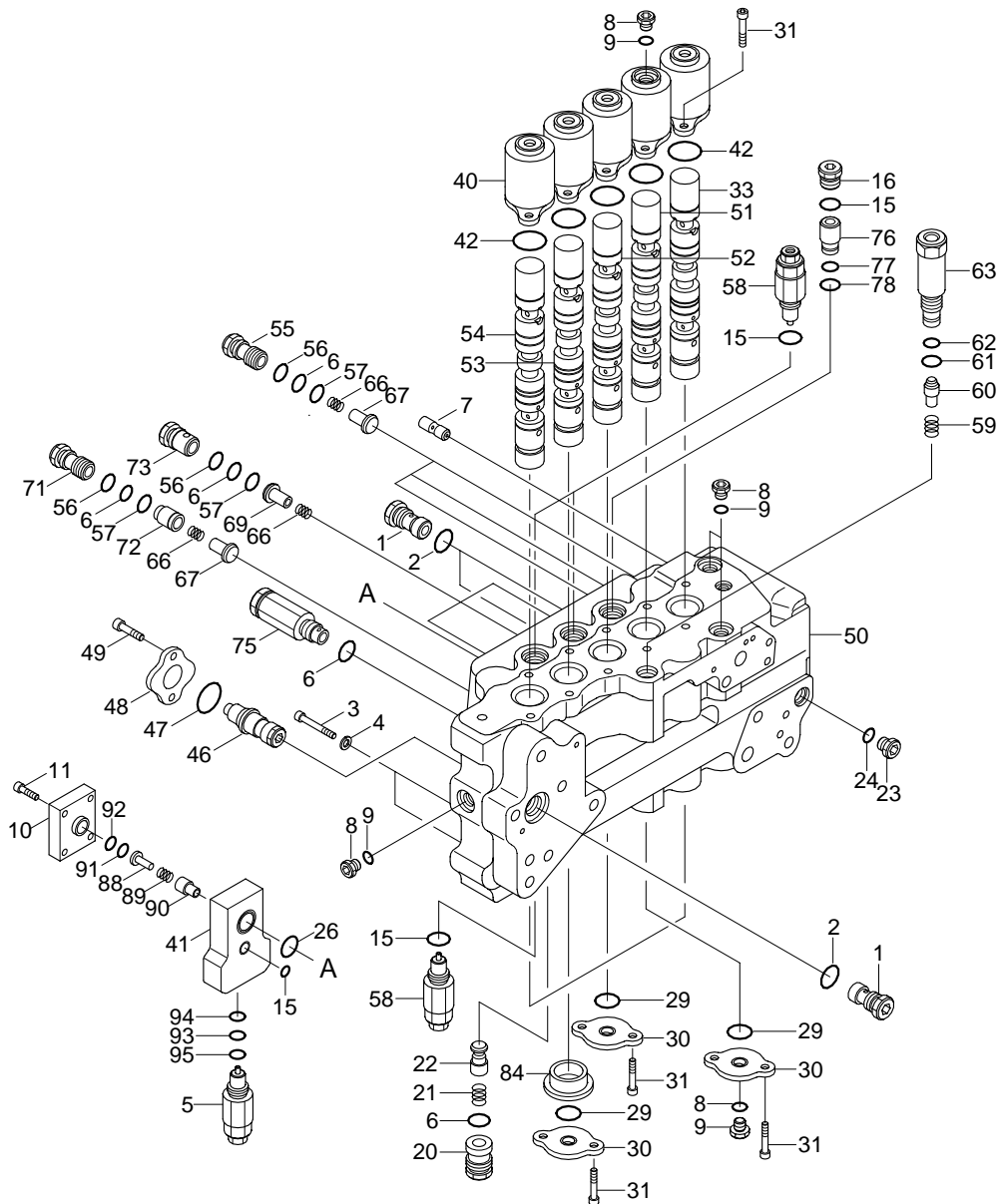
GROUP 2 MAIN CONTROL VALVE

1. STRUCTURE(1/2)



- | | | | | | |
|----|---------------|----|--------------|----|----------------------|
| 1 | Cap | 14 | Cap | 27 | O-ring |
| 2 | O-ring | 15 | O-ring | 28 | Housing |
| 3 | Socket bolt | 16 | Cap | 29 | O-ring |
| 4 | Spring washer | 17 | Spring | 30 | Retainer |
| 5 | Overload assy | 18 | Spring guide | 31 | Socket bolt |
| 6 | O-ring | 19 | Spring guide | 32 | Plunger assy(TS) |
| 7 | Orifice | 20 | Cap | 33 | Plunger assy(TL, TR) |
| 8 | Cap | 21 | Spring | 34 | Plunger assy(SW) |
| 9 | O-ring | 22 | Check | 35 | Plunger assy(BM2) |
| 10 | Cover | 23 | Cap | 36 | Plunger assy(AM1) |
| 11 | Socket bolt | 24 | O-ring | 37 | Cover assy |
| 12 | Sleeve | 25 | O-ring | | |
| 13 | Check | 26 | O-ring | | |

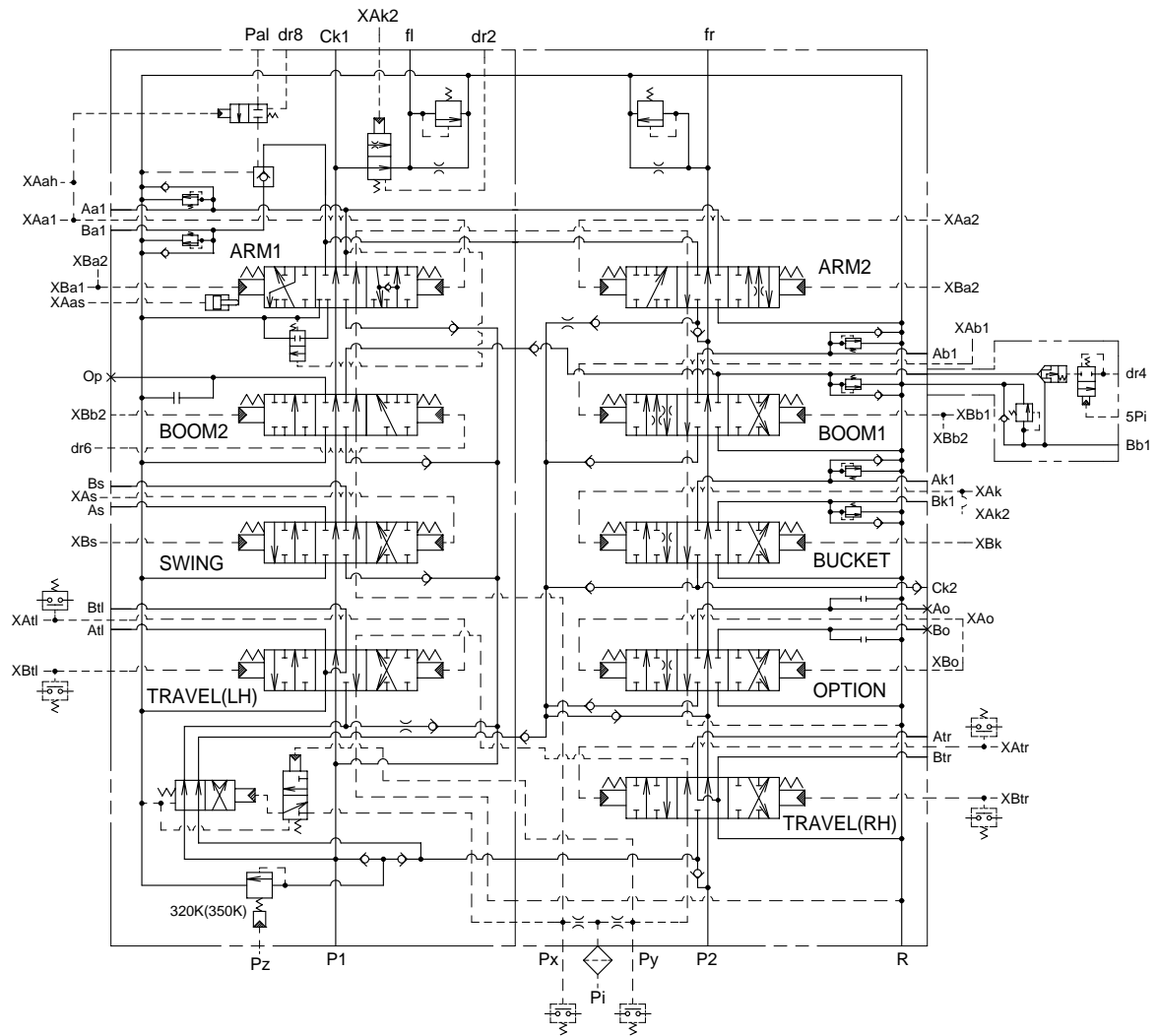
STRUCTURE(2/2)



38	Spring	53	Plunger assy(BM1)	68	Spacer	83	Spool
39	Poppet	54	Plunger assy(AM2)	69	Cover	84	Stopper
40	Cover	55	Cap	70	Piston	85	Selector assy
41	Manifold	56	Back up ring	71	Cap	86	O-ring
42	O-ring	57	Nylon chip	72	Check	87	O-ring
43	Cap	58	Overload assy	73	Cap	88	Spring guide
44	Spring	59	Spring	74	Cap	89	Spring
45	Spool	60	Check	75	Foot relief assy	90	Poppet
46	Plug	61	O-ring	76	Plug	91	O-ring
47	O-ring	62	Back up ring	77	Back up ring	92	Back up ring
48	Retainer	63	Cap	78	O-ring	93	O-ring
49	Socket bolt	64	Main relief assy	79	Cap	94	Back up ring
50	Housing	65	Cap	80	Spacer	95	O-ring
51	Plunger assy(OPT)	66	Spring	81	Check		
52	Plunger assy(BKT)	67	Check	82	Spring		

2. FUNCTION

1) HYDRAULIC CIRCUIT



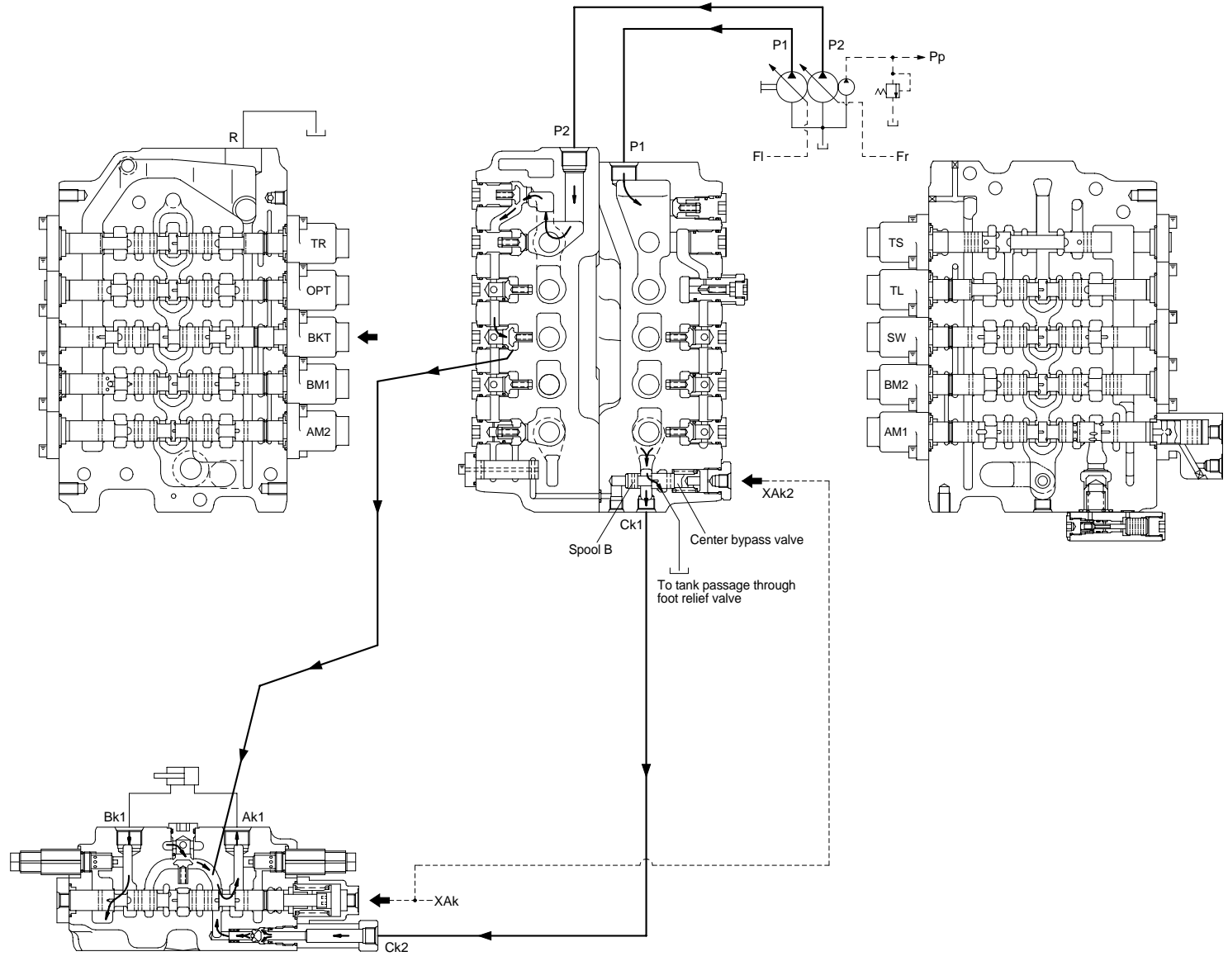
2) BASIC OPERATION

(1) Bucket flow summation circuit

Oil from pump P2 is fed into cylinder port Ak1 by adding pressure to bucket plunger pilot port XAk and the oil from actuator flow tank through cylinder port Bk1.

The center bypass valve is changeover by the pilot pressure XAk2 and the oil from center bypass passage flows to the bucket summation port Ck2 via outside piping and some others flow into foot relief valve.

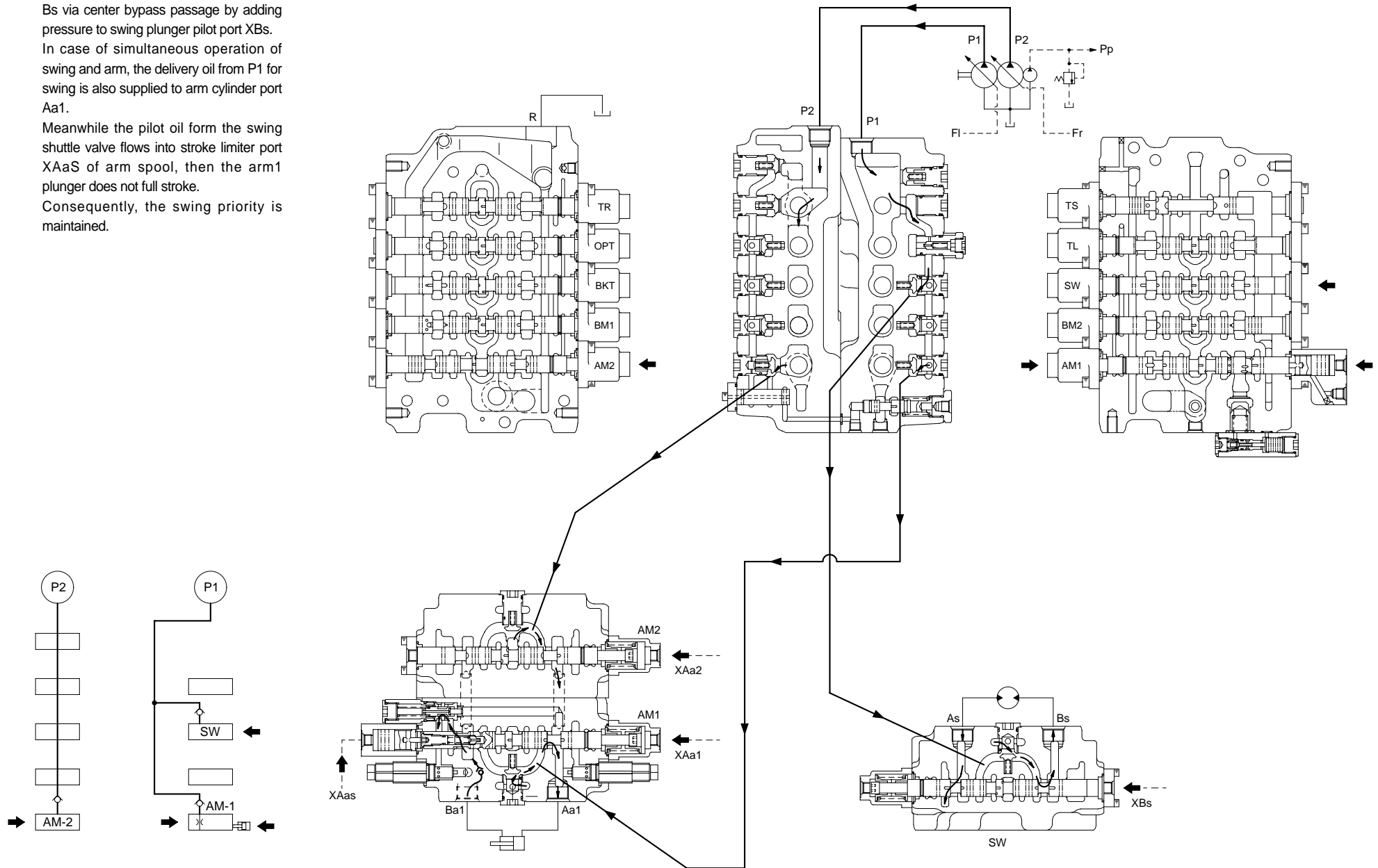
Then the oil from pump P1 joins to the flow from the pump P2 via confluence passage.



(2) Swing priority circuit

Oil from pump P1 is fed into cylinder port Bs via center bypass passage by adding pressure to swing plunger pilot port XBs. In case of simultaneous operation of swing and arm, the delivery oil from P1 for swing is also supplied to arm cylinder port Aa1.

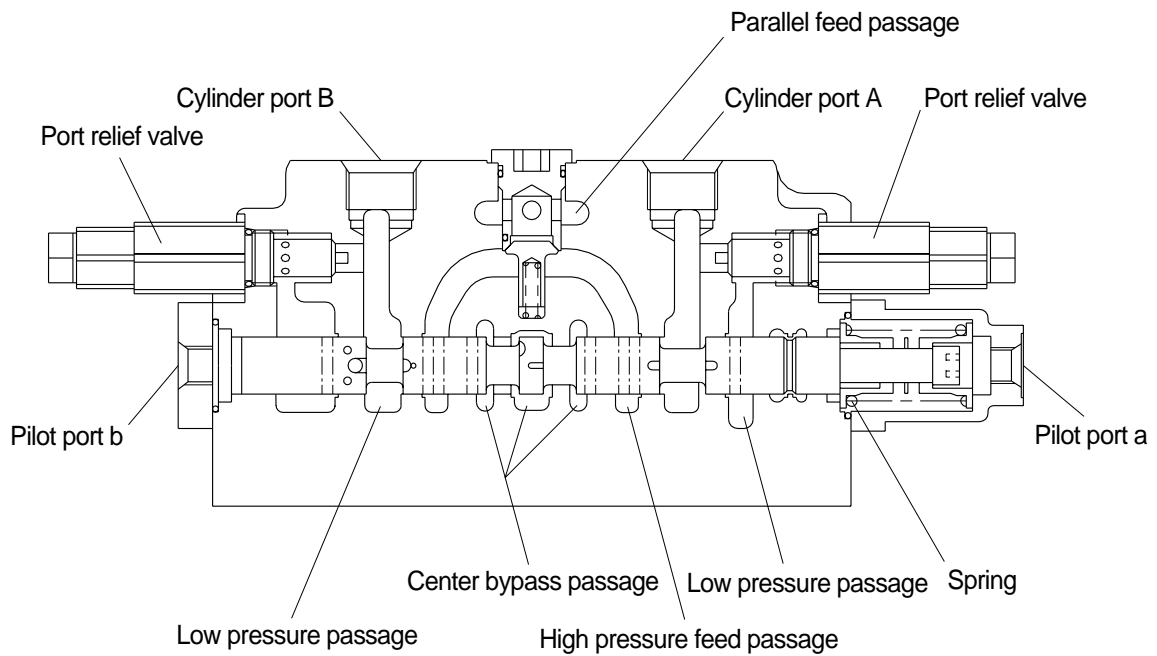
Meanwhile the pilot oil from the swing shuttle valve flows into stroke limiter port XAaS of arm spool, then the arm1 plunger does not full stroke. Consequently, the swing priority is maintained.



3) OPERATIONAL DESCRIPTION OF CONTROL VALVE

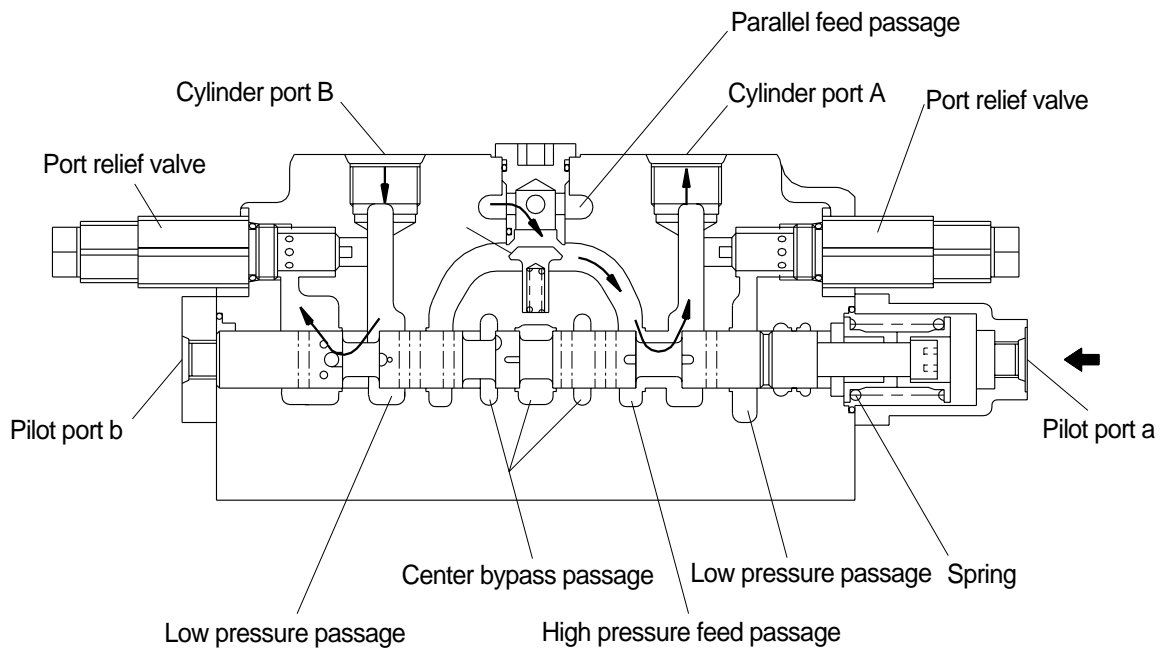
(1) Plunger operation

① Neutral position of plunger



In neutral, spring sets the plunger at the neutral position; The high pressure feed passage is shut off by the plunger; Oil from the pump flows through the center bypass.

② Operation of plunger



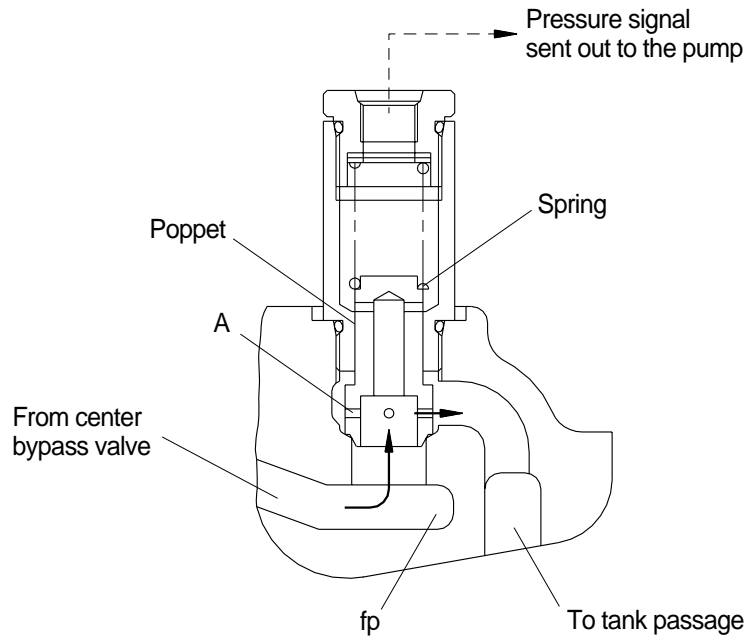
When actuated (Pressure is applied to pilot port a), the plunger moves to the left, the center bypass is shut off; Oil from the parallel feed passage opens the check valve C1 and flows into cylinder port A via the high pressure feed passage.

The return oil from cylinder port B flows into the tank via the low pressure feed passage.

※ Reversed when pressure is applied to pilot port b.

(2) Foot relief valve operation

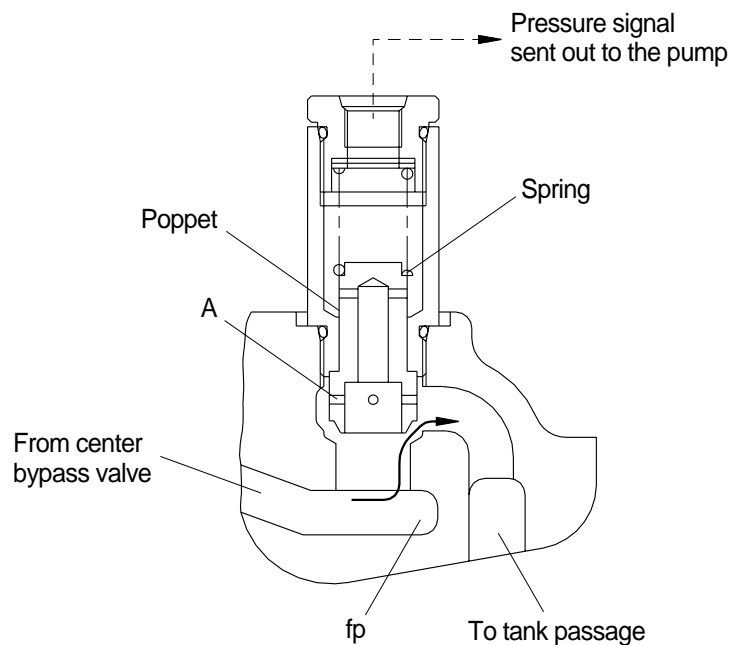
① f_p is lower than spring force



Oil from the center bypass valve flows into the tank via orifice(A) of poppet.

Pressure f_p generated by orifice(A) is led to the pump, to control the pump delivery flow.

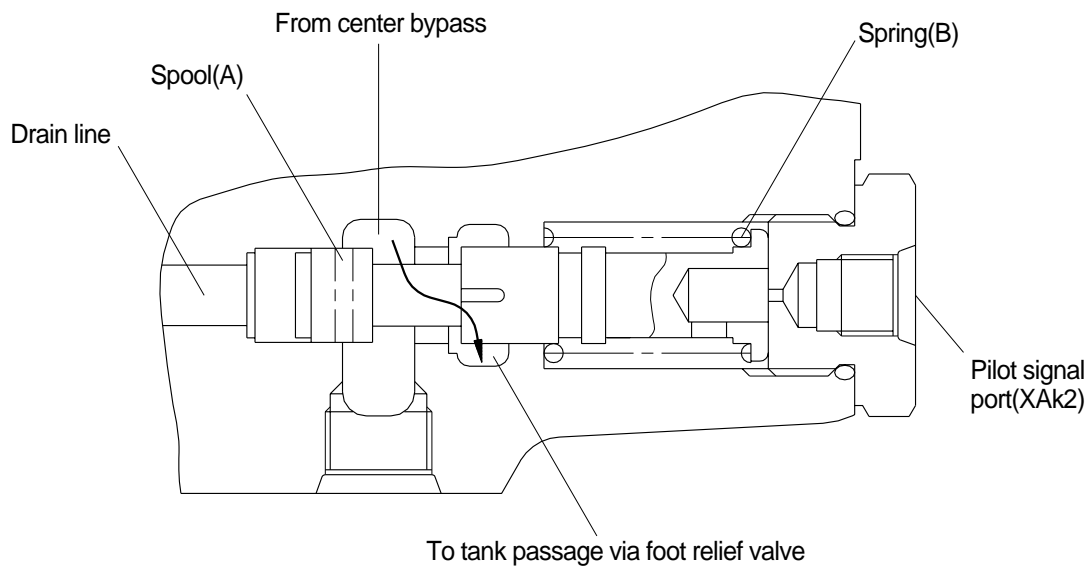
② f_p is higher than spring force



If a large amount flows due to delayed pump response, etc., and pressure f_p reaches the preset spring force, then the poppet is lifted and functions as a relief valve.

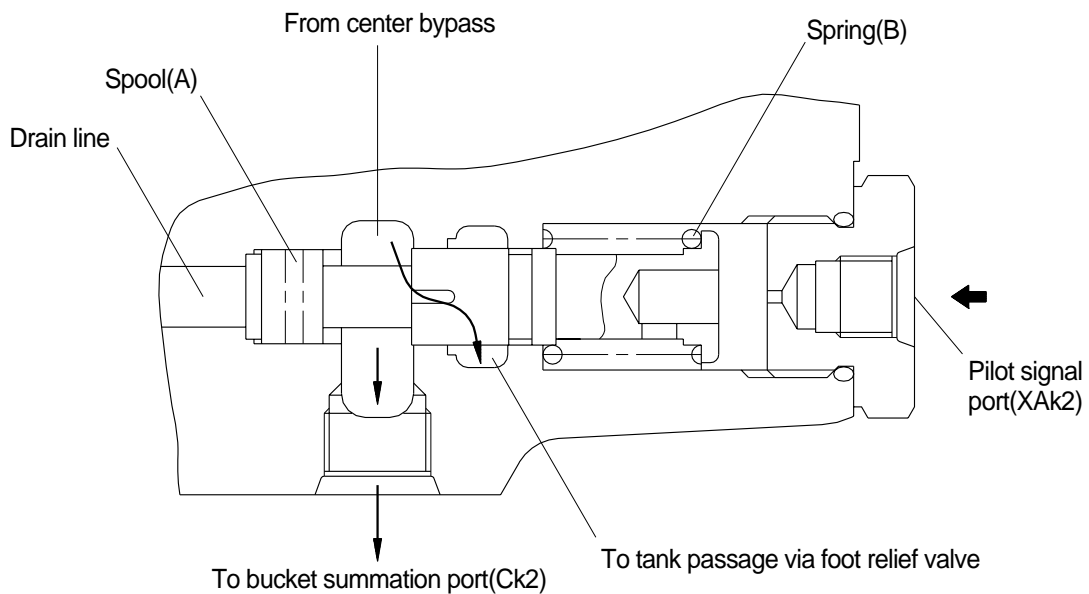
(3) Center bypass valve operation

① Pilot pressure signal : OFF



Spring(B) sets spool(A) in position; Oil from center bypass flows into the tank passage via the foot relief valve.

② Pilot pressure signal : ON

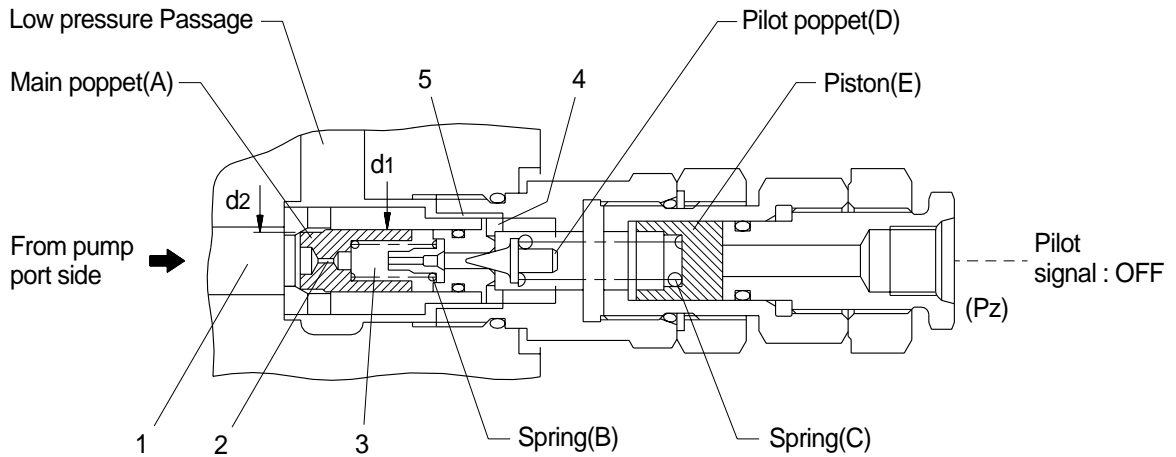


When pilot pressure reaches a preset spring force, the spool(A) moves left and orificed the flow to the foot relief valve.

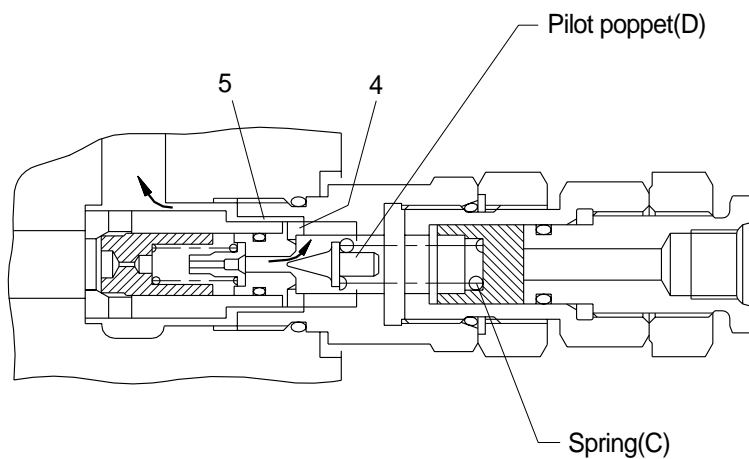
Then the oil from center bypass flow into bucket summation port Ck2 via out side piping.

(4) Main relief valve operation

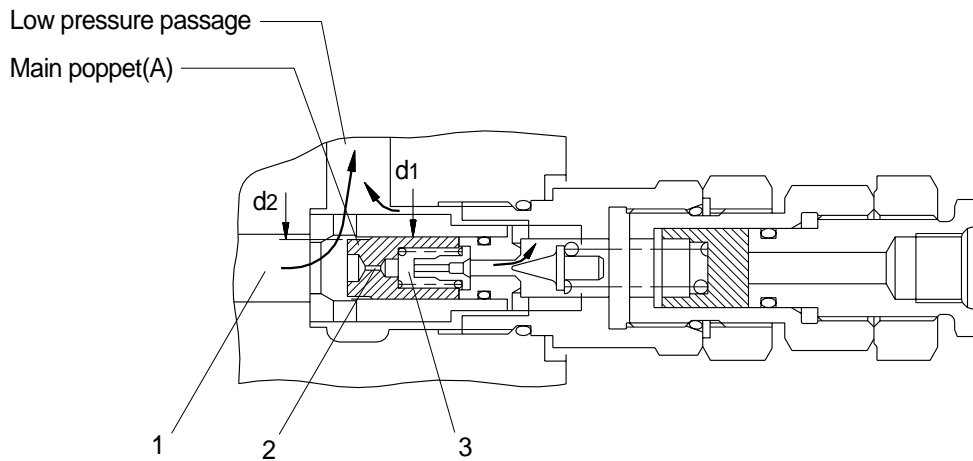
① High pressure setting pilot signal : OFF



- A. This relief valve is built in between the pump port side(1) and low pressure passage. Piston(E) is seated right end by spring(C). Hydraulic oil from the pump port side enters chamber(3) via orifice(2) of main poppet(A). Because $d_2 < d_1$, main poppet(A) is securely seated.

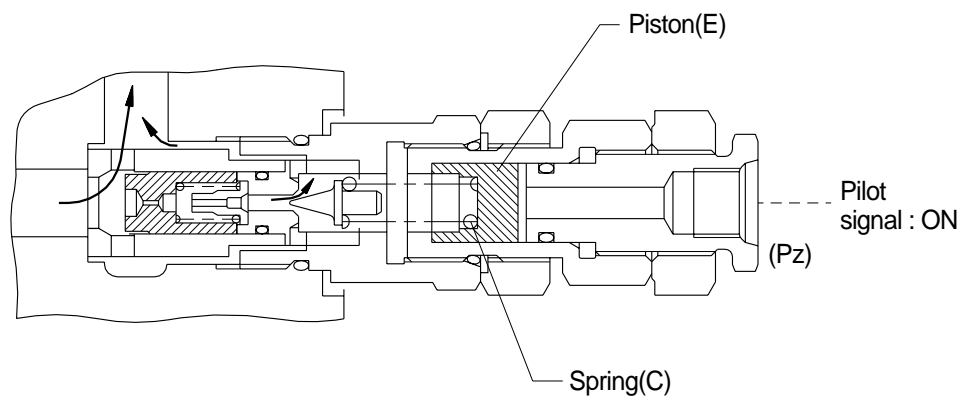


- B. When hydraulic oil reaches the pressure preset by spring(C), pilot poppet(D) opens; oil flows around poppet(D) and into the low pressure passage via side hole(4) and passage(5).



C. When the above oil flow is formed, pressure drops before and behind orifice(2) ; When pressure of chamber(1) x area d2 is large than pressure of chamber(3) x area d1, main poppet(A) is opened and hydraulic oil flows into the low pressure passage.

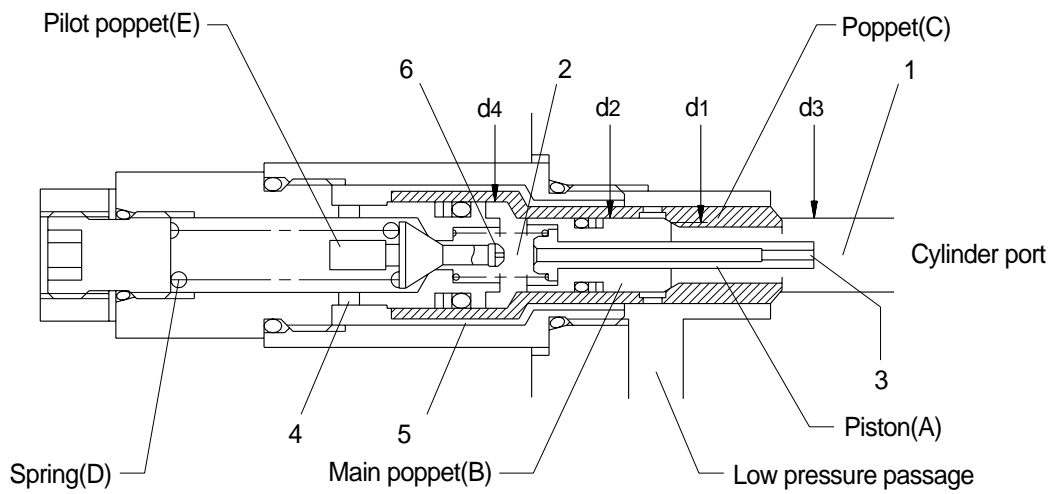
② High pressure setting pilot signal : ON



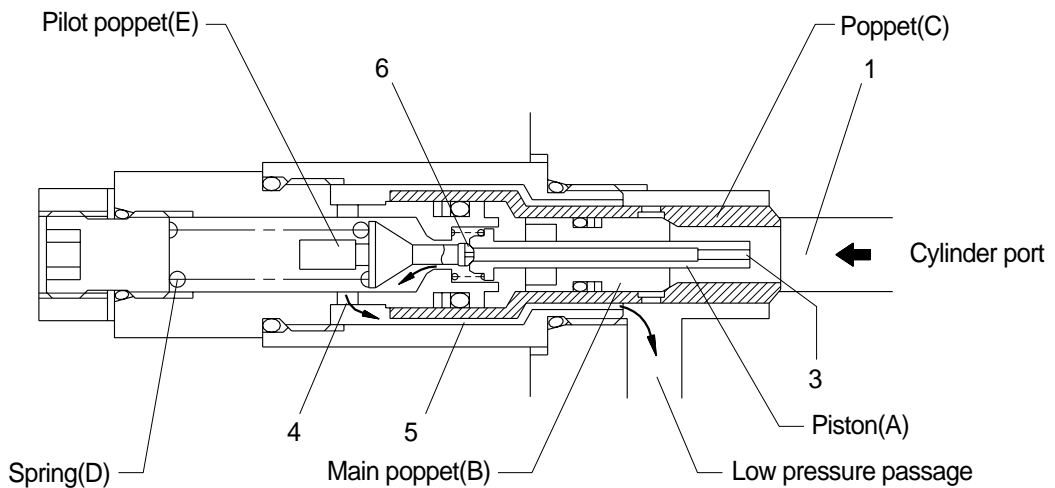
Piston(E) move to left by high pressure setting pilot signal ; Set pressure of spring(C) rises, making high pressure setting.

(5) Overload relief valve operation

① Overload working operation



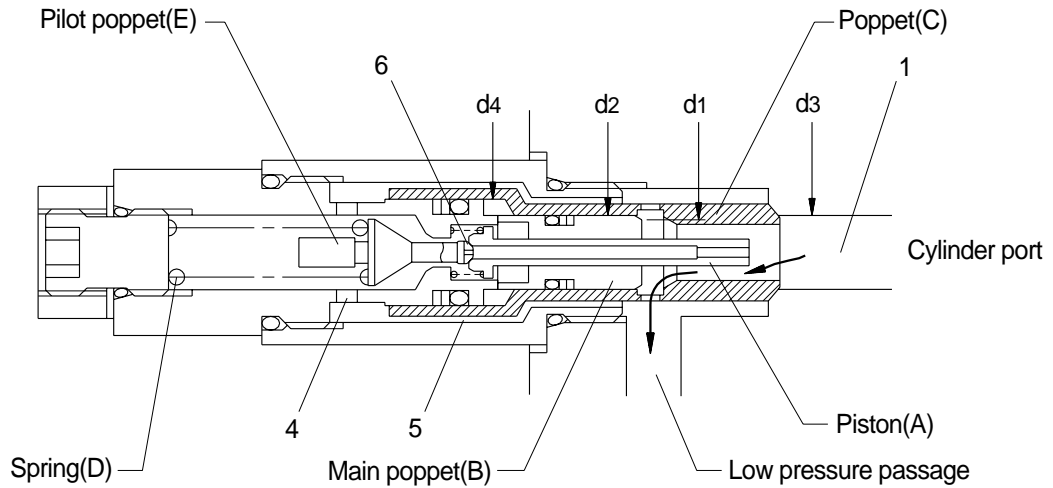
A. Hydraulic oil from cylinder port enters chamber(2) via orifice(3) of piston(A). Because $d_1 < d_2$ and $d_3 < d_4$, main poppet(B) and poppet(C) are securely seated.



B. When hydraulic pressure reaches the preset force of spring(D), pilot poppet(E) opens ; Oil flows around pilot poppet(E) and into the low pressure passage via side hole(4) and passage(5).

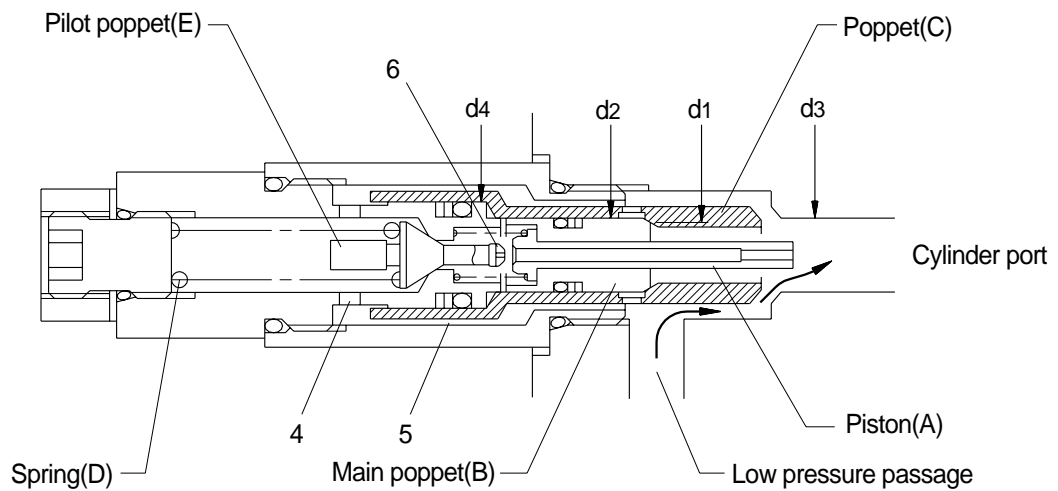
C. Oil flow is formed ; Pressure drops before and behind orifice(3) ; Piston(A) moves to left and seats at the tip of pilot poppet(E).

D. Hydraulic oil from chamber(1) enters chamber(2) via throttle(6) at the tip of pilot poppet(E) ; It flows into the low pressure passage via side hole(4) and passage(5).



E. Pressure drops before and behind throttle(6), making pressure of chamber(1) x area $d_1 >$ pressure of chamber(2) x area d_2 ; Main poppet(B) is opened and hydraulic oil flows into the low pressure passage.

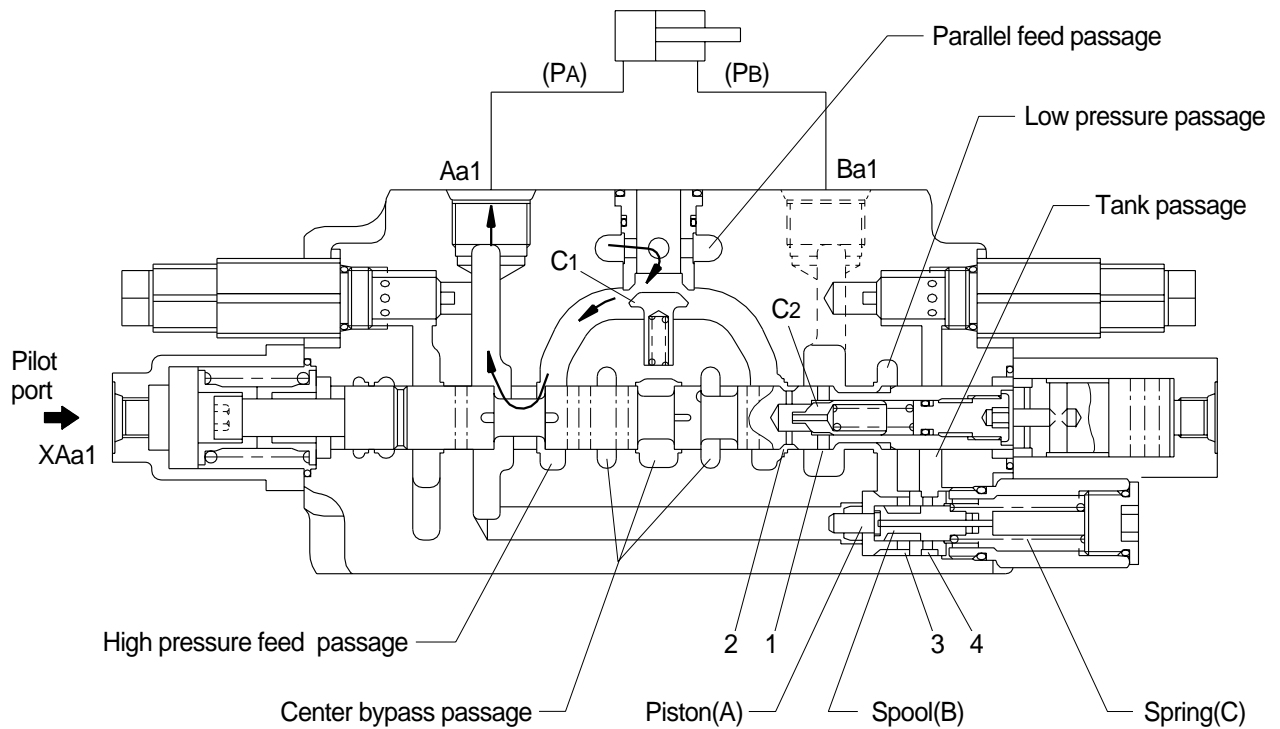
② Make up operation



- A. Poppet(C) is securely seated because the cylinder port pressure is normally higher than the tank pressure and $d3 < d4$.
- B. When the cylinder port pressure drops (Closer to negative pressure) until the cylinder port pressure is lower than the tank pressure, poppet(C) opens receiving the tank pressure for the difference in area between $d3$ and $d4$; oil flows from the low pressure passage (Tank passage) to the cylinder port in order to prevent cavitation.

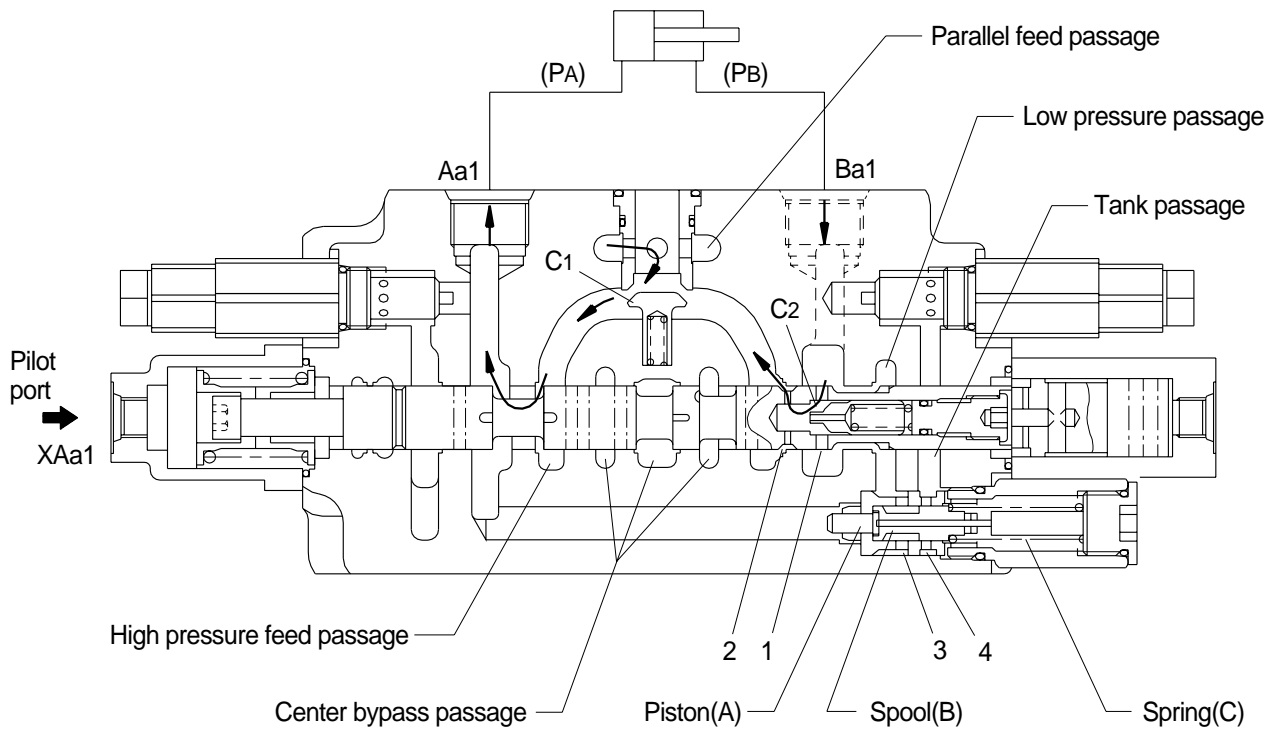
(6) Arm regeneration operation

① Arm operation



When pressure is applied to pilot port XAa1 of the arm plunger, the plunger moves to right as shown ; The center bypass passage is shut off ; Oil from the parallel feed passage opens check valve(C1) and flows into cylinder port Aa1(Head side) via the high pressure feed passage.

② PB is higher than PA



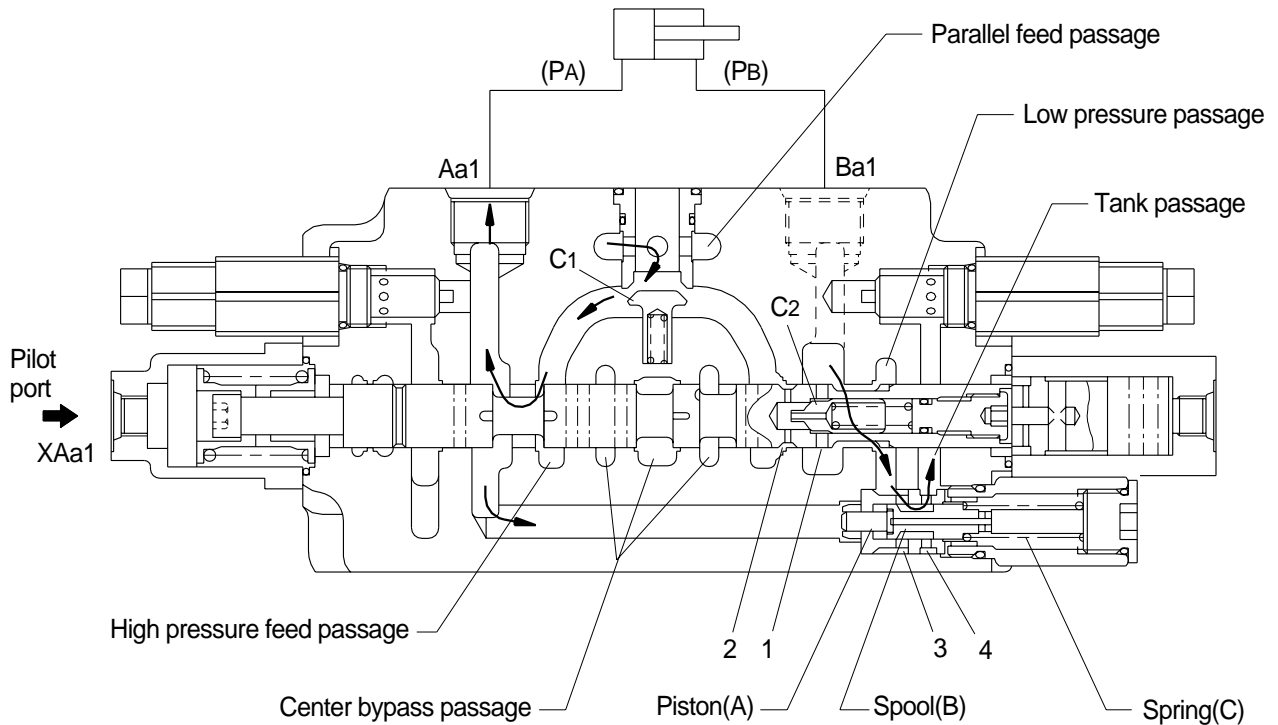
PA : Pressure of cylinder head side

PB : Pressure of cylinder rod side

Return oil from cylinder rod side opens check valve(C2) in the plunger ; It flows into cylinder head side after returning to the high pressure feed passage via passage(1) and (2) in the plunger.

At this time, the regeneration selector spool(B) is at the shown position; as passage(3) is shut off from passage(4) return oil from cylinder rod side does not flow into the tank passage.

③ PA is higher than PB

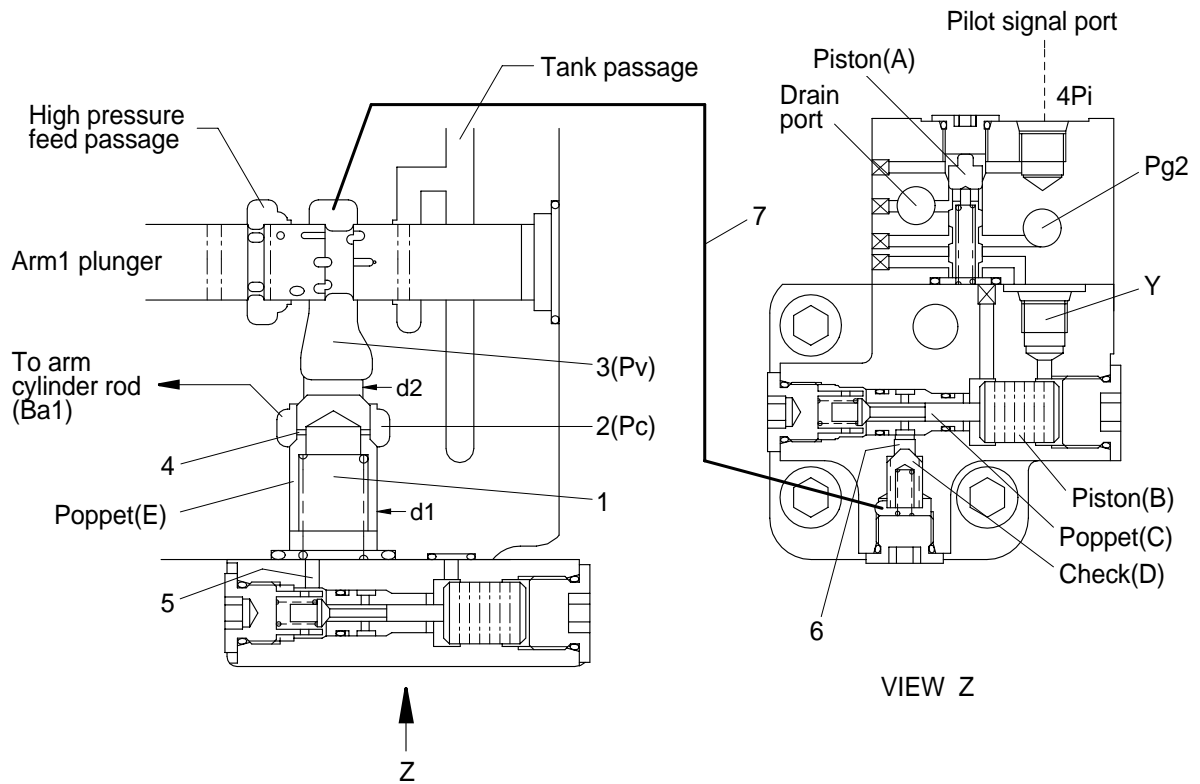


Return oil from cylinder rod side is shut off by check(C2) in the plunger and passage(2) is blocked from passage(1).

When pressure PA rises higher than the preset pressure of spring(C) and pushes piston(A) in the regeneration selector to right as shown ; Spool(B) move to right ; Passage(3) and passage(4) are connected ; Return oil from cylinder rod side flows into tank passage via low pressures passage(3) and passage(4).

(7) Arm holding valve operation

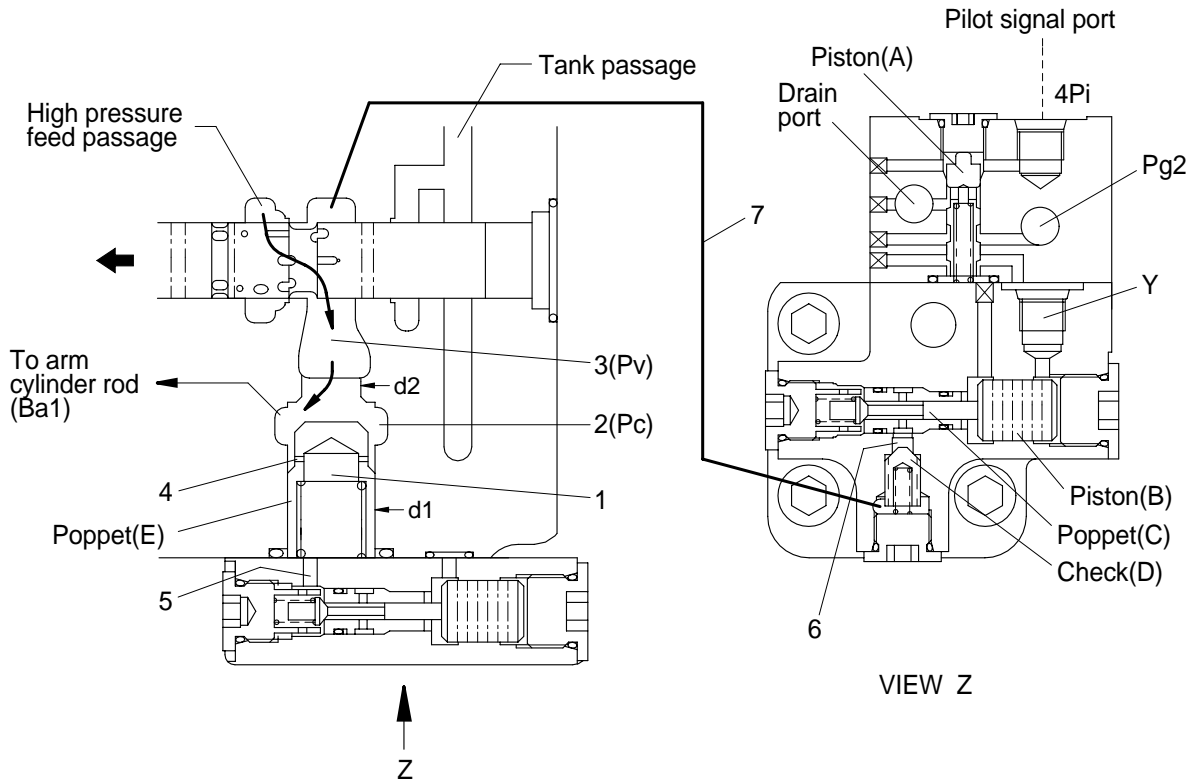
① When the plunger is in neutral(4Pi pilot signal : OFF)



Piston(A) is in the status as shown ; Pressure signal(Pg2) and chamber(Y) are shut off.
 Thus piston(B) and poppet(C) are in the status as shown; Passages(5) and (6) are shut off by poppet(C).
 Therefore, the pressure of chamber(1) becomes pressure Pc as it is connected with chamber(2) via orifice(4). Since $d_1 > d_2$, poppet(E) is seated and chambers(2) and (3) are completely blocked.

② When the plunger is in operation (4Pi pilot signal : OFF)

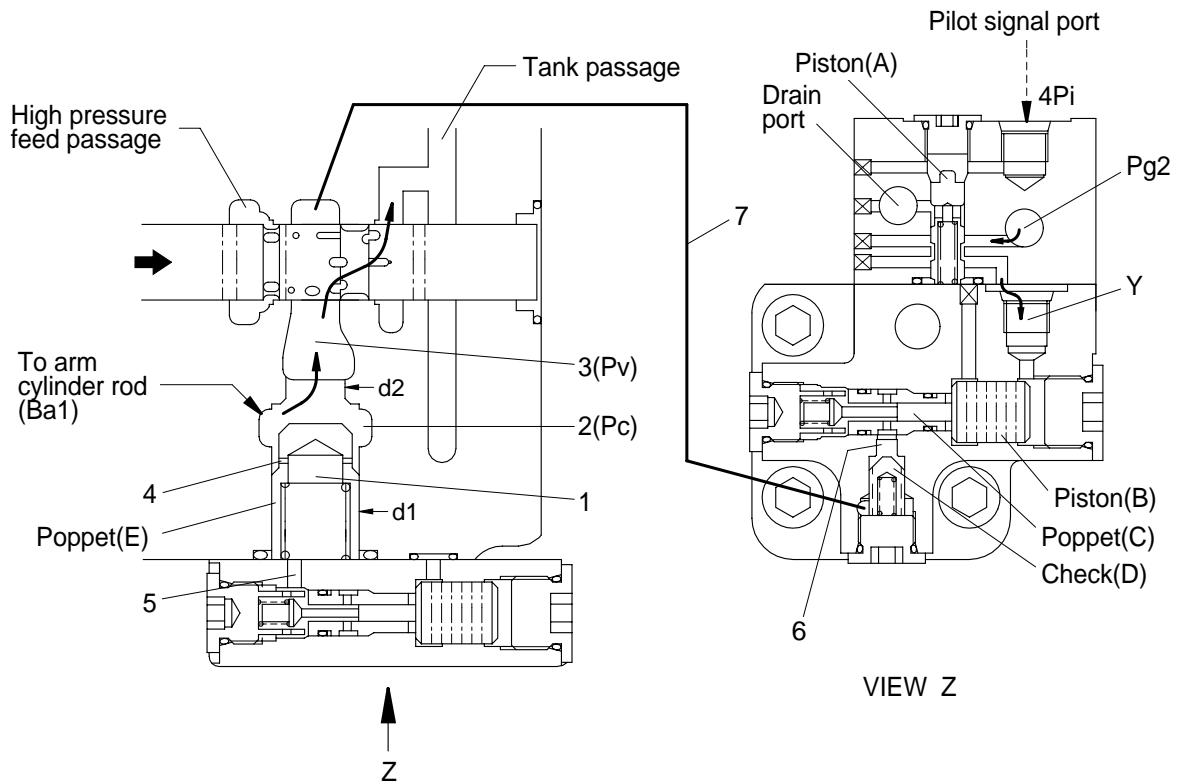
- If Pv is higher than Pc (In the case of arm out)



When the plunger moves to left, the high pressure oil enters to chamber(3).

Therefore, the pressure of chamber(1) becomes Pc as it is connected to chamber(2) via orifice(4) ; Poppet(E) is opened ; Oil from high pressure feed passage flows into the cylinder rod side.

- If P_c is higher than P_v (In the case of arm in operation)



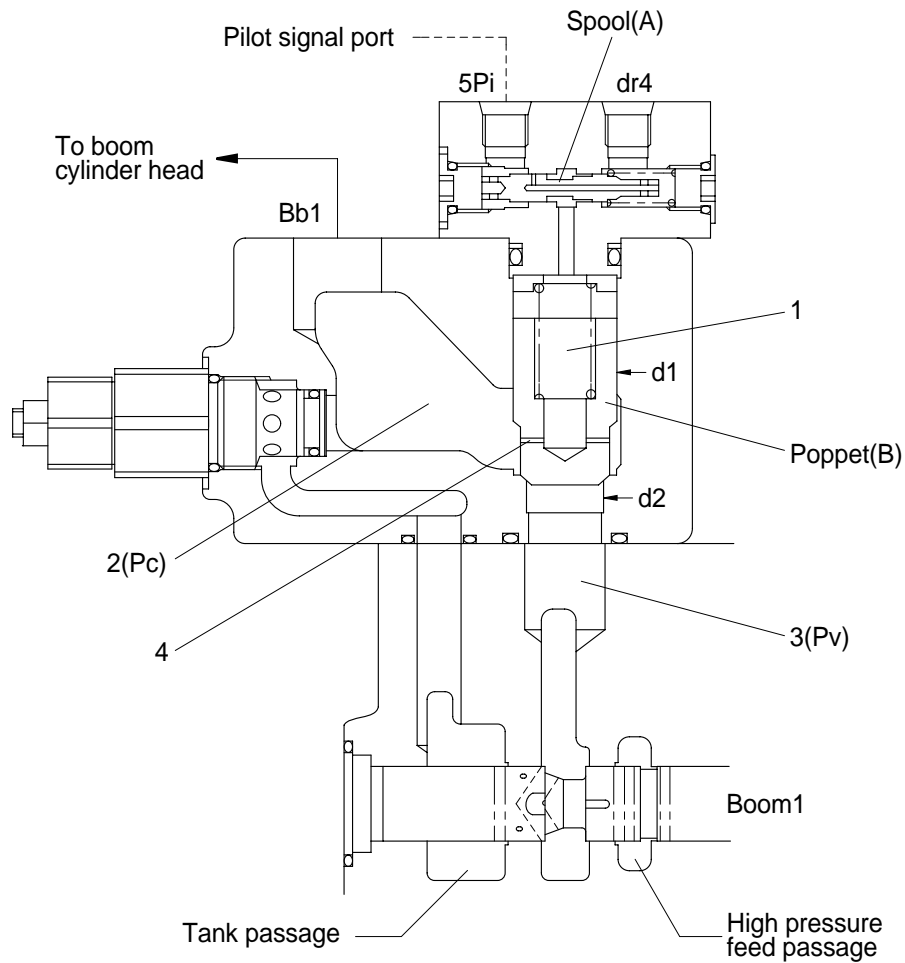
When the pressure of pilot signal enters, piston(A) moves to down.

When the pressure signal(P_{g2}) enters to chamber(Y), piston(B) moves to left and poppet(C) opens ; Passages(5) and (6) are connected.

If pressure P_c of cylinder port chamber(2) is higher than pressure P_v of chamber(3)(In the case of arm in operation) oil from chamber(1) pushes up check valve(C) via passages(5) and (6) and enters chamber(3) through passage(7). Chamber(3) is connected with the tank passage because the arm plunger is moved to right. Therefore, pressure P_c is applied to(Area d_1 - area d_2), pushing open poppet(E), and return oil from the cylinder rod side flows into the tank passage.

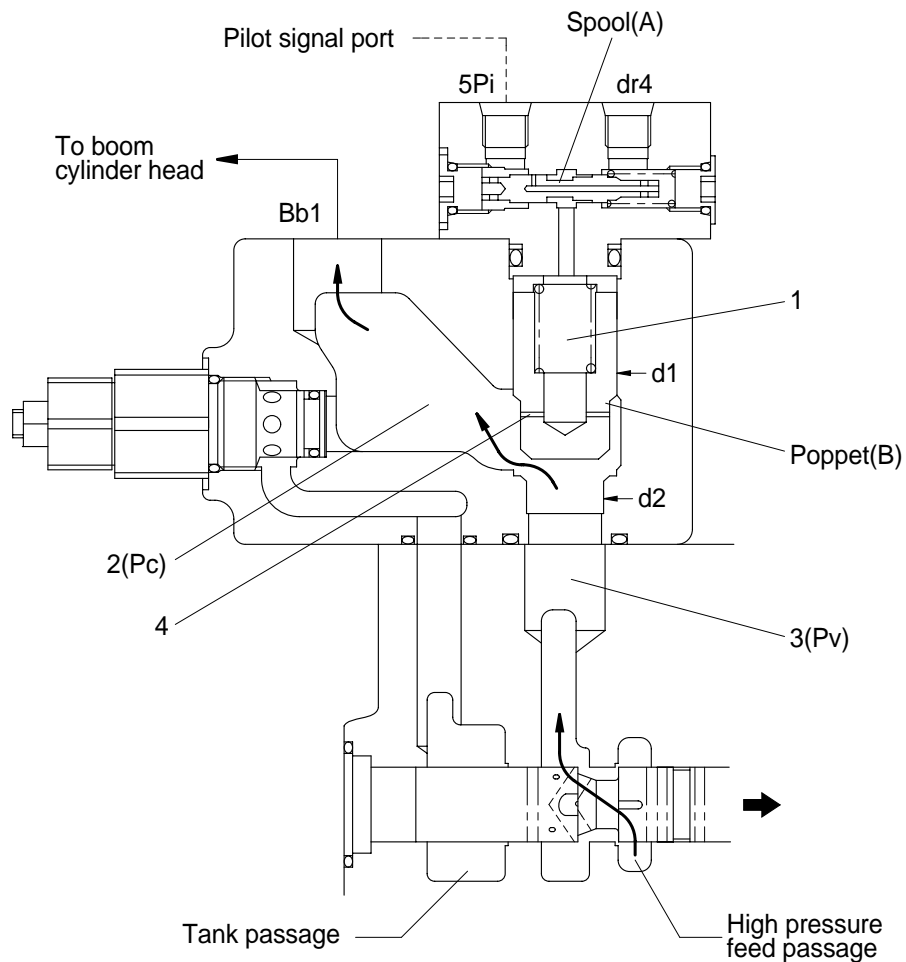
(8) Boom holding valve operation

① When the plunger is in neutral(5Pi pilot signal : OFF)



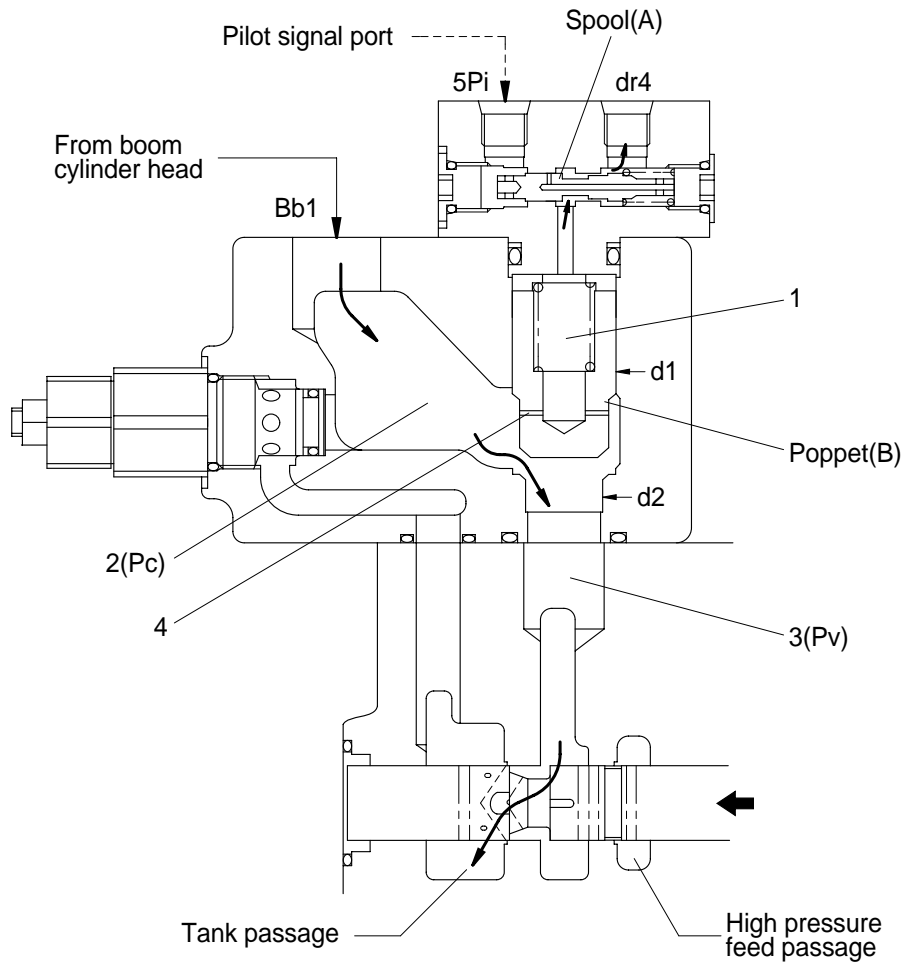
Spool(A) is in the status as shown ; Chamber(1) and drain port(dr4) are shut off by spool(A). Therefore, the pressure of chamber(1) becomes pressure Pc as it is connected with chamber(2) via orifice(4). Since $d_1 > d_2$, poppet(B) is seated and chambers(2) and (3) are completely blocked.

- ② When the plunger is in operation(5Pi pilot signal : OFF)
- If Pv is higher than Pc(In the case of boom raise)



When the plunger moves to right, the high pressure oil enters to chamber(3). Therefore, the pressure of chamber(1) becomes P_c as it is connected to chamber(2) via orifice(4) ; Poppet(B) is opened by pressure(P_v) of chamber(3) ; Oil from high pressure feed passage flows into the cylinder head side.

- If P_c is higher than P_v (In the case of boom down operation)



When plunger moves to left, chamber(3) is connected with tank passage. At the same time, spool(A) moves to right by the pressure of pilot signal ; Chamber(1) and drain port(dr4) are connected.

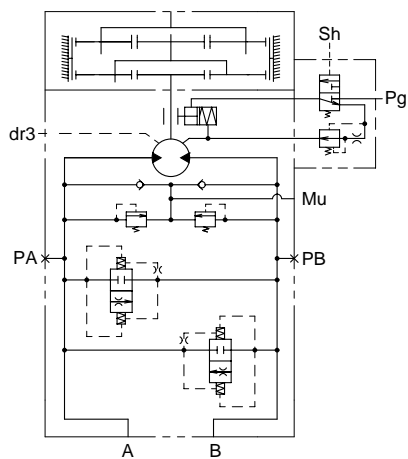
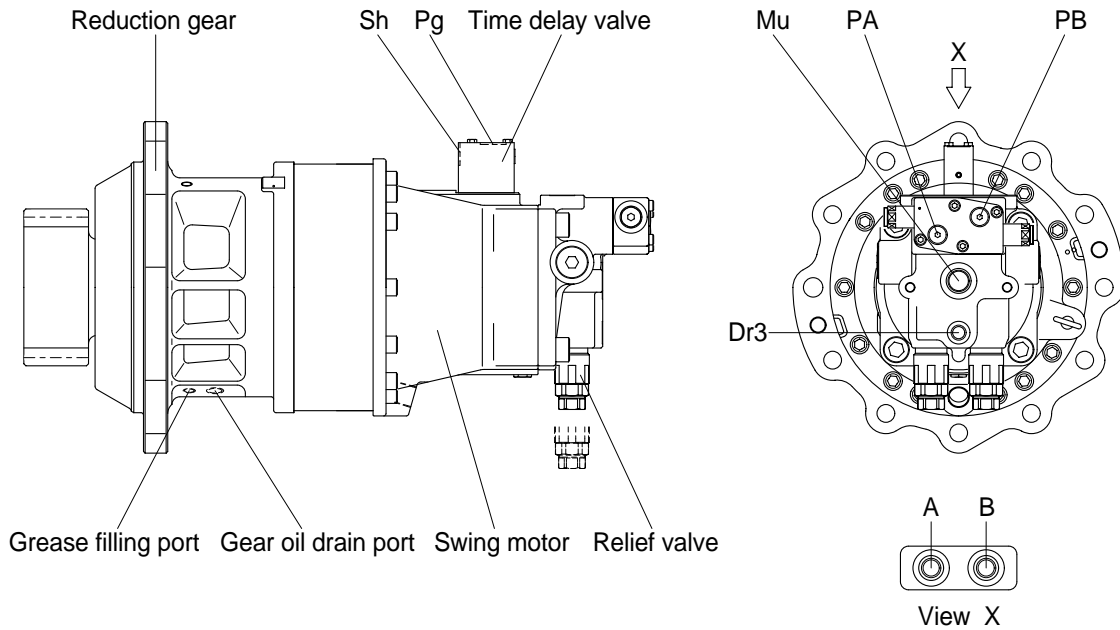
Therefore, pressure of chamber(1) becomes low ; Pressure P_c is applied to(Area d_1 - area d_2), pushing open poppet(B), and return oil from the cylinder head side flows into the tank passage.

GROUP 3 SWING DEVICE

1. STRUCTURE

Swing device consists swing motor, swing reduction gear.

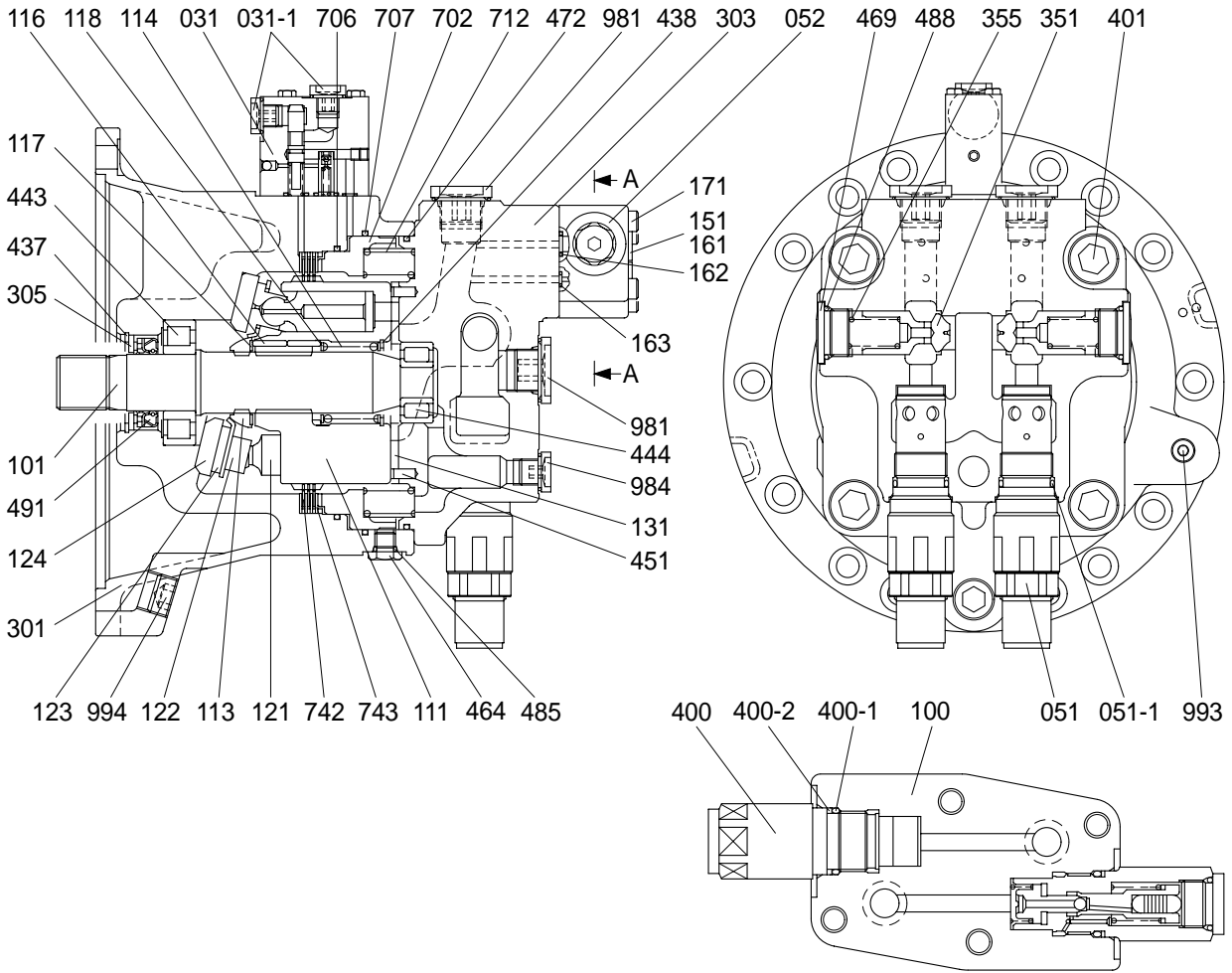
Swing motor include mechanical parking valve, relief valve, make up valve and time delay valve.



Hydraulic circuit

Port	Port name	Port size
A	Main port	PF 3/4
B	Main port	PF 3/4
dr3	Drain port	PF 3/8
Mu	Make up port	PF 3/4
Sh	Brake release port	PF 1/4
Pg	Stand by port	PF 1/4
PA,PB	Gauge port	PF 1/4

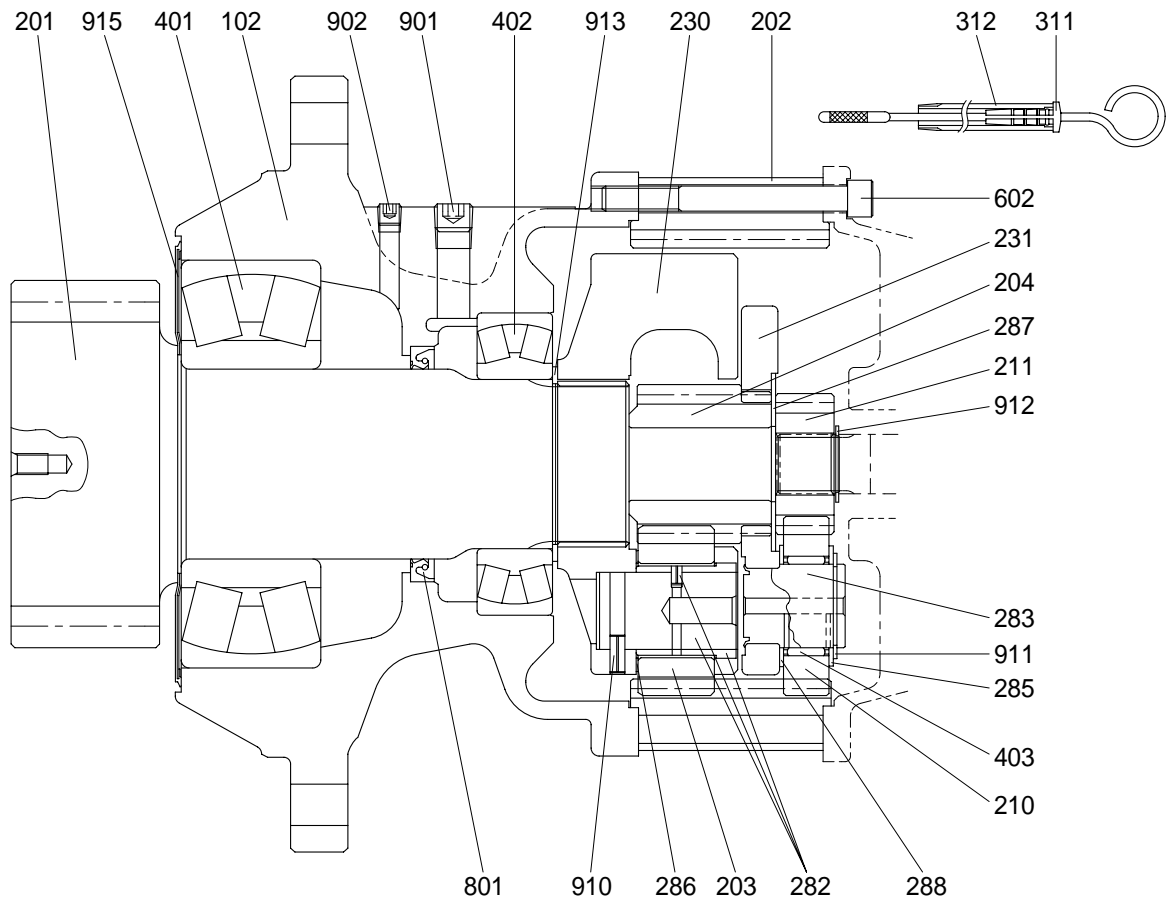
1) SWING MOTOR



SECTION A-A

031	Time delay valve	161	O-ring	464	Plug
031-1	Plug	162	O-ring	469	Plug
051	Relief valve assembly	163	O-ring	472	O-ring
051-1	O-ring	171	Hexagon socket bolt	485	O-ring
100	Casing	301	Casing	488	O-ring
101	Drive shaft	303	Valve casing	491	Seal
111	Cylinder	305	Seal cover	702	Brake piston
113	Retainer ring	351	Plunger	706	O-ring
114	Spring	355	Spring	707	O-ring
116	Push rod	400	Reactionless valve	712	Brake spring
117	Spacer	400-1	O-ring	742	Friction plate
118	Spacer	400-2	Back up ring	743	Separate plate
121	Piston	401	Hexagon socket bolt	981	Plug
122	Shoe	437	Snap ring	984	Plug
123	Plate	438	Snap ring	993	Plug
124	Shoe plate	443	Roller bearing	994	Plug
131	Valve plate	444	Roller bearing		
151	Plug	451	Pin		

2) REDUCTION GEAR



102	Casing	283	Pin	602	Hexagon socket bolt
201	Drive shaft	285	Side plate	801	Seal
202	Ring gear	286	Side plate	901	Plug
203	Planetary gear 2	287	Side plate	902	Plug
204	Sun gear 2	288	Side plate	910	Spring pin
210	Planetary gear 1	311	Level bar	911	Snap ring
211	Sun gear 1	312	Pipe	912	Snap ring
230	Carrier 2	401	Roller bearing	913	Snap ring
231	Carrier 1	402	Roller bearing	915	Bearing seal
282	Pin	403	Needle cage		

2. FUNCTION

1) ROTARY PART

When high pressurized oil enters a cylinder through port(a), which is the inlet of balance plate(131), hydraulic pressure acting on the piston causes axial force F. The pressure force F works via the piston(121) upon the return plate(123) which acts upon the swash plate(124) via an hydrostatic bearing. Force F1 perpendicular to swash plate(124) and force F2 perpendicular to cylinder center. Being transferred to the cylinder block(111) 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.

$$T = \frac{p \times q}{2\pi} , q = Z \cdot A \cdot \text{PCD} \cdot \tan\theta , F_1 = \frac{F}{\cos\theta} , F_2 = F \tan\theta , S = \text{PCD} \times \tan\theta$$

Where p : Effective difference of pressure(kgf/cm²)

q : Displacement(cc/rev)

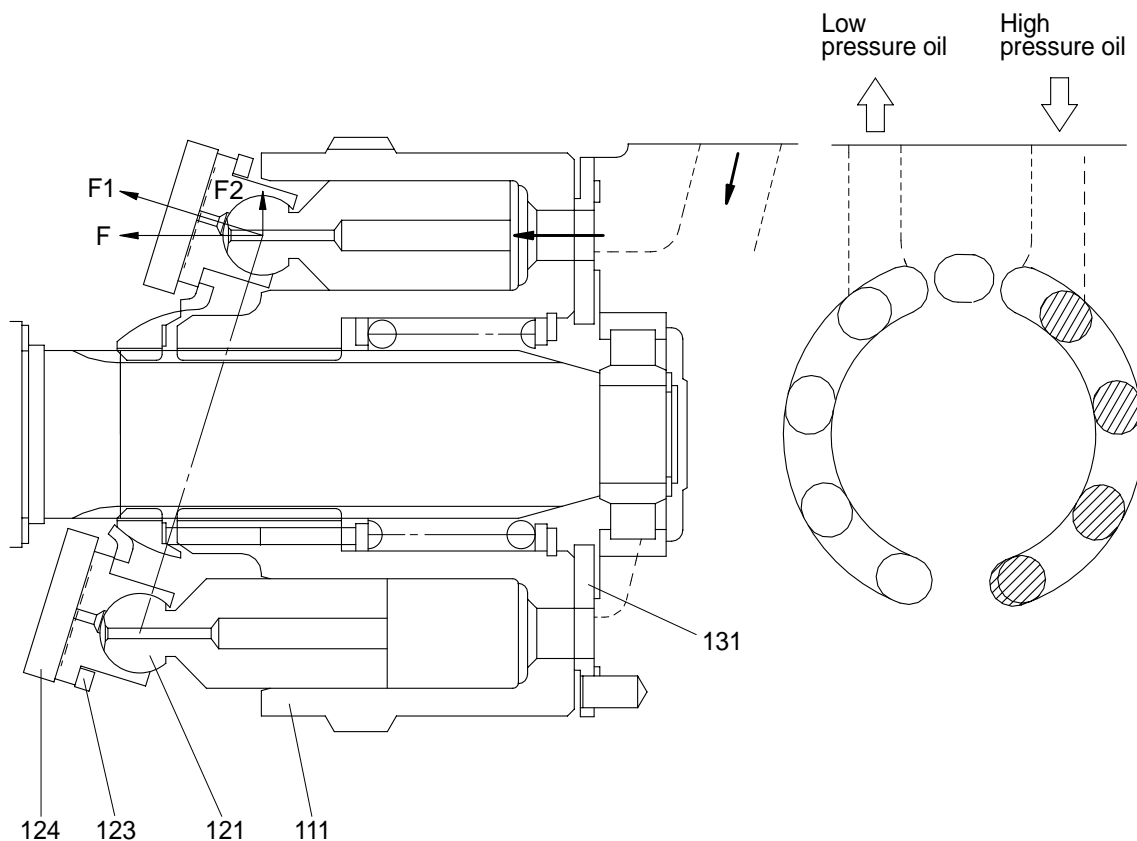
T : Output torque(kgf · cm)

Z : Piston number(9EA)

A : Piston area(cm²)

θ : Tilting angle of swash plate(degree)

S : Piston stroke(cm)



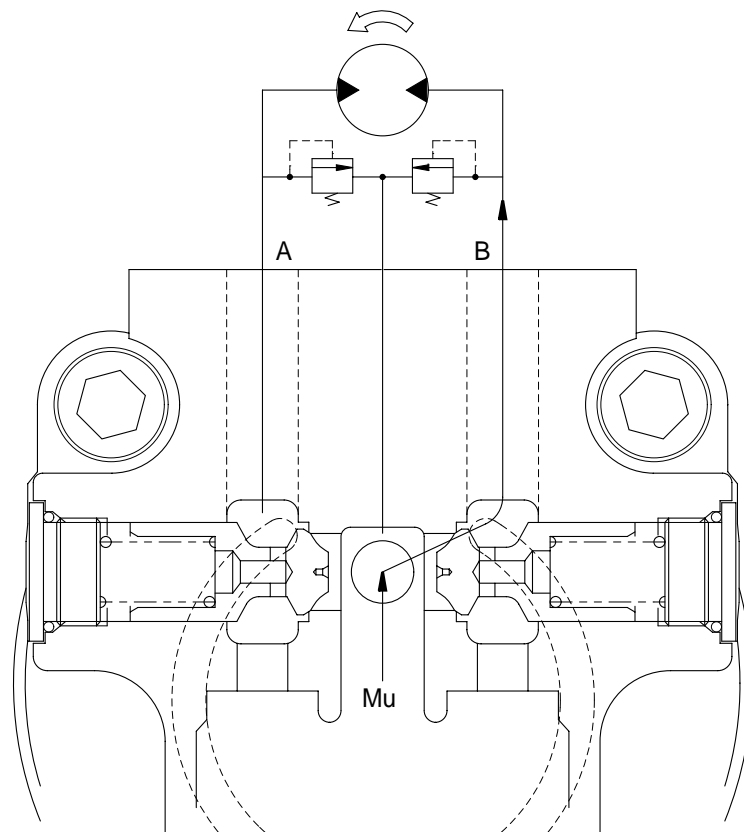
2) MAKE UP VALVE

In the system using this type of motor, there is no counter balance functioning valve and there happens the case of revolution exceeding hydraulic supply of motor. To prevent the cavitation caused by insufficient oil flow there is a make up valve to fill up the oil insufficiency.

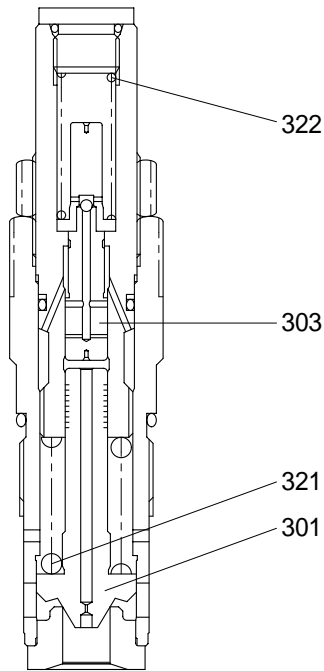
A make up valve is provided immediately before the port leading to the hydraulic oil tank to secure feed pressure required when the hydraulic motor makes a pumping action. The boost pressure acts on the hydraulic motor's feed port via the make up valve.

Pressurized oil into the port B, the motor rotate counterclockwise.

If the plunger of MCV moves neutral position, the drain oil from Mu port run into motor via right make up valve, which prevent the cavitation of motor.



3) RELIEF VALVE



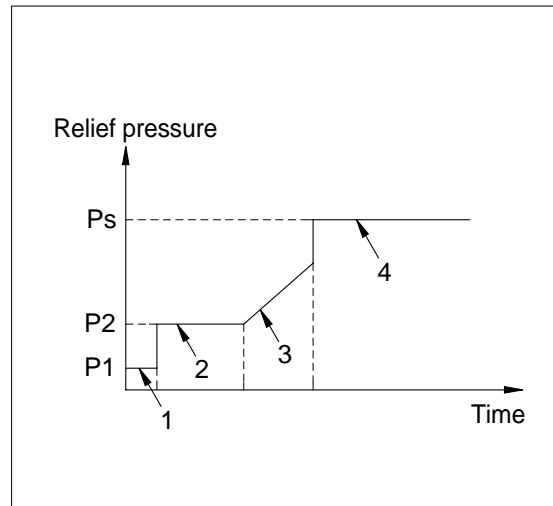
- 301 Plunger
- 303 Piston
- 321 Spring
- 322 Spring

(1) Construction of relief valve

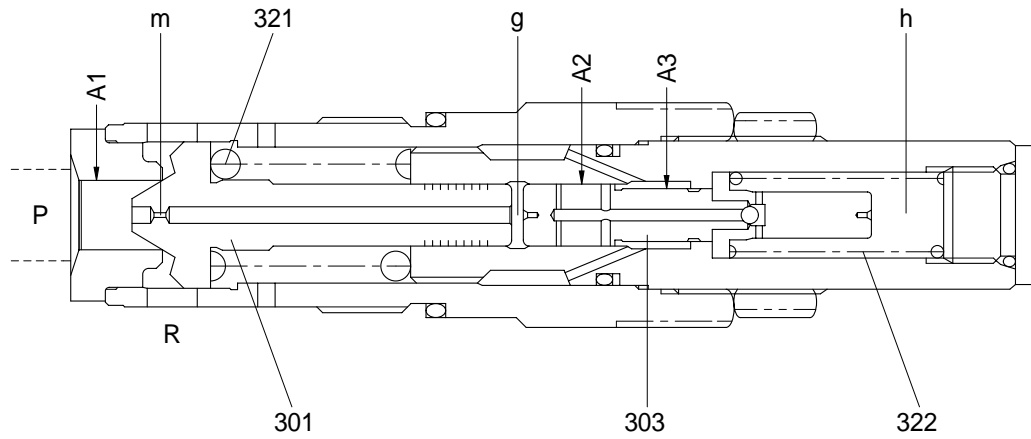
The valve casing contains two cartridge type relief valves that stop the regular and reverse rotations of the hydraulic motor. The relief valves relieve high pressure at start or at stop of swing motion and can control the relief pressure in two steps, high and low, in order to insure smooth operation.

(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.



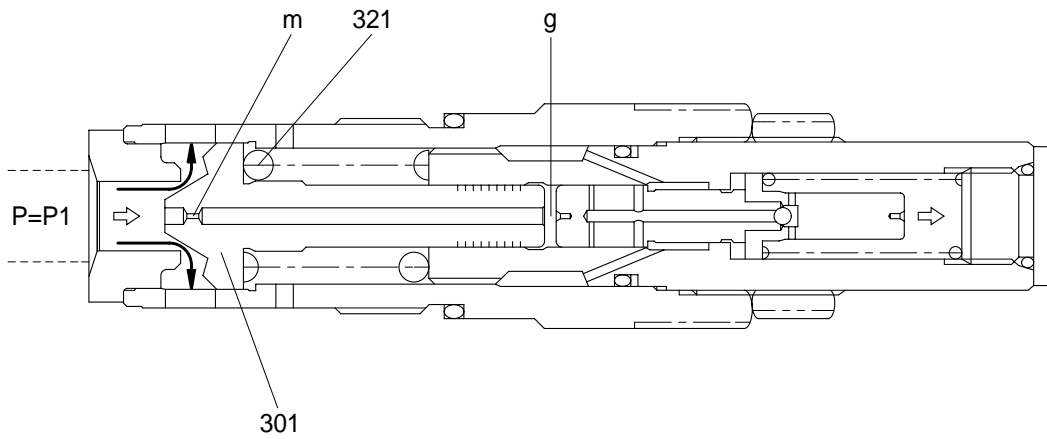
① Ports(P,R) at tank pressure.



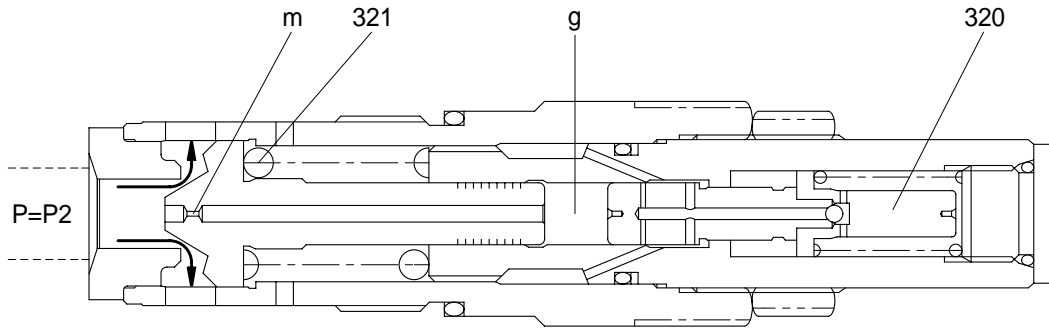
② When hydraulic oil pressure($P \times A_1$) reaches the preset force(F_{sp}) of spring(321), the plunger(301) moves to the right as shown. Also the oil flow chamber g via orifice m.

$$P_1 \times A_1 = F_{sp} + P_g \times A_2$$

$$P_1 = \frac{F_{sp} + P_g \times A_2}{A_1}$$



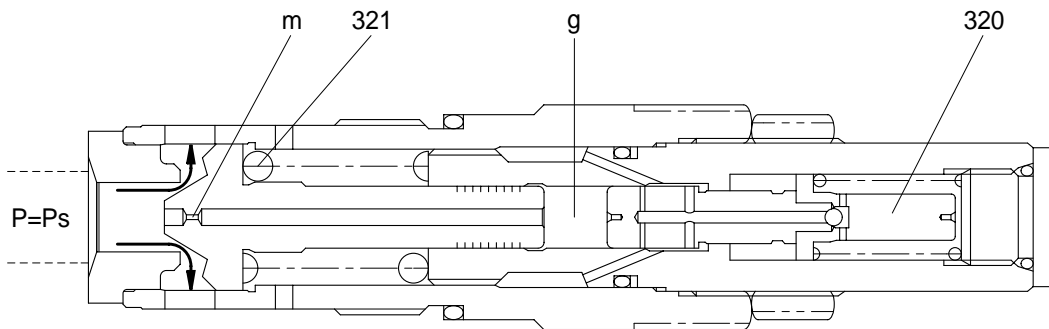
- ③ When the pressure of chamber g reaches the preset force(F_{sp}) of spring(321), the piston(320) moves right and stop the piston(320) hits the end of body.



- ④ When piston(320) hits the end of body, it stops moving to the right any further. As the result, the pressure in chamber g equals P_s .

$$P_s \times A_1 = F_{sp} + P_s \times A_2$$

$$P_s = \frac{F_{sp}}{A_1 - A_2}$$

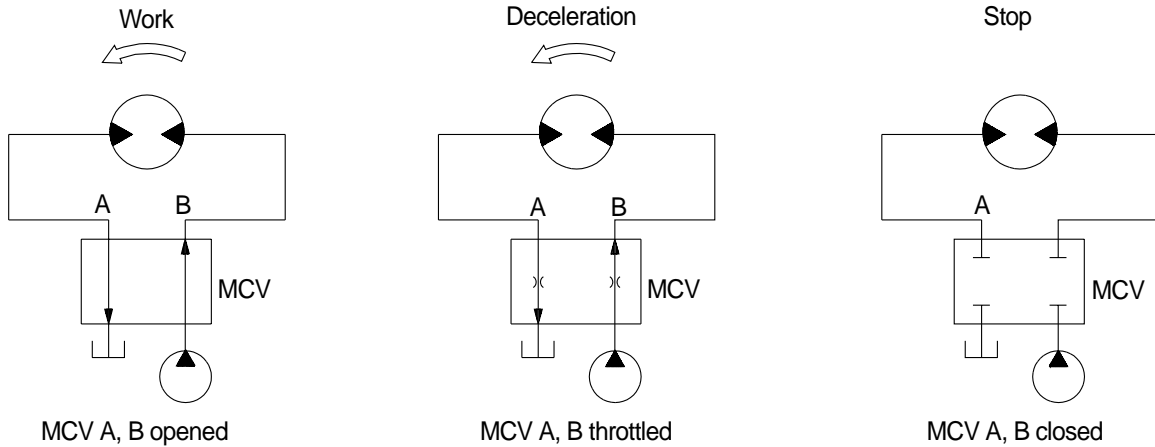


4) BRAKE SYSTEM

(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.



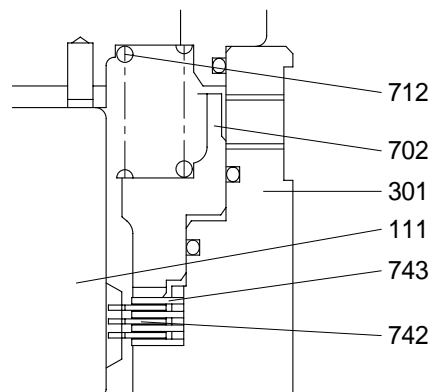
(2) Mechanical swing parking brake system

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 slope, work can be done more easily and safely.

① Brake assembly

Circumferential rotation of separate plate(743) is constrained by the groove located at casing(301). When casing is pressed down by brake spring(702) through friction plate(742), separate plate(743) and brake piston(702), friction force occurs there.

Cylinder(111) is constrained by this friction force and brake acts, while brake releases when hydraulic force exceeds spring force.

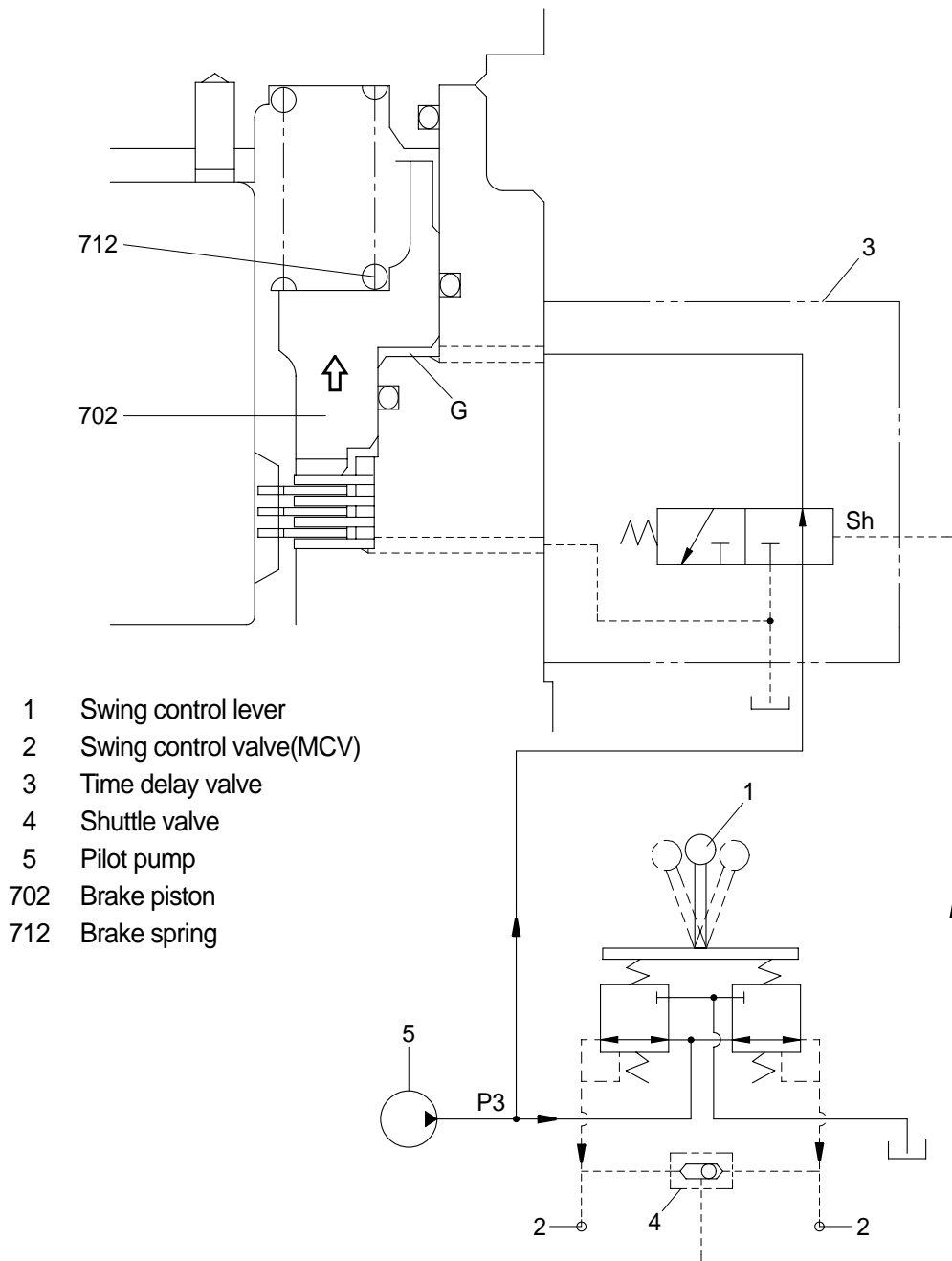


111	Cylinder	712	Brake spring
301	Casing	742	Disc
702	Brake piston	743	Separate plate

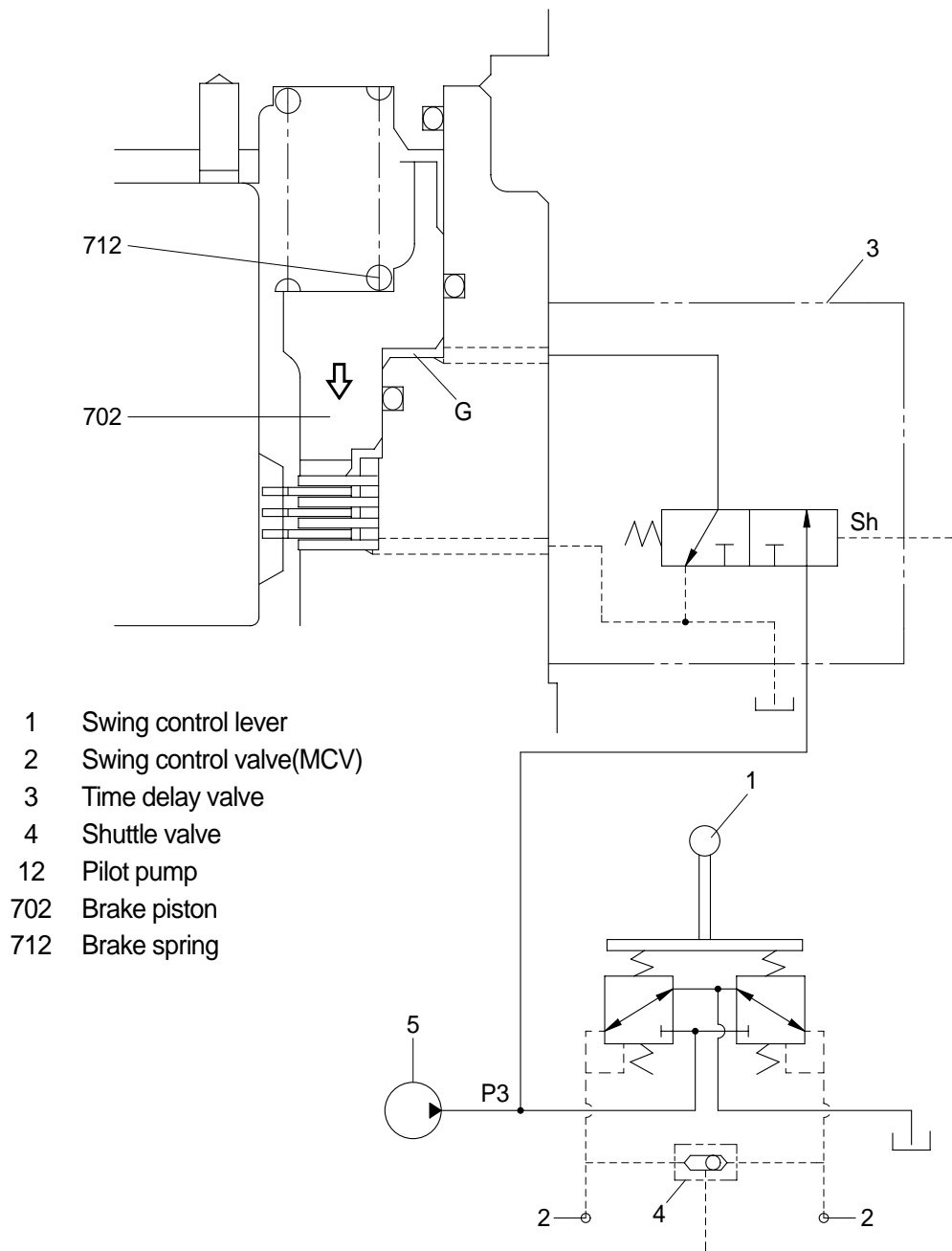
② Operating principle

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 shift time delay valve so, pilot pump charged oil(P3) go to the chamber G.

This pressure is applied to move the piston(702) to the upward against the force of the spring(712) thus releasing the brake force.



b. When the swing control(1) lever is set the neutral position, the time delay valve(3) shifts the neutral position and the pilot oil blocked chamber G. Then, the piston(702) is moved lower by spring force and the return oil from the chamber G is drain.

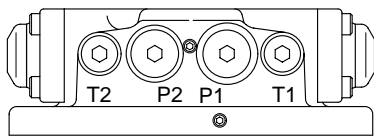
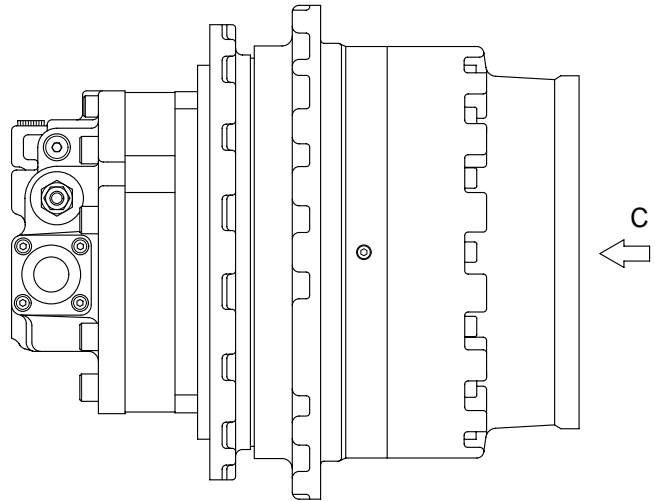
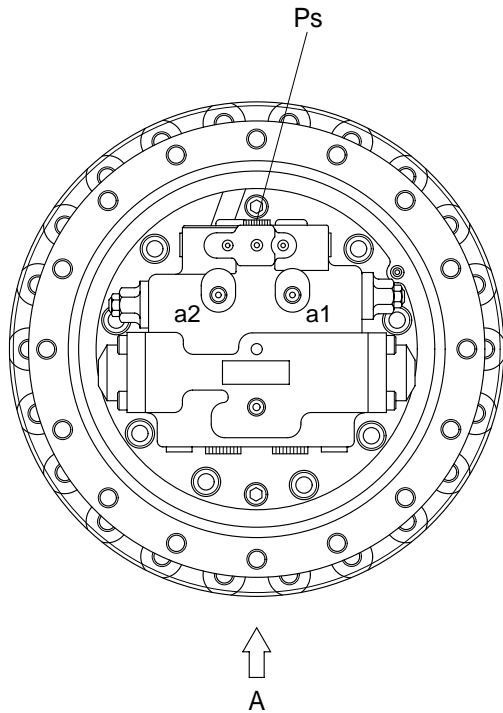


GROUP 4 TRAVEL DEVICE

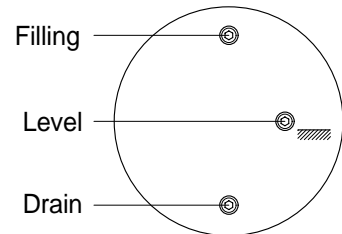
1. CONSTRUCTION

Travel device consists travel motor and gear box.

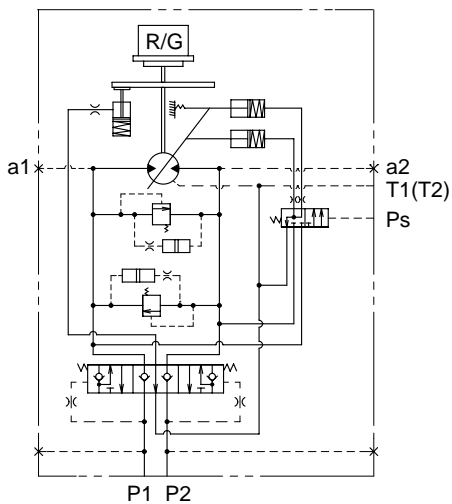
Travel motor include counter balance valve, cross over relief valve.



VIEW A



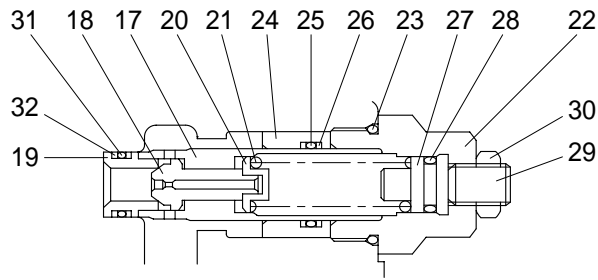
VIEW C



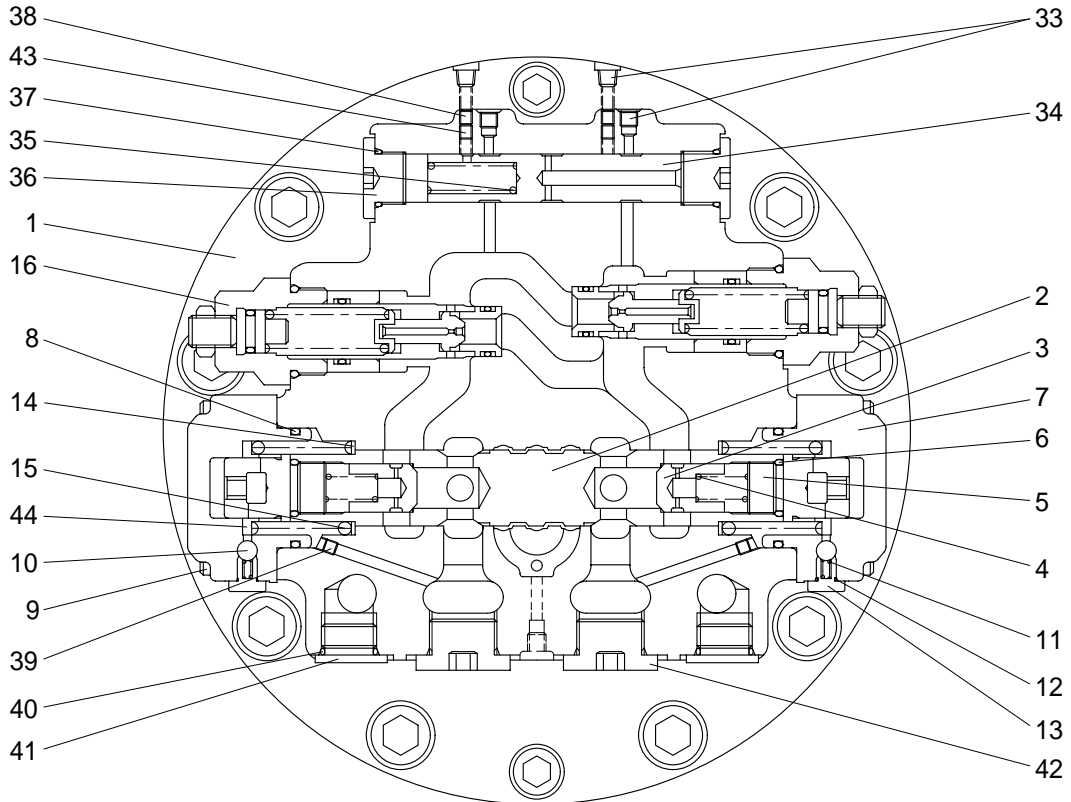
Hydraulic circuit

Port	Port name	Port size
P1	Main port	PT 3/4
P2	Main port	PT 3/4
a1	Gauge port(For P1)	PT 1/4
a2	Gauge port(For P2)	PT 1/4
T1	Drain port	PF 1/2
T2	Drain port	PF 1/2
Ps	2 speed control port	PT 1/4

1) TRAVEL MOTOR(1/2)



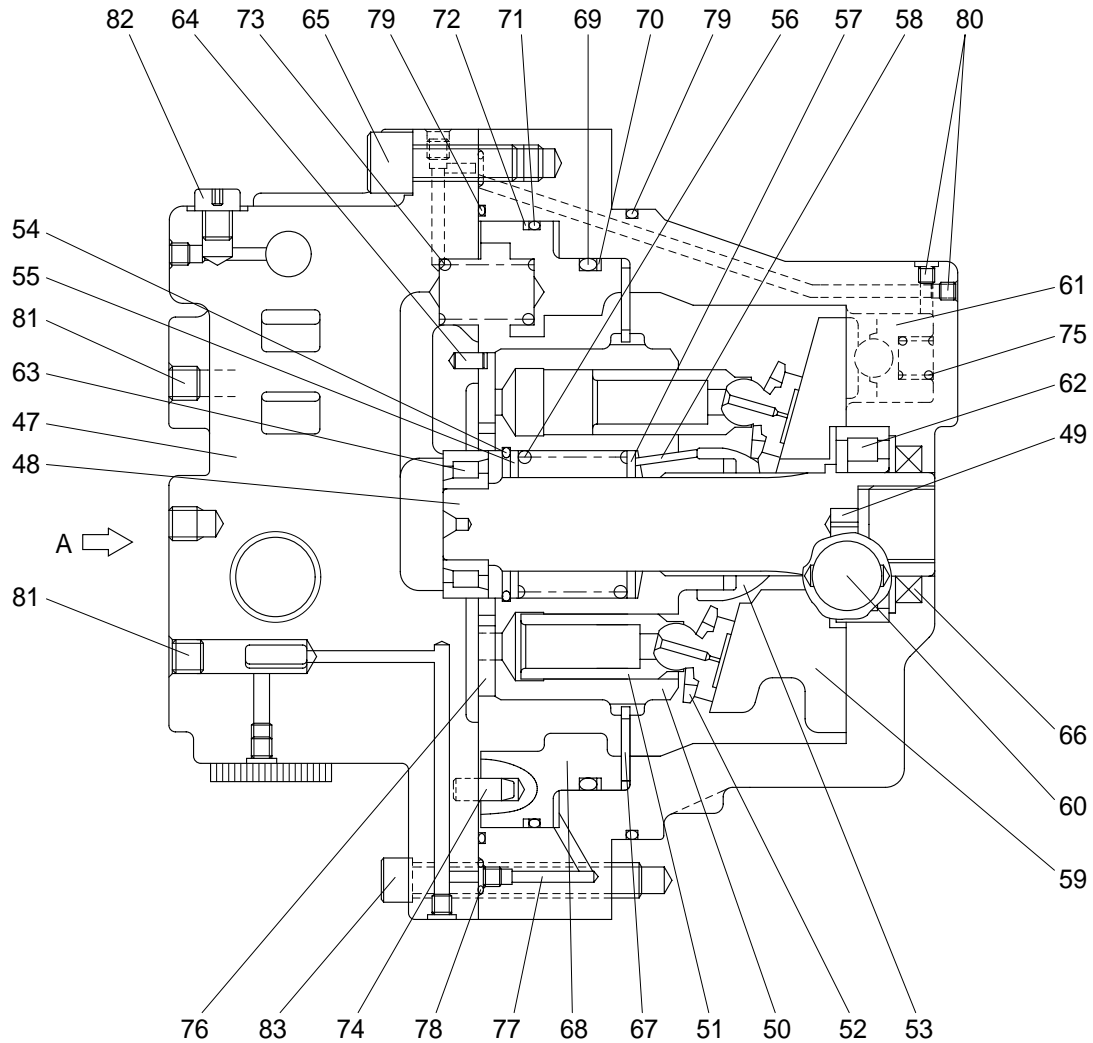
RELIEF VALVE DETAIL



VIEW A

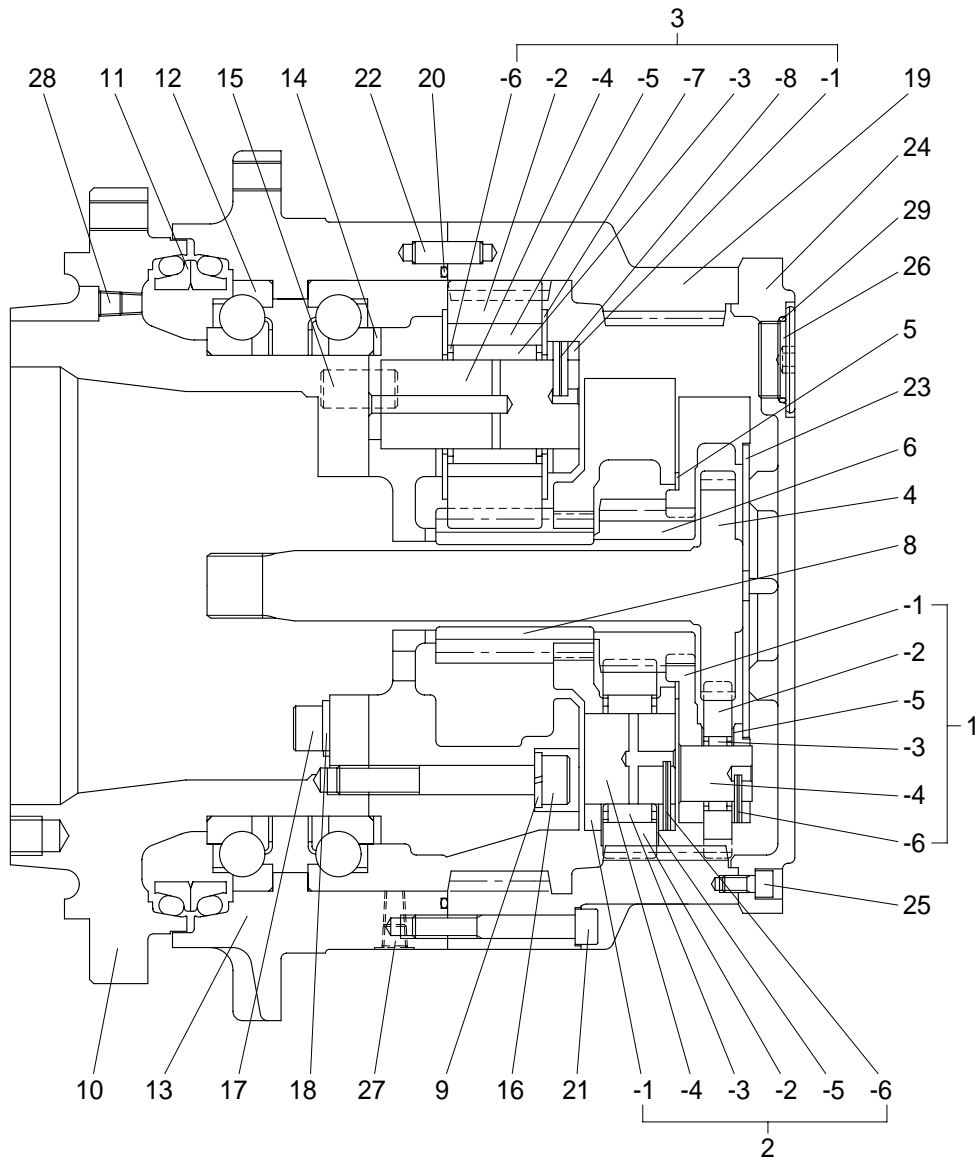
- | | | | | | |
|----|-----------------------|----|----------------|----|---------|
| 1 | Base plate | 17 | Relief housing | 33 | Plug |
| 2 | Plunger | 18 | Poppet | 34 | Spool |
| 3 | Check valve | 19 | Poppet seat | 35 | Spring |
| 4 | Spring | 20 | Spring seat | 36 | Plug |
| 5 | Plug | 21 | Spring | 37 | O-ring |
| 6 | O-ring | 22 | Plug | 38 | Orifice |
| 7 | Cap | 23 | O-ring | 39 | Orifice |
| 8 | O-ring | 24 | Free piston | 40 | O-ring |
| 9 | Socket head bolt | 25 | O-ring | 41 | Plug |
| 10 | Steel ball | 26 | Back up ring | 42 | Plug |
| 11 | Spring | 27 | Spring guide | 43 | Orifice |
| 12 | O-ring | 28 | O-ring | 44 | Flange |
| 13 | Plug | 29 | Set screw | | |
| 14 | Spring seat | 30 | Nut | | |
| 15 | Spring | 31 | O-ring | | |
| 16 | Relief valve assembly | 32 | Back up ring | | |

TRAVEL MOTOR(2/2)



47	Casing	60	Steel ball	73	Spring
48	Shaft	61	Piston assembly	74	Pin
49	Spring pin	62	Roller bearing	75	Spring
50	Cylinder block	63	Roller bearing	76	Valve plate
51	Piston assembly	64	Spring pin	77	Orifice
52	Retainer plate	65	Socket head bolt	78	O-ring
53	Retainer holder	66	Oil seal	79	O-ring
54	Snap ring	67	Disc plate	80	Plug
55	Collar	68	Brake piston	81	Plug
56	Spring	69	O-ring	82	Plug
57	Collar	70	Back up ring	83	Socket head bolt
58	Pin	71	O-ring		
59	Swash plate	72	Back up ring		

2) REDUCTION GEAR

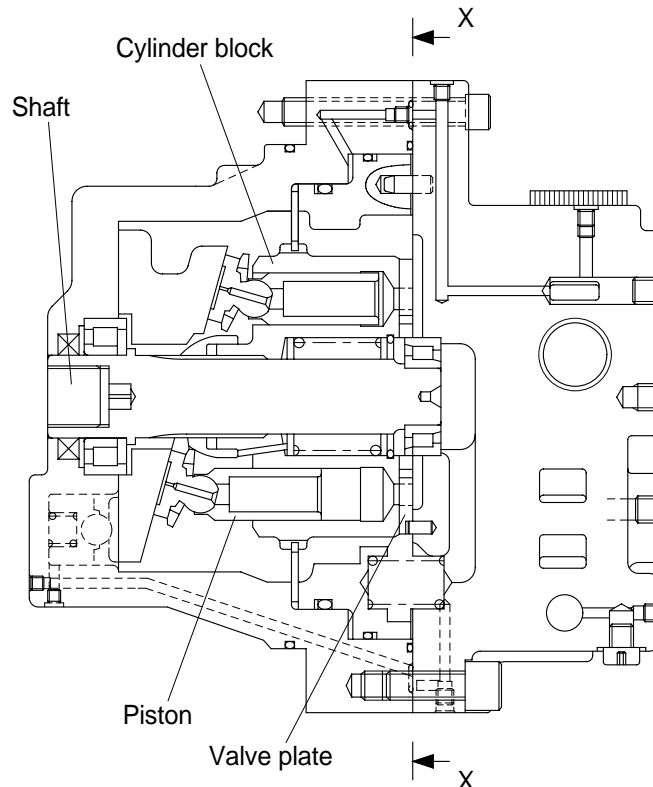


1	Holder A assembly	3-2	Planet gear C	14	Shim(0.1~0.05t)
1-1	Holder A	3-3	Roller bearing	15	Pin
1-2	Planet gear A	3-4	Gear shaft C	16	Socket head bolt
1-3	Needle bearing	3-5	Floating bushing	17	Socket head bolt
1-4	Gear shaft A	3-6	Collar	18	Plate
1-5	Thrust washer	3-7	Thrust washer	19	Ring gear
1-6	Spring pin	3-8	Spring pin	20	O-ring
2	Holder B assembly	4	Drive gear	21	Socket head bolt
2-1	Holder B	5	Thrust plate	22	Pin
2-2	Planet gear B	6	Sun gear B	23	Thrust plate(1.8~3.2t)
2-3	Needle bearing	8	Sun gear C	24	Cover
2-4	Gear shaft B	9	Spring washer	25	Socket head bolt
2-5	Thrust washer	10	Flange	26	Plug(PF 3/4)
2-6	Spring pin	11	Floating seal	27	Plug(PT 1/4)
3	Holder C assembly	12	Angular bearing	28	Plug(PT 1/8)
3-1	Holder C	13	Housing		

2. FUNCTION

1) HYDRAULIC MOTOR

(1) Rotary group



- (1) The cylinder block contains nine pistons. The end face of the cylinder block is in contact with the valve plate that has two semicircular ports B and C (Distributor valve that changes over high and low pressures).

(2) Principle of generating torque

If high pressure oil (Pressure P) is admitted to port P, force $F (=P \times A)$, A : Cross-sectional area of a piston) per piston acts on the shaft and generates radial component F_t . As the result, the total sum of radial forces of the pistons on the high pressure side produces a rotating torque in the direction of the shaft.

Inversely, if high pressure oil is admitted to port C, the motor turns in the opposite direction.

The output torque and revolution of the motor available by the above-mentioned principle depend upon pressure (P) and inflow rate (Q) supplied to the motor and are calculated as below:

- Output torque

$$T = \frac{P \times D \times \eta_m}{2 \times \pi \times 100} \text{ (kg} \cdot \text{m)}, \quad N = \frac{Q \times 1000 \times \eta_v}{D} \text{ (rpm)},$$

Where ; D : Displacement capacity (cc/rev)

P : Effective drive pressure (kg/cm²)

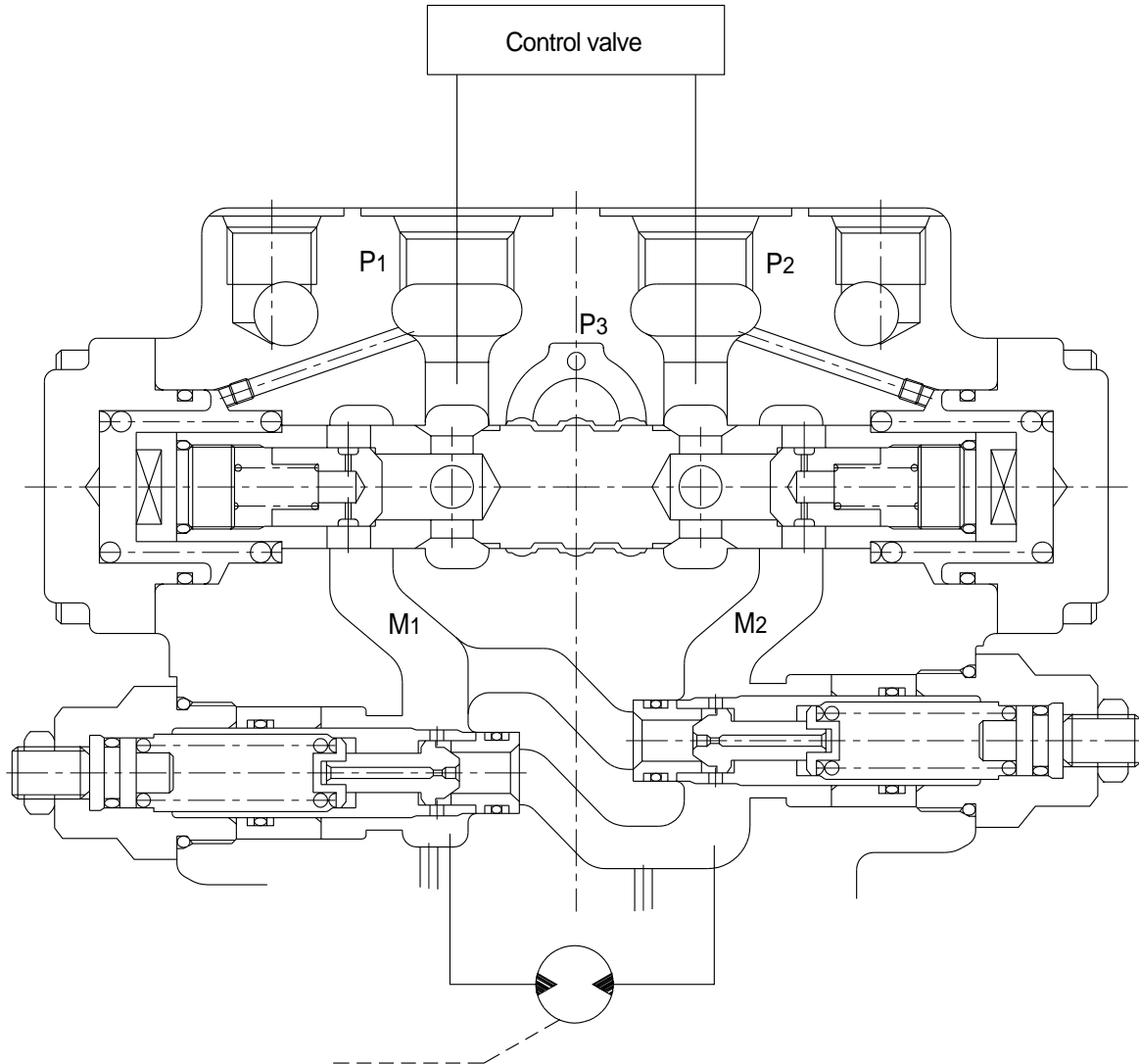
Q : Incoming flow (l/min)

η_m : Mechanical efficiency (% $\times 10^{-2}$)

η_v : Volumetric efficiency (% $\times 10^{-2}$)

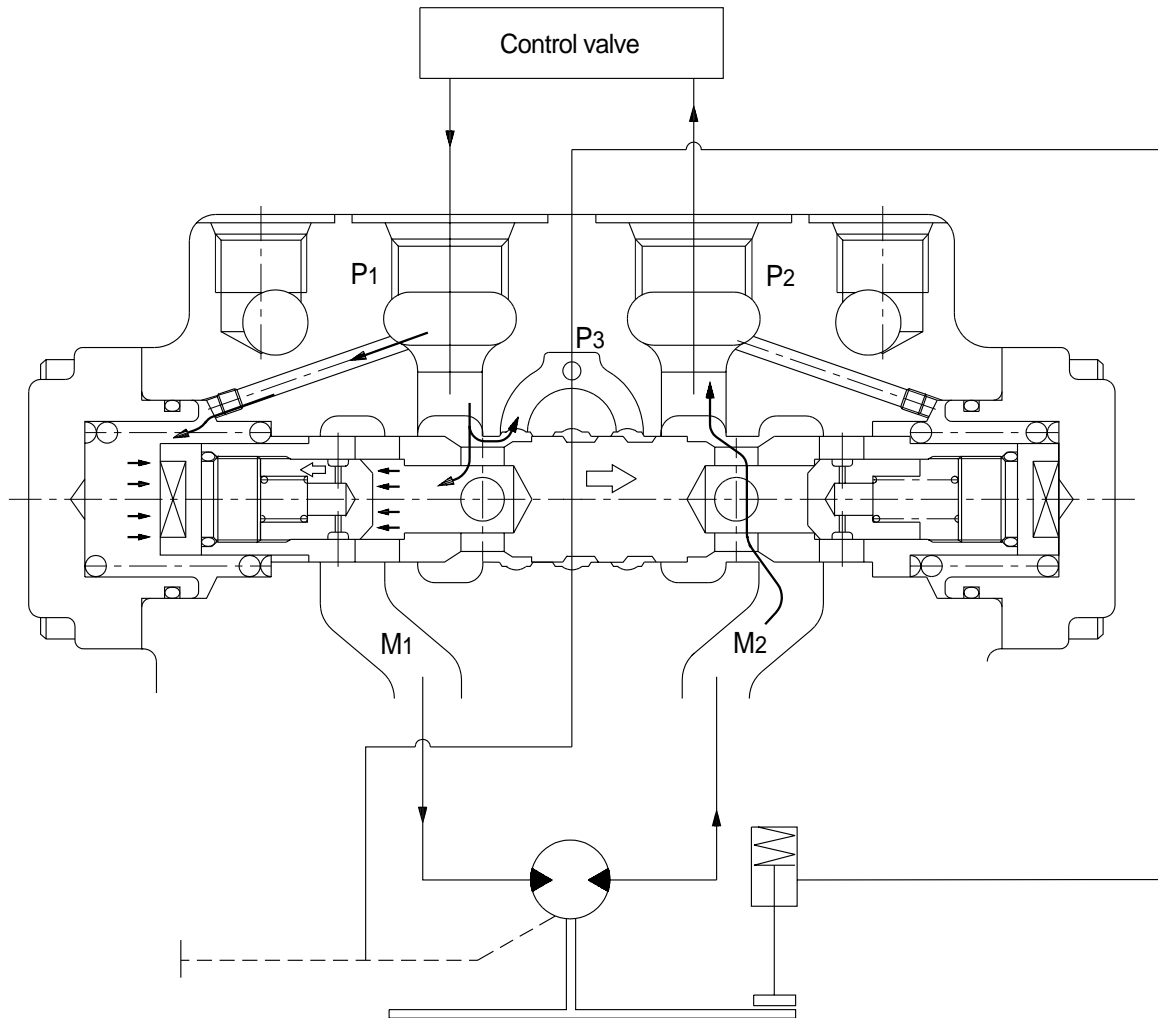
2) COUNTER BALANCE VALVE

(1) Neutral position



Counter balance valve controls according to oil supply so as to prevent reckless of running of the motor. When the control valve is in neutral position, oil does not supply the port P1 and P2. This blocks the motor port to prevent the motor from rotating.

(2) Counter balance function



Oil discharged from main pump flows into the counter balance valve port P1 via control valve.

The oil flows into piston motor via check valve and M1 port.

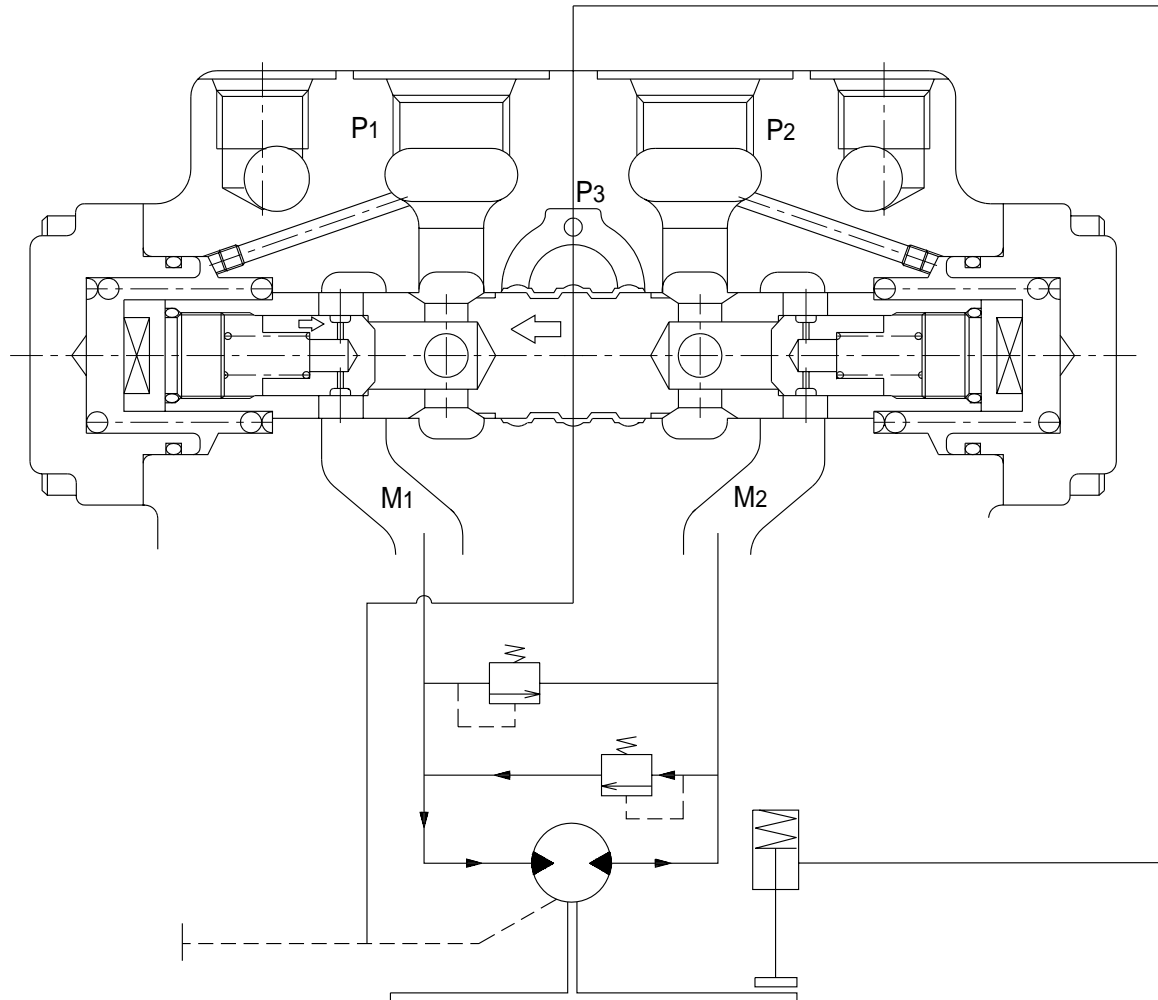
Since the return oil from motor port M2 is blocked by check valve, the pressure of port P1 is increased.

Accordingly, the pressure applied through the orifice to left chamber of plunger and move plunger rightward.

Port M1 is connected by notch of plunger to port P2, then the return oil of motor port M2 is discharged, and the travel motor starts revolution.

※ Reversed when hydraulic oil pressure is applied to port P2.

(3) Brake function

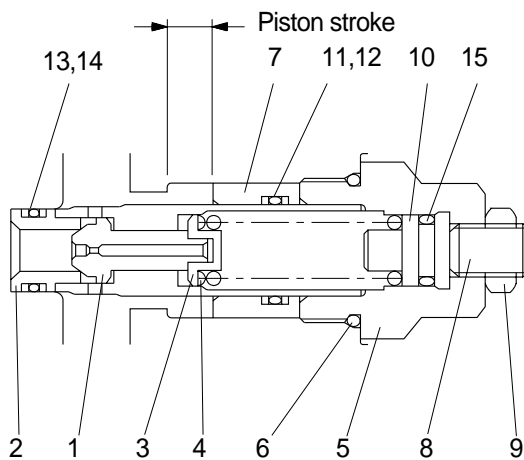


When the travel lever return to neutral position, the oil from the main pump is blocked, and the plunger return the neutral position by spring force.

But the motor is rotated by inertia, so the pressure at the output port of motor rises, then motor is braked.

If the pressure reaches the set pressure of relief valve, oil flows into port M1. As a result, the shock pressure caused by inertia force is released and prevent cavitation of port M1.

3) RELIEF VALVE



- 1 Poppet
- 2 Poppet seat
- 3 Spring seat
- 4 Spring
- 5 Plug
- 6 O-ring
- 7 Shockless piston
- 8 Adjust screw
- 9 Nut
- 10 Spring guide
- 11 O-ring
- 12 Back up ring
- 13 O-ring
- 14 Back up ring
- 15 O-ring

(1) Construction of relief valve

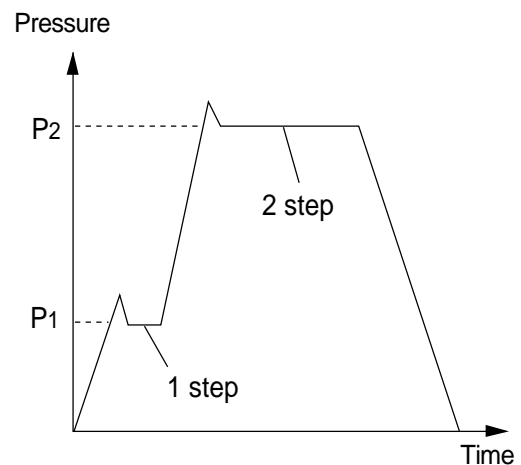
The release valve determines the drive force and the brake force of the machine during running and is mounted to the cross line. The relief valve is provided with a shockless function to relieve shocks that may be generated at the beginning of acceleration and deceleration.

- a) Differential area type interlocking relief valve
- b) It consists of a shockless piston.

As explained above, the relief valve functions in the following two stages when the control valve is operated to drive or brake the piston motor.

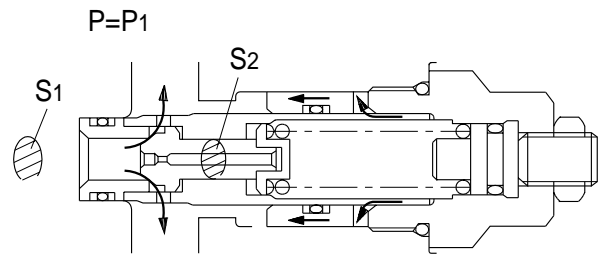
(2) Function of relief

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.



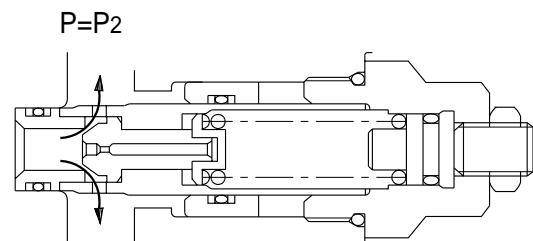
① First stage

At the beginning of the relief valve operation, the pressure in the spring chamber is held low by the shockless piston, with the result that the pressure receiving area of the poppet equals the area (S_1) of the poppet seat. As the result, the pressure receiving area is comparatively large as compared to the area ($S_1 - S_2$) obtained during regular relief setting. This makes the operating relief pressure low (About a third of a regular set pressure) which is maintained till the shockless piston finishes travel. The duration in which low pressure is held depends upon the diameter of the poppet orifice, the pressure receiving area of the piston and the piston stroke.



② Second stage

When the shockless piston finishes travel, the pressure in the spring chamber of the relief valve rises, equaling the pressures before and after the poppet to set it to a regular set pressure.



4) 2-SPEED CONTROL

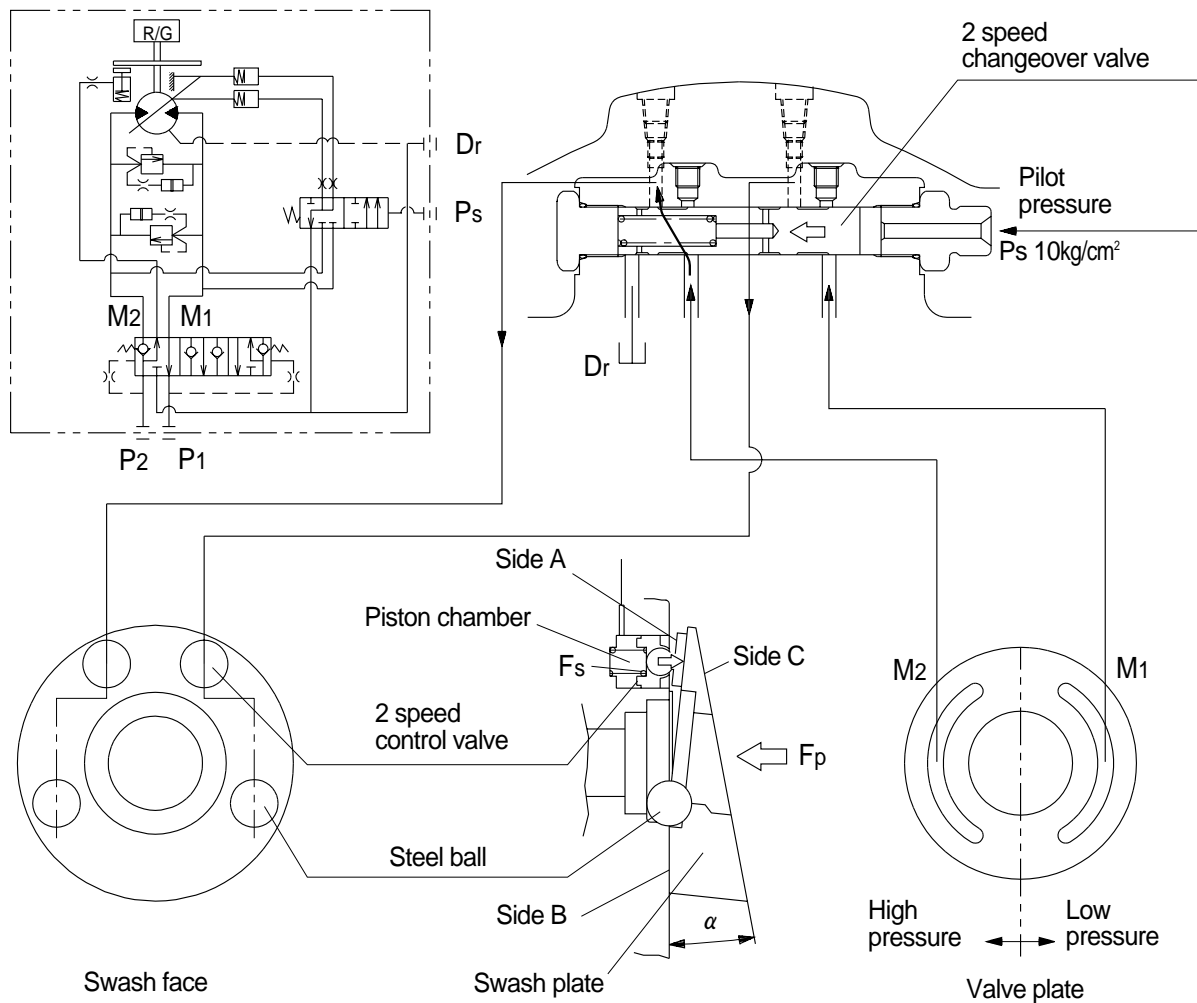
The 2-speed mechanism consists of a 2-speed changeover valve (Hereinafter called valve), a two-speed control piston (Hereinafter called piston) and a swash plate.

The swash plate, which has three faces A~C, is fixed to the motor case by two steel balls so that it can be tilted.

The two-speed changeover valve is fixed in the base plate.

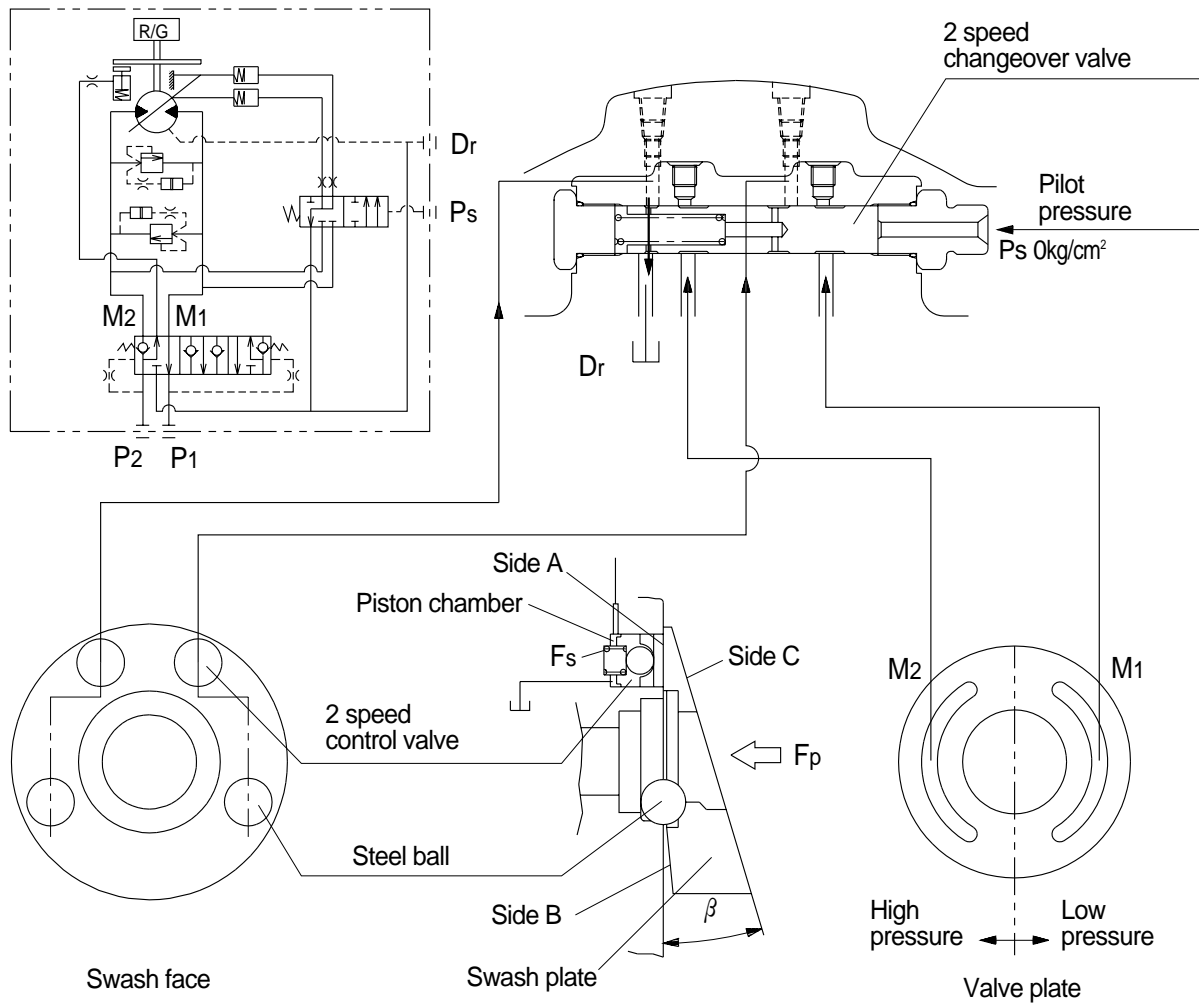
The two-speed control piston is fixed in the motor casing.

(1) High speed control



If pilot pressure from port Ps is exerted on the valve, it is switched to the condition shown in Fig. Causing the motor drive pressure to act on the 2 speed control piston. This pushes the swash plate up, inclines it to a position in which the propelling force (F_p) of the piston and the spring force (F_s) balance with the propelling force of the pistons and finally stabilizes upon contact of the face B of the swash plate with the casing. At that time, the tilting angle (β) of the swash plate is P and the motor revolution gets to the 2nd shift (High speed).

(2) Low speed control

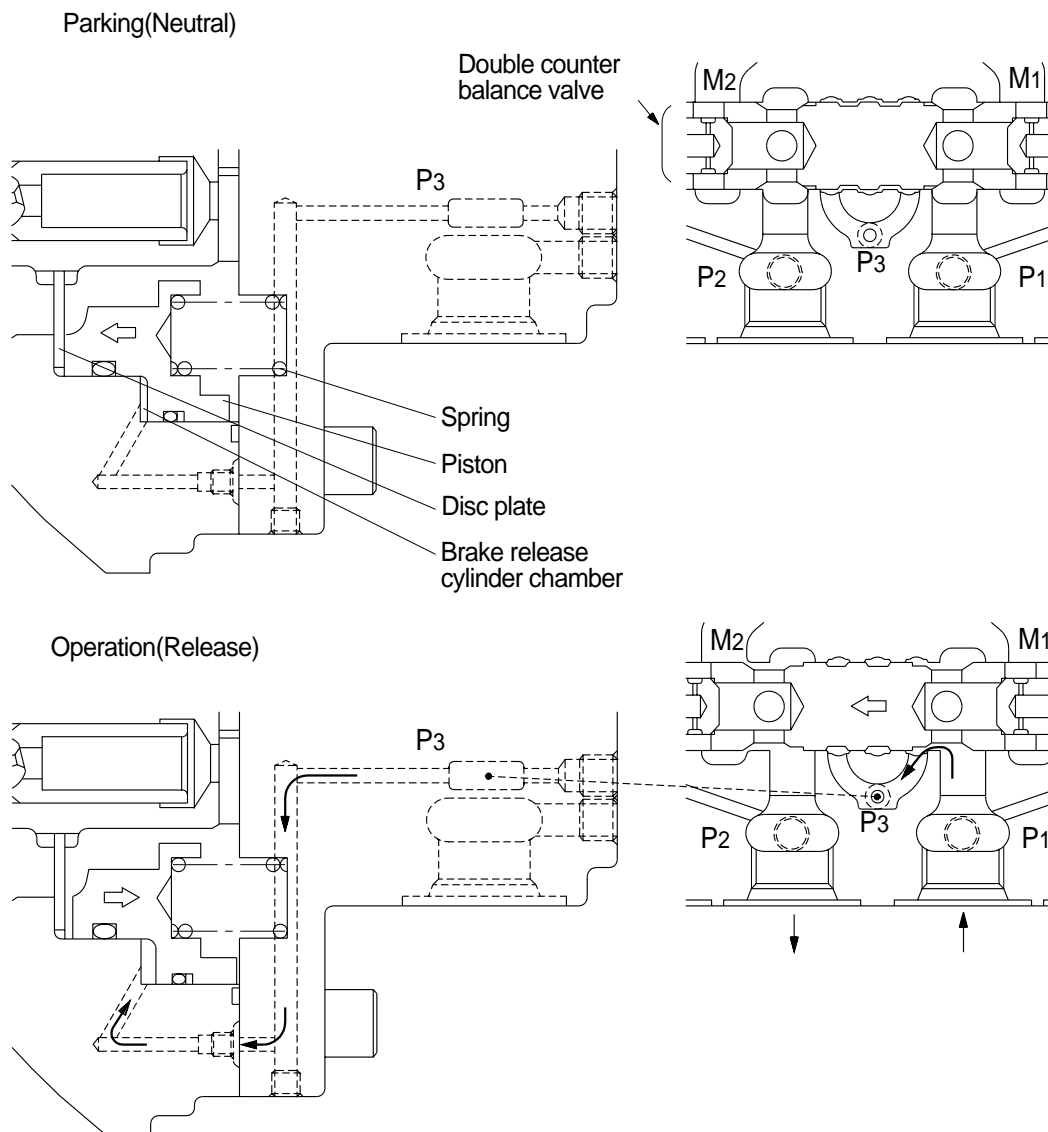


If the changeover pilot pressure P_s is shut off, the valve is brought to the condition in Fig. As the result the piston chamber is connected with the drain line in the motor casing.

Consequently, the swash plate is pressed by the combined force of the propelling force of the piston high pressure and the spring force till the face A of the swash plate comes in contact with the casing to stabilize the swash plate. On that occasion, the tilting angle (α) of the swash plate is and the motor revolution gets to the 1st shift (low speed) condition.

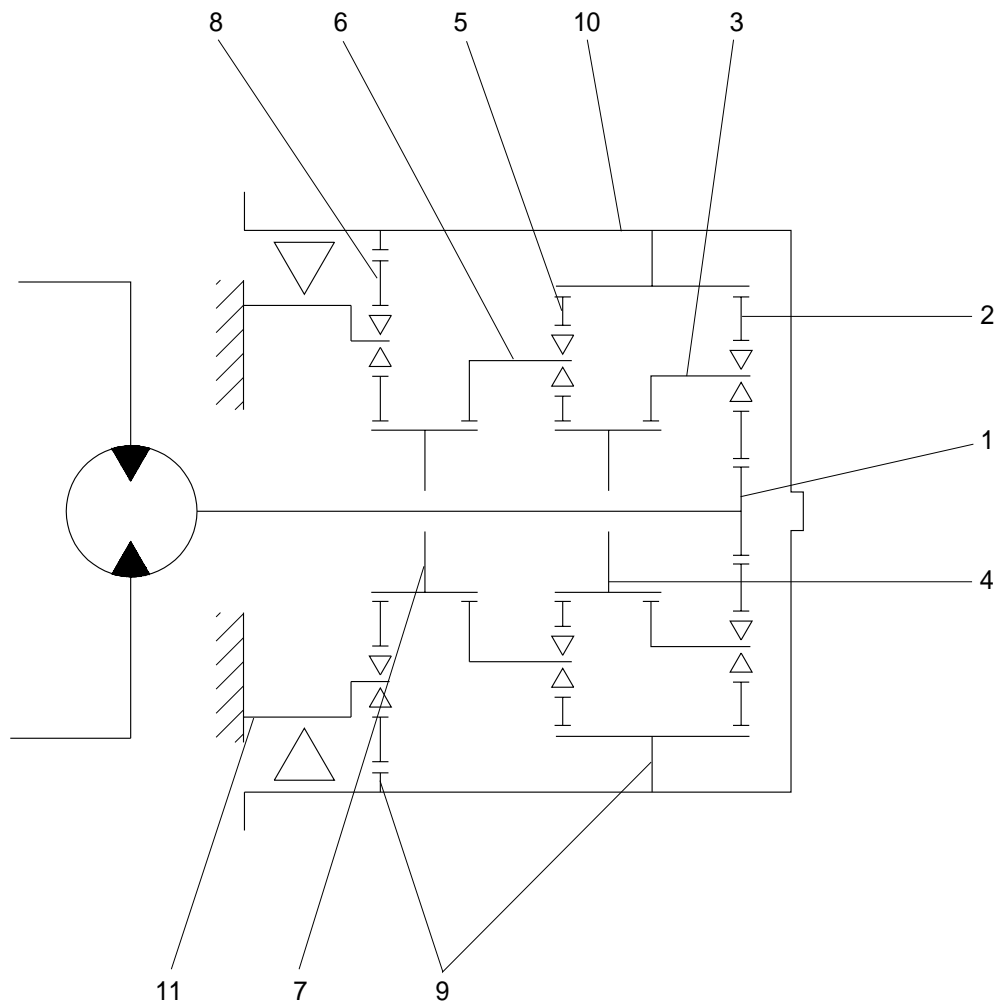
If the changeover pilot pressure is shut off at an engine stop or on some other occasion, the swash plate is pressed by the spring action till it contacts face A of the casing. The swash plate takes a tilting angle (α) a then to pick up the 1st shift (Low speed).

5) PARKING BRAKE



The parking brake is a negative brake consisting of a disc plate, brake piston and a spring. When pressurized oil runs into the motor, it then runs into port P3 via the double counter balance valve and is admitted into the brake release cylinder chamber. The pressurized oil produces a force in proportion to the pressure receiving area of the piston. This force overcomes the spring action and pushes the brake piston to release the braking force. At parking or on stop of the machine, the hydraulic oil in the brake release cylinder chamber is released to the tank, which causes a braking force to be produced by spring action.

6) GEAR BOX



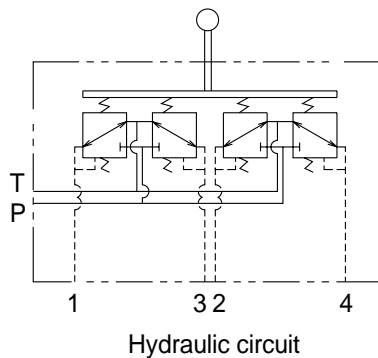
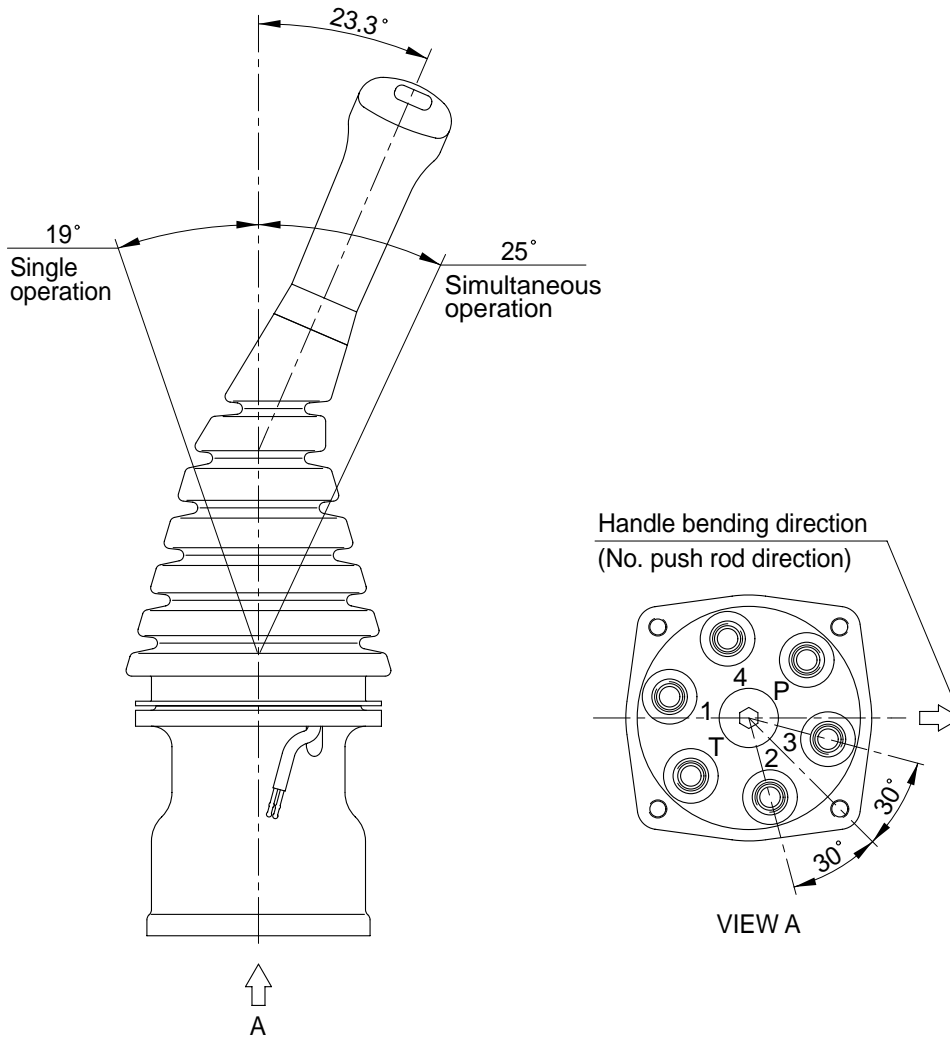
- | | | | | | |
|---|--------------------------|---|--------------------|----|-------------|
| 1 | Drive gear(1st sun gear) | 5 | 2nd planetary gear | 9 | Ring gear |
| 2 | 1st planetary gear | 6 | 2nd carrier | 10 | Casing |
| 3 | 1st carrier | 7 | 3rd sun gear | 11 | 3rd carrier |
| 4 | 2nd sun gear | 8 | 3rd planetary gear | | |

(1) The reduction gear is composed of a three stage planetary gear mechanism shown in the figure.

GROUP 5 RCV LEVER

1. STRUCTURE

The casing has the oil inlet port P(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.



Port	LH	RH	Port size
P	Pilot oil inlet port	Pilot oil inlet port	PF 1/4
T	Pilot oil return port	Pilot oil return port	
1	Left swing port	Bucket out port	
2	Arm in port	Boom down port	
3	Right swing port	Bucket in port	
4	Arm out port	Boom up port	

CROSS SECTION

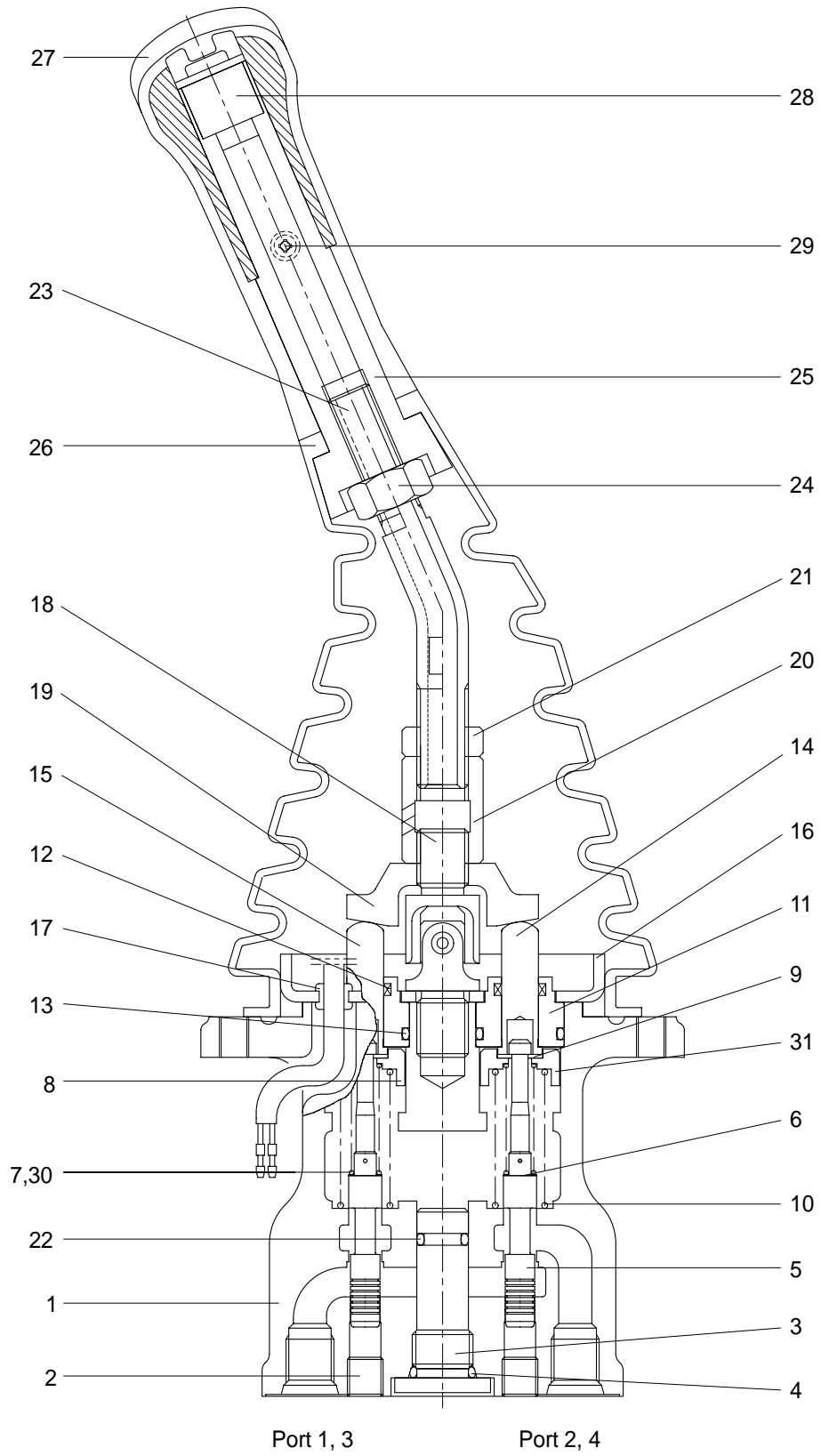
The construction of the pilot valve is shown in the attached cross section drawing. The casing has vertical holes in which reducing valves are assembled.

The pressure reducing section is composed of the spool(5), spring(7, 30) for setting secondary pressure, return spring(10), stopper(9), spring seat(8, 31) and shim(6). The spring for setting the secondary pressure has been generally so preset that the secondary pressure is 5 to 20.5kgf/cm² (Depending on the type). The spool is pushed against the push rod(14, 15) by the return spring.

When the push rod is pushed down by tilting the handle, the spring seat comes down simultaneously and changes setting of the secondary pressure spring.

1	Case	12	Rod seal	22	O-ring
2	Plug	13	O-ring	23	Handle connector
3	Plug	14	Push rod	24	Nut
4	O-ring	15	Push rod	25	Insert
5	Spool	16	Plate	26	Boot
6	Shim	17	Bushing	27	Handle
7	Spring	18	Joint assembly	28	Switch assembly
8	Spring seat	19	Swash plate	29	Screw
9	Stopper	20	Adjusting nut	30	Spring
10	Spring	21	Lock nut	31	Spring seat
11	Plug				

CROSS SECTION



2. FUNCTIONS

1) FUNDAMENTAL FUNCTIONS

The pilot valve is a valve that controls the spool stroke, direction, etc of a main control valve. This function is carried out by providing the spring at one end of the main control valve spool and applying the output pressure(Secondary pressure) of the pilot valve to the other end.

For this function to be carried out satisfactorily, the pilot valve is composed of the following elements.

- (1) Inlet port(P) where oil is supplied from hydraulic pump.
- (2) Output ports(1,2,3 & 4) to apply pressure supplied from inlet port to ends of control valve spools.
- (3) Tank port(T) necessary to control the above output pressure.
- (4) Spool to connect output port to inlet port or tank port.
- (5) Mechanical means to control output pressure, including springs that work on the above spools.

2) FUNCTIONS OF MAJOR SECTIONS

The functions of the spool(5) are to receive the supply oil pressure from the hydraulic pump at its port P, and to change over oil paths to determine whether the pressure oil of port P is led to output ports 1,2,3 & 4 or the output port pressure oil to tank port T.

The spring(7, 30) works on this spool to determine the output pressure.

The change the deflection of this spring, the push rod(14, 15) is inserted and can slide in the plug (11).

For the purpose of changing the displacement of the push rod through the plate(19) and adjusting nut(20) are provided the handle(27) that can be tilted in any direction around the fulcrum of the universal joint(18) center.

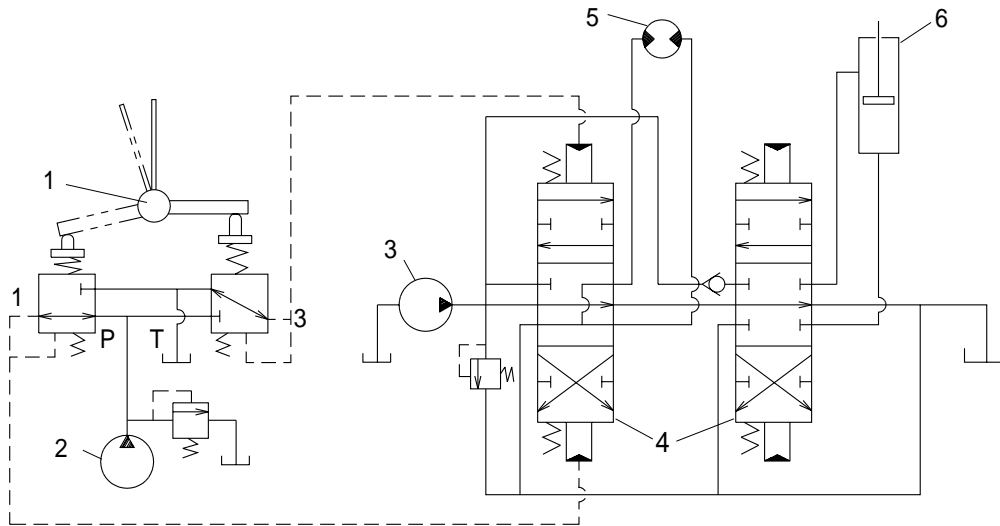
The spring(10) works on the case(1) and spring seat(8) and tries to return the push rod(14, 15) to the zero-displacement position irrespective of the output pressure, securing its resetting to the center position.

This also has the effect of a reaction spring to give appropriate control feeling to the operator.

3) OPERATION

The operation of the pilot valve will be described on the basis of the hydraulic circuit diagram shown below and the attached operation explanation drawing.

The diagram shown below is the typical application example of the pilot valve.

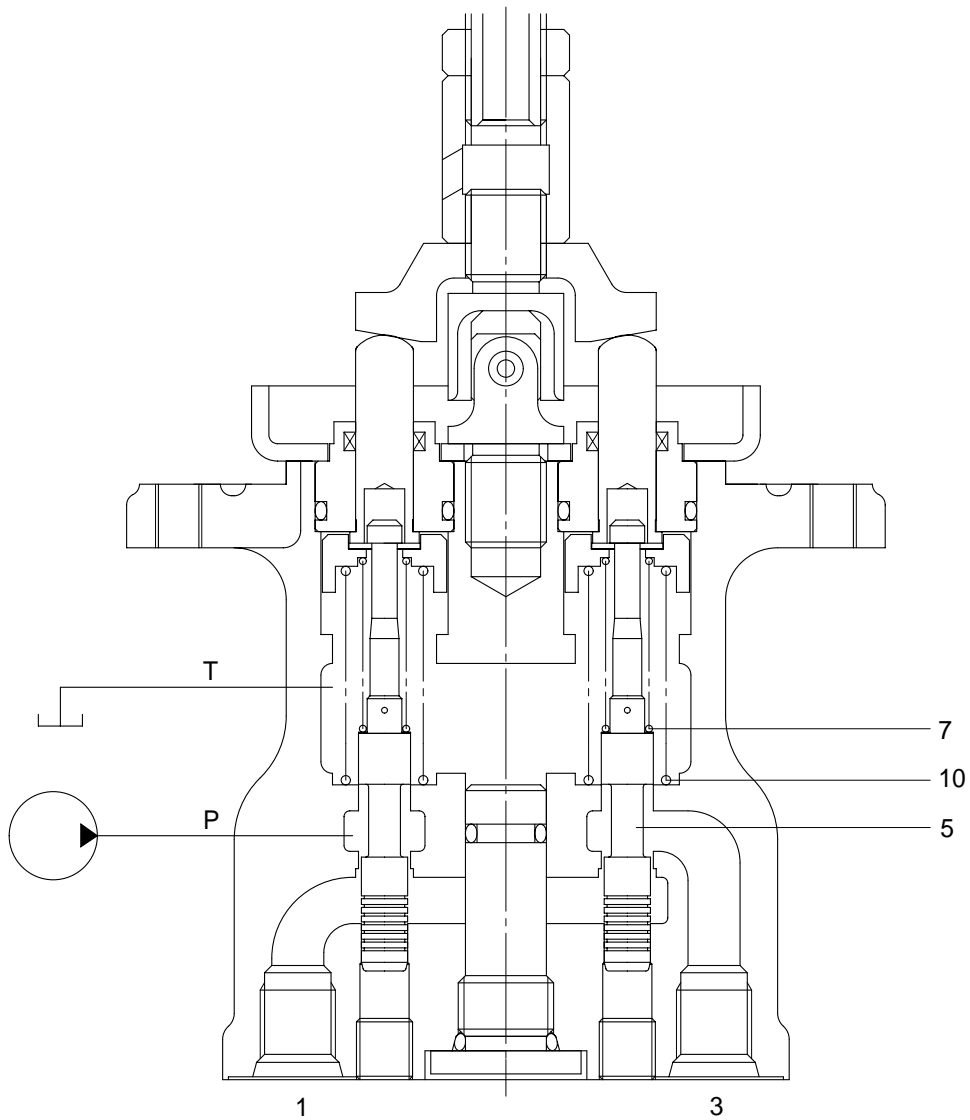


1 Pilot valve
2 Pilot pump

3 Main pump
4 Main control valve

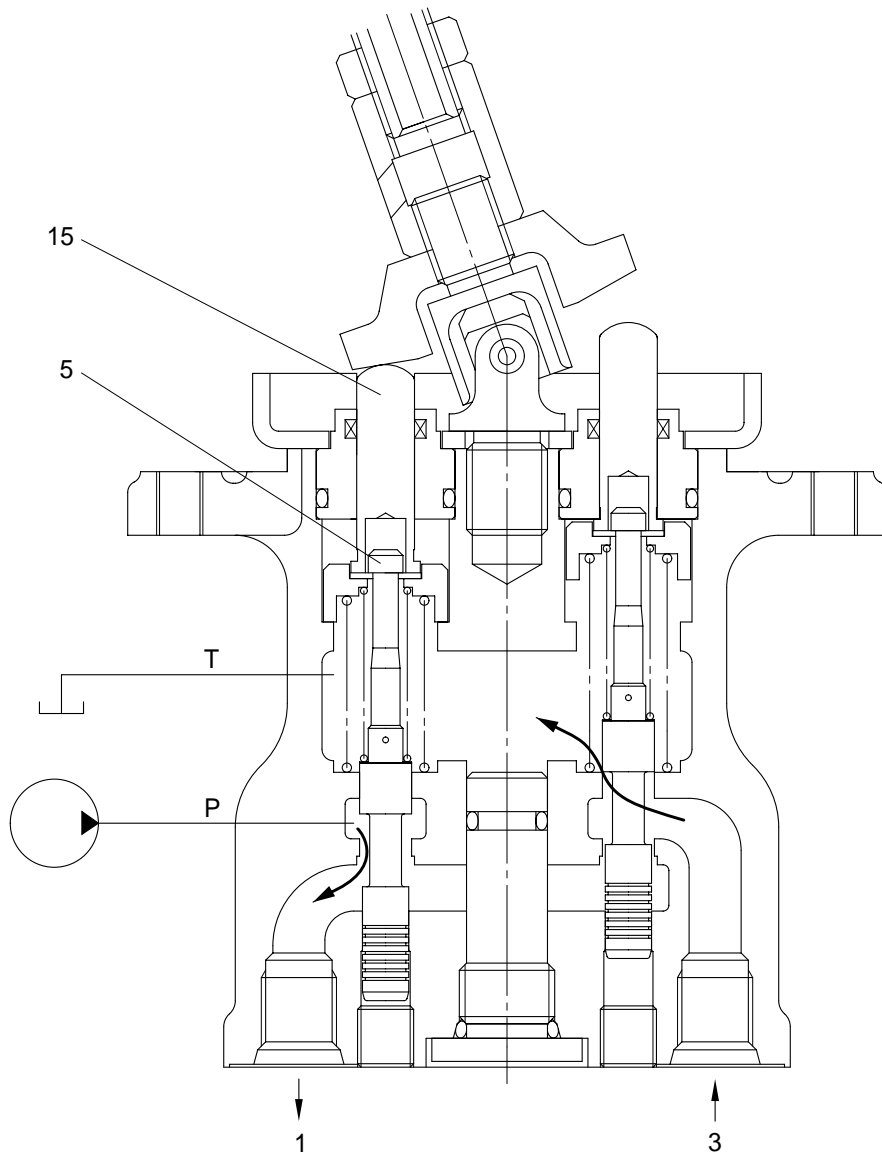
5 Hydraulic motor
6 Hydraulic cylinder

(1) Case where handle is in neutral position



The force of the spring(7) that determines the output pressure of the pilot valve is not applied to the spool(5). Therefore, the spool is pushed up by the spring(10) to the position of port(1,3) in the operation explanation drawing. Then, since the output port is connected to tank port T only, the output port pressure becomes equal to tank pressure.

(2) Case where handle is tilted



When the push rod(15) is stroked, the spool(5) moves downwards.

Then port P is connected with port(1) and the oil supplied from the pilot pump flows through port(1) to generate the pressure.

When the pressure at port(1) increases to the value corresponding to the spring force set by tilting the handle, the hydraulic pressure force balances with the spring force. If the pressure at port(1) increases higher than the set pressure, port P is disconnected from port(1) and port T is connected with port(1). If it decreases lower than the set pressure, port P is connected with port(1) and port T is disconnected from port 1.

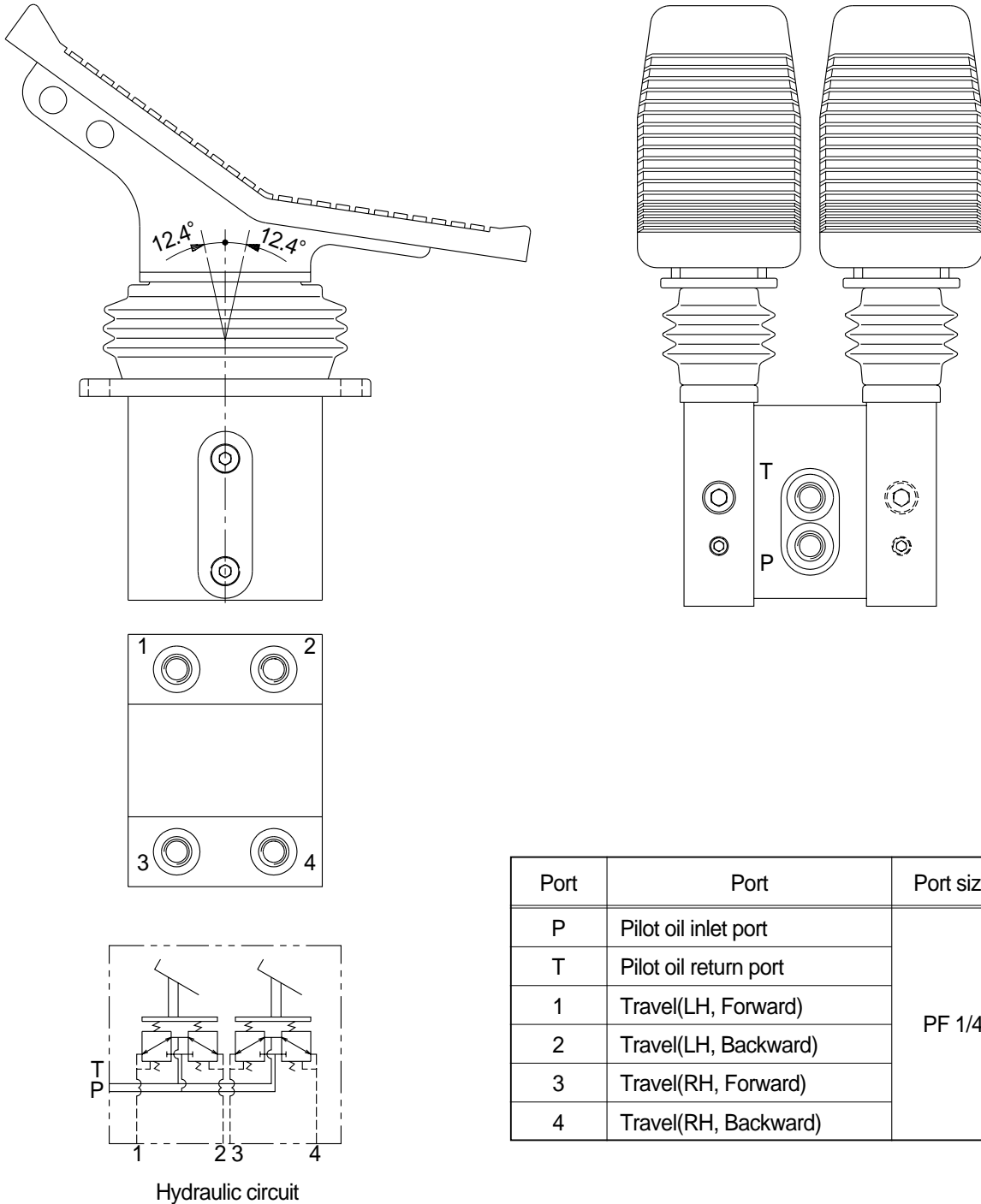
In this manner the secondary pressure is kept at the constant value.

Besides, in some type, when the handle is tilted more than a certain angle, the upper end of the spool contacts with the inside bottom of the push rod and the output pressure is left to be connected with port P.

GROUP 6 RCV PEDAL

1. STRUCTURE

The casing(Spacer) has the oil inlet port P(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.



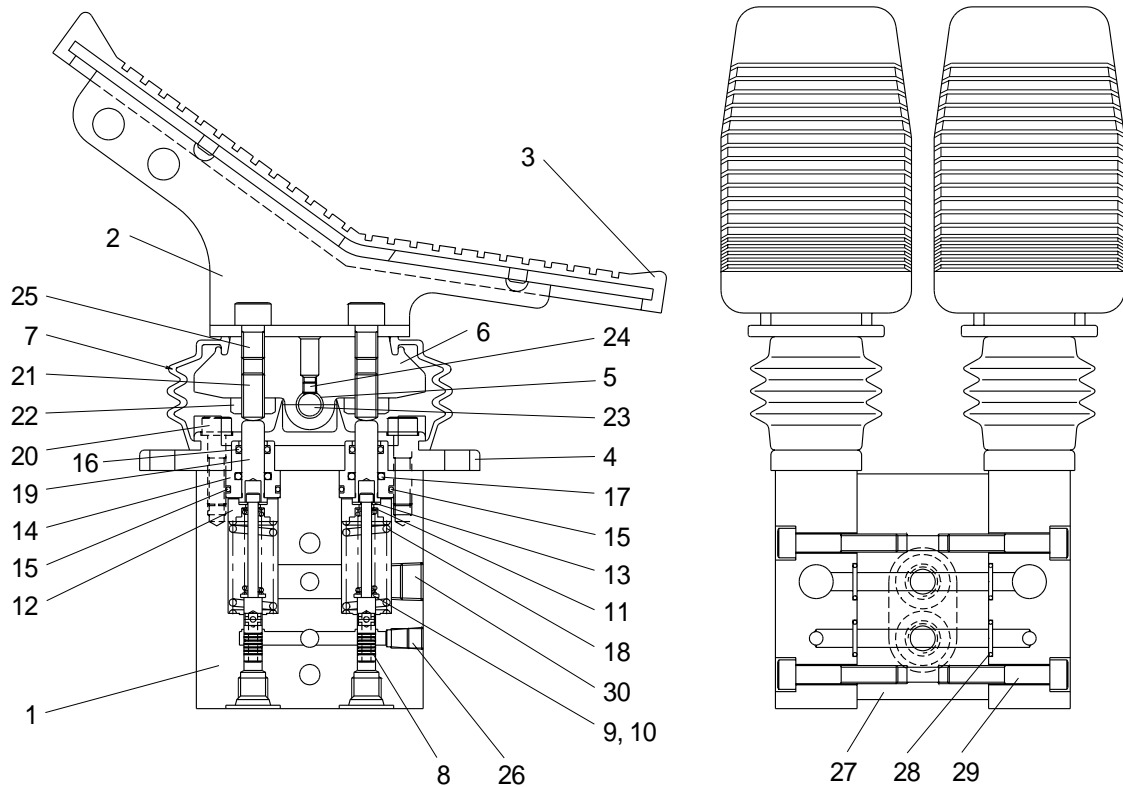
Port	Port	Port size
P	Pilot oil inlet port	PF 1/4
T	Pilot oil return port	
1	Travel(LH, Forward)	
2	Travel(LH, Backward)	
3	Travel(RH, Forward)	
4	Travel(RH, Backward)	

CROSS SECTION

The construction of the RCV pedal is shown in the below drawing. The casing has vertical holes in which reducing valves are assembled.

The pressure reducing section is composed of the spool(8), spring(11) for setting secondary pressure, return spring(18), stopper(13), spring seat(12) and shim(9). The spring for setting the secondary pressure has been generally so preset that the secondary pressure is 5 to 19 kgf/cm²(Depending on the type). The spool is pushed against the push rod(19) by the return spring.

When the push rod is pushed down by tilting pedal, the spring seat comes down simultaneously and changes setting of the secondary pressure spring.



1	Casing	11	Spring	21	Set screw
2	Pedal	12	Spring seat	22	Nut
3	Pedal cover	13	Stopper	23	Cam shaft
4	Cover	14	Plug	24	Set screw
5	Bushing	15	O-ring	25	Hexagon socket bolt
6	Cam	16	Dust seal	26	Plug
7	Bellows	17	Rod seal	27	Spacer
8	Spool	18	Spring	28	O-ring
9	Shim	19	Push rod	29	Hexagon socket bolt
10	Spring seat	20	Hexagon socket bolt	30	Plug

2. FUNCTION

1) FUNDAMENTAL FUNCTIONS

The pilot valve is a valve controls the spool stroke, direction, etc of a main control valve. This function is carried out by providing the spring at one end of the main control valve spool and applying the output pressure(Secondary pressure) of the pilot valve to the other end.

For this function to be carried out satisfactorily, the pilot valve is composed of the following elements.

- (1) Inlet port(P) where oil is supplied from hydraulic pump.
- (2) Output port(1,2,3 & 4) to apply pressure supplied from inlet port to ends of control valve spools.
- (3) Tank port(T) necessary to control the above output pressure.
- (4) Spool to connect output port to inlet port tank port.
- (5) Mechanical means to control output pressure, including springs that work on the above spools.

2) FUNCTIONS OF MAJOR SECTIONS

The functions of the spool(8) are to receive the supply oil pressure from the hydraulic pump at its port P, and to change over oil paths to determine whether the pressure oil of port P is led to output ports 1,2,3 & 4 or the output spool to determine the output pressure.

The spring(11) works on this spool to determine the output pressure.

The change the deflection of this spring, the push rod(19) is inserted and can slide in the plug(14).

For the purpose of changing th displacement of the push rod through the cam(6) and adjusting nut(22) are provided the pedal(2) that can be tilted in any direction around the fulcrum of the cam(6) center.

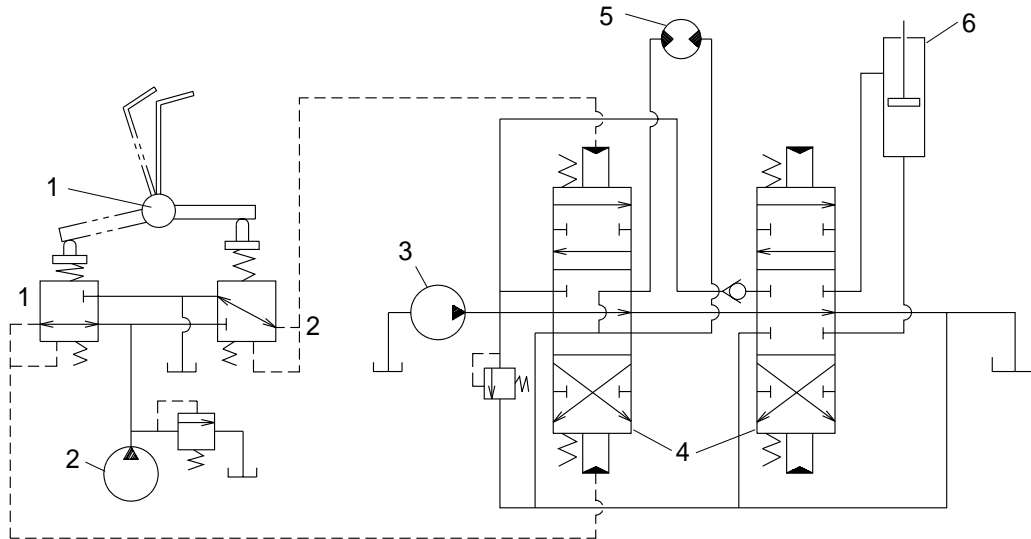
The spring(18) works on the casing(1) and spring seat(12) and tries to return the push rod(19) to the zero-displacement position irrespective of the output pressure, securing its resetting to the center position.

This also has the effect of a reaction spring to give appropriate control feeling to the operator.

3) OPERATION

The operation of the pilot valve will be described on the basis of the hydraulic circuit diagram shown below and the attached operation explanation drawing.

The diagram shown below is the typical application example of the pilot valve.

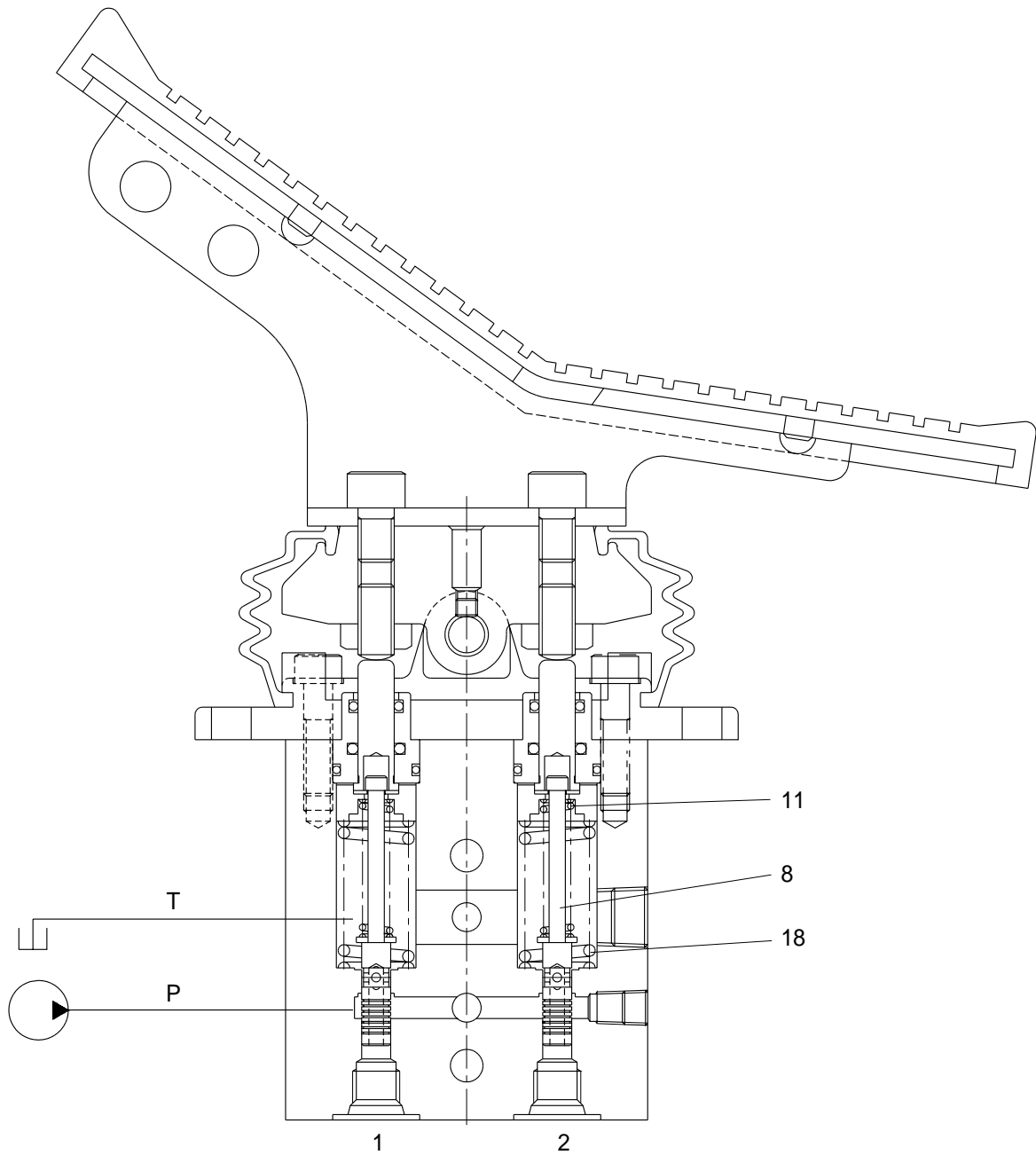


1 Pilot valve
2 Pilot pump

3 Main pump
4 Main control valve

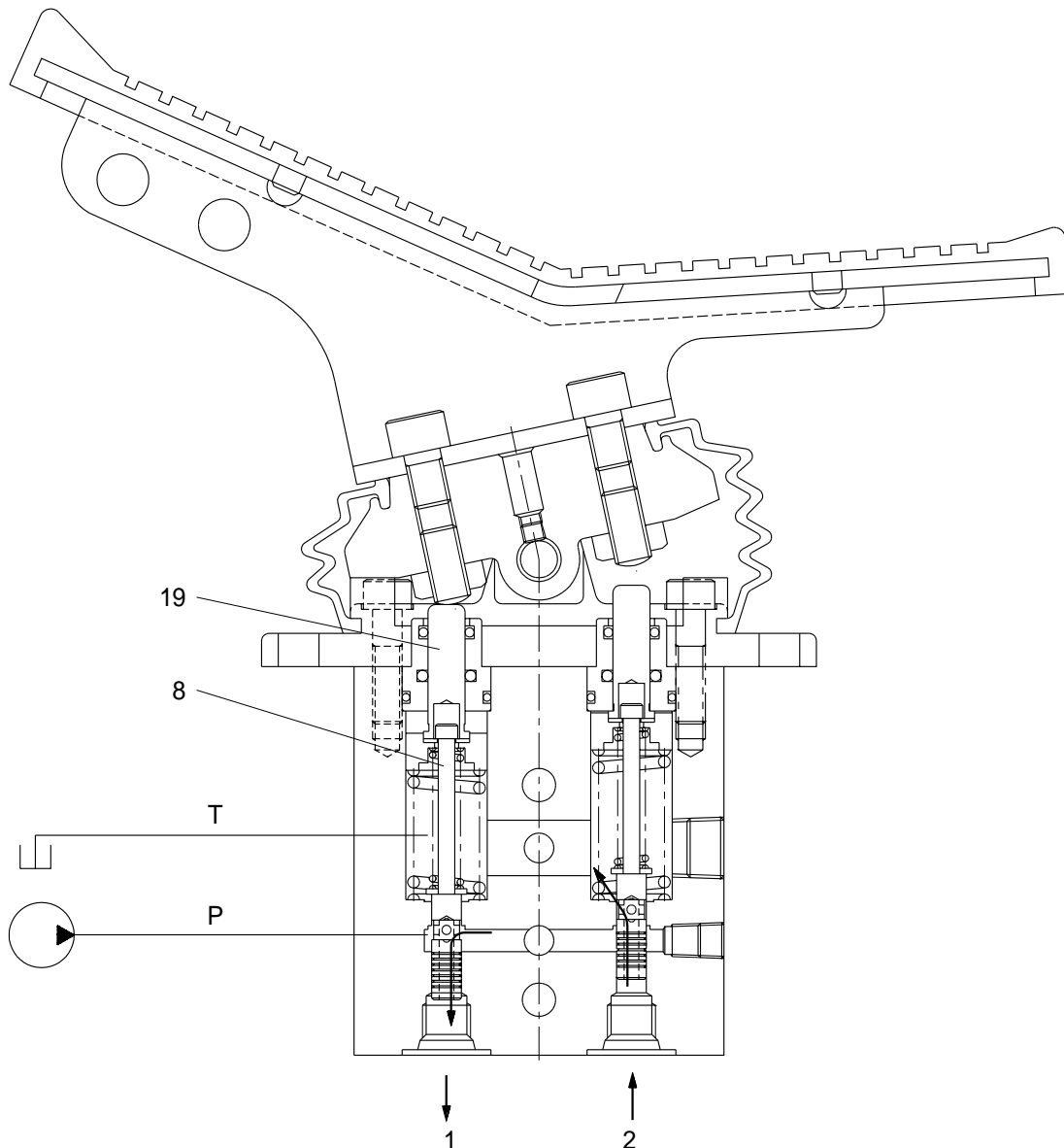
5 Hydraulic motor
6 Hydraulic cylinder

(1) Case where pedal is in neutral position



The force of the spring(11) that determines the output pressure of the pilot valve is not applied to the spool(8). Therefore, the spool is pushed up by the spring(18) to the position of port 2 in the operation explanation drawing. Then, since the output port is connected to tank port T only, the output port pressure becomes equal to tank pressure.

(2) Case where pedal is tilted



When the push rod(19) is stroked, the spool(8) moves downwards.

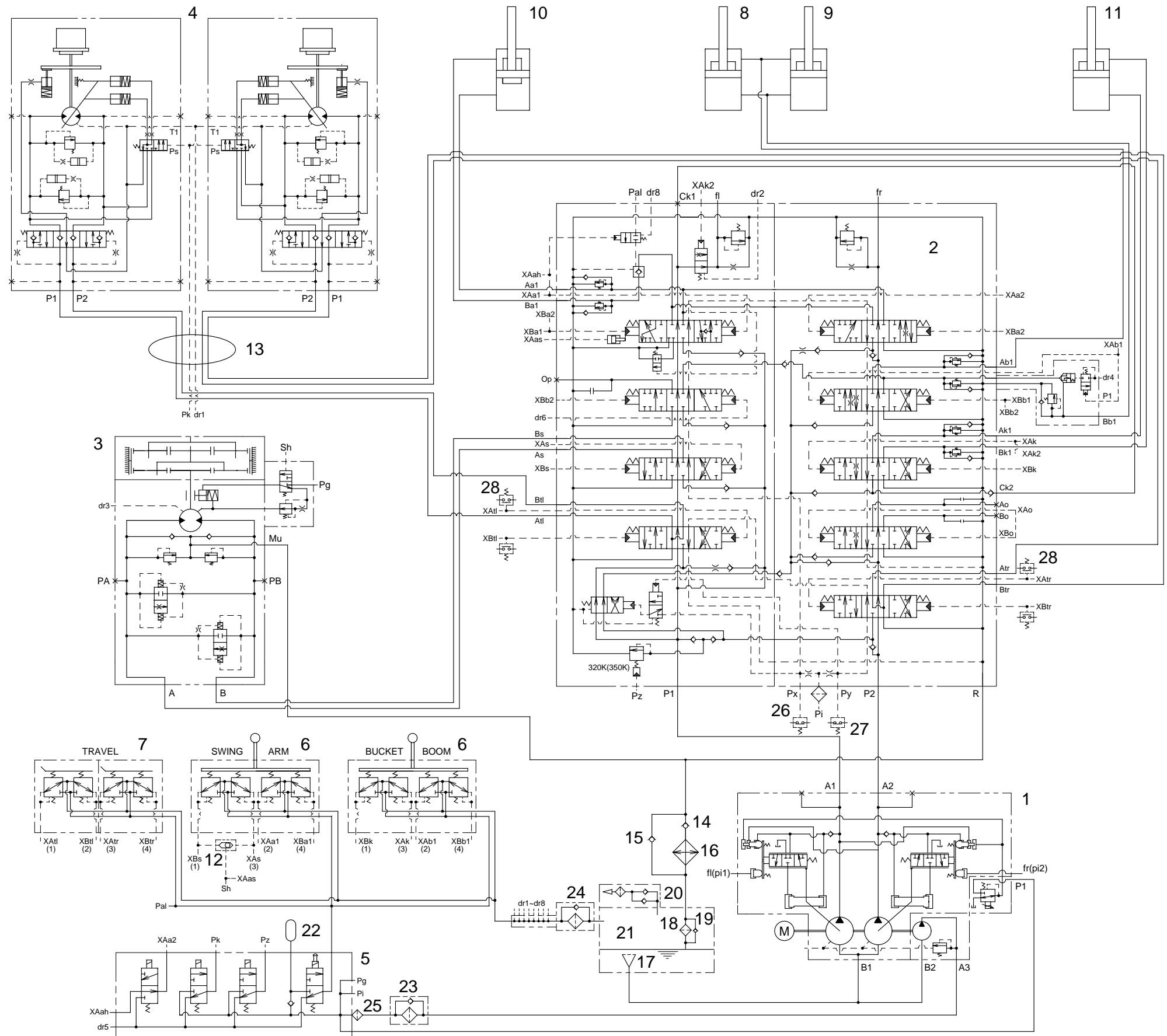
Then port P is connected with port 1, and the oil supplied from the pilot pump flows through port 1 to generate the pressure.

When the pressure at port 1 increases to the value corresponding to the spring force set by tilting the handle, the hydraulic pressure force balances with the spring force. If the pressure at port 1 increases higher than the set pressure, port P is disconnected from port 1 and port T is connected with port 1. If it decreases lower than the set pressure, port P is connected with port 1 and port T is disconnected from port 1.

In this manner the secondary pressure is kept at the constant value.

Besides, in some type, when the handle is tilted more than a certain angle, the upper end of the spool contacts with inside bottom of the push rod and the output pressure is left to be connected with port P.

GROUP 1 HYDRAULIC CIRCUIT



- 1 Main pump
- 2 Main control valve
- 3 Swing motor
- 4 Travel motor
- 5 Solenoid valve
- 6 RCV lever
- 7 RCV pedal
- 8 Boom cylinder(RH)
- 9 Boom cylinder(LH)
- 10 Arm cylinder
- 11 Bucket cylinder
- 12 Shuttle valve
- 13 Turning joint
- 14 Check valve
- 15 Check valve
- 16 Oil cooler
- 17 Strainer
- 18 Return filter
- 19 Bypass valve
- 20 Air breather
- 21 Hydraulic tank
- 22 Accumulator
- 23 Line filter
- 24 Spin filter
- 25 Last guard filter
- 26 Last guard filter
- 27 Pressure switch
- 28 Pressure switch

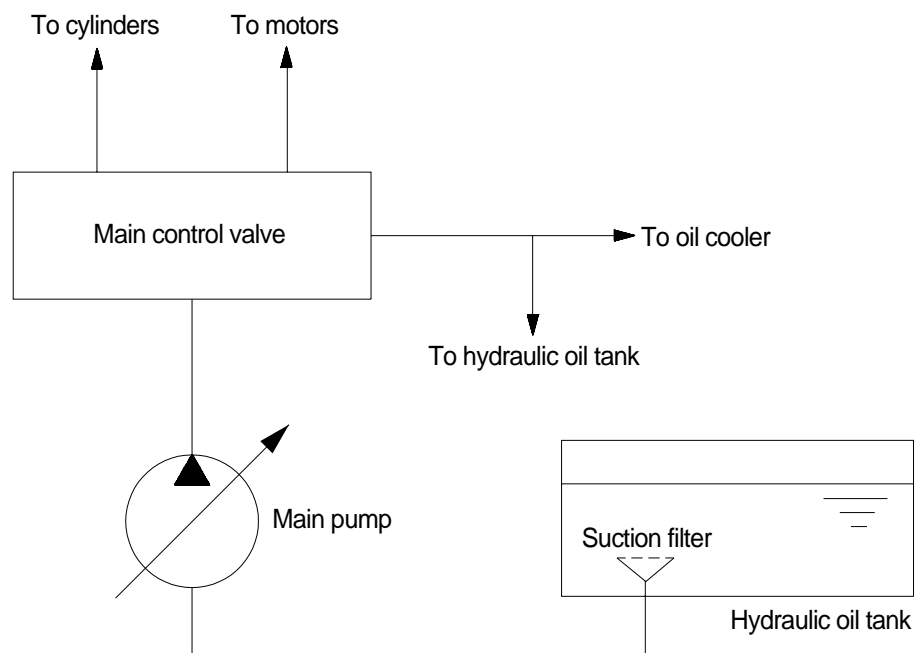
GROUP 2 MAIN CIRCUIT

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 variable displacement open loop bent axis double 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



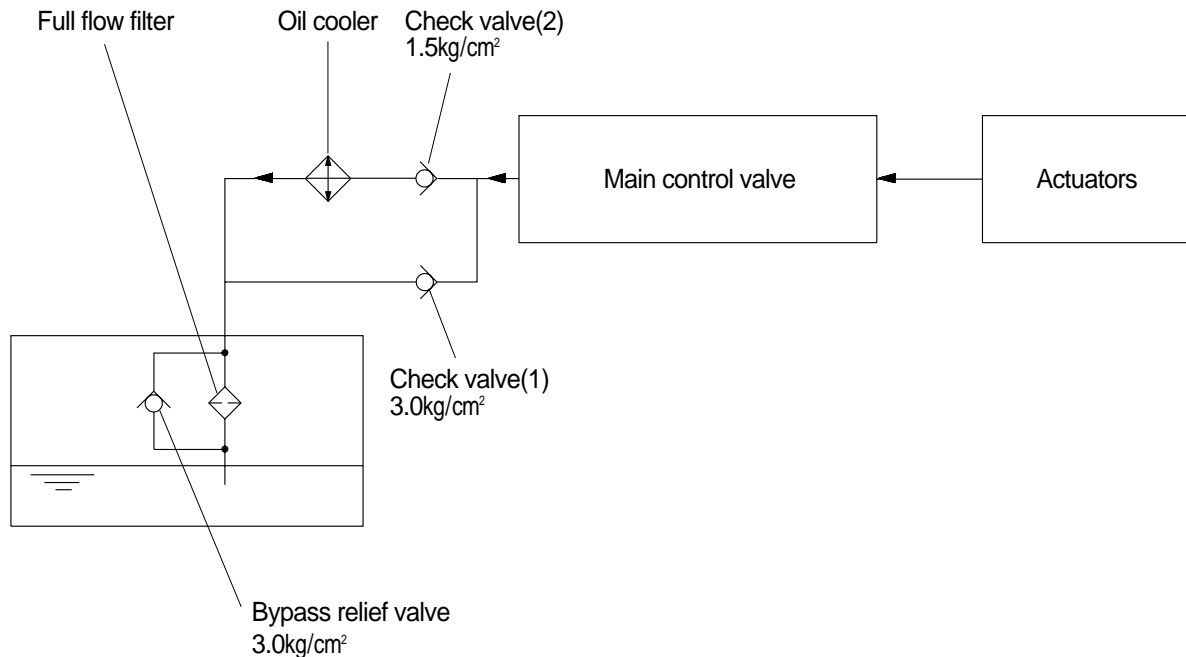
The pumps receive oil from the hydraulic tank through a suction filter. The discharged oil from the pump flows into the control valve and goes out the tank ports.

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

The control valve controls the hydraulic functions.

The oil returned 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 1.5kg/cm²(21psi) and 3.0kg/cm²(43psi). 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. The oil pressure exceeds 3.0kg/cm²(43psi), the oil returns directly to the hydraulic tank, resulting in the oil temperature being raised quickly at an appropriate level.

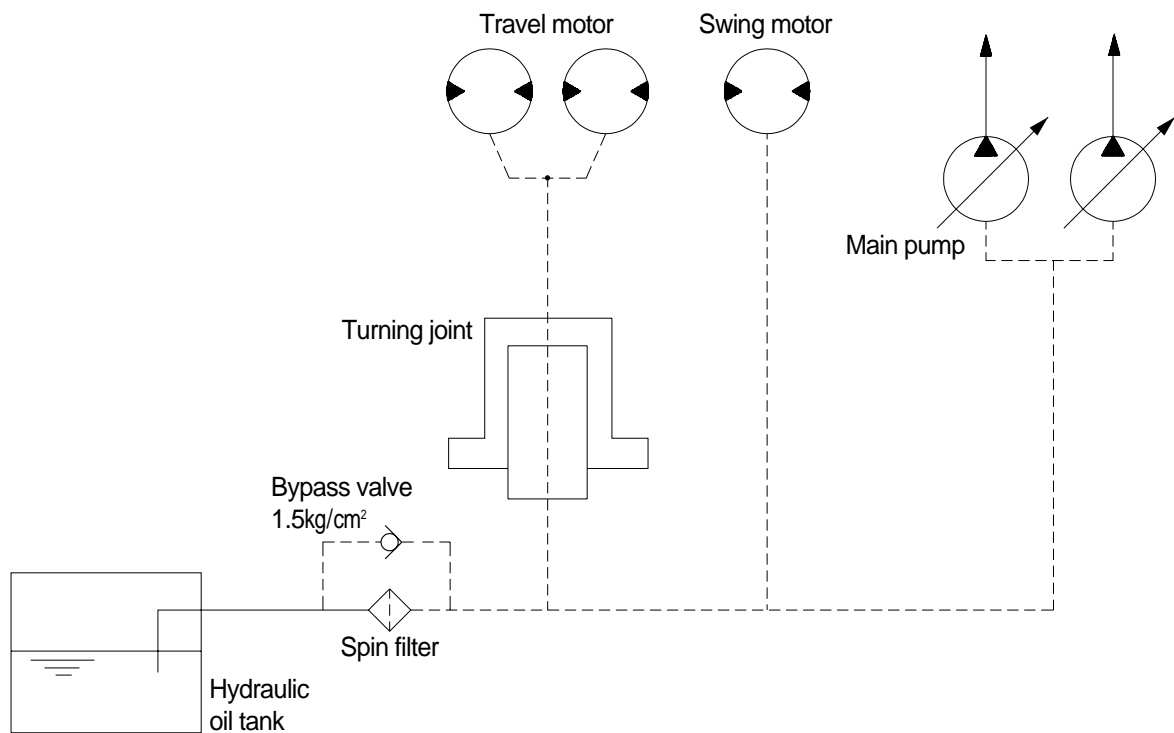
When the oil cooler is clogged, the oil returns directly to the hydraulic tank through bypass check valve(1).

The return filter and bypass relief valve are provided in the hydraulic tank.

The oil from right and left side of control valve is combined and filtered by the return filter. A bypass relief valve is provided in the full-flow filter.

When the filter element is clogged, the bypass relief valve opens at 3.0kg/cm²(43psi) differential pressure.

3. DRAIN CIRCUIT



Besides internal leaks from the motors and main pump, the oil for lubrication circulates. These oil have to be fed to the hydraulic tank passing through spin filter.

When the drain oil pressure exceed 1.5kg/cm^2 (21psi), the oil returns to the hydraulic tank directly.

1) TRAVEL MOTOR DRAIN CIRCUIT

Oil leaking 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 spin filter.

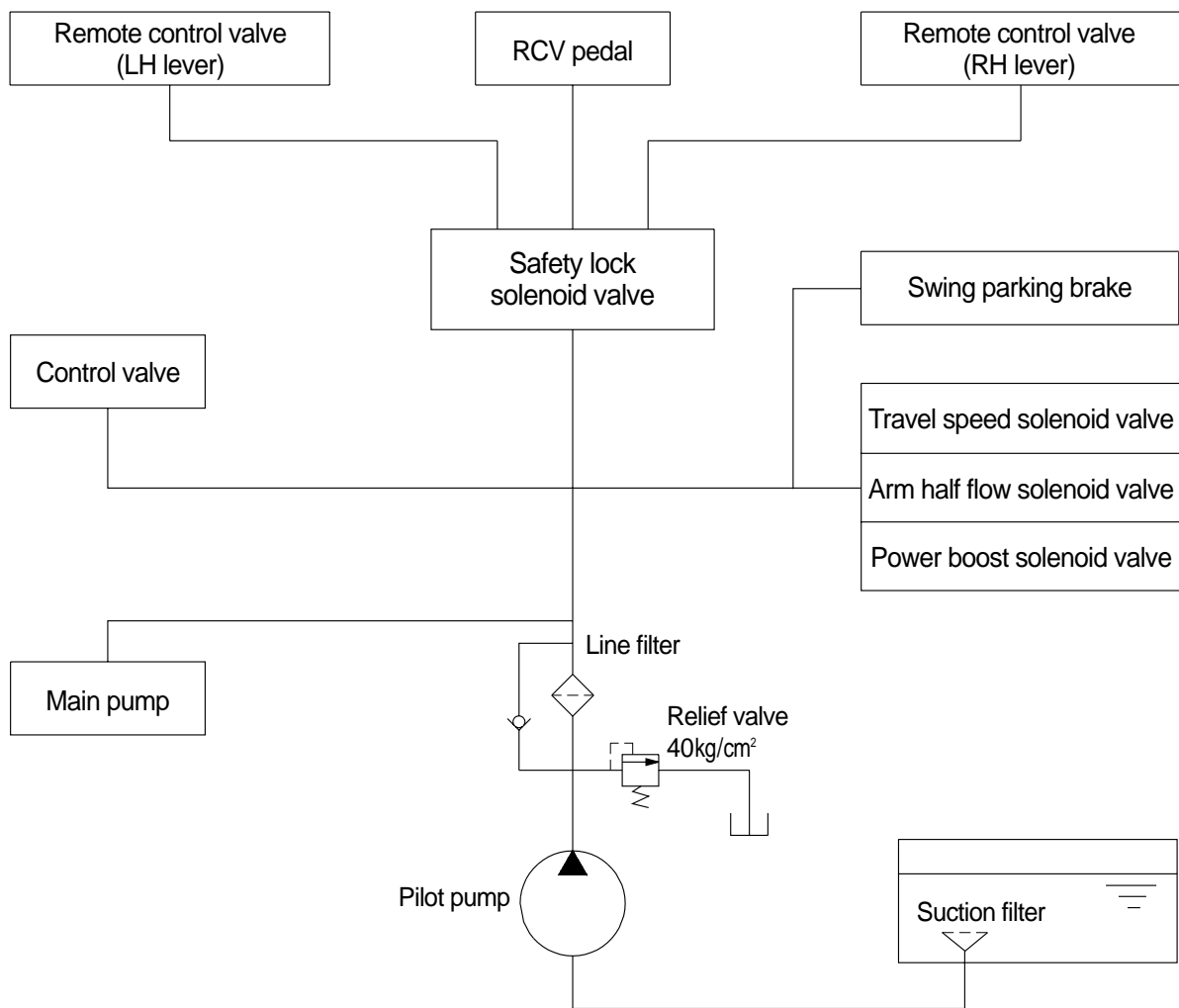
2) SWING MOTOR DRAIN CIRCUIT

Oil leaking from the swing motor come out and return to the hydraulic tank passing through a drain filter.

3) MAIN PUMP DRAIN CIRCUIT

Oil leaking from main pump come out and return to the hydraulic tank passing through drain filter.

GROUP 3 PILOT CIRCUIT

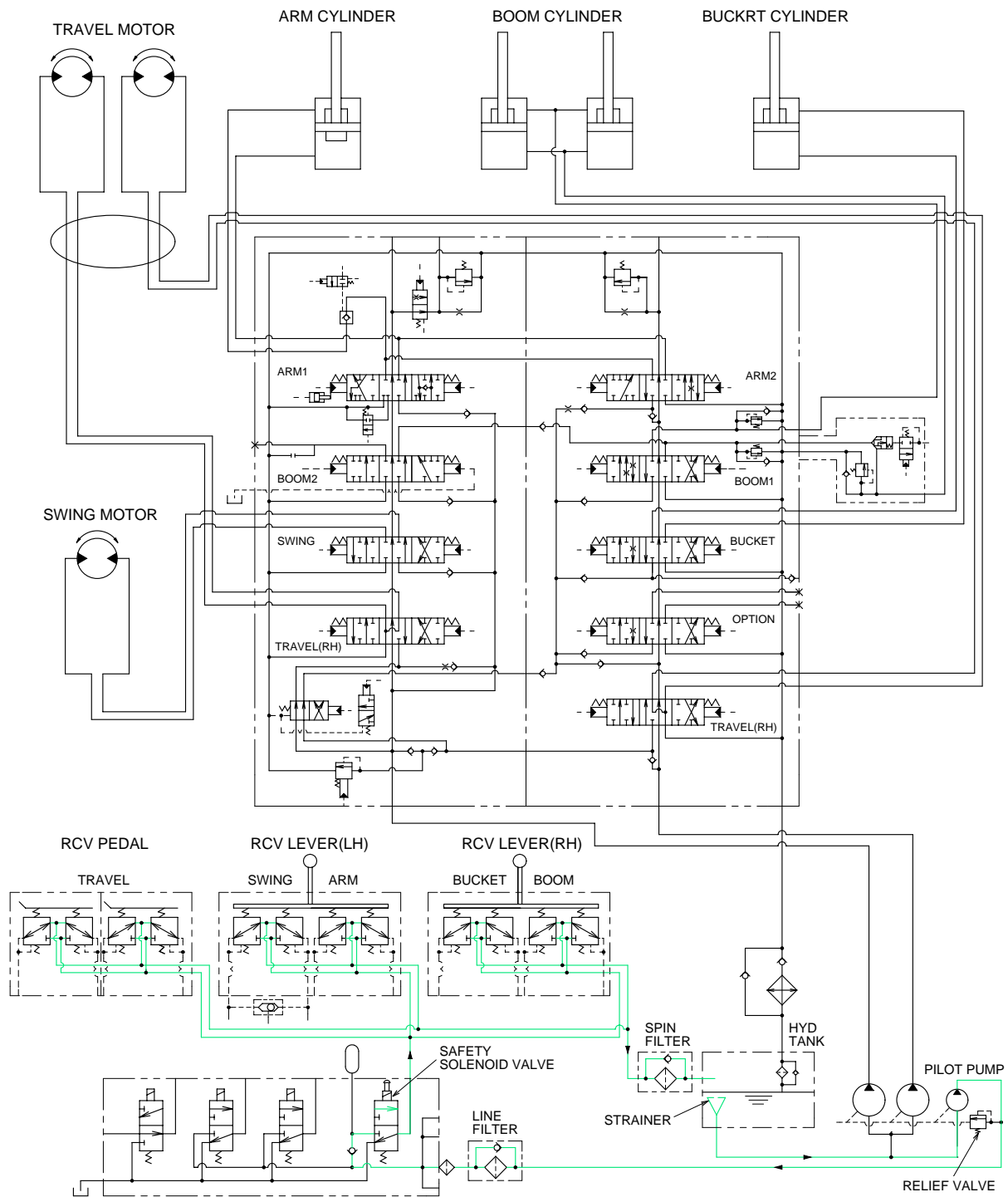


The pilot circuit consists of suction circuit, delivery circuit and return circuit.

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

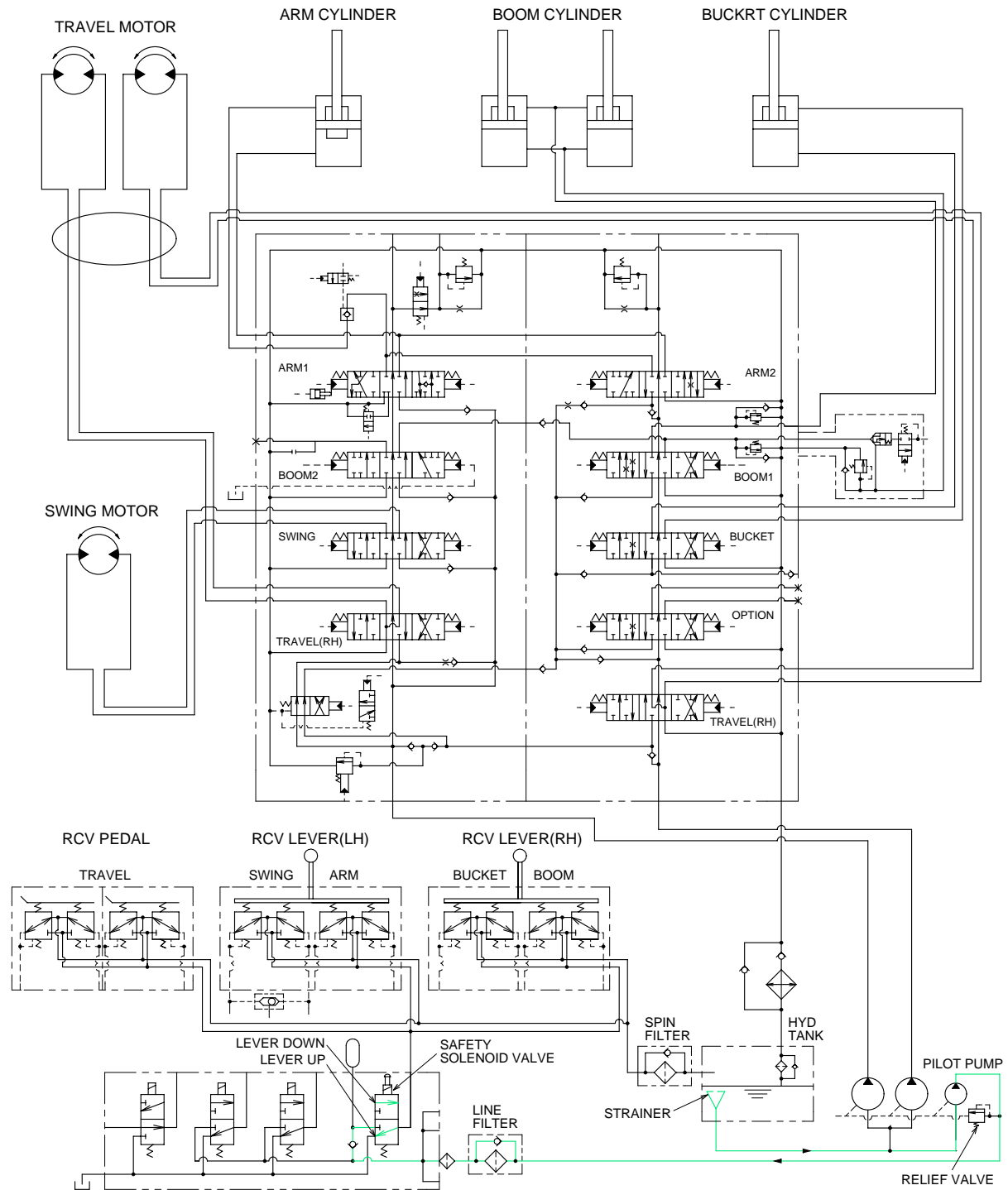
The discharged oil from the pilot pump flows to the remote control valve through line filter, EPPR valve, solenoid valve assemblies, swing parking brake, main control valve and safety lock solenoid valve.

1. SUCTION, DELIVERY AND RETURN CIRCUIT



The pilot pump receive oil from the hydraulic tank. The discharged oil from the pilot pump flows to the safety solenoid valve through the line filter. The oil is filtered by the line filter. The pilot relief valve is provided in the pilot pump for limiting the pilot circuit pressure. The oil filtered by line filter flows remote control valve through safety solenoid valve. The return oil from remote control valve returned to hydraulic tank through the spin filter.

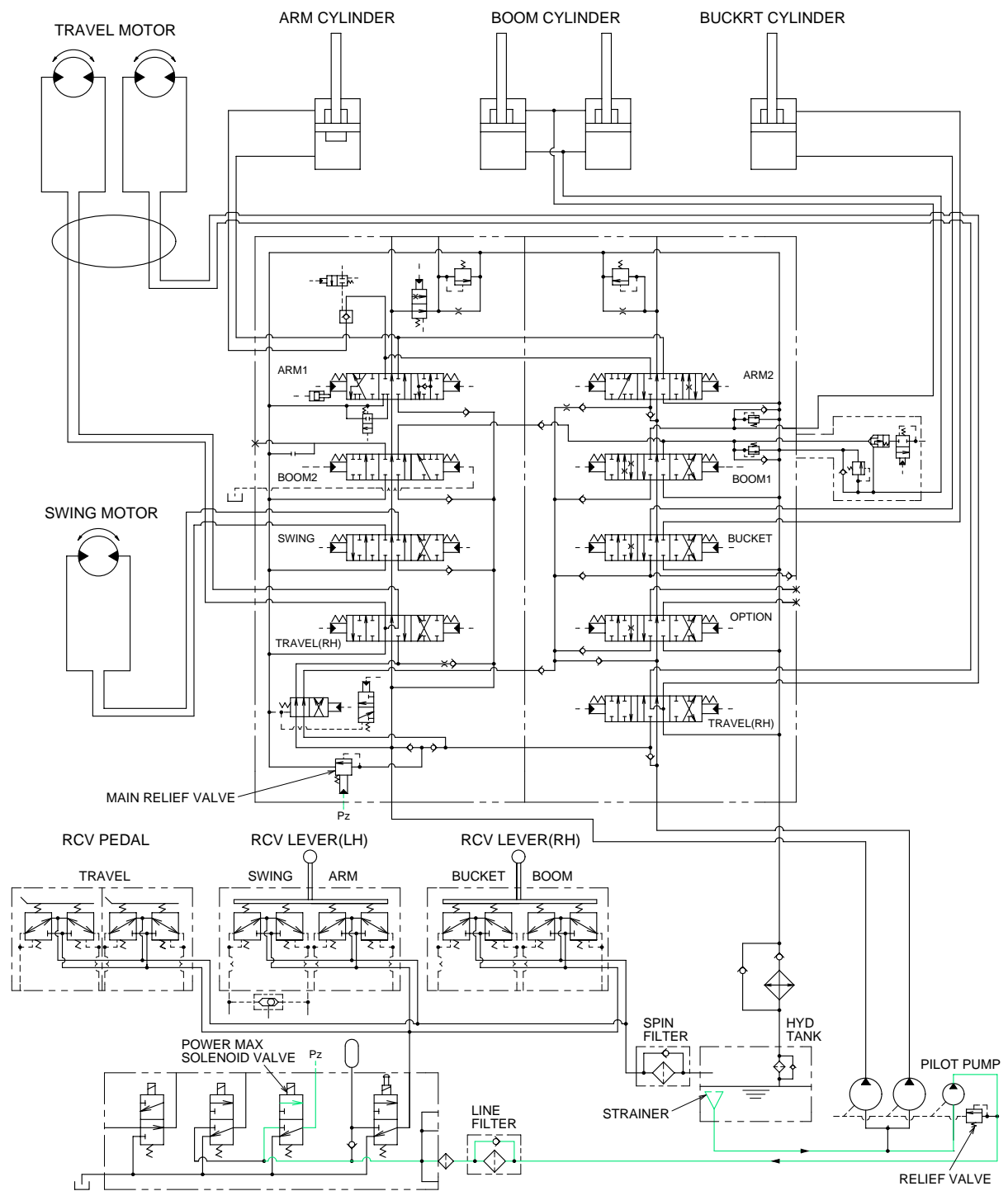
2. SAFETY SOLENOID VALVE(SAFETY LEVER)



When the lever of the safety solenoid valve is moved downward, oil flows into the remote control valve through solenoid valve and line filter.

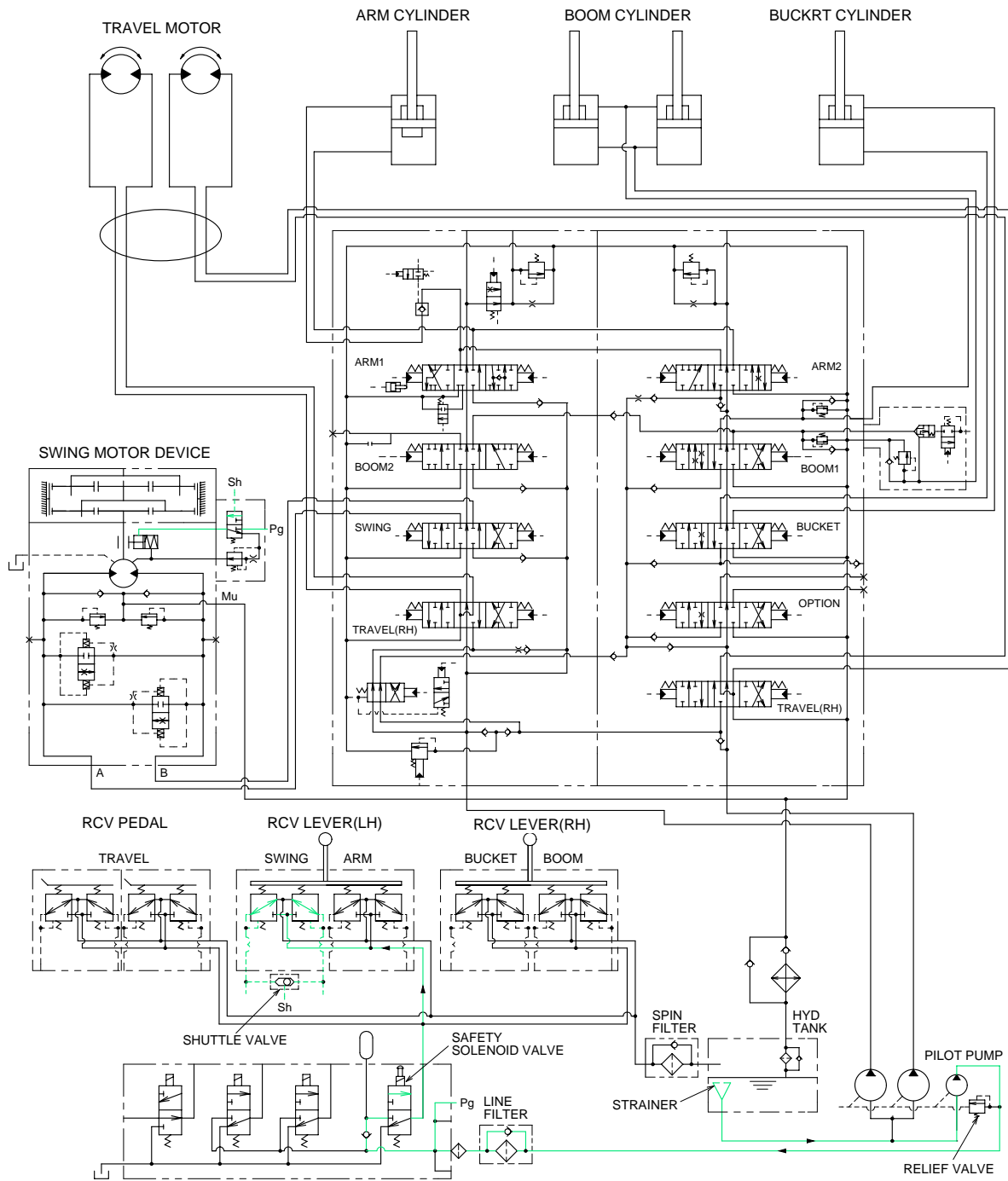
When the lever of the safety solenoid valve moved upward, oil does not flow into the remote control valve, because of blocked by the spool.

3. MAIN RELIEF PRESSURE CHANGE CIRCUIT



When the power max switch on the left control lever is pushed ON, the power max solenoid valve is actuated, the discharged oil from the pilot pump flows into Pz port of the main relief valve of main control valve ; Then the setting pressure of the main control valve is raises from 320kgf/cm² to 350kgf/cm² for increasing the digging power. And even when pressed continuously, it is canceled after 8 seconds.

4. SWING PARKING BRAKE RELEASE

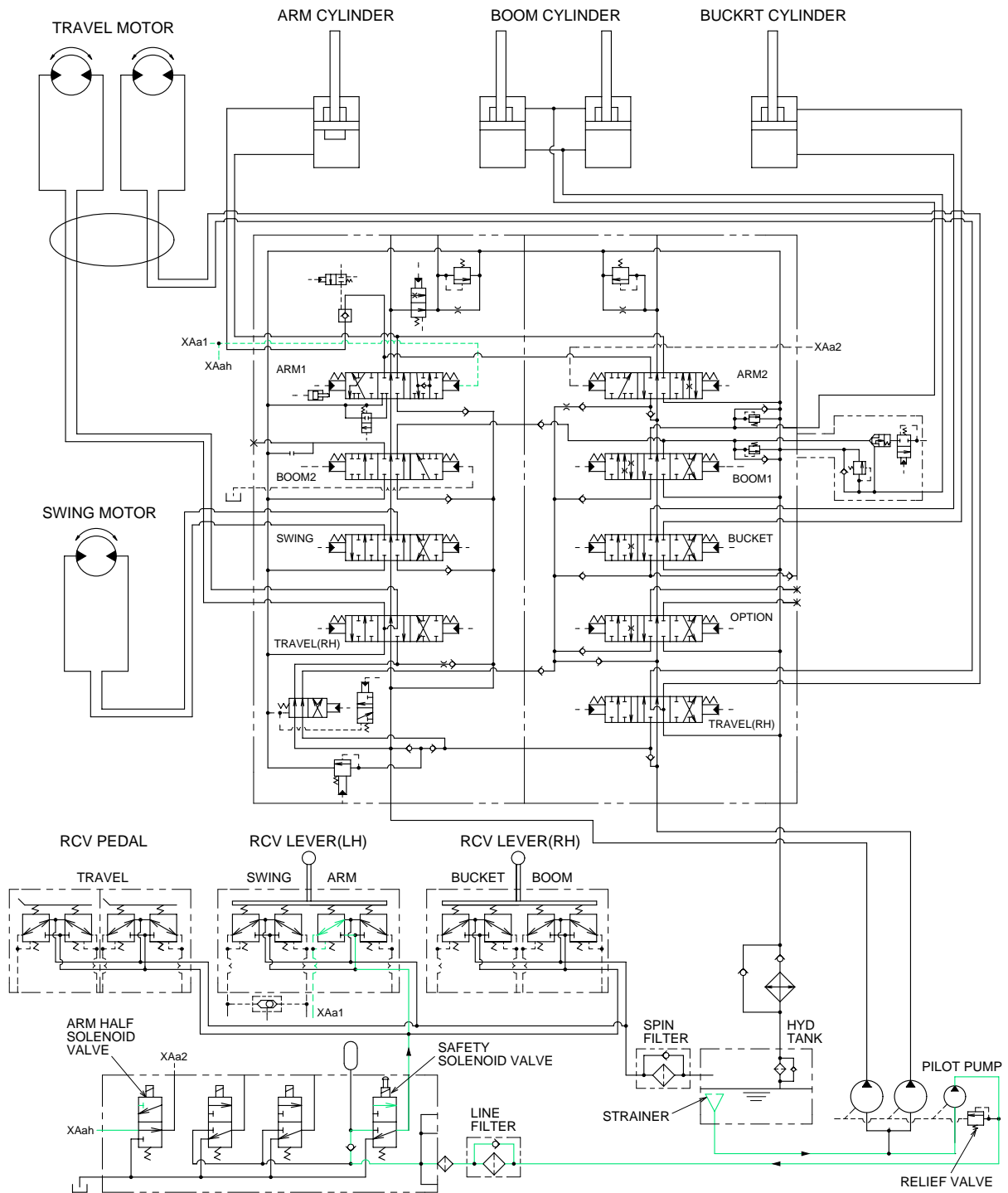


When the swing control lever is operated, the pilot oil flows to Sh port of shuttle valve, this pressure move spool so, discharged oil from pilot pump flows to Pg port.

This pressure is applied to swing motor disc cylinder, thus the brake released.

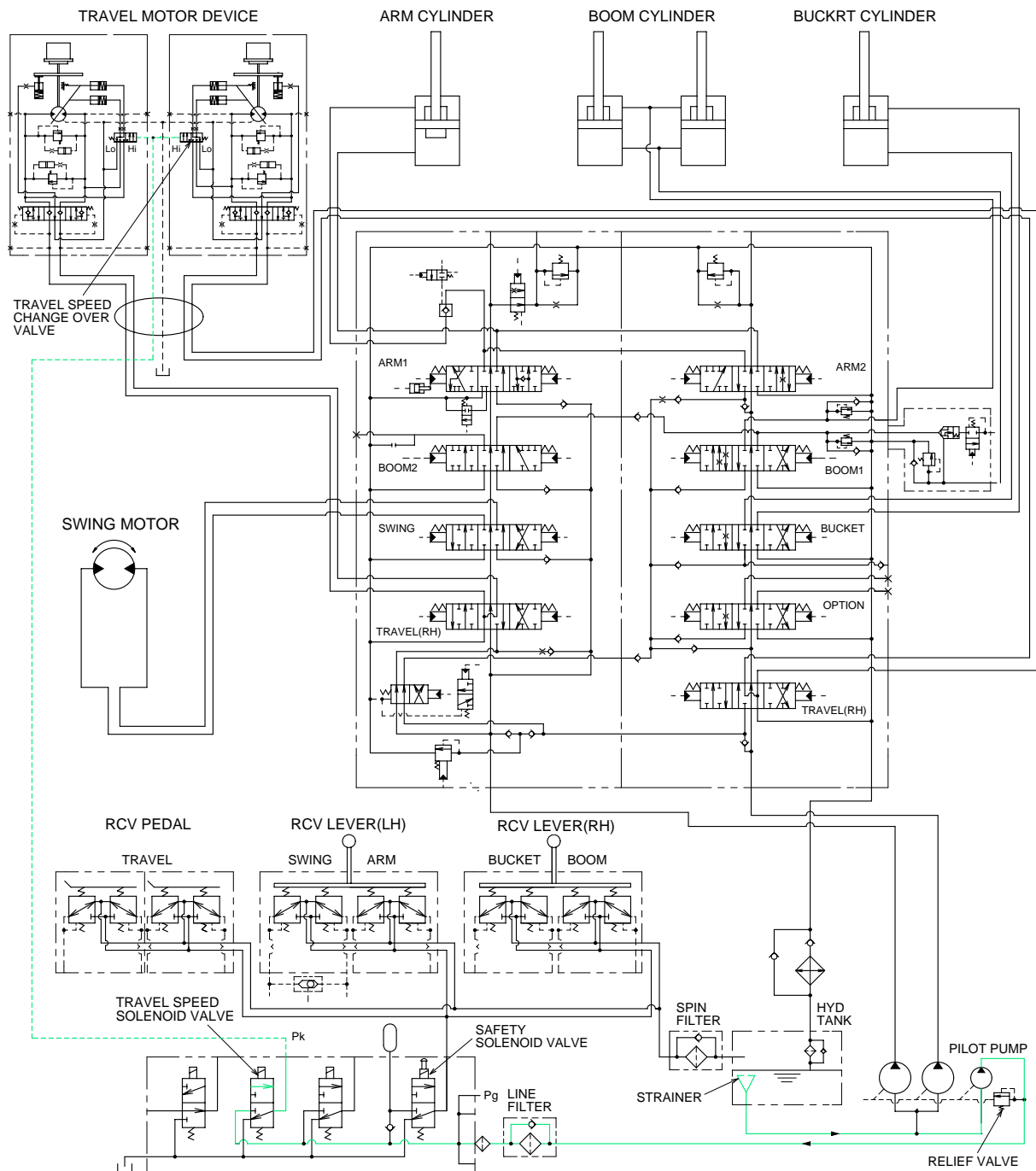
When the swing control lever is set neutral position, oil in the swing motor disc cylinder is drain, thus the brake is applied.

5. ARM HALF FLOW SYSTEM



When the arm half flow switch is turned ON, the arm half flow solenoid valve is switched to ON and Arm2 pilot port XAa2 is connect with drain line : So the spool of ARM2 is not actuated. As a result, the arm in operation is only the ARM1 section. This function is useful to fine control of the arm in case of finishing work.

6. TRAVEL SPEED CONTROL PRESSURE

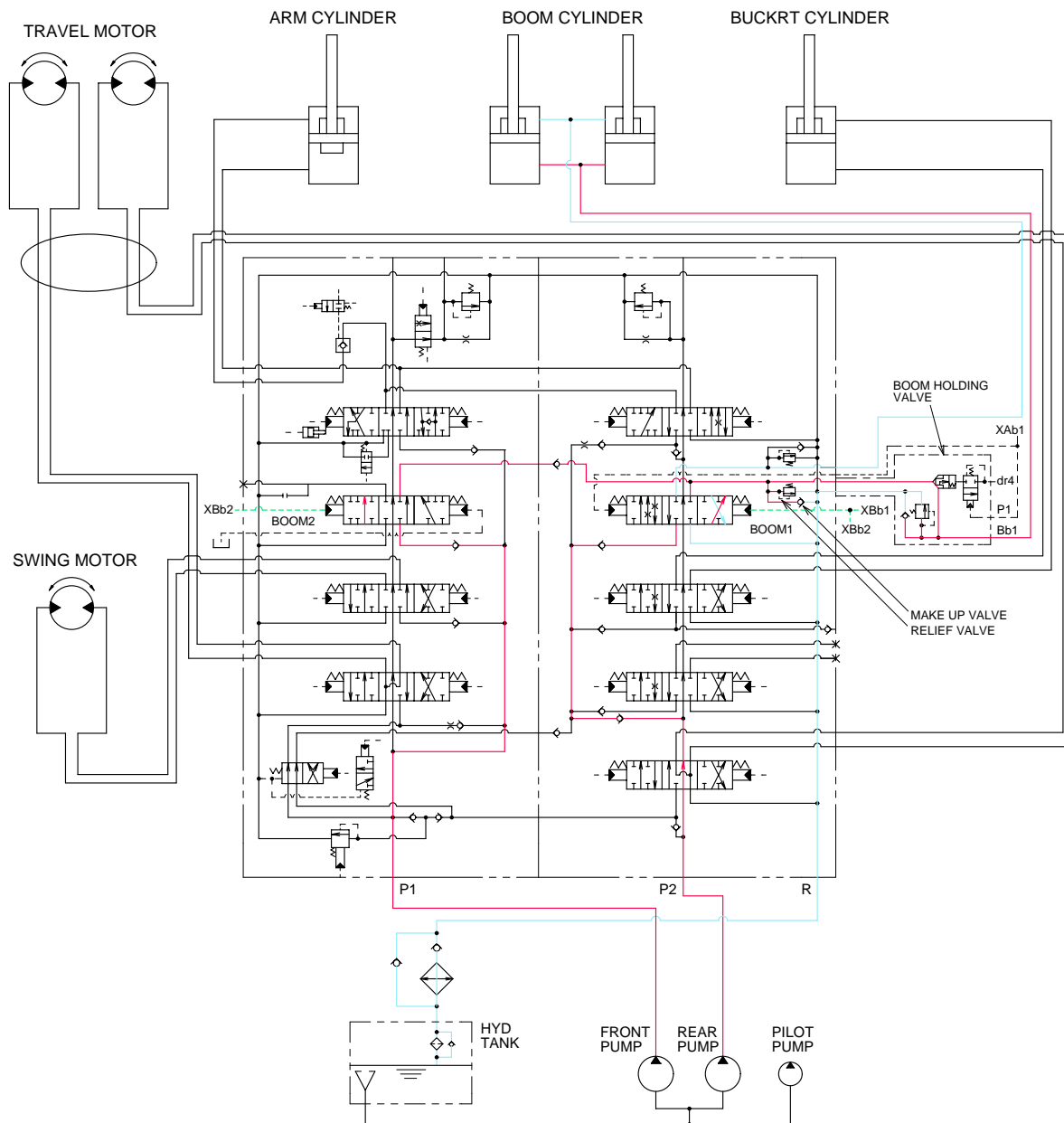


When the travel speed solenoid valve was placed in the Hi position, the pressure oil from pilot pump through last guard filter flows to port(Pk) of travel speed change over valve, and the control piston is pushed up, thus minimizing the displacement.

When the travel speed solenoid valve was placed in the Lo position, the oil of Pk port return to the tank and the control piston is returned, thus maximizing the displacement.

GROUP 4 SINGLE OPERATION

1. BOOM RAISE OPERATION



When the right control lever is pulled back, the boom spools in the main control valve are moved to the raise position by the pilot oil pressure from the remote control valve.

The oil from the front and rear pump flows into the main control valve and then goes to the large chamber of boom cylinders.

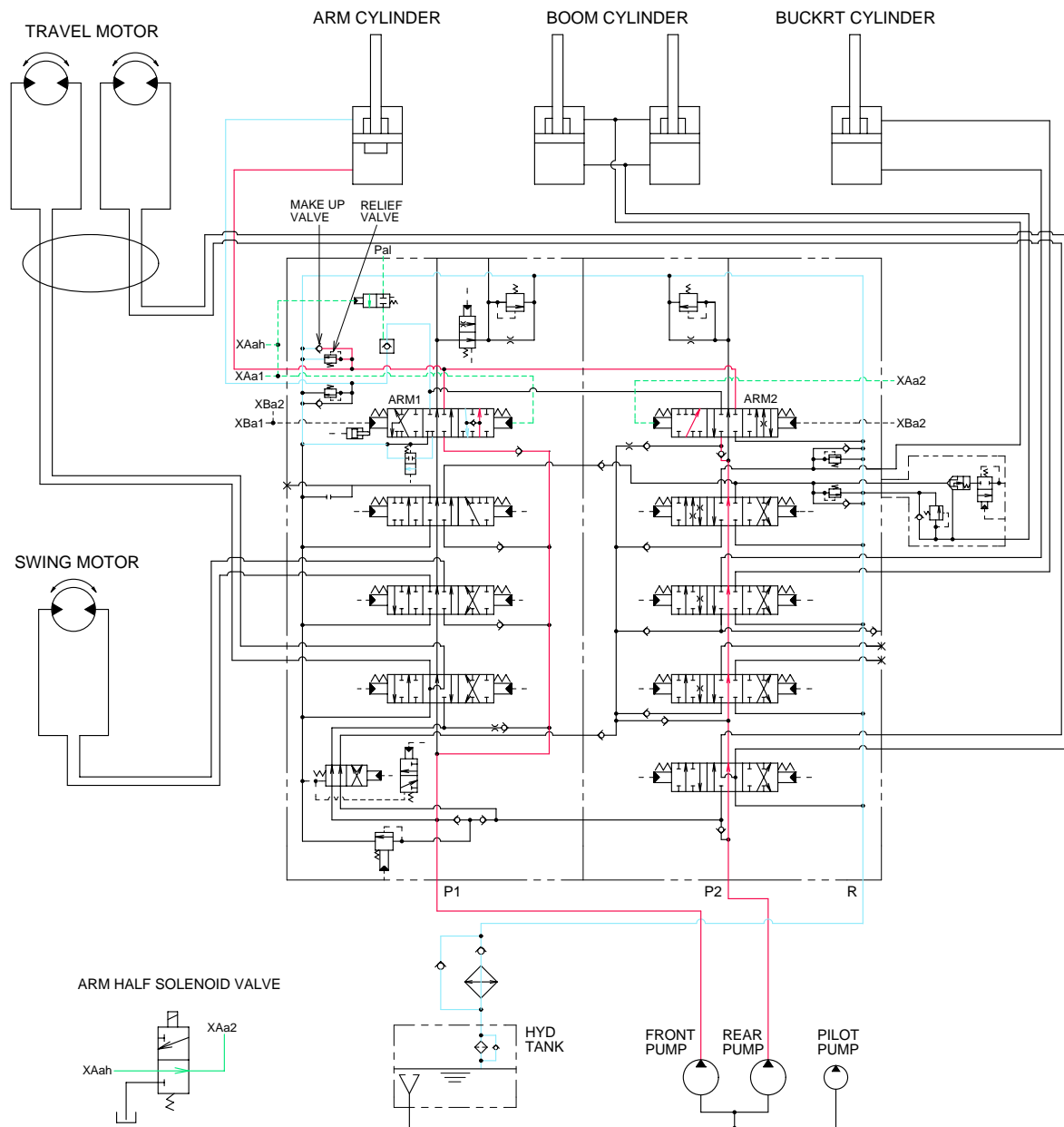
At the same time, the oil from the small chamber of boom cylinders returns to the hydraulic oil tank through the boom spool in the main control valve. When this happens, the boom goes up.

The excessive pressure in the boom cylinder bottom end circuit is prevented by relief valve.

When the boom is raised and the control lever is returned to neutral position, the circuit for the holding pressure at the bottom end of the boom cylinder is closed by the boom holding valve.

This prevents the hydraulic drift of boom cylinder.

3. ARM ROLL IN OPERATION



When the left control lever manually is placed in the arm roll in position.

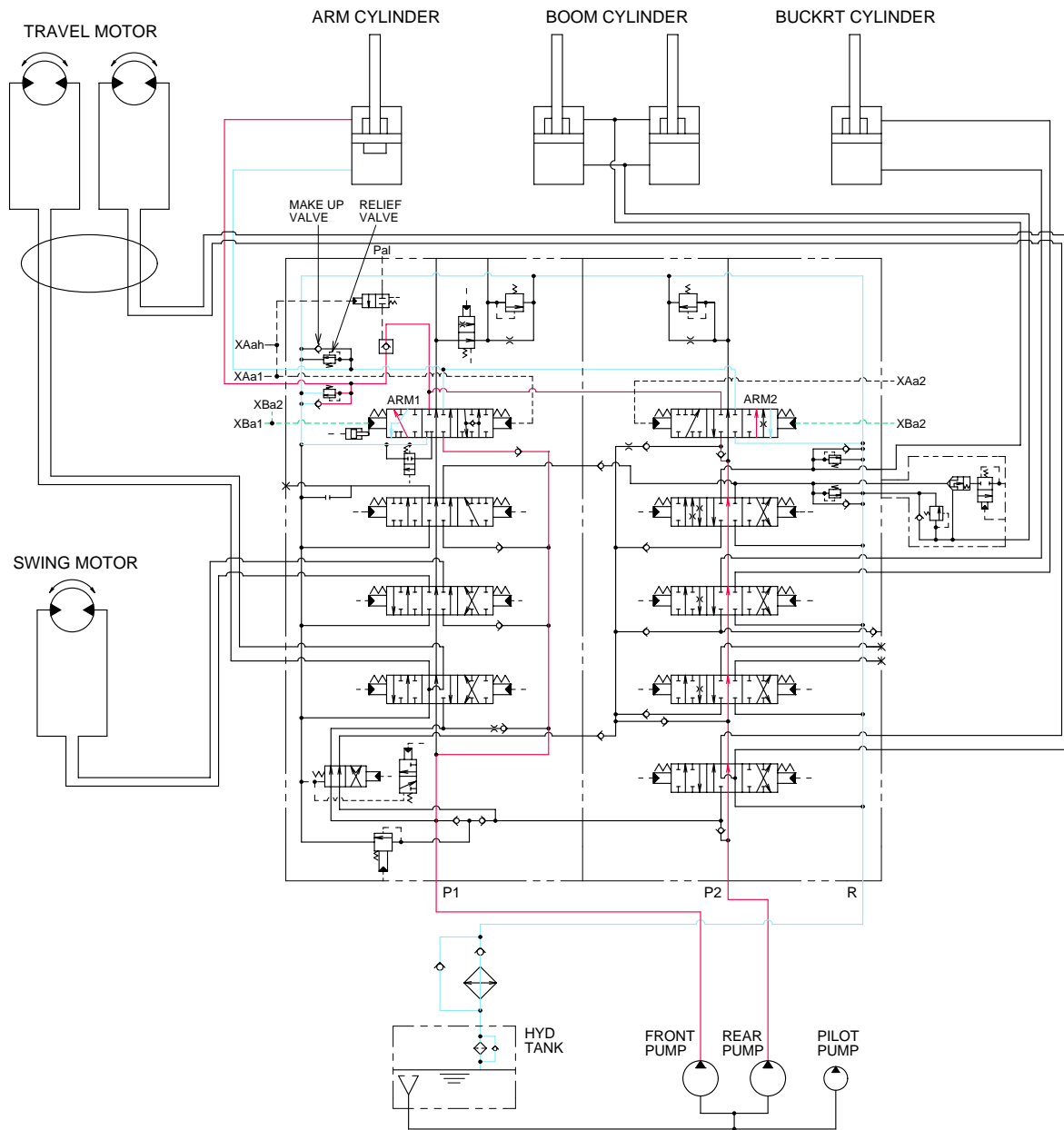
Then the oil flows from pilot pump through the remote control valve to arm sections of the main control valve. Here, the spool positions are moved to arm roll in position.

The oil flows from both main pump through arm section of the main control valve to the bottom end of the arm cylinder, and to roll in arm.

The return oil flows from the rod end of the cylinder through the arm1 section returned to the tank.

Then cavitation which will happen to the bottom of the arm cylinder is prevented by a make up valve, on other hand. The excessive pressure is also prevented by an overload relief valve in the main control valve.

4. ARM ROLL OUT OPERATION



When the left control lever manually is placed in the arm roll out position.

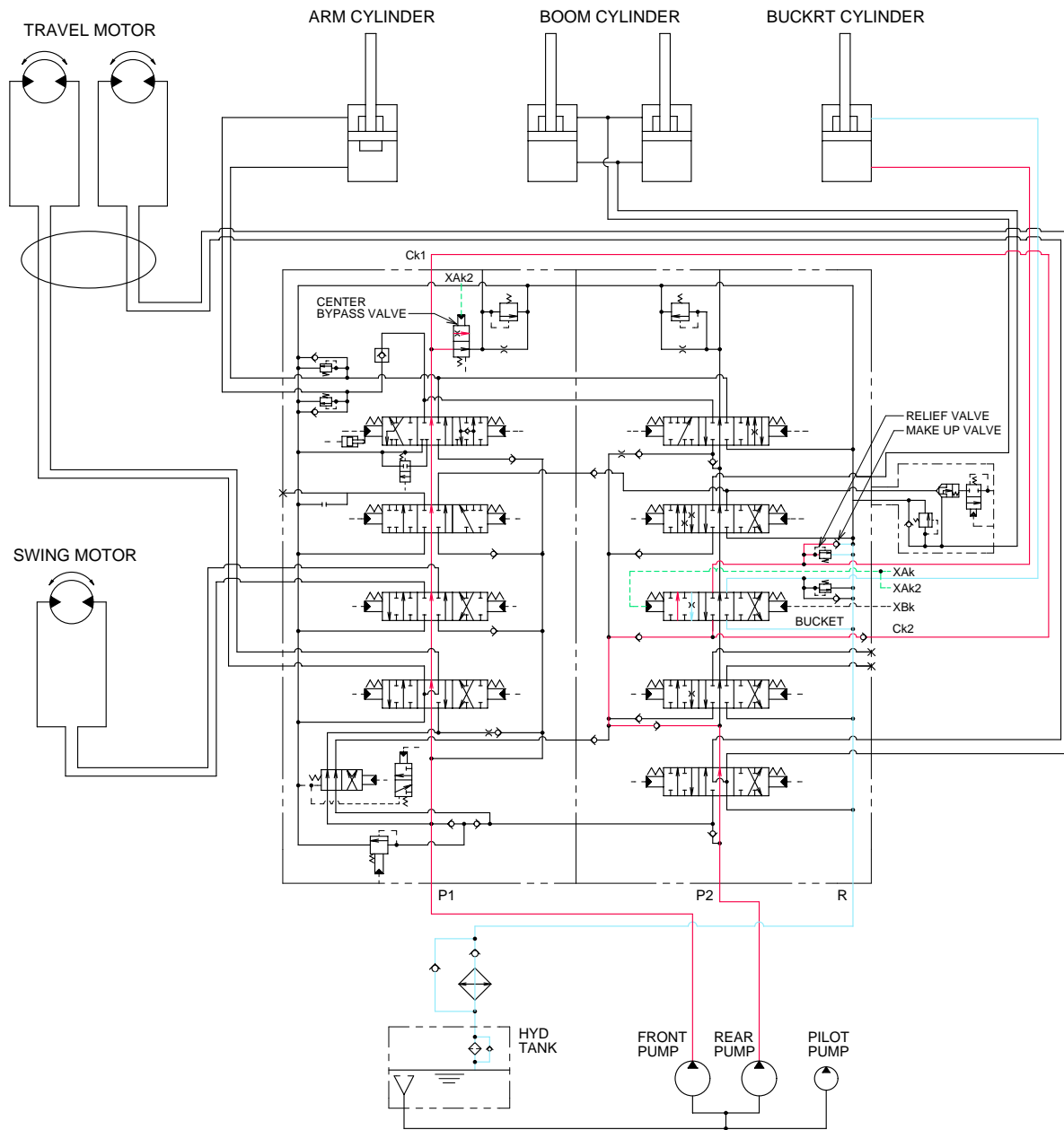
Then the oil flows from pilot pump through the remote control valve to arm sections of the main control valve. Here, the spool positions are moved to arm roll out position.

The oil flows from both pump through arm section of main control valve to the rod end of the arm cylinder, and to roll out arm.

The return oil flows from the bottom end of the cylinder through the arm section returned to the tank.

The cavitation which will happen to the rod of the arm cylinder is prevented by a make up valve, on other hand. The excessive pressure is also prevented by an overload relief valve in the main control valve.

5. BUCKET ROLL IN OPERATION



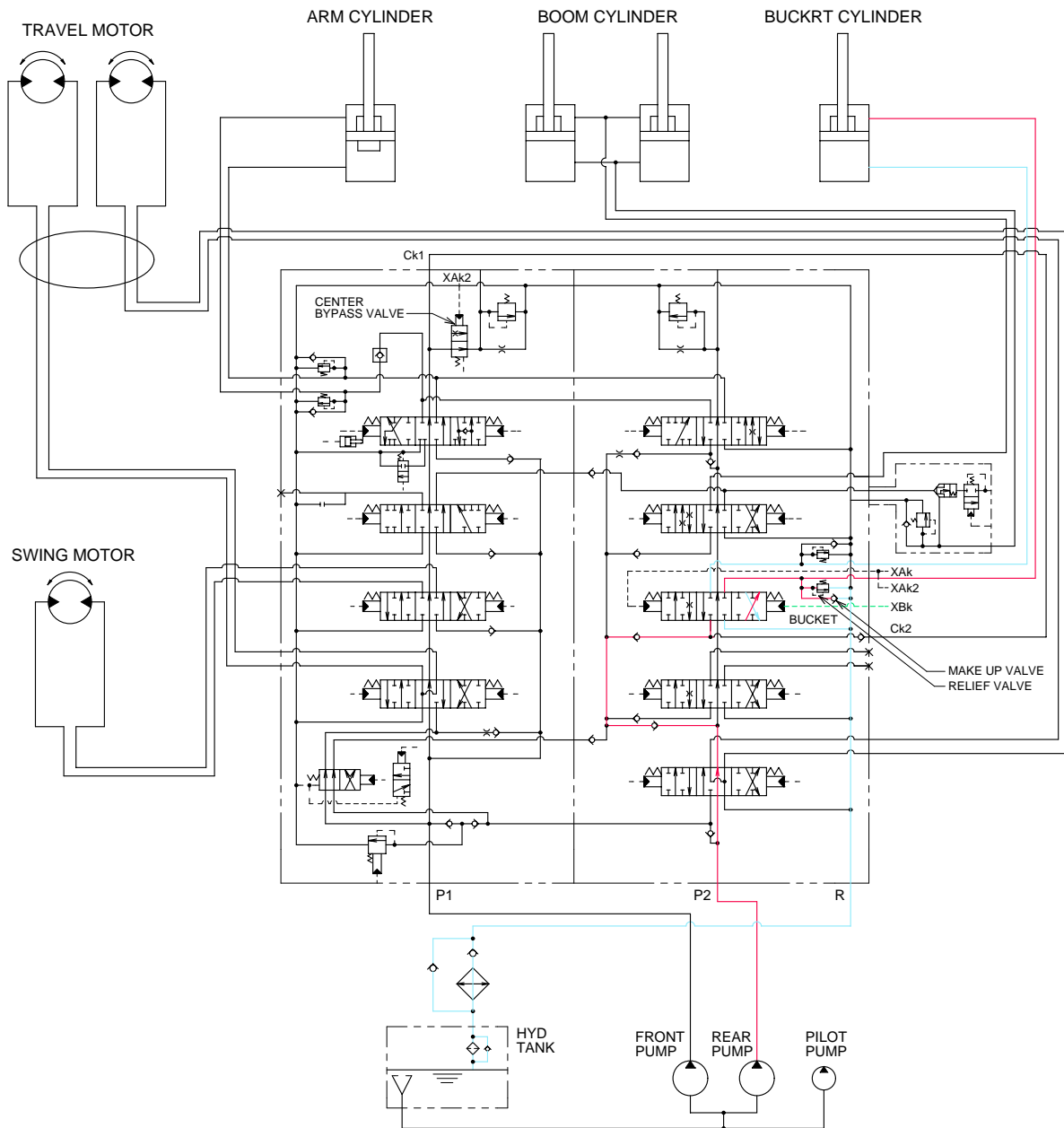
When the right control lever is manually placed in the bucket roll in position. Then the oil flows from pilot through the pilot valve to bucket section of the main control valve. Here the spool position is moved to bucket roll in position.

The center bypass valve is change over by the pilot pressure(XAk2) and then the oil from front pump is joint to the flow of rear pump via confluence passage.

The oil flows from both pump through rod end of the cylinder through the bucket section returned to the tank.

The cavitation which will happen to the bottom of the bucket cylinder is prevented by a make up valve, on other hand. The excessive pressure is also prevented by an overload relief valve in the main control valve.

6. BUCKET ROLL OUT OPERATION



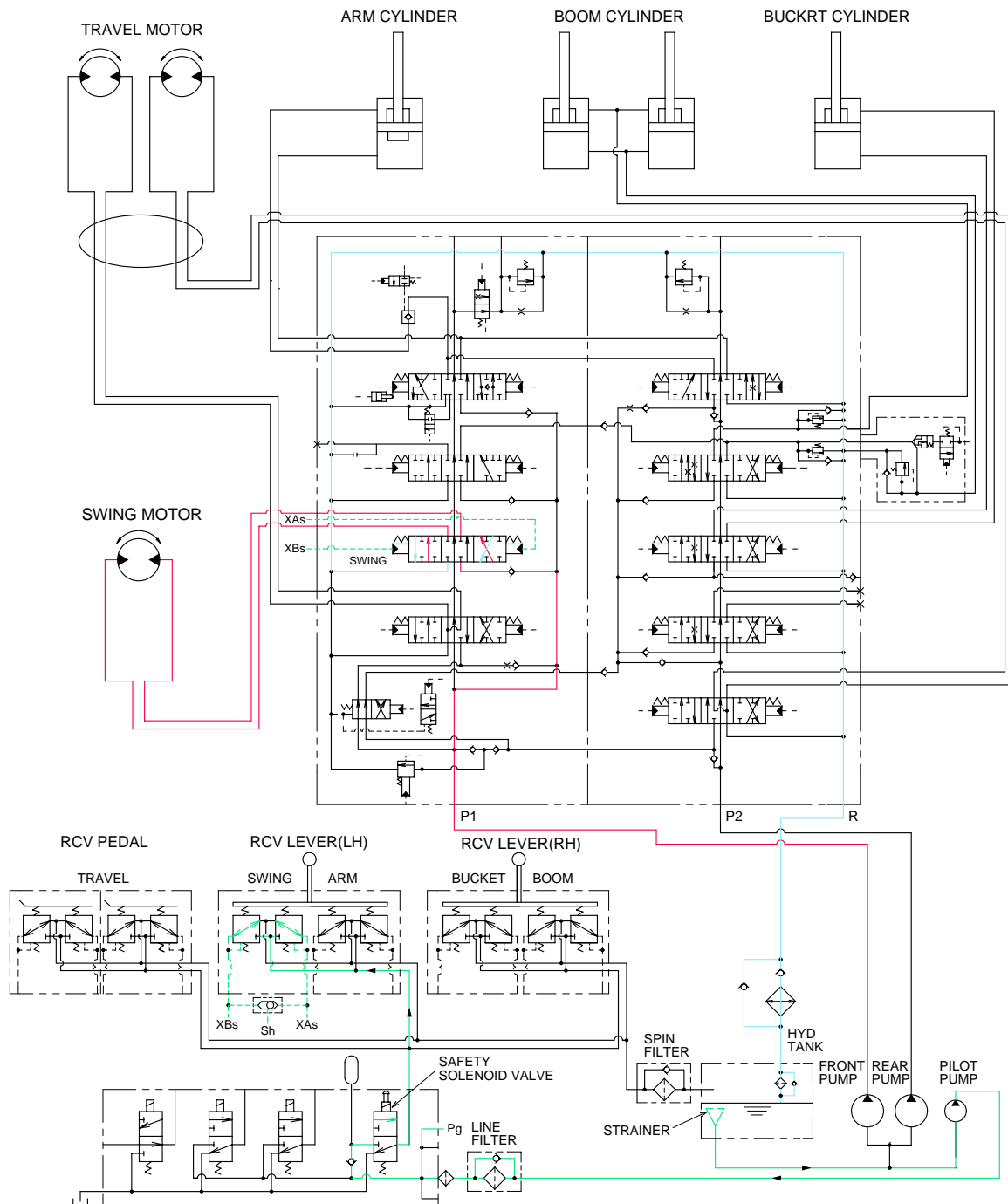
When the right control lever is manually placed in the bucket roll out position. Then the oil flows from pilot pump through the pilot valve to bucket section of the main control valve. Here the spool position is moved to bucket roll out position.

The oil flows from rear pump through bucket section of main control valve to the rod end of the bucket cylinder, and to roll out bucket.

The return oil flows from the bottom end of the cylinder through the bucket section returned to the tank.

The cavitation which will happen to the rod of the bucket cylinder is prevented by a make up valve, on other hand. The excessive pressure is also prevented by an overload relief valve in the main control valve.

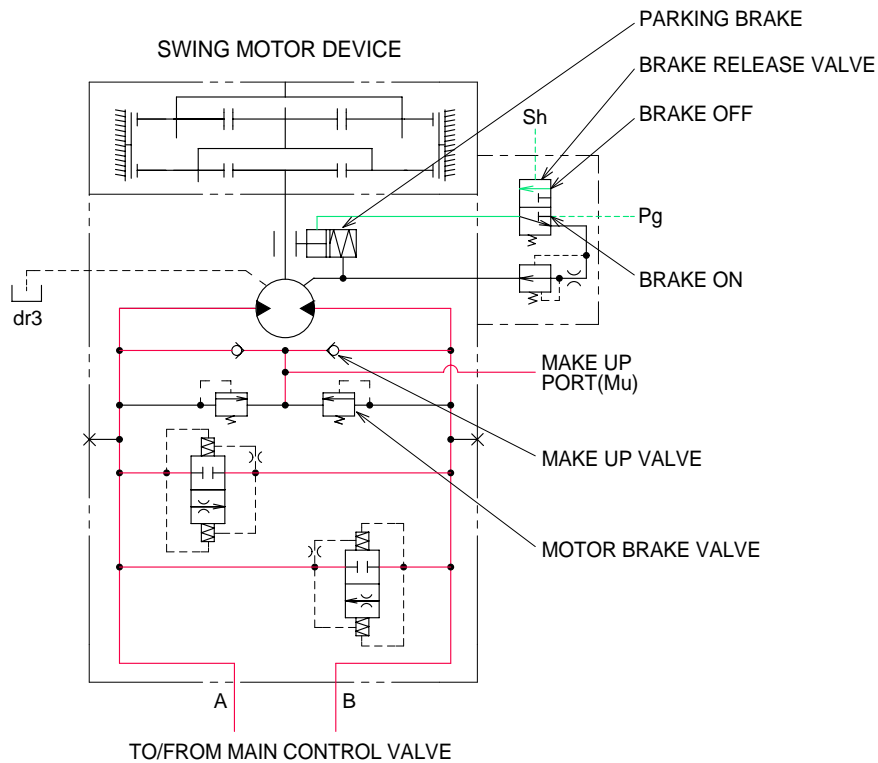
7. SWING OPERATION



When the left control lever is manually placed in the left(Right) swing position. Then the oil flows from front pump through the swing section of the main control valve to swing motor to left(Right) swing the superstructure. The return oil flows from swing motor through the swing section of the main control valve returned to the tank.

When the control lever placed in the neutral position, the pressure of the pilot oil passage down. Then the brake release valve returned to the neutral position and the oil is returned from the brake piston to the tank. And the brake is set to "ON". The swing parking brake, make up valve and the overload relief valve are provide in the swing motors. The cavitation which will happen to the swing motor is prevented by the make up valve in the swing motor itself.

SWING CIRCUIT OPERATION



1) MOTOR BRAKE VALVE

Motor brake valve for the swing motor limits to cushion the starting and stopping pressure of swing operation.

2) MAKE UP VALVE

The make up valves prevent cavitation by supplying return oil to the vacuum side of the motor.

3) PARKING BRAKE

In case that the parking, of the machine at slope is required during operation, there is the danger of involuntary swing caused by the self weight of the machine. The brake is connected to prevent this involuntary swing.

PARKING BRAKE "OFF" OPERATION

The parking brake is released by the pilot pressure oil from the pilot pump.

When the left control lever placed in the swing position, the pilot pressure at the shuttle valve is transferred to the brake release valve and the brake release valve is change over. Then the pilot pressure lift the brake piston and release the parking brake.

PARKING BRAKE "ON" OPERATION

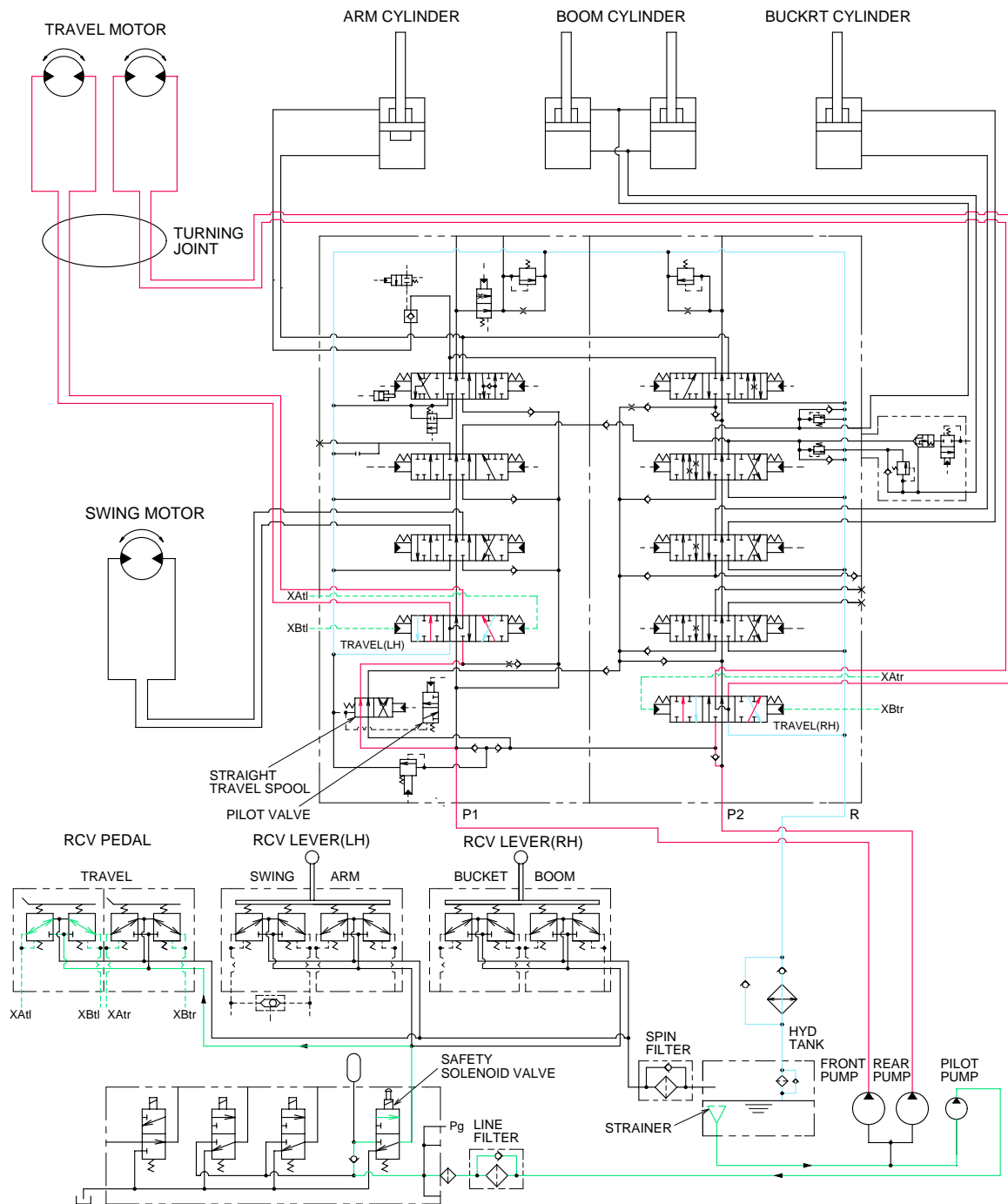
When the control lever placed in the neutral position, the pressure of the pilot oil passage down.

Then the brake release valve returned to the neutral position and the oil is returned from the brake piston to the tank. And the brake is set to 'ON'.

BYPASS VALVE

This bypass valve absorbs shocks produced as swing motion stops and reduced oscillation cause by swing motion.

8. TRAVEL FORWARD AND REVERSE OPERATION

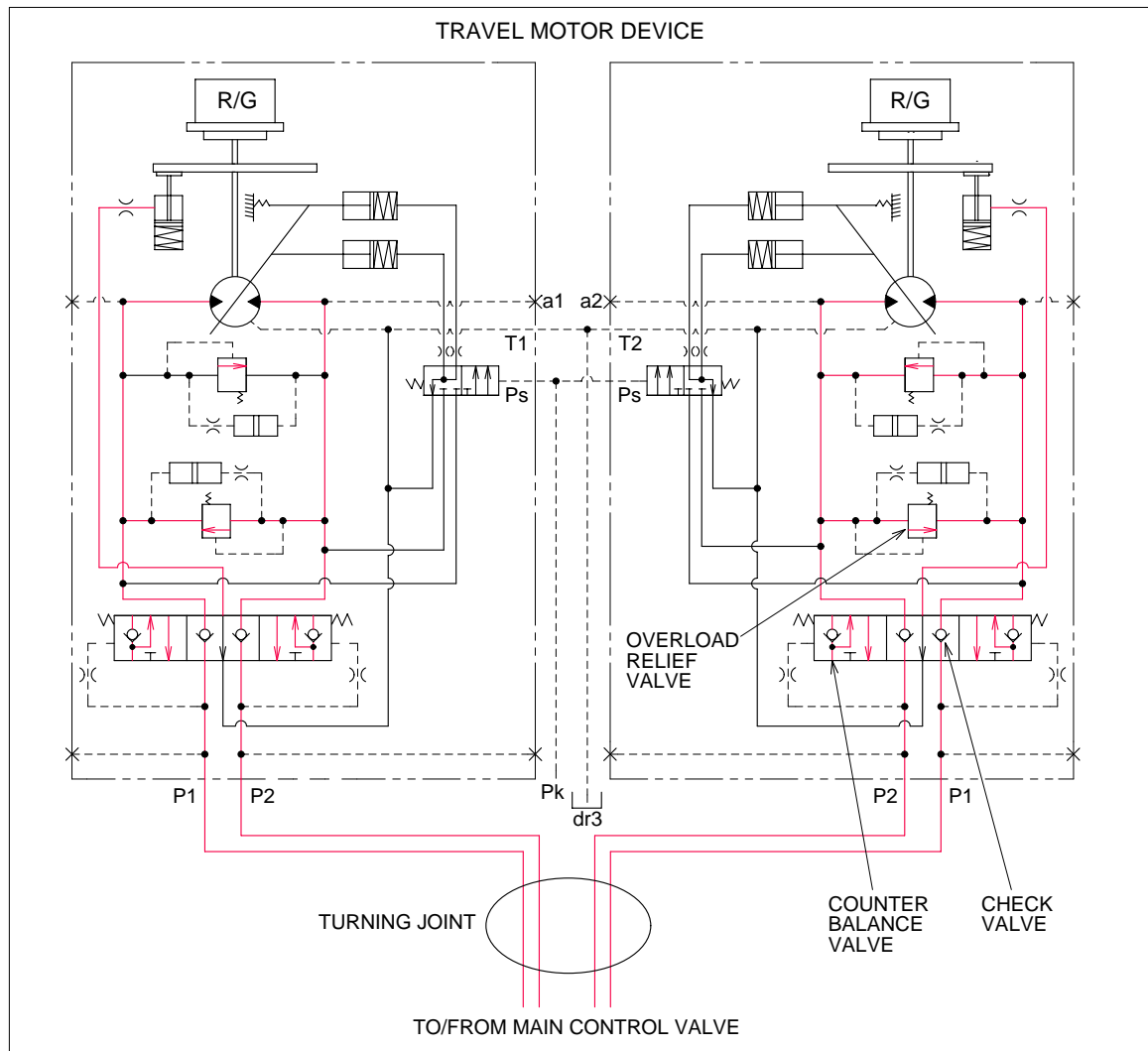


When the right and left travel levers are manually placed to the forward or reverse position, the oil flows from pilot pump through the pilot valve to travel sections of the main control valve.

Here, spool position is moved to forward and reverse position. The oil flows from rear pump through the travel(RH) section of the main control valve and turning joint to the right travel motor and oil flows from front pump through the travel(LH) section of the main control valve and turning joint to the left travel motor and move the machine forward or reverse.

The return oil flows from both travel motor through the turning joint and travel(Rh, LH) sections returned to the tank.

TRAVEL CIRCUIT OPERATION



Valves are provided on travel motors to offer the following functions.

1) COUNTER BALANCE VALVE

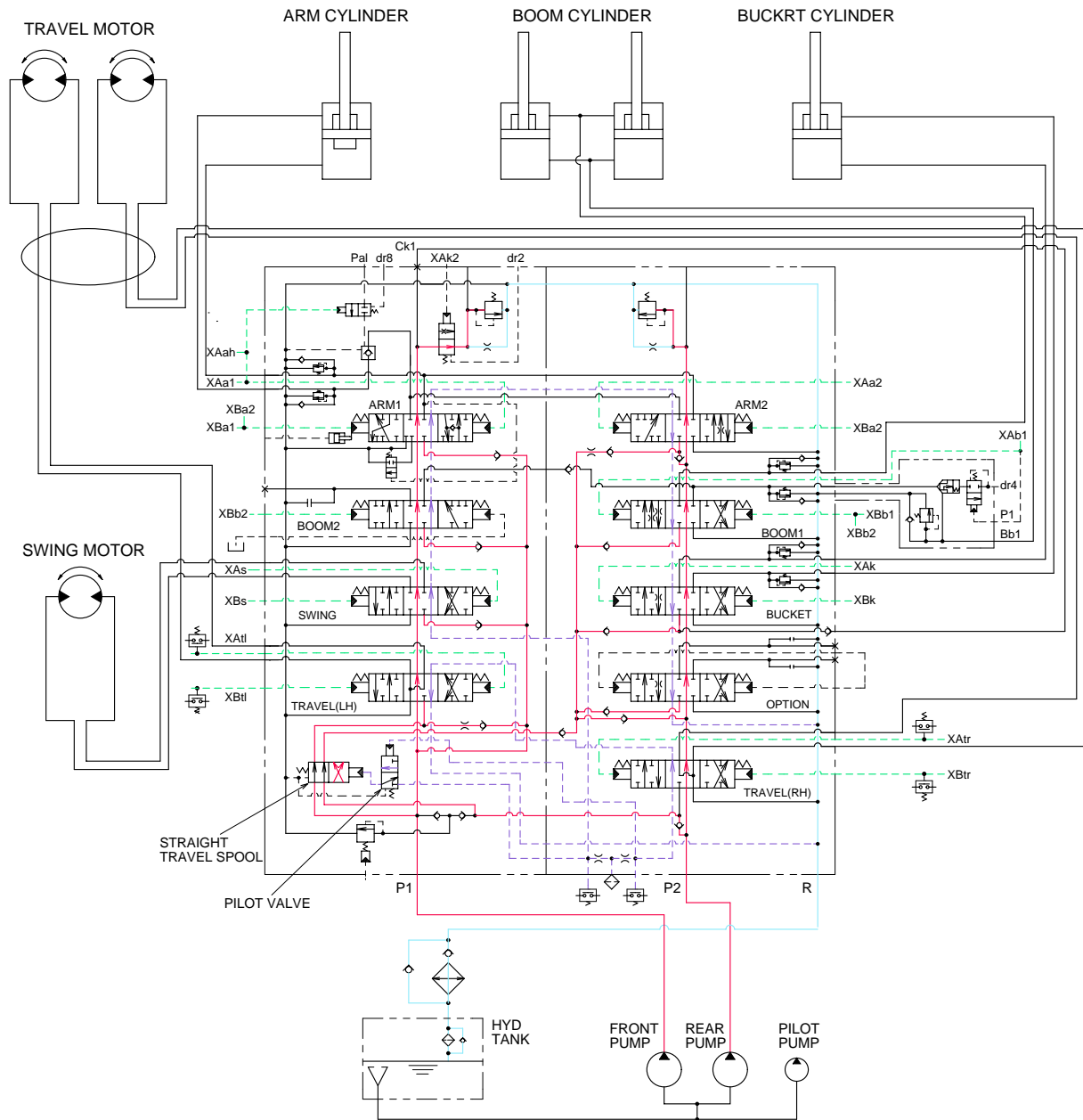
When stopping the motor of slope descending, this valve to prevent the motor over run.

2) OVERLOAD RELIEF VALVE

Relief valve limit the circuit pressure below 350kgf/cm^2 to prevent high pressure generated at at time of stopping the machine. Stopping the motor, this valve sucks the oil from lower pressure passage for preventing the negative pressure and the cavitation of the motor.

GROUP 5 COMBINED OPERATION

1. OUTLINE



The oil from the front and rear pump flows through the neutral oil passage, bypass oil passage and confluence oil passage in the main control valve. Then the oil goes to each actuator and operates them. Check valves and orifices are located on these oil passage in the main control valve. These control the oil from the main pumps so as to correspond to the operation of each actuator and smooth the combined operation.

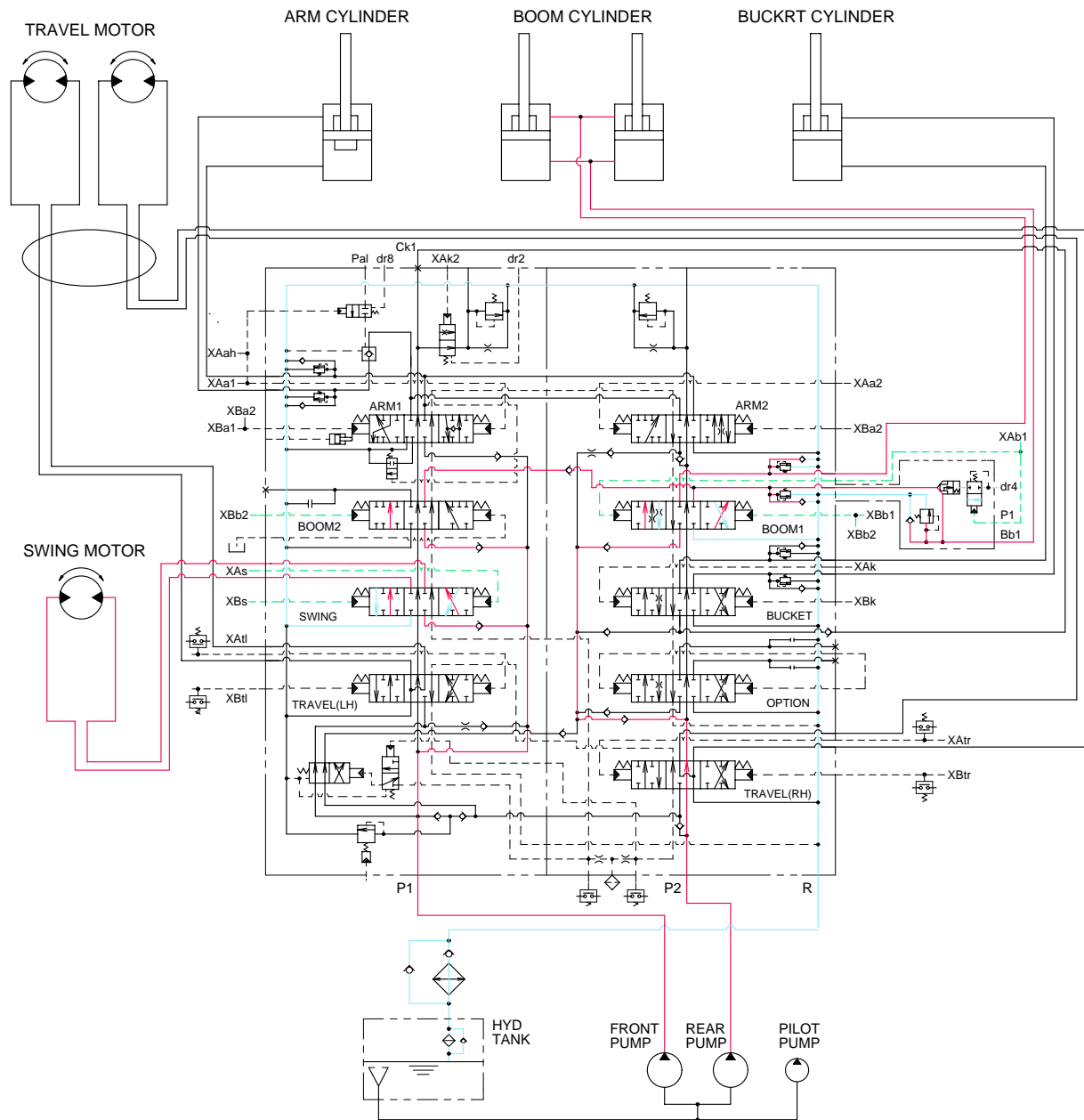
PILOT VALVE FOR STRAIGHT TRAVEL

This pilot valve for straight travel is provided in the main control valve.

If any actuator is operated when traveling, the spool of pilot valve is pushed to the downward by the pilot oil pressure from the pilot pump. At the same time, the straight travel spool is pushed to the left by the oil through the pilot valve for straight travel.

Consequently, the left and right travel oil supply passage are connected, and equivalent amount of oil flows into the left and right travel motors. This keeps the straight travel.

2. COMBINED SWING AND BOOM OPERATION

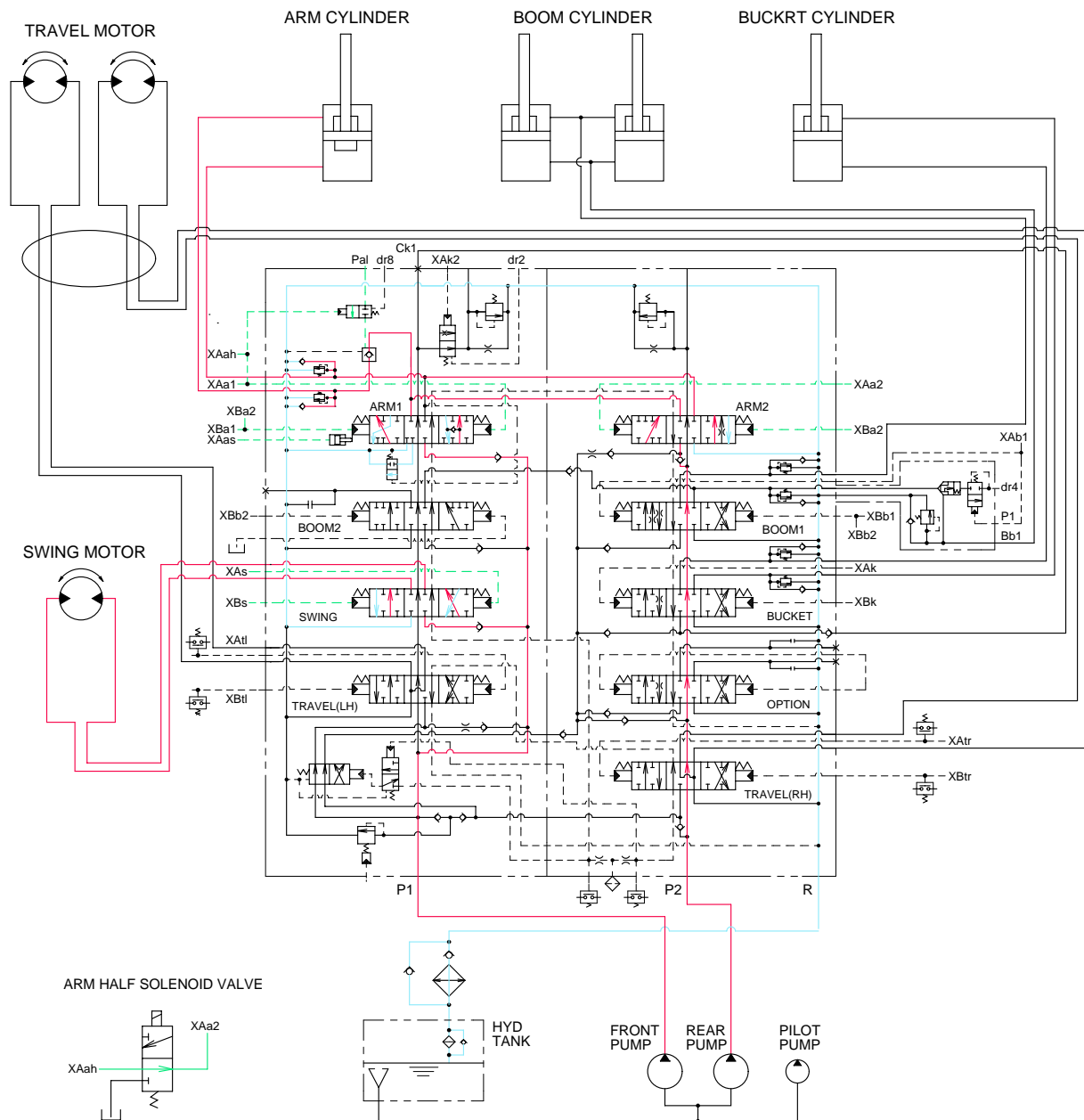


When the swing and boom functions are operated, simultaneously the swing spool and boom spools changed. The oil flows from the rear pump through boom1 section of the main control valve to boom cylinders and the boom functions.

The oil flows from front pump through swing section to swing motor.

At the same time the pressure in the boom circuits can be high while the swing pressure is low, therefore the oil flows from front pump to boom cylinders through boom2 section via confluence passage in case boom raise operation.

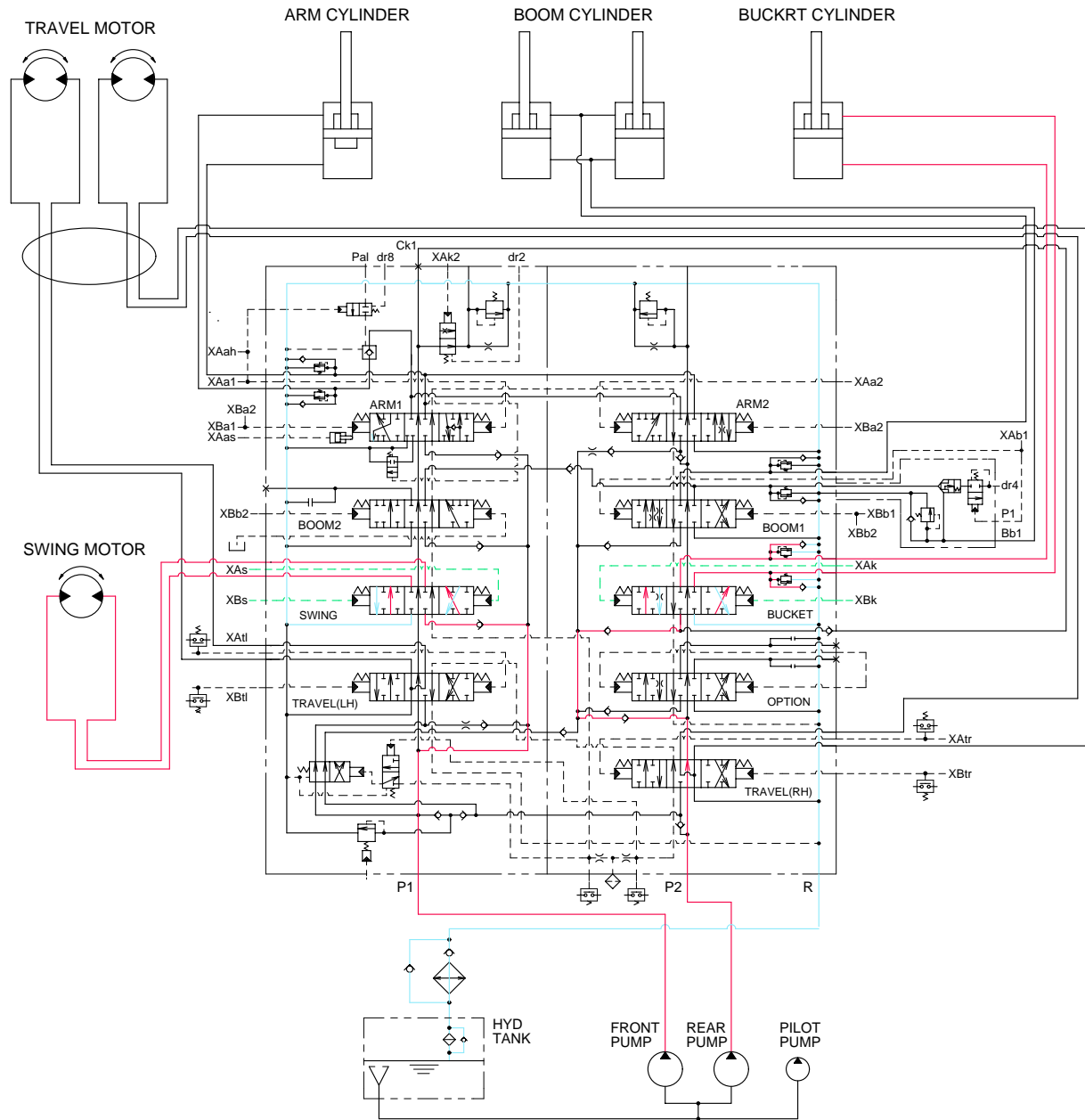
3. COMBINED SWING AND ARM OPERATION



When the swing and arm functions are operated, simultaneously the swing spool and arm spools changed. The oil flows from the front pump through arm1 and swing section of the main control valve to arm cylinder and swing motor, and the arm and swing functions.

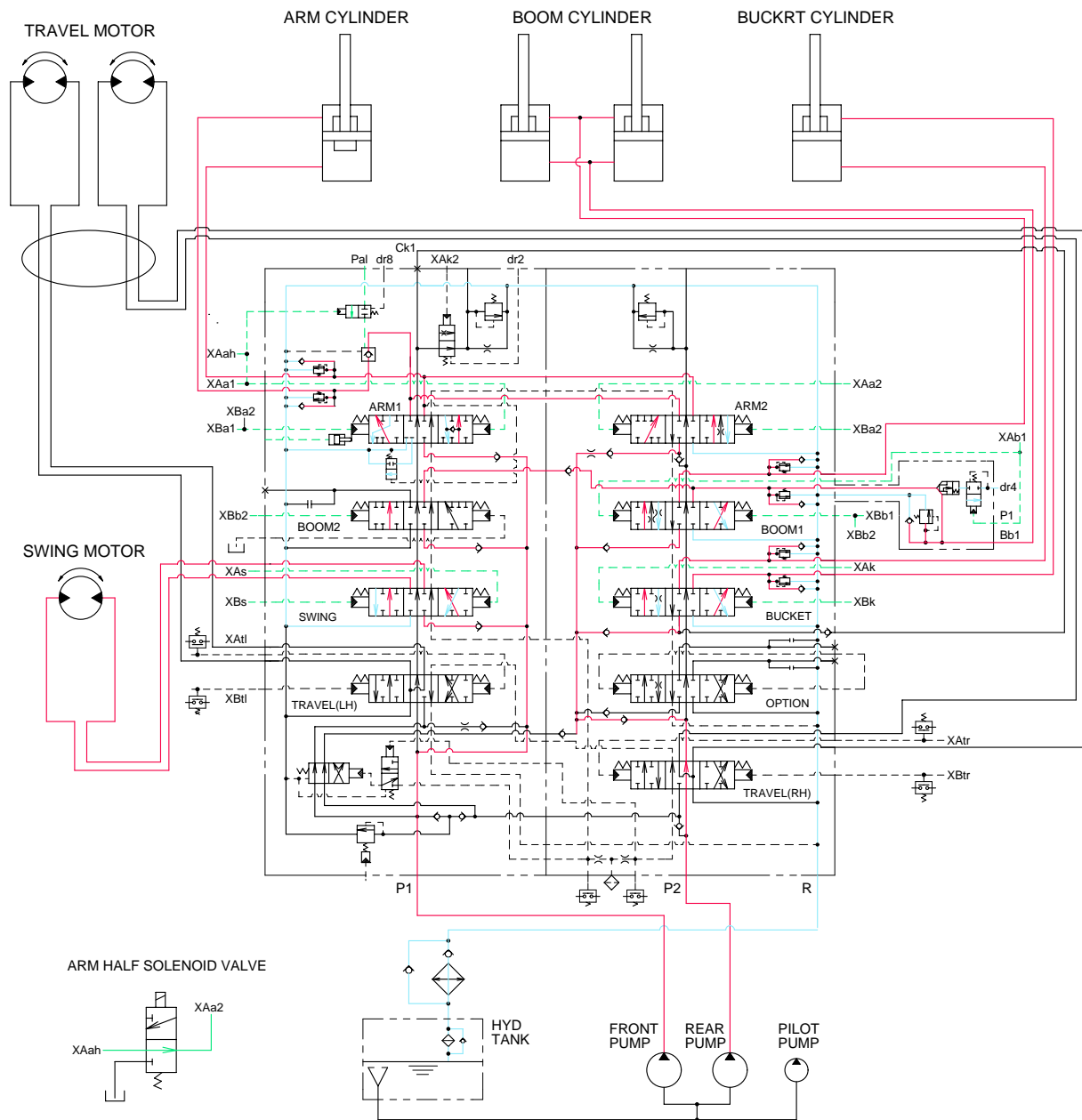
At the same time, the pressure in the arm circuit can be high while the swing pressure is low, therefore the oil flows from rear pump to arm cylinder through arm2 section via confluence passage. Mean while the pilot oil pressure(XAAs) of swing shuttle valve flows into the stroke limiter of arm spool, then the swing priority is maintained.

4. COMBINED SWING AND BUCKET OPERATION



When the swing and bucket functions are operated, the swing and bucket spools changed. The oil flows from the rear pump through the bucket section of the main control valve to the bucket cylinder and the bucket function. The oil flows from front pump through swing section of the main control valve to the swing motor and swing the superstructure.

5. COMBINED SWING, BOOM, ARM AND BUCKET OPERATION

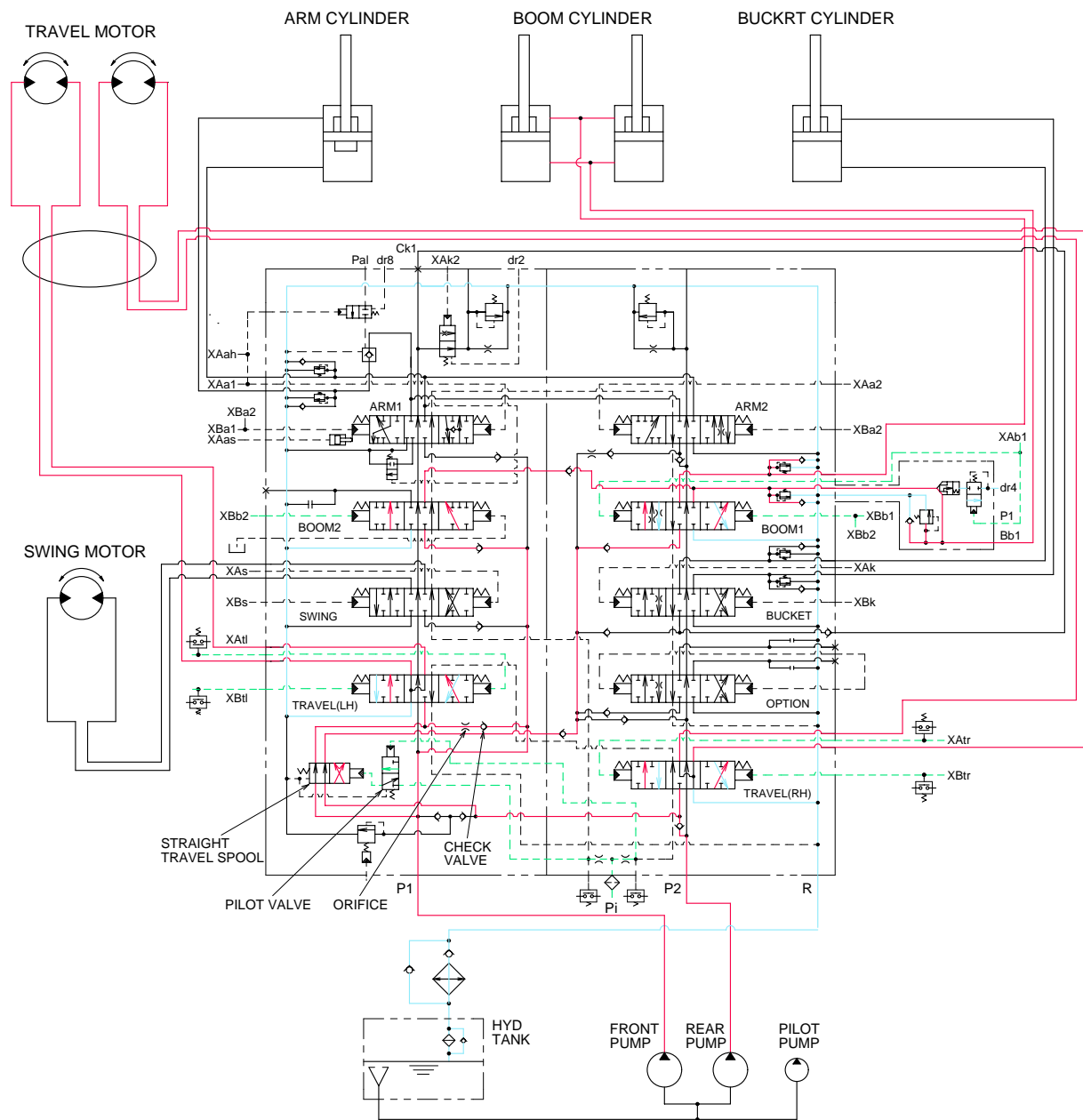


When the swing, boom, arm and bucket functions are operated, the each spools of the main control valve changed.

The oil flows from rear pump through arm2, boom1 and bucket section to boom, arm and bucket cylinders. The oil flows from front pump through swing, boom2 and arm1 section to swing motor, boom and arm cylinder. Then the functions to each actuators.

According to the state of each actuators functioning, the oil flows from front and rear pump through the confluence oil passage to the each actuators.

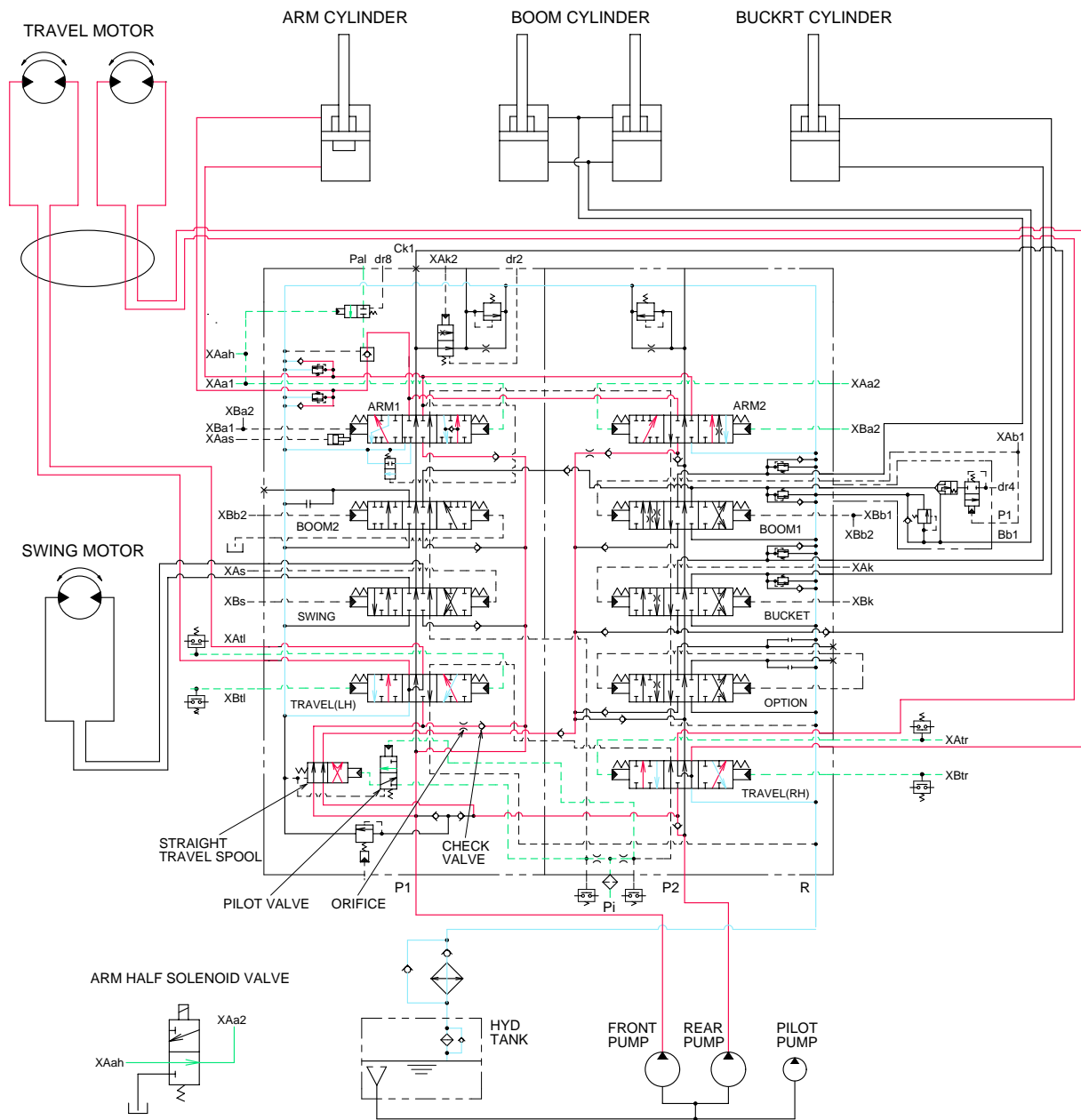
7. COMBINED BOOM AND TRAVEL OPERATION



When the boom and travel functions are operated, simultaneously the boom spools and travel spools in the main control valve are moved to the functional position by the pilot oil pressure from the remote control valve and the spool of pilot valve is pushed to the downward by the pilot oil pressure from the pilot pump. At the same time, the straight travel spool is pushed to the left by the oil through the pilot valve for straight travel. The oil from the rear pump flows into the boom cylinders through the boom 2 spool and boom 1 spool via the parallel and confluence oil passage. The oil from the front pump flows into the travel motors through the RH travel spool of the right control valve and the LH travel spool of the left control valve via the straight travel spool.

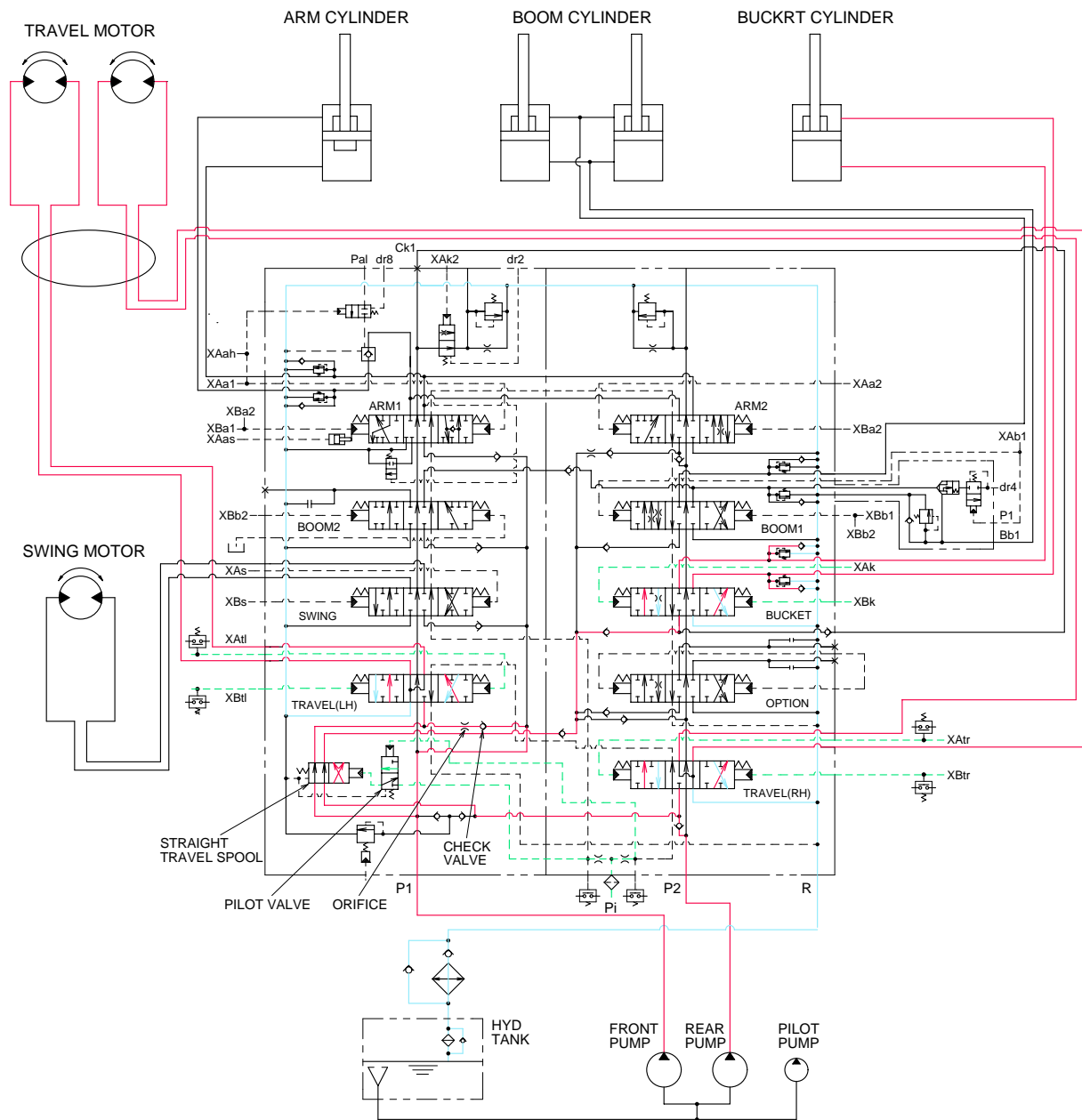
Check valve the pressure in the travel circuit can be high while the boom pressure is low. When the travel circuit pressure drops lower than boom pressure, as when traveling downhill, boom priority and smoothness are maintained because of the orifice. In ether case, the machine will continue to travel straight.

8. COMBINED ARM AND TRAVEL OPERATION



When the arm and travel functions are operated, simultaneously the arm spools and travel spools in the main control valve are moved to the functional position by the pilot oil pressure from the remote control valve and the spool of pilot valve is pushed to the downward by the pilot oil pressure from the pilot pump. At the same time, the straight travel spool is pushed to the left by the oil through the pilot valve for straight travel. The oil from the rear pump flows into the arm cylinders through the arm 1 spool and arm 2 spool via the parallel and confluence oil passage. The oil from the front pump flows into the travel motors through the RH travel spool of the right control valve and the LH travel spool of the left control valve via the straight travel spool. Check valve the pressure in the travel circuit can be high while the arm pressure is low. When the travel circuit pressure drops lower than arm pressure, as when traveling downhill, arm priority and smoothness are maintained because of the orifice. In either case, the machine will continue to travel straight.

9. COMBINED BUCKET AND TRAVEL OPERATION



When the bucket and travel functions are operated, simultaneously the bucket spool and travel spools in the main control valve are moved to the functional position by the pilot oil pressure from the remote control valve, and the spool of pilot valve is pushed to the downward by the pilot oil pressure from the pilot pump. At the same time, the straight travel spool is pushed to the left by the oil through the pilot valve for straight travel. The oil from the rear pump flows into the bucket cylinder through the bucket spool via the confluence oil passage. The oil from the front pump flows into the travel motors through the RH travel spool of the right control valve and the LH travel spool of the left control valve via the straight travel spool of the control valve.

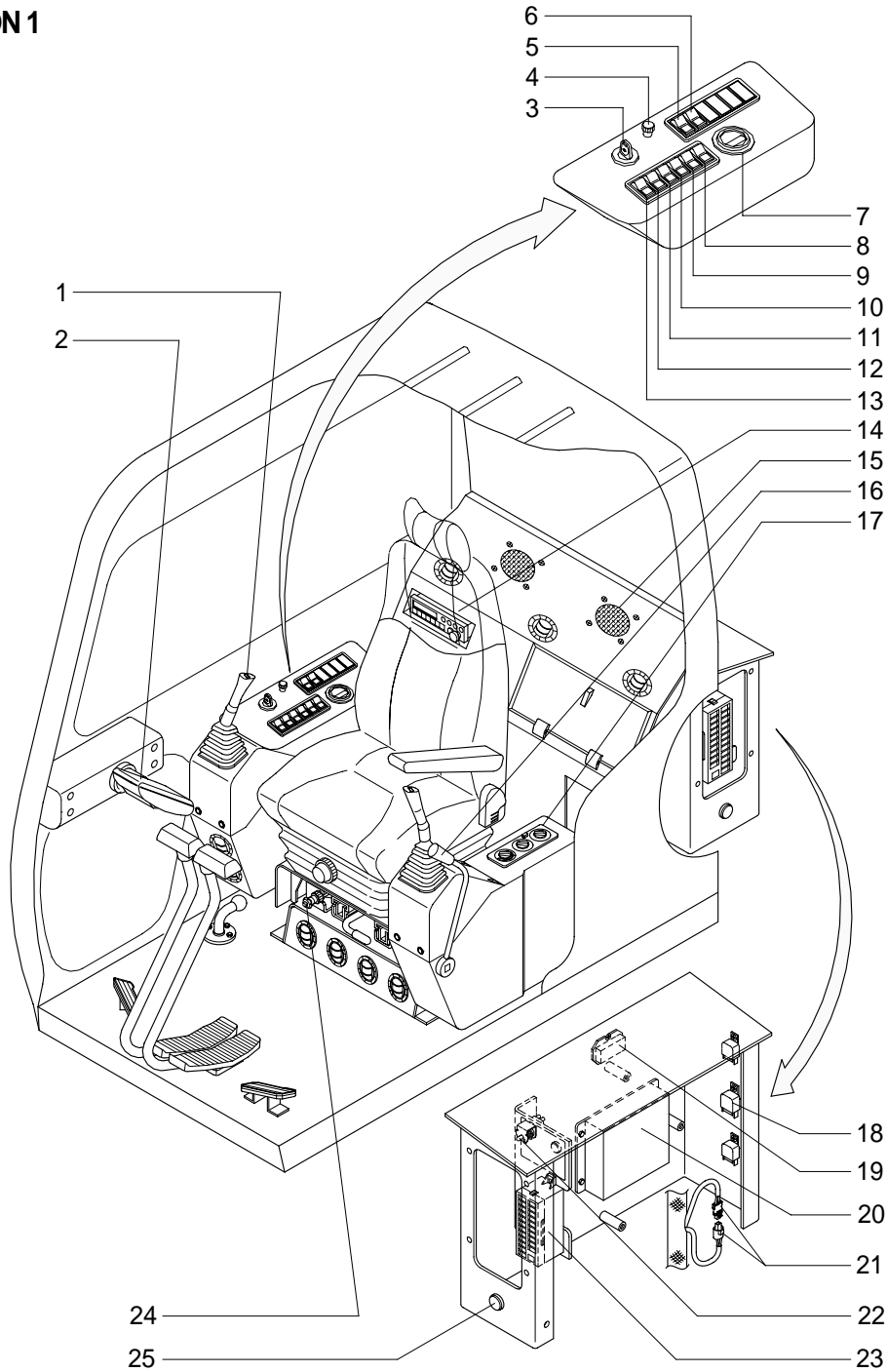
Check valve the pressure in the travel circuit can be high while the bucket pressure is low. When the travel circuit pressure drops lower than bucket pressure, as when traveling downhill, bucket priority and smoothness are maintained because of the orifice.

In either case, the machine will continue to travel straight.

SECTION 4 ELECTRICAL SYSTEM

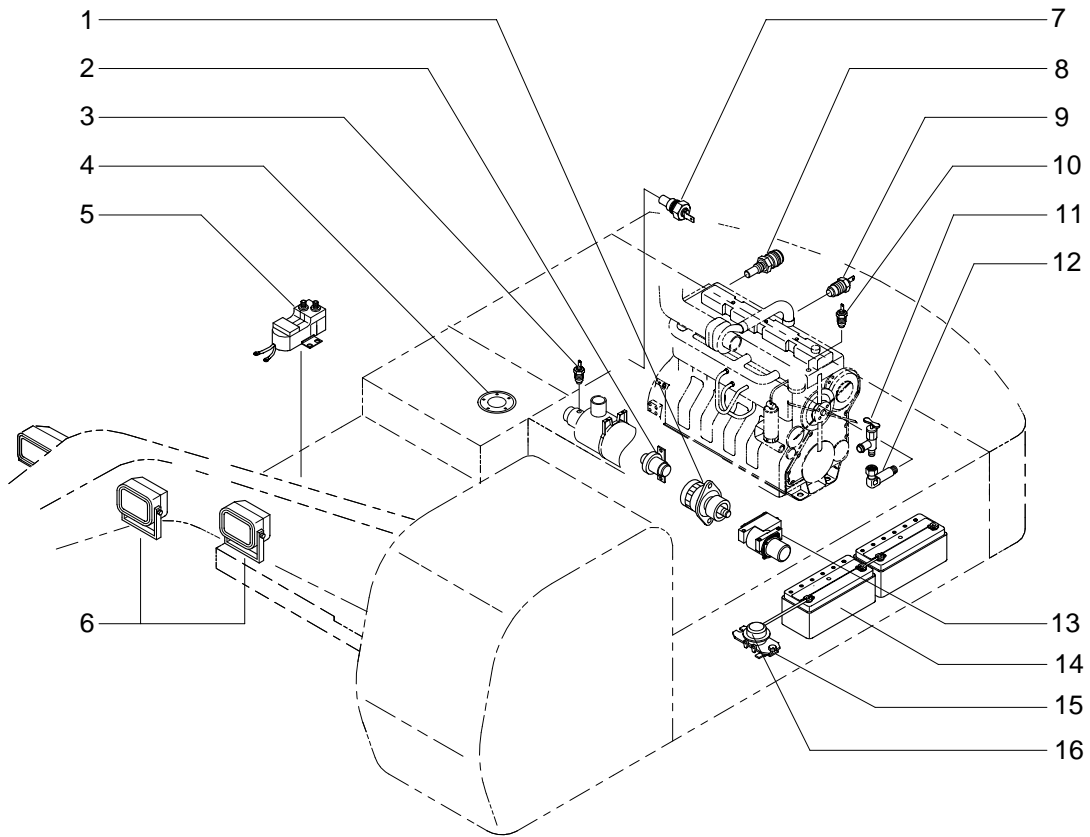
GROUP 1 COMPONENT LOCATION

1. LOCATION 1



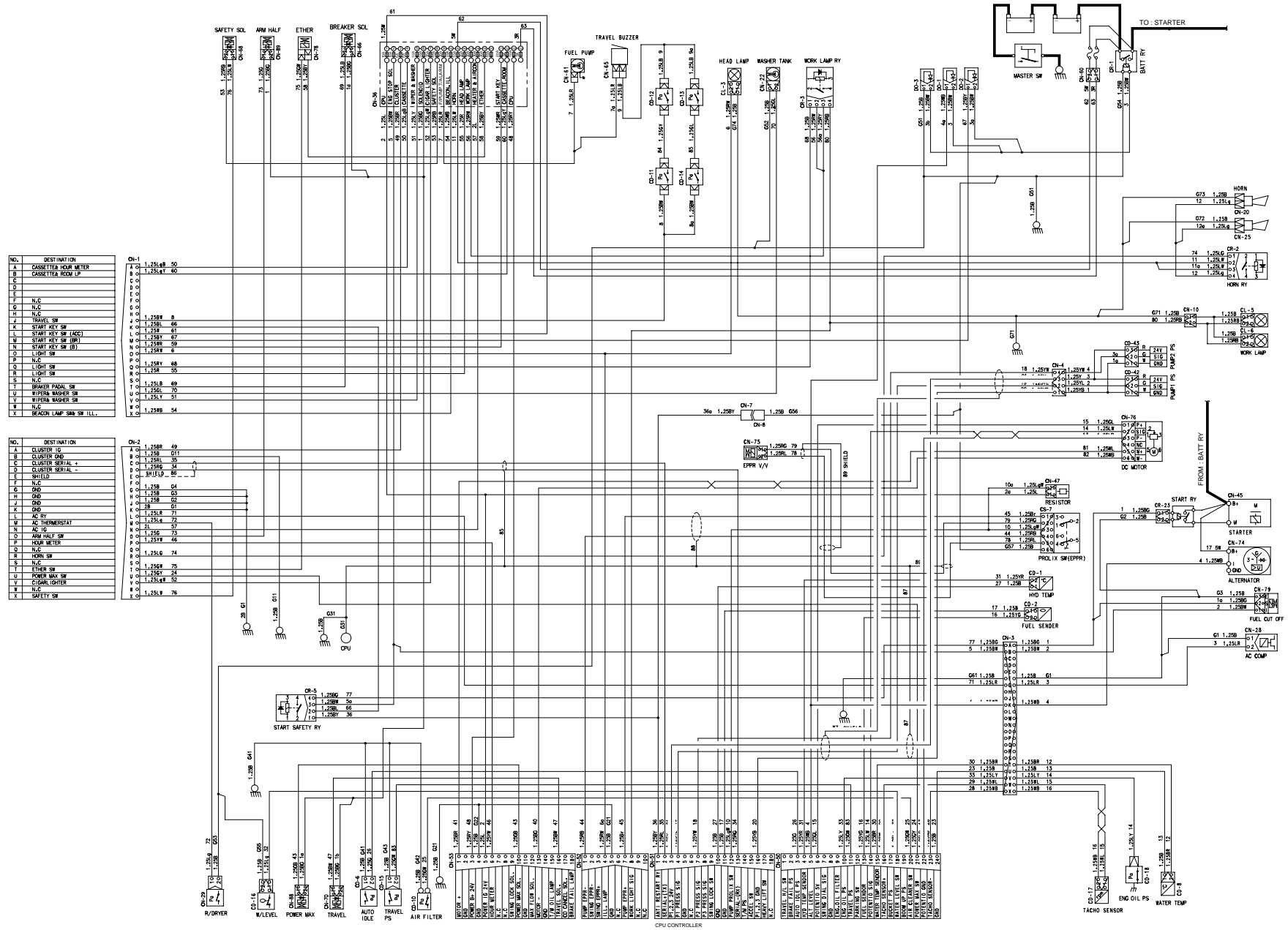
- | | | | | | |
|---|---------------------|----|------------------------|----|-----------------------------------------------------|
| 1 | Horn switch | 10 | Arm half switch | 19 | Resistor |
| 2 | Cluster | 11 | Aircon switch | 20 | CPU controller |
| 3 | Starting switch | 12 | Main light switch | 21 | Emergency engine starting connector |
| 4 | Cigar lighter | 13 | Wiper & washer switch | 22 | Prolix switch |
| 5 | Breaker switch | 14 | Cassette & radio | 23 | Fuse box |
| 6 | Beacon switch | 15 | Speaker | 24 | Emergency engine control lever
(Push pull cable) |
| 7 | Service meter | 16 | Safety lever | 25 | Master switch |
| 8 | Travel alarm switch | 17 | Aircon & heater switch | | |
| 9 | Cold start switch | 18 | Relay | | |

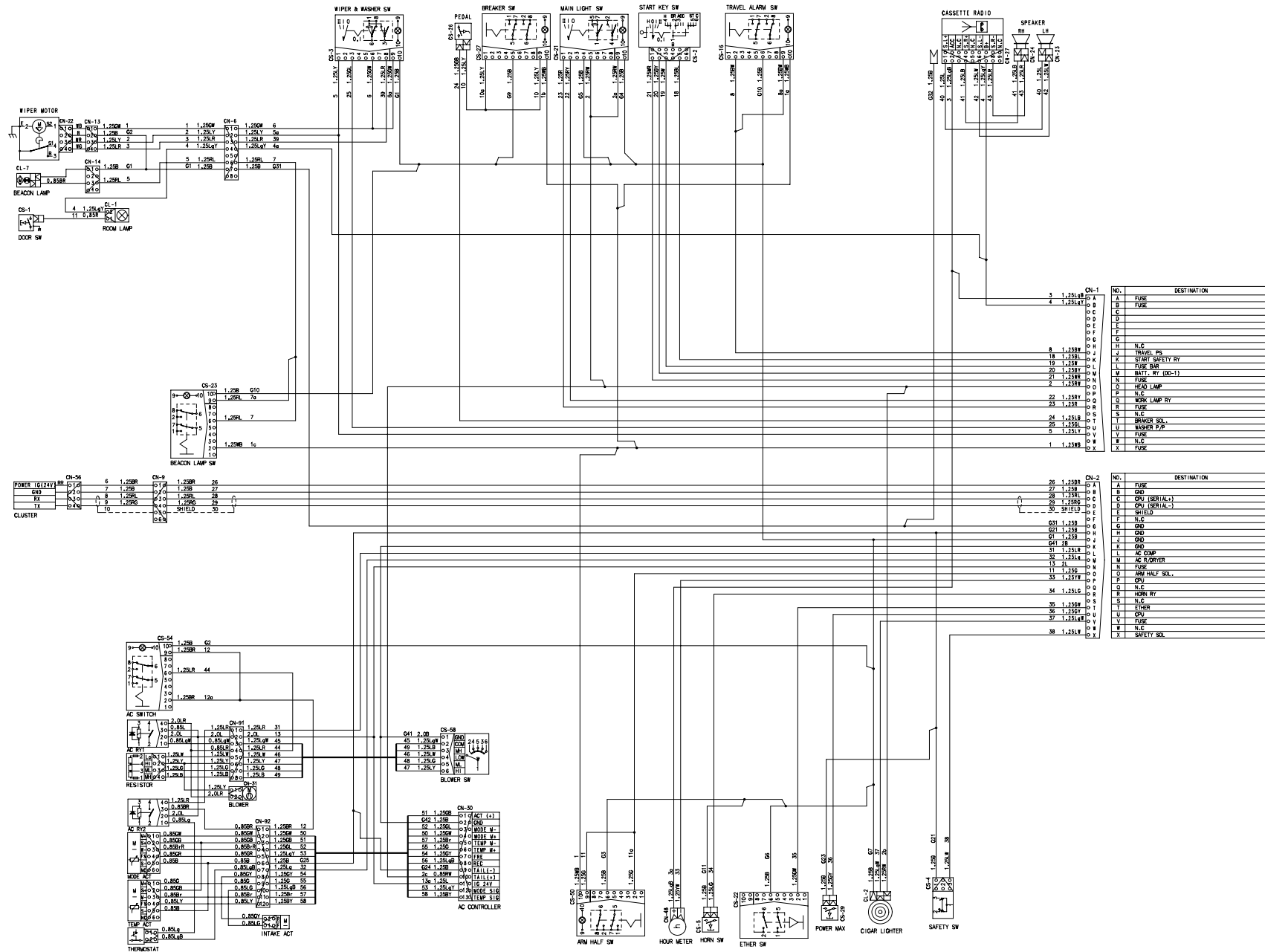
2. LOCATION 2



- | | | | | | |
|---|--------------------|----|----------------------------|----|-----------------|
| 1 | Alternator | 7 | Hyd temperature sender | 13 | Accel actuator |
| 2 | Start relay | 8 | Engine speed sensor | 14 | Battery |
| 3 | Air cleaner switch | 9 | Engine oil pressure switch | 15 | Connector plate |
| 4 | Fuel sender | 10 | Water temperature sender | 16 | Battery relay |
| 5 | Fuel filler pump | 11 | Heater valve | | |
| 6 | Lamp | 12 | Heater adapter | | |

GROUP 2 ELECTRICAL CIRCUIT



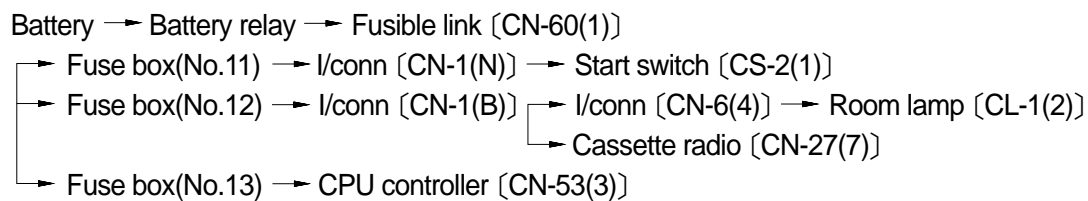


1. POWER CIRCUIT

The negative terminal of battery is grounded to the machine chassis through master switch.

When the start switch is in the OFF position, the current flows from the positive battery terminal as shown below.

1) OPERATING FLOW



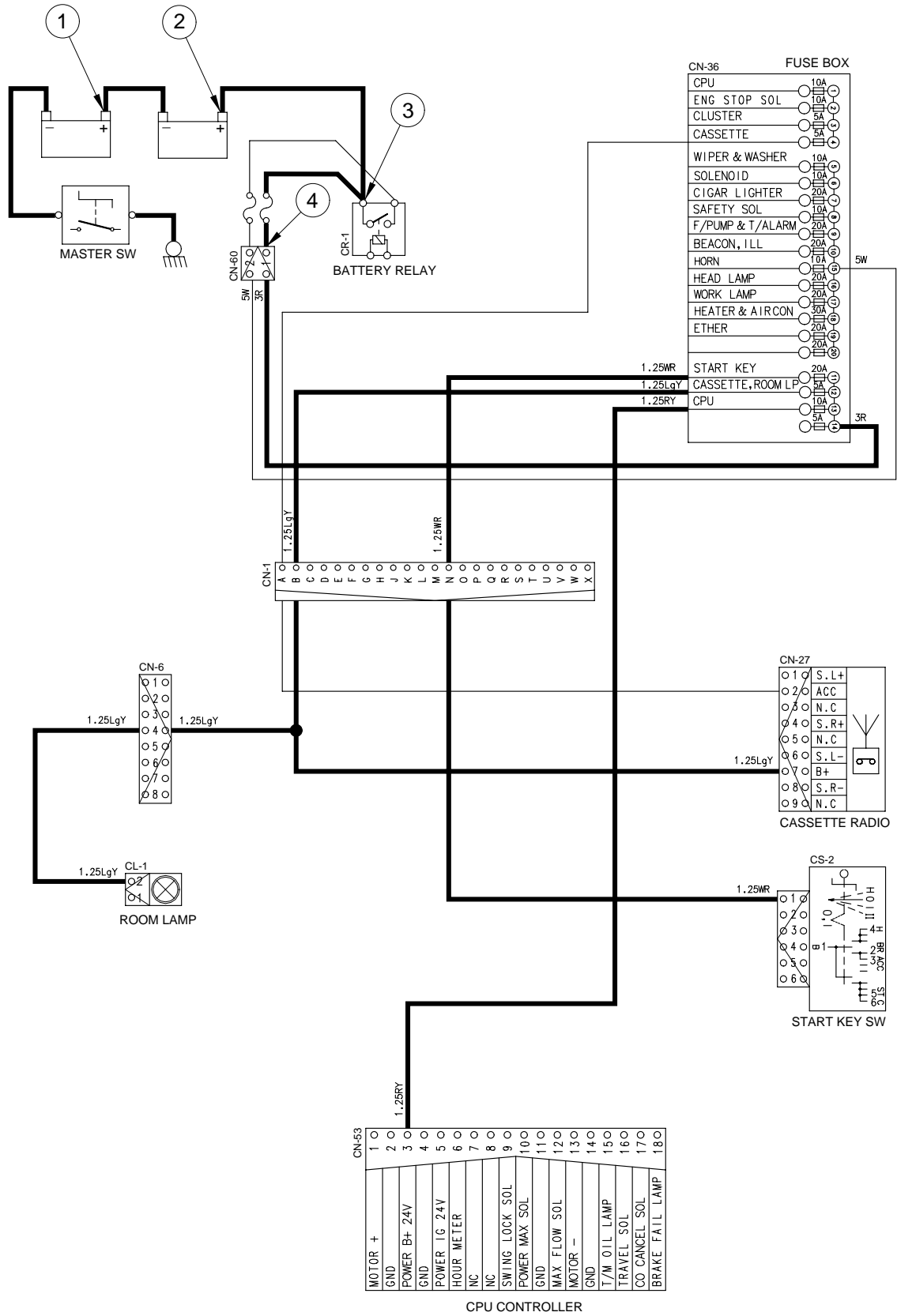
※ I/conn : Intermediate connector

2) CHECK POINT

Engine	Start switch	Check point	Voltage
OFF	OFF	①- GND(Battery 1EA) ②- GND(Battery 2EA) ③- GND(Battery 2EA) ④- GND(Fusible link)	10~12.5V 20~25V 20~25V 20~25V

※ GND : Ground

POWER CIRCUIT



2. STARTING CIRCUIT

1) OPERATING FLOW

Battery(+) terminal → Battery relay(M8, B⁺ terminal) → Fusible link [CN-60(1)]
 → Fuse box(No.11) → I/conn [CN-1(N)] → Start switch [CS-2(1)]

(1) When start key switch is in ON position

→ Start switch ON [CS-2(2)] → I/conn [CN-1(M)] → Battery relay [M4 terminal]
 → Battery relay operating(All power is supplied with the electric component)
 → Start switch ON [CS-2(3)] → I/conn [CN-1(L)]
 → Fuse box(No.1)
 → Fuse box(No.2) → I/conn [CN-3(B)] → Fuel cut-off [CN-79(1)]

(2) When start key switch is in START position

Start switch START [CS-2(5)] → I/conn [CN-1(K)] → Start safety relay [CR-5(2)]
 → I/conn [CN-3(A)] → Start relay [CR-23(1)]

2) CHECK POINT

Engine	Start switch	Check point	Voltage
OPERATING	START	①- GND(Battery) ②- GND(Start key) ③- GND(Battery relay M4) ④- GND(Start B+) ⑤- GND(Start M) ⑥- GND(Start relay) ⑦- GND(Battery relay M8)	20~25V

※ GND : Ground

3. CHARGING CIRCUIT

When the starter is activated and the engine is started, the operator releases the key switch to the ON position.

Charging current generated by operating alternator flows into the battery through the Battery relay(CR-1).

The current also flows from alternator to each electrical component and controller through the fuse box.

1) OPERATING FLOW

(1) Warning flow

Alternator "I" terminal → I/conn [CN-3(K)] → CPU Alternator power level [CN-50(5)]
→ Cluster charging warning lamp

(2) Charging flow

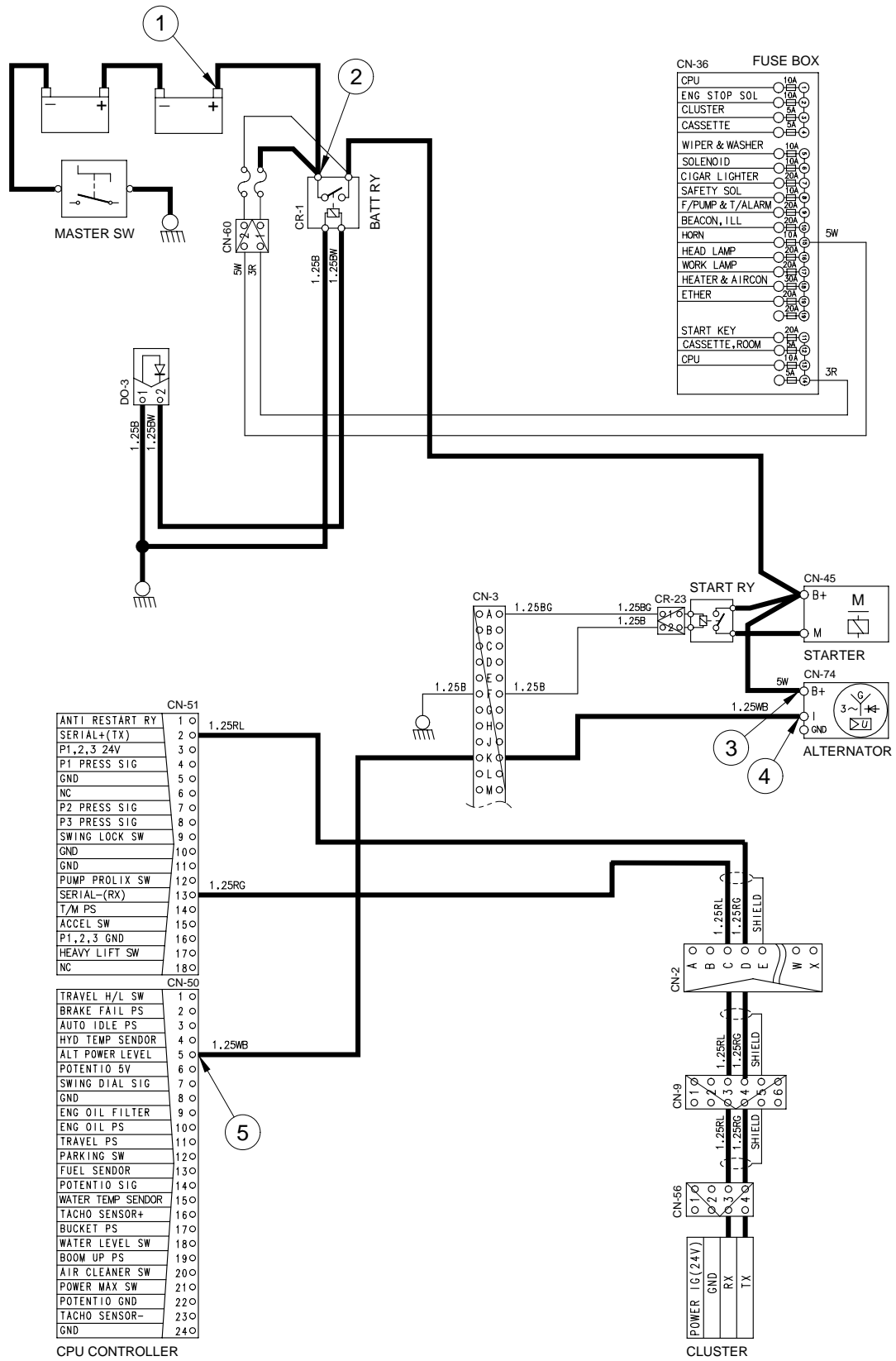
Alternator B⁺ terminal → Battery relay(M8) → Battery(+) terminal

2) CHECK POINT

Engine	Start switch	Check point	Voltage
RUN	ON	①- GND(Battery voltage) ②- GND(Battery relay) ③- GND(Alternator B terminal) ④- GND(Alternator I terminal) ⑤- GND(CPU)	20~30V

※ GND : Ground

CHARGING CIRCUIT



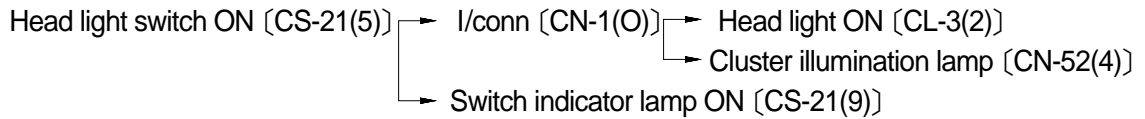
4. HEAD AND WORK LIGHT CIRCUIT

1) OPERATING FLOW

Fuse box(No.16) → I/conn [CN-1(R)] → Main light switch [CS-21(1)]

Fuse box(No.17) → Work light relay [CR-3(2, 3)]

(1) Head light switch ON : 1st step



(2) Work light switch ON : 2nd step

Work light switch ON [CS-21(2)] → I/conn [CN-1(Q)] → Work light relay [CR-3(1)]

I/conn [CN-10(2)] → Work light ON [CL-6(2), CL-5(2)]

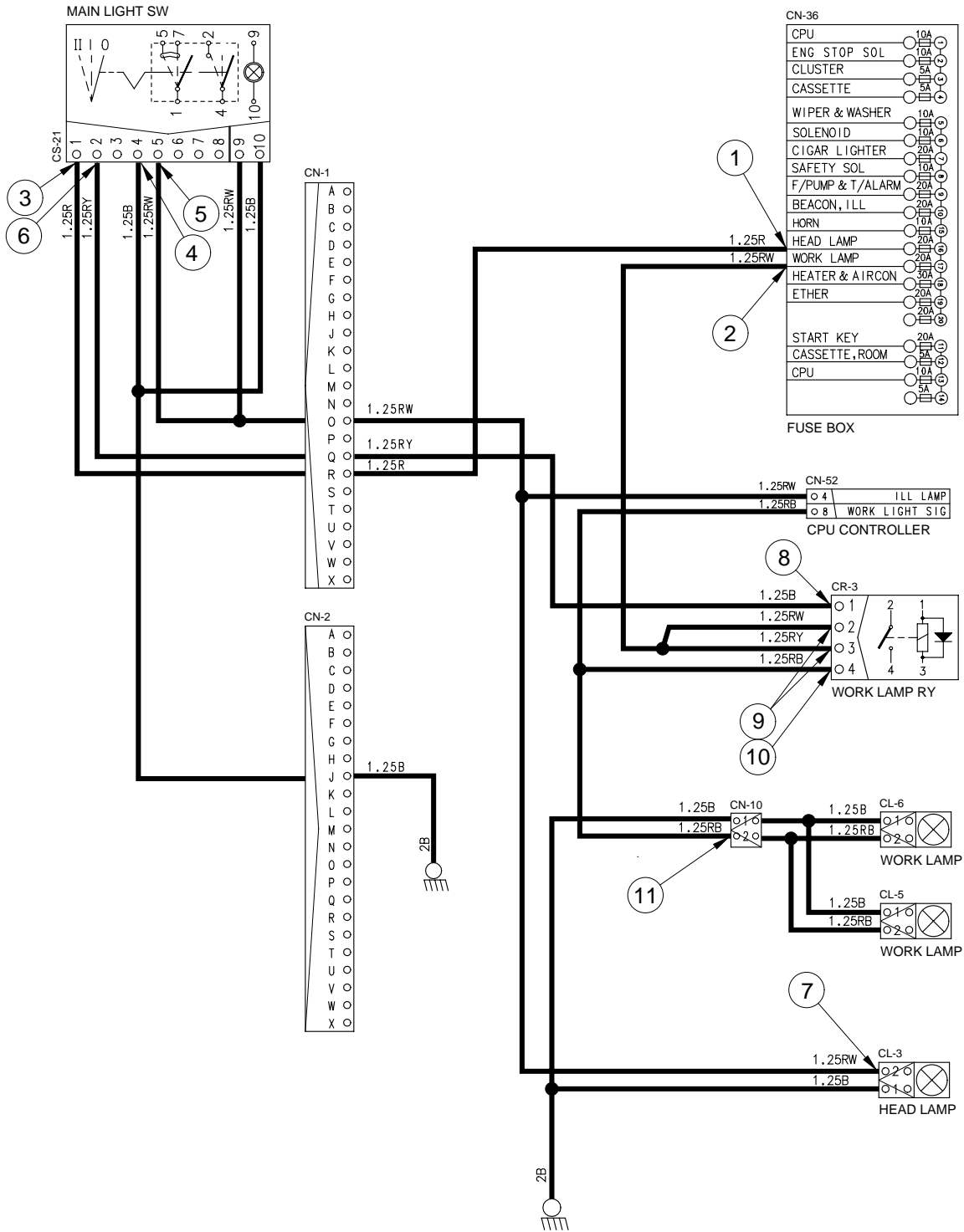
I/conn [CN-10(2)] → Cluster work light pilot lamp ON [CN-52(8)]

2) CHECK POINT

Engine	Start switch	Check point	Voltage
STOP	ON	①- GND(Fuse box) ③- GND(Switch power input) ⑤- GND(Switch power output) ⑦- GND(Head lamp)	20~25V
STOP	ON	②- GND(Fuse box) ④- GND(Switch signal input) ⑥- GND(Switch signal output) ⑧- GND(Relay coil) ⑨- GND(Relay power input) ⑩- GND(Relay power output) ⑪- GND(Work lamp)	20~25V

※ GND : Ground

HEAD AND WORK LIGHT CIRCUIT



5. BEACON LAMP CIRCUIT

1) OPERATING FLOW

Fuse box(No.10) → I/conn [CN-1(X)] → Beacon lamp switch [CS-23(2)]

※ When Lamp switch ON

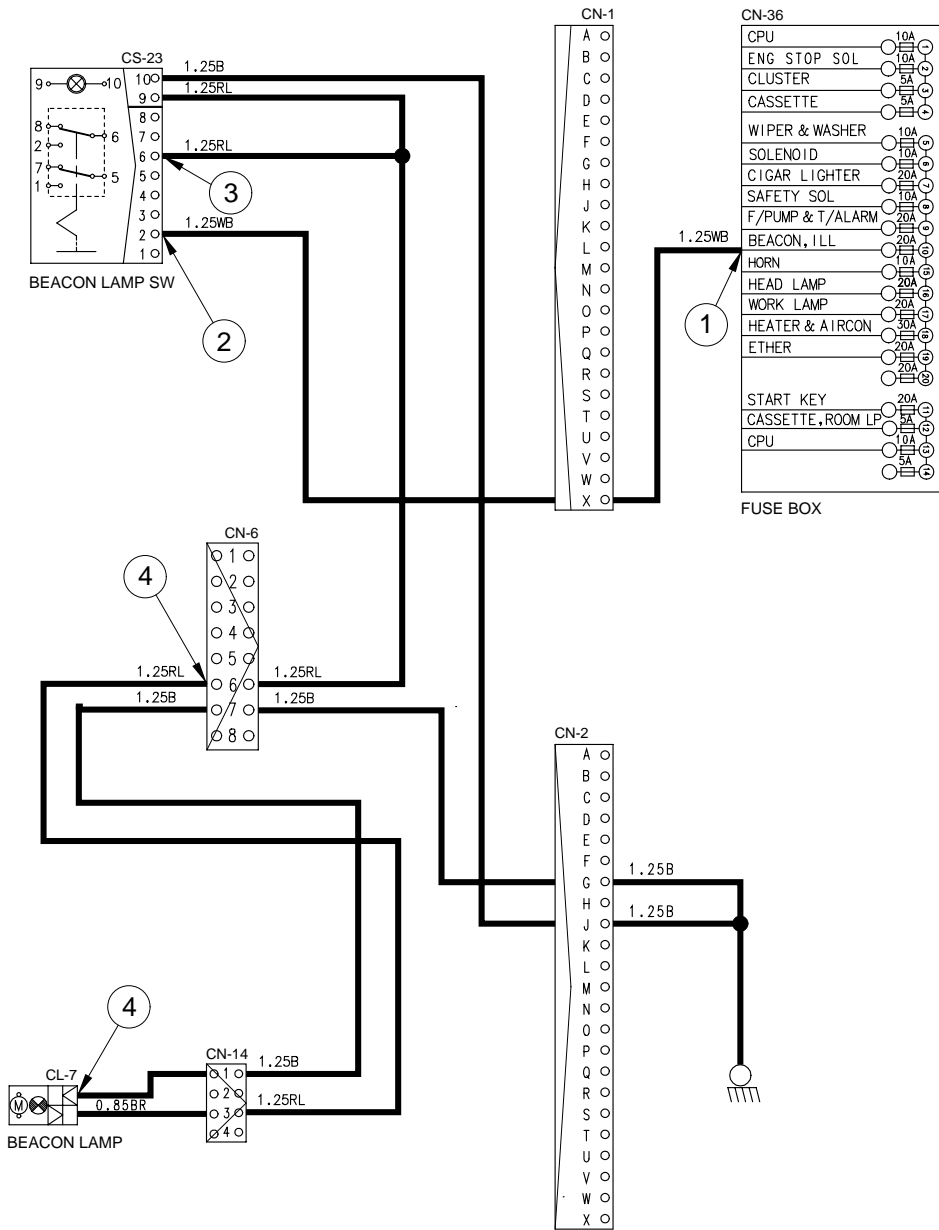
Beacon lamp switch ON [CS-23(6)] → Switch indicator lamp ON [CS-23(9)]
 → I/conn [CN-6(6)] → I/conn [CN-14(3)]
 → Beacon lamp ON [CL-7]

2) CHECK POINT

Engine	Start switch	Check point	Voltage
STOP	ON	①- GND(Fuse box) ②- GND(Switch power input) ③- GND(Switch power output) ④- GND(Beacon lamp)	20~25V

※ GND : Ground

BEACON LAMP CIRCUIT



6. WIPER AND WASHER CIRCUIT

1) OPERATING FLOW

(1) Wiper motor switch ON : 1st step

Fuse box(No.5) → I/conn [CN-1(V)] → Wiper and washer switch [CS-3(1) → (6)]
 → I/conn [CN-6(1)] → I/conn [CN-13(1)] → Wiper motor operation [CN-21(1)]

(2) Washer switch ON : 2nd step

Fuse box(No.5) → I/conn [CN-1(V)] → Wiper and washer switch [CS-3(1) → (3)]
 → I/conn [CN-1(U)] → Washer tank [CN-22(2) → (1)]
 → Washer operation
 → I/conn [CN-6(1)] → I/conn [CN-13(1)]
 → Wiper motor operation [CN-21(1)]

(3) Auto parking(When switch OFF)

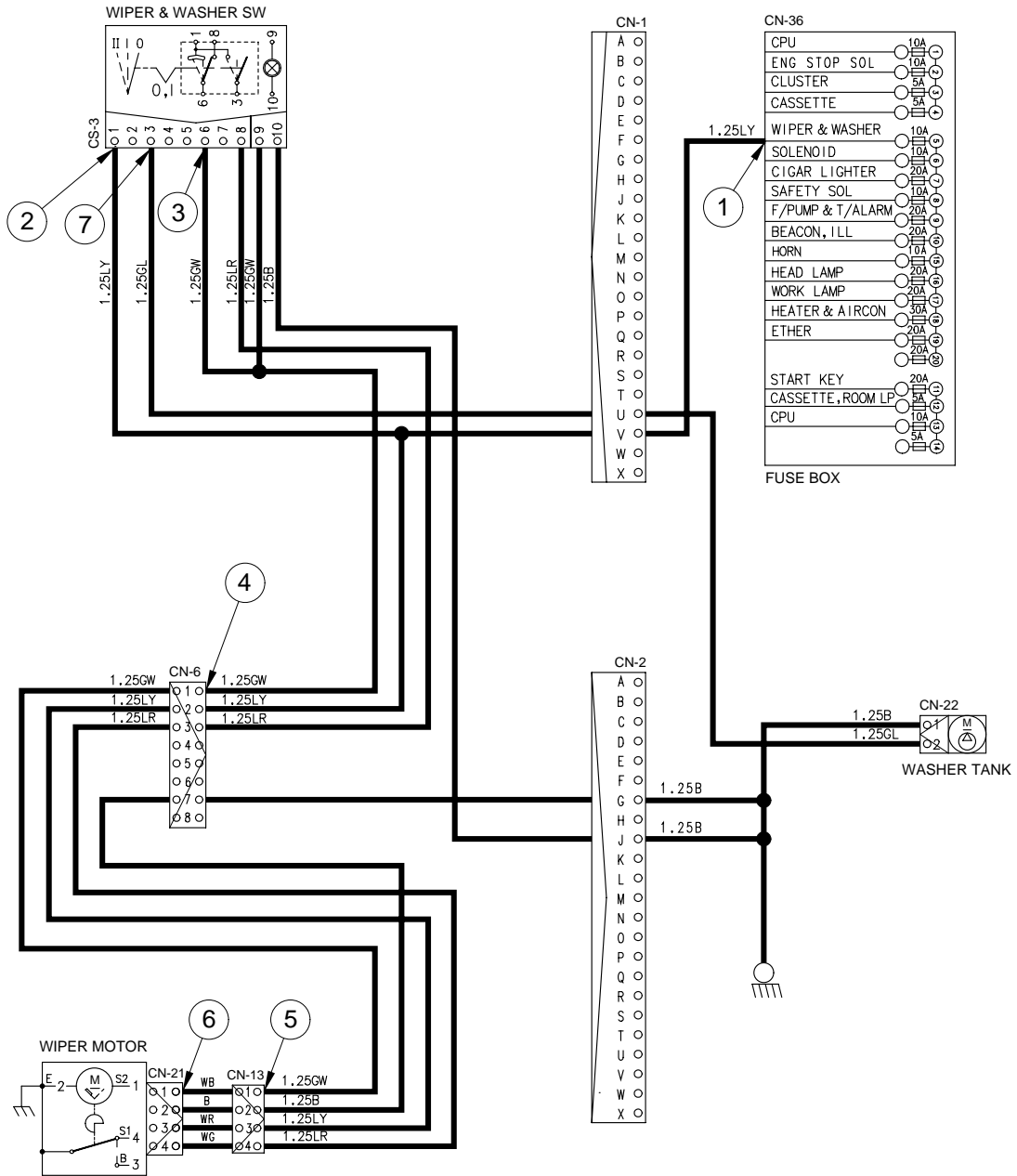
Wiper & washer switch OFF [CS-3(6) → (8)] → Wiper motor [CN-21(1)]
 → Fuse box(No.5) → I/conn [CN-1(V)] → I/conn [CN-6(2)] → I/conn [CN-13(3)]
 → Wiper & washer switch [CN-21(3) → (4)] → Wiper motor stop

2) CHECK POINT

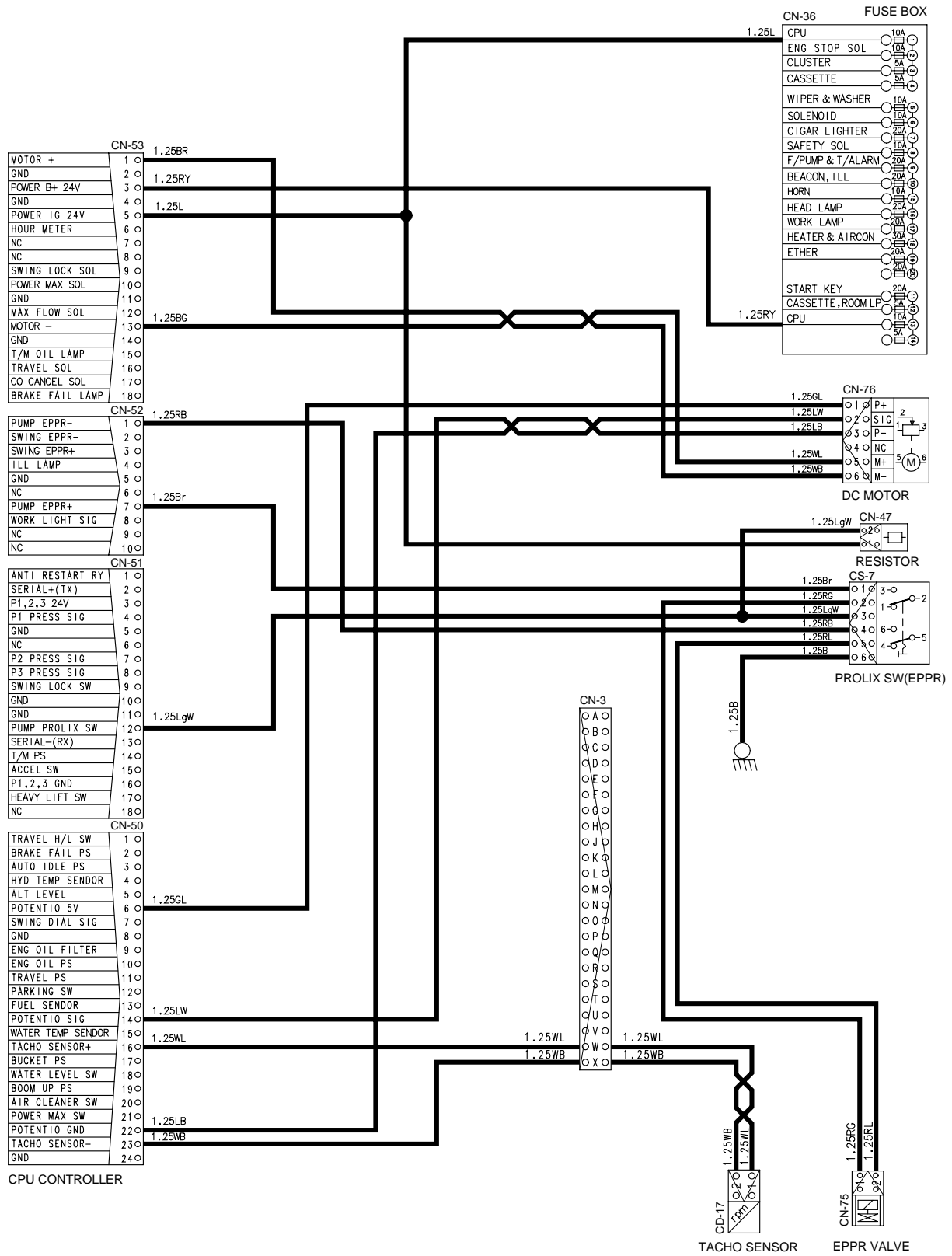
Engine	Start switch	Check point	Voltage
STOP	ON	①- GND(Fuse box) ②- GND(Switch power input) ③- GND(Switch power output) ④- GND(Wiper power input) ⑤- GND(Wiper power input) ⑥- GND(Wiper motor) ⑦- GND(Switch power output)	20~25V

※ GND : Ground

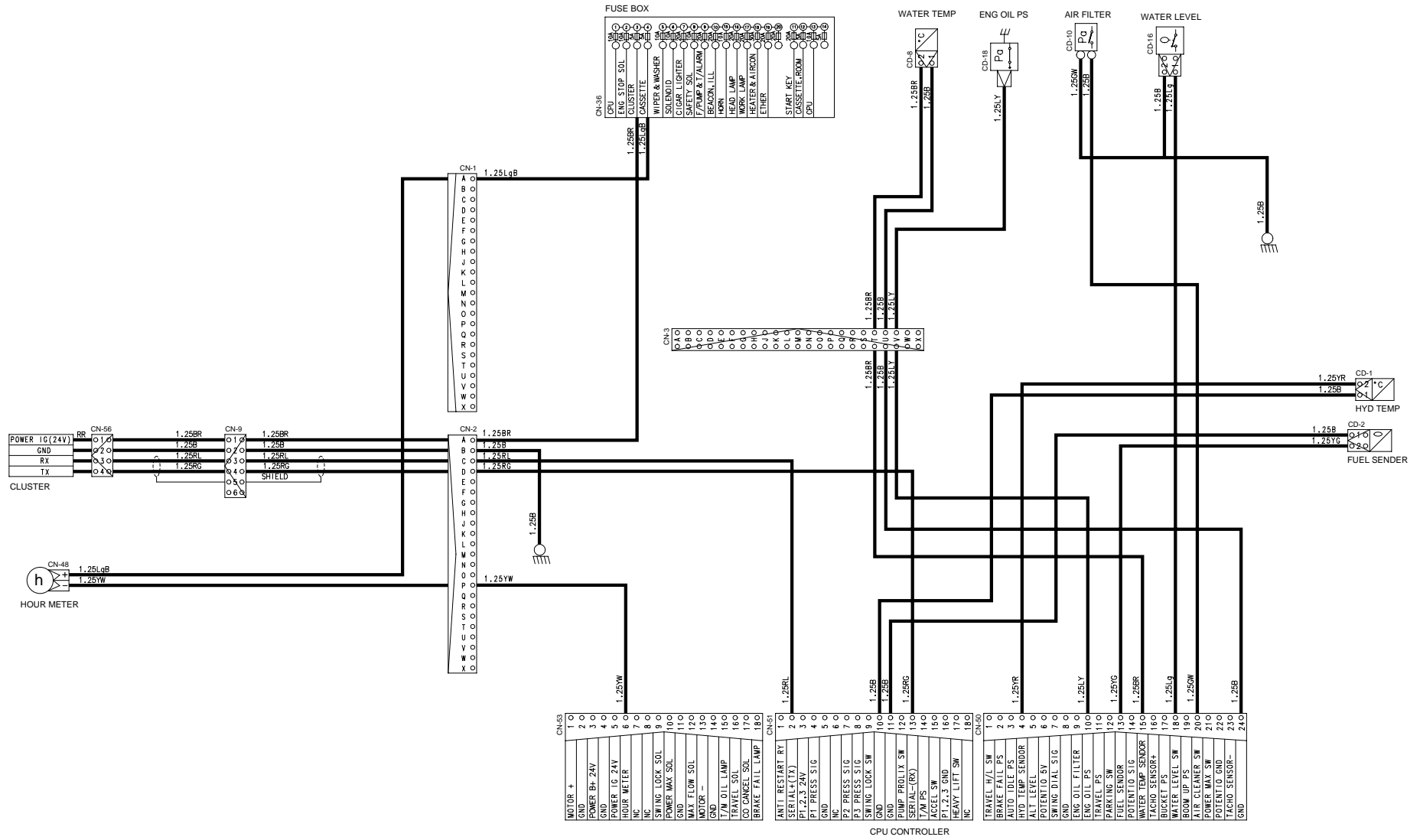
WIPER AND WASHER CIRCUIT



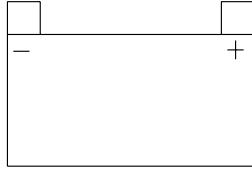
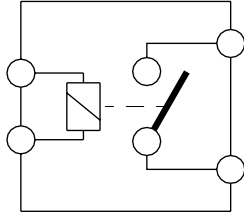
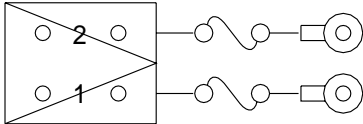
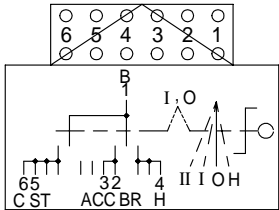
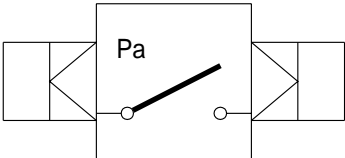
CONTROLLER CIRCUIT

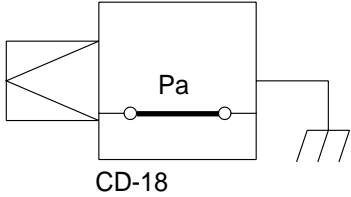
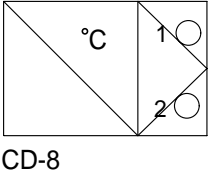
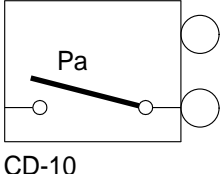
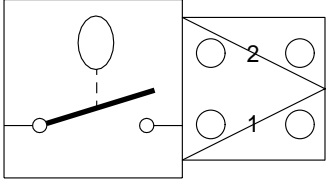
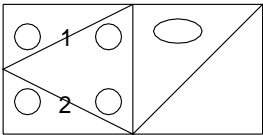
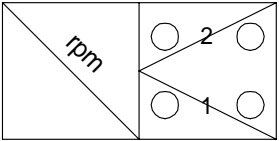


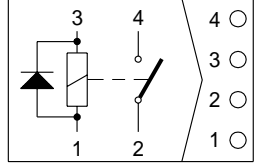
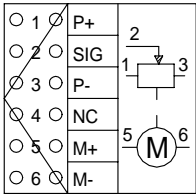
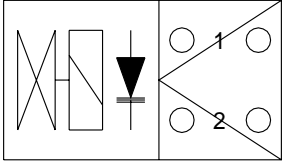
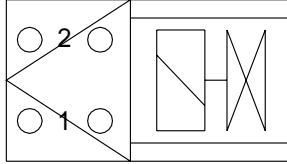
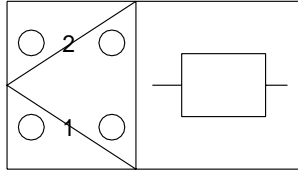
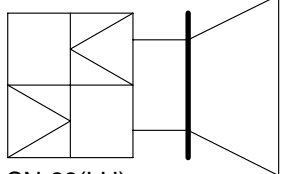
MONITORING CIRCUIT

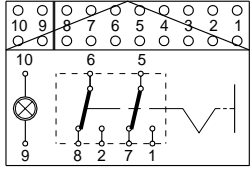
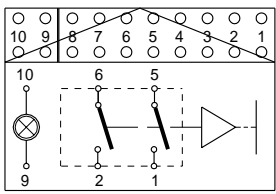
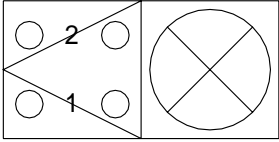
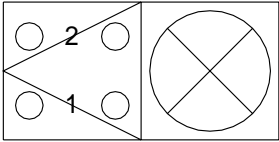
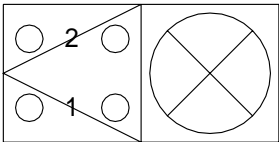
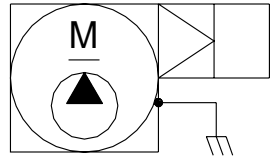


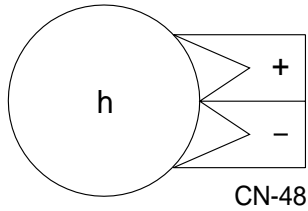
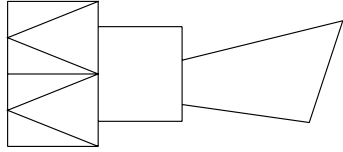
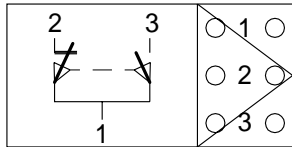
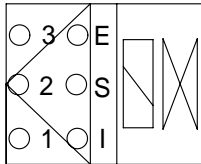
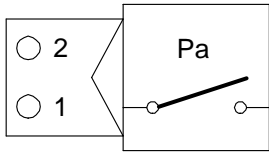
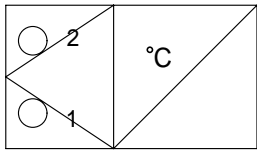
GROUP 3 ELECTRICAL COMPONENT SPECIFICATION

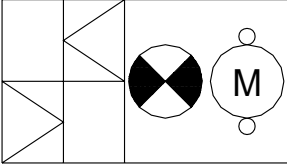
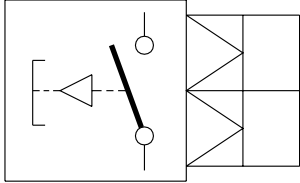
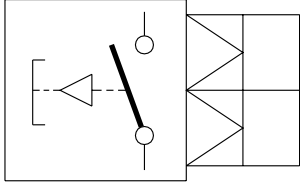
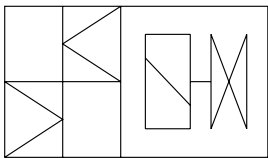
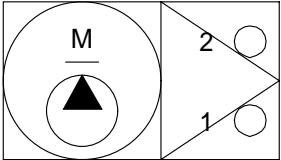
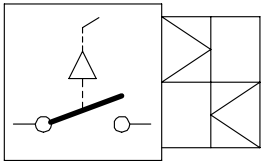
Part name	Symbol	Specifications	Check
Battery		12V × 160Ah (2EA)	<ul style="list-style-type: none"> ※ Check specific gravity 1.280 over : Over charged 1.280~1.250 : Normal 1.250 below : Recharging
Battery relay	 <p style="text-align: center;">CR-1</p>	Rated load : 24V 100A(Continuity) 1000A(30sec)	<ul style="list-style-type: none"> ※ Check coil resistance(M4 to M4) Normal : About 50 Ω ※ Check contact Normal : ∞ Ω
Fusible link	 <p style="text-align: center;">CN-60</p>	60A	<ul style="list-style-type: none"> ※ Check disconnection Normal : About 0 Ω (For terminal 1-ring term, terminal 2-ring term)
Start key	 <p style="text-align: center;">CS-2</p>	24V 40A	<ul style="list-style-type: none"> ※ Check contact OFF : ∞ Ω (For each terminal) ON : 0 Ω (For terminal 1-3, 1-2) START : 0 Ω (For terminal 1-5)
Pressure switch (For travel alarm)	 <p style="text-align: center;">CD-11~CD-14</p>	3~6kg/cm ² (N.O TYPE)	<ul style="list-style-type: none"> ※ Check contact Normal : ∞(OPEN)

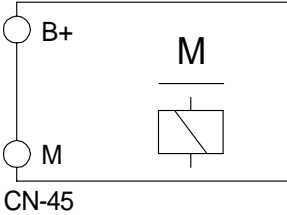
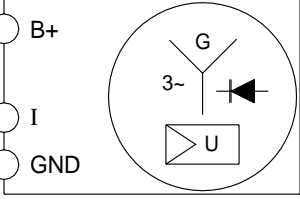
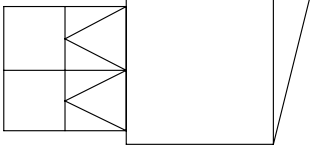
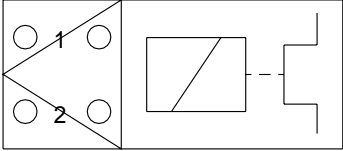
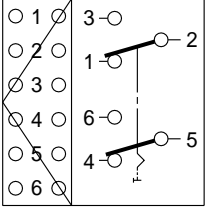
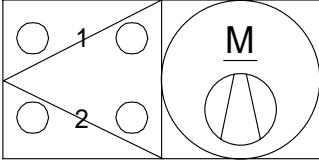
Part name	Symbol	Specifications	Check
Pressure switch (For engine oil)		0.5kg/cm ² (N. C TYPE)	※ Check resistance Normal : 0 Ω (CLOSE)
Coolant temperature sensor		-	※ Check resistance 50°C : 800 Ω 80°C : 310 Ω 100°C : 180 Ω
Air cleaner pressure switch		Pressure:635mm H ₂ O (N.O TYPE)	※ Check contact Normal : ∞ Ω
Coolant level sensor		24V 0.5A	※ Check contact High level : ∞ Ω Low level : 0 Ω
Fuel sender		-	※ Check resistance Full : 100 Ω 5/6 : 200 Ω 4/6 : 300 Ω 3/6 : 400 Ω 2/6 : 500 Ω 1/6 : 600 Ω Empty warning : 700 Ω
Tacho sensor		-	※ Check resistance Normal : 300 Ω (For terminal 1-2)

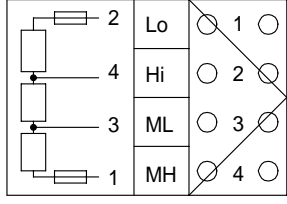
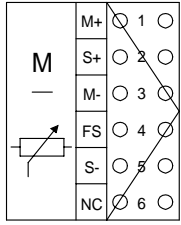
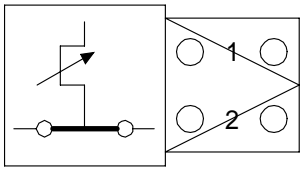
Part name	Symbol	Specifications	Check
Relay	 <p>CR-2, CR-3, CR-5</p>	24V 20A	※ Check resistance Normal : About 200 Ω (For terminal 1-3) ∞ Ω (For terminal 2-4)
Accel actuator	 <p>CN-76</p>	-	※ Check resistance Normal : 1~2 Ω (For terminal 5-6) 0.8~1.2kΩ (For terminal 1-3)
Solenoid valve	 <p>CN-66, CN-68, CN-70 CN-88, CN-89</p>	24V 1A	※ Check resistance Normal : 15~25 Ω (For terminal 1-2)
EPPR valve	 <p>CN-75</p>	700mA	※ Check resistance Normal : 15~25 Ω (For terminal 1-2)
Resistor	 <p>CN-47</p>	50 Ω	※ Check resistance Normal : 45~55 Ω
Speaker	 <p>CN-23(LH) CN-24(RH)</p>	20W	※ Check resistance Normal : 3~5 Ω

Part name	Symbol	Specifications	Check
Switch (Locking type)	 <p>CS-16, CS-23, CS-27, CS-50, CS-54</p>	24V 8A	※ Check contact Normal ON : 0 Ω (For terminal 1-5, 2-6) ∞ Ω (For terminal 5-7, 6-8) OFF : ∞ Ω (For terminal 1-5, 2-6) 0 Ω (For terminal 5-7, 6-8)
Switch (Non-locking type)	 <p>CS-22</p>	24V 8A	※ Check contact Normal ON : 0 Ω (For terminal 1-5, 2-6) ∞ Ω (For terminal 5-7, 6-8) OFF : ∞ Ω (For terminal 1-5, 2-6) 0 Ω (For terminal 5-7, 6-8)
Head lamp	 <p>CL-3</p>	24V 70W (H3 TYPE)	※ Check disconnection Normal : 1.2 Ω (For terminal 1-2)
Work lamp	 <p>CL-5, CL-6</p>	24V 70W (H3 TYPE)	※ Check disconnection Normal : 1.2 Ω (For terminal 1-2)
Room lamp	 <p>CL-1</p>	24V 10W	※ Check disconnection Normal : A few Ω (For terminal 1-2)
Fuel filler pump	 <p>CN-61</p>	24V 10A 35 l /min	※ Check operation <ul style="list-style-type: none"> · Supply power(24V) to terminal 1 pin · Connect ring terminal with ground and turn the operation switch ON.

Part name	Symbol	Specifications	Check
Hour meter		-	※ Check operation · Supply power(24V) to terminal (+) and connect terminal (-) to ground.
Horn		DC 22.0~28.0V 2A	※ Check operation · Supply power(24V) to each terminal and connect ground.
Safety switch		24V 15A (N.C TYPE)	※ Check contact Normal : 0 Ω (For terminal 1-2) - ∞ Ω (For terminal 1-3) Operating : ∞ Ω (For terminal 1-2) - 0 Ω (For terminal 1-3)
Fuel cut-off		24V 25W	※ Check resistance Normal : 15~25 Ω
Pressure switch (Auto idle, travel)		DC 5V 10mA~100mA (N.O TYPE)	※ Check contact Normal : 100M Ω
Hydraulic temperature sensor		-	※ Check resistance 50°C : 800 Ω 80°C : 310 Ω 100°C : 180 Ω 120°C : 100 Ω

Part name	Symbol	Specifications	Check
Beacon lamp	 <p>CL-7</p>	24V 70W	※ Check disconnection Normal : 1.1 Ω
Power boost switch	 <p>CS-29</p>	24V 6A	※ Check contact Normal : 15M Ω
Horn switch	 <p>CS-5</p>	24V 6A	※ Check contact Normal : 15M Ω
Ether	 <p>CN-78</p>	24V 15A	※ Check contact Normal : 1.1 Ω
Washer tank	 <p>CN-22</p>	24V 3.8A	※ Check contact Normal : 10.7 Ω (For terminal 1-2)
Pedal switch	 <p>CS-26</p>	24V 15A	※ Check contact Normal ON : 0 Ω (For terminal)

Part name	Symbol	Specifications	Check
Starter	 <p>CN-45</p>	DELCO REMY 28MT 24V	※ Check contact Normal : 0.1 Ω
Alternator	 <p>CN-74</p>	24V 60A	※ Check contact Normal : 0 Ω (For terminal B ⁺ - I) Normal : 24~27.5V
Travel alarm	 <p>CN-65</p>	24V 0.5A	※ Check contact Normal : 5.2 Ω
Compressor	 <p>CN-28</p>	24V 79W	※ Check contact Normal : 13.4 Ω
Prolix switch	 <p>CS-7</p>	24V~150V 15A	※ Check contact Normal : 0.2 Ω (For terminal 1-2) Emergency : 1.2 Ω (For terminal 2-3) : 50 Ω (For terminal 2-6) : 0 Ω (For terminal 5-6)
Blower		24V 9A	-

Part name	Symbol	Specifications	Check
Aircon resistor		24~28V	※ Check contact Normal : 0.9 Ω (For terminal 2-4) : 3.3 Ω (For terminal 1-3) : 5.4 Ω (For terminal 1-4) : 5.7 Ω (For terminal 1-2)
Mode actuator & Temp actuator		9~16V 300mA MAX	-
Thermostat		-	※ Working temperature of contact point : AC ON → 4.5°C AC OFF → 1.5°C Differential of temperature → 3° C Reted input volt : 24V

GROUP 4 CONNECTORS

1. CONNECTOR DESTINATION

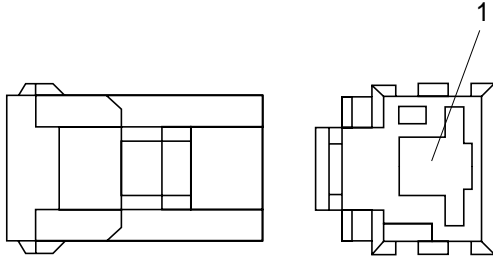
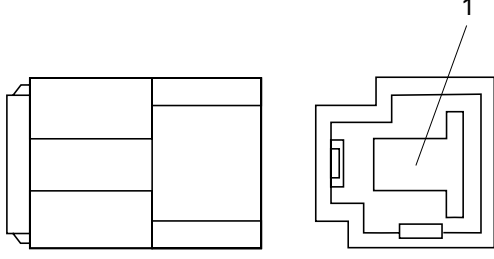
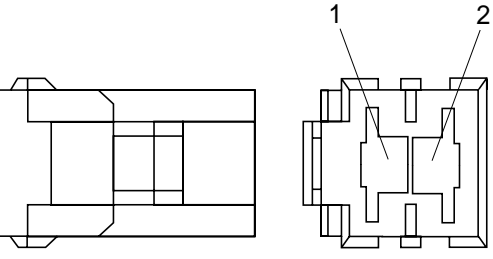
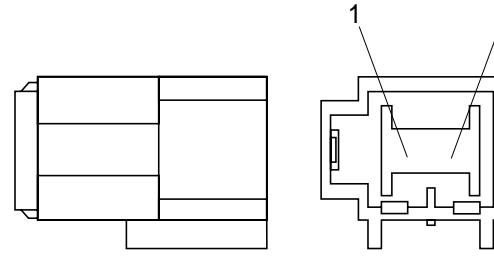
Connector number	Type	No. of pin	Destination	Destination	
				Female	Male
CN-1	DEUTSCH	23	I/conn(Frame harness-main harness)	HD36-24-23SE	HD34-24-23PE
CN-2	DEUTSCH	23	I/conn(Frame harness-main harness)	HD36-24-23SE	HD34-24-23PE
CN-3	DEUTSCH	23	I/conn(Engine harness-frame harness)	HD36-24-23SE	HD34-24-23PE
CN-4	SWP	4	I/conn(Engine harness)	S814-004001	-
CN-6	SWP	8	I/conn(Cabin harness-main harness)	S814-008001	S814-108001
CN-9	SWP	6	I/conn(Cabin harness-main harness)	S814-006001	S814-106001
CN-10	BS	2	I/conn(Boom harness-frame harness)	MG610574-4	MG640188
CN-13	CN	4	I/conn(Wiper harness-cabin harness)	S810-004503	7122-2040
CN-14	CN	4	I/conn(Cabin harness-beacon lamp)	S810-004202	-
CN-20	MARK- II	1	Horn	S819-010112	-
CN-21	CN	4	Wiper motor	S810-004202	-
CN-22	CN	2	Washer tank	MG640605	-
CN-23	KET	1	Speaker(LH)	S822-014000	S822-114000
CN-24	KET	1	Speaker(RH)	S822-014000	S822-114000
CN-25	MARK- II	1	Horn	S819-010112	-
CN-27	PA	9	Cassette & radio	S811-009003	-
CN-28	CN	2	Compressor	0297-3407	-
CN-29	AMP	2	Receiver dryer	21L7-12000	-
CN-30	AMP	13	Aircon controller	S811-013002	-
CN-31	CN	2	Blower	S810-002202	-
CN-36	SWP	20	Fuse box	21L7-00250	-
CN-45	RING-TERM	-	Start motor B ⁺	S820-406000	-
CN-47	CN	2	Resistor	S810-002202	-
CN-48	CN	2	Hour meter	S810-002202	-
CN-50	T&B	24	CPU controller	943700-52	-
CN-51	T&B	18	CPU controller		-
CN-52	T&B	10	CPU controller		-
CN-53	T&B	18	CPU controller	951400-18	-
CN-56	DEUTSCH	4	Cluster	DT04-4P-E003	-
CN-60	58-L	2	Fusible link	S813-030200	S813-130200
CN-61	KET	1	Fuel filler pump	S822-015004	S822-115001
CN-65	KET	1	Travel alarm buzzer	S822-014000	S822-114001

Connector number	Type	No. of pin	Destination	Destination	
				Female	Male
CN-66	SWP	2	Breaker solenoid	S814-002000	S814-102001
CN-68	SWP	2	Safety solenoid	S814-002000	S814-102001
CN-70	SWP	2	Travel solenoid	S814-002000	S814-102001
CN-74	RING-TERM	-	Alternator "I" term	S820-104000	-
CN-75	AMP	2	EPPR valve	174354-2	174352-2
CN-76	DEUTSCH	6	DC motor	DT06-6S-E003	-
CN-78	KET	1	Ether	S822-014000	S822-114000
CN-79	RING-TERM	3	Fuel cut-off solenoid	S818-020311	-
CN-88	SWP	2	Power boost solenoid	S814-002000	S814-102001
CN-89	SWP	2	Arm half solenoid	S814-002000	S814-102001
CN-91	CN	8	AC EVA assembly	S810-008202	-
CN-92	SWP	12	AC EVA assembly	S814-012001	-
· Relay					
CR-1	RING-TERM	-	Battery relay	S820-104000	-
CR-2	CN	4	Horn relay	S810-004202	-
CR-3	CN	4	Work lamp relay	S810-004202	-
CR-5	CN	4	Start safety	S810-004202	-
CR-23	CN	2	Start relay	S810-004202	-
· Switch					
CS-1	KET	1	Door switch	S822-004202	-
CS-2	SWP	6	Start switch	S814-006001	-
CS-3	SWF	10	Wiper & washer switch	SWF, 593757	-
CS-4	CN	3	Safety switch	S810-003202	-
CS-5	KET	1	Horn switch	S822-014000	-
CS-7	SWP	6	Prolix switch	S814-006001	-
CS-16	SWF	10	Travel alarm switch	SWF, 593757	-
CS-21	SWF	10	Light switch	SWF, 593757	-
CS-22	SWF	10	Cold start switch	SWF, 593757	-
CS-23	SWF	10	Beacon lamp switch	SWF, 593757	-
CS-26	KET	1	Pedal switch	S822-014000	S822-114000
CS-27	SWF	10	Breaker switch	SWF, 593757	-
CS-29	KET	1	Power boost switch	S822-014000	-
CS-50	SWF	10	Arm half switch	SWF, 593757	-
CS-54	SWF	10	Aircon switch	SWF, 593757	-
CS-58	CN	6	Aircon blower switch	S810-006202	-

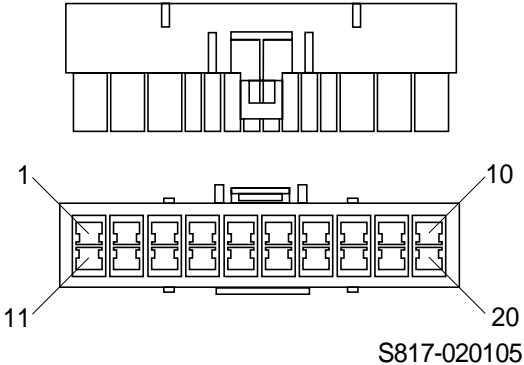
Connector number	Type	No. of pin	Destination	Destination	
				Female	Male
· Light					
CL-1	CN	2	Room lamp	MG610392	-
CL-2	KET	1	Cigar lighter	S822-014000	S822-114000
CL-3	SWP	2	Head lamp	S814-002001	S814-102001
CL-5, 6	SWP	2	Work lamp	S814-002000	S814-102000
CL-7	AMP	1	Beacon lamp	S822-014000	S822-114000
· Sensor, sendor					
CD-1	AMP	2	Hydraulic oil temp sender	85202-1	-
CD-2	SWP	2	Fuel sender	S814-002001	-
CD-6	AMP	1	Auto idle pressure switch	MG640795	-
CD-8	MARK- II	2	Water temp sender	85202-1	-
CD-10	RING-TERM	2	Air cleaner switch	S820-104000	-
CD-11	KET	1	Travel alarm pressure switch	1-150656	-
CD-12	KET	1	Travel alarm pressure switch	1-150656	-
CD-13	KET	1	Travel alarm pressure switch	1-150656	-
CD-14	KET	1	Travel alarm pressure switch	1-150656	-
CD-16	NC	2	Water level sender	S814-002001	-
CD-17	TWP	2	Tachosensor	-	S818-120221
CD-18	RING-TERM	2	Engine oil pressure switch	-	S820-104000

2. CONNECTION TABLE FOR CONNECTORS

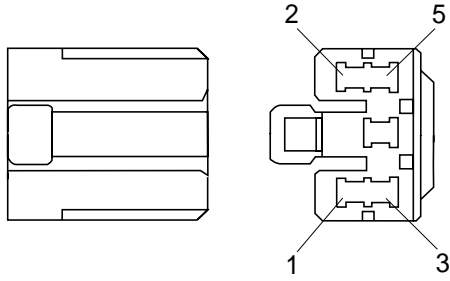
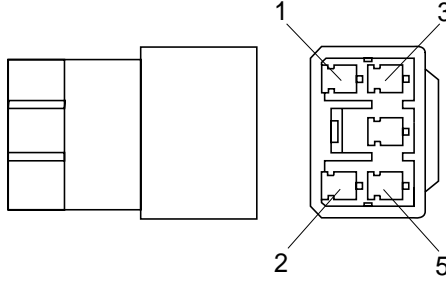
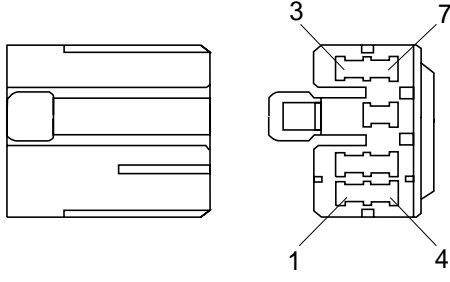
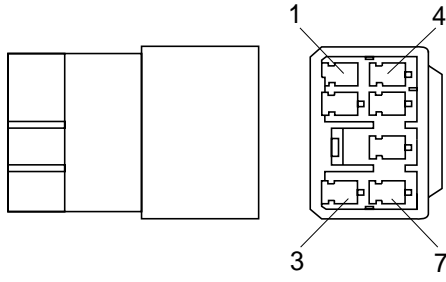
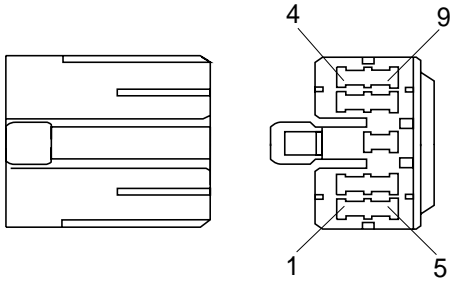
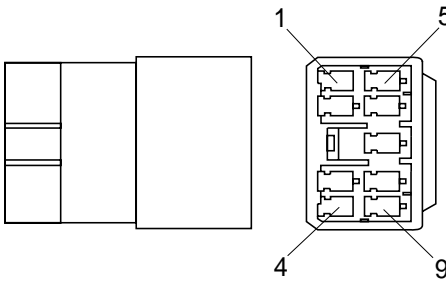
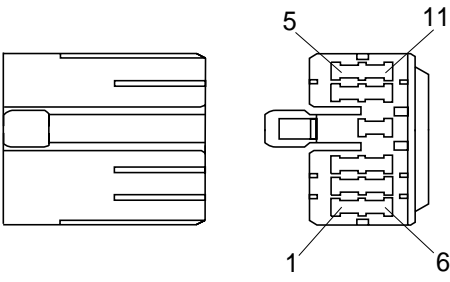
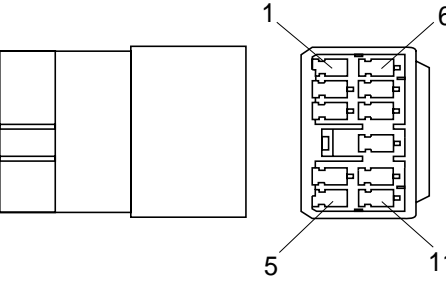
1) 58-L TYPE CONNECTOR

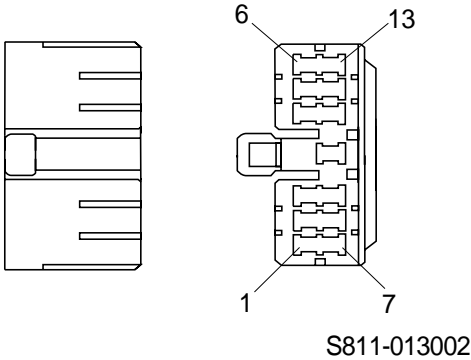
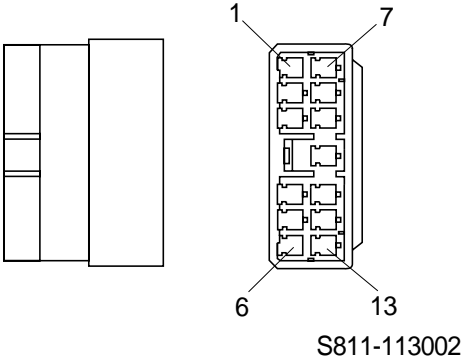
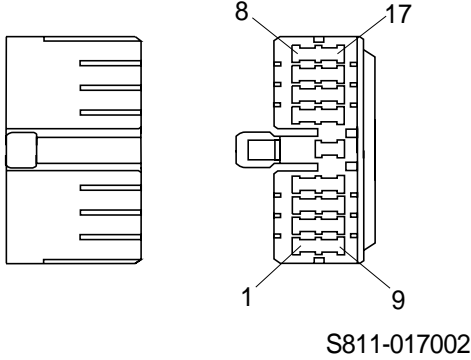
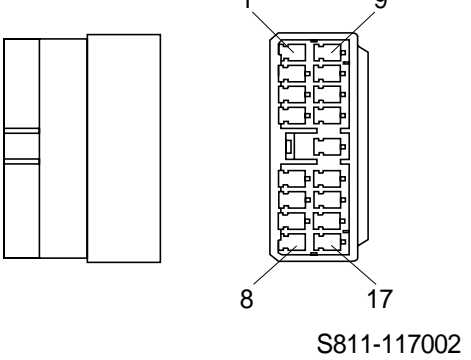
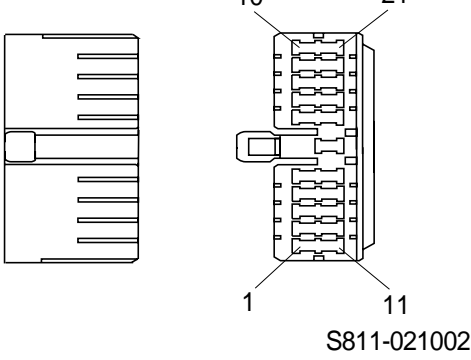
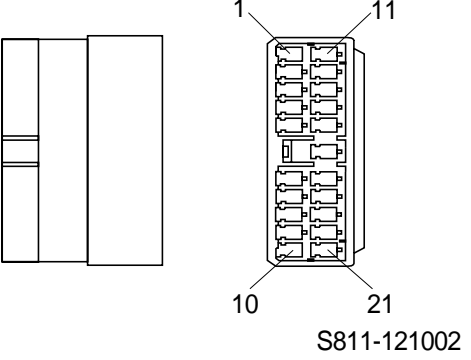
No. of pin	Receptacle connector(Female)	Plug connector(Male)
1	 <p style="text-align: center;">S813-030100</p>	 <p style="text-align: center;">S813-130100</p>
2	 <p style="text-align: center;">S813-030200</p>	 <p style="text-align: center;">S813-130200</p>

2) MULTILOCK TYPE CONNECTOR

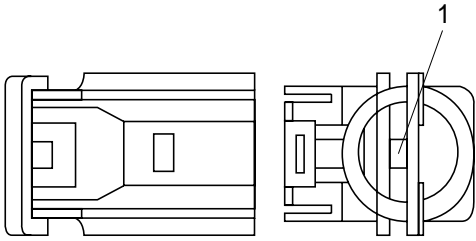
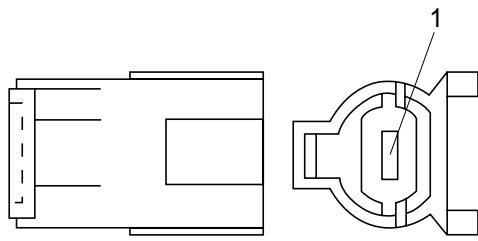
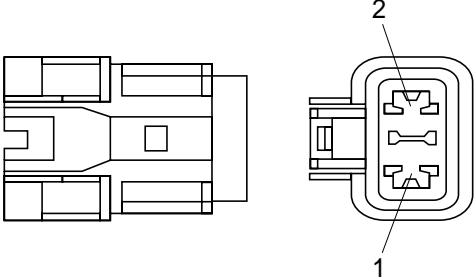
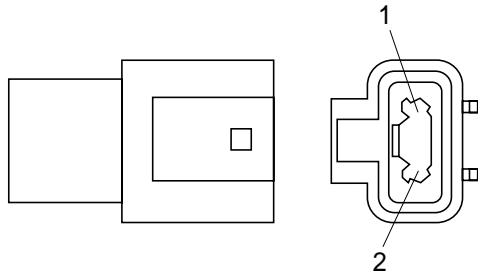
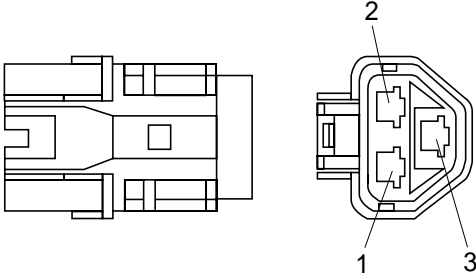
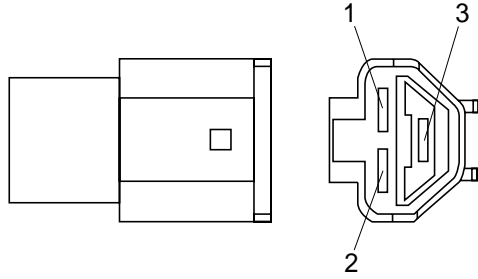
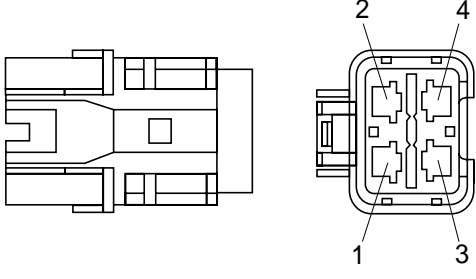
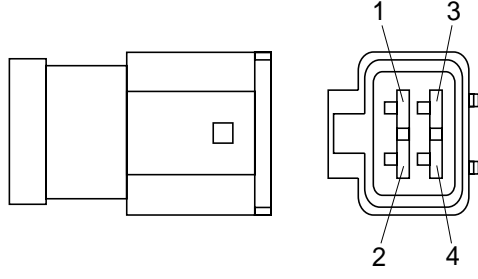
No. of pin	Receptacle connector(Female)	Plug connector(Male)
20	 <p>S817-020105</p>	

3) PA TYPE CONNECTOR

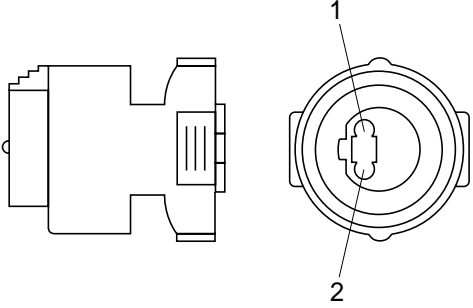
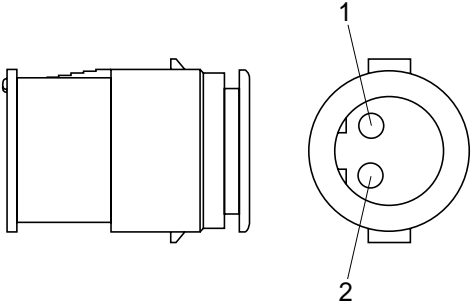
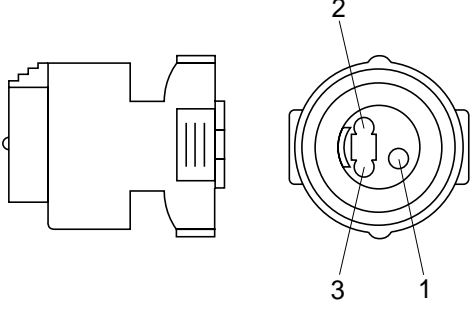
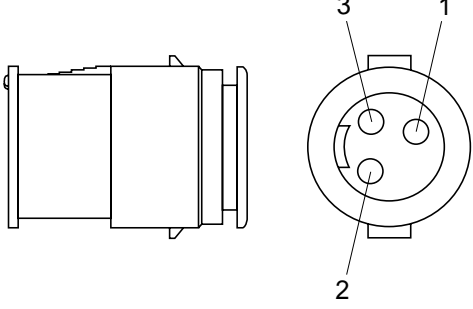
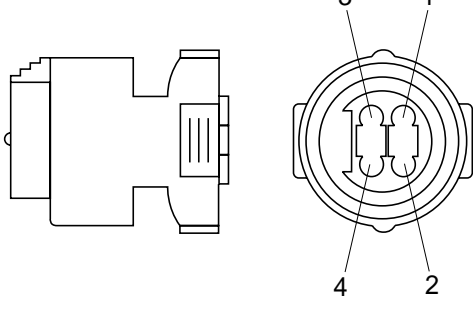
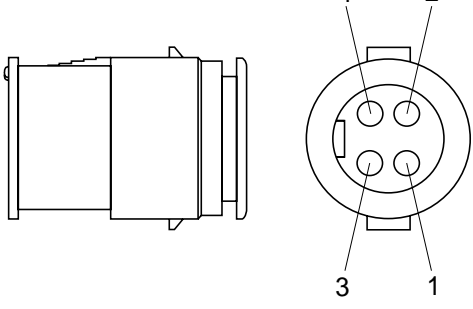
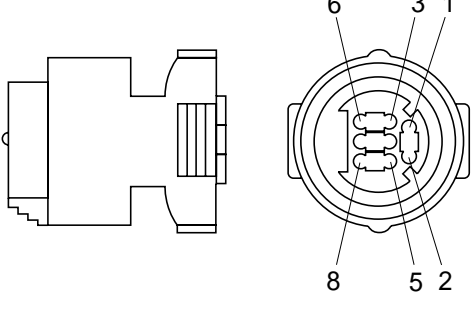
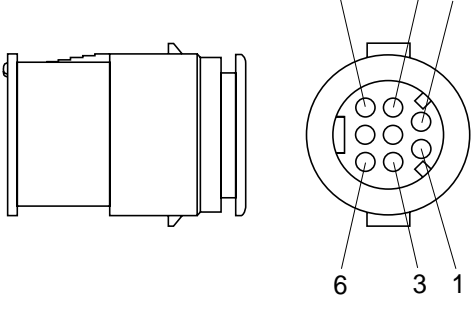
No. of pin	Receptacle connector(Female)	Plug connector(Male)
5	 <p style="text-align: center;">S811-005002</p>	 <p style="text-align: center;">S811-105002</p>
7	 <p style="text-align: center;">S811-007002</p>	 <p style="text-align: center;">S811-107002</p>
9	 <p style="text-align: center;">S811-009002</p>	 <p style="text-align: center;">3S811-109002</p>
11	 <p style="text-align: center;">S811-011002</p>	 <p style="text-align: center;">S811-111002</p>

No. of pin	Receptacle connector(Female)	Plug connector(Male)
13	 <p style="text-align: center;">S811-013002</p>	 <p style="text-align: center;">S811-113002</p>
17	 <p style="text-align: center;">S811-017002</p>	 <p style="text-align: center;">S811-117002</p>
21	 <p style="text-align: center;">S811-021002</p>	 <p style="text-align: center;">S811-121002</p>

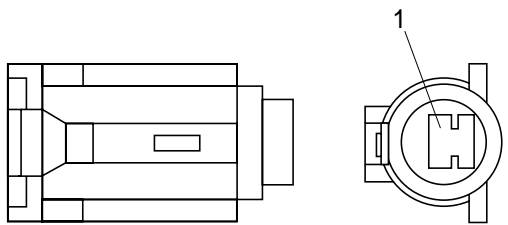
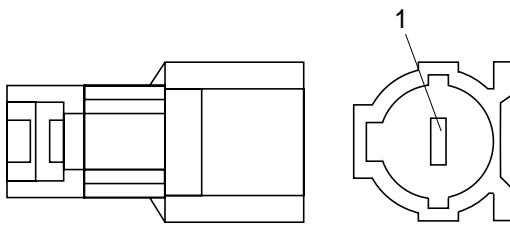
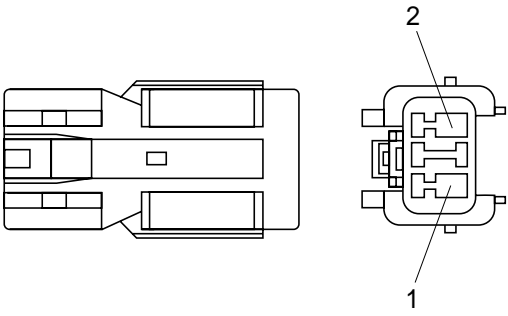
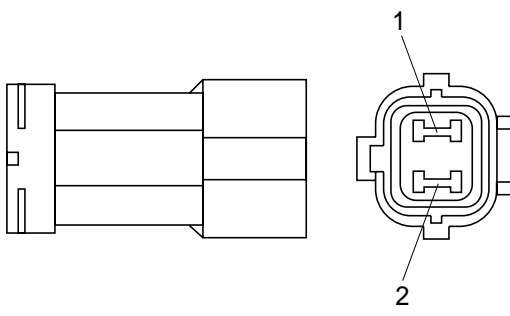
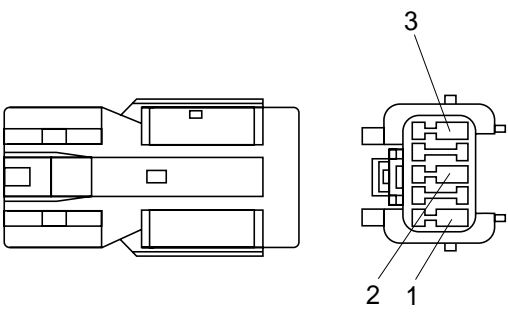
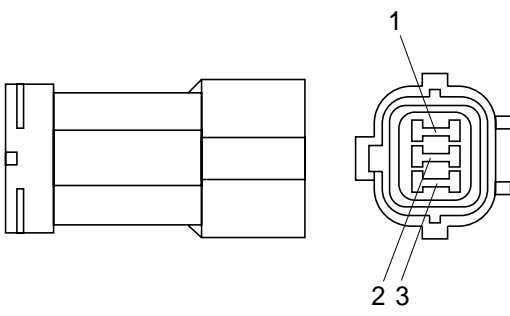
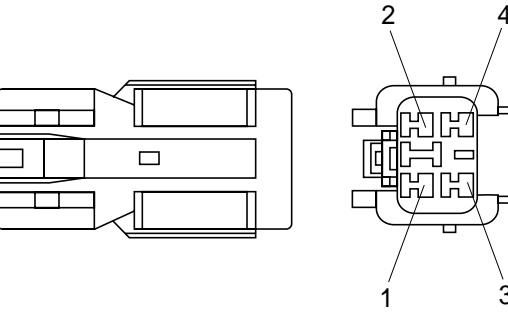
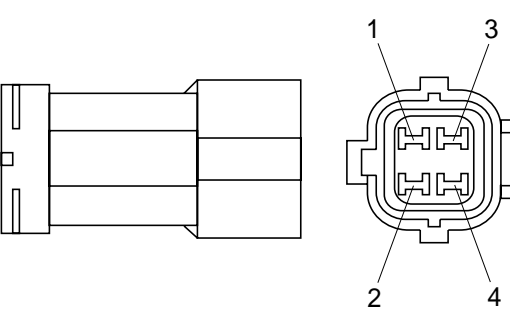
4) 58-X TYPE CONNECTOR

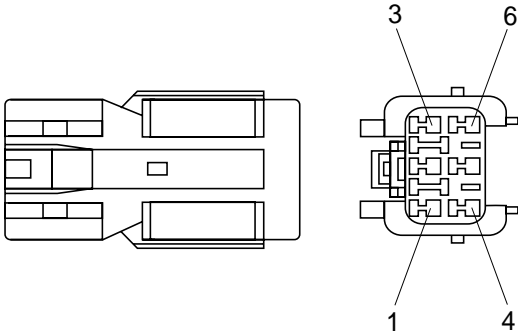
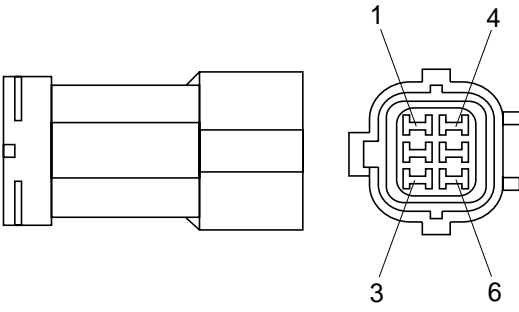
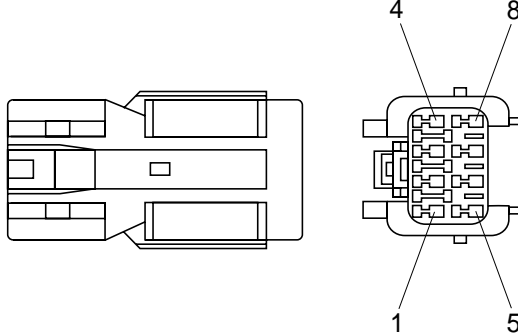
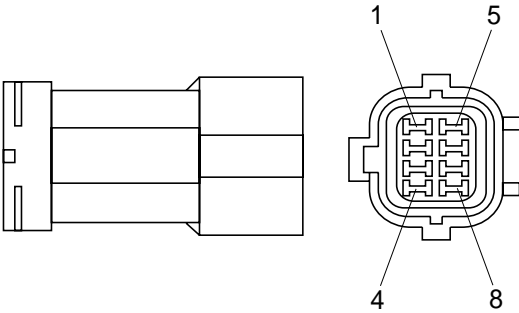
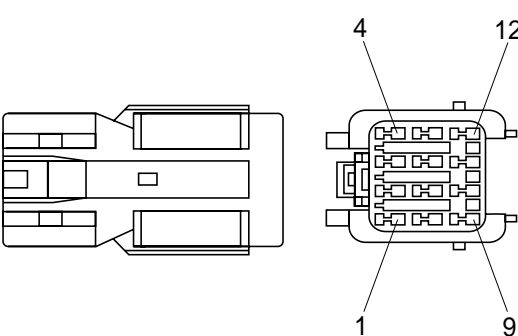
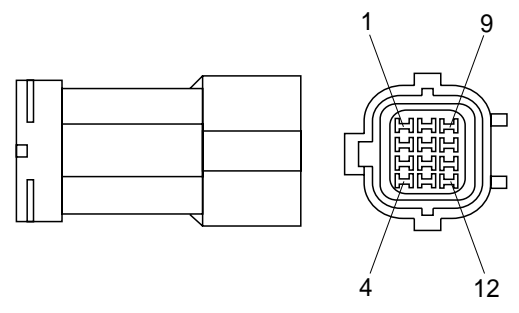
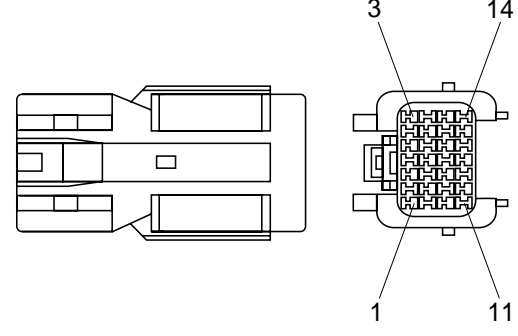
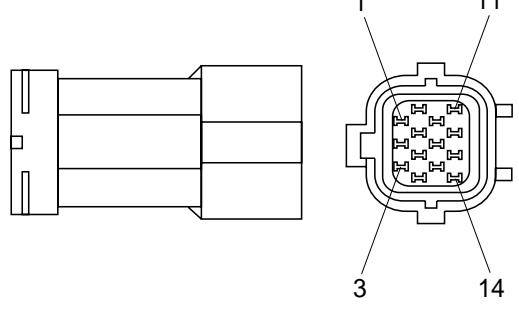
No. of pin	Receptacle connector(Female)	Plug connector(Male)
1	 <p data-bbox="686 678 837 712">S813-060100</p>	 <p data-bbox="1236 678 1388 712">S813-160100</p>
2	 <p data-bbox="686 1081 837 1115">S813-060200</p>	 <p data-bbox="1236 1081 1388 1115">S813-160200</p>
3	 <p data-bbox="686 1482 837 1516">S813-060300</p>	 <p data-bbox="1236 1482 1388 1516">S813-160300</p>
4	 <p data-bbox="686 1892 837 1926">S813-060400</p>	 <p data-bbox="1236 1892 1388 1926">S813-160400</p>

5) J TYPE CONNECTOR

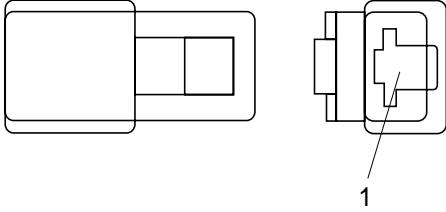
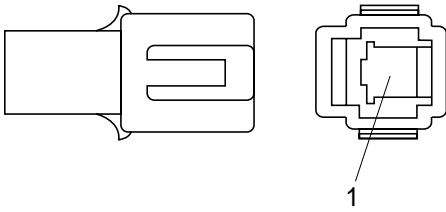
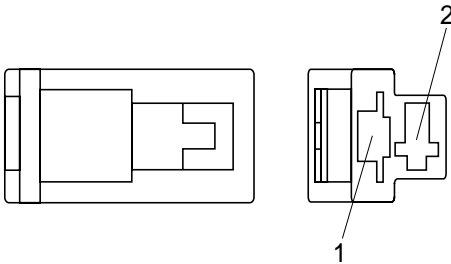
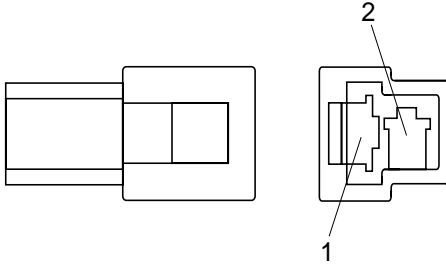
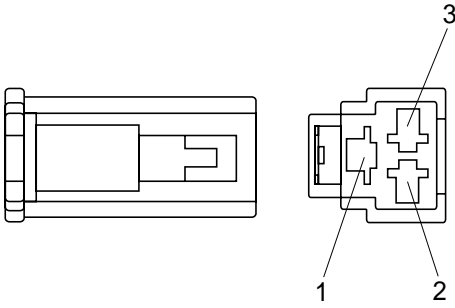
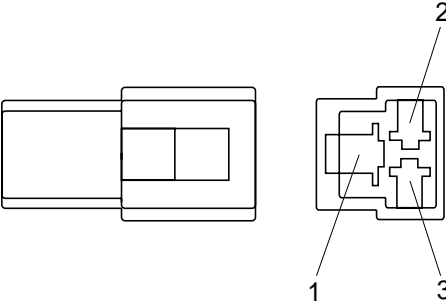
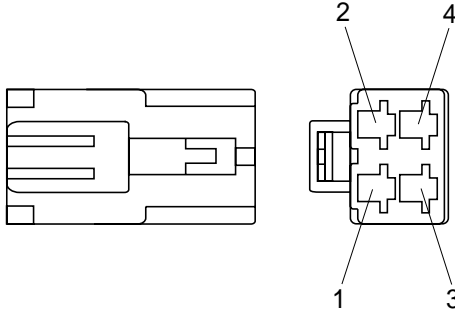
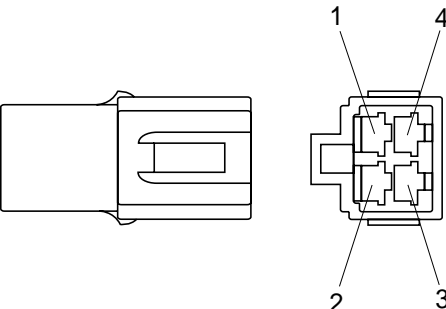
No. of pin	Receptacle connector(Female)	Plug connector(Male)
2	 <p style="text-align: center;">S816-002001</p>	 <p style="text-align: center;">S816-102001</p>
3	 <p style="text-align: center;">S816-003001</p>	 <p style="text-align: center;">S816-103001</p>
4	 <p style="text-align: center;">S816-004001</p>	 <p style="text-align: center;">S816-104001</p>
8	 <p style="text-align: center;">S816-008001</p>	 <p style="text-align: center;">S816-108001</p>

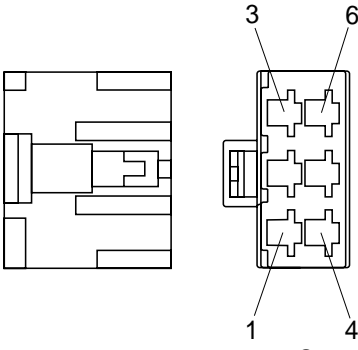
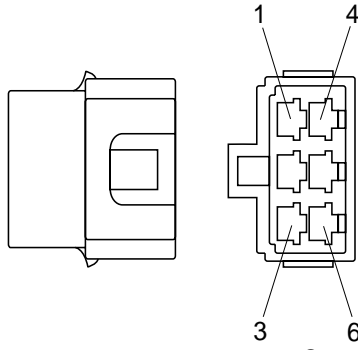
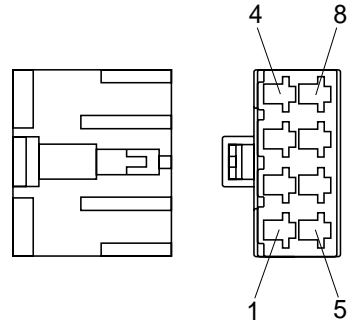
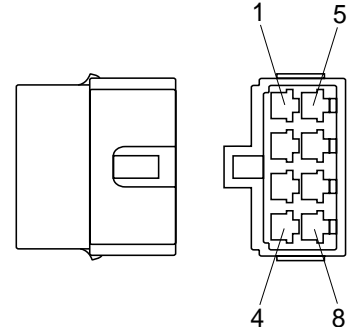
6) SWP TYPE CONNECTOR

No. of pin	Receptacle connector(Female)	Plug connector(Male)
1	 <p data-bbox="686 672 837 705">S814-001000</p>	 <p data-bbox="1236 672 1388 705">S814-101000</p>
2	 <p data-bbox="686 1086 837 1120">S814-002000</p>	 <p data-bbox="1236 1086 1388 1120">S814-102000</p>
3	 <p data-bbox="686 1489 837 1523">S814-003000</p>	 <p data-bbox="1236 1489 1388 1523">S814-103000</p>
4	 <p data-bbox="686 1892 837 1926">S814-004000</p>	 <p data-bbox="1236 1892 1388 1926">S814-104000</p>

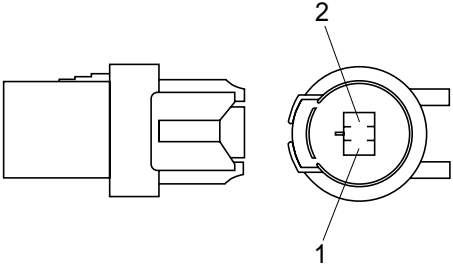
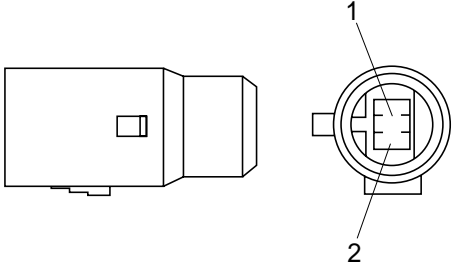
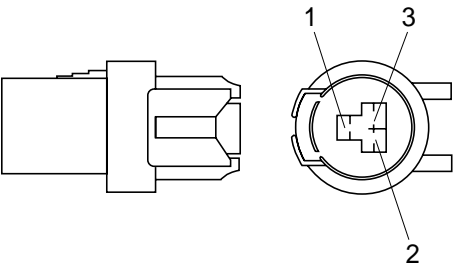
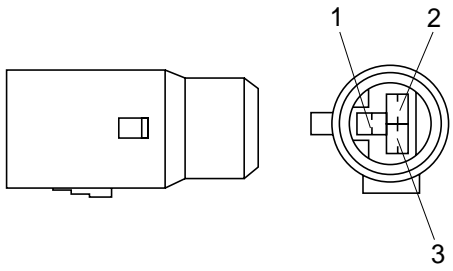
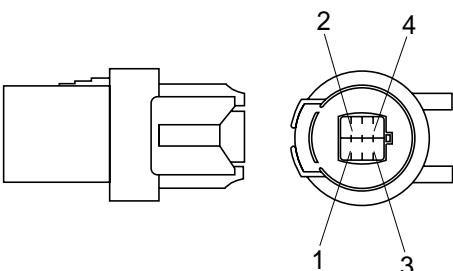
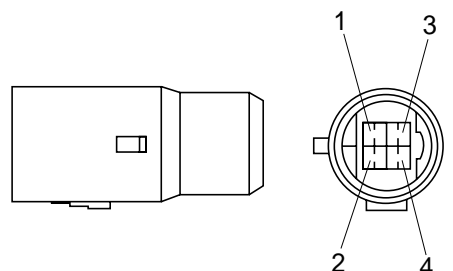
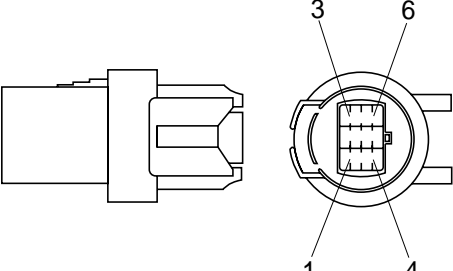
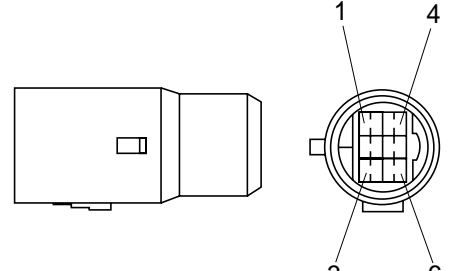
No. of pin	Receptacle connector(Female)	Plug connector(Male)
6	 <p data-bbox="687 680 836 707">S814-006000</p>	 <p data-bbox="1241 680 1390 707">S814-106000</p>
8	 <p data-bbox="687 1090 836 1117">S814-008000</p>	 <p data-bbox="1241 1090 1390 1117">S814-108000</p>
12	 <p data-bbox="687 1500 836 1527">S814-012000</p>	 <p data-bbox="1241 1500 1390 1527">S814-112000</p>
14	 <p data-bbox="687 1910 836 1937">S814-014000</p>	 <p data-bbox="1241 1910 1390 1937">S814-114000</p>

7) CN TYPE CONNECTOR

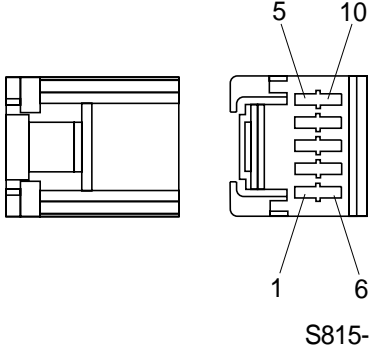
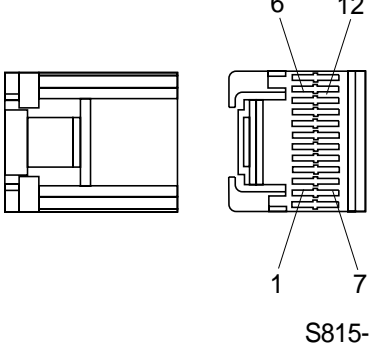
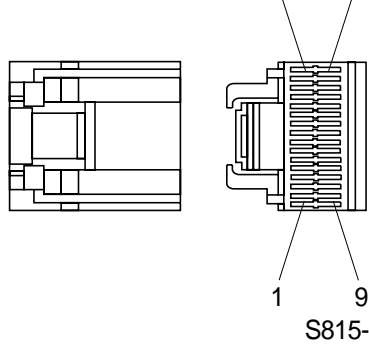
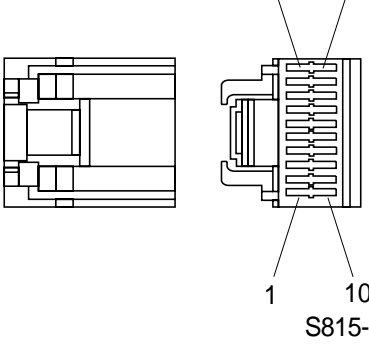
No. of pin	Receptacle connector(Female)	Plug connector(Male)
1	 <p style="text-align: center;">S810-001202</p>	 <p style="text-align: center;">S810-101202</p>
2	 <p style="text-align: center;">S810-002202</p>	 <p style="text-align: center;">S810-102202</p>
3	 <p style="text-align: center;">S810-003202</p>	 <p style="text-align: center;">S810-103202</p>
4	 <p style="text-align: center;">S810-004202</p>	 <p style="text-align: center;">S810-104202</p>

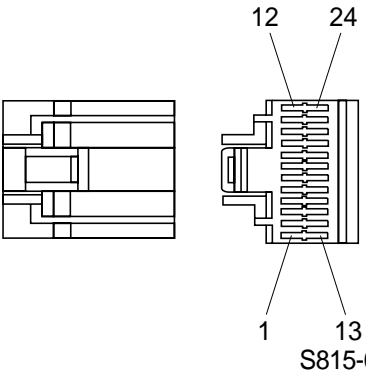
No. of pin	Receptacle connector(Female)	Plug connector(Male)
6	 <p data-bbox="686 683 837 712">S810-006202</p>	 <p data-bbox="1244 683 1396 712">S810-106202</p>
8	 <p data-bbox="686 1086 837 1115">S810-008202</p>	 <p data-bbox="1244 1086 1396 1115">S810-108202</p>

8) BS TYPE CONNECTOR

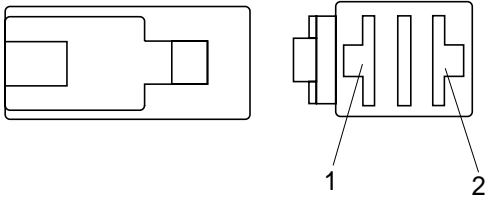
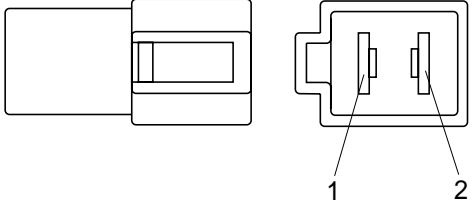
No. of pin	Receptacle connector(Female)	Plug connector(Male)
2	 <p style="text-align: center;">S812-002001</p>	 <p style="text-align: center;">S812-102001</p>
3	 <p style="text-align: center;">S812-003001</p>	 <p style="text-align: center;">S812-103001</p>
4	 <p style="text-align: center;">S812-004001</p>	 <p style="text-align: center;">S812-104001</p>
6	 <p style="text-align: center;">S812-006001</p>	 <p style="text-align: center;">S812-106001</p>

9) LC TYPE CONNECTOR

No. of pin	Receptacle connector(Female)	Plug connector(Male)
10	 <p style="text-align: center;">S815-010000</p>	
12	 <p style="text-align: center;">S815-012000</p>	
16	 <p style="text-align: center;">S815-016000</p>	
18	 <p style="text-align: center;">S815-018000</p>	

No. of pin	Receptacle connector(Female)	Plug connector(Male)
24	 <p style="text-align: center;">S815-024000</p>	

10) 375 FASTEN TYPE CONNECTOR

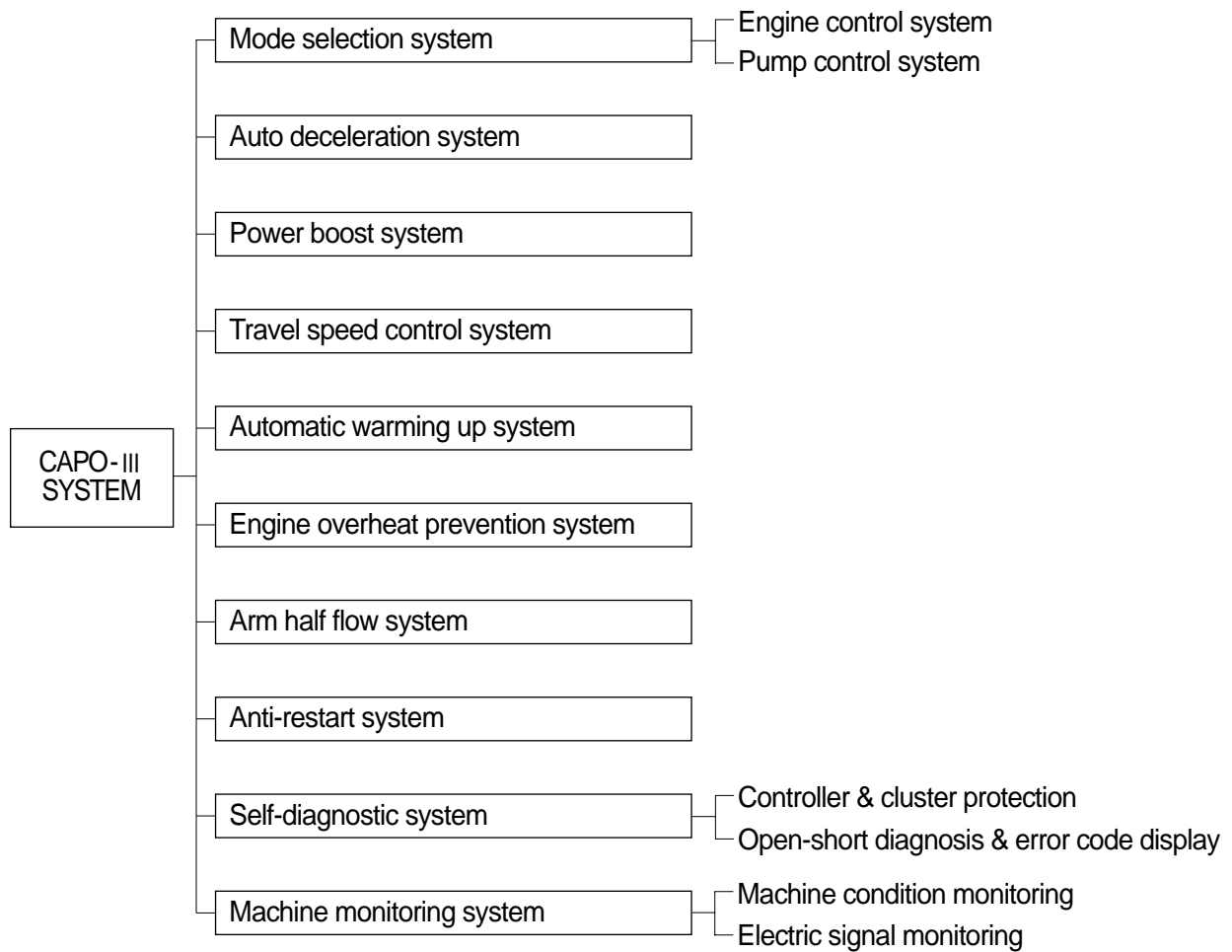
No. of pin	Receptacle connector(Female)	Plug connector(Male)
2	 <p style="text-align: center;">S810-002402</p>	 <p style="text-align: center;">S810-102402</p>

SECTION 5 MECHATRONICS SYSTEM

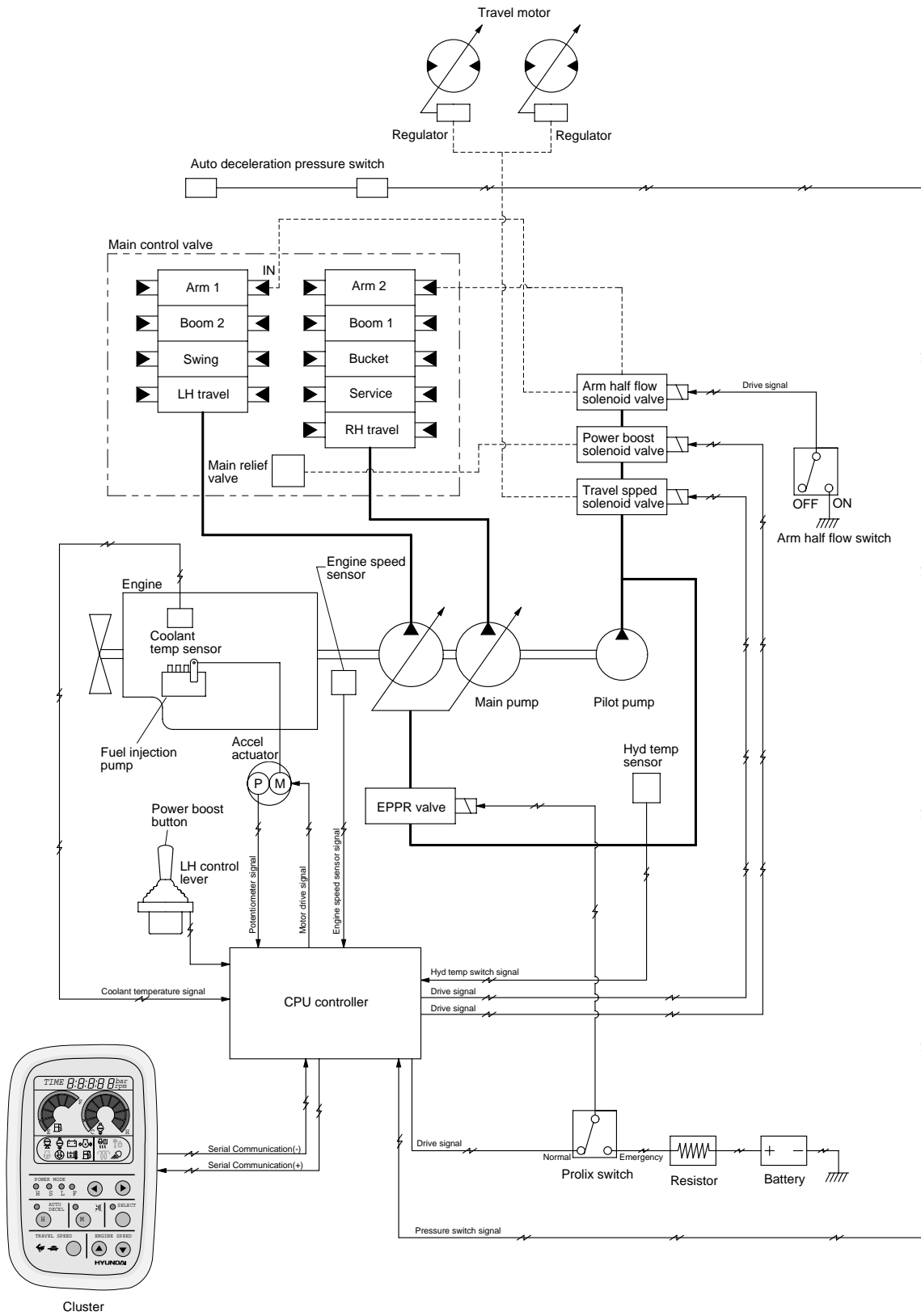
GROUP 1 OUTLINE

The CAPO(Computer Aided Power Optimization)-III system controls engine and pump mutual power at an optimum and less fuel consuming state for the selected work by mode selection, auto-deceleration, power boost function, etc. It monitors machine conditions, for instance, engine speed, coolant temperature, hydraulic oil temperature, and hydraulic oil pressure, etc.

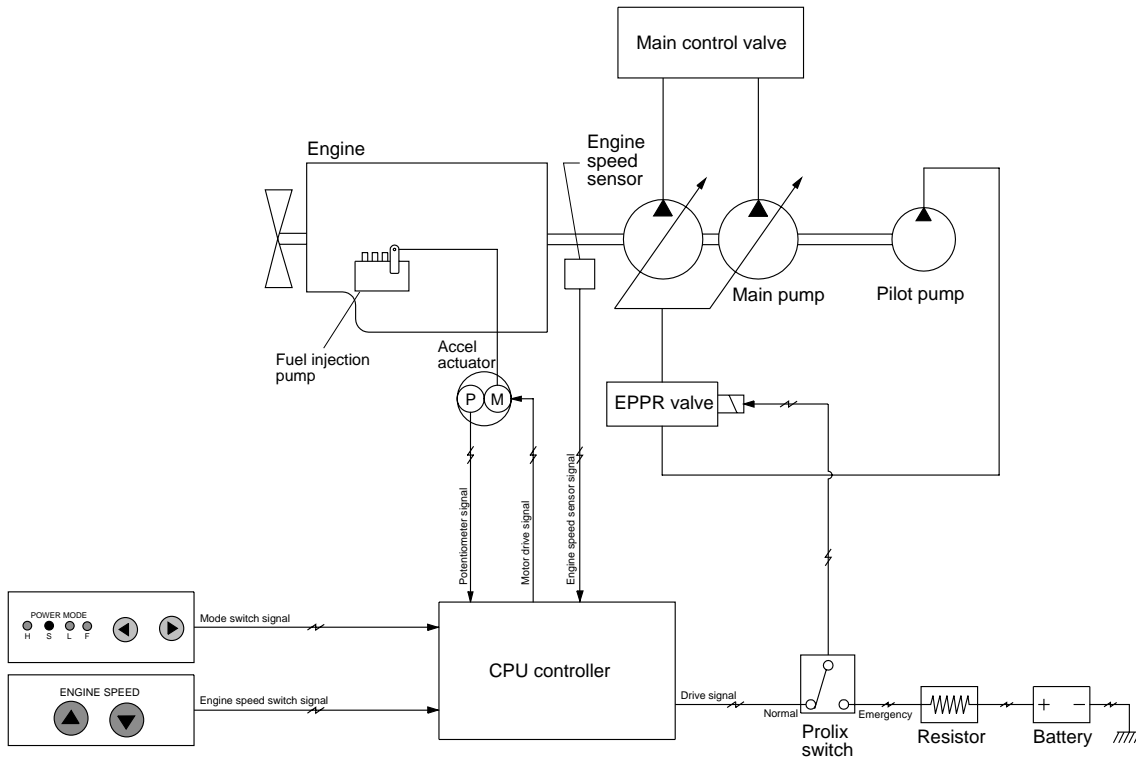
It consists of a CPU controller, a cluster, an accel actuator, an EPPR valve, and other components. The CPU controller and the cluster protect themselves from over-current and high voltage input, and diagnose malfunctions caused by short or open circuit in electric system, and display error codes on the cluster.



SYSTEM DIAGRAM



GROUP 2 MODE SELECTION SYSTEM



1. OUTLINE

Mode selection system(Micro computer based electro-hydraulic pump and engine mutual control system) optimizes the engine and pump performance.

The combination of 4 power modes(H, S, L, F) makes it possible to use the engine and pump power more effectively corresponding to the work conditions from a heavy and great power requesting work to a light and precise work.

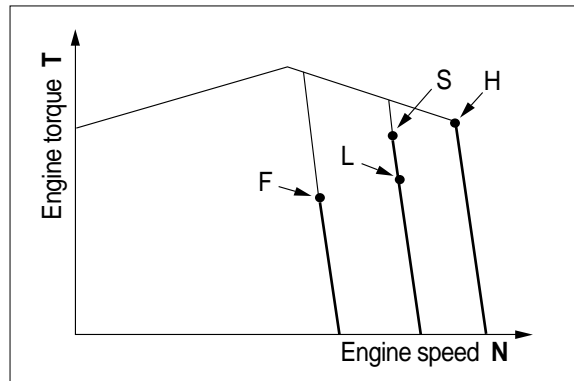
Mode	Application	Power set (%)	Engine rpm		Power shift by EPPR valve	
			Unload	Load	Current (mA)	Pressure (kgf/cm ²)
H	Heavy duty operation	100	2450±50	2200	160±30	0
S	Standard operation	85	2250±50	2000	260±30	6
L	Light duty operation	70	2250±50	2000	430±30	18
F	Finishing and precise operation	50	1750±50	1500	440±30	19
AUTO DECEL	Engine deceleration	-	1200±100	-	700±30	40
KEY START	Key switch start position	-	950±100	-	700±30	40

2. PUMP CONTROL BY ENGINE SPEED SENSING

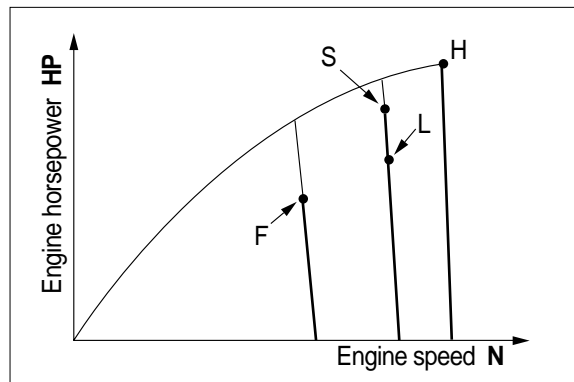
If any engine speed drops under the reference rpm of each mode set caused by the pump load are detected by the engine speed sensor, CPU controller sends calculated current signal to EPPR(Electro Proportional Pressure Reducing) valve to match engine torque with pump torque optimally by controlling the pump discharge volume.

- **H** : Heavy duty operation mode
- **S** : General operation mode
- **L** : Lifting operation mode
- **F** : Finishing operation mode

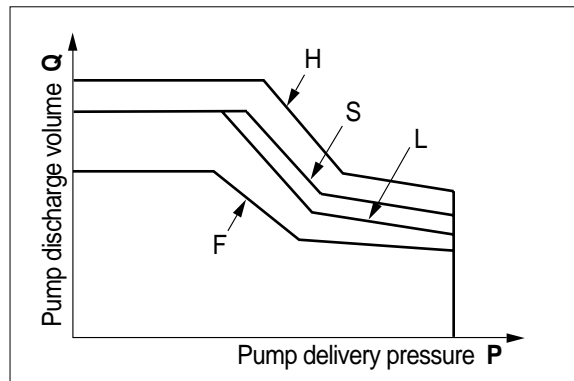
• Engine Torque



• Engine horsepower



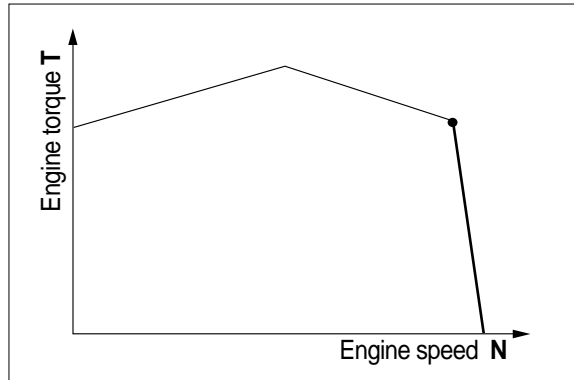
• Main pump delivery



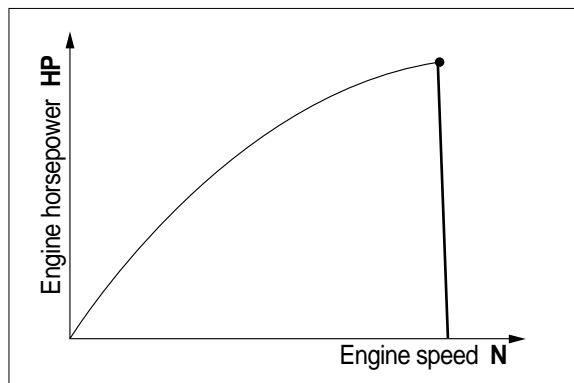
3. MAXIMUM POWER OF "H" MODE

- 1) When **H** mode is selected in the cluster, CPU controller moves the engine accel actuator to set the throttle lever to the full position and sends initial current signal to the EPPR valve to set the pump absorption torque high. So, it is possible to maximize the work performance by using 100% of the engine power at this mode.
- 2) If the pump load becomes too high and the engine speed drops, the CPU controller reduces the pump discharge amount and momentarily resets the engine speed to the rated point through engine speed sensing.

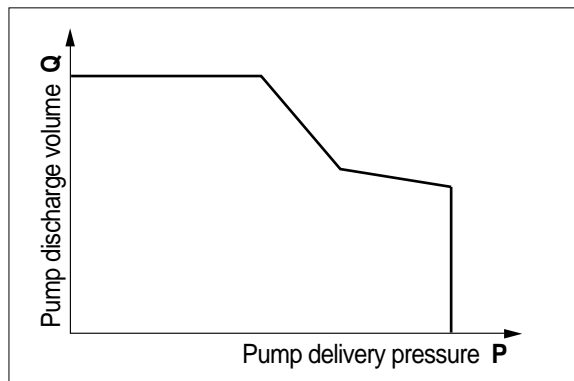
• Engine Torque



• Engine horsepower



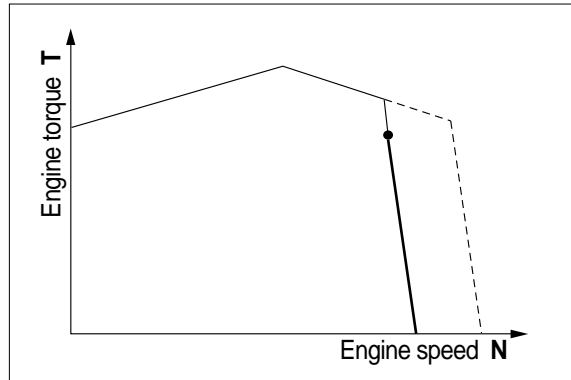
• Main pump delivery



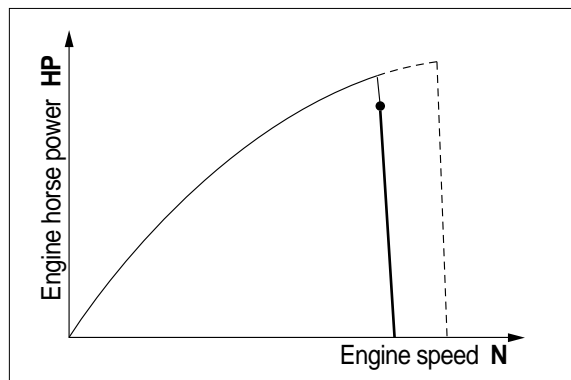
4. GENERAL STANDARD POWER OF "S" MODE

- 1) When **S** mode is selected in the cluster, CPU controller moves the engine accel actuator to set the throttle lever to the partial position and sends power shift current to EPPR valve which reduces the pump discharge. So the pump absorption horsepower is reduced by 15%.
- 2) At **S** mode operation energy saving is about 15% and engine speed sensing at the matching point is the same as for **H** mode.

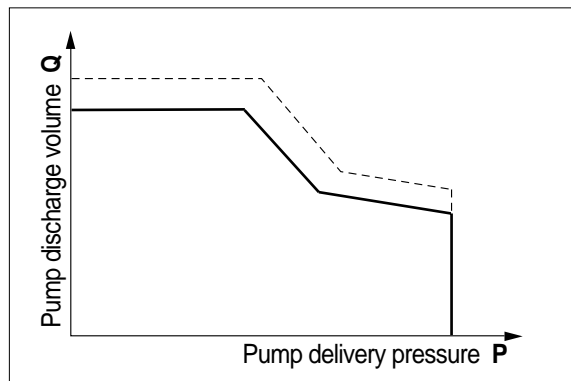
• Engine Torque



• Engine horsepower



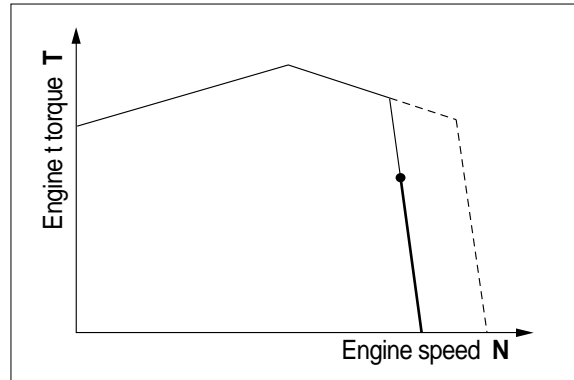
• Main pump delivery



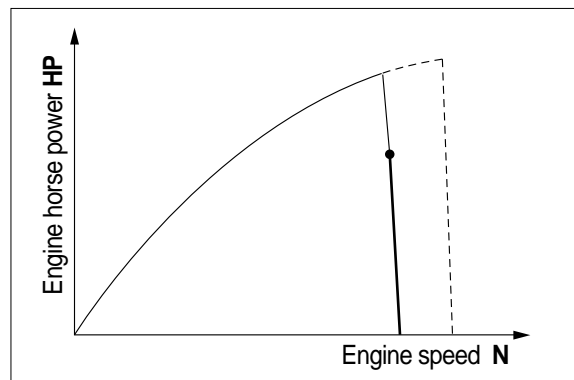
5. ENERGY SAVING AND LIGHT POWER OF "L" MODE

- 1) When L mode is selected in the cluster, CPU controller moves the engine accel actuator to set the throttle lever to the partial position and it sends large amount of power shift current to EPPR valve, which reduces the pump absorption horsepower 30%. So, at this mode it is useful for light work and energy saving.
- 2) Engine speed and pump absorption torque are different, but the engine speed sensing at the matching point is the same as for H mode.

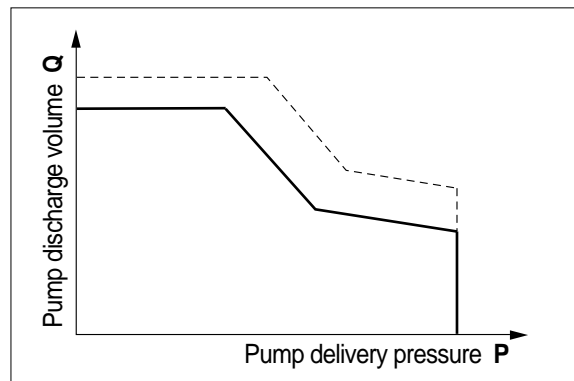
• Engine Torque



• Engine horsepower



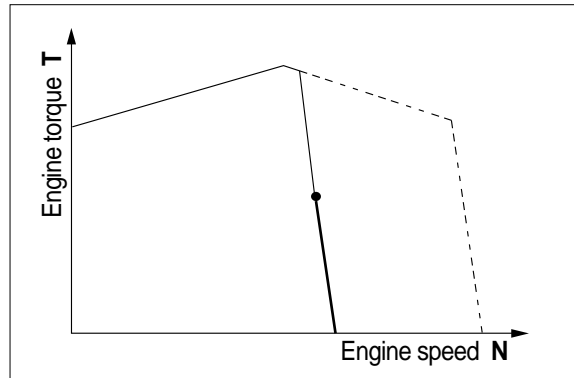
• Main pump delivery



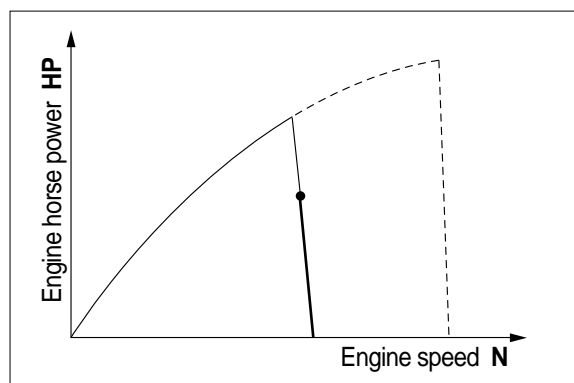
6. FINISHING WORK OF "F" MODE

- 1) When **F** mode is selected in the cluster, CPU controller moves the engine accel actuator to set the throttle lever to the partial position and it sends large amount of power shift current to EPPR valve to reduce the pump absorption horsepower to 50% of full horsepower. So, at this mode it is useful for light and precise work, especially for finishing work.
- 2) Engine speed is set at highly efficient area for engine fuel consumption, so the fuel reduction effect is extremely high.

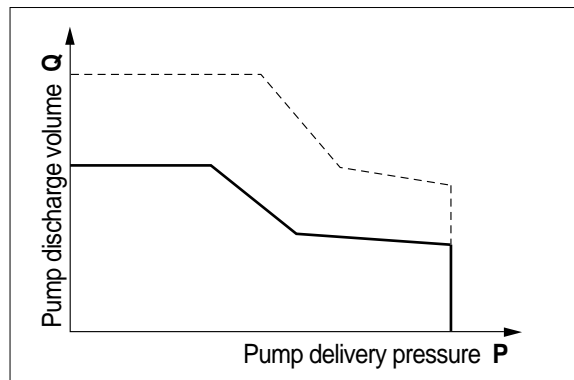
• Engine Torque

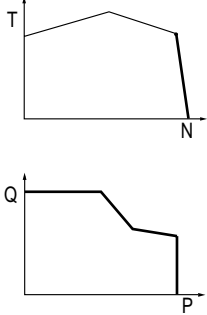
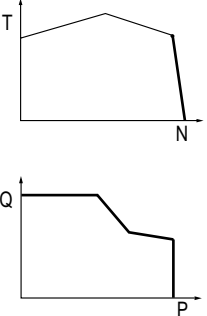
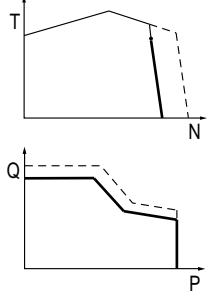
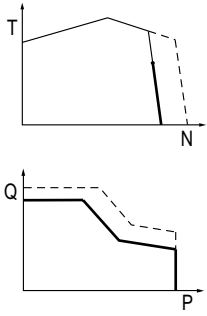
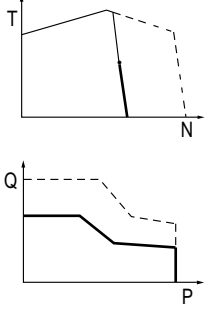


• Engine horsepower

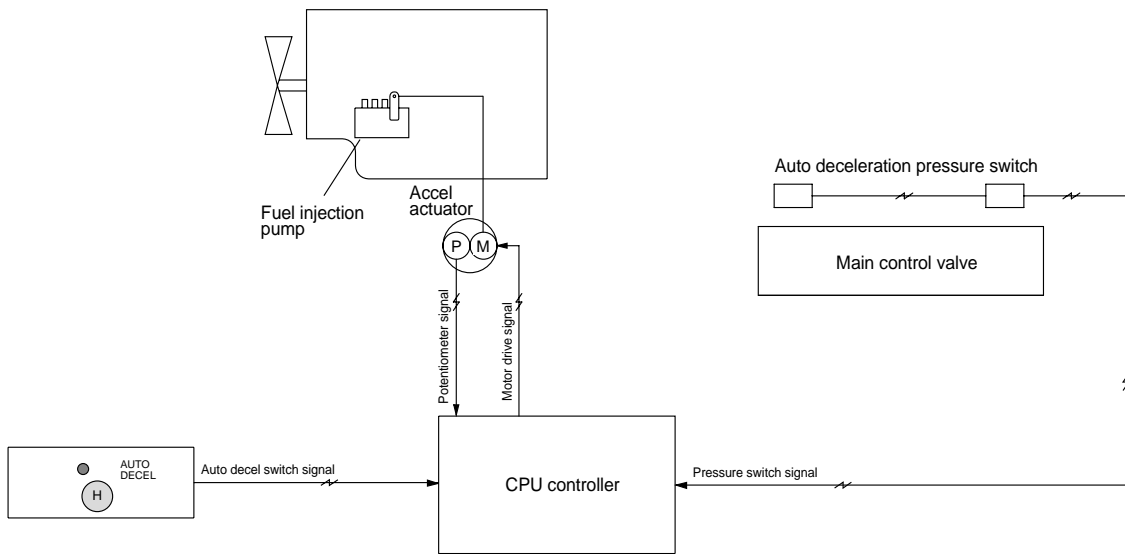


• Main pump delivery



Mode	Power boost switch OFF		Power boost switch ON		Other functions	
	Power set	Level of achievement	Power set	Level of achievement	Auto decel	Overheat prevention
H	100HP/ 2200rpm	<ul style="list-style-type: none"> Full power used by engine speed sensing. 	161HP/ 2200rpm	<ul style="list-style-type: none"> Full power used by engine speed sensing. Power increased by power boost solenoid valve. 	ON / OFF	ON
S	85HP/ 2000rpm	<ul style="list-style-type: none"> Fuel consumption improved by partial use of engine power. 			ON / OFF	ON
L	70HP/ 2000rpm	<ul style="list-style-type: none"> Slow and precise machine operation. 		←	ON / OFF	ON
F	50HP/ 1500rpm	<ul style="list-style-type: none"> Increase of fine control range. High improvement in fuel consumption by lowering engine speed. 		←	ON / OFF	ON

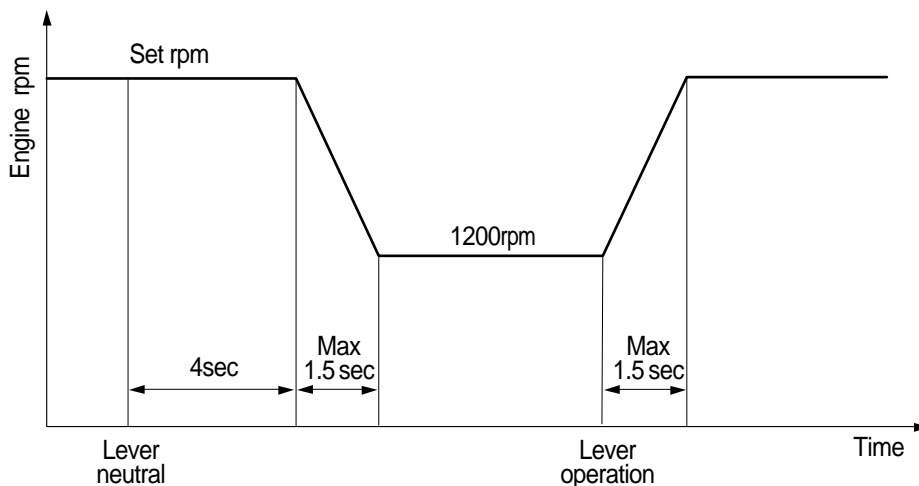
GROUP 3 AUTOMATIC DECELERATION SYSTEM



1. WHEN AUTO DECEL LAMP ON

If all the work equipment control levers including swing and travel levers are at neutral for at least 4 seconds, CPU controller drives the accel actuator to reduce the engine speed to 1200rpm. As the result of reducing the engine speed, fuel consumption and noise are effectively cut down during non-operation of the control levers.

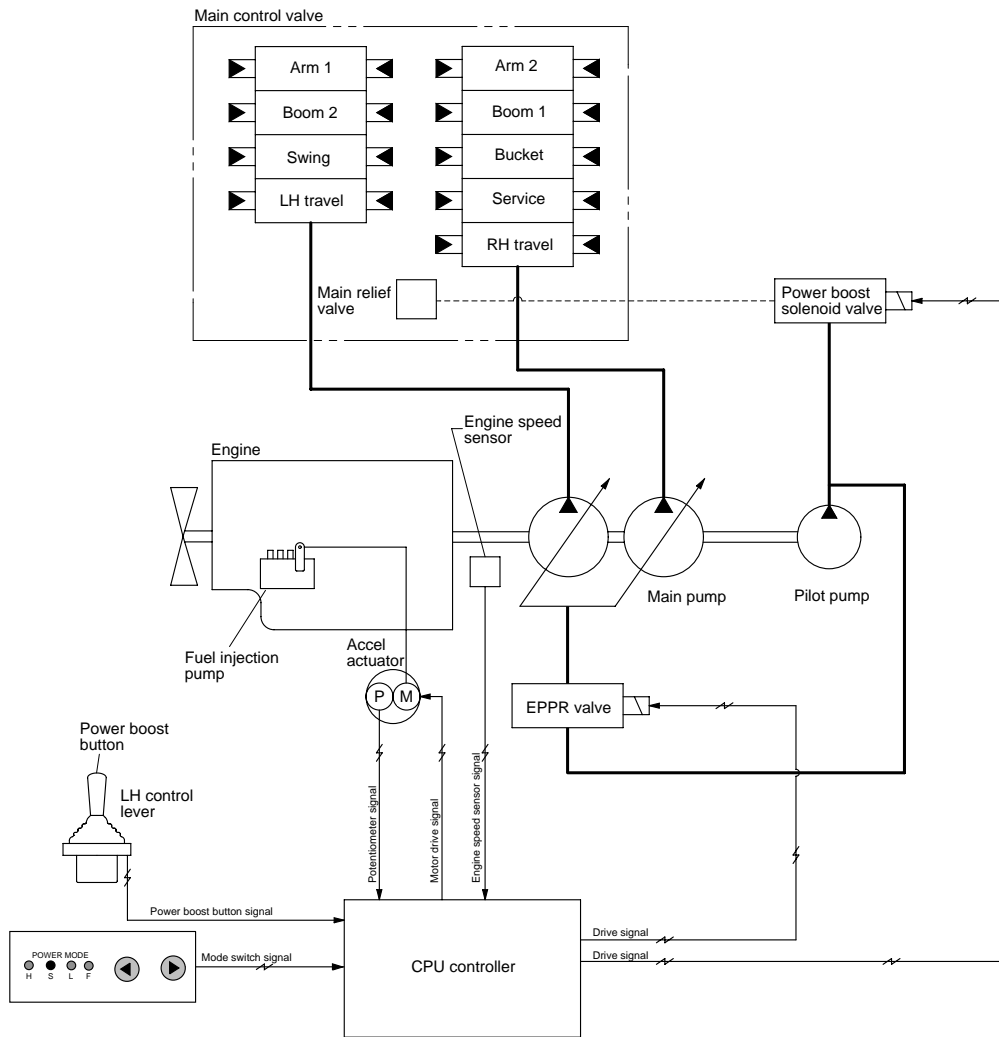
When the auto decel lamp is turned off by pressing the auto decel switch or any control lever is operated, the reduced engine speed rises up to the speed set before deceleration in a second.



2. WHEN AUTO DECEL LAMP OFF

Auto deceleration function is not activated, and the engine speed can be set as desired by power mode switches and engine speed switches on the cluster.

GROUP 4 POWER BOOST SYSTEM



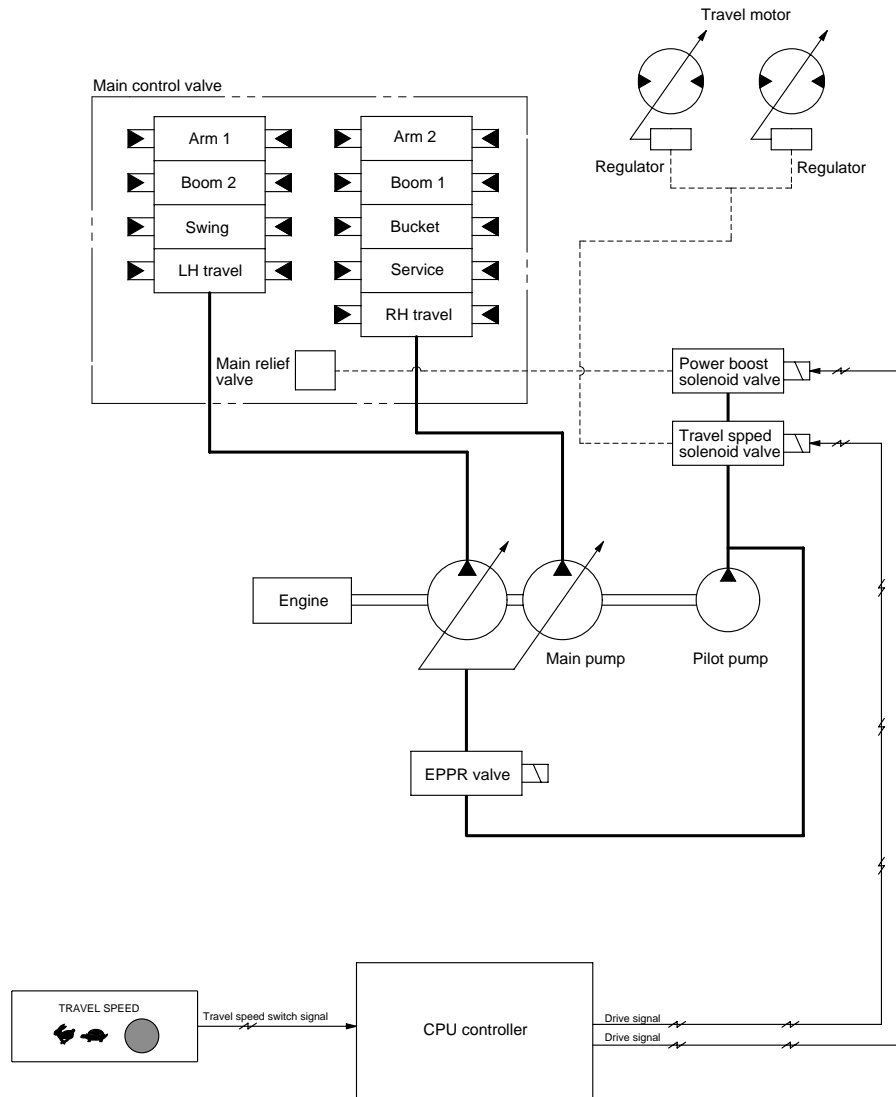
- When the power boost switch on the left control lever knob is pushed ON, the maximum digging power is increased by 10%.
- When the power set is at H or S and the power boost function is activated, the power boost solenoid valve pilot pressure raises the set pressure of the main relief valve to increase the digging power.

Description	Power boost switch	
	OFF	ON
Power set	H or S	H
Main relief valve set pressure	320kgf/cm ²	350kgf/cm ²
Time of operation	-	Even when pressed continuously, it is canceled after 8 sec.

※ This function does not work at L and F.

※ Default — Power boost solenoid valve : OFF

GROUP 5 TRAVEL SPEED CONTROL SYSTEM



1. TRAVEL SPEED SELECTION

Travel speed can be switched manually by pressing the travel speed switch on the cluster.

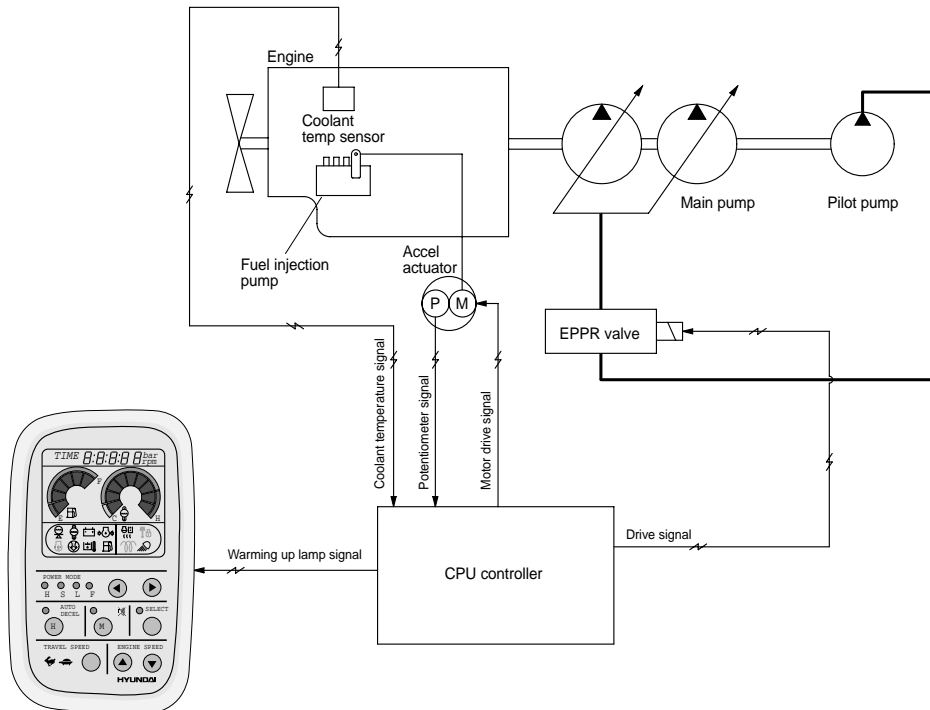
Speed	Travel speed solenoid valve	Lamp on cluster	Operation
Lo	OFF	Turtle	Low speed, high driving torque in travel motors
Hi	ON	Rabbit	High speed, low driving torque in travel motors

※ Default : Turtle(Lo)

2. POWER BOOST IN TRAVEL

When the operation of travel control levers is detected by travel oil pressure switch, CPU controller send signal to set the pressure of the main relief valve from 320kgf/cm² to 350kgf/cm² to indrease travel power.

GROUP 6 AUTOMATIC WARMING UP FUNCTION

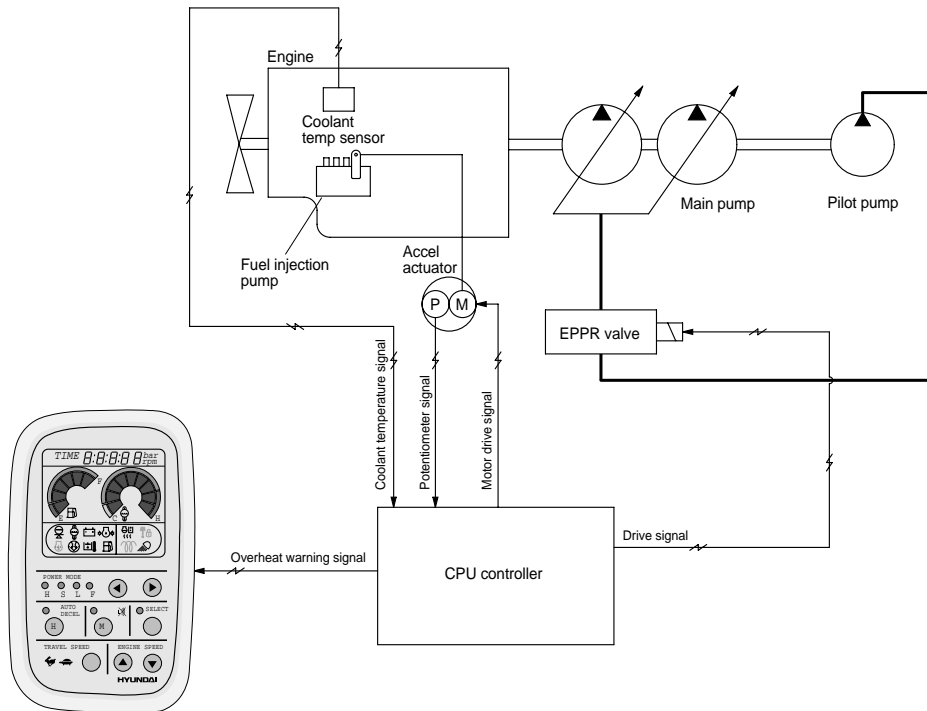


1. CPU controller reads engine coolant temperature through the temperature sensor, and if the coolant temperature is less than 30°C, it increases the engine speed from key start rpm to 1200rpm. At this time the mode does not change.
2. In case of the coolant temperature increases upto 30°C, the engine speed is decreased to key start speed. And if an operator changes mode set during the warming up function, the CPU controller cancels the automatic warming up function.

3. LOGIC TABLE

Description	Condition	Function
Actuated	- Coolant temperature : Less than 30°C(After engine run)	- Mode : Default(S mode) - Warming up time : 10 minutes(Max) - Warming up lamp : ON
Canceled	- Coolant temperature : Above 30°C - Warming up time : Above 10 minutes - Changed mode set by operator ※ If any of the above conditions is applicable, the automatic warming up function is canceled	- Default mode - Default mode - Changed mode
Warming up lamp	- Coolant temperature : Above 30°C	- Warming up lamp : OFF

GROUP 7 ENGINE OVERHEAT PREVENTION FUNCTION

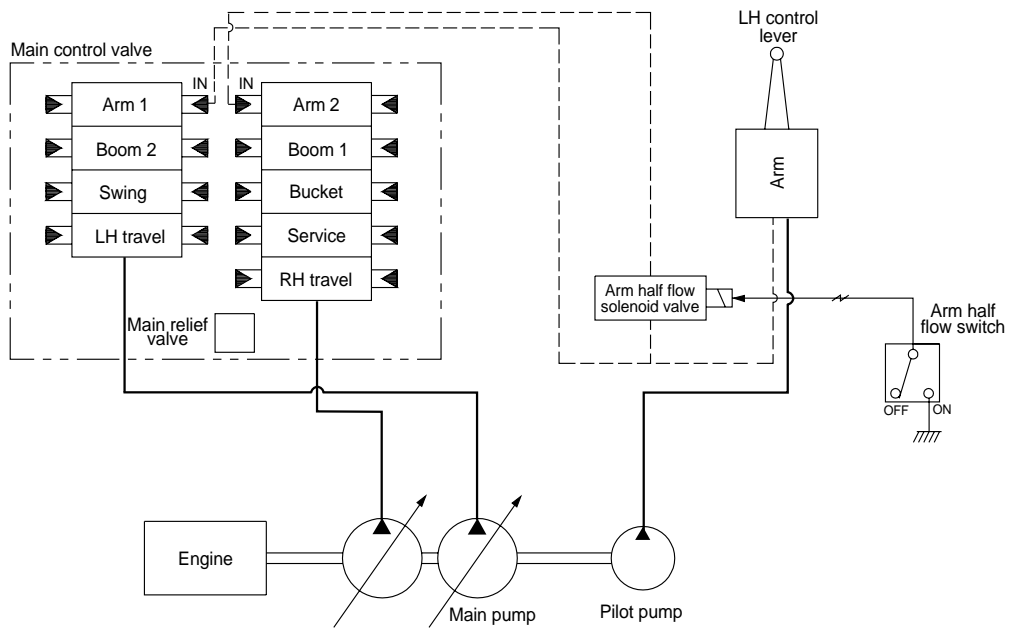


1. CPU controller reads engine coolant temperature through the temperature sensor and when the engine coolant boils upto 110°C, it sends overheat warning signal to the cluster and changes mode set to **F** mode.
2. If the coolant temperature drops less than 100°C, the CPU controller returns the mode to the mode set before. And if mode set is changed during the function, the CPU controller cancels the function. Even if the overheat prevention function is canceled by mode change, the overheat warning lamp turns OFF only when the coolant temperature is less than 100°C.

3. LOGIC TABLE

Description	Condition	Function
Actuated	- Coolant temperature : Above 110°C	- Mode : H, S, L → F - Overheat warning lamp & buzzer : ON
Canceled	- Coolant temperature : Less than 100°C - Changed mode set by operator ※ If any of the above conditions is applicable, engine overheat prevention function is canceled	- Return to the mode set before - Hold on the changed mode
Overheat warning lamp	- Coolant temperature : Less than 100°C	- Overheat warning lamp : OFF

GROUP 8 ARM HALF FLOW SYSTEM



When arm half flow switch is turned ON, the arm half flow solenoid valve is switched to ON and it cancels the junction of the oil flow from two pumps.

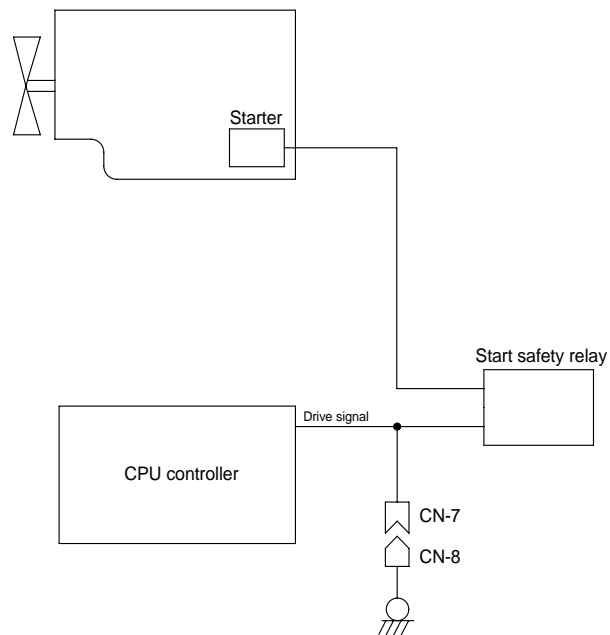
This function is useful to fine control of the arm in in case of finishing work.

Mode	Boom		Arm			Bucket	Swing	Travel	
	up	down	in		out			LH	RH
			ON	OFF					
H	200	100	100	200	200	100	100	100	100
S									
L									
F									

※ The portion for one pump is taken as 100%.

※ When the arm **out** and bucket are operated simultaneously, the Arm half flow function does not work.

GROUP 9 ANTI-RESTART SYSTEM



1. ANTI-RESTART FUNCTION

After 10 seconds from the engine starts to run, CPU controller turns off the start safety relay to protect the starter from inadvertent restarting.

2. When a replacement or taking-off of the CPU controller is needed, connect CN-7 and CN-8 to ensure the engine start without the CPU controller.

GROUP 10 SELF-DIAGNOSTIC SYSTEM

1. OUTLINE

When any abnormality occurs in the CAPO-III system caused by electric parts malfunction and by open or short circuit, the CPU controller diagnoses the problem and sends the error codes to the cluster and also stores them in the memory.

The current or recorded error codes are displayed at the error display mode selected by touching **SELECT** switch 2 times while pressing **BUZZER STOP** switch.

2. CURRENT ERROR DISPLAY

Cluster displays **Co : Err** and makes buzzer sound itself to warn the communication error when communication problem caused by wire-cut or malfunction of the CPU controller occurs.

Cluster displays real time error codes received from CPU controller through communication. In case of no problem it displays **Err : 00**.

If there are more than 2 error codes, each one is displayed for 2 seconds respectively, and there is short term beep at every number change.

Examples :

1) Communication Error

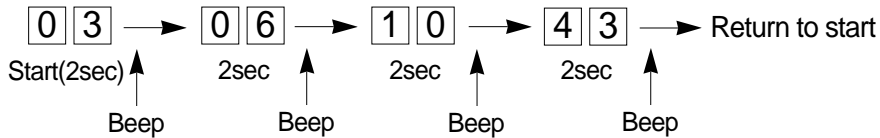
Co : Err & Buzzer sound

2) No problem

Err : 00

3) 4 Error codes(03, 06, 10, 43) display

Err : 03



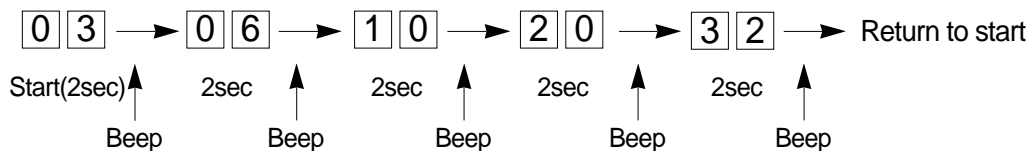
3. RECORDED ERROR DISPLAY

The recorded error can be displayed only when the key switch is at ON position.

Each recorded error code memoried in the CPU controller is displayed for 2 seconds respectively, and there is short term beep at every number change.

Examples : 5 Recorded error codes(03, 06, 10, 20, 32) display

TIME Err : 03



4. DELETE ALL RECORDED ERROR CODES

Select recorded error(TIME Err) display and press engine speed up(▲) and down(▼) switch at the same time for 2 seconds or more. Cluster display changes to TIME Err : 00, which shows that CPU controller deleted all the recorded error in the memory.

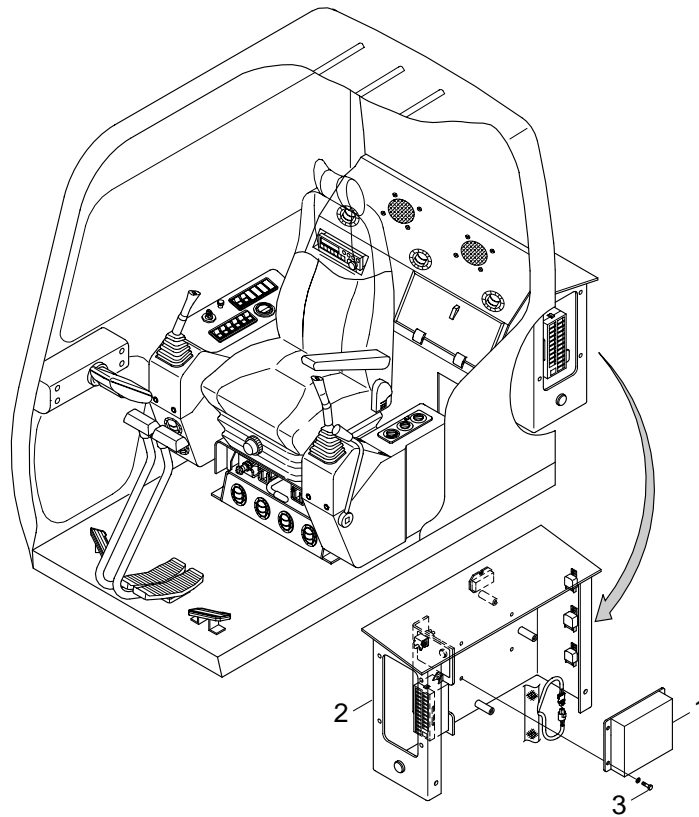
5. ERROR CODES TABLE

Display		Problems
Current error	Recorded error	
Err : 00	TIME Err : 00	No problem
Err : 01	TIME Err : 01	Short circuit in accel actuator 2 lines
Err : 02	TIME Err : 02	Potentiometer is shorted to Vcc(5V) or battery(+)
Err : 03	TIME Err : 03	Short circuit in pump EPPR valve 2 lines
Err : 04	TIME Err : 04	Short circuit in swing EPPR valve 2 lines
Err : 05	TIME Err : 05	Short circuit in travel solenoid 2 lines
Err : 06	TIME Err : 06	Short circuit in power max solenoid 2 lines
Err : 07	TIME Err : 07	Short circuit in max flow solenoid 2 lines
Err : 08	TIME Err : 08	Short circuit in cut off cancel solenoid 2 lines
Err : 09	TIME Err : 09	Short circuit in swing lock solenoid 2 lines
Err : 10	TIME Err : 10	Short circuit in hourmeter 2 lines
Err : 12	TIME Err : 12	P1 pressure sensor is shorted to battery(+)
Err : 13	TIME Err : 13	P2 pressure sensor is shorted to battery(+)
Err : 14	TIME Err : 14	P3 pressure sensor is shorted to battery(+)
Err : 16	TIME Err : 16	Accel actuator circuit is open or shorted to ground
Err : 17	TIME Err : 17	Potentiometer circuit is open or shorted to ground
Err : 18	TIME Err : 18	Pump EPPR valve circuit is open or shorted to ground
Err : 19	TIME Err : 19	Swing EPPR valve circuit is open or shorted to ground
Err : 20	TIME Err : 20	Travel solenoid circuit is open or shorted to ground
Err : 21	TIME Err : 21	Power max solenoid circuit is open or shorted to ground
Err : 22	TIME Err : 22	Max flow solenoid circuit is open or shorted to ground
Err : 23	TIME Err : 23	Cut off cancel solenoid circuit is open or shorted to ground
Err : 24	TIME Err : 24	Swing lock solenoid circuit is open or shorted to ground
Err : 25	TIME Err : 25	Hourmeter circuit is open or shorted to ground
Err : 26	TIME Err : 26	Swing speed dial circuit is open or shorted to ground
Err : 27	TIME Err : 27	P1 pressure sensor circuit is open or shorted to ground
Err : 28	TIME Err : 28	P2 pressure sensor circuit is open or shorted to ground
Err : 29	TIME Err : 29	P3 pressure sensor circuit is open or shorted to ground
Err : 32	TIME Err : 32	Battery power input circuit is open
Err : 33	TIME Err : 33	No alternator voltage input
Err : 34	TIME Err : 34	Controller input voltage is less than 18V
Err : 35	TIME Err : 35	Controller input voltage is greater than 38V
-	TIME Err : 36	Error in data receiving from cluster
Err : 37	TIME Err : 37	Engine speed sensor circuit is open or shorted to ground or sensor signal is less than 1V
Err : 38	TIME Err : 38	Anti-restart relay circuit is open or shorted to ground
Err : 39	TIME Err : 39	Accel actuator does not stop at a target position
Err : 40	TIME Err : 40	There is more than 500rpm difference between target speed and actual speed
Err : 41	TIME Err : 41	Hydraulic oil temperature sensor circuit is shorted to ground
Err : 42	TIME Err : 42	Fuel level sensor circuit is shorted to ground
Err : 43	TIME Err : 43	Coolant temperature sensor circuit is shorted to ground
Err : 45	TIME Err : 45	Hydraulic oil temperature sensor circuit is open or shorted to battery(+)
Err : 46	TIME Err : 46	Fuel level sensor circuit is open or shorted to battery(+)
Err : 47	TIME Err : 47	Coolant temperature sensor circuit is open or shorted to battery(+)

※ Every machine may not have all of the above error codes. For example, machines not equipped pressure sensors will not have the error codes 12, 13, 14, 27, 28, 29.

GROUP 11 ENGINE CONTROL SYSTEM

1. CPU CONTROLLER MOUNTING



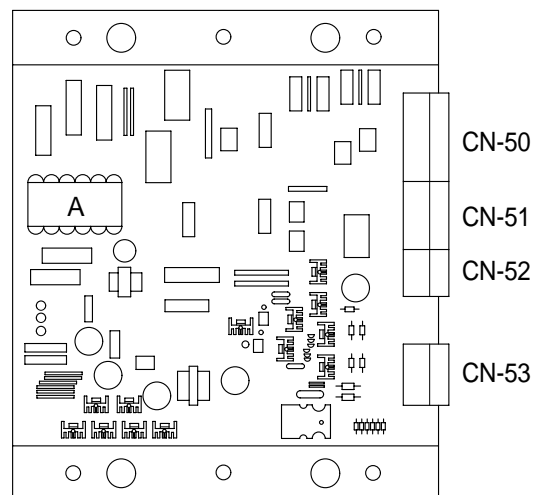
1 CPU controller

2 Electric box

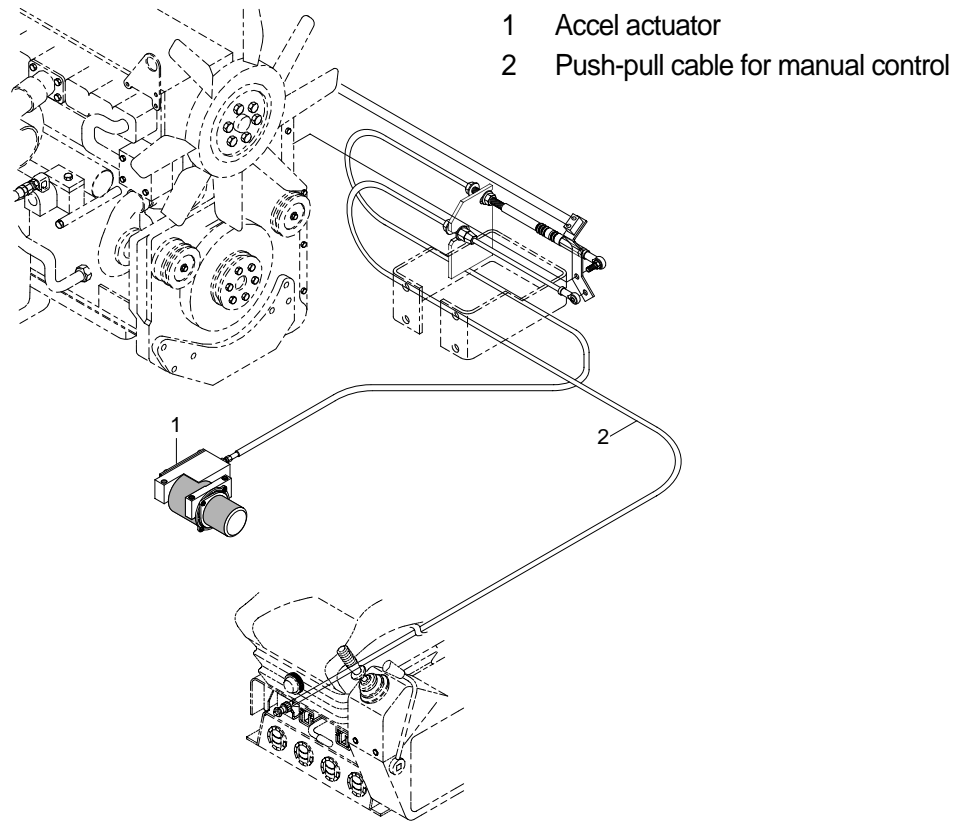
3 Bolt(M8)

2. CPU CONTROLLER ASSEMBLY

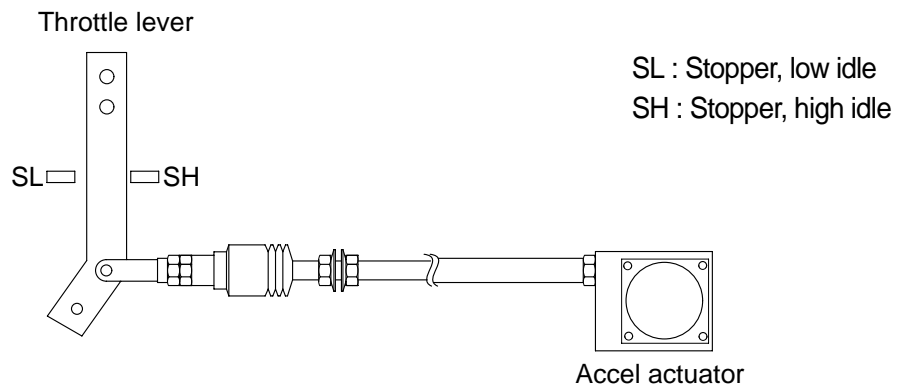
- 1) Remove 4 CPU controller mounting bolt(3).
- 2) Disconnect 4 connectors from CPU controller.
- 3) Remove 6 pieces of screw and open the cover of CPU controller.
- 4) Inspection : Check PCB(Printed Circuit Board)
 - (1) If any damage is found, replace CPU controller assembly.
 - (2) If not, but CAPO system does not work then replace **A** only.(A : EPROM)
 - ※ Removal : Insert small screwdriver or knife to bottom of EPROM and lift up carefully.
 - ※ Assembly : Assemble EPROM to mach with semicircle mark.



3. ENGINE GOVERNOR MOTOR



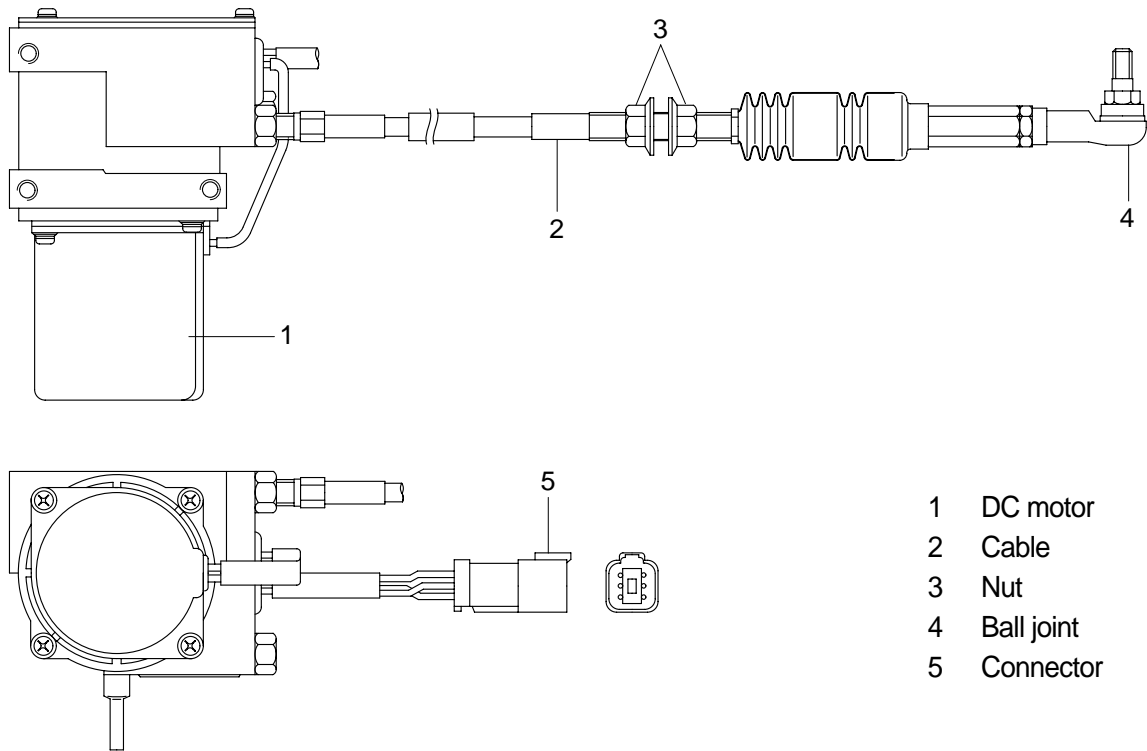
1) ENGINE THROTTLE LEVER



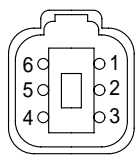
2) EMERGENCY CABLE (Push-pull cable)

It controls engine speed by connecting onto the lever of the injection pump when the malfunction of the CPU controller or the accel actuator happen.

2) ACCEL ACTUATOR

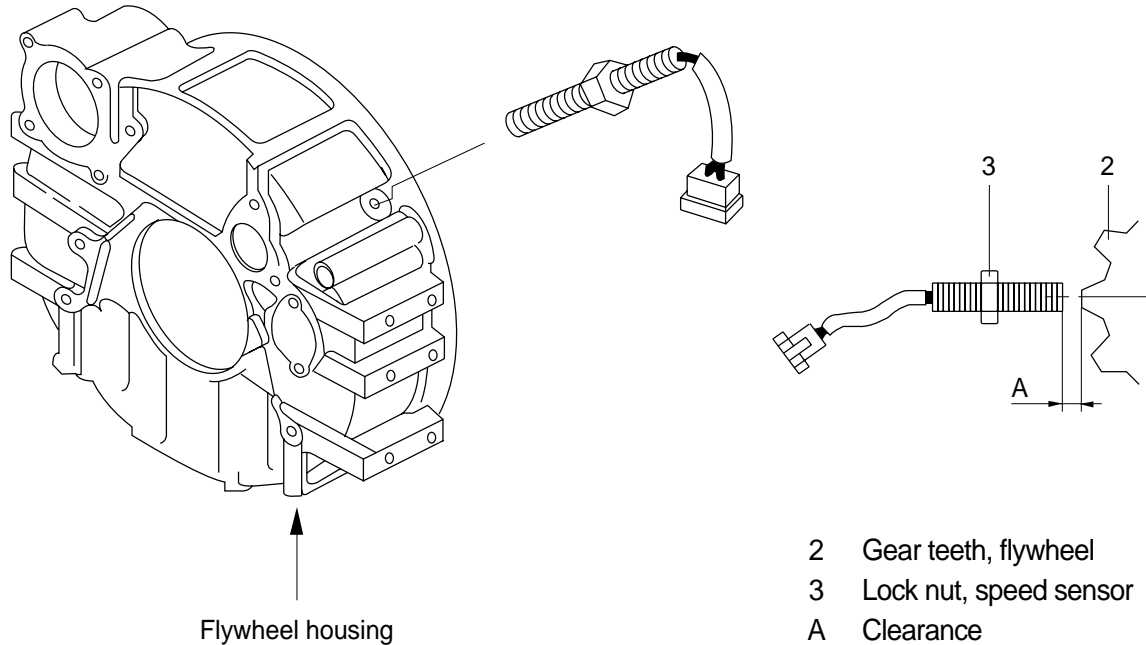


- 1 DC motor
- 2 Cable
- 3 Nut
- 4 Ball joint
- 5 Connector

Connector		
Type	6P, female	
Line color & description	1	White(Potentiometer 5V)
	2	Blue(Potentiometer SIG)
	3	Black(Potentiometer GND)
	4	-
	5	Green(Motor+)
	6	Yellow(Motor -)
Inspection	Check resistance Spec : 1~2 Ω (Between No.5-6) 0.8~1.2kΩ (Between No.1-3)	

4. ENGINE SPEED SENSOR

1) DETECT ACTUAL ENGINE RPM AND SEND SIGNAL TO TACHOMETER



2) INSTALLATION

- (1) Clean contacting point of sensor.
- (2) Loosen lock nut.
- (3) Screw speed sensor into flywheel housing.
- (4) Turn it back 135° when it contacts with gear teeth.
- (5) Tight lock nut and connect wiring.

3) INSPECTION

- (1) Check resistance
 - SPEC : 300 Ω
- (2) Check voltage while engine run.
 - SPEC : 2~28Vac, dependent on the engine speed(rpm)

GROUP 12 EPPR VALVE

1. COMPOSITION OF EPPR VALVE

EPPR(Electro Proportional Pressure Reducing) valve consists of electro magnet and spool valve installed at main hydraulic pump.

1) ELECTRO MAGNET VALVE

Receive electric current from CPU controller and move the spool proportionally according to the specific amount of electric current value.

2) SPOOL VALVE

Is the two way direction control valve for pilot pressure to reduce hydraulic pump flow.

When the electro magnet valve is activated, pilot pressure enters into flow regulator of hydraulic pump. So, pump flow decreases to prevent engine stall.

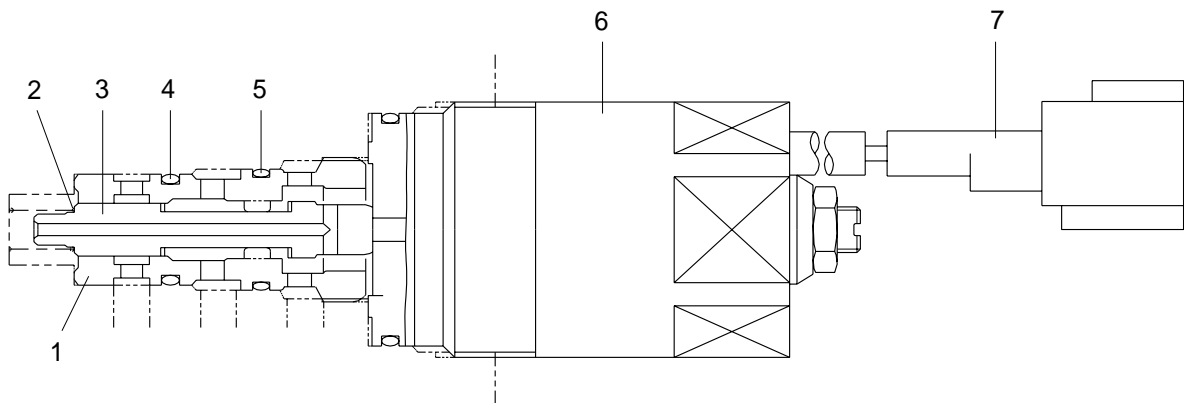
3) PRESSURE AND ELECTRIC CURRENT VALUE FOR EACH MODE

Mode	Pressure		Electric current(mA)	Engine rpm
	kg/cm ²	psi		
H	0 ± 3	0 ± 40	160 ± 30	2450 ± 50
S	6 ± 3	87 ± 40	260 ± 30	2250 ± 50
L	18 ± 3	261 ± 40	430 ± 30	2250 ± 50
F	19 ± 3	275 ± 40	440 ± 30	1750 ± 50
★	16 ± 3	228 ± 40	410 ± 30	-

★ Manually operated condition when prolix switch is selected emergency position.

2. OPERATING PRINCIPLE

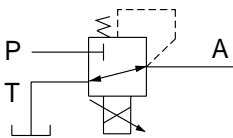
1) STRUCTURE



- 1 Sleeve
- 2 Spring
- 3 Spool

- 4 O-ring
- 5 O-ring

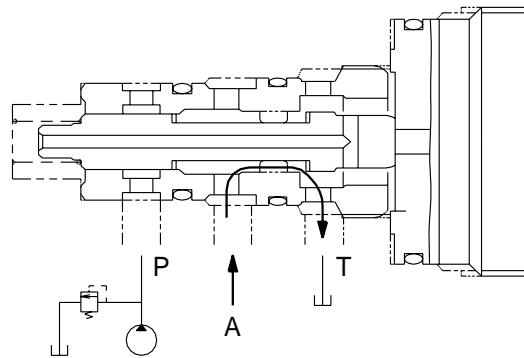
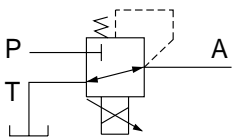
- 6 Solenoid valve
- 7 Connector



- P Pilot oil supply line(Pilot pressure)
- T Return to tank
- A Secondary pressure to flow regulator at hydraulic pump

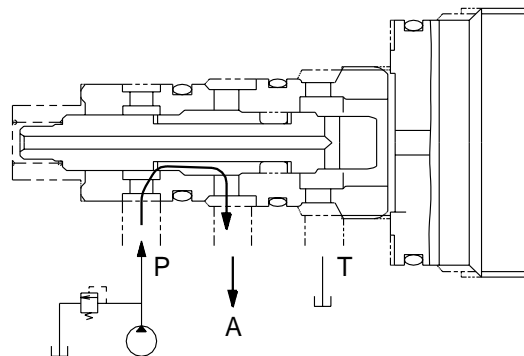
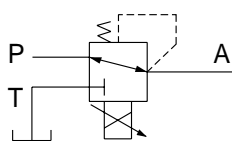
2) AT H MODE

Pressure line is blocked and A oil returns to tank.



3) AT S, L, F MODE

Secondary pressure enters into A.

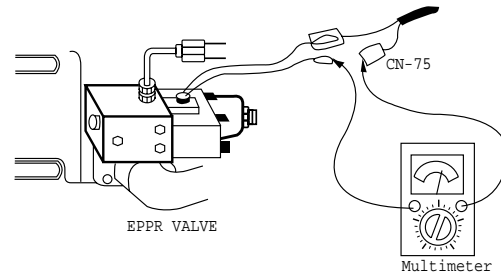


3. EPPR VALVE CHECK PROCEDURE

1) CHECK ELECTRIC VALUE AT EPPR VALVE

- (1) Start engine.
- (2) Set S-mode and cancel auto decel mode.
- (3) If tachometer show approx 2250 ± 50 rpm, disconnect one wire harness from EPPR valve.
- (4) Install multimeter as figure.
- (5) Check electric current at bucket circuit relief position.

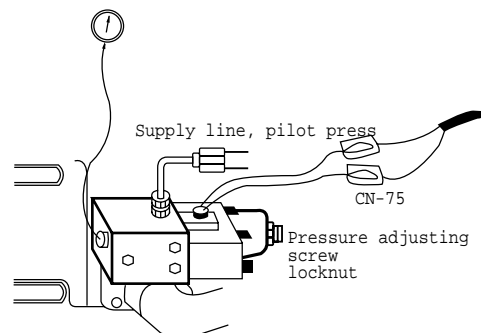
Spec : 200~400mA



2) CHECK PRESSURE AT EPPR VALVE

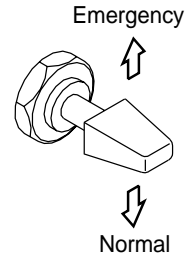
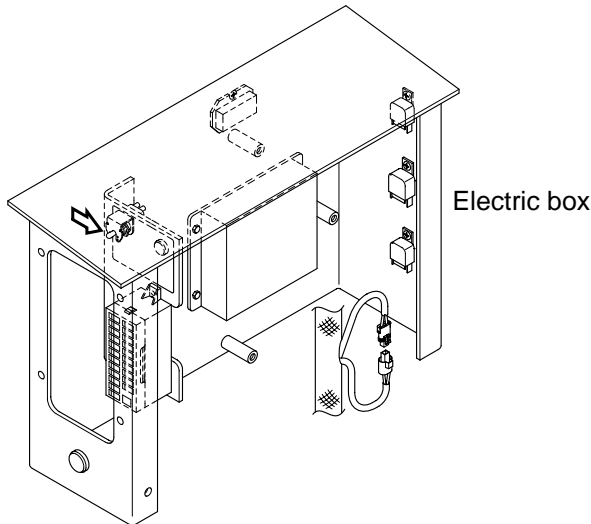
- (1) Remove plug and connect pressure gauge as figure.
Gauge capacity : 0 to 40-50kgf/cm²
(0 to 570-710psi)
- (2) Start engine.
- (3) Set S-mode and cancel auto decel mode.
- (4) If tachometer show approx 2250 ± 50 rpm.
- (5) Check pressure at relief position of bucket circuit by operating bucket control lever.
- (6) If pressure is not correct, adjust it.
- (7) After adjust, test the machine.

Spec : 2~10kgf/cm²(30~140psi)



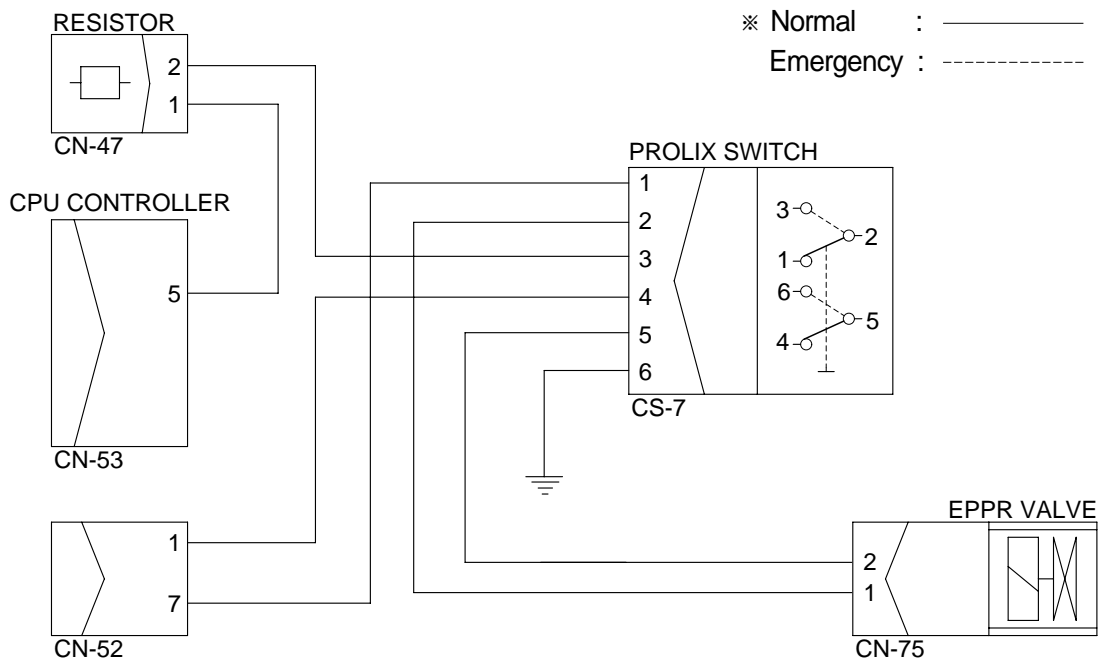
GROUP 13 PROLIX SWITCH

Is the conversion switch to manual control temporarily when the electronic control system is out of order, until repair work be done.



Never place this switch in EMERGENCY position when the CPU is in normal operation.

1. OPERATING PRINCIPLE WIRING DIAGRAM



1) NORMAL POSITION

- EPPR valve supply specified amount of pilot pressure to the flow regulator of hydraulic pump and regulate hydraulic pump delivery amount depending upon the signal of CPU controller by selected mode.

2) EMERGENCY POSITION

- If prolix switch is set at the emergency position when any abnormality occurs in CAPO system, constant electric current from battery flows to EPPR valve so that EPPR valve can be fixed at the predetermined position.
- In this case excavator can be operated at an equivalent performance to S mode.

GROUP 14 MONITORING SYSTEM

1. OUTLINE

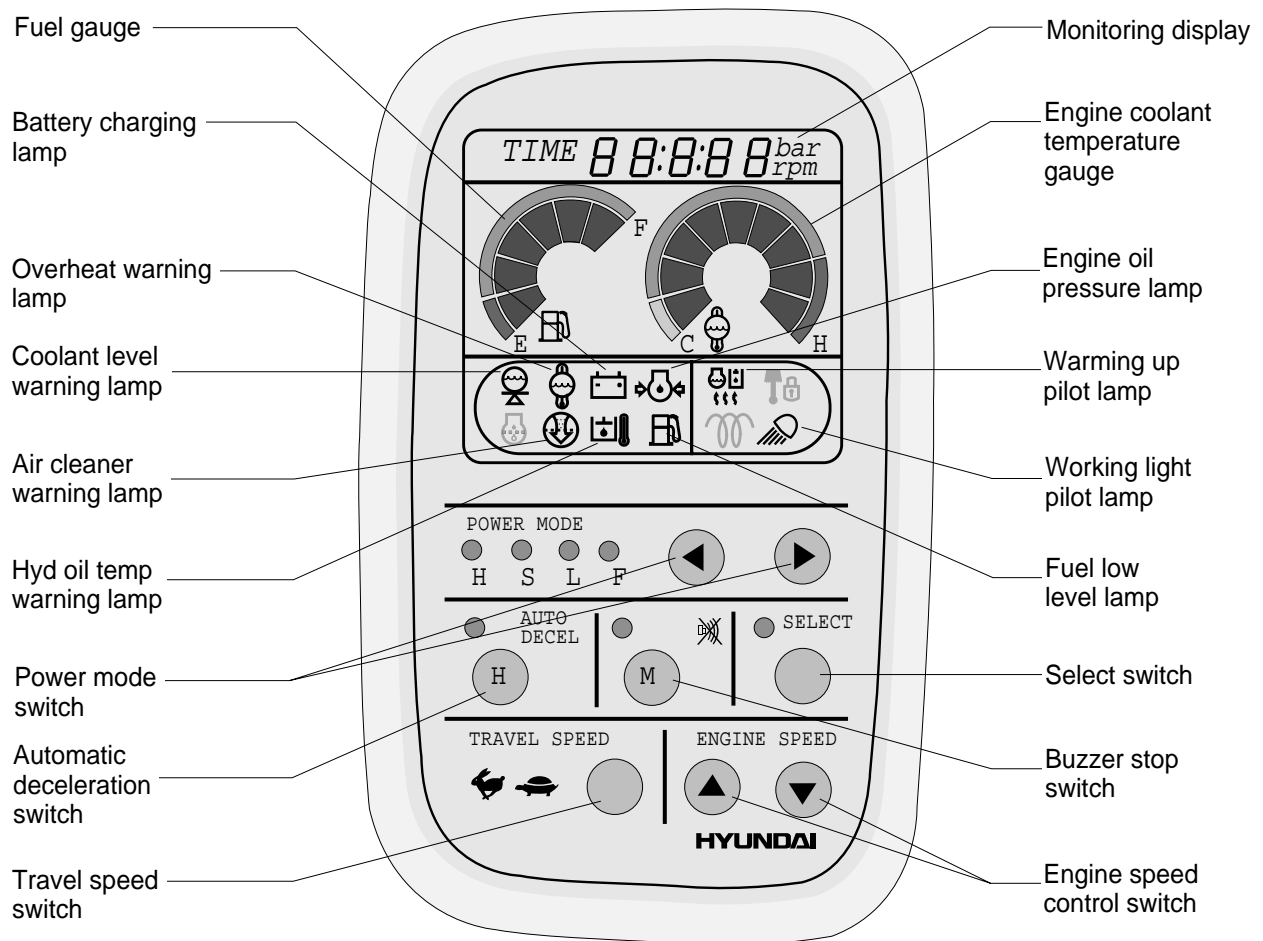
Monitoring system consists of the monitor part and switch part.

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



2) CLUSTER CHECK PROCEDURE

(1) Start key : ON

- ① Check monitor initial 2 seconds
 - a. All lamps light up.
 - b. Buzzer sound.
- ② Check monitor after 2 seconds : Indicate cluster version and machine condition
 - a. Cluster program version : CLS : 11 ← Indicates program version 1.1 for 2 seconds.
 - b. Tachometer : 0rpm
 - c. Fuel gauge : All light up below appropriate level
 - d. Engine coolant temperature gauge : All light up below appropriate level
 - e. Warning lamp
 - ※ During start key **ON** the engine oil pressure lamp and battery charging lamp go on, but it is not abnormal.
 - ※ When engine coolant temperature below 30°C, the warming up lamp lights up.
- ③ Switch portion
 - a. Mode selection : S mode
 - b. Auto decel LED : ON
 - c. Travel speed switch : Low(Turtle)

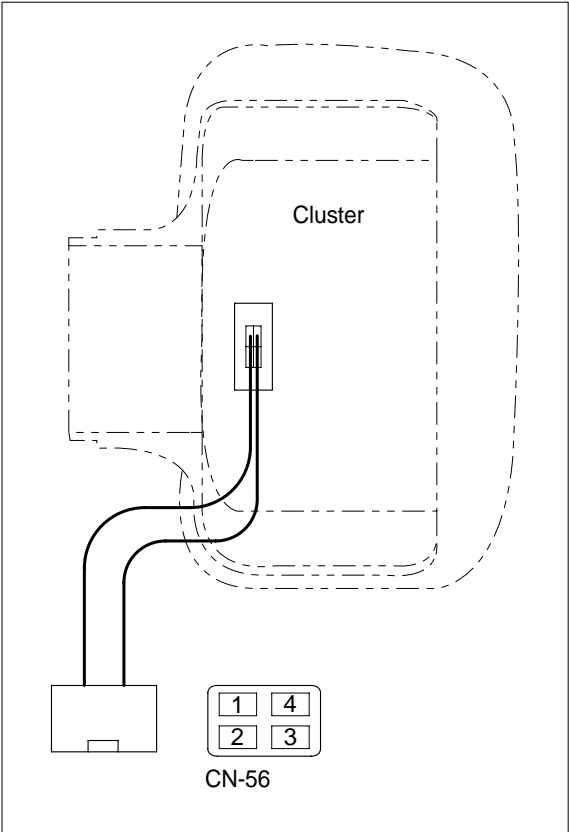
(2) Start of engine

- ① Check machine condition
 - a. Tachometer indicate at present rpm
 - b. Gauge and warning lamp : Indicate at present condition.
 - ※ When normal condition : All warning lamp OFF
 - c. Mode selection : S mode
 - d. Auto decel : ON(About 950rpm)
 - e. Travel speed : Low(Turtle)
- ② When warming up operation
 - a. Warming up lamp : ON
 - b. 10 seconds after engine started, engine speed increases to1200rpm(Auto decel LED : ON)
Others same as above ①.
- ③ When abnormal condition
 - a. The lamp lights up and the buzzer sounds.
 - b. If **BUZZER STOP** switch is pressed, buzzer sound is canceled but the lamp light up until normal condition.

3. CLUSTER CONNECTOR

1) CONNECTOR

No.	Signal	Input / Output
1	Power IG(24V)	Input(20~32V)
2	GND	Input(0V)
3	Serial-(RX)	Input(Vpp=12V)
4	Serial+(TX)	Output(Vpp=4V)



4. CLUSTER FUNCTION

1) TACHOMETER



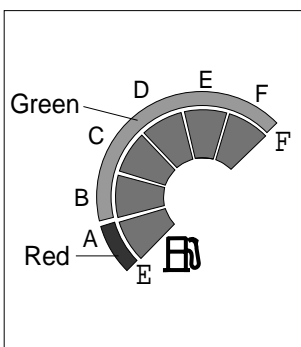
- ① Tachometer displays the number of engine revolutions.
- ② Refer select switch for the selection and adjustment.

2) CLOCK



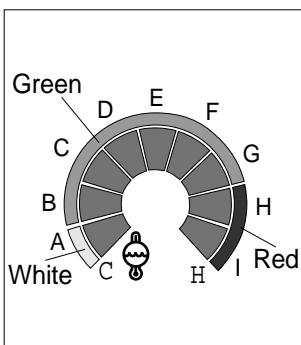
- ① Clock displays the current time by electric digital timer.
- ② Refer select switch for the selection and adjustment.

3) FUEL GAUGE



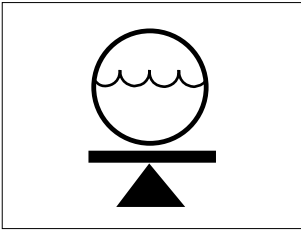
- ① This gauge indicates the amount of fuel in the fuel tank.
 - Warning lamp display : Approximately 40 l
 - Segment A : Approximately 72 l
 - Segment B : Approximately 107 l
 - Segment C : Approximately 143 l
 - Segment D : Approximately 178 l
 - Segment E : Approximately 213 l
 - Segment F : Approximately 250 l
 - Quantity of fuel tank : Approximately 250 l

4) ENGINE COOLANT TEMPERATURE GAUGE



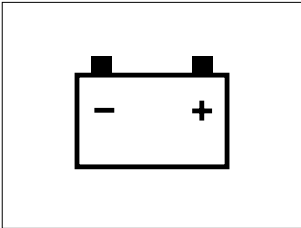
- ① This gauge indicates the temperature of coolant.
 - Segment A : Approximately 40~60°C(White)
 - Segment B : Approximately 60~70°C(Green)
 - Segment C : Approximately 70~85°C(Green)
 - Segment D : Approximately 85~98°C(Green)
 - Segment E : Approximately 98~101°C(Green)
 - Segment F : Approximately 101~103°C(Green)
 - Segment G : Approximately 103~105°C(Green)
 - Segment H : Approximately 105~110°C(Red)
 - Segment I : Approximately 110°C over(Red)

5) COOLANT LEVEL WARNING LAMP



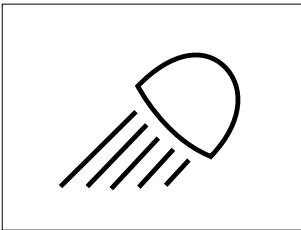
- ① This lamp is turned ON when the coolant is below LOW in the reservoir tank of radiator.
- ② Check if the coolant level is between FULL and LOW in the reservoir tank located at the side of radiator after opening the engine cover, and check if there is mixture of oil and coolant.

6) BATTERY CHARGING LAMP



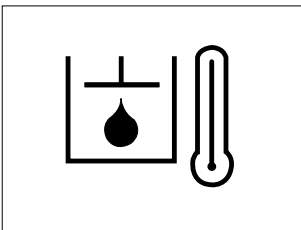
- ① Check if the charging lamp is OFF during engine operation. If the lamp is turned ON, it is not charged.
- ② This lamp is ON before starting the engine, but it is turned OFF after starting the engine. Check the battery charging circuit when this lamp comes ON while the engine runs.

7) WORK LAMP INDICATOR LAMP



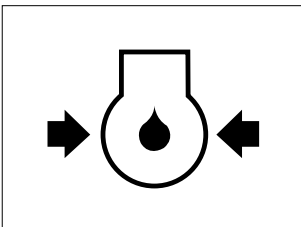
- ① When the work lamp switch is turned ON, the work lamp mounted on boom and the work lamp indicator lamp light ON.

8) HYDRAULIC OIL OVERHEAT WARNING LAMP



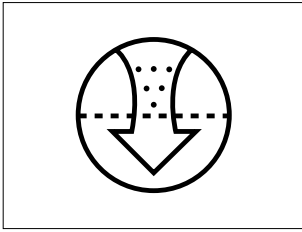
- ① This warning lamp operates and the buzzer sounds when the temperature of hydraulic oil is over 100°C(216°F).
- ② Check the coolant when the lamp is turned ON.

9) ENGINE OIL PRESSURE WARNING LAMP



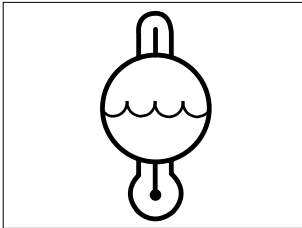
- ① This lamp is turned ON before starting the engine but turned OFF after starting the engine as the pressure caused from the engine oil pump lubricates each part.

10) AIR CLEANER WARNING LAMP



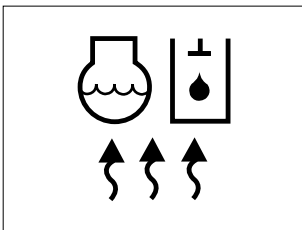
- ① This lamp is turned on when the filter in the air cleaner is clogged.
- ② Check the filter and wash or replace it when the lamp is ON.

11) OVERHEAT WARNING LAMP



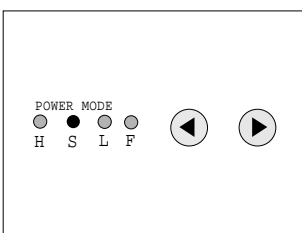
- ① This lamp is turned ON when the temperature of coolant is over the normal temperature(110°C) and lose the cooling function.
- ② Check the coolant when the lamp is ON.

12) WARMING UP LAMP



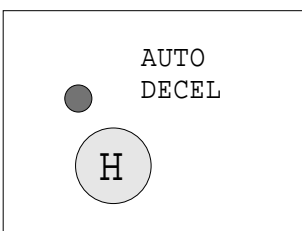
- ① This lamp is turned ON when the coolant temperature is below 30°C.
- ② The automatic warming up is canceled when the engine coolant temperature is above 30°C, or when 10 minutes have passed since starting.

13) MODE SELECTION SWITCH



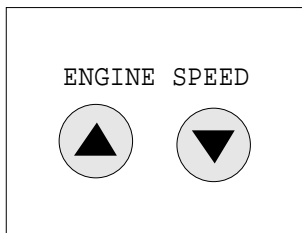
- ① The lamp of selected mode is turned ON by pressing the right switch(◀, ▶), when selecting the mode to use.
 - H : This is used for heavy-duty work.
 - S : This is used for ordinary work.
 - L : This is used for light-duty work.
 - F : This is used for light-duty work, especially for finishing work.
- ② At each pressing of the switch, a short term beep sounds.

14) AUTO DECELERATION SWITCH



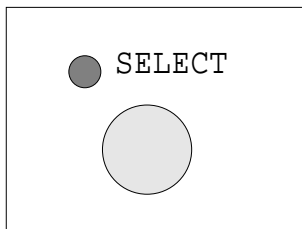
- ① This switch is used to select the auto-deceleration function.
- ② If the auto deceleration function is activated the engine speed is lowered when temporary stop or stand-by for dump is required.
- ③ At each pressing of the switch, a short term beep sounds.

15) ENGINE SPEED CONTROL SWITCH



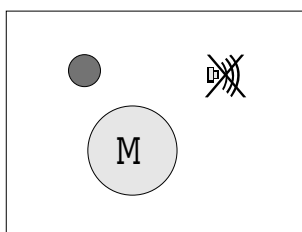
- ① This switch is to control the engine speed, which is increased by pressing ▲ switch and decreased by pressing ▼ switch.
- ② At each pressing of the switches, a short term beep sounds.

16) SELECTION SWITCH(Tachometer and clock)



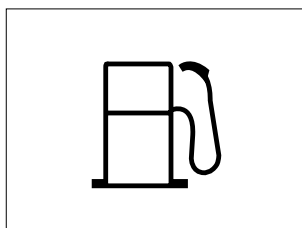
- ① This switch is used to select the tachometer or clock.
- ② The switch is pressed, each function is selected by turns.
- ③ The switch is pressed over 3 seconds, it is selected time adjusting function.
 - Hour : Auto decel switch
 - Minute : Buzzer stop switch
- ④ After time set, if the switch is pressed, it is returned to clock.
- ⑤ If any pump pressure sensor is installed pump pressure display (P1, P2, P3) is also selected by this switch.
- ⑥ At each pressing of the switch, a short term beep sounds.

17) BUZZER STOP SWITCH



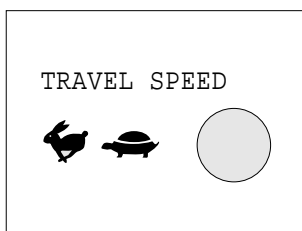
- ① The buzzer sounds is stopped by touching this buzzer stop switch.
- ② Buzzer sound comes out when cluster lights up a warning indicator lamp.
- ③ At each pressing of the switch, a short term beep sounds.

18) FUEL LOW LEVEL LAMP



- ① This lamp lights on when fuel level is below 40 l .
In that case, fill up fuel again.

19) TRAVEL SPEED SWITCH



- ① This switch controls the travel speed.
- ② When you press the switch once, travel speed is change over high speed(🐰), and press once more, travel speed is changed over low speed(🐢).
- ③ At each pressing of the switch, a short term beep sounds.

5.MONITORING DISPLAY

1) OUTLINE

Information of machine performance as monitored by the CPU controller can be displayed on the cluster when the operator selects a display mode by touching **SELECT** switch alone or with **BUZZER STOP** switch on the cluster as below.

Display group	How to select display mode		Name	Display on the cluster	
	Group selection	Display mode selection			
Group 0 (Default)	Way 1 Key switch ON or START	Initial	Engine rpm	950 _{rpm}	
		Touch SELECT 1 time	Time	<i>TIME</i> 12:30	
	Way 2 Touch AUTO DECEL switch while pressing BUZZER STOP at group 1~4.	Touch SELECT 2 times	Option (Only when a pressure sensor is installed)	Front pump pressure	P 1:100 _{bar}
		Touch SELECT 3 times		Rear pump pressure	P 2:200 _{bar}
		Touch SELECT 4 times		Pilot pressure	P 3:30 _{bar}
Group 1 (Volt, temp, EPPR press, version)	Touch SELECT switch once while pressing BUZZER STOP . In this group SELECT LED ON	Default	Battery voltage(V)	b 2 4:8	
		Touch SELECT 1 time	Potentiometer voltage(V)	P o:2:5	
		Touch SELECT 2 times	Hydraulic oil temperature(°C)	H d:50	
		Touch SELECT 3 times	Power shift pressure (EPPR valve)	E P r:10 _{bar}	
		Touch SELECT 4 times	Model & Version	1 6 C:10	
Group 2 (Error code)	Touch SELECT switch twice while pressing BUZZER STOP . In this group BUZZER STOP LED blinks	Default	Current error	E r r:03	
		Touch SELECT 1 time	Recorded error (Only key switch ON)	<i>TIME</i> E r r:03	
		Press speed up(▲) & speed down(▼) at the same time	Recorded error deletion (Only key switch ON)	<i>TIME</i> E r r:00	
Group 3 (Switch input)	Touch SELECT switch 3 times while pressing BUZZER STOP . In this group SELECT LED blinks at 0.5sec intervals	Default	Pump prolix switch	P P:on or oFF	
		Touch SELECT 1 time	Auto decel pressure switch	d P:on or oFF	
		Touch SELECT 2 times	Power boost switch	P b:on or oFF	
		Touch SELECT 3 times	Travel oil pressure switch	o P:on or oFF	
Group 4 (Output)	Touch SELECT switch 4 times while pressing BUZZER STOP . In this group SELECT LED blinks at 1sec intervals	Default	Hourmeter	H o:on or oFF	
		Touch SELECT 1 time	Neutral relay (Anti-restart relay)	n r:on or oFF	
		Touch SELECT 2 times	Travel solenoid	S S:on or oFF	
		Touch SELECT 3 times	Power boost solenoid (2-stage relief solenoid)	P S:on or oFF	

※ By touching **SELECT** switch once while pressing **BUZZER STOP**, display group shifts.

Example : Group 0 → 1 → 2 → 3 → 4 → 0

2) DESCRIPTION OF MONITORING DISPLAY

Group	Display	Name	Description
Group 0	2450 rpm	Engine speed	It displays current engine speed detected by engine speed sensor from 500 to 3000rpm. Range : 500~3000rpm by 10rpm
	TIME 12 : 30	Time	It displays current time(12 is hour and 30 is minute) Range : Hour(1~12), minute(00~59)
	P1 : 100bar (Option)	Front pump pressure	It displays front pump pressure of 100bar which is detected by pressure sensor. Range : 000~ 500bar by 10bar
	P2 : 200bar (Option)	Rear pump pressure	It displays rear pump pressure of 200bar which is detected by pressure sensor. Range : 000~ 500bar by 10bar
	P3 : 30bar (Option)	Pilot pump pressure	It displays pilot pump pressure of 30bar which is detected by pressure sensor. Range : 00~50bar by 1bar
Group 1	b24 : 8	Battery voltage	It shows that battery power of 24.8V is supplied into CPU controller. Range : 00.0~48.0V by 0.1V
	Po : 2 : 5	Potentiometer voltage	It shows that potentiometer signal voltage is 2.5V. Range : 0.0~5.0V by 0.1V
	Hd : 50	Hydraulic oil temperature	It shows that hydraulic oil temperature detected by temperature sensor is 50°C. Range : Lo(Below 20°C) ; 30~90°C by 10°C, Hi(Above 100°C).
	EPr : 10bar	Power shift pressure of EPPR valve	It shows that pump power shift pressure of EPPR valve being controlled by the CPU controller is 10bar. Range : 00~50bar by 1bar
	16C : 10	Model and CPU program version	It shows that machine model(R160LC-3) and the program version of the CPU controller is 1.0. Version display range : 0.0~9.9 by 0.1
Group 2	Err : 03	Current error	It shows that current error of 03(Short circuit in pump EPPR valve 2 lines) is diagnosed by self diagnosis system in the CPU controller. If more than 2 errors, each error code is displayed for 2 seconds and changes to other error codes continuously. Range : 00~47
	TIME Err : 03	Recorded error	It shows recorded error code of 03 which is diagnosed before. If more than 2 error codes, each error code is displayed for 2 seconds and changes to other error codes continuously. Range : 00~47
	TIME Err : 00	Recorded error deletion	It shows all recorded error codes are removed in the CPU controller memory.

Group	Display	Name	Description
Group 3	PP : on or oFF	Pump prolix switch	PP : on Shows that pump prolix switch is turned on(At emergency position). PP : oFF Shows that pump prolix switch is turned off(At normal position).
	dP : on or oFF	Auto decel pressure switch	dP : on Shows that auto decel pressure switch is pressed on (Operation of control lever). dP : oFF Shows that auto decel pressure switch is released off (No operation of control lever).
	Pb : on or oFF	Power boost switch	Pb : on Shows that power boost switch is pressed on (Activated). Pb : oFF Shows that power boost switch is released off (Canceled).
	oP : on or oFF	Travel oil pressure switch	oP : on Shows that travel oil pressure switch is pressed on (Operation of travel control lever) oP : oFF Shows that travel oil pressure switch is released off (No operation of travel control lever)
Group 4	Ho : on or oFF	Hourmeter	Ho : on Shows that hourmeter is activated by CPU controller. Ho : oFF Shows that hourmeter is turned off.
	nr : on or oFF	Neutral relay (Anti-restart relay)	nr : on Shows that neutral relay for anti-restarting function is activated(Engine start is possible). nr : oFF Shows that neutral relay is turned off to disable the engine restart.
	SS : on or oFF	Travel speed solenoid	SS : on Shows that travel speed solenoid is activated(Hi travel speed). SS : oFF Shows that travel speed solenoid is turned off(Lo travel speed).
	PS : on or oFF	Power boost solenoid	PS : on Shows that power boost solenoid is activated to maximize the power(Power up). PS : oFF Shows that power boost solenoid is turned off(Cancel the power boost function).

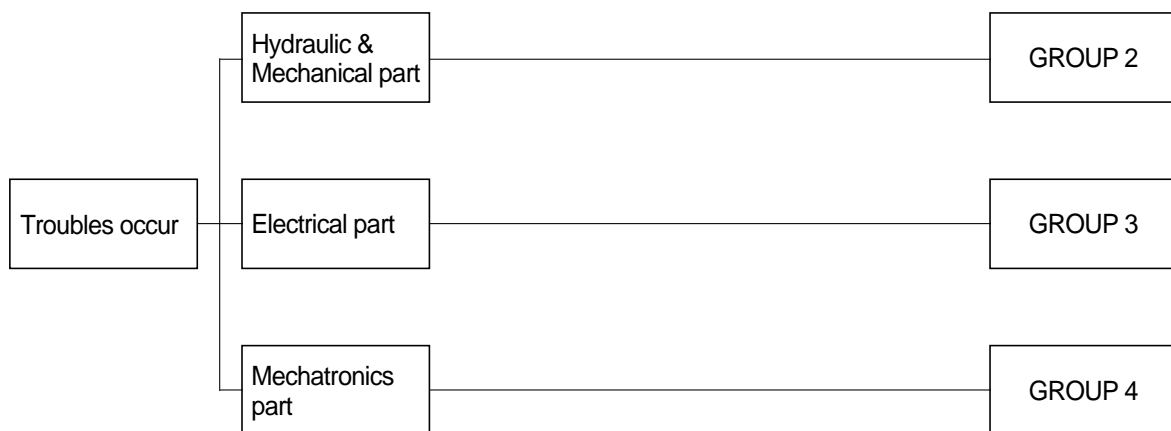
SECTION 6 TROUBLESHOOTING

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



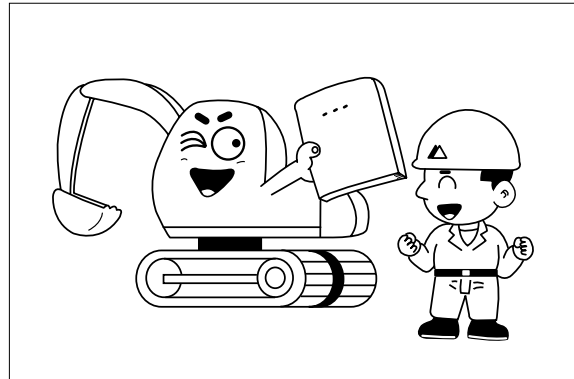
2. DIAGNOSING PROCEDURE

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.

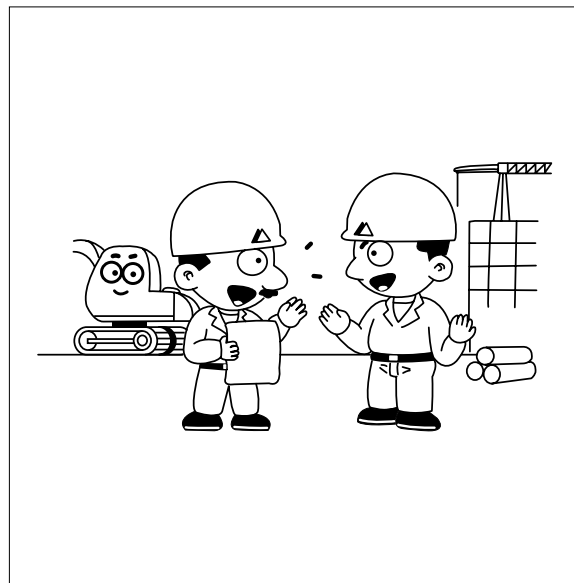
Especially, deepen the knowledge for the related parts of the trouble.



STEP 2. Ask the operator

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

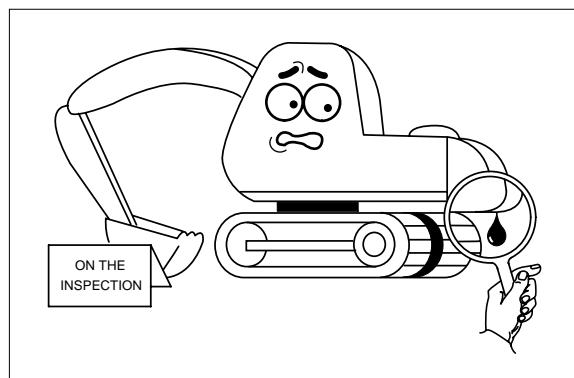
- 1) How the machine is used and when it is serviced?
- 2) When the trouble was noticed and what work the machine was doing at that time?
- 3) What is the phenomenon of the trouble?
Was the trouble getting worse, or did it come out suddenly for the first time?
- 4) Did the machine have any troubles previously?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

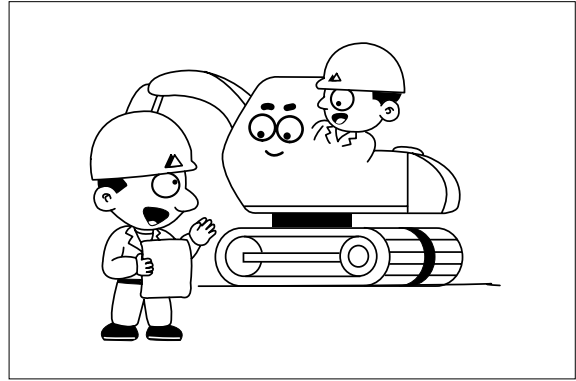
And also check the electrical system including batteries, as the troubles in the electrical system such as low battery voltage, loose connections and blown out fuses will result in malfunction of the controllers causing total operational failures of the machine.



STEP 4. Inspect the trouble actually on the machine

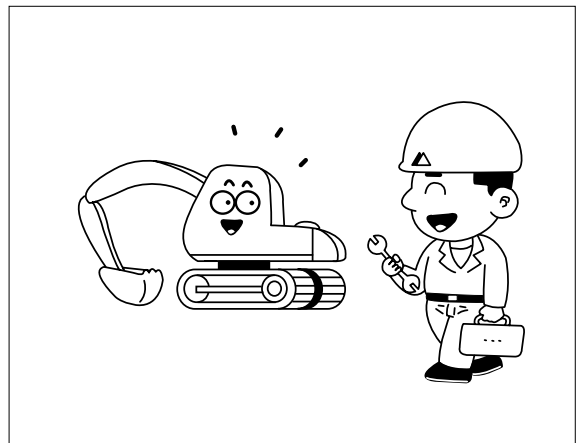
In case that some trouble cannot be confirmed, obtain the details of the malfunction from the operator.

Also, check if there are any incomplete connections of the wire harnesses or not.



STEP 5. Perform troubleshooting

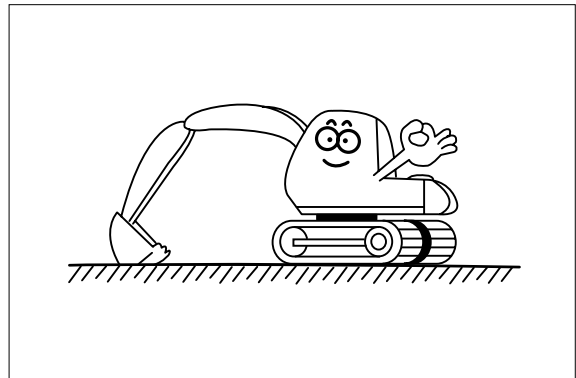
According to where the trouble parts are located, hydraulic & mechanical system part or electrical system part or mechatronics system part, perform troubleshooting the machine refer to the each system part's troubleshooting process diagram.



STEP 6. Trace a cause

Before reaching a conclusion, check the most susceptible 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.



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.

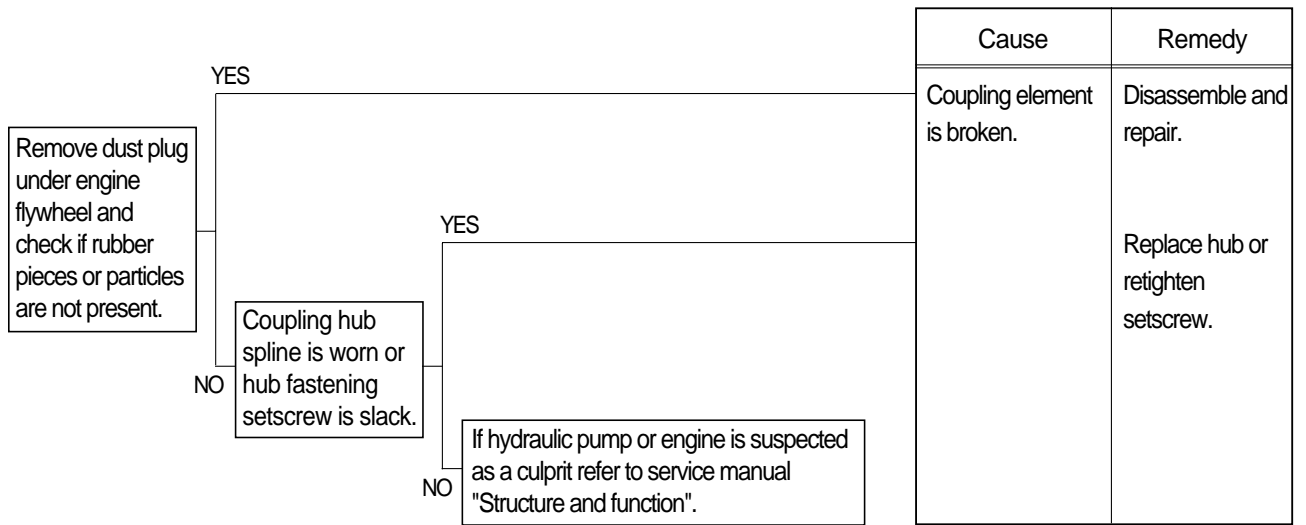
- ① Was there any strange thing about machine before failure occurred?
- ② Under what conditions did the failure occur?
- ③ Have any repairs been carried out before the failure?

(5) Check before troubleshooting.

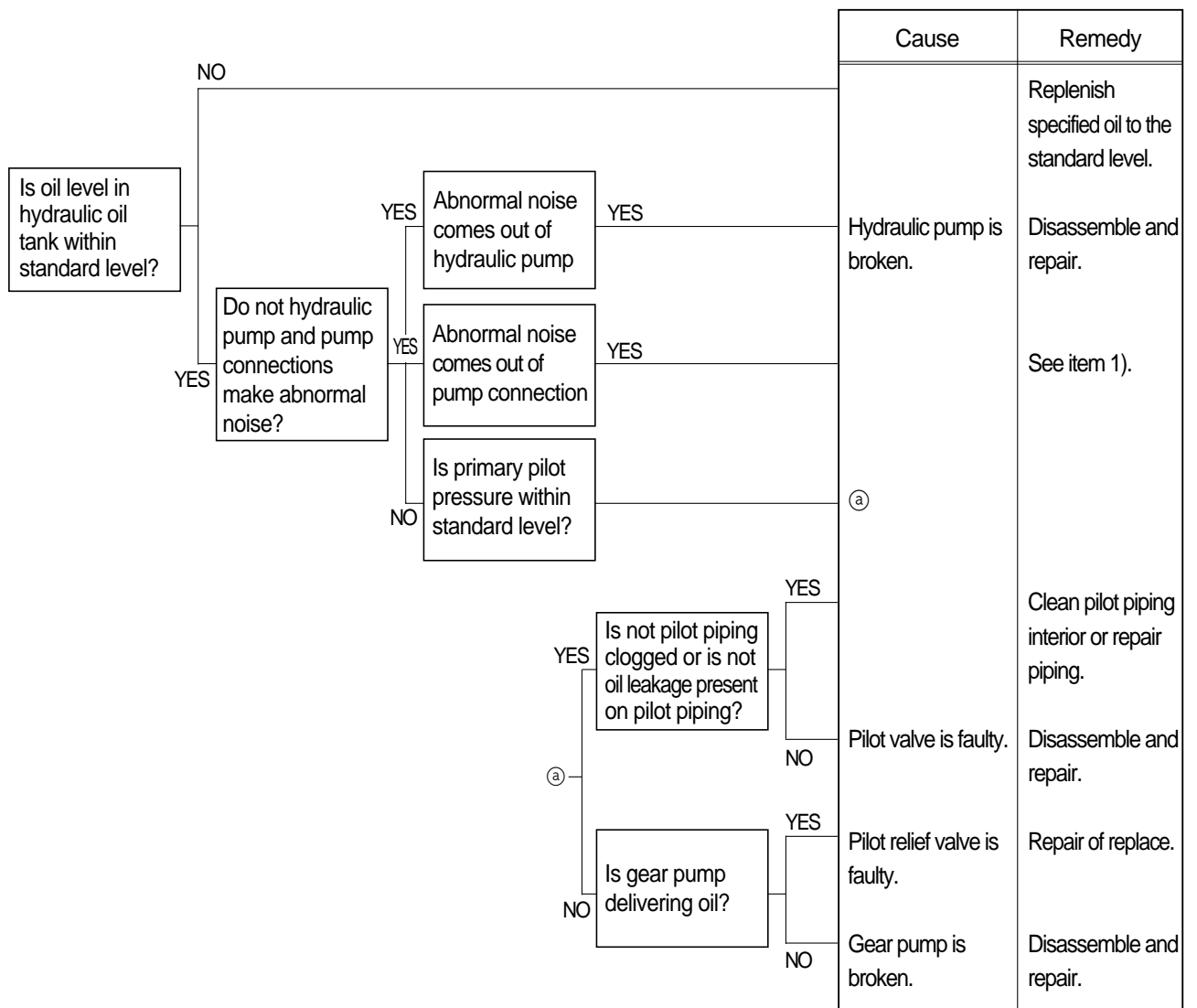
- ① Check oil and fuel level.
- ② Check for any external leakage of oil from components.
- ③ Check for loose or damage of wiring and connections.

2. DRIVE SYSTEM

1) UNUSUAL NOISE COMES OUT OF PUMP CONNECTION

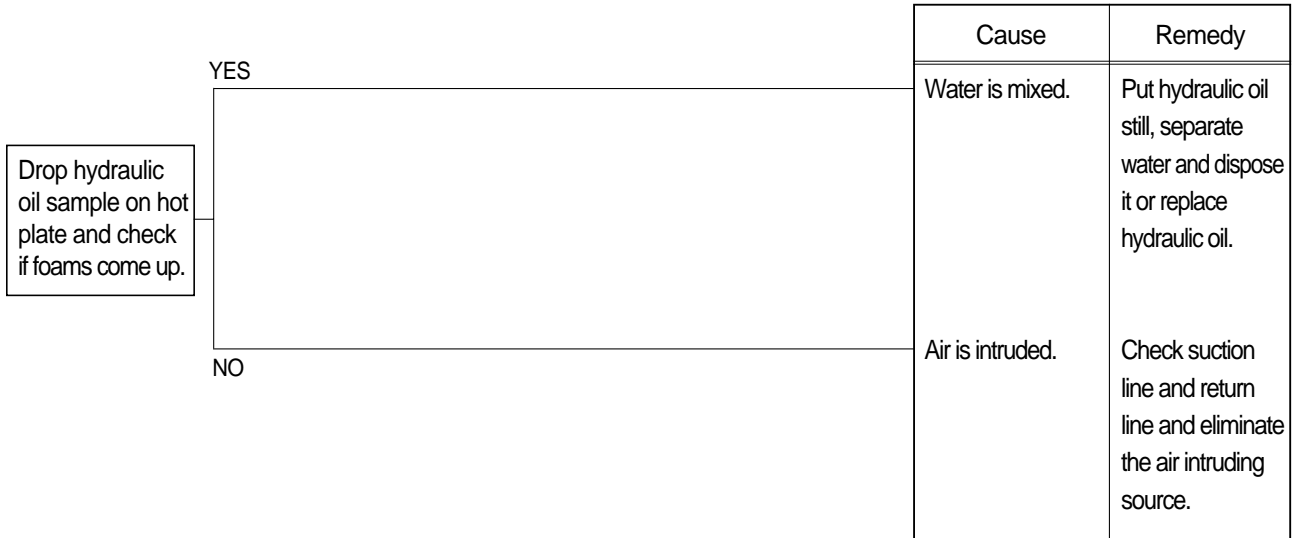


2) ENGINE STARTS BUT MACHINE DOES NOT OPERATE AT ALL

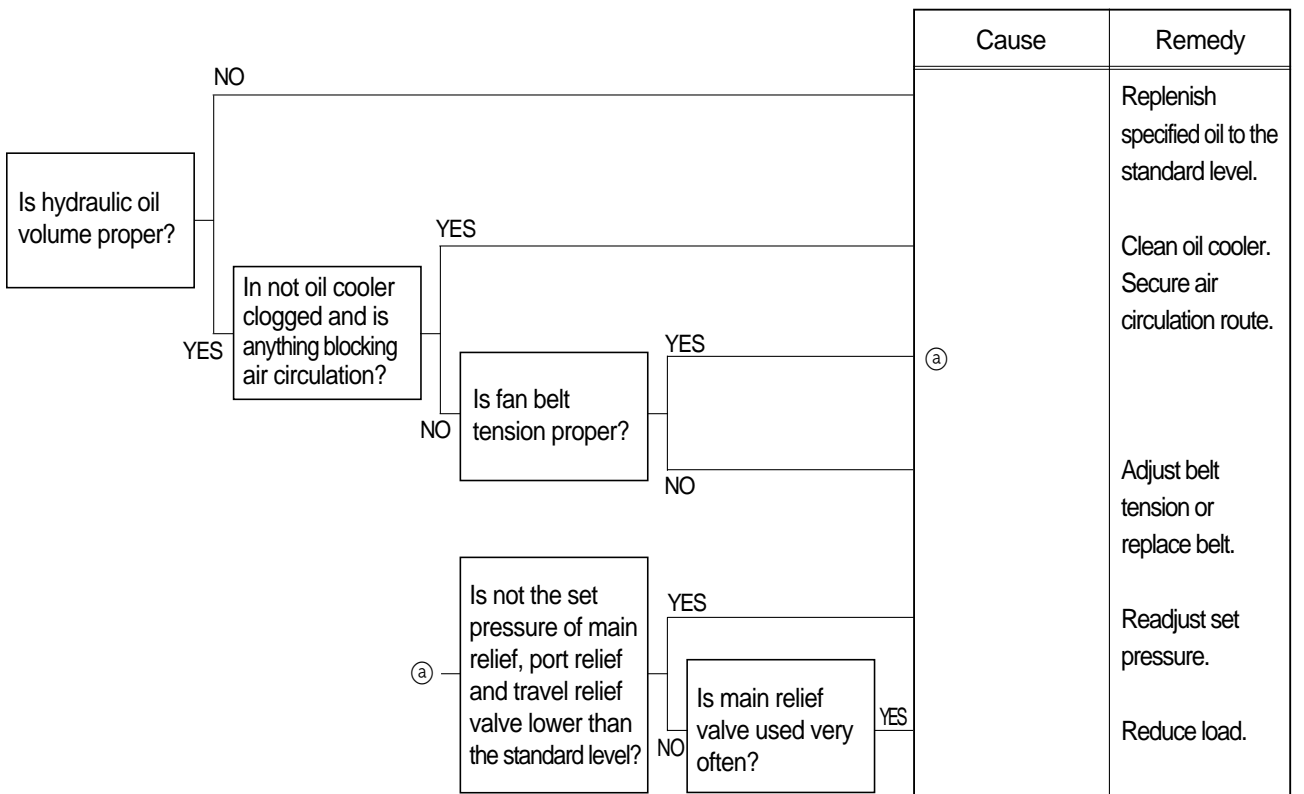


3. HYDRAULIC SYSTEM

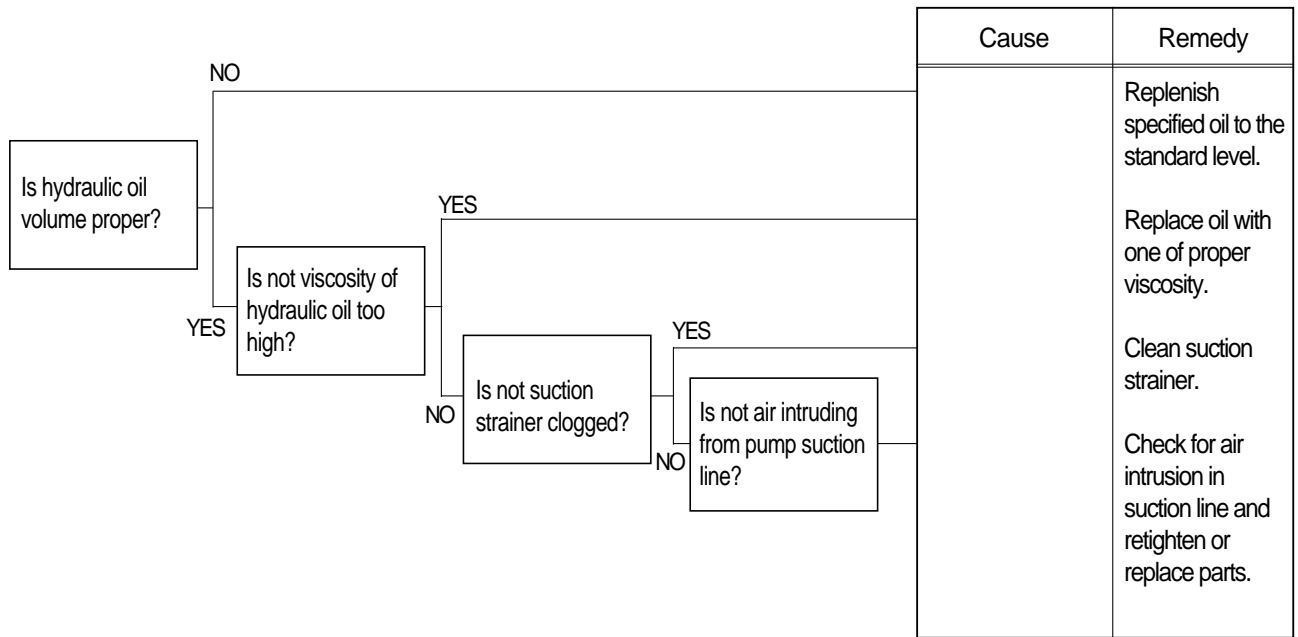
1) HYDRAULIC OIL IS CLOUDY



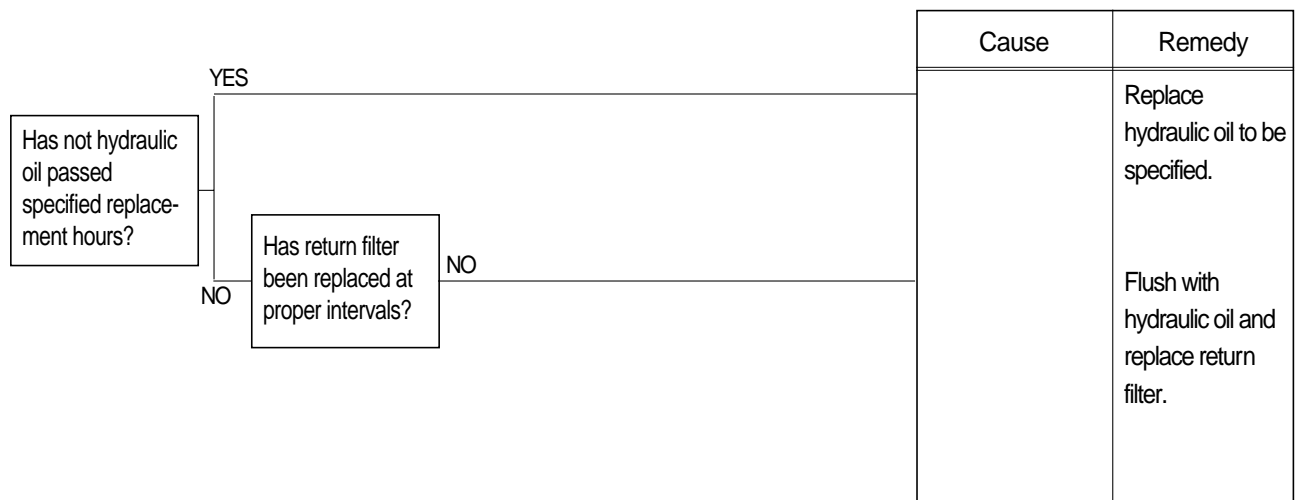
2) HYDRAULIC OIL TEMPERATURE HAS RISEN ABNORMALLY



3) CAVITATION OCCURS WITH PUMP

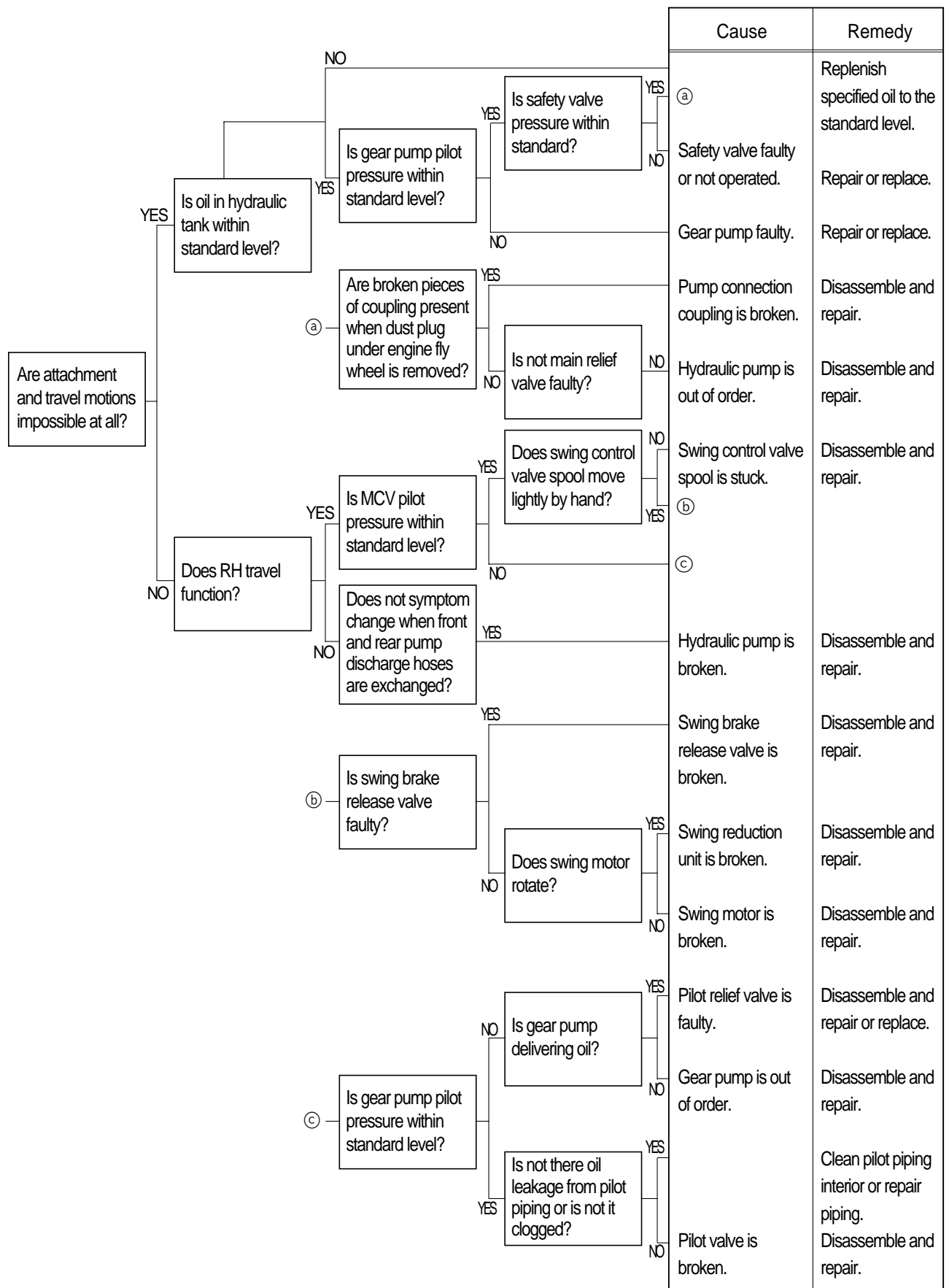


4) HYDRAULIC OIL IS CONTAMINATED

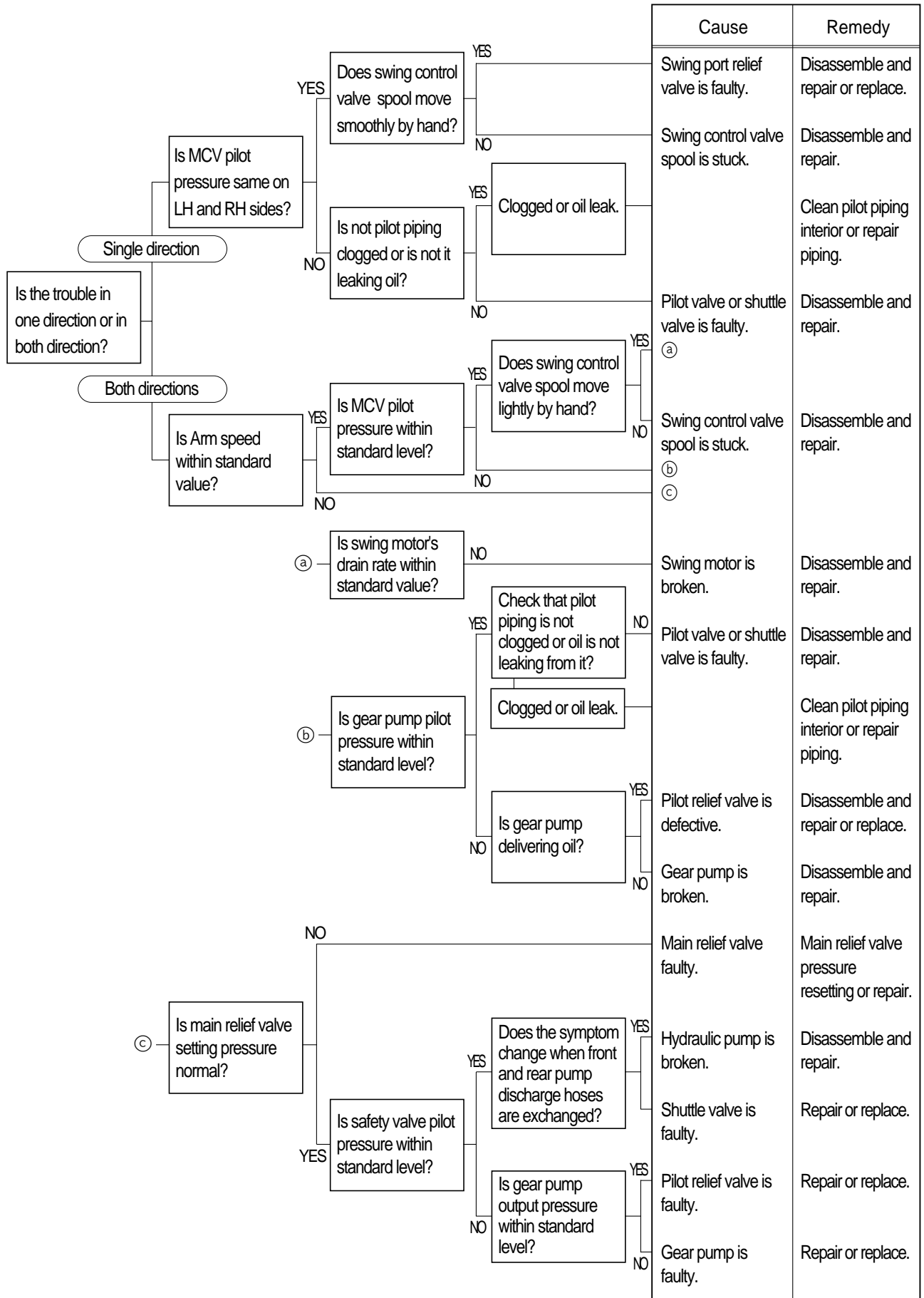


4. SWING SYSTEM

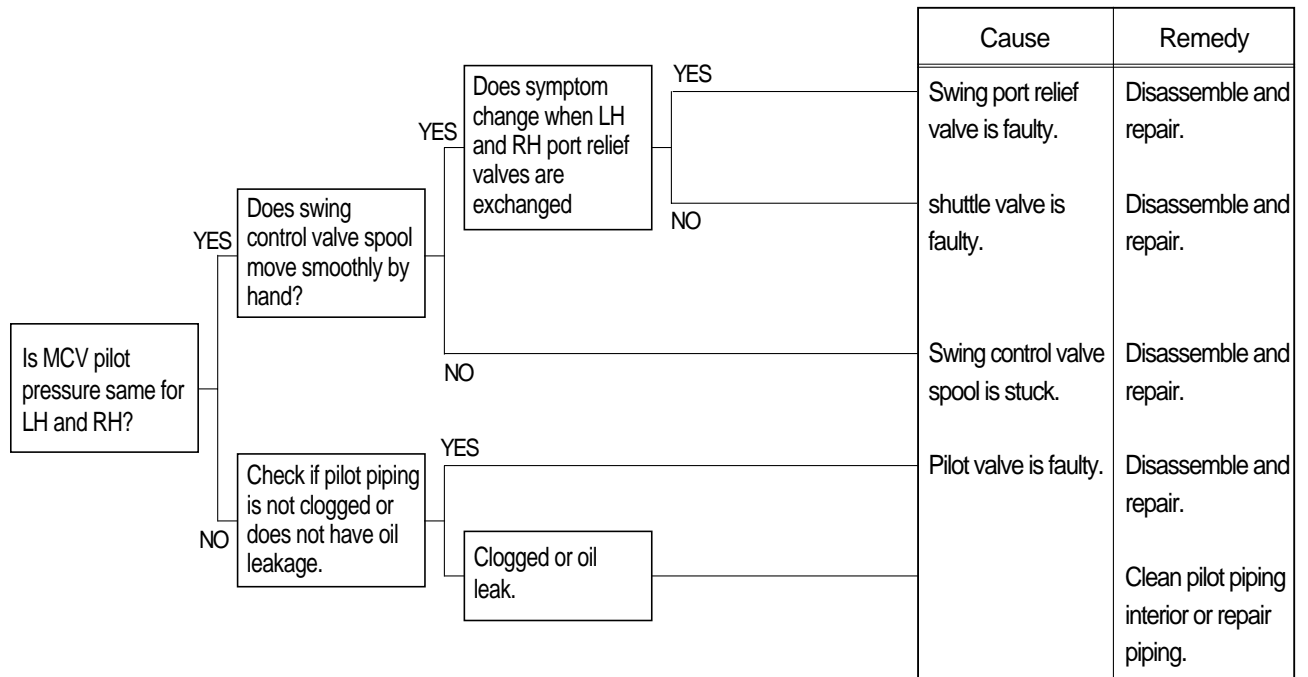
1) BOTH LH AND RH SWING ACTIONS ARE IMPOSSIBLE



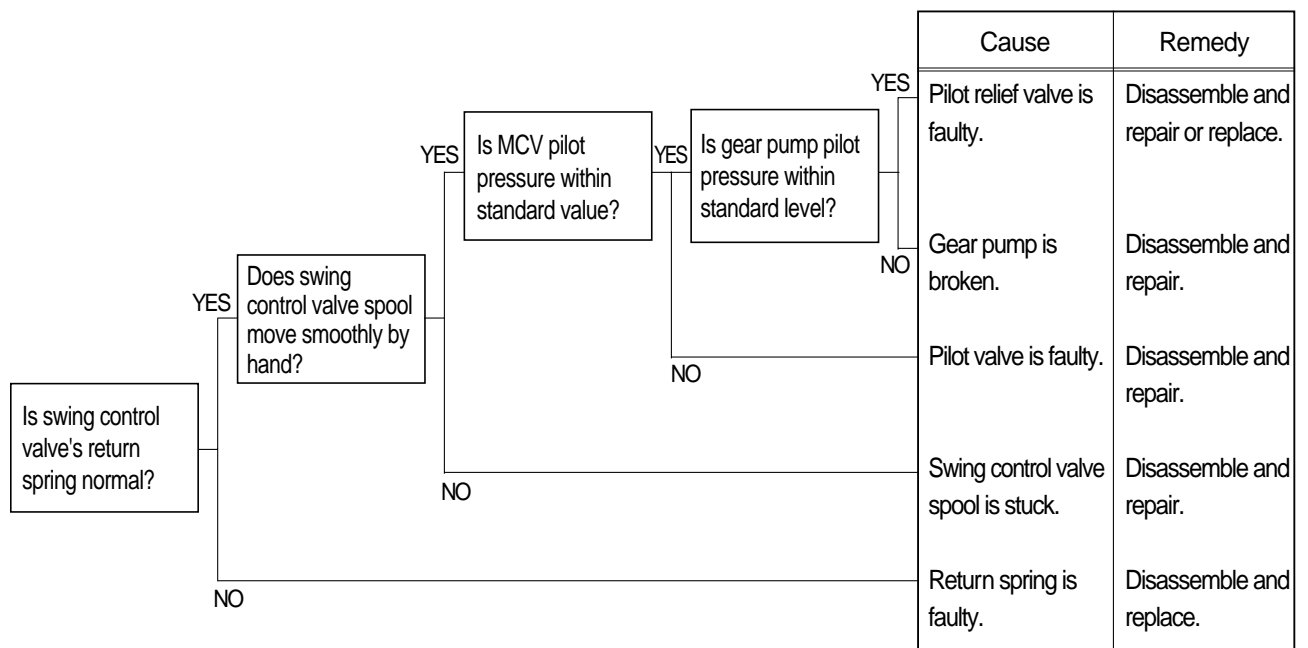
2) SWING SPEED IS LOW



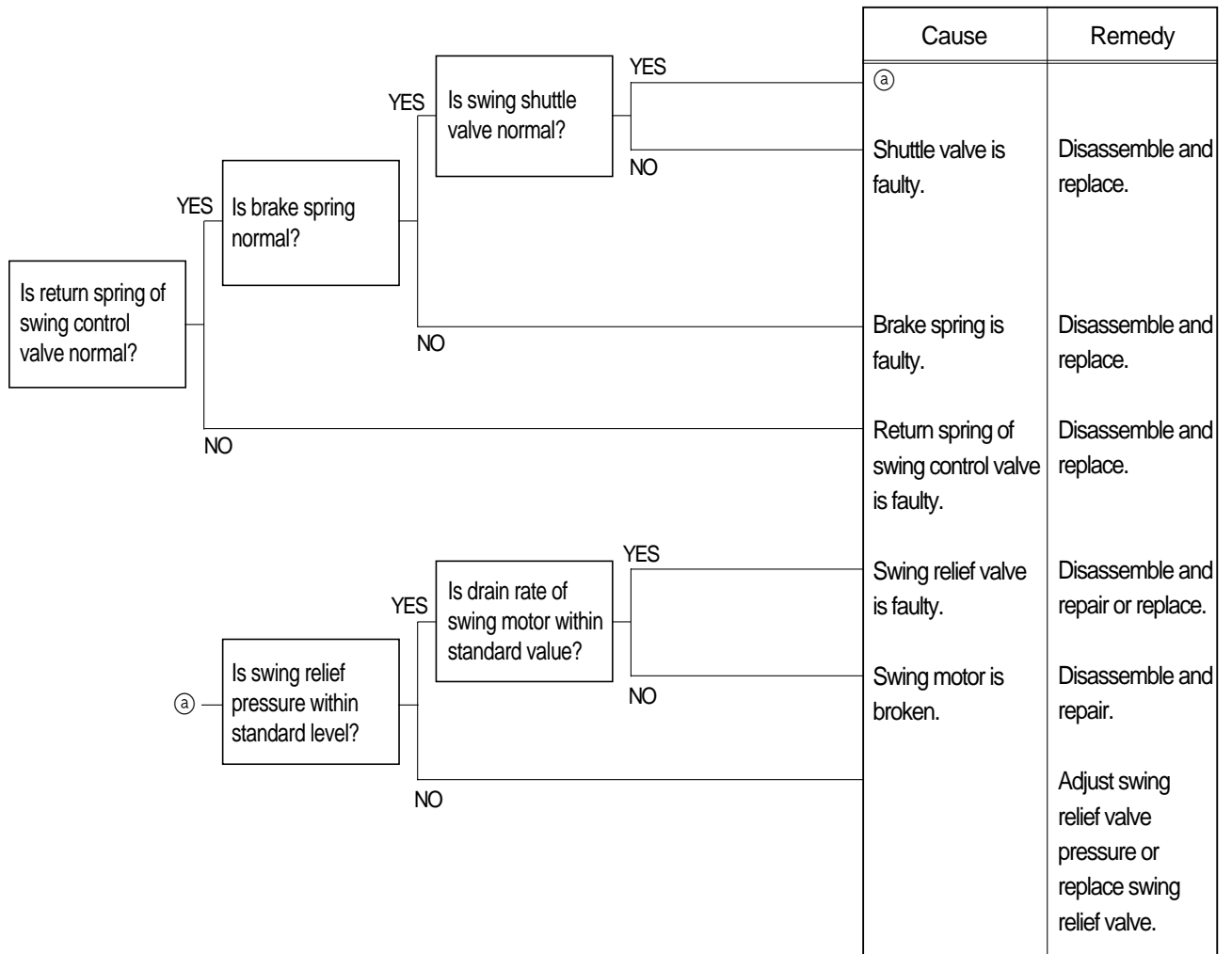
3) SWING MOTION IS IMPOSSIBLE IN ONE DIRECTION



4) MACHINE SWINGS BUT DOES NOT STOP

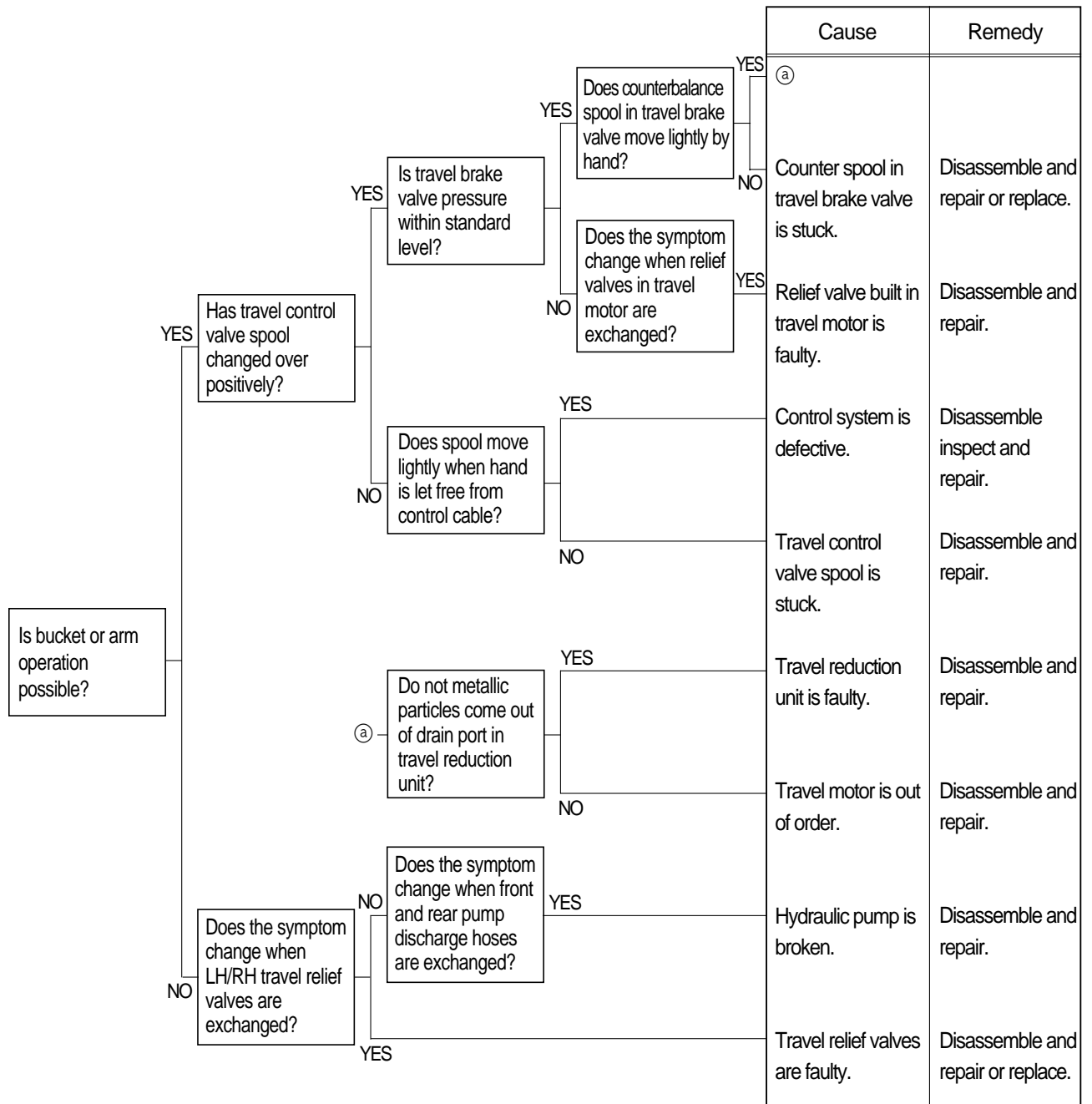


5) THE SWING UNIT DRIFTS WHEN THE MACHINE IS AT REST ON A SLOPE

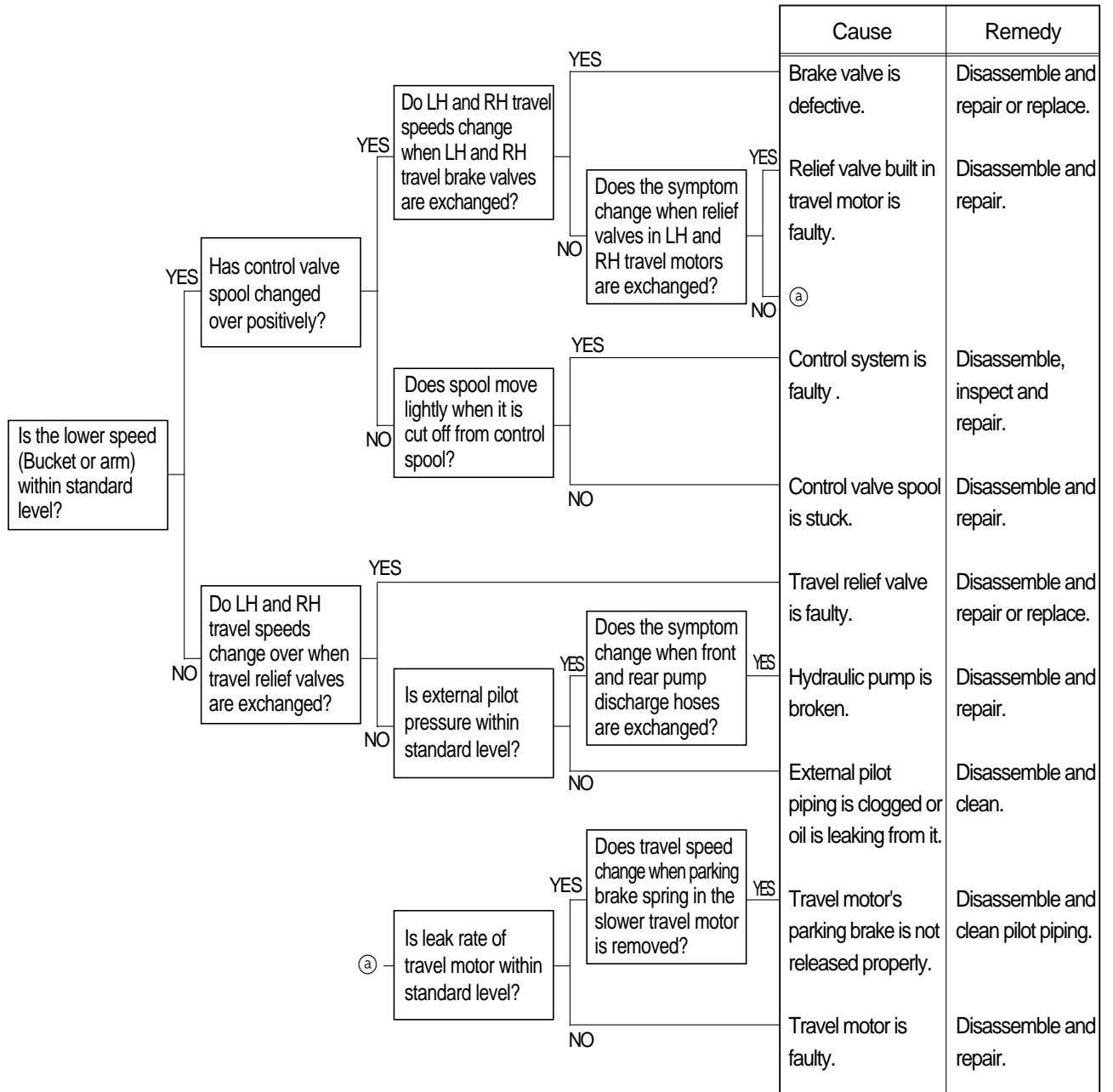


5. TRAVEL SYSTEM

1) TRAVEL DOES NOT FUNCTION AT ALL ON ONE SIDE

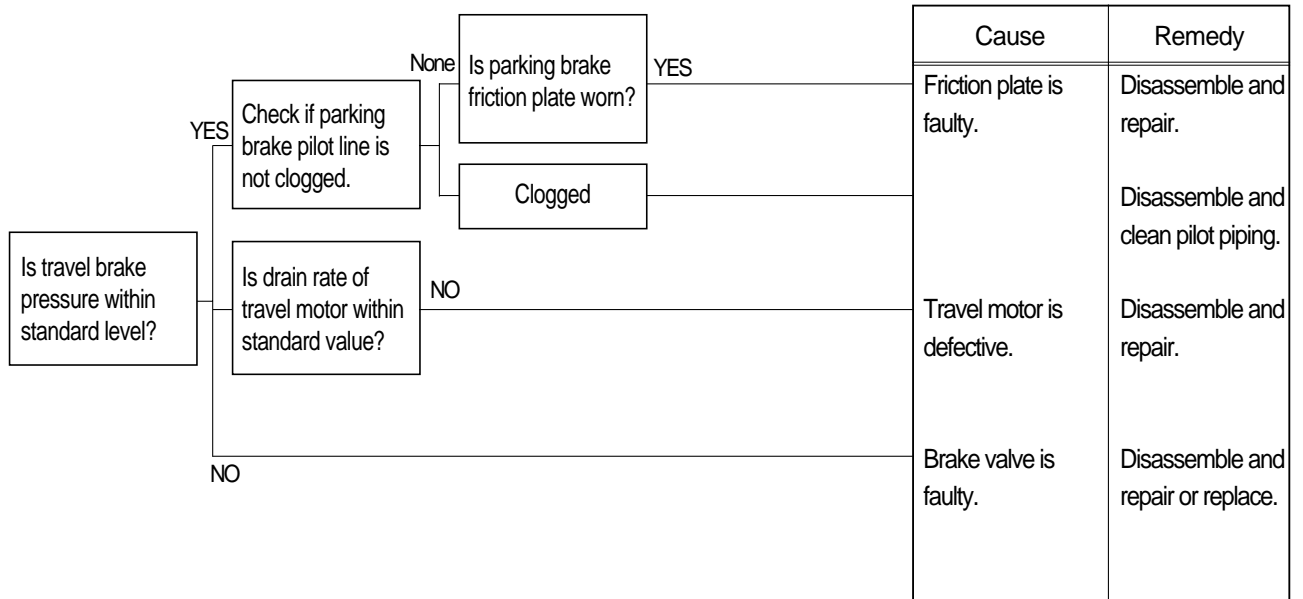


2) SPEED ON ONE SIDE FALLS AND THE MACHINE CURVES

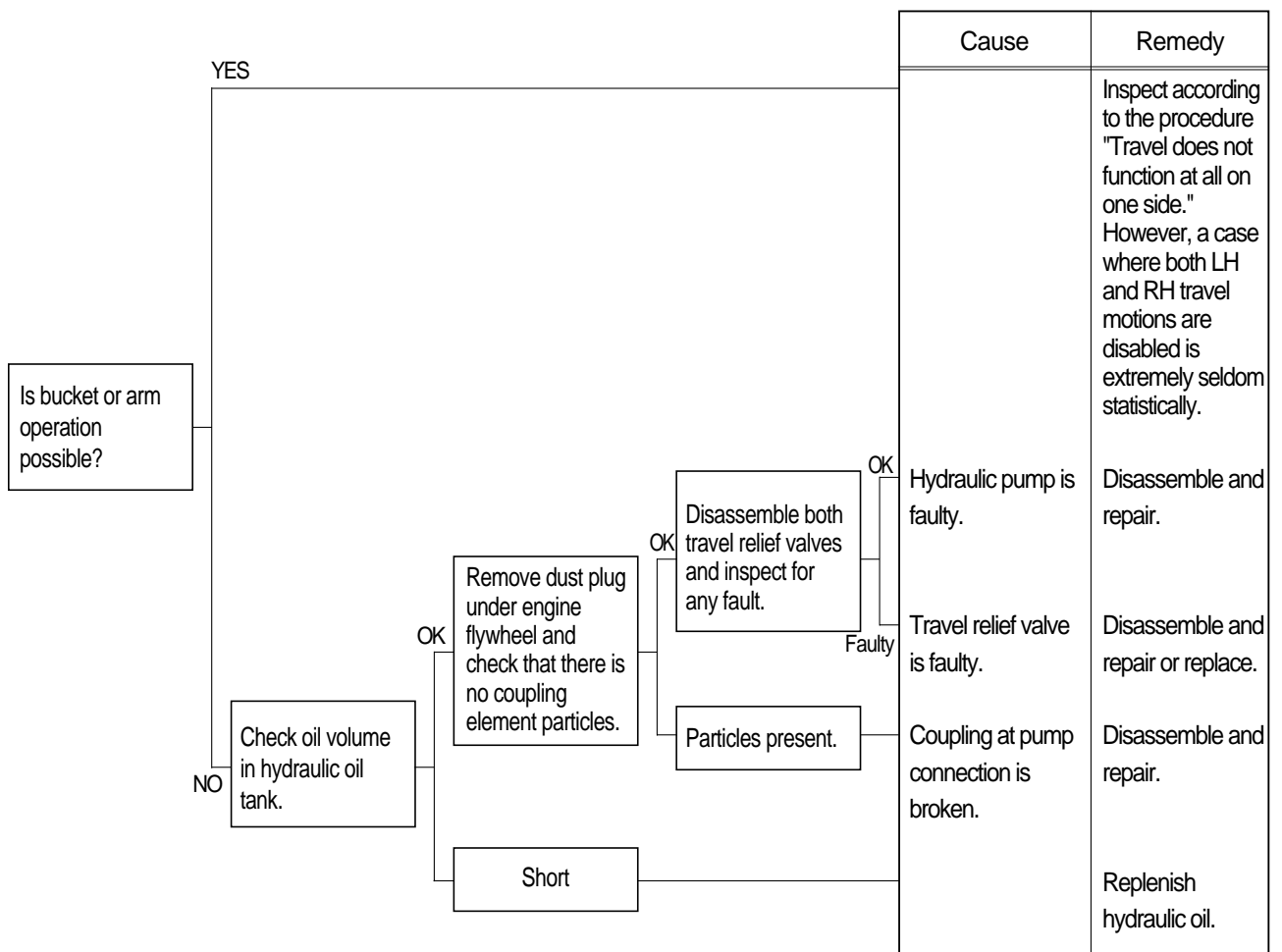


3) MACHINE DOES NOT STOP ON A SLOPE

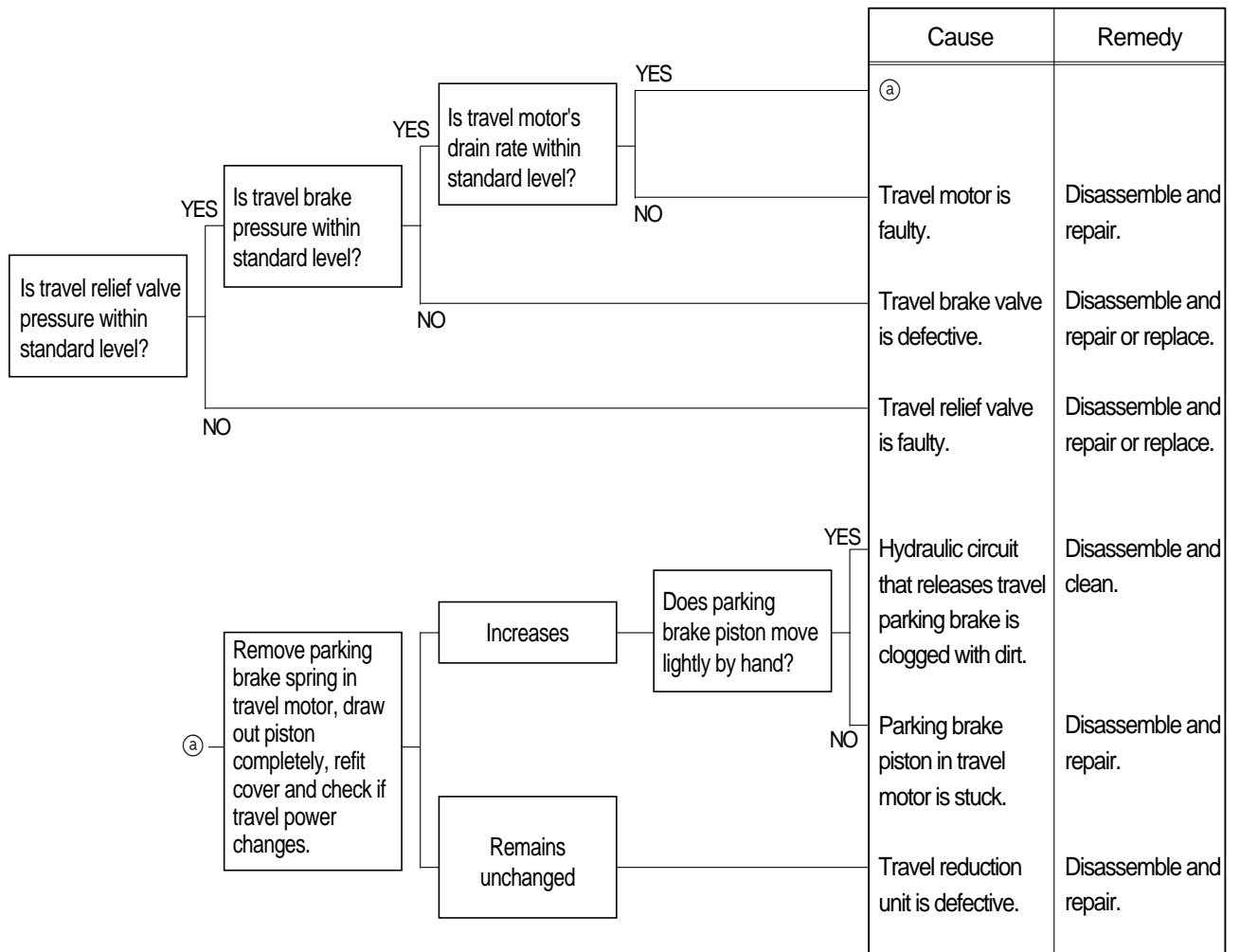
Machine is pulled forward as sprocket rotates during digging operation.



4) LH AND RH TRAVEL MOTIONS ARE IMPOSSIBLE



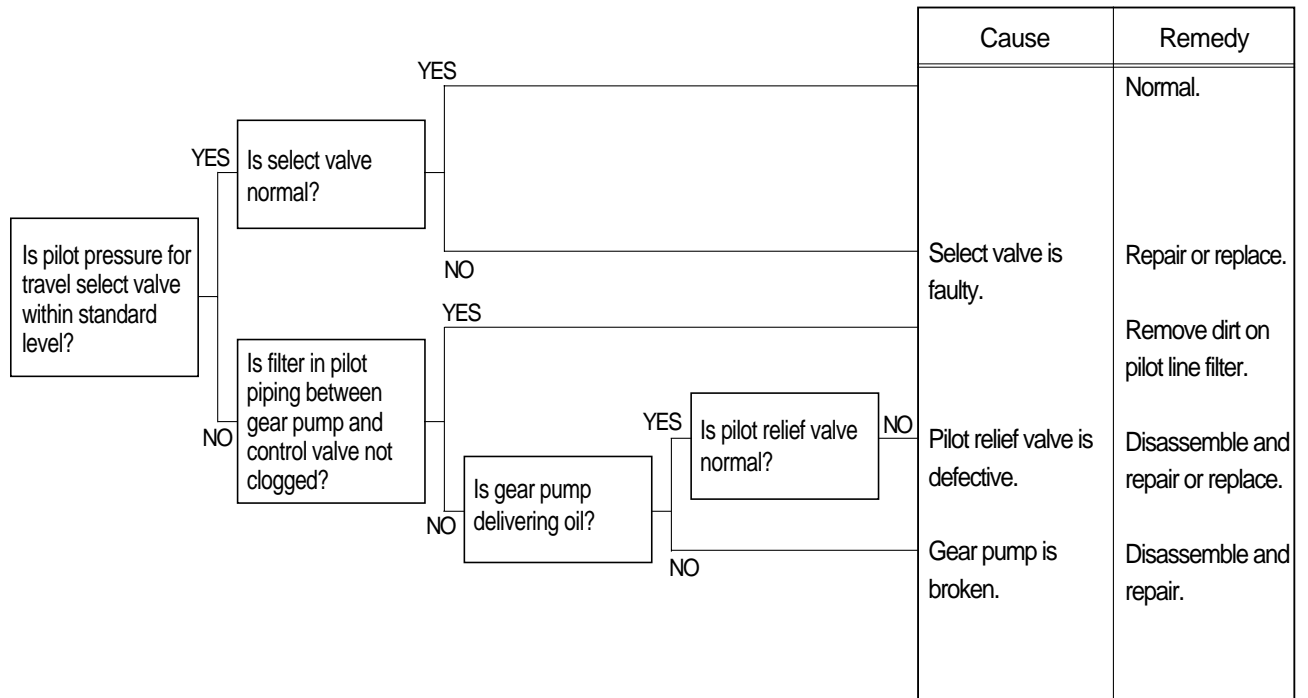
5) TRAVEL ACTION IS POWERLESS(Travel only)



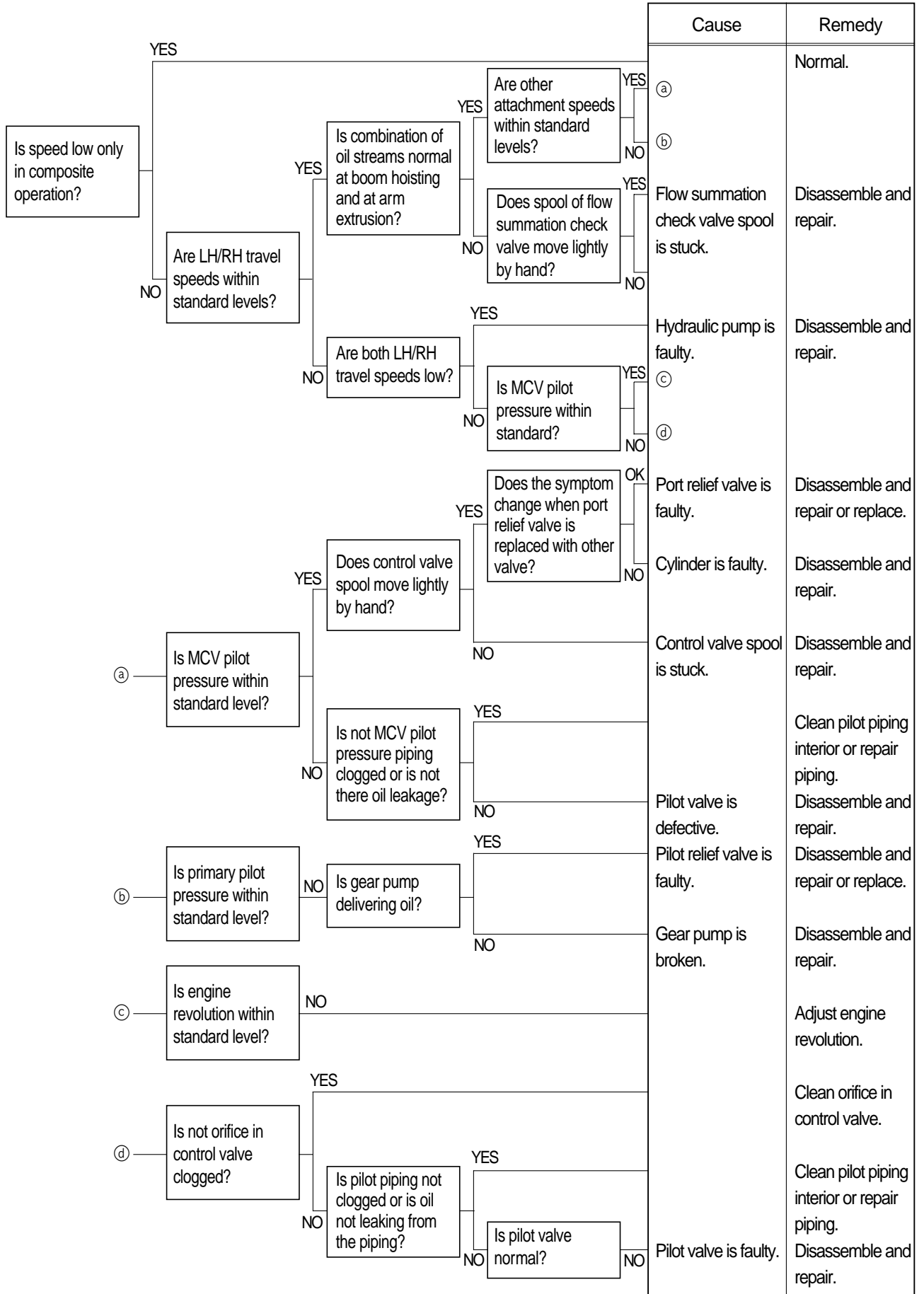
6) MACHINE RUNS RECKLESSLY ON A SLOPE



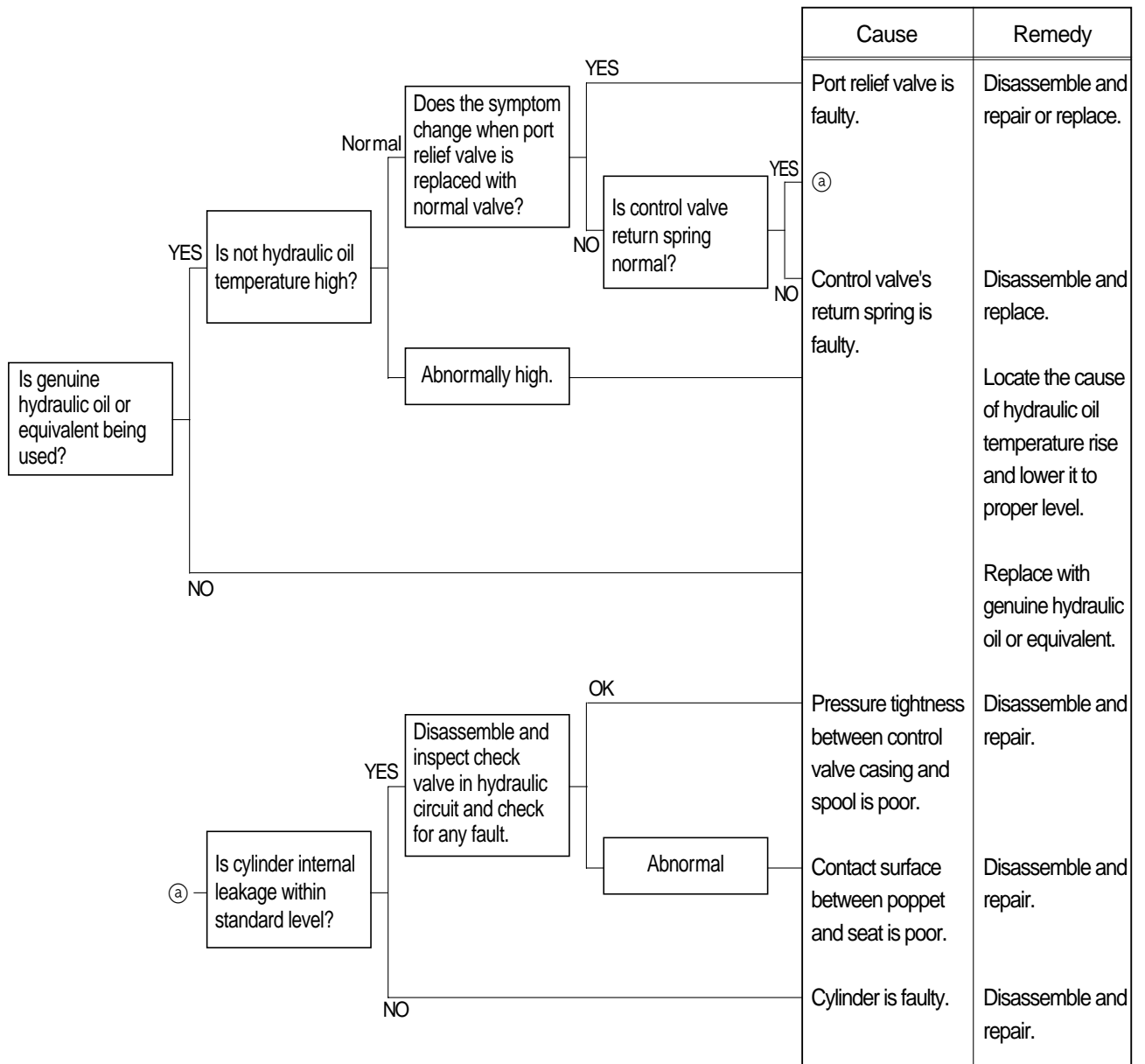
7) MACHINE MAKES A CURVED TRAVEL OR DOES NOT TRAVEL AT ALL WHEN TRAVEL AND ATTACHMENT OPERATIONS ARE EXECUTED AT THE SAME TIME



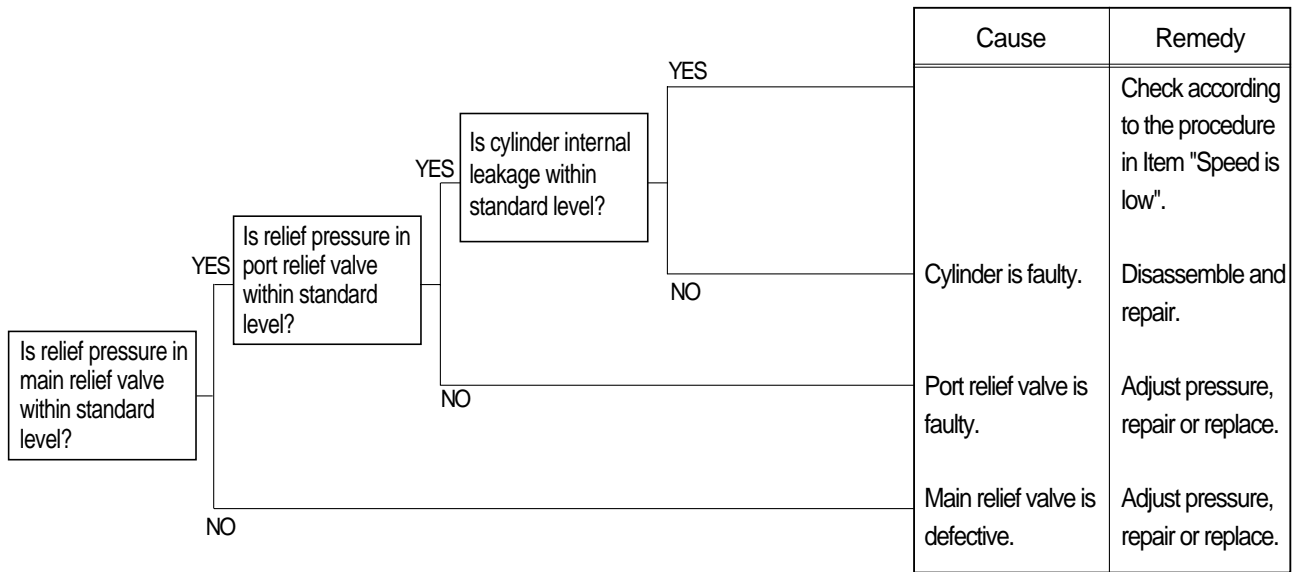
2) BOOM, ARM OR BUCKET SPEED IS LOW



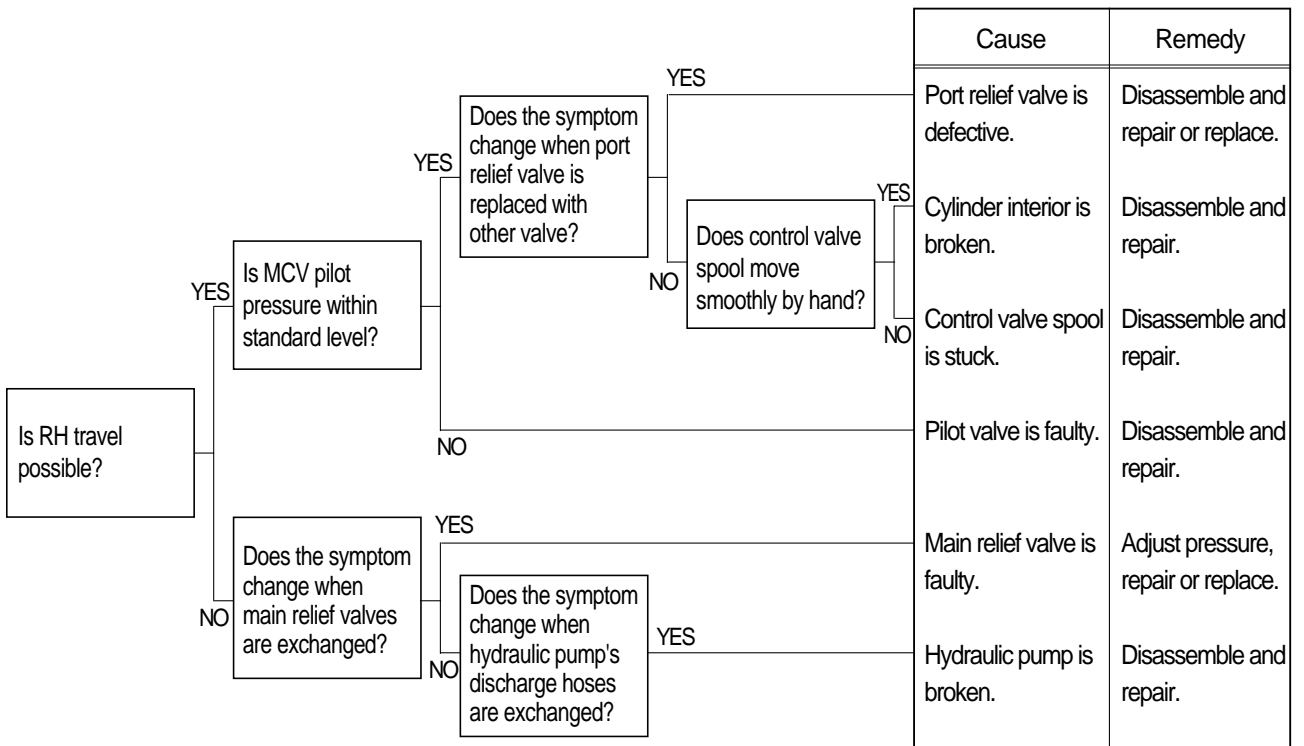
3) BOOM, ARM OR BUCKET CYLINDER EXTENDS OR CONTRACTS ITSELF AND ATTACHMENT FALLS



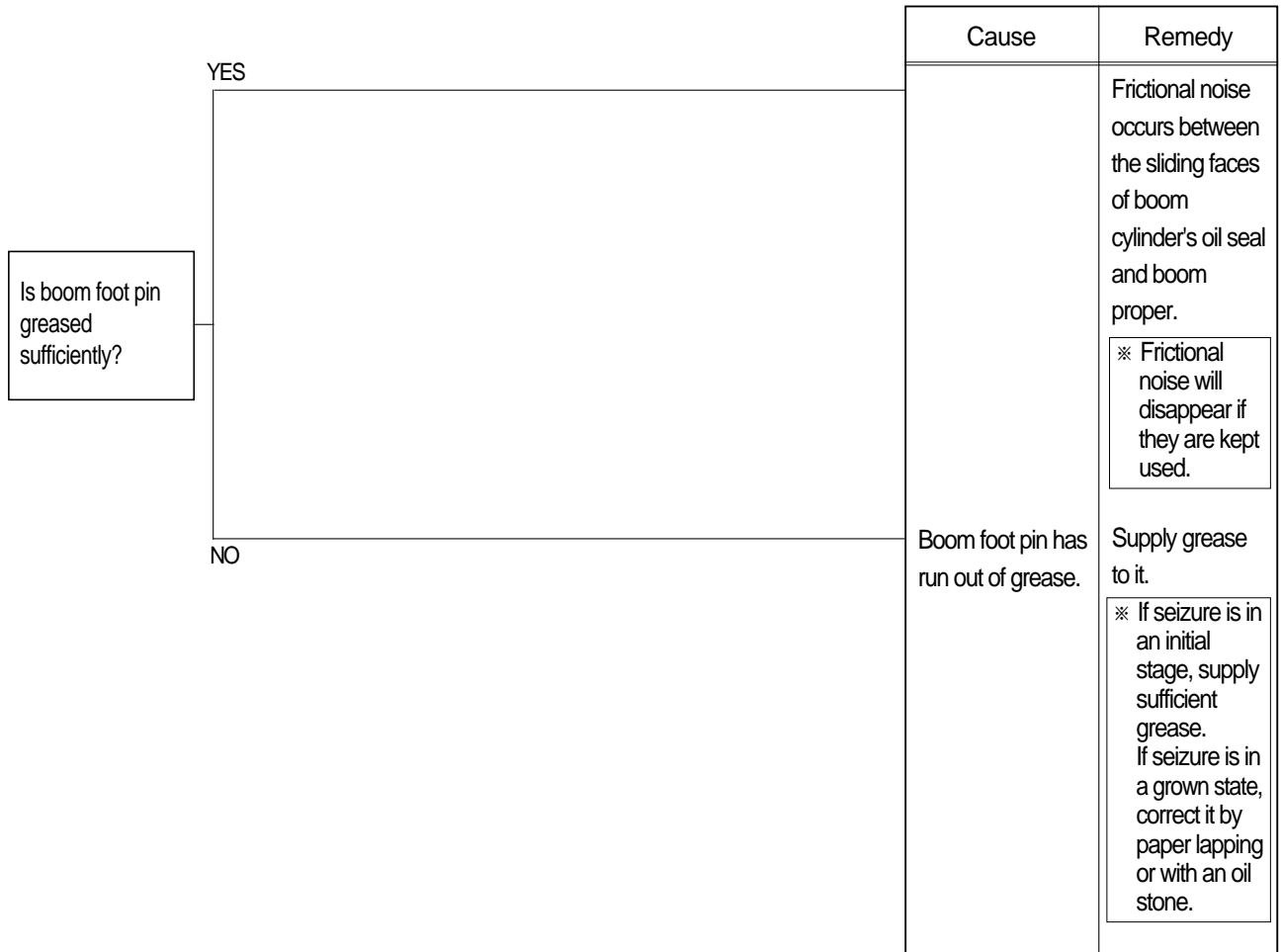
4) BOOM, ARM OR BUCKET POWER IS WEAK



5) ONLY BUCKET OPERATION IS TOTALLY IMPOSSIBLE

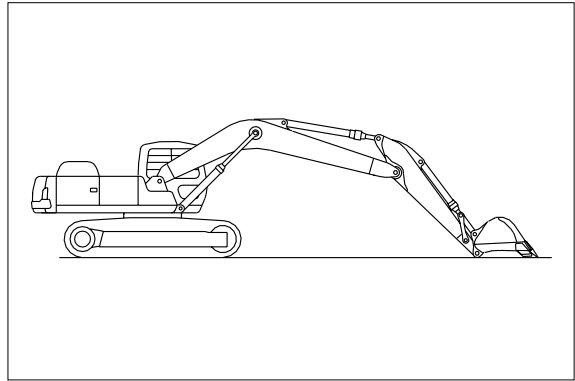


6) BOOM MAKES A SQUEAKING NOISE WHEN BOOM IS OPERATED

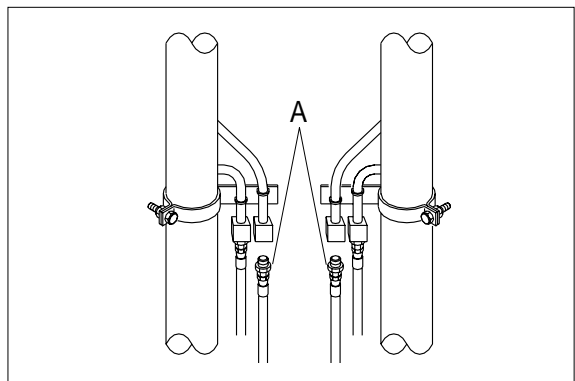


※ **HOW TO CHECK INTERNAL BOOM CYLINDER LEAKAGE**

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

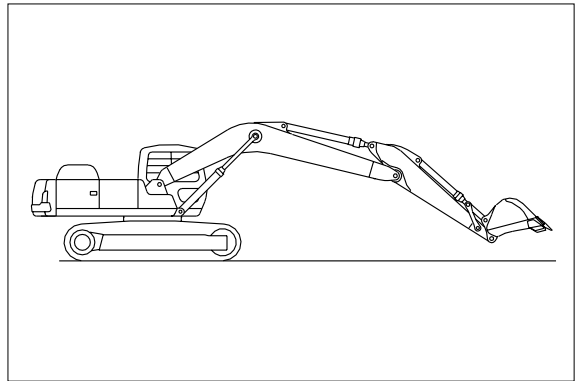


2. Disconnect hose(A) from rod side of boom cylinder and drain oil from cylinders and hose.(Put cups on piping and hose ends)



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

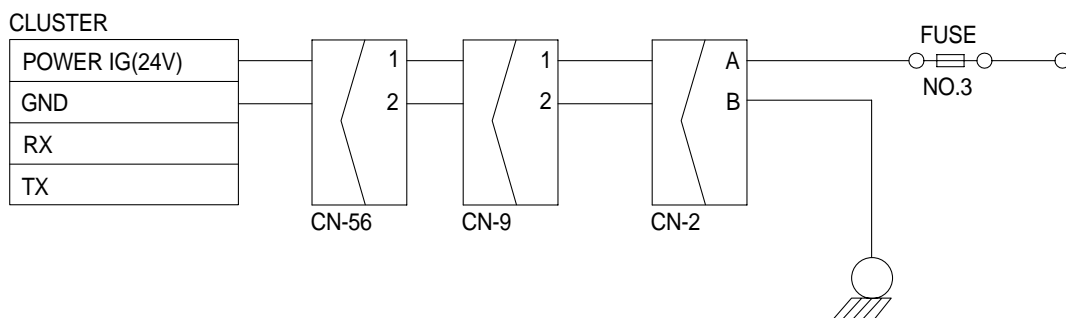
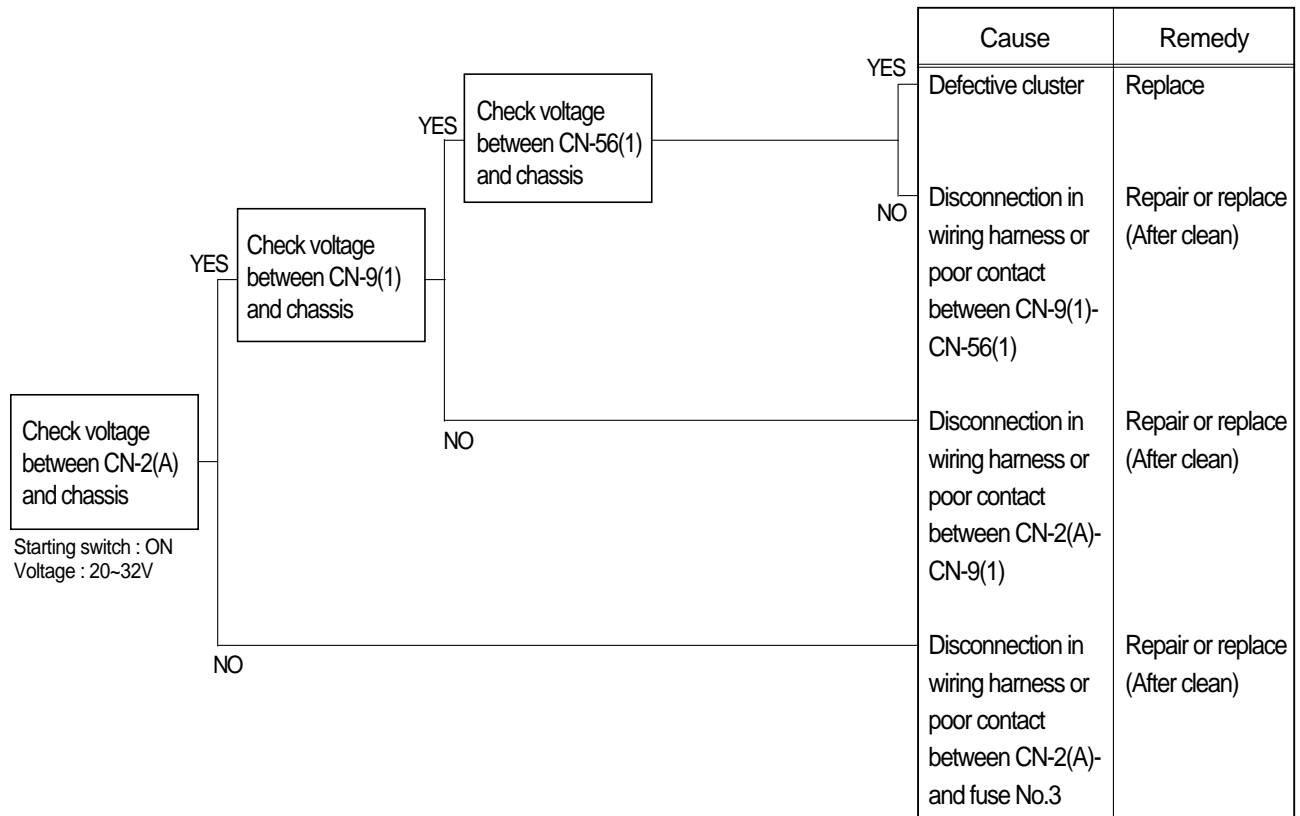
If oil leaks from piping side and boom cylinder rod is retracted there is an internal leak in the cylinder.
If no oil leaks from piping side and boom cylinder rod is retracted, there is an internal leak in the control valve.



GROUP 3 ELECTRICAL SYSTEM

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.3.
- After checking, insert the disconnected connectors again immediately unless otherwise specified.

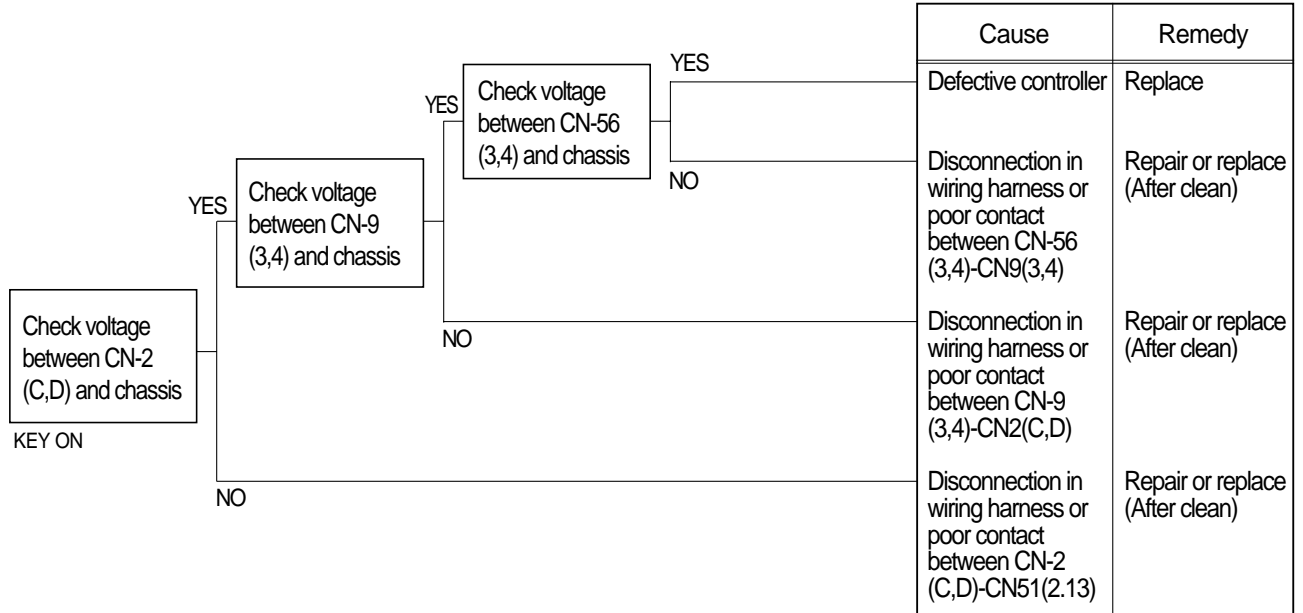


Check voltage

YES	20 ~ 32V
NO	0V

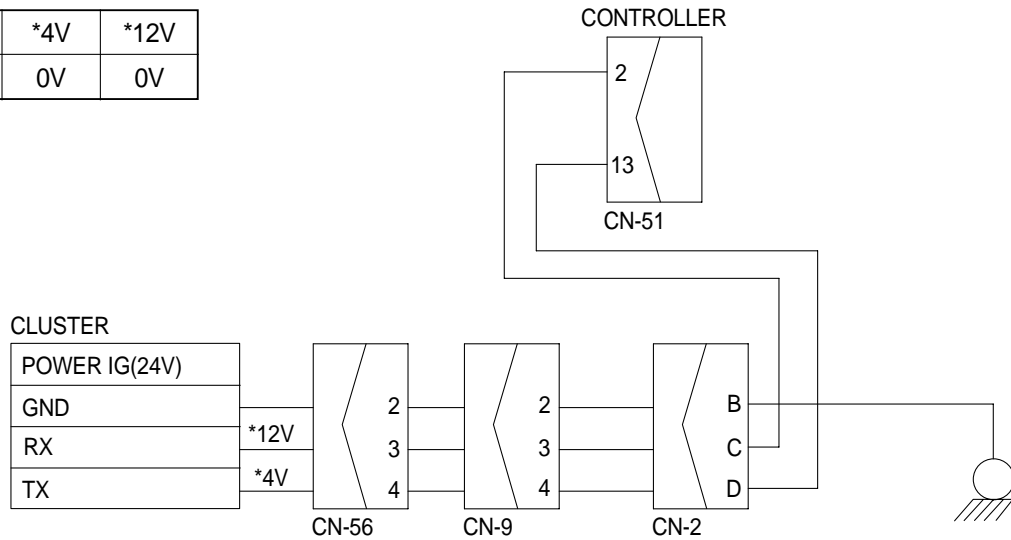
2. COMMUNICATION ERROR "Co : Err" FLASHES ON THE CLUSTER

- 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.



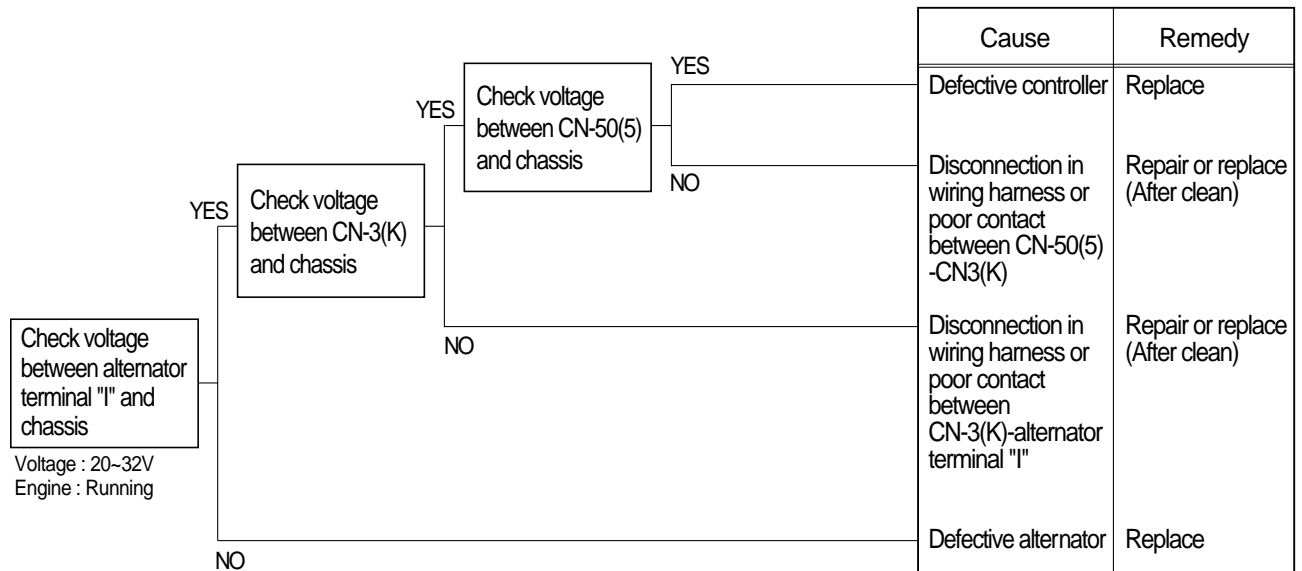
Check voltage

YES	*4V	*12V
NO	0V	0V



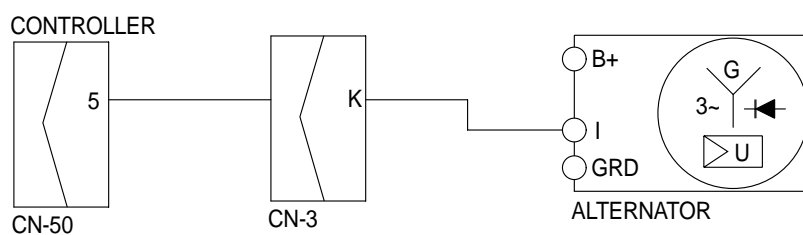
3. BATTERY CHARGING LAMP LIGHTS UP(Starting switch : ON)

- 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.



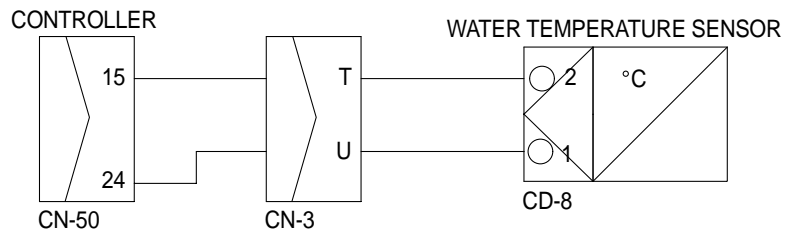
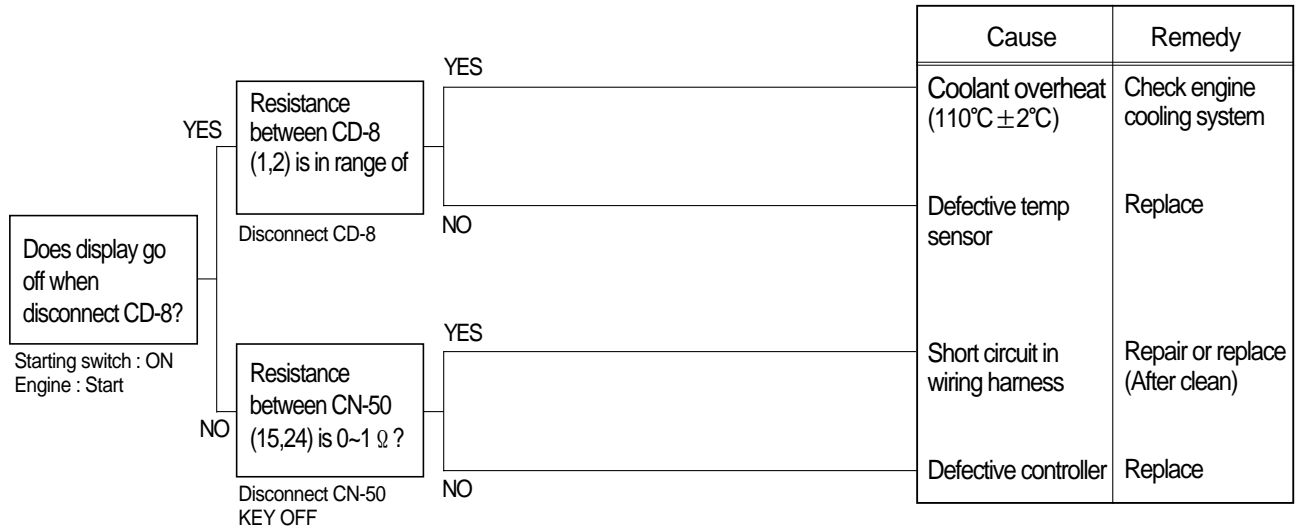
Check voltage

YES	20 ~ 32V
NO	0V



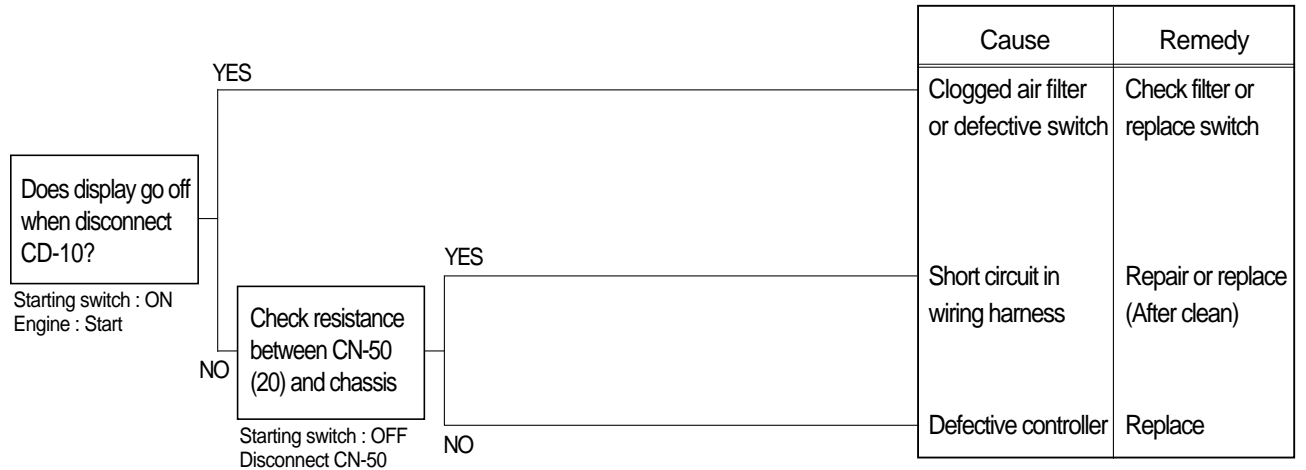
4. WHEN COOLANT OVERHEAT LAMP LIGHTS UP(Engine is started)

- 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.



5. WHEN AIR CLEANER 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.



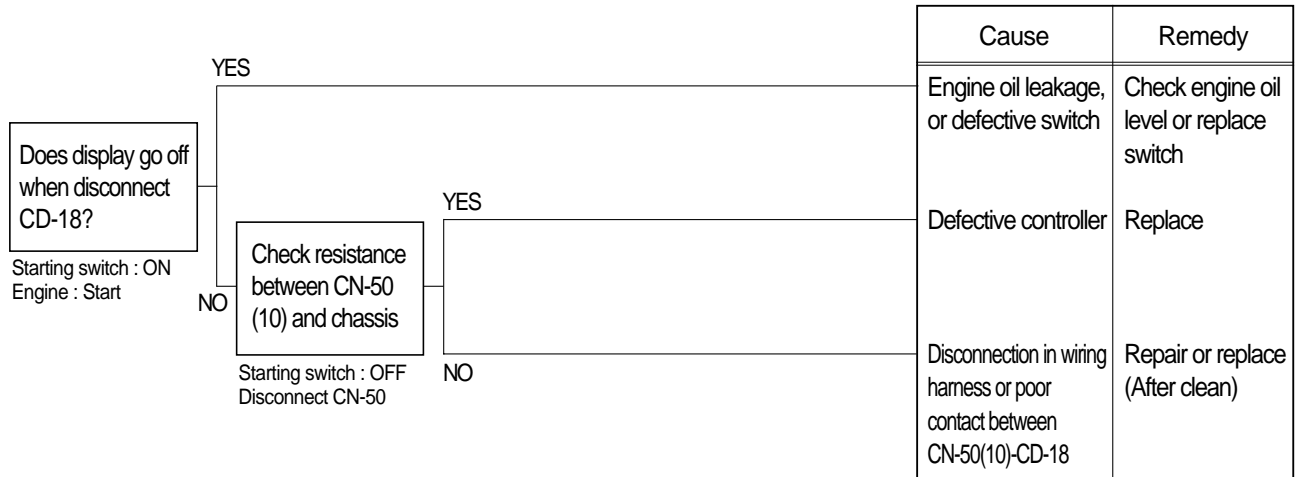
Check resistance

YES	MAX 1Ω
NO	MIN 1MΩ



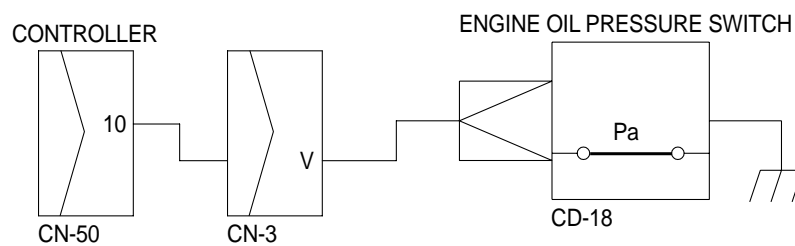
6. WHEN ENGINE OIL PRESSURE LAMP LIGHTS UP(Engine is started)

- 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.



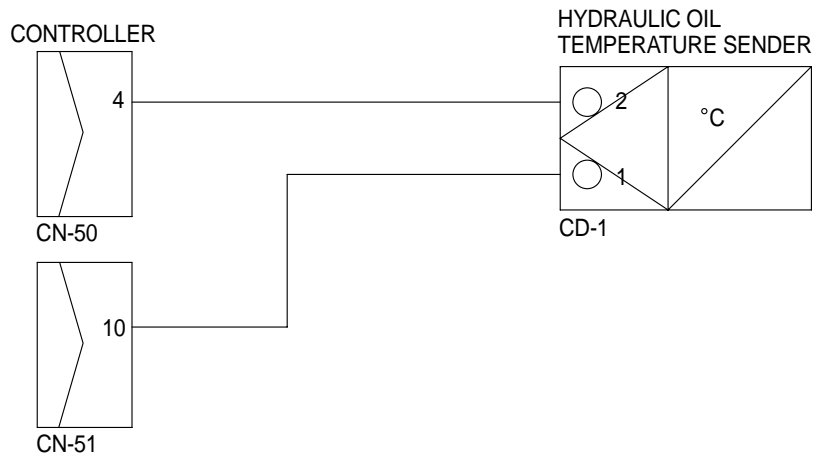
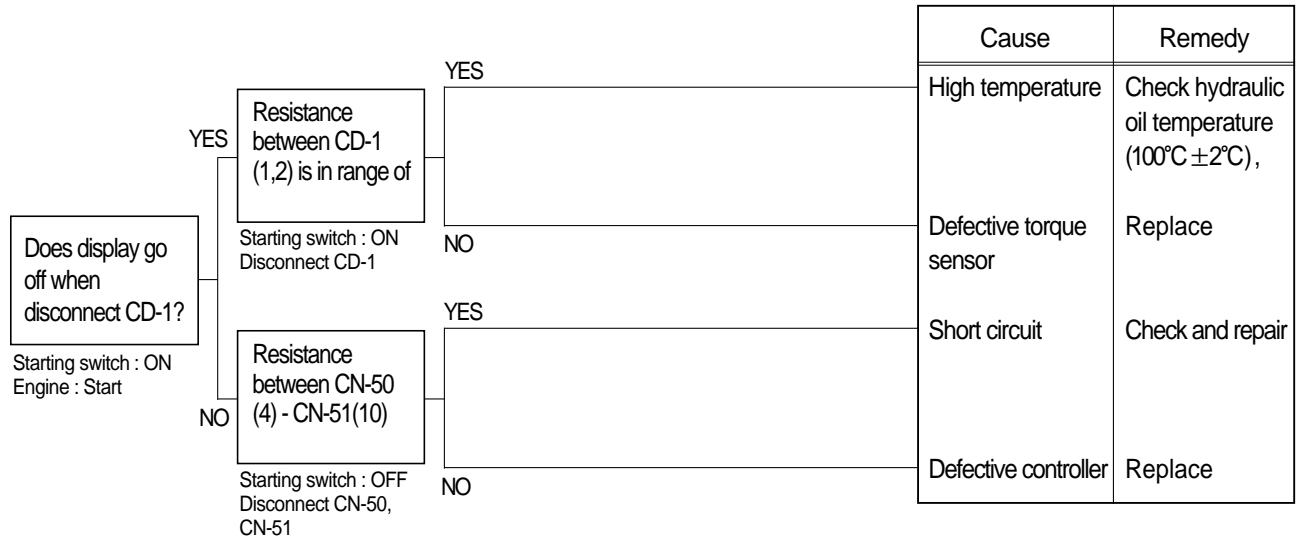
Check resistance

YES	MAX 1Ω
NO	MIN 1MΩ



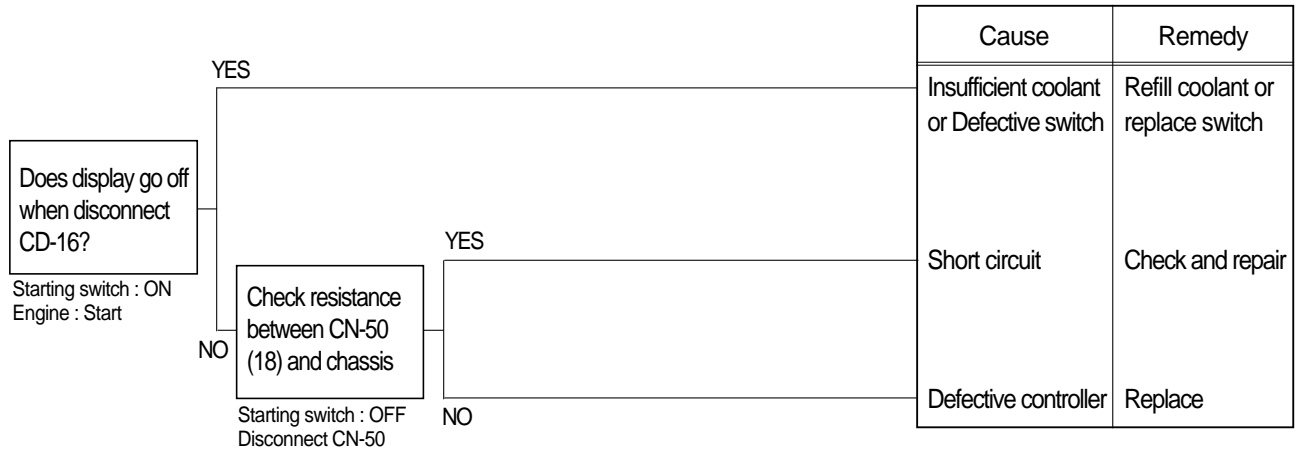
7.  **WHEN HYDRAULIC OIL TEMPERATURE LAMP LIGHTS UP**(Engine is started)

- 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.



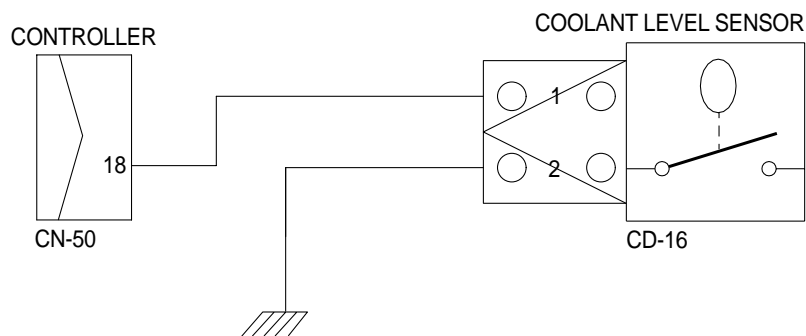
8.  **WHEN COOLANT LEVEL LAMP LIGHTS UP**(Engine is started)

- 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.



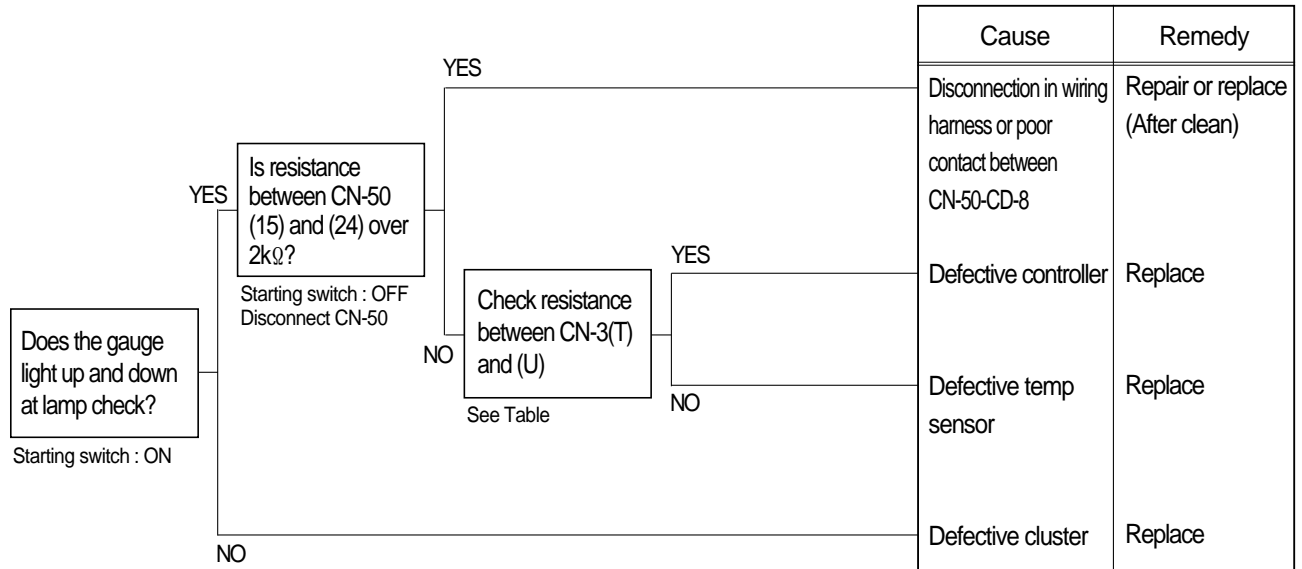
Check resistance

YES	MAX 1Ω
NO	MIN 1MΩ

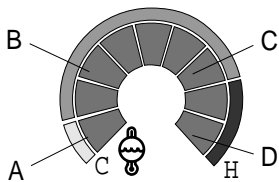


9. WHEN COOLANT TEMPERATURE GAUGE DOES NOT OPERATE

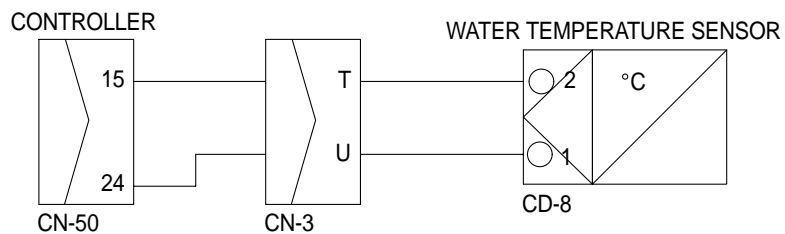
- Before disconnecting the connector, always turn the starting switch OFF.
- Before carrying out below procedure, check all the related connectors are properly inserted.
- After checking, insert the disconnected connectors again immediately unless otherwise specified.



Check Table

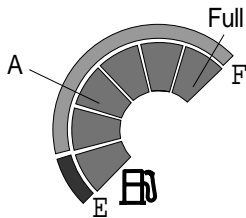
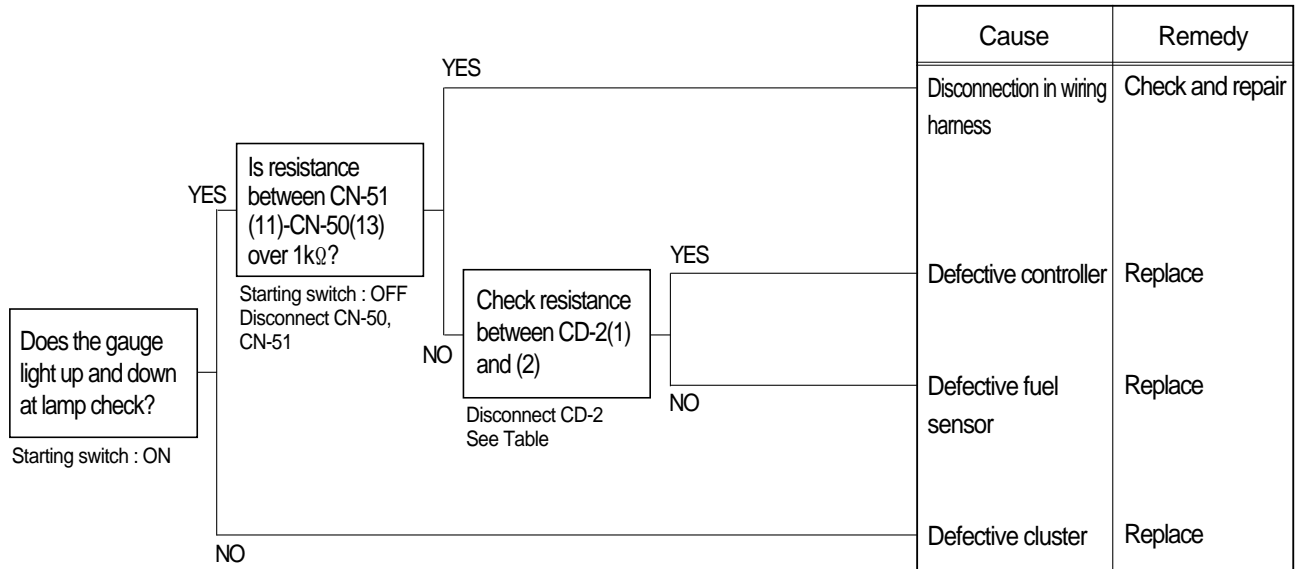


Temperature	A (50°C)	B (80°C)	C (100°C)	D (120°C)
Unit Resistance(Ω)	800	310	180	100
Tolerance	±70	±30	±10	±4



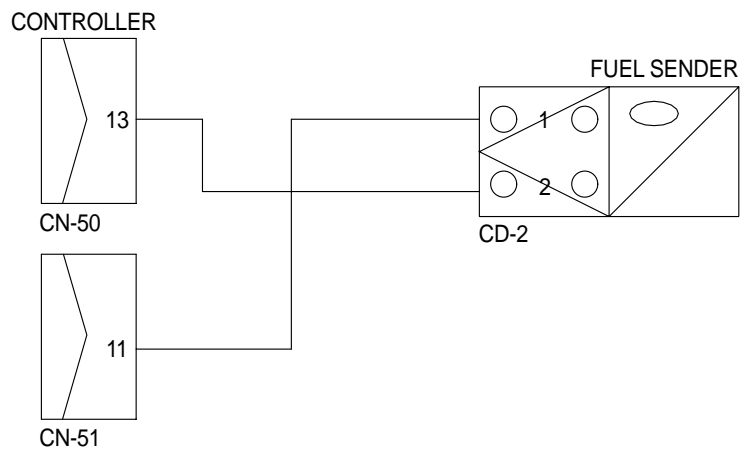
10. WHEN FUEL GAUGE DOES NOT OPERATE(Check warning lamp ON/OFF)

- 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.



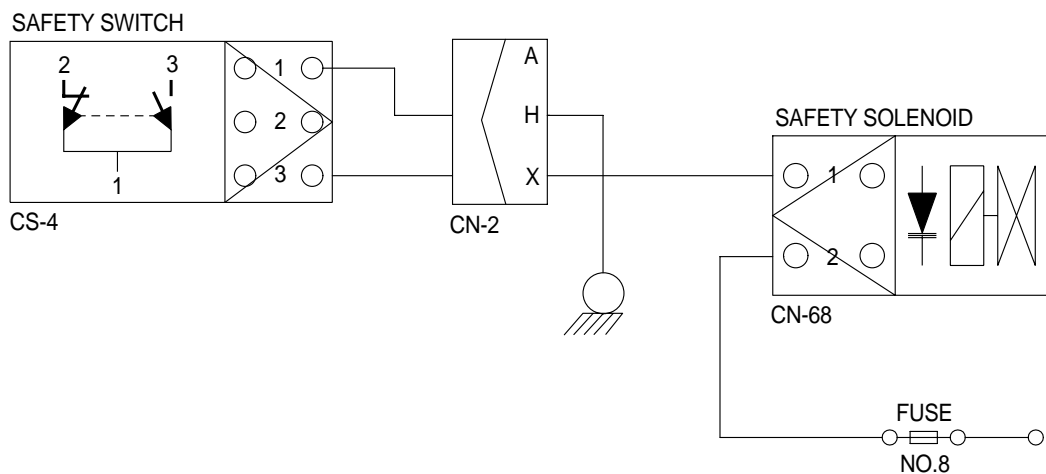
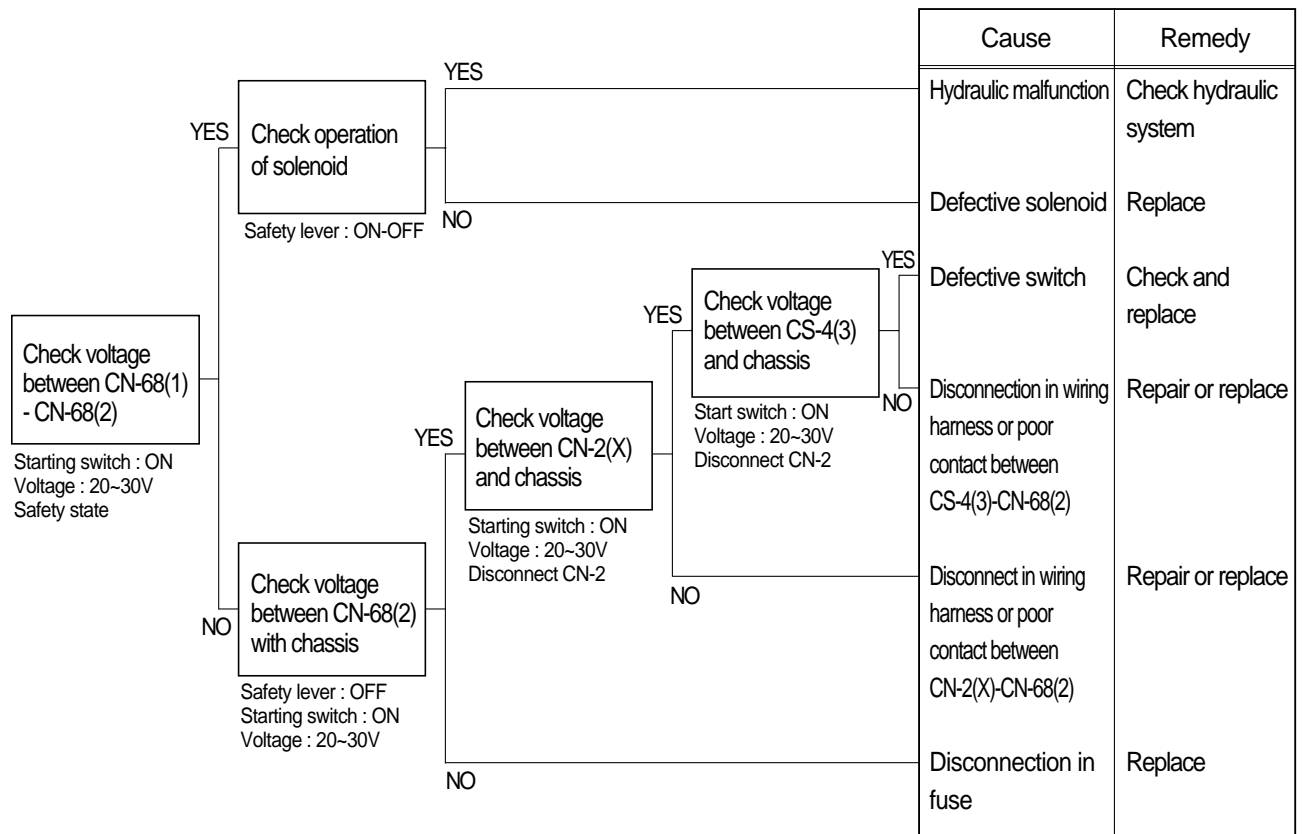
Check Table

Item \ Level	Empty	A	Full
Unit Resistance(Ω)	700	400	100
Tolerance	± 50	± 50	± 50



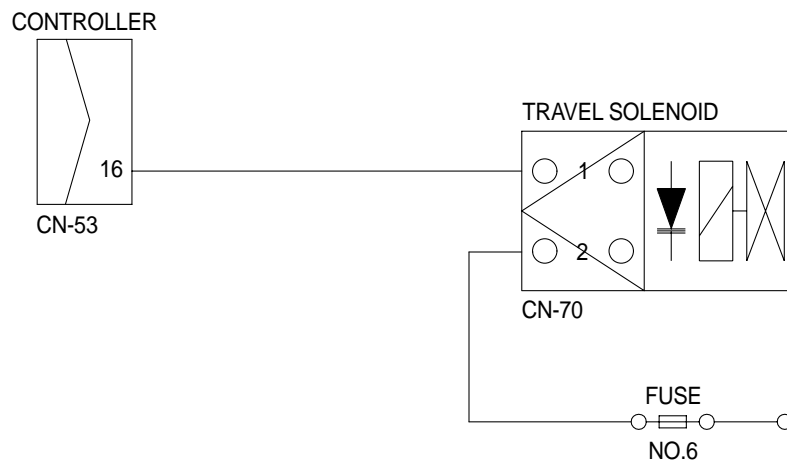
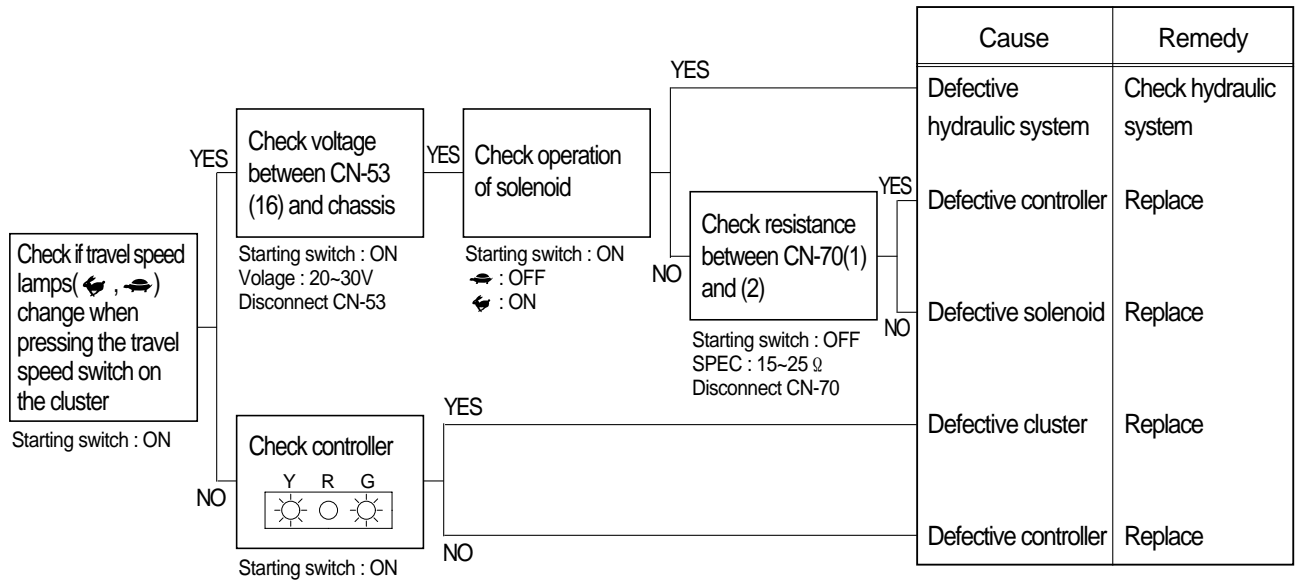
11. WHEN SAFETY SOLENOID DOES NOT OPERATE

- 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.8.
- After checking, insert the disconnected connectors again immediately unless otherwise specified.



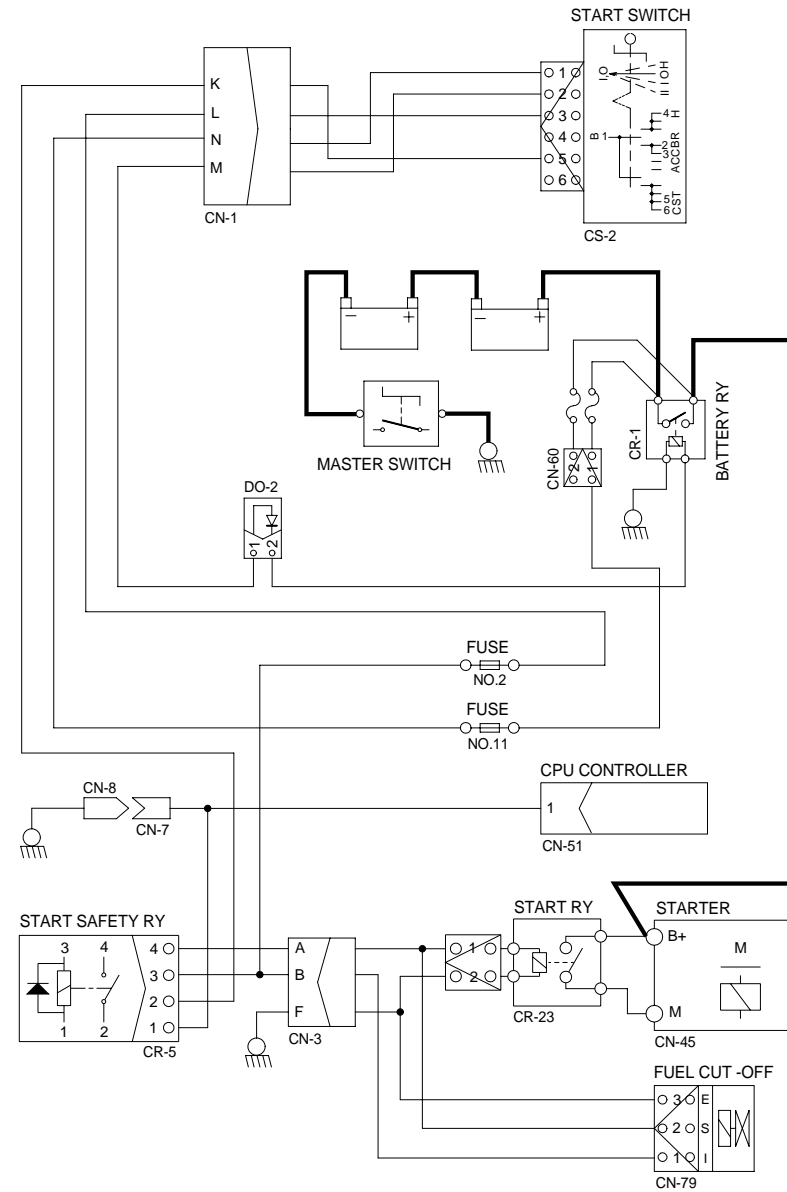
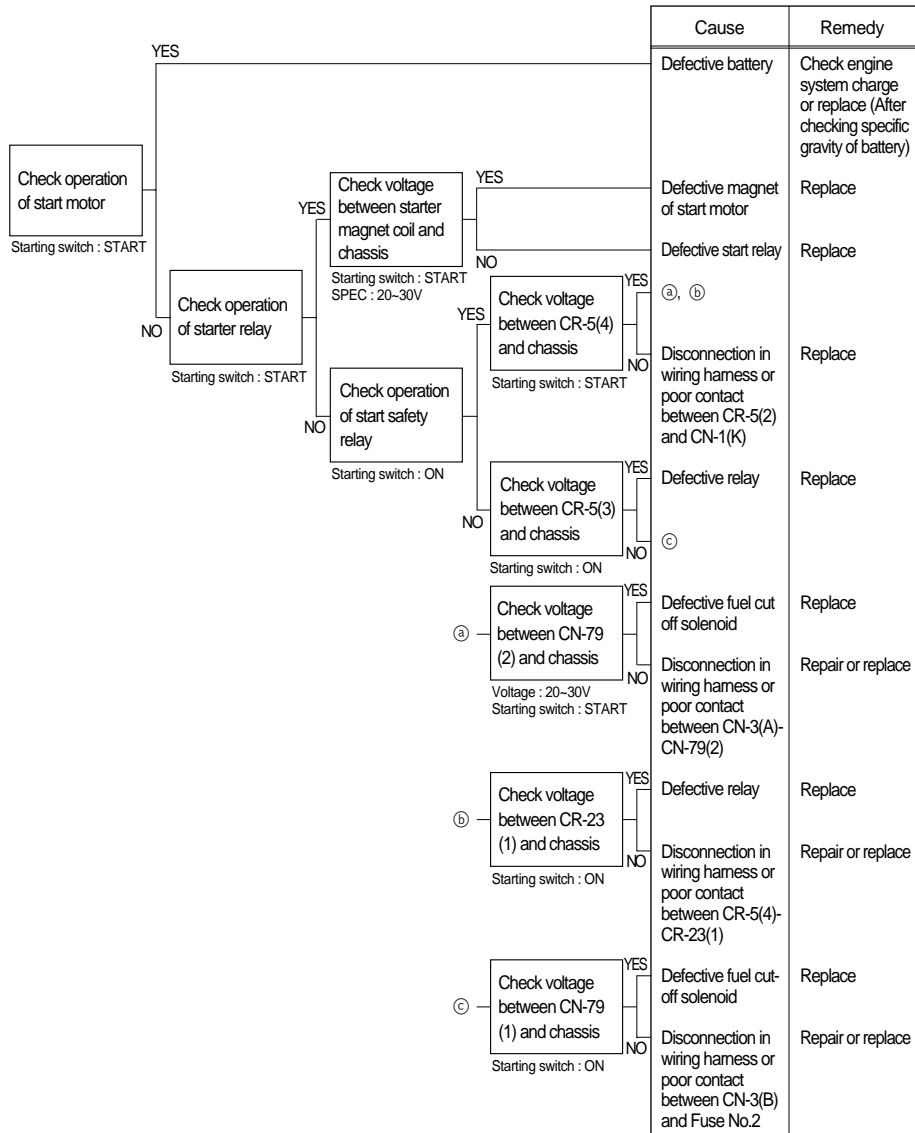
12. WHEN TRAVEL SPEED 1, 2 DOES NOT OPERATE

- 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.6.
- After checking, insert the disconnected connectors again immediately unless otherwise specified.



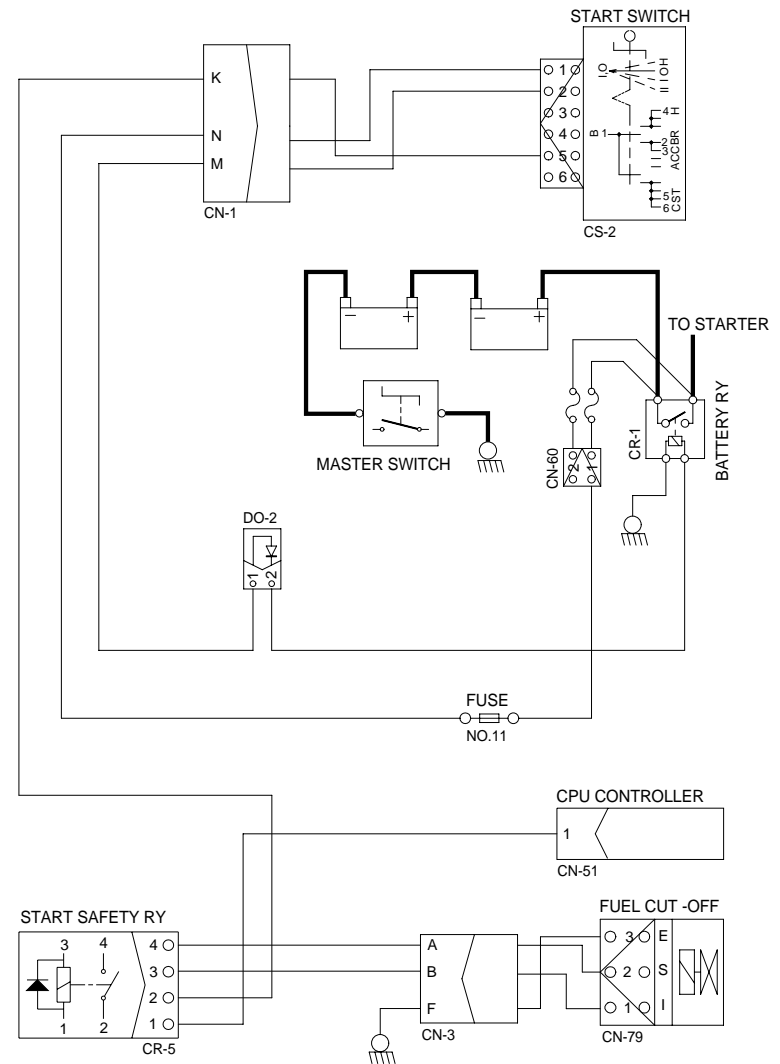
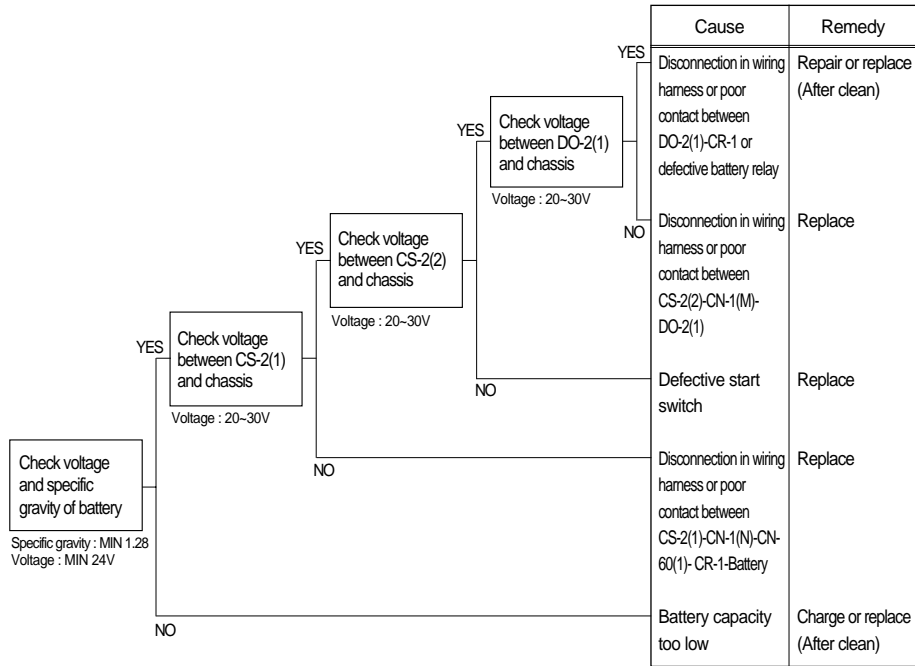
13. WHEN ENGINE DOES NOT START

- Check supply of the power at engine stop solenoid while starting switch is 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.



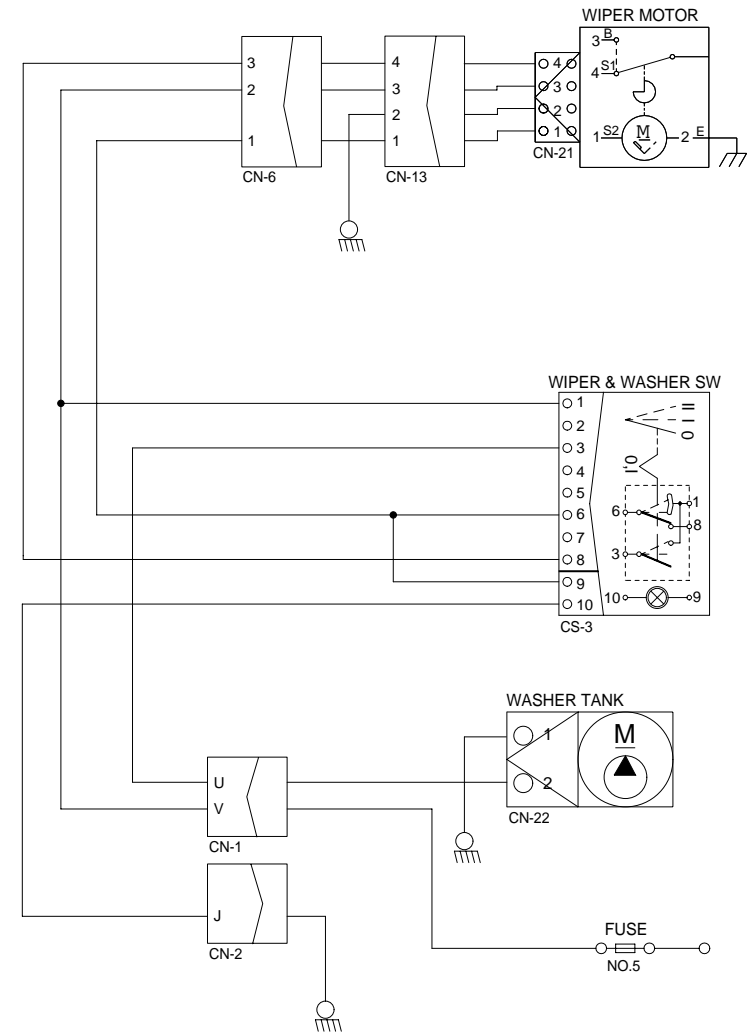
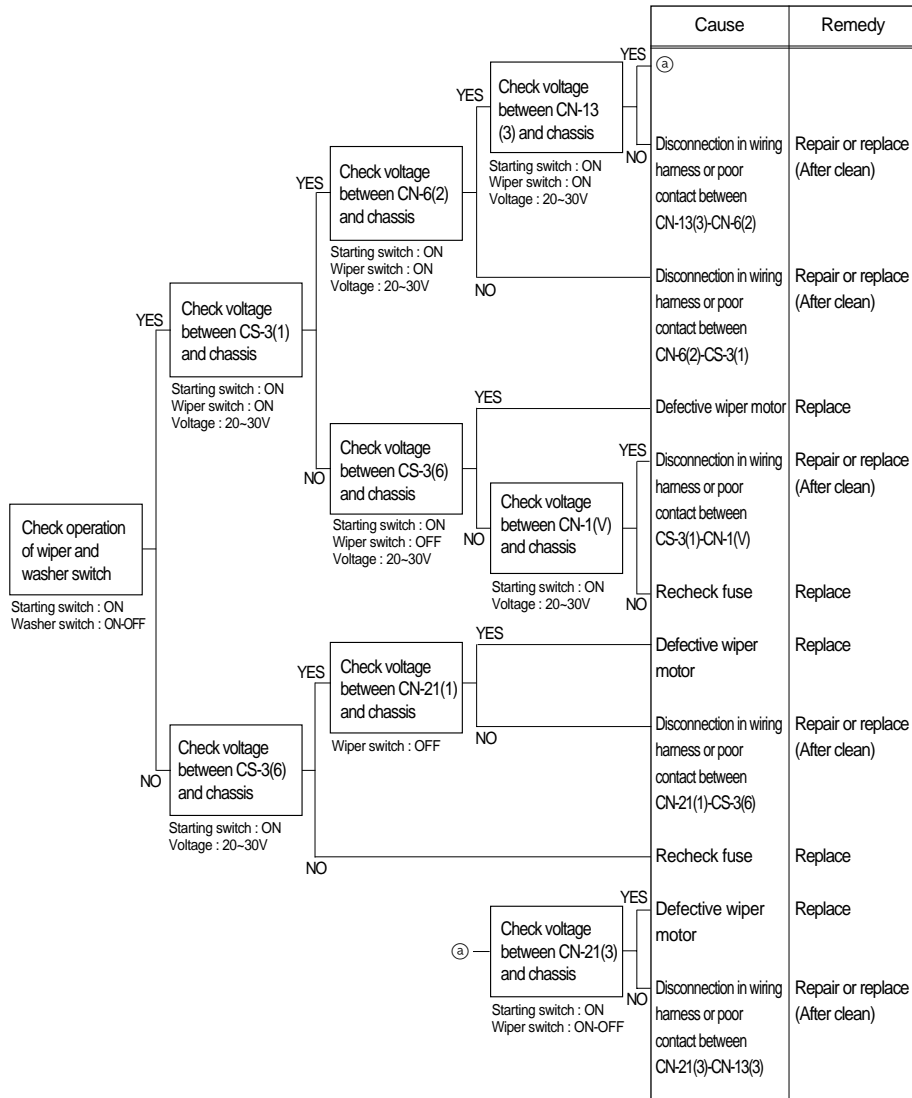
14. WHEN STARTING SWITCH ON DOES NOT OPERATE

- 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.



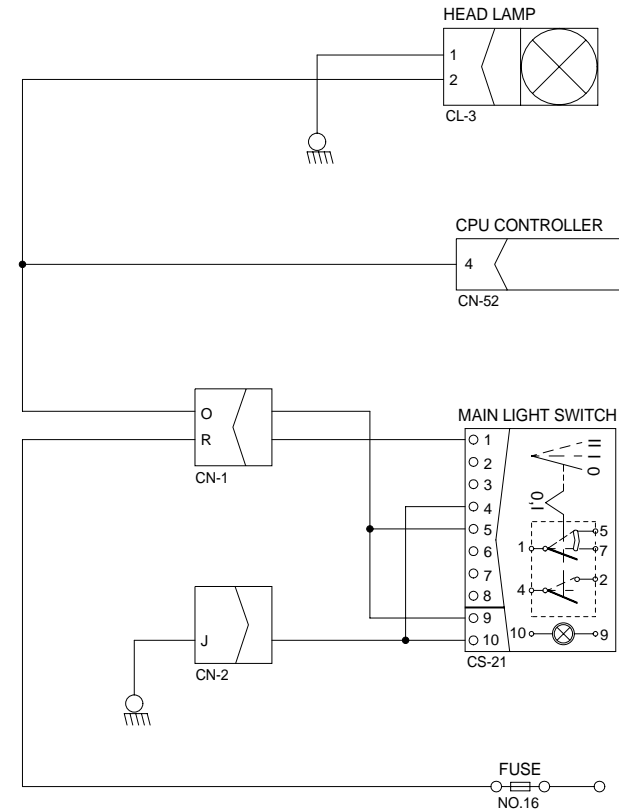
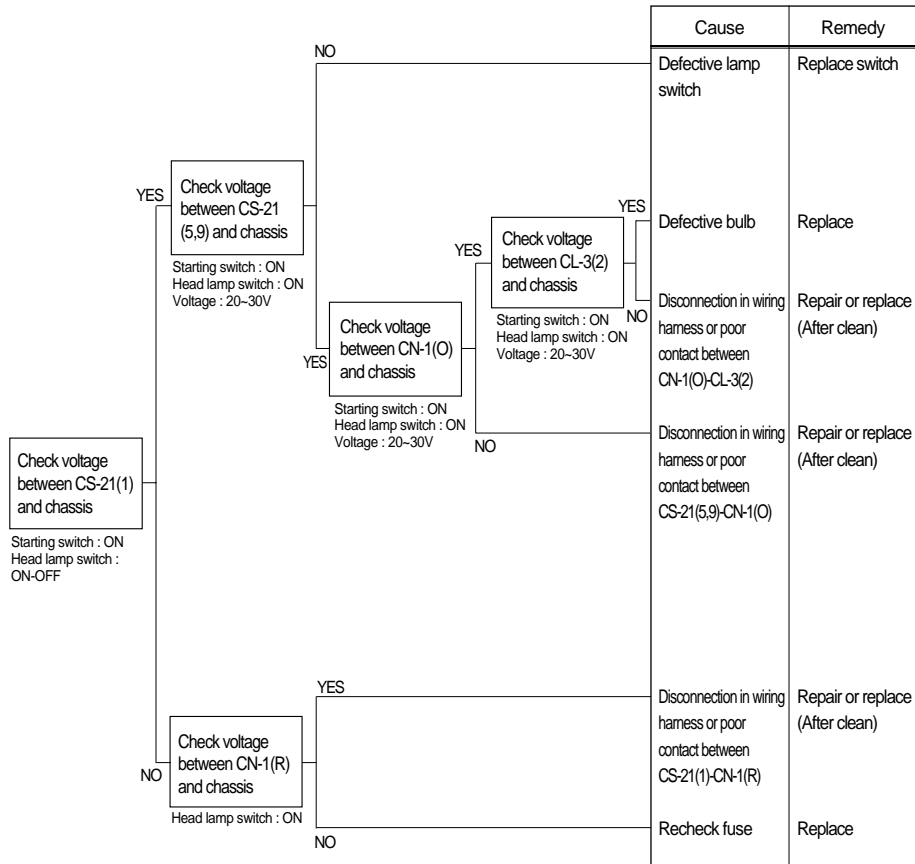
15. WHEN STARTING SWITCH IS TURNED ON, WIPER MOTOR DOES NOT OPERATE

- Before disconnecting the connector, always turn the starting switch OFF.
- Before carrying out below procedure, check all the related connectors are properly inserted and the fuse No.5 is not blown out.
- After checking, insert the disconnected connectors again immediately unless otherwise specified.



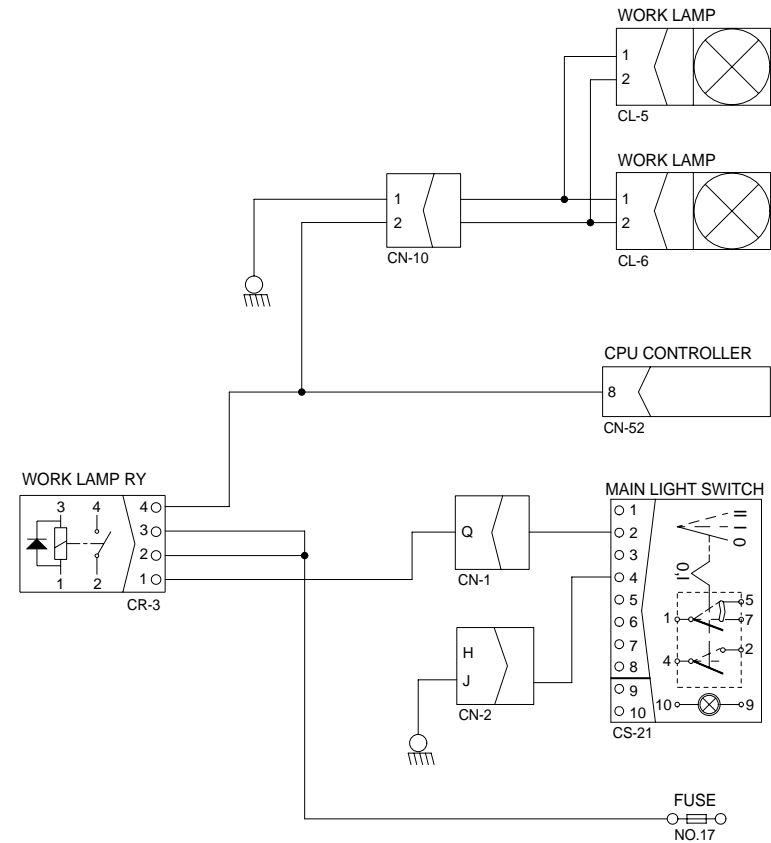
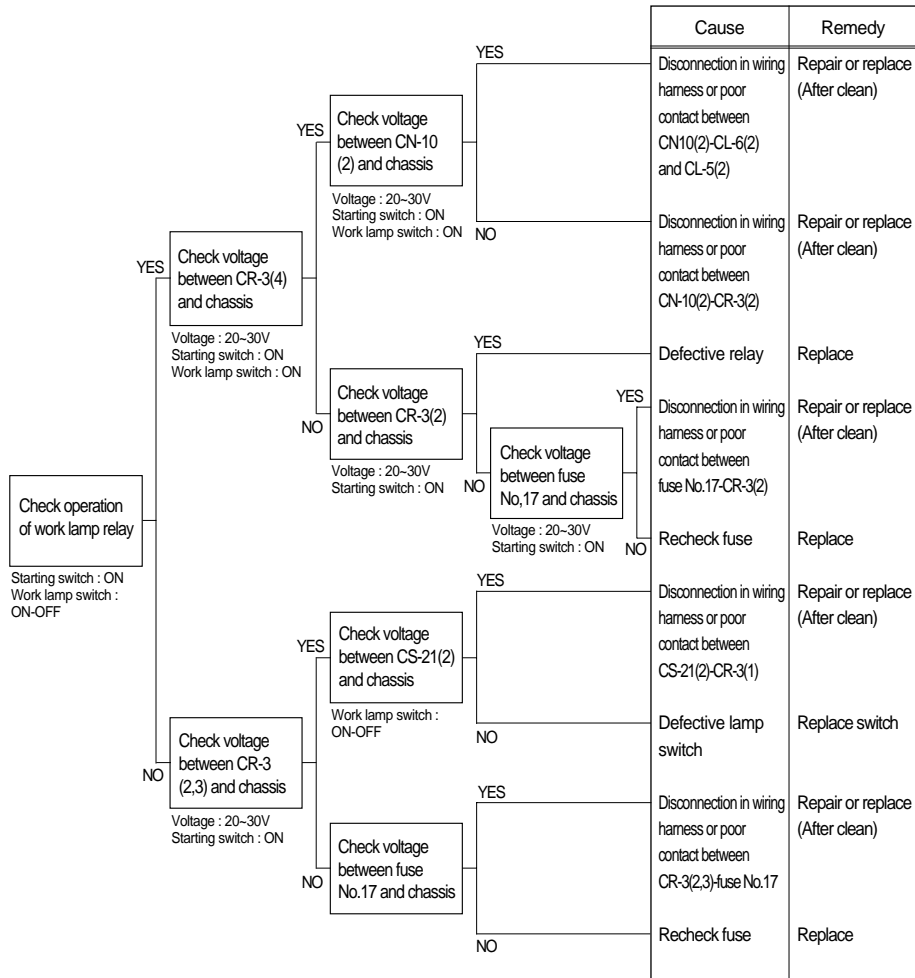
16. WHEN STARTING SWITCH IS TURNED ON, HEAD LAMP DOES NOT LIGHTS UP

- 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.16.
- After checking, insert the disconnected connectors again immediately unless otherwise specified.



17. 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.17.
- After checking, insert the disconnected connectors again immediately unless otherwise specified.

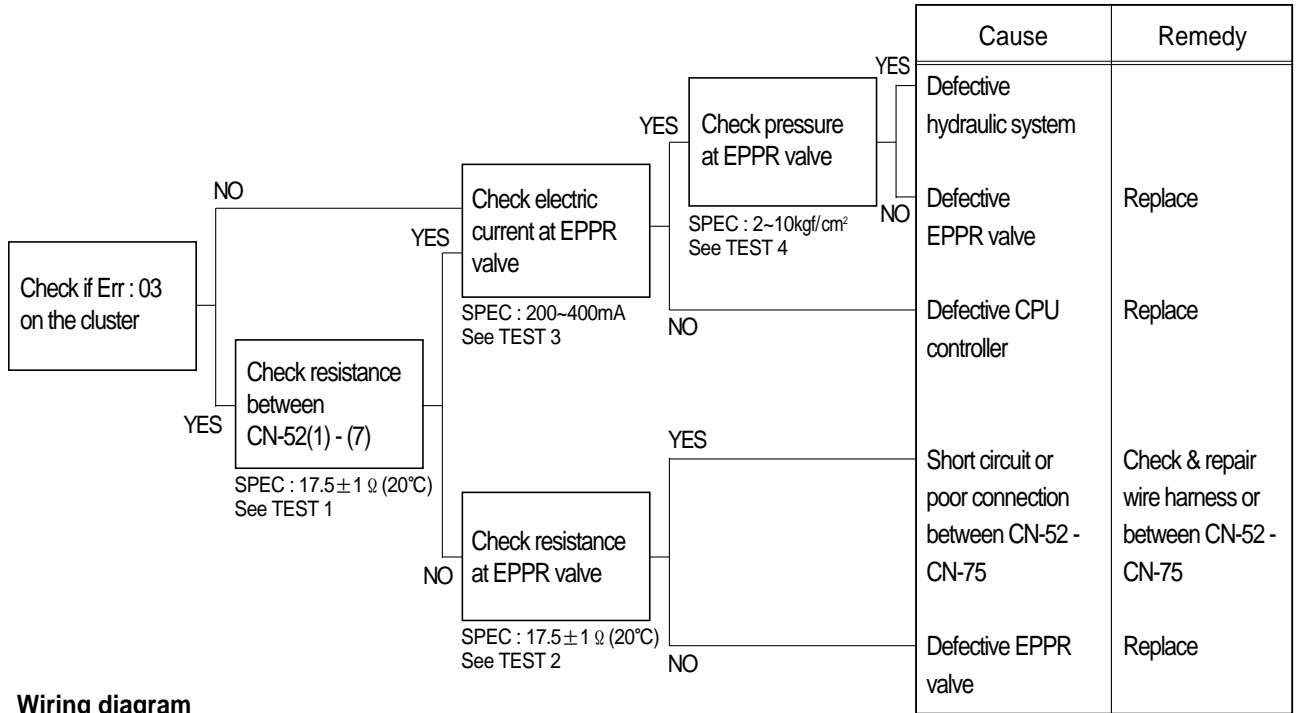


GROUP 4 MECHATRONICS SYSTEM

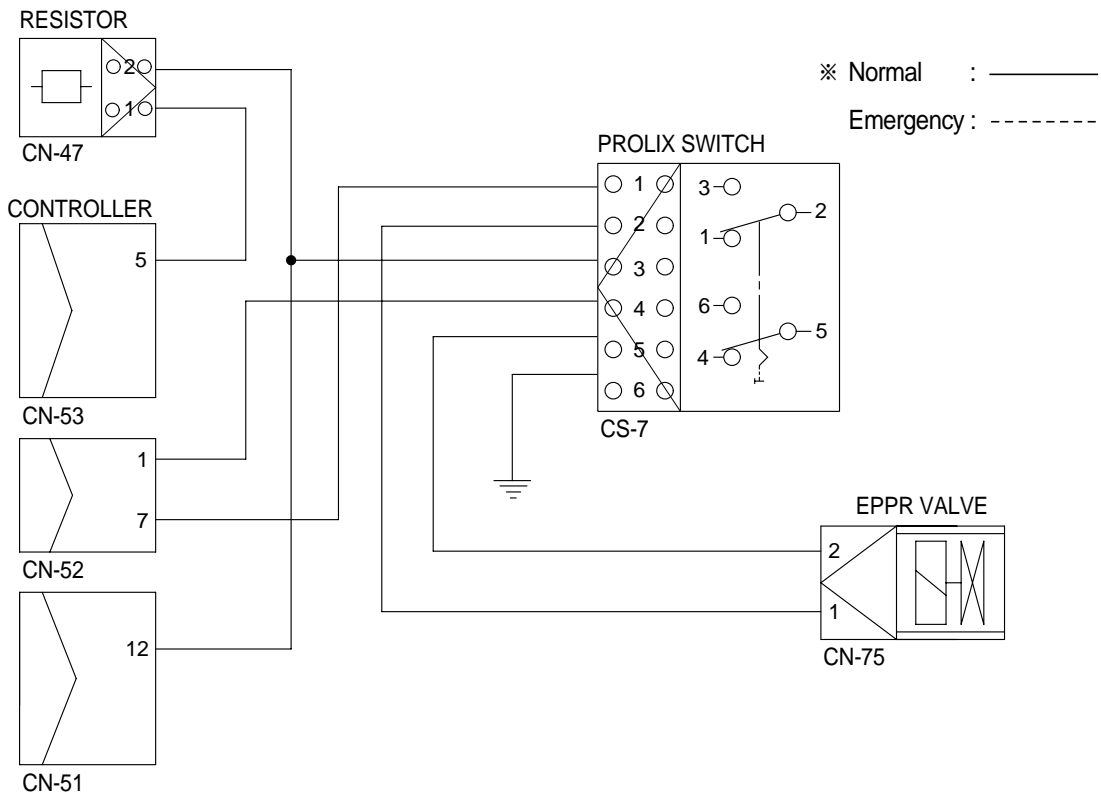
1. ALL ACTUATORS SPEED ARE SLOW

- ※ Boom, Arm, Bucket, Swing and travel speed are slow, but engine speed is good.
- ※ Spec : H-mode 2450 ± 50rpm S-mode 2250 ± 50rpm
 L-mode 2250 ± 50rpm F-mode 1750 ± 50rpm
- ※ Before carrying out below procedure, check all the related connectors are properly inserted.

1) INSPECTION PROCEDURE



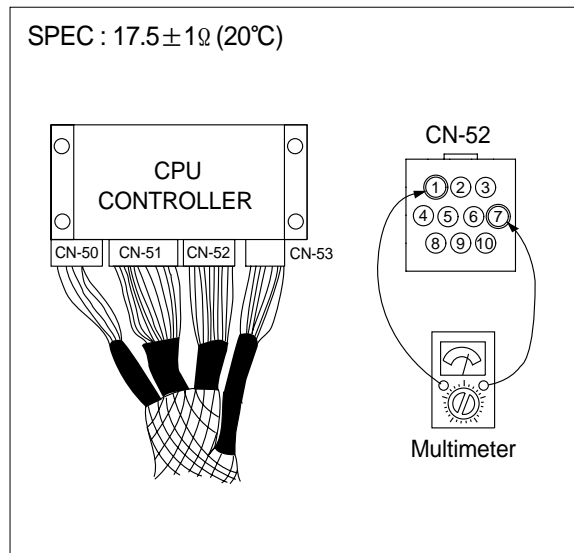
Wiring diagram



2) TEST PROCEDURE

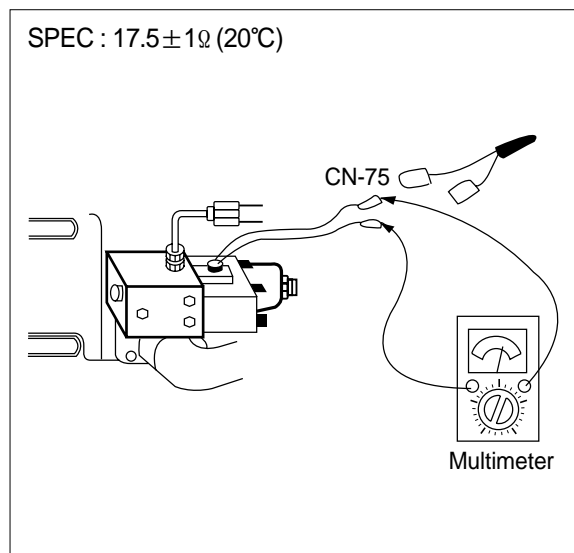
(1) **Test 1** : Check resistance at connector CN-52(1)-(7).

- ① Starting key OFF.
- ② Disconnect connector CN-52.
- ③ Check resistance between pin and at connector CN-52(1)-(7).



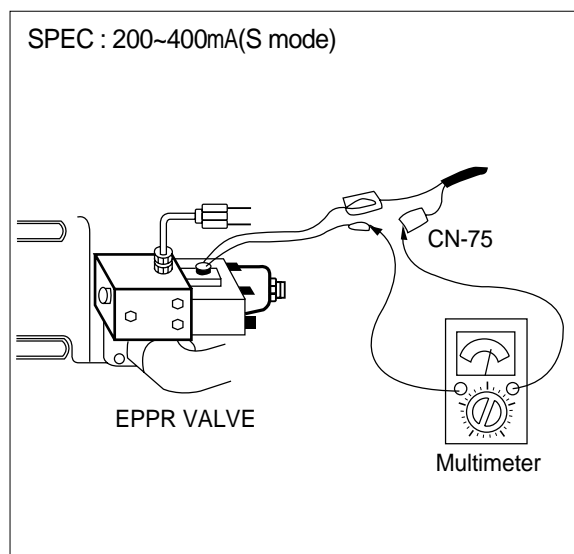
(2) **Test 2** : Check resistance at connector CN-75.

- ① Starting key OFF.
- ② Disconnect connector CN-75 from EPPR valve at main hydraulic pump.
- ③ Check resistance between 2 lines as figure.



(3) **Test 3** : Check electric current at EPPR valve.

- ① Install multimeter as figure.
- ② Start engine.
- ③ Set S-mode and cancel auto decel mode.
- ④ If tachometer show approx 2250 ± 50 rpm, check electric current.

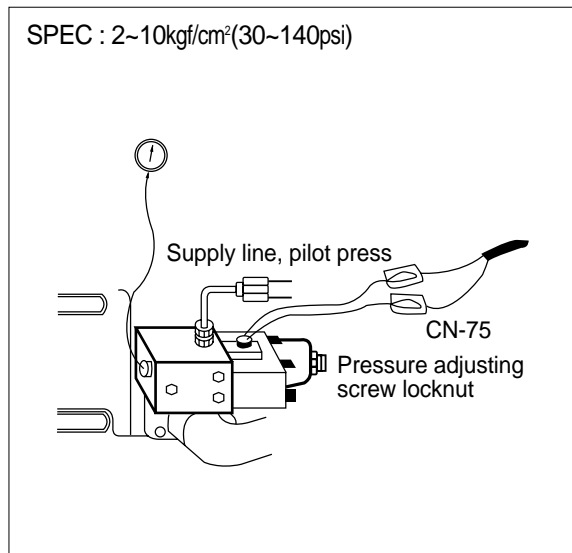


(2) **Test 4** : Check pressure at EPPR valve.

- ① Remove plug and connect pressure gauge as figure.

Gauge capacity : 0 to 40~50kgf/cm²
(0 to 570~710psi)

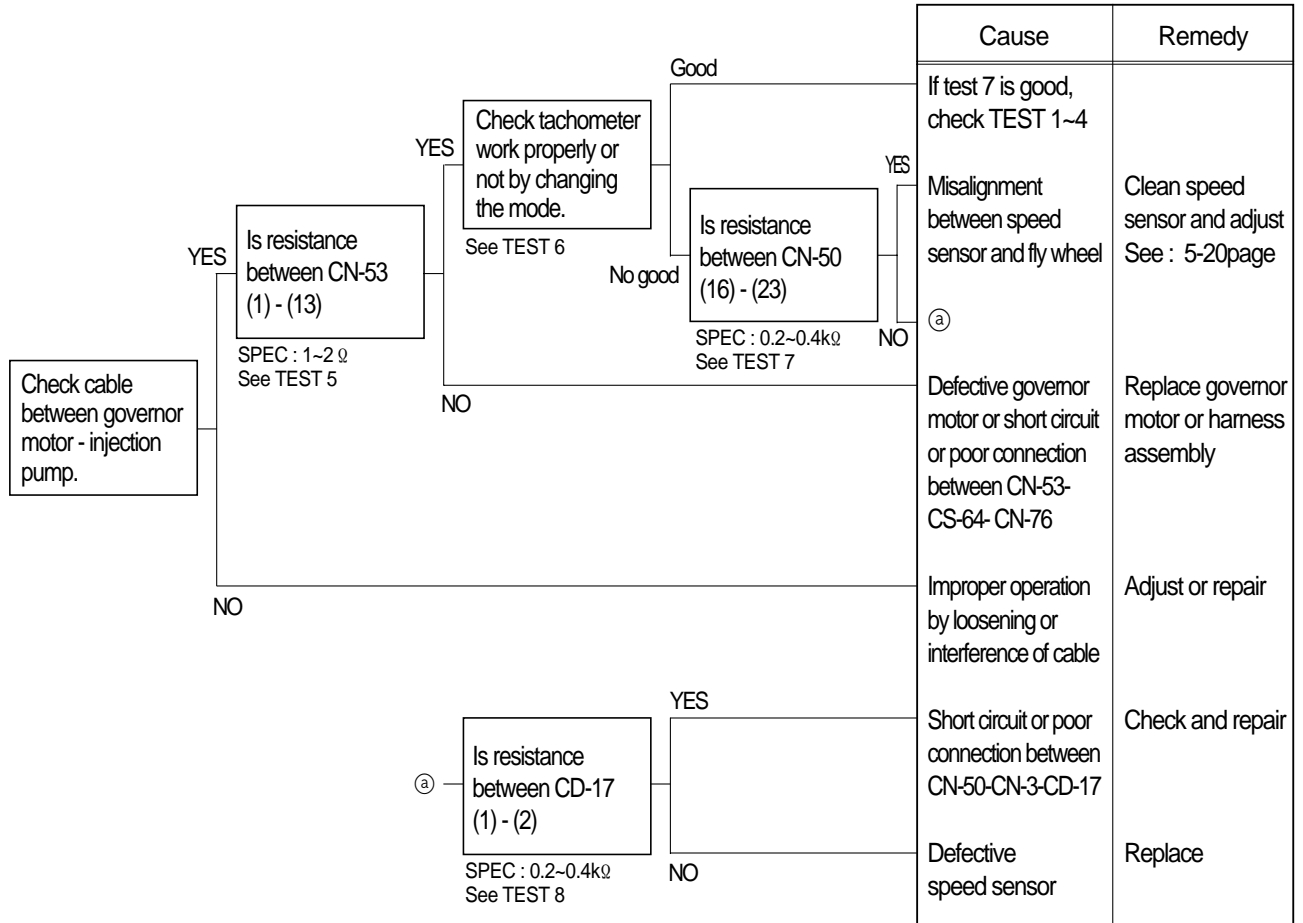
- ② Start engine.
③ Set S-mode and cancel auto decel mode.
④ If tachometer show approx 2250 ± 50rpm, check pressure.
⑤ If pressure is not correct, adjust it.
⑥ After adjust, test the machine.



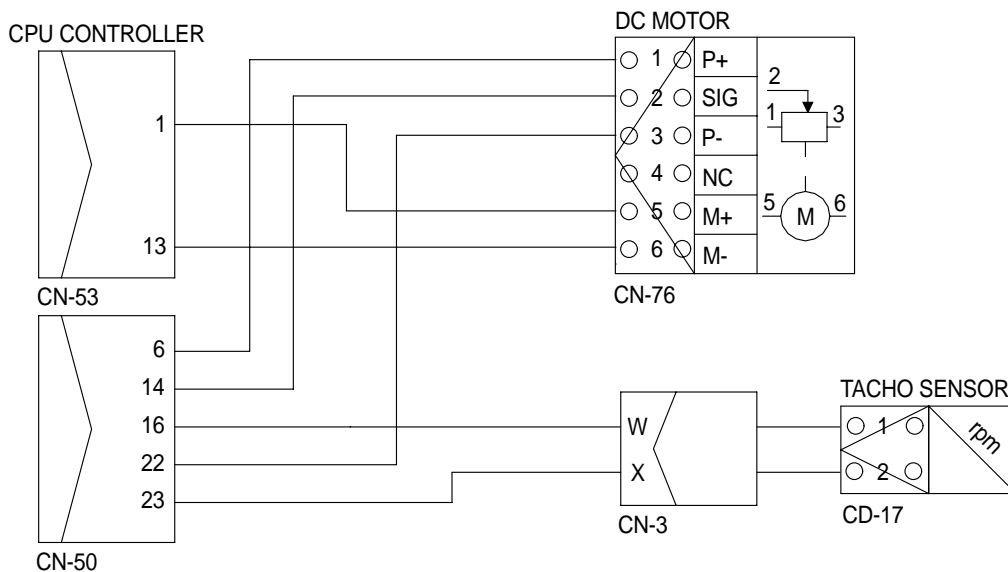
2. ENGINE SPEED IS SLOW AT ALL MODE

※ Before carrying out below procedure, check all the related connectors are properly inserted.

1) INSPECTION PROCEDURE



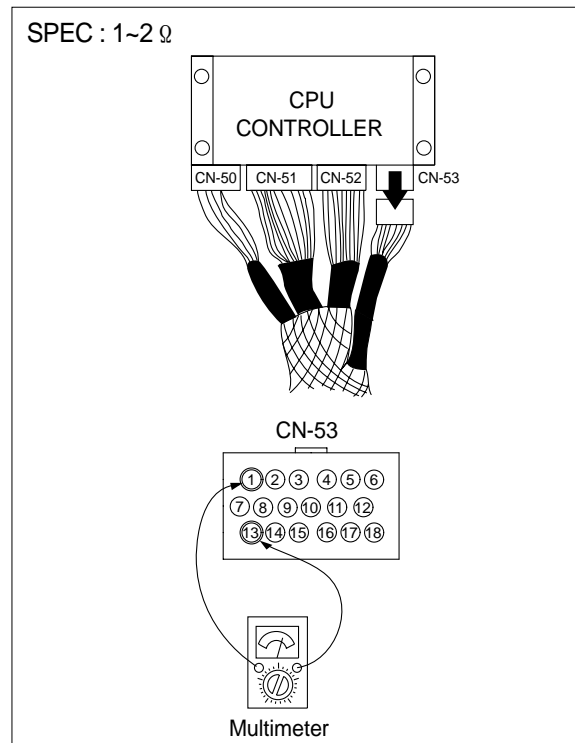
Wiring diagram



2) TEST PROCEDURE

(1) **Test 5** : Check resistance between CN-53 (1)-(13).

- ① Starting key OFF.
- ② Disconnect connector CN-53 from CPU controller.
- ③ Check resistance as figure.



(2) **Test 6** : Check tachometer(Work properly or not)

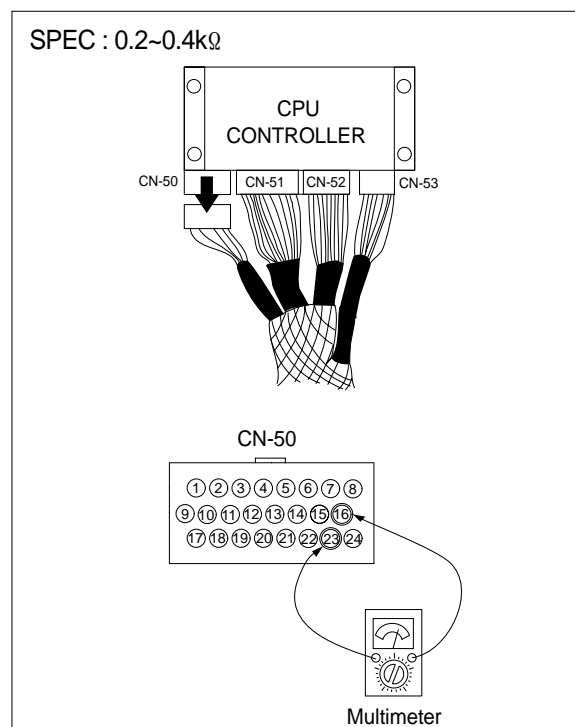
- ① Start engine.
- ② Check tachometer reading.

Unit : rpm

Spec		Remark
H-mode	2450 ± 50rpm	Check rpm after cancel the Auto decel mode.
S-mode	2250 ± 50rpm	
L-mode	2250 ± 50rpm	
F-mode	1750 ± 50rpm	

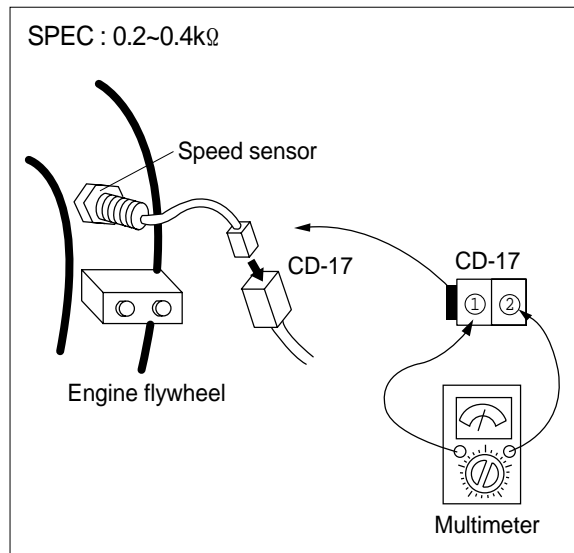
(3) **Test 7** : Check resistance between CN-50 (16) and CN-50(23).

- ① Starting key OFF.
- ② Disconnect connector CN-50 from CPU controller.
- ③ Check resistance as figure.



(4) **Test 8** : Check resistance at speed sensor.

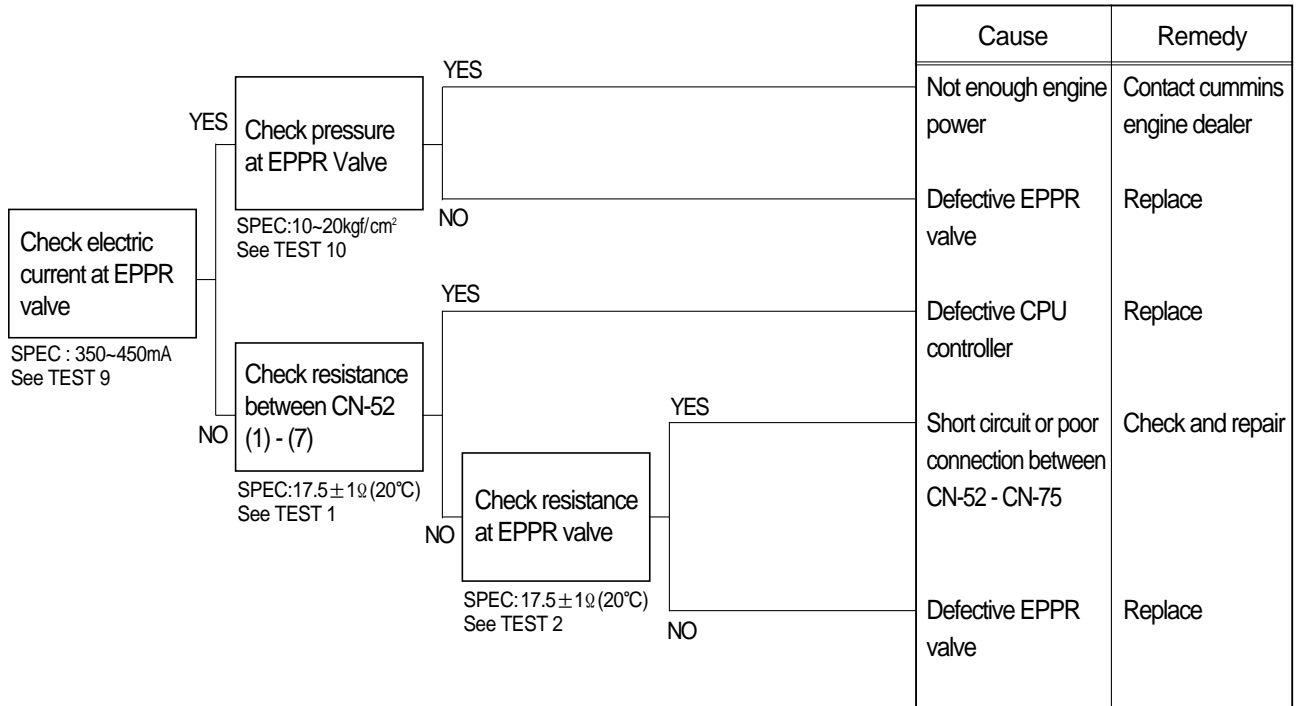
- ① Starting key OFF.
- ② Disconnect connector CD-17 of speed sensor at engine flywheel housing.
- ③ Check resistance as figure.



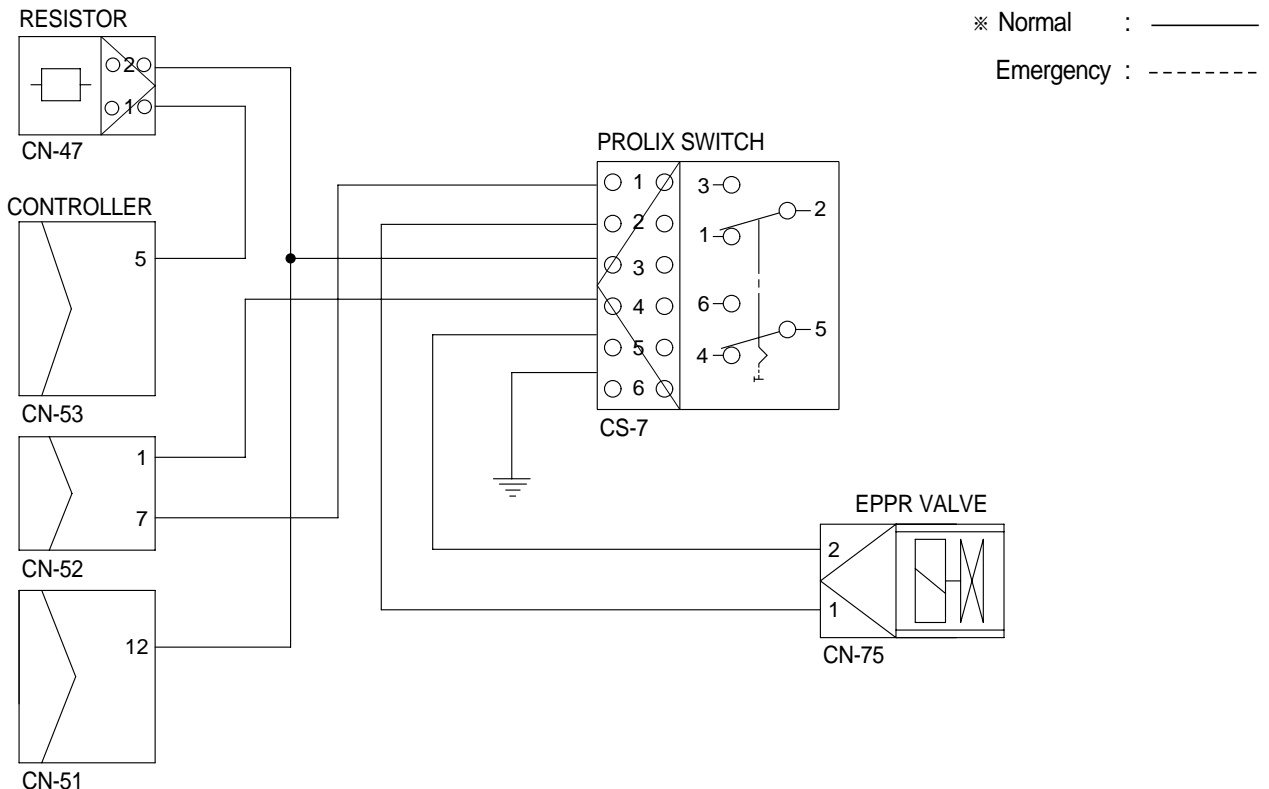
3. ENGINE STALL

※ Before carrying out below procedure, check all the related connectors are properly inserted.

1) INSPECTION PROCEDURE



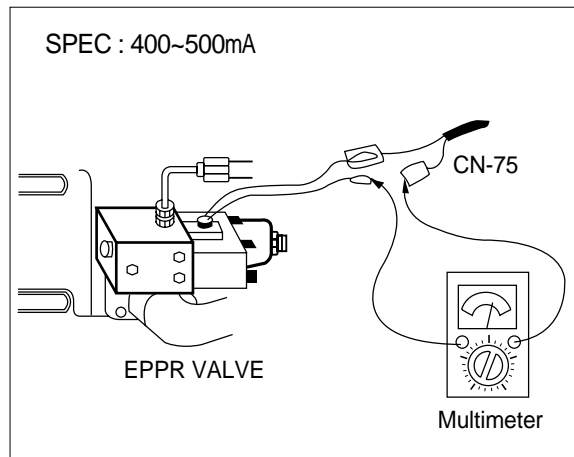
Wiring diagram



2) TEST PROCEDURE

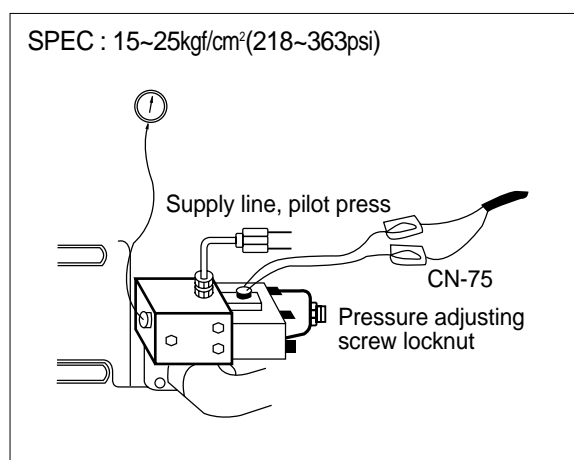
(1) **Test 9** : Check electric current at EPPR valve at F-mode

- ① Install multimeter as figure.
- ② Start engine.
- ③ Set F-mode with 1750 ± 50 rpm.
- ④ Check electric current.



(2) **Test 10** : Check pressure at EPPR valve at F-mode

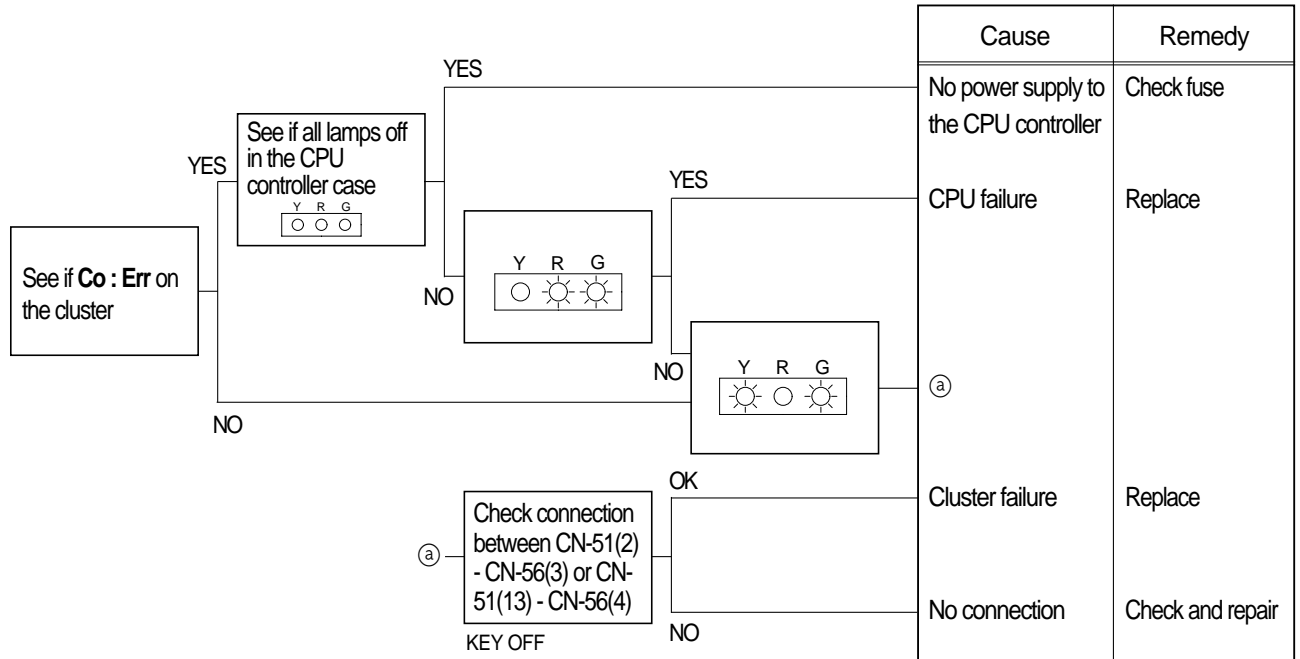
- ① Connect pressure gauge at EPPR valve.
- ② Start engine.
- ③ Set F-mode with 1750 ± 50 rpm.
- ④ Operate bucket lever completely push or pull.
- ⑤ Hold arm lever at the end of stroke.
- ⑥ Check pressure at relief position.



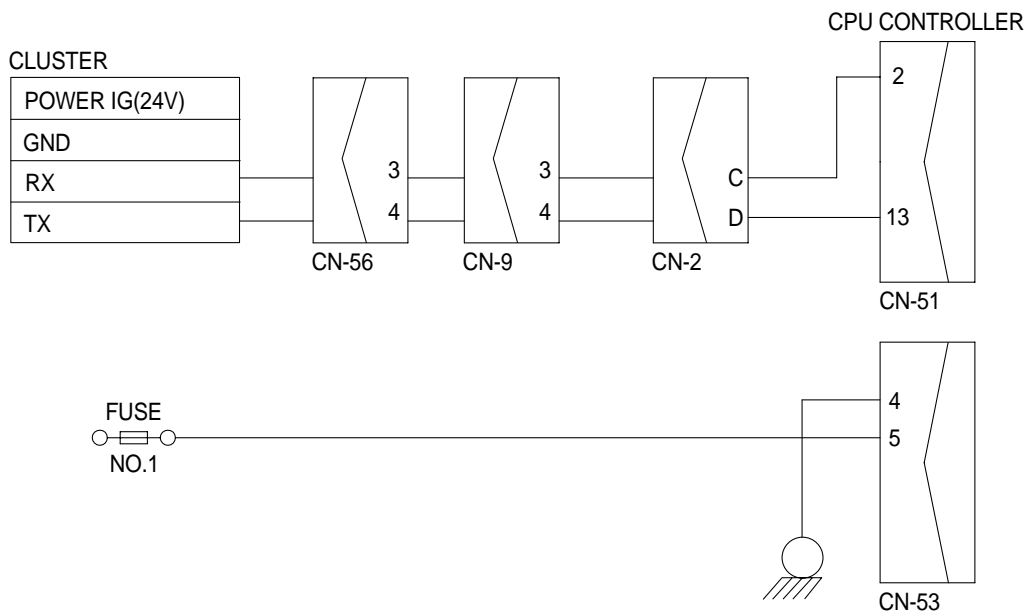
4. MALFUNCTION OF CLUSTER OR MODE SELECTION SYSTEM

※ Before carrying out below procedure, check all the related connectors are properly inserted.

1) INSPECTION PROCEDURE



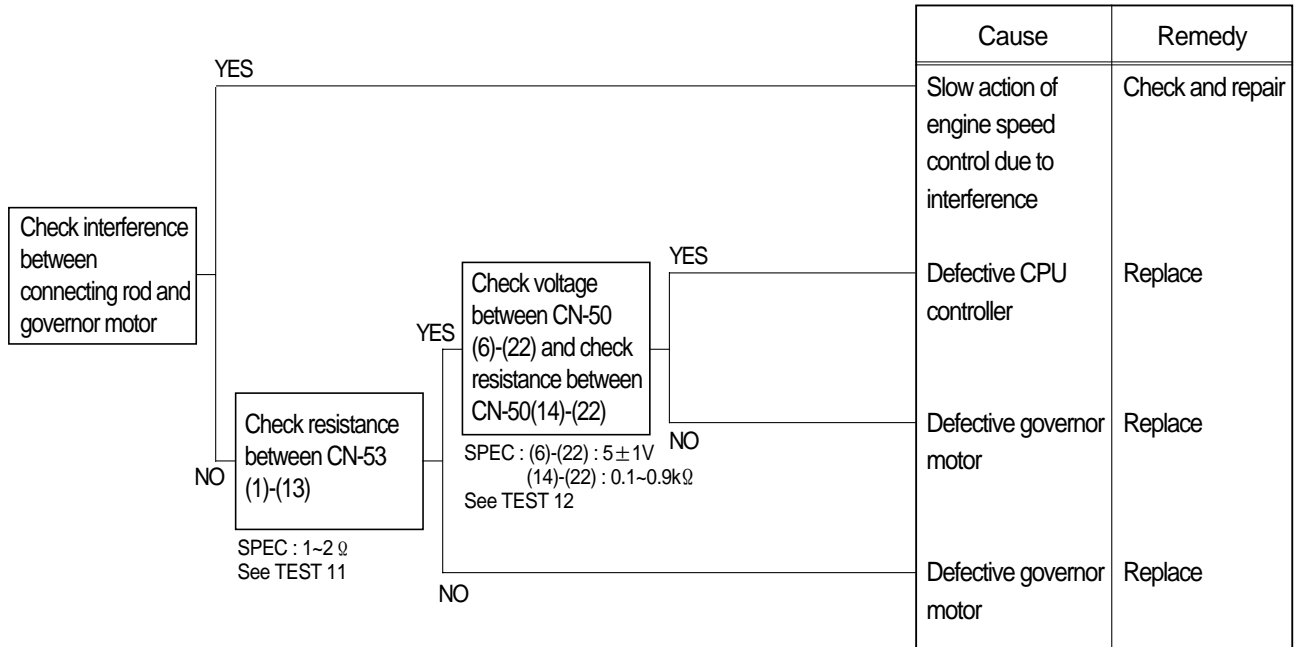
Wiring diagram



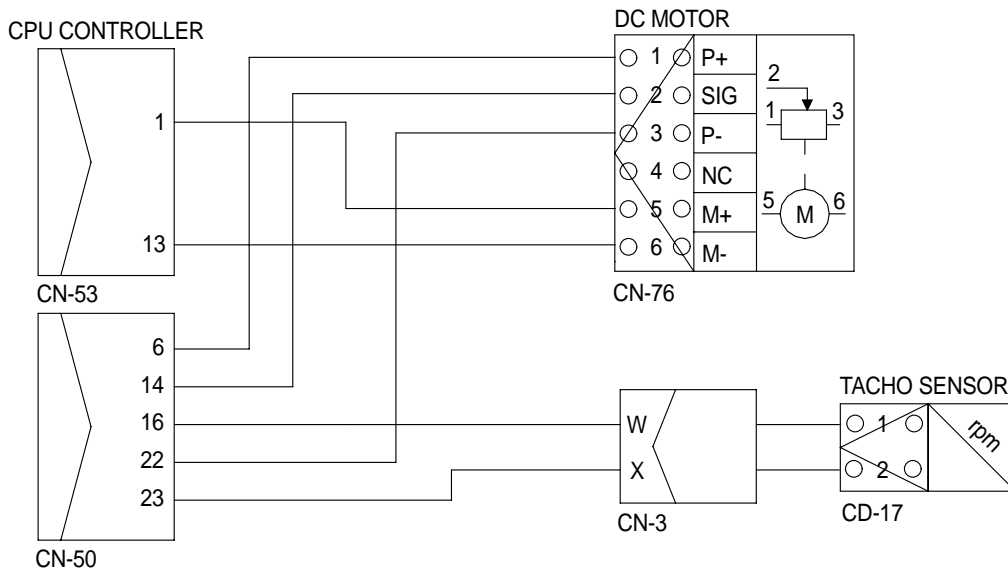
5. SLOW ACTION OF ENGINE SPEED CHANGE WHEN CHANGE THE MODE

※ Before carrying out below procedure, check all the related connectors are properly inserted.

1) INSPECTION PROCEDURE



Wiring diagram

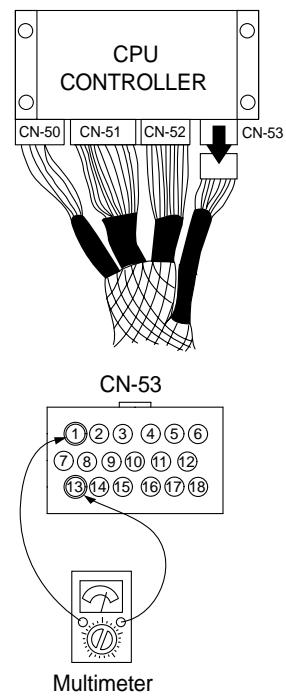


2) TEST PROCEDURE

(1) **Test 11** : Check resistance.

- ① Starting key OFF.
- ② Disconnect connector CN-53 from CPU controller.
- ③ Check resistance between CN-53(1)-(13) as figure.

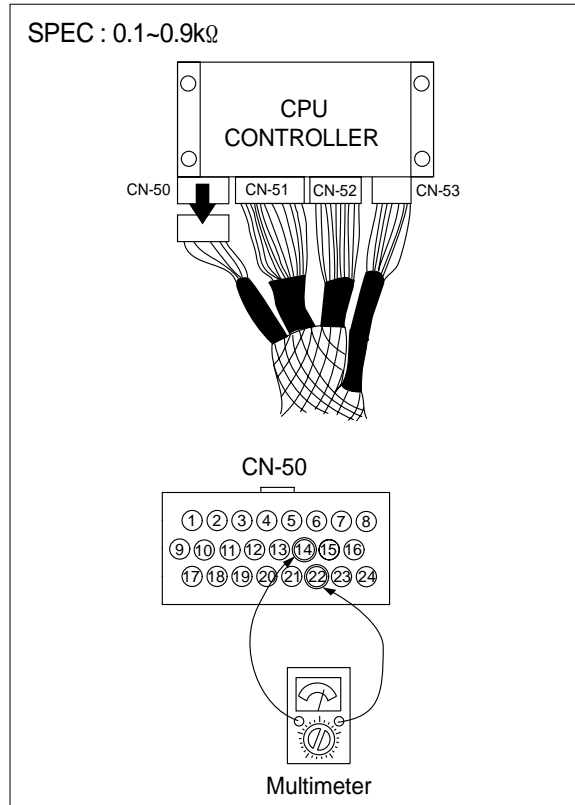
SPEC : 1~2 Ω



(2) **Test 12** : Check voltage and resistance.

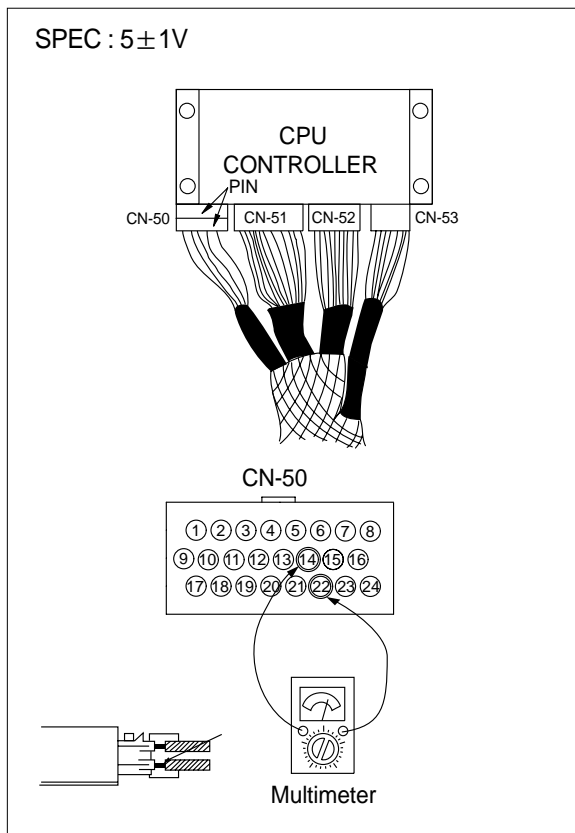
① Check resistance between CN-50(14)-(22).

- Starting key OFF.
- Disconnect connector CN-50 from CPU controller.
- Check resistance value with multimeter as figure.



② Check voltage between CN-50(6) and CN-50(22).

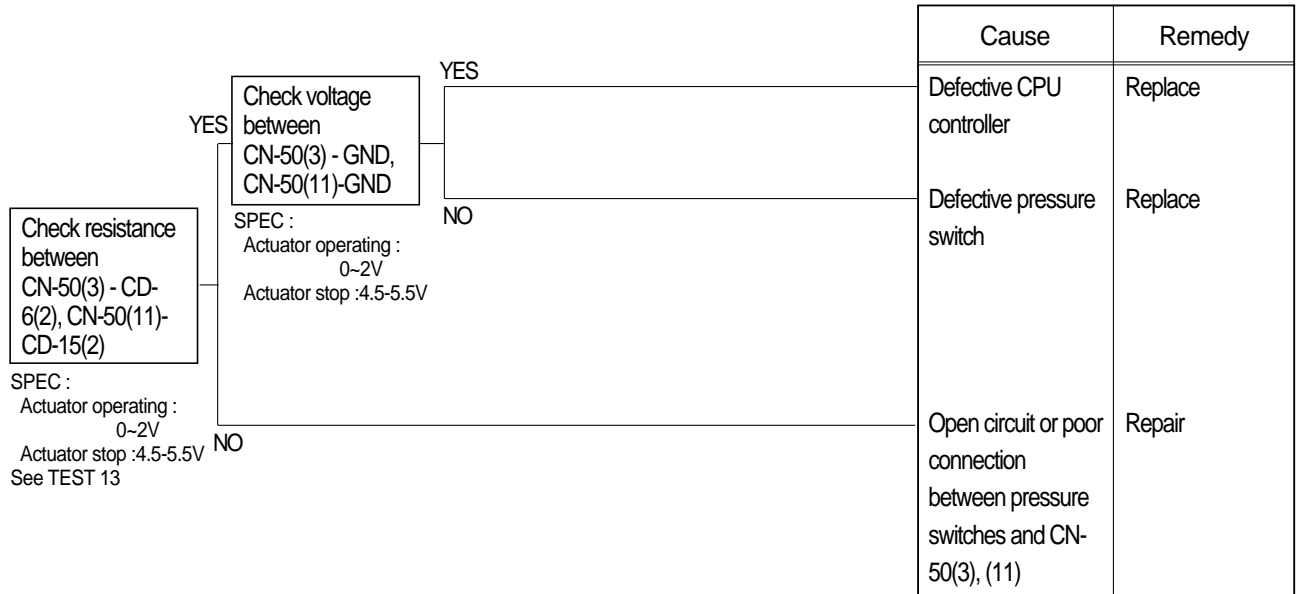
- Prepare 2 pieces of thin sharp pin, steel or copper.
- Starting key ON.
- Insert prepared pins to rear side of connectors : One pin to CN-50(6)
Other pin to CN-50(22)
- Check voltage.



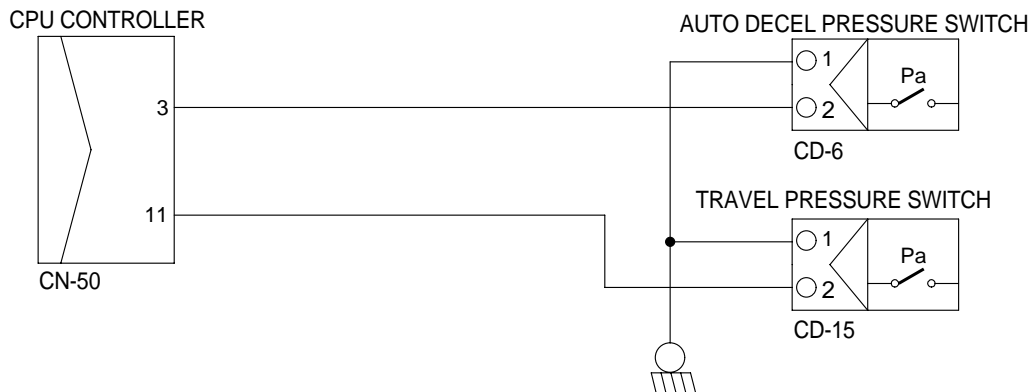
6. AUTO DECEL SYSTEM DOES NOT WORK

※ Before carrying out below procedure, check all the related connectors are properly inserted.

1) INSPECTION PROCEDURE



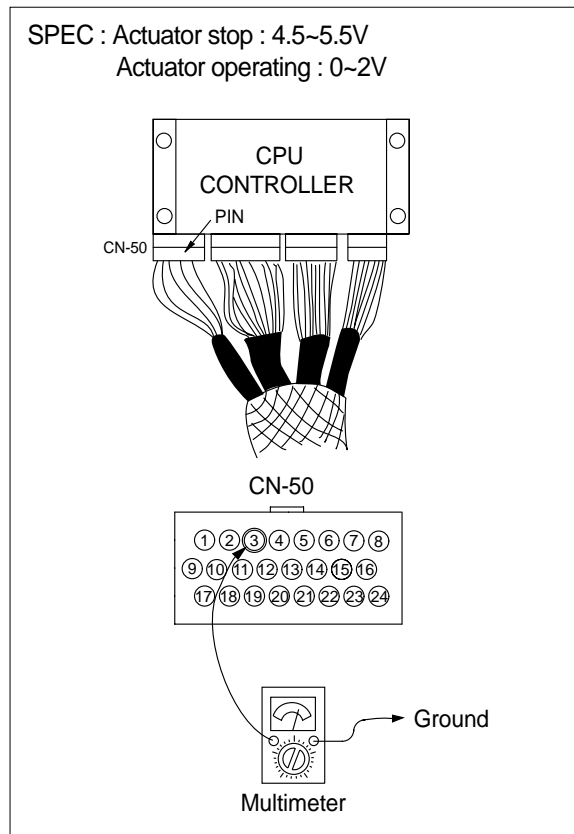
Wiring diagram



2) TEST PROCEDURE

(1) **Test 13** : Check voltage at CN-51(3) and ground.

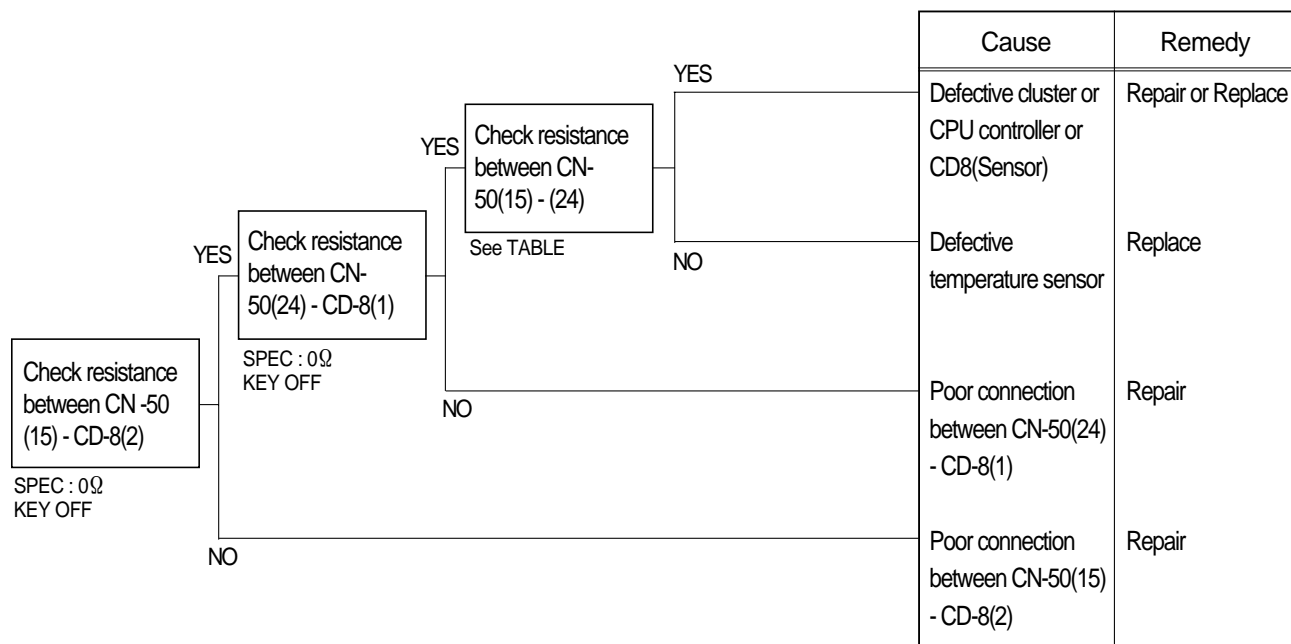
- ① Prepare 1 piece of thin sharp pin, steel or copper.
- ② Starting key ON.
- ③ Insert prepared pin to rear side of connectors : One pin to (3) of CN-50.
- ④ Check voltage as figure.



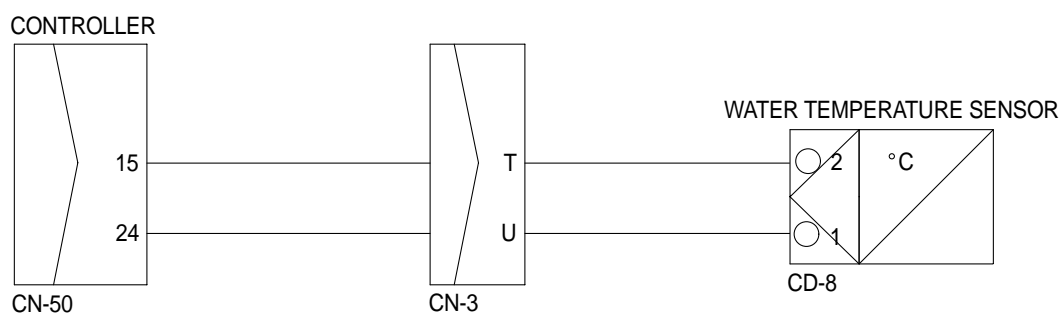
7. MALFUNCTION OF WARMING UP

※ Before carrying out below procedure, check all the related connectors are properly inserted.

1) INSPECTION PROCEDURE



Wiring diagram



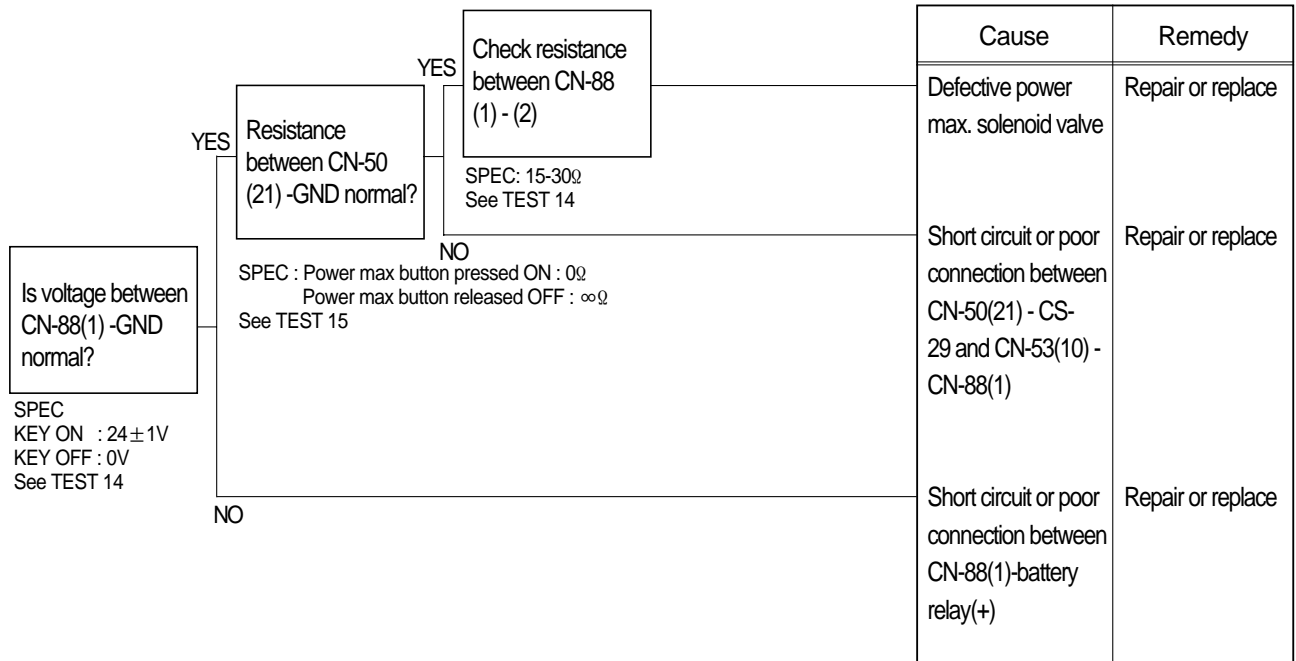
Table

Temp(°C)	-20° C	-10° C	0° C	15° C	30° C
Resistance	15kΩ	9kΩ	5.7kΩ	3kΩ	1.6kΩ
Tolerance	±1.5kΩ	±0.9kΩ	±0.57kΩ	±0.3kΩ	±0.16kΩ

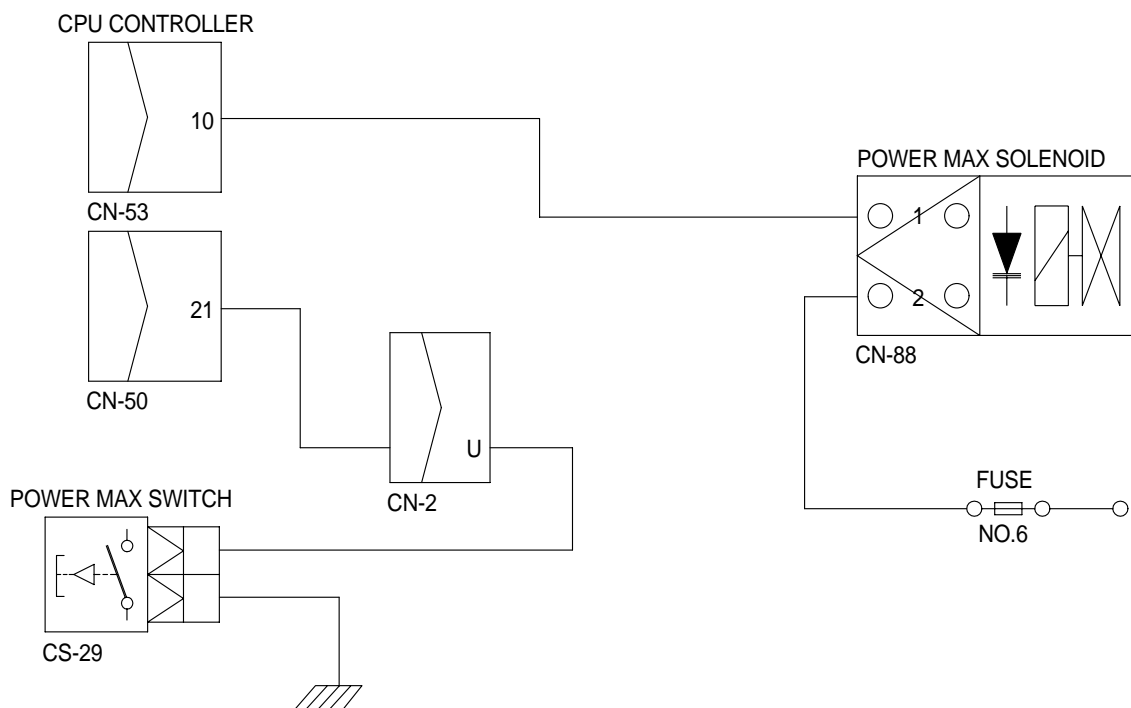
8. MALFUNCTION OF POWER MAX

※ Before carrying out below procedure, check all the related connectors are properly inserted.

1) INSPECTION PROCEDURE



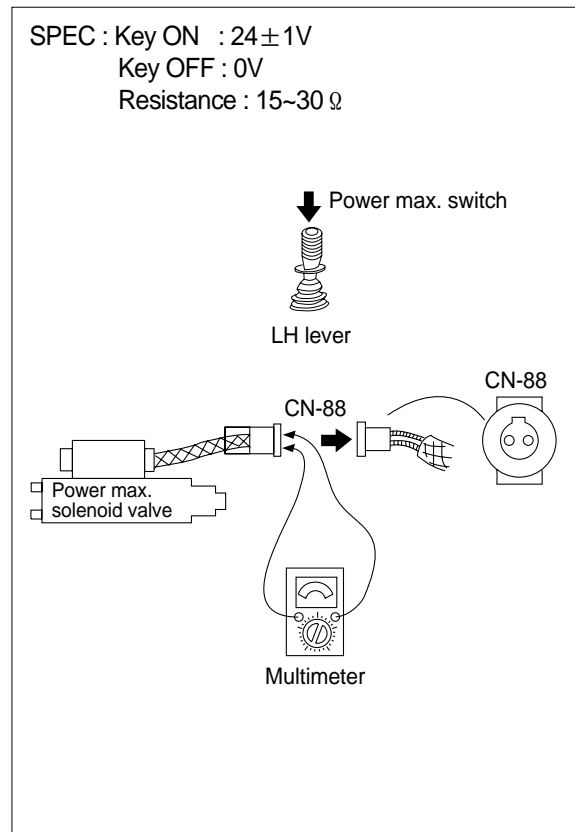
Wiring diagram



2) TEST PROCEDURE

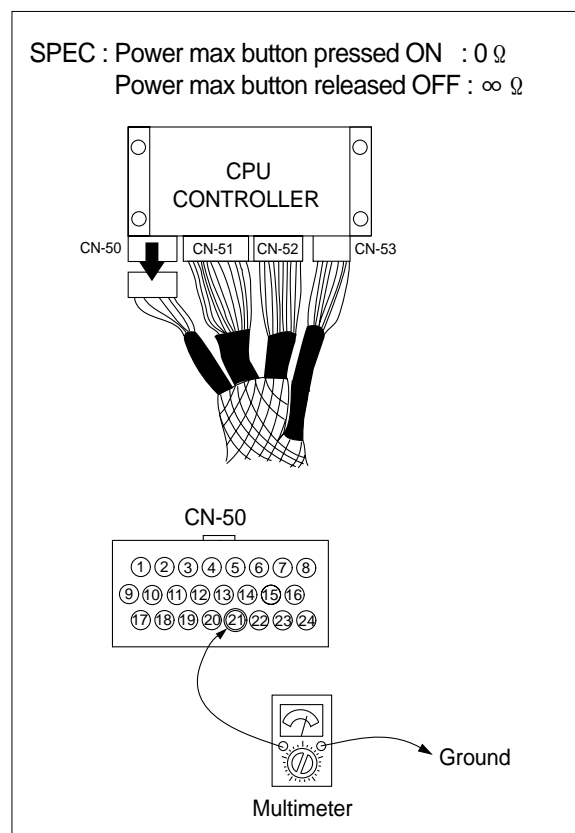
(1) **Test 14** : Check voltage between connector CN-88 - GND.

- ① Start key ON.
- ② Disconnect connector CN-88 from power max solenoid valve.
- ③ Check voltage as figure.



(2) **Test 15** : Check resistance between connector CN-50(21)-GND.

- ① Starting key OFF.
- ② Remove CPU controller and disconnect connector CN-50 from CPU controller.
- ③ Check resistance as figure.



SECTION 7 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.**

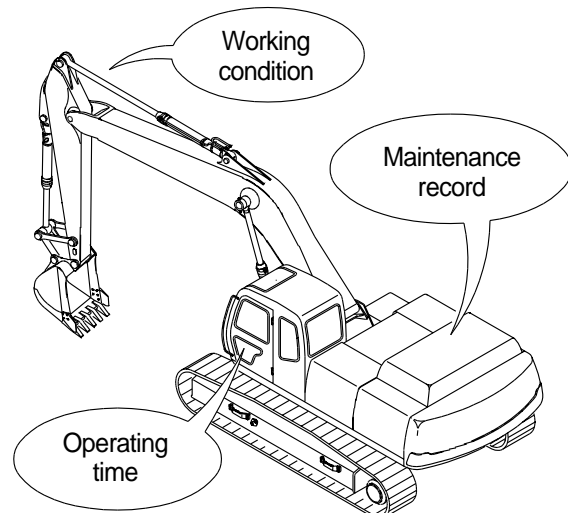
2) OPERATIONAL PERFORMANCE OF A WORKING MACHINE

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

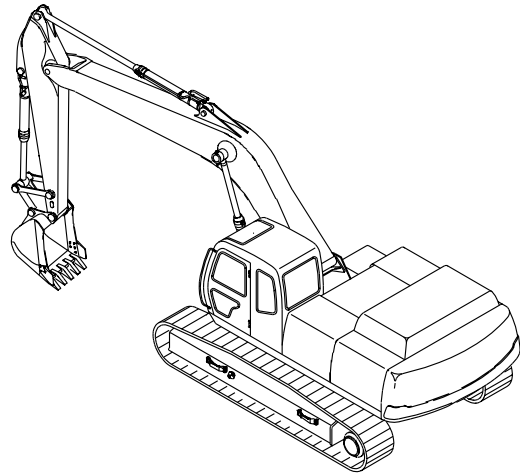
After the machine is repaired or serviced, it must be tested to confirm that its operational performance was restored by the repair and/or service work done.



2. TERMINOLOGY

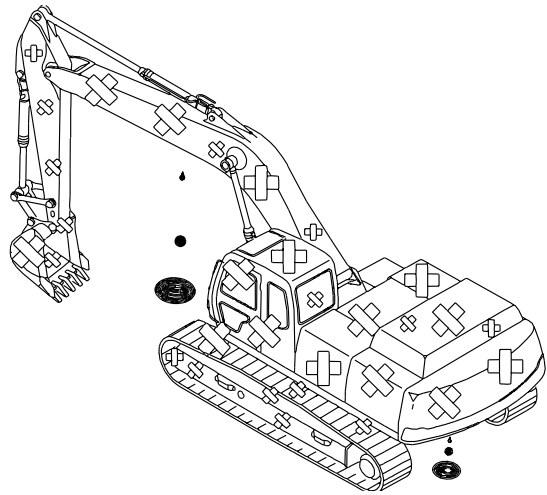
1) STANDARD

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

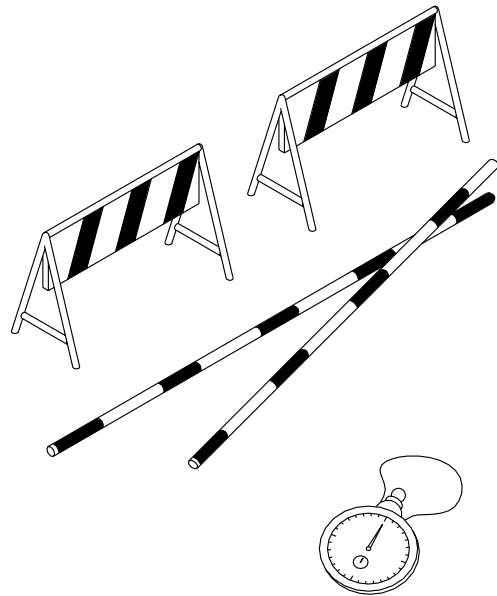
- ① Select a hard, flat surface.
- ② Secure enough space to allow the machine to run straight more than 20m, and to make a full swing with the front attachment extended.
- ③ If required, rope off the test area and provide signboards to keep unauthorized personnel away.

(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 Push the H-mode switch and confirm that the fuel injection pump governor lever comes into contact with the high-idle stopper.
- ③ To measure engine RPM.

(3) Measurement

- ① Start the engine. The engine will run at start idle speed. Measure engine speed with a tachometer.
- ② Measure and record the engine speed at each mode(H.S.L.F).
- ③ Select the H-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.

(4) Evaluation

The measured speeds should meet the following specifications.

Unit : rpm

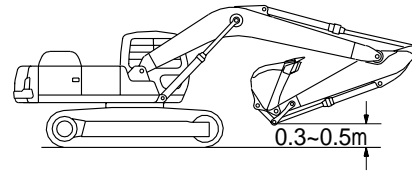
Model	Engine speed	Standard	Remarks
R160LC-3	Start idle	950±100	
	H mode	2450±50	
	S mode	2250±50	
	L mode	2250±50	
	F mode	1750±50	
	Auto decel	1200±100	

3) TRAVEL SPEED

(1) Measure the time required for the excavator to travel a 20m test track.

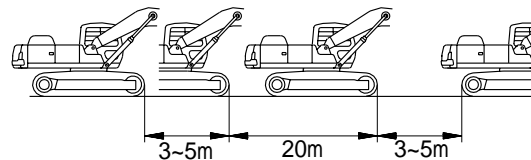
(2) Preparation

- ① Adjust the tension of both tracks to be equal.
- ② Prepare a flat and solid test track 20m in length, with extra length of 3 to 5m on both ends for machine acceleration and deceleration.
- ③ Hold the bucket 0.3 to 0.5m above the ground with the arm and bucket rolled in.
- ④ Keep the hydraulic oil temperature at $50 \pm 5^\circ\text{C}$.



(3) Measurement

- ① Measure both the low and high speeds of the machine.
- ② Before starting either the low or high speed tests, adjust the travel mode switch to the speed to be tested, then select the following switch positions.
 - Mode selector : H mode
- ③ Start traveling the machine in the acceleration zone with the travel levers at full stroke.
- ④ Measure the time required to travel 20m.
- 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 / 20m

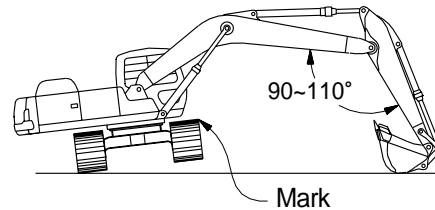
Model	Travel speed	Standard	Maximum allowable	Remarks
R 160LC-3	1 Speed	22.6 ± 2.0	30.2	
	2 Speed	13.3 ± 1.0	17.3	

4) TRACK REVOLUTION SPEED

(1) Measure the track revolution cycle time with the track raised off ground.

(2) Preparation

- ① Adjust the tension of both side tracks to be equal.
- ② On the track to be measured, mark one shoe with chalk.
- ③ Swing the upperstructure 90° and lower the bucket to raise the track off ground. Keep the boom-arm angle between 90 to 110° as shown. Place blocks under machine frame.
- ④ Keep the hydraulic oil temperature at $50 \pm 5^\circ\text{C}$.



(3) Measurement

- ① Select the following switch positions.
 - Travel mode switch : 1 or 2 speed
 - Mode selector : H mode
 - Auto decel switch : OFF
- ② Operate the travel control lever of the raised track in full forward and reverse.
- ③ Rotate 1 turn, then measure time taken for next 3 revolutions.
- ④ Raise the other side of machine and repeat the procedure.
- ⑤ Repeat steps ③ and ④ three times and calculate the average values.

(4) Evaluation

The revolution cycle time of each track should meet the following specifications.

Unit : Seconds / 3 revolutions

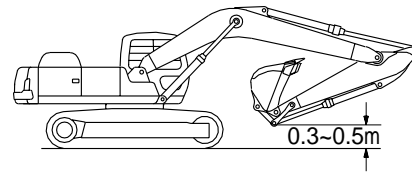
Model	Travel speed	Standard	Maximum allowable
R160LC-3	1 Speed	25.0 ± 2.0	32
	2 Speed	16.0 ± 2.0	22

5) TRAVEL DEVIATION

- (1) Measure the deviation by the tracks from a 20m straight line.

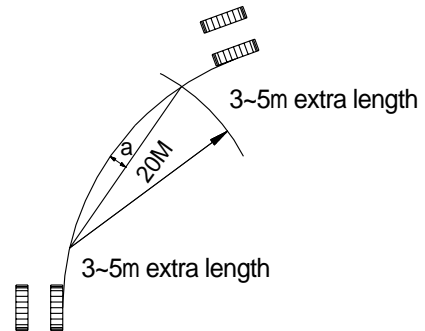
(2) Preparation

- ① Adjust the tension of both tracks to be equal.
- ② Provide a flat, solid test yard 20m in length, with extra length of 3 to 5m on both ends for machine acceleration and deceleration.
- ③ Hold the bucket 0.3 to 0.5m above the ground with the arm and bucket rolled in.
- ④ Keep the hydraulic oil temperature at $50 \pm 5^\circ\text{C}$.



(3) Measurement

- ① Measure the amount of mistracking at high and low travel speeds.
- ② Before beginning each test, select the following switch positions.
 - Mode selector : H mode
- ③ Start traveling the machine in the acceleration zone with the travel levers at full stroke.
- ④ Measure the distance between a straight 20m line and the track made by the machine. (Dimension a)
- ⑤ After measuring the tracking in forward travel, turn the upperstructure 180° and measure that in reverse travel.
- ⑥ Repeat steps ④ and ⑤ three times and calculate the average values.



(4) Evaluation

Mistrack should be within the following specifications.

Unit : mm / 20m

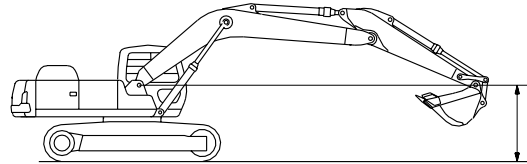
Model	Standard	Maximum allowable	Remarks
R160LC-3	200 below	240	

6) 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 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.
- ④ Keep the hydraulic oil temperature at $50 \pm 5^\circ\text{C}$.



(3) Measurement

- ① Select the following switch positions.
 - Mode selector : Each mode
- ② Operate swing control lever fully.
- ③ Swing 1 turn and measure time taken to swing next 3 revolutions.
- ④ Repeat steps ② and ③ three times and calculate the average values.

(4) Evaluation

The time required for 3 swings should meet the following specifications.

Unit : Seconds / 3 revolutions

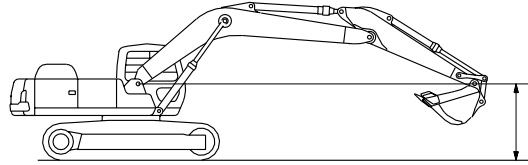
Model	Power selector switch	Standard	Maximum allowable
R160LC-3	H mode	15.0 ± 1.5	17.5 ± 1.5

7) SWING FUNCTION DRIFT CHECK

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

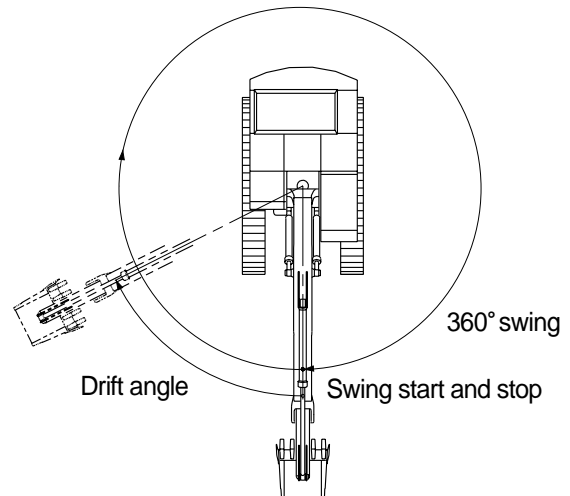
(2) Preparation

- 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 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.
- ④ Make two chalk marks: one on the swing bearing and one directly below it on the track frame.
- ⑤ Swing the upperstructure 360°.
- ⑥ Keep the hydraulic oil temperature at $50 \pm 5^\circ\text{C}$.



(3) Measurement

- ① Conduct this test in the H mode.
- ② Select the following switch positions.
 - Mode selector : H mode
- ③ 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°.
- ④ Measure the distance between the two marks.
- ⑤ Align the marks again, swing 360°, then test the opposite direction.
- ⑥ Repeat steps ③ and ⑤ three times each and calculate the average values.



(4) Evaluation

The measured drift angle should be within the following specifications.

Unit : Degree

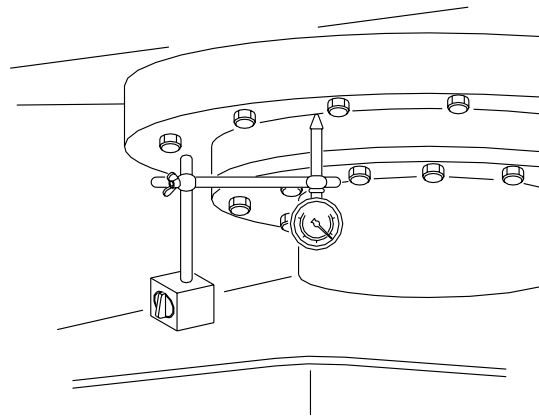
Model	Mode select switch	Standard	Maximum allowable	Remarks
R160LC-3	H mode	90 below	120	

8) 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 idlers.
- 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.

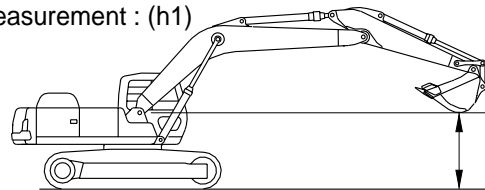


(3) Measurement

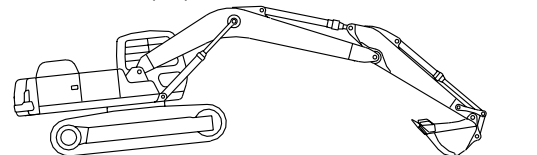
- ① With the arm rolled out and bucket rolled in, hold the bottom face of the bucket to the same height of the boom foot pin. Record the dial gauge reading(h1).
- ② Lower the bucket to the ground and use it to raise the front idler 50cm. Record the dial gauge reading(h2).
- ③ Calculate bearing play(H)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

Model	Standard	Maximum allowable	Remarks
R160LC-3	1.5 below	3.0	

9) 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 cylinders.

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 $50 \pm 5^\circ\text{C}$.

(3) Measurement

- ① Select the following switch positions.

- Mode selector : H mode

- ② To measure cylinder cycle times.

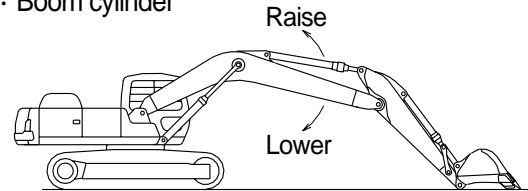
-Boom cylinders.

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.

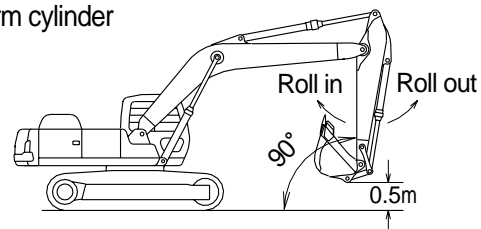
-Arm cylinder.

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.

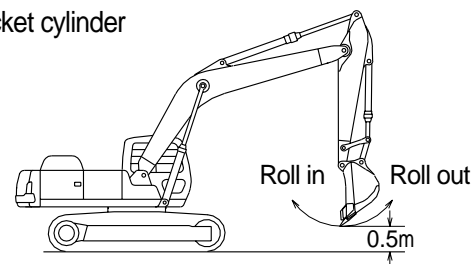
- Boom cylinder



- 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
R 160LC-3	Boom raise	3.2 ± 0.3	3.8	
	Boom lower	2.7 ± 0.3	3.0	
	Arm in	3.5 ± 0.4	4.6	
	Arm out	2.7 ± 0.3	3.8	
	Bucket load	2.2 ± 0.4	3.9	
	Bucket dump	2.1 ± 0.3	2.6	

10) 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.

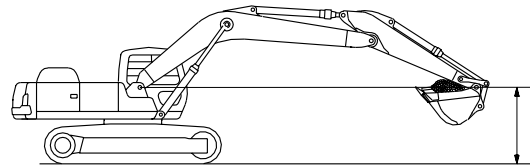
$$W = M^3 \times 1.5$$

Where :

$$M^3 = \text{Bucket heaped capacity}(m^3)$$

$$1.5 = \text{Soil specific gravity}$$

- ② Position the arm cylinder with the rod 20 to 30mm extended from the fully retracted position.
- ③ Position the bucket cylinder with the rod 20 to 30mm 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 $50 \pm 5^\circ\text{C}$.



(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) Evaluation

The measured drift should be within the following specifications.

Unit : mm / 5min

Model	Drift to be measured	Standard	Maximum allowable	Remarks
R 160LC-3	Boom cylinder	40 below	55	
	Arm cylinder	60 below	75	
	Bucket cylinder	40 below	60	

11) 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 $50 \pm 5^\circ\text{C}$.

(3) Measurement

- ① Start the engine.
- ② Select the following switch positions.
 - Mode selector : H mode
- ③ Operate each boom, arm, bucket and swing lever at full stroke and measure the maximum operating force for each.
- ④ Lower the bucket to the ground to raise one track off the ground. Operate the travel lever at full stroke and measure the maximum operating force required. When finished, lower the track and then jack-up the other track.
- ⑤ Repeat steps ③ and ④ 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
R 160LC-3	Boom lever	1.6 or below	1.9	
	Arm lever	1.6 or below	1.9	
	Bucket lever	1.6 or below	1.9	
	Swing lever	1.6 or below	1.9	
	Travel lever	2.1 or below	2.9	

12) 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 $50 \pm 5^{\circ}\text{C}$.

(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.

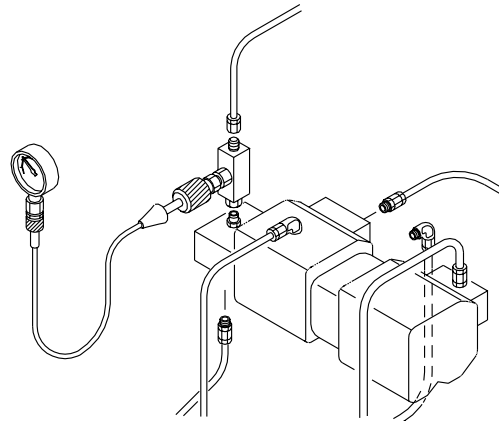
Unit : mm

Model	Kind of lever	Standard	Maximum allowable	Remarks
R 160LC-3	Boom lever	83 ± 10	103	
	Arm lever	83 ± 10	103	
	Bucket lever	83 ± 10	103	
	Swing lever	83 ± 10	103	
	Travel lever	150 ± 10	195	

13) PILOT PRIMARY PRESSURE

(1) Preparation

- ① Stop the engine.
- ② Remove the top cover of the hydraulic tank oil supply port with a wrench.
- ③ Loosen and remove plug on the pilot pump delivery port and connect pressure gauge.
- ④ Start the engine and check for oil leakage from the port.
- ⑤ Keep the hydraulic oil temperature at $50 \pm 5^{\circ}\text{C}$.



(2) Measurement

- ① Select the following switch positions.
 - Mode selector : H mode
 - Auto decel switch : OFF
- ② Measure the primary pilot pressure in the H mode.

(3) Evaluation

The average measured pressure should meet the following specifications.

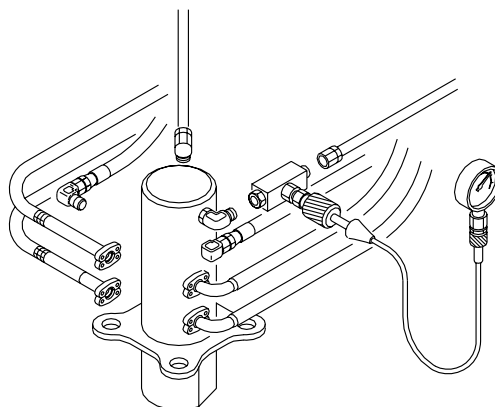
Unit : kgf / cm^2

Model	Engine speed	Standard	Allowable limits	Remarks
R160LC-3	H mode	40 ± 5	-	

14) 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 E port as shown.
- ④ Start the engine and check for on leakage from the adapter.
- ⑤ Keep the hydraulic oil temperature at $50 \pm 5^{\circ}\text{C}$.



(2) Measurement

- ① Select the following switch positions.
 - Travel mode switch : 1 speed
2 speed
 - Mode selector : H mode
- ② Measure the travel speed selecting pressure in the Hi or Lo mode.
- ③ Lower the bucket to the ground to raise the track off the ground. Operate the travel lever at full stroke and measure the fast speed pressure.
- ④ Repeat steps ② and ③ three times and calculate the average values.

(3) Evaluation

The average measured pressure should be within the following specifications.

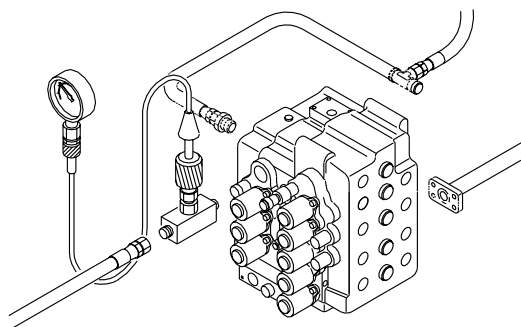
Unit : kgf / cm²

Model	Travel speed mode	Standard	Maximum allowable	Remarks
R160LC-3	1 Speed	0	-	
	2 Speed	40 ± 5	-	

15) Power boost pressure

(1) Preparation

- ① Stop the engine.
- ② Remove the top cover of the hydraulic tank oil supply port with wrench.
- ③ Turn the pressure release L wrench to bleed air.
- ④ To measure the power boost pressure.
Install a connector and pressure gauge assembly to main relief valve, as shown.
- ⑤ Start the engine and check for oil leakage from the adapter.
- ⑥ Keep the hydraulic oil temperature at $50 \pm 5^\circ\text{C}$.



(2) Measurement

- ① Select the following switch positions.
 - Mode selector : H mode
 - Auto decel switch : OFF
 - Power boost switch : ON
- ② Measure the power boost pressure in the normal and power boost.

(3) Evaluation

The average measured pressure should meet the following specifications.

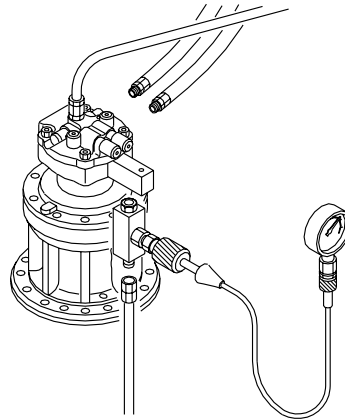
Unit : kgf / cm²

Model	Power boost switch	Standard	Allowable limits	Remarks
R160LC-3	Normal	0	-	
	Power boost	40 ± 5	-	

16) SWING PARKING BRAKE RELEASING PRESSURE

(1) Preparation

- ① Stop the engine.
- ② The pressure release L wrench 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 $50 \pm 5^{\circ}\text{C}$.



(2) Measurement

- ① Select the following switch positions.
 - Mode selector : H mode
- ② 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. Repeat step ② three times and calculate the average values.

(3) Evaluation

The average measured pressure should be within the following specifications.

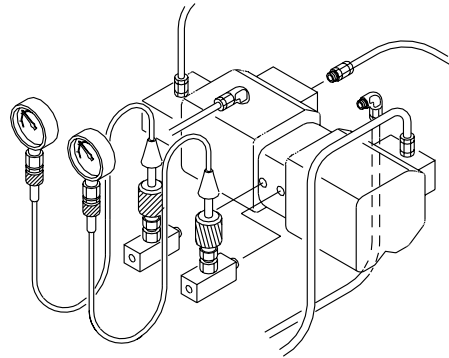
Unit : kgf / cm²

Model	Description	Standard	Allowable limits	Remarks
R 160LC-3	Brake disengaged	40	22~50	
	Brake applied	0	-	

17) MAIN PUMP DELIVERY PRESSURE

(1) Preparation

- ① Stop the engine.
- ② Remove the top cover of the hydraulic tank oil supply port with a wrench.
- ③ Push the pressure release button to bleed air.
- ④ To measure the main pump pressure.
Install a connector and pressure gauge assembly main pump gauge port as shown.
- ⑤ Start the engine and check for oil leakage from the port.
- ⑥ Keep the hydraulic oil temperature at $50 \pm 5^{\circ}\text{C}$.



(2) Measurement

- ① Select the following switch positions.
 - Mode selector : H mode
 - Auto decel switch : OFF
- ② Measure the main pump delivery pressure in the H mode(High idle).

(3) Evaluation

The average measured pressure should meet the following specifications.

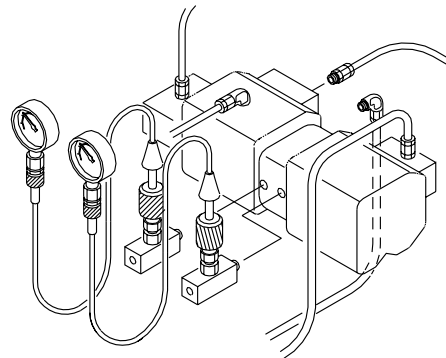
Unit : kgf / cm²

Model	Engine speed	Standard	Allowable limits	Remarks
R160LC-3	High idle	30+5	-	

18) SYSTEM PRESSURE REGULATOR RELIEF SETTING

(1) Preparation

- ① Stop the engine.
- ② Remove the top cover of the hydraulic tank oil supply port with a wrench.
- ③ Push the pressure release button to bleed air.
- ④ To measure the system relief pressure.
Install a connector and pressure gauge assembly main pump gauge port, as shown.
- ⑤ Start the engine and check for oil leakage from the port.
- ⑥ Keep the hydraulic oil temperature at $50 \pm 5^{\circ}\text{C}$.



(2) Measurement

- ① Select the following switch positions.
 - Mode selector : H mode
 - Auto decel switch : OFF
- ② Slowly operate each control lever of boom, arm and bucket functions at full stroke over relief and measure the pressure.
- ③ In the swing function, place bucket against an immovable object and measure the relief pressure.
- ④ In the travel function, lock undercarriage with an immovable object and measure the relief pressure.
- ⑤ In the power boost function, pushing the power boost switch at the top of right control lever an immovable object and measure the relief pressure.

(3) Evaluation

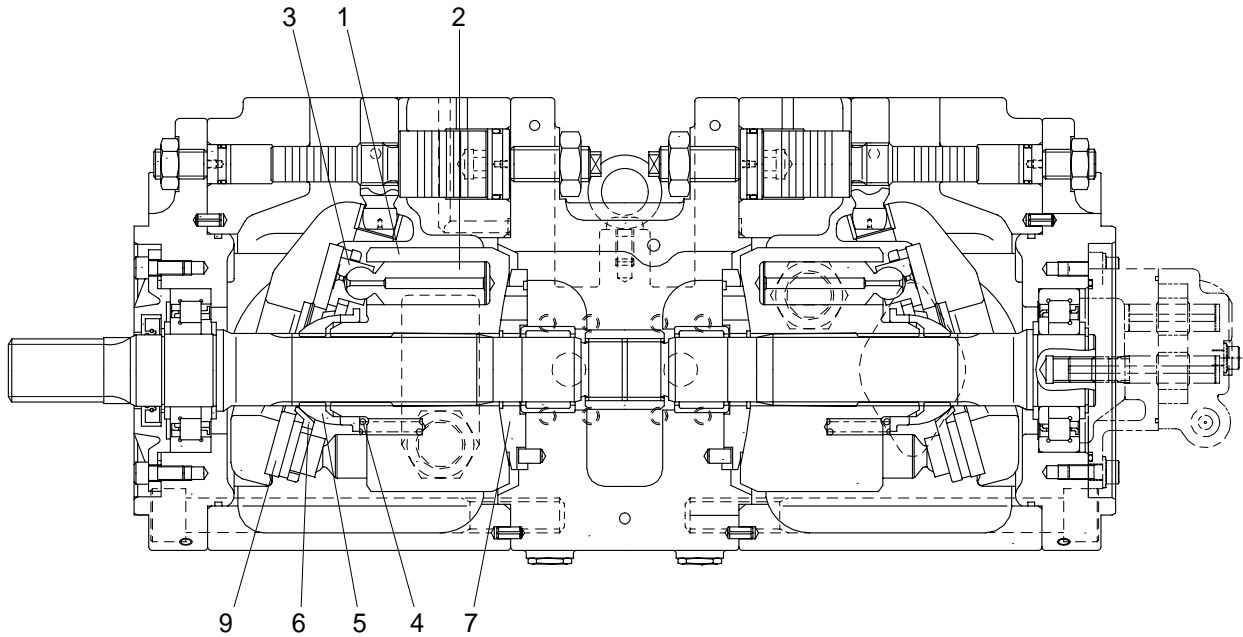
The average measured pressure should be within the following specifications.

Unit : kgf / cm²

Model	Function to be tested	Normal	Power boost	Overload
R 160LC-3	Boom, Arm, Bucket	320 ± 10	350 ± 10	380
	Travel	350 ± 10	350 ± 10	-
	Swing	260	260	-

GROUP 2 MAJOR COMPONENT

1. MAIN PUMP

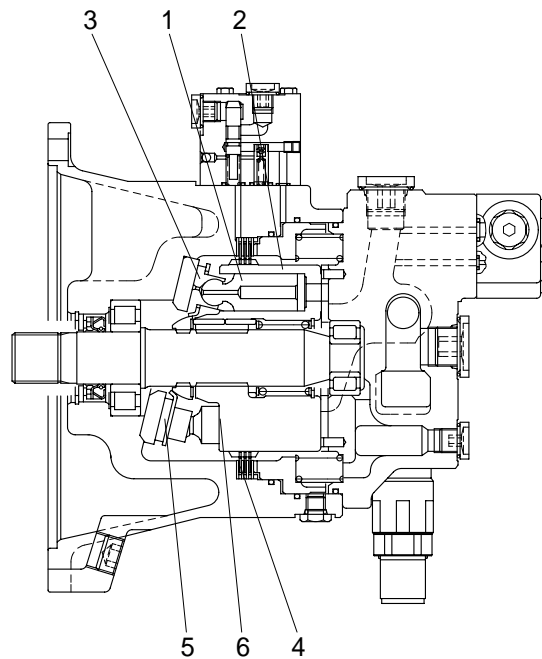


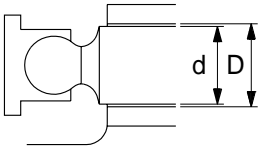
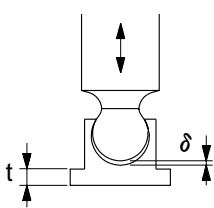
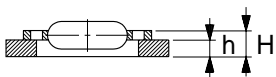
Part name & inspection item		Standard dimension	Recommended replacement value	Counter measures
Clearance between piston(1) & cylinder bore(2) (D-d)		0.028	0.056	Replace piston or cylinder
Play between piston(1) & shoe caulking section(3) (δ)		0-0.1	0.3	Replace assembly of piston & shoe
Thickness of shoe (t)		3.9	3.7	
Free height of cylinder spring(t) (L)		31.3	30.5	Replace cylinder spring
Combined height of set plate(H) & spherical bushing(h) (H-h)		10.5	9.8	Replace retainer or set plate
Surface roughness for valve plate(Sliding face) (7,8), swash plate(Shoe plate area)(9), & cylinder(2) (Sliding face)	Surface roughness necessary to be corrected	3z		Lapping
	Standard surface roughness (Corrected value)	0.4z or lower		

2. MAIN CONTROL VALVE

Part name	Inspection item	Criteria & measure
Casing	<ul style="list-style-type: none"> Existence of scratch, rusting or corrosion 	<ul style="list-style-type: none"> In case of damage in following section, replace part <ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> Existence of scratch, gnawing, rusting or corrosion O-ring seal sections at both ends Insert spool in casing hole, rotate and reciprocate it 	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> Damage of poppet or spring Insert poppet into casing and function it 	<ul style="list-style-type: none"> Correction or replacement when sealing is incomplete Normal when it can function lightly without being caught
Around spring	<ul style="list-style-type: none"> Rusting, corrosion, deformation or breaking of spring, spring seat, plug or cover 	<ul style="list-style-type: none"> Replacement for significant damage
Around seal for spool	<ul style="list-style-type: none"> External oil leakage Rusting, corrosion or deformation of seal plate 	<ul style="list-style-type: none"> Correction or replacement Correction or replacement
Main relief valve, port relief valve & negative control relief valve	<ul style="list-style-type: none"> External rusting or damage Contacting face of valve seat Contacting face of poppet Abnormal spring O-rings, back up rings and seals 	<ul style="list-style-type: none"> Replacement Replacement when damaged Replacement when damaged Replacement 100% replacement in general

3. SWING DEVICE



Part name & inspection item	Standard dimension	Recommended replacement value	Counter measures	
Clearance between piston(1) & cylinder bore(2) (D-d)		0.028	0.058	Replace piston or cylinder
Play between piston(1) & shoe caulking section(3) (δ)		0	3	Replace assembly of piston & shoe
Thickness of shoe (t)		5.5	5.3	
Thickness of friction plate(4)	-	4.0	3.6	Replace cylinder friction plate
Combined height of set plate(5) & spherical bushing(6) (H-h)		6.5	12.5	Replace retainer or set plate

4. TRAVEL DEVICE

1) MOTOR

Part name	General view	Standard dimension	Recommended replacement value	Remedy
Piston subassembly(159)	· Sliding surface has a deep score or is roughened.	-	-	Replace cylinder block kit
	· The clearance between the piston and the cylinder block bore is large.	0.035	0.050	
	· Shoe ball has a large gap.	0.15	0.4	
Cylinder block(157)	· Sliding surface has a deep score or is roughened.	-	-	Replace cylinder block kit
	· Bore is worn very much.	-	-	
	· Wear or breakage occurred during meshing of gear teeth.	-	-	
Valve plate(158)	· Sliding surface has a deep cut, seizure, uneven wear or is roughened.	-	-	Replace cylinder block kit
Retainer plate(160) Retainer holder(161)	· Sliding surface has a deep cut, seizure, uneven wear or is roughened.	-	-	Replace cylinder plate kit
Swash plate(162)	· Sliding surface has a deep cut, seizure, uneven wear or is roughened.	-	-	Replace swash plate steel ball
	· The swash plate has deep score and seizure in the face in contact with steel ball(174).	Depth of sphere 14.3	Depth of sphere 14.5	
Shaft(156)	· Sliding surface of oil seal(163) is deeply scored or roughened.	-	-	Replace shaft
	· Meshing gear teeth have been abnormally worn or broken.	-	-	
Valve(145)	· Sliding surface is deeply scored or roughened.	-	-	Replace base plate subassembly
	· The clearance between the valve and base plate(103) is large.	0.025	0.050	
Collar(142)	· Sliding surface is deeply scored or roughened.	-	-	Replace base plate subassembly
	· The clearance between the collar and valve(145) is large.	0.030	0.060	
Spring guide(144)	· Sliding surface is deeply scored or roughened.	-	-	Replace base plate subassembly
	· The clearance between the spring guide and valve(145) is large.	0.030	0.060	

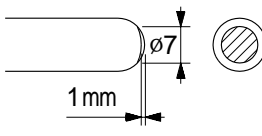
Part name	General view	Standard dimension	Recommended replacement value	Remedy
Free piston(136)	· The clearance between the piston and base plate(103) is large.	-	-	Replace valve subassembly
	· Sliding surface is deeply scored or roughened.	-	-	
Relief housing subassembly(122)	· Sliding surface of free piston is deeply scored or roughened.	-	-	Replace valve subassembly
Spring(107) Spring(111) Spring(118) Spring(126) Spring(150) Spring(169) Spring(183) Spring(194)	· Spring is deformed or broken excessively.	-	-	Replace spring
Brake piston(178) Friction plate(180)	· Sliding surface is deeply scored or roughened.	-	-	Replace brake piston Replace friction plate
Disc plate(181)	· Disc(Abrasive agent)is deeply scored or peeled off.	-	-	Replace disc plate
Roller bearing(165)	· Rolling surface has developed flaking or peeling.	-	-	Replace roller bearing
	· Rolling surface has blow marks.	-	-	
	· Rotation is abnormal. (Abnormal sound and unsmooth rotation)	-	-	
Piston subassembly (164)	· Sliding surface is deeply scored or roughened.	-	-	Replace piston case subassembly
	· The clearance between the piston and the casing is large.	0.020	0.040	
	· The shoe ball has a large gap.	0.5	1.0	
Steel ball(163)	· The contact surface of the steel ball with swash plate(162) is seized.	-	-	Replace swash plate steel ball
Plunger(105)	· Sliding surface is deeply scored or roughened.	-	-	Replace base plate subassembly
	· The clearance between the plunger and base plate(103) is large.	0.020	0.060	
Base plate(103)	· Sliding surface is deeply scored or roughened.	-	-	Replace base plate subassembly
	· Surface is so roughened that oil leak may occur.	-	-	

2) REDUCTION GEAR

Replace parts according to the standards of the below table : Handle parts with care so that too face and the sliding surface of bearings may not be scored. Do not reuse seals once used after disassembly, but replace all of them with new ones.

Part Name	Standard dimension	Recommended replacement value	Parts replacement standard
Holder A subassembly(301) Holder B subassembly(308) Holder C subassembly(315)	-	-	<ul style="list-style-type: none"> · When gear teeth develop pitting or peeling. · When flaking occurs on the rolling surface of needle bearings, gear shafts and planetary gears. · Rotation of bearings is abnormal(Abnormal sound, unsmooth rotation, etc). · When gears have gap in their axial direction.
Drive gear(323) Sun gear B(325) Sun gear C(327) Link gear(342)	-	-	<ul style="list-style-type: none"> · When gear tooth face develops pitting or peeling.
Planetary gear A(303) Planetary gear B(310) Planetary gear C(317)	-	-	<ul style="list-style-type: none"> · When gear tooth develop pitting or peeling. · When the rolling surface of needle bearings develops pitting or peeling(Bore of gears).
Needle bearing(304) Bar-shape roller(311) Bar-shape roller(318) Bar-shape roller(305) Bar-shape roller(312) Bar-shape roller(319) Floating bush(320)	-	-	<ul style="list-style-type: none"> · When the needle and the rolling surface develop flaking and peeling. · When the needle and the rolling surface develop blow marks. · The rotation of bearings is unusual. (Abnormal sound, unsmooth rotation, etc.)
Holder A(302) Holder B(309) Holder C(316)	-	-	<ul style="list-style-type: none"> · Large gap is present between holder and gear shaft.
Thrust plate(324)	2.0	1.9	
Thrust plate(346)	3.2 3.0 2.8 2.3 1.8	3.1 2.9 2.7 2.2 1.7	
Angular bearing(12)	-	-	<ul style="list-style-type: none"> · When rotation is abnormal.(Abnormal sound, unsmooth rotation, etc)
Floating seal(11)	-	-	<ul style="list-style-type: none"> · When the sliding surface has such faults that may cause oil leakage.

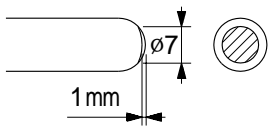
5. RCV LEVER

Maintenance check item	Criteria	Remark
Leakage	The valve is to be replaced when the leakage becomes more than 1000cc/m at neutral handle position, or more than 2000cc/m during operation.	Conditions : Primary pressure : 30kgf/cm ² Oil viscosity : 23cSt
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	 <p>This is to be replaced when the top end has worn more than 1mm.</p>	
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.

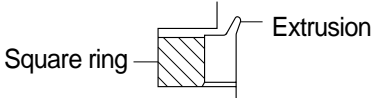
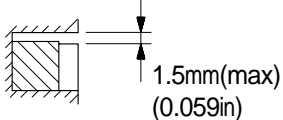
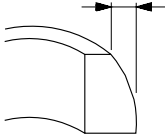
2. When loosening the hexagon socket head cap screw(125), replace the seal washers(121) without fail.

6. RCV 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 : 30kgf/cm ² Oil viscosity : 23cSt
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	 <p>This is to be replaced when the top end has worn more than 1mm.</p>	
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 0.1mm (0.0039in) in depth due to seizure contamination	Replace
		• Damaged more than 0.1mm(0.0039in) in depth	Smooth with oilstone
	Sliding surface with thrust plate	• Worn more than 0.5mm(0.02in) or abnormality	Replace
		• Worn less than 0.5mm(0.02in)	Smooth
		• Damage due to seizure or contamination remediable within wear limit (0.5mm)(0.02in)	Smooth
Cover	Sliding surface with thrust plate	• Worn more than 0.5mm(0.02in) or abnormality	Replace
		• Worn less than 0.5mm (0.02in)	Smooth
		• Damage due to seizure or contamination remediable within wear limit (0.5mm)(0.02in)	
Seal set	-	<ul style="list-style-type: none"> • Extruded excessively from seal groove square ring 	Replace
	-	<ul style="list-style-type: none"> • Slipper ring 1.5mm(0.059in) narrower than seal groove, or narrower than back ring 	Replace
	-	<ul style="list-style-type: none"> • Worn more than 0.5mm(0.02in) ~ 1.5mm(MAX) (0.059in) 	Replace

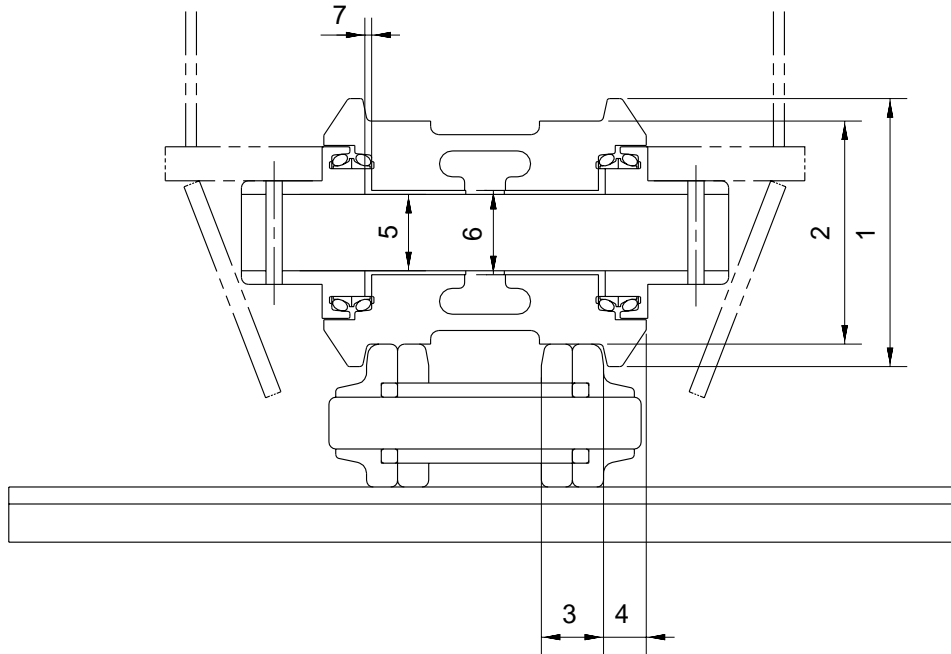
8. CYLINDER

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 • Scratches are not present	• Replace or replate • 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

GROUP 3 TRACK AND WORK EQUIPMENT

1. TRACK

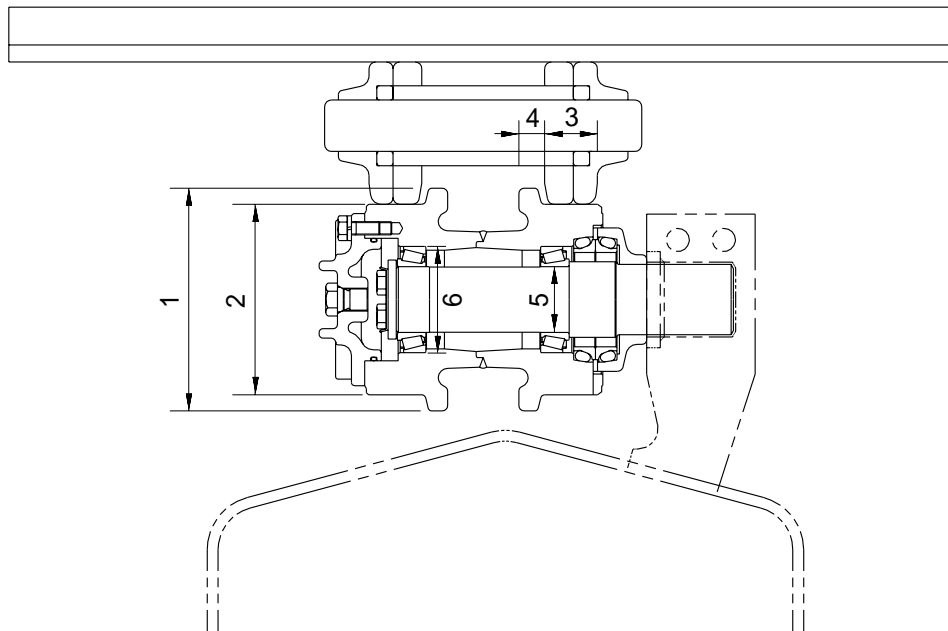
1) TRACK ROLLER



Unit : mm

No.	Check item	Criteria				Remedy
		Standard size		Repair limit		
1	Outside diameter of flange	ø 193		-		Rebuild or replace
2	Outside diameter of tread	ø 160		ø 148		
3	Width of tread	46.5		51.5		
4	Width of flange	32		-		
5	Clearance between shaft and bushing	Standard size	Tolerance		Standard clearance 0.35 to 0.455	Clearance limit 1.5
		ø 60	Shaft 0 -0.055	Hole +0.40 +0.35		
6	Interference between roller and bushing	Standard size	Tolerance		Standard Interference 0.056 to 0.132	Interference limit -
		ø 68	+0.132 +0.102	+0.046 0		
7	Side clearance of roller	Standard clearance		Clearance limit		Replace
		0.35 to 1.3		1.5		

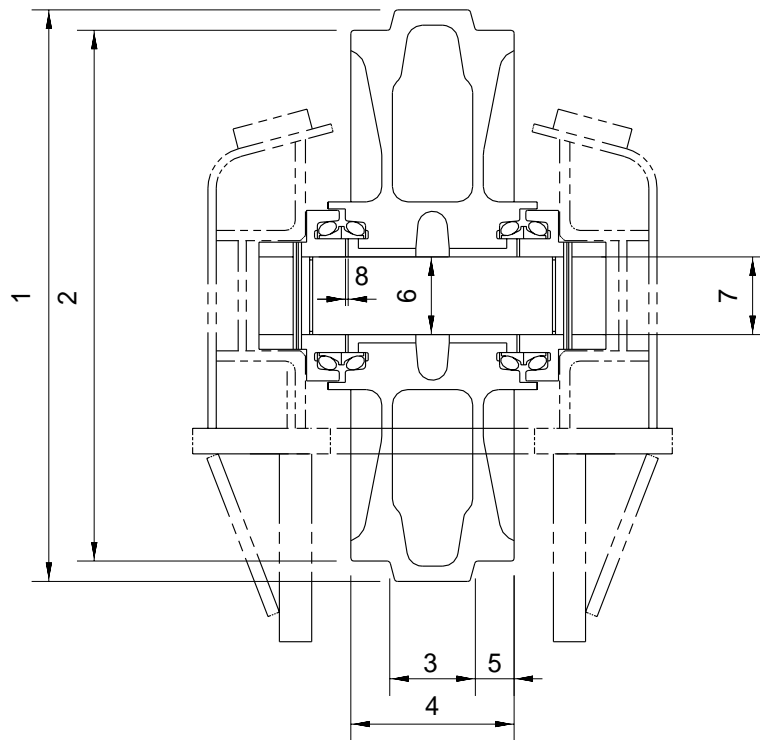
2) CARRIER ROLLER



Unit : mm

No.	Check item	Criteria		Remedy
1	Outside diameter of flange	Standard size	Repair limit	Rebuild or replace
		$\varnothing 169$	-	
2	Outside diameter of tread	$\varnothing 144$	$\varnothing 134$	
3	Width of tread	45.7	50.7	
4	Width of flange	17	-	
5	Clearance between shaft and bearing	Standard size & Tolerance		Standard Interference
		Shaft	Bearing	
		$\varnothing 50 \begin{matrix} +0.033 \\ +0.017 \end{matrix}$	$\varnothing 50 \begin{matrix} 0 \\ -0.012 \end{matrix}$	0.017 to 0.045
6	Interference between bearing and roller	Bearing	Hole	0.018 to 0.073
		$\varnothing 82 \begin{matrix} 0 \\ -0.020 \end{matrix}$	$\varnothing 82 \begin{matrix} -0.038 \\ -0.073 \end{matrix}$	

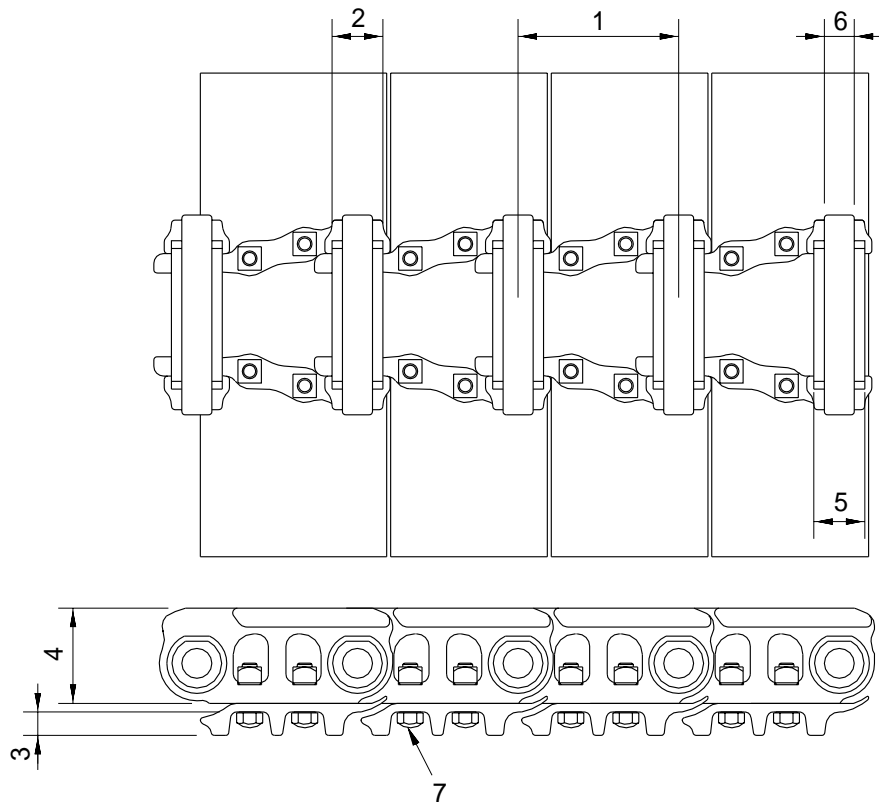
3) IDLER



Unit : mm

No.	Check item	Criteria				Remedy
		Standard size		Repair limit		
1	Outside diameter of protrusion	ø 560		-		Rebuild or replace
2	Outside diameter of tread	ø 520		ø 510		
3	Width of protrusion	84		-		
4	Total width	160		-		
5	Width of tread	38		45		
6	Clearance between shaft and bushing	Standard size & Tolerance		Standard clearance	Clearance limit	Replace bushing
		Shaft	Hole			
		ø 65 $\begin{matrix} 0 \\ -0.03 \end{matrix}$	ø 65.3 $\begin{matrix} +0.08 \\ -0.03 \end{matrix}$	0.27 to 0.41	1.5	
7	Clearance between shaft and support	ø 65 $\begin{matrix} 0 \\ -0.03 \end{matrix}$	ø 65 $\begin{matrix} +0.07 \\ +0.03 \end{matrix}$	0.03 to 0.1	-	Replace
8	Side clearance of idler (Both side)	Standard clearance		Clearance limit		Replace bushing
		0.65 to 1.2		2.0		

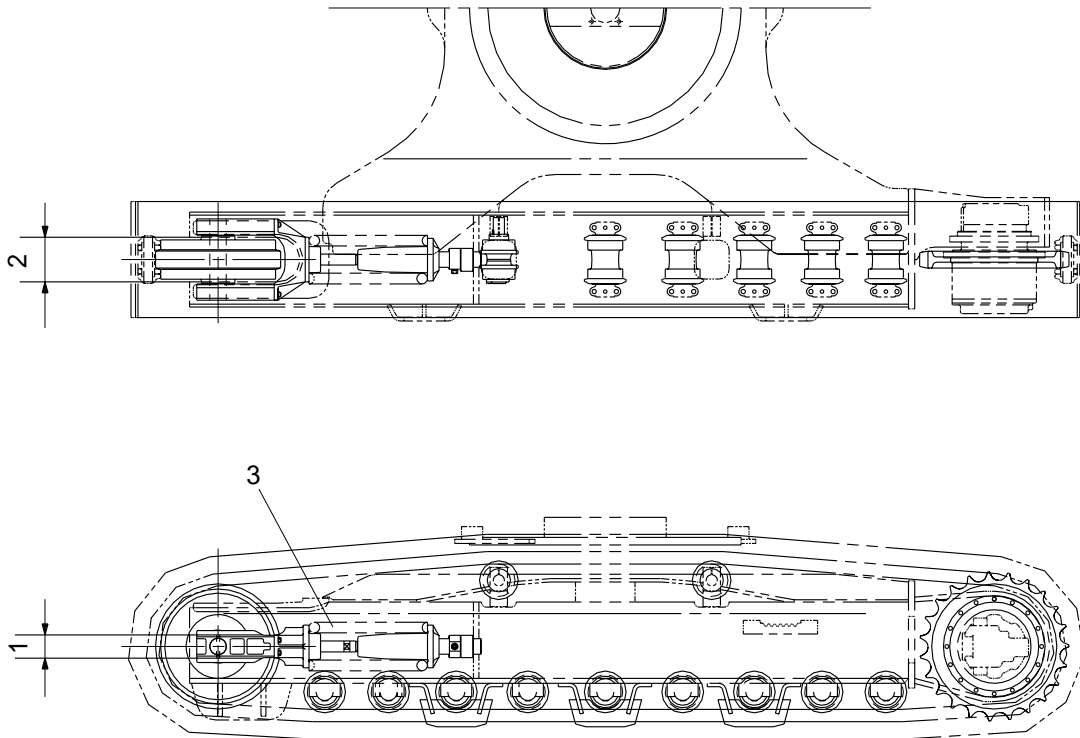
4) TRACK



Unit : mm

No.	Check item	Criteria				Remedy
		Standard size		Repair limit		
1	Link pitch	190		201.2		Turn or replace
2	Outside diameter of bushing	ø 60		ø 54.4		
3	Height of grouser	26		16		Replace
4	Height of link	105 ± 0.2		101		
5	Interference between bushing and link	Standard size & Tolerance		Standard interference	Interference limit	Replace
		Shaft	Hole			
		ø 55 ^{+0.38} / _{+0.22}	ø 54.96 ^{+0.1} / ₀	0.16 to 0.42	0.0424	
6	Interference between regular pin and link	ø 38 ^{+0.18} / _{+0.08}	ø 37.78 ^{+0.1} / ₀	0.20 to 0.40	0.1	
7	Tightening torque	Initial tightening torque : 81 ± 4kg · m				Check

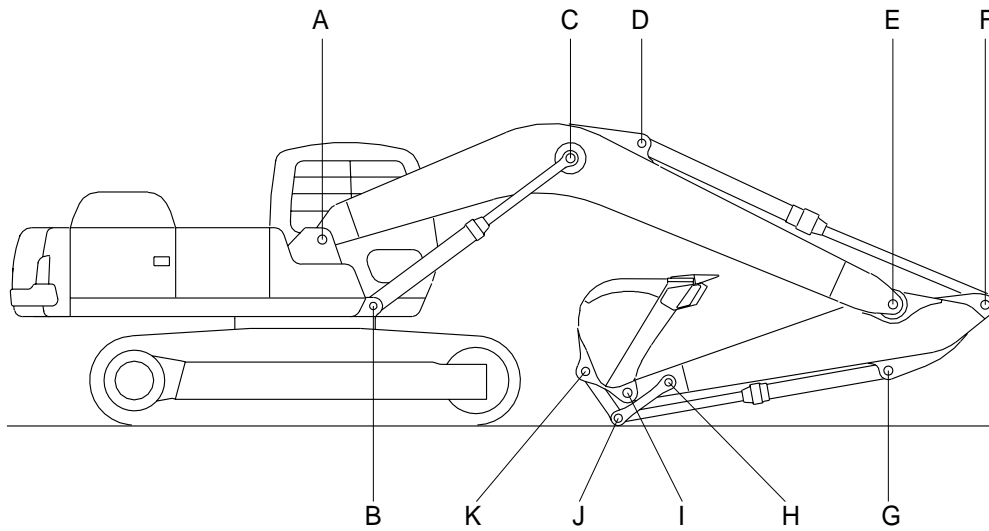
5) TRACK FRAME AND RECOIL SPRING



Unit : mm

No.	Check item	Criteria				Remedy	
			Standard size	Tolerance	Repair limit		
1	Vertical width of idler guide	Track frame	108	+2 0	112	Rebuild or replace	
		Idler support	105	-0.5 -1.0	101		
2	Horizontal width of idler guide	Track frame	249	+3 -1	254		
		Idler support	247	-	244		
3	Recoil spring	Standard size			Repair limit		Replace
		Free length	Installation length	Installation load	Free length	Installation load	
		∅ 238 × 558	437	11132kg	-	8900kg	

2. 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	75	74	73.5	75.5	76	Replace
B	Boom cylinder head	70	69	68.5	70.5	71	"
C	Boom cylinder rod	75	74	73.5	75.5	76	"
D	Arm cylinder head	70	69	68.5	70.5	71	"
E	Boom front	75	74	73.5	75.5	76	"
F	Arm cylinder rod	70	69	68.5	70.5	71	"
G	Bucket cylinder head	70	69	68.5	70.5	71	"
H	Arm link	70	69	68.5	70.5	71	"
I	Bucket and arm link	70	69	68.5	70.5	71	"
J	Bucket cylinder rod	70	69	68.5	70.5	71	"
K	Bucket link	70	69	68.5	70.5	71	"

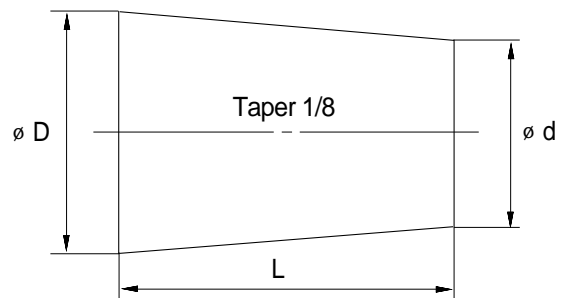
SECTION 8 DISASSEMBLY AND ASSEMBLY

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 100mm 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, nut	M22 × 2.5	48 ± 2.0	347 ± 14.4
2		Radiator mounting bolt	M12 × 1.75	12.8 ± 3.0	92.6 ± 21.7
3		Coupling mounting socket bolt	M16 × 2.0	22 ± 1.0	159 ± 7.2
4		Main pump housing mounting bolt	M10 × 1.5	6.9	49.9
5	Hydraulic system	Main pump mounting socket bolt	M16 × 2.0	22.1 ± 2.4	160 ± 17.4
6		Main control valve mounting nut	M12 × 1.75	12.2 ± 1.3	88.2 ± 9.4
7		Fuel tank mounting bolt	M20 × 2.5	46 ± 5.1	333 ± 37
8		Hydraulic oil tank mounting bolt	M20 × 2.5	46 ± 5.1	333 ± 37
9		Turning joint mounting bolt, nut	M12 × 1.75	12.2 ± 1.3	88.2 ± 9.4
10	Power train system	Swing motor mounting bolt	M20 × 2.5	57.9 ± 8.7	419 ± 62.9
11		Swing bearing upper mounting bolt	M20 × 2.5	57.8 ± 6.4	418 ± 46.3
12		Swing bearing lower mounting bolt	M20 × 2.5	57.8 ± 6.4	418 ± 46.3
13		Travel motor mounting bolt	M16 × 2.0	23 ± 2.5	166 ± 18.1
14		Sprocket mounting bolt	M16 × 2.0	23 ± 2.5	166 ± 18.1
15	Under carriage	Carrier roller mounting bolt, nut	M16 × 2.0	29.6 ± 3.2	214 ± 23
16		Track roller mounting bolt	M18 × 2.5	41.3 ± 5.0	299 ± 36.2
17		Track tension cylinder mounting bolt	M16 × 2.0	29.7 ± 4.5	215 ± 32.5
18		Track shoe mounting bolt, nut	M20 × 1.5	81 ± 4.0	586 ± 28.9
19		Track guard mounting bolt	M18 × 2.5	41.3 ± 5.0	299 ± 36.2
20	Others	Counter weight mounting bolt	M30 × 3.5	199 ± 30	1439 ± 217
21		Cab mounting bolt, nut	M12 × 1.75	12.2 ± 1.3	88.2 ± 9.4
22		Operator's seat mounting bolt	M 8 × 1.25	2.5 ± 0.5	18.1 ± 3.6

※ For tightening torque of engine and hydraulic components, see each components disassembly and assembly.

2. TORQUE CHART

The torques given are standard figures. Any figures specifically described in this manual has priority.

1) METRIC BOLT - Coarse thread

Bolt size	8T		10T	
	kgf · m	lbf · ft	kgf · m	lbf · 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	2.73 ~ 4.12	19.7 ~ 29.8
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 ~ 79.5	9.8 ~ 15.8	71 ~ 114
M14 × 2.0	12.2 ~ 16.6	88.2 ~ 120	16.7 ~ 22.5	121 ~ 167
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 ~ 343
M20 × 2.5	36.2 ~ 49.0	262 ~ 354	49.2 ~ 66.6	356 ~ 482
M22 × 2.5	48.3 ~ 63.3	350 ~ 457	65.8 ~ 98.0	476 ~ 709
M24 × 3.0	62.5 ~ 84.5	452 ~ 611	85.0 ~ 115	615 ~ 832
M30 × 3.5	124 ~ 168	898 ~ 1214	169 ~ 229	1223 ~ 1655
M36 × 4.0	174 ~ 236	1261 ~ 1703	250 ~ 310	1808 ~ 2242

2) METRIC BOLT - Fine thread

Bolt size	8T		10T	
	kgf · m	lbf · ft	kgf · m	lbf · ft
M 8 × 1.0	2.17 ~ 3.37	15.7 ~ 24.3	3.04 ~ 4.44	22.0 ~ 32.0
M10 × 1.25	4.46 ~ 6.66	32.3 ~ 48.2	5.93 ~ 8.93	42.9 ~ 64.6
M12 × 1.25	7.78 ~ 11.58	76.3 ~ 83.7	10.6 ~ 16.0	76.6 ~ 115
M14 × 1.5	13.3 ~ 18.1	96.2 ~ 130	17.9 ~ 24.1	130 ~ 174
M16 × 1.5	19.9 ~ 26.9	144 ~ 194	26.6 ~ 36.0	193 ~ 260
M18 × 1.5	28.6 ~ 43.6	207 ~ 315	38.4 ~ 52.0	278 ~ 376
M20 × 1.5	40.0 ~ 54.0	289 ~ 390	53.4 ~ 72.2	386 ~ 522
M22 × 1.5	52.7 ~ 71.3	381 ~ 515	70.7 ~ 95.7	512 ~ 692
M24 × 2.0	68 ~ 92	491 ~ 664	90.9 ~ 123	658 ~ 890
M30 × 2.0	137 ~ 185	990 ~ 1338	182 ~ 248	1314 ~ 1795
M36 × 3.0	192 ~ 260	1389 ~ 1879	262 ~ 354	1893 ~ 2561

3) PIPE AND HOSE

Thread size	Width across flat(mm)	kgf · m	lbf · ft
1/4"	19	3	21.7
3/8"	22	4	28.9
1/2"	27	5	36.2
3/4"	36	12	86.8
1"	41	14	101

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	6	43.4
3/4"	36	13	94.0
1"	41	15	109

GROUP 3 PUMP DEVICE

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 drain plug under the hydraulic tank and drain the oil from the hydraulic tank.

· Hydraulic oil quantity : 210 l

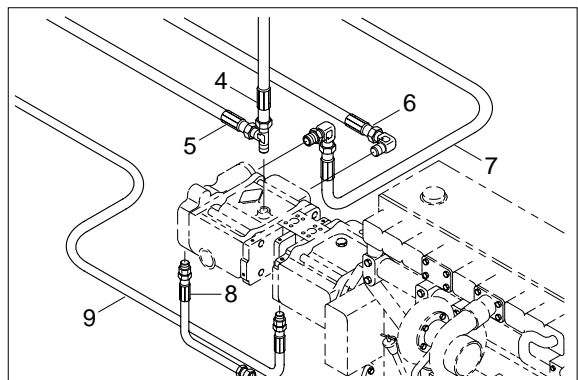
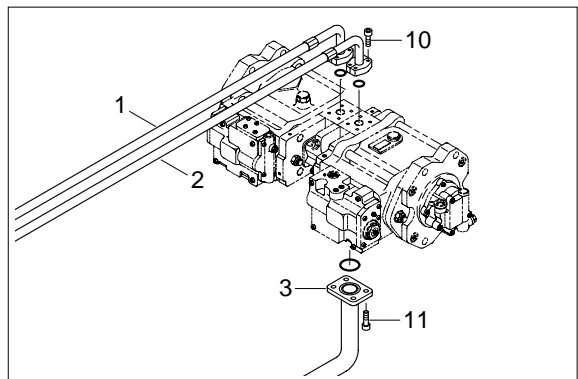
- (5) Remove socket bolts(10) and disconnect pipe(1, 2).
- (6) Disconnect pilot line hoses(4, 5, 6, 7, 8, 9).
- (7) Remove socket bolts(11) and disconnect pump suction tube (3).

※ When pump suction tube is disconnected, the oil inside the piping will flow out, so catch it in oil pan.

- (8) Sling the pump assembly and remove the pump mounting bolts.

· Weight : 125kg(276lb)

- ※ Pull out the pump assembly from housing. When removing the pump assembly, check that all the hoses have been disconnected.

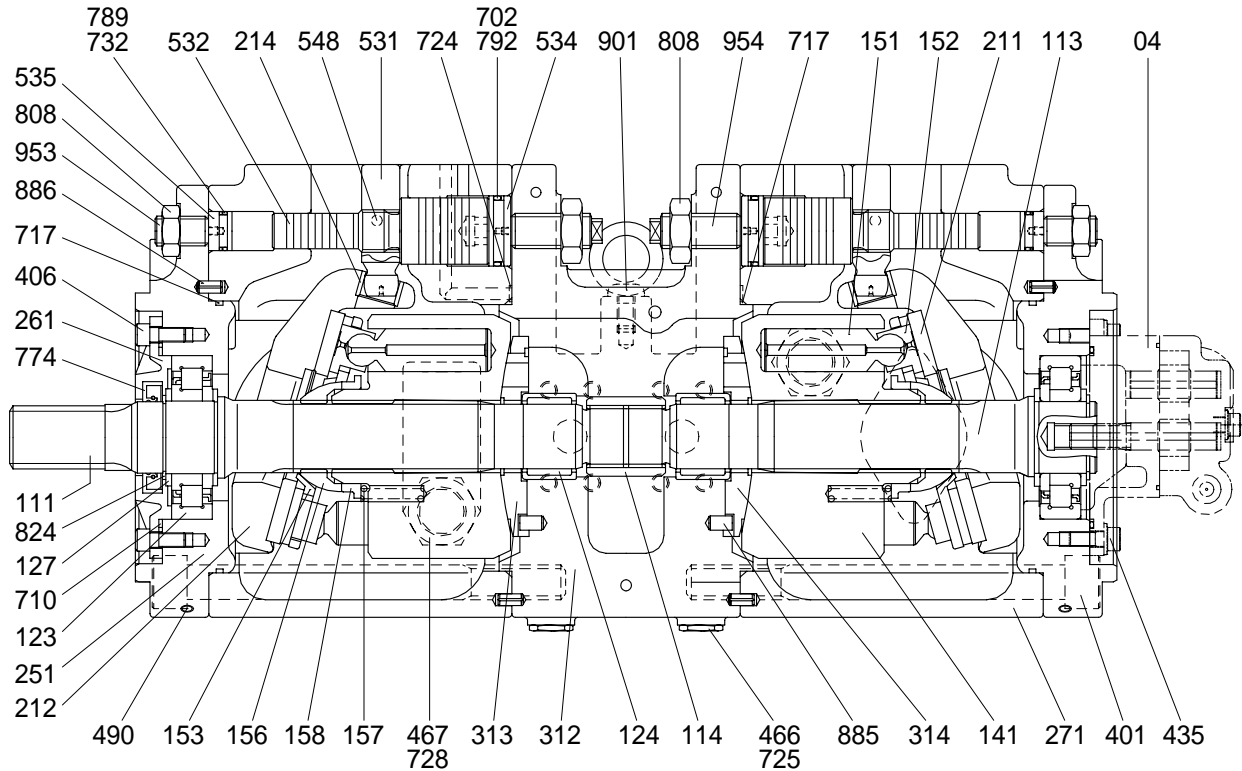


2) INSTALL

- (1) Carry out installation in the reverse order to removal.
- (2) Remove the suction strainer and clean it.
- (3) Replace return filter with new one.
- (4) Remove breather and clean it.
- (5) After adding oil to the hydraulic tank to the specified level.
- (6) Bleed the air from the hydraulic pump.
 - ① Remove the air vent plug(2EA).
 - ② Tighten plug lightly.
 - ③ Start the engine, run at low idling, and check oil come out from plug.
 - ④ Tighten plug.
- (7) Start the engine, run at low idling(3~5 minutes) to circulate the oil through the system.
- (8) Confirm the hydraulic oil level and check the hydraulic oil leak or not.

2. MAIN PUMP

1) STRUCTURE

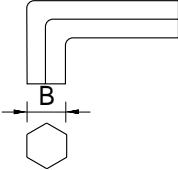
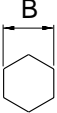


04	Gear pump	261	Seal cover(F)	717	O-ring
111	Drive shaft(F)	271	Pump casing	719	O-ring
113	Drive shaft(R)	312	Valve block	724	O-ring
114	Spline	313	Valve plate(R)	725	O-ring
123	Roller bearing	314	Valve plate(L)	728	O-ring
124	Needle bearing	401	Hexagon socket bolt	732	O-ring
127	Bearing spacer	406	Hexagon socket bolt	774	Oil seal
141	Cylinder block	435	Flange socket bolt	789	Back up ring
151	Piston	466	VP plug	792	Back up ring
152	Shoe	468	VP plug	808	Hexagon head nut
153	Push plate	490	VP plug	824	Snap ring
156	Bushing	531	Tilting pin	885	Pin
157	Cylinder spring	532	Servo piston	886	Spring pin
158	Spacer	534	Stopper(L)	901	Eye bolt
211	Shoe plate	535	Stopper(S)	953	Set screw
212	Swash plate	548	Pin	954	Set screw
214	Bushing	702	O-ring		
251	Swash plate support	710	O-ring		

2) TOOLS AND TIGHTENING TORQUE

(1) Tools

The tools necessary to disassemble/reassemble the pump are shown in the follow list.

Tool name & size		Part name			
Name	B	Hexagon socket head bolt	PT plug (PT thread)	PO plug (PF thread)	Hexagon socket head setscrew
Allen wrench 	4	M 5	BP-1/16	-	M 8
	5	M 6	BP-1/8	-	M10
	6	M 8	BP-1/4	PO-1/4	M12, M14
	8	M10	BP-3/8	PO-3/8	M16, M18
	17	M20, M22	BP-1	PO-1, 1 1/4, 1 1/2	-
Double ring spanner, socket wrench, double(Single) open end spanner 	-	Hexagon headed bolt	Hexagon nut	VP plug (PF thread)	
	19	M12	M12	VP-1/4	
	24	M16	M16	-	
	27	M18	M18	VP-1/2	
	30	M20	M20	-	
	36	-	-	VP-3/4	
Adjustable angle wrench		Medium size, 1 set			
Screw driver		Minus type screw driver, Medium size, 2 sets			
Hammer		Plastic hammer, 1 set			
Pliers		For snap ring, TSR-160			
Steel bar		Steel bar of key material approx. 10 × 8 × 200			
Torque wrench		Capable of tightening with the specified torques			

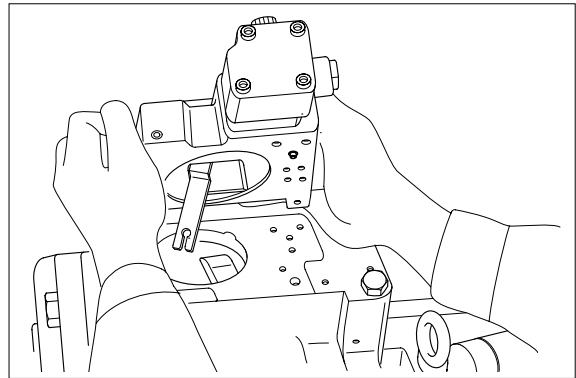
(2) Tightening torque

Part name	Bolt size	Torque		Wrench size	
		kgf · m	lbf · ft	in	mm
Hexagon socket head bolt (Material : SCM435)	M 5	0.7	5.1	0.16	4
	M 6	1.2	8.7	0.20	5
	M 8	3.0	21.7	0.24	6
	M10	5.8	42.0	0.31	8
	M12	10.0	72.3	0.39	10
	M14	16.0	115.7	0.47	12
	M16	24.0	173.6	0.55	14
	M18	34.0	245.9	0.55	14
	M20	44.0	318.3	0.67	17
PT plug(Material : S45C) ※ Wind a seal tape 1 1/2 to 2 turns round the plug	PT 1/16	0.7	5.1	0.16	4
	PT 1/8	1.05	7.59	0.20	5
	PT 1/4	1.75	12.66	0.24	6
	PT 3/8	3.5	25.3	0.31	8
	PT 1/2	5.0	36.2	0.39	10
PF Plug(Material : S45C)	PF 1/4	3.0	21.7	0.24	6
	PF 1/2	10.0	72.3	0.39	10
	PF 3/4	15.0	108.5	0.55	14
	PF 1	19.0	137.4	0.67	17
	PF 1 1/4	27.0	195.3	0.67	17
	PF 1 1/2	28.0	202.5	0.67	17

3) DISASSEMBLY

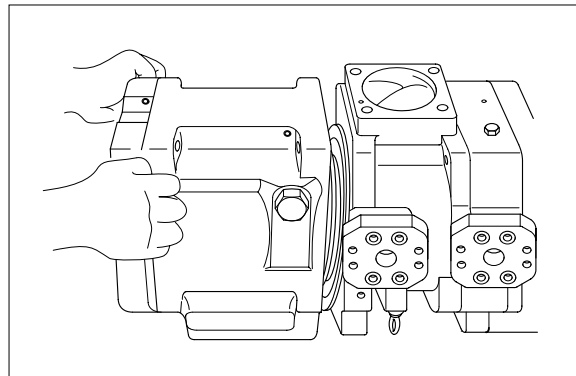
- (1) Select place suitable to disassembling.
 - ※ Select clean place.
 - ※ Spread rubber sheet, cloth or so on on overhaul workbench top to prevent parts from being damaged.
- (2) Remove dust, rust, etc. from pump surfaces with cleaning oil or so on.
- (3) Remove drain port plug(467) and let oil out of pump casing.(Front and rear pump)
- (4) Remove hexagon socket head bolts(412, 413) and remove regulator.

Remove hexagon socket head bolts(416) and remove gear pump.



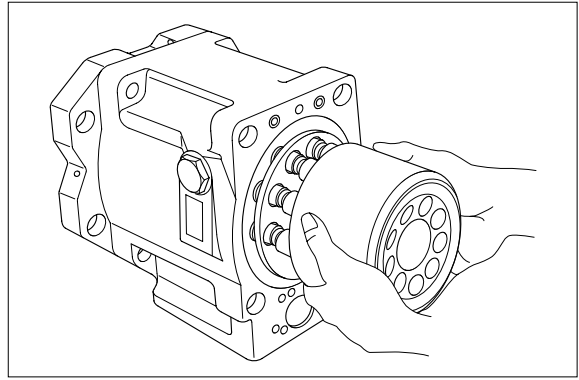
- (5) Loosen hexagon socket head bolts(401) which tighten swash plate support(251), pump casing(271) and valve block(312).

- (6) Place pump horizontally on workbench with its regulator-fitting surface down and separate pump casing(271) from valve block(312).
 - ※ Before bringing this surface down, spread rubber sheet on workbench without fail to prevent this surface from being damaged.



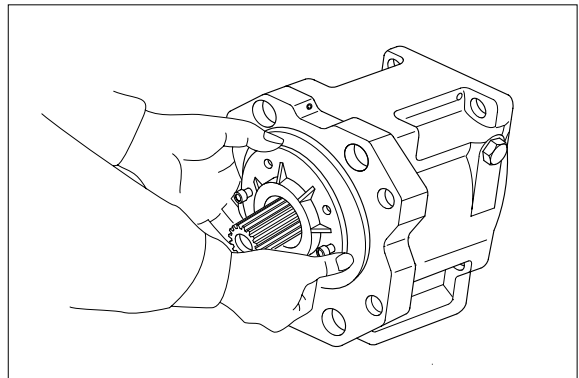
(7) Pull cylinder block(141) out of pump casing(271) straightly over drive shaft(111). Pull out also pistons(151), set plate(153), spherical bush(156) and cylinder springs(157) simultaneously.

- ※ Take care not to damage sliding surfaces of cylinder, spherical bushing, shoes, swash plate, etc.



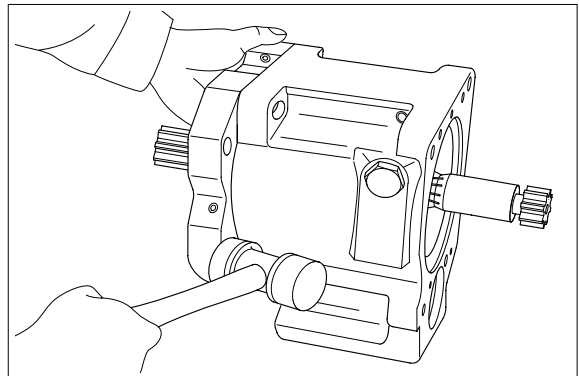
(8) Remove hexagon socket head bolts(406) and then seal cover(F, 261).

- ※ Fit bolt into pulling out tapped hole of seal cover(F), and cover can be removed easily.
- ※ Since oil seal is fitted on seal cover(F), take care not to damage it in removing cover.

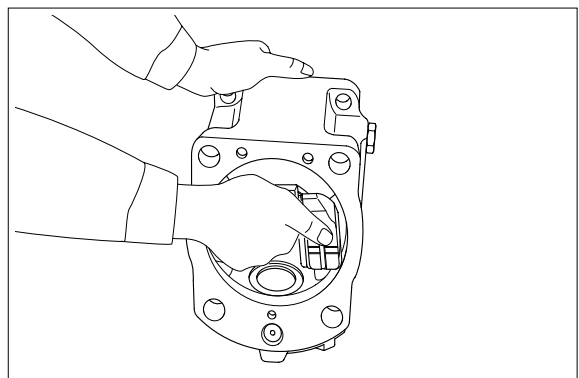


(9) Remove flange socket bolts(435) and then gear pump(04).

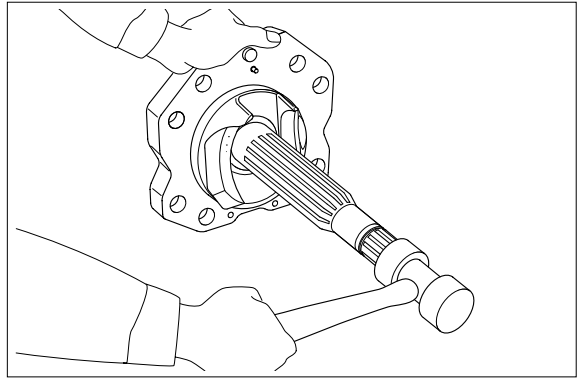
(10) Tapping lightly fitting flange section of swash plate support(251) on its pump casing side, separate swash plate support from pump casing.



(11) Remove shoe plate(211) and swash plate(212) from pump casing(271).

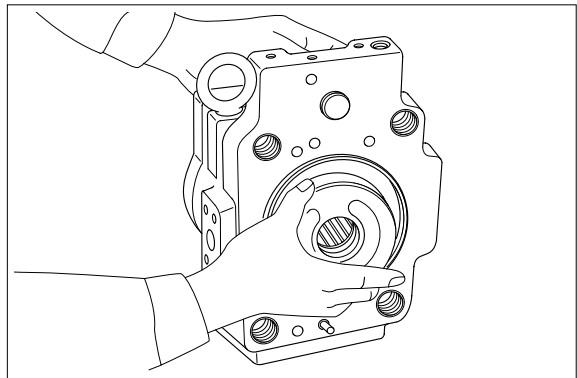


- (12) Tapping lightly shaft ends of drive shafts (111, 113) with plastic hammer, take out drive shafts from swash plate supports.



- (13) Remove valve plates(313, 314) from valve block(312).

※ These may be removed in work(6).



- (14) If necessary, remove stopper(L, 534), stopper(S, 535), servo piston(532) and tilting pin(531) from pump casing(271), and needle bearing(124) and spline coupling(114) from valve block(312).

※ In removing tilting pin, use a protector to prevent pin head from being damaged.

※ Since loctite is applied to fitting areas of tilting pin and servo piston, take care not to damage servo piston.

※ Do not remove needle bearing as far as possible, except when it is considered to be out of its life span.

※ Do not loosen hexagon nuts of valve block and swash plate support.

If loosened, flow setting will be changed.

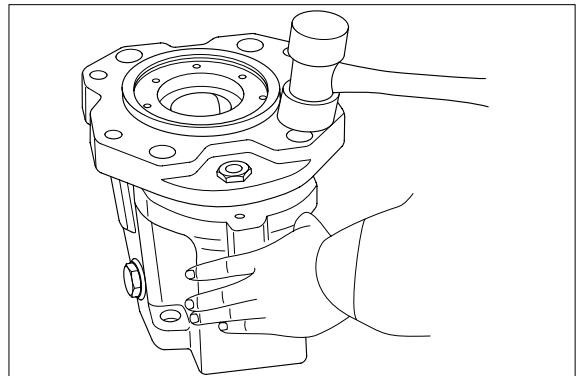
4) ASSEMBLY

(1) For reassembling reverse the disassembling procedures, pay attention to the following items.

- ① Do not fail to repair the parts damaged during disassembling, and prepare replacement parts in advance.
- ② Clean each part fully with cleaning oil and dry it with compressed air.
- ③ Do not fail to apply clean working oil to sliding sections, bearings, etc. before assembling them.
- ④ In principle, replace seal parts, such as O-rings, oil seals, etc.
- ⑤ For fitting bolts, plug, etc., prepare a torque wrench or so on, and tighten them with torques shown in page 8-10, 11.
- ⑥ For the double-pump, take care not to mix up parts of the front pump with those of the rear pump.

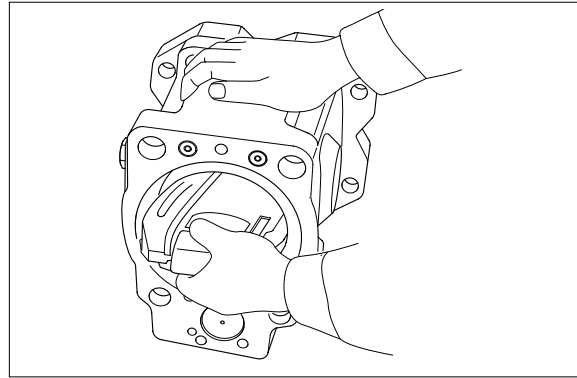
(2) Fit swash plate support(251) to pump casing(271), tapping the former lightly with a hammer.

- ※ After servo piston, tilting pin, stopper(L) and stopper(S) are removed, fit them soon to pump casing in advance for reassembling.
- ※ In tightening servo piston and tilting pin, use a protector to prevent tilting pin head and feedback pin from being damaged. In addition, apply loctite(Medium strength) to their threaded sections.



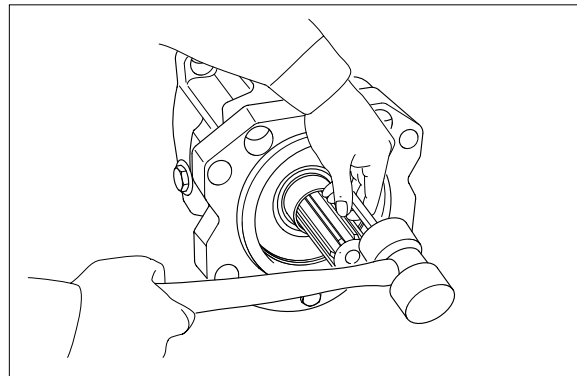
(3) Place pump casing with its regulator fitting surface down, fit tilting bush of swash plate to tilting pin(531) and fit swash plate (212) to swash plate support(251) correctly.

- ※ Confirm with fingers of both hands that swash plate can be removed smoothly.
- ※ Apply grease to sliding sections of swash plate and swash plate support, and drive shaft can be fitted easily.



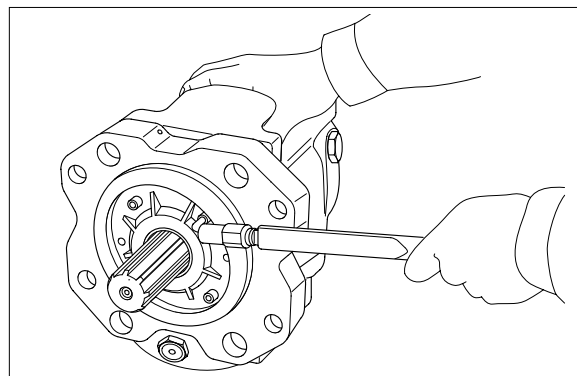
(4) To swash plate support(251), fit drive shaft(111) set with bearing(123), bearing spacer(127) and snap ring(824).

- ※ Do not tap drive shaft with hammer or so on.
- ※ Assemble them into support, tapping outer race of bearing lightly with plastic hammer.
- Fit them fully, using steel bar or so on.

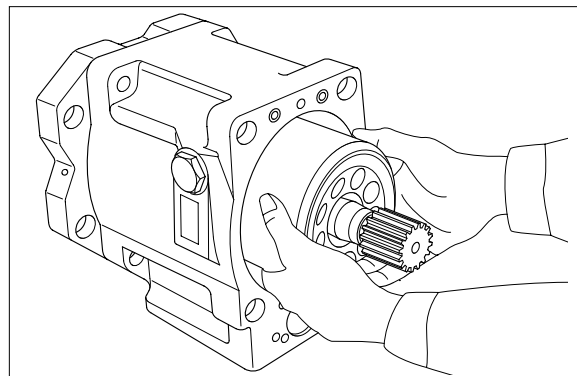


(5) Assemble seal cover(F, 261) to pump casing(271) and fix it with hexagon socket head bolts(406).

- ※ Assemble gear pump(04) to pump casing(271) and fix it with flange socket bolts(435).
- ※ Apply grease lightly to oil seal in seal cover(F).
- ※ Assemble oil seal, taking full care not to damage it.

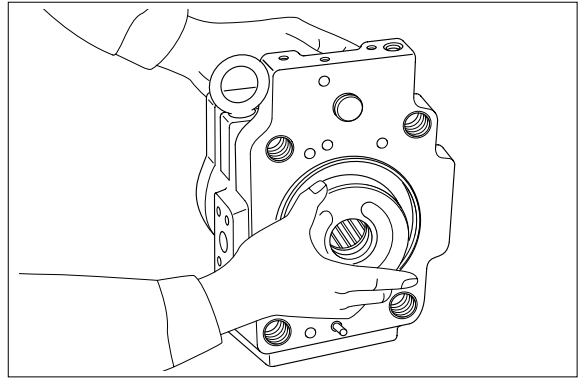


(6) Assemble piston cylinder subassembly [cylinder (141), piston subassembly (151, 152), set plate(153), spherical bush (156), spacer(158) and cylinder spring (157)]. Fit spline phases of retainer and cylinder. Then, insert piston cylinder subassembly into pump casing.



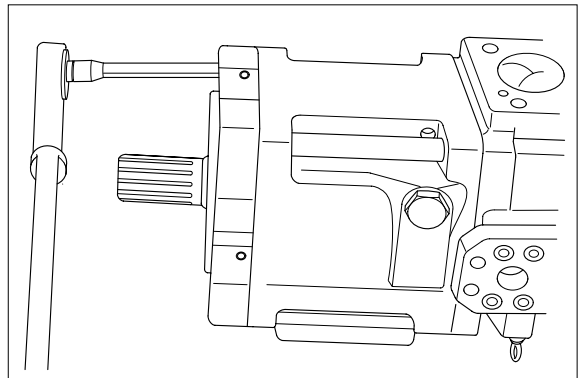
(7) Fit valve plate(313) to valve block(312), entering pin into pin hole.

- ※ Take care not to mistake suction / delivery directions of valve plate.



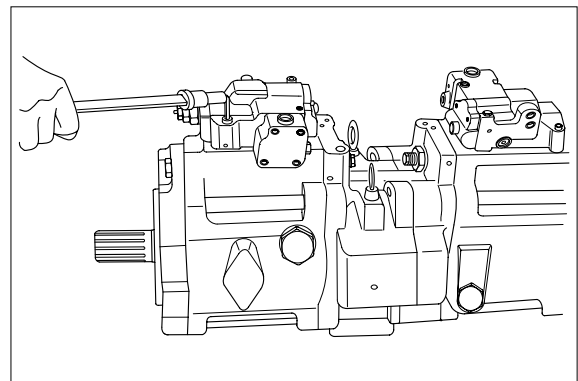
(8) Fit valve block(312) to pump casing(271) and tighten hexagon socket head bolts (401).

- ※ At first assemble this at rear pump side, and this work will be easy.
- ※ Take care not to mistake direction of valve block.
- ※ Clockwise rotation(Viewed from input shaft side).
- ※ Fit block with regulator up and with delivery flange left, viewed from front side.



(9) Putting feedback pin of tilting pin into feedback lever of regulator, fit regulator and tighten hexagon socket head bolts (412, 413).

- ※ Take care not to mistake regulator of front pump for that of rear pump.

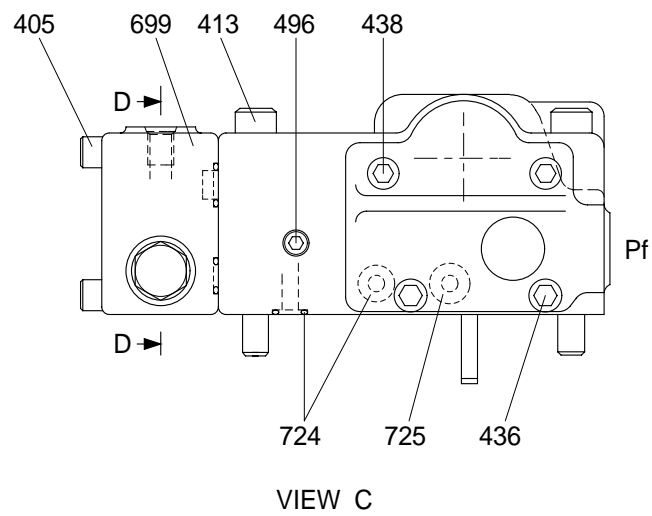
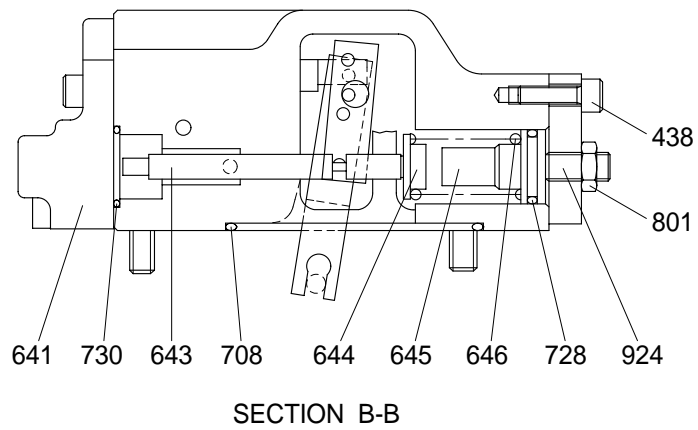
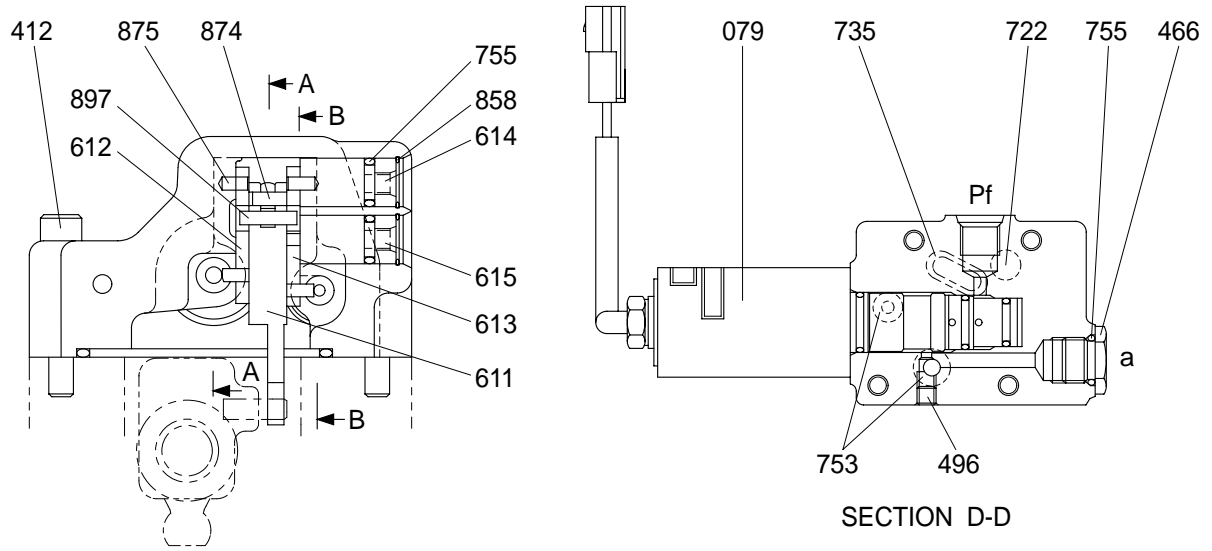


(10) Fit drain port plug(467).

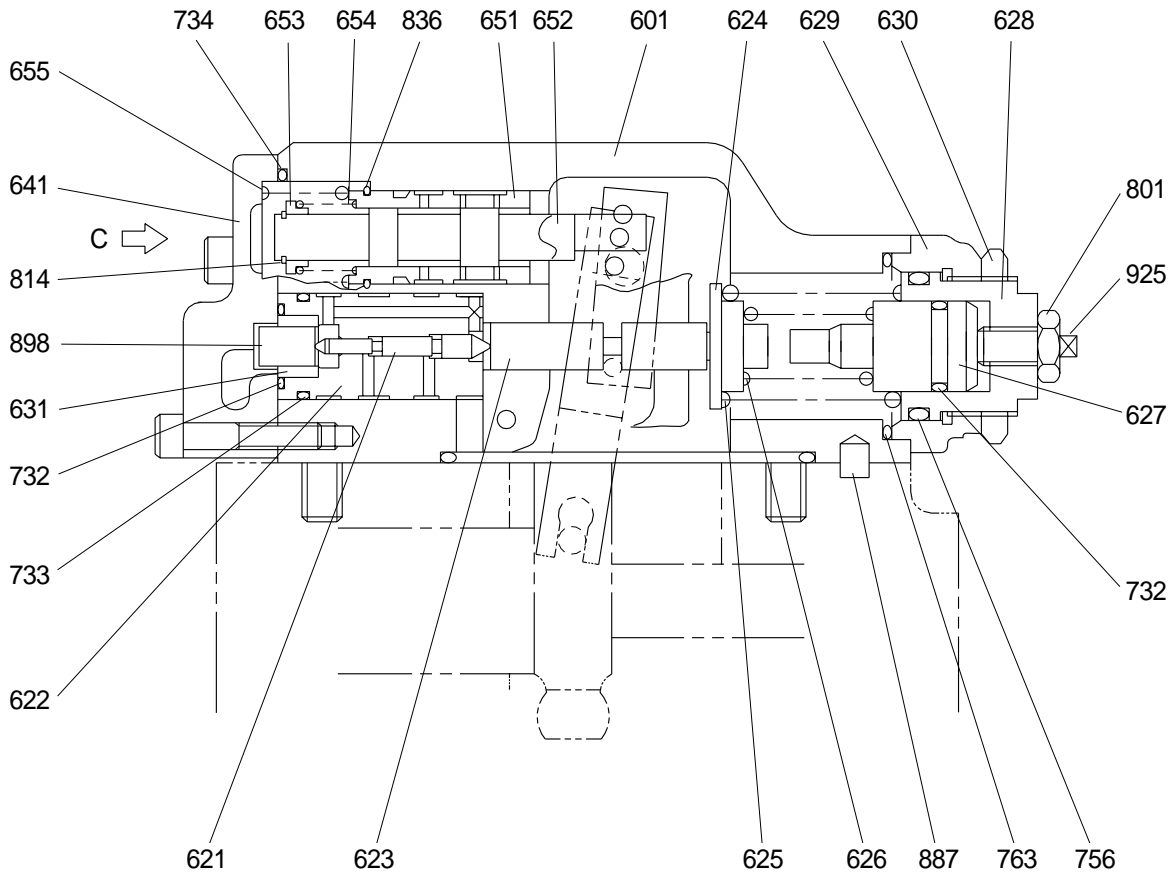
This is the end of reassembling procedures.

3. REGULATOR

1) STRUCTURE(1/2)



REGULATOR(2/2)



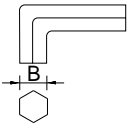

SECTION A-A

079	Proportional reducing valve	628	Adjust screw(C)	733	O-ring
405	Hexagon socket screw	629	Cover(C)	734	O-ring
412	Hexagon socket screw	630	Nut	735	O-ring
413	Hexagon socket screw	631	Sleeve	753	O-ring
436	Hexagon socket screw	641	Pilot cover	755	O-ring
438	Hexagon socket screw	643	Pilot piston	756	O-ring
466	Plug	644	Spring seat(Q)	763	O-ring
496	Plug	645	Adjust stem(Q)	801	Nut
601	Casing	646	Pilot spring	814	Snap ring
611	Feed back lever	651	Sleeve	836	Snap ring
612	Lever(1)	652	Spool	858	Snap ring
613	Lever(2)	653	Spring seat	874	Pin
614	Fulcrum plug	654	Return spring	875	Pin
615	Adjust plug	655	Set spring	887	Pin
621	Piston	708	O-ring	897	Pin
622	Piston case	722	O-ring	898	Pin
623	Compensator rod	724	O-ring	924	Set screw
624	Spring seat(C)	725	O-ring	925	Adjust screw(QI)
625	Outer spring	728	O-ring		
626	Inner spring	730	O-ring		
627	Adjust stem(C)	732	O-ring		

2) TOOLS AND TIGHTENING TORQUE

(1) Tools

The tools necessary to disassemble/reassemble the pump are shown in the follow list.

Tool name & size		Part name			
Name	B	Hexagon socket head bolt	PT plug (PT thread)	PO plug (PF thread)	Hexagon socket head setscrew
Allen wrench 	4	M 5	BP-1/16	-	M 8
	5	M 6	BP-1/8	-	M10
	6	M 8	BP-1/4	PO-1/4	M12, M14
Socket wrench, double(Single) open end spanner 	-	Hexagon headed bolt	Hexagon nut	VP plug (PF thread)	
	6	M 8	M 8	-	
Adjustable angle wrench		Small size, Max 36mm			
Screw driver		Minus type screw driver, Medium size, 2 sets			
Hammer		Plastic hammer, 1 set			
Pliers		For snap ring, TSR-160			
Steel bar		4 × 100mm			
Torque wrench		Capable of tightening with the specified torques			
Pincers		-			
Bolt		M4, Length : 50mm			

(2) Tightening torque

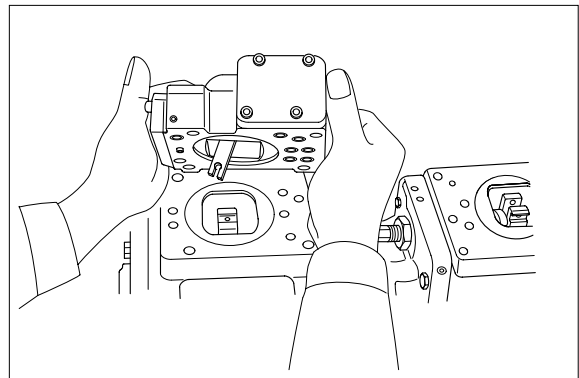
Part name	Bolt size	Torque		Wrench size	
		kgf · m	lbf · ft	in	mm
Hexagon socket head bolt (Material : SCM435)	M 5	0.7	5.1	0.16	4
	M 6	1.2	8.7	0.20	5
	M 8	3.0	21.7	0.24	6
	M10	5.8	42.0	0.31	8
	M12	10.0	72.3	0.39	10
	M14	16.0	115.7	0.47	12
	M16	24.0	173.6	0.55	14
	M18	34.0	245.9	0.55	14
	M20	44.0	318.3	0.67	17
PT Plug(Material : S45C) ※ Wind a seal tape 1 1/2 to 2 turns round the plug	PT 1/16	0.7	5.1	0.16	4
	PT 1/8	1.05	7.59	0.20	5
	PT 1/4	1.75	12.66	0.24	6
	PT 3/8	3.5	25.3	0.31	8
	PT 1/2	5.0	36.2	0.39	10
PF Plug(Material : S35C)	PF 1/4	3.0	21.7	0.24	6
	PF 1/2	3.0	21.7	0.39	10
	PF 3/4	10.0	72.3	0.55	14
	PF 1	15.0	108.5	0.67	17
	PF 1 1/4	27.0	195.3	0.67	17
	PF 1 1/2	28.0	202.5	0.67	17

3) DISASSEMBLY

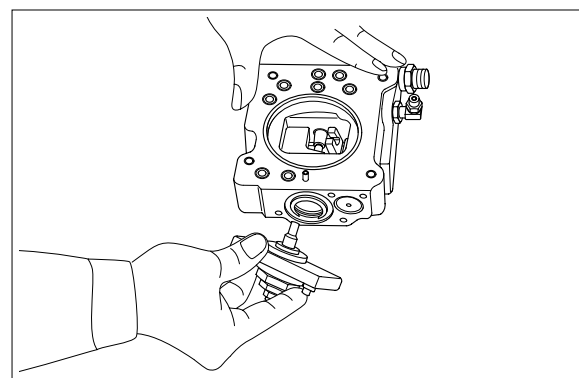
Since the regulator consists of small precision finished parts, disassembly and assembly are rather complicated.

For this reason, replacement of a regulator assembly is recommended, unless there is a special reason, but in case disassembly is necessary for an unavoidable reason, read through this manual to the end before starting disassembly.

- (1) Choose a place for disassembly.
 - ※ Choose a clean place.
 - ※ Spread rubber sheet, cloth, or so on on top of work-bench to prevent parts from being damaged.
- (2) Remove dust, rust, etc. from surfaces of regulator with clean oil.
- (3) Remove hexagon socket head screw (412, 413) and remove regulator main body from pump main body.
 - ※ Take care not to lose O-ring.



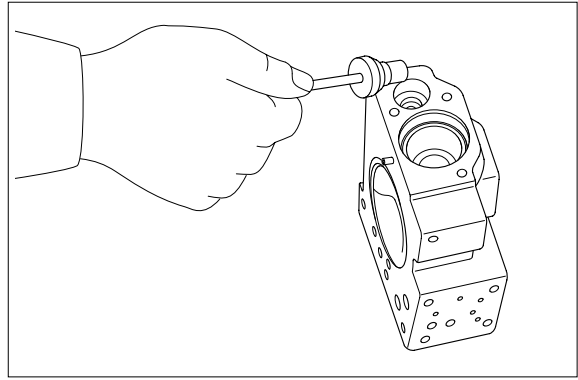
- (4) Remove hexagon socket head screw (438) and remove cover(C,629)
 - ※ Cover(C) is fitted with adjusting screw (C,QI) (628, 925), adjusting ring(C, 627), lock nut(630), hexagon nut(801) and adjusting screw(924).
Do not loosen these screws and nuts.
If they are loosened, adjusted pressure-flow setting will vary.



- (5) After removing cover(C, 629) subassembly, take out outer spring(625), inner spring (626) and spring seat(C, 624) from compensating section.

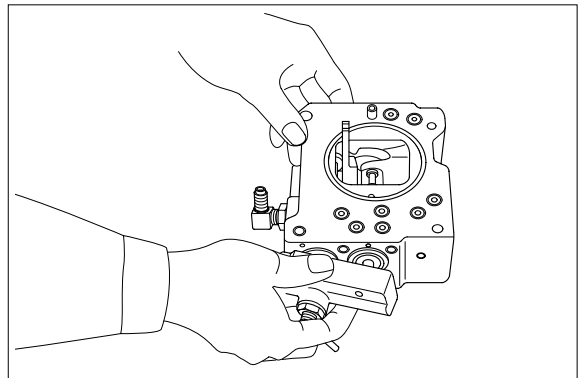
Then draw out adjusting ring(Q, 645), pilot spring(646) and spring seat(644) from pilot section.

- ※ Adjusting ring(Q,645) can easily be drawn out with M4 bolt.



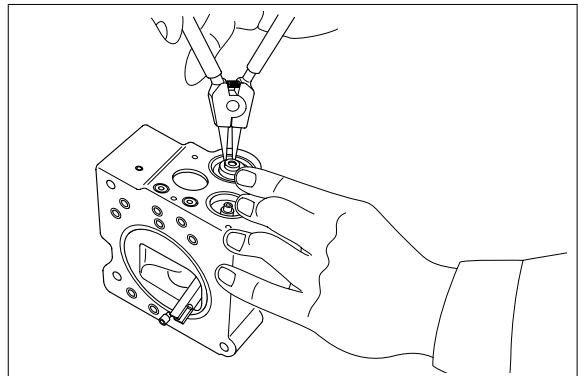
- (6) Remove hexagon socket head screws (436, 438) and remove pilot cover(641).

After removing pilot cover, take out set spring(655) from pilot section.



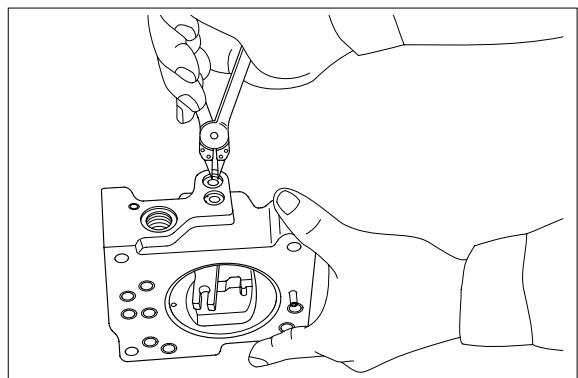
- (7) Remove snap ring(814) and take out spring seat(653), return spring(654) and sleeve(651).

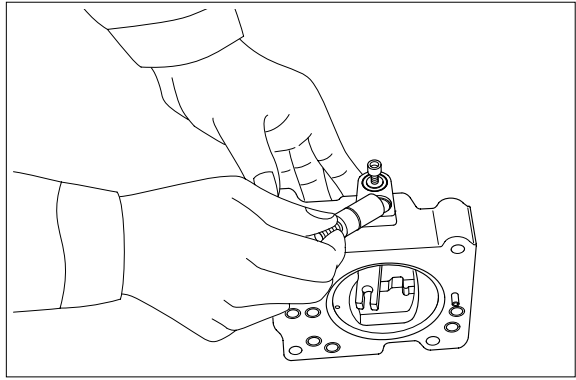
- ※ Sleeve(651) is fitted with snap ring(836).
- ※ When removing snap ring(814), return spring(654) may pop out. Take care not to lose it.



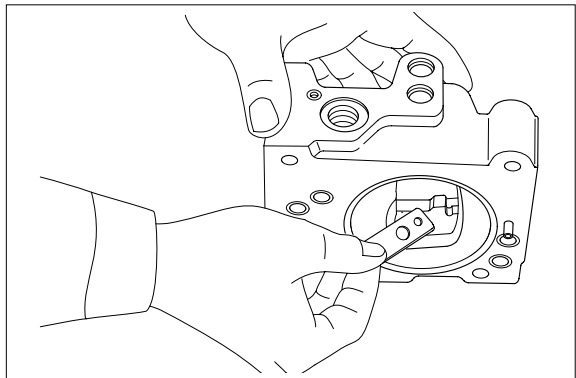
- (8) Remove snap ring(858) and take out fulcrum plug(614) and adjusting plug (615).

- ※ Fulcrum plug(614) and adjusting plug (615) can easily be taken out with M6 bolt.

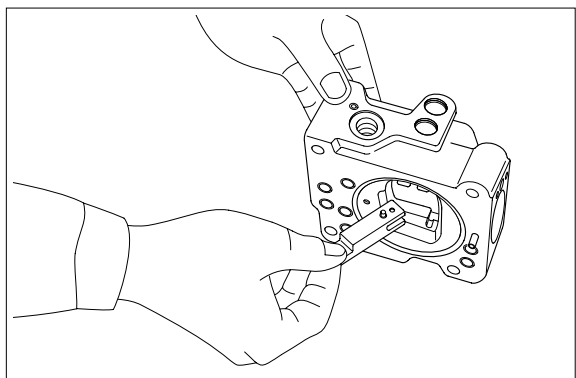
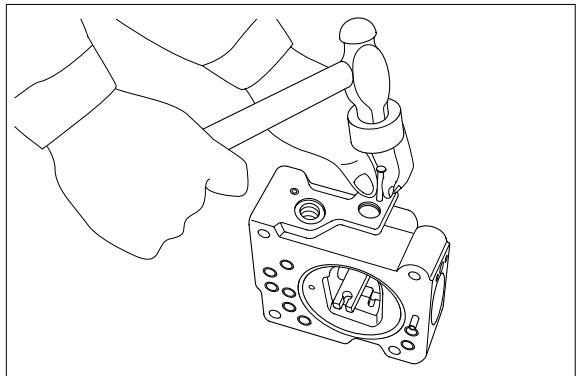




- (9) Remove lever(2, 613). Do not draw out pin(875).
※ Work will be promoted by using pincers or so on.



- (10) Draw out pin(874) and remove feedback lever(611).
Push out pin(874, 4mm in dia.) from above with slender steel bar so that it may not interfere with lever(1, 612).



(11) Remove lever(1, 612). Do not draw out pin(875).

(12) Draw out pilot piston(643) and spool(652).

(13) Draw out piston case(622), compensating piston(621) and compensating rod(623).

※ Piston case(622) can be taken out by pushing compensating rod(623) at opposite side of piston case.

This completes disassembly.

4) ASSEMBLY

(1) For assembly, reverse disassembly procedures, but pay attention to the following items.

① Always repair parts that were scored at disassembly.

Get replacement parts ready beforehand.

② Mixing of foreign matter will cause malfunction.

Therefore, wash parts well with cleaning oil, let them dry with jet air and handle them in clean place.

③ Always tighten bolts, plugs, etc. to their specified torques.

④ Do not fail to coat sliding surfaces with clean hydraulic oil before assembly.

⑤ Replace seals such as O-ring with new ones as a rule.

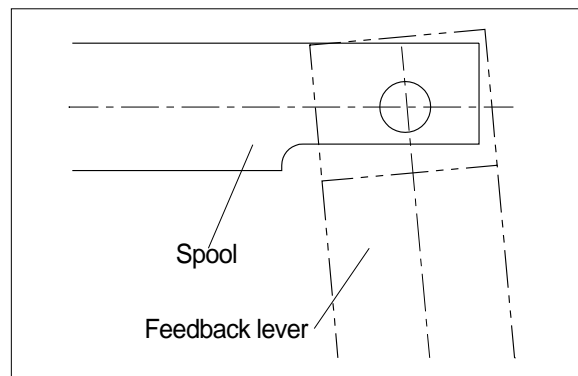
(2) Put compensating rod(623) into compensating hole of casing(601).

(3) Put pin force-fitted in lever(1, 612) into groove of compensating rod and fit lever (1) to pin force-fitted in casing.

(4) Fit spool(652) and sleeve(651) into hole in spool of casing.

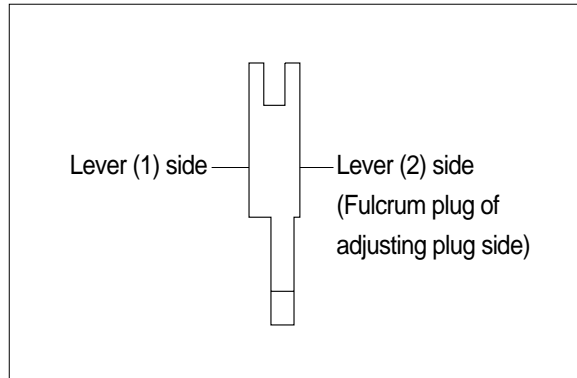
※ Confirm that spool and sleeve slide smoothly in casing without binding.

※ Pay attention to orientation of spool.



(5) Fit feedback lever(611), matching its pin hole with pin hole in spool.
Then insert pin(874).

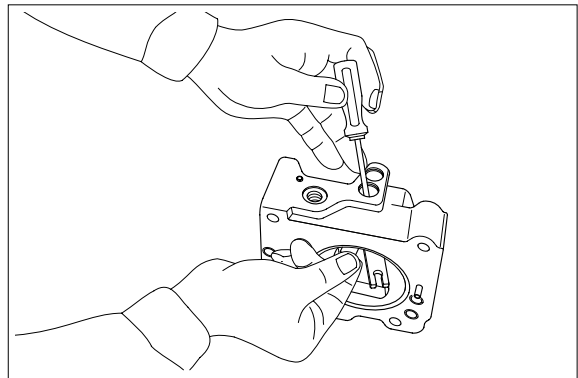
- ※ Insert pin in feedback lever a little to ease operation.
- ※ Take care not to mistake direction of feedback lever.



(6) Put pilot piston(643) into pilot hole of casing.

- ※ Confirm that pilot piston slides smoothly without binding.

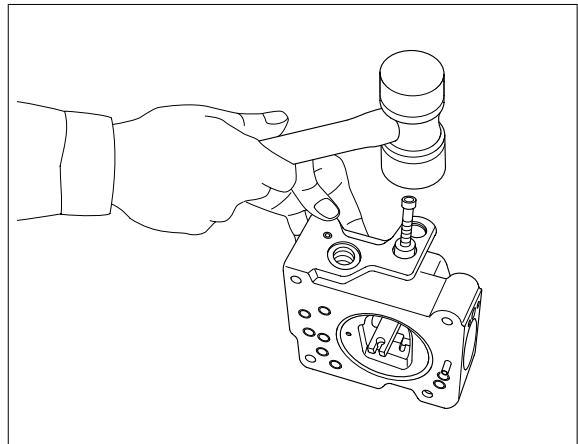
(7) Put pin force-fitted in lever(2, 613) into groove of pilot piston.
Then fix lever(2).



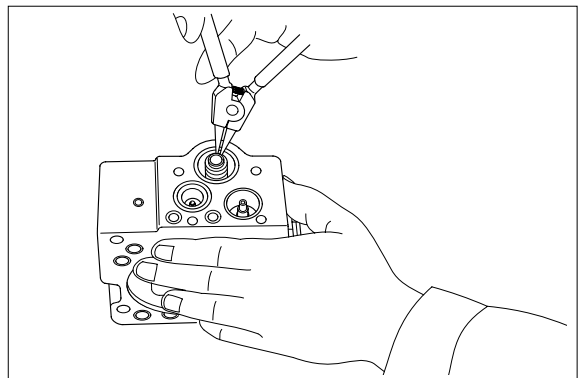
(8) Fit fulcrum plug(614) so that pin force-fitted in fulcrum plug(614) can be put into pin hole of lever(2).
Then fix locking ring(858).

(9) Insert adjusting plug(615) and fit locking ring.

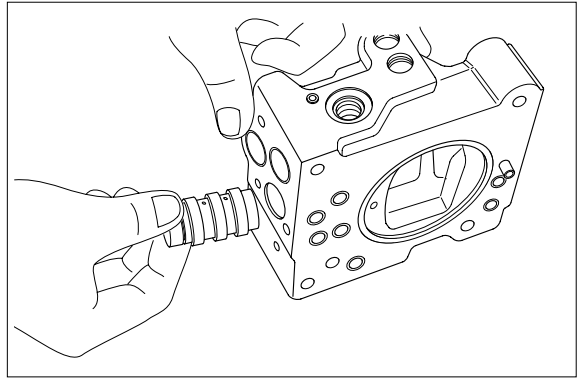
- ※ Take care not to mistake inserting holes for fulcrum plug and adjusting plug.
At this point in time move feedback lever to confirm that it has no large play and is free from binding.



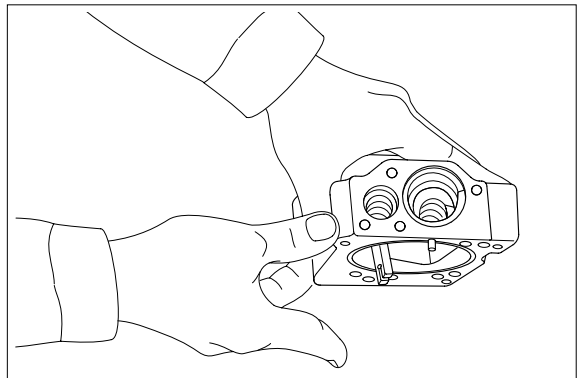
(10) Fit return spring(654) and spring seat (653) into spool hole and attach snap ring (814).



- (11) Fit set spring(655) to spool hole and put compensating piston(621) and piston case(622) into compensating hole.
Fit pilot cover(641) and tighten it with hexagonal socket head screws(436, 438).

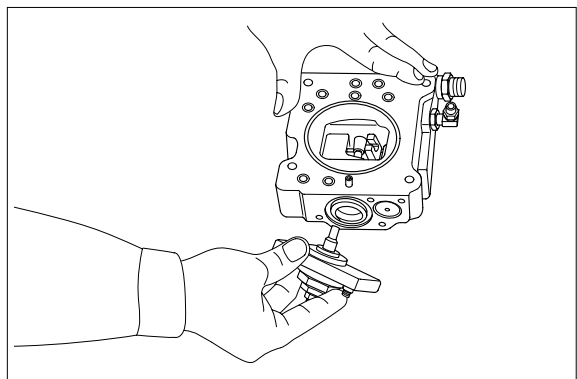


- (12) Put spring seat(644), pilot spring(646) and adjusting ring(Q, 645) into pilot hole.
Then fix spring seat(624), inner spring (626) and outer spring(625) into compensating hole.
※ When fitting spring seat, take care not to mistake direction of spring seat.



- (13) Install cover(C, 629) fitted with adjusting screws(628, 925), adjusting ring(C, 627), lock nut(630), hexagon nut(801) and adjusting screw(924).
Then tighten them with hexagonal socket head screws(438).

This completes assembly.



GROUP 4 MAIN CONTROL VALVE

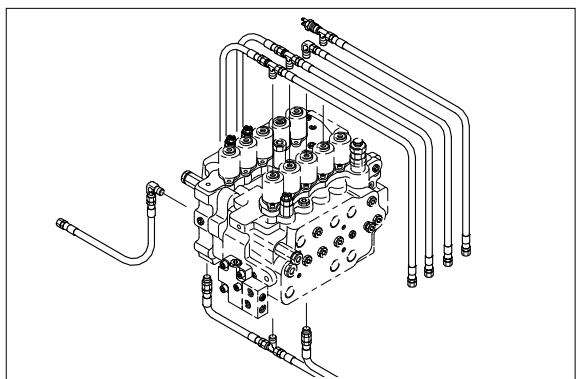
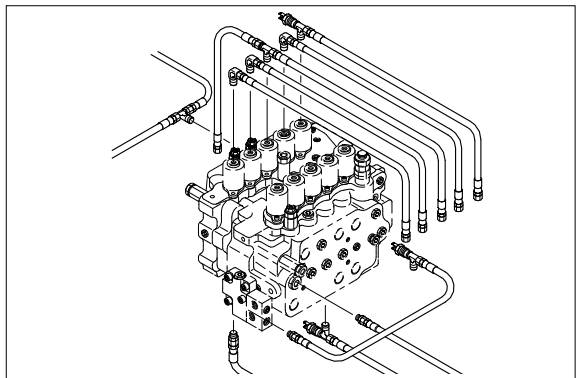
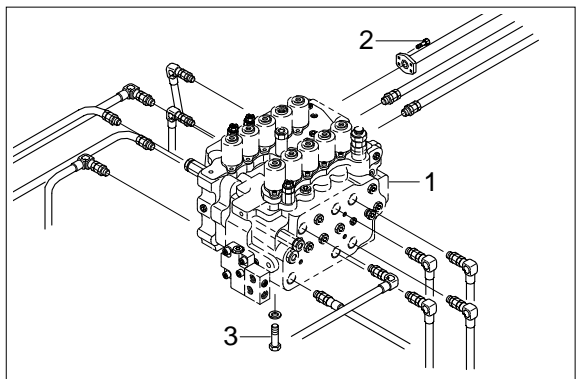
1. REMOVAL AND INSTALL

1) REMOVAL

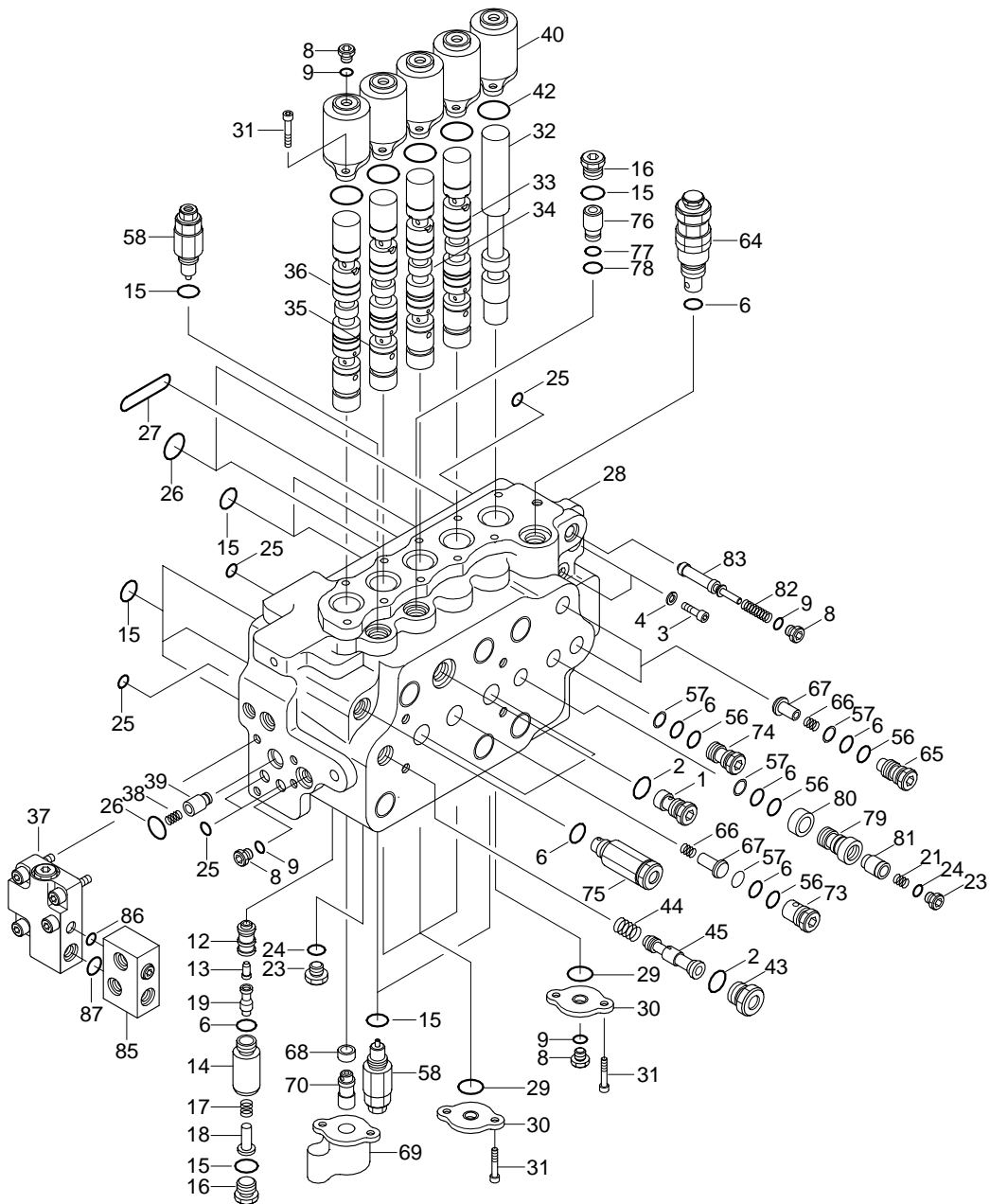
- (1) Lower the work equipment to the ground and stop the engine.
- (2) Operate the control levers and pedals several times to release the remaining pressure in the hydraulic piping.
- (3) Loosen the breather slowly to release the pressure inside the hydraulic tank.
▲ Escaping fluid under pressure can penetrate the skin causing serious injury.
※ When pipes and hoses are disconnected, the oil inside the piping will flow out, so catch it in oil pan.
- (4) Remove bolts(2) and disconnect pipe.
- (5) Disconnect pilot line hoses.
- (6) Disconnect pilot piping.
- (7) Sling the control valve assembly(1) and remove the control valve mounting bolt(3).
· Weight : 135kg(298lb)
- (8) Remove the control valve assembly(1).
※ When removing the control valve 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 below items.
 - ① Cylinder(Boom, arm, bucket).
 - ② Swing motor.
 - ③ Travel motor.※ See each item removal and install.
- (3) Confirm the hydraulic oil level and check the hydraulic oil leak or not.

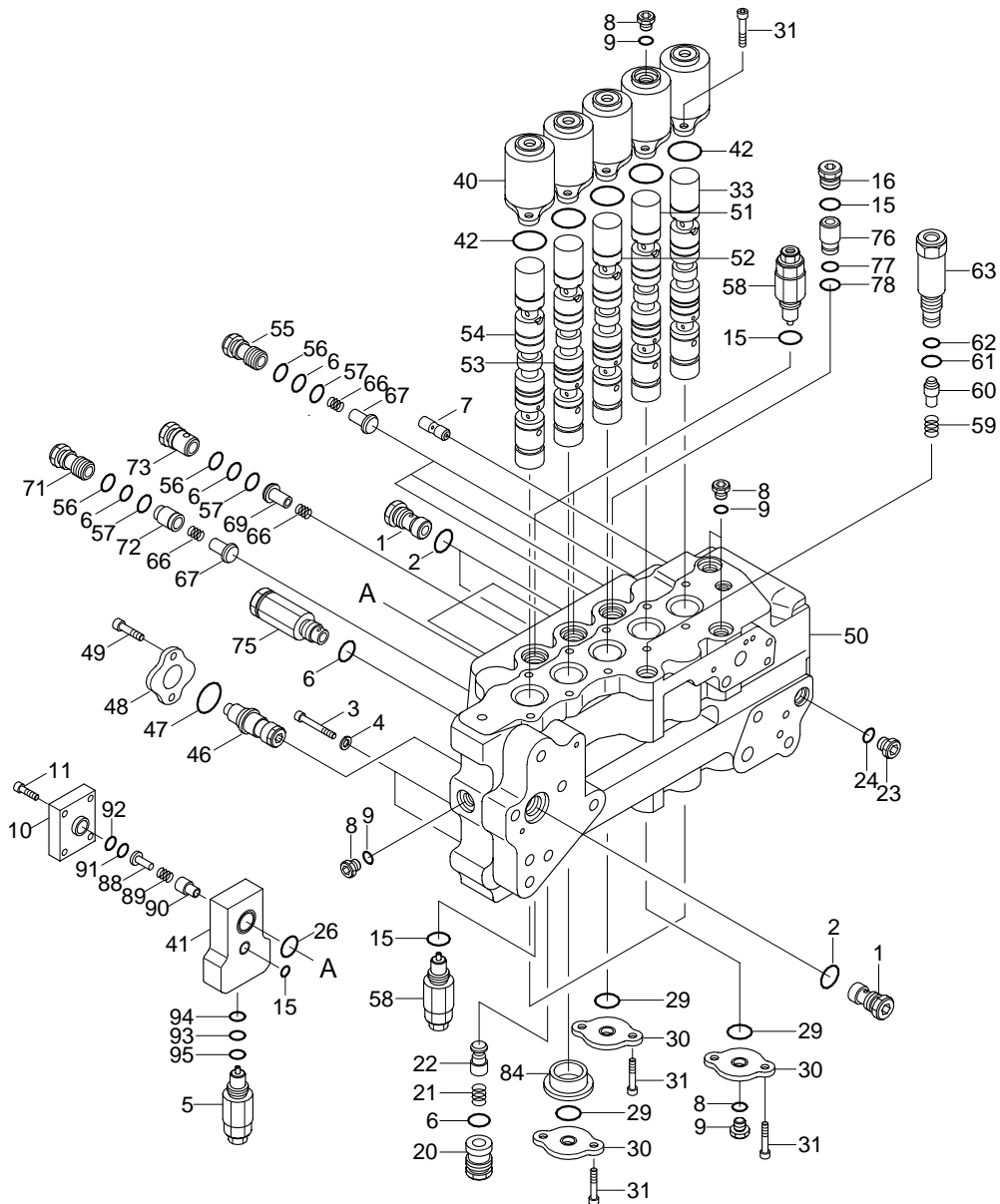


2. STRUCTURE(1/2)



- | | | | | | |
|----|---------------|----|--------------|----|----------------------|
| 1 | Cap | 14 | Cap | 27 | O-ring |
| 2 | O-ring | 15 | O-ring | 28 | Housing |
| 3 | Socket bolt | 16 | Cap | 29 | O-ring |
| 4 | Spring washer | 17 | Spring | 30 | Retainer |
| 5 | Overload assy | 18 | Spring guide | 31 | Socket bolt |
| 6 | O-ring | 19 | Spring guide | 32 | Plunger assy(TS) |
| 7 | Orifice | 20 | Cap | 33 | Plunger assy(TL, TR) |
| 8 | Cap | 21 | Spring | 34 | Plunger assy(SW) |
| 9 | O-ring | 22 | Check | 35 | Plunger assy(BM2) |
| 10 | Cover | 23 | Cap | 36 | Plunger assy(AM1) |
| 11 | Socket bolt | 24 | O-ring | 37 | Cover assy |
| 12 | Sleeve | 25 | O-ring | | |
| 13 | Check | 26 | O-ring | | |

STRUCTURE(2/2)



38	Spring	53	Plunger assy(BM1)	68	Spacer	83	Spool
39	Poppet	54	Plunger assy(AM2)	69	Cover	84	Stopper
40	Cover	55	Cap	70	Piston	85	Selector assy
41	Manifold	56	Back up ring	71	Cap	86	O-ring
42	O-ring	57	Nylon chip	72	Check	87	O-ring
43	Cap	58	Overload assy	73	Cap	88	Spring guide
44	Spring	59	Spring	74	Cap	89	Spring
45	Spool	60	Check	75	Foot relief assy	90	Poppet
46	Plug	61	O-ring	76	Plug	91	O-ring
47	O-ring	62	Back up ring	77	Back up ring	92	Back up ring
48	Retainer	63	Cap	78	O-ring	93	O-ring
49	Socket bolt	64	Main relief assy	79	Cap	94	Back up ring
50	Housing	65	Cap	80	Spacer	95	O-ring
51	Plunger assy(OPT)	66	Spring	81	Check		
52	Plunger assy(BKT)	67	Check	82	Spring		

3. DISASSEMBLY AND ASSEMBLY

1) PRECAUTION

(1) Disassembly

- ① Handle the components carefully not to drop them or bump them with each other as they are made with precision.
- ② Do not force the work by hitting or twisting as burred or damaged component may not be assembled or result in oil leakage or low performance.
- ③ When disassembled, tag the components for identification so that they can be reassembled correctly.
- ④ Once disassembled, O-rings and backup rings are usually not to be used again. (Remove them using a wire with its end made like a shoehorn. Be careful not to damage the slot.)
- ⑤ If the components are left disassembled or half-disassembled, they may get rust from moisture or dust. If the work has to be interrupted, take measures to prevent rust and dust.

(2) Assembly

- ① Take the same precautions as for disassembly.
- ② When assembling the components, remove any metal chips or foreign objects and check them for any burrs or dents. Remove burrs and dents with oil-stone, if any.
- ③ O-rings and backup rings are to be replaced with new ones, as a rule.
- ④ When installing O-rings and backup rings, be careful not to damage them. (Apply a little amount of grease for smoothness.)
- ⑤ Tighten the bolts and caps with specified torque. (See **Disassembly/Assembly**.)

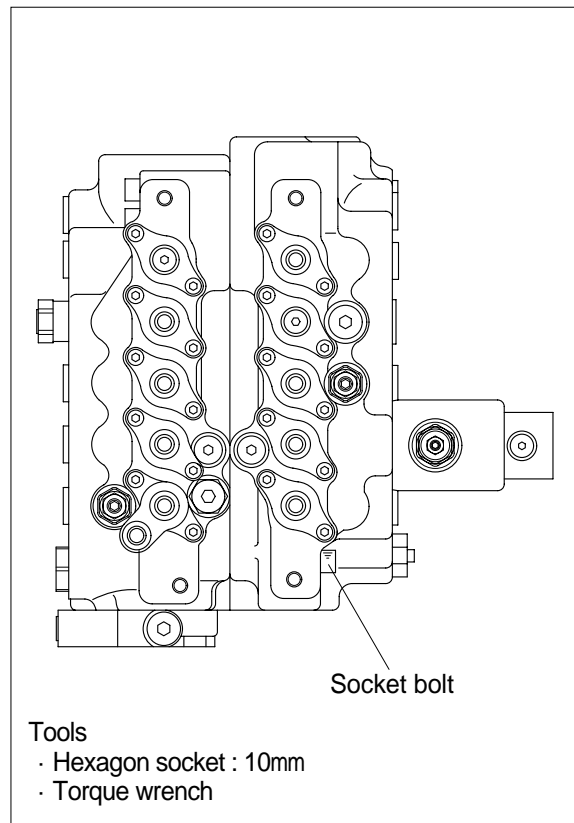
2) MOUNTING AND DISMOUNTING VALVES

(1) Disassembly

- ① Remove socket bolts and separate 4 spool valve and 5 spool valve.

(2) Assembly

- ※ Valves should be mounted after making sure that all O-rings and caps are placed on the assembling faces of 4 plunger valve.
- ① Carry out assembly in the reverse manner of disassembly.
 - ② Tighten the bolts to the specified torque.
 - Tightening torque : 10kgf · m
(72.3lbf · ft)

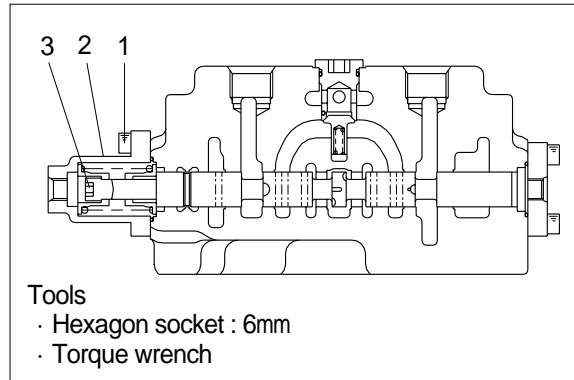


3) PLUNGER

- (1) Loosen socket bolt(1) and remove cover (2).

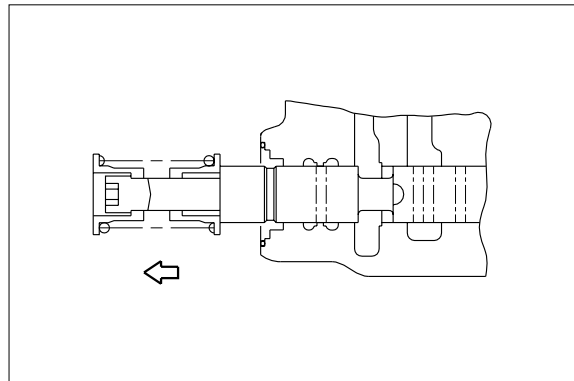
· Tightening torque : 3kgf · m(21.7lb · ft)

- ※ Install cover (2) after making sure that O-ring is placed on the edge of the valve hole.



- (2) Pull the plunger out while holding the spring.

- ※ Do not pull it out violently, but draw it out gently while making sure of its contact with housing hole.

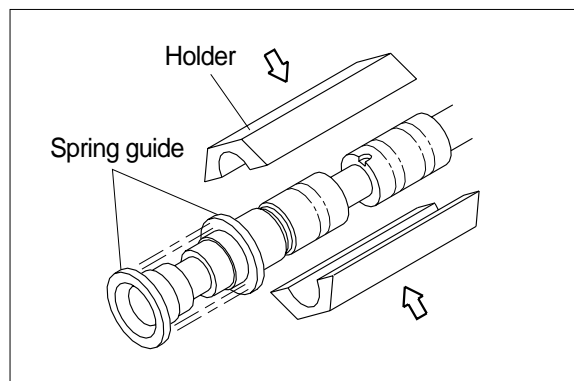


- (3) Place the plunger between holders and loosen plunger cap(3) by using a vise.

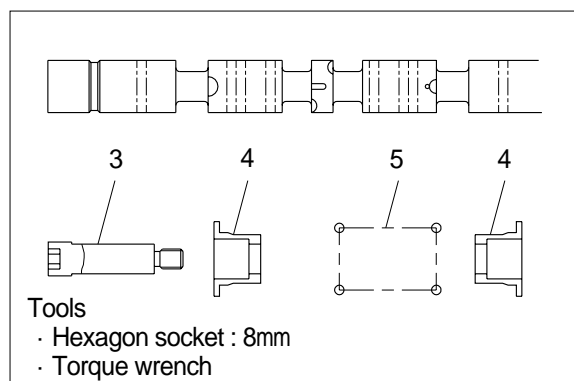
· Plunger cap

Hexagon socket : 8mm

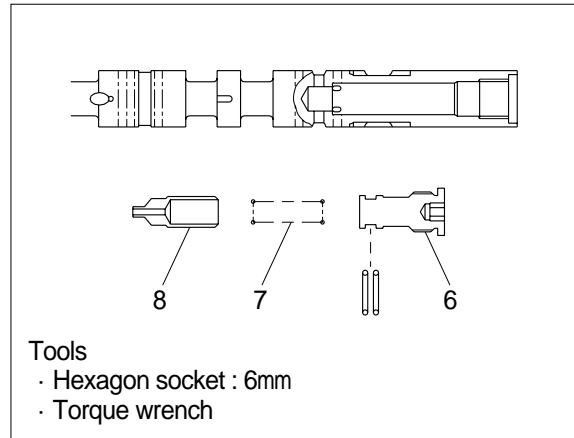
Tightening torque : 6kgf · m(43.4lb · ft)



- (4) Remove plunger cap(3), spring guide(4) and spring(5) in this order.



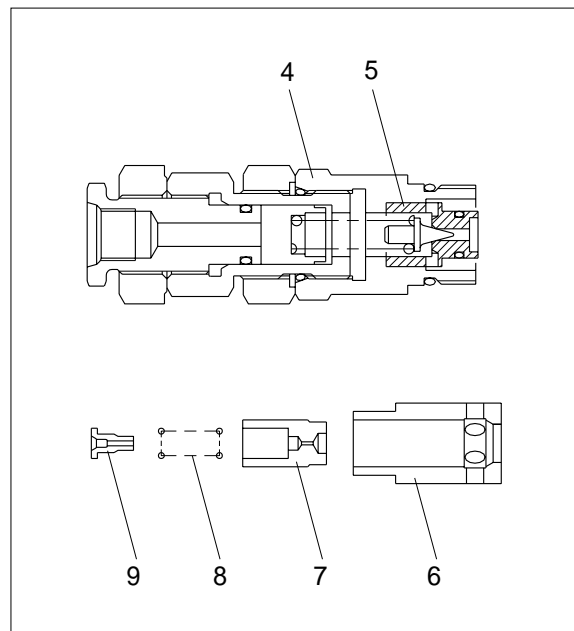
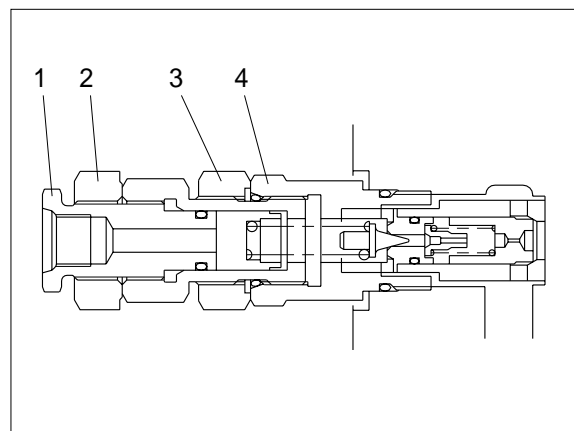
- (5) Arm plunger only (Remove check).
 Remove cap(6) and disassemble spring (7) and check(8).
 · Tightening torque : 3kgf · m(21.7lf · ft)



4) MAIN RELIEF ASSEMBLY

Relief assy is assembled into a single block as a cartridge. Do not disassemble the relief assembly as a rule.

- (1) Loosen the hexagon nut(2) with a holding adjust screw(1).
- (2) Loosen the hexagon nut(3) with a holding cap(4)
- (3) Loosen the cap(4) and remove the cartridge.
- (4) Pull out the sleeve(6) and take off the main poppet(7), spring(8) and orifice(9).
 ※ Can't remove the pilot seat(5) from the cap(4), because it was locked at the cap.
- (5) Loosen each screw and remove.



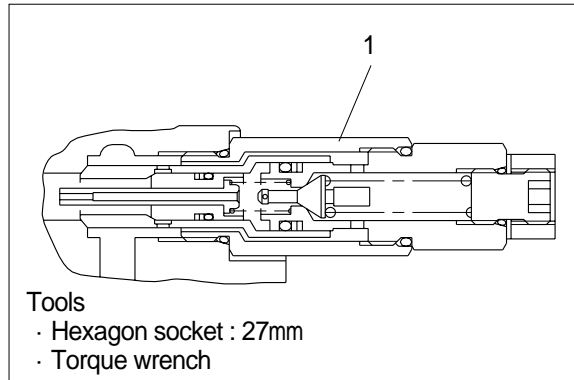
Item No.	Name	Socket
1	Adjust screw	22mm
2	Hexagon nut	30mm
3	Hexagon nut	30mm
4	Cap	30mm

5) OVERLOAD RELIEF VALVE ASSEMBLY

Relief assembly is assembled into a single block as a cartridge. Do not disassemble the relief assembly as a rule.

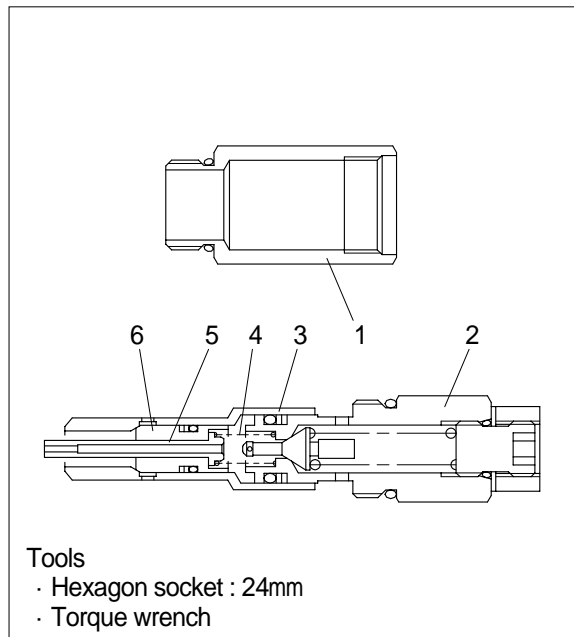
- (1) Loosen the relief sleeve (1) and remove the cartridge.

· Tightening torque : 4kgf · m(29lbf · ft)

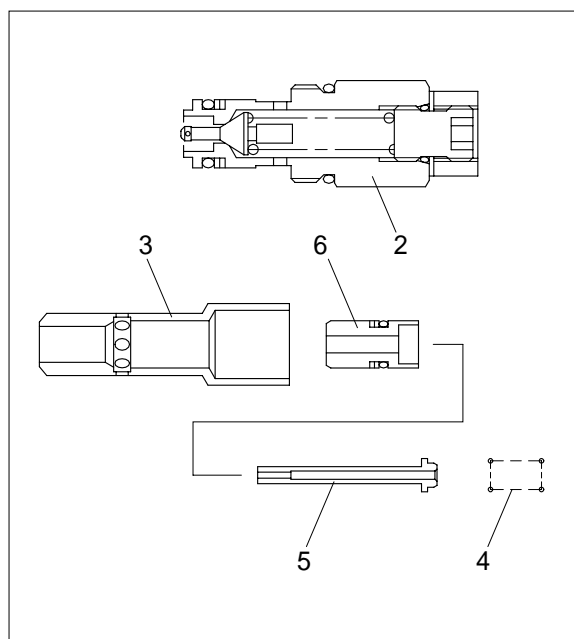


- (2) Loosen the relief seat (2) and remove the subassembly.

· Tightening torque : 6kgf · m(43.4lbf · ft)

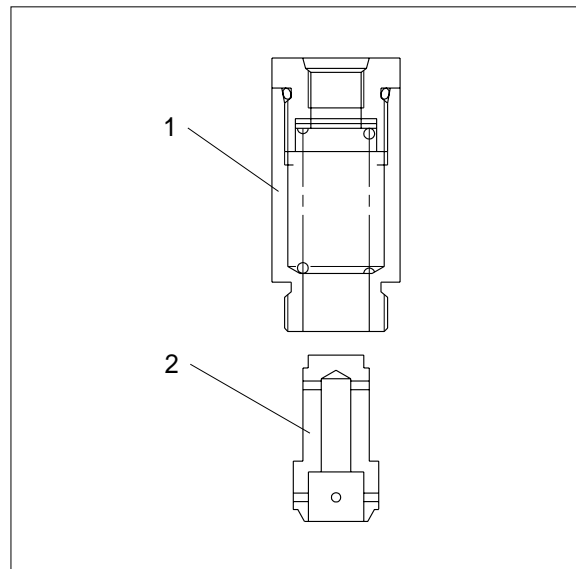
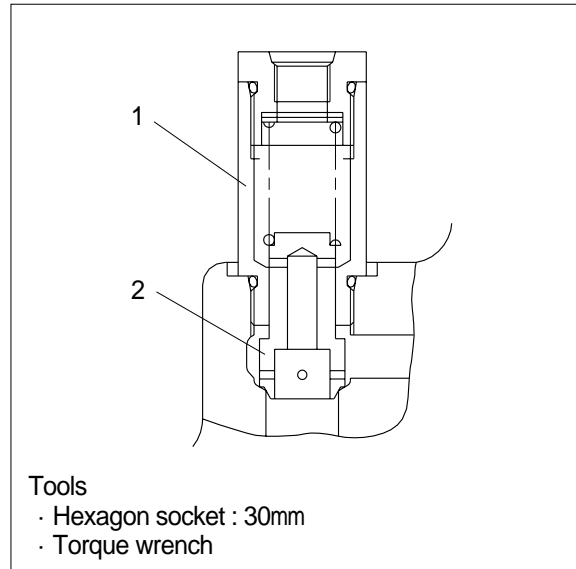


- (3) Pull out the poppet(3) and take off the spring(4), piston(5) and main poppet(6).

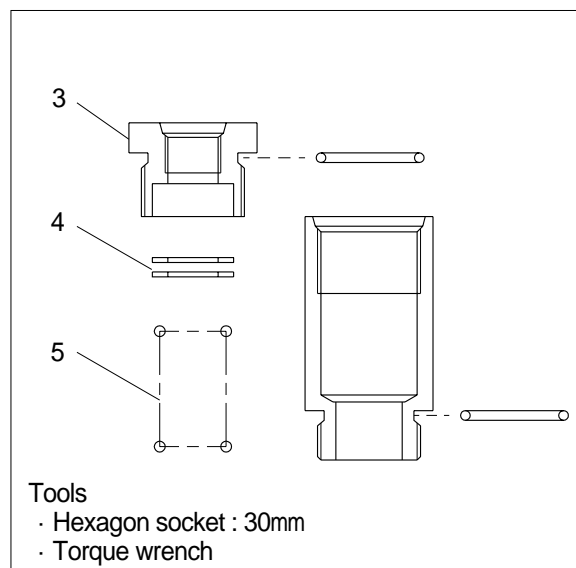


6) FOOT RELIEF ASSEMBLY

- (1) Loosen cap(1) and remove poppet (2).
· Tightening torque : 6kgf · m(43.4lbf · ft)

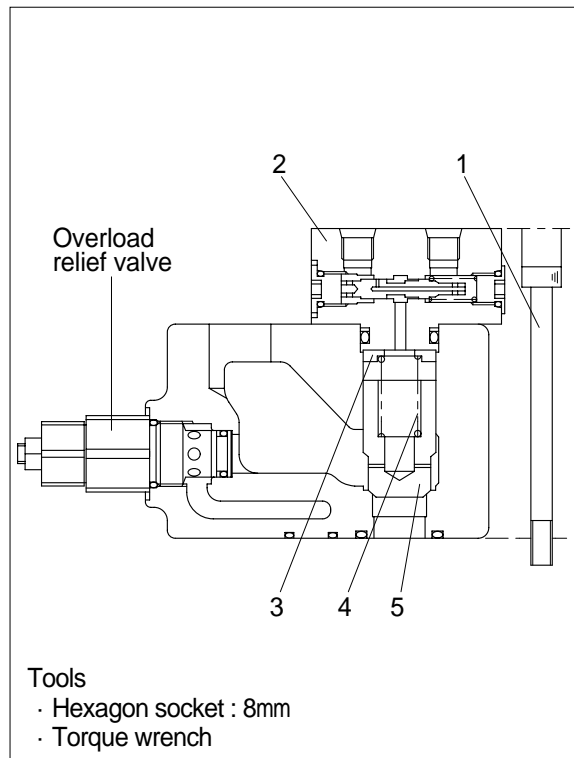


- (2) Remove cap (3) and take off shim (4) and spring (5).
· Tightening torque : 6kgf · m(43.4lbf · ft)
※ Make sure adjust shim quantity.

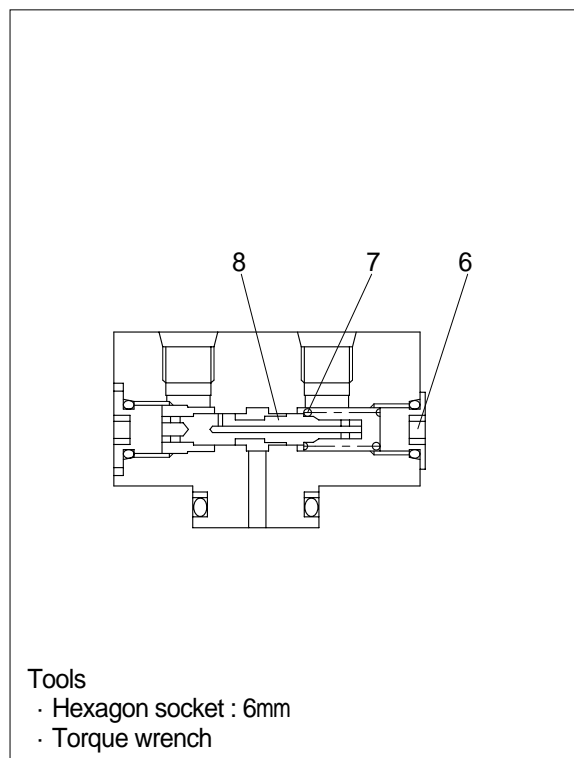


7) BOOM HOLDING VALVE ASSEMBLY

- (1) Loosen the socket bolt(1) and remove the cover assy(2).
 - Tightening torque : 5kgf · m(36.2lb · ft)
- ※ Install cover assy(2) after making sure that O-ring is placed on the edge of the valve hole.
- (2) Remove the spring guide(3), spring(4) and poppet(5).



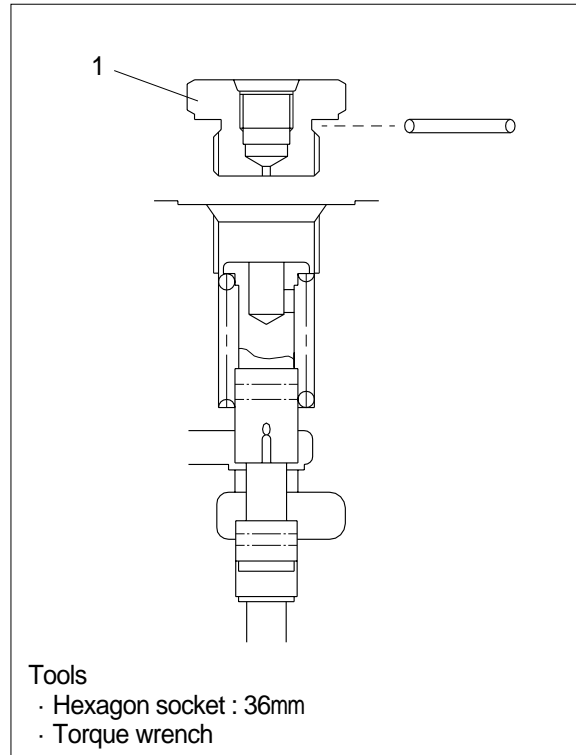
- (3) Remove the cap(6), spring(7) and spool(8).
- Tightening torque : 3kgf · m(21.7lb · ft)



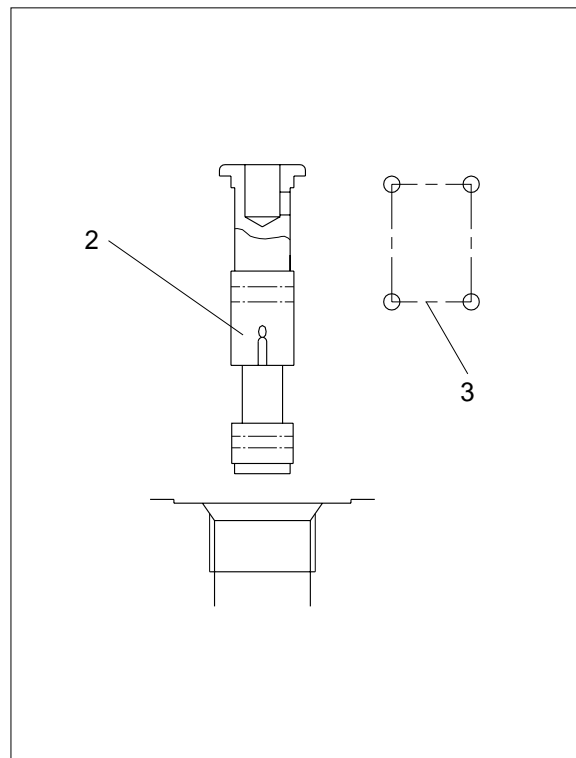
8) CENTER BYPASS VALVE ASSEMBLY

(1) Remove cap (1).

· Tightening torque : 8kgf · m(57.9lbf · ft)



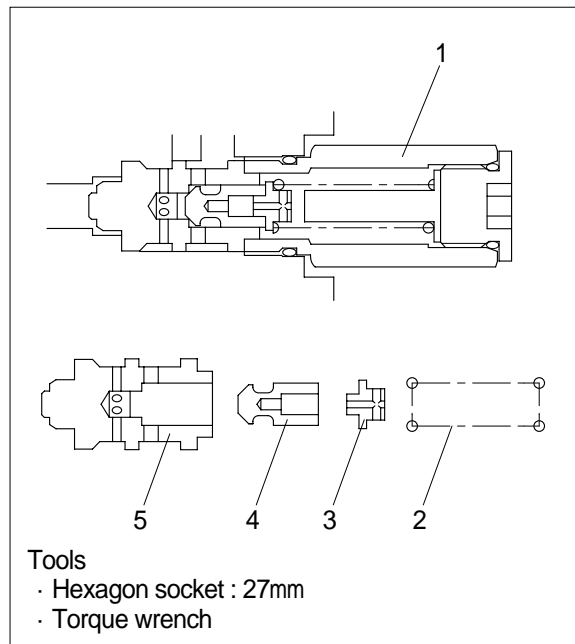
(2) Remove spool (2) and spring (3).



9) ARM REGENERATION VALVE

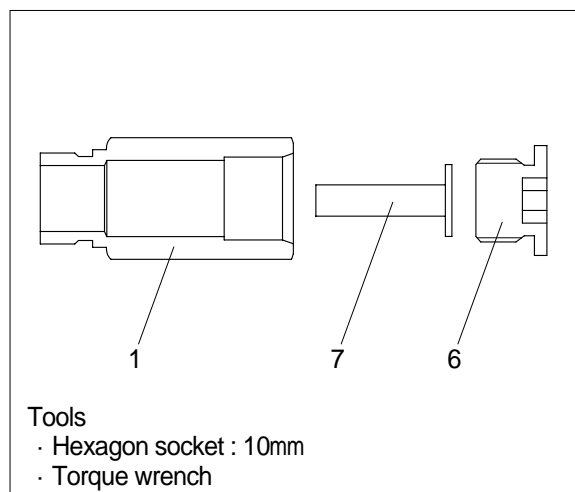
(1) Remove cap(1) and take off spring(2), spring guide(3), check(4) and sleeve(5).

· Tightening torque : 10kgf · m(72.3lbf · ft)



(2) Remove cap(6) and spring guide(7).

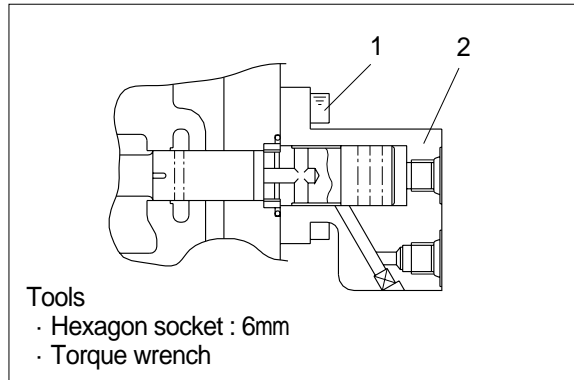
· Tightening torque : 6kgf · m(43.4lbf · ft)



10) ARM STROKE LIMIT ASSEMBLY

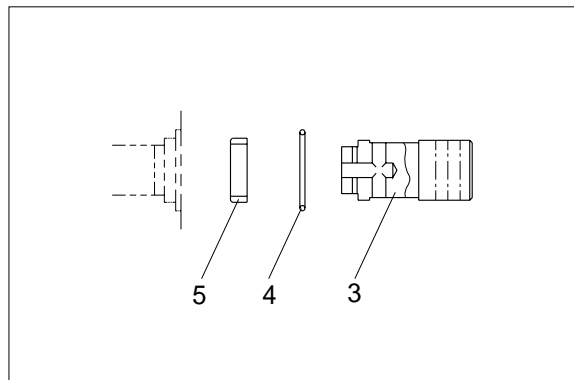
(1) Loosen the socket bolt(1) and remove cover(2).

- Tightening torque : 3kgf · m(21.7lbf · ft)



(2) Remove piston(3) and take off O-ring(4), spacer(5) from the valve hole.

- ※ Make sure inserting direction of the spacer.



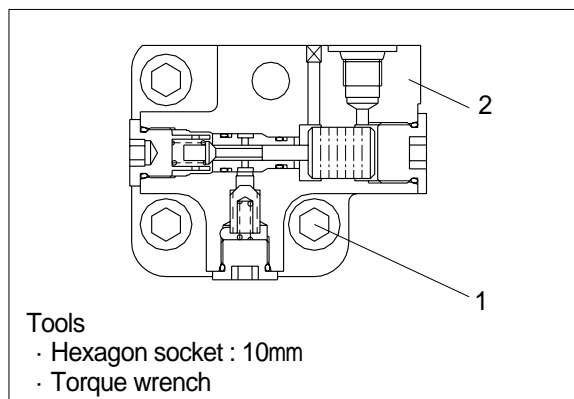
11) ARM LOAD HOLDING VALVE

(1) Basic unit

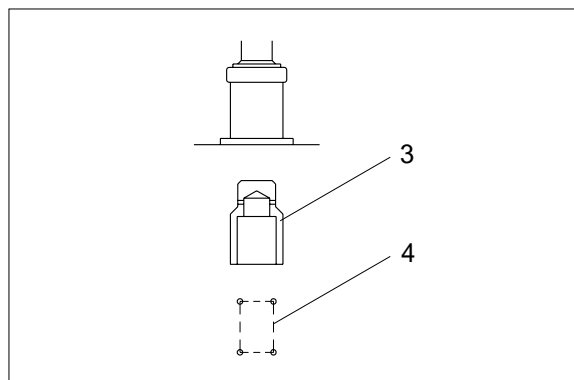
① Loosen socket bolt (1) and remove cover assembly (2).

- Tightening torque : 10kgf · m(72.3lbf · ft)

- ※ Install cover assembly (2) after making sure that O-ring is placed on the edge of the valve hole.

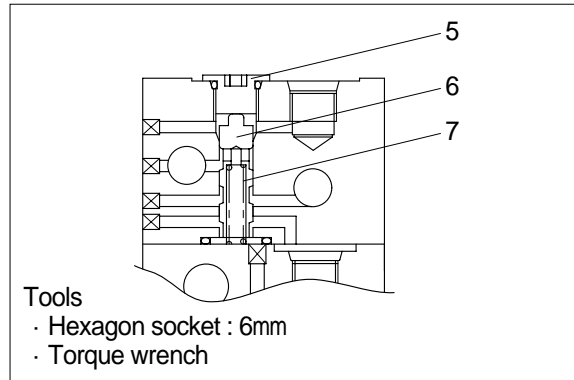


② Take off spring(3) and check valve(4).



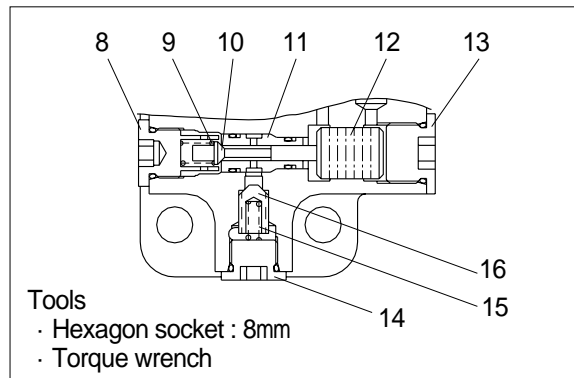
(2) Selector unit

- ① Remove cap (5).
Take off piston(6) and spring(7).
· Tightening torque : 3kgf · m(21.7lbf · ft)

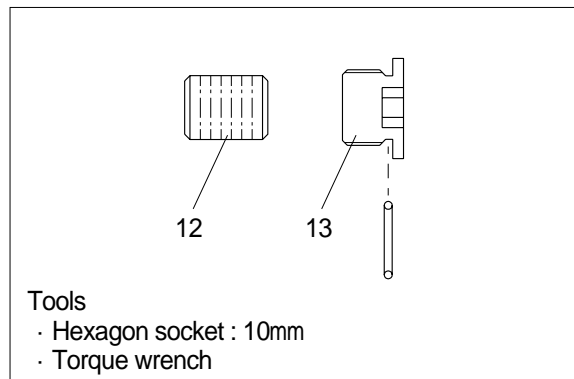


(3) Cover assembly

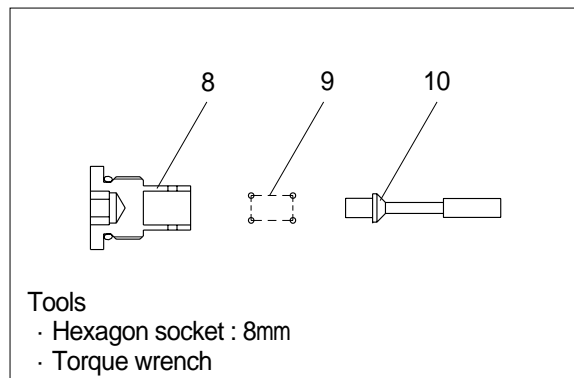
- ① Remove cap(14).
Take off spring(15) and check valve(16).
· Tightening torque : 5kgf · m(36.2lbf · ft)



- ② Remove cap (13) and take off piston (12).
· Tightening torque : 6 kgf · m(43.4lbf · ft)
- ③ Push sleeve (11) out with a rod or the like through the hole of cap (13).
- ※ Be careful not to damage the guideway (∅ 5) of the sleeve.



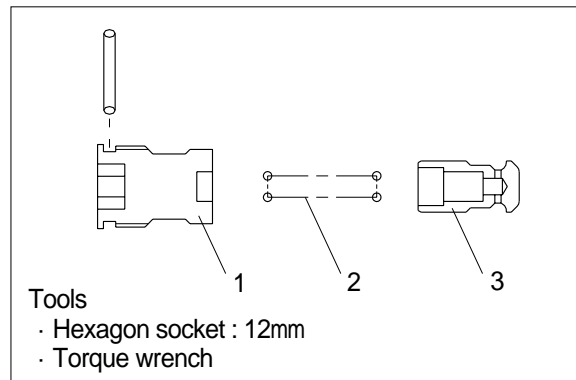
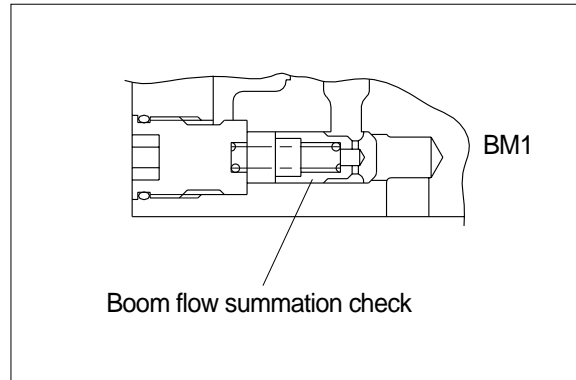
- ④ Remove cap (8).
Take off spring (9) and poppet (10).
· Tightening torque : 5kgf · m(36.2lbf · ft)



12) BOOM FLOW SUMMATION CHECK

(1) Remove the cap(1) and take off spring(2) and check(3).

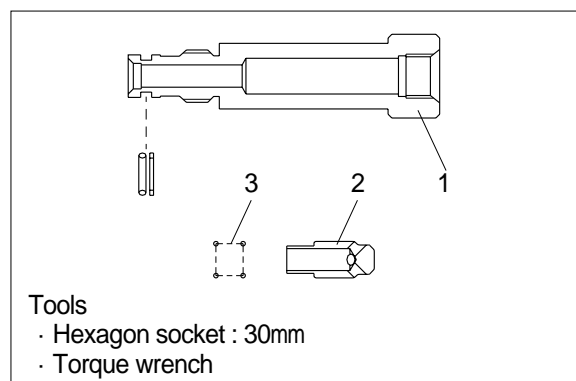
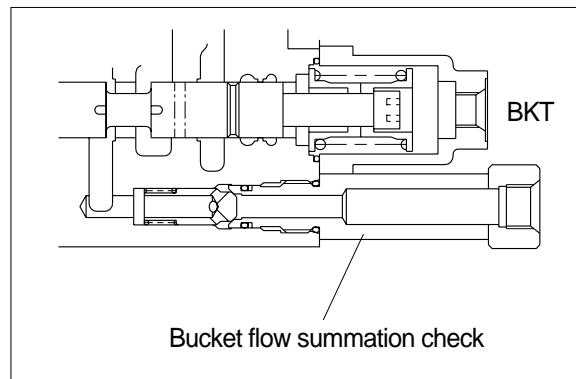
· Tightening torque : 10kgf · m(72.3lbf · ft)



13) BUCKET FLOW SUMMATION CHECK

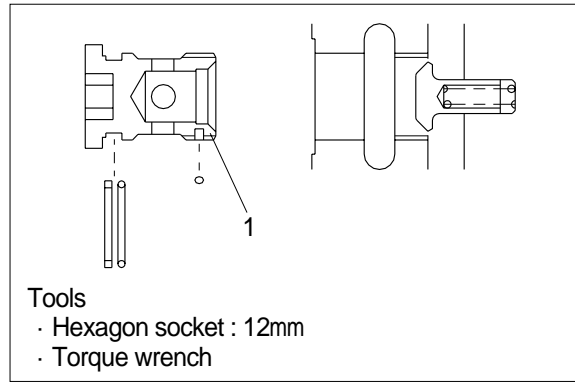
(1) Remove the cap(1) and take off check(2) and spring(3).

· Tightening torque : 6kgf · m(43.4lbf · ft)



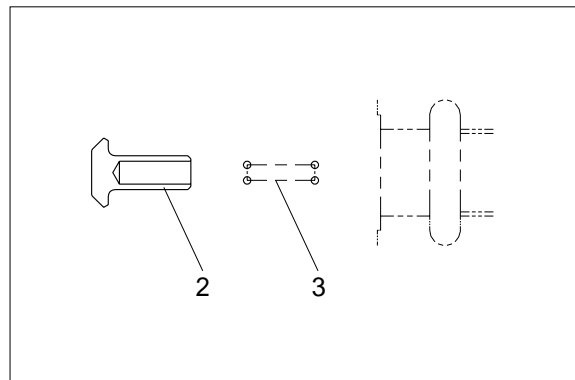
14) CHECK ASSEMBLY(BOOM1, 2, BUCKET, OPT, SWING, ARM-1)

(1) Remove cap(1).



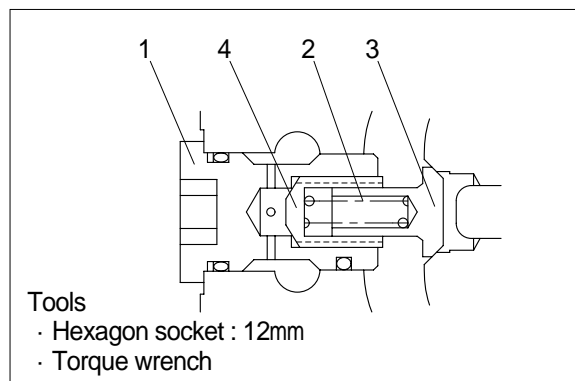
(2) Remove spring(2) and check(3).

· Tightening torque : 10kgf · m(72.3lbf · ft)



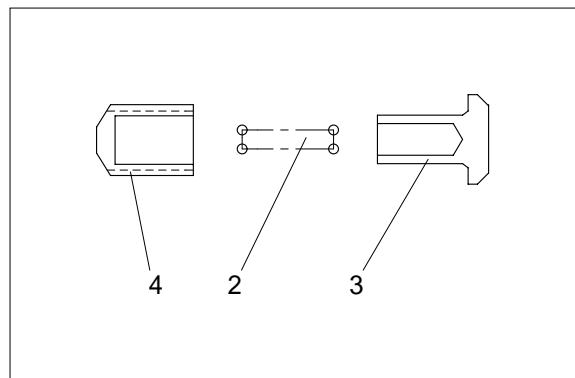
15) CHECK ASSEMBLY(ARM 2)

(1) Remove cap(1).



(2) Remove spring(2) and check(3, 4).

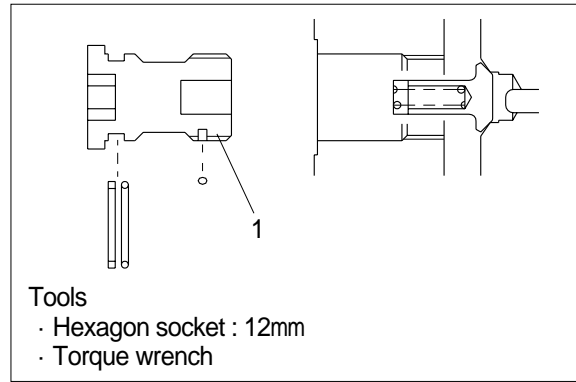
· Tightening torque : 10kgf · m(72.3lbf · ft)



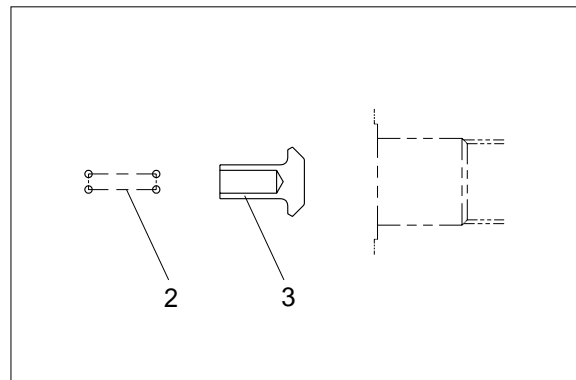
16) CHECK ASSEMBLY(TR)

(1) Remove cap(1).

· Tightening torque : 10kgf · m(72.3lbf · ft)



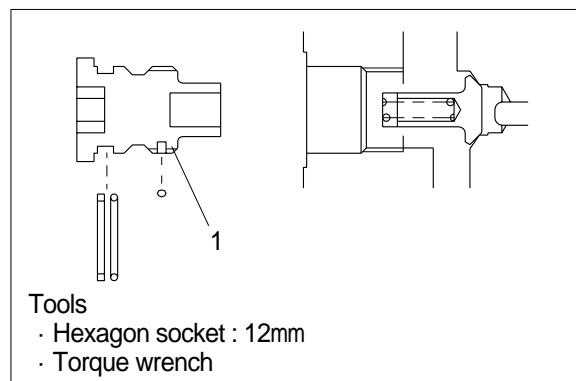
(2) Take off spring(2) and check(3).



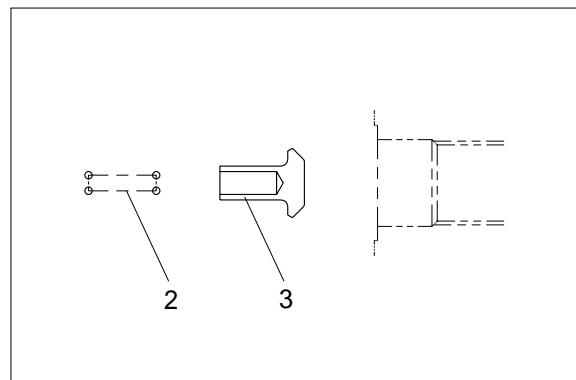
17) CHECK ASSEMBLY(P1)

(1) Remove cap(1).

· Tightening torque : 10kgf · m(72.3lbf · ft)

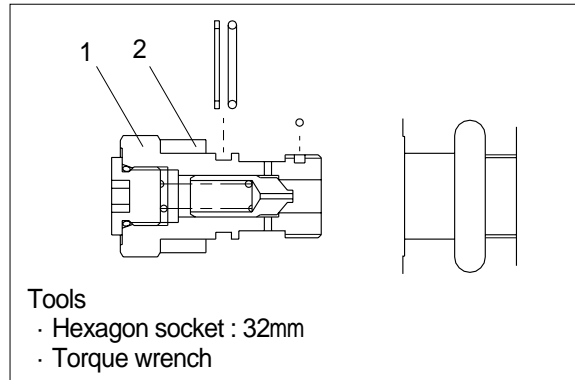


(2) Remove spring(2) and check(3).

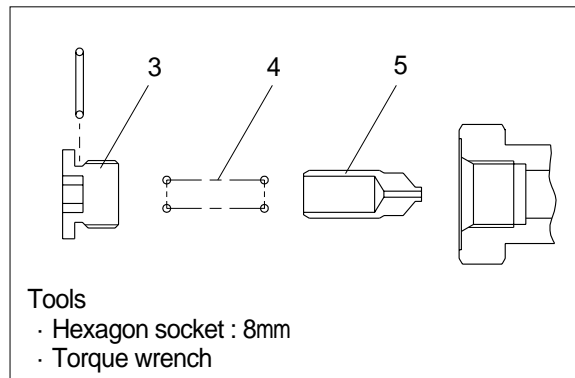


18) CHECK ASSEMBLY(TL)

- (1) Remove cap(1) and spacer(2).
· Tightening torque : 10kgf · m(72.3lbf · ft)

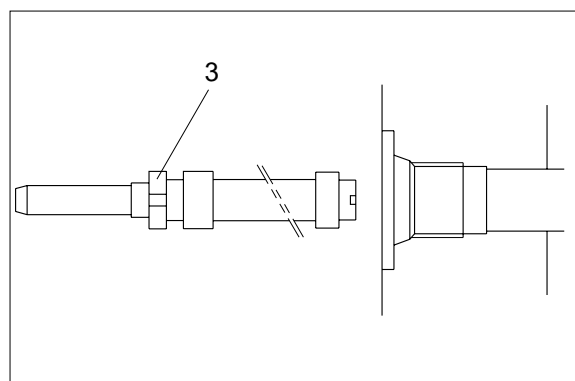
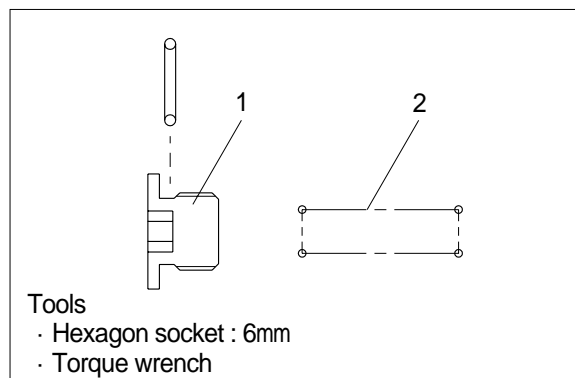


- (2) Remove cap(3) and take off spring(4) and check(5).
· Tightening torque : 4kgf · m(29lbf · ft)



19) SELECTOR VALVE ASSEMBLY

- (1) Remove cap(1) and take off spring(2) and spool(3).
· Tightening torque : 3kgf · m(21.7lbf · ft)

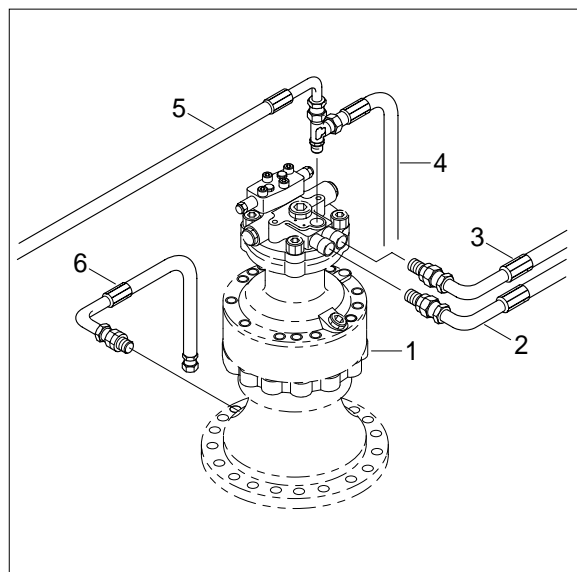


GROUP 5 SWING DEVICE

1. REMOVAL AND INSTALL OF MOTOR

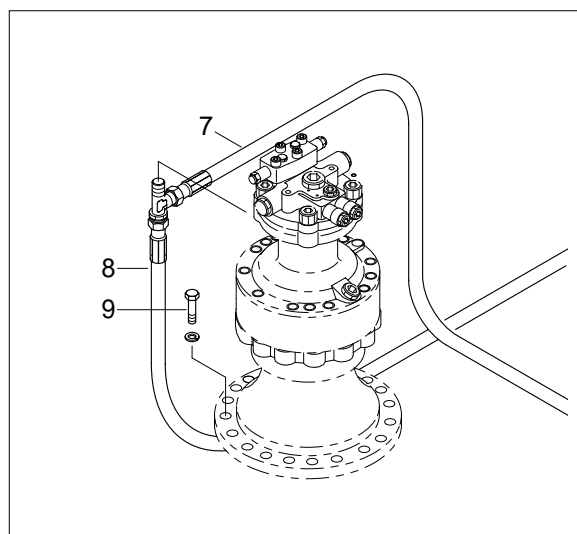
1) REMOVAL

- (1) Lower the work equipment to the ground and stop the engine.
- (2) 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.
- (3) Disconnect pipe assy(2, 3)
- (4) Disconnect pilot line hoses(4, 5, 6, 7, 8)
- (5) Sling the swing motor assembly(1) and remove the swing motor mounting bolts(9)
 - Motor device weight : 218kg(481lb)
 - Tightening torque : 57.9kgf · m
(418.8lbf · ft)
- (6) Remove the swing motor assembly.
 - ※ When removing the swing motor assembly, check that all the piping have been disconnected.



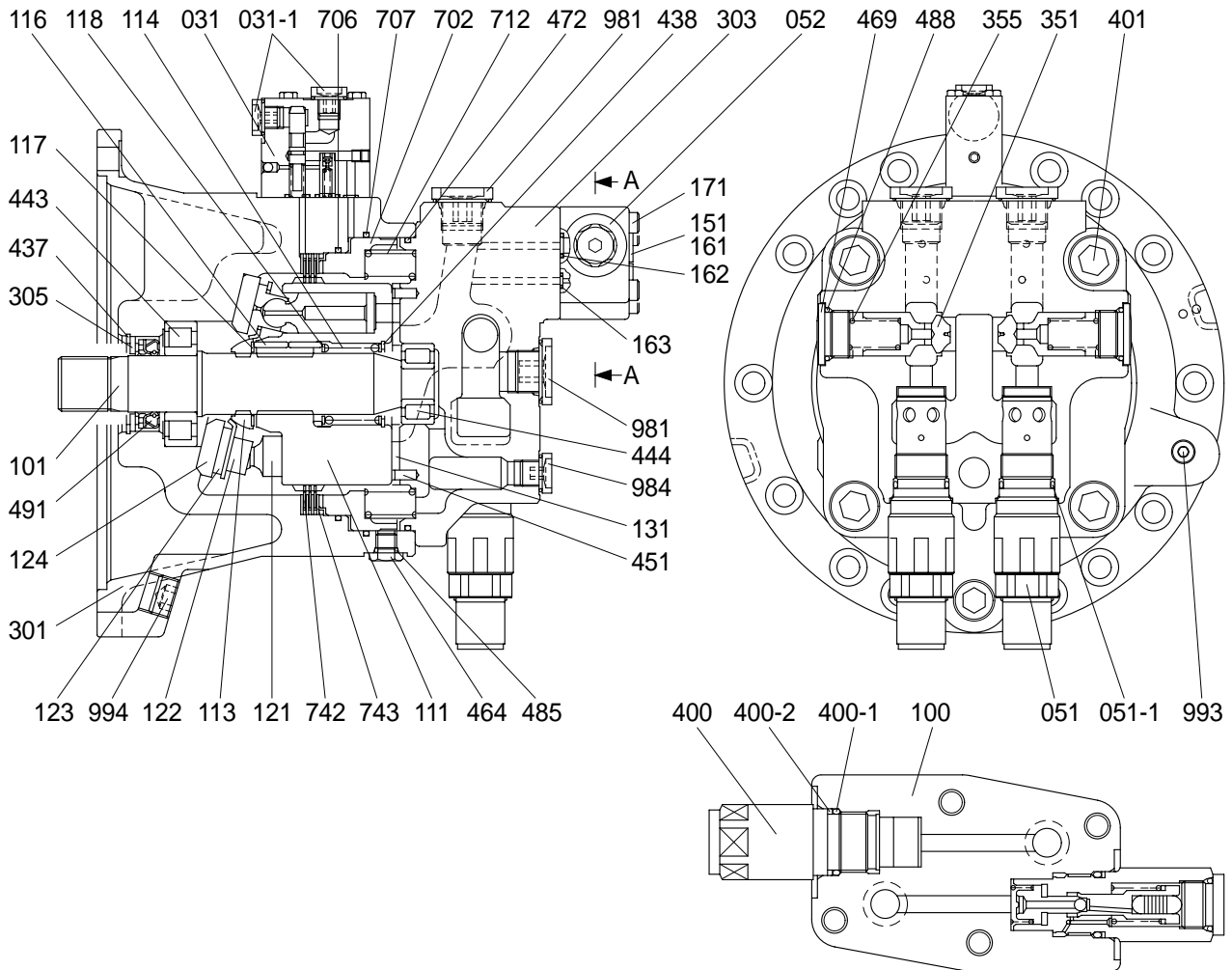
2) INSTALL

- (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 over flows 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) Confirmed the hydraulic oil level and check the hydraulic oil leak or not.



2. SWING MOTOR

1) STRUCTURE

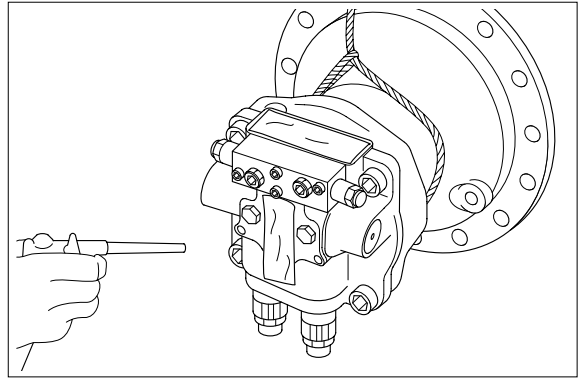


SECTION A-A

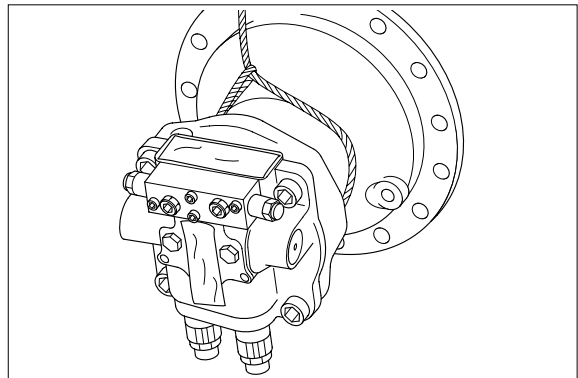
031	Time delay valve	161	O-ring	464	Plug
031-1	Plug	162	O-ring	469	Plug
051	Relief valve assembly	163	O-ring	472	O-ring
051-1	O-ring	171	Hexagon socket bolt	485	O-ring
100	Casing	301	Casing	488	O-ring
101	Drive shaft	303	Valve casing	491	Seal
111	Cylinder	305	Seal cover	702	Brake piston
113	Retainer ring	351	Plunger	706	O-ring
114	Spring	355	Spring	707	O-ring
116	Push rod	400	Reactionless valve	712	Brake spring
117	Spacer	400-1	O-ring	742	Friction plate
118	Spacer	400-2	Back up ring	743	Separate plate
121	Piston	401	Hexagon socket bolt	981	Plug
122	Shoe	437	Snap ring	984	Plug
123	Plate	438	Snap ring	993	Plug
124	Shoe plate	443	Roller bearing	994	Plug
131	Valve plate	444	Roller bearing		
151	Plug	451	Pin		

2) DISASSEMBLY

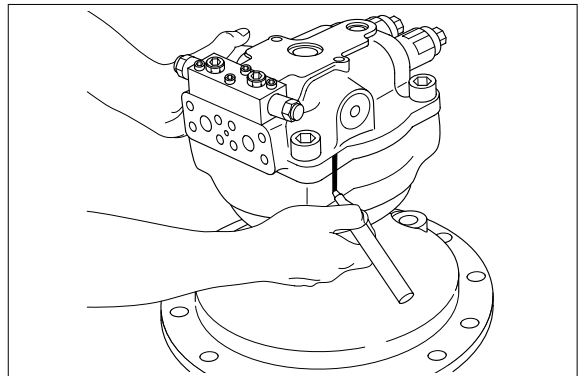
- (1) Lift the motor out. Clean the motor in kerosene and dry with compressed air.
※ To avoid dust inside the motor, mask all the ports of the motor with tapes.



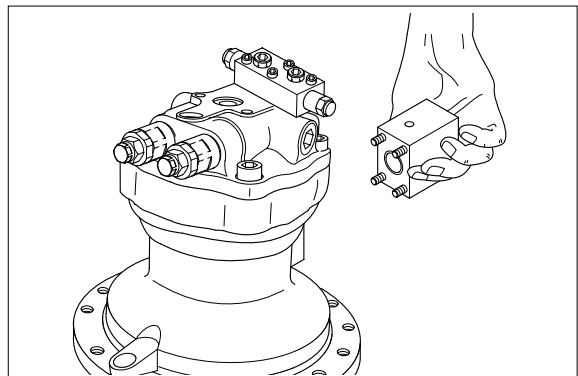
- (2) Loosen the drain plug to discharge oil in the casing(301).



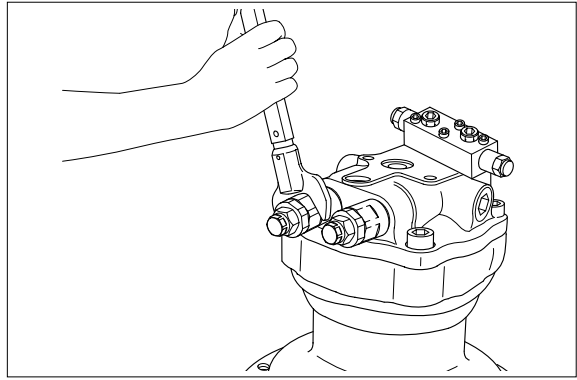
- (3) Fix the output drive shaft(101) on the workbench with the end of output shaft down. Put matching marks on casing(301) and valve casing(303) for easy reassembly.



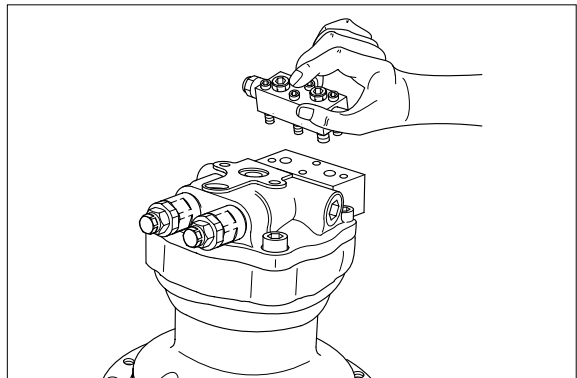
- (4) Remove the time delay valve(031).



- (5) Remove the relief valve(051) from valve casing(303).

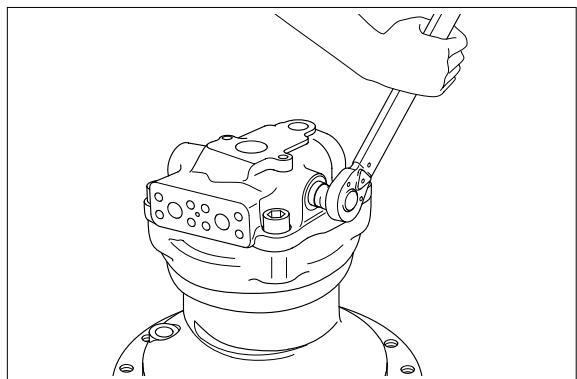


- (6) Remove the anti rotation valve(052) from valve casing(303).

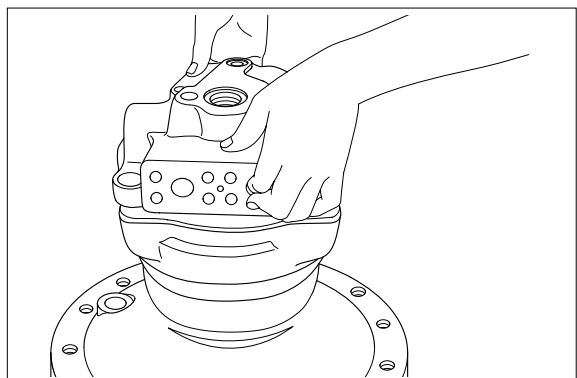


- (7) Remove RO plug(469) from valve casing(303) and take off spring(355) and plunger(351).

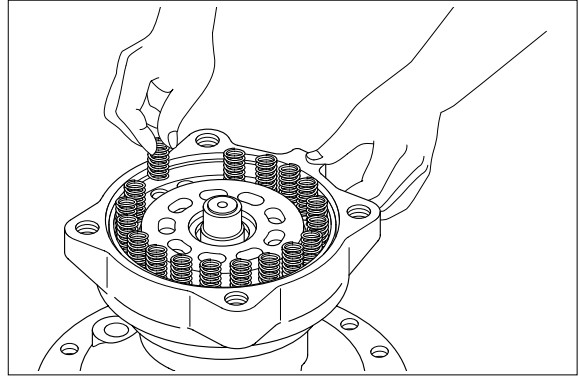
※ Be careful not to damage the plunger seat assembly.



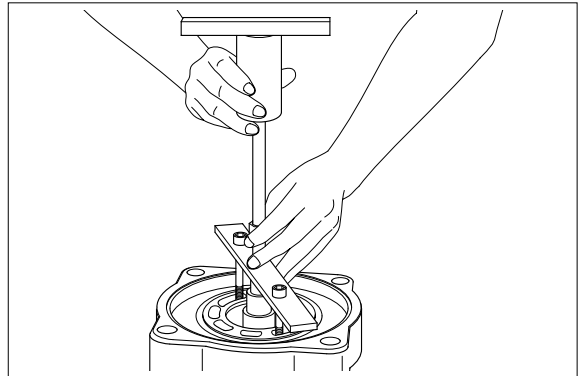
- (8) Loosen the socket bolt(401) and remove valve casing(303) from casing(301). Then, remove the valve plate(131) from valve casing(303) with care.



(9) Remove the brake spring(712) from brake piston(702).

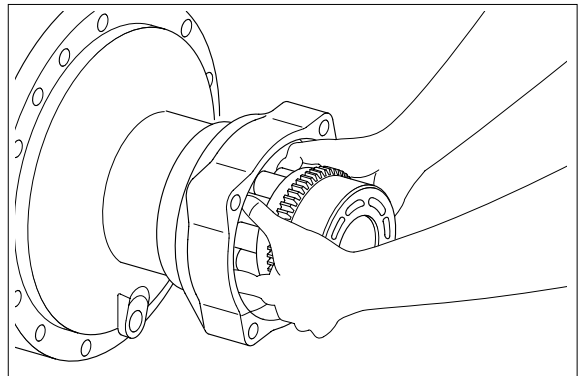


(10) Remove brake piston(702) from casing(301).

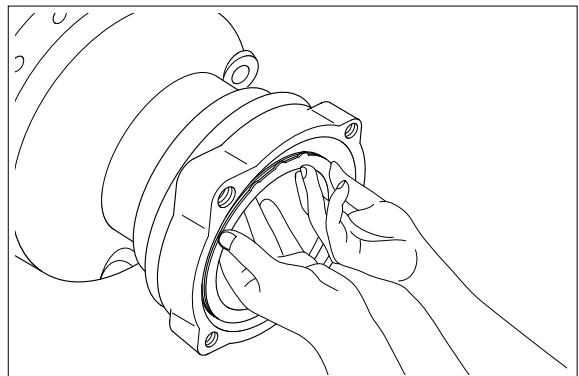


(11) Remove the cylinder(111) from the drive shaft (101) with the motor positioned horizontally. Remove piston(121), pushing plate(123), spherical bush(113) and spacer(117).

※ If shoe plate would not removed easily, try again after procedure(15).

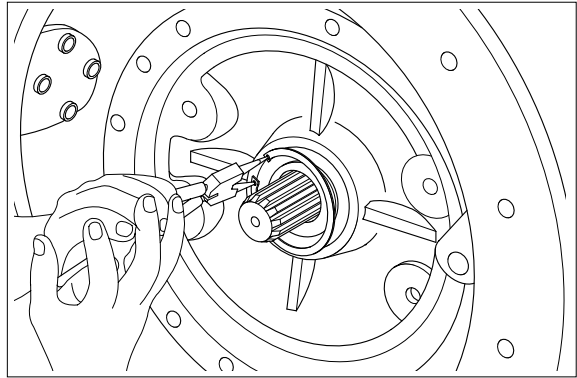


(12) Remove friction plate(742) and separate plate(743) from casing(301).

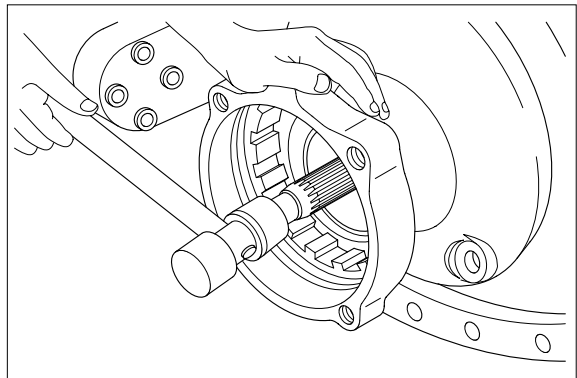


(13) Remove snap ring(437) with plier and remove the seal cover(305) from casing(301).

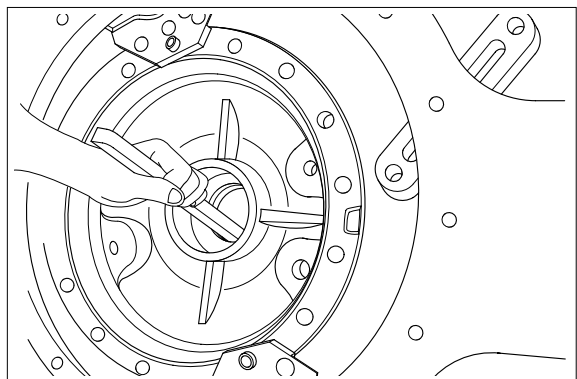
※ Seal cover could be removed with sliding shaft if necessary.



(14) Remove drive shaft(101) from casing(301).



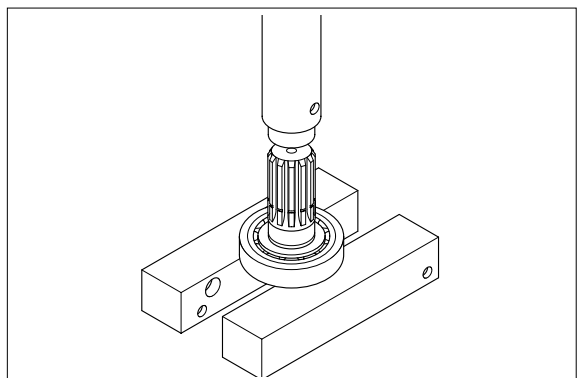
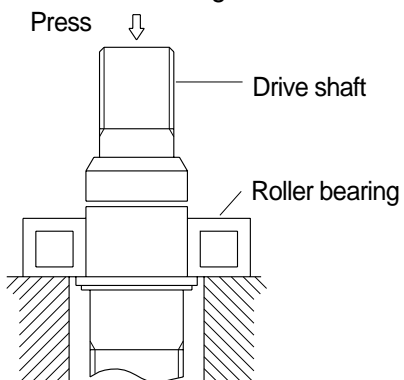
(15) Remove the shoe plate(124) from casing(301).



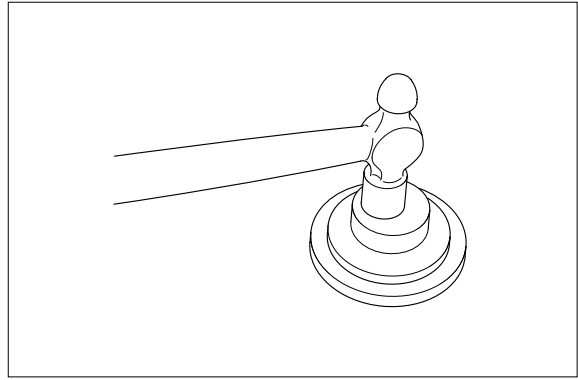
(16) Proceed with following job only when necessary.

① Remove the cone of roller bearing(443) from output drive shaft(101) by press.

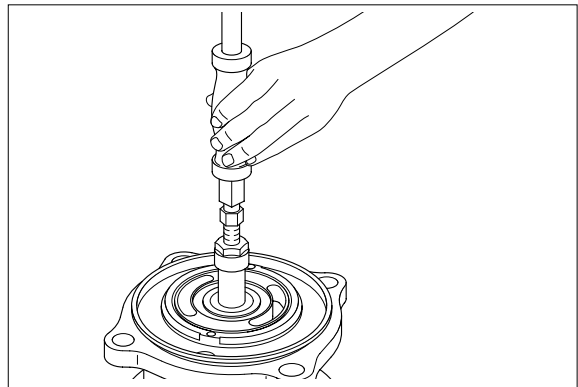
※ Do not reuse bearings.



- ② Remove oil seal(491) from seal cover(305).

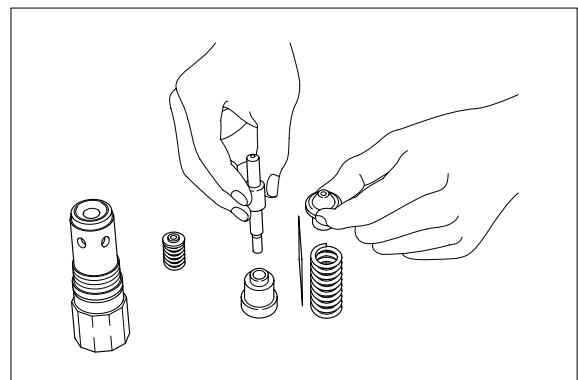
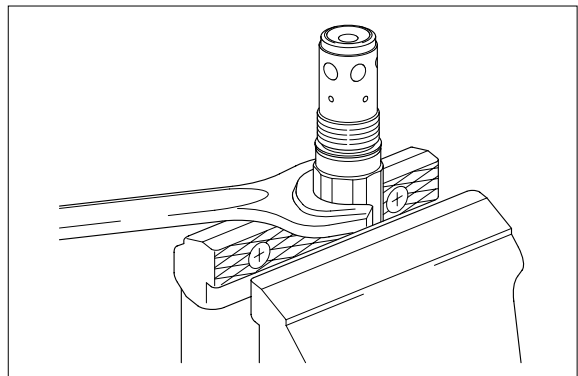


- ③ Remove the roller bearing(444) from the valve casing(303) by using slide hammer bearing puller.



- ④ When disassembling the relief valve, release the plug(201) and remove the bush(343), spring(322), and spring seat(333) from the rod(303) of the body(101). Remove the piston(302), rod(303), spring(321), spring seat(331) and plunger(301) with the body(101) downward.

- ※ Do not release the adjust bolt(471) and lock nut(472).

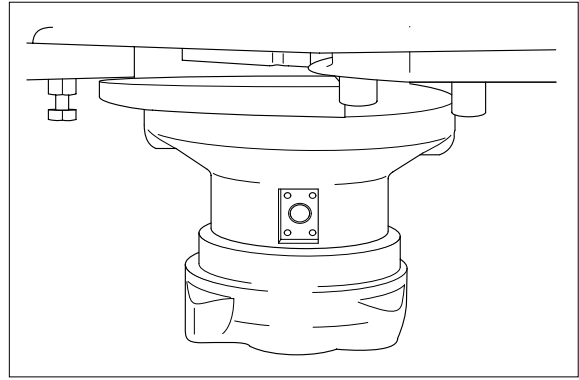


This completes disassembly.

3) ASSEMBLY

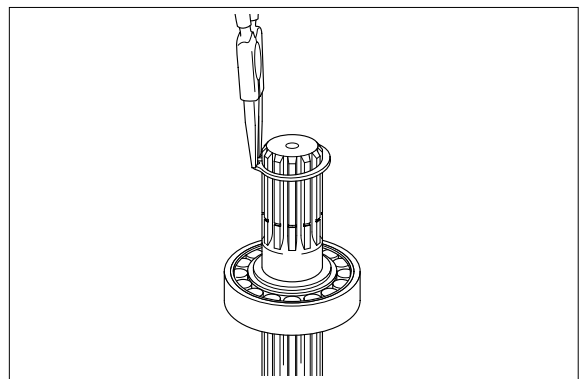
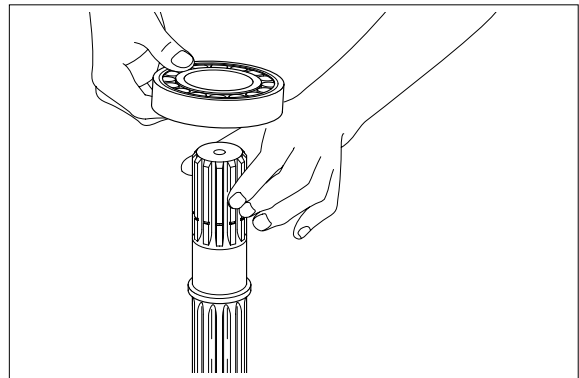
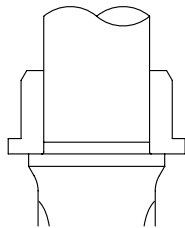
Do the reassembly in the reverse procedure of the disassembly.

- (1) Place the casing(301) on the workbench with the valve casing(303) downward.

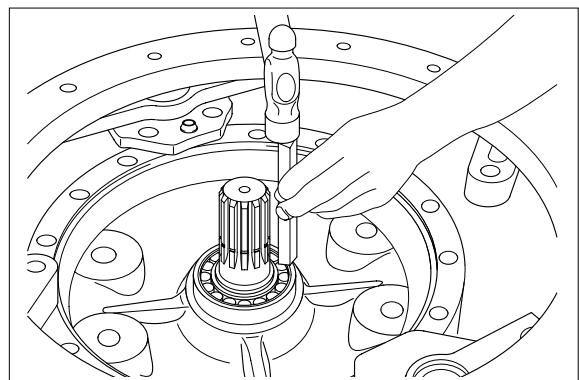


- (2) Install the cone of roller bearing(443) to the output drive shaft(101).
※ Pay attention to roller bearing(443) direction.

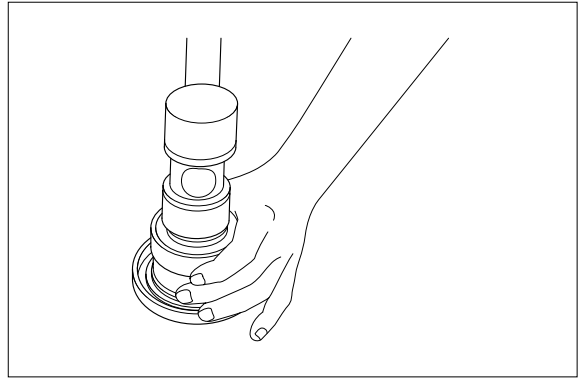
Output side



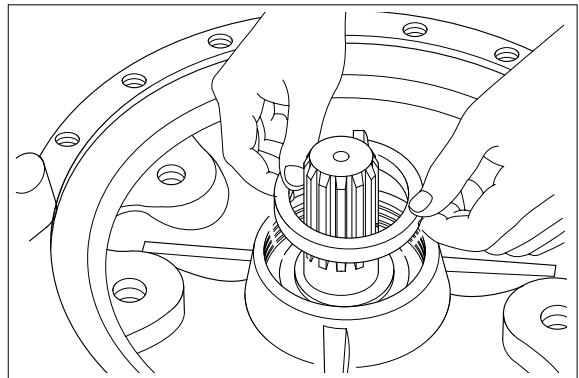
- (3) Insert the drive shaft(101) into the casing(301) with the end of output shaft upward and tap the outer race of roller bearing the hammer.



- (4) Insert the output drive shaft(101) in the casing.

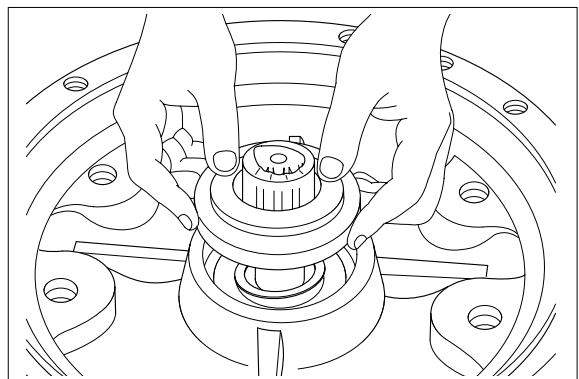


- (5) Tack oil seal(491) to the casing(301).

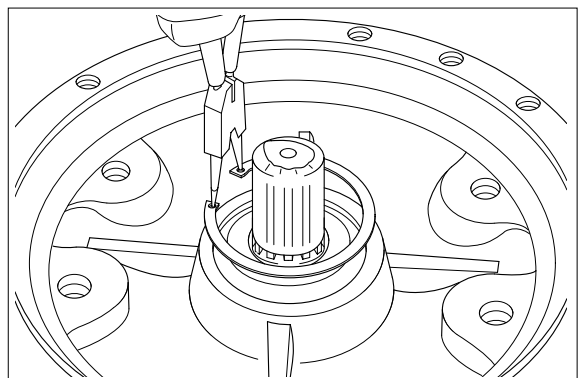


- (6) Reassemble the seal cover(305) to the casing(301).

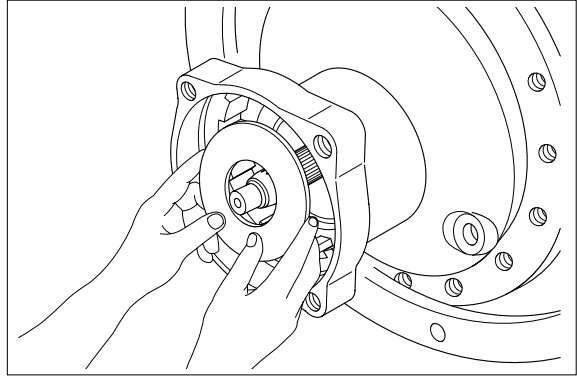
- ※ Apply grease to the rib of oil seal to avoid damage to the rib.



- (7) Install the snap ring(437) to the casing(301).

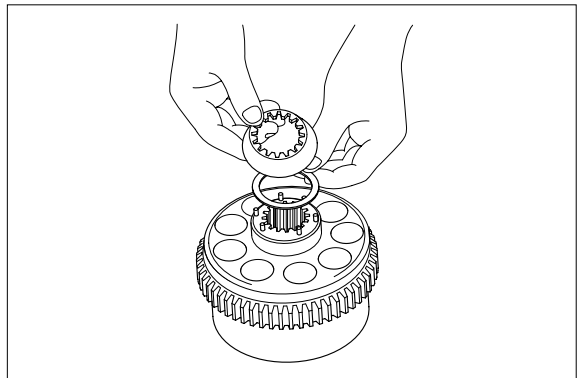


- (8) Insert the shoe plate(124) with the casing(301) position horizontally.

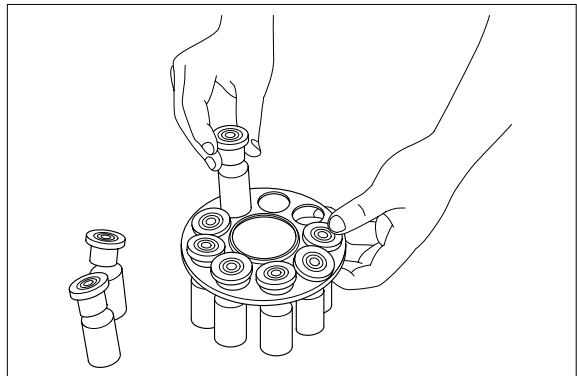


- (9) Insert the push rod(116) into the cylinder(111). Place the spherical bush(113) assembled with spacer(117) onto the cylinder.

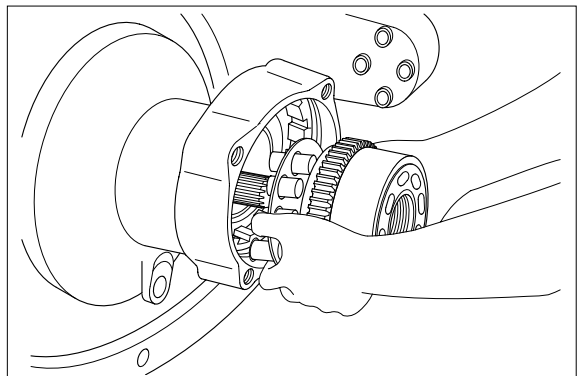
※ Insert two push rods in each hole.



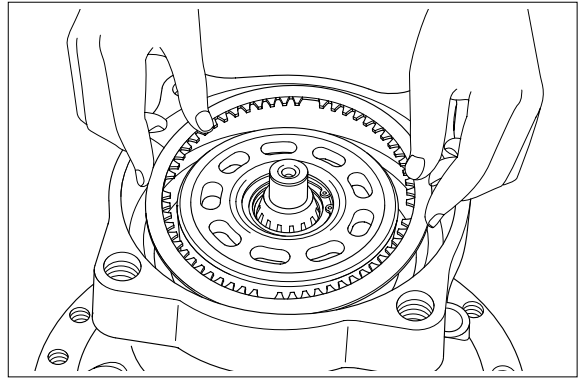
- (10) Install the piston sub-assembly(121, 122) to the push plate(123).



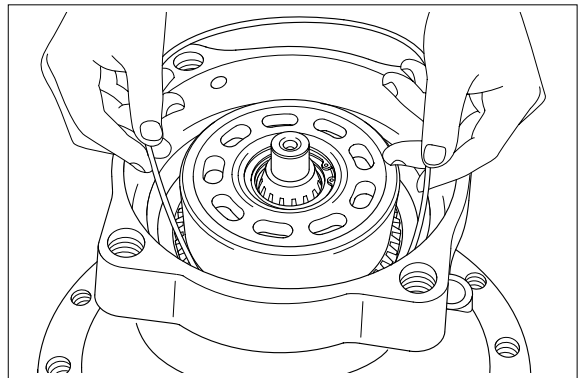
- (11) Reassemble the piston assembly(121, 122) to the cylinder(111). Then, insert the cylinder assembly into the casing(301).



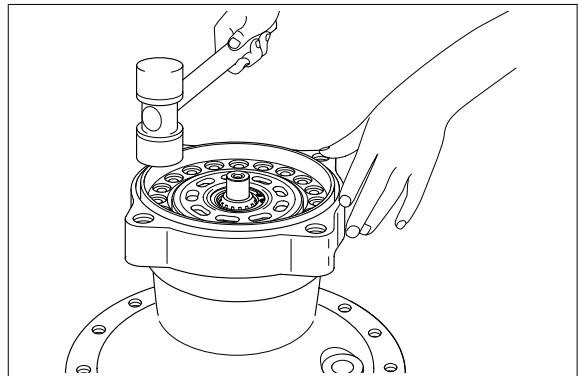
- (12) Place the casing(301) under the seal cover(305) and reassemble 3 sheets of separate plate(743) and then 2 sheets of friction plate(742) to the casing(301).



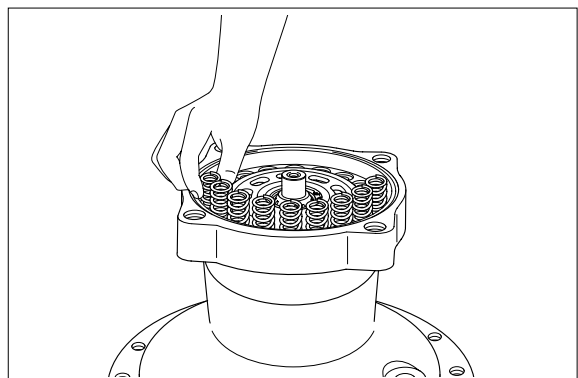
- (13) Insert O-ring(706, 707) in the casing (301).



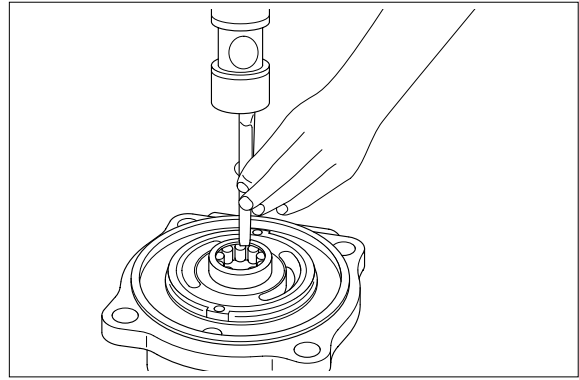
- (14) Reassemble brake piston(702) to the casing (301).



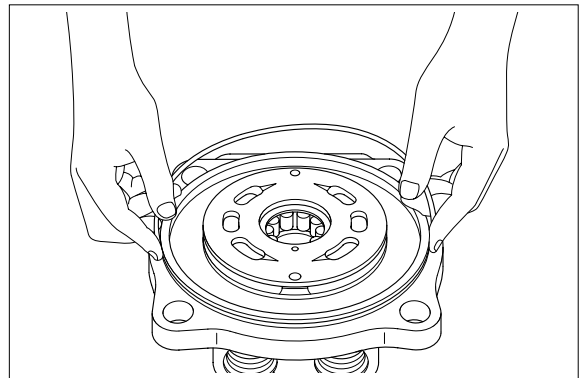
- (15) Reassemble brake spring(712) to the brake piston(702).



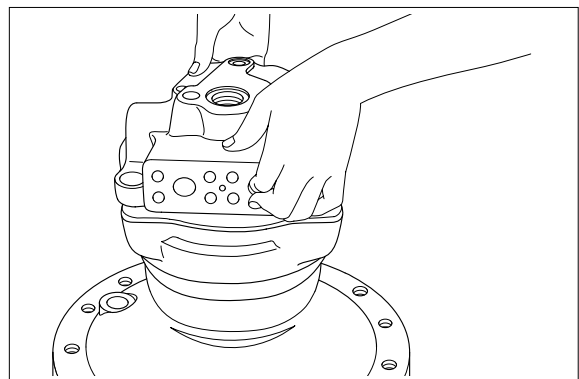
- (16) When the roller bearing(444) is removed.
Insert the roller bearing(444) into valve casing(303) with hammering.



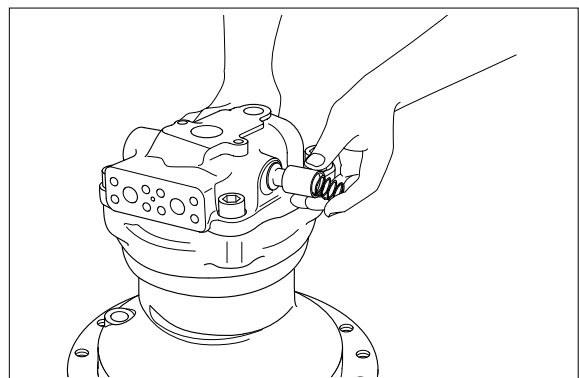
- (17) Reassemble valve plate(131) to the valve casing(303) and reassemble O-ring(472).



- (18) Connect the valve casing(303) with the casing(301) and tighten the hex socket bolt(401).

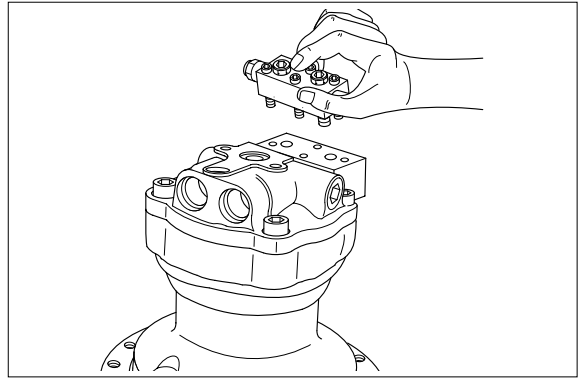


- (19) Insert plunger(351) and spring(355) in the valve casing and install O-ring(488). Tighten RO plug(469) to the valve casing.



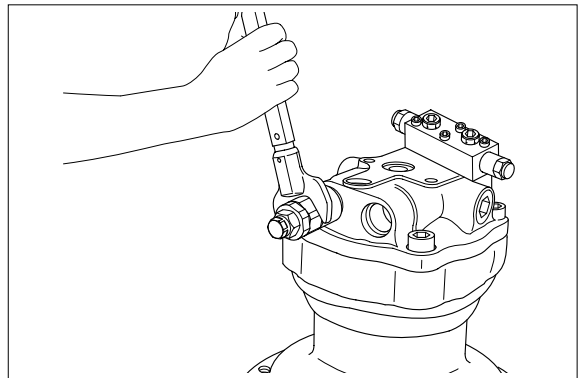
- (20) Connect the anti-rotation valve(052) with the casing(303) and tighten the hex socket bolt(171).

· Tightening torque : 3kgf · m(21.7lbf · ft)

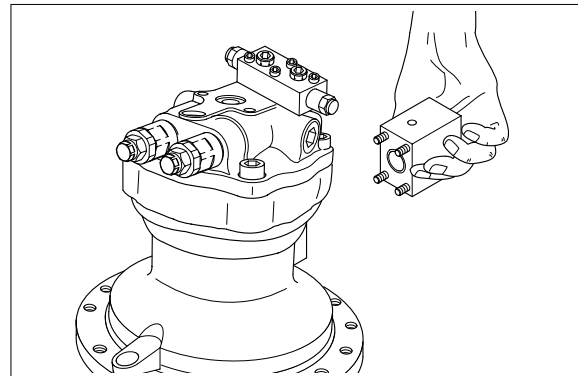


- (21) Insert back-up ring(162) and O-ring(161) to the relief valve(051), and reassemble them to valve casing(303).

· Tightening torque : 18kgf · m(130.2lbf · ft)



- (22) Connect the time delay valve(031) with the casing(301) and tighten the hex bolt.



- (23) Connect the valve casing(303) with the casing(301).

This completes assembly.

3. REMOVAL AND INSTALL OF REDUCTION GEAR

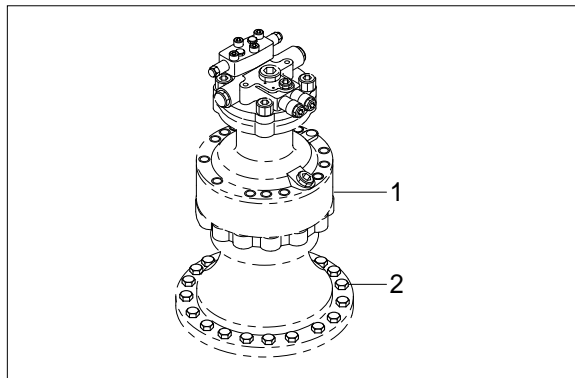
1) REMOVAL

- (1) Remove the swing motor assembly.
For details, see **removal of swing motor assembly**.
- (2) Slide reduction gear assembly(1) and remove mounting bolts(2).
- (3) Remove the reduction gear assembly.
 - Reduction gear device weight :
150kg (330lb)



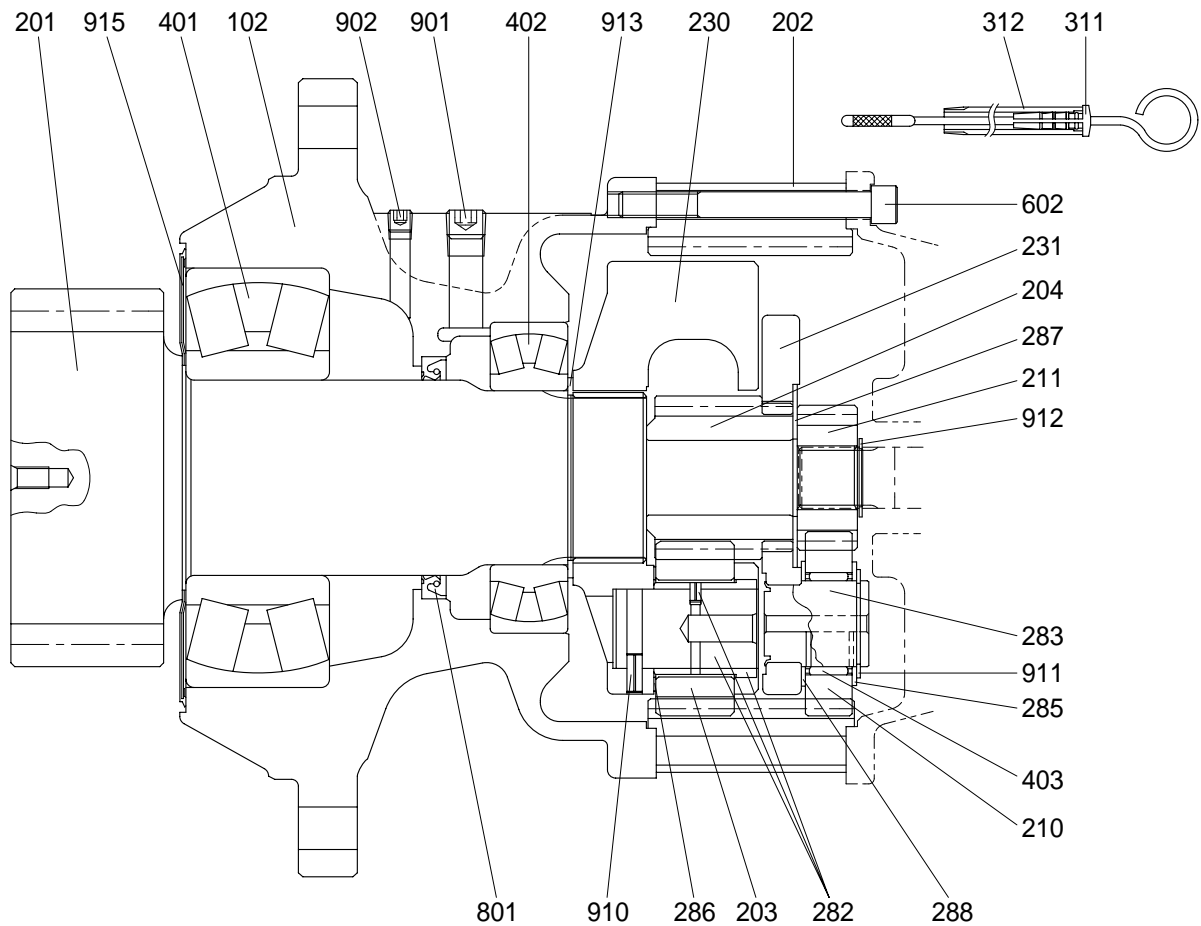
2) INSTALL

- (1) Carry out installation in the reverse order to removal.
 - Tightening torque : 57.9kgf · m
(418.8lbf · ft)



4. REDUCTION GEAR

1) STRUCTURE



102	Casing	283	Pin	602	Hexagon socket bolt
201	Drive shaft	285	Side plate	801	Seal
202	Ring gear	286	Side plate	901	Plug
203	Planetary gear 2	287	Side plate	902	Plug
204	Sun gear 2	288	Side plate	910	Spring pin
210	Planetary gear 1	311	Level bar	911	Snap ring
211	Sun gear 1	312	Pipe	912	Snap ring
230	Carrier 2	401	Roller bearing	913	Snap ring
231	Carrier 1	402	Roller bearing	915	Bearing seal
282	Pin	403	Needle cage		

2) INSPECTIONS

(1) Precautions

This assembly is designed to balance the life time of each part. Therefore, when replacing the parts, some parts could require another part's replacement at the same time because of their structural or functional correlations.

(2) Inspections replacement

- ① When the pitting happens on a tooth of sun gear, planetary gear or ring gear, replace the gear.(When a pit size is bigger than $\varnothing 1\text{mm}(0.04\text{'})$ or the pits are more than 5 percent of the tooth.)
- ② Replace the lock pin when loosely installed in the pin groove because of the wearing.
- ③ Replace the oil seal when damaged or weared. Replace the oil seal when reassembling the reduction gear assembly.
- ④ Replace the No.1 carrier assembly when flaking happens on the sliding surfaces of the No.1 planetary gear.
- ⑤ Replace the No.2 planetary gear assembly when radial clearance of bearing is more than $0.6\text{mm}(0.02\text{'})$.
Replace the No.2 planetary gear assembly when removing the output shaft.
- ⑥ Replace the thrust button when the sliding surface of the sun gear is badly damaged.
- ⑦ Replace the thrust washer only when it was damaged.
- ⑧ Replace the shaft support bearing when it was damaged. Do not reuse the disassemble shaft support bearing.
※ Inspect the No.2 planetary gear, thrust button, thrust washer, and shaft support bearing as in assembly.

3) DISASSEMBLY

- (1) Remove the level bar(311) and pipe(312) installed in the swing motor.
- (2) Loosen the drain plug in the swing gear box to discharge the gear oil.
※ Check the gear oil for contamination.
- (3) Release the bolt(602) and remove the swing motor from reduction gear assembly.
- (4) Release the No.1 sun gear(211).
- (5) Release the No.1 carrier assembly(231) including No.1 planetary gear(210).
- (6) Disassemble the No.1 carrier assembly, if necessary.
 - ① Release the snap ring(911) and remove the side plate(285).
 - ② Remove the No.1 planetary gear(210) and needle cage(403).
 - ③ Remove the side plate(288).
 - ④ Remove the side plate(287) in the center of No.1 carrier.
- (7) Release the No.2 sun gear(204).
- (8) Remove the No.2 carrier assembly(230) including No.2 planetary gear 2.
- (9) Disassemble the No.2 carrier assembly, if necessary.
- (10) Remove the ring gear(202).
- (11) Remove the snap ring(913) from drive shaft(201) assembly.
- (12) Remove the bearing seal(915) and roller bearing(401) from the casing(102), if necessary.
- (13) Remove oil seal(801) from casing(102).
※ Remove that the above articles(6,9,12) are applied for only special inspections or maintenance.

4) ASSEMBLY

- (1) Reassemble the drive shaft assembly.
 - ① Insert the bearing seal(915) in the drive shaft(201).
 - ② Install the roller bearing(401) in the drive shaft(201) after warming it up for about 10 minutes in the oil can at 80~100°C(176~ 212°F).
- (2) Insert the oil seal(801) in the casing(102).
- (3) Insert the roller bearing(402) with snap ring(913).
- (4) Reassemble the drive shaft assembly in the casing(102).
- (5) Reassemble the ring gear(202) after applying grease to the casing(102).
- (6) Reassemble the No.2 carrier assembly(230).
- (7) Reassemble No.2 sun gear(204) with the side plate(287).
- (8) Reassemble the No.1 carrier assembly(231).
 - ① Insert the No.1 pin(285)with the spring pin(910) in the No.1 carrier(231).
 - ② Insert the spring pin(910) in the No.1 carrier.
 - ③ Insert the side plate(287) in the center of No.1 carrier.
 - ④ Insert the side plate(288).
 - ⑤ Insert the side plate(285) with snap ring(911).

※ See the Table for the sizes of side plates.

Item no.	Inner dia.		Outer dia.		Thickness	
	mm	in	mm	in	mm	in
285	45	1.77	59	2.32	2	0.08
286	50	1.97	64	2.52	1	0.04
287	42	1.65	95	3.74	2	0.08
288	45	1.77	59	2.32	1	0.04

- (9) Install the No.1 carrier assembly in the No.2 sun gear.
- (10) Install the No.1 sun gear(211) with snap ring(912).
- (11) Install the swing motor with bolts(602) in the ring gear(202) with grease.
- (12) Insert the drain plug(901) of the gear.
- (13) Reassemble the level bar(311) and pipe(312).
- (14) Give gear oil.

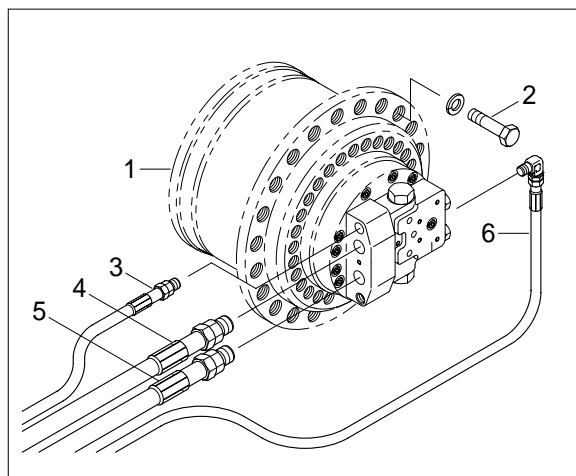
This completes assembly.

GROUP 6 TRAVEL DEVICE

1. REMOVAL AND INSTALL

1) REMOVAL

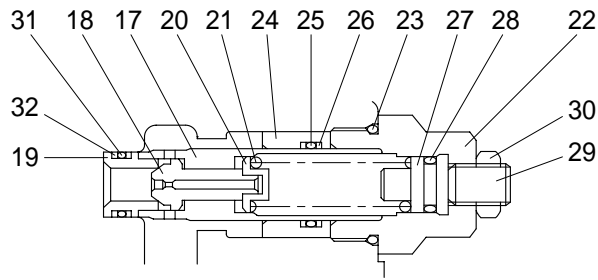
- (1) Swing the work equipment 90° and lower it completely to the ground.
- (2) Loosen the breather slowly to release the pressure inside the hydraulic tank.
 - ▲ Escaping fluid under pressure can penetrate the skin causing serious injury.
 - ※ When pipes and hoses are disconnected, the oil inside the piping will flow out, so catch it in oil pan.
- (3) Remove the track shoe assembly.
For details, see **removal of track shoe assembly**.
- (4) Remove the cover.
- (5) Remove the hose(3, 4, 5, 6).
 - ※ Fit blind plugs to the disconnected hoses.
- (6) Remove the bolts and the sprocket.
- (7) Sling travel device assembly(1).
- (8) Remove the mounting bolts(2), then remove the travel device assembly.
 - Weight : 210kg(463lb)



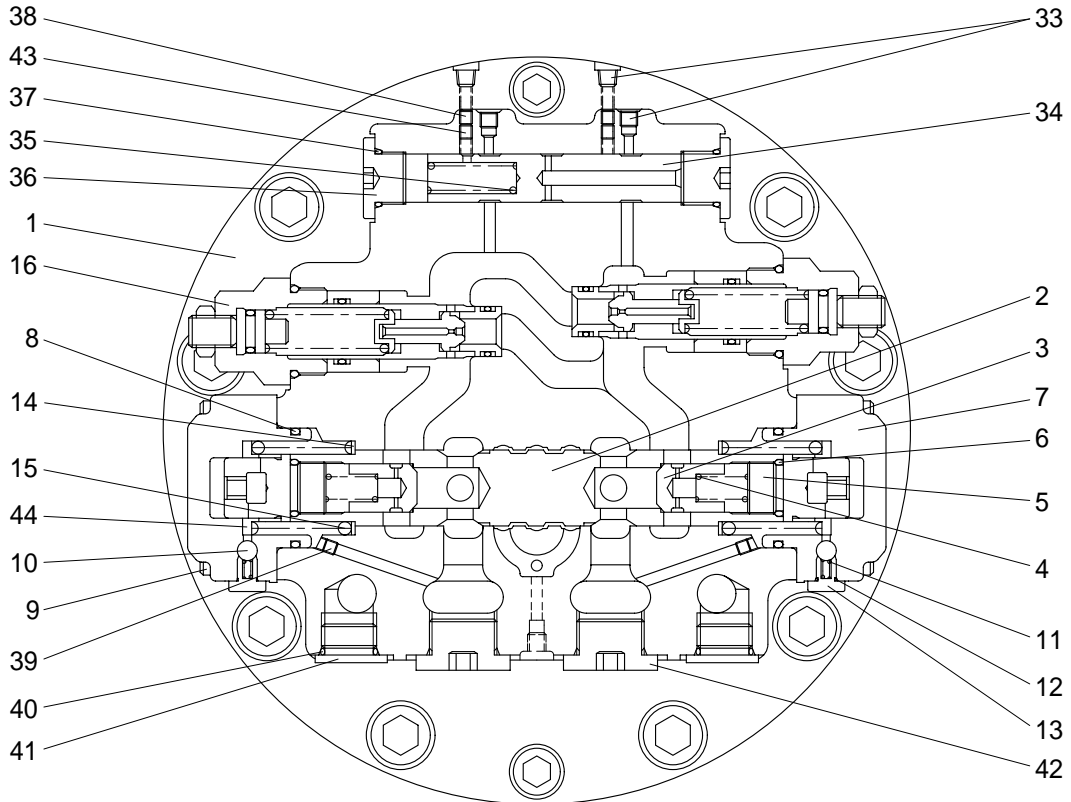
2) INSTALL

- (1) Carry out installation in the reverse order to removal.
- (2) Bleed the air from the travel 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.

1) TRAVEL MOTOR(1/2)



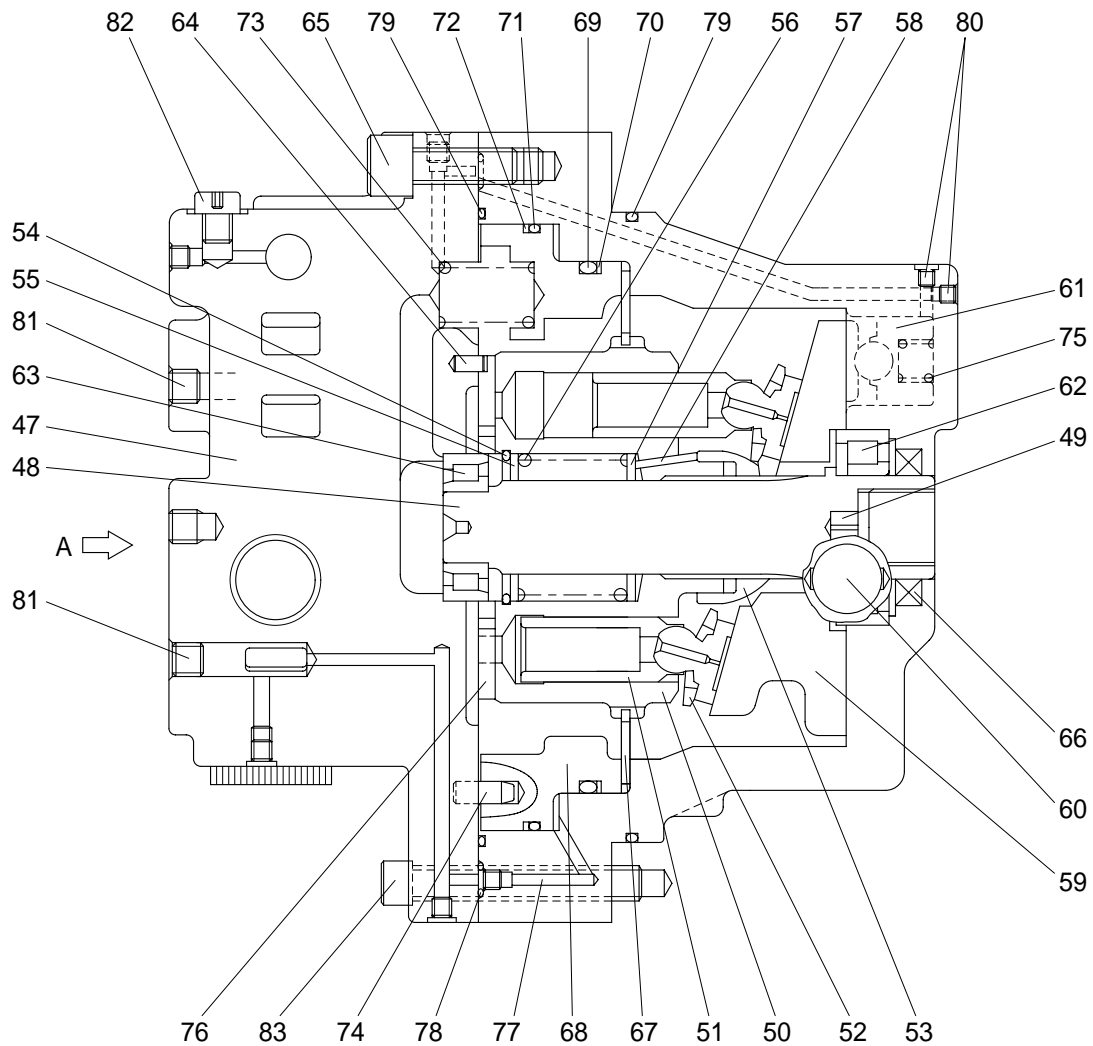
RELIEF VALVE DETAIL



VIEW A

1	Base plate	17	Relief housing	33	Plug
2	Plunger	18	Poppet	34	Spool
3	Check valve	19	Poppet seat	35	Spring
4	Spring	20	Spring seat	36	Plug
5	Plug	21	Spring	37	O-ring
6	O-ring	22	Plug	38	Orifice
7	Cap	23	O-ring	39	Orifice
8	O-ring	24	Free piston	40	O-ring
9	Socket head bolt	25	O-ring	41	Plug
10	Steel ball	26	Back up ring	42	Plug
11	Spring	27	Spring guide	43	Orifice
12	O-ring	28	O-ring	44	Flange
13	Plug	29	Set screw		
14	Spring seat	30	Nut		
15	Spring	31	O-ring		
16	Relief valve assembly	32	Back up ring		

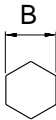
TRAVEL MOTOR(2/2)



47	Casing	60	Steel ball	73	Spring
48	Shaft	61	Piston assembly	74	Pin
49	Spring pin	62	Roller bearing	75	Spring
50	Cylinder block	63	Roller bearing	76	Valve plate
51	Piston assembly	64	Spring pin	77	Orifice
52	Retainer plate	65	Socket head bolt	78	O-ring
53	Retainer holder	66	Oil seal	79	O-ring
54	Snap ring	67	Disc plate	80	Plug
55	Collar	68	Brake piston	81	Plug
56	Spring	69	O-ring	82	Plug
57	Collar	70	Back up ring	83	Socket head bolt
58	Pin	71	O-ring		
59	Swash plate	72	Back up ring		

2) TOOLS AND TIGHTENING TORQUE

(1) Tools

Tool name	Remark	
Allen wrench	2.5	
	4	
	6	
	8	
	14	
Socket for socket wrench	27	
Spanner	27	
Torque wrench	Capable of tightening with the specified torques	
Pliers	-	
(-) Driver	6 × 100	
Hammer	Steel and plastic	
Eye bolt	M10, M16	

(2) Tightening torque

Part name	Item	Size	Torque		Wrench size	
			kgf · m	lbf · ft	in	mm
Plug	5	M20 × 1.5	10~12	72.3~86.8	0.75	19
Socket head bolt	9	M10 × 1.5	5.5~6.5	39.8~47.0	0.31	8
Relief valve	16	1 5/16	36~40	260~289	1.06	27
Plug	33, 80	NPT 1/16	0.9~1.1	6.5~8.0	0.16	4
Plug	36	PF 3/8	6.7~7.3	48.5~52.8	0.31	8
Orifice	38, 39, 43	M5 × 0.8	0.2~0.3	1.4~2.2	0.10	2.5
Socket head bolt	66	M16 × 2.0	28~32	203~232	0.55	14
Plug	81	PT 1/4	1.5~2.0	10.8~14.4	0.24	6

3) DISASSEMBLY

(1) Fixed the motor

Direct the output shaft up and fix the base plate (3) in a vise.

(2) Disassembling the base plate assembly

① Disassembling the relief valve assembly.

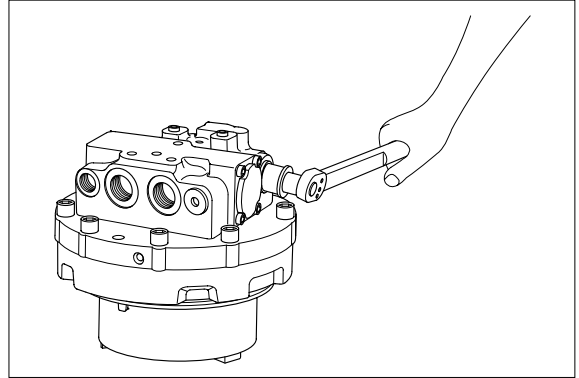
Loosen plug(21) and remove the relief assembly(15).

The plug(21) is lightly pressed into the relief housing(16), but in case it comes off, hold and turn the outer periphery of the relief housing(16) to separate them.

※ If nut(30) and setscrew(29) are loosened to remove the relief valve assembly (15), the set relief pressure will vary. Therefore, do not loosen them.

Do not disassemble the relief valve assembly except when necessary.

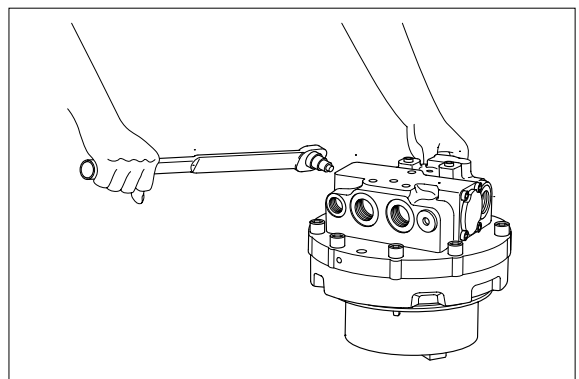
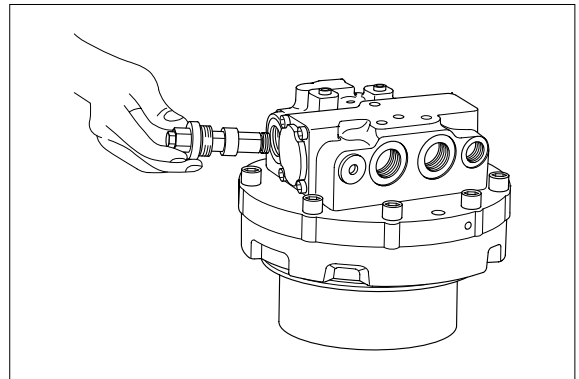
※ When holding the periphery of the relief valve housing with pincers, protect it with rag or something to protect the outer.



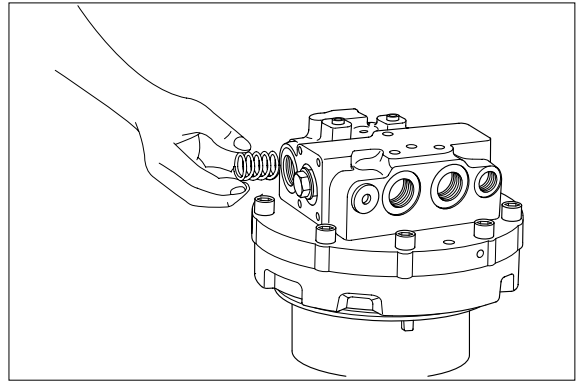
② Disassembling the Double Counterbalance valve.

Loosen socket bolts(13) and remove the flange(12).

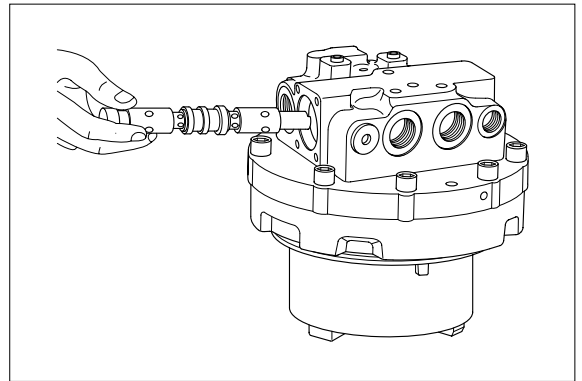
※ Since the flange(12) is held down by spring(11), loosen the socket bolts(13) halfway and hold the flange(12) down till the socket bolts(13) come off.



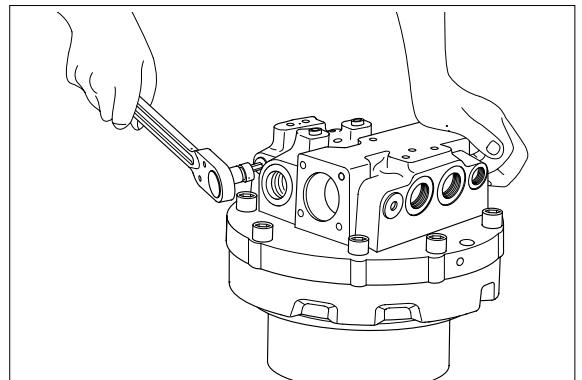
- ③ Remove spring seat(10) and spring(11).



- ④ Draw out the plunger assembly(4).
※ Draw it out, turning it slowly.

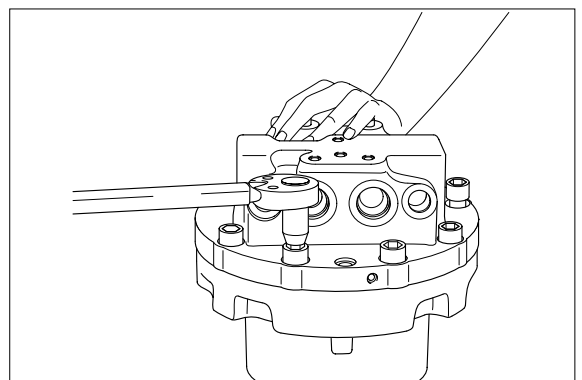


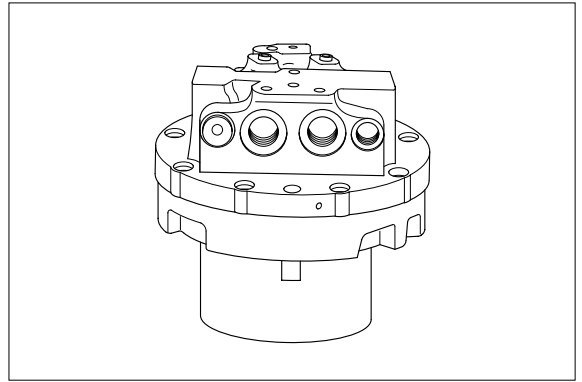
- ⑤ Disassembling the 2-speed control valve.
Loosen plugs(36) and remove spring (35)
and spool(34).
※ Draw out it, by turning is slowly.



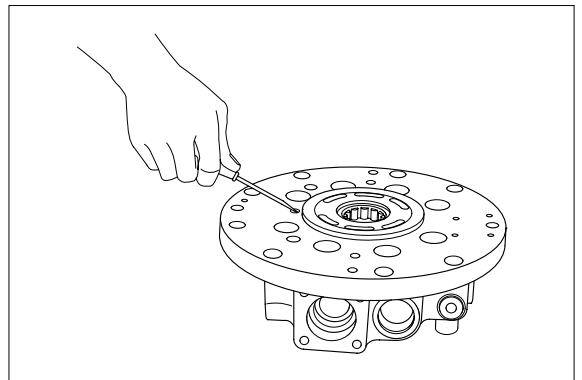
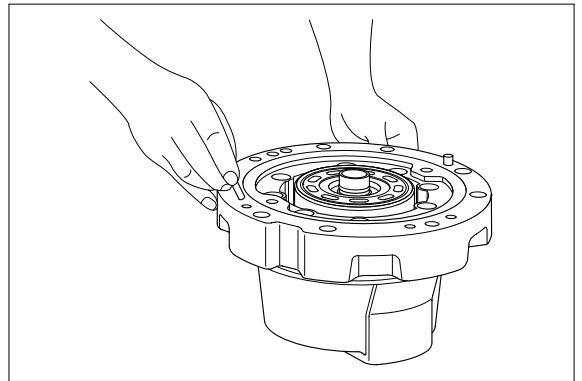
(3) Disassembling the base plate

- ① Loosen socket bolts(66).
※ Loosen the bolts evenly as the base
plate(3) is pushed up by spring(74).

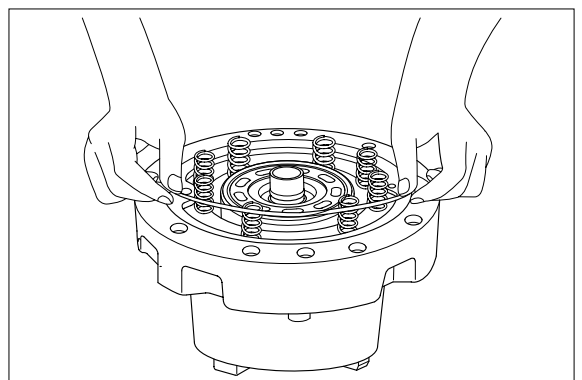




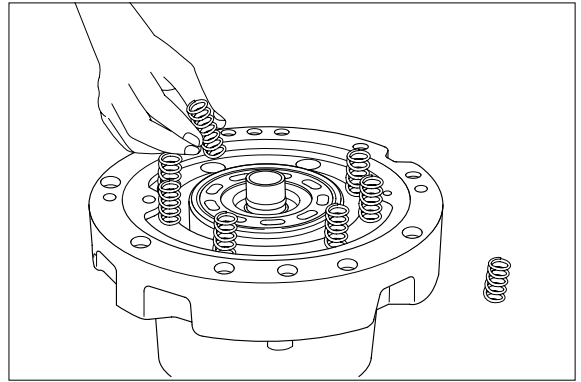
- ② Remove socket bolts(66) and take off base plate assembly(3), using a screwdriver.
※ Do not pry the base plate assembly gerkily with a screwdriver.



- ③ Remove O-ring(79, 80) from casing(1).

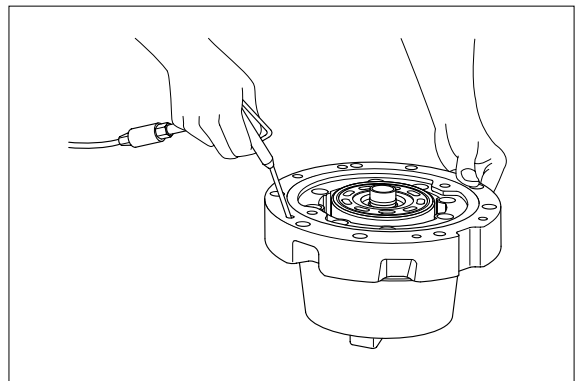


- ④ Separate valve plate(77), pins(75), O-ring(79, 80) and spring(74) from base plate(3).



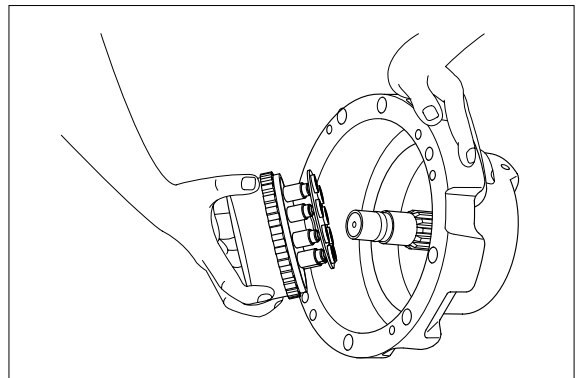
(4) Disassembling the brake piston

- ① Separate brake piston(69) from casing (1), using jet air and utilizing the pilot port hole of the casing(1).
- ② Remove disc plate(68).
- ※ Brake piston(69) may pop up by air pressure. Therefore, use care to avoid danger by utilizing a pop-out preventing jig or something.

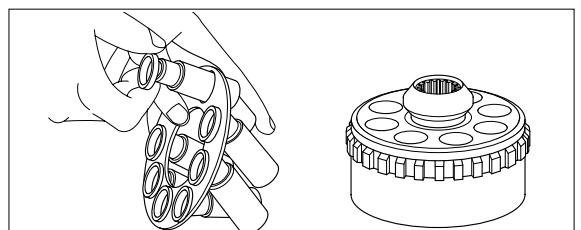
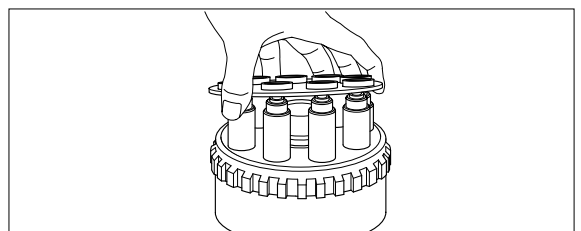


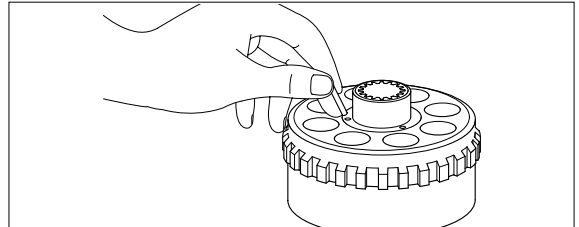
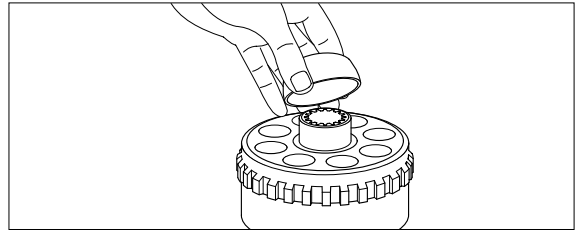
(5) Disassembling the cylinder block assembly

- ① With casing(1) placed on the side on the work bench, draw out the cylinder block assembly(50) from casing(1).
- ※ Be cautious not to damage on sliding face of cylinder.

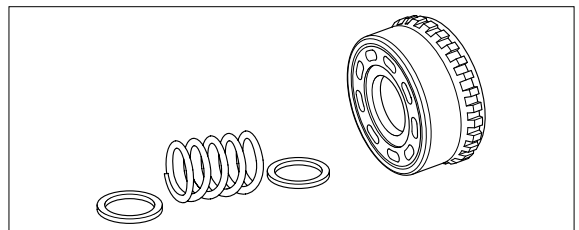
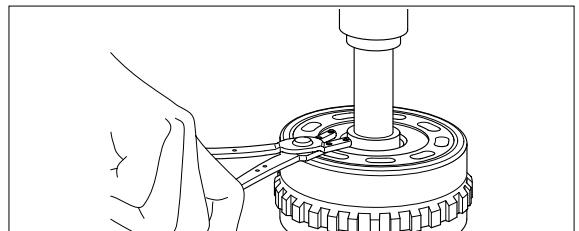


- ② Draw out piston assembly(52) from cylinder block(51), separate retainer plate(53), retainer holder(54) and pin(59) and disassemble the cylinder block.

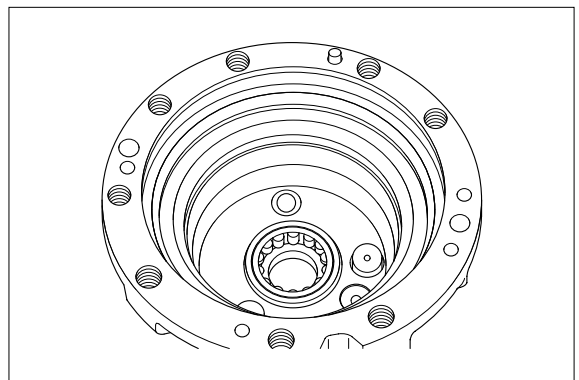




- ③ Remove snap ring(55) using a jig and separate collar(56), spring(57) and collar(58).

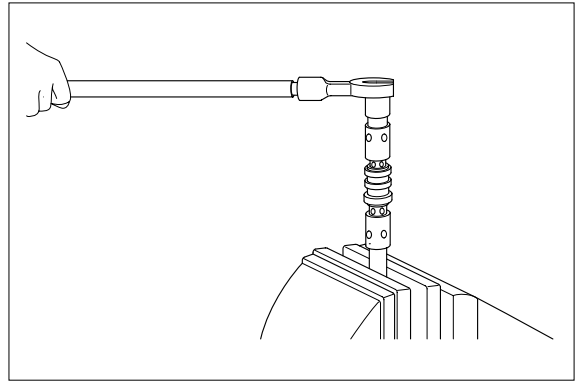


- (6) Separate shaft(40) from casing(1).
(7) Separate swash plate(60) from casing(1) and then take off steel ball(61), spring (76) and piston assembly(62).
※ Steel balls(61) can easily be taken out if a magnet is used.

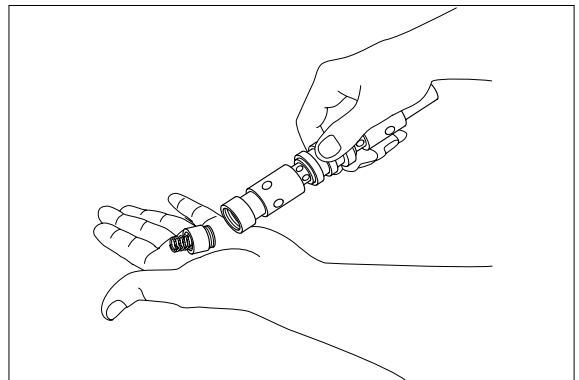


(8) Disassembling the plunger assembly

- ① Fit round bar($\varnothing 10$) into plunger(5) and fix in a vise and then remove plug(8).



- ② Separate spring(7) and check valve(6).



This completes disassembly.

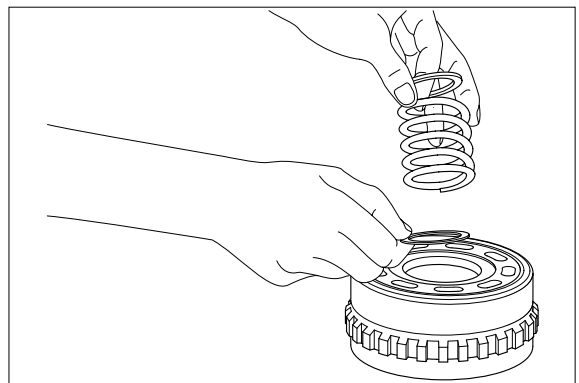
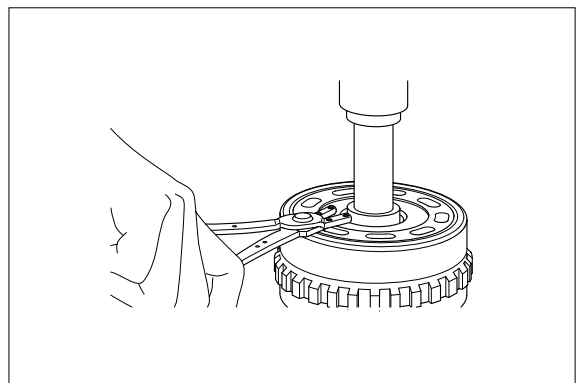
4) ASSEMBLY

(1) Precautions

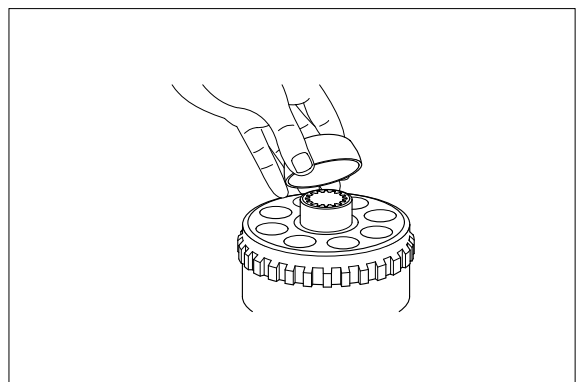
- ① Clean parts with clean washing oil and blow it with jet air.
- ② Handle cleaned parts with care to be free from dust and scoring.
- ③ Replace seals, bearings and pins with new ones.
- ④ Tighten the fastening parts to specified torques.
- ⑤ Coat oil seals and O-rings with grease. (Oil seal lip, in particular)

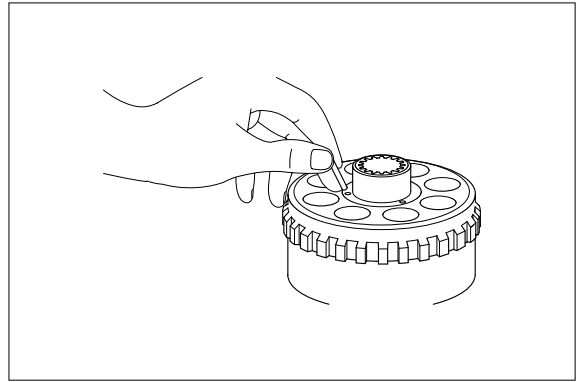
(2) Assembling the cylinder block assembly

- ① Fix collar(58), spring(57) and collar(56) to cylinder block(51) in that order and then fit snap ring(55).

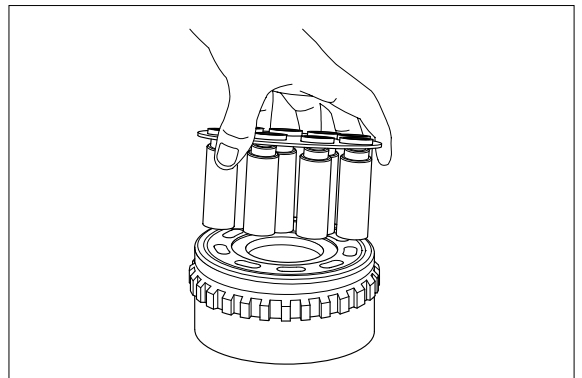
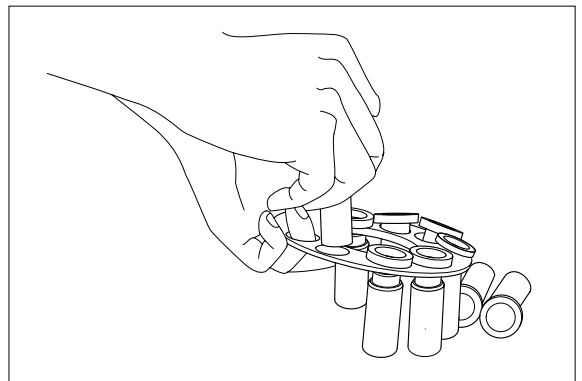


- ② Fix pin(59) and retainer holder(54) to cylinder block(51).



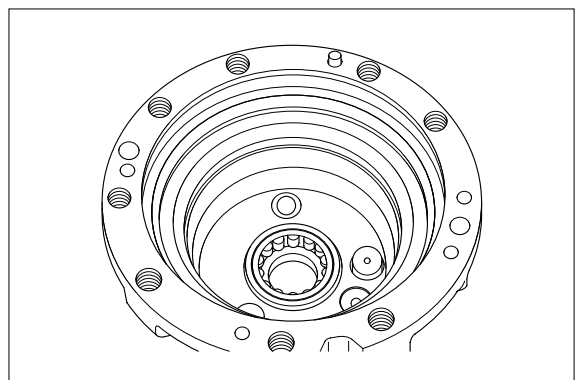


- ③ Fix piston assembly(52) to retainer plate(53) and fit it into cylinder block (51).
 ※ Fix the retainer plate so the small diameter part of the retainer plate bore taper comes in contact with the flange of the piston shoe. Fix it after coating the piston hole with hydraulic oil.

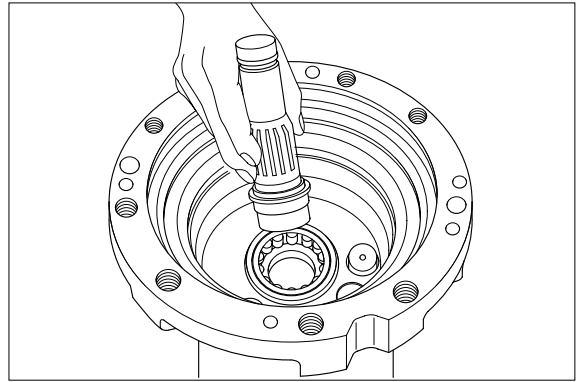


(3) Fixing Casing(1)

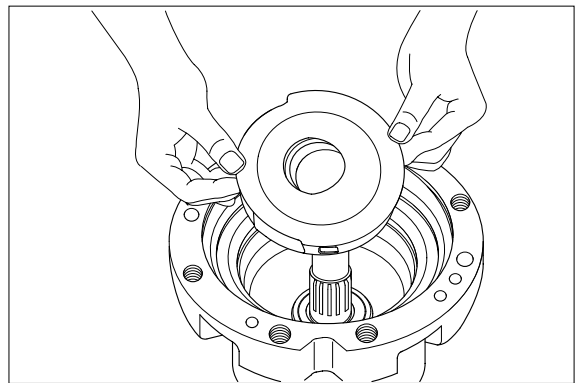
- ① Place a suitable jig on a work bench and mount casing(101) on it.
 ② Fix spring(76), piston assembly(62) and steel ball(61) to casing(1).



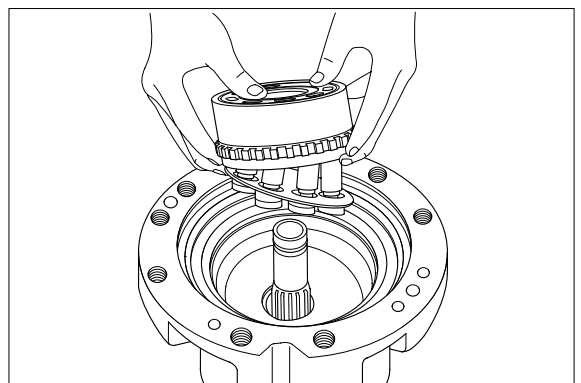
③ Fix shaft(40) to casing(1).



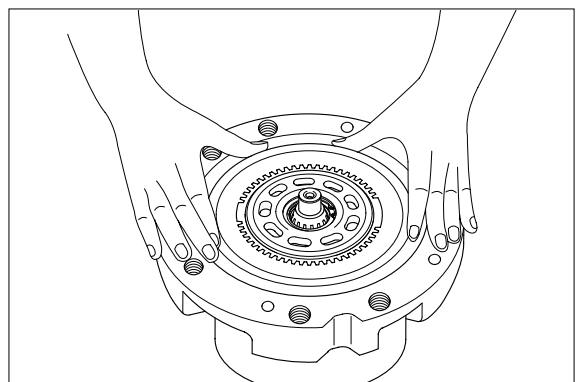
④ Fix swash plate(60) to casing(1).



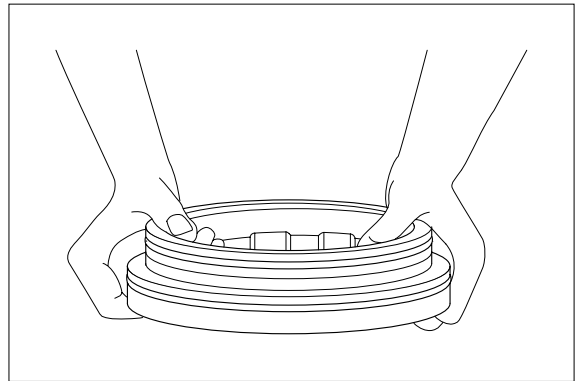
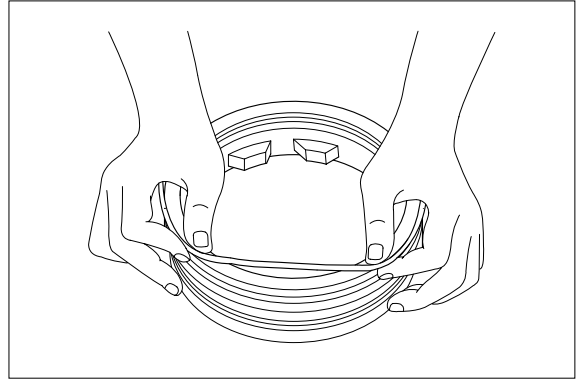
⑤ Insert the cylinder block assembly(50) into casing(1) and assemble them together.
Insert the cylinder block so piston assembly(62) and retainer holder(54) may not come off.



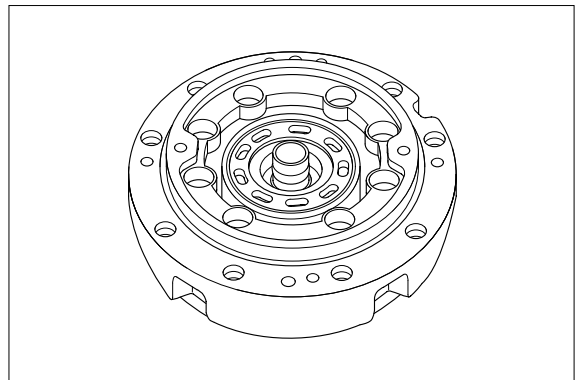
⑥ Fix disc plate(68) to casing(1)



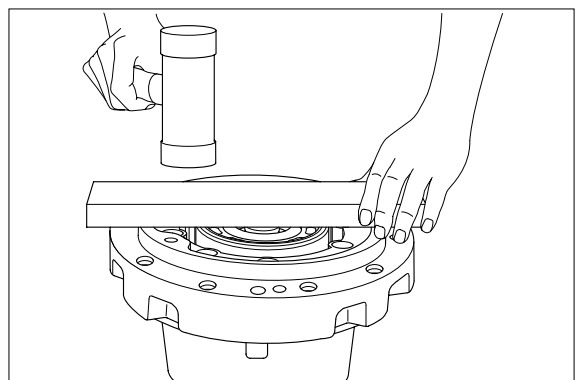
- ⑦ Fix O-ring(70, 72) and back up ring(71, 73) to brake piston(69).



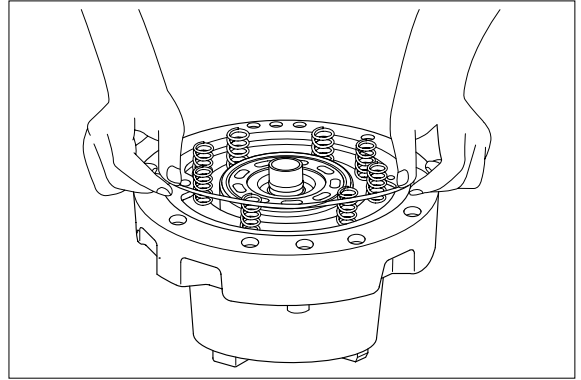
- ⑧ Fix brake piston(69) to casing(1).



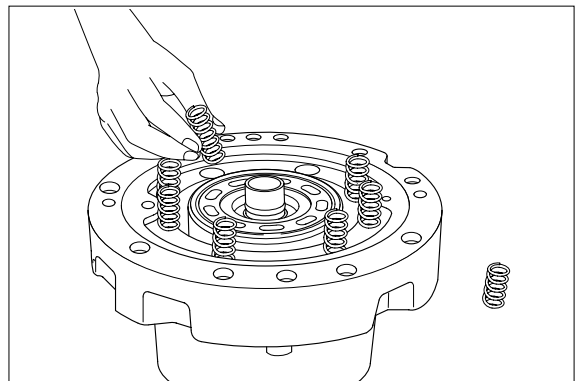
- ⑨ Place a suitable jig on the brake piston and insert brake piston by tapping with plastic hammer.



⑩ Fix O-ring(79, 80) to casing(1).

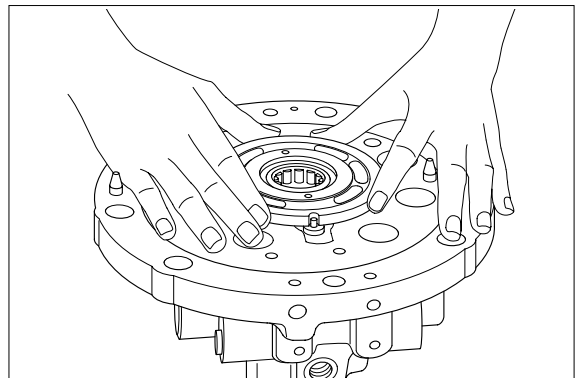


⑪ Fix spring(74) to brake piston(69).



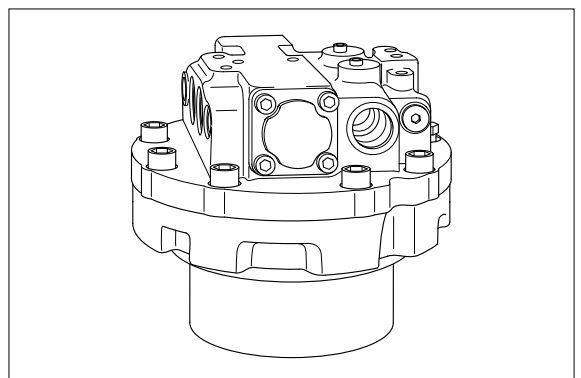
(4) Assembling the base plate

- ① Place a suitable jig on a work bench and mount base plate(3) on it.
- ② Fix the out race of roller bearing(64) to base plate(3).
- ③ Fix pin(75), spring pin(65) and valve plate(77) to the base plate(3).

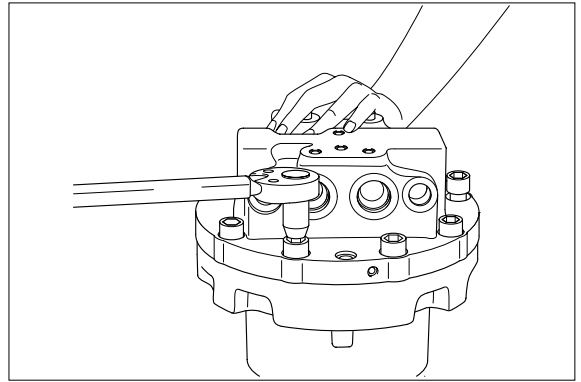


(5) Assembling the base plate

- ① Fix base plate(3) to casing(1).
- ※ Fix cylinder block(51) and valve plate(77) after applying hydraulic oil to them.

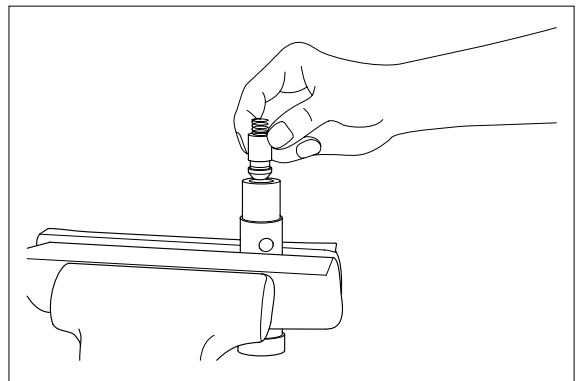


- ② Tighten socket bolts(66).
- ※ Tightening torque : 10~11kgf · m

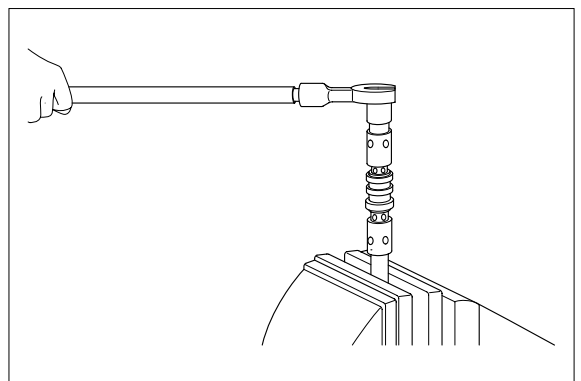


(6) Assembling the plunger

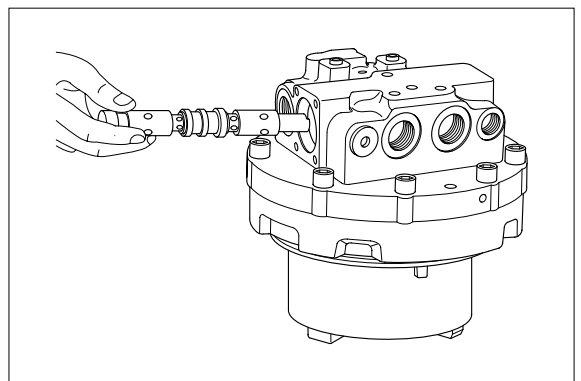
- ① Fix round bar(Ø10) into plunger(4) and fix it in a vise.
- Fix check valve(6) and spring(7) to plunger(5).



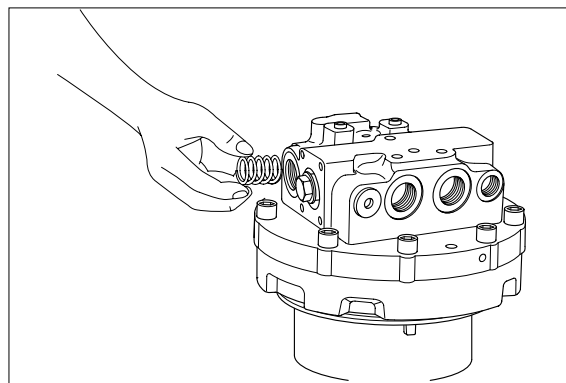
- ② Fix O-ring(9) and plug(8) to plunger(5).



- ③ Fix plunger(4) to base plate(3).
- ※ Before assembling, applying hydraulic oil to sliding surface of plunger.
- ※ Fix plunger(4) by turning it slowly and confirm that it slides smoothly.

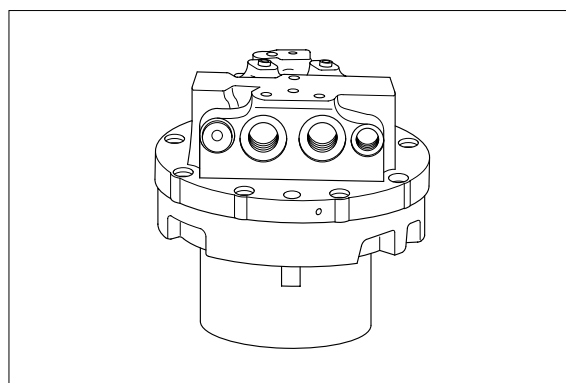
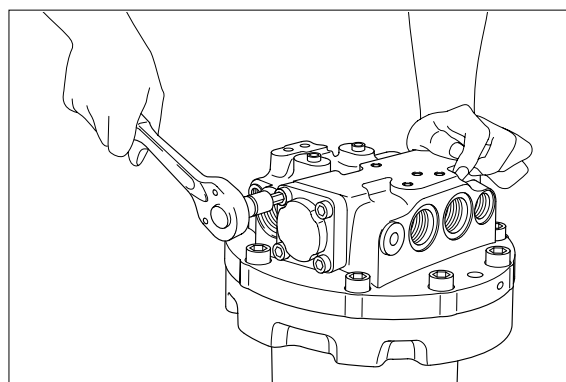


④ Fit spring seat(10) and spring(11).

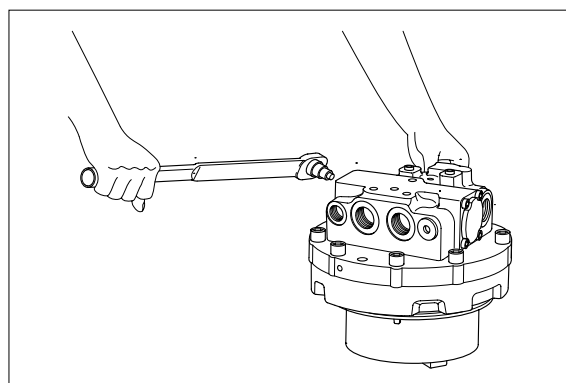


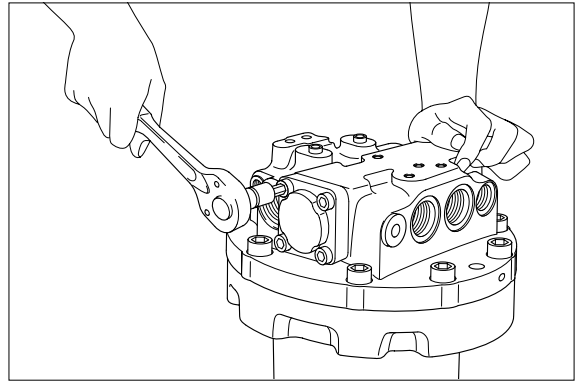
⑤ Fit flange(12) to base plate(3) and fasten them with socket bolts(13) together.

※ Since it is pushed by spring(11), tighten socket bolts(13), holding it down by hand.

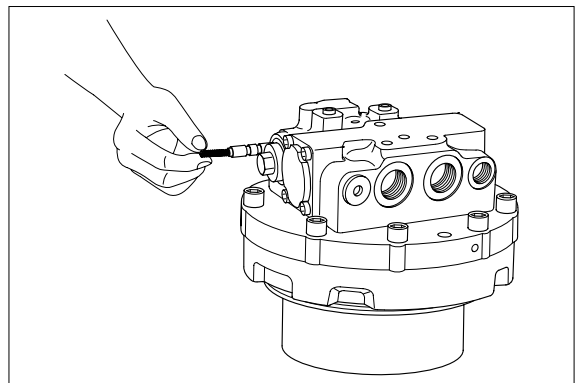


(7) Fit relief valve(15) to base plate(3) and tighten specified torque.



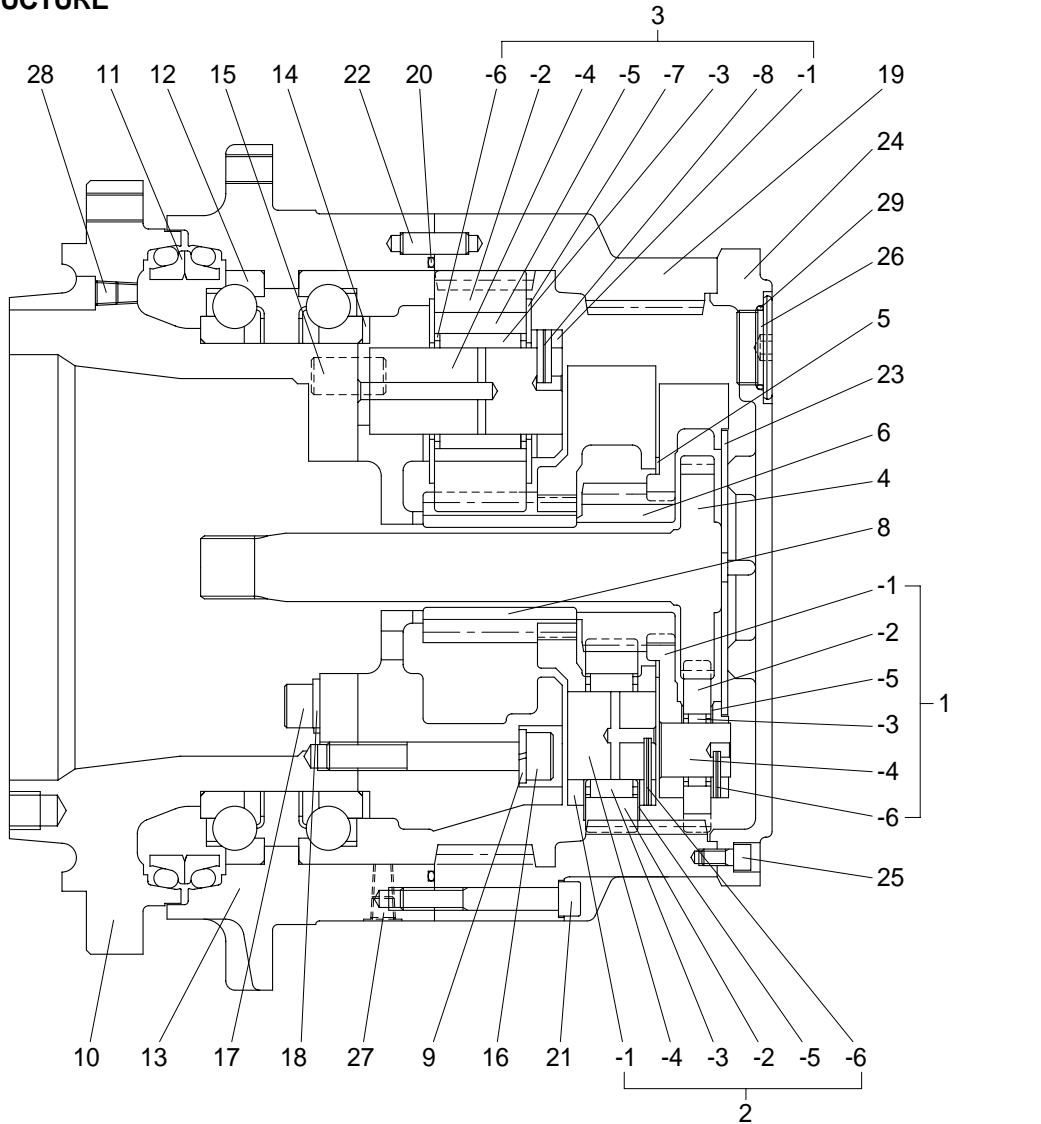


- (8) Fit spool(34), spring(35) to base plate(3)
and tighten plug(36).
※ Pay attention to spool direction.



3. TRAVEL REDUCTION GEAR

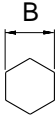
1) STRUCTURE



- | | | | | | |
|-----|-------------------|-----|-----------------|----|------------------------|
| 1 | Holder A assembly | 3-2 | Planet gear C | 14 | Shim(0.1~0.05t) |
| 1-1 | Holder A | 3-3 | Roller bearing | 15 | Pin |
| 1-2 | Planet gear A | 3-4 | Gear shaft C | 16 | Socket head bolt |
| 1-3 | Needle bearing | 3-5 | Floating seal | 17 | Socket head bolt |
| 1-4 | Gear shaft A | 3-6 | Collar | 18 | Plate |
| 1-5 | Thrust washer | 3-7 | Thrust washer | 19 | Ring gear |
| 1-6 | Spring pin | 3-8 | Spring pin | 20 | O-ring |
| 2 | Holder B assembly | 4 | Drive gear | 21 | Socket head bolt |
| 2-1 | Holder B | 5 | Thrust plate | 22 | Pin |
| 2-2 | Planet gear B | 6 | Sun gear B | 23 | Thrust plate(1.8~3.2t) |
| 2-3 | Needle bearing | 8 | Sun gear C | 24 | Cover |
| 2-4 | Gear shaft B | 9 | Spring washer | 25 | Socket head bolt |
| 2-5 | Thrust washer | 10 | Flange | 26 | Plug(PF 3/4) |
| 2-6 | Spring pin | 11 | Floating seal | 27 | Plug(PT 1/4) |
| 3 | Holder C assembly | 12 | Angular bearing | 28 | Plug(PT 1/8) |
| 3-1 | Holder C | 13 | Housing | | |

2) TOOLS AND TIGHTENING TORQUE

(1) Tools

Tool name	Remark	
Allen wrench	5	
	6	
	8	
	10	
	12	
	14	
	16	
Socket for socket wrench	27	
Spanner	27	
Torque wrench	Capable of tightening with the specified torques	
Pliers	-	
(-) Driver	6 × 100	
Hammer	Steel and plastic	
Eye bolt	M10, M16	

(2) Tightening torque

Part name	Item	Size	Torque		Wrench size	
			kgf · m	lbf · ft	in	mm
Socket head bolt	16	M16 × 2.0	28~32	203~232	0.55	14
	17	M18 × 2.5	40~45	289~326	0.55	16
	21	M12 × 1.75	12.3~13.7	89.0~99.1	0.39	10
	25	M10 × 1.5	5.5~6.5	39.9~47.0	0.31	8
Plug	26	PF 3/4	15.2~16.8	110~122	0.47	12
	27	PT 1/4	1~1.5	7.2~10.8	0.24	6
	28	PT 1/8	0.9~1.0	6.5~7.2	0.20	5

3) DISASSEMBLY

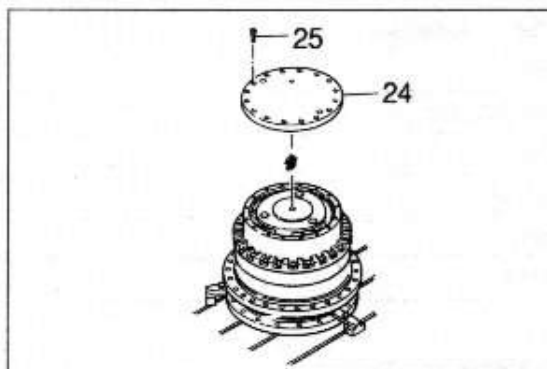
(1) Preparation

- ① Drain out the oil from inside the reduction unit.
 - ② Clean the outside of the reduction unit with cleaning oil and let it dry.
- ※ Before cleaning, confirm that each port is plugged.

(2) Disassembling the cover

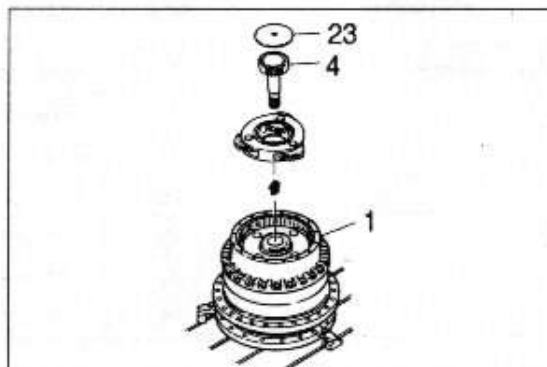
With the motor placed on its mounting surface, fix the reduction unit assembly on a stable work bench.

Loosen socket bolts(25) and remove cover(24).

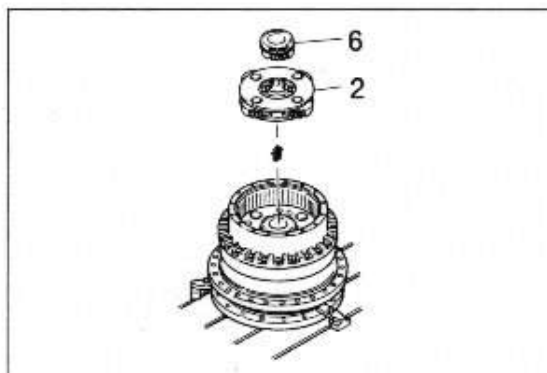


(3) Disassembling the gears

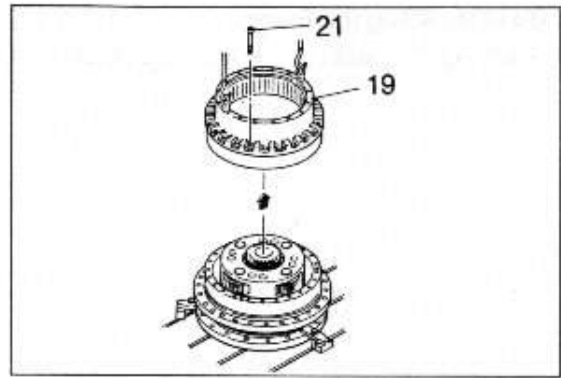
- ① Remove thrust plate(23). Then remove drive gear(4) and holder A assembly (1).



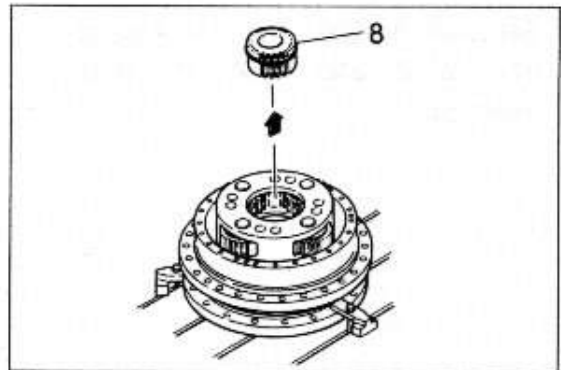
- ② Remove sun gear B(6) and holder B assembly(2).



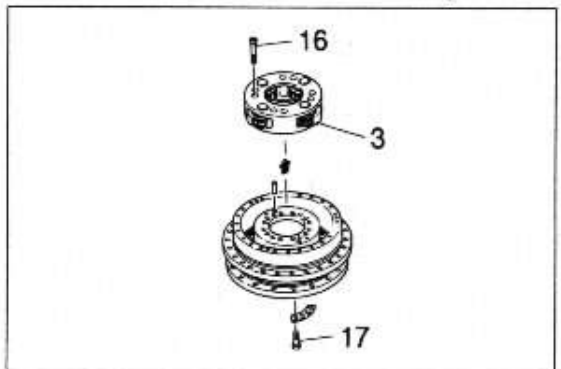
- ③ Loosen socket bolts(21) and remove ring gear(19).



- ④ Remove sun gear C(8).



- ⑤ Loosen socket bolts(17,16)and remove holder C assembly(3).



(4) Disassembling the holders assembly

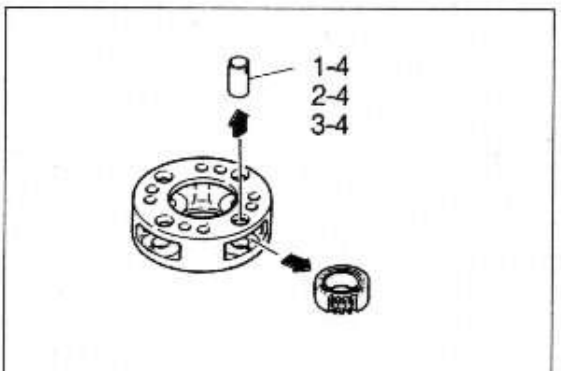
Knock a spring pin into the gear shaft and disassemble the holder assembly.

Holder A : Spring pin(1-6)
Gear shaft A(1-4)

Holder B : Spring pin(2-6)
Gear shaft B(2-4)

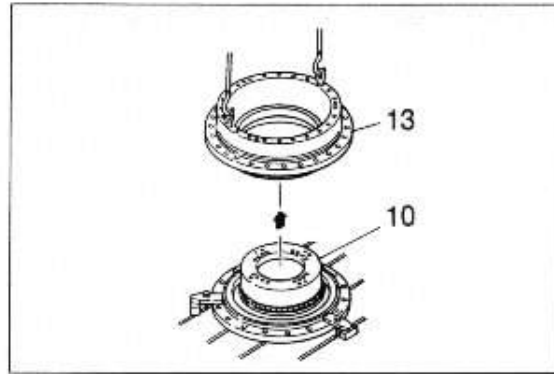
Holder C : Collar(3-6)
Gear shaft C(3-4)

- * Exercise care so as not to knock a pin in too much.(to a depth of about 14mm)
A spring pin knock-in tool with be convenient for this operation.

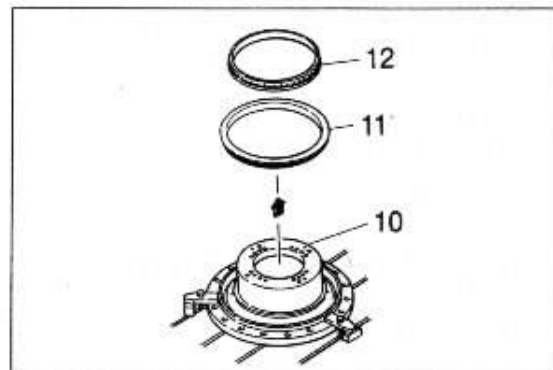


(5) Disassembling the flange

① Fix flange(10) and remove housing(13).



② Separate floating seal(11), angular bearing(12) and flange(10) from housing(13).



With this, disassembly is over.

4) ASSEMBLY

(1) Preparation

① Inspecting parts

Inspect that each of the parts is reusable referring to **maintenance standard**.

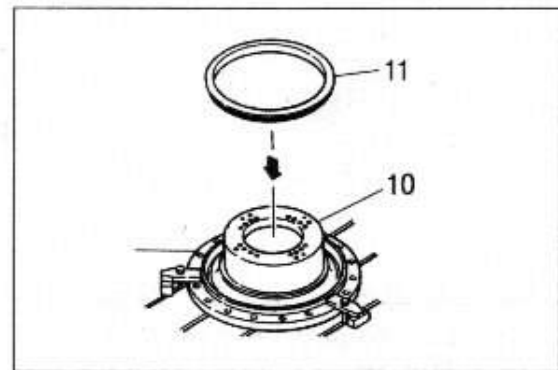
② Cleaning parts

Clean the matching surface and screwed parts to be free from moisture, dirt and other foreign matter, using clean cleaning oil. Degrease parts to which loctite #515 and #242 are applied, using thinner or something.

(2) Assembling the Housing

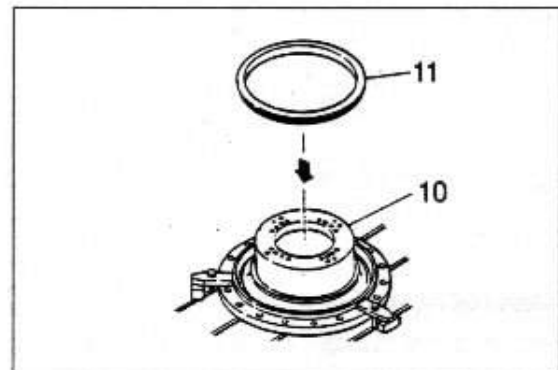
① Fix flange(10) and fix one end of floating seal(11) to flange(10).

※ Apply sufficient grease to floating seal(11).

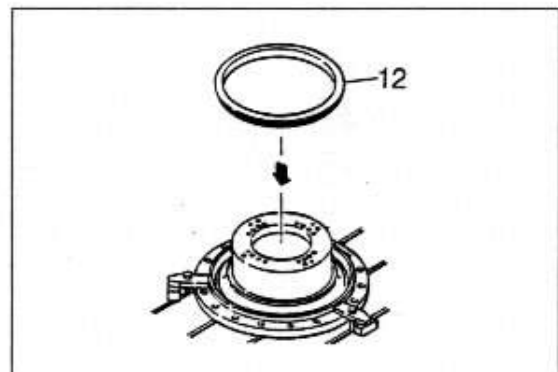


② Fix another end of floating seal(11) to flange(10) so they are aligned on the same line.

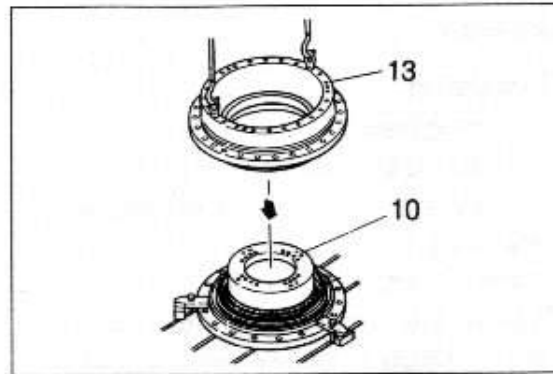
※ Apply the sealing surface with grease or gear oil.



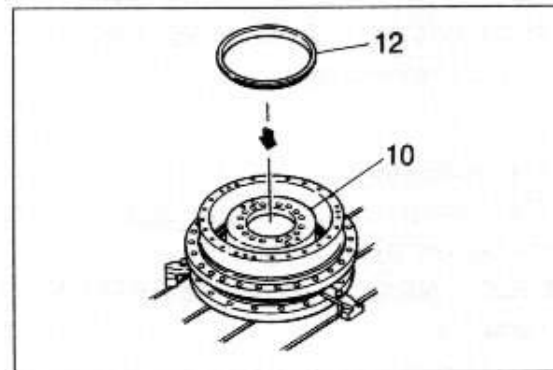
③ Fit the inner race assembly of angular bearing(12) to flange(10).



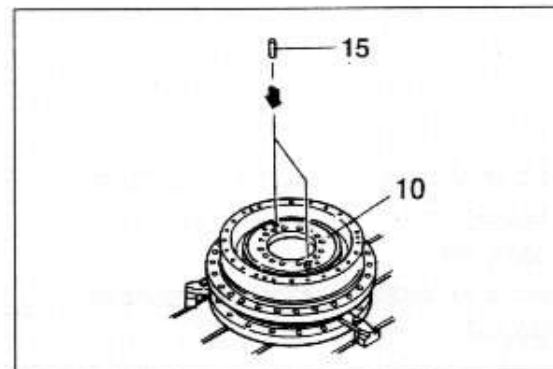
- ④ Press the outer race of angular bearing (12) into housing(13) and mount it gently onto flange(10).



- ⑤ Fit the inner race assembly of one of the angular bearings(12) to flange(10).

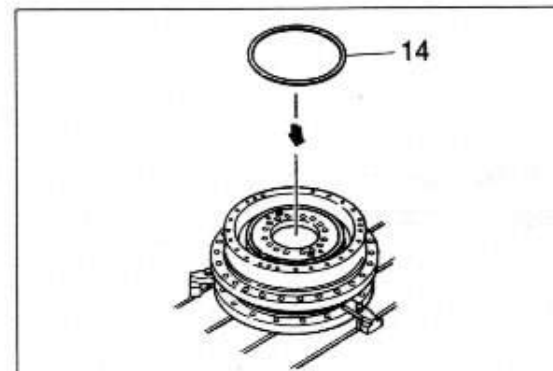


- ⑥ Press pin(15) into flange(10). At that time, adjust the height of pin(15) so it sticks 21.5~22.2mm above the end surface of flange(10).



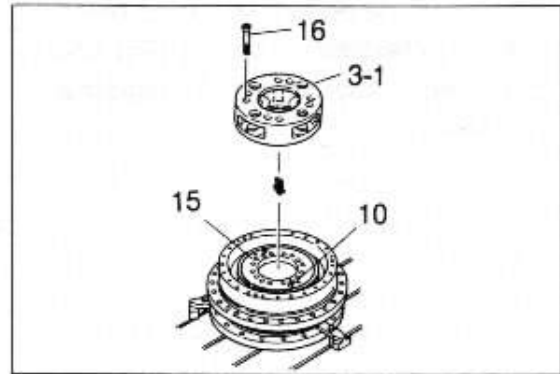
(3) Assembling the holder C

- ① Fit the same number of shims(14) used at disassembly.



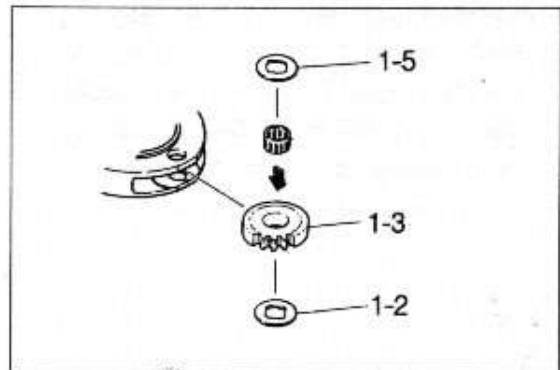
- ② Match the pin hole in holder C (3-1) to pin(15), fit holder C(3-1) to flange(10) and then tighten socket bolts(16).

* Tightening torque : 40 ~45kgf · m
Apply bolt lock(equivalent to loctite #271) to socket bolts.



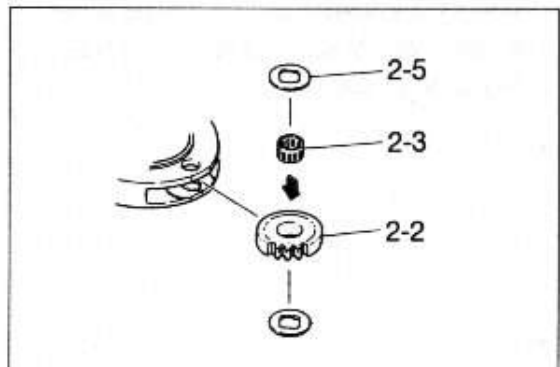
(4) Assembling the holder A assembly

- ① Fit needle bearing(1-3) to planetary gear(1-2) and place thrust plate(1-5) to the side face of the planetary gear(1-2).



(5) Assembling the holder B assembly

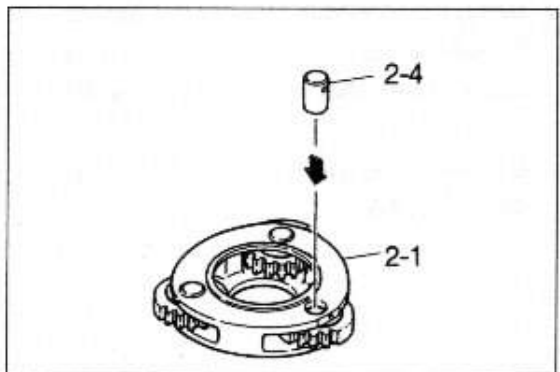
- ① Fit needle bearing(2-3) to planetary gear(2-2) and place thrust plate(2-5) to the side face of the planetary gear(2-2).



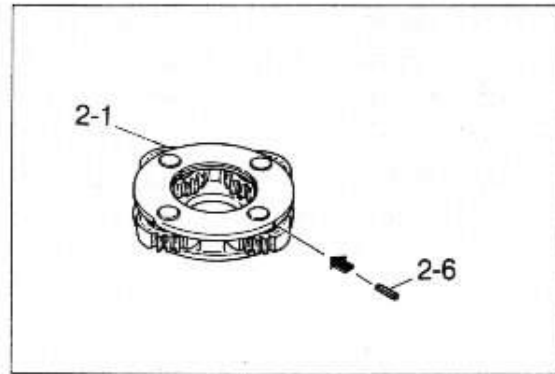
- ② Then, fit it to holder B (2-1), match hole positions and attach gear shaft(2-4).

* Since the thrust washer is thin, match holes together and use care so as not to damage shaft A when inserting it.

* Insert gear shaft B (2-4) by matching the spring hole of the gear shaft with the spring pin hole of holder B. Confirm that planetary gear A turns smoothly.

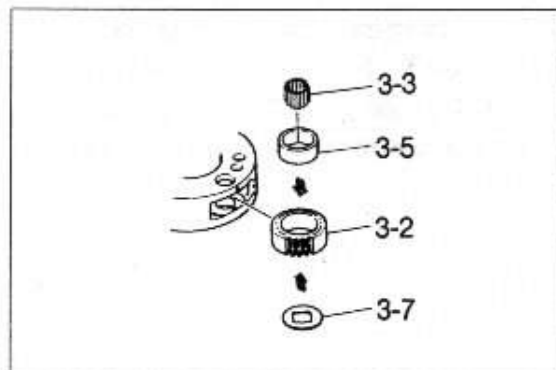


- ③ Knock spring pin(2-6) till it sinks below the outer perimeter of holder B(2-1), and then caulk four diagonally opposite positions.

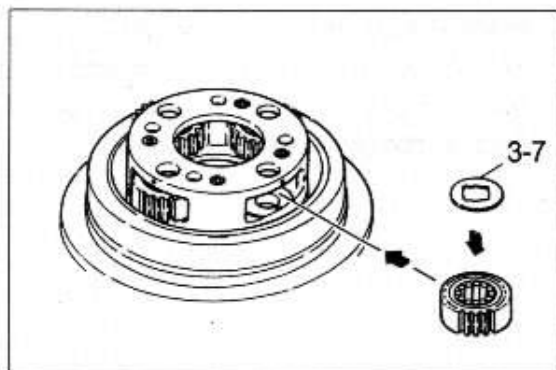


(6) Assembling the holder C assembly

- ① Apply grease to the inner surface of planetary gear C put it under thrust washer(3-7) and fit the floating bushing (3-5). Apply grease to eighteen bar-shape rollers(3-3) and assemble it.

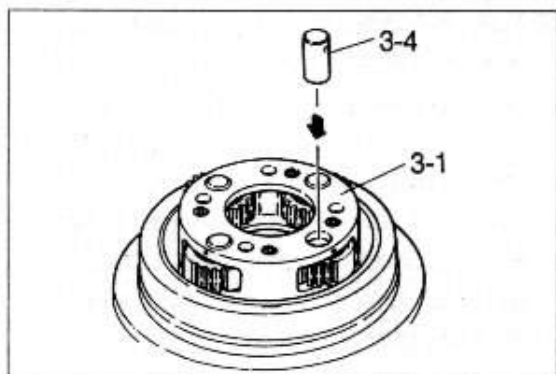


- ② Mount thrust washer(3-7) to the top, fix it to holder C(3-1) and match it to the hole of gear shaft(3-4).

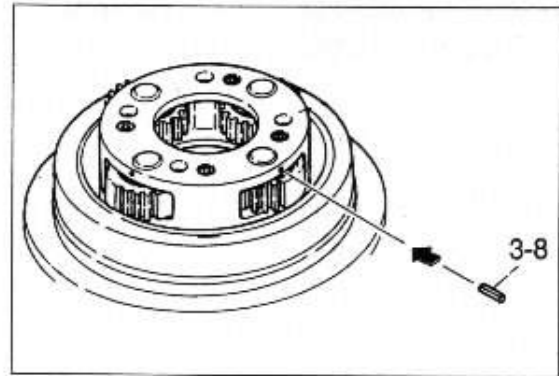


- ③ Match the spring pin hole of gear shaft C to the spring hole of holder C and insert gear shaft C (3-4) into holder C(3-1).

* Confirm that planetary gear C(3-2) turns smoothly.

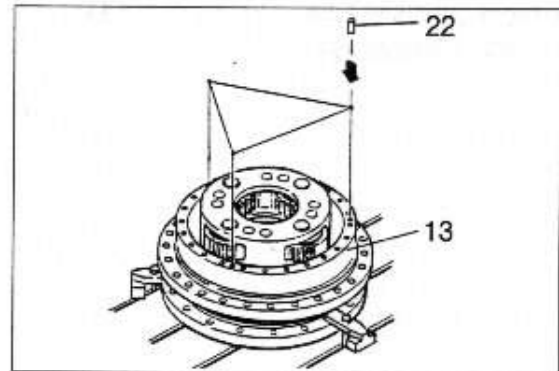


- ④ Knock spring pin (3-8) till it sinks below the outer perimeter of holder C and caulk four diagonally opposite positions.

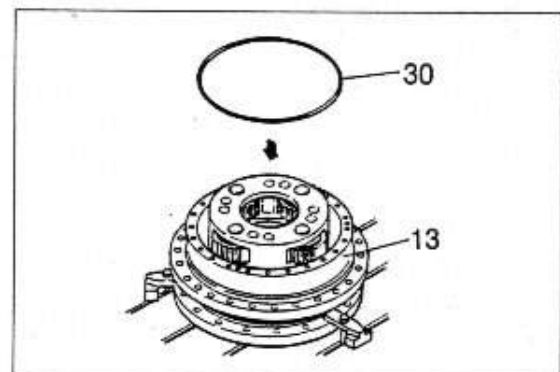


(7) Assembling the ring gear

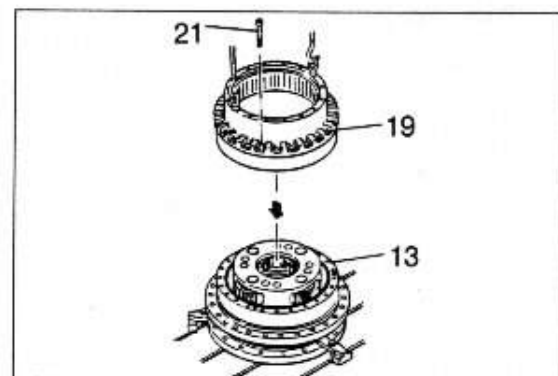
- ① Knock three pins (22) into housing (13).
* Adjust so pin (22) sticks 22~22.5mm above housing(13).



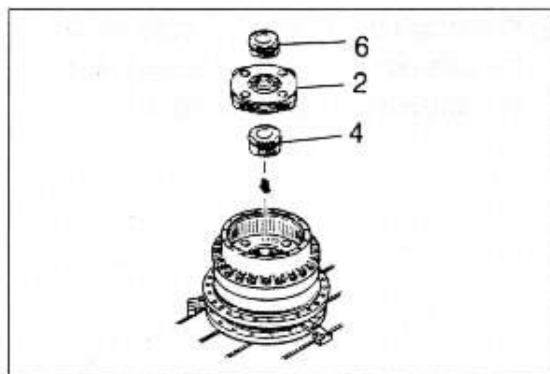
- ② Apply grease to O-ring (30) and fit it to housing (13).



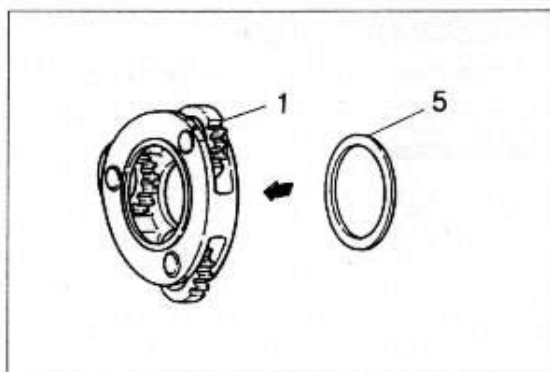
- ③ Fit ring gear (19) to housing (13) and fasten them together with socket bolts (21).



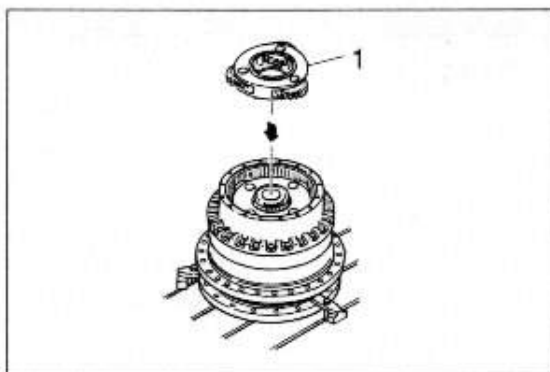
- (8) Attach sun gear C(8), holder B assembly (2) and sun gear B(6) in that order.



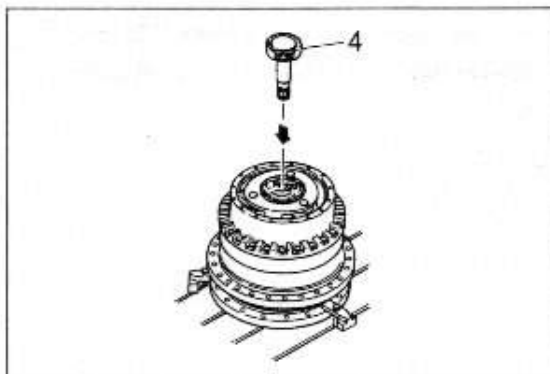
- (9) Apply grease to thrust plate (5) and fit it to holder A assembly (1).



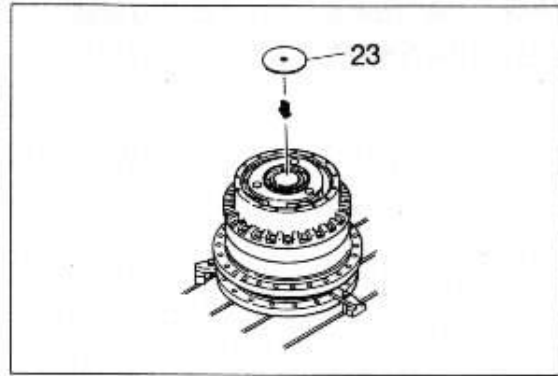
- (10) Fit holder A assembly (1).



- (11) Fit drive gear (4).

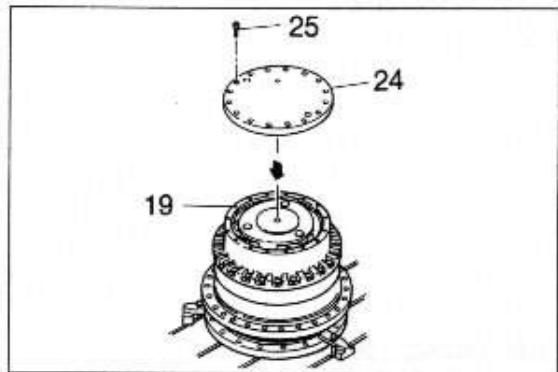


(12) Attach thrust plate (23).

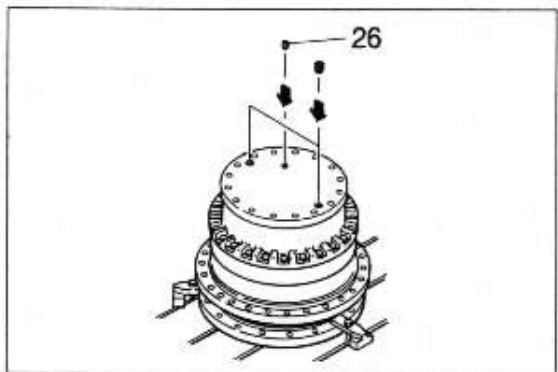


(13) Apply liquid packing three-bond #1211 evenly to the spigot joint of cover (24), fix the cover to ring gear (19) and fasten them with socket bolts (25).

※ Degrease the matching areas clean.

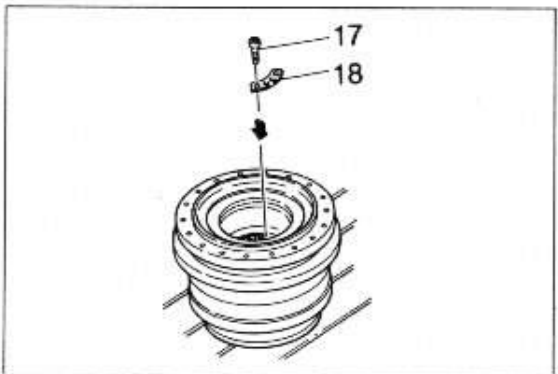


(14) Place seal tape around plugs (26) and tighten them up.

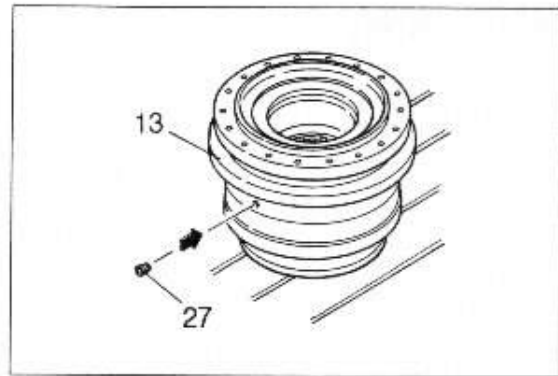


(15) Turn over the reduction unit, attach plate (18) and tighten socket bolts (17).

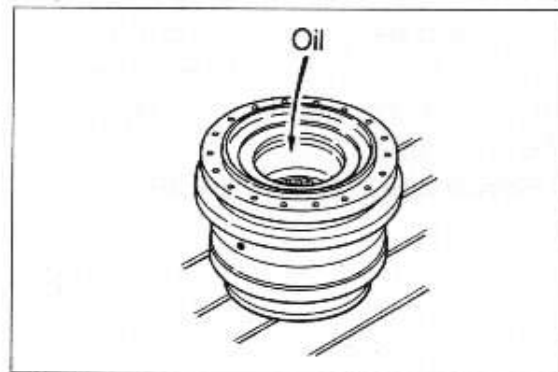
※ Degrease socket bolts and female threads sufficiently and coat socket bolts (17) with loctite #271.



(16) Place seal tape around plug (27) and tighten it to housing (13).



(17) Do not forget to fill lube oil.
Quantity : 2.6 l



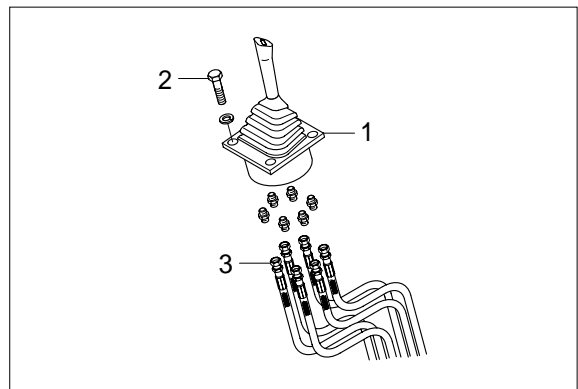
This completes assembly.

GROUP 7 RCV LEVER

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 bolt(2).
- (5) Remove the cover of the console box.
- (6) Disconnect pilot line hoses(3).
- (7) Remove the pilot valve assembly(1).
※ When removing the pilot valve assembly, check that all the hoses have been disconnected.

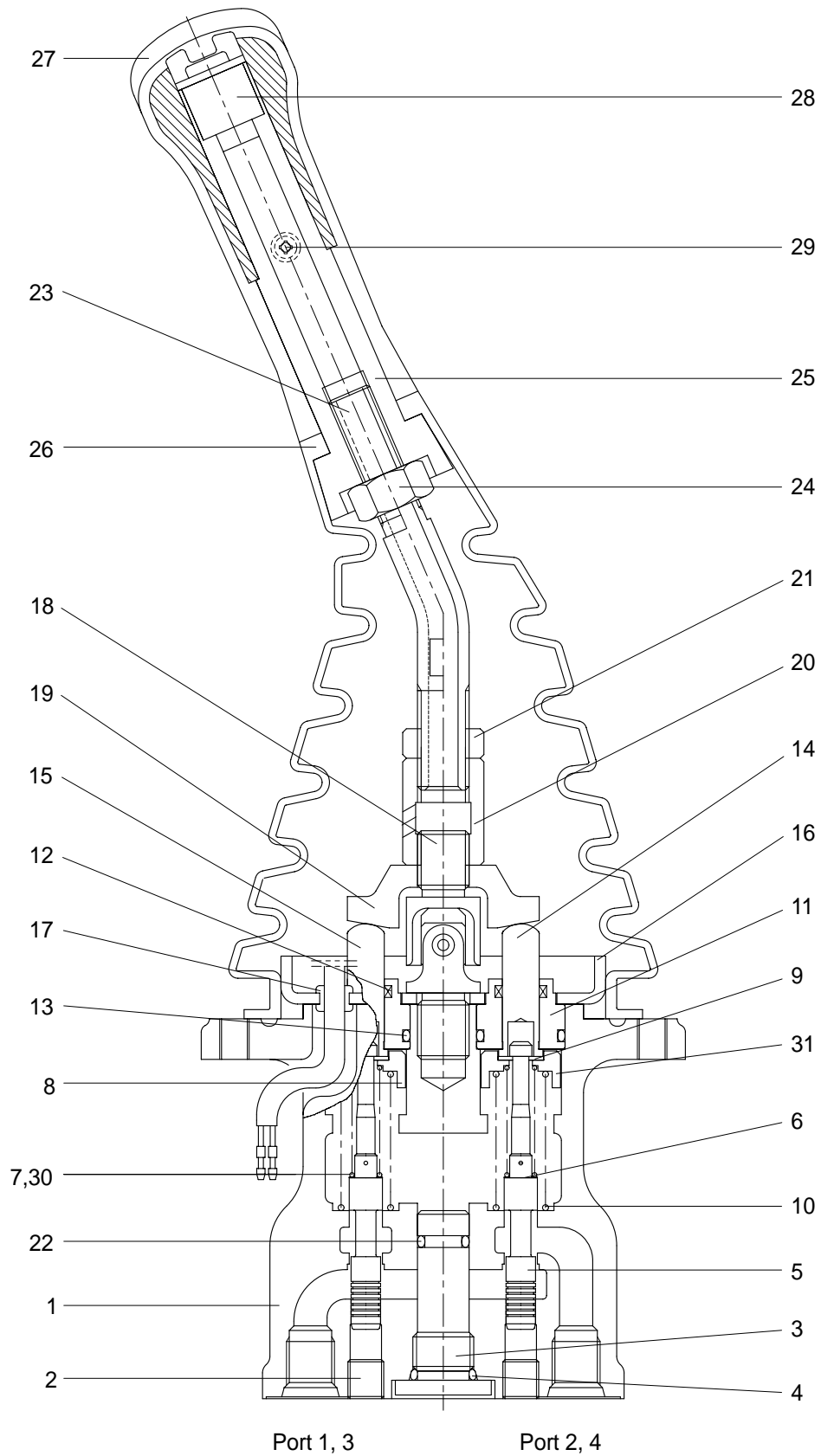


2) INSTALL

- (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. DISASSEMBLY AND ASSEMBLY

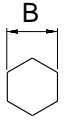
1) STRUCTURE



1	Case	12	Rod seal	22	O-ring
2	Plug	13	O-ring	23	Handle connector
3	Plug	14	Push rod	24	Nut
4	O-ring	15	Push rod	25	Insert
5	Spool	16	Plate	26	Boot
6	Shim	17	Bushing	27	Handle
7	Spring	18	Joint assembly	28	Switch assembly
8	Spring seat	19	Swash plate	29	Screw
9	Stopper	20	Adjusting nut	30	Spring
10	Spring	21	Lock nut	31	Spring seat
11	Plug				

2) TOOLS AND TIGHTENING TORQUE

(1) Tools

Tool name	Remark	
Allen wrench	6	
Spanner	22	
	27	
(+) Driver	Length 150	
(-) Driver	Width 4~5	
Torque wrench	Capable of tightening with the specified torques	

(2) Tightening torque

Part name	Item	Size	Torque	
			kgf · m	lbf · ft
Plug	2	PT 1/8	3.0	21.7
Joint	18	M14	3.5	25.3
Swash plate	19	M14	5.0±0.35	36.2±2.5
Adjusting nut	20	M14	5.0±0.35	36.2±2.5
Lock nut	21	M14	5.0±0.35	36.2±2.5
Screw	29	M 4	0.05	0.36

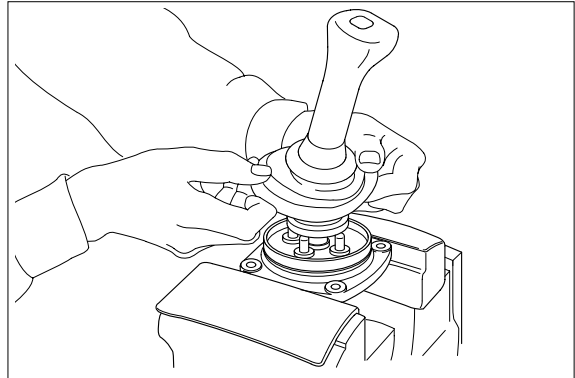
3) DISASSEMBLY

(1) Clean pilot valve with kerosene.

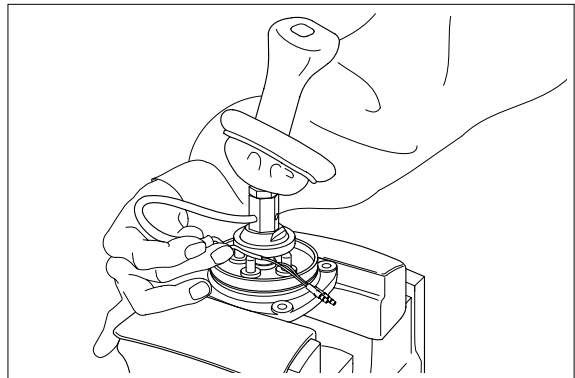
※ Put blind plugs into all ports

(2) Fix pilot valve in a vise with copper(or lead) sheets.

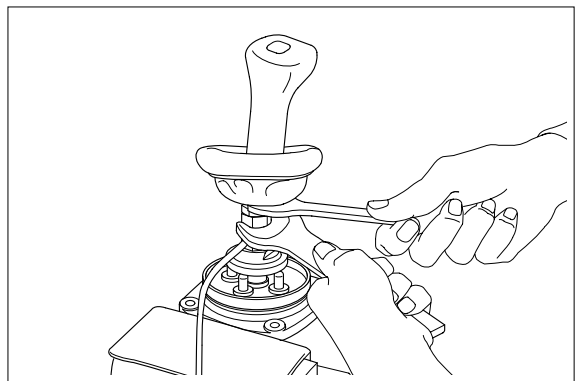
(3) Remove end of boot(26) from case(1) and take it out upwards.



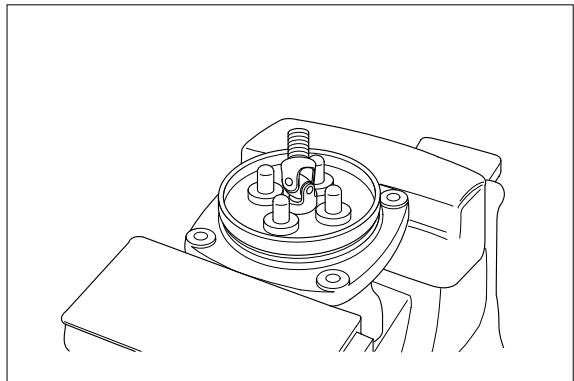
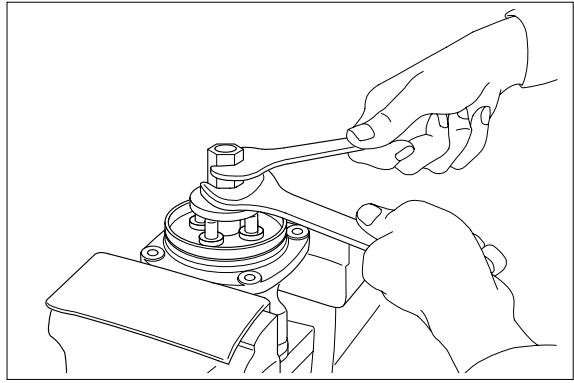
※ For valve with switch, remove cord also through hole of casing.



(4) Loosen lock nut(21) and adjusting nut(20) with spanners on them respectively, and take out handle section as one body.

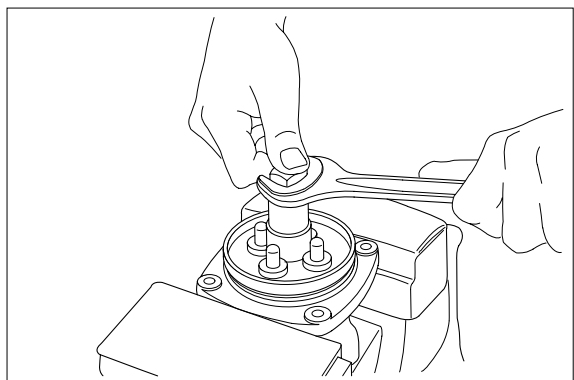
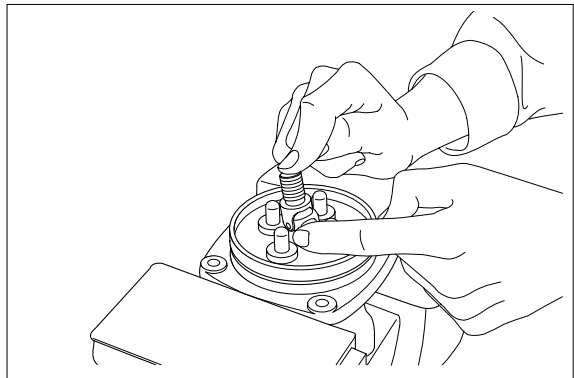


- (5) Loosen adjusting nut(20) and plate(19) with spanners on them respectively, and remove them.

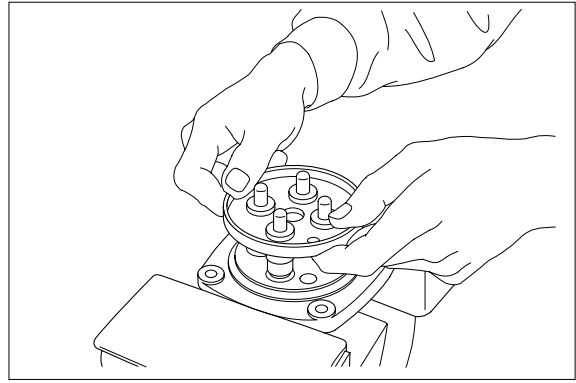


- (6) Turn joint anticlockwise to loosen it, utilizing jig(Special tool).

- ※ When return spring(10) is strong in force, plate(16), plug(11) and push rod(14, 15) will come up on loosening joint.
Pay attention to this.



(7) Remove plate(16).



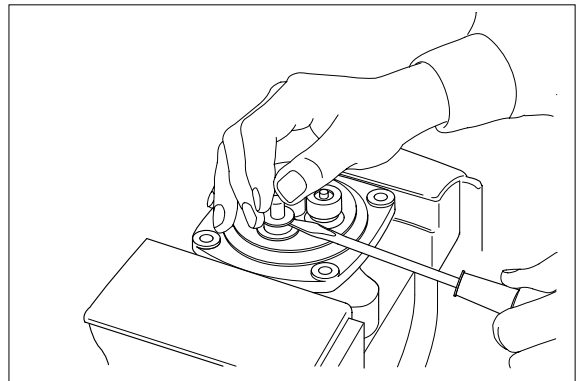
(8) When return spring(10) is weak in force, plug(11) stays in casing because of sliding resistance of O-ring.

※ Take it out with minus screwdriver.

Take it out, utilizing external periphery groove of plug and paying attention not to damage it by partial loading.

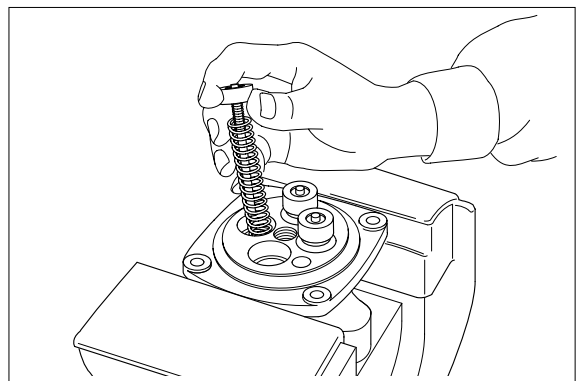
※ During taking out, plug may jump up due to return spring(10) force.

Pay attention to this.

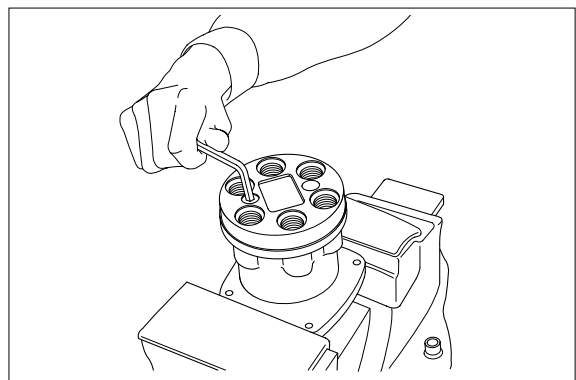


(9) Remove reducing valve subassembly and return spring(10) out of casing.

※ Record relative position of reducing valve subassembly and return springs.

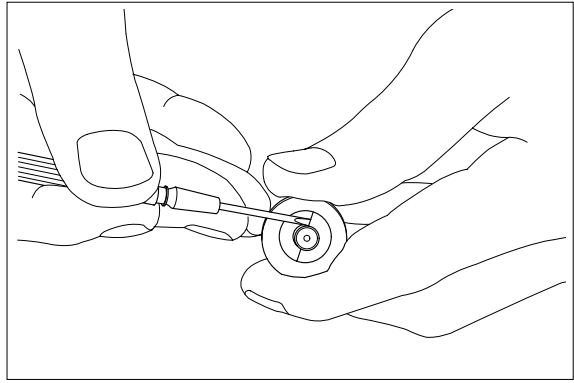


(10) Loosen hexagon socket head plug(2) with hexagon socket screw key.



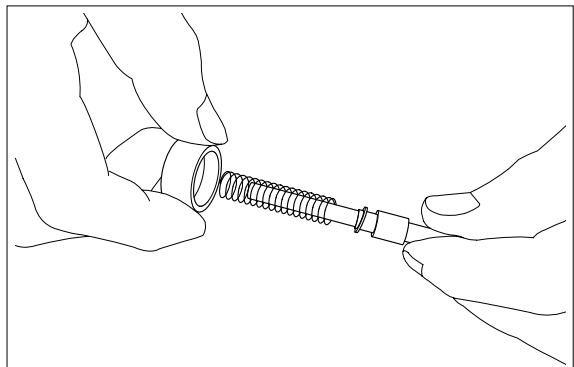
(11) For disassembling reducing valve section, stand it vertically with spool(5) bottom placed on flat workbench. Push down spring seat(8, 31) and remove two pieces of semicircular stopper(9) with tip of small minus screwdriver.

- ※ Pay attention not to damage spool surface.
- ※ Record original position of spring seat(8, 31).
- ※ Do not push down spring seat more than 6mm.

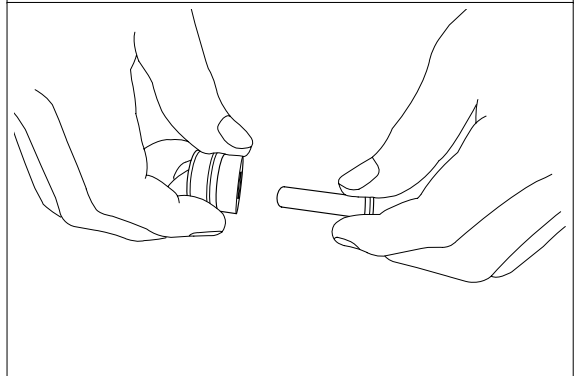


(12) Separate spool(5), spring seat(8, 31), spring(7, 30) and shim(6) individually.

- ※ Until being assembled, they should be handled as one subassembly group.

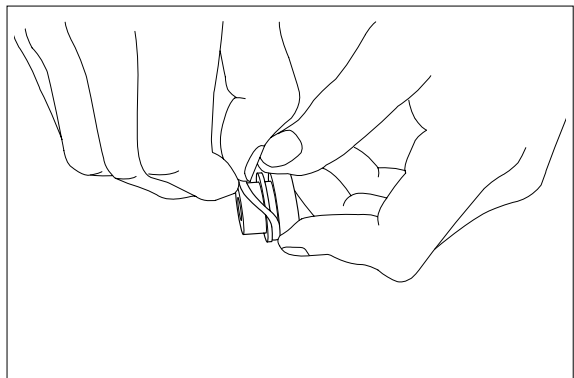


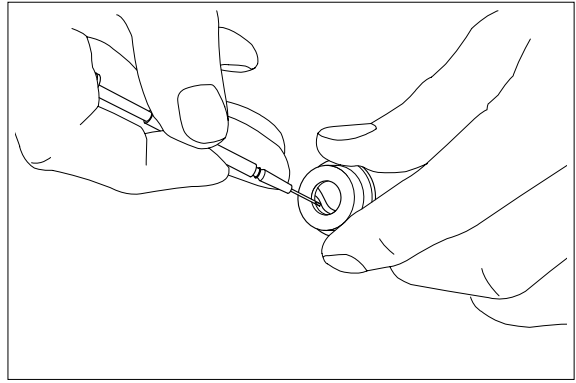
(13) Take push rod(14, 15) out of plug(11).



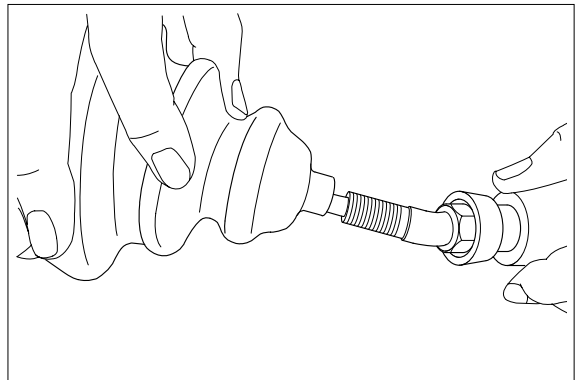
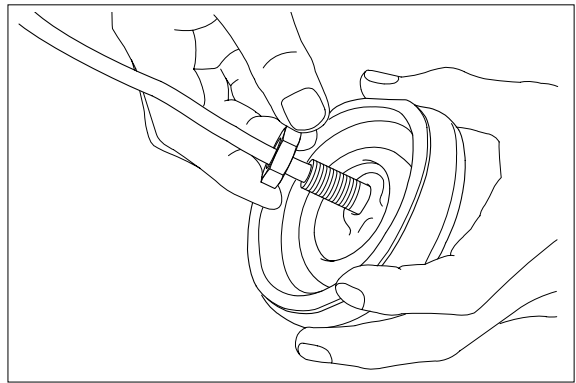
(14) Remove O-ring(13) and seal(12) from plug(11).

Use small minus screwdriver or so on to remove this seal.





(15) Remove lock nut(21) and then boot(26).



(16) Cleaning of parts

- ① Put all parts in rough cleaning vessel filled with kerosene and clean them (Rough cleaning)
 - ※ If dirty part is cleaned with kerosene just after putting it in vessel, it may be damaged. Leave it in kerosene for a while to loosen dust and dirty oil.
 - ※ If this kerosene is polluted, parts will be damaged and functions of reassembled valve will be degraded.
Therefore, control cleanliness of kerosene fully.
- ② Put parts in final cleaning vessel filled with kerosene, turning it slowly to clean them even to their insides (Finish cleaning).
 - ※ Do not dry parts with compressed air, since they will be damaged and/or rusted by dust and moisture in air.

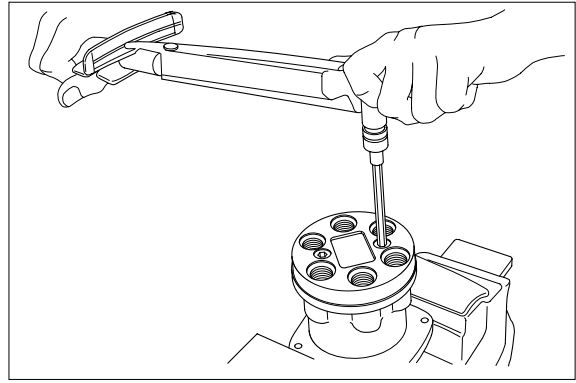
(17) Rust prevention of parts.

- Apply rust-preventives to all parts.
- ※ If left as they are after being cleaned, they will be rusted and will not display their functions fully after being reassembled.

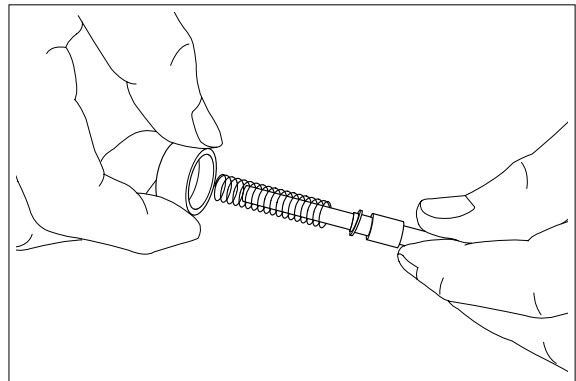
4) ASSEMBLY

(1) Tighten hexagon socket head plug(2) to the specified torque.

※ Tighten two bolts alternately and slowly.

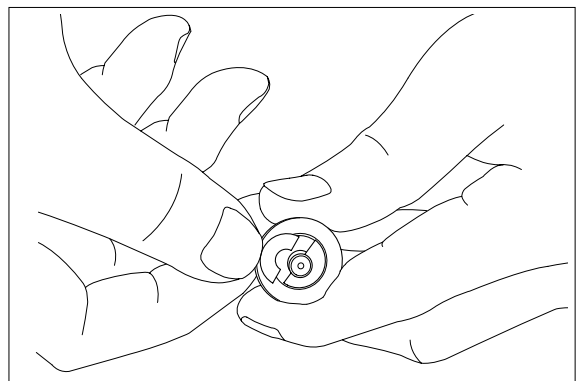


(2) Put shim(6), springs(7, 30) and spring seat(8, 31) onto spool(5) in this order.



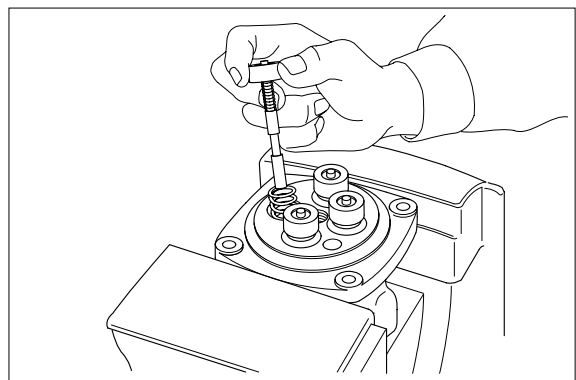
(3) Stand spool vertically with its bottom placed on flat workbench, and with spring seat pushed down, put two pieces of semicircular stopper(9) on spring seat without piling them on.

※ Assemble stopper(9) so that its sharp edge side will be caught by head of spool. Do not push down spring seat more than 6mm.

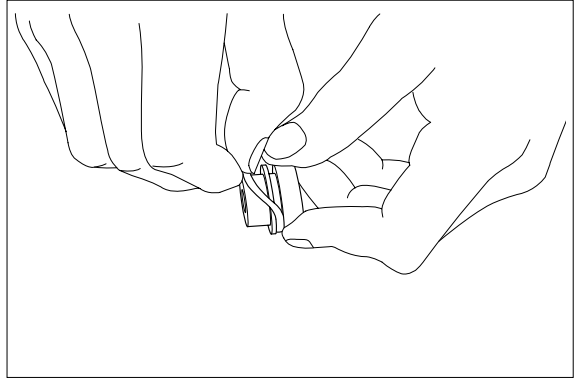


(4) Assemble spring(10) into casing. Assemble reducing valve subassembly into casing.

※ Assemble them to their original positions.

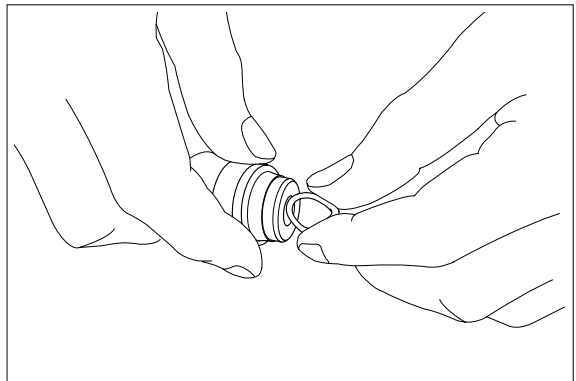


(5) Assemble O-ring(13) onto plug(11).



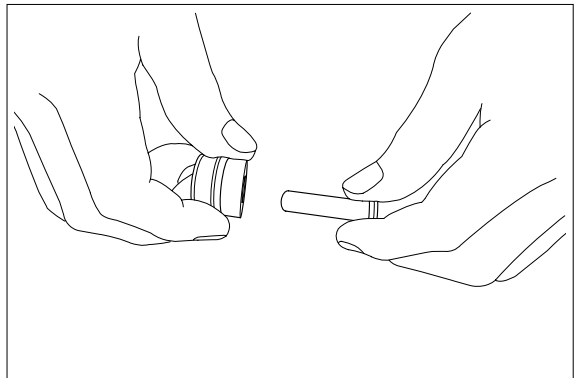
(6) Assemble seal(12) to plug(11).

※ Assemble seal in such lip direction as shown below.



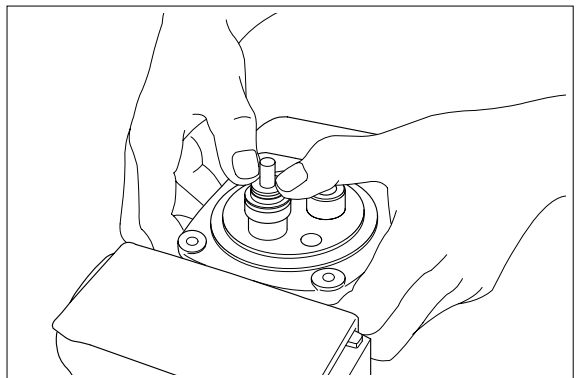
(7) Assemble push rod(14, 15) to plug(11).

※ Apply working oil on push-rod surface.

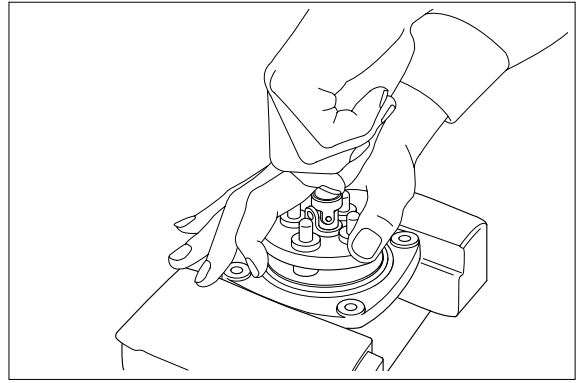


(8) Assemble plug subassembly to casing.

※ When return spring is weak in force, subassembly stops due to resistance of O-ring.

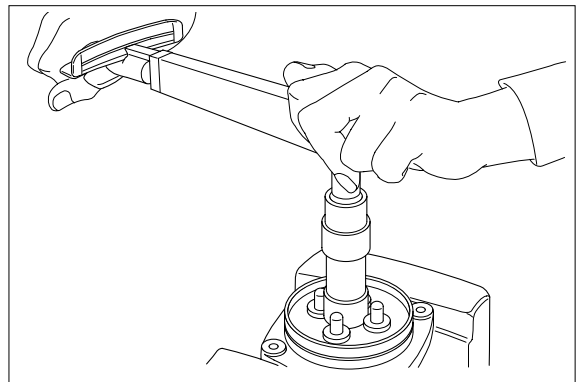


- (9) When return spring is strong in force, assemble 4 sets at the same time, utilizing plate(16), and tighten joint(18) temporarily.



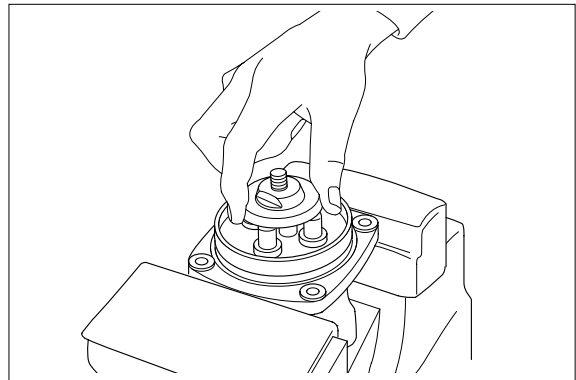
- (10) Fit plate(16).

- (11) Tighten joint(18) with the specified torque to casing, utilizing jig.



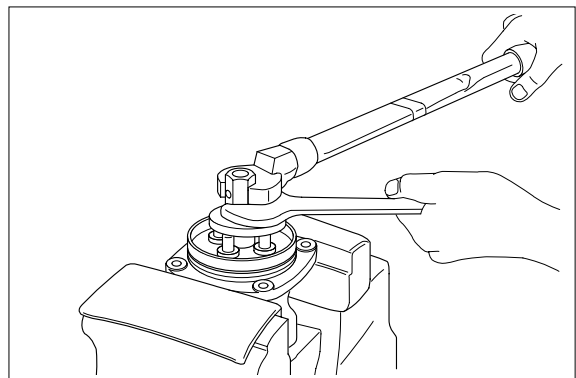
- (12) Assemble plate(19) to joint(18).

- ※ Screw it to position that it contacts with 4 push rods evenly.
- ※ Do not screw it over.

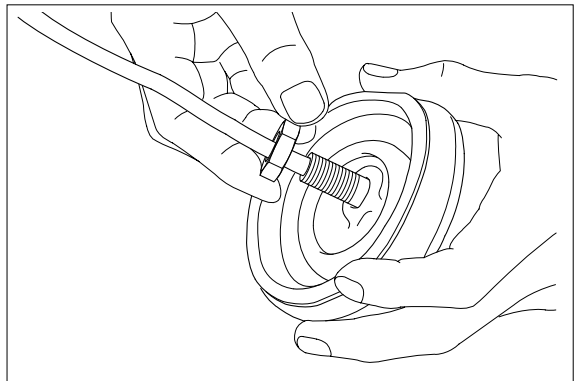
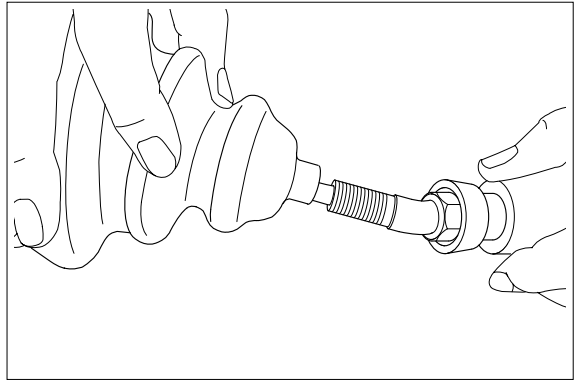


- (13) Assemble adjusting nut(20), apply spanner to width across flat of plate(19) to fix it, and tighten adjusting nut to the specified torque.

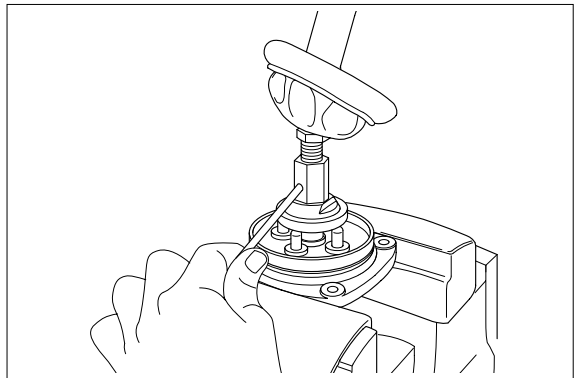
- ※ During tightening, do not change position of disk.



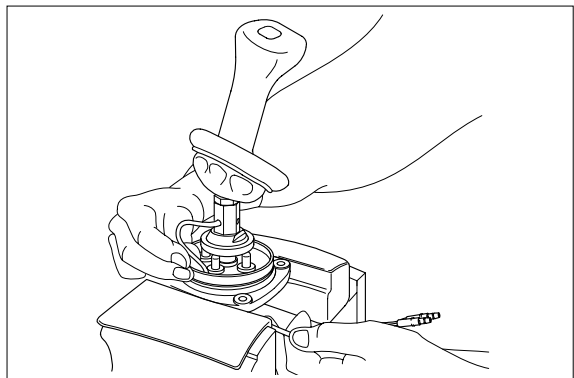
(14) Fit boot(26) and lock nut(21), and handle subassembly is assembled completely.



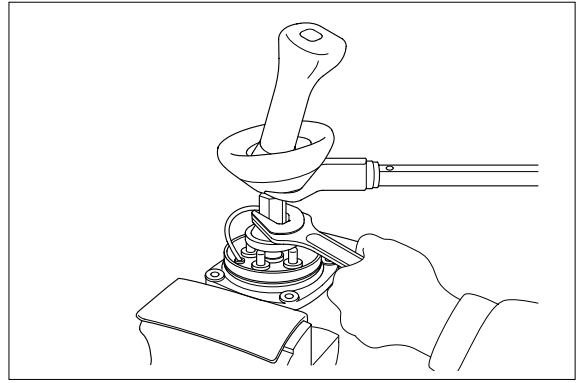
(15) Pull out cord and tube through adjusting nut hole provided in direction 60° to 120° from casing hole.



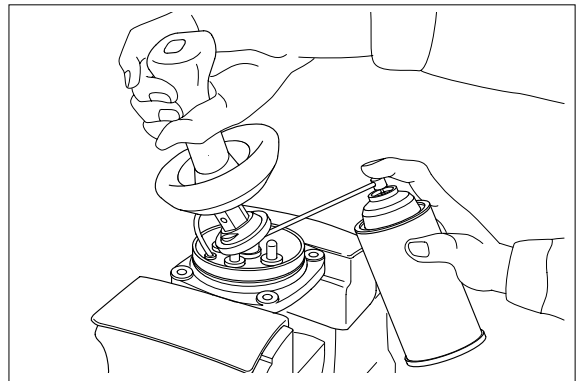
(16) Assemble bushing(17) to plate and pass cord and tube through it.
※ Provide margin necessary to operation.



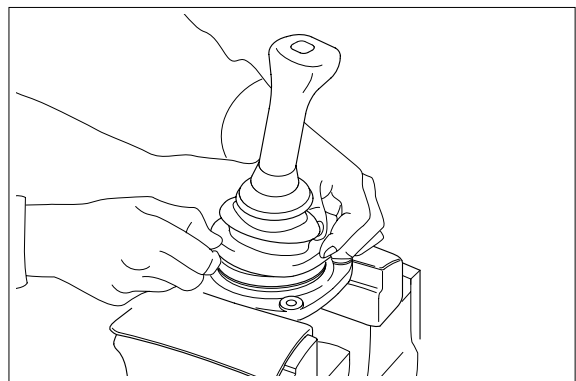
(17) Determine handle direction, tighten lock nut(21) to specified torque to fix handle.



(18) Apply grease to rotating section of joint and contacting faces of disk and push rod.



(19) Assemble lower end of bellows to casing.



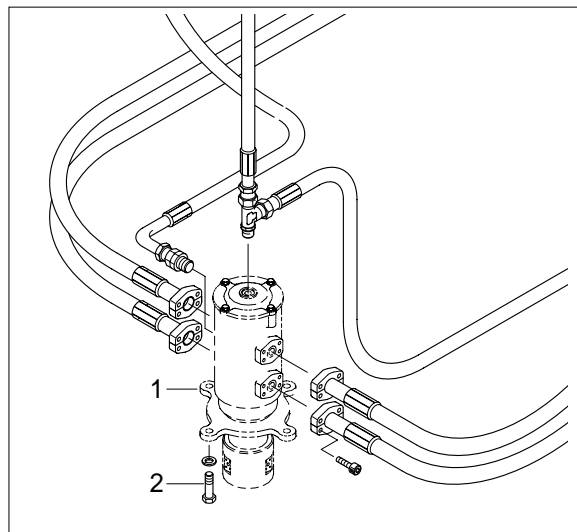
(20) Inject volatile rust-preventives through all ports and then put blind plugs in ports.

GROUP 8 TURNING JOINT

1. REMOVAL AND INSTALL

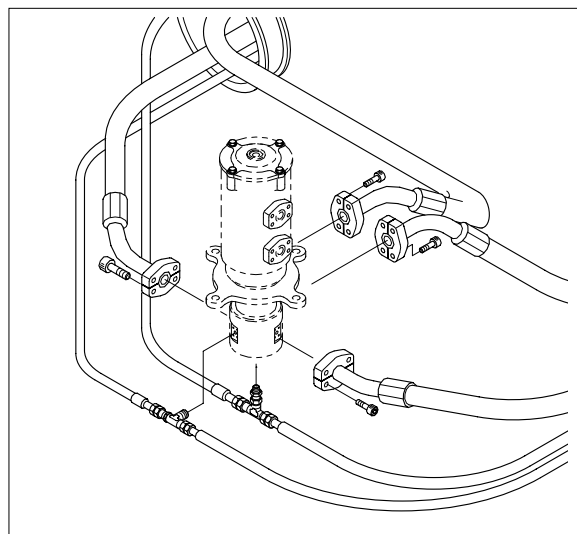
1) REMOVAL

- (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 : 36kg(79lb)
 - Tightening torque : $12.2 \pm 1.3\text{kgf} \cdot \text{m}$
($88.2 \pm 9.4\text{lb} \cdot \text{ft}$)
- (6) Remove the turning joint assembly.
 - ※ When removing the turning joint, check that all the hoses have been disconnected.



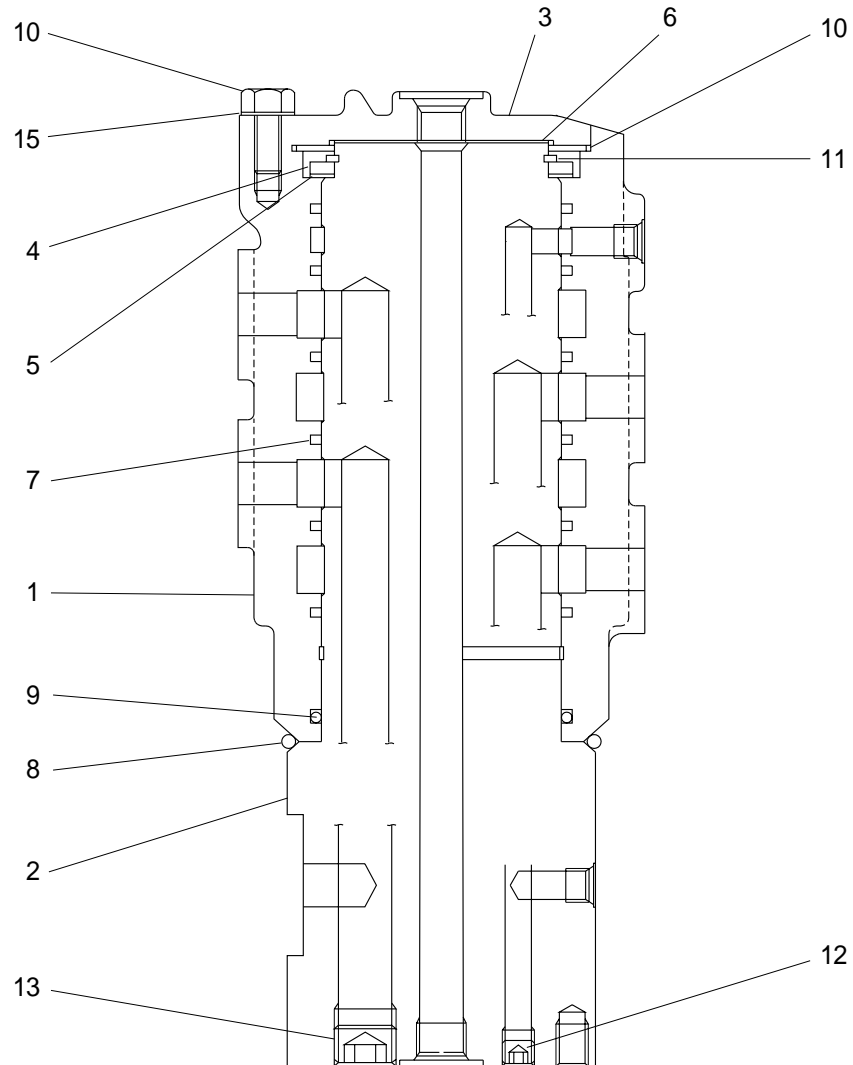
2) INSTALL

- (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

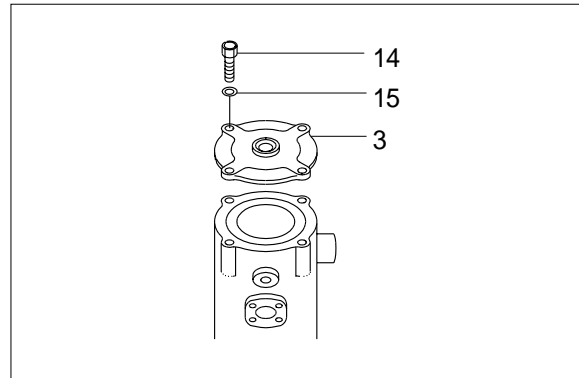
1) STRUCTURE



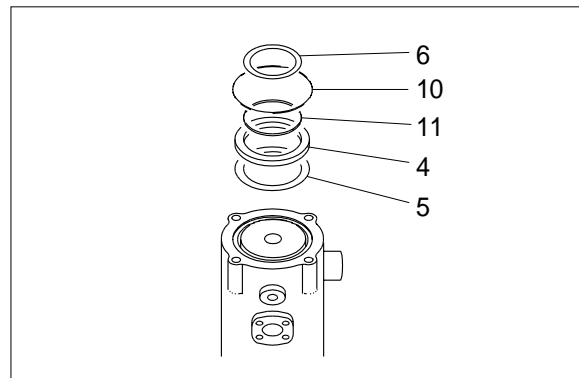
1	Hub	6	Shim	11	Retaining ring
2	Shaft assembly	7	Slipper seal	12	Plug
3	Cover	8	O-ring	13	Plug
4	Spacer	9	O-ring	14	Hexagon head bolt
5	Shim	10	O-ring	15	Spring washer

2) DISASSEMBLY

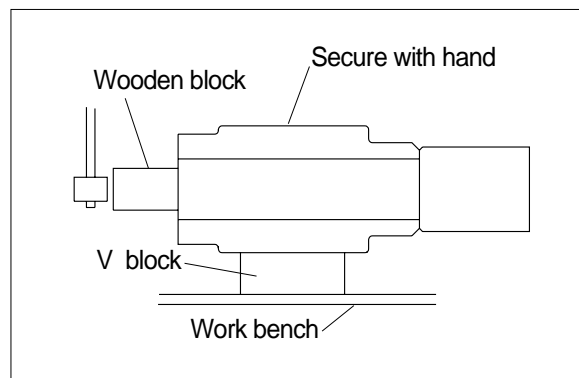
- (1) Before the disassembly, clean the turning joint.
Remove bolts(14), washer(15) and cover (3).



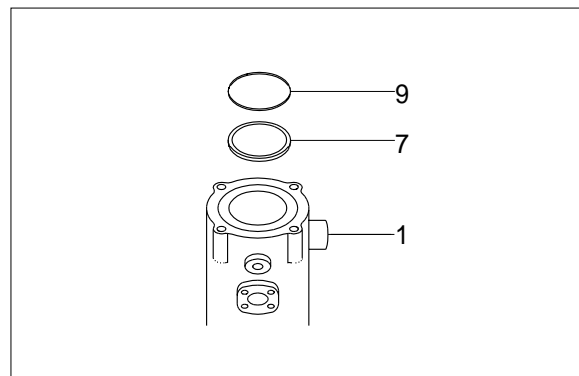
- (2) Remove shim(6) and O-ring(10).
(3) Remove retainer ring(11), spacer(4) and shim(5).



- (4) Place hub(1) on a V-block and by using a wood buffer at the shaft end, hit out shaft(2) to about 1/2 from the hub with a hammer.
※ Take care not to damage the shaft(2) when remove hub(1) or rest it sideways.
※ Put a fitting mark on hub(1) and shaft(2).



- (5) Remove six slipper seals(7) and O-ring(9) from hub(1).

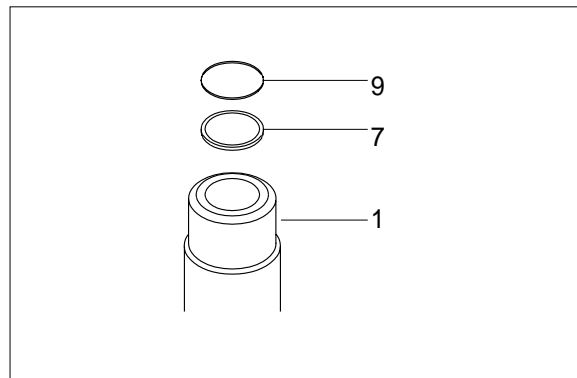


3) ASSEMBLY

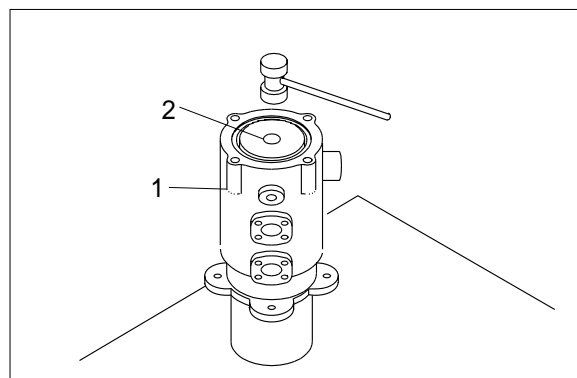
- ※ Clean all parts.
- ※ As a general rule, replace oil seals and O-ring.
- ※ Coat the sliding surfaces of all parts with engine oil or grease before installing.

(1) Fix seven slipper seal(7) and O-ring(9) to hub(1).

(2) Fit O-ring(8) to shaft(2).



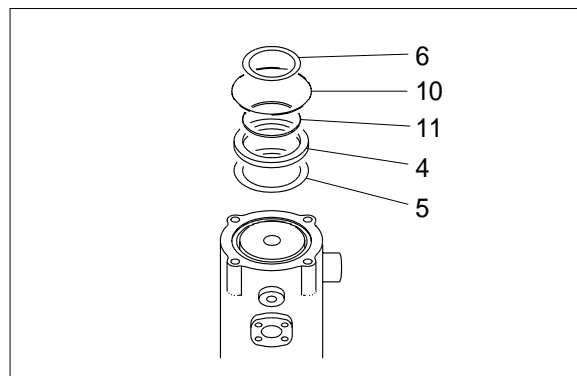
(3) Set shaft(2) on block, tap hub(1) with a plastic hammer to install.



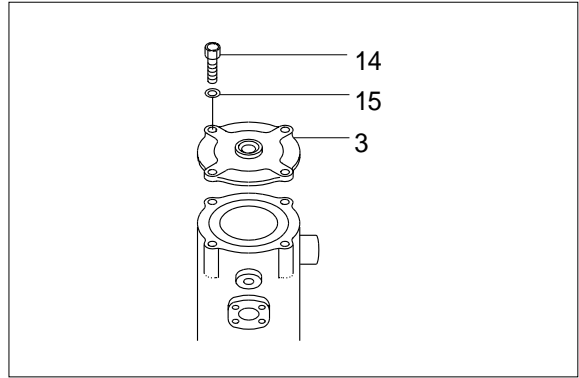
(4) Fit shim(5), spacer(4) and retainer ring(11) to shaft(2).

(5) Fit O-ring(10) to hub(1).

(6) Fit shim(6) to shaft(2).



- (7) Install cover(3) to hub(1) and tighten bolts(14).
• Torque : 5.5 ~ 12.5kgf · m(40 ~ 90lbf · ft)



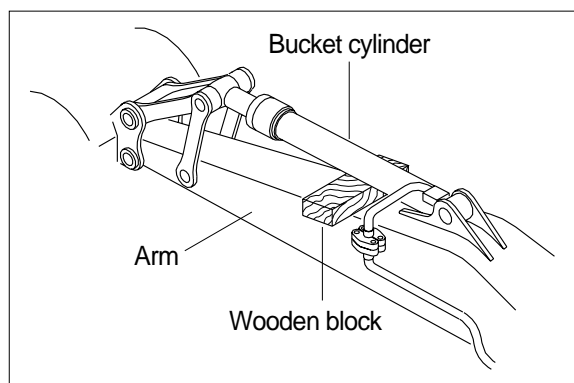
GROUP 9 BOOM, ARM AND BUCKET CYLINDER

1. REMOVAL AND INSTALL

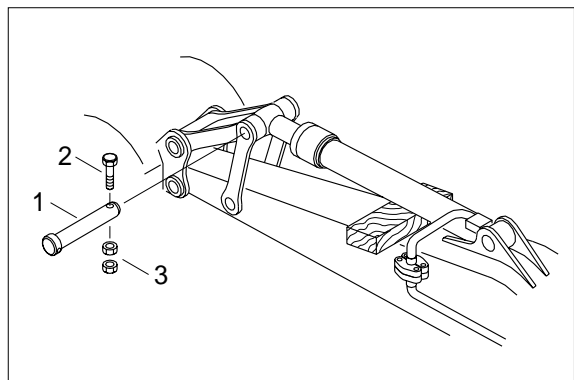
1) BUCKET CYLINDER

(1) Removal

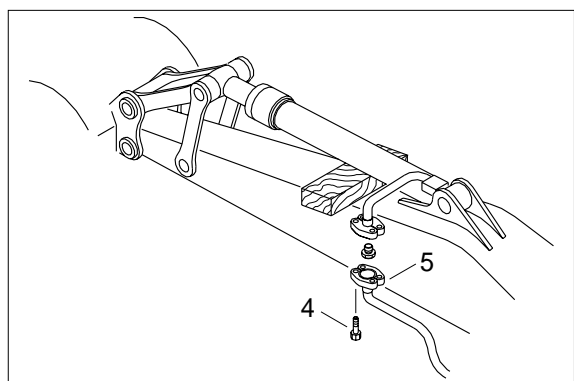
- ※ Expand the arm and bucket fully, lower the work equipment to the ground and stop the engine.
 - ※ Operate the control levers and pedals several times to release the remaining pressure in the hydraulic piping.
 - ※ Loosen the breather slowly to release the pressure inside the hydraulic tank.
 - ⚠ 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.



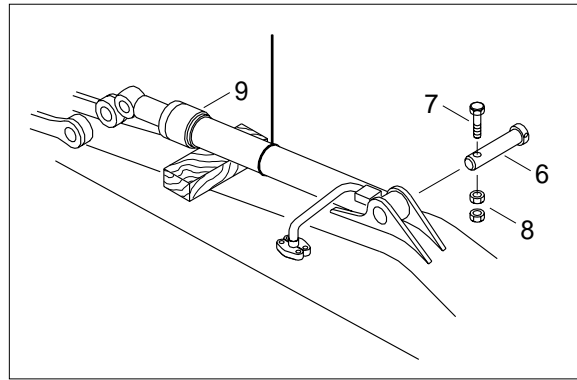
- ② Remove nut(3), bolt(2) and pull out pin(1).
- ※ Tie the rod with wire to prevent it from coming out.



- ③ Loosen socket bolt(4) to disconnect bucket cylinder hoses(5) and put plugs on cylinder pipe.



- ④ Sling bucket cylinder assembly(9), and remove nut(8), bolt(7), then pull out pin(6).
- ⑤ Remove bucket cylinder assembly(9)
 - Weight : 125kg(276lb)



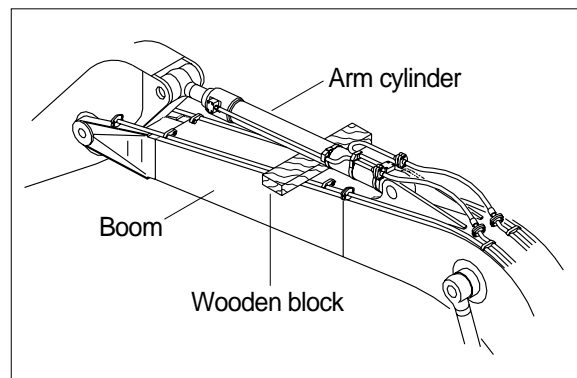
(2) Install

- 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.

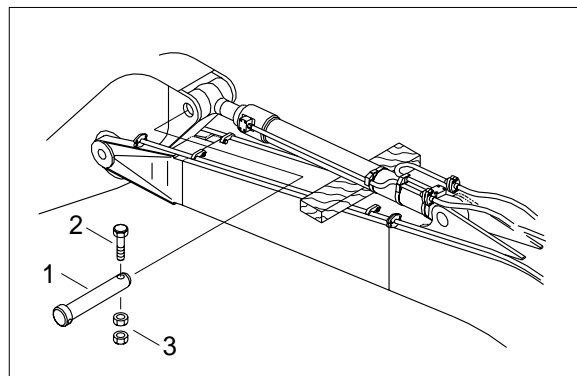
2) ARM CYLINDER

(1) Removal

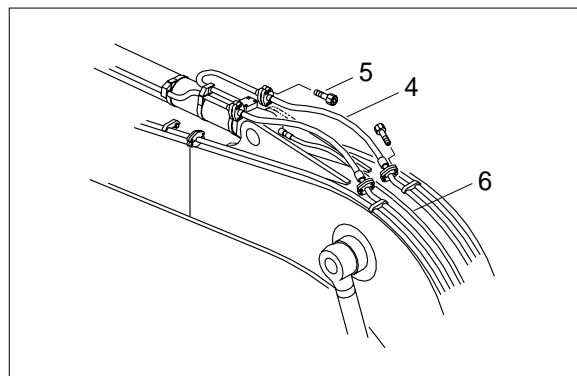
- ※ Expand the arm and bucket fully, lower the work equipment to the ground and stop the engine.
 - ※ Operate the control levers and pedals several times to release the remaining pressure in the hydraulic piping.
 - ※ Loosen the breather slowly to release the pressure inside the hydraulic tank.
 - ▲ 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.



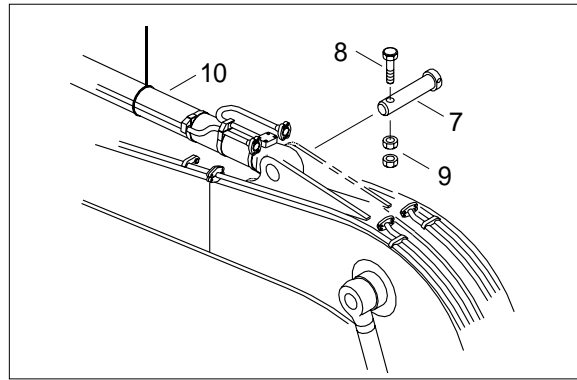
- ② Remove nut(3), bolt(2) and pull out pin(1).
- ※ Tie the rod with wire to prevent it from coming out.



- ③ Loosen socket bolt(4) to disconnect arm cylinder hose(5) and put plugs on cylinder pipe.
- ④ Disconnect greasing hoses(6).



- ⑤ Sling arm cylinder assembly(10), and remove nut(9), bolt(8), then pull out pin(7).
- ⑥ Remove arm cylinder assembly(10).
 - Weight : 183kg(403lb)



(2) Install

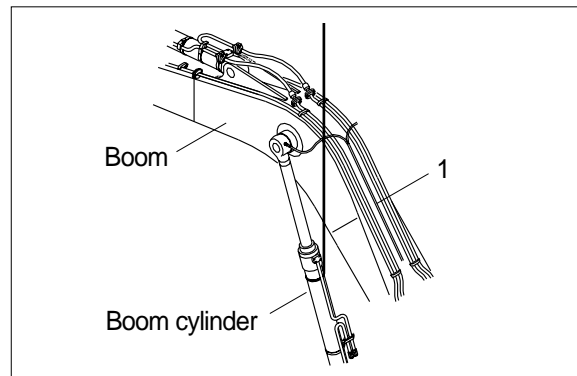
- ① Carry out installation in the reverse order to removal.
- ▲ When aligning the mounting position of the pin, do not insert your fingers in the pin hole.
- ※ Bleed the air from the arm cylinder.
 - ※ Confirm the hydraulic oil level and check the hydraulic oil leak or not.

3) BOOM CYLINDER

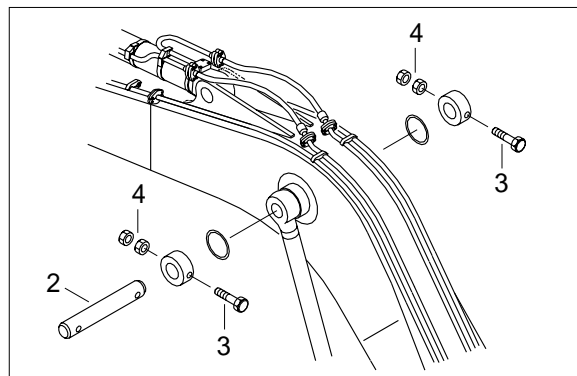
(1) Removal

- ※ 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.

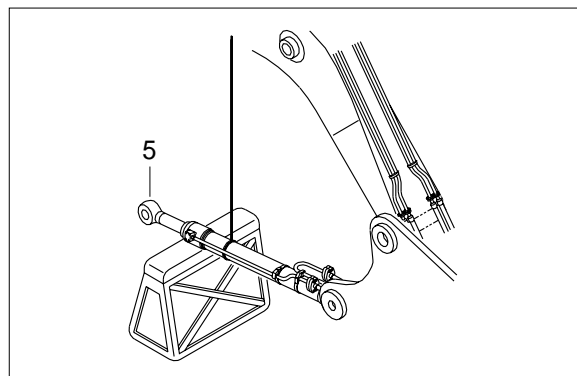
- ① Disconnect greasing hoses(1).
- ② Sling boom cylinder assembly.



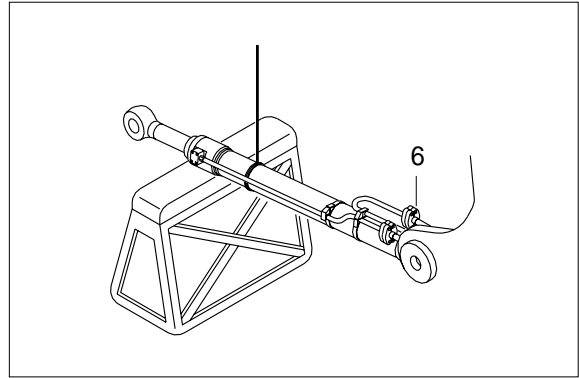
- ③ Remove nut(4), bolt(3) and pull out pin(2).
- ※ Tie the rod with wire to prevent it from coming out.



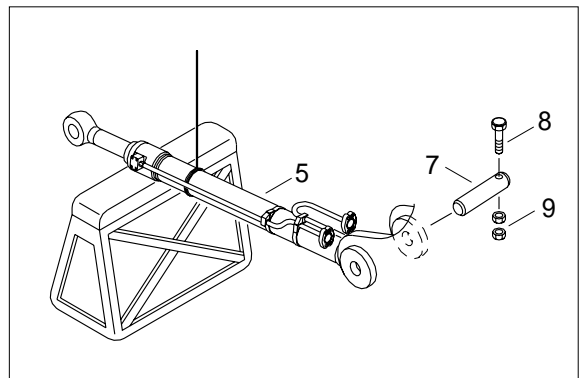
- ④ Lower the boom cylinder assembly(5) on a stand.



- ⑤ Disconnect boom cylinder hoses(6), and put plugs on cylinder pipe.



- ⑥ Remove spring(9), pin stopper(8), then pull out pin(7).
⑦ Remove boom cylinder assembly(5).
· Weight : 135kg(298lb)



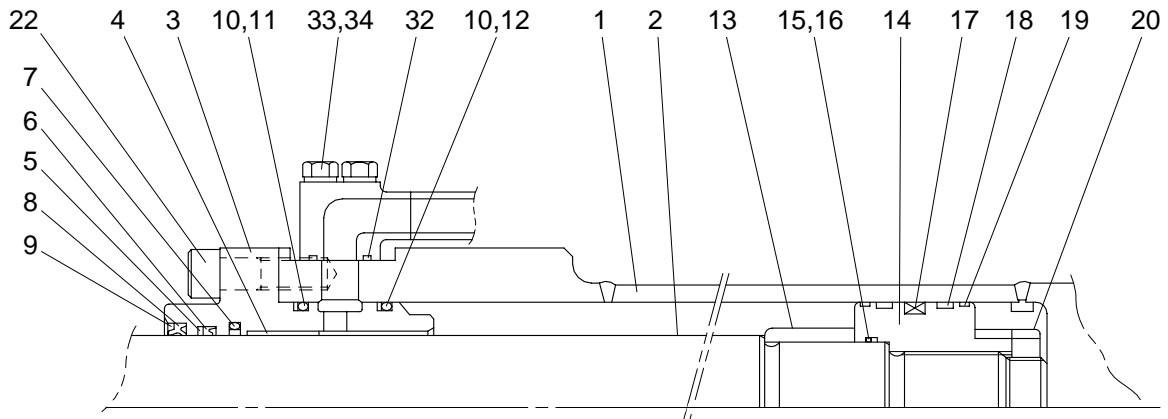
(2) Install

- 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.
 - ※ Conform the hydraulic oil level and check the hydraulic oil leak or not.

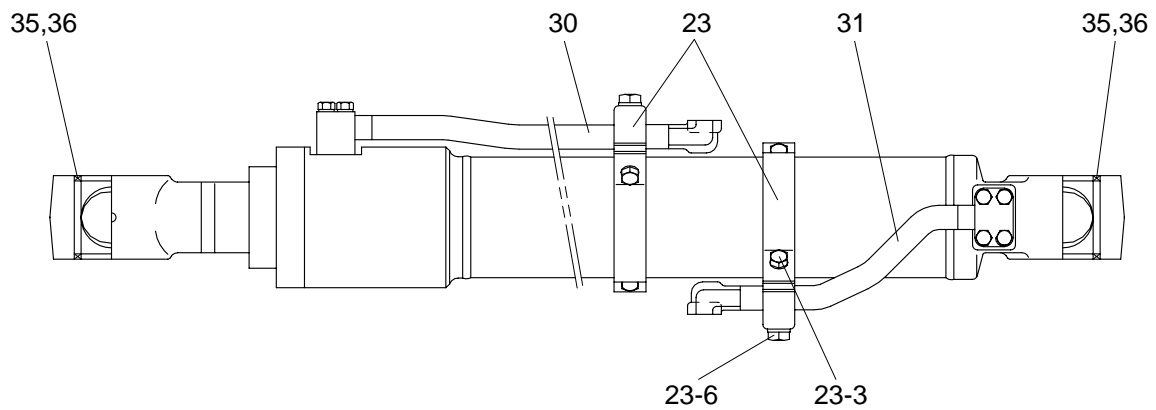
2. DISASSEMBLY AND ASSEMBLY

1) STRUCTURE

(1) Bucket cylinder

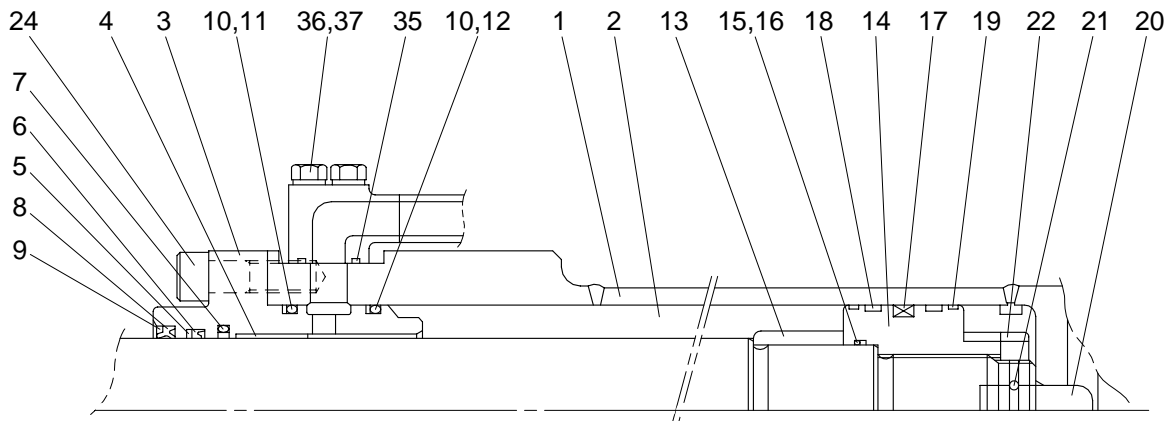


Internal detail

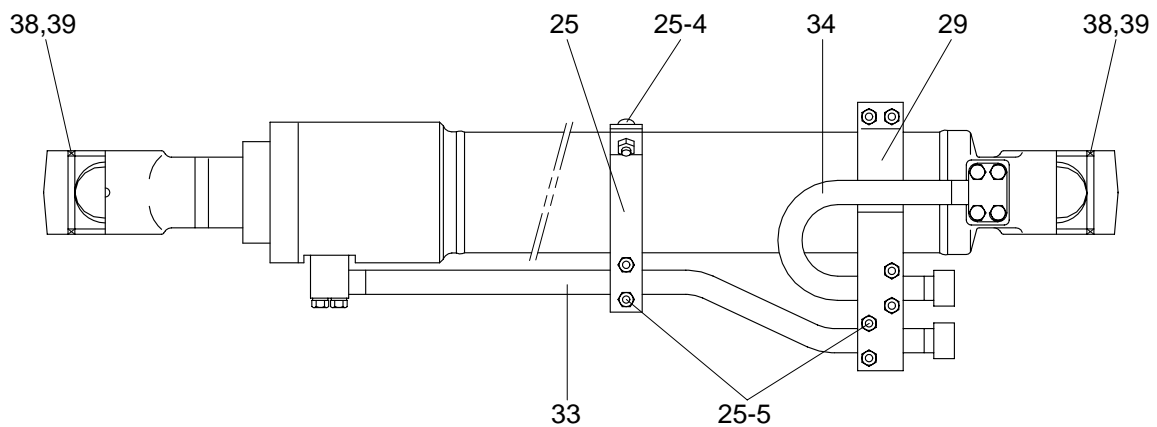


1	Tube assembly	12	Back up ring	23-3	Hexagon bolt
2	Rod assembly	13	Cushion ring	23-6	Hexagon bolt
3	Gland	14	Piston	30	Pipe assembly(R)
4	Du bushing	15	O-ring	31	Pipe assembly(B)
5	Rod seal	16	Back up ring	32	O-ring
6	Back up ring	17	Piston seal	33	Hexagon bolt
7	Step seal	18	Wear ring	34	Spring washer
8	Dust wiper	19	Dust ring	35	Pin bushing
9	Snap ring	20	Lock nut	36	Dust seal
10	O-ring	22	Hexagon socket head bolt		
11	Back up ring	23	Band assembly		

(2) Arm cylinder

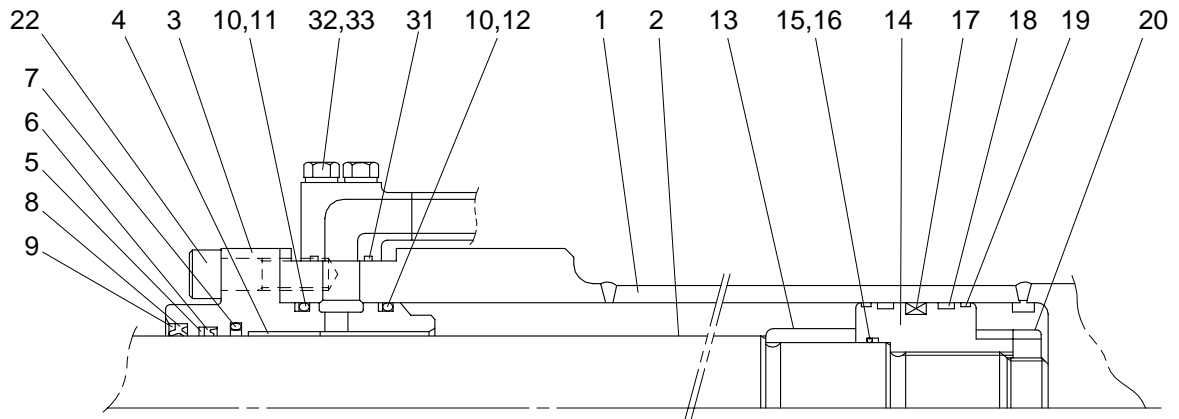


Internal detail

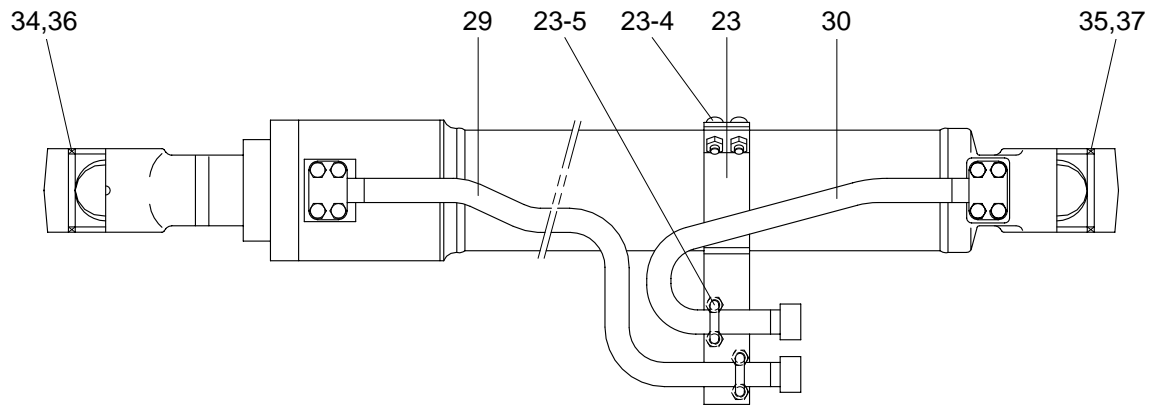


1	Tube assembly	13	Cushion ring	25-4	Hexagon bolt
2	Rod assembly	14	Piston	25-5	Hexagon nut
3	Gland	15	O-ring	29	Band assembly(B)
4	Du bushing	16	Back up ring	33	Pipe assembly(R)
5	Rod seal	17	Piston seal	34	Pipe assembly(B)
6	Back up ring	18	Wear ring	35	O-ring
7	Step seal	19	Dust ring	36	Hexagon bolt
8	Dust wiper	20	Cushion spear	37	Spring washer
9	Snap ring	21	Steel ball	38	Pin bushing
10	O-ring	22	Lock nut	39	Dust seal
11	Back up ring	24	Hexagon socket head bolt		
12	Back up ring	25	Band assembly(R)		

(3) Boom cylinder



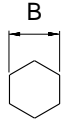
Internal detail



- | | | | | | |
|----|---------------|----|--------------------------|------|------------------|
| 1 | Tube assembly | 12 | Back up ring | 23-4 | Hexagon bolt |
| 2 | Rod assembly | 13 | Cushion ring | 23-5 | Hexagon nut |
| 3 | Gland | 14 | Piston | 29 | Pipe assembly(R) |
| 4 | Du bushing | 15 | O-ring | 30 | Pipe assembly(B) |
| 5 | Rod seal | 16 | Back up ring | 31 | O-ring |
| 6 | Back up ring | 17 | Piston seal | 32 | Hexagon bolt |
| 7 | Step seal | 18 | Wear ring | 33 | Spring washer |
| 8 | Dust wiper | 19 | Dust ring | 34 | Pin bushing |
| 9 | Snap ring | 20 | Lock nut | 35 | Pin bushing |
| 10 | O-ring | 22 | Hexagon socket head bolt | 36 | Dust seal |
| 11 | Back up ring | 23 | Band assembly | 37 | Dust seal |

2) TOOLS AND TIGHTENING TORQUE

(1) Tools

Tool name	Remark	
Allen wrench	14	
	19	
Spanner	13	
	17	
	19	
(-)Driver	Small and large sizes	
Torque wrench	Capable of tightening with the specified torques	

(2) Tightening torque

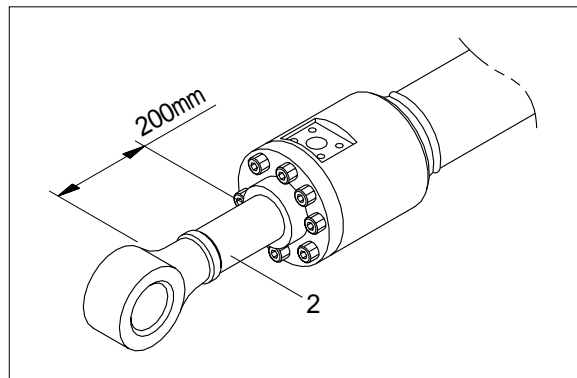
Part name		Item	Size	Torque	
				kgf · m	lbf · ft
Socket head bolt	Bucket cylinder	22	M16	23±2	166.4±14.5
	Boom cylinder				
	Arm cylinder	24	M20	46±4.6	332.7±33.3
Hexagon head bolt	Bucket cylinder	23-3	M10	3.2±0.3	23.1±2.2
	Arm cylinder	25-4			
	Boom cylinder	23-4			
	Bucket cylinder	23-6	M12	5.5±0.6	39.8±4.3
	Arm cylinder	36	M10	5.4±0.5	39.1±3.6
	Boom cylinder	32			
	Bucket cylinder	33	M10	3.2±0.3	23.1±2.2
Hexagon head nut	Arm cylinder	25-5	M10	3.2±0.3	23.1±2.2
	Boom cylinder	23-5			
Lock nut	Bucket cylinder	20	-	100±10	723.3±72.3
	Boom cylinder				
	Arm cylinder	22	-		
Piston	Bucket cylinder	14	-	150±15	1085±109
	Arm cylinder				
	Boom cylinder				

1) DISASSEMBLY

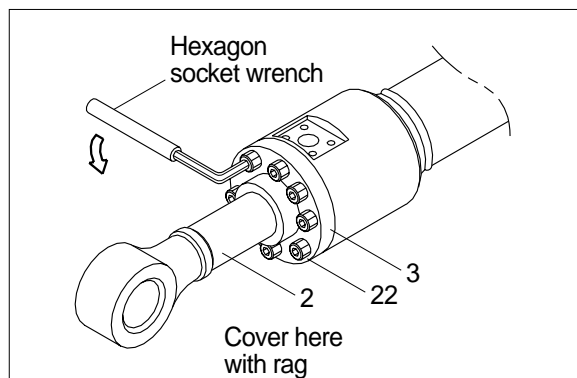
(1) Remove cylinder head and piston rod

- 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.

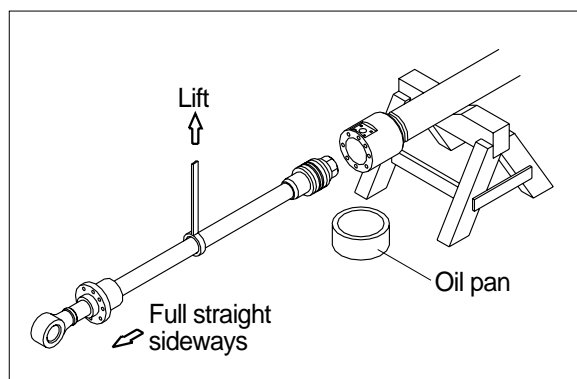
- ② Pull out piston rod(2) about 200mm(8in).
Because the piston rod is rather heavy, finish extending it with air pressure after the oil draining operation.



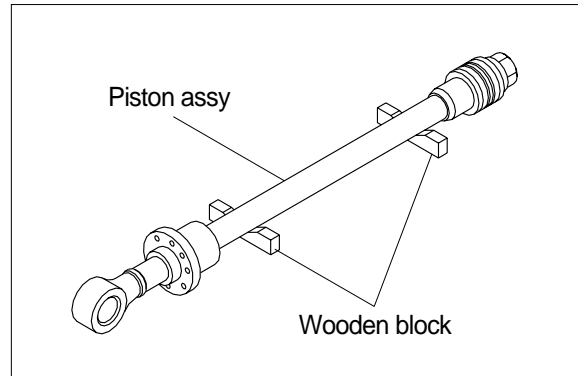
- ③ Loosen and remove socket bolts(22) of the cylinder head in sequence.
 - * Cover the extracted piston rod(2) with rag to prevent it from being accidentally damaged during operation.



- ④ Draw out gland(3) and piston rod assembly(2) together from cylinder tube (1).
 - * Since the piston rod assembly is heavy in this case, lift the tip of the piston rod(2) with a crane or some means and draw it out. However, when piston rod(2) has been drawn out to approximately two thirds of its length, lift it in its center to draw it completely.

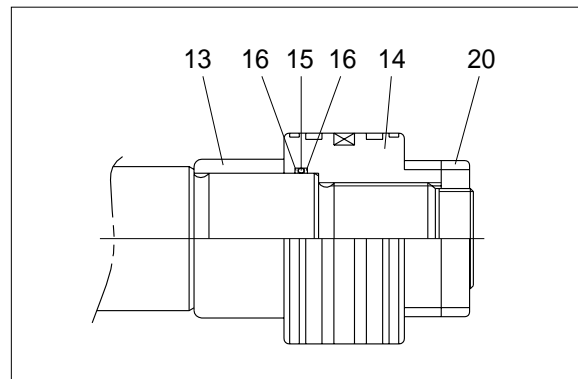


- ※ Note that the plated surface of piston rod(2) is to be lifted. For this reason, do not use a wire sling and others that may damage it, but use a strong cloth belt or a rope.
- ⑤ Place the removed piston rod assembly on a wooden V-block that is set level.
- ※ Cover a V-block with soft rag.

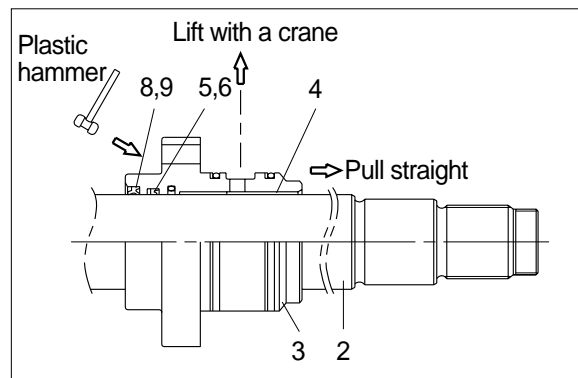


(2) Remove piston and cylinder head

- ① Remove lock nut(20).
- ※ Since lock nut(20) is tightened to a high torque, use a hydraulic and power wrench that utilizes a hydraulic cylinder, to remove the lock nut(20).
- ② Remove piston assembly(14), back up rings(16), and O-ring(15) and cushion ring(13).

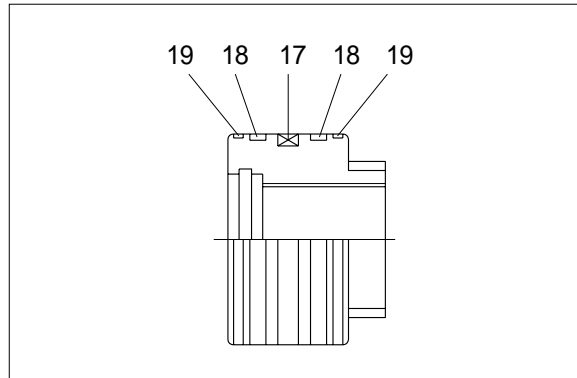


- ③ Remove the cylinder head assembly from piston rod(2).
 - ※ If it is too heavy to move, move it by striking the flanged part of gland(3) with a plastic hammer.
 - ※ Pull it straight with gland assembly lifted with a crane.
- Exercise care so as not to damage the lip of Du bushing(4) and packing (5,6,8,9) by the threads of piston rod(2).



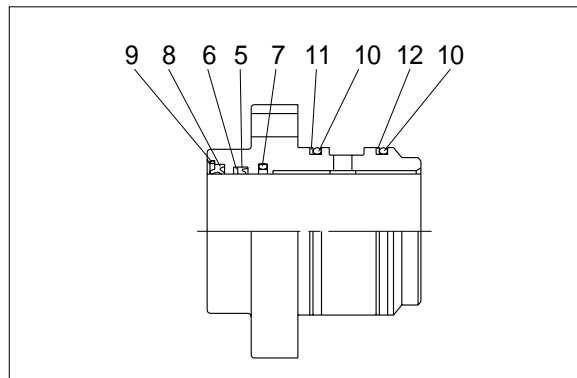
(3) Disassemble the piston assembly

- ① Remove wear ring(18).
- ② Remove dust ring(19) and piston seal(17).
- * Exercise care in this operation not to damage the grooves.



(4) Disassemble cylinder head assembly

- ① Remove back up ring(12) and O-ring (10).
- ② Remove back up ring(11) and O-ring(10).
- ③ Remove snap ring(9) and dust wiper(8).
- ④ Remove back up ring(6), rod seal(5) and step seal(7).
- * Exercise care in this operation not to damage the grooves.
- * Do not remove seal and ring, if does not damaged.

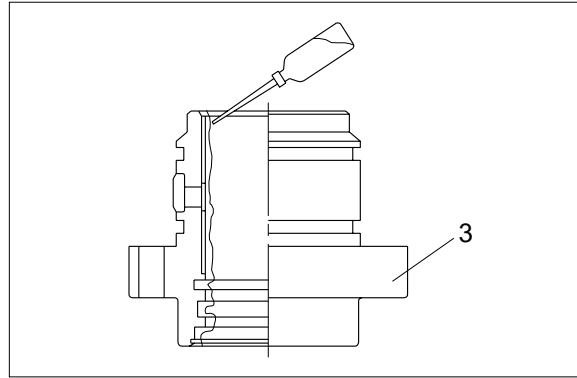


4) ASSEMBLY

(1) Assemble cylinder head assembly

※ Check for scratches or rough surfaces if found smooth with an oil stone.

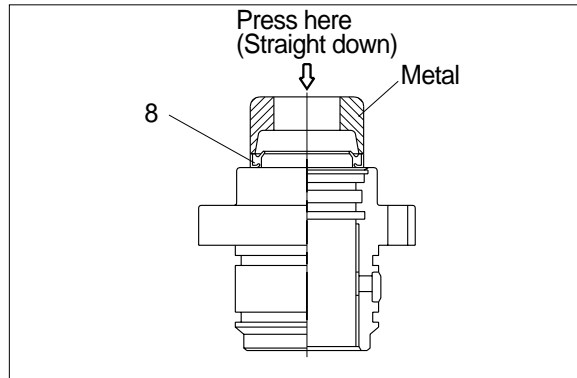
① Coat the inner face of gland(3) with hydraulic oil.



② Coat dust wiper(8) with grease and fit dust wiper(8) to the bottom of the hole of dust wiper.

At this time, press a pad metal to the metal ring of dust wiper.

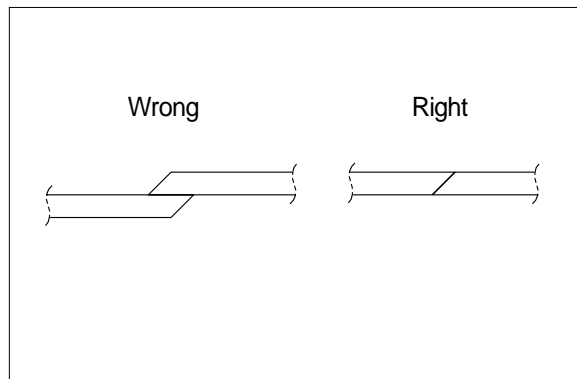
③ Fit snap ring(9) to the stop face.



④ Fit back up ring(6), rod seal(5) and step seal(7) to corresponding grooves, in that order.

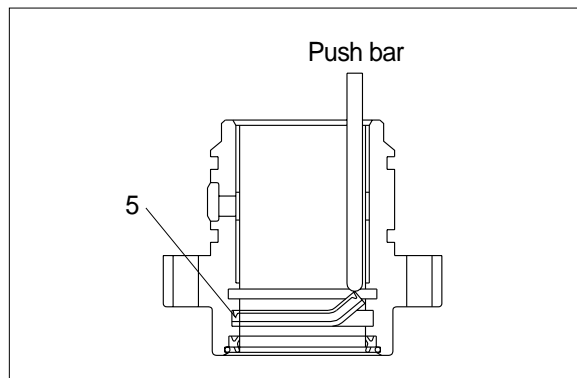
※ Coat each packing with hydraulic oil before fitting it.

※ Insert the backup ring until one side of it is inserted into groove.

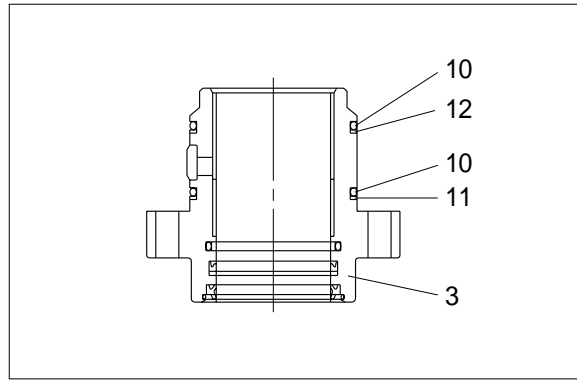


※ Rod seal(5) has its own fitting direction. Therefore, confirm it before fitting them.

※ Fitting rod seal(5) up side down may damage its lip. Therefore check the correct direction that is shown in fig.

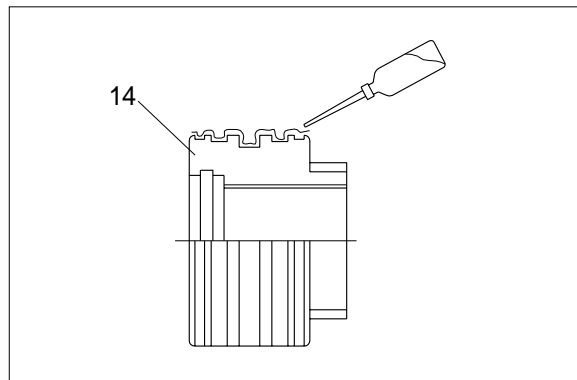


- ⑤ Fit back up ring(11,12) to gland(3).
- ※ Put the backup ring in the warm water of 30~50°C
- ⑥ Fit O-rings(10) to gland(3).

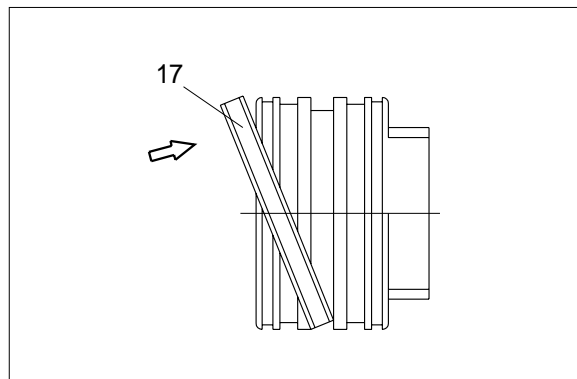


(2) Assemble piston assembly

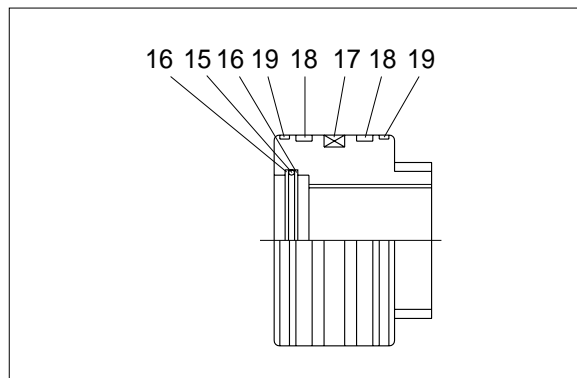
- ※ Check for scratches or rough surfaces.
If found smooth with an oil stone.
- ① Coat the outer face of piston(14) with hydraulic oil.



- ② Fit piston seal(17) to piston(14).
- ※ 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.

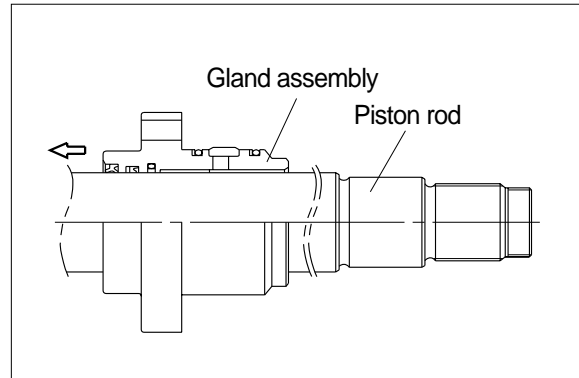


- ③ Fit wear ring(18) and dust ring(19) to piston(14).
- ④ Fit back up rings(16) and O-ring(15) to piston(14).

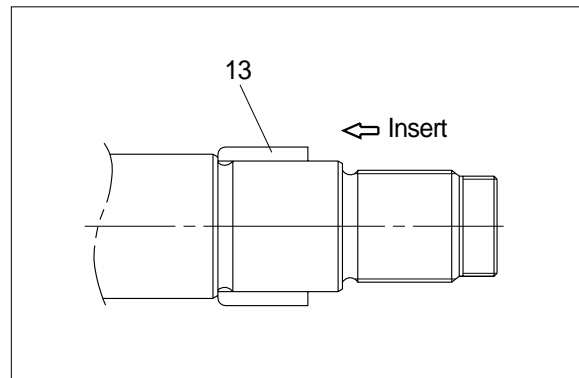


(3) Install piston and cylinder head

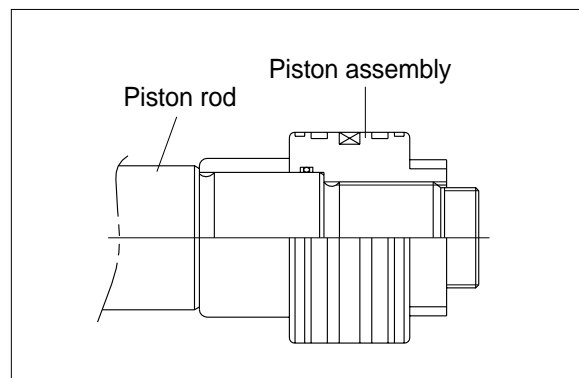
- ① Fix the piston rod assembly to the work bench.
- ② Apply hydraulic oil to the outer surface of piston rod(2), the inner surface of piston and cylinder head.
- ③ Insert cylinder head assembly to piston rod.



- ④ Insert cushion ring(13) to piston rod.
- ※ Note that cushion ring(13) has a direction in which it should be fitted.

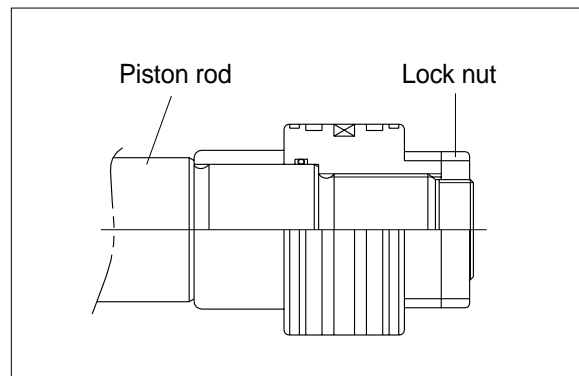


- ⑤ Fit piston assembly to piston rod(2).
- Tightening torque :
 $100 \pm 10 \text{ kgf} \cdot \text{m} (723.3 \pm 72.3 \text{ lbf} \cdot \text{ft})$



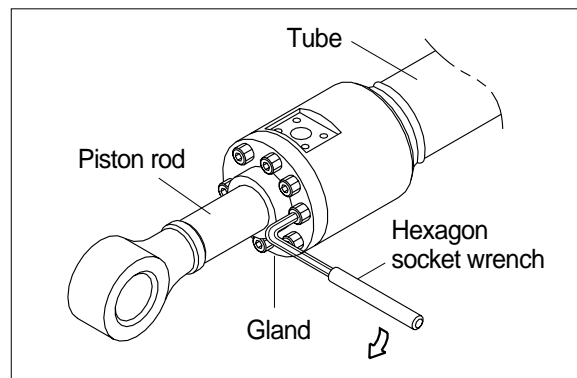
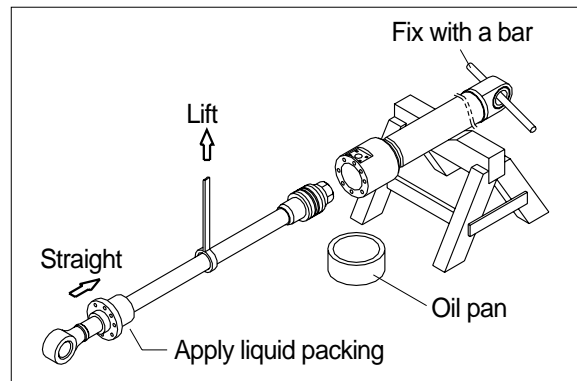
- ⑥ Fit lock nut(20) to piston rod(2).
- Tightening torque

Item	kgf · m	lbf · ft
Bucket(20)	100 ± 10	723.3 ± 72.3
Boom(20)		
Arm(22)		



(4) Overall assemble

- ① Place a V-block on a rigid work bench.
Mount the cylinder 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 piston rod assembly in to the cylinder tube assembly, while lifting and moving the piston rod assembly with a crane.
 - ※ Be careful not to damage piston seal by thread of tube assembly.
- ③ Match the bolt holes in the gland flange to the tapped holes in the cylinder tube assembly and tighten socket bolts to a specified torque.
 - ※ Refer to the table of tightening torque.

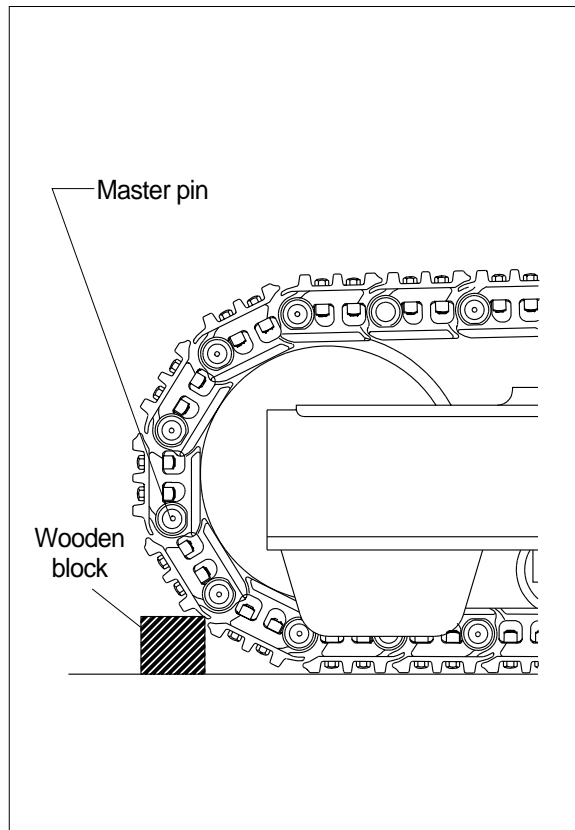


GROUP 10 UNDERCARRIAGE

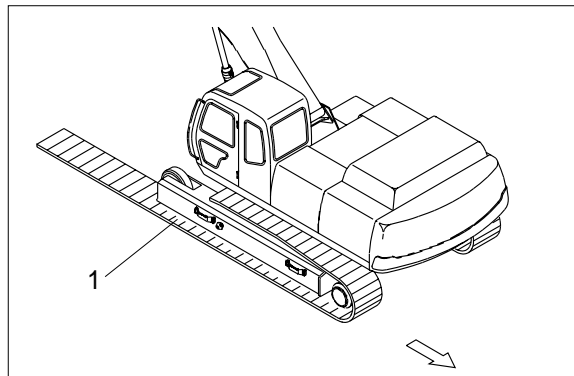
1. TRACK LINK

1) REMOVAL

- (1) Move track link until master pin is over front idler in the position put wooden block as shown.
- (2) Loosen tension of the track link.
 - ※ If track tension is not relieved when the grease valve is loosened, move the machine backwards and forwards.
- (3) Push out master pin by using a suitable tool.

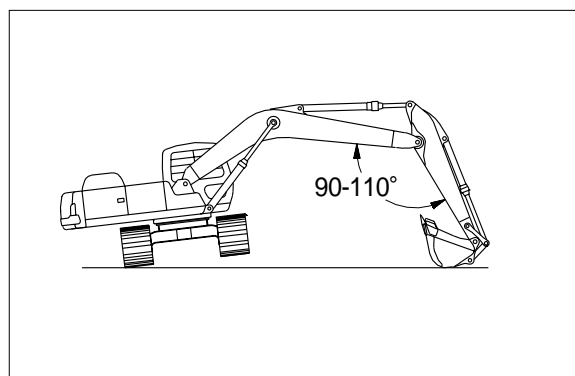


- (4) Move the machine slowly in reverse, and lay out track link assembly (1).
 - ※ Jack up the machine and put wooden block under the machine.
 - ※ Don't get close to the sprocket side as the track shoe plate may fall down on your feet.



2) INSTALL

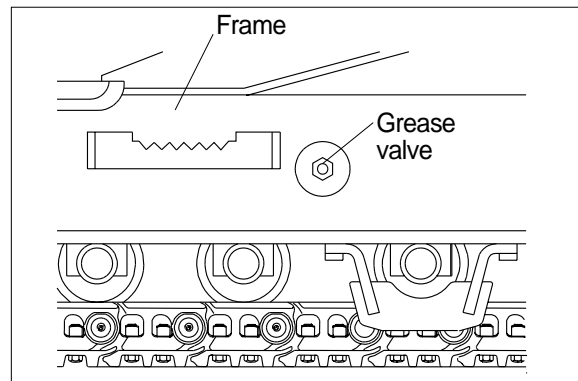
- (1) Carry out installation in the reverse order to removal.
 - ※ Adjust the tension of the track link.



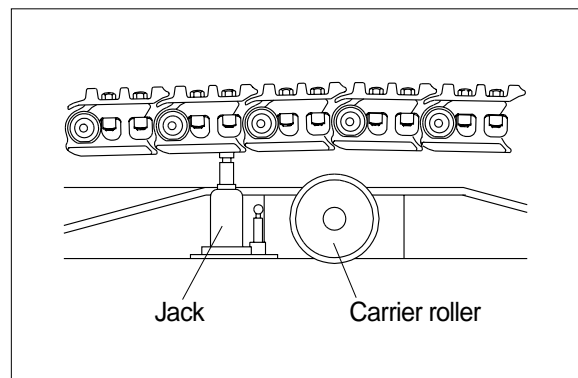
2. CARRIER ROLLER

1) REMOVAL

(1) Loosen tension of the track link.



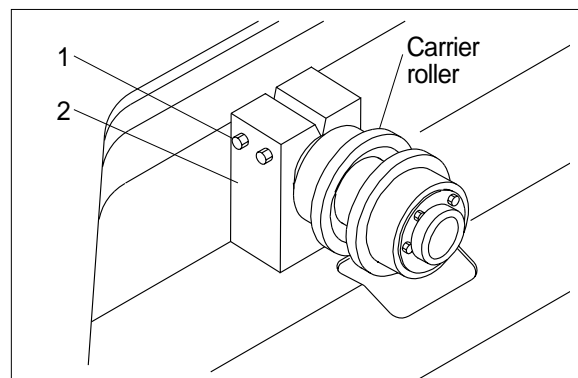
(2) Jack up the track link height enough to permit carrier roller removal.



(3) Loosen the lock nut (1).

(4) Open bracket(2) with a screwdriver, push out from inside, and remove carrier roller assembly.

• Weight : 20.6kg(45.4lb)



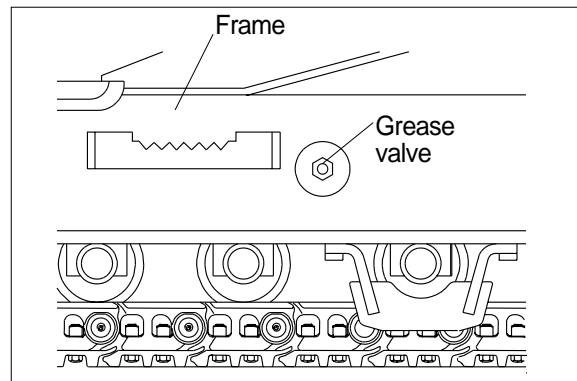
2) INSTALL

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

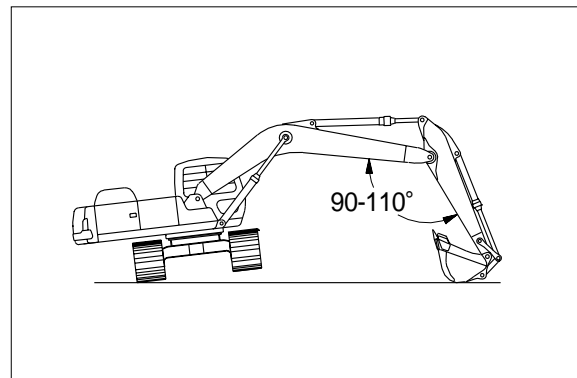
3. TRACK ROLLER

1) REMOVAL

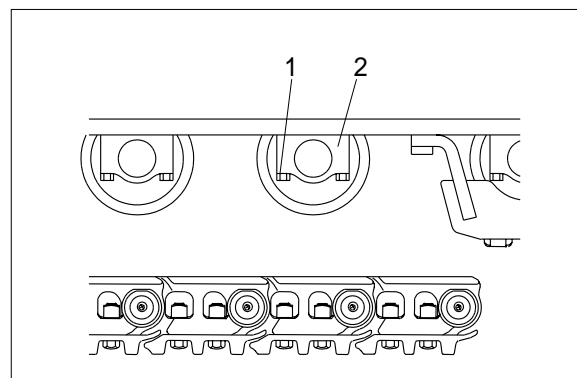
- (1) Loosen tension of the track link.



- (2) Using the work equipment, push up track frame on side which is to be removed.
※ After jack up the machine, set a block under the unit.



- (3) Remove the mounting bolt(1) and draw out the track roller(2).
· Weight : 38.3kg(84.4lb)



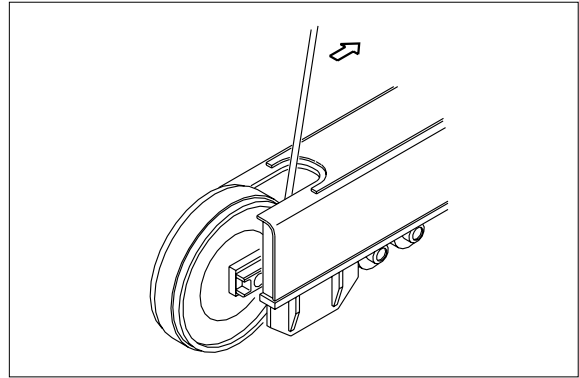
2) INSTALL

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

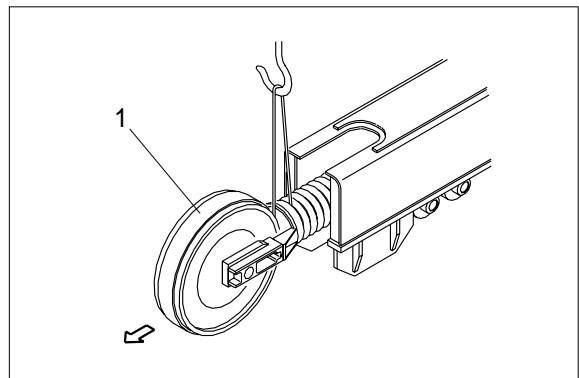
4. IDLER AND RECOIL SPRING

1) REMOVAL

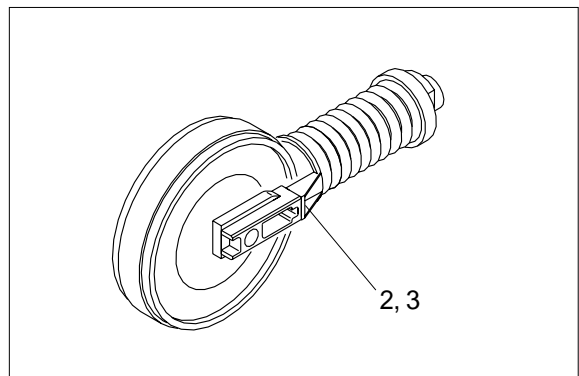
- (1) Remove the track link.
For detail, see **removal of track link**



- (2) Sling the adjust component(1) and pull out idler and recoil spring assembly from track frame, using a pry.
· Weight : 270kg (595lb)

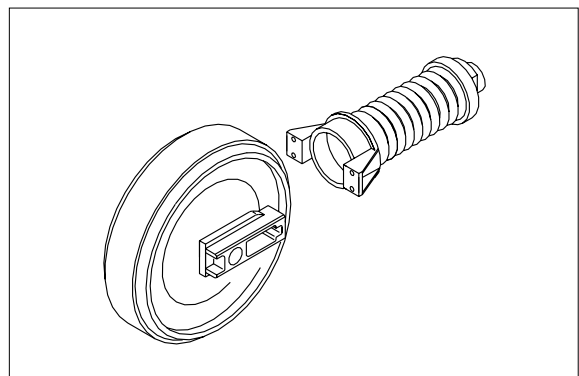


- (3) Remove the bolts(2), washers(3) and separate idler from recoil spring.



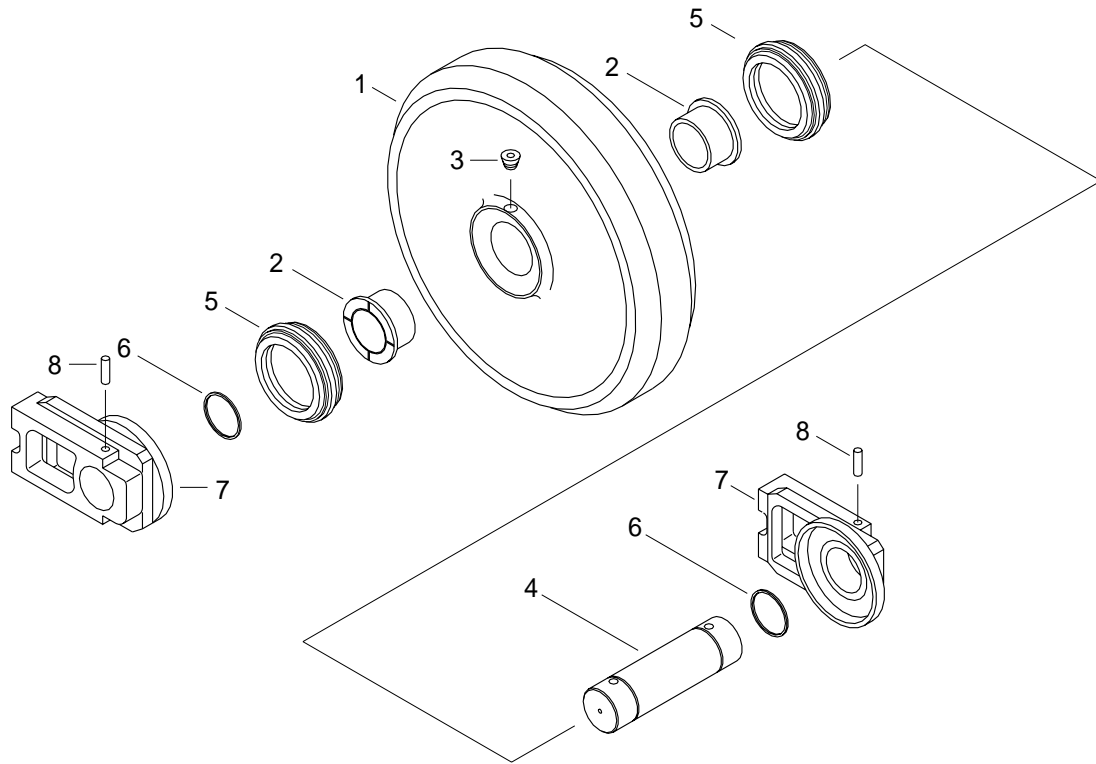
2) INSTALL

- (1) Carry out installation in the reverse order to removal.
※ **Make sure that the boss on the end face of the recoil cylinder rod is in the hole of the track frame.**



3) DISASSEMBLY AND ASSEMBLY OF IDLER

(1) Structure



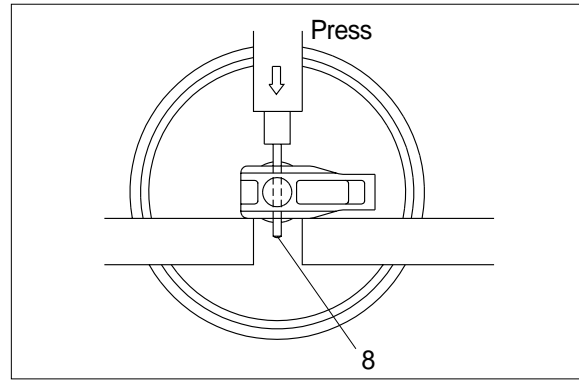
- 1 Idler
- 2 Bushing
- 3 Plug

- 4 Shaft
- 5 Seal assembly
- 6 O-ring

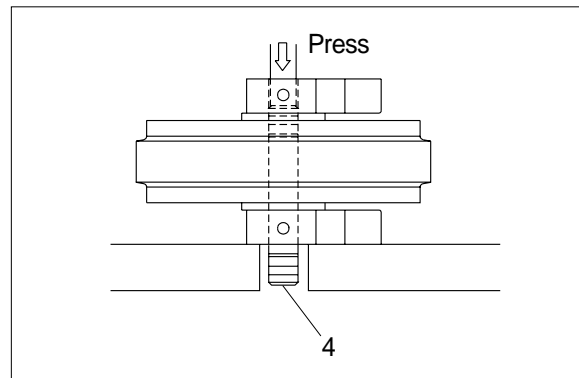
- 7 O-ring
- 8 Bracket
- 9 Dowel pin

(2) Disassembly

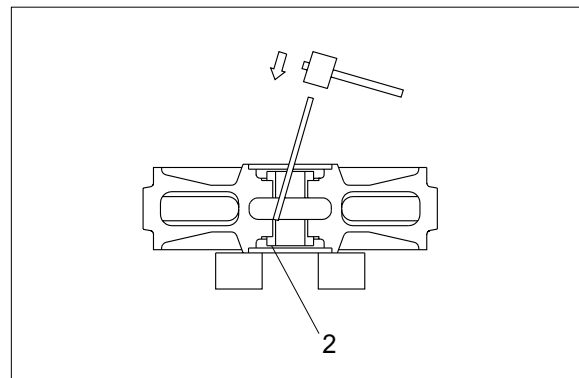
- ① Remove plug and drain oil.
- ② Draw out the dowel pin(8), using a press.



- ③ Pull out the shaft(4) with a press.
- ④ Remove seal assembly(5) from idler(1) and bracket(8).
- ⑤ Remove O-ring(6) from shaft.



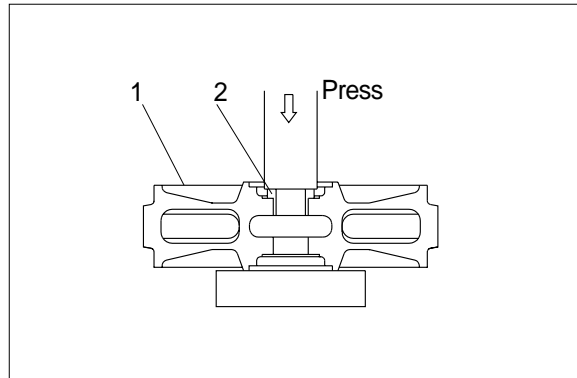
- ⑥ Remove the bushing(2) from idler, using a special tool.
- ※ Only remove bushing if replacement is necessary.



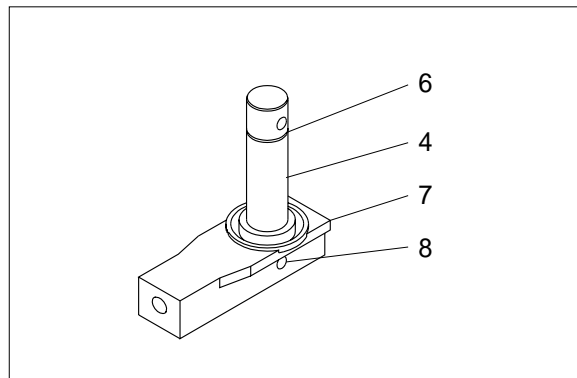
(3) Assembly

- ※ Before assembly, clean the parts.
- ※ Coat the sliding surfaces of all parts with oil.

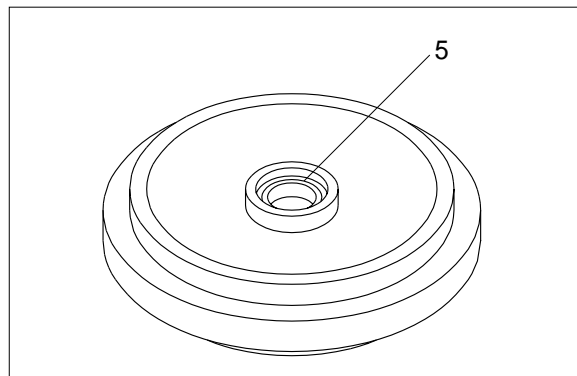
- ① Cool up bushing(2) fully by some dry ice and press it into shell(1).
Do not press it at the normal temperature, or not knock in with a hammer even after the cooling.



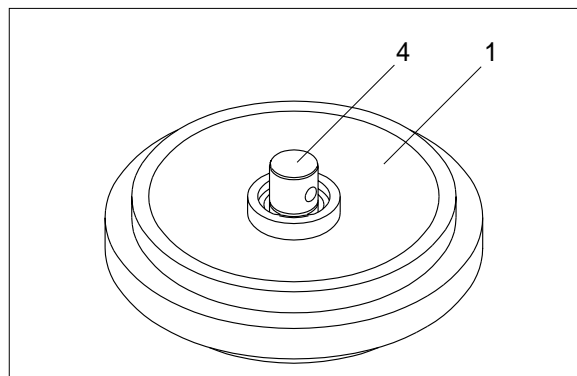
- ② Coat O-ring(6) with grease thinly, and install it to shaft(4).
③ Insert shaft(4) into bracket(7), and drive in the dowel pin(8).



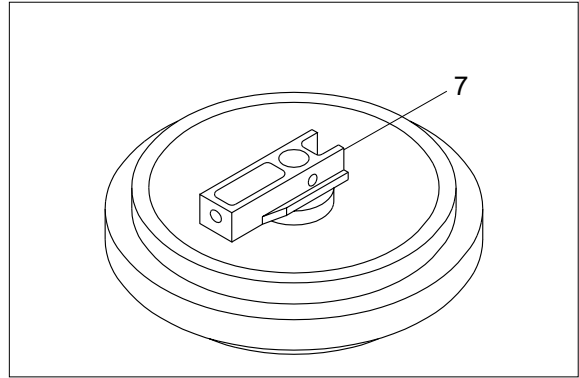
- ④ Install seal assembly(5) to idler(1) and bracket(7).



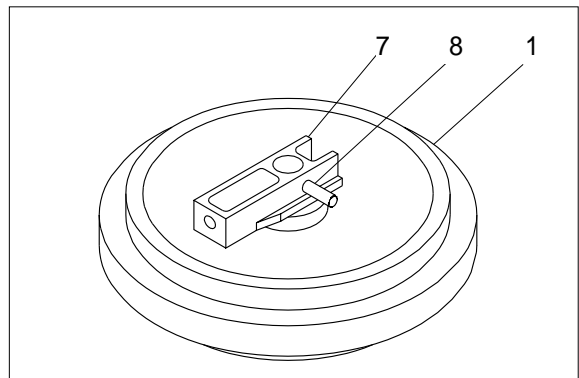
- ⑤ Install shaft(4) to idler(1).



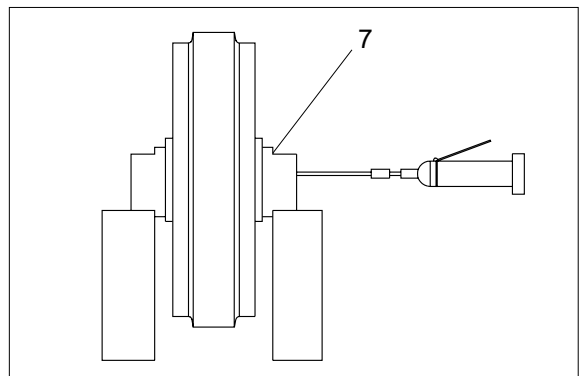
- ⑥ Install bracket(7) attached with seal assembly(5).



- ⑦ Knock in the dowel pin(8) with a hammer.

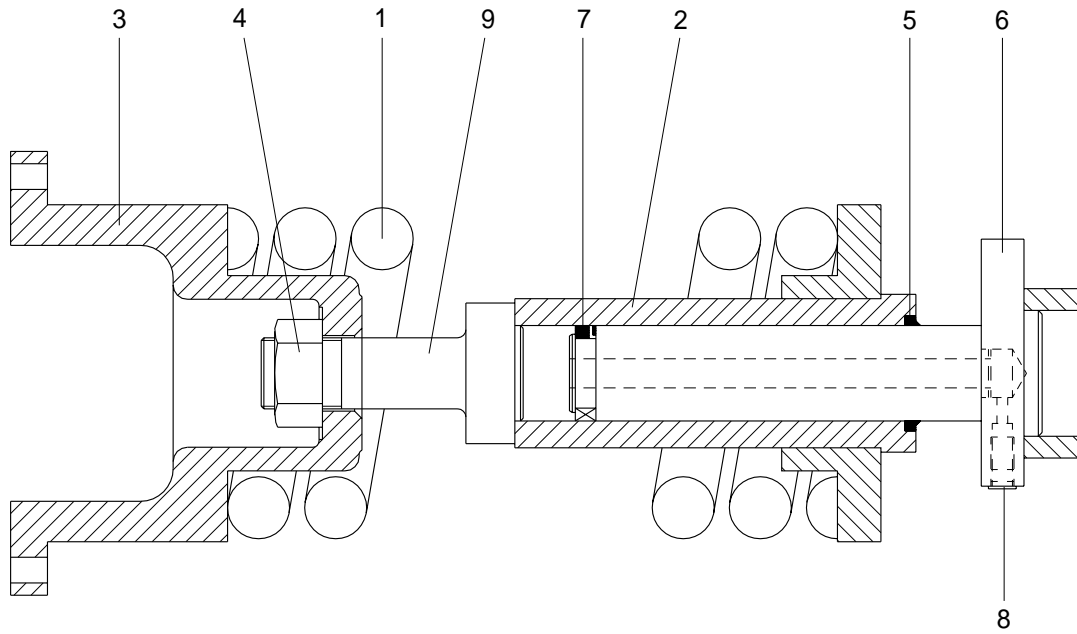


- ⑧ Lay bracket(7) on its side.
Supply engine oil to the specified level,
and tighten plug.



4) DISASSEMBLY AND ASSEMBLY OF RECOIL SPRING

(1) Structure



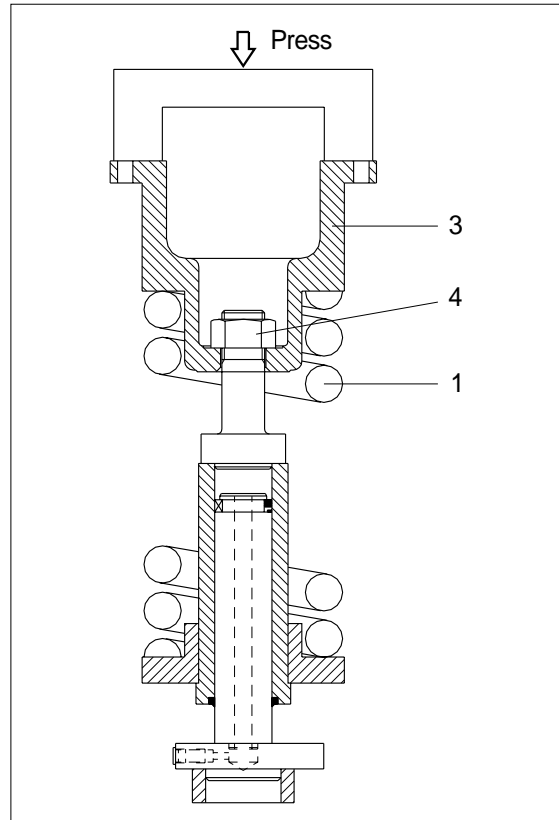
- 1 Spring
- 2 Cylinder
- 3 Fork

- 4 Nut
- 5 Packing
- 6 Piston

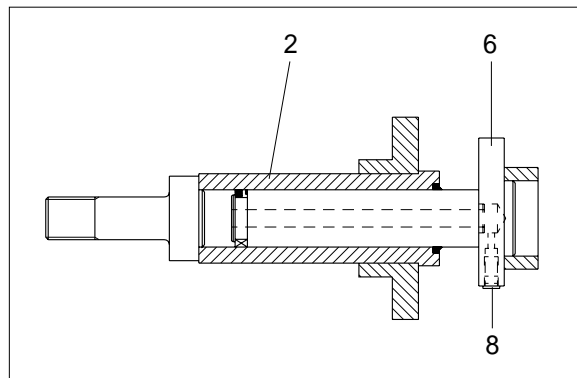
- 7 Packing
- 8 Plug
- 9 Tie rod

(2) Disassembly

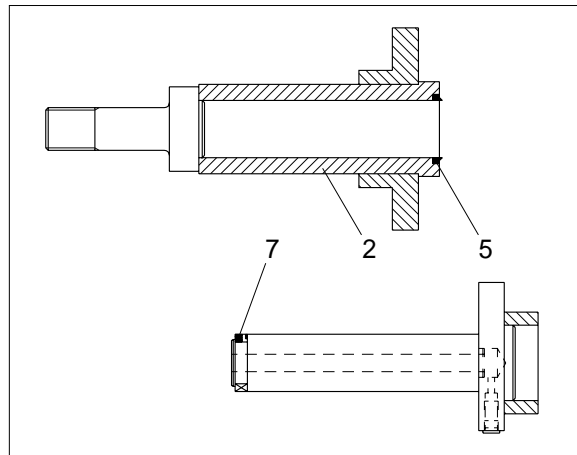
- ① Apply pressure on spring(1) with a press.
 - ※ The spring is under a large installed load. This is dangerous, so be sure to set properly.
Spring set load : 11000kg(24250lb)
- ② Remove lock nut(4).
- ※ Take enough notice so that the press which pushes down the spring, should not be slipped out in its operation.
- ③ Lighten the press load slowly, and remove fork(3) and spring(1).



- ④ Remove piston(6) from cylinder liner(2).
- ⑤ Remove plug(8) from piston(6).

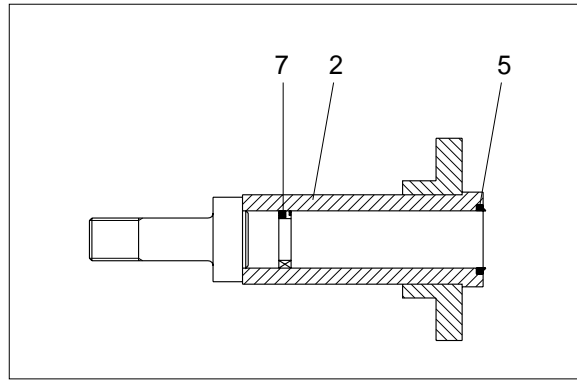


- ⑥ Remove packings(5,7).



(3) Assembly

- ① Install packings(5,7) to cylinder liner(2).
- ※ When installing packing(5,7) take full care so as not to damage the lip.

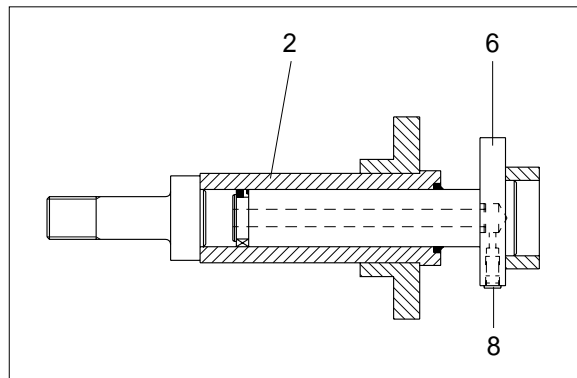


- ② Pour grease into cylinder liner(2), then push in piston(6) by hand.
After take grease out of plug mounting hole, let air out.

※ If air letting is not sufficient, it may be difficult to adjust the tension of crawler.

- ③ Fit plug(8) to piston(6).

Tightening torque : $10 \pm 1 \text{ kg} \cdot \text{m}$
($72.3 \pm 7.2 \text{ lbf} \cdot \text{ft}$)



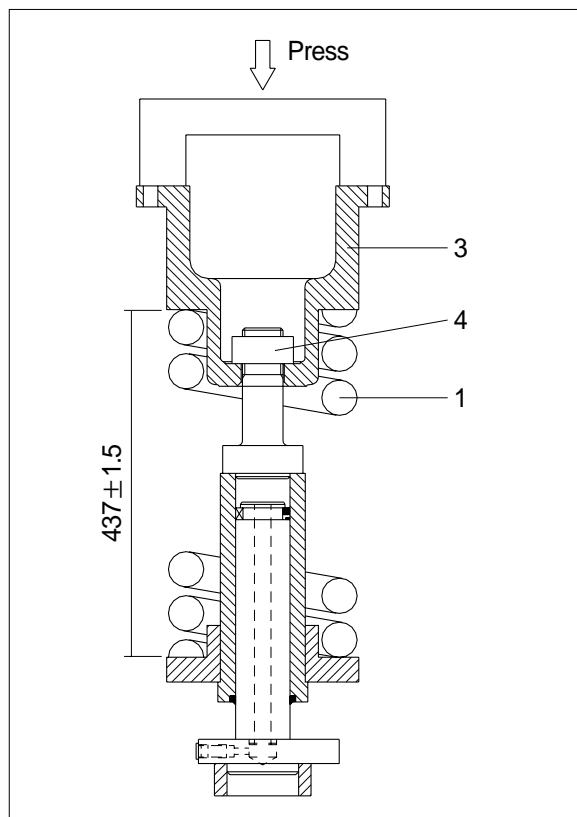
- ④ Install spring(1) and fork(3) to cylinder liner(2).

- ⑤ Apply pressure to spring(1) with a press and tighten lock nut(4).

※ Apply sealant before assembling.

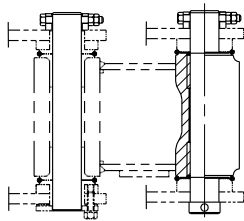
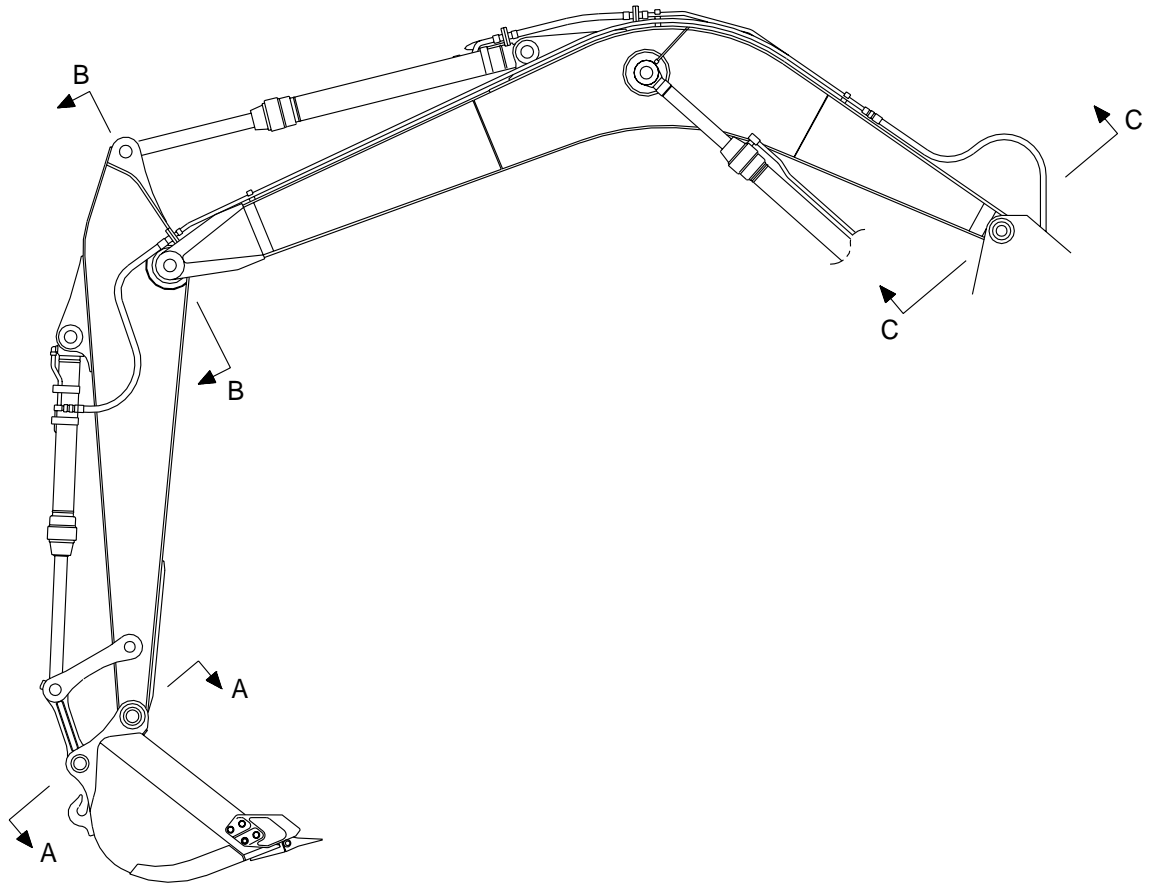
※ During the operation, pay attention specially to prevent the press from slipping out.

- ⑥ Lighten the press load and confirm the set length of spring(1).

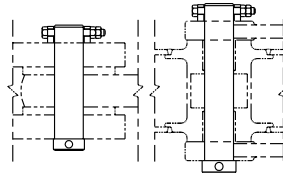


GROUP 11 WORK EQUIPMENT

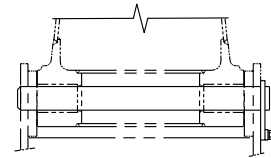
1. STRUCTURE



SECTION A



SECTION B



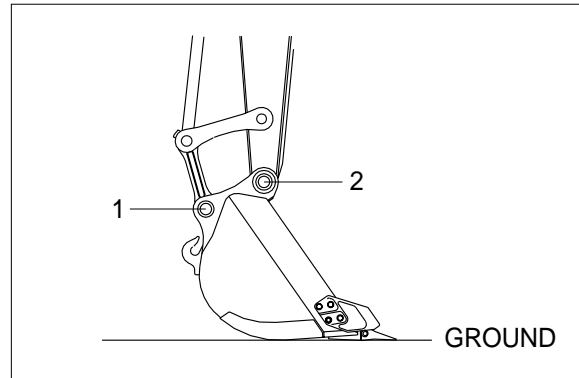
SECTION C

2. REMOVAL AND INSTALL

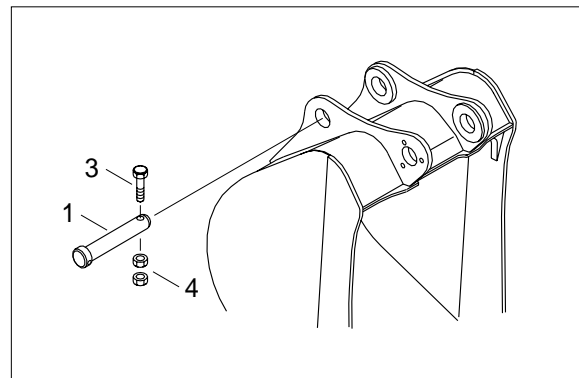
1) BUCKET ASSEMBLY

(1) Removal

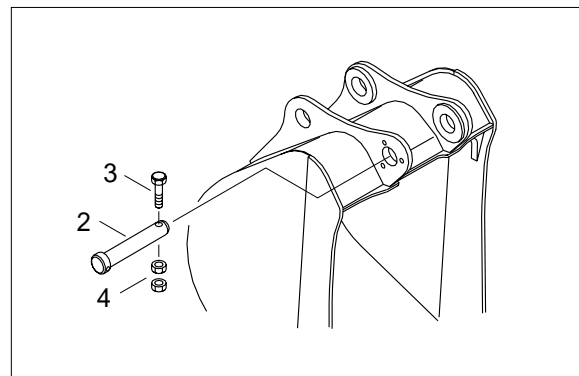
- ① Lower the work equipment completely to ground with back of bucket facing down.



- ② Remove nut(4), bolt(3), and draw out the pin(1).

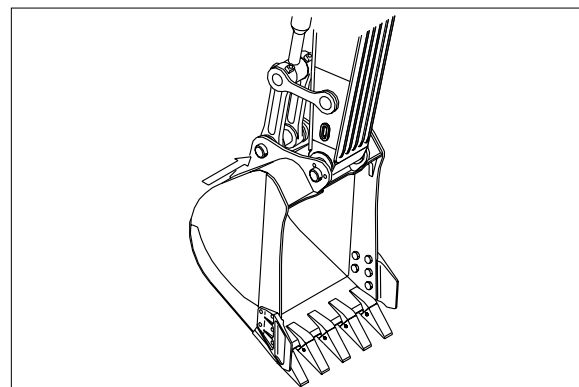


- ③ Remove nut(4), bolt(3), and draw out the pin(2).



(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

- ※ 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.

① Remove bucket assembly.

For details, see **removal of bucket assembly**.

② Loosen socket bolt(2) to disconnect bucket cylinder hoses(1).

- ▲ Fit blind plugs in the piping at the chassis end securely to prevent oil from spurting out when the engine is started.

③ Sling arm cylinder assembly, and remove nut, bolt, then pull out pin.

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

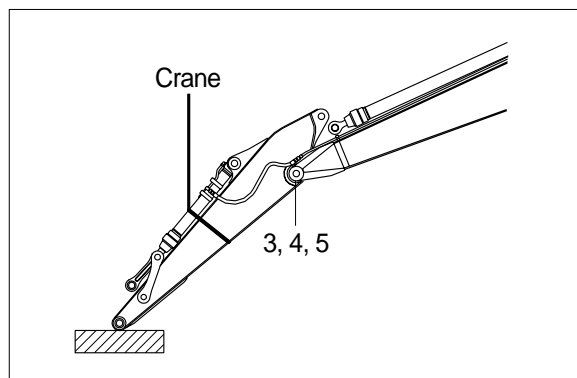
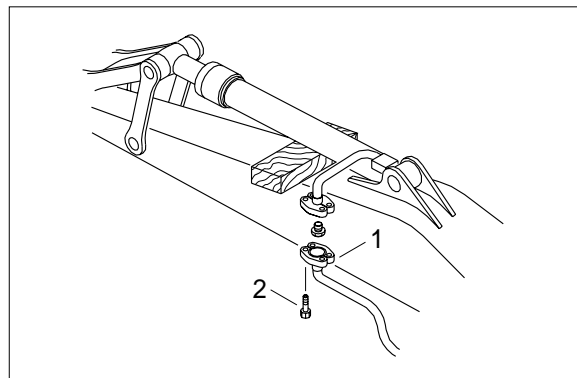
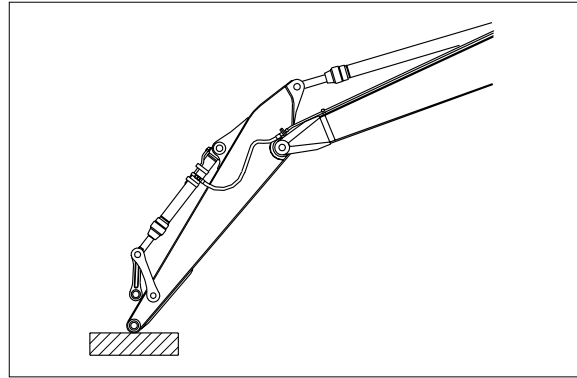
For details, see **removal of arm cylinder assembly**.

④ Place a wooden block under the cylinder and bring the cylinder down to it.

⑤ Remove nut(5), bolt(4) and pull out the pin(3) then remove the arm assembly.

· Weight : 800kg(1760lb)

- ※ When lifting the arm assembly, always lift the center of gravity.



(2) Install

① Carry out installation in the reverse order to removal.

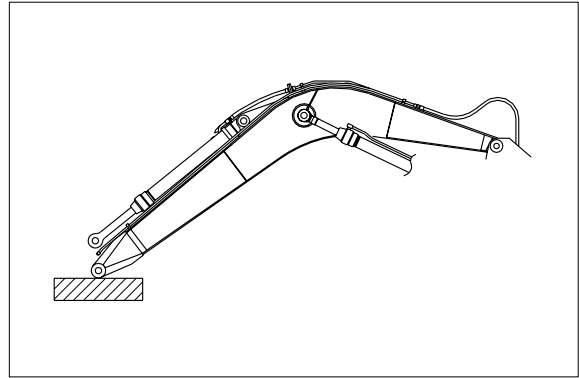
- ▲ When lifting the arm assembly, always lift the center of gravity.

- ※ Bleed the air from the cylinder.

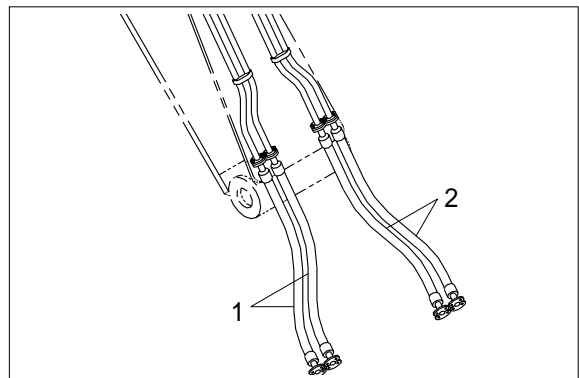
3) BOOM ASSEMBLY

(1) Removal

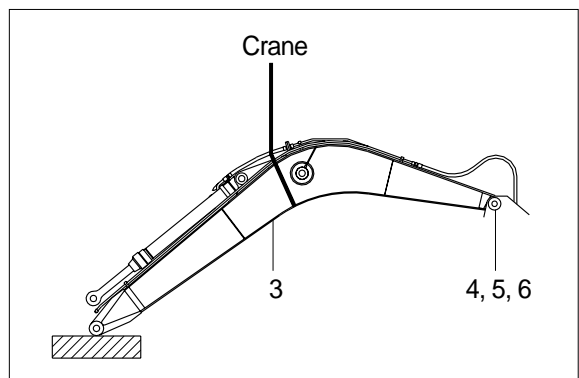
- ① Remove arm and bucket assembly.
For details, see **removal of arm and bucket assembly**.
- ② Remove boom cylinder assembly from boom.
For details, see **removal of boom cylinder assembly**.



- ③ Disconnect head work wiring.
 - ④ Disconnect bucket cylinder hose(2) and arm cylinder hose(1).
- ※ When the hoses are disconnected, oil may spurt out.



- ⑤ Sling boom assembly(3).
 - ⑥ Remove bolt(4), nut(5) and pull out the pin(6) then remove boom assembly.
· Weight :1230kg(2710lb)
- ※ 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 boom assembly, always lift the center of gravity.
- ※ Bleed the air from the cylinder.

