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## 1. STRUCTURE

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

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

For ease of understanding, the manual is divided into the following sections.

### SECTION 1 GENERAL

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

### SECTION 2 STRUCTURE AND FUNCTION

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

### SECTION 3 HYDRAULIC SYSTEM

This section explains the hydraulic circuit, single and combined operation.

### SECTION 4 ELECTRICAL SYSTEM

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

### SECTION 5 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.

### SECTION 9 COMPONENT MOUNTING TORQUE

This section shows bolt specifications and standard torque values needed when mounting components to the machine.

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

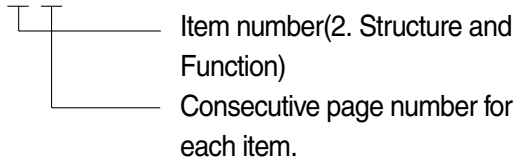
1. See the page number on the bottom of the page.

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

10 - 4 - 2

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Added pages

### 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 ①, then draw a horizontal line from ①.
- (2) Locate the number 5 in the row across the top, take this as ②, then draw a perpendicular line down from ②.
- (3) Take the point where the two lines cross as ③. This point ③ 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

②

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
① 50	1.969	2.008	2.047	2.087	2.126	③ 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	25.631	25.625	25.889	26.153

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

kgf · m to lbf · ft

1 kgf · m = 7.233 lbf · ft

	0	1	2	3	4	5	6	7	8	9
		7.2	14.5	21.7	28.9	36.2	43.4	50.6	57.9	65.1
10	72.3	79.6	86.8	94.0	101.3	108.5	115.7	123.0	130.2	137.4
20	144.7	151.9	159.1	166.4	173.6	180.8	188.1	195.3	202.5	209.8
30	217.0	224.2	231.5	238.7	245.9	253.2	260.4	267.6	274.9	282.1
40	289.3	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

kgf/cm<sup>2</sup> to lbf/in<sup>2</sup>1 kgf / cm<sup>2</sup> = 14.2233 lbf / in<sup>2</sup>

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

## TEMPERATURE

Fahrenheit-Centigrade Conversion.

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

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

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

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

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

## SECTION 1 GENERAL

Group 1 Safety Hints .....	1-1
Group 2 Specifications .....	1-9

## SECTION 1 GENERAL

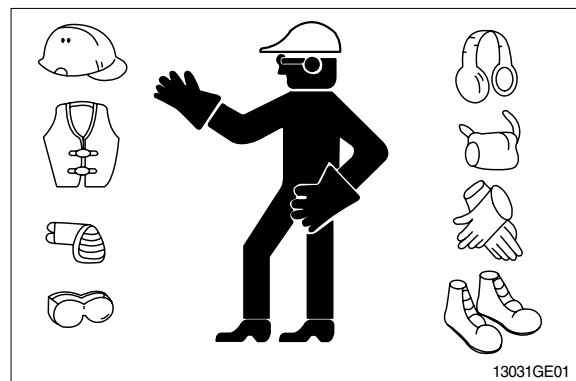
### GROUP 1 SAFETY

#### FOLLOW SAFE PROCEDURE

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

#### WEAR PROTECTIVE CLOTHING

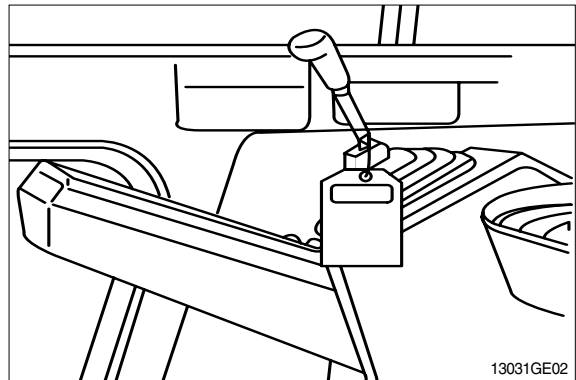
Wear close fitting clothing and safety equipment appropriate to the job.



#### 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.

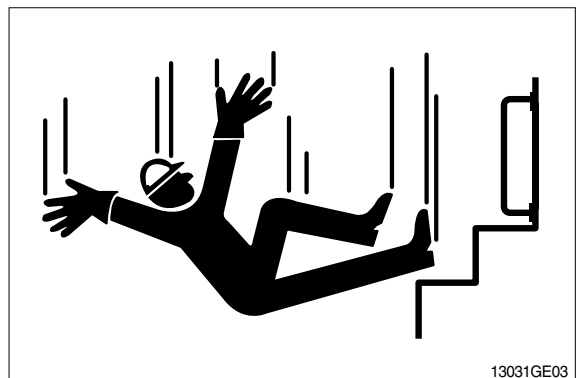


#### USE HANDHOLDS AND STEPS

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.



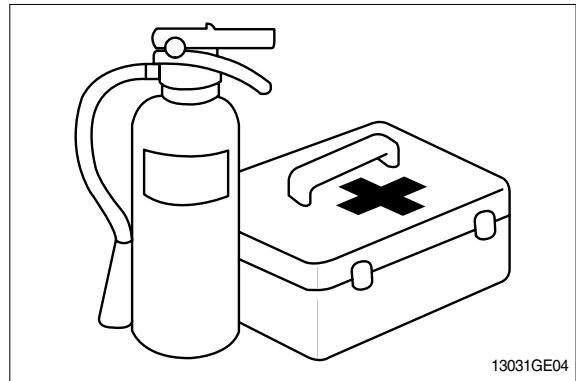


## PREPARE FOR EMERGENCIES

Be prepared if a fire starts.

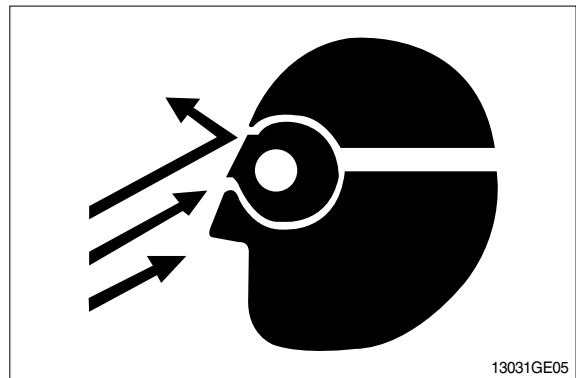
Keep a first aid kit and fire extinguisher handy.

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



## PROTECT AGAINST FLYING DEBRIS

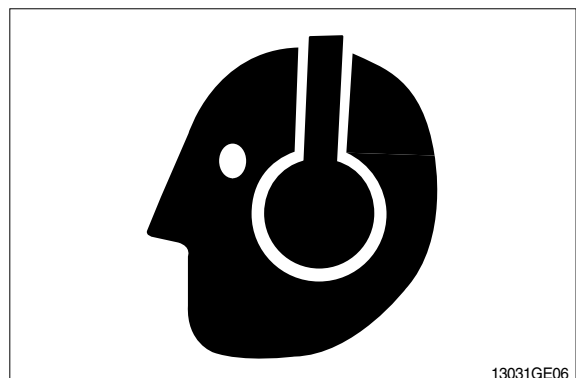
Guard against injury from flying pieces of metal or debris; Wear goggles or safety glasses.



## PROTECT AGAINST NOISE

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

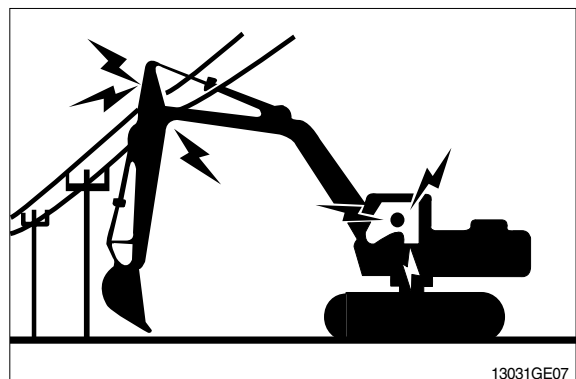
Wear a suitable hearing protective device such as earmuffs or earplugs to protect against objectionable or uncomfortable loud noises.



## AVOID POWER LINES

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

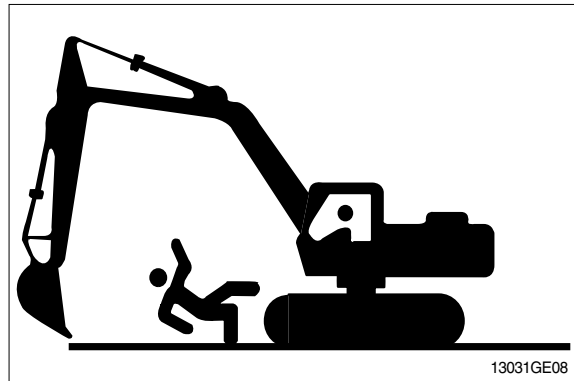
Never move any part of the machine or load closer to electric line than 3m(10ft) plus twice the line insulator length.



## 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.

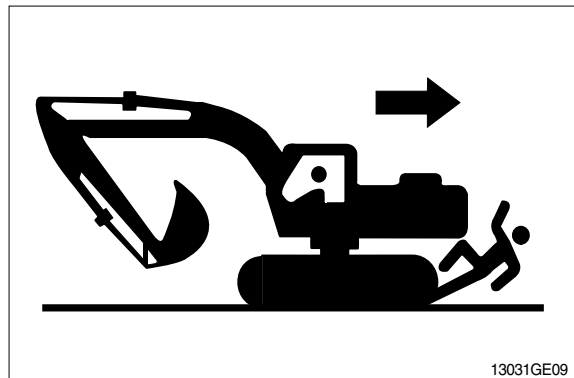


## MOVE AND OPERATE MACHINE SAFELY

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

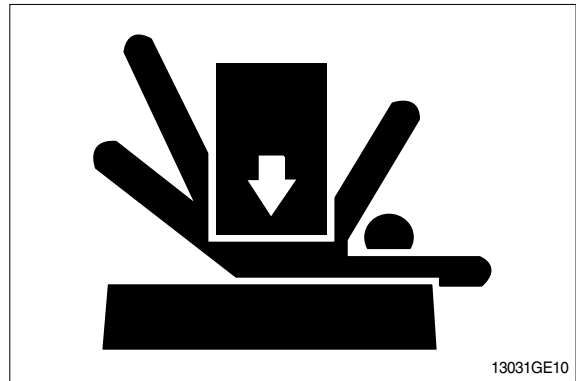
Before working on the machine:

- 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.

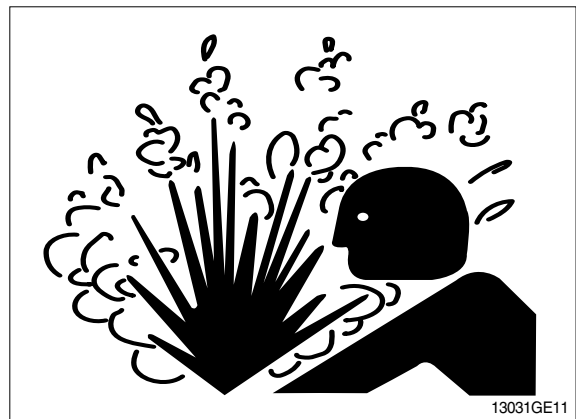
Do not support the machine on cinder blocks, hollow tiles, or props that may crumble under continuous load. Do not work under a machine that is supported solely by a jack. Follow recommended procedures in this manual.



## SERVICE COOLING SYSTEM SAFELY

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

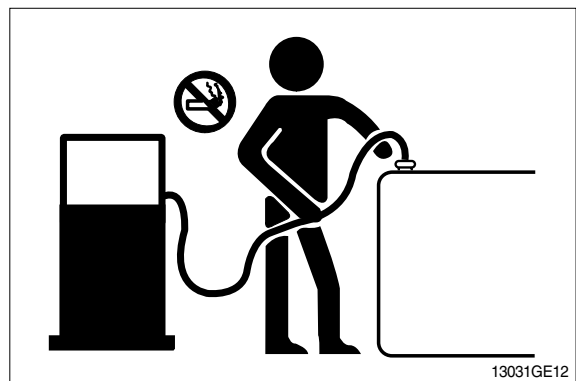
Shut off engine. Only remove filler cap when cool enough to touch with bare hands.



## 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

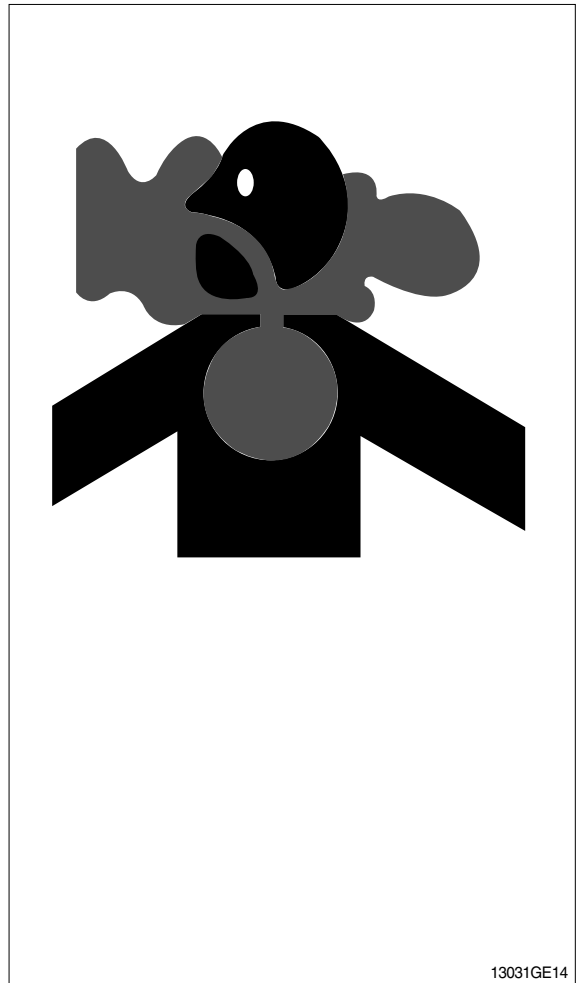
Avoid potentially toxic fumes and dust.

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

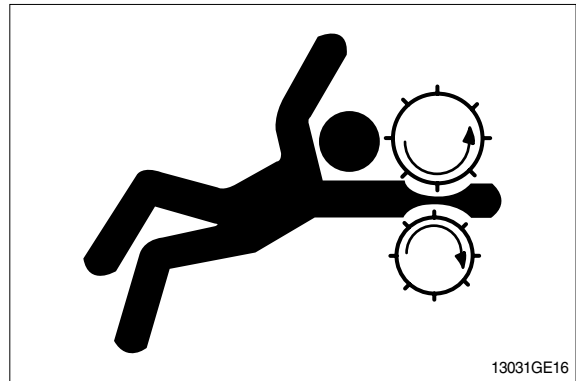
Illuminate your work area adequately but safely. Use a portable safety light for working inside or under the machine. Make sure the bulb is enclosed by a wire cage. The hot filament of an accidentally broken bulb can ignite spilled fuel or oil.



## 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.

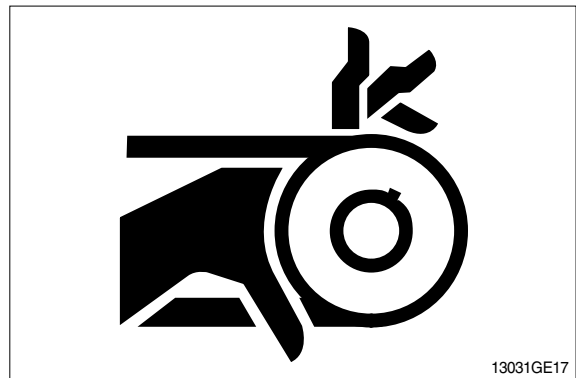
Remove rings and other jewelry to prevent electrical shorts and entanglement in moving parts.



## STAY CLEAR OF MOVING PARTS

Entanglements in moving parts can cause serious injury.

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



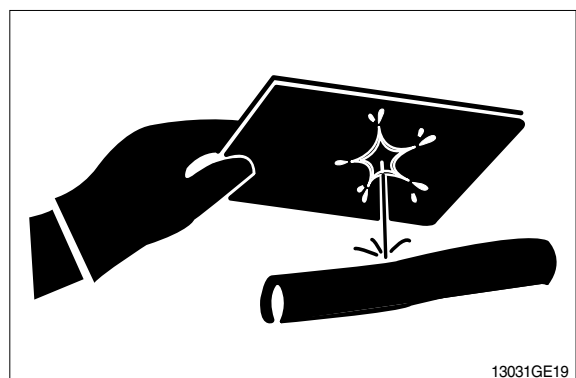
## AVOID HIGH PRESSURE FLUIDS

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:

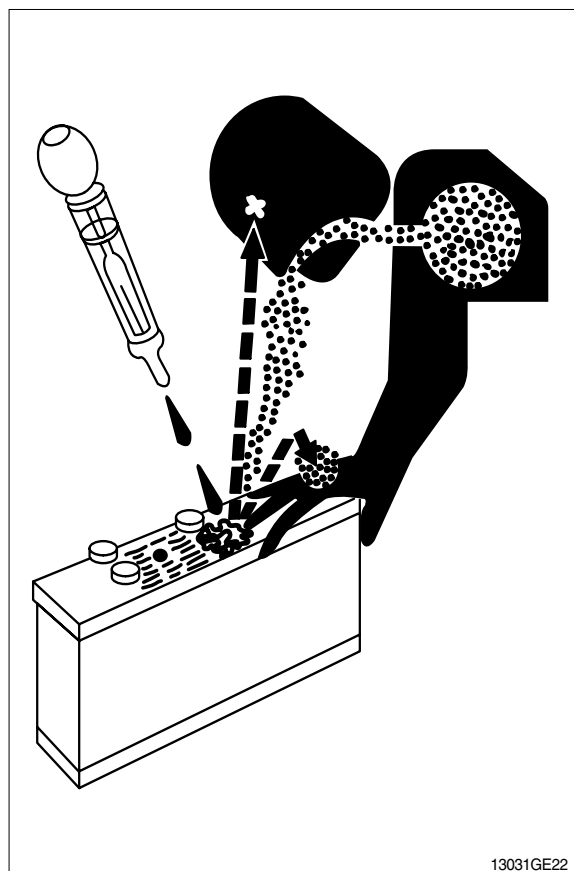
1. Filling batteries in a well-ventilated area.
2. Wearing eye protection and rubber gloves.
3. Avoiding breathing fumes when electrolyte is added.
4. Avoiding spilling or dripping electrolyte.
5. Use proper jump start procedure.

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.



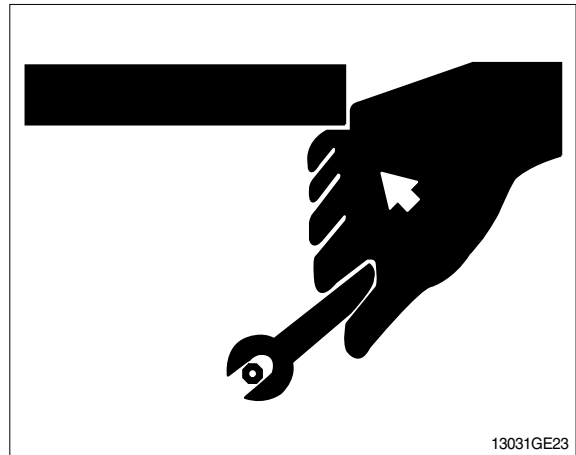
## USE TOOLS PROPERLY

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.)

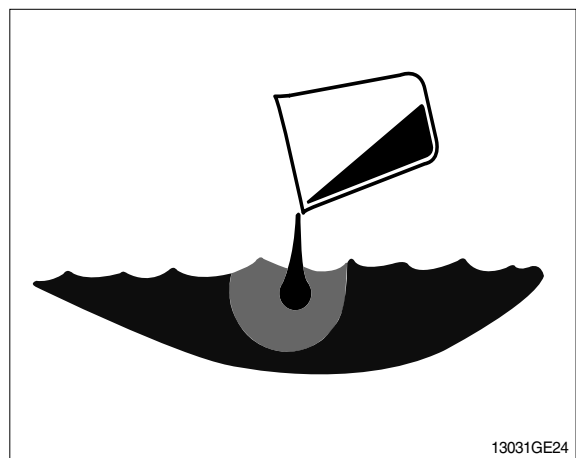


## DISPOSE OF FLUIDS PROPERLY

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.

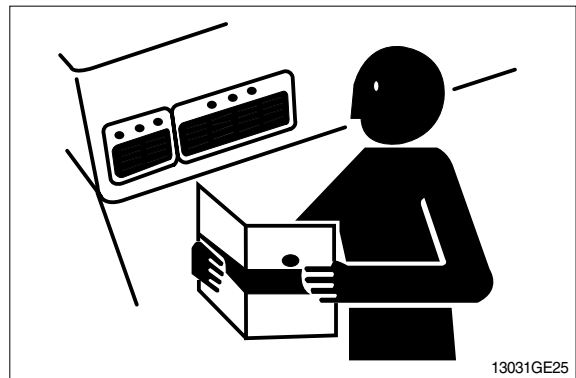
Use proper containers when draining fluids. Do not use food or beverage containers that may mislead someone into drinking from them.

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.

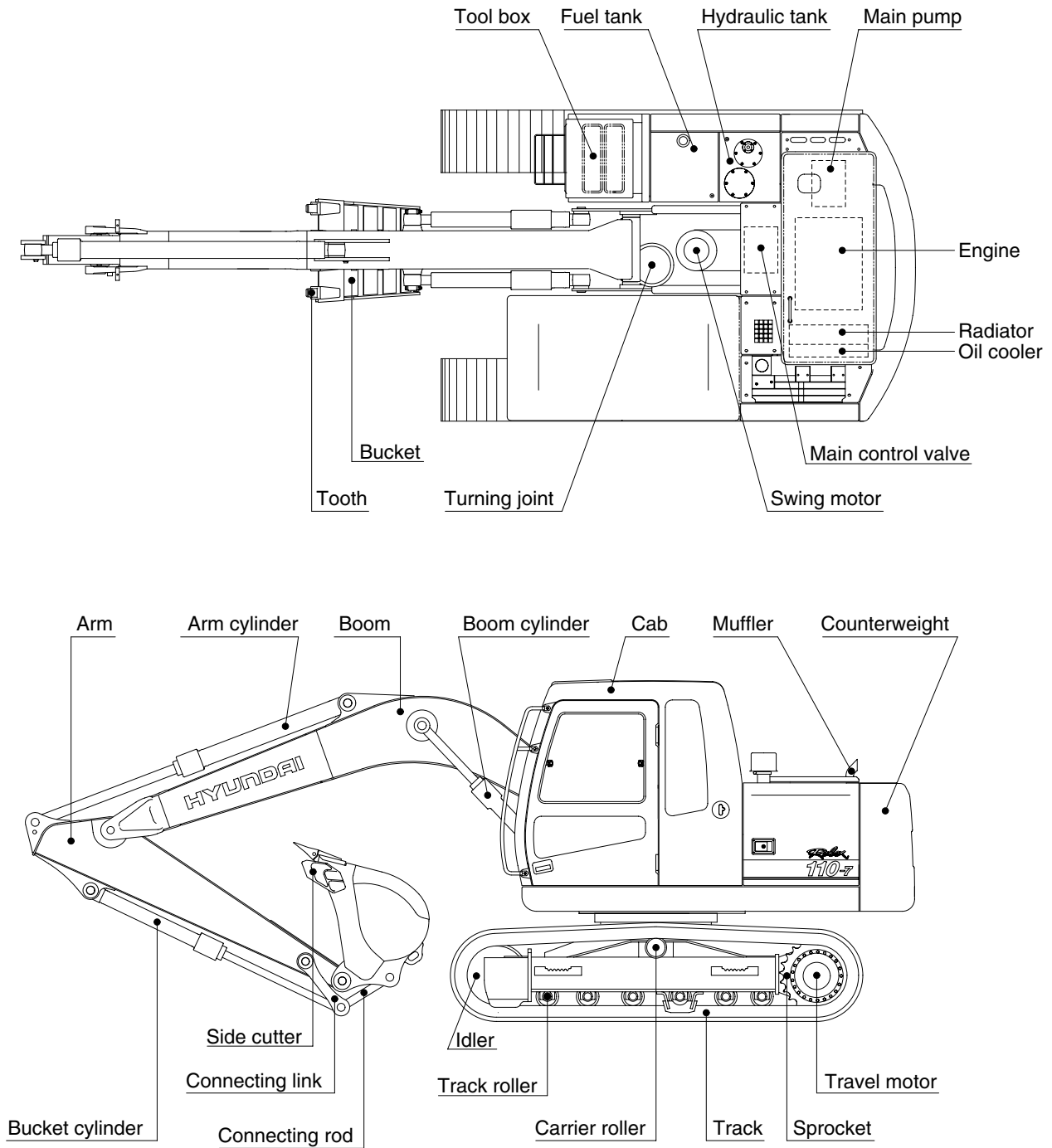


## LIVE WITH SAFETY

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



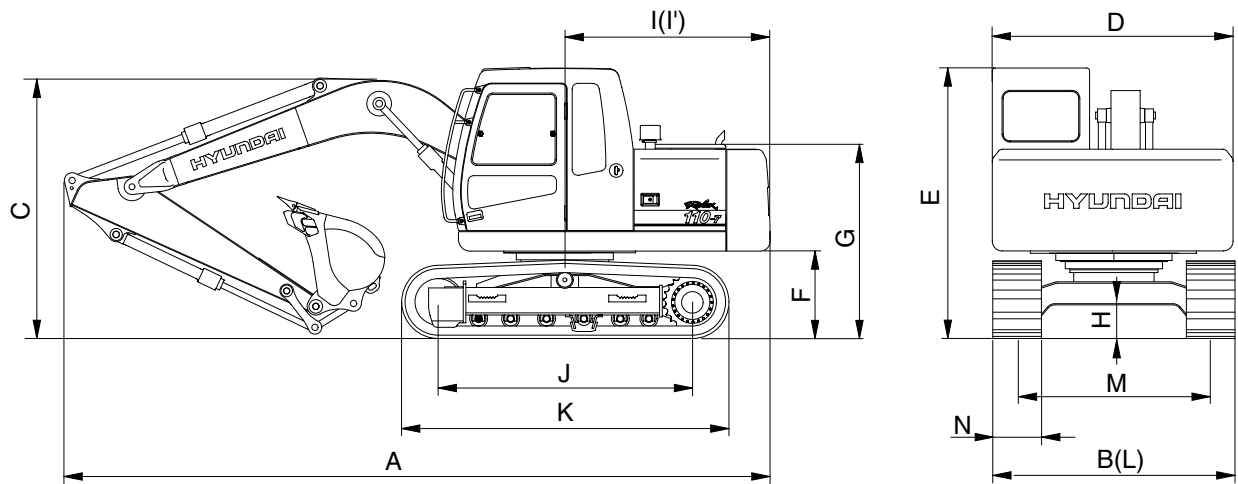
11072SP01



## 2. SPECIFICATIONS

### 1) R110-7

#### (1) 4.3m(14' 1") MONO BOOM, 2.26m(7' 5") ARM

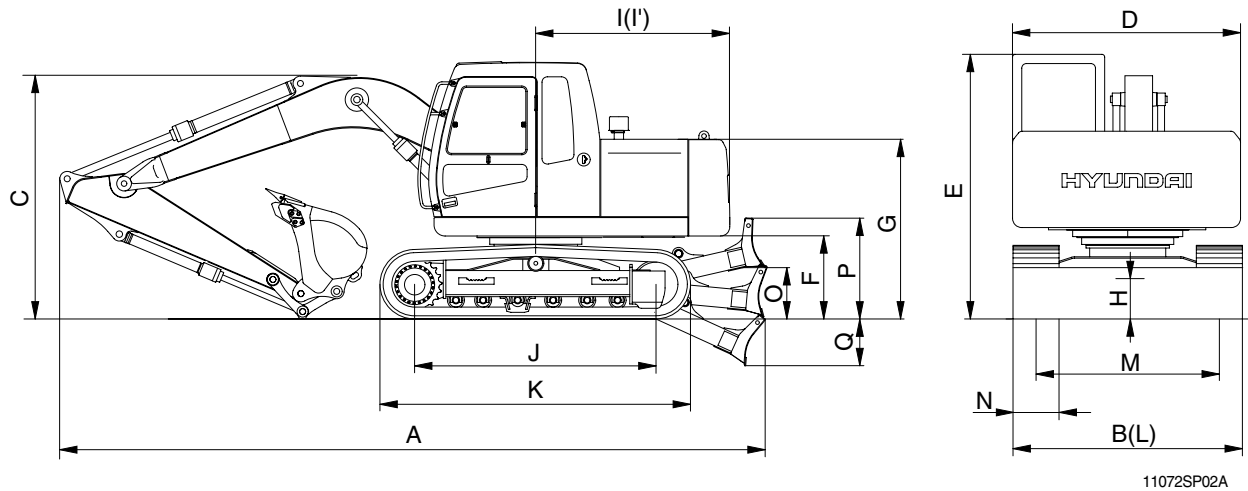


11072SP02

Description		Unit	Specification
Operating weight		kg(lb)	11200(24690)
Bucket capacity(SAE heaped), standard		m <sup>3</sup> (yd <sup>3</sup> )	0.45(0.59)
Overall length	A	mm(ft-in)	7270(23' 10")
Overall width, with 500mm shoe	B		2490( 8' 2")
Overall height	C		2720( 8' 11")
Superstructure width	D		2475( 8' 1")
Overall height of cab	E		2800( 9' 2")
Ground clearance of counterweight	F		900( 2' 11")
Engine cover height	G		1990( 6' 6")
Minimum ground clearance	H		440( 1' 5")
Rear-end distance	I		2110( 6' 11")
Rear-end swing radius	I'		2130( 7' 0")
Distance between tumblers	J		2610( 8' 7")
Undercarriage length	K		3340(10' 11")
Undercarriage width	L		2490( 8' 2")
Track gauge	M		1990( 6' 6")
Track shoe width, standard	N		500(20")
Travel speed(Low/high)		km/hr(mph)	3.4/5.5(2.1/3.4)
Swing speed		rpm	13.0
Gradeability		Degree(%)	35(70)
Ground pressure(500mm shoe)		kgf/cm <sup>2</sup> (psi)	0.39(5.55)

## 2) R110D-7

### (1) 4.3m(14' 1") MONO BOOM, 2.26m(7' 5") ARM AND REAR DOZER BLADE

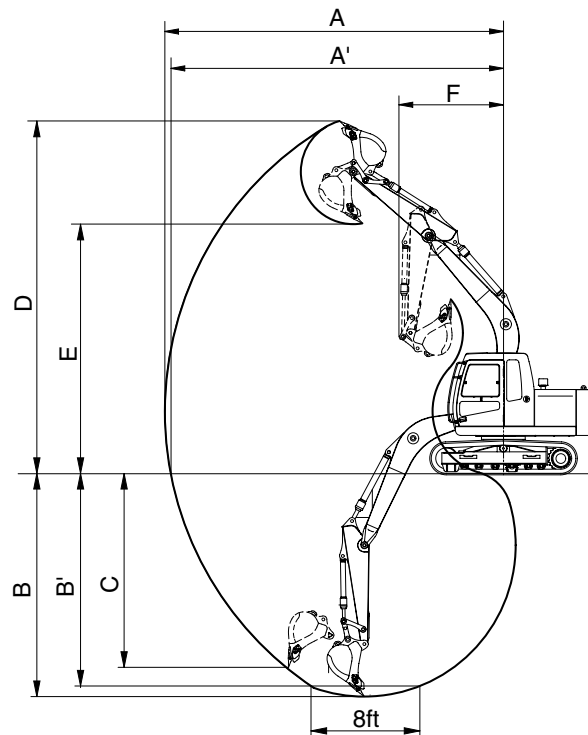


Description		Unit	Specification
Operating weight		kg(lb)	11900(26230)
Bucket capacity(SAE heaped), standard		m <sup>3</sup> (yd <sup>3</sup> )	0.45(0.59)
Overall length	A	mm(ft-in)	7650(25' 1")
Overall width, with 500mm shoe	B		2500( 8' 2")
Overall height	C		2720( 8' 11")
Superstructure width	D		2475( 8' 1")
Overall height of cab	E		2800( 9' 2")
Ground clearance of counterweight	F		900( 2' 11")
Engine cover height	G		1990( 6' 6")
Minimum ground clearance	H		440( 1' 5")
Rear-end distance	I		2110( 6' 11")
Rear-end swing radius	I'		2130( 7' 0")
Distance between tumblers	J		2610( 8' 7")
Undercarriage length	K		3340(10' 11")
Undercarriage width	L		2500( 8' 2")
Track gauge	M		1990( 6' 6")
Track shoe width, standard	N		500(20")
Height of blade	O		550( 1' 10")
Ground clearance of blade up	P		500( 1' 8")
Depth of blade down	Q		520( 1' 8")
Travel speed(Low/high)		km/hr(mph)	3.4/5.5(2.1/3.4)
Swing speed		rpm	13.0
Gradeability		Degree(%)	35(70)
Ground pressure(500mm shoe)		kgf/cm <sup>2</sup> (psi)	0.42(5.97)

### 3. WORKING RANGE

#### 1) R110-7

##### (1) 4.3m(14' 1") MONO BOOM



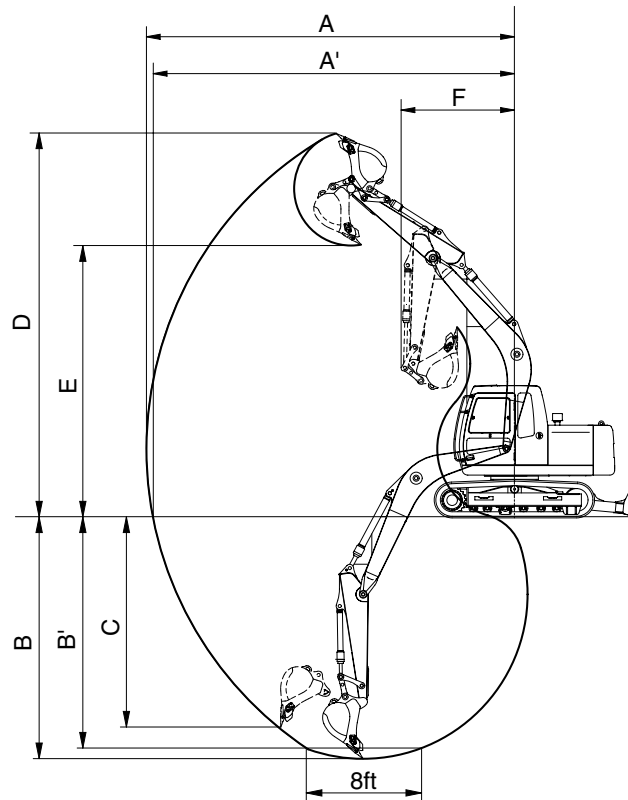
11072SP03

Description		1.96m(6' 5") Arm	2.26m(7' 5") Arm	2.81m(9' 3") Arm
Max digging reach	A	7460mm (24' 6")	7740mm (25' 5")	8270mm (27' 2")
Max digging reach on ground	A'	7320mm (24' 0")	7610mm (25' 0")	8140mm (26' 8")
Max digging depth	B	4770mm (15' 8")	5090mm (16' 8")	5620mm (18' 5")
Max digging depth (8ft level)	B'	4510mm (14' 10")	4870mm (16' 0")	5410mm (17' 9")
Max vertical wall digging depth	C	4070mm (13' 4")	4430mm (14' 6")	4940mm (16' 2")
Max digging height	D	7900mm (25' 11")	8070mm (26' 6")	8460mm (27' 9")
Max dumping height	E	5540mm (18' 2")	5710mm (18' 9")	6100mm (20' 0")
Min swing radius	F	2340mm ( 7' 8")	2380mm ( 7' 10")	2510mm ( 8' 3")
Bucket digging force	SAE	78.5 [85.6] kN	78.5 [85.6] kN	78.5 [85.6] kN
		8000 [8730] kgf	8000 [8730] kgf	8000 [8730] kgf
		17640 [19240] lbf	17640 [19240] lbf	17640 [19240] lbf
	ISO	90.2 [98.4] kN	90.2 [98.4] kN	90.2 [98.4] kN
		9200 [10040] kgf	9200 [10040] kgf	9200 [10040] kgf
		20280 [22120] lbf	20280 [22120] lbf	20280 [22120] lbf
Arm digging force	SAE	60.2 [65.7] kN	55.7 [60.8] kN	48.1 [52.4] kN
		6140 [6700] kgf	5680 [6200] kgf	4900 [5350] kgf
		13540 [14770] lbf	12520 [13660] lbf	10800 [11780] lbf
	ISO	62.9 [68.6] kN	58.1 [63.3] kN	49.7 [54.2] kN
		6410 [6990] kgf	5920 [6460] kgf	5070 [5530] kgf
		14130 [15410] lbf	13050 [14240] lbf	11180 [12200] lbf

[ ] : Power boost

## 2) R110D-7

### (1) 4.3m(14' 1") MONO BOOM



11072SP04

Description		1.96m(6' 5") Arm	2.26m(7' 5") Arm	2.81m(9' 3") Arm
Max digging reach	A	7460mm (24' 6")	7740mm (25' 5")	8270mm (27' 2")
Max digging reach on ground	A'	7320mm (24' 0")	7610mm (25' 0")	8140mm (26' 8")
Max digging depth	B	4770mm (15' 8")	5090mm (16' 8")	5620mm (18' 5")
Max digging depth (8ft level)	B'	4510mm (14' 10")	4870mm (16' 0")	5410mm (17' 9")
Max vertical wall digging depth	C	4070mm (13' 4")	4430mm (14' 6")	4940mm (16' 2")
Max digging height	D	7900mm (25' 11")	8070mm (26' 6")	8460mm (27' 9")
Max dumping height	E	5540mm (18' 2")	5710mm (18' 9")	6100mm (20' 0")
Min swing radius	F	2340mm ( 7' 8")	2380mm ( 7' 10")	2510mm ( 8' 3")
Bucket digging force	SAE	78.5 [85.6] kN	78.5 [85.6] kN	78.5 [85.6] kN
		8000 [8730] kgf	8000 [8730] kgf	8000 [8730] kgf
		17640 [19240] lbf	17640 [9240] lbf	17640 [19240] lbf
	ISO	90.2 [98.4] kN	90.2 [98.4] kN	90.2 [98.4] kN
		9200 [10040] kgf	9200 [10040] kgf	9200 [10040] kgf
		20280 [22120] lbf	20280 [22120] lbf	20280 [22120] lbf
Arm digging force	SAE	60.2 [65.7] kN	55.7 [60.8] kN	48.1 [52.4] kN
		6140 [6700] kgf	5680 [6200] kgf	4900 [5350] kgf
		13540 [14770] lbf	12520 [13660] lbf	10800 [11780] lbf
	ISO	62.9 [68.6] kN	58.1 [63.3] kN	49.7 [54.2] kN
		6410 [6990] kgf	5920 [6460] kgf	5070 [5530] kgf
		14130 [15410] lbf	13050 [14240] lbf	11180 [12200] lbf

[ ] : Power boost

#### 4. WEIGHT


Item	kg	lb
Upperstructure assembly	3300	7280
Main frame weld assembly	1030	2270
Engine assembly	550	1210
Main pump assembly	90	200
Main control valve assembly	130	260
Swing motor assembly	80	180
Hydraulic oil tank assembly	180	400
Fuel tank assembly	130	290
Counterweight	1450	3200
Cab assembly	310	680
Lower chassis assembly	3990	8800
Track frame weld assembly	1260	2780
Swing bearing	160	250
Travel motor assembly	330	730
Turning joint	60	130
Track recoil spring	210	460
Idler	390	860
Carrier roller	30	66
Track roller	300	660
Track-chain assembly(500mm standard triple grouser shoe)	1350	2980
Front attachment assembly(4.3m boom, 2.26m arm, 0.45m³ SAE heaped bucket)	1640	3620
4.3m boom assembly	740	1630
2.26m arm assembly	340	750
0.45m³ SAE heaped bucket	440	970
Boom cylinder assembly	230	510
Arm cylinder assembly	140	310
Dozer blade cylinder	47	100
Bucket cylinder assembly	90	200
Bucket control link assembly	80	180
Dozer blade assembly	700	1540











## 5. LIFTING CAPACITIES

### 1) ROBEX 110-7











(1) 4.3m(14' 1") boom, 2.26m(7' 5") arm equipped with 0.45m<sup>3</sup>(SAE heaped) bucket and 500mm(20") 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)		Capacity		Reach
												m(ft)
6.0m (20ft)	kg lb					*1750 <b>*3860</b>	*1750 <b>*3860</b>			*1750 <b>*3860</b>	*1560 <b>*3440</b>	5.99 <b>(19.7)</b>
4.5m (15ft)	kg lb					*1790 <b>*3950</b>	*1790 <b>*3950</b>	*1530 <b>*3370</b>	1490 <b>3280</b>	1520 <b>3350</b>	1130 <b>2490</b>	6.92 <b>(22.7)</b>
3.0m (10ft)	kg lb			*2820 <b>*6220</b>	*2820 <b>*6220</b>	*2270 <b>*5000</b>	*2270 <b>*5000</b>	1940 <b>4280</b>	1450 <b>3200</b>	1300 <b>2870</b>	940 <b>2070</b>	7.38 <b>(24.2)</b>
1.5m (5ft)	kg lb			*4700 <b>*10360</b>	4370 <b>9630</b>	*2970 <b>*6550</b>	2250 <b>4960</b>	1840 <b>4060</b>	1360 <b>3000</b>	1240 <b>2730</b>	880 <b>1940</b>	7.46 <b>(24.5)</b>
Ground Line	kg lb			5660 <b>12480</b>	3950 <b>8710</b>	2830 <b>6240</b>	2060 <b>4540</b>	1760 <b>3880</b>	1280 <b>2820</b>	1300 <b>2870</b>	930 <b>2050</b>	7.18 <b>(23.6)</b>
-1.5m (-5ft)	kg lb	*5580 <b>*12300</b>	*5580 <b>*12300</b>	5550 <b>12240</b>	3850 <b>8490</b>	2740 <b>6040</b>	1980 <b>4370</b>	1720 <b>3790</b>	1240 <b>2730</b>	1560 <b>3440</b>	1130 <b>2490</b>	6.49 <b>(21.3)</b>
-3.0m (-10ft)	kg lb	*8530 <b>*18810</b>	*8530 <b>*18810</b>	*5440 <b>*11990</b>	3930 <b>8660</b>	2770 <b>6110</b>	2010 <b>4430</b>			*2270 <b>*5000</b>	1730 <b>3810</b>	5.17 <b>(17.0)</b>

(2) 4.3m(14' 1") boom, 1.96m(6' 5") arm equipped with 0.45m<sup>3</sup>(SAE heaped) bucket and 500mm(20") 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)
6.0m (20ft)	kg lb					*1770 <b>*3900</b>	*1770 <b>*3900</b>			*1820 <b>*4010</b>	1710 <b>3770</b>	5.62 <b>(18.4)</b>
4.5m (15ft)	kg lb					*1950 <b>*4300</b>	*1950 <b>*4300</b>			1610 <b>3550</b>	1180 <b>2600</b>	6.62 <b>(21.7)</b>
3.0m (10ft)	kg lb			*3160 <b>*6970</b>	*3160 <b>*6970</b>	*2410 <b>*5310</b>	2390 <b>5270</b>	1870 <b>4120</b>	1380 <b>3040</b>	1350 <b>2980</b>	970 <b>2140</b>	7.10 <b>(23.3)</b>
1.5m (5ft)	kg lb			*4940 <b>*10890</b>	4150 <b>9150</b>	2930 <b>6460</b>	2150 <b>4740</b>	1780 <b>3920</b>	1290 <b>2840</b>	1280 <b>2820</b>	910 <b>2010</b>	7.18 <b>(23.6)</b>
Ground Line	kg lb			5490 <b>12100</b>	3800 <b>8380</b>	2740 <b>6040</b>	1980 <b>4370</b>	1700 <b>3750</b>	1220 <b>2690</b>	1360 <b>3000</b>	960 <b>2120</b>	6.89 <b>(22.6)</b>
-1.5m (-5ft)	kg lb	*6090 <b>*13430</b>	*6090 <b>*13430</b>	5440 <b>11990</b>	3750 <b>8270</b>	2670 <b>5890</b>	1910 <b>4210</b>			1670 <b>3680</b>	1200 <b>2650</b>	6.15 <b>(20.2)</b>
-3.0m (-10ft)	kg lb	*9180 <b>*20240</b>	*9180 <b>*20240</b>	*5080 <b>*11200</b>	3880 <b>8550</b>	2750 <b>6060</b>	1980 <b>4370</b>					











- 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.

(3) 4.3m(14' 1") boom, 2.81m(9' 3") arm equipped with 0.45m<sup>3</sup>(SAE heaped) bucket and 500mm(20") 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)
6.0m (20ft)	kg lb									*1570 *3460	1290 2840	6.66
4.5m (15ft)	kg lb							*1640 *3620	1570 3460	1330 2930	980 2160	7.50 (24.6)
3.0m (10ft)	kg lb					*1920 *4230	*1920 *4230	*1830 *4030	1500 3310	1160 2560	830 1830	7.92 (26.0)
1.5m (5ft)	kg lb			*4050 8940	*4050 8940	*2690 5930	2340 5150	1890 4170	1410 3110	1100 2420	780 1720	7.99 (24.5)
Ground Line	kg lb	*3230 *7120	*3230 *7120	*5580 *12300	4110 9060	2900 6390	2130 4700	1790 3950	1310 2890	1150 2540	820 1810	7.74 (25.4)
-1.5m (-5ft)	kg lb	*4960 *10930	*4960 *10930	5620 12390	3920 8640	2770 6110	2010 4430	1730 3810	1250 2760	1330 2930	960 2120	7.11 (23.3)
-3.0m (-10ft)	kg lb	*7230 *15940	*7230 *15940	5630 12410	3930 8660	2760 6080	2000 4410			1830 4030	1350 2980	5.96 (19.6)
-4.5m	kg			*4480	4100							

## 2) ROBEX 110D-7











(1) 4.3m(14' 1") boom, 2.26m(7' 5") arm equipped with 0.45m<sup>3</sup>(SAE heaped) bucket and 500mm(20") triple grouser shoe, and rear dozer blade down.

Load point height		Load radius								At max. reach		
		1.5m(5ft)		3.0m(10ft)		4.5m(15ft)		6.0m(20ft)		Capacity		Reach
												m(ft)
6.0m (20ft)	kg lb					*1750 *3860	*1750 *3860			*1750 *3860	*1750 *3860	5.99 (19.7)
4.5m (15ft)	kg lb					*1790 *3950	*1790 *3950	*1530 *3370	*1530 *3370	1650 3640	1340 2950	6.92 (22.7)
3.0m (10ft)	kg lb			*2820 *6220	*2820 *6220	*2270 *5000	*2270 *5000	*2060 *4540	1710 3770	1420 3130	1140 2510	7.38 (24.2)
1.5m (5ft)	kg lb			*4700 *10360	*4700 *10360	*2970 *6550	2650 5840	2000 4410	1620 3570	1360 3000	1080 2380	7.46 (24.5)
Ground Line	kg lb			*5860 *12920	4750 10470	3060 6750	2460 5420	1910 4210	1540 3400	1430 3150	1140 2510	7.18 (23.6)
-1.5m (-5ft)	kg lb	*5580 *12300	*5580 *12300	5980 13180	4640 10230	2970 6550	2370 5220	1880 4140	1500 3310	1700 3750	1360 3000	6.49 (21.3)
-3.0m (-10ft)	kg lb	*8530 *18810	*8530 *18810	*5440 *11990	4720 10410	3000 6610	2400 5290			*2270 *5000	2050 4520	5.17 (17.0)

(2) 4.3m(14' 1") boom, 1.96m(6' 5") arm equipped with 0.45m<sup>3</sup>(SAE heaped) bucket and 500mm(20") triple grouser shoe, and rear dozer blade down.

Load point height		Load radius								At max. reach		
		1.5m(5ft)		3.0m(10ft)		4.5m(15ft)		6.0m(20ft)		Capacity		Reach
												m(ft)
6.0m (20ft)	kg lb					*1770 <b>*3900</b>	*1770 <b>*3900</b>			*1820 <b>*4010</b>	*1820 <b>*4010</b>	5.62 <b>(18.4)</b>
4.5m (15ft)	kg lb					*1950 <b>*4300</b>	*1950 <b>*4300</b>			1750 <b>3860</b>	1420 <b>3130</b>	6.62 <b>(21.7)</b>
3.0m (10ft)	kg lb			*3160 <b>*6970</b>	*3160 <b>*6970</b>	*2410 <b>*5310</b>	*2410 <b>*5310</b>	2020 <b>4450</b>	1640 <b>3620</b>	1480 <b>3260</b>	1180 <b>2600</b>	7.10 <b>(23.3)</b>
1.5m (5ft)	kg lb			*4940 <b>*10890</b>	*4940 <b>*10890</b>	*3060 <b>*6750</b>	2550 <b>5620</b>	1940 <b>4280</b>	1560 <b>3440</b>	1410 <b>3110</b>	1120 <b>2470</b>	7.18 <b>(23.6)</b>
Ground Line	kg lb			*5870 <b>*12940</b>	4580 <b>10100</b>	2970 <b>6550</b>	2370 <b>5220</b>	1860 <b>4100</b>	1480 <b>3260</b>	1490 <b>3280</b>	1180 <b>2600</b>	6.89 <b>(22.6)</b>
-1.5m (-5ft)	kg lb	*6090 <b>*13430</b>	*6090 <b>*13430</b>	*5860 <b>*12920</b>	4540 <b>10010</b>	2900 <b>6390</b>	2310 <b>5090</b>			1820 <b>4010</b>	1460 <b>3220</b>	6.15 <b>(20.2)</b>
-3.0m (-10ft)	kg lb	*9180 <b>*20240</b>	*9180 <b>*20240</b>	*5080 <b>*11200</b>	4670 <b>10300</b>	2980 <b>6570</b>	2380 <b>5250</b>					

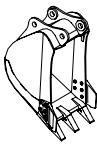
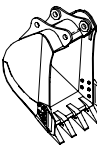
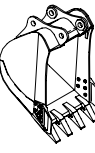
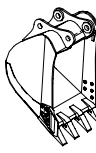
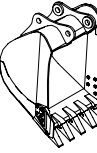
(3) 4.3m(14' 1") boom, 2.81m(9' 3") arm equipped with 0.45m<sup>3</sup>(SAE heaped) bucket and 500mm(20") triple grouser shoe, and rear dozer blade down.

Load point height		Load radius								At max. reach		
		1.5m(5ft)		3.0m(10ft)		4.5m(15ft)		6.0m(20ft)		Capacity		Reach
												m(ft)
6.0m (20ft)	kg lb									*1570 <b>*3460</b>	*1520 <b>*3350</b>	6.66 <b>(21.9)</b>
4.5m (15ft)	kg lb							*1640 <b>*3620</b>	*1640 <b>*3620</b>	1450 <b>3200</b>	1170 <b>2580</b>	7.50 <b>(24.6)</b>
3.0m (10ft)	kg lb					*1920 <b>*4230</b>	*1920 <b>*4230</b>	*1830 <b>*4030</b>	1770 <b>3900</b>	1270 <b>2800</b>	1020 <b>2250</b>	7.92 <b>(26.0)</b>
1.5m (5ft)	kg lb			*4050 <b>*8930</b>	*4050 <b>*8930</b>	*2690 <b>*5930</b>	*2690 <b>*5930</b>	2050 <b>4520</b>	1670 <b>3680</b>	1210 <b>2670</b>	960 <b>2120</b>	7.99 <b>(26.2)</b>
Ground Line	kg lb	*3230 <b>*7120</b>	*3230 <b>*7120</b>	*5580 <b>*12300</b>	4910 <b>10820</b>	3130 <b>6900</b>	2530 <b>5580</b>	1950 <b>4300</b>	1570 <b>3460</b>	1290 <b>2780</b>	1000 <b>2200</b>	7.74 <b>(25.4)</b>
-1.5m (-5ft)	kg lb	*4960 <b>*10930</b>	*4960 <b>*10930</b>	6060 <b>13360</b>	4710 <b>10380</b>	3000 <b>6610</b>	2410 <b>5310</b>	1890 <b>4170</b>	1510 <b>3330</b>	1460 <b>3220</b>	1170 <b>2580</b>	7.11 <b>(23.3)</b>
-3.0m (-10ft)	kg lb	*7230 <b>*15940</b>	*7230 <b>*15940</b>	*5830 <b>*12850</b>	4720 <b>10410</b>	2980 <b>6570</b>	2390 <b>5270</b>			1990 <b>4390</b>	1610 <b>3550</b>	5.96 <b>(19.6)</b>
-4.5m (-15ft)	kg lb			*4480 <b>*9880</b>	*4480 <b>*9880</b>							






## 6. BUCKET SELECTION GUIDE

### 1) GENERAL BUCKET

				
0.30m³ SAE heaped bucket	0.40m³ SAE heaped bucket	※ 0.45m³ SAE heaped bucket	0.50m³ SAE heaped bucket	0.59m³ SAE heaped bucket

Capacity		Width		Weight	Recommendation		
					4.3m (14' 1") Mono boom		
SAE heaped	CECE heaped	Without side cutter	With side cutter		1.96m arm (6' 5")	2.26m arm (7' 5")	2.81m arm (9' 3")
0.30m³ (0.39yd³)	0.27m³ (0.35yd³)	610mm (24.0")	720mm (28.3")	360kg (790lb)			
0.40m³ (0.52yd³)	0.44m³ (0.58yd³)	760mm (29.9")	870mm (34.3")	410kg (900lb)			
※ 0.45m³ (0.59yd³)	0.40m³ (0.52yd³)	830mm (32.7")	940mm (37.0")	430kg (950lb)			
0.50m³ (0.65yd³)	0.45m³ (0.59yd³)	900mm (35.4")	1010mm (39.8")	450kg (990lb)			
0.59m³ (0.77yd³)	0.52m³ (0.68yd³)	1020mm (40.2")	1130mm (44.5")	490kg (1080lb)			

※ : Standard bucket

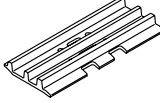
-  Applicable for materials with density of 2000kg/m³ (3370lb/yd³) or less
-  Applicable for materials with density of 1600kg/m³ (2700lb/yd³) or less
-  Applicable for materials with density of 1100kg/m³ (1850lb/yd³) or less

## 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		
					
R110-7	Shoe width	mm(in)	500(20)	600(24)	700(28)
	Operating weight	kg(lb)	11200(24690)	11500(25350)	11800(26010)
	Ground pressure	kgf/cm <sup>2</sup> (psi)	0.39(5.55)	0.34(4.84)	0.30(4.27)
	Overall width	mm(ft-in)	2490(8' 2")	2590(8' 6")	2690(8'10")
R110D-7	Shoe width	mm(ft-in)	500(20)	600(24)	700(28)
	Overall width	mm(ft-in)	11900(26230)	12200(26900)	12500(27560)
	Overall width	mm(ft-in)	0.42(5.97)	0.36(5.12)	0.31(4.41)
	Overall width	mm(ft-in)	2500(8' 2")	2590(8' 6")	2690(8'10")

### 3) NUMBER OF ROLLERS AND SHOES ON EACH SIDE

Item	Quantity
Carrier rollers	1EA
Track rollers	6EA
Track shoes	41EA

#### 4) SELECTION OF TRACK SHOE

Suitable track shoes should be selected according to operating conditions.

##### Method of selecting shoes

Confirm the category from the list of applications in **table 2**, then use **table 1** to select the shoe. Wide shoes(Categories B) have limitations on applications. Before using wide shoes, check the precautions, then investigate and study the operating conditions to confirm if these shoes are suitable.

Select the narrowest shoe possible to meet the required flotation and ground pressure. Application of wider shoes than recommendations will cause unexpected problem such as bending of shoes, crack of link, breakage of pin, loosening of shoe bolts and the other various problems.

※ **Table 1**

Track shoe	Specification	Category
500mm triple grouser	Standard	A
600mm triple grouser	Option	A
700mm triple grouser	Option	B

※ **Table 2**

Category	Applications	Precautions
A	Rocky ground, river beds, normal soil	• Travel at low speed on rough ground with large obstacles such as boulders or fallen trees
B	Normal soil, soft ground	• These shoes cannot be used on rough ground with large obstacles such as boulders or fallen trees • Travel at high speed only on flat ground • Travel slowly at low speed if it is impossible to avoid going over obstacles

## 8. SPECIFICATIONS FOR MAJOR COMPONENTS

### 1) ENGINE

Item	Specification
Model	Kirloskar 4R1040T
Type	4-cycle turbocharged diesel engine, low emission
Cooling method	Water cooling
Number of cylinders and arrangement	4 cylinders, in-line
Firing order	1-3-4-2
Combustion chamber type	Direct injection type
Cylinder bore × stroke	105 × 120mm(4.1" × 4.7")
Piston displacement	4160cc(253.8cu in)
Compression ratio	17:1
Rated gross horse power(SAE J1995)	94Hp at 1950rpm(69.1kW at 1950rpm)
Maximum torque at 1400rpm	38.2kgf · m(276.6lbf · ft)
Engine oil quantity	11.5 l (3.0U.S. gal)
Dry weight	550kg(1213lb)
High idling speed	2069+ 50rpm
Low idling speed	750 ± 50rpm
Rated fuel consumption	163.5g/Hp · hr at 1950rpm
Starting motor	LUCAS 24V-5.0kW
Alternator	MICO 24V-55A
Battery	2 × 12V × 80Ah

### 2) MAIN PUMP

Item	Specification
Type	Variable displacement tandem axis piston pumps
Capacity	2 × 57.5cc/rev
Maximum pressure	330kgf/cm <sup>2</sup> (4694psi) [360kgf/cm <sup>2</sup> (5120psi)]
Rated oil flow	2 × 112 l /min (2 × 29.6U.S.gpm)
Rated speed	1950rpm

[ ]: Power boost

### 3) GEAR PUMP

Item	Specification
Type	Fixed displacement gear pump single stage
Capacity	15cc/rev
Maximum pressure	35kgf/cm <sup>2</sup> (500psi)
Rated oil flow	29.3 l /min(7.7U.S.gpm/6.4U.K.gpm)

### 4) MAIN CONTROL VALVE

Item	Specification
Type	11 spools mono-block
Operating method	Hydraulic pilot system
Main relief valve pressure	330kgf/cm <sup>2</sup> (4695psi)[360kgf/cm <sup>2</sup> (5120psi)]
Overload relief valve pressure	380kgf/cm <sup>2</sup> (5550psi)

[ ]: Pooer boost

### 5) SWING MOTOR

Item	Specification
Type	Axial piston motor
Capacity	64.3cc/rev
Relief pressure	240kgf/cm <sup>2</sup> (3414psi)
Braking system	Automatic, spring applied hydraulic released
Braking torque	25kgf · m <sup>2</sup> (181lbf · ft)
Brake release pressure	33~50kgf/cm <sup>2</sup> (469~711psi)
Reduction gear type	2 - stage planetary
Swing speed	13.0rpm

### 6) TRAVEL MOTOR

Item	Specification
Type	Variable displacement axial piston motor
Relief pressure	330kgf/cm <sup>2</sup> (4695psi)
Reduction gear type	2 stage planetary
Braking system	Automatic, spring applied hydraulic released
Brake release pressure	Less then 9kgf/cm <sup>2</sup> (128psi)
Braking torque	24.36kgf · m <sup>2</sup> (176lbf · ft)

## 7) REMOTE CONTROL VALVE

Item		Specification
Type		Pressure reducing type
Operating pressure	Minimum	6.5kgf/cm <sup>2</sup> (92psi)
	Maximum	26kgf/cm <sup>2</sup> (370psi)
Single operation stroke	Lever	61mm(2.4in)
	Pedal	123mm(4.84in)

## 8) CYLINDER

Item		Specification
Boom cylinder	Bore dia × Rod dia × Stroke	∅ 95 × ∅ 70 × 1015mm
	Cushion	Extend only
Arm cylinder	Bore dia × Rod dia × Stroke	∅ 110 × ∅ 75 × 1070mm
	Cushion	Extend and retract
Bucket cylinder	Bore dia × Rod dia × Stroke	∅ 95 × ∅ 65 × 855mm
	Cushion	Extend only
Dozer cylinder	Bore dia × Rod dia × Stroke	∅ 100 × ∅ 70 × 240mm
	Cushion	-

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

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

## 9) SHOE

Item		Width	Ground pressure	Link quantity	Overall width
R110-7 R110D-7	Standard	500mm(20")	0.39kgf/cm <sup>2</sup> (5.55psi)	41	2490mm( 8' 2")
	Option	600mm(24")	0.34kgf/cm <sup>2</sup> (4.84psi)	41	2590mm( 8' 6")
	Option	700mm(28")	0.30kgf/cm <sup>2</sup> (4.27psi)	41	2690mm( 8' 10")

## 10) BUCKET

Item		Capacity		Tooth quantity	Width	
		SAE heaped	CECE heaped		Without side cutter	With side cutter
R110-7 R110D-7	STD	0.45m <sup>3</sup> (0.59yd <sup>3</sup> )	0.40m <sup>3</sup> (0.52yd <sup>3</sup> )	4	830mm(32.7")	940mm(37.0")
	OPT	0.30m <sup>3</sup> (0.39yd <sup>3</sup> )	0.27m <sup>3</sup> (0.35yd <sup>3</sup> )	3	610mm(24.0")	720mm(28.3")
		0.40m <sup>3</sup> (0.52yd <sup>3</sup> )	0.44m <sup>3</sup> (0.58yd <sup>3</sup> )	4	760mm(29.9")	870mm(34.3")
		0.50m <sup>3</sup> (0.65yd <sup>3</sup> )	0.45m <sup>3</sup> (0.59yd <sup>3</sup> )	4	900mm(35.4")	1010mm(39.8")
		0.59m <sup>3</sup> (0.77yd <sup>3</sup> )	0.52m <sup>3</sup> (0.68yd <sup>3</sup> )	5	1020mm(40.2")	1130mm(44.5")

## 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	11.5(3.0)					SAE 30		
						SAE 10W			
							SAE 10W-30		
							SAE 15W-40		
Swing drive	Gear oil	2.5(0.7)							
Final drive		$\frac{2.5 \times 2}{0.7 \times 2}$					SAE 85W-140		
Swing drive	Grease	0.35(0.09)				NLGI NO.1			
							NLGI NO.2		
Hydraulic tank	Hydraulic oil	Tank:100(26.4) System: 210(55.5)					ISO VG 32		
							ISO VG 46		
							ISO VG 68		
Fuel tank	Diesel fuel	250(66.0)				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 .....	2-1
Group 2 Main Control Valve .....	2-19
Group 3 Swing Device .....	2-42
Group 4 Travel Device .....	2-54
Group 5 RCV Lever .....	2-68
Group 6 RCV Pedal .....	2-75

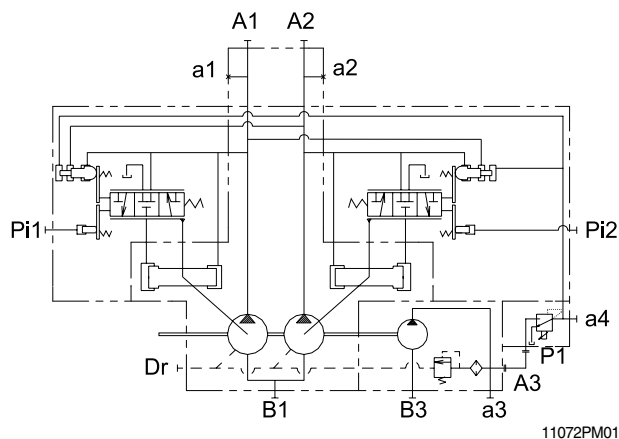
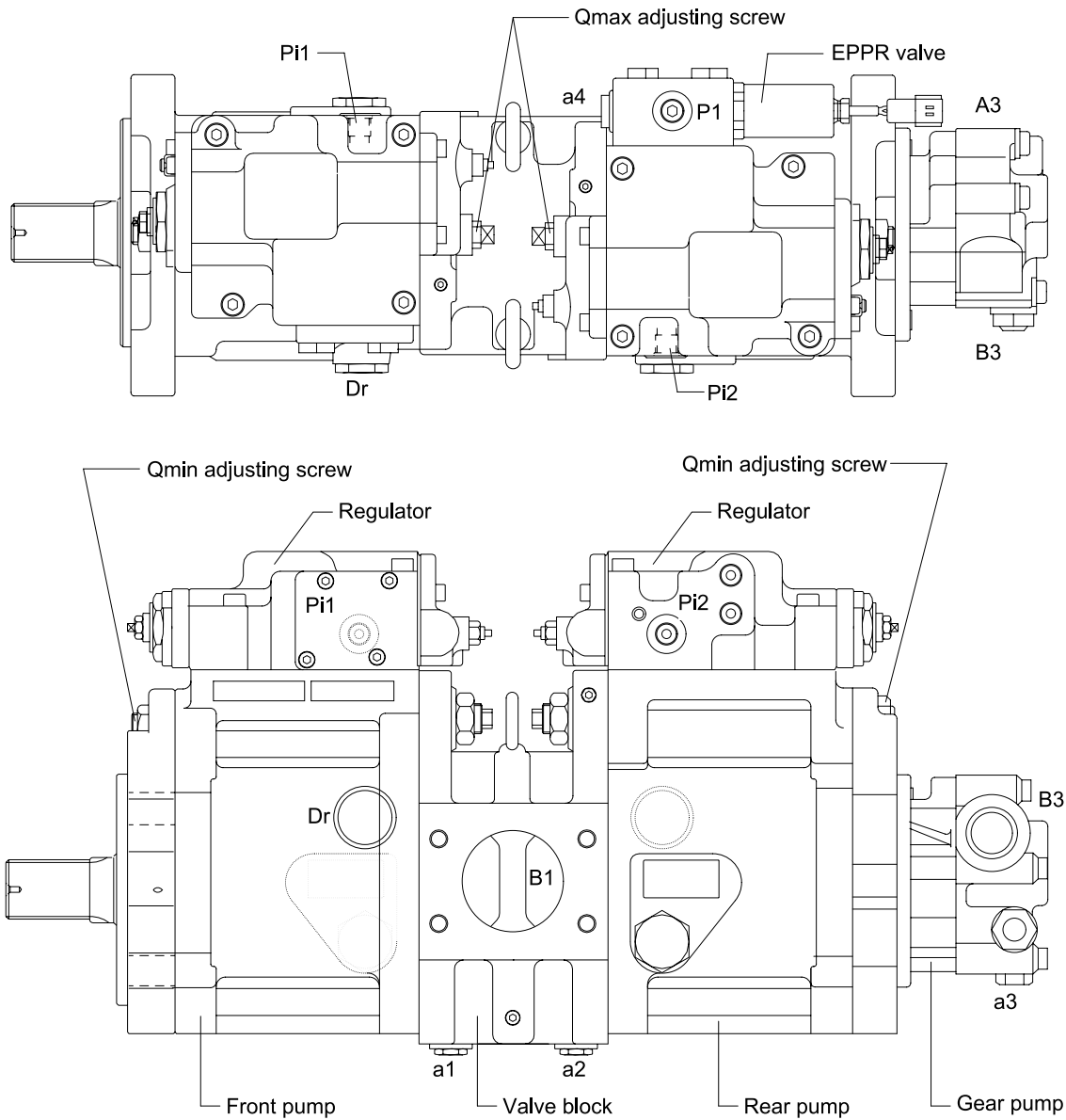


# SECTION 2 STRUCTURE AND FUNCTION

## GROUP 1 PUMP DEVICE

### 1. STRUCTURE

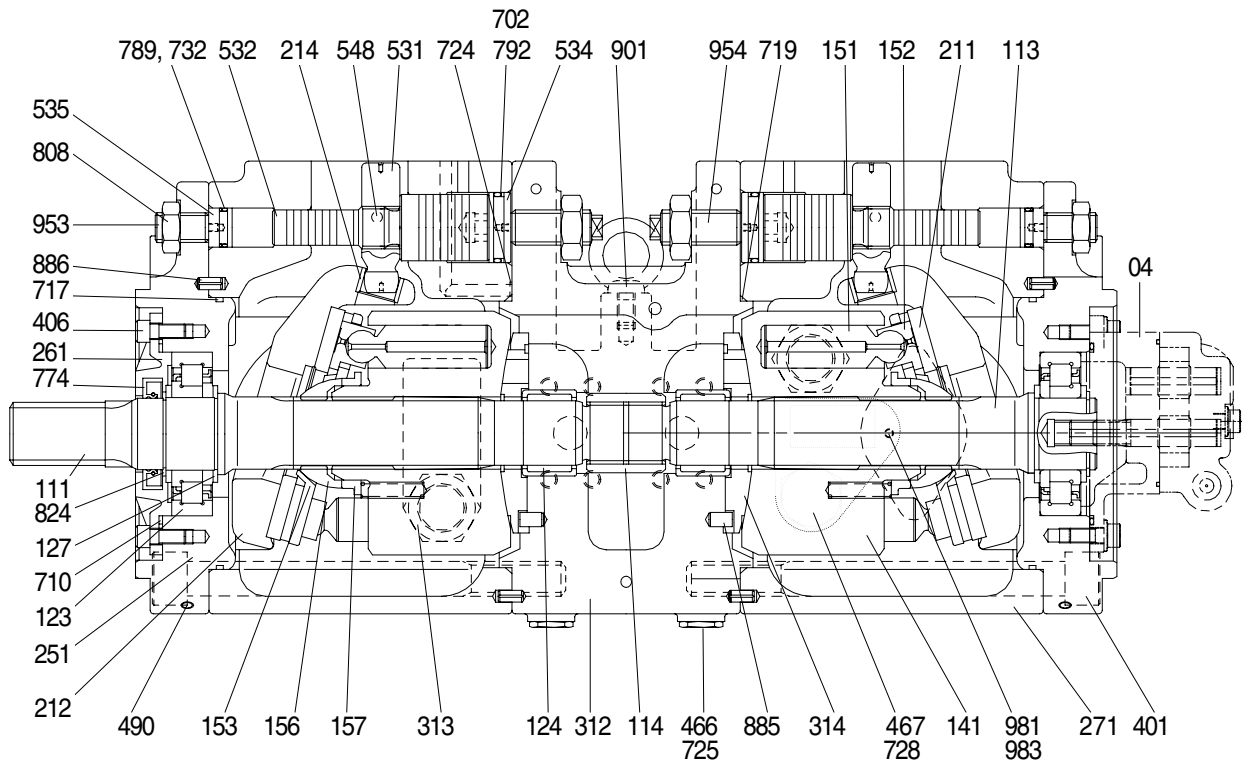
The pump device consists of main pump, regulator and gear pump.



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
Pi1,i2	Pilot port	PF 1/4 - 15
P1	EPPR port	PF 1/4 - 13
a1,2	Gauge port	PF 1/4 - 15
a3	Gauge port	PF 1/4 - 14
a4	Gauge port	PF 1/4 - 13
A3	Gear pump delivery port	PF 1/2 - 19
B3	Gear pump suction port	PF 3/4 - 20.5

## 1) MAIN PUMP(1/2)

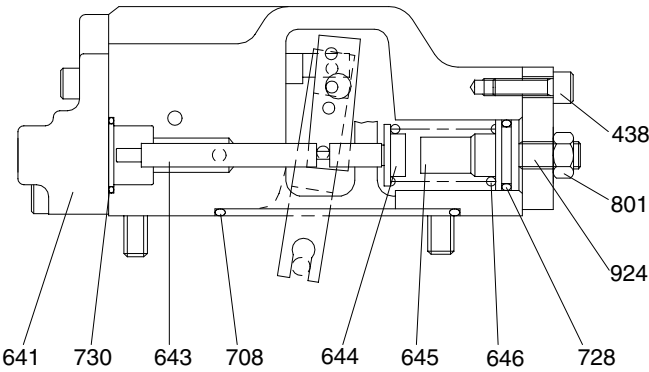
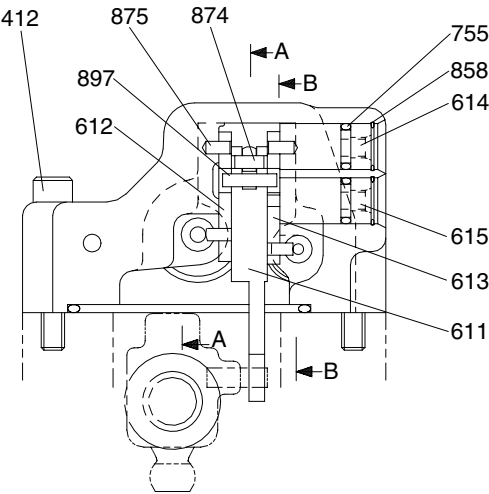
The main pump consists of two piston pumps(front & rear) and valve block.



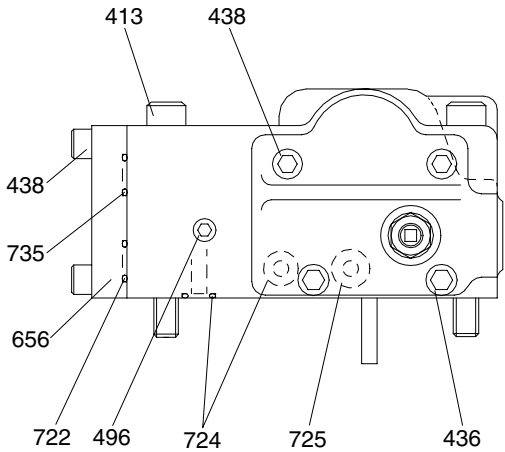
14072SF02

04	Gear pump	271	Pump casing	719	O-ring
111	Drive shaft(F)	312	Valve block	724	O-ring
113	Drive shaft(R)	313	Valve plate(R)	725	O-ring
114	Spline coupling	314	Valve plate(L)	728	O-ring
123	Roller bearing	401	Hexagon socket bolt	732	O-ring
124	Needle bearing	406	Hexagon socket bolt	774	Oil seal
127	Bearing spacer	466	VP Plug	789	Back up ring
141	Cylinder block	467	VP Plug	792	Back up ring
151	Piston	490	Plug	808	Hexagon head nut
152	Shoe	531	tilting pin	824	Snap ring
153	Set plate	532	Servo piston	885	Pin
156	Bushing	534	Stopper(L)	886	Spring pin
157	Cylinder spring	535	Stopper(S)	901	Eye bolt
211	Shoe plate	548	Pin	953	Set screw
212	Swash plate	702	O-ring	954	Set screw
214	Bushing	710	O-ring	981	Plate
251	Support	717	O-ring	983	Pin
261	Seal cover(F)				

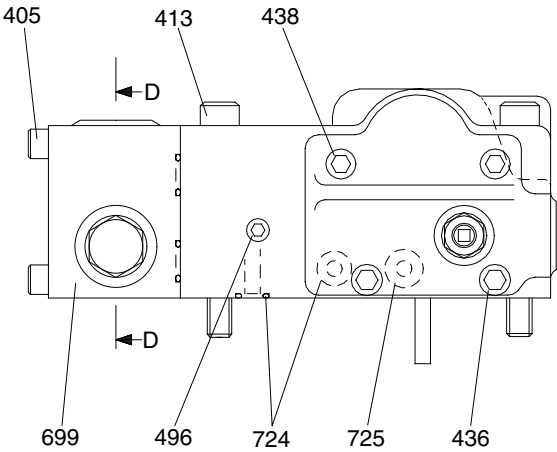
2) REGULATOR(1/2)



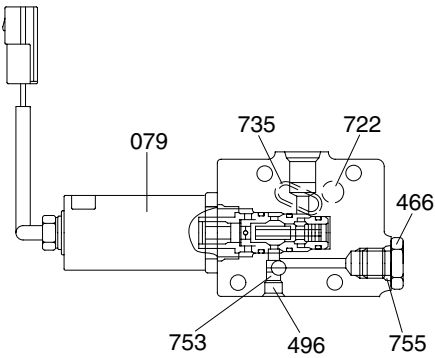
SECTION B-B



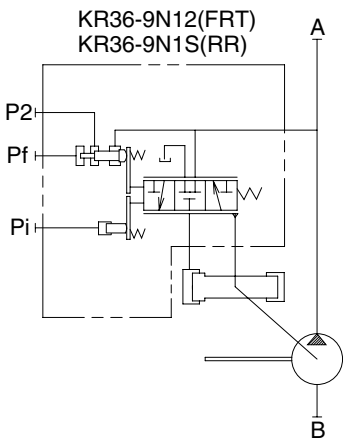
VIEW C(FRONT)



VIEW C(REAR)



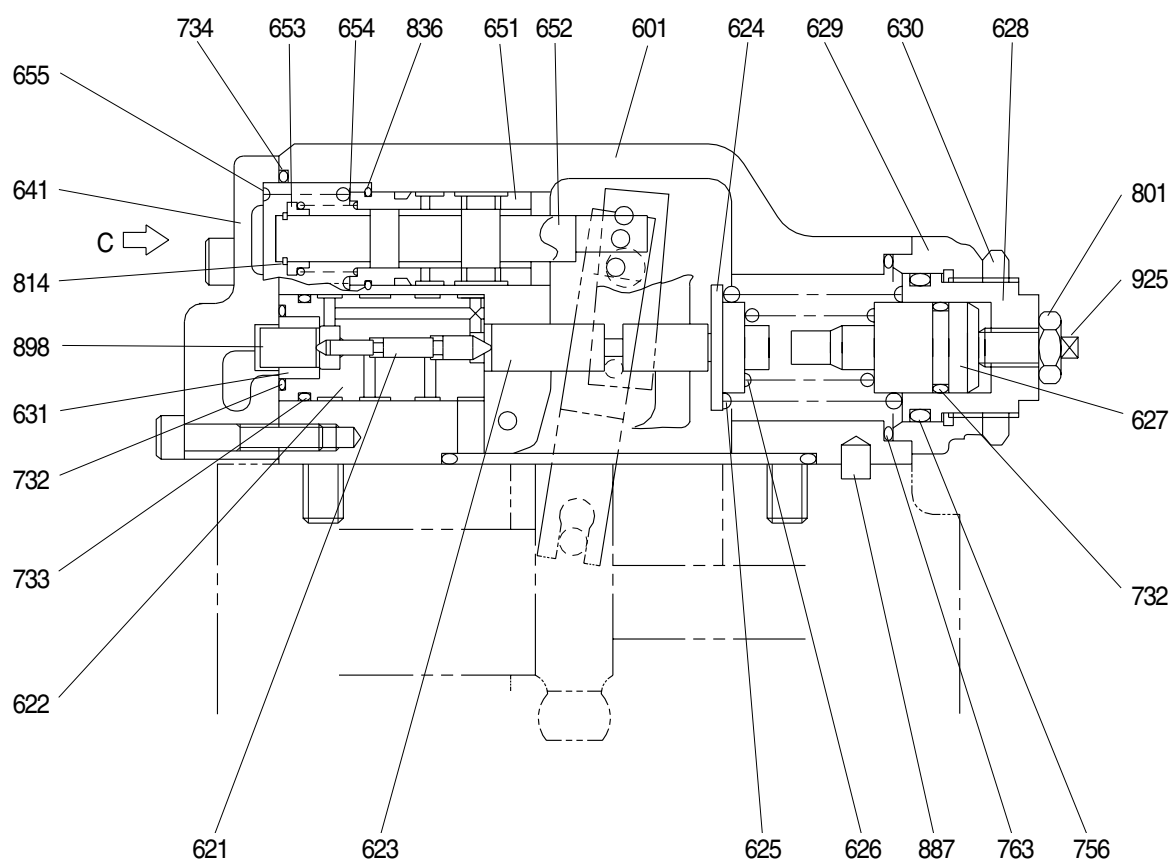
SECTION D-D



Port	Port name	port size
A	Delivery port	3/4"
B	Suction port	2 1/2"
Pn	Pilot port	PF 1/4-15
Pm	Qmax cut port	PF 1/4-15

11072PM03

## REGULATOR(2/2)

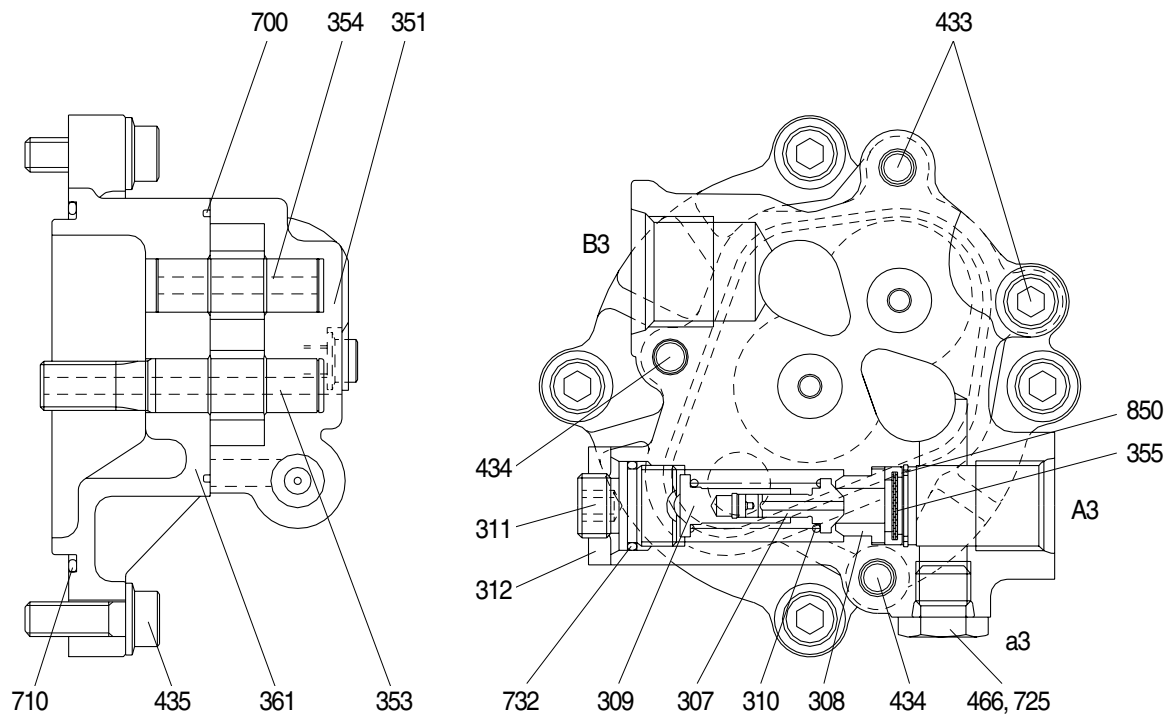


SECTION A-A

140LC-7 기타 2-5

405	Hexagon socket screw	629	Cover(C)	730	O-ring
412	Hexagon socket screw	630	Lock nut	732	O-ring
413	Hexagon socket screw	631	Sleeve, pf	733	O-ring
436	Hexagon socket screw	641	Pilot cover	734	O-ring
438	Hexagon socket screw	643	Pilot piston	735	O-ring
466	Plug	644	Spring seat(Q)	753	O-ring
496	Plug	645	Adjust stem(Q)	755	O-ring
601	Casing	646	Pilot spring	756	O-ring
611	Feed back lever	651	Sleeve	763	O-ring
612	Lever(1)	652	Spool	801	Nut
613	Lever(2)	653	Spring seat	814	Snap ring
614	Fulcrum plug	654	Return spring	836	Snap ring
615	Adjust plug	655	Set spring	858	Snap ring
621	Compensator piston	656	Block cover	874	Pin
622	Piston case	699	Valve casing	875	Pin
623	Compensator rod	708	O-ring	887	Pin
624	Spring seat(C)	722	O-ring	897	Pin
625	Outer spring	724	O-ring	898	Pin
626	Inner spring	725	O-ring	924	Set screw
627	Adjust stem(C)	728	O-ring	925	Adjust screw(QI)
628	Adjust screw(C)				

### 3) GEAR PUMP



140LC-7 기타 2-5

307 Poppet  
308 Seat  
309 Spring seat  
310 Spring  
311 Screw  
312 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

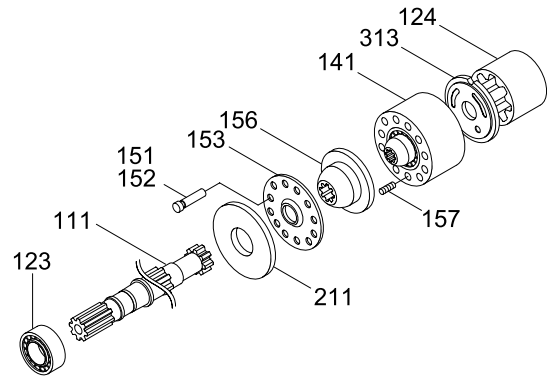
The pumps may classified roughly into the rotary group performing a rotary motion and working as the major part of the whole pump function: the swash plate group that varies the delivery rates: and the valve cover group that changes over oil suction and discharge.

#### (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) 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 the 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.



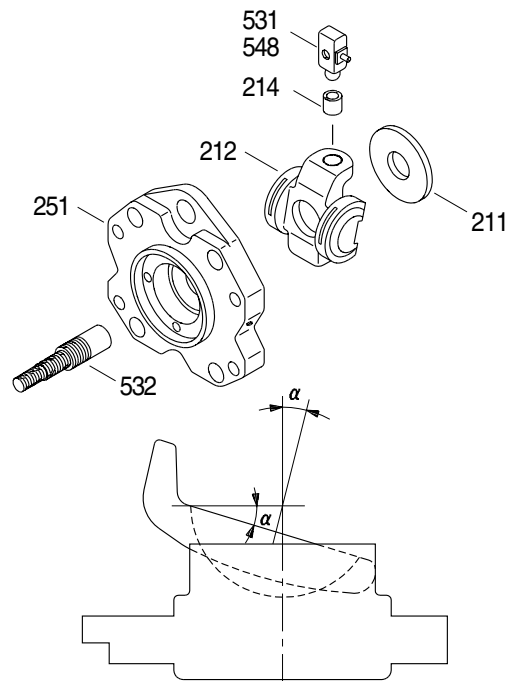
14072SF04

#### (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( $\alpha$ )



140LC-7 기타 2-7

### (3) Valve block group

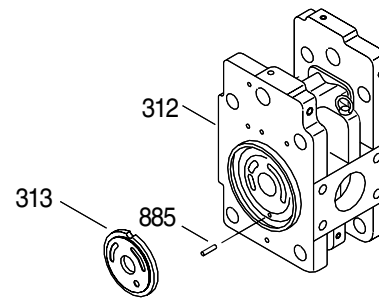
The valve block group consists of valve block(312), valve plate(313) and valve pin(885).

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.



140LC-7 기타 2-8

## 2) REGULATOR

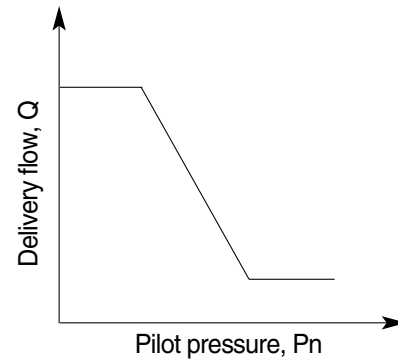
Regulator consists of the negative flow control, total horse power control and power shift control function.

### (1) Negative flow control

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

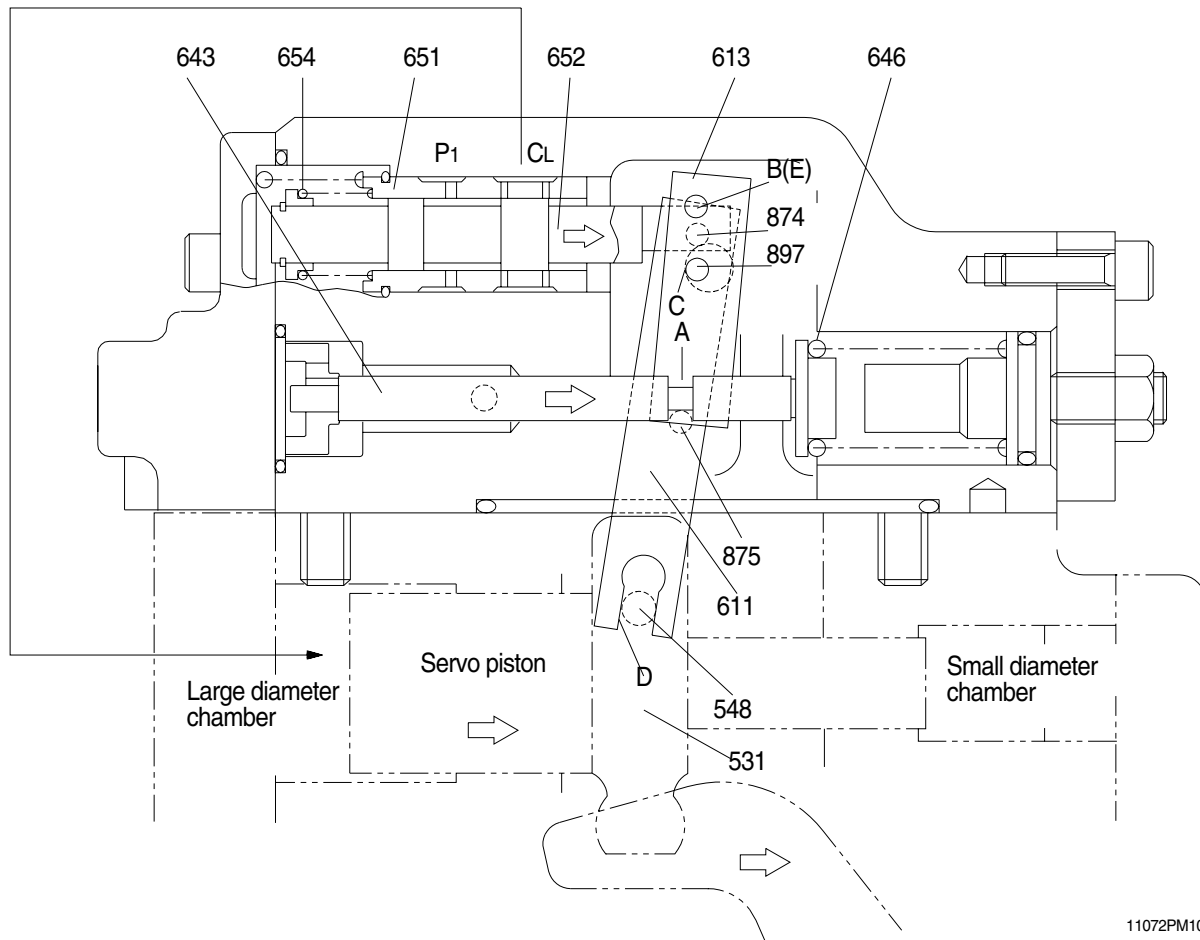
This regulator is of the negative flow control in which the delivery flow  $Q$  decreases as the pilot pressure  $P_n$  rises.

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



11072PM10

As the pilot pressure  $P_n$  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.

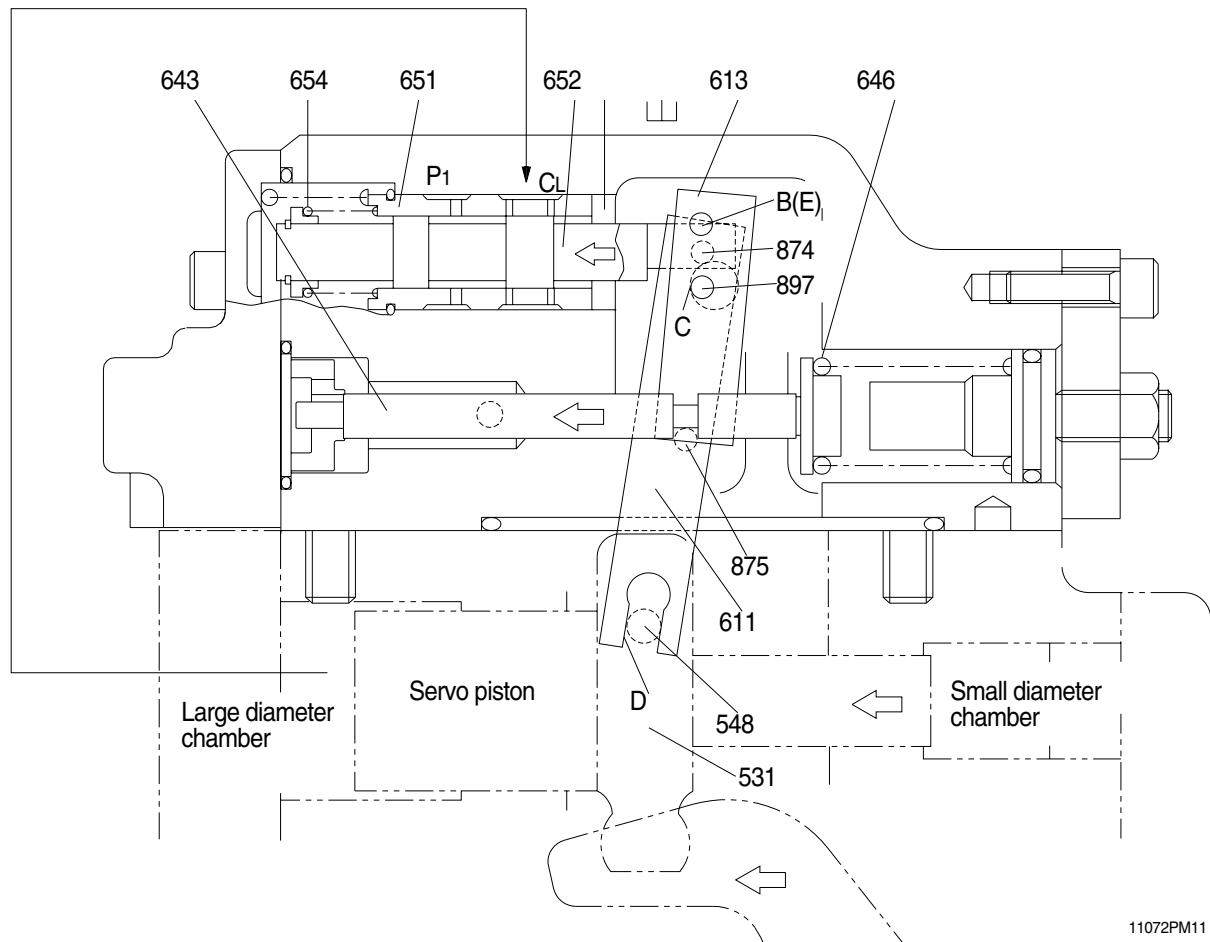
Since the feedback lever is connected with the spool(652) via the pin(874), the spool moves to the right.

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



11072PM11

As the pilot pressure  $P_n$  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

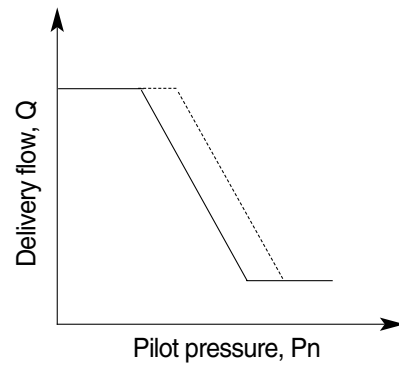
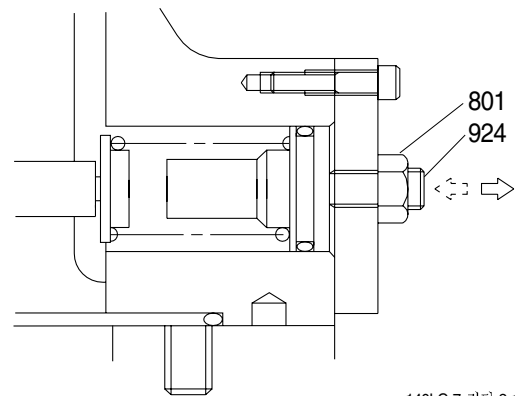
The flow control characteristic can be adjusted with the adjusting screw.

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 <sup>-1</sup> )	(Turn)	(kgf/cm <sup>2</sup> )	( l /min)
1950	+1/4	+1.5	+7.3



## (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.

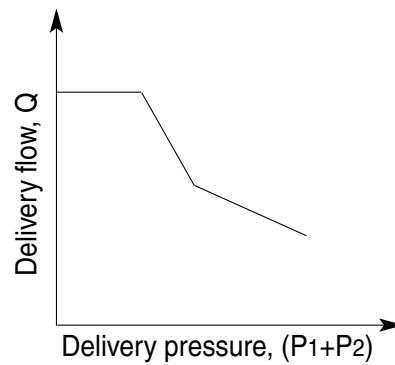
(The input horsepower is constant when the speed is constant.)

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.

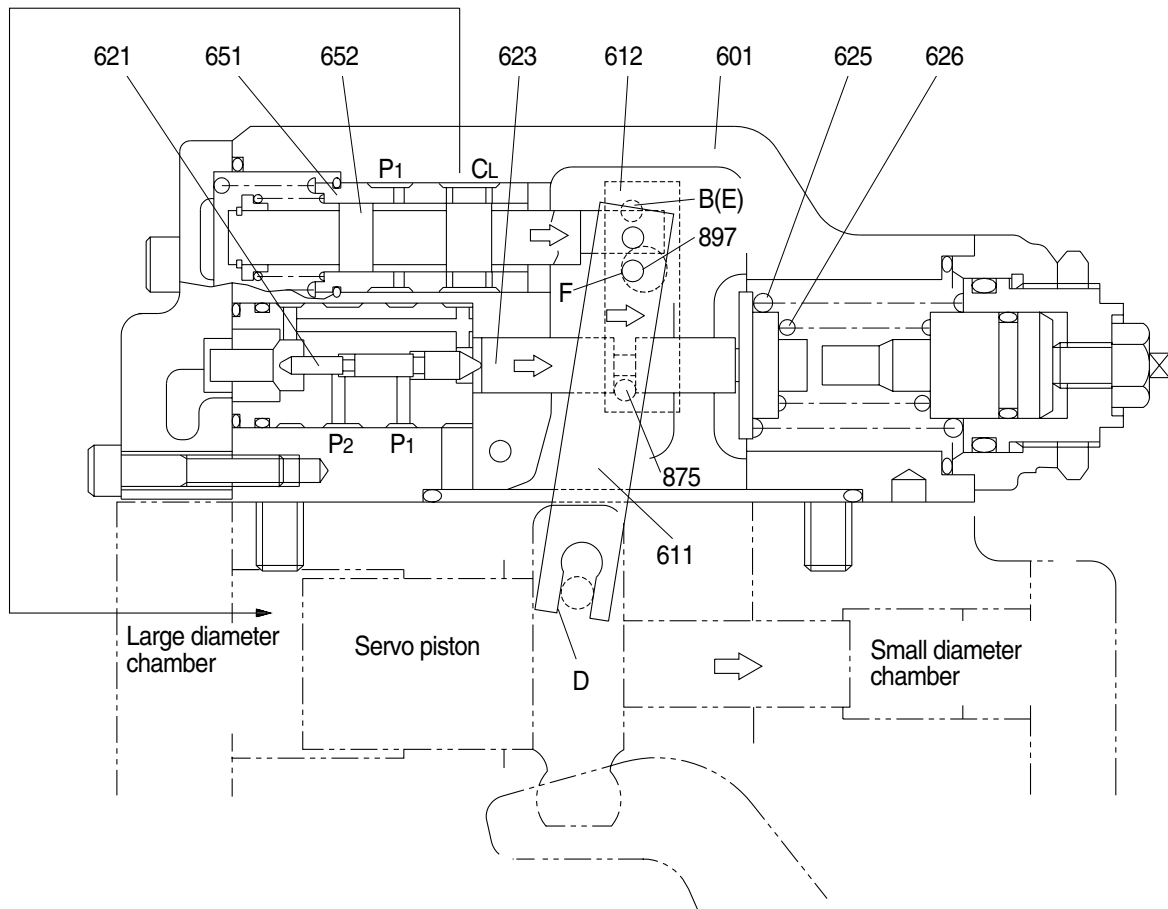
Since this regulator is of the simultaneous total horsepower type, it controls the tilting angles(displacement volumes) of the two pumps to the same value as represented by the following equation :

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

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



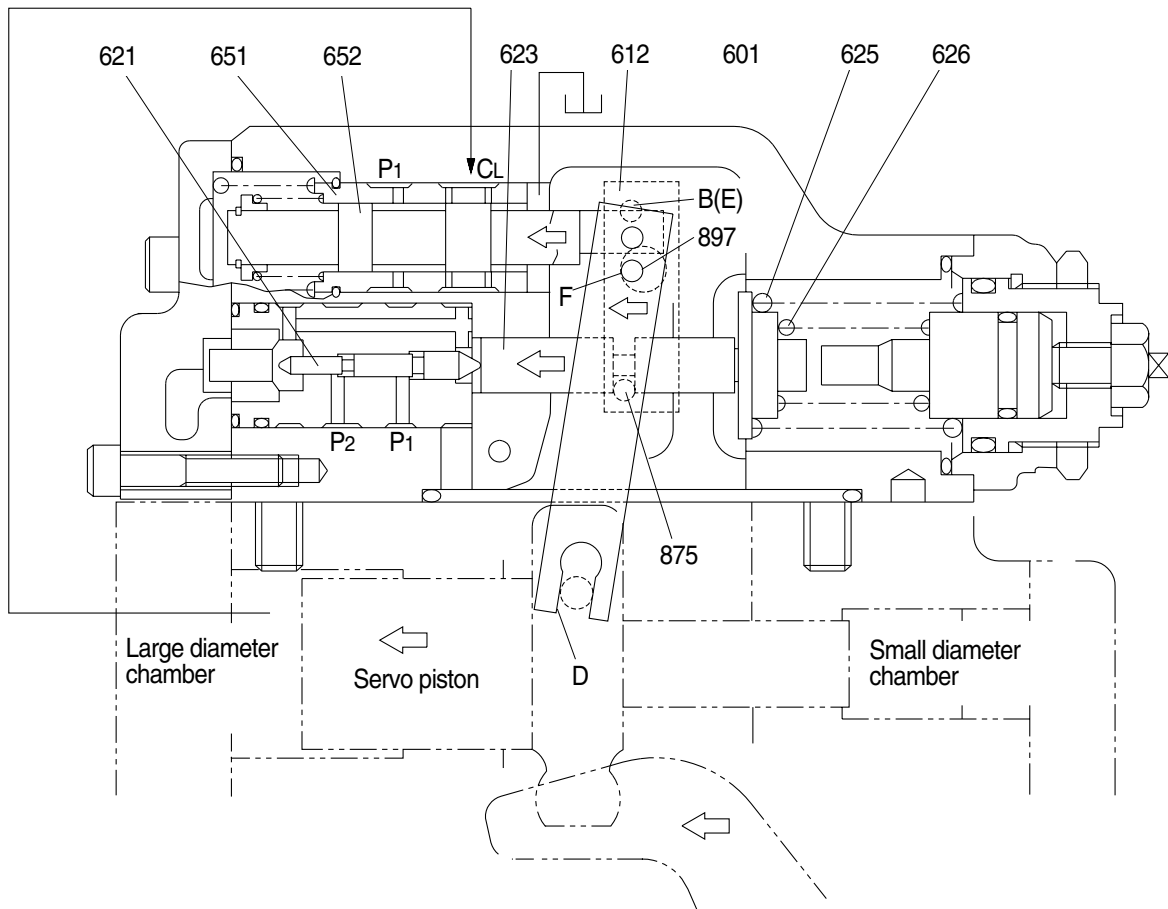
140LC-7 기타 2-14

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



140LC-7 기타 2-15

As the self pump delivery pressure P1 or the companion pump delivery pressure P2 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

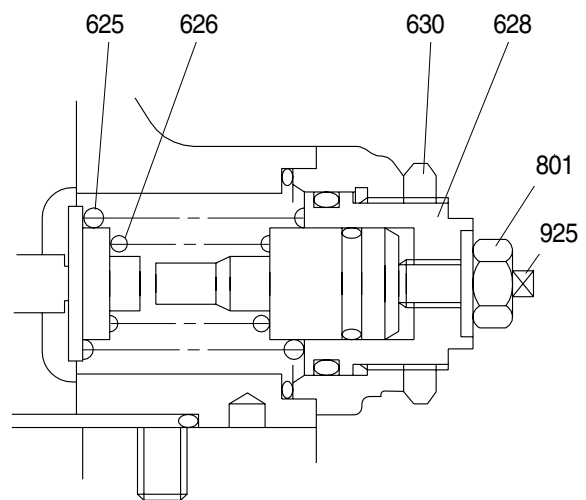
As mentioned above, flow control and horsepower control tilting angle commands are transmitted to the feedback lever and spool via the large-hole sections(C & F) of levers 1 and 2. However, since sections C and F have the pins( $\varnothing 4$ ) protruding from the large hole( $\varnothing 8$ ), only 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

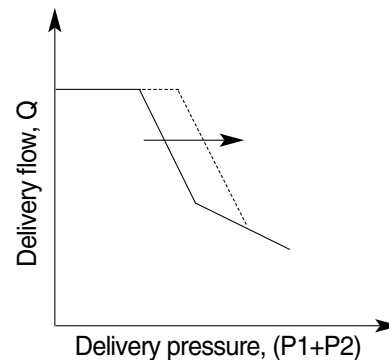
Adjust it by loosening the hexagon nut(630) and by tightening(or loosening) the adjusting screw C(628). Tightening the screw shifts the control chart to the right and increases the input horsepower as shown in the figure. Since turning the adjusting screw C by N turns changes the setting of the inner spring(626), return the adjusting screw QI(925) by  $N \times A$  turns at first. ( $A=1.9$ )



140LC-7 기타 2-16

※ Adjusting values are shown in table

Speed	Adjustment of outer spring		
	Tightenin amount of adjusting screw(C) (924)	Compens- ationg control pressure change amount	Input torque change amount
(min <sup>-1</sup> )	(Turn)	(kgf/cm <sup>2</sup> )	(kgf · m)
1950	+1/4	+19.2	+2.71



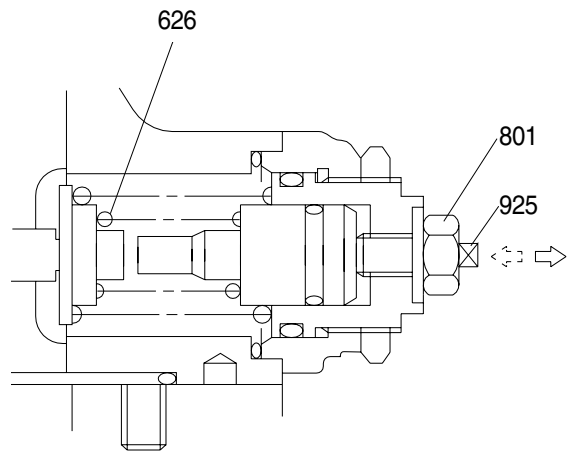
### b. Adjustment of inner spring

Adjust it by loosening the hexagon nut (801) and by tightening(or loosening) the adjusting screw QI(925).

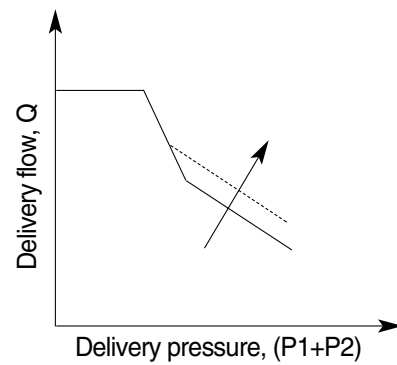
Tightening the screw increases the flow and then the input horsepower as shown in the figure.

※ Adjusting valves are shown in table

Speed	Adjustment of outer spring		
	Tightenin amount of adjusting screw(C) (925)	Flow change amount	Input torque change amount
(min <sup>-1</sup> )	(Turn)	( l /min)	(kgf · m)
1950	+1/4	+5.2	+2.3



140LC-7 기타 2-17





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.

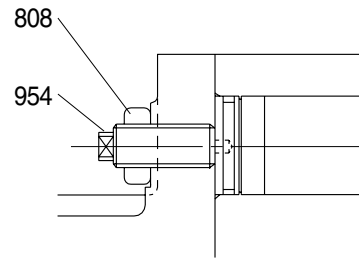


#### (4) Adjustment of maximum and minimum flows

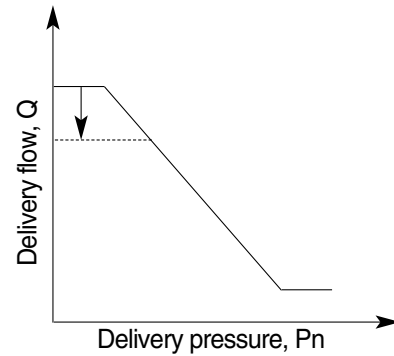
- ① Adjust it by loosening the hexagon nut(808) and by tightening(or loosening) the set screw(954).

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 <sup>-1</sup> )	(Turn)	( l /min)
1950	+1/4	-3.1



140LC-7 기타 2-19(1)

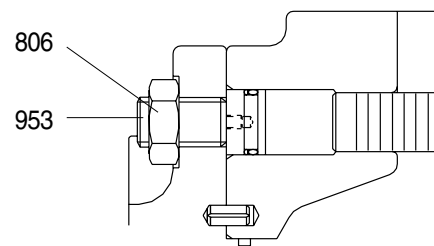


#### ② Adjustment of minimum flow

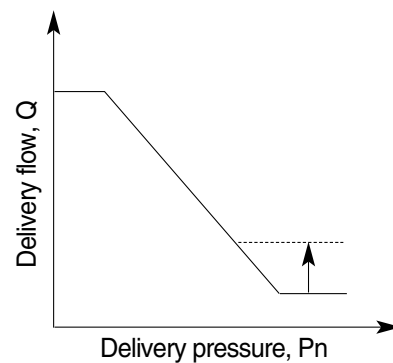
Adjust it by loosening the hexagon nut(808) and by tightening(or loosening) the hexagonal socket head set screw (953). Similarly to the adjustment of the maximum flow, other characteristics are not changed.

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 <sup>-1</sup> )	(Turn)	( l /min)
1950	+1/4	+3.1

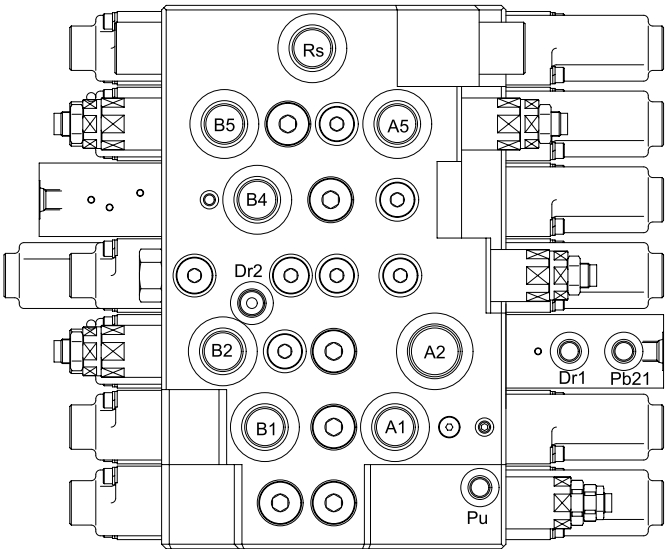


140LC-7 기타 2-19(2)

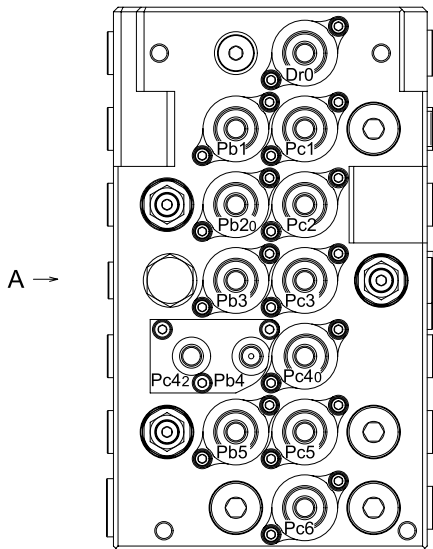
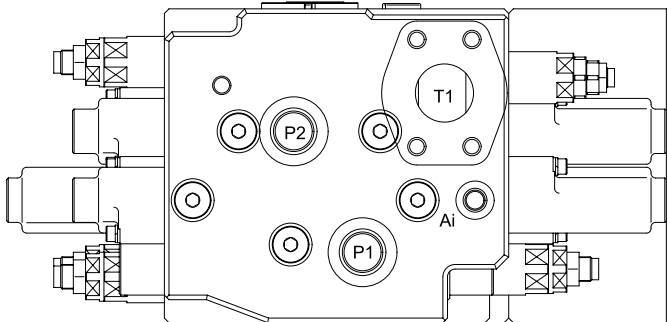


# GROUP 2 MAIN CONTROL VALVE

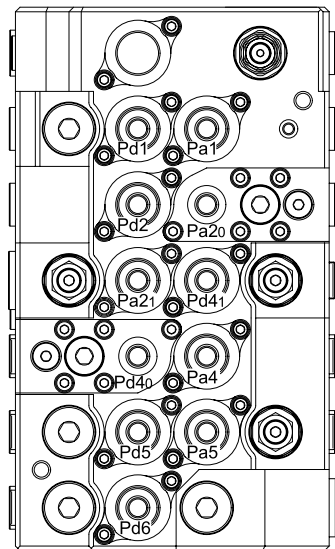
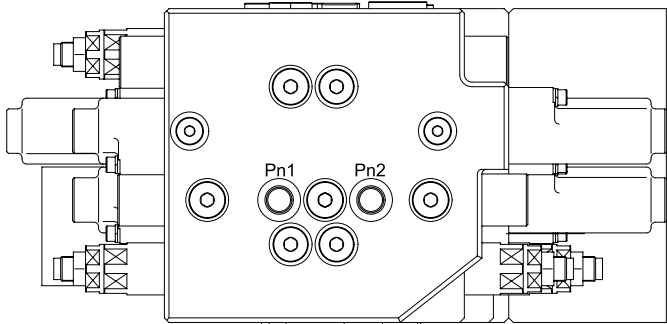
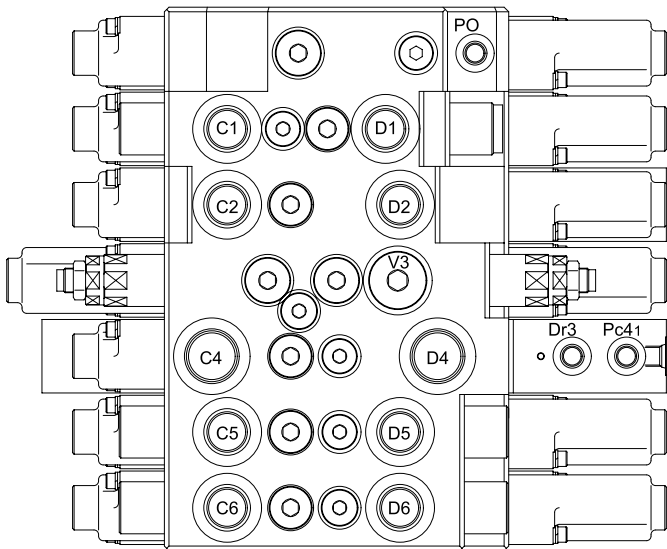
## 1. STRUCTURE



VIEW A

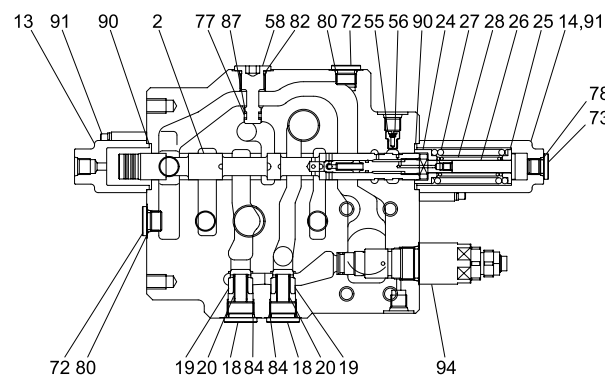
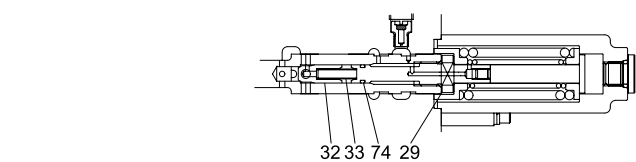


A →

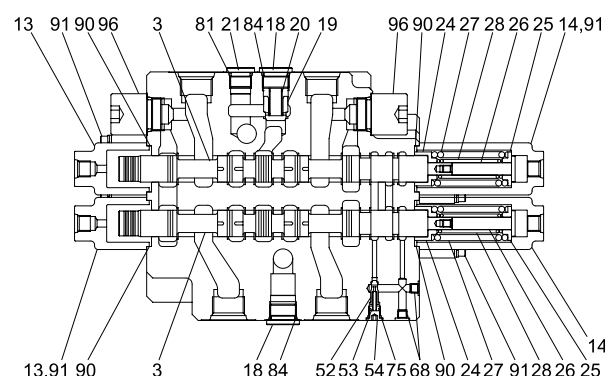


Mark	Port name	Port size	Tightening torque
Rs	Make up for swing motor	G1/4	3.5~3.9kgf · m (25.3~28.2lbf · ft)
Pa1	Travel left pilot port(FW)		
Pb1	Travel left pilot port(BW)		
Pc1	Travel right pilot port(BW)		
Pd1	Travel right pilot port(FW)		
Pa20	Boom up pilot port		
Pa21	Boom up confluence pilot port		
Pb20	Boom down pilot port		
Pb21	Lock valve pilot port(Boom)		
Pc2	Swing pilot port(RH)		
Pd2	Swing pilot port(LH)		
Pb3	Arm in confluence pilot port		
Pc3	Swing priority pilot port		
Pa4	Option A pilot port(Breaker)		
Pb4	Arm in regeneration cut port		
Pc40	Arm in pilot port		
Pc41	Lock valve pilot port(Arm)		
Pc42	Arm in regen-cut signal selector port		
Pd40	Arm out pilot port		
Pd41	Arm out confluence pilot port		
Pa5	Bucket in pilot port		
Pb5	Bucket out pilot port		
Pc5	Option B pilot port		
Pd5	Option B pilot port		
Pc6	Option C pilot port		
Pd6	Option C pilot port		
PO	Pilot pressure port	G3/4	15~18kgf · m (109~130lbf · ft)
Pu	Main relief pressure up		
Ai	Auto idle signal port		
Dr0	Drain port(Travel straight)		
Dr1	Drain port(Boom holding valve)		
Dr2	Drain port(Boom2 & swing priority)		
Dr3	Drain port(Arm holding valve)		
Pn1	Negative control signal port(P1 port side)		
Pn2	Negative control signal port(P2 port side)		
A1	Travel motor left side port(FW)	G1	20~25kgf · m (115~180lbf · ft)
B1	Travel motor left side port(BW)		
C1	Travel motor right side port(BW)		
D1	Travel motor right side port(FW)		
B2	Boom rod side port		
C2	Swing motor port(LH)		
D2	Swing motor port(RH)		
B4	Option A port(Breaker)		
A5	Bucket head side port		
B5	Bucket rod side port		
C5	Option B port		
D5	Option B port		
C6	Option C port	SAE3000, 1 1/2 (M12)	8.5~11.5kgf · m (61.5~83.1lbf · ft)
P1	Pump port(P1 side)		
P2	Pump port(P2 side)		
A2	Boom head side port	G1	20~25kgf · m (115~180lbf · ft)
C4	Arm head side port		
D4	Arm rod side port		
T1	Return port	SAE3000, 1 1/2 (M12)	8.5~11.5kgf · m (61.5~83.1lbf · ft)

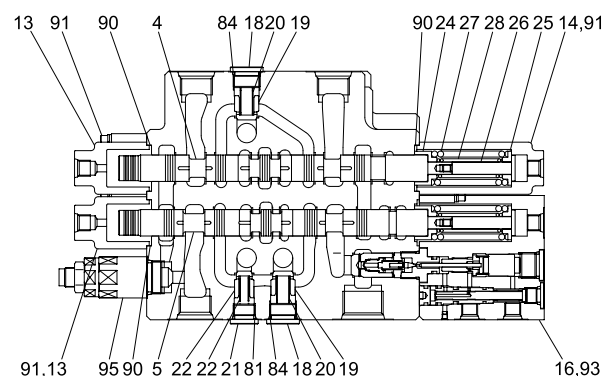
14072SF10



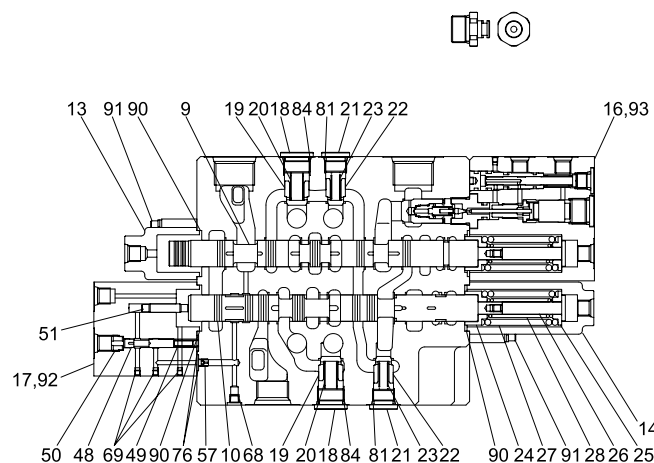
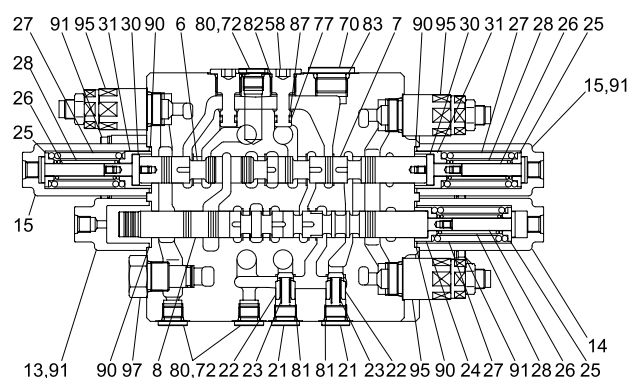
A - A(STRAIGHT-TRAVEL & SUPPLY)



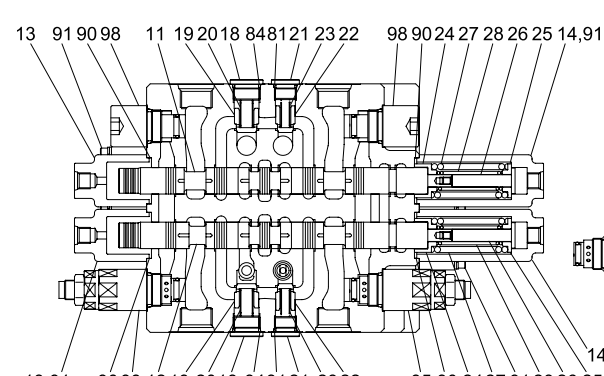
B - B(TRAVEL RIGHT & LEFT)



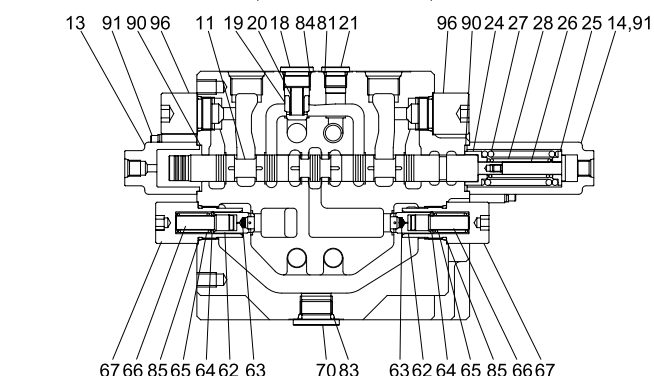
C - C(SWING & BOOM)



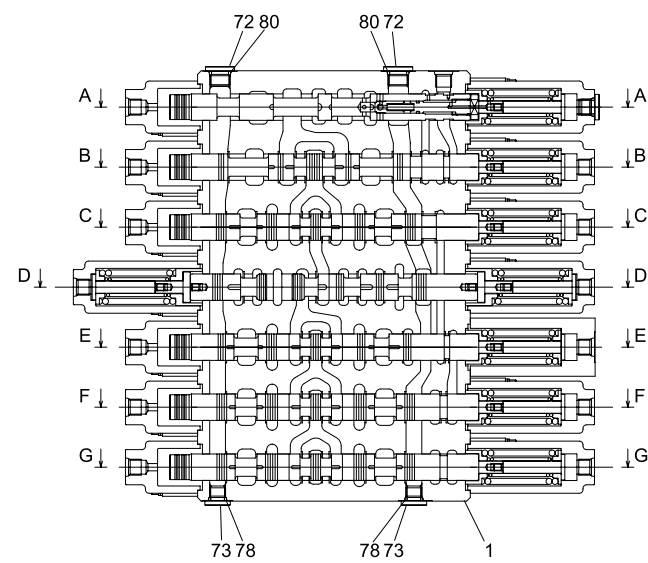
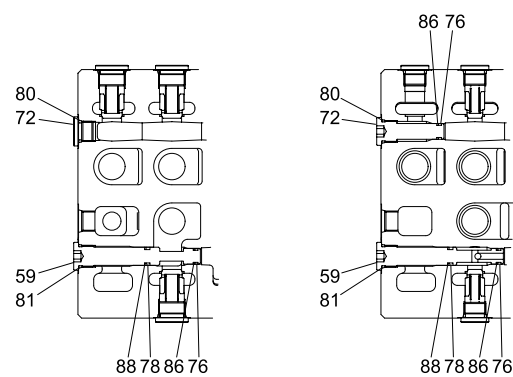
E - E(ARM & ARM REGENERATION /BREAKER)



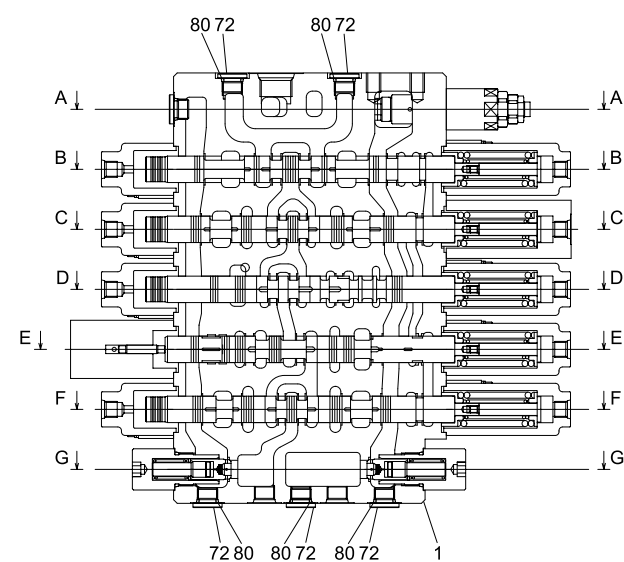
F - F(OPTION & BUCKET)



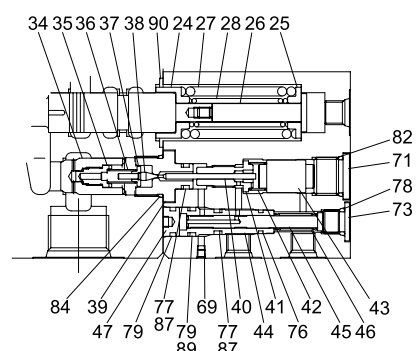
G - G(OPTION & NEGATIVE CONTROL)



P2 SIDE



P1 SIDE

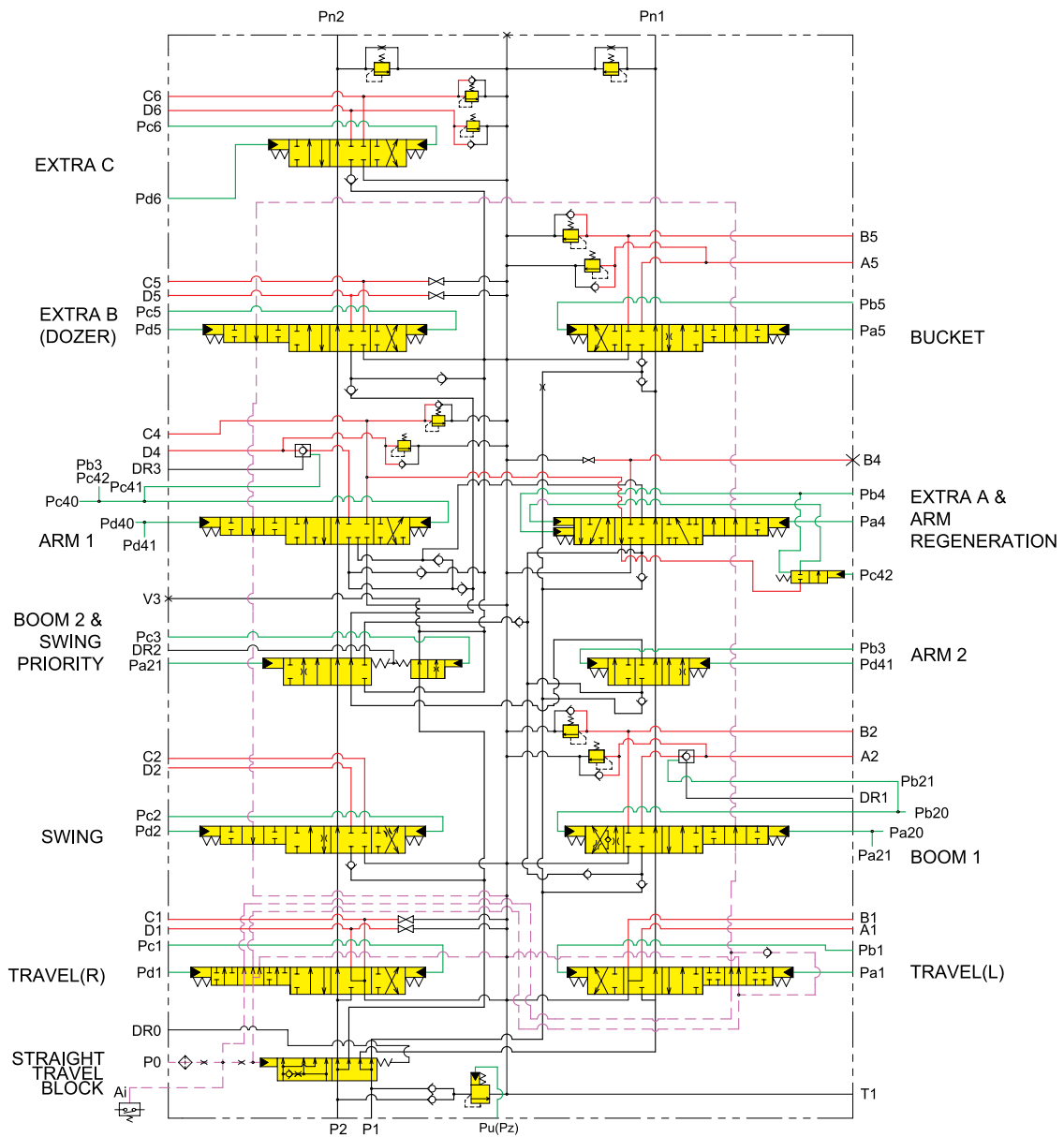


DETAIL OF LOCK VALVE(BOOM & ARM)

1	Body	50	Stopper-regeneration
2	Spool-straight travel	51	Piston-cut off
3	Spool-travel	52	Poppet-signal
4	Spool-swing	53	Spring-signal
5	Spool-boom	54	Plug
6	Spool-swing priority	55	Orifice-signal
7	Spool-boom2	56	Coin type filter
8	Spool-arm2	57	Orifice-plug
9	Spool-arm	58	Plug
10	Spool-arm regeneration & breaker	59	Plug
11	Spool-option	60	Plug
12	Spool-bucket	61	Plug-orifice
13	Cover-pilot A	62	Poppet-negative control
14	Cover-pilot B1	63	Coin type filter
15	Cover-Pilot B2	64	Spring seat
16	Block-holding	65	Spring-negative control
17	Block-regeneration	66	Piston-negative control
18	Plug	67	Socket-negative control
19	Poppet1-check valve	68	Plug
20	Spring-check valve	69	Plug
21	Plug	70	Plug
22	Poppet2-check valve	71	Plug
23	Spring-check valve	72	Plug
24	Spring seat1	73	Plug
25	Spring seat3	74	O-ring
26	Spacer bolt	75	O-ring
27	Spring-return(L)	76	O-ring
28	Spring-return(S)	77	O-ring
29	Stopper1-TS	78	O-ring
30	Stopper2-priority	79	O-ring
31	Spring seat2	80	O-ring
32	Poppet-TS check valve	81	O-ring
33	Spring-TS check valve	82	O-ring
34	Poppet-lock valve	83	O-ring
35	Restrictor-lock valve	84	O-ring
36	Spring-lock valve pilot	85	O-ring
37	Guide poppet	86	Back-up ring
38	Poppet-pilot	87	Back-up ring
39	Seat-poppet	88	Back-up ring
40	Piston1	89	Back-up ring
41	Guide-piston	90	O-ring
42	Spring1-lock valve	91	Bolt with washer
43	Piston2	92	Socket head bolt
44	Socket-lock valve	93	Socket head bolt
45	Spool-lock valve	94	Main relief valve
46	Spring2-lock valve	95	Over load relief valve
47	Stopper-lock valve	96	Plug-relief valve
48	Spool-regen selector	97	Plug-relief valve
49	Spring-regeneration	98	Plug-relief valve
		99	Over load relief valve

14072SF11

## 2. HYDRAULIC CIRCUIT

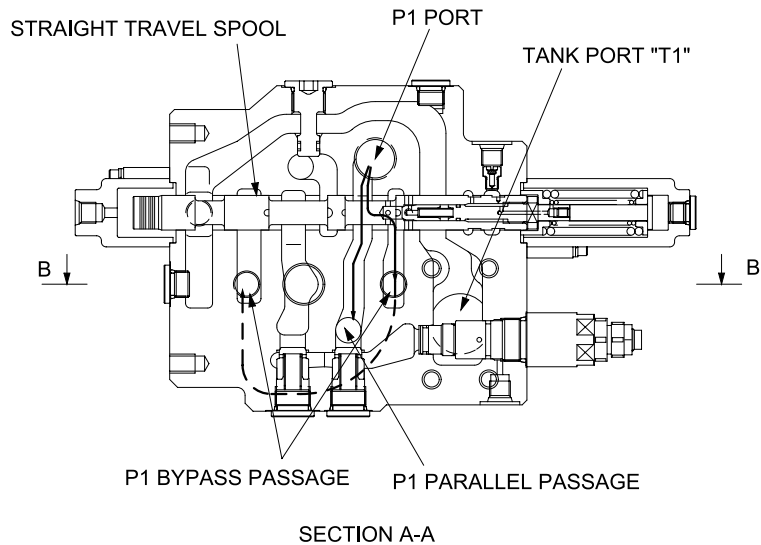


14072SF05

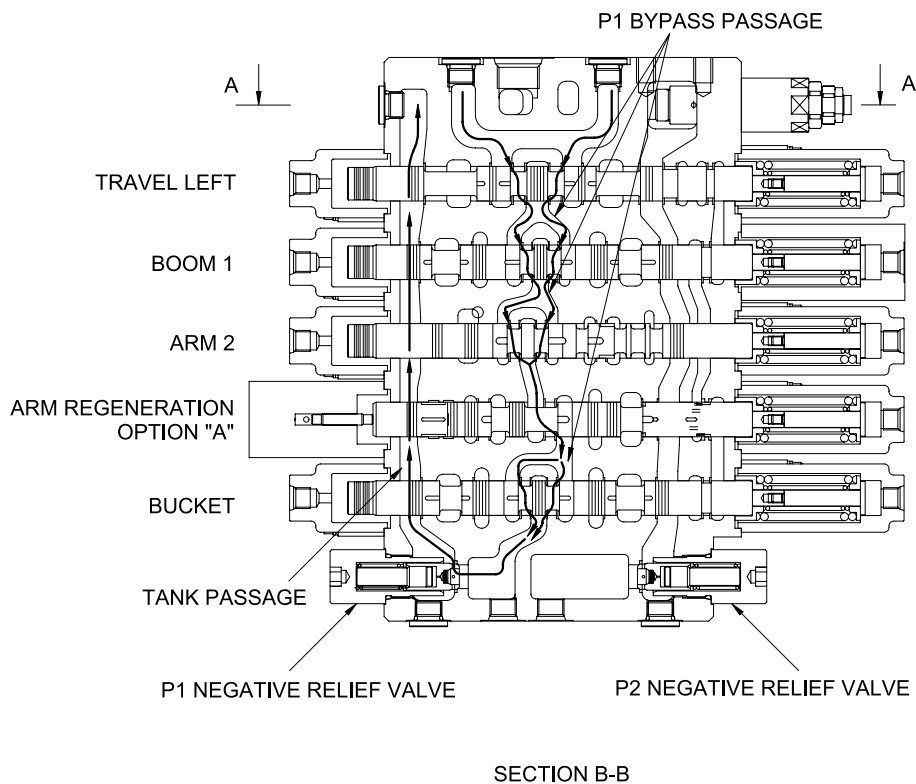
### 3. FUNCTION

#### 1) CONTROL IN NEUTRAL FUNCTION

##### (1) P1 SIDE



14072SF13

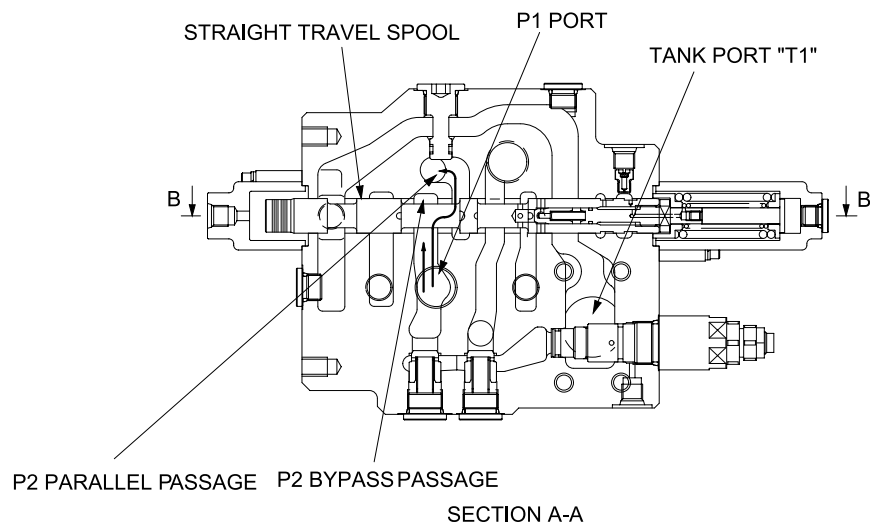


14072SF15

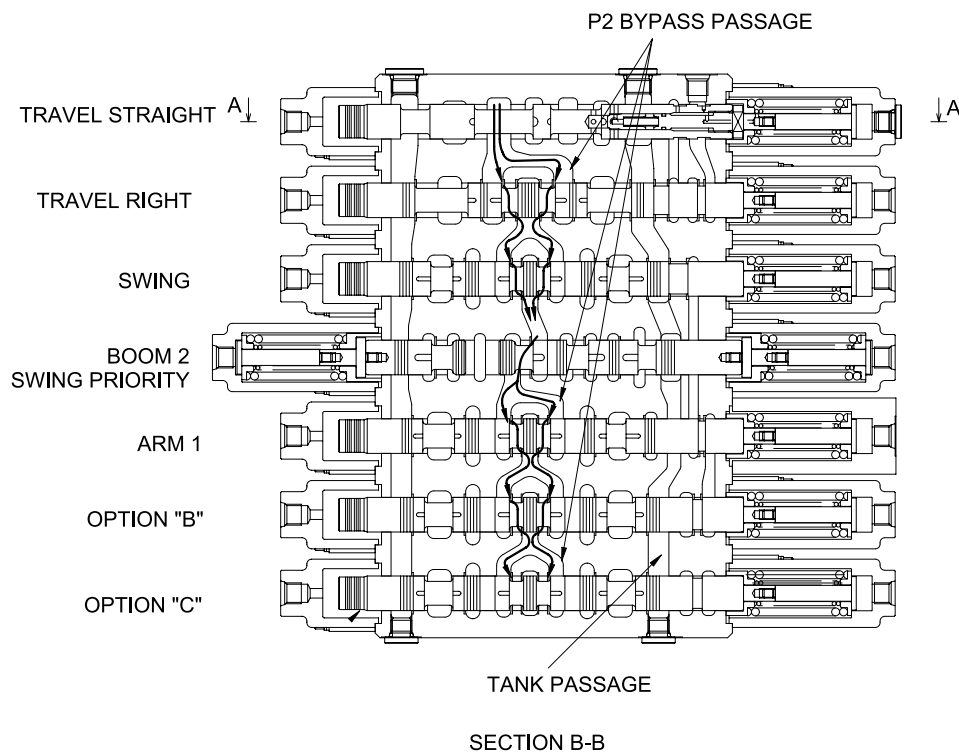
The hydraulic fluid from pump P1 flows into the main control valve through the inlet port "P1", pass the travel straight spool, into the P1 bypass passage and P1parallel passage.

The hydraulic fluid from the pump P1 is directed to the tank through the bypass passage of spools : travel left, boom1, arm2, arm regeneration & option A and bucket, the negative relief valve, tank passage, and the tank port "T1"

## (2) P2 SIDE



14072SF14



14072SF16

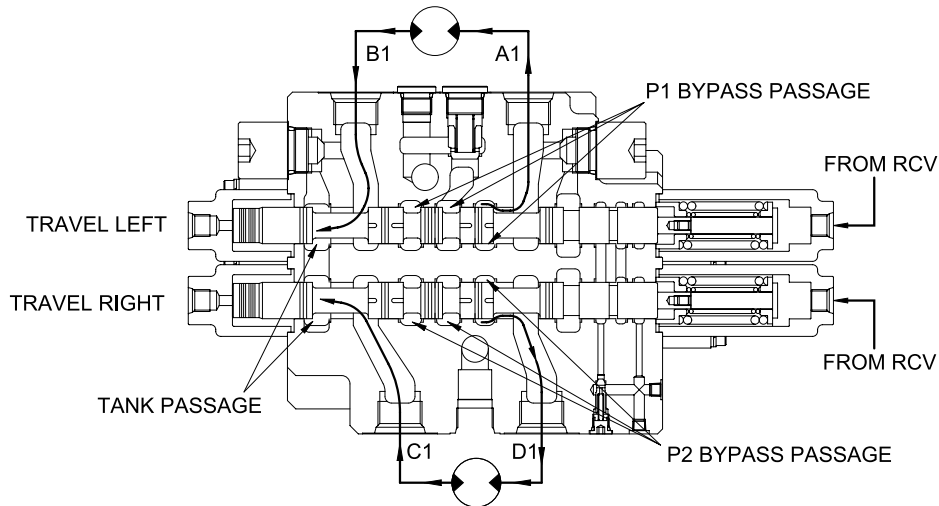
The hydraulic fluid from pump P2 flows into the main control valve through the inlet port "P2", pass the straight travel spool, into the P2 bypass passage and P2 parallel passage.

The hydraulic fluid from the pump P2 is directed to the tank through the bypass passage of spools : travel right, swing, boom2 & swing priority, arm1, option "B" and option "C", and the negative relief valve with the tank passage.

## 2) EACH SPOOL OPERATION

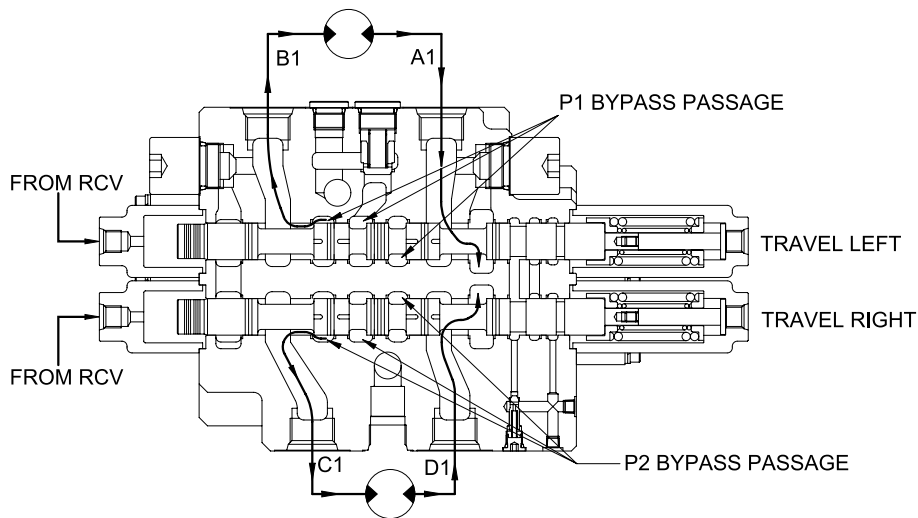
### (1) TRAVEL OPERATION

#### ① Travel forward operation



14072SF17

#### ② Travel backward operation



14072SF18

During the travel operation, the hydraulic fluid of the pump P1 is supplied to the travel motor and the hydraulic fluid of the pump P2 is supplied to the other travel motor.

The pilot pressure from the pilot control valve is supplied to the spring side of pilot port (pa1, pd1).

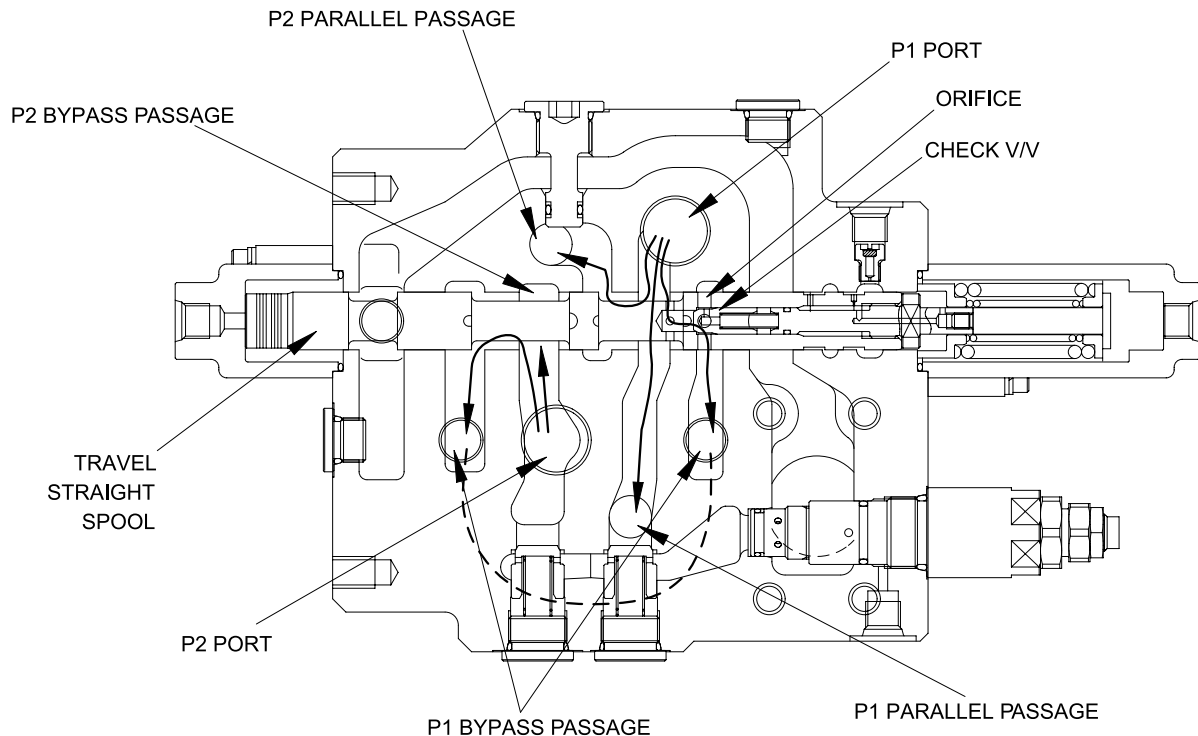
And it shifts travel right and left spools in the left direction against springs. Hydraulic fluid from the pump P1 flow into the travel left spool through the bypass passage and hydraulic fluid from the pump P2 flow into the travel right spool through the bypass passage.

Then they are directed to the each travel motor through port A1 and D1. As a result, the travel motors turn and hydraulic fluid returns to the tank passage through the travel spools.

In case of the opposite operation, the operation is similar.



## (2) TRAVEL STRAIGHT FUNCTION



14072SF19

This function keeps straight travel in case of simultaneous operation of other actuators(boom, arm, bucket, swing) during a straight travel.

### ① **During travel only :**

The hydraulic fluid of the pump P1 is supplied to the travel motor and the pump P2 is supplied to the other motor.

Thus, the machine keep travel straight.

### ② **The other actuator operation during straight travel operation :**

When the other actuator spool(s) is selected under straight travel operation, the straight travel spool is moved.

The hydraulic fluid from pump P1 is supplied actuator through P1 and P2 parallel pass and travel motors through orifice at side of straight travel spool.

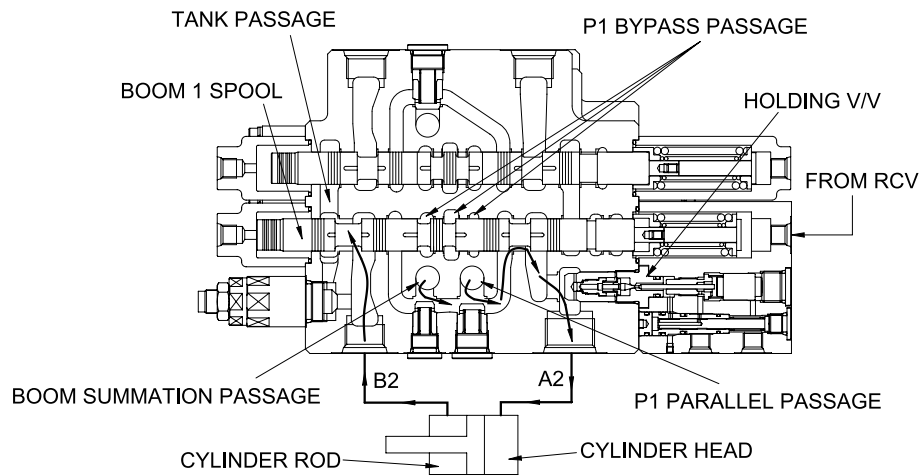
The hydraulic oil fluid from pump P2 is supplied to travel motors(left/right).

Therefore, the other actuator operation with straight travel operation, hydraulic oil fluid from pump P1 is mainly supplied to actuator, and the hydraulic oil fluid form pump P2 is mainly supplied to travel motors(left/right).

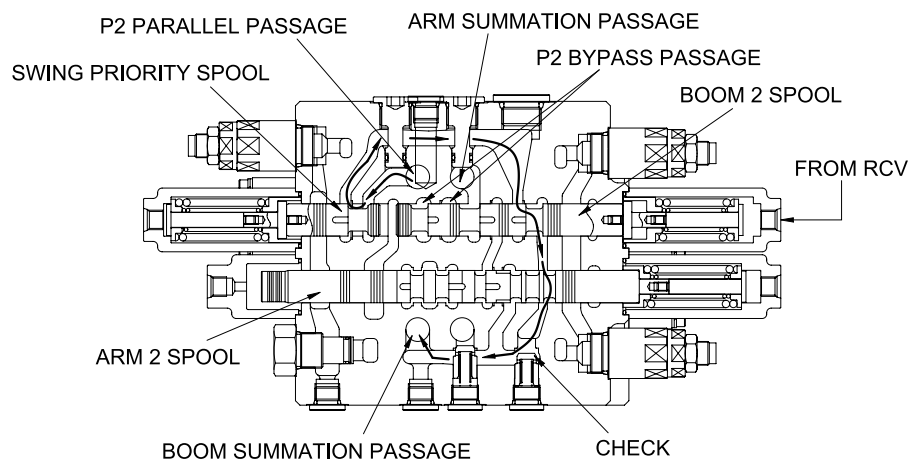
Then the machine keeps straight travel.

### (3) BOOM OPERATION

#### ① Boom up operation



14072SF24



14072SF25

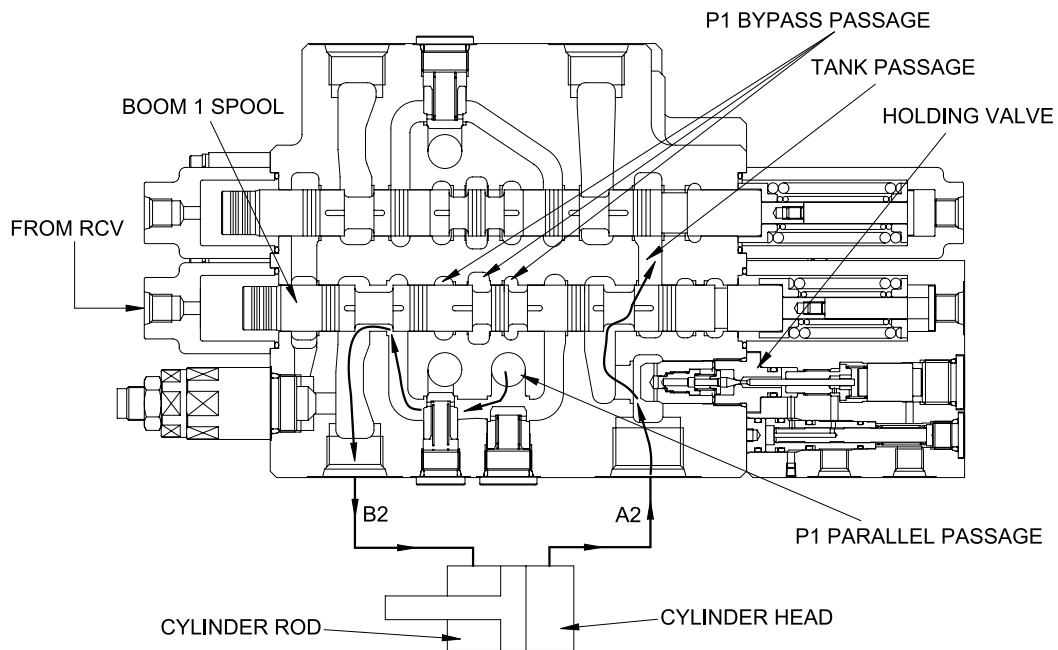
During boom up operation, the pilot pressure from RCV is supplied into the port Pa20 and shift the boom1 spool in the left direction. The hydraulic oil fluid from pump P1 is entered P1 parallel passage and then passes through the load check valve and boom holding valve then flows into the port A2. Following this it flows into the head side of the boom cylinder.

(In this case, the boom holding valve is free flow condition)

At the same time the pilot pressure through the port Pa21 shifts the boom2 spool. The hydraulic oil fluid from pump P2 entered boom summation passage via the P2 parallel passage, the swing priority spool, the boom2 spool, arm1 spool and the check. The flows combine in passage and are directed to port A2 and head side of boom cylinder.

The flow from rod side of the boom cylinder return to the boom1 spool through the port B2. There after it is directed to the hydraulic oil tank through the tank passage.

## ② Boom down operation



14072SF26

During the boom lowering operation, the pilot pressure from RCV is supplied to the port Pb20 and shift the boom1 spool in the right direction.

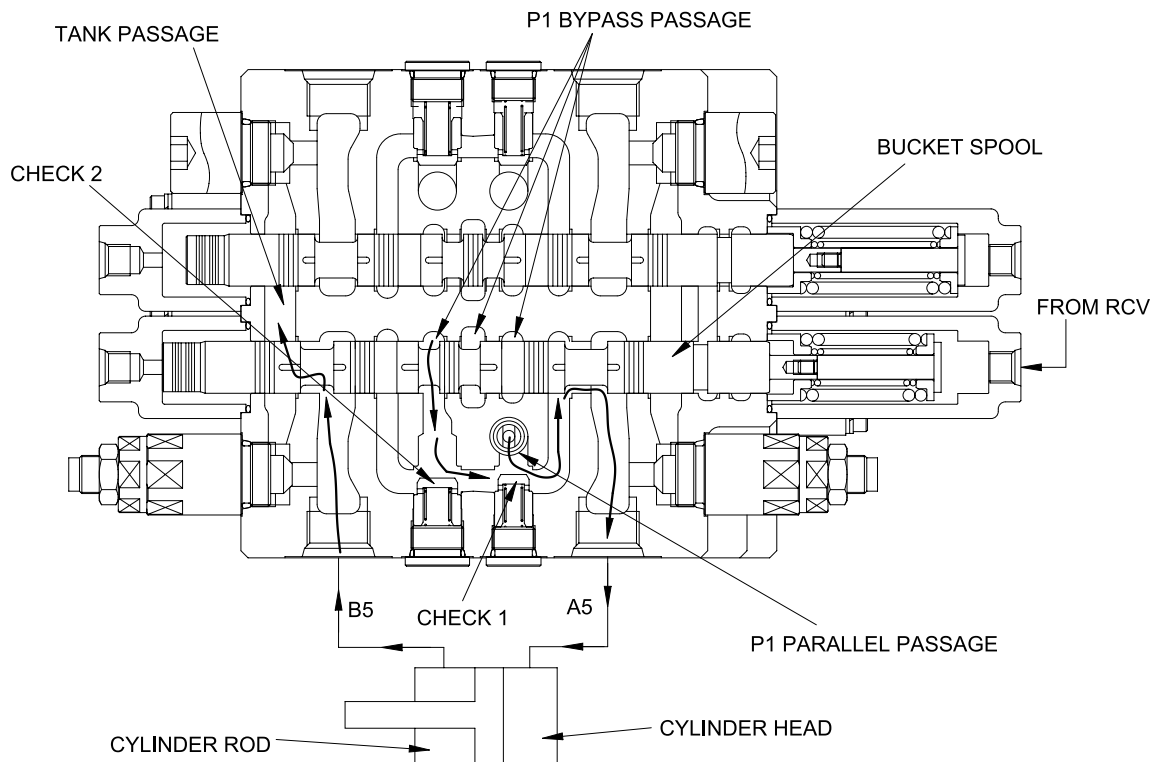
The hydraulic fluid from the pump P1 enters the parallel passage and is directed to the port B2 through the load check valve. Following this, it flows into the rod side of the boom cylinder.

The return flow from the head side of the boom cylinder returns to the boom1 spool through the port A2 and boom holding valve. Thereafter it is directed to the hydraulic oil tank through tank passage.

For details of the boom holding valve, see page 2-36.

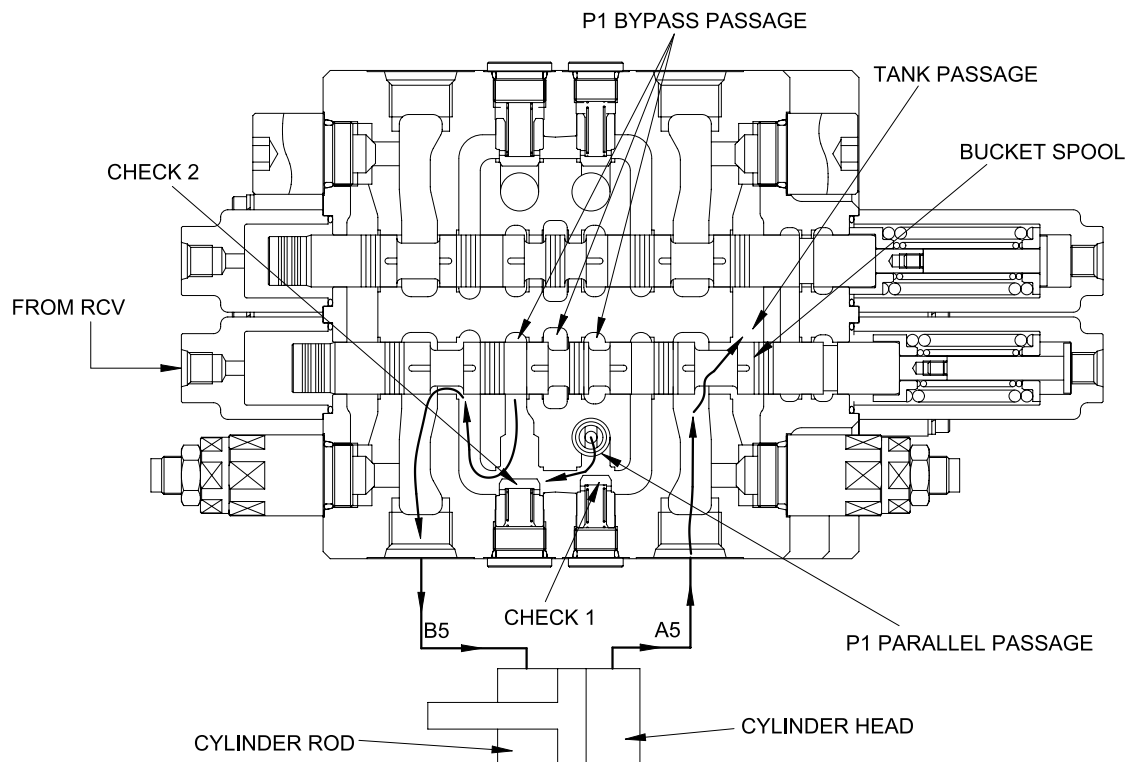
#### (4) BUCKET OPERATION

##### ① Bucket roll in operation



14072SF34

##### ② Bucket roll out operation



14072SF35

① **Bucket roll in operation**

During the bucket roll in operation, the pilot pressure from RCV is supplied to port Pa5 and shift the bucket spool in the left direction.

The hydraulic fluid from pump P1 entered P1 parallel passage and is directed to the port A5 through the check1.

At the same time, the hydraulic fluid from P1 bypass passage is directed to the port A5 through the check2.

Following this it flows into the head side of the bucket cylinder.

The return flow from the rod side of the bucket cylinder returns to the bucket spool through the port B5. Thereafter it is directed to the hydraulic oil tank through the tank passage.

② **Bucket roll out operation**

In case of the bucket roll out operation, the operation is similar

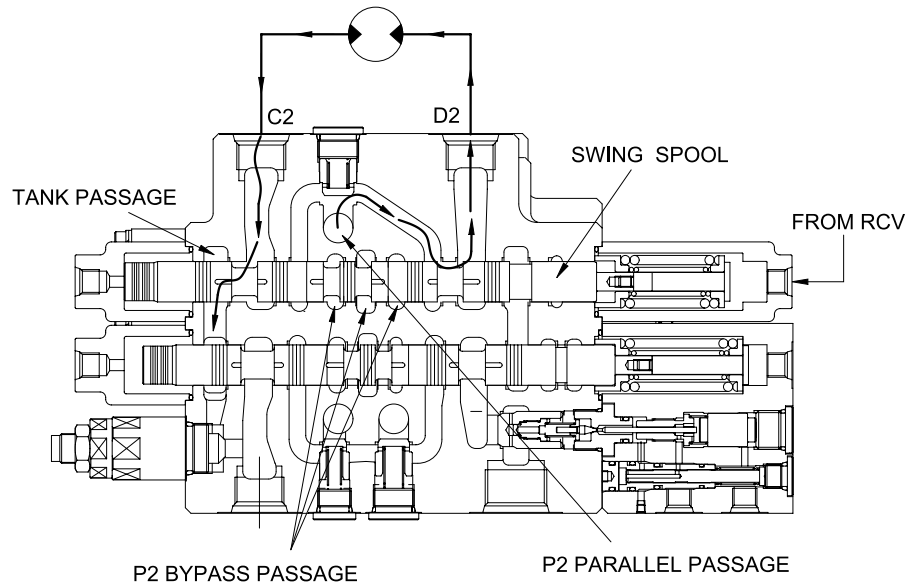
③ **Bucket operation with arm or boom operation**

When combined operation, mostly same as above but the fluid from bypass passage is empty.

So only the fluid from parallel passage is supplied to the bucket cylinder. Also, parallel passage is installed the orifice for supplying the fluid from pump to the boom or the arm operation prior to the bucket operation.

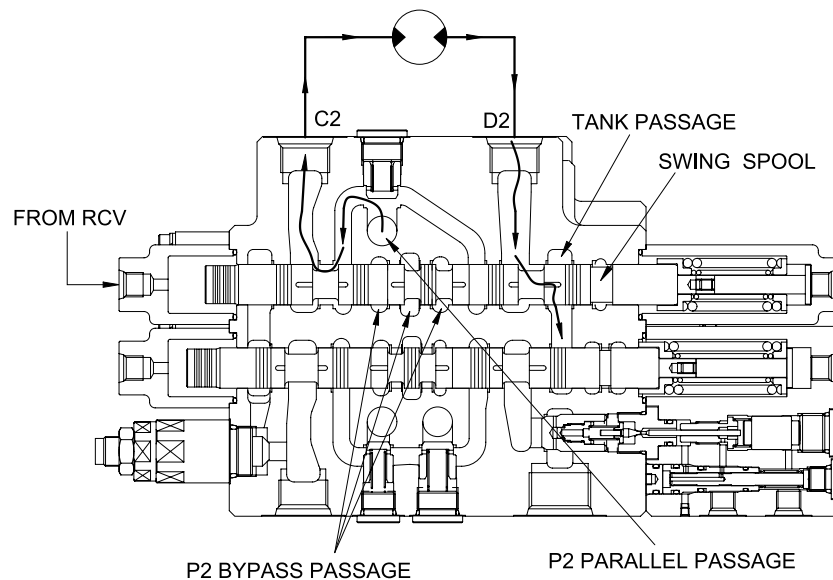
## (5) SWING OPERATION

### ① Swing left operation



14072SF32

### ② Swing right operation

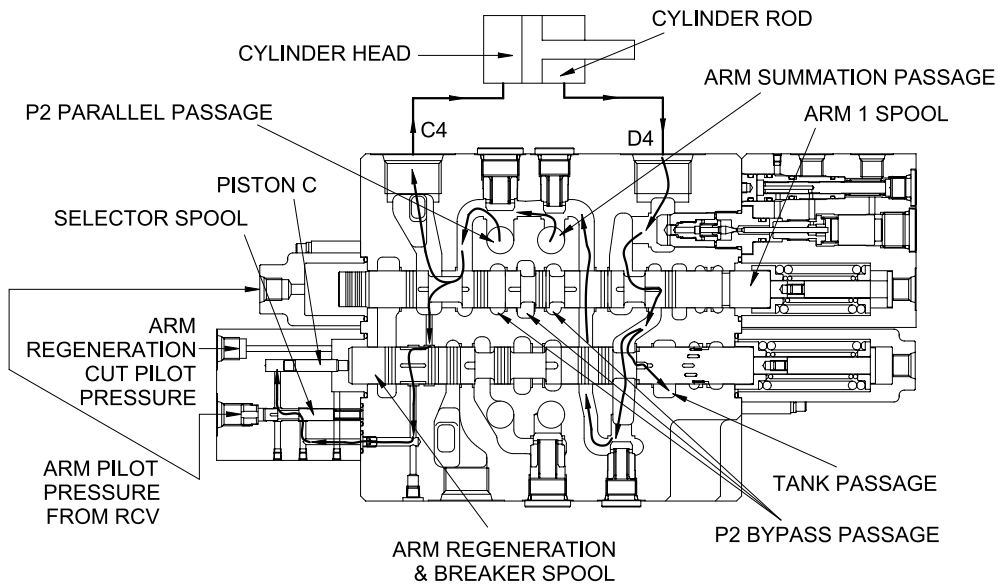


14072SF33

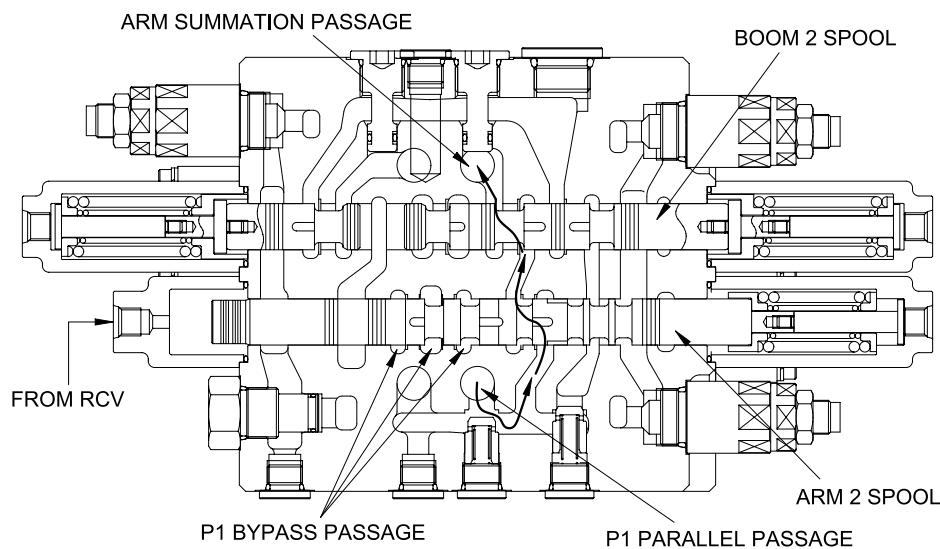
The pilot pressure from the RCV is supplied to the Pd2 and shift the swing spool in left direction. The hydraulic fluid from pump P2 flows into swing spool through the parallel passage. Then it is directed to swing motor through the port D2. As the result, swing motor turns and flow from the swing motor returns to the hydraulic oil tank through the port C2, swing spool and the tank passage . In case of swing right operation, the operation is similar.

## (6) ARM OPERATION

### ① Arm roll in operation



14072SF21



14072SF20

#### • Arm roll in operation :

During arm roll in operation the pilot pressure from the RCV is supplied to the port Pc40 and Pb3 and shifts arm1 spool and arm2 spool in the right direction.

The hydraulic oil from the pump P2 flows into the arm cylinder head side through P2 parallel passage, the load check valve and the port C4.

At same time, the hydraulic fluid from the pump P1 flows into the arm summation passage through parallel passage, the check valve, the arm2 spool and the boom2 spool. Then it entered the arm cylinder head side with hydraulic fluid from arm1 spool.

• **Arm regeneration :**

The return flow from the arm cylinder rod side is pressurized by self weight of arm and so, returns to port D4. The pressurized oil returning to port D4 enters the arm regeneration & breaker spool through the arm holding valve and the arm1 spool. It is supplied the arm cylinder head through internal passage. This is called the arm regeneration function.

The amount of regeneration fluid are changed by movement of the arm regeneration & breaker spool.

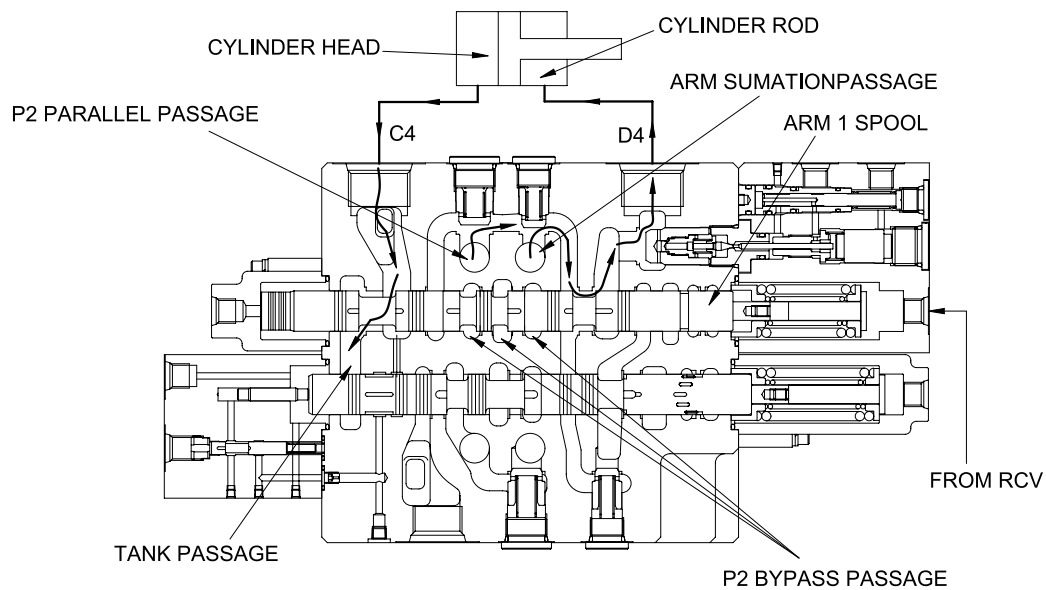
A few fluid after P2 parallel passage is push piston "C" through the notch of arm regeneration spool and selector spool. At this time, the selector spool is opened by pilot pressure from RCV.

Then, the arm regeneration spool shift to right side and flow to tank pass increases and regeneration flow decreases. Therefore, pressure of arm cylinder head increases, then, arm regeneration flow decreases.

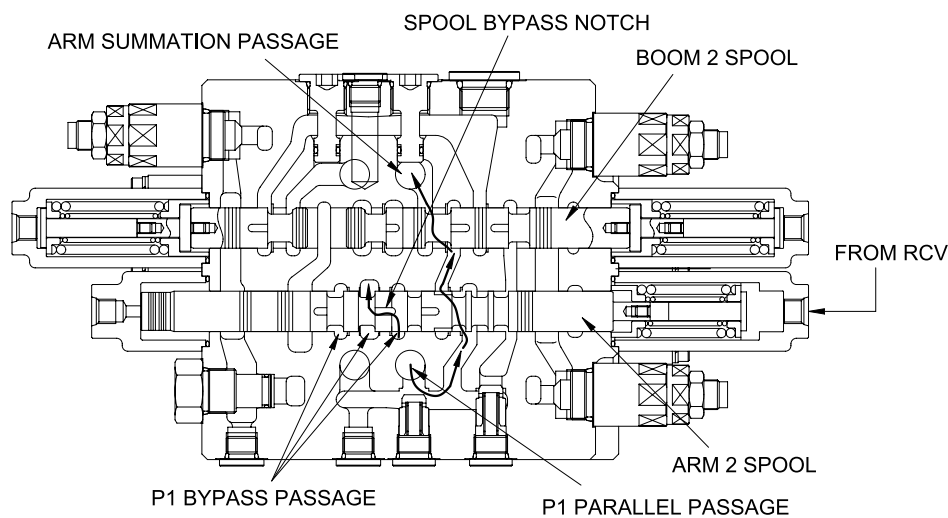
Furthermore, the arm regeneration cut pressure is supplied to port and arm regeneration spool is move into the right direction fully. The flow from the arm cylinder rod is returned to the hydraulic oil tank and regeneration function is not activated.



## ② Arm roll out operation



14072SF23



14072SF22

During arm roll out operation the pilot pressure from RCV is supplied to the port Pd40 and the Pd41 and shifts arm1 spool and arm2 spool in the right direction.

The hydraulic fluid from pump P2 flows into arm1 spool through the parallel passage. Then it enters into the arm cylinder rod side through the load check valve, bridge passage, arm holding valve and the port D4.

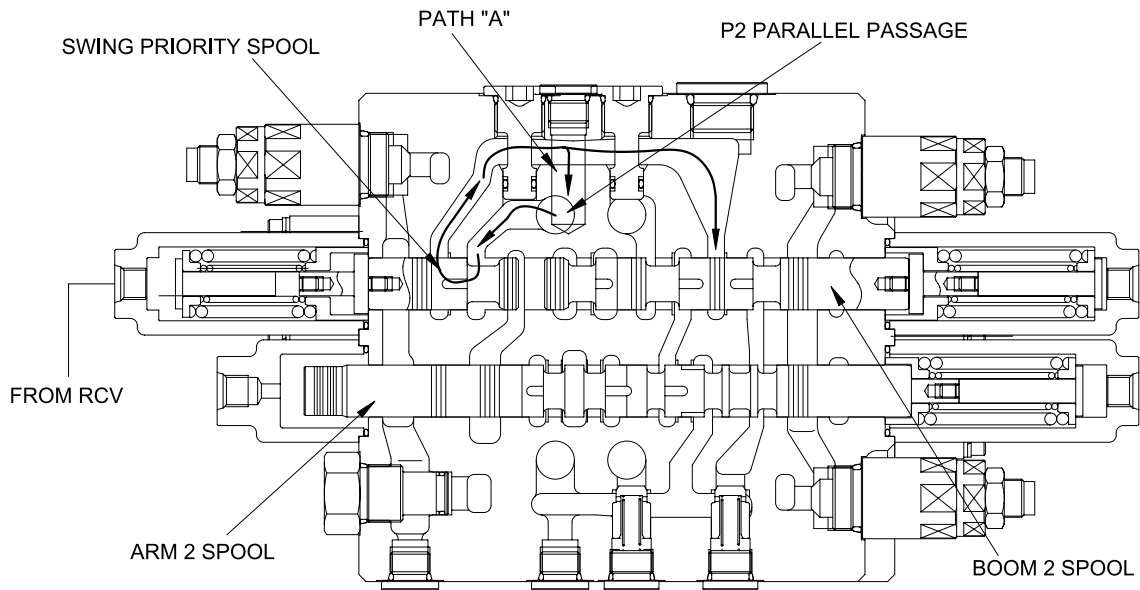
Some of the hydraulic fluid from pump P2 bypassed through bypass notch.

The rest of hydraulic fluid from pump P2 flows into the arm summation passage through P1 parallel passage the check valve arm2 spool and boom2 spool.

Then it enters into the arm cylinder rod side with the fluid from the arm1 spool.

The return flow from the arm cylinder head side returns to the hydraulic tank through the port C4 the arm1 spool and tank passage.

## (7) SWING PRIORITY FUNCTION



14072SF27

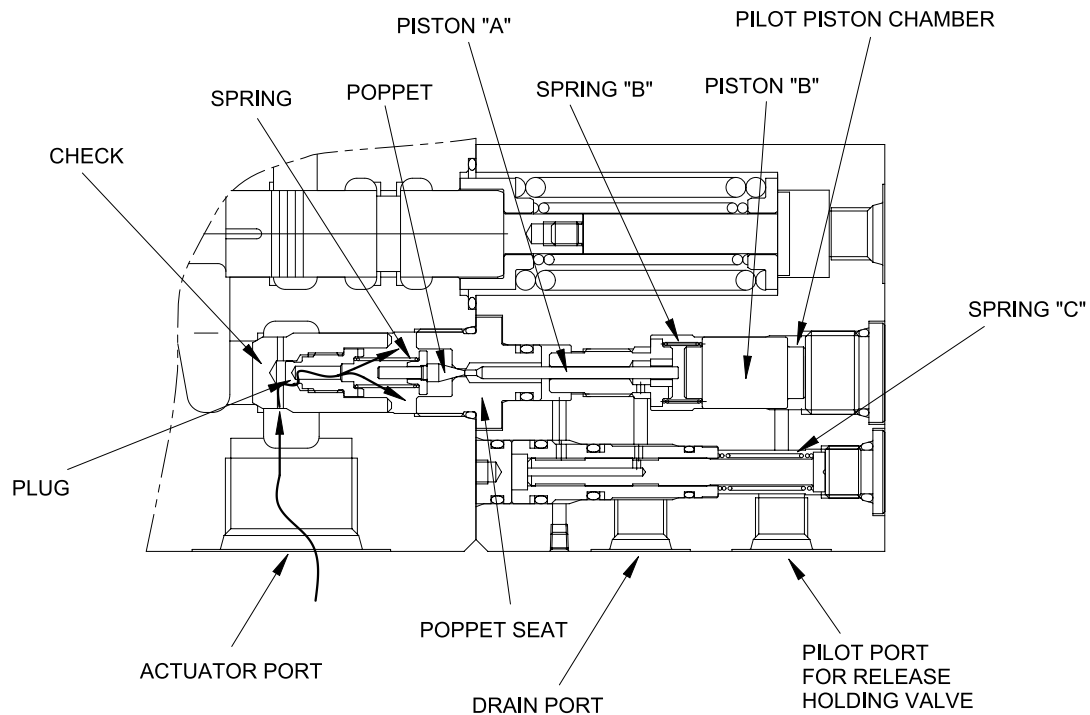
During swing priority operation, the pilot pressure is supplied to the port Pc3 and shift swing priority spool in the right direction.

The hydraulic fluid from P2 parallel passage flows into the parallel passage of arm1 side through swing priority spool and the passage "A" and also flows into the boom2 spool.

Due to shifting of the swing priority spool, the fluid from pump P2 flows to swing side more then next spools to make the swing operation most preferential.

## (8) HOLDING VALVE OPERATION

### ① Holding operation



14072SF30

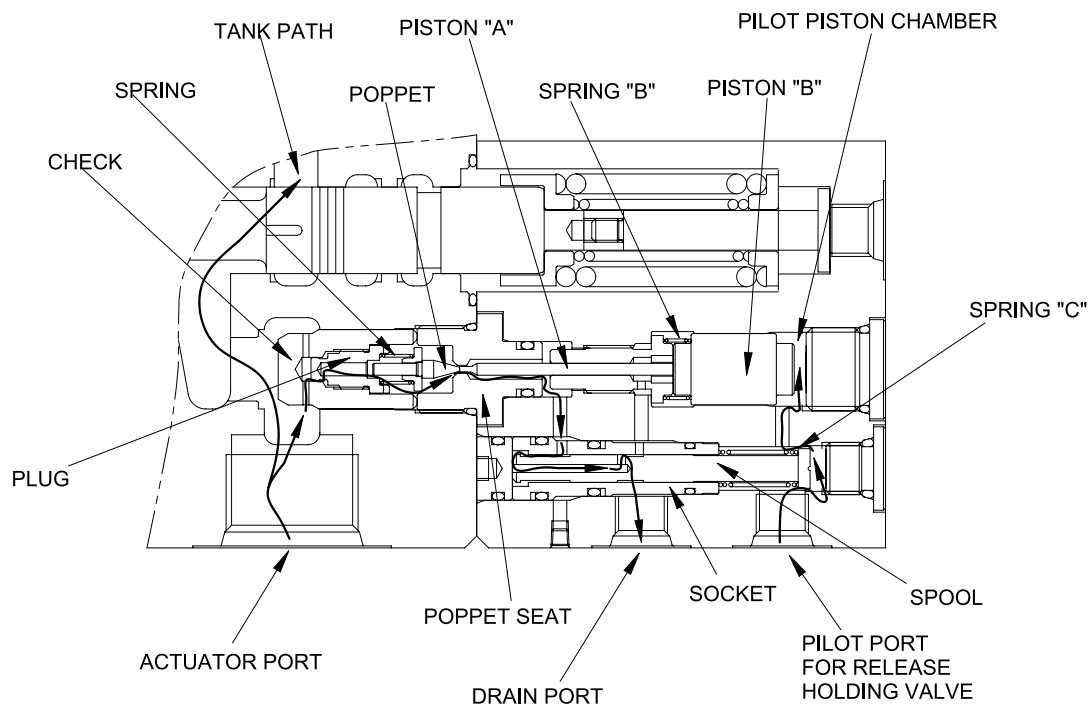
At neutral condition, the pilot piston chamber is connected to drain port through the pilot port.

And the piston "B" is supported with spring "B" and the pressured fluid from actuator entered to inside of the holding valve through the periphery hole of check, crevice of the check and the plug and the periphery hole of plug.

Then, this pressured oil pushed the poppet to the poppet seat and the check to the seat of body.

So the hydraulic fluid from actuator is not escaped and the actuator is not moved.

## ② Release holding operation



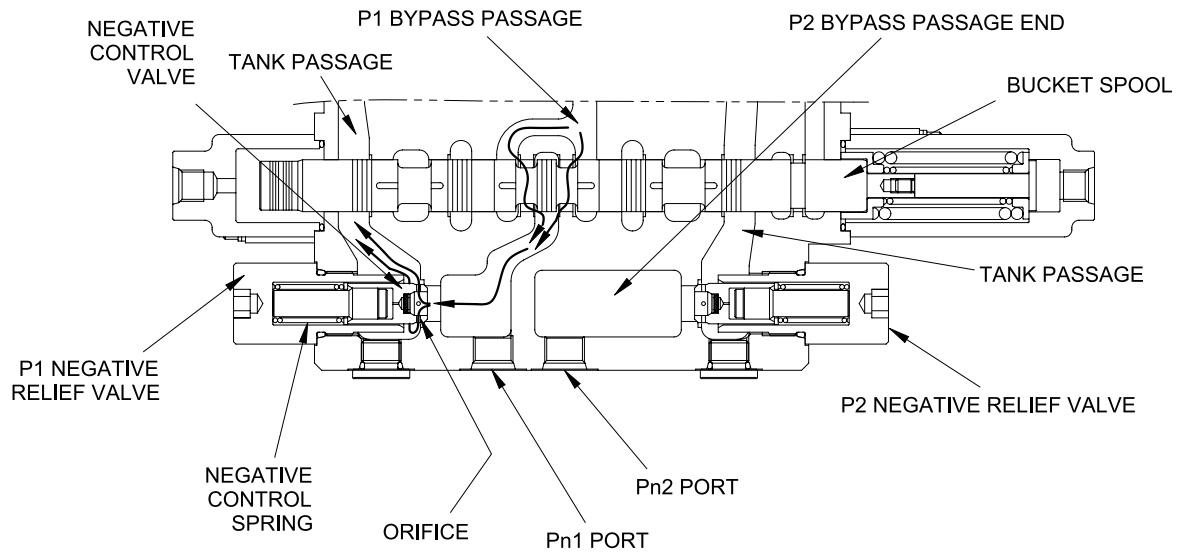
14072SF31

The pilot pressure is supplied to the pilot port for release holding valve and shifts the piston "B" in the left direction against the spring "B", and shifts the poppet in the left direction through piston "B" and piston "A" against spring "B" and shifts the spool in the left side.

At same time, the return fluid from actuator returns to the drain port through the periphery hole of check, crevice of the check and the plug, the periphery hole of the plug, in side of holding valve, crevice of the poppet and the poppet seat, the periphery hole of the poppet seat, crevice of the socket and spool and inside of spool.

When the poppet is opened, pressure of inside of holding valve is decreased and the return fluid from actuator returns to the tank passage through the notch of spool.

## (9) NEGATIVE CONTROL



14072SF28

When no function is being actuated on P1 side, the hydraulic fluid from the pump P1, flows into the tank passage through the bypass passage and orifice. The restriction caused by this orifice thereby pressurizes. This pressure is transferred as the negative control signal pressure Pn1 to the pump P1 regulator.

It controls the pump regulator so as to minimize the discharge of the pump P1.

The bypass passage is shut off when the shifting of one or more spools and the flow through bypass passage became zero. The pressure of negative control signal become zero and the discharge of the pump P1 become maximum.

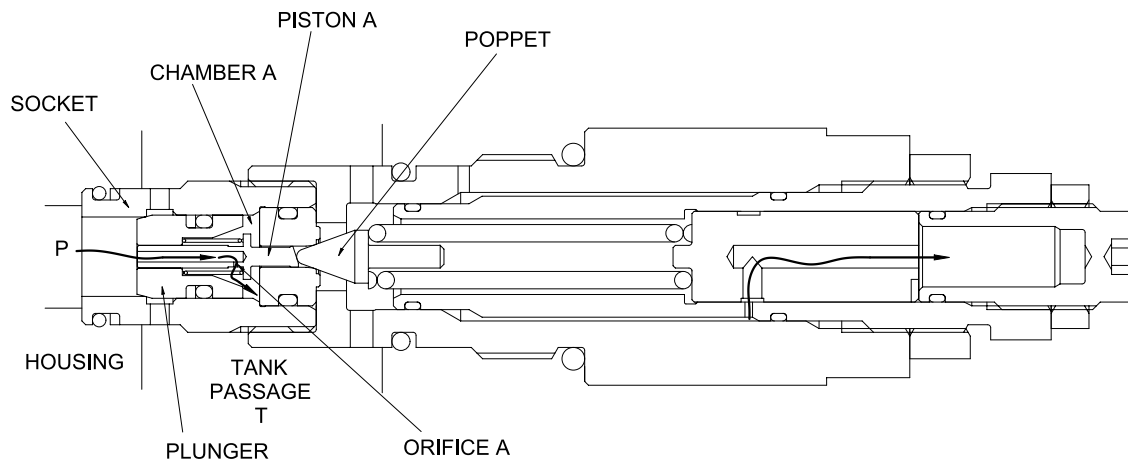
The negative control pressure reaches to the set level, the hydraulic fluid in the passage pushes open negative control valve and escapes into the return passage.

For the pump P2 the same negative control principle.

## (10) OPERATION OF MAIN RELIEF VALVE

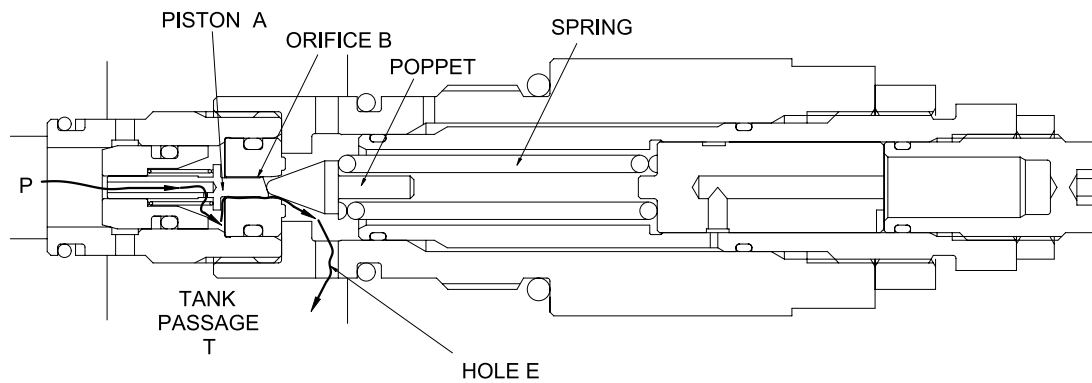
The main relief valve is fitted to the straight travel valve block and functions as follows :

- ① The pressurized oil passes through the orifice (A) of the plunger is filled up in chamber A of the inside space, and seats the plunger against the housing securely.



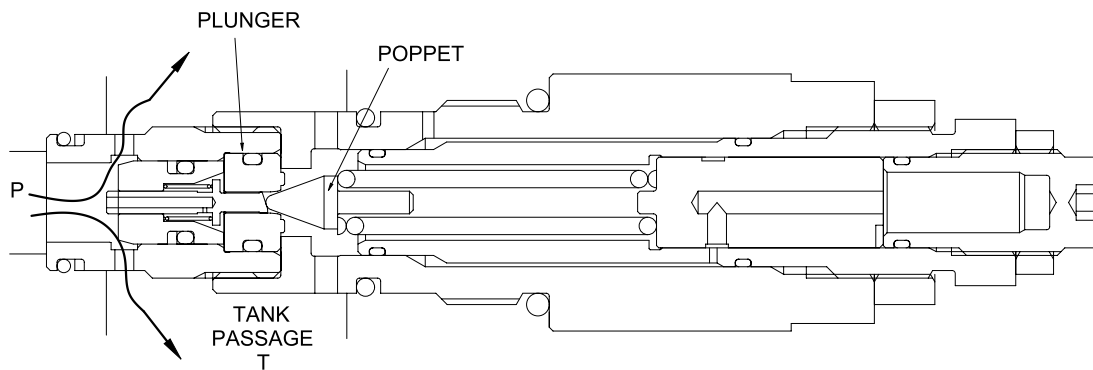
14072SF36

- ② When the pressure at (P) becomes equal to the set pressure of the spring the hydraulic oil passes through the piston (A) pushes open the poppet and flows to tank passage (T) through the hole (E).



14072SF37

- ③ Opening the poppet causes the pressure in chamber A to fall and the plunger to open. As the result the pressurized oil at port P runs into tank passage (T)

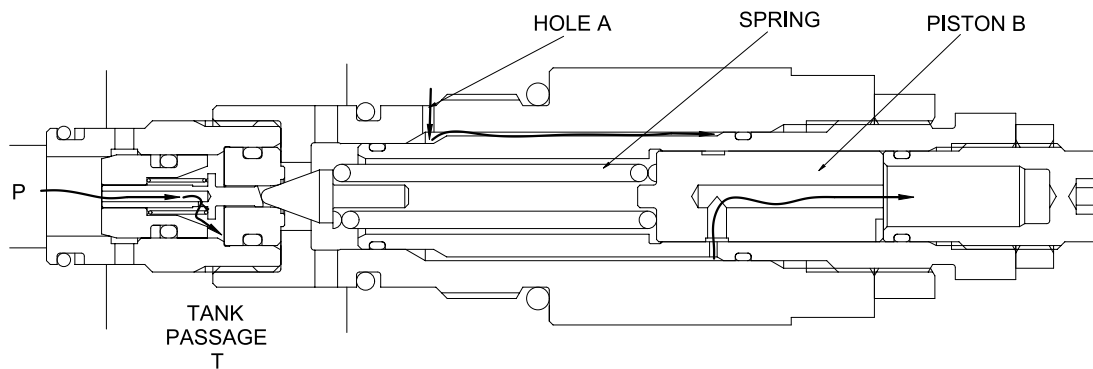


14072SF38

- ④ High pressure setting pilot signal(Pu) : ON

When the power boost switch is ON, the pilot pressure enters through hole A.

It pushes the piston(B) in the left direction to increase the force of the spring and change the relief set pressure to the high pressure.

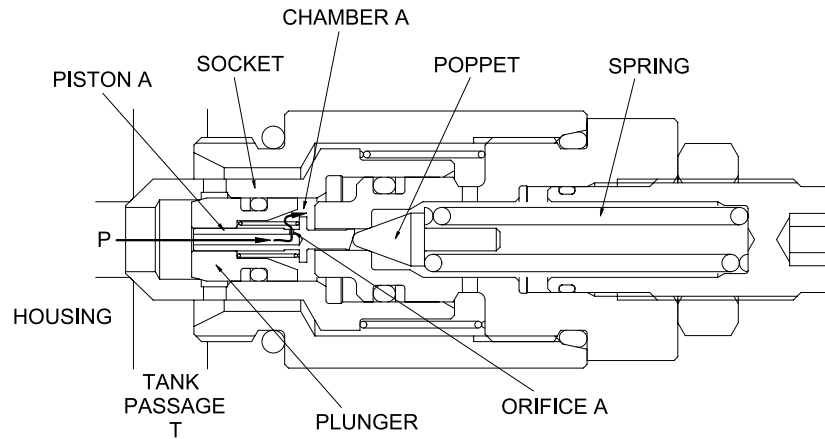


14072SF36

## (11) OPERATION OF PORT RELIEF VALVE

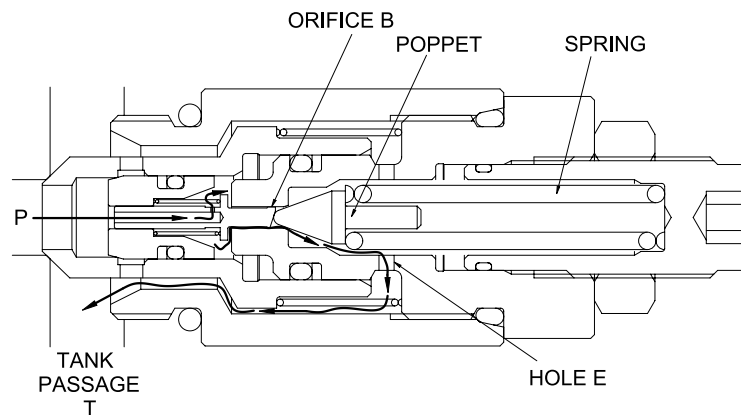
### ① Function as relief valve

- ① The pressurized oil passes through the piston A and orifice is filled up in chamber A of the inside space and seat the plunger against the socket and the socket against the housing securely.



14072SF39

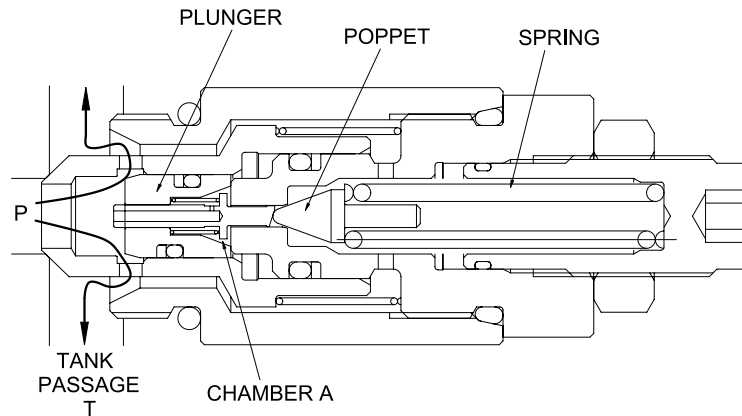
- ② When the pressure at port P becomes equal to the set pressure of the spring, the pressurized oil pushes open the poppet flows to tank passage (T) through hole E.



14072SF40



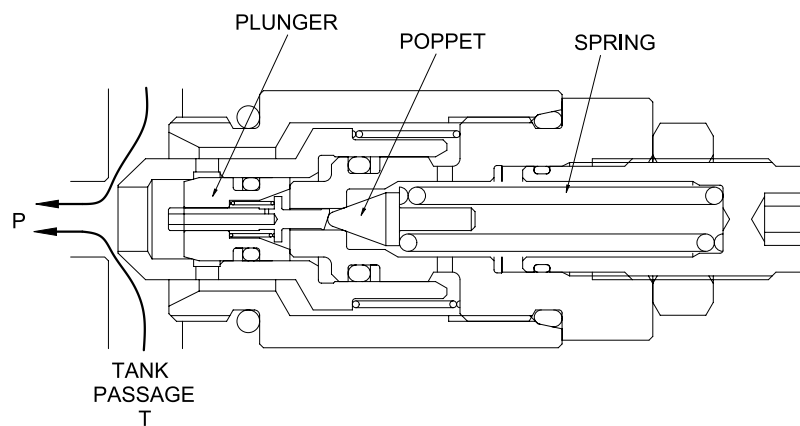
- © Opening of the poppet causes the pressure in chamber A to fall and the plunger to open. As the result the pressurized oil at port P runs into tank passage (T).



14072SF41

## ② Make-up function

When negative pressure exists at port P, the oil is supplied through tank passage (T). When the pressure at tank passage (T) becomes higher than that at port P, the socket moves in the right direction. Then, sufficient oil passes around the socket from tank passage (T) to port P and fills up the space.



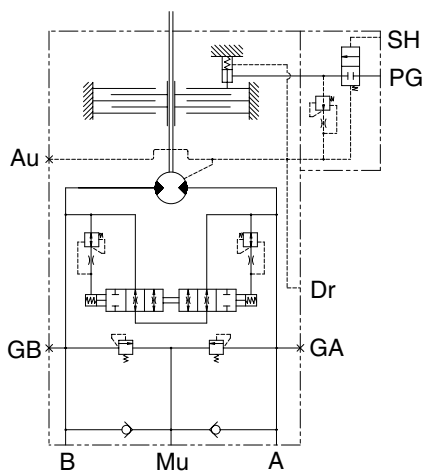
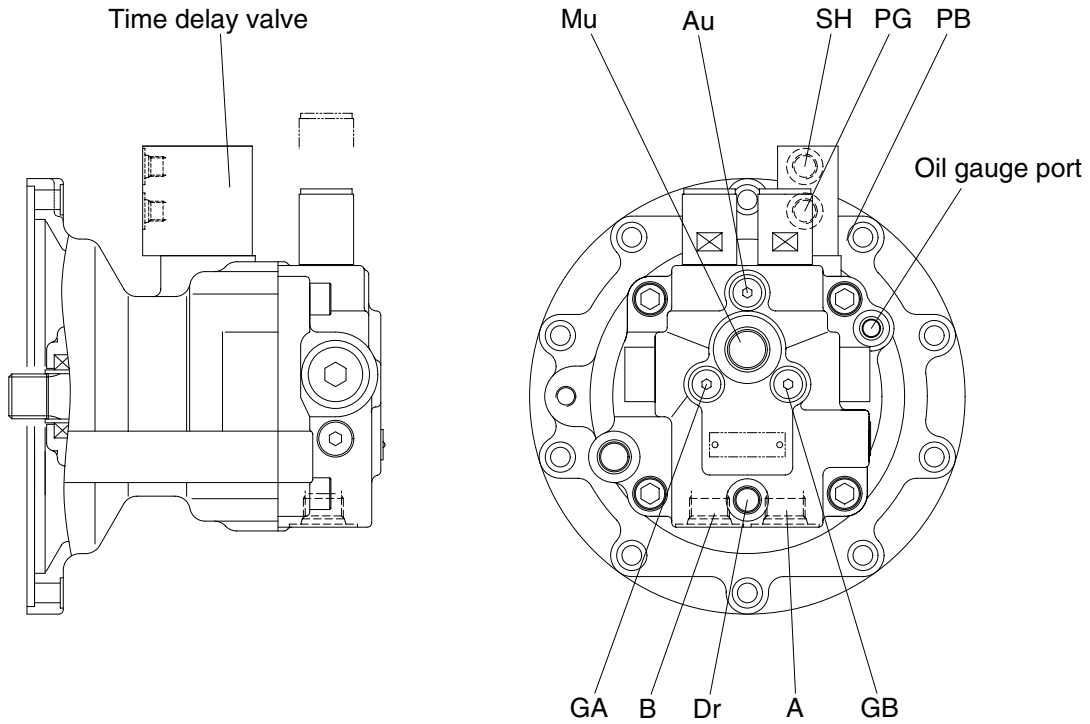
14072SF42

## 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.

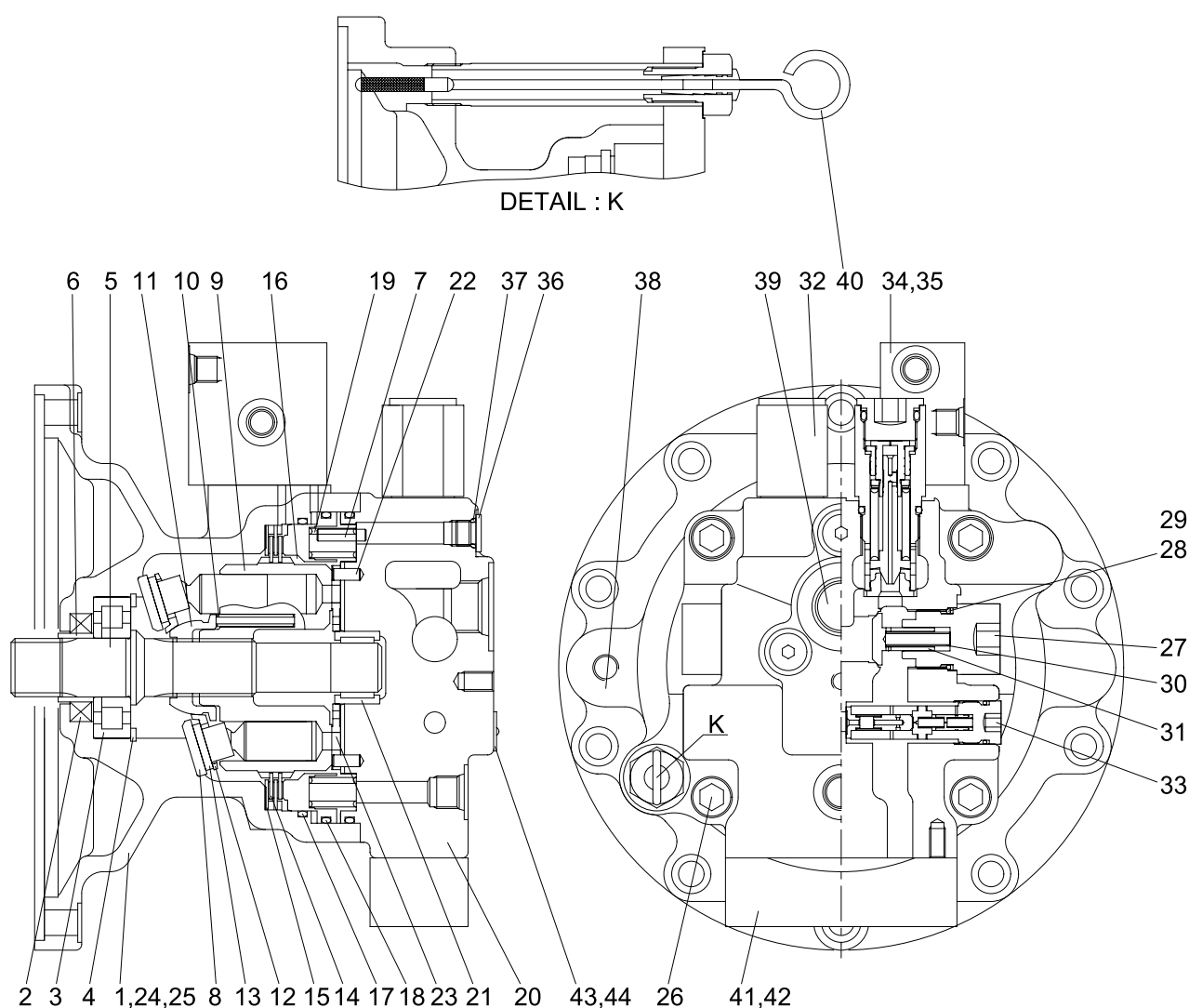


Hydraulic circuit

Port	Port name	Port size
A	Main port	PF 3/4
B	Main port	PF 3/4
Dr	Drain port	PF 3/8
Mu	Make up port	PF 1
SH	Brake release port	PF 1/4
PG	Stand by port	PF 1/4
GA, GB	Gage port	PF 1/4
Au	Air bleed port	PF 1/4

11072SM01

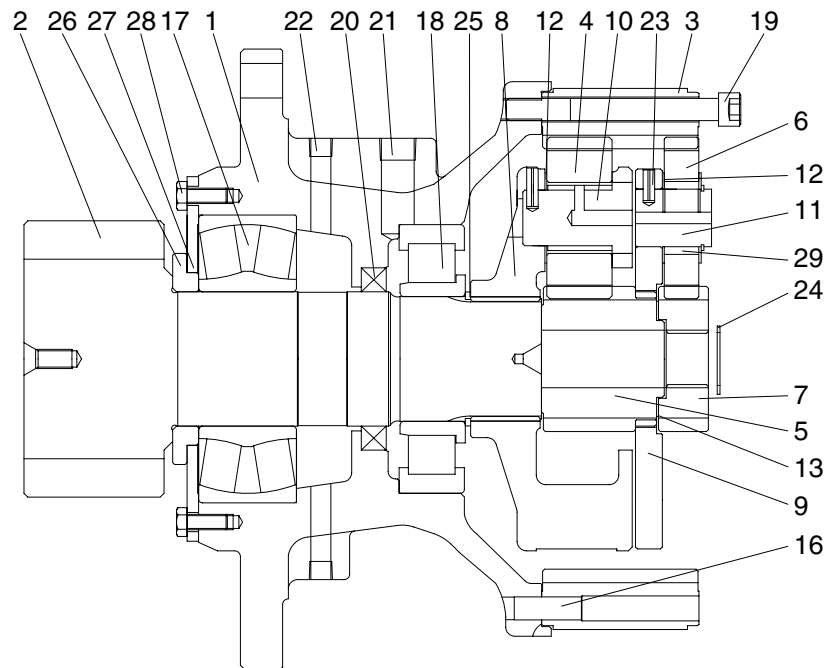
## 1) SWING MOTOR



11072SM02

1 Body	16 Brake piston	31 Check
2 Oil seal	17 O-ring	32 Relief valve assy
3 Roll bearing	18 O-ring	33 Reactionless valve assy
4 Snap ring	19 Spring	34 Time delay valve assy
5 Shaft	20 Rear cover	35 Wrench bolt
6 Bushing	21 Needle bearing	36 Plug
7 Pin	22 Pin	37 O-ring
8 Shoe plate	23 Valve plate	38 Plug
9 Cylinder block	24 O-ring	39 Plug
10 Spring	25 O-ring	40 Level gauge
11 Ball guide	26 Wrench bolt	41 Flange
12 Set plate	27 Plug	42 O-ring
13 Piston assy	28 Back up ring	43 Name plate
14 Friction plate	29 O-ring	44 Rivet
15 Plate	30 Spring	

## 2) REDUCTION GEAR



11072SM03

1	Casing	10	Pin No.2 assembly	21	Plug(B)
2	Drive shaft	11	Pin No.1	22	Plug(A)
3	Ring gear	12	Thrust washer(B)	23	Spring pin
4	Planet gear No.2	13	Thrust washer(A)	24	Stop ring
5	Sun gear No.2	16	Knock pin	25	Stop ring
6	Planet gear No.1	17	Sph roller bearing	26	Spacer
7	Sun gear No.1	18	Cyl roller bearing	27	Cover plate
8	Carrier No.2	19	Bolt	28	Bolt
9	Carrier No.1	20	Oil seal	29	Needle cage

## 2. FUNCTION

### 1) ROTARY PART

When high pressurized oil enters a cylinder through port(a), which is the inlet of balance plate(1), hydraulic pressure acting on the piston causes axial force F. The pressure force F works via the piston(2) upon the return plate(3) which acts upon the swash plate(4) via an hydrostatic bearing. Force F1 perpendicular to swash plate(4) and force F2 perpendicular to cylinder center.

Being transferred to the cylinder block(5) 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.

$$T = \frac{p \times q}{2\pi}, q = Z \cdot A \cdot \text{PCD} \cdot \tan\theta, F1 = \frac{F}{\cos\theta}, F2 = F \tan\theta, S = \text{PCD} \times \tan\theta$$

Where p : Effective difference of pressure(kgf/cm<sup>2</sup>)

q : Displacement(cc/rev)

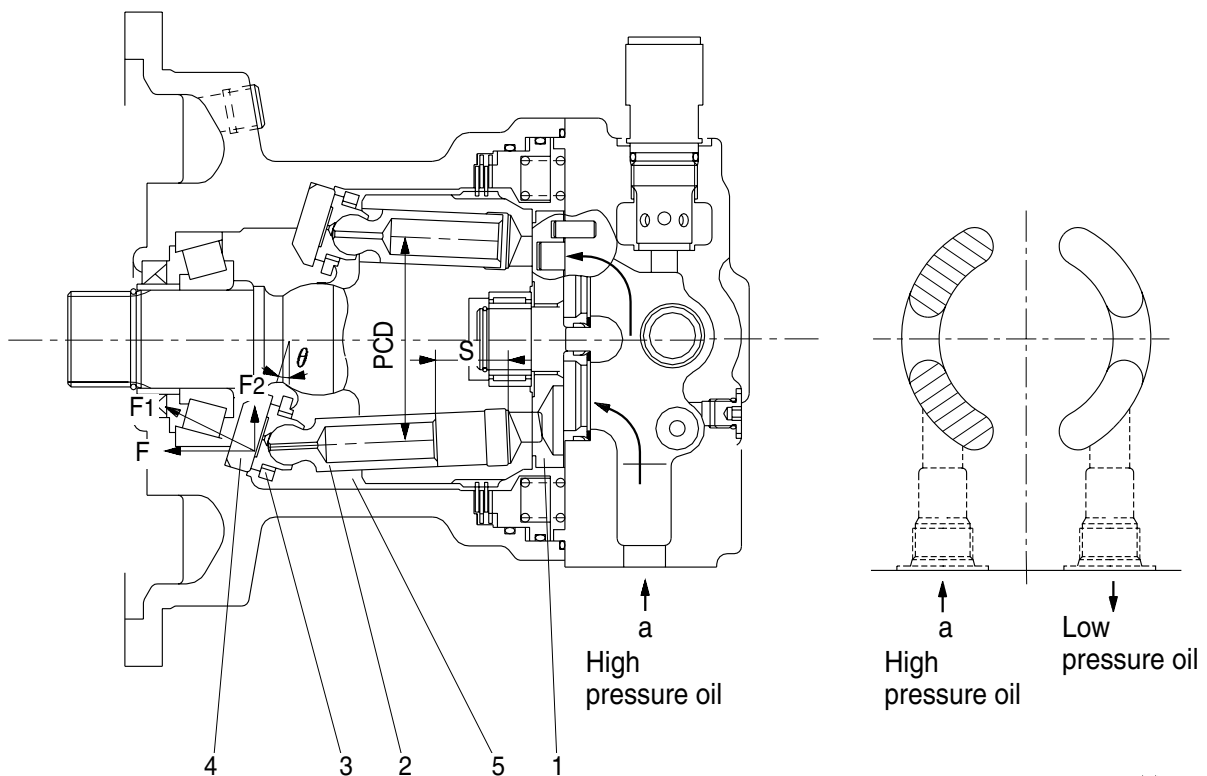
T : Output torque(kgf · cm)

Z : Piston number(9EA)

A : Piston area(cm<sup>2</sup>)

θ : Tilting angle of swash plate(degree)

S : Piston stroke(cm)



R140LC-7 기타 2-46

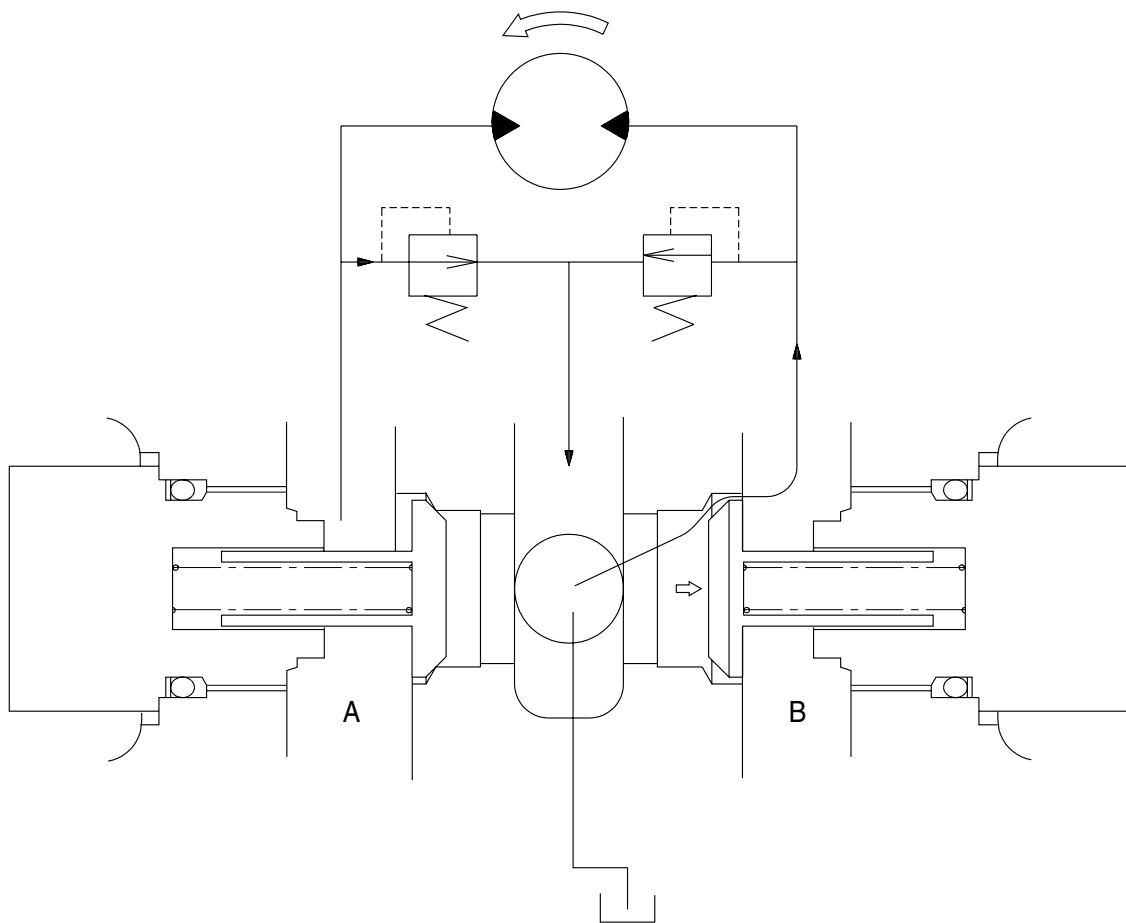
## 2) MAKE UP VALVE

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.

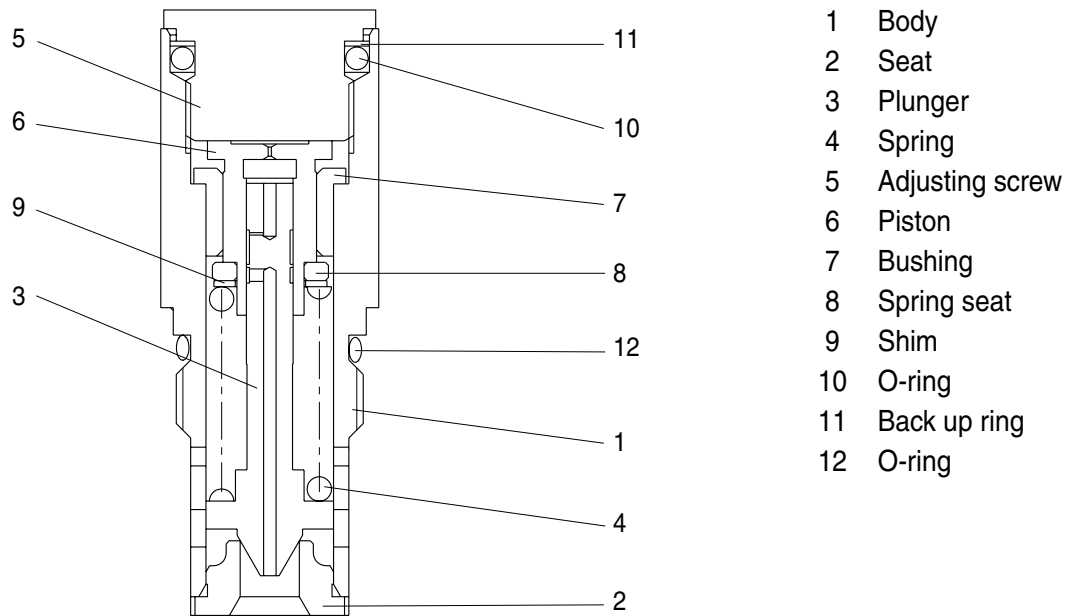
Pressurized oil into the port B, the motor rotate counterclockwise.

If the plunger of MCV moves neutral position, the oil in the motor is drain via left relief valve, the drain oil run into motor via right make up valve, which prevent the cavitation of motor.



R140LC-7 기타 2-47

### 3) RELIEF VALVE

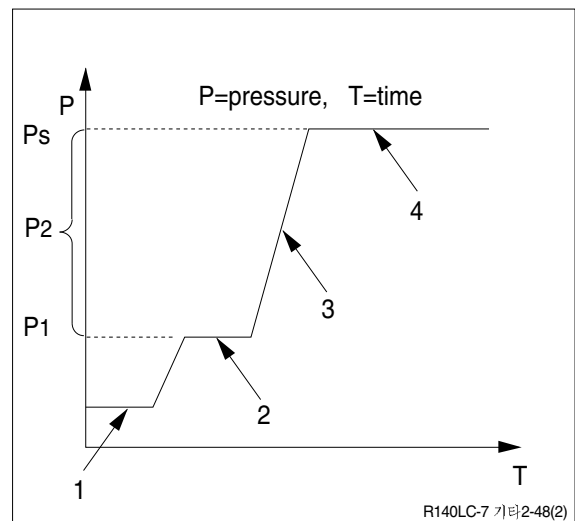


#### (1) Construction of relief valve

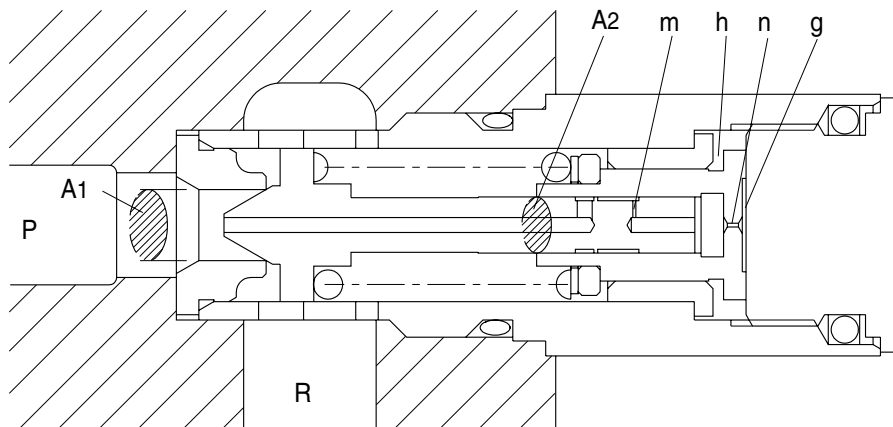
The valve casing contains two cartridge type relief valves that stop the regular and reverse rotations of the hydraulic motor. The relief valves relieve high pressure at start or at stop of swing motion and can control the relief pressure in two steps, high and low, in order to insure smooth operation.

#### (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.

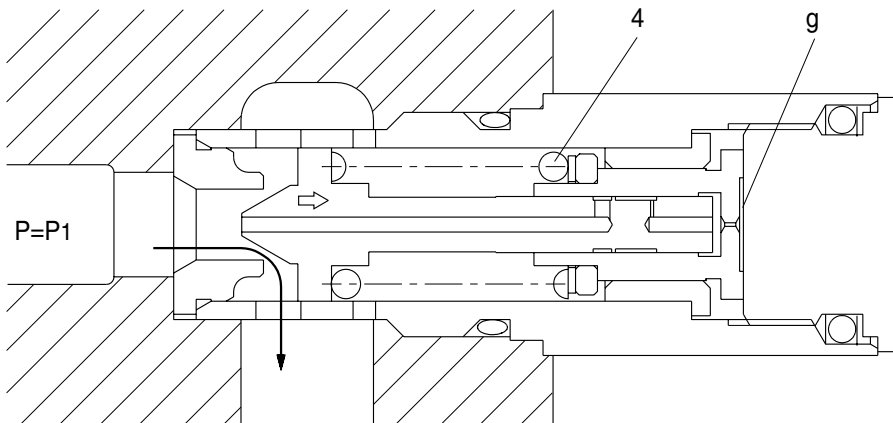


R140LC-7 기타 2-49

- ② When hydraulic oil pressure( $P \times A1$ ) reaches the preset force( $F_{sp}$ ) of spring(4), the plunger(3) moves to the right as shown.

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

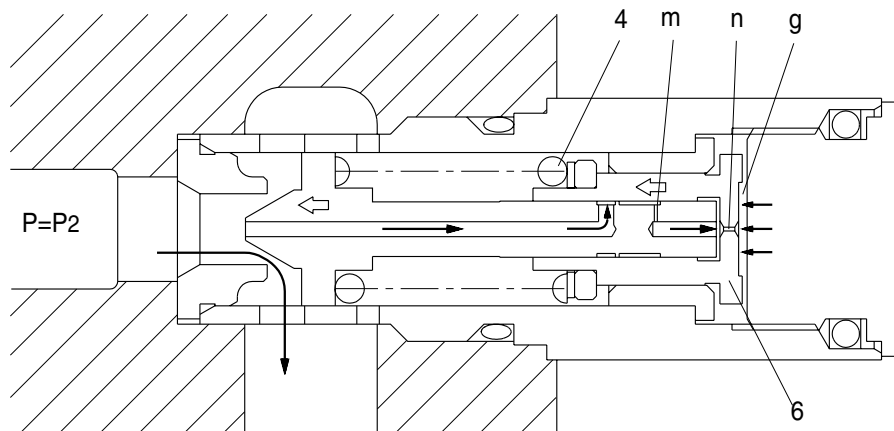
$$P_1 = \frac{F_{sp} + P_g \times A_2}{A_1}$$



R140LC-7 기타 2-49



- ③ The oil flow chamber g via orifice m and n. When the pressure of chamber g reaches the preset force( $F_{sp}$ ) of spring(4), the piston(6) moves left and stop the piston(6) hits the bottom of bushing(7).

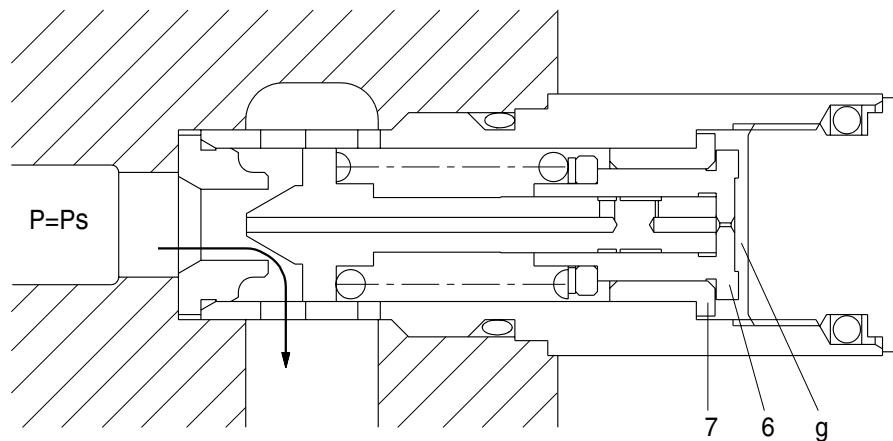


R140LC-7 기타 2-49

- ④ When piston(6) hits the bottom of bushing(7), it stops moving to the left any further. As the result, the pressure in chamber(g) equals( $P_s$ ).

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

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



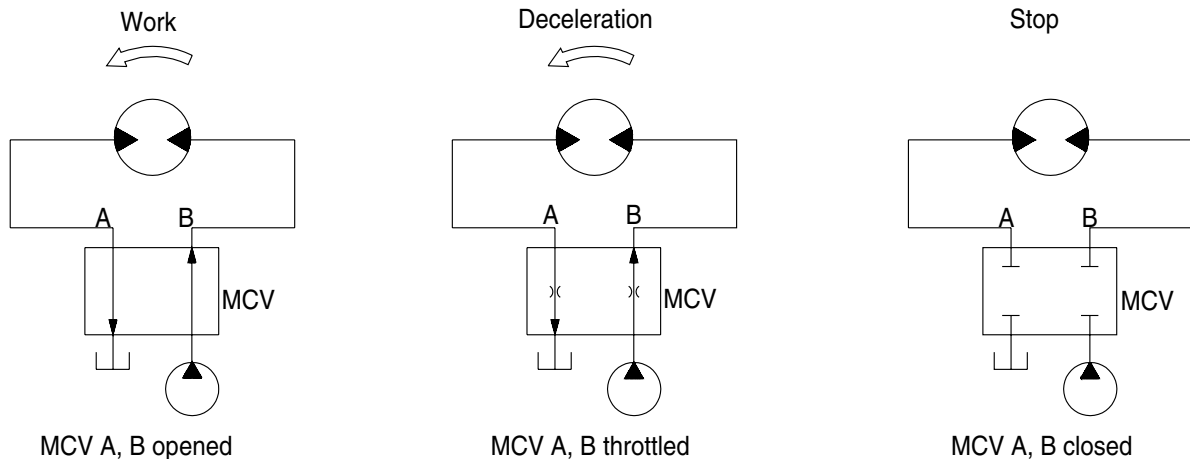
R140LC-7 기타 2-49

## 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.



R140LC-7 기타 2-48(1)

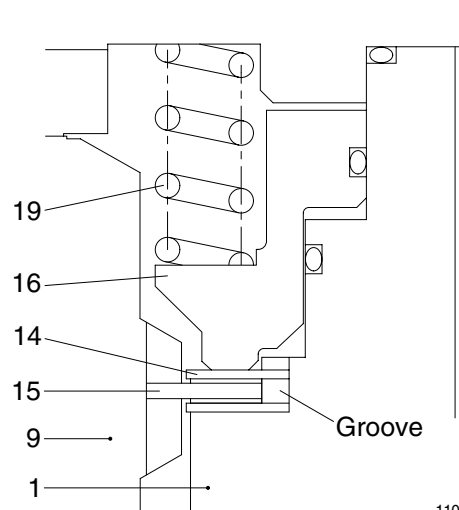
### (2) Mechanical swing parking brake system

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(14) is constrained by the groove located at body(1). When housing is pressed down by brake spring(19) through lining plate(15), separate plate(14) and brake piston(16), friction force occurs there.

Cylinder(9) is constrained by this friction force and brake acts, while brake releases when hydraulic force exceeds spring force.



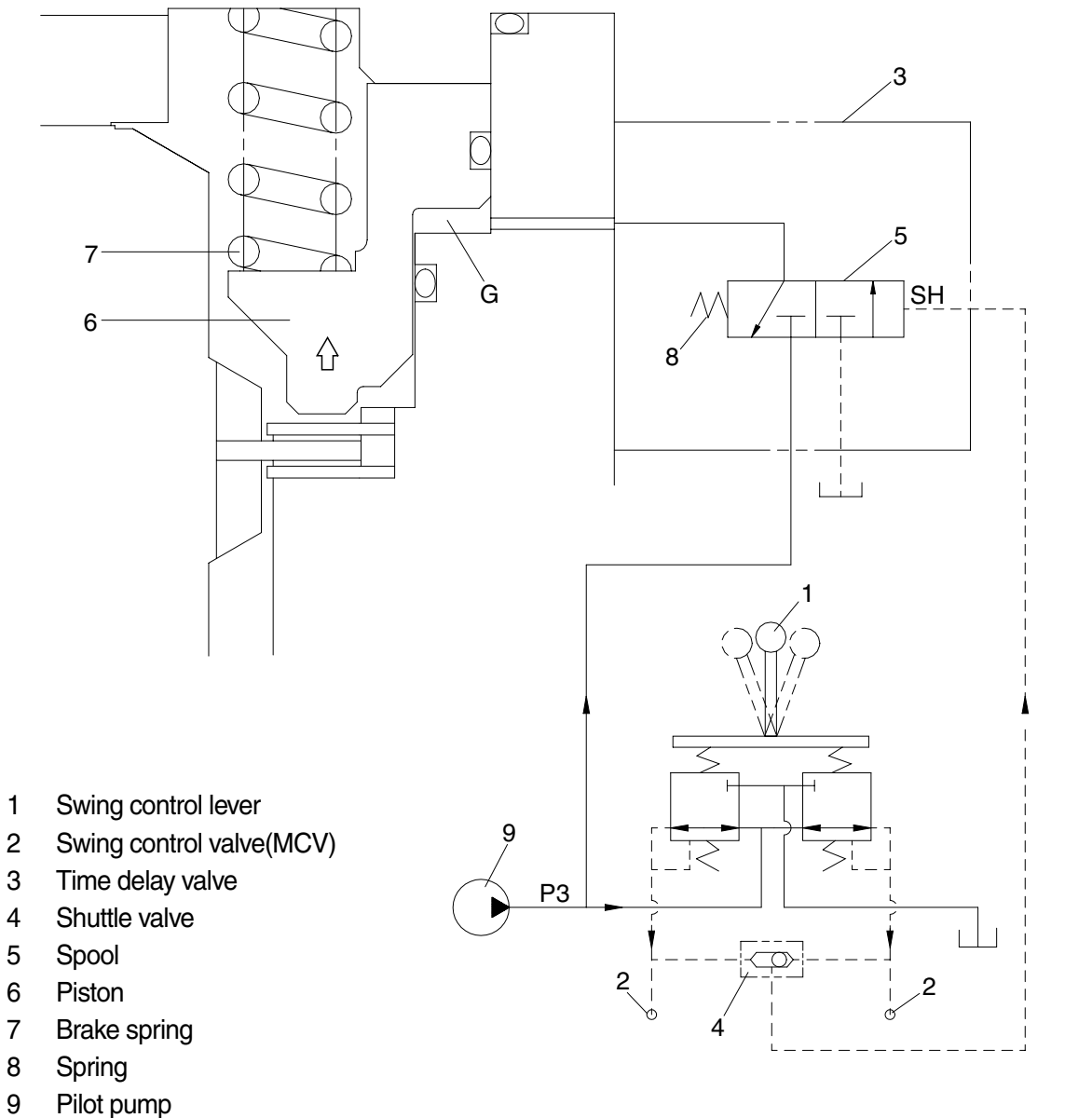
11072SM05

1	Body	15	Lining plate
9	Cylinder	16	Brake piston
14	Separate plate	19	Spring

## ② Operating principle

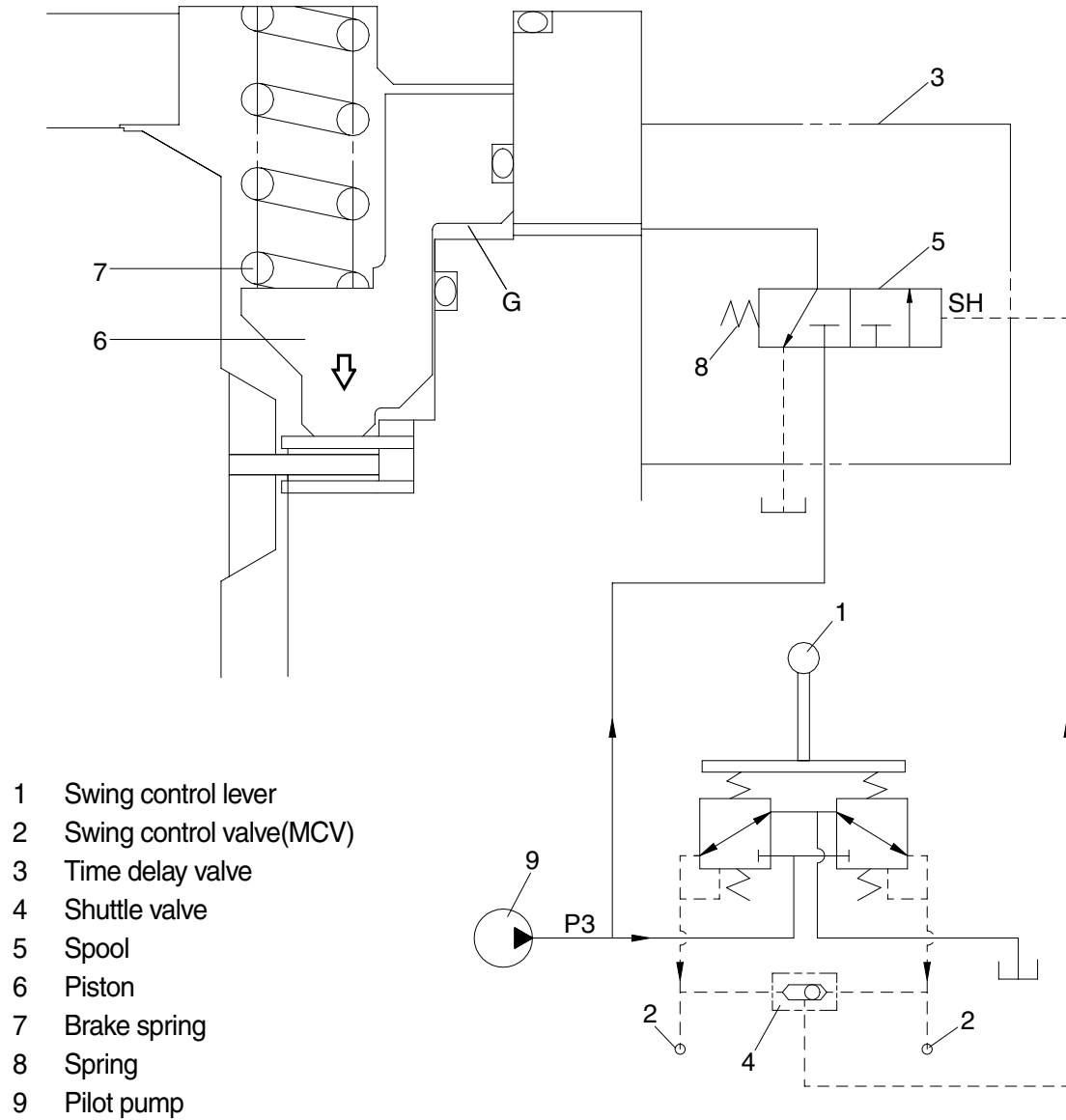
- a. When the swing control lever(1) is set to the swing position, the pilot oil go to the swing control valve(2) and to Sh of the time delay valve(3) via the shuttle valve(4), this pressure move spool(5) to the leftward against the force of the spring(8), so pilot pump charged oil(P3) goes to the chamber G.

This pressure is applied to move the piston(6) to the upward against the force of the spring(7). Thus, it releases the brake force.



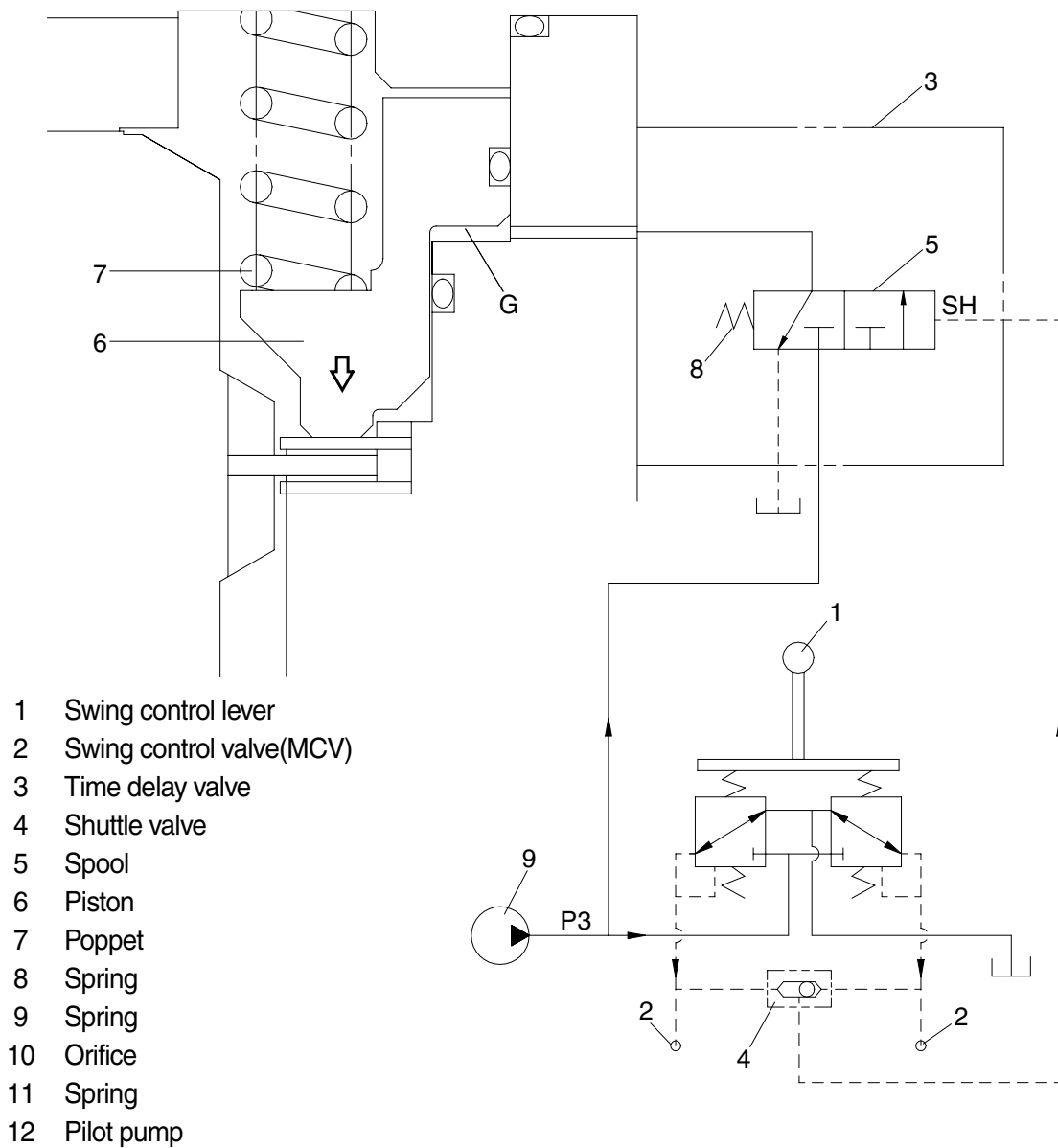
11072SM06

- b. Meantime, the oil pressure of port D balance with the preset force of spring(7), the pressure of chamber G keeps constant pressure.



11072SM07

- c. When the swing control(1) lever is set the neutral position, the spool(5) returns right in the time delay valve(3).  
Then, the piston(6) is moved lower by spring force and the return oil from the chamber G flows back to tank.  
At this time, the poppet works to make a time lag for 5 seconds.



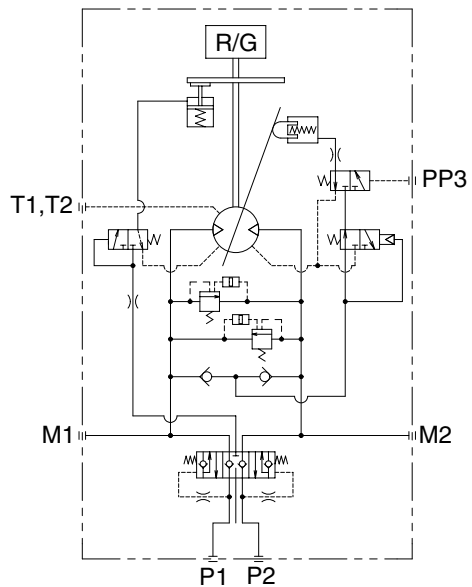
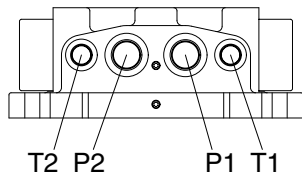
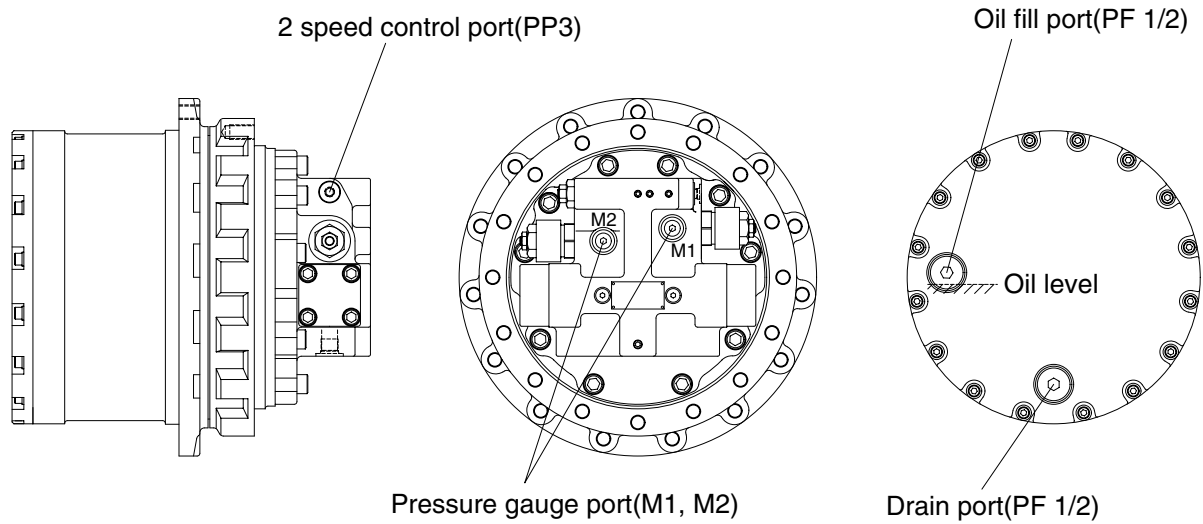
11072SM07

## GROUP 4 TRAVEL DEVICE

### 1. CONSTRUCTION

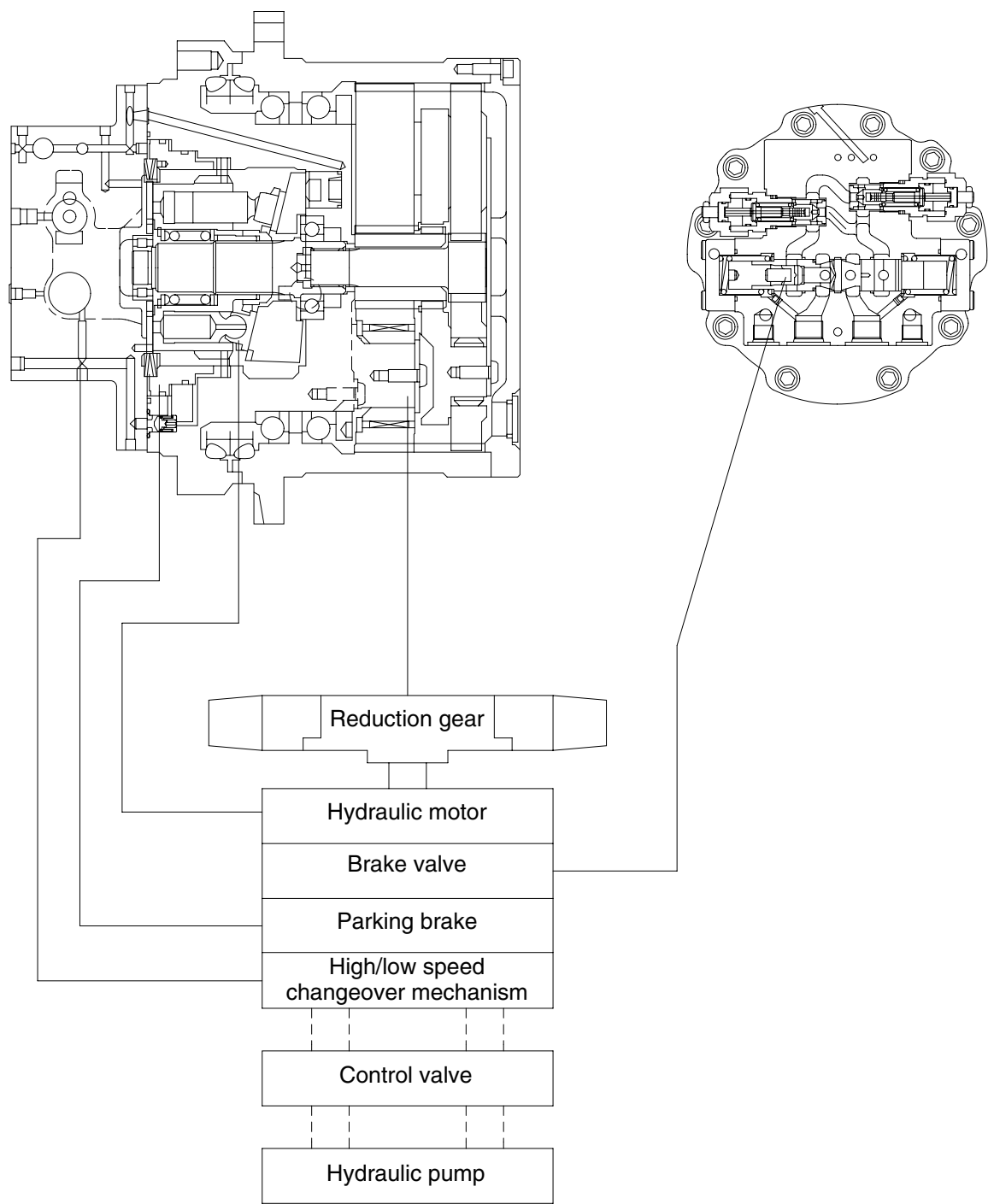
Travel device consists travel motor and gear box.

Travel motor includes brake valve, parking brake and high/low speed changeover mechanism.



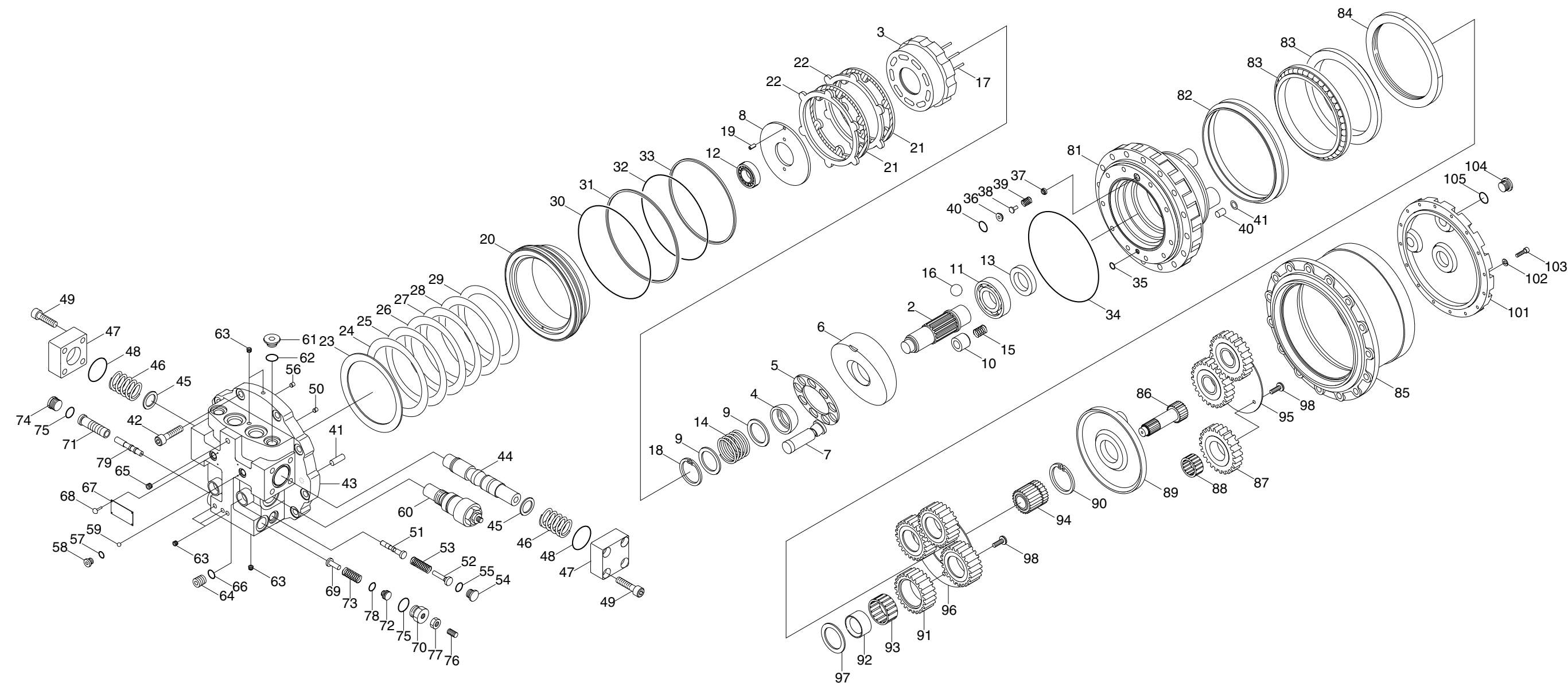
Port	Port name	Port size
P1	Main port	SAE 5000psi 1"
P2	Main port	SAE 5000psi 1"
M1, M2	Gauge port	PT 1/4
T1, T2	Drain port	PF 1/2
PP3	2 speed control port	PF 1/4

1) BASIC STRUCTURE



11072TM02

2) STRUCTURE



2	Shaft	20	Brake piston	37	Retainer	54	Plug	71	Sleeve	89	Carrier
3	Cylinder barrel	21	Friction plate	38	Poppet	55	O-ring	72	Stopper	90	Sun gear B
4	Ball retainer	22	Steel plate	39	Spring	56	Orifice	73	Spring	91	Planetary gear B
5	Retainer	23	Disk spring	40	O-ring	57	Steel ball	74	Plug	92	Bushing
6	Cam	24	Shim(1.0T)	41	Pin	58	Plug	75	O-ring	93	Needle bearing B
7	Piston assembly	25	Shim(1.2T)	42	Bolt	59	O-ring	76	Screw	94	Snap ring
8	Valve plate	26	Shim(1.4T)	43	Motor cover assembly	60	Relief valve assembly	77	Nut	95	Thrust plate(2)
9	Plate	27	Shim(1.6T)	44	Spool assembly	61	Plug	78	O-ring	96	Thrust plate(3)
10	Piston assembly	28	Shim(1.8T)	45	Washer	62	O-ring	79	Rod	97	Thrust plate(4)
11	Ball bearing	29	Shim(2.0T)	46	Spring	63	Plug	80	Casing body	98	Screw
12	Roller bearing	30	O-ring	47	Cover	64	Plug	81	Floating seal	99	Washer
13	Oil seal	31	Back up ring	48	O-ring	65	Plug	82	Angular bearing	100	Parallel pin
14	Spring	32	O-ring	49	Bolt	66	O-ring	83	Ring nut	101	Cover
15	Spring	33	Back up ring	50	Orifice	67	Name plate	84	Casing gear	102	Spring washer
16	Steel ball	34	O-ring	51	Spool	68	Rivet	85	Sun gear A	103	Bolt
17	Pin	35	O-ring	52	Stopper	69	Spring guide	86	Planetary gear A	104	Plug
18	Snap ring	36	Seat	53	Spring	70	Plug	87	Needle bearing A	105	O-ring
19	Spring pin										

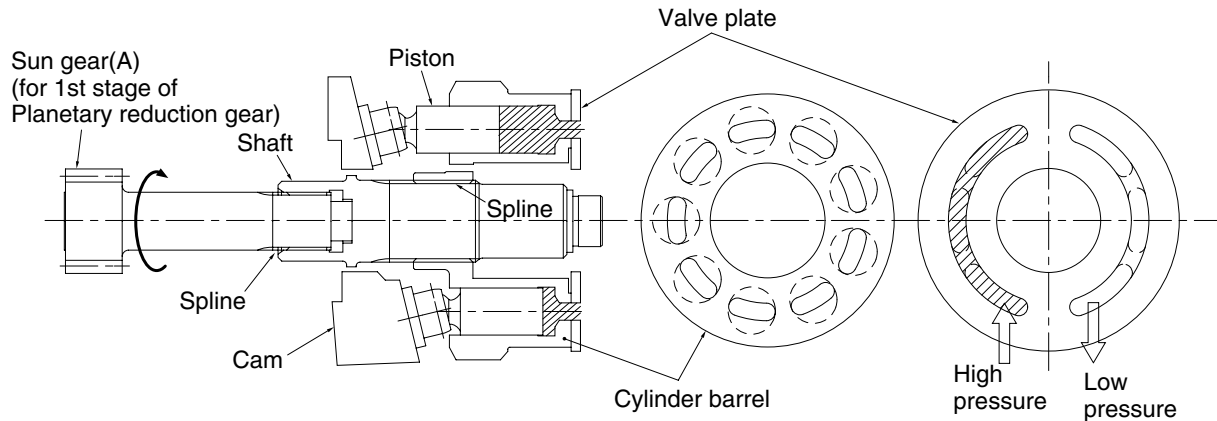
11072TM04



## 2. FUNCTION

### 1) HYDRAULIC MOTOR

#### (1) Motoring function



11072TM05

High-pressure oil is supplied to the left port of motor.

The oil goes into the cylinder barrel through the valve plate. The high pressure pushes the piston to the left. The piston moves to the left position and simultaneously rotates the cylinder barrel sliding on the cam surface. Shaft is connected to the cylinder barrel and the planetary gear (A) is connected to the shaft. So, the rotation is taken out by the sun gear rotation as shown.

When high-pressure oil is supplied to the opposite port of the motor, then the rotating direction is reversed and the sun gear (A) rotates in the reversed direction.

The rotation of sun gear (A) is transferred to the reduction gear section.

The torque and speed generated by the motor depends on the displacement (=volume per revolution) of the motor.

The volume per revolution depends on the cam angle  $\phi$ .

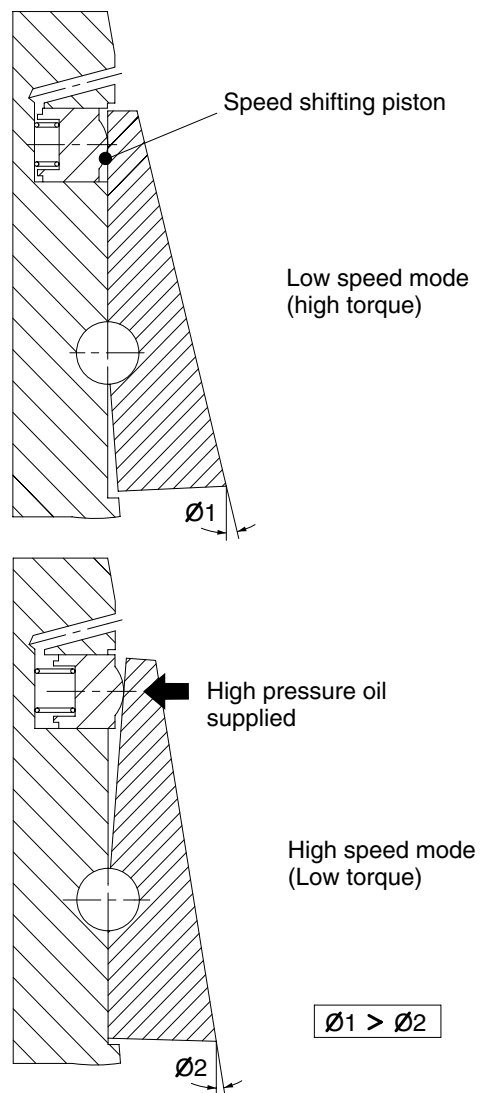
## (2) Speed-shifting function

The torque and speed generated by the motor depends on the displacement of the motor. And the displacement depends on the cam angle  $\phi$ .

The bigger the cam angle  $\phi$  is, the higher the torque is and the lower the speed is.

The smaller the cam angle  $\phi$  is, the lower the torque is and the higher the speed is.

This travel drive is equipped with a speed shifting piston, and when high pressure oil is supplied to it, the speed-shifting piston pushes cam and makes the cam angle smaller. This means that the mode is shifted from low speed mode to high speed mode.



11072TM06

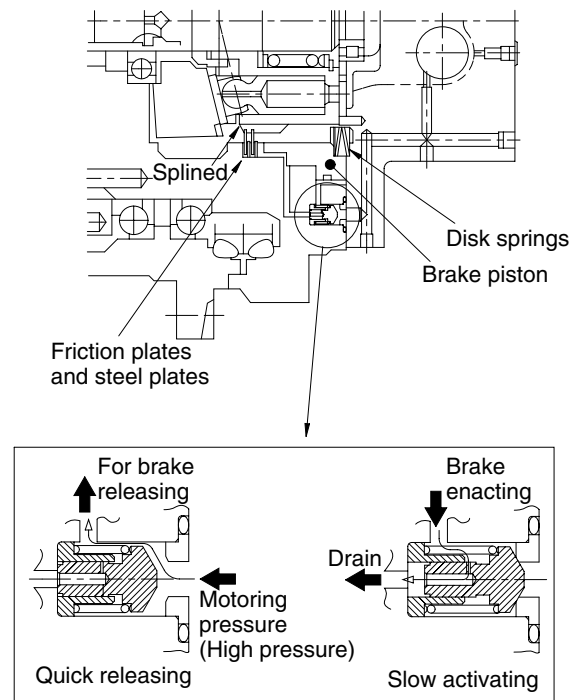
### (3) Parking brake function

This travel drive is equipped with a parking brake. It gives parking brake torque to the motor when high pressure oil is NOT supplied to the motor and the motor is NOT traveling. Also, it releases parking brake when high-pressure oil is supplied to the motor and the motor is traveling.

As high-pressure oil is supplied to the travel motor, the parking brake is quickly released and the motor starts rotation.

When the high pressure oil supply to the motor stops, the motor stops rotation and the parking brake is slowly activated by the brake piston motion because of the force of a pair of disk springs.

Slow activating and quick releasing of parking brake can prevent possible damage to friction plates and steel plates.



11072TM07

## 2) BRAKE VALVE

### (1) Counterbalance valve function

#### ① Level travel

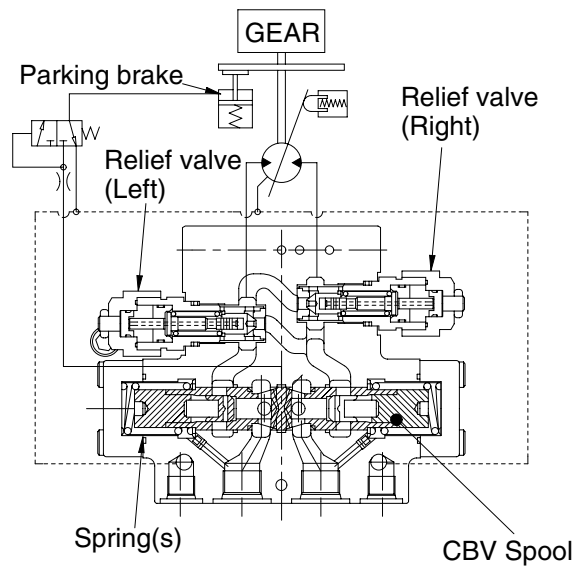
When high pressure oil is NOT supplied to the brake valve, CBV spool is at the center because of two springs beside it. Now oil flow passage from motor is closed.

When high-pressure oil is supplied to the right port of brake valve, CBV spool is moved to the left position because of the pressure at the right end of CBV spool. Now that oil-flow passage from the motor is open at the left shoulder of the CBV spool, oil flows and motor rotates.

When supplied pressure at the right port is decreased during the vehicle deceleration or stopping process, there is a pressure decrease at the right end of CBV spool.

Then CBV spool is moved to the right direction because of the spring force at the left side of CBV spool. Then oil-flow passage from the motor at the shoulder of the CBV spool gets narrower and at last it is closed when high pressure oil supply is shut-up to brake valve.

In this passage closing process, there occurs a pressure increase in outlet side of the motor ("=back pressure").



11072TM08

## ② Down-slope travel

- If there is NOT a counterbalance valve equipped

When the vehicle travels down a slope, gravity makes the travel drives rotate more speedily than you intended. The "overrunning" cannot be controlled by the supplying oil flow rate. Also, the pumps cannot maintain the oil supply to the motors and there will be a negative pressure in the inlet side of motor. This might cause cavitation in the travel motors.

- Function and mechanism of counterbalance valve

In down-slope traveling, the pressure at the right port decreases because of lack of supplied oil. Then, the pressure at the right end of CBV spool also decreases and CBV spool moves back to the right direction from the left position. Now that oil-flow passage from the motor at the shoulder of the CBV spool gets narrower and then there will occur a pressure increase in outlet side of the motor (= "back pressure").

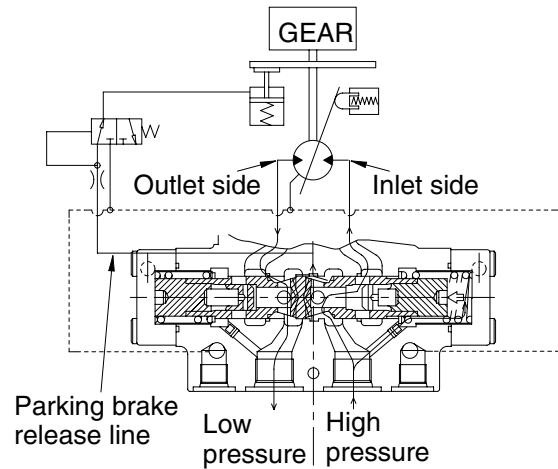
This "back pressure" can prevent the motor from "overrunning" and cavitation.

## ③ Oil supply for parking brake release

For starting the travel drive rotation, when pump oil is supplied to the right port of brake valve, CBV spool moves to the left position and also opens passage to parking brake releasing.

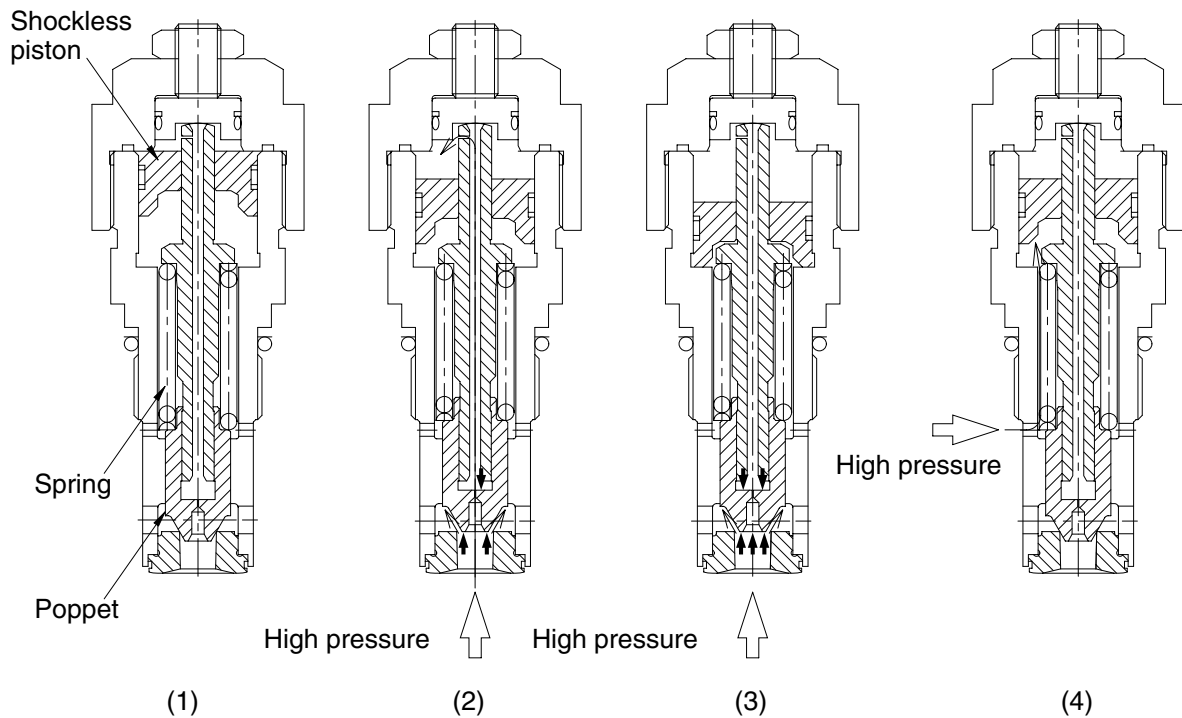
When the travel drive is in "stop" state, passage to brake releasing is closed.

As to the detail of parking brake function, please refer to "(3) parking brake function".



11072TM09

## (2) Crossover relief valve function



11072TM10

This travel drive is equipped with a pair of shockless crossover relief valves. The purpose is as below :

- The relief valve prevents the occurrence of a shock load while travel deceleration or stopping process.
- It prevents overload to the motor.
- It compensates for the lack of oil during vehicle deceleration or stopping processes.
- The relief valves are "shockless" type, which is effective for shock reduction.

### ① If there is NOT a crossover relief valves equipped(considering two cases for example)

- When the vehicle is in slowing down or stopping operation stage, a pressure increase (= "back pressure") occurs in the motor because of the function of counterbalance valve as mentioned in "2)-(1) counterbalance valve function". If the stopping operation for vehicle is sudden, this "back pressure" occurs suddenly and it may cause a shocking feeling for the operator, or in worse cases, break down of the machine.
- When the vehicle is in the rotation starting operation stage, high pressure will be applied into the motor. If the starting operation is too sudden, a sudden pressure increase occurs in the motor. It may cause a shock.

In order to make the harmful pressure shock softer, and for operator feeling improvement or for machine protection, this travel drive is equipped with crossover relief valve.

## ② **Function and mechanism of shock-less crossover relief valves**

Please refer to the figures in "2)-(1) counterbalance valve function" and on this page.

The explanation below is described about relief valve(right).

Firstly, the relief valve(right) is in condition (1) previous page.

When a sudden pressure increase occurs in the outlet side of the motor in deceleration or stopping process, the shock of high pressure pushes down shockless piston in the relief valve as shown in (2), while relieving high pressure oil with poppet moving up.

During moving down shockless piston, the pressure behind the poppet is not so high because of the existence of flow moving down the shockless piston, and relieving pressure is rather low.

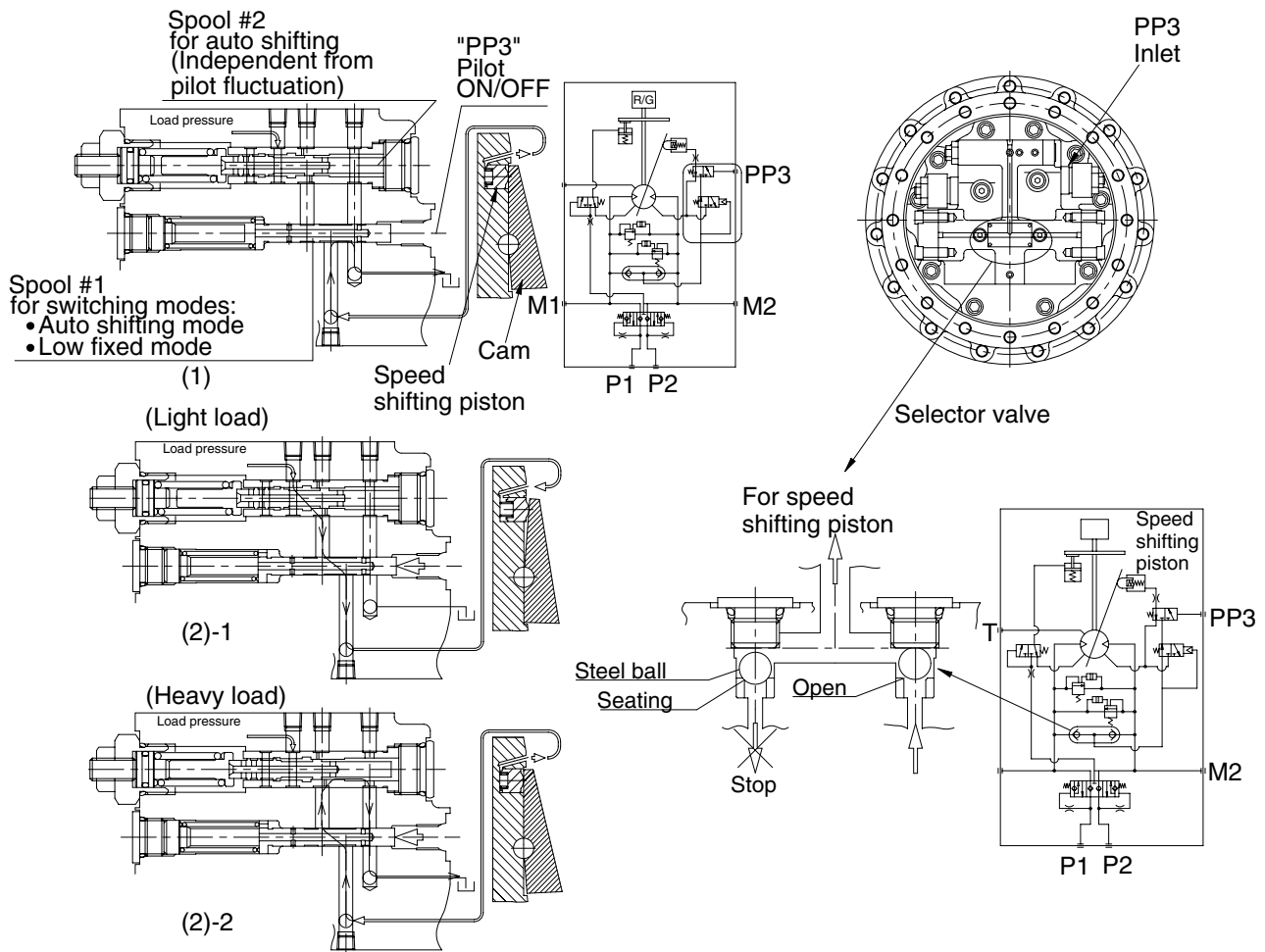
Next, when the shockless piston has been completely pushed down to the end of stroke as shown in (3), the relieving pressure increases to the finally intended set pressure, because there is no more flow moving down the shockless piston, and the pressure behind the poppet is high.

After stopping the motor, when you start rotating the motor again, resetting of shockless piston occurs, pushing up the shockless piston up with the high pressure in the inlet side of the motor.

## ③ **Oil compensation**

During the relieving action, the relief valve also have a function of oil flow compensation giving the relieved oil flow from the outlet side to the inlet side. This function helps to prevent a vacuum condition in the motor.

### (3) Automatic 2-speed shifting function



11072TM11

Automatic 2-speed shifting function has two modes (1) and (2) as below :

- (1) Low speed fixed mode... always low speed
- (2) Automatic 2-speed shifting mode
  - (2)-1 When motor load pressure is light, High speed.
  - (2)-2 When motor load pressure is heavy, Low speed.

This function above consists of three components.

- Spool #1 for switching modes
  - Auto-shifting mode(if PP3 is applied)
  - Low-speed-fixed mode (if PP3 is NOT applied)
- Spool #2 for auto shifting
  - If load pressure < set value then High-speed
  - If load pressure > set value then Low-speed
- Selector valve, which always picks out high pressure and provide it to the SPOOL #2 regardless of the rotating direction of motor.



## **Functions**

Please refer to (1) shown above.

When the pilot pressure PP3 is NOT applied, SPOOL #1 is at the right position because of the spring behind the spool. Now the motor is always at low speed regardless of the position of SPOOL #2.

When the pilot pressure PP3 is applied, SPOOL #1 is at the left position because of PP3. Now the motor is at automatic 2-speed-shifting mode. The displacement of the motor can be changed based on the motor load pressure.

Please refer to (2)-1.

Now the pilot pressure is applied, and the motor is at automatic 2-speed-shifting mode. When the motor load pressure is low, SPOOL #2 is at the right position because of the spring behind the spool. And the load pressure is led to the chamber behind the speed-shifting piston and it pushes piston and changes the cam angle smaller. This means that the motor is at High speed.

Please refer to (2)-2.

Now the pilot pressure is applied, and the motor is at automatic 2-speed-shifting mode. When the motor load pressure is high, SPOOL #2 is at the left position because of the motor load pressure pushing the spool to the left. Then the load pressure is locked at the SPOOL #2 and is NOT led to the chamber behind the speed-shifting piston. The cam angle remains big. This means that the motor is at Low speed.

As to the detail of cam angle change, please refer to "1) Hydraulic motor section (2) speed-shifting function".

### 3) REDUCTION GEAR

#### (1) Function

A general construction of planetary reduction gear system is as shown right. The system mainly consists of these parts below.

NAME	Number of teeth
Sun Gear	$Z_s$
Planetary gears	$Z_p$
Carrier	-
Ring gear	$Z_r$

#### ① Planetary type

Firstly, let's think about the case that Ring Gear is fixed and rotation is given to Sun gear. This is called "PLANETARY TYPE" as sun gear rotates clockwise, planetary gears will revolve around sun gear, and the revolution will rotate carrier.

Now we can take the clockwise rotation at carrier by giving a clockwise rotation to sun gear.

The rotation speed of carrier(output) is different from that of sun gear(input) as below.

(input)/(output) is called "Reduction ratio(i)".

$$\text{Reduction ratio (i)} = (\text{Input})/(\text{Output}) = Z_r / Z_s + 1$$

#### ② Star type

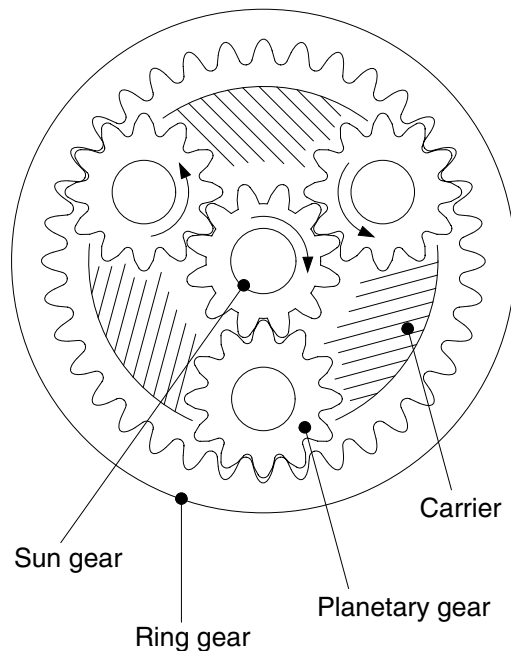
Next let's think about the case that the carrier is fixed and rotation is given to sun gear. This is called "STAR TYPE" as sun gear rotates clockwise, planetary gears will rotate at the same position, and they will make ring gear rotate counter-clockwise.

Now we can take out a counterclockwise rotation at ring gear by giving a clockwise rotation to sun gear.

The rotation speed of ring gear is different from that of sun gear as below.

$$\text{Reduction ratio (i)} = (\text{Input})/(\text{Output}) = Z_r / Z_s$$

Planetary reduction gear system



11072TM12

### ③ In the travel drive

This travel drive is equipped with 2-stage planetary reduction gear system, which consists of mixture of PLANETARY TYPE and STAR TYPE.

Input is given to sun gear of 1<sup>ST</sup> stage and output is taken out at ring gear.

Ring gear is commonly used in 1<sup>ST</sup> stage and 2<sup>ND</sup> stage.

The reduction ratio is as below

$$\begin{aligned}\text{Reduction ratio (i)} &= (\text{Input})/(\text{Output}) \\ &= (Z_r / Z_{s1} + 1) \times (Z_r / Z_{s2} + 1) - 1\end{aligned}$$

Here

$Z_{s1}$  = Number of teeth for 1<sup>ST</sup> stage  
sun gear

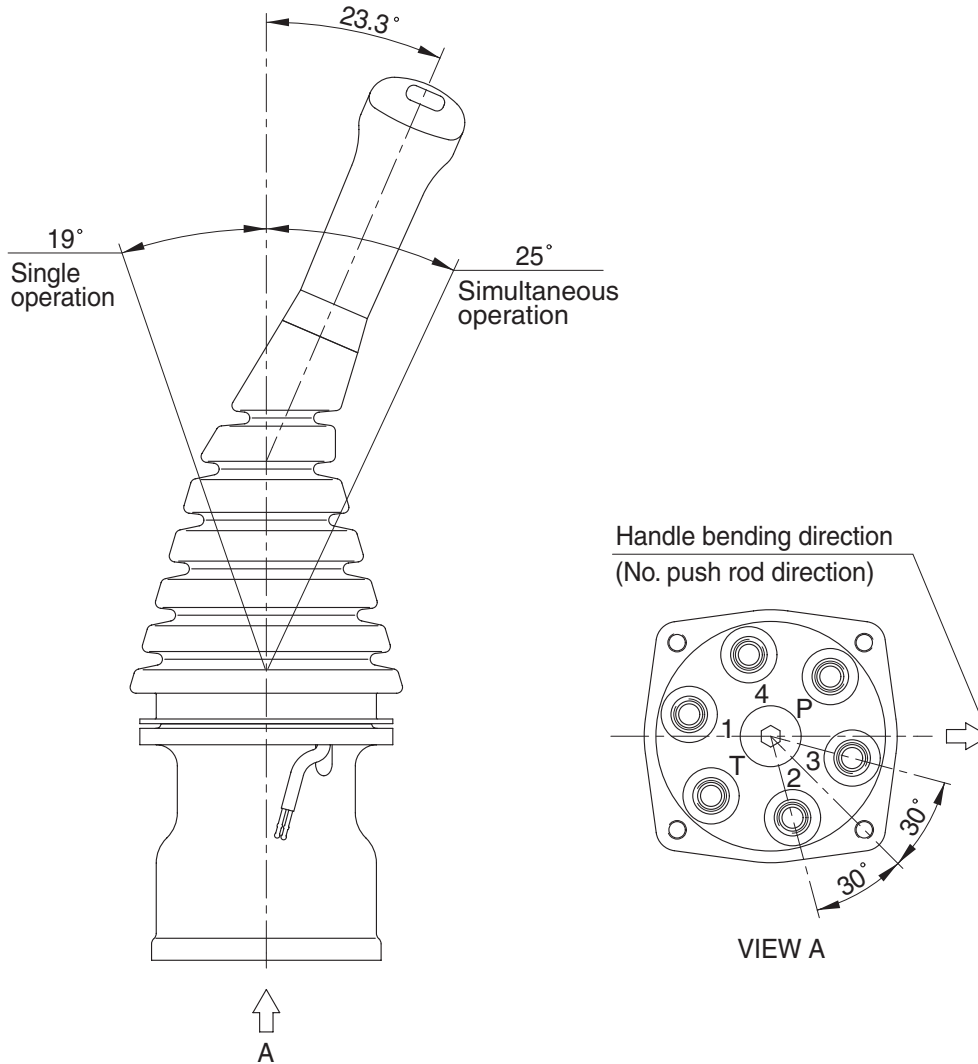
$Z_{s2}$  = Number of teeth for 2<sup>ND</sup> stage  
sun gear

$Z_r$  = Number of teeth for ring gear

## 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	

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## CROSS SECTION

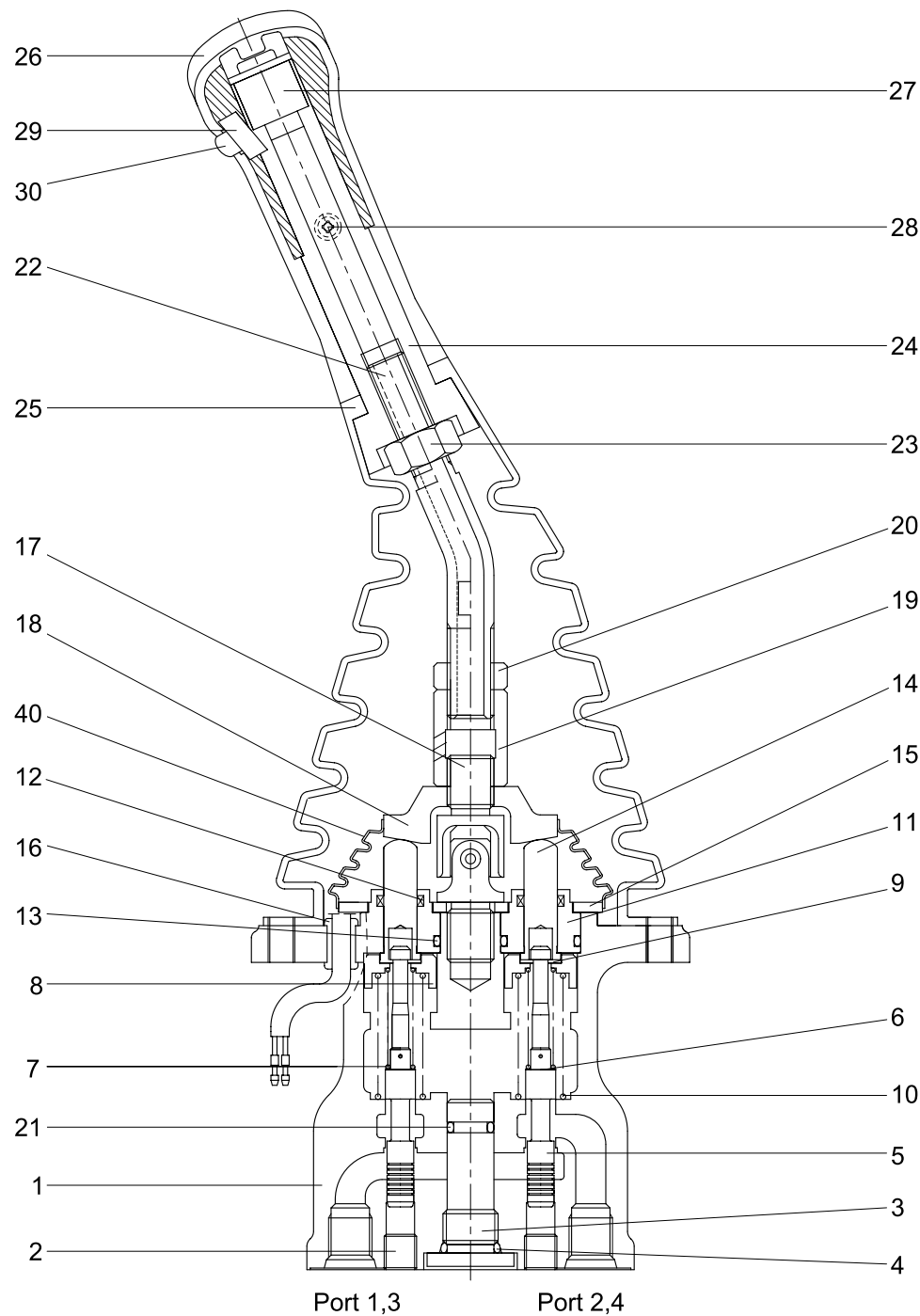
The construction of the pilot valve is shown in the attached cross section drawing. The casing has vertical holes in which reducing valves are assembled.

The pressure reducing section is composed of the spool(5), spring(7) for setting secondary pressure, return spring(10), stopper(9), spring seat(8) and shim(6). The spring for setting the secondary pressure has been generally so preset that the secondary pressure is 5 to 20.5kgf/cm<sup>2</sup>(Depending on the type). The spool is pushed against the push rod(14) 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	Handle connector
2	Plug	13	O-ring	23	Nut
3	Plug	14	Push rod	24	Insert
4	O-ring	15	Plate	25	Boot
5	Spool	16	Bushing	26	Handle
6	Shim	17	Joint assembly	27	Switch assembly
7	Spring	18	Swash plate	28	Screw
8	Spring seat	19	Adjusting nut	29	Switch assembly
9	Stopper	20	Lock nut	30	Switch cover
10	Spring	21	O-ring	40	Boot
11	Plug				

CROSS SECTION



14072SF80

## **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) works on this spool to determine the output pressure.

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

For the purpose of changing the displacement of the push rod through the switch 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.

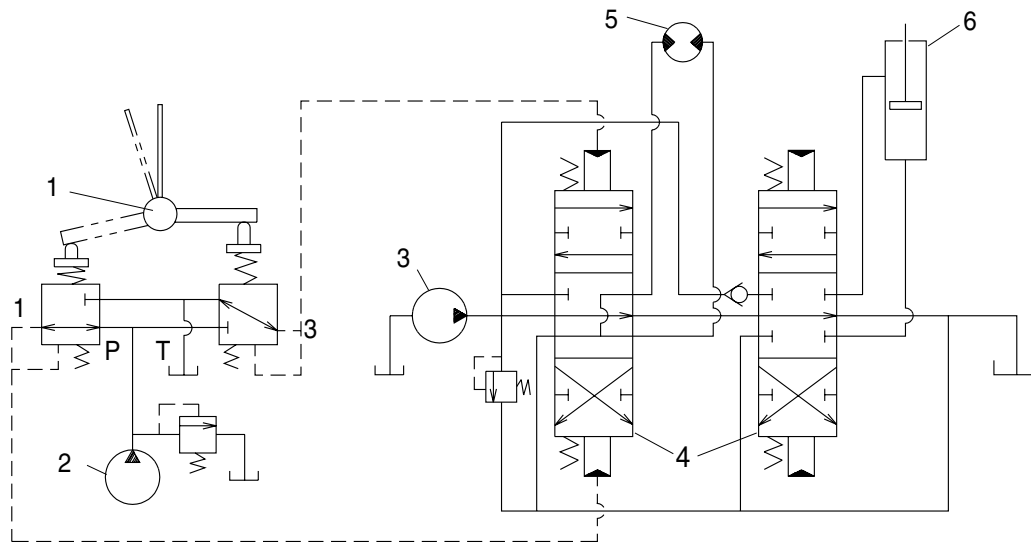
The spring(10) works on the case(1) and spring seat(8) and tries to return the push rod(14) to the zero-displacement position irrespective of the output pressure, securing its resetting to the center position.

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.

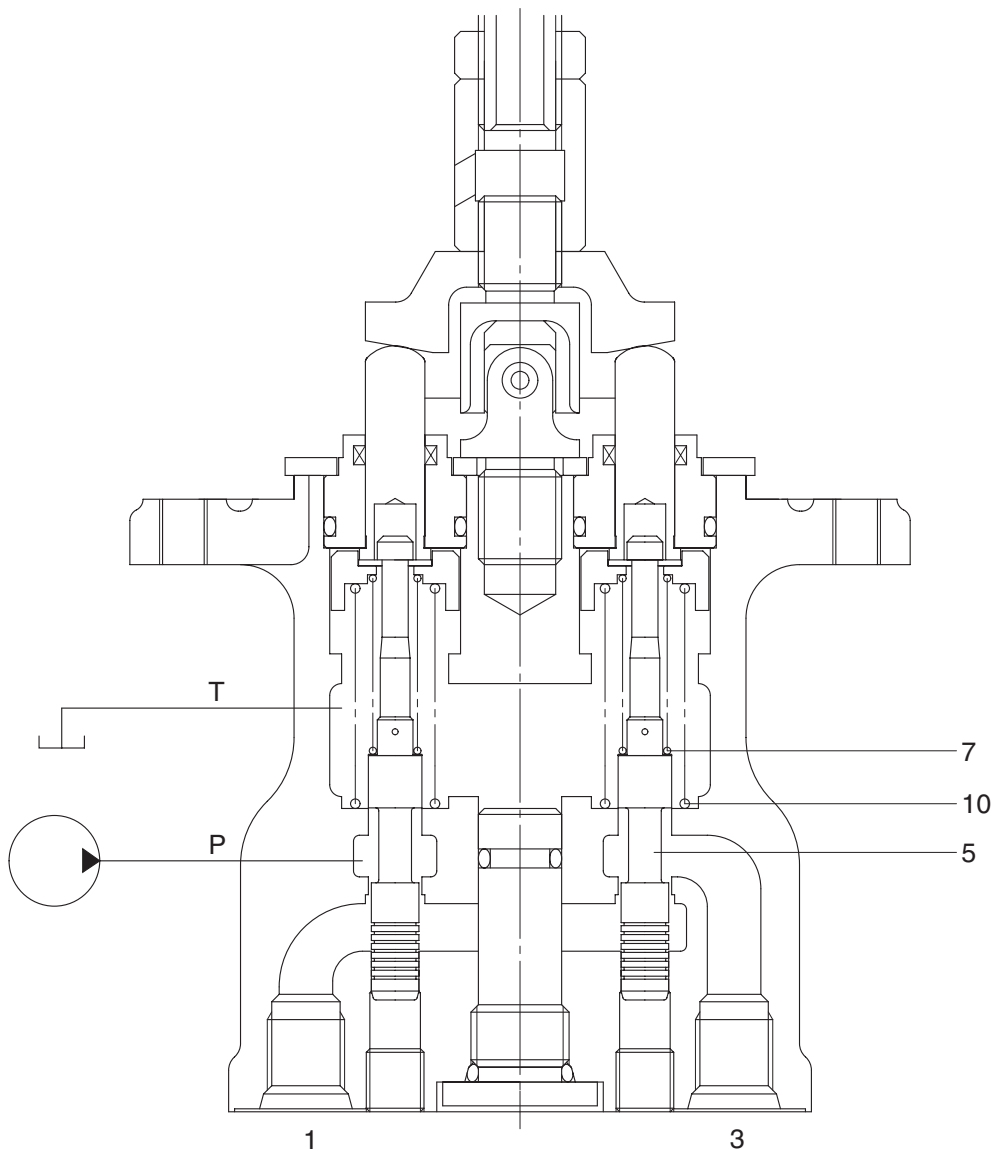


140LC-7 기타2-70

- |   |             |   |                    |   |                    |
|---|-------------|---|--------------------|---|--------------------|
| 1 | Pilot valve | 3 | Main pump          | 5 | Hydraulic motor    |
| 2 | Pilot pump  | 4 | Main control valve | 6 | Hydraulic cylinder |



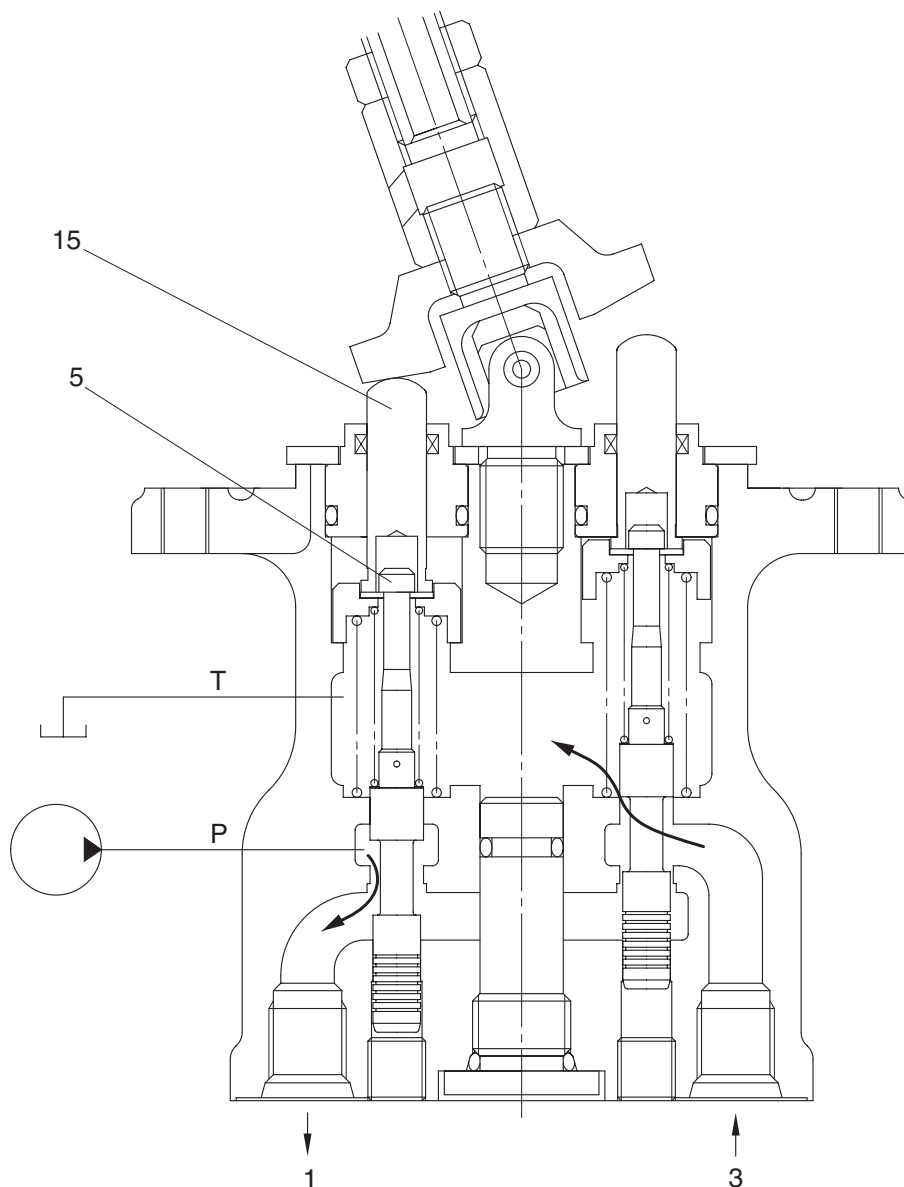
**(1) Case where handle is in neutral position**



25032RL03

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



25032RL04

When the push rod(14) 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.

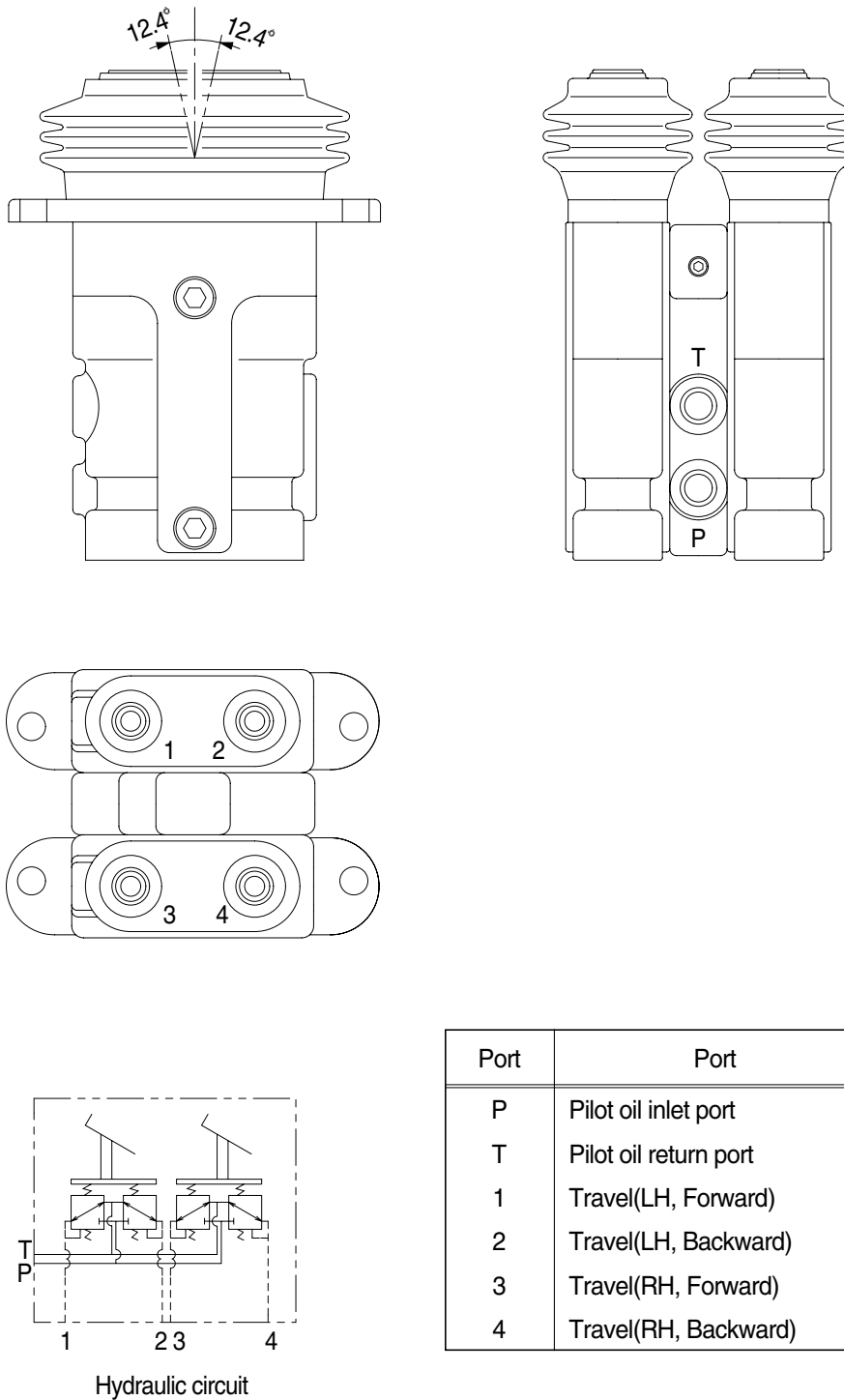
In this manner the secondary pressure is kept at the constant value.

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)	

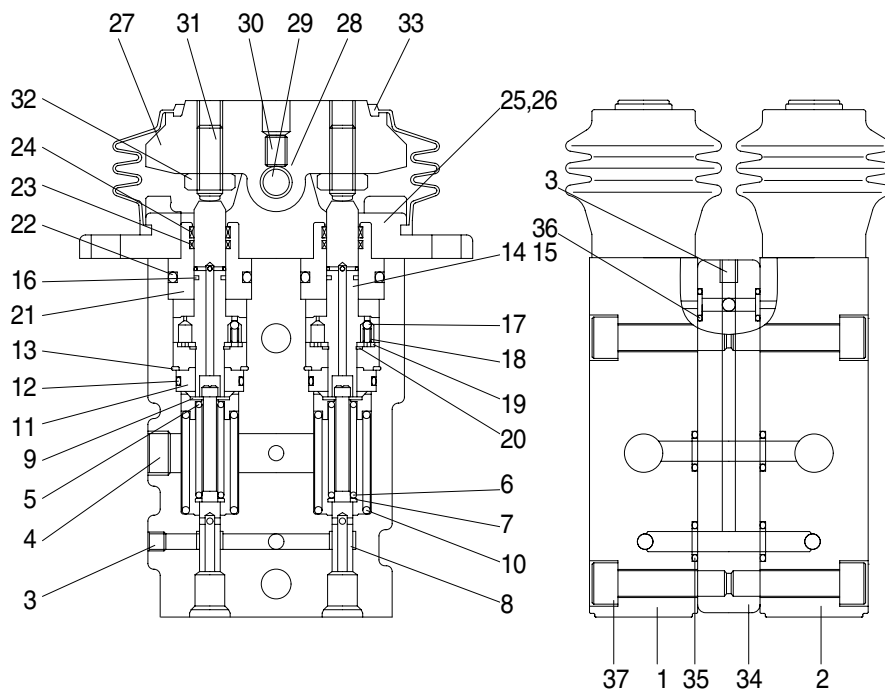
14072SF73

## 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(6) for setting secondary pressure, return spring(10), stopper(9), and spring seat(7). The spring for setting the secondary pressure has been generally so preset that the secondary pressure is 5 to 19 kgf/cm<sup>2</sup> (depending on the type). The spool is pushed against the push rod(14) 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	Body(1)	14	Push rod	26	Bolt
2	Body(2)	15	Spring pin	27	Cam
3	Plug	16	Seal	28	Bushing
4	Plug	17	Steel ball	29	Cam shaft
5	Spring seat	18	Spring	30	Set screw
6	Spring	19	Plate	31	Set screw
7	Spring seat	20	Snap ring	32	Nut
8	Spool	21	Plug	33	Bellows
9	Stopper	22	O-ring	34	Space
10	Spring	23	Rod seal	35	O-ring
11	Rod guide	24	Dust seal	36	O-ring
12	O-ring	25	Cover	37	Bolt
13	Snap ring				

14072SF70

## **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(6) works on this spool to determine the output pressure.

The change the deflection of this spring, the push rod(14) is inserted and can slide in the plug(21).

For the purpose of changing th displacement of the push rod through the cam(27) and adjusting nut(32) are provided the pedal that can be tilted in any direction around the fulcrum of the cam(27) center.

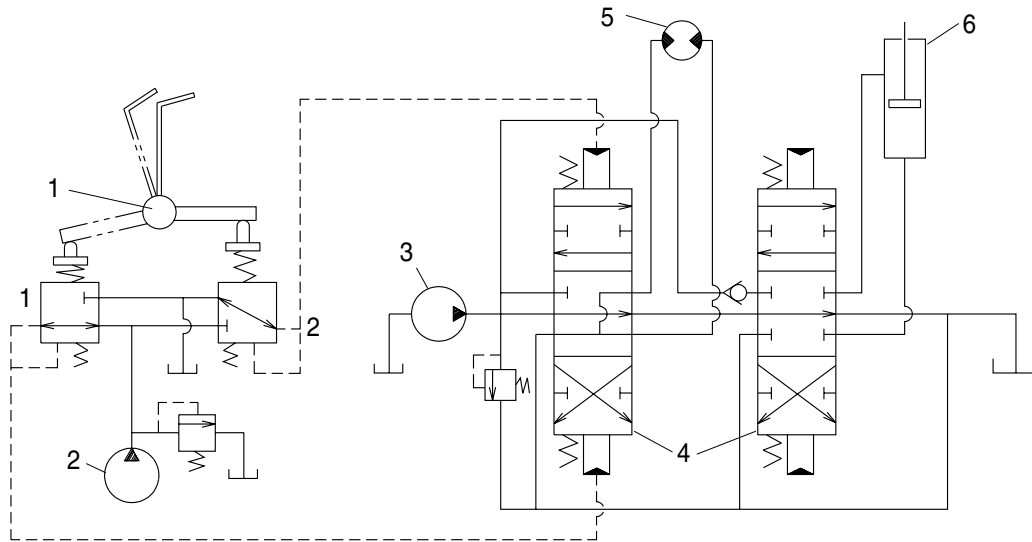
The spring(10) works on the casing(1) and spring seat(7) and tries to return the push rod(14) to the zero-displacement position irrespective of the output pressure, securing its resetting to the center position.

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.



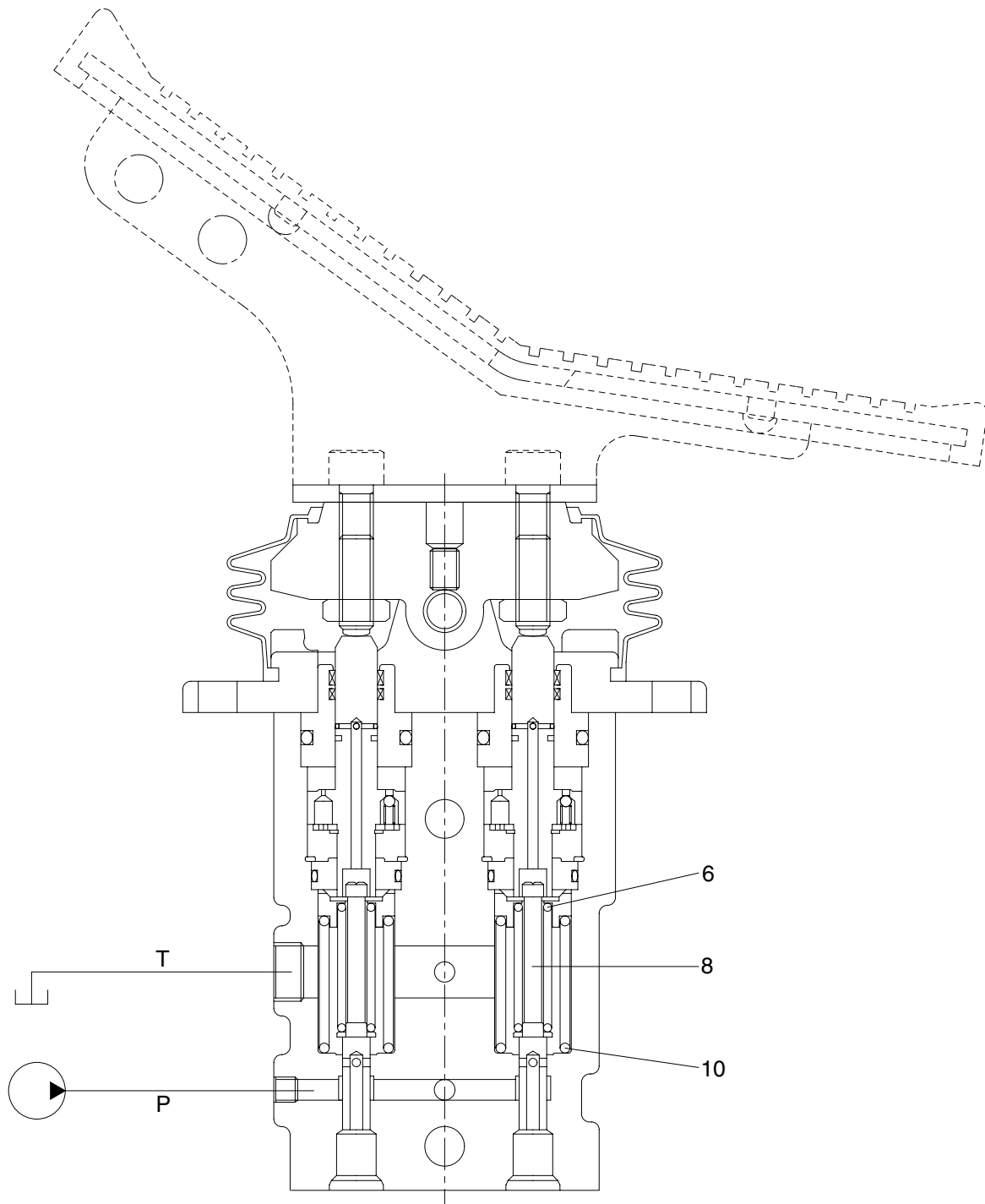
140LC-7 기어2-76

- 1 Pilot valve
- 2 Pilot pump

- 3 Main pump
- 4 Main control valve

- 5 Hydraulic motor
- 6 Hydraulic cylinder

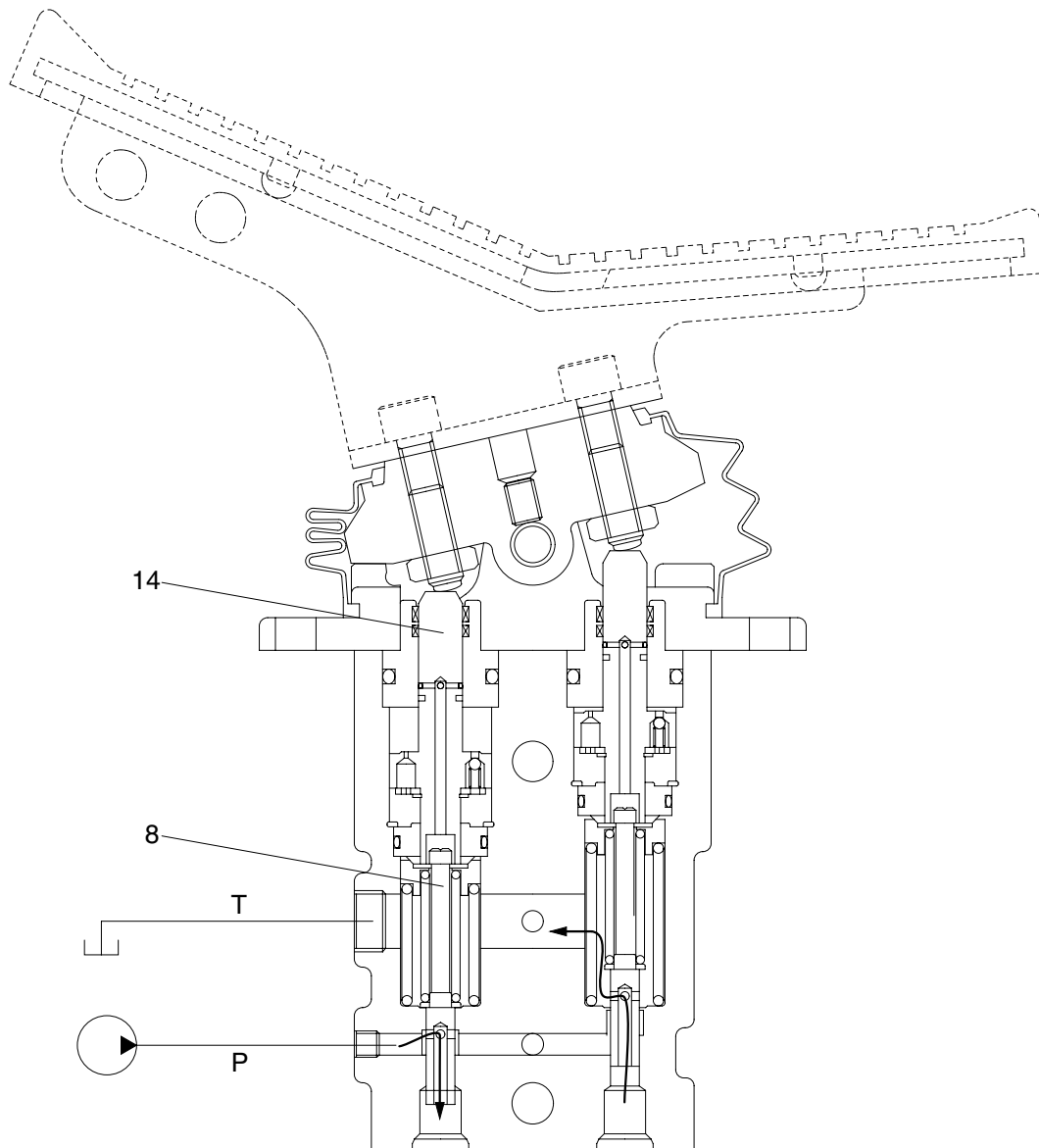
**(1) Case where pedal is in neutral position**



14072SF74

The force of the spring(6) 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(10) 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



14072SF75

When the push rod(14) 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.

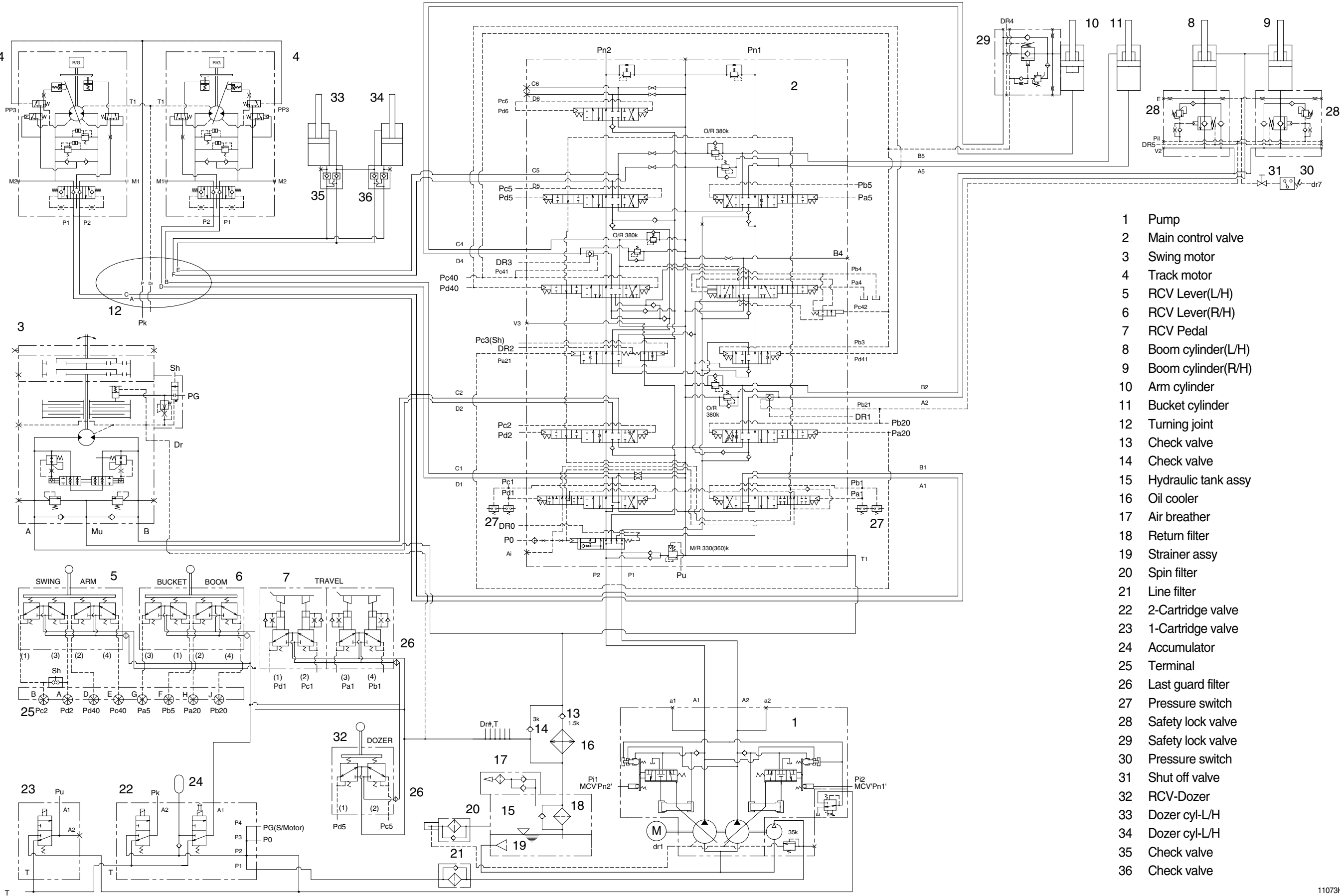
Besides, in some type, when the handle is tilted more than a certain angle, the upper end of the spool contacts with inside bottom of the push rod and the output pressure is left to be connected with port P.



## SECTION 3 HYDRAULIC SYSTEM

Group 1	Hydraulic Circuit .....	3-1
Group 2	Main Circuit .....	3-2
Group 3	Pilot Circuit .....	3-5
Group 4	Single Operation .....	3-12
Group 5	Combined Operation .....	3-24

GROUP 1 HYDRAULIC CIRCUIT



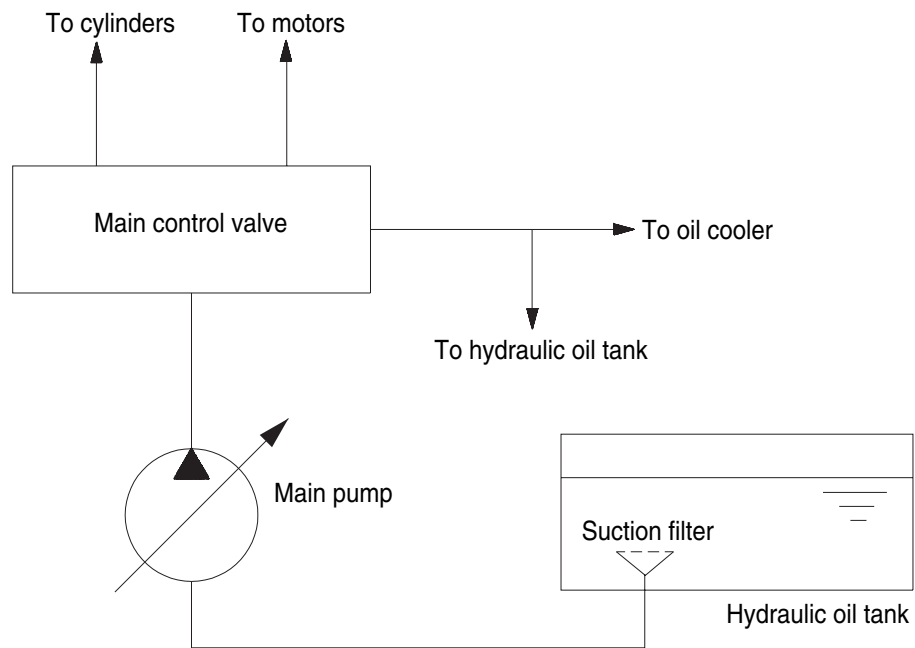
## GROUP 2 MAIN CIRCUIT

The main hydraulic circuit consists of suction circuit, delivery circuit, return circuit and drain circuit.

The hydraulic system consists of one main pump, one control valve, one swing motor, four cylinders and two travel motors.

The swash plate type variable displacement axial piston pump is used as the main pump and is driven by the engine at ratio 1.0 of engine speed.

### 1. SUCTION AND DELIVERY CIRCUIT



140LC-77] 3-02

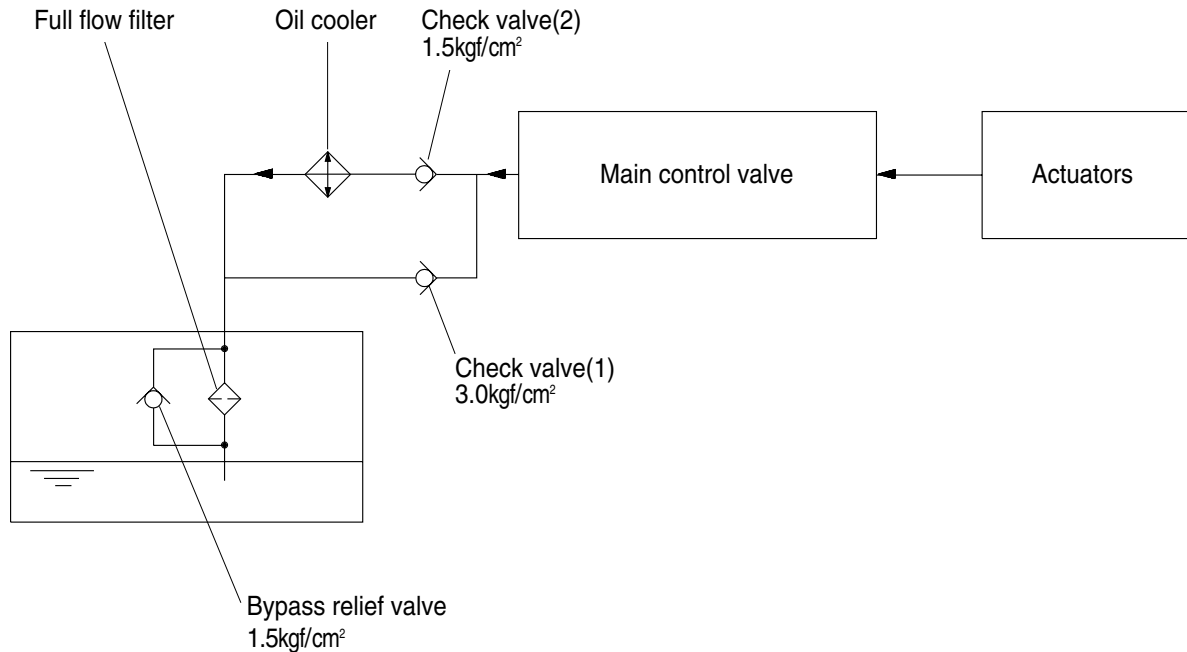
The pumps receive oil from the hydraulic tank through a suction filter. The discharged oil from the pump flows into the control valve and goes out the tank ports.

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

The control valve controls the hydraulic functions.

The return oil from the actuators flows to the hydraulic tank through the control valve and the oil cooler.

## 2. RETURN CIRCUIT



140LC-77]타 3-03

All oil returned from each actuator returns to the hydraulic tank through the control valve.

The bypass check valves are provided in the return circuit.

The setting pressure of bypass check valves are  $1.5\text{kgf/cm}^2$  (21psi) and  $3.0\text{kgf/cm}^2$  (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. When the oil pressure exceeds  $3.0\text{kgf/cm}^2$  (43psi), the oil returns directly to the hydraulic tank, resulting in the oil temperature being raised quickly at an appropriate level.

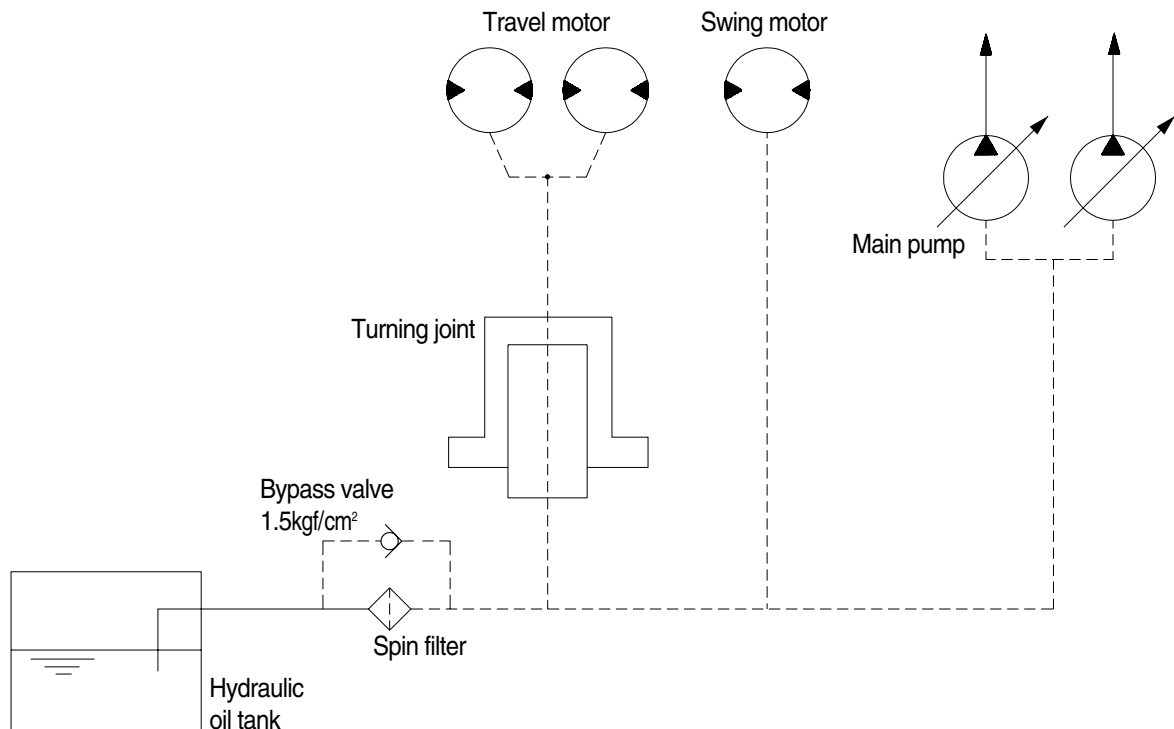
When the oil cooler is clogged, the oil returns directly to the hydraulic tank through bypass check valve(1).

The full-flow filter and bypass relief valve are provided in the hydraulic tank.

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

When the filter element is clogged, the bypass relief valve opens at  $1.5\text{kgf/cm}^2$  (21psi) differential pressure.

### 3. DRAIN CIRCUIT



140LC-77 3-04

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  $1.5\text{kgf/cm}^2$  (21psi), the oil returns to the hydraulic tank directly.

#### 1) TRAVEL MOTOR DRAIN CIRCUIT

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

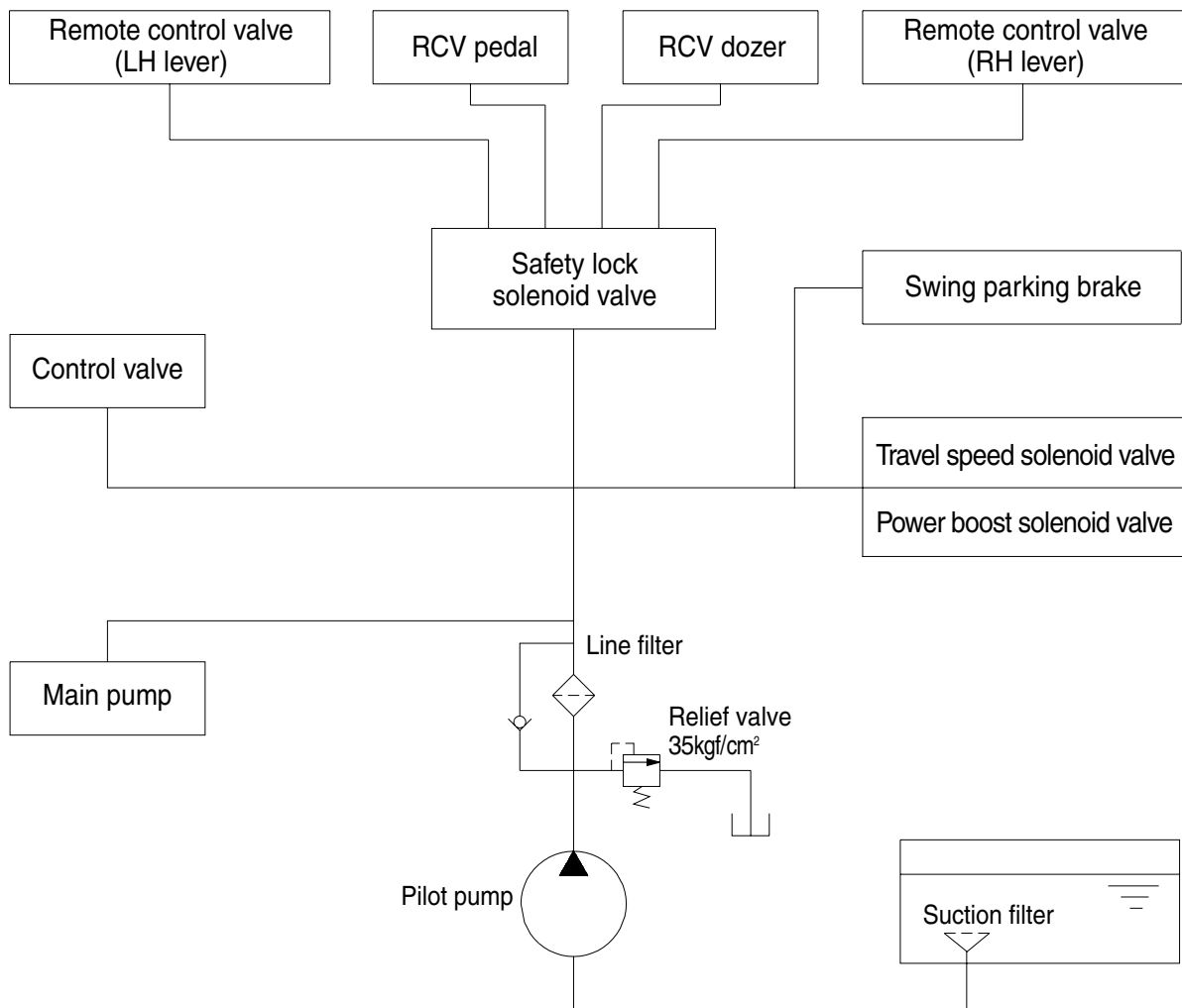
#### 2) SWING MOTOR DRAIN CIRCUIT

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

#### 3) MAIN PUMP DRAIN CIRCUIT

Oil leaked from main pump returns to the hydraulic tank passing through spin filter.

## GROUP 3 PILOT CIRCUIT



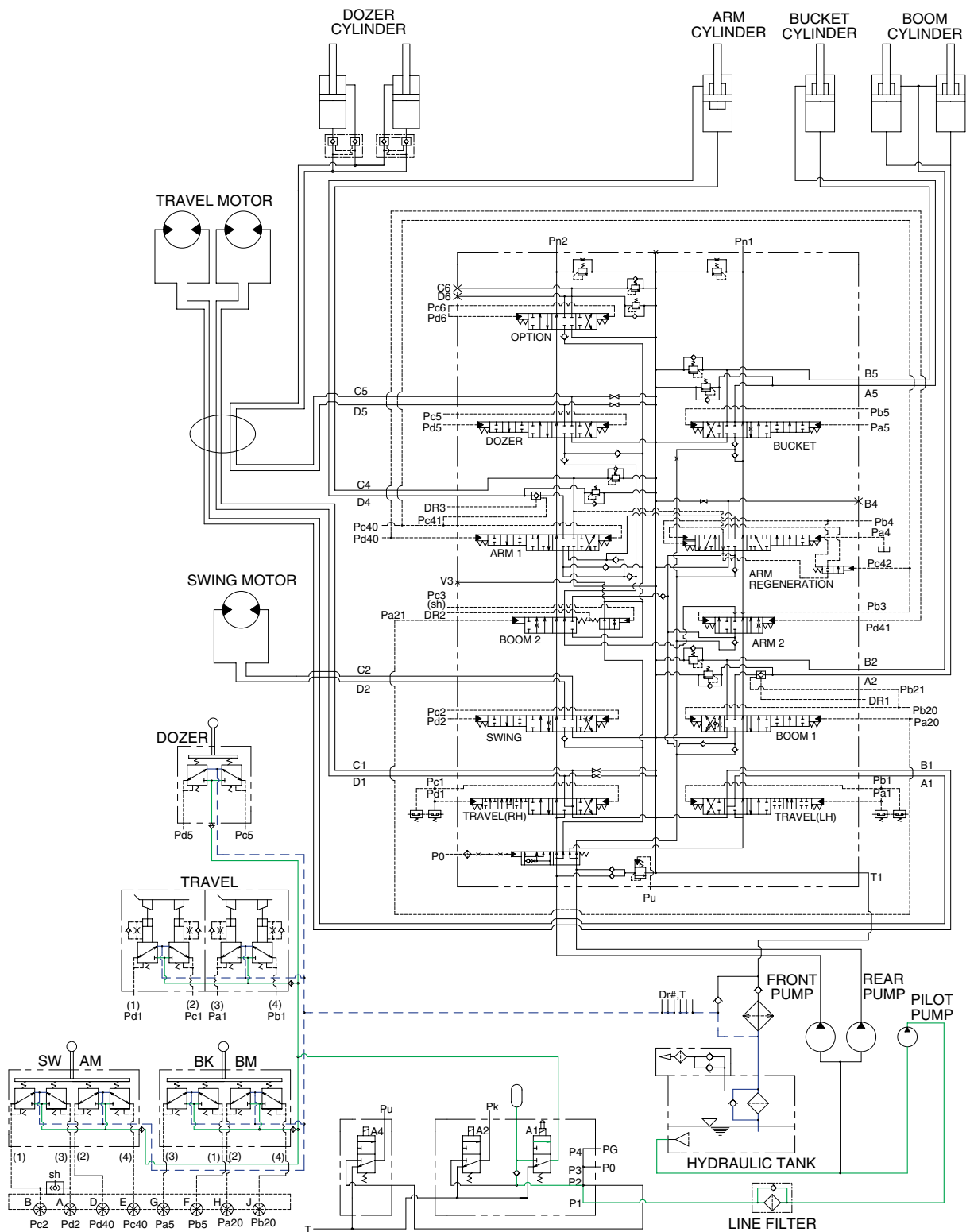
11073HC00

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



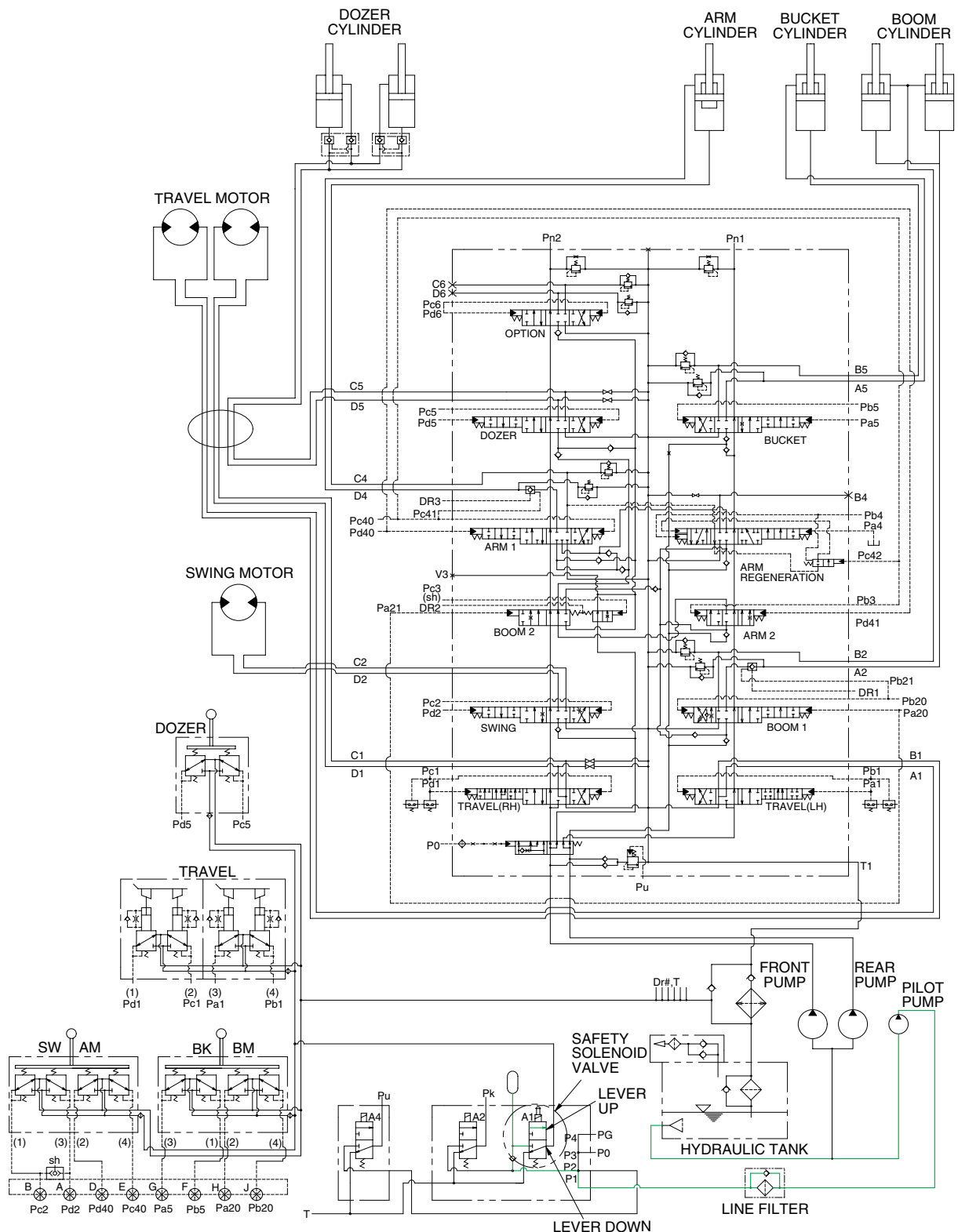
11073HC02

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 flow into the hydraulic tank.

## 2. SAFETY VALVE(SAFETY LEVER)



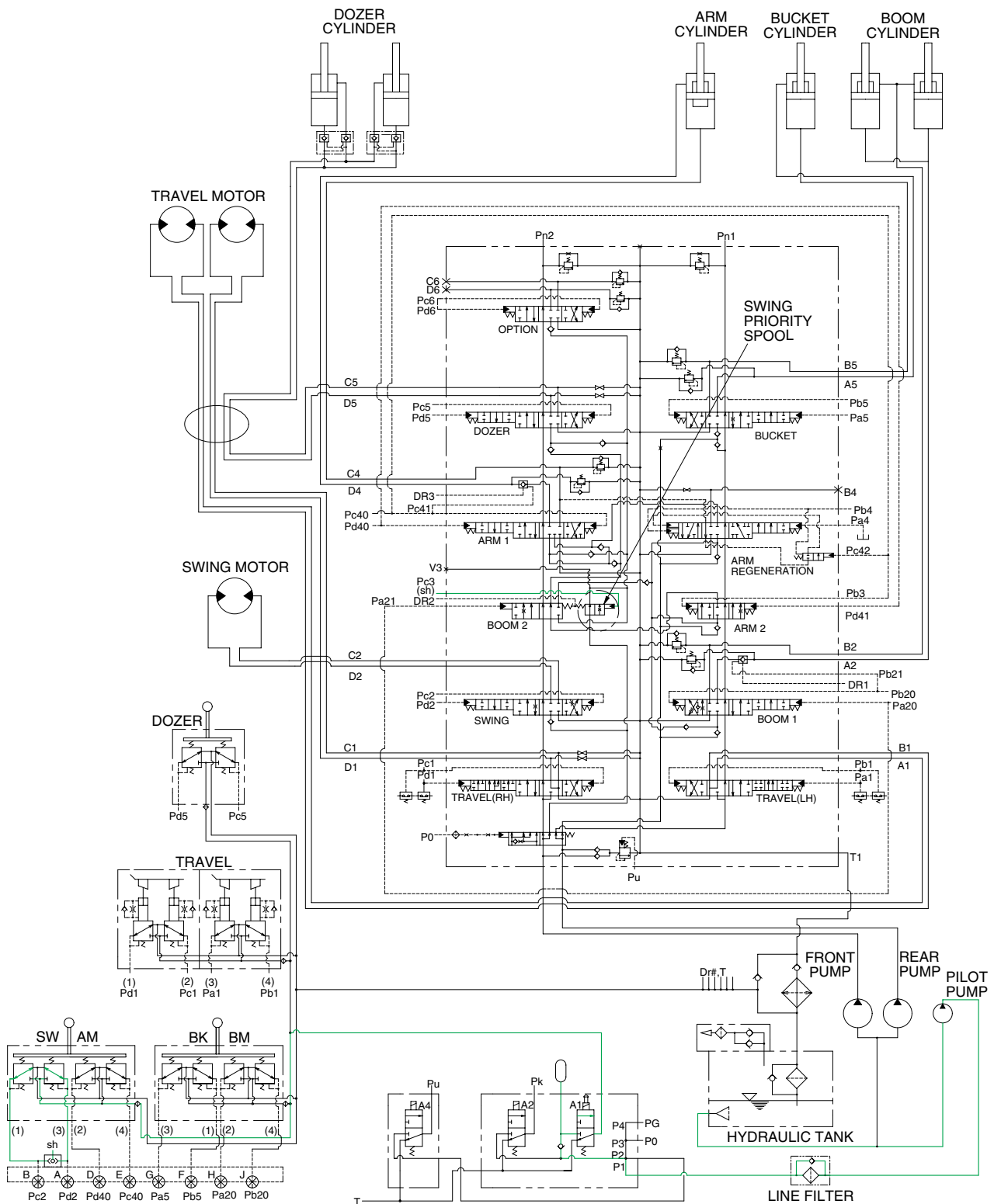
11073HC03

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

When the lever of the safety solenoid valve is moved downward, oil does not flow into the remote control valve, because of the blocked port.



### 3. SWING PRIORITY SYSTEM

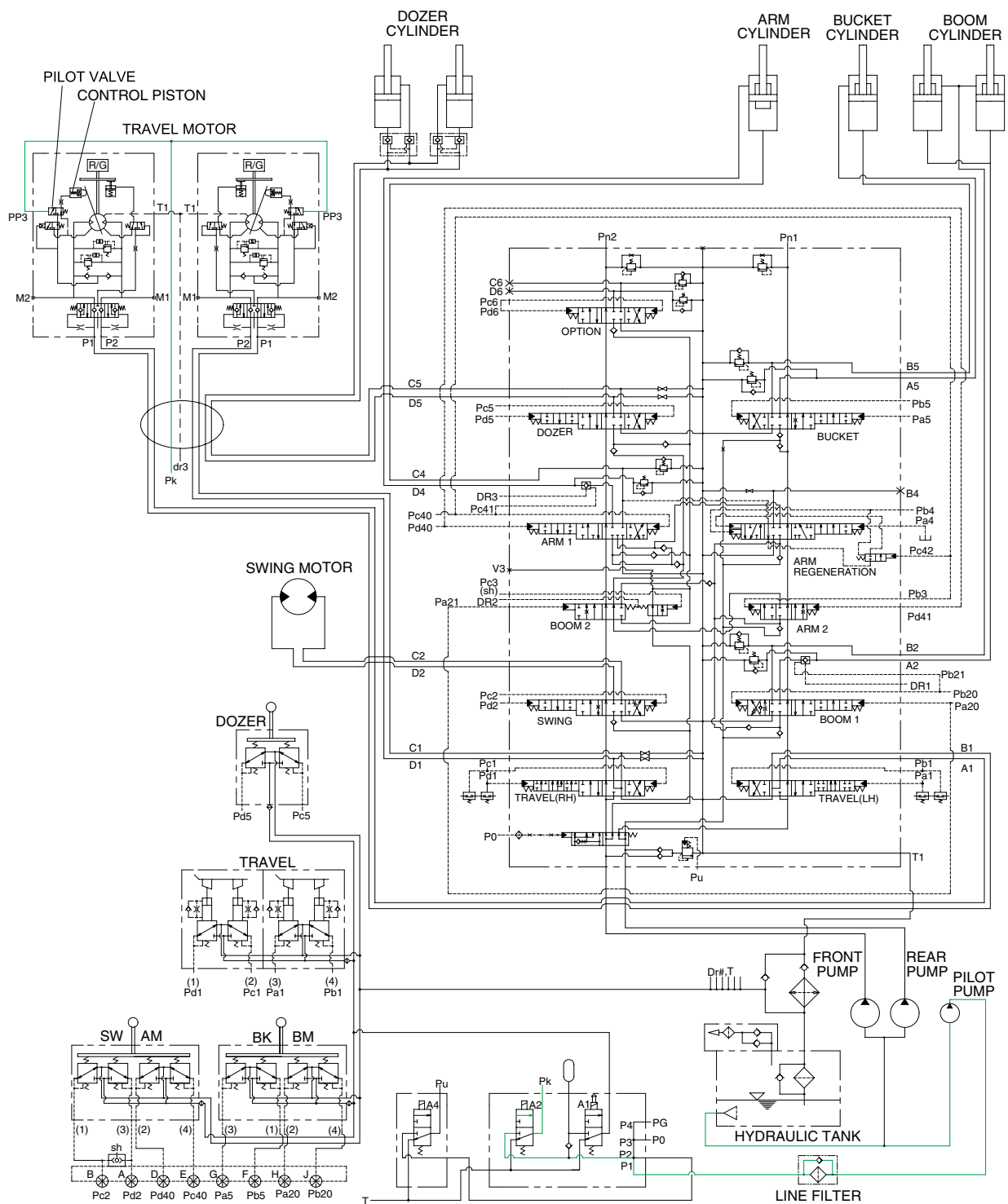


11073HC04

When carrying out the combined operation of swing and boom or arm of the left control valve, the swing speed can be lowered than operating speed of boom or arm. To prevent it, swing priority spool is used. Pc3 pressure from shuttle valve(sh) shifts the swing priority spool to the left and decreases the oil flow rate to the boom or arm section by orifice.

This is called the swing priority system.

## 4. TRAVEL SPEED CONTROL SYSTEM



11073HC05

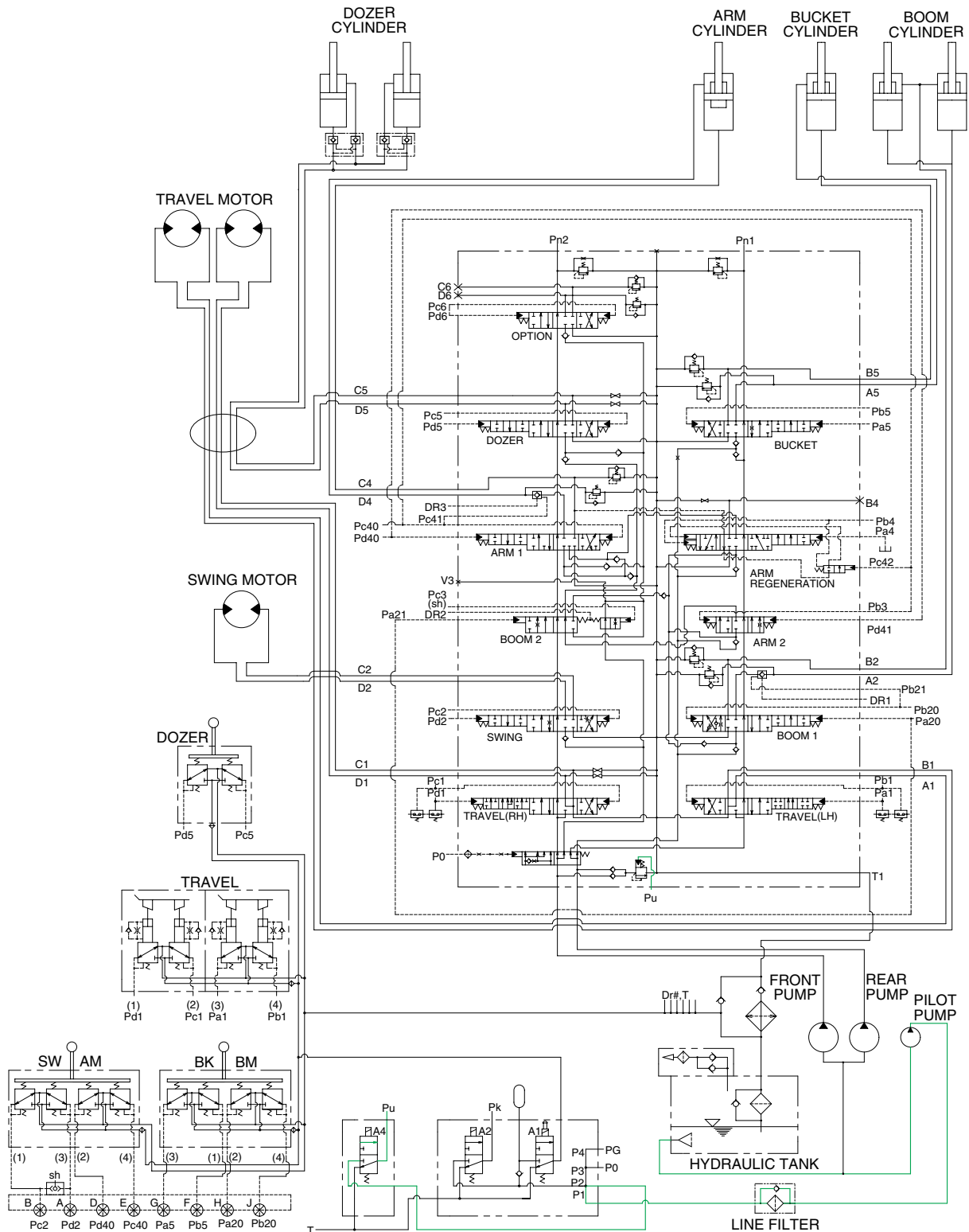
When the travel speed switch is pushed, the travel speed solenoid valve is actuated and the discharged oil from the pilot pump flows to the Pk port of pilot valve in the travel motors.

As a result, the control piston is pushed by the main oil flow, thus the displacement is minimized.

When the travel speed switch is pushed once more, the travel speed solenoid valve is return to original position by the force of spring, the hydraulic oil of Pk port returns to the hydraulic tank.

As a result, the control piston is returned by the main oil flow, thus the displacement is maximized.

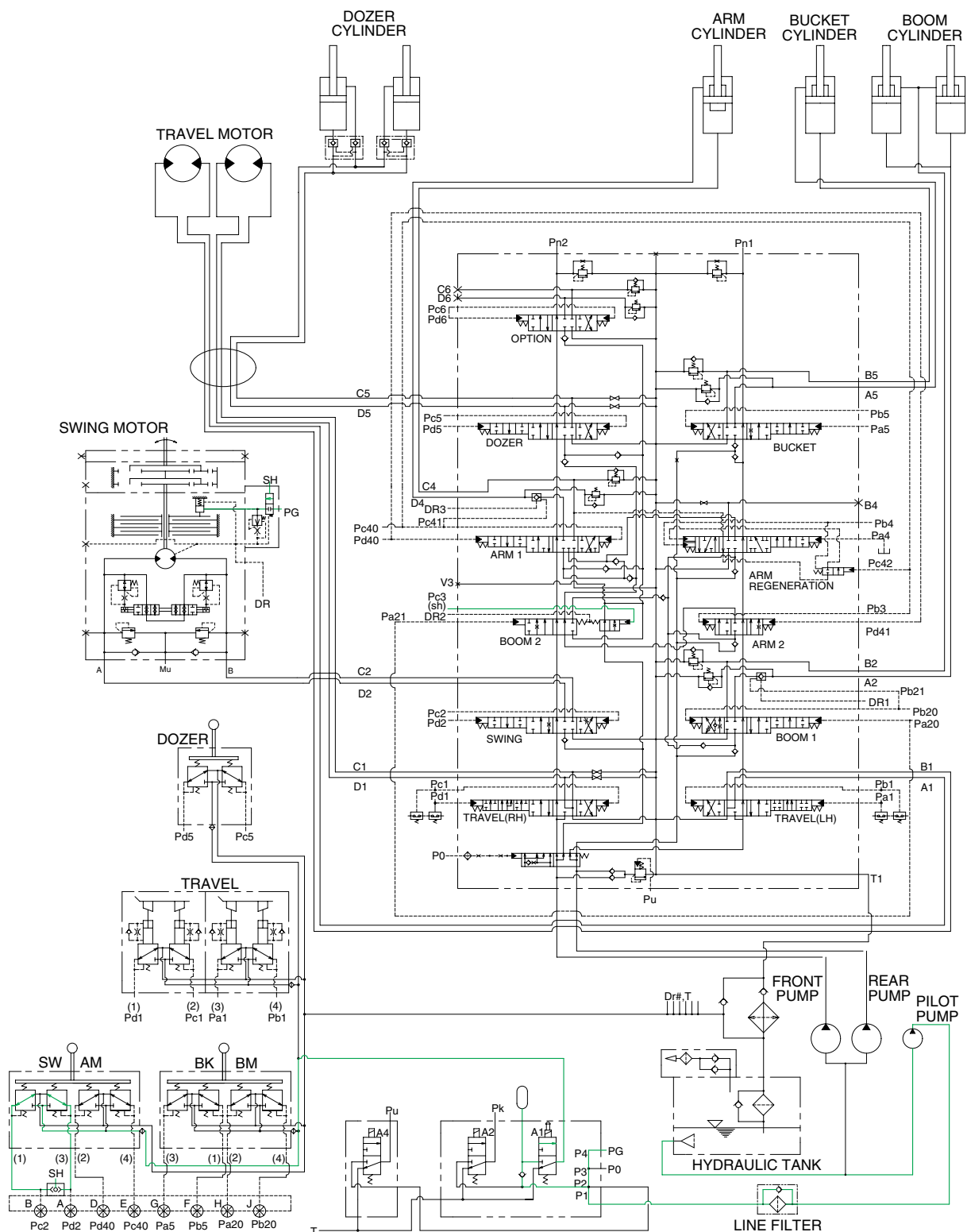
## 5. MAIN RELIEF PRESSURE CHANGE SYSTEM



11073HC06

When the power boost switch on the left control lever is pushed ON, the power boost solenoid valve is actuated, the discharged oil from the pilot pump flows into Pu port of the main relief valve of main control valve; then the setting pressure of the main relief valve is raised from 330kgf/cm<sup>2</sup> to 360kgf/cm<sup>2</sup> for increasing the digging power. And even when pressed continuously, it is canceled after 8 seconds.

## 6. SWING PARKING BRAKE RELEASE



11073HC07

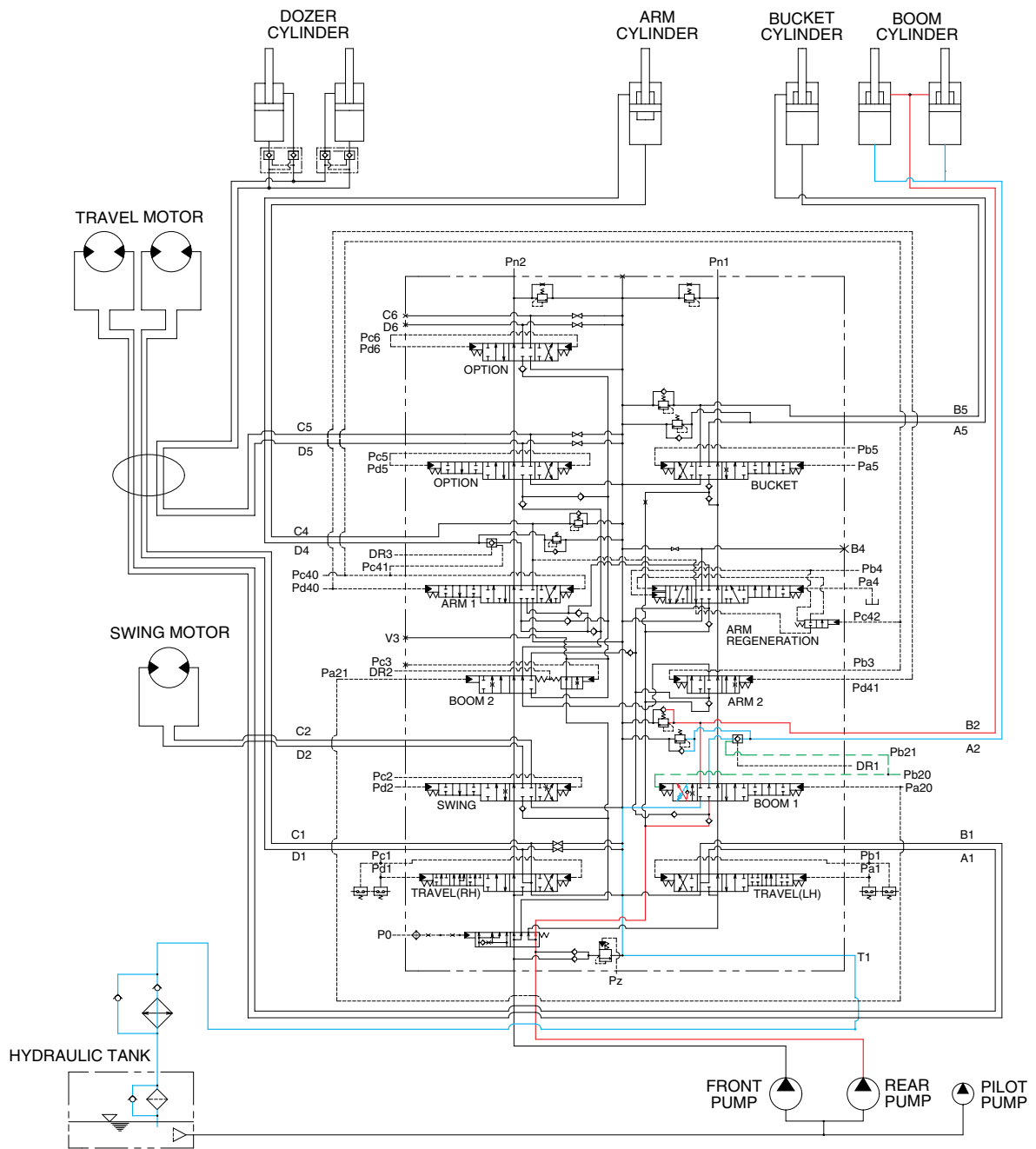
When the swing control lever is tilted, the pilot oil flow into SH port of shuttle valve, this pressure move spool so, discharged oil from pilot valve flow into PG port.

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

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



## 2. BOOM DOWN OPERATION



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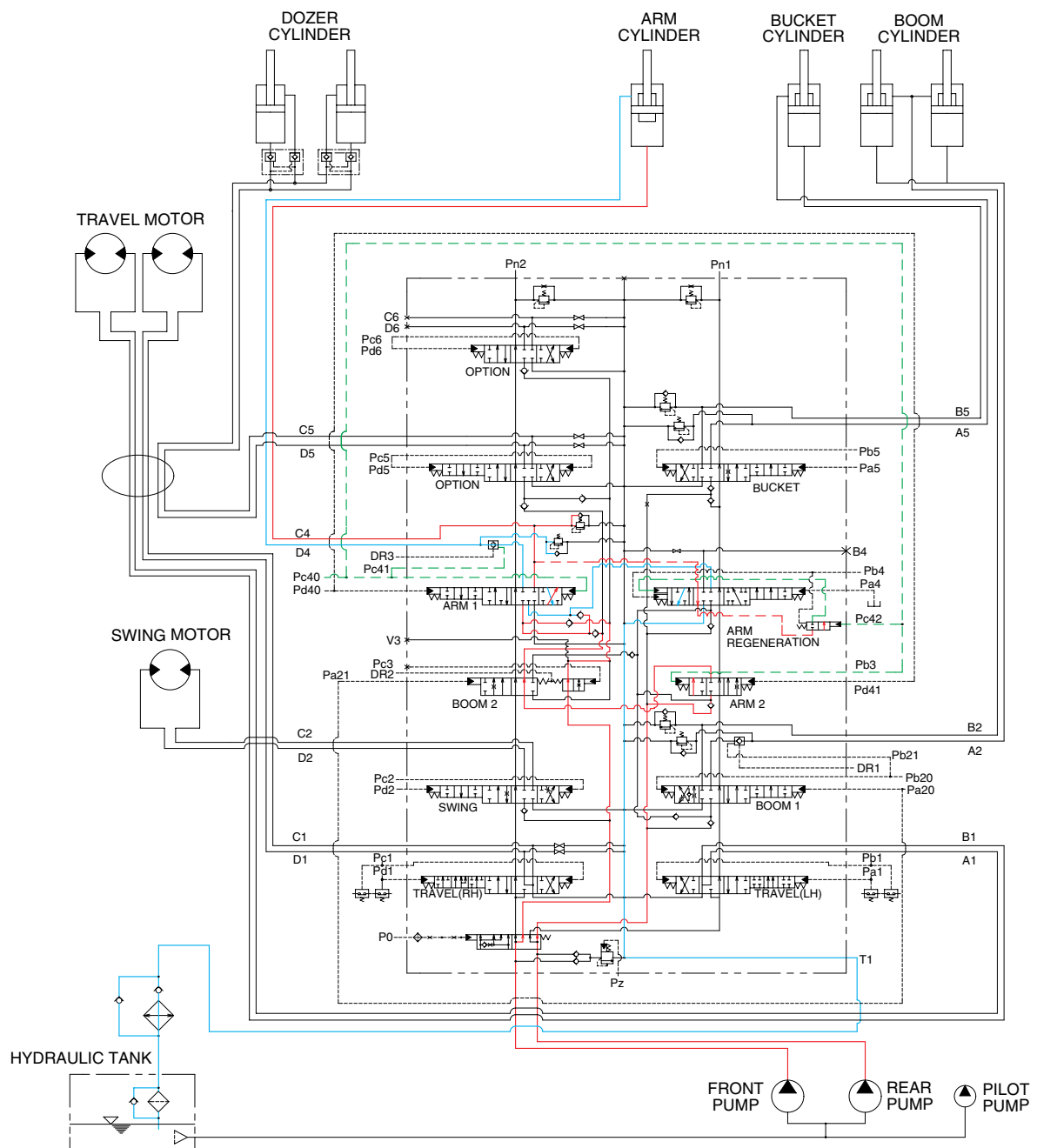
When the right control lever is pushed forward, the boom spools in the main control valve are moved to the down position by the pilot oil pressure from the remote control valve.

The oil from the front pump flows into the main control valve and then goes to the small chamber of boom cylinders. At the same time, the oil from the large chamber of boom cylinders returns to the hydraulic tank through the boom spool in the main control valve.

When the down speed of boom is faster, the oil returned from the large chamber of boom cylinder combines with the oil from the front pump, and flows into the small chamber of the cylinder.

This prevents cylinder cavitation by the negative pressure when the front pump flow can not match the boom down speed. And the excessive pressure in the boom cylinder rod end circuit is prevented by the relief valve.

### 3. ARM ROLL IN OPERATION



11073HC12

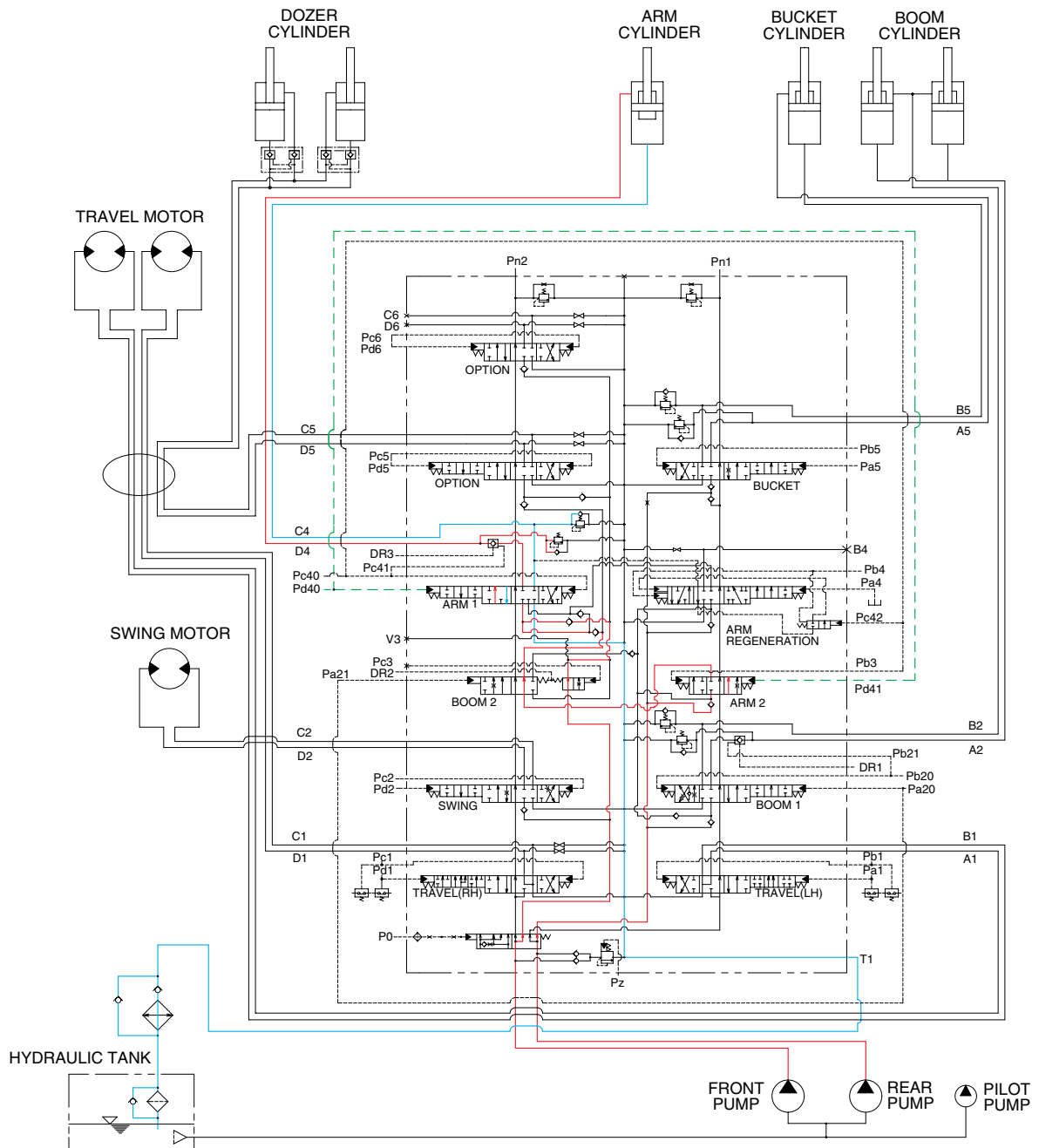
When the left control lever is pulled back, the arm spools in the main control valve are moved to the roll in position by the pilot oil pressure from the remote control valve.

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

At the same time, the oil from small chamber of arm cylinder returns to the hydraulic oil tank through the arm spool in the main control valve. When this happens, the arm rolls in.

The cavitation which will happen to the bottom of the arm cylinder is also prevented by the make-up valve in the main control valve.

## 4. ARM ROLL OUT OPERATION



11073HC13

When the left control lever is pushed forward, the arm spool in the main control valve are moved to the roll out position by the pilot oil pressure from the remote control valve.

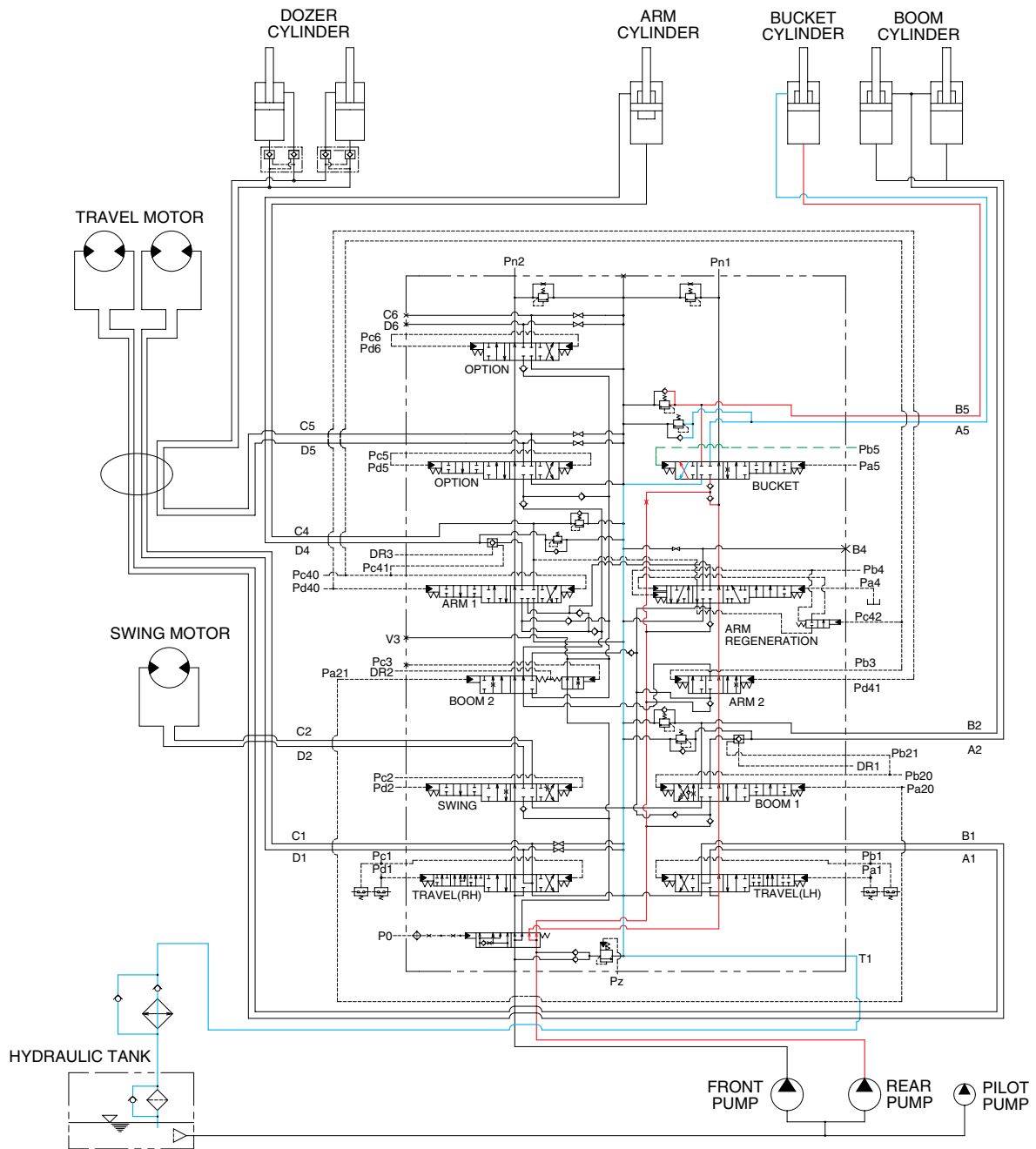
The oil from the front and rear pump flows into the main control valve and then goes to the small chamber of arm cylinder.

At the same time, the oil from the large chamber of arm cylinder returns to the hydraulic oil tank through the arm spool in the main control valve. When this happens, the arm rolls out.

The cavitation which will happen to the rod of the arm cylinder is also prevented by the make-up valve in the main control valve.



## 5. BUCKET ROLL IN OPERATION



11073HC14

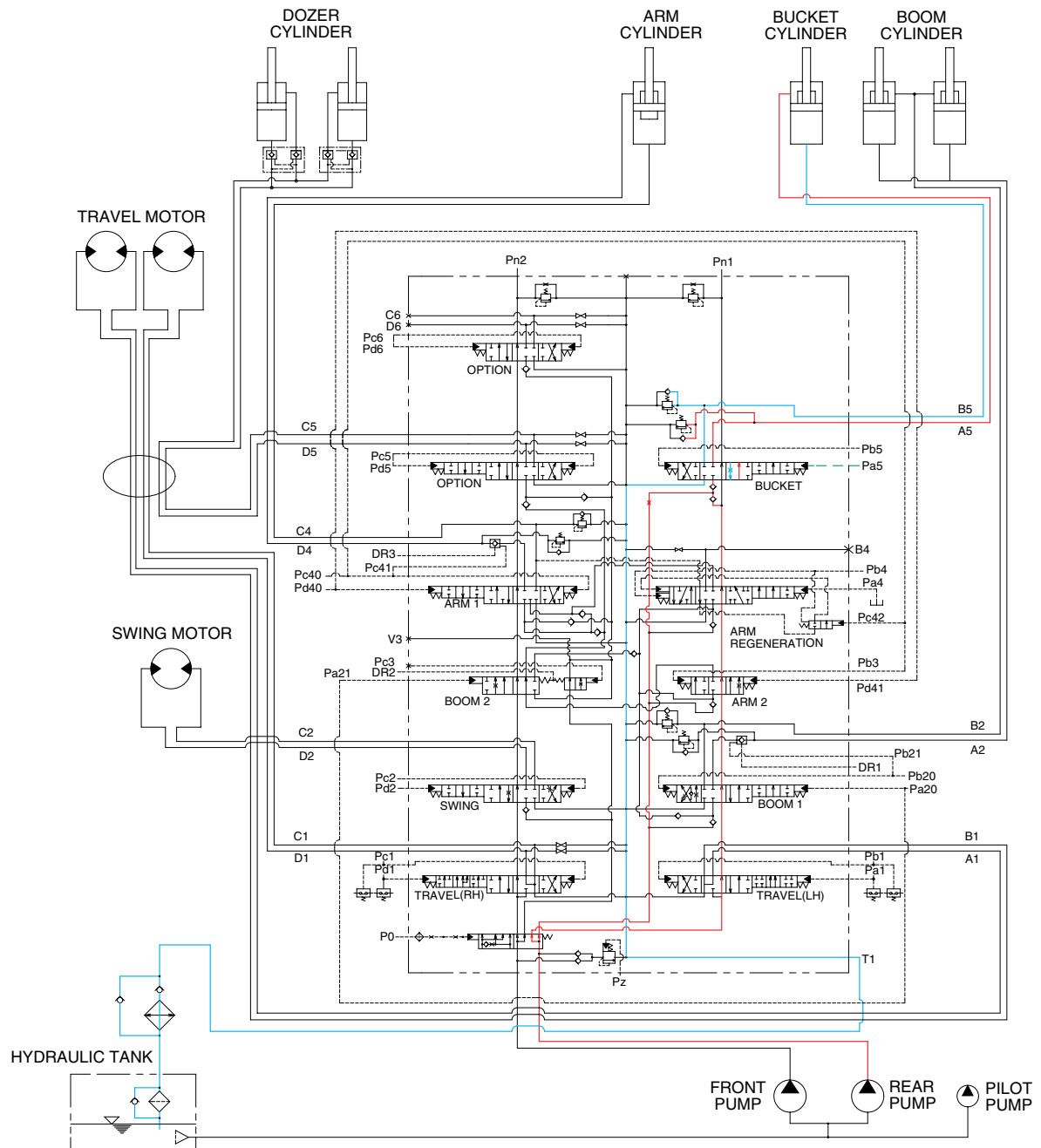
When the right control lever is pulled left, the bucket spool in the main control valve is moved to the roll in position by the pilot oil pressure from the remote control valve.

The oil from the front pump flows into the main control valve and then goes to the large chamber of bucket cylinder.

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

The cavitation which will happen to the bottom of the bucket cylinder is also prevented by the make-up valve in the main control valve.

## 6. BUCKET ROLL OUT OPERATION



11073HC15

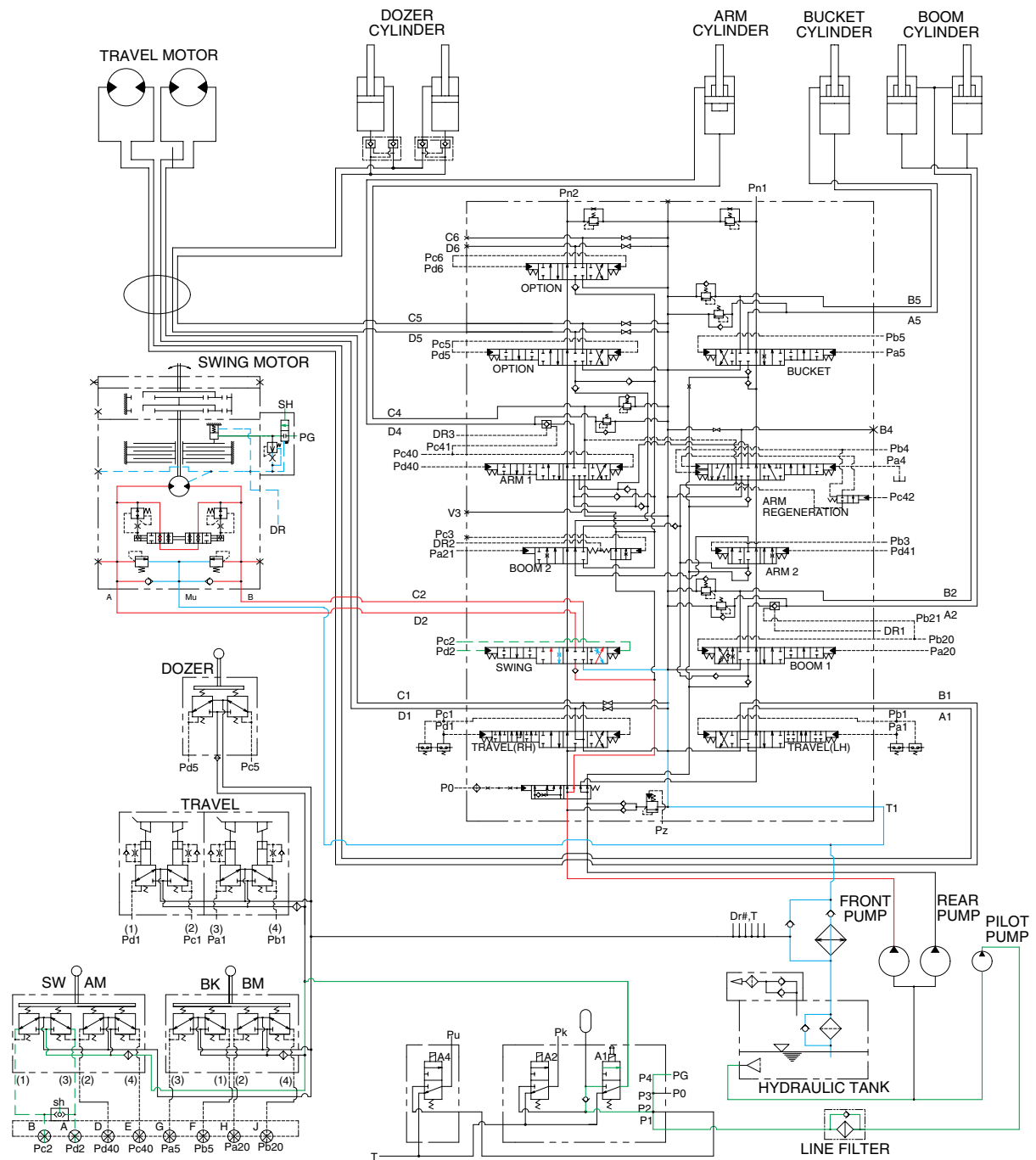
When the right control lever is pushed right, the bucket spool in the main control valve is moved to the roll out position by the pilot oil pressure from the remote control valve.

The oil from the front pump flows into the main control valve and then goes to the small chamber of bucket cylinder.

At the same time, the oil from the large chamber of bucket cylinder returns to the hydraulic oil tank through the bucket spool in the main control valve. When this happens, the bucket rolls out.

The cavitation which will happen to the rod of the bucket cylinder is also prevented by the make-up valve in the main control valve.

## 7. SWING OPERATION



11073HC16

When the left control lever is pushed left or right, the swing spool in the main control valve is moved to the left or right swing position by the pilot oil pressure from the remote control valve.

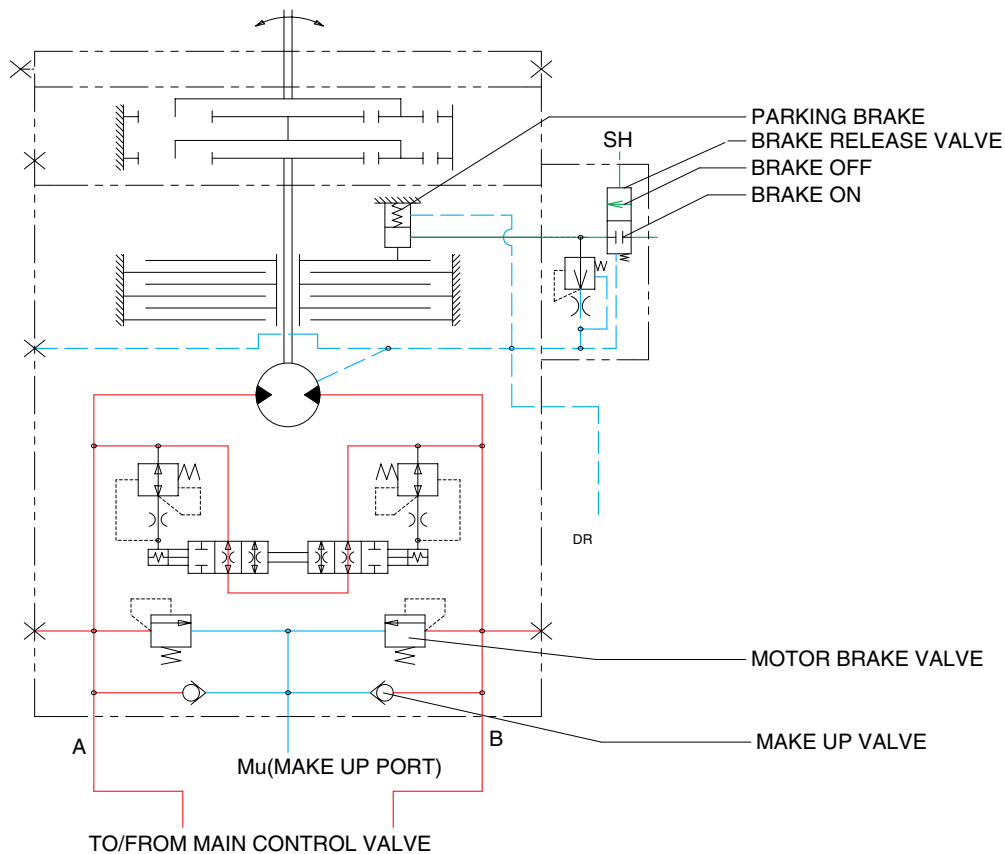
The oil from the rear pump flows into the main control valve and then goes to the swing motor.

At the same time, the return oil from the swing motor returns to the hydraulic oil tank through the swing spool in the main control valve.

When this happens, the superstructure swings to the left or right.

The swing parking brake, make up valve and the overload relief valve are provided in the swing motors. The cavitation which will happen to the swing motor is also prevented by the make up valve in the swing motor itself.

## SWING CIRCUIT OPERATION



11073HC30

### 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

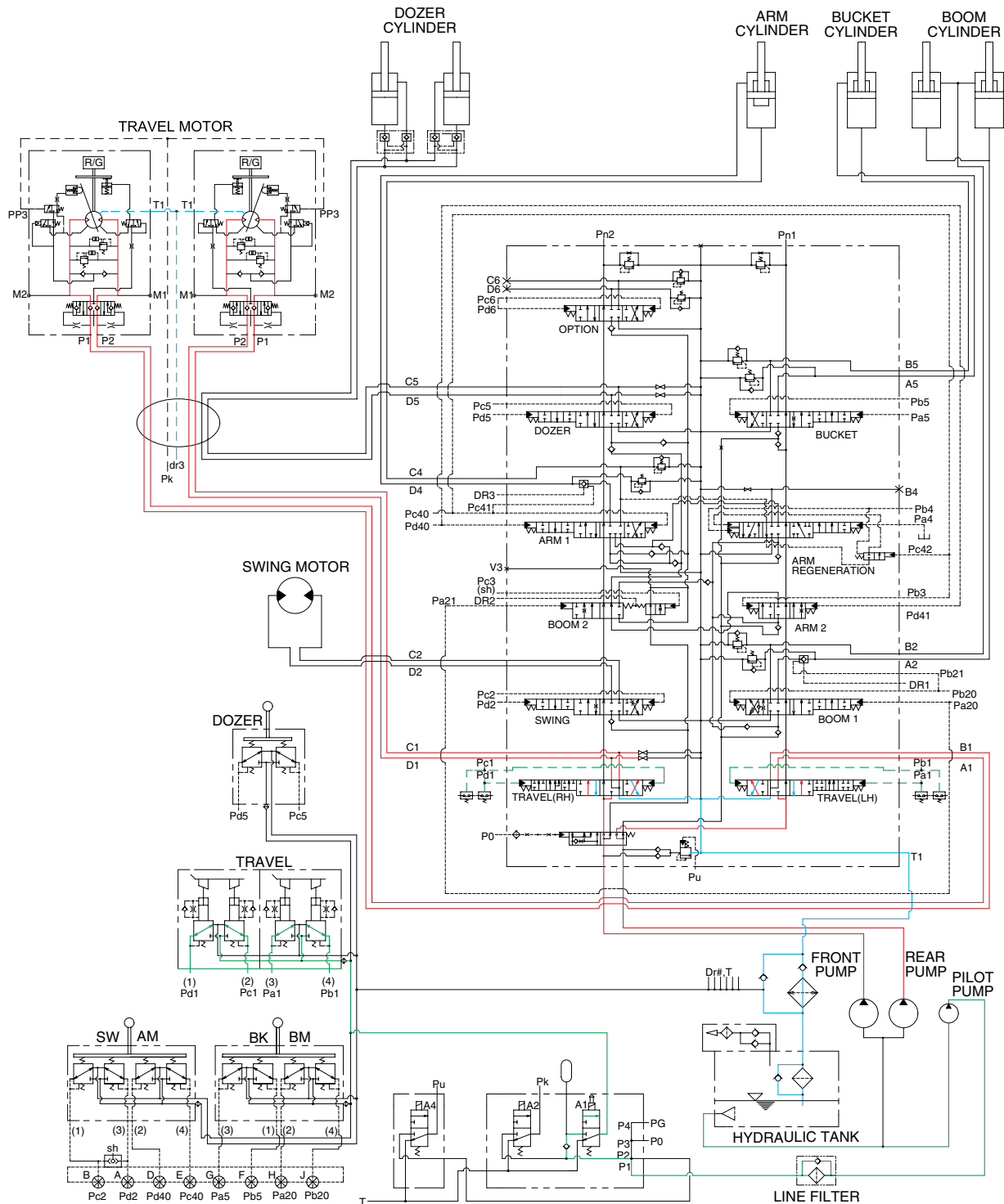
When the control lever placed in the neutral position, the pressure of the pilot oil passage down.

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



11073HC17

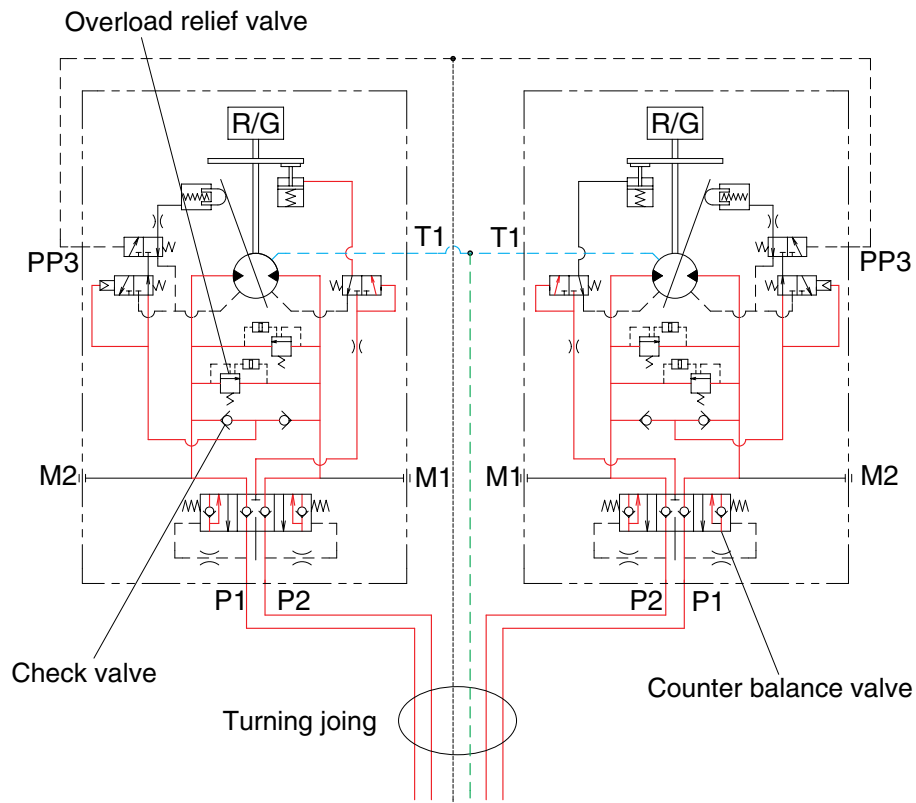
When the travel levers are pushed forward or reverse position, the travel spools in the main control valve are moved to the forward or reverse travel position by the pilot oil pressure from the remote control valve.

The oil from the both pumps flows into the main control valve and then goes to the both travel motors through the turning joint.

The return oil from both travel motors returns to the hydraulic oil tank through the turning joint and the travel spools in the main control valve.

When this happens, the machine moves to the forward or reverse.

## TRAVEL CIRCUIT OPERATION



11073HC17A

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

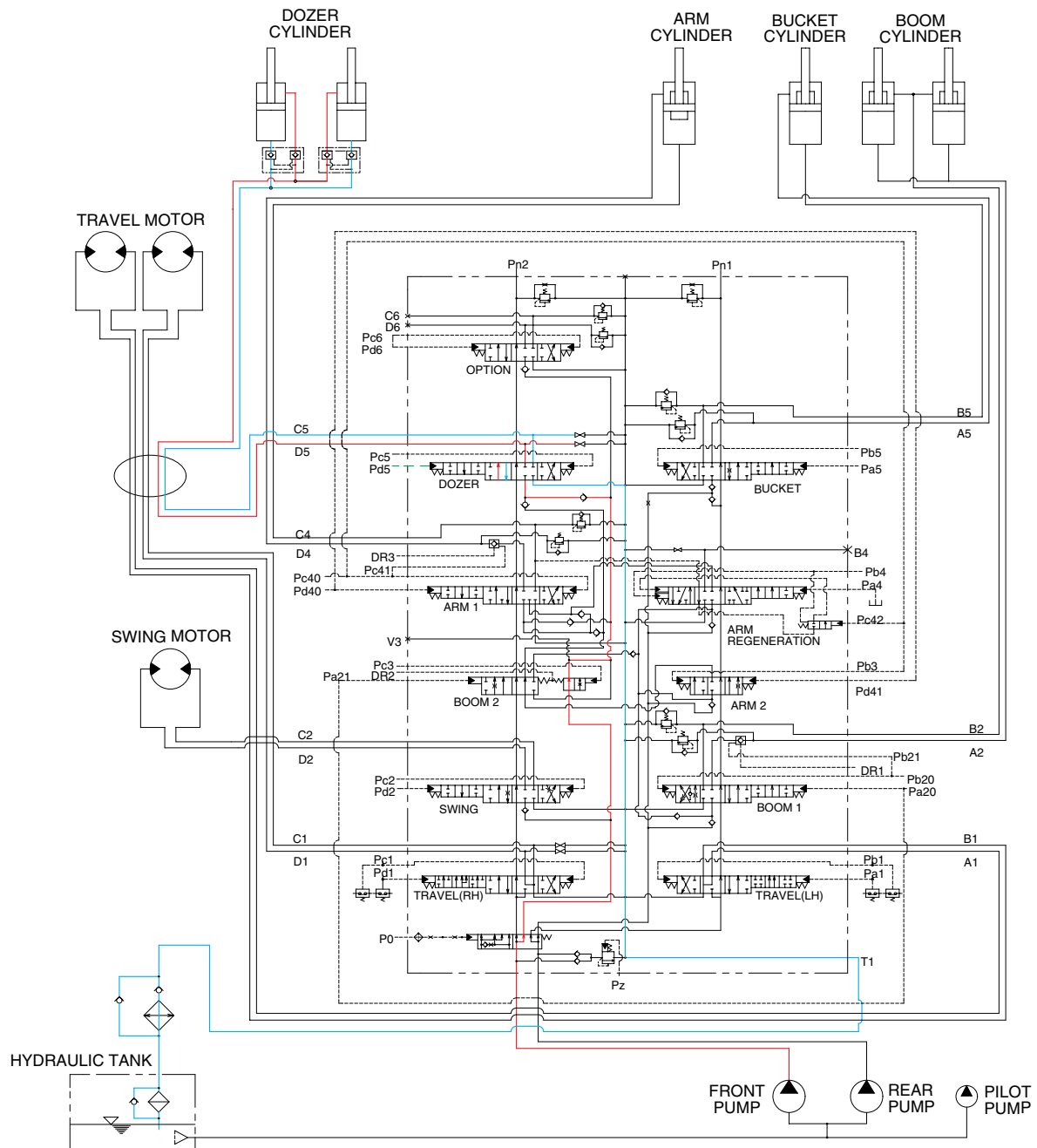
### 1) COUNTER BALANCE VALVE

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  $365\text{kgf/cm}^2$  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.

## 9. DOZER UP OPERATION



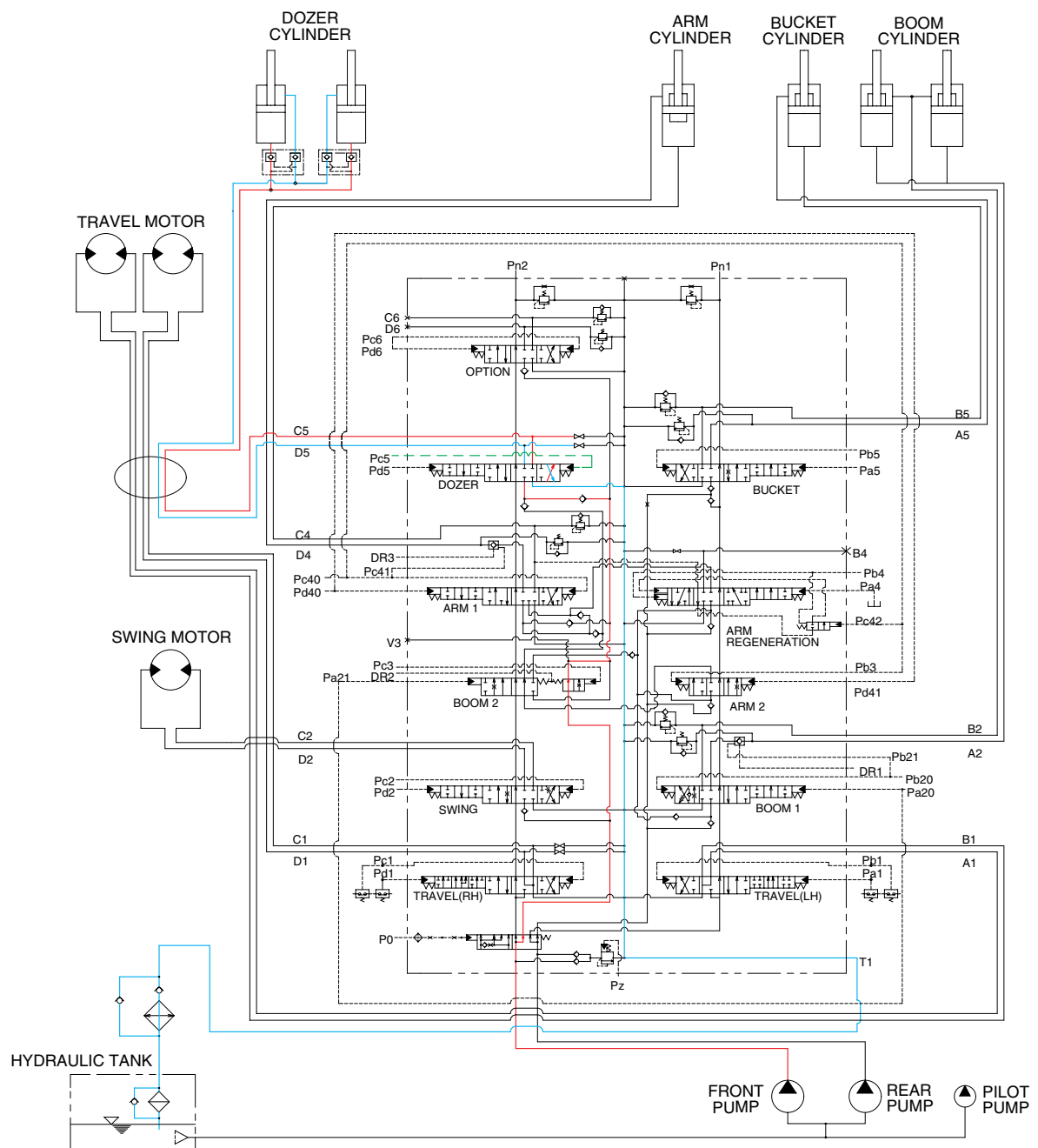
11073HC18

When the dozer control lever is pulled back, the dozer spool in the main control valve is moved to the dozer up position by the pilot oil pressure from the remote control valve.

The oil from the rear pump flows into the main control valve and then goes to the small chamber of dozer cylinders.

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

## 10. DOZER DOWN OPERATION



11073HC19

When the dozer control lever is pushed forward, the dozer spool in the main control valve is moved to the dozer down position by the pilot oil pressure from the remote control valve.

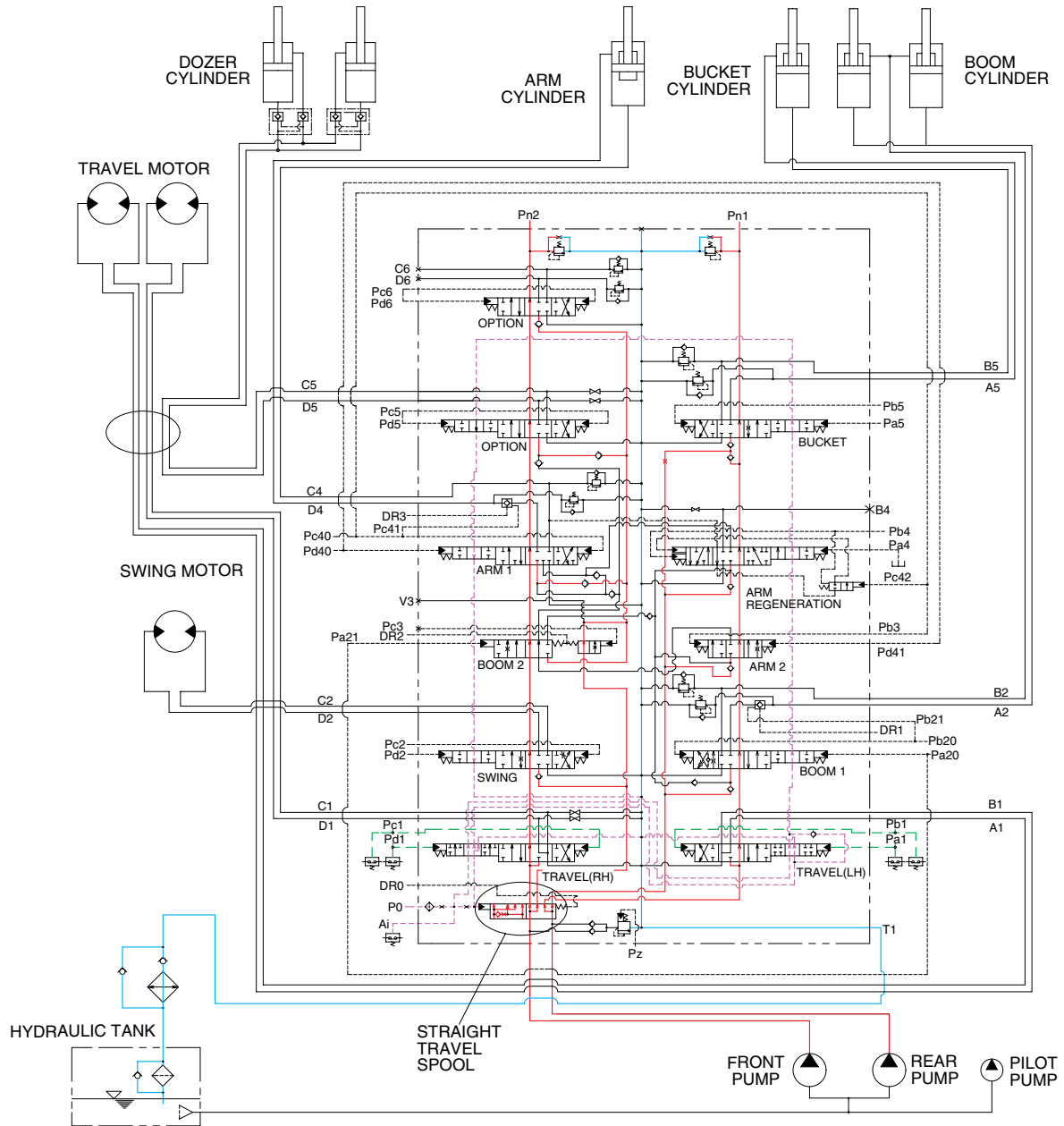
The oil from the rear pump flows into the main control valve and then goes to the large chamber of dozer cylinders.

At the same time, the oil from the small chamber of dozer cylinders returns to the hydraulic oil tank through the dozer spool in the main control valve. When this happens, the dozer blade is down.



## GROUP 5 COMBINED OPERATION

### 1. OUTLINE



11073HC20

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.

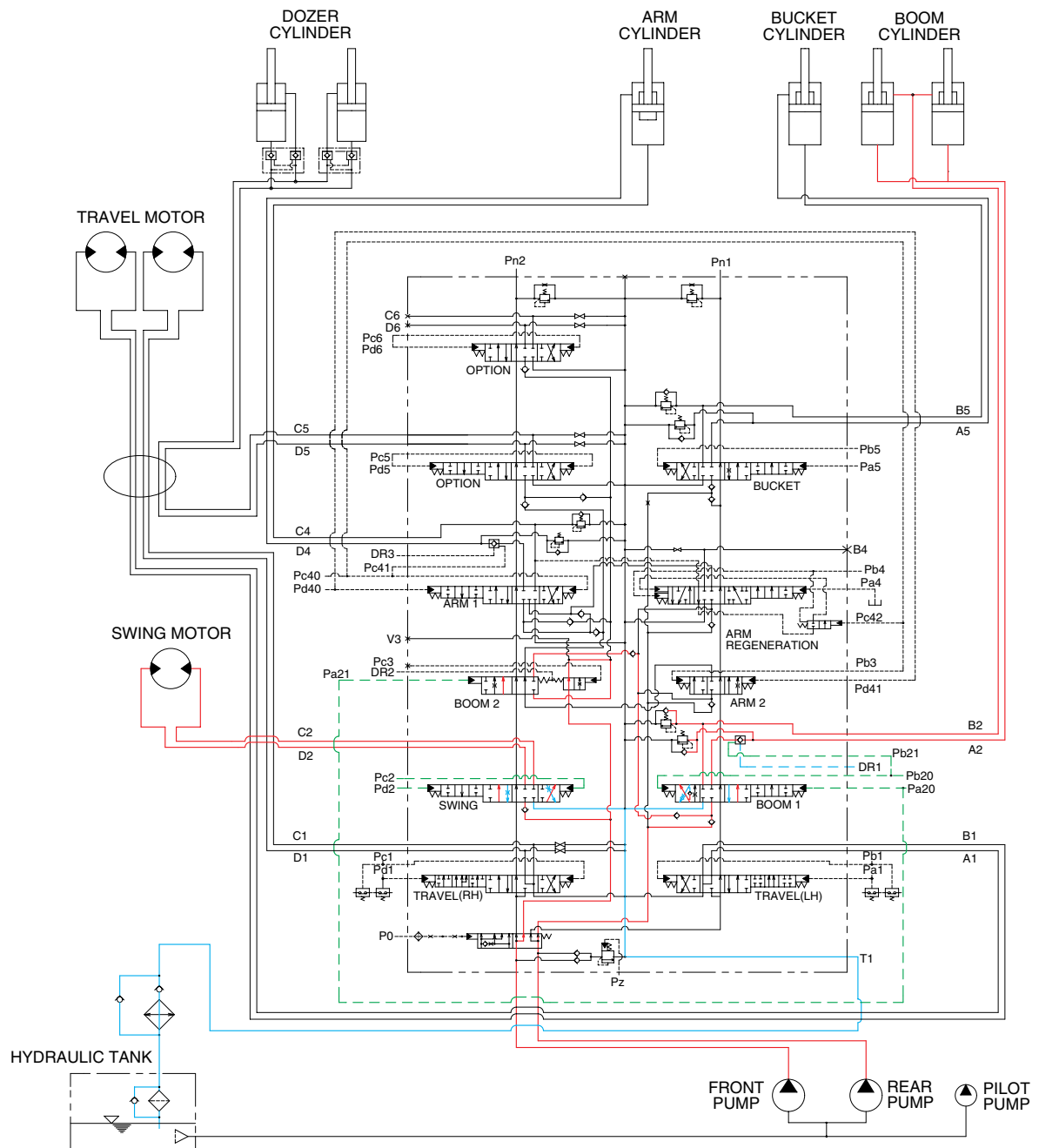
#### STRAIGHT TRAVEL SPOOL

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

If any actuator is operated when traveling, the straight travel spool is pushed to the left by the pilot oil pressure.

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



11073HC21

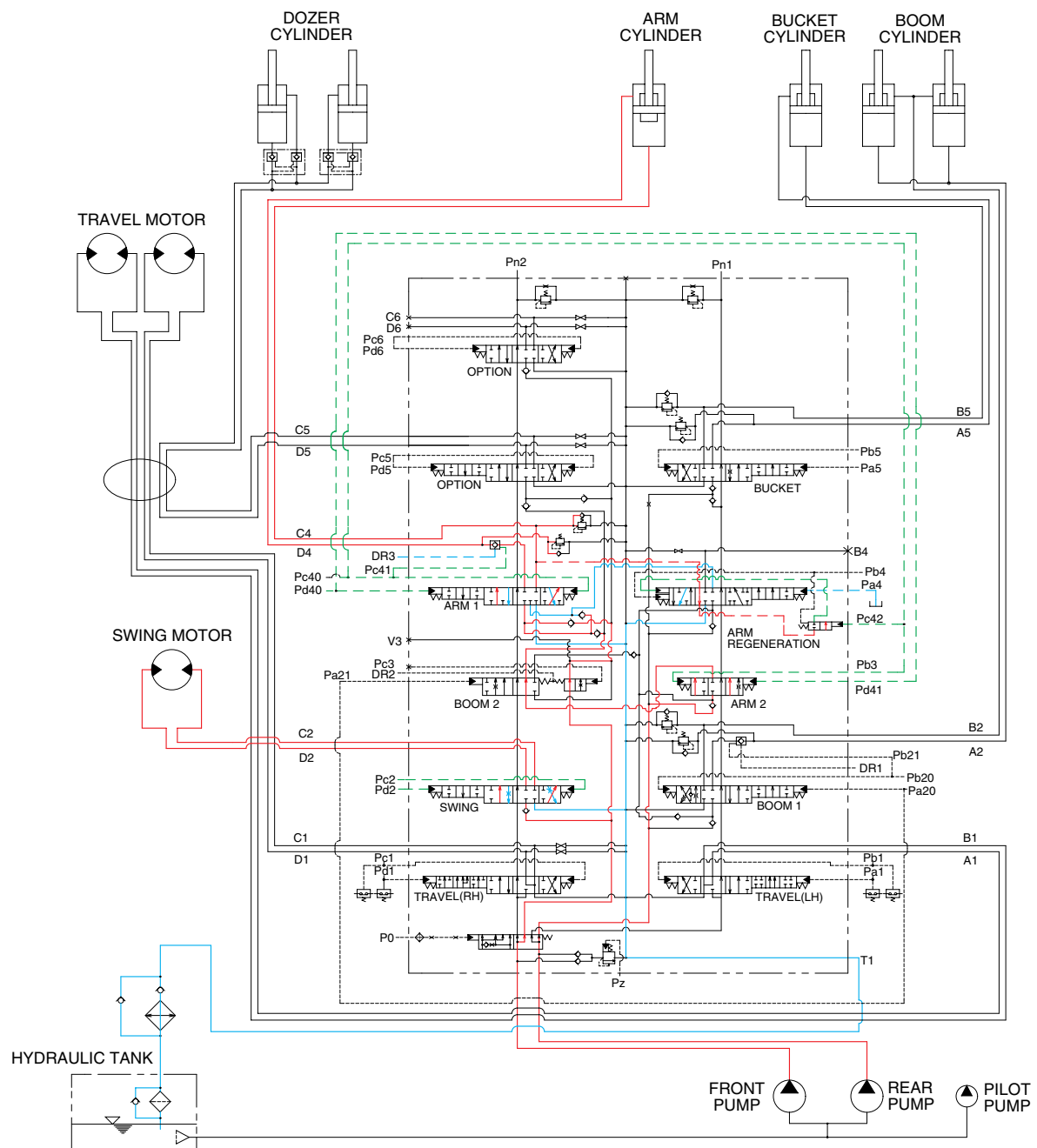
When the swing and boom functions are operated, simultaneously the swing spool and boom spools in the main control valve are moved to the functional position by the pilot oil pressure from the remote control valve.

The oil from the rear pump flows into the swing motor through swing spool and the boom cylinder through boom 2 spool.

The oil from the front pump flows into the boom cylinders through the boom 1 spool.

The superstructure swings and the boom is operated.

### 3. COMBINED SWING AND ARM OPERATION



11073HC22

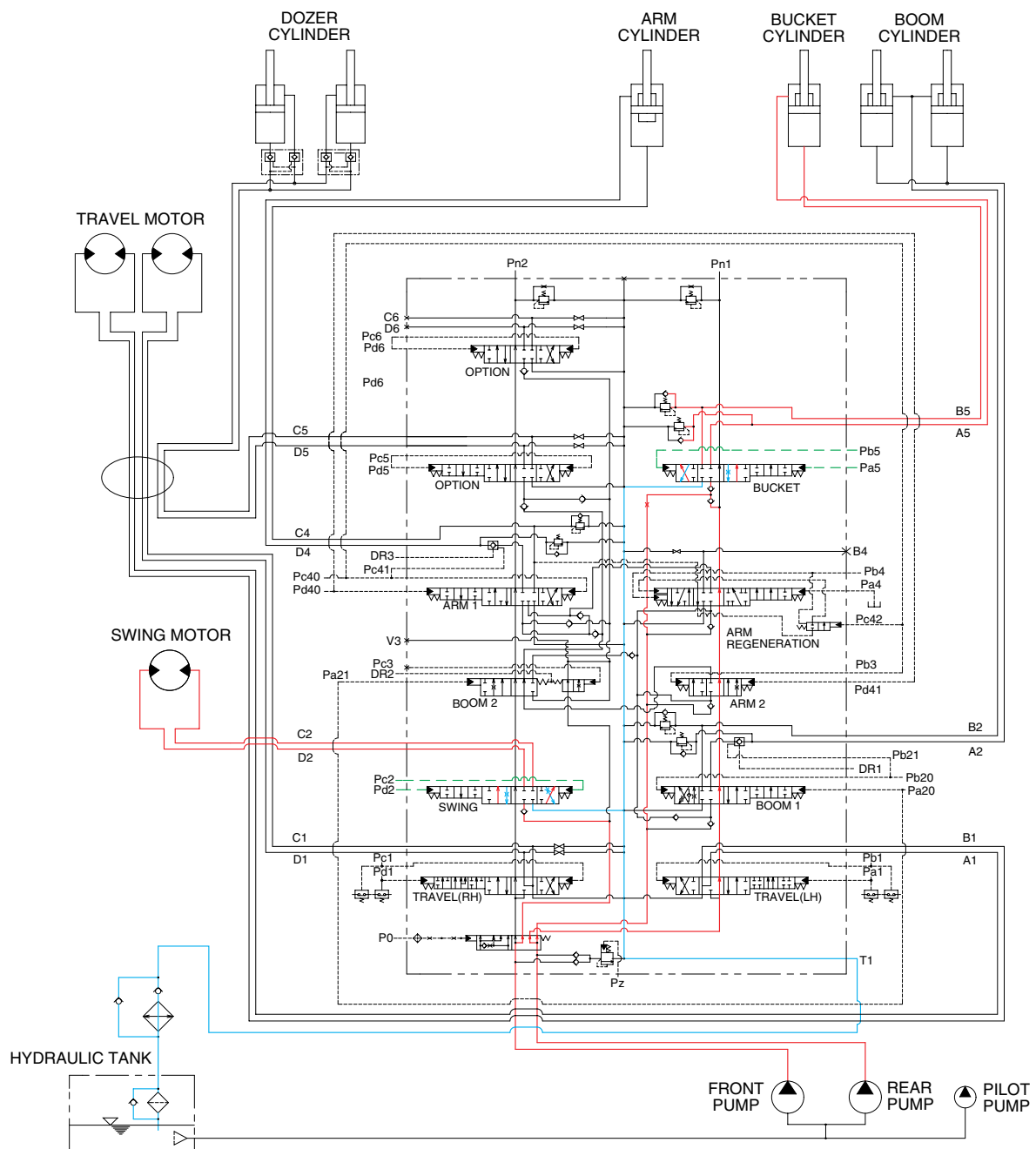
When the swing and arm functions are operated, simultaneously the swing spool and arm spools in the main control valve are moved to the functional position by the pilot oil pressure from the remote control valve.

The oil from the rear pump flows into the swing motor through swing spool and the arm cylinder through arm 1 spool.

The oil from the front pump flows into the arm cylinder through the arm 2 spool.

The superstructure swings and the arm is operated.

#### 4. COMBINED SWING AND BUCKET OPERATION



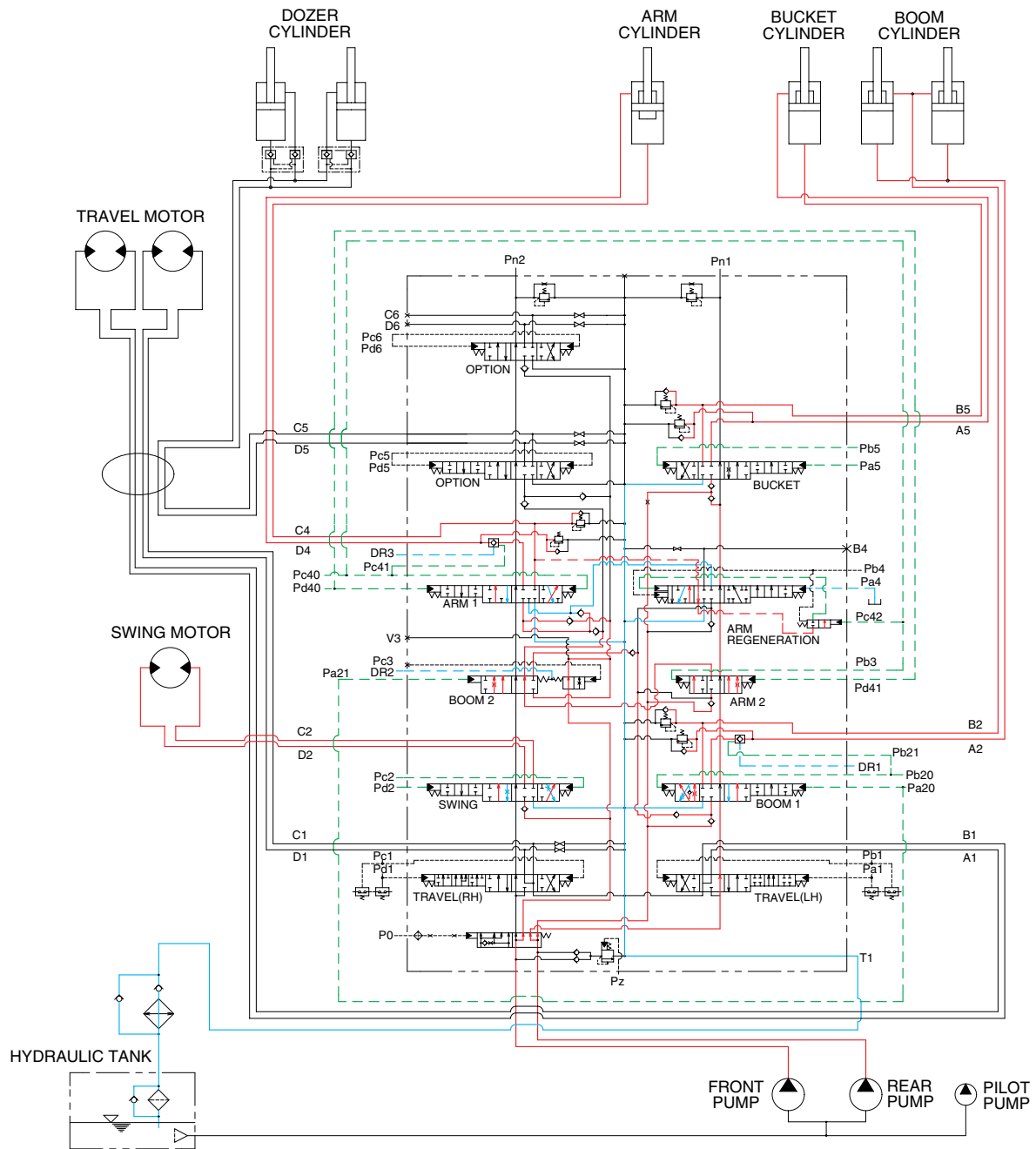
11073HC23

When the swing and bucket functions are operated, simultaneously the swing spool and bucket spool in the main control valve are moved to the functional position by the pilot oil pressure from the remote control valve.

The oil from the rear pump flows into the swing motor through the swing spool.

The oil from the front pump flows into the bucket cylinder through the bucket spool.

## 5. COMBINED SWING, BOOM, ARM AND BUCKET OPERATION



11073HC24

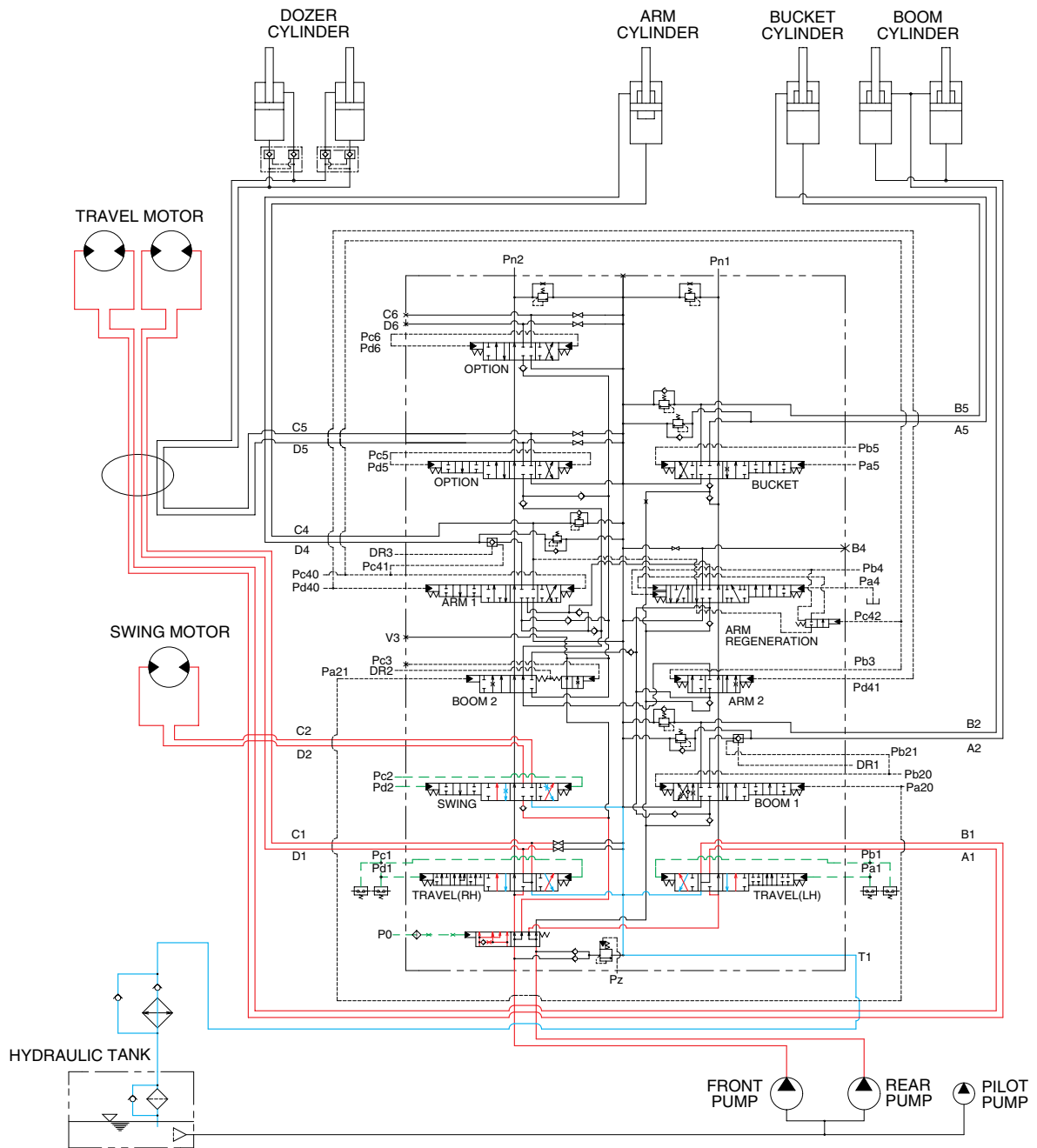
When the swing, boom, arm and bucket functions are operated, simultaneously each spool in the main control valve is moved to the functional position by the pilot oil pressure from the remote control valve.

The oil from the rear pump flows into the swing motor, boom cylinders and arm cylinder through the swing spool, boom 2 spool, arm 1 spool, and the parallel and confluence oil passage.

The oil from the front pump flows into the boom cylinders, arm cylinder and bucket cylinder through the boom 1 spool, arm 2 spool, bucket spool and the parallel and confluence oil passage.

The superstructure swings and the boom, arm and bucket are operated.

## 6. COMBINED SWING AND TRAVEL OPERATION

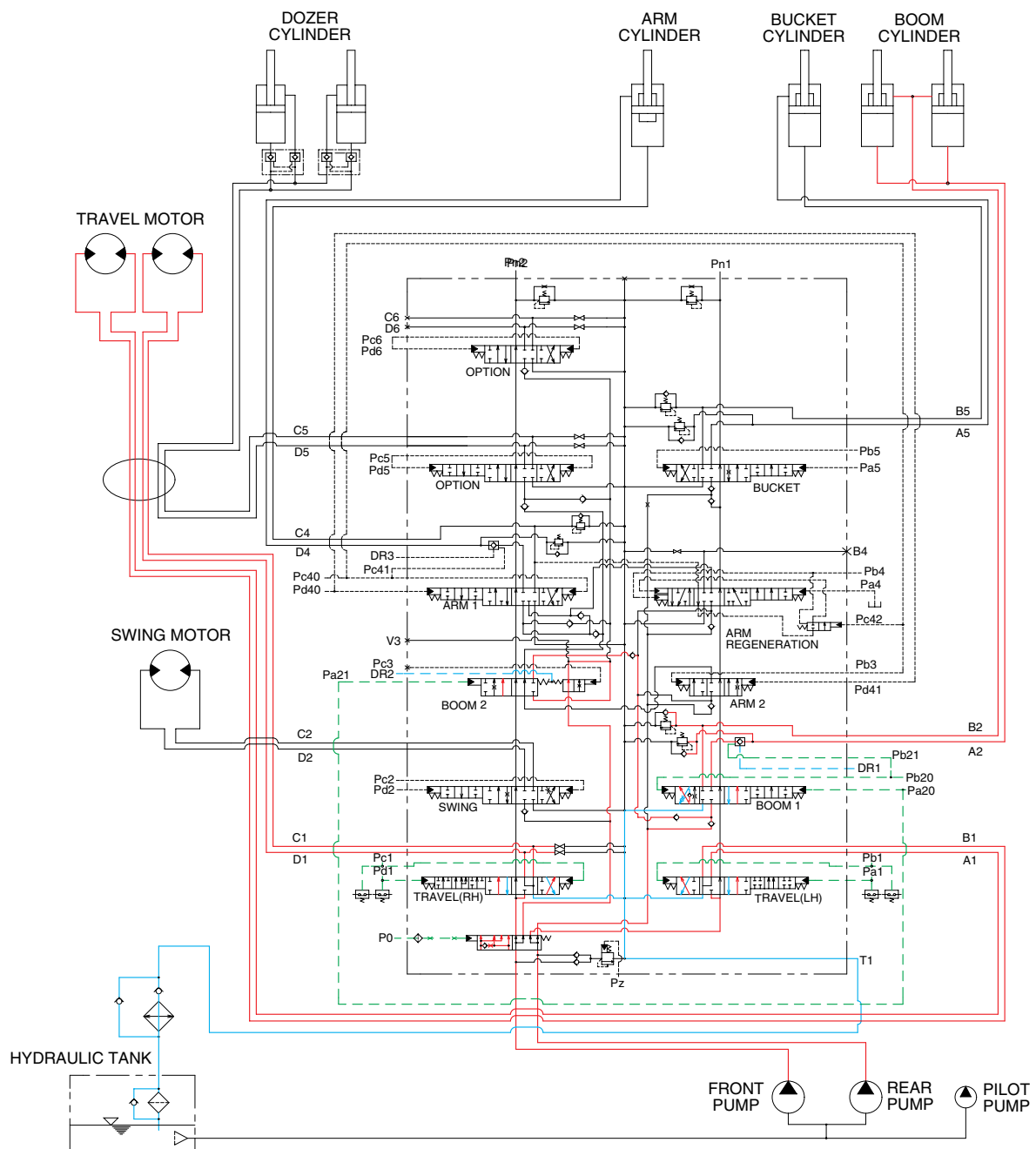


11073HC25

When the swing and travel functions are operated, simultaneously the swing 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 straight travel spool is pushed to the left by the pilot oil pressure from the pilot pump. The oil from the rear pump flows into the swing motor through the swing spool. The oil from the front pump flows into the travel motor through the RH travel spool and the LH travel spool via the straight travel spool.

The superstructure swings and the machine travels straight.

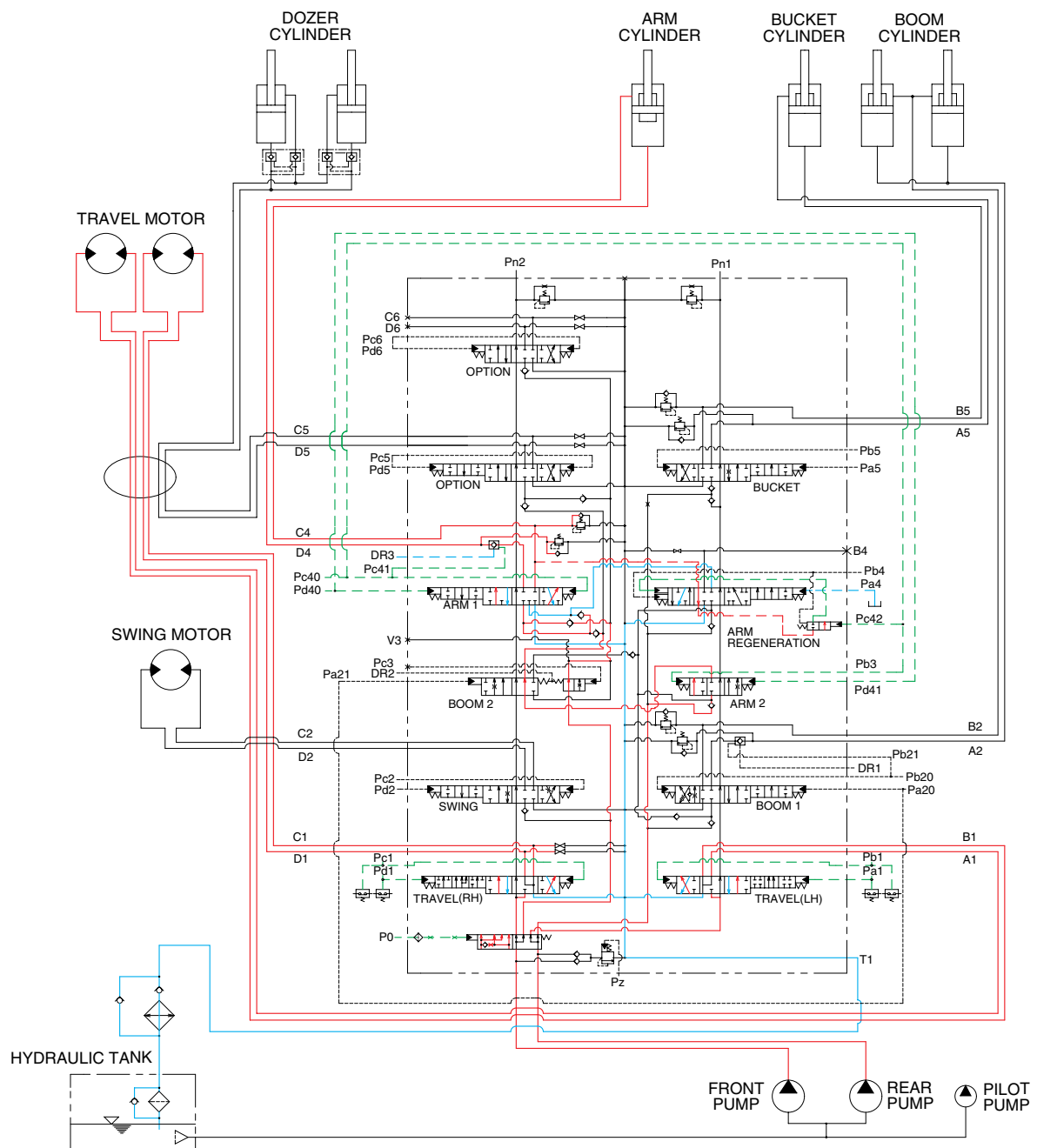
## 7. COMBINED BOOM AND TRAVEL OPERATION



11073HC26

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 straight travel spool is pushed to the left by the oil pressure from pilot pump. 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 in case boom up operation. The oil from the front pump flows into the travel motors through the RH travel spool and the LH travel spool via the straight travel spool.

## 8. COMBINED ARM AND TRAVEL OPERATION

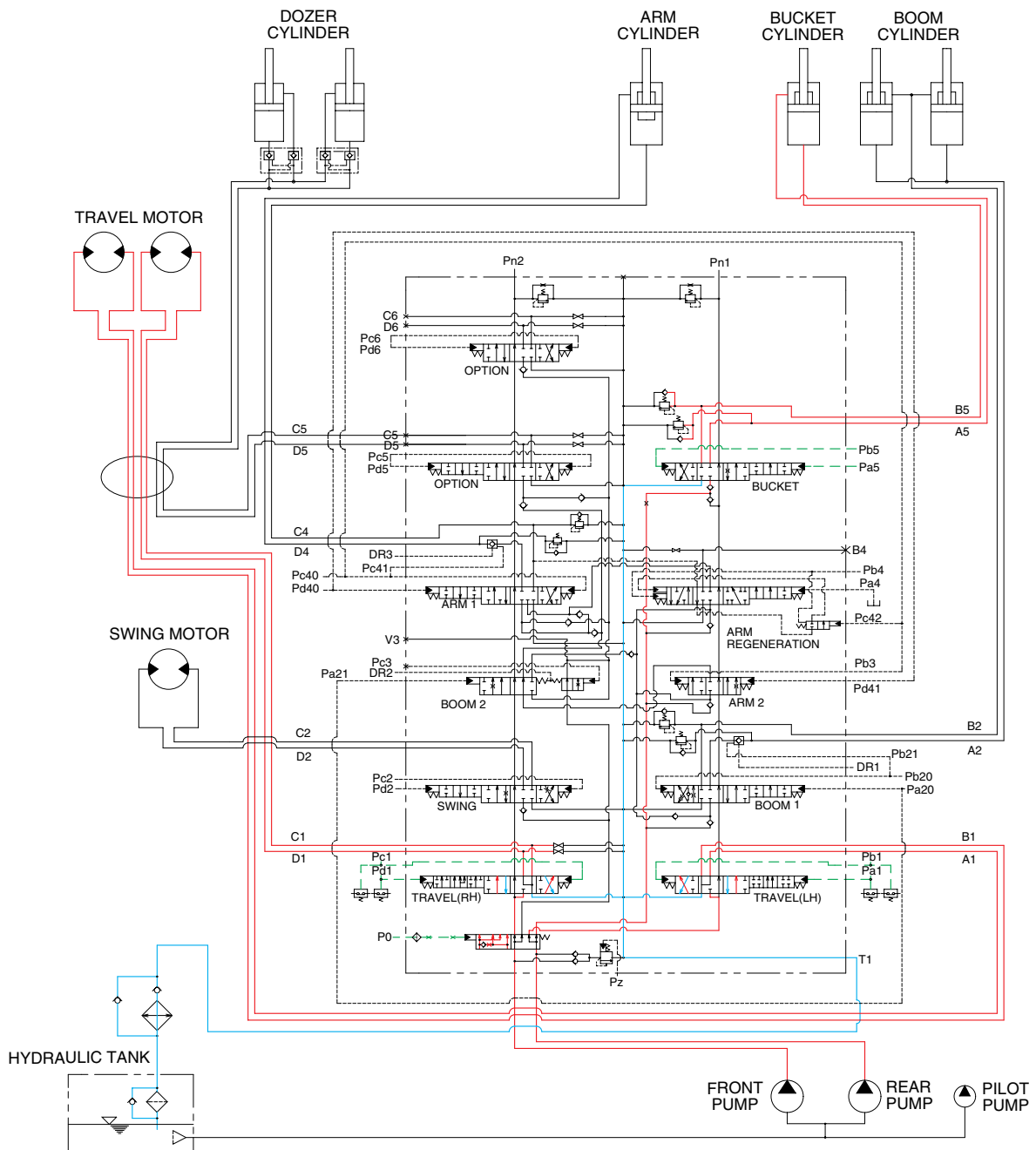


11073HC27

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 straight travel spool is pushed to the left by the oil pressure from pilot pump. 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 and the LH travel spool via the straight travel spool. The arm is operated and the machine travels straight.



## 9. COMBINED BUCKET AND TRAVEL OPERATION



11073HC28

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 straight travel spool is pushed to the left by the oil pressure from pilot pump. 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 and the LH travel spool via the straight travel spool of the control valve. The bucket is operated and the machine travels straight.

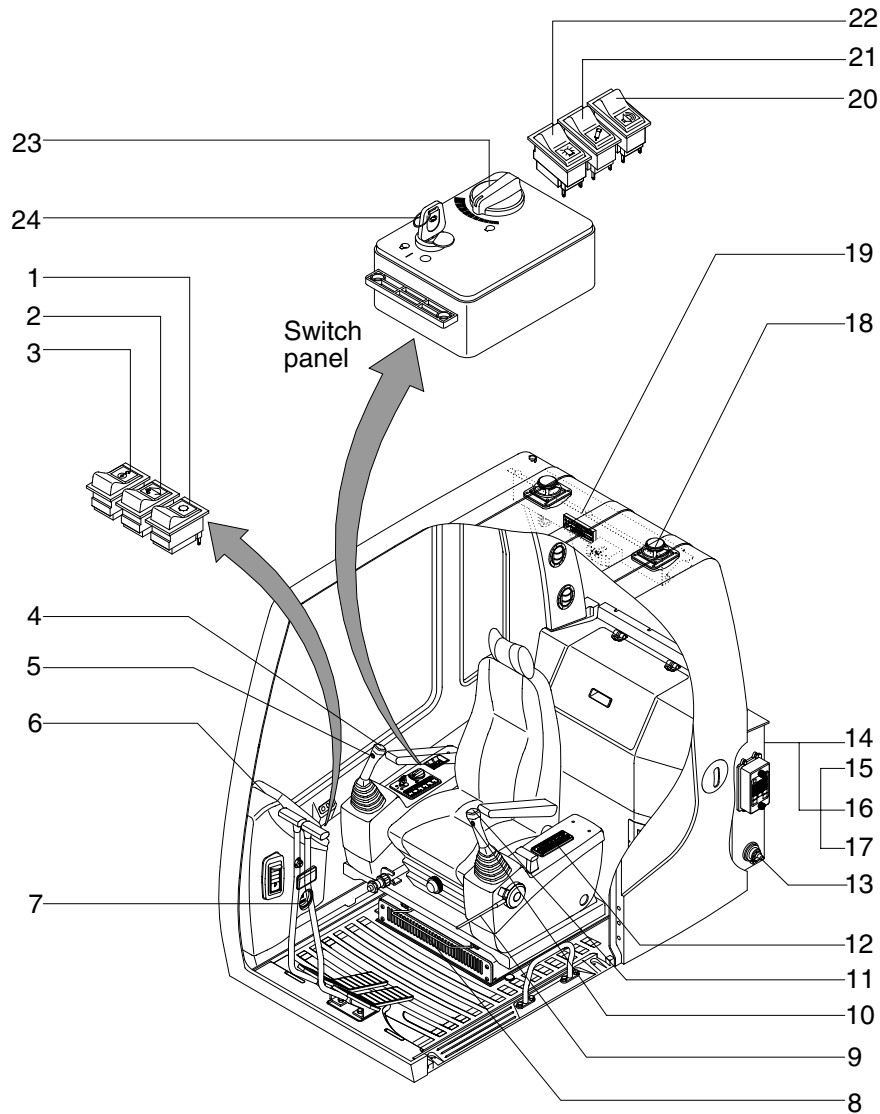
# SECTION 4 ELECTRICAL SYSTEM

Group 1 Component Location .....	4-1
Group 2 Electrical Circuit .....	4-3
Group 3 Electrical Component Specification .....	4-23
Group 4 Connectors .....	4-35

# SECTION 4 ELECTRICAL SYSTEM

## GROUP 1 COMPONENT LOCATION

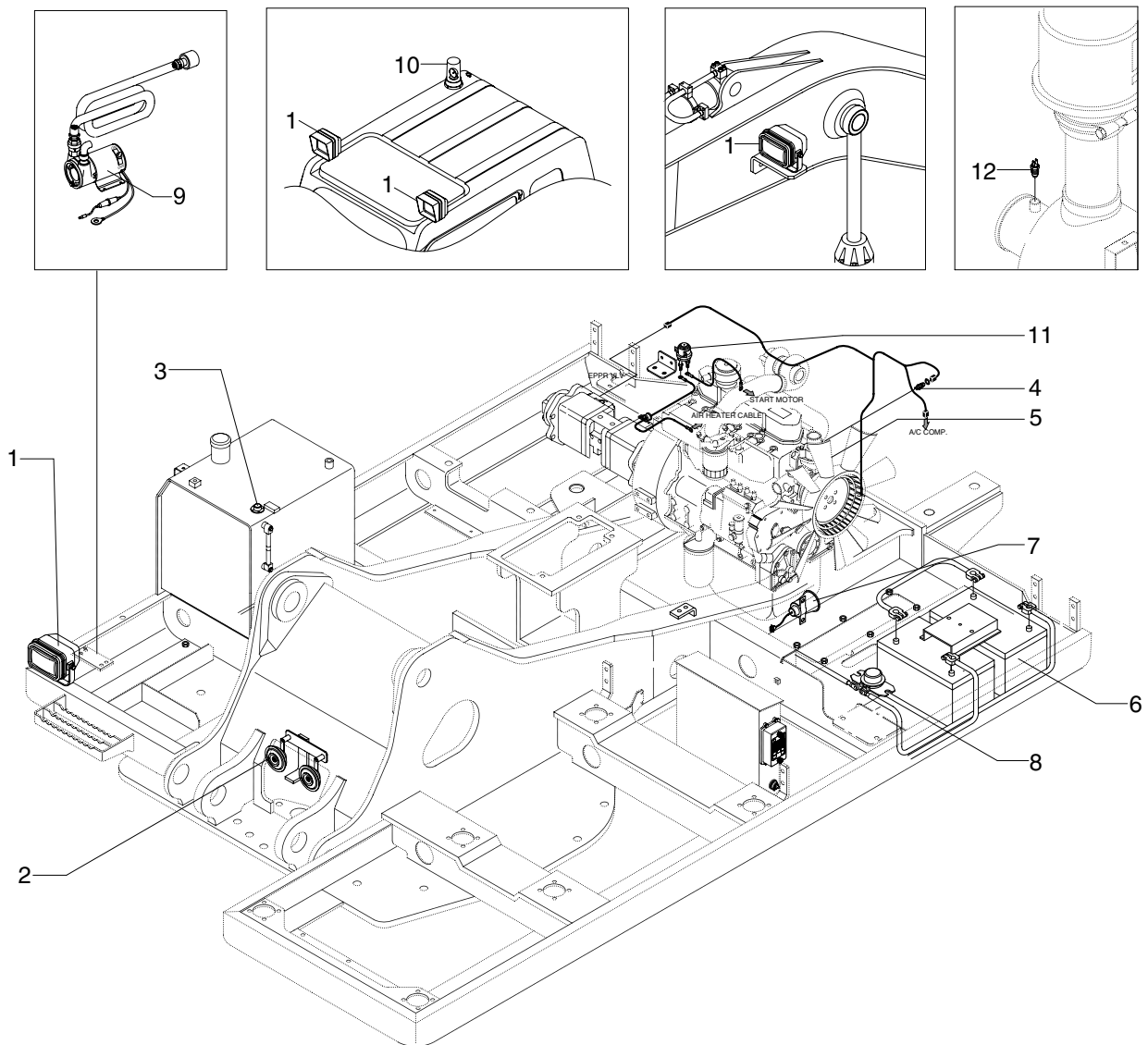
### 1. LOCATION 1



11074EL01

- |                                       |                           |                             |
|---------------------------------------|---------------------------|-----------------------------|
| 1 Main light switch                   | 9 Safety lever            | 17 Fuse box                 |
| 2 Quick coupling switch               | 10 Power max switch       | 18 Speaker                  |
| 3 Overload switch                     | 11 One touch decel switch | 19 Cassette radio           |
| 4 Horn switch                         | 12 Air-con switch         | 20 Travel alarm stop switch |
| 5 Breaker operation switch            | 13 Master switch          | 21 Breaker selection switch |
| 6 Cluster                             | 14 Electric box           | 22 Beacon switch            |
| 7 Hour meter                          | 15 CPU controller         | 23 Accel dial               |
| 8 Emergency engine acceleration lever | 16 Prolix resistor        | 24 Start switch             |

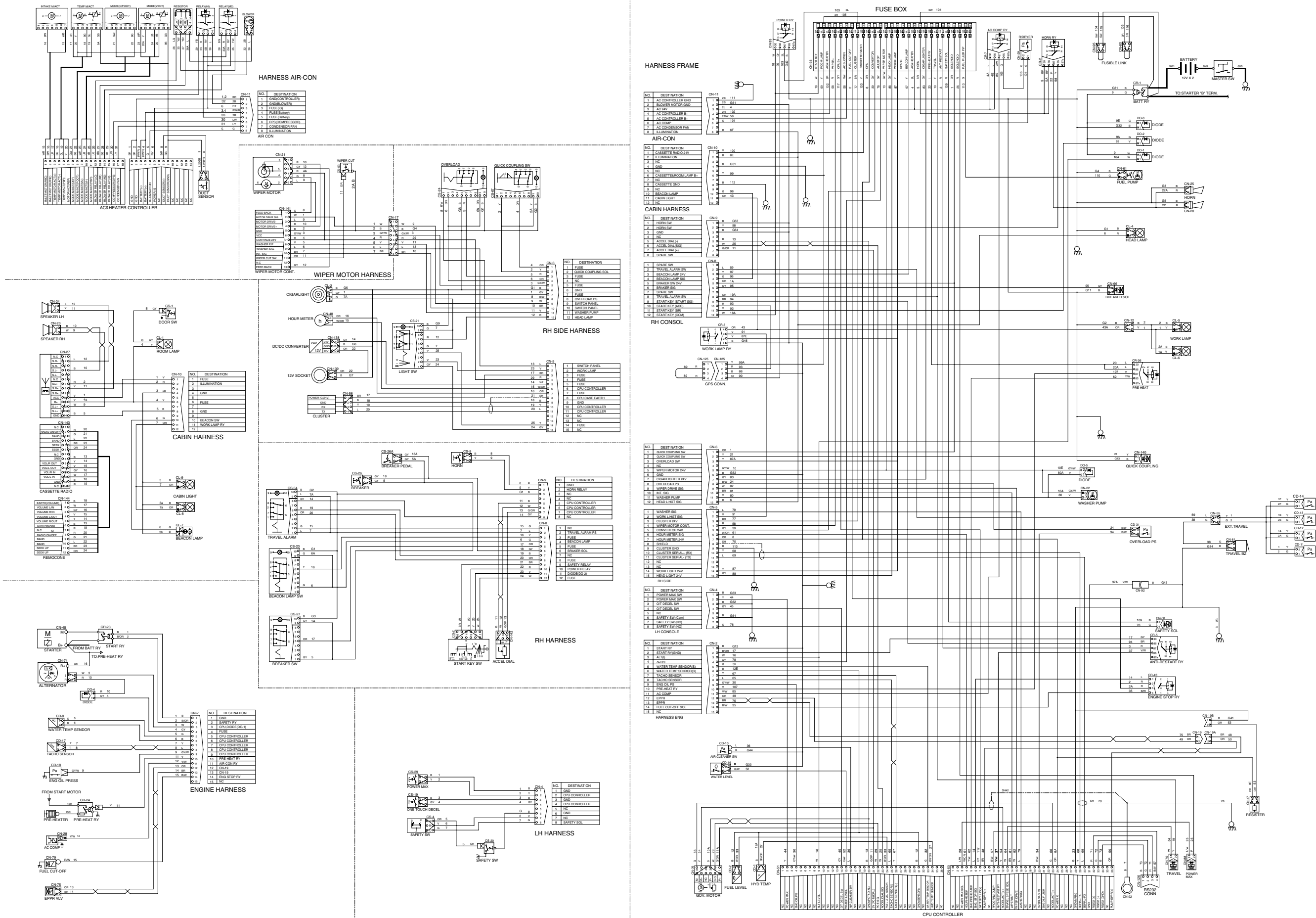
## 2. LOCATION 2



11074EL02

- |   |             |   |                     |    |                    |
|---|-------------|---|---------------------|----|--------------------|
| 1 | Lamp        | 5 | Alternator          | 9  | Fuel filler pump   |
| 2 | Horn        | 6 | Battery             | 10 | Beacon lamp        |
| 3 | Fuel sender | 7 | Travel alarm buzzer | 11 | Heater relay       |
| 4 | Temp sender | 8 | Battery relay       | 12 | Air cleaner switch |

**GROUP 2 ELECTRICAL CIRCUIT**

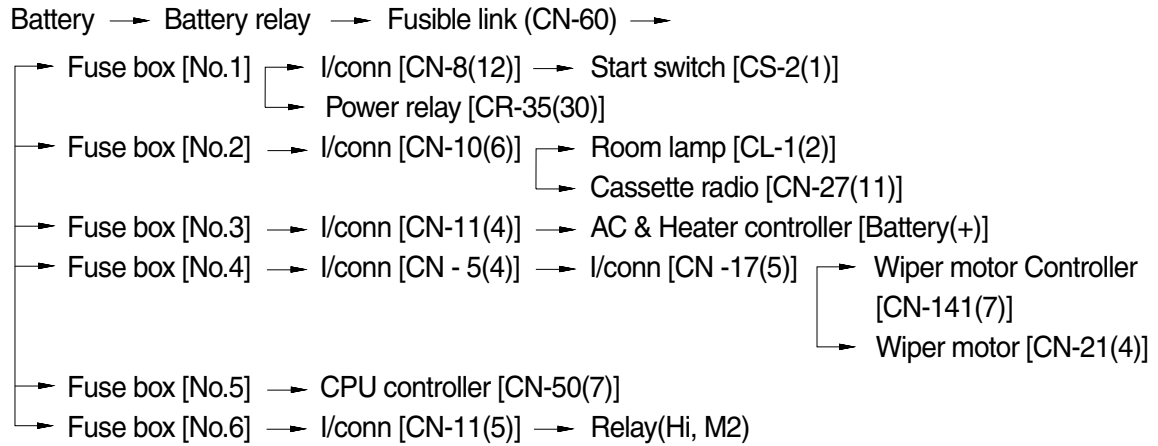


## 1. POWER CIRCUIT

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

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

### 1) OPERATING FLOW



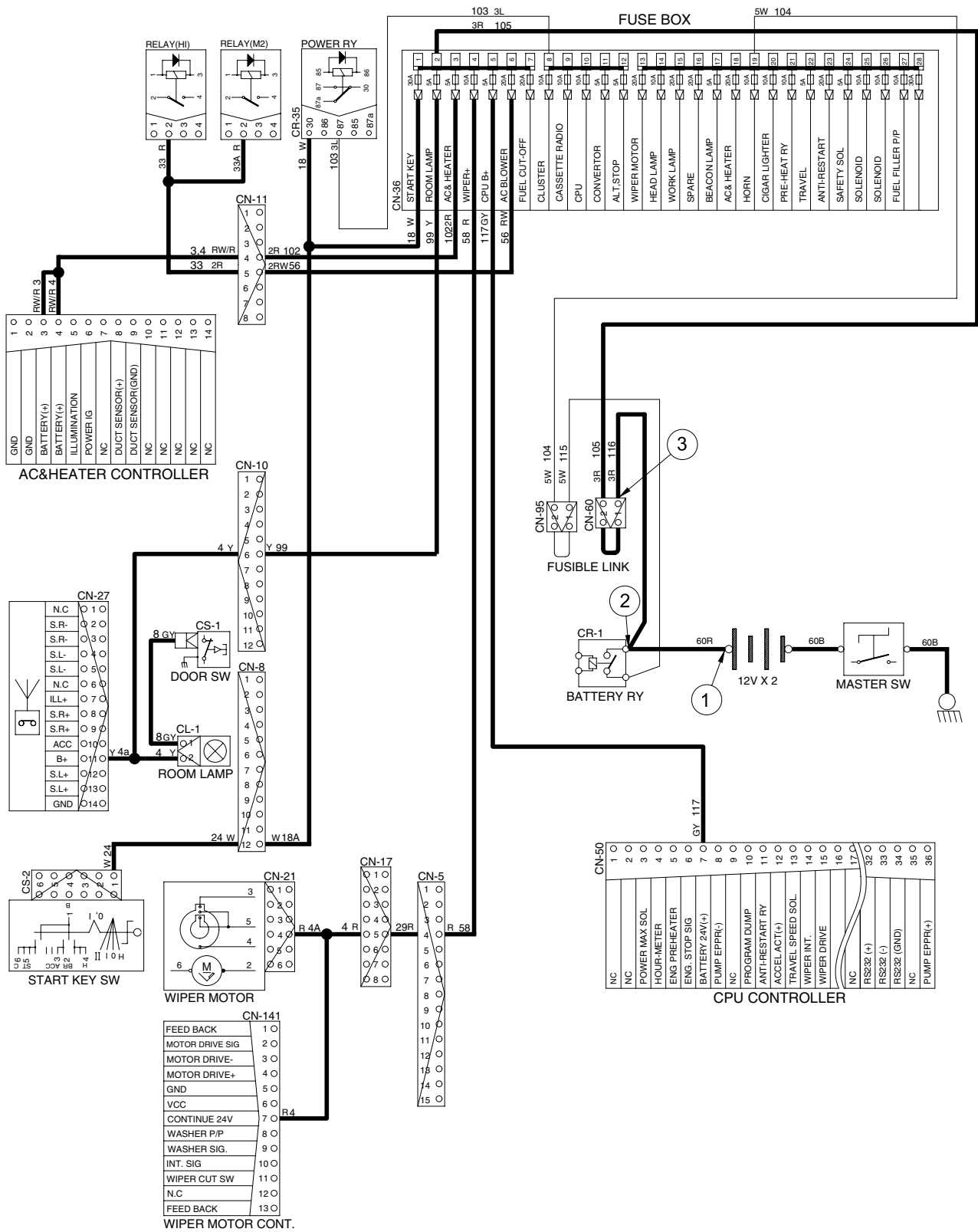
※ I/conn : Intermediate connector

### 2) CHECK POINT

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

※ GND : Ground

## POWER CIRCUIT



## 2. STARTING CIRCUIT

### 1) OPERATING FLOW

Battery(+) terminal → Battery relay[CR-1] → Fusible link → Fuse box No.1  
 → I/conn [CN-8(12)] → Start key [CS-2(1)]

※ Start switch : ON

→ Start switch ON [CS-2(2)] → I/conn [CN-8(11)] → Diode[DO-2] →  
 Battery relay [CR-1]:Battery relay operating(All power is supplied with the electric component)  
 → Start switch ON [CS-2(3)] → I/conn [CN-8(10)] →  
 GPS Connector[CN-125(2) → CN-125(4)] → Power relay [CR-35(86) → (87)] →  
 Fuse box No.12 → I/conn [CN-2(4)] → Alterlator[CN-74(2)]

※ Start switch : START

Start switch START[CS-2(5)] → I/conn[CN-8(9)] → Anti-restart relay [CR-5(86) → (30)]  
 → I/conn [CN-2(2)] → Start relay [CR-23]

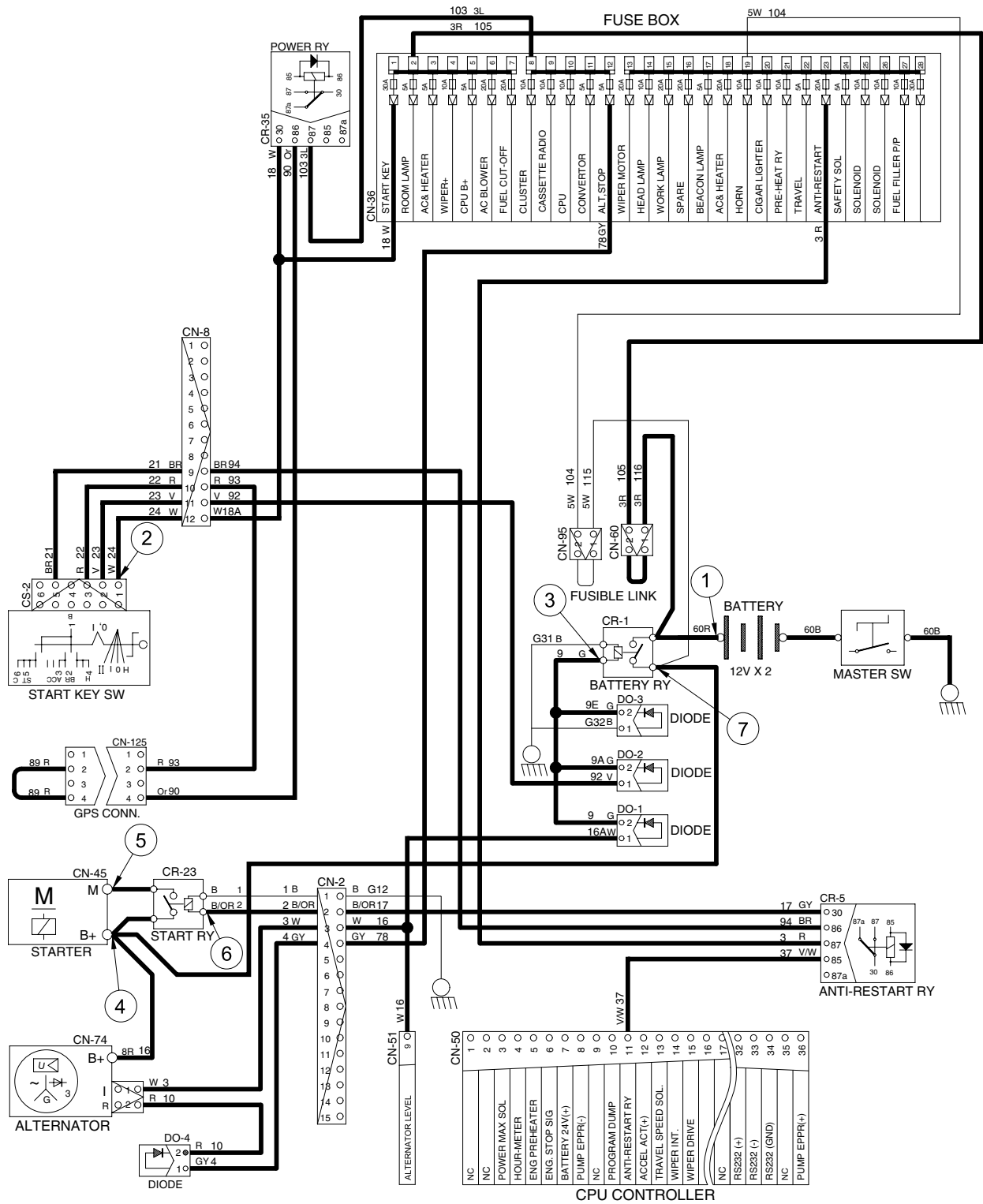
### 2) CHECK POINT

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

※ GND : Ground



# STARTING CIRCUIT



### 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-2(3)] → CPU Controller [CN-51(9)] →  
Cluster warning lamp (Via serial interface)

##### (2) Charging flow

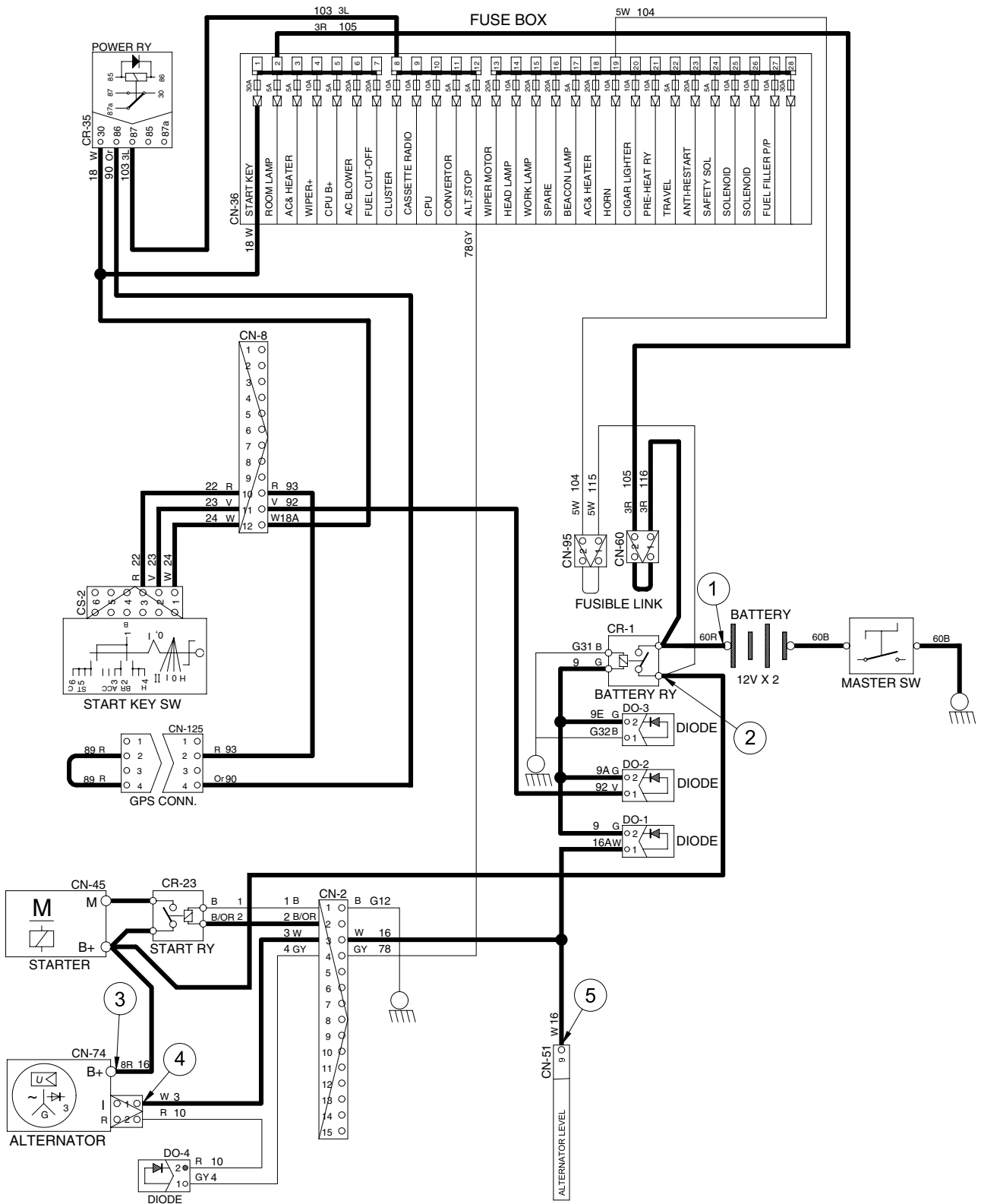
Alternator "B+" terminal → Battery relay → Battery(+) terminal  
→ Fusible link → Fuse box

#### 2) CHECK POINT

Engine	Start switch	Check point	Voltage
ON	ON	① - GND (Battery voltage) ② - GND (Battery relay) ③ - GND (Alternator B <sup>+</sup> terminal) ④ - GND (Alternator I terminal) ⑤ - GND (CPU)	20~27V

※ GND : Ground

# CHARGING CIRCUIT

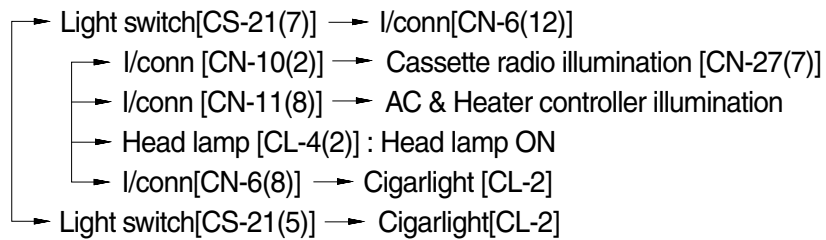


## 4. HEAD LAMP CIRCUIT

### 1) OPERATING FLOW

Fuse box (No.14) → I/conn [CN-5(15)] → Light switch[CS-21(1)]

※ When lamp switch ON

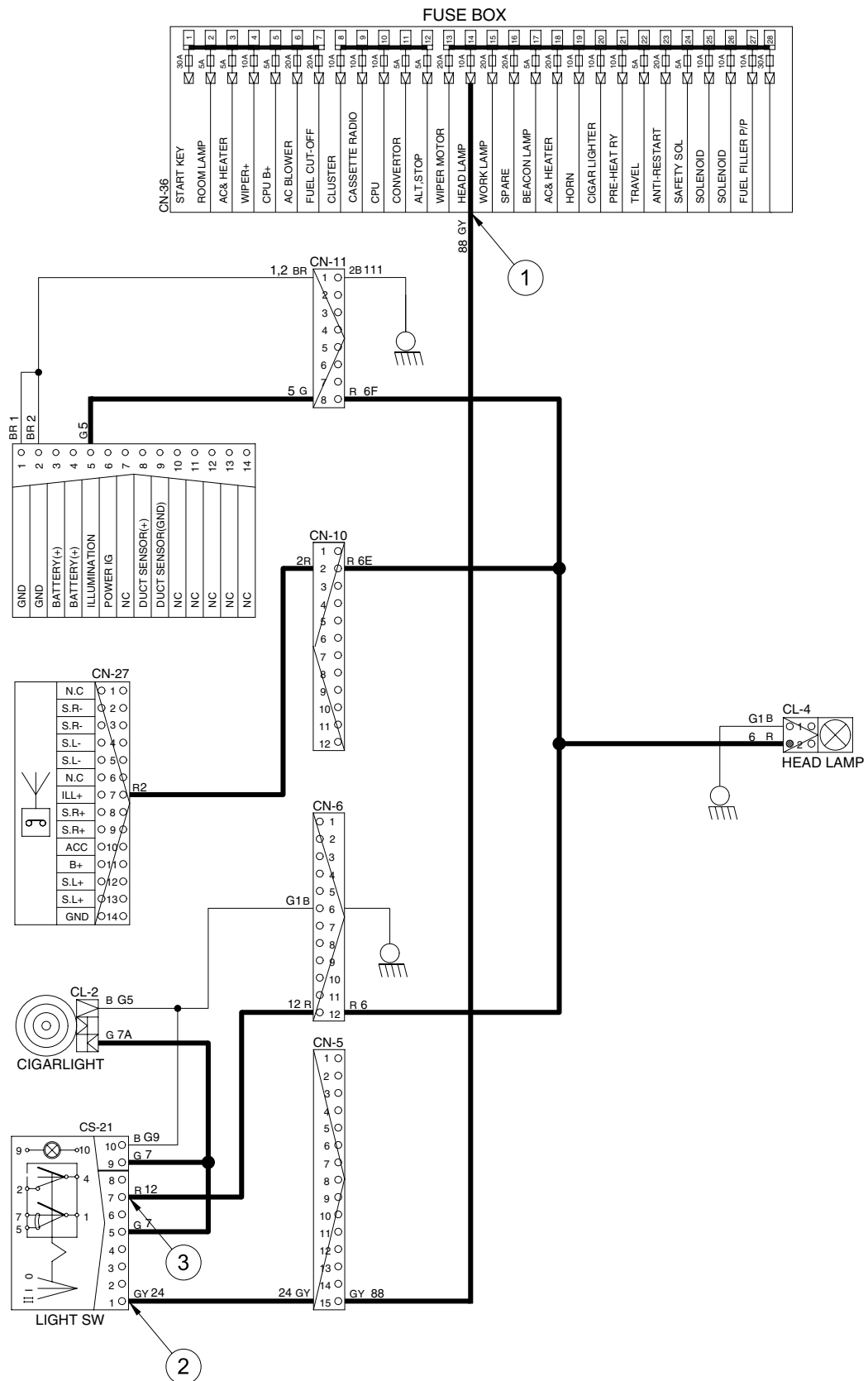


### 2) CHECK POINT

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

※ GND : Ground

# HEAD LAMP CIRCUIT



11074EL07

## 5. WORK LAMP CIRCUIT

### 1) OPERATING FLOW

Fuse box (No.15) → I/conn [CN-5(14)] → Light switch[CS-21(4)]

※ When work lamp switch ON

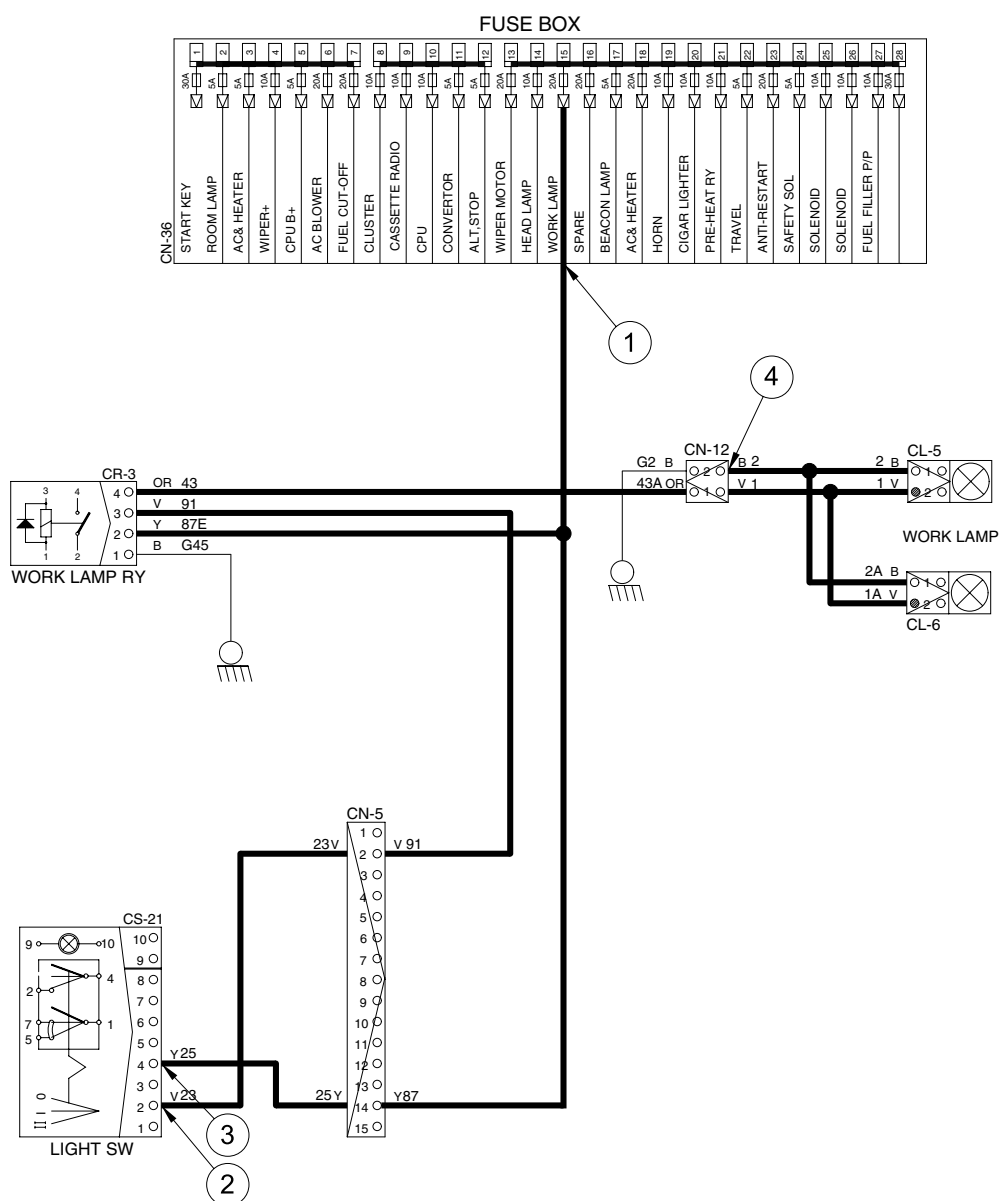
Work lamp switch ON [CS-21(2)] → I/conn [CN-5(2)] → Work lamp relay[CR-3(3)→(4)] →  
I/conn[CN-12(1)] → Work lamp ON [CL-5(2), CL-6(2)]

### 2) CHECK POINT

Engine	Key switch	Check point	Voltage
STOP	ON	① - GND (Fuse box) ② - GND (Light switch input) ③ - GND (Light switch output) ④ - GND (Work lamp)	20~25V

※ GND : Ground

## WORK LAMP CIRCUIT



11074EL08

## 6. CAB LAMP CIRCUIT

### 1) OPERATING FLOW

Fuse box (No.15) → I/conn [CN-5(14)] → Light switch[CS-21(4)]

※ When Lamp switch ON

Lamp switch ON [CS-21(2)] → I/conn [CN-5(2)] → Work lamp relay[CR-3(3)→(4)] →  
I/conn [CN-10(11)] → Cab light ON [CL-8(2), CL-9(2)]

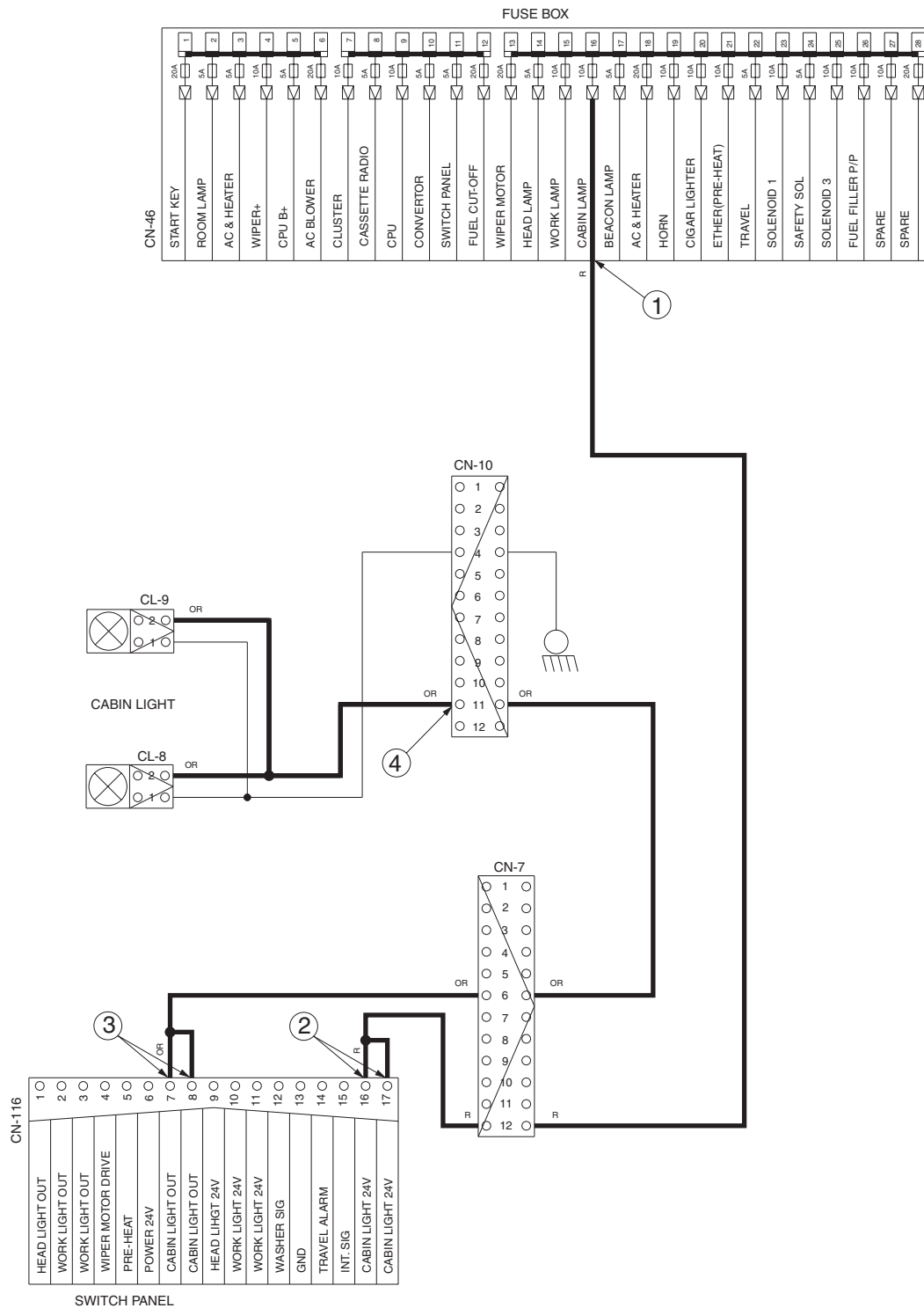
### 2) CHECK POINT

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

※ GND : Ground



# CAB LAMP CIRCUIT



14074EL09

## 7. BEACON LAMP CIRCUIT

### 1) OPERATING FLOW

Fuse box (No.16) → I/conn [CN-8(3)] → Beacon lamp switch [CS-23(6)]

※ When lamp switch ON

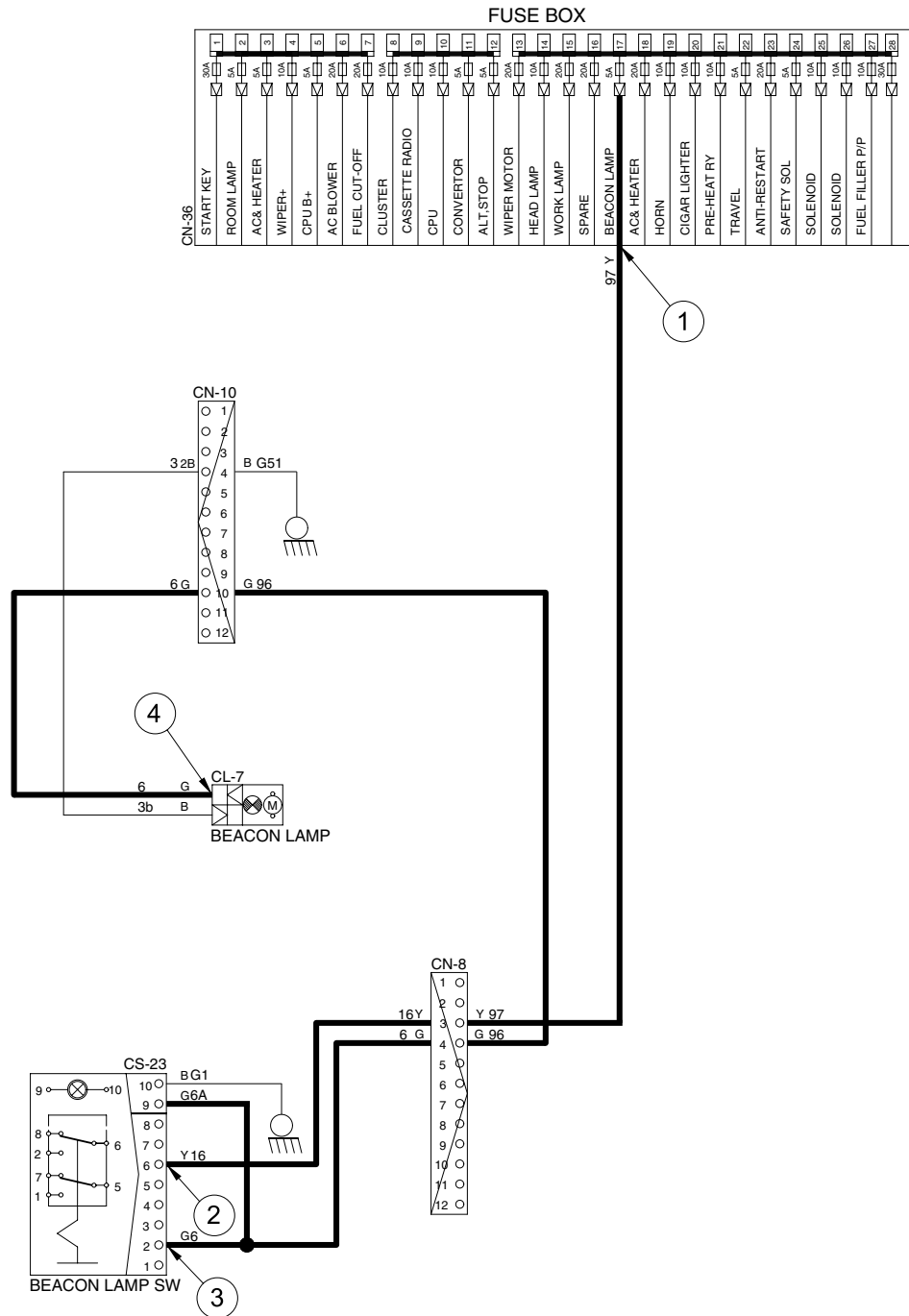
Beacon lamp switch ON [CS-23(2)]  
→ Switch Indicator lamp ON [CS-23(9)]  
→ I/conn [CN-8(4)] → I/conn [CN-10(10)]  
→ Beacon lamp ON [CL-7]

### 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

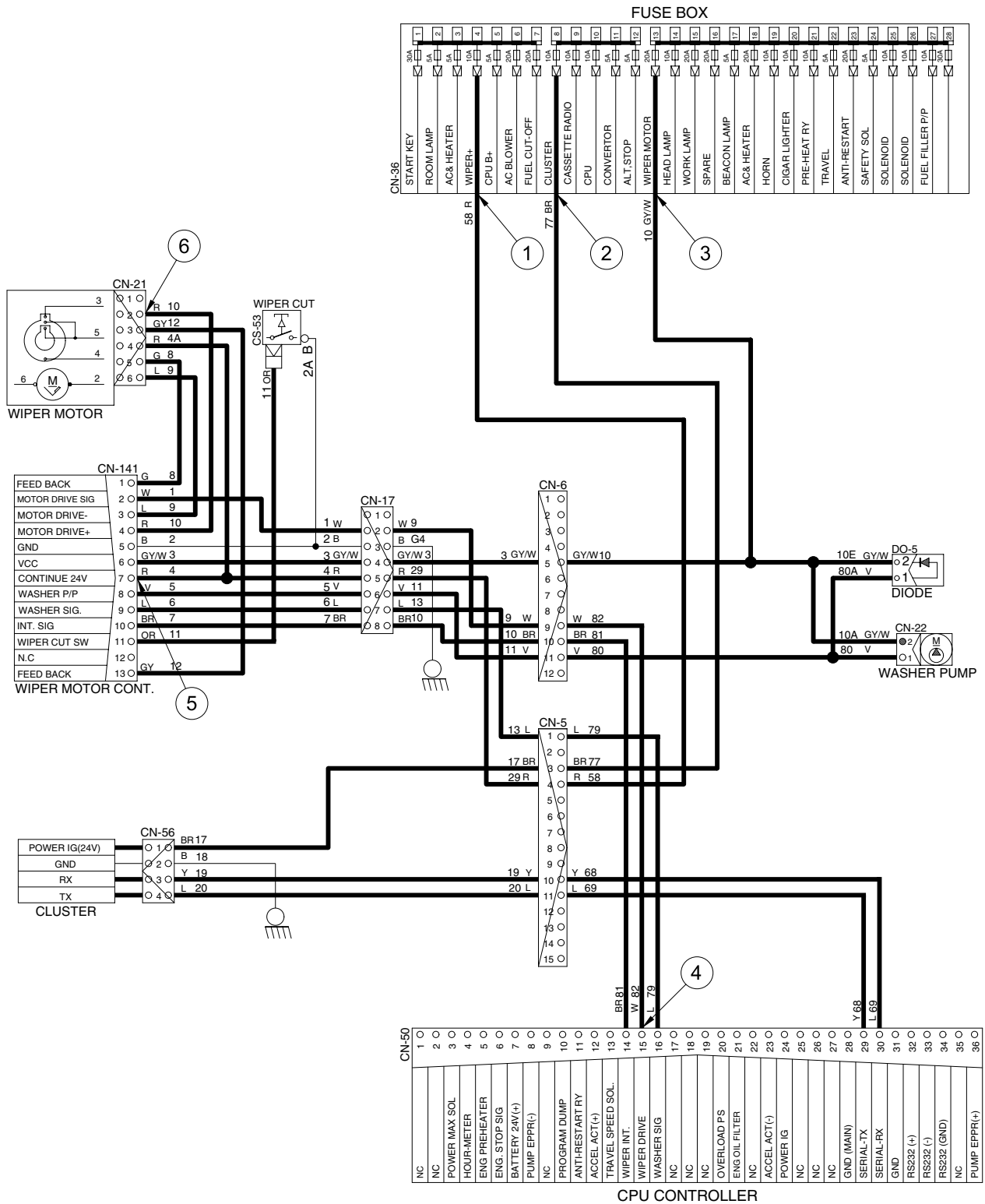
# BEACON LAMP CIRCUIT



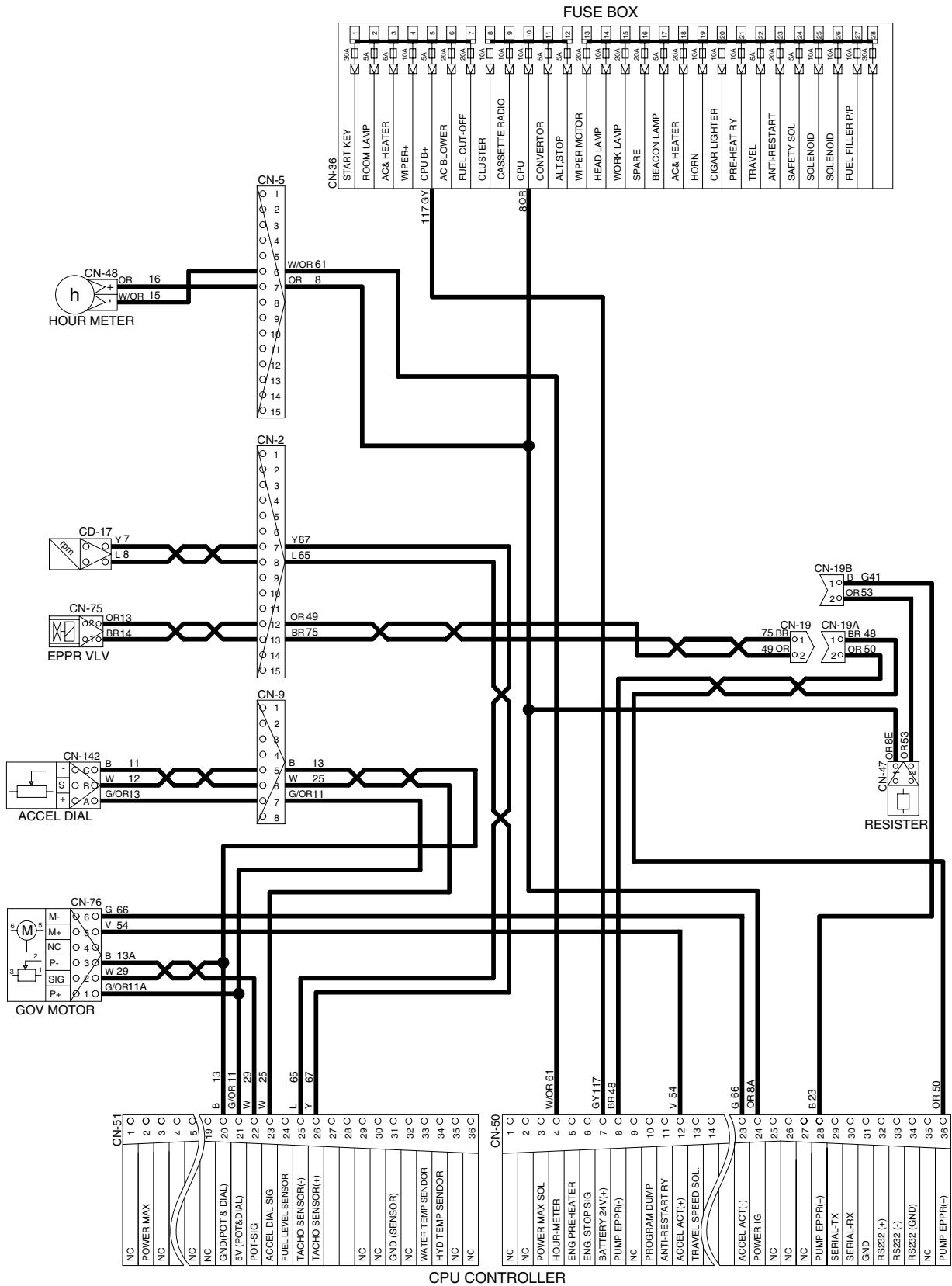
11074EL10



## WIPER AND WASHER CIRCUIT

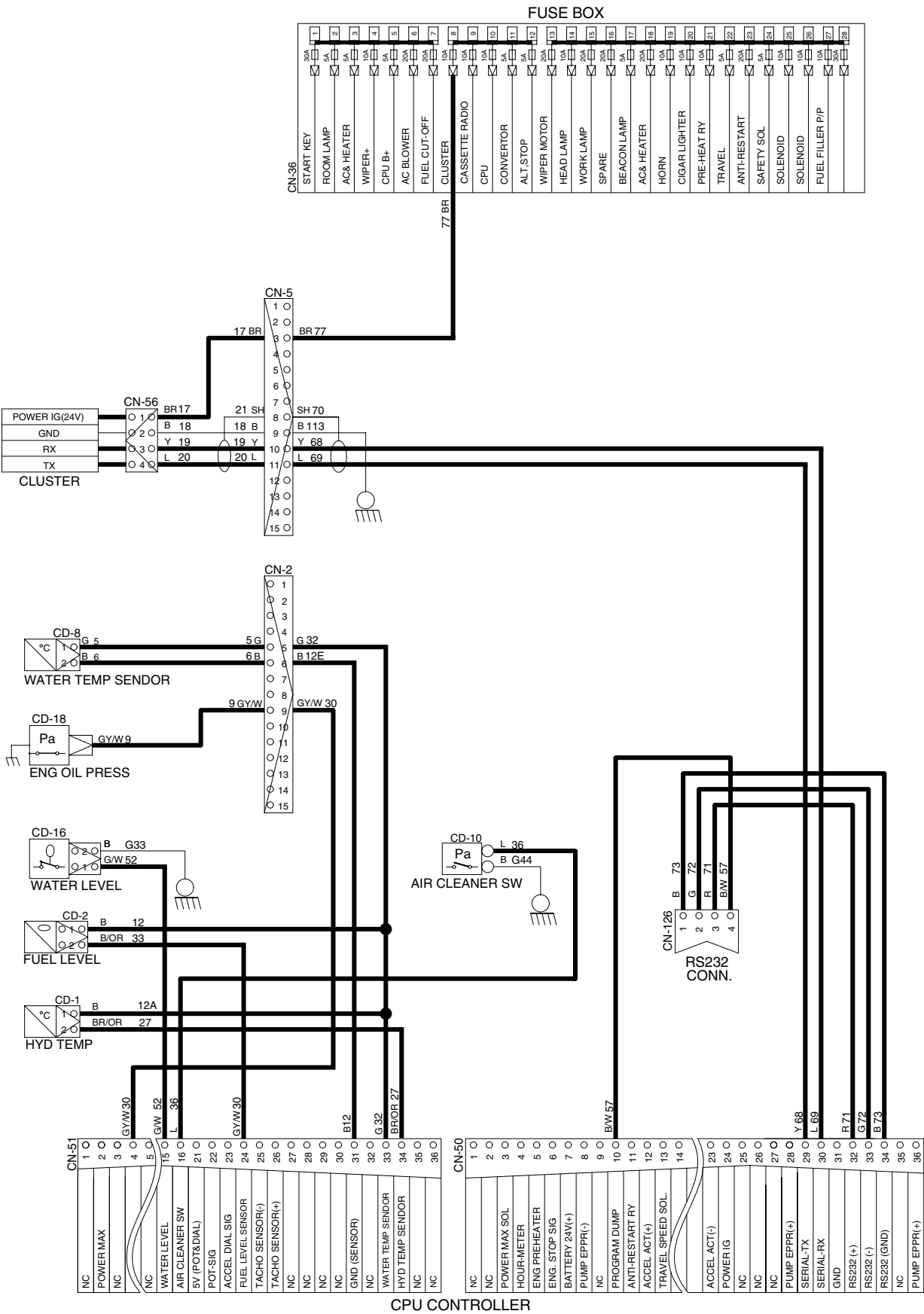


# CONTROLLER CIRCUIT

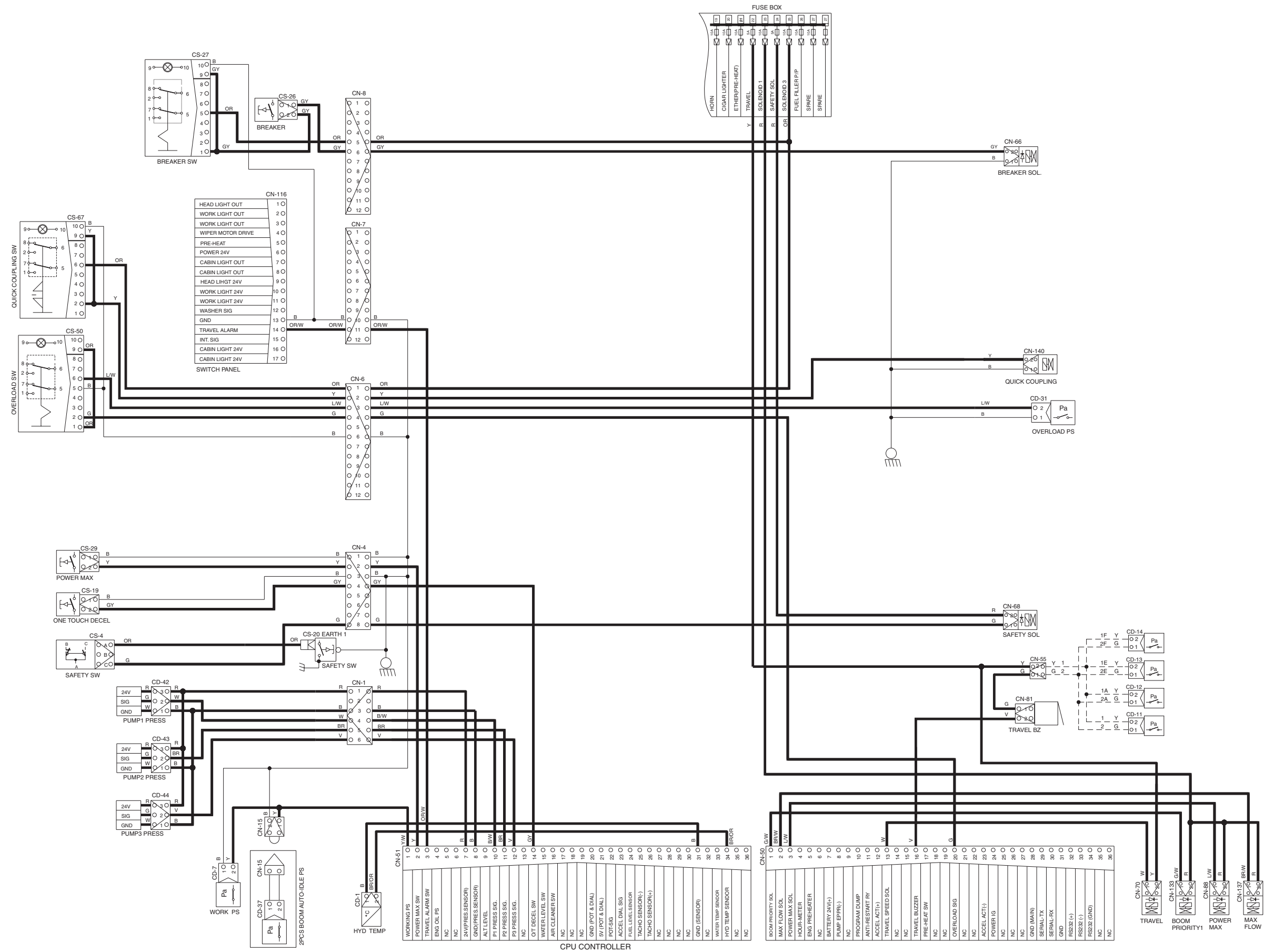


11074EL13

MONITORING CIRCUIT

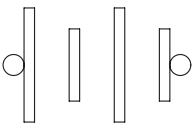
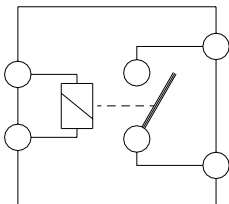
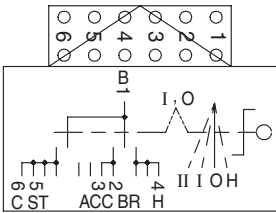
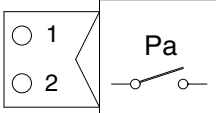
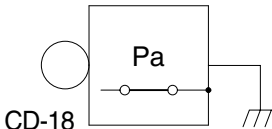


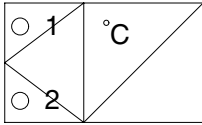
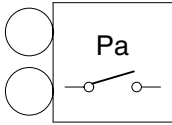
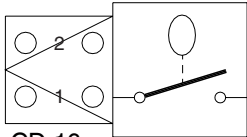
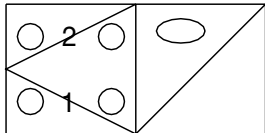
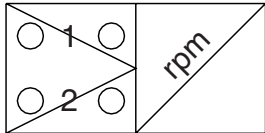
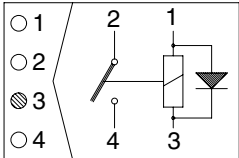
ELECTRIC CIRCUIT FOR HYDRAULIC

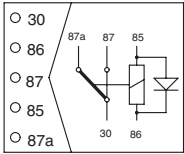
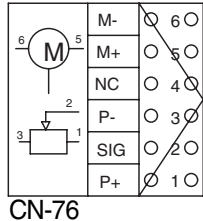
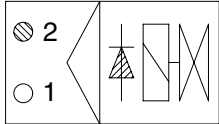
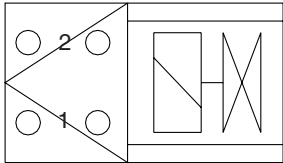
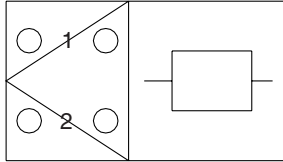
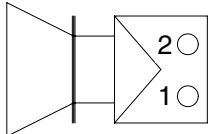


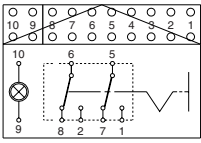
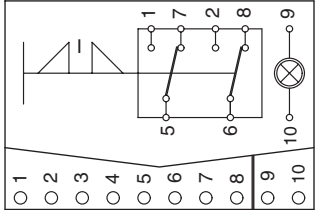
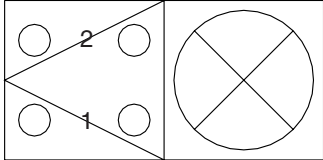
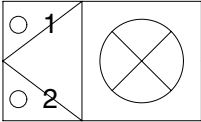
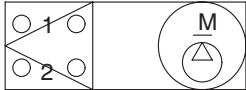
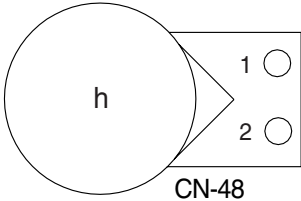


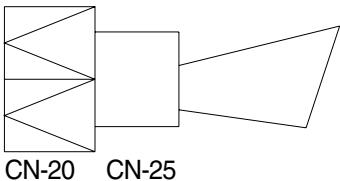
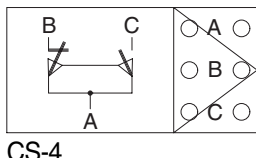
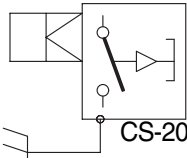
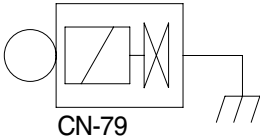
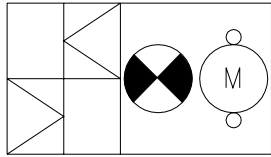
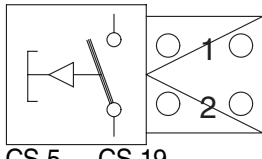
## GROUP 3 ELECTRICAL COMPONENT SPECIFICATION

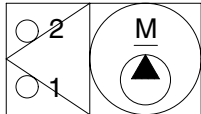
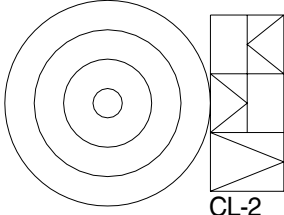
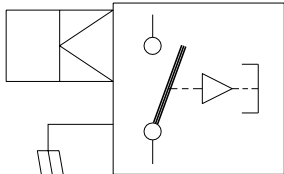
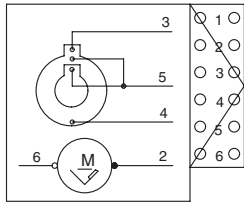
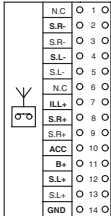
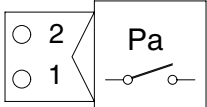
Part name	Symbol	Specification	Check
Battery		12V × 100Ah (2EA)	※ Check specific gravity 1.280 over : Over charged 1.280 ~ 1.250 : Normal 1.250 below : Recharging
Battery relay	 CR-1	Rated load : 24V 100A(continuity) 1000A(30second)	※ Check coil resistance (M4 to M4) Normal : About 50 Ω ※ Check contact Normal : ∞ Ω
Start key	 CS-2	24V 40A	※ Check contact OFF : ∞ Ω (For each terminal) ON : 0 Ω (For terminal 1-3 and 1-2) START : 0 Ω (For terminal 1-5)
Pressure switch (For overload)	 CD-11, CD-12, CD-13 CD-14, CD-31	3 ~ 6kgf/cm <sup>2</sup> (N.O TYPE)	※ Check contact Normal : ∞(OPEN)
Pressure switch (For engine oil)	 CD-18	0.5 kgf/cm <sup>2</sup> (N.C TYPE)	※ Check resistance Normal : 0 Ω (CLOSE)

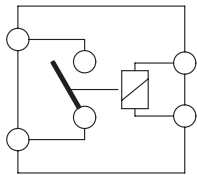
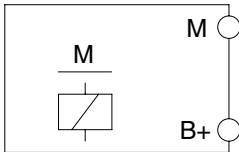
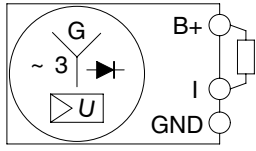
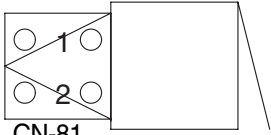
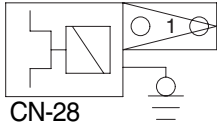
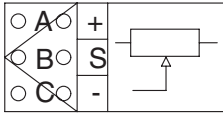
Part name	Symbol	Specification	Check
Temperature sensor (Coolant, hydraulic)	 CD-1, CD-8	-	※ Check resistance 50° C : 804 Ω 80° C : 310 Ω 100° C : 180 Ω
Air cleaner pressure switch	 CD-10	Pressure: 635mmH <sub>2</sub> O (N.O TYPE)	※ Check contact Normal : ∞ Ω
Coolant level sensor	 CD-16	24V 0.5A	※ Check contact High level : ∞ Ω Low level : 0 Ω
Fuel sender	 CD-2	-	※ Check resistance Full : 50 Ω      6/12 : 350 Ω 11/12 : 100 Ω    5/12 : 400 Ω 10/12 : 150 Ω    4/12 : 450 Ω 9/12 : 200 Ω     3/12 : 500 Ω 8/12 : 250 Ω     2/12 : 550 Ω 7/12 : 300 Ω     1/12 : 600 Ω Empty warning : 700 Ω
Tacho sensor	 CD-17	-	※ Check resistance Normal : 300 Ω (For terminal 1,2)
Relay	 CR-3	24V 20A	※ Check resistance Normal : About 200 Ω (For terminal 1-3) : 0 Ω (For terminal 2-4)

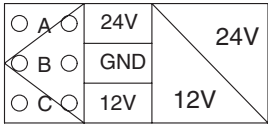
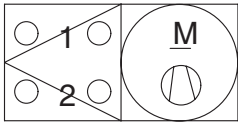
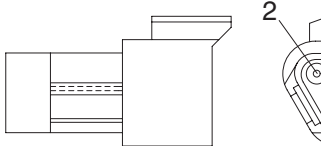
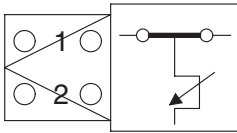
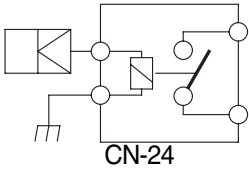
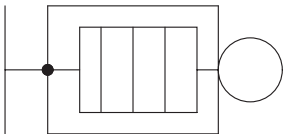
Part name	Symbol	Specification	Check
Relay	 <p>CR-2 CR-35 CR-5 CR-36 CR-7</p>	24V 16A	※ Check resistance Normal : About 160 Ω (For terminal 85-86) : 0 Ω (For terminal 30-87a) : ∞ Ω (For terminal 30-87)
Accel actuator	 <p>CN-76</p>	-	※ Check resistance Normal : 1-2 Ω (For terminal 5-6) 0.8-1.2kΩ (For terminal 1-3)
Solenoid valve	 <p>CN-66 CN-68 CN-70 CN-88 CN-140</p>	24V 1A	※ Check resistance Normal : 15~25 Ω (For terminal 1-2)
EPPR valve	 <p>CN-75</p>	700mA	※ Check resistance Normal : 18~25 Ω (For terminal 1-2)
Prolix resistor	 <p>CN-47</p>	50 Ω 20W± 5%	※ Check resistance Normal : 50 Ω
Speaker	 <p>CN-23(LH) CN-24(RH)</p>	4 Ω 20W	※ Check resistance Normal : 4 Ω

Part name	Symbol	Specification	Check
Switch (Looking type)	 <p>CS-23, CS-24, CS-27, 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	 <p>CS-67</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)
Lamp	 <p>CL-4, CL-5, CL-6, CL-8, CL-9</p>	24V 70W (H3 TYPE)	※ Check disconnection Normal : 1.2 Ω
Room lamp	 <p>CL-1</p>	24V 10W	※ Check disconnection Normal : A few Ω
Fuel filler pump	 <p>CN-61</p>	24V 10A 35 l/min	※ Check resistance Normal : 1.0 Ω
Hour meter	 <p>CN-48</p>	16V ~ 32V	※ Check operation ・ Supply power(24V) to terminal No. 2 and connect terminal No. 1 and ground.

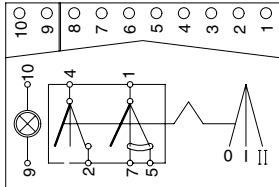
Part name	Symbol	Specification	Check
Horn	 CN-20 CN-25	DC 22.0 ~ 28.0V 2A	※ Check operation ・ Supply power(24V) to each terminal and connect ground.
Safety switch 1	 CS-4	24V 15A (N.C TYPE)	※ Check contact Normal : 0 Ω (For terminal A-B) : ∞ Ω (For terminal A-C) Operating : ∞ Ω (For terminal A-B) : 0 Ω (For terminal A-C)
Safety switch 2	 CS-20	24V (N.C TYPE)	※ Check contact Normal : 0 Ω (one pin to ground)
Fuel cut-off	 CN-79	24V	※ Check resistance Normal : 15~25 Ω
Beacon lamp	 CL-7	24V 70W	※ Check disconnection Normal : 1.1 Ω
Switch (Power max, One touch decal, Breaker, Horn)	 CS-5 CS-19 CS-26 CS-29	24V 6A	※ Check contact Normal : ∞ Ω

Part name	Symbol	Specification	Check
Washer pump	 CN-22	24V 3.8A	※ Check contact Normal : 10.7 Ω (For terminal 1-2)
Cigar lighter	 CL-2	24V 5A 1.4W	※ Check coil resistance Normal : About 1MΩ ※ Check contact Normal : ∞ Ω Operating time : 5~15sec
Switch (Door, Safety, Wiper cut)	 CS-1, CS-20, CS-53	24V 2W	※ Check resistance Normal : About 5MΩ
Wiper motor	 CN-21	24V 2A	※ Check contact Normal : 7 Ω (For terminal 2-6)
Cassette radio	 CN-27	24V 2A	※ Check voltage 20 ~ 25V (For terminal 10-14,11-14)
Receiver dryer	 CN-29	24V 2.5A	※ Check contact Normal : 0 Ω

Part name	Symbol	Specification	Check
Start relay	 CR-23	24V 300A	※ Check contact Normal : 0.94 Ω (For terminal 1-2)
Starter	 CN-45	Delco Remy 28MT 24V	※ Check contact Normal : 0.1 Ω
Alternator	 CN-74	24V 60A	※ Check contact Normal : 0 Ω (For terminal B □1) Normal : 24 ~ 27.5V
Travel alarm	 CN-81	24V 0.5A	※ Check contact Normal : 5.2 Ω
Aircon compressor	 CN-28	24V 79W	※ Check contact Normal : 13.4 Ω
Accel dial	 CN-142	-	※ Check resistance Normal : About 5KΩ (For terminal A-C) ※ Check valtage Normal : About 5V (For terminal A-C) : 2 ~ 4.5V (For terminal C-B)

Part name	Symbol	Specification	Check
DC/DC Converter	 CN-138	12V 3A	24V(A-B) 12V(B-C)
Blower motor		24V 9.5A	※ Check resistance 2.5 Ω (For terminal 1-2)
Resistor		-	※ Check resistance 1.12 Ω (For terminal 4-2) 2.07 Ω (For terminal 2-3) 3.17 Ω (For terminal 3-1)
Duct sensor (Switch)		1°C OFF 4°C ON	※ Check resistance : 0 Ω (For terminal 1-2, the atmosphere temp : over 4°C)
Preheater relay	 CN-24	24V 200A	※ Check contact Normal : 0.94 Ω (For terminal 1-GND)
Preheater		24V 200A	※ check resistance : 0.25 ~ 0.12 Ω



Part name	Symbol	Specification	Check
Main light switch	 <p>CS-21</p>	24V 8A	※ Check contact OFF : $\infty \Omega$ (For terminal 1-5, 2-4)

## GROUP 4 CONNECTORS

### 1. CONNECTOR DESTINATION

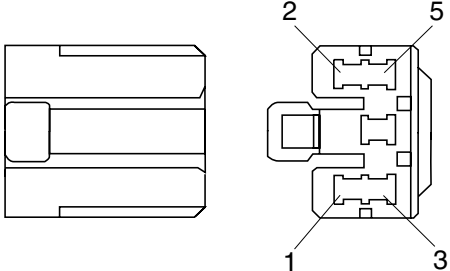
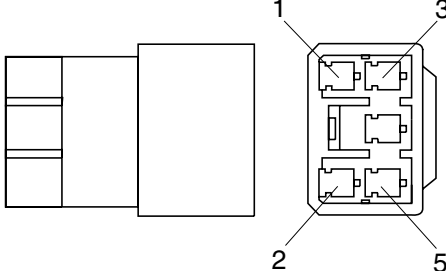
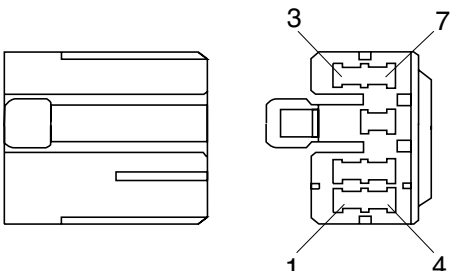
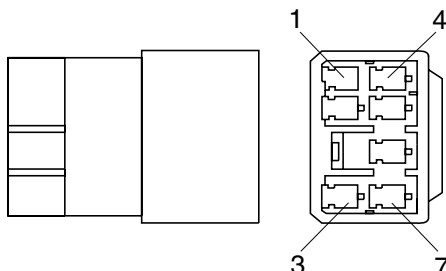
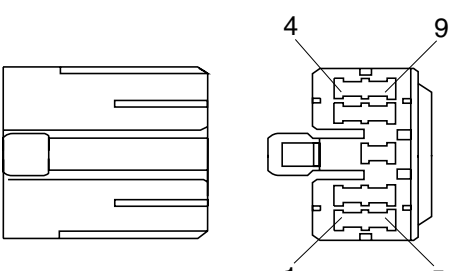
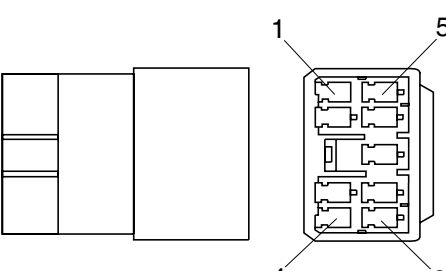
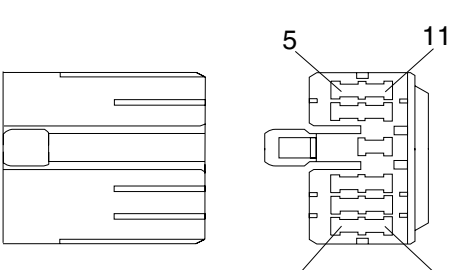
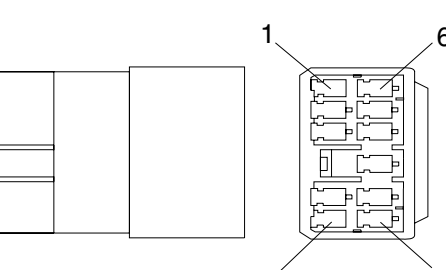
Connector number	Type	No. of pin	Destination	Connector part No.	
				Female	Male
CN-2	AMP	15	Engine harness	2-85262-1	S816-112002
CN-4	AMP	8	LH console wire harness	S816-008002	S816-108002
CN-5	AMP	15	RH side harness	2-85262-1	S816-112002
CN-6	AMP	12	RH side harness	S816-012002	S816-112002
CN-8	AMP	12	RH console wire harness	S816-012002	S816-112002
CN-9	AMP	8	RH console wire harness	S816-008002	S816-108002
CN-10	DEUTSCH	12	Cab harness	DT06-12S	DT04-12P
CN-11	DEUTSCH	8	LH console wire harness	DT06-8S	-
CN-12	DEUTSCH	2	Work lamp harness	DT06-2S-EP06	DT04-2P
CN-17	DEUTSCH	8	Wipe harness	DT06-8S	DT04-8P
CN-20	MOLEX	2	Horn	35825-0211	-
CN-21	AMP	6	Wiper motor	925276-0	-
CN-22	-	2	Washer tank	MG640605	-
CN-23	KET	2	LH speaker	MG610070	7322-1520
CN-24	KET	2	RH speaker	MG610070	7322-1520
CN-25	MOLEX	2	Horn	35825-0211	-
CN-27	AMP	14	Cassette radio	173852	AMP14P
CN-28	-	1	Air-con comp	MWP-01F-B	-
CN-29	KET	2	Receiver dryer	MG640795	-
CN-45	RING TERM	1	Starter	S820-308000	-
CN-47	AMP	2	Emergency resistor	S810-002202	-
CN-48	-	2	Hour meter	S810-002202	-
CN-50	AMP	36	CPU	3441111-1	-
CN-51	AMP	36	CPU	3441111-1	-
CN-55	AMP	2	Travel alarm pressure switch	S816-002002	S816-102002
CN-56	DEUTSCH	4	Cluster	-	DT04-4P
CN-60	-	2	Fusible link	-	7122-4125-50
CN-61	DEUTSCH	2	Fuel filler pump	DT06-2S-EP06	DT01-2P-P012
CN-66	DEUTSCH	2	Breaker solenoid valve	DT06-2S-EP06	DT04-2P-E005
CN-68	DEUTSCH	2	Safety solenoid valve	DT06-2S-EP06	-
CN-70	DEUTSCH	2	Travel speed solenoid valve	DT06-2S-EP06	-
CN-74	KET	2	Alternator	MG640188-4	-
CN-75	-	2	EPPR valve	S816-002002	-
CN-76	DEUTSCH	6	Accel actuator	DT06-6S-EP06	-
CN-79	RING TERM	1	Fuel cut-off solenoid	S820-104000	-
CN-81	DEUTSCH	2	Travel buzzer	DT06-2S-EP06	DP04-2P-E005
CN-88	DEUTSCH	2	Power max solenoid valve	DT06-2S-EP06	-
CN-92	AMP	1	Safety	S814-101100	S814-001100

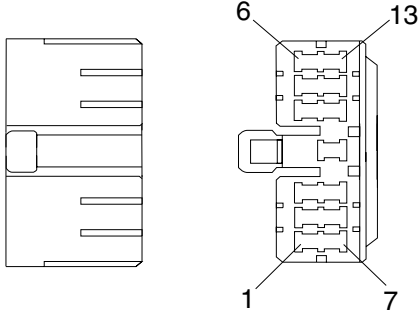
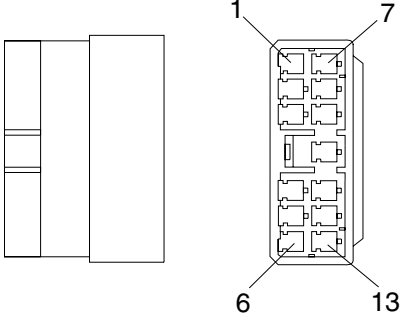
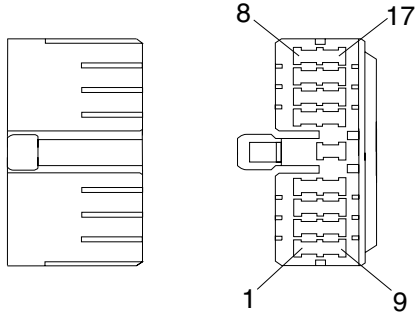
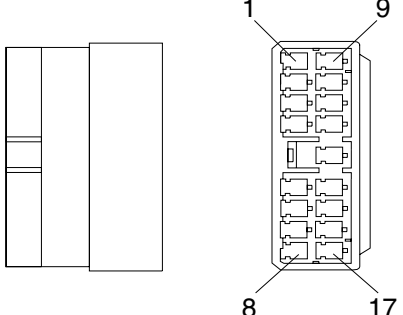
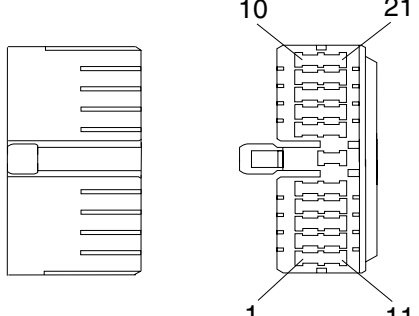
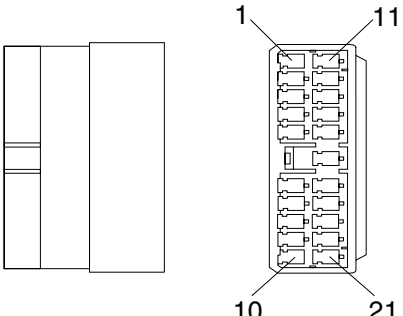
Connectorn umber	Type	No. of pin	Destination	Connector part No.	
				Female	Male
CN-95	KET	2	Fusible link	-	S813-130200
CN-125	-	4	GPS	S816-004002	S816-104002
CN-126	DEUTSCH	4	RS232C connector	DT06-4S-P012	DT04-4P-E004
CN-138	DEUTSCH	3	DC/DC converter	DT06-3S	DT04-3P
CN-139	DEUTSCH	2	12V Socket	-	DT04-2P
CN-140	DEUTSCH	2	Quick coupling	DT06-2S-EP06	DT04-2P-E005
CN-141	AMP	13	Wiper motor control unit	172498-1	-
CN-142	DEUTSCH	3	Accel dial	DT06-3S	-
CN-143	KET	14	Cassette radio	MG610406	-
CN-144	AMP	12	Remocon	174045-2	-
RELAY					
CR-1	RING TERM	1	Battery relay	S820-104002	-
CR-3	-	4	Work lamp relay	S820-104000	-
CR-23	-	2	Start relay	S820-104000	-
CR-24	-	1	Pre-heater relay	S822-014000	-
CR-43	-	4	Engine stop relay	S810-004202	-
SWITCH					
CS-1	CB104	1	Door switch	S822-014004	-
CS-2	-	6	Start key switch	S814-006000	-
CS-4	DEUTSCH	6	Safety switch	DT06-3S	-
CS-5	DEUTSCH	2	Horn switch	-	DT04-2P
CS-19	DEUTSCH	2	One touch decel	DT06-2S	DT04-2P
CS-20	AMP	1	Safety switch	S822-014002	-
CS-21	SWF	10	Main light switch	SWF593757	-
CS-23	SWF	10	Beacon lamp switch	SWF593757	-
CS-24	SWF	10	Overload switch	SWF593757	-
CS-26	DEUTSCH	2	Breaker switch	SWF593757	-
CS-27	SWF	10	Breaker switch	SWF593757	-
CS-29	DEUTSCH	2	Power max	DT06-2S	DT04-2P
CS-53	AMP	1	Wiper cut switch	S822-014002	-
CS-54	SWF	10	Travel alarm	SWF593757	-
CS-67	SWF	10	Quick coupling switch	SWF593757	-
LAMP					
CL-1	KET	2	Cab room lamp	MG610392	-
CL-2	-	1	Cigar light	S822-014002	-
CL-4	DEUTSCH	2	Head lamp	-	DT04-2P-E005
CL-5	DEUTSCH	2	Work lamp-LH	-	DT04-2P
CL-6	DEUTSCH	2	Work lamp-RH	-	DT04-2P
CL-7	CB104	1	Beacon lamp	S822-014004	-
CL-8	DEUTSCH	2	LH cabin light	-	DT04-2P
CL-9	DEUTSCH	2	RH cabin light	-	DT04-2P

Connectorn umber	Type	No. of pin	Destination	Connector part No.	
				Female	Male
SENDER					
CD-1	AMP	2	Hydraulic Temp sender	963040-3	-
CD-2	DEUTSCH	2	Fuel sender	DT06-2S-EP06	-
CD-8	-	2	Water temp sender	85202-1	-
CD-10	RING TERM	1	Air cleaner switch	S820-104002	-
CD-11	AMP	2	Travel alarm pressure switch	S816-102002	-
CD-12	AMP	2	Travel alarm pressure switch	S816-102002	-
CD-13	AMP	2	Travel alarm pressure switch	S816-102002	-
CD-14	AMP	2	Travel alarm pressure switch	S816-102002	-
CD-16	-	2	Water level	S814-002100	-
CD-17	-	2	Tacho sensor	S814-002001	-
CD-18	RING TERM	1	Engine oil pressure switch	S819-010122	-
CD-31	DEUTSCH	2	Overload pressure switch	DT06-2S-EP06	-

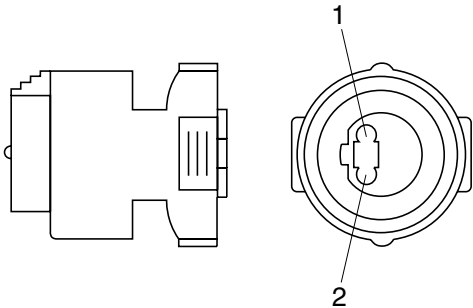
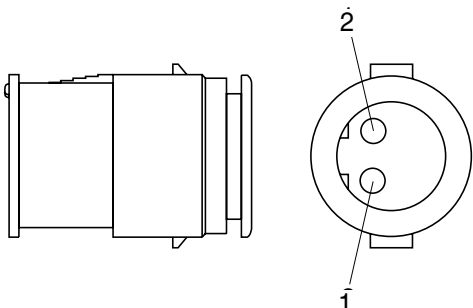
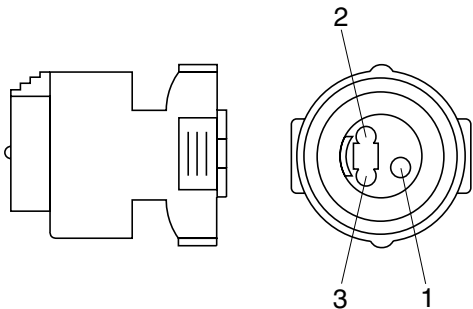
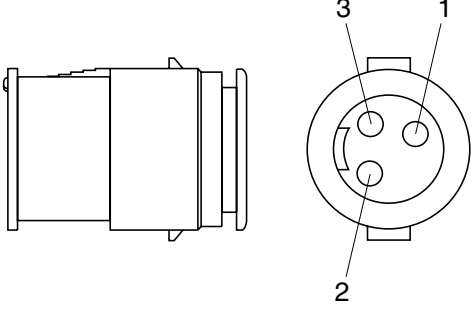
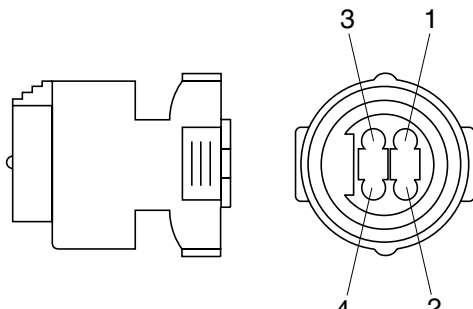
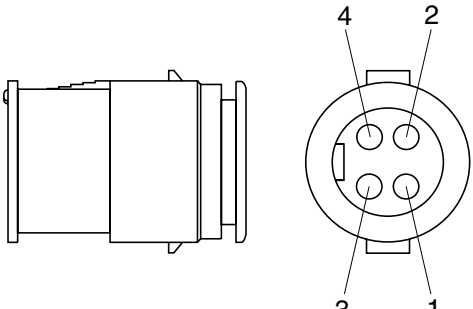
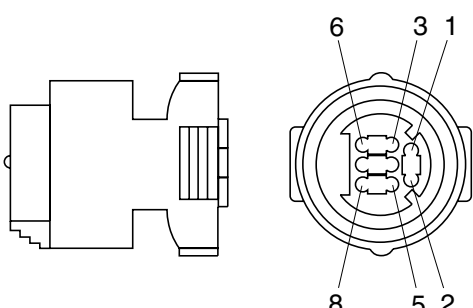
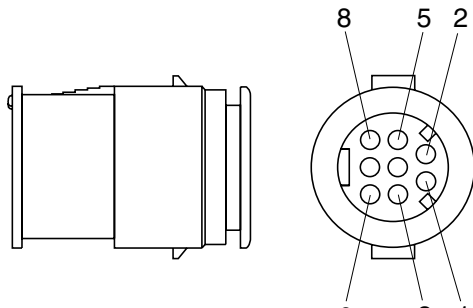
## 2. CONNECTION TABLE FOR CONNECTORS

### 1) PA TYPE CONNECTOR

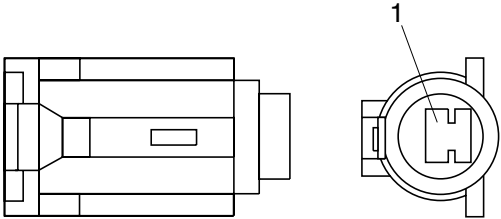
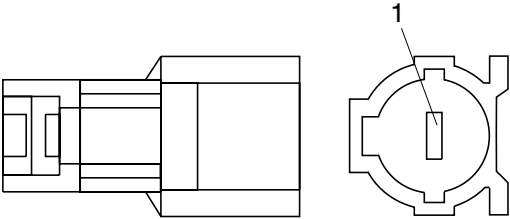
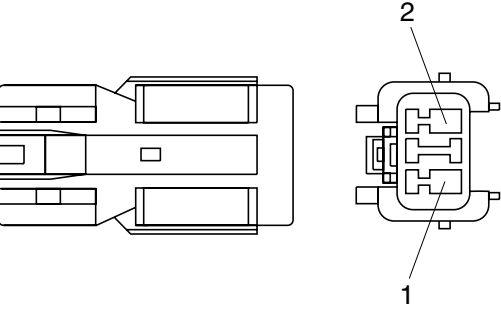
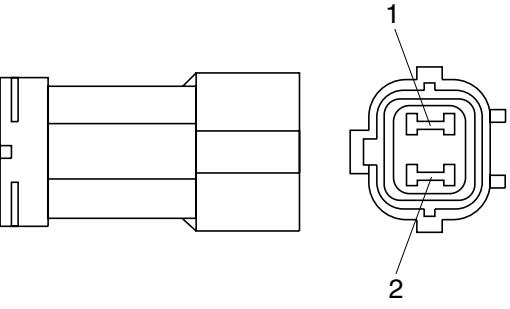
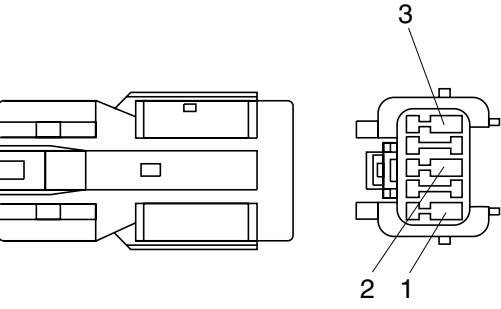
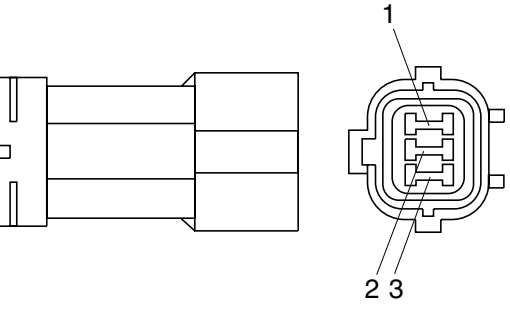
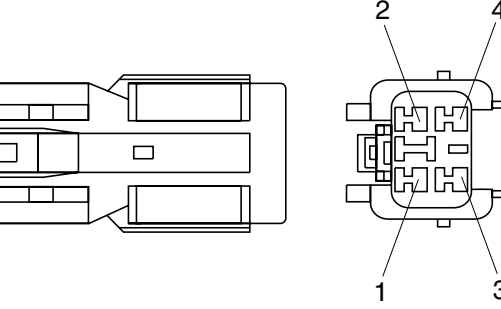
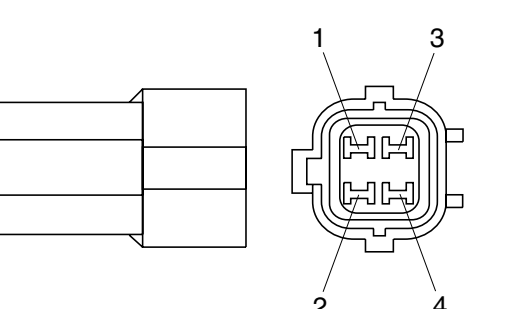
No. of pin	Receptacle connector(Female)	Plug connector(Male)
5	 <p>S811-005002</p>	 <p>S811-105002</p>
7	 <p>S811-007002</p>	 <p>S811-107002</p>
9	 <p>S811-009002</p>	 <p>3S811-109002</p>
11	 <p>S811-011002</p>	 <p>S811-111002</p>

No. of pin	Receptacle connector(Female)	Plug connector(Male)
13	 <p>S811-013002</p>	 <p>S811-113002</p>
17	 <p>S811-017002</p>	 <p>S811-117002</p>
21	 <p>S811-021002</p>	 <p>S811-121002</p>

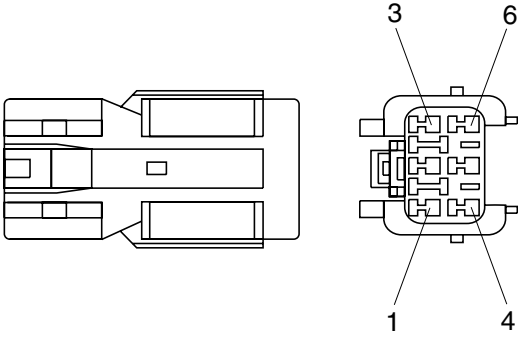
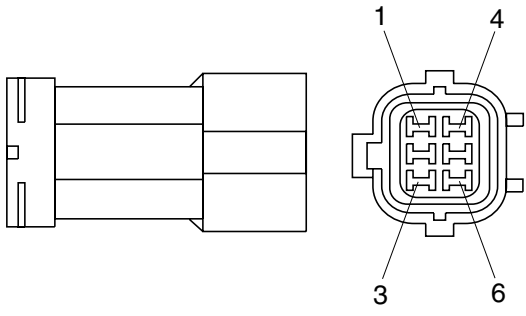
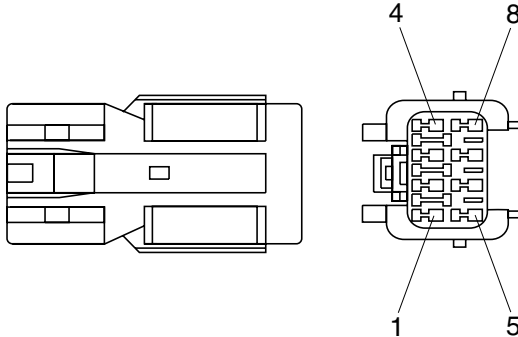
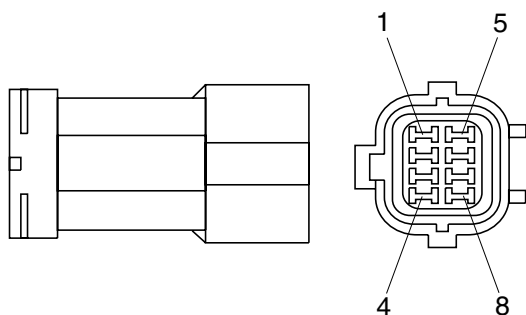
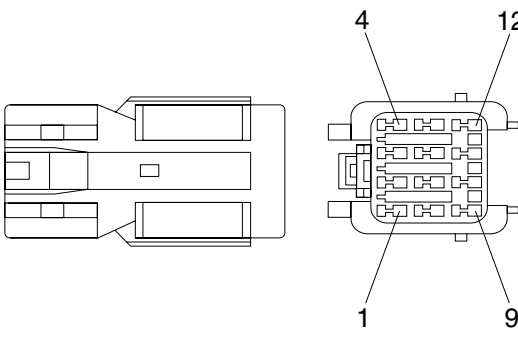
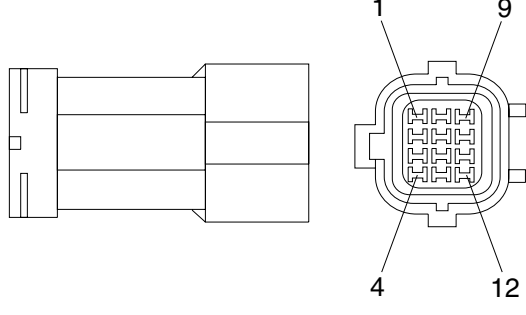
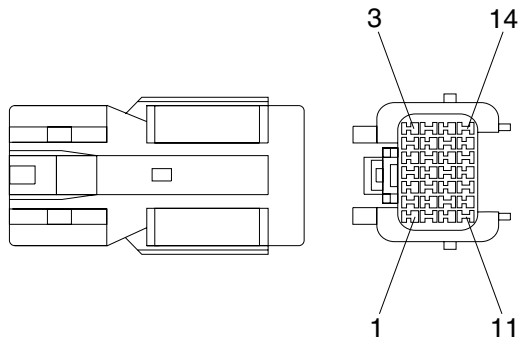
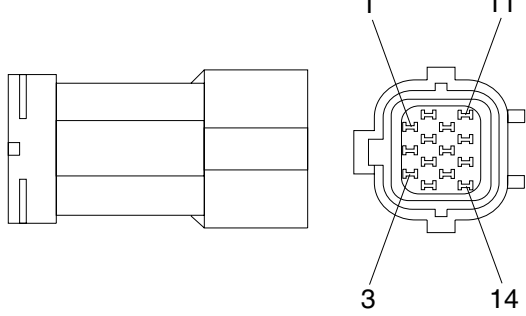
## 2) J TYPE CONNECTOR

No. of pin	Receptacle connector(Female)	Plug connector(Male)
2	 <p>S816-002001</p>	 <p>S816-102001</p>
3	 <p>S816-003001</p>	 <p>S816-103001</p>
4	 <p>S816-004001</p>	 <p>S816-104001</p>
8	 <p>S816-008001</p>	 <p>S816-108001</p>

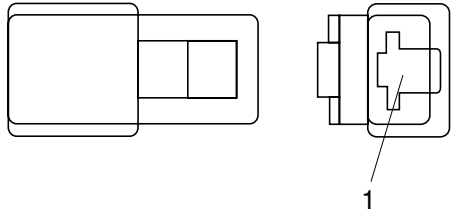
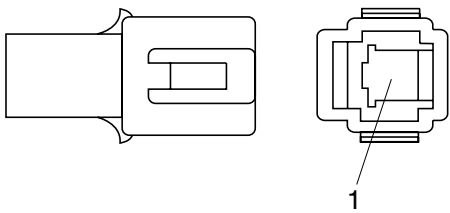
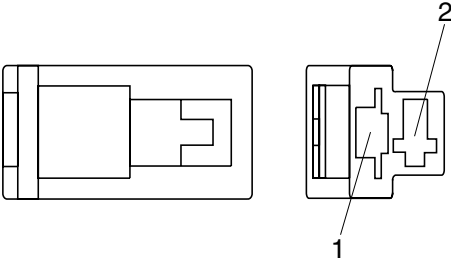
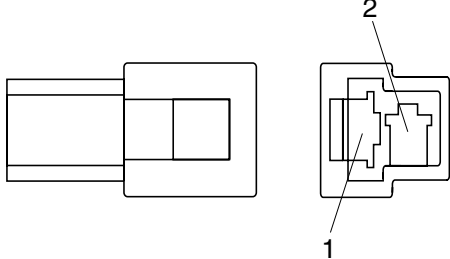
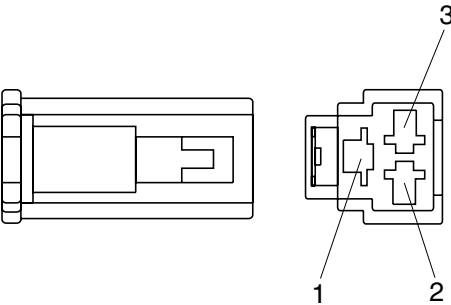
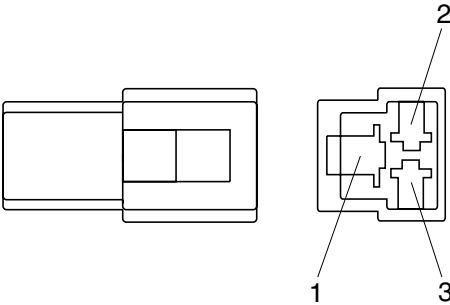
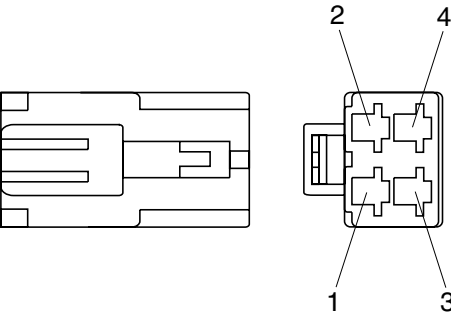
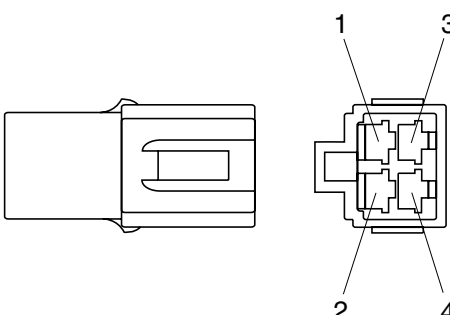
### 3) SWP TYPE CONNECTOR

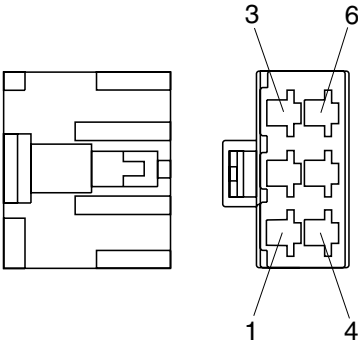
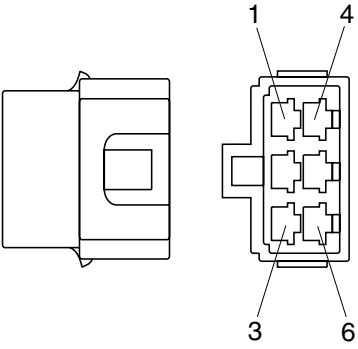
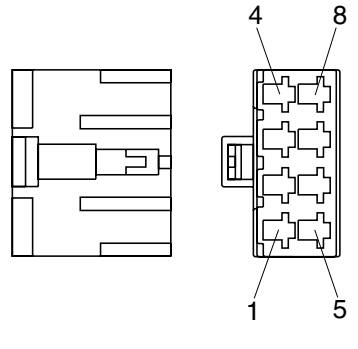
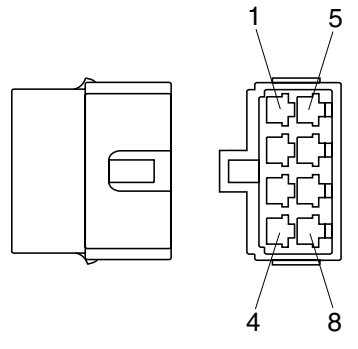
No. of pin	Receptacle connector(Female)	Plug connector(Male)
1	 <p>S814-001000</p>	 <p>S814-101000</p>
2	 <p>S814-002000</p>	 <p>S814-102000</p>
3	 <p>S814-003000</p>	 <p>S814-103000</p>
4	 <p>S814-004000</p>	 <p>S814-104000</p>



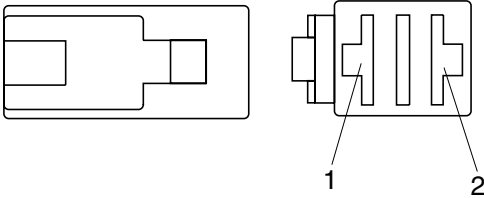
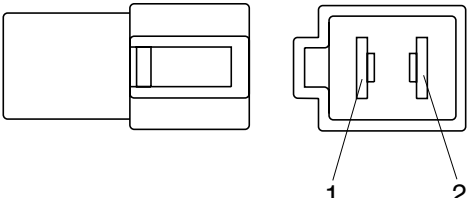
No. of pin	Receptacle connector(Female)	Plug connector(Male)
6	 <p>S814-006000</p>	 <p>S814-106000</p>
8	 <p>S814-008000</p>	 <p>S814-108000</p>
12	 <p>S814-012000</p>	 <p>S814-112000</p>
14	 <p>S814-014000</p>	 <p>S814-114000</p>

#### 4) CN TYPE CONNECTOR

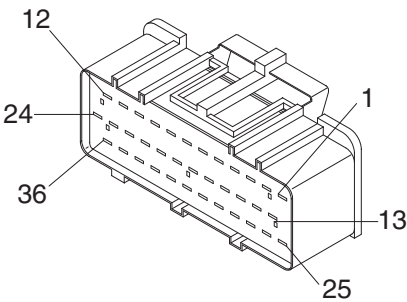
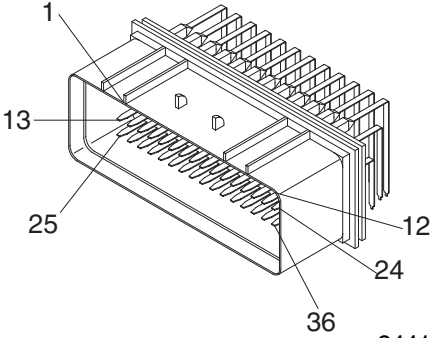
No. of pin	Receptacle connector(Female)	Plug connector(Male)
1	 <p>S810-001202</p>	 <p>S810-101202</p>
2	 <p>S810-002202</p>	 <p>S810-102202</p>
3	 <p>S810-003202</p>	 <p>S810-103202</p>
4	 <p>S810-004202</p>	 <p>S810-104202</p>

No. of pin	Receptacle connector(Female)	Plug connector(Male)
6	 <p>S810-006202</p>	 <p>S810-106202</p>
8	 <p>S810-008202</p>	 <p>S810-108202</p>

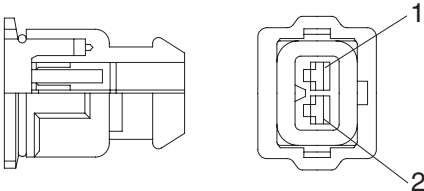
5) 375 FASTEN TYPE CONNECTOR

No. of pin	Receptacle connector(Female)	Plug connector(Male)
2	 <p>S810-002402</p>	 <p>S810-102402</p>

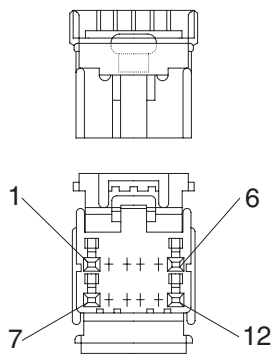
6) AMP ECONOSEAL CONNECTOR

No. of pin	Receptacle connector(Female)	Plug connector(Male)
36	 <p>344111-1</p>	 <p>344108-1</p>

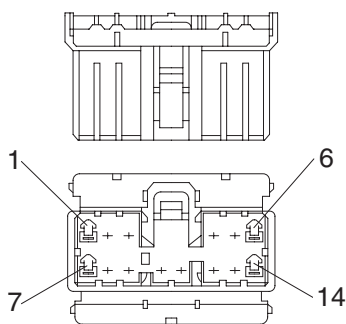
7) AMP TIMER CONNECTOR

No. of pin	Receptacle connector(Female)	Plug connector(Male)
2	 <p>85202-1</p>	

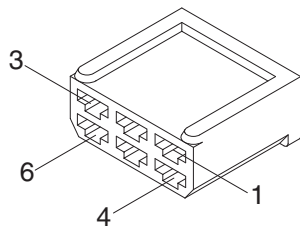
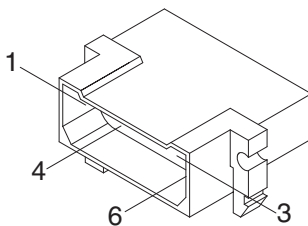
### 8) AMP 040 MULTILOCK CONNECTOR

No. of pin	Receptacle connector(Female)	Plug connector(Male)
12	 <p>174045-2</p>	

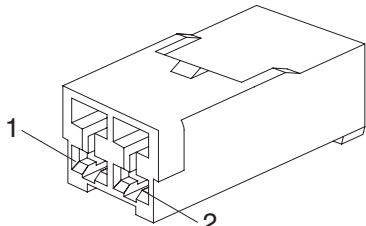
### 9) AMP 070 MULTILOCK CONNECTOR

No. of pin	Receptacle connector(Female)	Plug connector(Male)
14	 <p>173852</p>	

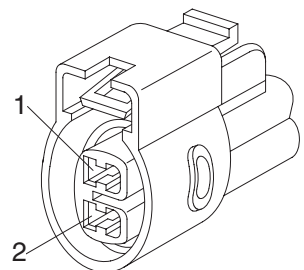
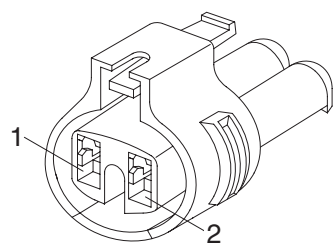
### 10) AMP FASTIN - FASTON CONNECTOR

No. of pin	Receptacle connector(Female)	Plug connector(Male)
6	 <p>925276-0</p>	 <p>480003-9</p>

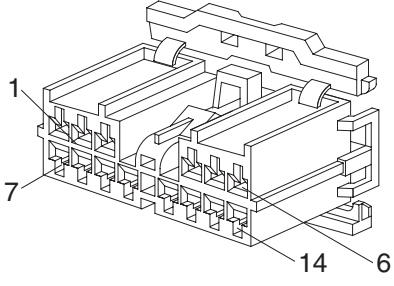
### 11) KET 090 CONNECTOR

No. of pin	Receptacle connector(Female)	Plug connector(Male)
2	 <p>MG610070</p>	

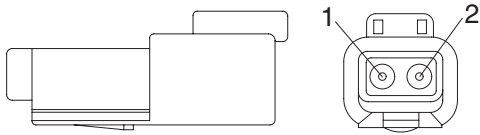
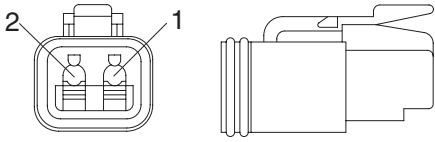
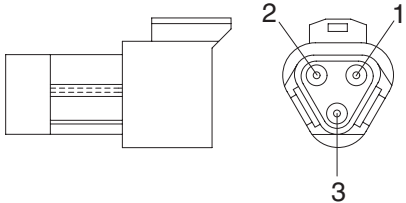
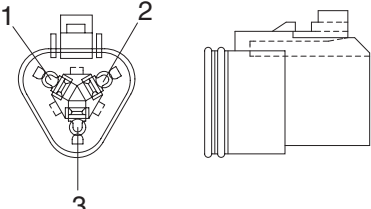
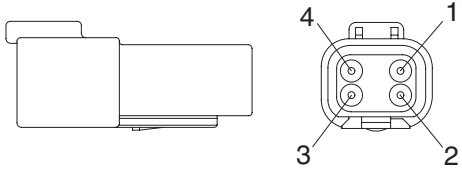
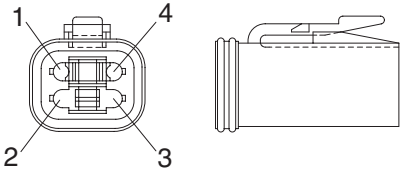
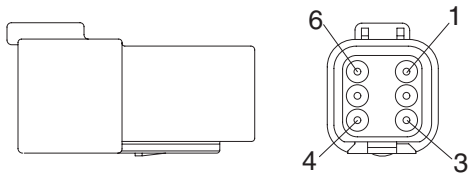
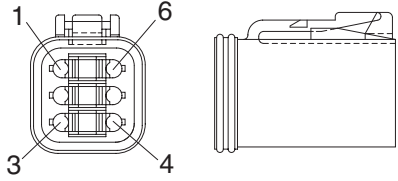
### 12) KET 090 WP CONNECTORS

No. of pin	Receptacle connector(Female)	Plug connector(Male)
2	 <p>MG640605</p>	
2	 <p>MG640795</p>	

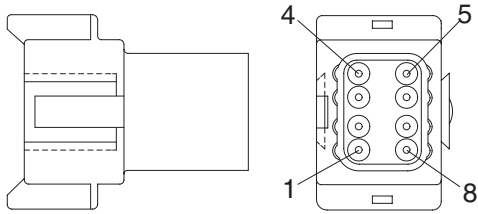
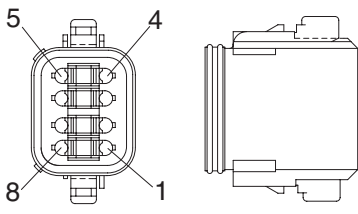
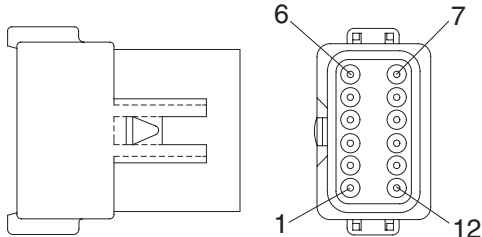
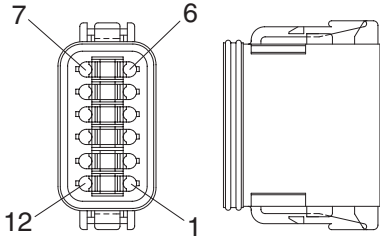
## 12) KET SDL CONNECTOR

No. of pin	Receptacle connector(Female)	Plug connector(Male)
14	 <p>MG610406</p>	

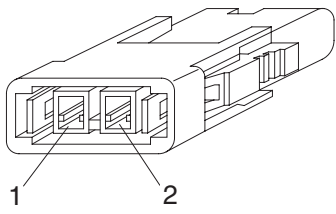
### 13) DEUTSCH DT CONNECTORS

No. of pin	Receptacle connector(Female)	Plug connector(Male)
2	 <p>DT06-2S</p>	 <p>DT06-2P</p>
3	 <p>DT06-3S</p>	 <p>DT06-3P</p>
4	 <p>DT06-4S</p>	 <p>DT06-4P</p>
6	 <p>DT06-6S</p>	 <p>DT06-6P</p>

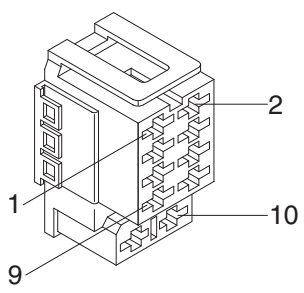


No. of pin	Receptacle connector(Female)	Plug connector(Male)
8	 <p>DT06-8S</p>	 <p>DT06-8P</p>
12	 <p>DT06-12S</p>	 <p>DT06-12P</p>

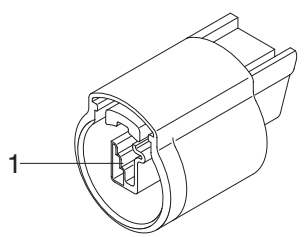
#### 14) MOLEX 2CKTS CONNECTOR

No. of pin	Receptacle connector(Female)	Plug connector(Male)
2	 <p>35215-0200</p>	

#### 15) ITT SWF CONNECTOR

No. of pin	Receptacle connector(Female)	Plug connector(Male)
10	 <p>SWF593757</p>	

#### 16) MWP NMWP CONNECTOR

No. of pin	Receptacle connector(Female)	Plug connector(Male)
1	 <p>NMWP01F-B</p>	

## SECTION 5 MECHATRONICS SYSTEM

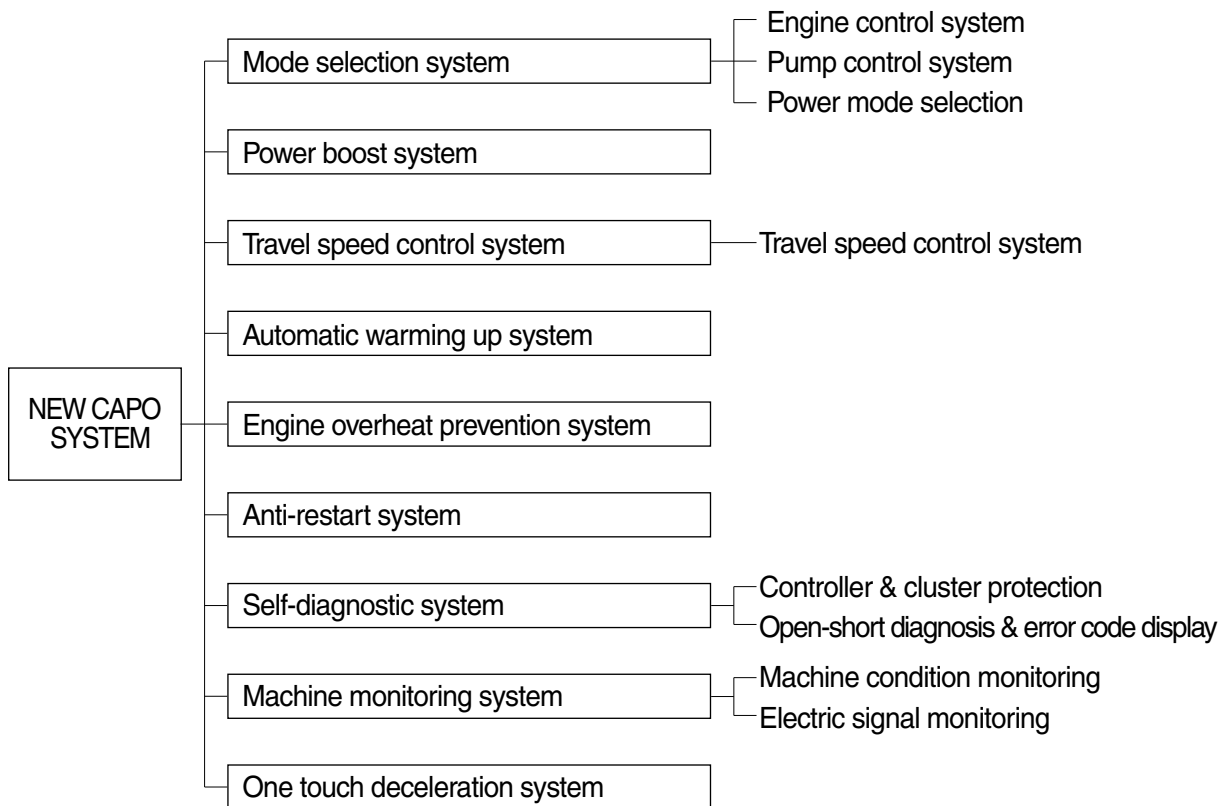
Group 1 Outline .....	5-1
Group 2 Mode Selection System .....	5-3
Group 3 Power Boost System .....	5-4
Group 4 Travel Speed Control System .....	5-5
Group 5 Automatic Warming Up Function .....	5-6
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Group 10 EPPR(Electro Proportional Pressure Reducing) Valve .....	5-17
Group 11 Prolix Switch .....	5-20
Group 12 Monitoring System .....	5-21

## SECTION 5 MECHATRONICS SYSTEM

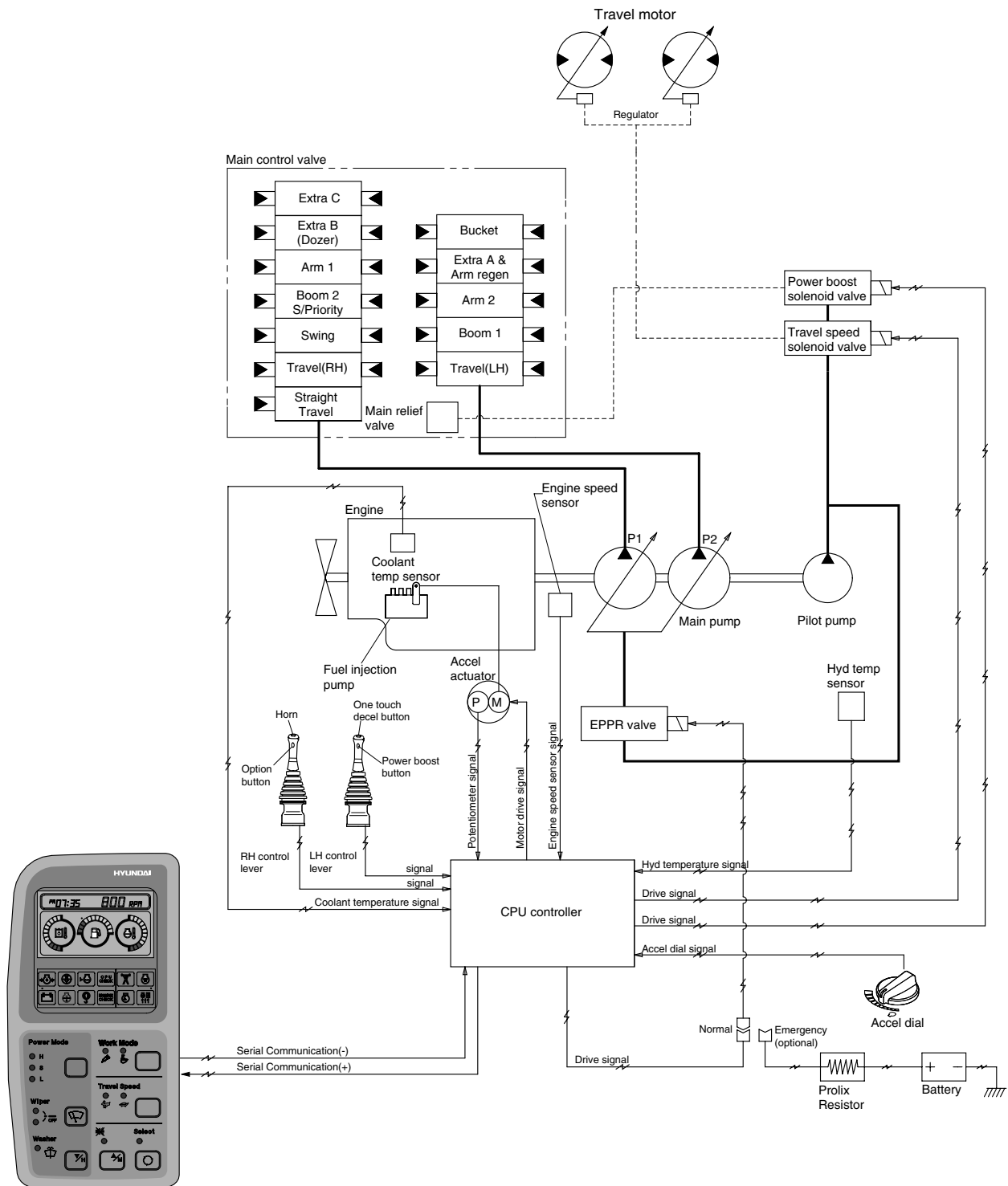
### GROUP 1 OUTLINE

The NEW CAPO(Computer Aided Power Optimization) system controls engine and pump mutual power at an optimum and less fuel consuming state for the selected work by mode selection, one touch 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.



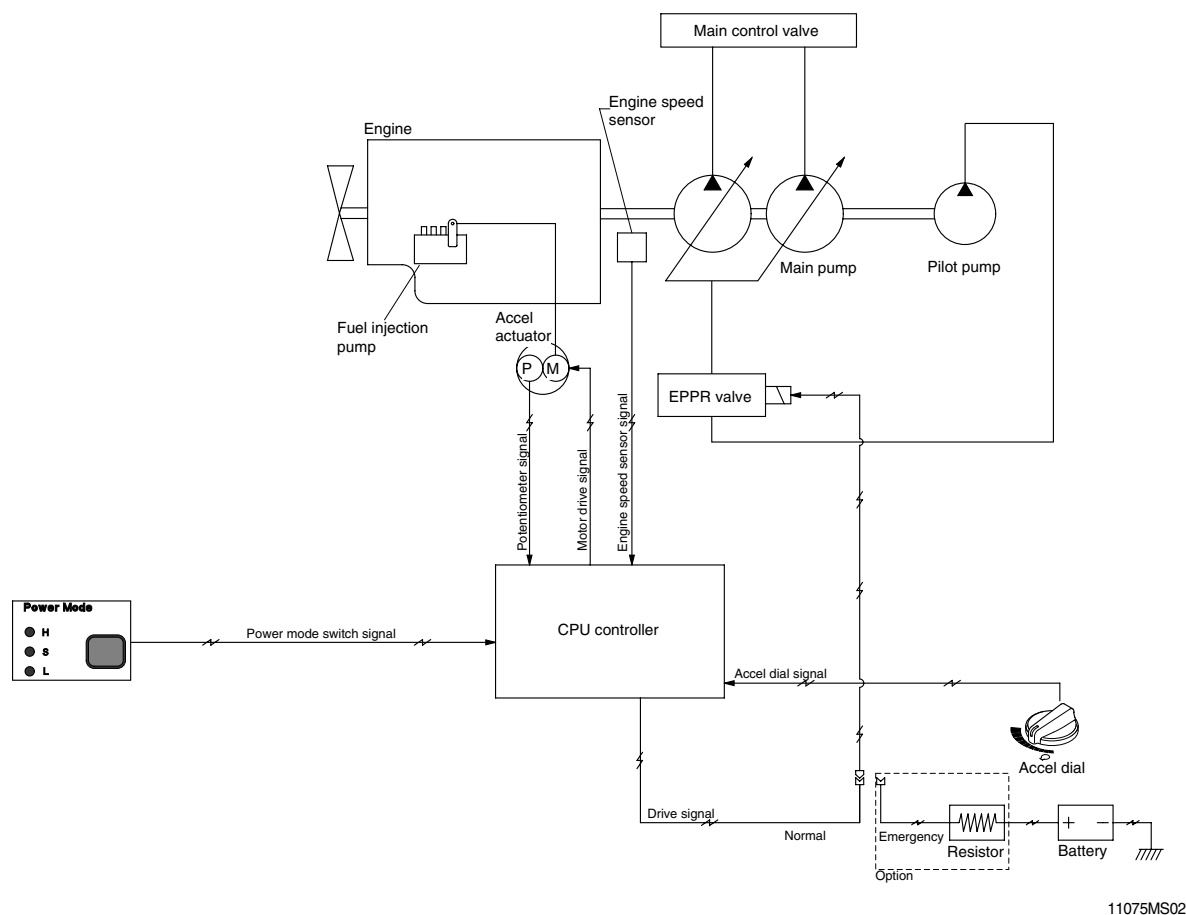
## SYSTEM DIAGRAM



RD11075MS01

## GROUP 2 MODE SELECTION SYSTEM

### 1. POWER MODE SELECTION SYSTEM



11075MS02

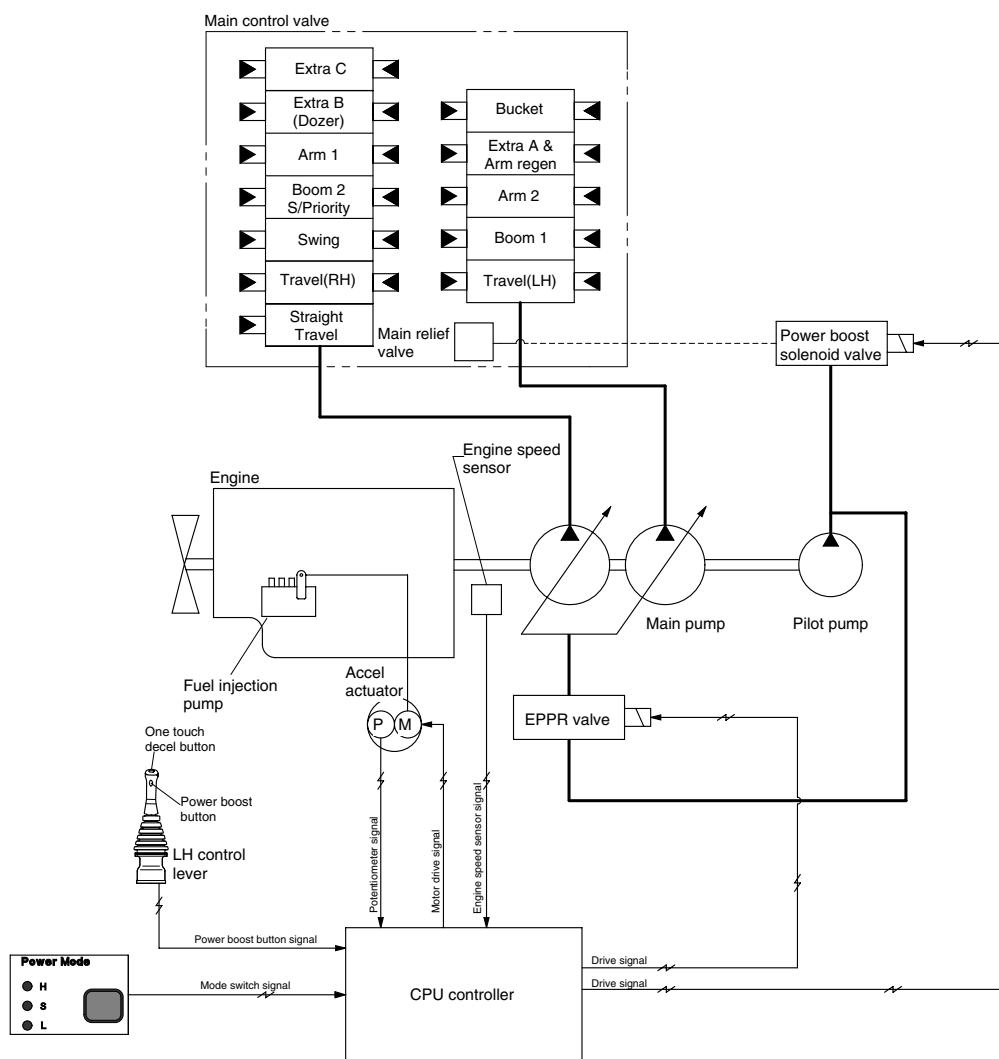
Mode selection system(Micro computer based electro-hydraulic pump and engine mutual control system) optimizes the engine and pump performance.

The combination of 3 power modes(H, S, L) and accel dial position(10 set) 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	Default		Other case ※	
					Current (mA)	Pressure (kgf/cm <sup>2</sup> )	Current (mA)	Pressure (kgf/cm <sup>2</sup> )
H	High power	100	1900±50	1800	245±30	4.1	245	4.1
S	Standard power	85	1800±50	1700	290±30	7.5	318	8.8
L	Light power	70	1750±50	1650	370±30	14.5	439	17.4
One touch decel	Engine quick deceleration	-	1050±100	-	650±30	46	650±30	40
KEY START	Key switch start position	-	1050±100	-	650±30	40	650±30	40

※ Other case can be set by pressing the "travel speed" switch and "buzzer stop switch" for 2 seconds at the same time in "model & version" display on the cluster(for detail, see 5-17)

## GROUP 3 POWER BOOST SYSTEM



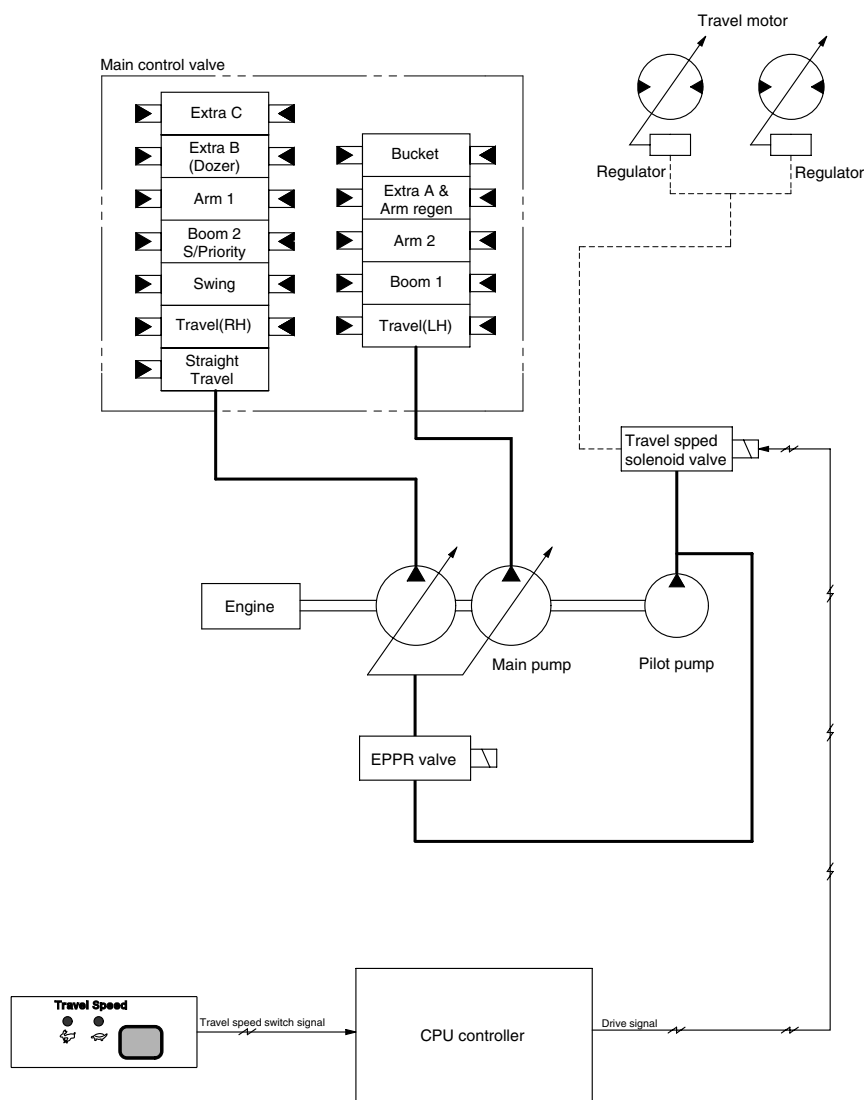
11075MS03

- 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	330kgf/cm <sup>2</sup>	360ksf/cm <sup>2</sup>
Time of operation	-	Even when pressed continuously, it is canceled after 8 sec.

※ Default - Power boost solenoid valve : OFF

## GROUP 4 TRAVEL SPEED CONTROL SYSTEM



11075MS04

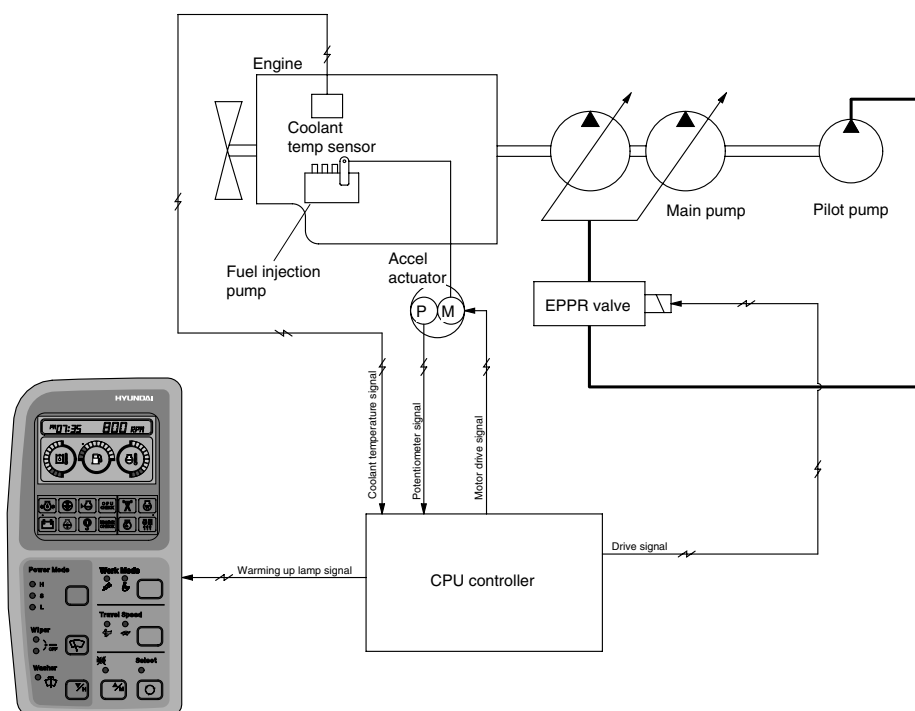
Travel speed can be switched manually by pressing the travel speed switch on the cluster.

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

※ Default : Turtle(Lo)



## GROUP 5 AUTOMATIC WARMING UP FUNCTION



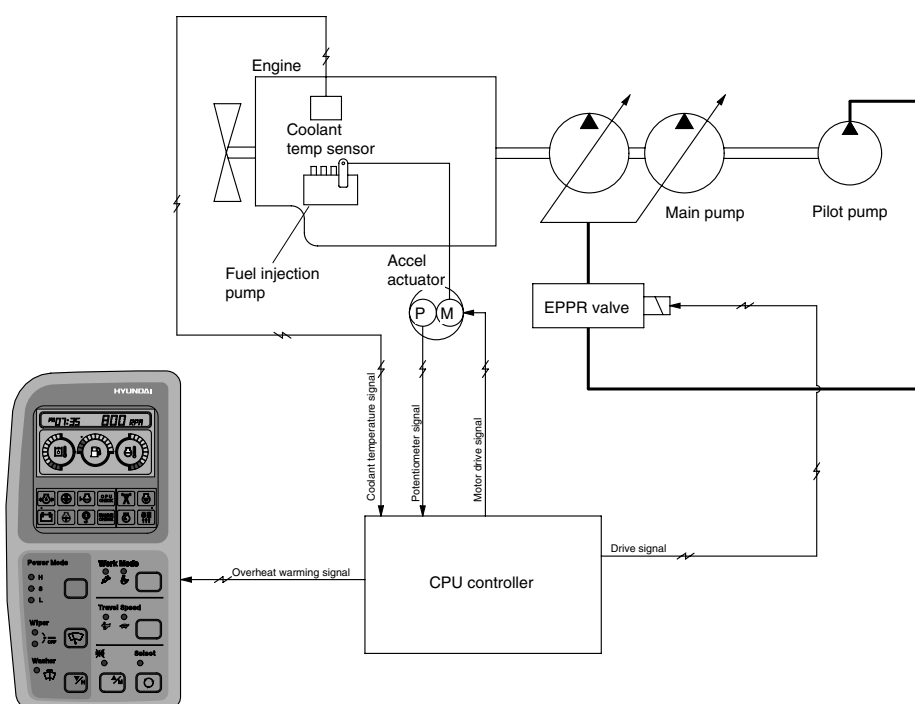
RD11075MS05

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.
2. In case of the coolant temperature increases up to 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	<ul style="list-style-type: none"> <li>- Coolant temperature : Less than 30°C(After engine run)</li> <li>- Accel dial position is under <b>3</b></li> </ul>	<ul style="list-style-type: none"> <li>- Mode : Default(<b>S</b> mode)</li> <li>- Warming up time : 10 minutes(Max)</li> <li>- Warming up lamp : ON</li> </ul>
Canceled	<ul style="list-style-type: none"> <li>- Coolant temperature : Above 30°C</li> <li>- Warming up time : Above 10 minutes</li> <li>- Changed mode set by operator</li> <li>- Increase engine speed by rotating accel dial clockwise</li> <li>※ If any of the above conditions is applicable, the automatic warming up function is canceled</li> </ul>	<ul style="list-style-type: none"> <li>- Default mode</li> <li>- Default mode</li> <li>- Changed mode</li> </ul>
Warming up lamp	<ul style="list-style-type: none"> <li>- Coolant temperature : Above 30°C</li> </ul>	<ul style="list-style-type: none"> <li>- Warming up lamp : OFF</li> </ul>

## GROUP 6 ENGINE OVERHEAT PREVENTION FUNCTION



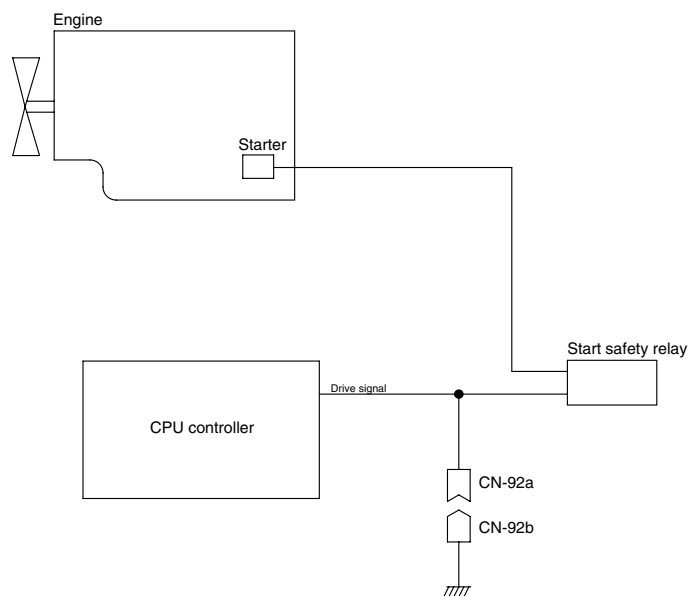
RD11075MS06

1. CPU controller reads engine coolant temperature through the temperature sensor and when the engine coolant boils up to 110°C, it sends overheat warning signal to the cluster and decrease the engine speed same as accel dial 7 position.
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 - Accel dial set : Above 8	- Engine rpm drop to accel dial 7 position - 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 and accel dial set before - Hold on the changed set
Overheat warning lamp	- Coolant temperature : Less than 100°C	- Overheat warning lamp : OFF

## GROUP 7 ANTI-RESTART SYSTEM



21075MS10

### 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-92a and CN-92b to ensure the engine start without the CPU controller.

## GROUP 8 SELF-DIAGNOSTIC SYSTEM

### 1. OUTLINE

When any abnormality occurs in the NEW CAPO 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 **CHECK Er : 00**.

If there are more than 2 error codes, each one can be displayed by pressing ▲ and ▼ switch respectively.

#### Examples :

1) Communication Error

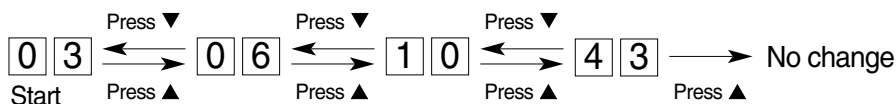
Co : Err & Buzzer sound

2) No problem

CHECK Er : 00

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

CHECK Er : 03

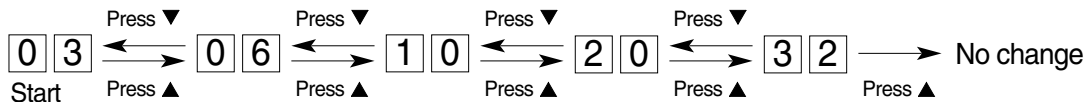


### 3. RECORDED ERROR DISPLAY

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

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

TIME Er : 03



### 4. DELETE ALL RECORDED ERROR CODES

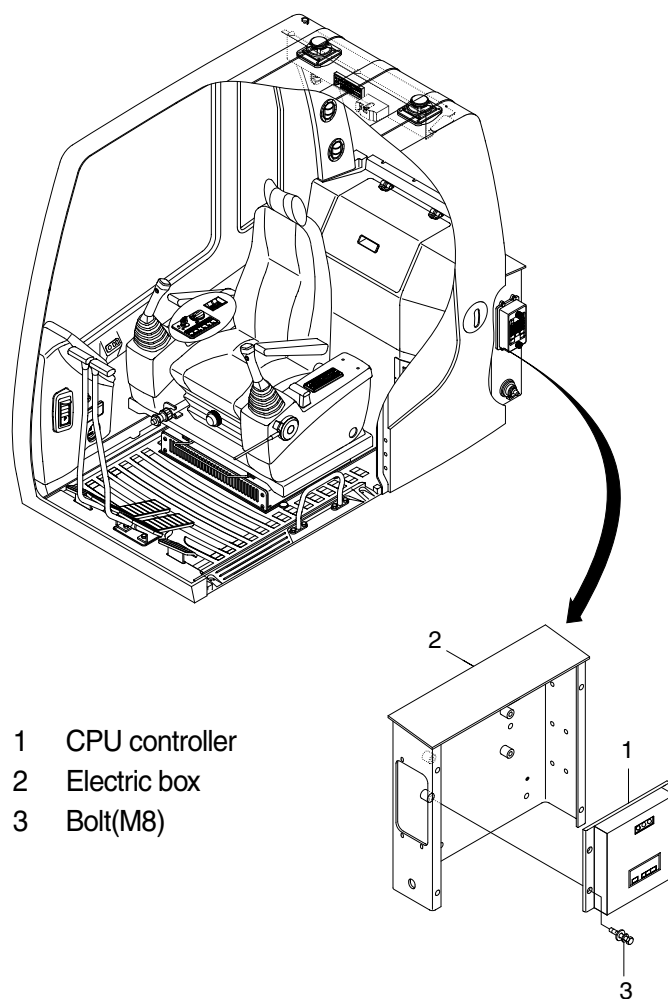
Select recorded error(TIME Er) display and press engine 1/2 and select switch 1/2 at the same time for 2 seconds or more. Cluster display changes to **TIME Er : 00**, which shows that CPU controller deleted all the recorded error codes in the memory.

## 5. ERROR CODES TABLE

Fault code No.	Description
00	No error
01	Short circuit in accel actuator motor system
02	Potentiometer circuit is shorted to Vcc(5V) or battery +
03	Short circuit in pump EPPR valve system
05	Short circuit in travel speed solenoid system
10	Short circuit in hour-meter system
11	Accel dial circuit is shorted to Vcc(5V) or battery +
16	Accel actuator motor circuit is open or shorted to ground
17	Potentiometer circuit is open or shorted to ground
18	Pump EPPR valve circuit is open or shorted to ground
20	Travel speed solenoid circuit is open or shorted to ground
25	Hour-meter circuit is open or shorted to ground
26	Accel dial circuit is open or shorted to ground
31	Engine preheater circuit is open or shorted to ground
33	Alternator circuit is open or shorted to ground
34	Actuator input voltage is below 18V
35	Actuator input voltage is over 38V
36	Communication error with cluster
37	Engine speed sensor circuit is open or shorted to ground
40	There is more than 500rpm difference between target speed and actual speed
41	Hydraulic oil temperature sensor circuit is shorted to ground
42	Fuel level sensor circuit is shorted to ground
43	Coolant temperature sensor circuit is shorted to ground
45	Hydraulic oil temperature sensor circuit is open or shorted to battery +
46	Fuel level sensor circuit is open or shorted to battery +
47	Coolant temperature sensor circuit is open or shorted to battery +
49	Engine preheater circuit is shorted to battery +

## GROUP 9 ENGINE CONTROL SYSTEM

### 1. CPU CONTROLLER MOUNTING



- 1 CPU controller
- 2 Electric box
- 3 Bolt(M8)

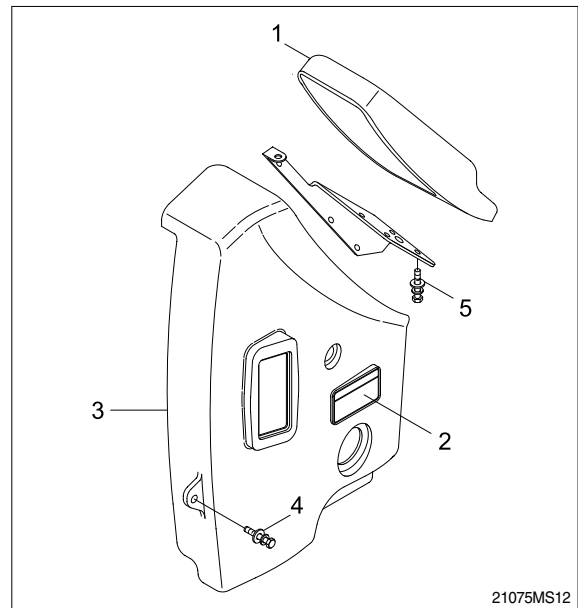
11075MS12

### 2. CPU CONTROLLER ASSEMBLY

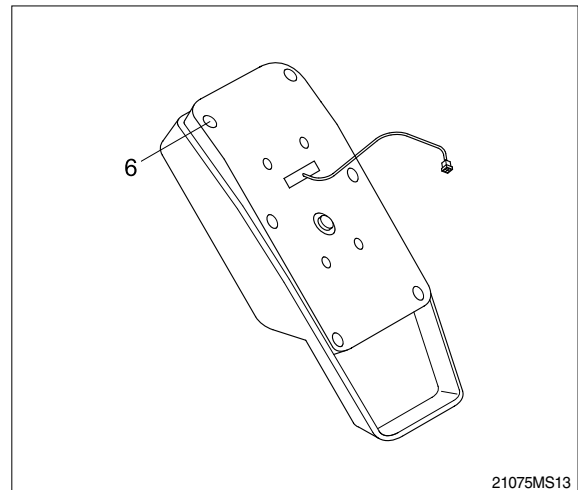
- 1) Remove four pieces of bolt(3) of electric box(2).
- 2) Disconnect 2 connectors from CPU controller.
- 3) Remove 6 pieces of screw and open the cover of CPU controller.
- 4) Inspection : Check PCB(Printed Circuit Board)
  - (1) If any damage is found, replace CPU controller assembly.
  - (2) If not, but CAPO system does not work please report it to HHI dealer or A/S department.

### 3. EXCHANGE METHOD OF THE ROM

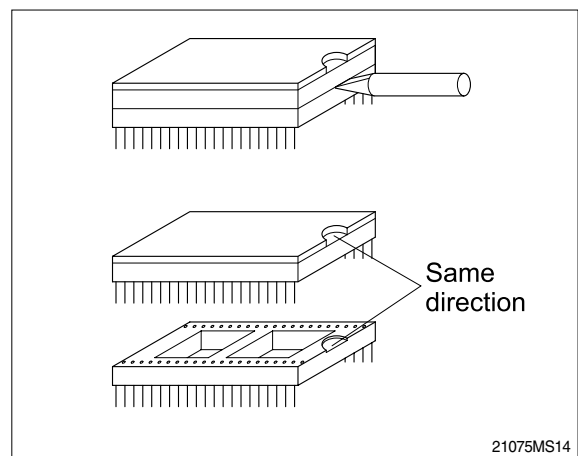
- 1) Disassemble the ash tray(2).
- 2) Disassemble the wiper motor cover(3).
- 3) Disassemble the cluster(1).



- 4) Loosen the screws(6EA) located back of the cluster.
- 5) Then you can open the upper case of the cluster easily.

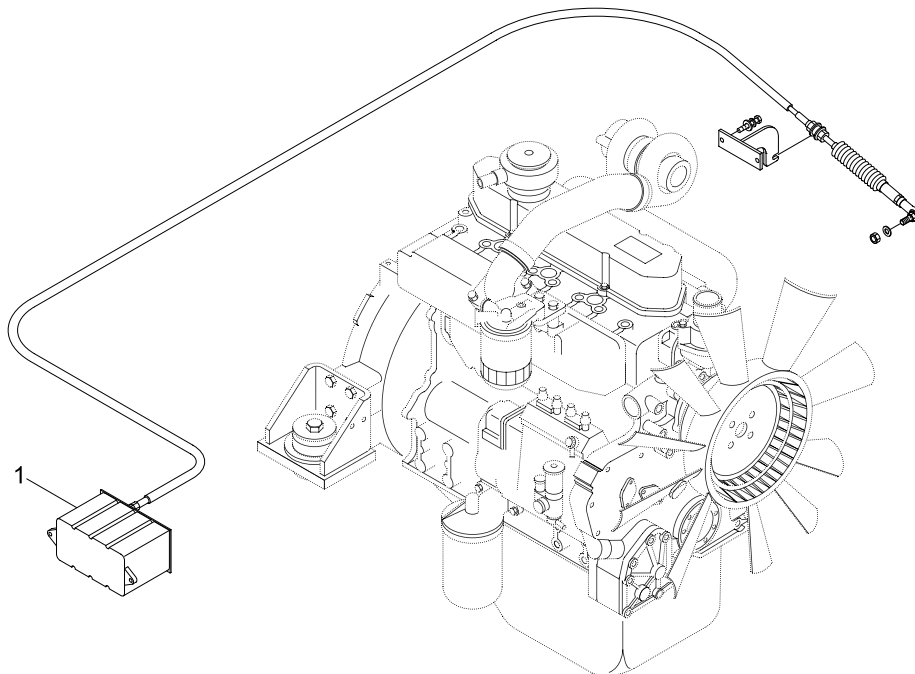


- 6) Install the new ROM.(Be careful of direction and assmelbe the cluster in the reverse order to removal).



## 4. ENGINE ACCEL ACTUATOR

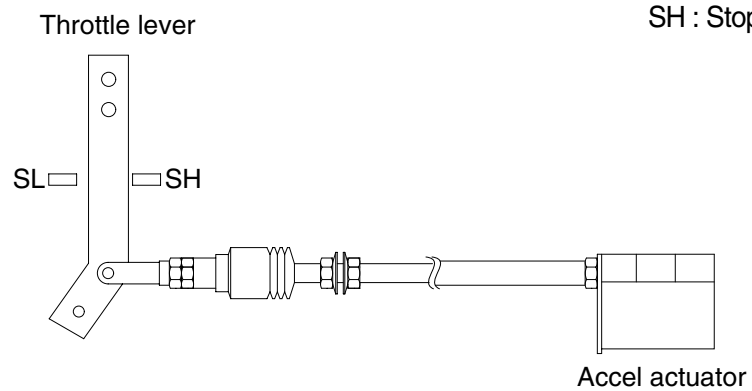
1 Accel actuator



RD8075MS07

### 1) ENGINE THROTTLE LEVER

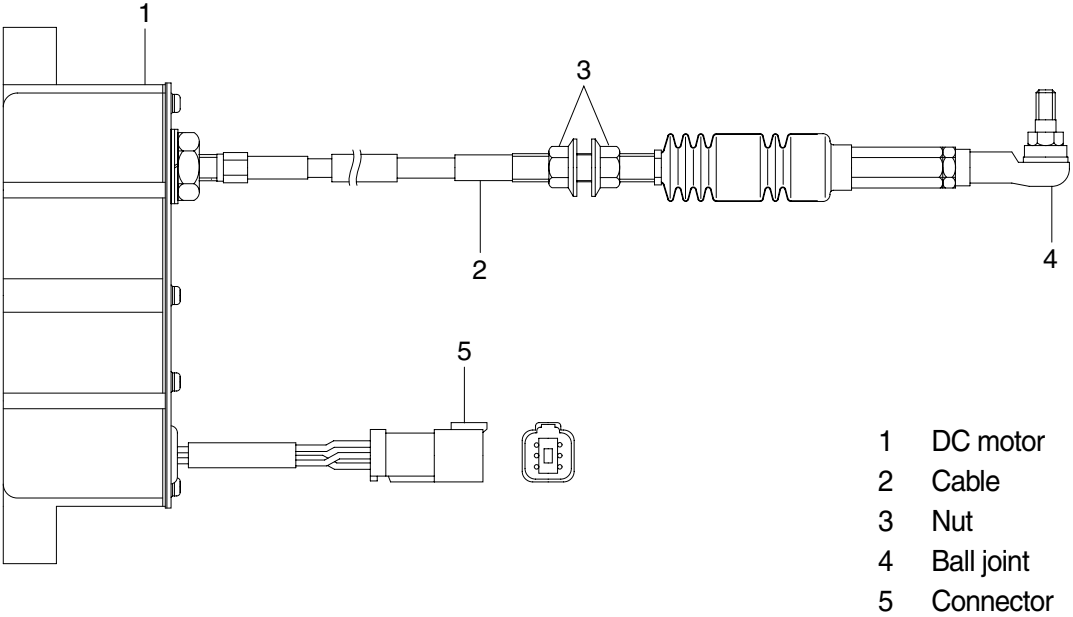
SL : Stopper, low idle  
SH : Stopper, high idle



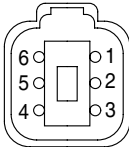
11075MS08



2) ACCEL ACTUATOR



11075MS09

Connector		
Type		6P, female
Line color & description	1	Green(Potentiometer 5V)
	2	White(Potentiometer SIG)
	3	Yellow(Potentiometer GND)
	4	-
	5	Red(Motor+)
	6	Blue(Motor -)
Inspection		Check resistance Spec : 10 Ω (Between No.5-6) 5kΩ (Between No.1-3)

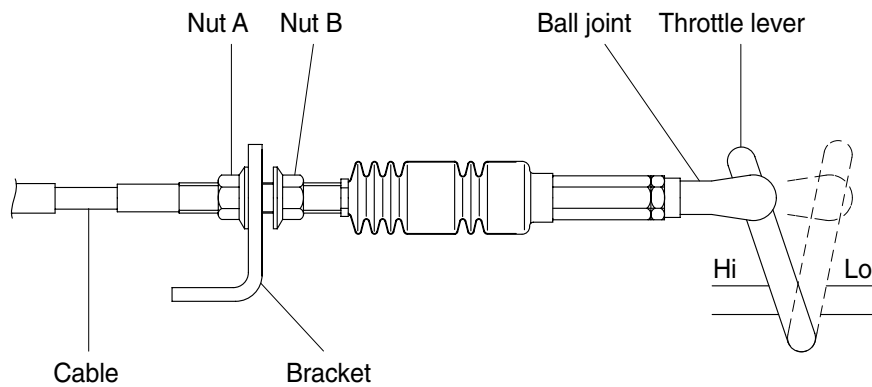
#### 4) ACCEL ACTUATOR CABLE SETTING PROCEDURE

##### (1) Key ON

- ① Set the engine control dial max position and the one touch decel switch OFF.
- ② Connect the ball joint of cable to engine throttle lever.
- ③ Pull the cable to high stopper and put nut **A** edge to yoke of the bracket.  
※ Make throttle lever not contact to the edge of high stopper.

##### (2) Key START

- ④ Confirm if the engine speed on cluster is same as each mode specification.
- ⑤ If the engine speed displayed on cluster is higher than each mode specification, then turn the nut **A** to counter clockwise and make the engine speed same to each mode specification.
- ⑥ If the engine speed displayed on cluster is lower than each mode specification, then turn the nut **A** to clockwise and make the engine speed same to each mode specification.
- ⑦ Turn nut **B** to clockwise and fix the cable to bracket.

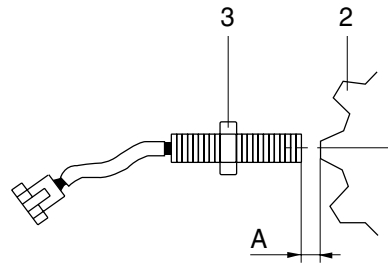
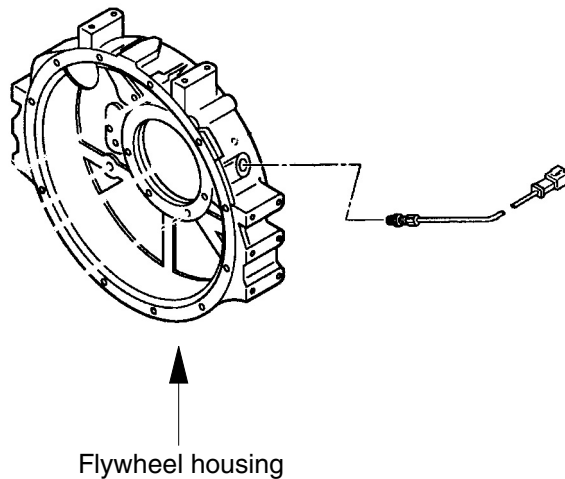


130W5MS05

Mode	RPM
H	$1900 \pm 50$
S	$1800 \pm 50$
L	$1750 \pm 50$
Key start(one touch decel)	$1050 \pm 100$

## 5. ENGINE SPEED SENSOR

### 1) DETECT ACTUAL ENGINE RPM AND SEND SIGNAL TO TACHOMETER



- 2 Gear teeth, flywheel
- 3 Lock nut, speed sensor
- A Clearance

11075MS10/R140LC-7 7타 5-20

### 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  $\Omega$
- (2) Check voltage while engine run.
  - SPEC : 2~28Vac, dependent on the engine speed(rpm)

## GROUP 10 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 (At accel dial 10)
		kgf/cm <sup>2</sup>	psi		
Standard (Ver : 1.x)	H	5 ± 3	71 ± 40	245 ± 30	1900 ± 50
	S	11 ± 3	156 ± 40	290 ± 30	1800 ± 50
	L	17 ± 3	242 ± 40	370 ± 30	1750 ± 50
Option (Ver : 2.x)	H	5 ± 3	71 ± 40	245 ± 30	1950 ± 50
	S	11 ± 3	156 ± 40	318 ± 30	1850 ± 50
	L	14 ± 3	199 ± 40	439 ± 30	1750 ± 50
★		19.8 ± 3	280 ± 40	471 ± 30	-



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

### 2. HOW TO SWITCH THE VERSION(1.x ↔ 2.x) ON THE CLUSTER

You can switch the EPPR valve pressure set by selecting the version(1.x ↔ 2.x).

Step 1. Turn the key switch **ON**.

Step 2. Press the **SELECT** switch 3 times.

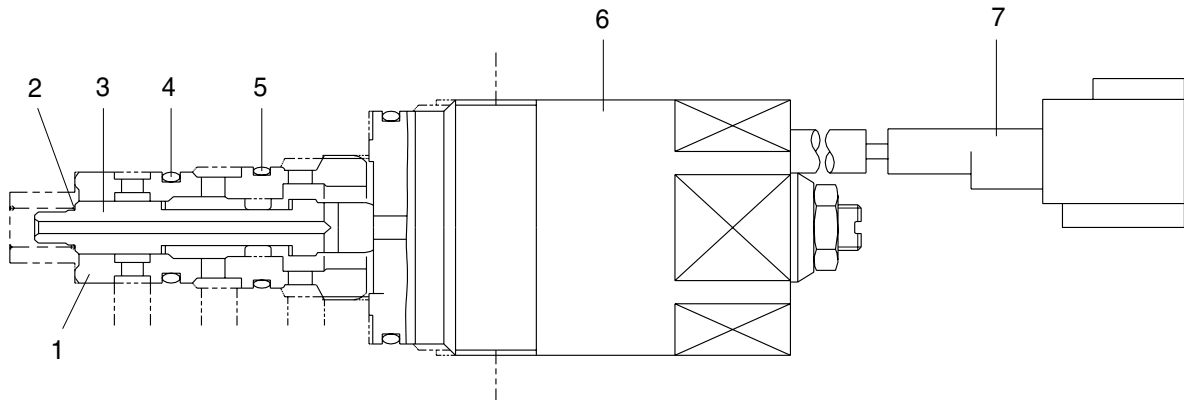
Step 3. While 7 segment on the cluster shows the version of the CPU controller program, for example **11:C1.0** press the buzzer stop switch(  ) + travel speed control switch(  ) at the same time for 2 seconds.

The display changes to **11:C2.0**, and it indicates that version 2.0(Option) is selected.

※ If you want to get back to ver:1.x, go to step 1~3.

## 2. OPERATING PRINCIPLE

### 1) STRUCTURE

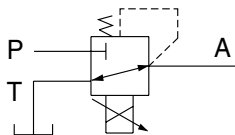


R140LC-7 기타 5-22(1)

- 1 Sleeve
- 2 Spring
- 3 Spool

- 4 O-ring
- 5 O-ring

- 6 Solenoid valve
- 7 Connector



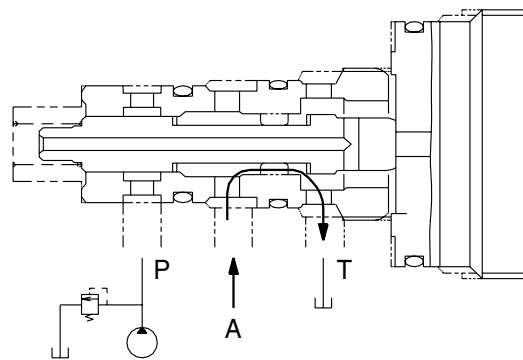
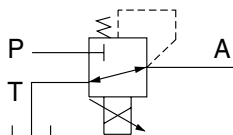
P Pilot oil supply line(Pilot pressure)

T Return to tank

A Secondary pressure to flow regulator at hydraulic pump

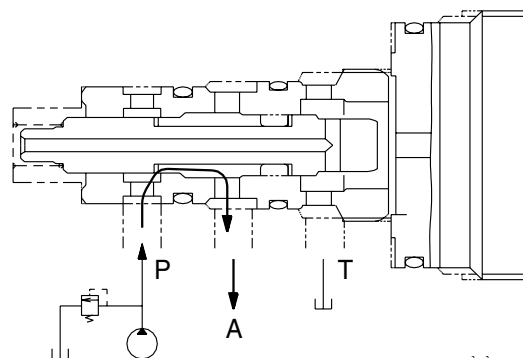
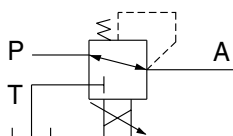
### 2) AT H MODE

Pressure line is blocked and A oil returns to tank.



### 3) AT S MODE

Secondary pressure enters into A.



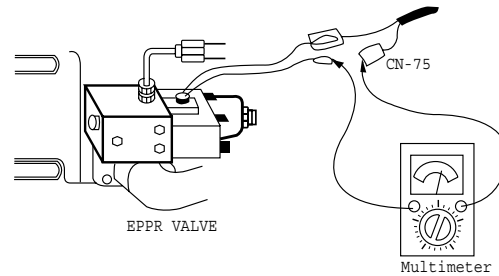
R140LC-7 기타 5-22(2)

### 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) Position the accel dial at 10.
- (4) If tachometer show approx  $1950 \pm 50$ rpm, disconnect one wire harness from EPPR valve.
- (5) Install multimeter as figure.
- (6) Check electric current at bucket circuit relief position.

Spec : 200~500mA

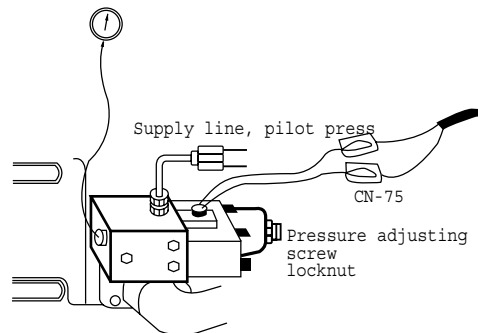


R140LC-7 기타 5-23(1)

#### 2) CHECK PRESSURE AT EPPR VALVE

- (1) Remove plug and connect pressure gauge as figure.
  - Gauge capacity : 0 to 40-50kgf/cm<sup>2</sup>  
(0 to 580-725psi)
- (2) Start engine.
- (3) Set S-mode and cancel auto decel mode.
- (4) Position the accel dial at 10.
- (5) If tachometer show approx  $1950 \pm 50$ rpm, 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.

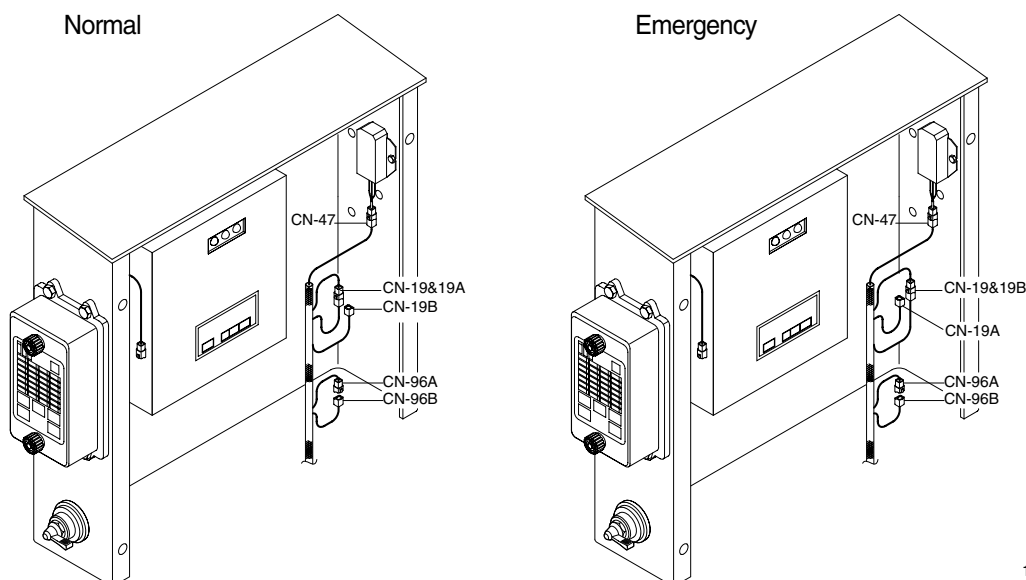
Spec : 2~25kgf/cm<sup>2</sup>(30~350psi)



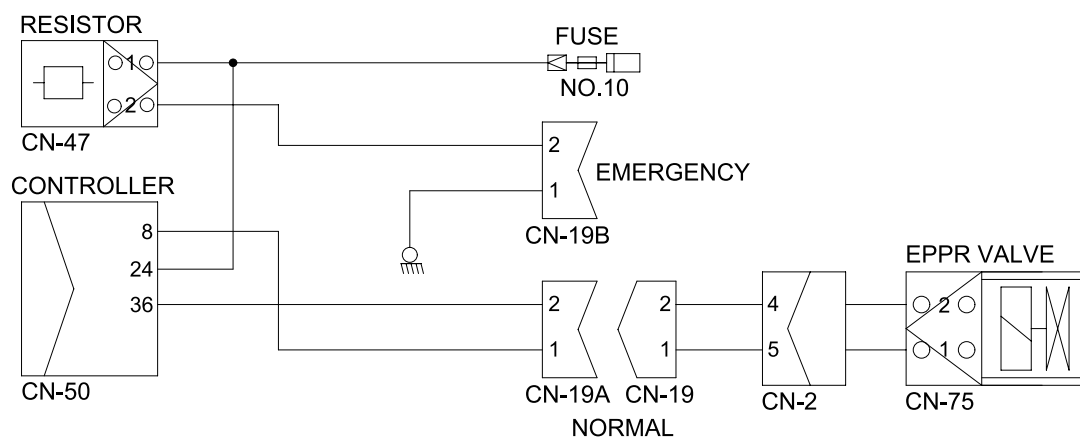
R140LC-7 기타 5-23(2)

## GROUP 11 PUMP PROLIX

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



## 1. OPERATING PRINCIPLE WIRING DIAGRAM



### 1) NORMAL

- 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

- If prolix resistor(CN-19) is connected with CN-19B when any abnormality occurs in NEW 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 12 MONITORING SYSTEM(Machine serial No. : -#0265)

### 1. OUTLINE

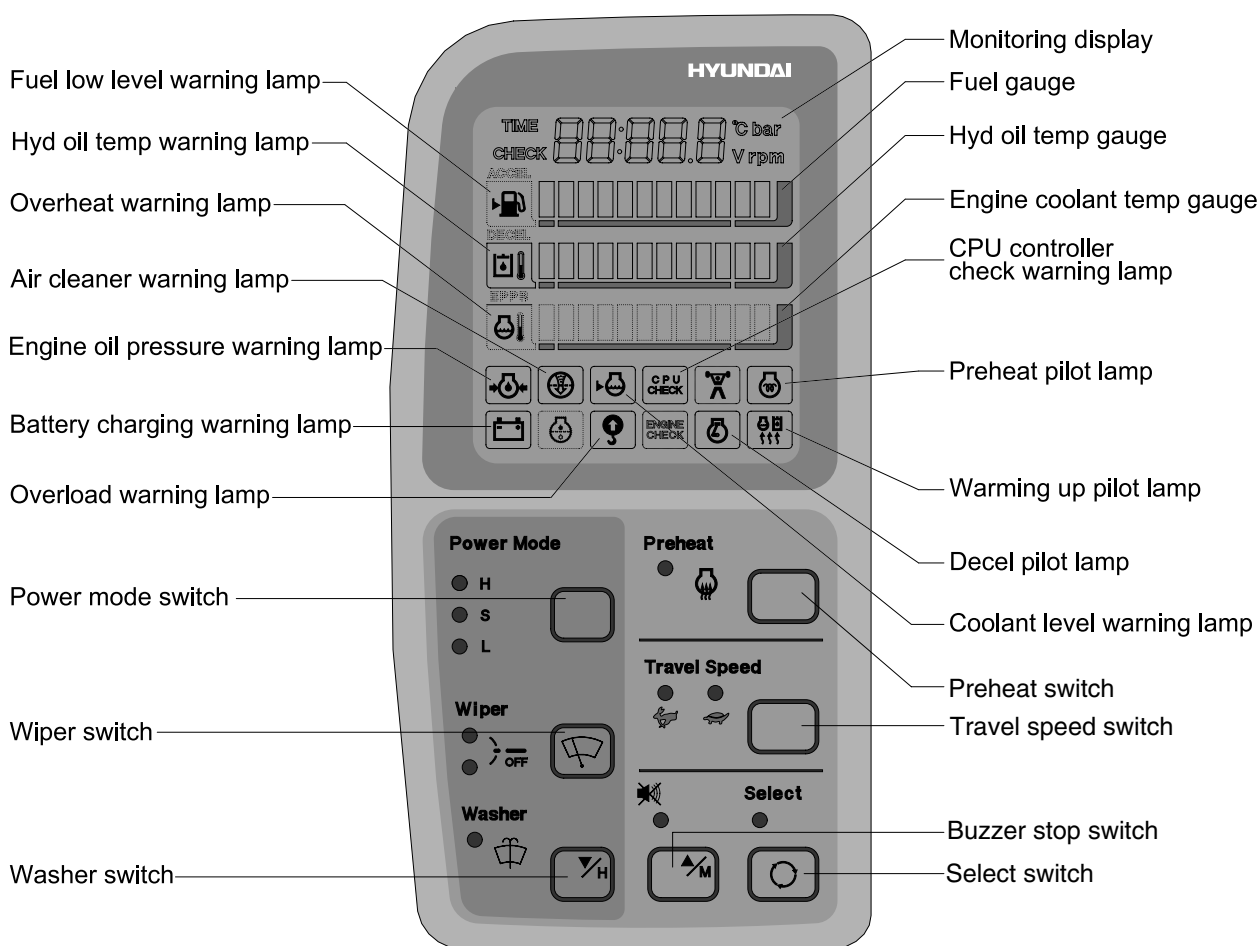
Monitoring system consists of the monitor part and switch part.

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



7075MS11



## 2) CLUSTER CHECK PROCEDURE

### (1) Start key : ON

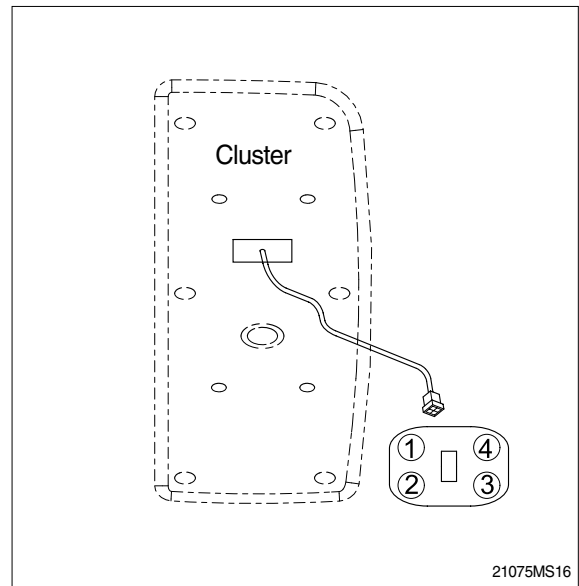
- ① Check monitor initial 5 seconds
  - a. All lamps light up.
  - b. Buzzer sound.
- ② Check monitor after 5 seconds : Indicate cluster version and machine condition
  - a. Cluster program version : CL : 2.0 ← Indicates program version 2.0 for 2 seconds.
  - b. Tachometer : 0rpm
  - c. Fuel gauge : All light up below appropriate level
  - d. Hydraulic temperature : All light up below appropriate level
  - e. Engine coolant temperature gauge : All light up below appropriate level
  - f. 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 Indicating lamp state
  - a. Power mode selection : S mode
  - b. Preheat : No LED ON
  - c. Wiper : No LED ON
  - d. Washer : No LED ON
  - e. Travel speed pilot lamp : Low(Turtle)

### (2) Start of engine

- ① Check machine condition
  - a. Tachometer indicates at present rpm
  - b. Gauge and warning lamp : Indicate at present condition.
    - ※ When normal condition : All warning lamp OFF
  - c. Preheat : No LED ON
  - d. Power mode selection : S mode
  - e. Wiper : No LED ON
  - f. Washer : No LED ON
  - g. Travel speed pilot lamp : Low(Turtle)
- ② When warming up operation
  - a. Warming up lamp : ON
  - b. 10 seconds after engine started, engine speed increases to 1200 rpm
    - ※ 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.

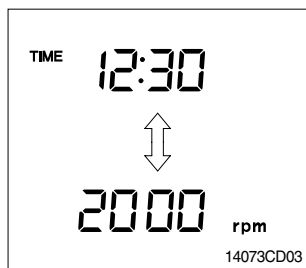
### 3. CLUSTER CONNECTOR

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

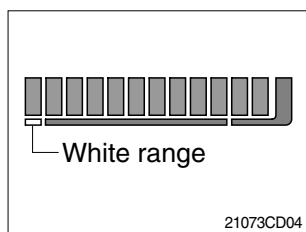
### 1) MONITORING DISPLAY





- ① This displays the current time and machine information such as engine rpm, coolant/hydraulic oil temperature, hydraulic oil pressure and also error codes.

※ **Refer to the page 5-24 for details.**

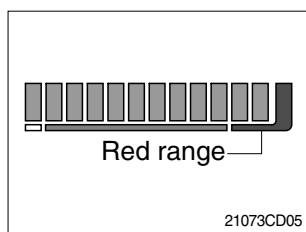
### 2) FUEL GAUGE



- ① This gauge indicates the amount of fuel in the fuel tank.  
② Fill the fuel when the white range or warning lamp  blinks.

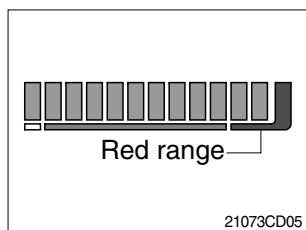
※ **If the gauge illuminates the white range or warning lamp  blinks even though the machine is on the normal condition, check the electric device as that can be caused by the poor connection of electricity or sensor.**

### 3) HYDRAULIC OIL TEMPERATURE GAUGE



- ① This indicates the temperature of coolant.  
· White range : 30°C(86°F) below  
· Green range : 30-105 °C(86-221°F)  
· Red range : 105°C(221°F) above  
② The green range illuminates when operating.  
③ Keep idling engine at low speed until the green range illuminates, before operation of machine.  
④ When the red range illuminates, reduce the load on the system. If the gauge stays in the red range, stop the machine and check the cause of the problem.

### 4) ENGINE COOLANT TEMPERATURE GAUGE



- ① This indicates the temperature of coolant.  
· White range : 30°C(86°F) below  
· Green range : 30-105 °C(86-221°F)  
· Red range : 105°C(221°F) above  
② The green range illuminates when operating.  
③ Keep idling engine at low speed until the green range illuminates, before operation of machine.  
④ When the red range illuminates, turn OFF the engine, check the radiator and engine.

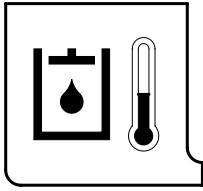
### 5) FUEL LOW LEVEL WARNING LAMP



21073CD04A

- ① This lamp blinks and the buzzer sounds when the level of fuel is below 21.5 l (5.7U.S. gal).
- ② Fill the fuel immediately when the lamp blinks.

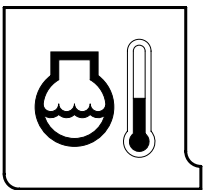
### 6) HYDRAULIC OIL TEMPERATURE WARNING LAMP



21073CD05A

- ① This warning lamp operates and the buzzer sounds when the temperature of hydraulic oil is over 105 °C ( 221 °F) .
- ② Check the hydraulic oil level when the lamp blinks.
- ③ Check for debris between oil cooler and radiator.

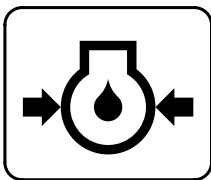
### 7) OVERHEAT WARNING LAMP



21073CD06A

- ① This lamp blinks and the buzzer sounds when the temperature of coolant is over the normal temperature 110°C ( 230°F) .
- ② Check the cooling system when the lamp blinks.

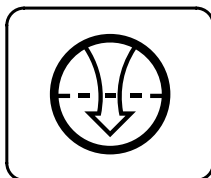
### 8) ENGINE OIL PRESSURE WARNING LAMP



21073CD07

- ① This lamp blinks and the buzzer sounds after starting the engine because of pressure.
- ② If the lamp blinks during engine operation, shut OFF engine immediately. Check oil level.

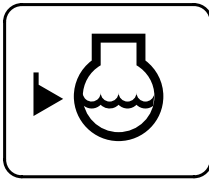
### 9) AIR CLEANER WARNING LAMP



21073CD08

- ① This lamp is operated by the vacuum caused inside when the filter of air cleaner is clogged which supply air to the engine.
- ② Check the filter and clean or replace it when the lamp blinks.

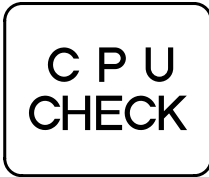
#### 10) COOLANT LEVEL WARNING LAMP



21073CD09

- ① This lamp blinks and the buzzer sounds when the coolant is below LOW in the reservoir tank of radiator.
- ② Check the reservoir tank when the lamp blinks.

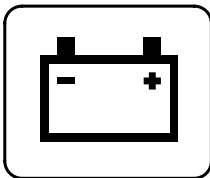
#### 11) CPU CONTROLLER CHECK WARNING LAMP



21073CD10

- ① Communication problem with CPU controller makes the lamp blinks and the buzzer sounds.
- ② With lamp blinks all of the lamp on the cluster LCD will be OFF.

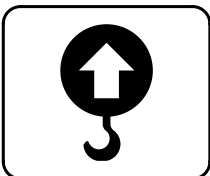
#### 12) BATTERY CHARGING WARNING LAMP



21073CD13

- ① This lamp blinks and the buzzer sounds when the starting switch is ON, it is turned OFF after starting the engine.
- ② Check the battery charging circuit when this lamp blinks, during engine operation.

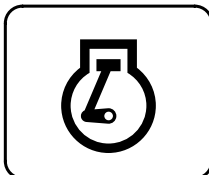
#### 13) OVERLOAD WARNING LAMP



21073CD15

- ① When the machine is overload, the overload warning lamp blinks during the overload switch ON.

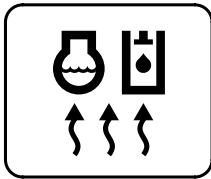
#### 14) ONE TOUCH DECEL PILOT LAMP



21073CD17

- ① Operating auto decel or one touch decel makes the lamp ON.
- ② The lamp will be ON when pushing one touch decel switch on the LH RCV lever.

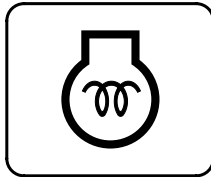
### 15) WARMING UP PILOT LAMP



21073CD18

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

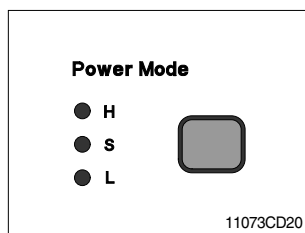
### 16) PREHEAT PILOT LAMP



21073CD12

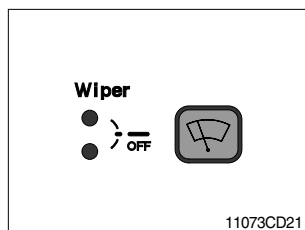
- ① This lamp is turned ON when the preheating function is actuated in cold weather.
- ② Start the engine as this lamp is OFF.

### 17) POWER MODE SWITCH



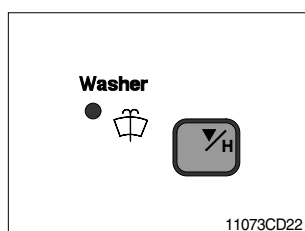
- ① This switch is to select the machine power mode, which shifts from high power work to standard power work and light power work in a row by pressing the switch.
  - **H** : This is used for high power work
  - **S** : This is used for standard power work
  - **L** : This is used for light power work

### 18) WIPER SWITCH



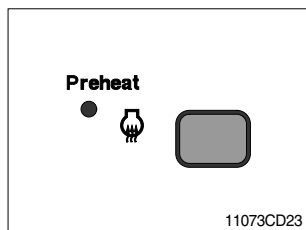
- ① This switch is used to operate wiper.
    - Press the switch once to operate wiper.
    - Press the switch once more to intermittently operate wiper low speed.
    - Press the switch more than one second to turn off wiper.
- ※ **Wiper motor doesn't operate with front sliding door open.**
- ※ **If wiper does not operate with the switch in the ON position, turn the switch off immediately. Check the cause. If the switch remains ON, it can result in motor failure.**

### 19) WASHER SWITCH



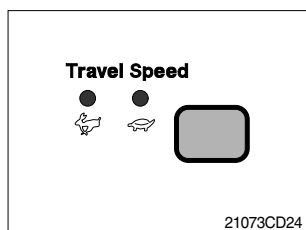
- ① The washer liquid is sprayed and the wiper is operated only while pressing this switch.
- ② The indicator lamp is turned ON when operating this switch.

## 20) PREHEAT SWITCH



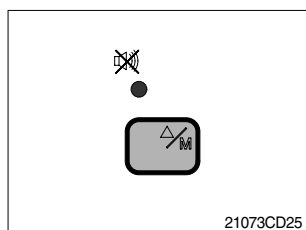
- ① This switch is used for starting the engine in cold weather.  
If pressed, grid heater is activated to get easier engine starting.  
※ **Never hold the push button switch in for more than 30 seconds, as this can damage the grid heater.**
- ② The indicator lamp is turned ON when operating this switch.

## 21) TRAVEL SPEED CONTROL SWITCH



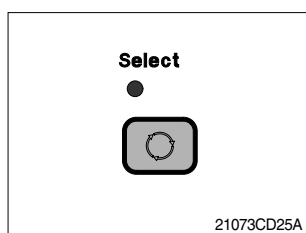
- ① This switch is to control the travel speed which is changed to high speed(Rabbit mark) by pressing the switch and low speed(Turtle mark) by pressing again.

## 22) BUZZER STOP SWITCH



- ① When the starting switch is turned ON first, normally the alarm buzzer sounds for 5 seconds during lamp check operation.
- ② The red lamp lights ON and the buzzer sounds when the machine has a problem.  
In this case, press this switch and buzzer stops, but the red lamp lights until the problem is cleared.

## 23) SELECT SWITCH



- ① This switch is used to select the monitor display function.  
※ **Refer to the page 5-24 for details.**
- ② If the switch is pressed for 3 seconds in time display mode, it is selected time adjusting function, as below.
  - ・ Hour by auto decel switch
  - ・ Minute by buzzer stop switch.
- ③ After time set, the switch is pressed, it is returned clock.

## 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		
<b>Group 0</b> (Default)	Way 1 Key switch <b>ON</b> or <b>START</b> Way 2 Touch <b>WASHER</b> switch while pressing <b>BUZZER STOP</b> at group 1~4.	Initial	Engine rpm	1750 rpm
		Touch <b>SELECT</b> 1 time	Time	TIME 12:30
		Touch <b>SELECT</b> 2 times	CPU model & version	08C 10
<b>Group 1</b> (Volt, temp, EPPR press, version)	Touch <b>SELECT</b> switch <b>once</b> while pressing <b>BUZZER STOP</b> . In this group <b>SELECT</b> LED <b>ON</b>	Default	Battery voltage(V)	b:24.8v
		Touch <b>SELECT</b> 1 time	Potentiometer voltage(V)	Pa: 2.5v
		Touch <b>SELECT</b> 2 times	Accel dial voltage(V)	dL: 3.8v
		Touch <b>SELECT</b> 3 times	Hydraulic oil temperature(°C)	Hd: 105°C
		Touch <b>SELECT</b> 4 times	Coolant temperature(°C)	Ct: 107°C
<b>Group 2</b> (Error code)	Touch <b>SELECT</b> switch <b>twice</b> while pressing <b>BUZZER STOP</b> . In this group <b>BUZZER STOP</b> LED blinks	Default	Current error	CHECK Er: 03
		Touch <b>SELECT</b> 1 time	Recorded error (Only key switch ON)	TIME Er: 03
		Press down(▼) & <b>SELECT</b> at the same time	Recorded error deletion (Only key switch ON)	TIME Er: 00
<b>Group 3</b> (Switch input)	Touch <b>SELECT</b> switch <b>3 times</b> while pressing <b>BUZZER STOP</b> . In this group <b>SELECT</b> LED blinks at 0.5sec interval	Default	One touch decel switch	od: on or off
		Touch <b>SELECT</b> 1 time	Preheat switch	Ph: on or off
		Touch <b>SELECT</b> 2 times	Overload pressure switch	o: on or off
<b>Group 4</b> (Output)	Touch <b>SELECT</b> switch <b>4 times</b> while pressing <b>BUZZER STOP</b> . In this group <b>SELECT</b> LED blinks at 1sec interval	Default	Hourmeter	Ho: on or off
		Touch <b>SELECT</b> 1 time	Neutral relay (Anti-restart relay)	nr: on or off
		Touch <b>SELECT</b> 2 times	Travel speed solenoid	SS: on or off
		Touch <b>SELECT</b> 3 times	Preheat relay	PR: 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
<b>Group 0</b>	<b>2200 rpm</b>	Engine speed	It displays current engine speed detected by engine speed sensor from 500 to 3000rpm. Range : 500~3000rpm by 10rpm
	<b>TIME 12 : 30</b>	Time	It displays current time(12 is hour and 30 is minute) Range : Hour(1~12), minute(00~59)
	<b>08 : C1.0</b>	Model and CPU program version	It shows that machine model(R80-7) and the program version of the CPU controller is 1.0. Version display range : 0.0~9.9 by 0.1
<b>Group 1</b>	<b>b24 : 8V</b>	Battery voltage	It shows that battery power of 24.8V is supplied into CPU controller. Range : 00.0~48.0V by 0.1V
	<b>Po : 2.5V</b>	Potentiometer voltage	It shows that potentiometer signal voltage is 2.5V. Range : 0.0~5.0V by 0.1V
	<b>dL : 3.8V</b>	Accel dial voltage	It shows that accel dial signal voltage is 3.8V. Range : 0.0~5.0V by 0.1V
	<b>Hd : 50°C</b>	Hydraulic oil temperature	It shows that hydraulic oil temperature detected by temperature sensor is 50°C. Range : 0~150°C by 1°C
	<b>Ct : 85°C</b>	Coolant temperature	It shows that coolant oil temperature detected by temperature sensor is 50°C. Range : 0~150°C by 1°C
<b>Group 2</b>	<b>CHECK Er : 01</b>	Current error	It shows that current error of 01(Short circuit in accel actuator motor system) is diagnosed by self diagnosis system in the CPU controller. If more than 2 errors, when pressing ▼ or ▲ switch, other error codes show. Range : 00~58
	<b>TIME Er : 03</b>	Recorded error	It shows recorded error code of 03 which is diagnosed before. If more than 2 error codes, when pressing ▼ or ▲ switch, other error codes show. Range : 00~58
	<b>TIME Er : 00</b>	Recorded error deletion	It shows all recorded error codes are removed in the CPU controller memory.

Group	Display	Name	Description
<b>Group 3</b>	<b>od : on</b> or <b>oFF</b>	One touch decel switch	<b>od : on</b> Shows that one touch decel switch is pressed. <b>od : oFF</b> Shows that one touch decel switch is released.
	<b>PH : on</b> or <b>oFF</b>	Preheat switch	<b>PH : on</b> Shows that preheat switch is pressed. <b>PH : oFF</b> Shows that preheat switch is released.
	<b>ol : on</b> or <b>oFF</b>	Overload pressure switch	<b>ol : on</b> Shows that overload pressure switch is turned ON. <b>ol : oFF</b> Shows that overload pressure switch is turned OFF.
<b>Group 4</b>	<b>Ho : on</b> or <b>oFF</b>	Hourmeter	<b>Ho : on</b> Shows that hourmeter is activated by CPU controller. <b>Ho : oFF</b> Shows that hourmeter is turned off.
	<b>nr : on</b> or <b>oFF</b>	Neutral relay (Anti-restart relay)	<b>nr : on</b> Shows that neutral relay for anti-restarting function is activated(Engine start is possible). <b>nr : oFF</b> Shows that neutral relay is turned off to disable the engine restart.
	<b>ts : on</b> or <b>oFF</b>	Travel speed solenoid	<b>ts : on</b> Shows that travel speed solenoid is activated (High speed). <b>ts : oFF</b> Shows that travel speed solenoid is released (Low speed).
	<b>PR : on</b> or <b>oFF</b>	Preheat relay	<b>PR : on</b> Shows that preheat relay is activated. <b>PR : oFF</b> Shows that preheat relay is released.

## ■ MONITORING SYSTEM(Machine serial No. : #0266-)

### 1. OUTLINE

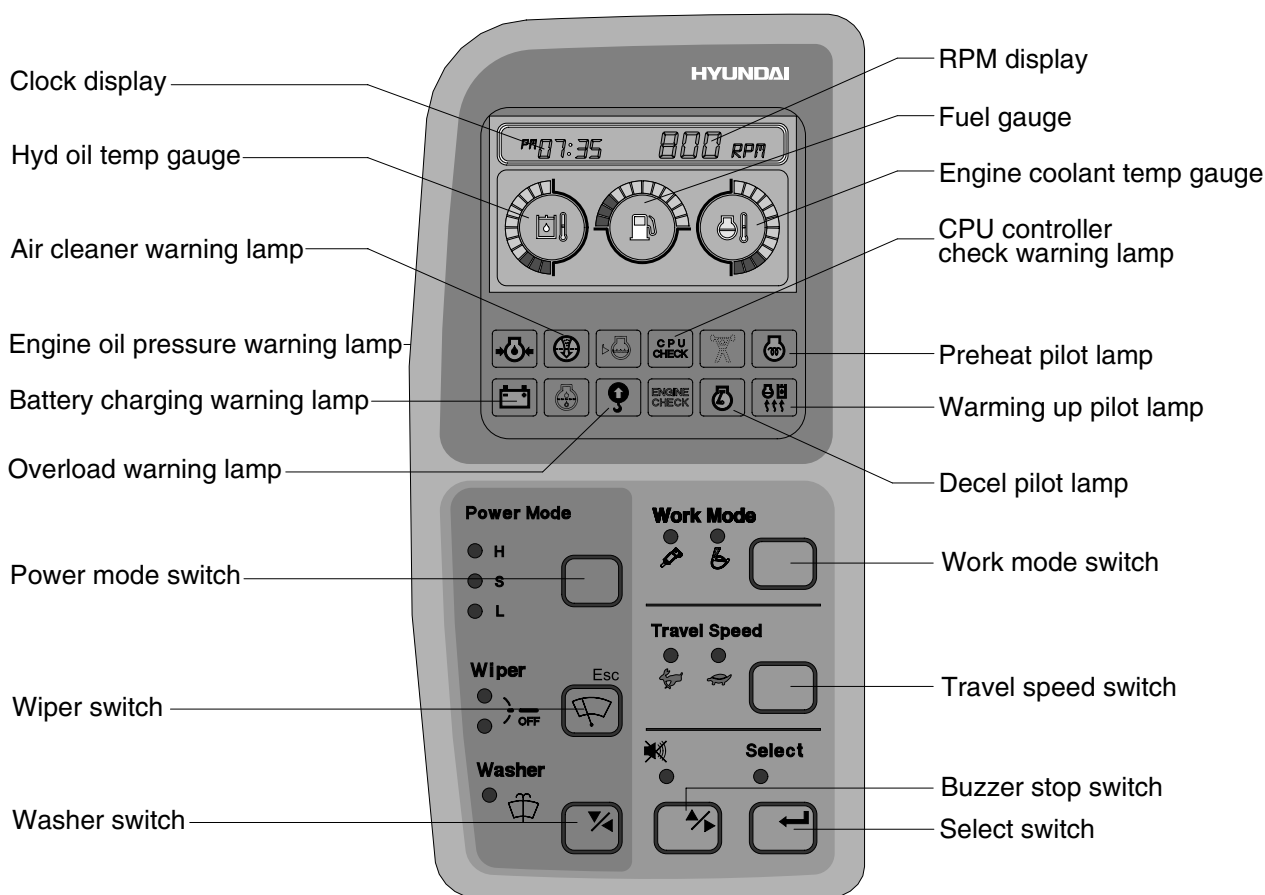
Monitoring system consists of the monitor part and switch part.

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



RD8075MS08

## 2) CLUSTER CHECK PROCEDURE

### (1) Start key : ON

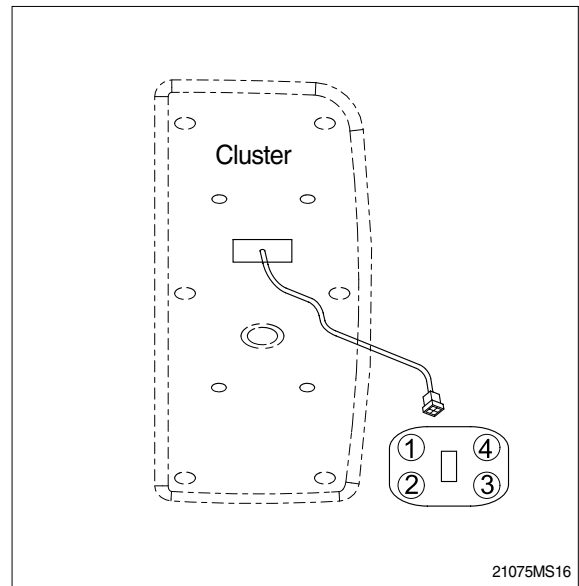
- ① Check monitor initial 5 seconds
  - a. All lamps light up.
  - b. Buzzer sound.
- ② Check monitor after 5 seconds : Indicate cluster version and machine condition
  - a. Cluster program version : 「1.00」 ← Indicates program version 「1.00」 for 5 seconds.
  - b. Tachometer : 0rpm
  - c. Fuel gauge : All light up below appropriate level
  - d. Hydraulic temperature : All light up below appropriate level
  - e. Engine coolant temperature gauge : All light up below appropriate level
  - f. 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 Indicating lamp state
  - a. Power mode selection : S mode
  - b. Preheat : No LED ON
  - c. Wiper : No LED ON
  - d. Washer : No LED ON
  - e. Travel speed pilot lamp : Low(Turtle)

### (2) Start of engine

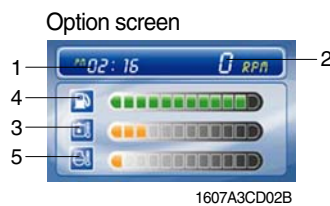
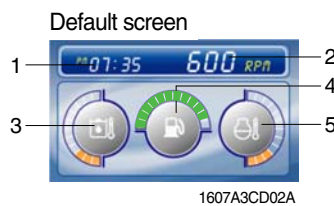
- ① Check machine condition
  - a. Tachometer indicates at present rpm
  - b. Gauge and warning lamp : Indicate at present condition.
    - ※ When normal condition : All warning lamp OFF
  - c. Preheat : No LED ON
  - d. Power mode selection : S mode
  - e. Wiper : No LED ON
  - f. Washer : No LED ON
  - g. Travel speed pilot lamp : Low(Turtle)
- ② When warming up operation
  - a. Warming up lamp : ON
  - b. 10 seconds after engine started, engine speed increases to 1200 rpm
    - ※ 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

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. LCD main operation display



- 1 Time display
- 2 RPM display
- 3 Hydraulic oil temperature gauge
- 4 Fuel level gauge
- 5 Engine coolant temperature gauge

### 1) Time display



- ① This displays the current time.

※ Refer to the page 5-34 to set time for details.

### 2) RPM display



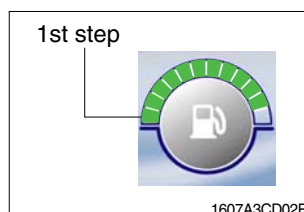
- ① This displays the engine rpm.

### 3) Hydraulic oil temperature gauge



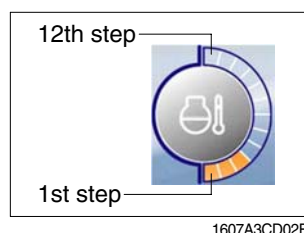
- ① This gauge indicates the temperature of hydraulic oil in 12 step gauge.
  - 1st step : Below 30°C(86°F)
  - 2nd~10th step : 30-105 °C(86-221°F)
  - 11th~12th step : Above 105°C(221°F)
- ② The gauge between 2nd and 10th steps illuminates when operating.
- ③ Keep idling engine at low speed until the gauge between 2nd and 10th steps illuminates, before operation of machine.
- ④ When the gauge of 11th and 12th steps illuminates, reduce the load on the system. If the gauge stays in the 11th~12th steps, stop the machine and check the cause of the problem.

### 4) Fuel level gauge



- ① This gauge indicates the amount of fuel in the fuel tank.
- ② Fill the fuel when the 1st step or fuel icon blinks in red.
- ※ If the gauge illuminates the 1st step or fuel icon blinks in red even though the machine is on the normal condition, check the electric device as that can be caused by the poor connection of electricity or sensor.

### 5) Engine coolant temperature gauge



- ① This gauge indicates the temperature of coolant in 12 step gauge.
  - 1st step : Below 30°C(86°F)
  - 2nd~10th step : 30-105 °C(86-221°F)
  - 11th~12th step : Above 105°C(221°F)
- ② The gauge between 2nd and 10th steps illuminates when operating.
- ③ Keep idling engine at low speed until the gauge between 2nd and 10th steps illuminates, before operation of machine.
- ④ When the gauge of 11th and 12th steps illuminates, turn OFF the engine, check the radiator and engine.

## 5. Warning of main operation screen

### 1) Warning display

#### (1) Engine coolant temperature



- This lamp blinks and the buzzer sounds when the temperature of coolant is over the normal temperature 105°C ( 221°F ) .
- Check the cooling system when the lamp blinks.

#### (2) Fuel level



- This lamp blinks and the buzzer sounds when the level of fuel is below 28 l (7.4U.S. gal).
- Fill the fuel immediately when the lamp blinks.

#### (3) Hydraulic oil temperature



- This warning lamp operates and the buzzer sounds when the temperature of hydraulic oil is over 105 °C ( 221 °F ) .
- Check the hydraulic oil level when the lamp blinks.
- Check for debris between oil cooler and radiator.

#### (4) All gauge



- This lamp blinks and the buzzer sounds when the all gauge is abnormal.
- Check the each system when the lamp blinks.

#### (5) Communication error



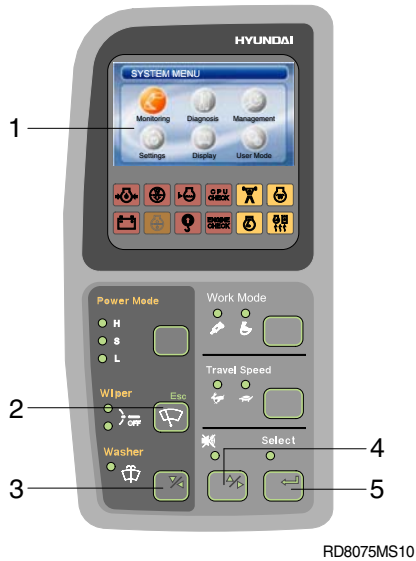
- Communication problem between MCU controller and cluster makes the lamp blinks and the buzzer sounds.
- Check if any fuse for MCU burnt off.  
If not check the communication line between them.






### 2) Pop-up icon display

No	Switch	Selected mode	Display
1	Power mode switch	High power work mode	
		Standard power work mode	
		Light power work mode	

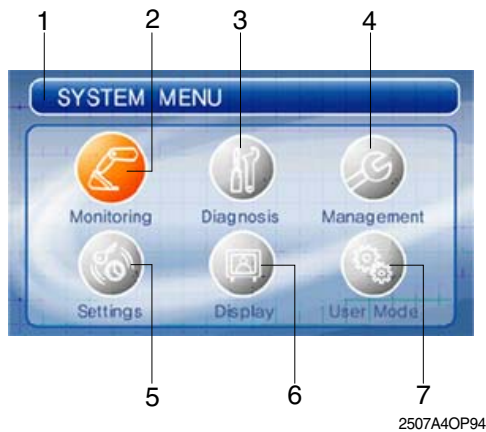
No	Switch	Selected mode	Display
2	Travel speed control switch	Low speed	
		High speed	


### 3) LCD



- 1  : LCD
- 2  : Esc  
: Escape,  
Return to the previous menu
- 3  : Down/Left Direction
- 4  : Up/Right Direction
- 5  : Select(Enter)  
Activate the currently chosen item

### (1) Main menu

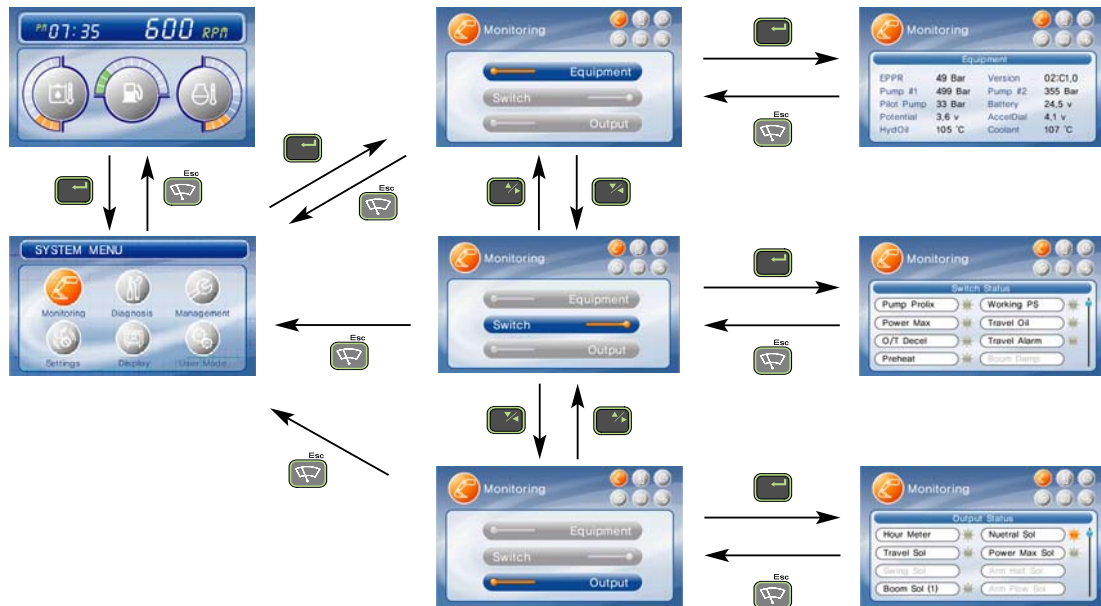


- 1  : Menu information
- 2  : Monitoring  
Equipment, Switch, Output
- 3  : Diagnosis  
Current error, Recorded error
- 4  : Maintenance
- 5  : Settings  
Time set, Dual mode  
System lock(Reserved)
- 6  : Display  
Operation skin, Brightness, Language
- 7  : User mode(null)



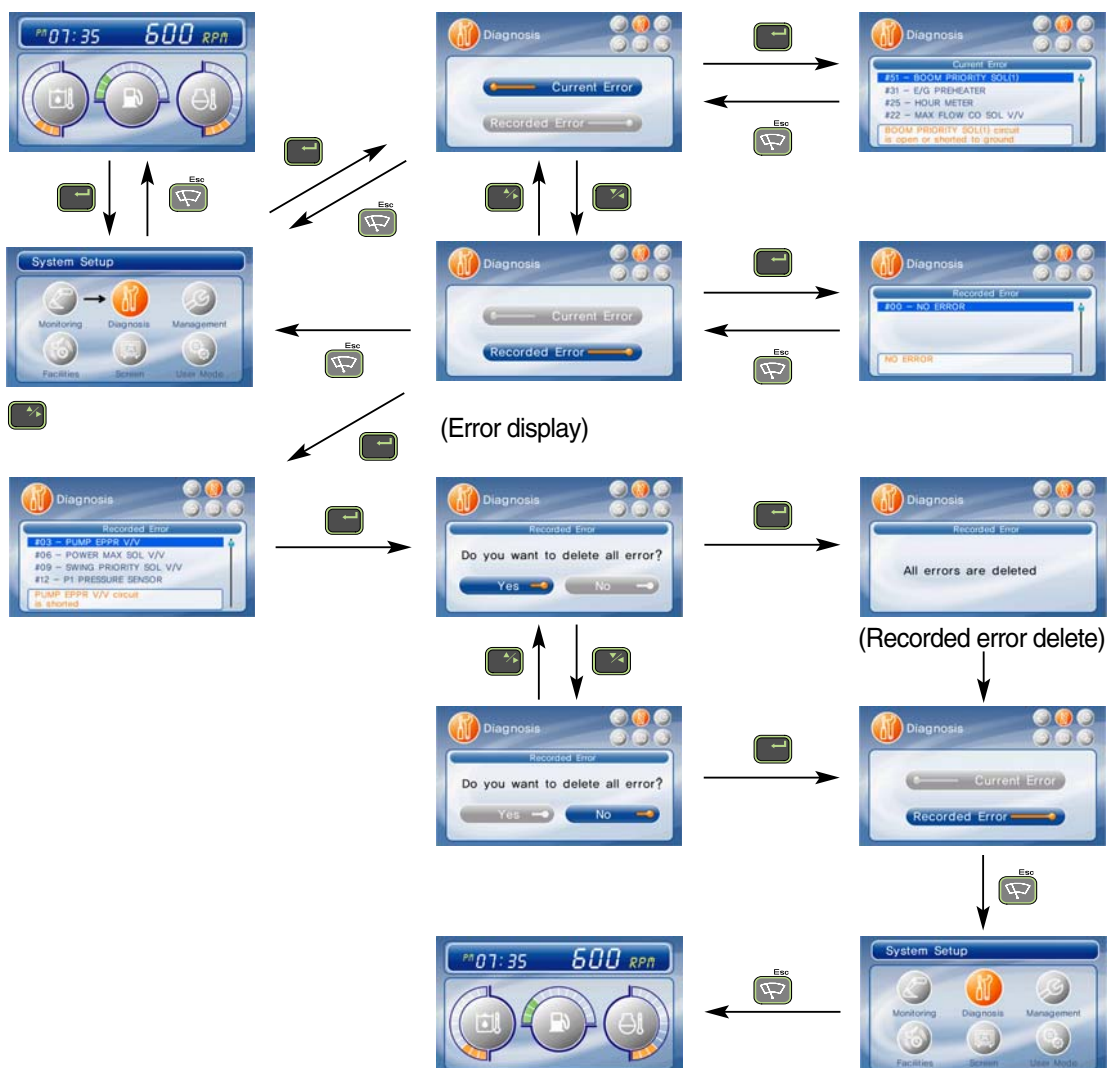
## (2) Display map

### ① Monitoring



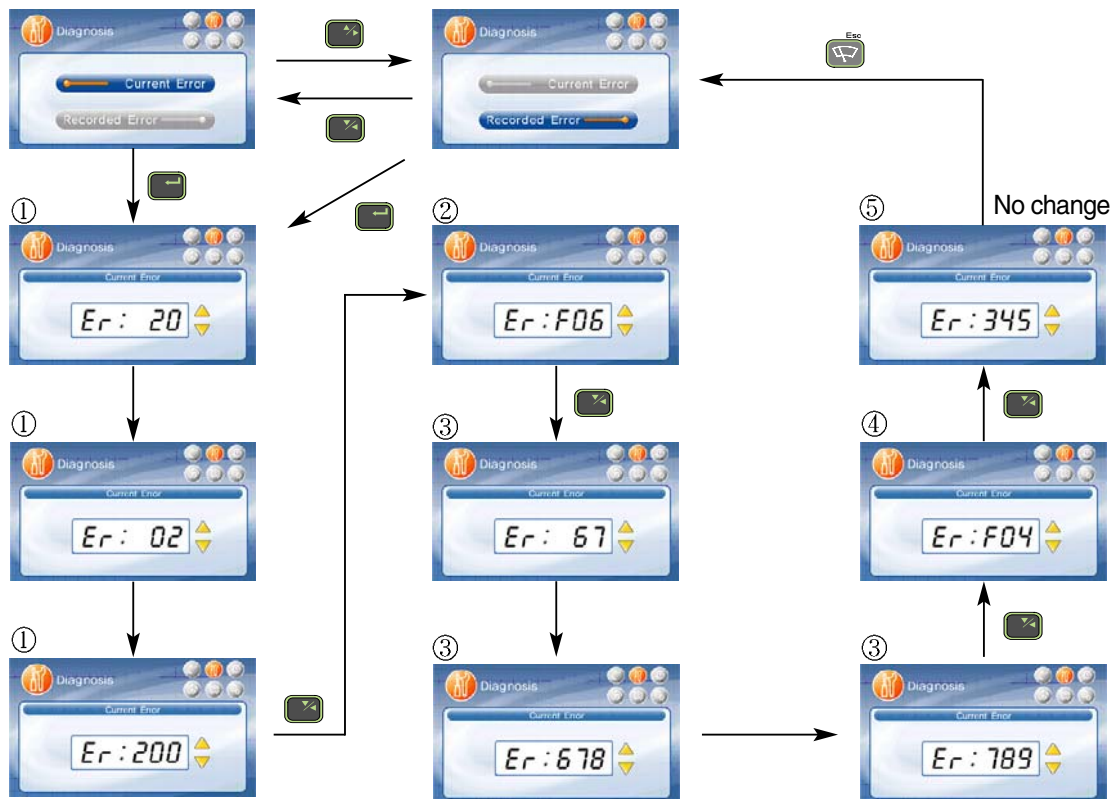
### ② Diagnosis

#### a. Protocol type 1

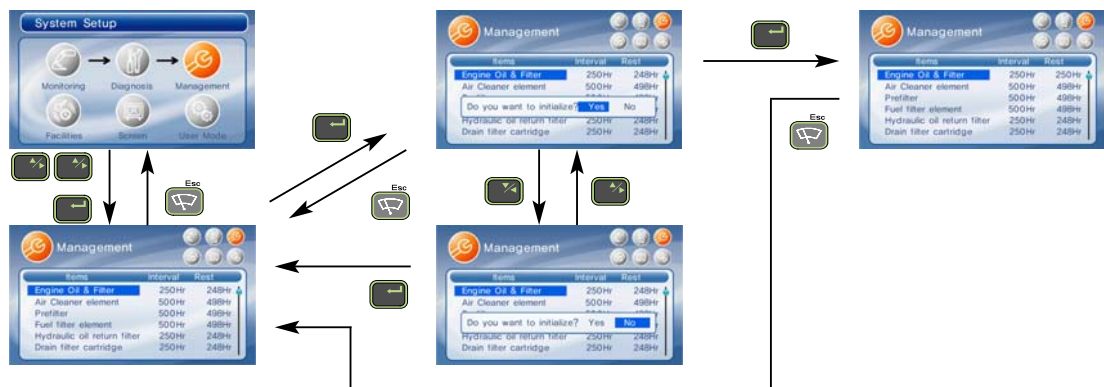


b. Protocol type 2

- If there are more than 2 error codes, each one can be displayed by pressing or switch respectively.
- 3 error codes (①SPN200200, ②FMI06, ③SPN6789, ④FMI04, ⑤345) display.



③ Maintenance



④ Setting

a. Time set



b. System lock - Reserved

- c. Dual mode  
- Changing the MCU mode

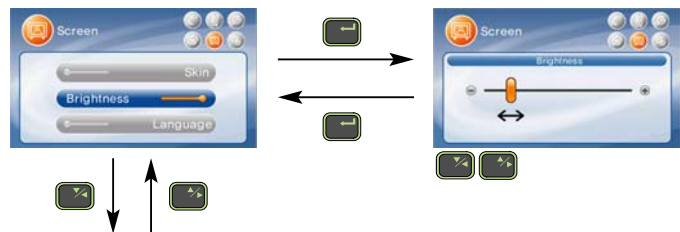


⑤ Display

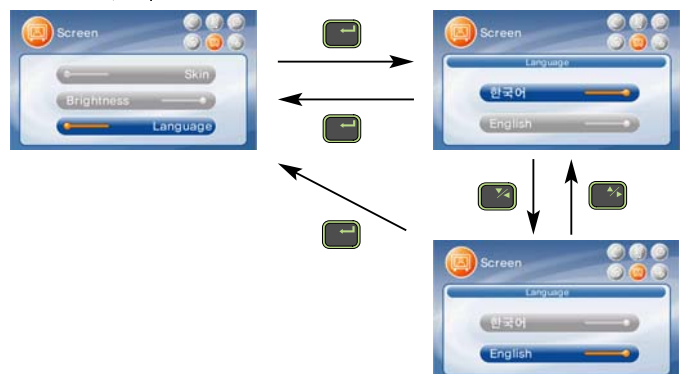
- a. Operation skin



- b. Brightness

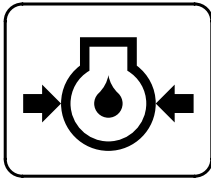


- c. Language



#### 4) Warning and pilot lamp

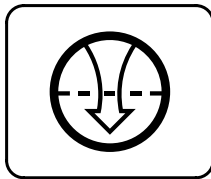
##### (1) Engine oil pressure warning lamp



21073CD07

- ① This lamp blinks and the buzzer sounds after starting the engine because of the low oil pressure.
- ② If the lamp blinks during engine operation, shut OFF engine immediately. Check oil level.

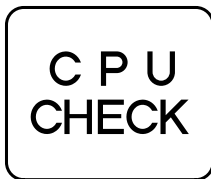
##### (2) Air cleaner warning lamp



21073CD08

- ① This lamp blinks and the buzzer sounds when the filter of air cleaner is clogged.
- ② Check the filter and clean or replace it.

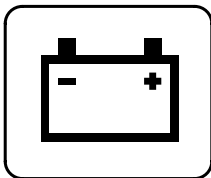
##### (3) MCU controller check warning lamp



21073CD10

- ① If any fault code is received from MCU controller, this lamp blinks and the buzzer sounds.
- ② Check the communication line between MCU controller and cluster.

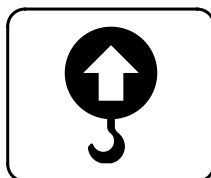
##### (4) Battery charging warning lamp



21073CD13

- ① This lamp blinks and the buzzer sounds when the starting switch is ON, it is turned OFF after starting the engine.
- ② Check the battery charging circuit when this lamp blinks during engine operation.

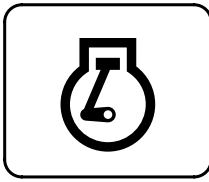
##### (5) Overload warning lamp



21073CD15

- ① When the machine is overload, the overload warning lamp blinks during the overload switch is ON.

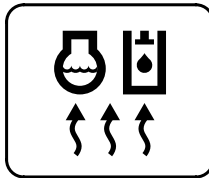
#### (6) Decel pilot lamp



21073CD17

- ① Operating auto decel or one touch decel makes the lamp ON.
- ② The lamp will be ON when pushing one touch decel switch on the LH RCV lever.

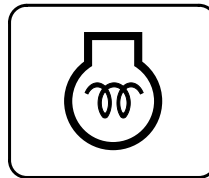
#### (7) Warming up pilot lamp



21073CD18

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

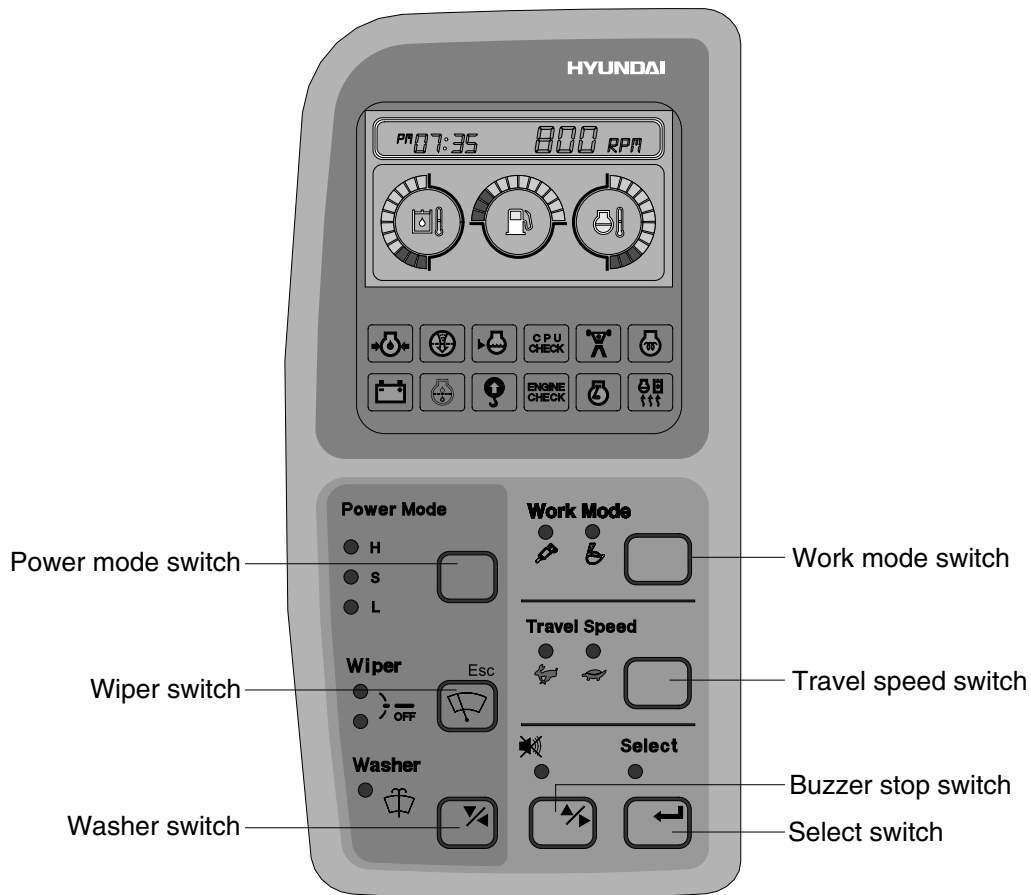
#### (8) Preheat pilot lamp



21073CD12

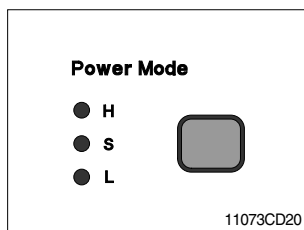
- ① Turning the start key switch ON position starts preheating in cold weather.
- ② Start the engine as this lamp is OFF.

## 5) SWITCH PANEL



RD8075MS11

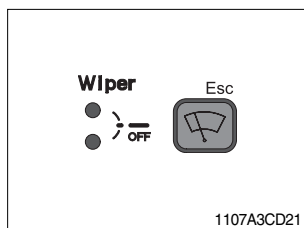
### (1) Power mode switch



- ① This switch is to select the machine power mode, which shifts from high power work to standard power work and light power work in a row by pressing the switch.

- **H** : High power work mode
- **S** : Standard power work mode
- **L** : Light power work mode

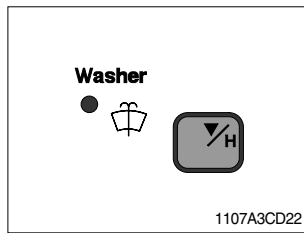
### (2) Wiper mode switch



- ① This switch is used to operate wiper.
- Press the switch once to operate wiper.
  - Press the switch once more to intermittently operate wiper low speed.
  - Press the switch once more to turn off wiper.

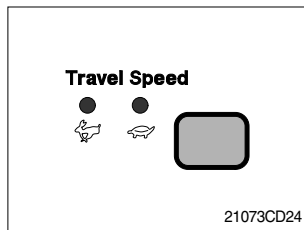
- ※ **Wiper motor doesn't operate with front sliding door open.**
- ※ **If wiper does not operate with the start switch in the ON position, turn the switch off immediately. Check the cause. If the switch remains ON, it can result in motor failure.**

### (3) Washer switch



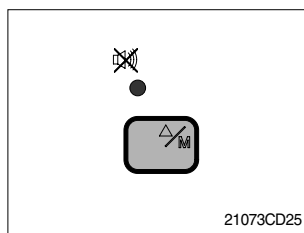
- ① The washer liquid is sprayed and the wiper is operated only while pressing this switch.
- ② The indicator lamp is turned ON when operating this switch.

### (4) Travel speed control switch



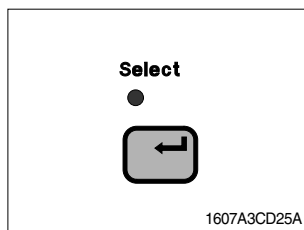
- ① This switch is to control the travel speed which is changed to high speed(Rabbit mark) by pressing the switch and low speed(Turtle mark) by pressing it again.

### (5) Buzzer stop switch



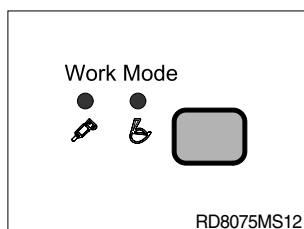
- ① When the starting switch is turned ON first, normally the alarm buzzer sounds for 2 seconds during lamp check operation.
- ② The red lamp lights ON and the buzzer sounds when the machine has a problem.  
In this case, press this switch and buzzer stops, but the red lamp lights until the problem is cleared.



### (6) Select switch



- ① This switch is used to enter main menu and sub menu for LCD.  
※ **Refer to the page 5-32 for details.**

### (7) Work mode switch



- ① This switch is to select the machine operation mode, which shifts from general operation mode to breaker mode by pressing the switch.
  -  : General work mode
  -  : Breaker operation mode

## SECTION 6 TROUBLESHOOTING

Group 1 Before Troubleshooting .....	6-1
Group 2 Hydraulic and Mechanical System .....	6-4
Group 3 Electrical System .....	6-24
Group 4 Mechatronics System .....	6-41

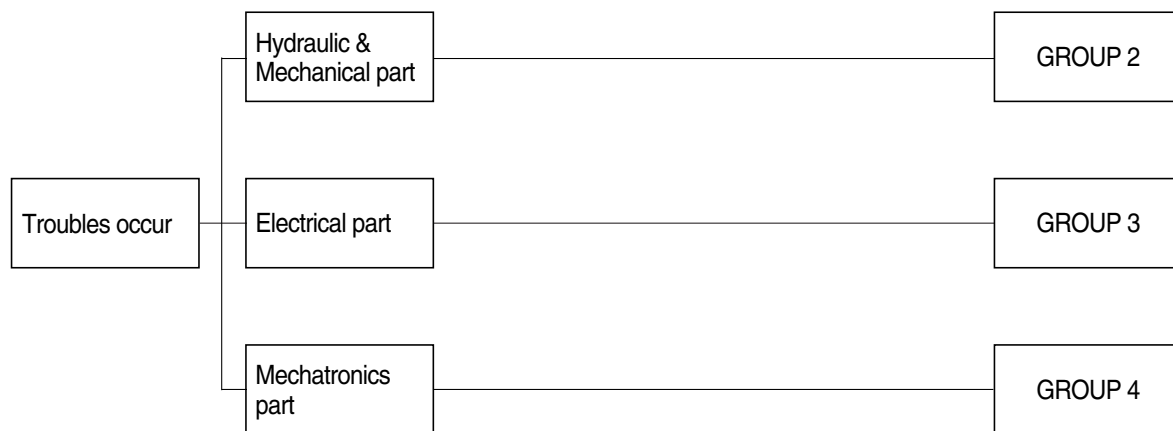


## GROUP 1 BEFORE TROUBLESHOOTING

### 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.



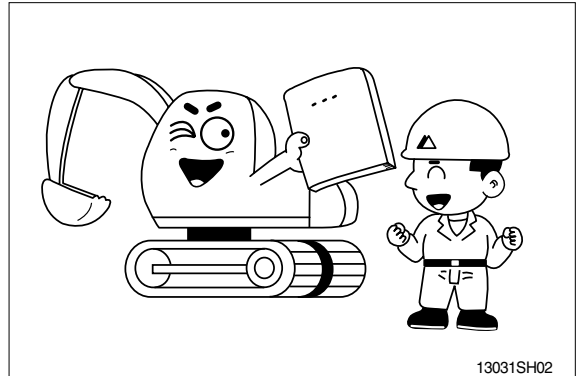
## 2. DIAGNOSING PROCEDURE

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.

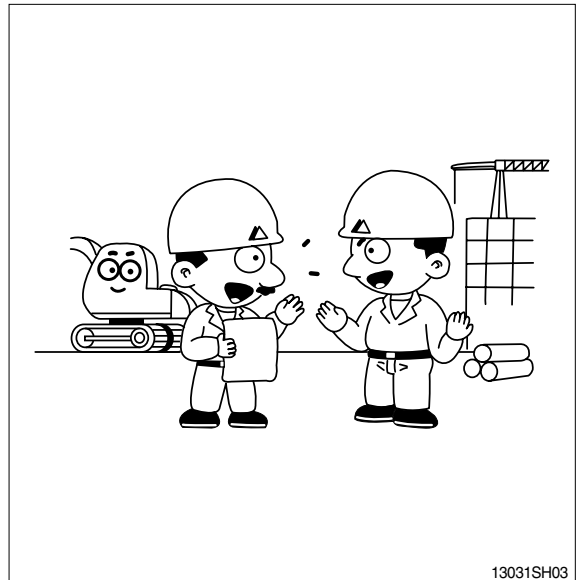
Especially, deepen the knowledge for the related parts of the trouble.



### STEP 2. Ask the operator

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

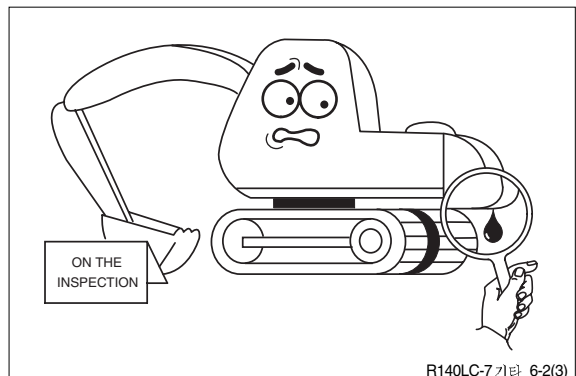
- 1) How the machine is used and when it is serviced?
- 2) When the trouble was noticed and what work the machine was doing at that time?
- 3) What is the phenomenon of the trouble?  
Was the trouble getting worse, or did it come out suddenly for the first time?
- 4) Did the machine have any troubles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

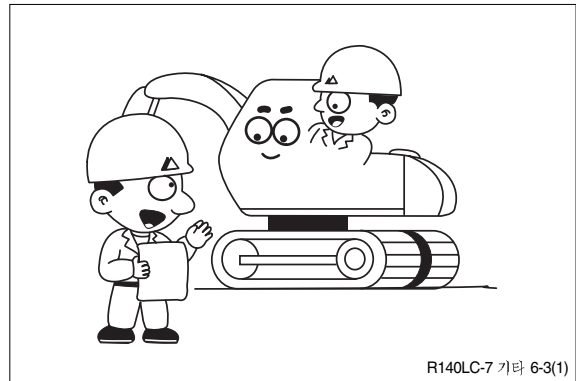
And also check the electrical system including batteries, as the troubles in the electrical system such as low battery voltage, loose connections and blown out fuses will result in malfunction of the controllers causing total operational failures of the machine.



#### STEP 4. Inspect the trouble actually on the machine

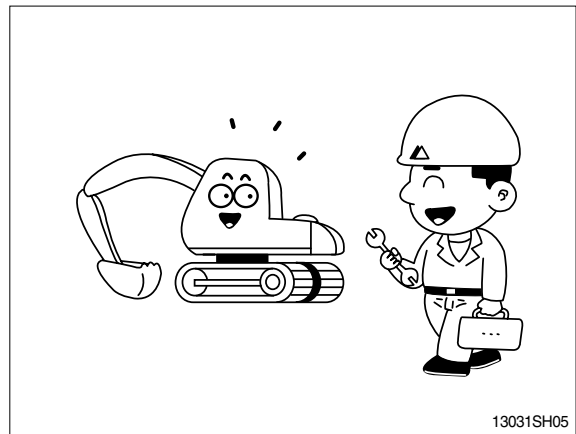
In case that some trouble cannot be confirmed, obtain the details of the malfunction from the operator.

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



#### STEP 5. Perform troubleshooting

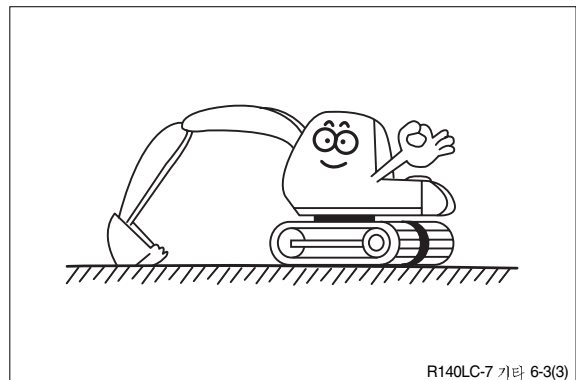
According to where the trouble parts are located, hydraulic & mechanical system part or electrical system part or mechatronics system part, perform troubleshooting the machine refer to the each system part's troubleshooting process diagram.



#### STEP 6. Trace a cause

Before reaching a conclusion, check the most 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.



## **GROUP 2 HYDRAULIC AND MECHANICAL SYSTEM**

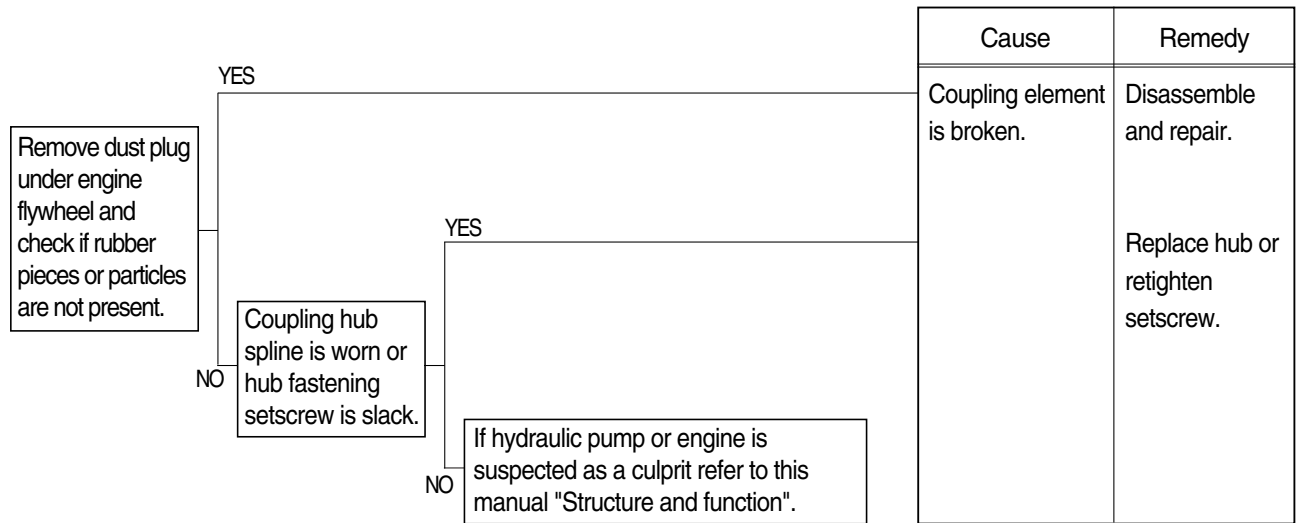
### **1. INTRODUCTION**

#### **1) MACHINE IN GENERAL**

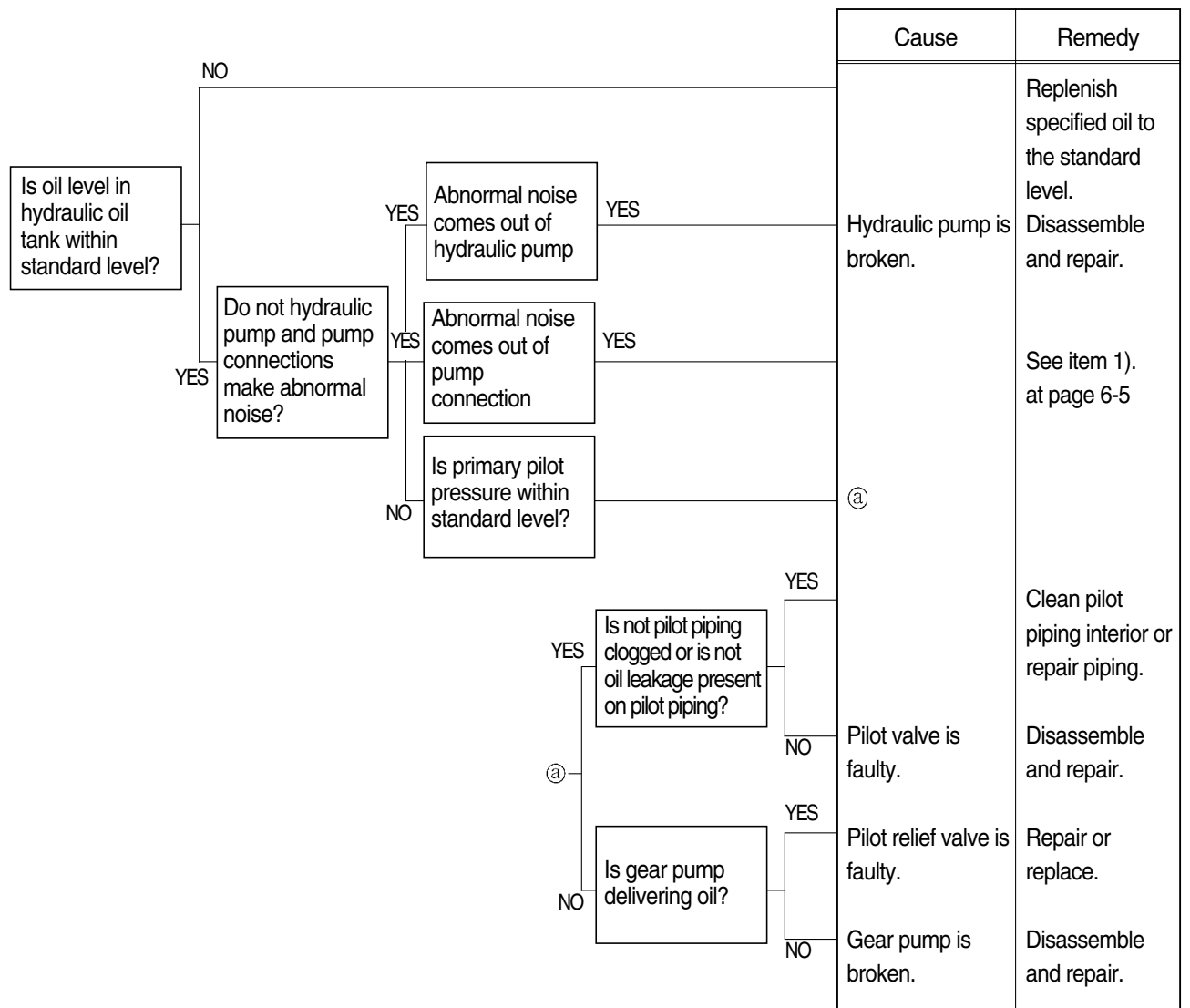
- (1) If even a minor fault is left intact and operation is continued, a fatal failure may be caused, entailing a large sum of expenses and long hours of restoration.  
Therefore when even a small trouble occurs, do not rely on your intuition and experience, but look for the cause based on the troubleshooting principle and perform maintenance and adjustment to prevent major failure from occurring. Keep in mind that a fault results from a combination of different causes.
- (2) The following lists up commonly occurring faults and possible causes with this machine. For the troubleshooting of the engine, refer to the coming troubleshooting and repair.
- (3) When carrying out troubleshooting, do not hurry to disassemble the components.  
It will become impossible to find the cause of the problem.
- (4) Ask user or operator the following.
  - ① Was there any strange thing about machine before failure occurred?
  - ② Under what conditions did the failure occur?
  - ③ Have any repairs been carried out before the failure?
- (5) Check before troubleshooting.
  - ① Check oil and fuel level.
  - ② Check for any external leakage of oil from components.
  - ③ Check for loose or damage of wiring and connections.

## 2. DRIVE SYSTEM

### 1) UNUSUAL NOISE COMES OUT OF PUMP CONNECTION



## 2) ENGINE STARTS BUT MACHINE DOES NOT OPERATE AT ALL



### 3. HYDRAULIC SYSTEM

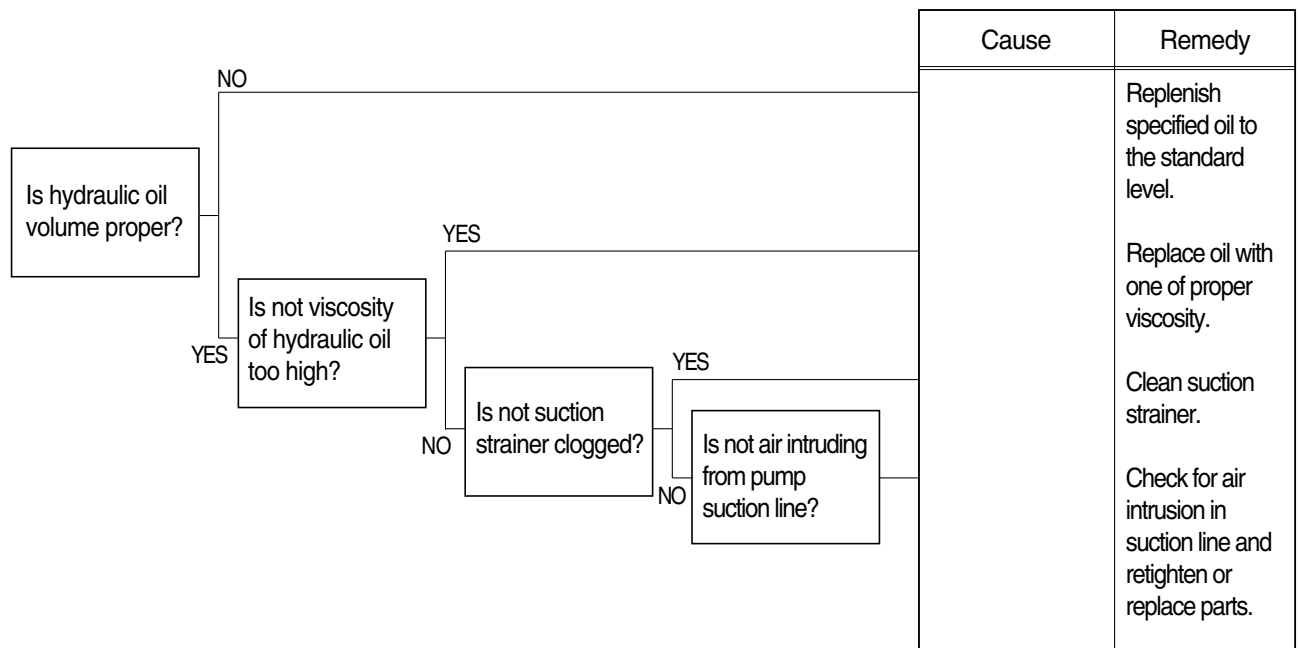
#### 1) HYDRAULIC OIL IS CLOUDY

		Cause	Remedy
<div>Drop hydraulic oil sample on hot plate and check if foams come up.</div>	YES	Water is mixed.	Put hydraulic oil still, separate water and dispose it or replace hydraulic oil.
	NO	Air is intruded.	Check suction line and return line and eliminate the air intruding source.

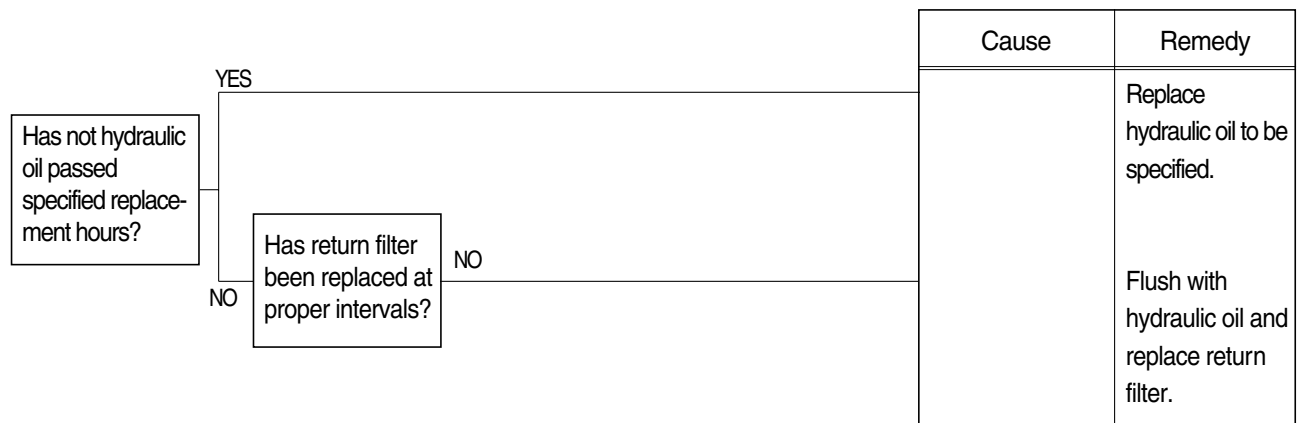
#### 2) HYDRAULIC OIL TEMPERATURE HAS RISEN ABNORMALLY

		Cause	Remedy
<div>Is hydraulic oil volume proper?</div>	NO	<div>①</div>	Replenish specified oil to the standard level. Clean oil cooler. Secure air circulation route.
	YES		Adjust belt tension or replace belt.
	<div>Is not oil cooler clogged and is anything blocking air circulation?</div>		
	YES		Readjust set pressure.
	<div>Is fan belt tension proper?</div>		
	<div>Is not the set pressure of main relief, relief and travel relief valve lower than the standard level?</div>		Reduce load.
<div>①</div>		<div>Is main relief valve used very often?</div>	
		YES	
		NO	

### 3) CAVITATION OCCURS WITH PUMP



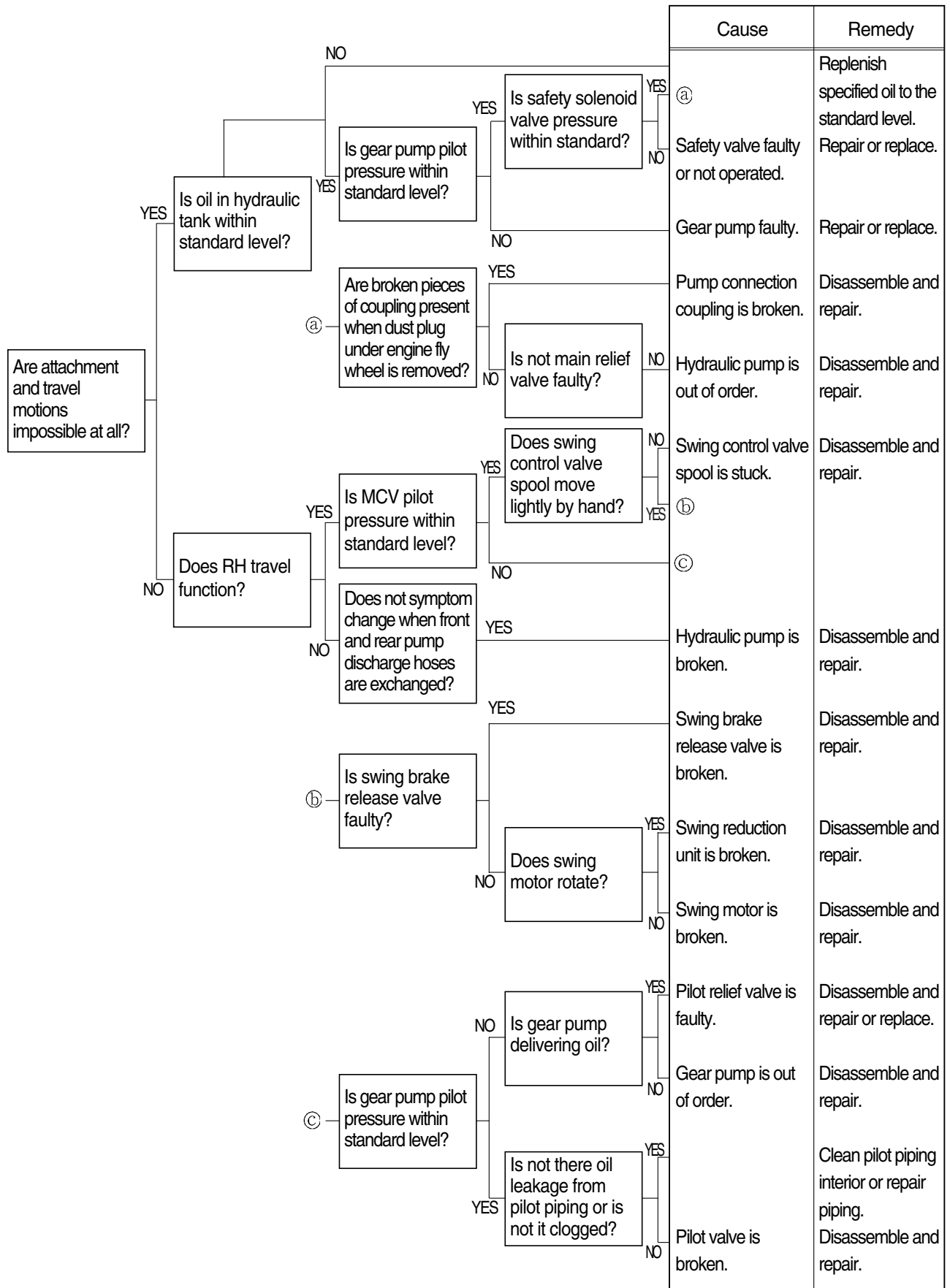
### 4) HYDRAULIC OIL IS CONTAMINATED



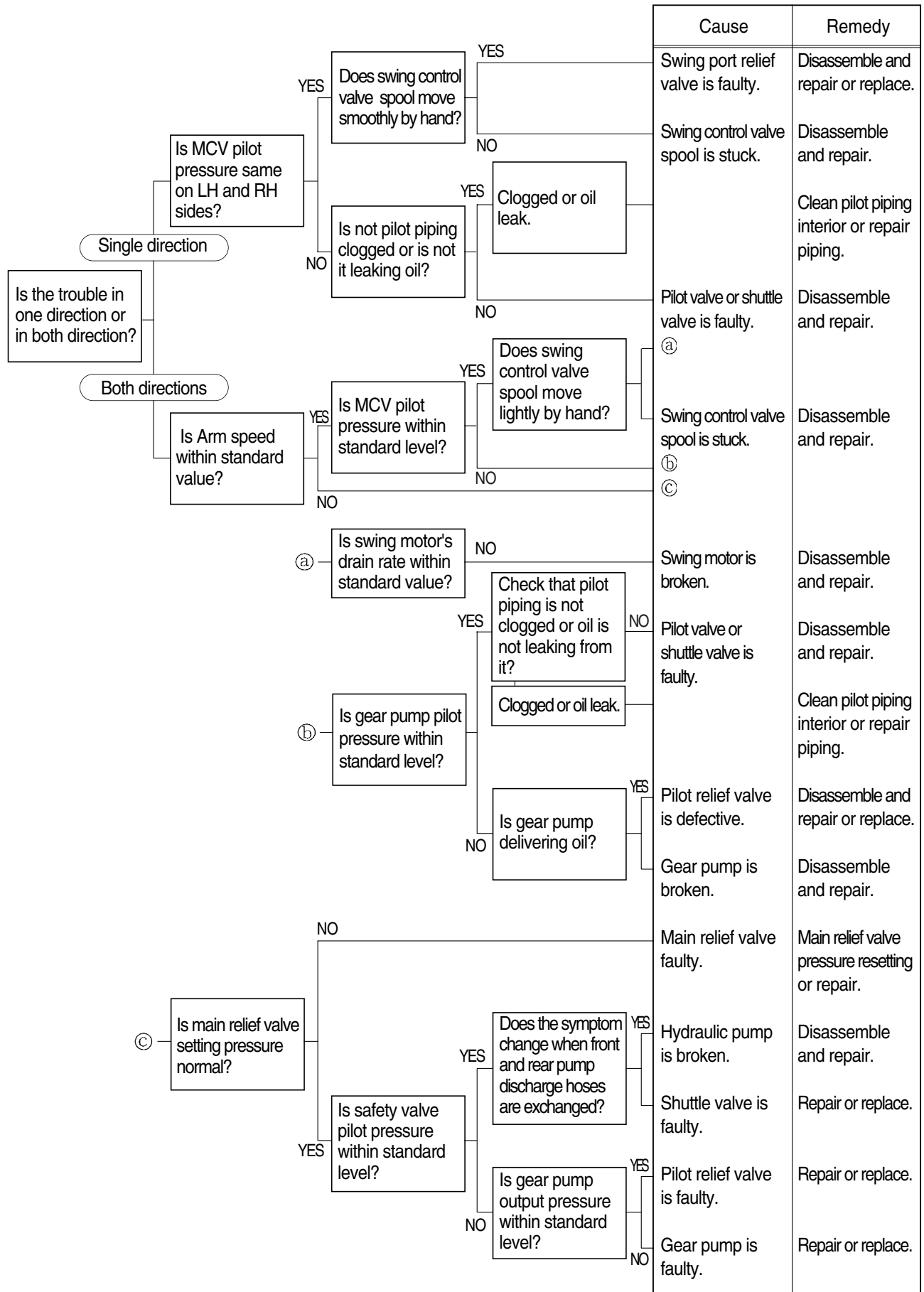


## 4. SWING SYSTEM

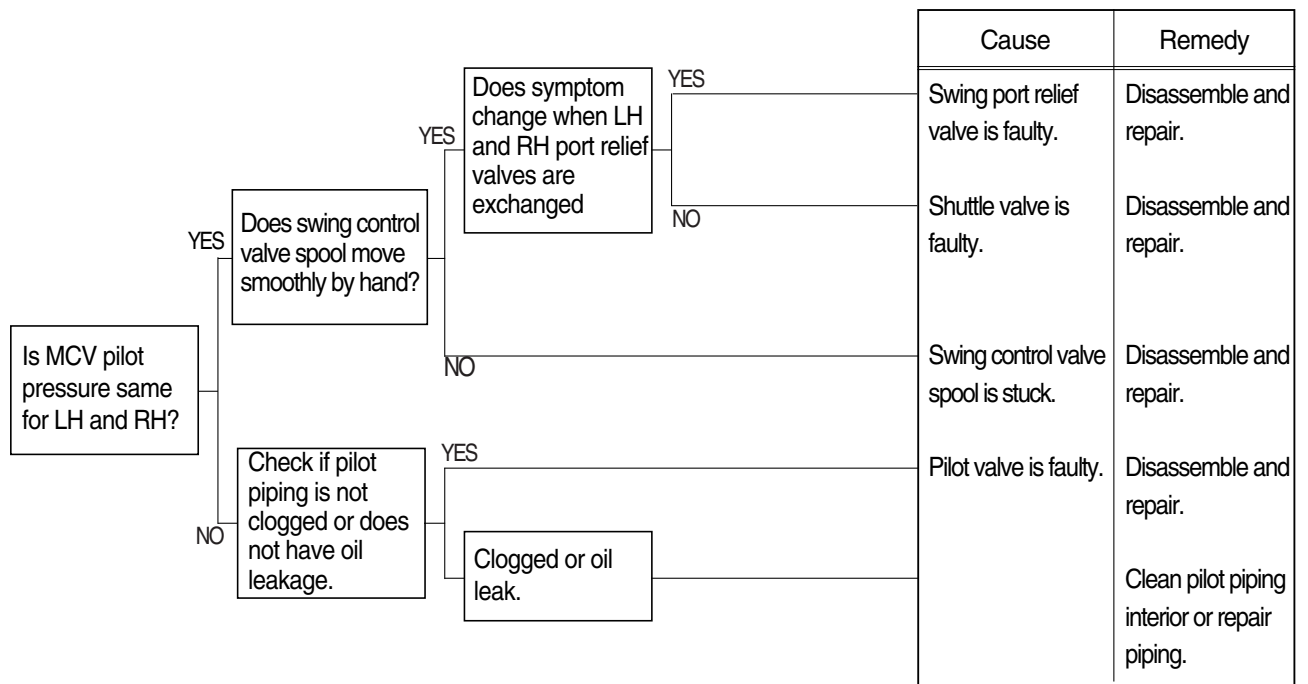
### 1) BOTH LH AND RH SWING ACTIONS ARE IMPOSSIBLE



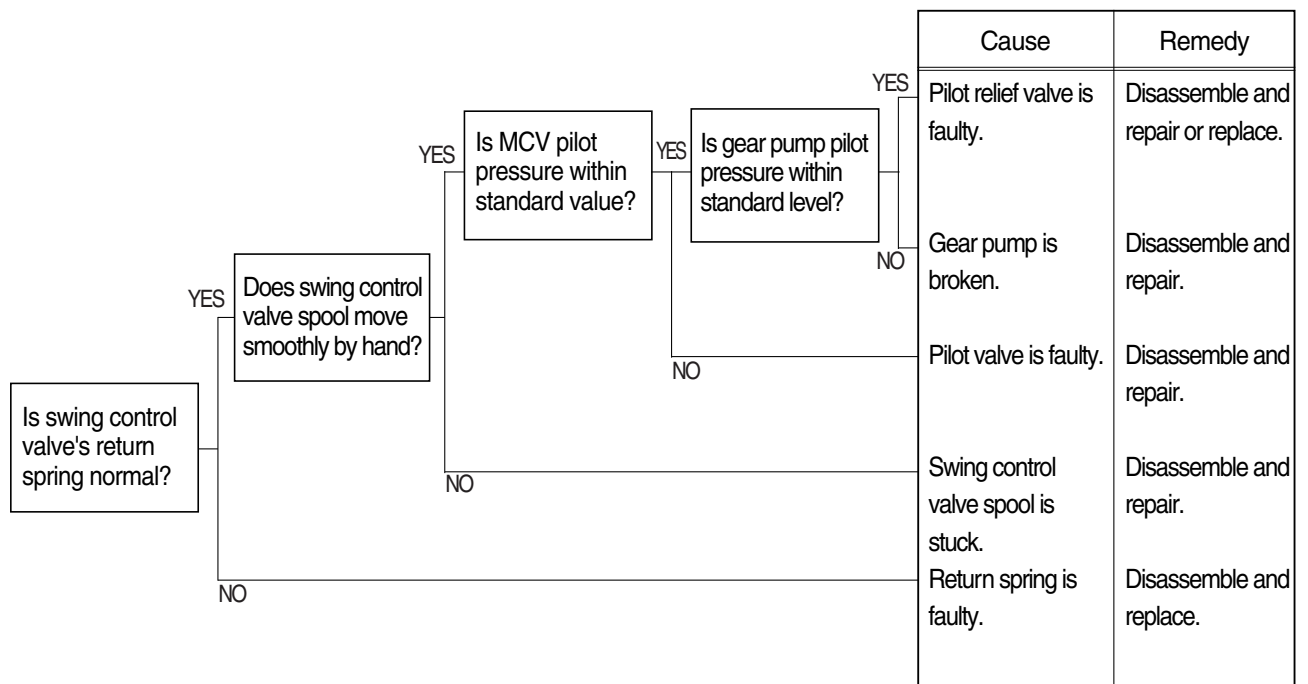
## 2) SWING SPEED IS LOW



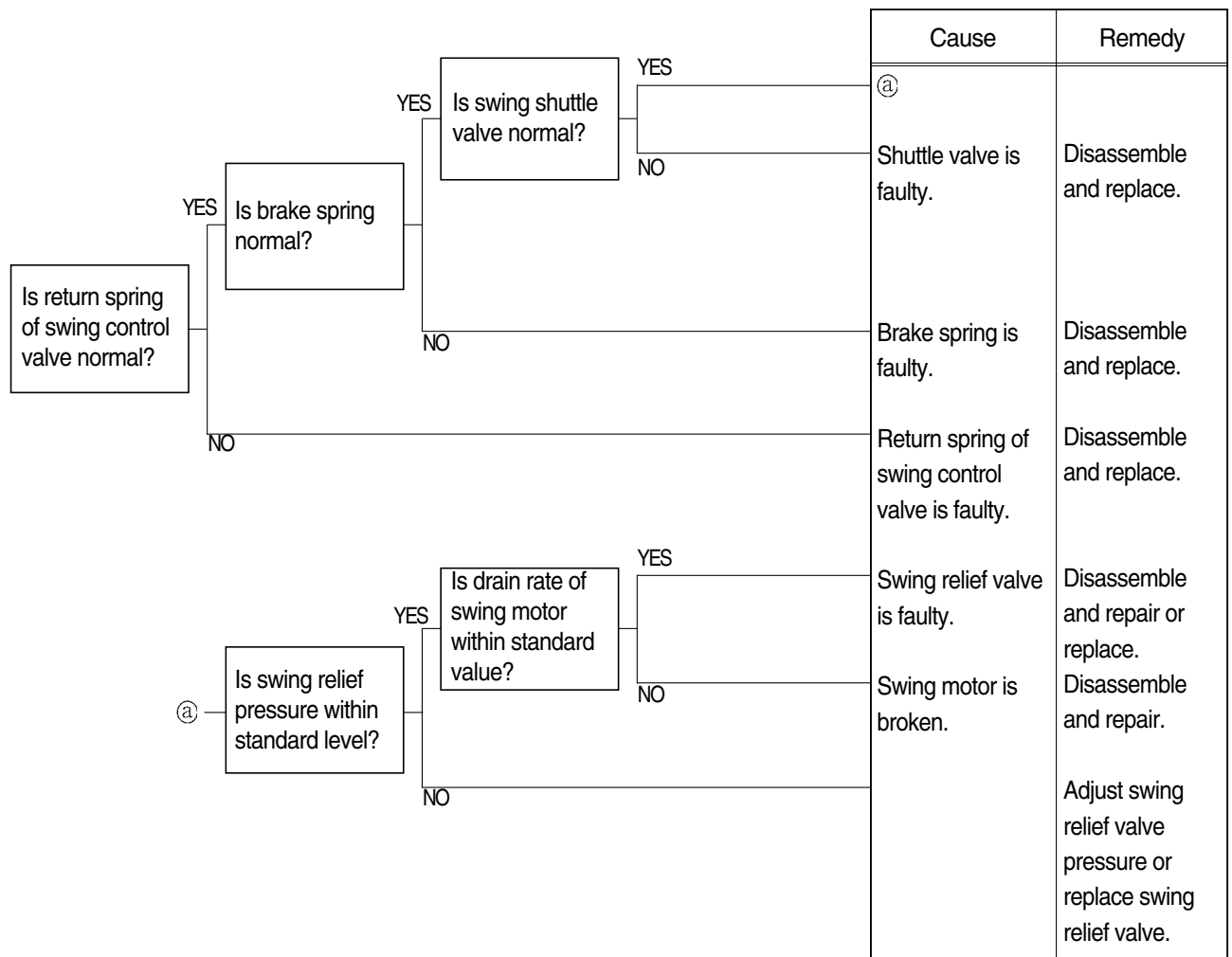
### 3) SWING MOTION IS IMPOSSIBLE IN ONE DIRECTION



### 4) MACHINE SWINGS BUT DOES NOT STOP

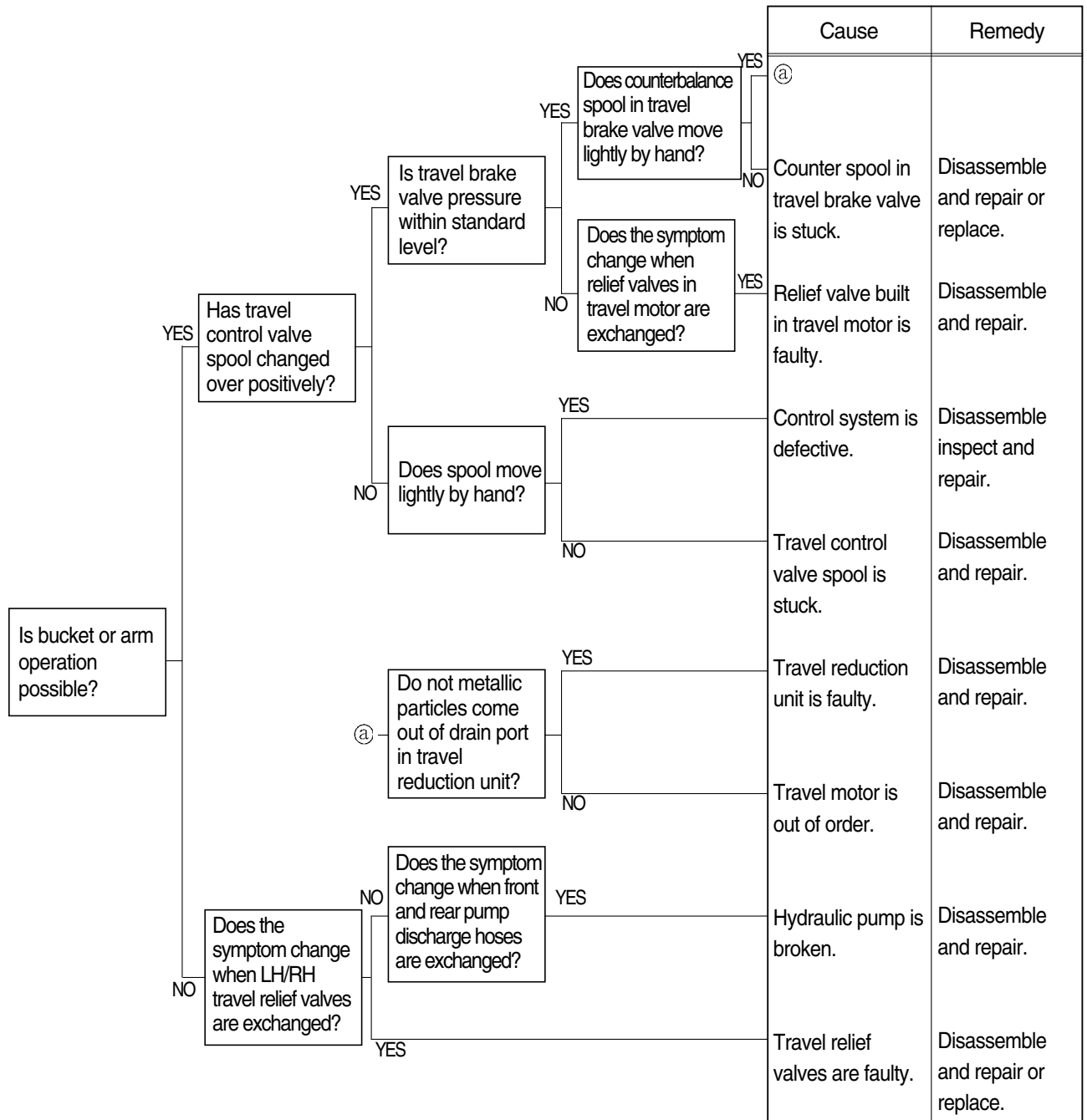


## 5) THE SWING UNIT DRIFTS WHEN THE MACHINE IS AT REST ON A SLOPE

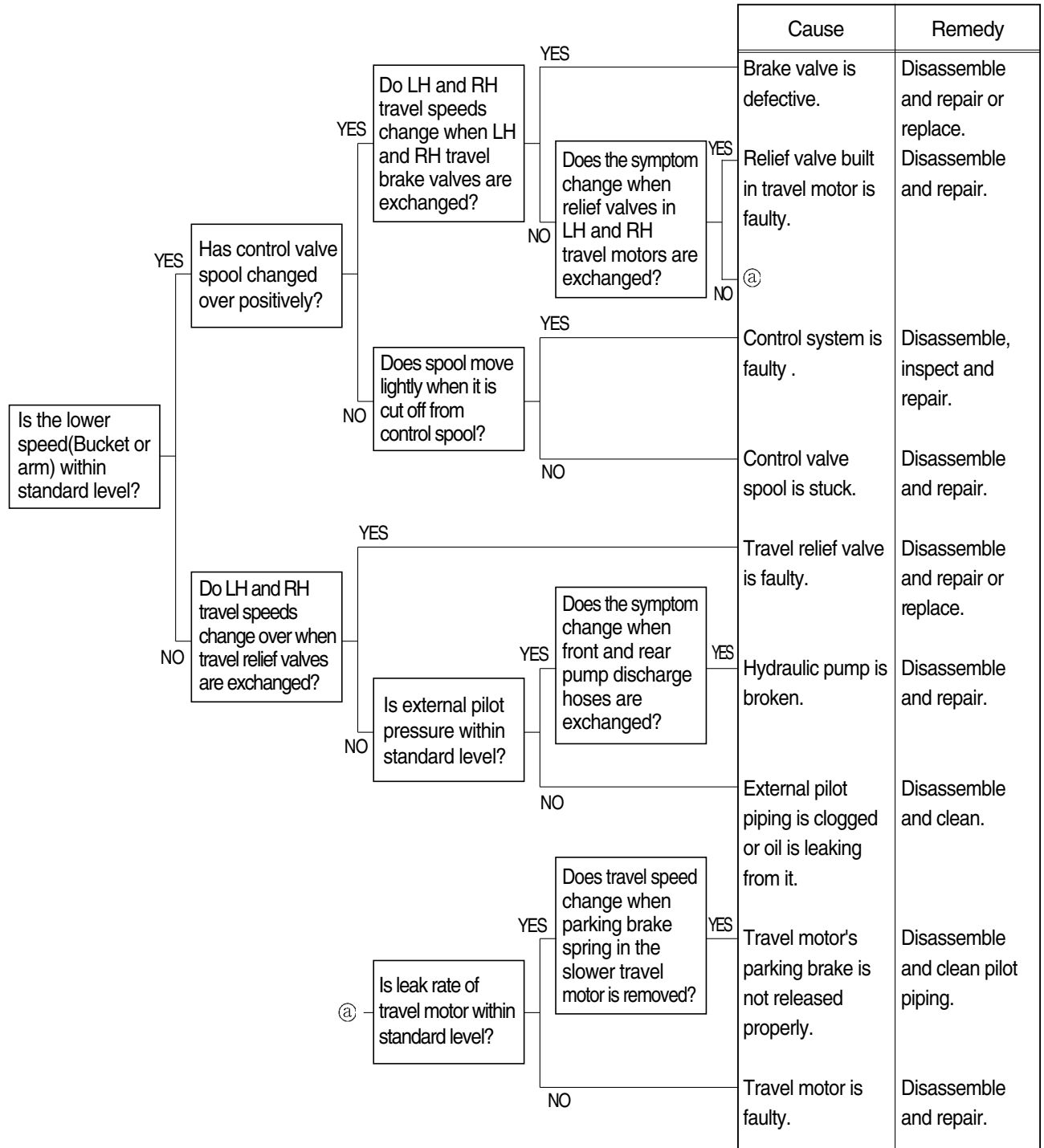


## 5. TRAVEL SYSTEM

### 1) TRAVEL DOES NOT FUNCTION AT ALL ON ONE SIDE

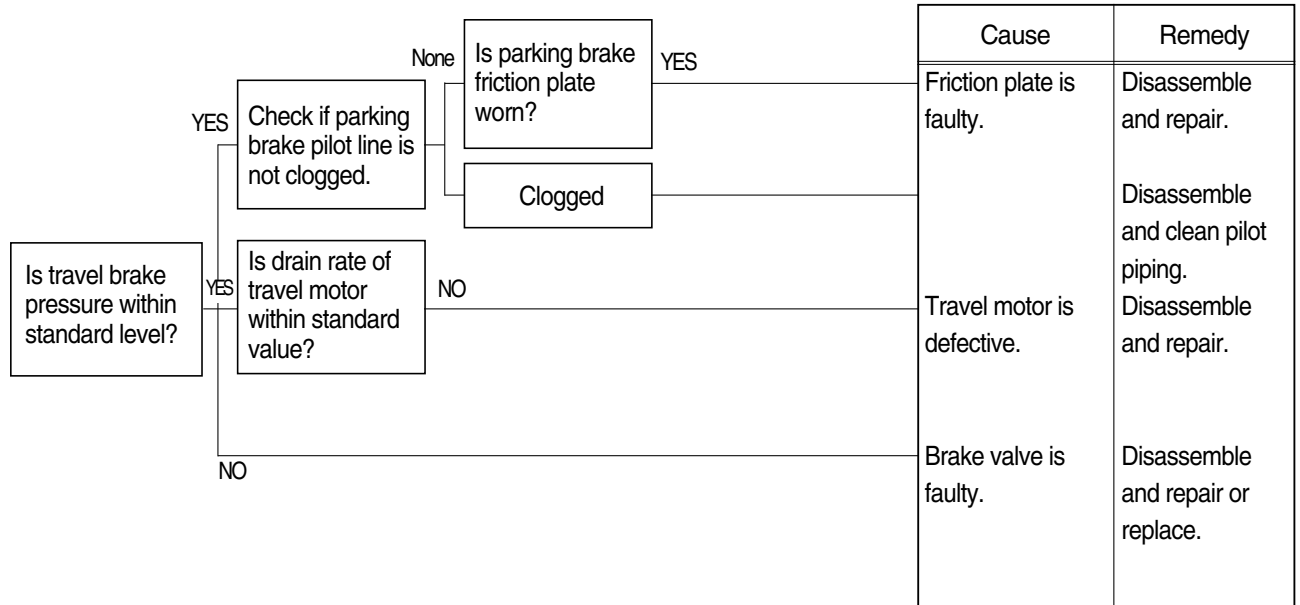


## 2) SPEED ON ONE SIDE FALLS AND THE MACHINE CURVES

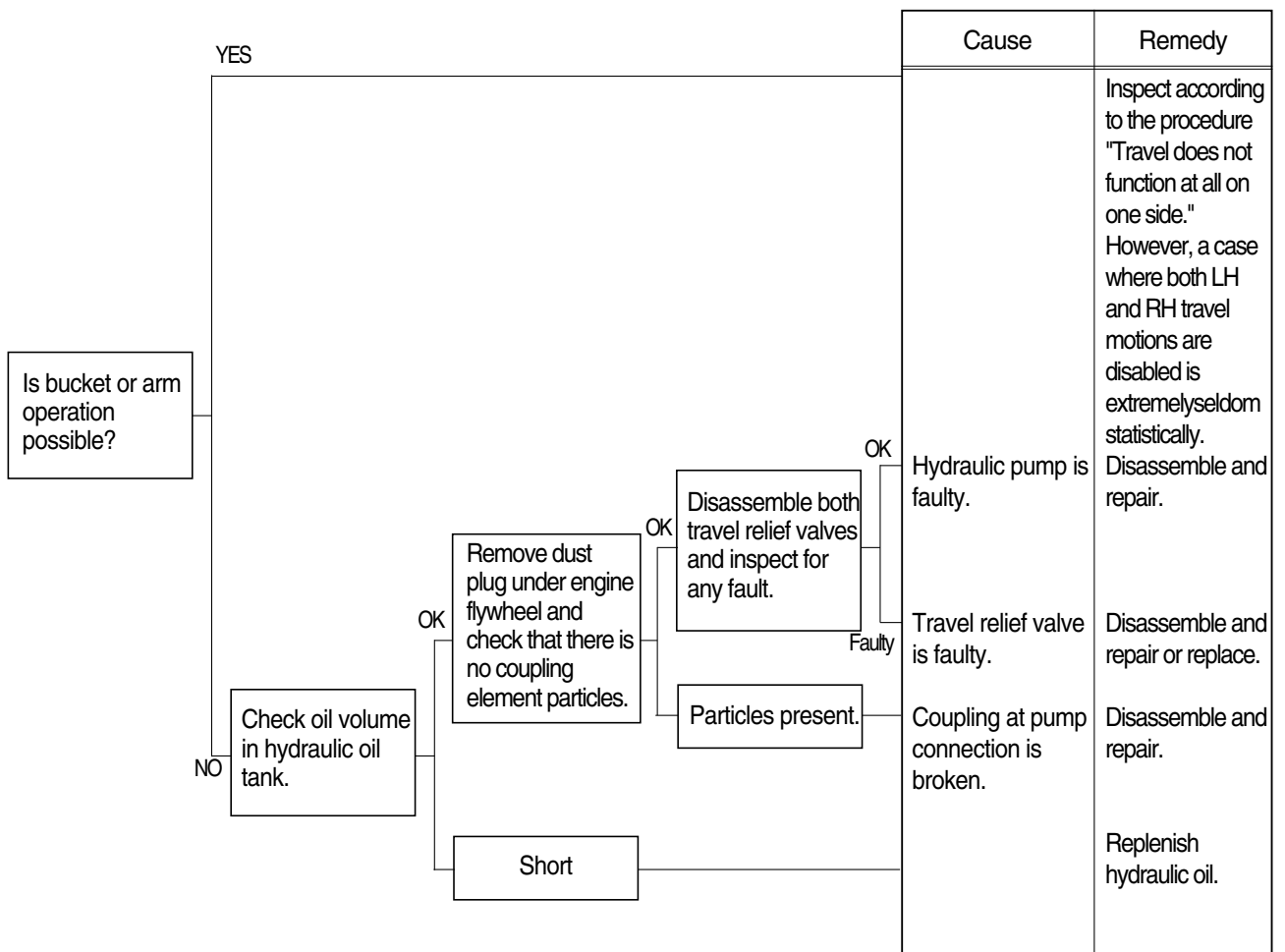


### 3) MACHINE DOES NOT STOP ON A SLOPE

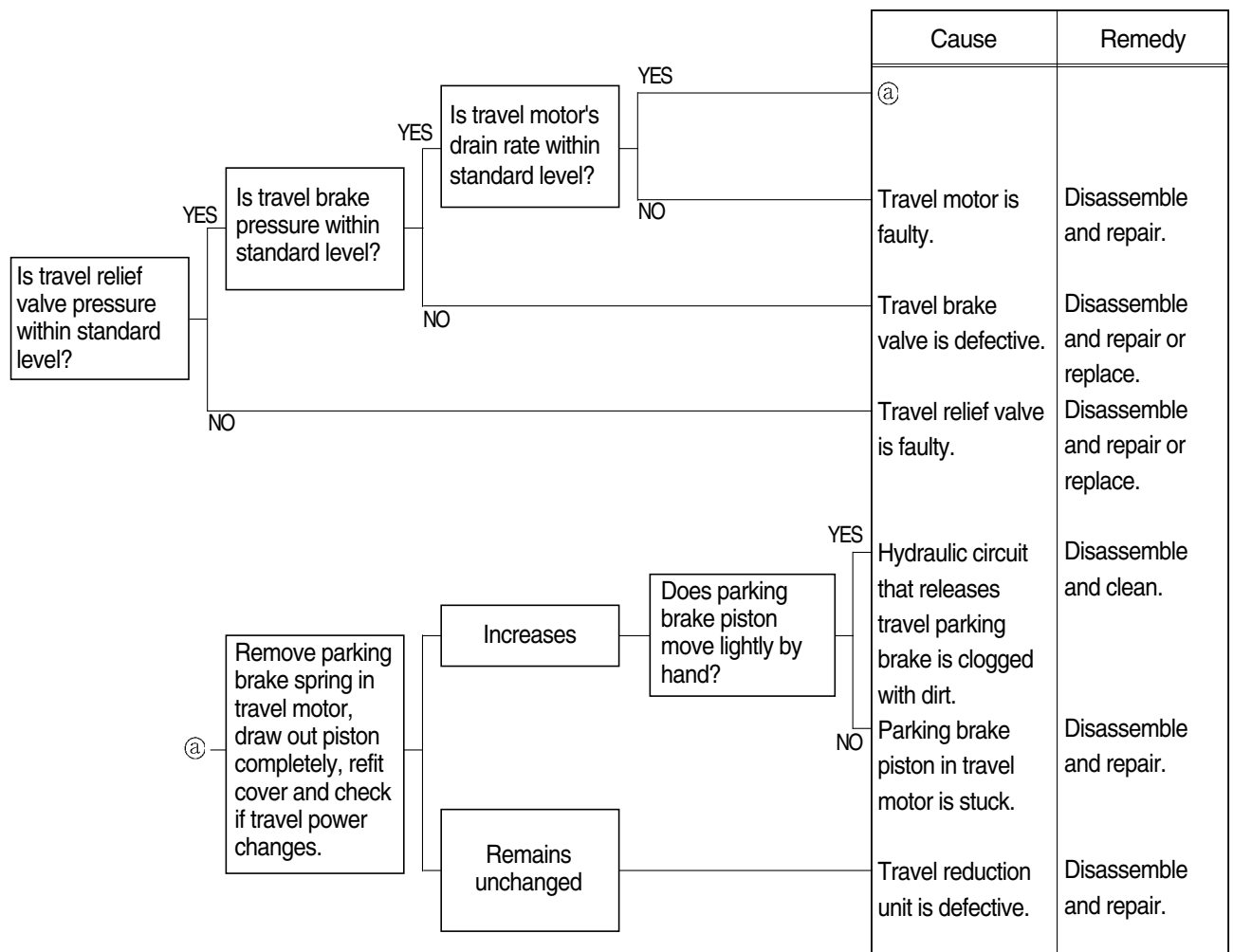
Machine is pulled forward as sprocket rotates during digging operation.



### 4) LH AND RH TRAVEL MOTIONS ARE IMPOSSIBLE



## 5) TRAVEL ACTION IS POWERLESS(Travel only)

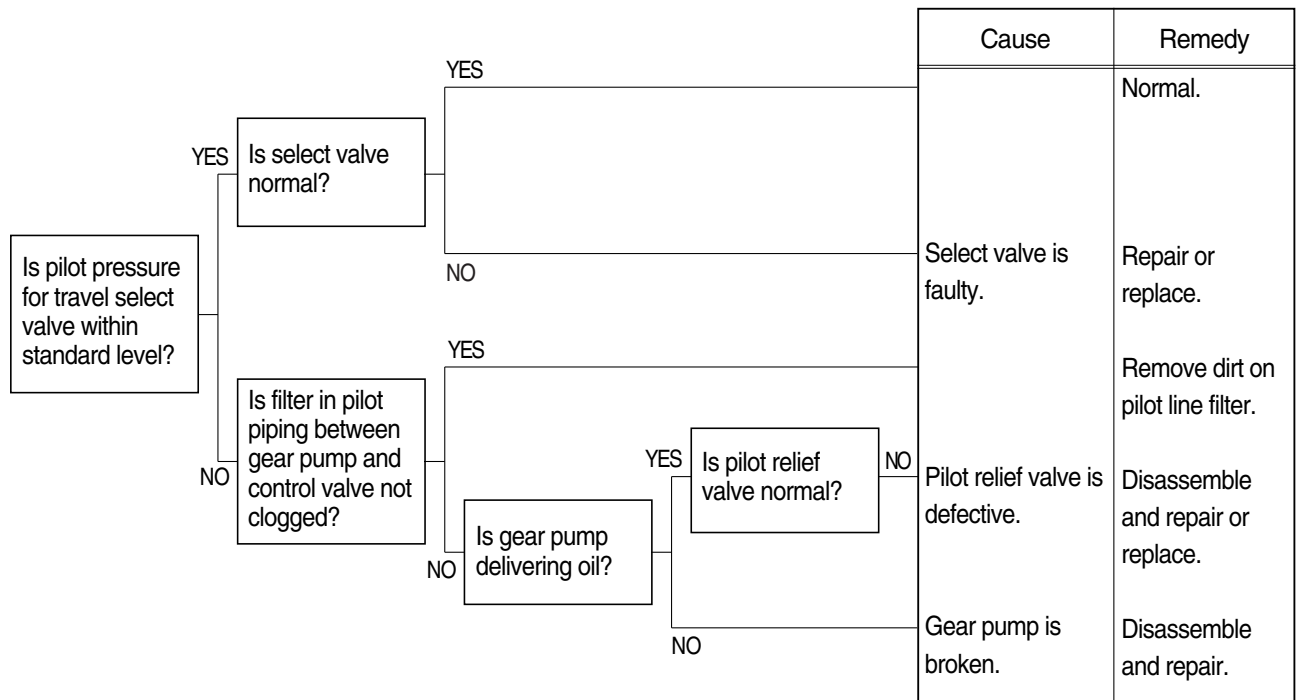


## 6) MACHINE RUNS RECKLESSLY ON A SLOPE



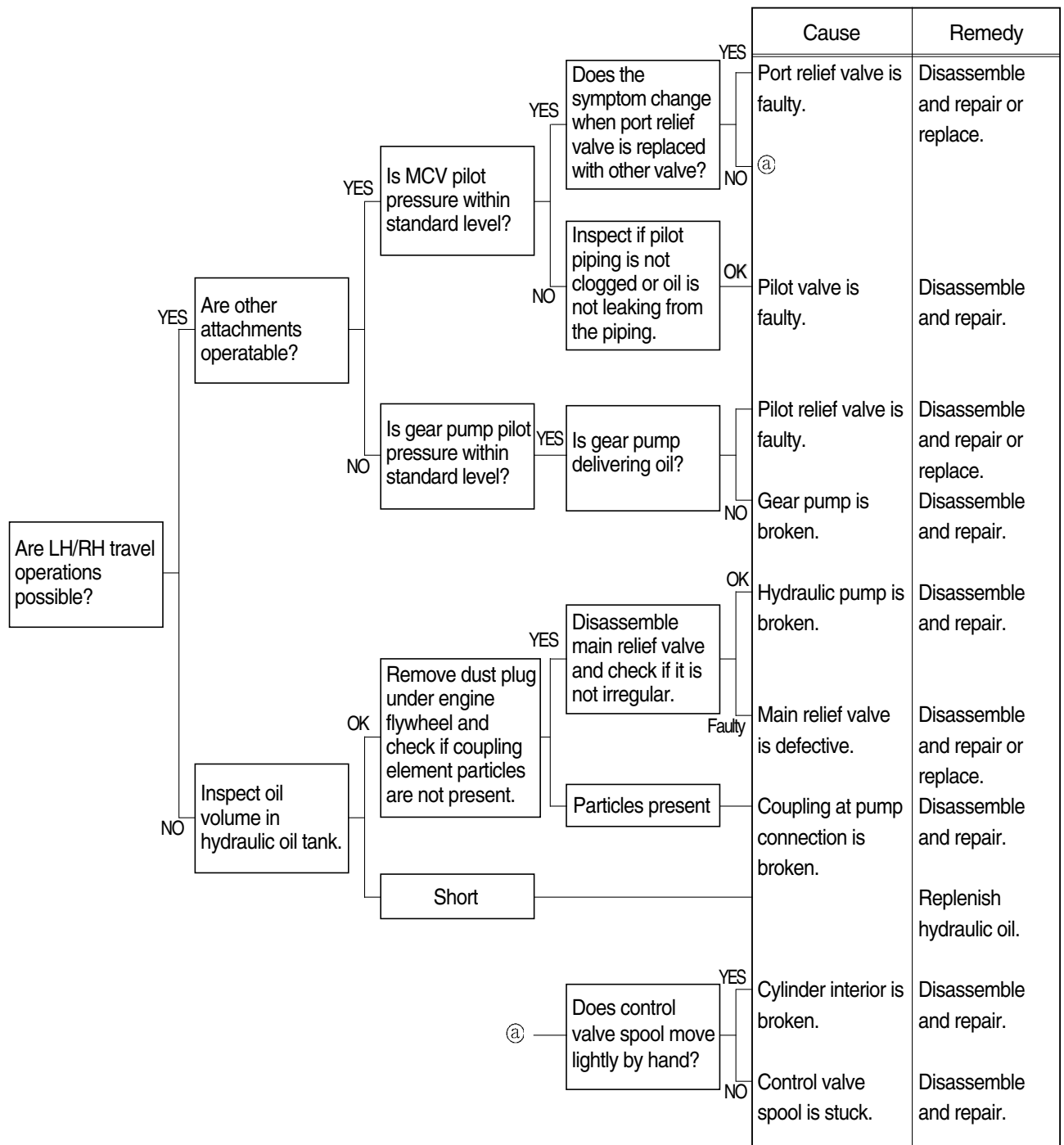


**7) MACHINE MAKES A CURVED TRAVEL OR DOES NOT TRAVEL AT ALL WHEN TRAVEL AND ATTACHMENT OPERATIONS ARE EXECUTED AT THE SAME TIME**

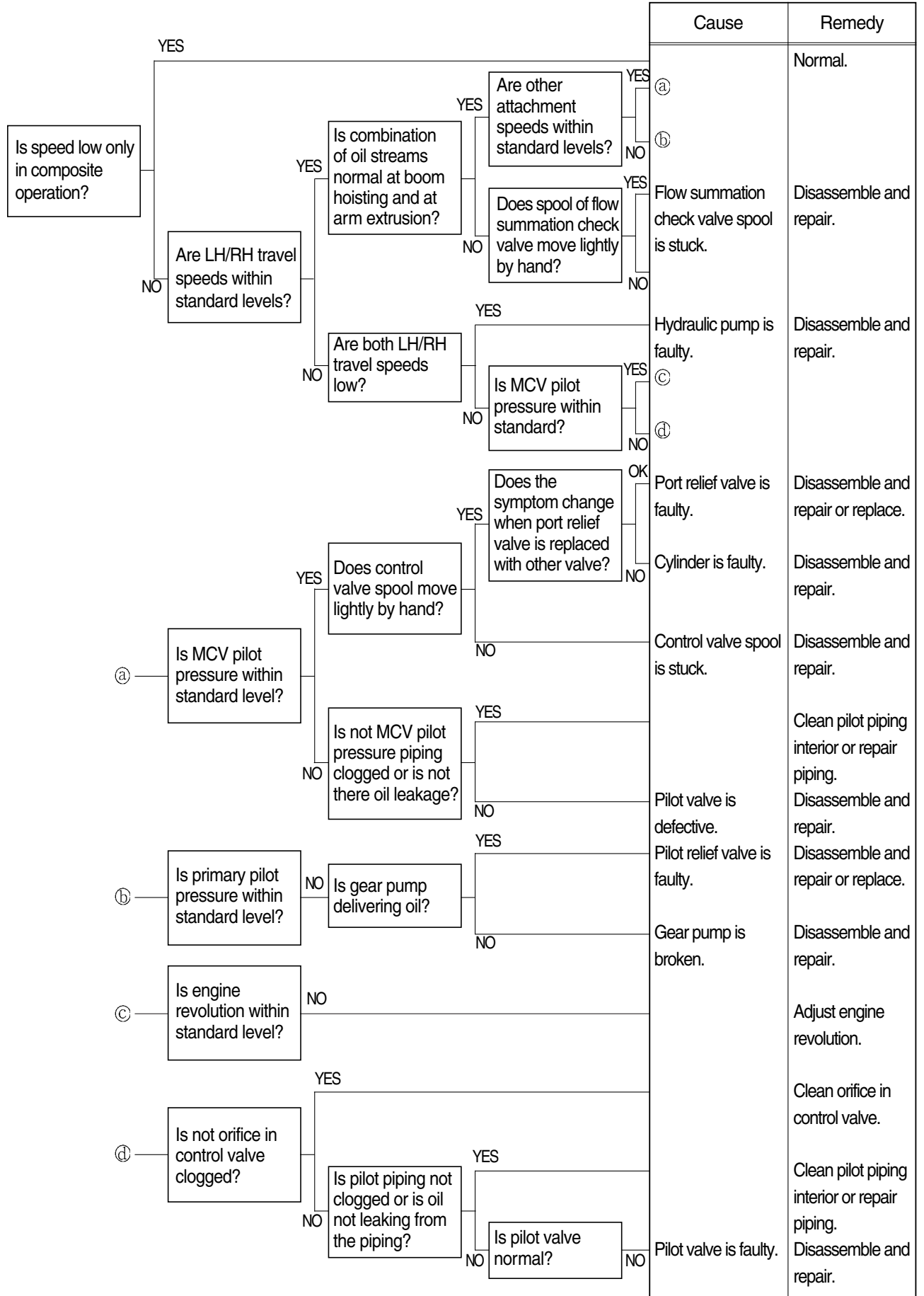


## 6. ATTACHMENT SYSTEM

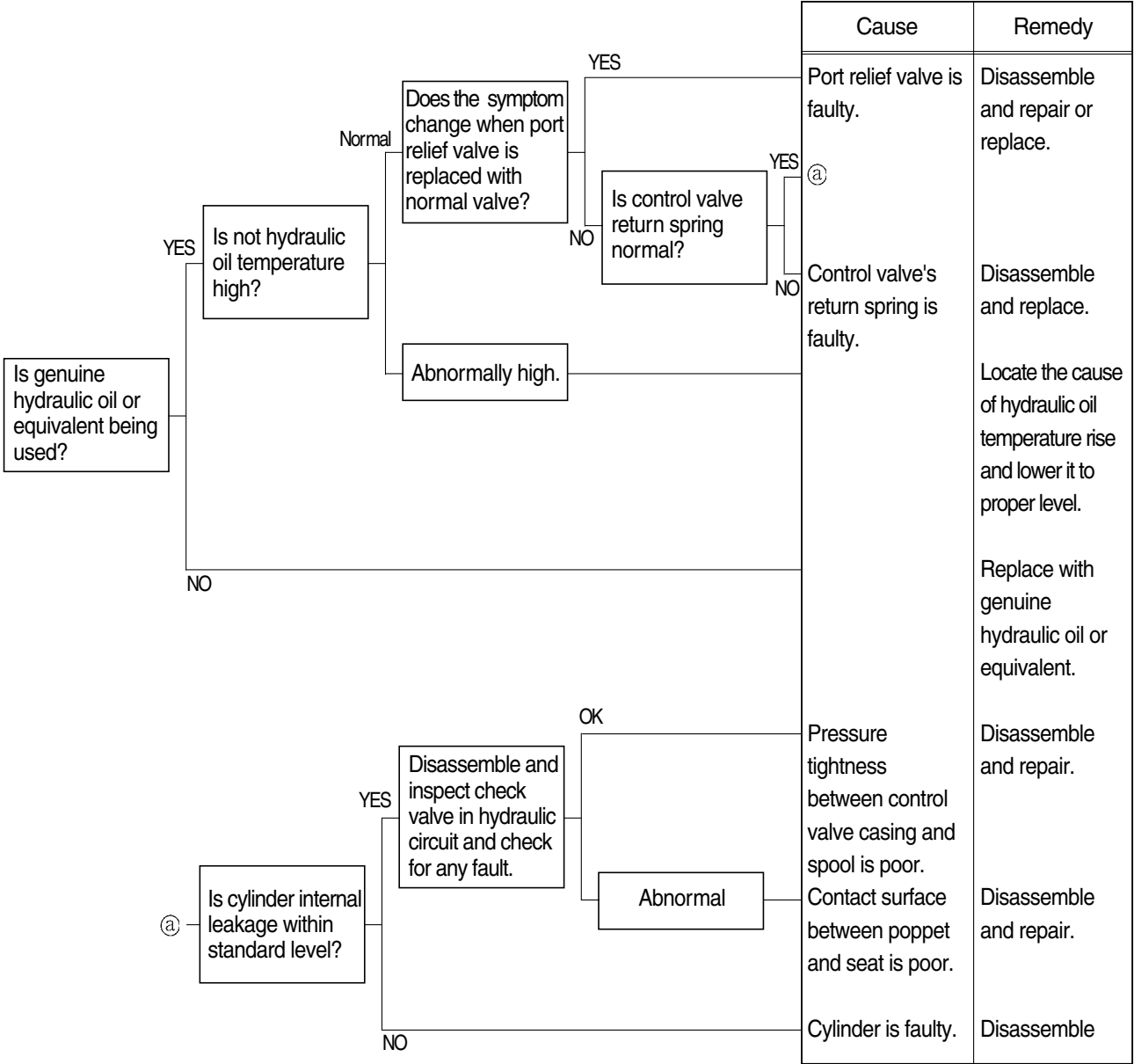
### 1) BOOM OR ARM ACTION IS IMPOSSIBLE AT ALL



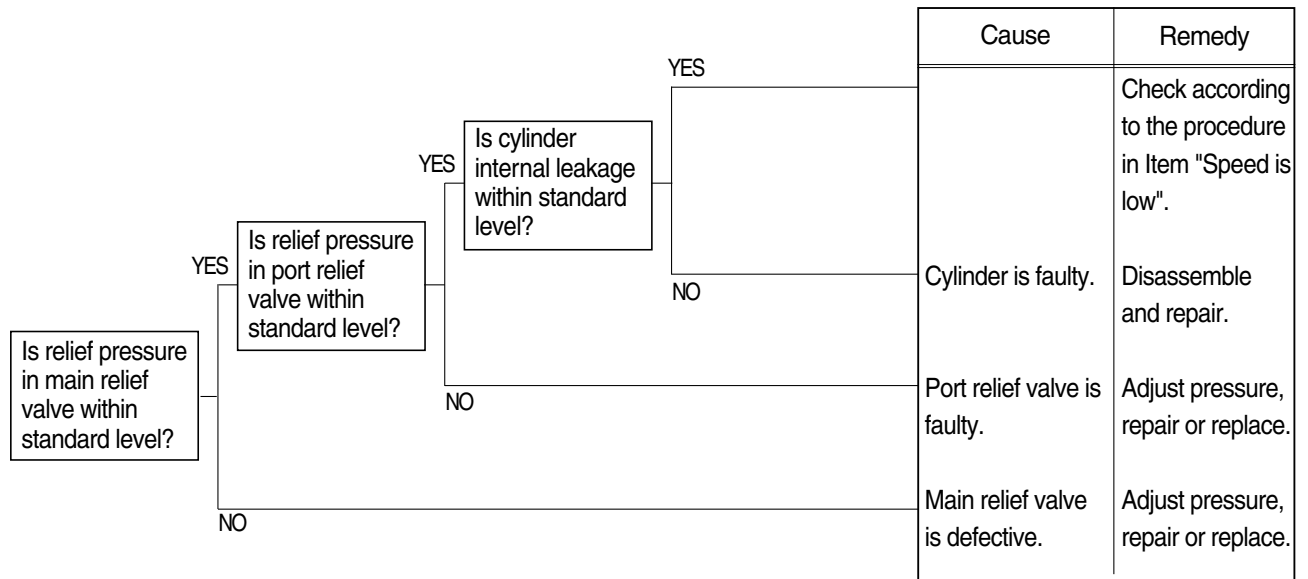
## 2) BOOM, ARM OR BUCKET SPEED IS LOW



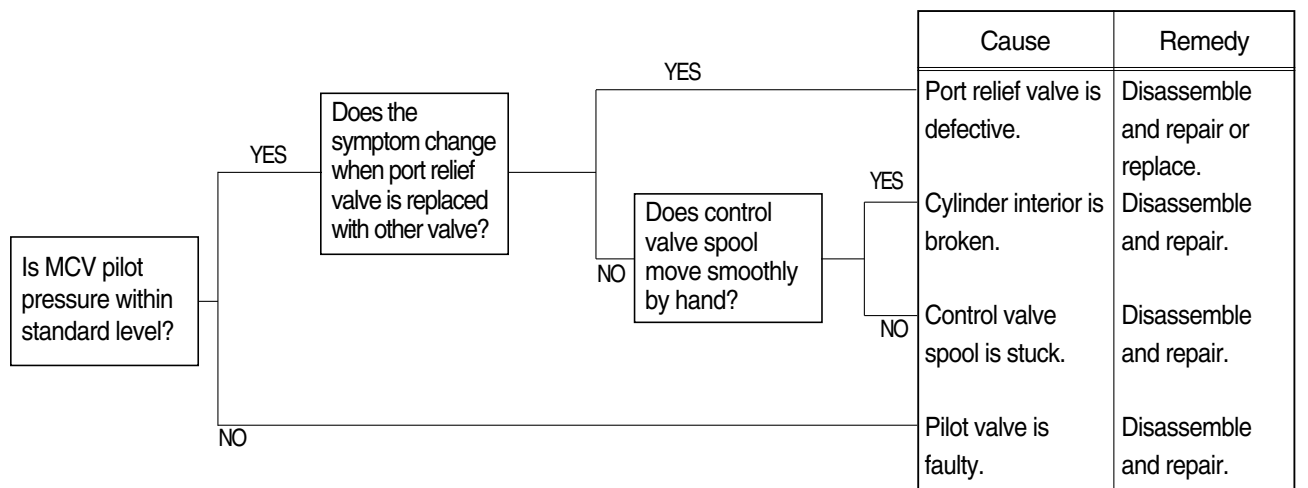
3) BOOM, ARM OR BUCKET CYLINDER EXTENDS OR CONTRACTS ITSELF AND ATTACHMENT FALLS



#### 4) BOOM, ARM OR BUCKET POWER IS WEAK



#### 5) ONLY BUCKET OPERATION IS TOTALLY IMPOSSIBLE

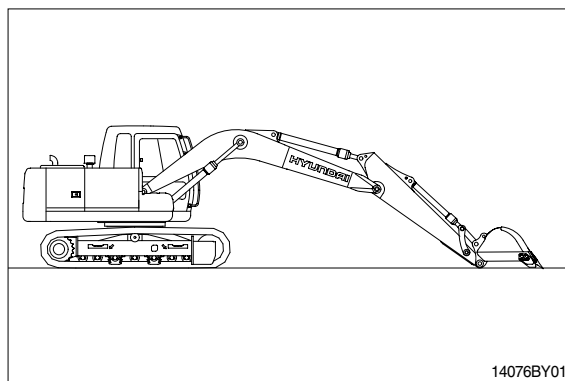


## 6) BOOM MAKES A SQUEAKING NOISE WHEN BOOM IS OPERATED

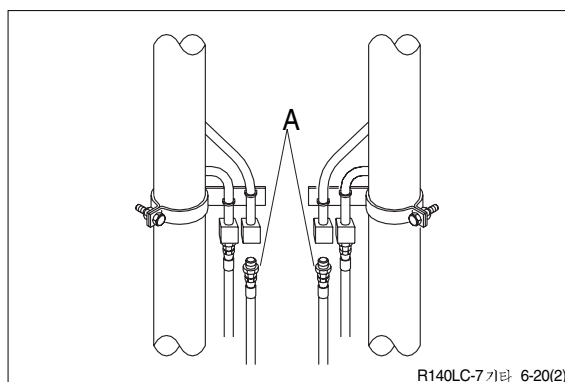
		Cause	Remedy
Is boom foot pin greased sufficiently?	YES		Frictional noise occurs between the sliding faces of boom cylinder's oil seal and boom proper.  ※ Frictional noise will disappear if they are kept used.
	NO	Boom foot pin has run out of grease.	Supply grease to it.  ※ If seizure is in an initial stage, supply sufficient grease. If seizure is in a grown state, correct it by paper lapping or with an oil stone.

## ※ HOW TO CHECK INTERNAL BOOM CYLINDER LEAKAGE

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



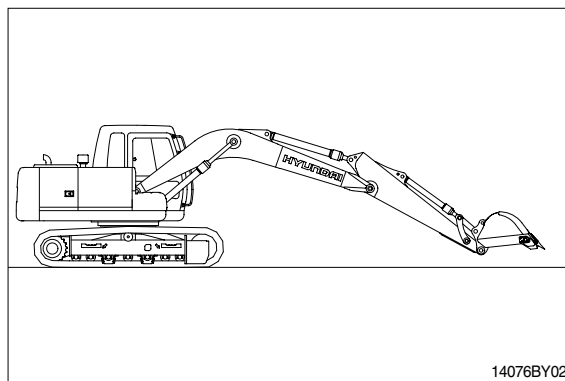
2. Disconnect hose(A) from rod side of boom cylinder and drain oil from cylinders and hose.(Put cups on piping and hose ends)



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.

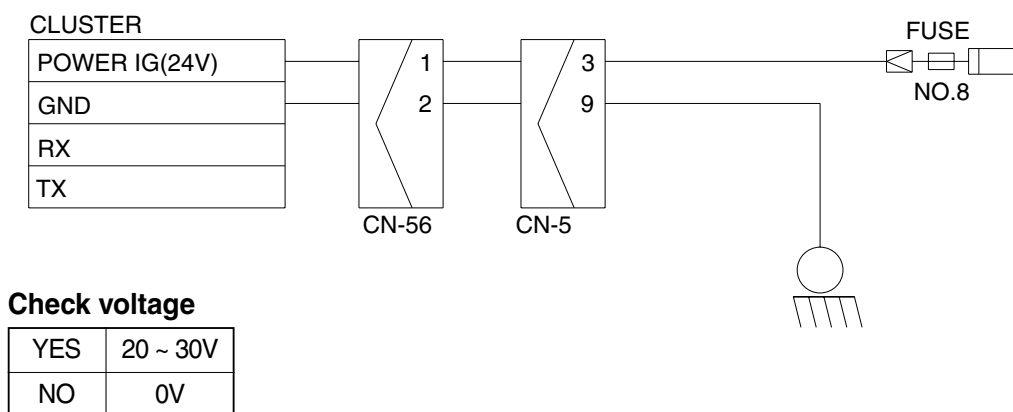
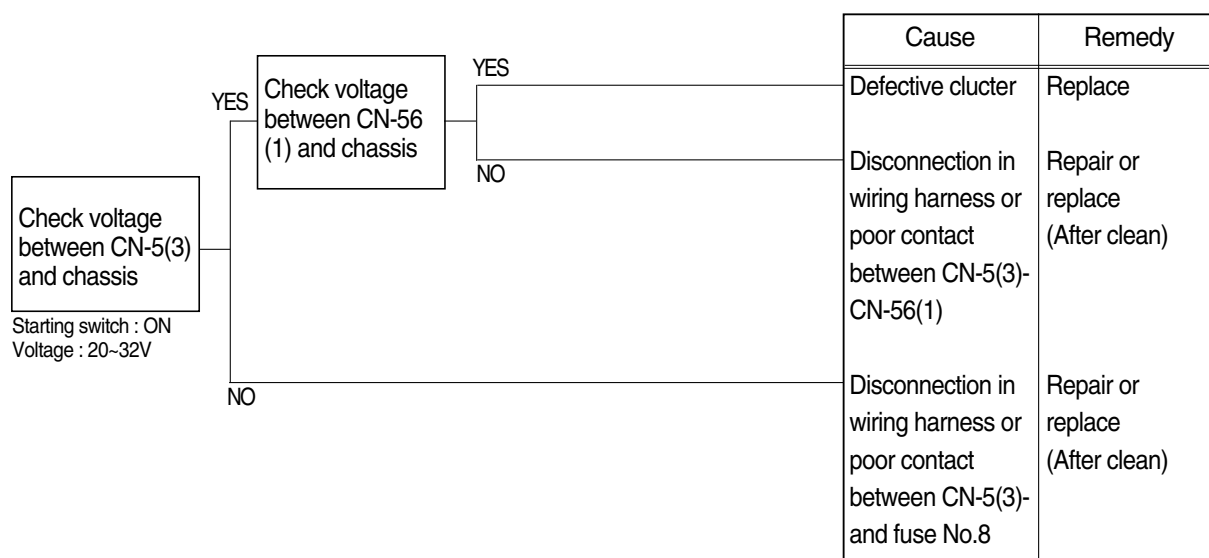
If no oil leaks from piping side and boom cylinder rod is retracted, there is an internal leak in the control valve.



## GROUP 3 ELECTRICAL SYSTEM

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

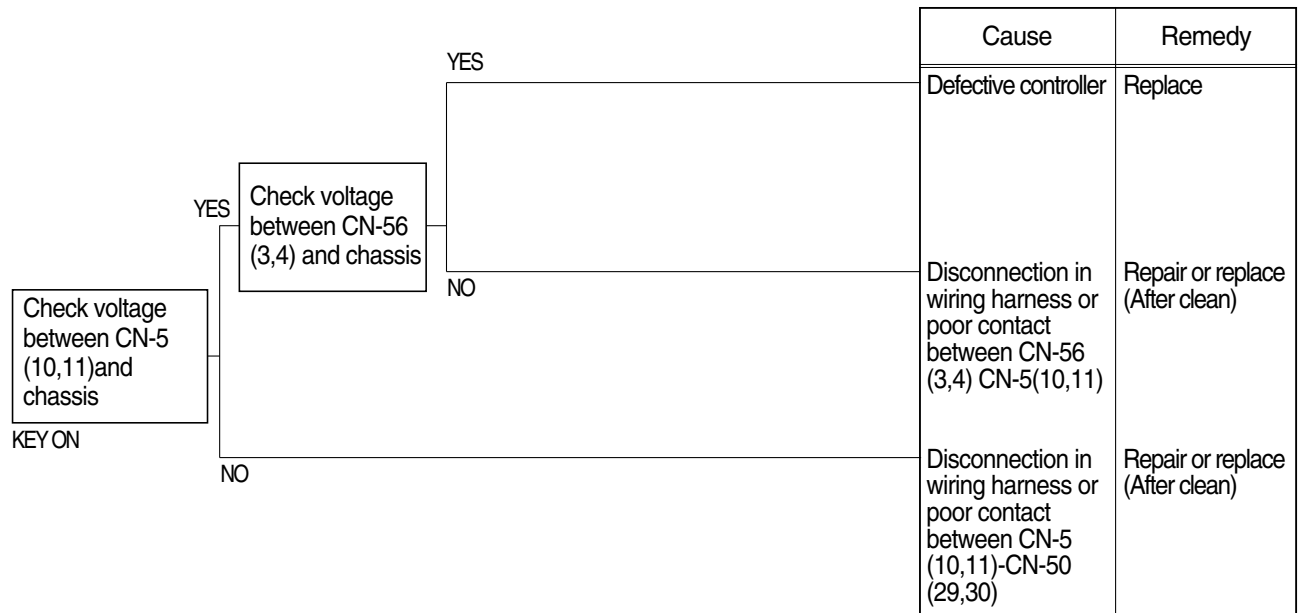
- Before disconnecting the connector, always turn the starting switch OFF.
- Before carrying out below procedure, check all the related connectors are properly inserted and short of fuse No.8.
- After checking, insert the disconnected connectors again immediately unless otherwise specified.





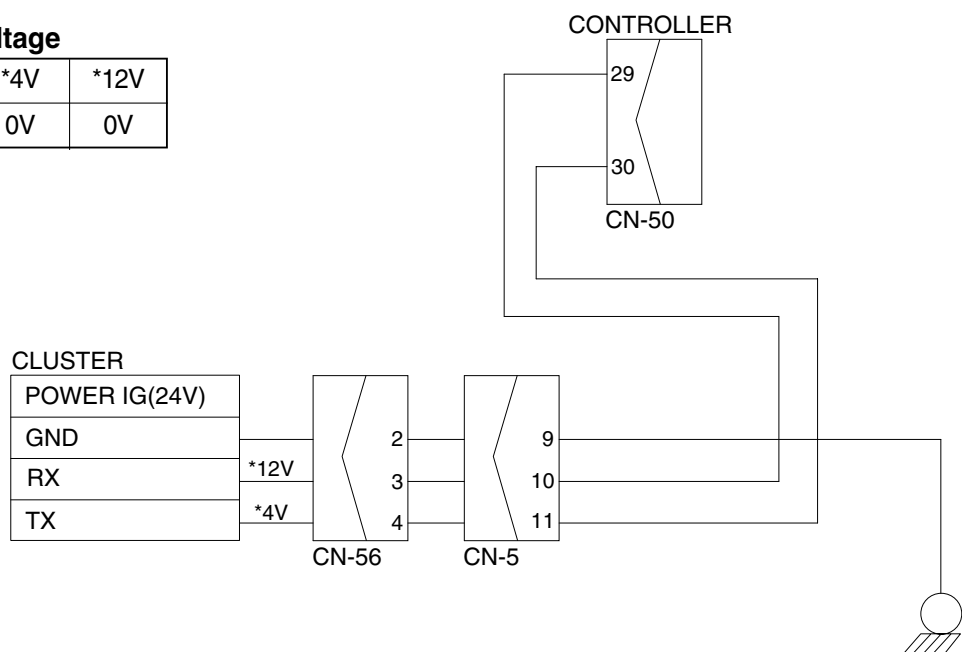
## 2. COMMUNICATION ERROR "Co : Err" FLASHES ON THE CLUSTER

- 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

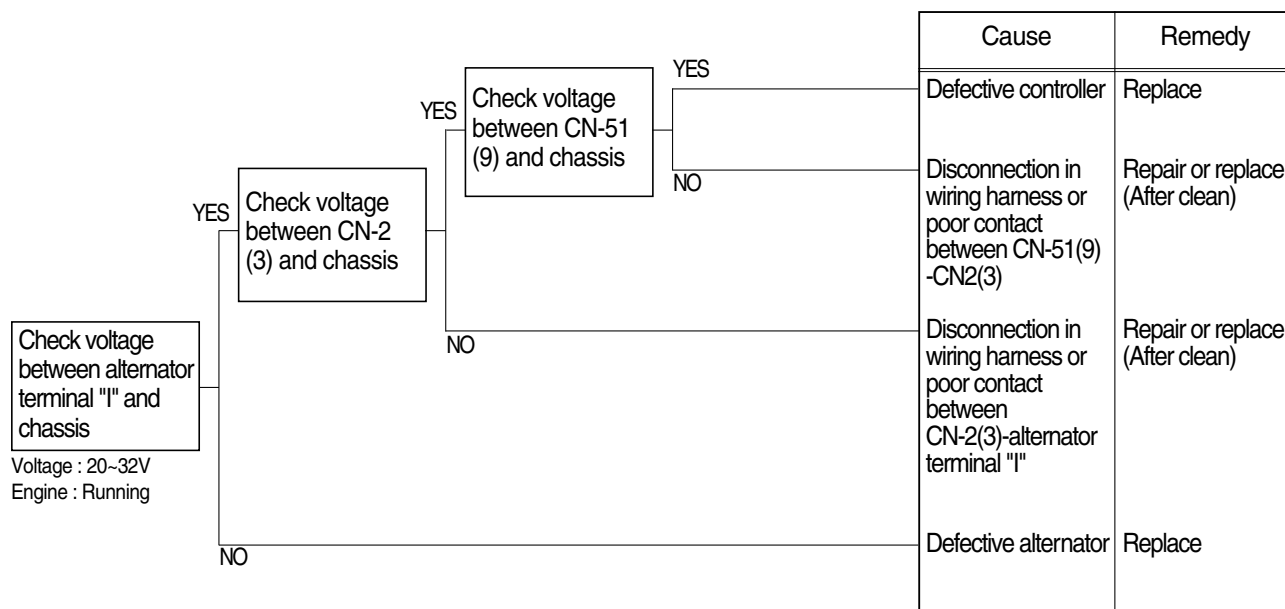
YES	*4V	*12V
NO	0V	0V



29076ES02

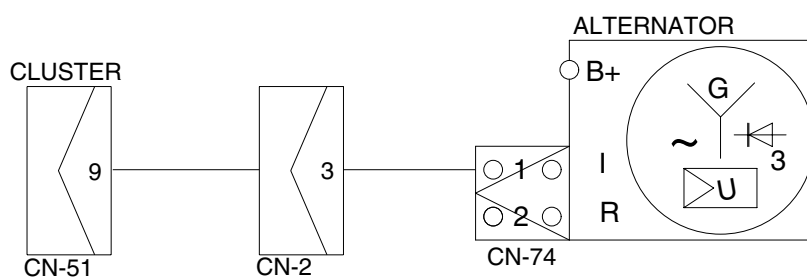
### 3. BATTERY CHARGING WARNING LAMP LIGHTS UP(Starting switch : ON)

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



#### Check voltage

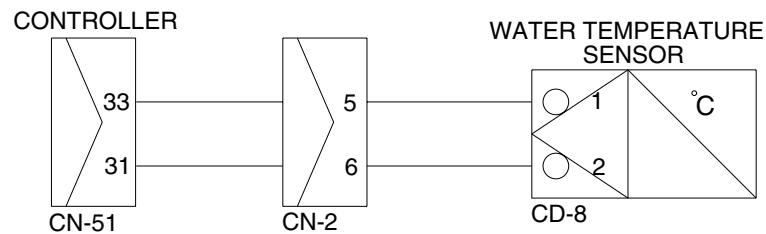
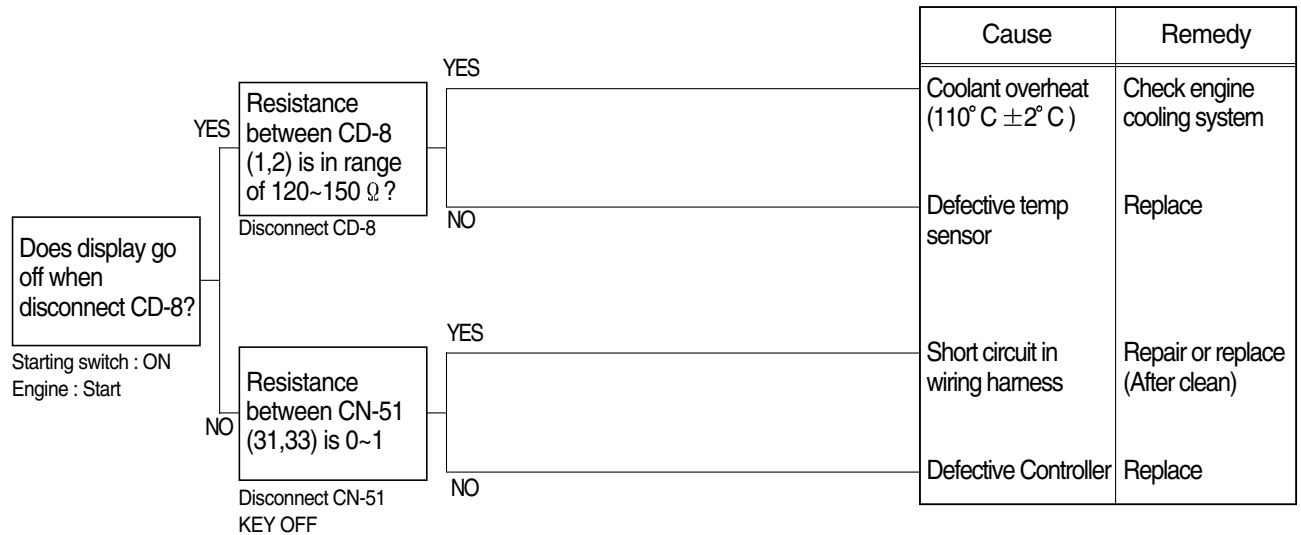
YES	20 ~ 32V
NO	0V



11076TS21

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

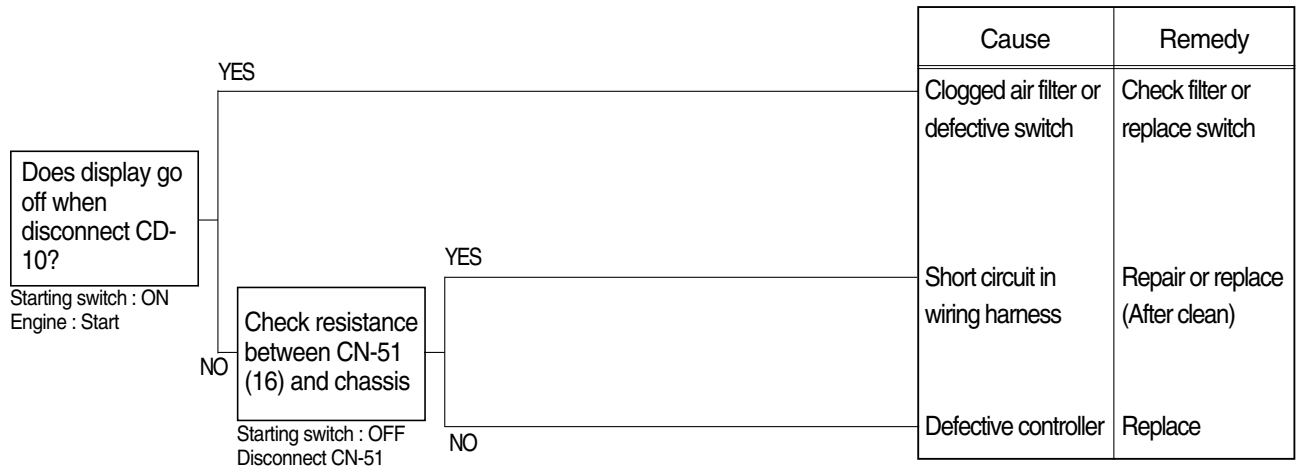
- Before disconnecting the connector, always turn the starting switch OFF.
- Before carrying out below procedure, check all the related connectors are properly inserted.
- After checking, insert the disconnected connectors again immediately unless otherwise specified.



11076TS22

## 5. WHEN AIR CLEANER WARNING LAMP LIGHTS UP(Engine is started)

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



### Check resistance

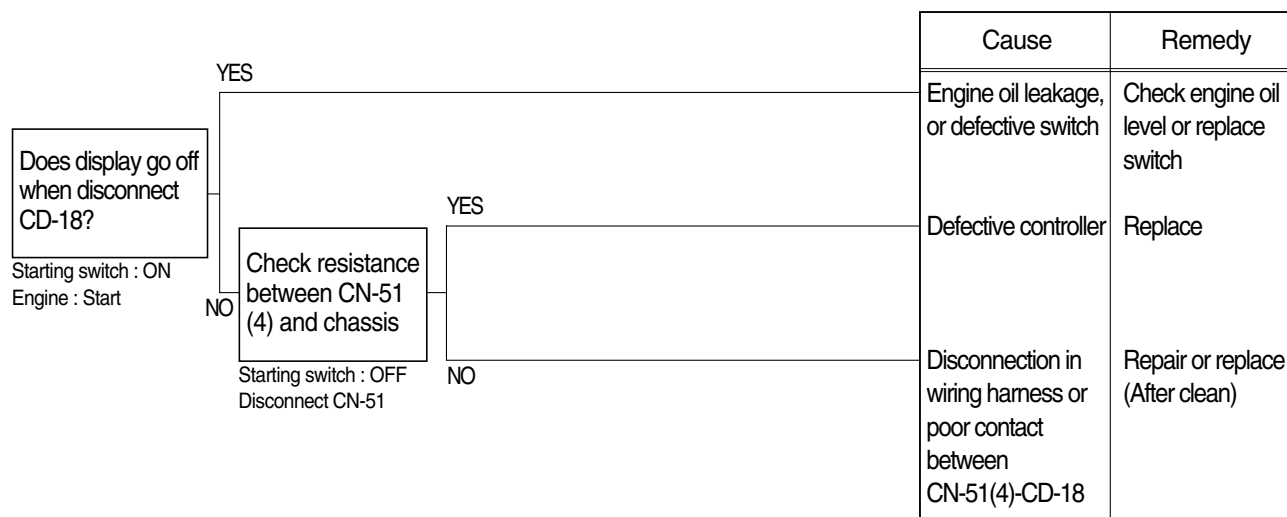
YES	MAX 1Ω
NO	MIN 1M Ω



25036EL05

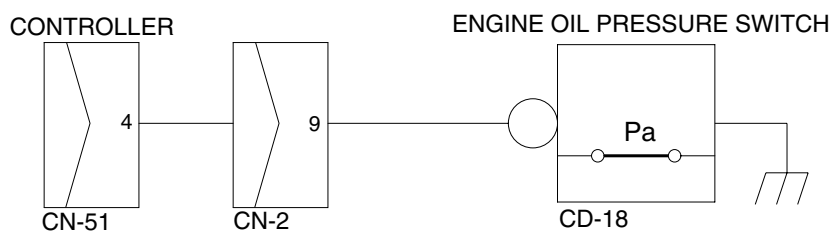
## 6. WHEN ENGINE OIL PRESSURE WARNING LAMP LIGHTS UP (Engine is started)

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



### Check resistance

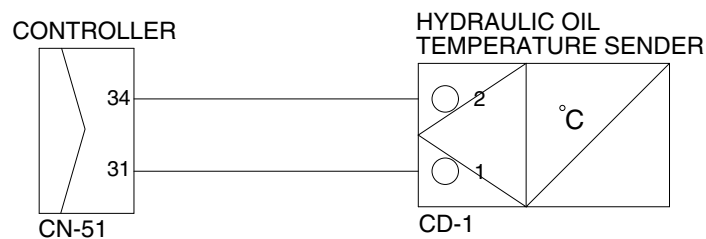
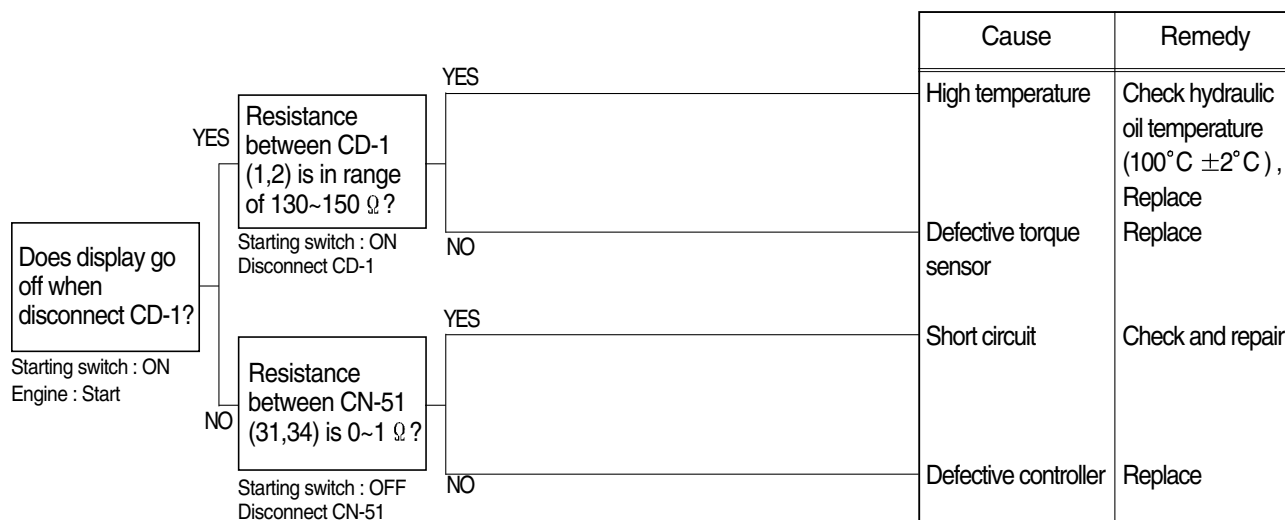
YES	MAX 1Ω
NO	MIN 1MΩ



11076TS23

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

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



29076ES04

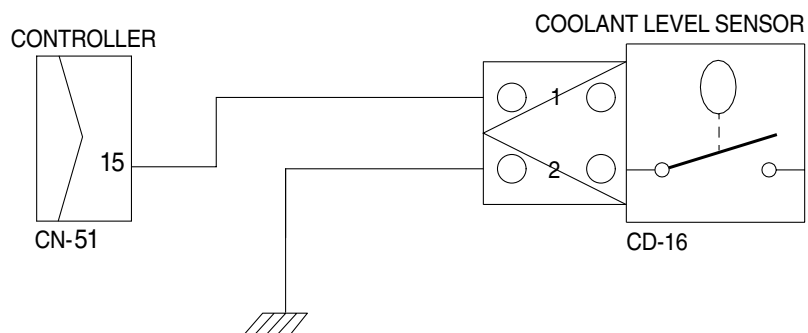
## 8. WHEN COOLANT LEVEL WARNING LAMP LIGHTS UP(Engine is started)

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



### Check resistance

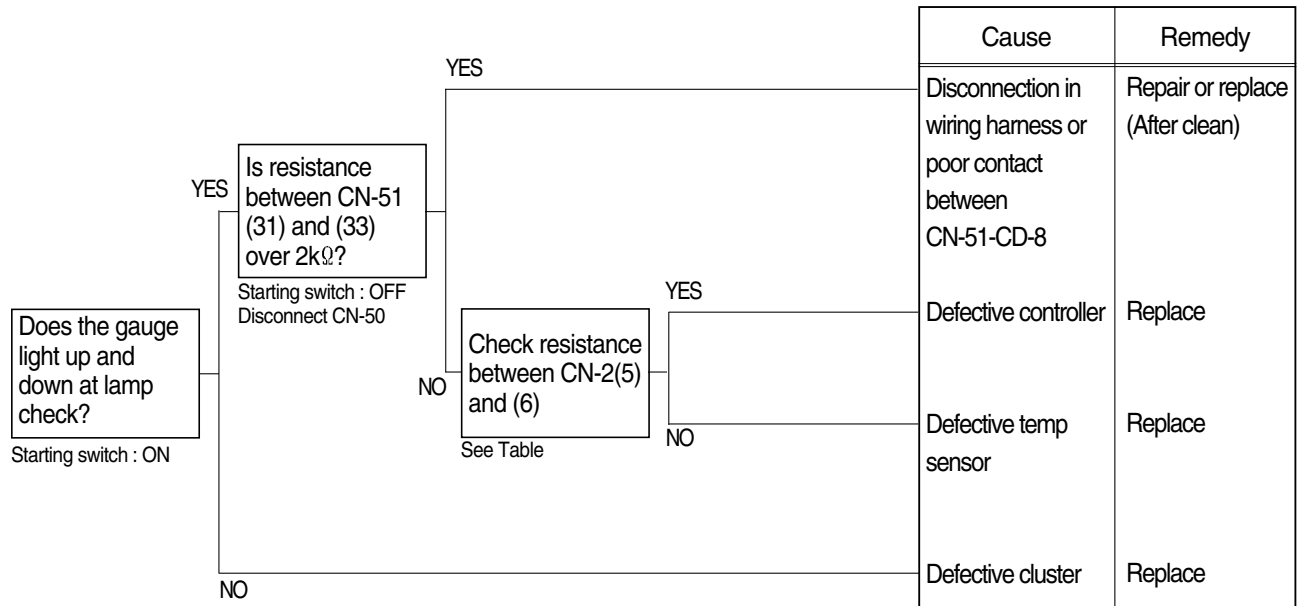
YES	MAX 1Ω
NO	MIN 1MΩ



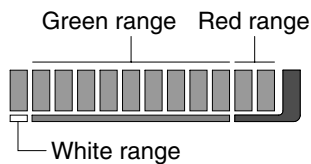
25076ES08

## 9. WHEN COOLANT TEMPERATURE GAUGE DOES NOT OPERATE

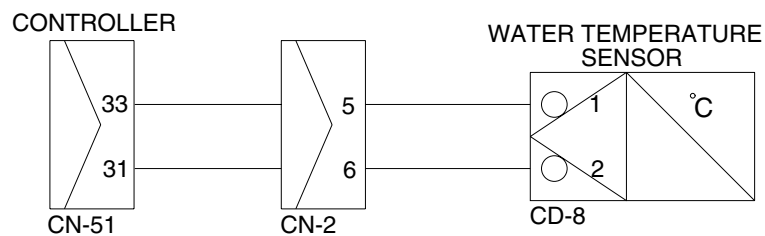
- Before disconnecting the connector, always turn the starting switch OFF.
- Before carrying out below procedure, check all the related connectors are properly inserted.
- After checking, insert the disconnected connectors again immediately unless otherwise specified.



Check Table



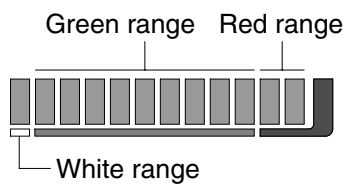
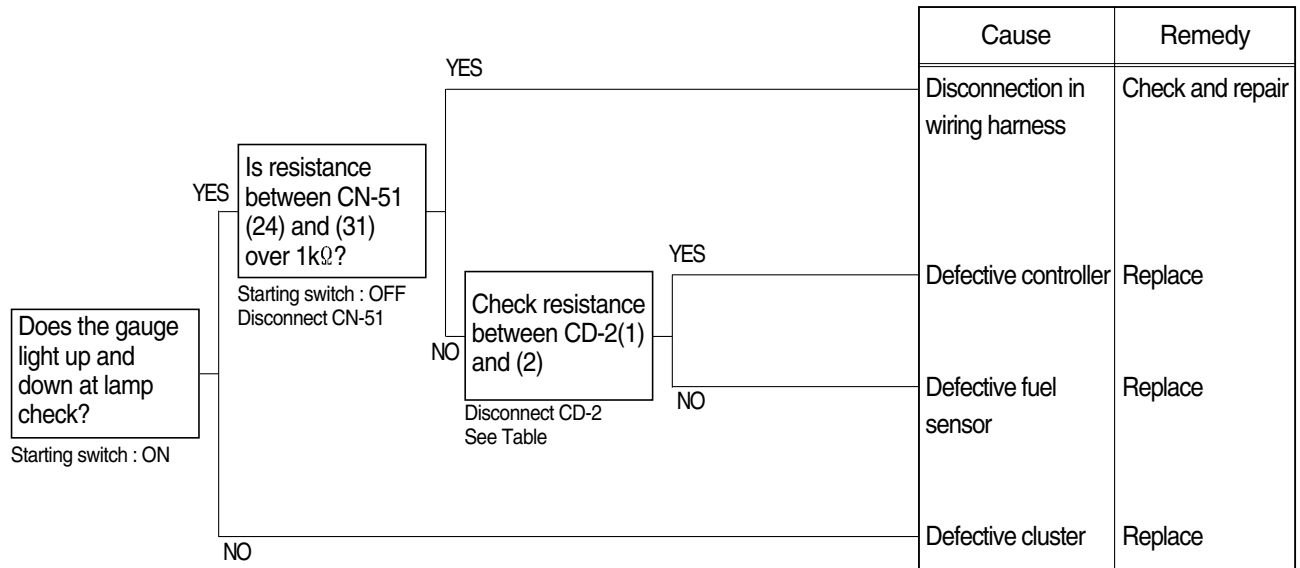
Temperature Item	White range (~29°C)	Green range (30~105°C)	Red range (105°C ~)
Unit Resistance( $\Omega$ )	1646~	1645~158	~139
Tolerance(%)	$\pm 20$	$\pm 20$	$\pm 20$





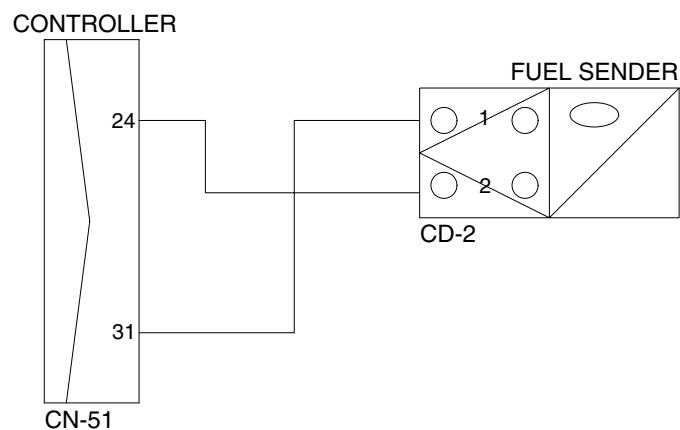
## 10. WHEN FUEL GAUGE DOES NOT OPERATE(Check warning lamp ON/OFF)

- 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.



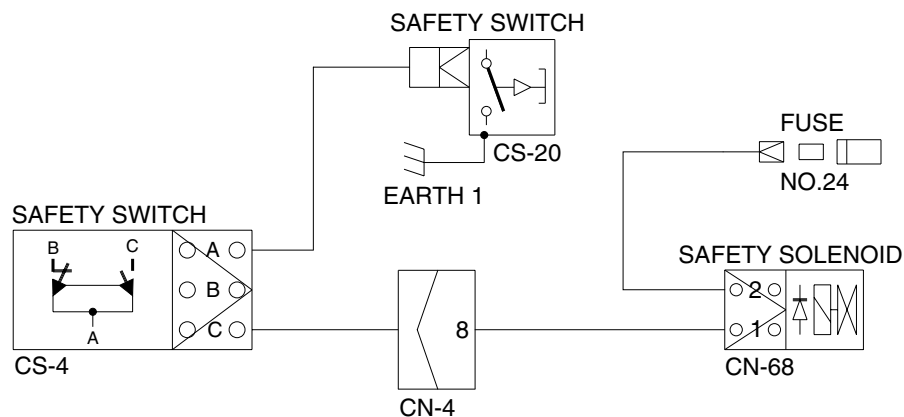
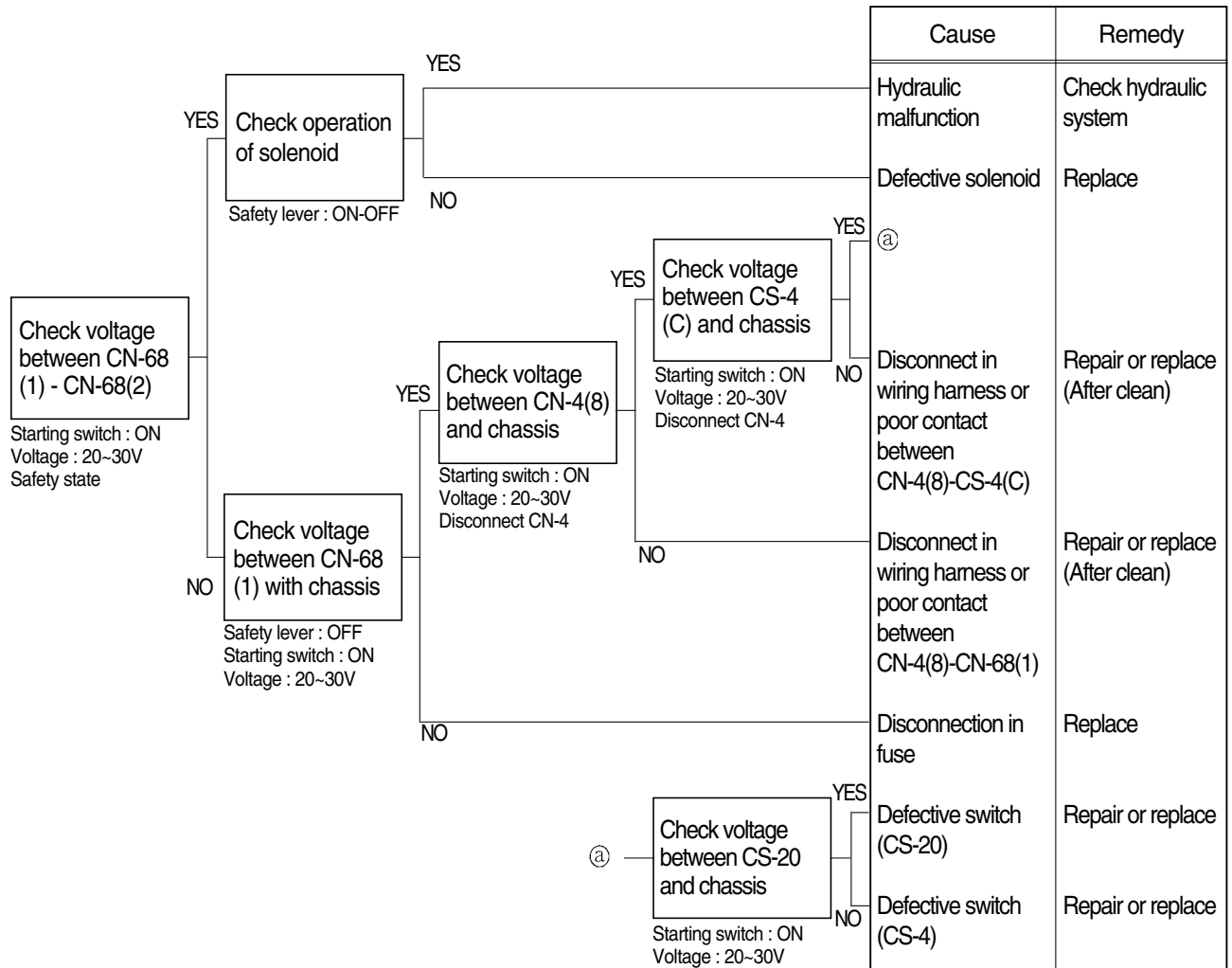
**Check Table**

Item \ Level	White range	Green range	Red range
Unit Resistance( $\Omega$ )	700~601	600~101	~100
Tolerance(%)	$\pm 5$	$\pm 5$	$\pm 5$



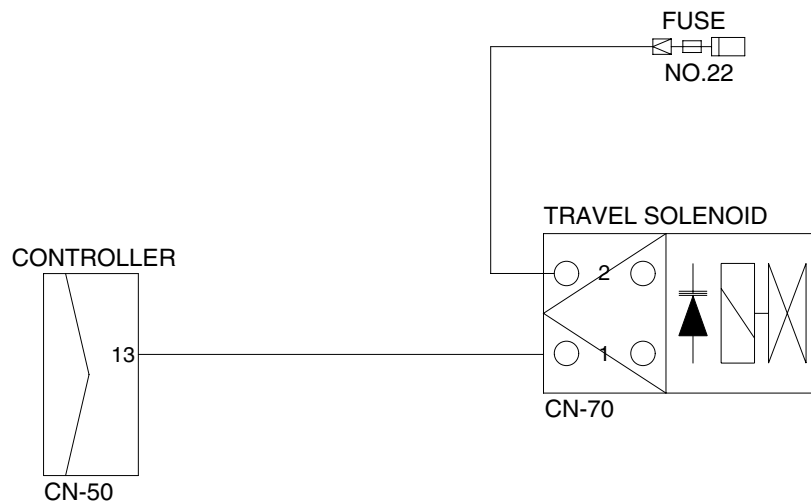
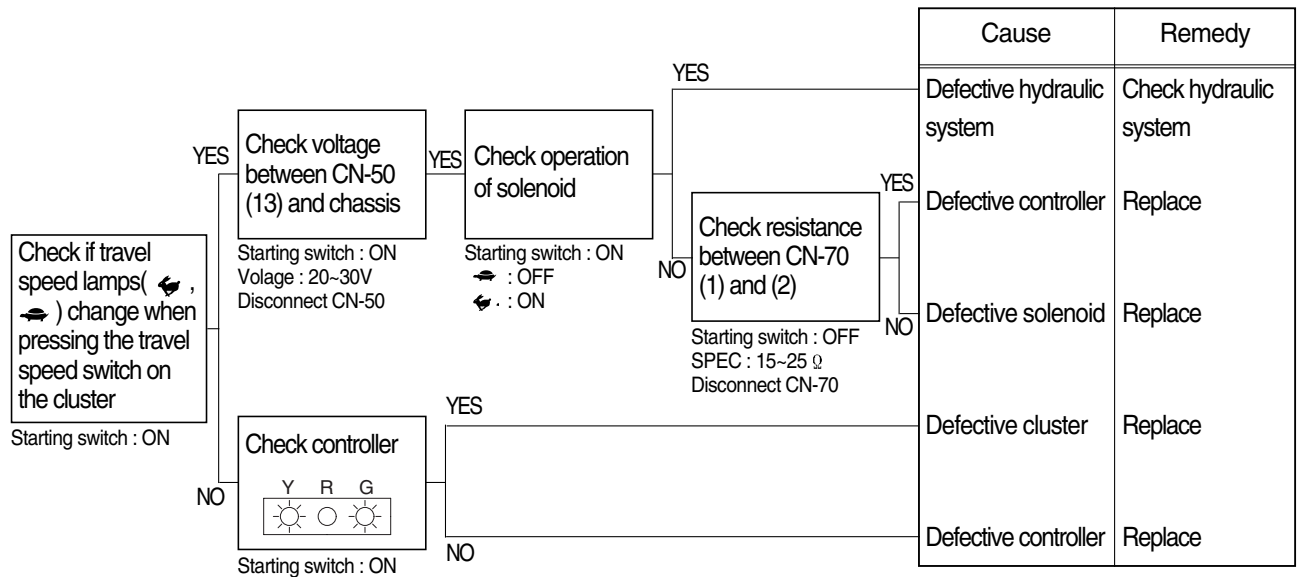
## 11. WHEN SAFETY SOLENOID DOES NOT OPERATE

- 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.24.
- After checking, insert the disconnected connectors again immediately unless otherwise specified.



## 12. WHEN TRAVEL SPEED 1, 2 DOES NOT OPERATE

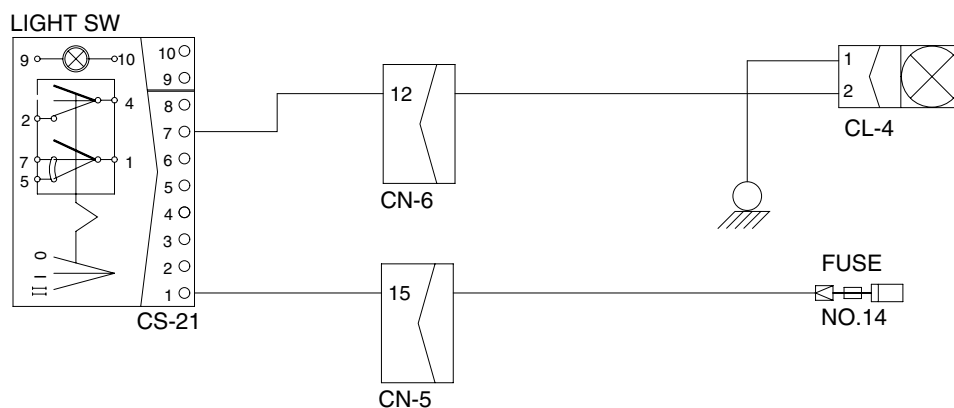
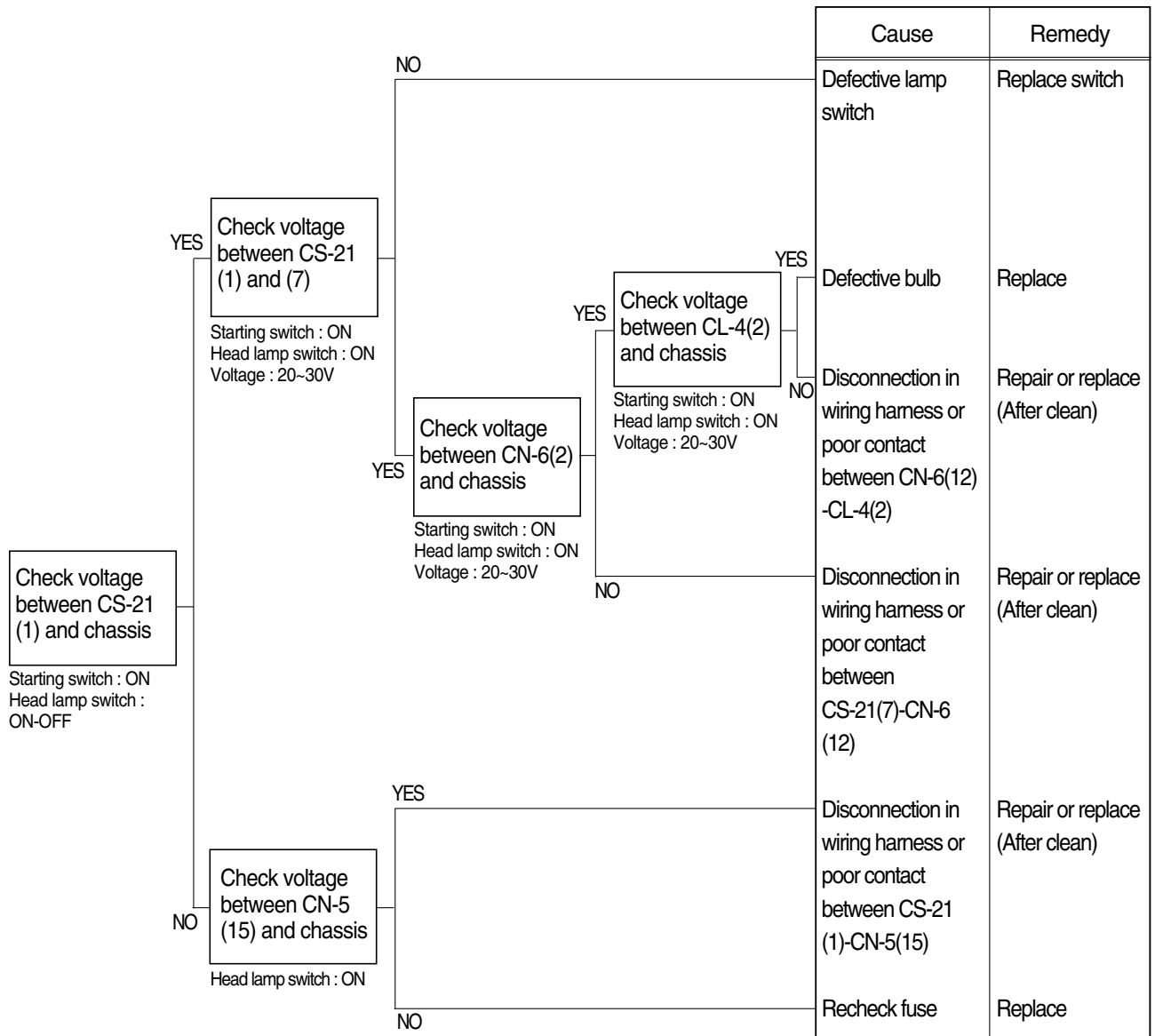
- Before disconnecting the connector, always turn the starting switch OFF.
- Before carrying out below procedure, check all the related connectors are properly inserted and short of fuse No.22 .
- After checking, insert the disconnected connectors again immediately unless otherwise specified.



21076ES04

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

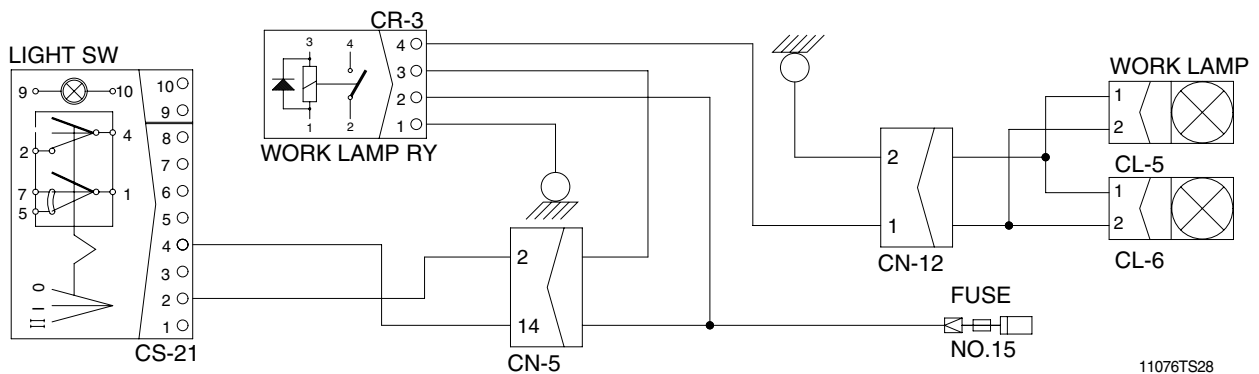
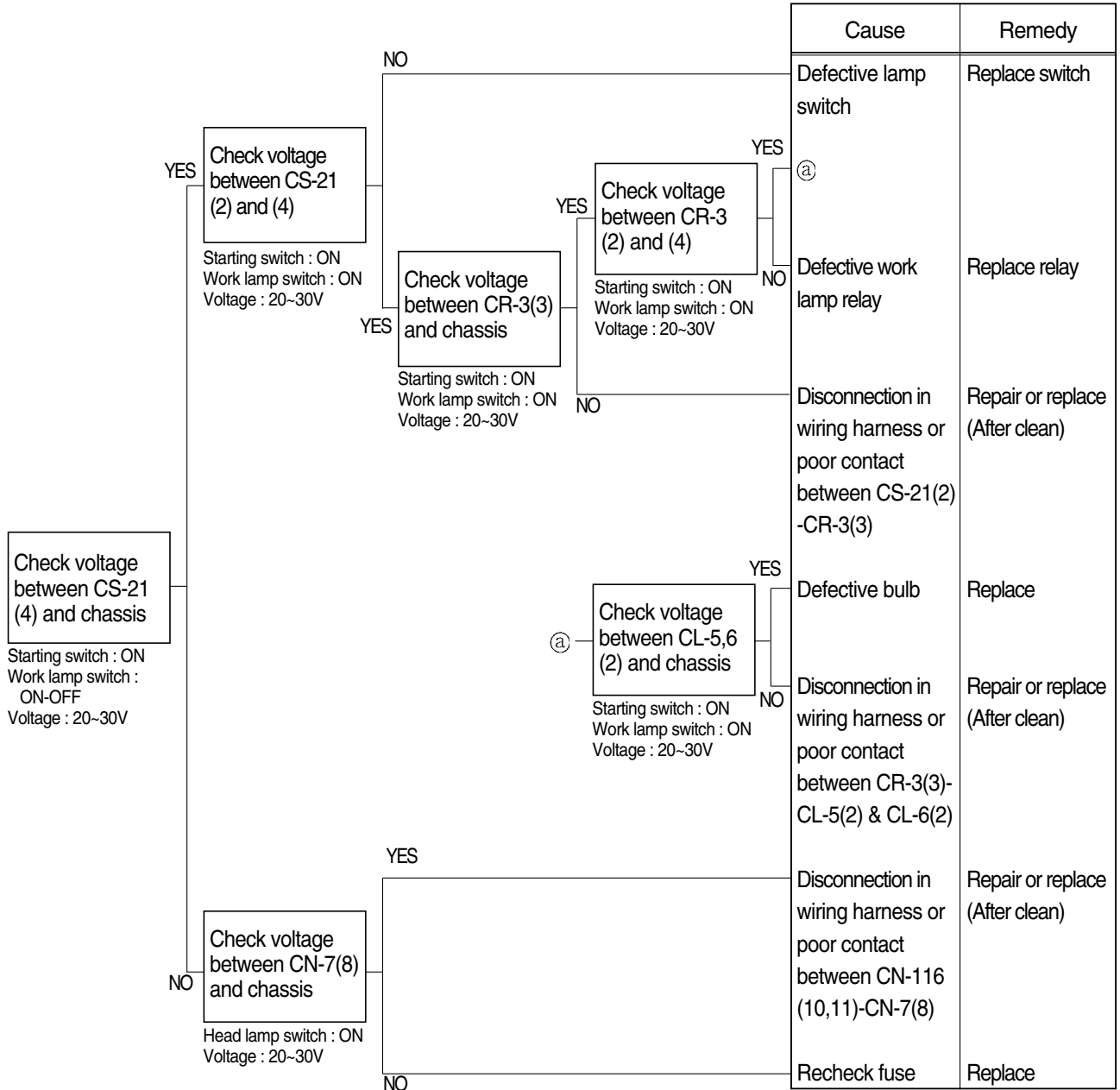
- Before disconnecting the connector, always turn the starting switch OFF.
- Before carrying out below procedure, check all the related connectors are properly inserted and short of fuse No.14.
- After checking, insert the disconnected connectors again immediately unless otherwise specified.



11076TS27

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

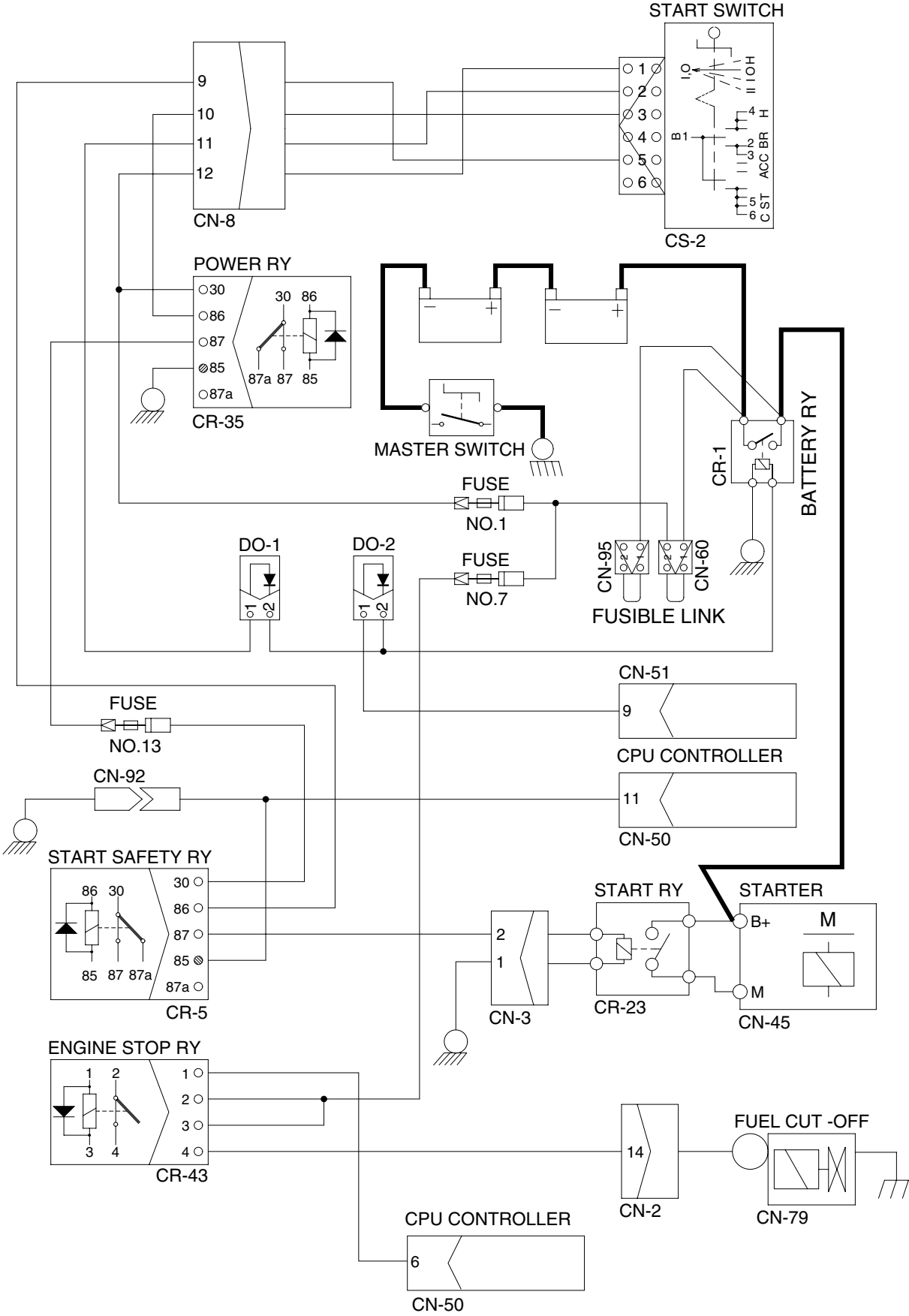
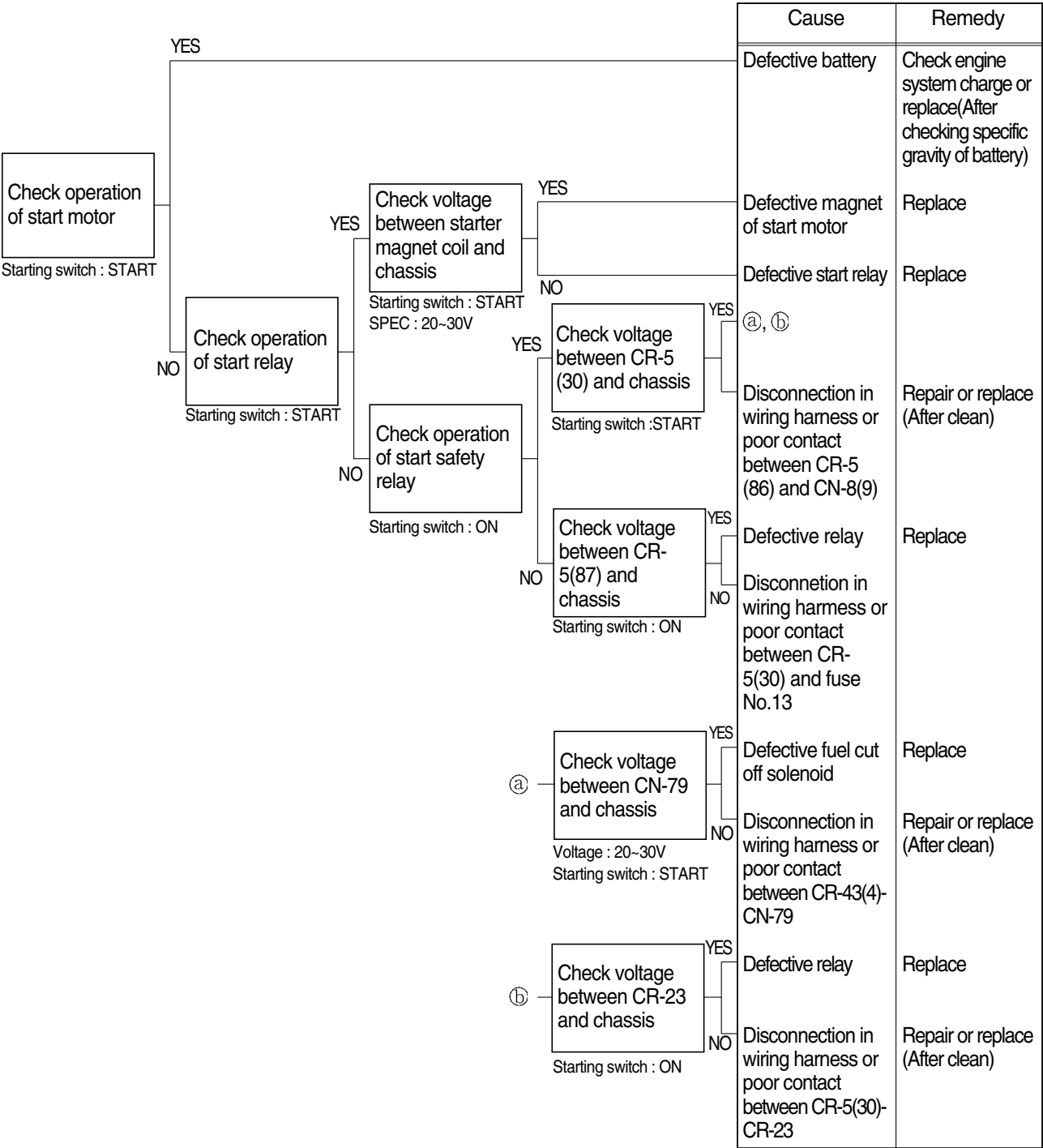
- Before disconnecting the connector, always turn the starting switch OFF.
- Before carrying out below procedure, check all the related connectors are properly inserted and short of fuse No.15.
- After checking, insert the disconnected connectors again immediately unless otherwise specified.



11076TS28

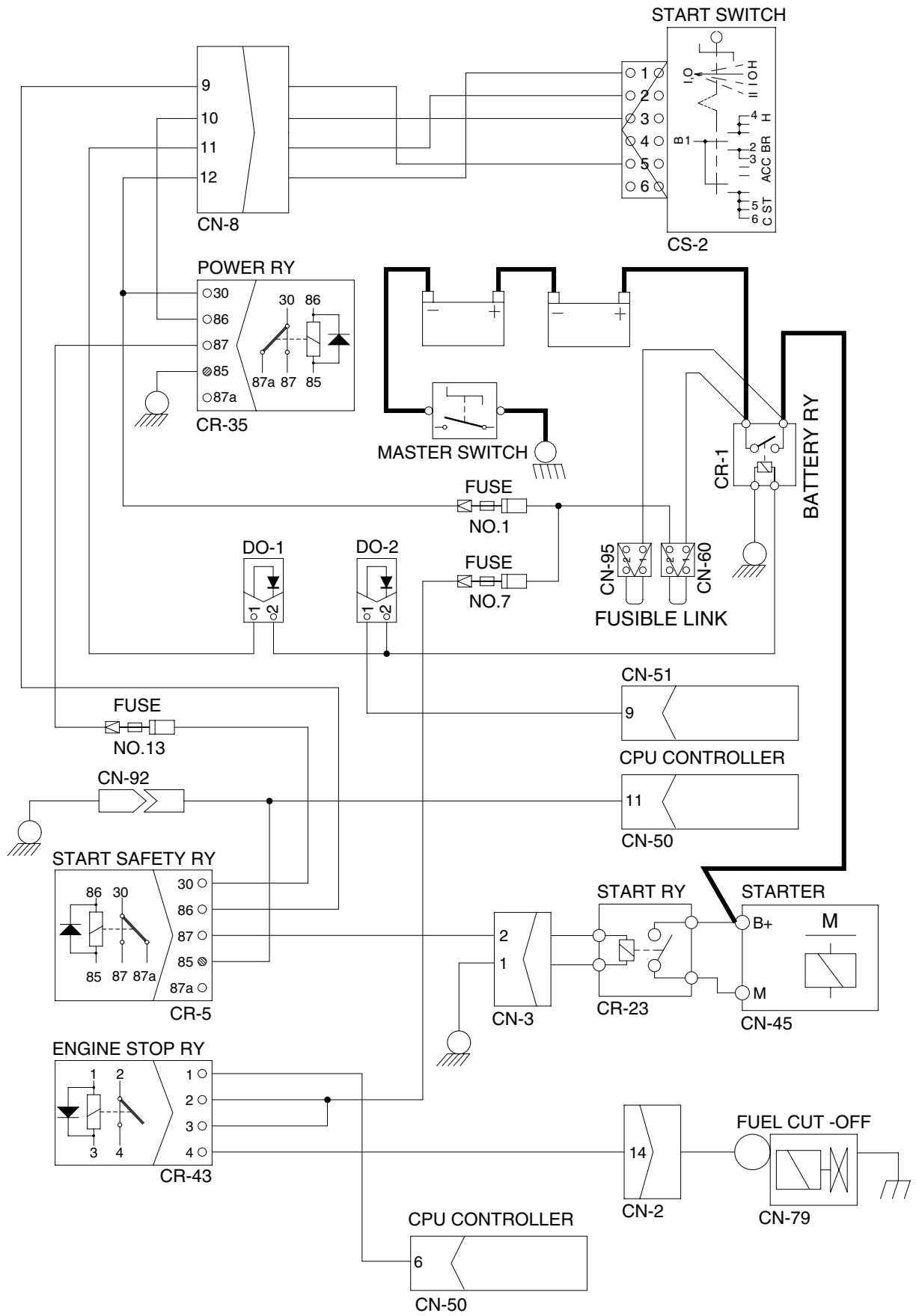
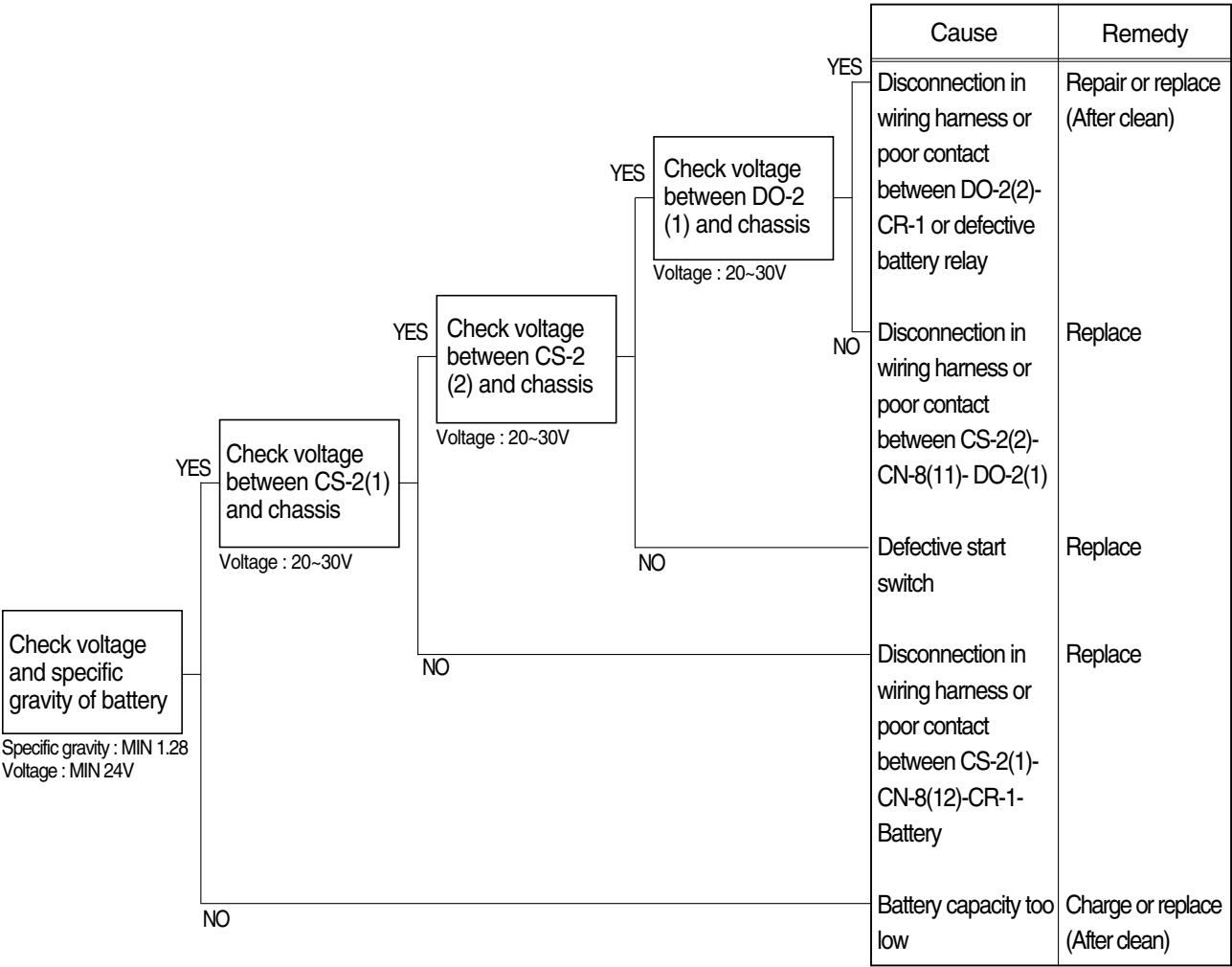
15. WHEN ENGINE DOES NOT START

- 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.



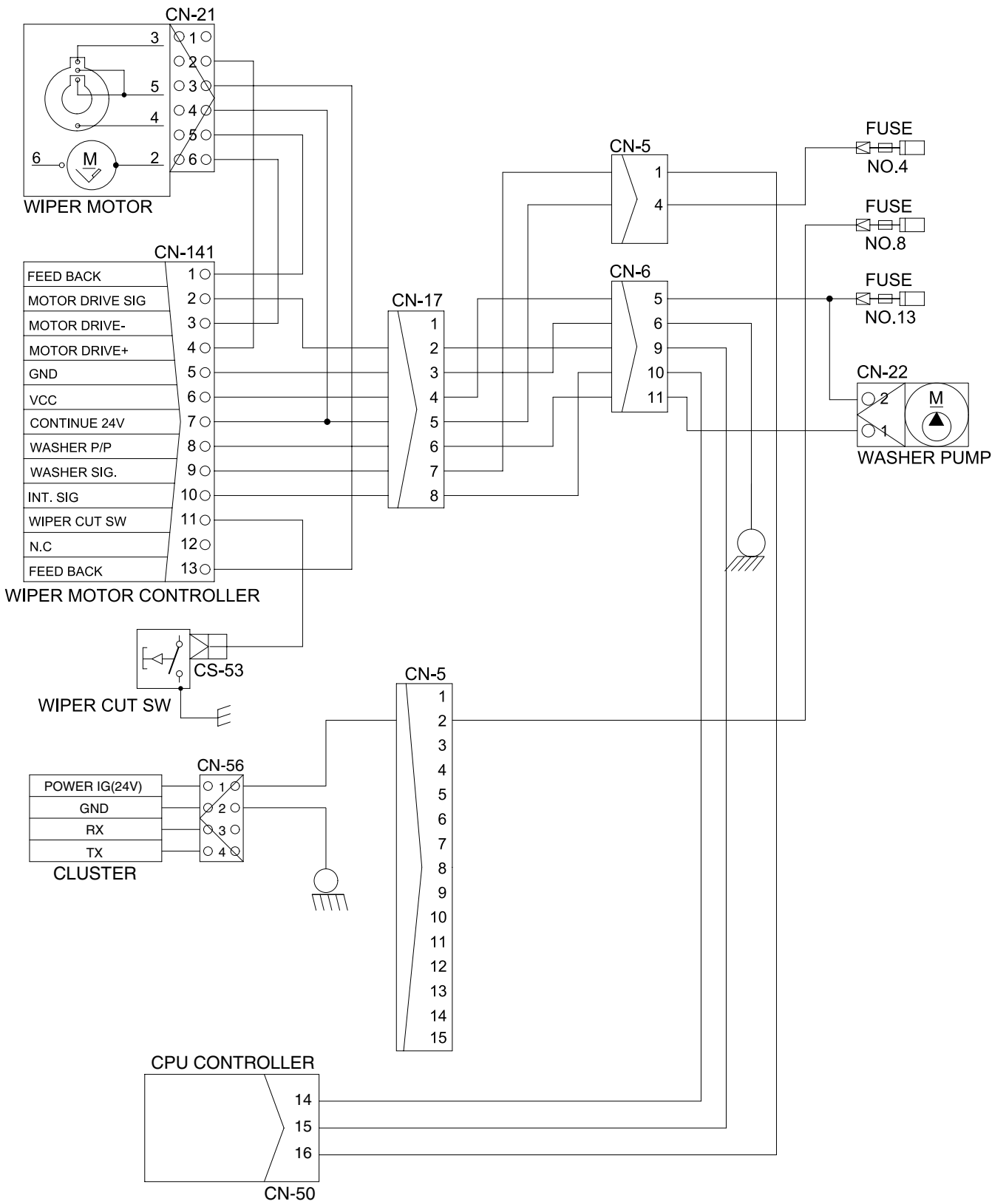
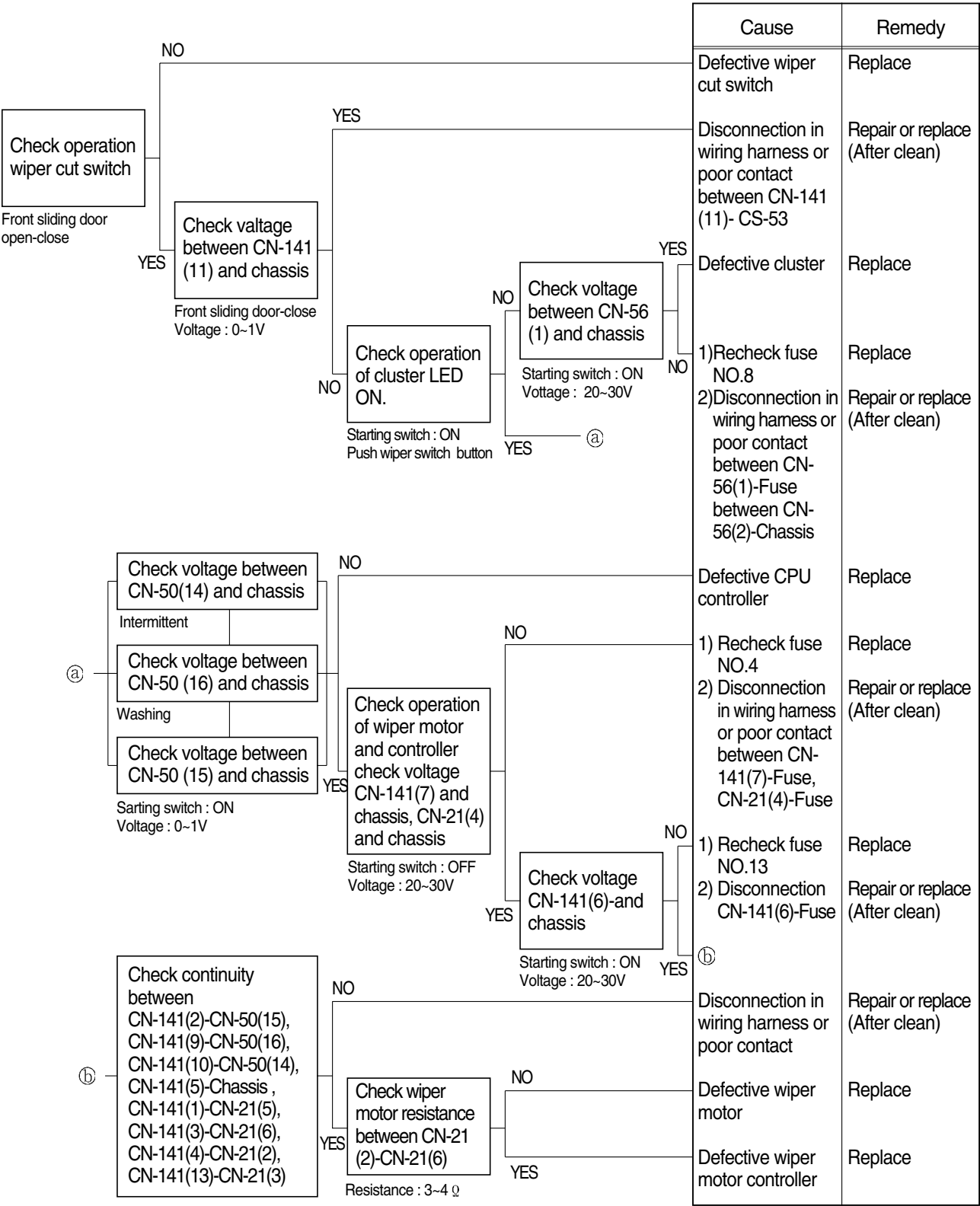
16. WHEN STARTING SWITCH ON DOES NOT OPERATE

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



17. 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.4, 8 and 13 is not blown out.
- After checking, insert the disconnected connectors again immediately unless otherwise specified.



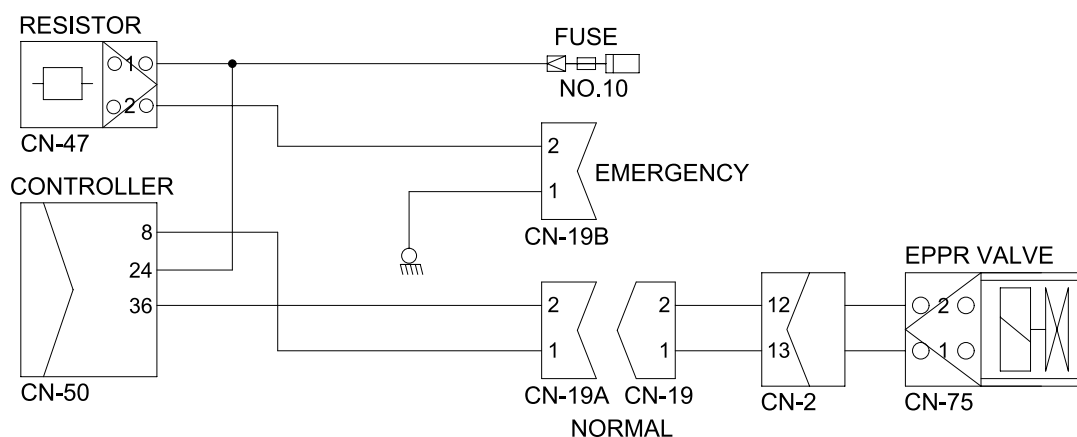
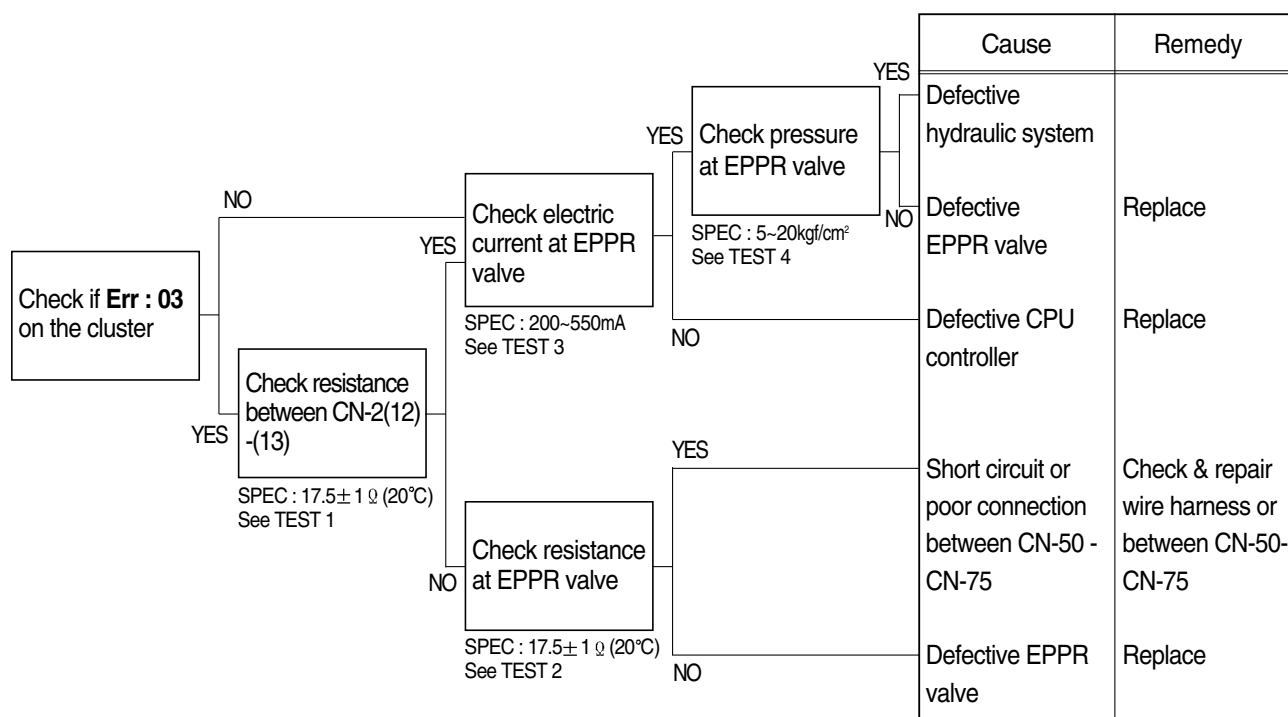


## GROUP 4 MECHATRONICS SYSTEM

### 1. ALL ACTUATORS SPEED ARE SLOW

- ※ Boom, Arm, Bucket, Swing and travel speed are slow, but engine speed is good.
- ※ Spec : H-mode  $2050 \pm 50 \text{rpm}$  S-mode  $1950 \pm 50 \text{rpm}$  L-mode  $1850 \pm 50$
- ※ Before carrying out below procedure, check all the related connectors are properly inserted.

#### 1) INSPECTION PROCEDURE

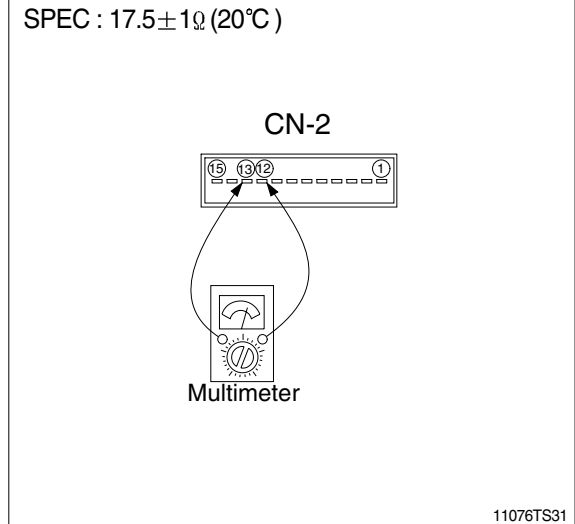


11076TS30

## 2) TEST PROCEDURE

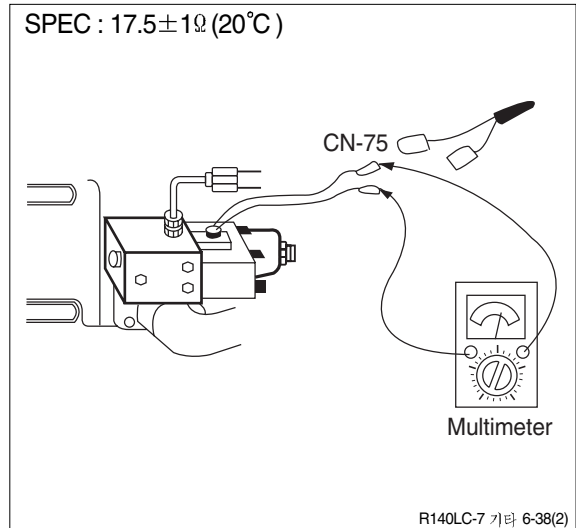
(1) **Test 1** : Check resistance at connector CN-2(12)-(13).

- ① Starting key OFF.
- ② Disconnect connector CN-2.
- ③ Check resistance between pin and at connector CN-2(12)-(13).



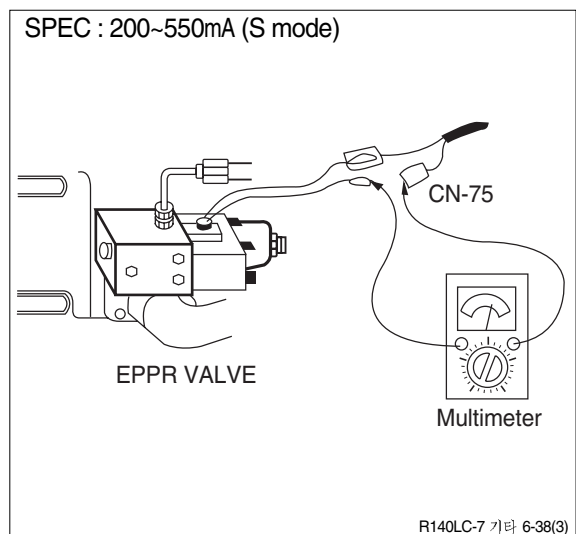
(2) **Test 2** : Check resistance at connector CN-75.

- 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 the accel dial at "10"(MAX)
- ④ Set S-mode and cancel auto decel mode.
- ⑤ If tachometer show approx  $1950 \pm 50$ 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/cm<sup>2</sup>  
(0 to 570~710psi)

② Start engine.

③ Set the accel dial at "10"(Max)

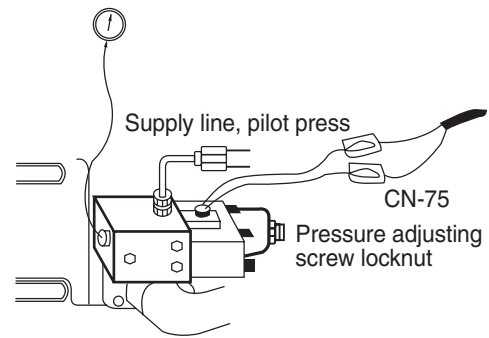
④ Set S-mode and cancel auto decel mode.

⑤ If tachometer show approx  $1950 \pm 50$ rpm, check pressure.

⑥ If pressure is not correct, adjust it.

⑦ After adjust, test the machine.

SPEC : 5~20kgf/cm<sup>2</sup>(70~280psi)

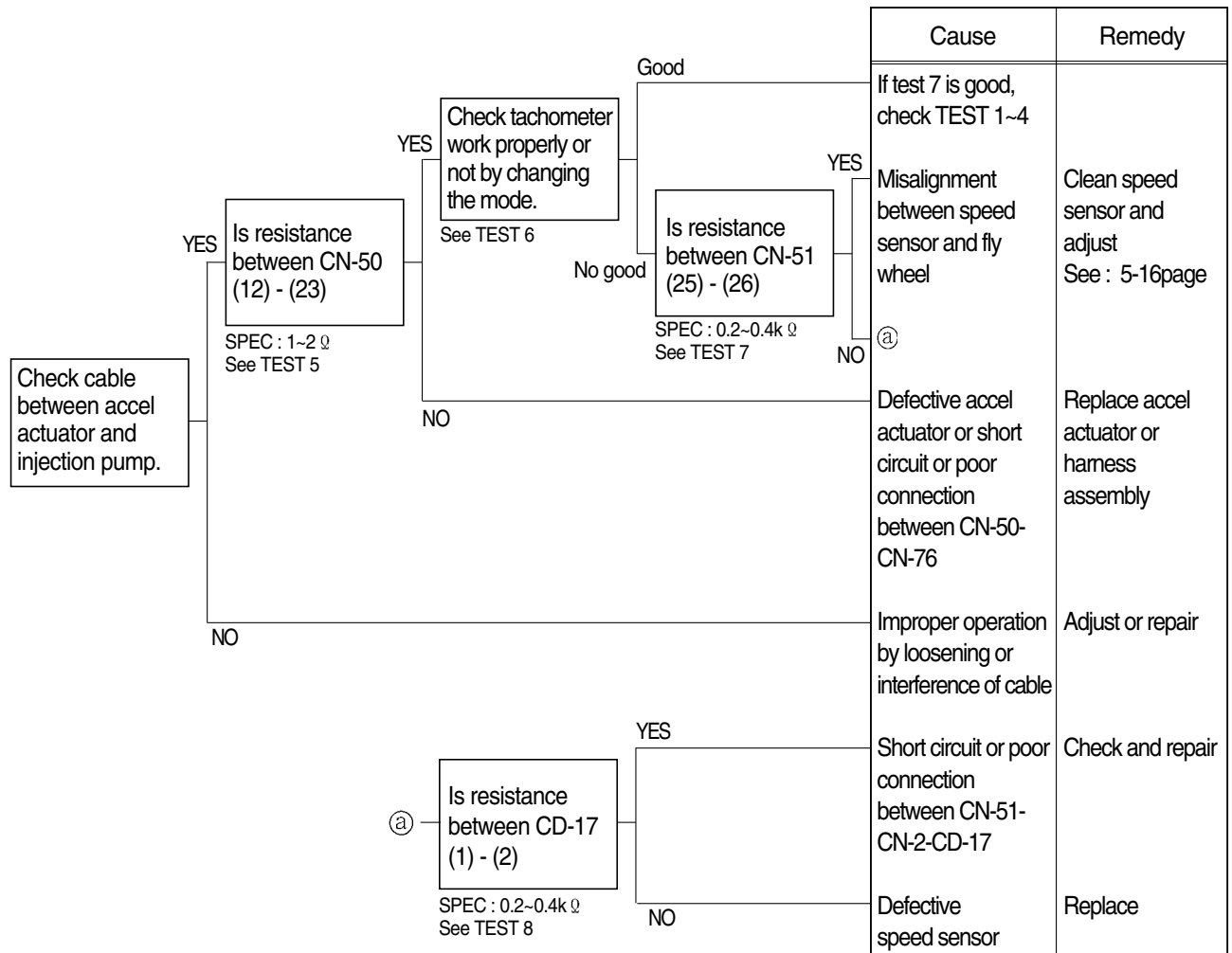


R140LC-7 기타 6-39(1)

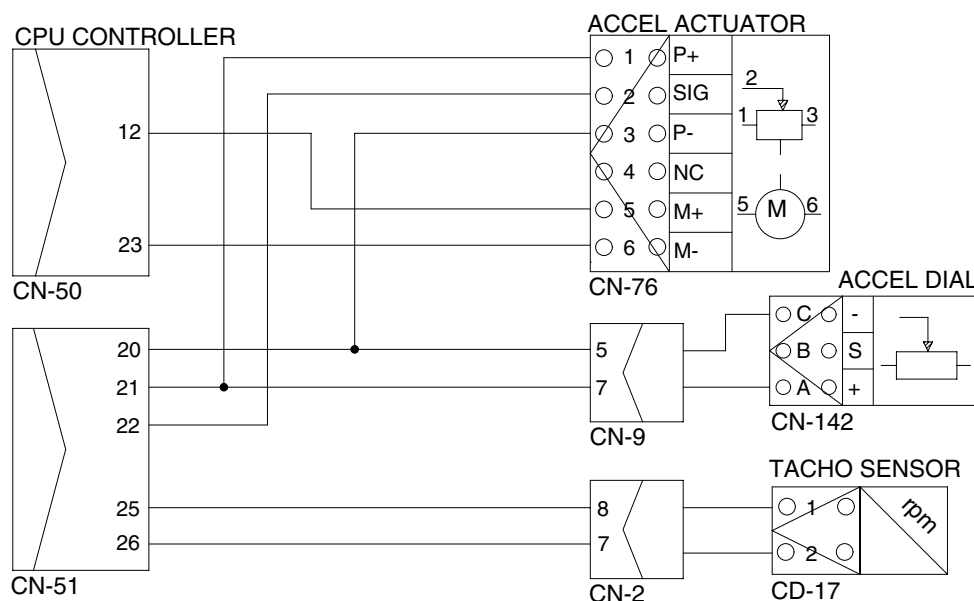
## 2. ENGINE SPEED IS SLOW AT ALL MODE

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

### 1) INSPECTION PROCEDURE



### Wiring diagram

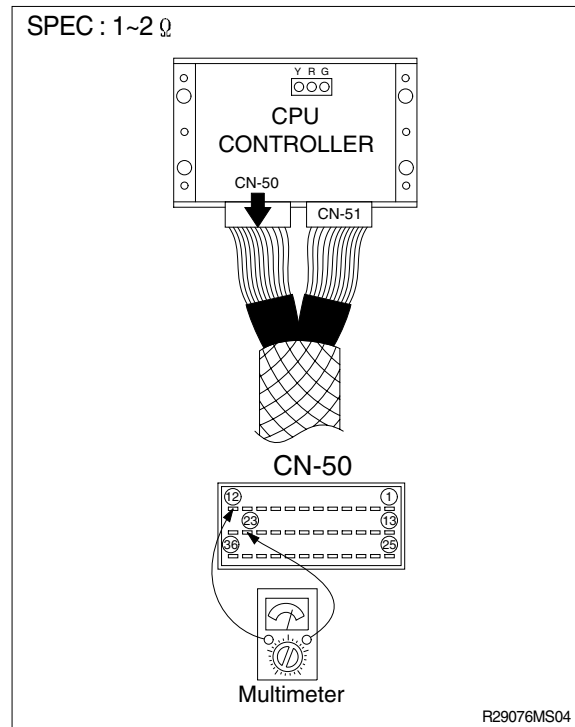


11076TS32

## 2) TEST PROCEDURE

(1) **Test 5** : Check resistance between CN-50 (12)-(23).

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



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

- ① Start engine.
- ② Check tachometer reading.

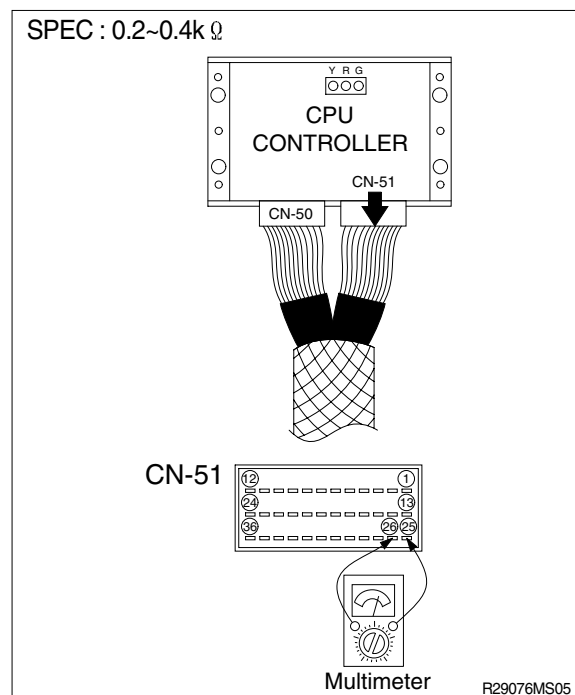
Unit : rpm

Spec		Remark
H-mode	2050 $\pm$ 50	Check rpm after cancel the Auto decel mode.
	※2150 $\pm$ 50	
S-mode	1950 $\pm$ 50	
	※2050 $\pm$ 50	
L-mode	1850 $\pm$ 50	
	※1950 $\pm$ 50	

※ Option

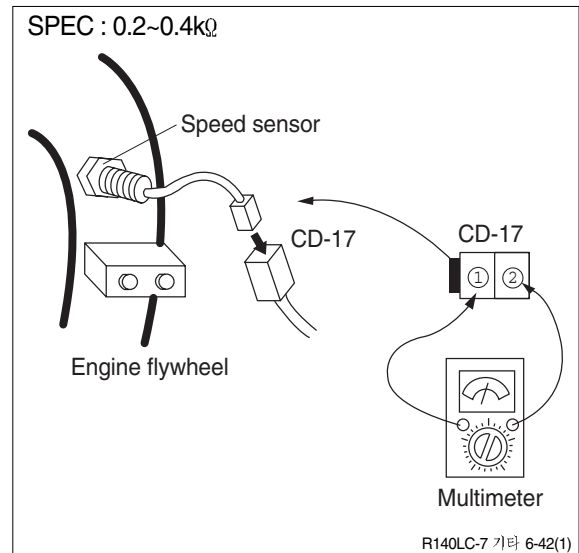
(3) **Test 7** : Check resistance between CN-51 (25) and CN-51(26).

- ① Starting key OFF.
- ② Disconnect connector CN-51 from CPU controller.
- ③ Check resistance as figure.



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

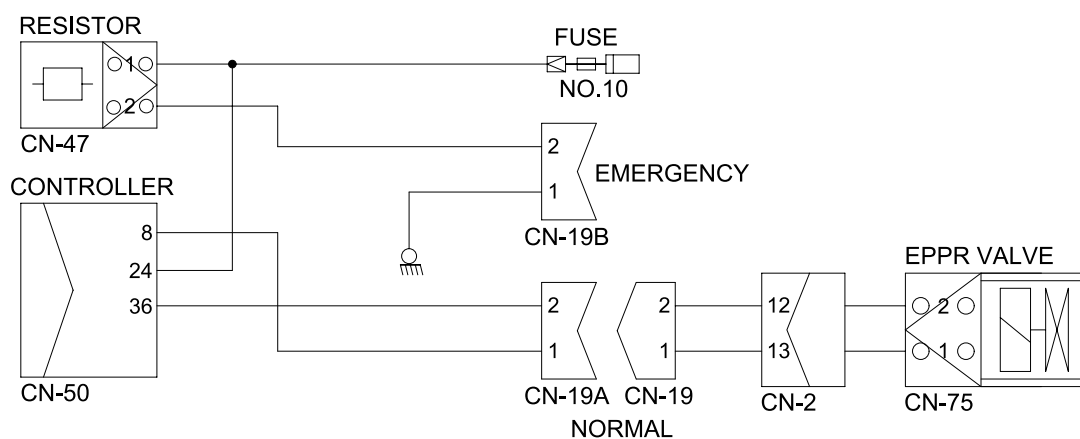
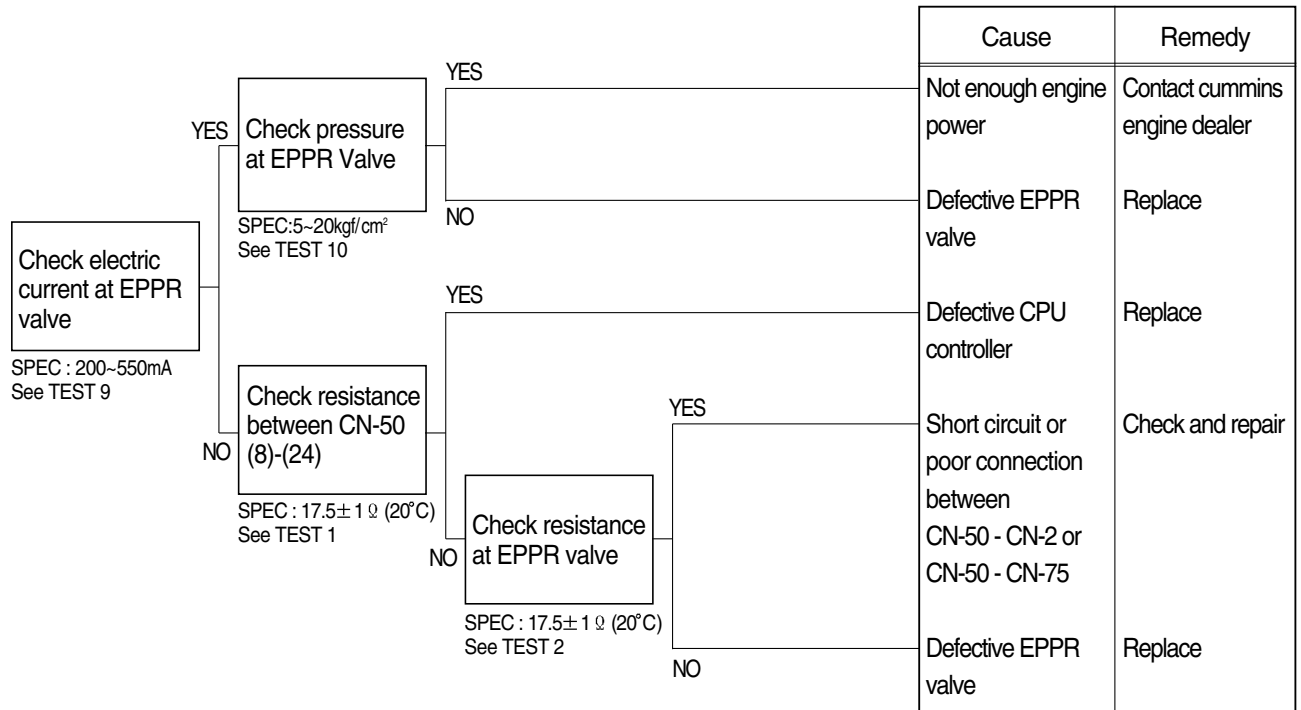
- ① Starting key OFF.
- ② Disconnect connector CD-17 of speed sensor at engine flywheel housing.
- ③ Check resistance as figure.



### 3. ENGINE STALL

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

#### 1) INSPECTION PROCEDURE

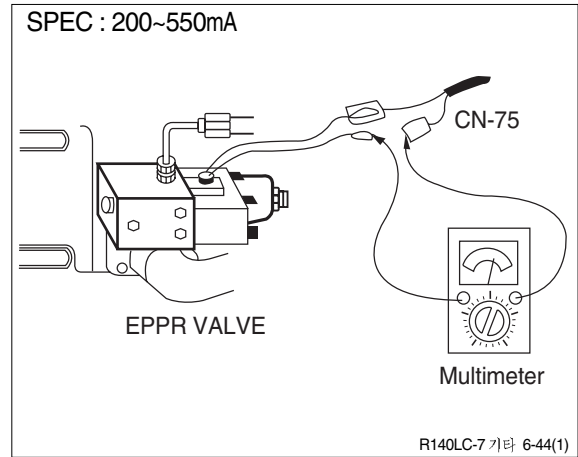


11076TS30

## 2) TEST PROCEDURE

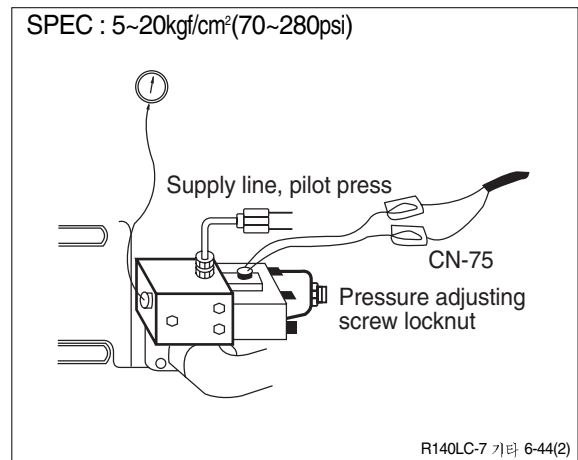
### (1) **Test 9** : Check electric current at EPPR valve at S-mode

- ① Install multimeter as figure.
- ② Start engine.
- ③ Set the accel dial at "10"(max)
- ④ Set S-mode with  $1950 \pm 50$ rpm.
- ⑤ Check electric current.



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

- ① Connect pressure gauge at EPPR valve.
- ② Start engine.
- ③ Set the accel dial at "10"(max)
- ④ Set S-mode with  $1950 \pm 50$ rpm.
- ⑤ Operate bucket lever completely push or pull.
- ⑥ Hold arm lever at the end of stroke.
- ⑦ Check pressure at relief position.

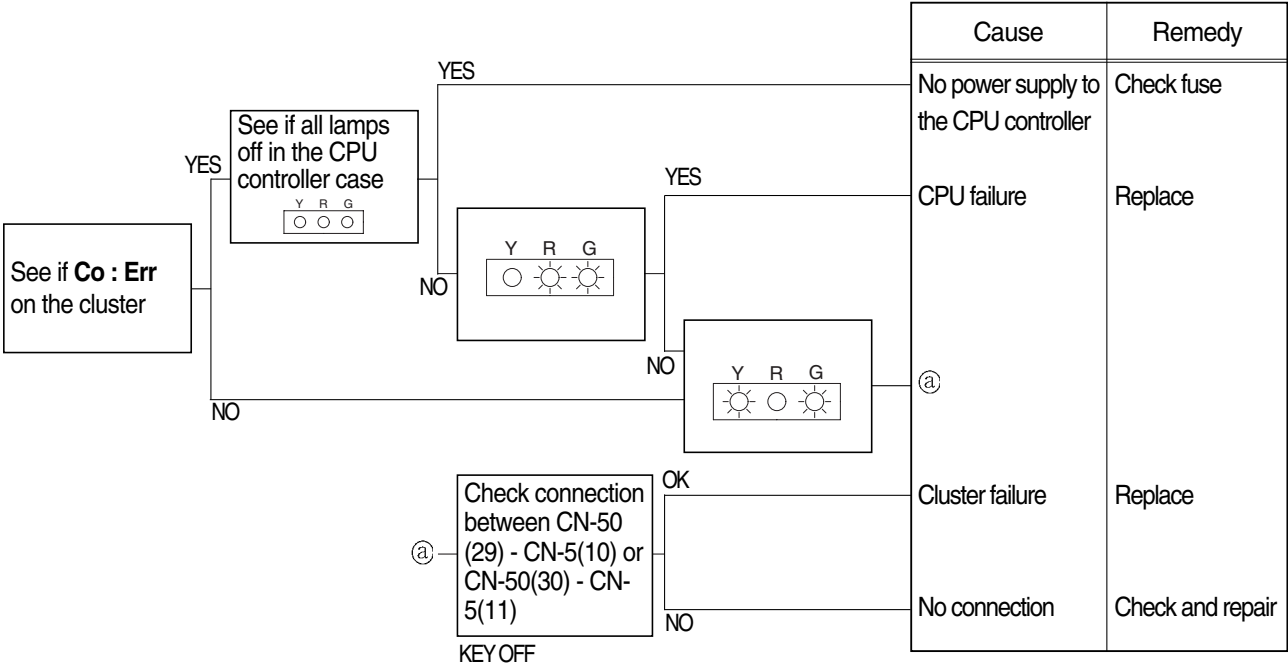




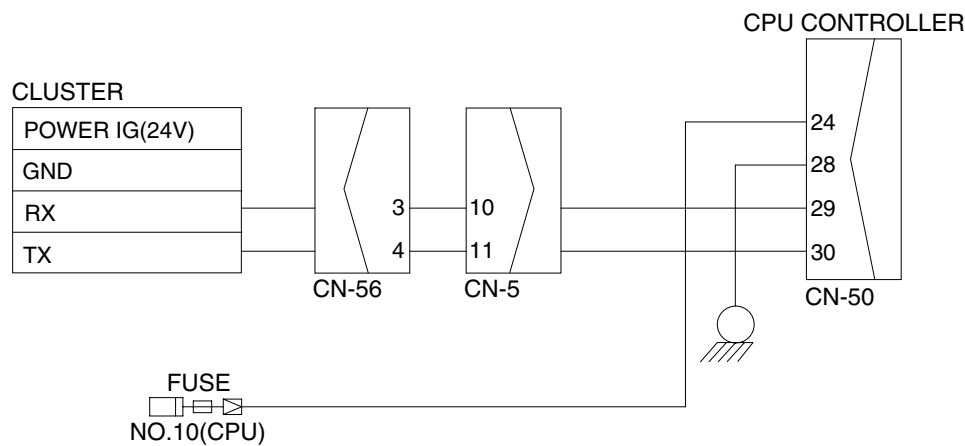
4. MALFUNCTION OF CLUSTER OR MODE SELECTION SYSTEM

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

1) INSPECTION PROCEDURE



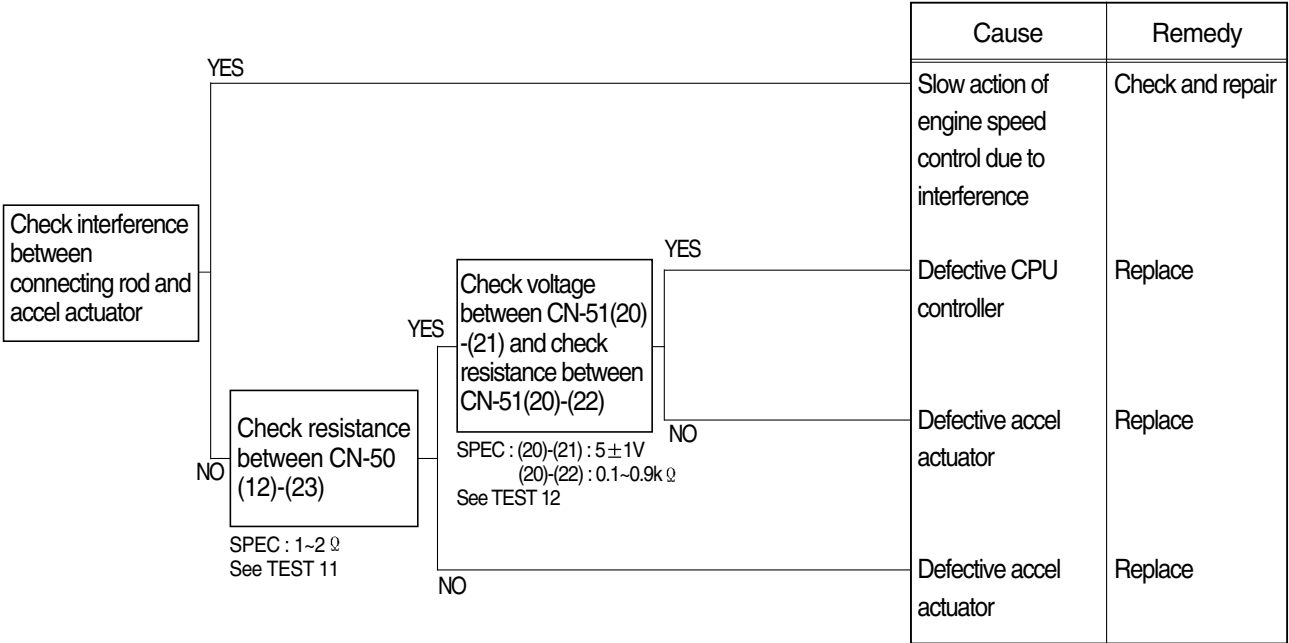
Wiring diagram



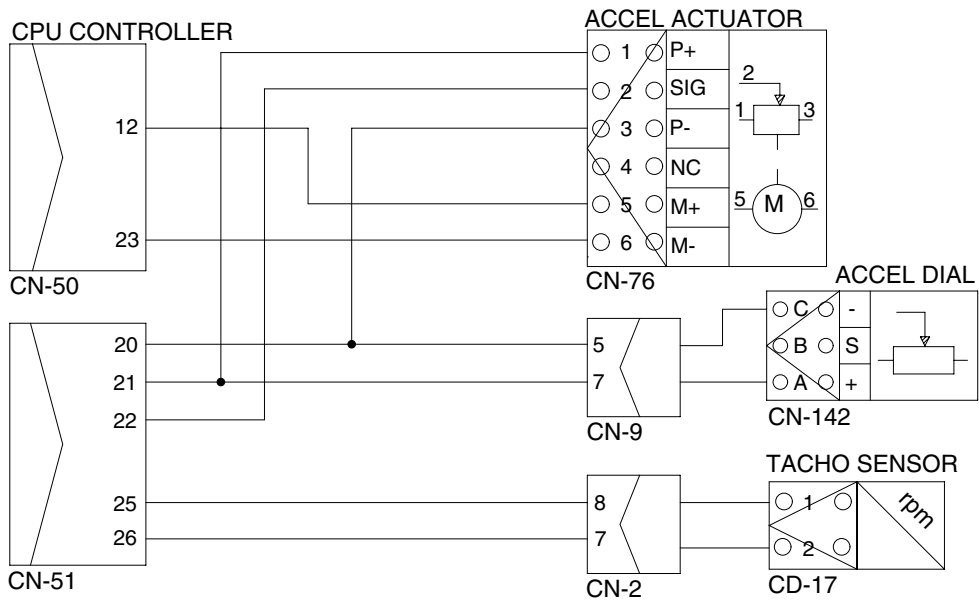
5. SLOW ACTION OF ENGINE SPEED CHANGE WHEN CHANGE THE MODE

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

1) INSPECTION PROCEDURE



Wiring diagram

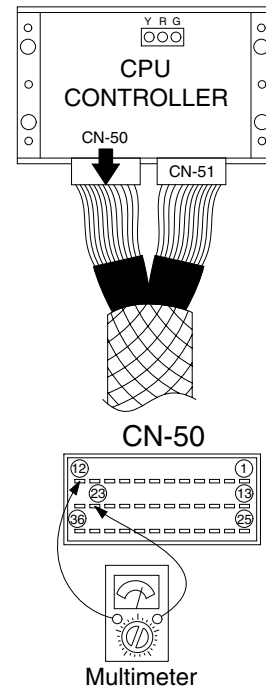


## 2) TEST PROCEDURE

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

- ① Starting key OFF.
- ② Disconnect connector CN-50 from CPU controller.
- ③ Check resistance between CN-50(12)-(23) as figure.

SPEC : 1~2  $\Omega$



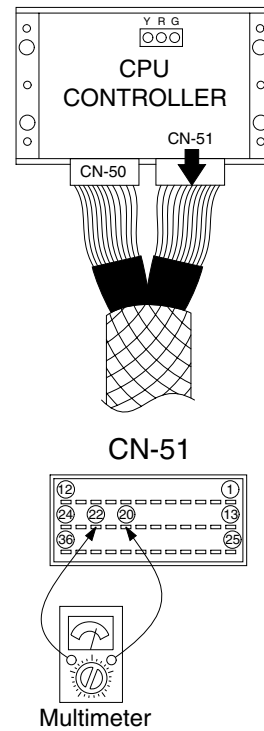
R29076MS04

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

① Check resistance between CN-51(20)-(22).

- Starting key OFF.
- Disconnect connector CN-51 from CPU controller.
- Check resistance value with multimeter as figure.

SPEC : 0.1~0.9k $\Omega$

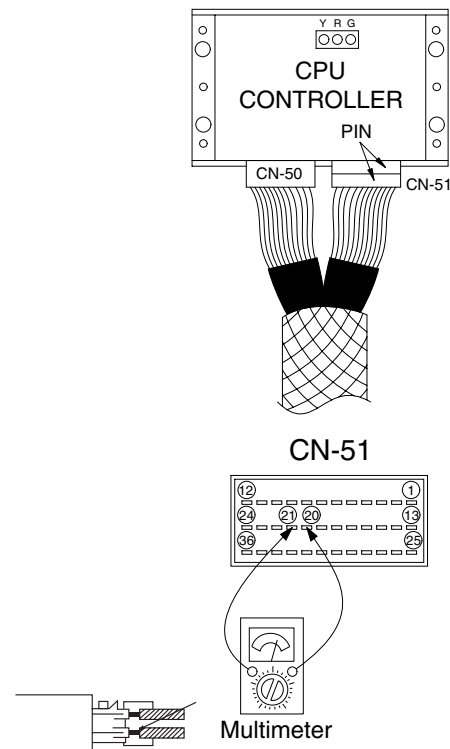


R29076MS08

② Check voltage between CN-51(20) and CN-51(21).

- 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-51(20)  
Other pin to CN-51(21)
- Check voltage.

SPEC : 5 $\pm$ 1V

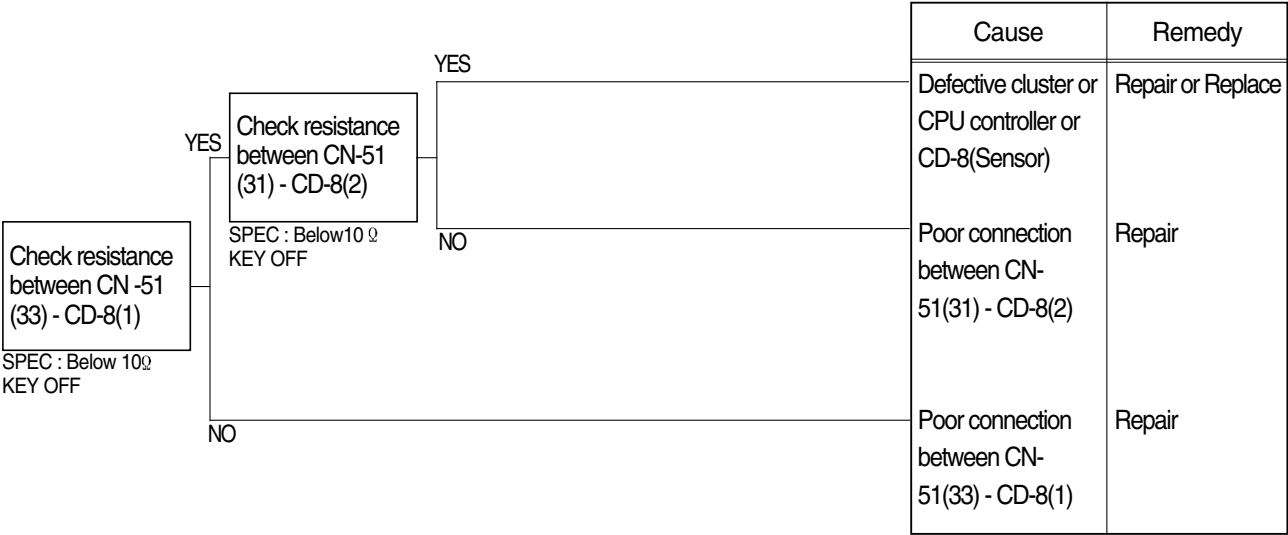


R140LC-7 기타 6-48(3)/R29076MS09

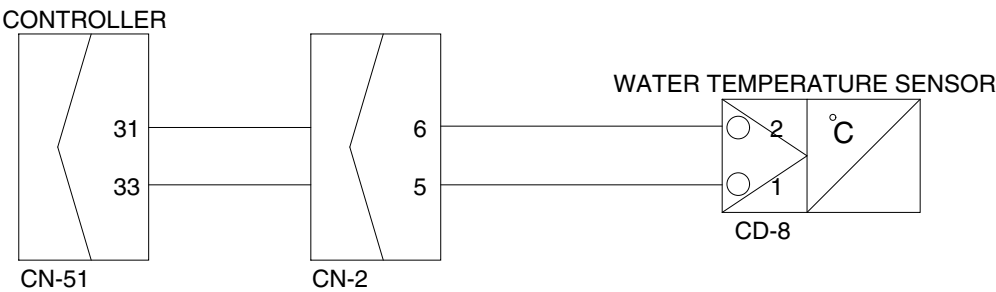
6. MALFUNCTION OF WARMING UP

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

1) INSPECTION PROCEDURE



Wiring diagram

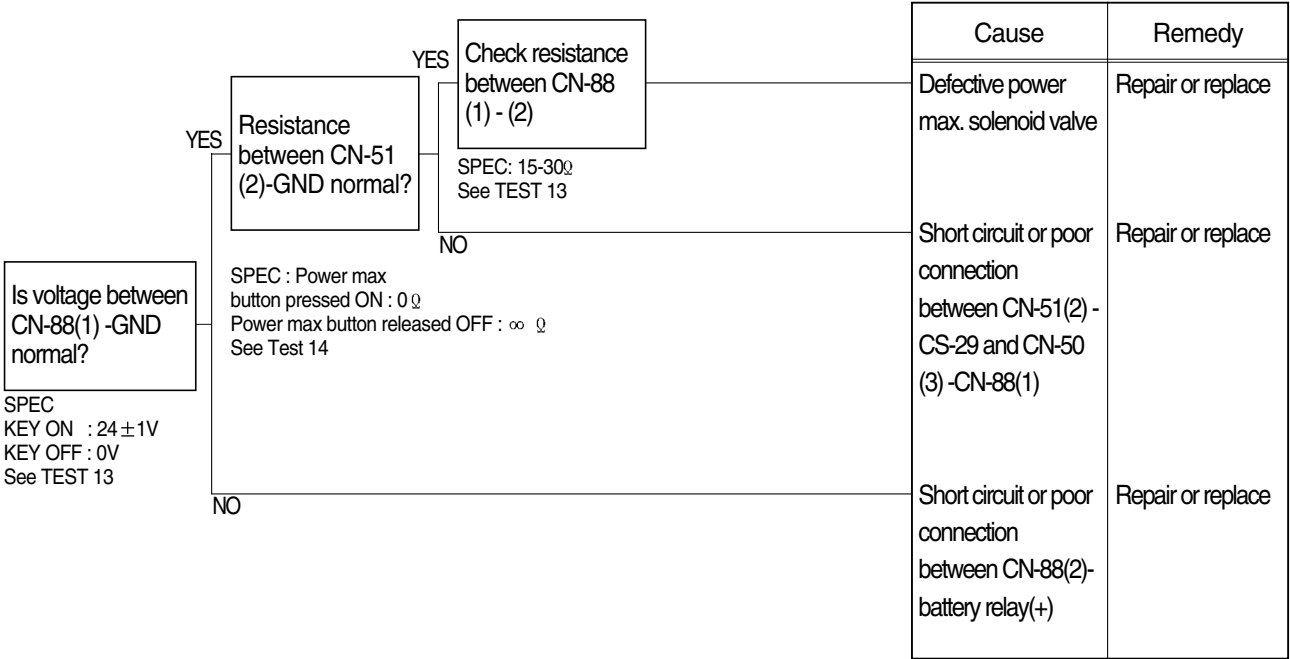


11076TS33

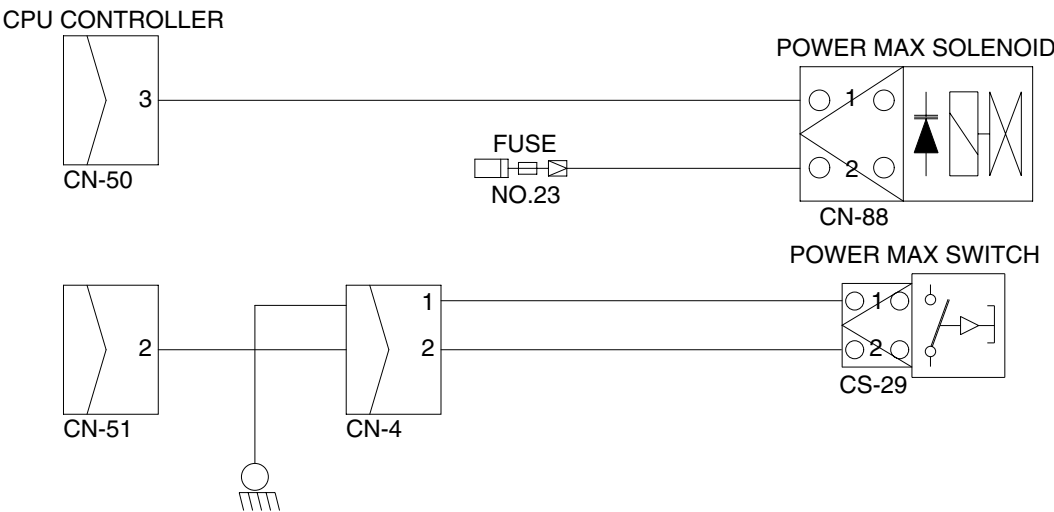
7. MALFUNCTION OF POWER MAX

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

1) INSPECTION PROCEDURE



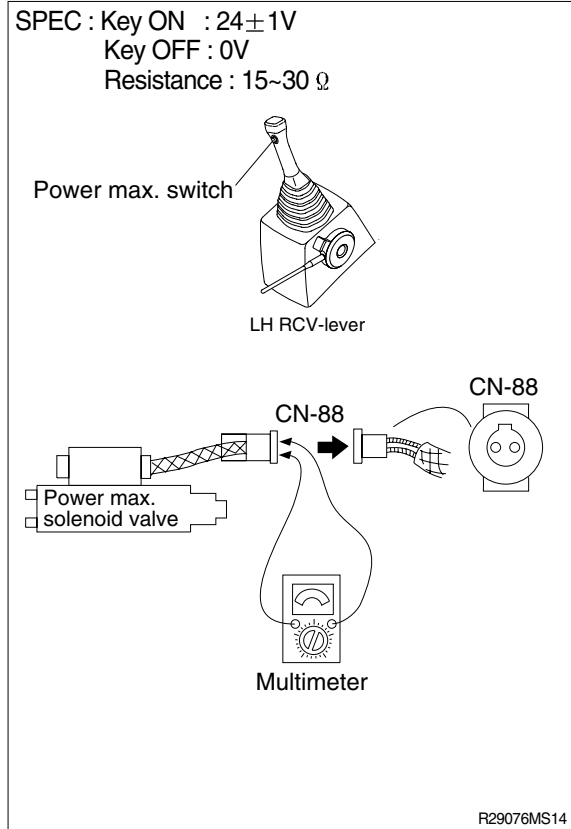
Wiring diagram



## 2) TEST PROCEDURE

(1) **Test 13:** Check voltage between connector CN-88 - GND.

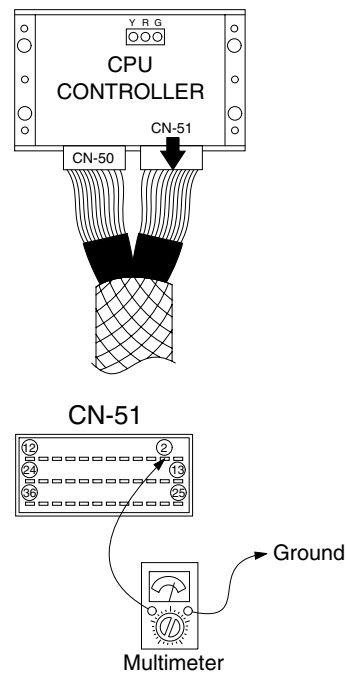
- ① Start key ON.
- ② Disconnect connector CN-88 from power max solenoid valve.
- ③ Check voltage as figure.



(2) **Test 14:** Check resistance between connector CN-51(2)-GND.

- ① Starting key OFF.
- ② Remove CPU controller and disconnect connector CN-51 from CPU controller.
- ③ Check resistance as figure.

SPEC : Power max button pressed ON : 0  $\Omega$   
Power max button released OFF :  $\infty \Omega$



## SECTION 7 MAINTENANCE STANDARD

Group 1	Operational Performance Test .....	7-1
Group 2	Major Components .....	7-21
Group 3	Track and Work Equipment .....	7-28



# 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.**

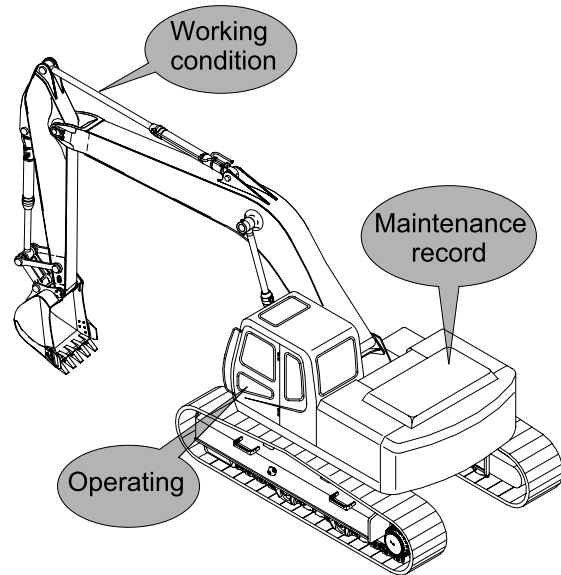
#### 2) OPERATIONAL PERFORMANCE OF A WORKING MACHINE

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.

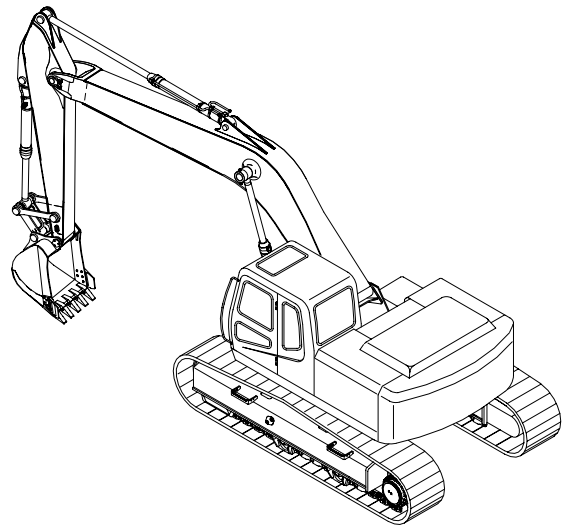


140LC7MS01

## 2. TERMINOLOGY

### 1) STANDARD

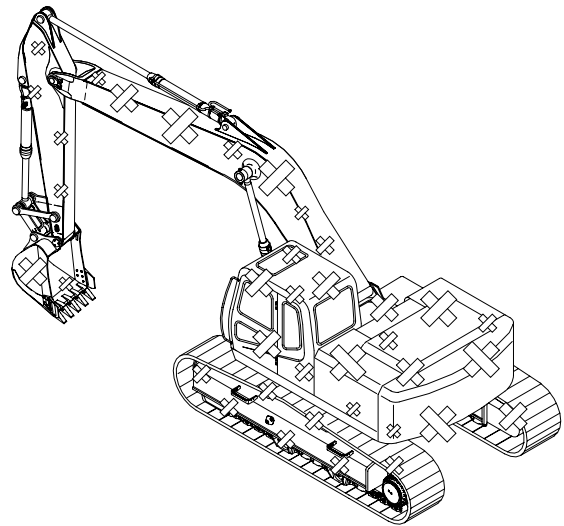
Specifications applied to the brand-new machine, components and parts.



140LC-7MS02

### 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.



140LC-7MS03

### 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

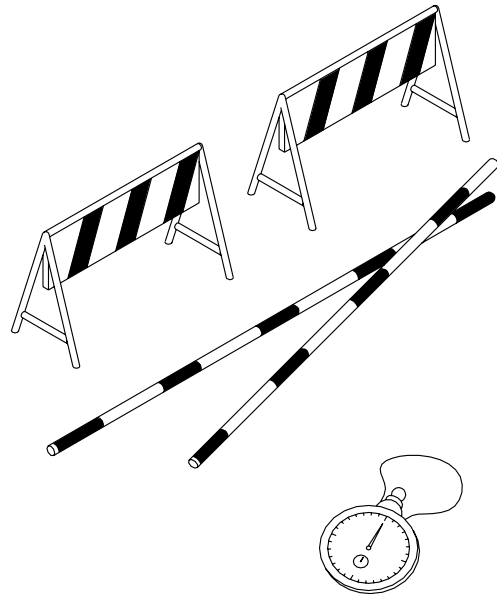
- ① Select a hard, flat surface.
- ② Secure enough space to allow the machine to run straight more than 20m, and to make a full swing with the front attachment extended.
- ③ If required, rope off the test area and provide signboards to keep unauthorized personnel away.

#### (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.



140LC-7 기타 7-3

## 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  $50 \pm 5^\circ\text{C}$ .
- ② Set the accel dial at 10(Max) position.
- ③ Push the H-mode switch and confirm that the fuel injection pump governor lever comes into contact with the high-idle stopper.
- ④ Measure the 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).
- ③ Select the H-mode.
- ④ Lightly operate the bucket control lever a few times, then return the control lever to neutral. Select one touch decel ON.
- 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
R110-7	Start/one touch idle	$950 \pm 100$	One touch decal
	H mode	$2050 \pm 50$	
	S mode	$1950 \pm 50$	
	L mode	$1850 \pm 50$	

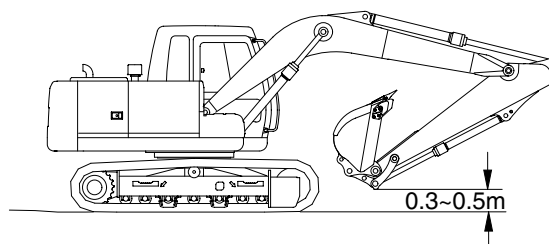
Condition : Set the accel dial at 10(Max) position.

### 3) TRAVEL SPEED

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

#### (2) Preparation

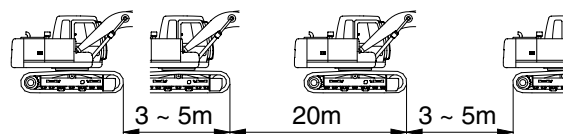
- ① Adjust the tension of both tracks to be equal.
- ② Prepare a flat and solid test track 20m in length, with extra length of 3 to 5m on both ends for machine acceleration and deceleration.
- ③ Hold the bucket 0.3 to 0.5m above the ground with the arm and bucket rolled in.
- ④ Keep the hydraulic oil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



11077MS04

#### (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.



11077MS05

#### (4) Evaluation

The average measured time should meet the following specifications.

Unit : Seconds / 20m

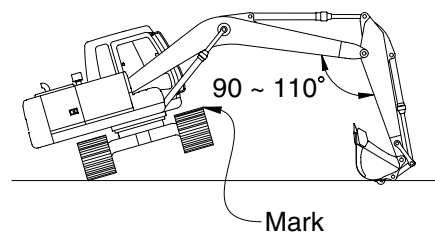
Model	Travel speed	Standard	Maximum allowable	Remarks
R110-7	1 Speed	$21.2 \pm 2.0$	26.5	
	2 Speed	$13.1 \pm 1.0$	16.4	

#### 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
- 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.

11077MS06

##### (4) Evaluation

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

Unit : Seconds / 3 revolutions

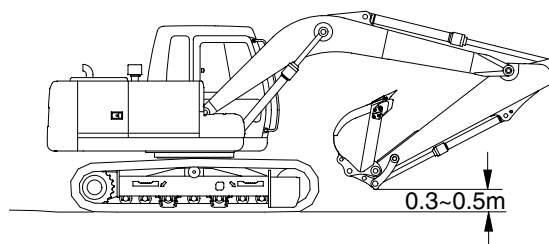
Model	Travel speed	Standard	Maximum allowable
R110-7	1 Speed	$21.3 \pm 2.0$	26.6
	2 Speed	$13.0 \pm 2.0$	16.3

## 5) TRAVEL DEVIATION

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

### (2) Preparation

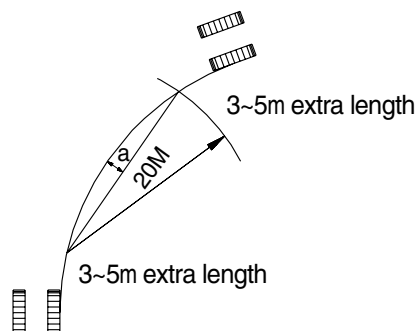
- ① Adjust the tension of both tracks to be equal.
- ② Provide a flat, solid test yard 20m in length, with extra length of 3 to 5m on both ends for machine acceleration and deceleration.
- ③ Hold the bucket 0.3 to 0.5m above the ground with the arm and bucket rolled in.
- ④ Keep the hydraulic oil temperature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



11077MS04

### (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.



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### (4) Evaluation

Mistrack should be within the following specifications.

Unit : mm / 20m

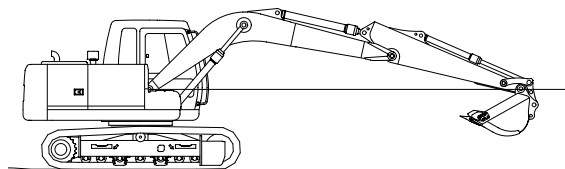
Model	Standard	Maximum allowable	Remarks
R110-7	200 below	240	

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



11077MS07

### (3) Measurement

- ① Select the following switch positions.
  - Mode selector : H 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	Standard	Maximum allowable	Remark
R110-7	$13.8 \pm 1.5$	16.6	

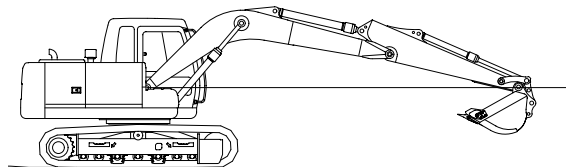


## 7) SWING FUNCTION DRIFT CHECK

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

### (2) Preparation

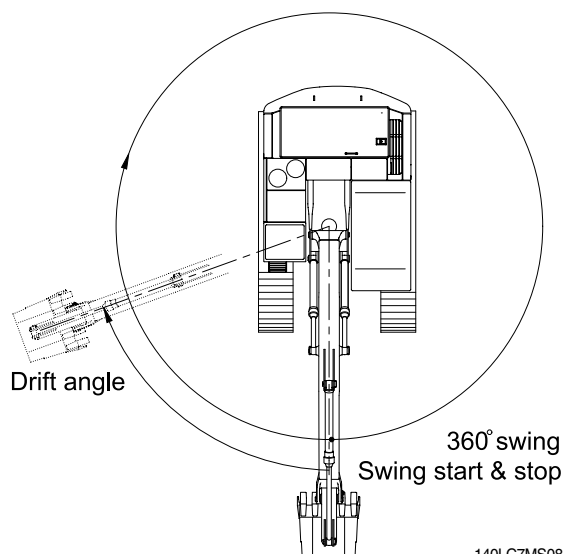
- ① Check the lubrication of the swing gear and swing bearing.
- ② Place the machine on flat, solid ground with ample space for swinging. Do not conduct this test on slopes.
- ③ With the arm rolled out and bucket rolled in, hold the bucket so that the height of the bucket pin is the same as the boom 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  $50 \pm 5^{\circ}\text{C}$ .



11077MS07

### (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 ④ and ⑤ three times each and calculate the average values.



140LC7MS08

### (4) Evaluation

The measured drift angle should be within the following specifications.

Unit : Degree

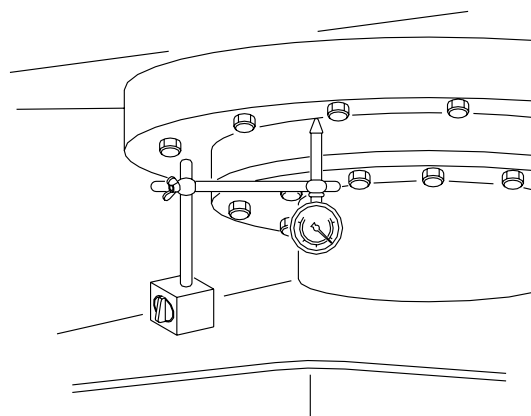
Model	Mode select switch	Standard	Maximum allowable	Remarks
R110-7	H mode	90 below	157.5	

## 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.



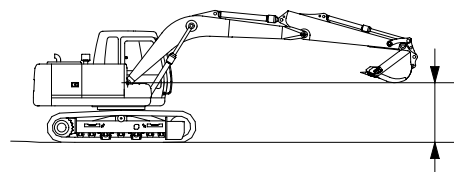
140LC-7 기타 7-10(1)

### (3) Measurement

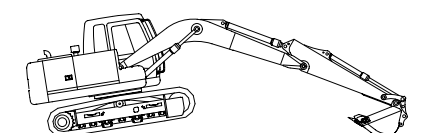
- ① With the arm rolled out and bucket rolled in, hold the bottom face of the bucket to the same height of the boom foot pin. Record the dial gauge reading(h1).
- ② Lower the bucket to the ground and use it to raise the front idler 50cm. Record the dial gauge reading(h2).
- ③ Calculate bearing play(H)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

$$H = h2 - h1$$

Measurement : (h1)



Measurement : (h2)



11077MS09

### (4) Evaluation

The measured drift should be within the following specifications.

Unit : mm

Model	Standard	Maximum allowable	Remarks
R110-7	0.5 ~ 1.5	3.0	

## 9) HYDRAULIC CYLINDER CYCLE TIME

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

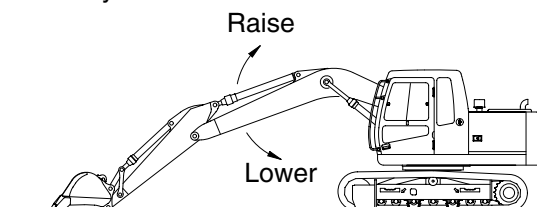
### (2) Preparation

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

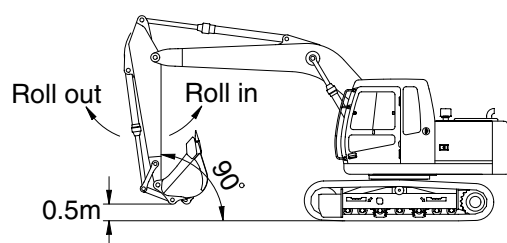
### (3) Measurement

- 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.

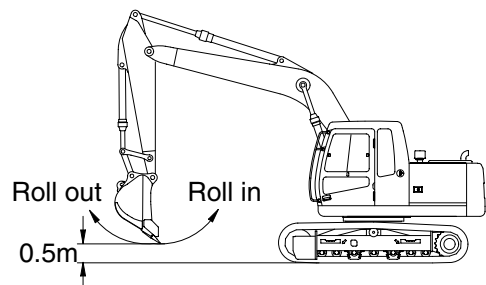
Boom cylinder



Arm cylinder



Bucket cylinder



11077MS10

- 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

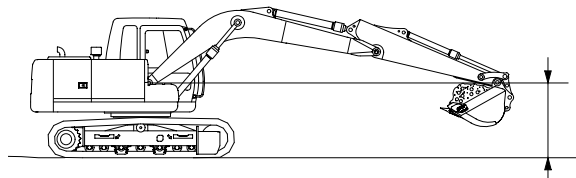
Model	Function	Standard	Maximum allowable	Remarks
R110-7	Boom raise	$2.9 \pm 0.4$	3.5	
	Boom lower	$2.6 \pm 0.4$	3.2	
	Arm in	$2.9 \pm 0.4$	3.5	
	Arm out	$2.8 \pm 0.3$	3.4	
	Bucket load	$3.6 \pm 0.4$	4.4	
	Bucket dump	$2.1 \pm 0.3$	2.5	

## 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 :
    - $M^3$  = Bucket heaped capacity( $m^3$ )
    - 1.5 = 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  $50 \pm 5^\circ\text{C}$ .



11077MS11

### (3) Measurement

- ① Stop the engine.
- ② Five minutes after the engine has been stopped, measure the changes in the positions of the boom, arm and bucket cylinders.
- ③ Repeat step ② three times and calculate the average values.

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

Unit : mm / 5min

Model	Drift to be measured	Standard	Maximum allowable	Remarks
R110-7	Boom cylinder	10 below	20	
	Arm cylinder	10 below	20	
	Bucket cylinder	40 below	50	

## 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
R110-7	Boom lever	1.6 or below	2.0	
	Arm lever	1.6 or below	2.0	
	Bucket lever	1.6 or below	2.0	
	Swing lever	1.6 or below	2.0	
	Travel lever	2.1 or below	3.15	

## 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.

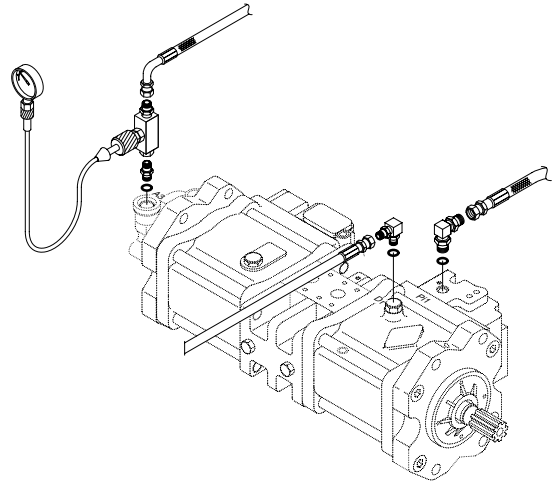
Unit : mm

Model	Kind of lever	Standard	Maximum allowable	Remarks
R110-7	Boom lever	$87 \pm 10$	109	
	Arm lever	$87 \pm 10$	109	
	Bucket lever	$87 \pm 10$	109	
	Swing lever	$87 \pm 10$	109	
	Travel lever	$142 \pm 10$	178	

### 13) PILOT PRIMARY PRESSURE

#### (1) Preparation

- ① Stop the engine.
- ② Push the pressure release button to bleed air.
- ③ Loosen and remove plug on the pilot pump delivery port and connect pressure gauge.
- ④ Start the engine and check for oil leakage from the port.
- ⑤ Keep the hydraulic oil temperature at  $50 \pm 5^{\circ}\text{C}$ .



11077MS16

#### (2) Measurement

- ① Select the following switch positions.
  - Engine rpm : 1950rpm
- ② Measure the primary pilot pressure in the H mode.

#### (3) Evaluation

The average measured pressure should meet the following specifications:

Unit :  $\text{kgf/cm}^2$

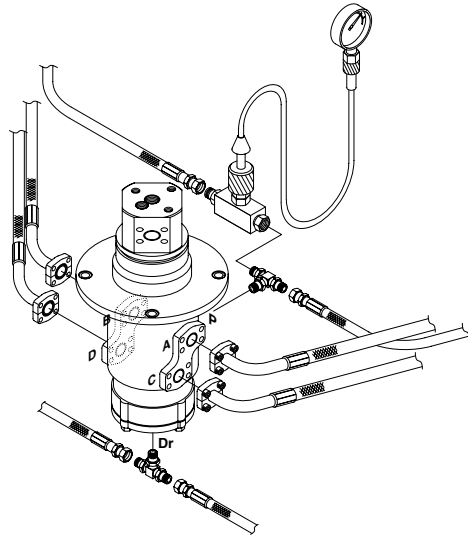
Model	Engine speed	Standard	Allowable limits	Remarks
R110-7	1950rpm	$35 \pm 5$	-	



**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
- ④ assembly to turning joint P port as shown.  
Start the engine and check for on  
leakage from the adapter.
- ⑤ Keep the hydraulic oil temperature at  
 $50 \pm 5^{\circ}\text{C}$ .



21077MS13

## (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.

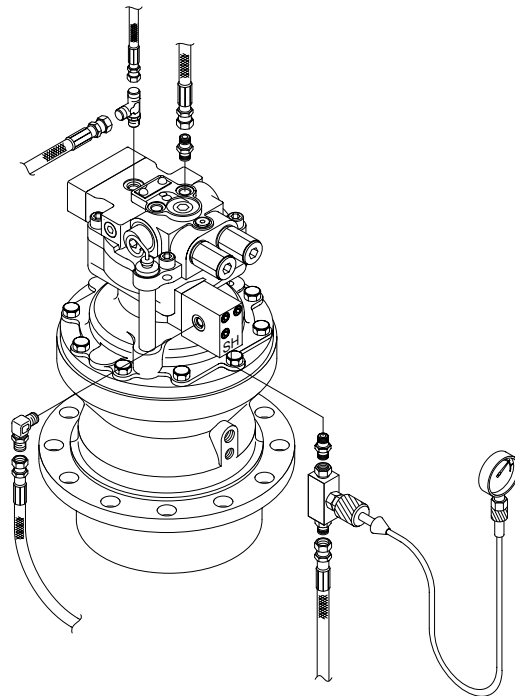
Unit : kgf / cm<sup>2</sup>

Model	Travel speed mode	Standard	Maximum allowable	Remarks
R110-7	1 Speed	0	-	
	2 Speed	35 ±5	-	

## 15) SWING PARKING BRAKE RELEASING PRESSURE

### (1) Preparation

- ① Stop the engine.
- ② Push the pressure release button to bleed air.
- ③ Install a connector and pressure gauge assembly to swing motor SH port, as shown.
- ④ Start the engine and check for oil leakage from the adapter.
- ⑤ Keep the hydraulic oil temperature at  $50 \pm 5^\circ\text{C}$ .



11077MS12

### (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.

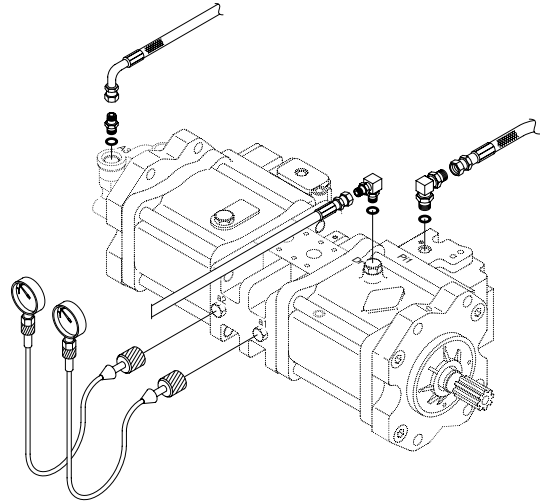
Unit : kgf / cm<sup>2</sup>

Model	Description	Standard	Allowable limits	Remarks
R110-7	Brake disengaged	35	15~44	
	Brake applied	0	-	

## 16) MAIN PUMP DELIVERY PRESSURE

### (1) Preparation

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



11077MS13

### (2) Measurement

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

### (3) Evaluation

The average measured pressure should meet the following specifications.

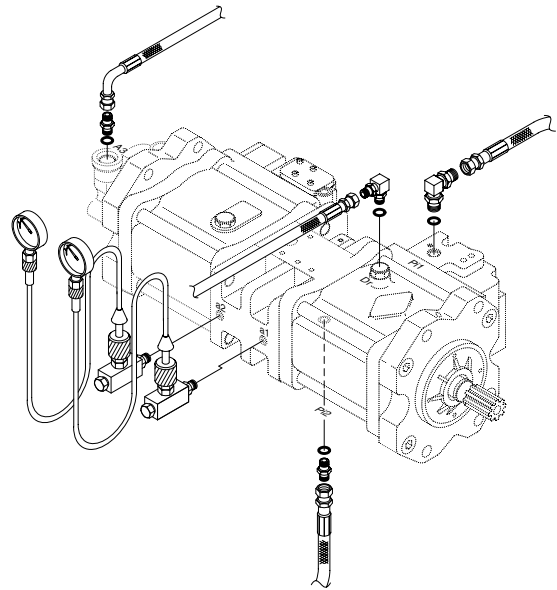
Unit :  $\text{kgf} / \text{cm}^2$

Model	Engine speed	Standard	Allowable limits	Remarks
R110-7	High ilde	$30 \pm 5$	-	

## 17) SYSTEM PRESSURE REGULATOR RELIEF SETTING

### (1) Preparation

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



### (2) Measurement

- ① Select the following switch positions.
  - Mode selector : H mode
- 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.

11077MS14

### (3) Evaluation

The average measured pressure should be within the following specifications.

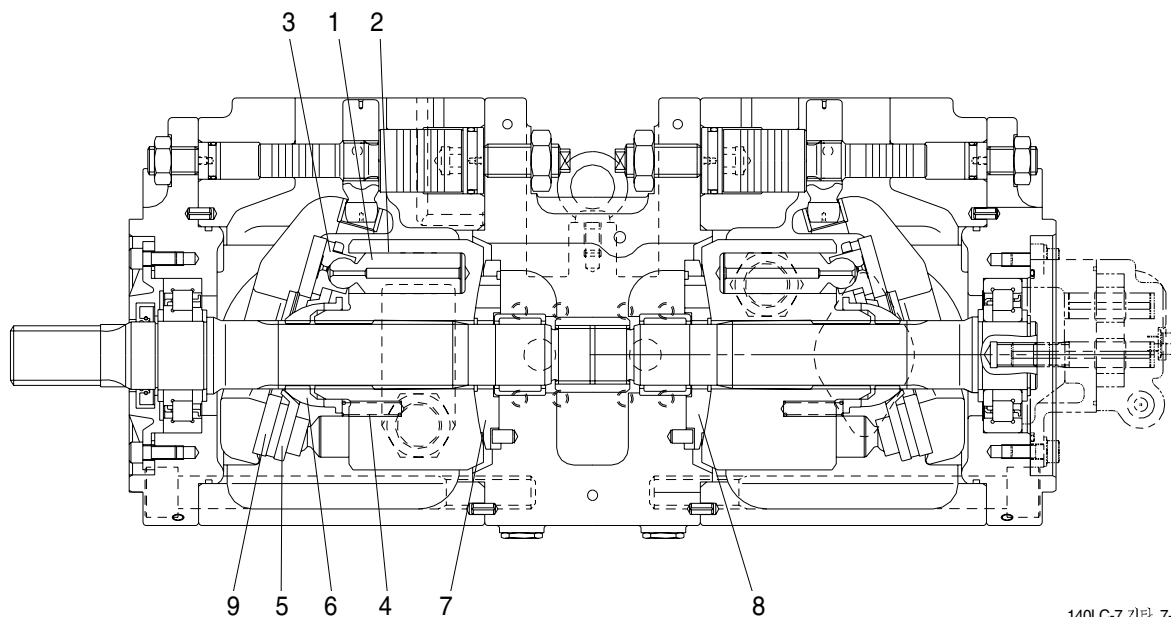
Unit :  $\text{kgf} / \text{cm}^2$

Model	Function to be tested	Standard	Port relief seting
R110-7	Boom, Arm, Bucket	$330(360) \pm 10$	$390 \pm 10$
	Travel	$330 \pm 10$	-
	Swing	$240 \pm 10$	-

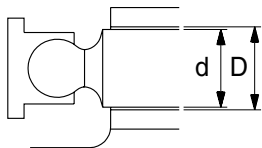
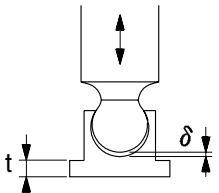
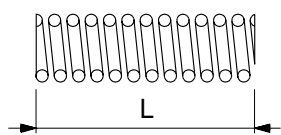
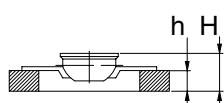
( ) : Power boost

## GROUP 2 MAJOR COMPONENT

### 1. MAIN PUMP




140LC-7 기타 7-21

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(4) (L)		31.3	30.5	Replace cylinder spring.
Combined height of set plate(5) & spherical bushing(6) (H-h)		19.0	18.3	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		

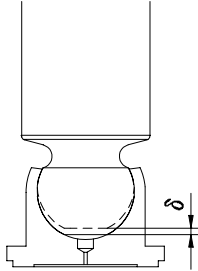
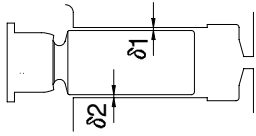
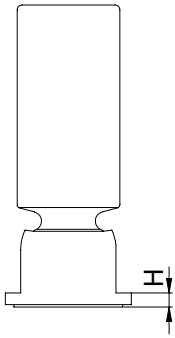
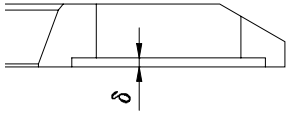
## 2. MAIN CONTROL VALVE

Part name	Inspection item	Criteria & measure
Casing	<ul style="list-style-type: none"> <li>Existence of scratch, rusting or corrosion.</li> </ul>	<ul style="list-style-type: none"> <li>In case of damage in following section, replace part.</li> <li>Sliding sections of casing fore and spool, especially land sections applied with holded pressure.</li> <li>Seal pocket section where spool is inserted.</li> <li>Seal section of port where O-ring contacts.</li> <li>Seal section of each relief valve for main, travel, and port.</li> <li>Other damages that may damage normal functions.</li> </ul>
Spool	<ul style="list-style-type: none"> <li>Existence of scratch, gnawing, rusting or corrosion.</li> <li>O-ring seal sections at both ends.</li> <li>Insert spool in casing hole, rotate and reciprocate it.</li> </ul>	<ul style="list-style-type: none"> <li>Replacement when its outside sliding section has scratch(Especially on seals-contacting section).</li> <li>Replacement when its sliding section has scratch.</li> <li>Correction or replacement when O-ring is damaged or when spool does not move smoothly.</li> </ul>
Poppet	<ul style="list-style-type: none"> <li>Damage of poppet or spring</li> <li>Insert poppet into casing and function it.</li> </ul>	<ul style="list-style-type: none"> <li>Correction or replacement when sealing is incomplete.</li> <li>Normal when it can function lightly without being caught.</li> </ul>
Around spring	<ul style="list-style-type: none"> <li>Rusting, corrosion, deformation or breaking of spring, spring seat, plug or cover.</li> </ul>	<ul style="list-style-type: none"> <li>Replacement for significant damage.</li> </ul>
Around seal for spool	<ul style="list-style-type: none"> <li>External oil leakage.</li> <li>Rusting, corrosion or deformation of seal plate.</li> </ul>	<ul style="list-style-type: none"> <li>Correction or replacement.</li> <li>Correction or replacement.</li> </ul>
Main relief valve, port relief valve & negative control relief valve	<ul style="list-style-type: none"> <li>External rusting or damage.</li> <li>Contacting face of valve seat.</li> <li>Contacting face of poppet.</li> <li>Abnormal spring.</li> <li>O-rings, back up rings and seals.</li> </ul>	<ul style="list-style-type: none"> <li>Replacement.</li> <li>Replacement when damaged.</li> <li>Replacement when damaged.</li> <li>Replacement.</li> <li>100% replacement in general.</li> </ul>
Balance plate	<ul style="list-style-type: none"> <li>Worn less than 0.03mm</li> <li>Worn more than 0.03mm</li> <li>Sliding surface has a seizure(Even through small).</li> </ul>	<ul style="list-style-type: none"> <li>Lapping</li> <li>Replace</li> <li>Replace</li> </ul>

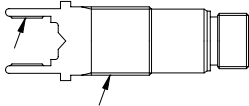
### 3. SWING DEVICE

Part name	Inspection item	Remedy
Shoe of piston assembly	<ul style="list-style-type: none"> <li>Sliding surface has a damage.</li> <li>Sliding surface depression( ) dimension less than 0.45mm or has a large damage.</li> </ul>	<ul style="list-style-type: none"> <li>Lapping</li> <li>Replace parts or motor</li> </ul>
Piston of piston assembly	<ul style="list-style-type: none"> <li>Sliding surface has a seizure(Even though small).</li> </ul>	<ul style="list-style-type: none"> <li>Replace motor</li> </ul>
Piston hole of cylinder assembly	<ul style="list-style-type: none"> <li>Sliding surface has a seizure.</li> <li>Sliding surface has a damage.</li> </ul>	<ul style="list-style-type: none"> <li>Replace motor</li> <li>Replace motor</li> </ul>
Taper roller bearing Needle bearing Roller bearing	<ul style="list-style-type: none"> <li>In case 3000hour operation.</li> <li>Rolling surface has a damage.</li> </ul>	<ul style="list-style-type: none"> <li>Replace</li> <li>Replace</li> </ul>

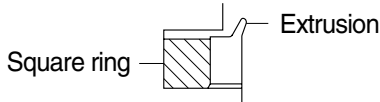
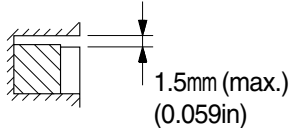
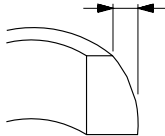
#### 4. TRAVEL DEVICE

Part name	Check point	Standard dimension	Maximum allowable value (Criteria)	Remedy
Piston assy(7) 	Play between piston and slipper	$\delta = 0.1\text{mm}$	$\delta < 0.5\text{mm}$	Replace 9 sets of piston assy
Piston assy(7) and cylinder barrel (3) 	Clearance/diameter between piston diameter and cylinder bore ( $\delta 1 + \delta 2$ )	0.03mm	$< 0.07\text{mm}$	Replace the set of 1 cylinder barrel and 9 piston assys
Slipper(7-2) 	Height of the plate	Height H 5mm	Height $H < 4.6\text{mm}$	Replace 9 sets of piston assy
Retainer(5) 	Wear		Wear depth $\delta < 0.2\text{mm}$	Replace
Cam(6)	Condition of sliding surface	Roughness $< \text{Ra } 0.2\mu\text{ m}$	Roughness $< \text{Ra } 1.6\mu\text{ m}$	Replace



Part name	Check point	Standard dimension	Maximum allowable value (Criteria)	Remedy
Shaft(2) 	Spline sections(connected to cylinder barrel, and bear part)	-	No abnormality such as crack, chipping, nonuniformly wear-ing out, etc.	Replace
Bearings(1-3), (1-8), (1-13), (11), (12)	Rolling surface	-	No flaking or other abnormal damage on the rolling surface	Replace
Oil seal(13)	Seal lip	-	No damage or partial wear	Replace
O-rings, Back-up rings	-	-	-	In reassembling, they should be replaced with new ones even if no abnormality is detected.
Cylinder barrel(3)	Condition of the surface sliding with valve plate	Roughness < Ra 0.2 $\mu$ m	Roughness < Ra 0.8 $\mu$ m	Replace the set of cylinder barrel and valve plate
Valve plate(8)	Condition of sliding surface	Roughness < Ra 0.4 $\mu$ m	Roughness < Ra 1.6 $\mu$ m	Replace the set of cylinder barrel and valve plate

## 5. 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).	Replace
Seal set	-	• Extruded excessively from seal groove square ring.  	Replace
	-	• Slipper ring 1.5mm(0.059in) narrower than seal groove, or narrower than back ring.  	Replace
	-	• Worn more than 0.5mm(0.02in) ~ 1.5mm(MAX.) (0.059in)  	Replace

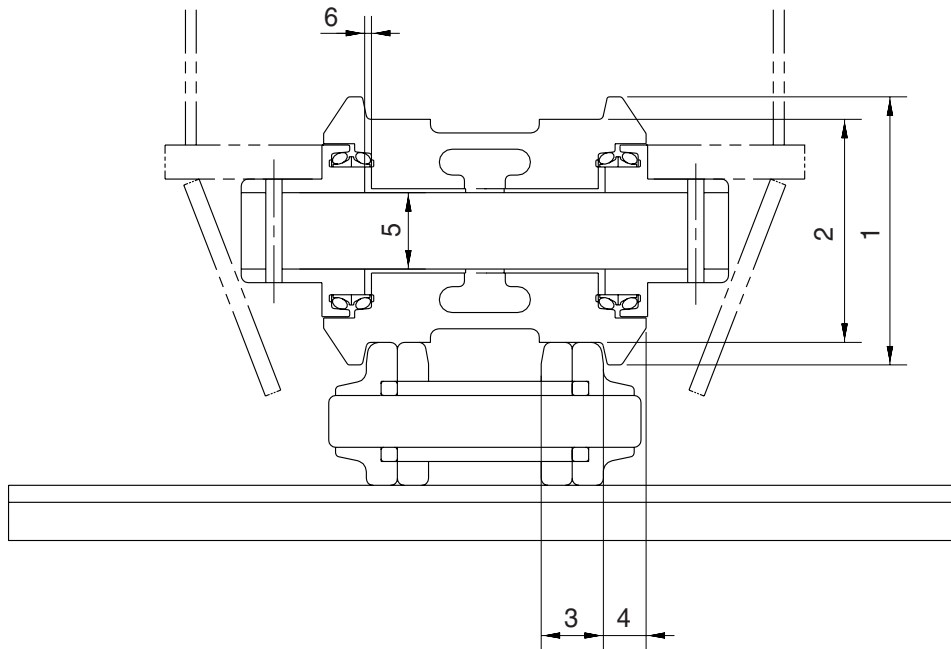
## 6. CYLINDER

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

## GROUP 3 TRACK AND WORK EQUIPMENT

### 1. TRACK

#### 1) TRACK ROLLER

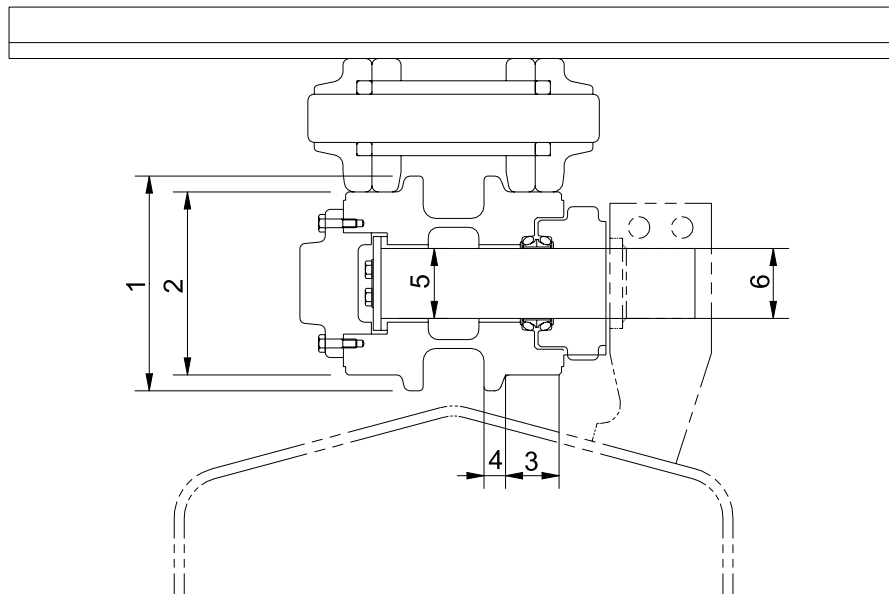


21037MS01

Unit : mm

No.	Check item	Criteria				Remedy	
1	Outside diameter of flange	Standard size		Repair limit		Rebuild or replace	
		∅ 170		-			
2	Outside diameter of tread	∅ 140		∅ 128			
3	Width of tread	39.5		45.5			
4	Width of flange	20		-			
5	Clearance between shaft and bushing	Standard size	tolerance		Standard clearance	Clearance limit	Replace bushing
			Shaft	Hole			
		∅ 50	0 -0.03	+0.4 +0.35	0.35 to 0.43	2.0	
6	Side clearance of roller (Both side)	Standard clearance		Clearance limit		Replace	
		0.25~0.65		2.0			

## 2) CARRIER ROLLER

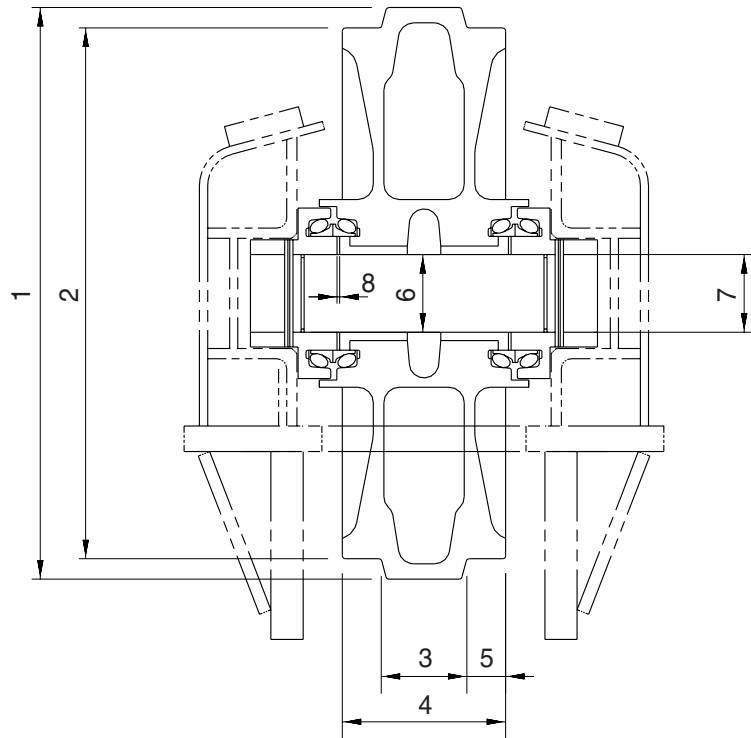


32077MS02

Unit : mm

No.	Check item	Criteria				Remedy
1	Outside diameter of flange	Standard size		Repair limit		Rebuild or replace
		ø 136		-		
2	Outside diameter of tread	ø 116		ø 108		
3	Width of tread	35.5		39.5		
4	Width of flange	15		-		Replace bushing or shaft
5	Clearance between shaft and bushing	Standard size & Tolerance		Standard clearance	Clearance limit	
		Shaft	Hole			
		ø 40 +0.085 +0.065	ø 40 +0.3 +0.25	0.165 to 0.235	2.0	
6	Clearance between shaft and support	ø 40.8 -0.05 -0.01	ø 40.8 +0.3 +0.1	0.15 to 0.4	1.2	

### 3) IDLER

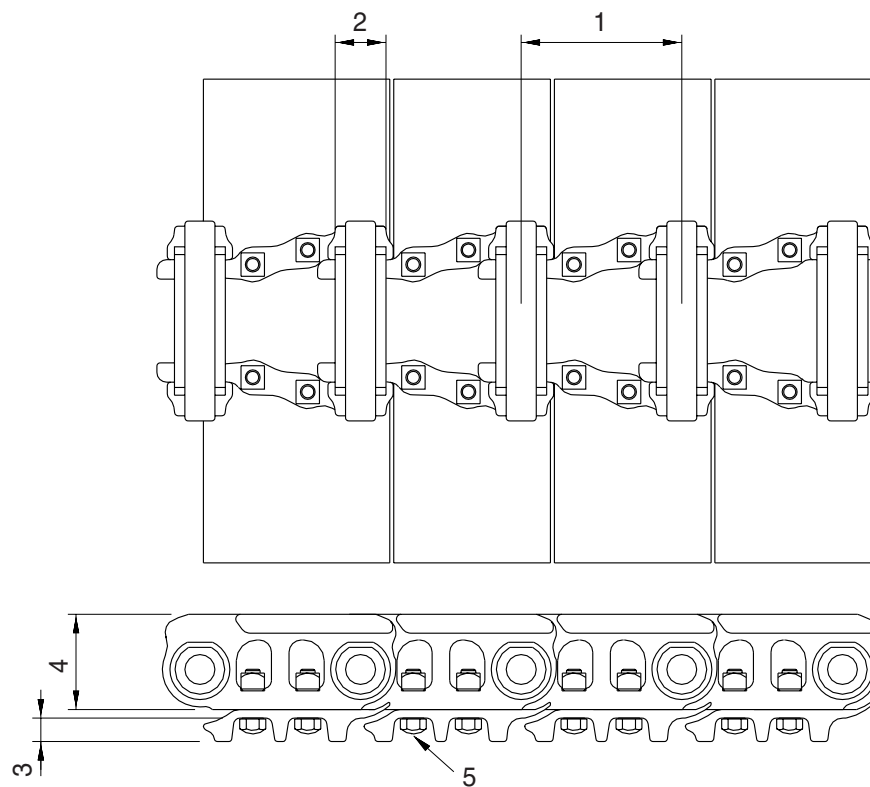


21037MS03

Unit : mm

No.	Check item	Criteria				Remedy
1	Outside diameter of protrusion	Standard size		Repair limit		Rebuild or replace
		ø 510		-		
2	Outside diameter of tread	ø 470		ø 460		
3	Width of protrusion	67		-		
4	Total width	135		-		
5	Width of tread	34		39		
6	Clearance between shaft and bushing	Standard size & tolerance		Standard clearance	Clearance limit	Replace bushing
		Shaft	Hole			
		ø 70 <sup>0</sup> <sub>-0.03</sub>	ø 70.3 <sup>+0.05</sup> <sub>0</sub>	0.3 to 0.38	2.0	
7	Clearance between shaft and support	ø 70 <sup>0</sup> <sub>-0.03</sub>	ø 70 <sup>+0.07</sup> <sub>+0.03</sub>	0.03 to 0.1	1.2	Rebuild or Replace
8	Side clearance of idler (Both side)	Standard clearance		Clearance limit		Replace bushing
		0.25~1.15		2.0		

#### 4) TRACK

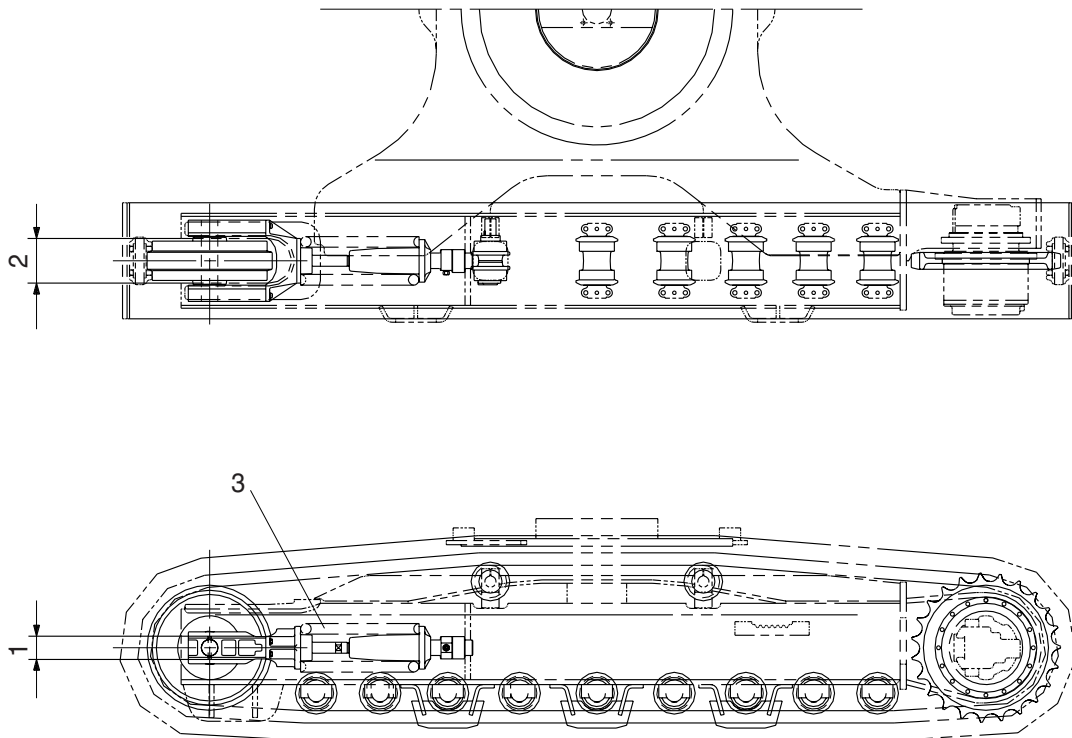


21037MS04

Unit : mm

No.	Check item	Criteria		Remedy
		Standard size	Repair limit	
1	Link pitch	171.45	175.45	Turn or replace
2	Outside diameter of bushing	ø 50.6	ø 40.8	Rebuild or replace
3	Height of grouser	20	16	
4	Height of link	90	82	
5	Tightening torque	Initial tightening torque : $42 \pm 4 \text{ kgf} \cdot \text{m}$		Retighten

## 5) TRACK FRAME AND RECOIL SPRING



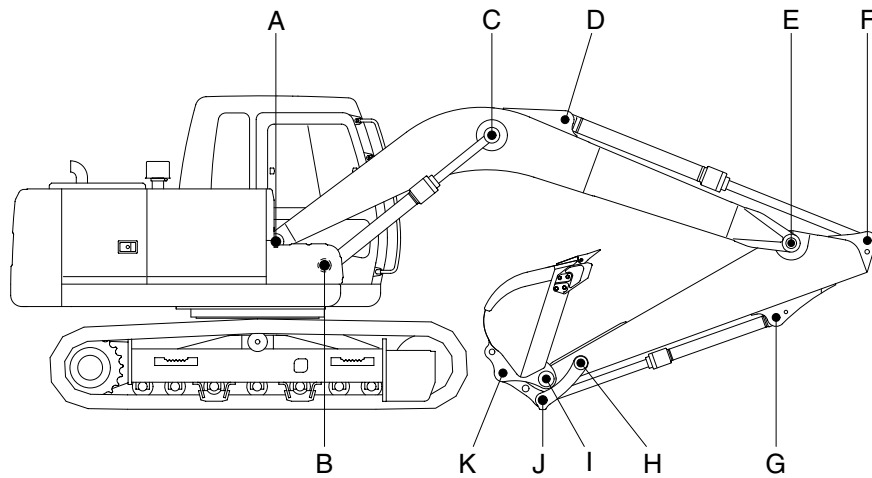
21037MS05

Unit : mm

No.	Check item	Criteria				Remedy
			Standard size	Tolerance	Repair limit	
1	Vertical width of idler guide	Track frame	103	+2 0	107	Rebuild or replace
		Idler support	100	-0 -0.5	98	
2	Horizontal width of idler guide	Track frame	192	+2 0	196	
		Idler support	190	-	188	
3	Recoil spring	Standard size			Repair limit	Replace
		Free length	Installation length	Installation load	Free length	Installation load
		∅ 192 × 470	405	8,497kg	-	6.978kg



## 2. WORK EQUIPMENT



11077MS15

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	70	69	68.5	70.5	71	Replace
B	Boom Cylinder Head	70	69	68.5	70.5	71	"
C	Boom Cylinder Rod	70	69	68.5	70.5	71	"
D	Arm Cylinder Head	65	64	63.5	65.5	66	"
E	Boom Front	70	69	68.5	70.5	71	"
F	Arm Cylinder Rod	65	64	63.5	65.5	66	"
G	Bucket Cylinder Head	65	64	63.5	65.5	66	"
H	Arm Link	65	64	63.5	65.5	66	"
I	Bucket and Arm Link	65	64	63.5	65.5	66	"
J	Bucket Cylinder Rod	65	64	63.5	65.5	66	"
K	Bucket Link	65	64	63.5	65.5	66	"

## SECTION 8 DISASSEMBLY AND ASSEMBLY

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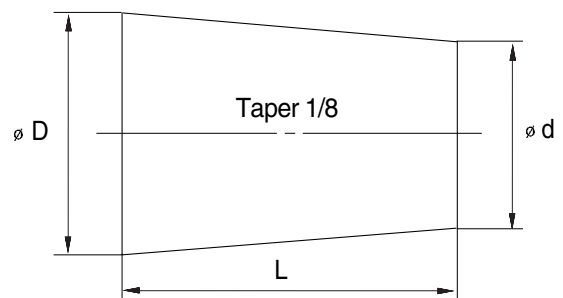
# SECTION 8 DISASSEMBLY AND ASSEMBLY

## 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(Engine-Bracket)	M12 × 1.75	10.0 ± 0.5	72.3 ± 3.6
2		Engine mounting bolt(Bracket-Frame, FR)	M16 × 2.0	55 ± 3.5	398 ± 25.3
3		Engine mounting bolt(Bracket-Frame, RR)	M20 × 2.5	30 ± 3.5	253 ± 25.3
4		Radiator mounting bolt, nut	M12 × 1.75	12.2 ± 1.3	88.2 ± 9.4
5		Coupling mounting bolt	M16 × 2.0	22.0 ± 1.0	159 ± 7.2
6	Hydraulic system	Main pump mounting bolt	M16 × 2.0	22.1 ± 2.4	159 ± 17.3
7		Main control valve mounting bolt	M12 × 1.75	12.2 ± 1.3	88.2 ± 9.4
8		Fuel tank mounting bolt	M20 × 2.5	45 ± 5.1	325 ± 36.9
9		Hydraulic oil tank mounting bolt	M20 × 2.5	45 ± 5.1	325 ± 36.9
10		Turning joint mounting bolt, nut	M12 × 1.75	12.3 ± 1.3	88.2 ± 9.4
11	Power train system	Swing motor mounting bolt	M16 × 2.0	29.6 ± 3.2	214 ± 23.1
12		Swing bearing upper mounting bolt	M18 × 2.0	41.3 ± 4.5	299 ± 32.5
13		Swing bearing lower mounting bolt	M16 × 2.0	29.7 ± 4.5	215 ± 32.5
14		Travel motor mounting bolt	M16 × 2.0	23 ± 2.5	166 ± 18.1
15		Sprocket mounting bolt	M16 × 2.0	29.7 ± 4.5	215 ± 32.5
16		Carrier roller mounting bolt, nut	M16 × 2.0	29.7 ± 4.5	215 ± 32.5
17	Under carriage	Track roller mounting bolt	M16 × 2.0	29.7 ± 4.5	215 ± 32.5
18		Track tension cylinder mounting bolt	M16 × 2.0	29.7 ± 4.5	215 ± 32.5
19		Track shoe mounting bolt, nut	M16 × 1.5	42 ± 4	304 ± 28.9
20		Track guard mounting bolt	M16 × 2.0	29.7 ± 4.5	215 ± 32.5
21	Others	Counter weight mounting bolt	M24 × 3.0	97.8 ± 10	707 ± 72.3
22		Cab mounting bolt, nut	M12 × 1.75	12.2 ± 1.3	88.2 ± 9.4
23		Operator's seat mounting bolt	M 8 × 1.25	1.17 ± 0.1	8.5 ± 0.7

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

## 2. TORQUE CHART

Use following table for unspecified torque.

### 1) BOLT AND NUT - 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) BOLT AND NUT - 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	67.9 ~ 91.9	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 tank quantity : 100 l

- (5) Remove socket bolts(75) and disconnect pipe(74).

- (6) Disconnect pilot line hoses(11, 13, 14, 35, 37,47).

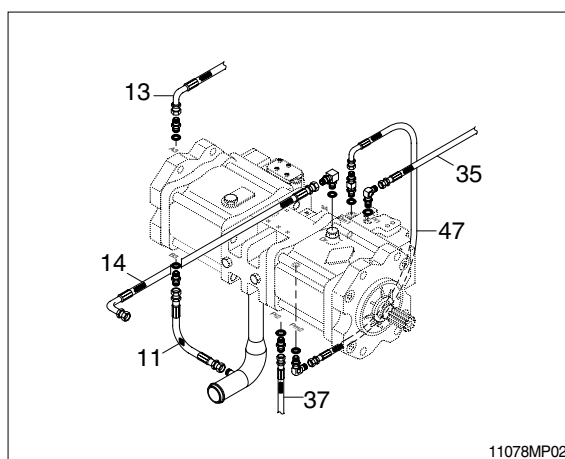
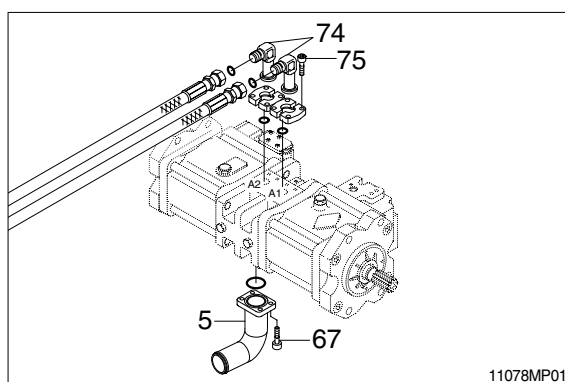
- (7) Remove socket bolts(67) and disconnect pump suction tube(5).

※ 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 : 90kg(200lb)

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

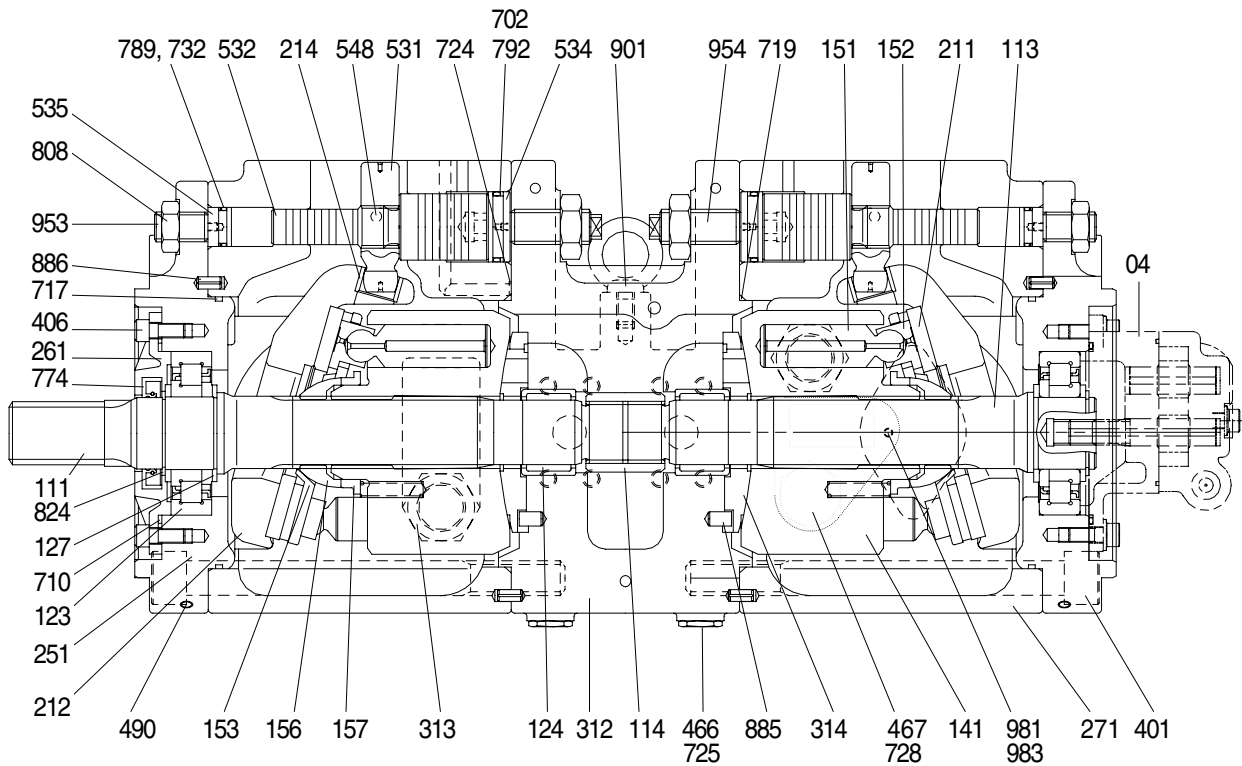


## **2) INSTALL**

- (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(1/2)

### 1) STRUCTURE



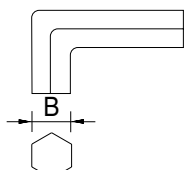
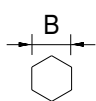
14072SF02

04	Gear pump	271	Pump casing	719	O-ring
111	Drive shaft(F)	312	Valve block	724	O-ring
113	Drive shaft(R)	313	Valve plate(R)	725	O-ring
114	Spline coupling	314	Valve plate(L)	728	O-ring
123	Roller bearing	401	Hexagon socket bolt	732	O-ring
124	Needle bearing	406	Hexagon socket bolt	774	Oil seal
127	Bearing spacer	466	VP Plug	789	Back up ring
141	Cylinder block	467	VP Plug	792	Back up ring
151	Piston	490	Plug	808	Hexagon head nut
152	Shoe	531	tilting pin	824	Snap ring
153	Set plate	532	Servo piston	885	Pin
156	Bushing	534	Stopper(L)	886	Spring pin
157	Cylinder spring	535	Stopper(S)	901	Eye bolt
211	Shoe plate	548	Pin	953	Set screw
212	Swash plate	702	O-ring	954	Set screw
214	Bushing	710	O-ring	981	Plate
251	Support	717	O-ring	983	Pin
261	Seal cover(F)				

## 2) TOOLS AND TIGHTENING TORQUE

### (1) Tools

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

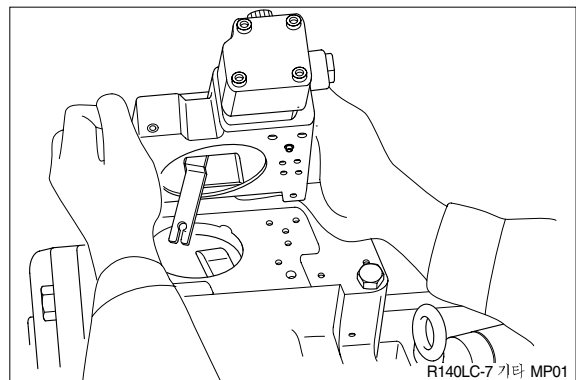
Tool name & size		Part name			
Name	B	Hexagon socket head bolt	PT plug (PT thread)	PO plug (PF thread)	Hexagon socket head setscrew
<div>Allen wrench</div> 	4	M 5	BP-1/16	-	M 8
	5	M 6	BP-1/8	-	M10
	6	M 8	BP-1/4	PO-1/4	M12, M14
	8	M10	BP-3/8	PO-3/8	M16, M18
	17	M20, M22	BP-1	PO-1, 1 1/4, 1 1/2	-
<div>Double ring spanner, socket wrench, double(Single) open end spanner</div> 	-	Hexagon socket head bolt	Henagon 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	116	0.47	12
	M16	24.0	174	0.55	14
	M18	34.0	246	0.55	14
	M20	44.0	318	0.67	17
PT Plug(Material : S45C) ※Wind a seal tape 1 1/2 to 2 turns round the plug	PT1/16	0.7	5.1	0.16	4
	PT 1/8	1.05	7.59	0.20	5
	PT 1/4	1.75	12.7	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	109	0.55	14
	PF 1	19.0	137	0.67	17
	PF 1 1/4	27.0	195	0.67	17
	PF 1 1/2	28.0	203	0.67	17

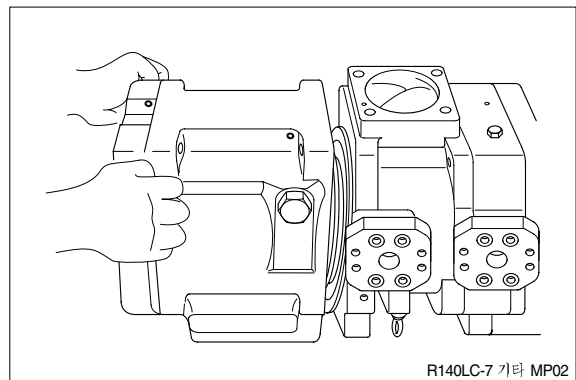
### 3) DISASSEMBLY

- (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(468) and let oil out of pump casing(Front and rear pump).
- (4) Remove hexagon socket head bolts(412, 413) and remove regulator.



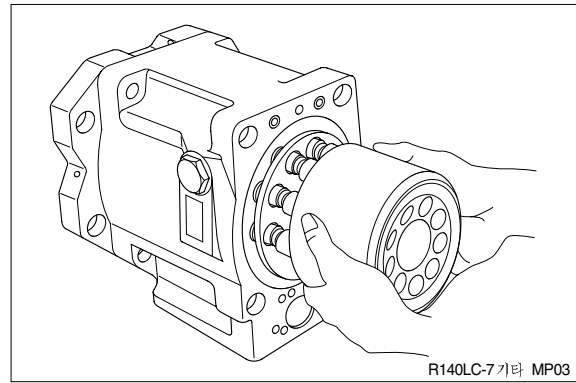
- (5) Loosen hexagon socket head bolts(401) which tighten swash plate support(251), pump casing(271) and valve block(312).
  - ※ If gear pump and so on are fitted to rear face of pump, remove them before starting this work.

- (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.

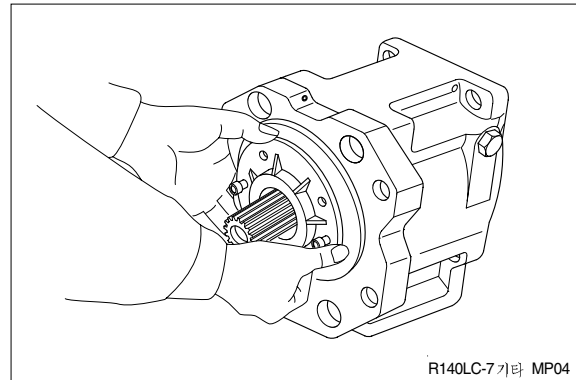
※ Take care not to damage sliding surfaces of cylinder, spherical bushing, shoes, swash plate, etc.



- (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.

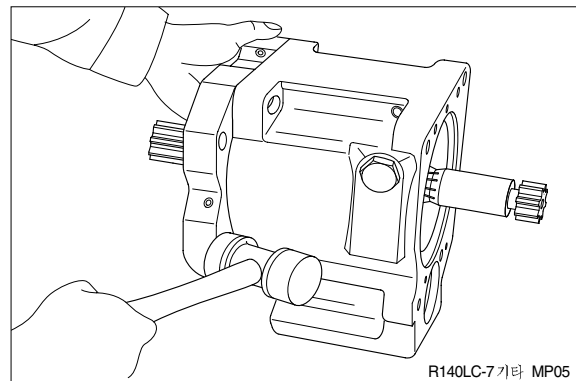
※ Since oil seal is fitted on seal cover(F), take care not to damage it in removing cover.



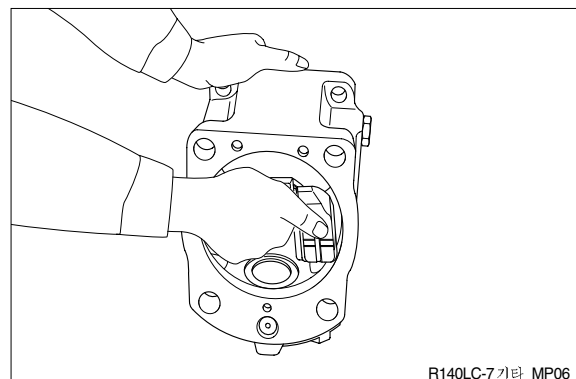
- (9) Remove hexagon socket head bolts(408) and then seal cover(R, 262).

In case fitting a gear pump, first, remove gear pump.

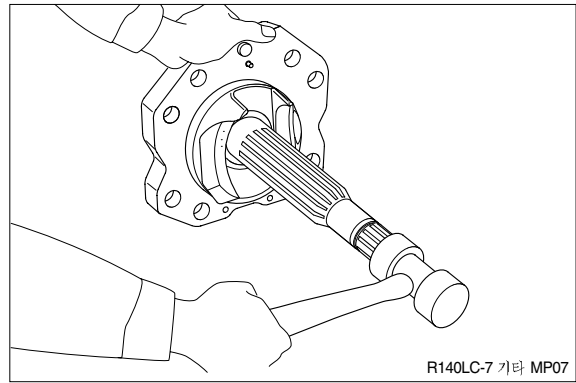
- (10) Tapping lightly fitting flange section of swash plate support(251) on its pump casing side, separate swash plate support from pump casing.



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

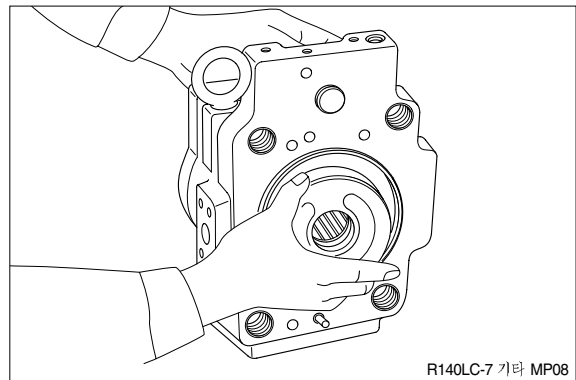


- (12) Tapping lightly shaft ends of drive shafts (111, 113) with plastic hammer, take out drive shafts from swash plate supports.



- (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 splined 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.



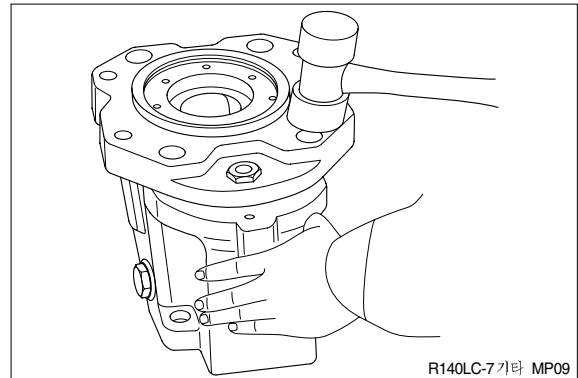
#### 4) ASSEMBLY

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

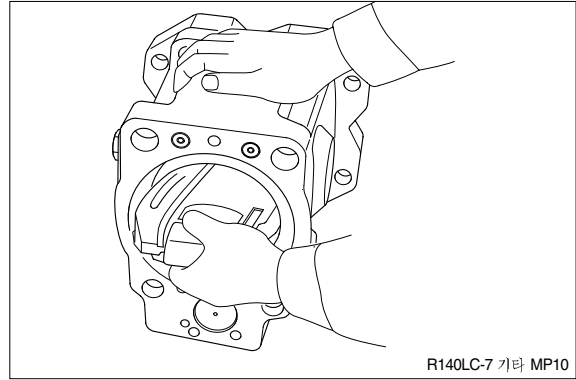
- ① Do not fail to repair the parts damaged during disassembling, and prepare replacement parts in advance.
- ② Clean each part fully with cleaning oil and dry it with compressed air.
- ③ Do not fail to apply clean working oil to sliding sections, bearings, etc. before assembling them.
- ④ In principle, 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 8-11, 12.
- 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.

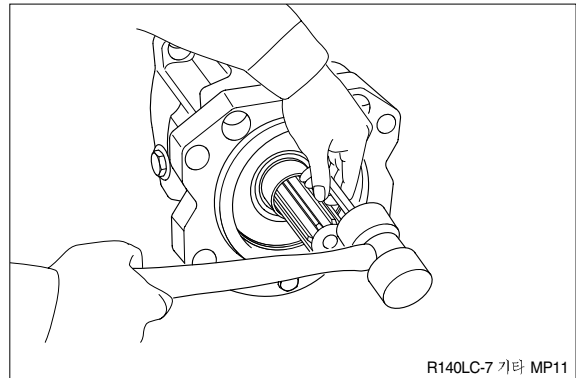
- ※ After servo piston, tilting pin, stopper(L) and stopper(S) are removed, fit them soon to pump casing in advance for reassembling.
- ※ In tightening servo piston and tilting pin, use a protector to prevent tilting pin head and feedback pin from being damaged. In addition, apply loctite(Medium strength)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



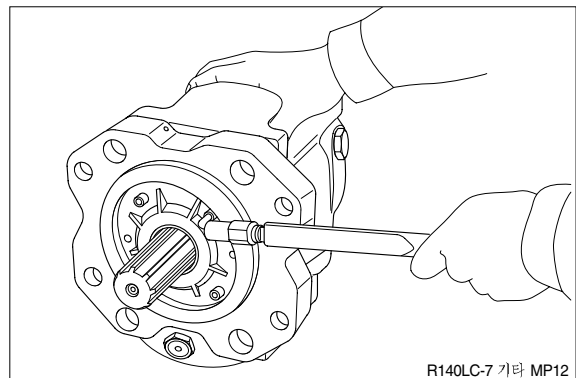
- (3) Place pump casing with its regulator fitting surface down, fit tilting bush of swash plate to tilting pin(531) and fit swash plate (212) to swash plate support(251) correctly.  
Confirm with fingers of both hands that
- ※ swash plate can be removed smoothly.
- Apply grease to sliding sections of swash plate and swash plate support, and drive shaft can be fitted easily.



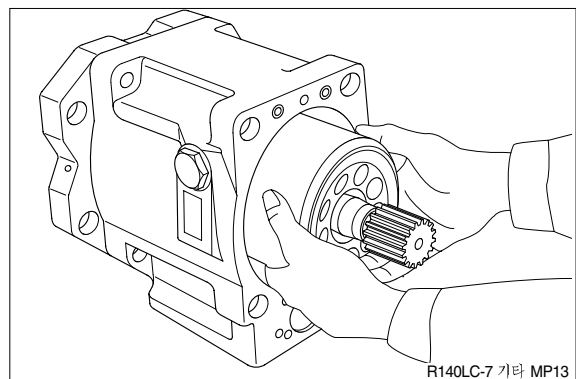
- (4) To swash plate support(251), fit drive shaft(111) set with bearing(123), bearing spacer(127) and snap ring(824).
- ※ Do not tap drive shaft with hammer or so on.
  - ※ Assemble them into support, tapping outer race of bearing lightly with plastic hammer.
- Fit them fully, using steel bar or so on.



- (5) Assemble seal cover(F, 261) to pump casing(271) and fix it with hexagon socket head bolts(406).
- ※ Apply grease lightly to oil seal in seal cover(F).
  - ※ Assemble oil seal, taking full care not to damage it.
  - ※ For tandem type pump, fit rear cover(263) and seal cover(262) similarly.

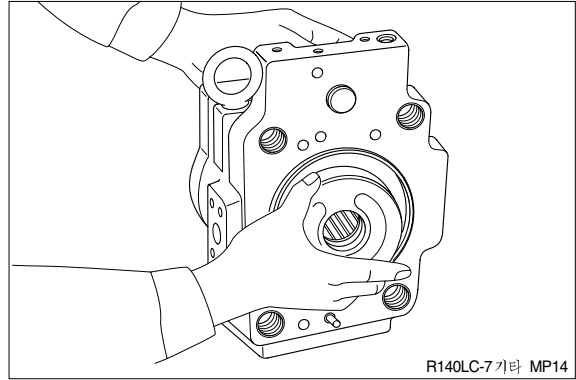


- (6) Assemble piston cylinder subassembly [cylinder block(141), piston subassembly (151, 152), set plate(153), spherical bush (156), spacer(158) and cylinder spring (157)].  
Fit spline phases of retainer and cylinder.  
Then, insert piston cylinder subassembly into pump casing.



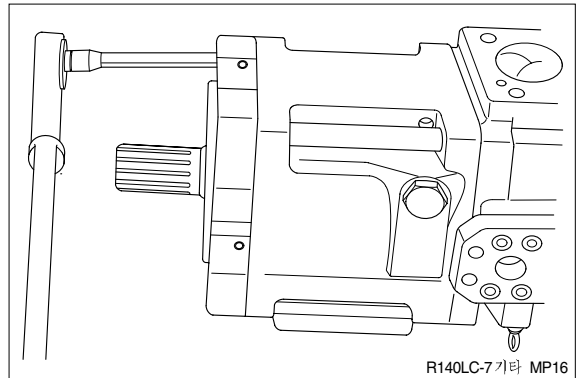
(7) Fit valve plate(313) to valve block(312), entering pin into pin hole.

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



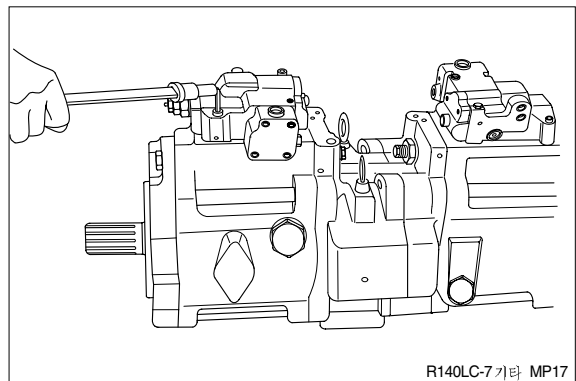
(8) Fit valve block(312) to pump casing(271) and tighten hexagon socket head bolts (401).

- ※ 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.
- ※ Counter clockwise rotation(Viewed from input shaft side) - Fit block with delivery flange right, 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.

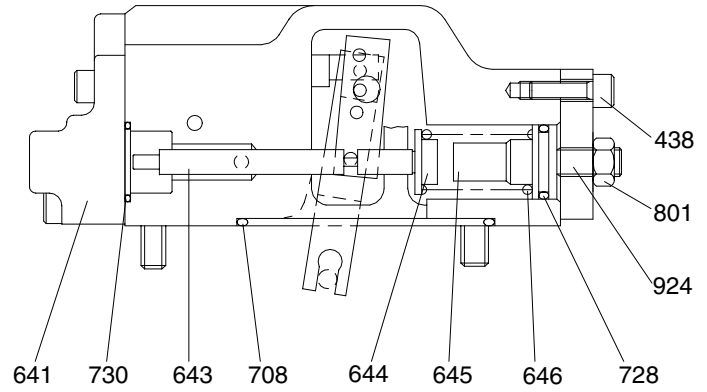
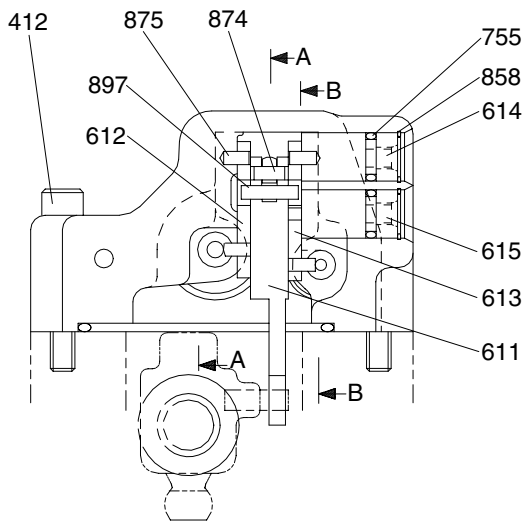


(10) Fit drain port plug(468).

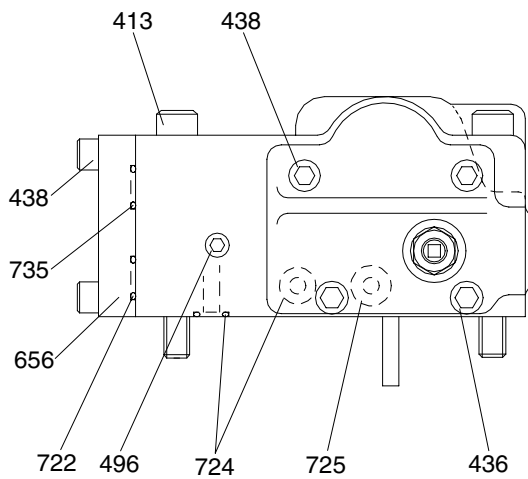
This is the end of reassembling procedures.

### 3. REGULATOR

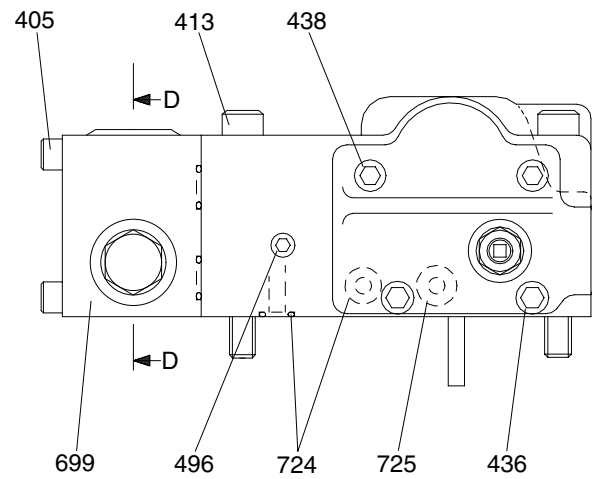
#### 1) STRUCTURE(1/2)



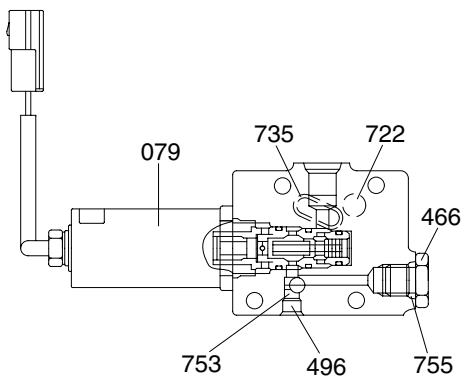
SECTION B-B



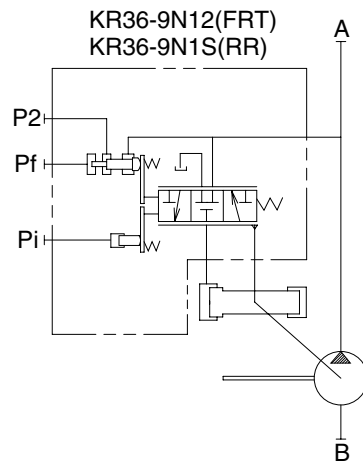
VIEW C(FRONT)



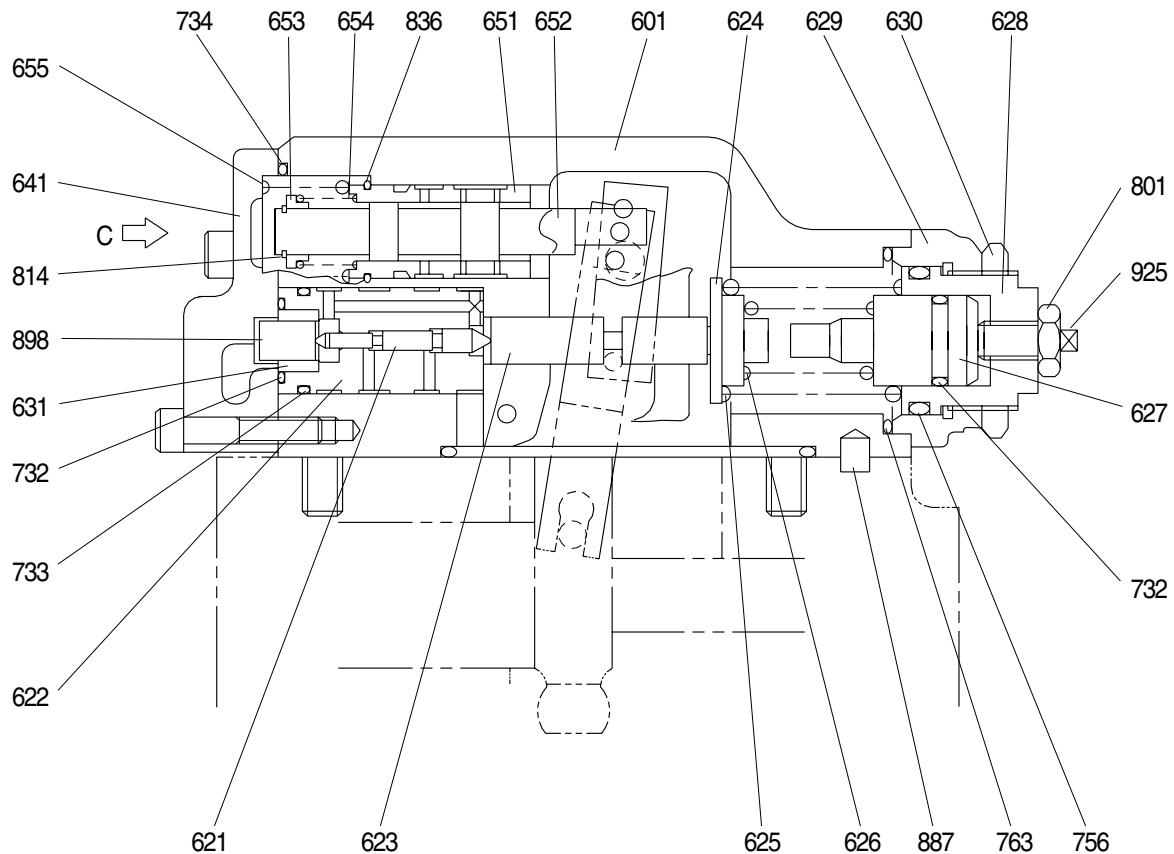
VIEW C(REAR)



SECTION D-D



## REGULATOR(2/2)



SECTION A-A

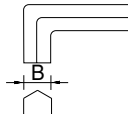

R140LC-7 기타 2-5

405 Hexagon socket screw	629 Cover(C)	730 O-ring
412 Hexagon socket screw	630 Lock nut	732 O-ring
413 Hexagon socket screw	631 Sleeve, pf	733 O-ring
436 Hexagon socket screw	641 Pilot cover	734 O-ring
438 Hexagon socket screw	643 Pilot piston	735 O-ring
466 Plug	644 Spring seat(Q)	753 O-ring
496 Plug	645 Adjust stem(Q)	755 O-ring
601 Casing	646 Pilot spring	756 O-ring
611 Feed back lever	651 Sleeve	763 O-ring
612 Lever(1)	652 Spool	801 Nut
613 Lever(2)	653 Spring seat	814 Snap ring
614 Fulcrum plug	654 Return spring	836 Snap ring
615 Adjust plug	655 Set spring	858 Snap ring
621 Compensator piston	656 Block cover	874 Pin
622 Piston case	699 Valve casing	875 Pin
623 Compensator rod	708 O-ring	887 Pin
624 Spring seat(C)	722 O-ring	897 Pin
625 Outer spring	724 O-ring	898 Pin
626 Inner spring	725 O-ring	924 Set screw
627 Adjust stem(C)	728 O-ring	925 Adjust screw(QI)
628 Adjust screw(C)		

## 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
Double ring spanner, socket wrench, double(Single) open end spanner 	-	Hexagon head 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	116	0.47	12
	M16	24.0	174	0.55	14
	M18	34.0	246	0.55	14
	M20	44.0	318	0.67	17
PT Plut(Material : S45C) ※Wind a seal tape 1 1/2 to 2 turns round the plug	PT1/16	0.7	5.1	0.16	4
	PT 1/8	1.05	7.59	0.20	5
	PT 1/4	1.75	12.7	0.24	6
	PT 3/8	3.5	25.3	0.31	8
	PT 1/2	5.0	36.2	0.39	10
PF Plut(Material : S35C)	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	109	0.55	14
	PF 1	19.0	137	0.67	17
	PF 1 1/4	27.0	195	0.67	17
	PF 1 1/2	28.0	203	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.

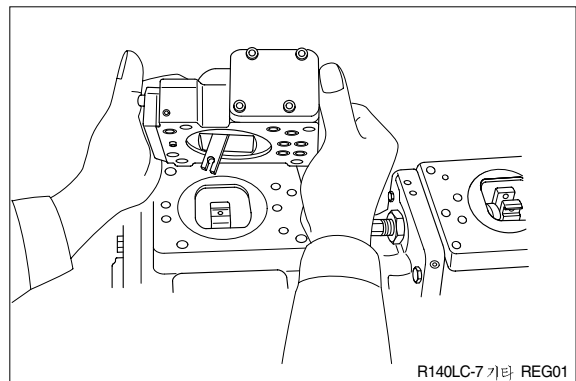
※ Choose a clean place.

※ Spread rubber sheet, cloth, or so on 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.

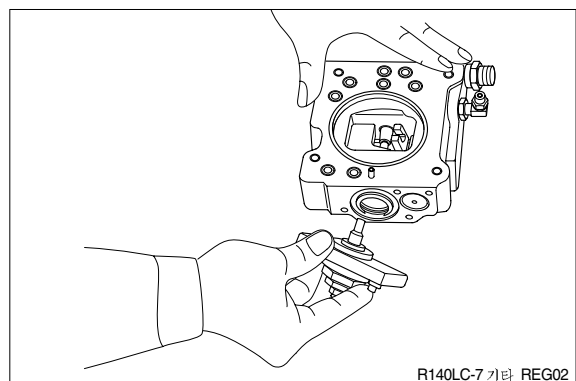


(4) Remove hexagon socket head screw (438) and remove cover(C,629)

※ 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.

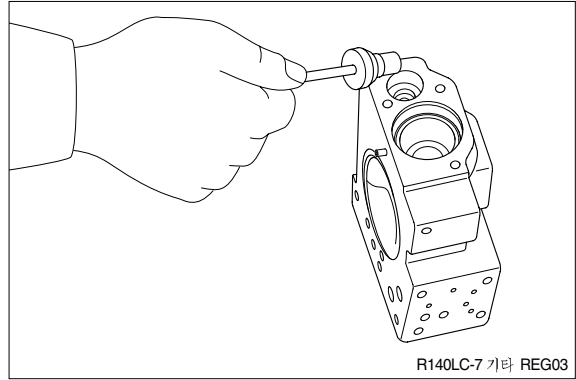




- (5) After removing cover(C, 629) subassembly, take out outer spring(625), inner spring (626) and spring seat(C, 624) from compensating section.

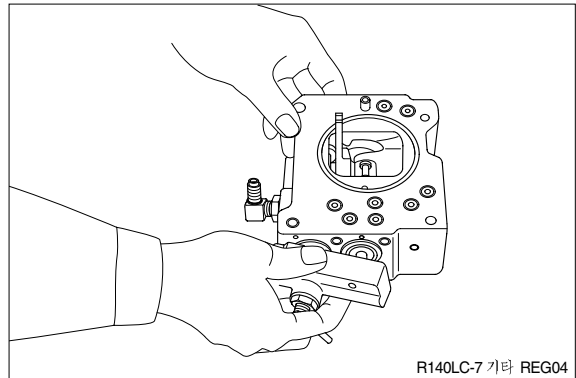
Then draw out adjusting ring(Q, 645), pilot spring(646) and spring seat(644) from pilot section.

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



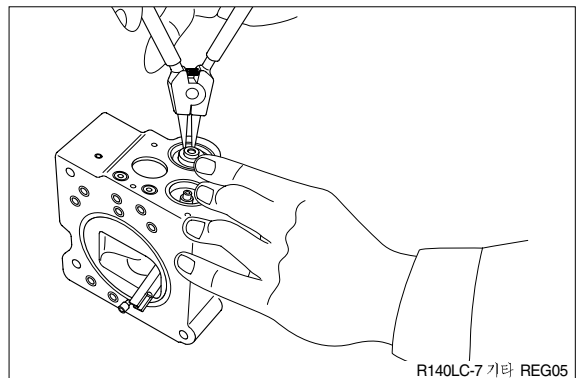
- (6) Remove hexagon socket head screws (436, 438) and remove pilot cover(641).

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



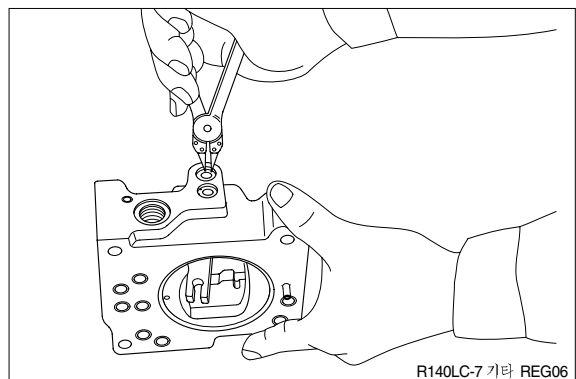
- (7) Remove snap ring(814) and take out spring seat(653), return spring(654) and sleeve(651).

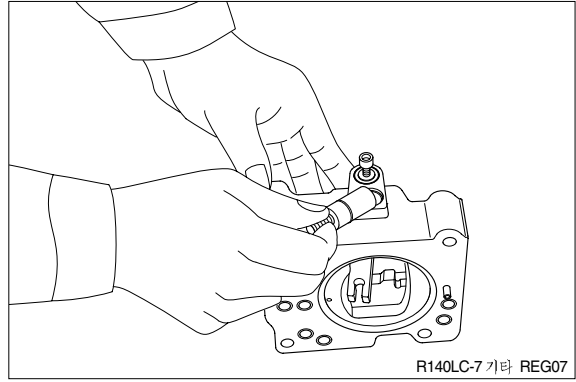
- ※ Sleeve(651) is fitted with snap ring(836).  
※ When removing snap ring(814), return spring(654) may pop out. Take care not to lose it.



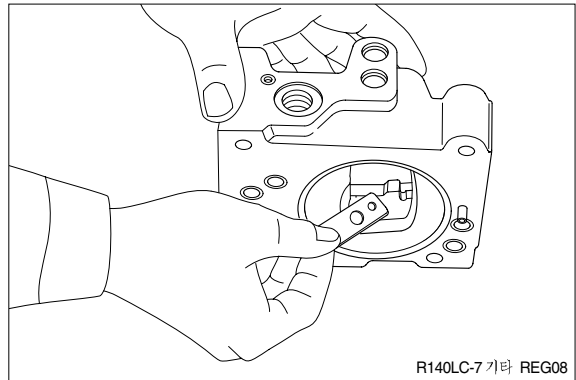
- (8) Remove locking ring(858) and take out fulcrum plug(614) and adjusting plug (615).

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

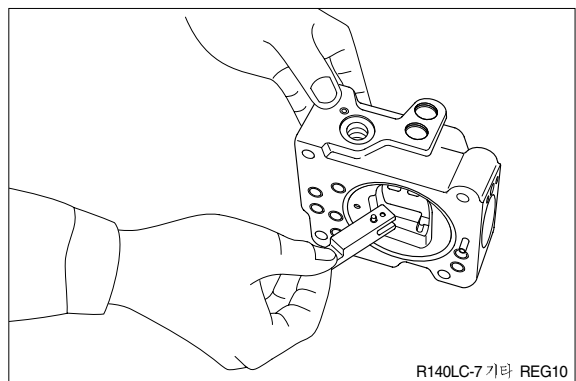
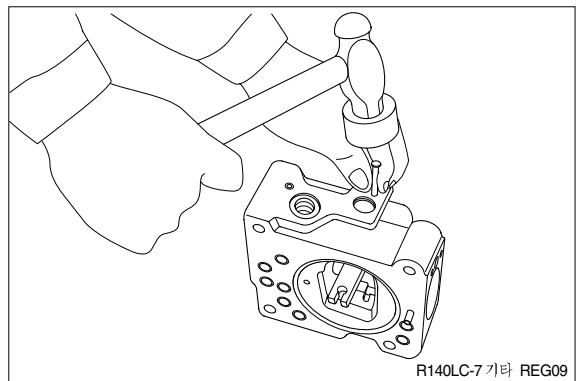




- (9) Remove lever(2, 613). Do not draw out pin(875).  
 ※ Work will be promoted by using pincers or so on.



- (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.

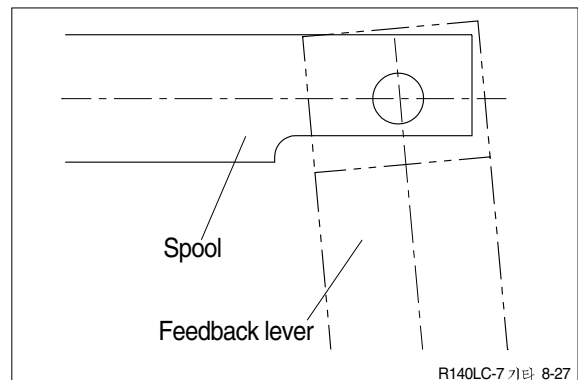
- ① Always repair parts that were scored at disassembly.
- ② Get replacement parts ready beforehand.  
Mixing of foreign matter will cause malfunction.  
Therefore, wash parts well with cleaning oil, let them dry with jet air and handle them in clean place.
- ③ Always tighten bolts, plugs, etc. to their 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.

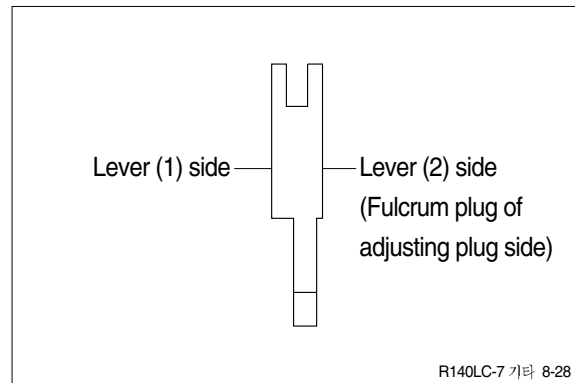
(4) Fit spool(652) and sleeve(651) into hole in spool of casing.

- ※ 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).

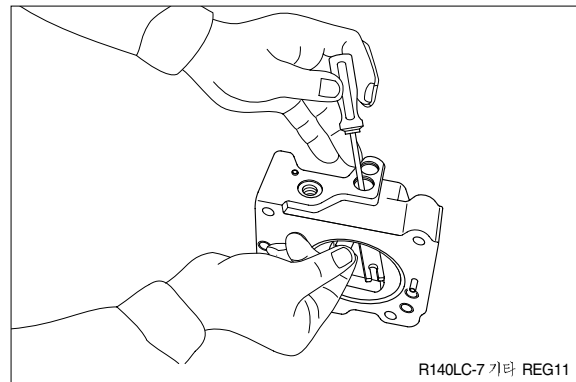
- ※ Insert pin in feedback lever a little to ease operation.
- ※ Take care not to mistake direction of feedback lever.



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

- ※ Confirm that pilot piston slides smoothly without binding.

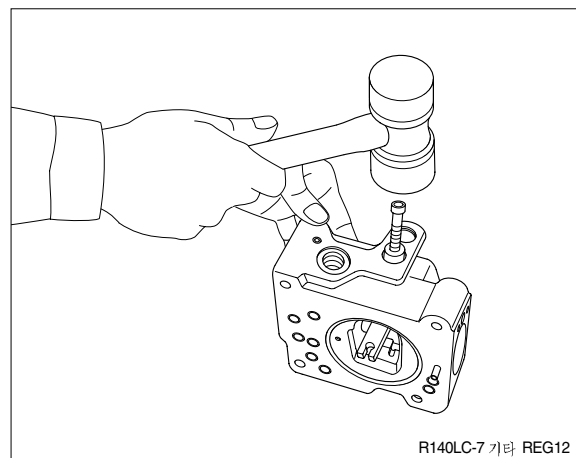
- (7) Put pin force-fitted in lever(2, 613) into groove of pilot piston.  
Then fix lever(2).



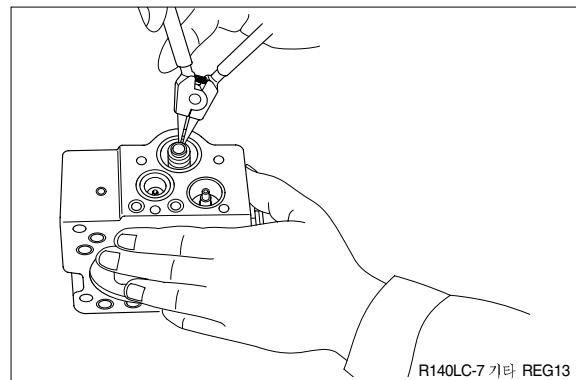
- (8) Fit fulcrum plug(614) so that pin force-fitted in fulcrum plug(614) can be put into pin hole of lever(2).  
Then fix locking ring(858).

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

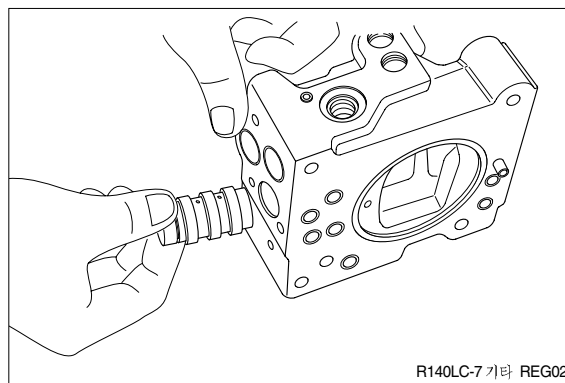
- ※ Take care not to mistake inserting holes for fulcrum plug and adjusting plug.  
At this point in time move feedback lever to confirm that it has no large play and is free from binding.



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

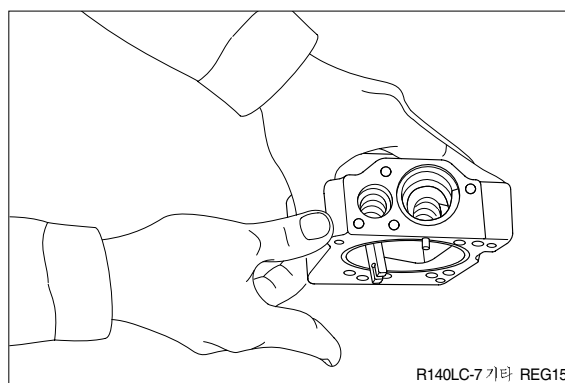


- (11) Fit set spring(655) to spool hole and put compensating piston(621) and piston case(622) into compensating hole.  
Fit pilot cover(641) and tighten it with hexagonal socket head screws(436, 438).

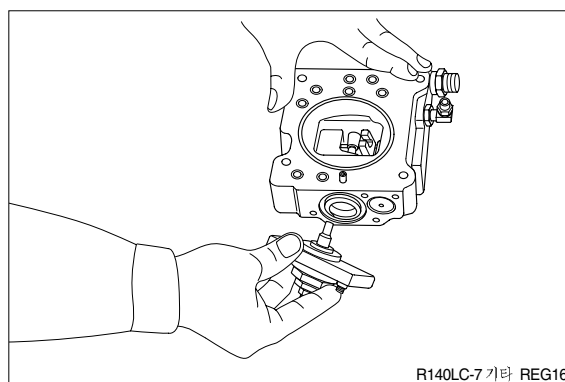


- (12) Put spring seat(644), pilot spring(646) and adjusting ring(Q, 645) into pilot hole.  
Then fix spring seat(624), inner spring (626) and outer spring(625) into compensating hole.

※ 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 OF MOTOR

#### 1) REMOVAL

- (1) Lower the work equipment to the ground and stop the engine.
- (2) Operate the control levers and pedals several times to release the remaining pressure in the hydraulic piping.
- (3) Loosen the breather slowly to release the pressure inside the hydraulic tank.

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

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

- (4) Remove bolts and disconnect pipe.
- (5) Disconnect pilot line hoses.
- (6) Disconnect pilot piping.
- (7) Sling the control valve assembly and remove the control valve mounting bolt.  
· Weight : 80kg(180lb)
- (8) Remove the control valve assembly.  
When removing the control valve assembly, check that all the piping have been disconnected.

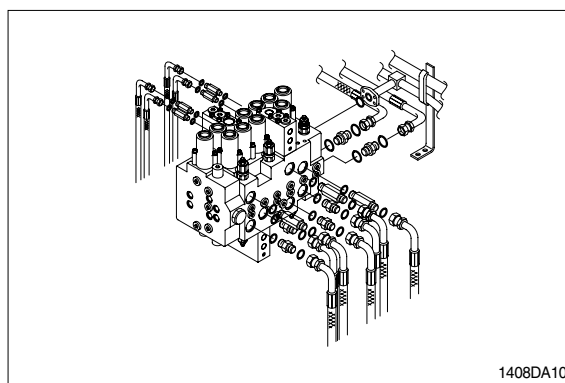
#### 2) INSTALL

- (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

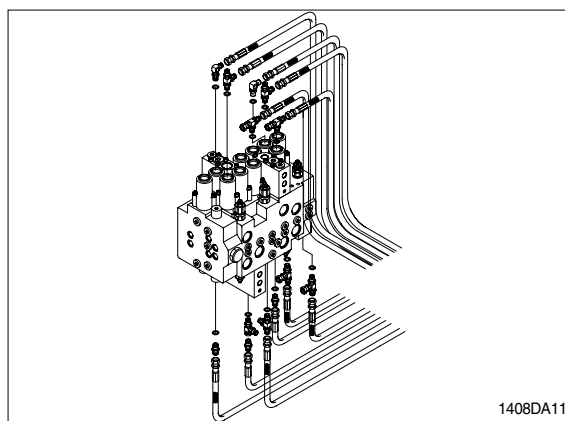
※ See each item removal and install.
- (3) Confirm the hydraulic oil level and recheck the hydraulic oil leak or not.



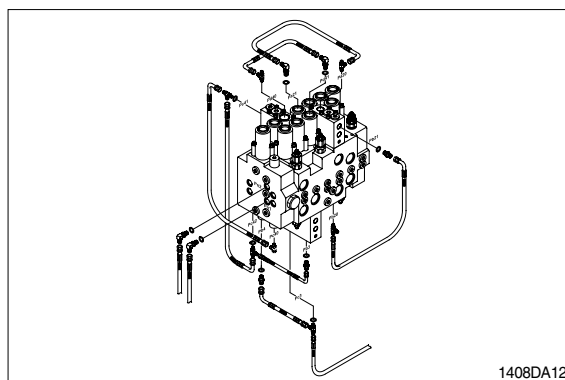
13031GE18



1408DA10

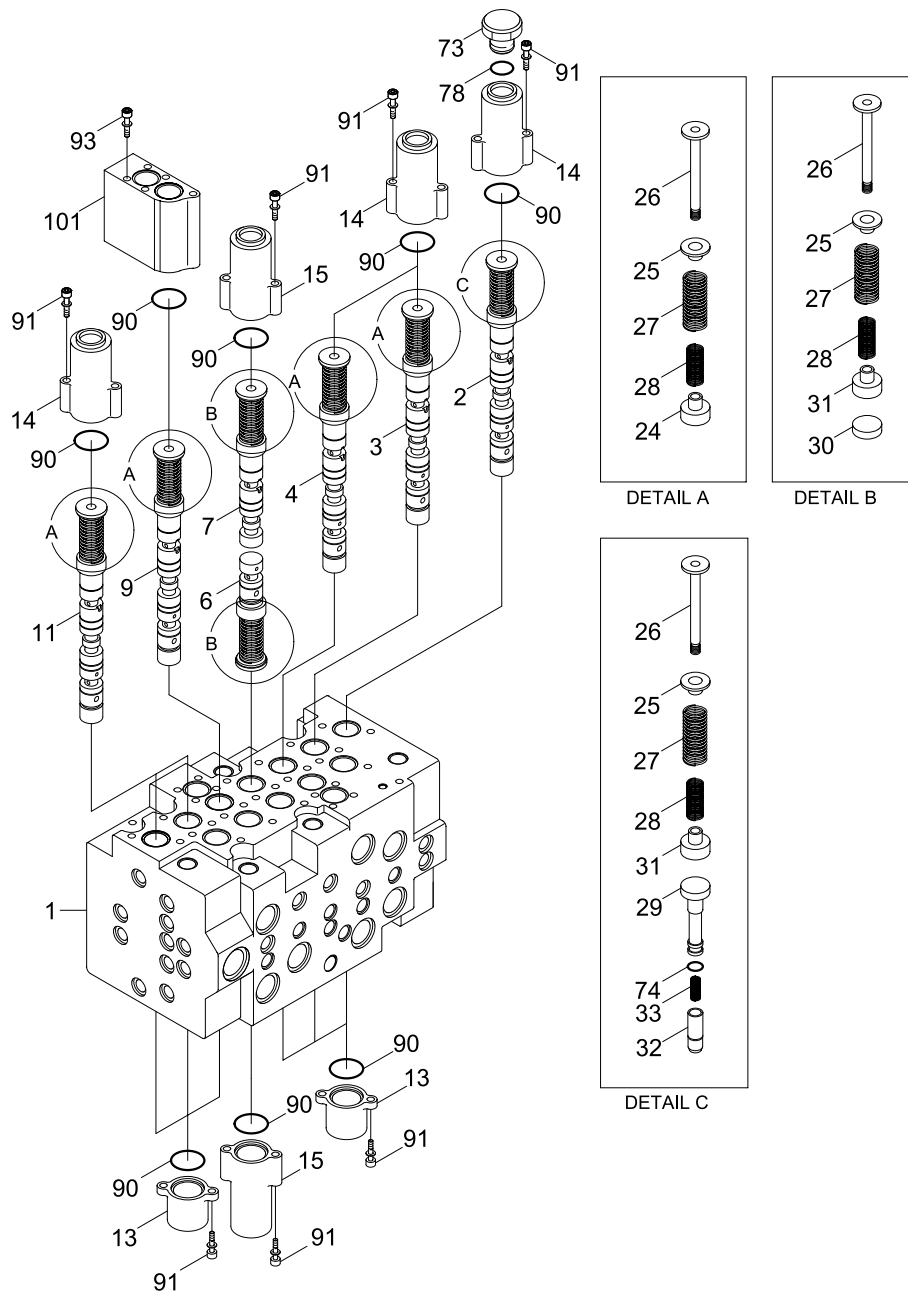


1408DA11



1408DA12

## 2. STRUCTURE(1/4)

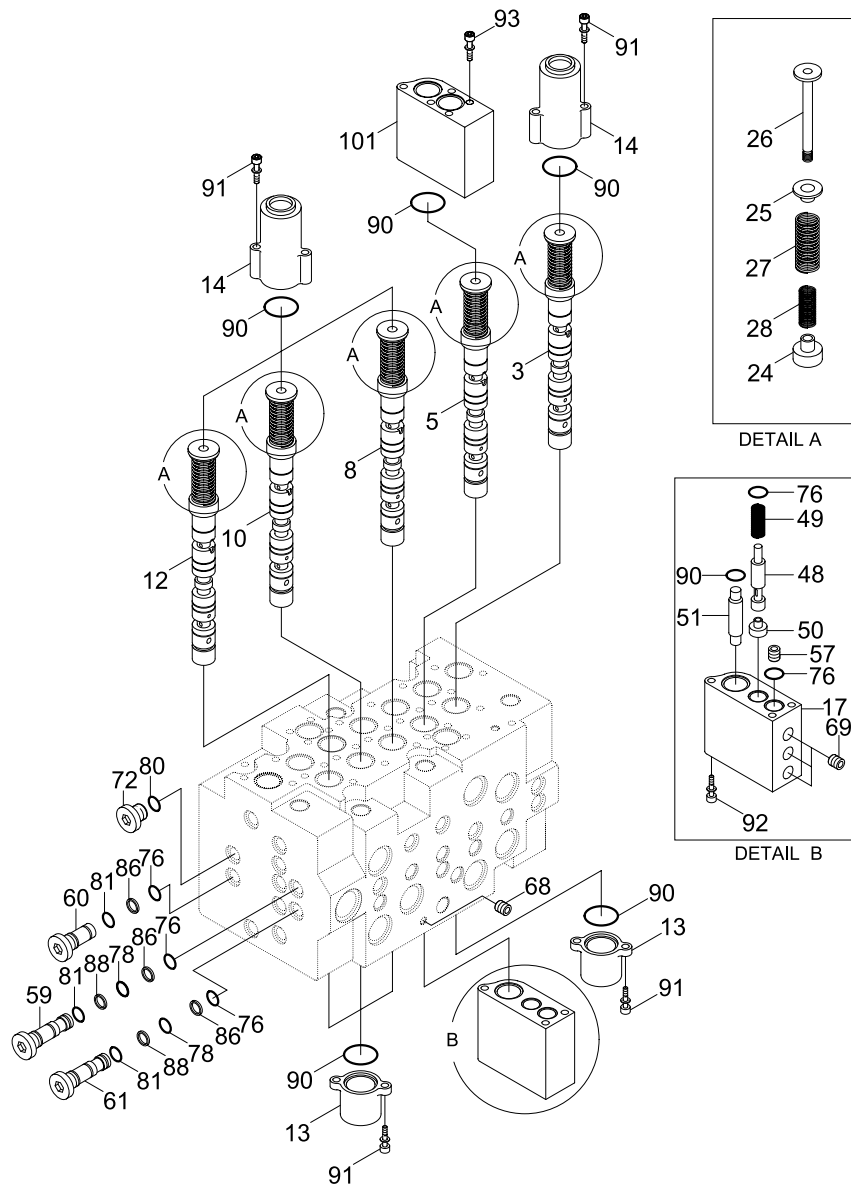


1	Body	15	Cover-pilot	32	Valve-check
2	Spool	24	Holder-spring	33	Spring-check valve
3	Spool	25	Holder-spring	73	Plug
4	Spool	26	End-spool	74	O-ring
6	Spool	27	Spring	78	O-ring
7	Spool	28	Spring	90	O-ring
9	Spool	29	Stopper	91	Bolt-socket head
11	Spool	30	Stopper	93	Bolt-socket head
13	Cover-pilot	31	Holder-spring	101	Lock-valve
14	Cover-pilot				

1408DA13



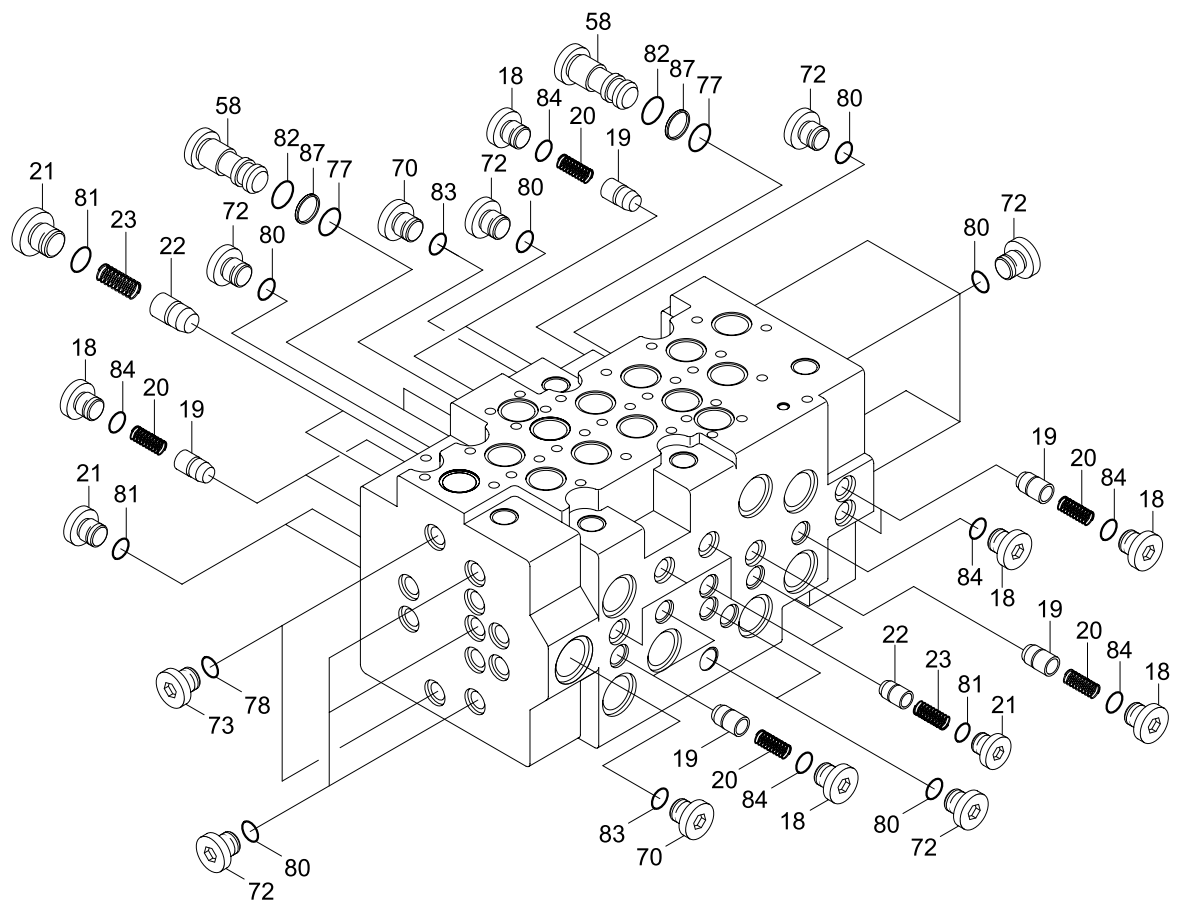
## STRUCTURE(2/4)



3	Spool	28	Spring	76	O-ring
5	Spool	48	Spool-selector	78	O-ring
8	Spool	49	Spring	80	O-ring
10	Spool	50	Stopper	81	O-ring
12	Spool	51	Piston	86	Back-up ring
13	Cover-pilot	57	Restrictor	88	Back-up ring
14	Cover-pilot	59	Plug	90	O-ring
17	Cover-pilot	60	Plug	91	Bolt-socket head
24	Holder-spring	61	Restrictor	92	Bolt-socket head
25	Holder-spring	68	Plug-socket head	93	Bolt-socket head
26	End-spool\	69	Plug-socket head	101	Lock-valve
27	Spring	72	Plug		

1408DA14

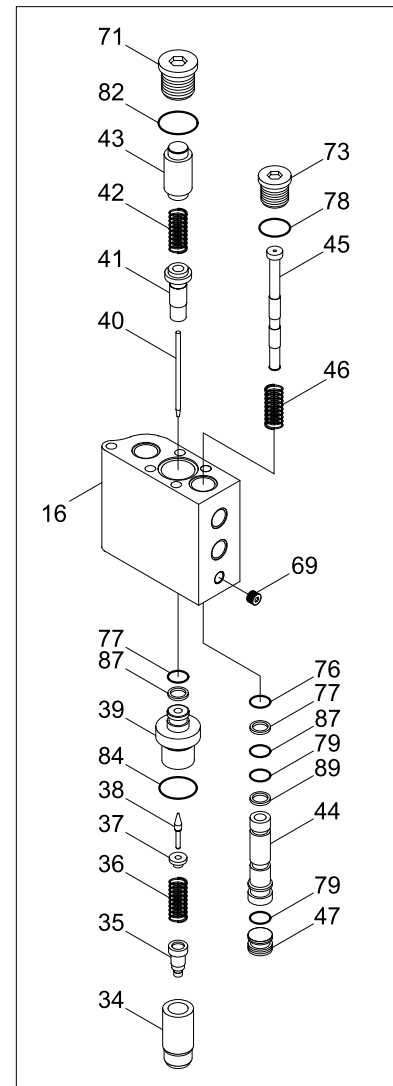
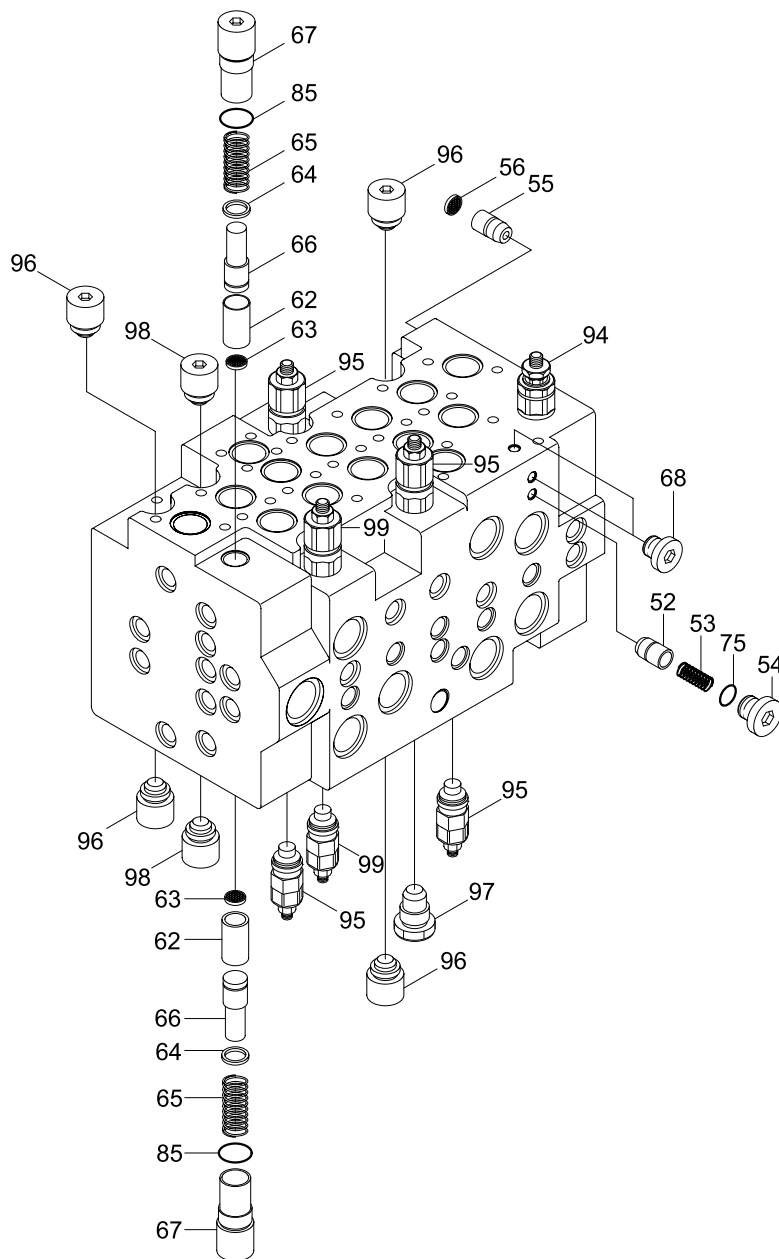
## STRUCTURE(3/4)



1408DA15

18	Plug	58	Plug	80	O-ring
19	Valve-check	70	Plug	81	O-ring
20	Spring-check valve	72	Plug	82	O-ring
21	Plug	73	Plug	83	O-ring
22	Valve-check	77	O-ring	84	O-ring
23	Spring-check valve	78	O-ring	87	Back-up ring

## STRUCTURE(4/4)



DETAIL OF LOCK VALVE

1408DA16

16	Cover-pilot	53	Spring-check valve	76	O-ring
34	Valve-lock	54	Plug	77	O-ring
35	Restrictor-lock valve	55	Restrictor	78	O-ring
36	Spring-lock valve	56	Filter-coin type	79	O-ring
37	Holder-spring	62	Poppet-negative	82	O-ring
38	Poppet	63	Filter-coin type	84	O-ring
39	Seat-poppet	64	Holder-spring	85	O-ring
40	Piston	65	Spring-negative	87	Back-up ring
41	Guide-piston	66	Piston-negative	89	Back-up ring
42	Spring-lock valve	67	Socket-negative	94	Relief valve-main
43	Piston	68	Plug	95	Bolt-socket head
44	Socket-lock valve	69	Plug	96	Relief valve-overload
45	Spool-lock valve	71	Plug	97	Plug-relief valve
46	Spring-lock valve	73	Plug	98	Plug-relief valve
47	Plug-lock valve	75	O-ring	99	Relief valve-overload
52	Valve-check				

### 3. DISASSEMBLY AND ASSEMBLY

#### 1) GENERAL PRECAUTIONS

- (1) All hydraulic components are manufactured to a high precision. Consequently, before disassembling and assembling them, it is essential to select an especially clean place.
- (2) In handling a control valve, pay full attention to prevent dust, sand, etc. from entering into it.
- (3) When a control valve is to be removed from the machine, apply caps and masking seals to all ports. Before disassembling the valve, recheck that these caps and masking seals are fitted completely, and then clean the outside of the assembly. Use a proper bench for working. Spread paper or a rubber mat on the bench, and disassemble the valve on it.
- (4) Support the body section carefully when carrying or transferring the control valve. Do not lift by the exposed spool, end cover section etc.
- (5) After disassembling and assembling of the component it is desired to carry out various tests (For the relief characteristics, leakage, flow resistance, etc.), but hydraulic test equipment is necessary for these tests. Therefore, even when its disassembling can be carried out technically, do not disassemble such components that cannot be tested, adjusted, and so on. Additionally one should always prepare clean cleaning oil, hydraulic oil, grease, etc. beforehand.

#### 2) TOOLS

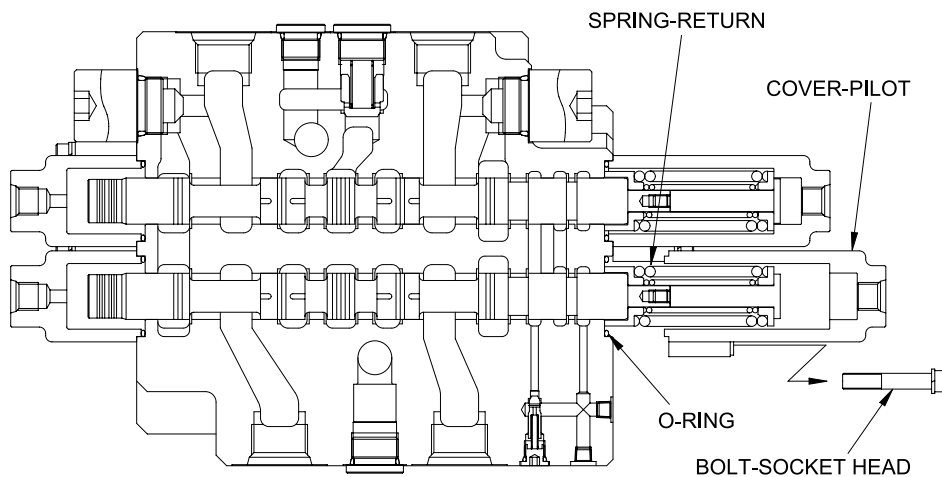
Before disassembling the control valve, prepare the following tools beforehand.

Name of tool	Quantity	Size(mm)
Vice mounted on bench(Soft jaws)	1 unit	
Hexagon wrench	Each 1 piece	5, 6, 10, 12 and 14
Socket wrench	Each 1 piece	27 and 32
Spanner	Each 1 piece	32(Main relief valve)

### 3) DISASSEMBLY

#### (1) Disassembly of spools without holding valve

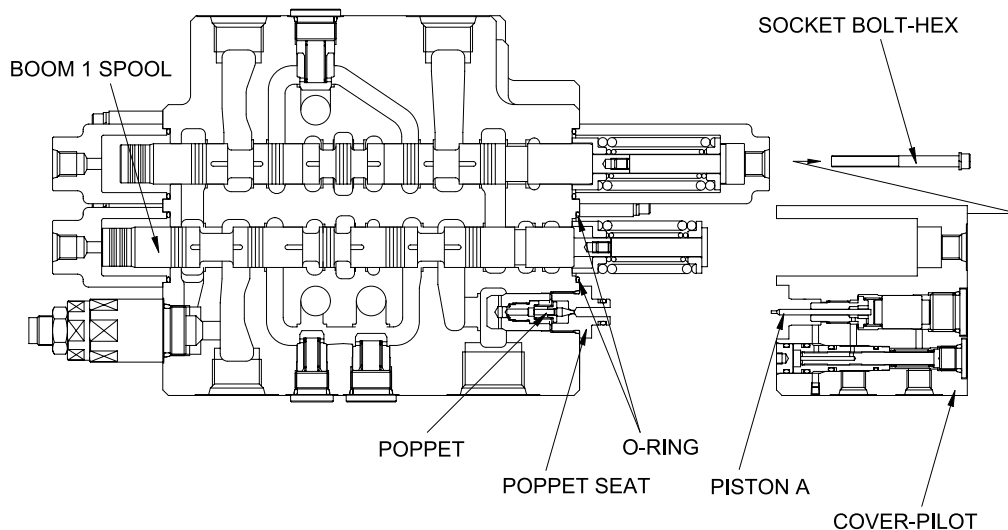
- ① Loosen hexagon socket head bolts with washer  
(Hexagon wrench : 5mm)
- ② Remove the pilot cover.
- ※ Pay attention not to lose the O-ring under the pilot cover.
- ③ Remove the spool assembly from the body by hand slightly.
- ※ When extracting each spool from its body, pay attention not to damage the body.
- ※ When extracting each spool assembly, it must be extracted from spring side only.
- ※ When any abnormal parts are found, replace it with completely new spool assembly.
- ※ When disassembled, tag the components for identification so that they can be reassembled correctly.



1408DA17

## (2) Disassembly of spools with holding valve(Boom 1, Arm 1 spool)

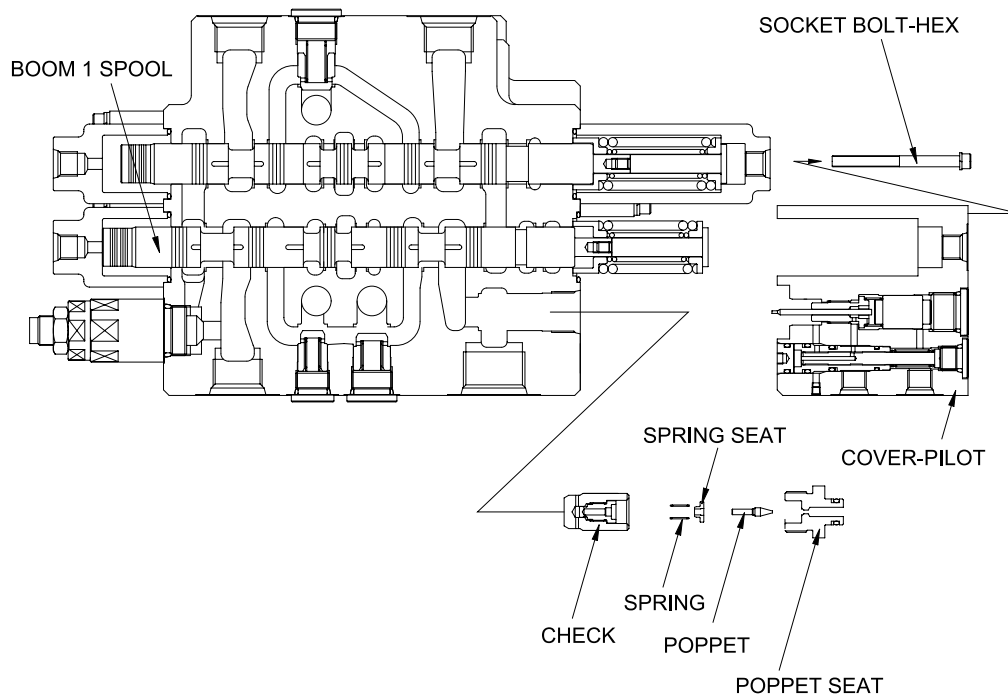
- ① Loosen hexagon socket head bolts with washer  
(Hexagon wrench : 5mm)
- ② Remove the pilot cover with internal parts.
  - ※ Pay attention not to lose the O-ring and the poppet under the pilot cover.
  - ※ Pay attention not to damage the "piston A" under pilot cover.
- ③ Remove the spool assembly from the body by hand slightly.
  - ※ When extracting each spool from its body, pay attention not to damage the body.
  - ※ When extracting each spool assembly, it must be extracted from spring side only.
  - ※ When any abnormal parts are found, replace it with completely new spool assembly.
  - ※ When disassembled, tag the components for identification so that they can be reassembled correctly.



1408DA22

### (3) Disassembly of the holding valve

- ① Remove the pilot cover with the holding valve as discribed on previous page.
  - ※ Do not disassembled internal parts of the pilot cover.
- ② Loosen the poppet seat and remove the poppet, the spring seat, the spring and the check.  
(Spanner : 32mm)
  - ※ Pay attention not to lose the poppet.
  - ※ Do not disassembled internal parts of the check.



1408DA23

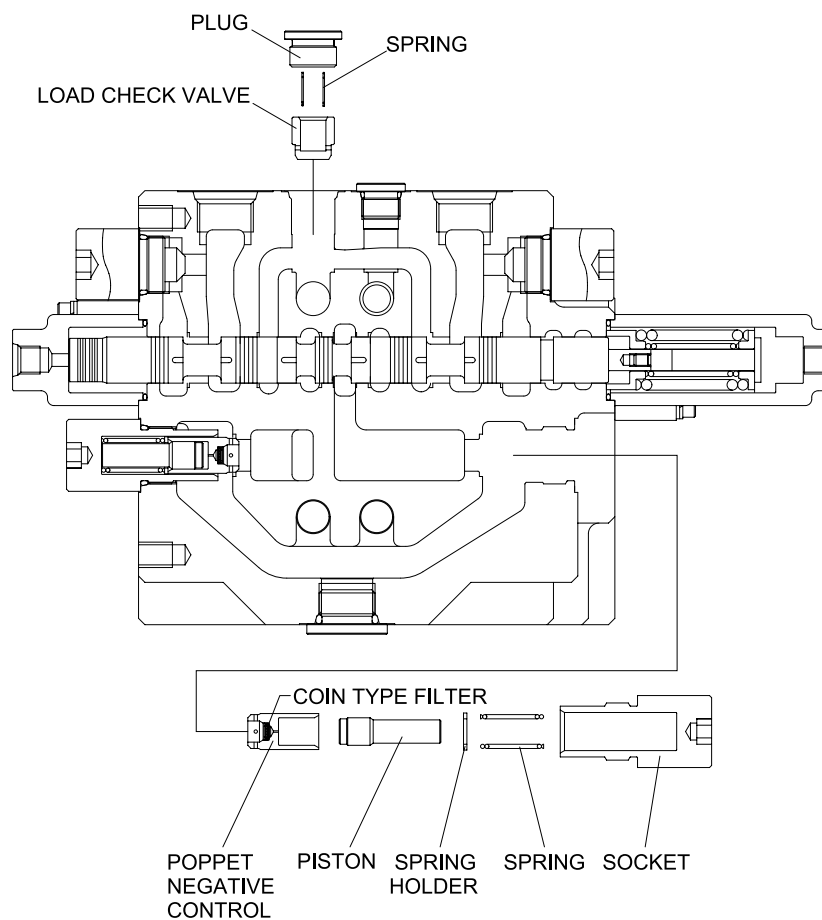
#### (4) Disassembly of the load check valve and the negative relief valve

##### ① The load check valve

- a. Fix the body to suitable work bench.
  - ※ Pay attention not to damage the body.
- b. Loosen the plug (Hexagon wrench : 10mm).
- c. Remove the spring and the load check valve with pincers or magnet.

##### ② The negative relief valve

- a. Loosen the socket (Hexagon wrench : 12mm).
- b. Remove the spring, the spring holder, the piston and the negative control poppet.

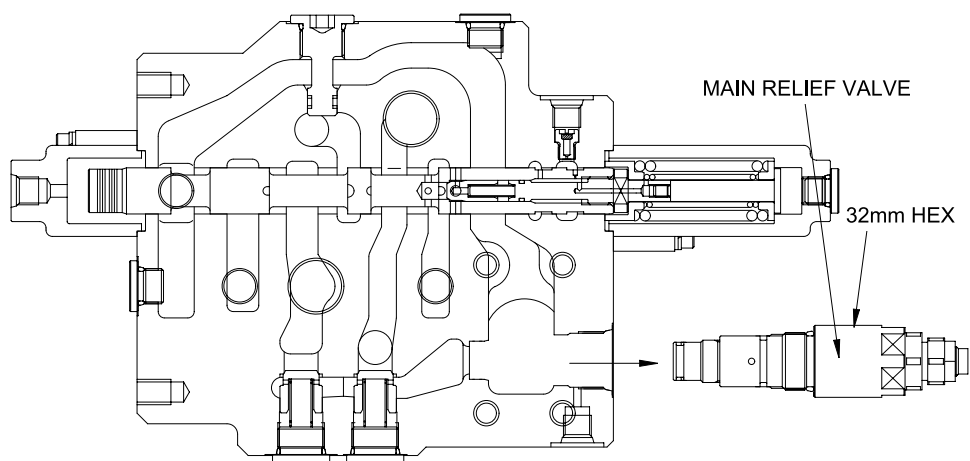


1408DA21

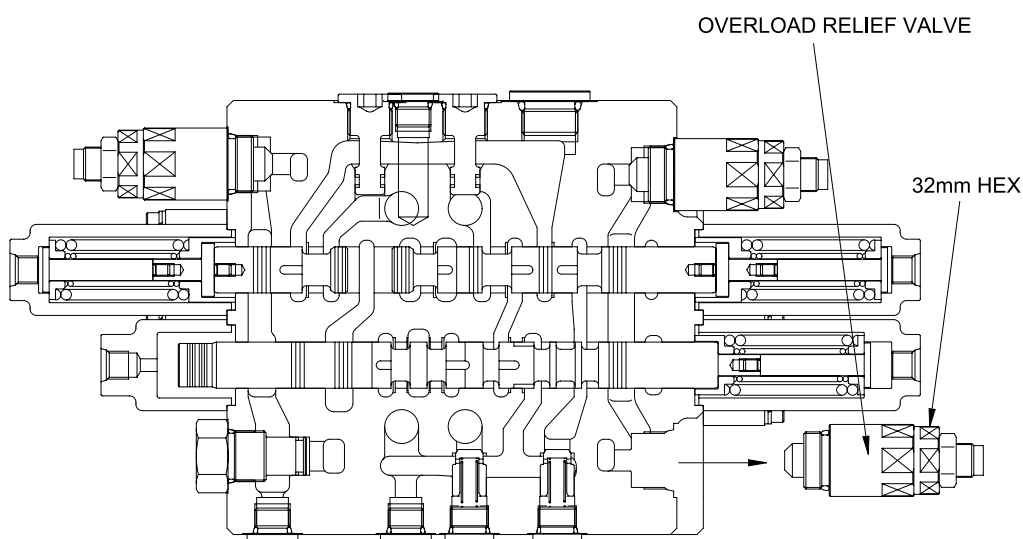


## (5) Disassembly of the main and overload relief valve

- ① Fix the body to suitable work bench.
  - ② Remove the main relief valve.  
(Spanner : 32mm)
  - ③ Remove the overload relief valve.  
(Spanner : 32mm)
- ※ When disassembled, tag the relief valve for identification so that they can be reassembled correctly.
  - ※ Pay attention not to damage seat face.
  - ※ When any abnormal parts are found, replace it with completely new relief valve assembly.



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## **(6) Inspection after disassembly**

Clean all disassembled parts with clean mineral oil fully, and dry them with compressed air. Then, place them on clean papers or cloths for inspection.

### **① Control valve**

- a. Check whole surfaces of all parts for burrs, scratches, notches and other defects.
- b. Confirm that seal groove faces of body and block are smooth and free of dust, dent, rust etc.
- c. Correct dents and damages and check seat faces within the body, if any, by lapping.
  - ※ Pay careful attention not to leave any lapping agent within the body.
- d. Confirm that all sliding and fitting parts can be moved manually and that all grooves and path's are free foreign matter.
- e. If any spring is broken or deformed, replace it with new one.
- f. When a relief valve does not function properly, repair it, following it's the prescribed disassembly and assembly procedures.
- g. Replace all seals and O-rings with new ones.

### **② Relief valve**

- a. Confirm that all seat faces at ends of all poppets and seats are free of defects and show uniform and consistent contact faces.
- b. Confirm manually that main poppet and seat can slide lightly and smoothly.
- c. Confirm that outside face of main poppet and inside face of seat are free from scratches and so on.
- d. Confirm that springs are free from breakage, deformation, and wear.
- e. Confirm that orifices of main poppet and seat section are not clogged with foreign matter.
- f. Replace all O-rings with new ones.
- g. When any light damage is found in above inspections, correct it by lapping.
- h. When any abnormal part is found, replace it with a completely new relief valve assembly.

## 4) ASSEMBLY

### (1) General precaution

- ① In this assembly section, explanation only is shown.  
For further understanding, please refer to the figures shown in the previous structure & disassembly section.
- ② Pay close attention to keeping all seals free from handling damage and inspect carefully for damage before using them.
- ③ Apply clean grease or hydraulic oil to the seal so as to ensure it is fully lubricated before assembly.
- ④ Do not stretch seals so much as to deform them permanently.
- ⑤ In fitting O-rings, pay close attention not to roll them into their final position in addition, a twisted O-ring cannot easily untwist itself naturally and could thereby cause inadequate sealing and thereby both internal and external oil leakage.
- ⑥ Tighten fitting bolts for all sections with a torque wrench adjusted to the respective tightening torque.
- ⑦ Do not reuse removed O-rings and seals.

### (2) Load check valve

- ① Assemble the load check valve and spring.
- ② Put O-rings on to plug.
- ③ Tighten plug to the specified torque.
  - Hexagon wrench : 10mm
  - Tightening torque : 6~7kgf · m(43.4~50.6lbf · ft)

### (3) Negative control relief valve

- ① Assemble the nega-con poppet, piston, spring holder and spring together into body.
- ② Put O-ring on to plug and tighten the latter to its specified torque.
  - Hexagon wrench : 12mm
  - Tightening torque : 8~9kgf · m(57.8~65.1lbf · ft)

### (4) Main relief, port relief valves

Install main relief valve, overload relief valve into the body and tighten to the specified torque.

Component	Tools	Tightening torque	
		kgf · m	lbf · ft
Main relief valve	Spanner 32mm	8~9	57.8~65.1
Overload relief valve	Spanner 32mm	8~9	57.8~65.1

### (5) Main spools

- ① Carefully insert the previously assembled spool assemblies into their respective bores within of body.
  - ※ Fit spool assemblies into body carefully and slowly. Do not under any circumstances push them forcibly in.

## **(6) Covers**

- ① Fit spool covers to the non-spring assembly end of the spool, and tighten the hexagonal socket head bolts to the specified torque.
  - Hexagon wrench : 5mm
  - Tightening torque : 1~1.1kgf · m(7.2~7.9lbf · ft)
- ※ Confirm that O-rings have been fitted.
- ② Fit spring covers to the spring end for the spools, and tighten hexagon socket head bolts to the specified torque.
  - Hexagon wrench : 5mm
  - Tightening torque : 1~1.1kgf · m(7.2~7.9lbf · ft)
- ※ Confirm that O-rings have been fitted.

## **(7) Holding valves**

- ① Assemble the check, spring seat and poppet together into body.
- ② Tighten the poppet seat to the specified torque.
  - Spanner : 26mm
  - Tightening torque : 6~7kgf · m(43.4~50.6lbf · ft)
- ③ Fit the "piston A" under pilot cover with internal parts into hole on the poppet seat.
- ④ Tighten hexagon socket head bolt to specified torque.
  - Hexagon wrench : 5mm
  - Tightening torque : 1~1.1kgf · m(7.2~7.9lbf · ft)

## GROUP 5 SWING DEVICE

### 1. REMOVAL AND INSTALL OF MOTOR

#### 1) REMOVAL

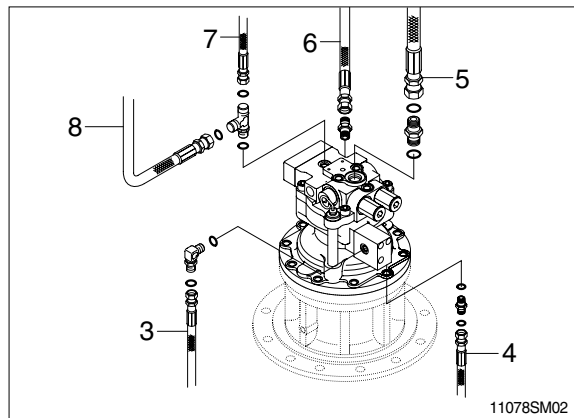
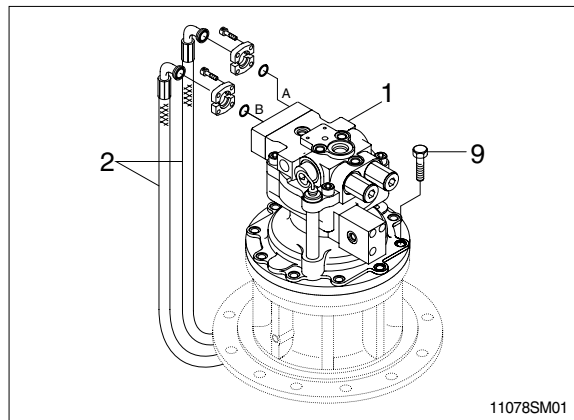
- (1) Lower the work equipment to the ground and stop the engine.
- (2) Operate the control levers and pedals several times to release the remaining pressure in the hydraulic piping.
- (3) Loosen the breather slowly to release the pressure inside the hydraulic tank.

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

- ※ When pipes and hoses are disconnected, the oil inside the piping will flow out, so catch it in oil pan.
- (4) Disconnect hose assembly(2).
  - (5) Disconnect pilot line hoses(3,4,5,6,7,8).
  - (6) Sling the swing motor assembly(1) and remove the swing motor mounting bolts (9).
- ※ Motor device weight : 32kg(70.5lb)
- (7) Remove the swing motor assembly.
- ※ When removing the swing motor assembly, check that all the piping have been disconnected.

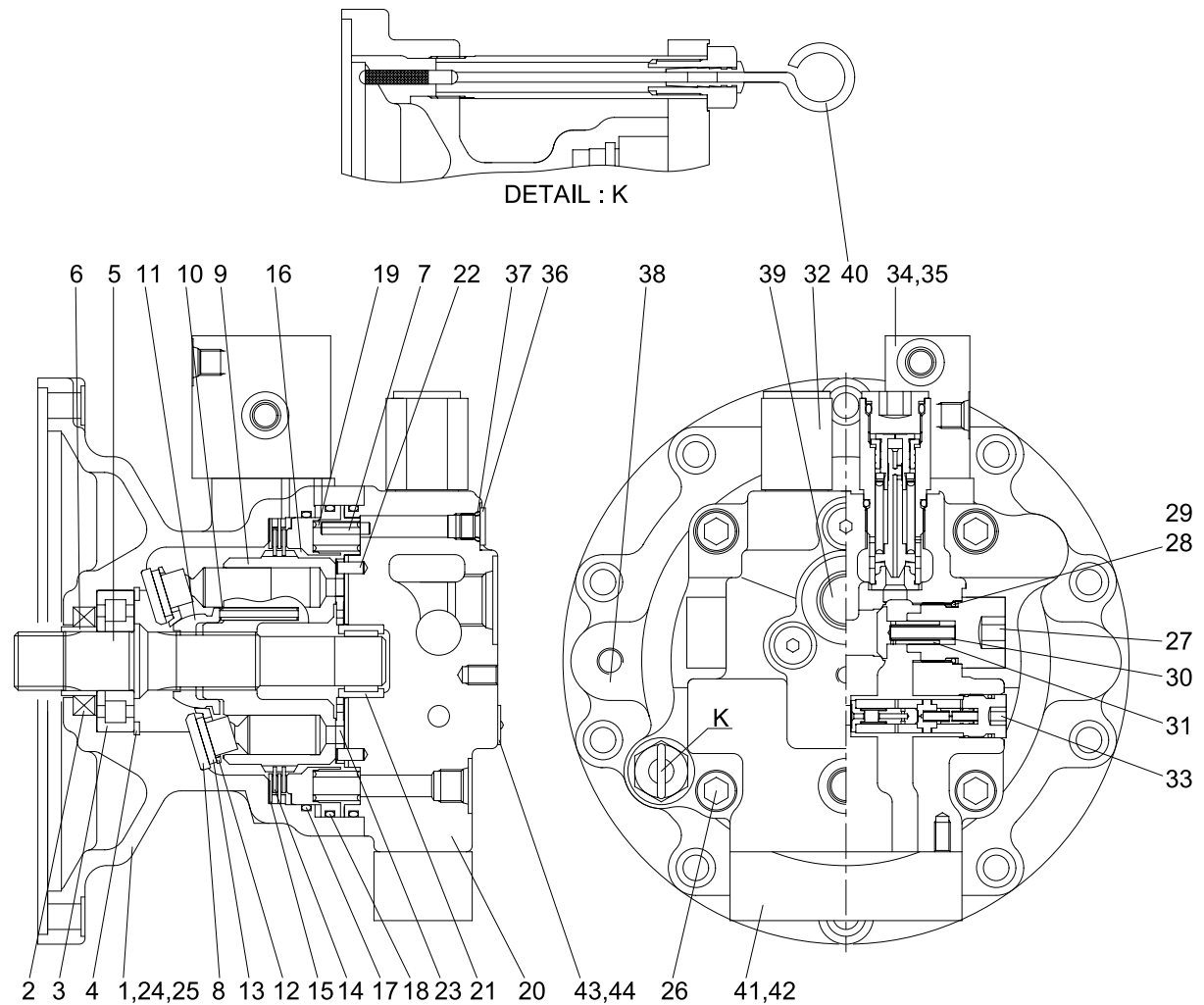
#### 2) INSTALL

- (1) Carry out installation in the reverse order to removal.
- (2) Bleed the air from the swing motor.
  - ① Remove the air vent plug.
  - ② Pour in hydraulic oil until it overflows from the port.
  - ③ Tighten plug lightly.
  - ④ Start the engine, run at low idling and check oil come out from plug.
  - ⑤ Tighten plug fully.
- (3) Confirm the hydraulic oil level and check the hydraulic oil leak or not.



## 2. DISASSEMBLY AND ASSEMBLY OF SWING MOTOR

### 1) STRUCTURE

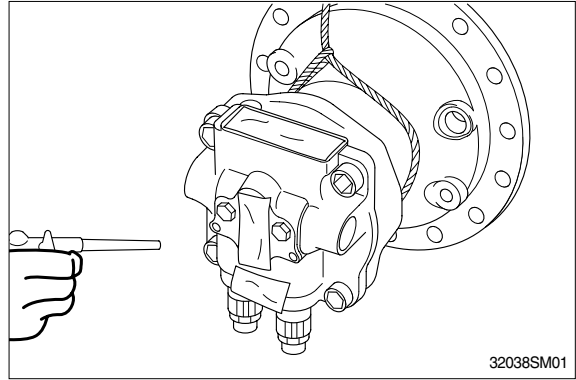


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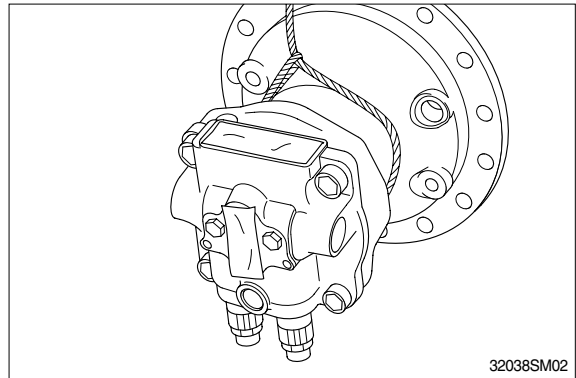
1 Body	16 Brake piston	31 Check
2 Oil seal	17 O-ring	32 Relief valve assembly
3 Roll bearing	18 O-ring	33 Reactionless valve assembly
4 Snap ring	19 Spring	34 Time delay valve assembly
5 Shaft	20 Rear cover	35 Wrench bolt
6 Bushing	21 Needle bearing	36 Plug
7 Pin	22 Pin	37 O-ring
8 Shoe plate	23 Valve plate	38 Plug
9 Cylinder block	24 O-ring	39 Plug
10 Spring	25 O-ring	40 Level gauge
11 Ball guide	26 Wrench bolt	41 Flange
12 Set plate	27 Plug	42 O-ring
13 Piston assembly	28 Back up ring	43 Name plate
14 Friction plate	29 O-ring	44 Rivet
15 Plate	30 Spring	

## 2) DISASSEMBLY

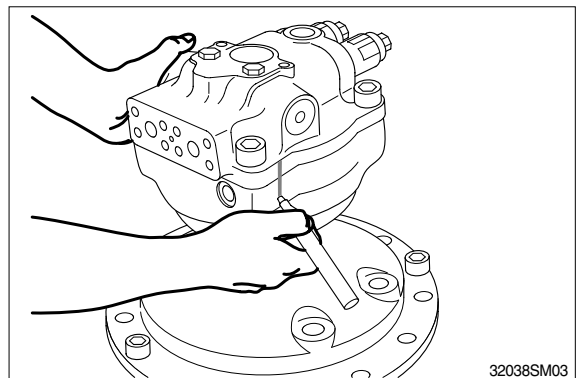
- (1) Lift the motor out. Clean the motor in kerosene and dry with compressed air.
  - ※ To avoid dust inside the motor, mask all the ports of the motor with tapes.



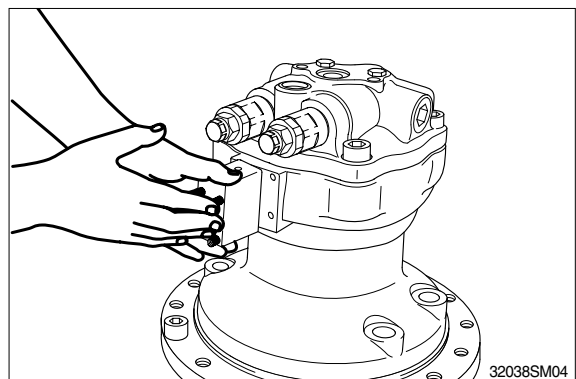
- (2) Loosen the drain plug to discharge oil in the body(1).



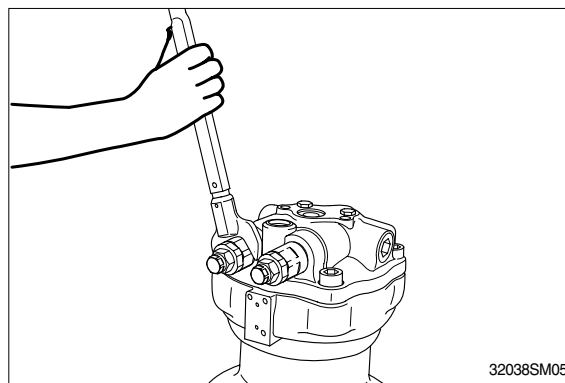
- (3) Fix the drive shaft(5) on the workbench with the end of output shaft down. Put matching marks on body (1) and valve rear cover(20) for easy reassembly.



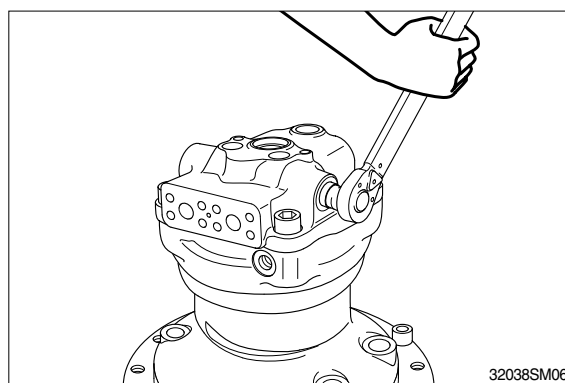
- (4) Remove the valve(34).



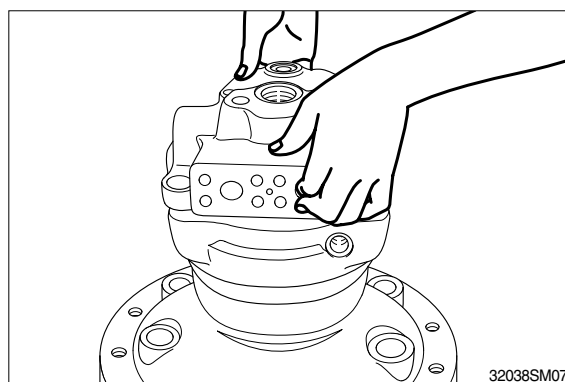
- (5) Remove the relief valve(32) from rear cover(20).



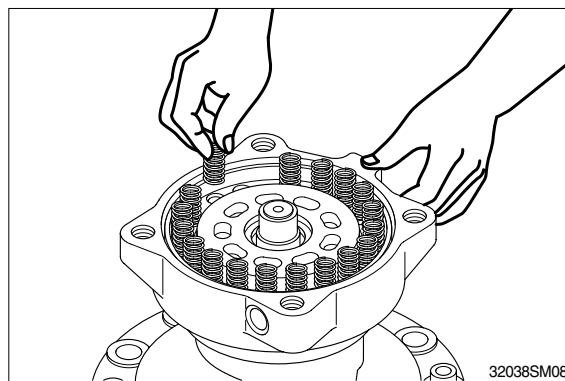
- (6) Remove plug(27) from rear cover(20) and spring(30), check(31).  
※ Be careful not to damage the check seat assembly.



- (7) Remove rear cover(20) from body(1).  
Then, remove the valve plate(23) from rear cover(20) with care.

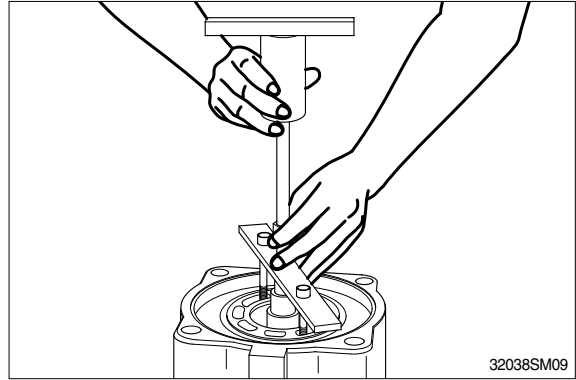


- (8) Remove the brake spring(19) from brake piston(16).

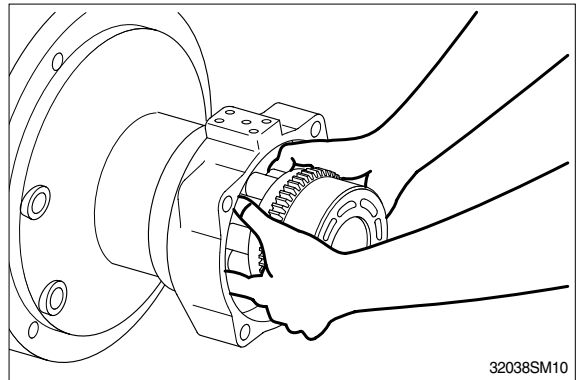




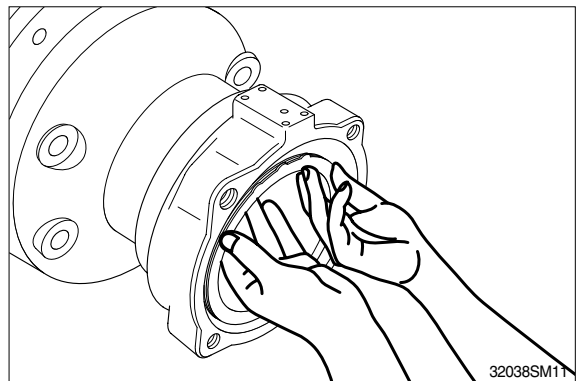
(9) Remove brake piston(16) from body(1).



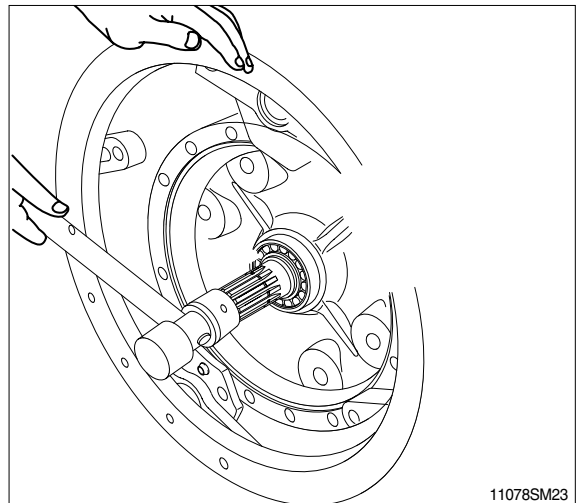
(10) Remove the cylinder(9) from the output shaft(5) with the motor positioned horizontally. Remove ball guide(11), set plate(12), piston(13) and shoe plate(8).



(11) Remove friction plate(14) and separate plate(15) from body(1).

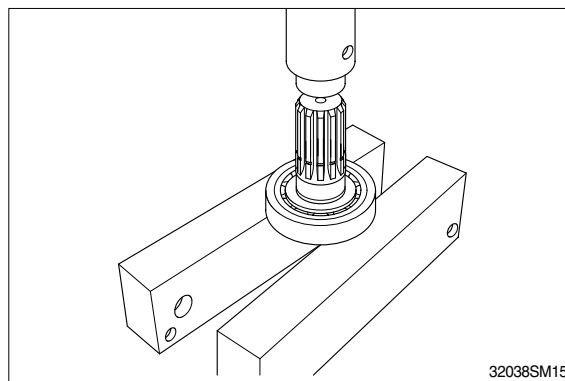
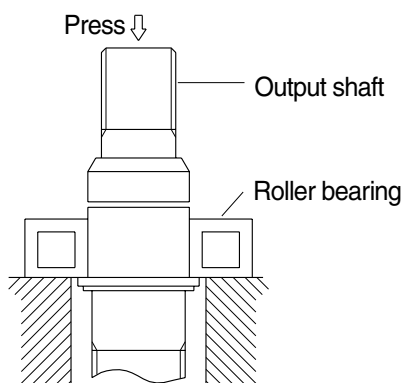


(12) Remove snap ring(4) and remove drive shaft(5) from body(1).

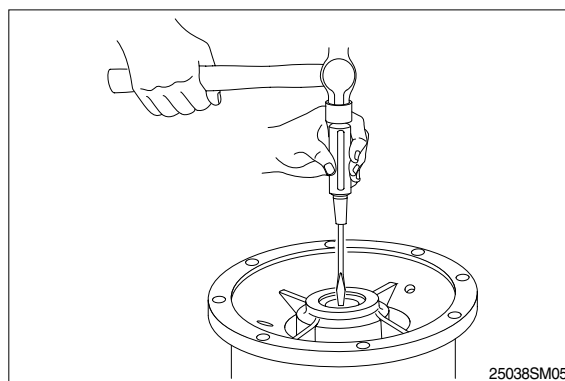


(13) Remove the cone of roller bearing(3) by press.

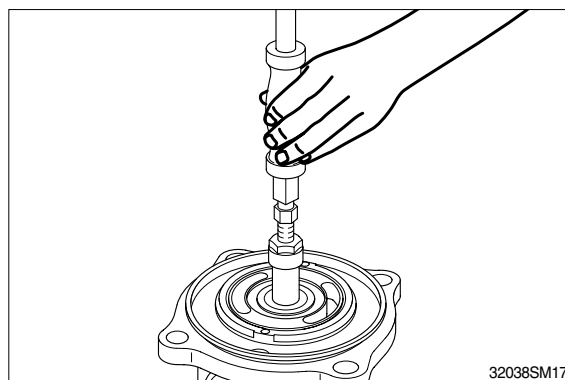
※ Do not reuse bearings.



(14) Remove bushing(6) and oil seal(2) from body(1).



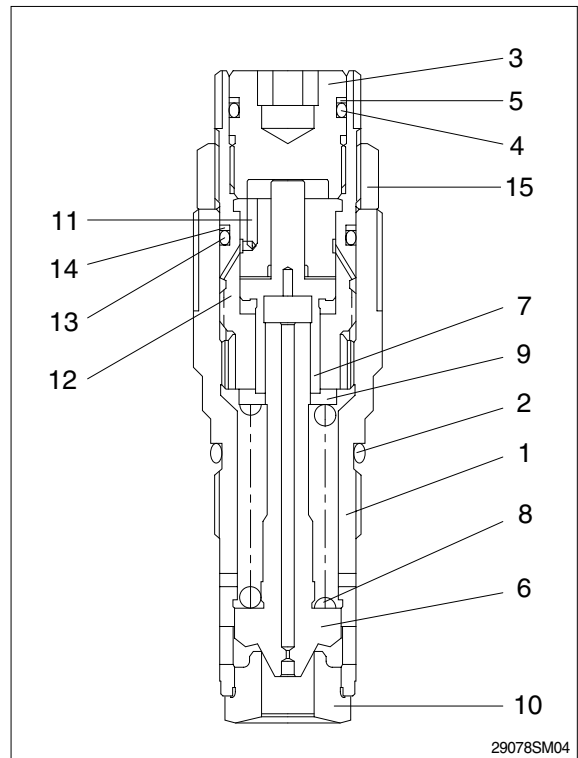
(15) Remove the needle bearing(21) from the rear cover(20) by using slide hammer bearing puller.



(16) When disassembling the relief valve, release the plug(3).

Remove the piston(7), spring seat(9), spring(8) and plunger(6) with the body(1) downwards.

※ Do not release the lock nut(15).

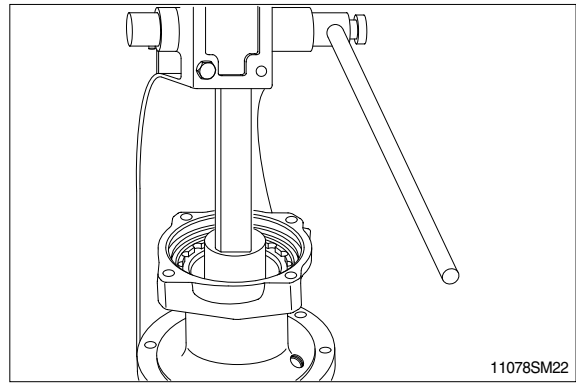


This completes disassembly.

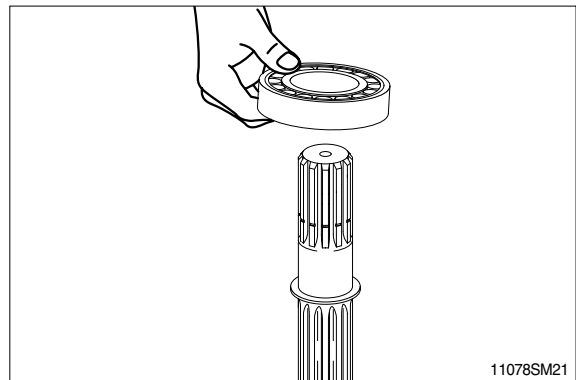
### 3) ASSEMBLY

Do the reassembly in the reverse procedure of the disassembly.

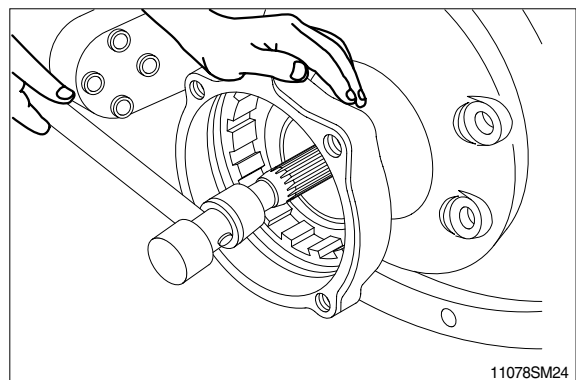
- (1) Apply three bond of white color on outer surface of oil seal(2) and insert it to the body(1).



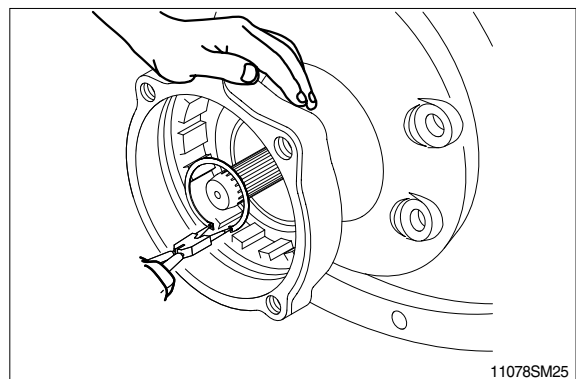
- (2) Install the roller bearing(3) to the drive shaft(5).



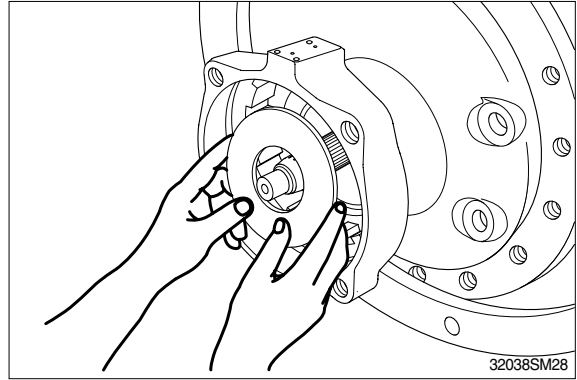
- (3) Insert the drive shaft(5) into the body(1) with the plastic hammer lightly.



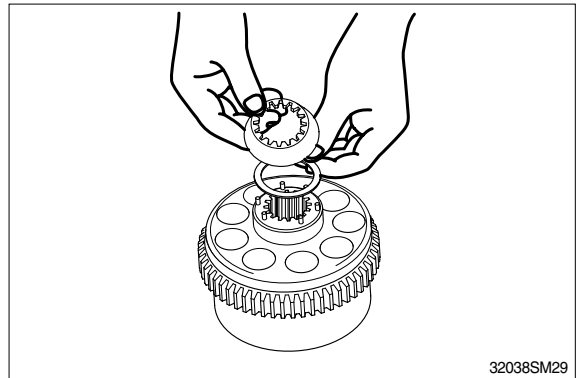
- (4) Install the snap ring(4) to the body(1).



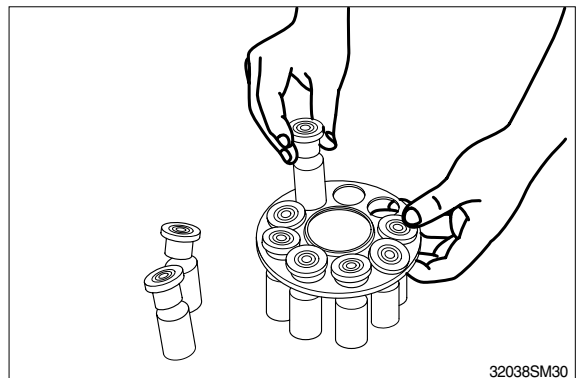
- (5) Insert the shoe plate(8) with the body(1) position horizontally.



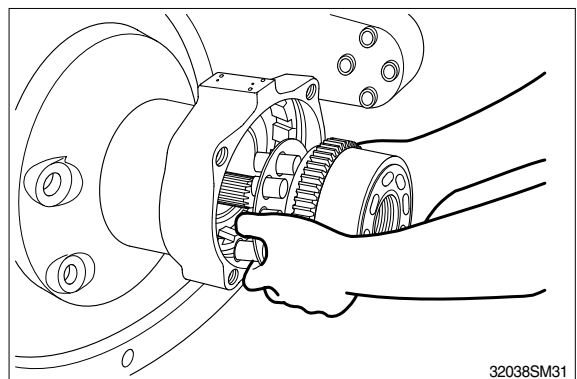
- (6) Insert the ball guide(11) into the cylinder (9).



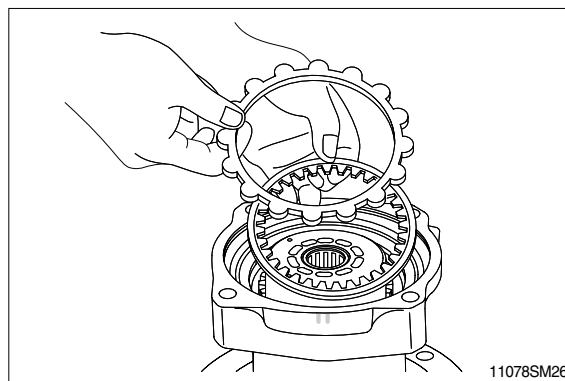
- (7) Install the piston sub-assembly(13) to the set plate(12).



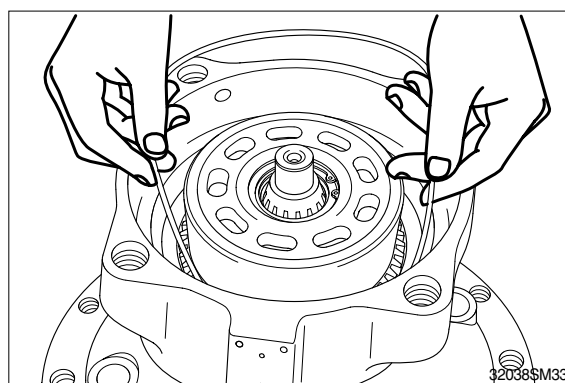
- (8) Reassemble the piston assembly(9) to the body(1).



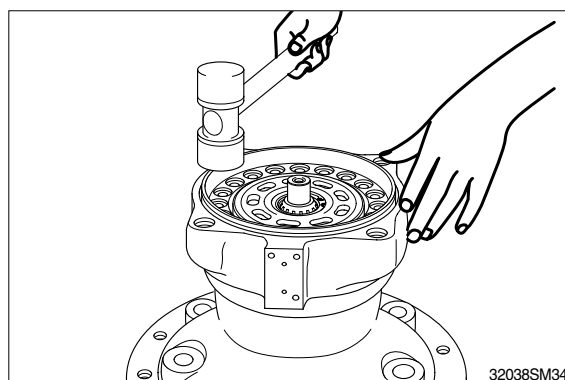
(9) Assembly friction plate(14) and plate(15) to the body(1).



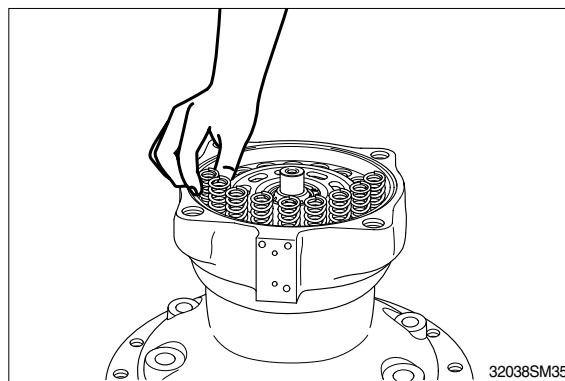
(10) Insert O-ring(17) inside the body(1).



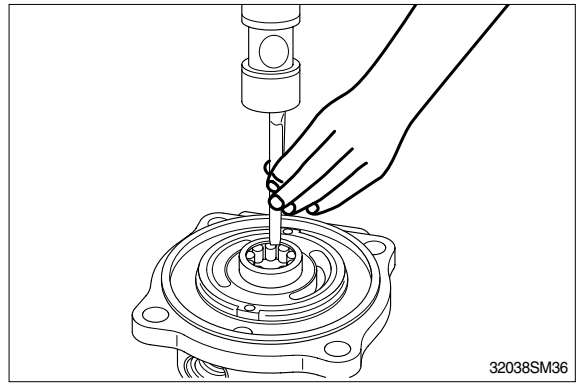
(11) Reassemble brake piston(16) to the body (1).



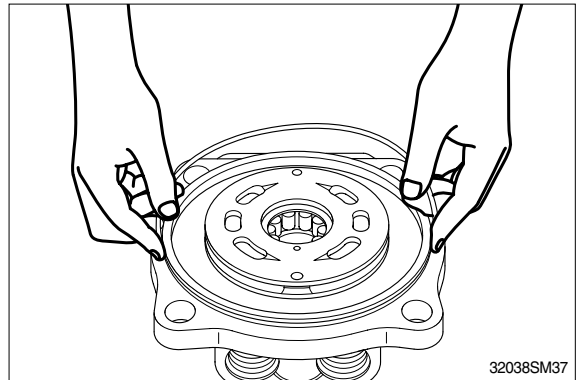
(12) Reassemble brake spring(19) to the brake piston(16).



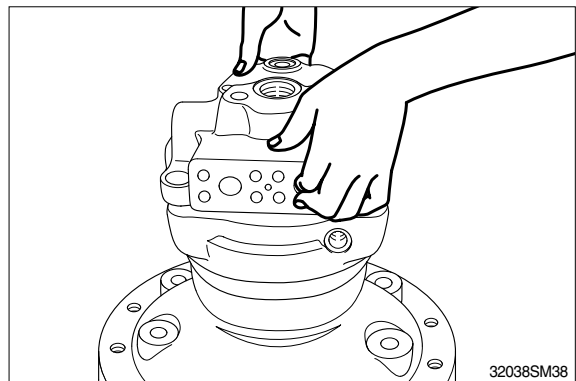
- (13) When assembling the needle bearing(21), insert the needle bearing(21) into rear cover(20) by hammering.



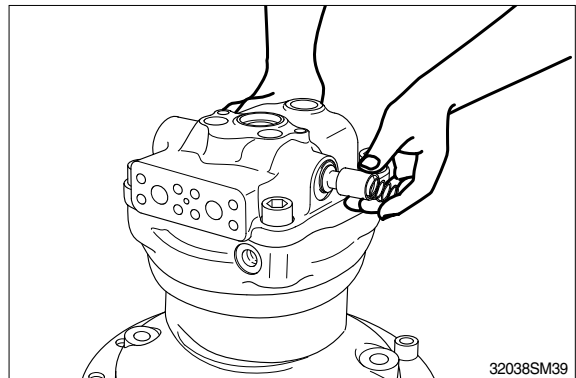
- (14) Reassemble valve plate(23) to the rear cover(20) and reassemble O-ring(18).



- (15) Connect the rear cover(20) with the body (1) and tighten the wrench bolt(26).

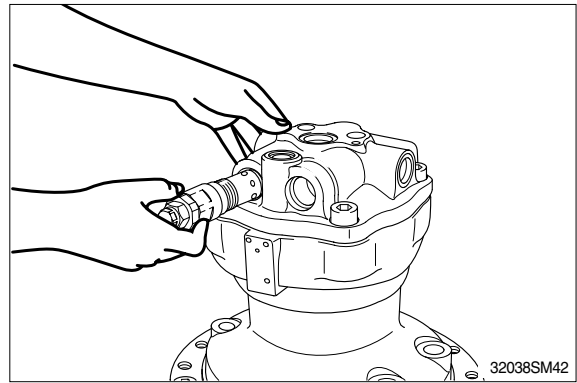


- (16) Insert check(31) and spring(30) in the valve casing and install O-ring(29) and back up ring(28). Tighten plug(27) to the rear cover(20).



(17) Insert O-rings to the relief valve (32) and reassemble them to rear cover(20).

This completes assembly.





### 3. REMOVAL AND INSTALL OF REDUCTION GEAR

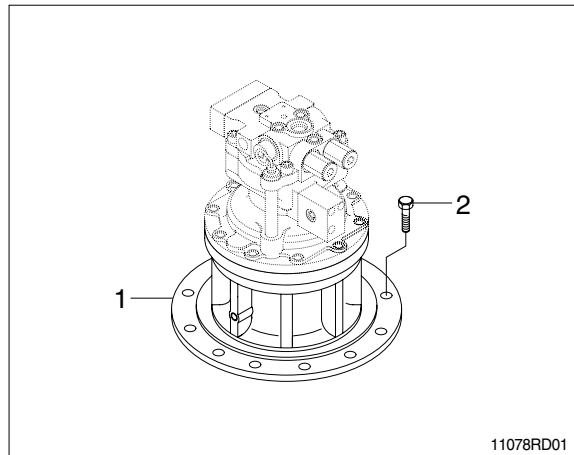
#### 1) REMOVAL

- (1) Remove the swing motor assembly.  
For details, see **removal of swing motor assembly**.
- (2) Sling reduction gear assembly(1) and remove mounting bolts(2).
- (3) Remove the reduction gear assembly.
  - Reduction gear device weight : 95kg  
(209lb)



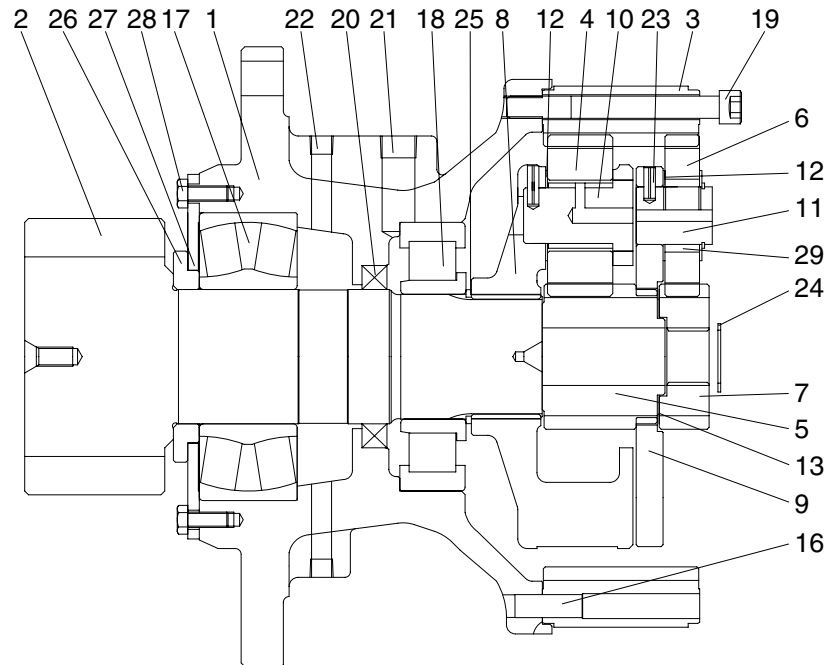
#### 2) INSTALL

- (1) Carry out installation in the reverse order to removal.
  - Tightening torque :  $29.7 \pm 4.5 \text{ kgf} \cdot \text{m}$   
( $215 \pm 32.5 \text{ lbf} \cdot \text{ft}$ )



## 4. DISASSEMBLY AND ASSEMBLY OF REDUCTION GEAR

### 1) STRUCTURE



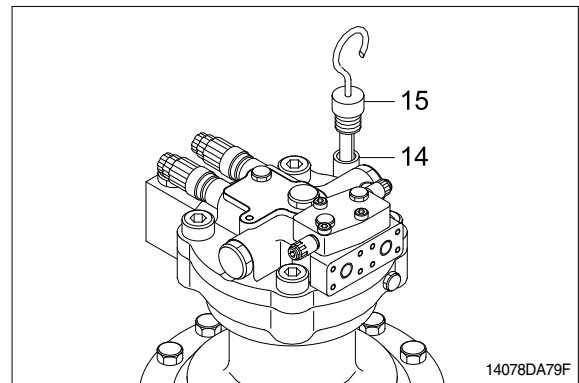
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1	Casing	10	Pin No.2 assembly	21	Plug(B)
2	Drive shaft	11	Pin No.1	22	Plug(A)
3	Ring gear	12	Thrust washer(B)	23	Spring pin
4	Planet gear No.2	13	Thrust washer(A)	24	Stop ring
5	Sun gear No.2	16	Knock pin	25	Stop ring
6	Planet gear No.1	17	Sph roller bearing	26	Spacer
7	Sun gear No.1	18	Cyl roller bearing	27	Cover plate
8	Carrier No.2	19	Bolt	28	Bolt
9	Carrier No.1	20	Oil seal	29	Needle cage

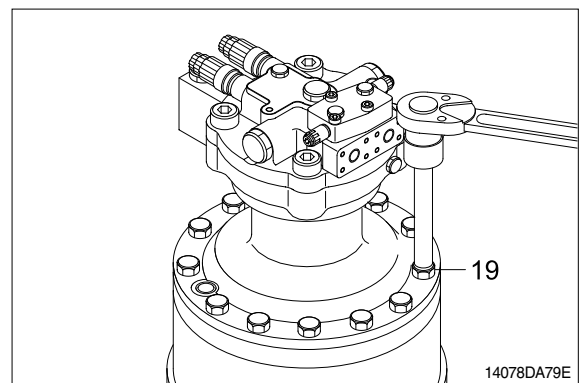
## 2) DISASSEMBLY

(1) Remove gauge bar(14) and gauge pipe (15) from the swing motor casing.

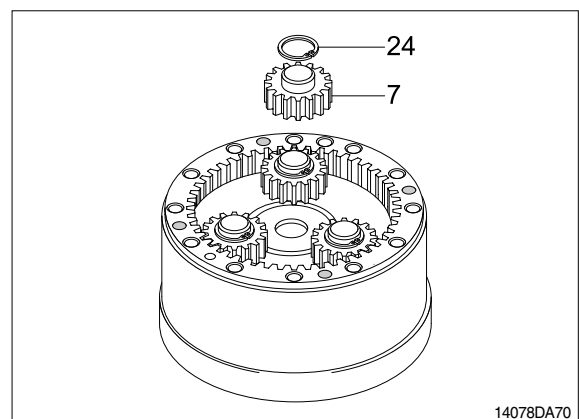
※ Pour the gear oil out of reduction gear into the clean bowl to check out the friction decrease.



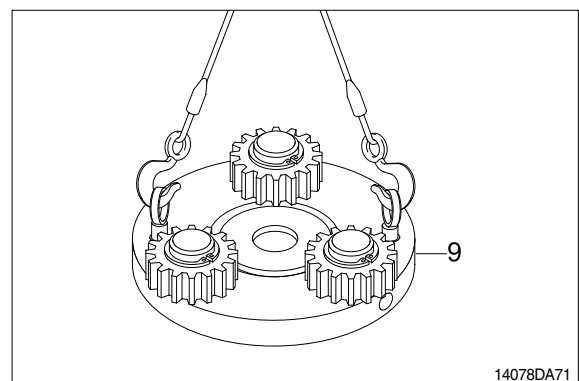
(2) Loosen the socket bolts(19) to separate swing motor from reduction gear.



(3) Remove stop ring(24) and then sun gear(7).

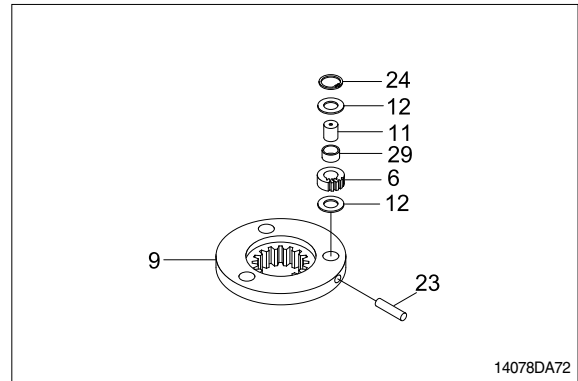


(4) Tighten two M10 eye bolts to carrier(9) and lift up and remove carrier(9) as subassembly.

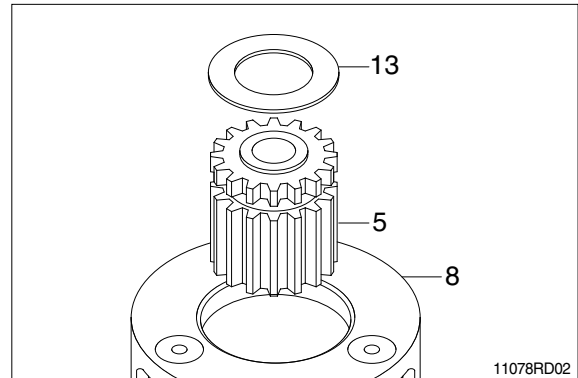


(5) Disassembling carrier1(9) assembly.

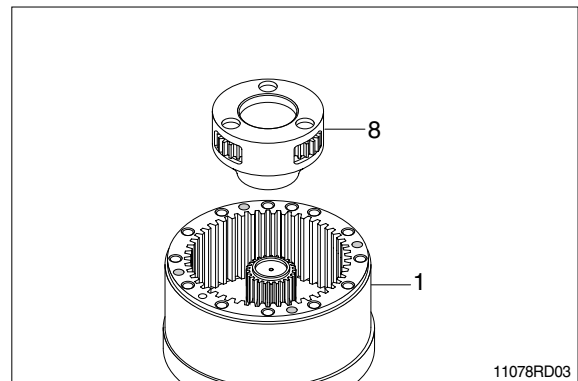
- ① Remove stop ring(24).
  - ② Remove thrust washer(12), planet gear1 (6), needle cage(29), and thrust washer(12) from the carrier.
  - ③ Using M8 solid drill, crush spring pin(23) so that the pin1(11) can be removed by hammering.
- ※ Do not reuse spring pin(23).
  - ※ Do not remove pin1(11), carrier1(9) and spring pin(23) but in case of replacement.
  - ※ Put matching marks on the planet gear1 (6) and the pin1(11) for easy reassembly.



(6) Remove sun gear2(5) and thrust washer (13).

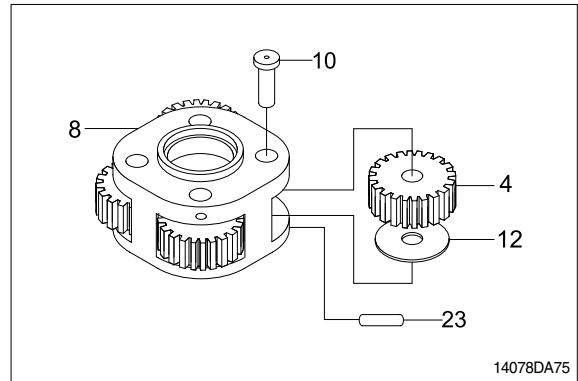


(7) Remove carrier2(8) assembly from casing (1).

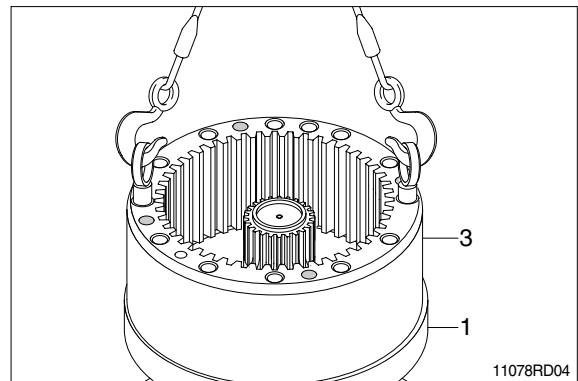


(8) Disassembling carrier2(8) assembly

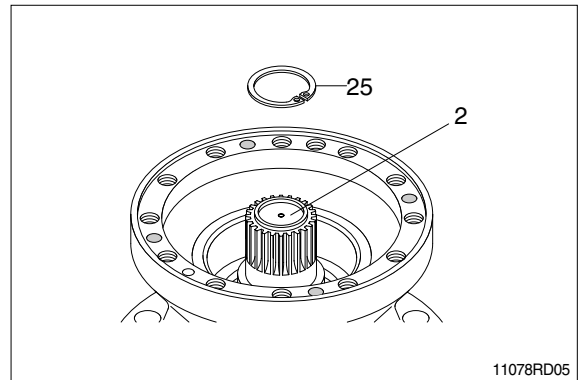
- ① Using M8 solid drill, crush spring pin(23) so that the pin2(10) can be removed.
- ※ Do not reuse spring pin(23).
- ② Remove pin2(10), planet gear2(4) and thrust washer(12) from the carrier2(8).
- ※ Put matching marks on the planet gear2(4) and the pin2(23) for easy reassembly.
- ※ Do not disassemble pin2(23), carrier2(8) and spring pin(23) but in case of replacement.



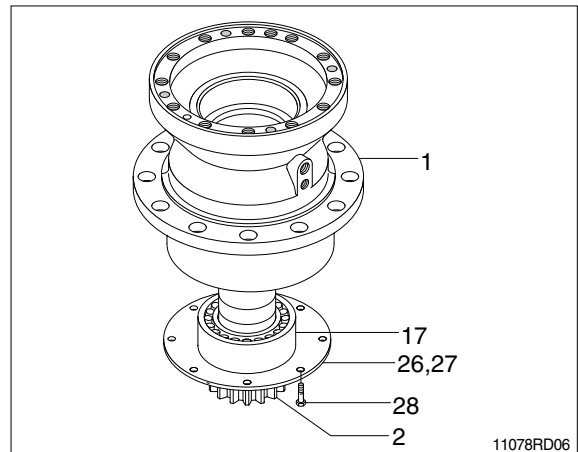
(9) Tighten two M16 eyebolt to the ring gear(3) and then lift the ring gear(3) out of casing(1).



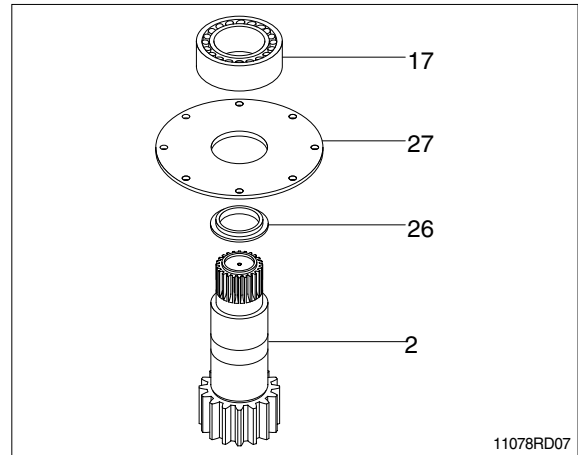
(10) Remove stop ring (25) from the drive shaft(2).



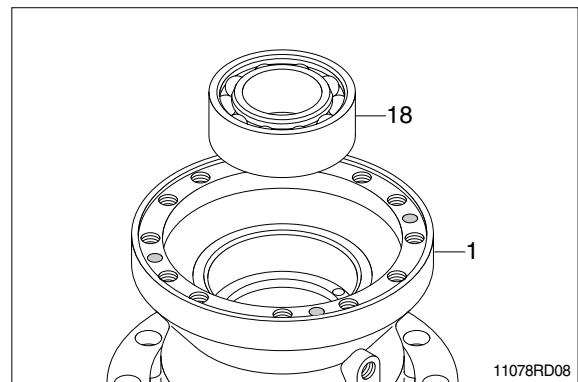
(11) Remove the bolt(28) and remove the drive shaft(2) with roller bearing(17), the spacer(26) and the cover plate(27).



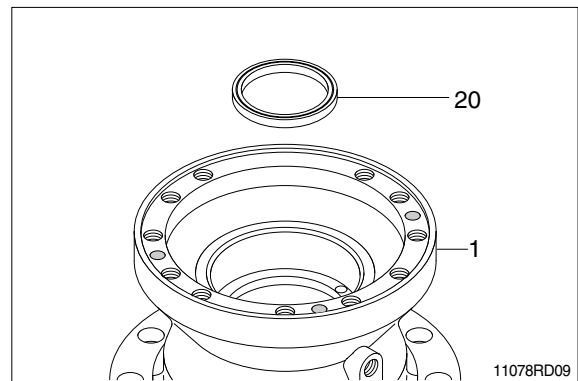
(12) Remove the roller bearing(17), the cover plate(27) and the spacer(26) from the drive shaft(2).



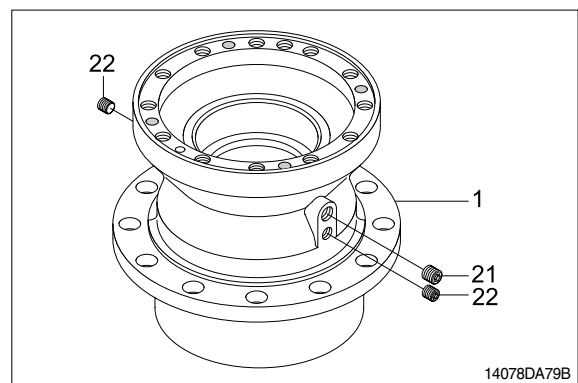
(13) Using the bearing disassembly tool, remove roller bearing(18).



(14) Remove the oil seal(20).

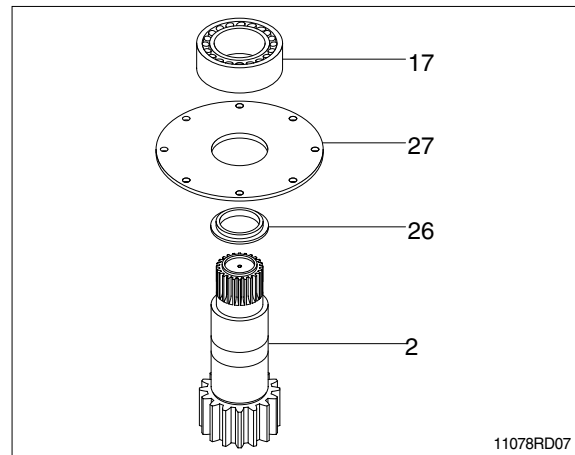


(15) Remove plugs(21, 22) from the casing(1).

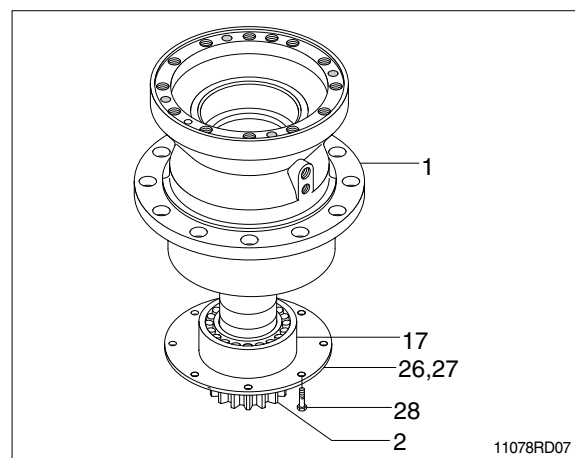


### 3) ASSEMBLY

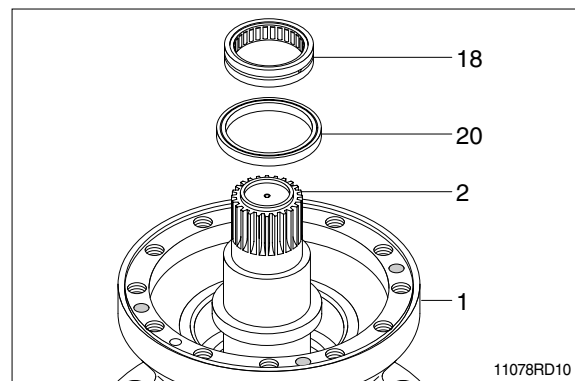
- (1) Assemble the spacer(26), the cover plate(27) and the roller bearing(17) on the drive shaft(2).



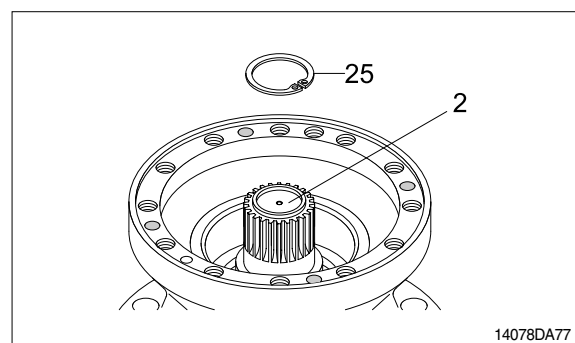
- (2) Assemble the drive shaft sub assembly(2) into the casing(1) and tighten the bolt(28) with loctite No.262.



- (3) Install the oil seal(20) and the roller bearing(18).



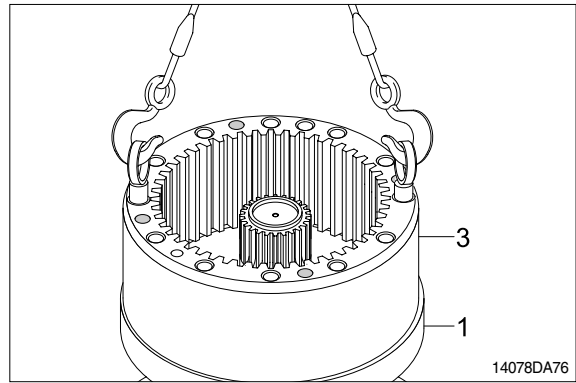
- (4) Install stop ring(25) on the drive shaft (2).



(5) Apply loctite to the tapped holes of casing (1).

(6) Tighten 2 M16 eye bolts to the ring gear(3) and lift up and then assemble it onto the casing(1).

※ Don't fail to coincide the knock pin(16) holes.



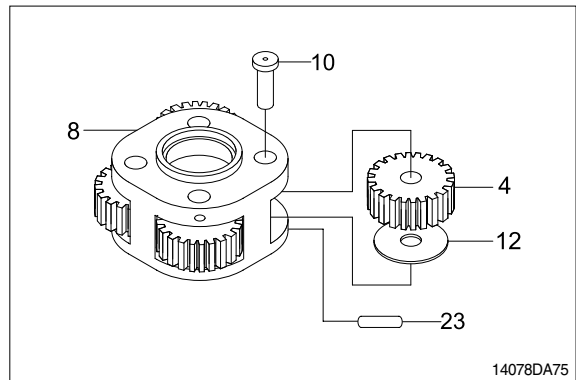
(7) Assembling carrier2(8) assembly.

① Install thrust washer(12) and the planet gear2(4) inside the carrier2(8).

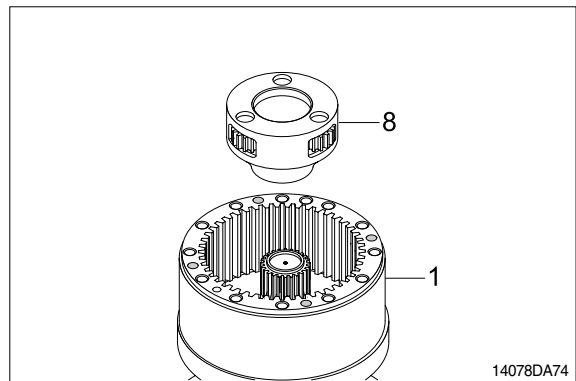
② Assemble the pin2(10) to the carrier2(8) and then press the spring pin(23) by hammering.

③ Punch 2 points of the spring pin(23) lip.

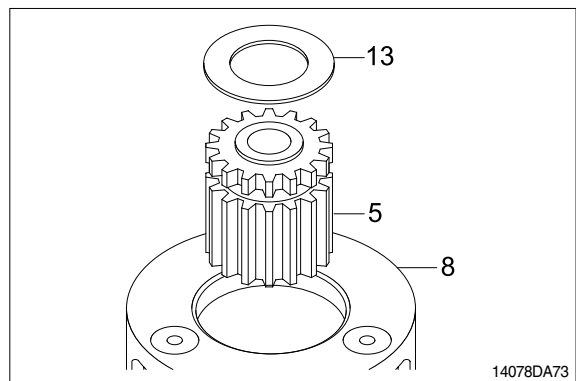
※ Take care not to mistake the matching marks of each part.



(8) Assemble carrier2(8) assembly correctly to the drive shaft(2).



(9) Assemble sun gear2(5) and thrust gear (13) to the center of the carrier2(8) assembly.

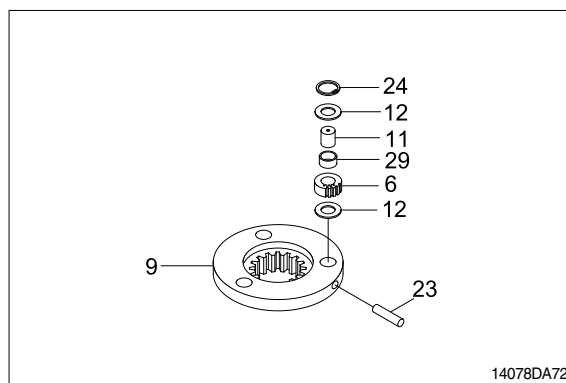




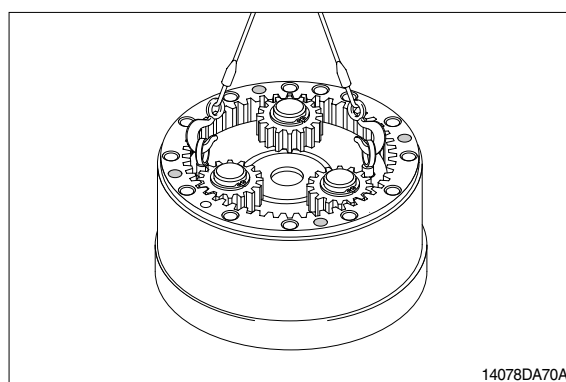
(10) Assembling carrier1(9) assembly.

- ① Assemble the pin1(11) to the carrier1(9) and then press the spring pin(23) by hammering.
- ② Punch 2 points of the spring pin's(23) lip.
- ③ Install needle cage(29) into the planet gear1(6).
- ④ Assemble thrust washer(12), planet gear1(6), and then stop ring(24) to the pin1(11).

※ Take care not to mistake the matching marks of each part.

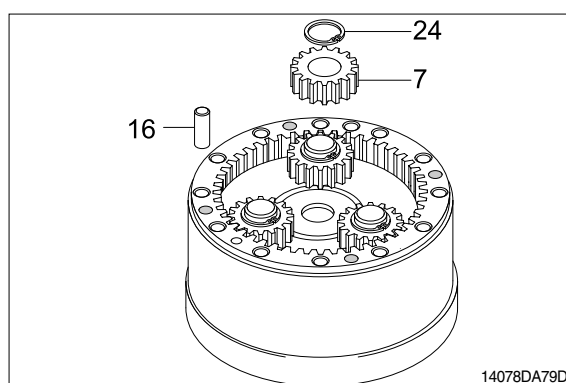


(11) Assemble carrier1(9) assembly into the ringgear.



(12) Hammer 4 knock pins(16) around the ring gear(3).

(13) Assemble sun gear1(7) and stop ring(24) to the drive shaft of the swing reduction gear.

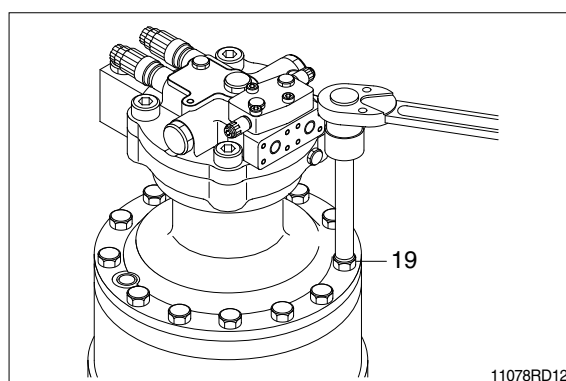


(14) Apply loctite to the tapped holes of the ring gear(3) and then mount swing motor onto the ring gear(3).

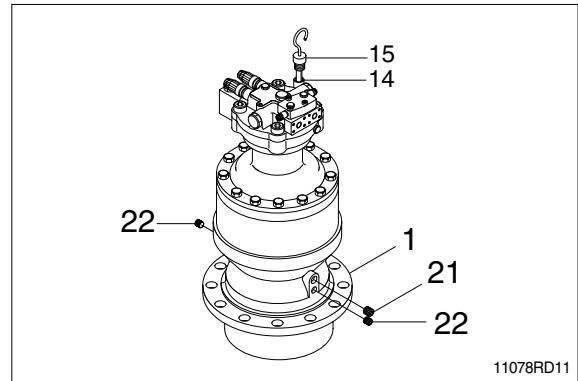
※ Don't fail to coincide the gauge bar(14) hole.

(15) Tighten socket bolts(19) around the swing motor assembly.

・ Tightening torque : 24kgf · m(173lbf · ft)



(16) Assemble plugs(21, 22), gauge bar(14) and gauge pipe(15).



## GROUP 6 TRAVEL DEVICE

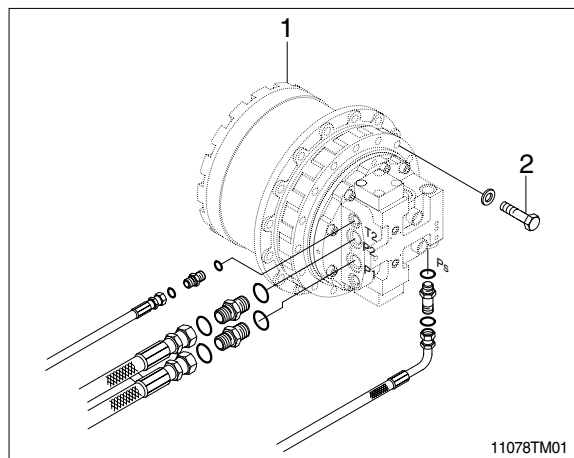
### 1. REMOVAL AND INSTALL

#### 1) REMOVAL

- (1) Swing the work equipment 90° and lower it completely to the ground.
- (2) Operate the control levers and pedals several times to release the remaining pressure in the hydraulic piping.
- (3) Loosen the breather slowly to release the pressure inside the hydraulic tank.

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

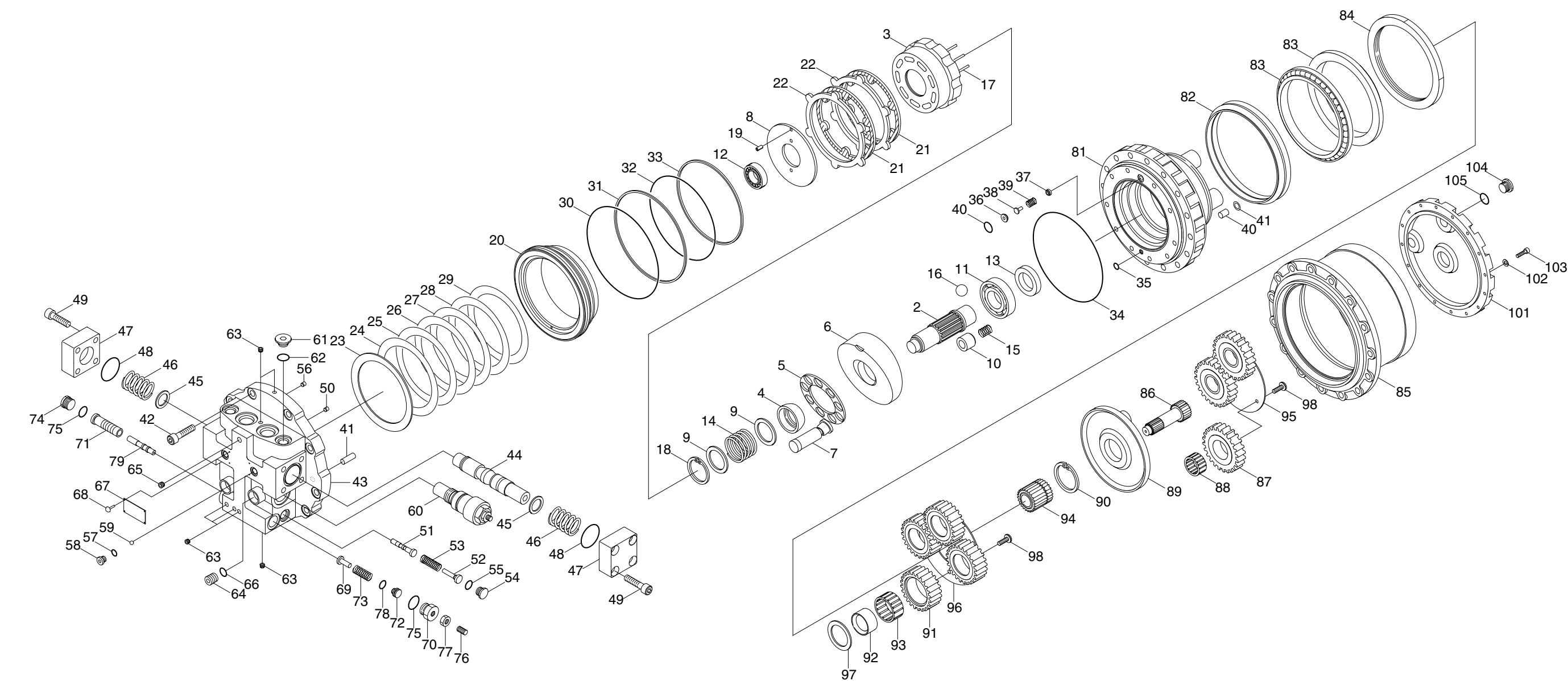
- ※ When pipes and hoses are disconnected, the oil inside the piping will flow out, so catch it in oil pan.
- (4) Remove the track shoe assembly.  
For details, see **removal of track shoe assembly**.
  - (5) Remove the cover.
  - (6) Remove the hose.
    - ※ Fit blind plugs to the disconnected hoses.
  - (7) Remove the bolts and the sprocket.
  - (8) Sling travel device assembly(1).
  - (9) Remove the mounting bolts(2), then remove the travel device assembly.
    - Weight : 165kg(240lb)



#### 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.

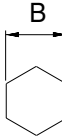
2. TRAVEL MOTOR  
2) STRUCTURE



2	Shaft	20	Brake piston	37	Retainer	54	Plug	71	Sleeve	89	Carrier
3	Cylinder barrel	21	Friction plate	38	Poppet	55	O-ring	72	Stopper	90	Sun gear B
4	Ball retainer	22	Steel plate	39	Spring	56	Orifice	73	Spring	91	Planetary gear B
5	Retainer	23	Disk spring	40	O-ring	57	Steel ball	74	Plug	92	Bushing
6	Cam	24	Shim(1.0T)	41	Pin	58	Plug	75	O-ring	93	Needle bearing B
7	Piston assembly	25	Shim(1.2T)	42	Bolt	59	O-ring	76	Screw	94	Snap ring
8	Valve plate	26	Shim(1.4T)	43	Motor cover assembly	60	Relief valve assembly	77	Nut	95	Thrust plate(2)
9	Plate	27	Shim(1.6T)	44	Spool assembly	61	Plug	78	O-ring	96	Thrust plate(3)
10	Piston assembly	28	Shim(1.8T)	45	Washer	62	O-ring	79	Rod	97	Thrust plate(4)
11	Ball bearing	29	Shim(2.0T)	46	Spring	63	Plug	81	Casing body	98	Screw
12	Roller bearing	30	O-ring	47	Cover	64	Plug	82	Floating seal	99	Washer
13	Oil seal	31	Back up ring	48	O-ring	65	Plug	83	Angular bearing	100	Parallel pin
14	Spring	32	O-ring	49	Bolt	66	O-ring	84	Ring nut	101	Cover
15	Spring	33	Back up ring	50	Orifice	67	Name plate	85	Casing gear	102	Spring washer
16	Steel ball	34	O-ring	51	Spool	68	Rivet	86	Sun gear A	103	Bolt
17	Pin	35	O-ring	52	Stopper	69	Spring guide	87	Planetary gear A	104	Plug
18	Snap ring	36	Seat	53	Spring	70	Plug	88	Needle bearing A	105	O-ring
19	Spring pin										

## 2) TOOLS AND TIGHTENING TORQUE

### (1) Tools

Tool name		Remark	
Allen wrench		5, 6, 8, 10, 14	
OSocket for socket wrench, spanner	Socket	22, 30, 32, 41	
	Rod	5, 6, 8, 10, 14, 19	
Torque wrench		Capable of tightening with the specified torques	
Pliers		-	
(-) Driver		150mm	
Plastic and iron hammer		Wooden hammer allowed. Normal 1 or so	
Steel rod approx		7 × 7 × 200mm	
Monkey wrench		-	
Oil seal inserting jig		-	
Bearing pliers		-	
Seal tape		-	
Eye bolt		PF1/2, M16	
Press(0.5 ton)		-	
Oil stone		-	
Bearing assembling jig		-	
Liquid packing		Loctite #577	
Screw lock		Loctite #243	

### (2) Tightening torque

Part name	Item	Size	Torque	
			kgf · m	lbf · ft
Screw	98	M10	7.0±0.5	50.6±3.6
Bolt	103	M8	3.6±0.2	26.0±1.4
Plug	104	PF3/4	10.0±1.0	72.3±7.2
Bolt	42	M14	19.5±1.5	141.0±10.8
Orifice	43	NPTF1/16	1.0±0.1	7.2±0.7
Plug	44	M20	8.6±0.8	62.2±5.8
Bolt	49	M12	8.0±0.8	57.9±5.8
Orifice	50	NPTF1/16	1.0±0.1	7.2±0.7
Plug	54	PF3/8	5.0±0.5	36.2±3.6
Orifice	56	NPTF1/16	1.0±0.1	7.2±0.7
Plug	58	PF1/8	2.0±0.2	14.5±1.4
Relief valve body	60-1	M28	20.0±2.0	144.7±14.5
Cap nut	60-7	M38	20.0±2.0	144.7±14.5
Screw	60-10	M10	3.5±0.2	25.3±1.4
Plug	61	3/4-16UNF	7.0±0.5	50.6±3.6
Plug	63	NPTF1/16	1.0±0.1	7.2±0.7
Plug	64	9/16-18UNF	5.0±0.5	36.2±3.6
Plug	65	PT1/8	2.0±0.2	14.5±1.4
Plug	70	7/8-14UNF	8.0±0.8	57.9±5.8
Plug	74	7/8-14UNF	8.0±0.8	57.9±5.8
Screw	76	M10	3.5±0.2	25.3±1.4

### **3. DISASSEMBLY**

#### **1) GENERAL PRECAUTIONS**

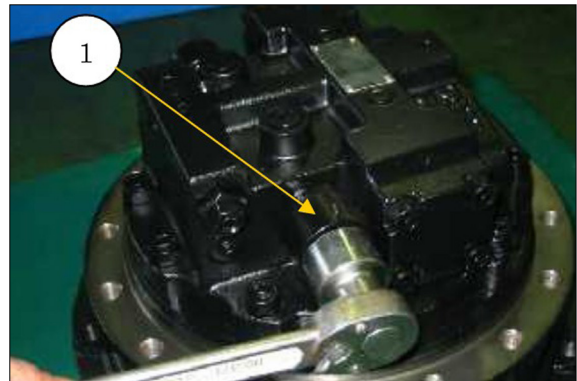
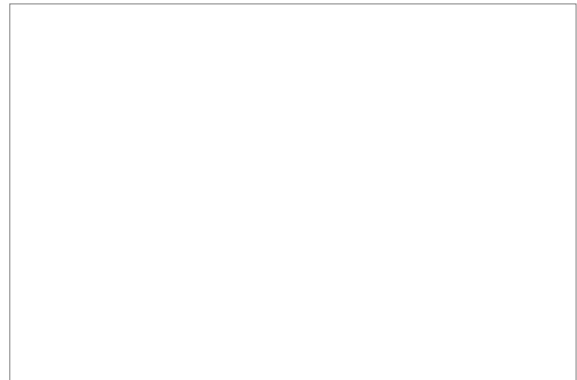
- (1) Before disassembling the motor, check the items to be inspected and, for remedy against trouble, closely examine the nature of the trouble, so that the motor can be disassembled effectively.
- (2) To disassemble the motor, use the disassembling procedures described in section 2) and select a clean place.
- (3) Place a rubber or vinyl sheet or other such protective materials on your working bench to protect the surface of the motor to be serviced.
- (4) During disassembly, give a match mark to the mating surfaces of each part.
- (5) Arrange removed parts in order so that they will not become damaged or missing during disassembly.
- (6) Once seals have been disassembled, they should be replaced even if damage is not observed. Have replacement seals ready on hand before starting your disassembling job.

## 2) DISASSEMBLING PROCEDURE

- (1) Clean the outside of the travel motor completely before disassembling.  
Be aware that in re-assembling, the parts must be installed in the original locations.  
For this purpose, it is strongly recommended to record the original positions of the parts before and during disassembling process.

- (2) Remove the drain plug and drain the lubricating oil. The capacity of the travel motor is 2.5 liters (0.55U.K.gal; 0.66U.S.gal). Place the travel motor on the flat clean ground.

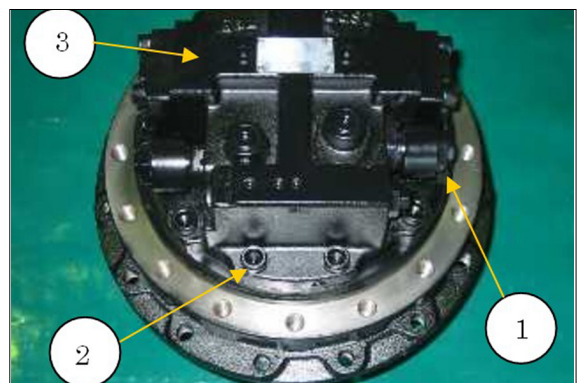
- (3) Remove one relief valve(1) shown in the picture.



11078TM12

- (4) Remove ten bolts(2) and motor cover(3).  
※ Removing the relief valve(1) first makes it easier to remove ten bolts(2) and brake valve(3) later as shown.

**⚠ Be careful not to drop a valve plate. Don't give damage to it. It is on the motor cover inside surface.**



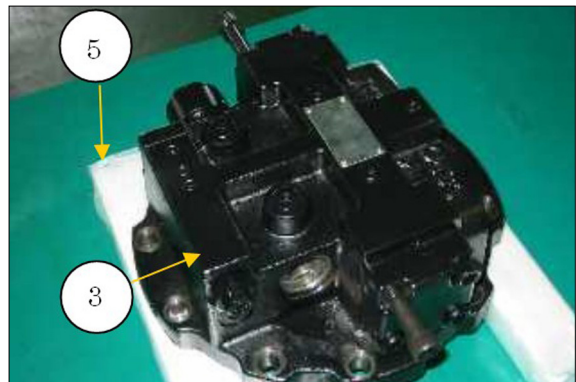
11078TM11

- ※ It would be easier to remove motor cover if you temporarily replace two bolts with two "tool" bolts(4) of yours as shown.  
(You don't have to use them necessarily).
- Bolt thread size = M12 × P1.75
  - Bolt length = about 70mm(for example)



11078TM13

- (5) Place brake valve(3) on wood blocks(5) as shown.



11078TM14

- (6) Remove back-up ring(6) and O-ring(7) from the relief valve(1).



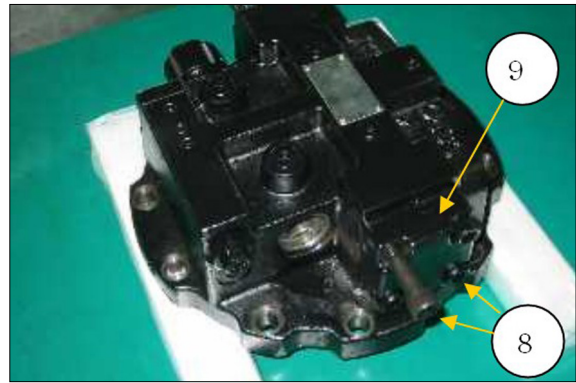
11078TM15



- (7) Remove two diagonal bolts(8) on one side as shown. Then, loosen the two remaining bolts little by little alternately until they are removed completely.  
Remove cover(9) from the brake valve.

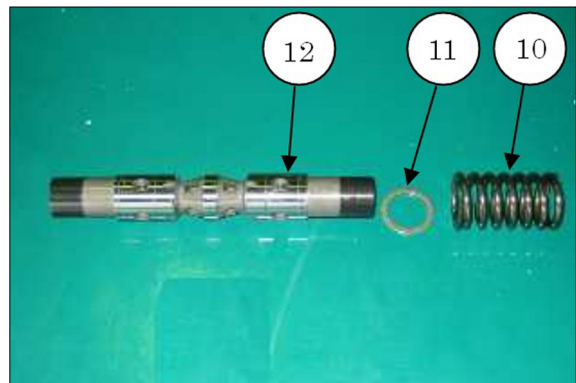
**▲ There is strong spring pressure under the cover(9). For your safety and preventing damage, be sure to loosen the bolts carefully so that spring pressure is under your control. Follow the procedure below.**

- ※ If it is difficult to pull out the spool assembly(12) because of vacuum action, it will be easier by loosening another 4 bolts(8) and cover(9) on the other side a little. (Face distance 0.5mm is enough)



11078TM16

- (8) Remove spring(10), washer(11) and spool assembly(12) from the brake valve. They are located behind the cover(9).
- ※ Don't disassemble spool assembly(12). The component(12) should be serviced only as an assembly.



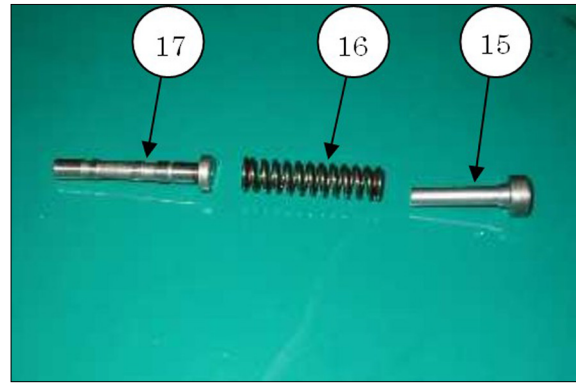
11078TM17

- (9) Remove O-ring(13) and plug(14) from the brake valve.  
Remove the O-ring from plug(14).

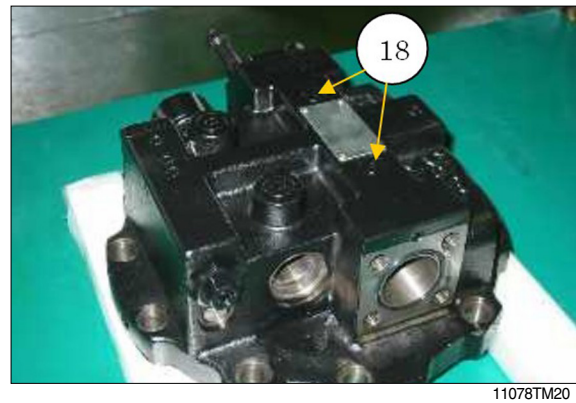


11078TM18

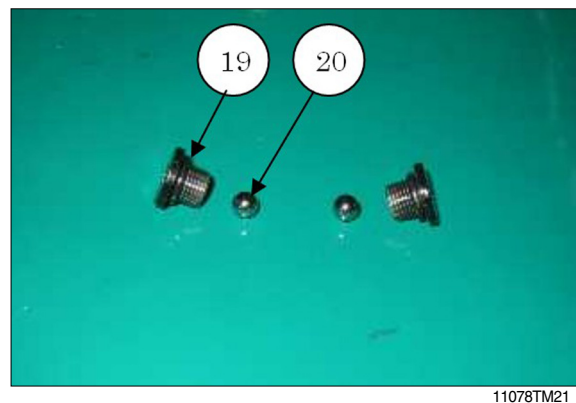
- (10) Remove stopper(15), spring(16), and spool(17) located behind plug(14), from the brake valve.



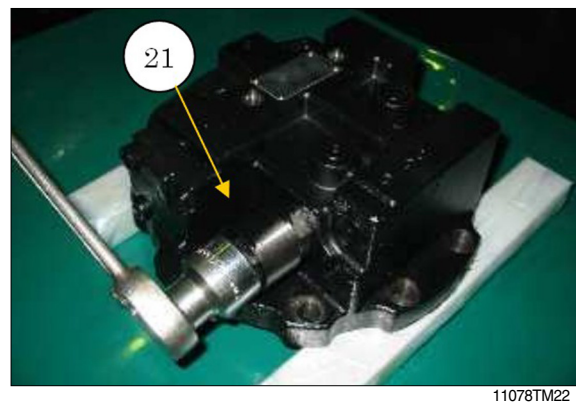
- (11) Remove two plugs(18).



- (12) Remove O-ring(19) from each plug.  
Remove steel balls(20) from the brake valve.



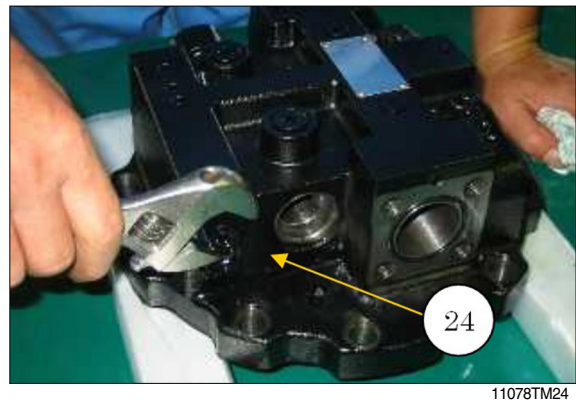
- (13) Remove one relief valve(21) shown in the picture.



- (14) Remove back-up ring(22) and O-ring(23) from the relief valve.



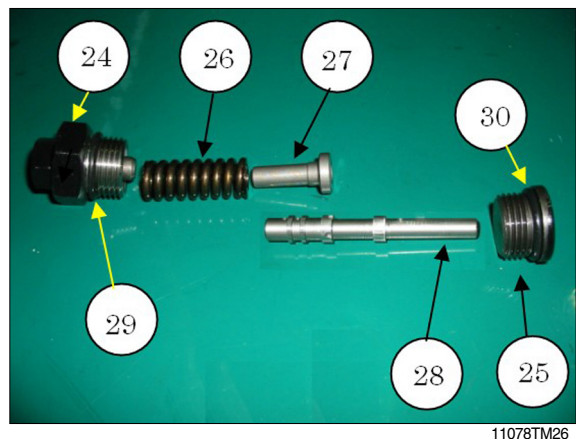
- (15) Remove plug assembly(24) from the brake valve.  
※ Don't disassemble plug assembly(24).  
The screw setting must be kept at the original condition.



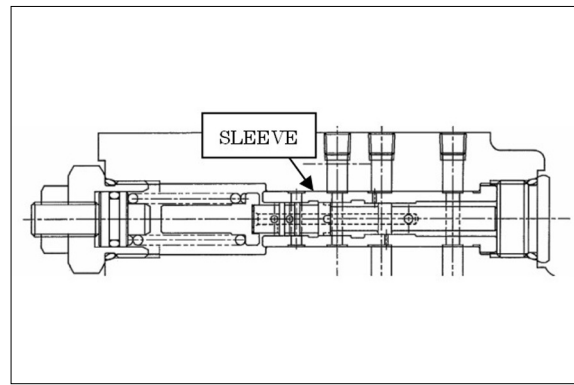
- (16) Remove plug(25).



- (17) Remove spring(26), spring guide(27) and rod(28) behind plug assembly(24).  
Remove the O-ring(29) from plug assembly(24). Remove the O-ring(30) from plug(25).

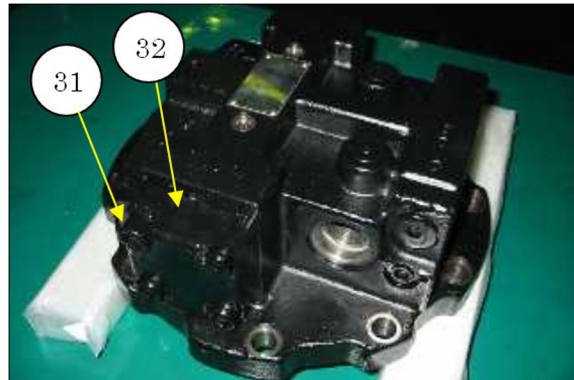


- ※ You don't have to remove sleeve inside the brake valve if the speed-shifting is functioning in order.



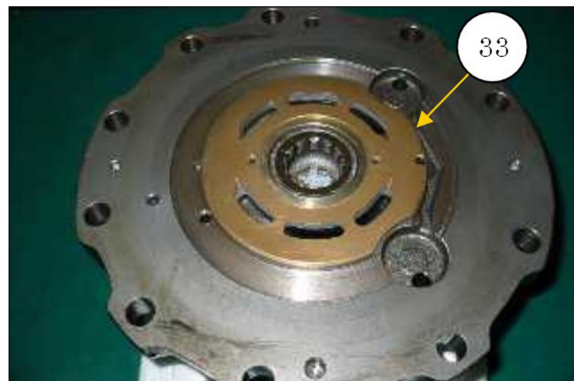
11078TM27

- (18) Remove four bolts(31) and remove cover (32). Refer to step 7.



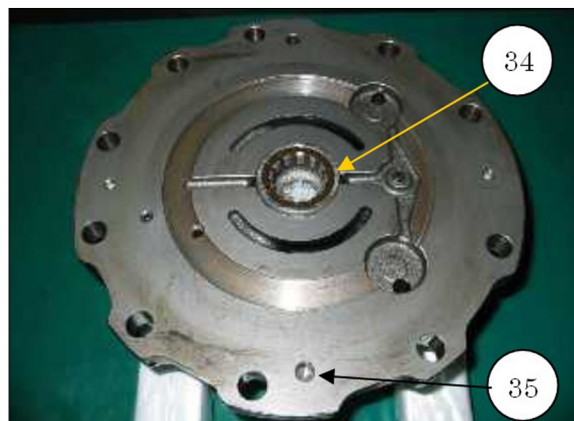
11078TM28

- (19) Place the brake valve upside-down as shown. Remove valve plate(33) from the brake valve.



11078TM29

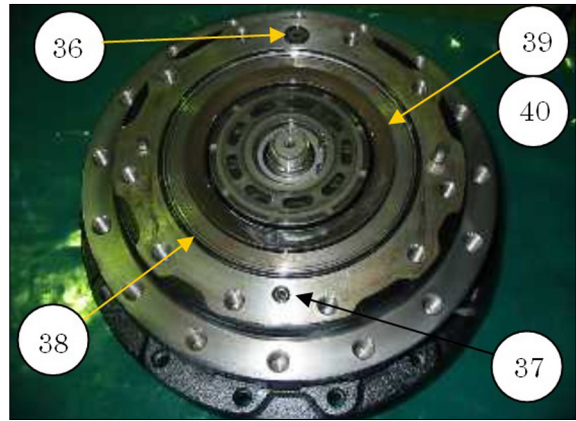
- (20) If necessary, remove bearing(34) and location pin(35).



11078TM30

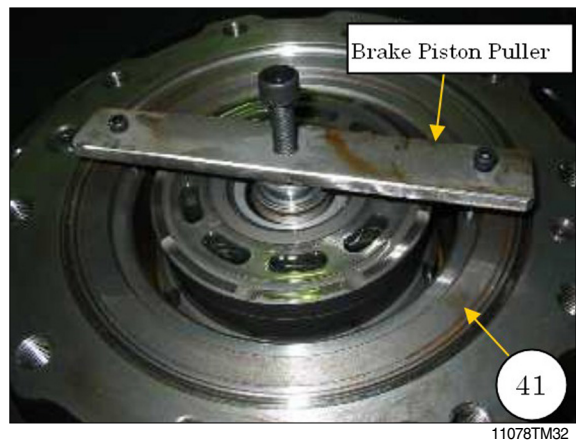


(21) Remove three O-rings(36)(37)(38), two disk springs(39), and shim(40) from the body casing.

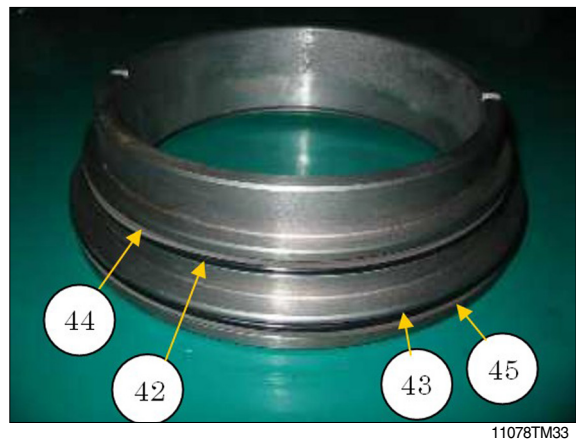


(22) Install tooling "Brake piston puller" as shown.

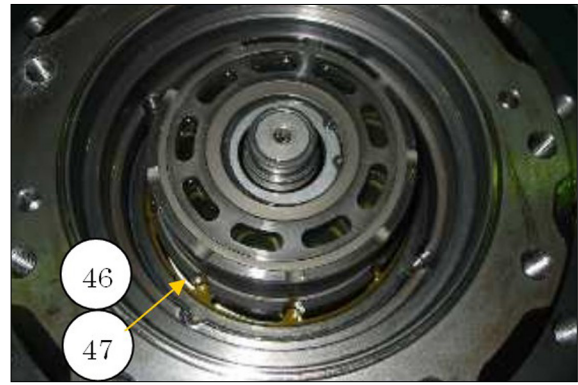
- a. Screw-in two bolts to the brake piston.
- b. Turn the center bolt little by little and let the center bolt push the shaft.  
Then the brake piston comes out.
- c. Remove brake piston(41).



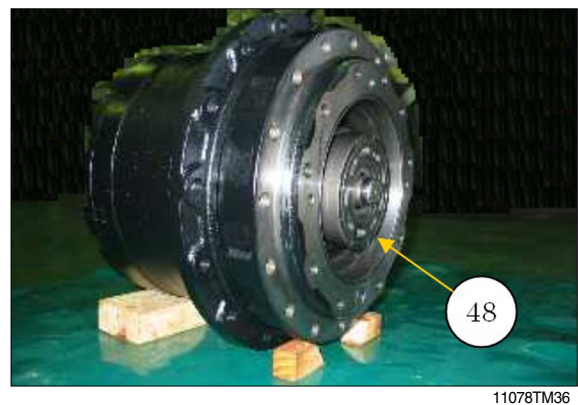
(23) Remove O-rings(42)(43) and back-up rings(44)(45) from the brake piston.



- (24) Remove two friction plates(46) and two steel plates(47) from the body casing, using a steel wire, a magnet, etc. Don't pull off the cylinder barrel component yet.



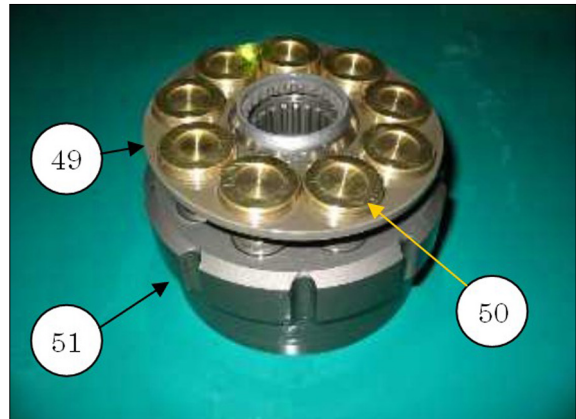
- (25) Position the travel motor as shown on a wood block and apply wood wedges that prevent the travel drive from rolling around. Remove cylinder barrel assembly (48) from the body casing.



(26) Be aware that in re-assembling, retainer(49), piston assemblies(50) and cylinder barrel(51) must be installed in the original locations.

For this purpose, it is strongly recommended to record the original positions of the parts before and during disassembling process.

(27) Remove retainer(49) and piston assemblies(50) from barrel(51). Separate the piston assemblies from the retainer.



(28) Remove retainer ball(52) from the cylinder barrel.



(29) Remove three pins(53) from the cylinder barrel.

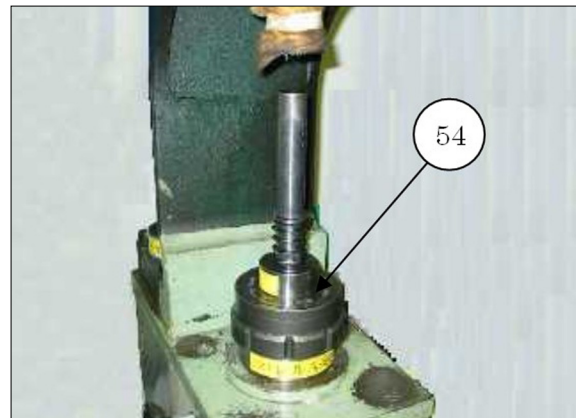


(30) Give a slight amount of compression on plate(54) with a press machine using a suitable size diameter jig.  
Remove snap ring(55). Remove plate(54) spring(56) and plate(57) from the cylinder barrel(51).

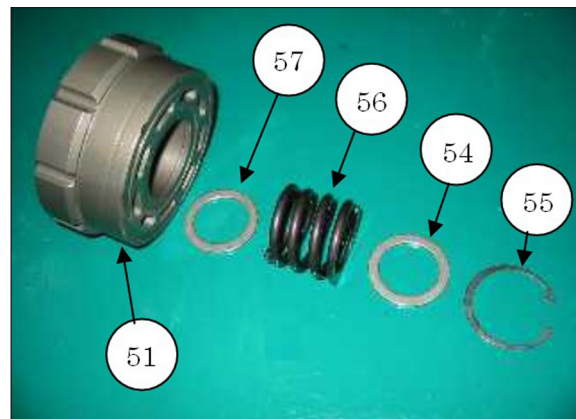
**▲ There is strong spring force behind plate (54). For your safety and avoid-ing damage, a press machine should be used to hold spring compression in disassembling the internal components in cylinder barrel.**



11078TM41



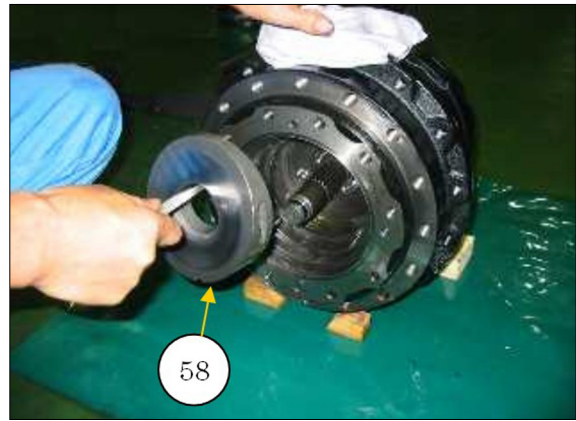
11078TM42



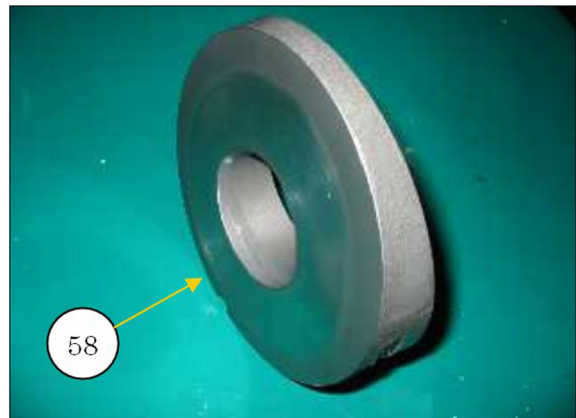
11078TM43



(31) Remove cam(58) from the body casing.

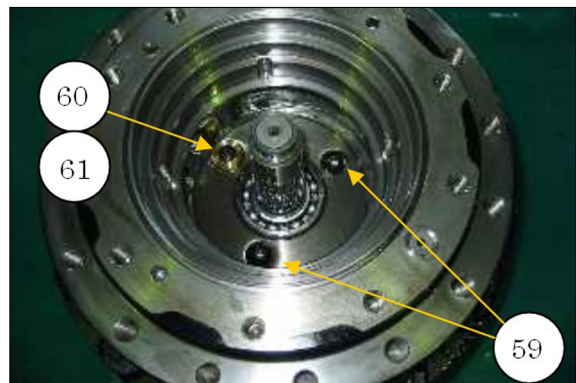


11078TM44



11078TM45

(32) Remove two steel balls(59) and piston(60) from the body casing. Remove the spring(61) behind the piston.



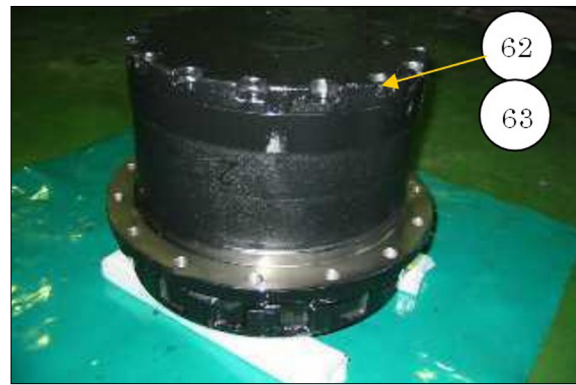
11078TM46



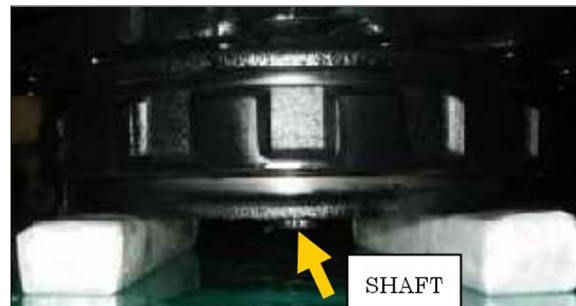
11078TM47

(33) Place the travel motor on wood blocks as shown. Remove sixteen bolts(62) and washers(63).

**⚠ To avoid damaging shaft, don't put the travel motor directly on a flat ground but use blocks.**



11078TM48

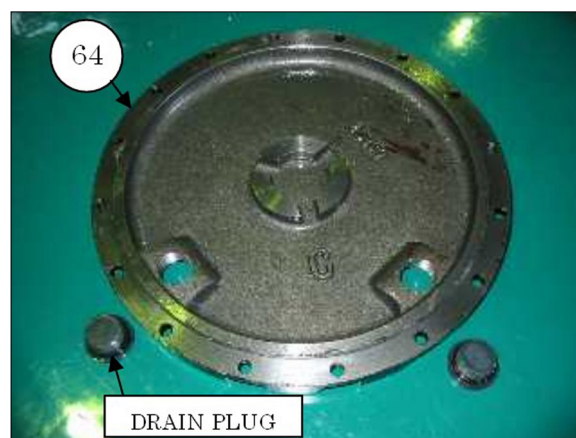


11078TM49

(34) With a soft-faced hammer, break the seal between cover(64) and gear casing(65). Remove the cover(64).

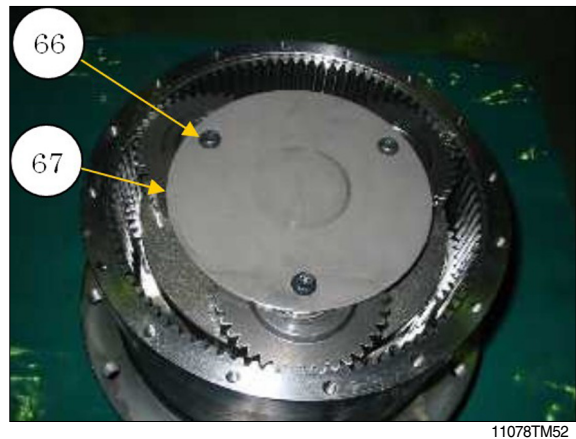


11078TM50

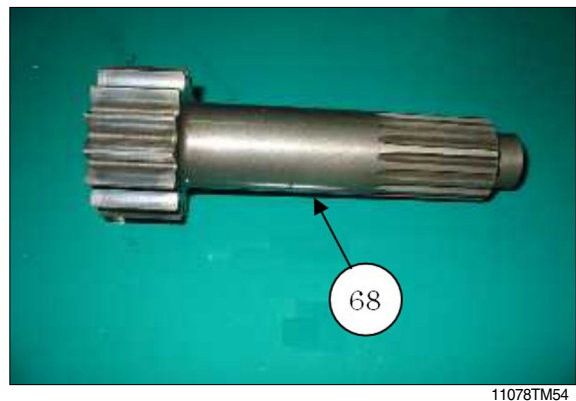
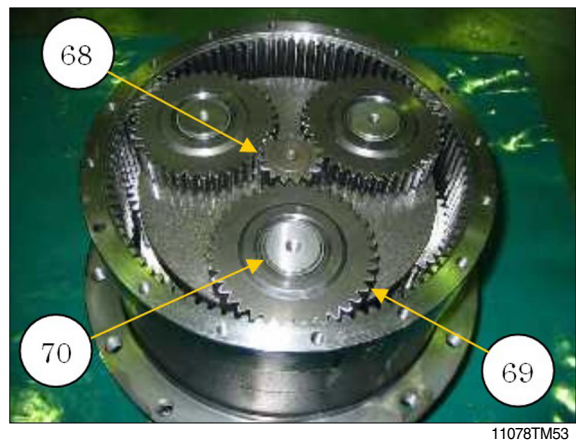


11078TM51

(35) Remove three bolts(66) and a thrust plate(67).



(36) Remove sun gear(68), three planetary gears(69) and three bearings(70).

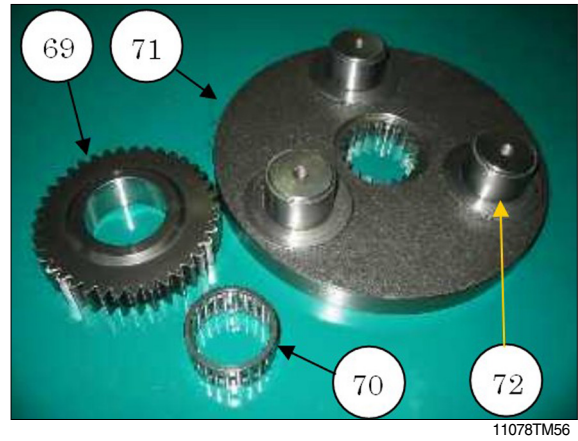


(37) Remove carrier(71).

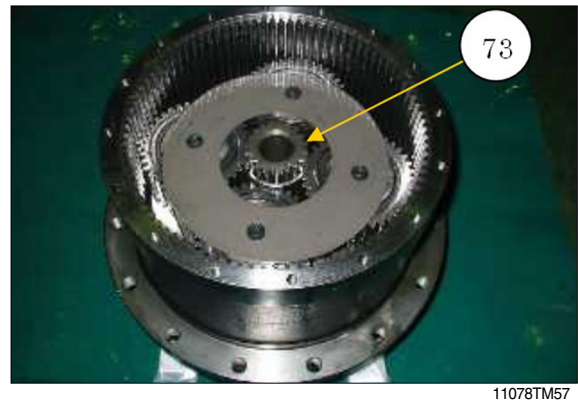




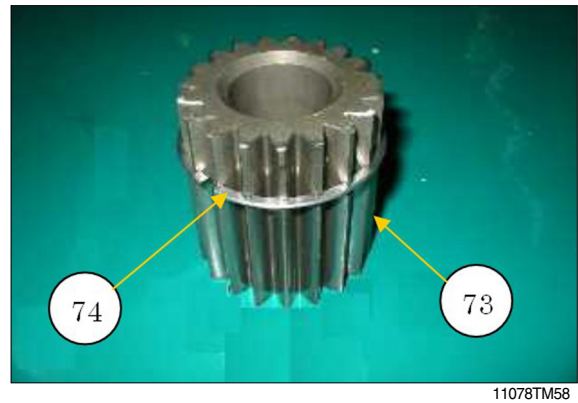
(38) If necessary, remove three inner races(72) from the carrier shaft.



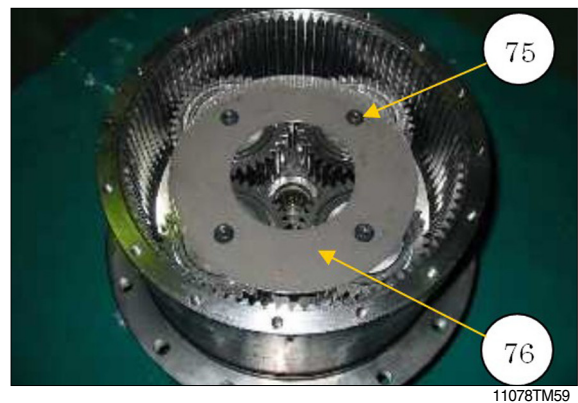
(39) Remove sun gear(73).



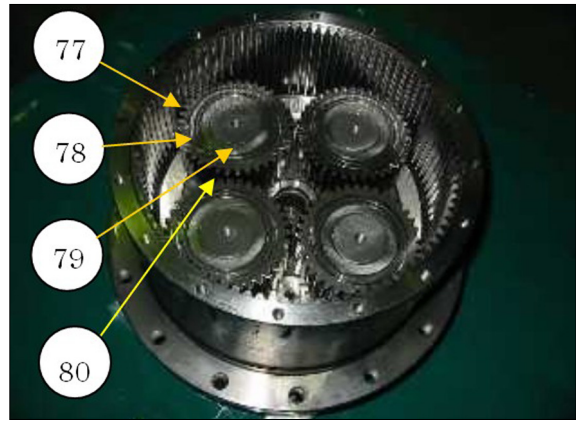
(40) Remove snap ring(74) from sun gear(73).



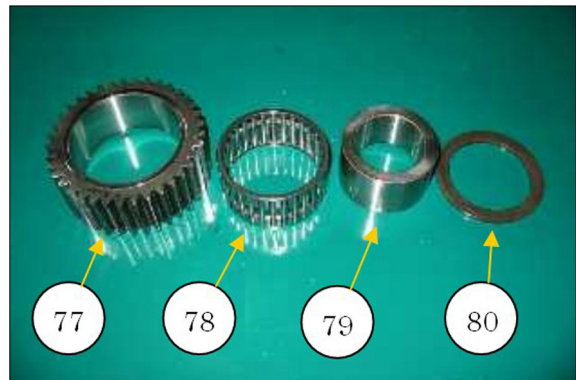
(41) Remove four bolts(75) and a thrust plate (76).



(42) Remove four planetary gears(77), four bearings(78), four bushes(79) and four plates(80).

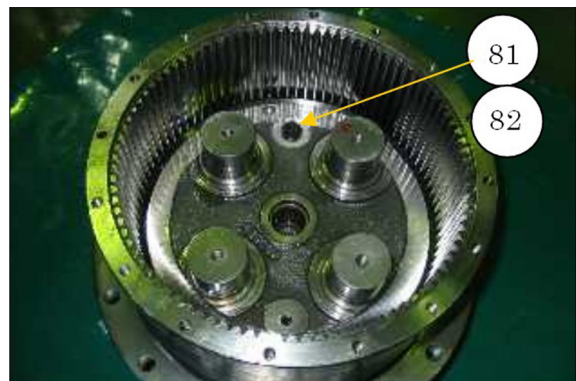


11078TM60



11078TM61

(43) Remove bolt(81) and washer(82).

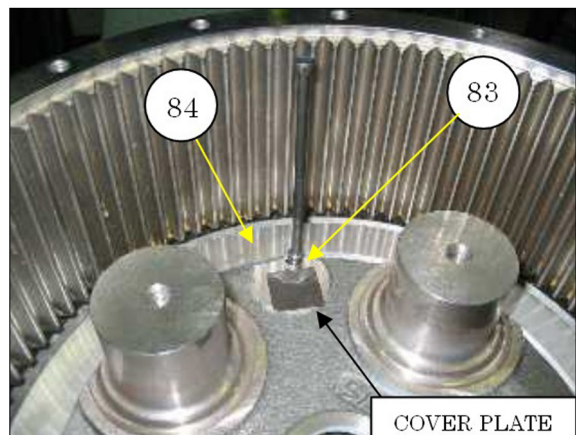


11078TM62

(44) Remove pin(83) with a magnet.  
If it is difficult, follow the procedure below.

- ① Put a cover plate over the tap hole as shown.
- ② Drill a hole to the pin(83).
- ③ Drill a tap to the hole in the pin(83).
- ④ Screw-in a bolt to some degree and pull off the pin with the bolt.

(45) Remove ring nut(84) from the body casing.

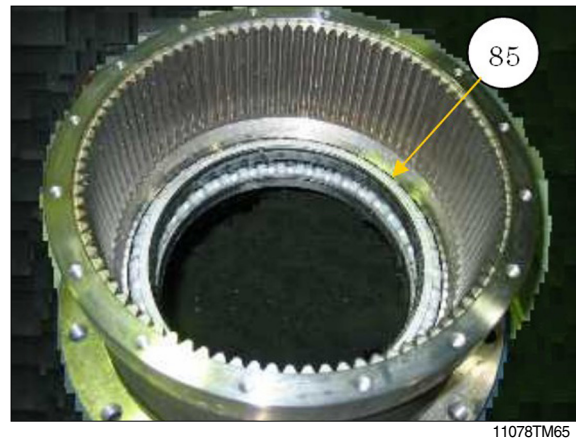


11078TM63

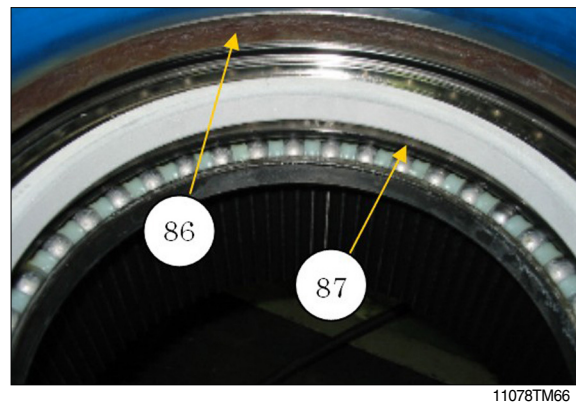
- (46) Remove the gear casing(65) from the body casing with a hoist.



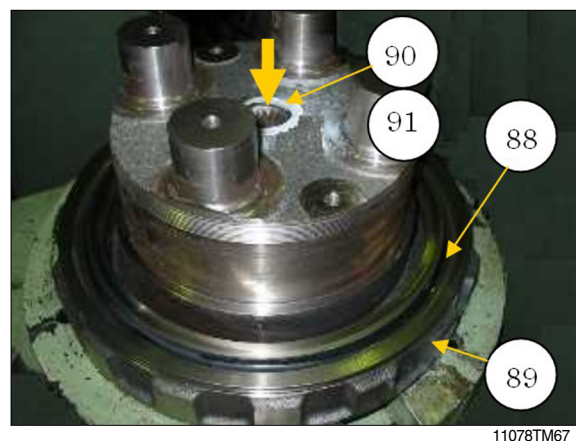
- (47) Remove an angular bearing(85) from the gear casing.



- (48) Put the gear casing upside-down. Remove a floating seal(86) and another angular bearing(87) from the gear casing.

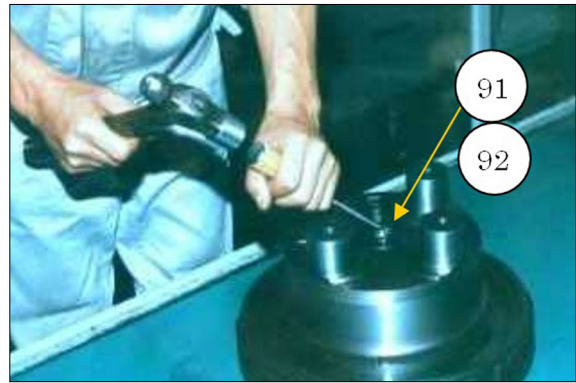


- (49) Remove another floating seal(88) from body casing(89). Remove shaft(90) and bearing(91) from the body casing by giving force as shown with an arrow in the picture using a soft-faced hammer and a proper jig. Sometimes, bearing(91) may remain in the body casing. In this case, remove the bearing(91) as shown in the step 50.



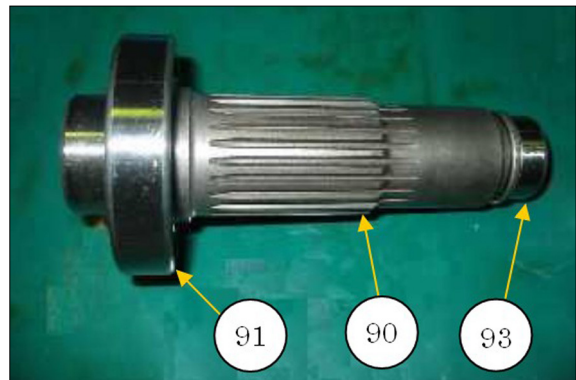


- (50) If necessary, remove a bearing(91) from the body casing.  
Remove an oil seal(92) from the body casing.



11078TM68

- (51) If necessary, remove a bearing(91) from the shaft(90). If necessary, remove an inner race(93) from the shaft(90).



11078TM69

This is the end of disassembling process.

## **4. ASSEMBLY**

### **1) GENERAL PRECAUTIONS**

- (1) Reassemble in a work area that is clean and free from dust and grit.
- (2) Handle parts with bare hands to keep them free of lint contaminants.
- (3) Repair or replace the damaged parts.  
Each part must be free of burrs at its corners.
- (4) Do not reuse O-rings, oil seal and floating seal that were removed in disassembly.  
Provide the new parts.
- (5) Wash all parts thoroughly in a suitable solvent.  
Dry thoroughly with compressed air.  
Do not use the cloths.
- (6) When reassembling oil motor components of motor, be sure to coat the sliding parts of the motor and valve with fresh hydraulic oil. (NAS class 9 or above)
- (7) Use a torque wrench to tighten bolts and plugs, to the torque specified as follows.

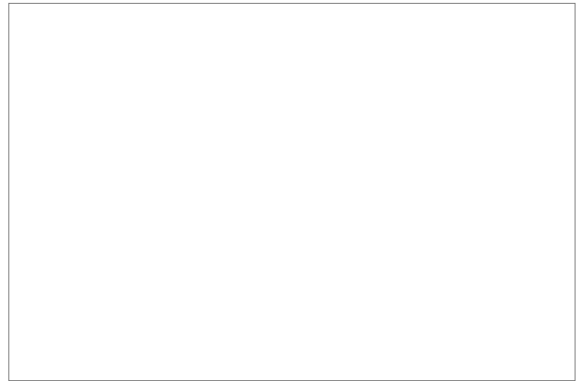


## 2) ASSEMBLING PROCEDURE

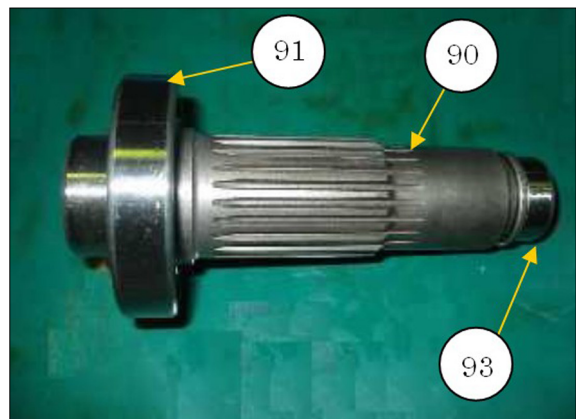
- (1) Make sure that all the parts are completely clean and free of dirt and debris before assembling.

Check the condition of all O-rings, back-up rings, and oil seal used in the travel motor. If any of them have any damage, replace them with new ones.

Put the body casing on a clean sheet spread on the flat base.



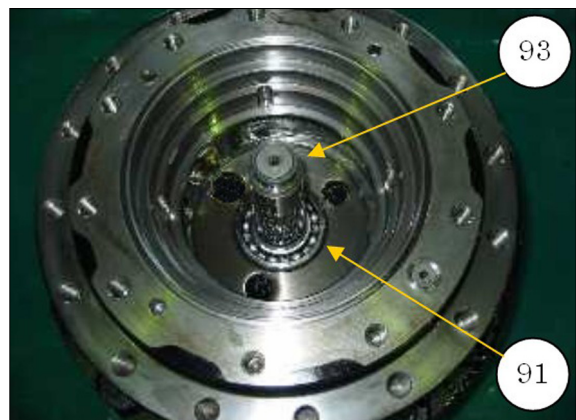
- (2) Install oil seal to body casing.  
Put bearing(91) and inner race(93) on shaft(90).  
Install shaft(90) into the body casing.



11078TM70

- ※ Before installing floating seals, make the O-ring(=rubber) and seal ring(=metal) clean and dry.

After installing the seals, put clean SAE30 engine oil or gear oil 80W-90 on the contact surfaces of the metal seals.



11078TM71

- (3) Place the body casing on wood blocks or other proper jigs with the shaft side down.

**▲ To avoid damaging shaft, don't put the body casing directly on a flat ground.**



11078TM72

- (4) Install floating seal(88) in the body casing, using tool "Floating seal installer".  
Then, put clean SAE30 engine oil or gear oil 80W-90 on the contact surface(flat surface) of the metal seal.

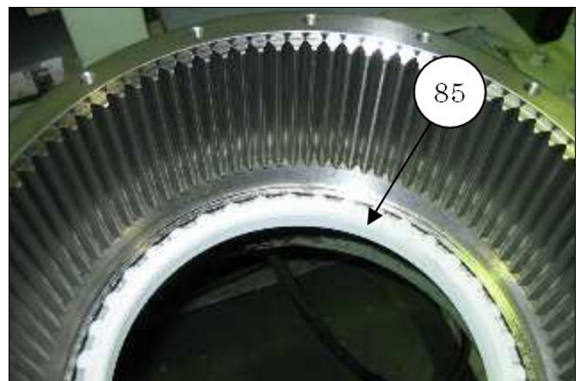


11078TM73



11078TM74

- (5) Install an angular bearing(85) to the gear casing.

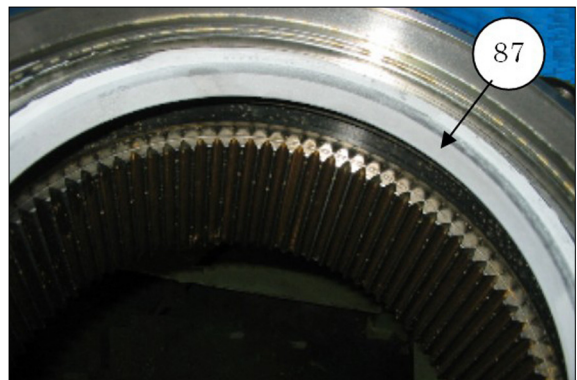


11078TM75

- (6) Put the gear casing upside-down as shown. Install another angular bearing(87) to the gear casing.

※ Before installing floating seals, make the O-ring(=rubber) and seal ring(=metal) clean and dry.

After the installation of the seals, put clean SAE30 engine oil or gear oil 80W-90 on the contact surfaces of the metal seals.

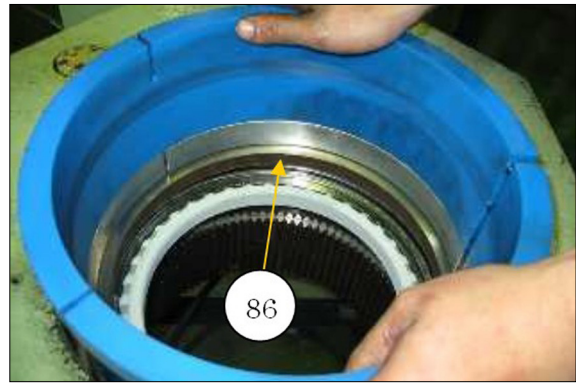


11078TM76

- (7) Install another floating seal(86) in the gear casing, using tooling "Floating seal installer".

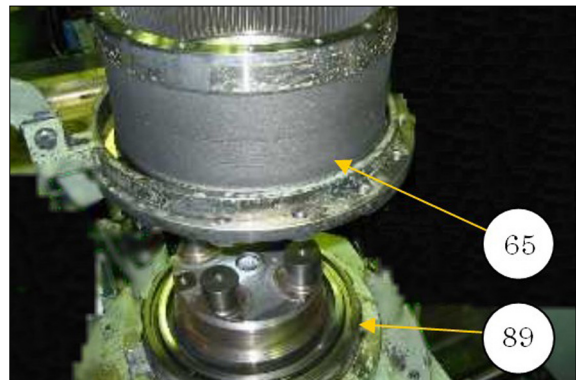
Then, put clean SAE30 engine oil or gear oil 80W-90 on the contact surface(flat surface) of the metal seal.

- ※ Be careful and don't scratch or damage the floating seals before and during assembling the two components.



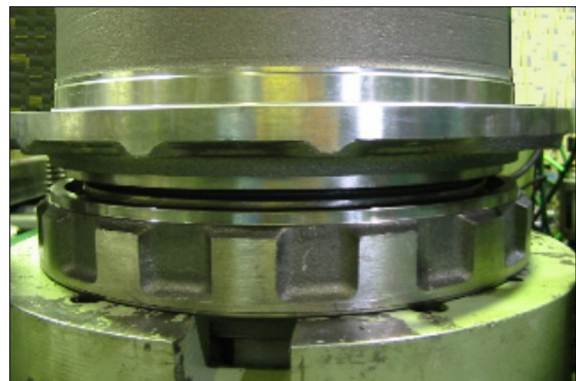
11078TM77

- (8) Hoist a gear casing(65) over the body casing(89) as shown. Install the gear casing on the body casing(89).



11078TM78

- ※ After installing the ring gear on the body casing, there will be a gap between two components. This is a normal phenomenon caused by the floating seals, and the gap will be eliminated by installing the ring nut(84).



11078TM79



(9) Use the following procedure to make a preload adjustment of bearings(85) and (87) as follows :

- a. Tighten the ring nut(84) strongly enough until there is no gap among body casing, two bearings, gear casing, and ring nut.
- b. Rotate gear casing(65) several turns.
- c. Turn the ring nut(84) forward/backward and adjust the tightening position of the ring nut(84) until the pull-force of spring scale to the tangent-line direction while turning(as shown below) is **216~294N (48.5~66.1lbf)**.

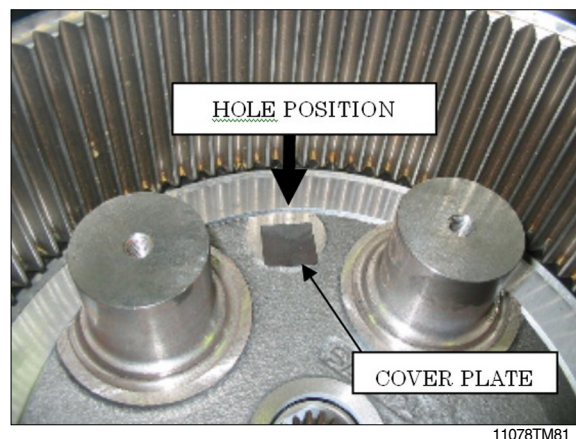
※ To apply a pin to the ring nut, a new hole should be drilled at the opposite position from the original position. It is because that the rotating position of ring nut is not necessarily the same as the original position when it is adjusted by the procedure (9).



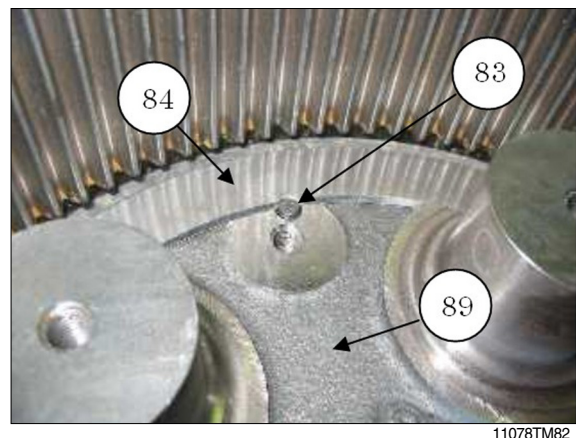
(10) Put a cover plate over the tap hole. Drill a new hole between body casing and ring nut as shown.

**Drill hole spec :**

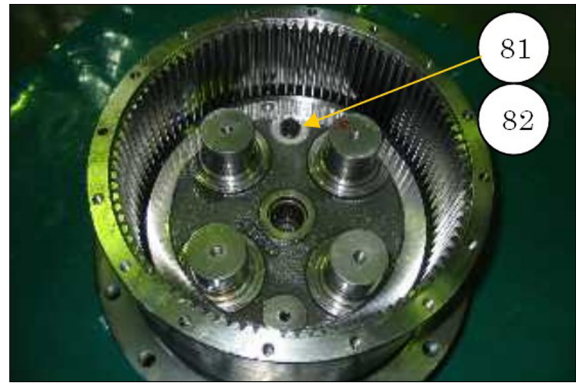
- Drill hole diameter =  $\varnothing 8.00 \sim \varnothing 8.15 \text{mm}$
- Drill hole depth = 11.0~11.5mm



(11) Take away all the debris caused by drilling. Install pin(83) in a newly drilled hole between body casing(89) and ring nut(84).

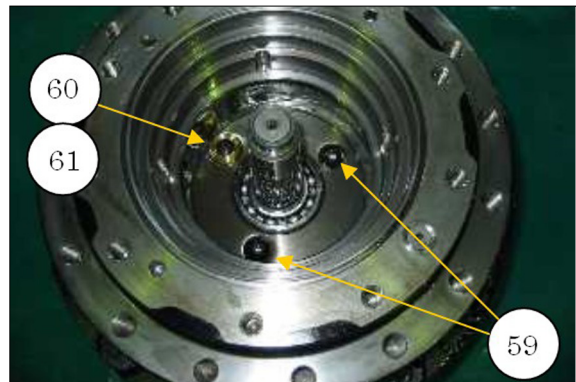


- (12) Apply **Thread Lock "THREE BOND 2403"** to bolt(81). Install bolt(81) and washer(82) to the body casing. Tighten the bolt to a torque of  $68.6 \pm 4.9$  N·m( $50.6 \pm 3.6$  lbf·ft).



11078TM83

- (13) Position the travel motor as shown. Install two steel balls(59), spring(61) and piston assembly(60) in the body casing.



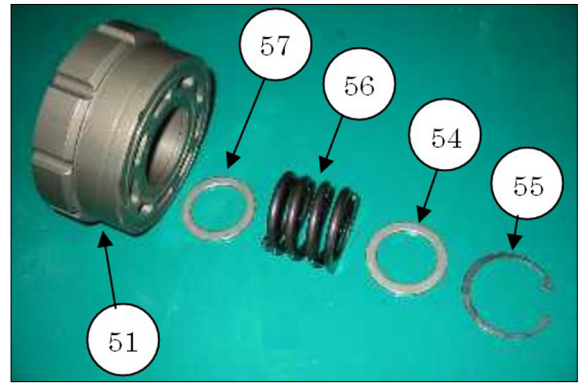
11078TM84

- (14) Install cam(58) in the travel motor body. By pushing the cam several times, confirm that the cam action is smooth.

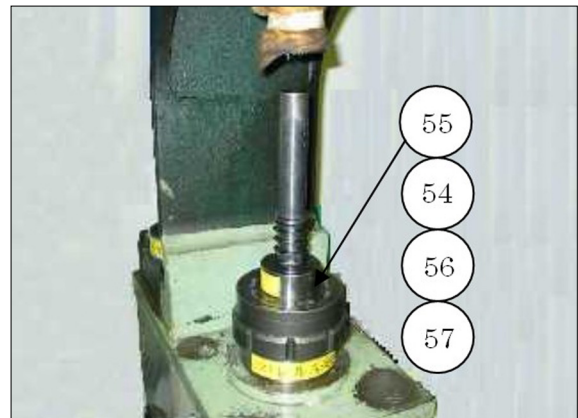


11078TM85

- (15) Install plate(57), spring(56) and plate(54) in cylinder barrel(51).  
Use a press machine on plate(54), and compress spring(56).  
Install snap ring(55).

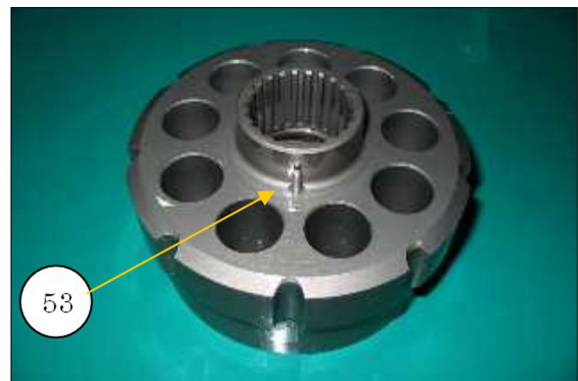


11078TM86



11078TM86

- (16) Install three pins(53) in the cylinder barrel.



11078TM88

- (17) Install retainer ball(52) to the cylinder barrel. Put clean hydraulic oil on retainer ball(52).

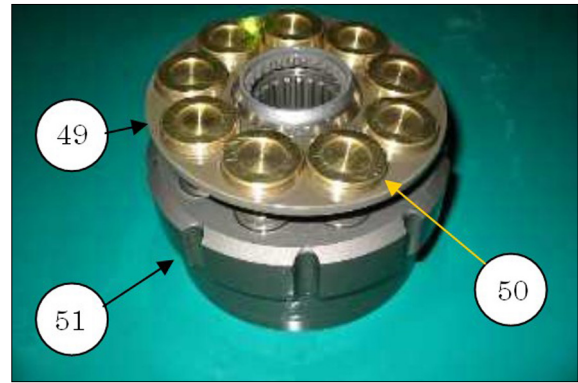


11078TM89



(18) Install piston assemblies(50) in their original holes of retainer(49).

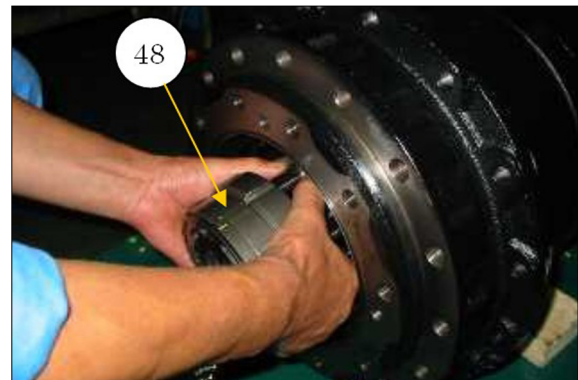
(19) Put clean hydraulic oil in the bores of the cylinder barrel and piston assemblies(50). Install the piston assemblies with the retainer in their original bores in cylinder barrel(51).



11078TM90

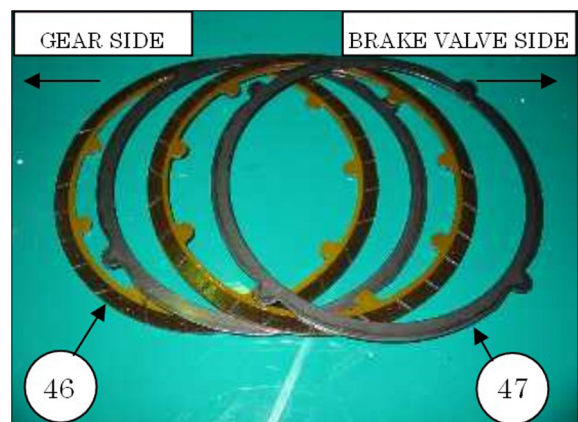
(20) Put clean hydraulic oil on the sliding surfaces of the cam, nine piston shoe surfaces sliding against cam, and on the splined shaft of the motor.

Then, put the travel motor body on its side and install cylinder barrel assembly(48) on the shaft as a unit.



11078TM91

(21) Put clean hydraulic oil on two friction plates(46) and two steel plates(47). Install the plates in alternating order in the travel motor body. Start with a friction plate and end with a steel plate.

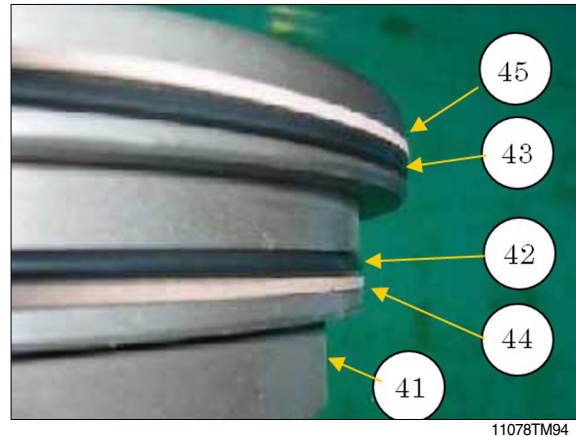


11078TM92



11078TM93

- (22) Make sure brake piston(41) is completely clean and free of dirt and debris. Check the condition of back-up rings(44)(45) and O-rings(42)(43). If any of them have any damage, replace them with new ones. Install back up rings(44)(45) and O-rings(42)(43) on brake piston(41) as shown. Put some grease on the back-up rings and the O-rings. Be careful about the installing position of O-rings and back-up rings.



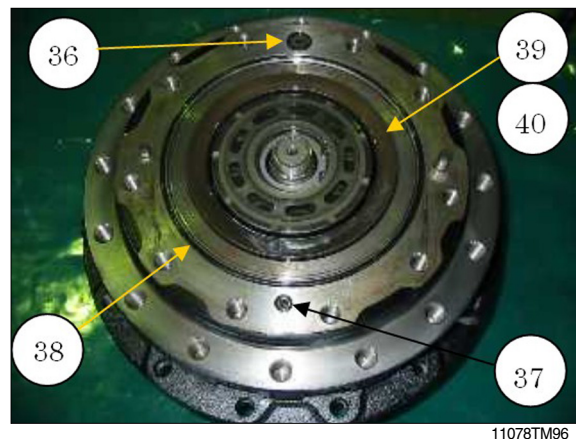
11078TM94

- (23) Put clean hydraulic oil on the surface of the body casing, which makes contact with brake piston(41). Install brake piston(41) in the travel motor body using a soft-faced hammer.

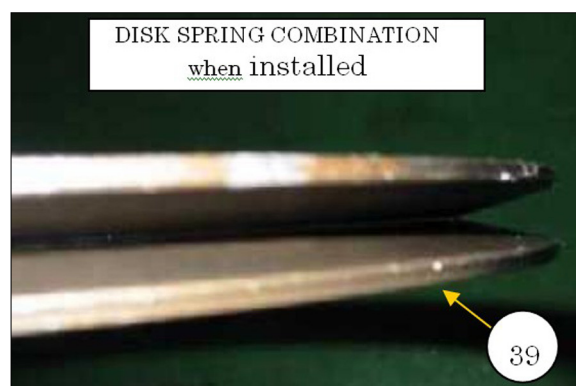


11078TM95

- (24) Install shim(40) in the brake piston. Next, install two disk springs(39) in the piston. The combination of the disk spring in installing is a shown. Install three O-rings(36)(37)(38) in the travel motor body.



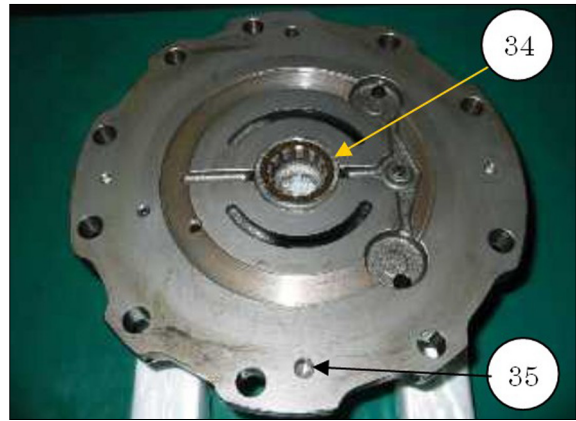
11078TM96



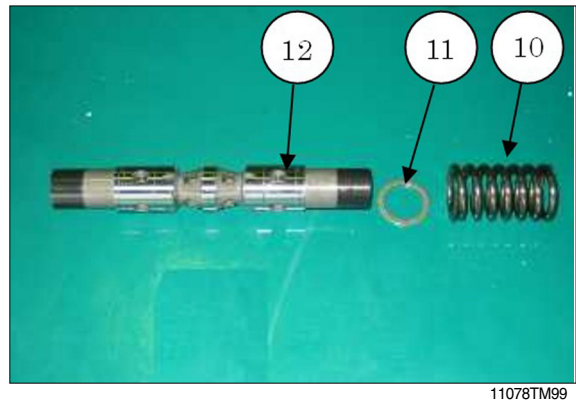
11078TM96



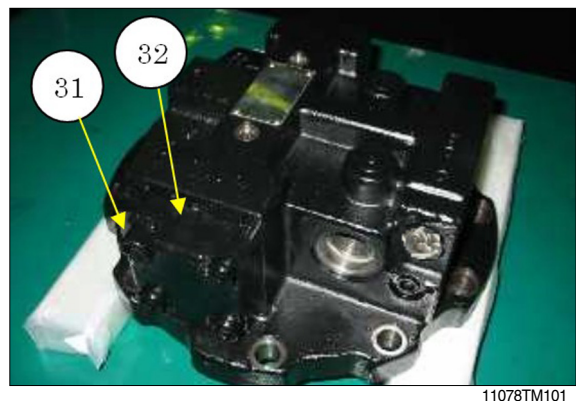
- (25) Install bearing(34) and location pin(35) in the brake valve.



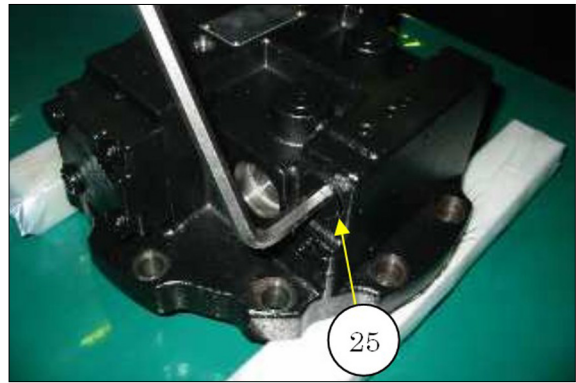
- (26) Put the motor cover upside-down on wood blocks. Put some clean hydraulic oil on spool assembly(12), and install it in the valve body. Install washer(11) and then spring(10) in the valve body. Install O-ring(94) as shown.



- (27) Install cover(32) and four bolts(31).  
Tighten the bolts to a torque of  **$78.5 \pm 7.8$  N·m ( $57.9 \pm 5.8$  lbf·ft)**.  
Be careful not to let the spool slip off the motor cover. The spool assembly(12) is not fixed yet.

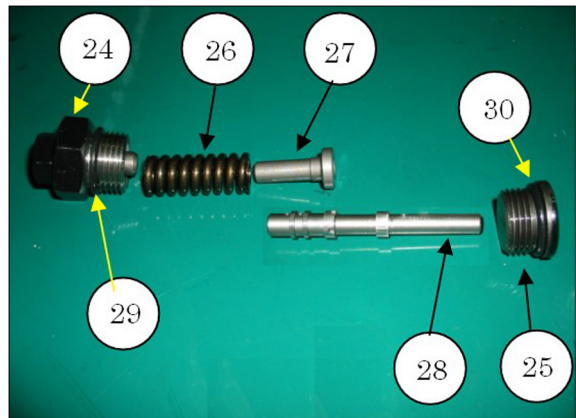


(28) Put O-ring(30) on plug(25). Install plug (25) to the brake valve. Tighten the plug(25) to a torque of  $78.5 \pm 7.8 \text{ N} \cdot \text{m}$  ( $57.9 \pm 5.8 \text{ lbf} \cdot \text{ft}$ ).

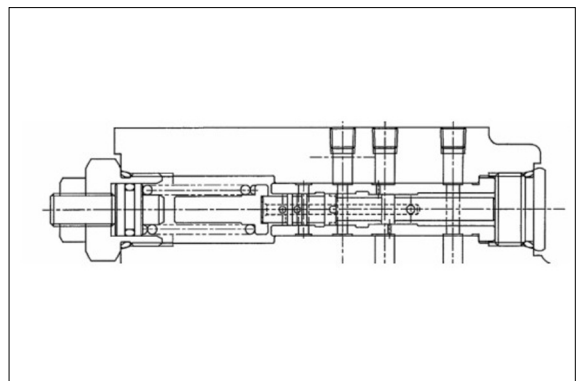


11078TM104

(29) Install rod(28), spring guide(27) and spring(26) to the brake valve.

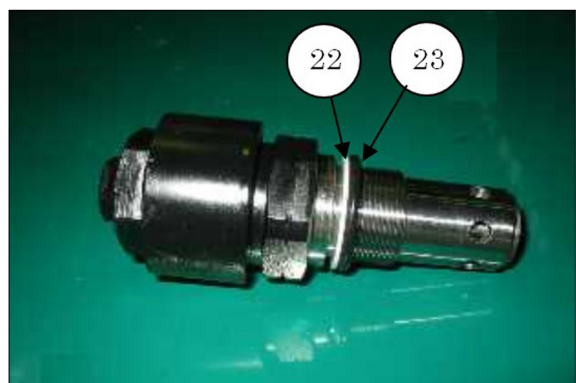


11078TM102



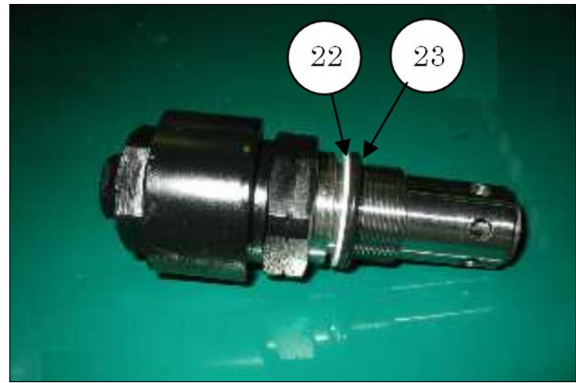
11078TM103

(30) Put O-ring(29) on plug assembly(24). Install plug assembly(24) to the brake valve. Tighten the plug assembly(24) to a torque of  $78.5 \pm 7.8 \text{ N} \cdot \text{m}$  ( $57.9 \pm 5.8 \text{ lbf} \cdot \text{ft}$ ).



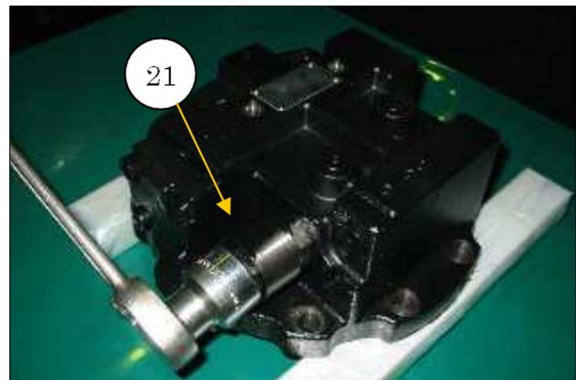
11078TM106

- (31) Install back-up ring(22) and O-rings(23) on the relief valve as shown.



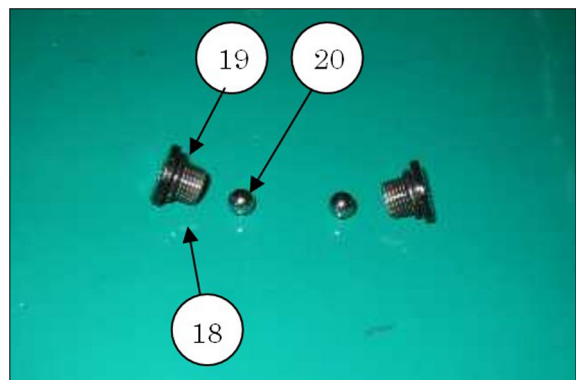
11078TM106

- (32) Install relief valve(21) in the travel brake valve body as shown. Tighten the relief valve body to a torque of  $196 \pm 19.6 \text{ N} \cdot \text{m}$  ( $145 \pm 14.5 \text{ lbf} \cdot \text{ft}$ ).



11078TM107

- (33) Install two balls(20) in the brake valve. Put O-rings(19) on plugs(18). Install the plugs to the travel brake valve. Tighten the plugs to a torque of  $19.6 \pm 2.0 \text{ N} \cdot \text{m}$  ( $14.5 \pm 1.5 \text{ lbf} \cdot \text{ft}$ ).



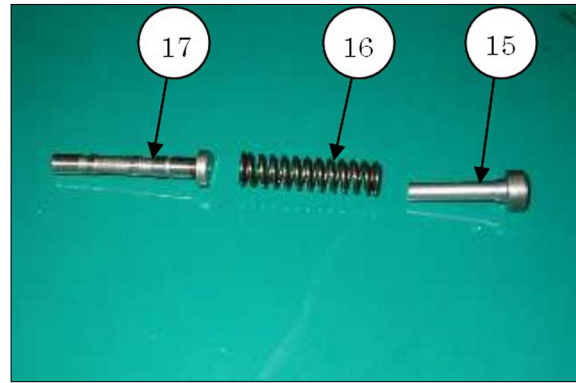
11078TM108



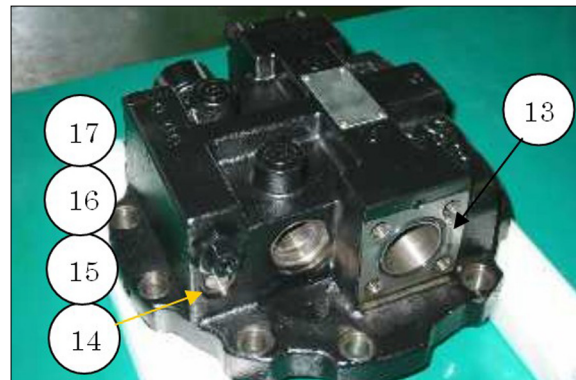
11078TM109

(34) Put spool(17), spring(16), and stopper(15) in the brake valve body. Put the O-ring on plug(14). Install plug(14) to the travel brake valve. Tighten the plug to a torque of  $49 \pm 4.9 \text{ N} \cdot \text{m}$  ( $36.1 \pm 3.6 \text{ lbf} \cdot \text{ft}$ ).

Put O-ring(13) on the brake valve body.



11078TM110

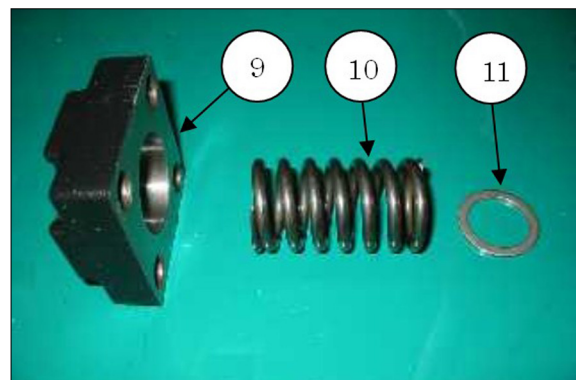


11078TM111

(35) Install plate(11) and then spring(10) in the brake valve.

Then, install cover(9) with four bolts(8).

Tighten the bolts(8) to a torque of  $78.5 \pm 7.8 \text{ N} \cdot \text{m}$  ( $57.9 \pm 5.8 \text{ lbf} \cdot \text{ft}$ ).



11078TM112



11078TM113

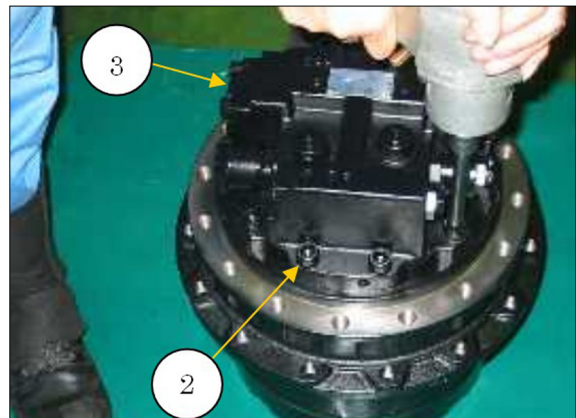


- (36) Put the brake valve upside-down.  
Install valve plate(33) in its original position on the brake valve.  
Put some clean hydraulic oil on the valve plate surface.



11078TM114

- (37) Position brake valve(3) on the body casing. Install ten bolts(2) that hold it. Tighten the bolts to a torque of  $191 \pm 14.7$  N·m ( $141 \pm 10.8$  lbf·ft).



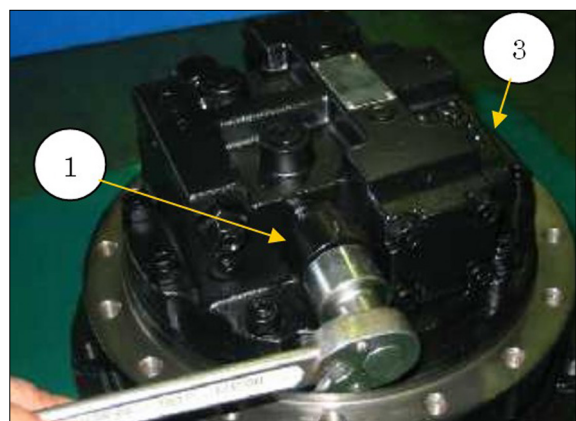
11078TM115

- (38) Install back-up ring(6) and O-ring(7) on the relief valve.



11078TM116

- (39) Install relief valve(1) to travel brake valve (3).  
Tighten the relief valve body to a torque of  $196 \pm 19.6$  N·m ( $145 \pm 14.5$  lbf·ft).



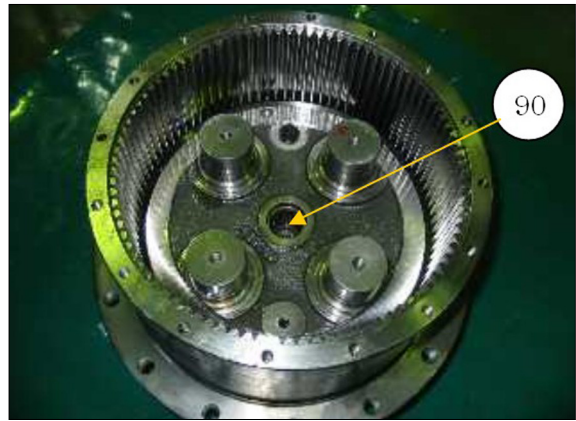
11078TM117

(40) Place the travel motor with brake valve upside down as shown. Apply torque to shaft(90) to confirm the parking brake torque. If the shaft starts rotating by a torque of more than **239N·m (176lbf·ft)**, it satisfies the spec. If the motor output shaft rotates at a less torque than above, shim(40) needs to be replaced with thicker one in order to get a higher parking brake torque.

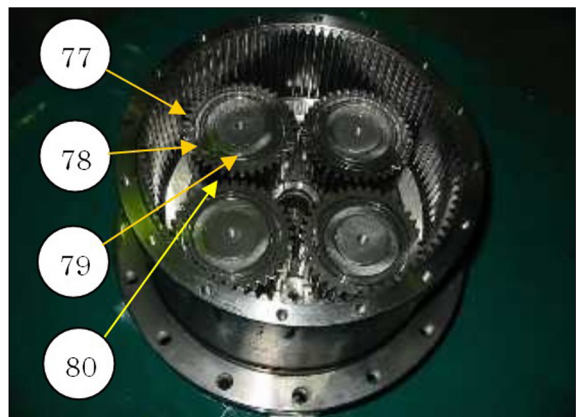
There are some variations of thickness available for shim(40). The thicker the shim is, the higher the parking brake torque is. The thinner the shim is, the lower the parking torque is.

**⚠ Don't apply too thick shim to the travel motor. It may cause damage to braking parts because of malfunction in brake-releasing action in traveling.**

(41) Install four plates(80), four bushes(79), four bearings(78) and four planetary gears(77) as shown.

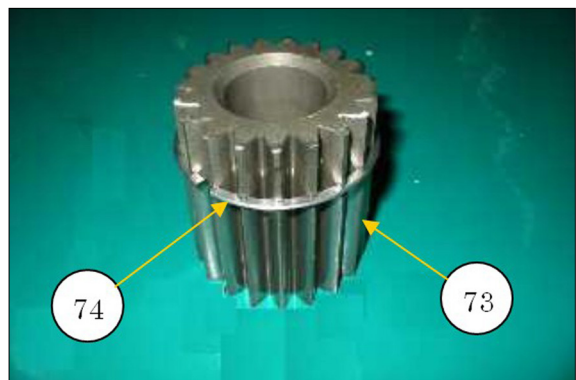


11078TM118



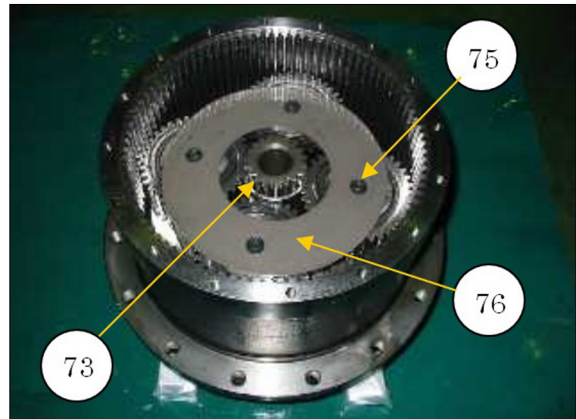
11078TM119

(42) Install snap ring(74) to sun gear(73).



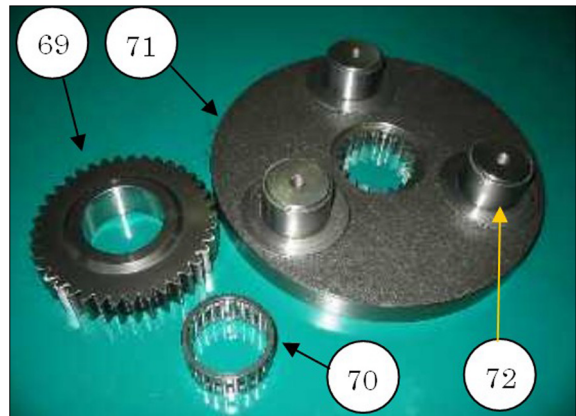
11078TM120

- (43) Put thrust plate(76) as shown. Apply **Thread Lock "THREE BOND 2403"** to bolts(75). Install four bolts(75). Tighten the bolts to a torque of  $68.6 \pm 4.9$  N·m ( $50.6 \pm 3.6$  lbf·ft). Then install sun gear(73).



11078TM121

- (44) Install three inner races(72) on the carrier shaft.



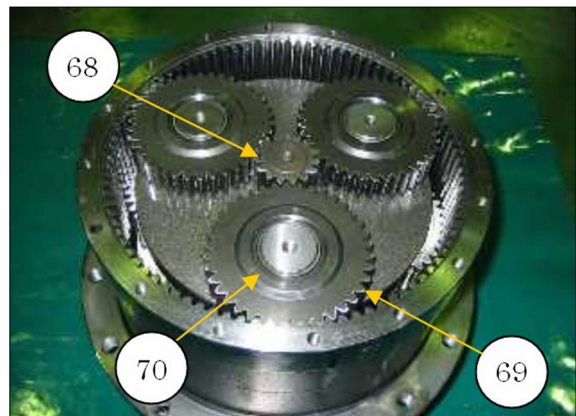
11078TM122

- (45) Install carrier(71) as shown.



11078TM123

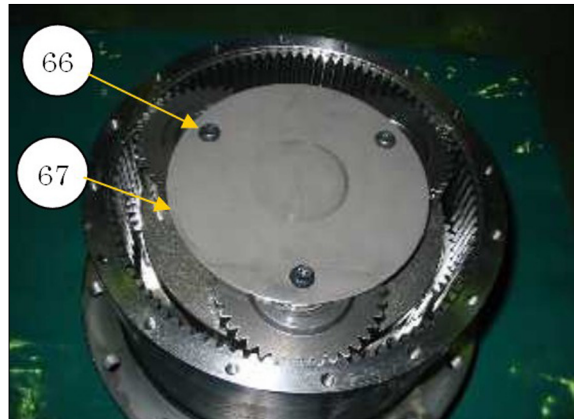
- (46) Install three bearings(70) and three planetary gears(69) on the carrier shaft assembly. Then install sun gear(68).



11078TM124

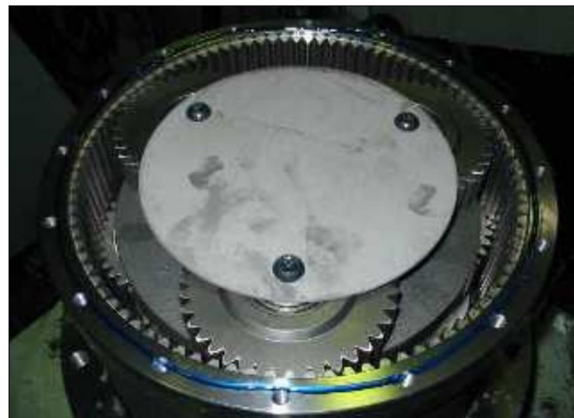


- (47) Put thrust plate(67) on the carrier. Apply **Thread Lock "THREE BOND 2403"** to bolts(66). Install three bolts(66) that hold plate(67) to the planetary carrier. Tighten the bolts to a torque of  $68.6 \pm 4.9$  N·m ( $50.6 \pm 3.7$  lbf·ft).



11078TM125

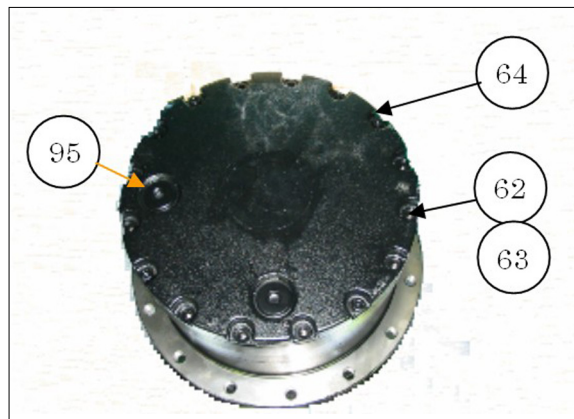
- (48) Make sure the machined surface of gear casing(65) and cover(64) is completely clean, free of dirt and debris, and is dry. Put a bead of **Gasket Maker "THREE BOND 1389"** around the machined surface of the gear casing as shown. Put cover(64) in its original position on the gear casing.



11078TM126

- (49) Install sixteen bolts(62) and sixteen washers(63) that hold the cover. Tighten the bolts to a torque of  $35.3 \pm 2$  N·m ( $26 \pm 1.5$  lbf·ft).  
Install lubricating oil from the drain port. The capacity of the travel motor is **2.5liters(0.55U.K.gal; 0.66U.S.gal)**.

- ⚠ **To prevent damage to the motor, the case of the motor must be filled with hydraulic oil before operation.**



11078TM127

This is the end of assembling process



## GROUP 7 RCV LEVER

### 1. REMOVAL AND INSTALL

#### 1) REMOVAL

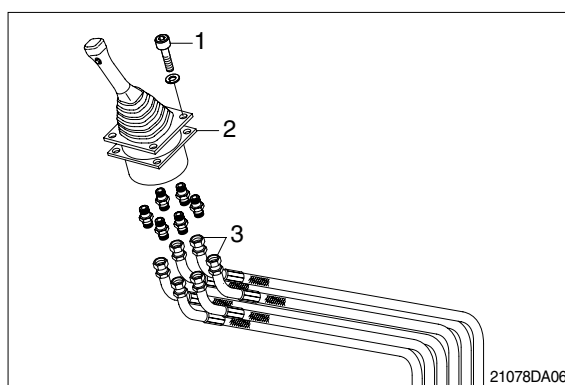
- (1) Lower the work equipment to the ground and stop the engine.
- (2) Operate the control levers and pedals several times to release the remaining pressure in the hydraulic piping.
- (3) Loosen the breather slowly to release the pressure inside the hydraulic tank.

**▲ 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.

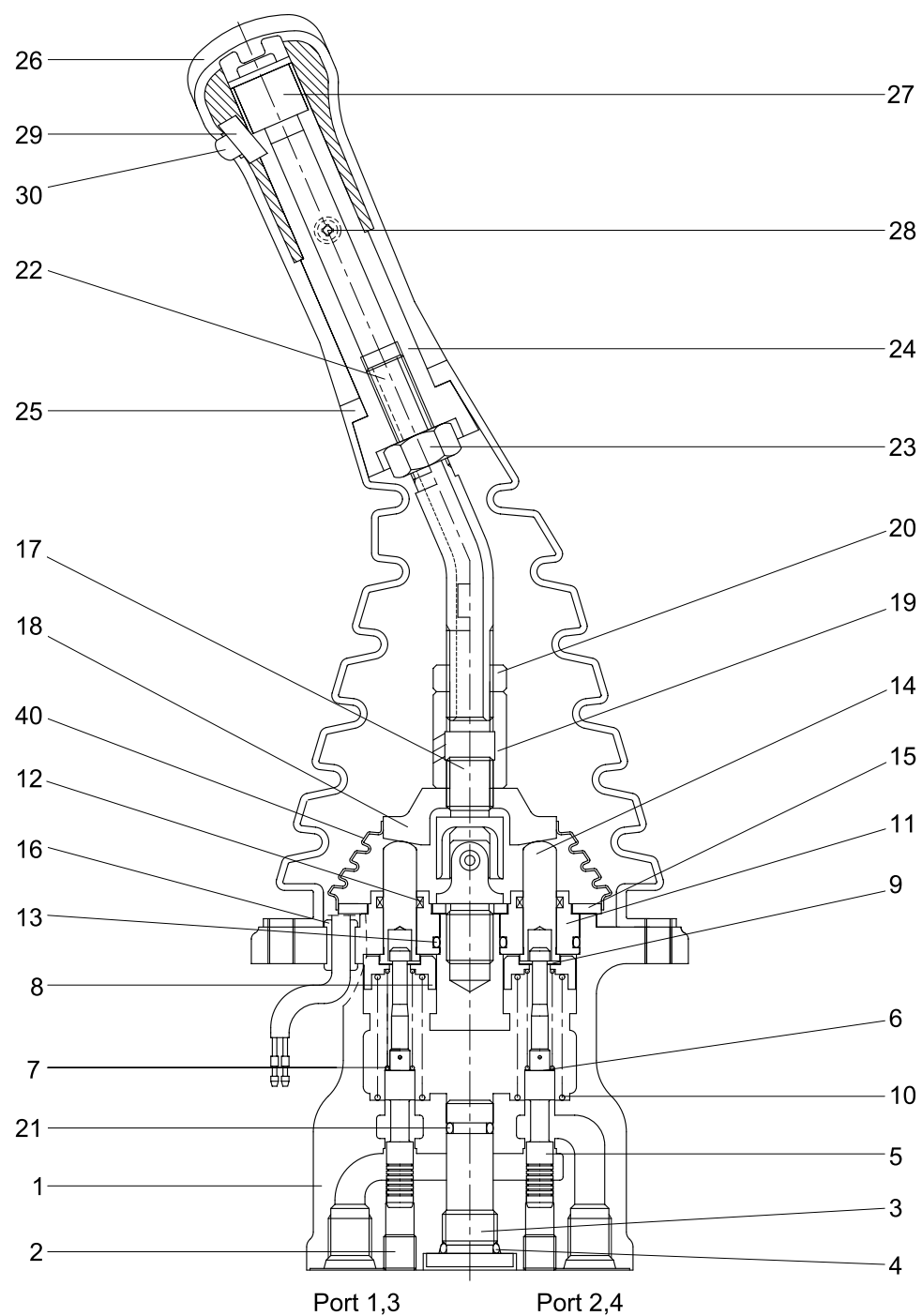
#### 2) INSTALL

- (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

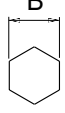


14072SF80

1	Case	12	Rod seal	22	Handle connector
2	Plug	13	O-ring	23	Nut
3	Plug	14	Push rod	24	Insert
4	O-ring	15	Plate	25	Boot
5	Spool	16	Bushing	26	Handle
6	Shim	17	Joint assembly	27	Switch assembly
7	Spring	18	Swash plate	28	Screw
8	Spring seat	19	Adjusting nut	29	Switch assembly
9	Stopper	20	Lock nut	30	Switch cover
10	Spring	21	O-ring	40	Boot
11	Plug				

## 2) TOOLS AND TIGHTENING TORQUE

### (1) Tools

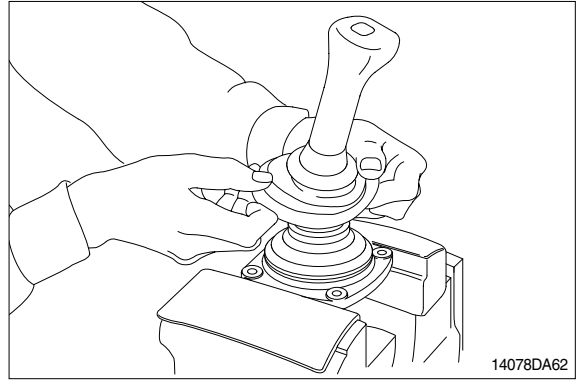
Tool name	Remark	
Allen wrench	6	
Spanner	22	
	27	
(+) Driver	Length 150	
(-) Driver	Width 4~5	
Torque wrench	Capable of tightening with the specified torques	

### (2) Tightening torque

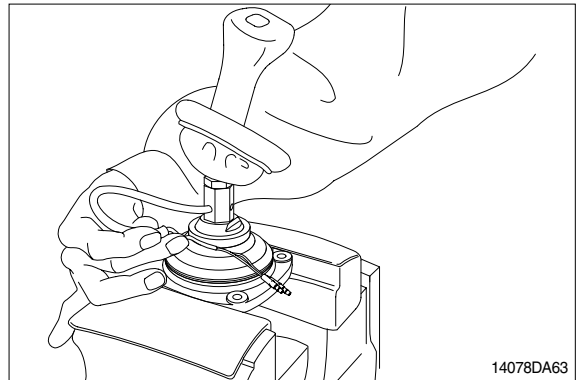
Part name	Item	Size	Torque	
			kgf · m	lbf · ft
Plug	2	PT 1/8	3.0	21.7
Joint	18	M14	3.5	25.3
Swash plate	19	M14	5.0±0.35	36.2±2.5
Adjusting nut	20	M14	5.0±0.35	36.2±2.5
Lock nut	21	M14	5.0±0.35	36.2±2.5
Screw	29	M 3	0.05	0.36

### 3) DISASSEMBLY

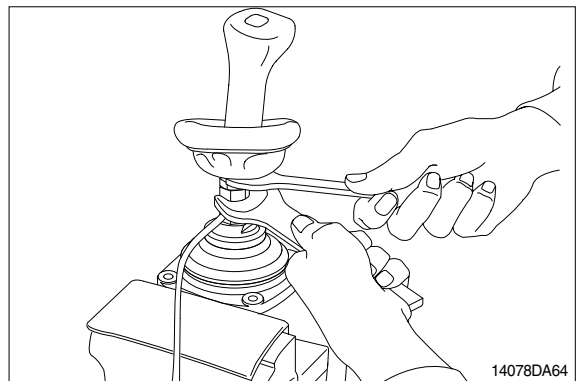
- (1) Clean pilot valve with kerosene.
  - ※ Put blind plugs into all ports
- (2) Fix pilot valve in a vise with copper(or lead) sheets.
- (3) Remove end of boot(26) from case(1) and take it out upwards.



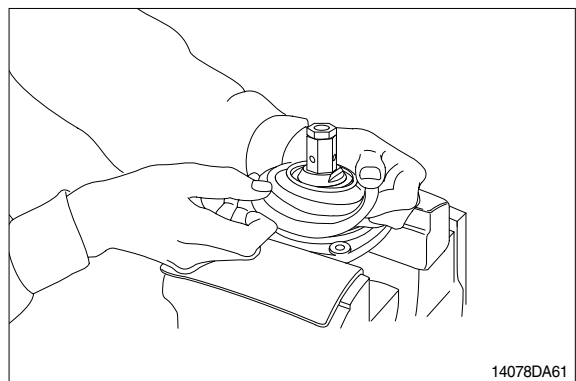
- ※ For valve with switch, remove cord also through hole of casing.



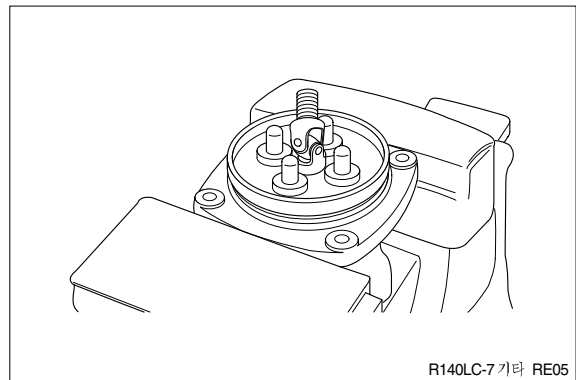
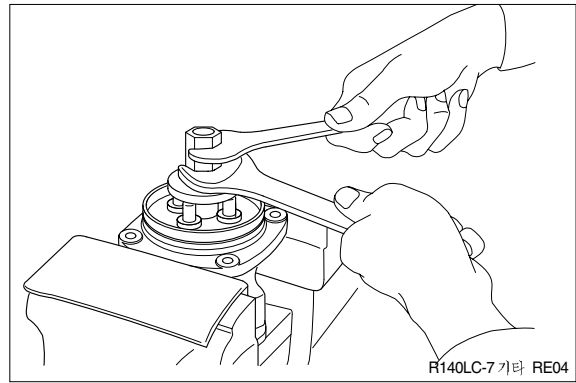
- (4) Loosen lock nut(21) and adjusting nut(20) with spanners on them respectively, and take out handle section as one body.



- (5) Remove the boot(40)

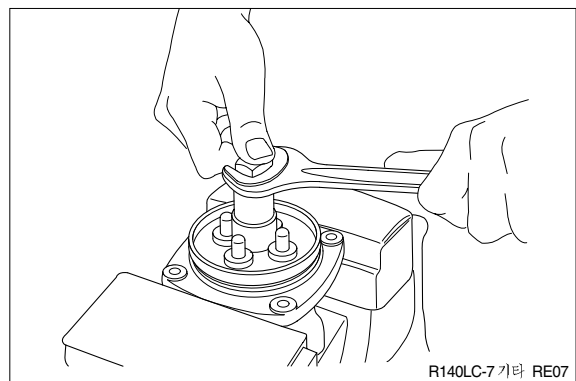
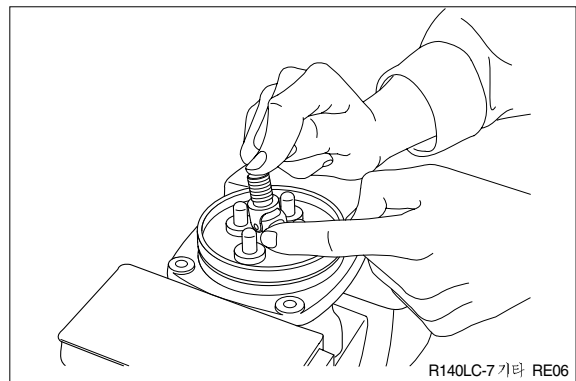


- (6) Loosen adjusting nut(20) and plate(19) with spanners on them respectively, and remove them.

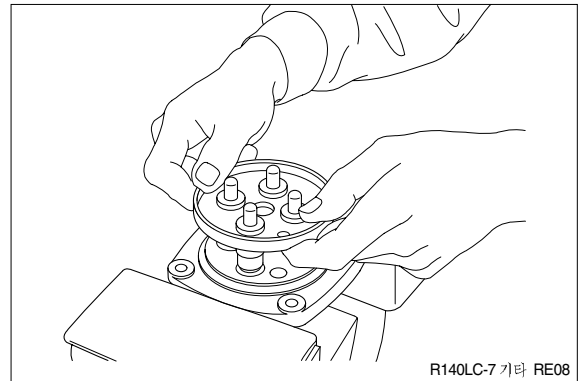


- (7) Turn joint anticlockwise to loosen it, utilizing jig(Special tool).

※ 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.



(8) Remove plate(16).



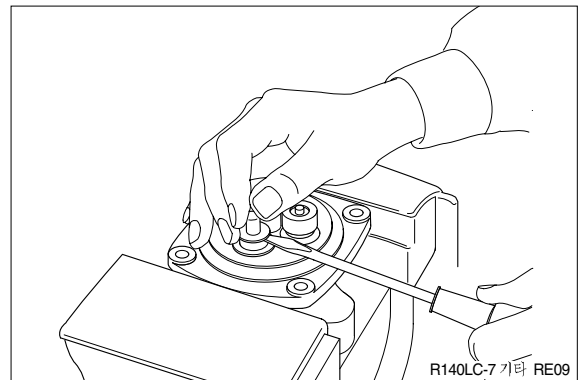
(9) When return spring(10) is weak in force, plug(11) stays in casing because of sliding resistance of O-ring.

※ 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.

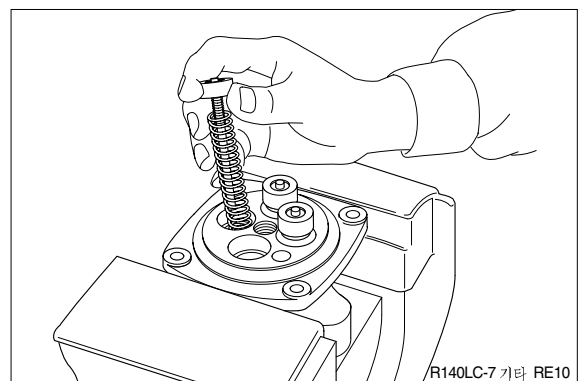
※ During taking out, plug may jump up due to return spring(10) force.

Pay attention to this.

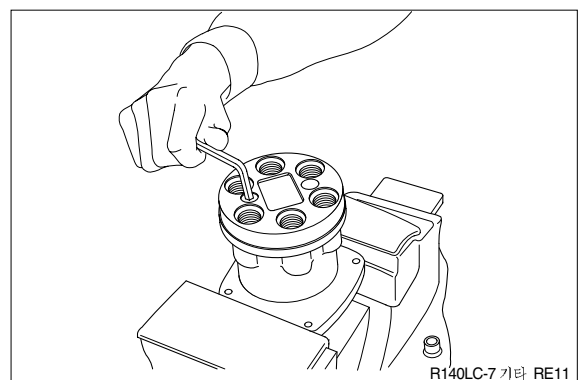


(10) Remove reducing valve subassembly and return spring(10) out of casing.

※ Record relative position of reducing valve subassembly and return springs.

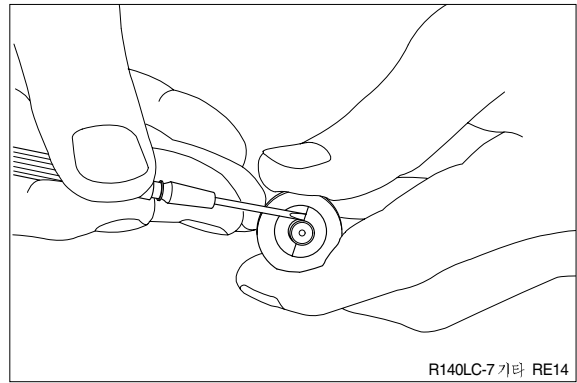


(11) Loosen hexagon socket head plug(2) with hexagon socket screw key.



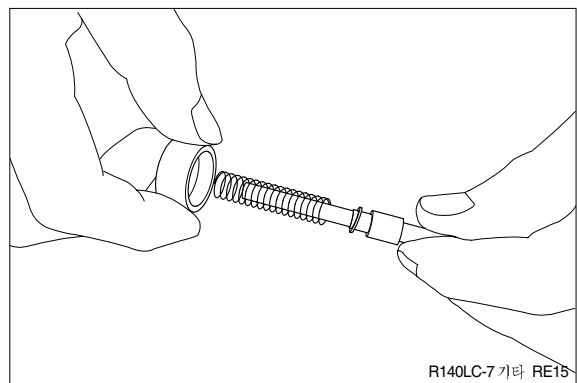
(12) For disassembling reducing valve section, stand it vertically with spool(5) bottom placed on flat workbench. Push down spring seat(8, 31) and remove two pieces of semicircular stopper(9) with tip of small minus screwdriver.

- ※ Pay attention not to damage spool surface.
- ※ Record original position of spring seat(8, 31).
- ※ Do not push down spring seat more than 6mm.

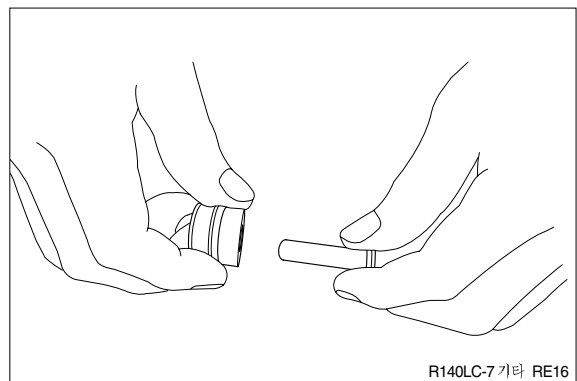


(13) Separate spool(5), spring seat(8, 31), spring(7, 30) and shim(6) individually.

- ※ Until being assembled, they should be handled as one subassembly group.

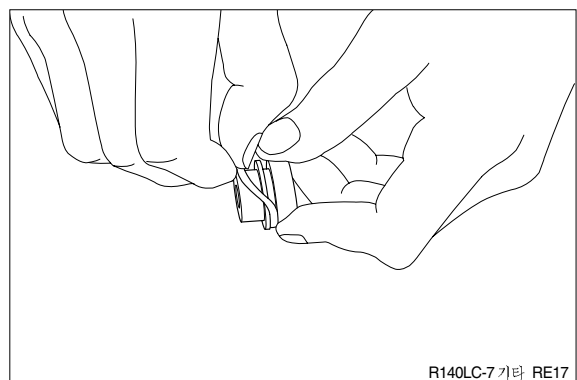


(14) Take push rod(14, 15) out of plug(11).

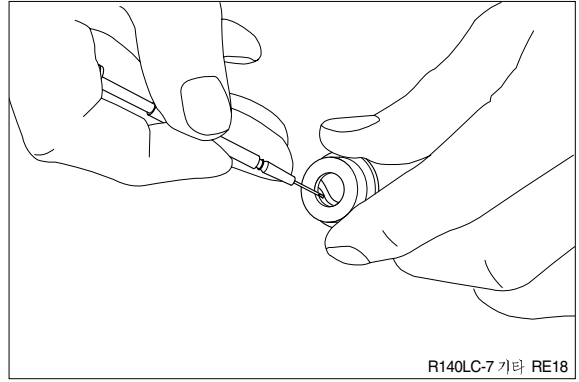


(15) Remove O-ring(13) and seal(12) from plug(11).

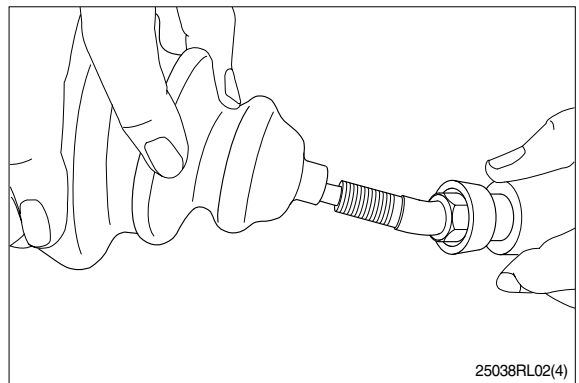
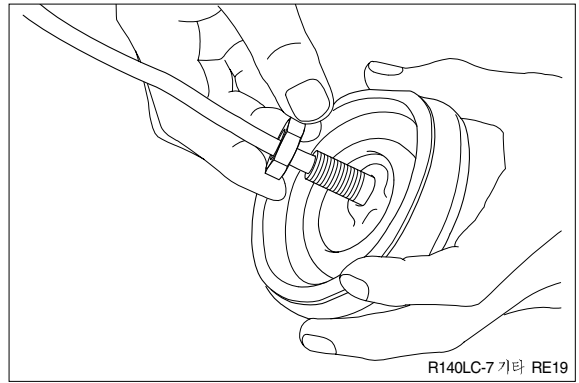
Use small minus screwdriver or so on to remove this seal.







(16) Remove lock nut(21) and then boot(26).



### **(17) 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.

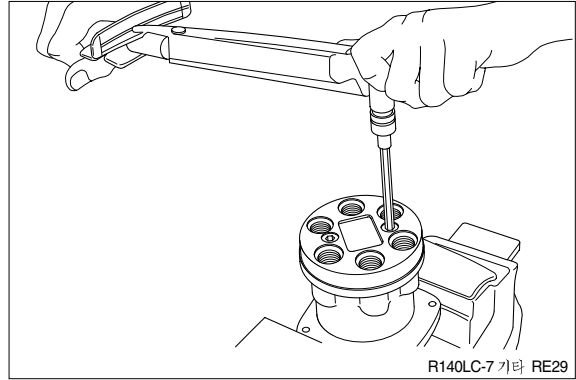
### **(18) Rust prevention of parts**

- 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.

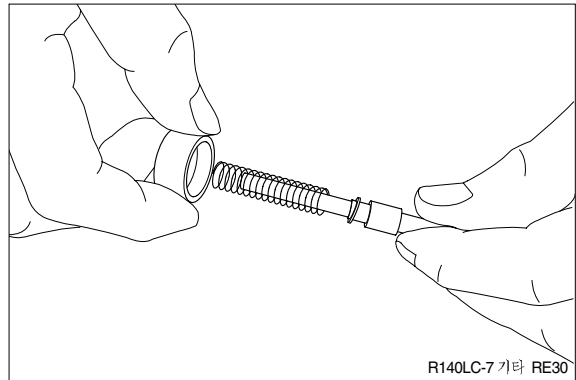
#### 4) ASSEMBLY

- (1) Tighten hexagon socket head plug(2) to the specified torque.

※ Tighten two bolts alternately and slowly.

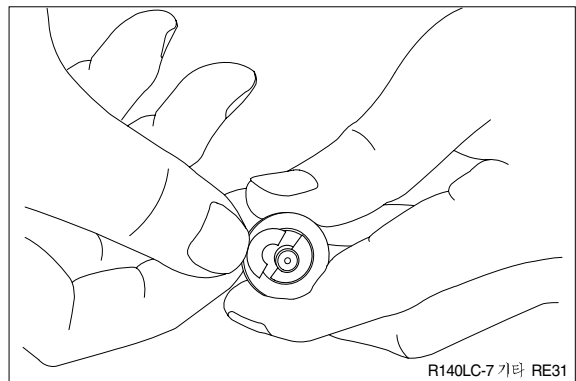


- (2) Put shim(6), springs(7, 30) and spring seat(8, 31) onto spool(5) in this order.



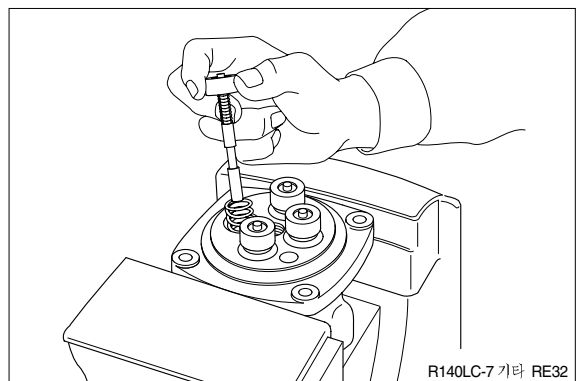
- (3) Stand spool vertically with its bottom placed on flat workbench, and with spring seat pushed down, put two pieces of semicircular stopper(9) on spring seat without piling them on.

※ 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.

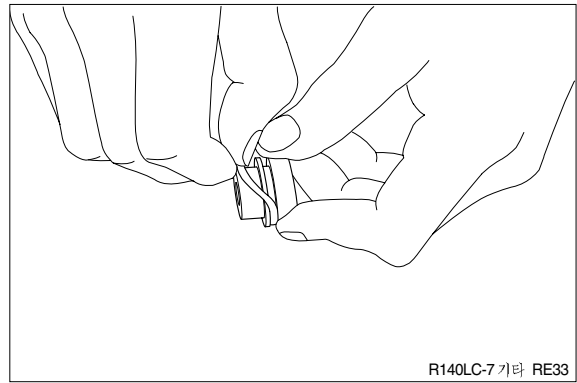


- (4) Assemble spring(10) into casing.  
Assemble reducing valve subassembly into casing.

※ Assemble them to their original positions.

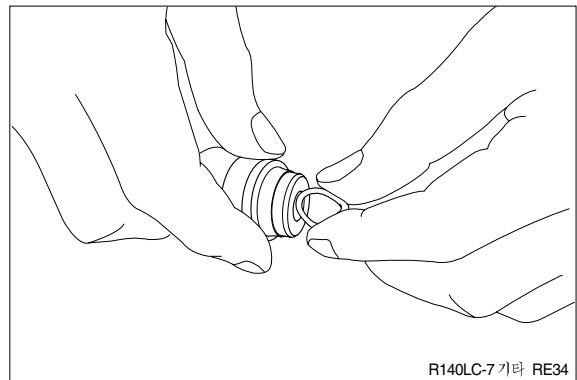


(5) Assemble O-ring(13) onto plug(11).



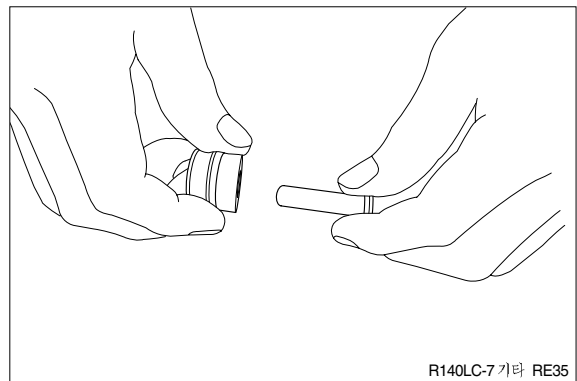
(6) Assemble seal(12) to plug(11).

※ Assemble seal in such lip direction as shown below.



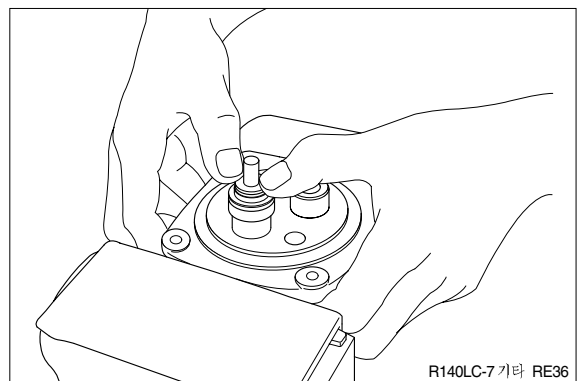
(7) Assemble push rod(14, 15) to plug(11).

※ Apply working oil on push-rod surface.

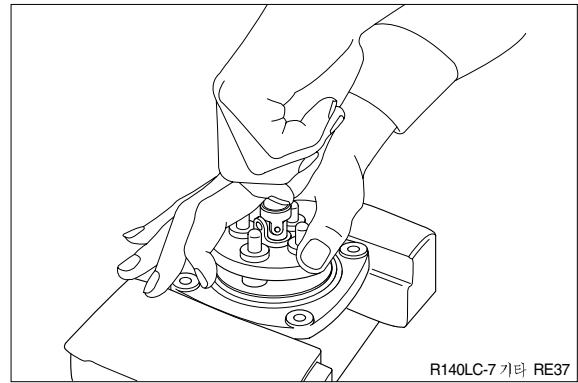


(8) Assemble plug subassembly to casing.

※ When return spring is weak in force, subassembly stops due to resistance of O-ring.

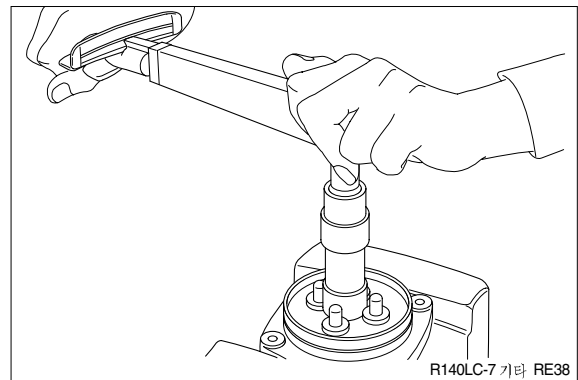


- (9) When return spring is strong in force, assemble 4 sets at the same time, utilizing plate(16), and tighten joint(18) temporarily.



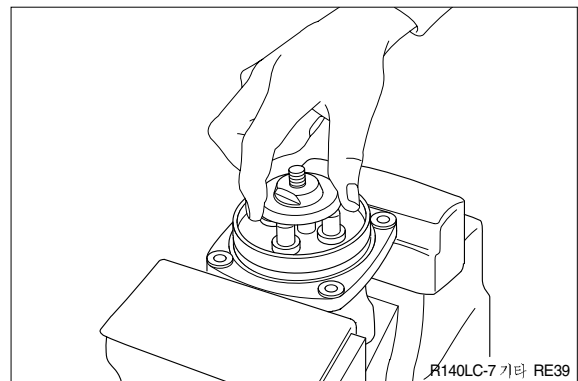
- (10) Fit plate(16).

- (11) Tighten joint(18) with the specified torque to casing, utilizing jig.



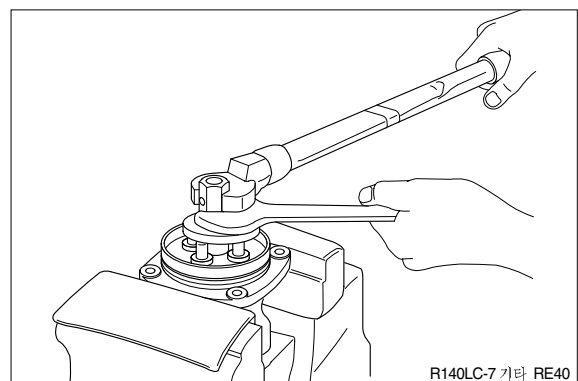
- (12) Assemble plate(19) to joint(18).

- ※ Screw it to position that it contacts with 4 push rods evenly.
- ※ Do not screw it over.

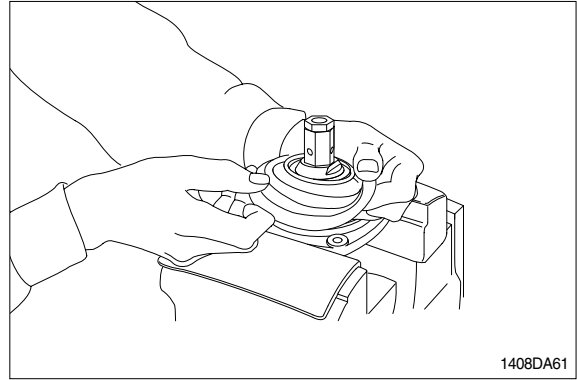


- (13) Assemble adjusting nut(20), apply spanner to width across flat of plate(19) to fix it, and tighten adjusting nut to the specified torque.

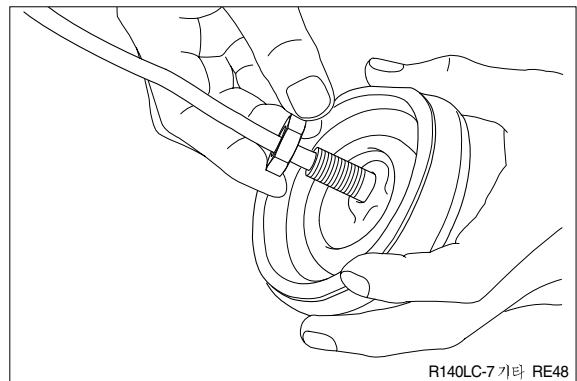
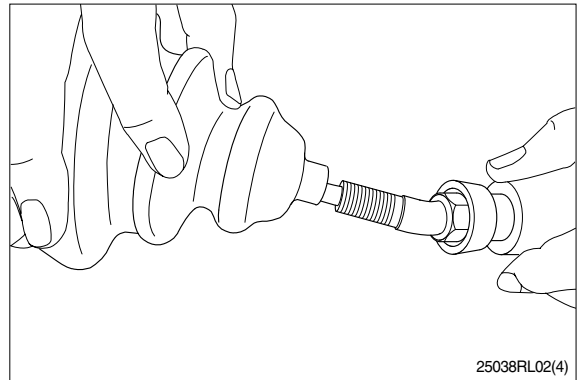
- ※ During tightening, do not change position of disk.



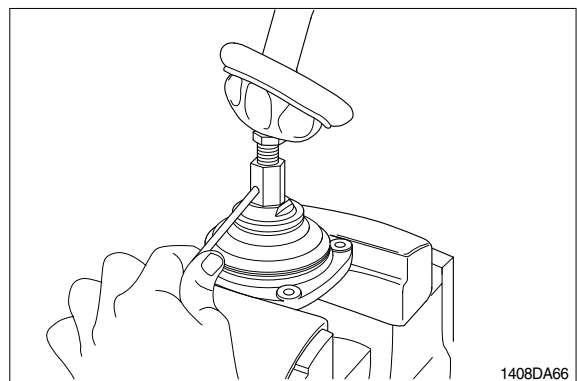
(14) Fit boot(40) to plate.



(15) Fit boot(26) and lock nut(21), and handle subassembly is assembled completely.

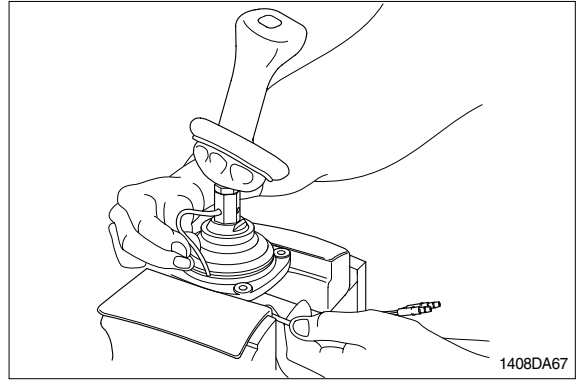


(16) Pull out cord and tube through adjusting nut hole provided in direction 60° to 120° from casing hole.

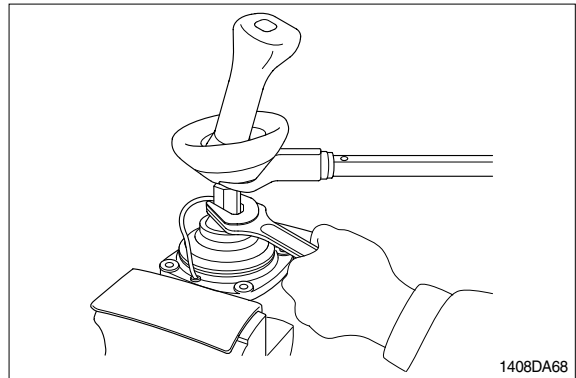


(17) Assemble bushing(17) to plate and pass cord and tube through it.

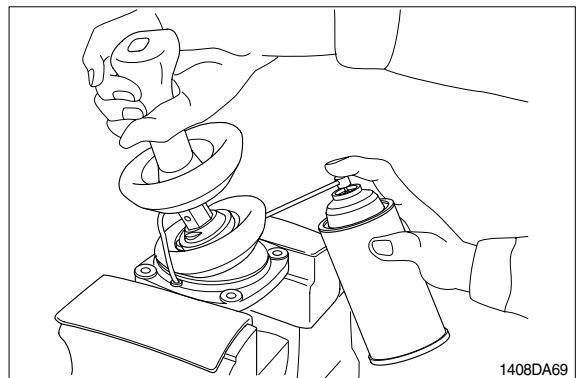
※ Provide margin necessary to operation.



(18) Determine handle direction, tighten lock nut(21) to specified torque to fix handle.

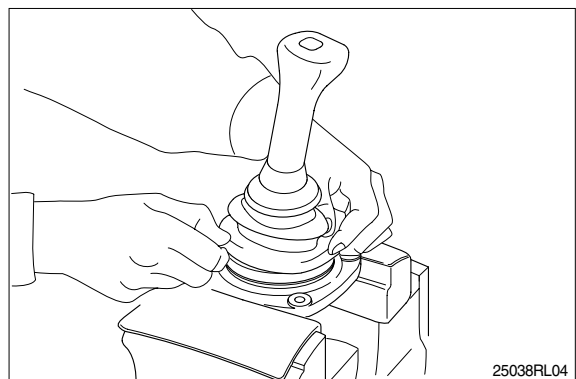


(19) Apply grease to rotating section of joint and contacting faces of disk and push rod.



(20) Assemble lower end of bellows to casing.

(21) 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.

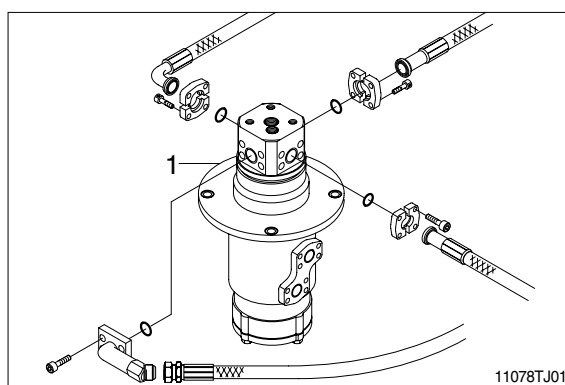
**▲ Escaping fluid under pressure can penetrate the skin causing serious injury.**

※ 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 : 54kg(119lb)
  - Tightening torque :  $12.3 \pm 1.3\text{kgf} \cdot \text{m}$   
( $88.2 \pm 9.4\text{lbf} \cdot \text{ft}$ )

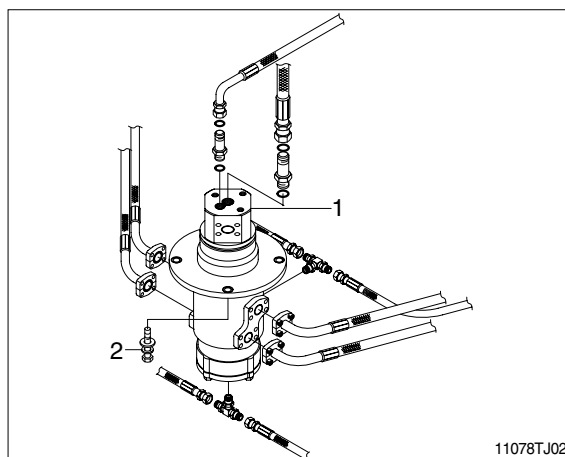
- (6) Remove the turning joint assembly.

※ When removing the turning joint, check that all the hoses have been disconnected.



#### 2) INSTALL

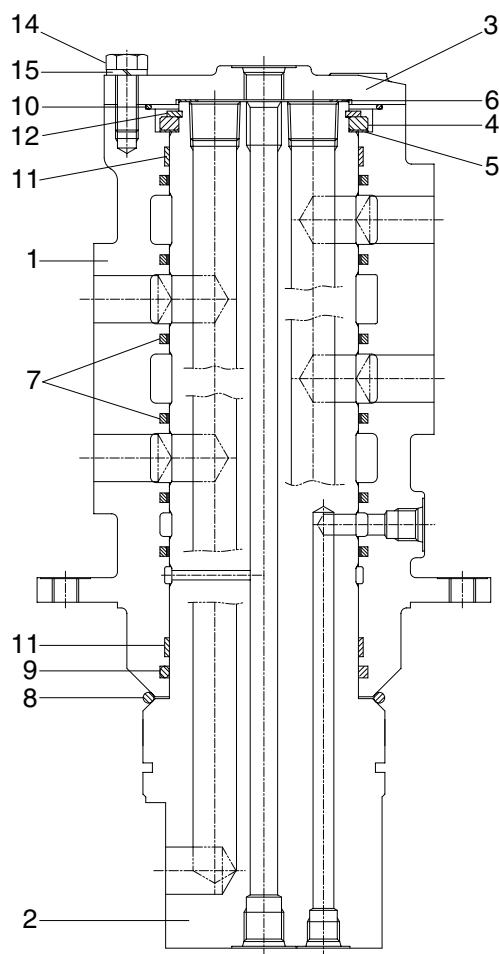
- (1) Carry out installation in the reverse order to removal.
  - ※ Take care of turning joint direction.
  - ※ Assemble hoses to their original positions.
  - ※ Confirm the hydraulic oil level and check the hydraulic oil leak or not.





## 2. DISASSEMBLY AND ASSEMBLY

### 1) STRUCTURE



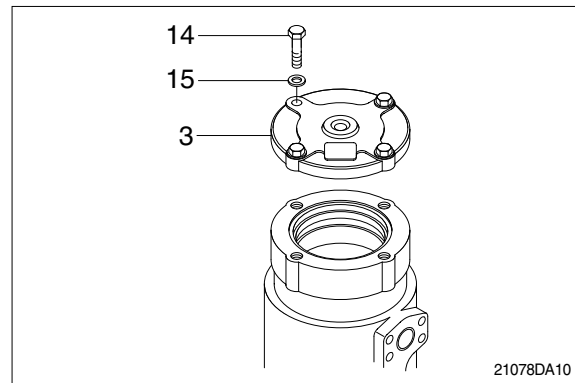
21078DA09

1	Hub	6	Shim	11	Wear ring
2	Shaft	7	Slipper seal	12	Retainer ring
3	Cover	8	O-ring	13	Plug
4	Spacer	9	O-ring	14	Hexagon bolt
5	Shim	10	O-ring	15	Spring washer

## 2) DISASSEMBLY

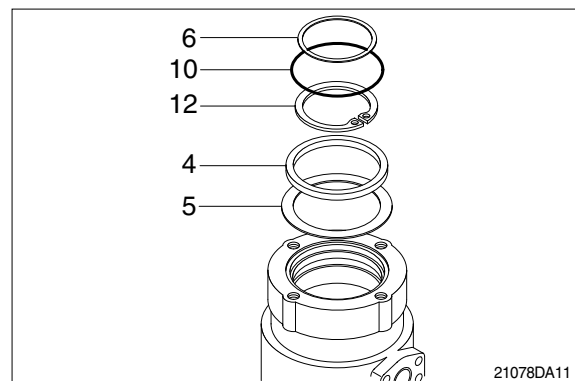
※ Before the disassembly, clean the turning joint.

- (1) Remove bolts(14), washer(15) and cover(3).



- (2) Remove shim(6) and O-ring(10).

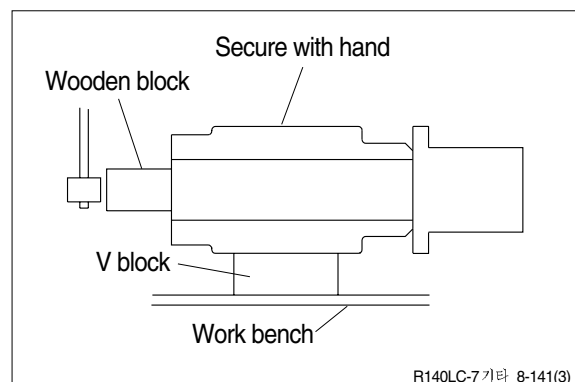
- (3) Remove retainer ring(12), spacer(4) and shim(5).



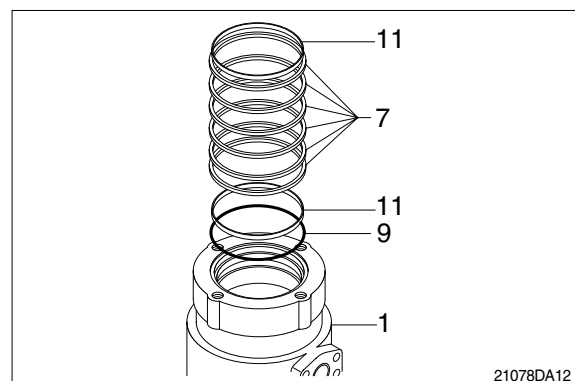
- (4) Place hub(1) on a V-block and by using a wood buffer at the shaft end, hit out shaft(2) to about 1/2 from the body with a hammer.

※ 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), two ring wear(11) from hub(1).

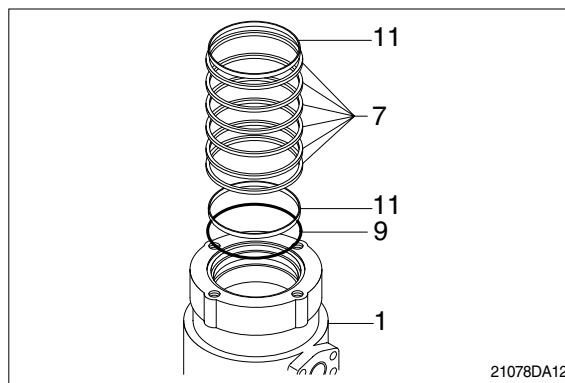


### 3) ASSEMBLY

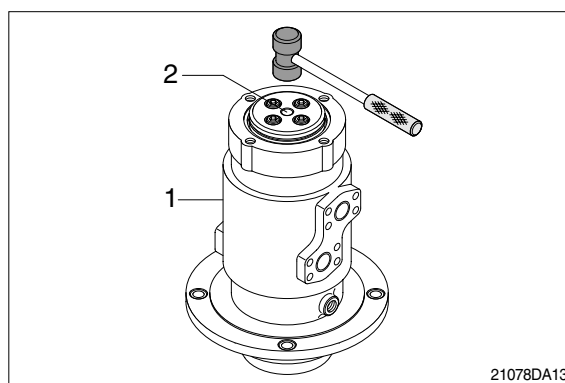
- ※ Clean all parts.
- ※ As a general rule, replace oil seals and O-ring.
- ※ Coat the sliding surfaces of all parts with engine oil or grease before installing.

(1) Fix seven slipper seal(7) and O-ring(9), two ring wear(11) to hub(1).

(2) Fit O-ring(8) to shaft(2).



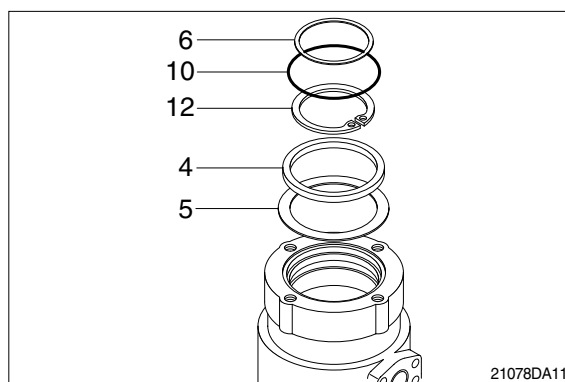
(3) Set shaft(2) on block, tap hub(1) with a plastic hammer to install.



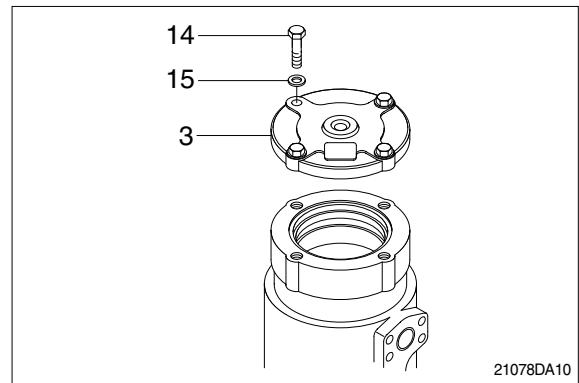
(4) Fit shim(5), spacer(4) and retainer ring (12) to shaft(2).

(5) Fit O-ring(10) to hub(1).

(6) Fit shim(6) to shaft(2).



- (7) Install cover(3) to body(1) and tighten bolts(14).
- Torque : 10~12.5kgf · m(72.3~90.4lbf · ft)



## GROUP 9 BOOM, ARM AND BUCKET CYLINDER

### 1. REMOVAL AND INSTALL

#### 1) BUCKET CYLINDER

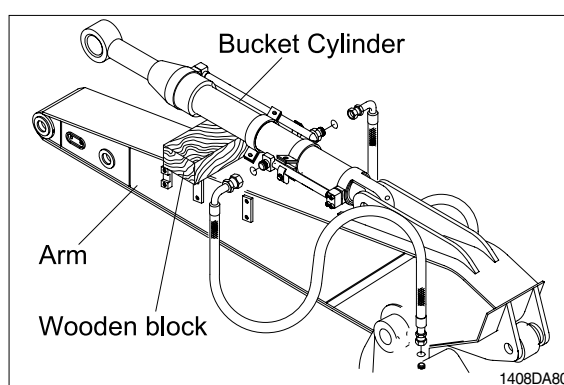
##### (1) Removal

- ※ 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.**

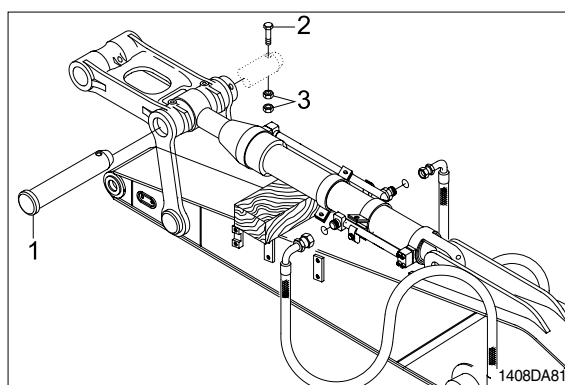
- ※ Escaping fluid under pressure can penetrate the skin causing serious injury. Fit blind plugs in the hoses after disconnecting them, to prevent dirt or dust from entering.

① Set block between bucket cylinder and arm.

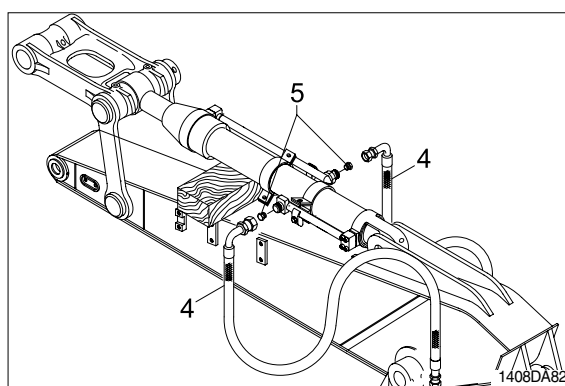


② Remove bolt(2), nut(3) and pull out pin (1).

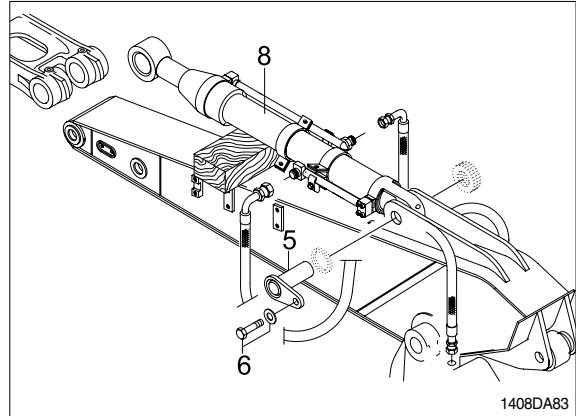
- ※ Tie the rod with wire to prevent it from coming out.



③ Disconnect bucket cylinder hoses(4) and put plugs(5) on cylinder pipe.



- ④ Sling bucket cylinder assembly(8) and remove bolt(6) then pull out pin (5).
- ⑤ Remove bucket cylinder assembly(8).
  - Weight : 90kg(200lb)



## (2) Install

- ① Carry out installation in the reverse order to removal.

**▲ When aligning the mounting position of the pin, do not insert your fingers in the pin hole.**

- ※ Bleed the air from the bucket cylinder.
- ※ Confirm the hydraulic oil level and check the hydraulic oil leak or not.

## 2) ARM CYLINDER

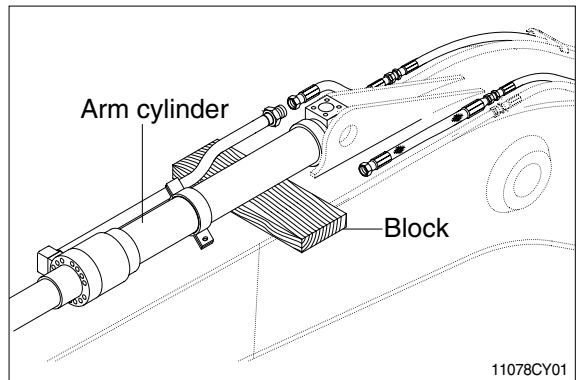
### (1) Removal

- ※ Expand the arm and bucket fully, lower the work equipment to the ground and stop the engine.
- ※ Operate the control levers and pedals several times to release the remaining pressure in the hydraulic piping.

**⚠ Loosen the breather slowly to release the pressure inside the hydraulic tank.**

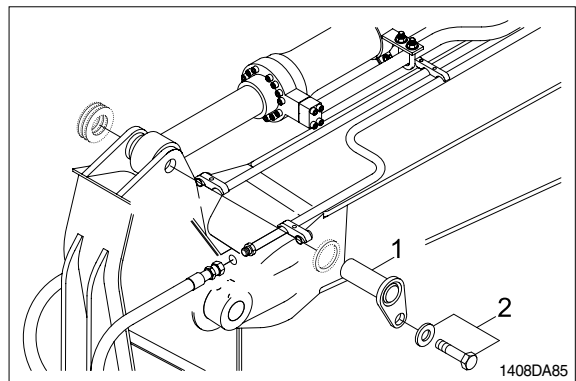
- ※ Escaping fluid under pressure can penetrate the skin causing serious injury. Fit blind plugs in the hoses after disconnecting them, to prevent dirt or dust from entering.

① Set block between arm cylinder and boom.



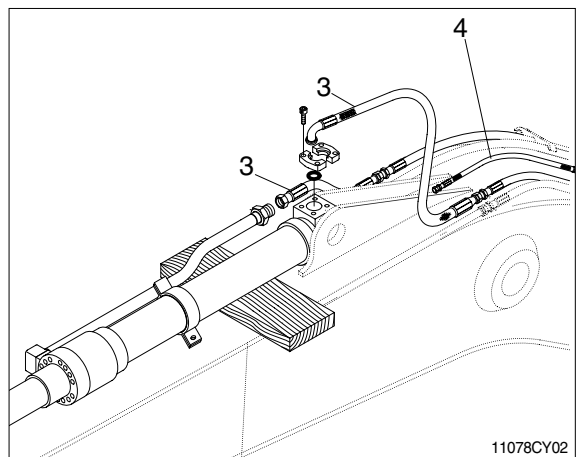
② Remove bolt(2) and pull out pin(1).

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

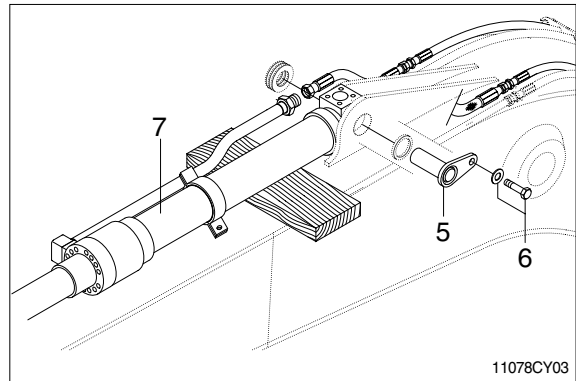


③ Disconnect arm cylinder hoses(3) and put plugs on cylinder pipe.

④ Disconnect greasing pipings(4).



- ⑤ Sling arm assembly(7) and remove bolt (6) then pull out pin(5).
- ⑥ Remove arm cylinder assembly(7).
  - Weight : 140kg(310lb)



## (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

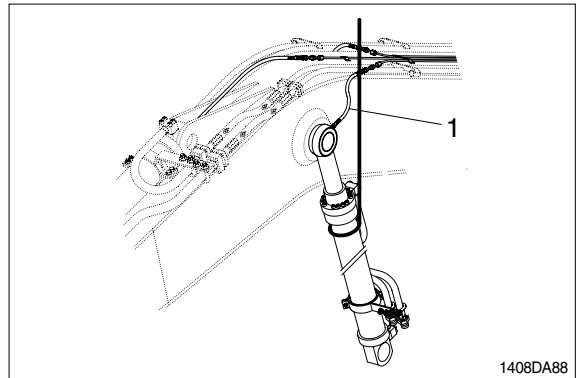
#### (1) Removal

- ※ 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.

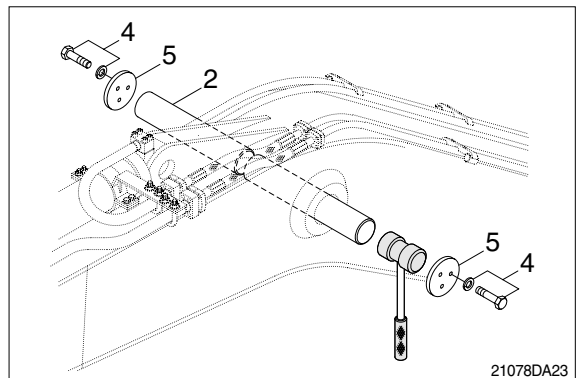
**▲ Loosen the breather slowly to release the pressure inside the hydraulic tank.**

- ※ 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.

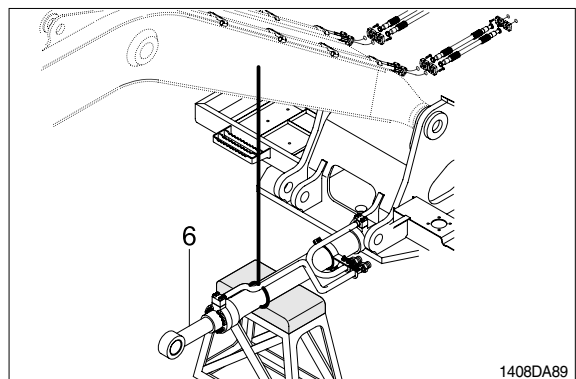
- ① Disconnect greasing hoses(1).
- ② Sling boom cylinder assembly.



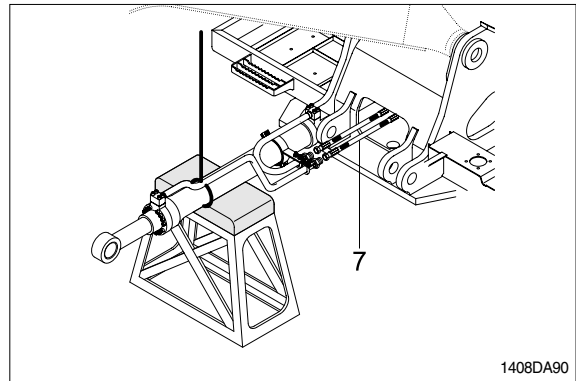
- ③ Remove bolt(4), stop plate(5) and pull out pin(2).
- ※ Tie the rod with wire to prevent it from coming out.



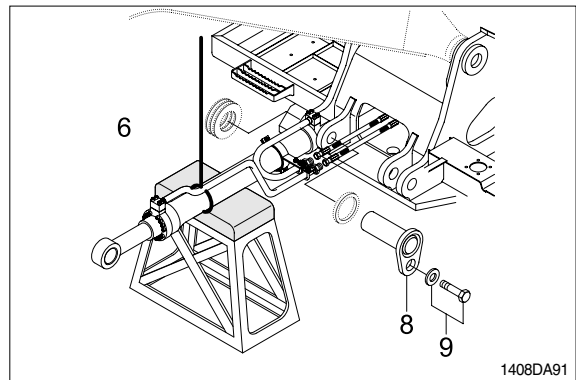
- ④ Lower the boom cylinder assembly(6) on a stand.



- ⑤ Disconnect boom cylinder hoses(7) and put plugs on cylinder pipe.



- ⑥ Remove bolt(9) and pull out pin(8).  
⑦ Remove boom cylinder assembly(6).  
· Weight : 115kg(255lb)



## (2) Install

- ① Carry out installation in the reverse order to removal.

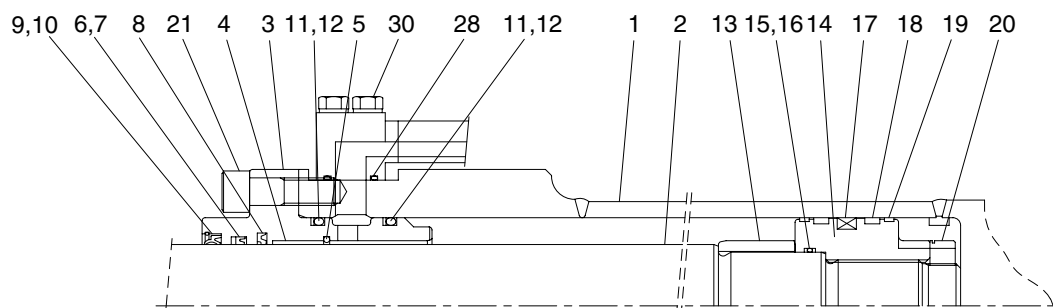
**▲ When aligning the mounting position of the pin, do not insert your fingers in the pin hole.**

- ※ Bleed the air from the boom cylinder.
- ※ Confirmed the hydraulic oil level and check the hydraulic oil leak or not.

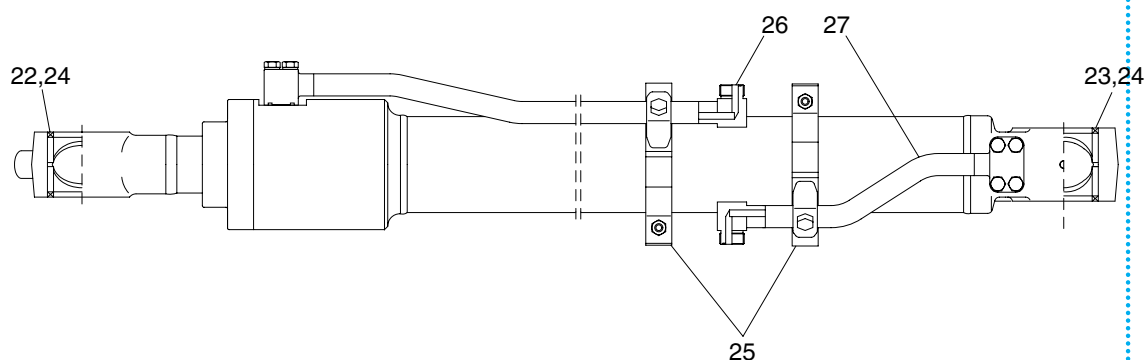
## 2. DISASSEMBLY AND ASSEMBLY

### 1) STRUCTURE

#### (1) Bucket cylinder



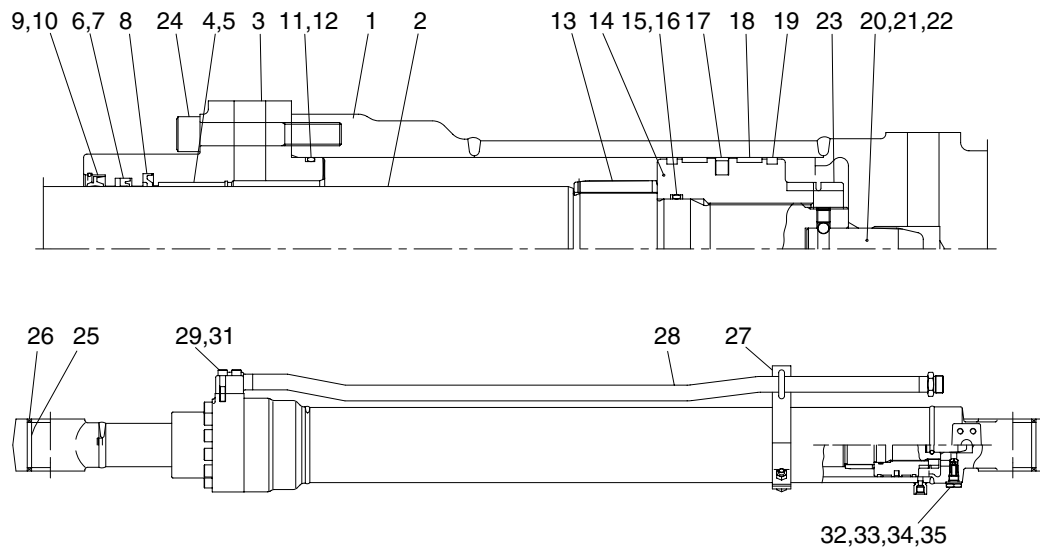
Internal detail



11078CY05

1	Tube assembly	11	O-ring	21	Hexagon socket head bolt
2	Rod assembly	12	Back up ring	22	Pin bush
3	Gland	13	Cushion ring	23	Pin bush
4	DD2 bush	14	Piston	24	Dust seal
5	Snap ring	15	O-ring	25	Band assembly
6	Rod seal	16	Back up ring	26	Pipe assembly(R)
7	Back up ring	17	Piston seal	27	Pipe assembly(B)
8	Buffer ring	18	Wear ring	28	O-ring
9	Dust wiper	19	Dust ring	29	O-ring
10	Snap ring	20	Lock nut	30	Hexagon socket head bolt

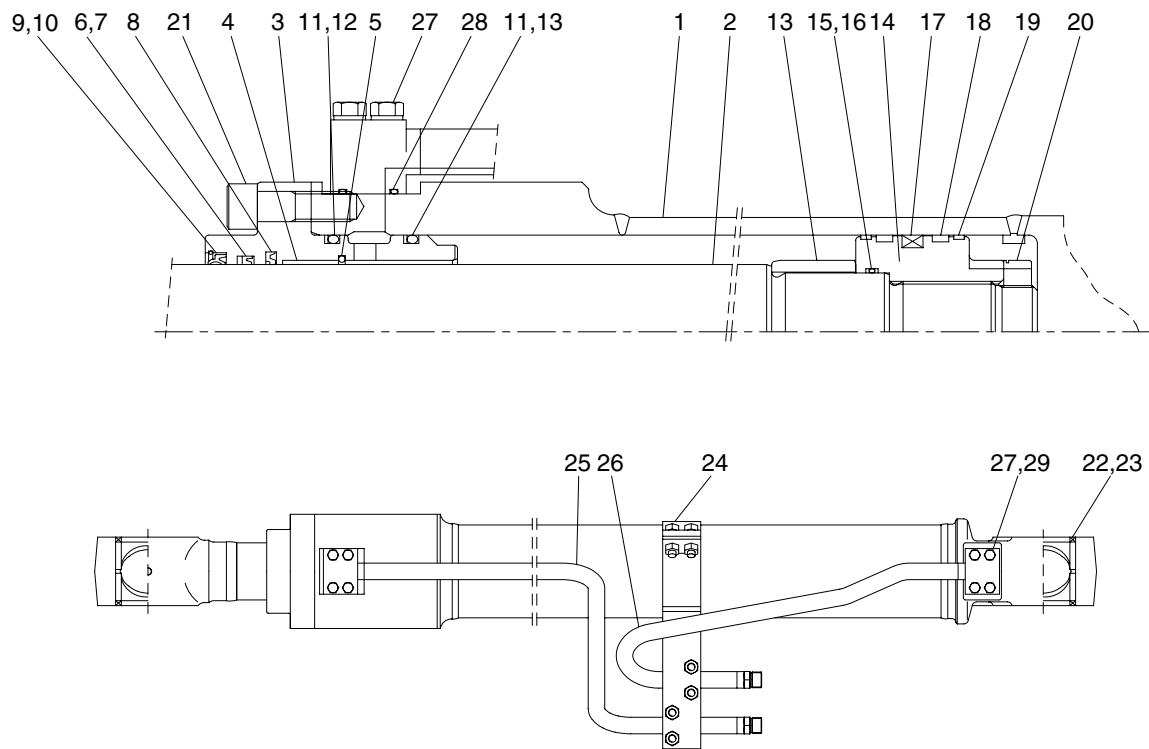
## (2) Arm cylinder



11078CY07

1	Tube assembly	13	Cushion ring	25	Pin bush
2	Rod assembly	14	Piston	26	Dust seal
3	Gland	15	O-ring	27	Band assembly
4	DD2 Bush	16	Back up ring	28	Pipe assembly(R)
5	Snap ring	17	Piston seal	29	O-ring
6	Rod seal	18	Wear ring	30	O-ring
7	Back up ring	19	Dust ring	31	Hexagon socket head bolt
8	Buffer ring	20	Cushion spear	32	Check valve
9	Dust wiper	21	Steel ball	33	Coil spring
10	Snap ring	22	Set screw	34	O-ring
11	O-ring	23	Lock nut	35	Plug
12	Back up ring	24	Hexagon socket head bolt		

### (3) Boom cylinder

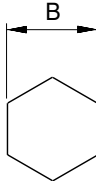


11078CY06

1	Tube assembly	11	O-ring	21	Hexagon socket head bolt
2	Rod assembly	12	Back up ring	22	Pin bush
3	Gland	13	Cushion ring	23	Dust seal
4	DD2 bush	14	Piston	24	Band assembly
5	Snpring	15	O-ring	25	Pipe assembly(R, LH/RH)
6	Rod seal	16	Back up ring	26	Pipe assembly(L, LH/RH)
7	Back up ring	17	Piston seal	27	O-ring
8	Buffer ring	18	Wear ring	28	O-ring
9	Dust wiper	19	Dust ring	29	Hexagon head bolt
10	Snap ring	20	Lock nut		

## 2) TOOLS AND TIGHTENING TORQUE

### (1) Tools

Tool name	B	Remark
Allen wrench	16	
	18	
Spanner	10	
	45	
	50	
	55	
(-) Driver		Small and large sizes
Torque wrench		Capable of tightening with the specified torques

### (2) Tightening torque

Part name		Item	Size	Torque	
				kgf · m	lbf · ft
Gland mounting bolt (Socket head bolt)	Bucket cylinder	21	M12	$9.4 \pm 1$	$68.0 \pm 7.2$
	Boom cylinder	21	M12	$9.4 \pm 1$	$68.0 \pm 7.2$
	Arm cylinder	24	M14	$15.0 \pm 2.0$	$109 \pm 14.5$
Pipe mounting bolt (Hexagon head bolt)	Bucket cylinder	30	M10	$5.4 \pm 0.5$	$39.1 \pm 3.6$
	Boom cylinder	29	M 8	$2.7 \pm 0.3$	$19.6 \pm 1.8$
	Arm cylinder	31	M10	$5.4 \pm 0.5$	$39.1 \pm 3.6$
Lock nut	Bucket cylinder	20	M40	$100 \pm 10.0$	$723 \pm 72.3$
	Boom cylinder	20	M40	$100 \pm 10.0$	$723 \pm 72.3$
	Arm cylinder	23	M50	$100 \pm 10.0$	$723 \pm 72.3$
Piston	Bucket cylinder	14	M45	$150 \pm 15.0$	$1085 \pm 109$
	Boom cylinder	15	M45	$150 \pm 15.0$	$1085 \pm 109$
	Arm cylinder	14	M55	$150 \pm 15.0$	$1085 \pm 109$

### 3) DISASSEMBLY

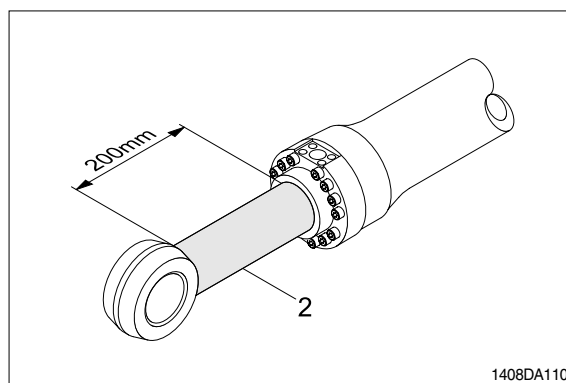
#### (1) Remove cylinder head and piston rod

※ Procedures are based on the bucket cylinder.

① Hold the clevis section of the tube in a vise.

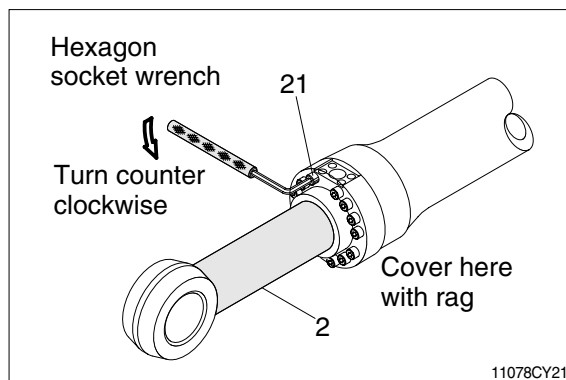
※ Use mouth pieces so as not to damage the machined surface of the cylinder tube. Do not make use of the outside piping as a locking means.

② Pull out rod assembly(2) about 200mm (7.1in). Because the rod assembly is rather heavy, finish extending it with air pressure after the oil draining operation.



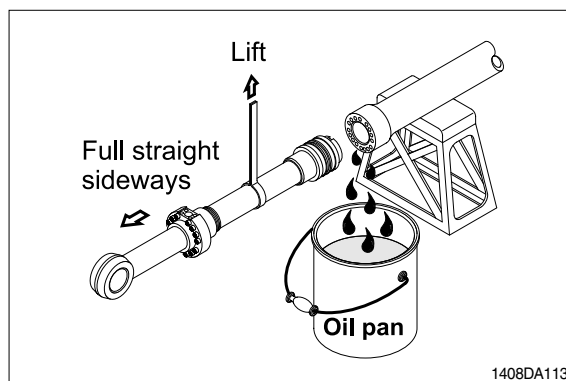
③ Loosen and remove socket bolts(21) of the gland in sequence.

※ Cover the extracted rod assembly(2) with rag to prevent it from being accidentally damaged during operation.



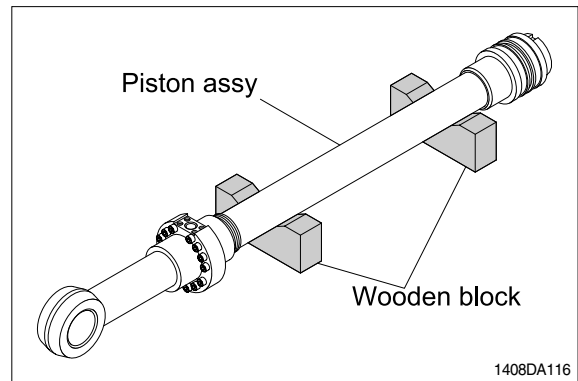
④ Draw out cylinder head and rod assembly together from tube assembly(1).

※ Since the rod assembly is heavy in this case, lift the tip of the rod assembly(2) with a crane or some means and draw it out. However, when rod assembly(2) has been drawn out to approximately two thirds of its length, lift it in its center to draw it completely.



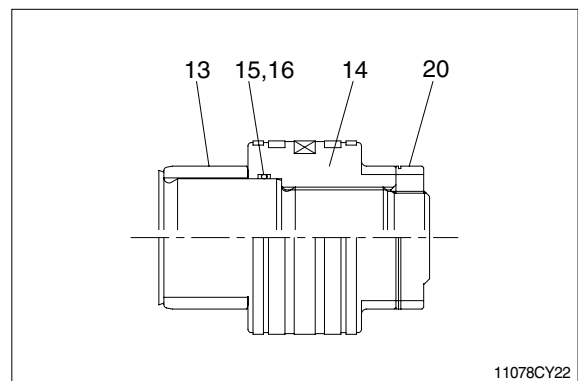
Note that the plated surface of rod assembly(2) is to be lifted. For this reason, do not use a wire sling and others that may damage it, but use a strong cloth belt or a rope.

- ⑤ Place the removed rod assembly on a wooden V-block that is set level.
- ※ Cover a V-block with soft rag.

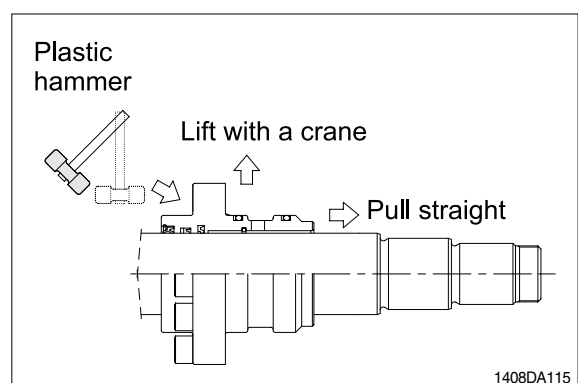


## (2) Remove piston and cylinder head

- 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 ring(16), and O-ring(15).



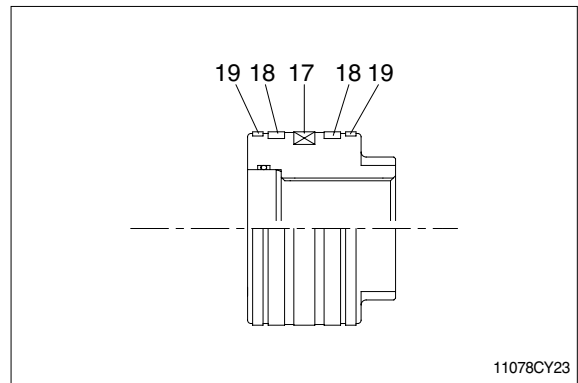
- ③ Remove the cylinder head assembly from rod assembly(2).
  - ※ If it is too heavy to move, move it by striking the flanged part of cylinder head with a plastic hammer.
  - ※ Pull it straight with cylinder head assembly lifted with a crane.
- Exercise care so as not to damage the lip of rod bushing(4) and packing (5,6,7,8,9,10) by the threads of rod assembly(2).





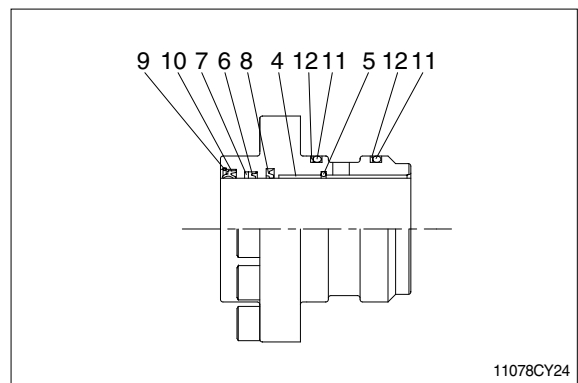
### (3) Disassemble the piston assembly

- 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(11) and O-ring (12).
  - ② Remove snap ring(10), dust wiper(9).
  - ③ Remove back up ring(7), rod seal(6) and buffer ring(8).
- ※ Exercise care in this operation not to damage the grooves.
- ※ Do not remove seal and ring, if does not damaged.

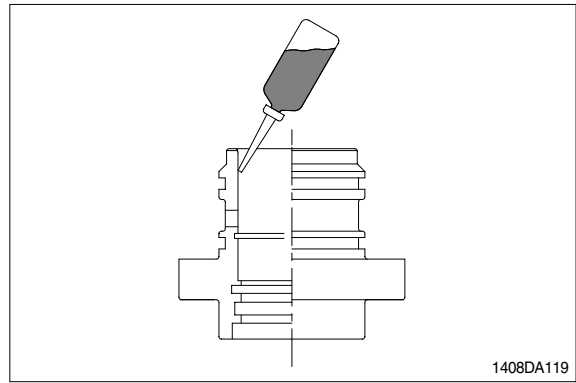


### 3) ASSEMBLY

#### (1) Assemble cylinder head assembly

- ※ Check for scratches or rough surfaces if found smooth with an oil stone.

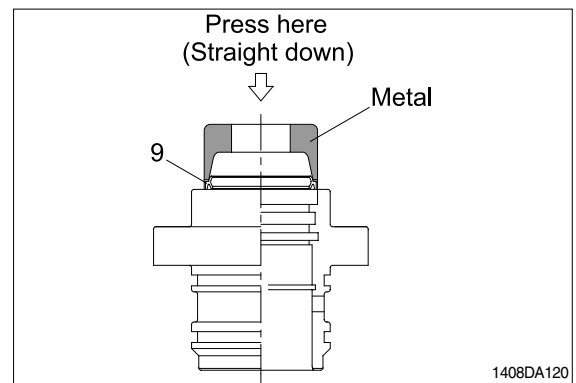
- ① Coat the inner face of gland(3) with hydraulic oil.



- ② Coat dust wiper(9) with grease and fit dust wiper(9) to the bottom of the hole of dust seal.

At this time, press a pad metal to the metal ring of dust seal.

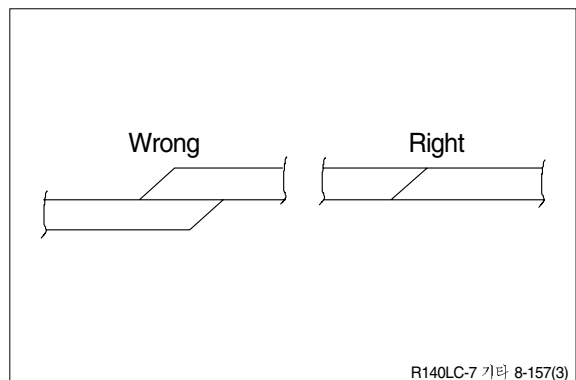
- ③ Fit snap ring(10) to the stop face.



- ④ Fit back up ring(7), rod seal(6) and buffer ring(8) to corresponding grooves, in that order.

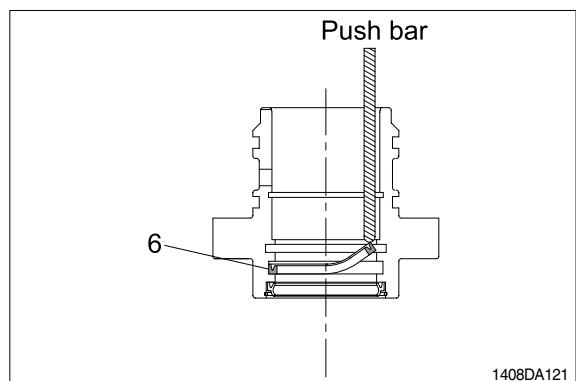
- ※ Coat each packing with hydraulic oil before fitting it.

- ※ Insert the backup ring until one side of it is inserted into groove.

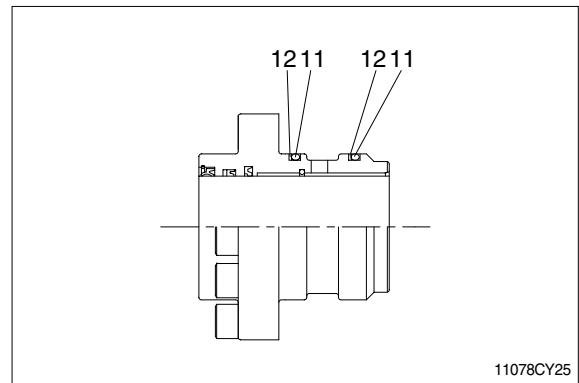


- ※ Rod seal(6) has its own fitting direction. Therefore, confirm it before fitting them.

- ※ Fitting rod seal(6) upside down may damage its lip. Therefore check the correct direction that is shown in fig.

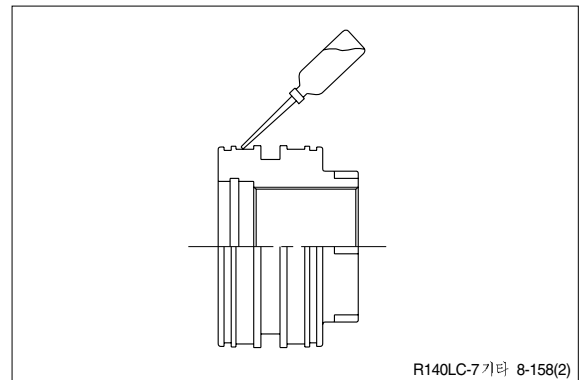


- ⑤ Fit back up ring(12) to gland(3).
- ※ Put the backup ring in the warm water of 30~50°C.
- ⑥ Fit O-ring(11) to gland(3).

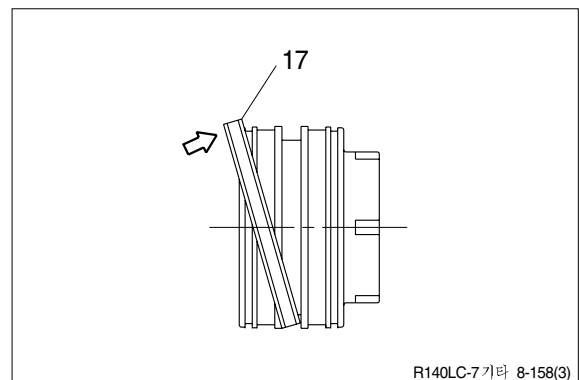


## (2) Assemble piston assembly

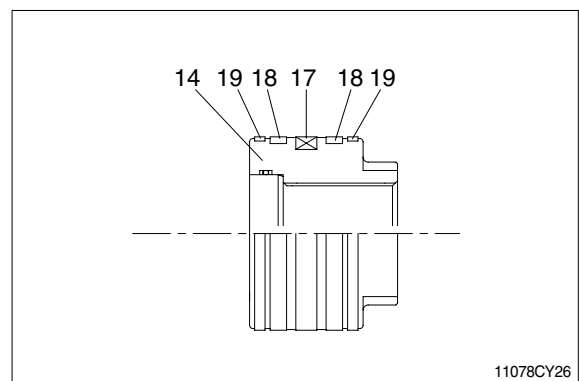
- ※ Check for scratches or rough surfaces.  
If found smooth with an oil stone.
- ① Coat the outer face of piston(14) with hydraulic oil.



- ② Fit piston seal(17) to piston.
- ※ 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.

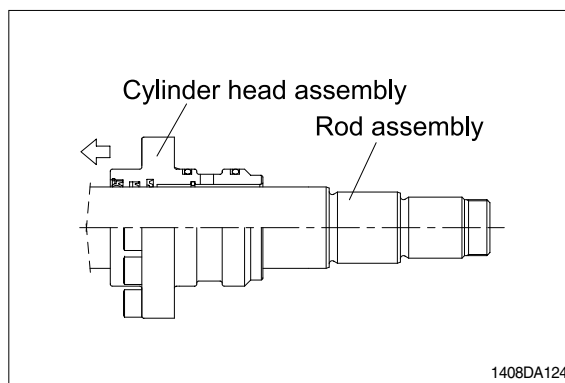


- ③ Fit wear ring(18) and dust ring(19) to piston(14).

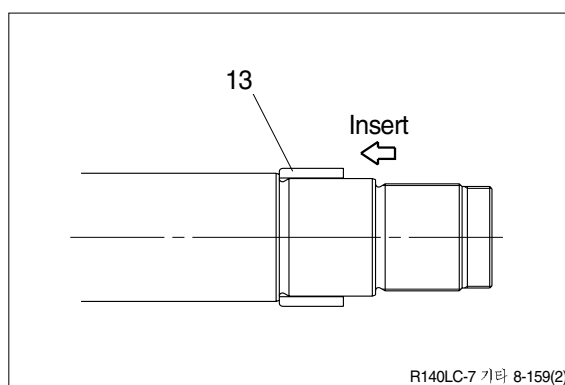


### (3) Install piston and cylinder head

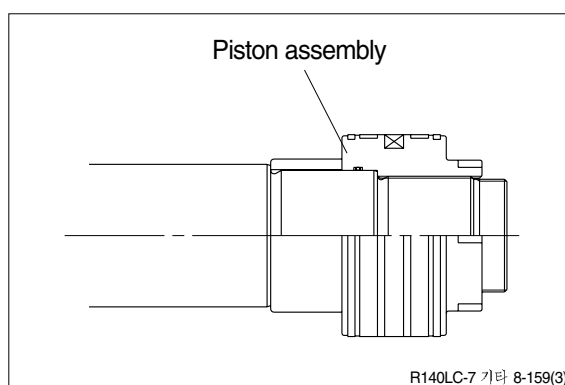
- ① Fix the rod assembly to the work bench.
- ② Apply hydraulic oil to the outer surface of rod assembly(2), the inner surface of piston and cylinder head.
- ③ Insert cylinder head assembly to rod assembly.



- ④ Insert cushion ring(13) to rod assembly.
- ※ Note that cushion ring(13) has a direction in which it should be fitted.

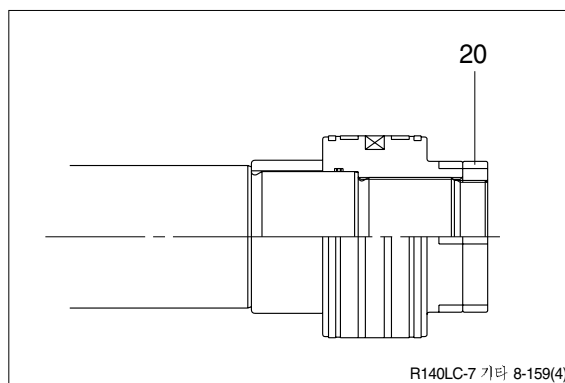


- ⑤ Fit piston assembly to rod assembly.
- Tightening torque :  $150 \pm 15 \text{ kgf} \cdot \text{m}$   
 $(1085 \pm 109 \text{ lbf} \cdot \text{ft})$



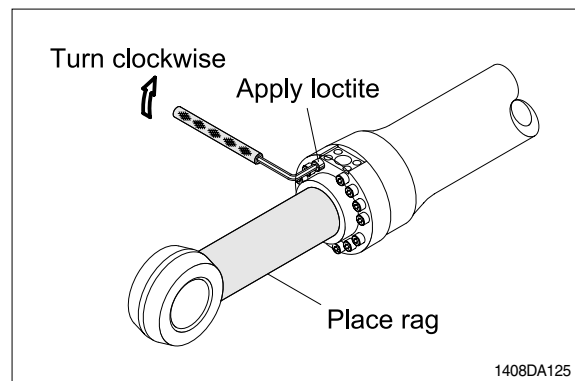
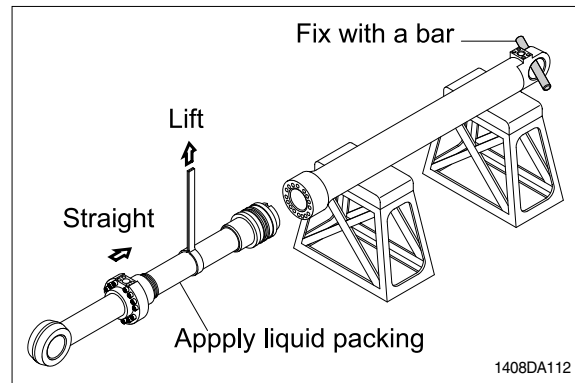
- ⑥ Fit lock nut(20) to piston.
- Tightening torque :

Item		kgf · m	lbf · ft
Bucket	20	$100 \pm 10$	$723 \pm 72.3$
Boom	20	$100 \pm 10$	$723 \pm 72.3$
Arm	23	$100 \pm 10$	$723 \pm 72.3$



### (3) Overall assemble

- ① Place a V-block on a rigid work bench.  
Mount the tube assembly(1) on it and fix the assembly by passing a bar through the clevis pin hole to lock the assembly.
- ② Insert the rod assembly in to the tube assembly, while lifting and moving the rod assembly with a crane.
  - ※ Be careful not to damage piston seal by thread of tube assembly.
- ③ Match the bolt holes in the cylinder head flange to the tapped holes in the tube assembly and tighten socket bolts to a specified torque.
  - ※ Refer to the table of tightening torque.

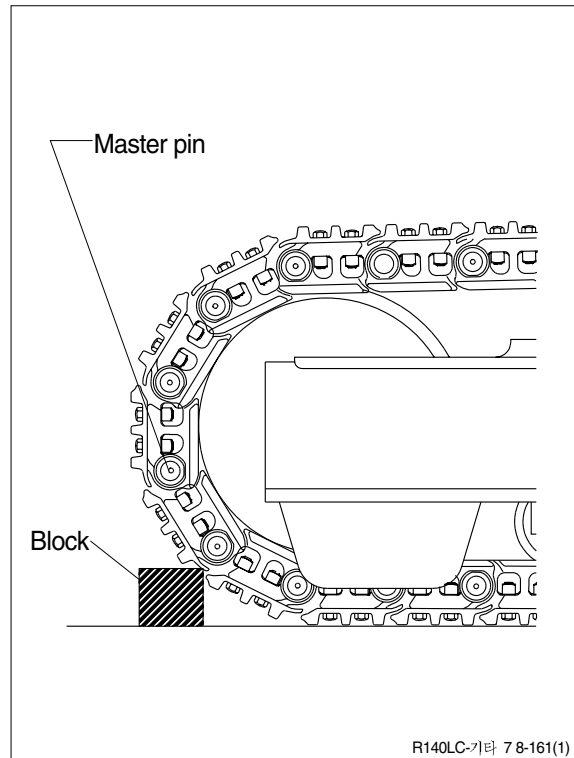


## GROUP 10 UNDERCARRIAGE

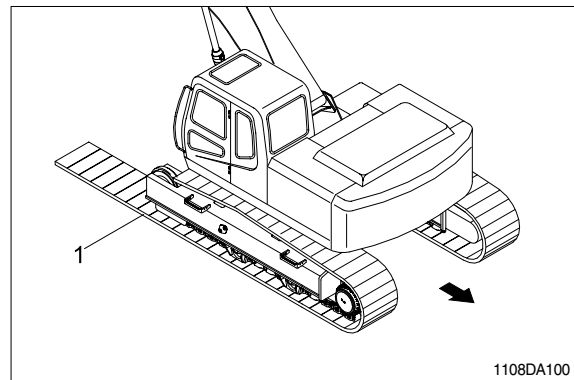
### 1. TRACK LINK

#### 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.

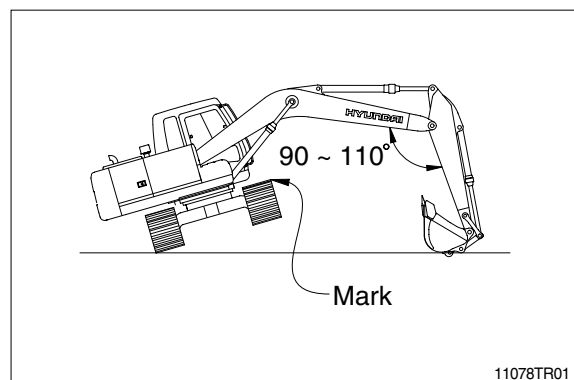


- (4) Move the machine slowly in reverse, and lay out track link assembly (1).
- ※ Jack up the machine and put wooden block under the machine.
- ※ Don't get close to the sprocket side as the track shoe plate may fall down on your feet.



#### 2) INSTALL

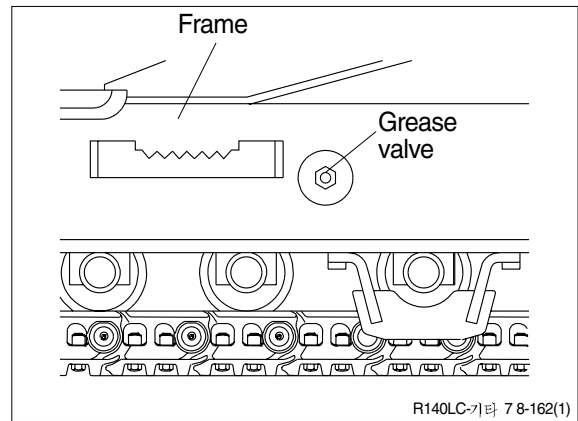
- (1) Carry out installation in the reverse order to removal.
- ※ Adjust the tension of the track link.



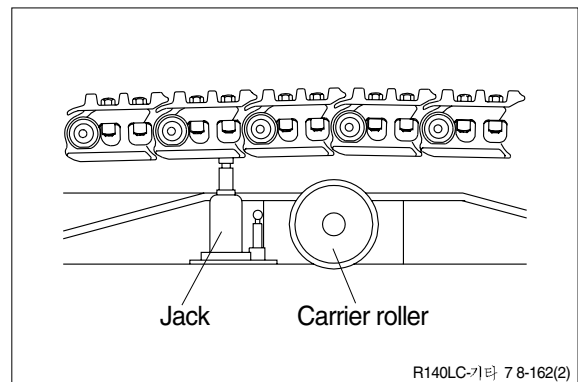
## 2. CARRIER ROLLER

### 1) REMOVAL

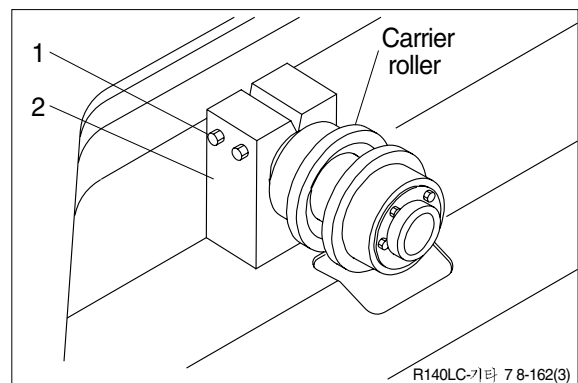
- (1) Loosen tension of the track link.



- (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 : 13kg(29lb)



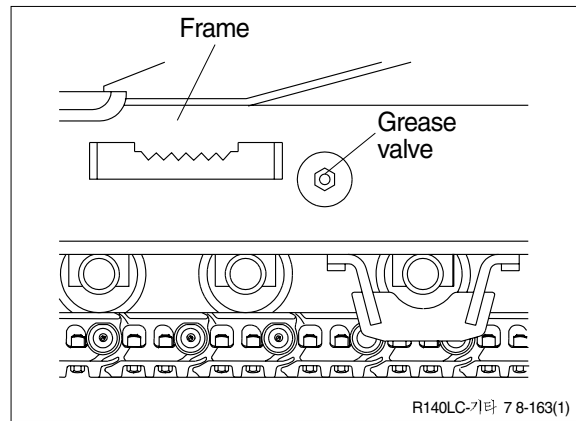
### 2) INSTALL

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

### 3. TRACK ROLLER

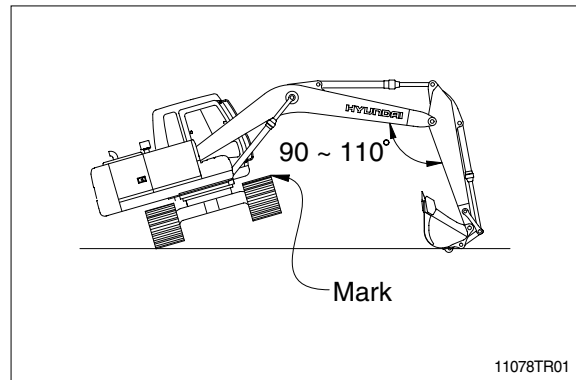
#### 1) REMOVAL

- (1) Loosen tension of the track link.



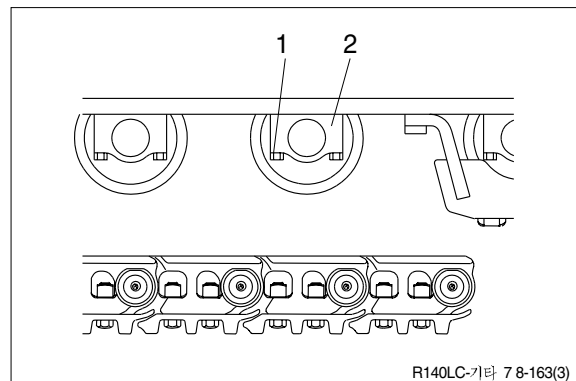
- (2) Using the work equipment, push up track frame on side which is to be removed.

※ 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 : 24.6kg(54.2lb)



#### 2) INSTALL

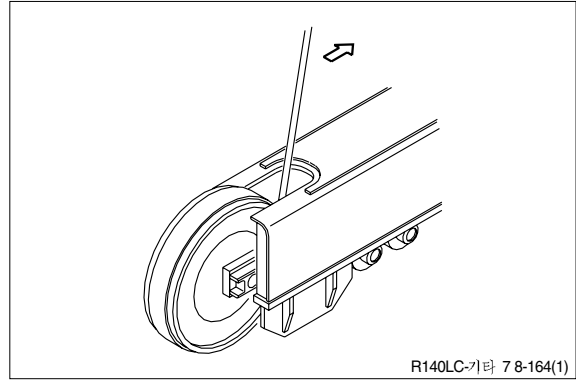
- (1) Carry out installation in the reverse order to removal.



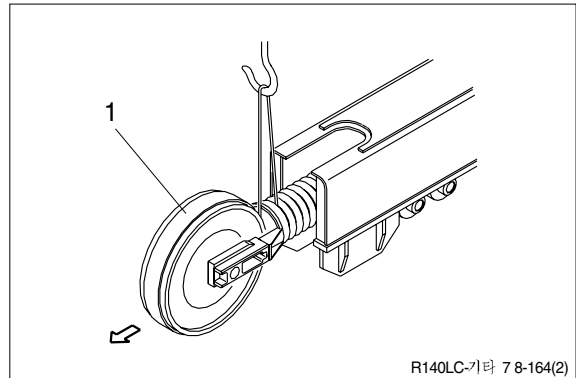
## 4. IDLER AND RECOIL SPRING

### 1) REMOVAL

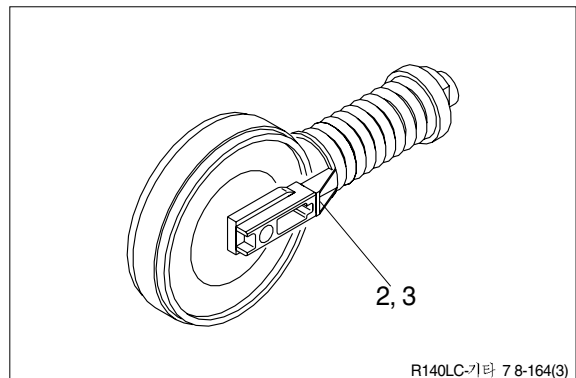
- (1) Remove the track link.  
For detail, see **removal of track link**.



- (2) Sling the recoil spring(1) and pull out idler and recoil spring assembly from track frame, using a pry.  
· Weight : 215kg(474lb)

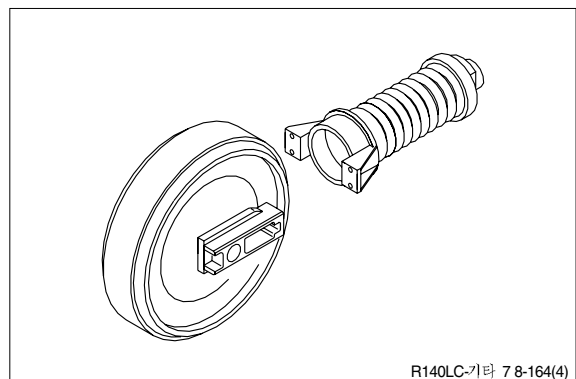


- (3) Remove the bolts(2), washers(3) and separate idler from recoil spring.



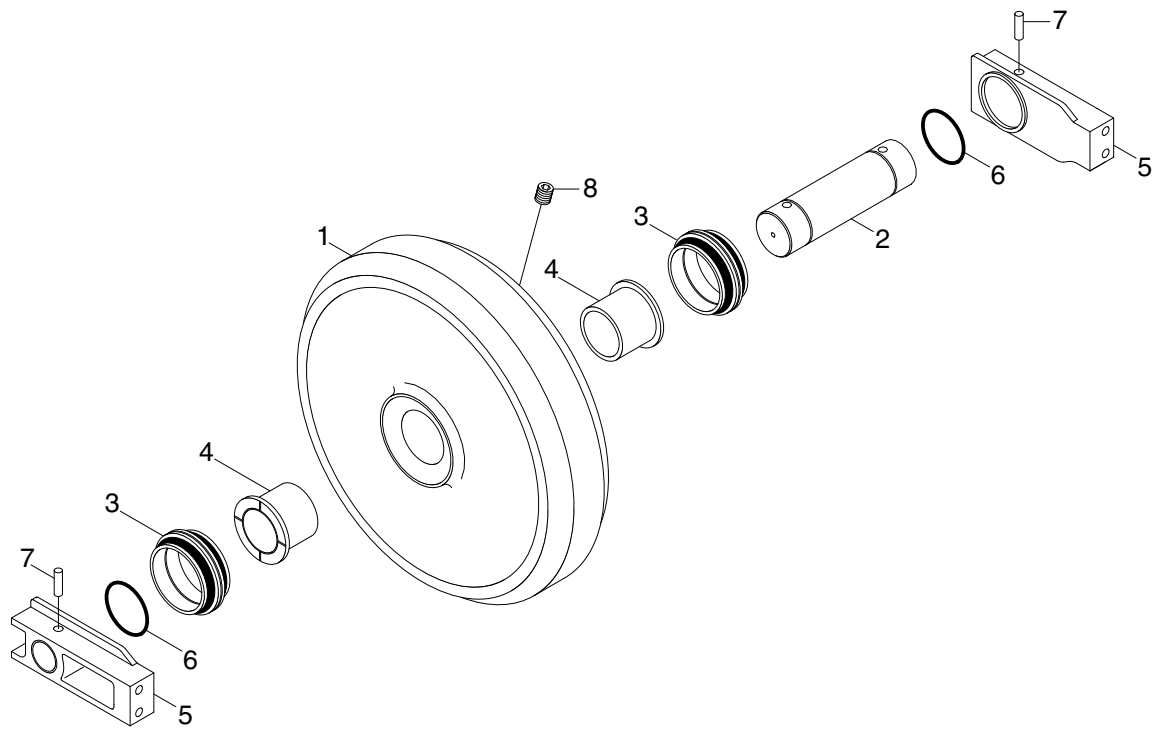
### 2) INSTALL

- (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



21078DA43

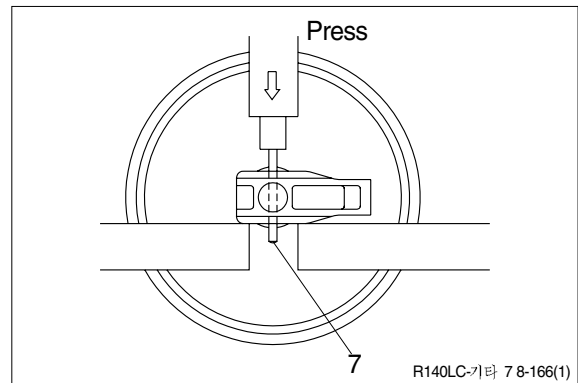
- 1 Shell
- 2 Shaft
- 3 Seal assembly

- 4 Bushing
- 5 Bracket
- 6 O-ring

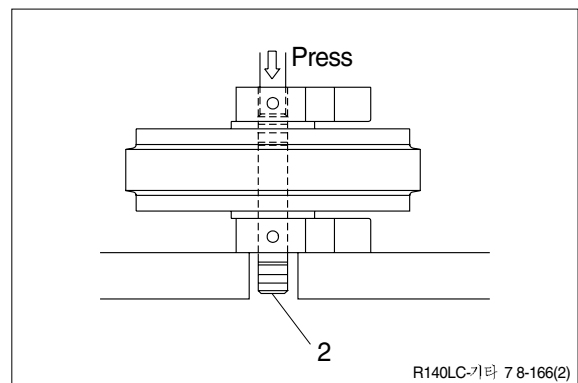
- 7 Spring pin
- 8 Plug

## (2) Disassembly

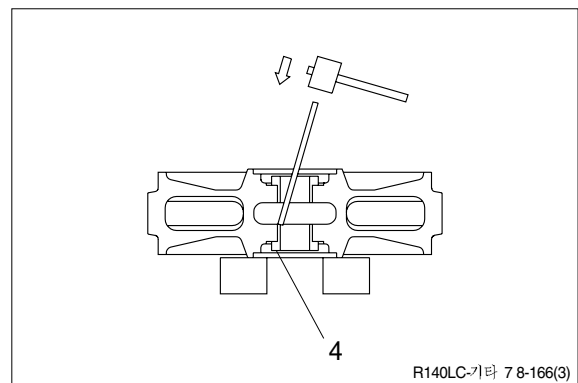
- ① Remove plug and drain oil.
- ② Draw out the spring pin(7), using a press.



- ③ Pull out the shaft(2) with a press.
- ④ Remove seal(3) from idler(1) and bracket (5).
- ⑤ Remove O-ring(6) from shaft.



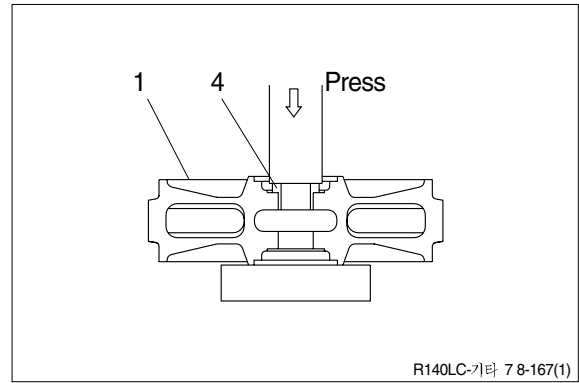
- ⑥ Remove the bushing(4) from idler, using a special tool.
- ※ Only remove bushing if replacement is necessity.



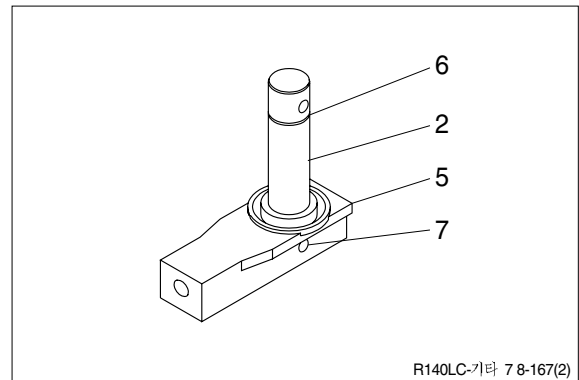
### (3) Assembly

- ※ Before assembly, clean the parts.
- ※ Coat the sliding surfaces of all parts with oil.

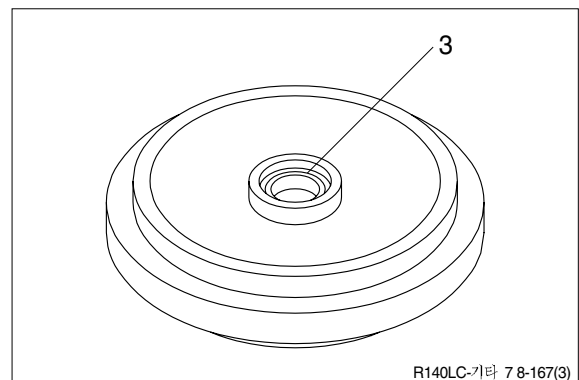
- ① Cool up bushing(4) fully by some dry ice and press it into shell(1).  
Do not press it at the normal temperature, or not knock in with a hammer even after the cooling.



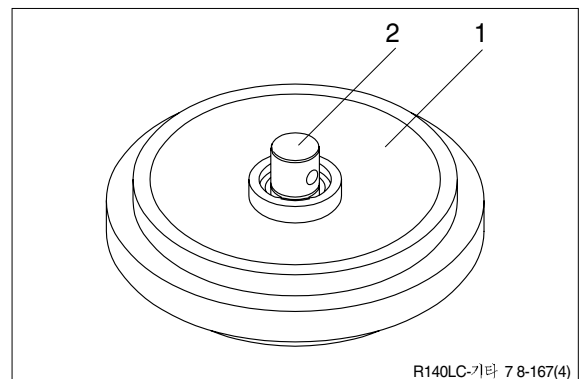
- ② Coat O-ring(6) with grease thinly, and install it to shaft(2).
- ③ Insert shaft(2) into bracket(5) and drive in the spring pin(7).



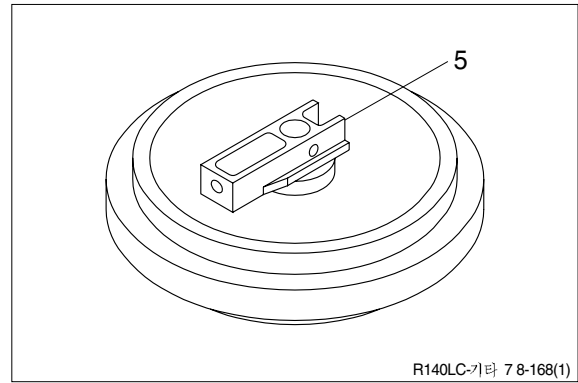
- ④ Install seal(3) to shell(1) and bracket(5).



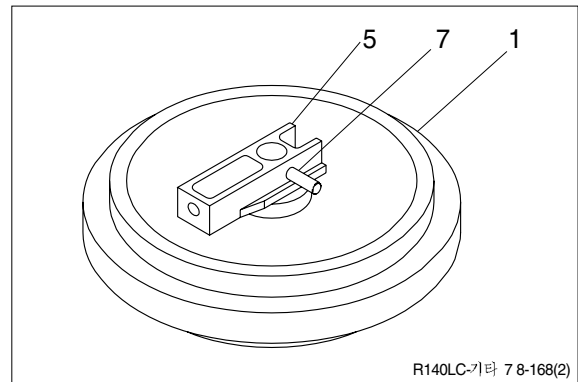
- ⑤ Install shaft(2) to shell(1).



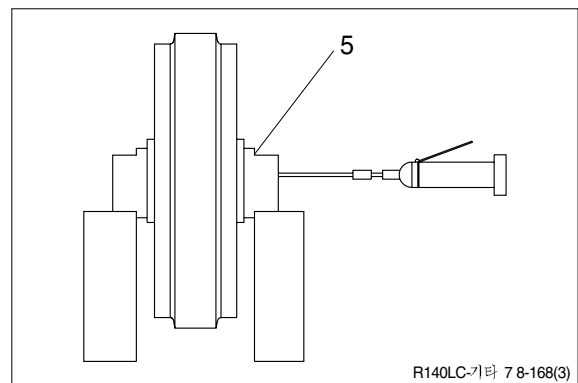
- ⑥ Install bracket(5) attached with seal(3).



- ⑦ Knock in the spring pin(7) with a hammer.

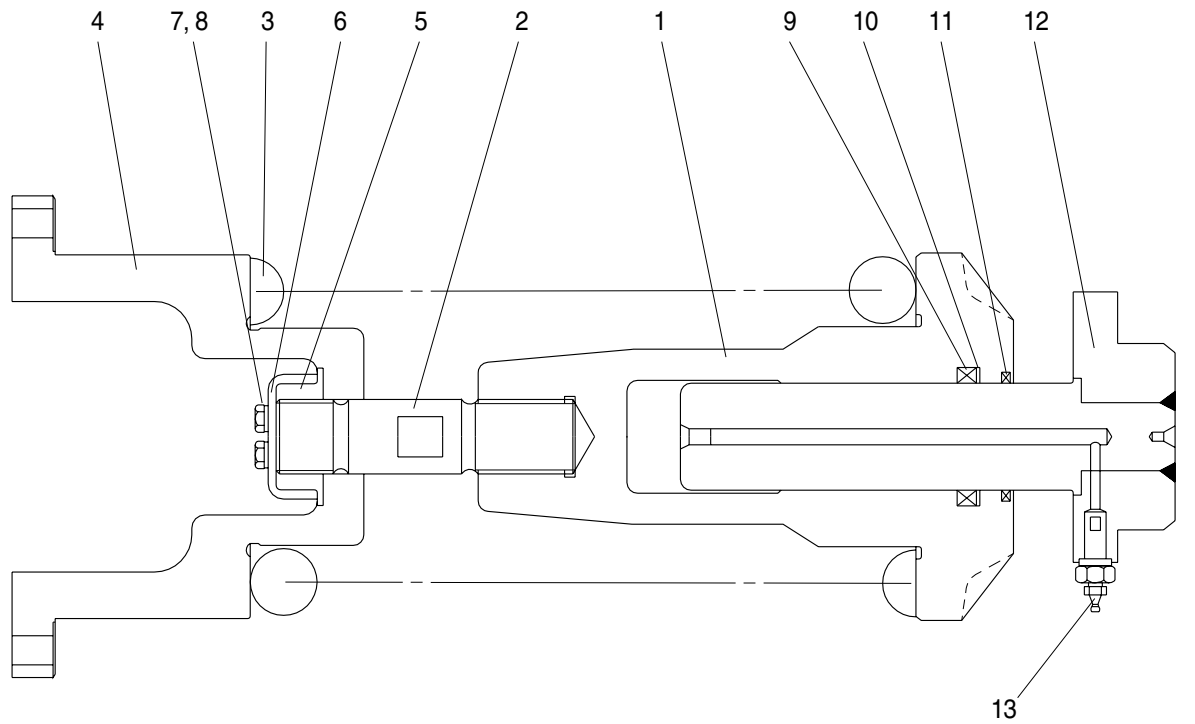


- ⑧ Lay bracket(5) on its side.  
Supply engine oil to the specified level,  
and tighten plug.



#### 4) DISASSEMBLY AND ASSEMBLY OF RECOIL SPRING

##### (1) Structure



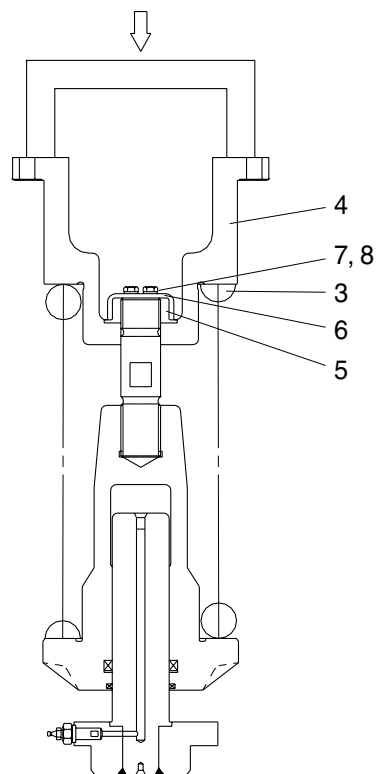
R210UCG1

- |   |          |    |               |    |              |
|---|----------|----|---------------|----|--------------|
| 1 | Body     | 6  | Lock plate    | 11 | Dust seal    |
| 2 | Tie bar  | 7  | Bolt          | 12 | Rod assembly |
| 3 | Spring   | 8  | Spring washer | 13 | Grease valve |
| 4 | Bracket  | 9  | Rod seal      |    |              |
| 5 | Lock nut | 10 | Back up ring  |    |              |

## (2) Disassembly

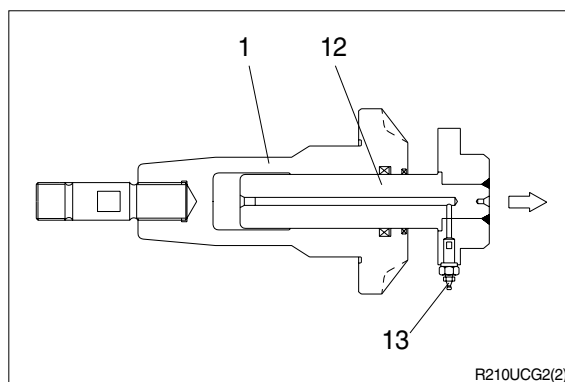
- ① Apply pressure on spring(3) with a press.
  - ※ The spring is under a large installed load. This is dangerous, so be sure to set properly.
    - ・ Spring set load : 8497kg(18733lb)
- ② Remove bolt(7), spring washer(8) and lock plate(6).
- ③ Remove lock nut(5).

Take enough notice so that the press which pushes down the spring, should not be slipped out in its operation.
- ④ Lighten the press load slowly and remove bracket(4) and spring(3).



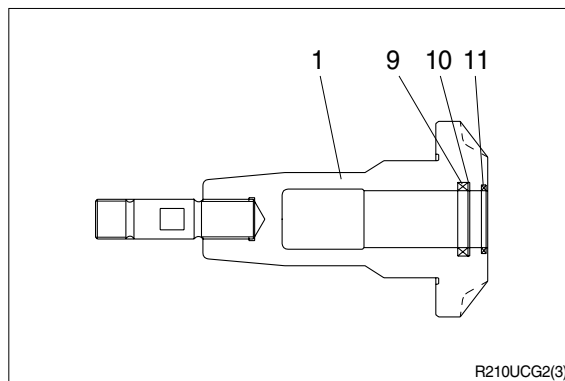
R210UCG2(1)

- ⑤ Remove rod(12) from body(1).
- ⑥ Remove grease valve(13) from rod(12).



R210UCG2(2)

- ⑦ Remove rod seal(9), back up ring(10) and dust seal(11).

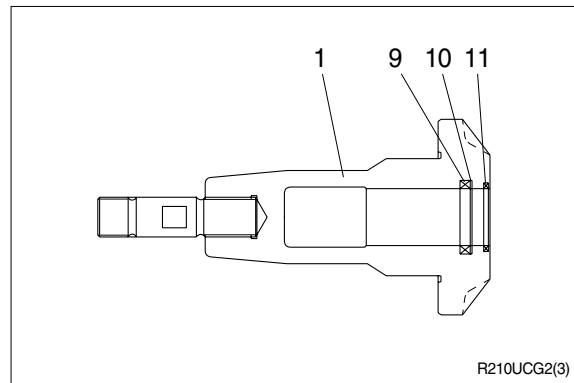


R210UCG2(3)

### (3) Assembly

- ① Install dust seal(11), back up ring(10) and rod seal(9) to body(1).

※ When installing dust seal(11) and rod seal(9), take full care so as not to damage the lip.



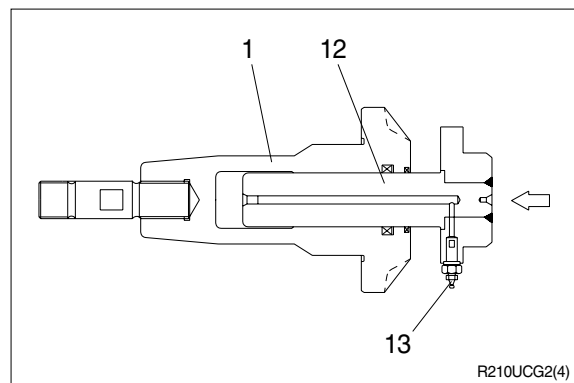
- ② Pour grease into body(1), then push in rod(12) by hand.

After take grease out of grease valve mounting hole, let air out.

※ If air letting is not sufficient, it may be difficult to adjust the tension of crawler.

- ③ Fit grease valve(13) to rod(12).

• Tightening torque :  $10 \pm 1 \text{ kg} \cdot \text{m}$   
( $72.4 \pm 7.2 \text{ lb} \cdot \text{ft}$ )

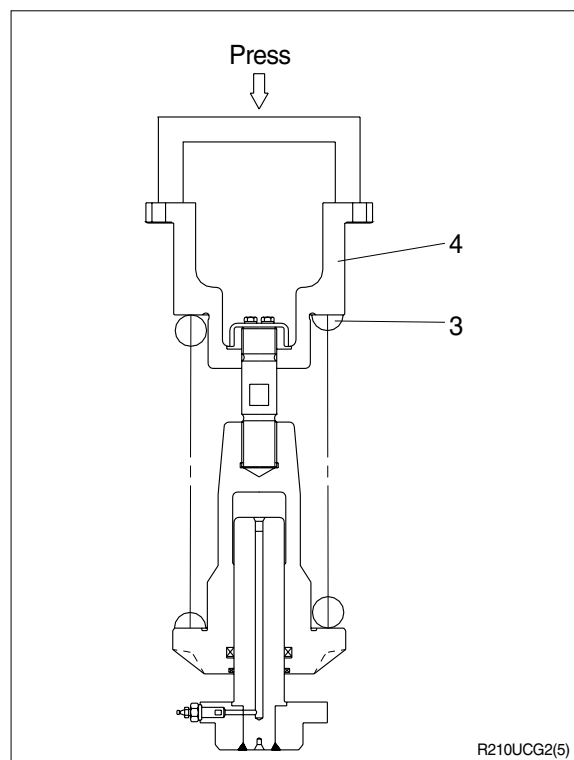


- ④ Install spring(3) and bracket(4) to body (1).

- ⑤ Apply pressure to spring(3) with a press and tighten lock nut(5).

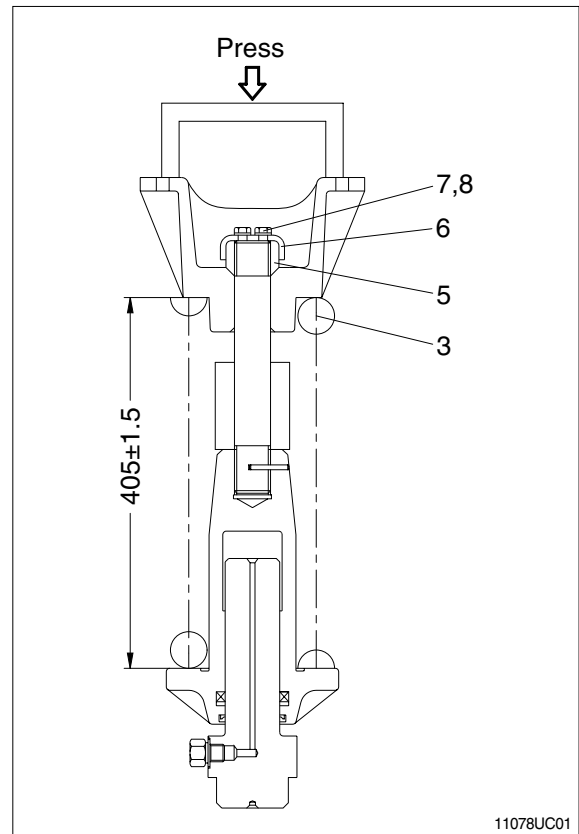
※ Apply sealant before assembling.

※ During the operation, pay attention specially to prevent the press from slipping out.



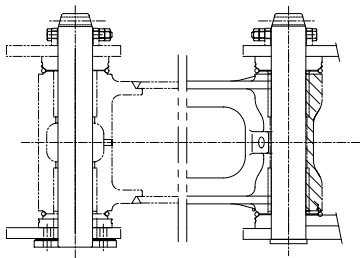
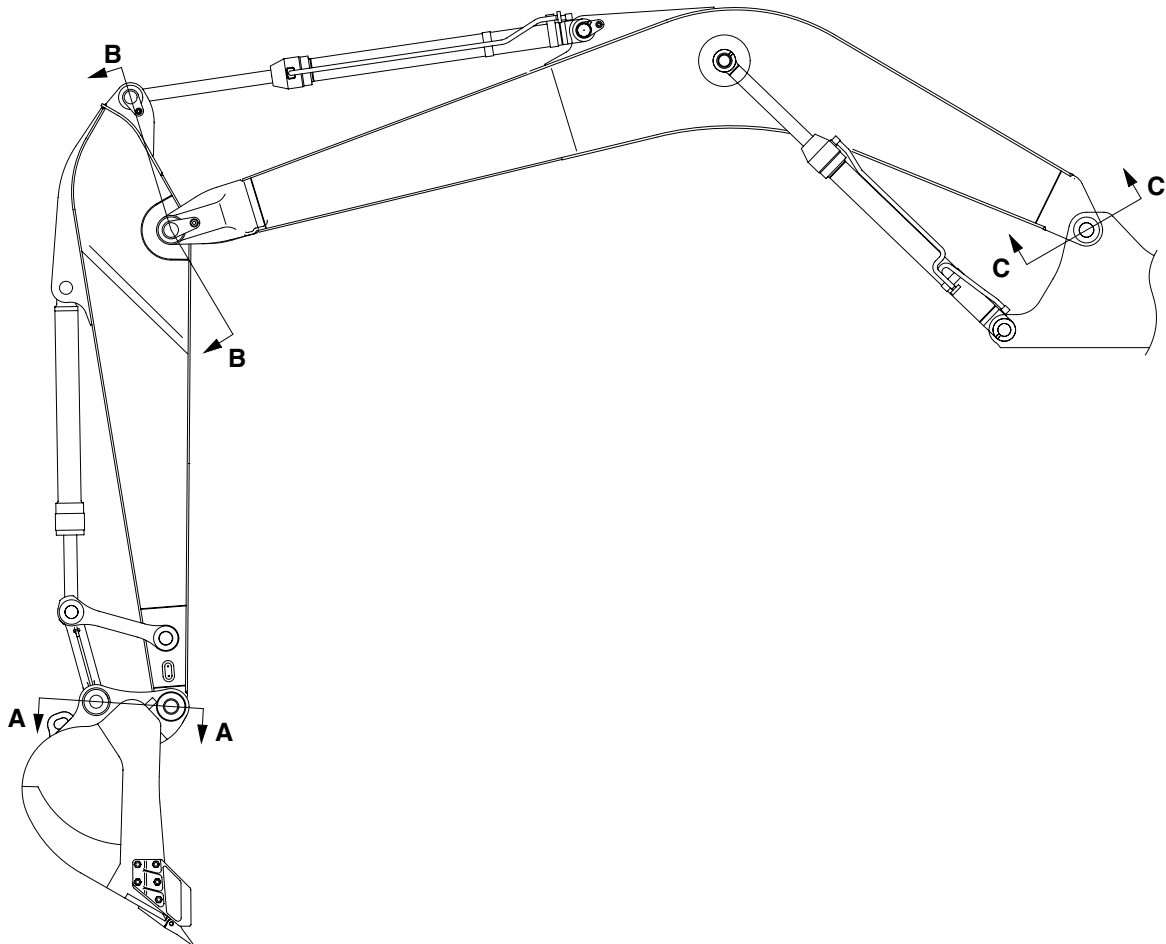


- ⑥ Lighten the press load and confirm the set length of spring(3).
- ⑦ After the setting of spring(3), install lock plate(6), spring washer(8) and bolt(7).

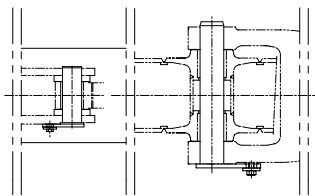


## GROUP 11 WORK EQUIPMENT

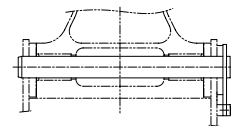
### 1. STRUCTURE



SECTION A



SECTION B



SECTION C

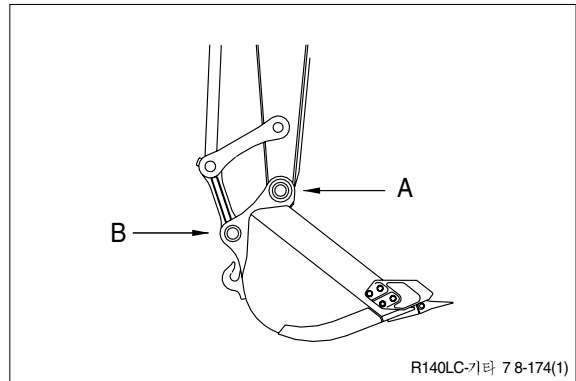
21078DA44

## 2. REMOVAL AND INSTALL

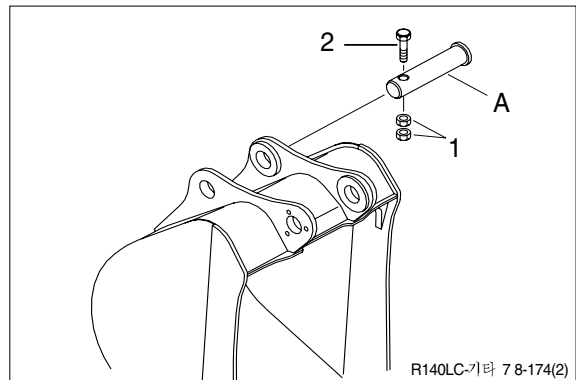
### 1) BUCKET ASSEMBLY

#### (1) Removal

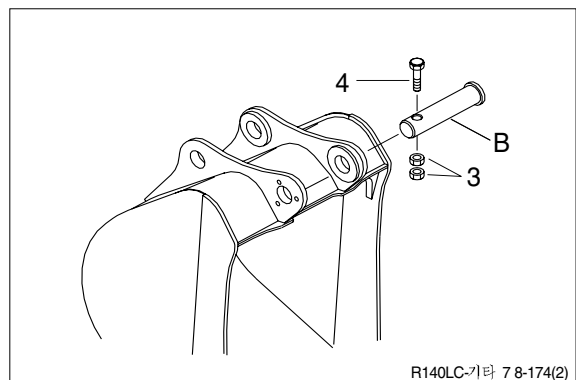
- ① Lower the work equipment completely to ground with back of bucket facing down.



- ② Remove nut(1), bolt(2) and draw out the pin(A).



- ③ Remove nut(3), bolt(4) and draw out the pin(B).

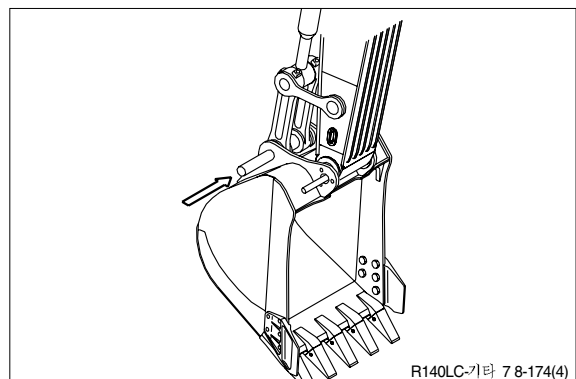


#### (2) Install

- ① Carry out installation in the reverse order to removal.

**▲ When aligning the mounting position of the pin, do not insert your fingers in the pin hole.**

※ Adjust the bucket clearance.  
For detail, see **operation manual**.



## 2) ARM ASSEMBLY

### (1) Removal

- ※ Loosen the breather slowly to release the pressure inside the hydraulic tank.

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

- ① Remove bucket assembly.  
For details, see **removal of bucket assembly**.
- ② Disconnect bucket cylinder hose(1).

**▲ Fit blind plugs(5) in the piping at the chassis end securely to prevent oil from spurting out when the engine is started.**

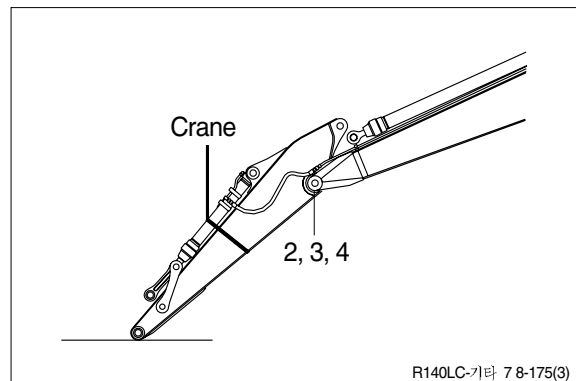
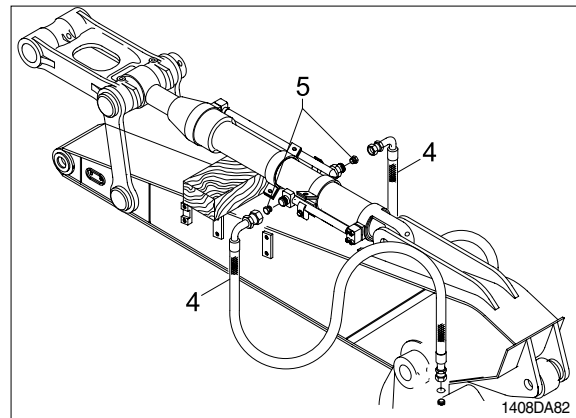
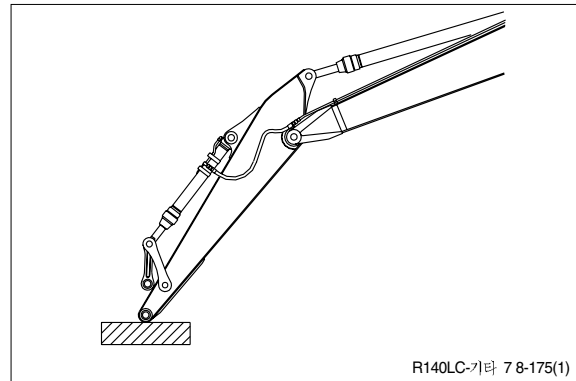
- ③ Sling arm cylinder assembly, remove spring, pin stopper and pull out pin.
- ※ Tie the rod with wire to prevent it from coming out.

- ④ For details, see **removal of arm cylinder assembly**.

Place a wooden block under the cylinder and bring the cylinder down to it.

- ⑤ Remove bolt(2), plate(3) and pull out the pin(4) then remove the arm assembly.  
· Weight : 950kg(2090lb)

- ※ When lifting the arm assembly, always lift the center of gravity.



### (2) Install

- ① Carry out installation in the reverse order to removal.

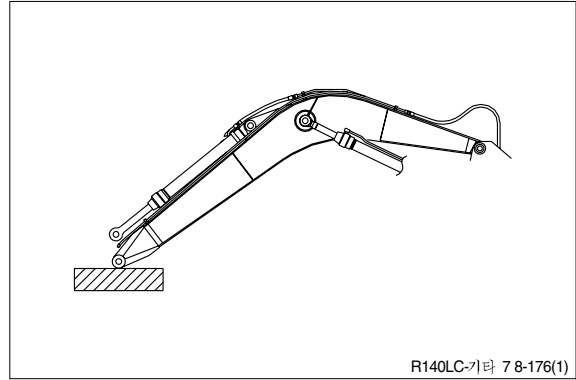
**▲ When lifting the arm assembly, always lift the center of gravity.**

- ※ Bleed the air from the cylinder.

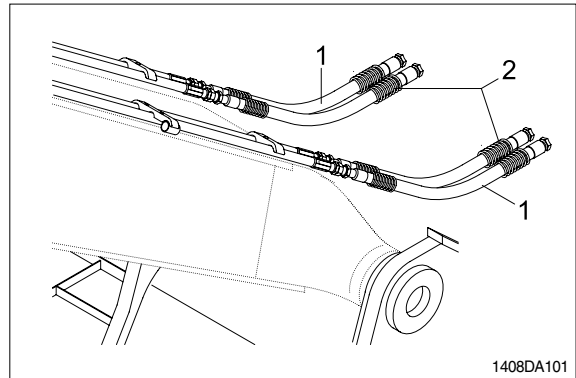
### 3) BOOM ASSEMBLY

#### (1) Removal

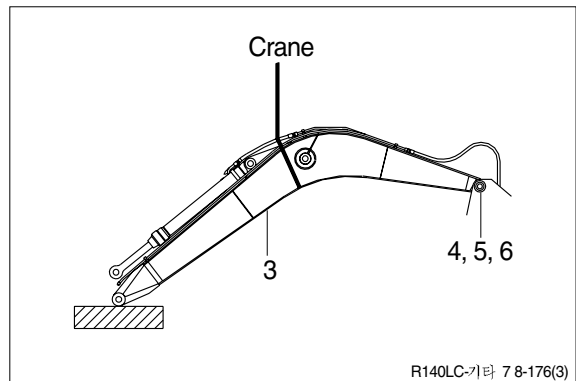
- ① Remove arm and bucket assembly.  
For details, see **removal of arm and bucket assembly**.
- ② Remove boom cylinder assembly from boom.  
For details, see **removal of arm cylinder assembly**.



- ③ Disconnect head lamp wiring.
- ④ Disconnect bucket cylinder hose(2) and arm cylinder hose(1).
- ※ When the hose are disconnected, oil may spurt out.
- ⑤ Sling boom assembly(3).

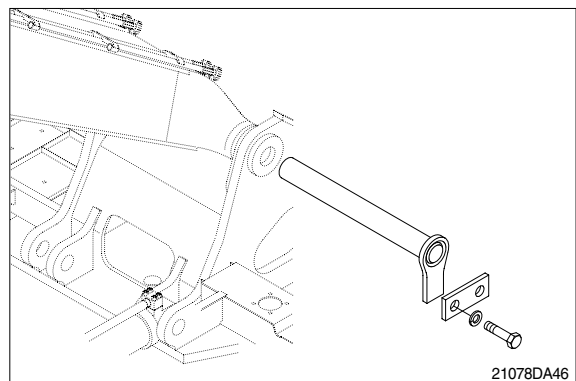


- ⑥ Remove bolt(4), plate(5) and pull out the pin(6) then remove boom assembly.  
· Weight :880kg(1940lb)
- ※ When lifting the boom assembly always lift the center of gravity.



#### (2) Install

- ① Carry out installation in the reverse order to removal.
- ▲ **When lifting the arm assembly, always lift the center of gravity.**
- ※ Bleed the air from the cylinder.



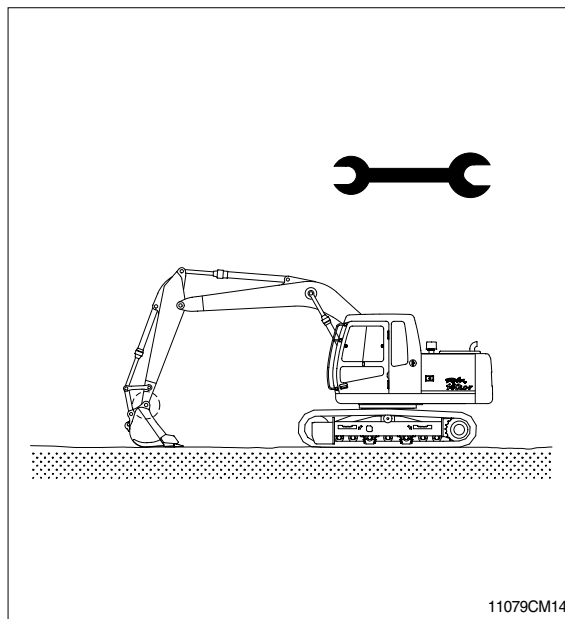
# SECTION 9 COMPONENT MOUNTING TORQUE

Group 1	Introduction guide .....	9-1
Group 2	Engine system .....	9-2
Group 3	Electric system .....	9-4
Group 4	Hydraulic system .....	9-6
Group 5	Undercarriage .....	9-10
Group 6	Structure .....	9-11
Group 7	Work equipment .....	9-14

## SECTION 9 COMPONENT MOUNTING TORQUE

### GROUP 1 INTRODUCTION GUIDE

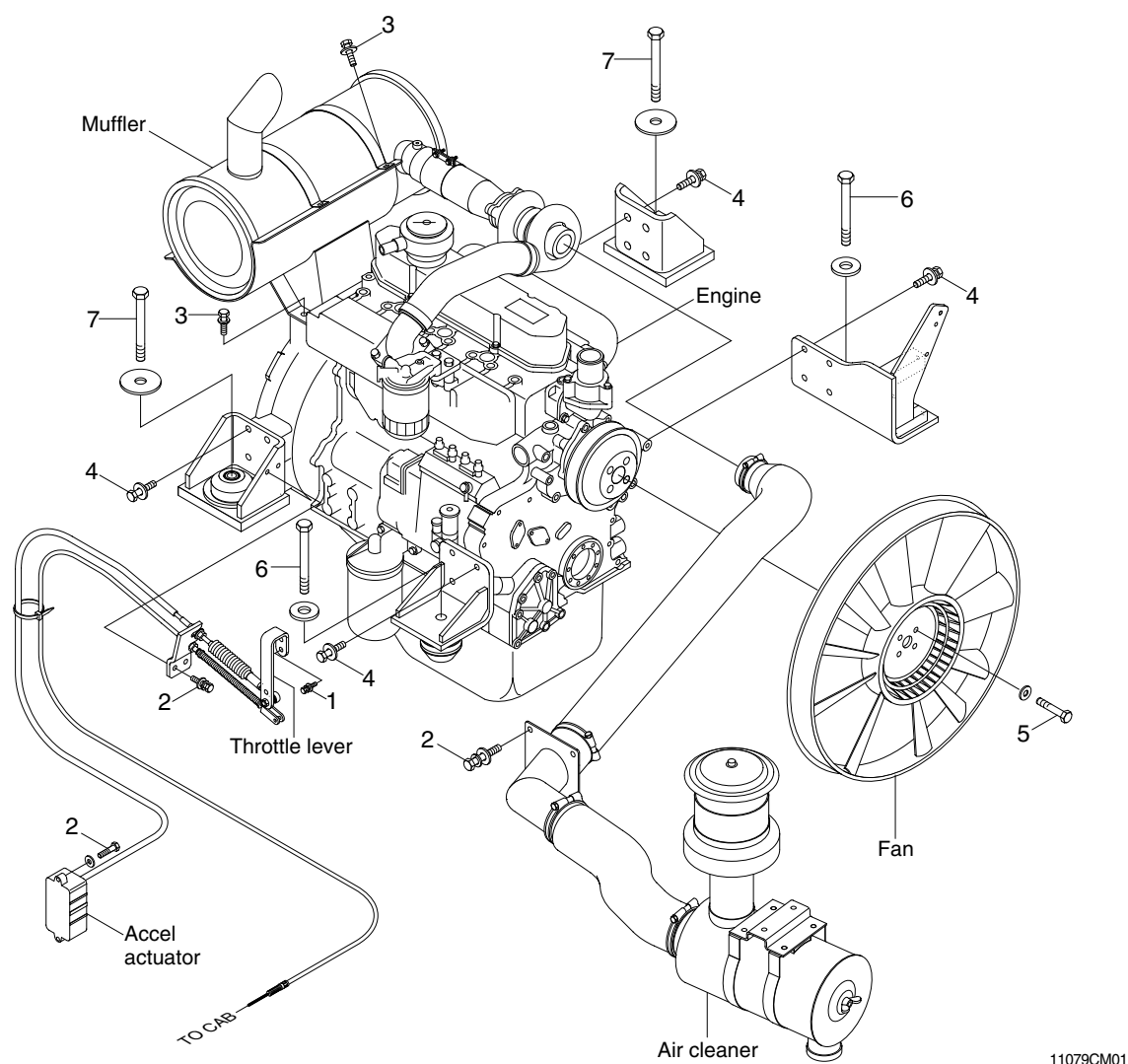
1. This section shows bolt specifications and standard torque values needed when mounting components to the machine.
  2. Use genuine Hyundai spare parts.  
We expressly point out that Hyundai will not accept any responsibility for defects resulted from non-genuine parts.  
In such cases Hyundai cannot assume liability for any damage.
- ※ **Only metric fasteners can be used and incorrect fasteners may result in machine damage or malfunction.**
  - ※ **Before installation, clean all the components with a non-corrosive cleaner. Bolts and threads must not be worn or damaged.**



11079CM14

## GROUP 2 ENGINE SYSTEM

### 1. ENGINE AND ACCESSORIES MOUNTING



11079CM01

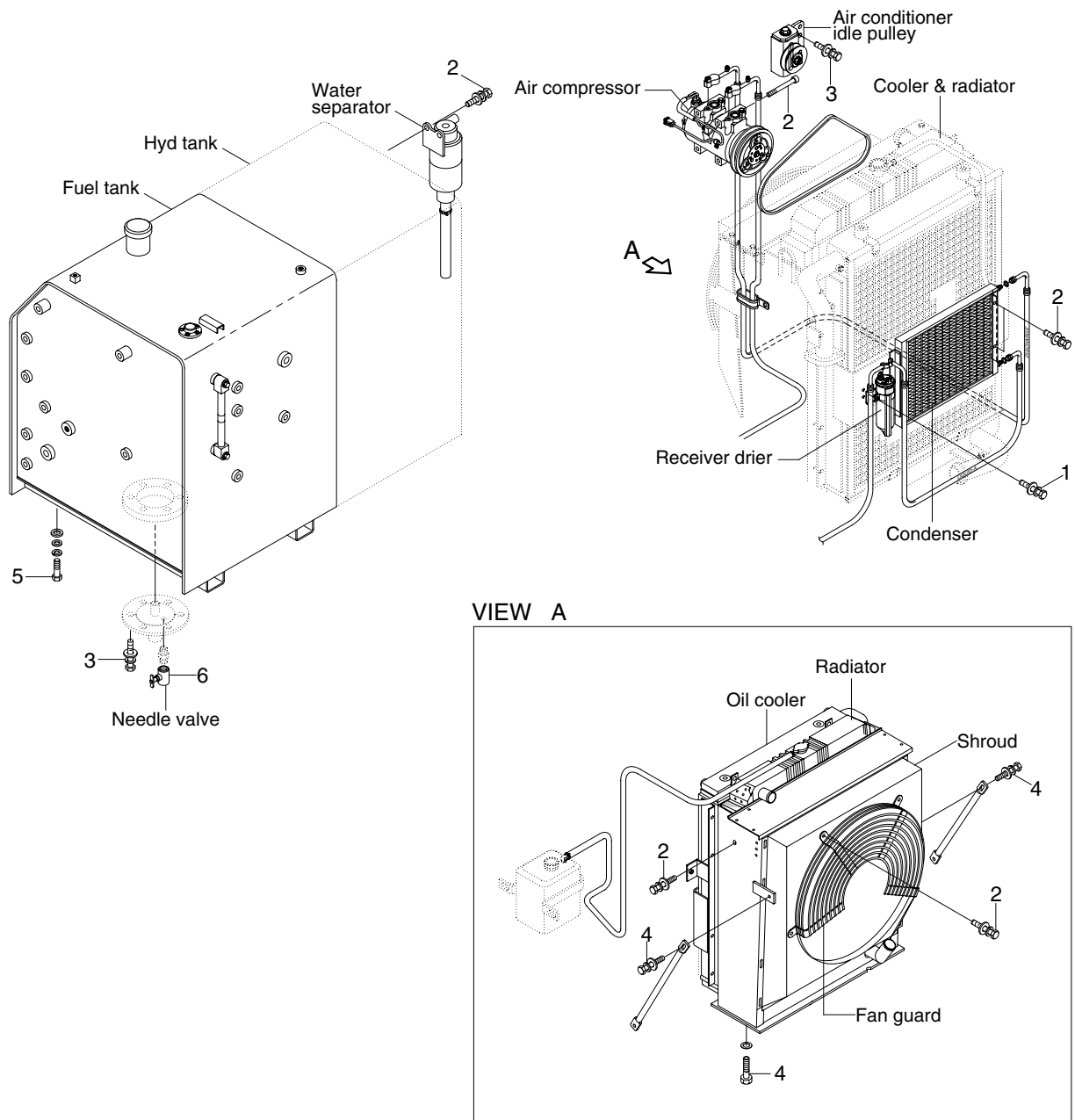
#### · Tightening torque

Item	Size	kgf · m	lbf · ft
1	M 6×1.0	1.1±0.2	7.95±1.45
2	M 8×1.25	2.5±0.5	18.1±3.6
3	M10×1.5	6.9±1.4	49.9±10.1
4	M12×1.75	10±2.0	72.3±14.5

Item	Size	kgf · m	lbf · ft
5	M8×1.25	2.5±0.5	18.1±3.6
6	M16×2.0	55±3.5	398±25.3
7	M20×2.5	30±3.5	217±25.3
-	-	-	-



## 2. COOLING SYSTEM AND FUEL TANK MOUNTING



11079CM02

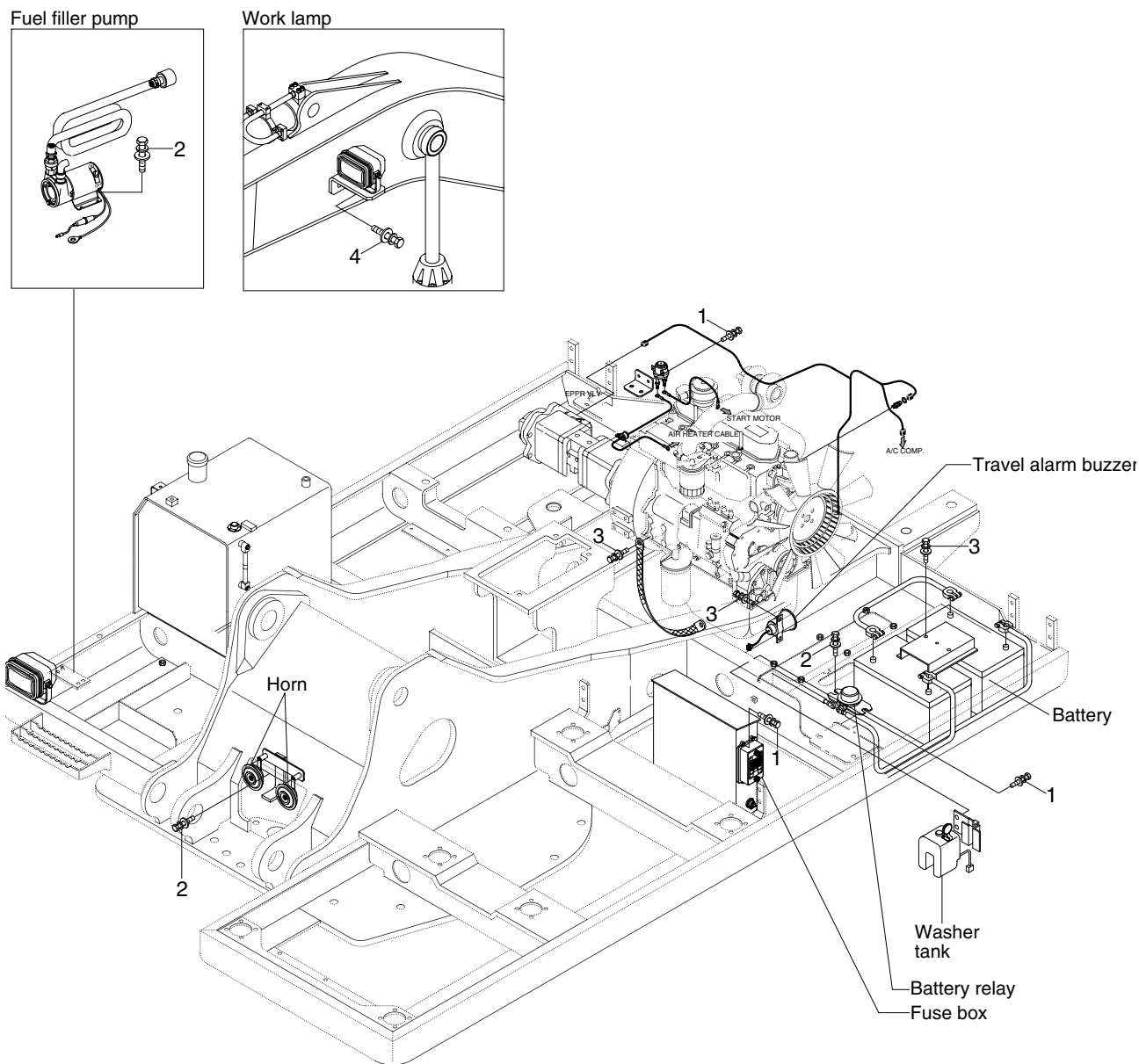
### · Tightening torque

Item	Size	kgf · m	lbf · ft
1	M 6×1.0	1.05±0.2	7.6±1.45
2	M 8×1.25	2.5±0.5	18.1±3.6
3	M10×1.5	6.9±1.4	49.9±10.1

Item	Size	kgf · m	lbf · ft
4	M12×1.75	12.8±3.0	92.6±21.7
5	M20×2.5	45±5.1	325±36.9
6	-	2.3±0.6	16.6±4.3

## GROUP 3 ELECTRIC SYSTEM

### 1. ELECTRIC COMPONENTS MOUNTING 1



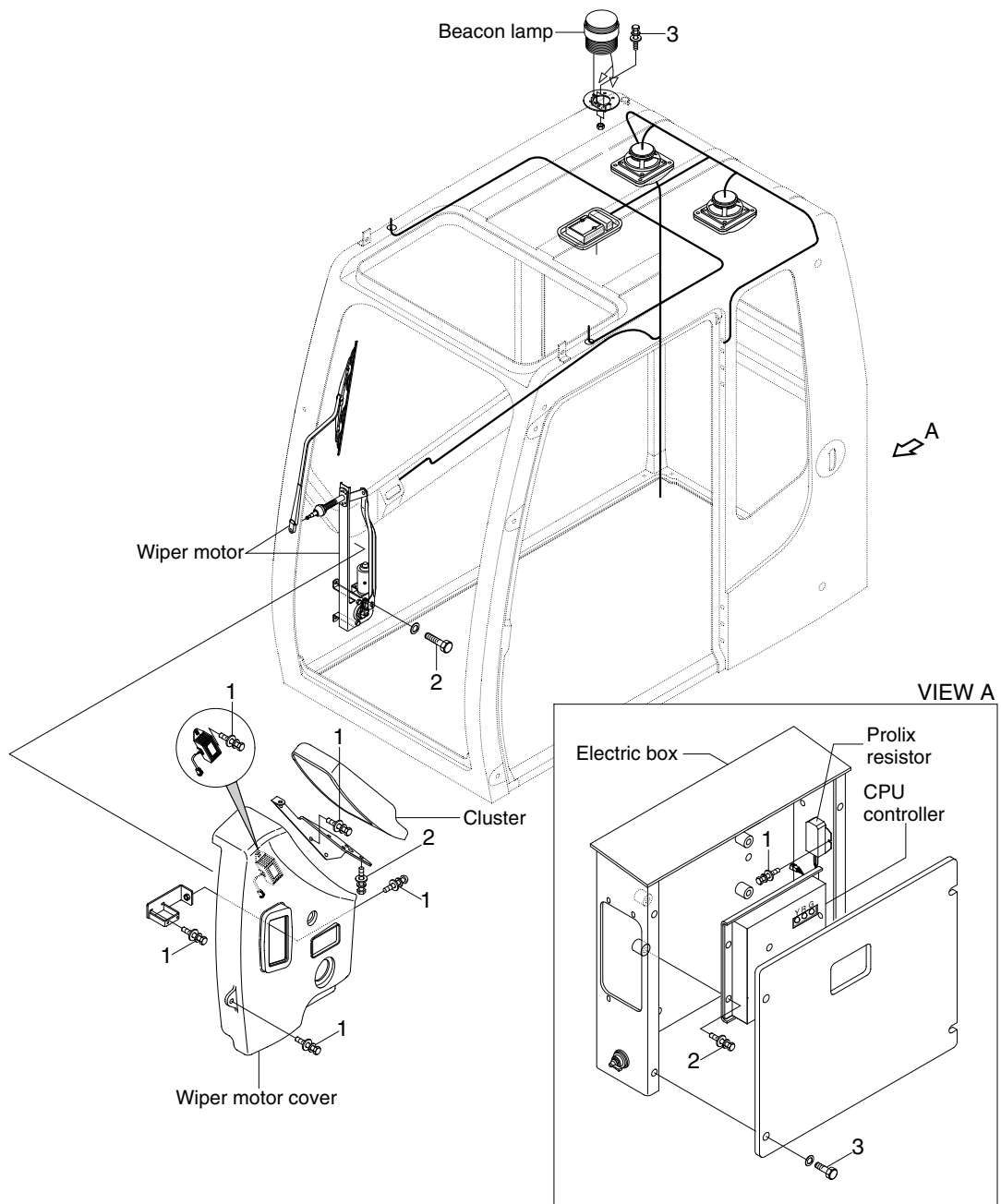
11079CM03

#### · Tightening torque

Item	Size	kgf · m	lbf · ft
1	M 6×1.0	1.05±0.2	7.6±1.45
2	M 8×1.25	2.5±0.5	18.1±3.6

Item	Size	kgf · m	lbf · ft
3	M10×1.5	6.9±1.4	49.9±10.1
4	M12×1.75	12.8±3.0	92.6±21.7

## 2. ELECTRIC COMPONENTS MOUNTING 2



11079CM04

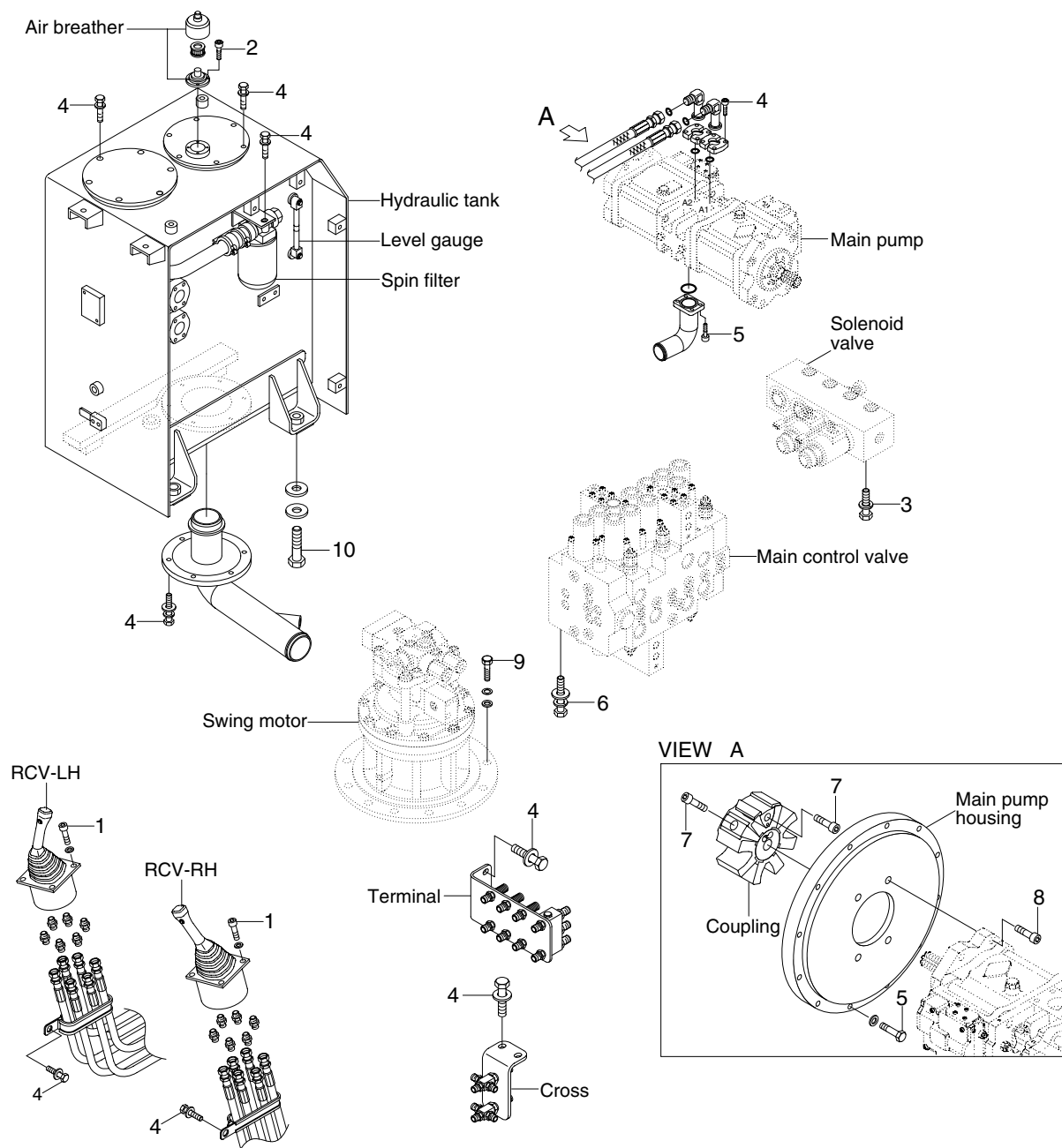
### • Tightening torque

Item	Size	kgf · m	lbf · ft
1	M 6×1.0	1.05±0.2	7.6±1.45
2	M 8×1.25	2.5±0.5	18.1±3.6

Item	Size	kgf · m	lbf · ft
3	M10×1.5	6.9±1.4	49.9±10.1
-	-	-	-

## GROUP 4 HYDRAULIC SYSTEM

### 1. HYDRAULIC COMPONENTS MOUNTING 1



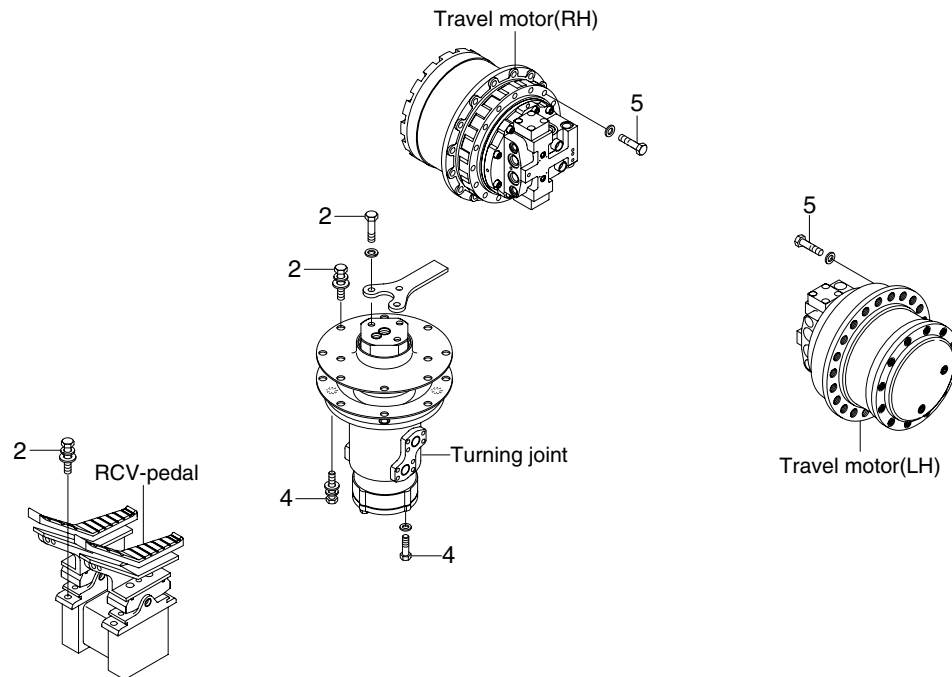
11079CM05

#### • Tightening torque

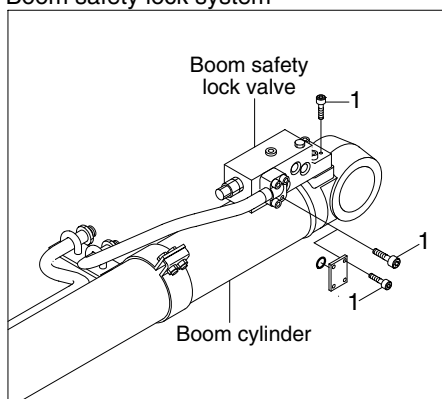
Item	Size	kgf · m	lbf · ft
1	M 6 × 1.0	1.05 ± 0.2	7.6 ± 1.45
2	M 6 × 1.0	1.44 ± 0.3	10.4 ± 2.2
3	M 8 × 1.25	2.5 ± 0.5	18.1 ± 3.6
4	M 10 × 1.5	6.9 ± 1.4	49.9 ± 10.1
5	M 10 × 1.5	6.1 ± 0.3	44.1 ± 2.2

Item	Size	kgf · m	lbf · ft
6	M 12 × 1.75	12.2 ± 1.3	88.2 ± 9.4
7	M 16 × 2.0	22.0 ± 1.0	159 ± 7.2
8	M 16 × 2.0	22.1 ± 2.4	160 ± 17.4
9	M 16 × 2.0	29.6 ± 3.2	214 ± 23.1
10	M 20 × 2.5	45 ± 5.1	325 ± 36.9

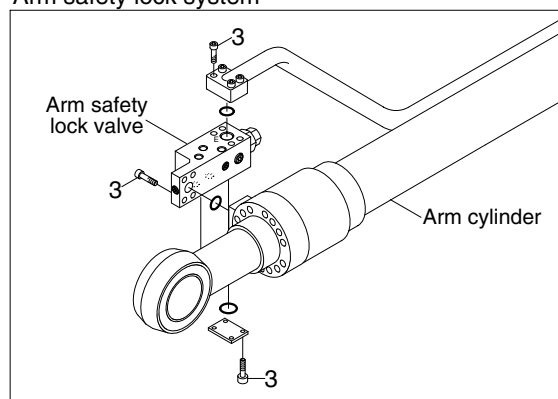
## 2. HYDRAULIC COMPONENTS MOUNTING 2



Boom safety lock system



Arm safety lock system



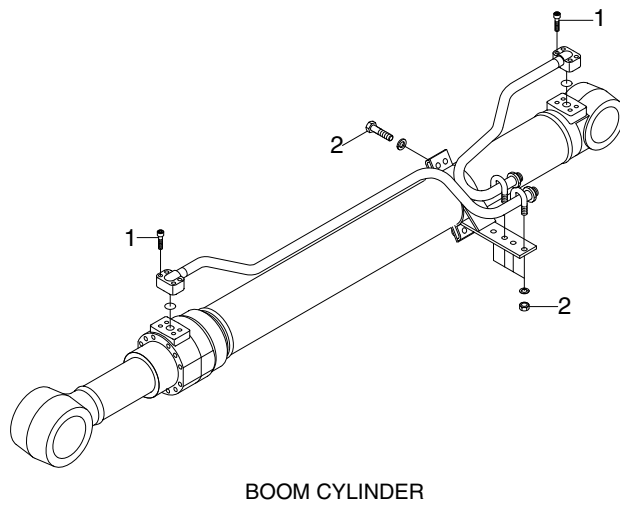
11079CM06

### • Tightening torque

Item	Size	kgf · m	lbf · ft
1	M 8 × 1.25	4.05 ± 0.8	29.3 ± 5.8
2	M10 × 1.5	6.9 ± 1.4	49.9 ± 10.1
3	M10 × 1.5	8.27 ± 1.7	59.8 ± 12.3

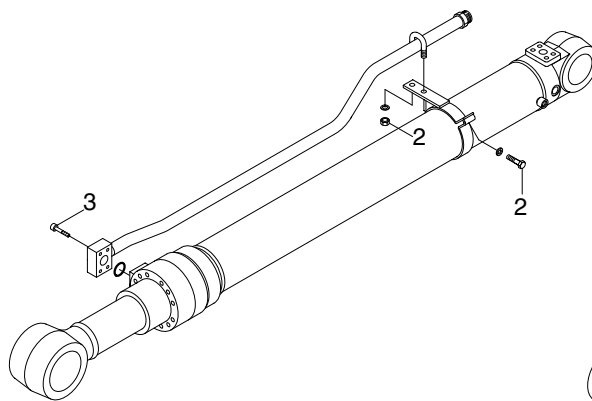
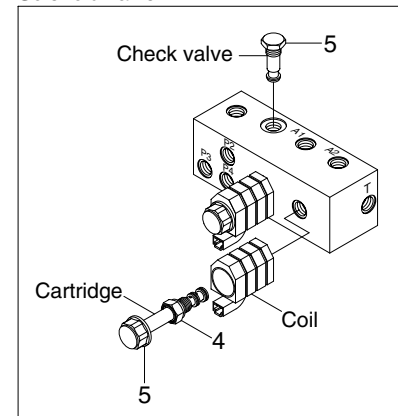
Item	Size	kgf · m	lbf · ft
4	M12 × 1.75	12.8 ± 3.0	92.6 ± 21.7
5	M16 × 2.0	23 ± 2.5	166.3 ± 18.1
-	-	-	-

### 3. HYDRAULIC COMPONENTS MOUNTING 3

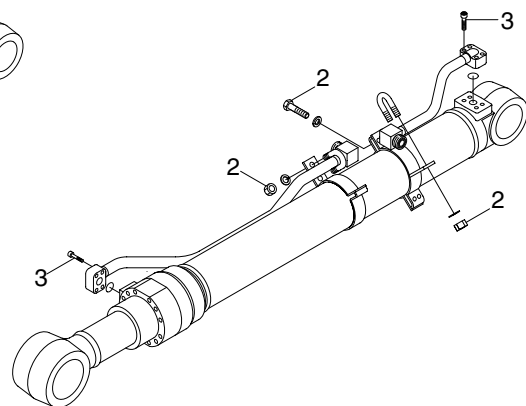


BOOM CYLINDER

Solenoid valve



ARM CYLINDER



BUCKET CYLINDER

11079CM07

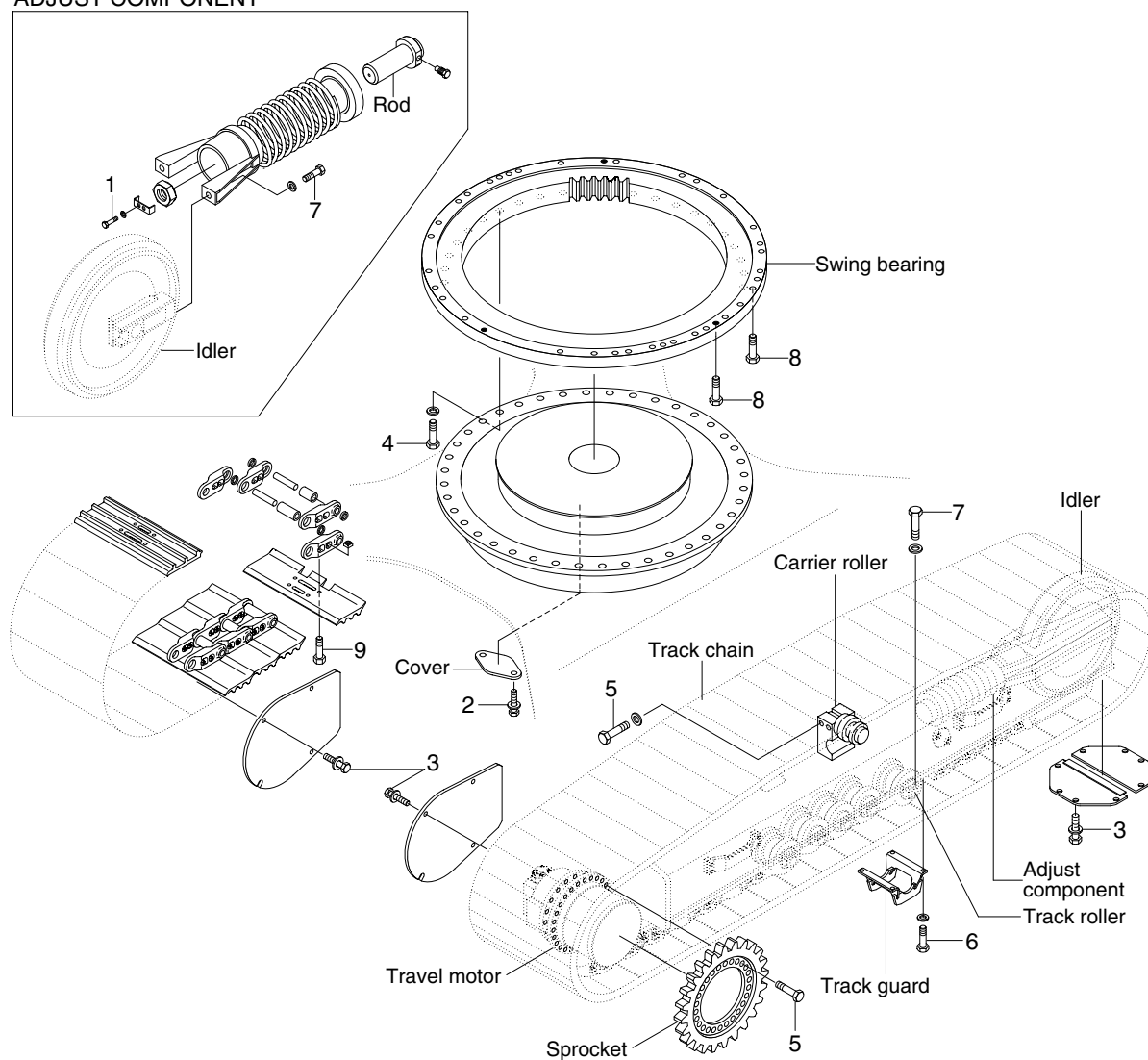
#### · Tightening torque

Item	Size	kgf · m	lbf · ft
1	M 8×1.25	2.7±0.3	19.5±2.2
2	M10×1.5	3.2±0.3	23.1±2.2
3	M10×1.5	5.4±0.5	39.1±3.6
4	-	0.4	2.9

Item	Size	kgf · m	lbf · ft
5	-	2.0	14.5

## GROUP 5 UNDERCARRIAGE

### ADJUST COMPONENT



11079CM08

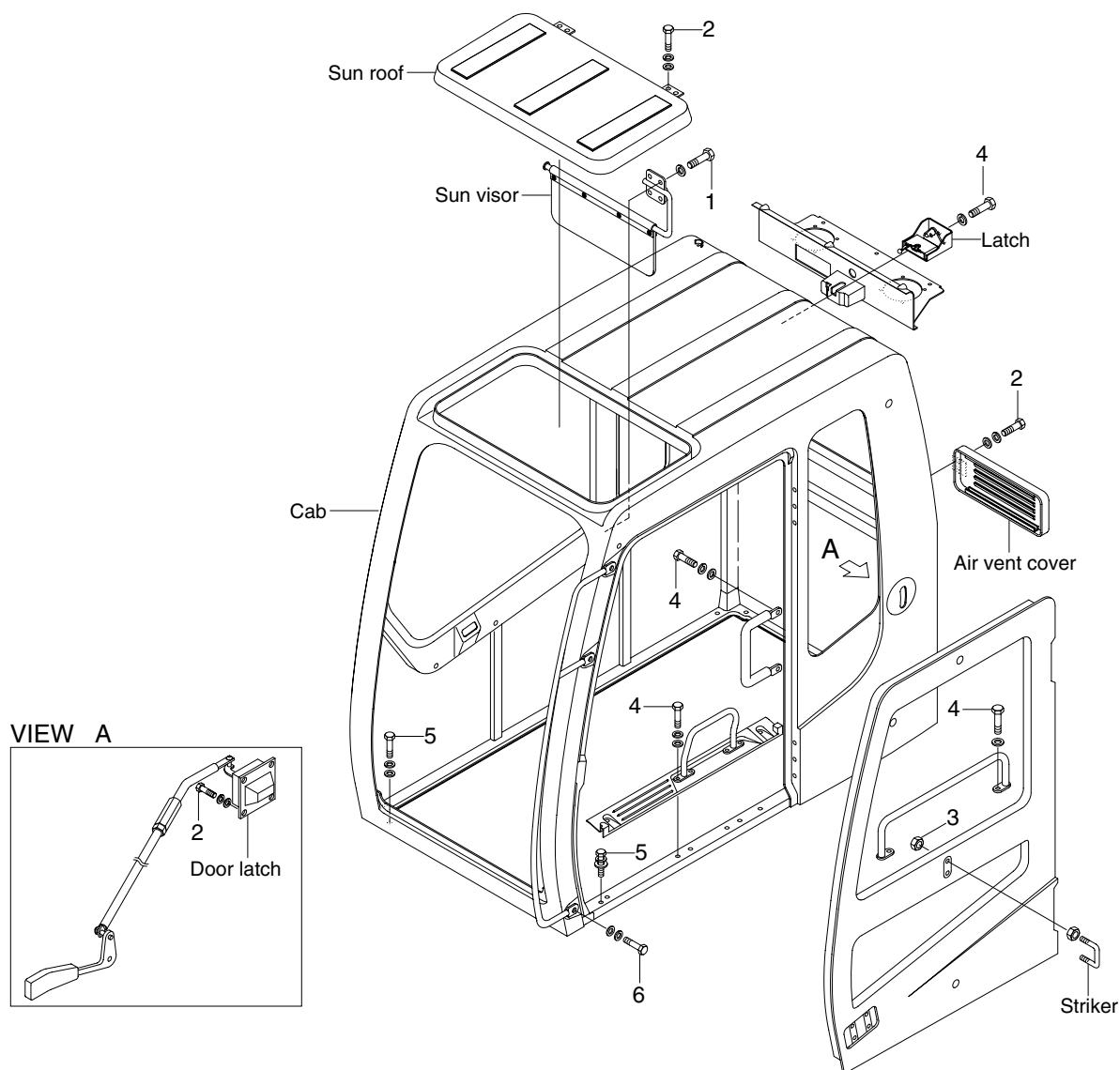
### · Tightening torque

Item	Size	kgf · m	lbf · ft
1	M 8 × 1.25	3.43 ± 0.7	24.8 ± 5.1
2	M10 × 1.5	6.9 ± 1.4	49.9 ± 10.1
3	M12 × 1.75	12.8 ± 3.0	92.6 ± 21.7
4	M16 × 1.5	31.3 ± 4.7	226 ± 34
5	M16 × 2.0	29.7 ± 4.5	215 ± 32.5

Item	Size	kgf · m	lbf · ft
6	M16 × 2.0	29.6 ± 3.2	214 ± 23.1
7	M16 × 2.0	29.7 ± 4.5	215 ± 32.5
8	M18 × 2.5	41.3 ± 6.2	299 ± 44.8
9	5/8"	42 ± 4.0	304 ± 29
-	-	-	-

## GROUP 6 STRUCTURE

### 1. CAB AND ACCESSORIES MOUNTING



11079CM09

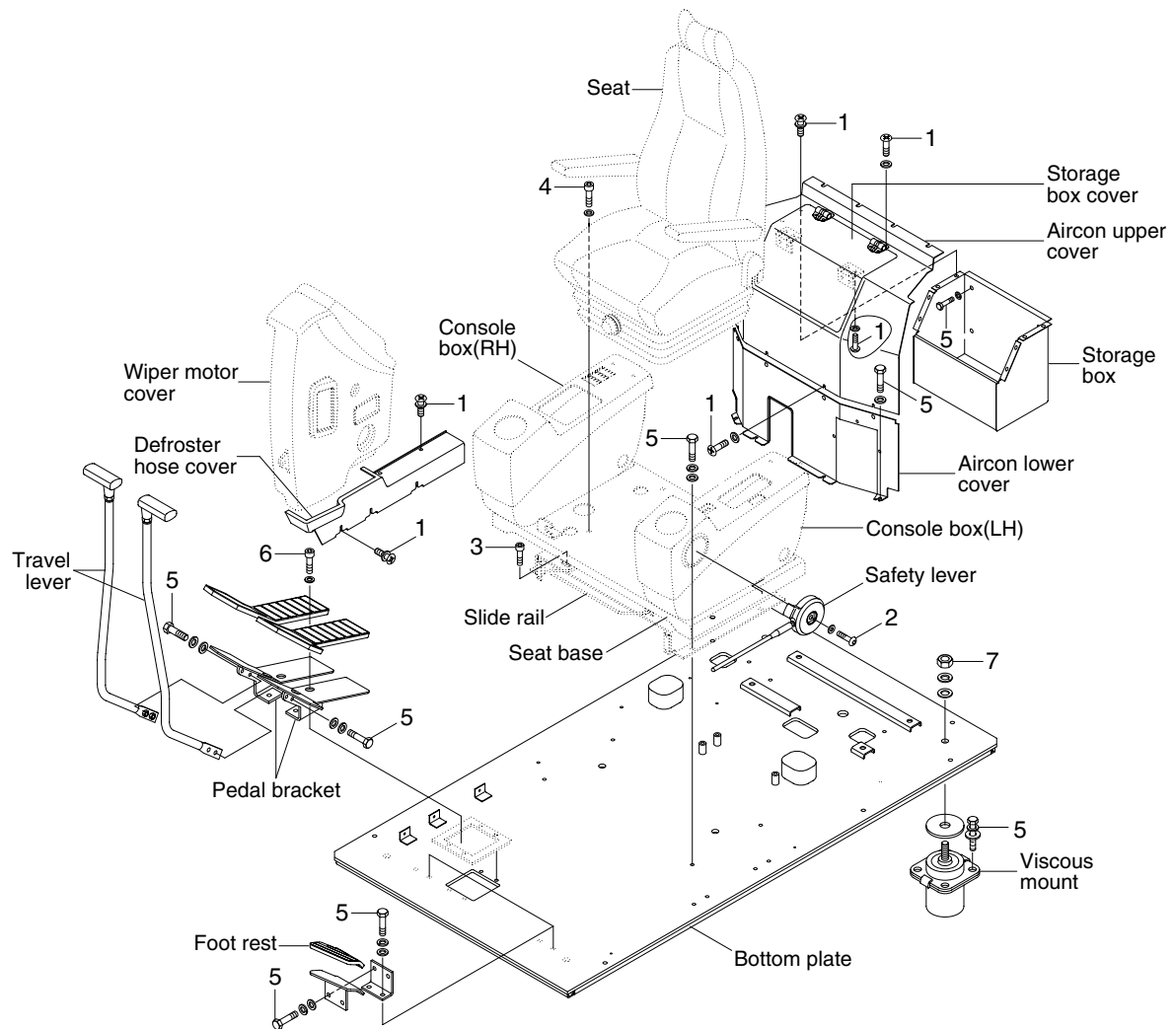
#### • Tightening torque

Item	Size	kgf · m	lbf · ft
1	M 6×1.0	0.49±0.1	3.5±0.7
2	M 8×1.25	2.5±0.5	18.1±3.6
3	M10×1.5	4.7±0.9	34±6.5

Item	Size	kgf · m	lbf · ft
4	M10×1.5	6.9±1.4	49.9±10.1
5	M12×1.75	12.8±3.0	92.6±21.7
6	M16×2.0	29.7±4.5	215±32.5



## 2. CAB INTERIOR MOUNTING



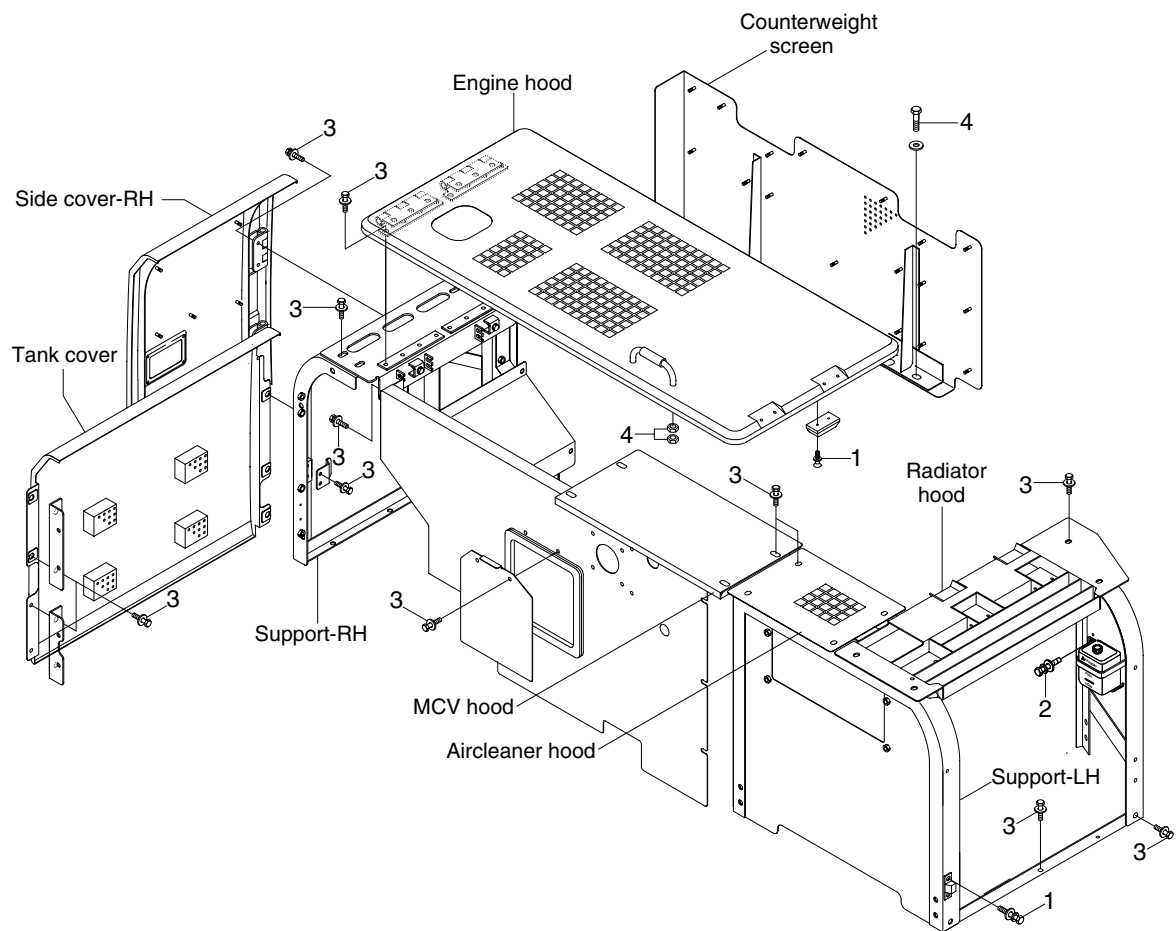
14079CM10

### • Tightening torque

Item	Size	kgf · m	lbf · ft
1	M 6×1.0	0.49±0.1	3.5±0.7
2	M 6×1.0	1.05±0.2	7.6±1.4
3	M 8×1.25	3.43±0.7	24.8±5.1
4	M 8×1.25	4.05±0.8	29.3±5.8

Item	Size	kgf · m	lbf · ft
5	M10×1.5	6.9±1.4	49.9±10.1
6	M10×1.5	8.27±1.7	59.8±12.3
7	M16×2.0	29.7±4.5	215±32.5
-	-	-	-

### 3. COWLING MOUNTING



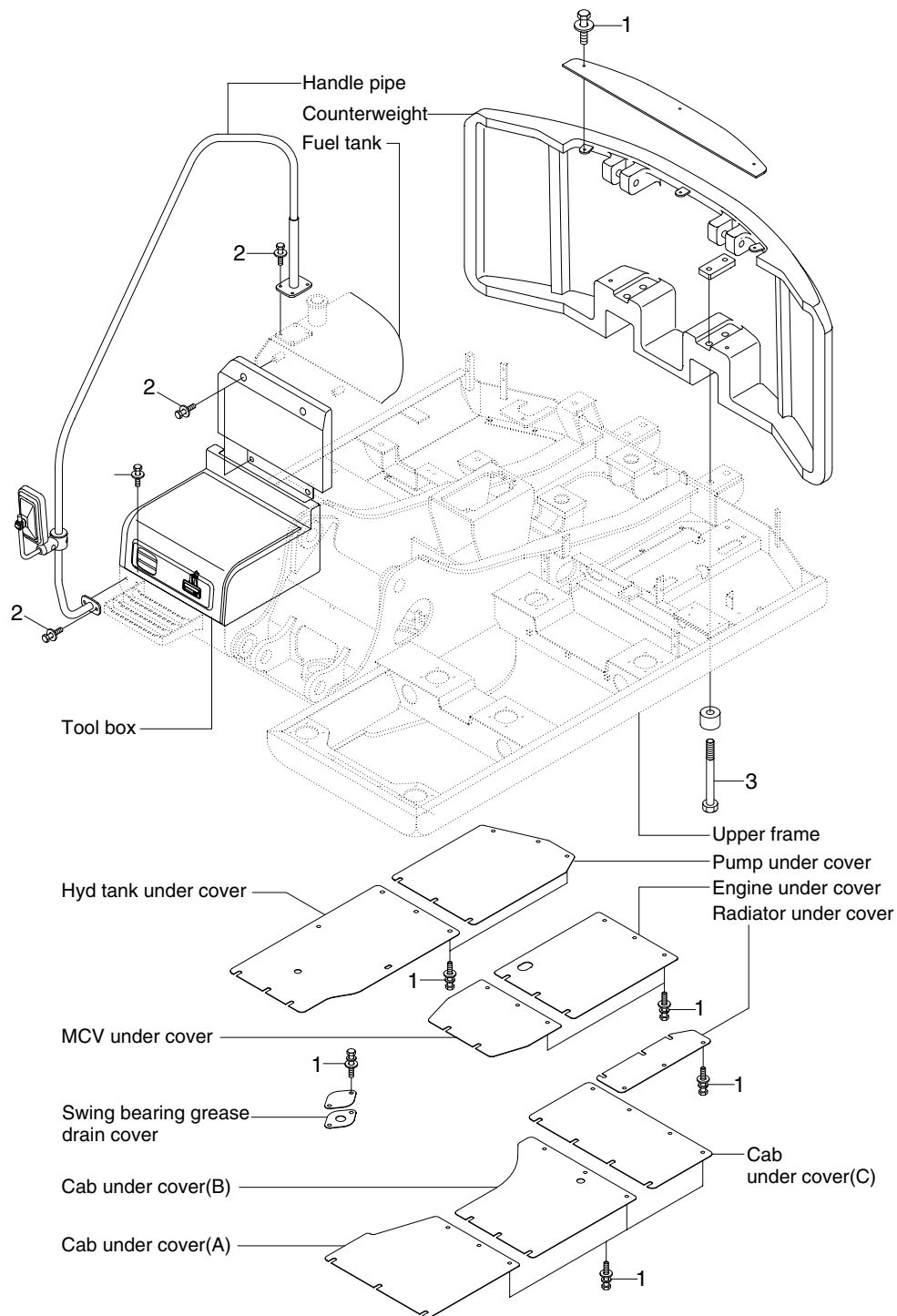
11079CM11

#### • Tightening torque

Item	Size	kgf · m	lbf · ft
1	M 6×1.0	0.49±0.1	3.5±0.7
2	M 8×1.25	2.5±0.5	18.1±3.6

Item	Size	kgf · m	lbf · ft
3	M12×1.75	12.8±3.0	92.6±21.7
4	M16×2.0	29.7±4.5	215±32.5

## 4. COUNTERWEIGHT AND COVERS MOUNTING



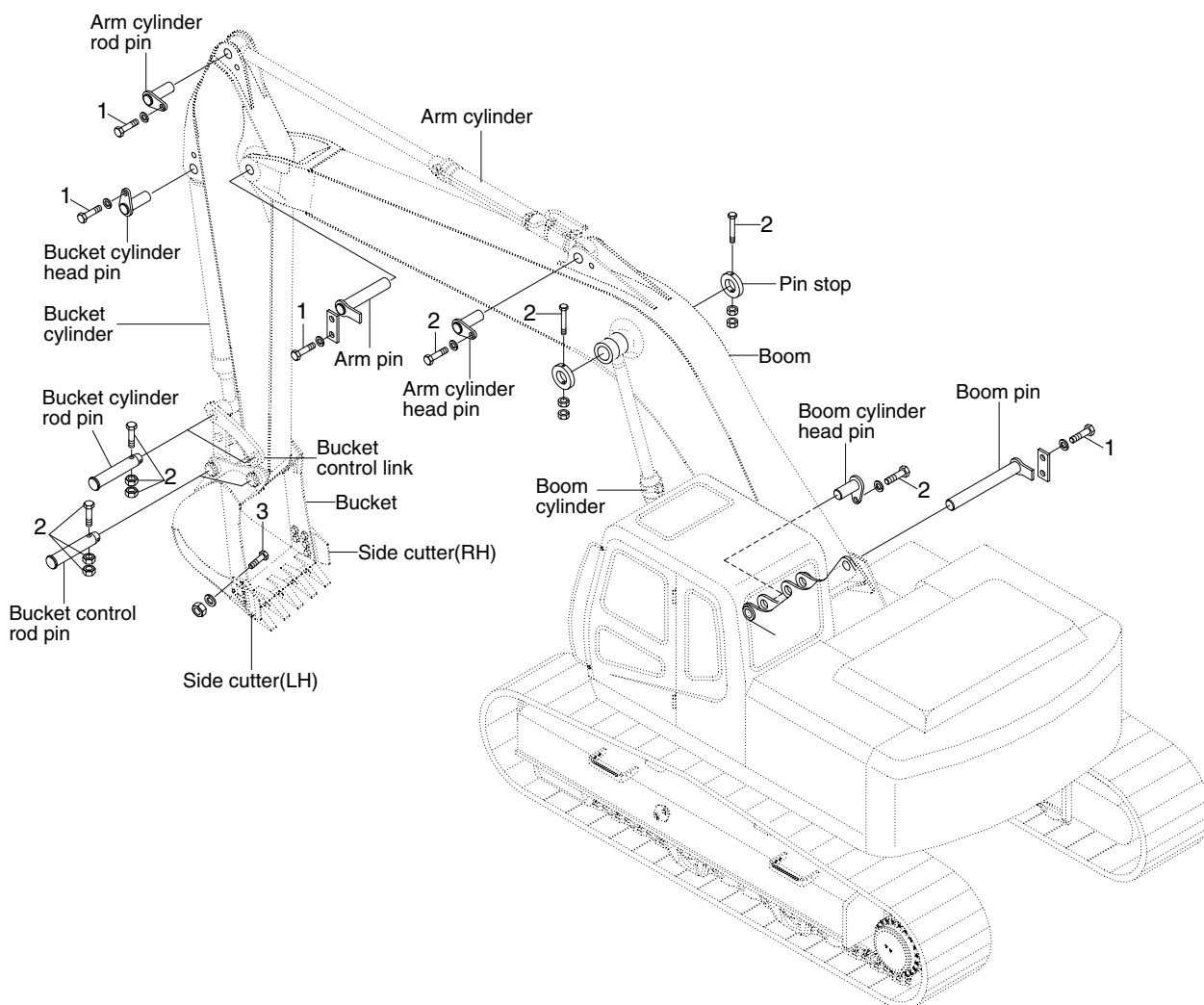
11079CM12

### · Tightening torque

Item	Size	kgf · m	lbf · ft
1	M10×1.5	6.9±1.4	49.9±10.1
2	M12×1.75	12.8±3.0	92.6±21.7

Item	Size	kgf · m	lbf · ft
3	M24×3.0	97.8±10	707±72.3
-	-	-	-

## GROUP 7 WORK EQUIPMENT



11079CM13

### • Tightening torque

Item	Size	kgf · m	lbf · ft
1	M12×1.75	12.8±3.0	92.6±21.7
2	M16×2.0	29.7±4.5	215±32.5

Item	Size	kgf · m	lbf · ft
3	M20×2.5	57.9±8.7	419±62.9
-	-	-	-