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.

Structure and function

This group 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.

Operational checks and troubleshooting

This group explains the system operational checks and troubleshooting charts correlating problem to remedy.

Tests and adjustments

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

Disassembly and assembly

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

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

2. HOW TO READ THE SERVICE MANUAL

Distribution and updating

Any additions, amendments or other changes will be sent to Hyundai distributors.
Get the most up-to-date information before you start any work.

Filing method

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

   3 - 3
   - 1st 3: Section number (3. Power train system)
   - 2nd 3: Consecutive page number for each section

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

Revised edition mark(①②③…)

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

Revisions

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

Symbols

So that the service 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 55㎜ into inches.
   (1) Locate the number 50 in the vertical column at the left side, take this as ⓐ, then draw a horizontal line from ⓐ.
   (2) Locate the number 5 in the row across the top, take this as ⓑ, then draw a perpendicular line down from ⓑ.
   (3) Take the point where the two lines cross as ⓒ. This point ⓒ gives the value when converting from millimeters to inches. Therefore, 55㎜ = 2.165 inches.

2. Convert 550㎜ into inches.
   (1) The number 550 does not appear in the table, so divide by 10(Move the decimal point one place to the left) to convert it to 55㎜.
   (2) Carry out the same procedure as above to convert 55㎜ to 2.165 inches.
   (3) The original value(550㎜) was divided by 10, so multiply 2.165 inches by 10(Move the decimal point one place to the right) to return to the original value.
   This gives 550㎜ = 21.65 inches.

Millimeters to inches

1㎜ = 0.03937 in

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

Millimeters to Inches

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	6.6076	6.340	6.604	6.869	7.133	7.397	7.661
30	7.925	8.189	8.454	8.718	8.982	9.246	9.510	9.774	10.039	10.303
40	10.567	10.831	11.095	11.359	11.624	11.888	12.152	12.416	12.680	12.944
50	13.209	13.473	13.737	14.001	14.265	14.529	14.795	15.058	15.322	15.586
60	15.850	16.115	16.379	16.643	16.907	17.171	17.435	17.700	17.964	18.228
70	18.492	18.756	19.020	19.285	19.549	19.813	20.077	20.341	20.605	20.870
80	21.134	21.398	21.662	21.926	22.190	22.455	22.719	22.983	23.247	23.511
90	23.775	24.040	24.304	24.568	24.832	25.096	25.631	25.625	25.889	26.153

Liter to U.K. Gallon

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	7.969	7.919	8.139	8.359	8.579
40	8.799	9.019	9.239	9.459	9.679	9.899	10.119	10.339	10.559	10.778
50	10.998	11.281	11.438	11.658	11.878	12.098	12.318	12.528	12.758	12.978
60	13.198	13.418	13.638	13.858	14.078	14.298	14.518	14.738	14.958	15.178
70	15.398	15.618	15.838	16.058	16.278	16.498	16.718	16.938	17.158	17.378
80	17.598	17.818	18.037	18.257	18.477	18.697	18.917	19.137	19.357	19.577
90	19.797	20.017	20.237	20.457	20.677	20.897	21.117	21.337	21.557	21.777

kg · m to lb · ft

1kg · m = 7.233lb · ft

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

kg/cm² to lb/in²

1kg/cm² = 14.2233lb/in²

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

TEMPERATURE

Fahrenheit-Centigrade Conversion.

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

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

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

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

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

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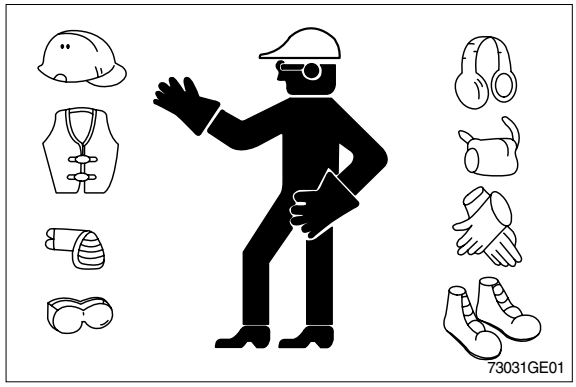
GROUP 1 SAFETY HINTS

FOLLOW SAFE PROCEDURE

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

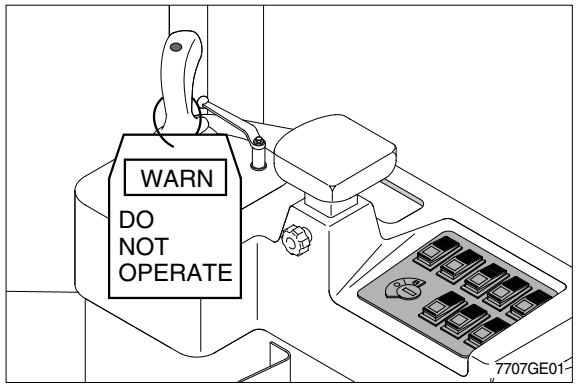
WEAR PROTECTIVE CLOTHING

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



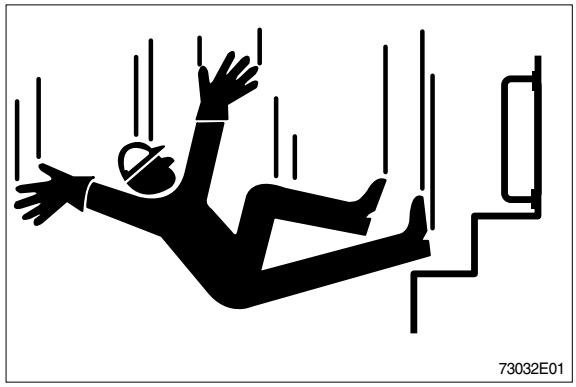
WARN OTHERS OF SERVICE WORK

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

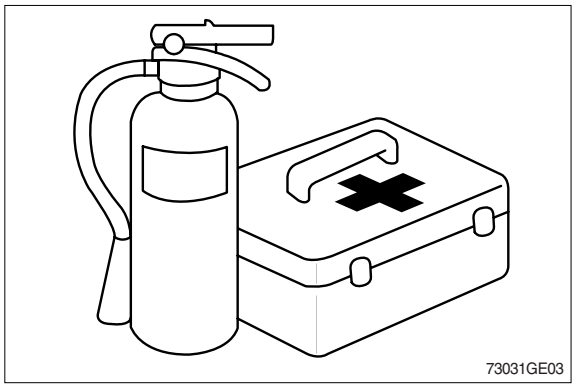


PREPARE FOR EMERGENCIES

Be prepared if a fire starts.

Keep a first aid kit and fire extinguisher handy.

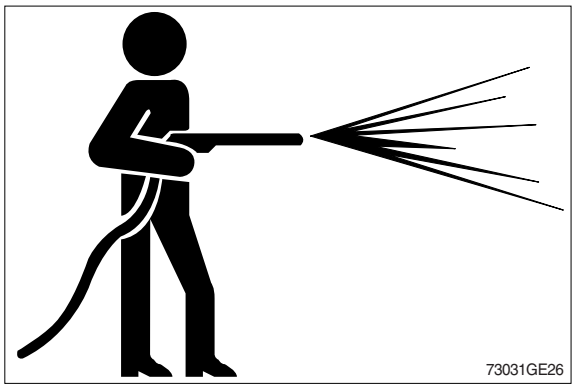
Keep emergency numbers for doctors, ambulance service, hospital, and fire department near your telephone.



WORK IN CLEAN AREA

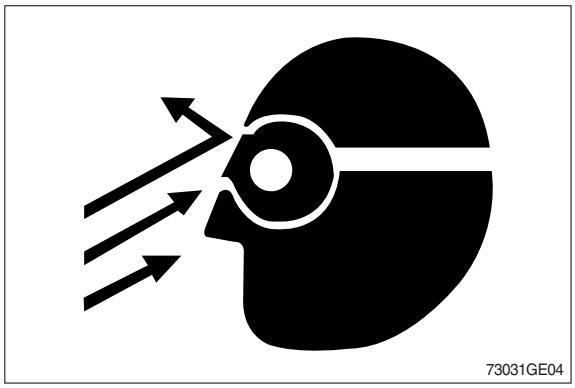
Before starting a job :

- Clean work area and machine.
- Make sure you have all necessary tools to do your job.
- Have the right parts on hand.
- Read all instructions thoroughly; Do not attempt shortcuts.



PROTECT AGAINST FLYING DEBRIS

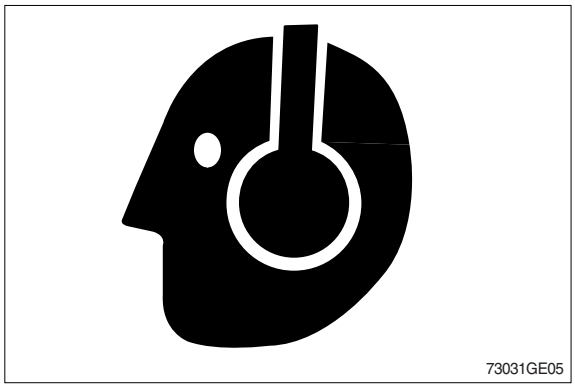
Guard against injury from flying pieces of metal or debris; Wear goggles or safety glasses.



PROTECT AGAINST NOISE

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

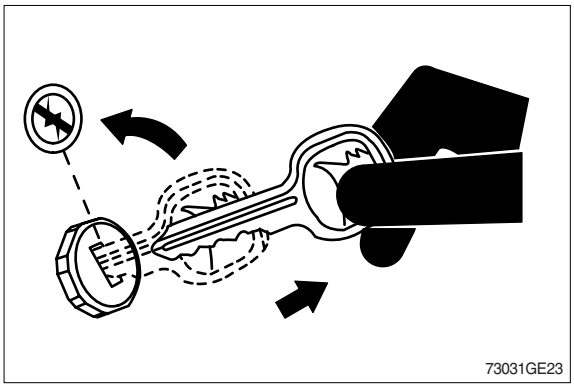
Wear a suitable hearing protective device such as earmuffs or earplugs to protect against objectionable or uncomfortable loud noises.



PARK MACHINE SAFELY

Before working on the machine:

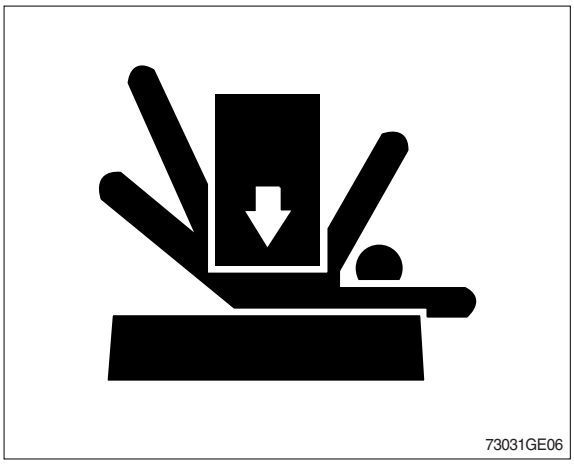
- Park machine on a level surface.
- Lower bucket to the ground.
- Turn key switch to OFF to stop engine. Remove key from switch.
- Move pilot control shutoff lever to locked position.
- Allow engine to cool.



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

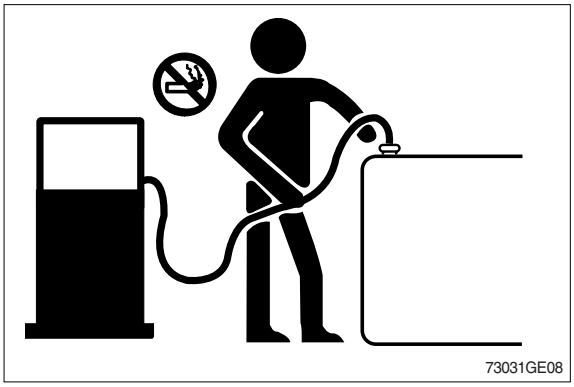
Explosive release of fluids from pressurized cooling system can cause serious burns.

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



HANDLE FLUIDS SAFELY-AVOID FIRES

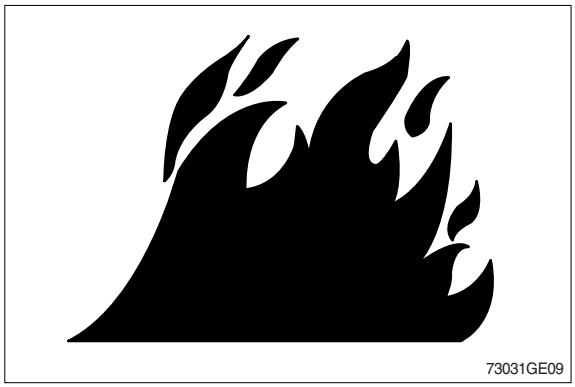
Handle fuel with care; It is highly flammable. Do not refuel the machine while smoking or when near open flame or sparks. Always stop engine before refueling machine.
Fill fuel tank outdoors.



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.



73031GE09

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

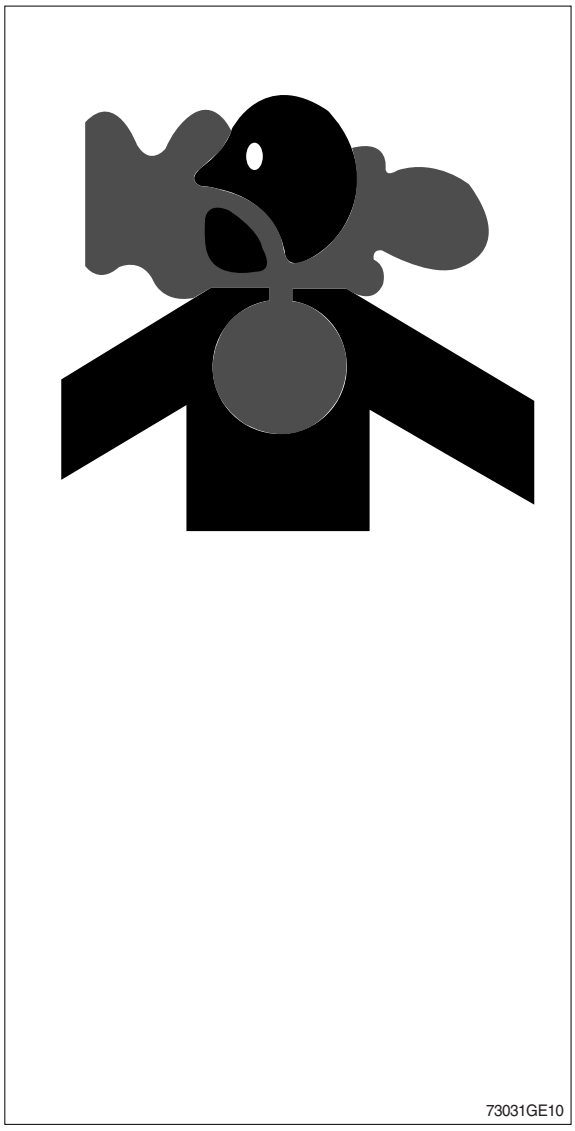
Avoid potentially toxic fumes and dust.

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:

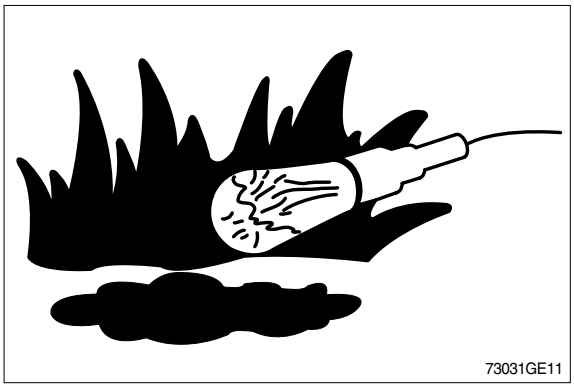
- If you sand or grind paint, avoid breathing the dust. Wear an approved respirator.
- If you use solvent or paint stripper, remove stripper with soap and water before welding. Remove solvent or paint stripper containers and other flammable material from area. Allow fumes to disperse at least 15 minutes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



73031GE10

ILLUMINATE WORK AREA SAFELY

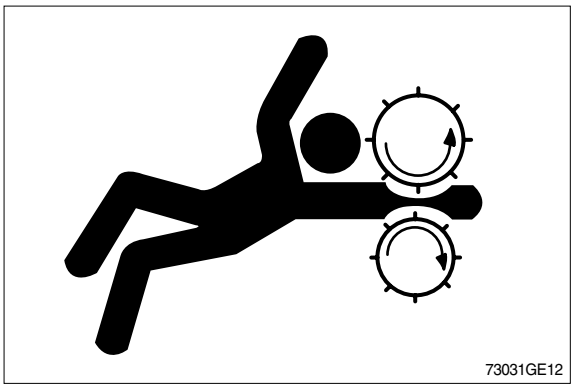
Illuminate your work area adequately but safely. Use a portable safety light for working inside or under the machine. Make sure the bulb is enclosed by a wire cage. The hot filament of an accidentally broken bulb can ignite spilled fuel or oil.



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.

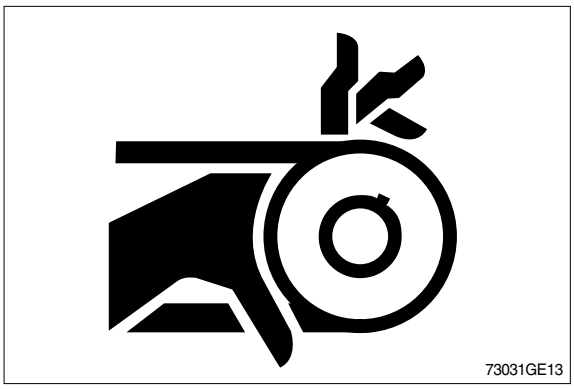
Remove rings and other jewelry to prevent electrical shorts and entanglement in moving parts.



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

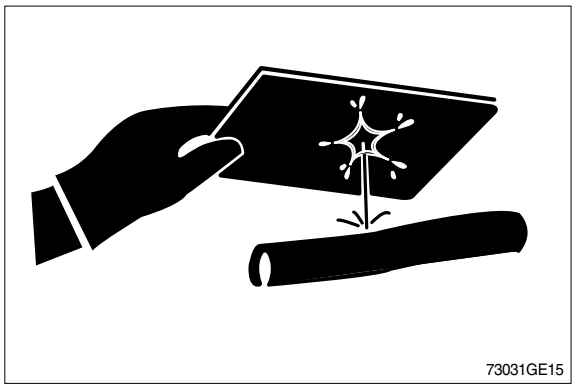
Escaping fluid under pressure can penetrate the skin causing serious injury.

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.


73031GE14


73031GE15

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.


73031GE16

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 do not charge a frozen battery; It may explode. Warm battery to 16°C(60°F).


73031GE17

PREVENT ACID BURNS

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

Avoid the hazard by:

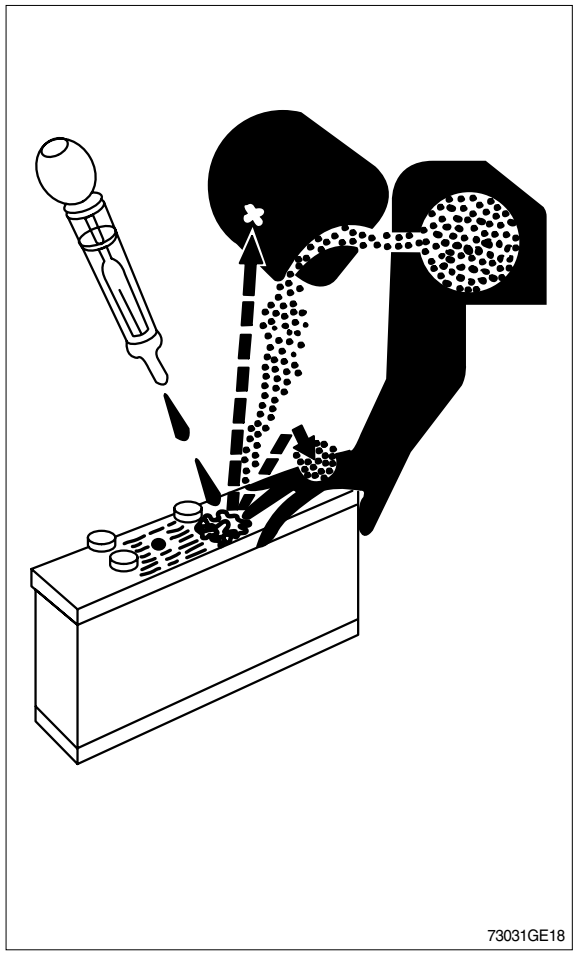
1. Filling batteries in a well-ventilated area.
2. Wearing eye protection and rubber gloves.
3. Avoiding breathing fumes when electrolyte is added.
4. Avoiding spilling of dripping electrolyte.
5. Use proper jump start procedure.

If you spill acid on yourself:

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

If acid is swallowed:

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



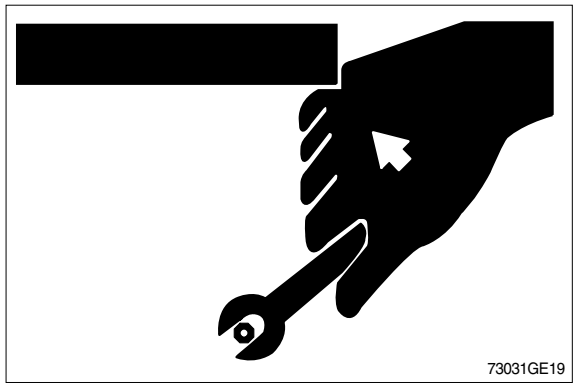
USE TOOLS PROPERLY

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

Use power tools only to loosen threaded tools and fasteners.

For loosening and tightening hardware, use the correct size tools. Avoid bodily injury caused by slipping wrenches.

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



SERVICE TIRES SAFELY

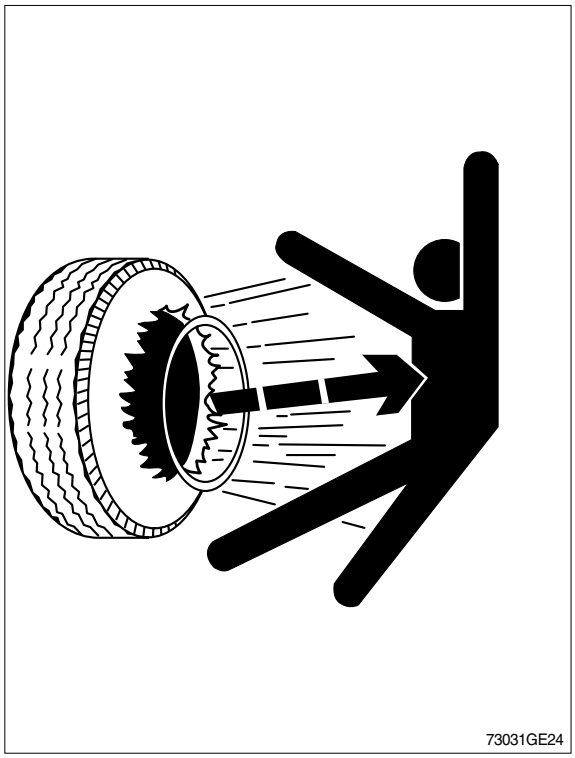
Explosive separation of a tire and rim parts can cause serious injury or death.

Do not attempt to mount a tire unless you have the proper equipment and experience to perform the job.

Always maintain the correct tire pressure. Do not inflate the tires above the recommended pressure. Never weld or heat a wheel and tire assembly. The heat can cause an increase in air pressure resulting in a tire explosion.
Welding can structurally weaken or deform the wheel.

When inflating tires, use a clip-on chuck and extension hose long enough to allow you to stand to one side and not in front of or over the tire assembly. Use a safety cage if available.

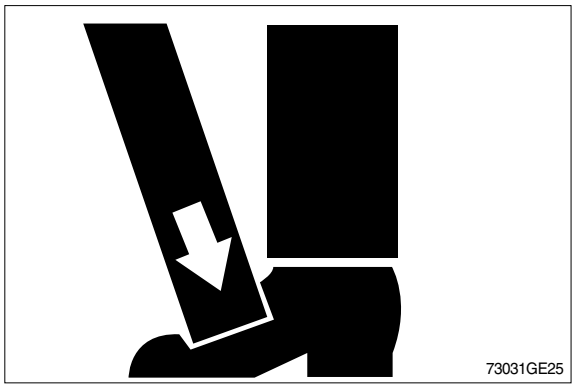
Check wheels for low pressure, cuts, bubbles, damaged rims or missing lug bolts and nuts.



USE PROPER LIFTING EQUIPMENT

Lifting heavy components incorrectly can cause severe injury or machine damage.

Follow recommended procedure for removal and installation of components in the manual.

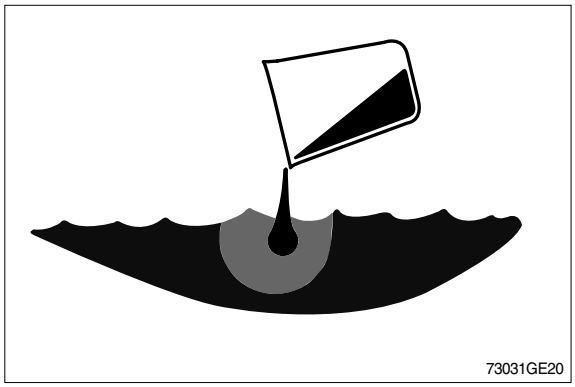


DISPOSE OF FLUIDS PROPERLY

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

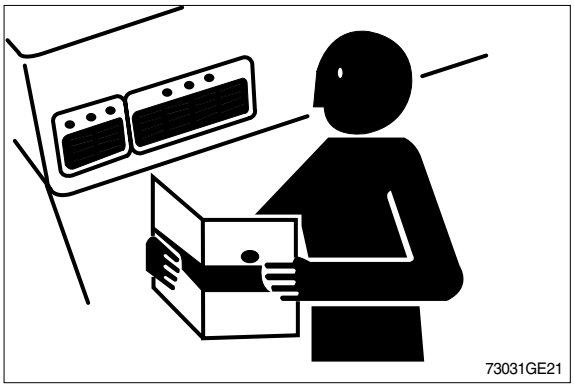
Use proper containers when draining fluids. Do not use food or beverage containers that may mislead someone into drinking from them.

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



REPLACE SAFETY SIGNS

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



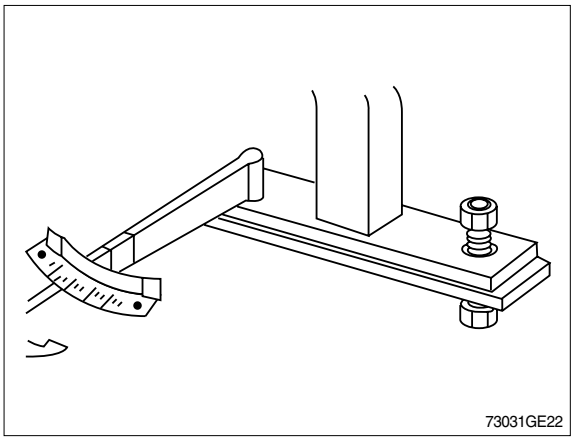
LIVE WITH SAFETY

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

KEEP ROPS INSTALLED PROPERLY

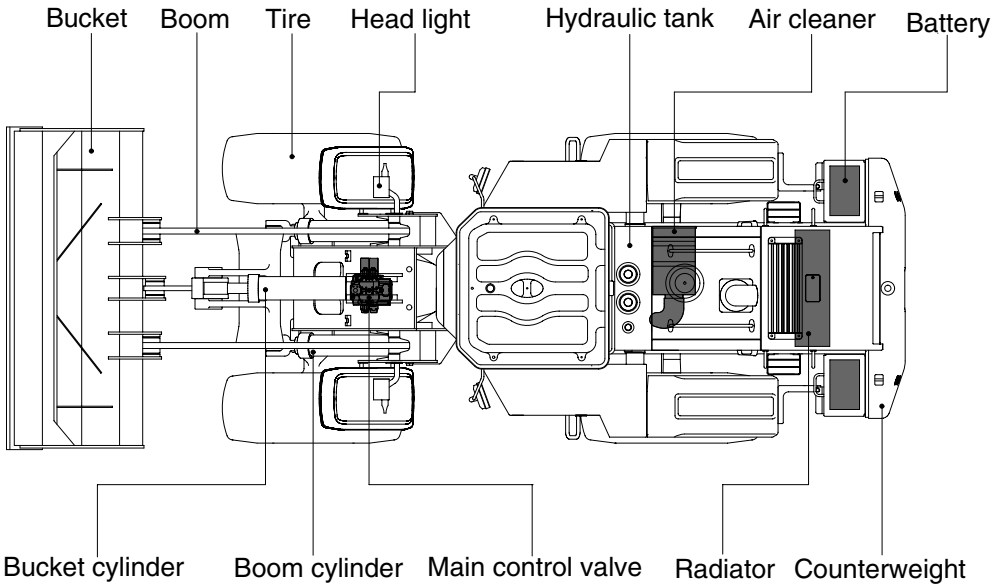
Make certain all parts are reinstalled correctly if the roll-over protective structure(ROPS) is loosened or removed for any reason. Tighten mounting bolts to proper torque.

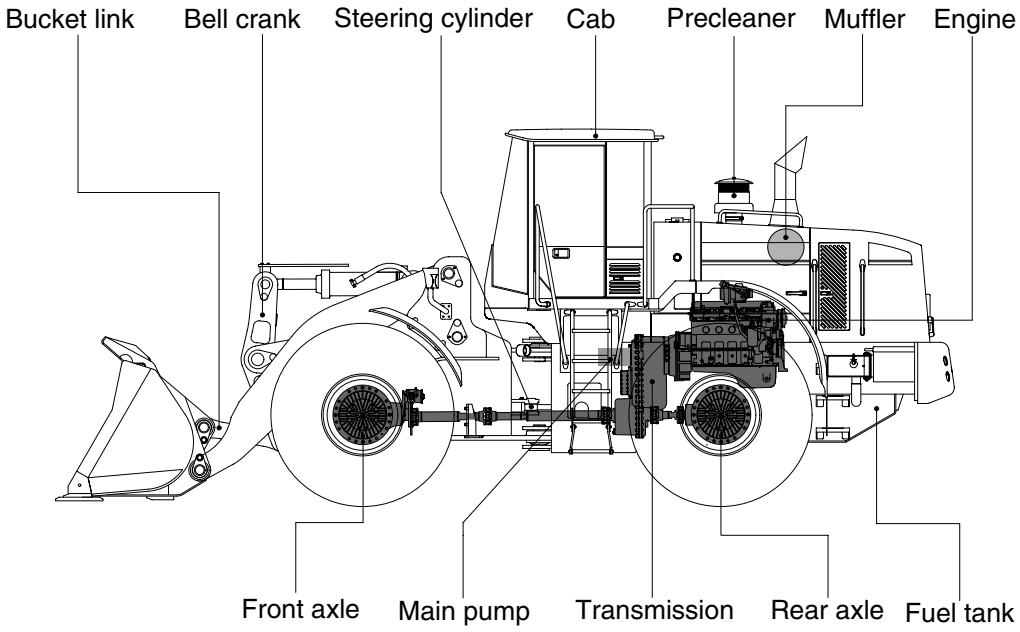
The protection offered by ROPS will be impaired if ROPS is subjected to structural damage, is involved in an overturn incident, or is in any way altered by welding, bending, drilling, or cutting. A damaged ROPS should be replaced, not reused.



GROUP 2 SPECIFICATION

1. MAJOR COMPONENT

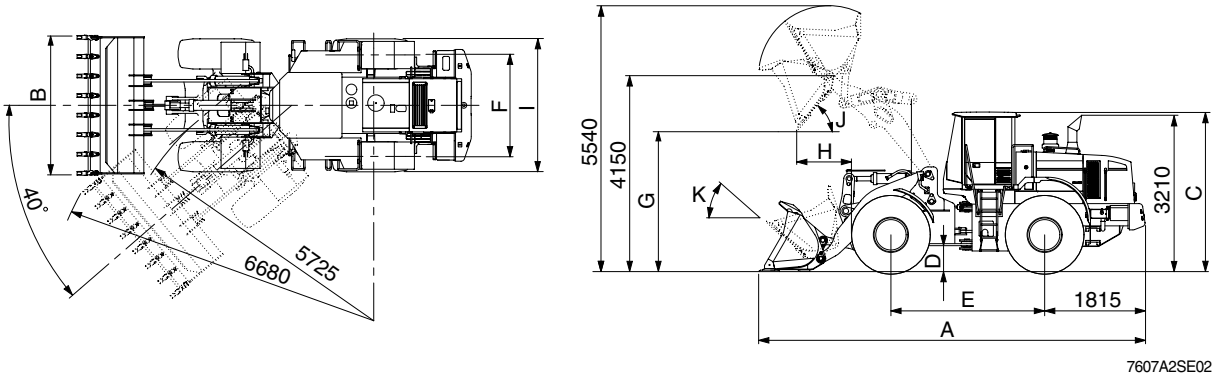




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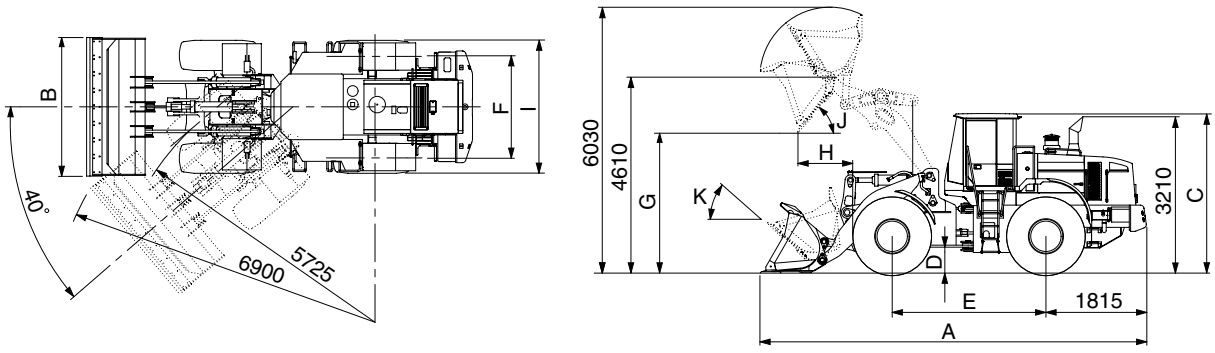
2. SPECIFICATIONS

1) WITH BOLT-ON CUTTING EDGE TYPE BUCKET(HL760-7A)



Description			Unit	Specification
Operating weight			kg(lb)	17900(39460)
Bucket capacity		Struck	$m^3(yd^3)$	2.7(3.5)
		Heaped		3.1(4.1)
Overall length		A	mm(ft-in)	8060(26' 5")
Overall width		B		2900(9' 6")
Overall height		C		3440(11' 3")
Ground clearance		D		420(1' 5")
Wheelbase		E		3300(10'10")
Tread		F		2160(7' 1")
Dump clearance at 45°		G		3000(9'10")
Dump reach(Full lift)		H		1190(3'11")
Width over tires		I		2770(9' 1")
Dump angle		J	Degree (°)	47
Roll back angle(Carry position)		K		47
Cycle time		Lift(With load)	sec	6.2
		Dump(With load)		1.3
		Lower(Empty)		3.0
Maximum travel speed			km/hr(mph)	34.3(21.3)
Braking distance			m(ft-in)	11(36' 1")
Minimum turning radius(Center of outside tire)				5.73(18' 9")
Gradability			Degree (°)	30
Travel speed	Forward	First gear	km/hr(mph)	6.2(3.9)
		Second gear		11.7(7.3)
		Third gear		22.3(13.9)
		Fourth gear		34.3(21.3)
	Reverse	First gear		6.6(4.1)
		Second gear		12.3(7.6)
		Third gear		23.3(14.5)

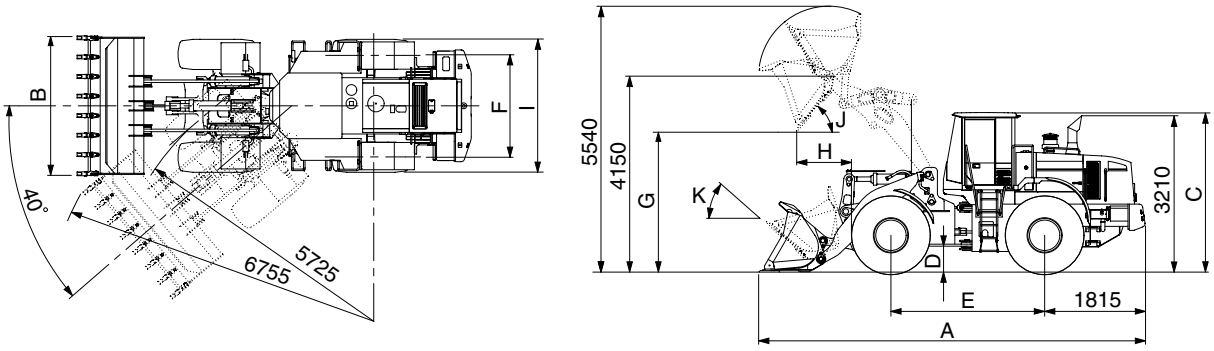
WITH BOLT-ON CUTTING EDGE TYPE BUCKET(HL760XTD-7A)



7607A2SE03

Description			Unit	Specification
Operating weight			kg(lb)	18700(41230)
Bucket capacity		Struck	$m^3(yd^3)$	2.7(3.5)
		Heaped		3.1(4.1)
Overall length		A	mm(ft-in)	8620(28' 3")
Overall width		B		2900(9' 6")
Overall height		C		3440(11' 3")
Ground clearance		D		420(1' 5")
Wheelbase		E		3300(10'10")
Tread		F		2160(7' 1")
Dump clearance at 45°		G		3490(11' 5")
Dump reach(Full lift)		H		1215(4' 0")
Width over tires		I		2770(9' 1")
Dump angle		J	Degree (°)	47
Roll back angle(Carry position)		K		49
Cycle time		Lift(With load)	sec	6.2
		Dump(With load)		1.3
		Lower(Empty)		3.0
Maximum travel speed			km/hr(mph)	34.3(21.3)
Braking distance			m(ft-in)	11(36' 1")
Minimum turning radius(Center of outside tire)				5.73(18' 9")
Gradability			Degree (°)	30
Travel speed	Forward	First gear	km/hr(mph)	6.2(3.9)
		Second gear		11.7(7.3)
		Third gear		22.3(13.9)
		Fourth gear		34.3(21.3)
	Reverse	First gear		6.6(4.1)
		Second gear		12.3(7.6)
		Third gear		23.3(14.5)

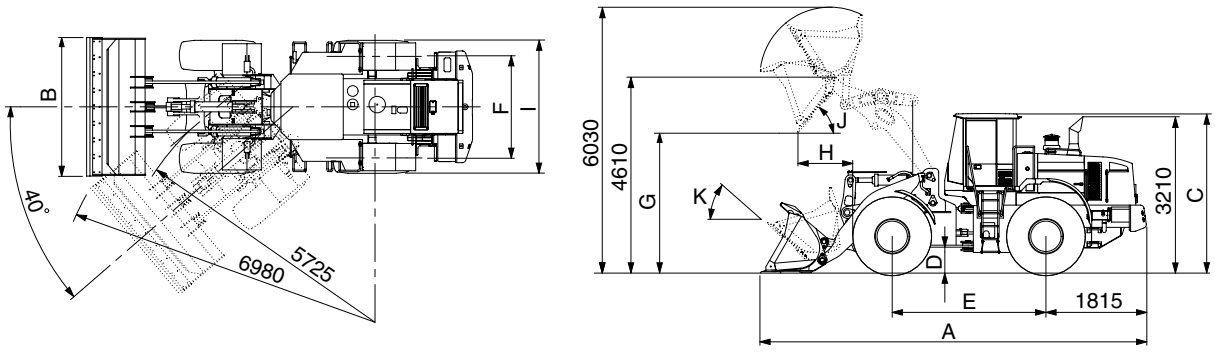
2) WITH TOOTH TYPE BUCKET(HL760-7A)



7607A2SE04

Description			Unit	Specification
Operating weight			kg(lb)	17900(39460)
Bucket capacity		Struck	$m^3(yd^3)$	2.6(3.4)
		Heaped		3.0(3.9)
Overall length		A	mm(ft-in)	8180(26'10")
Overall width		B		2950(9' 8")
Overall height		C		3440(11' 3")
Ground clearance		D		420(1' 5")
Wheelbase		E		3300(10'10")
Tread		F		2160(7' 1")
Dump clearance at 45°		G		2870(9' 5")
Dump reach(Full lift)		H		1270(4' 2")
Width over tires		I		2770(9' 1")
Dump angle		J	Degree (°)	47
Roll back angle(Carry position)		K		47
Cycle time		Lift(With load)	sec	6.2
		Dump(With load)		1.3
		Lower(Empty)		3.0
Maximum travel speed			km/hr(mph)	34.3(21.3)
Braking distance			m(ft-in)	11(36' 1")
Minimum turning radius(Center of outside tire)				5.73(18' 9")
Gradability			Degree (°)	30
Travel speed	Forward	First gear	km/hr(mph)	6.2(3.9)
		Second gear		11.7(7.3)
		Third gear		22.3(13.9)
		Fourth gear		34.3(21.3)
	Reverse	First gear		6.6(4.1)
		Second gear		12.3(7.6)
		Third gear		23.3(14.5)

WITH TOOTH TYPE BUCKET(HL760XTD-7A)



7607A2SE05

Description			Unit	Specification
Operating weight			kg(lb)	18700(41230)
Bucket capacity		Struck	$m^3(yd^3)$	2.6(3.4)
		Heaped		3.0(3.9)
Overall length		A	mm(ft-in)	8770(28' 9")
Overall width		B		2950(9' 8")
Overall height		C		3440(11' 3")
Ground clearance		D		420(1' 5")
Wheelbase		E		3300(10'10")
Tread		F		2160(7' 1")
Dump clearance at 45°		G		3360(11' 0")
Dump reach(Full lift)		H		1305(4' 3")
Width over tires		I		2770(9' 1")
Dump angle		J	Degree (°)	47
Roll back angle(Carry position)		K		49
Cycle time		Lift(With load)	sec	6.2
		Dump(With load)		1.3
		Lower(Empty)		3.0
Maximum travel speed			km/hr(mph)	34.3(21.3)
Braking distance			m(ft-in)	11(36' 1")
Minimum turning radius(Center of outside tire)				5.73(18' 9")
Gradability			Degree (°)	30
Travel speed	Forward	First gear	km/hr(mph)	6.2(3.9)
		Second gear		11.7(7.3)
		Third gear		22.3(13.9)
		Fourth gear		34.3(21.3)
	Reverse	First gear		6.6(4.1)
		Second gear		12.3(7.6)
		Third gear		23.3(14.5)

3. WEIGHT

Item		kg	lb
Front frame assembly		1652	3642
Rear frame assembly		1998	4405
Front fender(LH & RH)		28	62
Counterweight	HL760-7A	1050	2315
	HL760XTD-7A	1630	3594
Cab assembly		1020	2250
Engine assembly		485	1069
Transmission assembly		470	1036
Drive shaft(Front)		44	97
Drive shaft(Center)		46	101
Drive shaft(Rear)		27	60
Front axle(Include differential)	-#0293 (VOLVO)	970	2139
	#0294- (ZF)	630	1389
Rear axle(Include differential)	-#0293 (VOLVO)	840	1852
	#0294- (ZF)	632	1393
Tire(23.5-25, 20PR, L3)		300	661
Hydraulic tank assembly		210	463
Fuel tank assembly		372	820
Main pump assembly		37	82
Fan & brake pump assembly		7	15
Main control valve		51	112
Steering valve(EHPS)		15	33
Boom assembly	HL760-7A	1200	2646
	HL760XTD-7A	1360	3000
Bell crank assembly		360	794
Bucket link		57	126
3.1m^3 bucket, with bolt on cutting edge		1675	3693
3.0m^3 bucket, with tooth		1625	3583
3.0m^3 bucket, without tooth and cutting edge		1415	3120
Boom cylinder assembly		158	348
Bucket cylinder assembly		184	406
Steering cylinder assembly		29	64
Seat		40	88
Battery		55	121

4. SPECIFICATION FOR MAJOR COMPONENTS

1) ENGINE

Item	Specification
Model	Cummins QSB6.7
Type	4-cycle turbocharged, charge air cooled diesel engine
Control type	Electronic control
Cooling method	Water cooling
Number of cylinders and arrangement	6 cylinders, in-line
Firing order	1-5-3-6-2-4
Combustion chamber type	Direct injection type
Cylinder bore × stroke	104×132mm(4.10"×5.20")
Piston displacement	6700cc(409cu in)
Compression ratio	17.2 : 1
Rated gross horse power	218ps at 2100rpm
Maximum gross torque at 1500rpm	97kgf · m(702lbf · ft)
Engine oil quantity	18 ℓ (4.8 U.S. gal)
Wet weight	485kg(1062lb)
High idling speed	2230 ± 50rpm
Low idling speed	800 ± 50rpm
Rated fuel consumption	170g/ps · hr
Starting motor	Nippondenso 228000-7902 (24V-3.7kW)
Alternator	Delco Remy 22SI(24V-70Amp)
Battery	2×12V×160Ah

2) MAIN PUMP

Item	Specification	
	Steering	Loader
Type	Fixed displacement tandem gear pump	
Capacity	68cc/rev	68cc/rev
Maximum operating pressure	210kgf/cm²(2990psi)	
Rated oil quantity	140 ℓ /min(37.0U.S.gpm)	140 ℓ /min(37.0U.S.gpm)
Rated speed	2100rpm	

3) FAN + BRAKE PUMP

Item	Specification	
	Fan	Brake
Type	Fixed displacement tandem gear pump	
Capacity	19.0cc/rev	11.9cc/rev
Maximum operating pressure	180kgf/cm²(2560psi)	
Rated oil quantity	43 ℓ /min(11.4U.S.gpm)	27 ℓ /min(7.1U.S.gpm)
Rated speed	2100rpm	

4) MAIN CONTROL VALVE

Item	Specification
Type	2 spool
Operating method	Hydraulic pilot assist
Main relief valve pressure	210kgf/cm²(2990psi)
Overload relief valve pressure(Boom)	240kgf/cm²(3410psi)

5) REMOTE CONTROL VALVE

Item		Specification
Type		Pressure reducing type
Operating	Minimum	5.8kgf/cm²(82.5psi)
	Maximum	19kgf/cm²(270psi)
Single operation stroke	Lever	70mm(2.8in)

6) CYLINDER

Item		Specification
Boom cylinder	Bore dia × Rod dia × Stroke	ø 160 × ø 90 × 757mm
Bucket cylinder	Bore dia × Rod dia × Stroke	ø 180 × ø 90 × 530mm
Steering cylinder	Bore dia × Rod dia × Stroke	ø 80 × ø 45 × 440mm

7) DYNAMIC POWER TRANSMISSION DEVICES

Item			Specification
Transmission	Model		ZF 4WG210
	Type	Converter	Single-stage, single-phase
		Transmission	Full-automatic power shift
	Gear shift		Forward fourth gear, reverse third gear
	Adjustment		Electrical single lever type, kick-down system
Axle	Drive devices		4-wheel drive
	Front		Front fixed location
	Rear		Oscillation ±12° of center pin-loaded
Wheels	Tires		23.5-25, 20PR(L3)
Brakes	Travel		Four-wheel, wet-disc type, full hydraulic
	Parking		Spring applied, hydraulic released brake
Steering	Type		Full hydraulic, articulated
	Steering angle		40° to both right and left angle, respectively

5. TIGHTENING TORQUE OF MAJOR COMPONENT

No.	Items			Size	kgf · m	lbf · ft
1	Engine	Engine mounting bolt, nut(Rubber, 2EA)		M20×2.5	57.9 ± 8.7	419± 62.9
2		Engine mounling bolt(Bracket, 8EA)		M12×1.75	10.7 ± 1.6	77.4± 11.6
3		Engine mounting bolt(Fly wheel housing,12EA)		M10×1.5	4.6 ± 0.9	33.3± 6.5
4		Radiator mounting bolt		M16×2.0	29.7± 4.5	215± 32.5
5		Fuel tank mounting bolt, nut		M16×2.0	29.7 ± 4.5	215± 32.5
6	Hydraulic system	Main pump housing mounting bolt		M12×1.75	12.8 ± 3.0	92.6± 21.7
7		Brake pump housing mounting bolt		M10×1.5	6.9 ± 1.4	49.9± 10.1
8		Main control valve mounting bolt		M12×1.75	12.8 ± 3.0	92.6± 21.7
9		Steering unit mounting bolt		M10×1.5	6.9 ± 1.4	49.9± 10.1
10		Steering valve(EHPS) mounting bolt		M8×1.25	2.5 ± 0.5	18.1± 3.6
11		Brake valve mounting bolt		M8×1.25	2.5 ± 0.5	18.1± 3.6
12		Cut-off valve mounting bolt		M12×1.75	12.8 ± 3.0	92.6± 21.7
13		Remote control lever mounting bolt		M6×1.0	1.1± 0.2	8.0± 1.4
14		Pilot supply unit mounting bolt		M8×1.25	2.5 ± 0.5	18.1± 3.6
15		Safety valve		M8×1.25	2.5 ± 0.5	8.1± 3.6
16		Hydraulic oil tank mounting bolt		M16×2.0	29.7 ± 4.5	215 ± 32.5
17	Power train system	Transmission mounting bolt, nut(Rubber, 2EA)		M24×3.0	100 ± 15	723 ± 108
18		Transmission mounting bolt(Bracket)		M20×2.5	46.3 ± 7.0	335± 50.6
19		Front axle mounting bolt, nut	-#0293(VOLVO)	M24×2.0	100 ± 15	723± 108
			#0294-(ZF)	M27×2.0	135 ± 15	976± 108
20		Rear axle support mounting bolt, nut		M36×3.0	308 ± 46.2	2228± 334
21		Tire mounting nut		M22×1.5	61 ± 2.0	441± 14.5
22		Drive shaft joint mounting bolt, nut		1/2-20UNF	15 ± 2.0	108± 14.5
23	Others	Counterweight mounting bolt		M30×3.5	199 ± 29.9	1439± 216
24		Operator's seat mounting bolt		M8×1.25	3.4 ± 0.8	24.6± 5
25		ROPS Cab mounting bolt(4EA)		M27×2.0	125 ± 15	904 ± 108

6. TORQUE CHART

Use following table for unspecified torque.

1) BOLT AND NUT

(1) 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) 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

2) PIPE AND HOSE(FLARE TYPE)

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

3) PIPE AND HOSE(ORFS TYPE)

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

4) FITTING

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

7. RECOMMENDED LUBRICANTS

Use only oils listed below or equivalent.
Do not mix different brand oil.

Service point	Kind of fluid	Capacity ℓ (U.S. gal)	Ambient temperature ℃(°F) -20 (-4) / -10 (14) / 0 (32) / 10 (50) / 20 (68) / 30 (86) / 40 (104)
Engine oil pan	Engine oil	18(4.8)	SAE 30 SAE 10W SAE 10W-30 SAE 15W-40
Transmission	Oil	32(8.5)	SAE 10W-30 SAE 15W-40
VOLVO axle (-#0293)	Gear oil	Front : 45(11.9) Rear : 40(10.6)	SAE 80W-90LS/API GL-5
ZF axle (#0294-)	UTTO	Front : 38(10.0) Rear : 31(8.2)	*Refer to below list
Hydraulic tank	Hydraulic oil	Tank: 150(39.7) System: 260(69)	ISO VG 32 ISO VG 46 ISO VG 68
Fuel tank	Diesel fuel	330(87.2)	ASTM D975 NO. 1 ASTM D975 NO. 2
Fitting (Grease nipple)	Grease	As required	NLGI NO. 1 NLGI NO. 2
Radiator	Mixture of antifreeze and water 50 : 50	39(10.3)	Ethylene glycol base permanent type

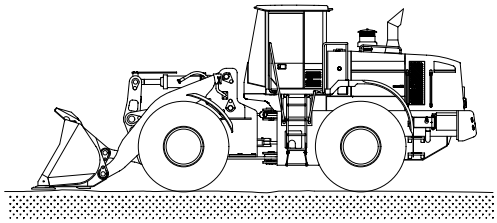
- SAE : Society of Automotive Engineers
- API : American Petroleum Institute
- ISO : International Organization for Standardization
- NLGI : National Lubricating Grease Institute
- ASTM : American Society of Testing and Material
- UTTO : Universal Tractor Transmission Oil

* Recommended oil list
- BP TERRAC SUPER TRANSMISSION 10W-30
- CASTROL AGRI TRANS PLUS 10W-30
- MOBILFLUID 426
- SHELL DONAX TD 10W-30
- TOTAL DYNATRANS MPV

GROUP 3 OPERATIONAL CHECKOUT RECORD SHEET

- Owner :
- Date :
- Hours :
- Serial No. :
- Technician :

※ **Use this sheet to record operational checkout results.**
Perform the operational check before installing any test equipment.



7707AGE02

Item	OK	NOT OK	Comments

1. Monitor indicator and gauge checks(Engine OFF)

- Hourmeter and gauge check _____
- Battery check _____
- Monitor indicator circuit check _____
- Monitor turn signals and warning indicator check _____

2. Transmission, axle and engine linkages, neutral start switch and reverse warning alarm switch checks

- Transmission control lever and neutral _____
- Neutral start and reverse warning _____
- Alarm circuit checks _____

3. Monitor indicator and gauge checks(Engine running)

- Monitor display and alternator output checks _____
- Monitor bypass circuit and seat belt indicator check _____
- Monitor primary and secondary level check _____
- Transmission oil warm up procedure _____
- Transmission temperature gauge check _____

4. Brake system and clutch cut off checks

- Park brake capacity check _____
- Park brake transmission lockout check _____
- Service brake pump flow check _____
- Service brake capacity check _____
- Brake accumulator precharge check _____
- Brake system leakage check _____
- Service brake pedal check _____
- Service and park brake system drag check _____
- Clutch cut off check _____

5. Driving checks

- Transmission oil warm up procedure _____
- Transmission noise check _____
- Speedometer check _____
- Transmission kick down system check _____
- 1st, 2nd, 3rd and 4th speed clutch pack drag check _____
- Transmission pressure, pump flow and leakage check _____
- Transmission shift modulation check _____
- Torque converter check _____
- Engine power check _____

6. Hydraulic system checks

- Hydraulic system warm up procedure _____
- Hydraulic pump performance check _____
- Pilot control valve boom float check _____
- Boom down solenoid valve check _____
- Control valve lift check _____
- Bucket rollback circuit relief valve check _____
- Bucket dump circuit relief
  Low pressure check _____
  High pressure check _____
- Boom and bucket cylinder drift check _____
- Boom down solenoid valve leakage check _____
- Pilot controller check _____
- Return to dig check _____
- Boom height kickout check-if equipped _____

7. Steering system checks

- Steering valve check _____
- Steering system leakage check _____
- Flow amplifier
  Low check pressure _____
  High check pressure _____

8. Accessory checks

- Operating lights check _____
- Work light check _____
- Brake light check _____
- Cab light check _____
- Horn circuit check _____
- Windshield washer and wiper check _____
- Defroster blower check _____
- Heater/Air conditioner blower check _____
- Heater functional check _____
- Air conditioner functional check _____
- Start aid system check _____

9. Cab components and vandal protection checks

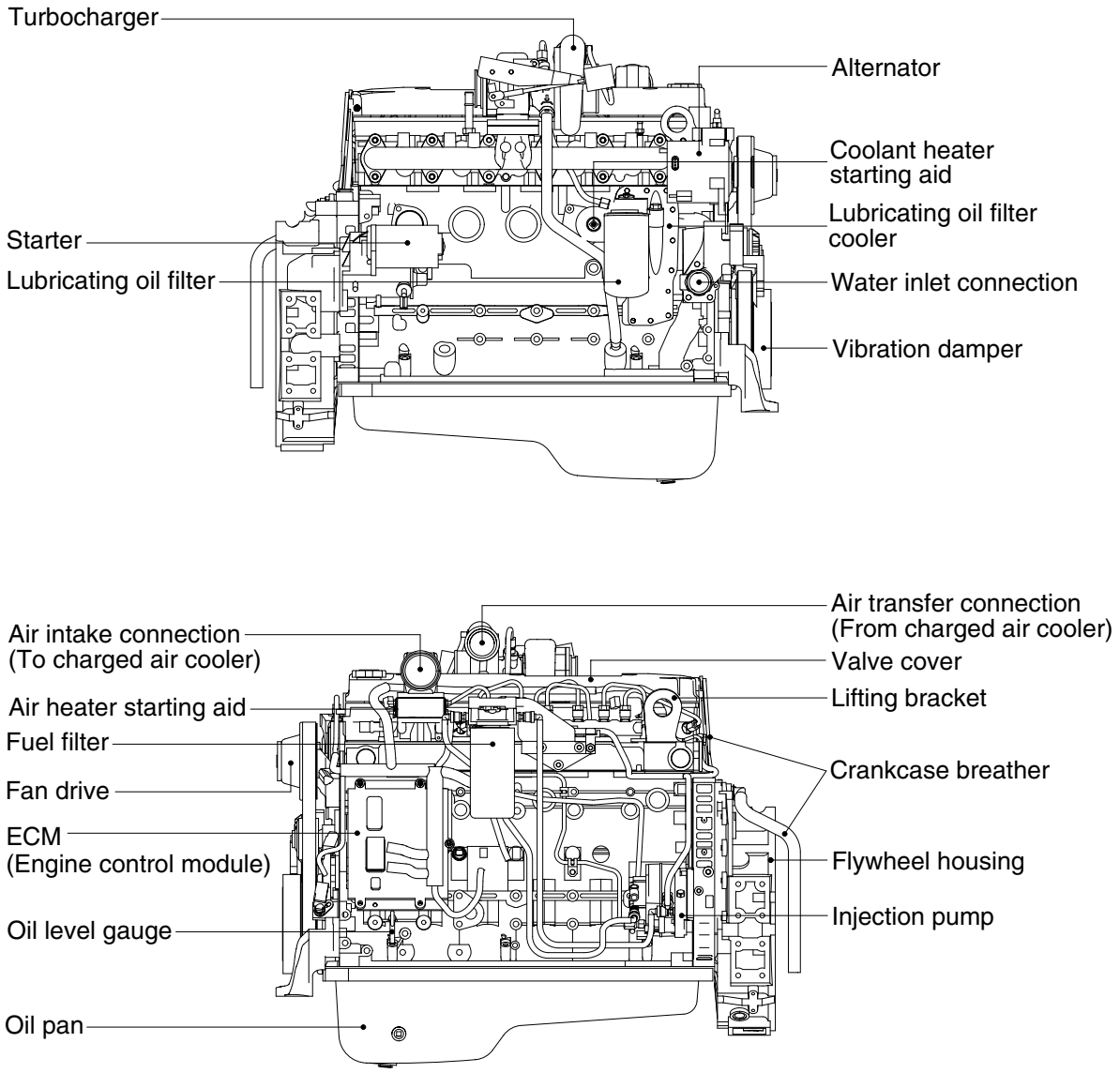
- Cab door latch check _____
- Cab door hold open latch check _____
- Cab door release button check _____
- Cab door lock check _____
- Cab door window check _____
- Cab window latch check _____
- Steering column adjustment check _____
- Seat and seat belt check _____
- Air intake filter door check _____
- Engine side panels check _____
- Radiator cap access door check _____
- Frame locking bar check _____
- Boom lock check _____
- Service decal check _____

SECTION 2 ENGINE

Group 1 Structure and Function ····· 2-1

GROUP 1 STRUCTURE AND FUNCTION

1. STRUCTURE

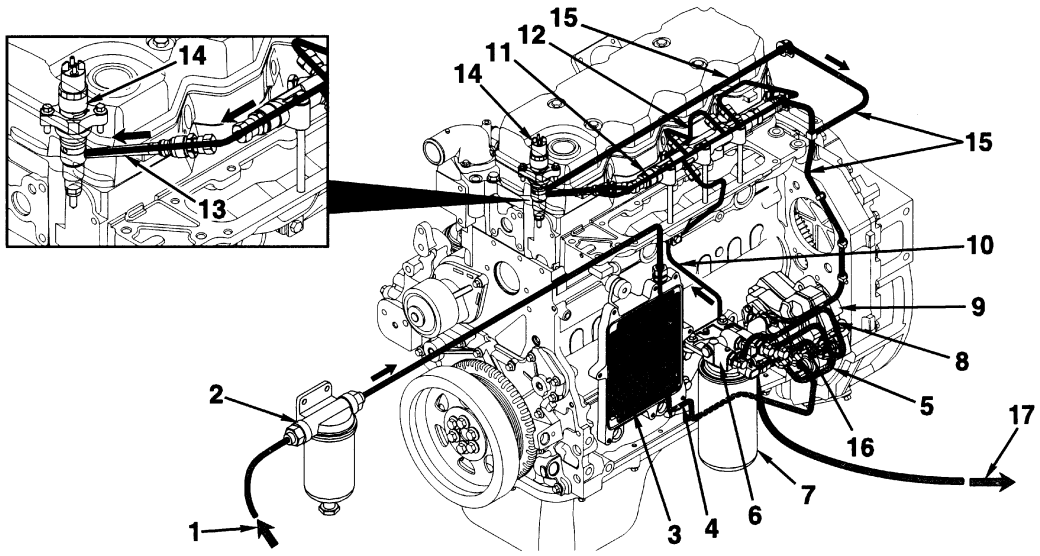


· Direct 4-stroke, 6-cylinders, water-cooling and charge air cooled diesel engine in installed, cylinder block and cylinder head are made of case iron and turbocharger is attached.

2. SYSTEM DIAGRAMS

The following drawings show the flow through the engine systems.

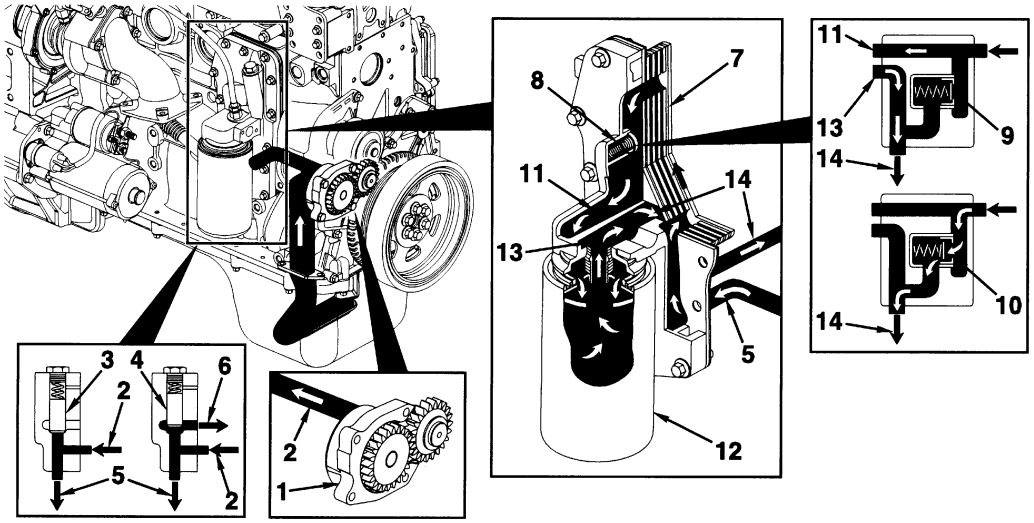
1) FUEL SYSTEM



7607AEG02

1 From fuel tank
2 Water/fuel separator(**not** mounted on engine)
3 ECM cooling plate
4 To fuel gear pump
5 To fuel filter
6 Fuel filter head
7 Fuel filter
8 To high-pressure pump
9 High-pressure pump
10 To fuel rail
11 Fuel rail
12 To injectors
13 High-pressure connector
14 Injector
15 Fuel return from injectors and fuel rail to fuel filter head
16 Fuel return from high-pressure pump to fuel filter head
17 To fuel tank

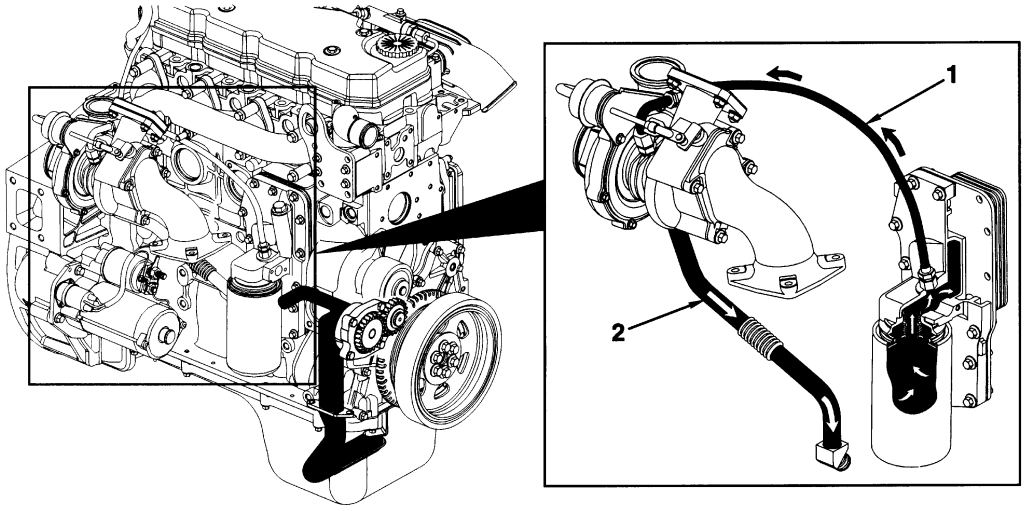
2) LUBRICATING OIL SYSTEM



7607AEG03

1 Gerotor lubricating oil pump
2 From lubricating oil pump
3 Pressure regulating valve closed
4 Pressure regulating valve open
5 To lubricating oil cooler
6 To lubricating oil pump supply
7 Lubricating oil cooler
8 Filter bypass valve
9 Filter bypass valve closed
10 Filter bypass valve open
11 To lubricating oil filter
12 Full-flow lubricating oil filter
13 From lubricating oil filter
14 Main lubricating oil rifle

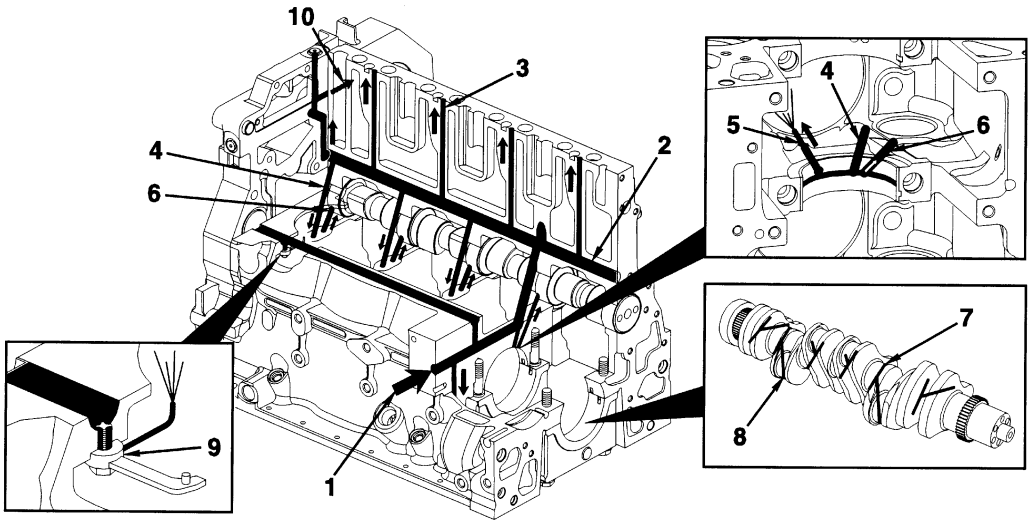
(1) Lubrication for the turbocharger



7607AEG04

1 Turbocharger lubricating oil supply
2 Turbocharger lubricating oil drain

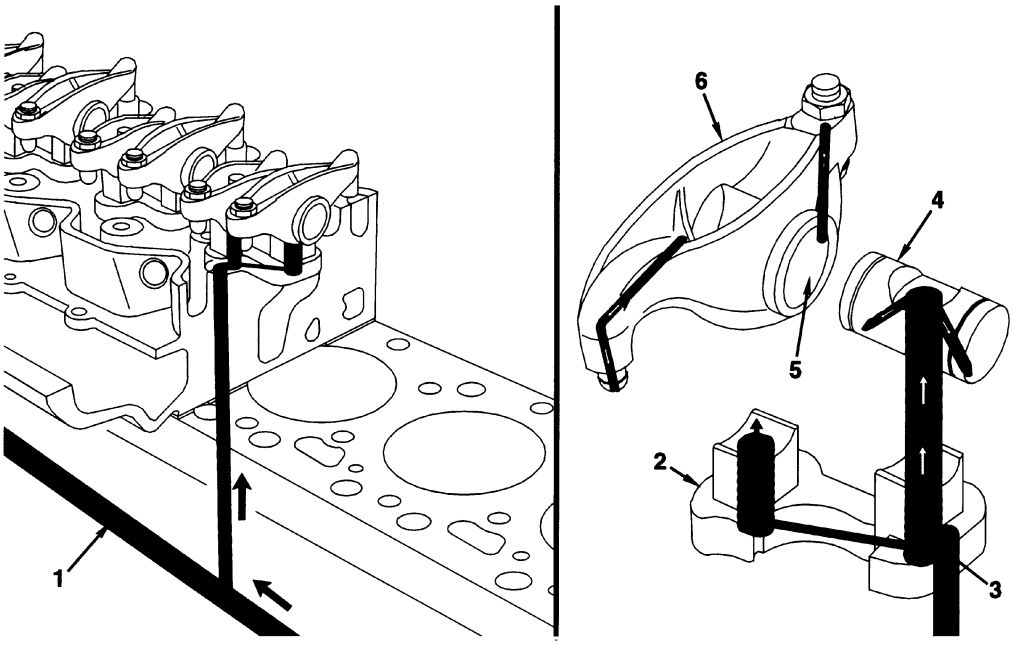
(2) Lubrication for the power components



7607AEG05

1 From lubricating oil cooler
2 Main lubricating oil rifle
3 To valve train
4 From main lubricating oil rifle
5 To piston-cooling nozzle
6 To camshaft
7 Crankshaft main journal
8 Oil supply to rod bearings
9 Directed piston-cooling nozzle
10 To internal lubrication of air compressor

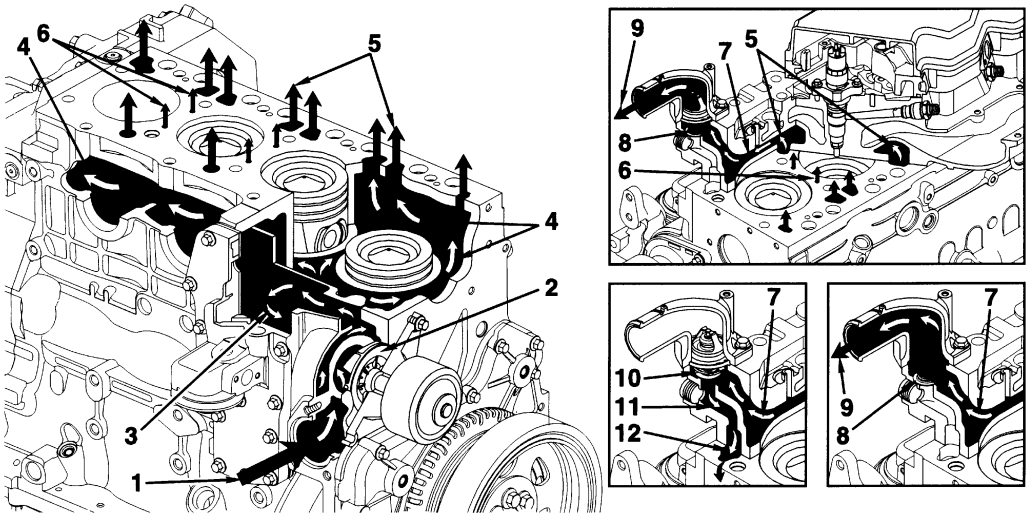
(3) Lubrication for the overhead



7607AEG06

1 Main lubricating oil rifle
2 Rocker lever support
3 Transfer slot
4 Rocker lever shaft
5 Rocker lever bore
6 Rocker lever

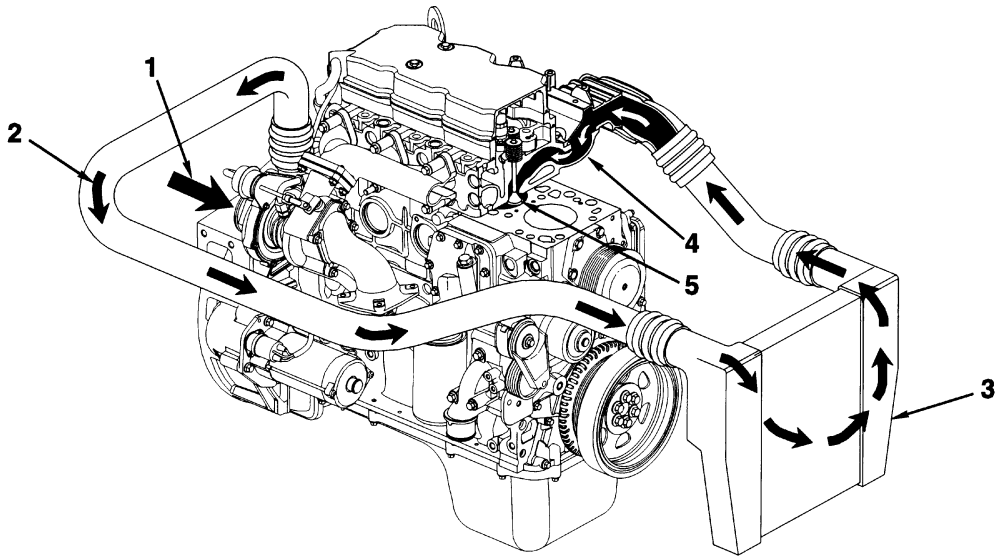
3) COOLING SYSTEM



7607AEG07

1 Coolant inlet
2 Pump Impeller
3 Coolant flow past lubricating oil cooler
4 Coolant flow past cylinders
5 Coolant flow from cylinder block to cylinder head
6 Coolant flow between cylinders
7 Coolant flow to thermostat housing
8 Coolant bypass passage
9 Coolant flow back to radiator
10 Bypass closed
11 Coolant bypass in cylinder head
12 Coolant flow to water pump inlet

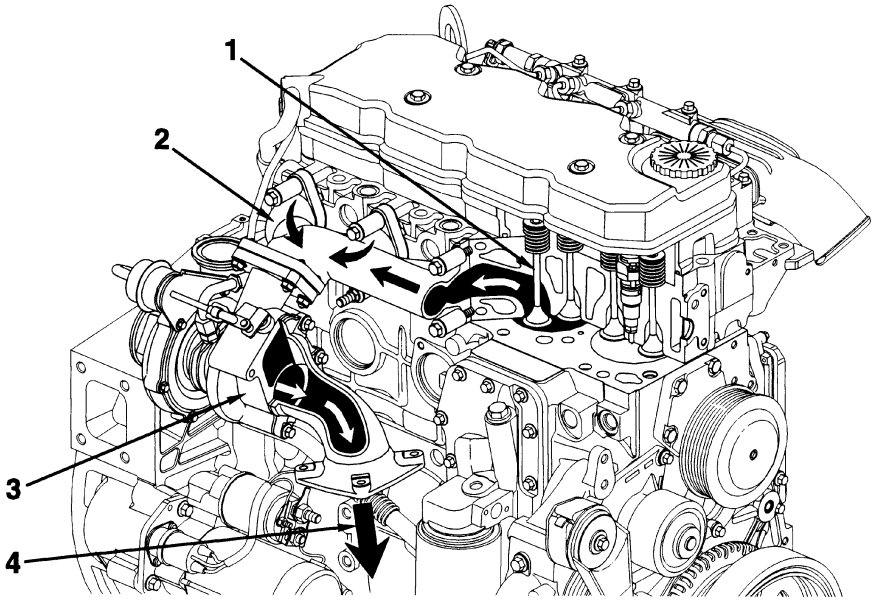
4) AIR INTAKE SYSTEM



7707AEG08

1 Intake air inlet to turbocharger
2 Turbocharger air to charge air cooler
3 Charge air cooler
4 Intake manifold (Integral part of cylinder head)
5 Intake valve

5) EXHAUST SYSTEM



7707AEG09

1 Exhaust valve
2 Exhaust manifold
3 Turbocharger
4 Turbocharger exhaust outlet

GROUP 2 ENGINE SPEED & STALL RPM

1. TEST CONDITION

1) Normal temperature of the whole system
- Coolant : Approx 80 ℃ (176 ℉)
- Hydraulic oil : 45 ± 5 ℃ (113 ± 10 ℉)
- Transmission oil : 75 ± 5 ℃ (167 ± 10 ℉)

2) Normal operating pressure : See page 6-53.

2. SPECIFICATION

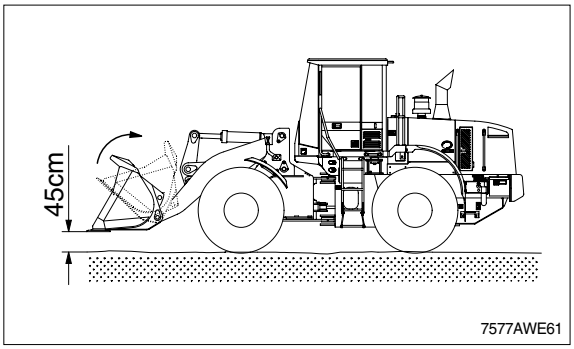
Engine speed, rpm					Remark
Low idle	High idle	Pump stall	Converter stall	Full stall	
800±25	2230±50	2100±70	2110±70	1670±100	

3. ENGINE RPM CHECK

Remark : If the checked data is not normal, it indicates that the related system is not working properly. Therefore, it is required to check the related system pressure : See page 6-53.

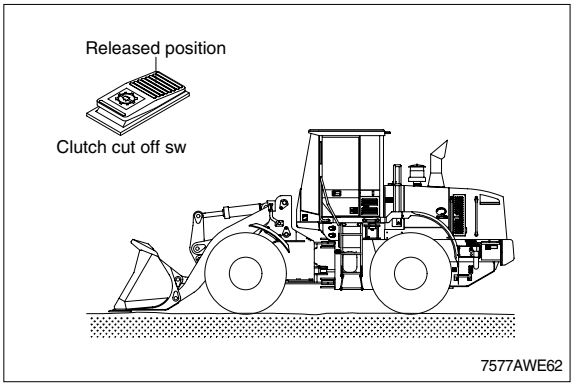
1) Pump stall rpm

- Start the engine and raise the bucket approx 45cm (1.5ft) as the figure.
- Press the accelerator pedal fully and operate the bucket control lever to the retract position fully.
- Check the engine rpm at the above condition.



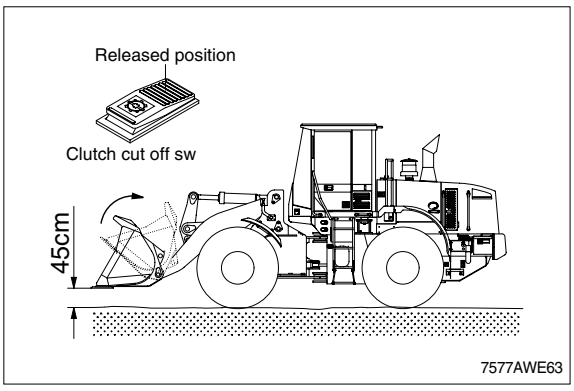
2) Convertor stall rpm

- Start the engine and lower the bucket on the ground as the figure.
- Set the clutch cut off switch at the released position.
- Press the brake pedal and accelerator pedal fully.
- Shift the transmission lever to the 4th forward position.
- Check the engine rpm at the above condition.



3) Full stall rpm

- Start the engine and raise the bucket approx 45 cm (1.5 ft) as the figure.
- Set the clutch cut off switch at the released position.
- Press the brake pedal and accelerator pedal fully .
- Shift the transmission lever to the 4th forward position and operate the bucket lever to the retract position fully.
- Check the engine rpm at the above condition.



SECTION 4 BRAKE SYSTEM

Group 1 Structure and Function ····· 4-1
Group 2 Operational Checks and Troubleshooting ····· 4-32
Group 3 Tests and Adjustments ····· 4-40
Group 4 Disassembly and Assembly ····· 4-42

SECTION 4 BRAKE SYSTEM

GROUP 1 STRUCTURE AND FUNCTION

1. OUTLINE

※ **The brakes are operated by a pressure compensated, closed center hydraulic system. Flow is supplied by a fixed displacement, gear type brake pump.**

BRAKE SYSTEM

The fixed displacement brake pump supplies flow to the cut-off valve for service brake circuit and park brake circuits. It flows to three accumulator. The accumulator has a gas precharge and an inlet check valve to maintain a pressurized volume of oil for reserve brake applications.

Oil through the accumulator flows to the brake valves. The brake valve is a closed center design, dual circuit operated by a pedal.

The front and rear brakes will operate simultaneously with only one brake pedal depressed.

The differential contains annular brake piston and double sided disk.

Brake pump flow also goes to the parking brake solenoid valve in cut-off valve.
The brake system contains the following components:

- Brake pump
- Parking brake solenoid valve in cut-off valve
- Cut-off valve
- Brake valve
- Accumulators
- Pressure switches

FULL POWER HYDRAULIC BRAKE SYSTEM

ADVANTAGES - The full power hydraulic brake system has several advantages over traditional brake actuation systems. These systems are capable of supplying fluid to a range of very small and large volume service brakes with actuation that is faster than air brake systems. Figure represents a time comparison between a typical air/hydraulic and full power hydraulic brake actuation system.

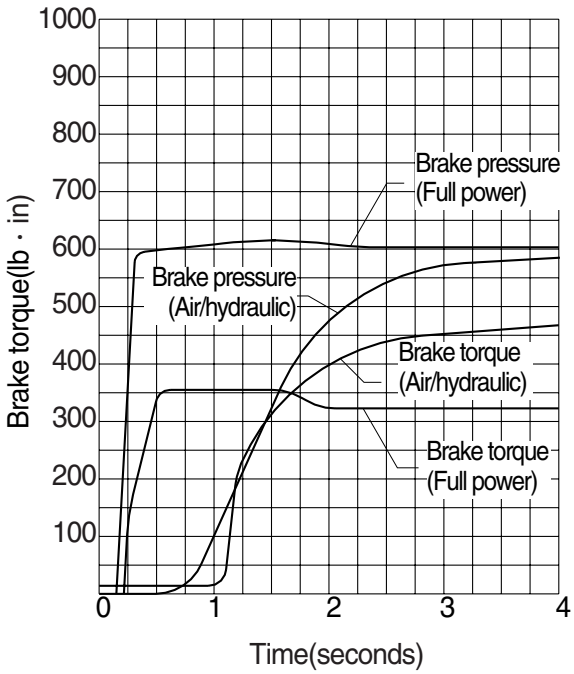
Full power systems can supply significantly higher brake pressures with relatively low reactive pedal forces. The reactive pedal force felt by the operator will be proportional to the brake line pressure being generated. This is referred to as brake pressure modulation.

Another key design feature of full power systems is the ability to control maximum brake line pressure. In addition, because these systems operate with hydraulic oil, filtration can be utilized to provide long component life and low maintenance operation.

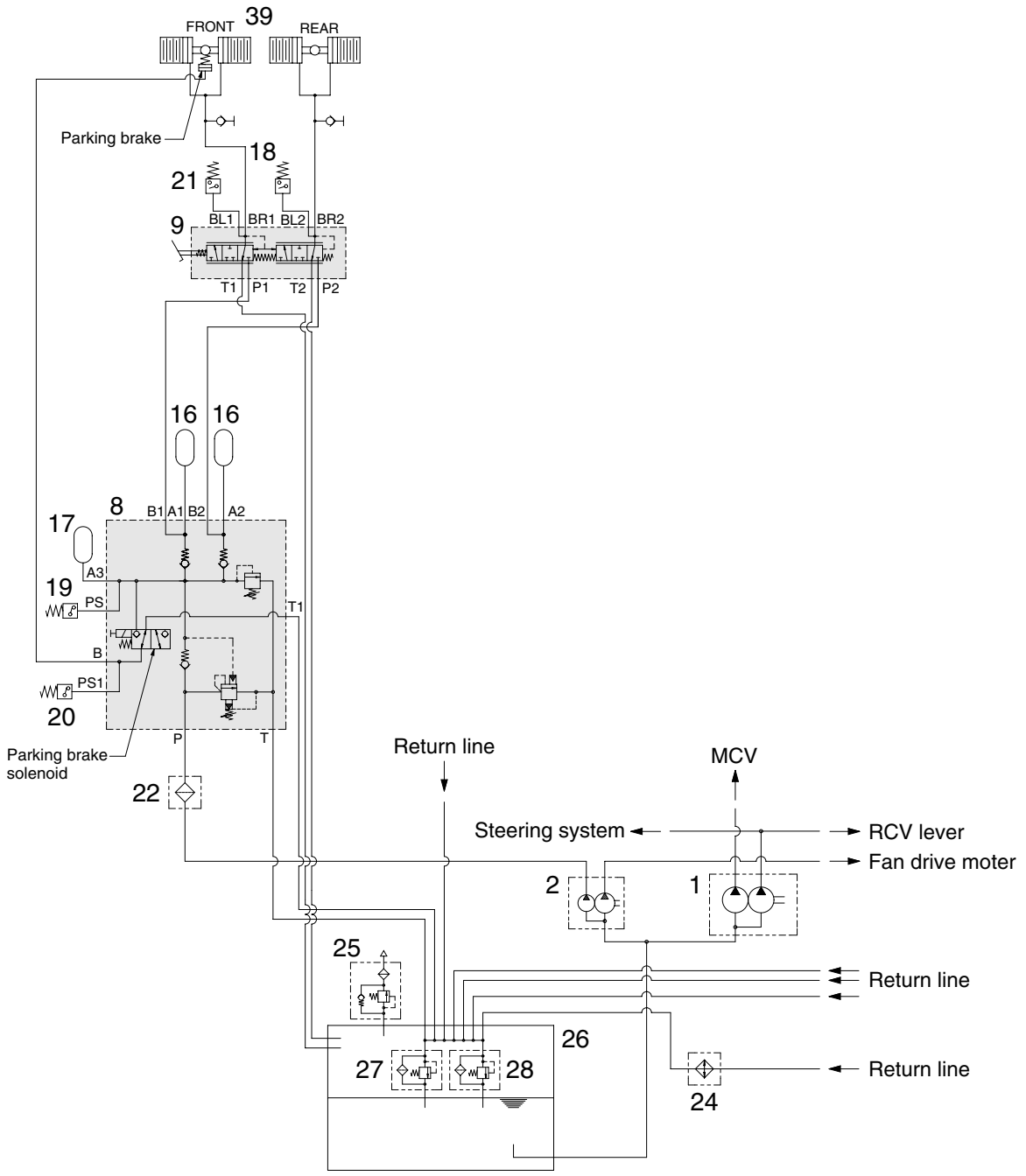
Because these systems are closed center, by using a properly sized accumulator, emergency power-off braking that is identical to power-on braking can be achieved. These systems can be either dedicated, where the brake system pump supplies only the demands of the brake system or non-dedicated, where the pump supplies the demands of the brake system as well as some secondary down stream hydraulic device.

Another important note is that all seals within these system must be compatible with the fluid medium being used.

Response time
Full power brake actuation VS
Air/Hydraulic brake actuation

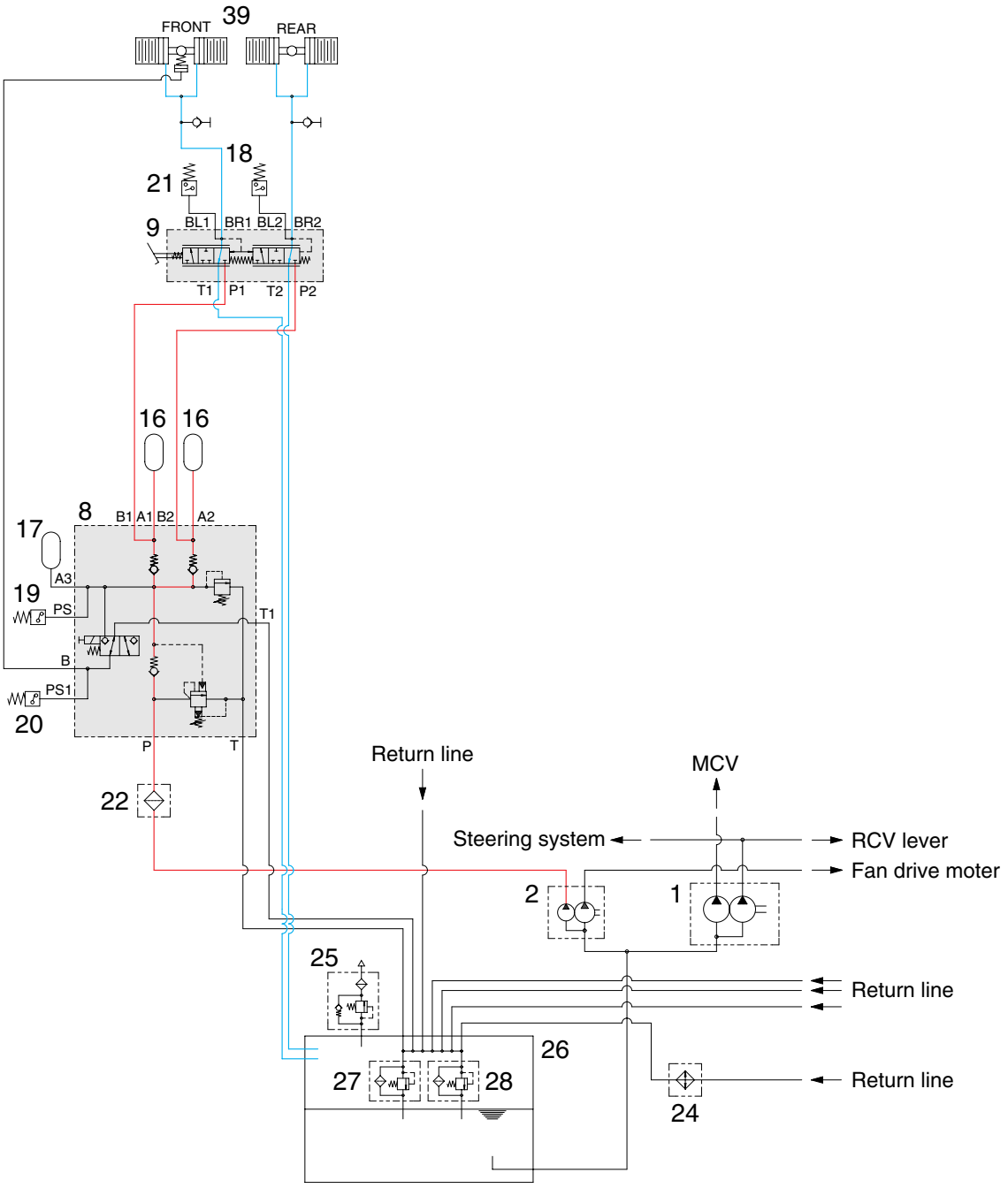


2. HYDRAULIC CIRCUIT



2	Fan & brake pump	19	Pressure switch	25	Air breather
8	Cut off valve	20	Pressure switch	26	Hydraulic tank
9	Brake valve	21	Pressure switch	27	Return filter
16	Accumulator	22	Line filter	28	Bypass valve
17	Accumulator	24	Oil cooler	39	Axle
18	Pressure switch				

1) SERVICE BRAKE RELEASED

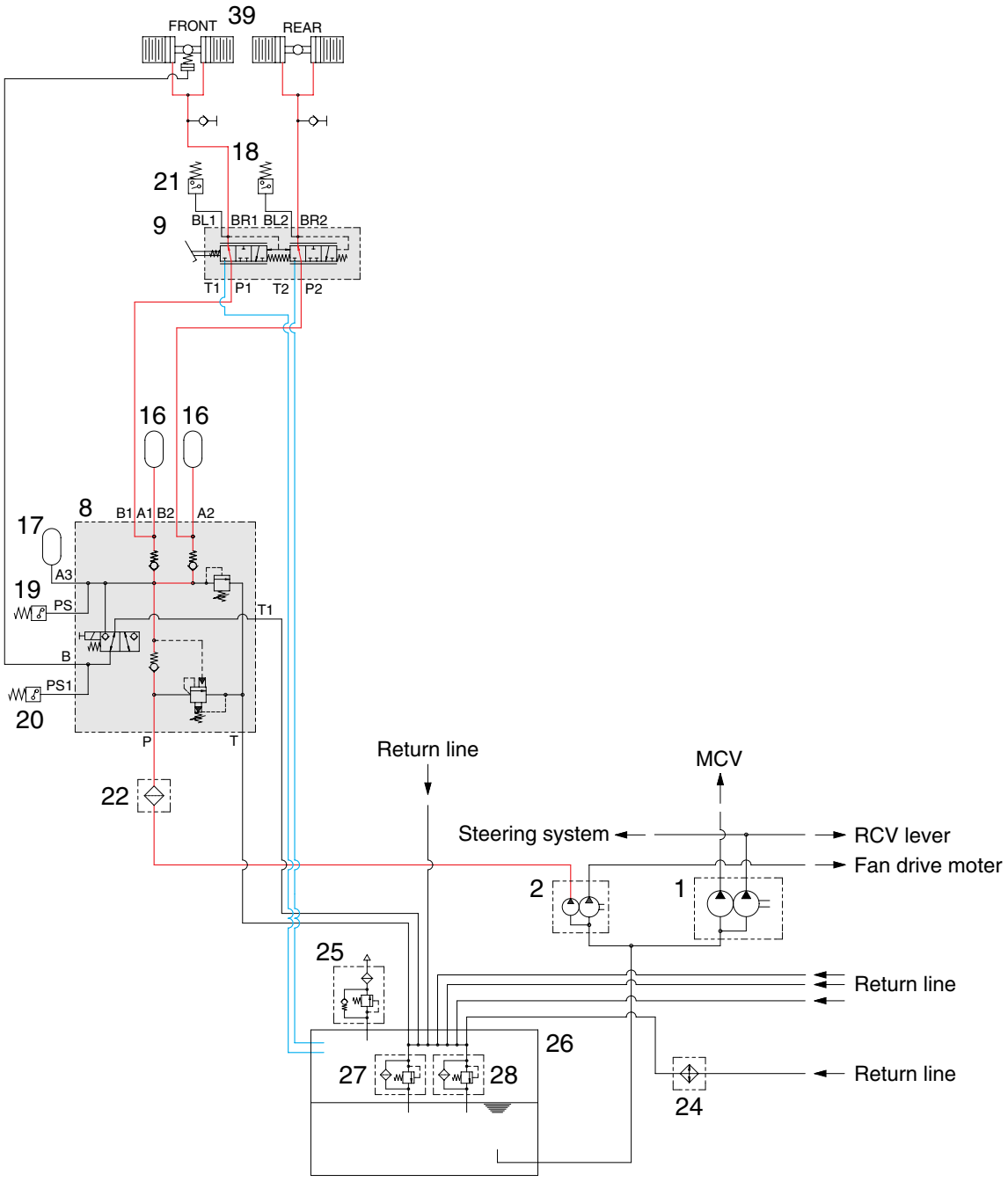


When the pedal of brake valve(9) is released, the operating force is eliminated by the force of the spring, and the spool is returned.

When the spool removes up, the drain port is opened and the hydraulic oil in the piston of axles return to the tank(26).

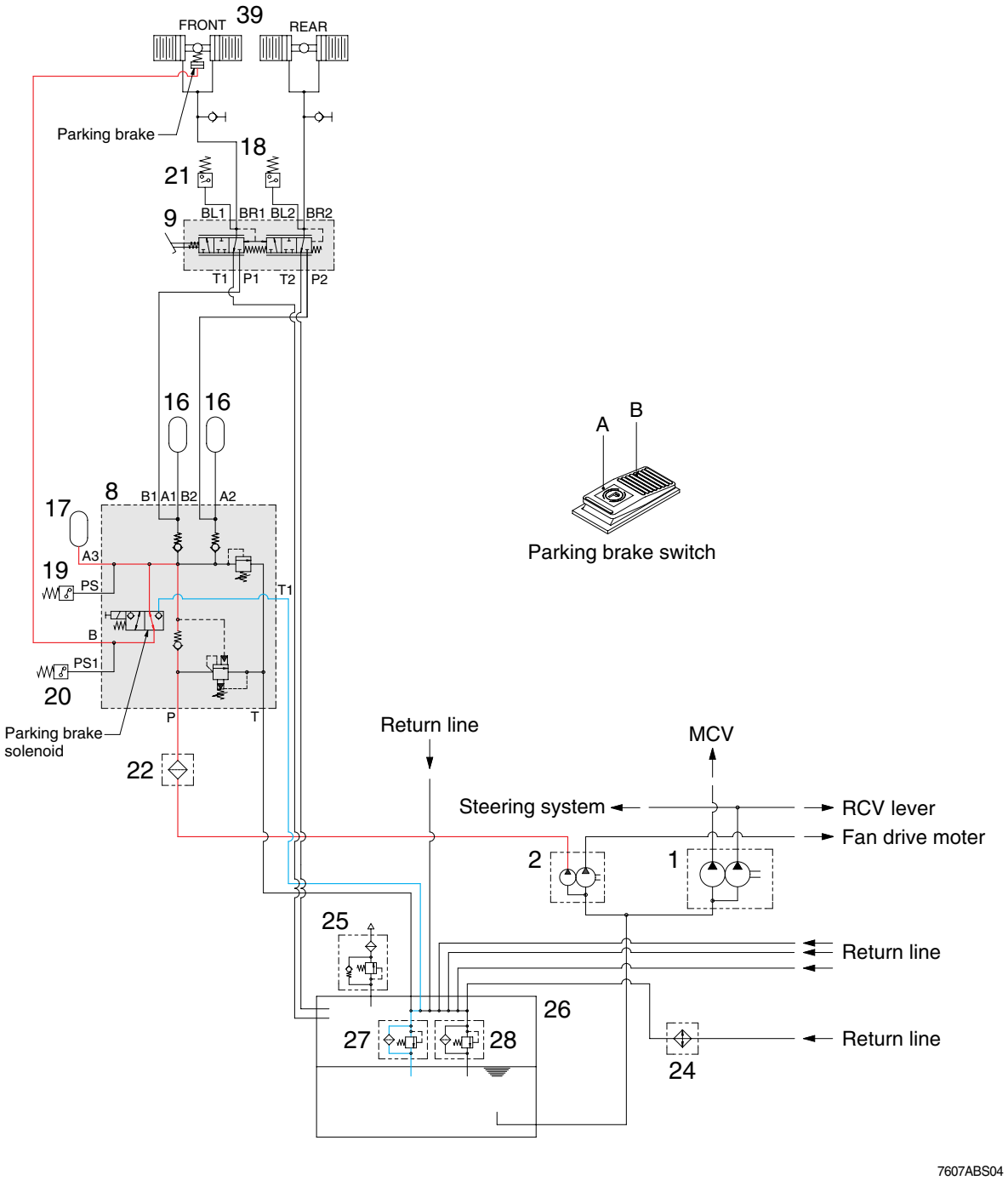
Therefore, the service brake is kept released.

2) SERVICE BRAKE OPERATED



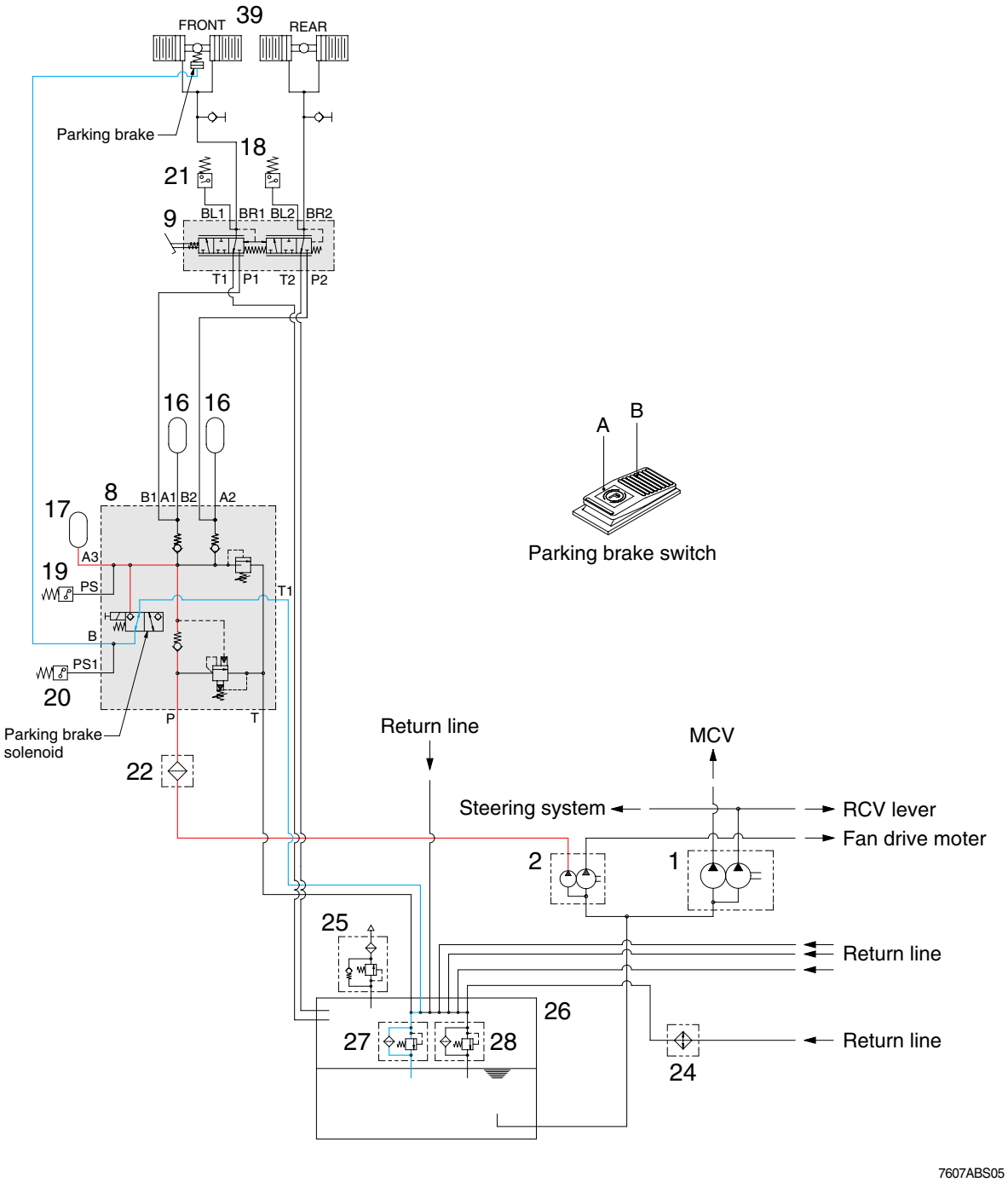
When the pedal of brake valve(9) is depressed, the operating force overcomes the force of the spring, and is transmitted to the spool. When the spool moves down, the inlet port is opened, and at the same time the hydraulic oil controlled the pressure level by the cut-off valve(8) enters the piston in the front and rear axles. Therefore, the service brake is applied.

3) PARKING BRAKE RELEASED



When the parking brake switch is pressed B position, the solenoid valve is energized and the hydraulic oil controlled the pressure level by the cut-off valve enters the parking brake. It overcomes the force of the spring and pushes the piston rod. This releases the brake.
Therefore, the hydraulic oil pressure is applied to the parking brake piston through the solenoid valve and the parking brake is kept released.

4) PARKING BRAKE OPERATED



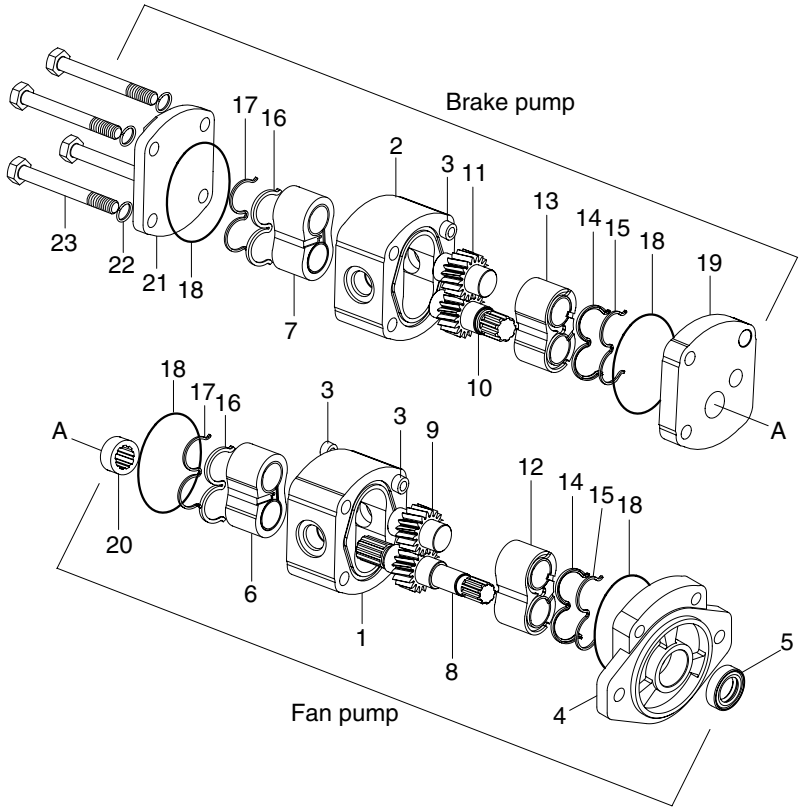
When the parking brake switch is pressed A position, the solenoid valve is deenergized and the valve open the drain port.

At the same time, the hydraulic oil in the parking brake return to the tank through the solenoid valve.

When the piston rod is returned by the force of the spring, the parking brake is applied.

3. BRAKE PUMP(+FAN PUMP)

1) STRUCTURE



7707BS19

1	Body	9	Driven gear	17	Backing ring
2	Body	10	Driver gear	18	Body O-ring
3	Dowel pin	11	Driven gear	19	Intermediate plate
4	Front cover	12	Bushing	20	Coupling
5	Shaft seal	13	Bushing	21	Rear cover
6	Bushing	14	Bushing seal	22	Spring washer
7	Bushing	15	Backing ring	23	Screw
8	Driver gear	16	Bushing seal		

This gear pump have a maximum delivery pressure of 150kgf/cm^2.
The pressure loaded type gear pump is designed so that the clearance between the gear and the bushing can be automatically adjusted according to the delivery pressure. Therefore, the oil leakage from the bushing is less than that in the case of the fixed bushing type under a high discharge pressure. Consequently, no significant reduction of the pump delivery occurs, even when the pump is operated under pressure.

2) PRINCIPLE OF OPERATION

(1) Mechanism for delivering oil

The drawing at right shows the operational principle of an external gear pump in which two gears are rotating in mesh.

The oil entering through the suction port is trapped in the space between two gear teeth, and is delivered to the discharge port as the gear rotates.

Except for the oil at the bottom of the gear teeth, the oil trapped between the gear teeth, is prevented from returning to the suction side with the gears in mesh.

Since the gears are constantly delivering oil, the oil delivered to the discharge port is forced out of the port.

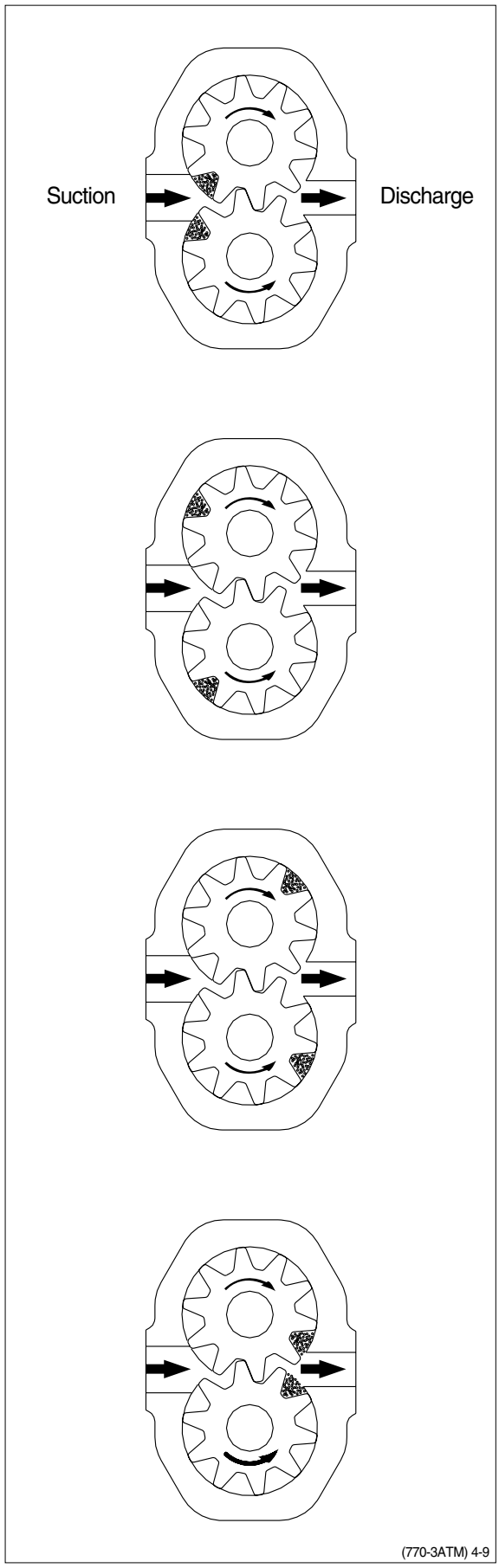
The amount of discharge increases with the speed of rotation of the gear.

If there is no resistance in the oil passage into which the discharged oil flows, the oil merely flows through the passage, producing no increase in pressure.

If however, the oil passage is blocked with something like a hydraulic cylinder, there will be no other place for the oil to flow, so the oil pressure will rise. But the pressure which rises in this way will never go higher, once the hydraulic cylinder piston starts moving because of the oil pressure.

As described earlier, the pump produces the oil flow, but not the oil pressure. We can therefore conclude that pressure is a consequence of load.

In other words, the pressure depends on a counterpart.



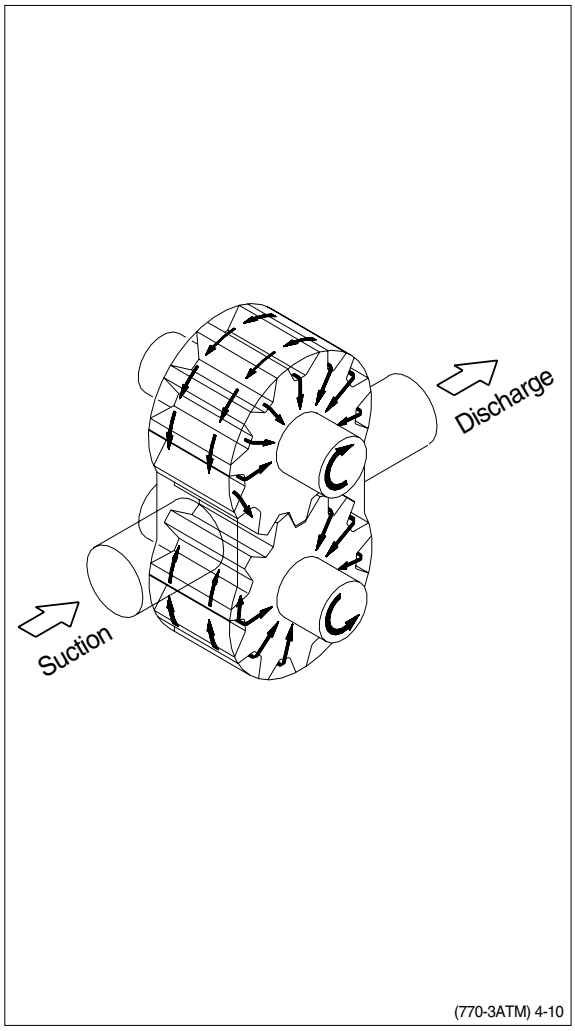
(2) Internal oil leakage

Oil leaks from a place under higher pressure to a place under lower pressure, provided that a gap or a clearance exists in between.

In the gear pump, small clearances are provided between the gear and the case and between the gear and the side plate to allow the oil to leak out and to serve as a lubricant so that the pump will be protected from seizure and binding.

The drawing at right shows how the leaked oil flows in the pump. As such, there is always oil leakage in the pump from the discharge side(under higher pressure) to the suction side. The delivery of the pump is reduced by an amount equal to the pump discharge.

In addition, the delivery of the pump will also decrease as the amount of oil leakage increases because of expanded radial clearance resulting from the wear of pump parts, the lower oil viscosity resulting from increases in the oil temperature, and the initial use of low viscosity oil.



(770-3ATM) 4-10

(3) Forces acting on the gear

The gear, whose outer surface is subjected to oil pressure, receives forces jointing towards its center.

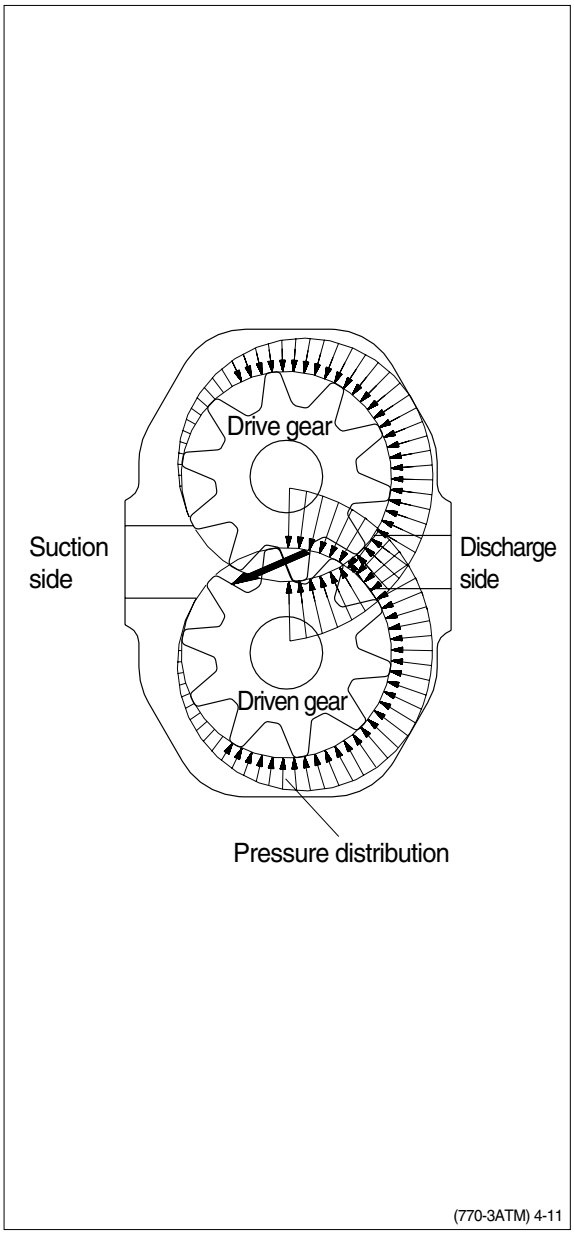
Due to the action of the delivery pressure, the oil pressure in higher on the delivery side of the pump, and due to suction pressure, is lower on the suction side. In the intermediate section, the pressure will gradually lower as the position moves from the delivery side to the suction side.

This phenomenon is shown in the drawing at right.

In addition, the gears in mesh will receive interacting forces.

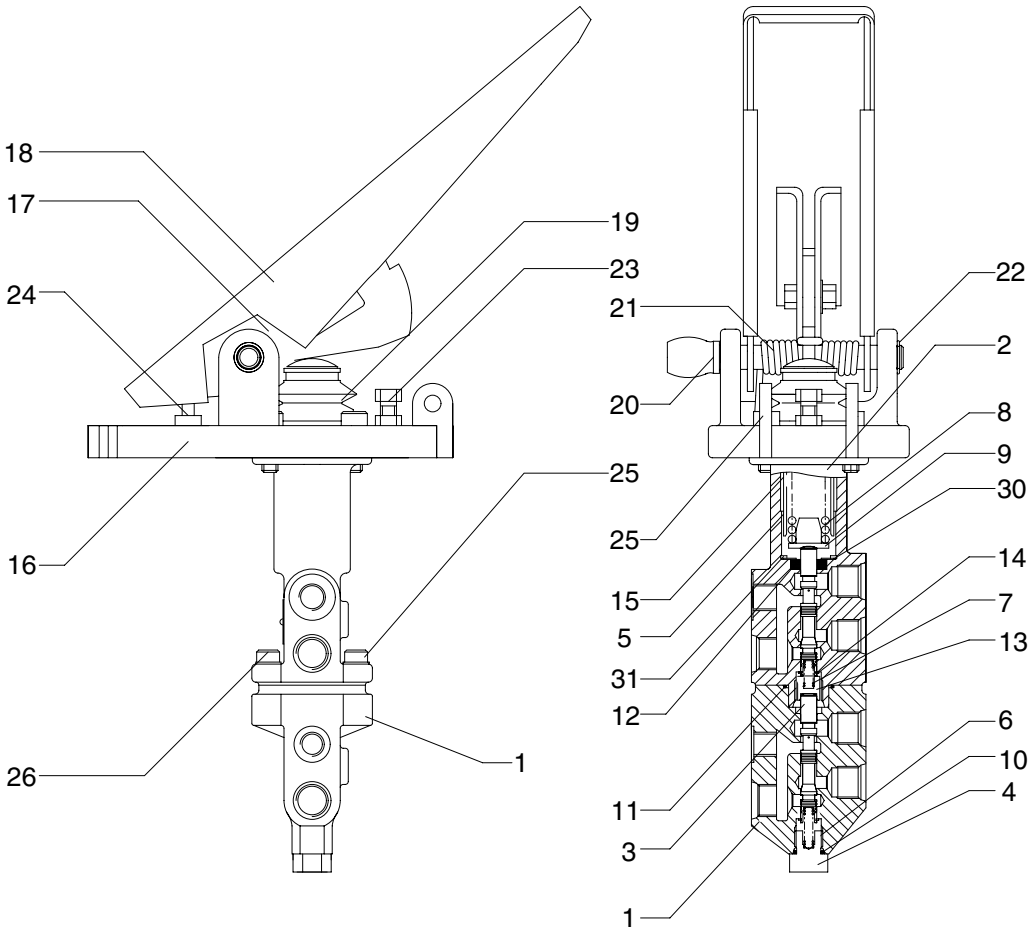
These forces pushing the gears toward the suction side are received by the bearings. Since the gears are pressed toward the suction side by these forces, the radial clearance becomes smaller on the suction side in the case. In some pumps, the clearance may become zero, thus allowing the gear teeth and the case to come into light contact.

For this reason, an excessive increase in the delivery pressure must be avoided, since it will produce a large force which will act on the gears, placing an overload on the bearings, and resulting in a shortened service life of the bearing or interference of the gear with the case.



4. BRAKE VALVE

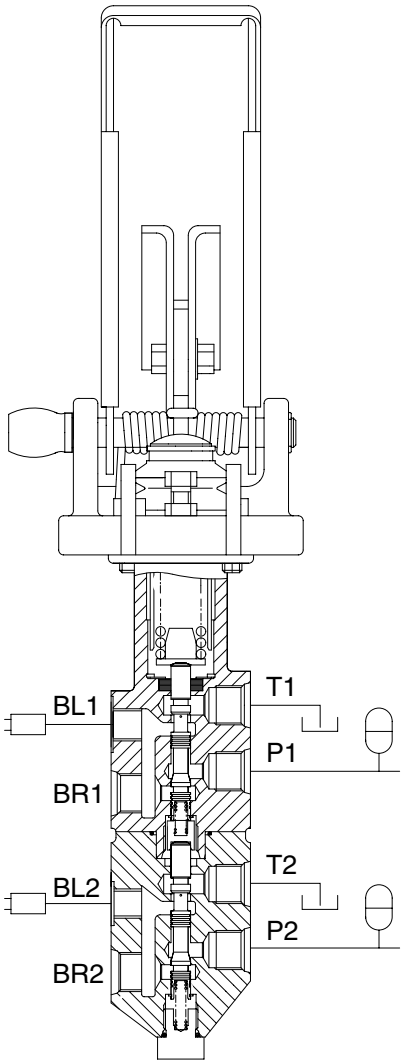
1) STRUCTURE

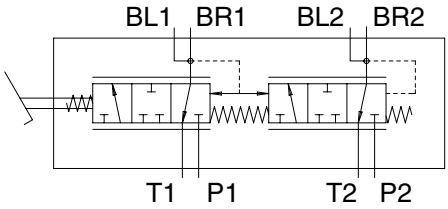


7807ABS21

1	Lower body	11	O-ring	21	Torsion spring
2	Upper body	12	Oil seal	22	Stop ring
3	Spool	13	Spring guide	23	Hexagon bolt
4	Plug	14	Stop ring	24	Hexagon nut
5	Holder	15	Bushing	25	Bolt
6	Lower spring	16	Pedal plate	26	Spring washer
7	Upper spring	17	Pedal assy	30	Plain washer
8	Main spring	18	Rubber(Pedal)	31	Stop ring
9	Spring retainer 1	19	Cover		
10	O-ring	20	Lock pin 1		

2) OPERATION





Hydraulic circuit

Porte	Port name	Port size
P1, P2	Port	PF3/8
T1, T2	Drain port	PF3/8
BR1, BR2	Brake cylinder port	PF3/8
BL1	Pressure switch port	PF1/4
BL2	Pressure switch port	M12×1.5

7807ABS22

(1) Purpose

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

(2) Ready position

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

(3) Partial braking

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

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

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

(4) Full braking position

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

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

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

(5) Limiting the braking pressure

Pedal restriction bolt(23) on base plate below pedal is used to limit the braking pressure.

(6) Failure of a circuit

In the event of the lower circuit failing, the upper circuit will remain operational. Spring assembly (8) will mechanically actuate spool. In the event of the upper circuit failing, the lower circuit will remain operational since the lower spool(31) is mechanically actuated by spring assembly(21) and spool.

(7) Installation requirements

Return lines(T1, T2) must be connected directly to the tank.
The connecting lines must be installed is such a way as to permit proper bleeding.

(8) Maintenance of the brake valve

No special maintenance beyond the legal requirements is necessary.

When using high-pressure cleaners on the machine, please make sure that the water jet is not aimed directly at the brake valve(To prevent damaging the bellows).

△ **For safety reasons the whole of the brake valve must be replaced if parts other than those listed above are damaged.**

(9) Repair work

△ **When working on the braking system, always make sure that there is absolutely no pressure in the system. Even when the engine is switched off there will be some residual pressure in the system.**

※ **When doing repair work, make sure your environment is very clean.**
Immediately close all open ports on the components and on pipes using plugs.

(10) Replacing the pedal cover

Pedal cover(18) is simply pulled of by hand. The new pedal cover is pushed over pedal(17) and tightened manually. Fasten the bellows with the strap retainers.

(11) Replacing the complete actuating mechanism

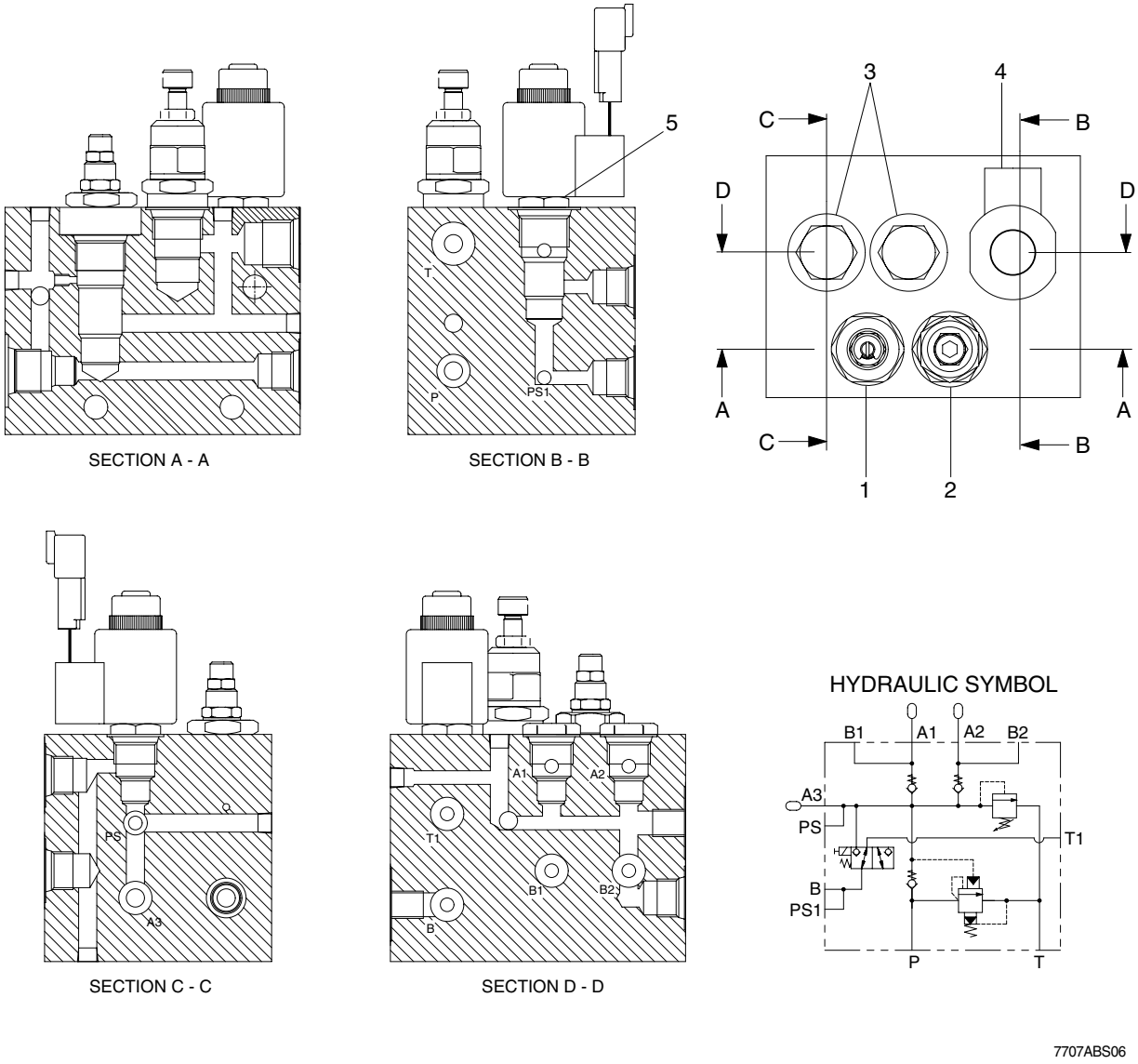
Carefully clamp the unit vertically in a fixture. The actuating mechanism can be removed by taking out the four bolts. Make sure that spring assembly(8) does not fall out. When installing the new actuating mechanism, make sure that spring assembly(8) is fitted in the right order. Tighten the four bolts(25).

(12) Replacing the bellows

To change bellows(19) it is advisable to remove pedal(17). For this purpose, loosen retaining ring (22) and knock out pin(20) using a mandrill. When knocking out the bolt, make sure that the mandrill is applied to the side of the bolt without a knurl. Remove pedal(17) and bellows(19).
Now fit the new bellows and proceed in reverse order as described above. The upper portion of bellows is fastened to piston, its lower portion to base plate(16) secure the bellows using clamps.

5. CUT-OFF VALVE

1) STRUCTURE



7707ABS06

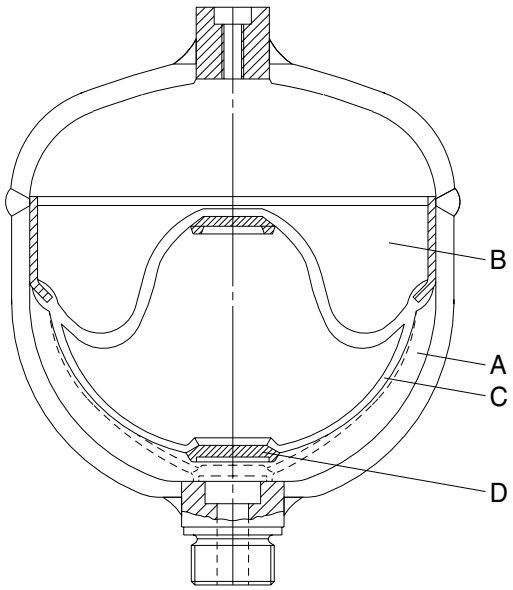
1 Cut-off valve
2 Relief valve
3 Check valve
4 Coil
5 Solenoid valve

2) OPERATION

When the pump works, the oil under the pressure flows into P port.
The oil in P port is stored in the accumulator on A3 port.
As the pressure on P line rises to 150bar, the cut off valve(1) starts cut-offing and the oil in the P port is unloaded. The pressure on P line goes down 120bar by the minute leakage from valve and other factors.
At this pressure, the cut-off valve starts cut-ining.
This process is repeated in the regular period of 30~40 seconds.

6. BRAKE ACCUMULATOR

1) STRUCTURE



(770-3ATM) 4-22

Item	81L1-0004 (Item16)	81L1-0003 (Item17)
Diameter	121mm	136mm
Mounting height	146mm	160mm
Norminal volume	0.75m^3	1.0m^3
Priming pressure	50kgf/cm^2	50kgf/cm^2
Operating medium	Oil	Oil
Operating pressure	Max 210kgf/cm^2	Max 200kgf/cm^2
Thread	M18 × 1.5	M18 × 1.5
Priming gas	Nitrogen	Nitrogen

A Fluid portion
B Gas portion
C Diaphragm
D Valve disk

2) OPERATION

(1) Purpose

Fluids are practically incompressible and are thus incapable of accumulating pressure energy. In hydropneumatic accumulators, the compressibility of a gas is utilized to accumulate fluid. The compressible medium used in the accumulators is nitrogen.

In braking systems, the purpose of the accumulators is to store the energy supplied by the hydraulic pump. They are also used as an energy reserve when the pump is not working, as a compensator for any losses through leakage, and as oscillation dampers.

(2) Operation

The accumulator consists of a fluid portion (A) and a gas portion (B) with a diaphragm (C) as a gas-tight dividing element. The fluid portion (A) is connected to the hydraulic circuit, causing the diaphragm accumulator to be filled and the gas volume to be compressed as the pressure rises.

When the pressure falls, the compressed gas volume will expand, thus displacing the accumulated pressure fluid into the circuit.

The diaphragm bottom contains a valve disk (D) which, if the diaphragm accumulator is completely empty, closes the hydraulic outlet, thus preventing damage to the diaphragm.

(3) Installation requirements

The accumulators can be fitted in the hydraulic circuit, directly on a component or in blocks on suitable consoles.

They should be fitted in as cool a location as possible.

Installation can be in any position.

(4) Maintenance of the accumulator

No special maintenance beyond the legal requirements is necessary.

The accumulator should be checked annually. It should be replaced if the initial gas pressure has fallen by more than 30%(Please refer to **Performance testing and checking of the accumulator).**

(5) Disposal of the accumulator

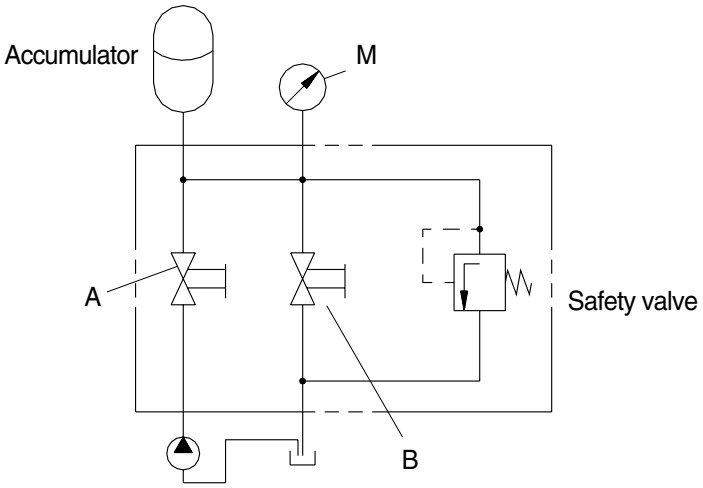
Before the accumulator is scrapped, its gas filling pressure must be reduced. For this purpose, drill a hole through gas chamber(B) using a drill approx. 3mm in diameter. The gas chamber is located on the side opposite the threaded port above the welding seam around the center of the accumulator.

※ **Wear safety goggles when doing this job.**

(6) Performance testing and checking of the accumulator

The accumulator is gradually pressurized via the test pump; until the initial gas pressure is reached, the hydraulic pressure in the accumulator will rise abruptly. This is apparent from gauge **M**. If the initial gas pressure is more than 30% below the prescribed value, the accumulator needs to be replaced. If the measuring process needs to be repeated, wait for intervals of 3 minutes between the individual tests. Any accumulator whose initial gas pressure is insufficient must be scrapped following the instructions under **Disposal of the accumulator.**

The amount of initial gas pressure can also be checked from the vehicle. Start the vehicle's engine. The pump will now supply oil to the accumulators. Until the initial gas pressure is reached, the hydraulic pressure in the accumulator will rise abruptly. This is apparent from the gauge in the cab. If the initial gas pressure is more than 30% below the prescribed value, that initial pressure lies outside the permissible range for **at least one** of the accumulators fitted in the vehicle. This accumulator can be traced only by using the method described above, i.e. all accumulators have to be individually tested. The accumulator whose initial gas pressure is insufficient must be replaced and scrapped following the instruction under **Disposal of the accumulator.**



(7) Repair work

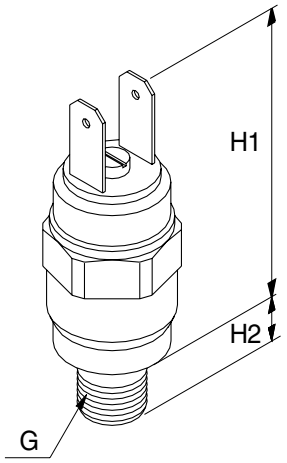
△ When working on the braking system, always make sure that there is absolutely no pressure in the system. Even when the engine in switched off there will be some residual pressure in the system.

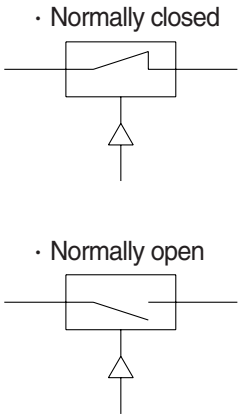
※ When doing repair work, make sure your environment is very clean.
Immediately close all open ports on the components and on pipes using plugs.

△ For safety reasons the accumulators need to be replaced as a whole if damaged.

7. PRESSURE SWITCHES

1) STRUCTURE





(770-3ATM) 4-25

· Technical data

Item	Type	Medium	G	H1 mm	H2 mm	Adjusting range kgf/cm²	Adjusting pressure kgf/cm²	Voltage V
Parking	NC	Oil	M12×1.5	55	9	50 ~ 150	100 ± 10	Max 42
Charging	NC	Oil	M12×1.5	55	9	50 ~ 150	100 ± 10	Max 42
Brake stop	NO	Oil	M12×1.5	55	9	1 ~ 10	5 ± 1	Max 42
Clutch cut-off	NO	Oil	PF 1/4"	55	9	20 ~ 50	24 ± 2	Max 42

NC : Normally closed NO : Normally open

2) OPERATION

(1) Purpose

The pressure switches are used to visually or audibly warn the driver of the pressure within the system.

(2) Make contact / circuit closer

The pressure switch can be fitted in the braking system or directly on one of its components.
The system pressure acts on an absorption area within the switch, making an electrical contact as the pressure on that area is increased. The resulting current is used to activate a warning facility, for instance.

(3) Break contact / circuit breaker

The pressure switch can be fitted in the braking system or directly on one of its components.
The system pressure acts on a absorption area within the switch, breaking an electrical contact as the pressure on that area is increased. The current is now broken, e.g. to deactivate a warning facility.

(4) Installation requirements

No special measures need to be taken.

(5) Maintenance of the pressure switch

No special maintenance beyond the legal requirements is necessary.
When using high-pressure cleaners on the vehicle, please make sure that the water jet is not directed at the pressure switch(Corrosion of contacts).

(6) Repair work

△ **When working on the braking system, always make sure that there is absolutely no pressure in the system. Even when the engine is switched off there will be some residual pressure in the system.**

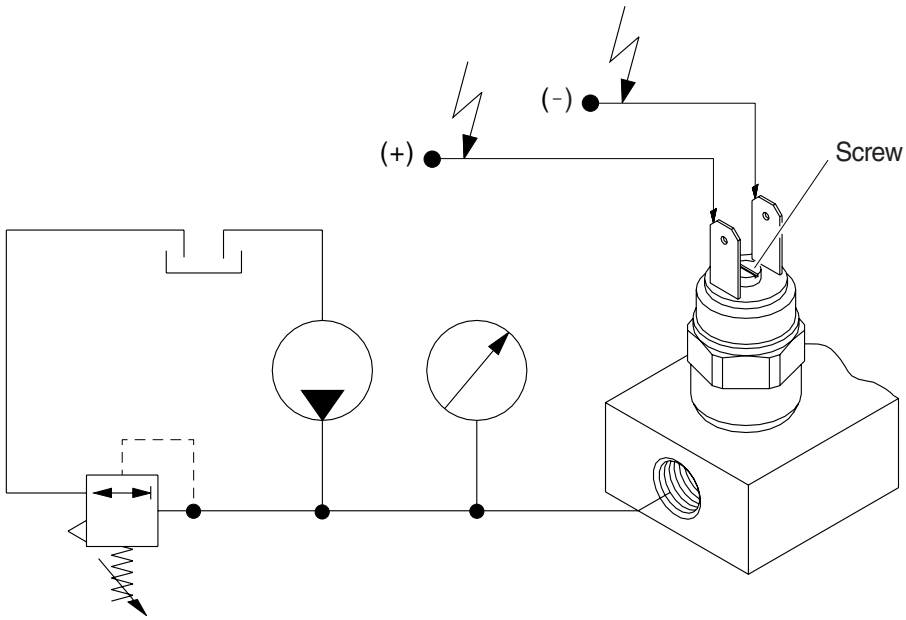
※ **When doing repair work, make sure your environment is very clean.**
Immediately close all open ports on the components and on pipes using plugs.

※ **For safety reasons the pressure switch needs to be replaced as a whole if damaged.**

(7) Adjusting and testing pressure switch

The adjusting screw located between the two contact plugs can be set to the desired value within a certain range. For adjusting range, please refer to the table **Technical data** on the previous page.

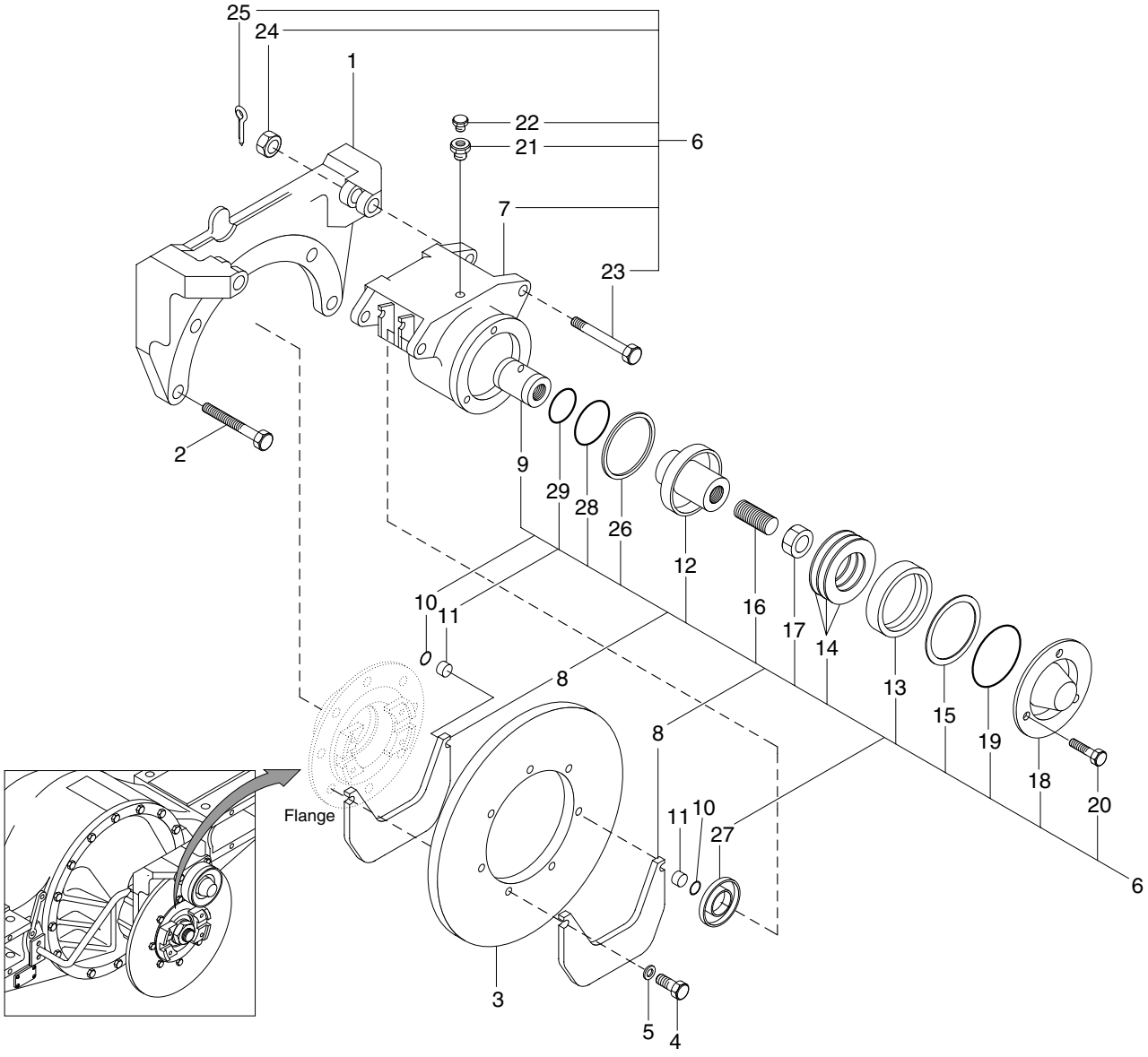
After making the adjustment, the adjusting screw should be secured using wax or a similar material.



(770-3ATM) 4-25

8. PARKING BRAKE SYSTEM (VOLVO AXLE)

· Machine serial No. ; ~#0293



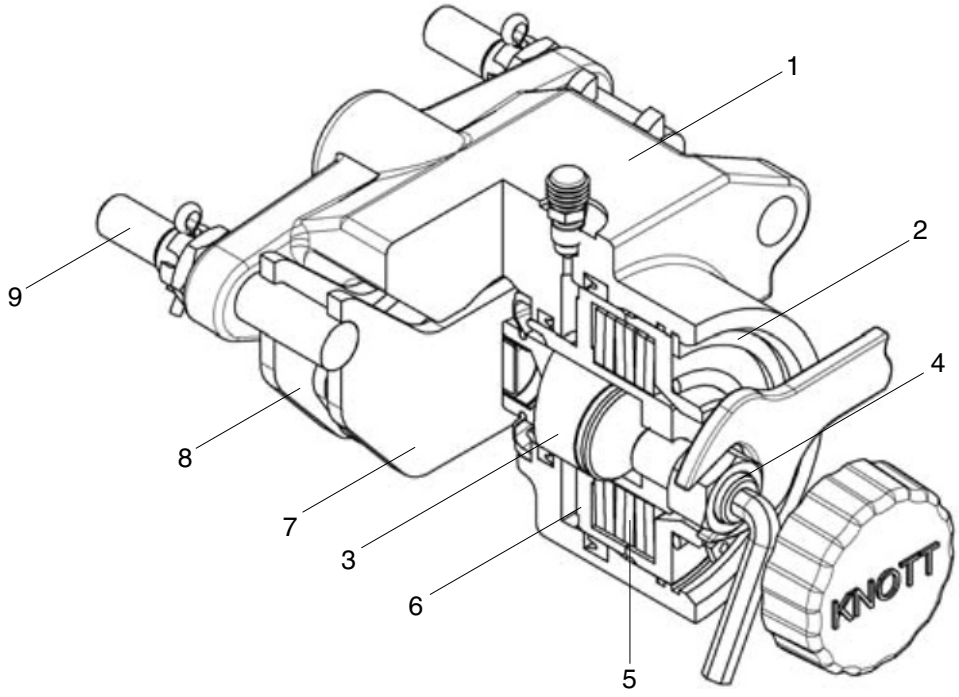
7607ABS06

1	Caliper bracket	11	Magnet	21	Breather
2	Bolt	12	Piston	22	Cap
3	Disc	13	Ring	23	Bolt
4	Bolt	14	Plate ring	24	Nut
5	Spring washer	15	Lock plate	25	Split pin
6	Brake caliper	16	Pin	26	Ring
7	Body	17	Nut	27	Seal
8	Pad	18	Cover	28	Ring
9	Shuttle	19	O-ring	29	O-ring
10	Ring	20	Bolt		

PARKING BRAKE SYSTEM (ZF AXLE)

· Machine serial No. ; #0294~

1) STRUCTURE



100D7BS111

1	Housing	4	Adjust screw	7	Lining pad
2	Pressure ring	5	Bank of cup springs	8	Lining pad
3	Thrust bolt	6	Piston	9	Gliding bolt

2) OPERATION

The two identical brake pads and slide freely on the guide bolt, which is fastened in the housing. The guide bolts are guided in an additional brake anchor plate which in turn is screwed onto the vehicle, i.e. its axle.

On actuation, the brake generates a clamping force at the brake lining pads, which cause a tangential force/braking moment to be generated at the brake disk, the extent of which depends on the coefficients of friction generated by the linings.

The clamping force is generated by the bank of cup springs, during which the piston is moved together with the adjusting screw, the thrust bolt and the brake pad towards the brake disk.

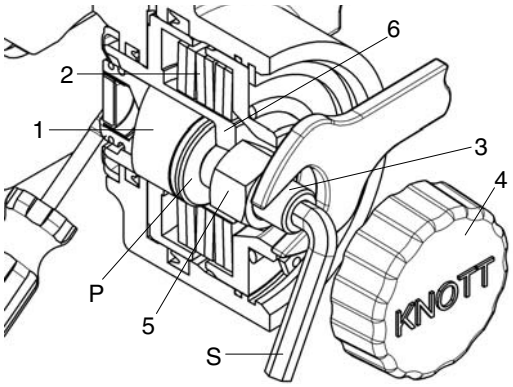
When the brake pad comes into contact with the brake disk, the reaction force shifts the housing onto the guide bolts until the brake pad is also pressed against the brake disk.

The brake is released by complete pre-tensioning of the bank of cup springs. Du-ring this process, through application of the necessary release pressure after overcoming the cup spring force, the piston must move back until it comes to rest against the pressure ring.

The clamping force diminishes with wear of the brake lining and brake disk. The brake must be adjusted at the latest at the times indicated by the adjusting specification followings.

3) MOUNTING AND BASIC SETTING REGULATIONS

Basic brake setting is required after mounting new brake lining plates or brake disks, as well as during all repair stages and in the event of insufficient braking performance.



100D7BS112

1	Thrust bolt	4	Screw cap	P	Even surface
2	Bank of cup springs	5	Lock nut	S	Socket wrench
3	Adjusting screw	6	Piston		

※ **All mounting and basic setting work must be carried out on the brake when cold.**

(1) Mounting the brake

① Stand the vehicle on an even surface and secure against rolling away.

② Release the screw cap.

③ Release the lock nut(size 24 or 30) and turn the adjusting screw anticlockwise using a size 8 or 10 socket wrench until the pressure bolt comes to rest against the even surface of the piston. In this status, the brake can be mounted onto the brake disk and fastened.

④ Mount the pressure connection again.

Apply the necessary release pressure to the brake until the bank of cup springs is completely pre-tensioned. Following carry out the following page basic setting regulation.

(2) BASIC SETTING REGULATION

① Turn the adjusting screw manually clockwise until both brake pads make contact with the brake disk. Then it is not longer possible to turn the adjusting screw without exerting a major amount of force.

② Turn the adjusting screw anticlockwise in order to set the following rated clearances.

Adjusting screw	Clearance(㎜)		Turns
M16(SW 8)	Min.	0.5	1/4
	Clearance	1.0	1/2
	Max.	1.5	3/4

③ Hold the adjusting screw in position with a hexagonal socket wrench and lock with lock nut.

④ Mount the screw cap and tighten as far as possible manually.

⑤ Mount the pressure connection in accordance with the instructions of the axle.

※ For bleeding the piston chamber use the socket spanner size 13 for the bleeding valve.

(3) ADJUSTING REGULATIONS

During this adjusting process, the parking brake must be released, i.e. the bank of cup springs must be completely pre-tensioned.

① Stand the vehicle on an even surface and secure against rolling away.

② Release the parking brake by using the required release pressure.

③ Release the screw cap and unscrew.

④ Release the lock nut(size 24 or 30) and turn the adjusting screw with socket wrench size 8 or 10 manually clockwise until the two brake pads make contact with the brake disk.

⑤ Turn the adjusting screw anti-clockwise and set the clearance specified in the above table.

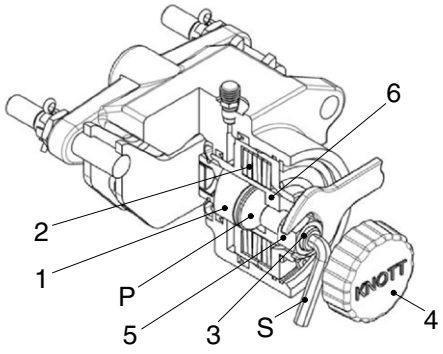
⑥ Hold the adjusting screw in position with the hexagonal socket wrench and lock with the lock nut.

⑦ Mount the screw cap and tighten as far as possible manually.

※ Actuate the brake valve several times and check the braking efficiency of the parking brake on a slope.

4) EMERGENCY RELEASE OF THE PARKING BRAKE

After the failure of the pressure release the parking brake by using following manual procedure.



100D7BS117

1	Thrust bolt	4	Screw cap	P	Even surface
2	Bank of cup springs	5	Lock nut	S	Socket wrench
3	Adjusting screw	6	Piston		

(1) The vehicle has to be secured against rolling away.
(2) Release the screw cap and unscrew
(3) Release the lock nut(size 24 or 30) and turn the adjusting screw with socket wrench size 8 or 10 manually counter-clockwise until the brake disc is free.

⚠ **For the emergency release is an actuation torque of 40Nm respectively 70Nm required.**

(4) Mount the lock nut and the screw cap and tighten both as far as possible manually.(protection against dirt)

⚠ **Now, the vehicle do not have any brake function. The vehicle must be secured against moving away with proper means. Before putting the vehicle into operation again, the brake has to be adjusted again. Refer to previous page. "Assembly and basic setting regulations".**

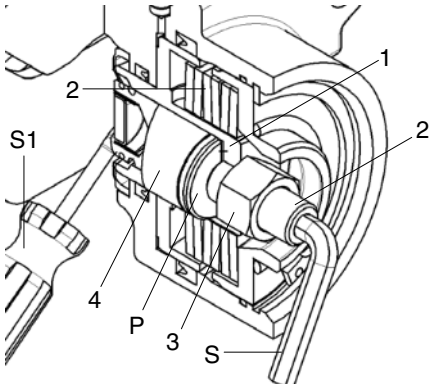
5) MAINTENANCE AND REPAIR WORK

(1) Maintenance and exchange of brake pads

The brake pads themselves are maintenance free. All that is required here is a check for damaged parts, as well as inspection to ensure that the brake disk remains easy running.

The thickness of the brake lining must be subjected to a visual inspection at regular intervals, which depend on vehicle usage, but every six months at the latest. In the event of a minimal residual lining thickness, these intervals must be reduced accordingly in order to avoid major damage to the brake or disk.

Min. residual thickness 1.0㎜ per lining pad(6㎜ carrier plate thickness).

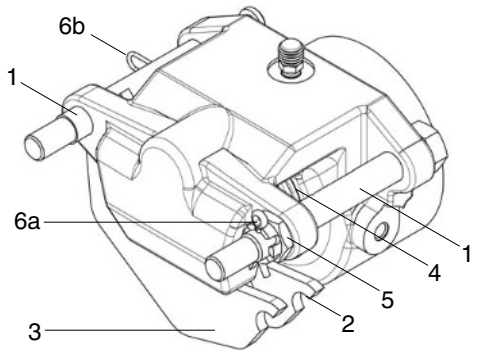


100D7BS113

1	Piston	S	Socket wrench
2	Adjusting screw	S1	Screwdriver
3	Lock nut	P	Inside of the piston
4	Thrust bolt		

※ Only original spare lining plates may be used. If any other spare parts are used, no warranty claims will be accepted either for the brakes or their functional characteristics.

① Stand the vehicle on an even surface and secure against rolling away.
② Release the parking brake by applying the required release pressure.
③ Release the screw cap and unscrew.
④ Release the lock nut(size 24 or 30) and turn the adjusting screw with socket wrench size 8 or 10 manually clockwise until it lies flush with the inside of the piston.
⑤ Press back the thrust bolt using a suitable screwdriver until it has contact with the piston.



100D7BS114

1	Guide bolt	5	Castellated nut
2	Lining pad	6a	Safety splint
3	Lining pad	6b	Safety clip
4	Permanent magnet		

⑥ Depending on the free space available, release one of the two guide bolts, removing the safety splint, unscrewing the castellated nut and pulling the guide bolt out of the brake anchor plate. Now, the brake lining pads can be removed tangentially to the brake disk.

※ In the event of minimal clearance, i.e. it is not possible for space reasons to exchange the brake lining plate in accordance with these instructions, the brake must be removed completely. To do this, pull both guide bolts out of the brake anchor plate.

⚠ Check the pressure hose. If the pressure hose is to short, it must be unscrewed to remove the brake. Before the pressure hose can be released the brake must be emergency released.

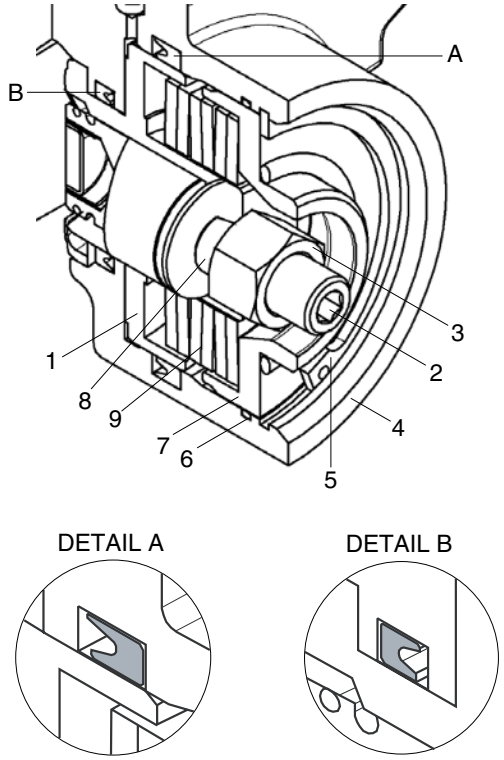
⑦ Exchange the brake pads and insert the guide bolts into the brake anchor plate. If you have removed the complete brake you have to amount the brake on both guide bolt again, now.

⑧ Check both permanent magnets if they still have sufficient magnetic force to hold the brake lining plates. Should this not be the case, the permanent magnets must also be changed by using a suitable screw driver.

⑨ Secure the guide bolt with the castellated nut and the safety splint respective safety clip.

⚠ After mounting new brake lining plates or their repair, the brake must be correctly set in accordance with the instructions "Adjusting regulations".

(2) Changing the seal



100D7BS115

1	Piston	5	Circlip	9	Bank of cup spring
2	Adjusting screw	6	Seal	A	Detail of the seal
3	Lock nut	7	Guide bolt	B	Detail of the seal
4	Housing	8	Thrust bolt		

※ Faulty seals must be exchanged in accordance with the instructions below.

① Stand the vehicle on an even surface and secure against rolling away.
② Release the parking brake by applying the necessary release pressure.
③ Release the screw cap and unscrew.
④ Release the lock nut(size 24 or 30) and turn the adjusting screw with socket wrench size 8 or 10 manually counter clockwise until the adjuster screw is flush with the inner side of the piston.
⑤ Push back the thrust bolt until it has contact with the piston. Following actuate the hand brake valve(No pressure must be in the piston chamber). The bank of cup springs is now completely depressurized.
⑥ Unscrew the pressure hose and remove the brake.
⑦ Release the circlip and remove the pressure ring of the housing.
⑧ Release the bank of cup spings and the piston.

⚠ Pay attention to the mounting direction of the seal rings, otherwise leaks can occur.

⚠ Use for mounting the new seal rings a suitable mounting needle with rounded edge. Be careful.

⑨ Change all seals and mount the parts of the brake in other way round order. By mounting the piston, the sliding and sealing surfaces must be greased lightly using lubricating grease to DIN 51825. The dust protection cap is fitted with a vulcanized-in steel ring which is used to press it through the locating hole. For exchanging, "lever out" the ring using a suitable tool. The new dust protection cap must be pressed in with the aid of a suitable mounting ring and screw clamps or a lever press.

(2) General

Any discovered defects or damage to parts not listed here must naturally be repaired or replaced using original parts.

For any other information not contained in these instructions or for more detailed instructions, please contact Hyundai dealer.

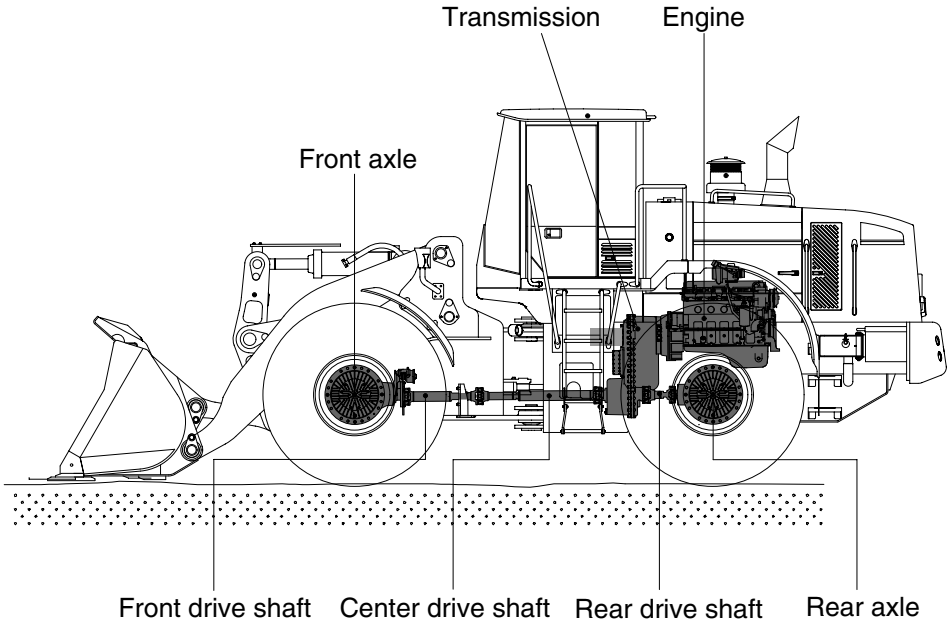
SECTION 3 POWER TRAIN SYSTEM

Group 1 Structure and Function ····· 3-1
Group 2 Operational Checks and Troubleshooting ····· 3-71
Group 3 Tests and Adjustments ····· 3-82
Group 4 Disassembly and Assembly ····· 3-85

SECTION 3 POWER TRAIN SYSTEM

GROUP 1 STRUCTURE AND FUNCTION

1. POWER TRAIN COMPONENT OVERVIEW



7607APT01

The power train consists of the following components:

- Transmission
- Front, center and rear drive shafts
- Front and rear axles

Engine power is transmitted to the transmission through the torque converter.

The transmission is a hydraulically engaged four speed forward, three speed reverse countershaft type power shift transmission. A calliper-disc type parking brake is located on the front axle.

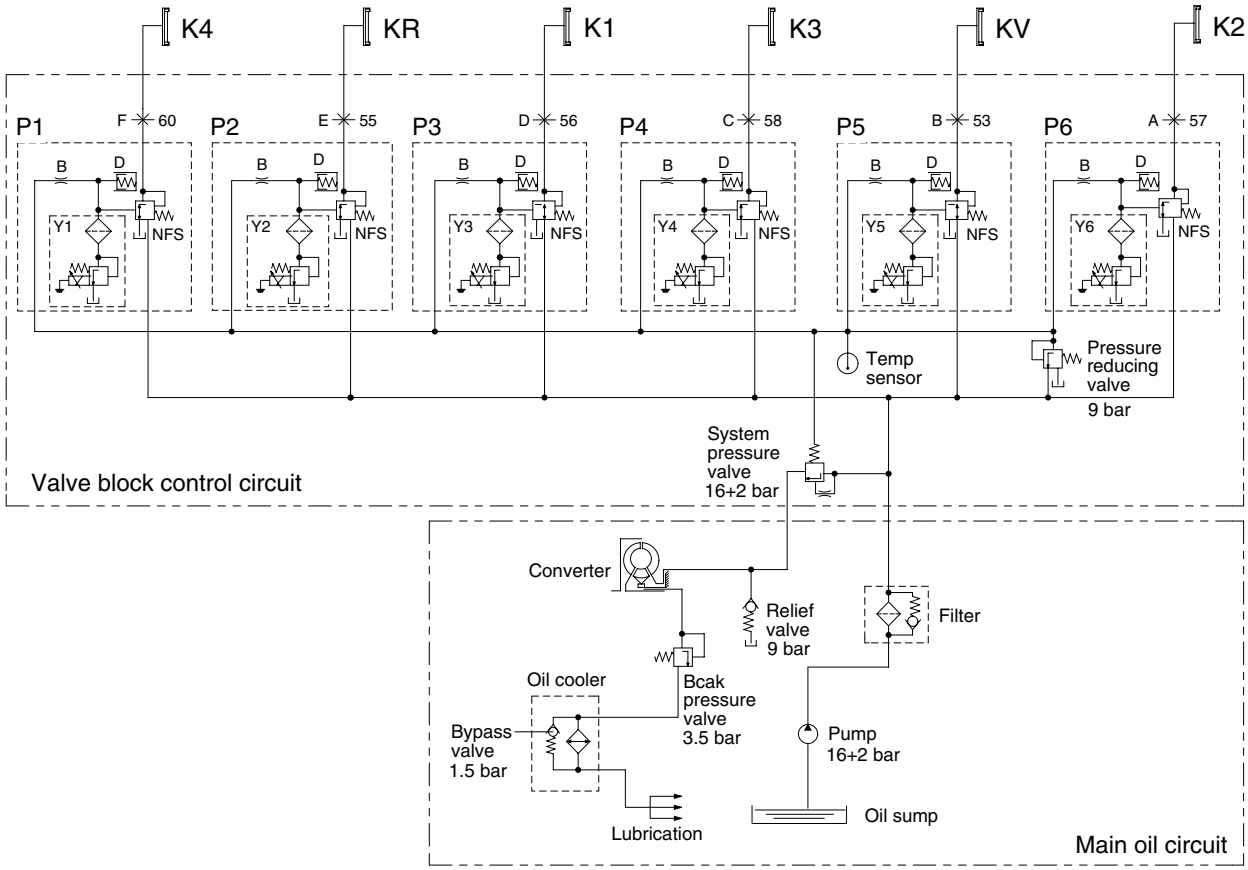
The transmission outputs through universal joints to three drive shaft assemblies. The front drive shaft is a telescoping shaft which drives the front axle. The front axle is mounted directly to the loader frame. The front and rear axle is equipped with torque proportioning differential.(Limited slip differential : option)

The rear axle is mounted on an oscillating pivot.

The power transmitted to front axle and rear axle is reduced by the pinion gear and ring gear of differential. It then passes from the differential to the sun gear shaft(Axle shaft) of final drive.

The power of the sun gear is reduced by a planetary mechanism and is transmitted through the planetary hub to the wheel.

HYDRAULIC CIRCUIT



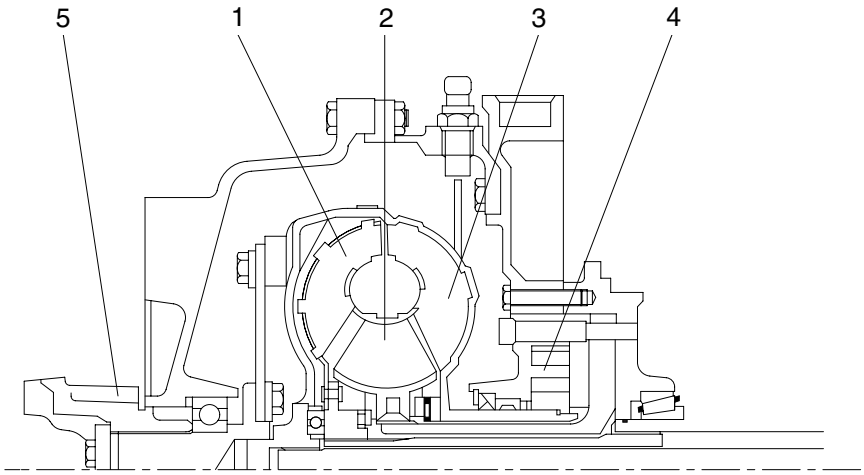
76043PT18

NFS	Follow-on slide	P3	Proportional valve clutch K1
D	Oscillation damper	P4	Proportional valve clutch K3
B	Orifice	P5	Proportional valve clutch KV
P1	Proportional valve clutch K4	P6	Proportional valve clutch K2
P2	Proportional valve clutch KR	Y1~Y6	Pressure regulator

Speed	Forward				Reverse			Neutral	Engaged clutch	Positions on the valve block	Current No. of the measuring points
	1	2	3	4	1	2	3				
Y1				X					K4	F	60
Y2					X	X	X		KR	E	55
Y3	X				X				K1	D	56
Y4			X	X			X		K3	C	58
Y5	X	X	X						KV	B	53
Y6		X				X			K2	A	57
Engaged clutch	K1,KV	KV,K2	K3,KV	K4,K3	KR,K1	KR,K2	KR, K3		-	-	-

X : Pressure regulator under voltage

2. TORQUE CONVERTER



73033TM00

1	Pump	3	Turbine	5	Input flange
2	Stator	4	Transmission pump		

The converter is working according to the Trilok-system, i.e. it assumes at high turbine speed the characteristics, and with it the favorable efficiency of a fluid clutch.
The converter will be defined according to the engine power so that the most favorable operating conditions for each installation case are given.

The Torque converter is composed of 3 main components :
Pump wheel - turbine wheel - stator(Reaction member)

These 3 impeller wheels are arranged in such a ring-shape system that the fluid is streaming through the circuit components in the indicated order.

Pressure oil is constantly streaming out of the transmission pump through the converter. In this way, the converter can fulfill its task to multiply the torque of the engine, and at the same time, the heat created in the converter is dissipated through the escaping oil.
The oil, escaping out of the pump wheel, enters the turbine wheel and is there inversed in the direction of flow.

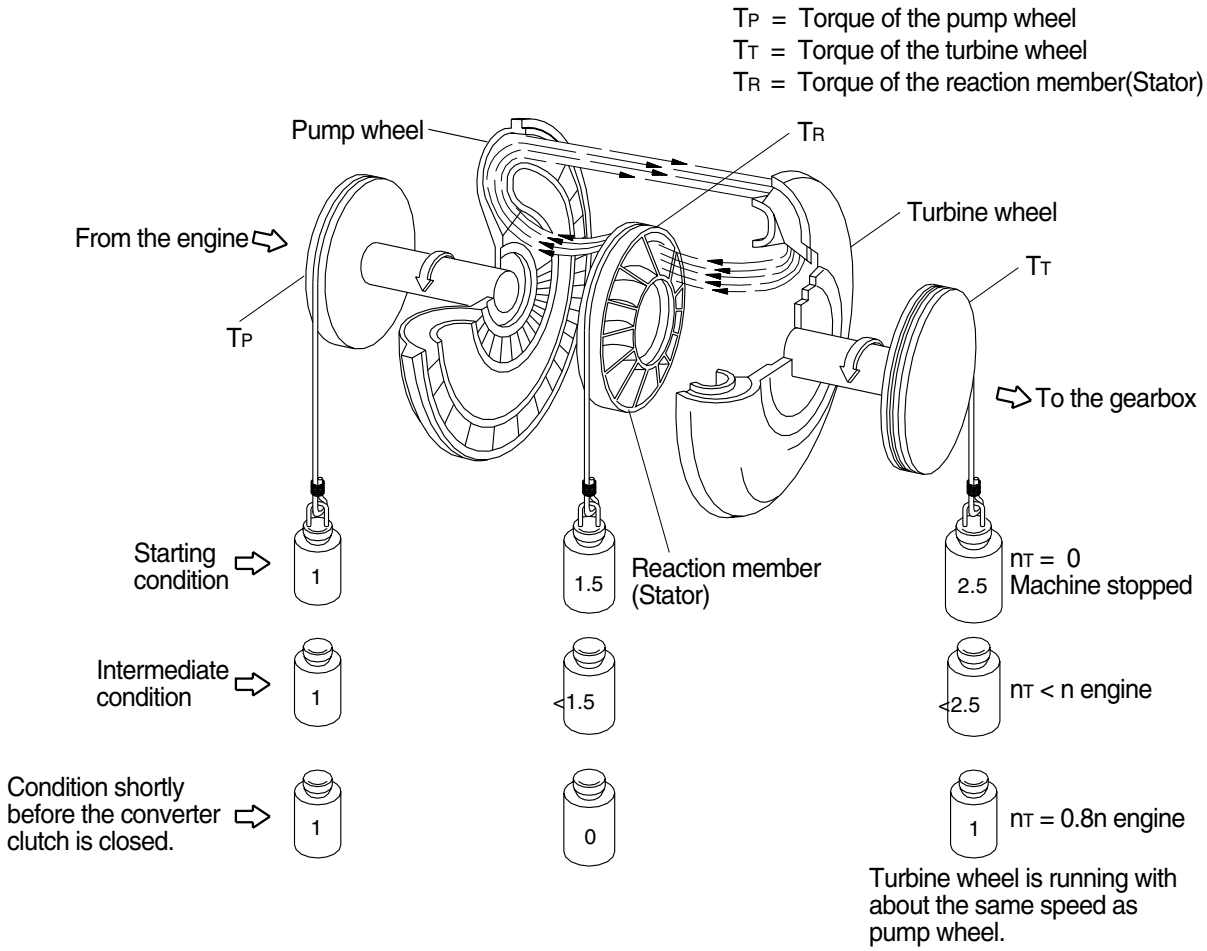
According to the rate of inversion, the turbine wheel and with it also the output shaft, receive a more or less high reaction moment. The stator(Reaction member), following the turbine, has the task to inverse again the oil which is escaping out of the turbine and to delivery it under the suitable discharge direction to the pump wheel.
Due to the inversion, the stator receives a reaction moment.
The relation turbine moment/pump moment is called torque conversion. This is the higher the greater the speed difference of pump wheel and turbine wheel will be.

Therefore, the maximum conversion is created at standing turbine wheel.
With increasing output speed, the torque conversion is decreasing. The adaption of the output speed to a certain required output moment is infinitely variable and automatically achieved by the torque converter.

If the turbine speed is reaching about 80% of the pump speed, the conversion becomes 1.0 i.e. the turbine moment becomes equal to that of the pump moment.
From this point on, the converter is working similar to a fluid clutch.

A stator freewheel serves to improve the efficiency in the upper driving range, it is backing up in the conversion range the moment upon the housing, and is released in the coupling range.
In this way, the stator can rotate freely.

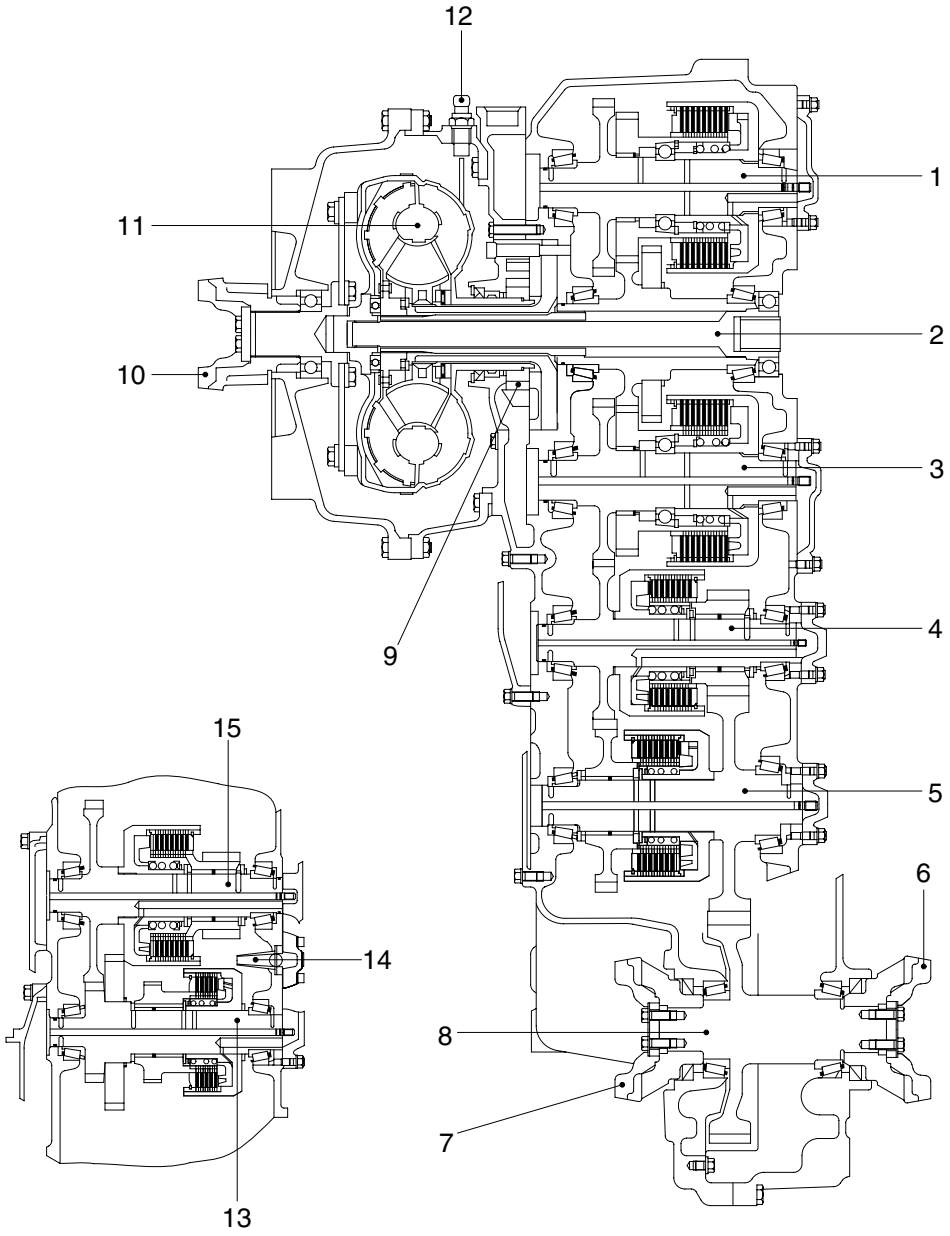
Function of a hydrodynamic torque converter(Schematic view)



(760) 3-4

3. TRANSMISSION

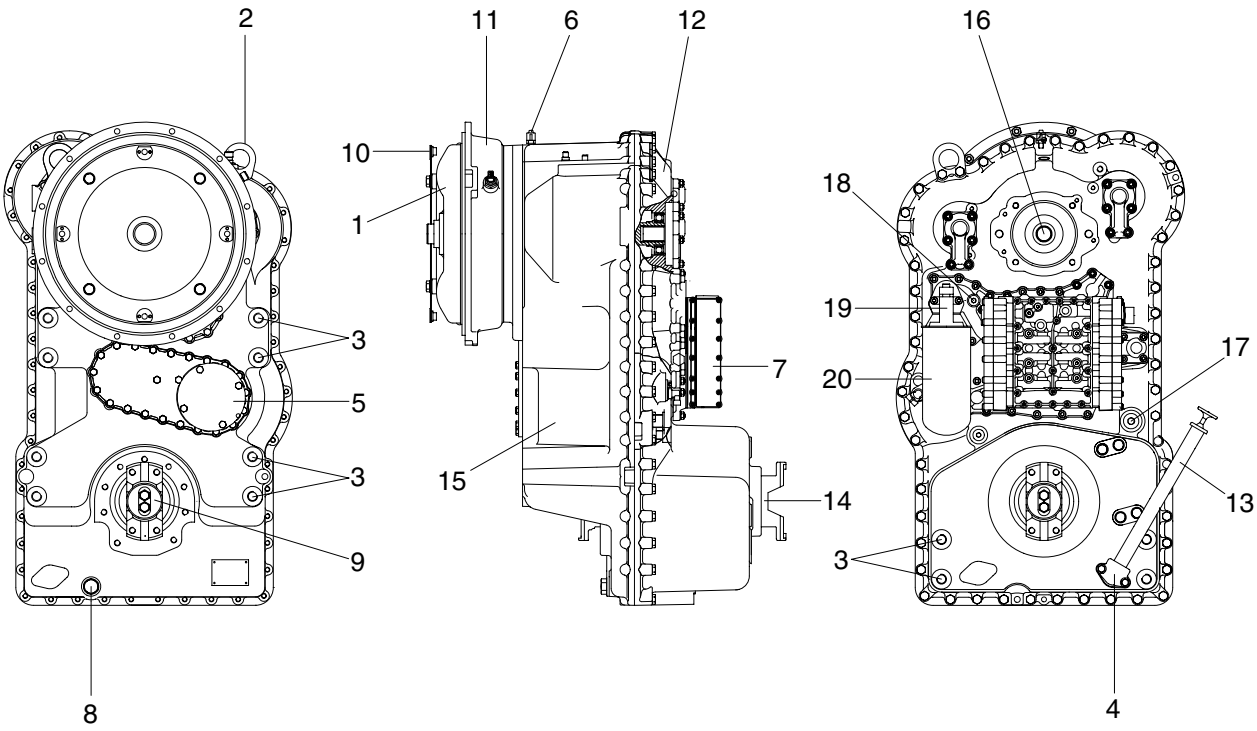
1) LAYOUT



7607PT03

1	Reverse clutch(KR)	6	Rear output flange	11	Converter
2	Engine-dependent power take-off	7	Converter side output flange	12	Inductive transmitter for engine speed
3	Forward clutch(KV)	8	Output shaft	13	4th clutch(K4)
4	2nd clutch(K2)	9	Transmission pump	14	Converter relief valve
5	3rd clutch(K3)	10	Input flange	15	1st clutch(K1)

2) INSTALLATION VIEW



7607PT02

1	Converter	10	Connection to engine
2	Lifting lugs	11	Converter bell housing
3	Transmission suspension bores M20	12	Transmission case cover
4	Attachment possiblility for oil level tube with oil dipstick(Converter side)	13	Oil filler pipe with oil dipstick
		14	Output flange-Rear
5	Attachment possibility for emergency steering pump	15	Transmission case
		16	Power take-off; Coaxial; Engine dependent
6	Breather	17	Port return line M26 × 1.5(From brake)
7	Electro hudraulic control	18	Port system pressure M16 × 1.5
8	Oil drain plug with magnetic insert M38 × 1.5	19	Filter head
9	Output flange-Converter side	20	Filter

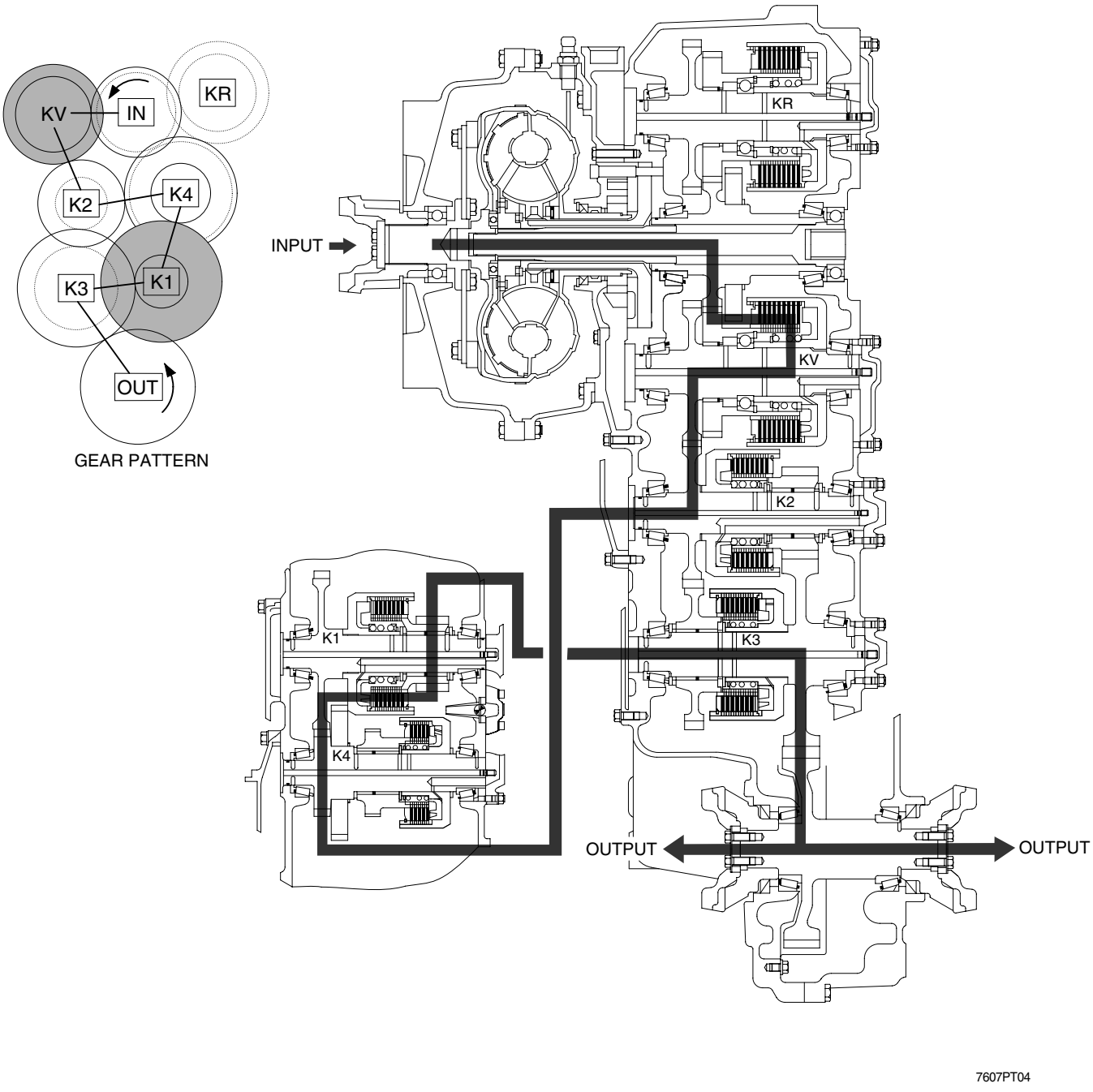
3) OPERATION OF TRANSMISSION

(1) Forward

① Forward 1st

In 1st forward, forward clutch(KV) and 1st clutch(K1) are engaged.

Forward clutch and 1st clutch are actuated by the hydraulic pressure applied to the clutch piston.

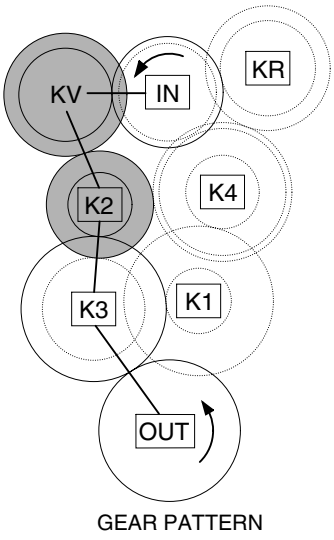


7607PT04

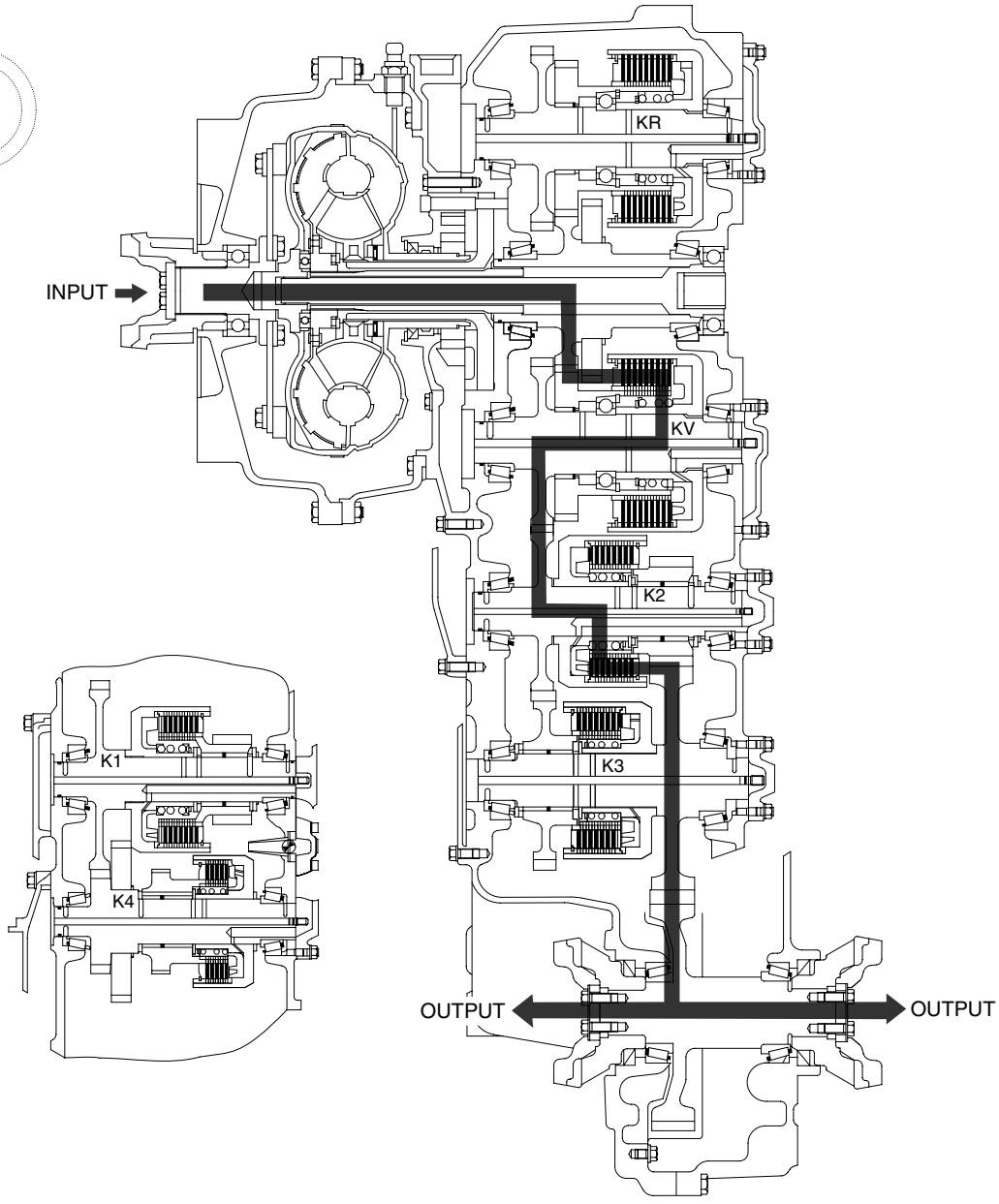
② Forward 2nd

In 2nd forward, forward clutch(KV) and 2nd clutch(K2) are engaged.

Forward clutch and 2nd clutch are actuated by the hydraulic pressure applied to the clutch piston.



GEAR PATTERN

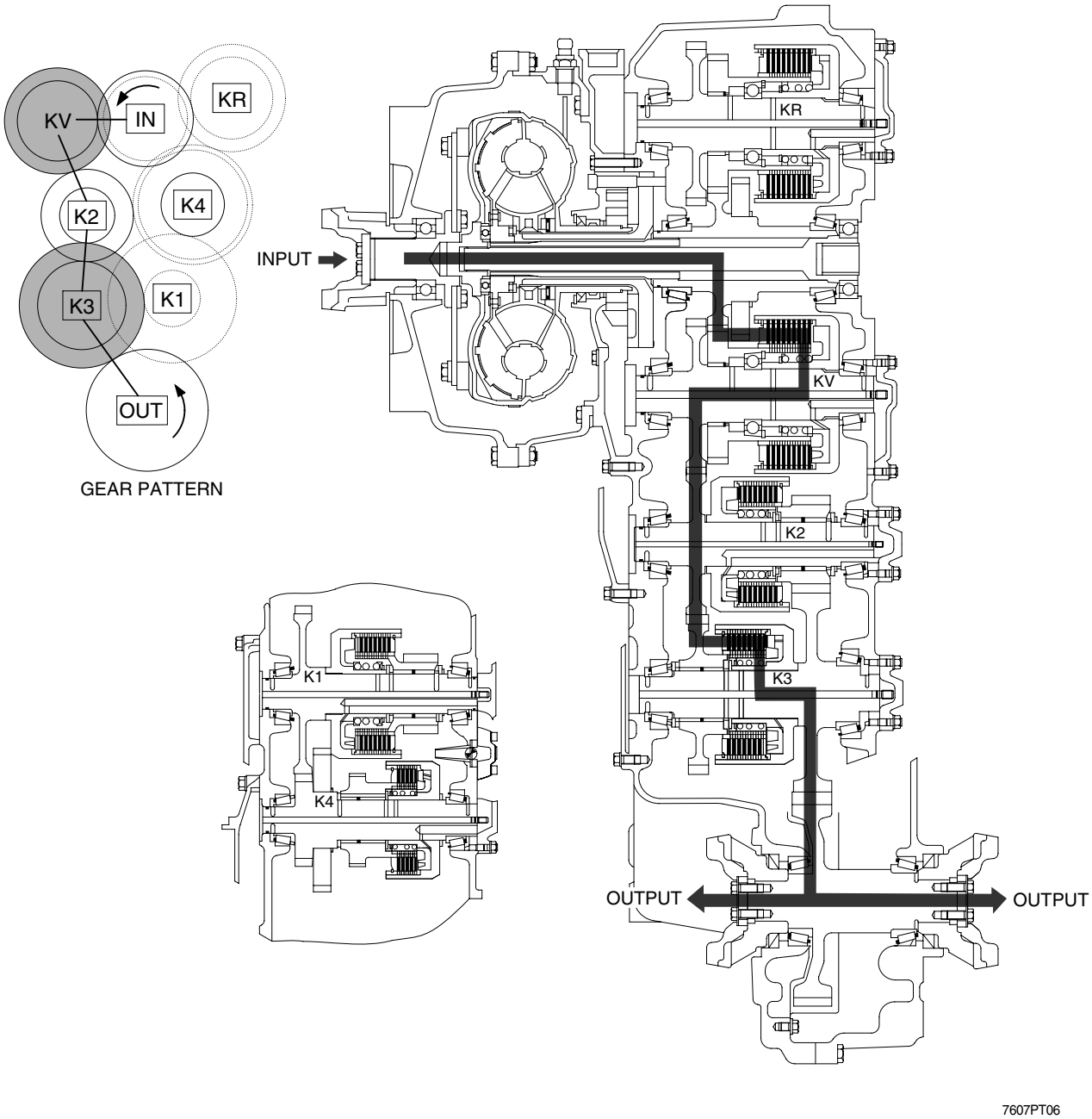


7607PT05

③ Forward 3rd

In 3rd forward, forward clutch(KV) and 3rd clutch(K3) are engaged.

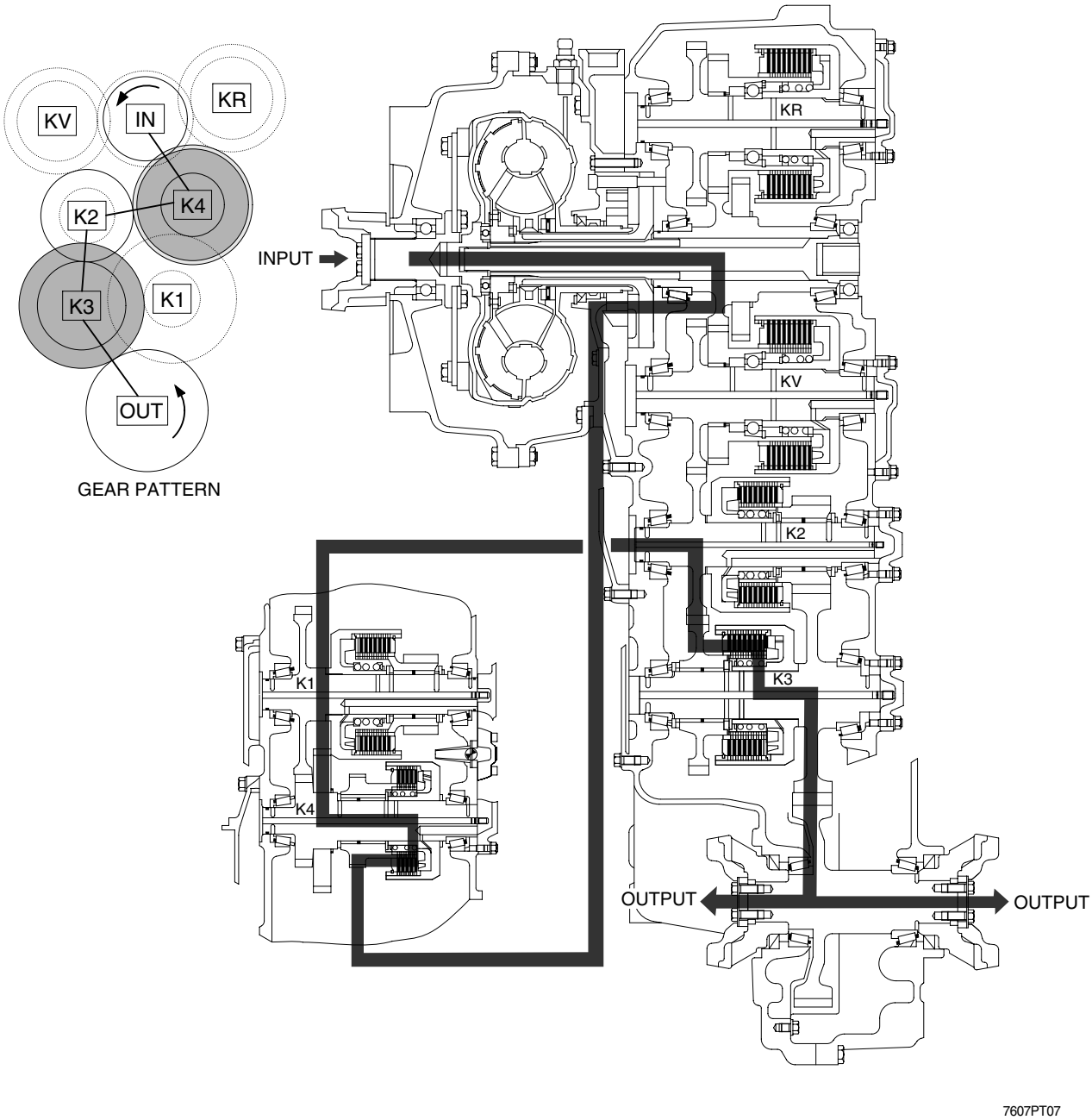
Forward clutch and 3rd clutch are actuated by the hydraulic pressure applied to the clutch piston.



④ **Forward 4th**

In 4th forward, 4th clutch(K4) and 3rd clutch(K3) are engaged.

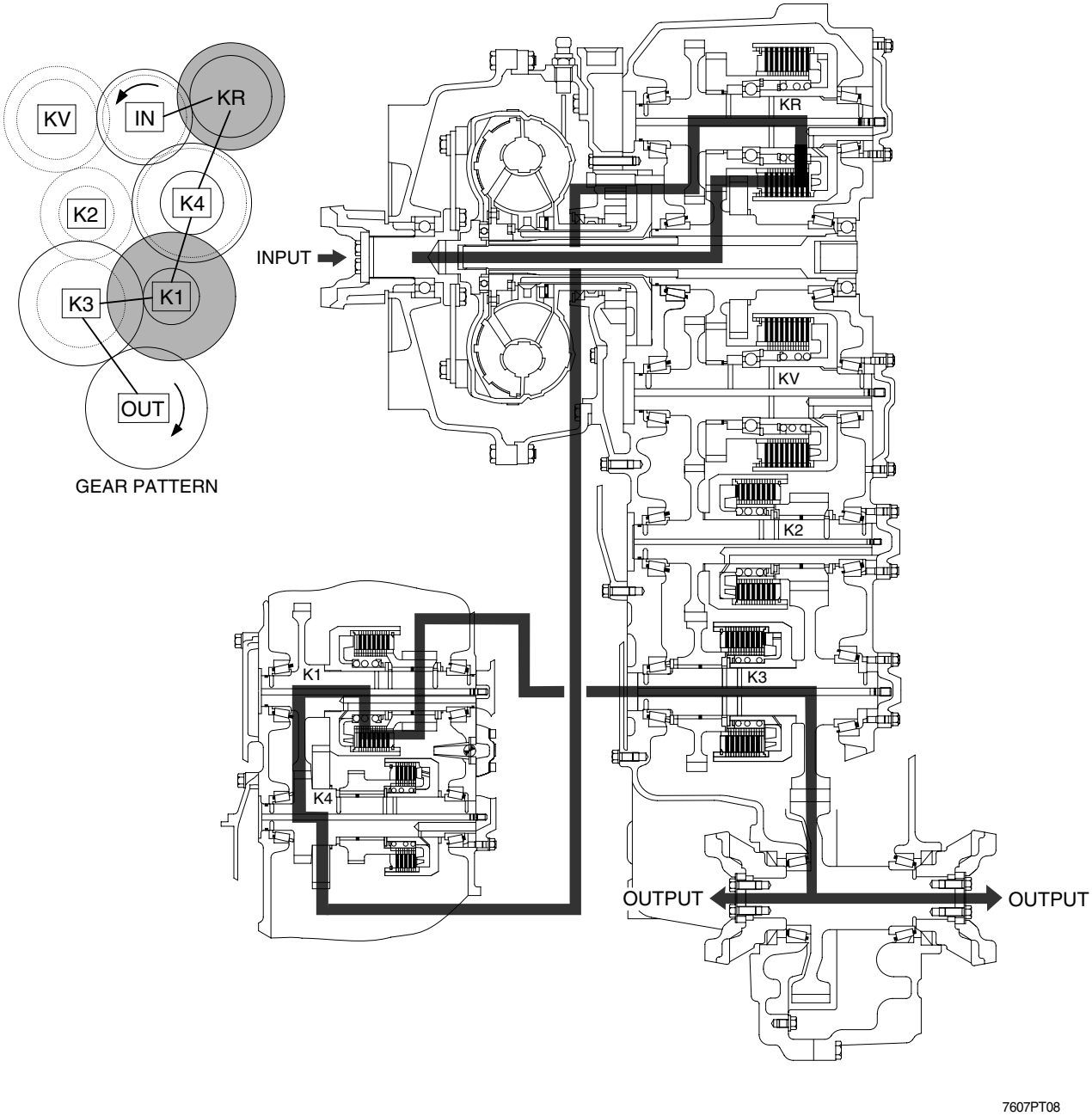
4th clutch and 3rd clutch are actuated by the hydraulic pressure applied to the clutch piston.



(2) Reverse

① Reverse 1st

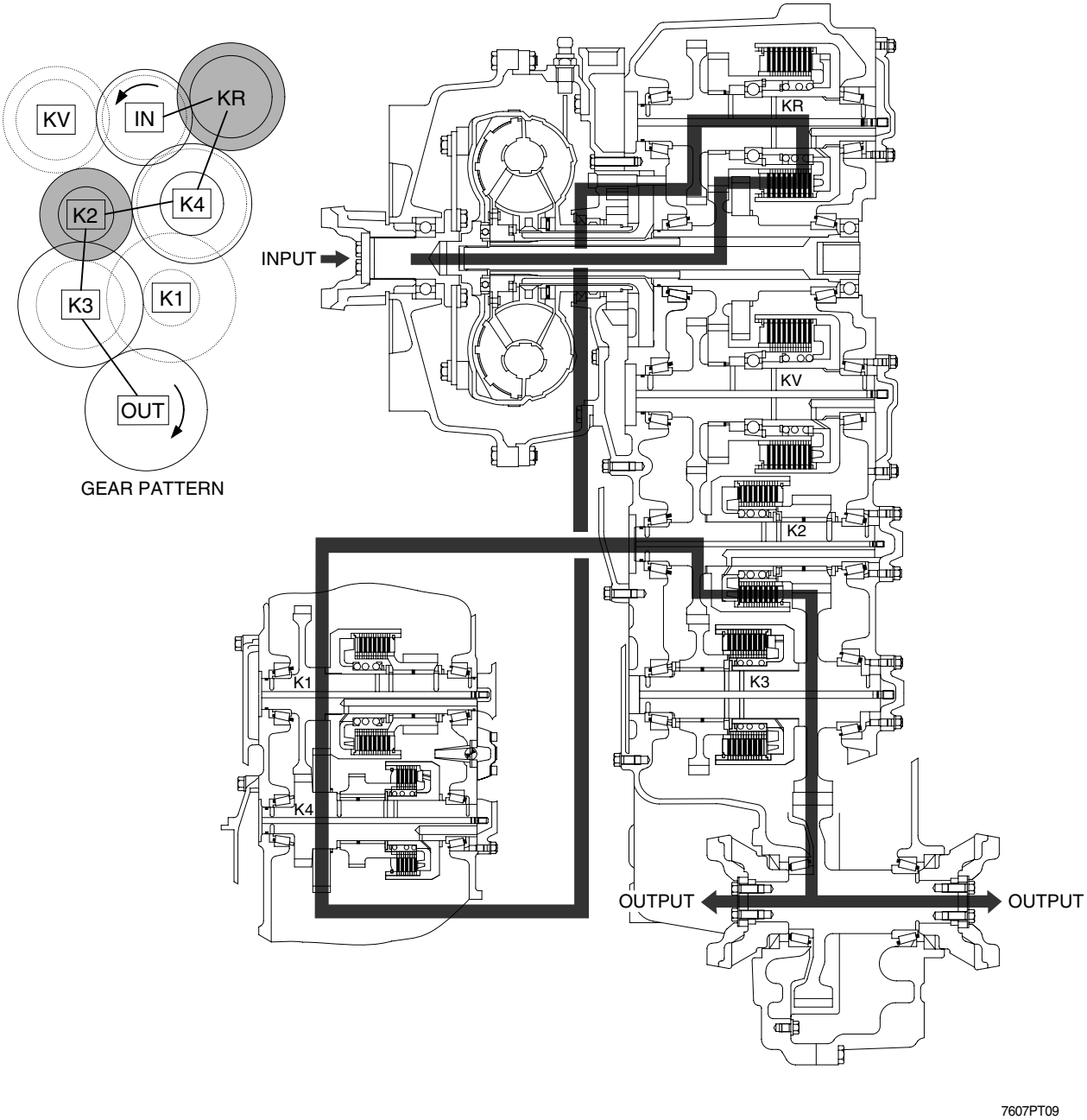
In 1st reverse, reverse clutch(KR) and 1st clutch(K1) are engaged.
Reverse clutch and 1st clutch are actuated by the hydraulic pressure applied to the clutch piston.



② Reverse 2nd

In 2nd reverse, reverse clutch(KR) and 2nd clutch(K2) are engaged.

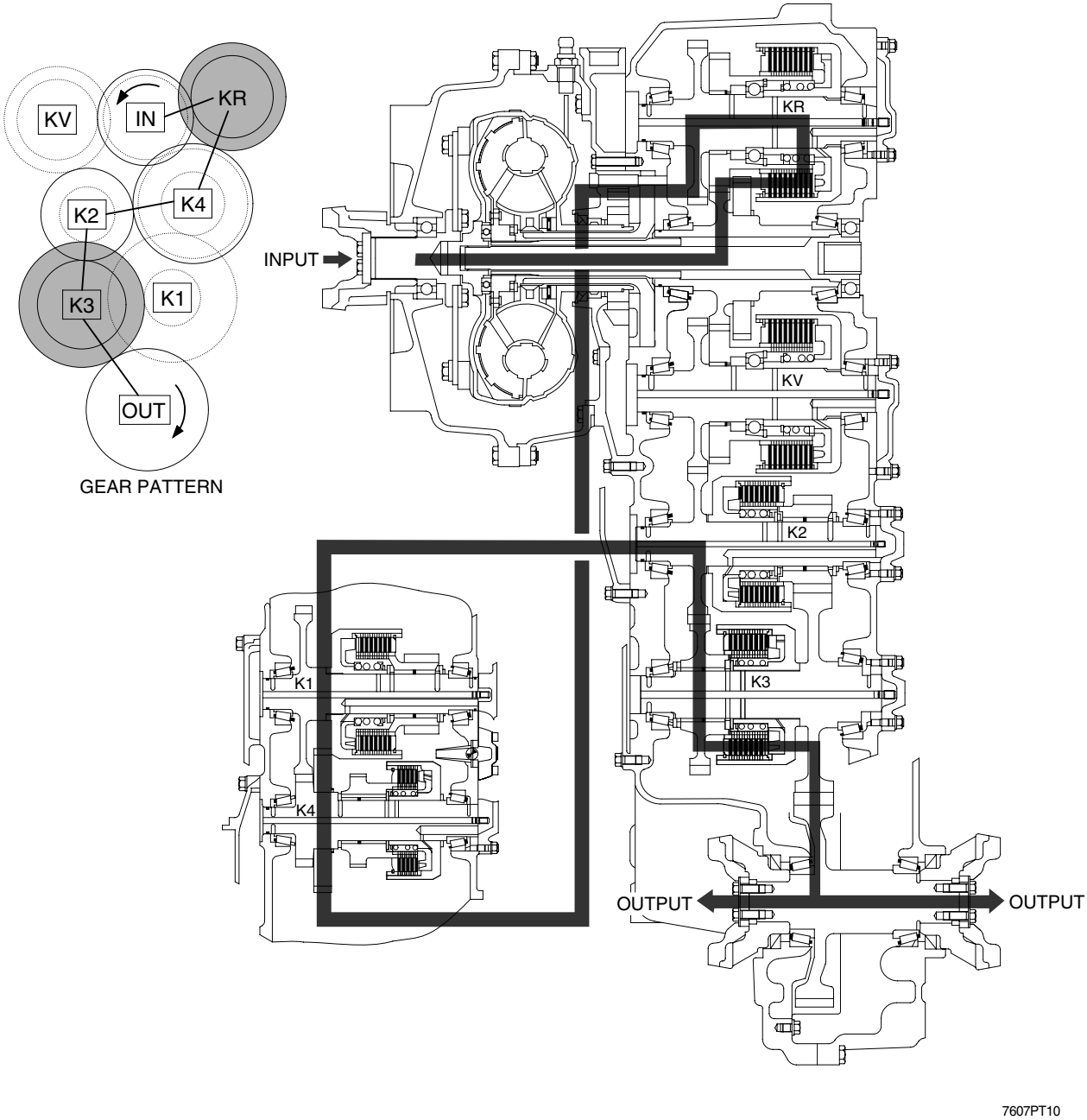
Reverse clutch and 2nd clutch are actuated by the hydraulic pressure applied to the clutch piston.



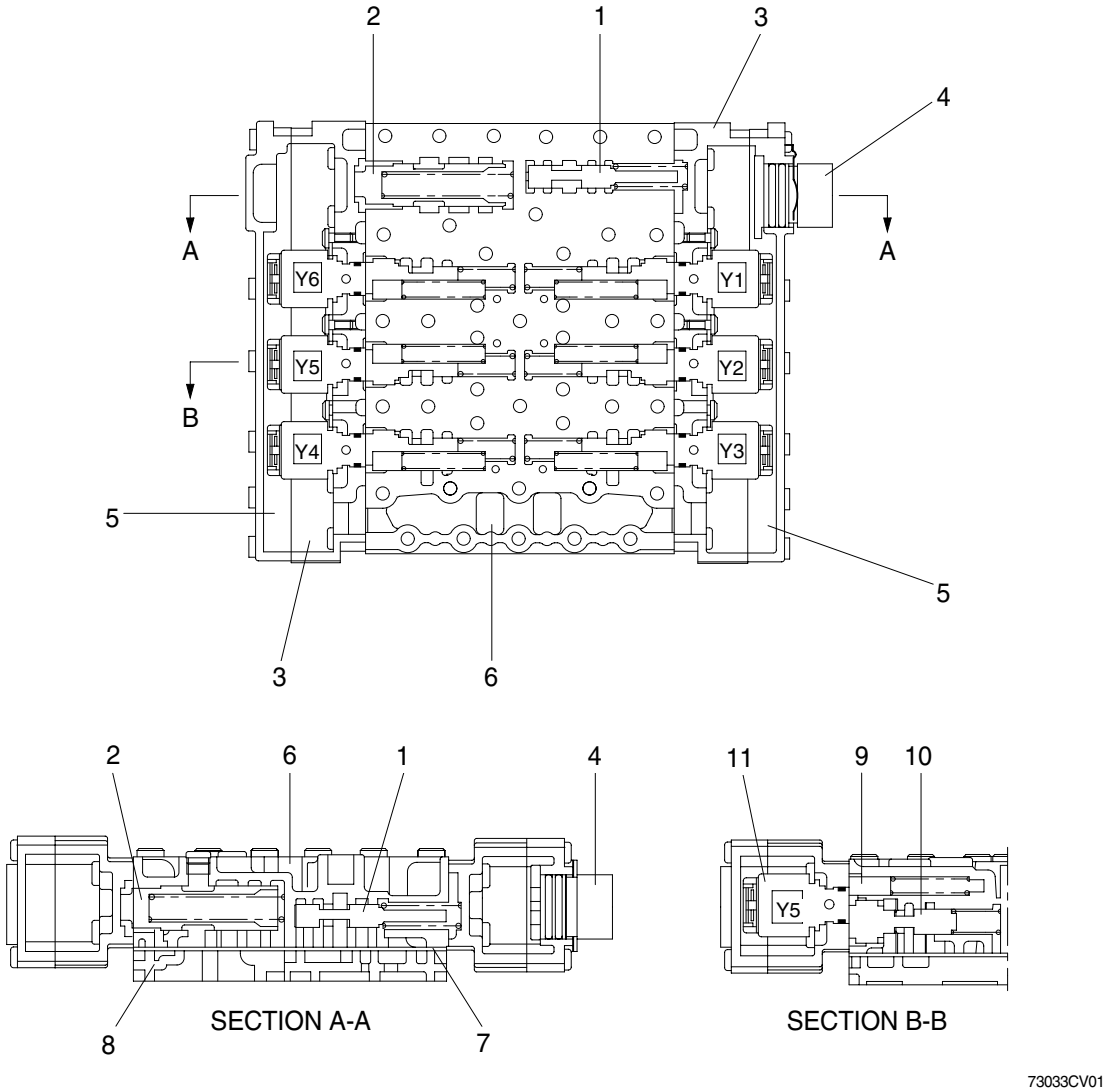
③ Reverse 3rd

In 3rd reverse, reverse clutch(KR) and 3rd clutch(K3) are engaged.

Reverse clutch and 3rd clutch are actuated by the hydraulic pressure applied to the clutch piston.



4) ELECTRO-HYDRAULIC SHIFT CONTROL WITH PROPORTIONAL VALVE



1 Pressure reducing valve(9bar)
2 System pressure valve(16+2bar)
3 Housing
4 Cable harness
5 Cover
6 Valve block
7 Intermediate sheet
8 Duct plate
9 Oscillation damper
10 Follow-on slide
11 Pressure regulator

Transmission control see schedule of measuring points, hydraulic schematic and electro-hydraulic control unit at page 3-2, 3-14 and 3-83.

The six clutches of the transmission are selected through the 6 proportional valves P1 to P6. The proportional valve(Pressure regulator-unit) consists of pressure regulator(e.g. Y1), booster valve oscillation damper.

The pilot pressure of 9 bar for the control of the follow-on slides is created by the reducing valve. The pressure oil (16+2bar) is directed through the follow-on slide to the corresponding clutch.

By the direct proportional selection with separate pressure modulation for each clutch, the pressures to the clutches, taking part in the gear change, are controlled. In this way, a hydraulic overlab of the clutches to be engaged and disengaged is achieved.

This is leading to fast shiftings without traction force interruption.

At the shifting, the following criteria are considered:
- Speed of engine, turbine, central gear train and output.
- Transmission temperature.
- Shifting mode(Up-, down-, reverse shifting and gear engaging from neutral).
- Load level(Full- and partial load, traction, coasting inclusive consideration of load cycles during the shifting).

The system pressure valve is limiting the maximum control pressure to 16+2 bar and releases the main stream to the converter and lubricating circuit.
A converter relief valve is installed in the converter inlet, which protects the converter against high internal pressures(Opening pressure 9bar).
Within the converter, the oil transfers the power transmission according to the well-known hydrodynamic principle(See torque converter, page 3-3).
In order to avoid cavitation, the converter must be always completely filled with oil.
This is achieved by a converter back pressure valve, following the converter, with an opening pressure of about 3.5bar.
The oil, escaping from the converter, is directed to a oil cooler.

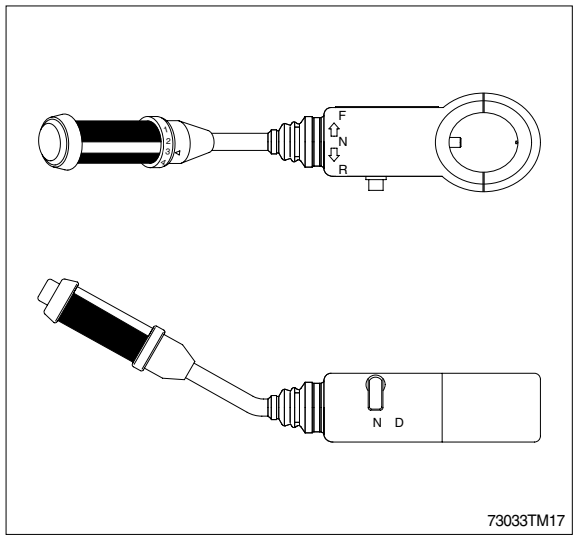
The oil is directed from the oil cooler to the transmission and from there to the lubricating-oil circuit so that all lubricating points are supplied with cooled oil.

In the electro-hydraulic control unit there are 6 pressure regulators installed.

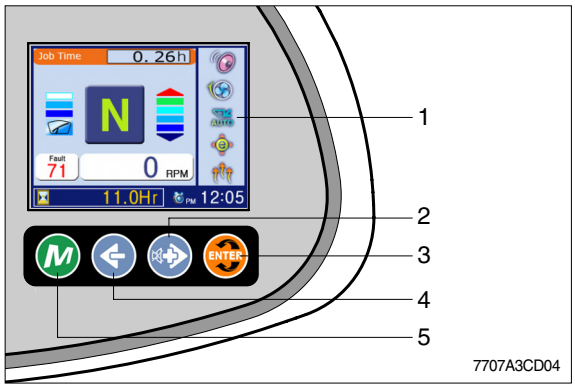
5) GEAR SELECTOR(DW-3)

The gear selector is designed for the mounting on the left side of the steering column. The positions(Speeds) 1 to 4 are selected by a rotary motion, the driving direction Forward(F)-Neutral(N)-Reverse(R) by tilting the gear selector lever.
The gear selector is also available with integrated kickdown control knob.

A neutral lock is installed as protection against inadvertent drive off.
Position **N** - Gear selector lever blocked in this position.
Position **D** - Driving.

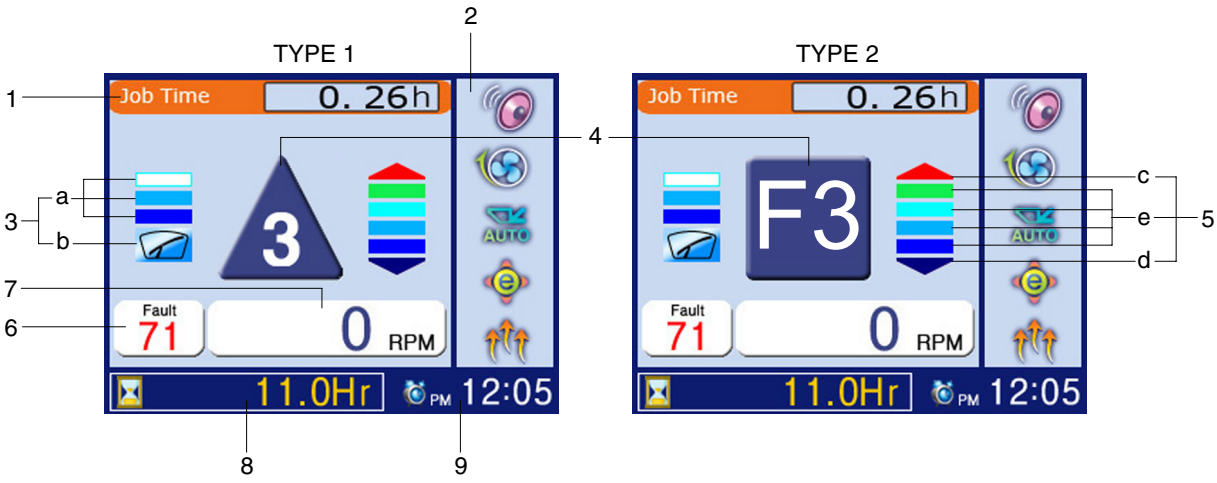


6) LCD



1 LCD
2 ( ) Right, Buzzer stop
Move to the next selection
3 ( ) Select(Enter)
Activate the currently chosen item
4 ( ) Escape
Return to the previous menu
5 ( ) Main, Menu
- Display menu
- Return to the main display

(1) Main display

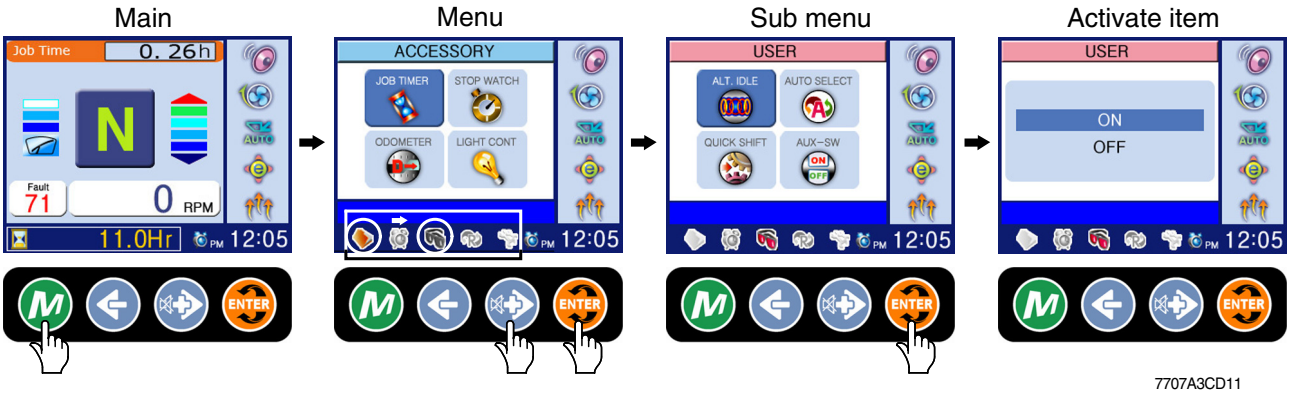


7707A3CD10

No	Symbol	Meaning	Remark		
1	Job Time 1.26h	Monitoring information	Job timer, Odometer, Hydraulic temperature, Battery voltage, Coolant temperature, T/M oil temperature.		
2	AUTO	State information	Buzzer, Fan state, Ride state(option), Steering joystic(option), Warming up		
3	a	Wiper display	When operating intermittently, it shows an operating time interval		
	b		Wiper motor intermittently operating		
4	△, ▽, □	Actual gear display	Forward, reverse, neutral	LCD type 1	
	F, R, N		Forward, reverse, neutral	LCD type 2	
	1, 2, 3, 4		Actual gear		
	P		Parking brake mode active		
5	c, d	Select gear display	Up and down shifting	c: Forward, d: Reverse	Automatic mode
	e		Pre-selected gear		
6	Fault 71	Fault code display	Fault code state display		
7	0 RPM	Engine rpm display	Now engine rpm state display		
8	11.0Hr	Hour meter display	Hour meter state display		
9	PM 12:05	Timer & alarm display	Now time & alarm state display		

※ Both type1 and type2 are LCD modes and they can be changed each other by operator's selection.
(Adjustment/Display, see page 3-18)

(2) Display map



7707A3CD11

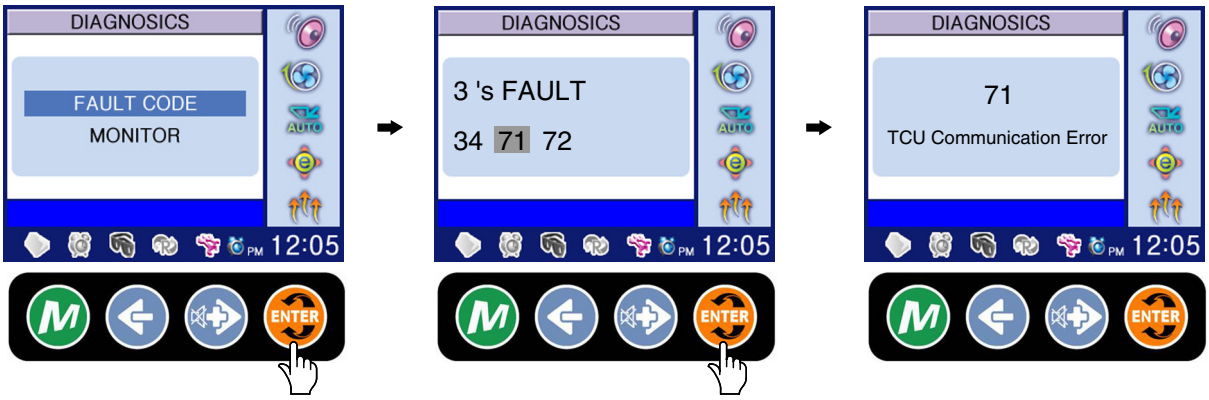
Main group	Sub group		Meaning	Display on LCD
Accessory	Job timer		· Measure the various job time. · Press ENTER : Display ON, OFF or RESET	Job Time 1.26h
	Stop watch		· Measures time in seconds. · Press ENTER : Start. Press ENTER again : Stop.	-
	Odometer	Latest	· Distance until recent times.	Latest 20.5 Km
		Total	· Total distance.	Total 30.5 Km
	Light control		· Control of LCD display luminosity. · Brightness control : ◀▶ .	-
Clock	Time set		· When 12H or 24H is selected, the current hour appears. · ◀▶ : input, ENTER : setting.	PM 22:05
	Clock ON/OFF		· ENTER : Clock display ON or OFF.	
	Alarm	1	· Alarm setting. It is possible to set 3 alarms. · Stop alarming : ◀▶	
		2		
		3		
User	Alternate idle	ON	· Raise the idle rpm to 1200rpm automatically to warm up the engine.	-
		OFF		
	Auto select	Mode 1 (1st-4th)	· Automatic travelling speed is applied from 1st to 4th gear.	-
		Mode 2 (2nd-4th)	· Automatic travelling speed is applied from 2nd to 4th gear.	-
	Quick shift	Mode 1 (Down/Up)	· Press button once : Shift down, press button again ; shift up.	-
		Mode 2 (Down only)	· Press button every time : Shift to lower gear respectively.	-
	Aux-sw	Auto select	· ON : Transmission auto condition. · OFF : Transmission semi-auto condition.	
		Clutch cut-off	· ON : Clutch cut-off is activated. · OFF : Clutch cut-off is cancelled.	-
	Fan control	Forward	· Forward active	
		Reverse	· Reverse active★	

★Reverse mode cleans out quickly dirt and dust on radiator and cooler by reverse rotation of cooling fan.

Main group	Sub group		Meaning	Display on LCD
Adjustment	Unit	MKS ENG	· Choose between metric and inch unit display.	Total 50.7 Km Total 31.5 Mile
	Wiper Intermittence		· When using the intermittent function of wiper motor, it regulates operation time.	
	Alternate RPM		· Regulate idle rpm. · Press : Adjust idle rpm increments (or decrement) by 25rpm.	-
	Pulse		· Press : Modification.	-
	AEB		· It controls the disk interval of the transmission, automatically.	ST
	Model		· It is set at the factory, so there's no need to change.	-
	ENG/KOR		· English : Display in English. · Korean : Display in Korean.	-
	Display 1/2		· Type 1 : Indicate with the symbol. · Type 2 : Indicate with a letter.	3, F3
Diagnostics	Machine	Fault code	· Error code display. · Refer to page 3-19.	-
		Monitor	· Hydraulic temperature and battery voltage display. · Press : Display ON or OFF.	HYD temp 100.6℃ Bat Volt 27.5 V
	Engine	Fault code	· Error code display. · Consult a Hyundai dealer to error code.	-
		Monitor	· Engine coolant temperature display. · Press : Display ON or OFF.	Coolant Temp 57.6℃
	Transmis-sion	Fault code	· Error code display. · Consult a Hyundai dealer to error code.	-
		Monitor	Transmission oil temperature display. · Press : Display ON or OFF.	Oil Temp 37.6℃
	Version		· Display the controller(MCU) and cluster version.	-

(3) Machine fault code

When selecting the fault code menu, it shows all of the fault codes which mean abnormal conditions of present time.



7707A3CD36

※ To go out from fault explanation window, press ◀ button.
(Press ENTER , M to go out to main.)

※ **No error** will be indicated in case that there's no fault.

Description	Code	Meaning	Remark
Electrical system	010	Power input voltage low	Below 18V
	011	Power input voltage high	Above 38V
	012	Alternator voltage low	Below 5V
	013	Alternator voltage high	Above 36V
	014	Buzzer circuit open or short to ground	
	015	Buzzer circuit short to power	
Hydraulic system	020	Hydraulic oil temperature sensor open or short to power	
	021	Hydraulic oil temperature sensor short to ground	
Engine system	030	Fuel level sensor open or short to power	
	031	Fuel level sensor short to ground	
	034	Cooling fan driving valve open or short to ground	
	035	Cooling fan driving valve short to power	
T/M system	050	Auto select switch supply power open or short to power	
	051	Auto select switch supply power short to ground	
	052	Clutch cutoff supply power open or short to power	
	053	Clutch cutoff supply power short to ground	
Steering system	060	Emergency steering relay open or short to ground	Option
	061	Emergency steering relay short to power	Option
Communication	070	MCU communication error	
	071	TCU communication error	
	072	ECM communication error	

MCU : Machine control unit TCU : Transmission control unit ECM : Engine control module

(4) Transmission warning

Symbol	Meaning	Remarks
LF, LR	Limp home gear	-
F/R/△/▽ flashing	Direction F or R selected while turbine speed is too high, CAUTION gear will engage if turbine speed drops	-
	Oil temperature too low, no gear available	Warm up engine / transmission
WS	Warning sump temperature	Changes between actual gear/direction while driving, in neutral only displayed if no fault is detected
WT	Warning torque converter temperature	Changes between actual gear/direction while driving, in neutral only displayed if no fault is detected
WE	Warning high engine speed	Changes between actual gear/direction while driving, in neutral only displayed if no fault is detected

(5) Display during AEB mode

Symbol	Meaning	Remarks
K1~K4, KV, KR	Calibrating clutch K1~K4, KV or KR respectively	
- And Kx	Wait for start, initialization of clutch Kx, x : 1, 2, 3, 4, V, R	
≡ And Kx	Fast fill time determination of clutch Kx	
= And Kx	Compensating pressure determination of clutch Kx	
OK	Calibration for all clutches finished	Transmission stays in neutral, you have to restart the TCU(Ignition off/on)
STOP	AEB cancled(Activation stopped)	Transmission stays in neutral, you have to restart the TCU(Ignition off/on)
STOP and Kx	AEB stopped, clutch Kx can't be calibrated	Transmission stays in neutral, you have to restart the TCU(Ignition off/on)
Spanner and Kx	Kx couldn't be calibrated, AEB finished	Transmission stays in neutral, you have to restart the TCU(Ignition off/on)
△E	Engine speed too low, - Raise engine speed	
▽E	Engine speed too high, - Lower engine speed	
△T	Transmission oil temperature too low, - Heat up transmission	
▽T	Transmission oil temperature too high, - Cool down transmission	
FT	Transmission temperature not in defined range during calibration	Transmission stays in neutral, you have to restart the TCU(Ignition off/on)
FB	Operating mode not NORMAL or transmission temperature sensor defective or storing of calibrated values to EEPROM has failed	Transmission stays in neutral, you have to restart the TCU(Ignition off/on)
FO	Output speed not zero	Transmission stays in neutral, you have to restart the TCU(Ignition off/on)
FN	Shift lever not in neutral position	Transmission stays in neutral, you have to restart the TCU(Ignition off/on)
FP	Park brake not applied	Transmission stays in neutral, you have to restart the TCU(Ignition off/on)

※ **AEB mode :** It controls the disk internal of the transmission, automatically.

(6) Engine fault codes

Fault code No.	Reason	Effect (only when fault code is active)
111	Engine control module critical internal failure - Bad intelligent device or component. Error internal to the ECM related to memory hardware failures or internal ECM voltage supply circuits.	Possible no noticeable performance effects, engine dying, or hard starting.
115	Engine magnetic crankshaft speed/position lost both of two signals - Data erratic, intermittent, or incorrect. The ECM has detected that the primary engine speed sensor and the backup engine speed sensor signals are reversed.	Fueling to injectors is disabled and the engine can not be started.
122	Intake manifold 1 pressure sensor circuit - Voltage above normal, or shorted to high source. High signal voltage detected at the intake manifold pressure circuit.	Engine power derate.
123	Intake manifold 1 pressure sensor circuit - Voltage below normal, or shorted to low Source. Low signal voltage or open circuit detected at the intake manifold pressure circuit.	Engine power derate.
124	Intake manifold 1 pressure - Data valid but above normal operational range - Moderately severe level. Intake manifold pressure has exceeded the maximum limit for the given engine rating.	Engine power derate.
131	Accelerator pedal or lever position sensor 1 circuit - Voltage above normal, or shorted to high source. High voltage detected at accelerator pedal position circuit.	Severe derate in power output of the engine. Limp home power only.
132	Accelerator pedal or lever position sensor 1 circuit - Voltage below normal, or shorted to low source. Low voltage detected at accelerator pedal position signal circuit.	Severe derate in power output of the engine. Limp home power only.
133	Remote accelerator pedal or lever position sensor 1 circuit - Voltage above normal, or shorted to high source. High voltage detected at remote accelerator pedal position circuit.	Remote accelerator will not operate. Remote accelerator position will be set to zero percent.
134	Remote accelerator pedal or lever position sensor 1 circuit - Voltage below normal, or shorted to low source. Low voltage detected at remote accelerator pedal position signal circuit.	Remote accelerator will not operate. Remote accelerator position will be set to zero percent.
135	Engine oil rifle pressure 1 sensor circuit - Voltage above normal, or shorted to high source. High signal voltage detected at the engine oil pressure circuit.	None on performance. No engine protection for oil pressure.
141	Engine oil rifle pressure 1 sensor circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at engine oil pressure circuit.	None on performance. No engine protection for oil pressure.
143	Engine oil rifle pressure - Data valid but below normal operational range - Moderately severe level.	None on performance.
144	Engine coolant temperature 1 sensor circuit - Voltage above normal, or shorted to high source. High signal voltage or open circuit detected at engine coolant temperature circuit.	Possible white smoke. Fan will stay ON if controlled by ECM. No engine protection for engine coolant temperature.

Fault code No.	Reason	Effect (only when fault code is active)
145	Engine Coolant Temperature 1 Sensor Circuit - Voltage Below Normal, or Shorted to Low Source. Low signal voltage detected at engine coolant temperature circuit.	Possible white smoke. Fan will stay ON if controlled by ECM. No engine protection for engine coolant temperature.
146	Engine Coolant Temperature - Data Valid but Above Normal Operational Range - Moderately Severe Level. Engine coolant temperature signal indicates engine coolant temperature is above engine protection warning limit.	Progressive power derate increasing in severity from time of alert.
147	Accelerator Pedal or Lever Position 1 Sensor Circuit Frequency - Data Valid but Below Normal Operational Range - Most Severe Level. A frequency of less than 100 Hz has been detected at the frequency throttle input to the ECM.	Severe derate in power output of the engine. Limp home power only.
148	Accelerator Pedal or Lever Position Sensor 1 - Data Valid but Above Normal Operational Range - Most Severe Level. A frequency of more than 1500 Hz has been detected at the frequency throttle input to the ECM.	Severe derate in power output of the engine. Limp home power only.
151	Engine Coolant Temperature - Data Valid but Above Normal Operational Range - Most Severe Level. Engine coolant temperature signal indicates engine coolant temperature above engine protection critical limit.	Progressive power derate increasing in severity from time of alert. If Engine Protection Shutdown feature is enabled, engine will shut down 30 seconds after Red Stop Lamp starts flashing.
153	Intake Manifold 1 Temperature Sensor Circuit - Voltage Above Normal, or Shorted to High Source. High signal voltage detected at intake manifold air temperature circuit.	Possible white smoke. Fan will stay ON if controlled by ECM. No engine protection for intake manifold air temperature.
154	Intake Manifold 1 Temperature Sensor Circuit - Voltage Below Normal, or Shorted to Low Source. Low signal voltage detected at intake manifold air temperature circuit.	Possible white smoke. Fan will stay ON if controlled by ECM. No engine protection for intake manifold air temperature.
155	Intake Manifold 1 Temperature - Data Valid but Above Normal Operational Range - Most Severe Level. Intake manifold air temperature signal indicates intake manifold air temperature above engine protection critical limit.	Progressive power derate increasing in severity from time of alert. If Engine Protection Shutdown feature is enabled, engine will shut down 30 seconds after Red Stop Lamp starts flashing.
187	Sensor Supply 2 Circuit - Voltage Below Normal, or Shorted to Low Source. Low voltage detected at the sensor supply number 2 circuit.	Engine power derate.
195	Coolant Level Sensor 1 Circuit - Voltage Above Normal, or Shorted to High Source. High signal voltage detected at engine coolant level circuit.	None on performance.
196	Coolant Level Sensor 1 Circuit - Voltage Below Normal, or Shorted to Low Source. Low signal voltage detected at engine coolant level circuit.	None on performance.
197	Coolant Level - Data Valid but Below Normal Operational Range - Moderately Severe Level. Low coolant level has been detected.	None on performance.
221	Barometric Pressure Sensor Circuit - Voltage Above Normal, or Shorted to High Source. High signal voltage detected at barometric pressure circuit.	Engine power derate.

Fault code No.	Reason	Effect (only when fault code is active)
222	Barometric Pressure Sensor Circuit - Voltage Below Normal, or Shorted to Low Source. Low signal voltage detected at barometric pressure circuit.	Engine power derate.
234	Engine Crankshaft Speed/Position - Data Valid but Above Normal Operational Range - Most Severe Level. Engine speed signal indicates engine speed above engine protection limit.	Fuel injection disabled until engine speed falls below the overspeed limit.
235	Coolant Level - Data Valid but Below Normal Operational Range - Most Severe Level. Low engine coolant level detected.	Progressive power derate increasing in severity from time of alert. If Engine Protection Shutdown feature is enabled, engine will shut down 30 seconds after Red Stop Lamp starts flashing.
237	External Speed Command Input (Multiple Unit Synchronization) - Data Erratic, Intermittent, or Incorrect. Communication between multiple engines may be intermittent.	
238	Sensor Supply 3 Circuit - Voltage Below Normal, or Shorted to Low Source. Low voltage detected on the +5 volt sensor supply circuit to the engine speed sensor.	Possible hard starting and rough running.
241	Wheel-based vehicle speed - Data erratic, intermittent, or incorrect. The ECM lost the vehicle speed signal.	Engine speed limited to ,mximum engine speed without VSS parameter value. Cruise control, gear-down protection, and road speed governor will not work.
242	Wheel-based vehicle speed sensor circuit tampering has been detected - Abnormal rate of change. Signal indicates an intermittent connection or VSS tampering.	Engine speed limited to maximum engine speed without VSS parameter value. Cruise control, gear-down protection, and road speed g+H53overnor will not work.
245	Fan control circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at the fan control circuit when commanded on.	The fan may stay on continuously or not run at all.
271	Fuel pump pressurizing assembly 1 circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at the fuel pump actuator circuit.	Engine will run poorly at idle. Engine will have low power. Fuel pressure will be higher than commanded.
272	Fuel pump pressurizing assembly 1 circuit - Voltage above normal, or shorted to high source. High signal voltage or open circuit detected at the fuel pump actuator circuit.	Engine will not run or engine will run poorly.
281	Fuel pump pressurizing assembly 1 - Mechanical system not responding properly or out of adjustment.	Engine will not run or possible low power.
285	SAE J1939 multiplexing PGN timeout error - Abnormal update rate. The ECM expected information from a multiplexed device but did not receive it soon enough or did not receive it at all.	At least one multiplexed device will not operate properly.
286	SAE J1939 multiplexing configuration error - Out of calibration. The ECM expected information from a multiplexed device but only received a portion of the necessary information.	At least one multiplexed device will not operate properly.
287	SAE J1939 multiplexed accelerator pedal or lever sensor system - received network data In error. The OEM vehicle electronic control unit (VECU) detected a fault with its accelerator pedal.	Engine may only idle or engine will not accelerate to full speed.

Fault code No.	Reason	Effect (only when fault code is active)
288	SAE J1939 Multiplexing Remote Accelerator Pedal or Lever Position Sensor Circuit - Received Network Data In Error. The OEM vehicle electronic control unit (VECU) detected a fault with the remote accelerator.	The engine will not respond to the remote throttle. Engine may only idle. The primary or cab accelerator may be able to be used.
292	Auxiliary temperature Sensor Input 1 - Special instructions.	Possible engine power derate.
293	Auxiliary temperature sensor input 1 circuit - Voltage above normal, or shorted to high source. High signal voltage or open circuit detected at the OEM auxiliary temperature circuit.	None on performance.
294	Auxiliary temperature sensor input 1 circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at the OEM auxiliary temperature circuit.	None on performance.
296	Auxiliary pressure sensor input 1 - Special instructions.	Possible engine power derate.
297	Auxiliary pressure sensor input 1 circuit - Voltage above normal, or shorted to high source. High signal voltage detected at the OEM pressure circuit.	None on performance.
298	Auxiliary pressure sensor input 1 circuit - Voltage below normal, or shorted to low source. Low signal voltage or open circuit detected at the OEM pressure circuit.	None on performance.
319	Real time clock power interrupt - Data erratic, intermittent, or incorrect. Real time clock lost power.	None on performance. Data in the ECM will not have accurate time and date information.
322	Injector solenoid driver cylinder 1 circuit - Current below normal, or open circuit. High resistance detected on injector number 1 circuit or no current detected at number 1 injector driver or return pin when the voltage supply at the harness is on.	Engine can possibly misfire or run rough.
323	Injector solenoid driver cylinder 5 circuit - Current below normal, or open circuit. High resistance detected on injector number 5 circuit or no current detected at number 5 injector driver or return pin when the voltage supply at the harness is on.	Engine can possibly misfire or run rough.
324	Injector solenoid driver cylinder 3 circuit - Current below normal, or open circuit. High resistance detected on injector number 3 circuit or no current detected at number 3 injector driver or return pin when the voltage supply at the harness is on.	Engine can possibly misfire or run rough.
325	Injector solenoid driver cylinder 6 circuit - Current below normal, or open circuit. High resistance detected on injector number 6 circuit or no current detected at number 6 injector driver or return pin when the voltage supply at the harness is on.	Engine can possibly misfire or run rough.

Fault code No.	Reason	Effect (only when fault code is active)
331	Injector solenoid driver cylinder 2 circuit - Current below normal, or open circuit. High resistance detected on injector number 2 circuit or no current detected at number 2 injector driver or return pin when the voltage supply at the harness is on.	Engine can possibly misfire or run rough.
332	Injector solenoid driver cylinder 4 circuit - Current below normal, or open circuit. High resistance detected on injector number 4 circuit or no current detected at number 4 injector driver or return pin when the voltage supply at the harness is on.	Engine can possibly misfire or run rough.
334	Engine coolant temperature - Data erratic, intermittent, or incorrect. The engine coolant temperature reading is not changing with engine operating conditions.	The ECM will estimate engine coolant temperature.
342	Electronic calibration code incompatibilty - Out of calibration. An incompatible calibration has been detected in the ECM.	Possible no noticeable performance effects, engine dying, or hard starting.
343	Engine control module warning internal hardware failure - Bad intelligent device or component. Internal ECM failure.	No perfomance effects or possible severe power derate.
351	Injector power supply - Bad intelligent device or component. The ECM measured injector boost voltage is low.	Possible smoke, low power, engine misfire, and/or engine will not start.
352	Sensor supply 1 circuit - Voltage below normal, or shorted to low source. Low voltage detected at sensor supply number 1 circuit.	Engine power derate.
386	Sensor supply 1 circuit - Voltage above normal, or shorted to high source. High voltage detected at sensor supply number 1 circuit.	Engine power derate.
415	Engine oil rifle pressure - Data valid but below normal operational range - Most severe level. Oil pressure signal indicates oil pressure below the engine protection critical limit.	Progressive power derate increasing in severity from time of alert. If engine protection shutdown feature is enabled, engine will shut down 30 seconds after red stop lamp starts flashing.
418	Water in fuel indicator - Data valid but above normal operational range - Least severe level. water has been detected in the fuel filter.	Possible white smoke, loss of power, or hard starting.
428	Water in fuel indicator sensor circuit - Voltage above normal, or shorted to high source. High voltage detected at the water in fuel circuit.	None on performance. No water in fuel warning available.
429	Water in fuel indicator sensor circuit - Voltage below normal, or shorted to low source. Low voltage detected at the water in fuel circuit.	None on performance. No water in fuel warning available.
431	Accelerator pedal or lever idle validation switch - Data erratic, intermittent, or incorrect. Voltage detected simultaneously on both idle validation and off-idle validation switches.	Engine will only idle.
432	Accelerator pedal or lever idle validation circuit - Out of calibration. Voltage at idle validation on-idle and off-idle circuit does not match accelerator pedal position.	Engine will only idle.
435	Engine oil rifle pressure - Data erratic, intermittent, or incorrect. An error in the engine oil pressure switch signal was detected by the ECM.	None on performance. No engine protection for oil pressure.

Fault code No.	Reason	Effect (only when fault code is active)
441	Battery 1 voltage - Data valid but below normal operational range - Moderately severe level. ECM supply voltage is below the minimum system voltage level.	Engine may stop running or be difficult to start.
442	Battery 1 Voltage - Data valid but above normal operational range - Moderately severe level. ECM supply voltage is above the maximum system voltage level.	Possible electrical damage to all electrical components.
449	Injector metering rail 1 pressure - Data valid but above normal operational range - Most severe level.	None or possible engine noise associated with higher injection pressures (especially at idle or light load). Engine power is reduced.
451	Injector metering rail 1 pressure sensor circuit - Voltage above normal, or shorted to high source. High signal voltage detected at the rail fuel pressure sensor circuit.	Power and or speed derate.
452	Injector metering rail 1 pressure sensor circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at the rail fuel pressure sensor circuit.	Power and or speed derate.
488	Intake manifold 1 temperature - Data valid but above normal operational range - Moderately severe level. Intake manifold air temperature signal indicates intake manifold air temperature is above the engine protection warning limit.	Progressive power derate increasing in severity from time of alert.
497	Multiple unit synchronization switch - Data erratic, intermittent, or incorrect.	
523	Auxiliary intermediate (PTO) speed switch validation - Data erratic, intermittent, or incorrect.	None on performance.
527	Auxiliary input/output 2 circuit - Voltage above normal, or shorted to high source. High signal voltage or open circuit has been detected at the auxiliary input/output 2 circuit.	None on performance.
528	Auxiliary alternate torque validation switch - Data erratic, intermittent, or incorrect.	None on performance.
529	Auxiliary input/output 3 circuit - Voltage above normal, or shorted to high source. Low signal voltage has been detected at the auxiliary input/output 2 circuit.	
553	Injector metering rail 1 pressure - Data valid but above normal operational range - Moderately severe level. The ECM has detected that fuel pressure is higher than commanded pressure.	The ECM will estimate fuel pressure and power is reduced.
554	Injector metering rail 1 pressure - Data erratic, Intermittent, or incorrect. The ECM has detected that the fuel pressure signal is not changing.	Possibly hard to start, low power, or engine smoke.
559	Injector metering rail 1 pressure - Data Valid but Below Normal Operational Range - Moderately Severe Level. The ECM has detected that fuel pressure is lower than commanded pressure.	Either the engine will not start or the engine will not have starter lockout protection.
584	Starter relay driver circuit - Voltage above normal, or shorted to high source. Open circuit or high voltage detected at starter lockout circuit.	The engine will not have starter lockout protection.

Fault code No.	Reason	Effect (only when fault code is active)
585	Starter relay driver circuit - Voltage below normal, or shorted to low source. Low voltage detected at starter lockout circuit.	Engine power derate. The ECM uses an estimated turbocharger speed.
595	Turbocharger 1 speed - Data valid but above normal operational range - Moderately severe level. High turbocharger speed has been detected.	Amber lamp will light until high battery voltage condition is corrected.
599	Auxiliary commanded dual output shutdown - Special instructions.	None or possible engine noise associated with higher injection pressures (especially at idle or light load). Engine power is reduced.
687	Turbocharger 1 speed - Data valid but below normal operational range - Moderately severe level. Low turbocharger speed detected by the ECM.	Engine can run rough. Possibly poor starting capability. Engine runs using backup speed sensor. Engine power is reduced.
689	Engine crankshaft speed/position - Data erratic, intermittent, or incorrect. Loss of signal from crankshaft sensor.	Engine power derate.
691	Turbocharger 1 compressor inlet temperature circuit - Voltage above normal, or shorted to high source. High signal voltage detected at turbocharger compressor inlet air temperature circuit.	Engine power derate.
692	Turbocharger 1 compressor inlet temperature circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at turbocharger compressor inlet air tempera	Engine will run derated. Excessive black smoke, hard start, and rough idle possible.
731	Engine speed / position camshaft and crankshaft misalignment - Mechanical system not responding properly or out of adjustment. mechanical misalignment between the crankshaft and camshaft engine speed sensors.	Possible no noticeable performance effects, engine dying, or hard starting.
757	Electronic control module data lost - Condition exists. Severe loss of data from the ECM.	Possible poor starting. Engine power derate.
778	Engine camshaft speed / position sensor - Data erratic, intermittent, or incorrect. The ECM has detected an error in the camshaft position sensor signal.	Possible engine power derate.
779	Auxiliary equipment sensor input 3 - Root cause not known.	Possible no noticeable performance effects or engine dying or hard starting. Fault information, trip information, and maintenance monitor data may be inaccurate.
1117	Power supply lost with ignition on - Data erratic, intermittent, or incorrect. Supply voltage to the ECM fell below 6.2 volts momentarily, or the ECM was not allowed to power down correctly (retain battery voltage for 30 seconds after key OFF).	Engine will shut down.
1633	OEM datalink cannot transmit - Data erratic, intermittent, or incorrect. Communications within the OEM datalink network is intermittent.	Engine will only idle.
2185	Sensor supply 4 circuit - Voltage sbove normal, or shorted to high source. High voltage detected at +5 volt sensor supply circuit to the accelerator pedal position sensor.	Engine will only idle.

Fault code No.	Reason	Effect (only when fault code is active)
2186	Sensor supply 4 circuit - Voltage below normal, or shorted to low source. Low voltage detected at +5 volt sensor supply circuit to the accelerator pedal position sensor.	Possibly hard to start, low power, or engine smoke.
2249	Injector metering rail 1 pressure - Data valid but below normal operational range - Most severe level. The ECM has detected that fuel pressure is lower than commanded pressure.	Engine may be difficult to start.
2265	Electric lift pump for engine fuel supply circuit - Voltage above normal, or shorted to high source. High voltage or open detected at the fuel lift pump signal circuit.	Engine may be difficult to start.
2266	Electric lift pump for engine fuel supply circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at the fuel lift pump circuit.	Possible low power.
2311	Electronic fuel injection control valve circuit - Condition exists. Fuel pump actuator circuit resistance too high or too low.	Engine may exhibit misfire as control switches from the primary to the backup speed sensor. Engine power is reduced while the engine operates on the backup speed sensor.
2321	Engine crankshaft speed/position - Data erratic, intermittent, or incorrect. crankshaft engine speed sensor intermittent synchronization.	Possible low power.
2322	Engine camshaft speed / position sensor - Data erratic, intermittent, or incorrect. Camshaft engine speed sensor intermittent synchronization.	Engine power derate.
2345	Turbocharger 1 Speed - Abnormal rate of change. The turbocharger speed sensor has detected an erroneous speed value.	Engine power derate.
2346	Turbocharger turbine inlet temperature (Calculated) - Data valid but above normal operational range - Least severe level. Turbocharger turbine inlet temperature has exceeded the engine protection limit.	Engine power derate.
2347	Turbocharger compressor outlet temperature (Calculated) - Data valid but above normal operational range - Least severe level.	Engine brake on cylinders 1, 2, and 3 can not be activated or exhaust brake will not operate.
2377	Fan control circuit - Voltage above normal, or shorted to high source. Open circuit or high voltage detected at the fan control circuit.	Variable geometry turbocharger will go to the open position.
2384	VGT actuator driver circuit - Voltage below normal, or shorted to low source. Low voltage detected at turbocharger control valve circuit.	Variable geometry turbocharger may be in either the open or closed position.
2385	VGT actuator driver circuit - Voltage above normal, or shorted to high source. Open circuit or high voltage detected at turbocharger control valve circuit.	The intake air heaters may be ON or OFF all the time.
2555	Intake air heater 1 circuit - Voltage above normal, or shorted to high source. High voltage detected at the intake air heater signal circuit.	The intake air heaters may be ON or OFF all the time.
2556	Intake air heater 1 circuit - Voltage below normal, or shorted to low source. Low voltage detected at the intake air heater signal circuit.	Can not control transmission.
2557	Auxiliary PWM driver 1 circuit - Voltage above normal, or shorted to high source. High signal voltage detected at the analog torque circuit.	Can not control transmission.

Fault code No.	Reason	Effect (only when fault code is active)
2558	Auxiliary PWM driver 1 circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at the analog torque circuit.	Power derate and possible engine shutdown if engine protection shutdown feature is enabled.
2973	Intake manifold 1 pressure - Data erratic, intermittent, or incorrect. The ECM has detected an intake manifold pressure signal that is too high or low for current engine operating conditions.	

(7) DEFINITION OF OPERATING MODES

① Normal

There's no failure detected in the transmission system or the failure has no or slight effects on transmission control. TCU will work without or in special cases with little limitations.(See following table)

② Substitute clutch control

TCU can't change the gears or the direction under the control of the normal clutch modulation.

TCU uses the substitute strategy for clutch control. All modulations are only time controlled. (Comparable with EST 25)

③ Limp-home

The detected failure in the system has strong limitations to transmission control. TCU can engage only one gear in each direction. In some cases only one direction will be possible.

TCU will shift the transmission into neutral at the first occurrence of the failure. First, the operator must shift the gear selector into neutral position.

If output speed is less than a threshold for neutral to gear and the operator shifts the gear selector into forward or reverse, the TCU will select the limp-home gear.

If output speed is less than a threshold for reversal speed and TCU has changed into the limp-home gear and the operator selects a shuttle shift, TCU will shift immediately into the limp-home gear of the selected direction.

If output speed is greater than the threshold, TCU will shift the transmission into neutral. The operator has to slow down the vehicle and must shift the gear selector into neutral position.

④ Transmission-shutdown

TCU has detected a severe failure that disables control of the transmission.

TCU will shut off the solenoid valves for the clutches and also the common power supply(VPS1).

Transmission shifts to neutral. The park brake will operate normally, also the other functions which use ADM1 to ADM8.

The operator has to slow down the vehicle. The transmission will stay in neutral.

⑤ TCU-shutdown

TCU has detected a severe failure that disables control of system.

TCU will shut off all solenoid valves and also both common power supplies(VPS1, VPS2). The park brake will engage, also functions are disabled which use ADM 1 to ADM 8.

The transmission will stay in neutral.

※ Abbreviations

OC : Open circuit
SC : Short circuit
OP mode : Operating mode
TCU : Transmission control unit
EEC : Electronic engine controller
PTO : Power take off

(8) Transmission fault codes

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair	Remarks
11	**Logical error at gear range signal** TCU detected a wrong signal combination for the gear range • Cable from shift lever to TCU is broken • Cable is defective and is contacted to battery voltage or vehicle ground • Shift lever is defective	TCU shifts transmission to neutral OP-mode : Transmission shutdown	• Check the cables from TCU to shift lever • Check signal combinations of shift lever positions for gear range	Failure cannot be detected in systems with DW2/DW3 shift lever Fault is taken back if TCU detects a valid signal for the position
12	**Logical error at direction select signal** TCU detected a wrong signal combination for the direction • Cable from shift lever to TCU is broken • Cable is defective and is contacted to battery voltage or vehicle ground • Shift lever is defective	TCU shifts transmission to neutral OP-Mode : Transmission shutdown	• Check the cables from TCU to shift lever • Check signal combinations of shift lever positions F-N-R	Fault is taken back if TCU detects a valid signal for the direction at the shift lever
13	**Logical error at engine derating device** TCU detected no reaction of engine while derating device active	After selecting neutral, TCU change to OP mode limp home	• Check engine derating device	This fault is reset after power up of TCU
15	**Logical error at direction select signal 2 shift lever** TCU detected a wrong signal combination for the direction • Cable from shift lever 2 to TCU is broken • Cable is defective and is contacted to battery voltage or vehicle ground • Shift lever is defective	TCU shifts transmission to neutral if selector active OP mode : Transmission shutdown if selector active	• Check the cables from TCU to shift lever 2 • Check signal combinations of shift lever positions F-N-R	Fault is taken back if TCU detects a valid neutral signal for the direction at the shift lever
16	**Logical error at axle connection** Feedback axle connection measured by TCU and output signal axle connection don't fit • Axle can't be connected or disconnected due to mechanical problem • One of the cables from feedback axle connection switch to TCU is broken	OP mode : Normal	• Check the cables from TCU to feedback axle connection switch • Check signals of the feedback axle connection switch	

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair	Remarks
21	**S.C. to battery voltage at clutch cut off input** The measured voltage is too high: • Cable is defective and is contacted to battery voltage • Clutch cut off sensor has an internal defect • Connector pin is contacted to battery voltage	Clutch cut off function is disabled OP mode : Normal	• Check the cable from TCU to the sensor • Check the connectors • Check the clutch cut off sensor	
22	**S.C. to ground or O.C. at clutch cut off input** The measured voltage is too low: • Cable is defective and is contacted to vehicle ground • Cable has no connection to TCU • Clutch cut off sensor has an internal defect • Connector pin is contacted to vehicle ground or is broken	Clutch cut off function is disabled OP mode : Normal	• Check the cable from TCU to the sensor • Check the connectors • Check the clutch cut off sensor	
23	**S.C. to battery voltage at load sensor input** The measured voltage is too high: • Cable is defective and is contacted to battery voltage • Load sensor has an internal defect • Connector pin is contacted to battery voltage	Retarder function is affected TCU uses default load OP mode : Normal	• Check the cable from TCU to the sensor • Check the connectors • Check the load sensor • Check the assembly tolerances of load sensor	Availability of retarder depends on default load
24	**S.C. to ground or O.C. at load sensor input** The measured voltage is too low: • Cable is defective and is contacted to vehicle ground • Cable has no connection to TCU • Load sensor has as internal defect • Connector pin is contacted to vehicle ground or is broken	Retarder function is affected TCU use default load OP mode : Normal	• Check the cable from TCU to the sensor • Check the connectors • Check the load sensor • Check the assembly tolerances of load sensor	Availability of retarder depends on default load

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair	Remarks
25	**S.C. to battery voltage or O.C. at transmission sump temperature sensor input** The measured voltage is too high: • Cable is defective and is contacted to battery voltage • Cable has no connection to TCU • Temperature sensor has an internal defect • Connector pin is contacted to battery voltage or is broken	No reaction, TCU use default temperature OP mode : Normal	• Check the cable from TCU to the sensor • Check the connectors • Check the temperature sensor	
26	**S.C. to battery voltage or O.C. at transmission sump temperature sensor input** The measured voltage is too low: • Cable is defective and is contacted to vehicle ground • Temperature sensor has an internal defect • Connector pin is contacted to vehicle ground	No reaction, TCU uses default temperature OP mode : Normal	• Check the cable from TCU to the sensor • Check the connectors • Check the temperature sensor	
27	**S.C. to battery voltage or O.C. at retarder temperature sensor input** The measured voltage is too high: • Cable is defective and is contacted to battery voltage • Cable has no connection to TCU • Temperature sensor has an internal defect • Connector pin is contacted to battery voltage or is broken	No reaction, TCU uses default temperature OP mode : Normal	• Check the cable from TCU to the sensor • Check the connectors • Check the temperature sensor	
28	**S.C. to ground at retarder temperature sensor input** The measured voltage is too low: • Cable is defective and is contacted to vehicle ground • Temperature sensor has an internal defect • Connector pin is contacted to vehicle ground	No reaction, TCU uses default temperature OP mode : Normal	• Check the cable from TCU to the sensor • Check the connectors • Check the temperature sensor	

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair	Remarks
27	**S.C. to battery voltage or O.C. at converter output temperature sensor input** The measured voltage is too high: • Cable is defective and is contacted to battery voltage • Cable has no connection to TCU • Temperature sensor has an internal defect • Connector pin is contacted to battery voltage or is broken	No reaction, TCU uses default temperature OP mode : Normal	• Check the cable from TCU to the sensor • Check the connectors • Check the temperature sensor	
28	**S.C. to ground at converter output temperature sensor input** The measured voltage is too low: • Cable is defective and is contacted to vehicle ground • Temperature sensor has an internal defect • Connector pin is contacted to vehicle ground	No reaction, TCU uses default temperature OP mode : Normal	• Check the cable from TCU to the sensor • Check the connectors • Check the temperature sensor	
31	**S.C. to battery voltage or O.C. at engine speed input** TCU measures a voltage higher than 7.00V at speed input pin • Cable is defective and is contacted to battery voltage • Cable has no connection to TCU • Speed sensor has an internal defect • Connector pin is contacted to battery voltage or has no contact	OP mode : Substitute clutch control	• Check the cable from TCU to the sensor • Check the connectors • Check the speed sensor	
32	**S.C. to ground at engine speed input** TCU measures a voltage less than 0.45V at speed input pin • Cable/connector is defective and is contacted to vehicle ground • Speed sensor has an internal defect	OP mode : Substitute clutch control	• Check the cable from TCU to the sensor • Check the connectors • Check the speed sensor	

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair	Remarks
33	**Logical error at engine speed input** TCU measures a engine speed over a threshold and the next moment the measured speed is zero • Cable/connector is defective and has bad contact • Speed sensor has an internal defect • Sensor gap has the wrong size	OP mode : Substitute clutch control	• Check the cable from TCU to the sensor • Check the connectors • Check the speed sensor • Check the sensor gap	This fault is reset after power up of TCU
34	**S.C. to battery voltage or O.C. at turbine speed input** TCU measures a voltage higher than 7.00V at speed input pin • Cable is defective and is contacted to vehicle battery voltage • Cable has no connection to TCU • Speed sensor has an internal defect • Connector pin is contacted to battery voltage or has no contact	OP mode : Substitute clutch control If a failure is existing at output speed, TCU shifts to neutral OP mode : Limp home	• Check the cable from TCU to the sensor • Check the connectors • Check the speed sensor	
35	**S.C. to ground at turbine speed input** TCU measures a voltage less than 0.45V at speed input pin • Cable/connector is defective and is contacted to vehicle ground • Speed sensor has an internal defect	OP mode : Substitute clutch control If a failure is existing at output speed, TCU shifts to neutral OP mode : Limp home	• Check the cable from TCU to the sensor • Check the connectors • Check the speed sensor	This fault is reset after power up of TCU
36	**Logical error at turbine speed input** TCU measures a turbine speed over a threshold and at the next moment the measured speed is zero • Cable/connector is defective and has bad contact • Speed sensor has an internal defect • Sensor gap has the wrong size	OP mode : Substitute clutch control If a failure is existing at output speed, TCU shifts to neutral OP mode : Limp home	• Check the cable from TCU to the sensor • Check the connectors • Check the speed sensor • Check the sensor gap	

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair	Remarks
37	**S.C. to battery voltage or O.C. at internal speed input** TCU measures a voltage higher than 7.00V at speed input pin • Cable is defective and is contacted to vehicle battery voltage • Cable has no connection to TCU • Speed sensor has an internal defect • Connector pin is contacted to battery voltage or has no contact	OP mode : Substitute clutch control	• Check the cable from TCU to the sensor • Check the connectors • Check the speed sensor	
38	**S.C. to ground at turbine speed input** TCU measures a voltage less than 0.45V at speed input pin • Cable/connector is defective and is contacted to vehicle ground • Speed sensor has an internal defect	OP mode : Substitute clutch control	• Check the cable from TCU to the sensor • Check the connectors • Check the speed sensor	
39	**Logical error at internal speed input** TCU measures a internal speed over a threshold and at the next moment the measured speed is zero • Cable/connector is defective and has bad contact • Speed sensor has an internal defect • Sensor gap has the wrong size	OP mode : Substitute clutch control	• Check the cable from TCU to the sensor • Check the connectors • Check the speed sensor • Check the sensor gap	This fault is reset after power up of TCU
3A	**S.C. to battery voltage or O.C. at output speed input** TCU measures a voltage higher than 12.5V at speed input pin • Cable is defective and is contacted to battery voltage • Cable has no connection to TCU • Speed sensor has an internal defect • Connector pin is contacted to battery voltage or has no contact	Special mode for gear selection OP mode : Substitute clutch control If a failure is existing at turbine speed, TCU shifts to neutral OP mode : lamp home	• Check the cable from TCU to the sensor • Check the connectors • Check the speed sensor	

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair	Remarks
3B	**S.C. to ground at output speed input** TCU measures a voltage less than 1.00V at speed input pin • Cable/connector is defective and is contacted to vehicle ground • Speed sensor has an internal defect	Special mode for gear selection OP mode : Substitute clutch control If a failure is existing at turbine speed, TCU shifts to neutral OP mode : lamp home	• Check the cable from TCU to the sensor • Check the connectors • Check the speed sensor	
3C	**Logical error at output speed input** TCU measures a turbine speed over a threshold and at the next moment the measured speed is zero • Cable/connector is defective and has bad contact • Speed sensor has an internal defect • Sensor gap has the wrong size	Special mode for gear selection OP mode : Substitute clutch control If a failure is existing at turbine speed, TCU shifts to neutral OP mode : lamp home	• Check the cable from TCU to the sensor • Check the connectors • Check the speed sensor • Check the sensor gap	This fault is reset after power up of TCU
3D	**Turbine speed zero doesn't fit to other speed signals**	-	-	Not used
3E	**Output speed zero doesn't fit to other speed signals** If transmission is not neutral and the shifting has finished, TCU measures output speed zero and turbine speed or internal speed not equal to zero. • Speed sensor has an internal defect • Sensor gap has the wrong size	Special mode for gear selection OP mode : Substitute clutch control If a failure is existing at turbine speed, TCU shifts to neutral OP mode : lamp home	• Check the sensor signal of output speed sensor • Check the sensor gap of output speed sensor • Check the cable from TCU to the sensor	This fault is reset after power up of TCU

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair	Remarks
71	**S.C. to battery voltage at clutch K1** The measured resistance value of the valve is out of limit, the voltage at K1 valve is too high • Cable/connector is defective and has contact to battery voltage • Cable/connector is defective and has contact to another regulator output of the TCU • Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	• Check the cable from TCU to the gearbox • Check the connectors from TCU to the gearbox • Check the regulator resistance* • Check internal wire harness of the gearbox	* See Chapter (9)
72	**S.C. to ground at clutch K1** The measured resistance value of the valve is out of limit, the voltage at K1 valve is too low • Cable/connector is defective and has contact to vehicle ground • Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	• Check the cable from TCU to the gearbox • Check the connectors from gearbox to TCU • Check the regulator resistance* • Check internal wire harness of the gearbox	* See Chapter (9)
73	**O.C. at clutch K1** The measured resistance value of the valve is out of limit • Cable/connector is defective and has no contact to TCU • Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	• Check the cable from TCU to the gearbox • Check the connectors from gearbox to TCU • Check the regulator resistance* • Check internal wire harness of the gearbox	* See Chapter (9)
74	**S.C. to battery voltage at clutch K2** The measured resistance value of the valve is out of limit, the voltage at K2 valve is too high • Cable/connector is defective and has contact to battery voltage • Cable/connector is defective and has contact to another regulator output of the TCU • Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	• Check the cable from TCU to the gearbox • Check the connectors from gearbox to TCU • Check the regulator resistance* • Check internal wire harness of the gearbox	* See Chapter (9)

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair	Remarks
75	**S.C. to ground at clutch K2** The measured resistance value of the valve is out of limit, the voltage at K2 valve is too low • Cable/connector is defective and has contact to vehicle ground • Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	• Check the cable from TCU to the gearbox • Check the connectors from gearbox to TCU • Check the regulator resistance* • Check internal wire harness of the gearbox	* See Chapter (9)
76	**O.C. at clutch K2** The measured resistance value of the valve is out of limit • Cable/connector is defective and has no contact to TCU • Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	• Check the cable from TCU to the gearbox • Check the connectors from gearbox to TCU • Check the regulator resistance* • Check internal wire harness of the gearbox	* See Chapter (9)
77	**S.C. to battery voltage at clutch K3** The measured resistance value of the valve is out of limit, the voltage at K3 valve is too high • Cable/connector is defective and has contact to battery voltage • Cable/connector is defective and has contact to another regulator output of the TCU • Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	• Check the cable from TCU to the gearbox • Check the connectors from gearbox to TCU • Check the regulator resistance* • Check internal wire harness of the gearbox	* See Chapter (9)
78	**S.C. to ground at clutch K3** The measured resistance value of the valve is out of limit, the voltage at K3 valve is too low • Cable/connector is defective and has contact to vehicle ground • Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	• Check the cable from TCU to the gearbox • Check the connectors from gearbox to TCU • Check the regulator resistance* • Check internal wire harness of the gearbox	* See Chapter (9)

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair	Remarks
79	**O.C. at clutch K2** The measured resistance value of the valve is out of limit • Cable/connector is defective and has no contact to TCU • Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	• Check the cable from TCU to the gearbox • Check the connectors from gearbox to TCU • Check the regulator resistance* • Check internal wire harness of the gearbox	* See Chapter (9)
7A	**S.C. to battery voltage at converter clutch**	-	-	
7B	**S.C. to ground at converter clutch**	-	-	
7C	**O.C. at converter clutch**	-	-	Not used
7D	**S.C. ground at engine derating device** • Cable is defective and is contacted to vehicle ground • Engine derating device has an internal defect • Connector pin is contacted to vehicle ground	Engine derating will be on until TCU power down even if fault vanishes(Loose connection) OP mode : Normal	• Check the cable from TCU to the engine derating device • Check the connectors from engine derating device to TCU • Check the resistance* of engine derating device	Not used Not used * See Chapter (9)
7E	**S.C. battery voltage at engine derating device** • Cable/connector is defective and is contacted to battery voltage • Engine derating device has an internal defect	No reaction OP mode : Normal	• Check the cable from TCU to the engine derating device • Check the connectors from backup alarm device to TCU • Check the resistance* of backup alarm device	* See Chapter (9)
7F	**O.C. at engine derating device** TCU detected a wrong voltage at the output pin, that looks like a O.C. for this output pin • Cable is defective and has no connection to TCU • Engine derating device has an internal defect • Connector has no connection to TCU	No reaction OP mode : Normal	• Check the cable from TCU to the engine derating device • Check the connectors from engine derating device to TCU • Check the resistance* of engine derating device	* See Chapter (9)

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair	Remarks
81	**S.C. to battery voltage at clutch K4** The measured resistance value of the valve is out of limit, the voltage at K4 valve is too high • Cable/connector is defective and has contact to battery voltage • Cable/connector is defective and has contact to another regulator output of the TCU • Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	• Check the cable from TCU to the gearbox • Check the connectors from gearbox to TCU • Check the regulator resistance* • Check internal wire harness of the gearbox	* See Chapter (9)
82	**S.C. to ground at clutch K4** The measured resistance value of the valve is out of limit, the voltage at K4 valve is too low • Cable/connector is defective and has contact to vehicle ground • Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	• Check the cable from TCU to the engine derating device • Check the connectors from gearbox to TCU • Check the regulator resistance* • Check internal wire harness of the gearbox	* See Chapter (9)
83	**O.C. at clutch K4** The measured resistance value of the valve is out of limit • Cable/connector is defective and has contact to TCU • Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	• Check the cable from TCU to the gearbox • Check the connectors from gearbox to TCU • Check the regulator resistance* • Check internal wire harness of the gearbox	* See Chapter (9)
84	**S.C. to battery voltage at clutch K4** The measured resistance value of the valve is out of limit, the voltage at K4 valve is too high • Cable/connector is defective and has contact to battery voltage • Cable/connector is defective and has contact to another regulator output of the TCU • Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	• Check the cable from TCU to the gearbox • Check the connectors from gearbox to TCU • Check the regulator resistance* • Check internal wire harness of the gearbox	* See Chapter (9)

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair	Remarks
85	**S.C. to ground at clutch KV** The measured resistance value of the valve is out of limit, the voltage at K4 valve is too low • Cable/connector is defective and has contact to vehicle ground • Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	• Check the cable from TCU to the gearbox • Check the connectors from gearbox to TCU • Check the regulator resistance* • Check internal wire harness of the gearbox	* See Chapter (9)
86	**O.C. at clutch KV** The measured resistance value of the valve is out of limit • Cable/connector is defective and has contact to TCU • Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	• Check the cable from TCU to the gearbox • Check the connectors from gearbox to TCU • Check the regulator resistance* • Check internal wire harness of the gearbox	* See Chapter (9)
87	**S.C. to battery voltage at clutch KR** The measured resistance value of the valve is out of limit, the voltage at KR valve is too high • Cable/connector is defective and has contact to battery voltage • Cable/connector is defective and has contact to another regulator output of the TCU • Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	• Check the cable from TCU to the gearbox • Check the connectors from gearbox to TCU • Check the regulator resistance* • Check internal wire harness of the gearbox	* See Chapter (9)
88	**S.C. to ground at clutch KR** The measured resistance value of the valve is out of limit, the voltage at KR valve is too low • Cable/connector is defective and has contact to vehicle ground • Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	• Check the cable from TCU to the gearbox • Check the connectors from gearbox to TCU • Check the regulator resistance* • Check internal wire harness of the gearbox	* See Chapter (9)
89	**O.C. at clutch KR** The measured resistance value of the valve is out of limit • Cable/connector is defective and has no contact to TCU • Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	• Check the cable from TCU to the gearbox • Check the connectors from gearbox to TCU • Check the regulator resistance* • Check internal wire harness of the gearbox	* See Chapter (9)

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair	Remarks
91	**S.C. to ground at relay reverse warning alarm** TCU detected a wrong voltage at the output pin, that looks like a S.C. to vehicle ground • Cable is defective and is contact to vehicle ground • Backup alarm device has an internal defect • Connector pin is contacted to vehicle ground	Backup alarm will be on until TCU power down even if fault vanishes(Loose connection) OP mode : Normal	• Check the cable from TCU to the backup alarm device • Check the connectors from backup alarm device to TCU • Check the resistance* of backup alarm device	* See Chapter (9)
92	**S.C. to battery voltage at relay reverse warning alarm** TCU detected a wrong voltage at the output pin, that looks like a S.C. to battery voltage • Cable is defective and is contacted to battery voltage • Backup alarm device has an internal defect • Connector pin is contacted to battery voltage	No reaction OP mode : Normal	• Check the cable from TCU to the backup alarm device • Check the connectors from backup alarm device to TCU • Check the resistance* of backup alarm device	* See Chapter (9)
93	**O.C. at relay reverse warning alarm** TCU detected a wrong voltage at the output pin, that looks like a O.C. for this output pin • Cable is defective and has no connection to TCU • Backup alarm device has an internal defect • Connector has no connection to TCU	No reaction OP mode : Normal	• Check the cable from TCU to the backup alarm device • Check the connectors from backup alarm device to TCU • Check the resistance* of backup alarm device	* See Chapter (9)
94	**S.C. to ground at relay starter interlock** TCU detected a wrong voltage at the output pin, that looks like a S.C. to vehicle ground • Cable is defective and is connection to vehicle ground • Starter interlock relay has an internal defect • Connector pin is contacted to vehicle ground	No reaction OP mode : Normal	• Check the cable from TCU to the stater interlock relay • Check the connectors from starter interlock relay to TCU • Check the resistance* of starter interlock relay	* See Chapter (9)

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair	Remarks
95	**S.C. to battery voltage at relay starter interlock** TCU detected a wrong voltage at the output pin, that looks like a S.C. to battery voltage • Cable is defective and has no connection to battery voltage • Starter interlock relay has an internal defect • Connector pin is contacted to battery voltage	No reaction OP mode : Normal	• Check the cable from TCU to the starter interlock relay • Check the connectors from starter interlock relay to TCU • Check the resistance* of starter interlock relay	* See Chapter (9)
96	**O.C. at relay starter interlock** TCU detected a wrong voltage at the output pin, that looks like a O.C. for this output pin • Cable is defective and has no connection to TCU • Starter interlock relay has an internal defect • Connector has no connection to TCU	No reaction OP mode : Normal	• Check the cable from TCU to the starter interlock relay • Check the connectors from starter interlock relay to TCU • Check the resistance* of starter interlock relay	* See Chapter (9)
97	**S.C. to ground at park brake solenoid** TCU detected a wrong voltage at the output pin, that looks like a S.C. to vehicle ground • Cable is defective and is connection to vehicle ground • Park brake solenoid has an internal defect • Connector pin is contacted to vehicle ground	No reaction OP mode : Normal	• Check the cable from TCU to the park brake solenoid • Check the connectors from park brake solenoid to TCU • Check the resistance* of park brake solenoid	* See Chapter (9)
98	**S.C. to battery voltage at park brake solenoid** TCU detected a wrong voltage at the output pin, that looks like a S.C. to battery voltage • Cable is defective and is connection to battery voltage • Park brake solenoid has an internal defect • Connector pin is contacted to battery voltage	No reaction Optional : (Some customers) TCU shifts to neutral caused by park brake feed back OP mode : Normal	• Check the cable from TCU to the park brake solenoid • Check the connectors from park brake solenoid to TCU • Check the resistance* of park brake solenoid	* See Chapter (9)

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair	Remarks
99	**O.C. at park brake solenoid** TCU detected a wrong voltage at the output pin, that looks like a O.C. for this output pin • Cable is defective and has no connection to TCU • Park brake solenoid has an internal defect • Connector has no connection to TCU	No reaction Optional : Some customers TCU shifts to neutral caused by park brake feed back OP mode : Normal	• Check the cable from TCU to the park brake solenoid • Check the connectors from park brake solenoid to TCU • Check the resistance* of park brake solenoid	* See Chapter (9)
9A	**S.C. to ground at converter lock up clutch solenoid** TCU detected a wrong voltage at the output pin, that looks like a S.C. to vehicle ground • Cable is defective and is contacted to vehicle ground • Converter clutch solenoid has an internal defect • Connector pin is contacted to vehicle ground	No reaction OP mode : Normal	• Check the cable from TCU to the converter clutch solenoid • Check the connectors from converter clutch solenoid to TCU • Check the resistance* of park brake solenoid	* See Chapter (9)
9B	**O.C. at converter lock up clutch solenoid** TCU detected a wrong voltage at the output pin, that looks like a O.C. for this output pin • Cable is defective and has no connection to TCU • Converter clutch solenoid has an internal defect • Connector has no connection to TCU	Converter clutch always open, retarder not available OP mode : Normal	• Check the cable from TCU to the converter clutch solenoid • Check the connectors from converter clutch solenoid to TCU • Check the resistance* of park brake solenoid	* See Chapter (9)
9C	**S.C. to battery voltage at converter lock up clutch solenoid** TCU detected a wrong voltage at the output pin, that looks like a S.C. to battery voltage • Cable is defective and has no contacted to battery voltage • Converter clutch solenoid has an internal defect • Connector pin is contacted to battery voltage	No reaction OP mode : Normal	• Check the cable from TCU to the converter clutch solenoid • Check the connectors from converter clutch solenoid to TCU • Check the resistance* of converter clutch solenoid	* See Chapter (9)

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair	Remarks
9D	**S.C. to ground at retarder solenoid** TCU detected a wrong voltage at the output pin, that looks like a S.C. to vehicle ground • Cable is defective and is contacted to vehicle ground • Retarder solenoid has an internal defect • Connector pin is contacted to vehicle ground	No reaction OP mode : Normal	• Check the cable from TCU to the retarder solenoid • Check the connectors from retarder solenoid to TCU • Check the resistance* of retarder solenoid	* See Chapter (9)
9E	**O.C. at retarder solenoid** TCU detected a wrong voltage at the output pin, that looks like a O.C. for this output pin • Cable is defective and has no connection to TCU • Retarder solenoid has an internal defect • Connector has no connection to TCU	No reaction OP mode : Normal	• Check the cable from TCU to the retarder solenoid • Check the connectors from retarder solenoid to TCU • Check the resistance* of retarder solenoid	* See Chapter (9)
9F	**S.C. to battery voltage at retarder solenoid** TCU detected a wrong voltage at the output pin, that looks like a S.C. to battery voltage • Cable is defective and has no connection to battery voltage • Retarder solenoid has an internal defect • Connector pin is contacted to battery voltage	No reaction OP mode : Normal	• Check the cable from TCU to the retarder solenoid • Check the connectors from retarder solenoid to TCU • Check the resistance* of retarder solenoid	* See Chapter (9)

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair	Remarks
A1	**S.C. to ground at difflock or axle connection solenoid** TCU detected a wrong voltage at the output pin, that looks like a S.C. to vehicle ground • Cable is defective and is contacted to vehicle ground • Difflock solenoid has an internal defect • Connector pin is contacted to vehicle ground	No reaction OP mode : Normal	• Check the cable from TCU to the difflock solenoid • Check the connectors from difflock solenoid to TCU • Check the resistance* of difflock solenoid	* See Chapter (9)
A2	**S.C. to battery voltage at difflock or axle connection solenoid** TCU detected a wrong voltage at the output pin, that looks like a S.C. to battery voltage • Cable is defective and has no connection to battery voltage • Difflock solenoid has an internal defect • Connector pin is contacted to battery voltage	No reaction OP mode : Normal	• Check the cable from TCU to the difflock solenoid • Check the connectors from difflock solenoid to TCU • Check the resistance* of difflock solenoid	* See Chapter (9)
A3	**O.C. at difflock or axle connection solenoid** TCU detected a wrong voltage at the output pin, that looks like a O.C. for this output pin • Cable is defective and has no connection to TCU • Difflock solenoid has an internal defect • Connector has no connection to TCU	No reaction OP mode : Normal	• Check the cable from TCU to the difflock solenoid • Check the connectors from difflock solenoid to TCU • Check the resistance* of difflock solenoid	* See Chapter (9)
A4	**S.C. to ground at warning signal output** TCU detected a wrong voltage at the output pin, that looks like a S.C. to vehicle ground • Cable is defective and is contacted to vehicle ground • Warning device has an internal defect • Connector pin is contacted to vehicle ground	No reaction OP mode : Normal	• Check the cable from TCU to the warning device • Check the connectors from warning device to TCU • Check the resistance* of warning device	* See Chapter (9)

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair	Remarks
A5	**O.C. voltage at warning signal output** TCU detected a wrong voltage at the output pin, that looks like a O.C. for this output pin • Cable is defective and has no connection to TCU • Warning device has an internal defect • Connector has no connection to TCU	No reaction OP mode : Normal	• Check the cable from TCU to the warning device • Check the connectors from warning device to TCU • Check the resistance* of warning device	* See Chapter (9)
A6	**S.C. to battery voltage at warning signal output** TCU detected a wrong voltage at the output pin, that looks like a S.C. to battery voltage • Cable is defective and has is contacted to battery voltage • Warning device has an internal defect • Connector pin is contacted to battery voltage	No reaction OP mode : Normal	• Check the cable from TCU to the warning device • Check the connectors from warning device to TCU • Check the resistance* of warning device	* See Chapter (9)

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair	Remarks
B1	**Slippage at clutch K1** TCU calculates a differential speed at closed clutch K1. If this calculated value is out of range, TCU interprets this as slipping clutch • Low pressure at clutch K1 • Low main pressure • Wrong signal at internal speed sensor • Wrong signal at output speed sensor • Wrong size of the sensor gap • Clutch is defective	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	• Check pressure at clutch K1 • Check main pressure in the system • Check sensor gap at internal speed sensor • Check sensor gap at output speed sensor • Check signal at internal speed sensor • Check signal at output speed sensor • Replace clutch	
B2	**Slippage at clutch K2** TCU calculates a differential speed at closed clutch K2. If this calculated value is out of range, TCU interprets this as slipping clutch • Low pressure at clutch K2 • Low main pressure • Wrong signal at internal speed sensor • Wrong signal at output speed sensor • Wrong size of the sensor gap • Clutch is defective	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	• Check pressure at clutch K2 • Check main pressure in the system • Check sensor gap at internal speed sensor • Check sensor gap at output speed sensor • Check signal at internal speed sensor • Check signal at output speed sensor • Replace clutch	
B3	**Slippage at clutch K3** TCU calculates a differential speed at closed clutch K3. If this calculated value is out of range, TCU interprets this as slipping clutch • Low pressure at clutch K3 • Low main pressure • Wrong signal at internal speed sensor • Wrong signal at output speed sensor • Wrong size of the sensor gap • Clutch is defective	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	• Check pressure at clutch K3 • Check main pressure in the system • Check sensor gap at internal speed sensor • Check sensor gap at output speed sensor • Check signal at internal speed sensor • Check signal at output speed sensor • Replace clutch	

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair	Remarks
B4	**Slippage at clutch K4** TCU calculates a differential speed at closed clutch K4. If this calculated value is out of range, TCU interprets this as slipping clutch • Low pressure at clutch K4 • Low main pressure • Wrong signal at internal speed sensor • Wrong signal at turbine speed sensor • Wrong size of the sensor gap • Clutch is defective	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	• Check pressure at clutch K4 • Check main pressure in the system • Check sensor gap at internal speed sensor • Check sensor gap at turbine speed sensor • Check signal at internal speed sensor • Check signal at turbine speed sensor • Replace clutch	
B5	**Slippage at clutch KV** TCU calculates a differential speed at closed clutch KV. If this calculated value is out of range, TCU interprets this as slipping clutch • Low pressure at clutch KV • Low main pressure • Wrong signal at internal speed sensor • Wrong signal at turbine speed sensor • Wrong size of the sensor gap • Clutch is defective	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	• Check pressure at clutch KV • Check main pressure in the system • Check sensor gap at internal speed sensor • Check sensor gap at turbine speed sensor • Check signal at internal speed sensor • Check signal at turbine speed sensor • Replace clutch	
B6	**Slippage at clutch KR** TCU calculates a differential speed at closed clutch KR. If this calculated value is out of range, TCU interprets this as slipping clutch • Low pressure at clutch KR • Low main pressure • Wrong signal at internal speed sensor • Wrong signal at turbine speed sensor • Wrong size of the sensor gap • Clutch is defective	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	• Check pressure at clutch KR • Check main pressure in the system • Check sensor gap at internal speed sensor • Check sensor gap at turbine speed sensor • Check signal at internal speed sensor • Check signal at turbine speed sensor • Replace clutch	

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair	Remarks
B7	**Overtemp sump** TCU measured a temperature in the oil sump that is over the allowed threshold.	No reaction OP mode : Normal	• Cool down machine • Check oil level • Check temperature sensor	
B8	**Overtemp retarder** TCU measured a temperature in the retarder oil that is over the allowed threshold	TCU disables retarder OP mode : Normal	• Cool down machine • Check oil level • Check temperature sensor	
B9	**Overspend engine**	Retarder applies OP mode : Normal	-	
BA	**Differential pressure oil filter** TCU measured a voltage at differential pressure switch out of the allowed range • Oil filter is polluted • Cable/connector is broken or cable/ connector is contacted to battery voltage or vehicle ground • Differential pressure switch is defective	No reaction OP mode : Normal	• Check oil filter • Check wiring from TCU to differential pressure switch • Check differential pressure switch(Measure resistance)	
BB	**Slippage at converter lockup clutch** TCU calculates a differential speed at closed converter lockup clutch. If this calculated value is out of range, TCU interprets this as slipping clutch • Low pressure at converter lockup clutch • Low main pressure • Wrong signal at engine speed sensor • Wrong signal at turbine speed sensor • Wrong size of the sensor gap • Clutch is defective		• Check pressure at converter lockup clutch • Check main pressure in the system • Check sensor gap at engine speed sensor • Check sensor gap at turbine speed sensor • Check signal at engine speed sensor • Check signal at turbine speed sensor • Replace clutch	

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair	Remarks
BD	**S.C. to ground at engine brake solenoid** TCU detected a wrong voltage at the output pin, that looks like a S.C. to vehicle ground • Cable is defective and is contacted to vehicle ground • Engine brake solenoid has an internal defect • Connector pin is contacted to vehicle ground	No reaction OP mode : Normal	• Check the cable from TCU to engine brake solenoid • Check the connectors from engine brake solenoid to TCU • Check the resistance* of engine brake solenoid	* See Chapter (9)
BE	**S.C. to battery voltage at engine brake** TCU detected a wrong voltage at the output pin, that looks like a S.C. to battery voltage • Cable is defective and is contacted to battery voltage • Engine brake solenoid has an internal defect • Connector pin is contacted to battery voltage	No reaction OP mode : Normal	• Check the cable from TCU to the engine brake solenoid • Check the connectors from engine brake solenoid to TCU • Check the resistance* of engine brake solenoid	* See Chapter (9)
BF	**O.C. at engine brake** TCU detected a wrong voltage at the output pin, that looks like a O.C. for this output pin • Cable is defective and has no connection to TCU • Engine brake solenoid has an internal defect • Connector has no connection to TCU	No reaction OP mode : Normal	• Check the cable from TCU to the engine brake solenoid • Check the connectors from engine brake solenoid to TCU • Check the resistance* of engine brake solenoid	* See Chapter (9)

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair	Remarks
C3	**Overtemp converter output** TCU measured a oil temperature at the converter output that is the allowed threshold	No reaction OP mode : Normal	• Cool down machine • Check oil level • Check temperature sensor	
C4	**S.C. to ground at joystick status indicator** TCU detected a wrong voltage at the output pin, that looks like a S.C. to vehicle ground • Cable is defective and is contacted to vehicle ground • Joystick status indicator has an internal defect • Connector pin is contacted to vehicle ground	No reaction OP mode : Normal	• Check the cable from TCU to joystick status indicator • Check the connectors from joystick status indicator to TCU • Check the resistance* of joystick status indicator	*See chapter (9)
C5	**S.C. to battery voltage at joystick status indicator** TCU detected a wrong voltage at the output pin, that looks like a S.C. to battery voltage • Cable is defective and is contacted to battery voltage • Joystick status indicator has an internal defect • Connector pin is contacted to battery voltage	No reaction OP mode : Normal	• Check the cable from TCU to joystick status indicator • Check the connectors from joystick status indicator to TCU • Check the resistance* of joystick status indicator	*See chapter (9)
C6	**O.C. at joystick status indicator** TCU detected a wrong voltage at the output pin, that looks like a O.C. for this output pin • Cable is defective and has no connection to TCU • Joystick status indicator has an internal defect • Connector pin has no connection to TCU	No reaction OP mode : Normal	• Check the cable from TCU to joystick status indicator • Check the connectors from joystick status indicator to TCU • Check the resistance* of joystick status indicator	*See chapter (9)

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair	Remarks
D1	**S.C. to battery voltage at power supply for sensors** TCU measures more than 6V at the pin AU1 (5V sensor supply)	See fault codes No.21 to 2C	• Check cables and connectors to sensors, which are supplied from AU1 • Check the power supply at the pin AU1(Should be appx. 5V)	Fault codes No.21 to No.2C may be reaction of this fault
D2	**S.C. to ground at power supply for sensors** TCU measures less than 4V at the pin AU1 (5V sensor supply)	See fault codes No.21 to 2C	• Check cables and connectors to sensors, which are supplied from AU1 • Check the power supply at the pin AU1(Should be appx. 5V)	Fault codes No.21 to No.2C may be reaction of this fault
D3	**Low voltage at battery** Measured voltage at power supply is lower than 18V(24V device)	Shift to neutral OP mode : TCU shutdown	• Check power supply battery • Check cables from batteries to TCU • Check connectors from batteries to TCU	
D4	**High voltage at battery** Measured voltage at power supply is higher than 32.5V(24V device)	Shift to neutral OP mode : TCU shutdown	• Check power supply battery • Check cables from batteries to TCU • Check connectors from batteries to TCU	
D5	**Error at valve power supply VPS1** TCU switched on VPS1 and measured VPS1 is off or TCU switched off VPS1 and measured VPS1 is still on • Cable or connectors are defect and are contacted to battery voltage • Cable or connectors are defect and are contacted to vehicle ground • Permanent power supply KL30 missing • TCU has an internal defect	Shift to neutral OP mode : TCU shutdown	• Check fuse • Check cables from gearbox to TCU • Check connectors from gearbox to TCU • Replace TCU	

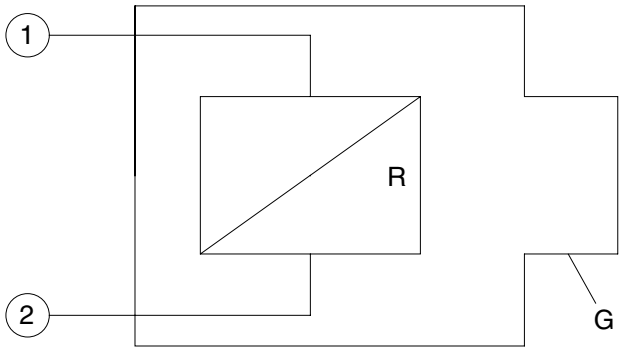
Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair	Remarks
D6	**Error at valve power supply VPS2** TCU switched on VPS2 and measured VPS2 is off or TCU switched off VPS2 and measured VPS2 is still on • Cable or connectors are defect and are contacted to battery voltage • Cable or connectors are defect and are contacted to vehicle ground • Permanent power supply KL30 missing • TCU has an internal defect	Shift to neutral OP mode : TCU shutdown	• Check fuse • Check cables from gearbox to TCU • Check connectors from gearbox to TCU • Replace TCU	

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair	Remarks
E1	**S.C. battery voltage at speedometer output**	-	-	Not used
E2	**S.C. to ground or O.C at speedometer output**	-	-	Not used
E3	**S.C. to battery voltage at display output** TCU sends data to the display and measures always a high voltage level on the connector • Cable or connectors are defective and are contacted to battery voltage • Display has an internal defect	No reaction OP mode : Normal	• Check the cable from TCU to the display • Check the connectors at the display • Change display	
E4	**S.C. to ground at display output** TCU sends data to the display and measures always a high voltage level on the connector • Cable or connectors are defective and are contacted to battery voltage • Display has an internal defect	No reaction OP mode : Normal	• Check the cable from TCU to the display • Check the connectors at the display • Change display	
E5	**Communication failure on DeviceNet**	Shift to neutral OP mode : TCU shutdown	• Check Omron master • Check wire of DeviceNet-Bus • Check cable to Omron master	
E5	**DISPID1 timeout** Timeout of CAN-massage DISPID1 from display controller • Interference on CAN-Bus • CAN wire/connector is defective • Can wire/connector is defective and has contact to vehicle ground or battery voltage	TCU select parameter set with ID0 OP mode : Limp home	• Check display controller • Check wire of CAN-Bus • Check cable display controller	

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair	Remarks
F1	**General EEPROM fault** TCU can't read non volatile memory • TCU is defective	No reaction OP mode : Normal	• Replace TCU	Often shown together with fault code F2
F2	**Configuration lost** TCU has lost the correct configuration and can't control the transmission • Interference during saving data on non volatile memory • TCU is brand new or from another vehicle	Transmission stay neutral OP mode : TCU shutdown	• Reprogram the correct configuration for the vehicle (e.g. with cluster controller,...)	
F3	**Application error** Something of this application is wrong	Transmission stay neutral OP mode : TCU shutdown	• Replace TCU	This fault occurs only if an test engineer did something wrong in the application of the vehicle
F5	**Clutch failure** AEB was not able to adjust clutch filling parameters • One of the AEB-Values is out of limit	Transmission stay neutral OP mode : TCU shutdown	• Check clutch	TCU shows also the affected clutch on the display
F6	**Clutch adjustment data lost** TCU was not able to read correct clutch adjustment parameters • Interference during saving data on non volatile memory • TCU is brand new	No reaction, Default values : 0 for AEB Offsets used OP mode : Normal	• Execute AEB	

(9) Measuring of resistance at actuator/sensor and cable

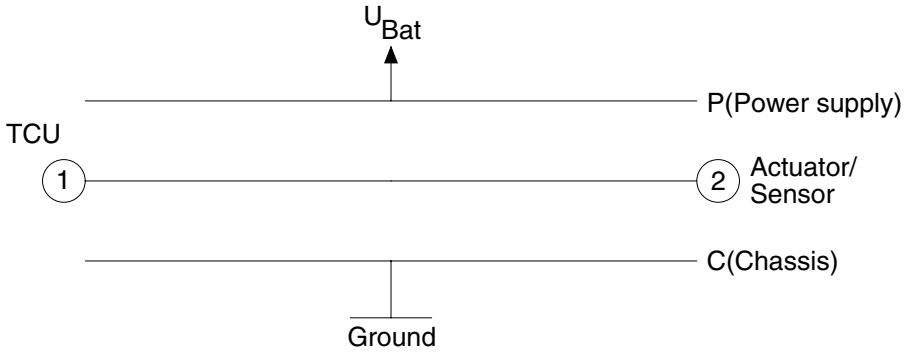
① Actuator



76043PT19

Open circuit	$R_{12} = R_{1G} = R_{2G} = \infty$
Short cut to ground	$R_{12} = R$; $R_{1G} = 0$, $R_{2G} = R$ or $R_{1G} = R$, $R_{2G} = 0$
	(For S.C. to ground, G is connected to vehicle ground)
Short cut to battery	$R_{12} = R$; $R_{1G} = 0$, $R_{2G} = R$ or $R_{1G} = R$, $R_{2G} = 0$
	(For S.C. to battery, G is connected to battery voltage)

② Cable

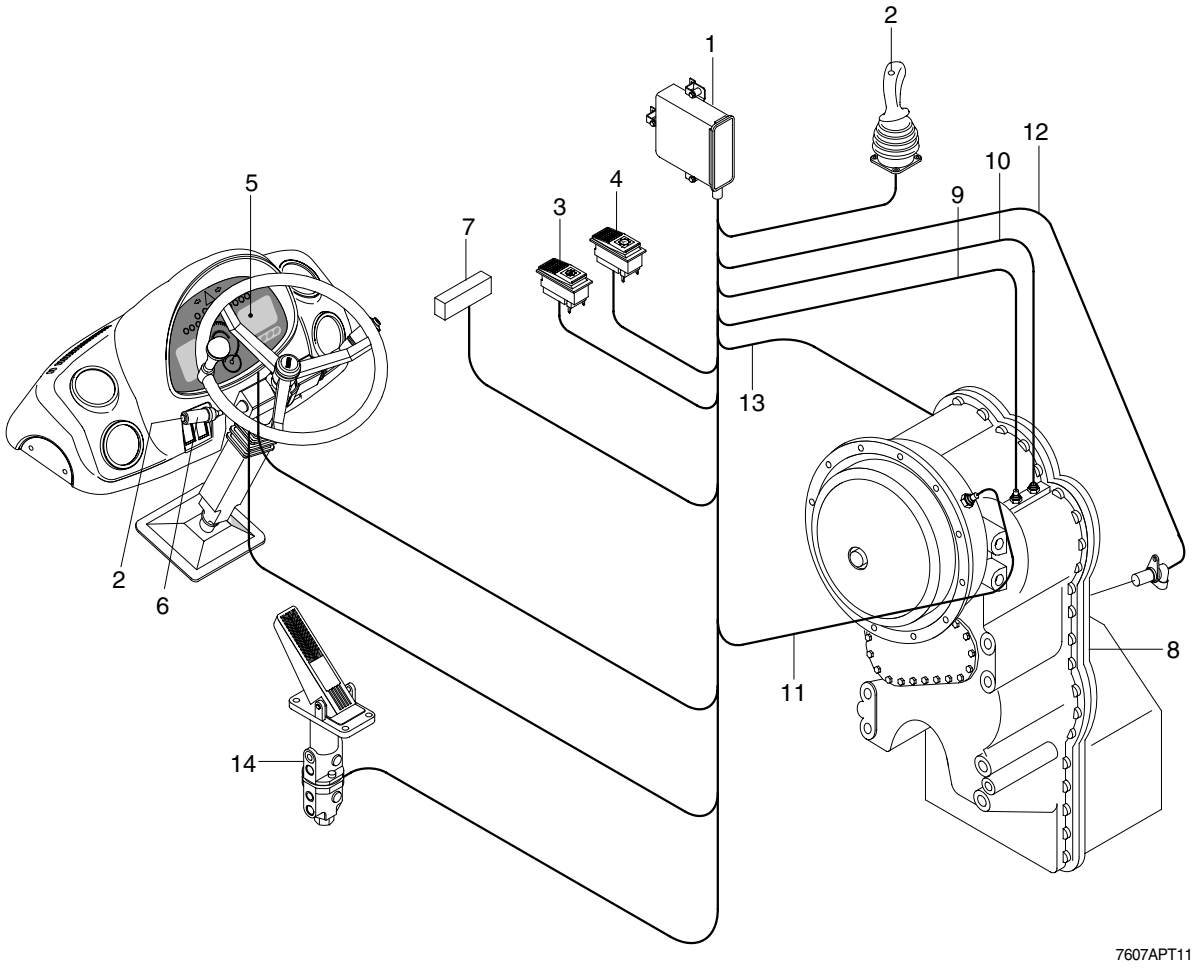


76043PT20

Open circuit	$R_{12} = R_{1P} = R_{1C} = R_{2P} = R_{2C} = \infty$
Short cut to ground	$R_{12} = 0$; $R_{1C} = R_{2C} = 0$, $R_{1P} = R_{2P} = \infty$
Short cut to battery	$R_{12} = 0$; $R_{1C} = R_{2C} = 0$, $R_{1P} = R_{2P} = 0$

7) ELECTRIC CONTROL UNIT

(1) Complete system



1 Control unit(EST-37A)
2 Kickdown switch
3 Clutch cut off switch
4 Full automatic switch
5 LCD
6 Gear selector(DW-3) with integrated kickdown switch
7 Supply-system connection
8 Transmission
9 Cable to inductive transmitter - speed central gear train
10 Cable to inductive transmitter - speed turbine
11 Cable to inductive transmitter - speed engine
12 Cable to speed sensor output and speedometer
13 Cable to plug connection on the electro - hydraulic control unit
14 Brake pressure sensor/load sensor

(2) Description of the basic functions

The powershift-reversing transmissions will be equipped with the electronic transmission control unit(EST-37A), developed for them.

The system is processing the wishes of the driver according to the following criteria.

· Speed definition as a function of gear selector position, driving speed and load level.

· Protection against operating errors, as far as possible and practical.
· Protection against overspeeds(On the basis of engine and turbine speed).
· Reversing-automatic system(Driving speed-dependent).
· Pressure cut off(Disconnecting of the drive train for maximum power on the power take-off).
· Switch for manual or automatic operation.
· Reversing function button, respectively kickdown function.

(3) Gearshifts

The control unit(EST-37A) is shifts the required speeds fully-automatically under consideration of the following criteria.

· Gear selector position
· Driving speed
· Load level

At the same time, the following speeds are picked up by the control unit(EST-37A).

· n Engine
· n Turbine
· n Central gear train
· n Output

- Neutral position

Neutral position is selected through the gear selector.
After the ignition is turned on, the electronics remains in the waiting state; By the position **neutral** of the gear selector, respectively by pressing on the key **neutral**, the control unit(EST-37A) becomes ready for operation.
Now, a speed can be engaged.

- Speed engagement

In principle, the speed, adapted to the driving speed(At standing, or rolling machine), will be engaged. The engagement is realized in dependence on load and rotational speed.

- Upshifting under load

Upshifting under load will be then realized if the machine can still accelerate by it.

- Downshifting under load

Downshifting under load will be realized if more traction force is needed.

- Upshifting in coasting condition

In the coasting condition, the upshifting will be suppressed if the speed of the machine on a slope shall not be further increased.

- Downshifting in coasting condition

Downshiftings in the coasting condition will be realized if the machine shall be retarded.

- Reversing

At speeds below the reversing limit, direct reversing can be carried out at any time in the speeds 1F 1R and 2F 2R(As a rule, this is the maximum driving speed of the 2nd speed).

Reversings in the speeds 3 and 4 are realized dependent on the driving speed.

- Above the programmed reversing limit, the machine is braked down by downshifts of the electronic control unit(EST-37A) to the permitted driving speed, and only then, the reversing into the correspondingly preselected speed will be carried out.
- Below the permitted driving speed, the reversing is carried out immediately.

(4) Specific kickdown function

By means of the kickdown-button, integrated in the gear selector, it is at any time possible to select in the speeds 2F and 2R(i.e. position 2 of the gear selector, at automatic mode also in the 2nd speed of the automatic range) the 1st speed by a short touch. This kickdown state can be cancelled by :

1. Pressing the kickdown-button again
2. Realization of a reversal operation
3. Change of the gear selector position by the following modification
   Gear selector(DW-3) - (Rotation) of the driving position 1···4.

The kickdown function will be always terminated by shifting to neutral.

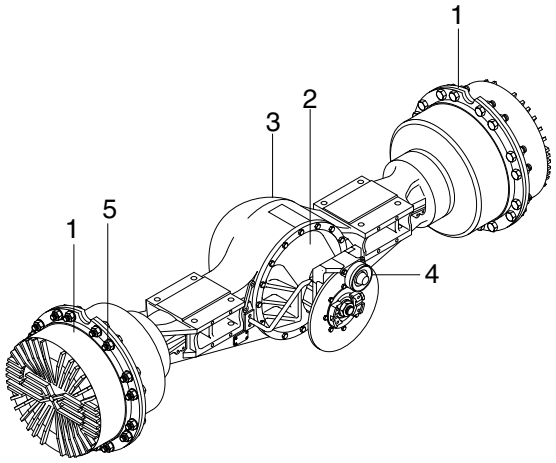
(5) Clutch cut off

Especially at wheel loaders, the clutch cut off can be activated through a switch signal. It is interrupting the power flow in the transmission as long as this signal is active. Besides, this function can be used for the transmission-neutral shifting at applied hand brake or as **emergency-stop**(In this case, a restarting is only possible through the gear selector-neutral position).

5. VOLVO AXLE

· Machine serial No. ; ~#0293

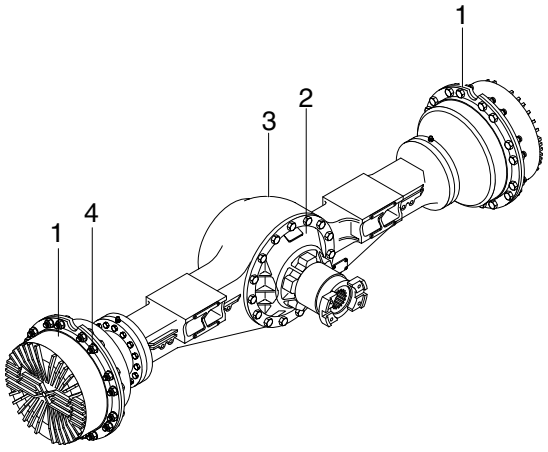
1) Front axle



7607PT12

1	Final drive	3	Housing	5	Wheel nut
2	Differential	4	Parking brake		

2) Rear axle



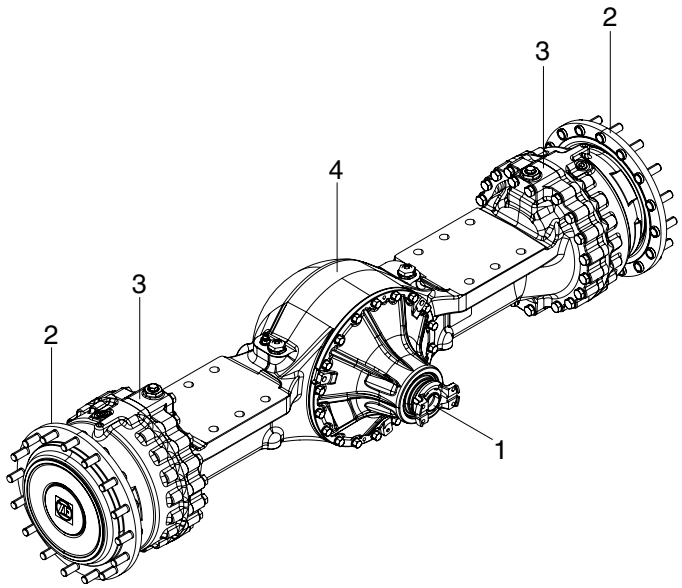
7607PT13

1	Final drive	2	Differential	3	Housing	4	Wheel nut

ZF AXLE

· Machine serial No. ; #0294~

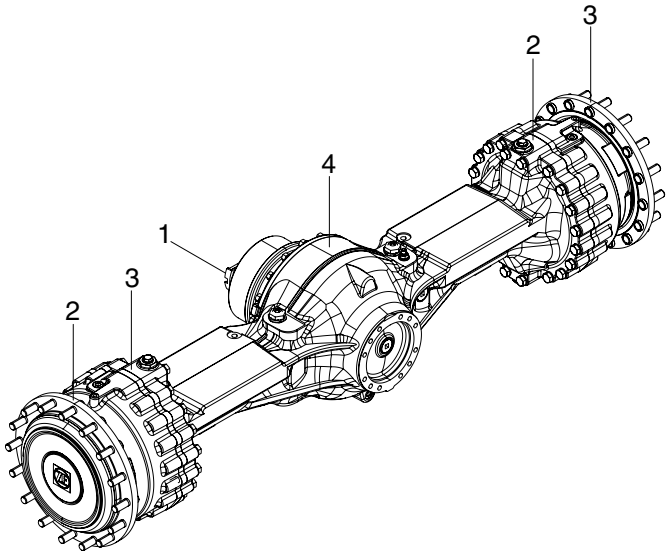
1) Front axle



7607APT15

1	Input	2	Output	3	Brake	4	Axle housing

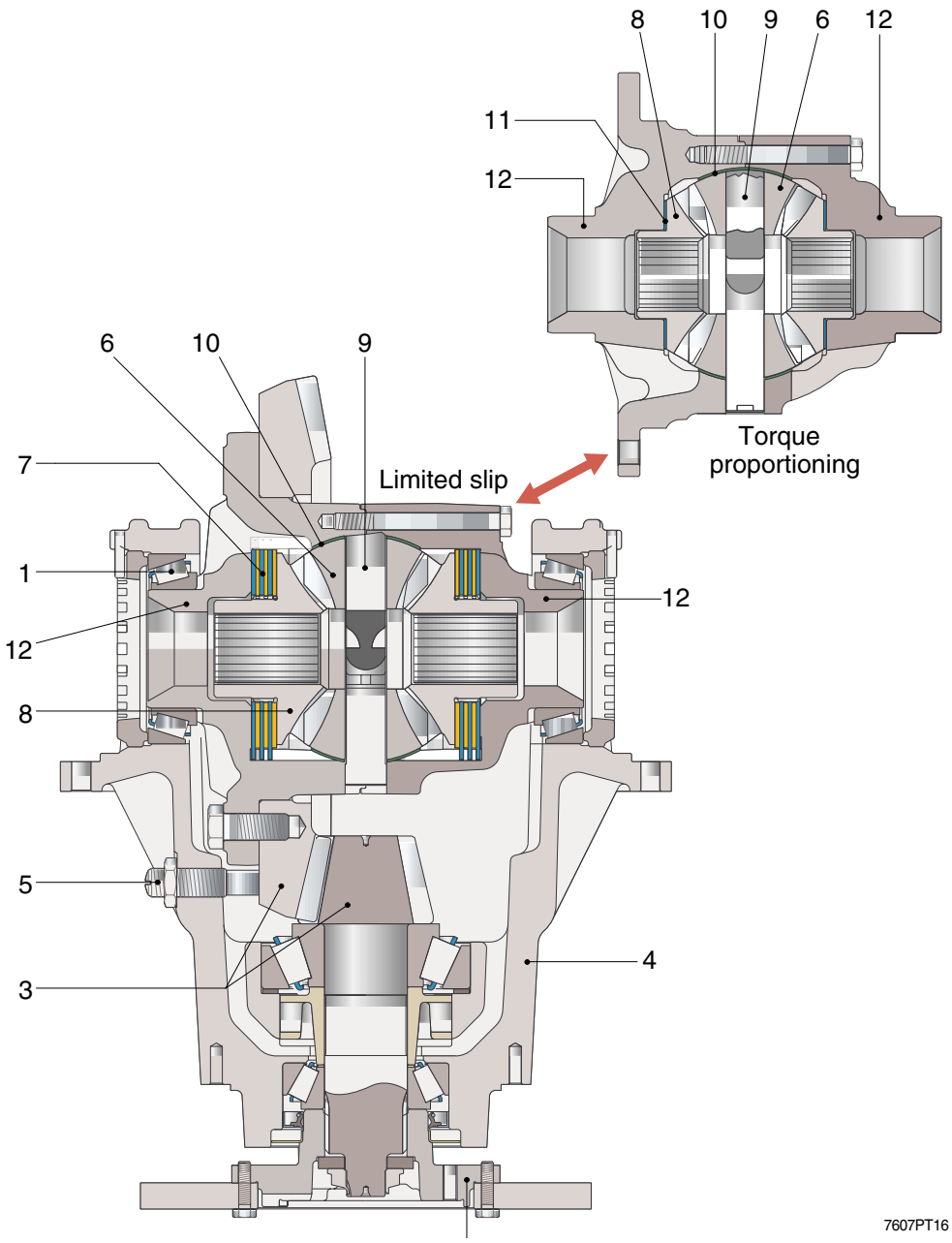
2) Rear axle



7607APT16

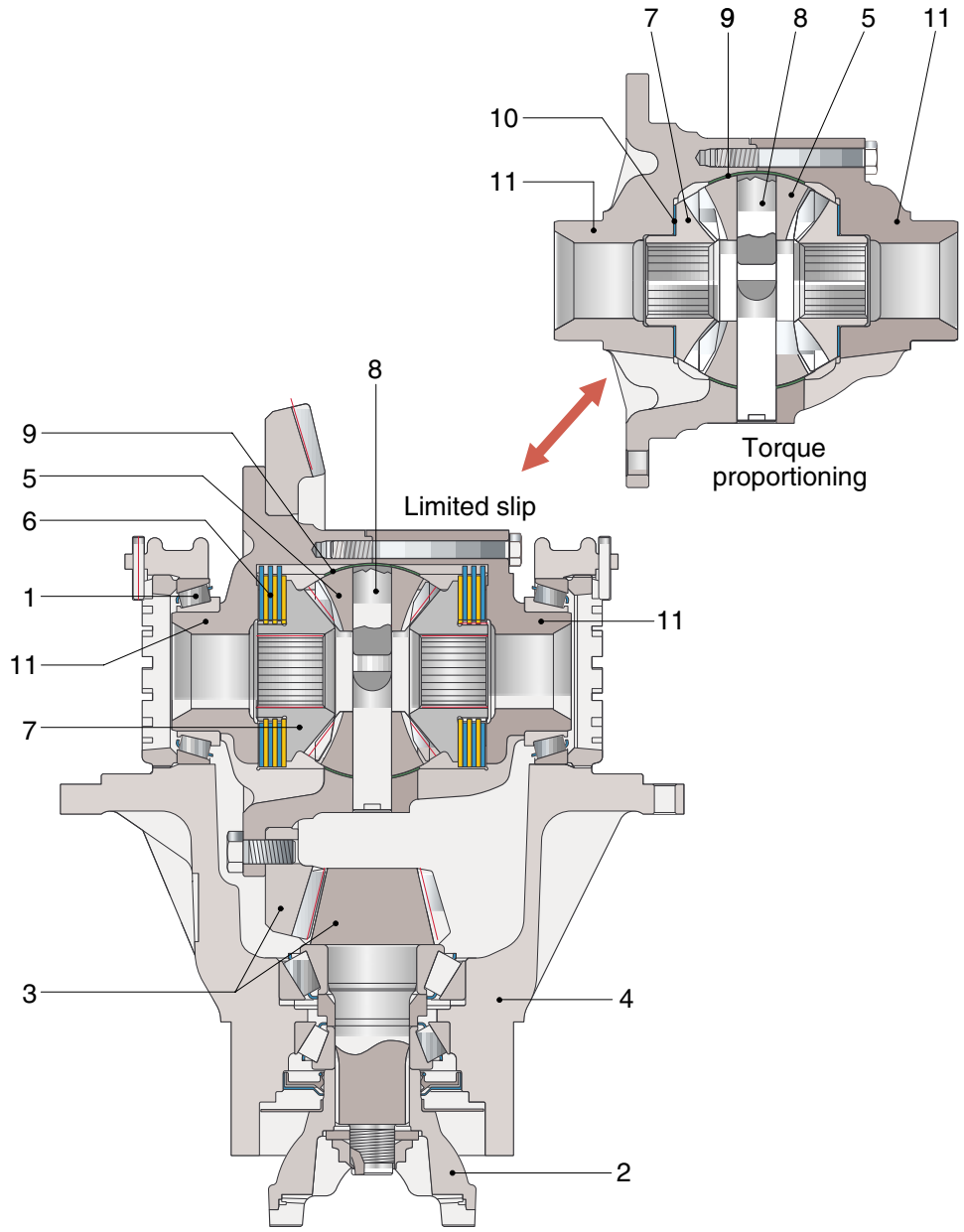
1	Input	2	Output	3	Brake	4	Axle housing

2) FRONT AXLE DIFFERENTIAL SECTION



1	Roller bearing	7	Clutch
2	Input flange	8	Planetary gear
3	Bevel gear set	9	Spider
4	Differential housing	10	Bevel thrust washer of side gear
5	Adjusting screw	11	Thrust washer of planetary gear
6	Side gear	12	Half case

3) REAR AXLE DIFFERENTIAL SECTION



7607PT17

1	Roller bearing	7	Planetary gear
2	Input flange	8	Spider
3	Bevel gear set	9	Bevel thrust washer of side gear
4	Difterential housing	10	Thrust washer of planetary gear
5	Side gear	11	Half case
6	Clutch		

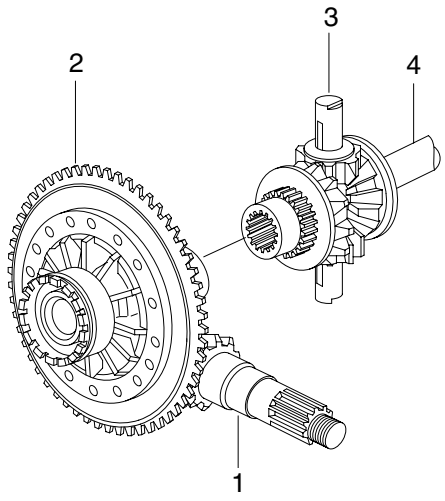
4) DIFFERENTIAL

(1) Description

When the machine makes a turn, the outside wheel must rotate faster than the inside wheel. A differential is a device which continuously transmits power to the right and left wheels while allowing them to turn a different speeds, during a turn.

The power from the drive shaft passes through bevel pinion(1) and is transmitted to the bevel gear(2). The bevel gear changes the direction of the motive force by 90 degree, and at the same time reduces the speed.

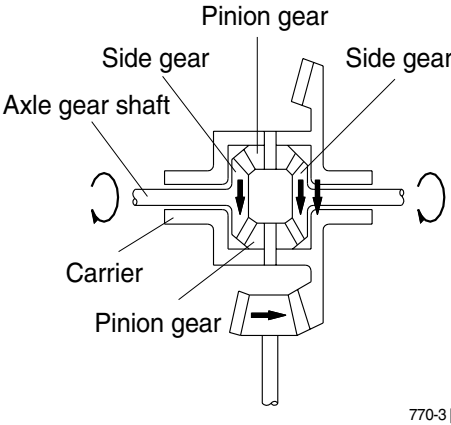
It then transmits the motive force through the differential(3) to the axle gear shaft(4).



770-3 [3-26(1)]

(2) When driving straight forward

When the machine is being driven straight forward and the right and left wheels are rotating at the same speed, so the pinion gear inside the differential assembly do not rotate. The motive force of the carrier is send through the pinion gear and the side gear, therefore the power is equally transmitted to the left and right axle gear shaft.

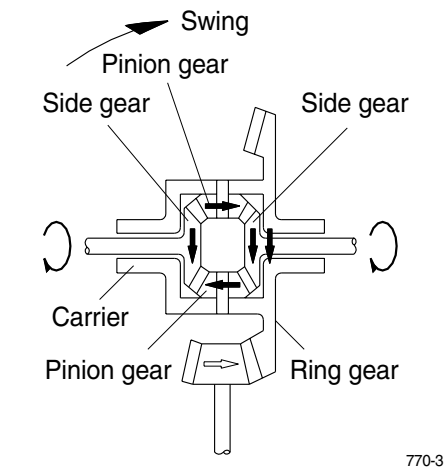


770-3 [3-26(2)]

(3) When turning

When turning, the rotating speed of the left and right wheels is different, so the pinion gear and side gear inside the differential assembly rotate in accordance with the difference between the rotating speed of the left and right wheels.

The power of the carrier is then transmitted to the axle gear shafts.



770-3 [3-26(3)]

5) TORQUE PROPORTIONING DIFFERENTIAL

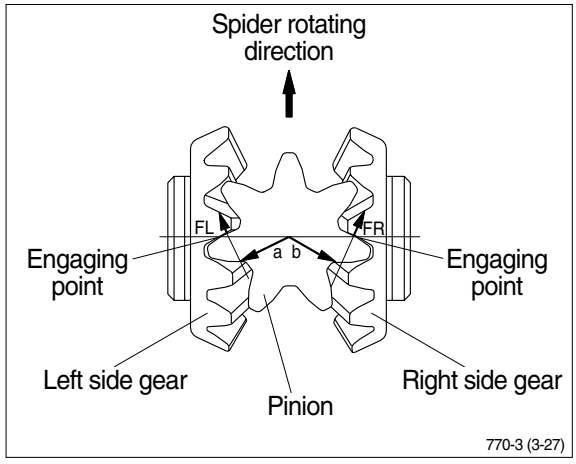
(1) Function

① Because of the nature of their work, 4-wheel-drive loaders have to work in places where the road surface is bad.
In such places, if the tires slip, the ability to work as a loader is reduced, and also the life of the tire is reduced.
The torque proportioning differential is installed to overcome this problem.
In structure it resembles the differential of an automobile, but the differential pinion gear has an odd number of teeth.
Because of the difference in the resistance from the road surface, the position of meshing of the pinion gear and side gear changes, and this changes the traction of the left and right tires.

(2) Operation

① **When traveling straight**

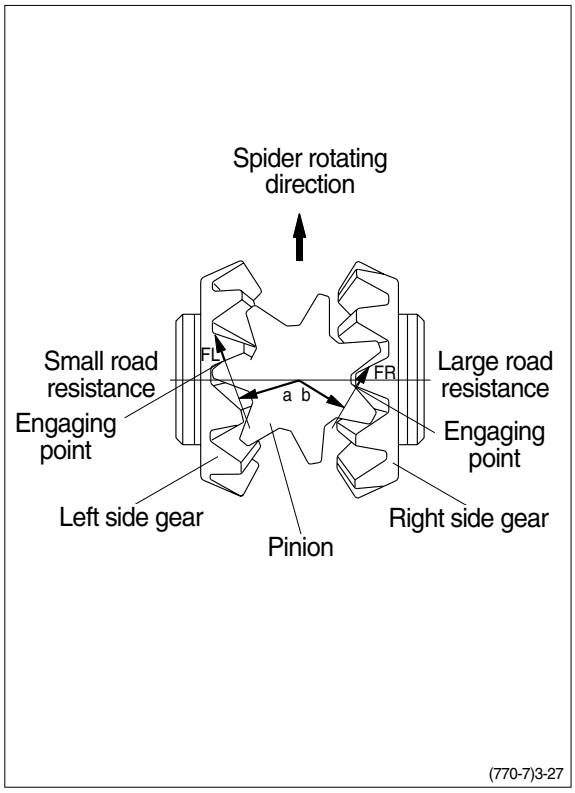
(Equal resistance from road surface to left and right tires)
Under this condition, the distances involving the engaging points between right and left side gears and pinion-a and b-are equal and the pinion is balanced as FL × a=FR × b. Thus, FL=FR, and the right and left side gears are driven with the same force.



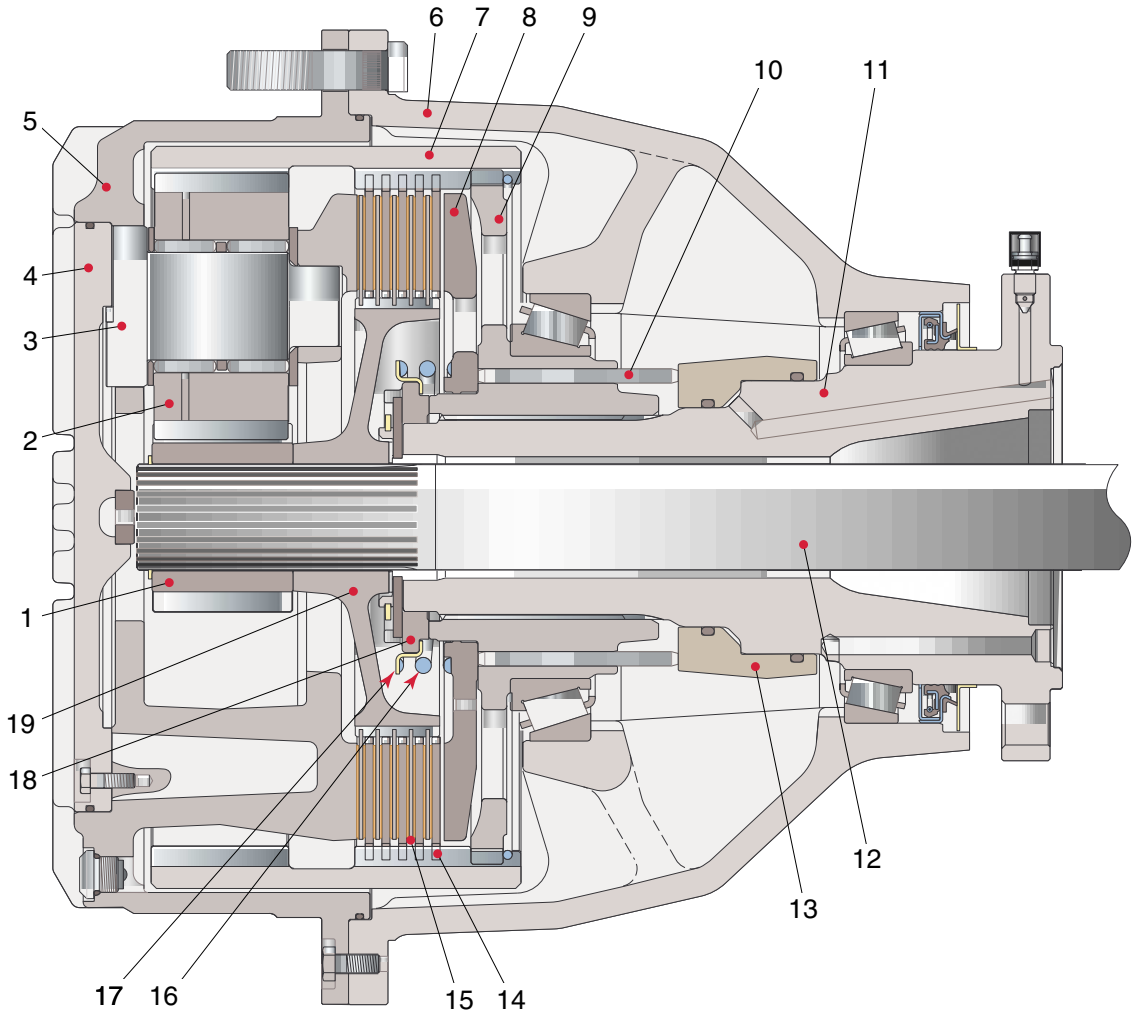
② **When traveling on soft ground**
(Resistance from road surface to left and right tires is different)

If the road resistance to the left wheel is smaller, the left side gear tends to rotate forward, and this rotation changes the engaging points between the side gears and pinion. As a result, the distances involving the engaging points becomes a>b. The pinion now is balanced as FL $\times$ a=FR $\times$ b, where FL>FR. The right side gear is driven with a greater force than the left side gear. The torque can be increased by up to about 30% for either side gear.

The pinion therefore does not run idle and driving power is transmitted to both side gears until the difference between road resistance to the right and left wheels reaches about 30%.



6) FINAL DRIVE SECTION(Front & rear)



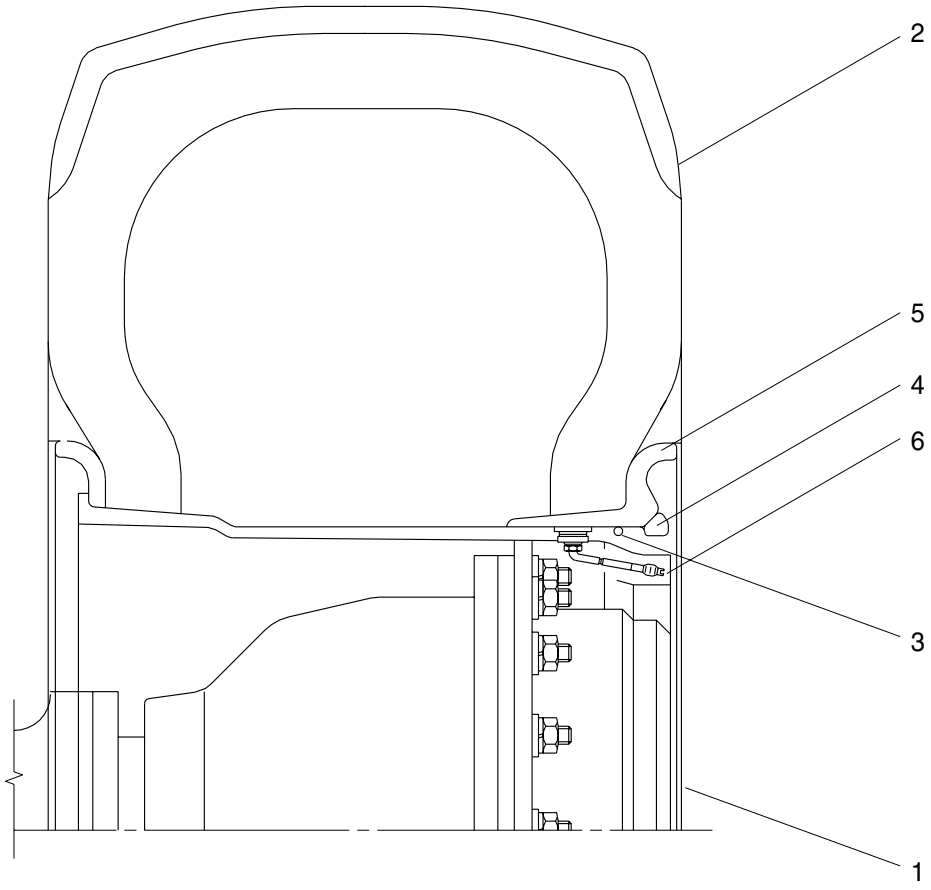
7707PT16

1	Sun gear	8	Pressure plate	14	Lug disc
2	Side gear(Planetary gear)	9	Bevel gear support	15	Brake disc(Friction plate)
3	Side gear carrier pin	10	Pin(Push rod)	16	Piston return spring
4	Final drive cover	11	Spindle	17	Retaining spring ring
5	Side gear carrier support(Hub drum)	12	Half shaft	18	Ring nut
6	Wheel hub	13	Brake drive piston	19	Disc carrier hub
7	Bevel gear(Ring gear)				

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

(2) The power transmitted from the differential through axle shaft(12) to sun gear(1) is transmitted to planetary gear(2). The planetary gear rotates around the inside of a fixed ring gear(7) and in this way transmits rotation at a reduced speed to the planetary carrier.
This power is then sent to the wheels which are installed to the planetary carriers.

6. TIRE AND WHEEL



770-3 (3-30)

1	Wheel rim	3	O-ring	5	Side ring
2	Tire	4	Lock ring	6	Valve assembly

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

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

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

1. POWER TRAIN OPERATIONAL CHECKS

This procedure is designed so that the mechanic can make a quick check of the system using a minimum amount of diagnostic equipment. If you need additional information, read **Structure and function**, Group 1.

A location will be required which is level and has adequate space to complete the checks.

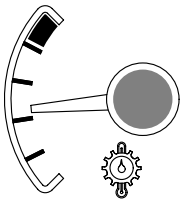
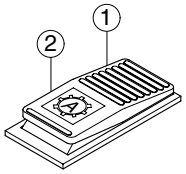
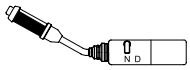
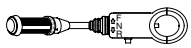
The engine and all other major components must be at operating temperature for some checks.

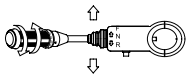
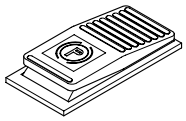
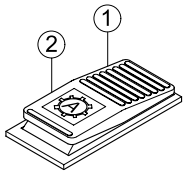
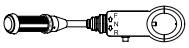
Locate system check in the left column and read completely, following the sequence from left to right. Read each check completely before performing.

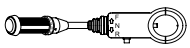
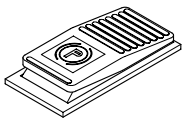
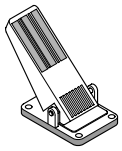
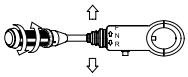
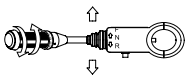
At the end of each check, if no problem is found(OK), that check is complete or an additional check is needed. If problem is indicated(NOT OK), you will be given repair required and group location.
If verification is needed, you will be given next best source of information :

Chapter 2 : Troubleshooting
Group 3 : Tests and adjustments

※ **Transmission oil must be at operating temperature for these checks.**

Item	Description	Service action
Transmission oil warm-up procedure	 Start engine. Apply service brakes and release parking brake. Select full automatic switch to manual mode①. Move gear selector lever to 3rd speed. Move gear selector lever to forward "F" position.  Increase engine speed to high idle for 30 seconds. Move gear selector lever to neutral "N" position and run for 15 seconds.  Repeat procedure until transmission temperature gauge arrow points to bar above dial.	**OK** Check completed.
Gear selector lever and neutral lock latch checks Engine OFF.	 Move gear selector lever to each position. **NOTE** : Gear selector lever position changes slightly as steering column is tilted.  **FEEL** : Lever must move freely through all positions. Engage neutral lock. Apply slight effort to move lever into forward(F) and reverse(R). **LOOK** : Neutral lock must stay engaged.	**OK** Check completed. **NOT OK** Repair lock or replace switch.
Automatic shifting check	 Start engine. Move gear selector lever to 4th speed. Turn full automatic switch ON. **LOOK** : Automatic sign on display.  Move gear selector lever to forward or reverse position. Increase engine rpm. **LOOK** : Speed(2nd~4th) on display must vary with machine speed.	**OK** Check completed. **NOT OK** Go to transmission error code group at page 3-32~3-58. Repair or replace the display or harness.

Item	Description	Service action
Transmission noise check Engine running.	 Run engine at approximately 1600rpm. Drive unit with transmission in each forward and reverse speed. **LISTEN** : Transmission must not make excessive noise in any range. Engine rpm must not "lug down" as unit is shifted between gears.	**OK** Check completed. **NOT OK** Go to transmission makes excessive noise group 3.
Transmission "quick shift" check Engine running.	 Release parking brake and select full automatic switch to manual mode①. Shift to 2nd forward.  Drive machine at approximately 5km/h and press gear selector lever kick down switch or RCV lever switch once. **LOOK/FEEL** : Transmission must shift to and remain in 1st gear.  Press gear selector lever kick down switch once. **LOOK/FEEL** : Transmission must shift back to 2nd gear. Shift to (3rd or 4th) gear and press gear selector lever kick down switch once. **LOOK/FEEL** : Transmission must not shift down. Select full automatic switch to automatic mode②. Drive machine at approximately 90% speed of max speed in each gear(2nd or 3rd or 4th). Shift to(2nd or 3rd or 4th) gear in each forward and reverse speed and press gear selector kick down lever switch or RCV lever switch once. **LOOK/FEEL** : Transmission must shift to lower(1st or 2nd or 3rd) gear respectively. Press gear selector lever kick down switch or RCV lever switch once again.	**OK** Check completed. **NOT OK** Check connector at base of control valve. **IF OK** Go to transmission controller circuit in group 1.

Item	Description	Service action
	LOOK/FEEL : Transmission must shift to former(2nd or 3rd or 4th) gear. **NOTE** : If gear selector lever kick down switch or RCV lever switch is pressed twice, transmission will shift down the immediately back to former gear.	
Forward, reverse and 4th speed clutch pack drag check ※ **Transmission must be warmed up for this check.** Engine running.	  	Park unit on level surface. Apply service brakes. Move gear selector lever to neutral. Move gear selector lever to 1st. Release parking brake and service brakes. Run engine at low idle. **LOOK** : Unit must not move in either direction. **NOTE** : If unit moves forward, either the forward pack or the 4th speed pack is dragging.	**OK** Check completed. **NOT OK** If unit moves, repair transmission.
Transmission shift modulation check Engine running.		Run engine at approximately 1300rpm. Put transmission in 1st forward, shift several times from forward to reverse and reverse to forward. Repeat check in 2nd gear. **LOOK** : Unit must slow down and change direction smoothly.	**OK** Check completed. **NOT OK** Go to unit shifts too fast, chapter 2 in this group.
Torque converter check		Start engine. Apply service brakes and release parking brake. Move gear selector lever to 3rd speed. Move gear selector control lever to forward "F" position. Increase engine speed to high idle. **LOOK** : Torque converter stall rpm must be within the following range. Stall rpm : 2110±70rpm Move gear selector control lever to neutral "N" position and run for 15 seconds.	**OK** Check completed. **NOT OK** If stall rpm are too low or too high, problem may be engine power or torque converter. **IF OK** Replace transmission torque converter.

2. TROUBLESHOOTING

1) TRANSMISSION

※ **Diagnose malfunction charts are arranged from most probable and simplest to verify, to least likely, more difficult to verify. Remember the following steps when troubleshooting a problem :**

Step 1. Operational check out procedure(See group 3 in section 1.)

Step 2. Operational checks(In this group.)

Step 3. Troubleshooting

Step 4. Tests and/or adjustments(See group 3.)

Problem	Cause	Remedy
Transmission slippage	Low oil level.	Add oil.
	Wrong oil grade.	Change oil.
	Restricted transmission pump suction screen.	Remove and clean screen.
	Leak in transmission control valve or gasket.	Remove valve and inspect gaskets.
	Low transmission pump flow due to worn pump.	Do transmission pump flow test.
	Weak or broken pressure regulating valve spring.	Do transmission system pressure test.
Error code on display	Something wrong in transmission.	Go to transmission error code group at page 3-32~3-58.

Problem	Cause	Remedy
Machine will not move	Low oil level.	Add oil.
	Applied park brake.	Check parking brake fuse. Check continuity to parking brake switch.
	No power to transmission controller.	Check transmission controller fuse.
	Malfunctioning parking brake solenoid valve.	Remove and inspect parking brake solenoid valve. Check for power to solenoid valve.
	Restricted orifice of PPC valve.	Remove orifice and check for contamination and/or plugging. (Do not remove valve housing for this purpose.)
	Excessive leakage in transmission element.	Do transmission element leakage test using system pressure.
	Worn clutch disks.	Repair transmission.
	Low or no transmission pressure.	See transmission pressure is low in this group.
	Service brake will not release.	Do brake pedal operational check. Do service and park system drag checks.
	Failed torque converter.	Do torque converter stall test. If engine pulldown in normal, torque converter is good.
	Broken shafts or gears.	Drain transmission to determine if large pieces of metal contamination are present.
	Broken drive shafts.	Inspect drive shafts and universal joints for external damage. Repair.
	Broken ring or pinion gear.	If drive shaft rotate with transmission in gear but machine does not move, a differential failure is indicated. Repair.
Machine does not engage in low gear	Malfunctioning transmission control solenoid valve.	Check solenoid valve.
	Stuck spool in transmission control valve.	Remove and inspect transmission control valve spools.
	Stuck PPC valve.	Remove end cover to inspect PPC valve. Replace if necessary.
	Malfunctioning transmission speed sensor.	Check speed sensor.

Problem	Cause	Remedy
Transmission pressure is low(All gears)	Low oil level.	Check transmission oil level and refill if necessary.
	Failed transmission pressure switch.	Verify transmission system pressure. Do transmission system pressure test.
	Plugged suction strainer.	Transmission pump may be noisy if transmission suction screen is clogged. Drain transmission. Remove and clean suction screen. Also, check condition of transmission filter.
	Stuck transmission pressure regulating valve or broken spring.	Remove transmission pressure regulating valve. Inspect for damage(See transmission control valve).
	Failed control valve gasket.	Inspect transmission control valve for external leakage. Remove control valve. Inspect or replace gasket.
	Stuck PPC valve.	Remove end cover to inspect modulation spool and check torque on cap screws retaining control valve to transmission.
Transmission system pressure is low (One or two gears)	Failed transmission pump.	Do pump flow test.
	Failed transmission control valve gasket.	Inspect transmission control valve for external leakage. Remove control valve. Inspect or replace gasket.
	Leakage in clutch piston or seal ring.	Disassemble and repair.
Transmission shifts too low	Low oil level(Aeration of oil).	Add oil.
	Low transmission pressure.	Do transmission system pressure test.
	Restricted transmission pump suction screen.	Remove and clean screen.
	Low transmission pump flow.	Do transmission pump flow test.
	Excessive transmission element leakage.	Do transmission element leakage test using system pressure.
	Stuck PPC valve.	Remove end cover to inspect modulation spool. Replace if necessary.
	Restricted PPC valve orifice.	Remove orifice and inspect for contamination and /or plugging.
	Restricted oil passages between control valve and transmission elements.	Remove control valve and inspect oil passage.
	Incorrect transmission oil.	Change oil(SAE 10W-30/15W-40)

Problem	Cause	Remedy
Transmission shifts too fast	Wrong transmission controller.	Check if transmission controller has been changed
	System pressure too high.	Do transmission system pressure test.
	Stuck PPC valve.	Remove and inspect PPC valve. Replace if necessary. Also remove end cover to inspect PPC valve and control valve housing. Replace if necessary.
	Stuck or missing check valves.	Inspect transmission control valve.
	Missing O-ring from end of modulation orifice.	Remove orifice and inspect port for O-ring.
	Broken piston return spring.	Disassemble and inspect clutch.
	Incorrect transmission oil.	Change oil(SAE 10W-30/15W-40)
Machine "creeps" in neutral	Warped disks and plates in transmission.	Check transmission.
Transmission hydraulic system overheats	High oil level.	Transmission overfilled or hydraulic pump seal leaking.
	Low oil level.	Add oil.
	Wrong oil grade.	Change oil.
	Park brake dragging.	Check for heat in park brake area.
	Pinched, restricted or leaking lube lines.	Check cooler lines.
	Machine operated in too high gear range.	Operate machine in correct gear range.
	Malfunction in temperature gauge or sensor.	Install temperature sensor the verify temperature. Do tachometer/temperature reader installation procedure.
	Restricted air flow through oil cooler or radiator.	Do radiator air flow test.
	Failed oil cooler bypass valve(In thermal bypass valve).	Disassemble and inspect.
	Failed thermal bypass valve.	Remove thermal bypass valve and check to see if machine still overheats. Do transmission oil cooler thermal bypass valve test.
	Internally restricted oil cooler.	Do oil cooler restriction test.
	Leakage in transmission hydraulic system.	Do transmission system pressure, element leakage test.
	Malfunction in converter relief valve.	Do converter out pressure test.
	Low transmission pump output.	Do transmission pump flow test.

Problem	Cause	Remedy
Excessive transmission noise(Under load or no load)	Too low engine low idle.	Check engine low idle speed.
	Worn parts or damaged in transmission.	Remove transmission suction screen. Inspect for metal particles. Repair as necessary.
	Warped drive line between engine and torque converter.	Inspect drive line.
	Low or no lube.	Do converter-out and lube pressure test. Do transmission pump flow test.
Foaming oil	Incorrect type of oil.	Change oil.
	High oil level.	Transmission overfilled or hydraulic pump seal leaking.
	Low oil level.	Add oil.
	Air leak on suction side of pump.	Check oil pickup tube on side of transmission.
Oil ejected from dipstick	Plugged breather.	Inspect breather on top of transmission. Replace.
Machine vibrates	Aerated oil.	Add oil.
	Low engine speed.	Check engine speed.
	Failed universal joints on transmission drive shaft or differential drive shafts.	Check universal joints.
Machine lacks power and acceleration	Engine high idle speed set too low.	Check high idle adjustment.
	Incorrect transmission oil.	Change oil.
	Aerated oil.	Add oil.
	Low transmission pressure.	Do transmission system pressure test.
	Warped transmission clutch.	Do transmission clutch drag checks.
	Torn transmission control valve gasket.	Inspect gasket.
	Brake drag.	Do brake drag check.
	Failed torque converter.	Do torque converter stall speed test.
	Low engine power.	Do engine power test.
Torque converter stall RPM too high	Aerated oil.	Put clear hose on thermal bypass outlet port. Run machine to check for bubbles in oil.
	Stuck open converter relief valve.	Do converter-out pressure test.
	Leakage in torque converter seal.	Do converter-out pressure test.
	Torque converter not transferring power(Bent fins, broken starter).	Replace torque converter.

Problem	Cause	Remedy
Torque converter stall RPM too low	Low engine power.	Do engine power test.
	Mechanical malfunction.	Remove and inspect torque converter.
Transmission pressure light comes ON when shifting from forward to reverse(All other gears OK)	Low oil level.	Add oil.
	Cold oil.	Warm oil to specification.
	Leak in reverse pack.	Do transmission pressure, pump flow, and leakage check.
Transmission pressure light comes ON for each shift	Cold oil.	Warm oil to specification.
	No time delay in monitor.	Do monitor check.
	Restriction in modulation orifice.	Remove orifice and inspect for restriction and/or plugging.
	Stuck PPC valve.	Remove and inspect.
	Low transmission pressure circuit.	Do transmission system pressure test.
	Leak in transmission pressure circuit.	Do converter out pressure test.
	Failed transmission pump.	Do transmission pump flow test.
	Clogged filter.	Inspect filter. Replace.

2) DIFFERENTIAL / AXLE

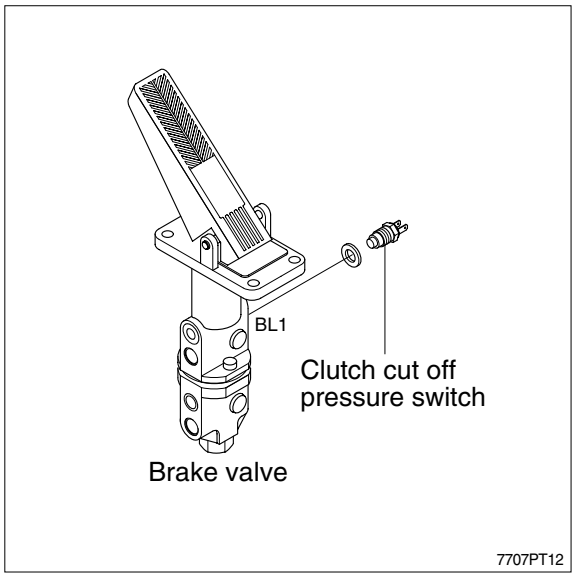
Problem	Cause	Remedy
Differential low on oil	External leakage.	Inspect axle and differential for leaks.
Excessive differential and/or axle noise	Low oil level in differential.	Check oil. Remove drain plug and inspect for metal particles in differential case. Disassemble and determine cause.
	Incorrect type of oil.	Change oil
	Dragging brakes.	Do brake check.
	Failed pinion bearing.	Remove and inspect pinion. Check to ensure pinion housing was indexed.
	Incorrect gear mesh pattern between ring and pinion gear.	Remove pinion gear housing and inspect ring and pinion gear.
	Failed differential pinion gears and/or cross shafts.	Remove differential housing drain plug and inspect for metal particles. Disassemble and inspect.
	Failed axle bearing.	Do axle bearing adjustment check.
	Mechanical failure in axle planetary.	Remove differential. Inspect, repair.
Oil seeping from outer axle seal	Excessive end play in axle.	Do axle bearing adjustment check.
	Worn outer bearing and/or cup.	Disassemble and inspect outer axle bearing, cup, spacer, and seal. Replace, if necessary.
	Overfilled differential.	Check differential oil return system for excessive internal restriction.
Axle overheats	Low differential oil.	Add oil.
	Overfilled differential.	See differential overfills with oil in this group.
	Brake drag.	See brakes drag in this group.

3) DRIVE LINE

Problem	Cause	Remedy
Excessive drive line vibration or noise	Yokes not in line on drive shafts.	Inspect. Align drive shaft yokes.
	Worn front drive line support bearing.	Inspect, repair.
	Bent drive shaft.	Inspect all drive shafts. Replace.
	Loose yoke retaining nuts(Drive shafts wobble at high speed).	Inspect. Replace.
	Rear axle oscillating support.	Inspect, repair.
	Lack of lubrication.	Lubricate with proper grade of grease.

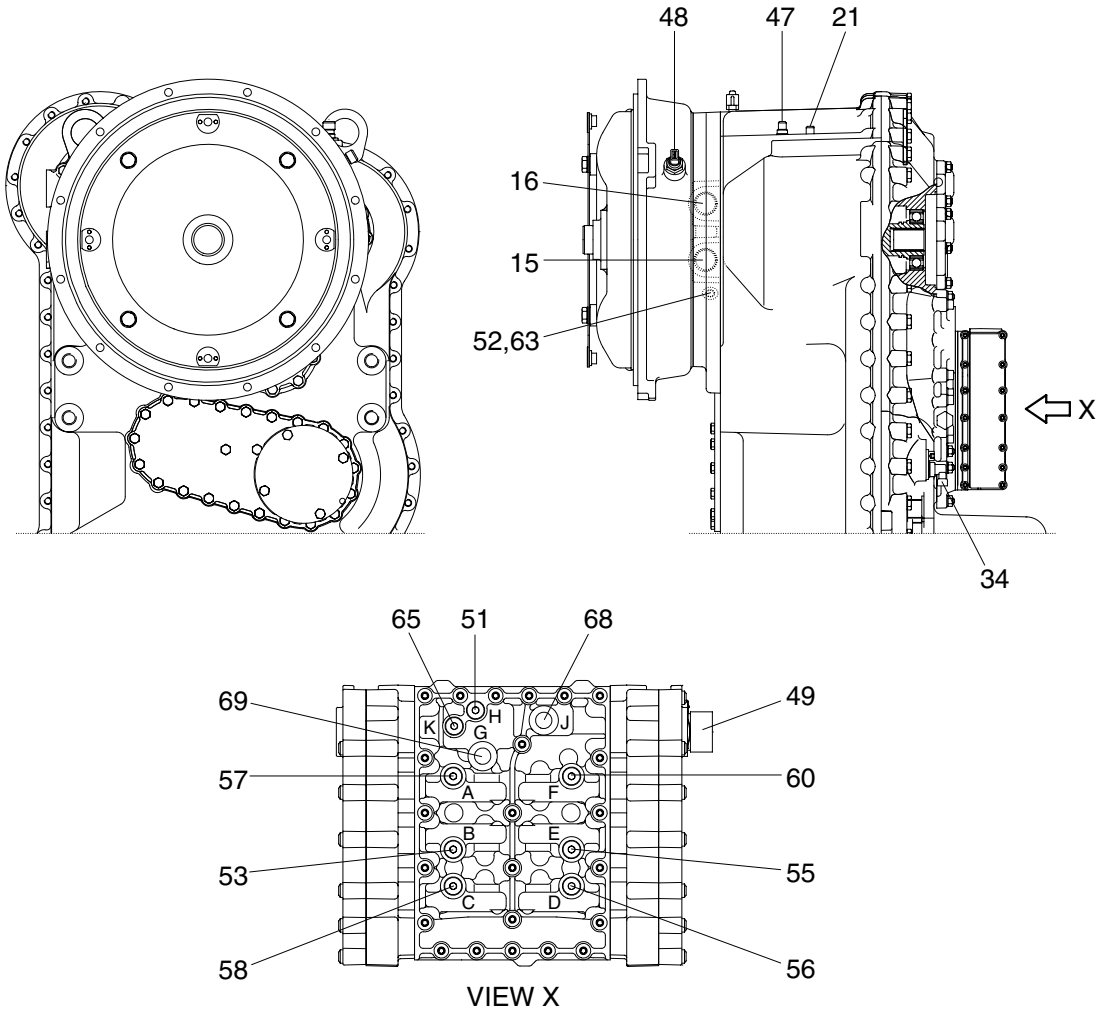
1. CLUTCH CUT-OFF PRESSURE SWITCH TEST

The setting pressure of the clutch cut-off pressure switch should be suited with the specification. The rated pressure is 25kgf/cm^2.
For the detailed method for pressure adjusting, refer to page 4-22.



2. TRANSMISSION MEASURING POINTS AND CONNECTIONS

The measurements have to be carried out at hot transmission(About 80~95° C).



7607PT14

1) OIL PRESSURE AND TEMPERATURE

Port	Description			Size
51	Converter inlet-opening pressure(9bar)		H	M10×1.0
52	Converter outlet-opening pressure(3.5bar)			M14×1.5
53	Forward clutch(16+2bar)	KV	B	M10×1.0
55	Reverse clutch(16+2bar)	KR	F	M10×1.0
56	1st clutch(16+2bar)	K1	D	M10×1.0
57	2nd clutch(16+2bar)	K2	A	M10×1.0
58	3rd clutch(16+2bar)	K3	C	M10×1.0
60	4th clutch(16+2barr)	K4	E	M10×1.0
63	Converter outlet temperature 100°C, short-time 120°C			M14×1.5
65	System pressure(16+2bar)		K	M10×1.0

2) DELIVERY RATES

Port	Description	Size
15	Connection to the oil cooler	1 5/6″-12UNF-2B
16	Connection from the oil cooler	1 5/6″-12UNF-2B

3) INDUCTIVE TRANSMITTER AND SPEED SENSOR

Port	Description		Size
21	Inductive transmitter	n turbine	M18×1.5
34	Speed sensor	n output and speedometer	-
47	Inductive transmitter	n central gear train	M18×1.5
48	Inductive transmitter	n engine	M18×1.5

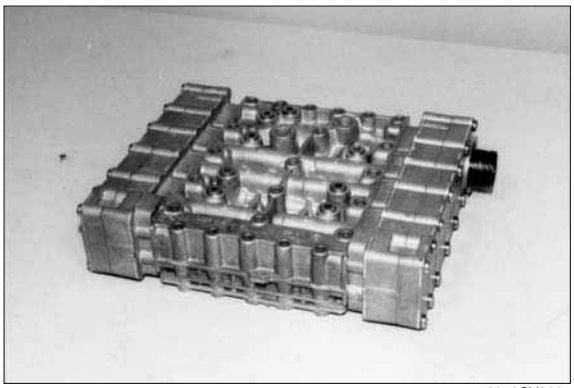
4) CONNECTIONS

Port	Description		Size
49	Plug connection on the hydraulic control unit		-
68	Pilot pressure(Option)	J	M16×1.5
69	System pressure(Option)	G	M16×1.5

1. CONTROL VALVE

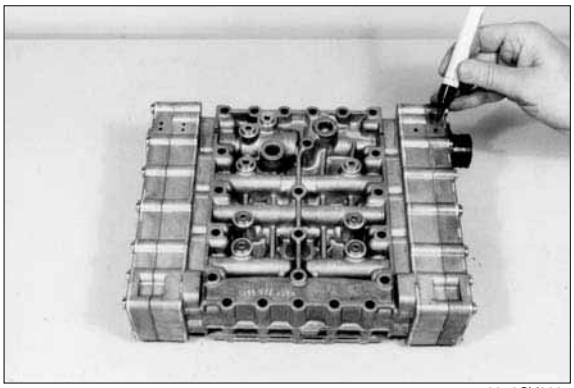
1) DISASSEMBLY

(1) Illustration on the right shows the complete control unit.



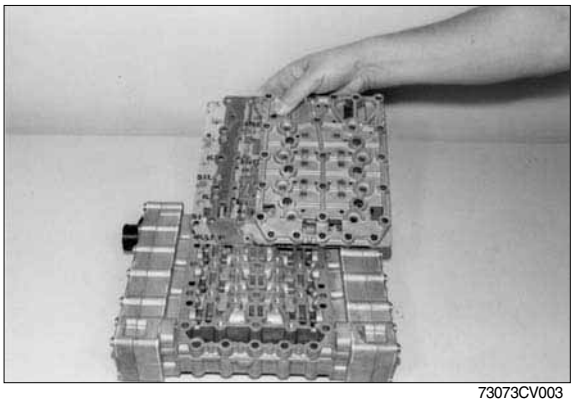
73073CV001

(2) Mark the installation position of the different covers, the housing and cable harness with the valve housing.



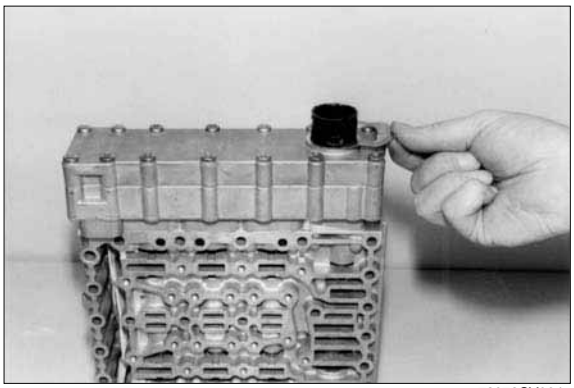
73073CV002

(3) Loosen socket head screws.
Separate duct plate, 1st gasket, intermediate plate and 2nd gasket from the valve housing.
Box spanner 5873 042 002



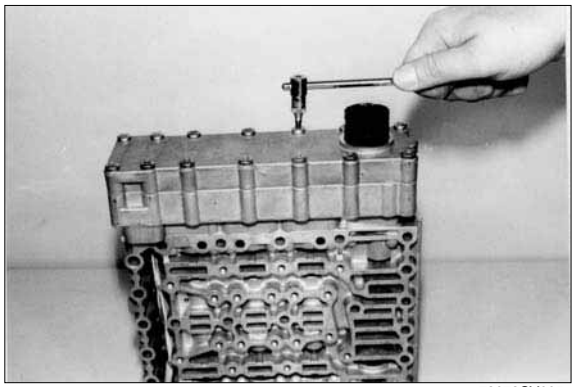
73073CV003

(4) Remove retaining clip.

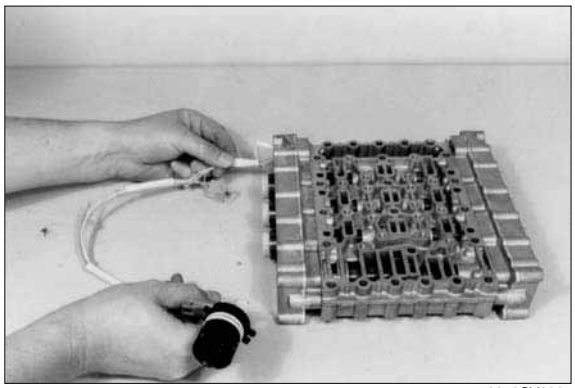


73073CV004

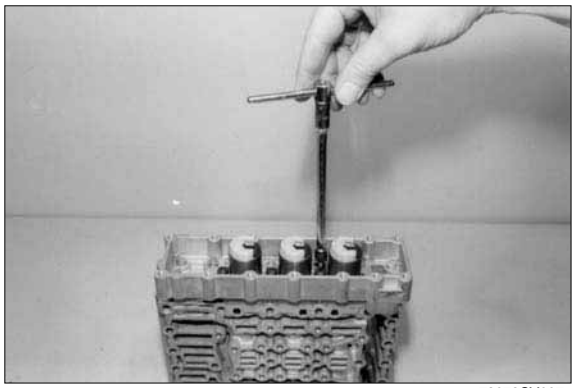
(5) Loosen socket head screws.
Separate cover from housing and cable harness.
Box spanner 5873 042 002


73073CV005

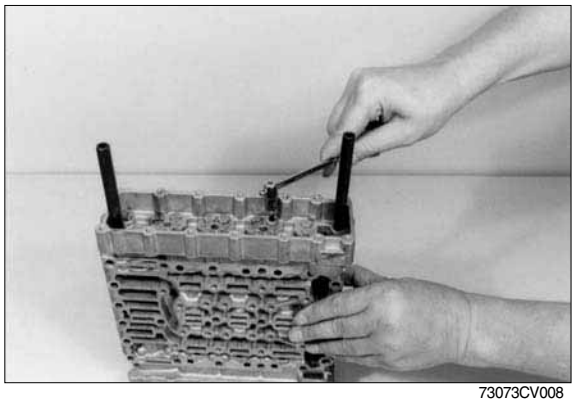
(6) Disassemble opposite cover.
Disconnect pressure regulator and remove cable harness.


73073CV006

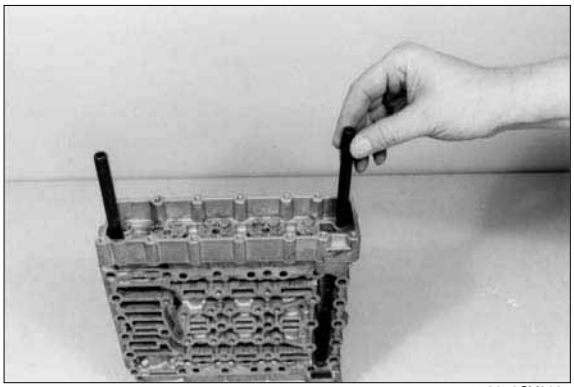
(7) Loosen socket head screws, remove fixing plate and pressure regulators(3EA).
Box spanner 5873 042 002


73073CV007

(8) Loosen two socket head screws and locate housing provisionally, using adjusting screws(Housing is under spring preload).
Now, loosen remaining socket head screws.
Box spanner 5873 042 002
Adjusting screws 5870 204 036

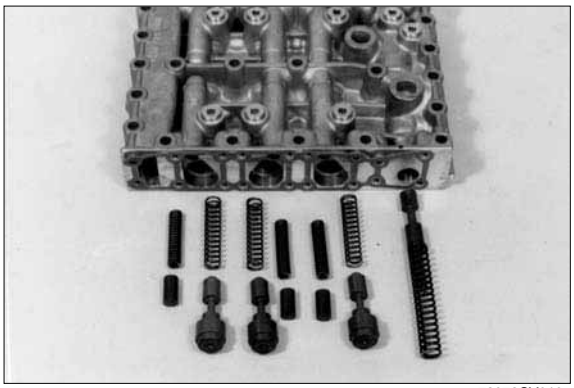

73073CV008

(9) Separate housing from valve housing by loosening the adjusting screws uniformly.
Adjusting screws 5870 204 036



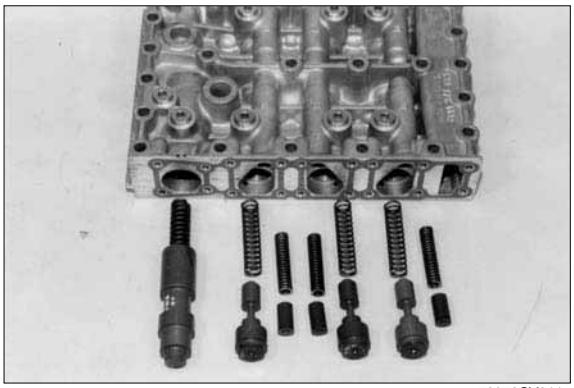
73073CV009

(10) Remove components.



73073CV010

(11) Remove opposite pressure regulators, housing as well as components accordingly.

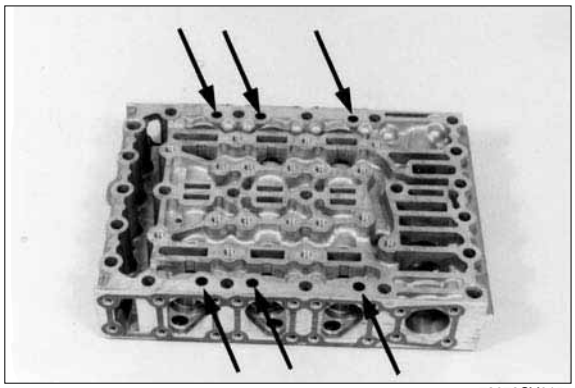


73073CV011

2) ASSEMBLY

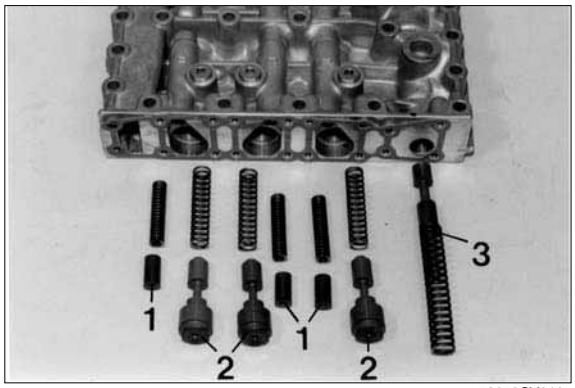
※ Check all components for damage and renew if necessary.
Prior to the installation, check free travel of all moving parts in the housing.
Spools can be exchanged individually.
Oil the components prior to the assembly.
Insert diaphragms with the concave side showing upward until contact is obtained.

※ Installation position, see arrows.



73073CV015

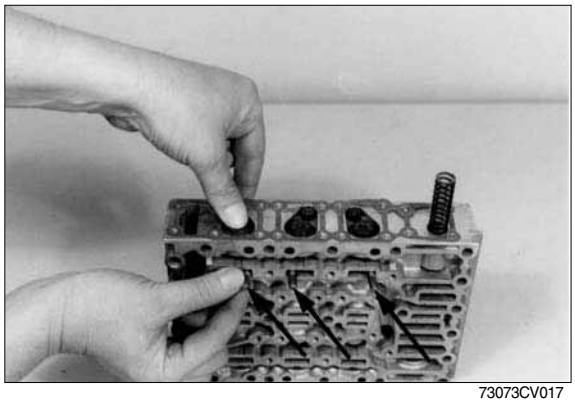
(1) Illustration on the right shows the following components.
1 Vibration damper
2 Follow-on slide
3 Pressure reducing valve



73073CV016

(2) Install components according to figure (1).

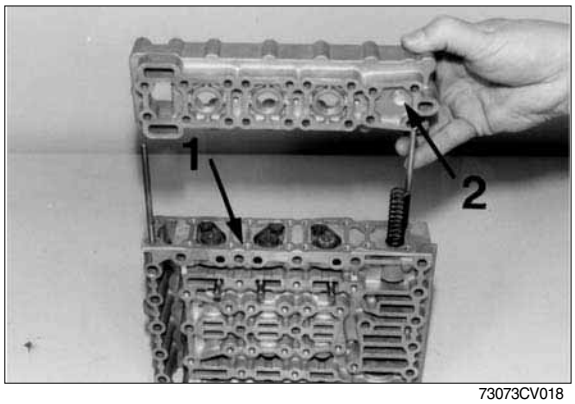
※ Preload compression spring of the follow-on slides and locate spool provisionally by means of cylindrical pins ø 5.0mm (Assembly aid), see arrows.



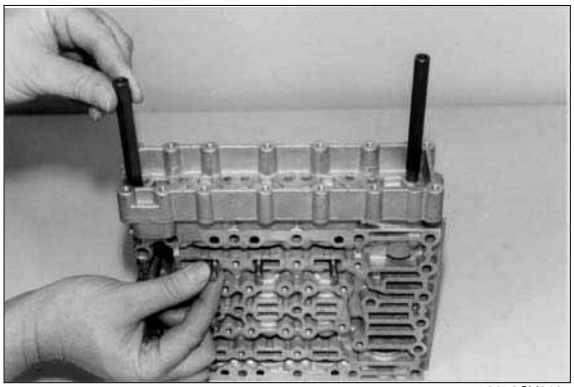
73073CV017

(3) Install two adjusting screws.
Assemble gasket(Arrow 1) and housing cover. Now, position the housing cover uniformly, using adjusting screws, until contact is obtained and remove cylindrical pins(Assembly aid) again(See the next figure).

※ Pay attention to the different housing covers.
Install recess ø 15mm (Arrow 2), facing the spring of the pressure reducing valve.
Adjusting screws 5870 204 036

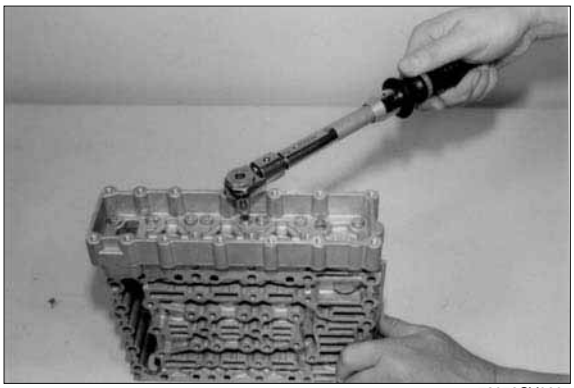


73073CV018



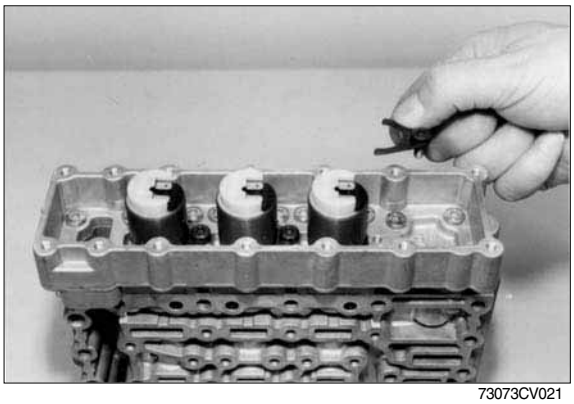
73073CV019

(4) Fasten housing cover by means of socket head screws.
· Torque limit : 0.56kgf · m(4.06lbf · ft)
Box spanner 5873 042 002



73073CV020

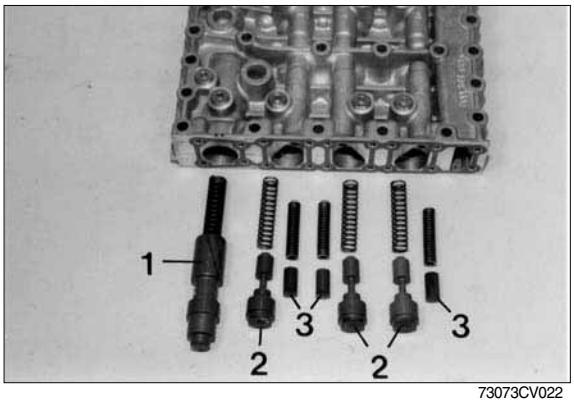
(5) Introduce pressure regulators and fix by means of fixing plates and socket head screws.
※ Install fixing plate, with the claw showing downward.
Pay attention to the radial installation position of the pressure regulators, see figure.
· Torque limit : 0.56kgf · m(4.06lbf · ft)
Box spanner 5873 042 002



73073CV021

Pre assemble opposite side

(6) Illustration on the right shows the following components.
1 Main pressure valve
2 Follow on slide
3 Vibration damper

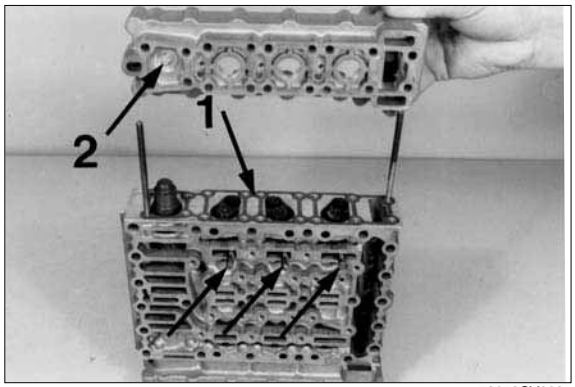


73073CV022

(7) Install components according to figure (6).
Preload compression springs of the follow-on slides and locate spool provisionally by means of cylindrical pins ø 5.0mm (Assembly aid), see arrows.
Install two adjusting screws.
Assemble gasket(Arrow 1) and housing cover, and position them uniformly against shoulder, using adjusting screws.

※ Pay attention to the different housing covers-install the recess ø 19mm(Arrow 2), facing the main pressure valve.
Now, fasten housing cover by means of socket head screws.
· Torque limit : 0.56kgf · m(4.06lbf · ft)
Remove cylindrical pins(Assembly aid) again.

Adjusting screws	5870 204 036
Box spanner	5873 042 002



73073CV023

(8) Introduce pressure regulators and fix by means of fixing plates and socket head screws.

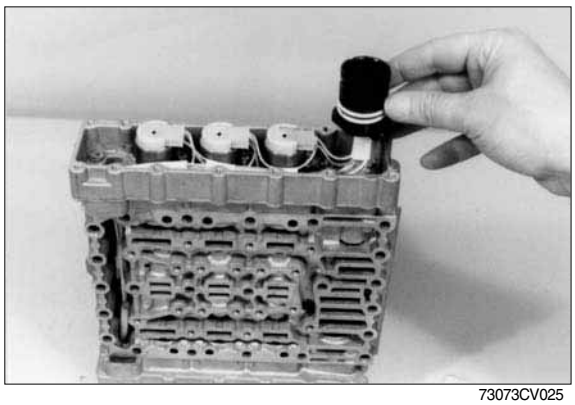
※ Install fixing plates, with the claw showing downward.
Pay attention to the radial installation position of the pressure regulators, see figure.
· Torque limit : 0.56kgf · m(4.06lbf · ft)

Box spanner	5873 042 002

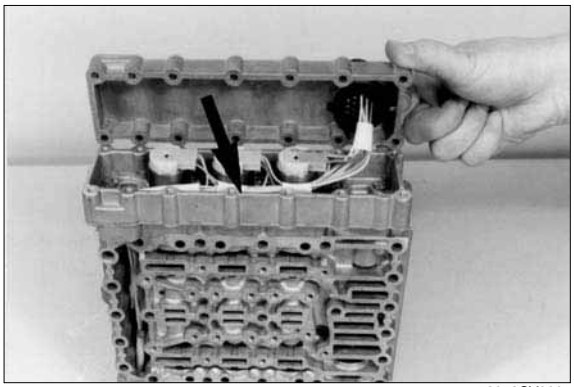

73073CV024

(9) Introduce cable harness and connect pressure regulators(6EA).

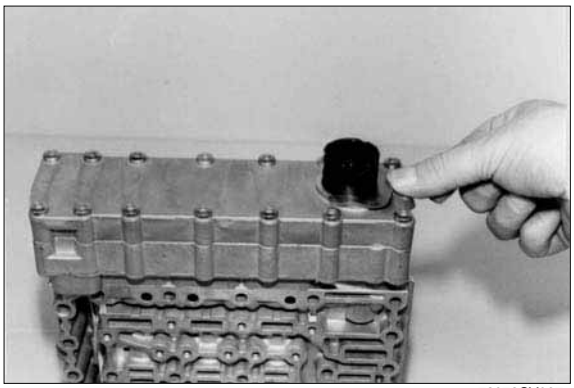
※ Pay attention to the installation position of the cable harness, ass also markings (See figure(2), page 3-85).


73073CV025

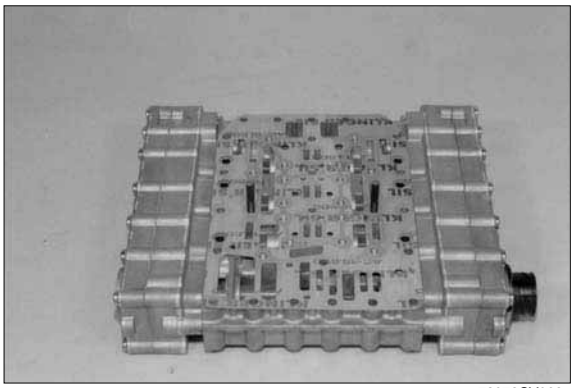
(10) Introduce female connector against shoulder, with the groove facing the guide nose of the cover.
Install gasket(Arrow) and fasten cover by means of socket head screws.
· Torque limit : 0.56kgf · m(4.06lbf · ft)
Box spanner 5873 042 002


73073CV026

(11) Fix female connector by means of retaining clamp, see figure.
Install opposite cover.

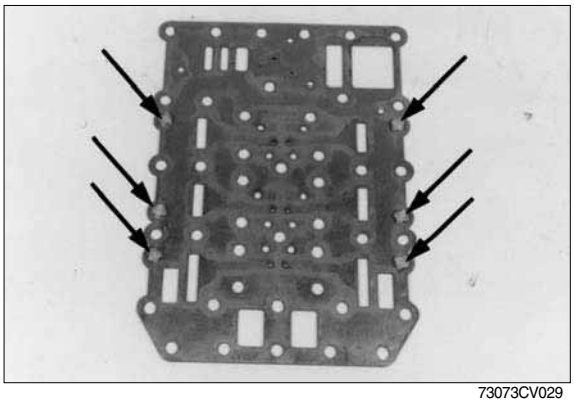

73073CV027

(12) Install two adjusting screws and mount gasket Ⅰ.
※ Pay attention to the different gaskets, see on the right figure and (15).
Adjusting screws 5870 204 063

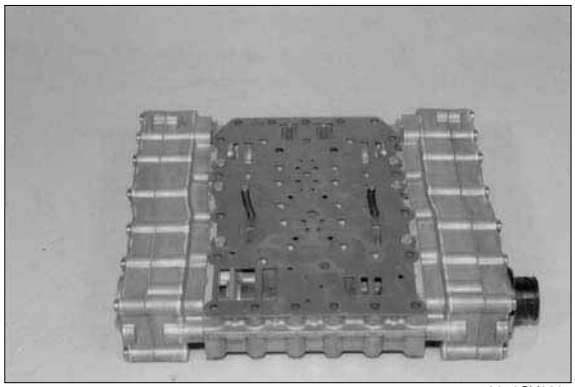

73073CV028

Intermediate plate-Version with screens

(13) Insert screws(6EA) flush mounted into the bore of the intermediate plate, see arrow.
※ Pay attention to the installation position-screws are showing upward(Facing the duct plate).

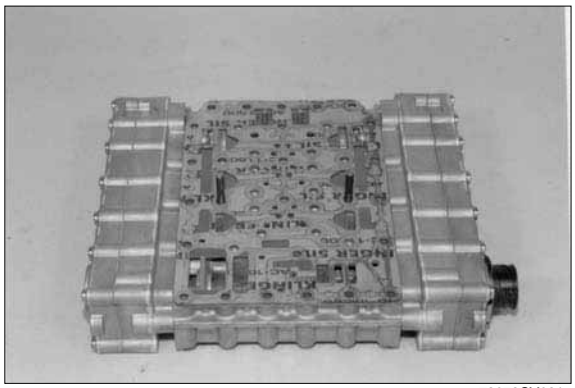

73073CV029

(14) Mount intermediate plate, with the screens showing upward.



73073CV030

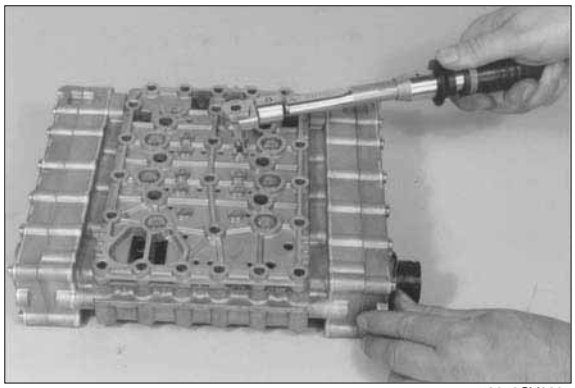
(15) Mount gasket Ⅱ.



73073CV031

(16) Mount duct plate and fasten it uniformly by means of socket head screws.
- Torque limit : 0.97kgf · m(7.0lbf · ft)

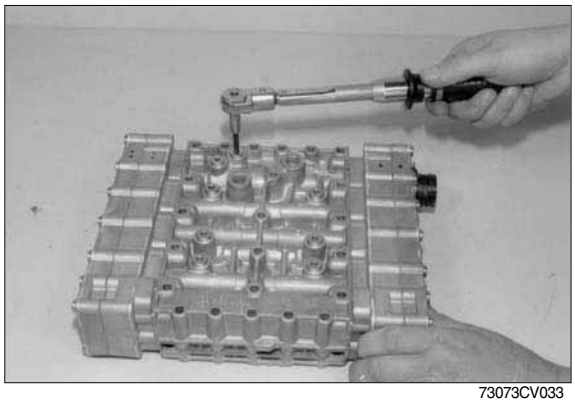
Box spanner 5873 042 002



73073CV032

(17) Equip screw plug(8EA) with new O-rings and install them.
- Torque limit : 0.56kgf · m(4.06lbf · ft)

※ The installation of the hydraulic control unit is described, starting from page 3-142.

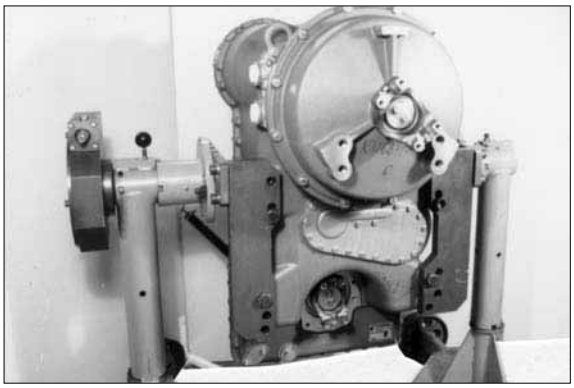


73073CV033

2. POWERSHIFT TRANSMISSION

Fasten transmission of the assembly car.

Assembly car	5870 350 000
Strips	5870 350 063
Support	5870 350 090



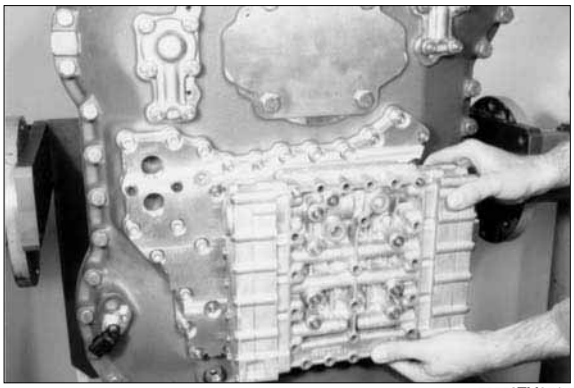
75773TM050

1) DISASSEMBLY

(1) Separate hydraulic control unit and duct plate from gearbox housing

① Loosen two socket head screws and install adjusting screws.
Now, loosen remaining socket head screws and separate valve housing from duct plate.

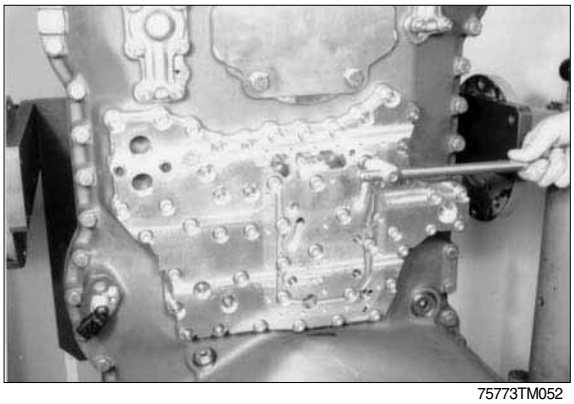
Adjusting screws(M6)	5870 204 063
Box spanner	5873 042 002



75773TM051

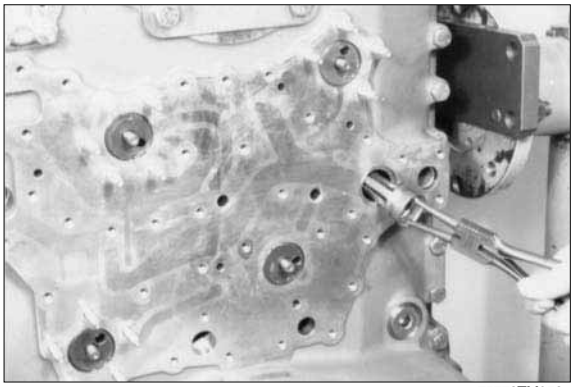
② Remove both gaskets and intermediate plate.
Loosen socket head screws as well as hexagon nuts and separate duct plate from gearbox housing.
Now, remove gasket.

Box spanner	5873 042 004



75773TM052

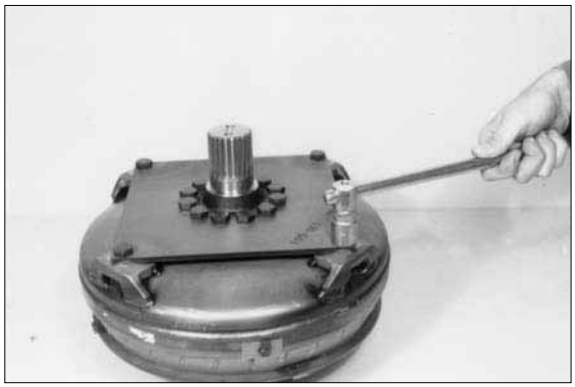
③ Pull converter safety valve out of the housing bore.



75773TM053

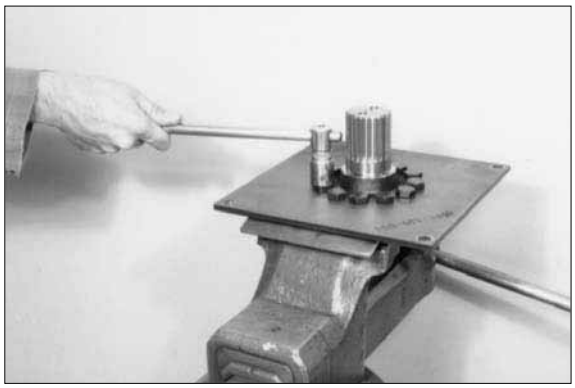
(2) Converter

① Loosen hexagon head screws and separate diaphragm from the converter.



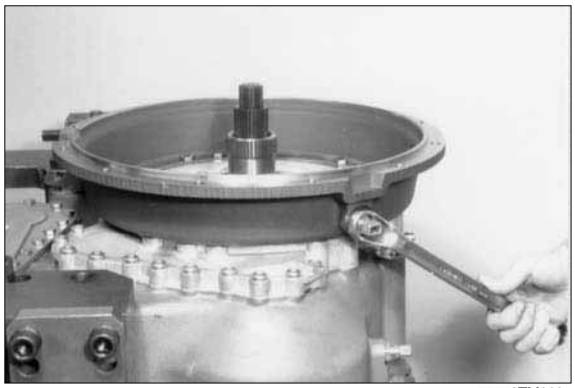
75773TM060

② Loosen hexagon head screws and separate drive shaft from the diaphragm.



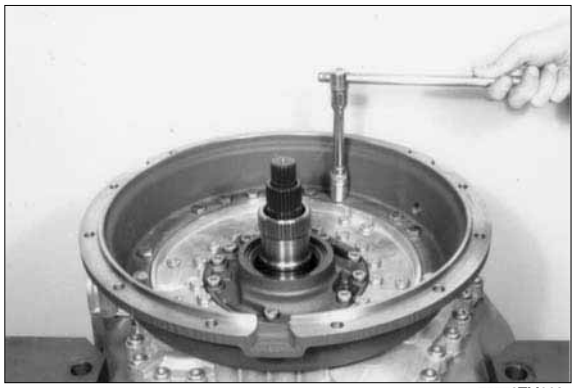
75773TM061

③ Remove inductive transmitter(Engine).



75773TM062

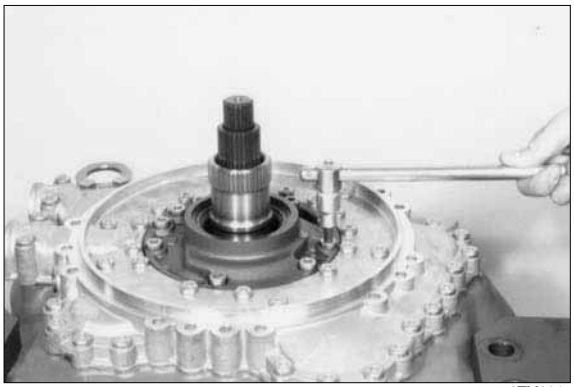
④ Loosen hexagon head screws and remove converter bell.



75773TM063

(3) Hydraulic pump

① Loosen socket head screws.



75773TM064

② Apply separating device on the gear teeth runout of the stator shaft and pull pump(Compl.) by means of two leg puller carefully out of the housing bores.

Separating device 5870 300 024
Two leg puller 5870 970 004



75773TM065

③ Separate hydraulic pump from stator shaft.

Separate control disk from pump.

※ If traces due to running in should be encountered in the pump housing or on the control disk, the complete pump has to be renewed.

Now, lay on control disk again and fix it by means of grooved pins(2EA).

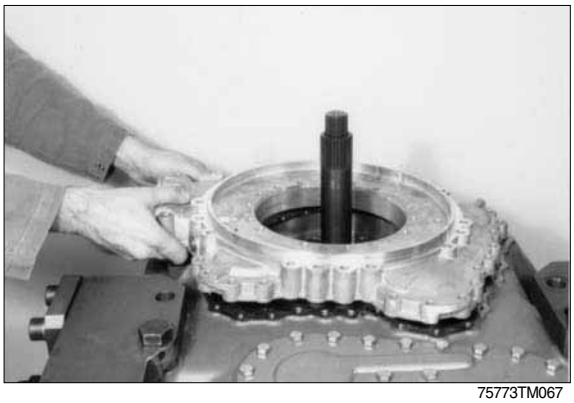


75773TM066

④ Loosen socket head screws as well as two hexagon head screws and remove oil feed housing.

Now, remove gasket.

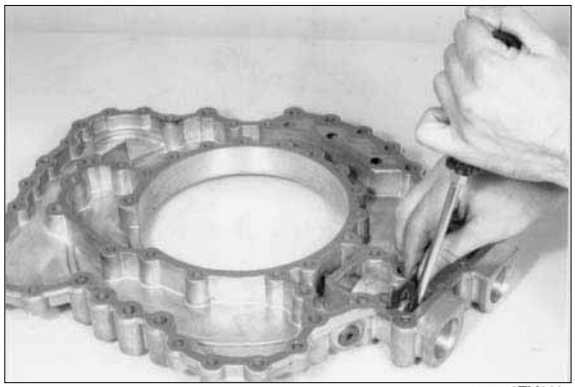
Box spanner 5873 024 004



75773TM067

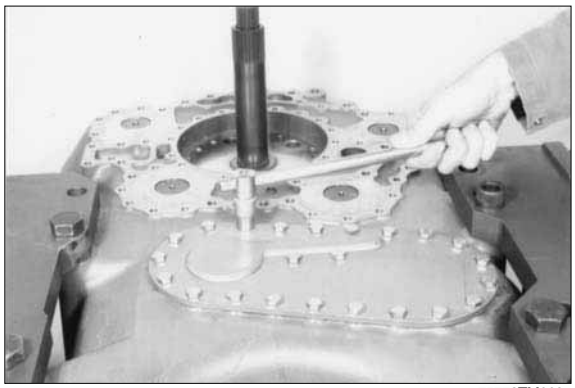
(4) Converter back pressure valve

① Preload compression spring and remove lock plate.
Remove released components.



75773TM068

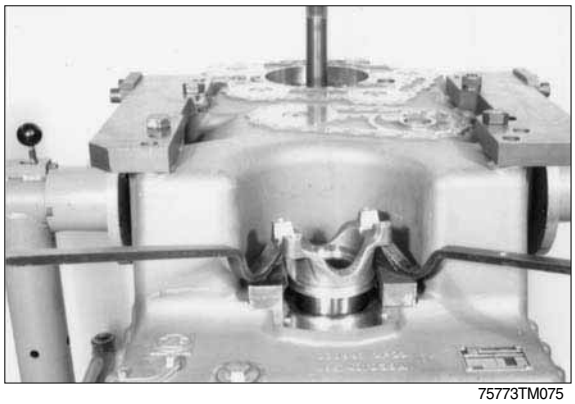
② Loosen hexagon head screws.
Remove cover and gasket.



75773TM069

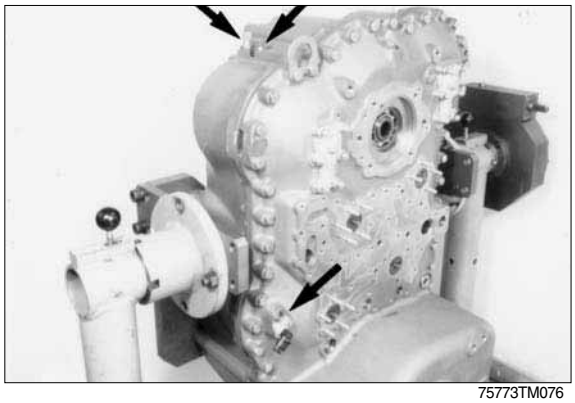
(5) Remove output, input and clutches

① Remove lock plate, loosen hexagon head screws and pry converter side output flange off the shaft.
Now, pry shaft seal out of the housing bore.
Tilt transmission 180° and remove rear side output flange accordingly.
Pry bar 5870 345 065



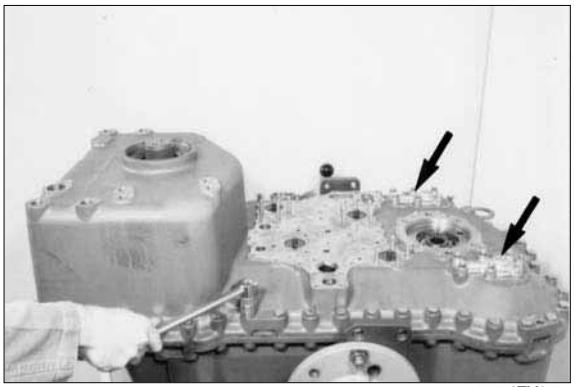
75773TM075

② Remove speed sensor as well as both inductive transmitters(Arrows).

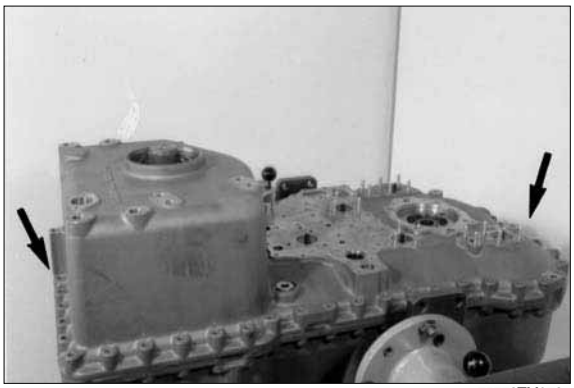


75773TM076

③ Loosen hexagon nuts and remove both covers(Arrows).
Loosen screw connection(Housing/ Housing cover).


75773TM077

④ Drive both cylindrical pins out(Arrows).

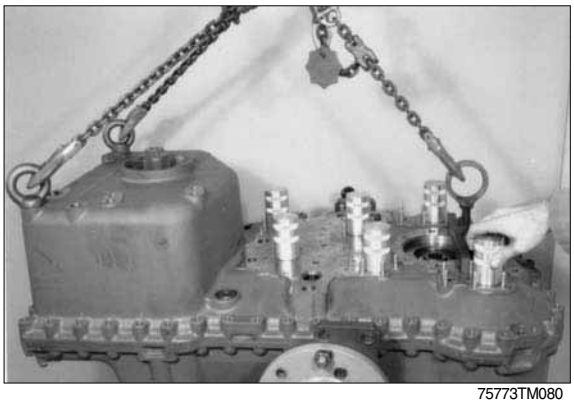

75773TM078

※ The following figures show the common removal of all clutches.
The removal of single clutches without use of the special tool(Handles 5870 260 010) is due to the installation conditions extremely difficult.

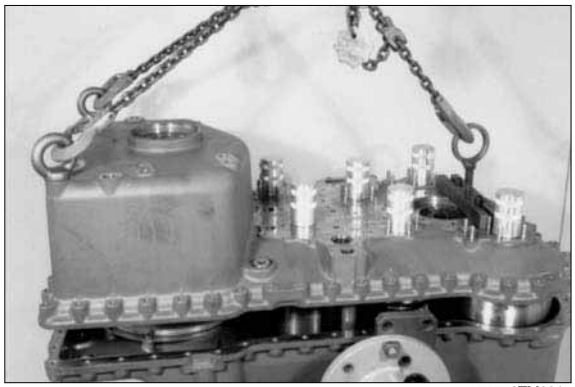
Besides there is the danger of injuries.

⑤ Locate all clutches by means of handles in the housing cover.
Install eye bolts and hang in the lifting device.

Handle(6 pieces needed)	5870 260 010
Eye bolt(M20, 2EA)	0636 804 003
Eye bolt(M16, 1EA)	0636 804 001
Puller device	5870 000 017
Lifting chain	5870 281 047


75773TM080

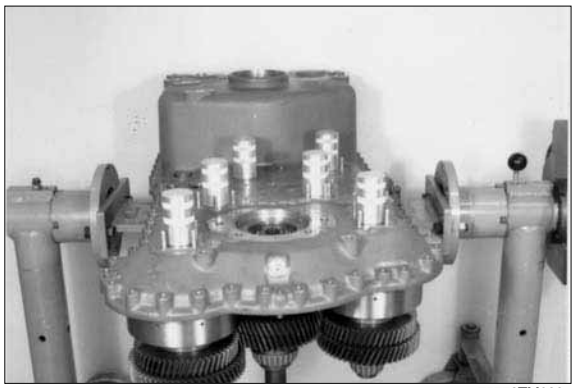
⑥ Separate housing cover along with clutches from the gearbox housing, using lifting device.



75773TM081

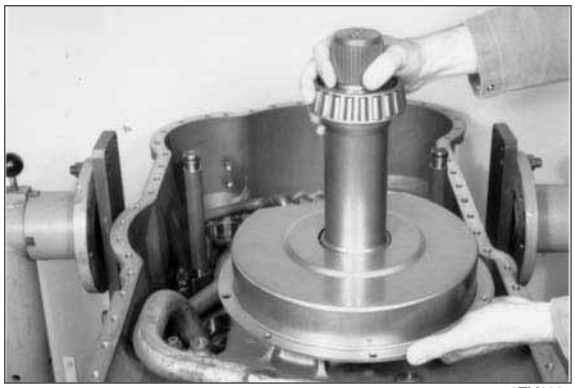
⑦ Fasten housing cover on the assembly car.

Assembly car	5870 350 000
Clamping bracket	5870 350 089



75773TM082

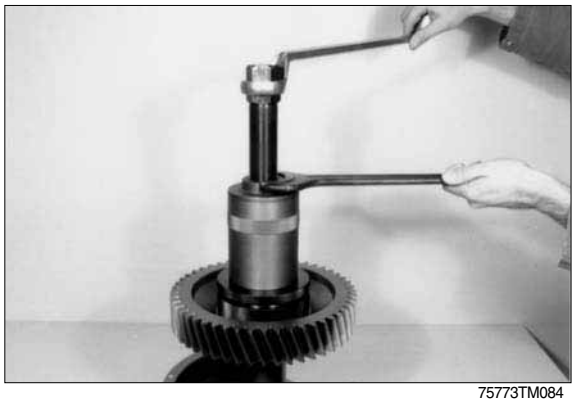
⑧ Loosen socket head screws and remove output shaft as well as the two oil collecting plate.



75773TM083

⑨ Pull off tapered roller bearing.
Remove opposite tapered roller bearing accordingly.

Grab sleeve	5873 002 038
Basic set	5873 002 001

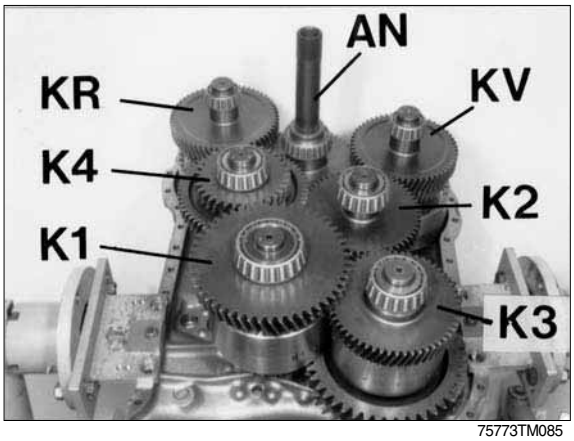


75773TM084

⑩ Tilt housing cover 180°.

Illustration on the right shows the arrangement of the single clutches and the input in the housing cover.

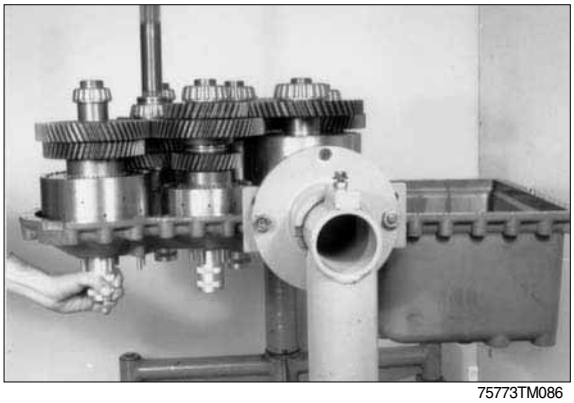
AN	Input
KV	Clutch-Forward
KR	Clutch-Reverse
K1	Clutch-1st speed
K2	Clutch-2nd speed
K3	Clutch-3rd speed
K4	Clutch-4th speed



75773TM085

⑪ Remove handles(See figure).

Handles 5870 260 010


75773TM086

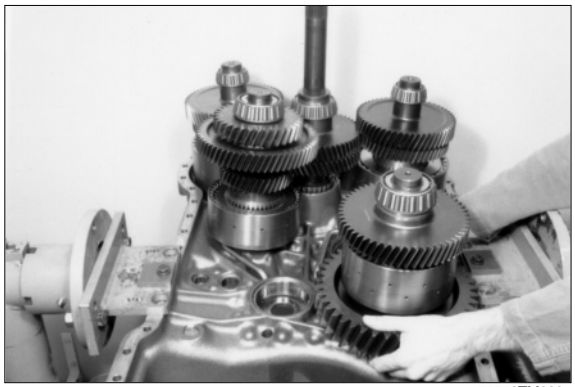
⑫ Lift clutch K4 a bit by means of pry bars and remove clutch K1.


75773TM087

⑬ Remove clutch K2.


75773TM088

⑭ Remove clutch K3.



75773TM089

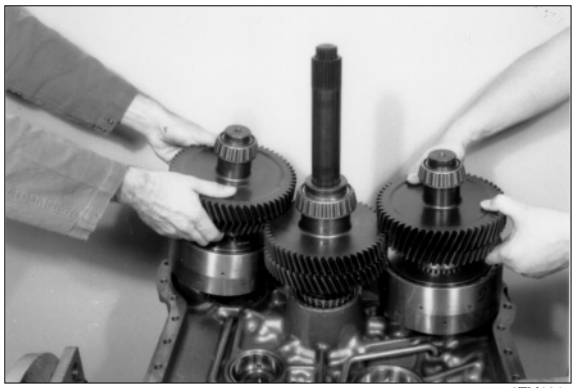
⑮ Lift clutch KV and KR by means of pry bars and remove clutch K4.
Pry bar 5870 345 065



75773TM090

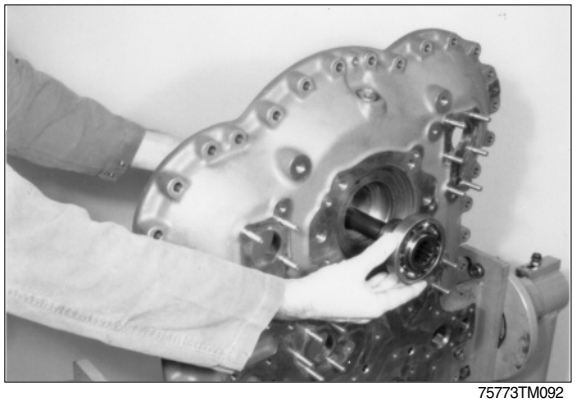
⑯ Lift clutch KV and clutch KR as well as input together out of the housing cover.
Remove bearing outer races out of the housing bores.

※ If contrary to the recommendation the tapered roller bearings of the clutches as well as of the input and output will not be renewed, the allocation(Bearing inner races to bearing outer races) must at least be maintained.
Mark bearing inner race and bearing outer race accordingly to each other.



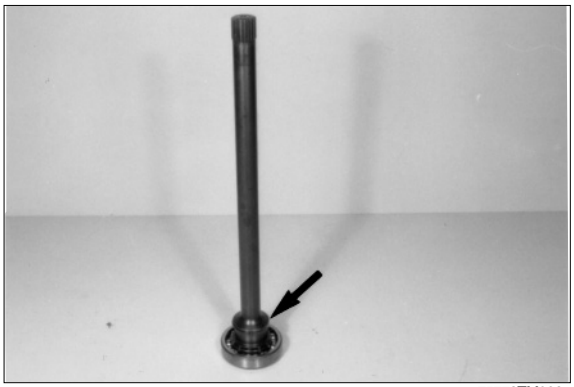
75773TM091

⑰ Tilt housing cover 90°.
Squeeze circlip out and separate pump shaft from housing cover.



75773TM092

⑱ Squeeze rectangular ring out(Arrow) and press ball bearing from the shaft.

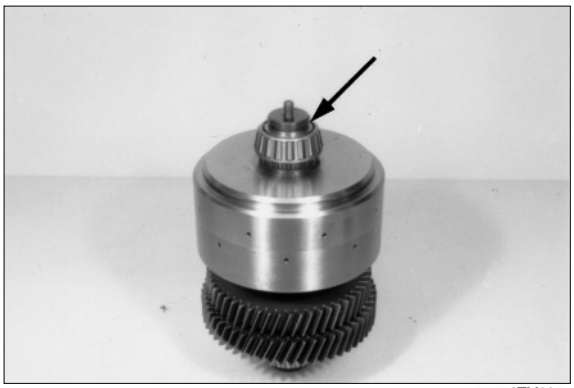


75773TM093

(6) Disassemble clutch KV and KR

※ The following figures show the disassembly of clutch KV.

① The disassembly of clutch KR is similar. Squeeze rectangular ring out(Arrow).



75773TM095

② Pull tapered roller bearing from the shaft. Remove opposite tapered roller bearing accordingly.

Grab sleeve	5873 001 057
Grab sleeve	5873 001 059
Basic set	5873 001 000



75773TM096

③ Squeeze circlip out.

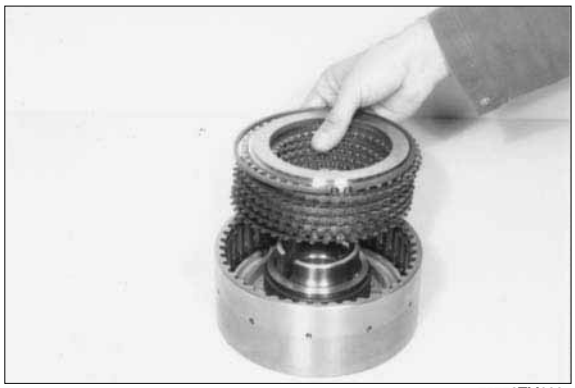


75773TM097

④ Separate plate carrier from the shaft.
Three leg puller 5870 971 003


75773TM098

⑤ Squeeze snap ring out and remove plate pack.


75773TM099

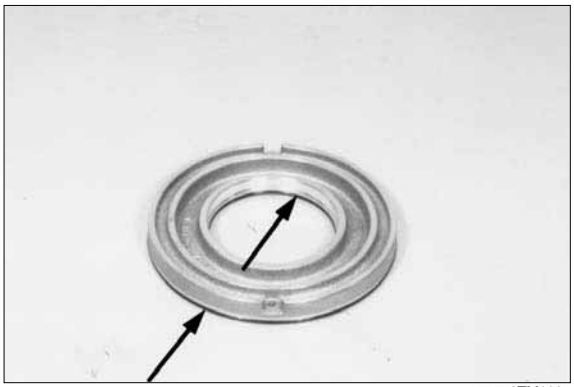
⑥ Preload compression spring, squeeze snap ring out and remove components.
Assembly aid 5870 345 088


75773TM100

⑦ Lift piston by means of compressed air out of the cylinder bore and remove it.

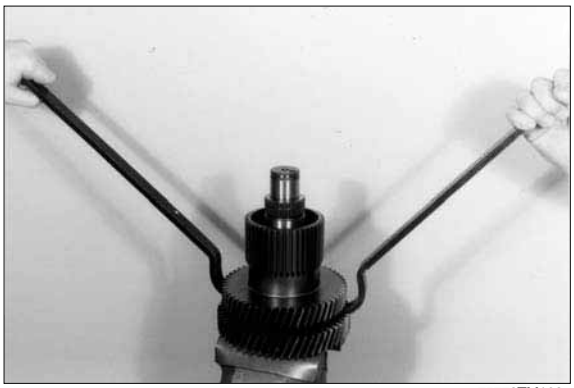

75773TM101

⑧ Remove both O-rings(Arrows).



75773TM102

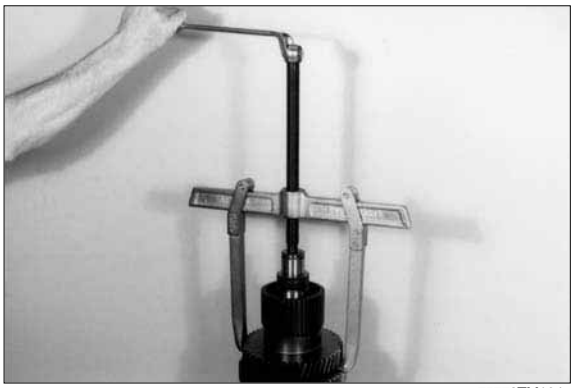
⑨ Lift idler gear a bit by means of pry bare.



75773TM103

⑩ Apply puller and separate idler gear from the clutch shaft.

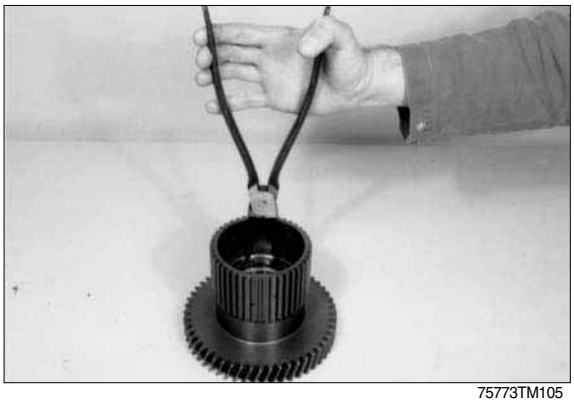
Pry bar	5870 345 065
Puller	5870 971 003



75773TM104

⑪ Squeeze circlip out and remove ball bearing.

※ The disassembly of clutch KR has to be carried out accordingly.



75773TM105

(7) Disassemble clutch K1, K2 and K3

※ The following figures show the disassembly of clutch K3.
The disassembly of the clutches K1 and K2 is similar.

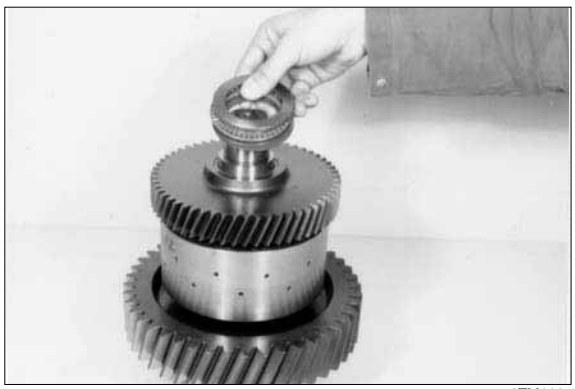
① Squeeze rectangular ring out.
Pull tapered roller bearing from the shaft.
Remove the opposite tapered roller bearing accordingly.

Grab sleeve(Bearing 33800)	5873 001 059
Grab sleeve(Bearing 39500)	5873 002 038
Basic set	5873 001 000
Basic set	5873 002 001



75773TM110

② Remove running disk, axial needle cage and axial washer.



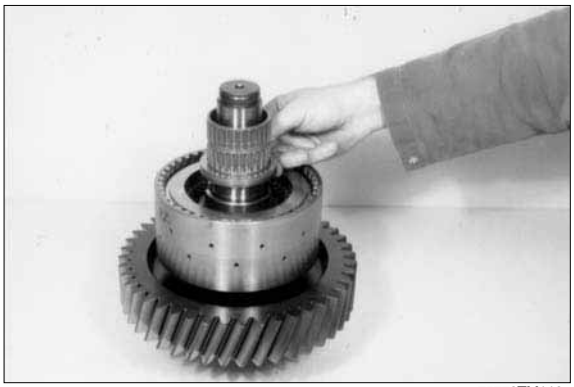
75773TM111

③ Remove idler gear.



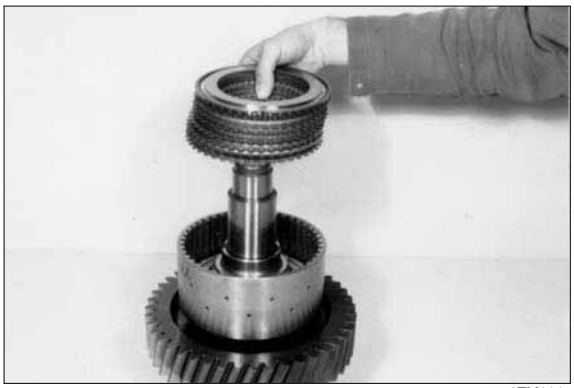
75773TM112

④ Remove both needle bearings as well as the axial bearing(Complete).



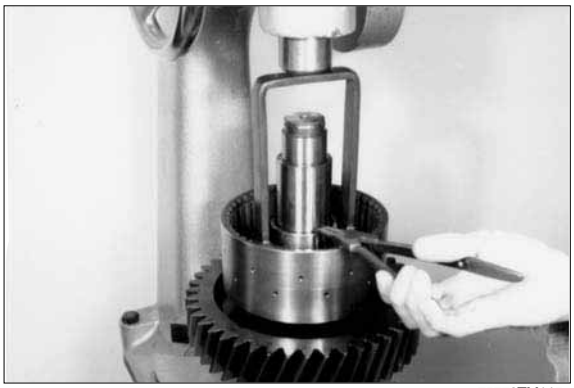
75773TM113

⑤ Squeeze snap ring out and remove plate pack.



75773TM114

⑥ Preload cup-spring pack and squeeze snap ring out.
Remove released components.
Assembly aid 5870 345 088



75773TM115

⑦ Squeeze circlip into the groove of the plate carrier.
Apply puller on the circlip and pull plate carrier from the clutch shaft.
Puller 5870 970 004
Circlip 0630 502 053



75773TM116

(8) Disassemble clutch K4

① Squeeze rectangular ring out(Arrow).



75773TM120

② Pull tapered roller bearing from the shaft. Remove opposite tapered roller bearing accordingly.

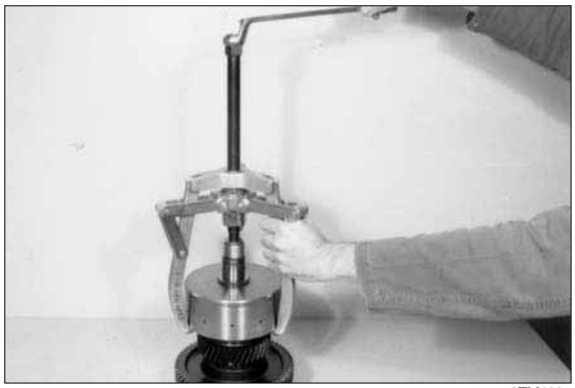
Grab sleeve	5873 001 057
Grab sleeve	5873 001 059
Basic set	5873 001 000



75773TM121

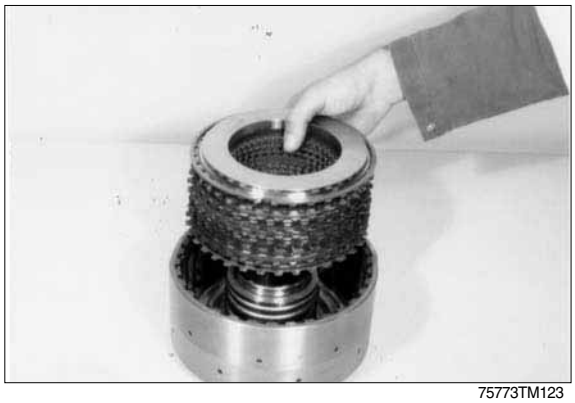
③ Squeeze circlip out and separate plate carrier from the shaft.

Three leg puller	5870 971 003



75773TM122

④ Squeeze snap ring out and remove plate pack.

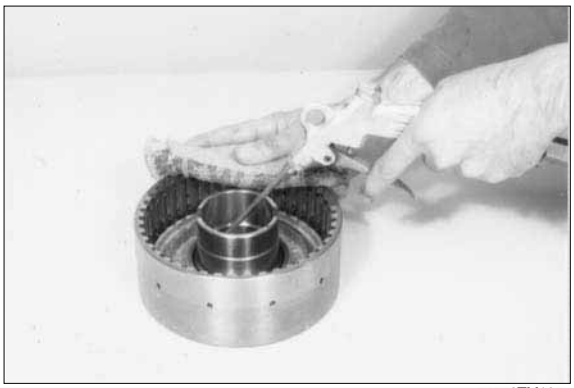


75773TM123

⑤ Preload cup-spring pack and squeeze snap ring out.
Remove released components.
Remove piston.
Assembly aid 5870 345 008

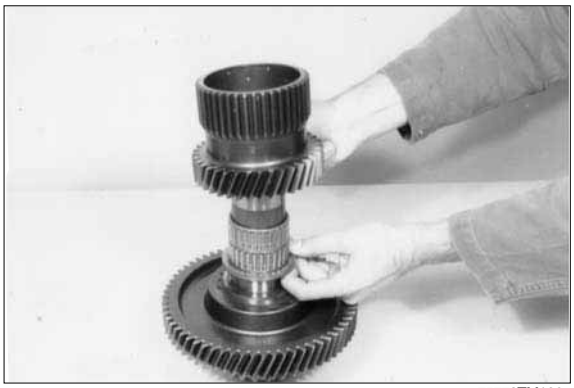

75773TM124

⑥ Lift piston by means of compressed air out of the cylinder bore and remove it.


75773TM125

⑦ Take off the idler gear and remove release components.

※ The separation of shaft and gear is not possible(Shrink fit).


75773TM126

(9) Disassemble drive shaft

① Squeeze rectangular ring out.
Pull off tapered roller bearing.
Remove opposite tapered roller bearing accordingly.

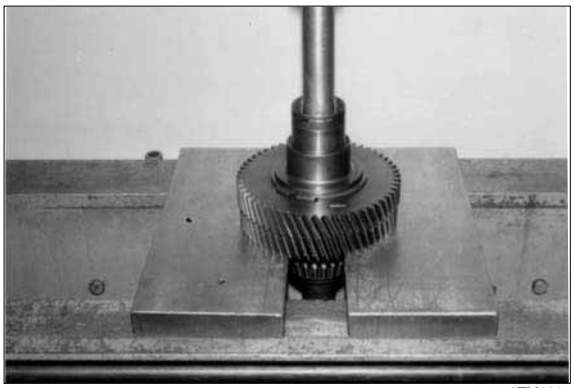
Grab sleeve	5873 002 045
Basic set	5873 002 001
Basic set	5873 002 006



75773TM130

② If necessary, press turbine shaft out of the drive shaft.

※ The turbine shaft is axially fixed with a snap ring which will be destroyed at the pressing out.



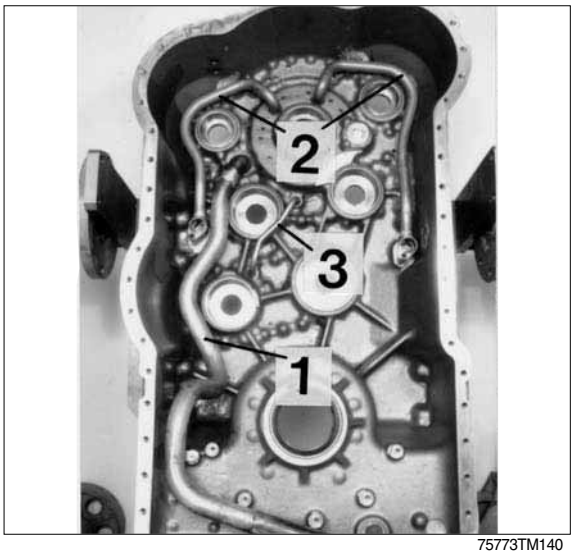
75773TM131

2) REASSEMBLY

(1) Install oil tubes

※ To ensure the correct installation of the oil tubes, the use of the indicated special tool is imperative.

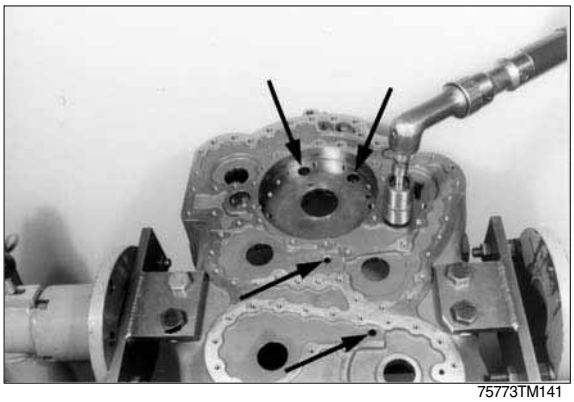
① Insert suction pipe(1), pressure pipes(2) and pressure pipelubrication(3) into the housing bores.
Fasten suction and pressure pipes by means of socket head screws.
· Torque limit : 2.3kgf · m(17.0lbf · ft)



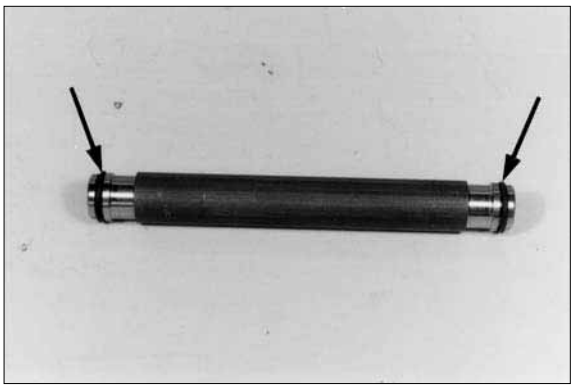
75773TM140

② Tilt housing 180°.
Roll suction as well as pressure pipes(Arrows) into the housing bores, using special tool.
The pipe end must be maximally plane with the housing face.
If necessary, equalize projection of pipe.

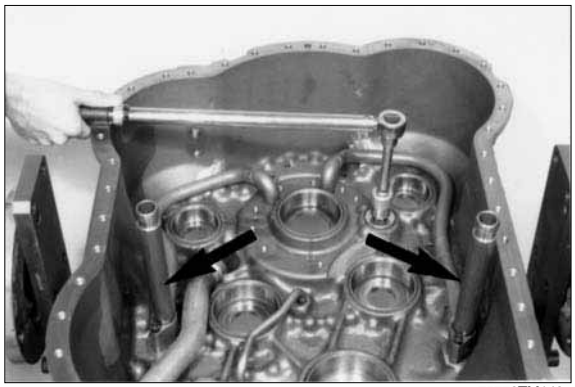
Rolling tool	5870 600 003
Rolling tool	5870 600 005
Rolling tool	5870 600 007


75773TM141

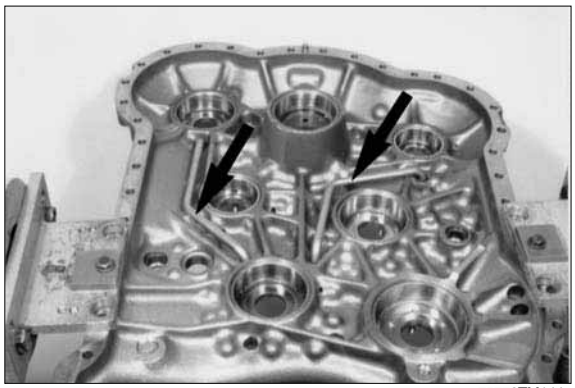
③ Insert O-rings(2EA/pipe) into the annular grooves of the two oil tubes and oil them.


75773TM142

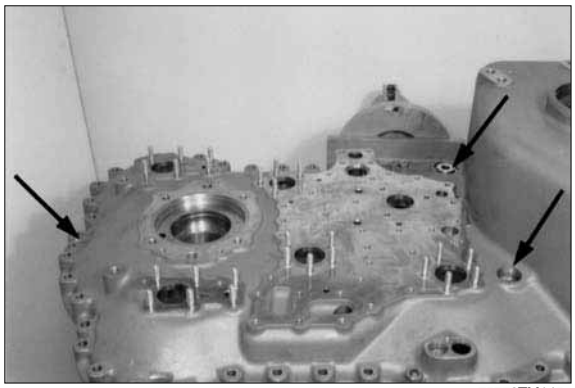
④ Assemble both oil tubes(Arrows) until contact is obtained.
Equip screw plug with new O-ring and install it.
· Torque limit : 14.3kgf · m(103lbf · ft)


75773TM143

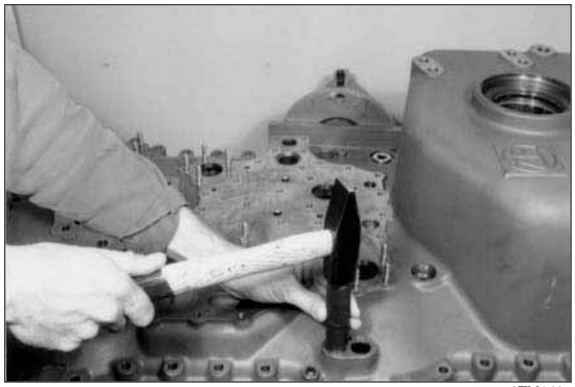
⑤ Insert both oil tubes(Arrows) into the housing cover, tilt housing cover 180° and roll oil tubes into the housing bores.
※ The tube end must be maximally plane with the housing face.
If necessary, equalize projection of the tube.
Rolling tool 5870 600 008


75773TM144

⑥ Mount studs(M8 × 25).
· Torque limit : 0.92kgf · m(6.64lbf · ft)
Wet screw in thread with loctite(Type No. 262).
Equip plugs(Arrows) with new O-rings and install them
· Torque limit(M16 × 1.5) : 4.1kgf · m (29.5lbf · ft)
· Torque limit(M18 × 1.5) : 5.1kgf · m (36.9lbf · ft)
· Torque limit(M26 × 1.5) : 8.2kgf · m (59.0lbf · ft)


75773TM145

⑦ Insert sealing cover, with the recess showing upward.
※ Wet contact face with loctite(Type No. 262).


75773TM146

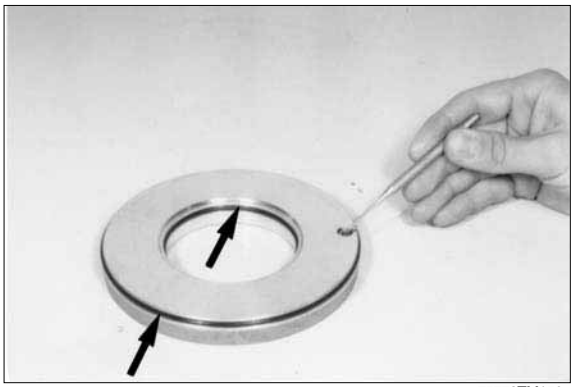
(2) Reassemble clutch KV and KR

※ The following figure show the reassembly of the clutch KV. The reassembly of the clutch KR has to be carried out accordingly.

Preassemble plate carrier

① Check function of the purge valve.

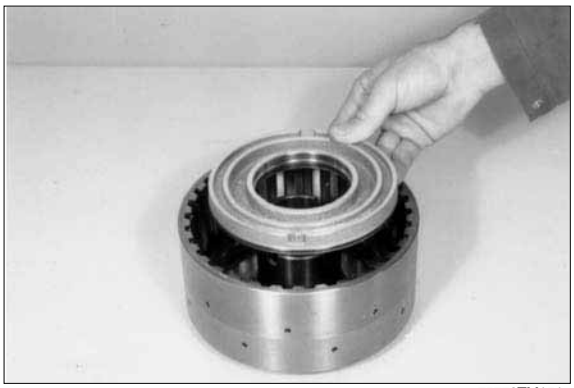
※ Ball must not stick, if necessary, clean with compressed air.



75773TM150

② Insert both O-ring(Arrows) scrollfree into the grooves of the piston and oil.
Introduce piston until contact is obtained.

※ Pay attention to the installation position, see figure.



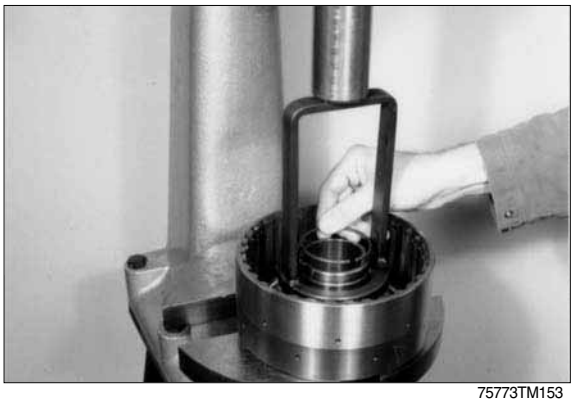
75773TM151

③ Install disk, compression spring and guide ring.



75773TM152

④ Preload compression spring and fix it by means of snap ring.
Assembly aid 5870 345 088



75773TM153

Plate pack KV, KR

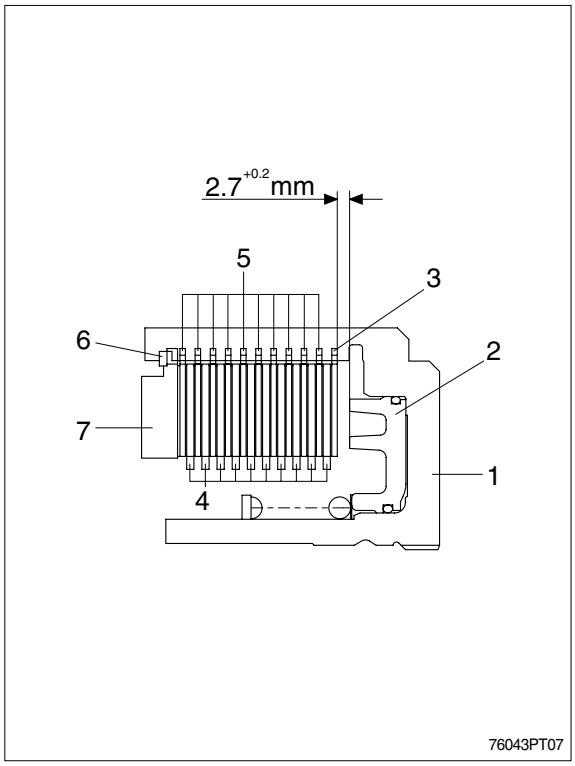
※ The plate arrangement respectively stacking of clutch KV and KR is identical.

⑤ The following draft shows the installation position of the components.

1 Plate carrier
2 Piston
3 Outer plate-one sided coated(1 piece)
4 Inner plates(10 pieces)
5 Outer plates-coated on both sides (10 pieces)
6 Snap ring(Optional s= 2.1~4.2㎜)
7 End shim

Effective number of friction surfaces = 20

※ Install outer plate 3 with the uncoated side facing the piston.
Install on the end-shim side two outer and inner plates each.



76043PT07

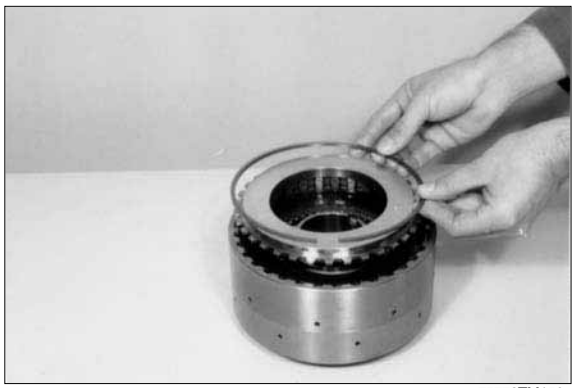
Adjust plate clearence : 2.7+0.2㎜

※ For the adjustment of the plate clearance are snap rings of different thickness available.
To ensure a faultless measuring result, install plates for the moment without oil.

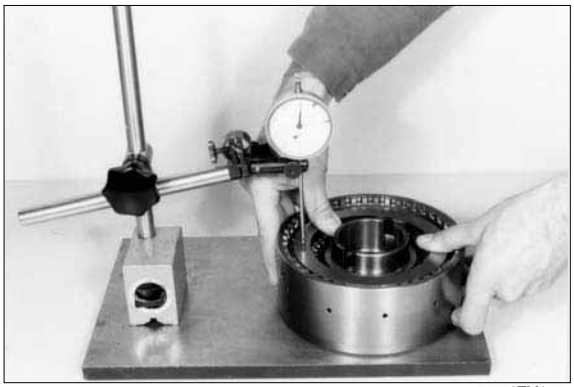
⑥ Introduce plate pack according to the upper draft.


75773TM155

⑦ Lay on the end shim and squeeze the snap ring in(e.g. s=2.55㎜)


75773TM156

⑧ Press on end shim with about 100N (10kg), apply dial indicator and set it at zero.

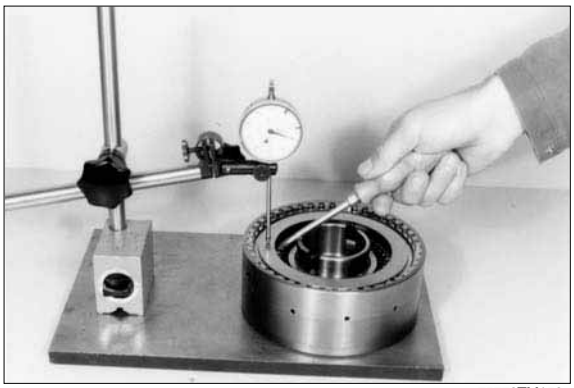

75773TM157

⑨ Now, push the end shim by means of screw driver against snap ring until contact is obtained(Upward) and read plate clearance on the dial indicator.

※ In case of a deviation from the required plate clearance, correct with corresponding snap ring(s=2.1~4.2㎜). After the adjustment of the plate clearance has been carried out, remove the plate pack, oil plates and install it again.

※ Use oil SAE 10W-30/15W-40.

Magnetic stand	5870 200 055
Dial indicator	5870 200 057

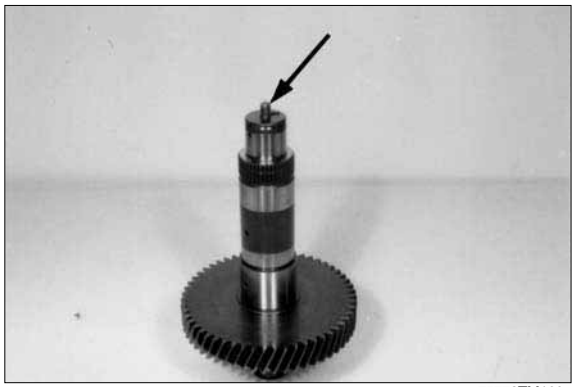

75773TM158

⑩ Introduce idler gear until all inner plates are accommodated.

※ This step makes the later assembly of the idler gear easier. Now, remove the idler gear again.


75773TM159

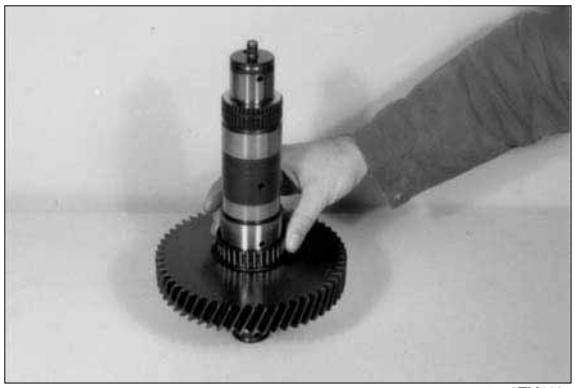
⑪ Mount stud(Arrow).
Wet screw-in thread with loctite(Type No.241).
· Torque limit(M10) : 1.7kgf · m(12.5lbf · ft)


75773TM160

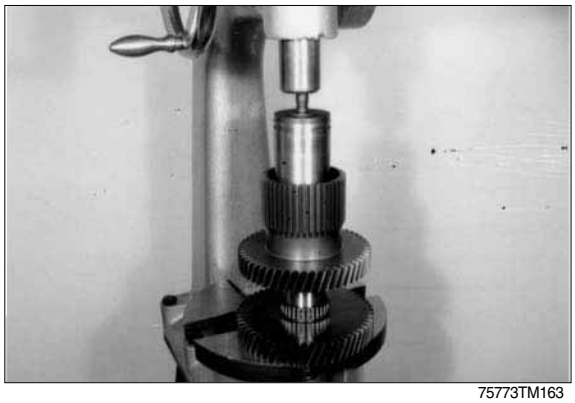
⑫ Insert ball bearing until contact is obtained and fix by means of circlip.


75773TM161

⑬ Assemble needle bearing.


75773TM162

⑭ Press idler gear against shoulder.
※ Support it on the bearing inner race.


75773TM163

⑮ Heat inner diameter of plate carrier (About 120°C).
Hot air blower 220V 5870 221 500
Hot air blower 110V 5870 221 501


75773TM164

⑯ Assemble preassembled plate carrier until contact is obtained.


75773TM165

⑰ Locate plate carrier axially by means of circlip.


75773TM166

⑱ Check function of clutch by means of compressed air.

※ At correctly installed components, the closing resp. opening of the clutch is clear audible.

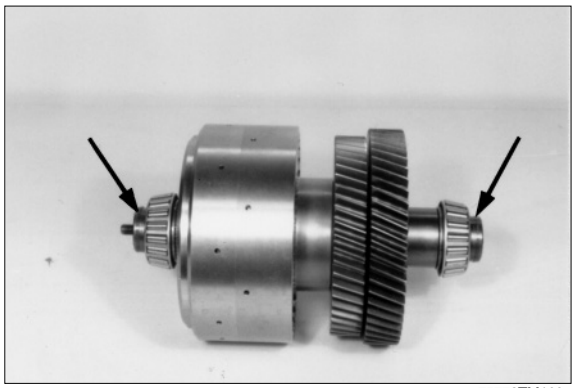

75773TM167

⑲ Press tapered roller bearing against shoulder.
Install opposite tapered roller bearing accordingly.



75773TM168

⑳ Squeeze rectangular rings in(Arrow) and let them snap in.



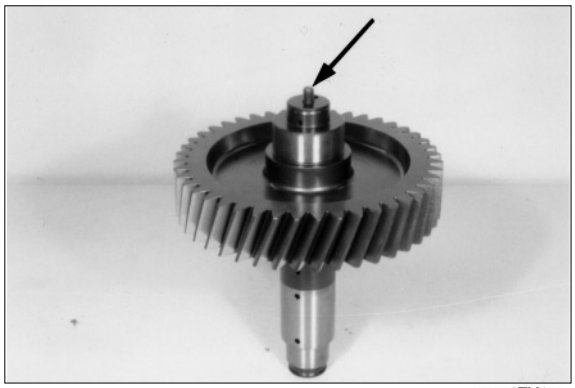
75773TM169

(3) Reassemble clutch K1, K2 and K3

※ The following figures show the reassembly of clutch K3.
The reassembly of the clutches K1 and K2 has to be carried out accordingly.

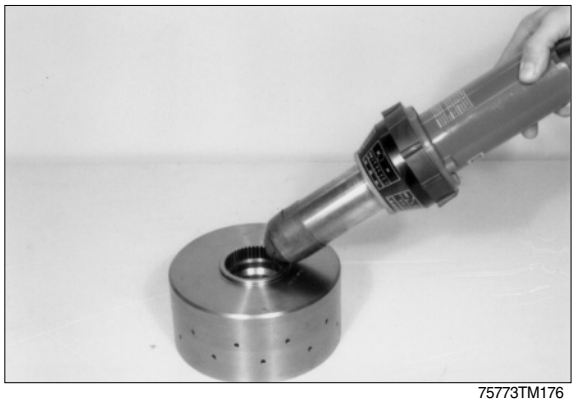
① Install stud(Arrow).

※ Wet screw in thread with loctite(Type No. 241).
· Torque limit(M10) : 1.7kgf · m(12.5lbf · ft)



75773TM175

② Heat inner diameter of plate carrier.

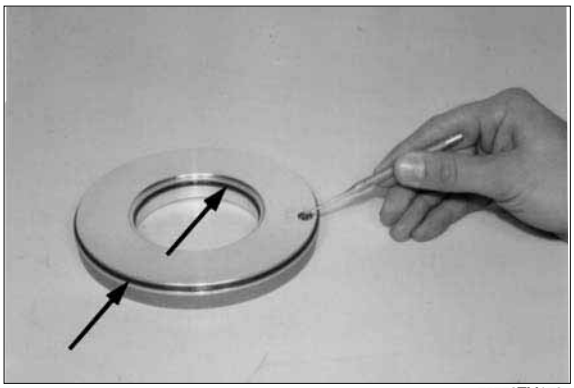


75773TM176

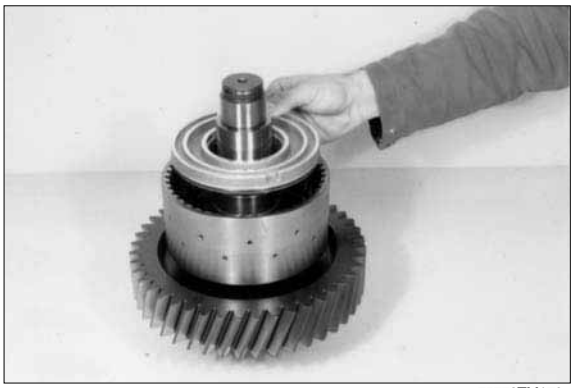
③ Assemble plate carrier until contact is obtained.
Hot air blower 220V 5870 221 500
Hot air blower 110V 5870 221 501


75773TM177

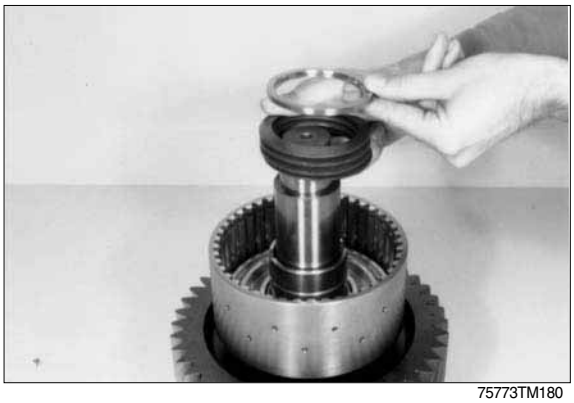
④ .Check function of the purge valve
※ Ball must not stick, if necessary clean with compressed air.
Insert both O-rings(Arrows) scrollfree into the grooves of the piston and oil.


75773TM178

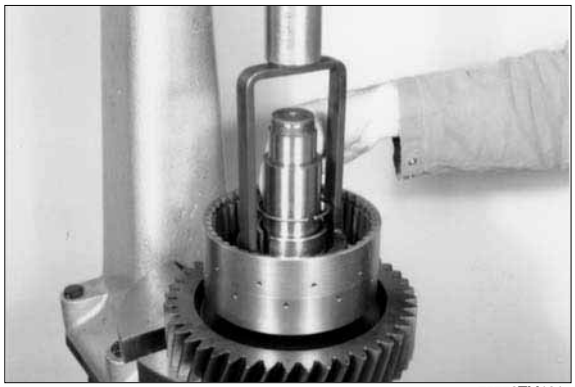
⑤ Introduce piston until contact is obtained.
※ Pay attention to the installation position, see figure.


75773TM179

⑥ Lay on cup spring pack and guide ring.
※ Pay attention to the stacking of the cup springs, see the next draft.


75773TM180

⑦ Preload cup spring pack and fix it by means of snap ring.
Assembly aid 5870 345 088


75773TM181

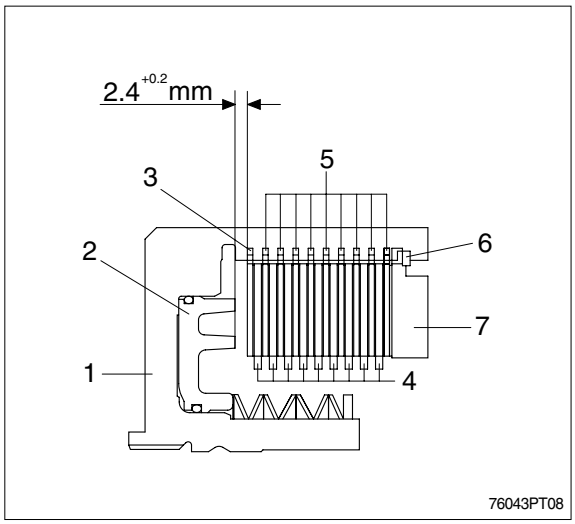
※ The plate arrangement of clutch K1 is identical with clutch K2 and K3.
In this connection see the following drafts.

Plate pack K1

1 Plate carrier
2 Piston
3 Outer plate-one side coated(1 piece)
4 Inner plates(9 pieces)
5 Outer plates-on both sides coated (9 pieces)
6 Snap ring(Optional s=2.1~4.2㎜)
7 End shim

Effective number of friction surfaces = 18

※ Install outer plate 3 with the uncoated side facing the piston.



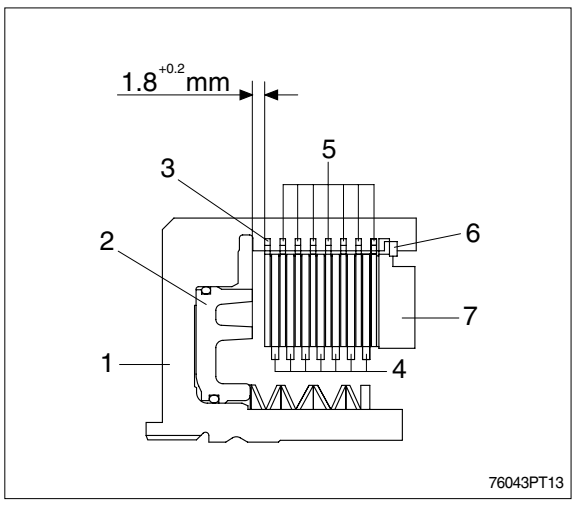
76043PT08

Plate pack K2 and K3

1 Plate carrier
2 Piston
3 Outer plate-one side coated(1 piece)
4 Inner plates(7 pieces)
5 Outer plates-on both side coated (7 pieces)
6 Snap ring(Optional s= 2.1~4.2㎜)
7 End shim

Effective number of friction surfaces = 14

※ Install outer plate 3 with the uncoated side facing the piston.
Install on the end-shim two outer and inner plates each.



76043PT13

Adjust plate clearance

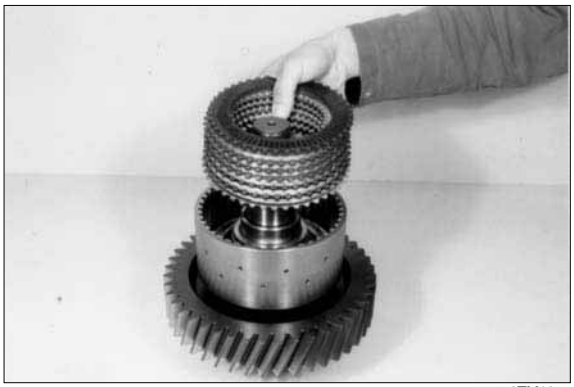
Plate clearance clutch K1 $2.4^{+0.2}$mm

Plate clearance clutch K2 and K3 $1.8^{+0.2}$mm

※ For the adjustment of the plate clearance are snap rings with different thickness available.

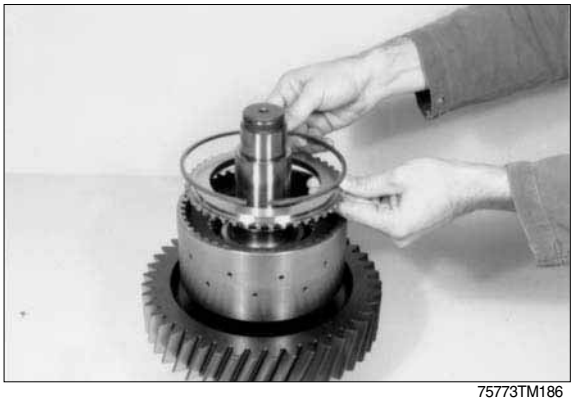
To ensure a faultless measuring result, install the plates for the moment without oil.

Introduce plate pack according to drafts / page 3-118.



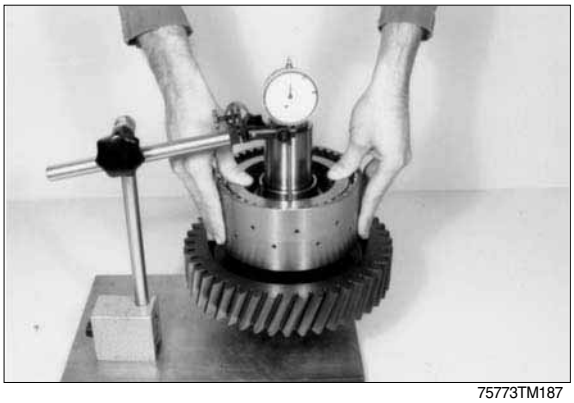
75773TM185

⑧ Lay on the end shim and squeeze circlip in(e.g. s=3.1mm).



75773TM186

⑨ Press on the end shim with about 100N (10kg), apply dial indicator and set it at zero.



75773TM187

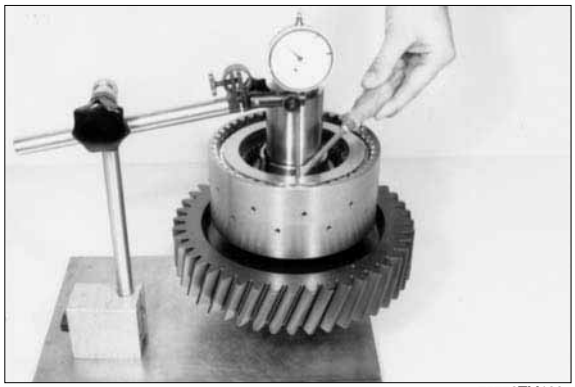
⑩ Now, push the end shim by means of screw driver against snap ring until contacts is obtained(Upward) and read plate clearance on the dial indicator.

※ In case of a deviation from the required plate clearance, correct with corresponding snap ring(s=2.1~4.2㎜).

After the adjustment of the plate clearance has been carried out, remove the plate pack, oil plates and install it again.

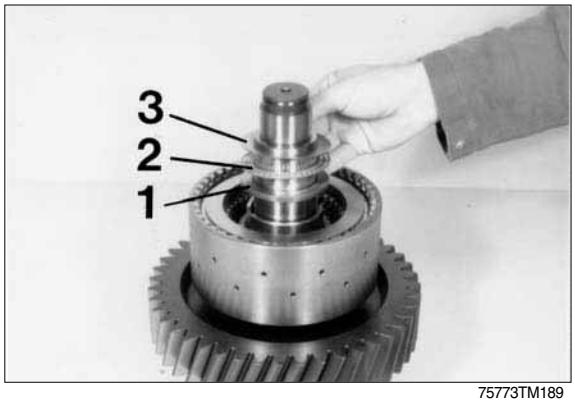
Use oil SAE 10W-30/15W-40.

Magnetic stand	5870 200 055
Dial indicator	5870 200 057


75773TM188

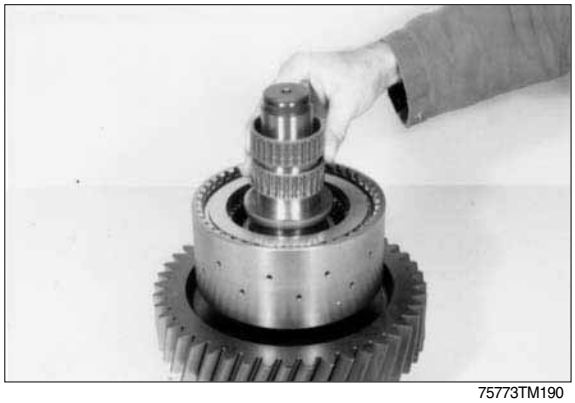
⑪ Assemble runing disk 1(55×78×5), axial needle cage 2 and axial washer 3 (55×78×1).

Install running disk 1, with the chamber facing the axial needle cage.



75773TM189

⑫ Assemble both needle bearings.


75773TM190

⑬ Introduce idler gear until all inner plates are accommodated.

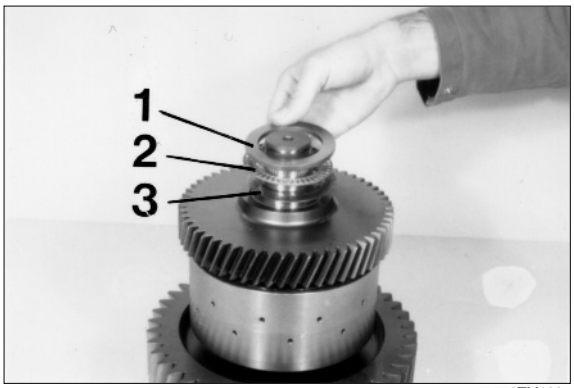


75773TM191

⑭ Assemble axial washer 3(55 × 78 × 1), axial needle cage 2 and running disk 1 (55 × 78 × 5).

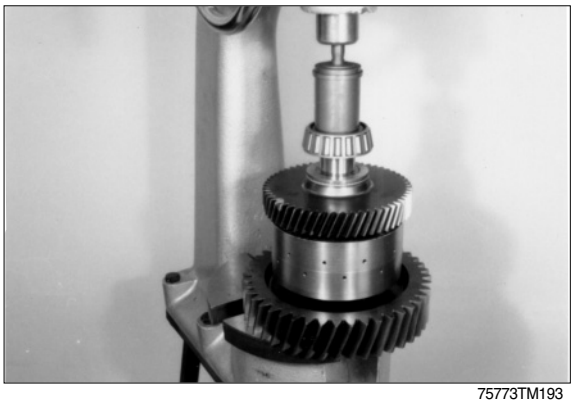
※ Install running disk 1, with the chamfer facing the axle needle cage.

※ Only if the running disk in overlapping with the shaft collar is ensured that all inner plates are accommodated.



75773TM192

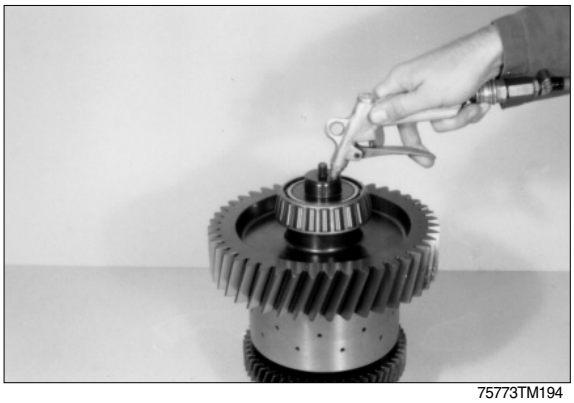
⑮ Press tapered roller bearing against shoulder.
Press opposite tapered roller bearing against shoulder.



75773TM193

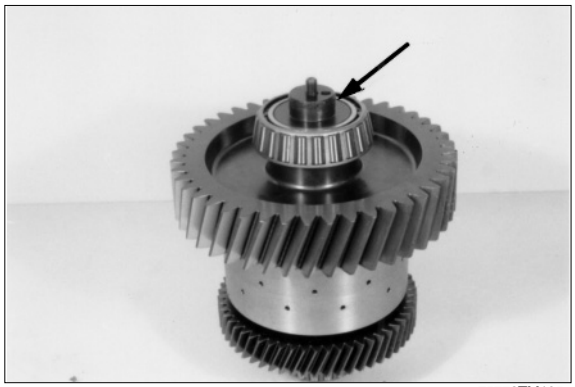
⑯ Check function of the clutch by means of compressed air.

※ At correctly installed components, the closing respectively opening of the clutch is clearly audible.



75773TM194

⑰ Squeeze rectangular ring in(Arrow) and let it snap in.
Install opposite rectangular ring accordingly.

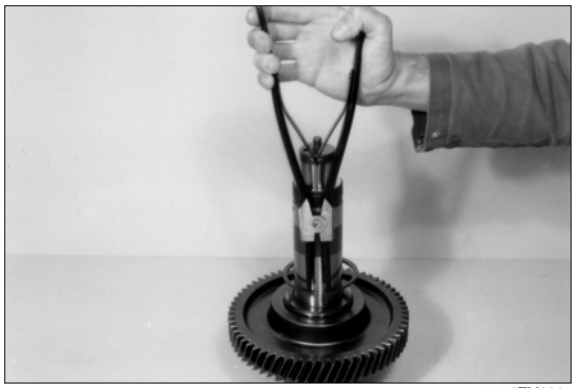

75773TM195

(4) Reassemble clutch K4

① Undercool shaft(About -80°C), heat gear (About +120°C) and assemble it until contact is obtained.


75773TM200

② Fix gear axially by means of circlip.
Set of external pliers 5870 900 015


75773TM201

③ Install stud(Arrow).

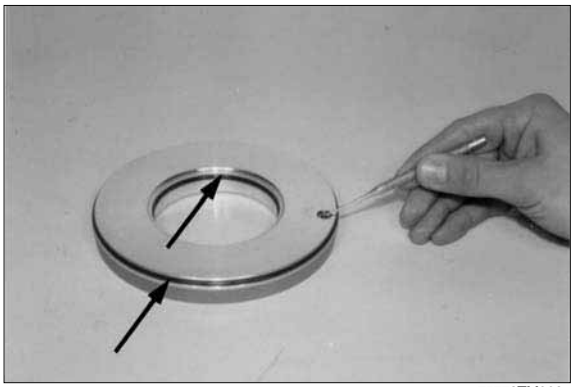
※ Wet screw-in thread with loctite(Type No. 241).

· Torque limit(M10) : 1.7kgf · m(12.5lbf · ft)


75773TM202

④ Check function of the purge valve.

※ Ball must not stick, if necessary clean with compressed air.
Insert both O-ring(Arrow) scrollfree into the grooves of the piston and oil them.



75773TM203

⑤ Introduce piston until contact is obtained.

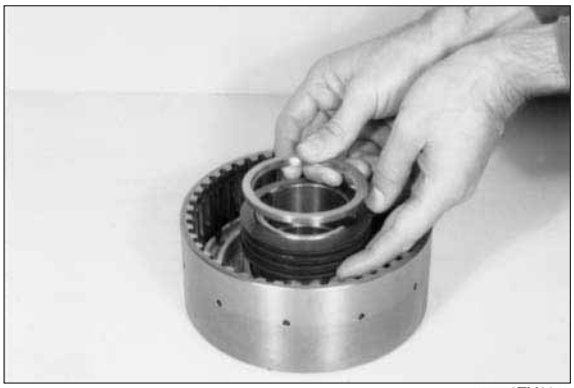
※ Pay attention to the installation position, see figure.



75773TM204

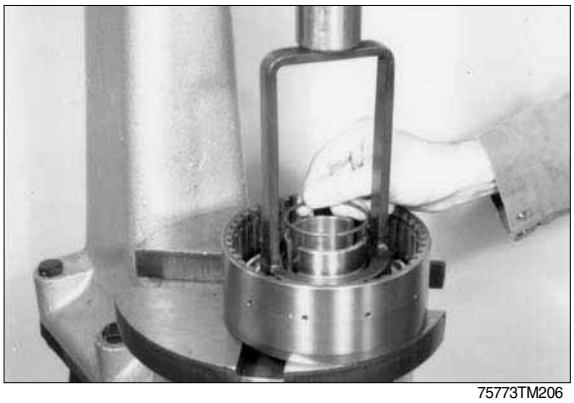
⑥ Install cup-spring pack and guide ring.

※ Pay attention to the stacking of the cup springs, see draft, page 3-124.



75773TM205

⑦ Preload cup-spring pack and fix it by means of snap ring.
Assembly aid 5870 345 088



75773TM206

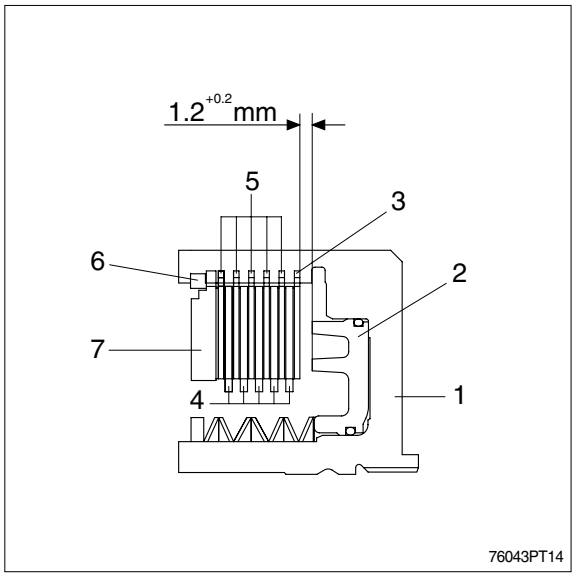
Plate pack K4

※ The following draft shows the installation position of the components.

1 Plate carrier
2 Piston
3 Outer plate-one side coated(1 piece)
4 Inner plates(5 pieces)
5 Outer plates-coated on both sides (5 pieces)
6 Snap ring(Optional s= 2.1~4.2mm)
7 End shim

Effective number of friction surfaces = 10

※ Install outer plate 3 with the uncoated side facing the piston.

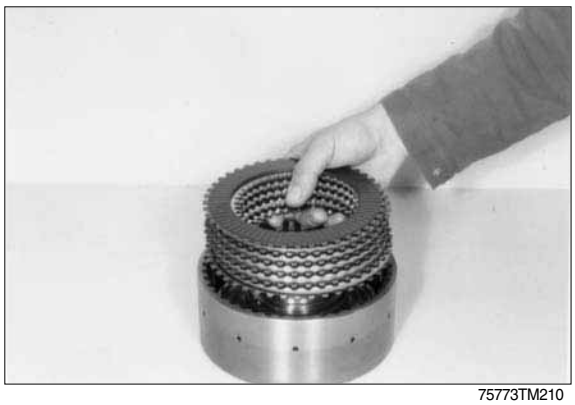


76043PT14

Adjust plate clearance = 1.2$^{+0.2}$mm

※ For the adjustment of the plate clearance are snap rings of different thickness available.
To ensure a faultless measuring result, install plates for the moment without oil.

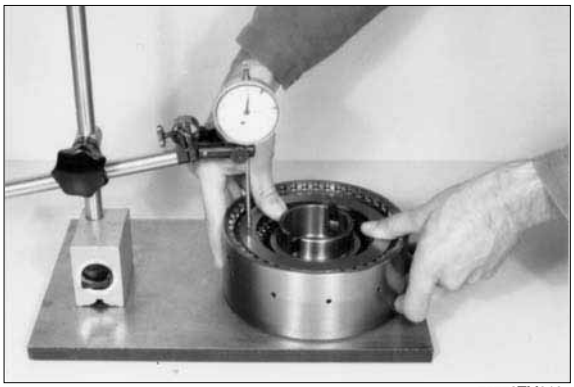
⑧ Introduce plate pack according to the draft.


75773TM210

⑨ Lay on end shim and squeeze snap ring in(e.g. s= 3.4mm).


75773TM211

⑩ Press on the end shim with about 100N (10kg), apply dial indicator and set it at zero.



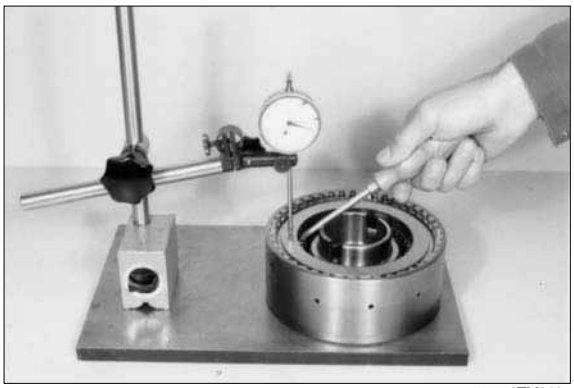
75773TM212

⑪ Now, push the end shim by means of screw driver against snap ring until contacts is obtained(Upward) and read plate clearance on the dial indicator.

※ In case of a deviation from the required plate clearance, correct with corresponding snap ring(s=2.1~4.2㎜).
After the adjustment of the plate clearance has been carried out, remove the plate pack, oil plates and install it again.

※ Use oil SAE 10W-30/15W-40.

Magnetic stand	5870 200 055
Dial indicator	5870 200 057



75773TM213

⑫ Introduce idler gear until all inner plates are accommodated.

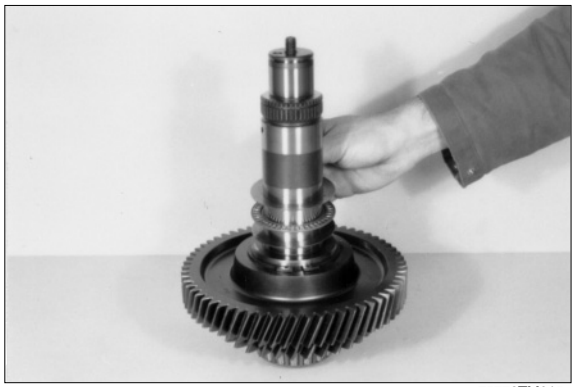
※ This step makes the later assembling of the idler gear easier.
Now, remove idler gear again.



75773TM214

⑬ Assemble both axial washers as well as needle case.

※ Upper and lower axial washer have the same thickness(55 × 78 × 1).



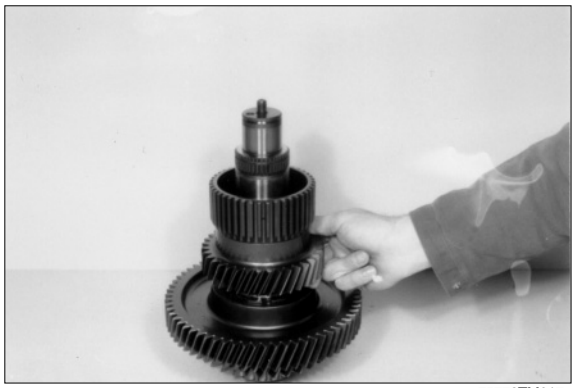
75773TM215

⑭ Assemble both needle bearings.



75773TM216

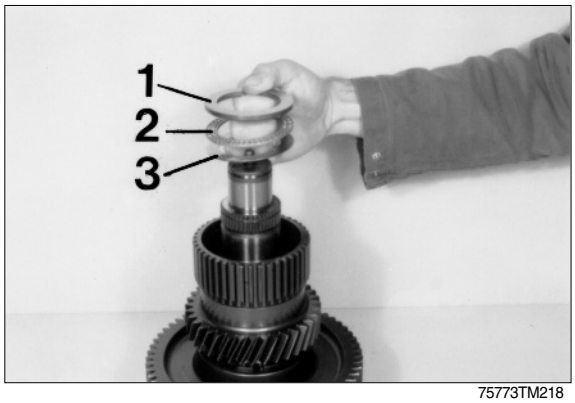
⑮ Assemble idler gear.



75773TM217

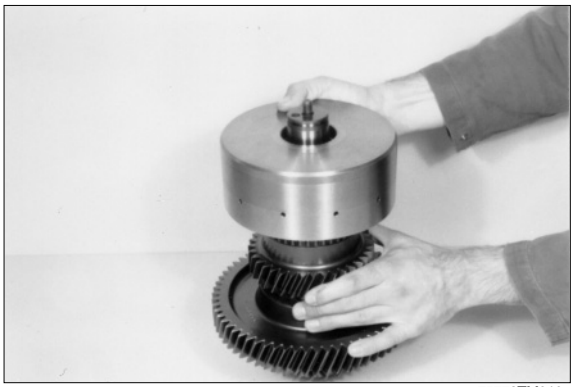
⑯ Assemble axial washer 3(55 × 78 × 1), needle cage 2 and running disk 1(55 × 78 × 5).

※ Install running disk 1, with the chamfer facing the needle cage.



75773TM218

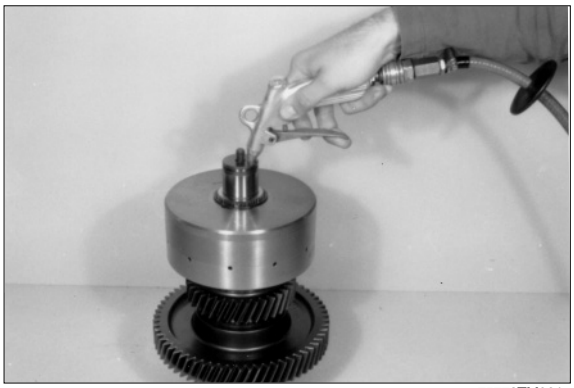
⑰ Heat inner diameter of the plate carrier (About 120℃).
Assemble preassembled plate carrier until all inner plates are accommodated.
※ Use safety gloves.


75773TM219

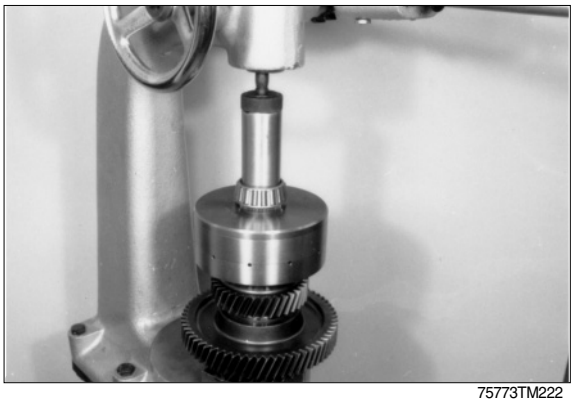
⑱ Fix plate carrier axially by means of circlip.
Set of external pliers 5870 900 015


75773TM220

⑲ Check function of the clutch by means of compressed air.
※ At correctly installed components, the closing respectively opening of the clutch is clearly audible.


75773TM221

⑳ Press tapered roller bearing against shoulder.
Install opposite tapered roller bearing.


75773TM222

Squeeze rectangular ring in(Arrow) and let it snap in.
Install opposite rectangular ring.



75773TM223

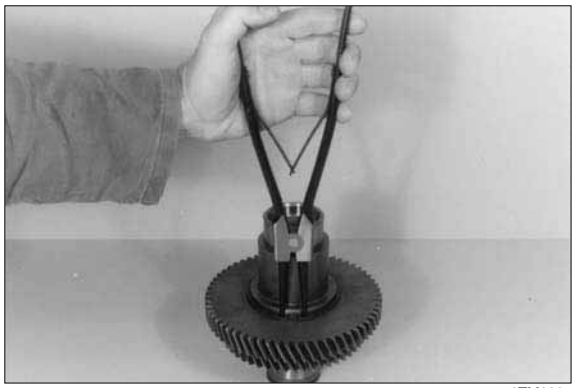
(5) Preassemble drive shaft

① Undercool the drive shaft(About -80°C), heat the gear(About +120° C) and assemble it until contact is obtained.



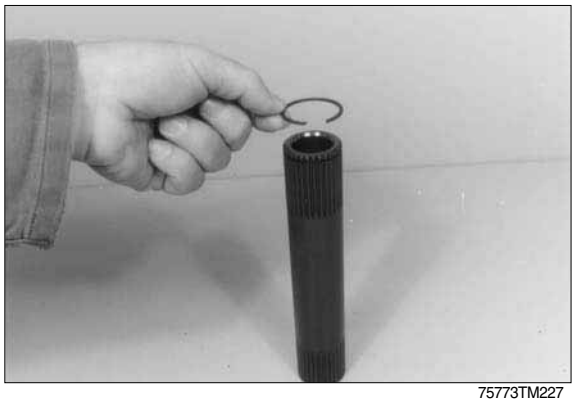
75773TM225

② Fix gear axially by means of circlip.



75773TM226

③ Squeeze snap ring into groove of the turbine shaft.



75773TM227

④ Introduce turbine shaft until the snap ring snaps into the groove of the drive shaft turbine shaft is axially fixed.



75773TM228

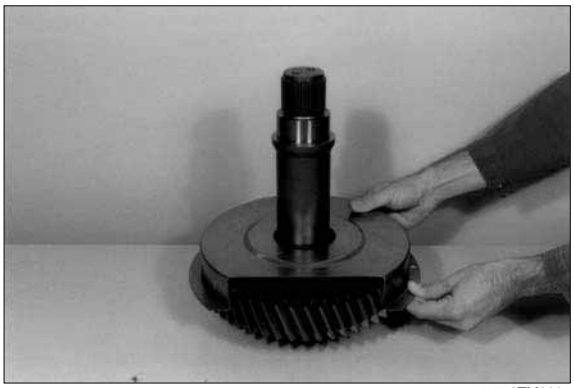
⑤ Press tapered roller bearing against shoulder.
Now, squeeze rectangular ring into the groove of the drive shaft and let it snap in.
Install opposite tapered roller bearing.



75773TM229

(6) Preassemble and install output

① Lay on screening plate



75773TM230

② Heat tapered roller bearing and assemble it until contact is obtained.
Install opposite tapered roller bearing accordingly.

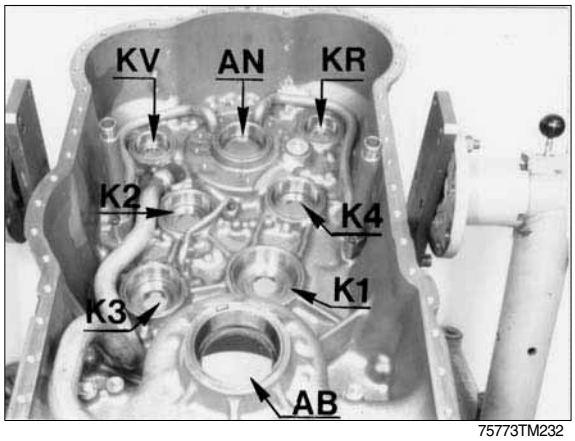


75773TM231

③ Insert all bearing outer races into the bearing bores of the housing.
Install O-ring(Arrows).

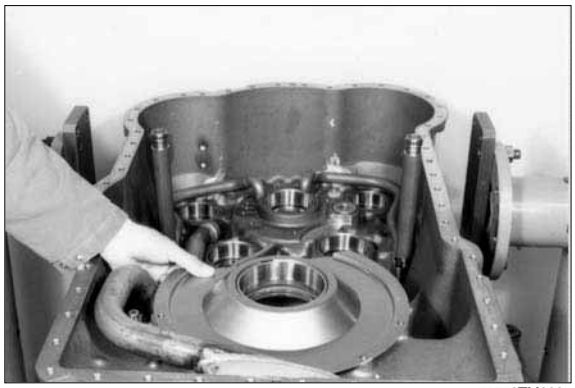
※ At the use of already run bearings, pay attention to the allocation of the bearing outer races, see also note/page 3-100.

AN Input
KV Clutch-Forward
KR Clutch-Reverse
K1 Clutch-1st speed
K2 Clutch-2nd speed
K3 Clutch-3rd speed
K4 Clutch-4th speed
AB Output



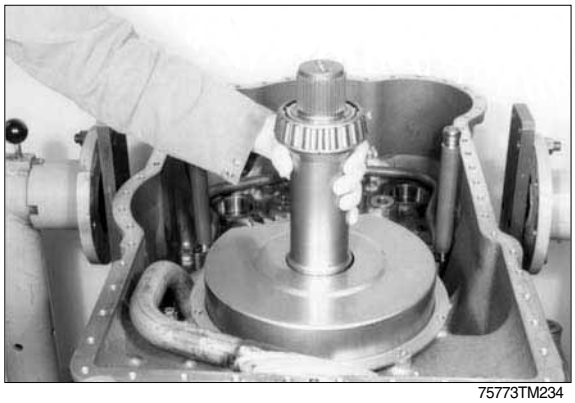
75773TM232

④ Lay on screening plate.


75773TM233

⑤ Insert preassembled output shaft.
Fix screening plates by means of socket head screws.

· Torque limit(M8/8.8) : 2.3kgf · m
(17.0lbf · ft)

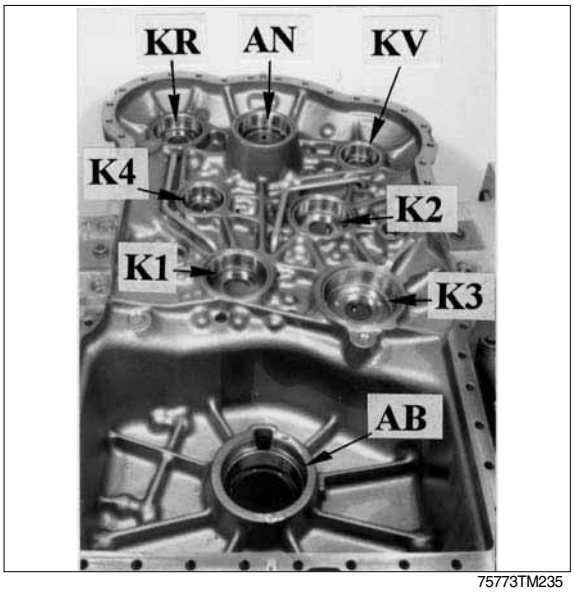

75773TM234

(7) Install preassembled drive shaft and clutches

① Insert all bearing outer races into the bearing bores of the housing cover.

※ At the use of already run bearings, pay attention to the allocation of the bearing outer races, see also note/page 3-100.

AN Input
KV Clutch-Forward
KR Clutch-Reverse
K1 Clutch-1st speed
K2 Clutch-2nd speed
K3 Clutch-3rd speed
K4 Clutch-4th speed
AB Output



75773TM235

※ Prior to the installation of the clutches and the drive shaft, grease rectangular rings and align them centrally.

② Insert clutch KR, drive shaft and clutch KV together into the housing cover.


75773TM236

③ Lift drive gear and position clutch K4.


75773TM237

④ Install clutch K3.



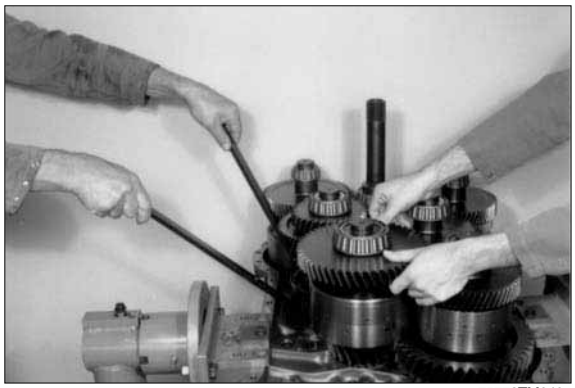
75773TM238

⑤ Position clutch K2.



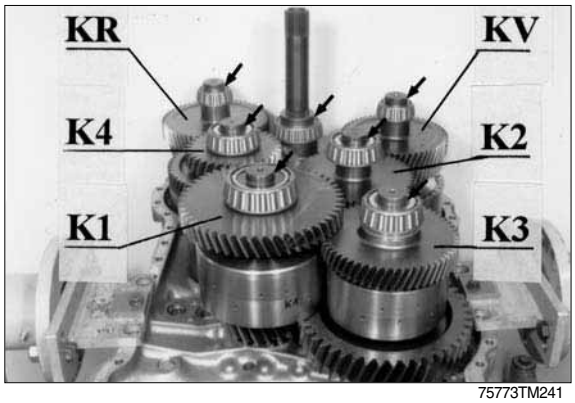
75773TM239

⑥ Lift clutch K4 and position clutch K1.



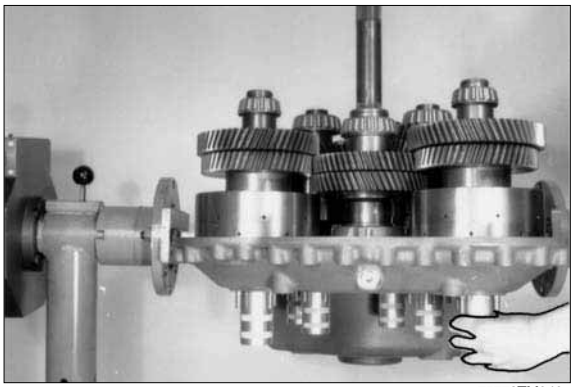
75773TM240

⑦ Illustration on the right shows the installation position of the single clutches in the housing cover.
Grease rectangular rings(Arrows) and align them centrally.



75773TM241

⑧ Fix all clutches by means of handles.
Handle(6 pieces needed) 5870 260 010


75773TM242

⑨ Tilt housing cover 180°.
Install eye bolts(Arrows).
Eye bolt(M20, 2EA) 0636 804 003
Eye bolt(M16, 1EA) 0636 804 001
Puller device 5870 000 017


75773TM243

⑩ Grease O-rings of the two oil tubes.
Wet mounting face with sealing compound loctite(Type No.574).
Position preassembled housing cover by means of lifting device carefully on the gearbox housing until contact is obtained.
※ Pay attention to the overlapping of the oil tubes with the bores in the housing cover.
Lifting chain 5870 281 047


75773TM244

⑪ Remove handles again.


75773TM245

⑫ Install both cylindrical pins centrally to the housing face.

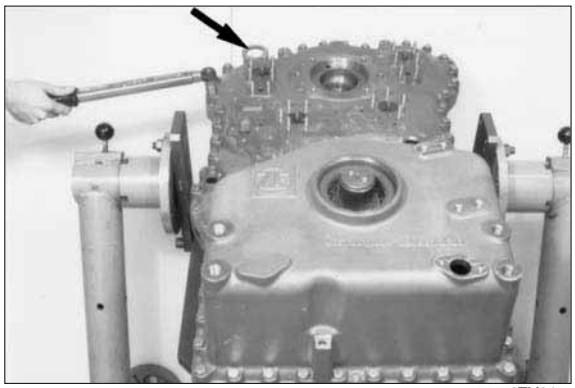


75773TM246

⑬ Fasten housing cover by means of hexagon head screws.

· Torque limit(M10/8.8) : 4.7kgf · m
(33.9lbf · ft)

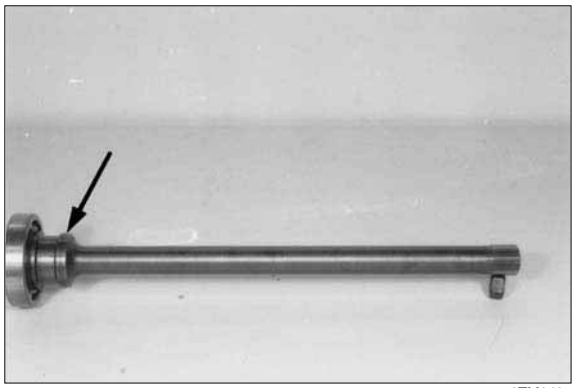
※ Pay attention to position of the fixing plate, see Arrow.



75773TM247

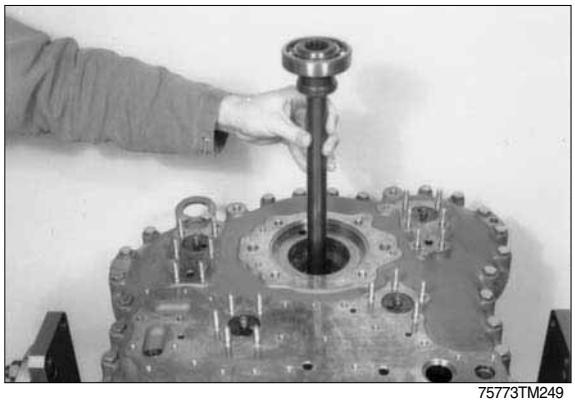
(8) Install pump shaft(Power take off)

① Install ball bearing.
Squeeze rectangular ring in(Arrow) and let it snap in.



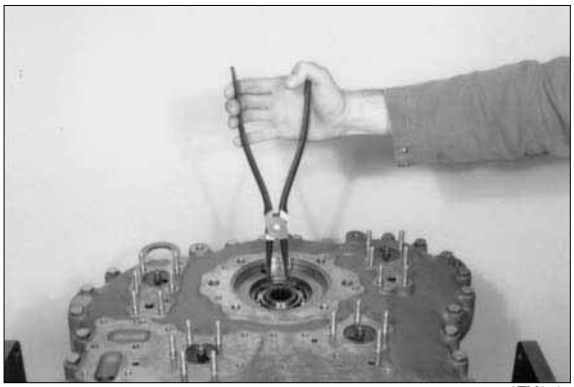
75773TM248

② Grease rectangular ring, align it centrally and introduce pump shaft until contact is obtained.



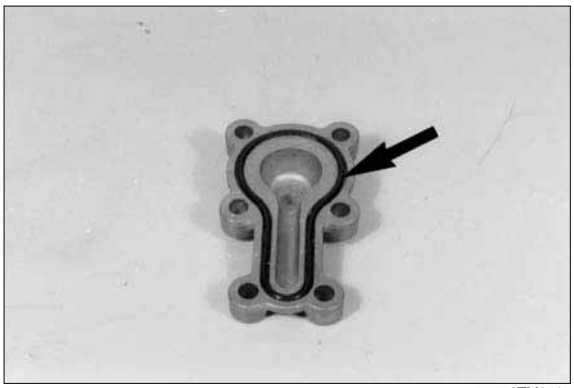
75773TM249

③ Fix pump shaft by means of circlip.



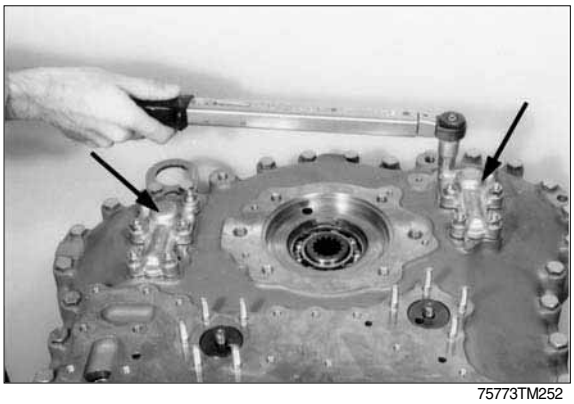
75773TM250

④ Insert O-ring(Arrow) into the annular groove of the oil feed covers.



75773TM251

⑤ Fasten both covers(Arrows) by means of hexagon nuts(Use plain washers).
- Torque limit : 2.3kgf · m(17.0lbf · ft)



75773TM252

(9) Install output flanges

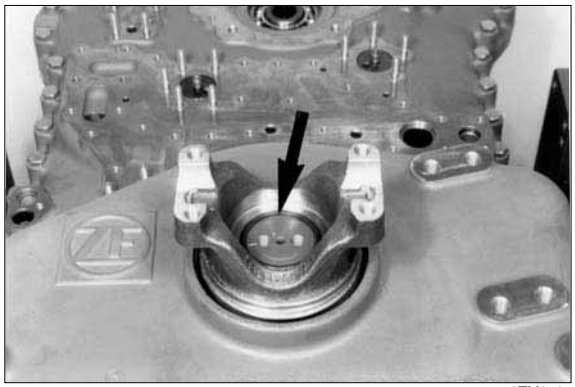
① Install shaft seal with the sealing lip facing the oil chamber.

※ At the use of the prescribed driver, the exact installation position is obtained.
Wet rubber coated outer diameter with spirit.
Grease sealing lip.
Driver 5870 048 213

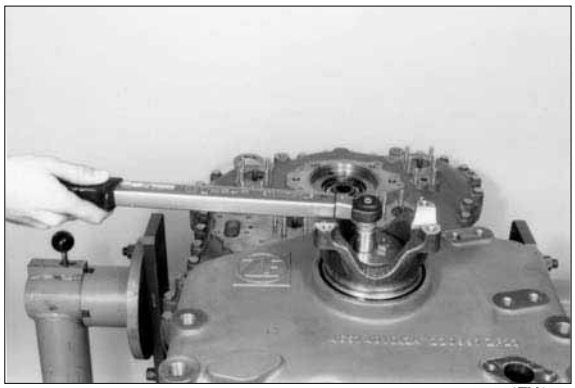


75773TM255

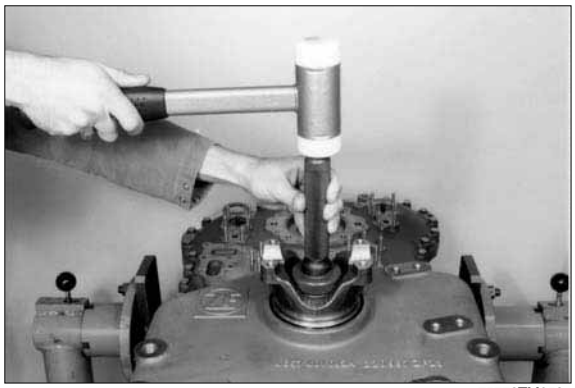
② Assemble output flange.
Insert O-ring(Arrow) into the gap of drive flange and shaft.


75773TM256

③ Fasten output flange by means of disk and hexagon head screws.
· Torque limit(M10/8.8) : 4.7kgf · m
(33.9lbf · ft)


75773TM257

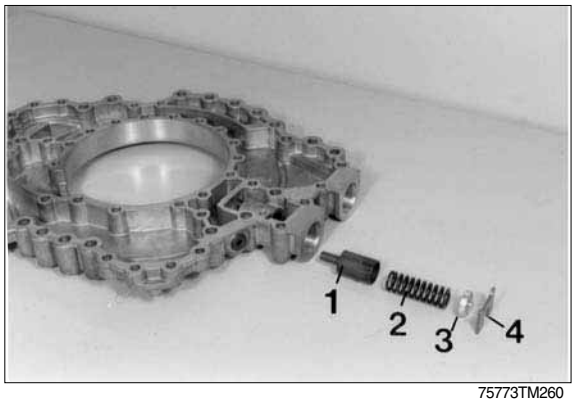
④ Fix hexagon head screws by means of lock plate.
Driver 5870 057 009
Handle 5870 260 002
Install converter side output flange accordingly.


75773TM258

(10) Converter back pressure valve

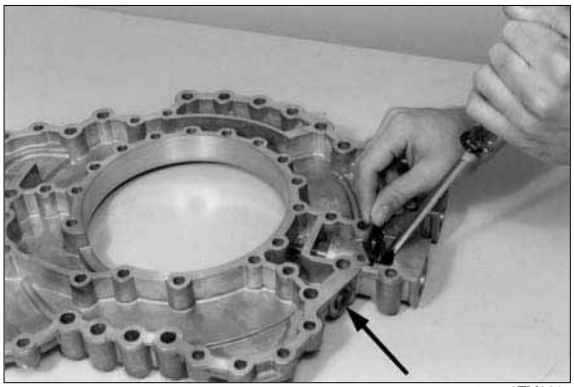
① Illustration on the right shows the components of the converter back pressure valve.
1 Piston
2 Compression spring
3 Pressure plate
4 Lock plate

※ Install pressure plate with the spigot (ø 6mm) facing the lock plate.



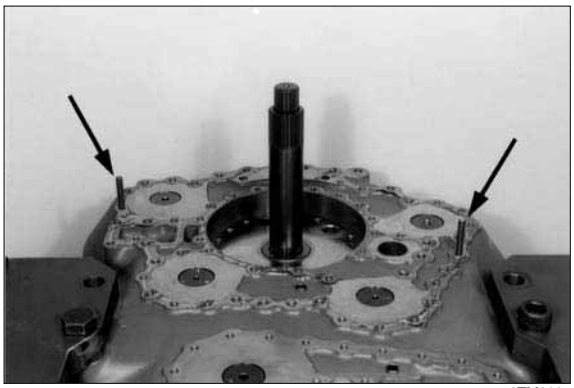
75773TM260

② Introduce components according to figure (10) ①, preload and fix by means of lock plate.
Equip plug(Arrow) with new O-ring and install it.
· Torque limit(M14 × 1.5) : 2.5kgf · m
(18.4bf · ft)

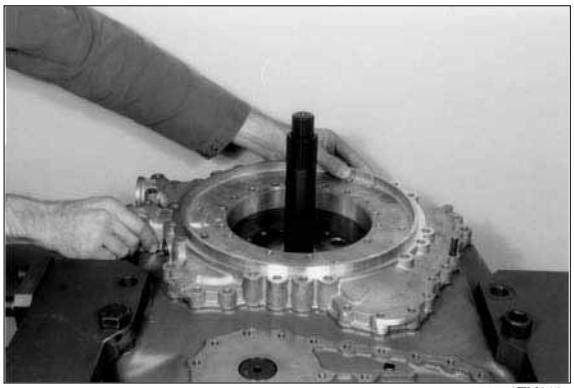

75773TM261

(11) Oil feed housing-Transmission pump

① Install two adjusting screws(Arrows) and lay on gasket.
Adjusting screws(M8) 5870 204 011


75773TM262

② Lay on oil feed housing and fix it provisionally by means of socket head screws.
※ Screw socket head screws only in until contact is obtained **do not tighten.**


75773TM263

③ Install two adjusting screws and introduce stator shaft until contact is obtained.
※ Pay attention to the overlapping of the bores.
Adjusting screws(M10) 5870 204 007

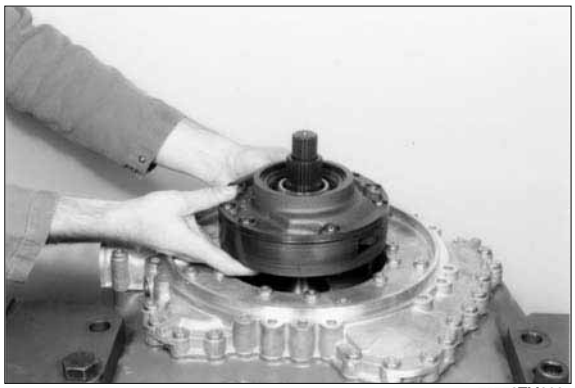

75773TM264

④ Insert O-ring(Arrow) into the annular groove and oil it.



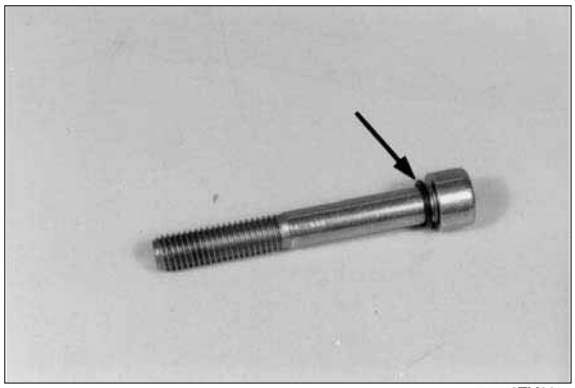
75773TM265

⑤ Introduce transmission pump(Complete) and put it by means of socket head screws(For the moment without O-rings) evenly against shoulder.
Now, remove socket head screws again.



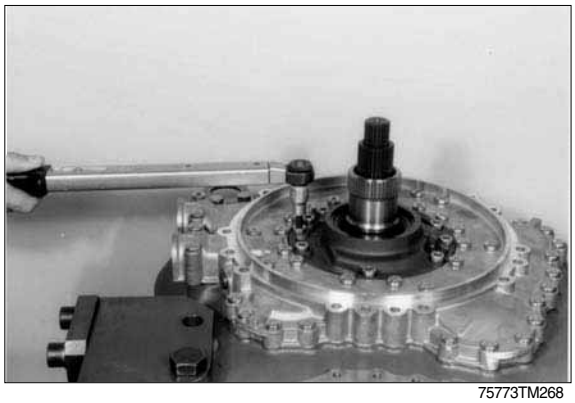
75773TM266

⑥ Equip socket head screws with new O-ring(Arrow).
※ Grease O-rings.



75773TM267

⑦ Fasten transmission pump by means of socket head screws.
· Torque limit : 4.7kgf · m(33.9lbf · ft)



75773TM268

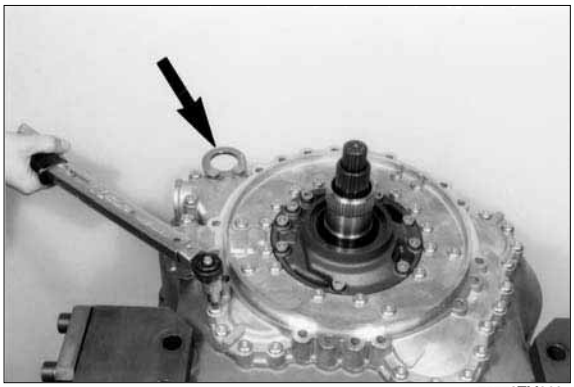
⑧ Fasten oil feed housing by means of socket head screws and hexagon head screws(2 pieces).

· Torque limit

- Socket head screw : 2.3kgf · m (16.6bf · ft)
- Hexagon head screw : 4.7kgf · m (33.9bf · ft)

※ Pay attention to the position of the fixing plate, see Arrow.

Box spanner(Torx, TX-40) 5873 042 004

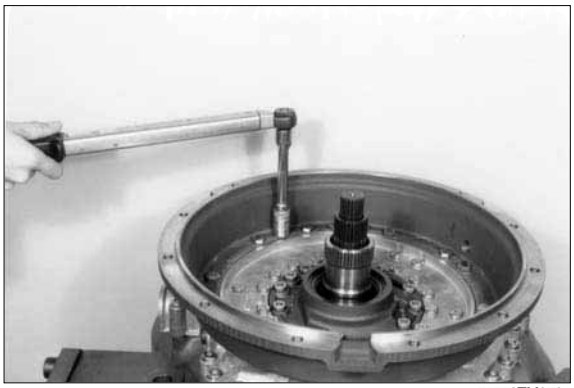


75773TM269

(12) Engine connection-Converter

① Fasten converter bell by means of hexagon head screws.

· Torque limit(M10/10.9) : 6.9kgf · m (50.1bf · ft)



75773TM270

② Screw drive shaft and diaphragm together.

· Torque limit(M12/10.9) : 11.7kgf · m (84.8bf · ft)

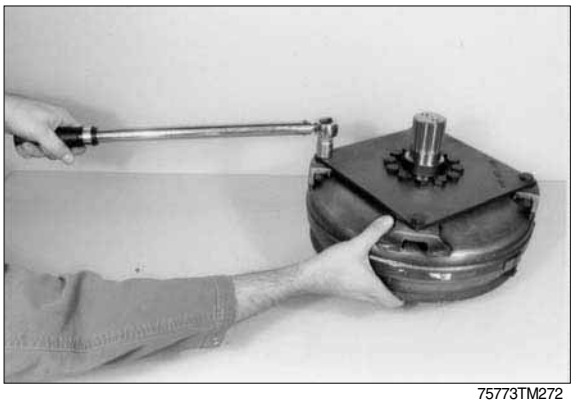


75773TM271

③ Fasten diaphragm by means of hexagon head screws on the converter.

· Torque limit(M12/10.9) : 11.7kgf · m (84.8bf · ft)

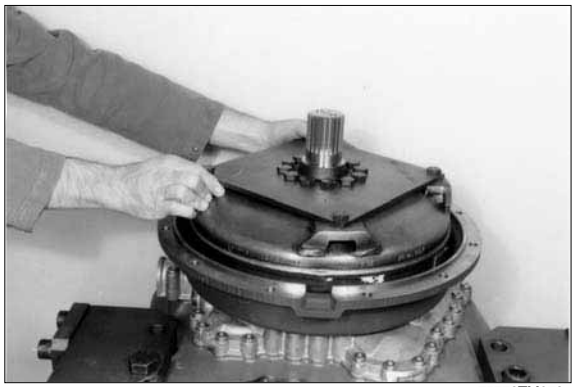
※ Insert hexagon head screws with loctite (Type No.262).



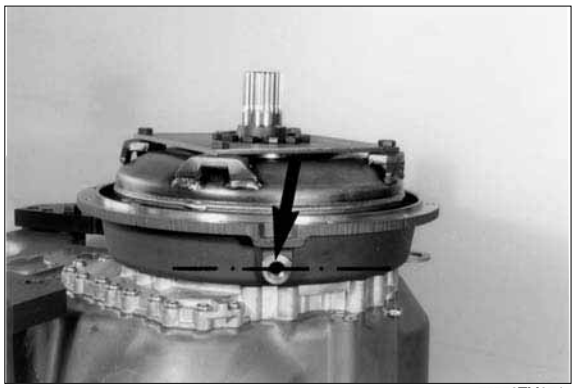
75773TM272

④ Introduce converter until contact is obtained.

※ Pulse disk of the converter must be positioned centrally to the bore of the inductive transmitter, see Arrow.
Only in this way will be ensured that the converter is perfectly introduced.



75773TM273



75773TM274

⑤ Insert ball bearing until contact is obtained and fix it by means of circlip.



75773TM275

⑥ Assemble housing cover.
Install drive flange, lay on disk an pull cover by means of hexagon head screws evenly against shoulder.
· Torque limit(M8/10.9) : 3.5kgf · m
(25.1bf · ft)

※ Pulse attention to the radial installation position of the cover, see figure.



75773TM276

⑦ Fix hexagon head screws by means of lock plate.

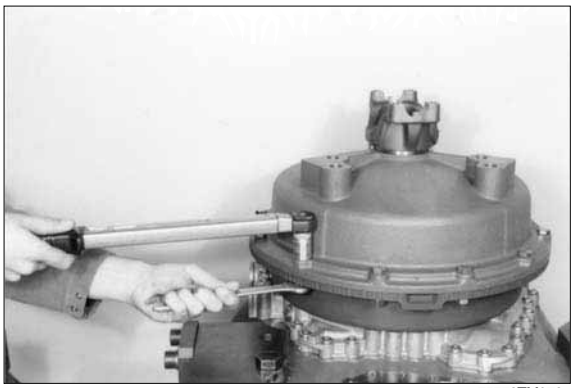
Driver	5870 057 010
Handle	5870 260 002



75773TM277

⑧ Fasten cover by means of hexagon head screws and nuts on the converter bell.

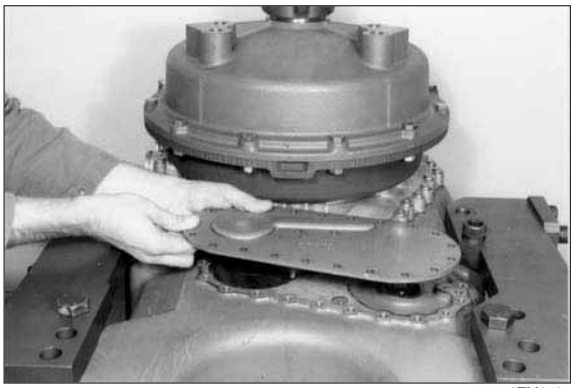
· Torque limit(M10/838) : 4.7kgf · m (33.9lbf · ft)



75773TM278

⑨ Mount gasket and fasten cover by means of hexagon head screws.

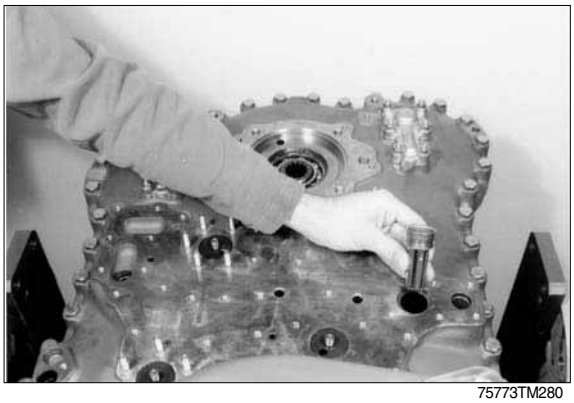
· Torque limit(M8/8.8) : 2.3kgf · m (17.0lbf · ft)



75773TM279

(13) Converter safety valve

① Insert converter safety valve(Complete) into the housing hose.



75773TM280

(14) Mount duct plate and hydraulic control unit

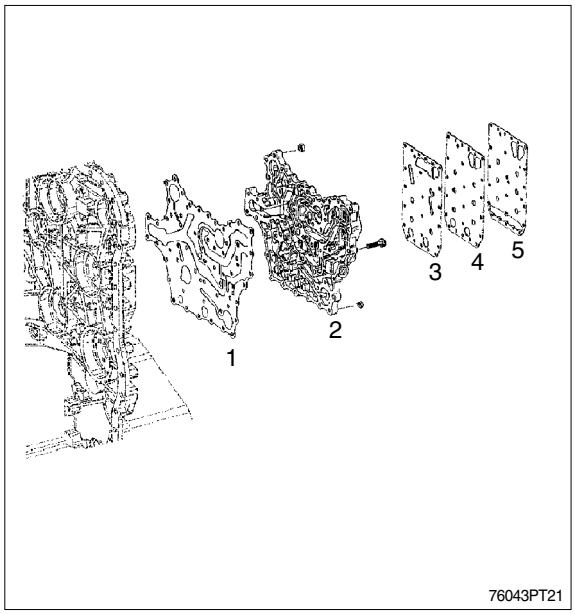
① Install components according to the following draft.

· Torque limit(M8) : 2.3kgf · m(17.0lbf · ft)

※ Pay attention to the installation position of the different gaskets, see draft.

1 Gasket
2 Duct plate
3 Gasket
4 Intermediate plate
5 Gasket

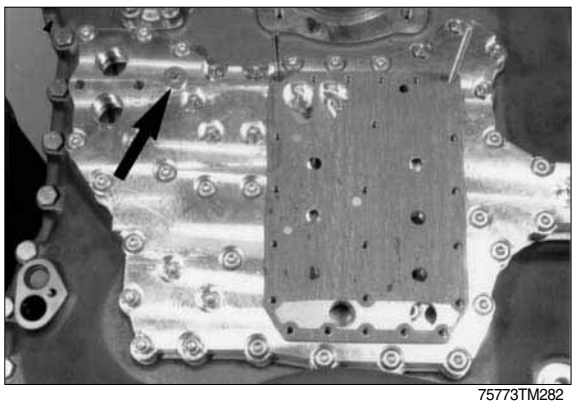
Adjusting screws	5870 204 063
Box spanne	5873 042 004



76043PT21

② Equip screw plug(Arrow) with new O-ring and install it.

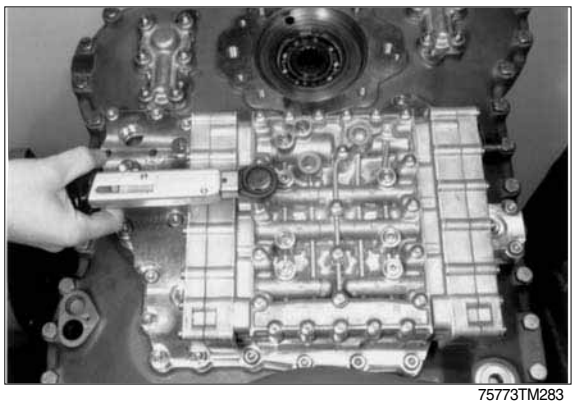
· Torque limit(M16 × 1.5) : 3.0kgf · m (21.7lbf · ft)


75773TM282

③ Fasten hydraulic control unit(HSG-94) by means of socket head screws.

· Torque limit(M6) : 0.97kgf · m(7.0lbf · ft)

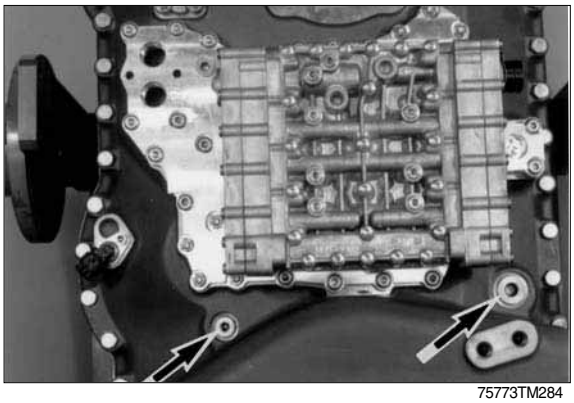
Adjusting screws	5870 204 063
Box spanner(Torx Tx-27)	5873 042 002


75773TM283

(15) Install plugs and oil level tube

① Equip both plugs(Arrows) with new O-rings and install them.

- Torque limit(M18 × 1.5) : 5.1kgf · m (36.9lbf · ft)
- Torque limit(M26 × 1.5) : 8.2kgf · m (59.0lbf · ft)

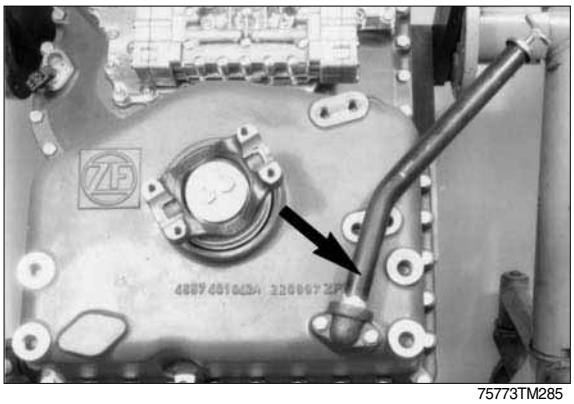


75773TM284

② Install oil level tube(Arrow).

※ Mount new gasket.

- Torque limit(M8/10.9) : 3.5kgf · m (25.1lbf · ft)



75773TM285

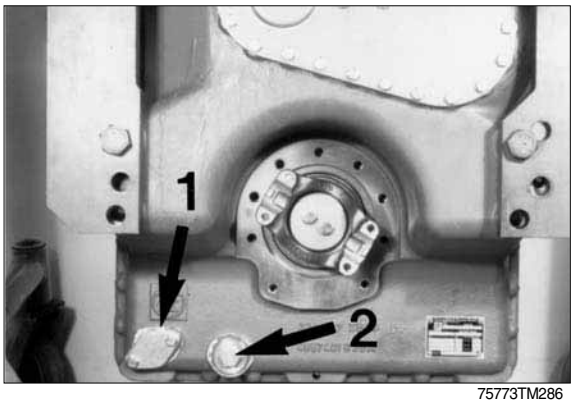
③ Install cover plate(Arrow 1).

※ Install new gasket.

- Torque limit(M8/8.8) : 2.3kgf · m (17.0lbf · ft)

Equip screw plug(Arrow 2) with new O-ring and install it.

- Torque limit(M38 × 1.5) : 14.3kgf · m (103lbf · ft)

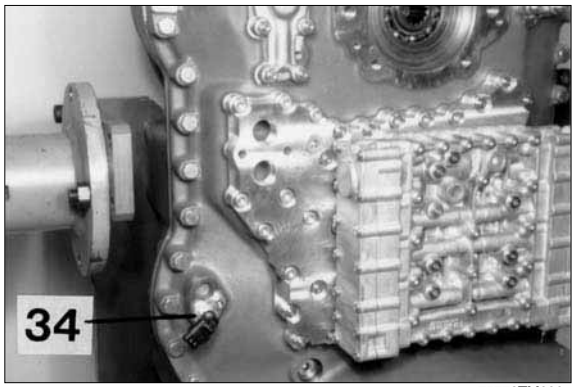


75773TM286

(16) Speed sensor and inductive transmitters

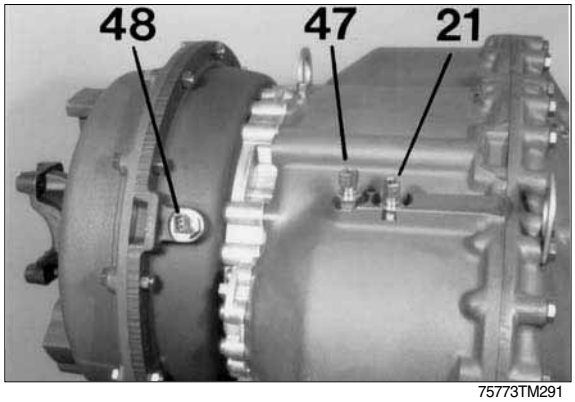
① The figures show the installation position of the single inductive transmitters and the speed sensor.

34 Speed sensor
n-Output and speedometer
21 Inductive transmitter
n-Turbine
47 Inductive transmitter
n-Central gear train
48 Inductive transmitter
n-Engine



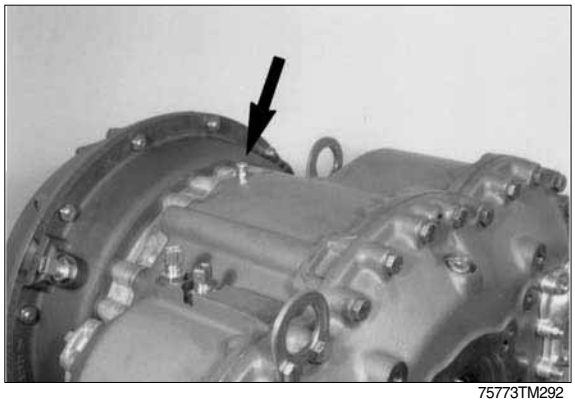
75773TM290

② Grease O-rings and install speed sensor as well as inductive transmitters.
- Torque limit : 2.3kgf · m(17.0lbf · ft) (Socket head screw/Speed sensor)
- Torque limit : 3.1kgf · m(22.1lbf · ft) (Inductive transmitter)



75773TM291

③ Install breather(Arrow).
- Torque limit : 1.2kgf · m(8.9lbf · ft)


75773TM292

3. VOLVO AXLE (Machine serial No. ; ~#0293)

1) GENERAL INSTRUCTIONS

(1) SHIMS

All adjustments shall be carried out after all adjustment shims have been selected measuring them one by one with a micrometer gauge and, then, summing up all values measured; don't trust incorrect measurement of pack as a unit or sum of nominal value printed on each shim.

(2) SEALS FOR REVOLVING SHAFTS

Proceed as follows for proper fitting of captioned seals:

① Prior assembly, seals should be kept, for at least half an hour, in a bath with the same oil to be sealed;

② Clean thoroughly shaft and make that working surface be not damaged;

③ Position sealing lip against the fluid to be sealed; in case of hydrodynamic lip lines should be oriented so as that, considering direction of revolving shaft, they lead fluid inside of sealing means;

④ Smear sealing lip with a film of lubricant(oil is better than grease) and fill up with grease the space between sealing lip and dust shield lip, if using double sealing lip type seals;

⑤ Press seal in relevant seat or use a proper fitter with flat contact surface; never use hammer or mallet to mount seal;

⑥ When press fitting seal make sure that it be correctly driven in relevant seat, i.e., perpendicular with respect to its seat, as fitting is completed make sure, if required, that seal itself be in contact with relevant shoulder;

⑦ To prevent damage of seal lip when inserting shaft, duly protect component during assembly.

(3) O-RING SEALS

Lubricate O-RING seals at assembly to prevent twisting that would impair correct sealing.

Clean matching surface as follows prior, smearing compound:

① Remove old deposits using a metal brush;

② Degrease surfaces by one the following cleaners: trichloroethylene, kerosene or a warm water and soda solution.

(4) BEARINGS

When assembling them it is advisable to proceed as follows:

① Heat them with 80 to 90°C before fitting on relevant shafts;

② Cool them before inserting in relevant external seats.

(5) SPRING PINS

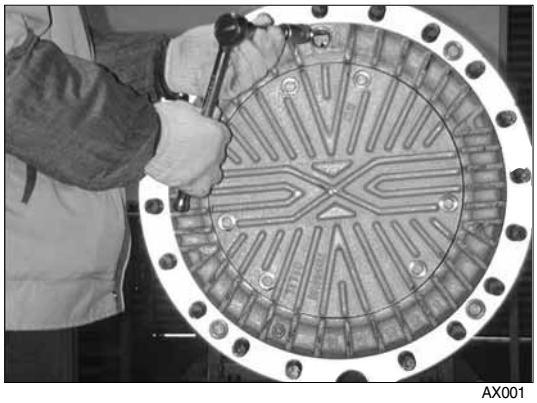
When using split pins be sure that lengthwise cleft be positioned toward stress on pin.

Coil pins don't require specific position.

2) REDUCTION ASSEMBLY

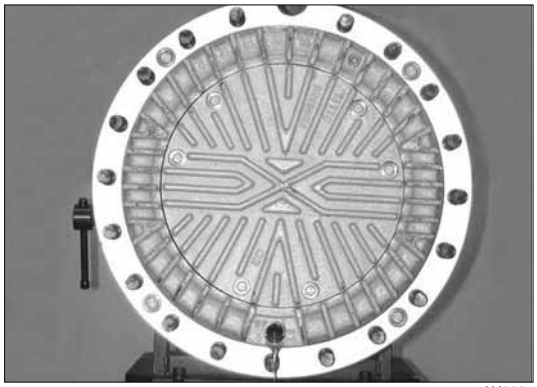
(1) DISASSEMBLY

① Turn the plug toward top position and remove the plug for the air vent.
Assemble the plug temporarily.



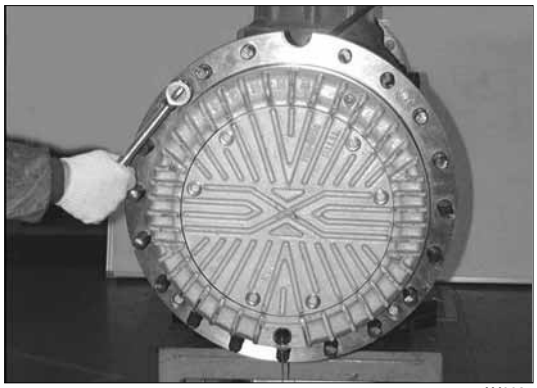
AX001

② Drain oil from final drive unit.



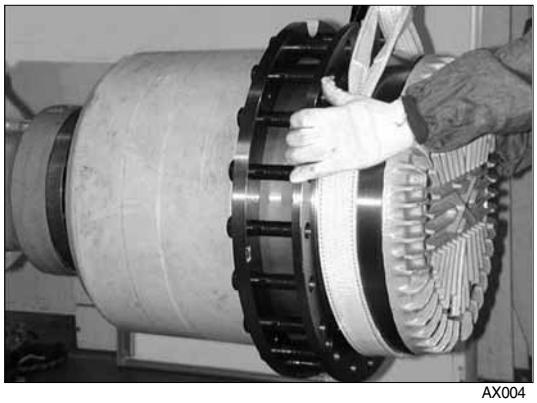
AX002

③ Loosen screws securing side gear carrier to wheel hub.



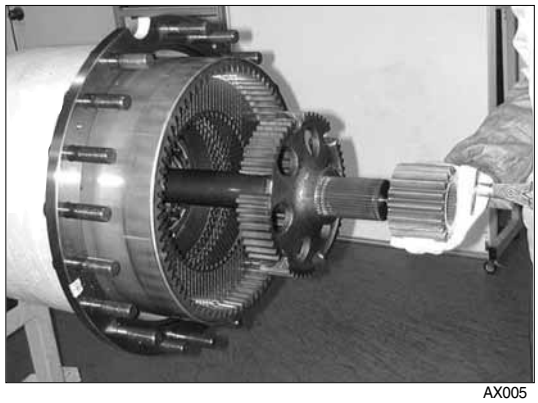
AX003

④ Pull out complete side gear carrier.



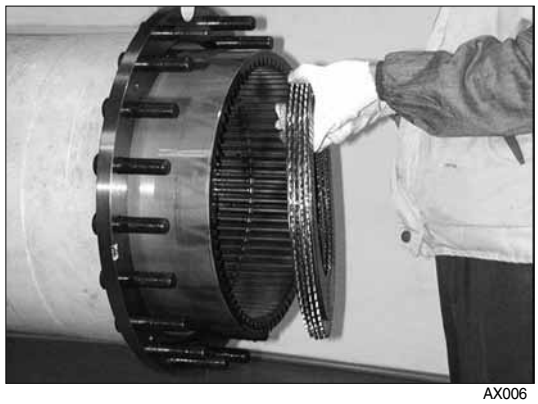
AX004

⑤ Pull out wheel shaft with sun gear, discs carrier hub and thrust plate.



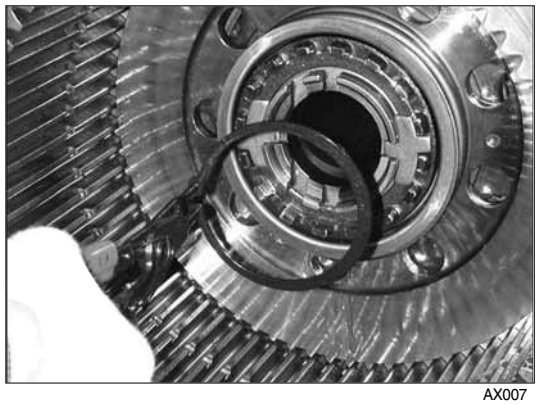
AX005

⑥ Remove brake disc pack.



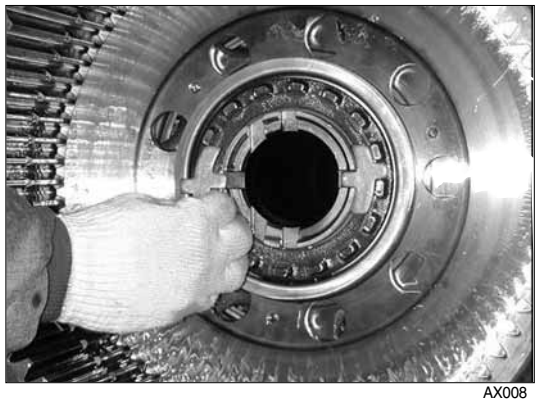
AX006

⑦ Remove lock ring nut locks.



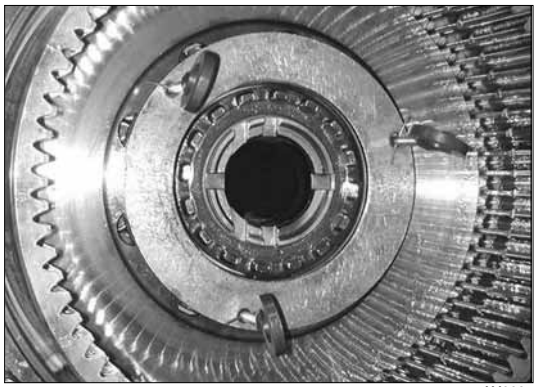
AX007

⑧ Remove locks.



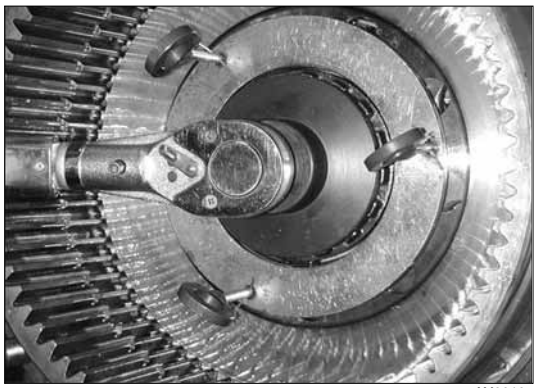
AX008

⑨ Install the proper tool on pressure plate and apply the eye bolt(3EA) temporarily.
Tighten the eye bolt tool perfectly.



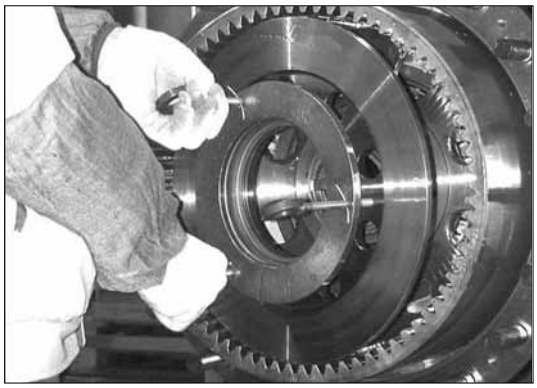
AX009

⑩ Remove the adjusting nut by the use of the special tool.



AX0010

⑪ Remove the pressure plate, return spring, cover and compression tool.



AX0011

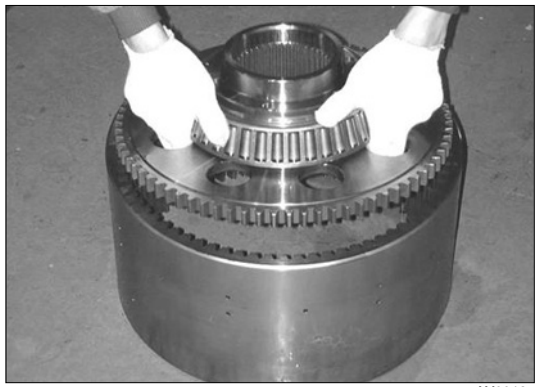
⑫ Remove the ring gear assembly.

※ Attention to the weight.



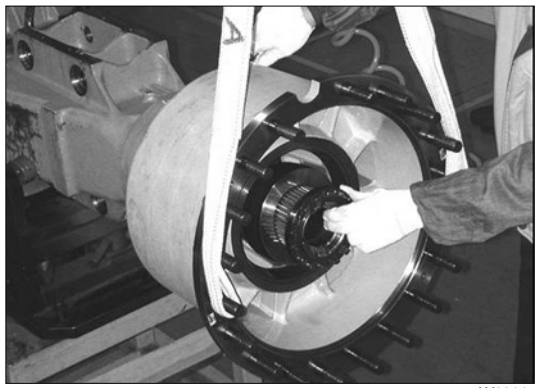
AX0012

⑬ Pry off lock ring from ring gear by a screw driver and remove ring gear support.



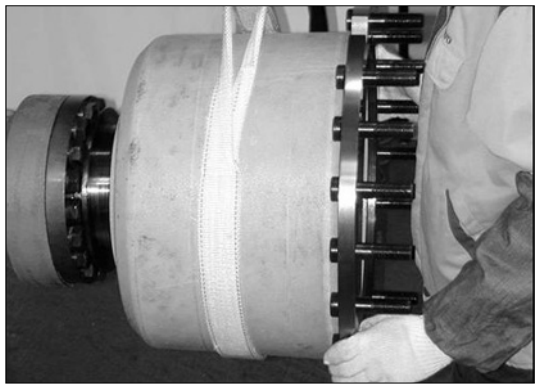
AX0013

⑭ Remove piston, it's easier by blowing compressed air in brake oil delivery ducting.



AX0014

⑮ Remove wheel hub assembly.



AX0015

⑯ Pry off wheel hub seal and remove inner race with roller cage of wheel inside bearing. By using a punch remove from wheel hub outer races of inner and outer bearings.

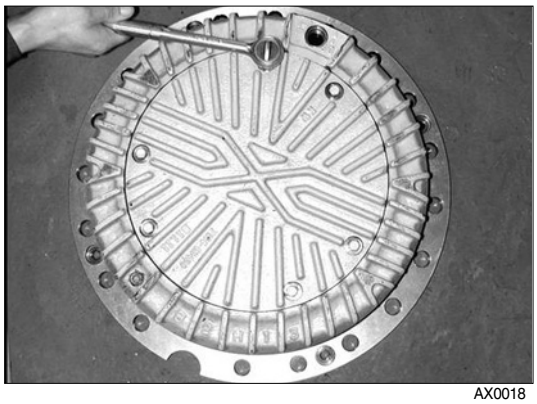


AX0016



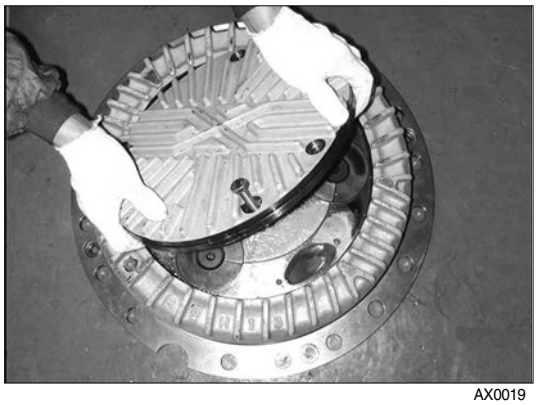
AX0017

⑰ Remove final drive cover.



AX0018

⑱ It is provided with three threaded holes (M10 × 1.5) to be used for puller screws.



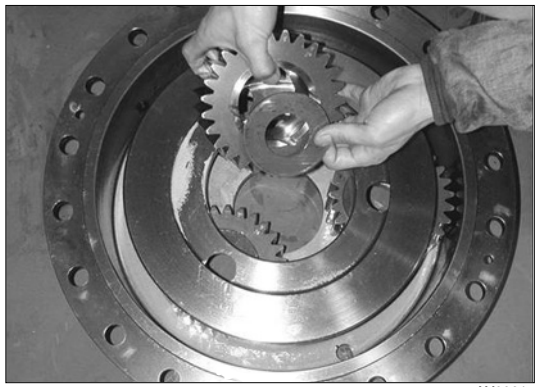
AX0019

⑲ Remove the planetary pin(3EA) from hub drum(Side gear carrier support) assembly.



AX0020

⑳ Remove the planetary gear and thrust washer step by step.



AX0021

(2) ASSEMBLY

① Insert the inner bearing cone.



AX085

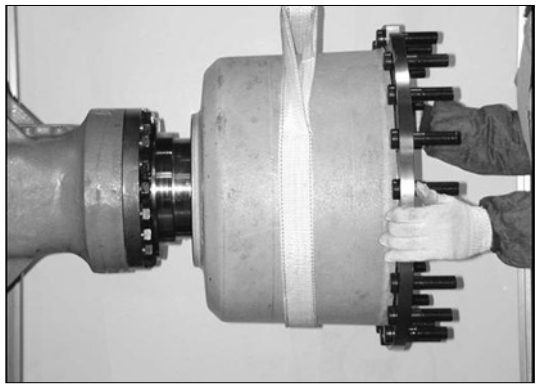
② Press fitting lip seal.

※ Smear loctite 573 or equivalent sealant on outer diameter surface.



AX086

③ Support suitably wheel hub while assembling parts to prevent damage of seal; then go on by fitting wheel bearing on hub spindle.



AX087

④ Replace O-ring seals on piston.

※ Cover the oil on O-ring seal enough.



AX088

⑤ Insert piston full travel down on hub spindle.



AX089

⑥ Insert ring gear support in ring gear, then fit spring ring retaining axle.



AX090

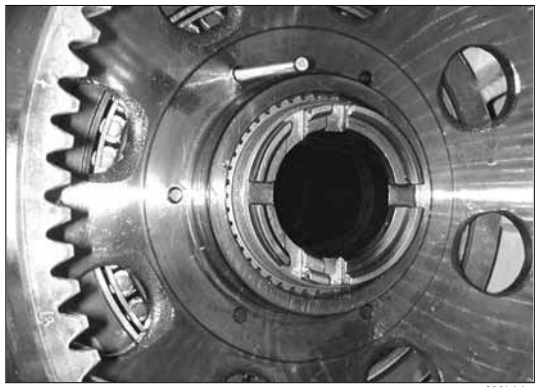
⑦ Mount on hub spindle the complete ring gear unit.

※ Attention to the weight.



AX091

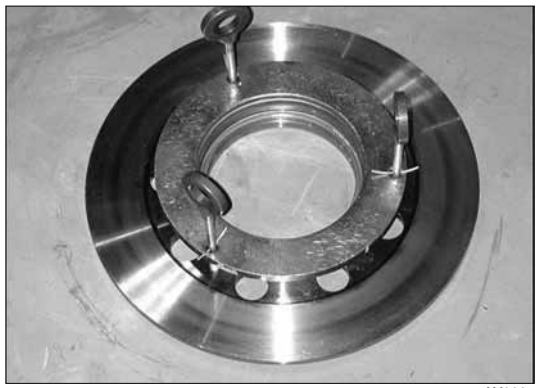
⑧ Insert into relevant holes the six pins that, for proper operation of whole system, have to be of the same length and however in accordance with relevant drawing.



AX092

⑨ Position return spring, cover and spacer on pressure plate, press compression tool. (Front axle only)

※ There is not spacer to the rear axle.



AX093

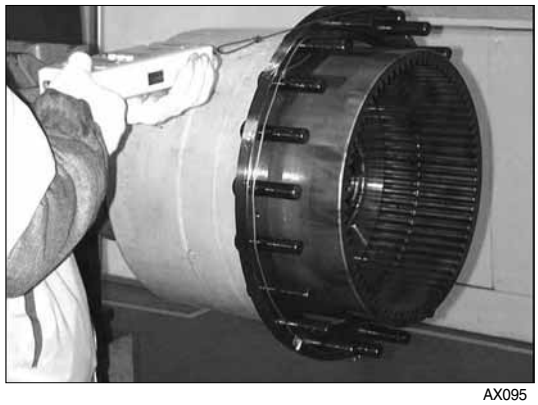
⑩ Assemble support assembly with spring compression tool on spindle and tighten adjusting nut.



AX094

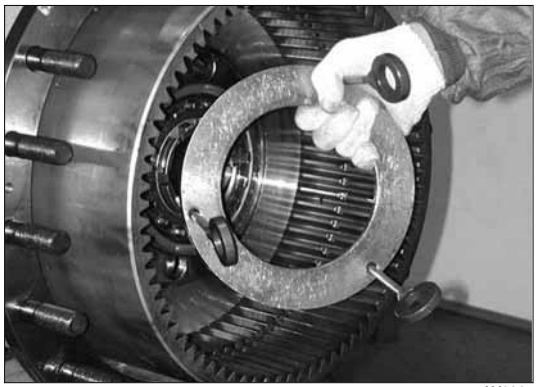
⑪ With proper wrench lock ring so to reach the specified wheel bearing pre-load corresponding to a rotation torque and a rope pull strength on studs included into 15~18kg.

To prevent wrong torque recording, it is advisable to set bearings, by various wheel revolutions, prior performing the check.



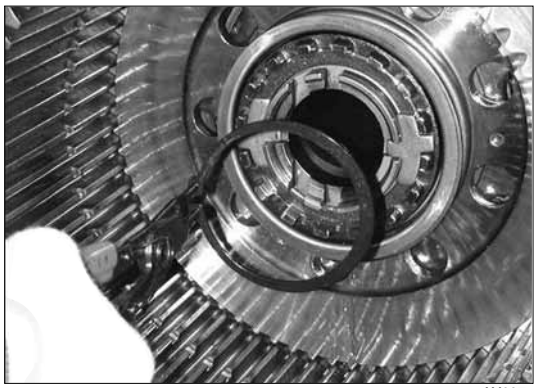
AX095

⑫ Remove spring compression tool.



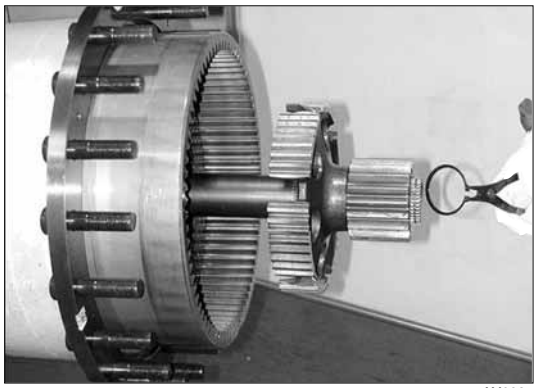
AX096

⑬ Fit plate and assemble retain ring.

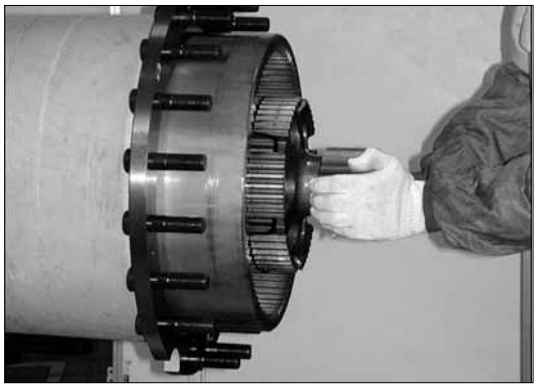


AX097

⑭ Insert wheel shaft on which sequentially mount ; the thrust washer, discs carrier hub, sun gear and lock ring ; then push all components fully down against hub spindle.



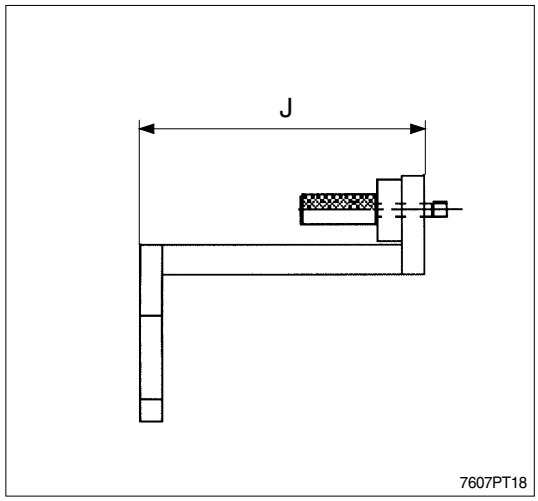
AX098



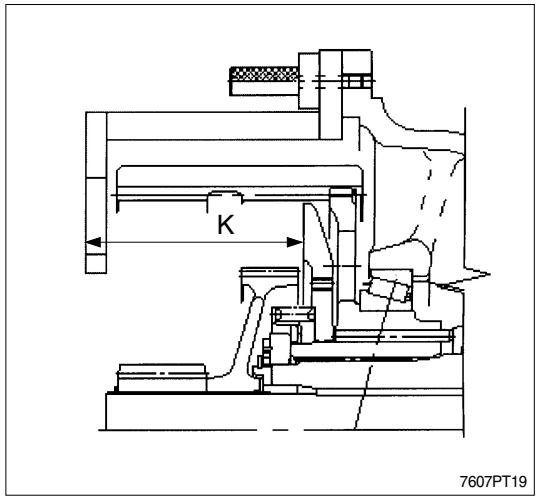
AX099

⑮ Install brake measuring tool on wheel hub.

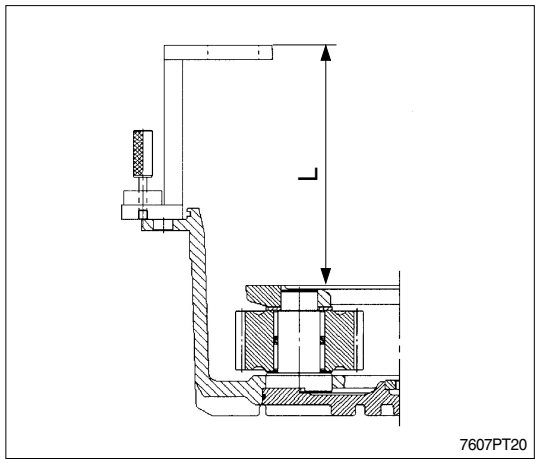
※ Distance of brake measuring tool **J**



⑯ Measure **K** between end of measuring tool and pressure plate.



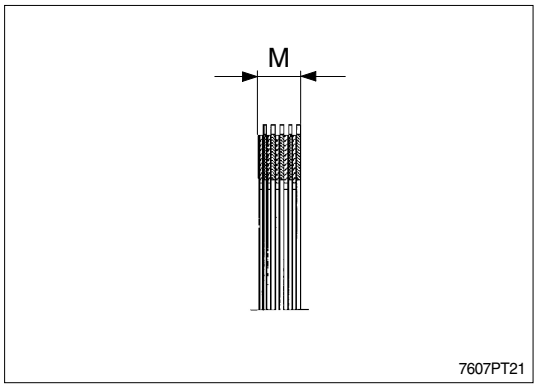
⑰ Install brake measuring tool on hub drum and measure **L**.



⑱ To determine thickness of disc pack from previsously computed value **M**.

※ Assembly procedure of brake disc pack :
To hub drum from pressure plate **C, B, C, B.....C, B**.(C=disc-count, B=disc-brake)

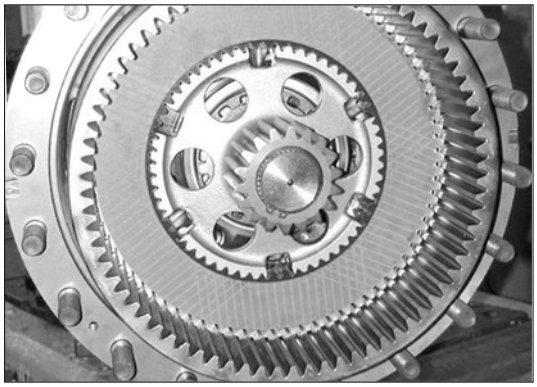
※ Quantity of brake disc.
- Front axle : disc-count 5EA
  disc-brake 5EA
- Rear axle : disc-count 4EA
  disc-brake 4EA



7607PT21

⑲ Calculate stroke, and if it is not satisfied with the specification, readjust stroke by means of change the thickness of each disc.
Stroke : S=(K+L-2J)-M
- Stroke
  Front axle : 3.5~4.0mm
  Rear axle : 3.6~4.0mm

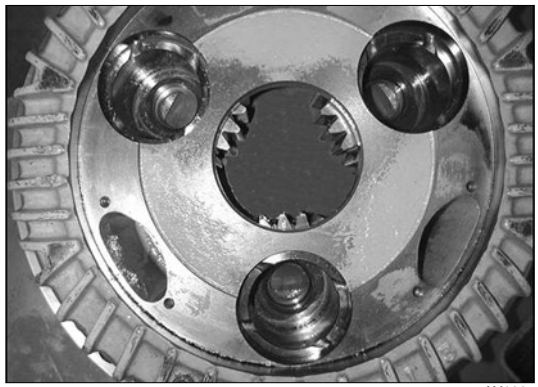
⑳ Assemble disc pack according to the procedure.


AX104

㉑ Arrange side gear carrier on blocks made of wood and remove pins.
Save needle rollers of filling bearing casings.
It is important to keep needle rollers joined with relevant pin for allowance question of pins themselves.


AX105

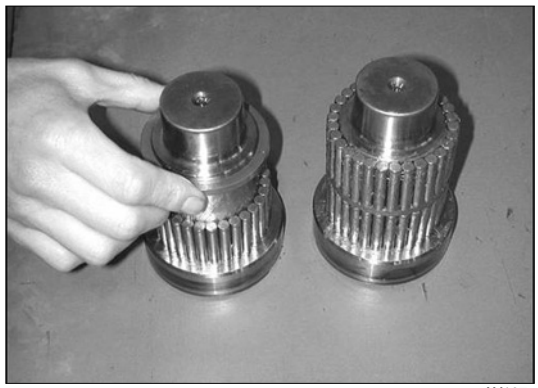
㉒ Arrange all the three side gears into relevant seats of side gear carrier, position inner thrust washers and align holes.



AX106

㉓ Mount on pins the two needle roller casings. Insert outer thrust washers, grease lower half of pin(head side) and position the first needle roller casing, insert spacer and position the second casing.

※ In case of needle roller replacement, use needle roller of the same selection class for the two casings of each side gear.



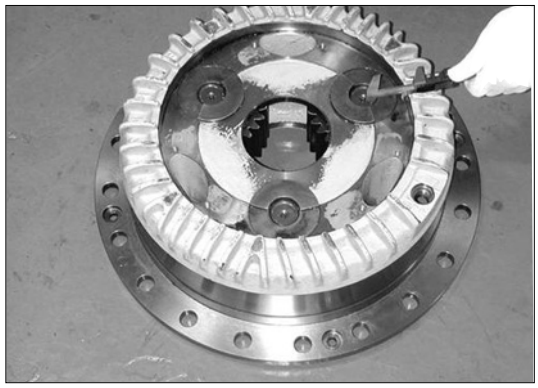
AX107

㉔ Insert the complete pins, taking care to avoid any bump, cause of needle rollers fall.



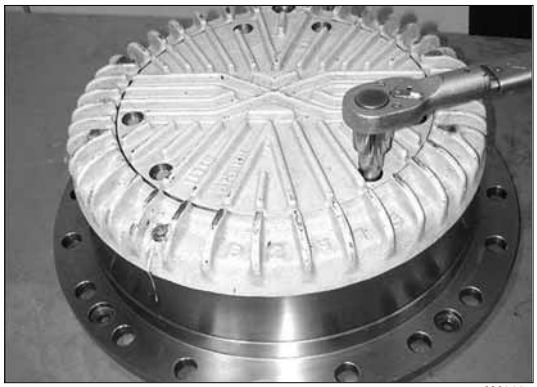
AX108

㉕ Rotate pins so to align them and allow fitting of cover that also prevent pin rotation.

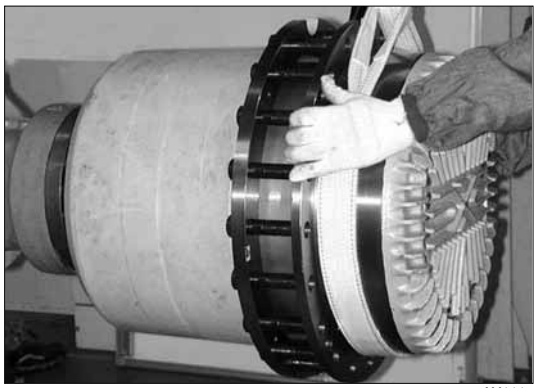


AX109

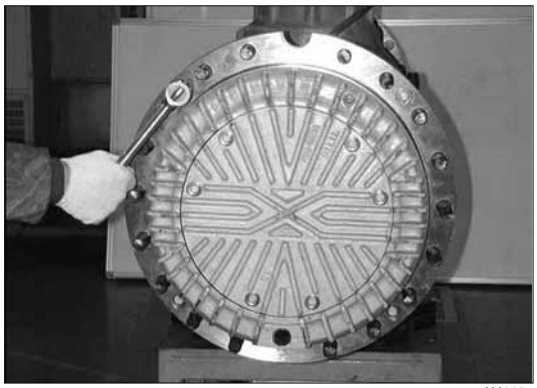
Fit O-ring seal on outer side.
Mount side cover on final drive.
· Tightening torque
Front and rear axle : 2.9~3.6kgf · m
(21.0~26.0lbf · ft)


AX110

Assemble hub drum on wheel hub.


AX111

Tight the fixed bolt of hub drum and assemble plug.
· Tightening torque
Front and rear axle : 6.3~6.9kgf · m
(45.6~50.0lbf · ft)


AX112

3) PARKING BRAKE(FRONT AXLE ONLY)

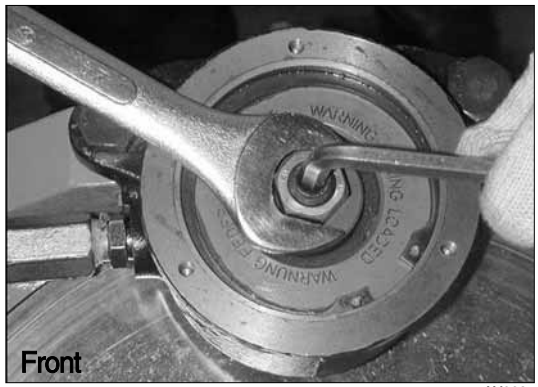
(1) DISASSEMBLY

① Insert through oil adding hole of gripper the pressure of 100~120bar, in order to obtain calipers release.
Remove the cover bolts of caliper.
· Brake port size : 7/16″-20UNF O-ring type



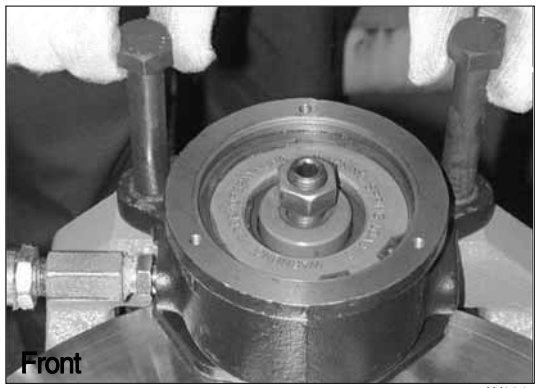
AX022

② Release nut and screw.



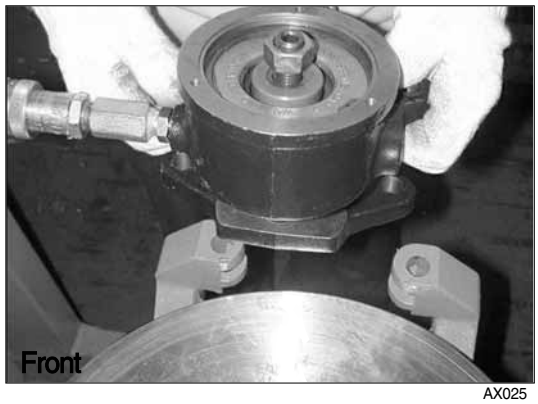
AX023

③ Remove the split pin and nut of caliper brake. Remove the bolts.



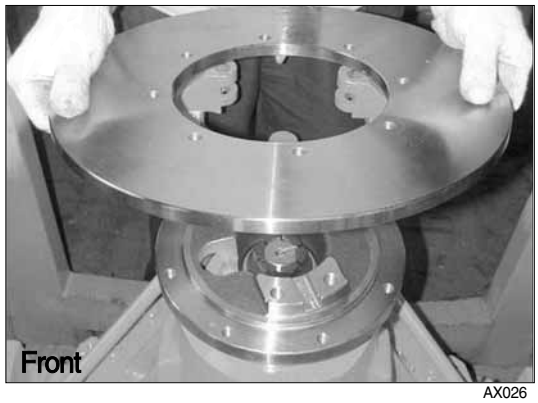
AX024

④ Remove the caliper brake.



AX025

⑤ Remove the disc.



AX026

⑥ Remove the fixed bolts of caliper bracket.



AX027

(2) ASSEMBLY

① Install caliper bracket.

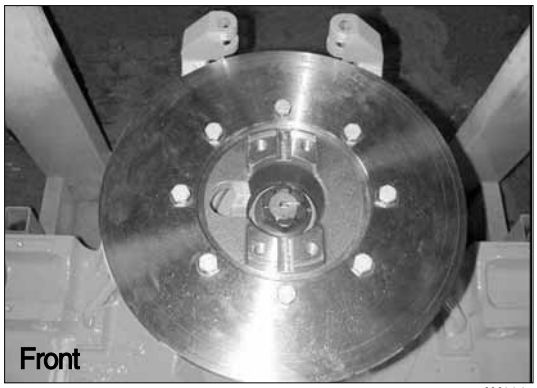
· Tightening torque
14.2~15.7kgf · m(103~114lbf · ft)



AX113

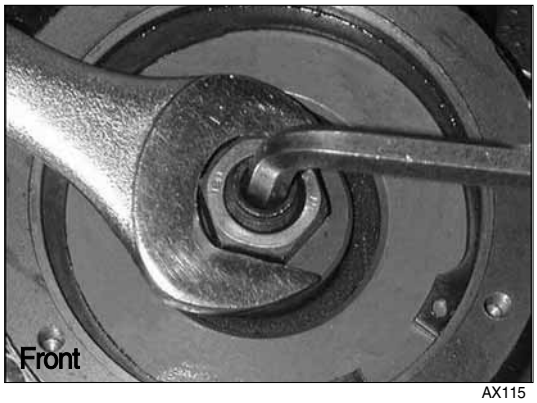
② Fit disc on flange, and tighten bolts.

· Tightening torque
6~7kgf · m(43.4~50.6lbf · ft)



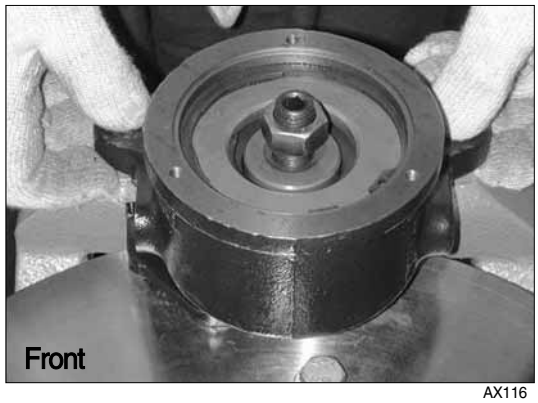
AX114

③ Remove cover and O-ring of caliper bracket, and release nut and pin screw.



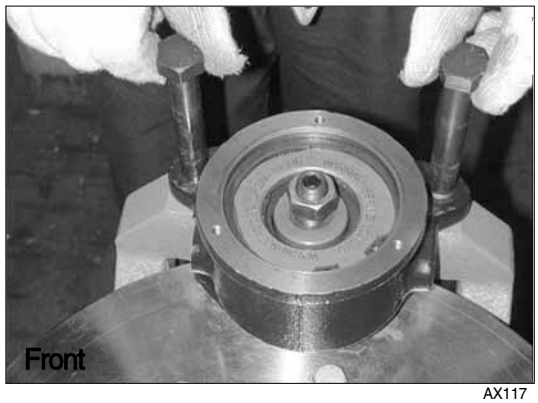
AX115

④ Release nuts on fixed bolts in order to obtain the maximum opening of gripper.



AX116

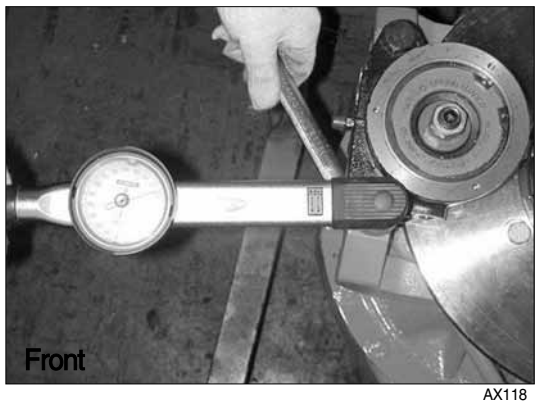
⑤ Insert fixed bolts on caliper bracket.



AX117

⑥ Tighten nuts and split pins.

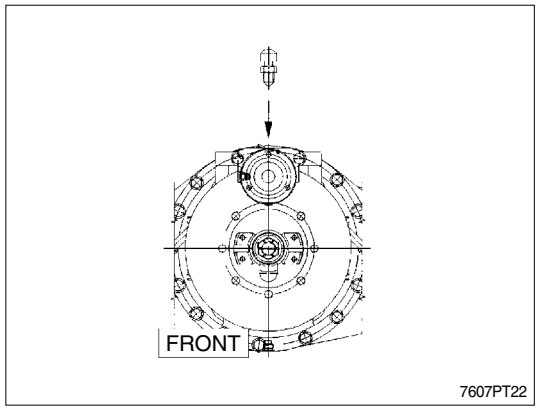
· Tightening torque
1~3kgf · m(7.2~21.7lbf · ft)



AX118

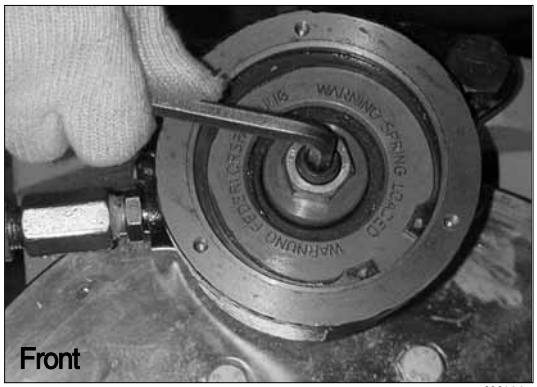
⑦ Assemble the bleeder on brake caliper.

· Bleeder tightening torque : 1.4~1.5kgf · m
(10.1~10.8lbf · ft)



7607PT22

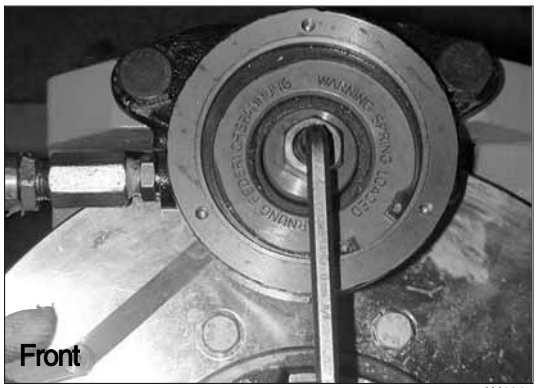
⑧ Press 110~120bar in brake port and close adhesion pad on disc by means of tightening screw pin.



AX120

⑨ Check the gap between discs after unscrewing pin screw 1/8~1/4turn.

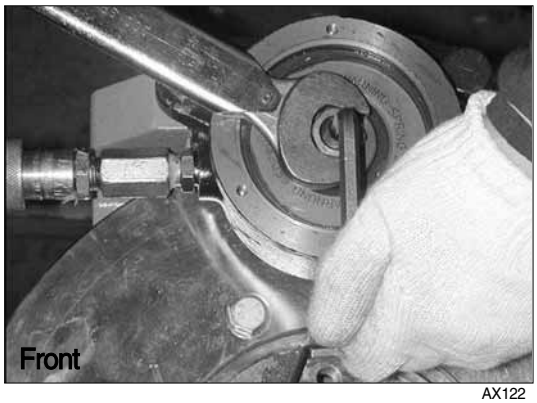
※ Disc gap : Each 0.125~0.25mm



AX121

⑩ Tighten nut.

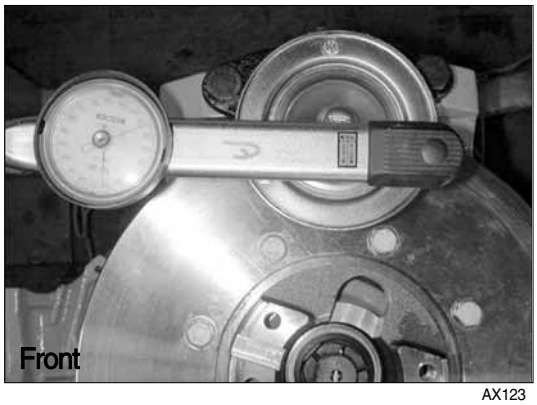
· Tightening torque : 14~16kgf · m
(101~116lbf · ft)



AX122

⑪ Tighten bolts after assembling O-ring on cover.

· Tightening torque : 1.3~1.5kgf · m
(9.4~10.8lbf · ft)

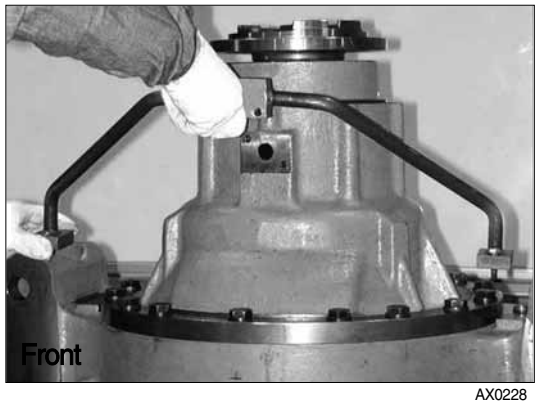


AX123

4) DIFFERENTIAL ASSEMBLY

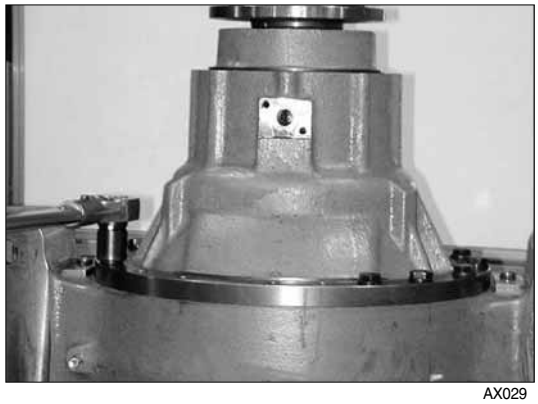
(1) REMOVAL

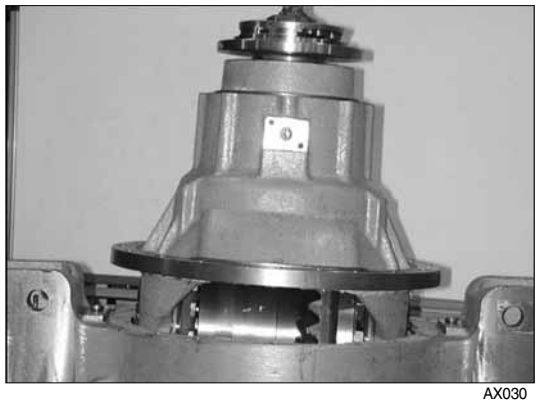
① Remove screws and take away air recirculation duct from differential support and axle case.(Front axle only)



AX0228

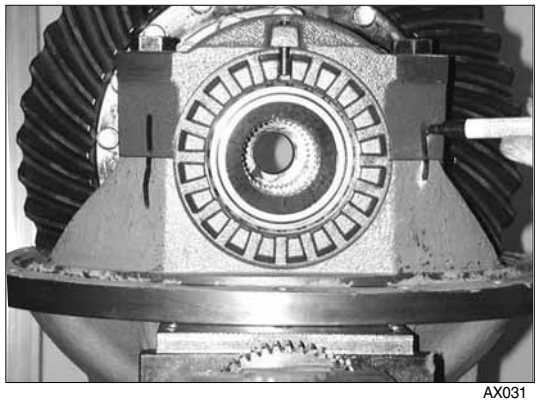
② Loosen the screws retaining different-ial group, then remove it from axle case.


AX029

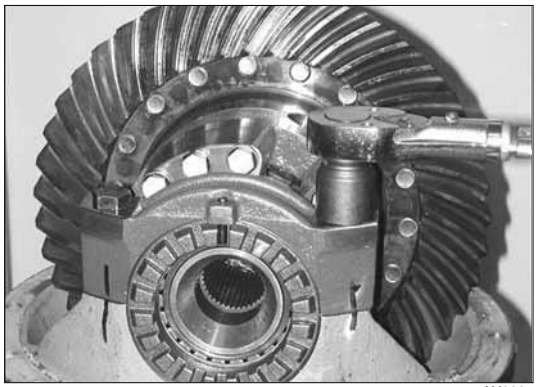

AX030

(2) DISASSEMBLY

① Place differential unit upside down; mark caps position.

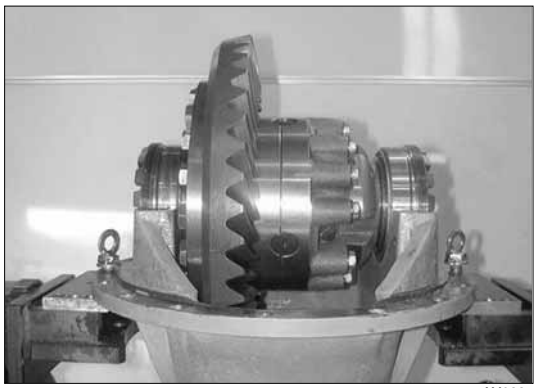

AX031

② Unlock and remove caps fixing screws.



AX032

③ Remove lock pin of ring nut, remove caps.



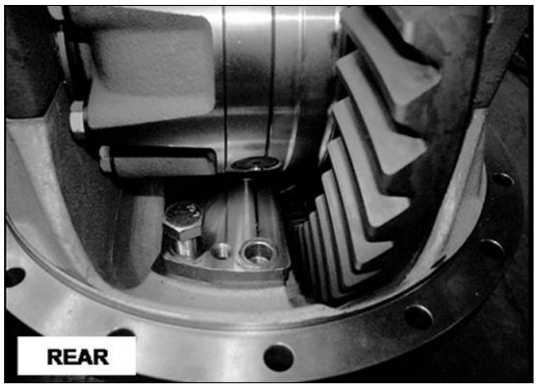
AX033

④ Unlock nut and remove screw.
(Rear differential only)



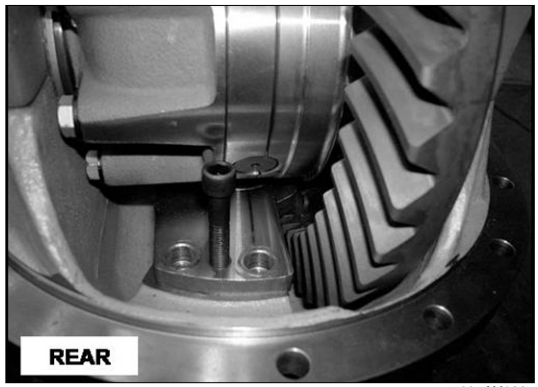
7607AX130

⑤ Remove fixing screws(4EA) of cross beam assembly. (Rear differential only)



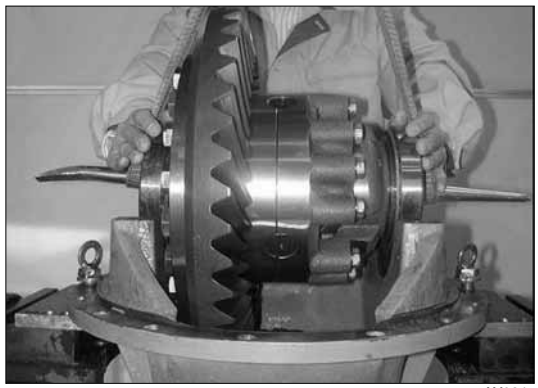
7607AX131

⑥ Install the disassembling bolt on tap (M12×1.75, 2EA) of cross beram assembly. (Rear differential only)



7607AX132

⑦ Lift up differential, cross beam assembly (Rear differential only) from support, by a lifting tool with proper capacity.


AX034

⑧ Remove pin, washer from cross beam assembly. (Rear differential only)



AX133

⑨ Remove bearing from cross beam. (Rear differential only)



AX134

⑩ Place on proper support and lock the differential. Straighten notches on pinion nut, then position reaction tool on P.T.O. flange and unlock nut; release pinion nut. Remove drive flange from pinion shank.



AX035



AX036

⑪ Pry off seal from P.T.O. flange.



AX037

⑫ Drive out bevel pinion from differential support hammering by a proper remover on shank, don't damage thread.



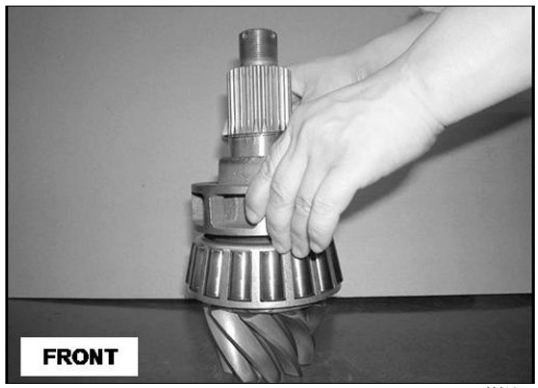
AX038

⑬ Remove the bearing cone.



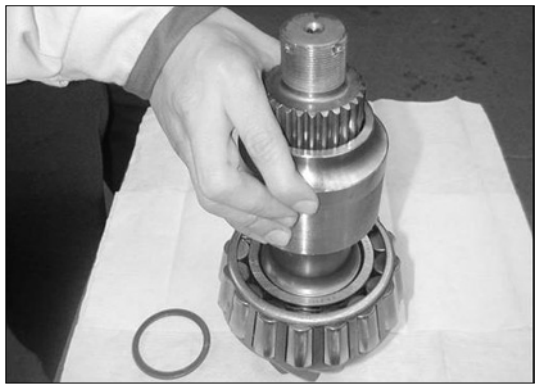
AX039

⑭ Remove pump and shim.
(Front differential only)



AX135

⑮ Remove the shim and spacer in removed pinion. (Rear differential only)



AX041

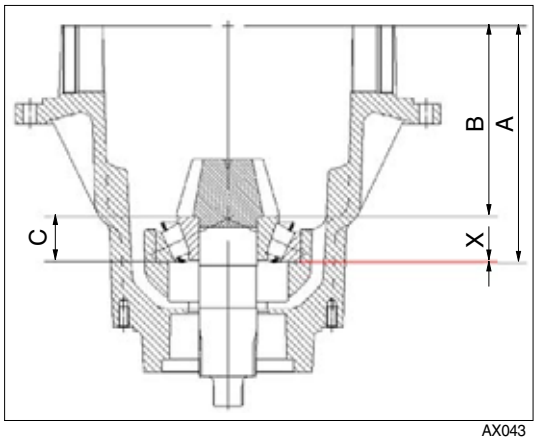
⑯ Remove shim and bearing cup from differential support, hammer pinion shank by a proper tool, taking care not to damage thread.



AX137

(3) ASSEMBLY

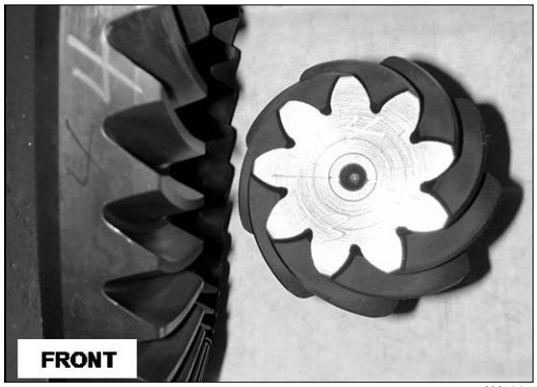
① Measure the dimensions for assembly position of pinion bevel.
Decide the dimension X(shim thickness) by the calculation.



AX043

② Both the bevel pinion and the bevel gear are marked with a number. Confirmed the some numbers both the pinion-bevel and gear-bevel.

※ Number location of bevel set
Bevel pinion : Head surface
Bevel ring : Outer cutting side



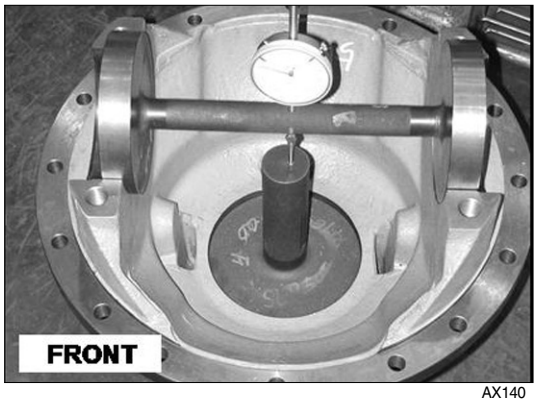
AX138



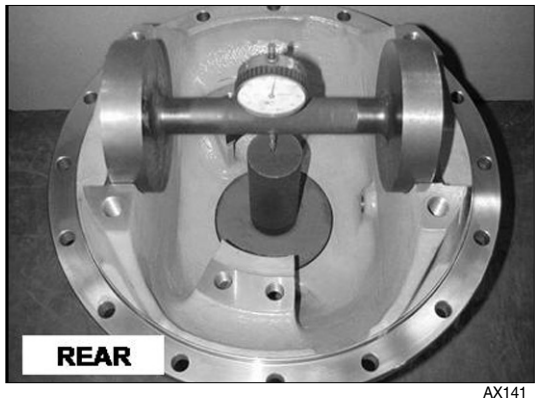
AX139

③ Measure the carrier height **A** by the special tool.

※ Standard value of **A**
- Front axle : 263.0mm
- Rear axle : 222.0mm



AX140

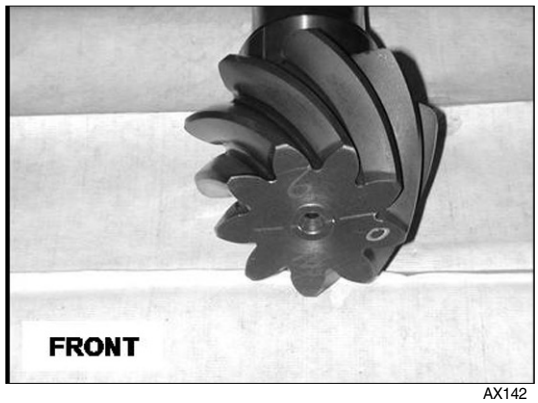


AX141

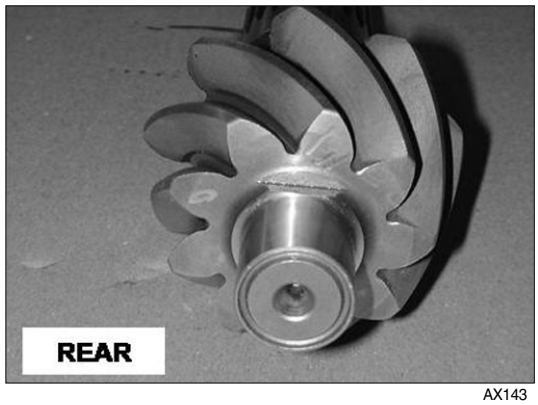
④ Decide a value **B** by the carved value of bevel pinion head.

- Front axle : B = 208.0±carved value
- Rear axle : B = 184.0±carved value

※ In case, the carved value is -10, **B** of Front axle =208.0 - 0.1 = 207.9mm



AX142

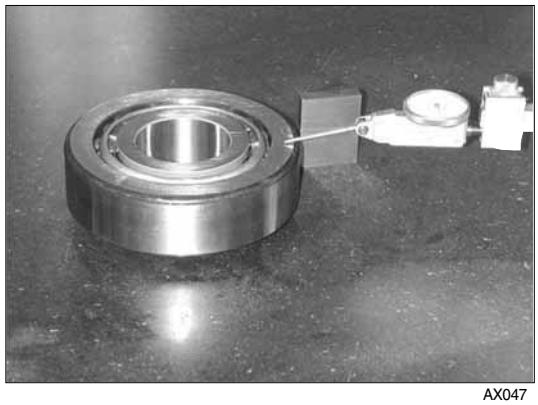


AX143

⑤ Measure the width of bearing **C**.

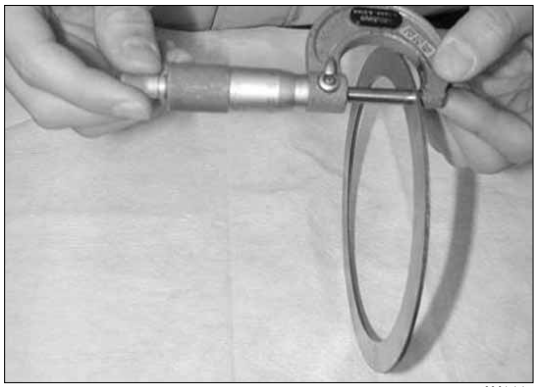
※ Standard value of **C**

- Front axle : 54.0mm
- Rear axle : 37.0mm


AX047

⑥ Determine shim X thickness for correct axial position of pinion-bevel.
X = A - (B + C)

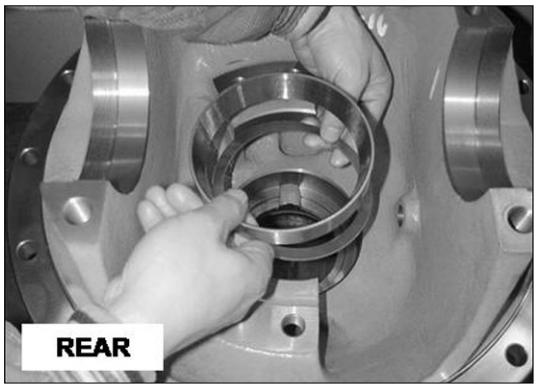
※ Round up or down to the nearest tenth of millimeter the computed thickness.
2.12 rounded down to = 2.1㎜
2.18 rounded up to =2.2㎜


AX144

⑦ Insert adjustment shim for axial position of pinion.
Its value was computed previously ; also, fit outer races of pinion under head and shank bearings.



AX145

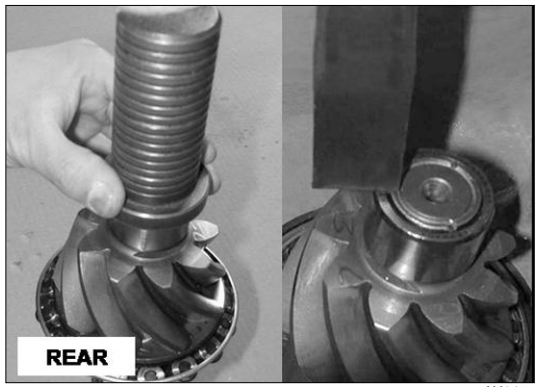


AX146

⑧ Fit in pinion shank inner race of under head bearing, heat or press-in part by installer.

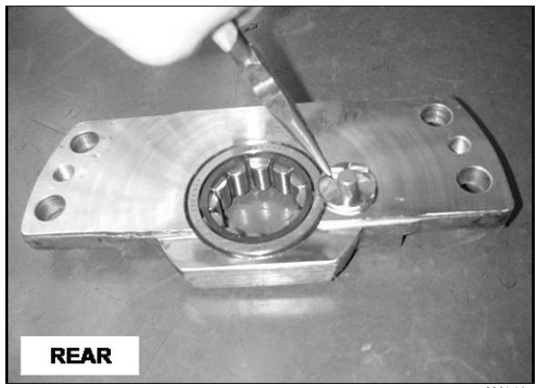

AX049

⑨ Fit in inner race bearing by pressing.



AX147

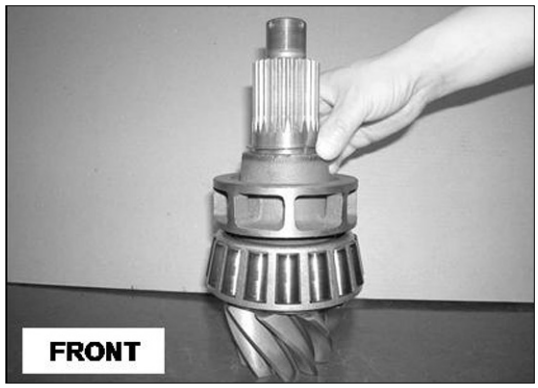
⑩ Fit in bearing by pressing.
Assemble the pin and washer.
(Rear differential only)



AX148

⑪ Assemble the pump and shims(3EA).
(Front differential only)

Asemble the spacer and shims(2EA).
(Rear differential only)



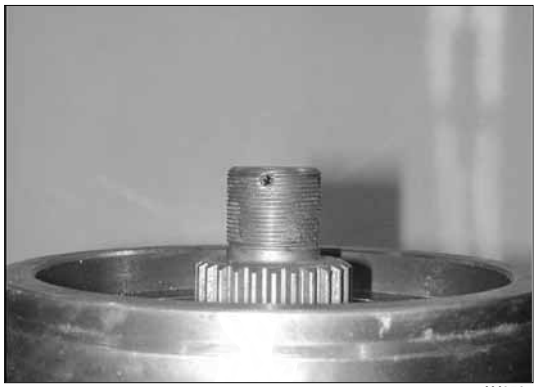
AX149



AX150

⑫ Turn the carrier upside down and assemble the bevel pinion assembly.

※ In order to contact between the bearing cone in pinion bevel and the cup bearing of carrier perfectly, support the bevel pinion by preferable tool.



AX052

⑬ Fit in cone bearing by heating or pressing.



AX055

⑭ Assemble flange and holder in bevel pinion, and tighten pinion nut.

※ Don't assemble seal.

· Tightening torque : 64~70kgf · m
(463~506lbf · ft)



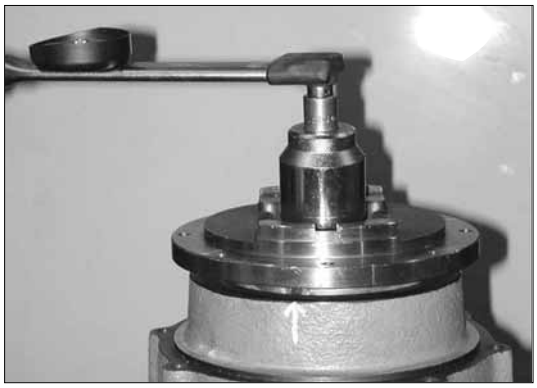
AX056

⑮ Measure prelood and confirm the follow value.

※ Bearing preload

· Front axle : 0.2~0.4kgf · m
· Rear axle : 0.2~0.4kgf · m

※ Before measuring preload, rotate two or three times. Disassemble and change adjustment shims and spacer(Rear axle only) to eliminate all end play up to reach a pre-load.



AX057

⑯ As bearing pre-load has been determined, remove drive flange and pinion nut holder.



AX058

⑰ Assemble seal.

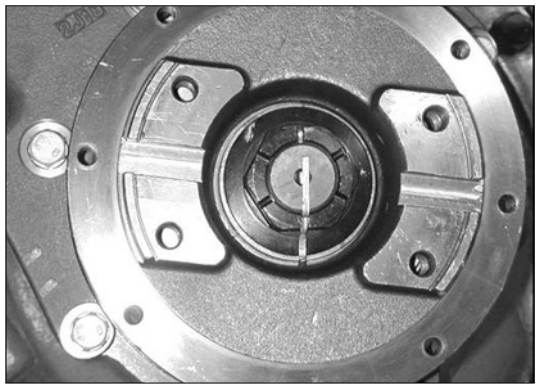
※ Cover the seal with retaining compound. Cover the seal lip and the flange with oil.



AX059

⑱ Assemble the flange and the holder on the bevel pinion, and tighten the pinion nut and the split pin.

· Tightening torque : 64~70kgf · m
(463~506lbf · ft)



AX060

⑲ Install cross beam assembly to the location of bolts fixing bevel ring. And then assemble the bearing inner race before mounting differential to carrier.



AX151

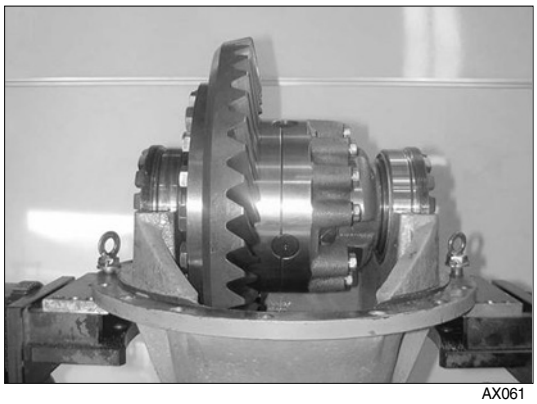
⑳ Tighten the fixing bolt of cross beam assembly.
(Rear differential only)
· Tightening torque : 31.3~34.6kgf · m
(226~250lbf · ft)



AX152

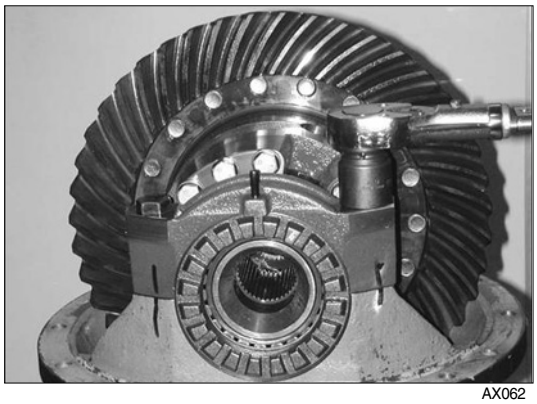
㉑ Fit in the differential assembly on the carrier, and assemble adjusting nut temporarily.
(Front differential only)

Assemble adjusting nut temporary.
(Rear differential only)


AX061

㉒ Install caps, care not to reverse position and lock screws fixing to differential support with belows.

※ Cap tightening torque
· Front axle : 63~69kgf · m(456~499lbf · ft)
· Rear axle : 31.3~34.6kgf · m(226~250lbf · ft)

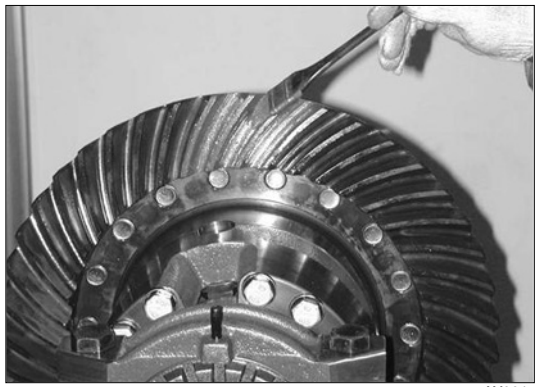

AX062

㉓ Position a dial gauge perpendicular than ring gear tooth and check, with pinion steady, backlash that has to be of 0.25~ 0.33mm (front) and 0.20~0.28mm(rear).
Otherwise rotate both ring nuts by displacing them of the same number of notches and nearing ring gear to pinion if backlash is excessive, by moving away on the contrary.

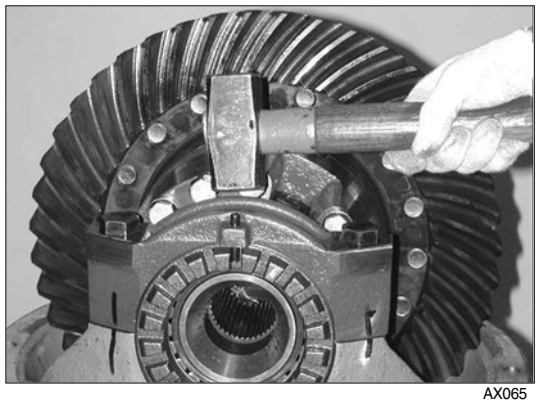
※ Bevel set back lash
· Front axle : 0.25~0.33mm
· Rear axle : 0.20~0.28mm


AX063

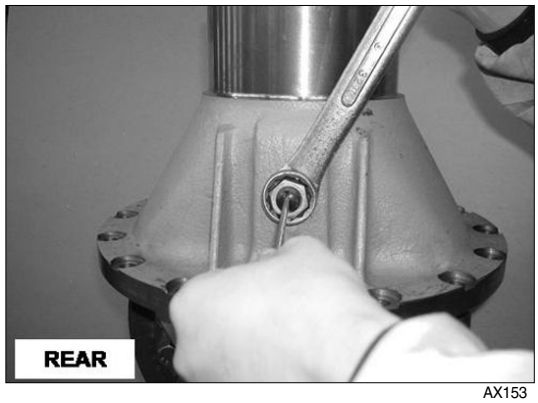
㉔ Brush red lead on some ring tooth, rotate to mesh pinion and ring gear repeatedly, so to make evident tooth contact. Proper and correct tooth contact marks are visible on a new bevel gear set as a result of an optimum contact approached on the tester, consequently, a proper axial position of pinion against ring gear will emphasise remarking of previous tester contact markings.


AX064

㉕ Fit spring pins locking threaded rings of differential unit.


AX065

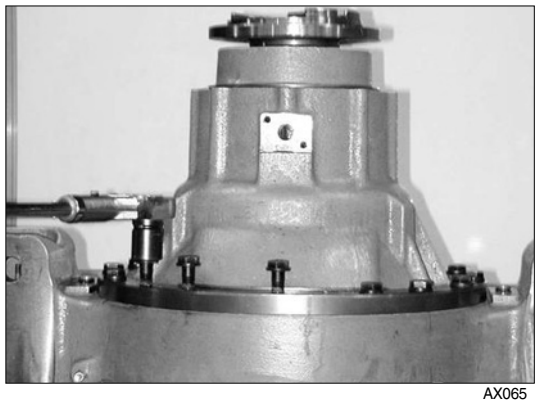
㉖ Apply flange sealant on the screw.
Tighten the screw until contacting the bevel gear and then loosen about 60¡ before tightening nut.



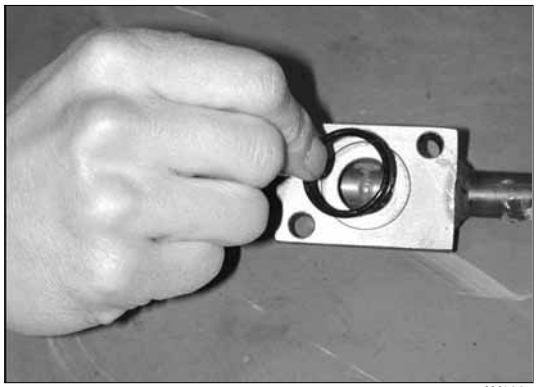
AX153

(4) HOUSING AND DIFFERENTIAL MOUNTING

① Perform two securing notches on pinion nut.
Clean with care contact surfaces, apply hard locking compound and then install the differential unit on axle case ; lock the connecting screws with a torque of 18.0~20.0Kgf · m(130~145lbf · ft).

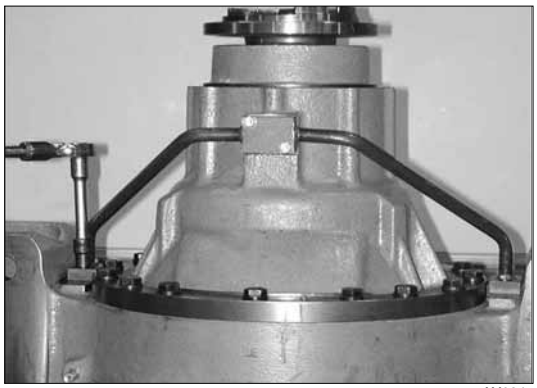

AX065

② Assemble O-ring on tube assembly port(3EA). (Front axle only)



AX083

③ Position the tube assembly, fit screws and lock with a torque of 3.0~3.6Kgf · m(21.7~26.0lbf · ft). (Front axle only)



AX084

5) SUPER MAX TRAC

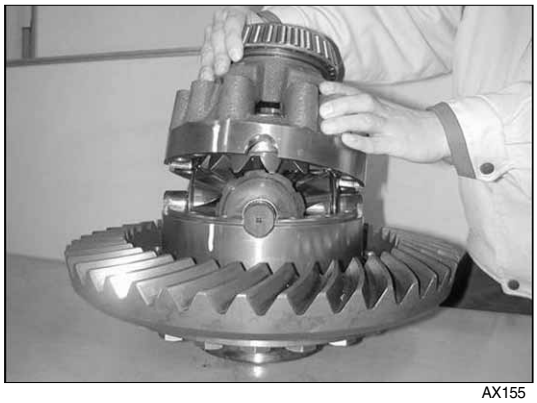
(1) DISASSEMBLY

① Mark the two half cases(LH/RH).



AX154

② Loosen the bolts of the case(RH) and remove the case(LH).



AX155

③ Remove the side gear and the trust washer.



AX156

④ Remove spider with the four side gears and relevant bevel thrust washers.



AX157

⑤ Remove the planetary gear with relevant intermediate and shim discs and clutch discs, in half case on bevel gear side.



AX158

⑥ Loosen bevel gear fixing screws.



AX159

(2) ASSEMBLY

① Install gear-bevel on case(LH) by bolts.

※ Tightening torque

- Front axle : 45.6~50.4kgf · m(330~365lbf · ft)
- Rear axle : 31.3~34.6kgf · m(226~250lbf · ft)



AX160

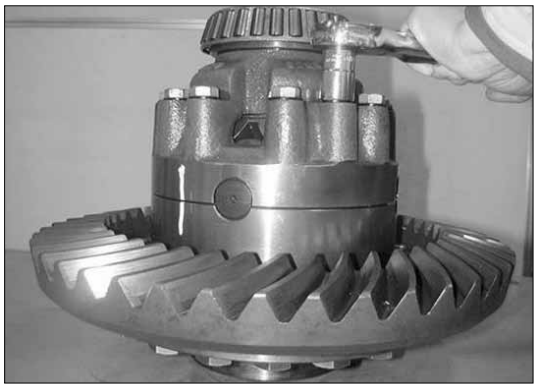
② Insert side gear assembly and thrust washer in case(LH).
Assemble spider and side gear according to procedure.



AX079

③ Mount the cover, taking care to align the reference marked done before disassembling ; close the two half casings.
Screw in fixing screws and lock a torgue of ;

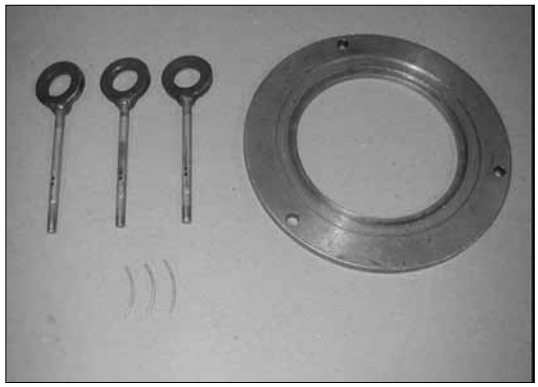
- Front and rear axle : 11.4~12.6kgf · m
  (82.5~91.1lbf · ft)



AX162

6) TOOLS

① Spring compression tool.



AX124

② Nut adjusting tool of reduction assembly.



AX125

4. ZF AXLE (Machine serial No. ; #0294~)

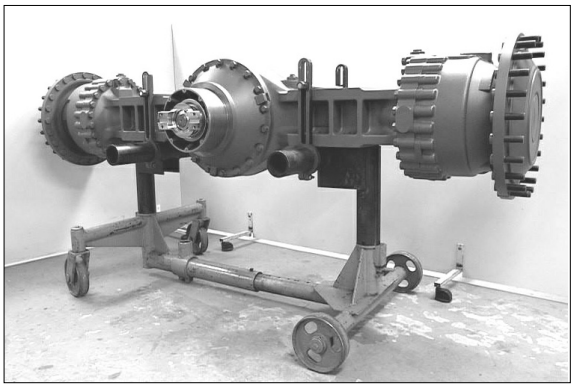
- FRONT AXLE

1) DISASSEMBLY OF OUTPUT AND BRAKE

(1) Fasten axle on assembly truck.

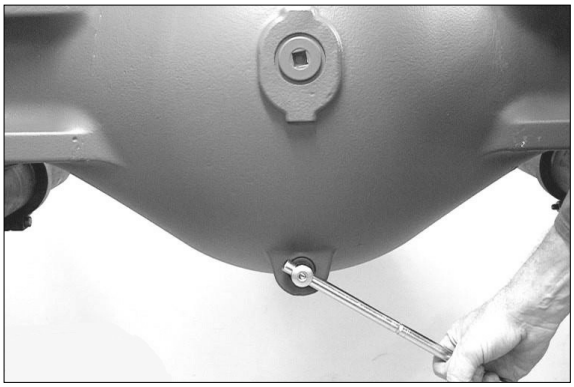
※ Special tool

Assembly truck	5870 350 000
Holding fixtures	5870 350 077
Clamps	5870 350 075

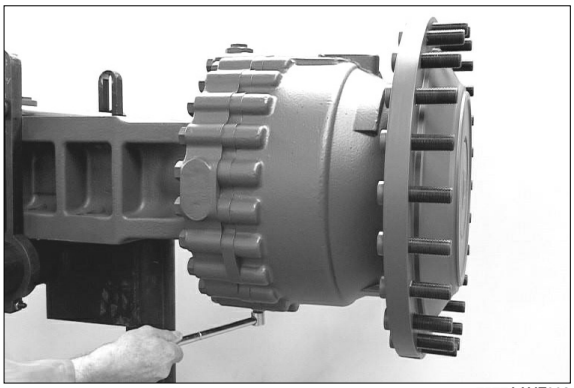


7577AAXF001

(2) Loosen screw plugs (3EA, see Figure 7577AAXF002 and 003) and drain oil from axle casing.



7577AAXF002

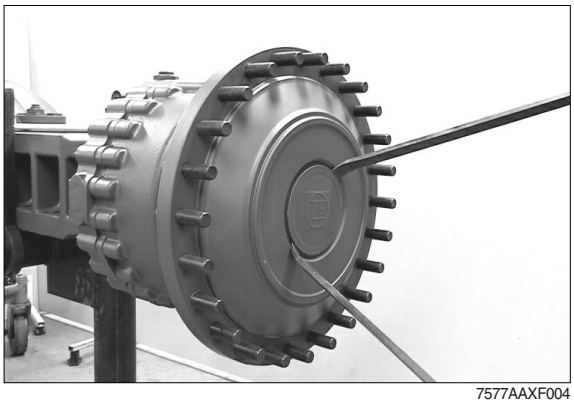


7577AAXF003

(3) Press off cover from the output shaft.

※ Special tool

Pry bar set	5870 345 065

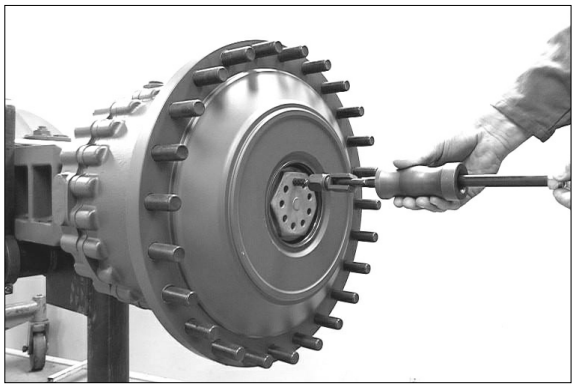


7577AAXF004

(4) Pull slotted pin by means of the striker out of the bore in the slotted nut.

※ Special tool

Striker	5870 650 001

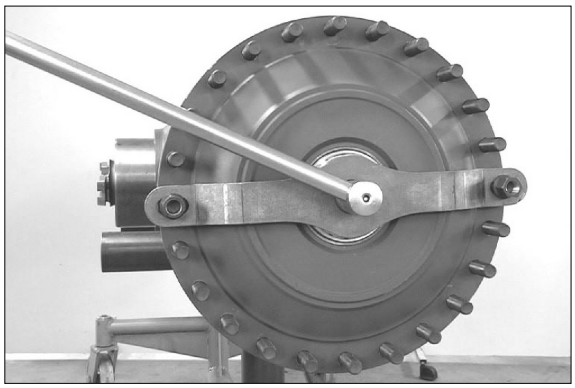


7577AAXF005

(5) Loosen slotted nut.

※ Special tool

Socket spanner	5870 656 078
Centering bracket	5870 912 028

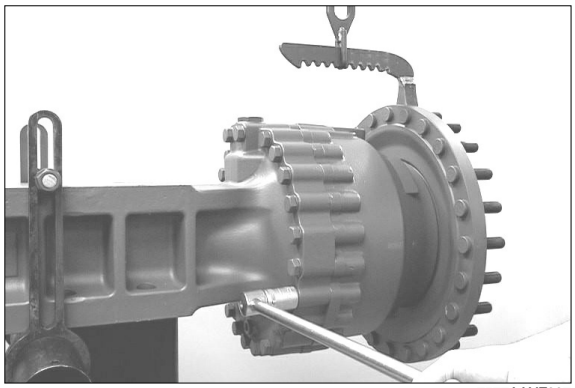


7577AAXF006

(6) Secure output by means of lifting tackle and loosen hexagon screws.

※ Special tool

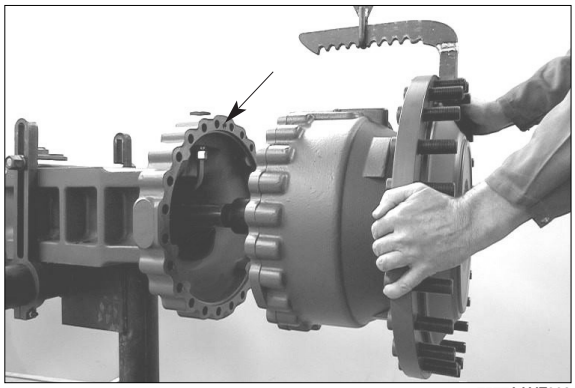
Lifting bracket	5870 281 043



7577AAXF007

(7) Separate complete output from the axle casing.

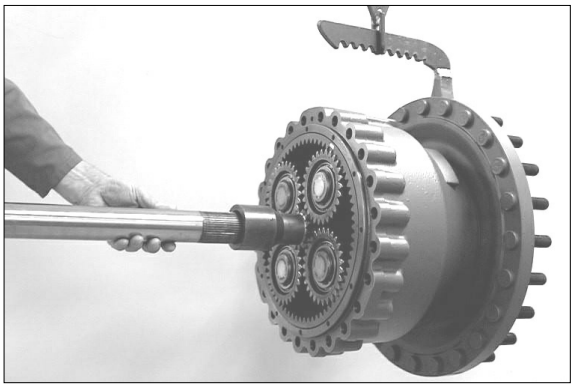
※ Pay attention to released O-ring (see arrow).



7577AAXF008

(8) Pull stub shaft out of the sun gear shaft.

※ Pay attention to possibly released shim(s).



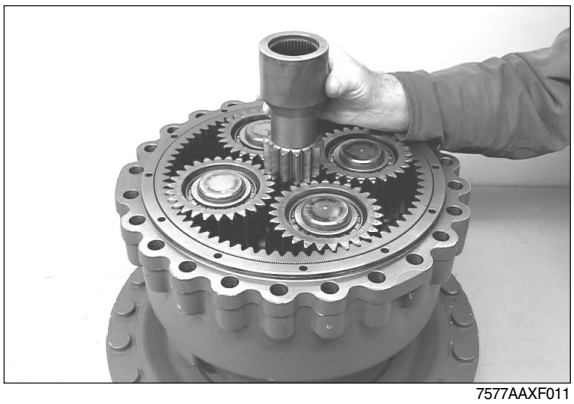
7577AAXF009

(9) Remove shim(s) from the sun gear shaft.



7577AAXF010

(10) Pull sun gear shaft out of the planet gears.

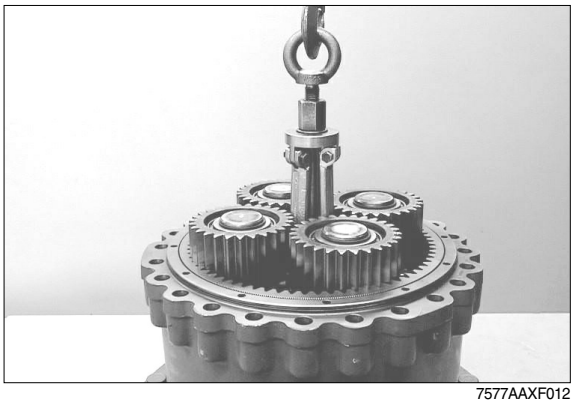


7577AAXF011

(11) Lift planet carrier out of the brake housing.

※ Special tool

Internal extractor	5870 300 019

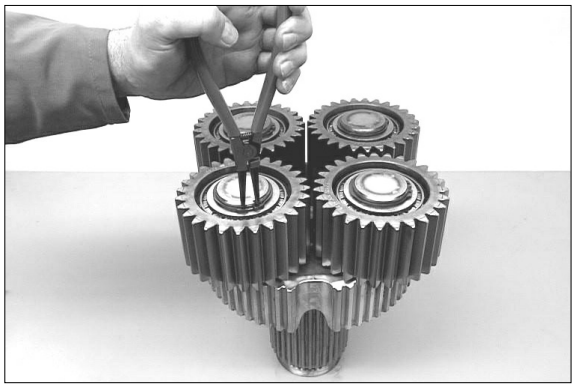


7577AAXF012

(12) Squeeze out the retaining ring.

※ Special tool

Set of external pliers	5870 900 015

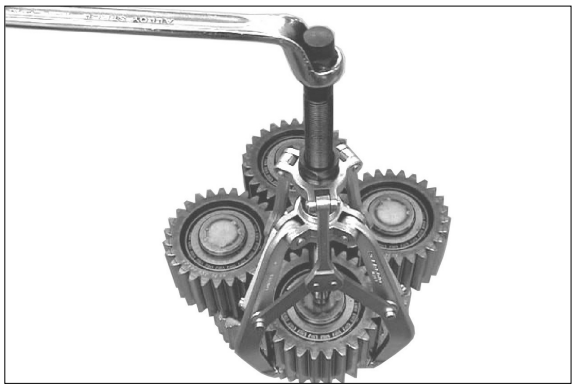


7577AAXF013

(13) Pull off the planet gear and remove the released bearing inner ring.

※ Special tool

Three-armed puller	5873 971 002

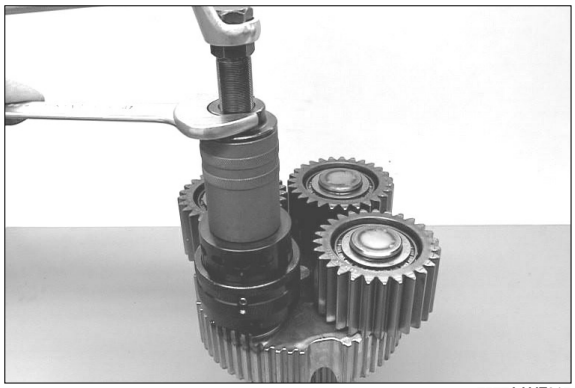


7577AAXF014

(14) Pull off the bearing inner ring.

※ Special tool

Gripping insert	5873 001 020
Basic set	5873 001 000

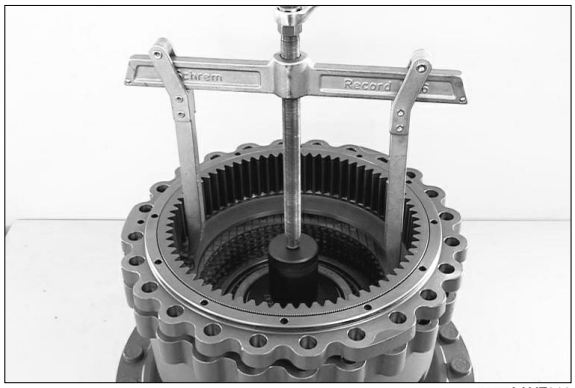


7577AAXF015

(15) Separate ring gear from the brake housing by means of two-armed puller.

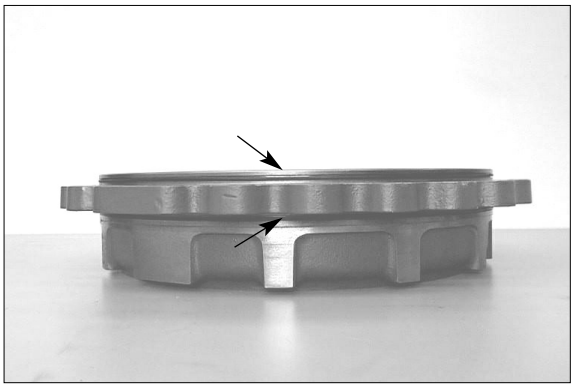
※ Special tool

Two-armed puller	5870 970 007



7577AAXF016

(16) Remove O-rings (see arrows) from the annular grooves of the ring gear.



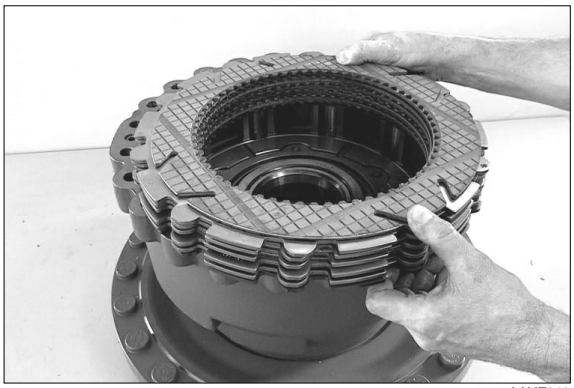
7577AAXF017

(17) Remove O-ring (see arrow) from the recess of the brake housing.



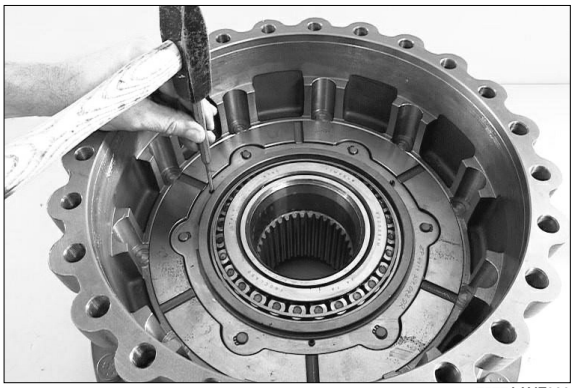
7577AAXF018

(18) Take the disc pack out of the brake housing.



7577AAXF019

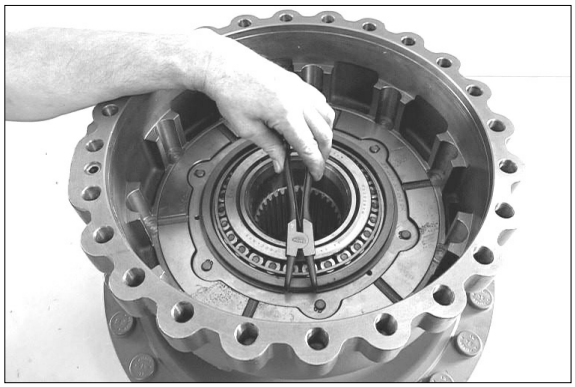
(19) Install slotted pins (6EA) in the support shim until they are flush-mounted.



7577AAXF020

(20) Squeeze out the circlip.

※ Special tool
Set of external pliers 5870 900 016



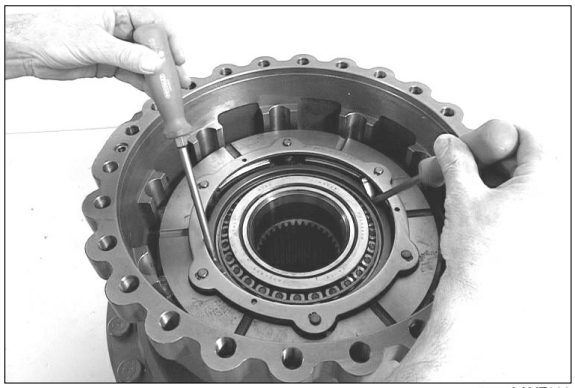
7577AAXF021

(21) Press piston out of the brake housing by means of compressed air.



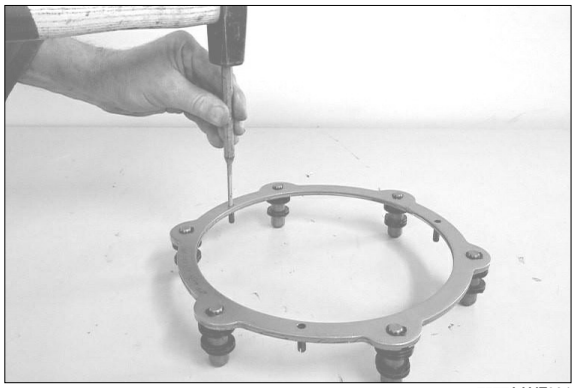
7577AAXF022

(22) Press support shim out of the piston by means of the automatic piston adjusting.



7577AAXF023

(23) Drive slotted pins (6EA) out of the support shim.

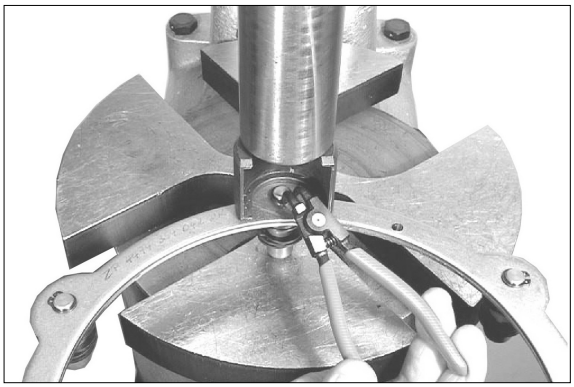


7577AAXF024

(24) Preload cup springs by means of a press and squeeze out the circlip.

※ Special tool

Assembly pliers	5870 900 051
Assembly fixture	5870 345 096



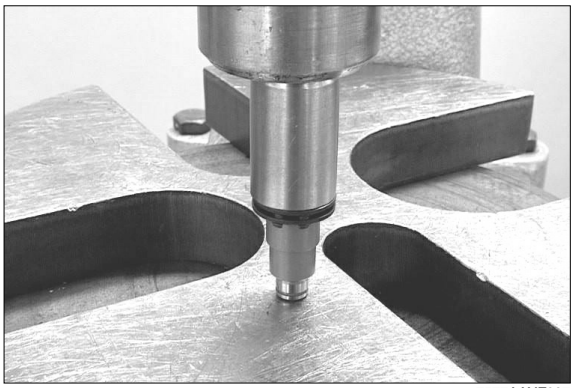
7577AAXF025

(25) Pull pin out of the support shim and remove released cup springs.



7577AAXF026

(26) Press gripping rings from the pin.

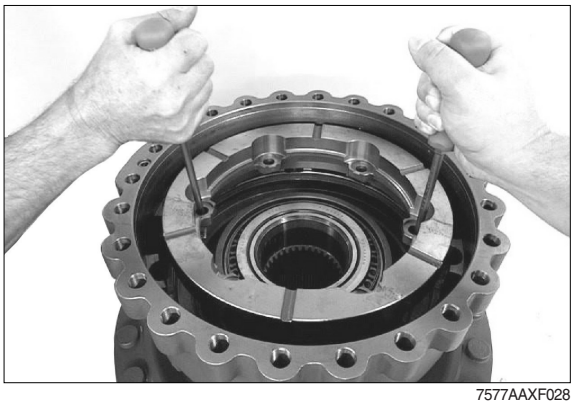


7577AAXF027

(27) Lift piston out of the brake housing.

※ Special tool

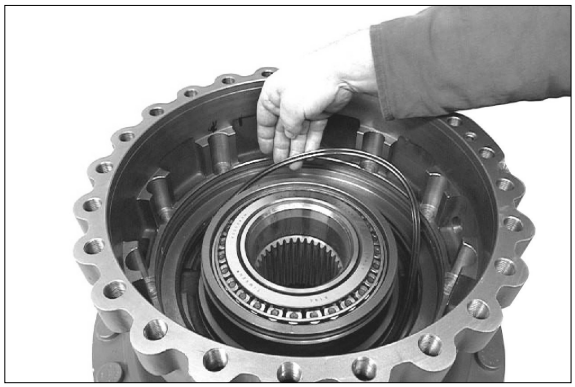
Adjusting device	5870 400 001



7577AAXF028

(28) Remove guide ring, support rings and U-rings from the annular grooves of the brake housing.

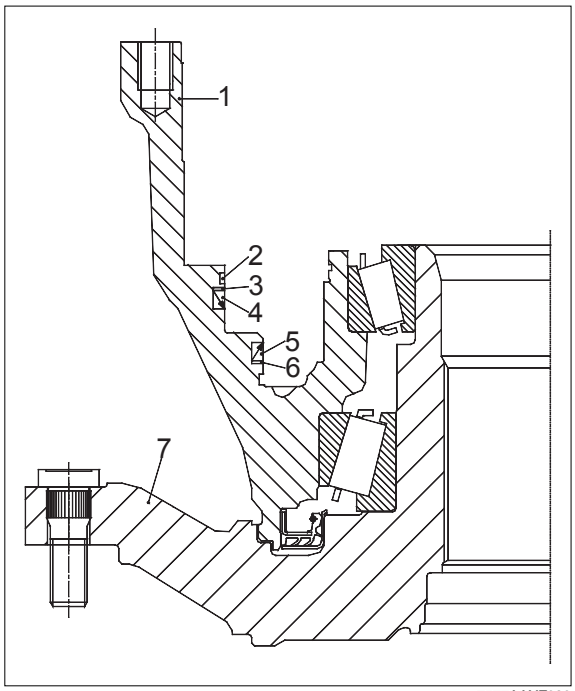
※ See below sketch for installation position of the single parts.



7577AAXF029

To the sketch :

1 Brake housing
2 Guide ring
3 Support ring
4 U-ring
5 U-ring
6 Support ring
7 Output shaft



7577AAXF030

(29) Pull brake housing by means of two-armed puller from the output shaft and remove the released bearing inner ring.

※ Special tool

Two-armed puller	5870 970 007
Clamping bracket	5870 654 034
Press bush	5870 506 140

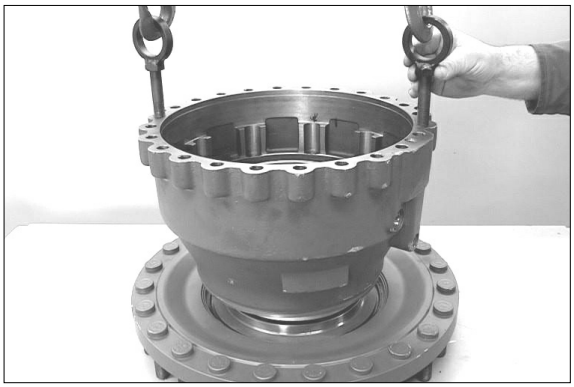


7577AAXF031

(30) Lift brake housing with lifting tackle from the output shaft.

※ Special tool

Lifting chain	5870 281 047
Eye bolts	5870 204 071



7577AAXF032

(31) If necessary drive both bearing outer rings out of the bearing bores in the brake housing.



7577AAXF033

(32) Press shaft seal out of the brake housing.

※ Special tool

Pry bar set	5870 345 065

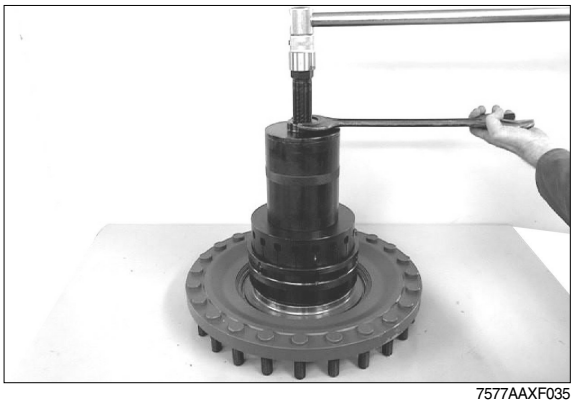


7577AAXF034

(33) Pull bearing inner ring from the output shaft.

※ Special tool

Rapid grip	5873 014 013
Basic set	5873 004 001

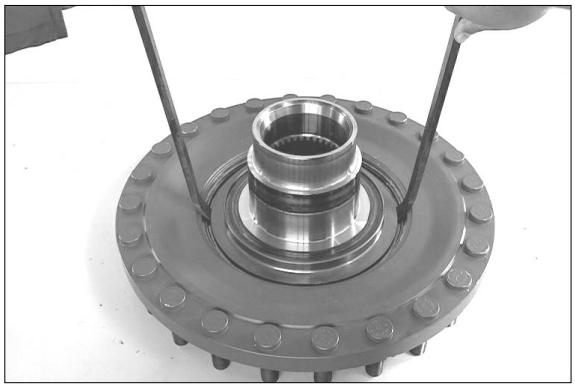


7577AAXF035

(34) Press off bearing sheet from the output shaft.

※ Special tool

Pry bar set	5870 345 065



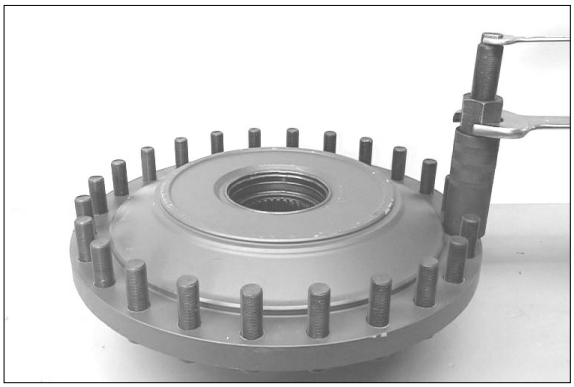
7577AAXF036

2) REASSEMBLY OF OUTPUT AND BRAKE

(1) Insert wheel bolt into the output shaft until contact.

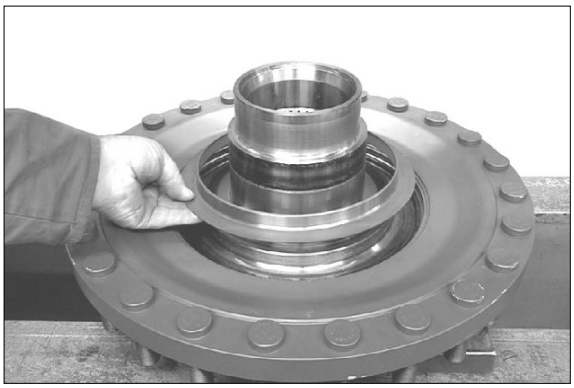
※ Special tool

Wheel bolt puller-basic set	5870 610 010
Insert (7/8"-14 UNF)	5870 610 011



7577AAXF037

(2) Assemble bearing sheet (shaft seal).



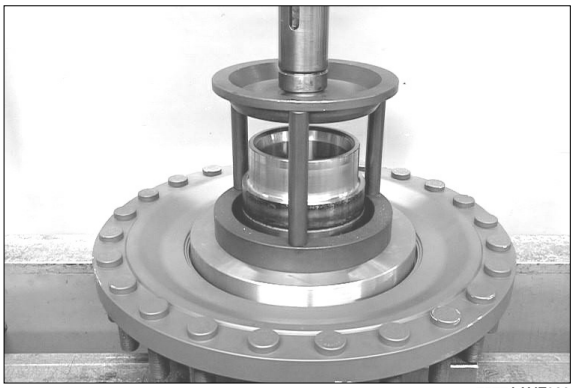
7577AAXF038

(3) Press bearing sheet over the collar of the output shaft.

※ Special tool

Pressure ring	5870 506 141

※ The exact installation position of the bearing sheet will be obtained by using the specified pressure ring.



7577AAXF039

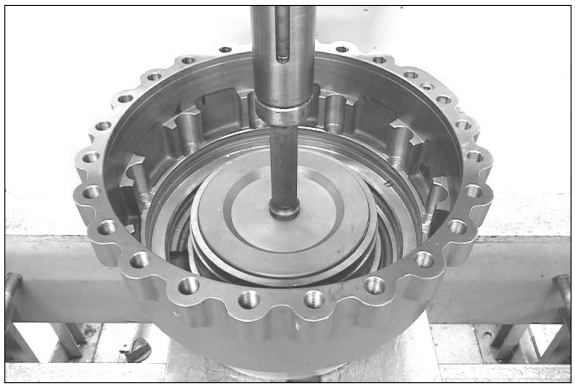
(4) Heat the roller bearing and install it until contact.

※ After cooling-down the bearing has to be installed subsequently.



7577AAXF040

(5) Press both bearing outer rings into the brake housing until contact.



7577AAXF041

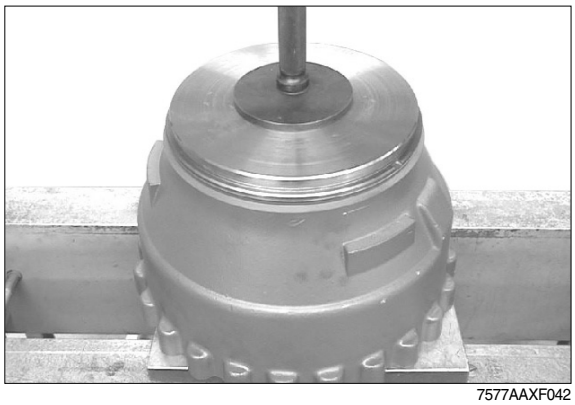
(6) Install shaft seal with the sealing lip showing to the oil chamber (see below sketch).

※ Special tool

Driver	5870 051 052

※ The exact installation position of the shaft seal will be obtained by using the specified driver.

⚠ **Just before the installation wet the outer diameter of the shaft seal with spirit.**

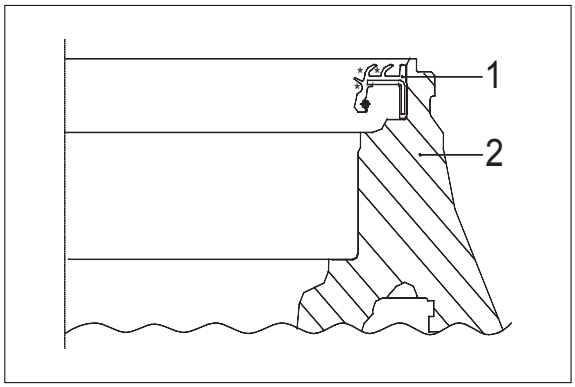


7577AAXF042

To the sketch :

1 Brake housing
2 Shaft seal
* Grease filling

※ Fill the space between sealing and dust lips with grease.

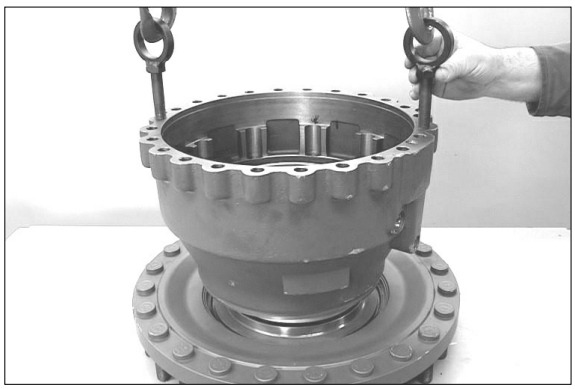


7577AAXF043

(7) Install the preassembled brake housing by means of the lifting tackle over the output shaft until contact.

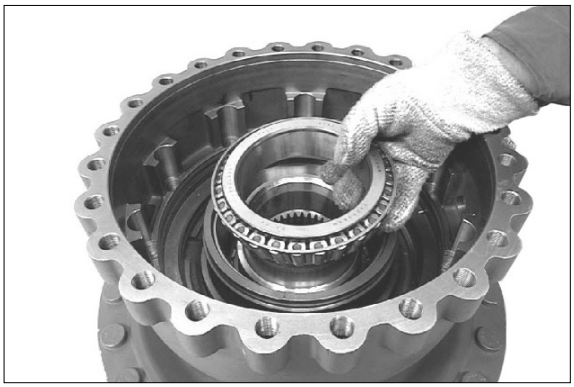
※ Special tool

Lifting chain	5870 281 047
Eye bolts	5870 204 071



7577AAXF044

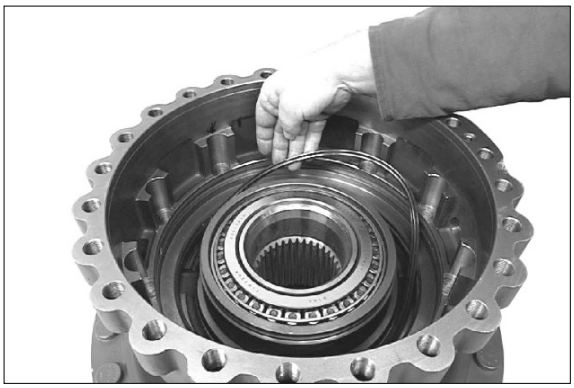
(8) Heat the roller bearing and install it until contact.



7577AAXF045

(9) Insert support and U-rings into the annular grooves of the brake housing.

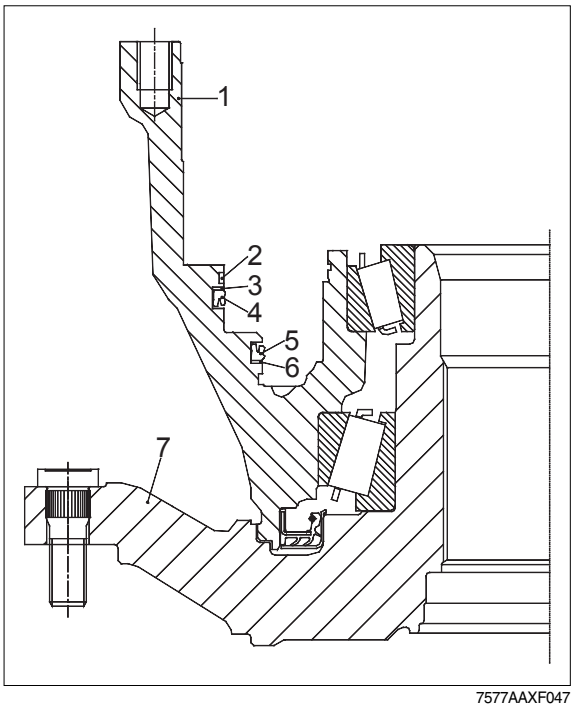
※ Pay attention to the installation position, see below sketch.



7577AAXF046

To the sketch :

1 Brake housing
2 Guide ring
3 Support ring
4 U-ring
5 U-ring
6 Support ring
7 Output shaft



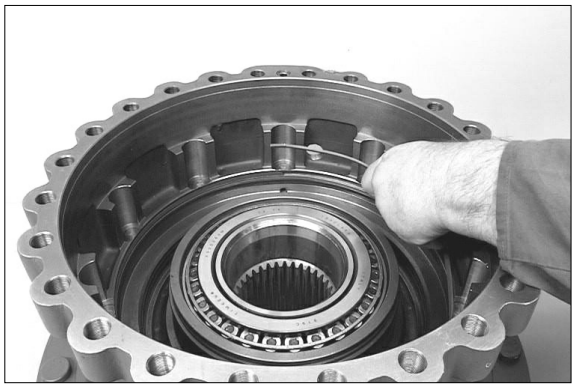
7577AAXF047

(10) Clean annular groove of the brake housing with spirit.

Then insert the guide ring into the annular groove (also see sketch page 3-192) and fix it with Loctite (Type No. 415) at its extremities.

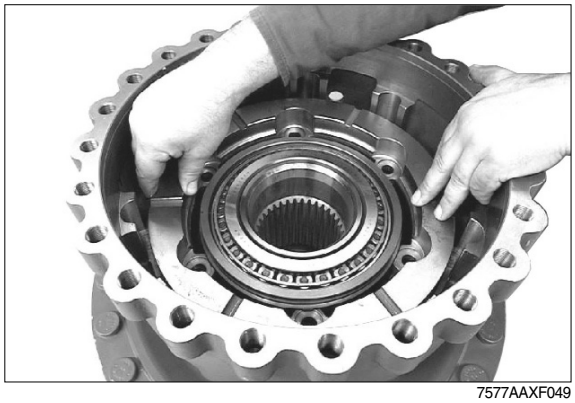
※ Guide ring must have contact on the whole circumference.

⚠ **Upon installation the orifice of the guide ring must show upwards (12 o'clock).**


7577AAXF048

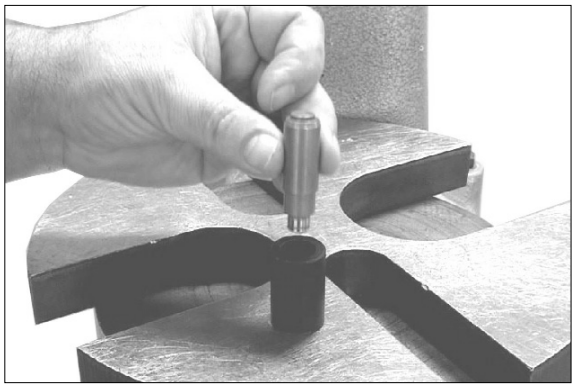
(11) Insert piston into the brake housing and install it cautiously until contact.

※ Apply sufficiently oil on the sliding surface of the piston or support rings, U-rings and guide ring (use W-10 oils).


7577AAXF049

(12) Insert pins into the assembly fixture until contact.

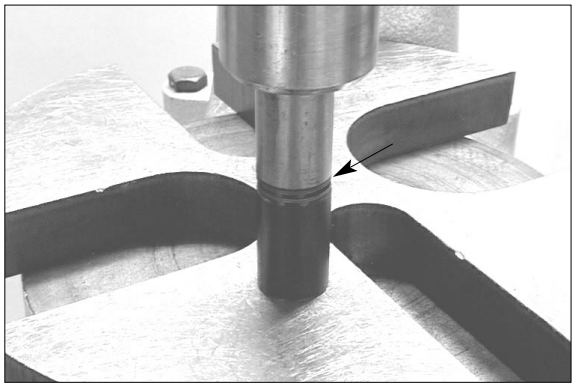
※ Special tool
Assembly fixture 5870 345 096


7577AAXF050

(13) Press gripping rings (4EA, see arrows) onto the pins until contact on the assembly fixture.

※ The exact installation dimension (see sketch page 3-194) of the gripping rings is obtained when using the specified assembly fixture.

⚠ **Observe the installation position, install gripping rings with the orifices offset by 180° to each other.**


7577AAXF051

(14) Install cup springs (7 pieces each/pin).

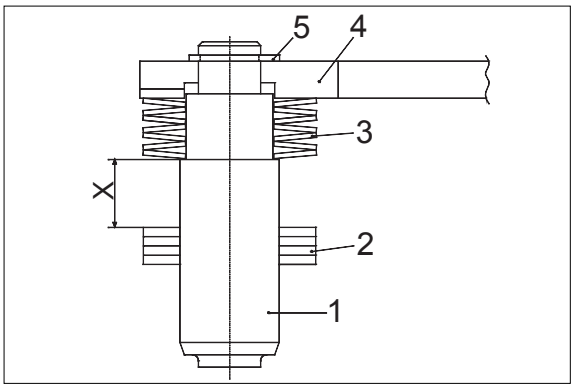
※ Pay attention to the installation position of the cup springs, see below sketch.



7577AAXF052

To the sketch :

1 Pin
2 Gripping rings
3 Cup springs
4 Support shim
5 Circlip
X Installation dimension gripping rings $10.5^{+0,3}$ mm

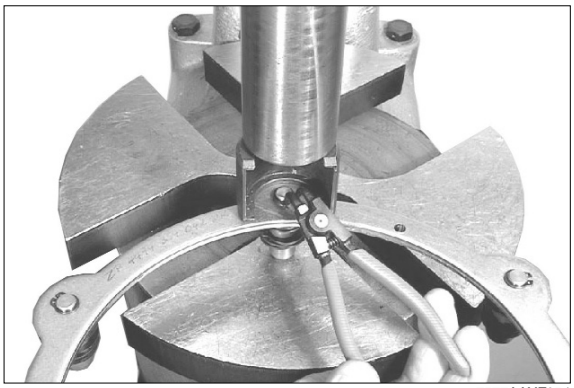


7577AAXF053

(15) Insert preassembled pins into the support shim and fix it by means of the circlip.

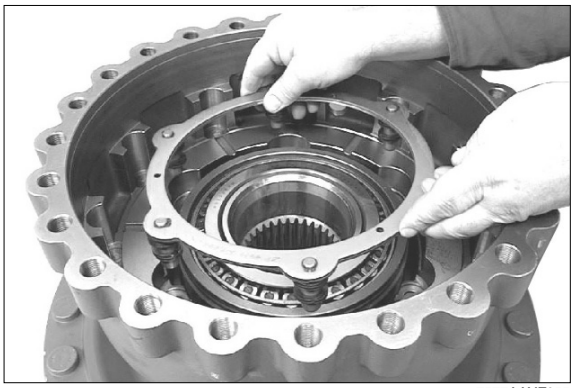
※ Special tool
Assembly pliers 5870 900 051

※ Pay attention to clearance of the cup springs.



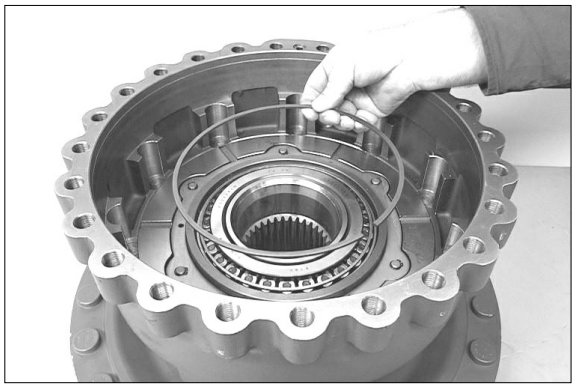
7577AAXF054

(16) Insert preassembled support shim into the piston.



7577AAXF055

(17) Fix support shim by means of the circlip.

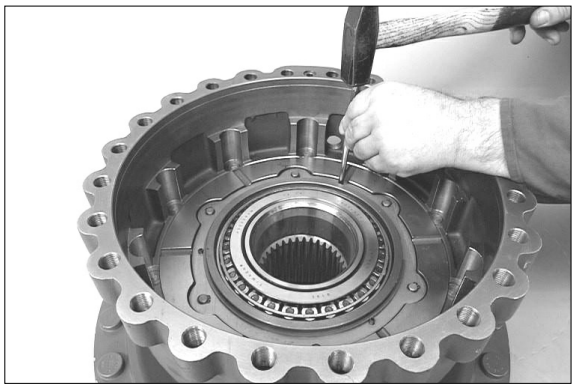


7577AAXF056

(18) Drive slotted pins (6EA) into the bores of the support shim to lock the circlip.

※ Special tool
Drive mandrel 5870 705 011

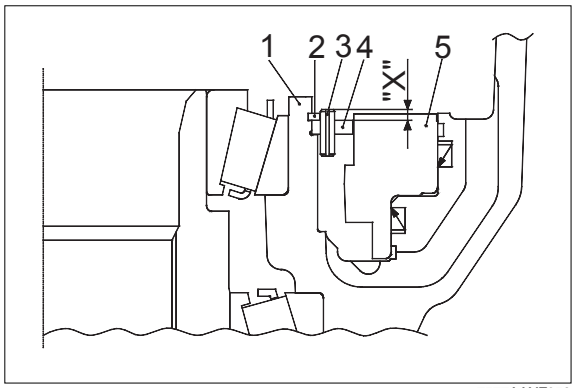
※ Pay attention to the installation position, see below sketch.



7577AAXF057

To the sketch :

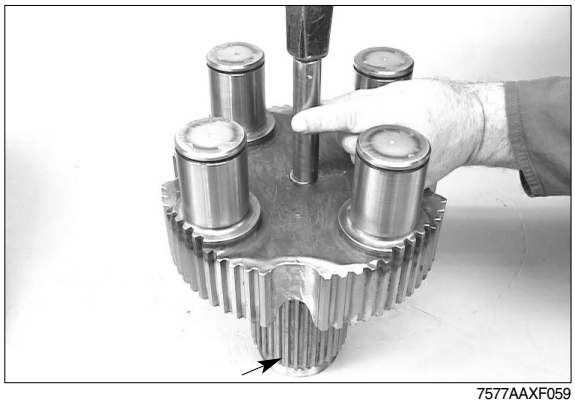
1 Brake housing
2 Circlip
3 Slotted pin
4 Support shim
5 Piston
X Installation dimension 4.0 $_{-0,5}$ mm



7577AAXF058

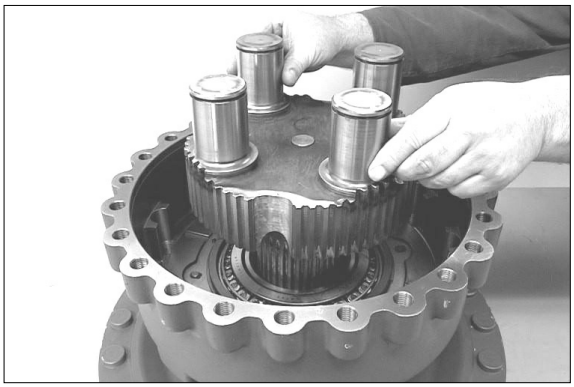
(19) Drive stop bolt into the planet carrier until contact.

Then wet spline (see arrow).



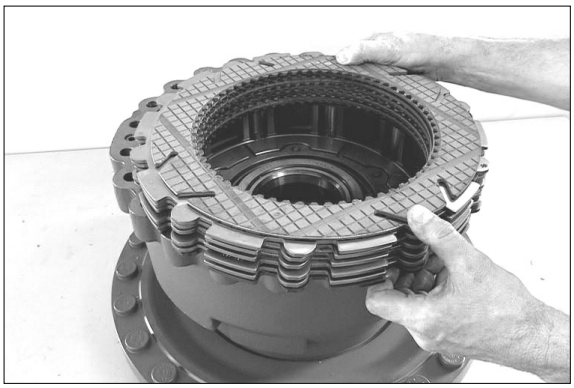
7577AAXF059

(20) Insert planet carrier into the spline of the output shaft until contact.



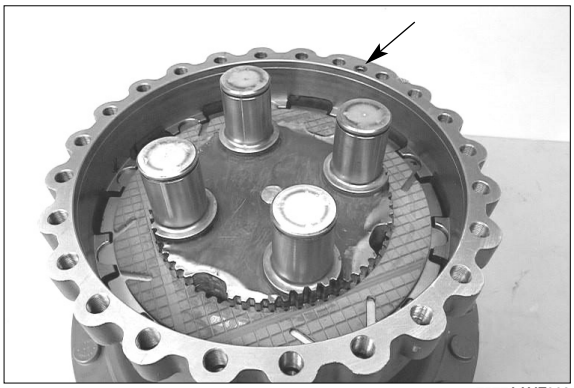
7577AAXF060

(21) Install outer-and inner clutch discs alternately starting with an outer clutch disc.



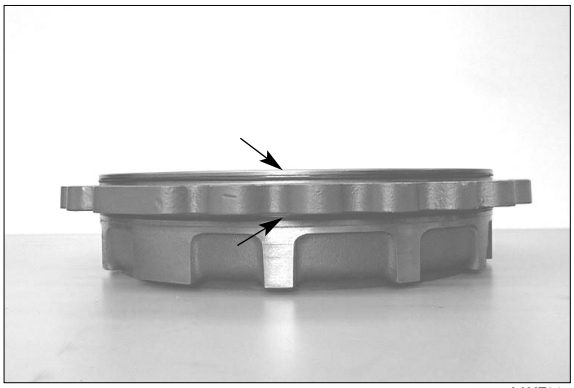
7577AAXF061

(22) Insert O-ring (see arrow) into the recess of the brake housing.



7577AAXF062

(23) Grease both O-rings (see arrows) and insert them into the annular grooves of the ring gear.

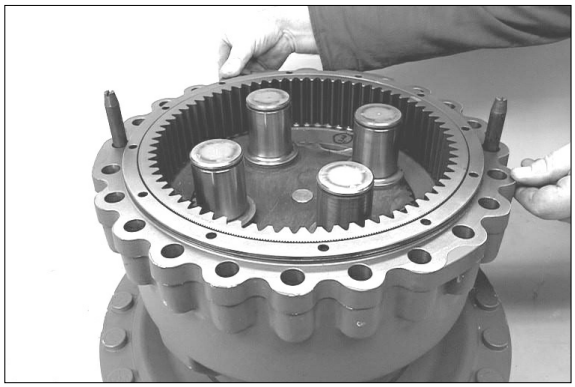


7577AAXF017

(24) Install two adjusting screws and insert ring gear into the brake housing until contact.

※ Special tool
Adjusting screws 5870 204 029

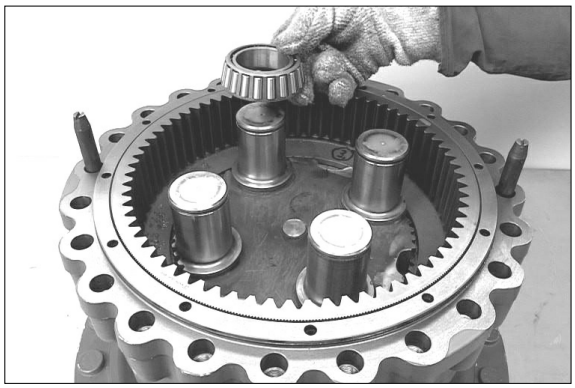
※ Pay attention to radial location.



7577AAXF063

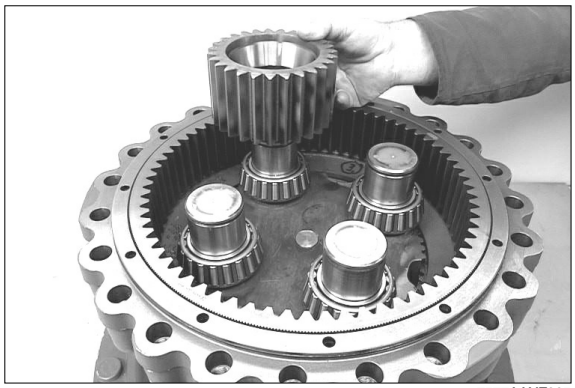
(25) Heat bearing inner rings and install them until contact with the big radius showing to the planet carrier (downwards).

※ Subsequently install bearing inner rings after cooling down.



7577AAXF064

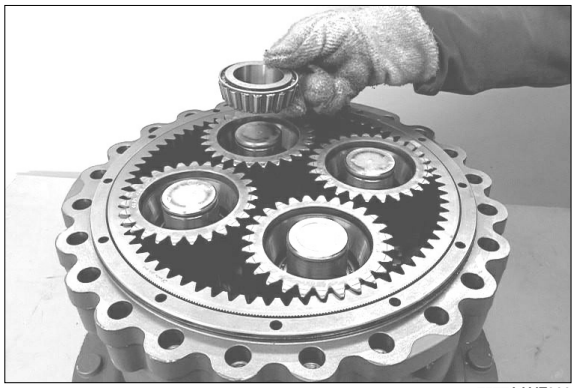
(26) Put planet gears onto the bearing inner rings.



7577AAXF065

(27) Heat bearing inner rings and install them on the planet gears until contact.

※ Subsequently install bearing inner rings after cooling down.

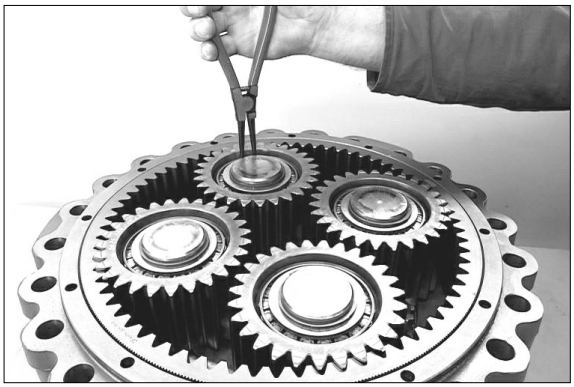


7577AAXF066

(28) Fasten plant gears by means of retaining rings.

※ Special tool

Set of external pliers	5870 900 015



7577AAXF067

Adjust end play of sun gear shaft 0.5 ~ 2.0mm

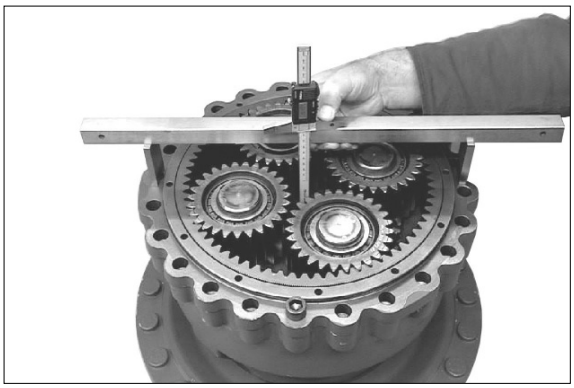
(29) Fasten ring gear by means of cap screws until contact.

Then determine dimension **l**, from the mounting face of the ring gear up to the face of the stop bolt.

Dimension **l** e.g . . . . . 46.20 mm

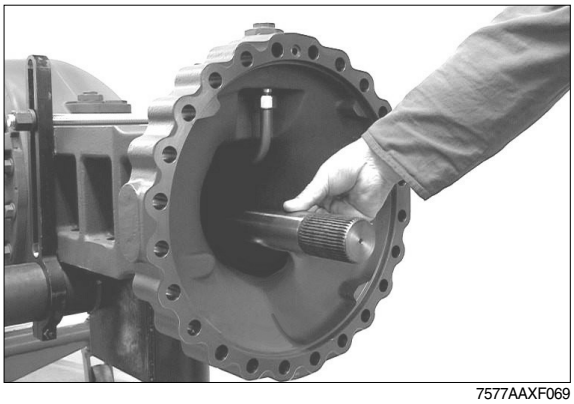
※ Special tool

Digital depth gauge	5870 200 072
Gauge blocks	5870 200 066
Straightedge	5870 200 022



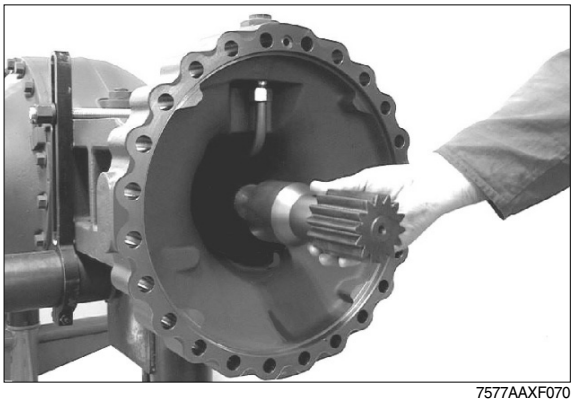
7577AAXF068

(30) Insert stub shaft into spline of the axle bevel gear until contact.



7577AAXF069

(31) Assemble sun gear shaft until contact.



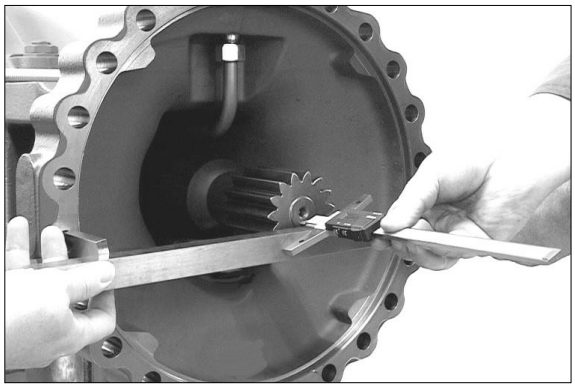
7577AAXF070

(32) Determine Dimension **II** from the face of the sun gear shaft up to the mounting face of the axle casing.

Dimension **II** e.g 43.00mm

※ Special tool

Digital depth gauge	5870 200 072
Gauge blocks	5870 200 066
Straightedge	5870 200 022



7577AAXF071

EXAMPLE **A** :

Dimension **I**	46.20mm
Dimension **II**	- 43.00mm
Difference	3.20mm
required end play e.g.	- 1.00mm
Difference = shim e.g. s =	**2.20mm**

(33) Insert sun gear shaft into the planet carrier.



7577AAXF072

(34) Fix determined shim(s), e.g. s = 2.20mm, into the sun gear shaft by means of grease.

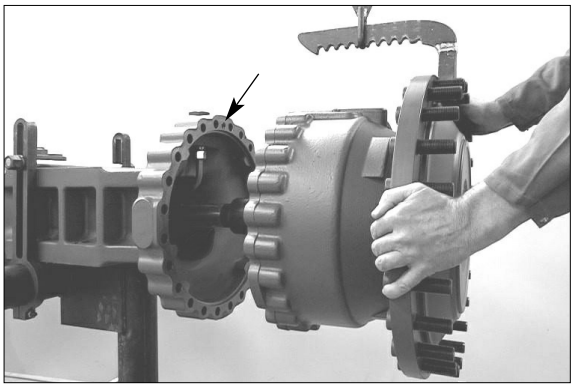


7577AAXF073

(35) Fix O-ring(see arrow) into the recess of the axle casing by means of grease and install the preassembled output to the axle casing until contact by means of lifting tackle.

※ Special tool

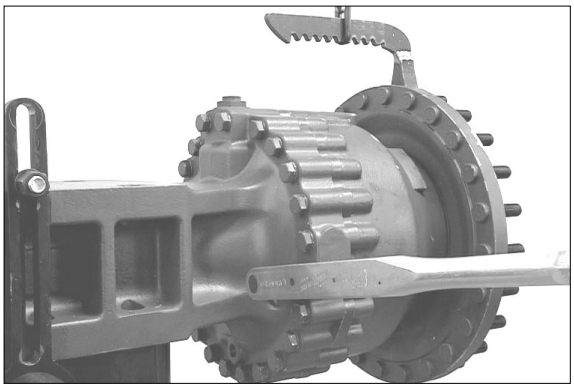
Lifting bracket	5870 281 043



7577AAXF074

(36) Fasten output by means of hexagon screws and washers.

· Tightening torque (M18/10.9) :
39.8 kgf · m(288lbf · ft)



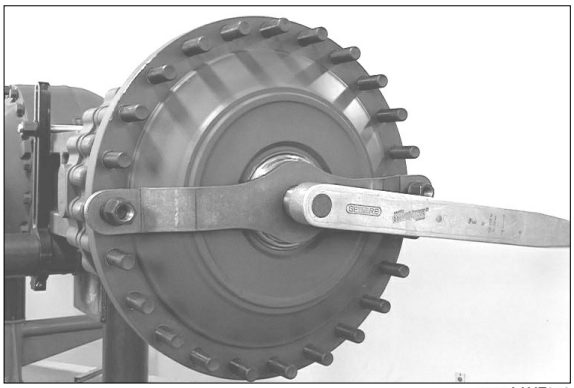
7577AAXF075

(37) Unscrew slotted nut by hand and then fasten it.

· Tightening torque : $153^{+20.4}$ kgf · m
(1107^{+148} lbf · ft)

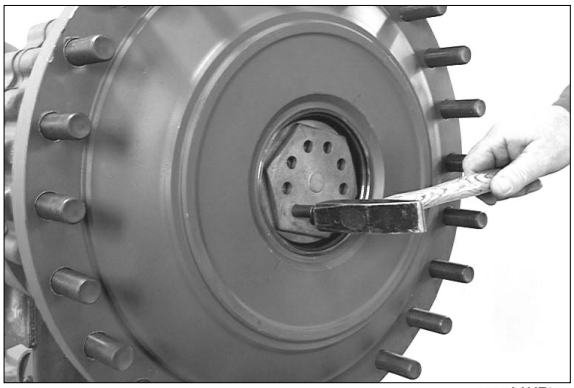
※ Special tool

Socket spanner	5870 656 078
Centering bracket	5870 912 028



7577AAXF076

(38) Secure slotted nut by means of slotted pin.



7577AAXF077

(39) Assemble O-ring (see arrow) to the cover.



7577AAXF078

(40) Insert cover into the output shaft until contact.

※ Special tool
Hammer (Plastic ø 60) 5870 280 004

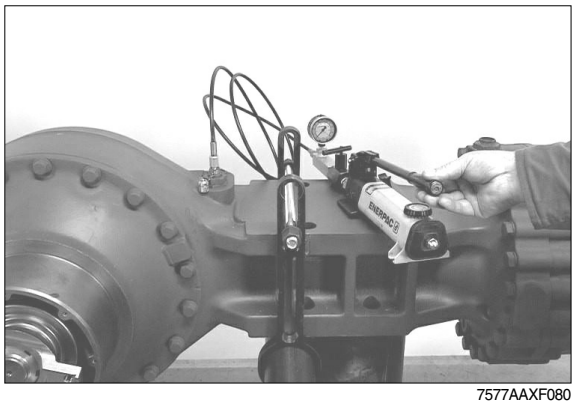


7577AAXF079

Leakage test of the brake hydraulics

※ Prior to start the test, ventilate the brake hydraulics completely.

1) Open the bleeder.
2) Slowly actuate the HP-pump until oil flows out of the bleeder.
3) Close the bleeder again.
4) Slowly pressurize the HP-pump with p > 10 bar and hold the pressure for some seconds.



7577AAXF080

※ The brake piston extends and the cylinder chamber fills up with oil. The air accumulates in the upper section of the cylinder chamber.

5) Loosen the shut-off valve on the HP-pump.

※ The reversing piston presses the air from the upper section of the cylinder into the brake line.

6) Open the bleeder again.
7) Slowly actuate the HP-pump until oil flows out of the bleeder.

※ Repeat procedure - Item 3)~7) until at 7) from the beginning of the actuation no more air exits from bleeder.

※ Then pressurize the brake temporarily (5EA) with p = 100 bar max..

High-pressure test :

Increase test pressure up to p = 100_{-10} bar and close connection to HP-pump by means of shut-off valve.
During a 5 min. testing time a pressure drop of max. 2% (2 bar) is allowed.

⚠ **If the maximum pressure of 100 bar is exceeded, there will be an excessive piston adjustment and a repeated disassembly of the brake or the adjusting is required to reset the gripping rings to the adjusting dimension.**

Low-pressure test :
Reduce test pressure to p = 5 bar and close the shut-off valve again.
During a 5 min. testing time a pressure drop is not allowed.

※ Special tool

HP-Pump	5870 287 007
Mini-measuring hub (9/16"- 18UNF)	5870 950 115

※ Prior to putting the axle into operation, fill in the oil acc. to the lubrication instructions.

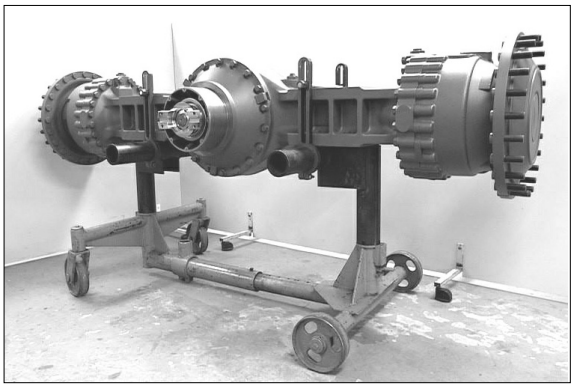
3) DISASSEMBLY OF DIFFERENTIAL CARRIER AND BRAKE TUBES

(1) Disassembly of differential carrier

① Fasten axle on assembly truck.

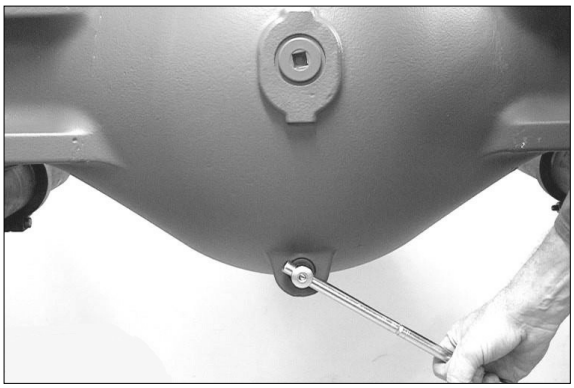
※ Special tool

Assembly truck	5870 350 000
Holding fixtures	5870 350 077
Clamps	5870 350 075

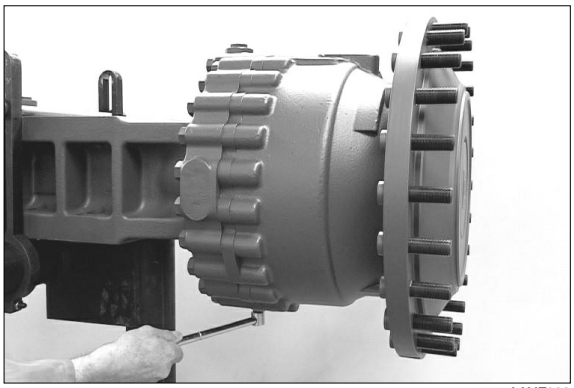


7577AAXF001

② Loosen screw plugs (3EA, see Figure 7577AAXF002 and 003) and drain oil from axle casing.



7577AAXF002



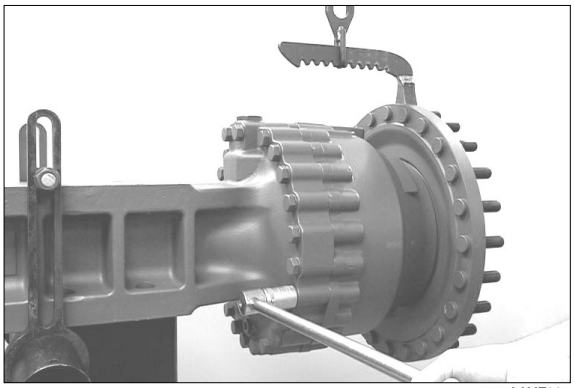
7577AAXF003

③ Secure output by means of lifting tackle and loosen hexagon screws.

※ Special tool

Lifting bracket	5870 281 043

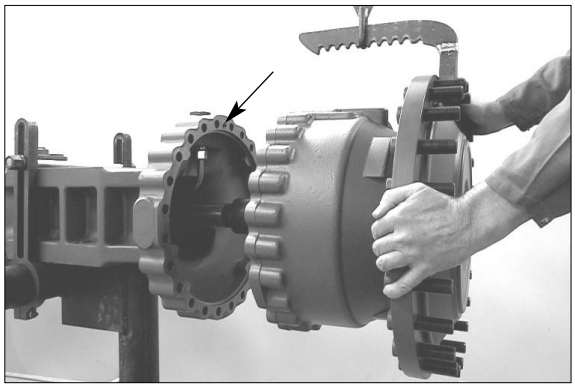
※ Make step (Fig. 7577AAXF007~9) on both output sides.



7577AAXF007

④ Separate complete output from the axle casing.

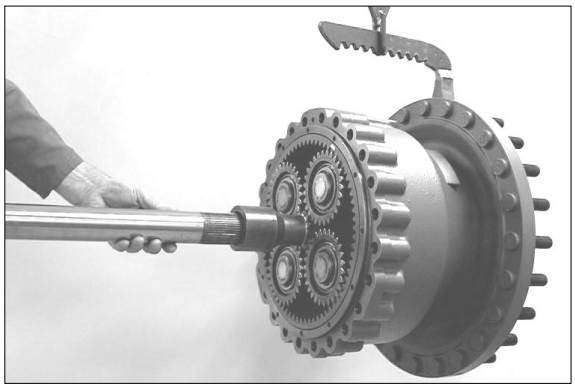
※ Pay attention to released O-ring(see arrow).



7577AAXF008

⑤ Pull stub shaft out of the sun gear shaft.

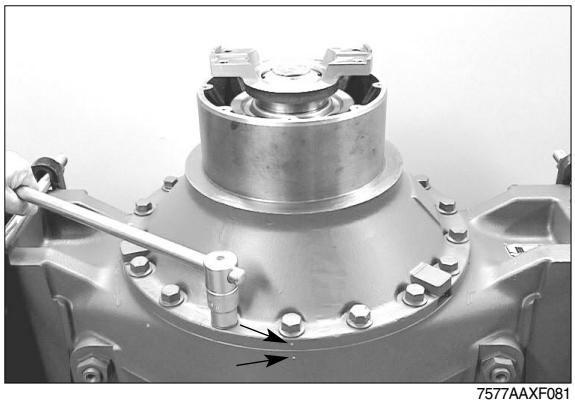
※ Pay attention to released shim(s).



7577AAXF009

⑥ Loosen hexagon screws.

※ Mark location of differential carrier to the axle casing (see arrows).

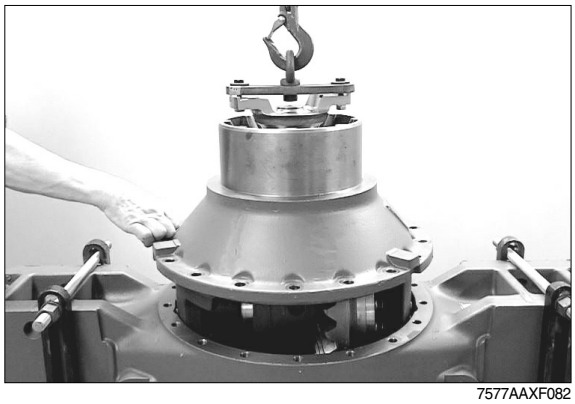


7577AAXF081

⑦ Lift differential carrier by means of lifting tackle out of the axle casing.

※ Special tool

Lifting tackle	5870 281 044

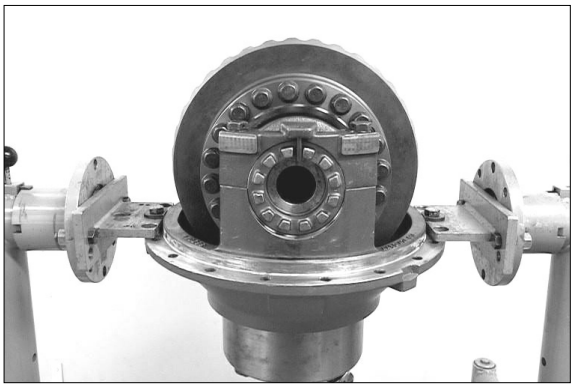


7577AAXF082

⑧ Fasten differential carrier to assembly truck.

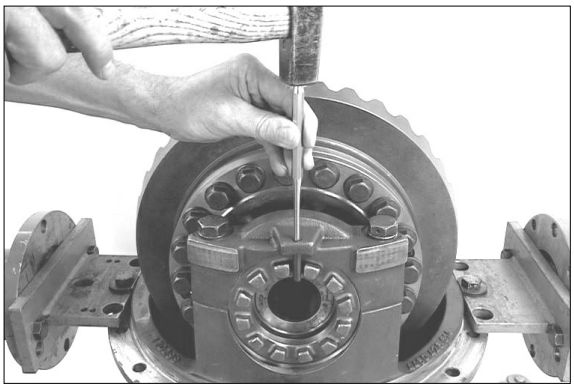
※ Special tool

Assembly truck	5870 350 000
Holding fixture	5870 350 034



7577AAXF083

⑨ Drive out slotted pins.

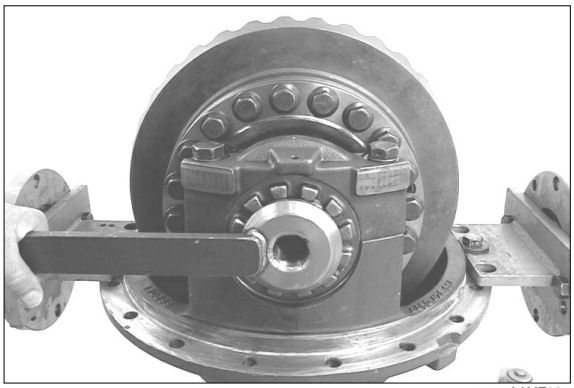


7577AAXF084

⑩ Loosen and remove both adjusting nuts.

※ Special tool

Socket spanner	5870 656 079



7577AAXF085

⑪ Heat axle drive housing by means of hot-air blower.

※ Special tool

Hot-air blower 230 V	5870 221 500
Hot-air blower 115 V	5870 221 501

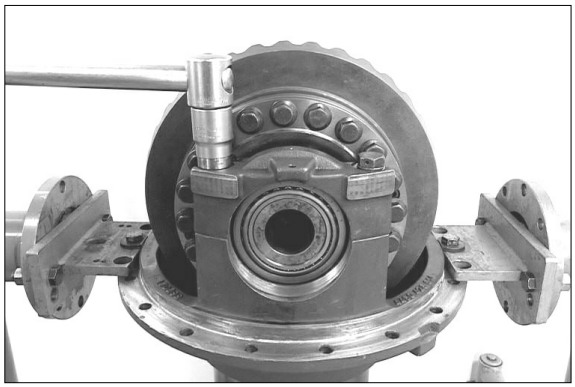
※ Hexagon screws are installed with Loctite (Type No. 262).



7577AAXF086

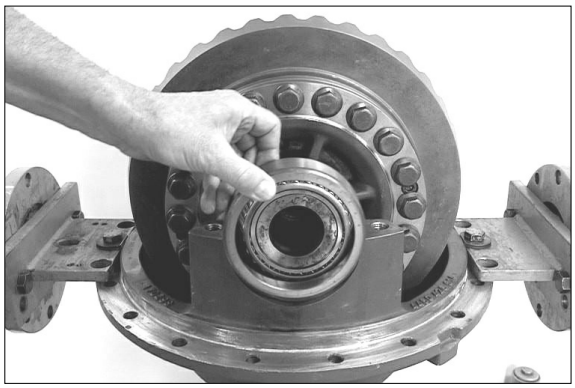
⑫ Loosen hexagon screws and take off bearing bracket.

⚠ Loosen hexagon screws by hand only.



7577AAXF087

⑬ Remove both bearing outer rings.

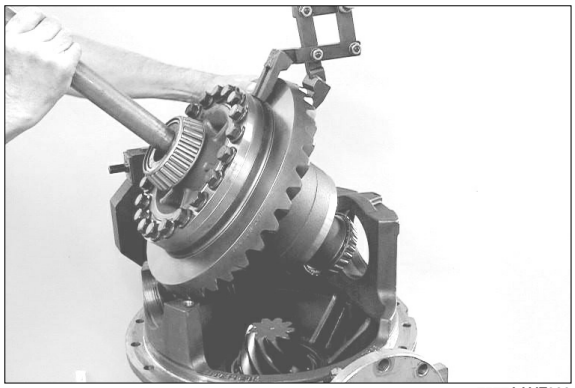


7577AAXF088

⑭ Lift differential out of the housing by means of lifting tackle.

※ Special tool

Lifting tackle	5870 281 013



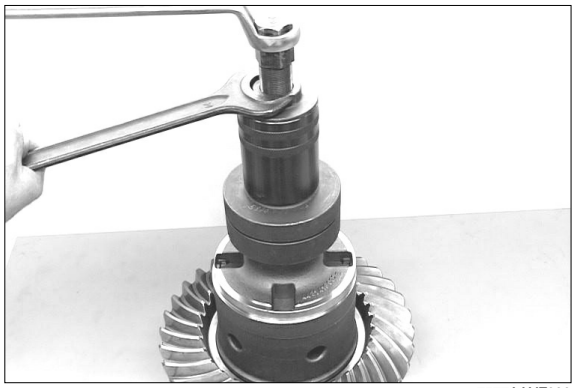
7577AAXF089

Disassembly of limited slip differential

⑮ Pull bearing inner ring from the differential housing.

※ Special tool

Gripping insert	5873 002 023
Basic set	5873 002 001



7577AAXF090

⑯ Pull bearing inner ring from the housing cover.

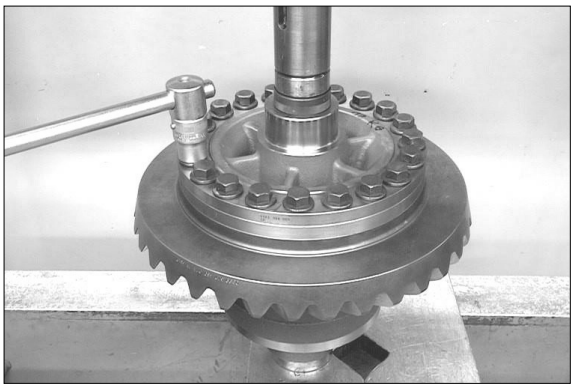
※ Special tool

Rapid grip	5873 012 018
Basic set	5873 002 001



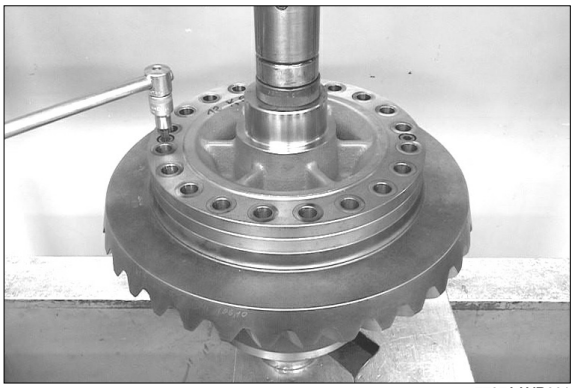
7577AAXF091

⑰ Fasten differential by means of press and loosen locking screws.



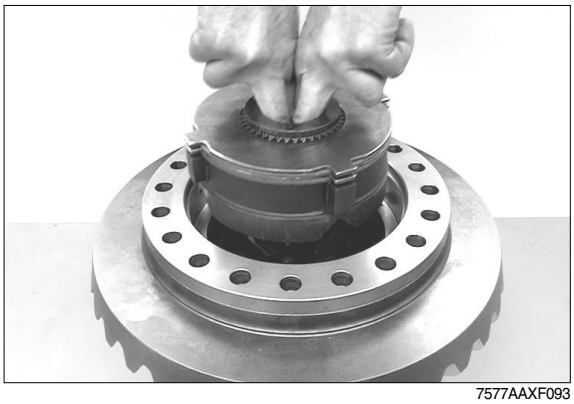
7577AAXF092

⑱ Loosen cap screws and remove released housing cover.



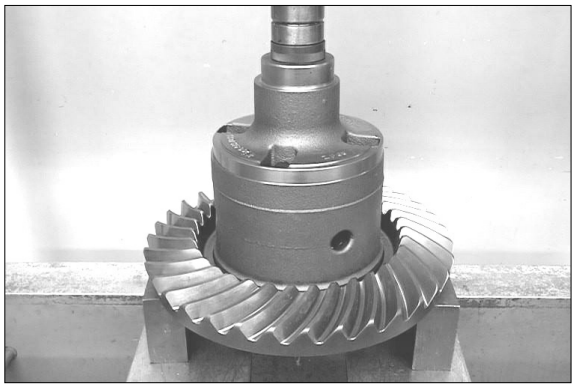
7707AAXR001

⑲ Remove all single parts from the differential housing.



7577AAXF093

⑳ Press off crown wheel from the differential housing.



7577AAXF094

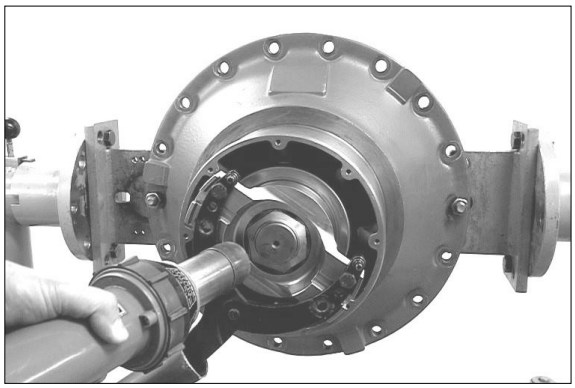
Disassembly of drive pinion

㉑ Heat slotted nut by means of hot-air blower.

※ Special tool

Hot-air blower 230 V	5870 221 500
Hot-air blower 115 V	5870 221 501

※ Slotted nut is locked with Loctite (Type No. 262).

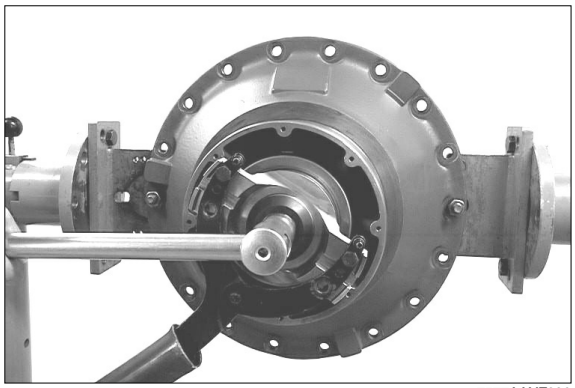


7577AAXF095

㉒ Loosen slotted nut and remove the washer behind it.

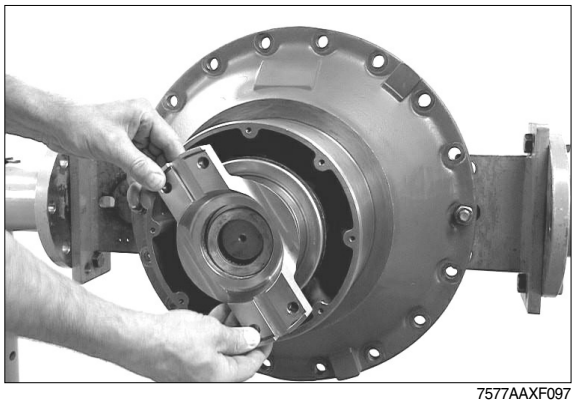
※ Special tool

Slotted nut wrench	5870 401 139
Fixture	5870 240 002



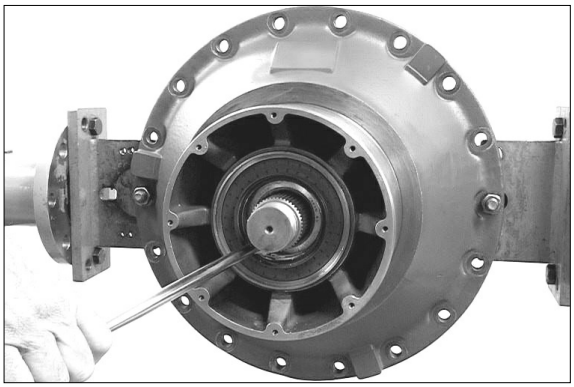
7577AAXF096

㉓ Pull input flange from the drive pinion.



7577AAXF097

㉔ Press shaft seal out of the axle drive housing.

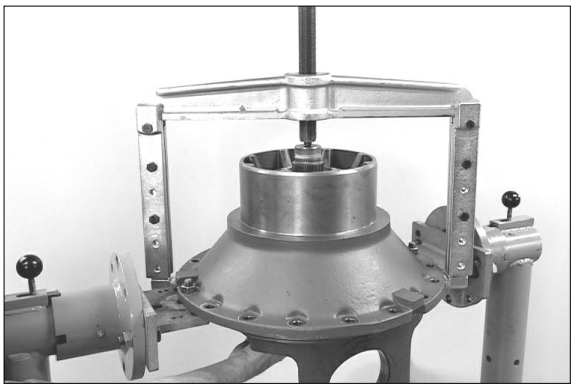


7577AAXF098

㉕ Press drive pinion out of the axle drive housing by means of two-armed puller and remove the released bearing inner ring.

※ Special tool

Two-armed puller	5870 970 007

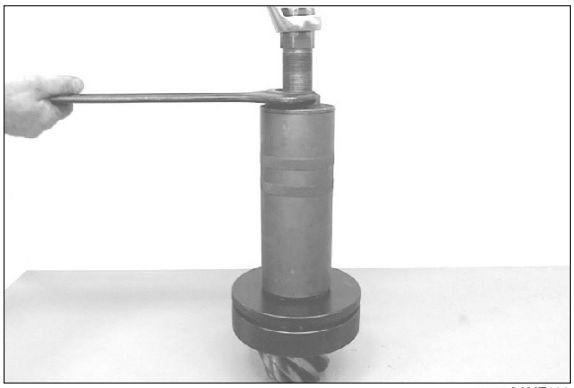


7577AAXF099

㉖ Take off spacer ring and pull bearing inner ring from the drive pinion.

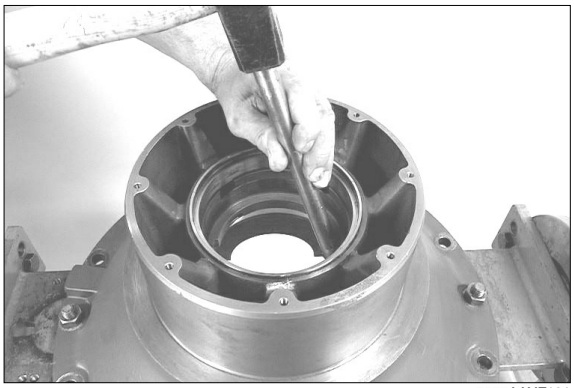
※ Special tool

Gripping insert	5873 002 032
Basic set	5873 002 001



7577AAXF100

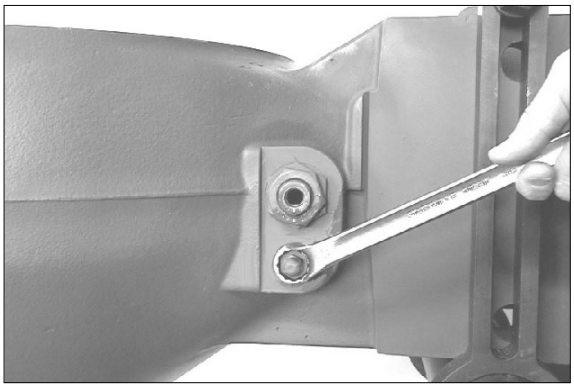
㉗ If necessary drive out both bearing outer rings from the axle drive housing.



7577AAXF101

(2) Disassembly of brake tubes

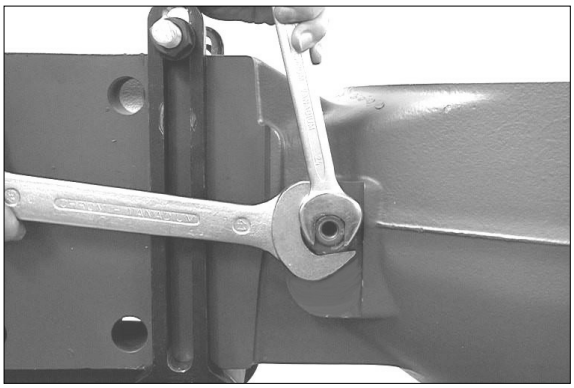
① Remove screw plug with vent valve from the axle casing.



7577AAXF102

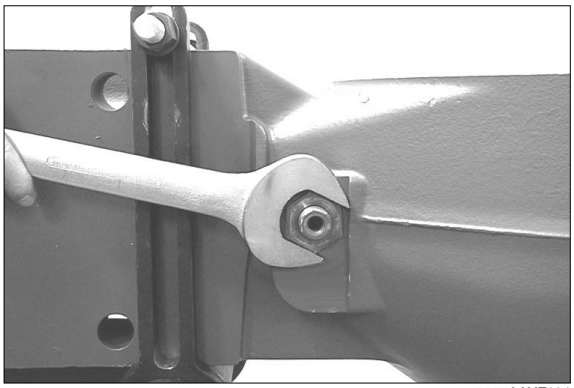
② Loosen hexagon nut.

※ Step (Figure 7577AAXF103~107) to be made on both sides.



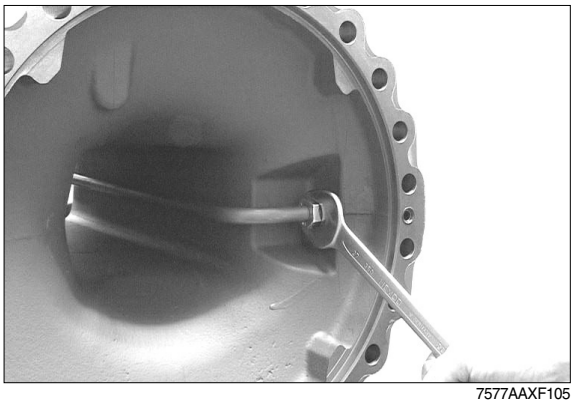
7577AAXF103

③ Loosen union screw.



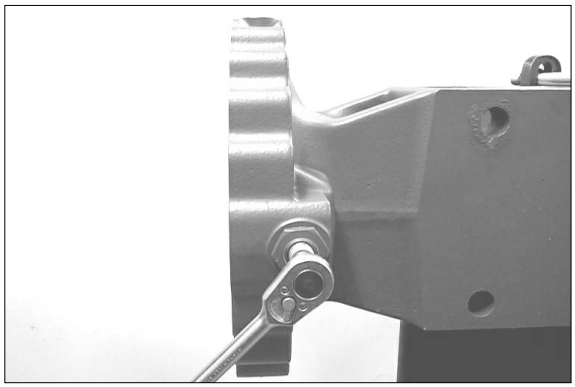
7577AAXF104

④ Loosen pipe union and remove released brake tube from the axle casing.



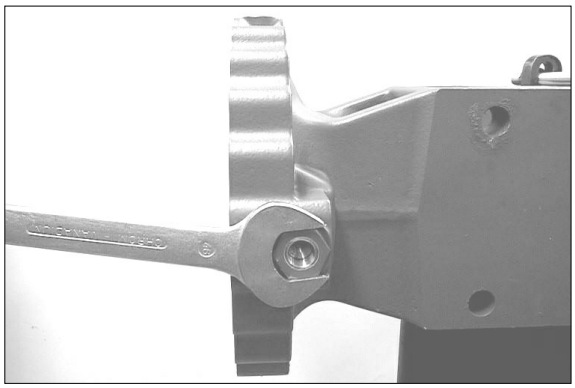
7577AAXF105

⑤ Remove vent valve from the connection part.



7577AAXF106

⑥ Loosen connection part and remove it from the axle casing.



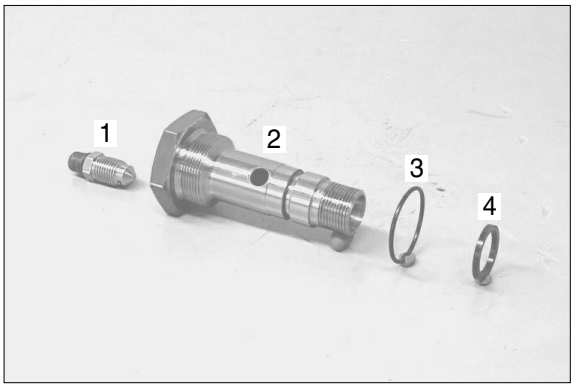
7577AAXF107

4) REASSEMBLY OF BRAKE TUBES AND DIFFERENTIAL CARRIER

(1) Reassembly of brake tubes

① Preassemble connection part as shown in opposite figure.

1 Vent valve
2 Connection part
3 O-Ring
4 Rectangular ring

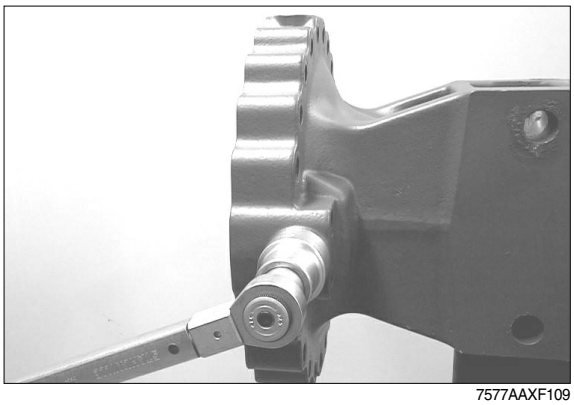


7577AAXF108

※ Step (Figure 7577AAXF108~114) is to be made on both output sides.

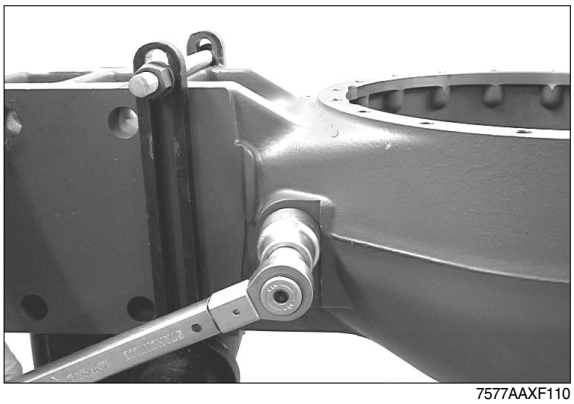
② Install connection part.

· Tightening torque : 13.3kgf · m (95.9lbf · ft)

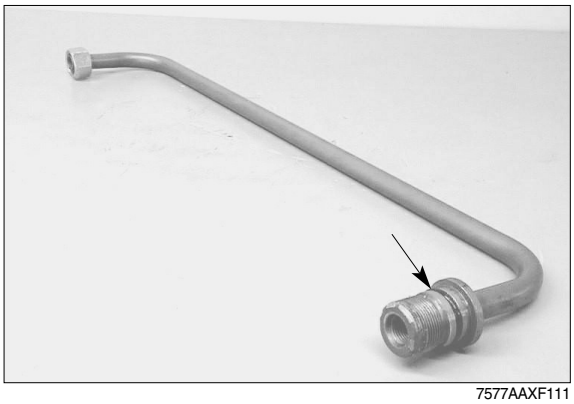

7577AAXF109

③ Provide union screw with new O-ring and install it.

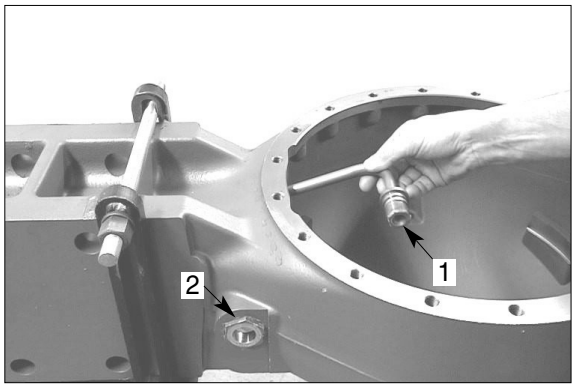
· Tightening torque : 15.3kgf · m (111lbf · ft)


7577AAXF110

④ Insert O-ring (see arrow) into the annular groove of the brake tube.


7577AAXF111

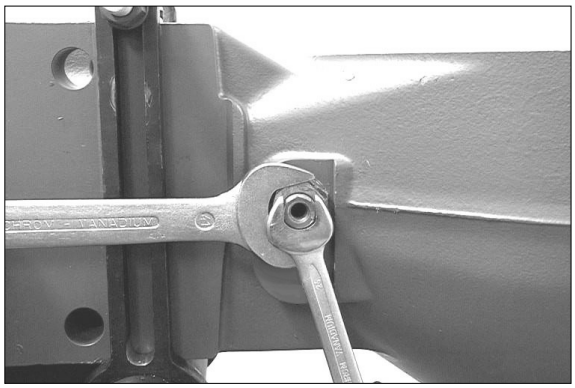
⑤ Insert brake tube into the axle casing, assembling the connection part (see arrow 1) through the union screw (see arrow 2).



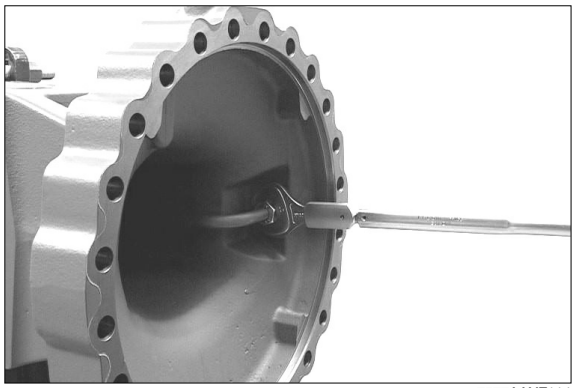
7577AAXF112

⑥ Fasten brake tube by means of hexagon nut and union nut (see below figure).

· Tightening torque : 10.2kgf · m (73.8lbf · ft)

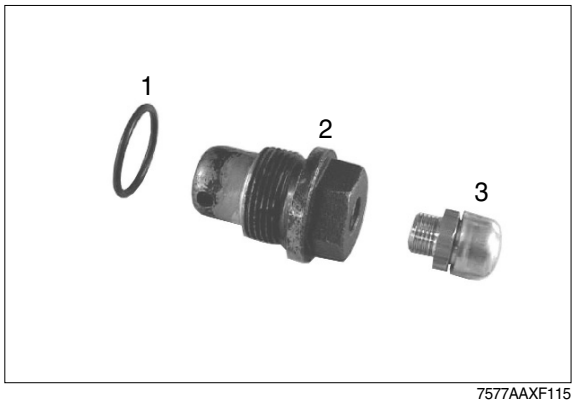

7577AAXF113

· Tightening torque : 8.2kgf · m (59lbf · ft)


7577AAXF114

⑦ Preassemble screw plug as shown in opposite figure.

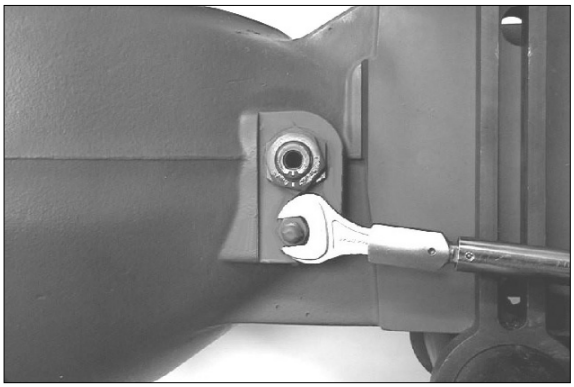
1 O-Ring
2 Screw plug
3 Vent valve



7577AAXF115

⑧ Install screw plug.

· Tightening torque : 7.1kgf · m
(51.6lbf · ft)



7577AAXF116

(2) Reassembly of differential carrier

※ If crown wheel or drive pinion are damaged, both parts have to be replaced together.
For new installation of a complete bevel gear set pay attention to the same pair number of drive pinion and crown wheel.

Determine shim thickness for a perfect tooth contact pattern

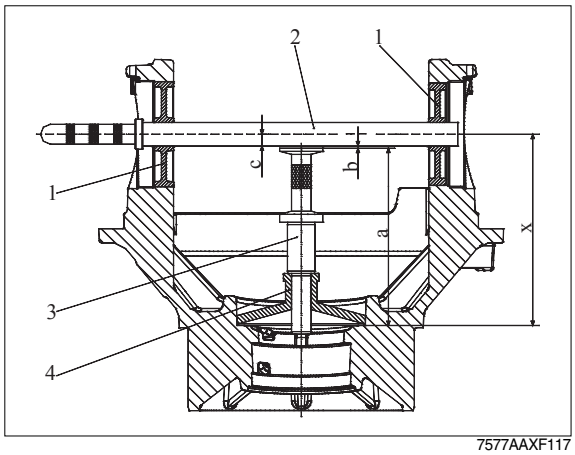
※ Make the following measuring steps at maximum accuracy.
Inexact measurements result in a faulty tooth contact pattern and require a repeated disassembly and reassembly of the drive pinion as well as of the differential.

① Install adapter pieces (1) and preliminarily fasten the bearing bracket by means of hexagon screws.

Then install stop washer (4) and measuring pin (3) and assemble measuring shaft (2) (see sketch).

※ Special tool

Adapter pieces	5870 500 044
Measuring shaft	5870 500 001
Measuring pin	5870 351 016
Stop washer	5870 351 029



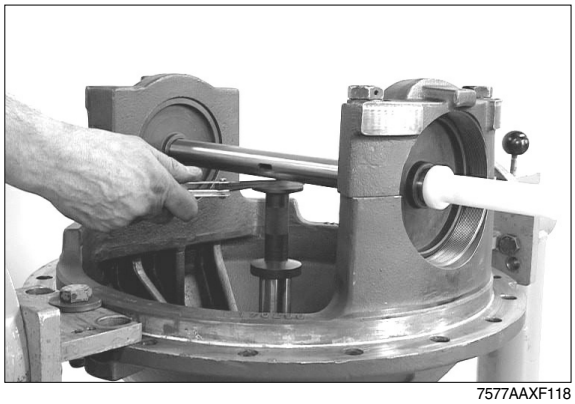
7577AAXF117

② Determine gap (dimension **b**) between measuring shaft and measuring pin by means of feeler gauge.

Dimension **b** e.g 0.20mm

EXAMPLE **A** :

Dimension **a** (= Measuring pin + stop washer) 206.00mm
Dimension **b** . . . . . + 0.20mm
Dimension **c** . . . . . + 15.00mm
results in dimension X = 221.20mm

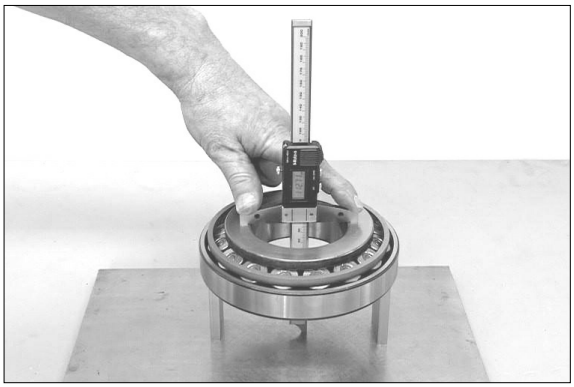

7577AAXF118

③ Determine dimension **I** (bearing width).

Dimension **I** e.g 39.05mm

※ Special tool

Digital depth gauge	5870 200 072
Gauge blocks	5870 200 066



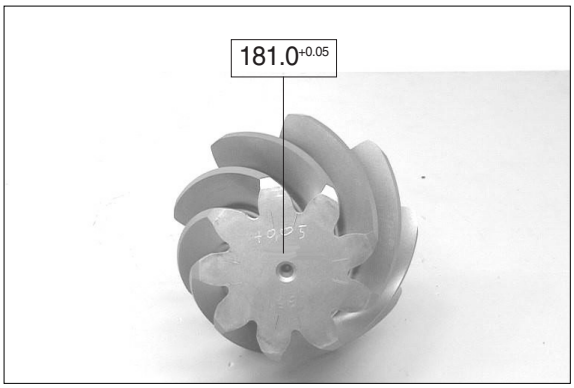
7577AAXF119

④ Read dimension **II** (dimension for pinion).

Dimension **II** e.g. 181.05mm

EXAMPLE **B** :

Dimension **I** 39.05mm
Dimension **II** . . . . . + 181.05mm
results in dimension Y = 220.10mm



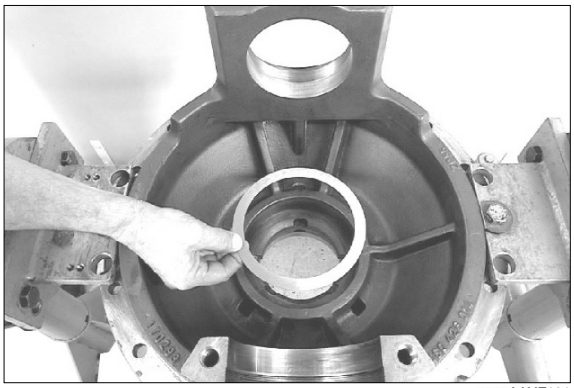
7577AAXF120

EXAMPLE **C** :

Dimension **X** 221.20mm
Dimension **Y** . . . . . - 220.10mm
Difference = shim e.g. s = 1.10mm

Install the drive pinion

⑤ Place determined shim e.g. s = 1.10mm into the bearing bore.

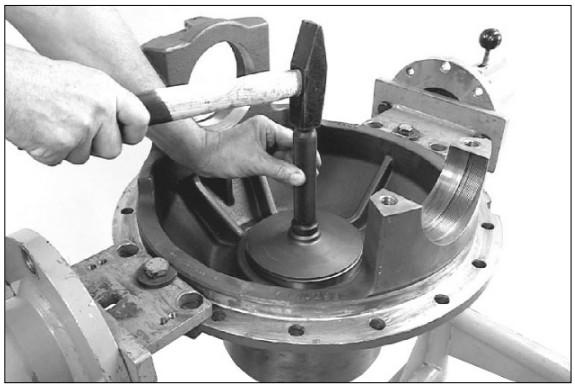


7577AAXF121

⑥ Undercool bearing outer ring and insert it into the bearing bore until contact.

※ Special tool

Driver	5870 058 060
Handle	5870 260 002



7577AAXF122

⑦ Undercool bearing outer ring on the input flange side and insert it until contact.

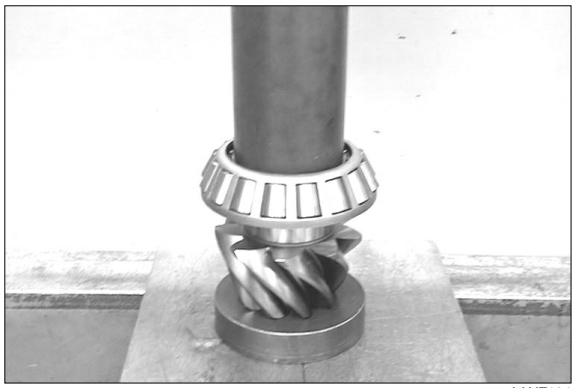
※ Special tool

Driver	5870 058 079
Handle	5870 260 002



7577AAXF123

⑧ Press bearing inner ring on the drive pinion until contact.

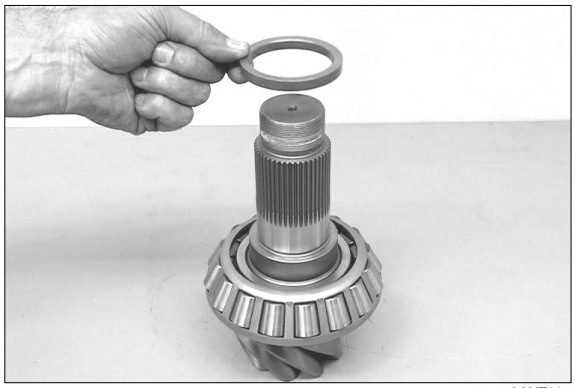


7577AAXF124

Adjust rolling moment of drive pinion bearing 0.15 ~ 0.31kgf · m (Figure 7577AAXF125~133) :

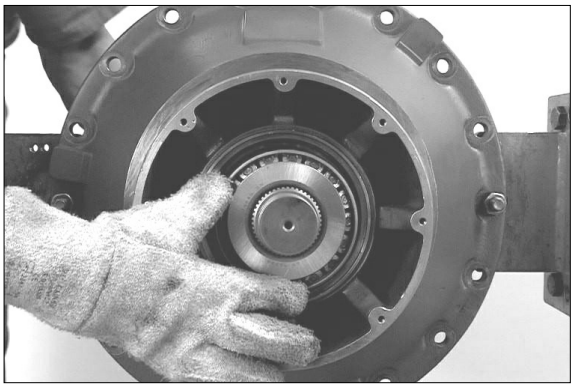
⑨ Assemble spacer ring (e.g. s = 8.10mm).

※ As per experience the required rolling moment is obtained by use of the spacer ring (e.g. s = 8.10mm) available at disassembly.
However, a later checking of the rolling moment is imperative.



7577AAXF125

⑩ Insert preassembled drive pinion into the axle drive housing and assemble the heated bearing inner ring until contact.

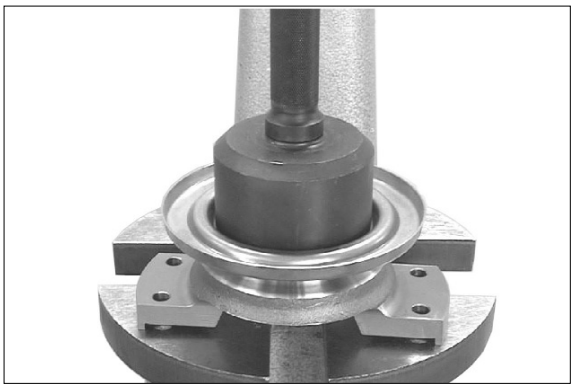


7577AAXF126

⑪ Press dust protection on the input flange until contact.

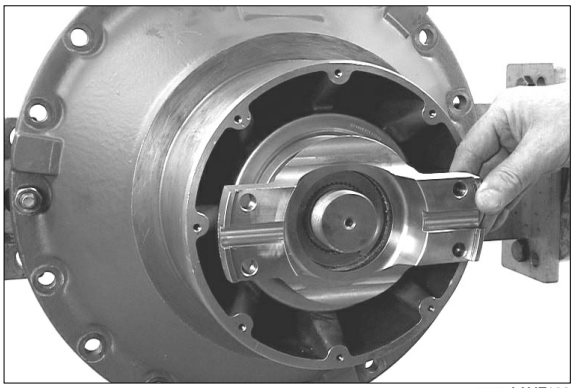
※ Special tool

Driver	5870 056 003



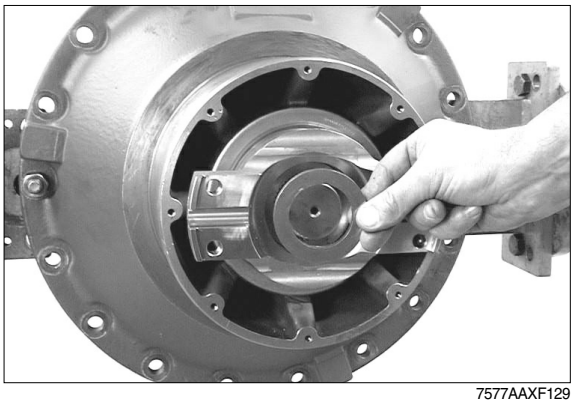
7577AAXF127

⑫ Assemble input flange.



7577AAXF128

⑬ Assemble washer.



7577AAXF129

⑭ Unscrew hexagon nut by hand and tighten it.

· Tightening torque : 122kgf · m (885lbf · ft)

※ Special tool

Slotted nut wrench	5870 401 139
Fixture	5870 240 002

※ When tightening rotate drive pinion in both directions several times.

⑮ Check rolling moment (0.15~0.30kgf · m).

※ For new bearings it should be tried to achieve the max. value of the rolling moment.

⚠ If the required rolling moment is not obtained, correct it with an adequate spacer ring (Figure 7577AAXF125), according to the following indications :

Rolling moment too low - install a thinner spacer ring

Rolling moment too high - install a thicker spacer ring.

⑯ Then loosen the slotted nut again and pull input flange from the drive pinion.

Install shaft seal with the sealing lip showing to the oil chamber (downwards).

※ Special tool

Driver	5870 048 233

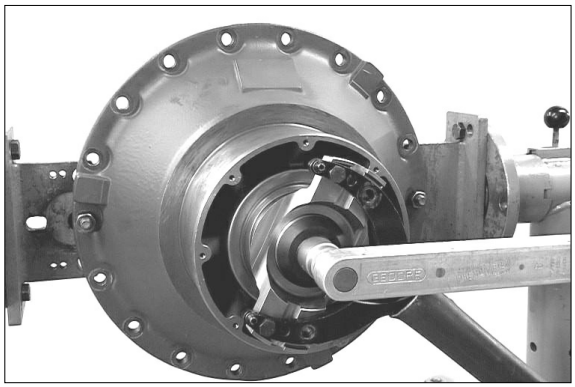
※ The exact installation position of the shaft seal will be obtained by using the exact driver.

⚠ Just before the installation wet the outer diameter of the shaft seal with spirit and fill the space between sealing and dust lip with grease.

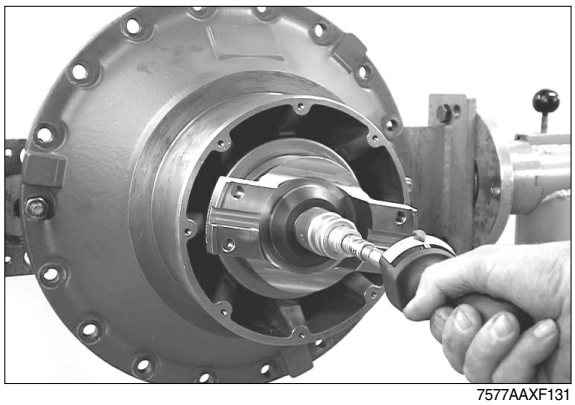
⑰ Assemble input flange and finally fasten it by means of washer and slotted nut.

· Tightening torque : 122kgf · m(885lbf · ft)

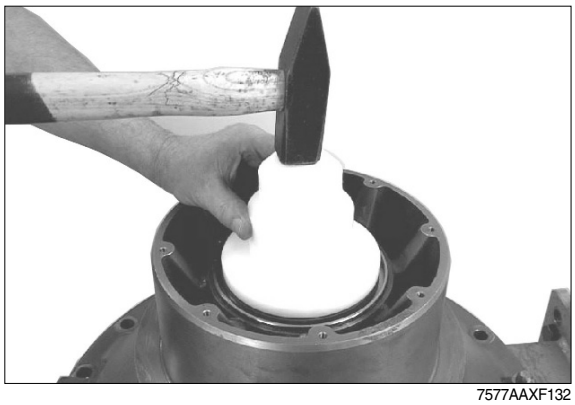
⚠ Apply Loctite (Type No. 262) onto the thread of the slotted nut.



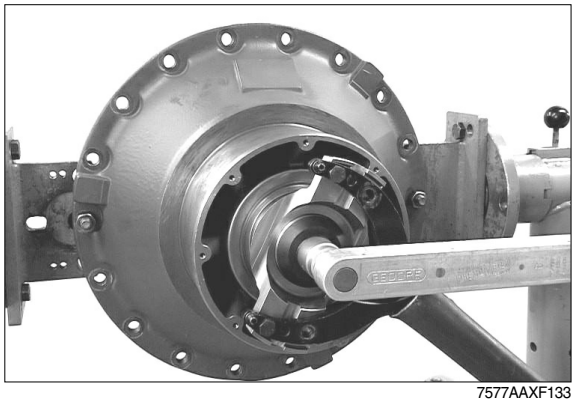
7577AAXF130



7577AAXF131



7577AAXF132

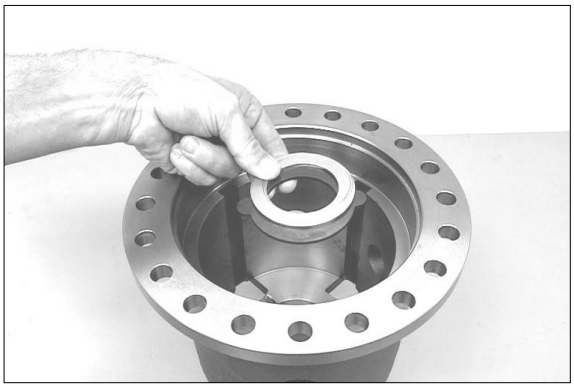


7577AAXF133

Reassembly of limited slip differential

⑱ Place both thrust washers into the differential housing.

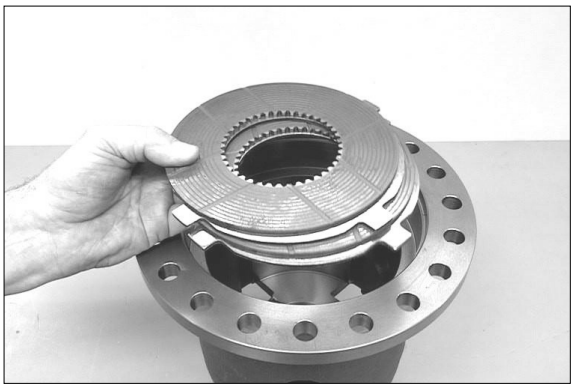
※ Prior to installation all single parts of the differential must be oiled.



7577AAXF134

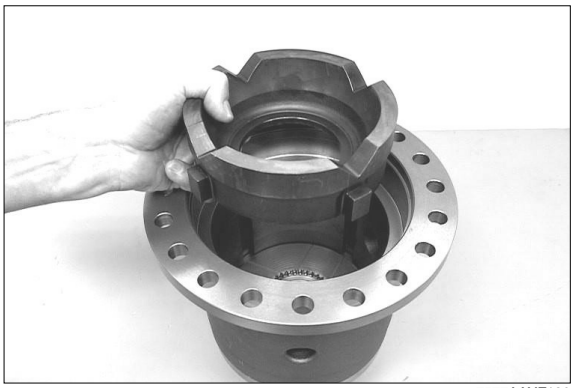
⑲ Starting with an outer clutch disc install alternately the outer and inner clutch discs.

⚠ Thickness of the disc pack must be identical on both sides.



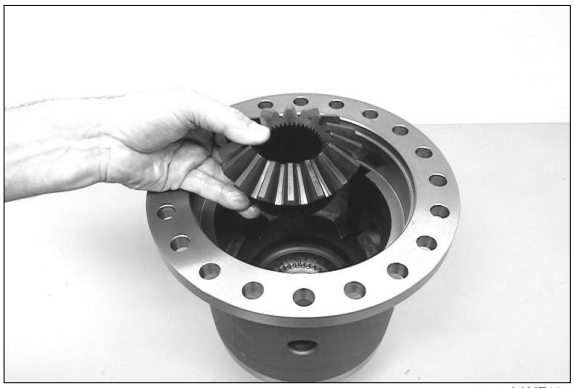
7577AAXF135

⑳ Put on the pressure ring.



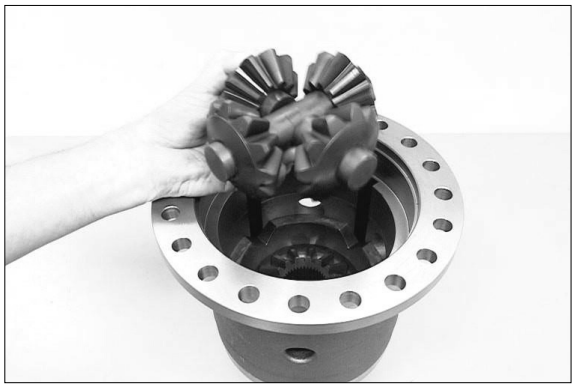
7577AAXF136

㉑ Insert axle bevel gear until contact and at the same time assemble all inner clutch discs with the spline.



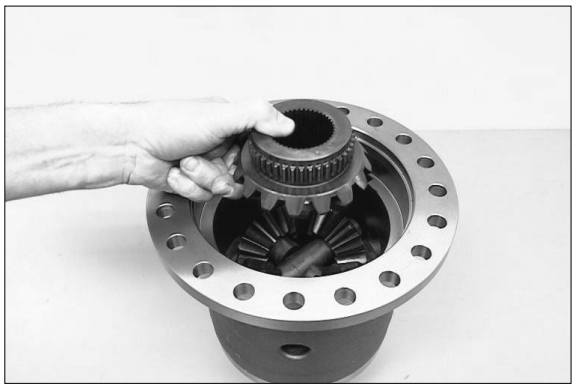
7577AAXF137

㉒ Preassemble differential spider and insert it into the differential housing.



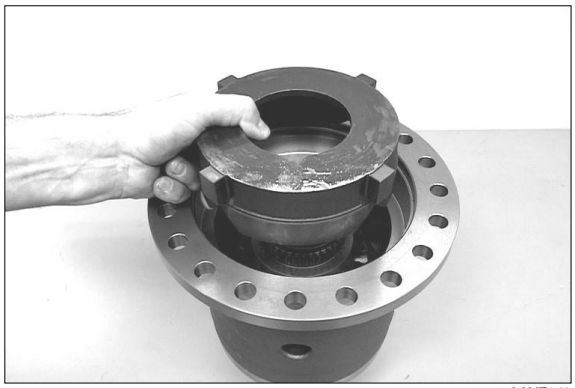
7577AAXF138

㉓ Put on the second axle bevel gear.



7577AAXF139

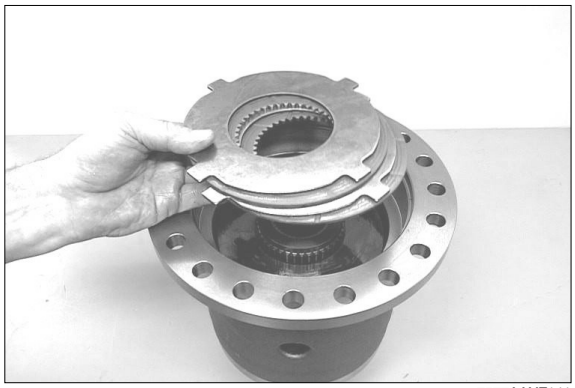
㉔ Insert the second pressure ring into the differential housing.



7577AAXF140

㉕ Starting with an inner clutch disc install alternately the inner and outer clutch discs.

⚠ Thickness of the clutch disc pack must be identical on both sides.



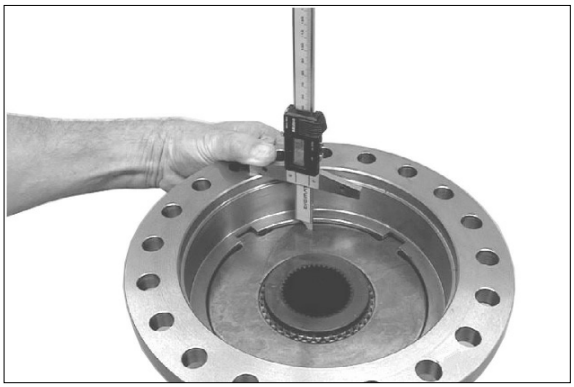
7577AAXF141

Determine disc clearance 0.2~0.8mm

㉖ Determine dimension **I**, from mounting face of the differential housing to plane face of the outer clutch disc.

Dimension **I** e.g 44.30mm

※ Special tool
Digital depth gauge 5870 200 072

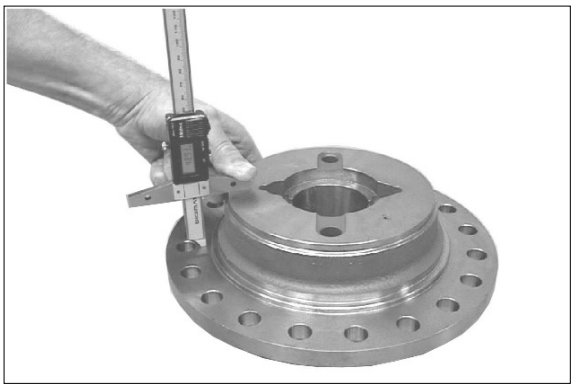


7577AAXF142

㉗ Determine dimension **II**, from contact surface of the outer clutch disc to the mounting face of the housing cover.

Dimension **II** e.g 43.95mm

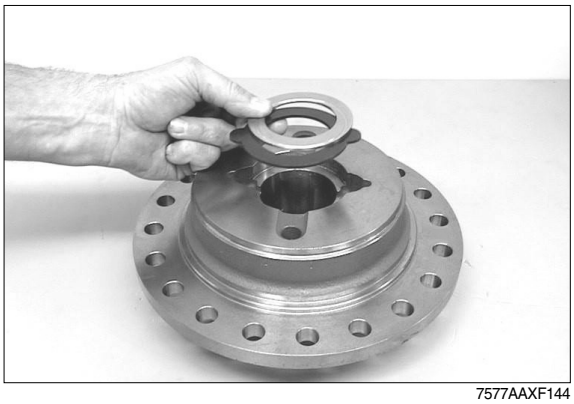
EXAMPLE **D** :
Dimension **I** 44.30mm
Dimension **II** . . . . . - 43.95mm
Difference = Disc clearance = 0.35mm



7577AAXF143

※ If the required disc clearance is not obtained, correct it with the adequate outer clutch discs (s = 2.7, s = 2.9, s = 3.0, s = 3.1 or s = 3.3 mm), taking care that the difference in thickness between the left and the right disc pack must only be 0.01 at a maximum.

㉘ Fix both thrust washers with grease into the recess of the housing cover.



7577AAXF144

㉙ Put on the housing cover and fasten it by means of cap screws(2EA).

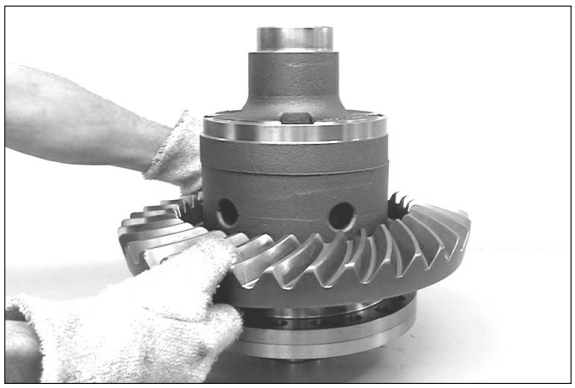
· Tightening torque (M10/8.8) :
4.7kgf · m(33.9lbf · ft)



7707AAXF015

㉚ Heat crown wheel and install it until contact.

※ Special tool
Adjusting screws 5870 204 040

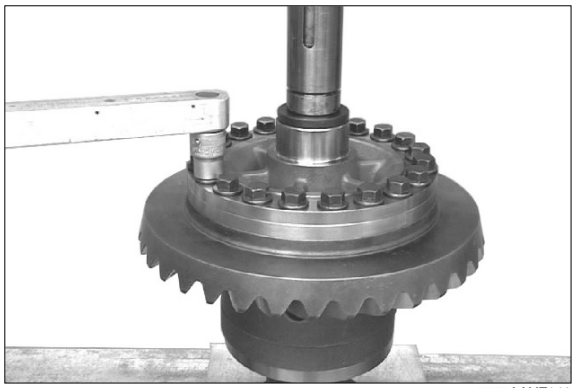


7577AAXF145

㉛ Fix differential by means of press and fasten crown wheel by means of **new** locking screws.

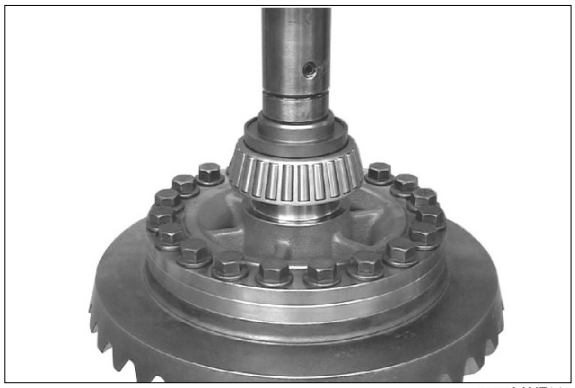
· Tightening torque : 41.8kgf · m
(302lbf · ft)

⚠ **Only use of new locking screws is permissible.**



7577AAXF146

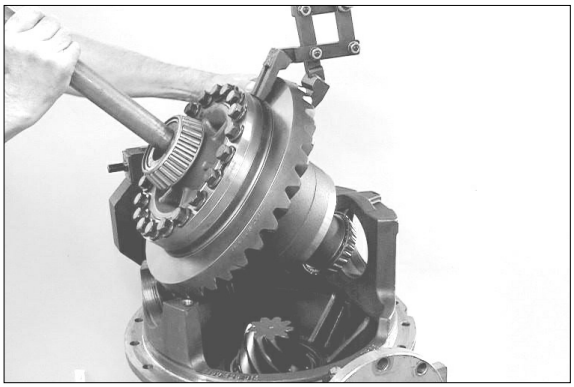
㉜ Press on both bearing outer rings until contact.



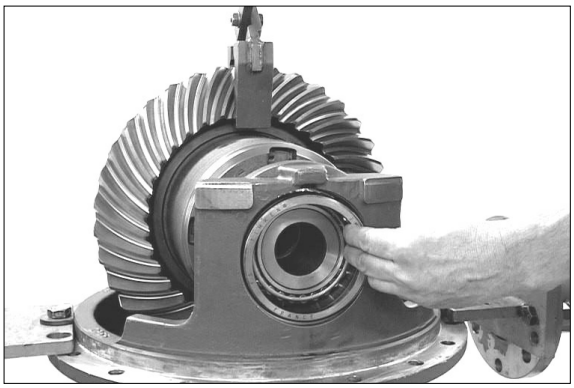
7577AAXF147

㉝ Insert differential into the axle drive housing by means of lifting tackle.

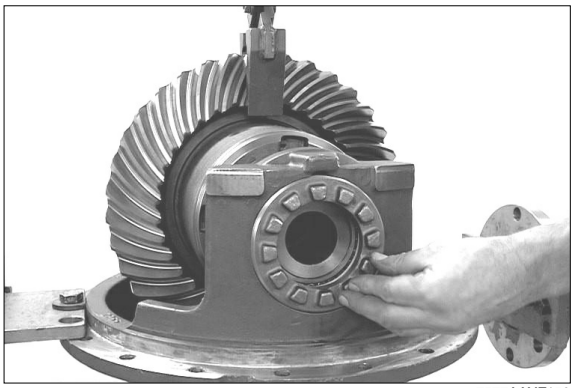
※ Special tool
Lifting tackle 5870 281 013


7577AAXF148

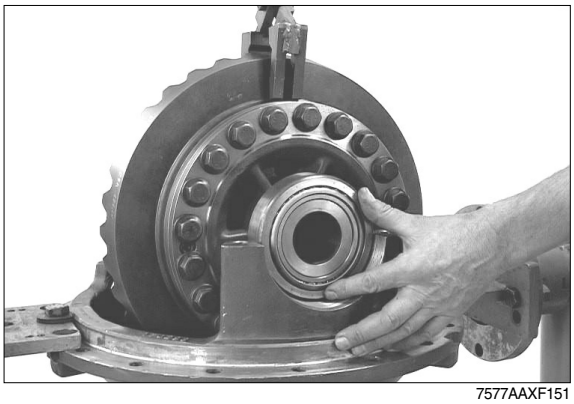
㉞ Place bearing outer ring into the axle drive housing.


7577AAXF149

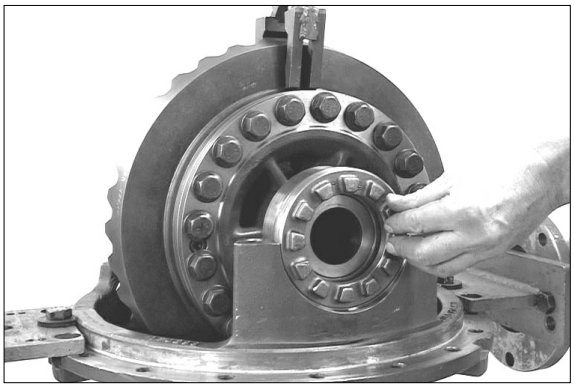
㉟ Preliminarily fix the bearing outer ring by means of adjusting nut.


7577AAXF150

㊱ Install crown wheel-sided bearing outer ring.


7577AAXF151

㊲ Preliminarily fix the crown wheel-sided bearing outer ring by means of the second adjusting nut.

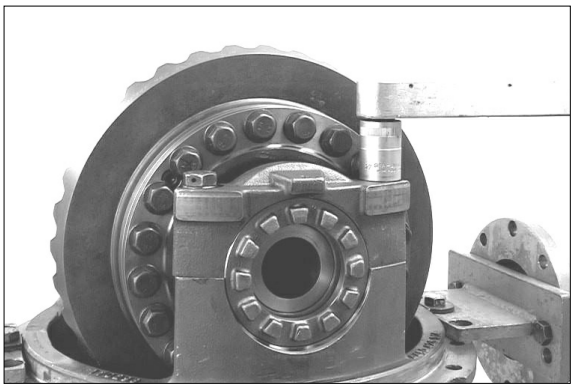

7577AAXF152

㊳ Put on bearing bracket and fasten it by means of hexagon screws and washers.

· Tightening torque (M16/10.9) :
28.6kgf · m(207lbf · ft)

※ Pay attention to clearance of the adjusting nut.

⚠ **Apply Loctite (Type No. 262) onto threads of the hexagon screws.**

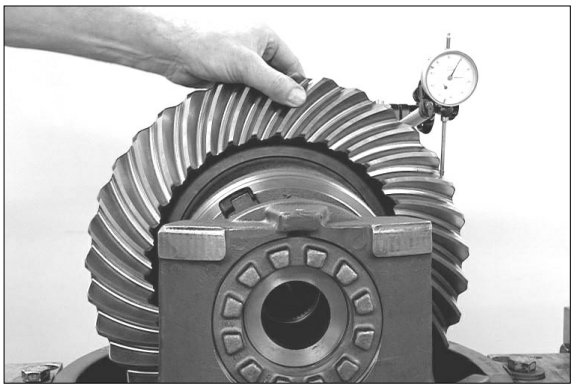

7577AAXF153

Adjustment of backlash and bearing preload

㊴ Place dial indicator right-angled at the outer diameter of the tooth flank (crown wheel).
Then install both adjusting nuts only to such an extent that the required backlash - see the value etched on the outer diameter of the crown wheel - is reached.

※ Special tool

Magnetic stand	5870 200 055
Dial indicator	5870 200 057
Socket spanner	5870 656 079


7577AAXF154

※ At this step rotate the differential several times.

㊵ Determine bracket width and correct it on both adjusting nuts, if required.

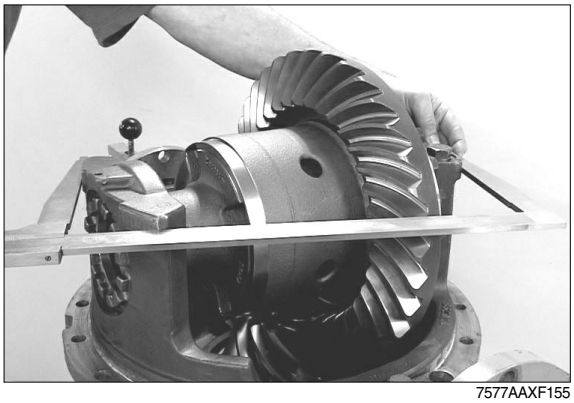
Bracket width . . . . . 418 $^{-0,05}$ mm

※ Special tool

Caliper gauge	5870 200 058

Then check backlash once again.

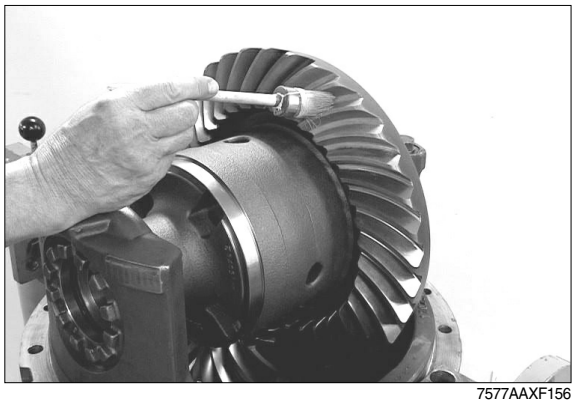
※ Adjusting of the bracket width results in the required bearing preload.


7577AAXF155

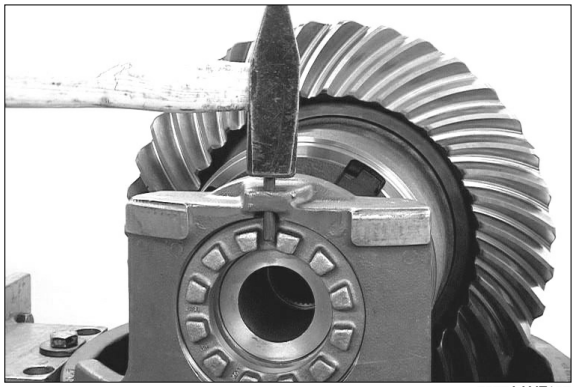
㊶ Cover some tooth flanks of the crown wheel with marking ink and roll crown wheel in both directions over the drive pinion.

Compare the obtained tooth contact pattern with the examples on page 3-228

⚠ If the tooth contact pattern differs, there has been a measuring error at determination of the shim (Figure 7577AAXF121/page 3-216), what is imperative to be corrected.


7577AAXF156

㊷ Secure both adjusting nuts by means of slotted pins.


7577AAXF157

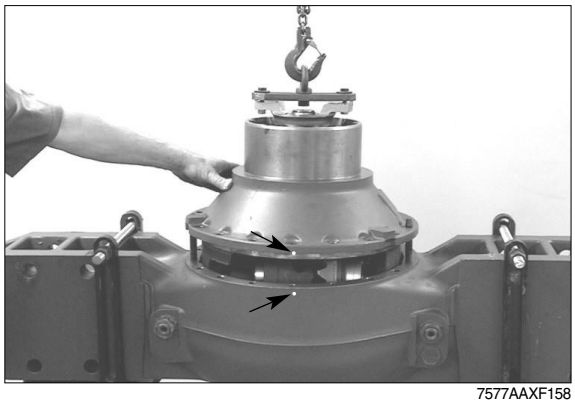
㊸ Install two adjusting screws and insert differential carrier into the axle casing until contact by means of lifting tackle.

※ Special tool

Adjusting screws	5870 204 023
Lifting tackle	5870 281 044

※ Observe radial location (see marking Page 3-204 / Figure 7577AAXF081).

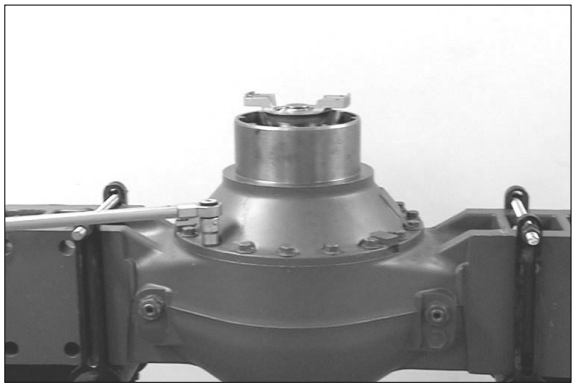
⚠ Apply sealing compound (Three Bond Type 1215) on mounting face.


7577AAXF158

㊹ Fasten differential carrier by means of **new** locking screws.

・Tightening torque : 25.5kgf・m (184lbf・ft)

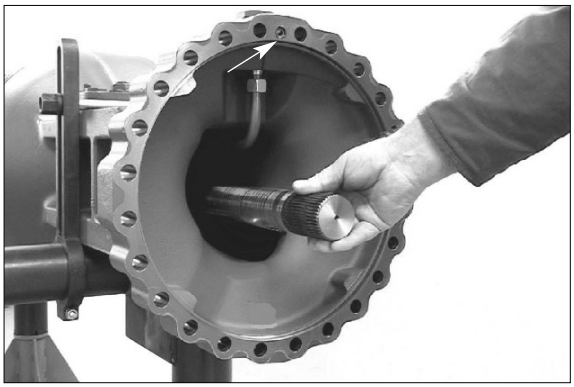
⚠ Only use of the new locking screws is permissible.


7577AAXF159

㊺ Insert stub shaft into spline of the axle bevel gear until contact.

Then fix O-ring (see arrow) by means of grease into the recess of the axle casing.

※ Step (Figure 7577AAXF160 ~ 163) is to be made on both output sides.



7577AAXF160

㊻ Thrust washer(s) removed at disassembly have to be fixed in the sun gear shaft by means of grease.

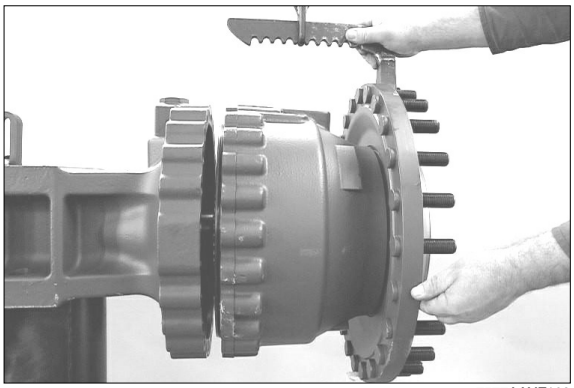


7577AAXF161

㊼ Place complete output by means of lifting tackle to the axle casing until contact.

※ Special tool

Lifting bracket	5870 281 043

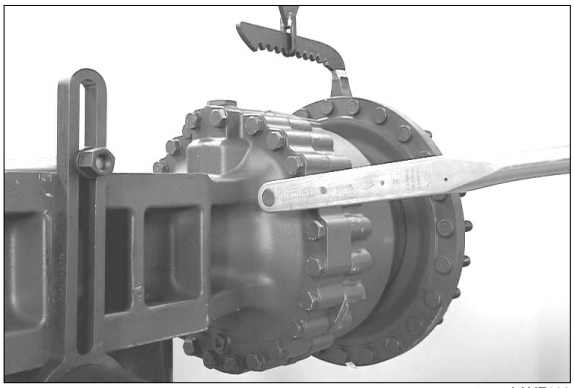


7577AAXF162

㊽ Fasten output by means of hexagon screws and washers.

· Tightening torque (M18/10.9) :
39.8kgf · m(288lbf · ft)

※ Prior to putting into operation of the axle, fill oil in accordance with lubrication instructions.

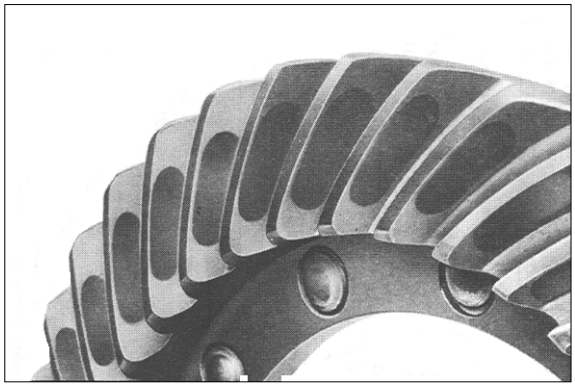


7577AAXF163

※ BACKLASH CHECK

- Applied the paint (or red lead) on the surface of several bevel gear teeth.
- Turn the pinioin gear and check the contact pattern.

Correct pattern



WTHAX16

Concave side

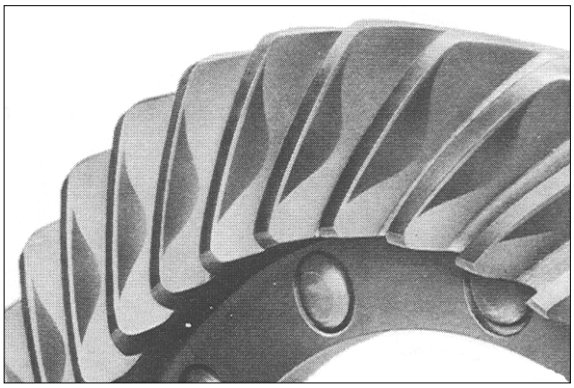


WTHAX17

Convex side

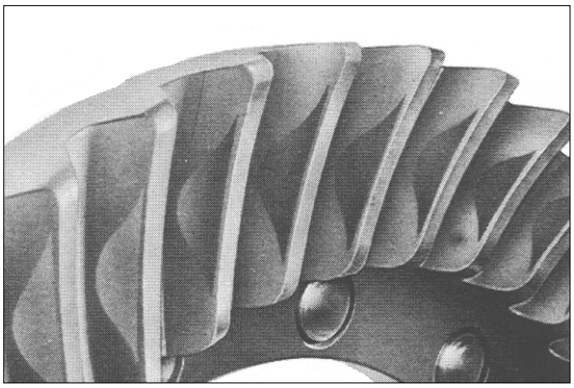
※ ADJUSTMENT

Incorrect pattern : high contact



WTHAX18

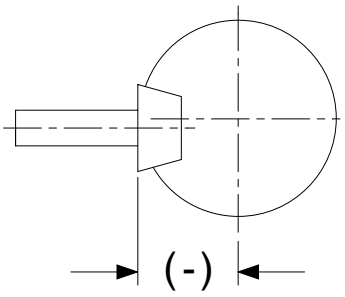
Concave side



WTHAX19

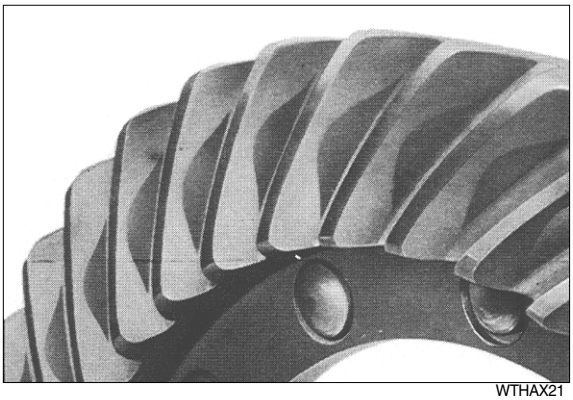
Convex side

- Reduce the distance (-)



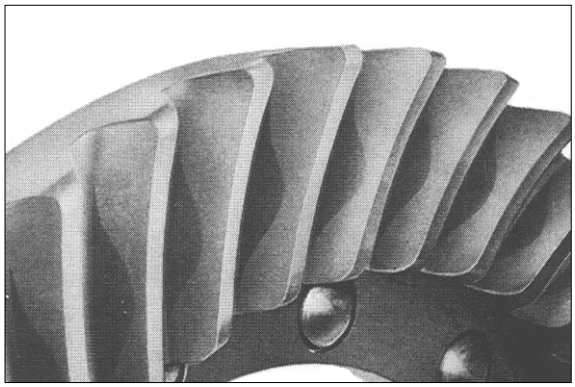
WTHAX20

Incorrect pattern, low contact



WTHAX21

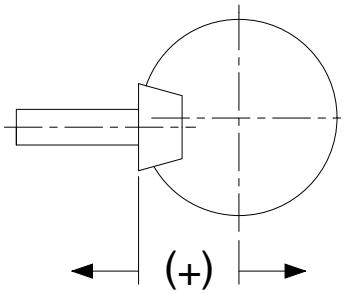
Concave side



WTHAX22

Convex side

- Add the distance (+)



WTHAX23

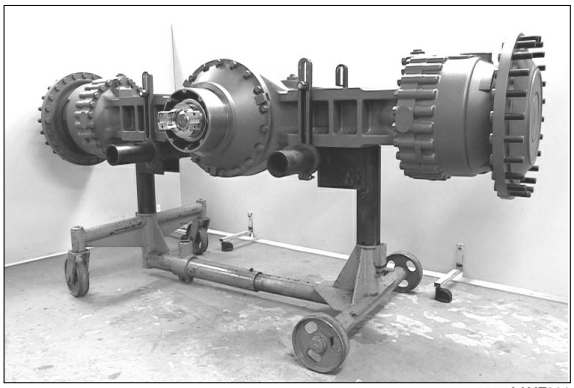
· REAR AXLE

1) DISASSEMBLY OF OUTPUT AND BRAKE

(1) Fasten axle on assembly truck.

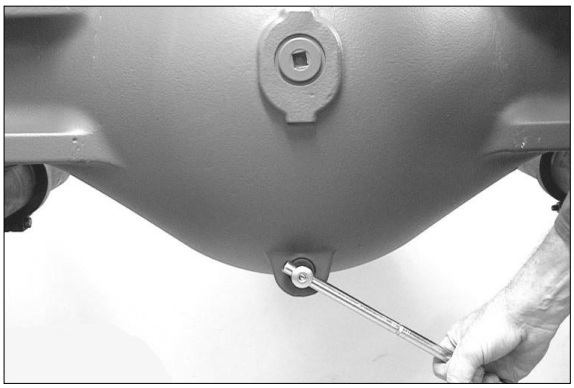
※ Special tool

Assembly truck	5870 350 000
Holding fixtures	5870 350 077
Clamps	5870 350 075

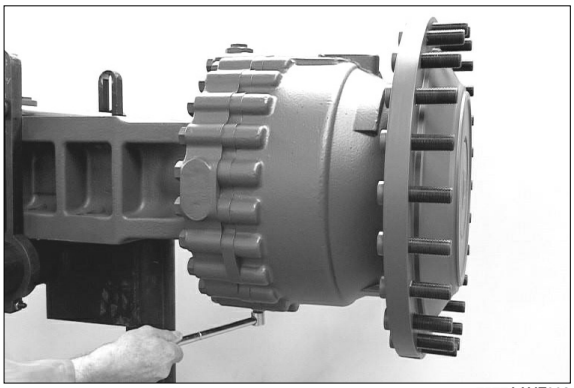


7577AAXF001

(2) Loosen screw plugs (3EA, see Figure 7577AAXF002 and 003) and drain oil from axle casing.



7577AAXF002

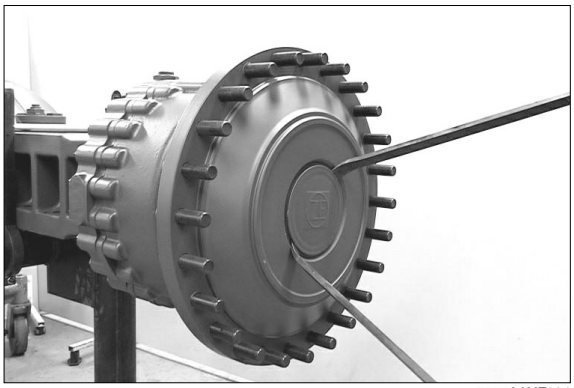


7577AAXF003

(3) Press off cover from the output shaft.

※ Special tool

Pry bar set	5870 345 065

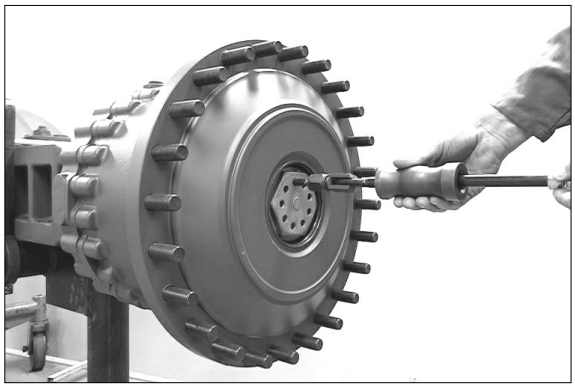


7577AAXF004

(4) Pull slotted pin by means of the striker out of the bore in the slotted nut.

※ Special tool

Striker	5870 650 001

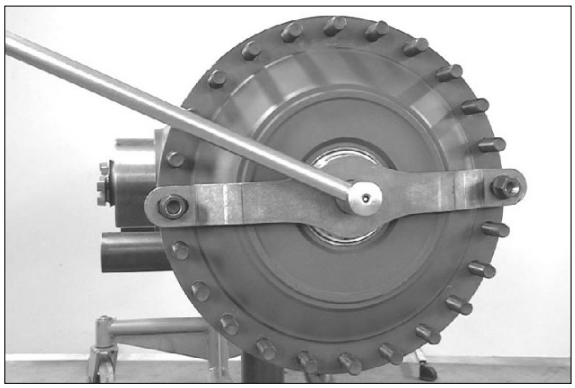


7577AAXF005

(5) Loosen slotted nut.

※ Special tool

Socket spanner	5870 656 077
Centering bracket	5870 912 028

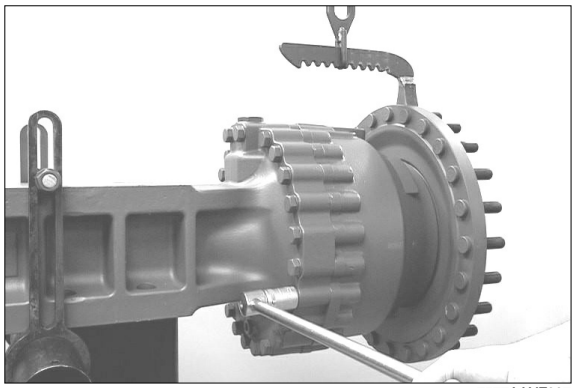


7577AAXF006

(6) Secure output by means of lifting tackle and loosen hexagon screws.

※ Special tool

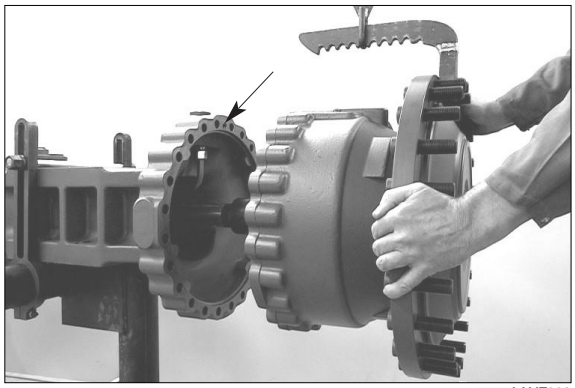
Lifting bracket	5870 281 043



7577AAXF007

(7) Separate complete output from the axle casing.

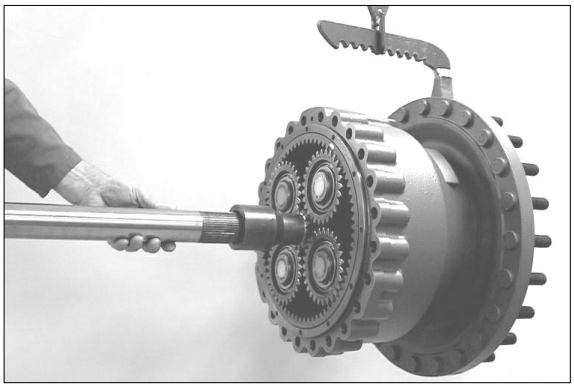
※ Pay attention to released O-ring (see arrow).



7577AAXF008

(8) Pull stub shaft out of the sun gear shaft.

※ Pay attention to possibly released shim(s).



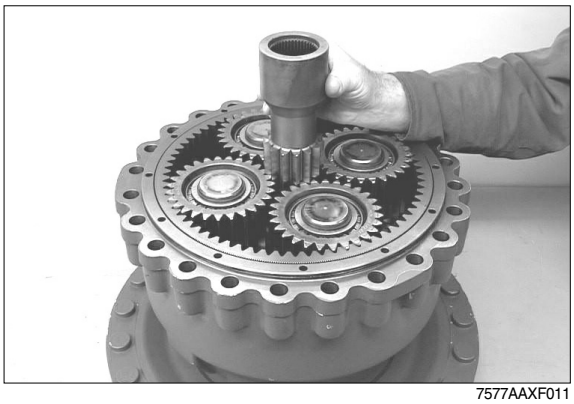
7577AAXF009

(9) Remove shim(s) from the sun gear shaft.



7577AAXF010

(10) Pull sun gear shaft out of the planet gears.

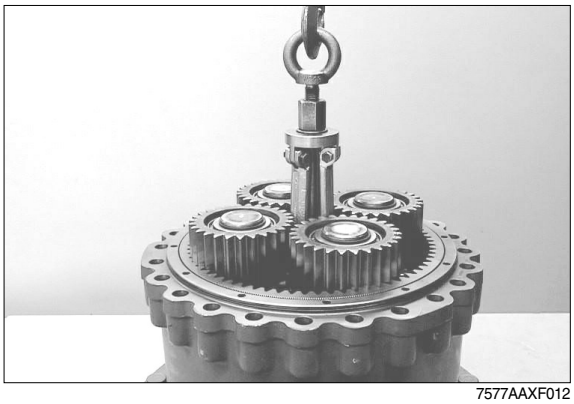


7577AAXF011

(11) Lift planet carrier out of the brake housing.

※ Special tool

Internal extractor	5870 300 019

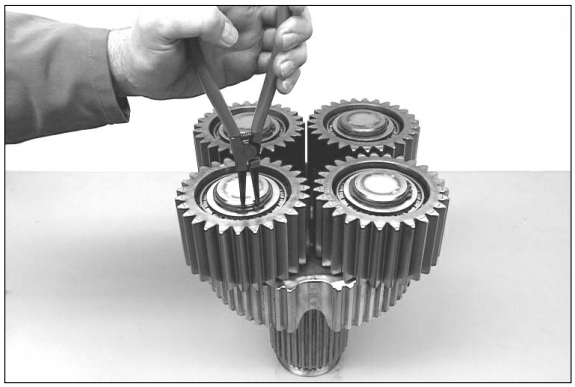


7577AAXF012

(12) Squeeze out the retaining ring.

※ Special tool

Set of external pliers	5870 900 015



7577AAXF013

(13) Pull off the planet gear and remove the released bearing inner ring.

※ Special tool

Three-armed puller	5873 971 002

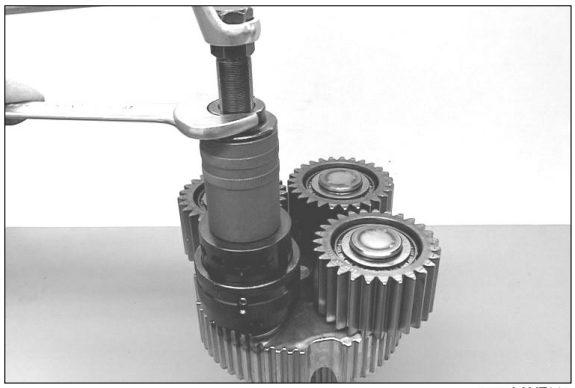


7577AAXF014

(14) Pull off the bearing inner ring.

※ Special tool

Gripping insert	5873 001 020
Back-off insert	5873 026 100

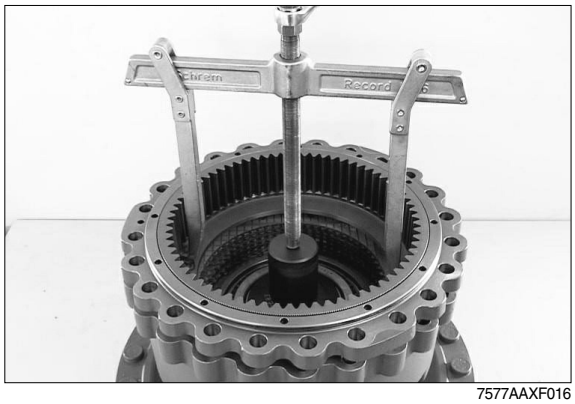


7577AAXF015

(15) Separate ring gear from the brake housing by means of two-armed puller.

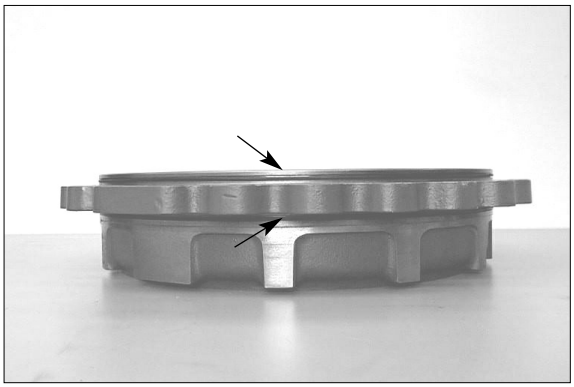
※ Special tool

Two-armed puller	5870 970 007



7577AAXF016

(16) Remove O-rings (see arrows) from the annular grooves of the ring gear.



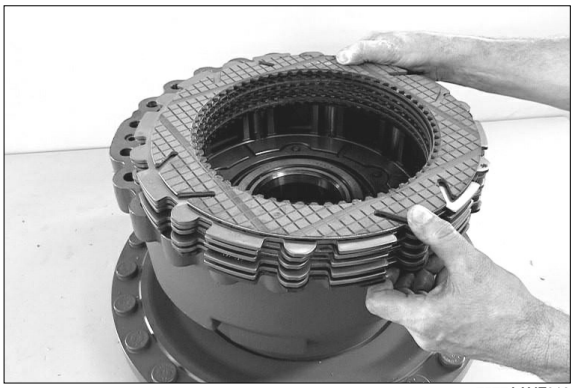
7577AAXF017

(17) Remove O-ring (see arrow) from the recess of the brake housing.



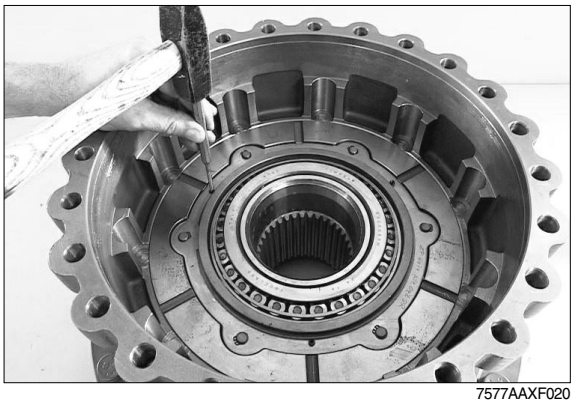
7577AAXF018

(18) Take the disc pack out of the brake housing.



7577AAXF019

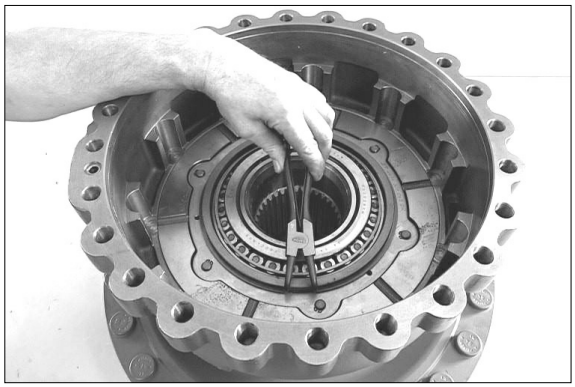
(19) Install slotted pins (6EA) in the support shim until they are flush-mounted.



7577AAXF020

(20) Squeeze out the circlip.

※ Special tool
Set of external pliers 5870 900 016



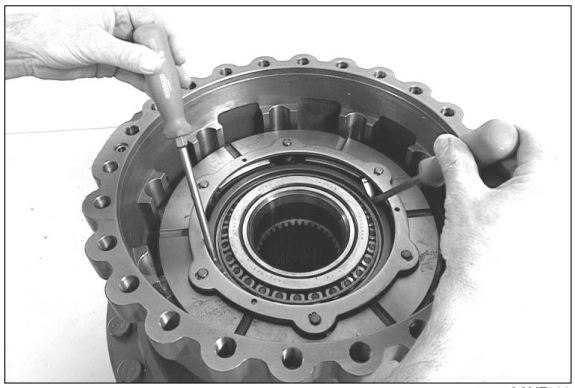
7577AAXF021

(21) Press piston out of the brake housing by means of compressed air.



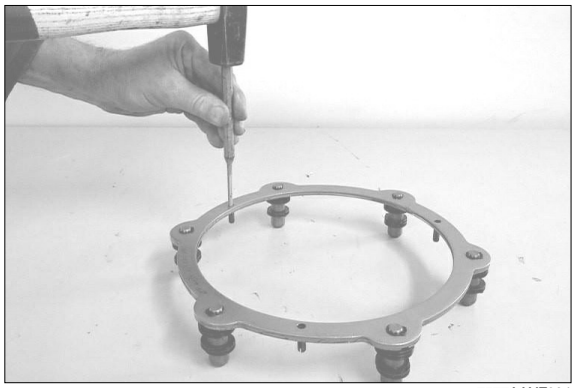
7577AAXF022

(22) Press support shim out of the piston by means of the automatic piston adjusting.



7577AAXF023

(23) Drive slotted pins (6EA) out of the support shim.

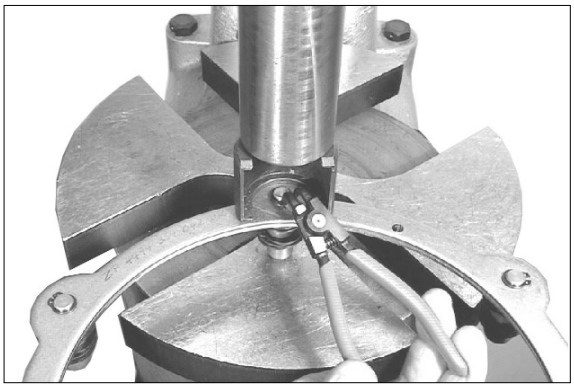


7577AAXF024

(24) Preload cup springs by means of a press and squeeze out the circlip.

※ Special tool

Assembly pliers	5870 900 051
Assembly fixture	5870 345 096



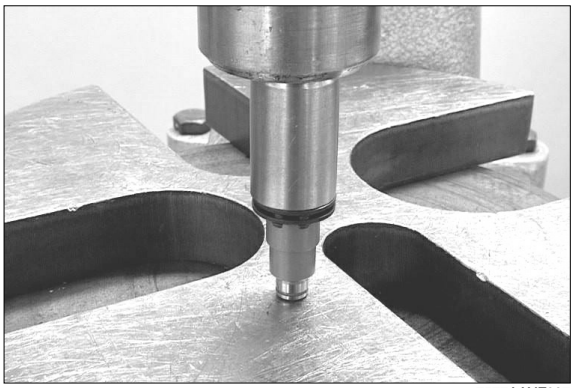
7577AAXF025

(25) Pull pin out of the support shim and remove released cup springs.



7577AAXF026

(26) Press gripping rings from the pin.

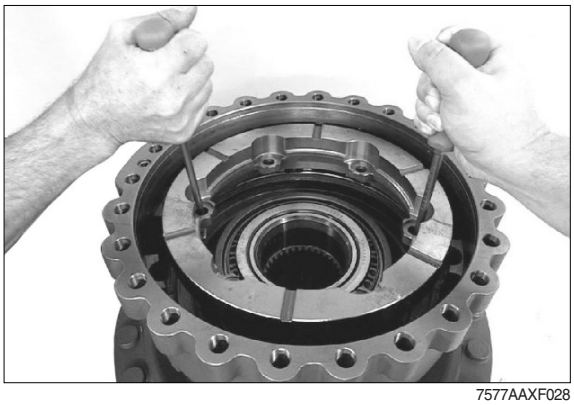


7577AAXF027

(27) Lift piston out of the brake housing.

※ Special tool

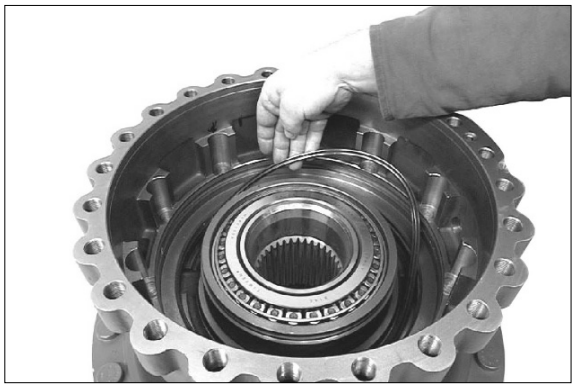
Adjusting device	5870 400 001



7577AAXF028

(28) Remove guide ring, support rings and U-rings from the annular grooves of the brake housing.

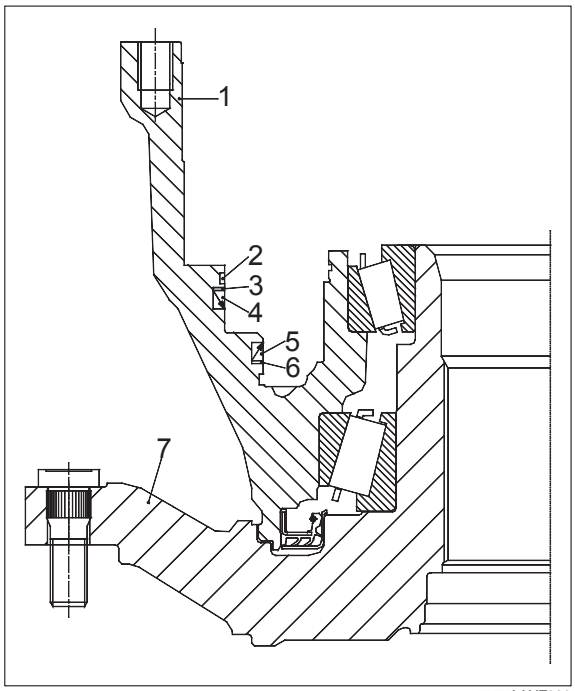
※ See below sketch for installation position of the single parts.



7577AAXF029

To the sketch :

1 Brake housing
2 Guide ring
3 Support ring
4 U-ring
5 U-ring
6 Support ring
7 Output shaft



7577AAXF030

(29) Pull brake housing by means of two-armed puller from the output shaft and remove the released bearing inner ring.

※ Special tool

Two-armed puller	5870 970 007
Clamping bracket	5870 654 034
Press bush	5870 506 140

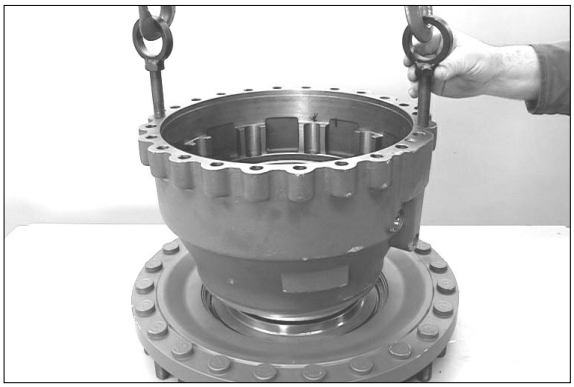


7577AAXF031

(30) Lift brake housing with lifting tackle from the output shaft.

※ Special tool

Lifting chain	5870 281 047
Eye bolts	5870 204 071



7577AAXF032

(31) If necessary drive both bearing outer rings out of the bearing bores in the brake housing.



7577AAXF033

(32) Press shaft seal out of the brake housing.

※ Special tool

Pry bar set	5870 345 065

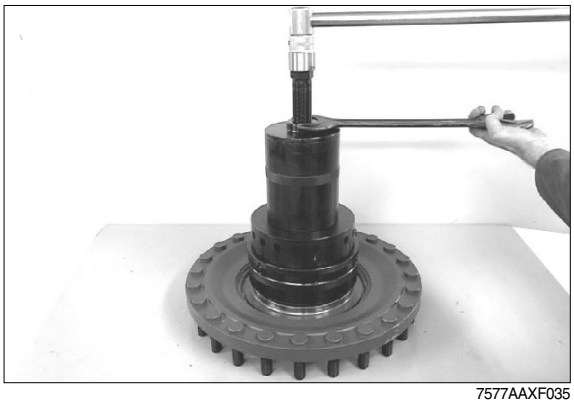


7577AAXF034

(33) Pull bearing inner ring from the output shaft.

※ Special tool

Rapid grip	5873 014 017
Basic set	5873 004 001

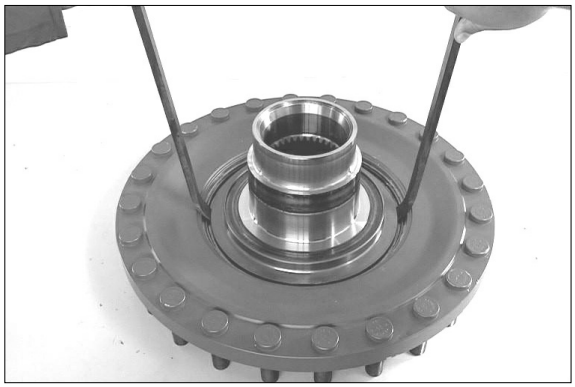


7577AAXF035

(34) Press off bearing sheet from the output shaft.

※ Special tool

Pry bar set	5870 345 065



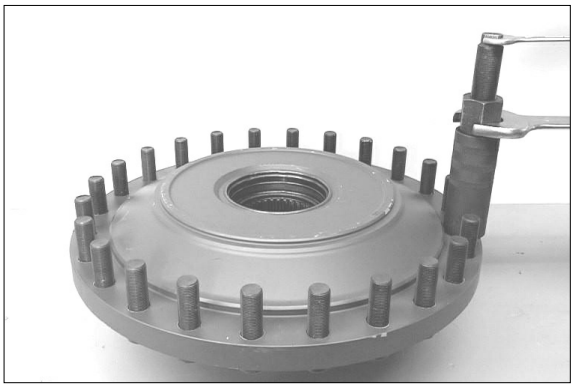
7577AAXF036

2) REASSEMBLY OF OUTPUT AND BRAKE

(1) Insert wheel bolt into the output shaft until contact.

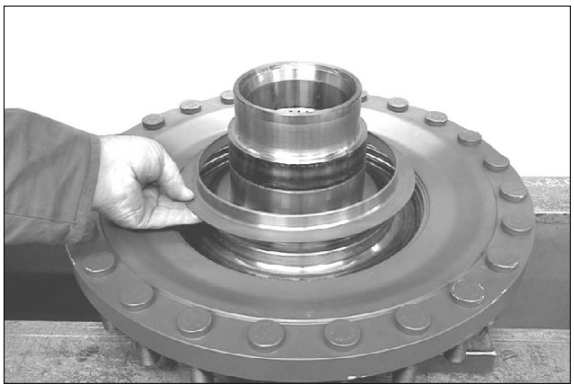
※ Special tool

Wheel bolt puller-basic set	5870 610 010
Insert (3/4"-16 UNF)	5870 610 005



7577AAXF037

(2) Assemble bearing sheet (shaft seal).



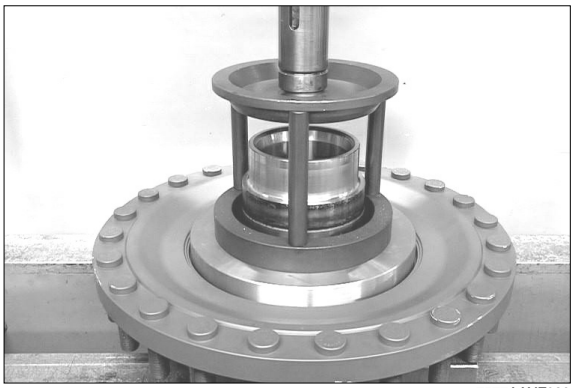
7577AAXF038

(3) Press bearing sheet over the collar of the output shaft.

※ Special tool

Pressure ring	5870 506 141

※ The exact installation position of the bearing sheet will be obtained by using the specified pressure ring.



7577AAXF039

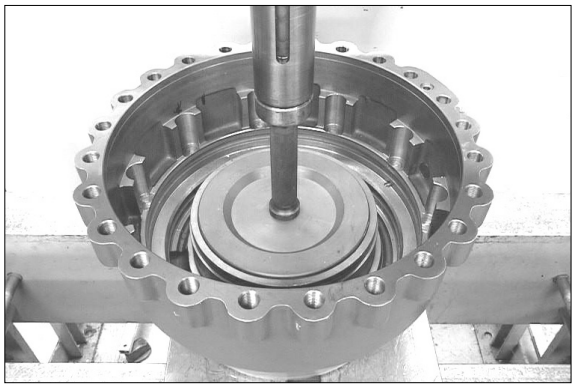
(4) Heat the roller bearing and install it until contact.

※ After cooling-down the bearing has to be installed subsequently.



7577AAXF040

(5) Press both bearing outer rings into the brake housing until contact.



7577AAXF041

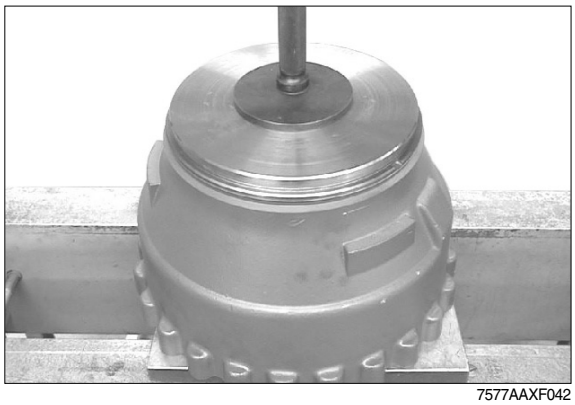
(6) Install shaft seal with the sealing lip showing to the oil chamber (see below sketch).

※ Special tool

Driver	5870 051 052

※ The exact installation position of the shaft seal will be obtained by using the specified driver.

⚠ **Just before the installation wet the outer diameter of the shaft seal with spirit.**

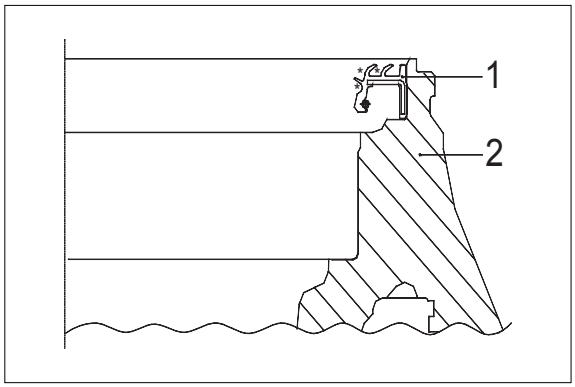


7577AAXF042

To the sketch :

1 Brake housing
2 Shaft seal
* Grease filling

※ Fill the space between sealing and dust lips with grease.

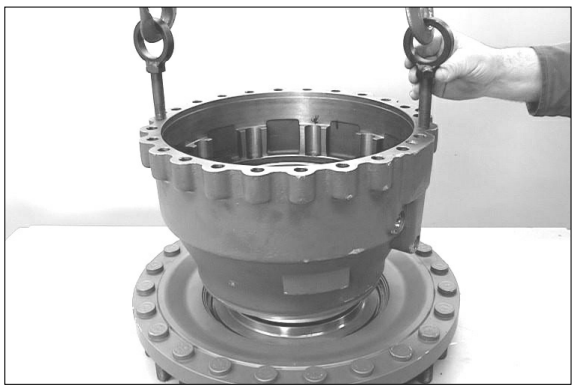


7577AAXF043

(7) Install the preassembled brake housing by means of the lifting tackle over the output shaft until contact.

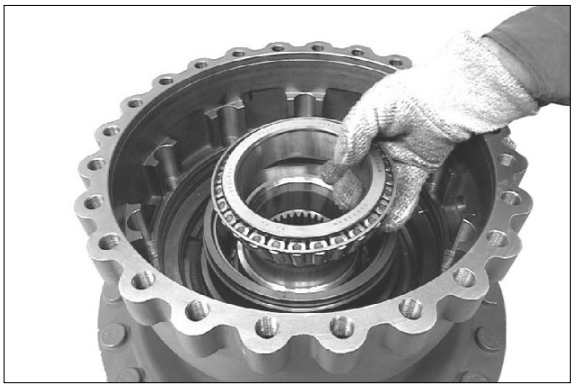
※ Special tool

Lifting chain	5870 281 047
Eye bolts	5870 204 071



7577AAXF044

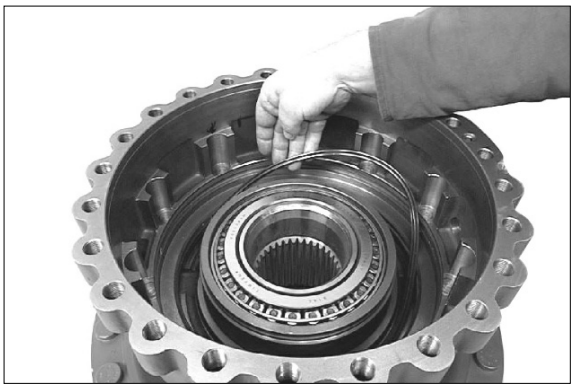
(8) Heat the roller bearing and install it until contact.



7577AAXF045

(9) Insert support and U- rings into the annular grooves of the brake housing.

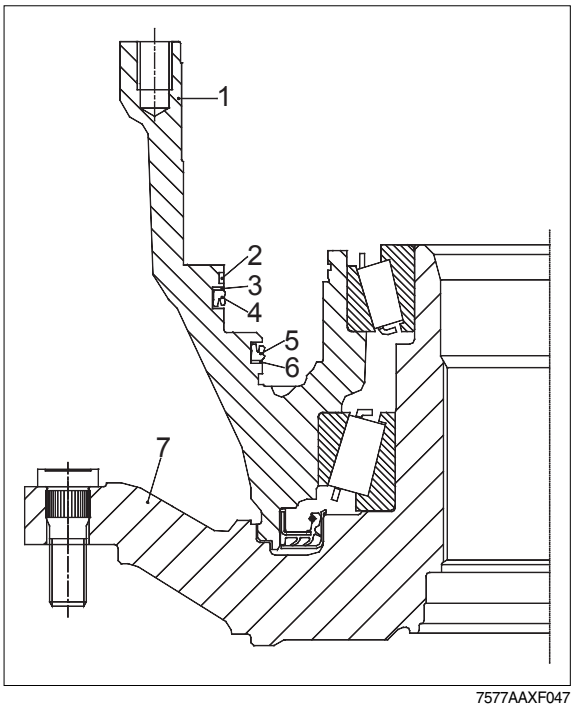
※ Pay attention to the installation position, see below sketch.



7577AAXF046

To the sketch :

1 Brake housing
2 Guide ring
3 Support ring
4 U-ring
5 U-ring
6 Support ring
7 Output shaft



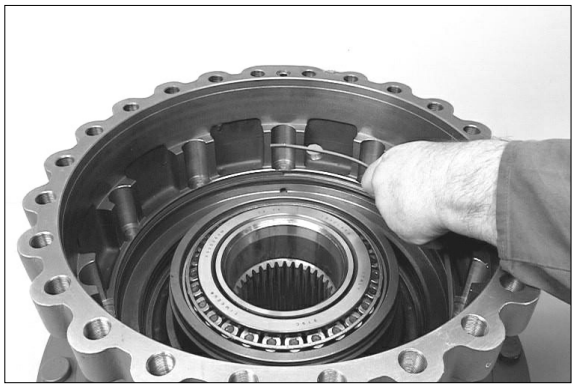
7577AAXF047

(10) Clean annular groove of the brake housing with spirit.

Then insert the guide ring into the annular groove (also see sketch page 3-242) and fix it with Loctite (Type No. 415) at its extremities.

※ Guide ring must have contact on the whole circumference.

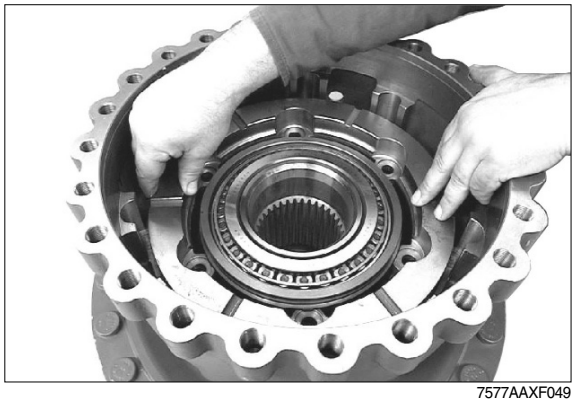
⚠ **Upon installation the orifice of the guide ring must show upwards (12 o'clock).**



7577AAXF048

(11) Insert piston into the brake housing and install it cautiously until contact.

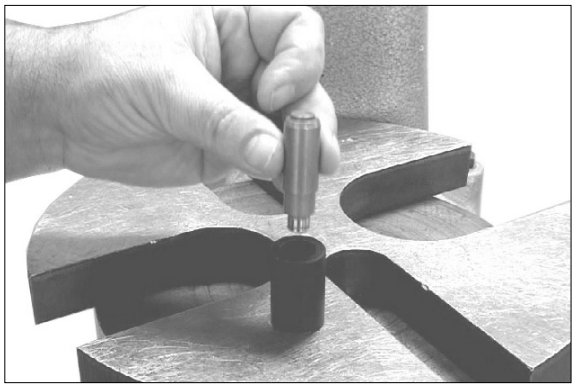
※ Apply sufficiently oil on the sliding surface of the piston or support rings, U-rings and guide ring (use W-10 oils).



7577AAXF049

(12) Insert pins into the assembly fixture until contact.

※ Special tool
Assembly fixture 5870 345 096

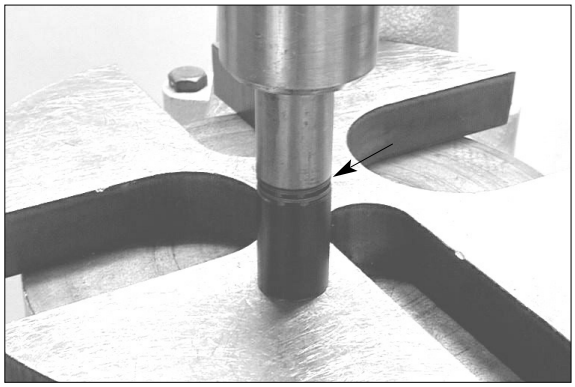


7577AAXF050

(13) Press gripping rings (4EA, see arrows) onto the pins until contact on the assembly fixture.

※ The exact installation dimension (see sketch page 3-244) of the gripping rings is obtained when using the specified assembly fixture.

⚠ **Observe the installation position, install gripping rings with the orifices offset by 180° to each other.**



7577AAXF051

(14) Install cup springs (7 pieces each/pin).

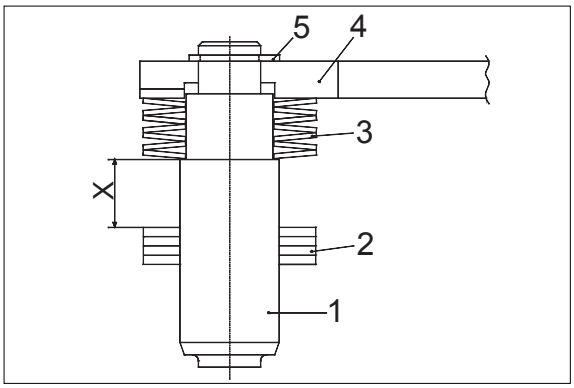
※ Pay attention to the installation position of the cup springs, see below sketch.



7577AAXF052

To the sketch :

1 Pin
2 Gripping rings
3 Cup springs
4 Support shim
5 Circlip
X Installation dimension gripping rings $10.5^{+0,3}$ mm

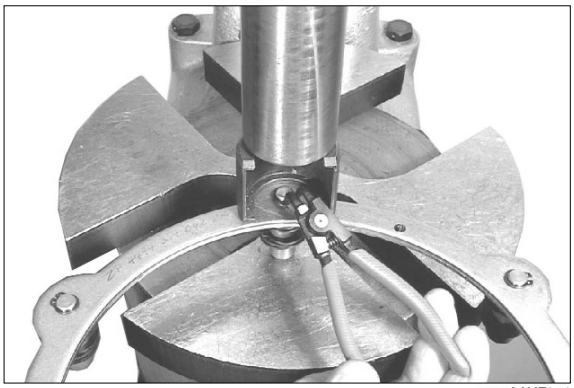


7577AAXF053

(15) Insert preassembled pins into the support shim and fix it by means of the circlip.

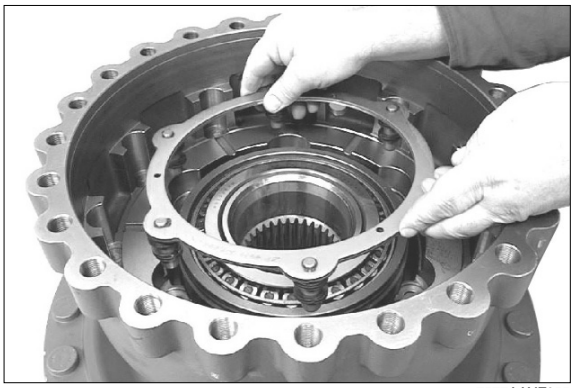
※ Special tool
Assembly pliers 5870 900 051

※ Pay attention to clearance of the cup springs.



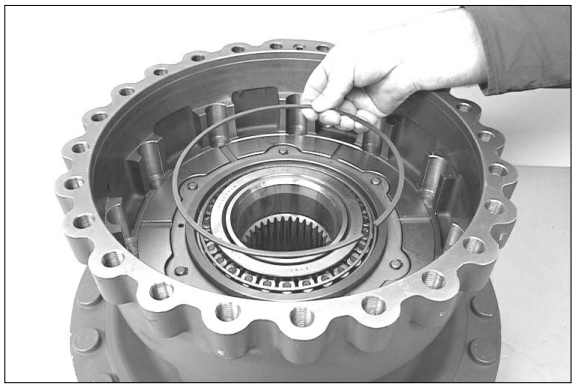
7577AAXF054

(16) Insert preassembled support shim into the piston.



7577AAXF055

(17) Fix support shim by means of the circlip.

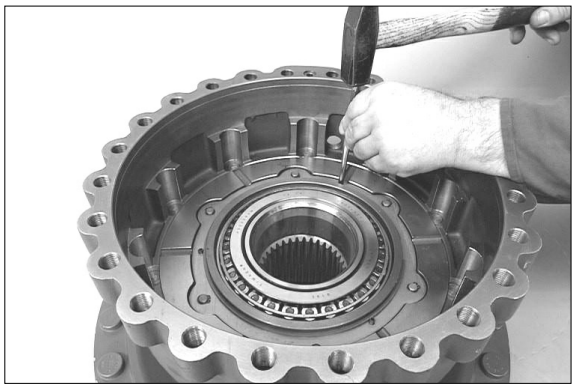


7577AAXF056

(18) Drive slotted pins (6EA) into the bores of the support shim to lock the circlip.

※ Special tool
Drive mandrel 5870 705 011

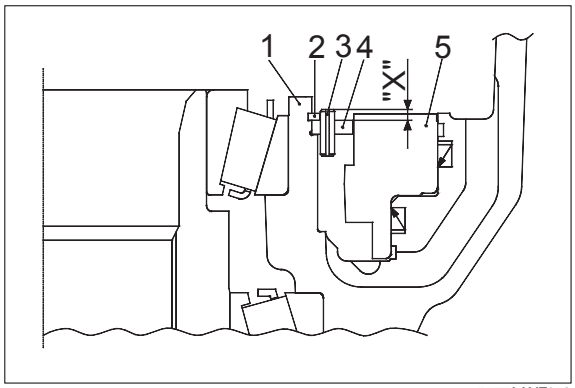
※ Pay attention to the installation position, see below sketch.



7577AAXF057

To the sketch :

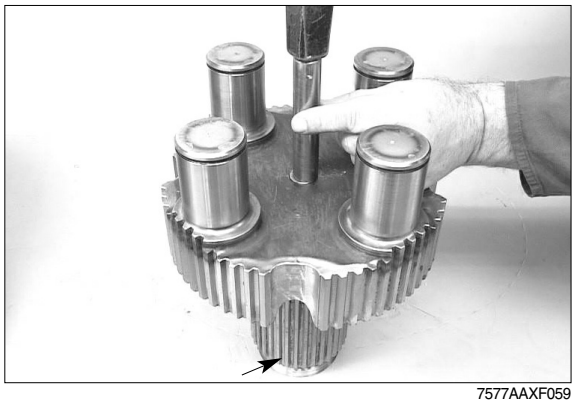
1 Brake housing
2 Circlip
3 Slotted pin
4 Support shim
5 Piston
X Installation dimension 4.0 $_{-0,5}$ mm



7577AAXF058

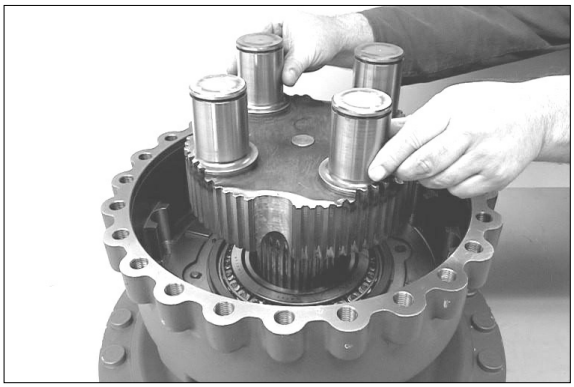
(19) Drive stop bolt into the planet carrier until contact.

Then wet spline (see arrow).



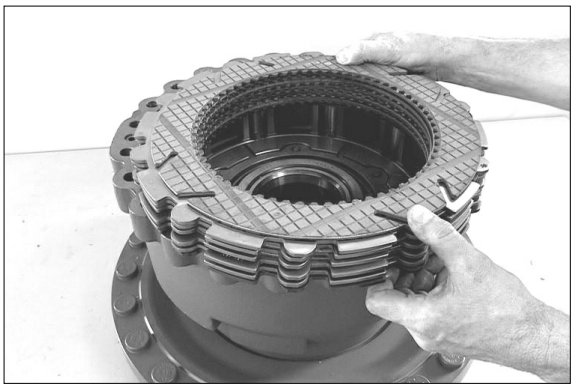
7577AAXF059

(20) Insert planet carrier into the spline of the output shaft until contact.



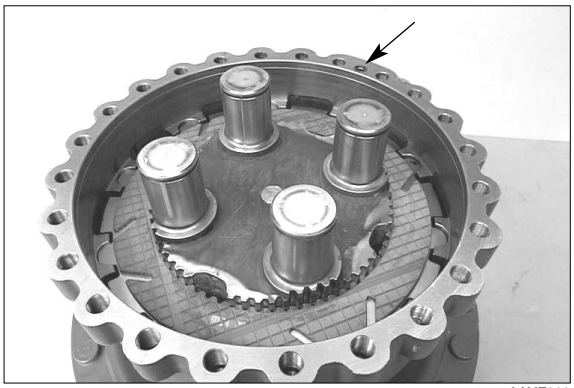
7577AAXF060

(21) Install outer- and inner clutch discs alternately starting with an outer clutch disc.



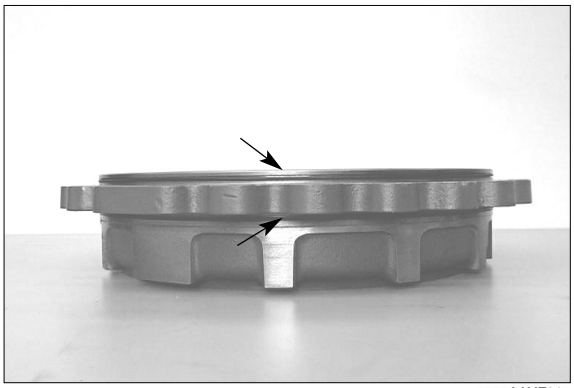
7577AAXF061

(22) Insert O-ring (see arrow) into the recess of the brake housing.



7577AAXF062

(23) Grease both O-rings (see arrows) and insert them into the annular grooves of the ring gear.

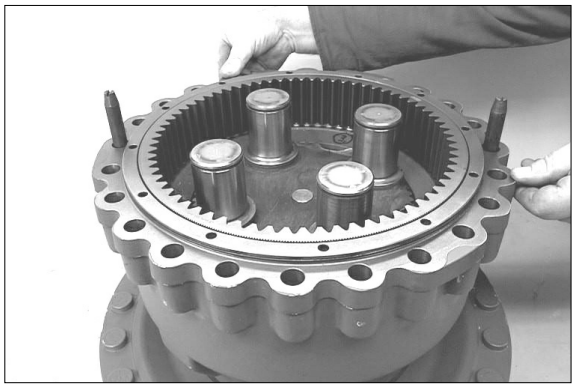


7577AAXF017

(24) Install two adjusting screws and insert ring gear into the brake housing until contact.

※ Special tool
Adjusting screws 5870 204 029

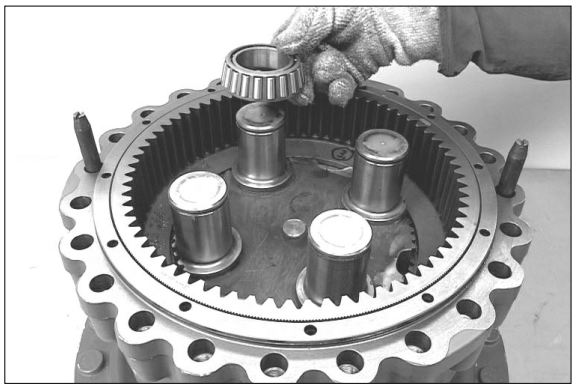
※ Pay attention to radial location.



7577AAXF063

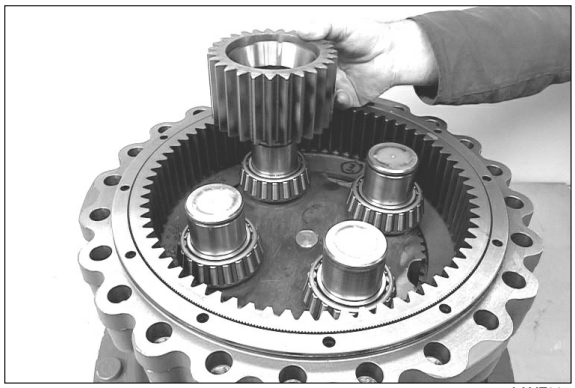
(25) Heat bearing inner rings and install them until contact with the big radius showing to the planet carrier (downwards).

※ Subsequently install bearing inner rings after cooling down.



7577AAXF064

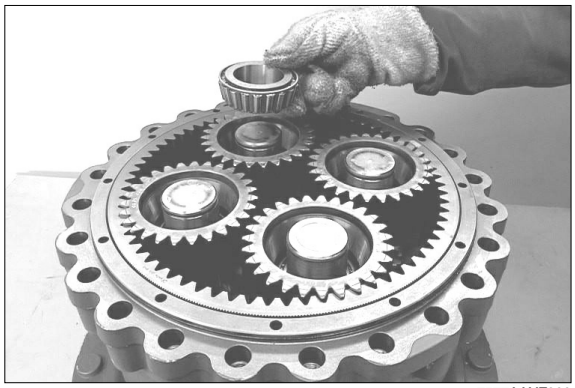
(26) Put planet gears onto the bearing inner rings.



7577AAXF065

(27) Heat bearing inner rings and install them on the planet gears until contact.

※ Subsequently install bearing inner rings after cooling down.

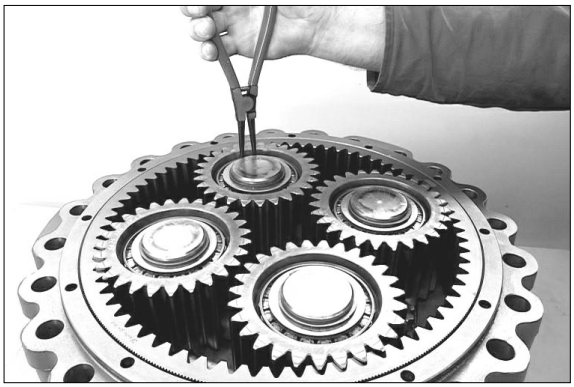


7577AAXF066

(28) Fasten plant gears by means of retaining rings.

※ Special tool

Set of external pliers	5870 900 015



7577AAXF067

Adjust end play of sun gear shaft 0.5 ~ 2.0mm

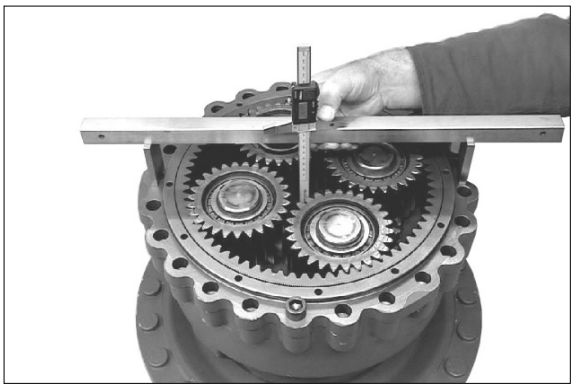
(29) Fasten ring gear by means of cap screws until contact.

Then determine dimension l, from the mounting face of the ring gear up to the face of the stop bolt.

Dimension l e.g . . . . . 46.20 mm

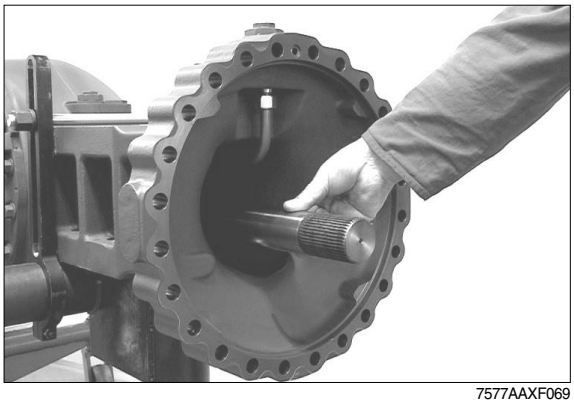
※ Special tool

Digital depth gauge	5870 200 072
Gauge blocks	5870 200 066
Straightedge	5870 200 022



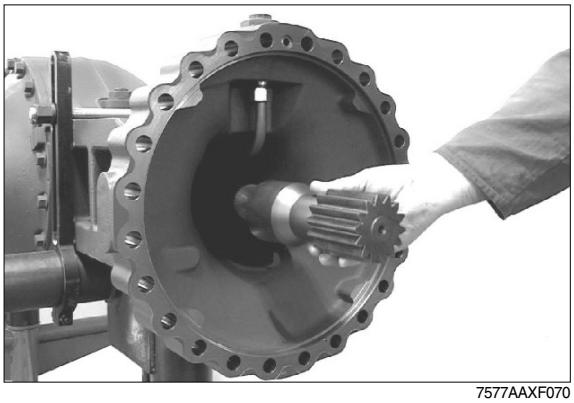
7577AAXF068

(30) Insert stub shaft into spline of the axle bevel gear until contact.



7577AAXF069

(31) Assemble sun gear shaft until contact.



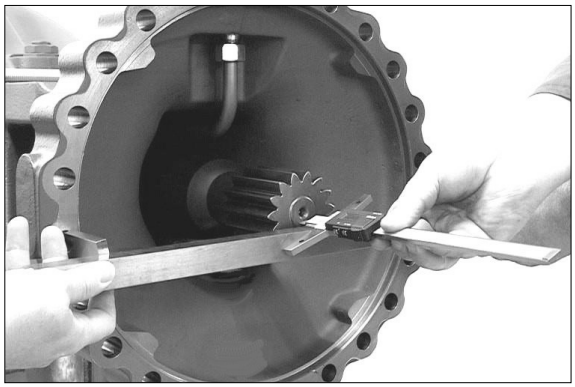
7577AAXF070

(32) Determine Dimension **II** from the face of the sun gear shaft up to the mounting face of the axle casing.

Dimension **II** e.g 43.00mm

※ Special tool

Digital depth gauge	5870 200 072
Gauge blocks	5870 200 066
Straightedge	5870 200 022



7577AAXF071

EXAMPLE **A** :

Dimension **I**	46.20mm
Dimension **II**	- 43.00mm
Difference	3.20mm
required end play e.g.	- 1.00mm
Difference = shim e.g. s =	**2.20mm**

(33) Insert sun gear shaft into the planet carrier.



7577AAXF072

(34) Fix determined shim(s), e.g. s = 2.20mm, into the sun gear shaft by means of grease.

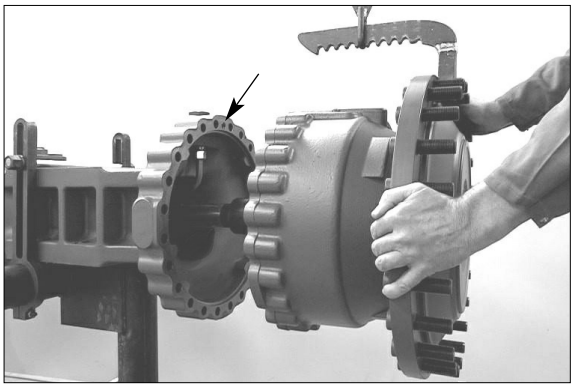


7577AAXF073

(35) Fix O-ring(see arrow) into the recess of the axle casing by means of grease and install the preassembled output to the axle casing until contact by means of lifting tackle.

※ Special tool

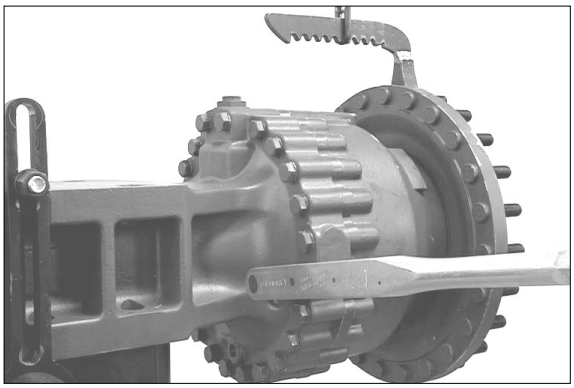
Lifting bracket	5870 281 043



7577AAXF074

(36) Fasten output by means of hexagon screws and washers.

· Tightening torque (M18/10.9) :
39.8kgf · m(288lbf · ft)



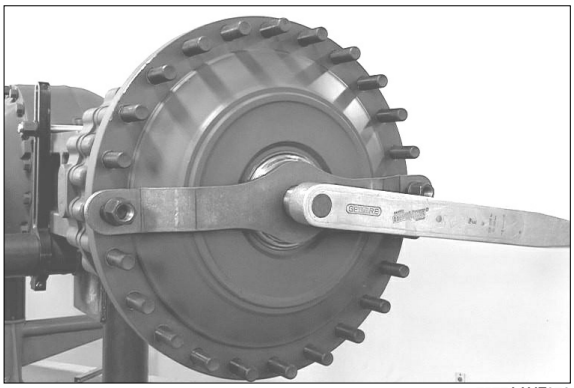
7577AAXF075

(37) Unscrew slotted nut by hand and then fasten it.

· Tightening torque : $71.4^{+30.6}$ kgf · m
(516^{+221} lbf · ft)

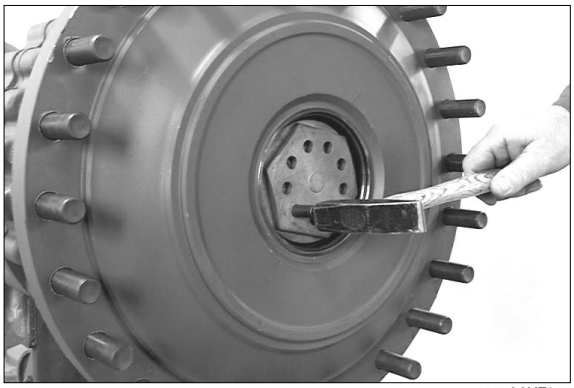
※ Special tool

Socket spanner	5870 656 077
Centering bracket	5870 912 028



7577AAXF076

(38) Secure slotted nut by means of slotted pin.



7577AAXF077

(39) Assemble O-ring (see arrow) to the cover.



7577AAXF078

(40) Insert cover into the output shaft until contact.

※ Special tool
Hammer (Plastic ø 60) 5870 280 004

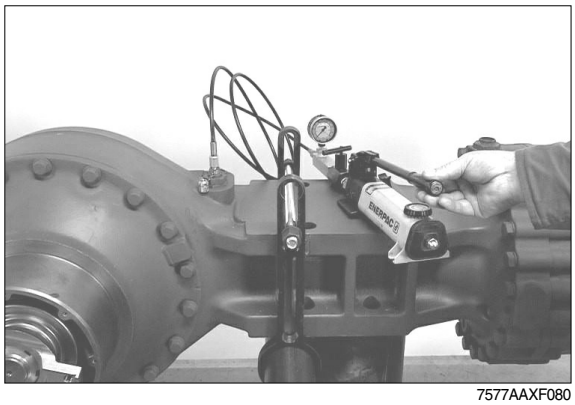


7577AAXF079

Leakage test of the brake hydraulics

※ Prior to start the test, ventilate the brake hydraulics completely.

1) Open the bleeder.
2) Slowly actuate the HP-pump until oil flows out of the bleeder.
3) Close the bleeder again.
4) Slowly pressurize the HP-pump with p > 10 bar and hold the pressure for some seconds.



7577AAXF080

※ The brake piston extends and the cylinder chamber fills up with oil. The air accumulates in the upper section of the cylinder chamber.

5) Loosen the shut-off valve on the HP-pump.

※ The reversing piston presses the air from the upper section of the cylinder into the brake line.

6) Open the bleeder again.
7) Slowly actuate the HP-pump until oil flows out of the bleeder.

※ Repeat procedure - Item 3)~7) until at 7) from the beginning of the actuation no more air exits from bleeder.

※ Then pressurize the brake temporarily (5EA) with p = 100 bar max..

High-pressure test :

Increase test pressure up to p = 100_{-10} bar and close connection to HP-pump by means of shut-off valve.
During a 5 min. testing time a pressure drop of max. 2% (2 bar) is allowed.

⚠ **If the maximum pressure of 100 bar is exceeded, there will be an excessive piston adjustment and a repeated disassembly of the brake or the adjusting is required to reset the gripping rings to the adjusting dimension.**

Low-pressure test :
Reduce test pressure to p = 5 bar and close the shut-off valve again.
During a 5 min. testing time a pressure drop is not allowed.

※ Special tool

HP-Pump	5870 287 007
Mini-measuring hub (9/16"- 18UNF)	5870 950 115

※ Prior to putting the axle into operation, fill in the oil acc. to the lubrication instructions.

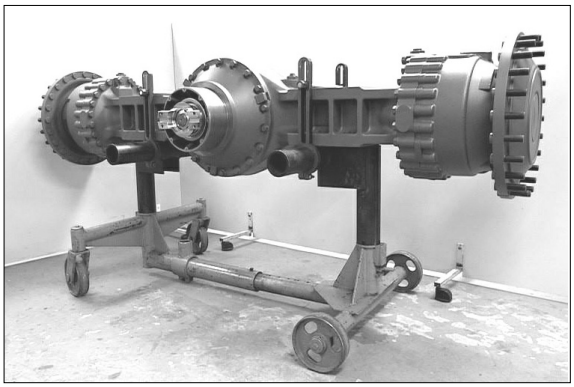
3) DISASSEMBLY OF DIFFERENTIAL CARRIER AND BRAKE TUBES

(1) Disassembly of differential carrier

① Fasten axle on assembly truck.

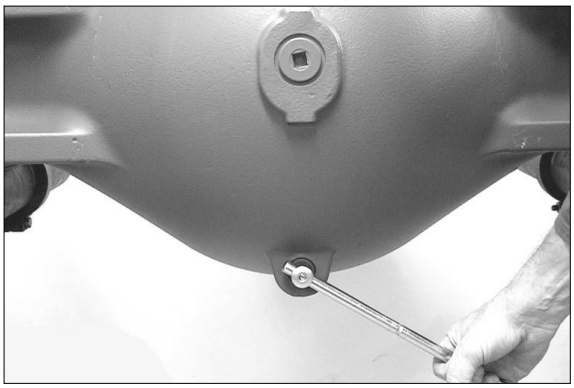
※ Special tool

Assembly truck	5870 350 000
Holding fixtures	5870 350 077
Clamps	5870 350 075

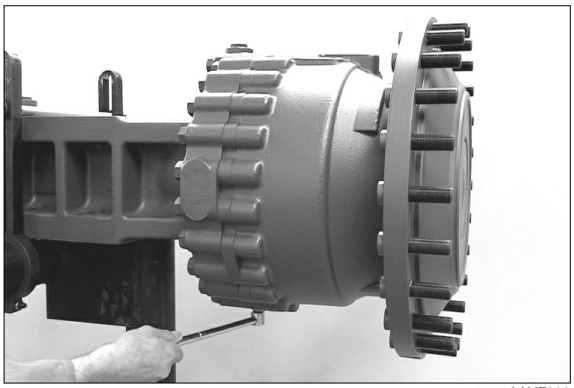


7577AAXF001

② Loosen screw plugs (3EA, see Figure 7577AAXF002 and 003) and drain oil from axle casing.



7577AAXF002



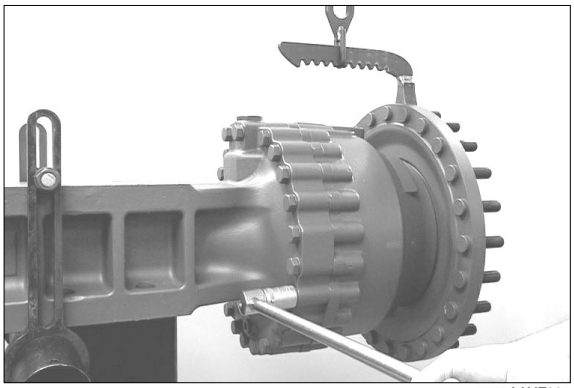
7577AAXF003

③ Secure output by means of lifting tackle and loosen hexagon screws.

※ Special tool

Lifting bracket	5870 281 043

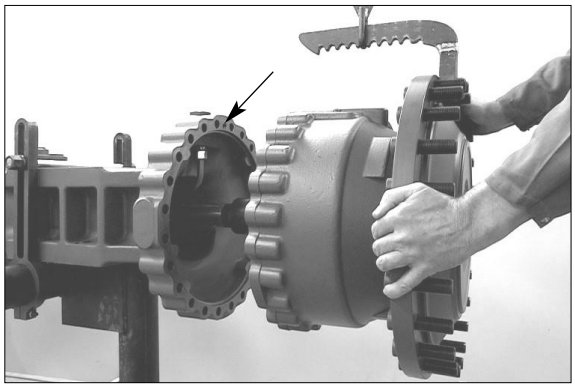
※ Make step (Fig. 7577AAXF007~9) on both output sides.



7577AAXF007

④ Separate complete output from the axle casing.

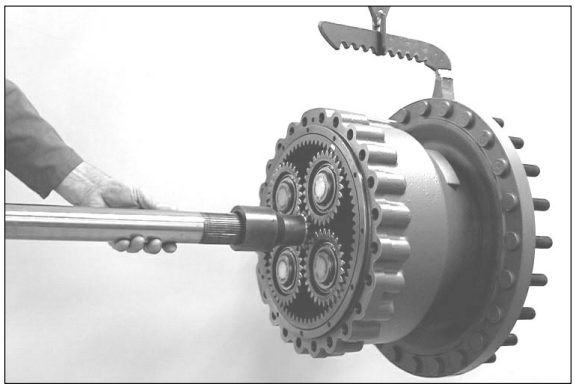
※ Pay attention to released O-ring(see arrow).



7577AAXF008

⑤ Pull stub shaft out of the sun gear shaft.

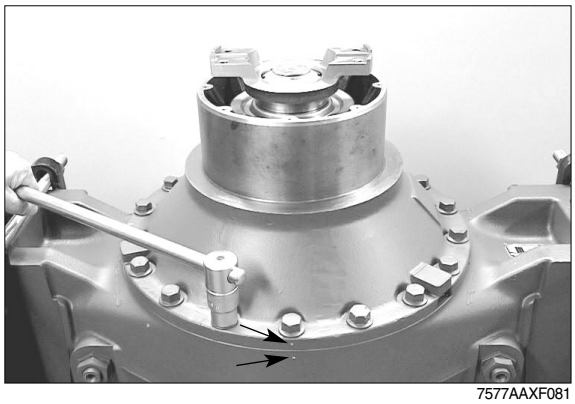
※ Pay attention to released shim(s).



7577AAXF009

⑥ Loosen hexagon screws.

※ Mark location of differential carrier to the axle casing (see arrows).

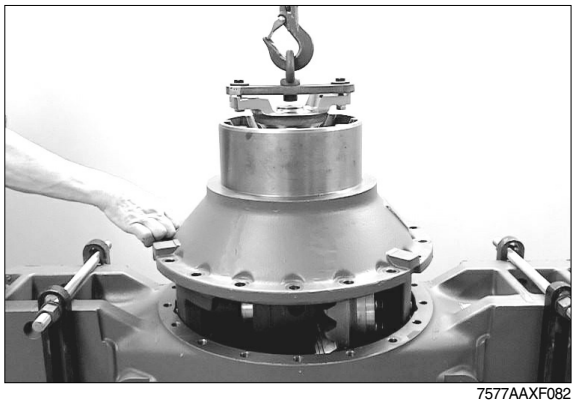


7577AAXF081

⑦ Lift differential carrier by means of lifting tackle out of the axle casing.

※ Special tool

Lifting tackle	5870 281 044

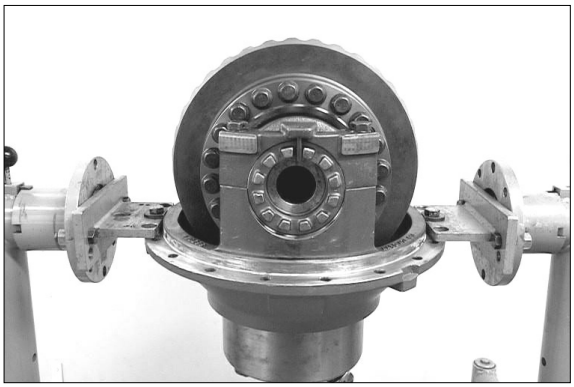


7577AAXF082

⑧ Fasten differential carrier to assembly truck.

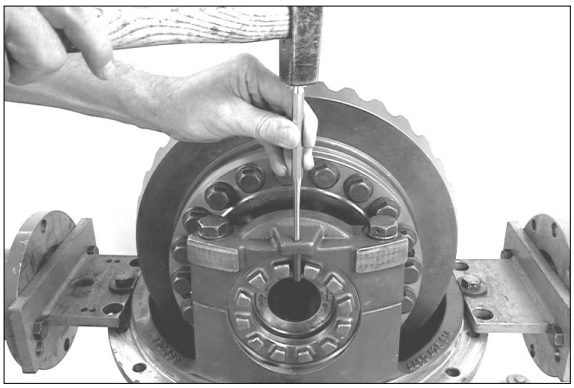
※ Special tool

Assembly truck	5870 350 000
Holding fixture	5870 350 004



7577AAXF083

⑨ Drive out slotted pins.

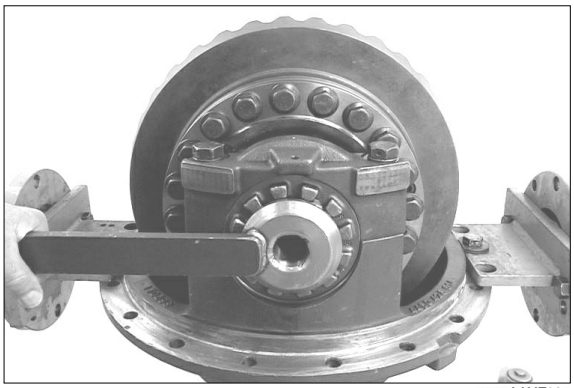


7577AAXF084

⑩ Loosen and remove both adjusting nuts.

※ Special tool

Socket spanner	5870 656 080



7577AAXF085

⑪ Heat axle drive housing by means of hot-air blower.

※ Special tool

Hot-air blower 230 V	5870 221 500
Hot-air blower 115 V	5870 221 501

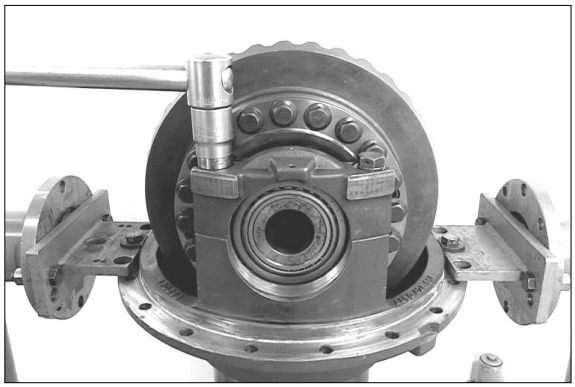
※ Hexagon screws are installed with Loctite (Type No. 262).



7577AAXF086

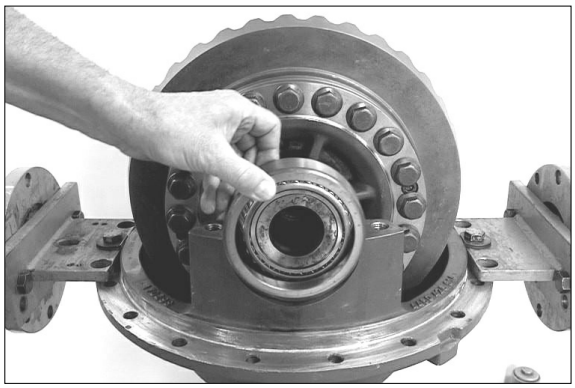
⑫ Loosen hexagon screws and take off bearing bracket.

⚠ Loosen hexagon screws by hand only.



7577AAXF087

⑬ Remove both bearing outer rings.

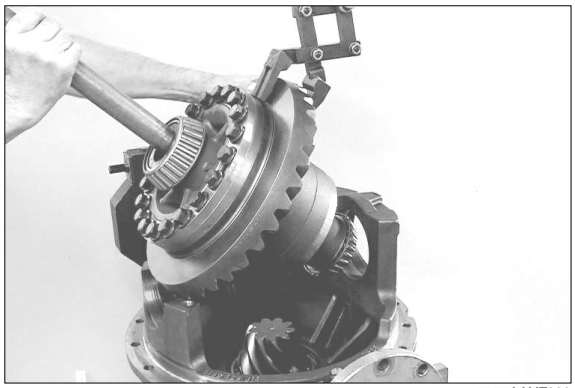


7577AAXF088

⑭ Lift differential out of the housing by means of lifting tackle.

※ Special tool

Lifting tackle	5870 281 013



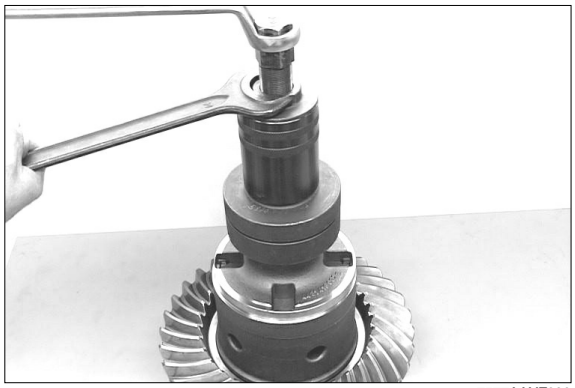
7577AAXF089

Disassembly of limited slip differential

⑮ Pull bearing inner ring from the differential housing.

※ Special tool

Gripping insert	5873 002 025
Basic set	5873 002 001



7577AAXF090

⑯ Pull bearing inner ring from the housing cover.

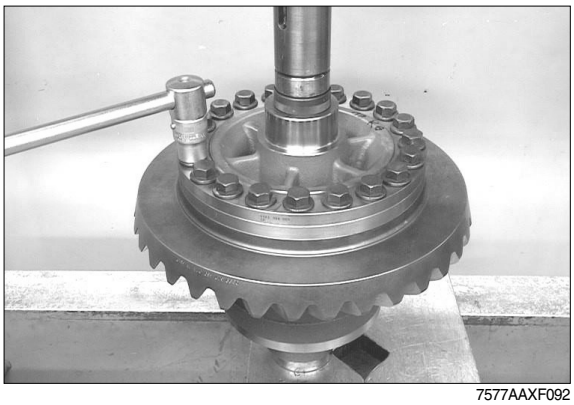
※ Special tool

Rapid grip	5873 012 012
Basic set	5873 002 001



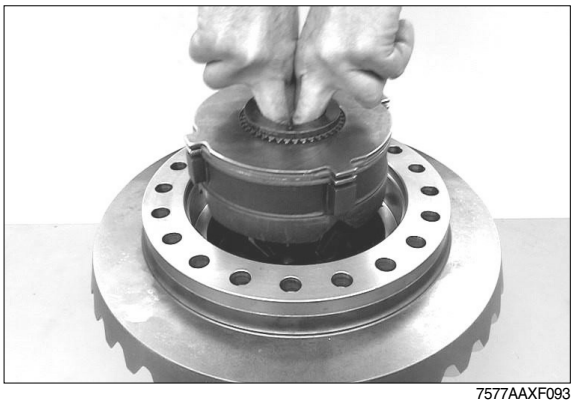
7577AAXF091

⑰ Fasten differential by means of press, loosen locking screws and remove released housing cover.



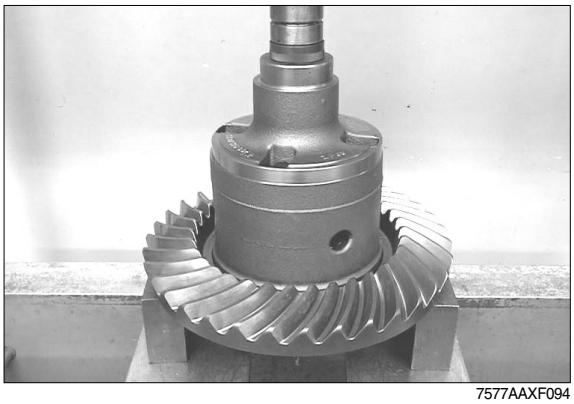
7577AAXF092

⑱ Remove all single parts from the differential housing.



7577AAXF093

⑲ Press off crown wheel from the differential housing.



7577AAXF094

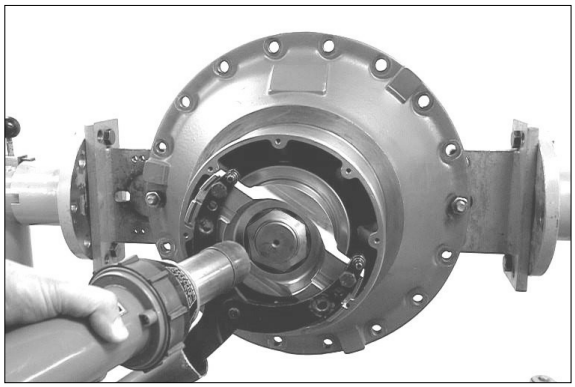
Disassembly of drive pinion

⑳ Heat hexagon nut by means of hot-air blower.

※ Special tool

Hot-air blower 230 V	5870 221 500
Hot-air blower 115 V	5870 221 501

※ Slotted nut is locked with Loctite (Type No. 262).

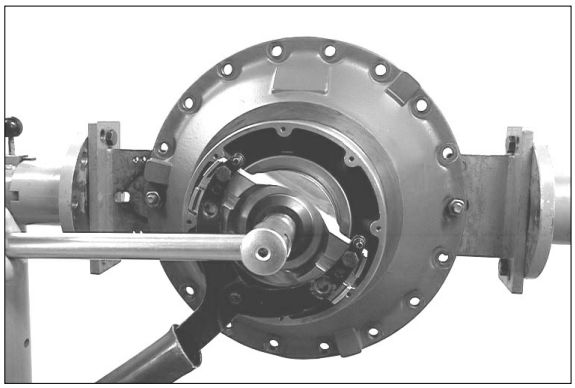


7577AAXF095

㉑ Loosen hexagon nut and remove the washer behind it.

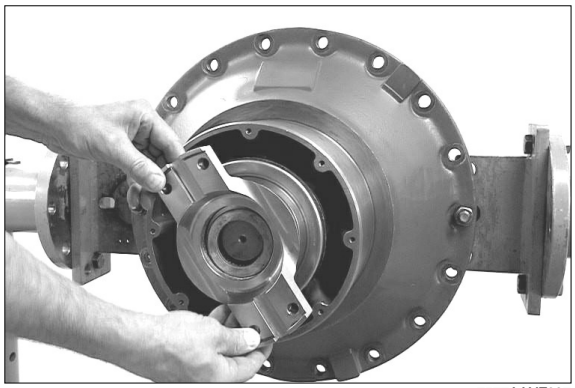
※ Special tool

Fixture	5870 240 002



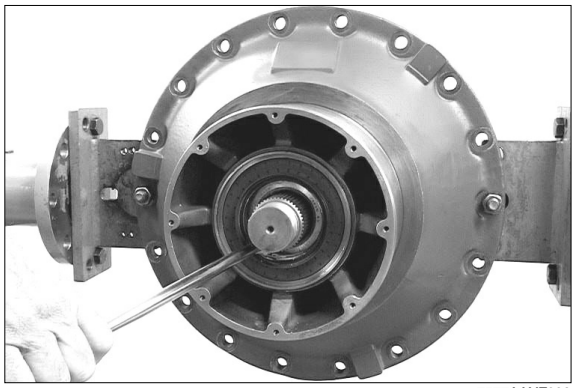
7577AAXF096

㉒ Pull input flange from the drive pinion.



7577AAXF097

㉓ Press shaft seal out of the axle drive housing.

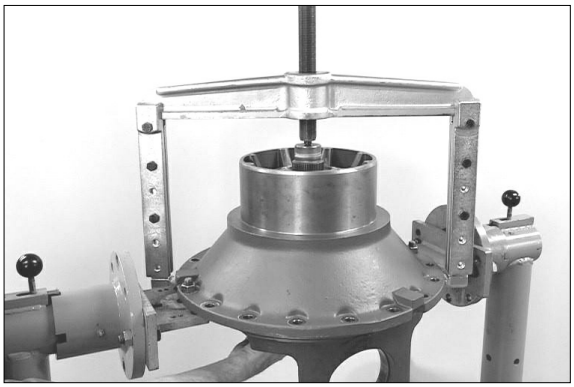


7577AAXF098

㉔ Press drive pinion out of the axle drive housing by means of two-armed puller and remove the released bearing inner ring.

※ Special tool

Two-armed puller	5870 970 007

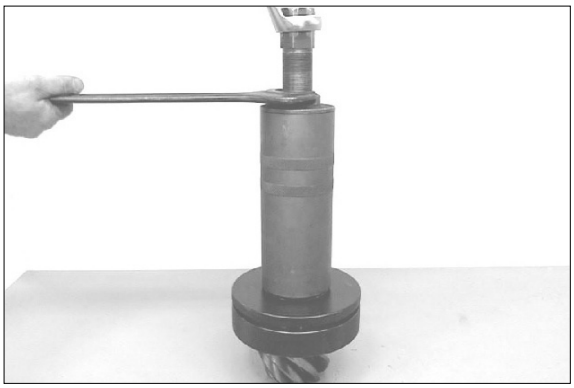


7577AAXF099

㉕ Take off spacer ring and pull bearing inner ring from the drive pinion.

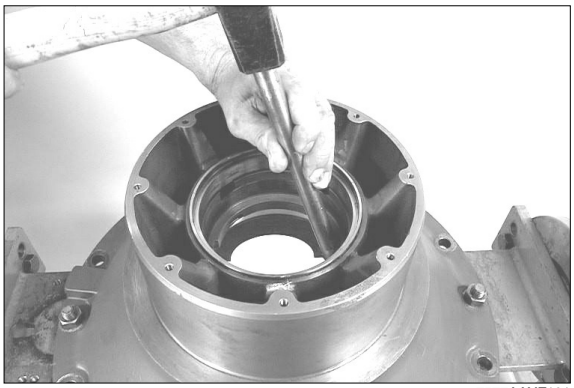
※ Special tool

Gripping insert	5873 002 032
Basic set	5873 002 001



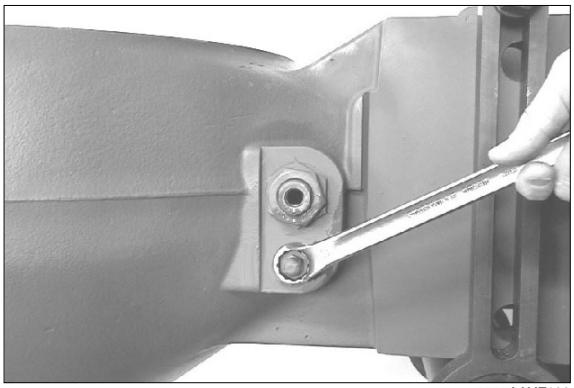
7577AAXF100

㉖ If necessary drive out both bearing outer rings from the axle drive housing.



7577AAXF101

㉗ Remove screw plug with vent valve from the axle casing.

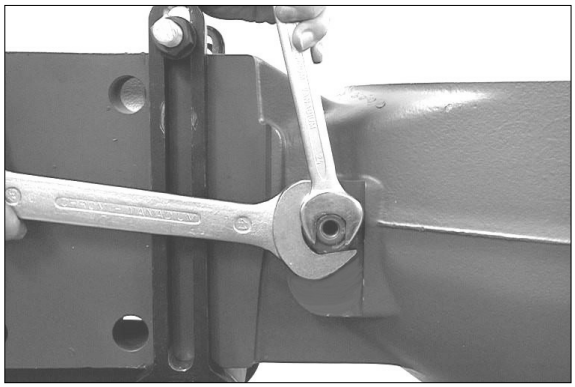


7577AAXF102

(2) Disassembly of brake tubes

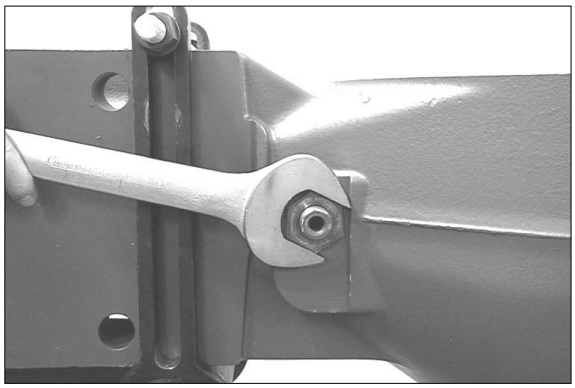
① Loosen hexagon nut.

※ Step (Figure 7577AAXF103~107) to be made on both sides.



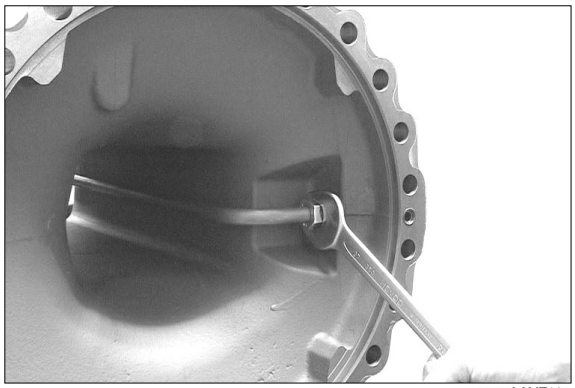
7577AAXF103

② Loosen union screw.



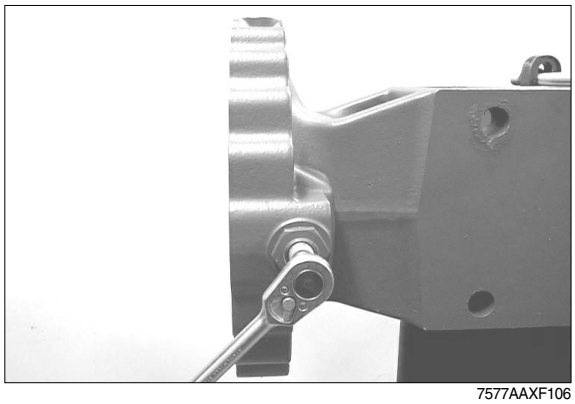
7577AAXF104

③ Loosen pipe union and remove released brake tube from the axle casing.



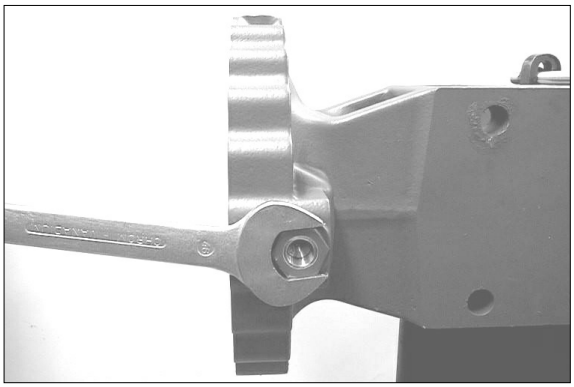
7577AAXF105

④ Remove vent valve from the connection part.



7577AAXF106

⑤ Loosen connection part and remove it from the axle casing.



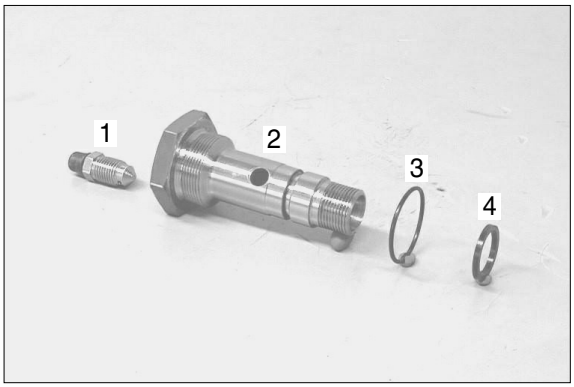
7577AAXF107

4) REASSEMBLY OF BRAKE TUBES AND DIFFERENTIAL CARRIER

(1) Reassembly of brake tubes

① Preassemble connection part as shown in opposite figure.

1 Vent valve
2 Connection part
3 O-Ring
4 Rectangular ring

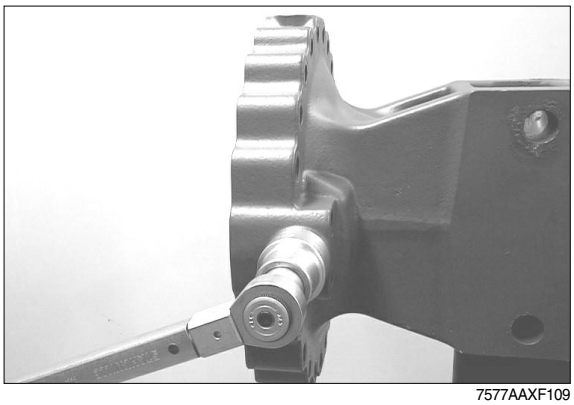


7577AAXF108

※ Step (Figure 7577AAXF108~114) is to be made on both output sides.

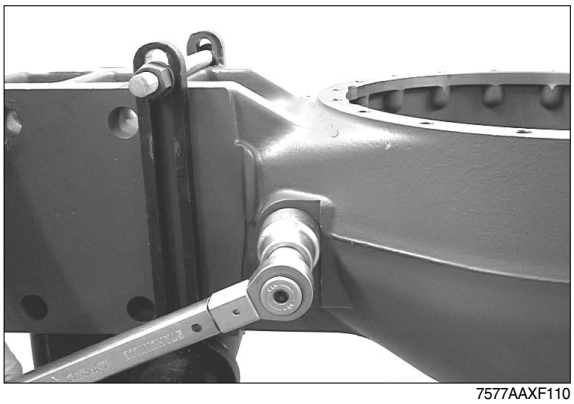
② Install connection part.

· Tightening torque : 13.3kgf · m (95.9lbf · ft)

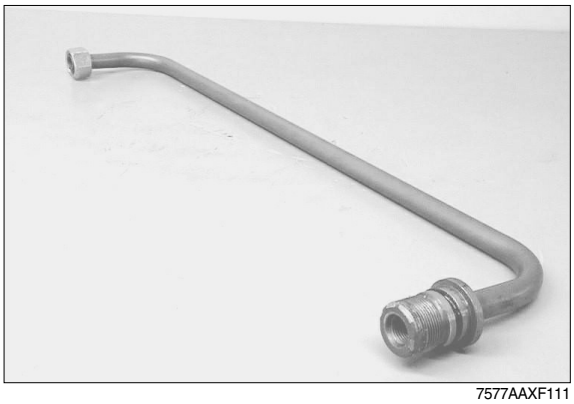

7577AAXF109

③ Provide union screw with new O-ring and install it.

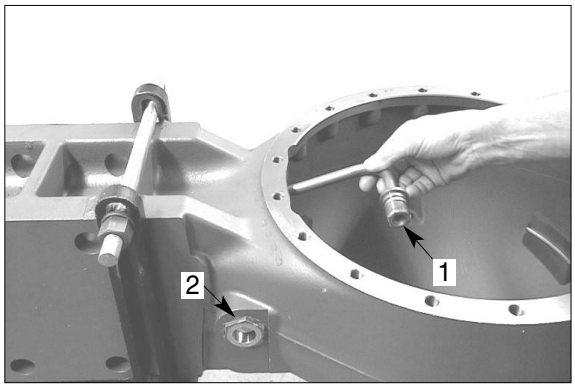
· Tightening torque : 15.3kgf · m (111lbf · ft)


7577AAXF110

④ Insert O-ring (see arrow) into the annular groove of the brake tube.


7577AAXF111

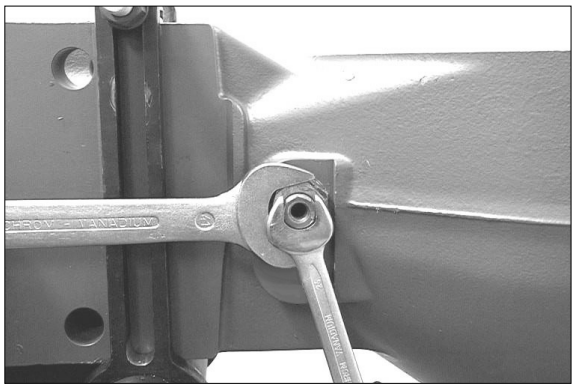
⑤ Insert brake tube into the axle casing, assembling the connection part (see arrow 1) through the union screw (see arrow 2).



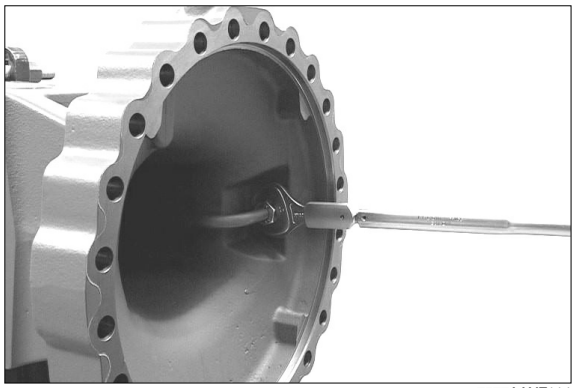
7577AAXF112

⑥ Fasten brake tube by means of hexagon nut and union nut (see below figure).

· Tightening torque : 10.2kgf · m (73.8lbf · ft)

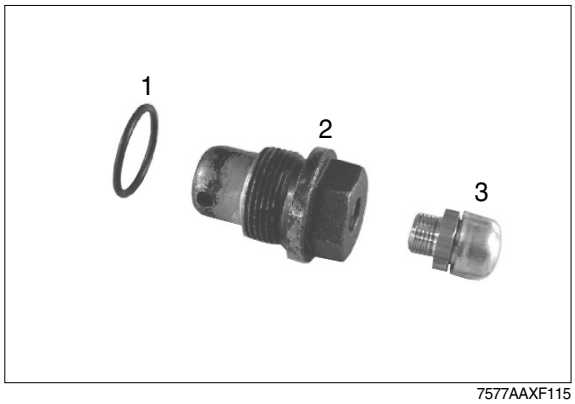

7577AAXF113

· Tightening torque : 8.2kgf · m (59lbf · ft)


7577AAXF114

⑦ Preassemble screw plug as shown in opposite figure.

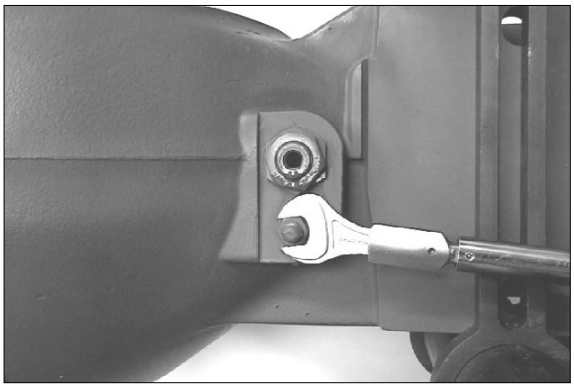
1 O-Ring
2 Screw plug
3 Vent valve



7577AAXF115

⑧ Install screw plug.

· Tightening torque : 7.1kgf · m
(51.6lbf · ft)



7577AAXF116

(2) Reassembly of differential carrier

※ If crown wheel or drive pinion are damaged, both parts have to be replaced together.
For new installation of a complete bevel gear set pay attention to the same pair number of drive pinion and crown wheel.

Determine shim thickness for a perfect tooth contact pattern

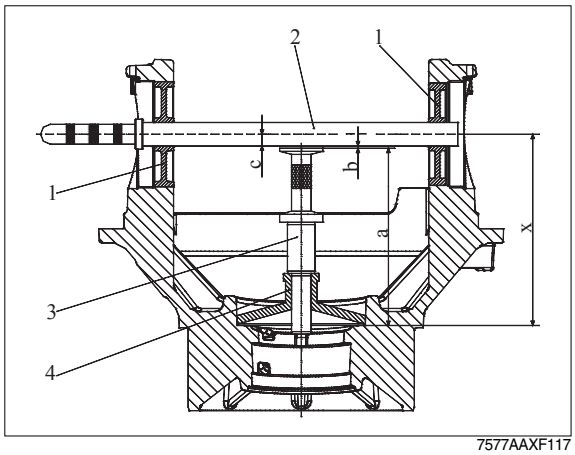
※ Make the following measuring steps at maximum accuracy.
Inexact measurements result in a faulty tooth contact pattern and require a repeated disassembly and reassembly of the drive pinion as well as of the differential.

① Install adapter pieces (1) and preliminarily fasten the bearing bracket by means of hexagon screws.

Then install stop washer (4) and measuring pin (3) and assemble measuring shaft (2) (see sketch).

※ Special tool

Adapter pieces	5870 500 044
Measuring shaft	5870 500 001
Measuring pin	5870 351 016
Stop washer	5870 351 027



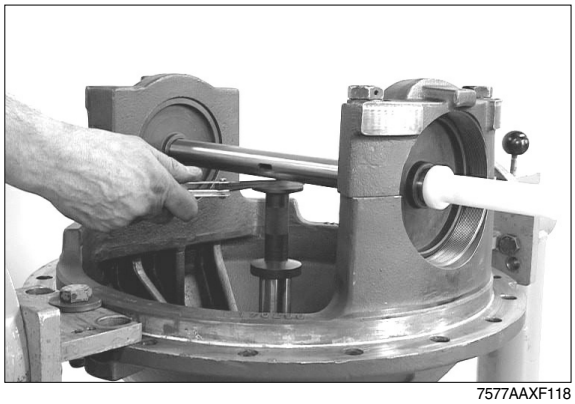
7577AAXF117

② Determine gap (dimension **b**) between measuring shaft and measuring pin by means of feeler gauge.

Dimension **b** e.g 0.25mm

EXAMPLE **A** :

Dimension **a** (= Measuring pin + stop washer) 190.00mm
Dimension **b** . . . . . + 0.25mm
Dimension **c** . . . . . + 15.00mm
results in dimension X = 205.25mm

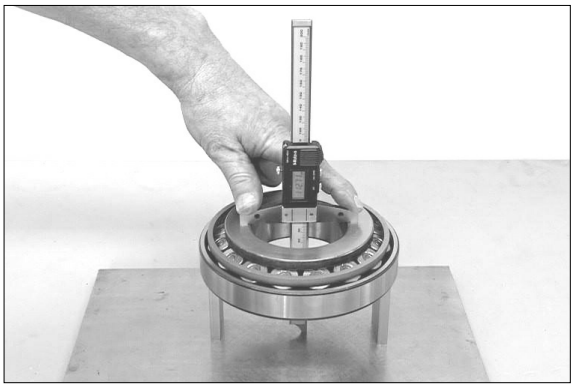

7577AAXF118

③ Determine dimension **I** (bearing width).

Dimension **I** e.g 36.00mm

※ Special tool

Digital depth gauge	5870 200 072
Gauge blocks	5870 200 066



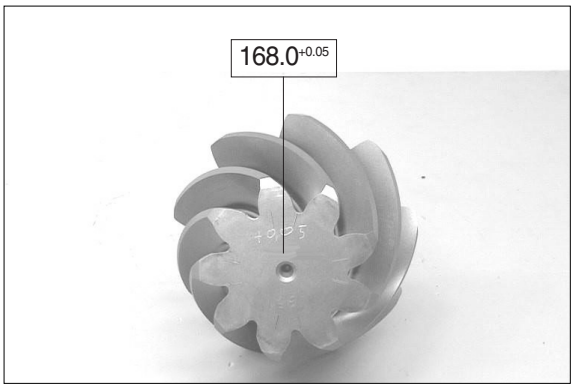
7577AAXF119

④ Read dimension **II** (dimension for pinion).

Dimension **II** e.g. 168.05mm

EXAMPLE **B** :

Dimension **I** 36.00mm
Dimension **II** . . . . . + 181.05mm
results in dimension Y = 204.05mm



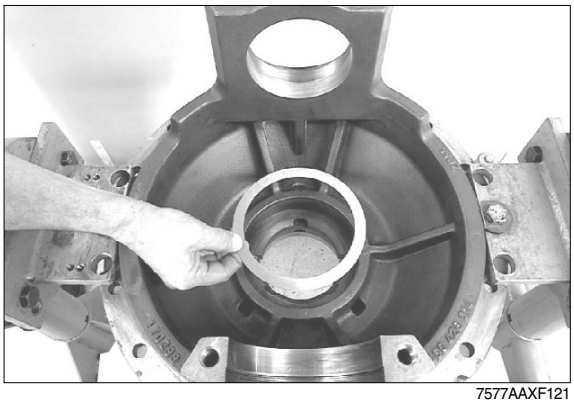
7577AAXF120

EXAMPLE **C** :

Dimension **X** 205.25mm
Dimension **Y** . . . . . - 204.05mm
Difference = shim e.g. s = 1.20mm

Install the drive pinion

⑤ Place determined shim e.g. s = 1.20mm into the bearing bore.

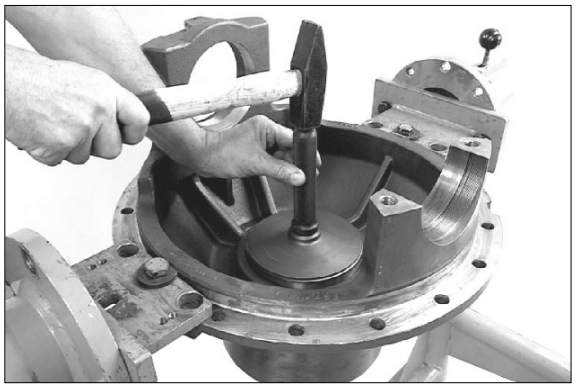


7577AAXF121

⑥ Undercool bearing outer ring and insert it into the bearing bore until contact.

※ Special tool

Driver	5870 058 060
Handle	5870 260 002



7577AAXF122

⑦ Undercool bearing outer ring on the input flange side and insert it until contact.

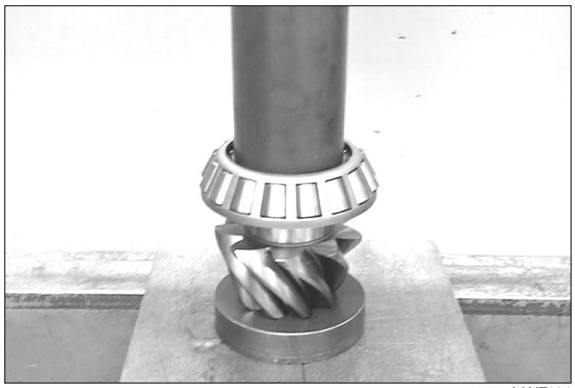
※ Special tool

Driver	5870 058 087
Handle	5870 260 002



7577AAXF123

⑧ Press bearing inner ring on the drive pinion until contact.

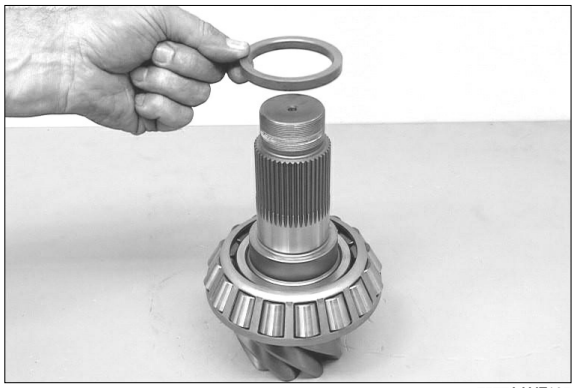


7577AAXF124

Adjust rolling moment of drive pinion bearing 0.15 ~ 0.31kgf · m (Figure 7577AAXF125~133) :

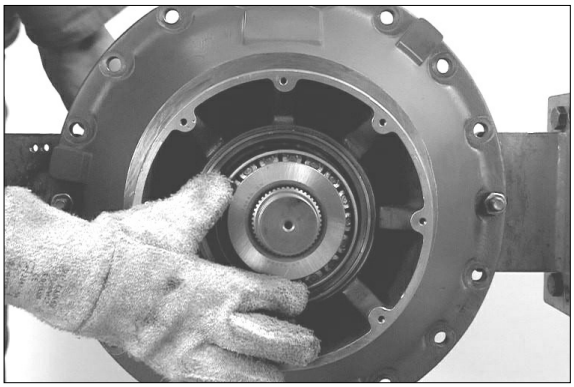
⑨ Assemble spacer ring (e.g. s = 8.70mm).

※ As per experience the required rolling moment is obtained by use of the spacer ring (e.g. s = 8.70mm) available at disassembly.
However, a later checking of the rolling moment is imperative.



7577AAXF125

⑩ Insert preassembled drive pinion into the axle drive housing and assemble the heated bearing inner ring until contact.

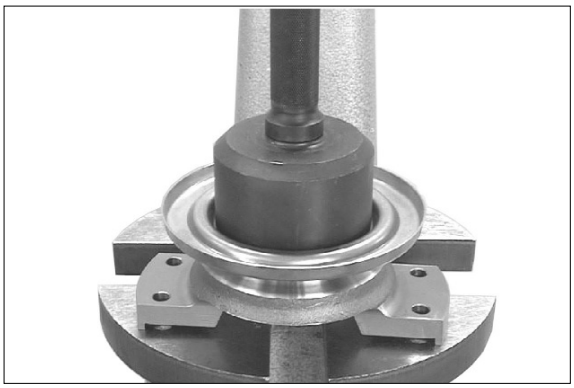


7577AAXF126

⑪ Press dust protection on the input flange until contact.

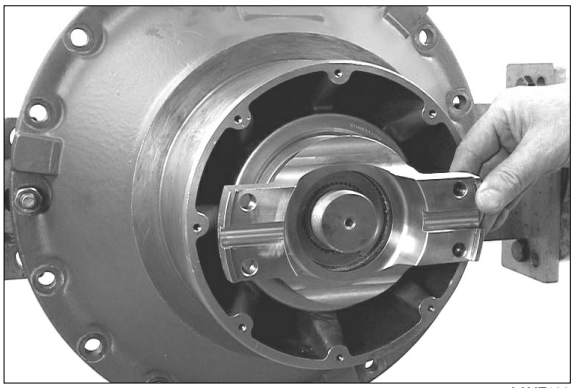
※ Special tool

Driver	5870 056 012
Handle	5870 260 002



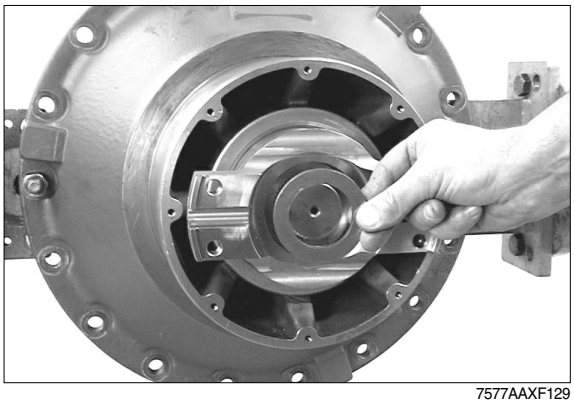
7577AAXF127

⑫ Assemble input flange.



7577AAXF128

⑬ Assemble washer.



7577AAXF129

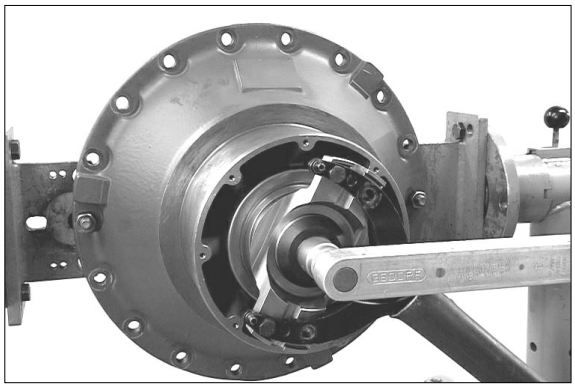
⑭ Unscrew hexagon nut by hand and tighten it.

· Tightening torque : 71.4kgf · m (516lbf · ft)

※ Special tool

Fixture 5870 240 002

※ When tightening rotate drive pinion in both directions several times.



7577AAXF130

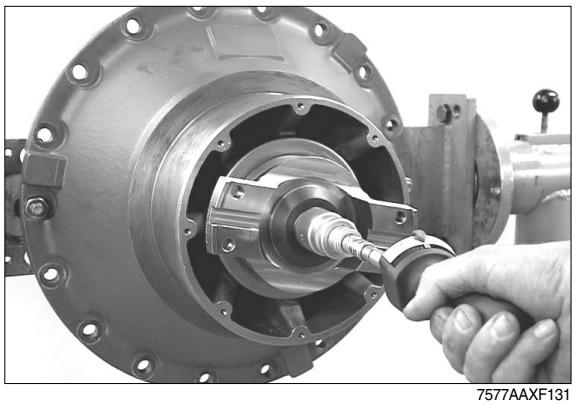
⑮ Check rolling moment (0.15~0.31kgf · m).

※ For new bearings it should be tried to achieve the max. value of the rolling moment.

⚠ If the required rolling moment is not obtained, correct it with an adequate spacer ring (Figure 7577AAXF125), according to the following indications :

Rolling moment too low - install a thinner spacer ring

Rolling moment too high - install a thicker spacer ring.



7577AAXF131

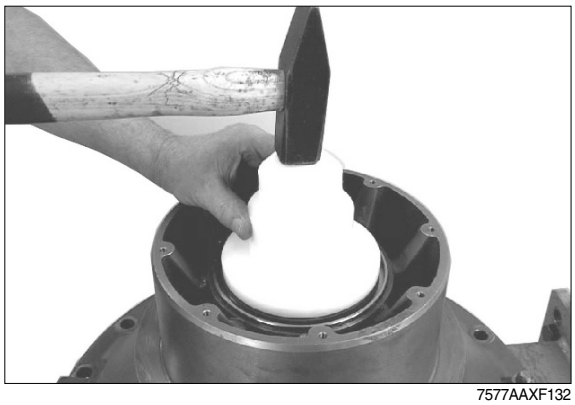
⑯ Then loosen the hexagon nut again and pull input flange from the drive pinion.

Install shaft seal with the sealing lip showing to the oil chamber (downwards).

※ Special tool

Driver 5870 048 225

※ The exact installation position of the shaft seal will be obtained by using the exact driver.



7577AAXF132

⚠ Just before the installation wet the outer diameter of the shaft seal with spirit and fill the space between sealing and dust lip with grease.

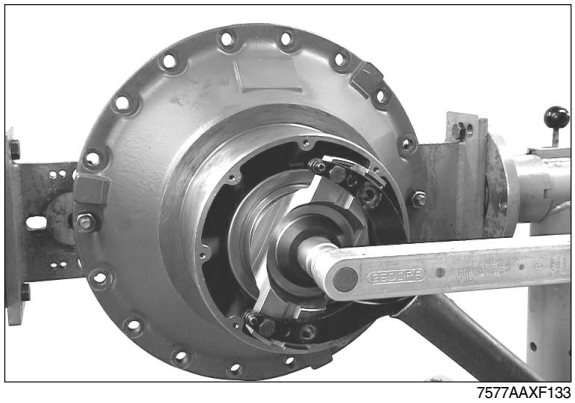
⑰ Assemble input flange and finally fasten it by means of washer and hexagon nut.

· Tightening torque : 71.4kgf · m(516lbf · ft)

※ Special tool

Fixture 5870 240 002

⚠ Apply Loctite (Type No. 262) onto the thread of the hexagon nut.

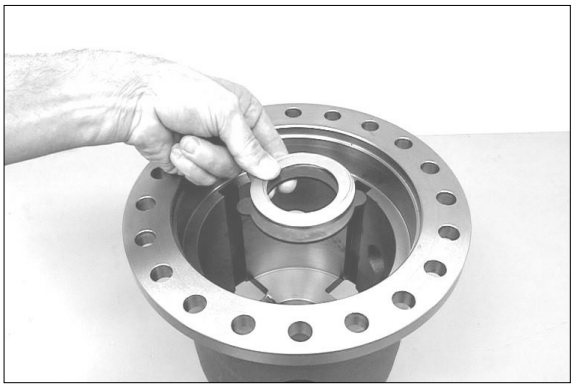


7577AAXF133

Reassembly of limited slip differential

⑱ Place both thrust washers into the differential housing.

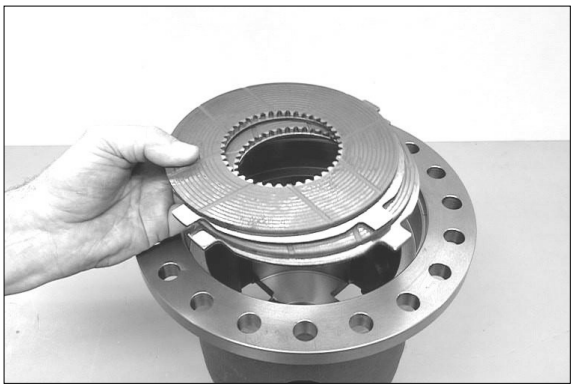
※ Prior to installation all single parts of the differential must be oiled.



7577AAXF134

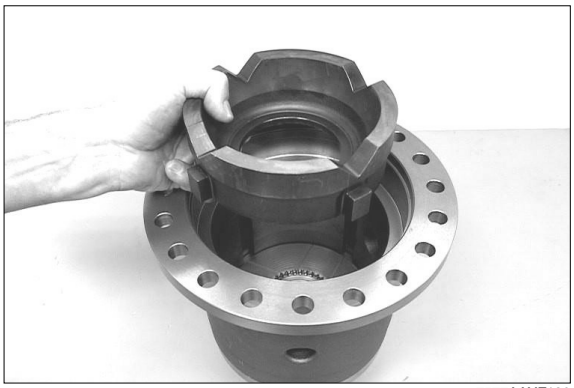
⑲ Starting with an outer clutch disc install alternately the outer and inner clutch discs.

⚠ Thickness of the disc pack must be identical on both sides.



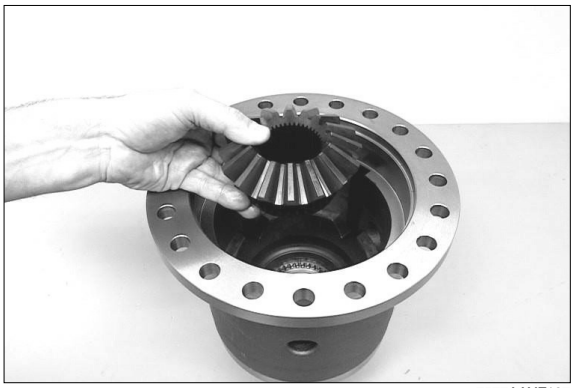
7577AAXF135

⑳ Put on the pressure ring.



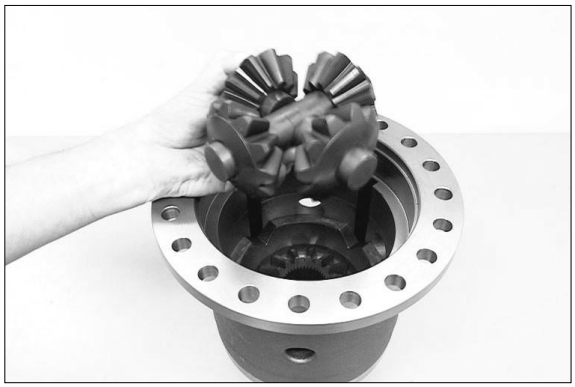
7577AAXF136

㉑ Insert axle bevel gear until contact and at the same time assemble all inner clutch discs with the spline.



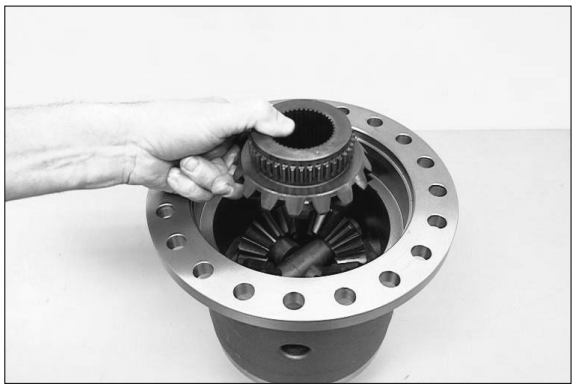
7577AAXF137

㉒ Preassemble differential spider and insert it into the differential housing.



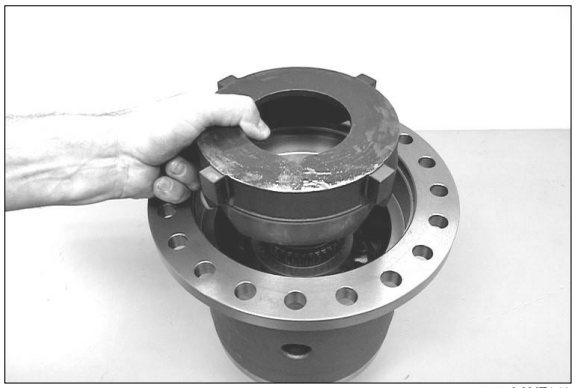
7577AAXF138

㉓ Put on the second axle bevel gear.



7577AAXF139

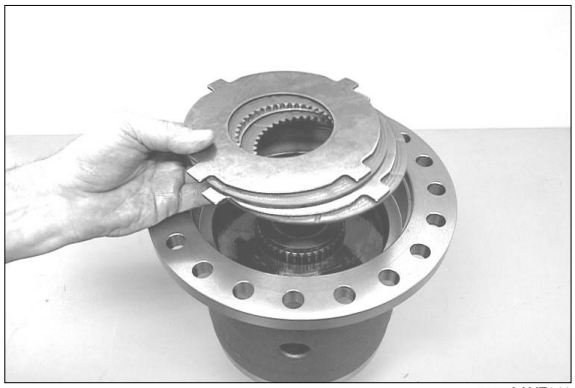
㉔ Insert the second pressure ring into the differential housing.



7577AAXF140

㉕ Starting with an inner clutch disc install alternately the inner and outer clutch discs.

⚠ Thickness of the clutch disc pack must be identical on both sides.



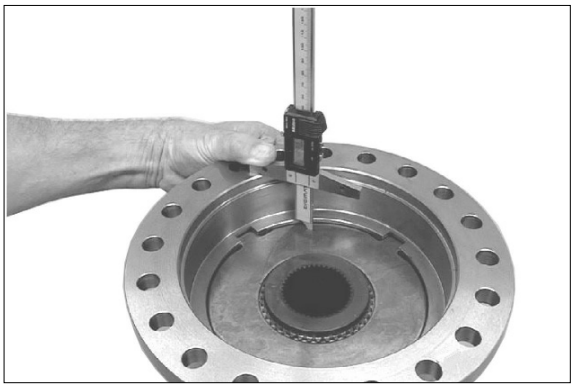
7577AAXF141

Determine disc clearance 0.2~0.8mm

㉖ Determine dimension **I**, from mounting face of the differential housing to plane face of the outer clutch disc.

Dimension **I** e.g 38.05mm

※ Special tool
Digital depth gauge 5870 200 072

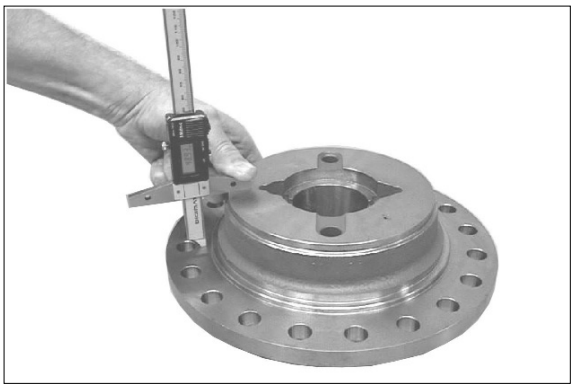


7577AAXF142

㉗ Determine dimension **II**, from contact surface of the outer clutch disc to the mounting face of the housing cover.

Dimension **II** e.g 37.75mm

EXAMPLE **D** :
Dimension **I** 38.05mm
Dimension **II** . . . . . - 37.75mm
Difference = Disc clearance = 0.30mm



7577AAXF143

※ If the required disc clearance is not obtained, correct it with the adequate outer clutch discs (s = 2.9, s = 3.0, or s = 3.3 mm), taking care that the difference in thickness between the left and the right disc pack must only be 0.01 at a maximum.

㉘ Fix both thrust washers with grease into the recess of the housing cover.



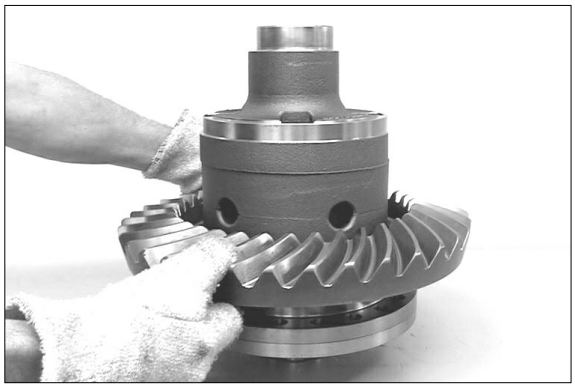
7577AAXF144

㉙ Put on the housing cover.

Then heat crown wheel and install it until contact.

※ Special tool

Adjusting screws	5870 204 040

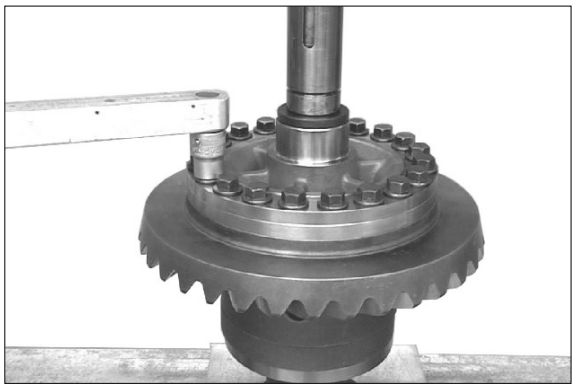


7577AAXF145

㉚ Fix differential by means of press and fasten crown wheel by means of **new** locking screws.

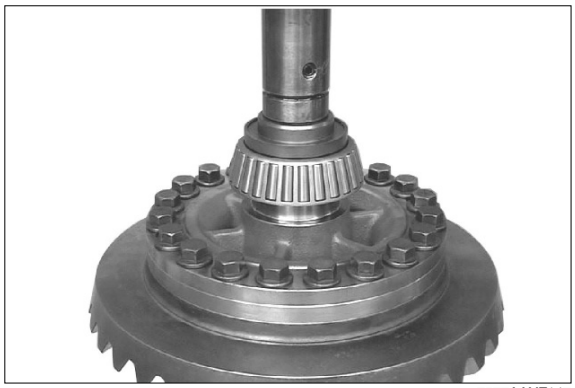
- Tightening torque : 41.8kgf · m (302lbf · ft)

⚠ **Only use of new locking screws is permissible.**



7577AAXF146

㉛ Press on both bearing outer rings until contact.

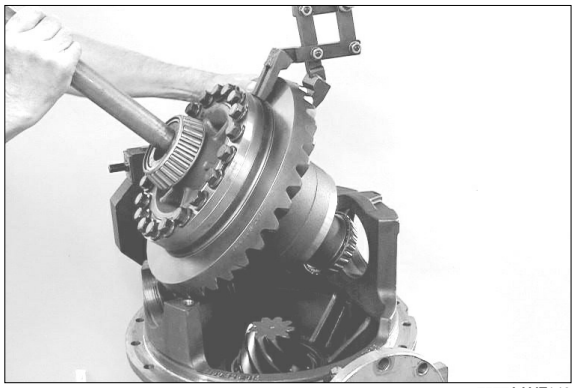


7577AAXF147

㉜ Insert differential into the axle drive housing by means of lifting tackle.

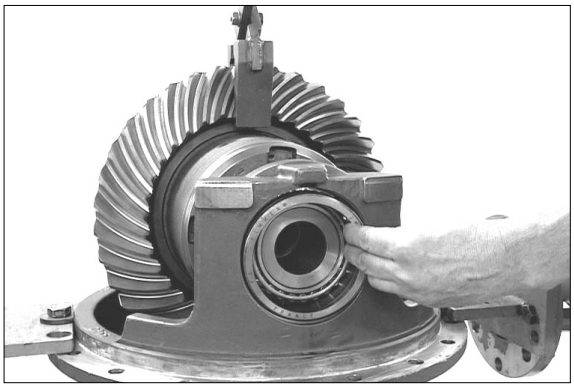
※ Special tool

Lifting tackle	5870 281 013



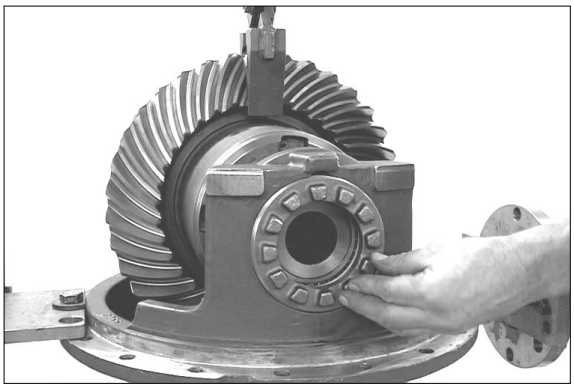
7577AAXF148

㉝ Place bearing outer ring into the axle drive housing.



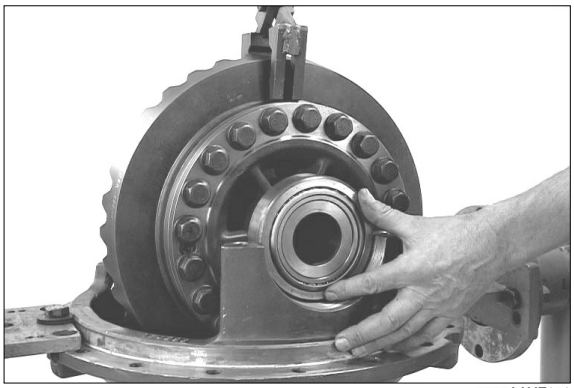
7577AAXF149

㉞ Preliminarily fix the bearing outer ring by means of adjusting nut.



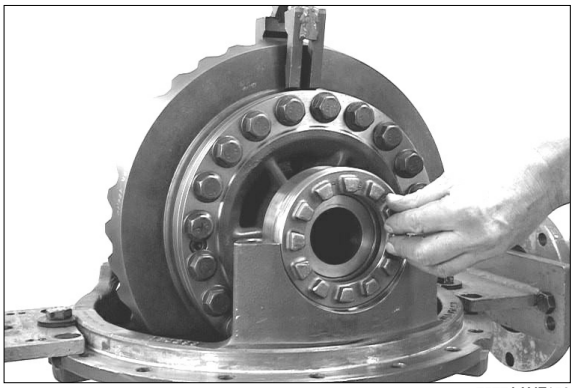
7577AAXF150

㉟ Install crown wheel-sided bearing outer ring.



7577AAXF151

㊱ Preliminarily fix the crown wheel-sided bearing outer ring by means of the second adjusting nut.



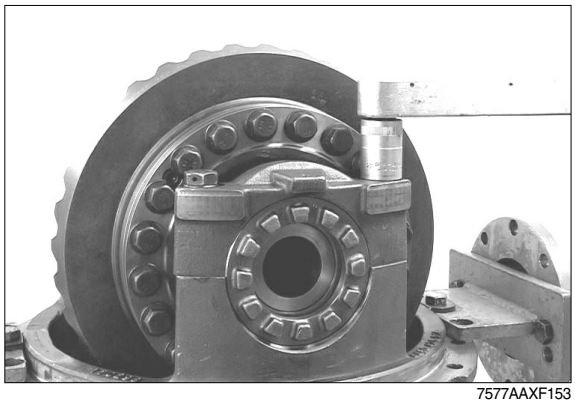
7577AAXF152

㊲ Put on bearing bracket and fasten it by means of hexagon screws and washers.

· Tightening torque (M16/10.9) :
28.6kgf · m(207lbf · ft)

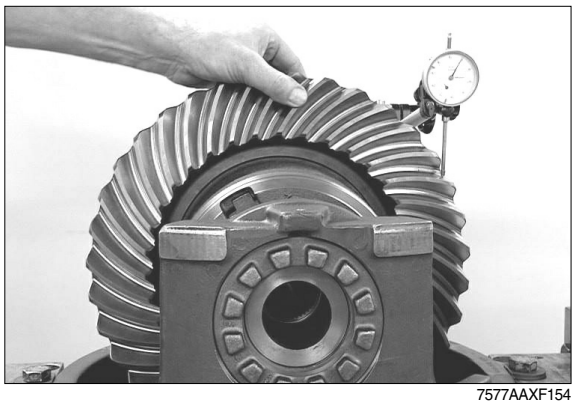
※ Pay attention to clearance of the adjusting nut.

⚠ **Apply Loctite (Type No. 262) onto threads of the hexagon screws.**


7577AAXF153

Adjustment of backlash and bearing preload

㊳ Place dial indicator right-angled at the outer diameter of the tooth flank (crown wheel).
Then install both adjusting nuts only to such an extent that the required backlash - see the value etched on the outer diameter of the crown wheel - is reached.


7577AAXF154

※ Special tool

Magnetic stand	5870 200 055
Dial indicator	5870 200 057

※ At this step rotate the differential several times.

㊴ Determine bracket width and correct it on both adjusting nuts, if required.

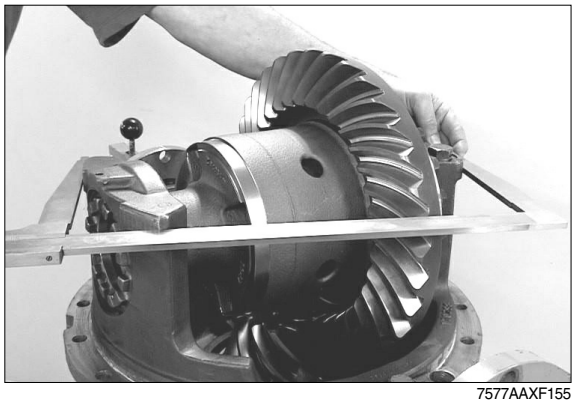
Bracket width . . . . . 367.90 $^{+0,05}$ mm

※ Special tool

Caliper gauge	5870 200 058

Then check backlash once again.

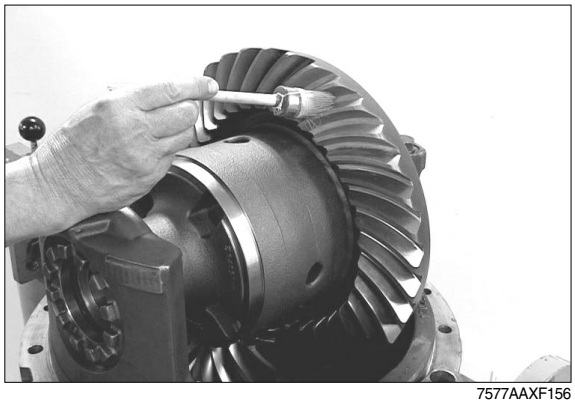
※ Adjusting of the bracket width results in the required bearing preload.


7577AAXF155

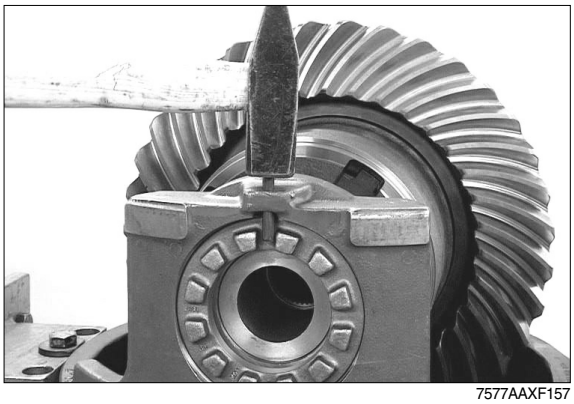
㊵ Cover some tooth flanks of the crown wheel with marking ink and roll crown wheel in both directions over the drive pinion.

Compare the obtained tooth contact pattern with the examples.

⚠ **If the tooth contact pattern differs, there has been a measuring error at determination of the shim (Figure 7577AAXF121/page 3-266), what is imperative to be corrected.**


7577AAXF156

㊶ Secure both adjusting nuts by means of slotted pins.



7577AAXF157

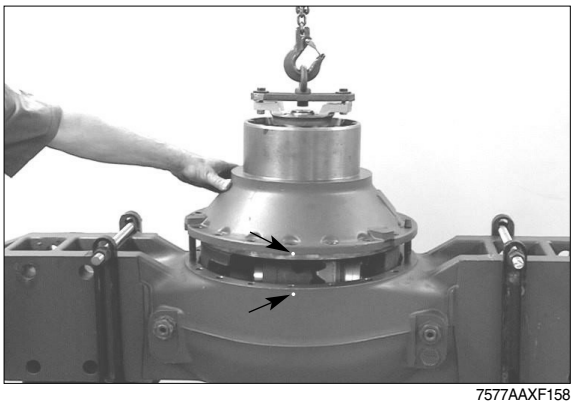
㊷ Install two adjusting screws and insert differential carrier into the axle casing until contact by means of lifting tackle.

※ Special tool

Adjusting screws	5870 204 022
Lifting tackle	5870 281 044

※ Observe radial location (see marking Page 3-254 / Figure 7577AAXF081).

⚠ Apply sealing compound (Three Bond Type 1215) on mounting face.

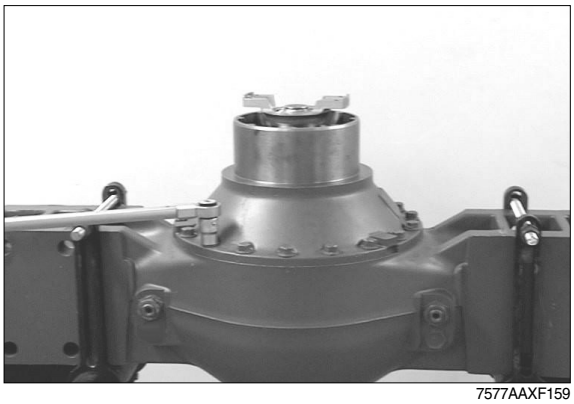


7577AAXF158

㊸ Fasten differential carrier by means of **new** locking screws.

· Tightening torque : 25.5kgf · m (184lbf · ft)

⚠ Only use of the new locking screws is permissible.

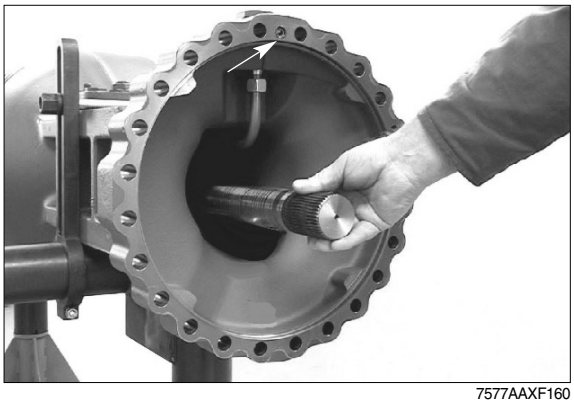


7577AAXF159

㊹ Insert stub shaft into spline of the axle bevel gear until contact.

Then fix O-ring (see arrow) by means of grease into the recess of the axle casing.

※ Step (Figure 7577AAXF160 ~ 163) is to be made on both output sides.



7577AAXF160

㊺ Thrust washer(s) removed at disassembly have to be fixed in the sun gear shaft by means of grease.

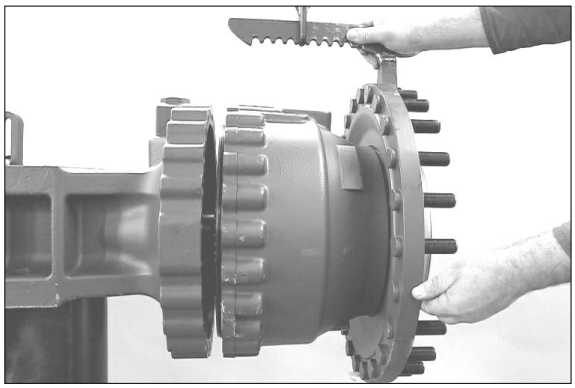


7577AAXF161

㊻ Place complete output by means of lifting tackle to the axle casing until contact.

※ Special tool

Lifting bracket 5870 281 043

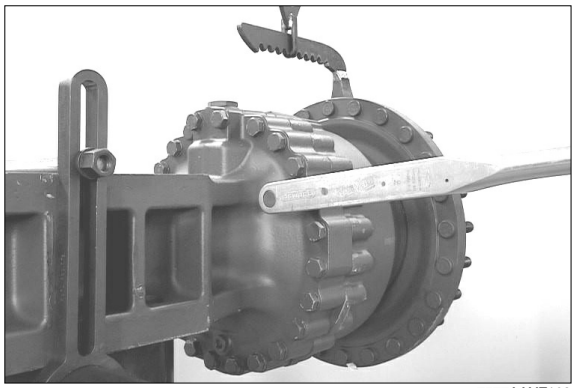


7577AAXF162

㊼ Fasten output by means of hexagon screws and washers.

· Tightening torque (M18/10.9) :
39.8kgf · m(288lbf · ft)

※ Prior to putting into operation of the axle, fill oil in accordance with lubrication instructions.



7577AAXF163

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

1. OPERATIONAL CHECKS

This procedure is designed so the mechanic can make a quick check of the system using a minimum amount of diagnostic equipment. If you need additional information, read **structure and function**, Group 1.
A location will be required which is level and has adequate space to complete the checks.

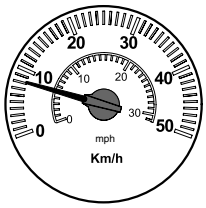
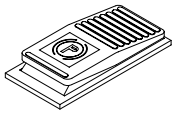
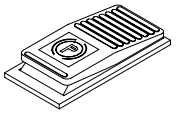
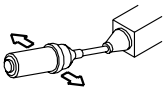
The engine and all other major components must be at operating temperature for some checks.

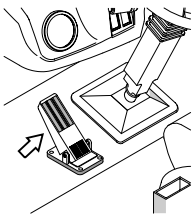
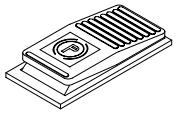
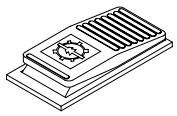
Locate system check in the left column and read completely, following the sequence from left to right. Read each check completely before performing.

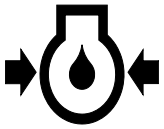
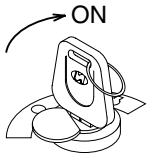
At the end of each check, if no problem is found(OK), that check is complete or an additional check is needed. If problem is indicated(NOT OK), you will be given repair required and group location.
If verification is needed, you will be given next best source of information:

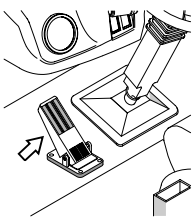
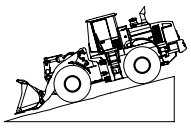
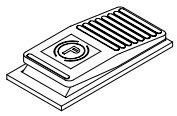
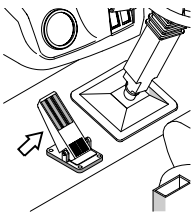
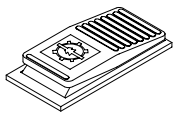
Chapter 2 : Troubleshooting
Group 3 : Tests and adjustments

※ Hydraulic oil must be at operating temperature for these checks(Refer to page 6-50).

Item	Description	Service action
Parking brake capacity check Seat belt must be worn while doing this check to prevent possible injury when machine stops suddenly.	 Start engine. Fasten seat belt. Release parking brake and put transmission in 2nd gear forward. Drive machine at 8 km/hr and switch parking brake ON. **LOOK/FEEL** : Machine must come to a stop within 2 meters(6 feet) when parking brake is engaged at 8 km/hr.  Transmission must shift to neutral.	**OK** Check completed. **NOT OK** Inspect parking brake. Go to group 3.
Parking brake transmission lockout check Engine running.	 Turn parking brake to ON. Place transmission in 1st forward. Slowly increase engine speed to high idle. **LOOK** : Machine must not move. 	**OK** Check completed. **NOT OK** Go to transmission control circuit in section 3.

Item	Description	Service action
Service brake pump flow check ※ Hydraulic oil must be at operating temperature for the check. Engine OFF.	 Stop engine. Operate brake pedal approximately 20 times. Start engine and run at low idle. Record number of seconds required for low brake pressure indicator lamp to go out.  **LOOK** : Indicator lamp must go out in less than 4 seconds from time engine starts. **NOTE** : Indicator will not come on approximately 1 second after starting engine.	**OK** Check completed. **NOT OK** Check for brake circuit leakage. Go to next page. **IF OK** Install a cap on line connected to inlet of brake valve and repeat pump flow check. If time does not decrease, check for worn brake pump. Go to brake pump flow test, in section 3.
Service brake capacity check Engine running.	Turn clutch cut-off switch OFF.  Apply service brakes, release park brake and put transmission in 2nd forward. Increase engine speed to high idle.  **LOOK** : Machine may not move or move at a very slow speed. Repeat check three times to ensure accurate results.	**OK** Check completed. **NOT OK** Check brake pressure in group 3. **IF OK** Inspect brake disk, see group 3.

Item	Description	Service action
Brake accumulator precharge check ※ The axles and hydraulic oil must be at operating temperature for this check.	 Start and run engine for 30 seconds. Stop engine and turn start switch to ON and wait 5 seconds. **NOTE** : Engine oil pressure lamp will be on due to no engine oil pressure.  Count the number of times the brake pedal can be fully depressed before the low brake pressure warning lamp comes ON. **LOOK** : Warning lamp must come on in 1-5 applications. Start engine and operate at low idle. Observe cluster while applying brake pedal with maximum force. **LOOK/LISTEN** : Brake pressure indicator must not come ON.	**OK** Check completed. **NOT OK** Make sure brake pedal is not binding and keeping brakes partially engaged. Bleed brakes in group 3. Check brake system pressure in group 3. **NOT OK** If light comes on with engine running, accumulator has lost it's charge. Inspect and recharge accumulator, group 3.
Brake system leakage check	 Start engine and wait 30 seconds. Stop engine. Wait 2 minutes. Turn start switch to ON and wait 5 seconds.  **LOOK** : Brake oil pressure warning lamp must not come on within 2 minutes after stopping engine.	**OK** Check completed. **NOT OK** If brake leakage is indicated with brakes released, check leakage at accumulator inlet check valve and brake valve. If brake leakage is indicated with brakes applied, check for leakage at brake valve and brake pistons. Check individual component leakage.

Item	Description	Service action
Service brake pedal check	 Slowly depress brake pedal. Listen for a hissing noise that indicates oil is flowing to brake pistons. **LISTEN/FEEL** : A hissing noise must be heard when pedal is depressed.	**OK** Check completed. **NOT OK** Inspect for debris under brake pedal. Inspect clutch cut-off linkage.
Service and parking brake system drag checks Engine running	 Position machine on gradual slope. Lower bucket approximately 50mm(2 in) from ground. Release parking and service brakes.  **LOOK** : Machine must move or coast. **NOTE** : If machine does not move, check brake pedals to be sure they fully release when feet are removed from pedals. Drive machine at high speed for about 5 minutes. Brake drag is indicated if brake areas in differential case are hot. **NOTE** : Observe parking brake. If disk is hot, parking brake drag is indicated.	**OK** Check completed. **NOT OK** Adjust park brake, go to group 3. **NOT OK** Check floor mat interference to pedal or debris build-up. **IF OK** Check for brake pressure when brake is released. Go to brake pressure test on group 3.
Clutch cut-off check	 Place clutch cut-off switch in ON position. Release parking brake. Run engine at half speed in 1st forward. Firmly depress brake pedal.  **FEEL** : Transmission must disengage when brake pedal is depressed at 30% of pedal stroke. **NOTE** : Clutch cut-off pressure switch can be adjusted to operator preference to match your loading needs.	**OK** Check completed. **NOT OK** Adjust clutch cut-off switch, see group 3.

2. TROUBLESHOOTING

1) SERVICE BRAKE

Diagnose malfunction charts are arranged from most probable and simplest to verify, to least likely, more difficult to verify. Remember the following steps when troubleshooting a problem :

Step 1. Operational check out procedure(See section 1)
Step 2. Operational checks(In this group)
Step 3. Troubleshooting
Step 4. Tests and adjustments(See group 3)

Problem	Cause	Remedy
Poor or no brakes	Brake accumulator charge low	Do brake accumulator check.
	Brake pump standby pressure low	Do brake pump standby pressure test.
	Brake pressure low	Do brake valve pressure test.
	Air in system	Bleed brakes.
	Worn brake surface material	Inspect brake surface material.
	Leakage in brake valve	Do brake valve leakage test.
	Leakage in brake piston seal	Check for an over filled differential. Apply brakes and check for leakage from check plug. ※ **It is normal for the oil level to be slightly above the check plug.**
Aggressive brakes	Internal restriction in circuit	Remove lines and components.
	Clutch cut-off switch out of adjustment	Adjust switch.
	Brake valve malfunction	Disassemble and inspect.
	Low oil level	Check oil level.
Brakes drag	Brake pedal not returning properly	Inspect floor mat and pedal.
	Debris holding valve partially open in brake valve	Do brake valve pressure test.
	Warped brake disk	Inspect brake disk.
	Stuck brake piston	Repair.
Brakes lock up	Brake valve malfunction	Clean or replace brake valve.

Problem	Cause	Remedy
Brakes chatter	Air in brake system	Do brake bleed procedure.
	Worn brake surface material	Inspect brake surface material.
	Wrong oil in differential	Drain. Refill.
Hissing noise when brake pedal is held with engine stopped	Leakage in brake valve, or brake piston	Do brake system leakage test.
Brake pressure warning light will not go out or stays on excessively long after start-up	Malfunction in brake low pressure warning switch	Replace switch.
	Brake accumulator pressure too low	Recharge accumulator.
	Low brake pump standby pressure setting.	Do brake pump standby pressure test.
	Leakage in pressure reducing manifold block	Do pressure reducing valve manifold leakage test.
	Leakage in brake system	Do brake system components leakage tests.
	Worn brake pump	Do brake pump flow test.
	Leakage in parking brake solenoid	Do parking brake pressure test.

2) PARKING BRAKE MALFUNCTIONS

Problem	Cause	Remedy
Brake will not hold	Pads not adjusted correctly	Adjust parking brake.
	Malfunctioning parking brake solenoid	Inspect and replace.
	Worn brake disk and / or brake pads	Disassemble, inspect, repair.
	Brake piston hangs up in bore	Remove and inspect. Repair.
Brake disk overheats	Pads out of adjustment	Adjust parking brake.
	Brake not released	Release parking brake. Disassemble, inspect brake. Repair if necessary. Inspect for loosen or broken lines between brake pressure switch and indicator on dash.
Parking brake indicator in monitor does not come on when brake applied	Faulty wiring or switch	Inspect for loose or broken lines between brake pressure switch and indicator on dash. Inspect for a faulty indicator on dash. Replace if necessary.
Brake will not apply	Pads out of adjustment	Adjust parking brake.
	Malfunctioning wiring, switch, or solenoid	Check electric circuit.
	Restriction between brake valve and brake	Remove hose and inspect. Replace.

1. PARKING BRAKE PERFORMANCE

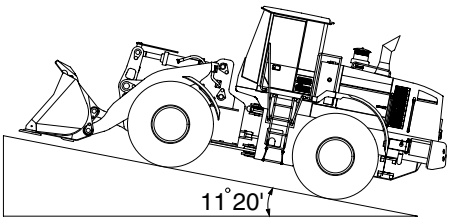
1) MEASUREMENT CONDITION

(1) Tire inflation pressure : Specified pressure

(2) Road surface : Flat, dry, paved surface with 1/5(11°20') gradient.

(3) Machine : In operating condition

Item	Standard valve
Parking brake performance	Keep machine on 20% (11°20') gradient



7707ABS16

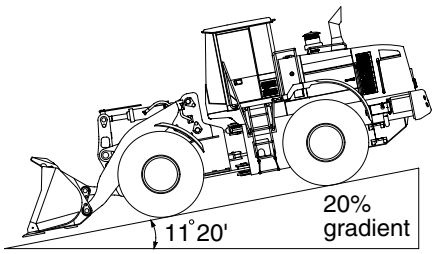
2) MEASURING PROCEDURE

(1) Start the engine and drive the machine straight up a 1/5 gradient with the bucket unloaded.

(2) Depress the service brake, place the gear selector lever in neutral, then stop the engine.

(3) Turn the parking brake switch ON, then slowly release the service brake pedal and the machine must be kept stopped.

※ **The measurement must be made with the machine facing either up or down the slope.**

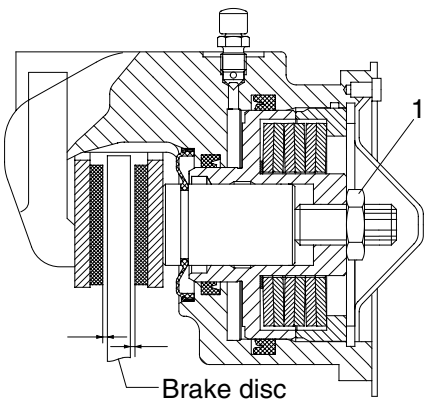


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2. EXTERNAL BRAKE INSPECTION

Inspect for wear of brake pad.

Adjust the gap(each 0.125~0.25㎜)by adjust nut(1).



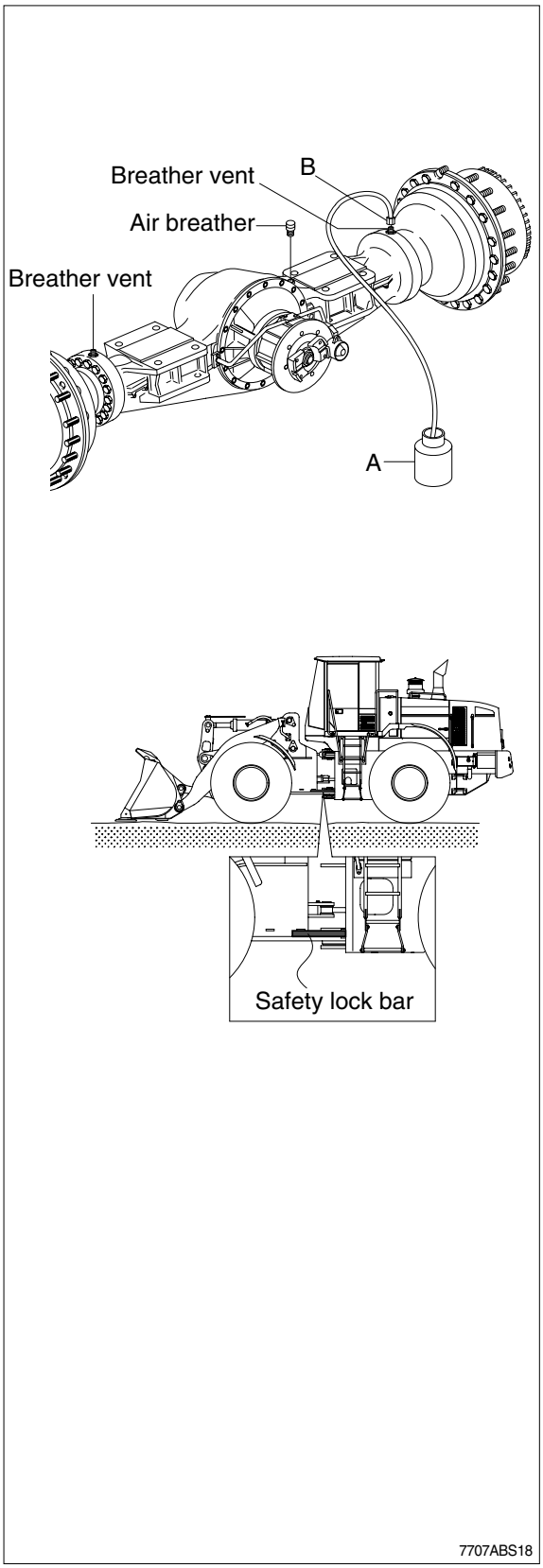
7707ABS26

3. HYDRAULIC BRAKE BLEEDING PROCEDURE

⚠ **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.

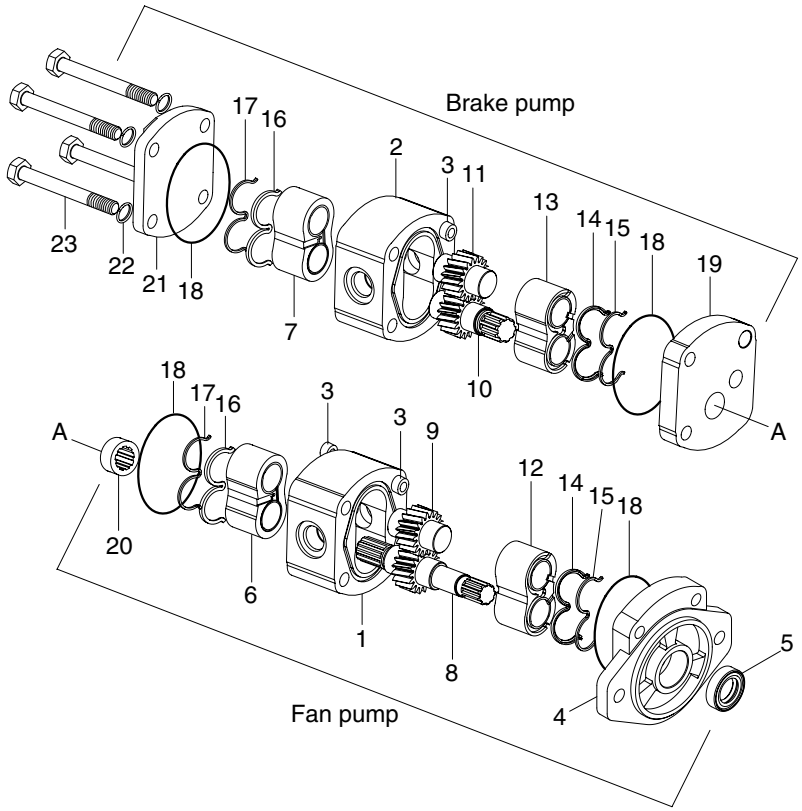
※ **If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result.**
Doctors unfamiliar with this type of injury should reference a knowledgeable medical source.
Two people are required to bleed brake system oil, one to operate brake valve and other to open and close bleed screws.

1) Install frame locking bar. Engage parking brake.
2) Put a clear plastic tube on bleed screw(B) to route low to hydraulic oil tank filler tube or container(A).
3) Start engine and run at low idle.
4) Push and hold brake pedal down until brake bleeding procedure is complete.
   ※ **If bubbles continue for more than 2 minutes, stop bleeding procedure.**
   Check for and correct problem, then continue.
5) Open on bleed screw on differential and axle assembly until hydraulic oil starts to flow. Close bleed screw when oil is free of air. Release brake pedal.
6) Repeat steps 1)~5) for each bleed screw.
7) Push either brake pedal and hold down.
8) Check hydraulic oil level.



1. BRAKE PUMP

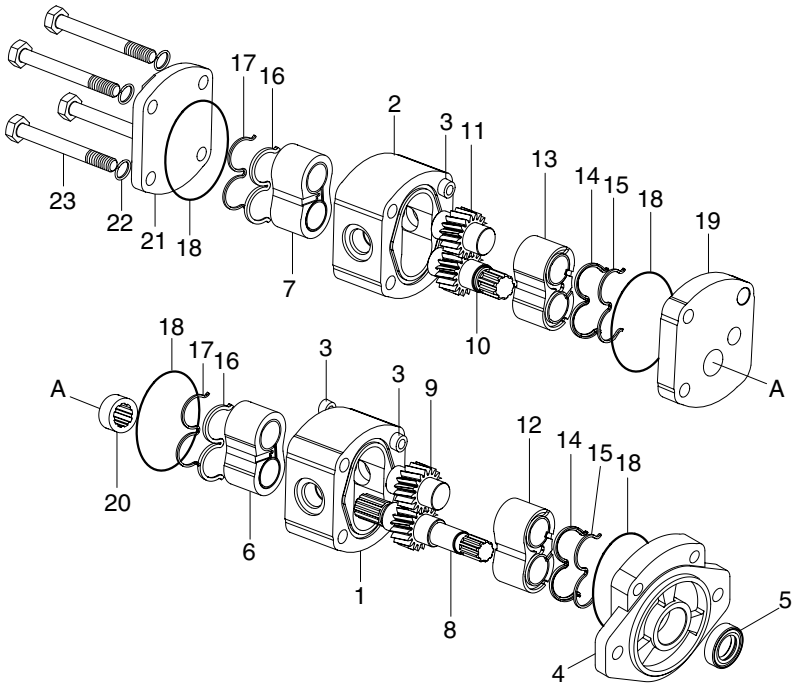
1) STRUCTURE



7707BS19

1	Body	9	Driven gear	17	Backing ring
2	Body	10	Driver gear	18	Body O-ring
3	Dowel pin	11	Driven gear	19	Intermediate plate
4	Front cover	12	Bushing	20	Coupling
5	Shaft seal	13	Bushing	21	Rear cover
6	Bushing	14	Bushing seal	22	Spring washer
7	Bushing	15	Backing ring	23	Screw
8	Driver gear	16	Bushing seal		

2) DISASSEMBLY



7707BS25

※ Before disassembling ensure that the unit itself, bench and tools are thoroughly clean.

(1) Lightly mark the rear cover(21), body(2) and plate(19) to ensure reassembly in the correct position.

(2) Remove the bolts(23) and separate the brake pump unit from the fan pump using a soft faced hammer.

(3) Remove splined coupling(20).

(4) Remove the plate(19) from the body(2), free from plate using a soft faced hammer.

(5) Remove the backing ring(15), the seal element(14) and the body O-ring(18).

(6) Remove the rear cover(21) from the body(2).

(7) Remove the backing ring(17), the seal element(16) and the body O-ring(18).

※ Before removing the internal components each bushing(7, 13) must be marked to denote its location within the body. On the plain area of the bush away from the seal location, lightly mark.

(8) With the unit laying on its side grasp hold of the drive shaft(10) and pull it squarely out of the body(2) bringing the bushing(13) with it.

(9) Remove the driven gear(11) and the remaining bushing(7).

3) INSPECTION AND REPAIR

(1) Assessment

Each components should be thoroughly cleaned, carefully examined and assessed for suitability re-use. Below is a guide for inspecting the various components.

(2) Body

① Inspect the body bore cut-in where both gears wipe into the body.

② The body can only be re-used if the **cut-in** is bright and polished in appearance and the depth does not exceed 0.15㎜(0.006").

③ The body should be replaced if the surface is scored, has a matt appearance or shows signs that the tip of the gears have dug in and torn away the surface material.

④ The body should be inspected to ensure that there is no superficial damage which may adversely effect performance or sealing. Pay particular attention to the port threads and body O-ring seal recesses.

(3) Plate and cover

① The inner surfaces should be inspected to ensure that there is no unusual wear or scoring in the regions where the body O-rings and backing rings contact, which result in external leakage.

② Check the shaft seal recess for scoring or damage that could result in oil leakage around the outer diameter of the shaft seal. Replacement shaft seals can be refitted with Loctite hydraulic sealant to overcome slight damage in this area.

(4) Bushes

① The side faces which abut the gears should be perfectly flat showing no sign of scoring. Characteristically there are bright polished areas on this surface caused by loading against the gear side faces, which is often more pronounced on the low pressure side. The bush should be replaced if there is any general scoring or fine scoring with a matt appearance or tearing of the surface material. Often there is a witness where the tips of the opposing gears have wiped an overlap reassembling a half moon shape. There must be no noticeable wear step as it is critical that the bush side face is completely flat to the gear side face.

② The bearing liners are acceptable providing that they are not scored or show other damage. The general outside area of the bush should not show any prominent signs of wear.

(5) Gears

① The gear side faces should be examined for bruising or scoring. Often operation on contaminated fluid shows scoring between the root of the gear and the journal undercut, which leaves a wear step. If a wear step can be felt, coincidental with the root diameter, by drawing a sharp pointed tool across the surface from the undercut outwards towards the tip of the gear, then the gear is unserviceable.

② The gear teeth should then be carefully examined to ensure that there are no signs of bruising or

③ pitting.

The journal bearing surfaces should be completely free from scoring or bruising. The surface

④ should appear highly polished and smooth to touch.

Examine the area where the shaft seal lips run on the drive shaft, this shows up as a polished

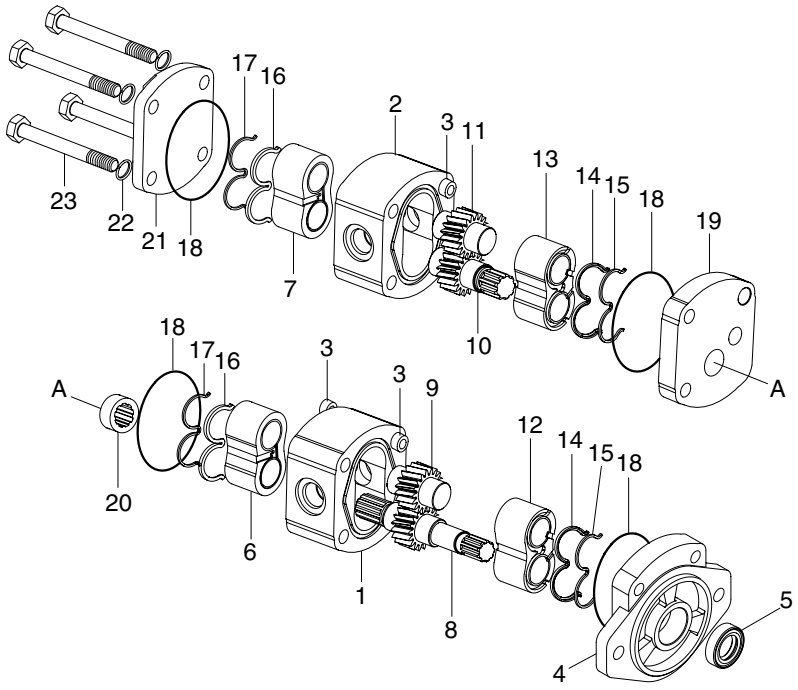
⑤ ring or rings. If a noticeable groove can be felt or there is scoring the shaft should be replaced.

Provided the drive shaft is not damaged from the drive-coupling and the gears have not been harmed as described above, then the gears can be re-used. If, however, the gears are

⑥ damaged they must be replaced as a matched pair.

As a matter of good practice, when pumps have been disassembled, all the seals should be

4) ASSEMBLY



7707BS25

※ Ensure that all parts are perfectly clean and lightly lubricate the bushes and gears with hydraulic oil(Ensure body O-ring recess and end faces remain free from oil). This will assist with their assembly when they are later fitted into the body.

(1) Refit the bushing(7) into the undowelled end of the body(2) from where they were removed.

(2) Place the rear cover(21) against the body(2) and then stand the assembly on the cover so that the hollow dowels are uppermost, i.e. the bushing should be at the bottom with the bushings against the cover.

(3) Fit the drive shaft(10) and driven gear(11) back into their original positions in the body(2).

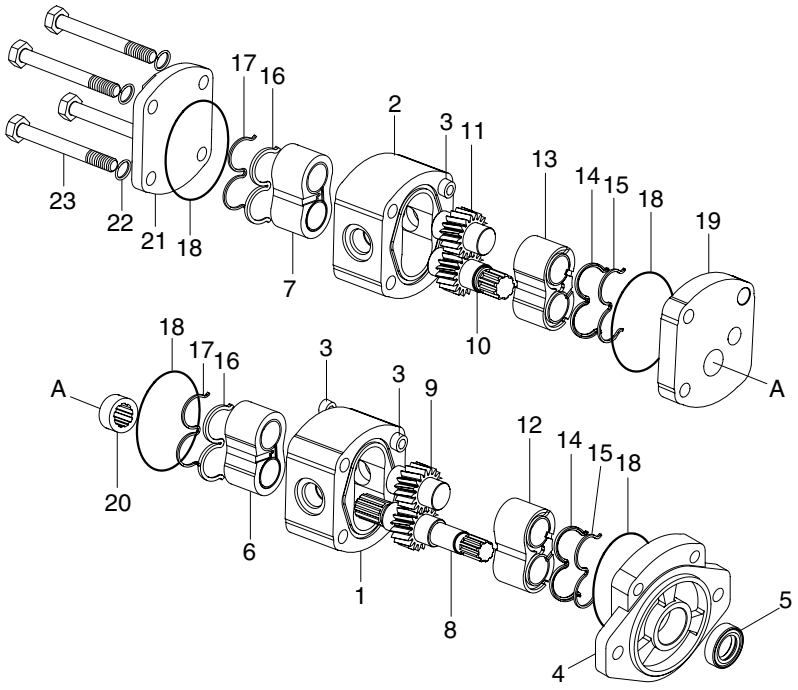
(4) Refit the plate bushing(13) into their original bores.

(5) Fit the new body O-ring(18).

(6) Fit the new seal element(14) and backing ring(15) to the bushing.

(7) Carefully refit the plate(19) to the body(2). If the plate(19) is not fitted squarely the backup seal(14) may become misplaced and trapped, resulting in internal damage if the unit is run in this condition.

ASSEMBLY



7707BS25

(8) Fit coupling(20) to the plate(19).

(9) Holding the whole unit together carefully turn it over, making sure it is supported on the spacer plate(19) not the shaft.

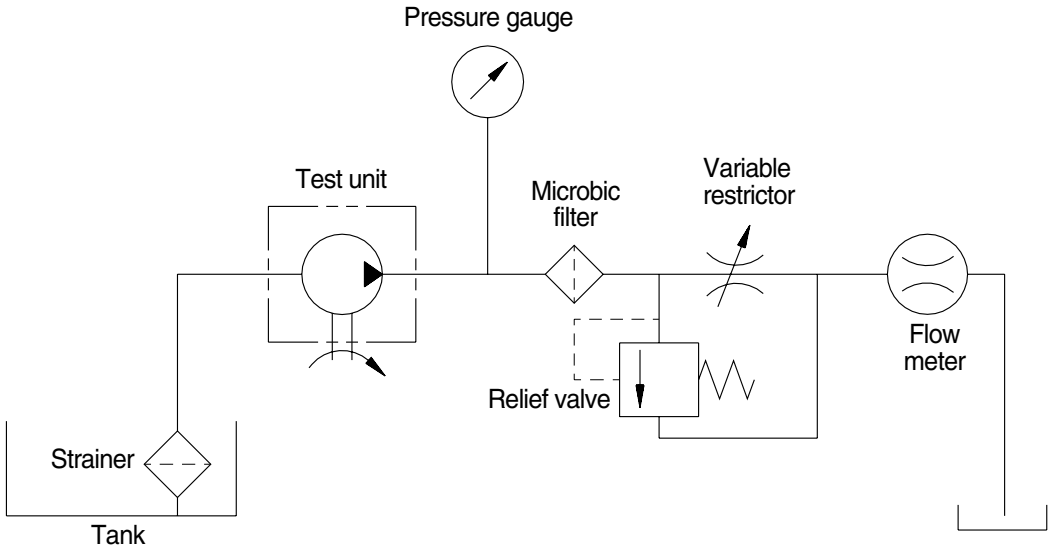
(10) Slide off the rear over and fit seals as in(5) and (6) above.

(11) Fit the rear cover(21), taking care not to dislodge the backup seal(16) and bolt(23) the unit together.

· Tightening torque : 4.8kgf · m(35lbf · ft)

※ Pour a small amount of oil into a port and check that the shaft can be rotated without undue force using a smooth jawed hand wrench hooked around the shaft or a suitable half coupling locked against the key.

5) RUNNING-IN



(730TM-3C) 4-48

(1) A unit which has been re-assembled with either new gears, bushes or body, must be carefully run-in before it is subjected to full working conditions.

(2) Ideally this should be done on a test rig(See figure) where pressure can be gradually applied and any wipings from the body cut-in arrested by filters.

(3) It is recommended that the unit is run-in at 1500rpm, initially, at zero pressure for one minute then in stages with the pressure increased by 500psi every minute, until maximum rated pressure has been attained. Frequently check the system temperature, ensuring that it does not exceed the maximum permissible figure of 80°C. If the temperature exceeds the system or unit specification the test must be delayed and operated off-load until acceptable temperatures are obtained.

SECTION 5 STEERING SYSTEM

Group 1 Structure and Function ····· 5-1
Group 2 Operational Checks and Troubleshooting ····· 5-15
Group 3 Tests and Adjustments ····· 5-23
Group 4 Disassembly and Assembly ····· 5-30

SECTION 5 STEERING SYSTEM

GROUP 1 STRUCTURE AND FUNCTION

1. OUTLINE

The steering system of this machine consists of a fixed-displacement pump supplying a load sensing steering system and an open center loader system.

The components of the steering system are :

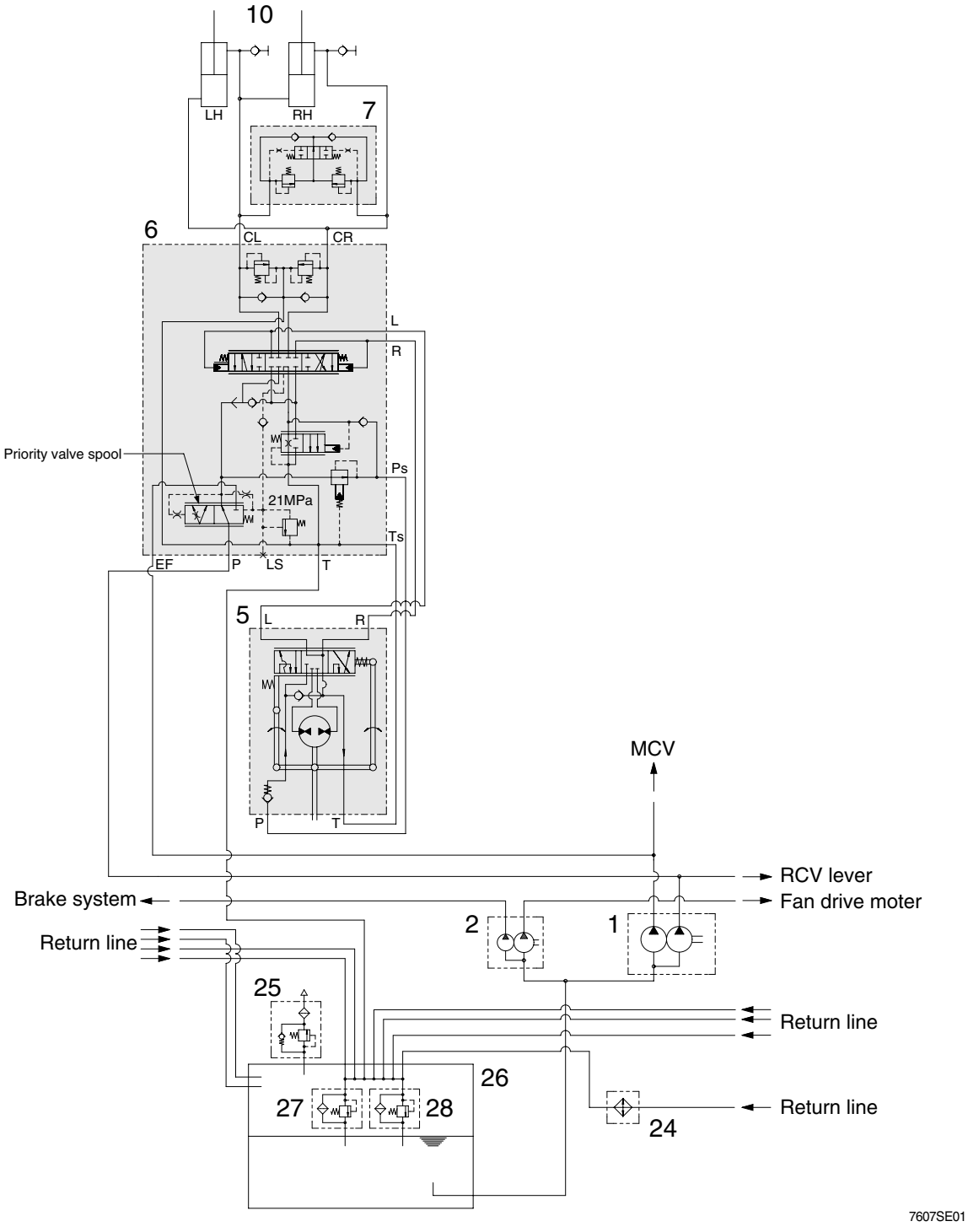
- Steering pump
- Steering valve(EHPS)
- Steering unit
- Cushion valve
- Steering cylinders

The steering pump, the first pump of main pump, draws hydraulic oil from the hydraulic tank.
Outlet flow from the pump flows to the priority valve of steering valve. The of steering valve preferentially supplies flow, on demand, to the steering unit. When the machine is steered, the steering unit routes flow to the steering cylinders to articulate the machine.

When the machine is not being steered, or if pump flow is greater than steering flow, the priority valve supplies flow to the loader system.

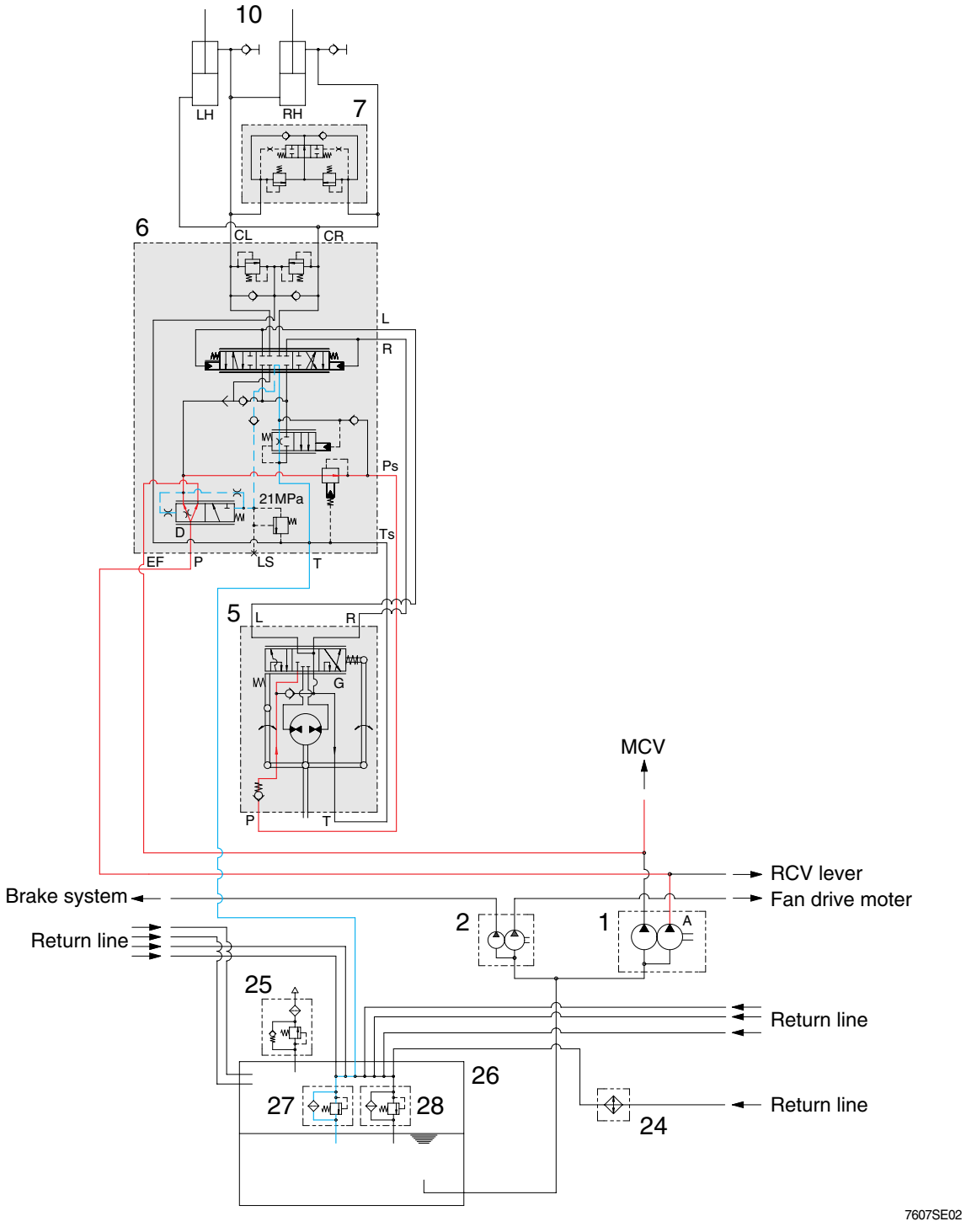
That is, output flow from the steering pump enters into the second pump of main pump for the operation of the attachment.

2. HYDRAULIC CIRCUIT



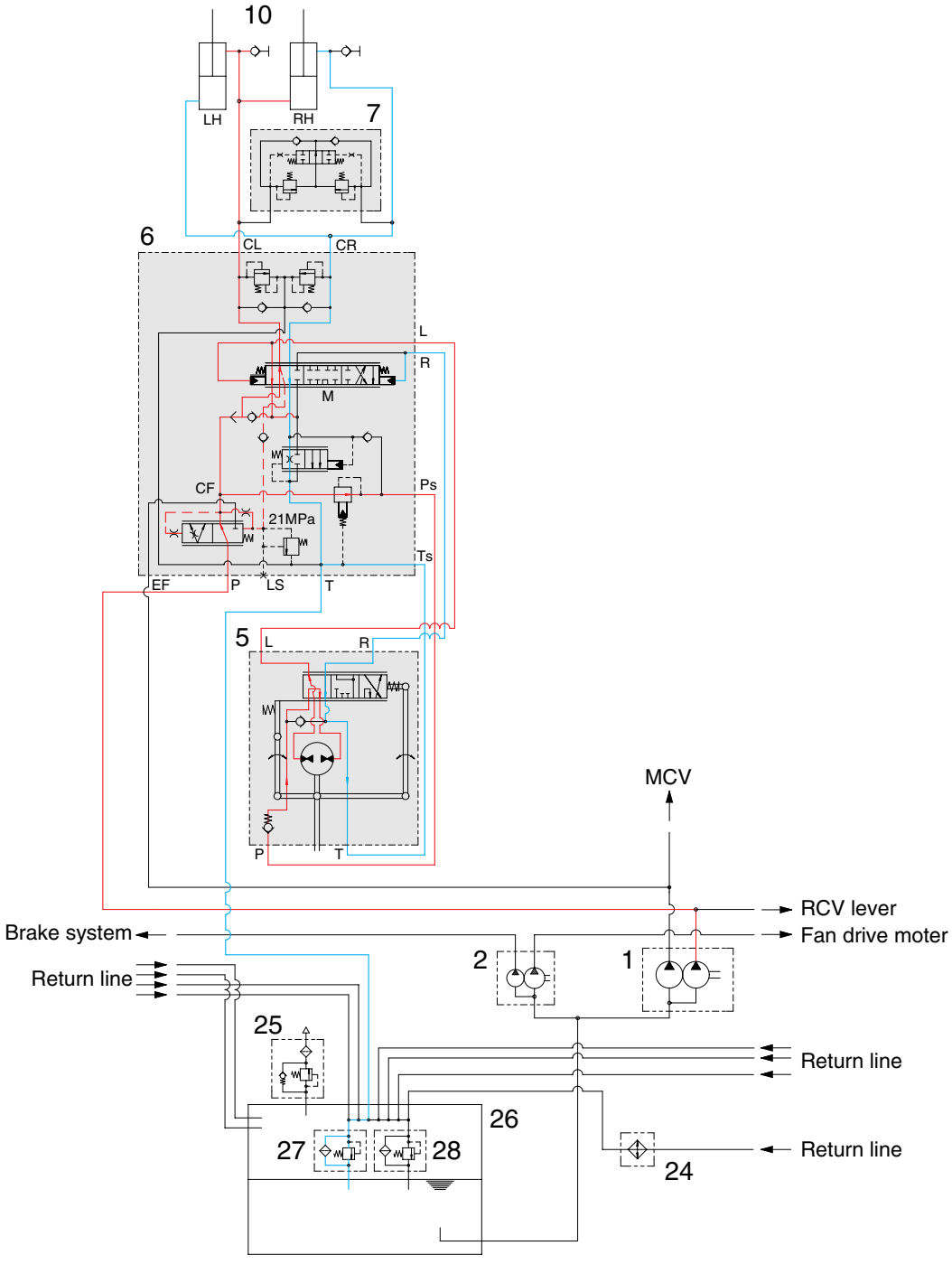
1	Main pump(Steering)	24	Oil cooler
2	Fan & brake pump	25	Air breather
5	Steering unit	26	Hydraulic tank
6	Steering valve(EHPS)	27	Return filter
7	Cushion valve	28	Bypass valve
10	Steering cylinder		

1) NEUTRAL



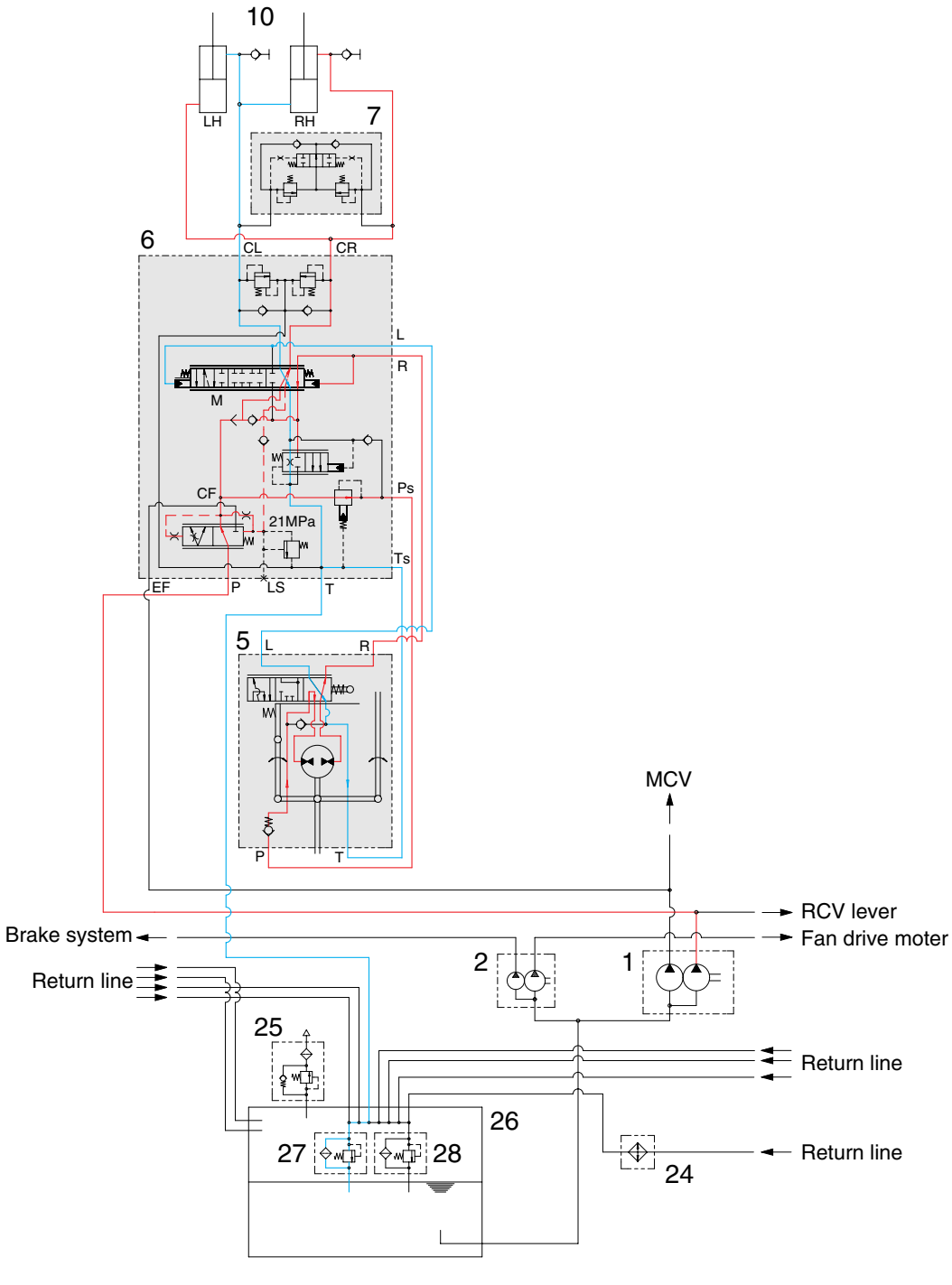
- The steering wheel is not being operated so control spool(G) does not move.
- The oil from the steering pump(A) enters port P of the priority valve in steering valve(EHPS) and the inlet pressure oil moves the spool(D) to the right.
- Almost all of pump flow goes to the loader system(main control valve) through the EF port and partly flows into the hydraulic tank(26) throught the spool(D).

2) LEFT TURN



- When the steering wheel is turned to the left, the pressure oil from the steering unit fill on the left side chamber of main steering spool(M), and main steering spool moves to the right in the direction.
- At the same time of moving of main steering spool, LS signal will be blocked.
- If LS signal of main steering spool is blocked, it cause to increase pressure of left chamber of priority valve and then priority valve to be pushed to left side.
  Consequently, oil will flow via CF of priority valve to main spool. That oil will push steering cylinder rod out and it will cause wheel loader to be steered to left side.
- The rate of movement of main steering spool is concluded as flow rate, which is kept in left chamber from steering unit. Furthermore the rate controls speed of movement for cylinder.

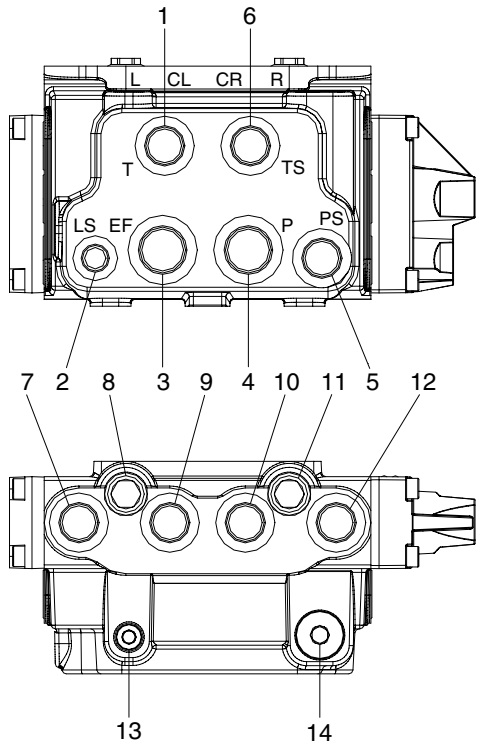
3) RIGHT TURN

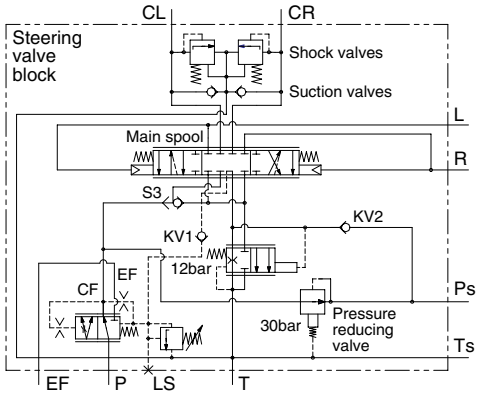


- When the steering wheel is turned to the right, the pressure oil from the steering unit fill on the right side chamber of main steering spool(M), and main steering spool moves to the left in the direction.
- At the same time of moving of main steering spool, LS signal will be blocked.
- If LS signal of main steering spool is blocked, it cause to increase pressure of left chamber of priority valve and then priority valve to be pushed to left side. Consequently, oil will flow via CF of priority valve to main spool. That oil will push steering cylinder rod out and it will cause wheel loader to be steered to right side.
- The rate of movement of main steering spool is concluded as flow rate, which is kept in right chamber from steering unit. Furthermore the rate controls speed of movement for cylinder.

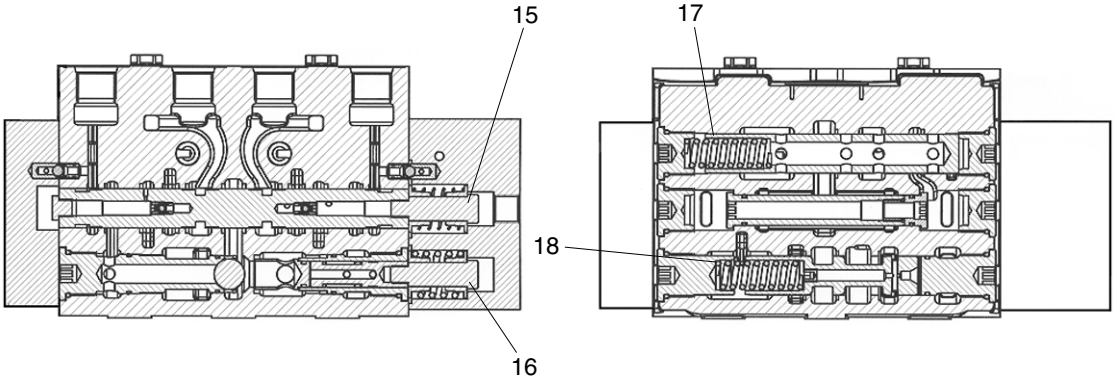
3. STEERING VALVE(EHPS)

1) STRUCTURE





Hydraulic circuit

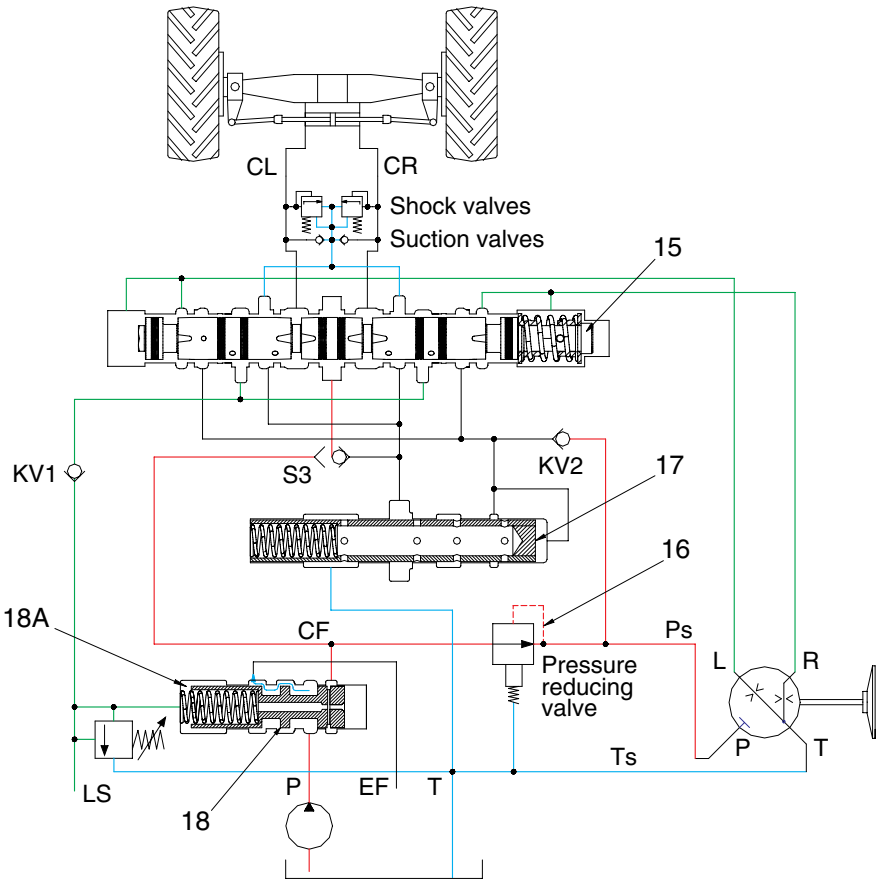


7607SE11

1	To tank	7	From steering unit L port	13	Relief valve
2	To emergency system	8	Shock & suction valve(Left side)	14	Check valve
3	To main control valve	9	To steering cylinder(Left side)	15	Main steering spool
4	From main pump	10	To steering cylinder(Right side)	16	Pressure reducing valve
5	To steering unit P port	11	Shock & suction valve(Right side)	17	Metering spool
6	From steering unit T port	12	From steering unit R port	18	Priority spool

2) OPERATION

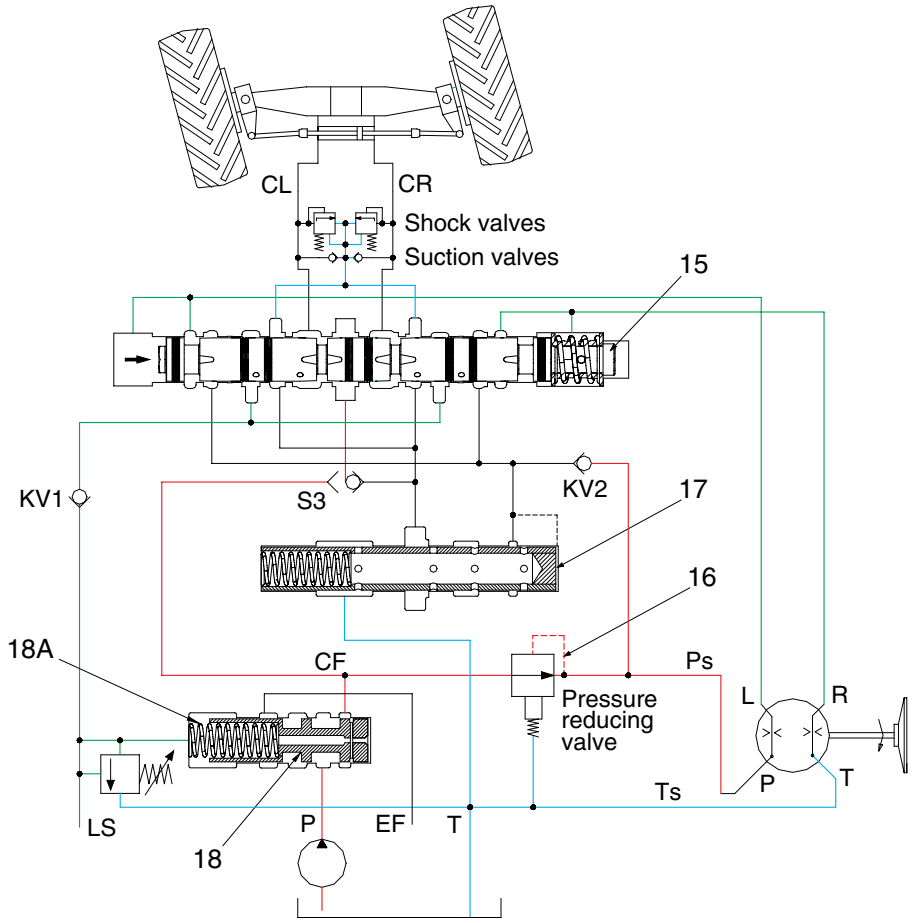
(1) Neutral



7607SE12

- In neutral position, the oil will pass from the pump across the integrated priority valve(18) in the steering valve for discharge through the EF port. When the steering unit is in neutral, flow through it is blocked and all flow through the priority valve(18) in steering valve is directed out the EF port and passed to the main control valve.
- When the engine is turned off, the priority valve spool(18) is pushed to the right by the spring. The passage to the EF port is blocked while the passage to the CF port is open.
- When the machine is started, EF port of the steering valve may be connected to the working hydraulic. Maximum pressure on the EF port = 210bar.
- The operating pressure in the loader system has not effected on the operation of the priority valve(18) of steering valve. Independently of operation of the loader actuated in relief, the priority valve(18) will not shift until the machine is steered.
- A part of flow through the priority valve spool(18) will flow to P port of steering unit through pressure reducing valve. Also flow as pilot signal of steering through the priority valve spool(18) passes from the P port through the dynamic orifice and into the LS line. It flows to the tank through the LS orifice in main spool.
- In neutral position, the main spool will be in its center position. This means that knocks and impacts from the cylinder are not transmitted to the steering unit. The steering valve is thus of the non-reaction type.

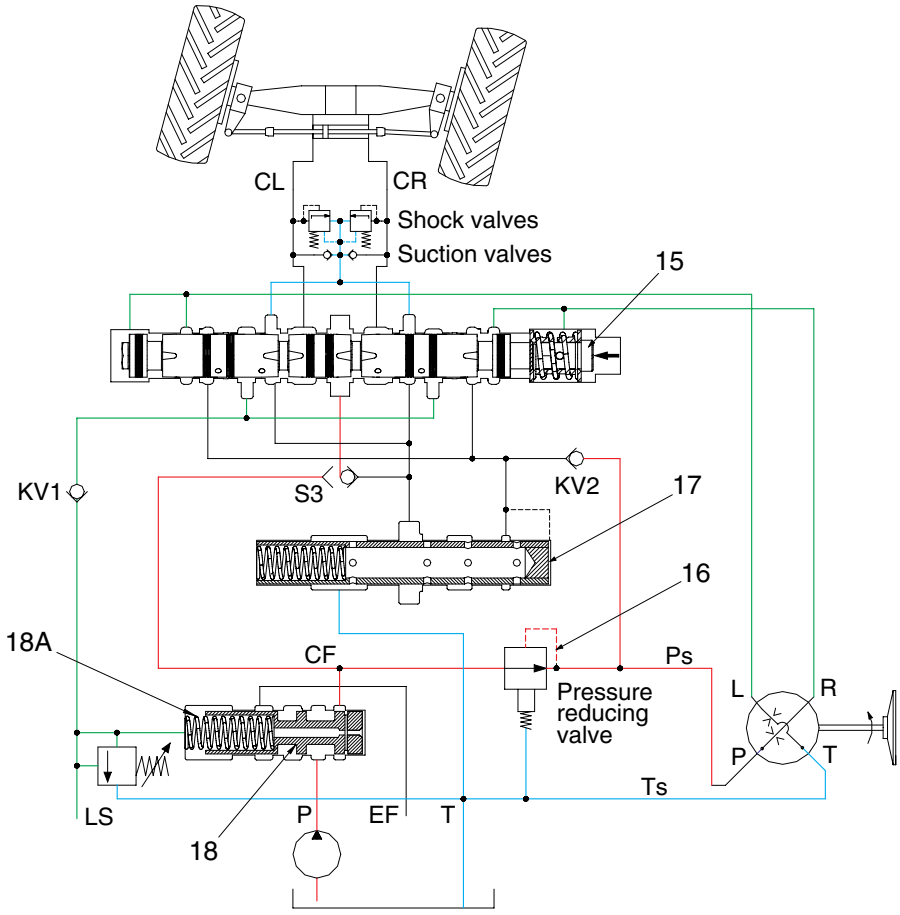
(2) Turning left



7607SE13

- When the steering wheel is turned to the left, the pressure oil from the steering unit fill on the left side chamber of main steering spool(15), and main steering spool(15) moves to the right in the direction.
- At the same time of moving of main steering spool(15), LS signal will be blocked.
- If LS signal of main steering spool(15) is blocked, it cause to increase pressure of left chamber of priority valve(18A) and then priority valve(18) to be pushed to right side.
  Consequently, oil will flow via CF of priority valve to main spool. That oil will push steering cylinder rod out and it will cause wheel loader to be steered to left side.
- The rate of movement of main steering spool(15) is concluded as flow rate, which is kept in left chamber from steering unit. Furthermore the rate controls speed of movement for cylinder.
- When the cylinder reaches to end position, pressure of oil flowing through main steering spool(15) will get to be increased. If the oil pressure increase up to relief pressure to be set, relief valve will be activated. It result in decreasing pressure of left chamber of priority valve(18A), and will push priority valve(18) to right side. Then, oil flow to cylinder will be blocked.

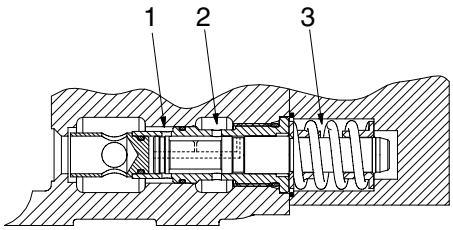
(3) Turning right



7607SE14

- When the steering wheel is turned to the right, the pressure oil from the steering unit fill on the right side chamber of main steering spool(15), and main steering spool(15) moves to the left in the direction.
- At the same time of moving of main steering spool(15), LS signal will be blocked.
- If LS signal of main steering spool(15) is blocked, it cause to increase pressure of left chamber of priority valve(18A) and then priority valve(18) to be pushed to right side. Consequently, oil will flow via CF of priority valve to main spool. that oil will push steering cylinder rod out and it will cause wheel loader to be steered to right side.
- The rate of movement of main steering spool(15) is concluded as flow rate, which is kept in right chamber from steering unit. Furthermore the rate controls speed of movement for cylinder.
- When the cylinder reaches to end position, pressure of oil flowing through main steering spool(15) will get to be increased. If the oil pressure increase up to relief pressure to be set, relief valve will be activated. It result in decreasing pressure of left chamber of priority valve(18A), and will push priority valve(18) to right side. Then, oil flow to cylinder will be blocked.

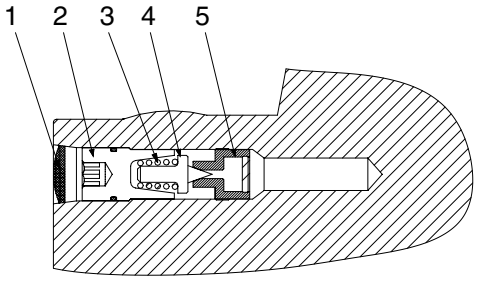
(4) Pressure reducing valves



7607SE15

- Pressure reducing valve is a valve, which is supplying pilot oil to steering unit.
  That is one of advantage of steering system adopting steering valve.
- Pressure reducing valves are pressure-limiting devices that limit pressure in one portion of a circuit while leaving system pressure unaffected.
  Pressure reducing valves allow flow to pass from(1) to (2) until the pressure at (1) reaches the predetermined setting, at which point the spool shifts to restrict input flow from(1) (reducing mode) or to open flow from (2) to (3) (relieving mode) as needed to maintain the regulated pressure at (2).

(5) Relief valve



7607SE16

1 Plastic plug
2 Adjustment screw
3 Spring
4 Thrust pad
5 Valve seat

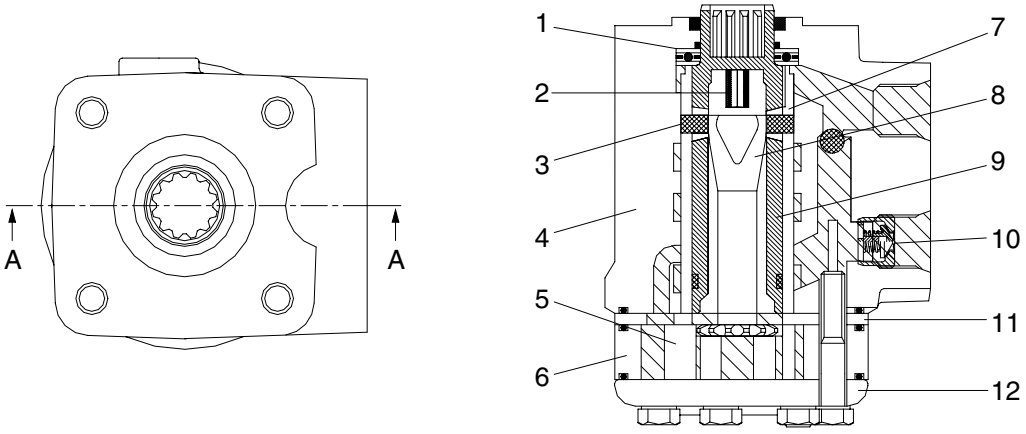
FUNCTION

The main relief valve is inside the steering valve, and set the maximum circuit pressure of the steering circuit.

When the steering valve is being actuated, if the steering circuit goes up above the set pressure of this valve, oil will be relieved, the priority valve spool will be actuated, and the oil will be flow to EF port.

4. STEERING UNIT

1) STRUCTURE



SECTION A - A

7607SE17

1	Bearing	5	Gear wheel	9	Spool
2	Neutral position spring	6	Gear rim	10	Check valve
3	Cross pin	7	Sleeve	11	Distributor plate
4	Housing	8	Cardan shaft	12	End cover

2) OPERATION

The steering unit consists of a rotary valve and a rotary meter.

Via a steering column the steering unit is connected to the steering wheel of the machine.

When the steering wheel is turned, oil is directed from the steering system pump via the rotary valve (spool and sleeve) and rotary meter(gear wheel set) to the cylinder ports L or R, depending on the direction of turn. The rotary meter meters the oil flow to the steering cylinder in proportion to the angular rotation of the steering wheel.

Spool(9) is connected directly to the drive shaft of steering wheel. It is connected to sleeve(7) by cross pin(3) (not in contact with the spool when the steering wheel is at neutral) and neutral position spring(2).

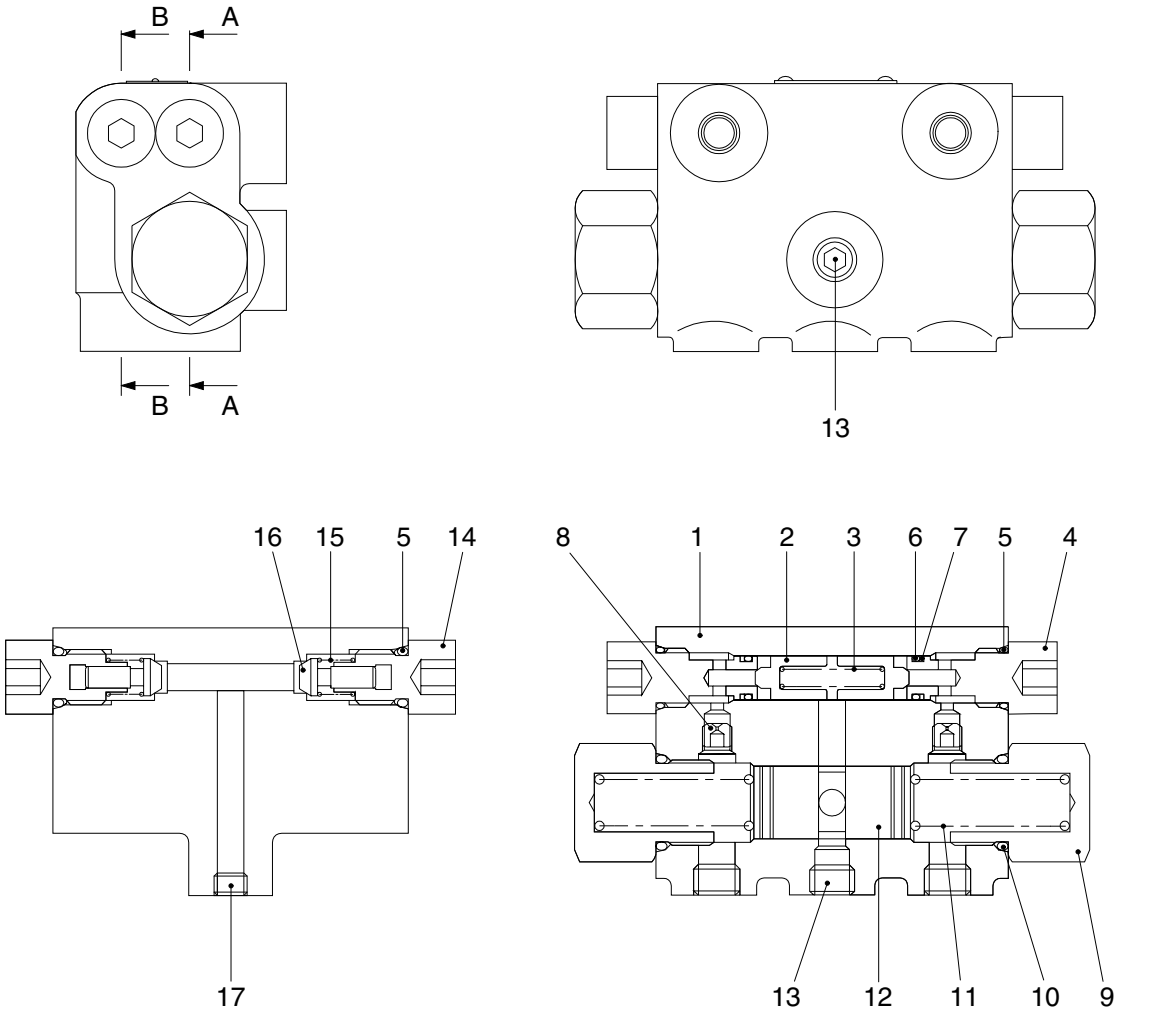
Cardan shaft(8) is meshed at the top with cross pin(3) and forms one unit with sleeve(7).

At the same time, it is meshed with gear rim(5) of the gerotor set by spline.

There are four ports in valve body. They are connected to the pump circuit, tank circuit, and the head, and left and right steering cylinder. In addition, the pump port and tank port are connected inside the body by the check valve. Therefore, if there is any failure in the pump of engine, oil can be sucked in directly from the tank through the check valve.

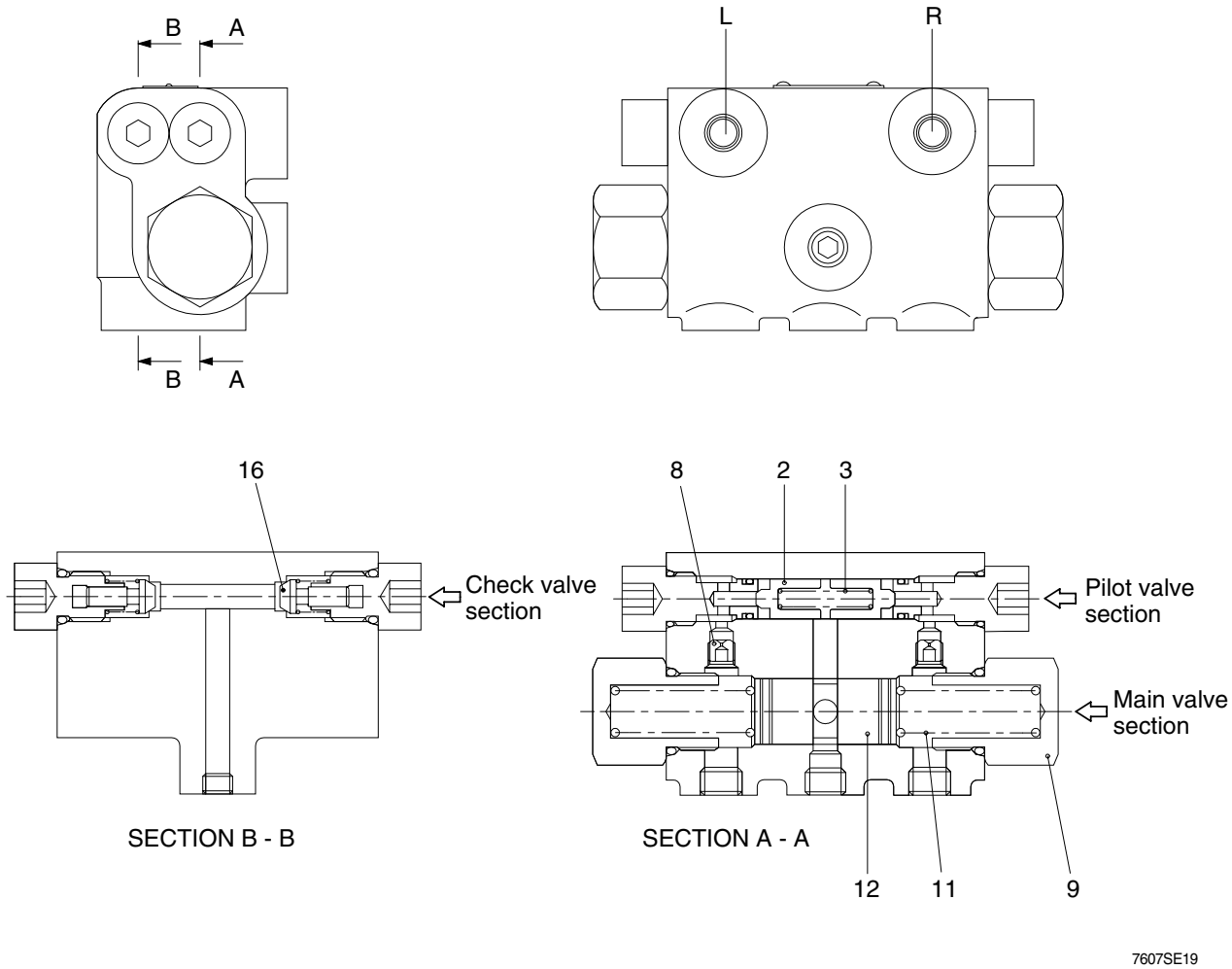
5. CUSHION VALVE

1) STRUCTURE



1	Housing	7	Back ring	13	Plug
2	Poppet	8	Orifice	14	Plug
3	Spring	9	Plug	15	Spring
4	Valve seat	10	O-ring	16	Poppet
5	O-ring	11	Spring	17	Plug
6	O-ring	12	Spool		

2) OPERATION



The cushion valve is a valve that eliminates steering jerk motion. It makes a higher pressurized oil to flow into another line in order to prevent the shock on steering system.

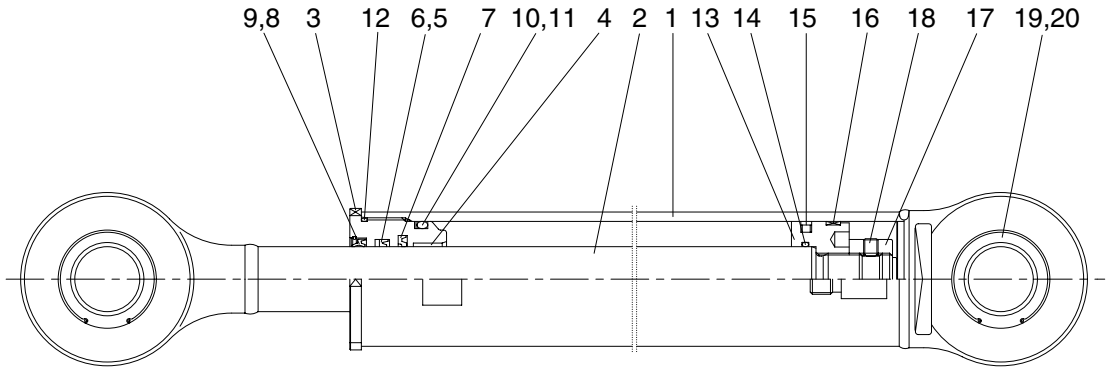
The pressure by rapid supplied pressurized oil from R port is higher than the spring(3) force, so it press and open the poppet(2). Then the oil flows to the central groove of the spool(12), and flows to L port through the poppet of the check valve(16) on L port side.

At this time, this pressurized oil flows to the pressure area of the plug(9) through the orifice(8), and this force is higher than the spring(11) force plus the oil pressure on L port side, so the spool(12) is shifted to the right. The flow of the supplied oil to L port side through the poppet(2) from R port side is trapped. The flow of this instant oil makes the function of the cushion. After this operation, the normal steering operation is not affected because this valve is not operated any longer.

Also, for the response of the pressure when the operation is slow as a cushion effect is not required, the spool(12) is closed before the poppet(2) is opened, so this valve is not operated.

6. STEERING CYLINDER

1) STRUCTURE



7607SE05

1	Tube assembly	8	Dust wiper	15	Piston seal
2	Rod assembly	9	Snap ring	16	Wear ring
3	Gland	10	O-ring	17	Lock nut
4	Bushing	11	Back up ring	18	Set screw
5	Rod seal	12	O-ring	19	Spherical bearing
6	Back up ring	13	Piston	20	Retaining ring
7	Buffer ring	14	O-ring		

2) OPERATION

This machine use to cross connected cylinder for steering operation.
The steering cylinder use a gland(3) to remove piston and sealed seals. Dust wiper(8) located on the in side of the gland protects cylinder inner parts from dust. The piston(13) is fastened to the rod(2) by a nut(17).

The piston uses a single wear ring(16) with a piston seal(15) to seal between the piston and tube. The gland seals against the tube with two O-rings. The rod is sealed against the gland with a rod seal(5).

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

1. OPERATIONAL CHECKS

This procedure is designed so the service man can make a quick check of the steering system using a minimum amount of diagnostic equipment. If you need additional information, prefer to structure and function in group 1.

A location will be required which is level and has adequate space to complete the checks.

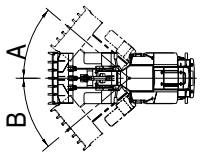
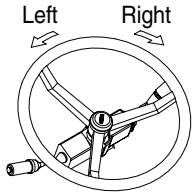
The engine and all other major components must be at operating temperature for some checks.

Locate system check in the left column and read completely, following this sequence from left to right. Read each check completely before performing.

At the end of each check, if no problem is found(OK), that check is complete or an additional check is needed. If problem is indicated(NOT OK), you will be give repair required and group location. If verification is needed, you will be give next best source of information :

- Chapter 2 : Troubleshooting
- Group 3 : Tests and adjustments

※ Hydraulic oil must be at operating temperature for these checks(Refer to page 6-50).

Item	Description	Service action
Steering unit check	 Run engine at low idle. Turn steering wheel until frames are at maximum right(A) and then left(B) positions. **LOOK** : Frames must move smoothly in both directions. When steering wheel is stopped, frames must stop. **FEEL** : Excessive effort must not be required to turn steering wheel. **NOTE** : It is normal for steering to drift from stops when steering wheel is released.	**OK** Check completed. **NOT OK** Go to next check.
Steering system leakage check Heat hydraulic oil to operating temperature. Run engine at high idle.	 Turn steering wheel rapidly until frames are against stop. Hold approximately 2kg on steering wheel. Count steering wheel revolutions for 1 minute. Repeat test in opposite direction. **LOOK** : Steering wheel should rotate less than 7rpm. **NOTE** : Use good judgment; Excessive steering wheel rpm does not mean steering will be affected.	**OK** Check completed. **NOT OK** Do steering system leakage test in group 3 to isolate the leakage.
Priority valve(In steering valve) low pressure check	Park machine on a hard surface. Hold brake pedal down. Run engine at high idle. Steer machine to the right and left as far as possible. **LOOK** : Machine must turn at least half way to the right and left stops.	**OK** Check completed. **NOT OK** Do priority valve pressure test in group 3.
Priority valve(In steering valve) high pressure check Run engine at high idle.	 Steer to steering stop and release steering wheel. Roll bucket back and hold over relief and observe engine rpm. Turn steering wheel to steering stop and hold, observe engine rpm. **LOOK** : Steering stall engine rpm must be higher than hydraulic stall rpm.	**OK** Check completed. **NOT OK** Priority pressure is set too high. Do priority valve pressure test in group 3.

2. TROUBLESHOOTING

※ **Diagnose malfunction charts are arranged from most probable and simplest to verify, to least likely, more difficult to verify. Remember the following steps when troubleshooting a problem :**

Step 1. Operational check out procedure(See group 3 in section 1)

Step 2. Operational checks(In this group)

Step 3. Troubleshooting

Step 4. Tests and adjustments(See group 3)

Problem	Cause	Remedy
No steering	Low oil level	Add recommended oil.
	Failed steering pump	Remove and inspect return filter for metal pump particles.
	Failed main pump drive	Do main pump flow test.
	Stuck priority valve spool	Remove and inspect priority valve spool.
	Broken priority valve spring	Remove and inspect spring.
	Relief valve in steering valve stuck open.	Do relief cartridge leakage test in group 3.
No hydraulic functions steering normal	Faulty or misadjusted pilot supply unit valve	Do pilot supply unit test in group 3.
	Stuck open system relief valve	Replace relief valve.
	Locked safety valve	Unlock safety valve.
	Plugged pilot line filter	Inspect and replace.
	Failed hydraulic pump	Remove and inspect the pump.
	Low secodary pressure of RCV	Check the pressure and replace if necessary.

Problem	Cause	Remedy
Slow or hard steering	Too much friction in the mechanical parts of the machine	Lubricate bearings and joints of steering column or repair if necessary. Check steering column installation.
	Cold oil	Warm the hydraulic oil.
	Low priority valve pressure setting	Do priority valve pressure test in group 3. Clean or replace cartridge in steering valve.
	Worn hydraulic pump	Do hydraulic pump performance check .
	Sticking priority valve spool	Remove and inspect.
	Broken priority valve spring	Remove and inspect.
Constant steering to maintain straight travel	Air in system	Check for foamy oil.
	Leakage in steering system	Do steering system leakage check.
	Worn steering unit	Do steering system leakage check. Do steering unit neutral leakage test in group 3.
	Leaf spring without spring force or broken	Replace leaf springs.
	Spring in double shock valve broken	Replace shock valve.
	Gear wheel set worn	Replace gear wheel set.
	Cylinder seized or piston seals worn	Replace defects parts.
Slow steering wheel movement will not cause any frame movement	Leakage in steering unit gerotor	Do steering system leakage check.
	Worn steering unit gerotor	Do steering leakage check.
Steering wheel can be turned with frames against steering stop	Leakage in steering system	Do steering system leakage check.
Steering wheel turns with no resistance and causes no frame movement	Broken steering column or splined coupling	Remove and inspect.
	Lack of oil in steering unit	Start engine and check steering operation.
	Leakage in steering system	Do steering system leakage test in group 3.

Problem	Cause	Remedy
Erratic steering	Air in oil	Check for foamy oil.
	Low oil level	Add recommended oil.
	Sticking priority valve spool	Remove and inspect spool.
	Loose cylinder piston	Remove rod to inspect piston.
	Damaged steering unit	Remove and inspect.
Spongy or soft steering	Air in oil	Check for foamy oil.
	Low oil level	Add recommended oil.
Free play at steering wheel	Loose steering wheel nut	Tighten.
	Worn or damaged splines on steering column or unit	Inspect.
Steering unit binding or steering wheel does not immediately return to neutral when released	Binding in steering column or misalignment of column	Inspect.
	High return pressure	Check for a pinched or damaged return line.
	Contamination in steering unit	Inspect hydraulic filter for contamination. Repair cause of contamination. Flush hydraulic system.
	Large particles of contamination in steering unit	Inspect hydraulic filter for contamination. Repair cause of contamination. Flush hydraulic system.
Steering unit locks up	Worn or damaged steering unit	Repair or replace steering unit.
Abrupt steering wheel oscillation	Improperly timed gerotor gear in steering unit	Time gerotor gear.
Steering wheel turns by itself	Lines connected to wrong port	Reconnect lines.
Vibration in steering system or hoses jump	High priority valve setting	Do priority valve pressure test in group 3.
Neutral position of steering wheel cannot be obtained, i.e. there is a tendency towards "motoring"	Steering column and steering unit out of line	Align the steering column with steering unit.
	Too little or no play between steering column and steering unit input shaft	Adjust the play and, if necessary, shorten the splines journal.
	Pinching between inner and outer spools	Contact the nearest service shop.

Problem	Cause	Remedy
"Motoring" effect. The steering wheel can turn on its own.	Leaf springs are stuck or broken and have therefore reduced spring force	Replace leaf springs.
	Inner and outer spools pinch, possibly due to dirt	Clean steering unit or contact the nearest service shop.
	Return pressure in connection with the reaction between differential cylinder and steering unit too high	Reduce return pressure.
	Oil is needed in the tank	Fill with clean oil and bleed the system.
	Steering cylinder worn	Replace or repair cylinder.
	Gear wheel set worn	Replace gear wheel set.
	Spacer across cardan shaft forgotten	Install spacer.

Problem	Cause	Remedy
Backlash	Cardan shaft fork worn or broken	Replace cardan shaft.
	Leaf springs without spring force or broken	Replace leaf springs.
	Worn splines on the steering column	Replace steering column.
"Shimmy" effect. The steered wheels vibrate. (Rough tread on tires gives vibrations)	Air in the steering cylinder	Bleed cylinder. Find and remove the reason for air collection.
	Mechanical connections or wheel bearings worn	Replace worn parts.
	High priority valve setting pressure	Set pressure as regular value.
Steering wheel can be turned slowly in one or both directions without the steered wheels turning.	One or both shock valves are leaky or are missing in steering valve	Clean or replace defective of missing valves.
Steering is too slow and heavy when trying to turn quickly.	Insufficient oil supply to steering unit, pump defective or number of revolutions too low	Replace pump or increase number of revolutions.
	Relief valve setting too low	Adjust valve to correct setting.
	Relief valve sticking owing to dirt	Clean the valve.
	Spool in priority valve sticking owing to dirt.	Clean the valve, check that spool moves easily without spring.
	Too weak spring in priority valve	Replace spring by a stronger.
"Kick back" in steering wheel from system. Kicks from wheels.	Fault in the system	Contact authorized man or shop.

Problem	Cause	Remedy
Heavy kick-back in steering wheel in both directions.	Wrong setting of cardan shaft and gear-wheel set	Correct setting as shown in service manual.
Turning the steering wheel activates the steered wheels opposite.	Hydraulic hoses for the steering cylinders have been switched around	Connect lines to correct ports.
Hard point when starting to turn the steering wheel	Spring force in priority valve too weak Oil is too thick(Cold)	Replace spring by a stronger. Let motor run until oil is warm.
Too little steering force (Possibly to one side only).	Pump pressure too low Too little steering cylinder Piston rod area of the differential cylinder too large compared with piston diameter	Correct pump pressure. Fit a larger cylinder. Fit cylinder with thinner piston rod or 2 differential cylinders.
Leakage at either input shaft, end cover, gear-wheel set, housing or top part.	Shaft defective Screws loose Washers or O-rings defective	Replace shaft seal. Tighten screws. Replace.

GROUP 3 TESTS AND ADJUSTMENTS

1. HYDRAULIC OIL CLEAN UP PROCEDURE USING PORTABLE FILTER CADDY

※ **Service equipment and tool.**

- Portable filter caddy
- Two 3658mm(12ft) × 1" I.D. 100R1 hoses with 3/4 M NPT ends
- Quick disconnect fittings
- Discharge wand
- Various size fittings and hoses

※ **Brake system uses oil from hydraulic oil tank. Flush all lines in the steering system.**
Disassemble and clean major components for steering system.
Steering components may fail if steering system is not cleaned after hydraulic oil tank contamination.

1) If hydraulic system is contaminated due to a major component failure, remove and disassemble steering cylinders to clean debris from cylinders.

2) Install a new return filter element. Clean filter housing before installing new element.

※ **For a failure that creates a lot of debris, remove access cover from hydraulic oil tank. Drain and clean hydraulic oil tank of fill the specified oil to hydraulic oil tank through upper cover.**

3) To minimize oil loss, pull a vacuum in hydraulic oil tank using a vacuum pump. Connect filter caddy suction line to drain port at bottom of hydraulic oil tank using connector. Check to be sure debris has not closed drain port.

4) Put filter caddy discharge line into hydraulic oil tank filter hole so end is as far away from drain port as possible to obtain a through cleaning of oil.

5) Start the filter caddy. Check to be sure oil is flowing through the filters.
Operate filter caddy approximately 10 minutes so oil in hydraulic oil tank is circulated through filter a minimum of four times.

※ **Hydraulic oil tank capacity 150 ℓ (39.7U.S. gal).**
Leave filter caddy operating for the next steps.

6) Start the engine and run it at high idle.

※ **For the most effective results, cleaning procedure must start with the smallest capacity circuit then proceed to the next largest capacity circuit.**

7) Operate all functions, one at a time, through a complete cycle in the following order: clam, steering, bucket, and boom. Also include all auxiliary hydraulic functions.

Repeat procedure until the total system capacity has circulated through filter caddy seven times, approximately 30 minutes.
Each function must go through a minimum of three complete cycles for a through cleaning for oil.

※ **Filtering time for machines with auxiliary hydraulic functions must be increased because system capacity is larger.**

8) Stop the engine. Remove the filter caddy.

9) Install a new return filter element.

10) Check oil level in hydraulic oil tank ; Add oil if necessary.

2. TEST TOOLS

1) CLAMP-ON ELECTRONIC TACHOMETER INSTALLATION

- Service equipment and tools

  Tachometer

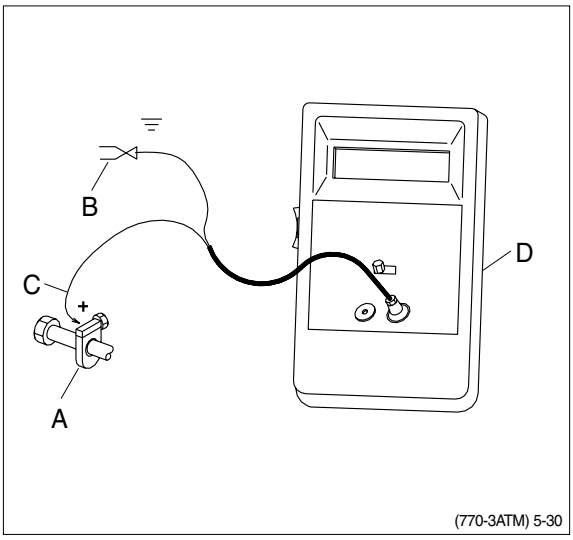
  A : Clamp on tachometer.

  Remove paint using emery cloth and connect to a straight section of injection line within 100㎜(4in) of pump. Finger tighten only-do not over tighten.

  B : Black clip(-). Connect to main frame.

  C : Red clip(+). Connect to transducer.

  D : Tachometer readout. Install cable.



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2) DIGITAL THERMOMETER INSTALLATION

- Service equipment and tools

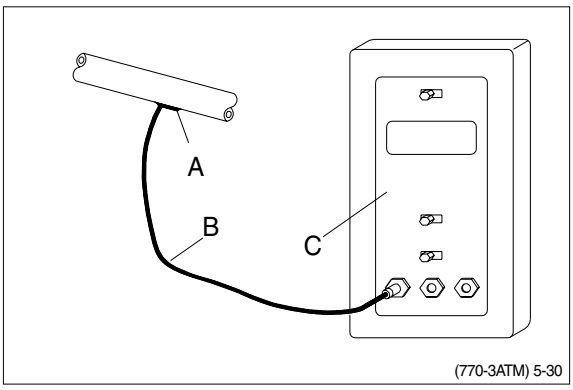
  Digital thermometer

  A : Temperature probe.

  Fasten to a bare metal line using a tie band. Wrap with shop towel.

  B : Cable.

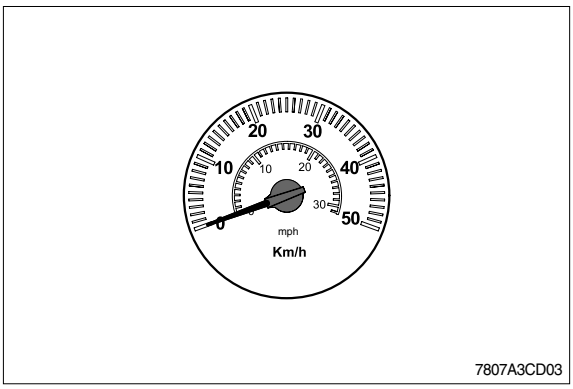
  C : Digital thermometer.



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3) DISPLAY MONITOR TACHOMETER

The display monitor tachometer is accurate enough for test work.



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3. STEERING SYSTEM RESTRICTION TEST

- **SPECIFICATION**

  Oil temperature 45±5°C(113±9°F)
  Engine speed High idle
  Maximum pressure 2.1MPa(21bar,300psi)
  at steering valve(EHPS)

- **GAUGE AND TOOL**

  Gauge 0~7MPa(0~70bar, 0~1000psi) 2EA

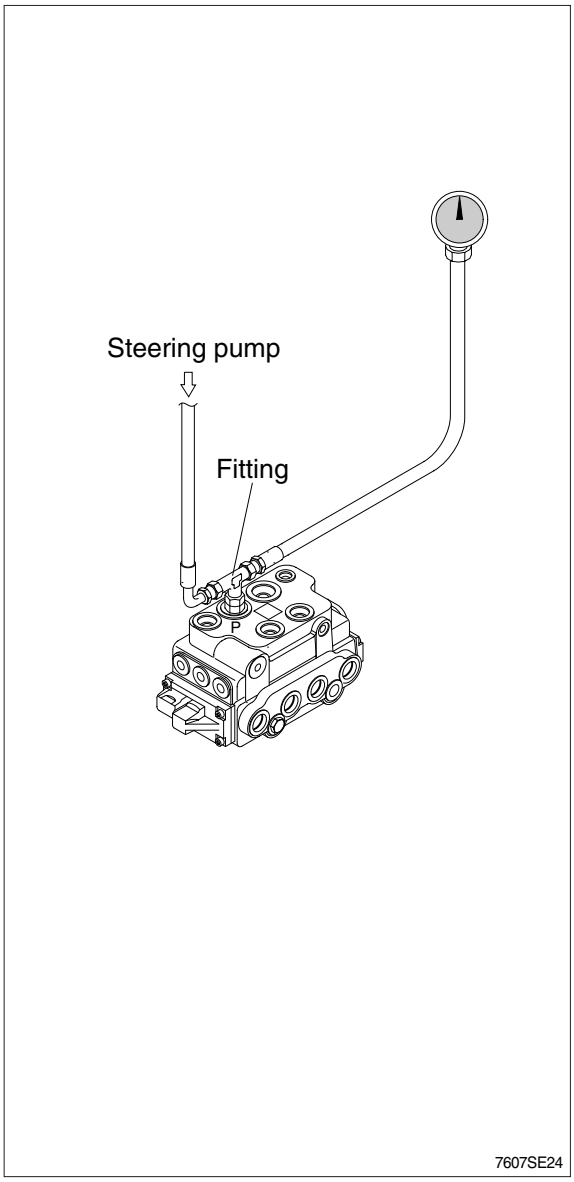
- This test will check for restrictions in the steering system which can cause overheating of hydraulic oil.

1) Install temperature reader.
   (See temperature reader installation procedure in this group).
2) Heat hydraulic oil to specifications.
   (See hydraulic oil warm up procedure at page 6-50).
3) Connect fitting and install gauge.

⚠ **Do not operate steering or loader functions or test gauge may be damaged.**

4) Run engine at specification and read pressure gauges.

   If pressure is more than specification at the steering valve, inspect steering valve for a priority valve spool. Make sure orifice plugs installed in ends of priority valve spool.



4. STEERING UNIT LEAKAGE TEST

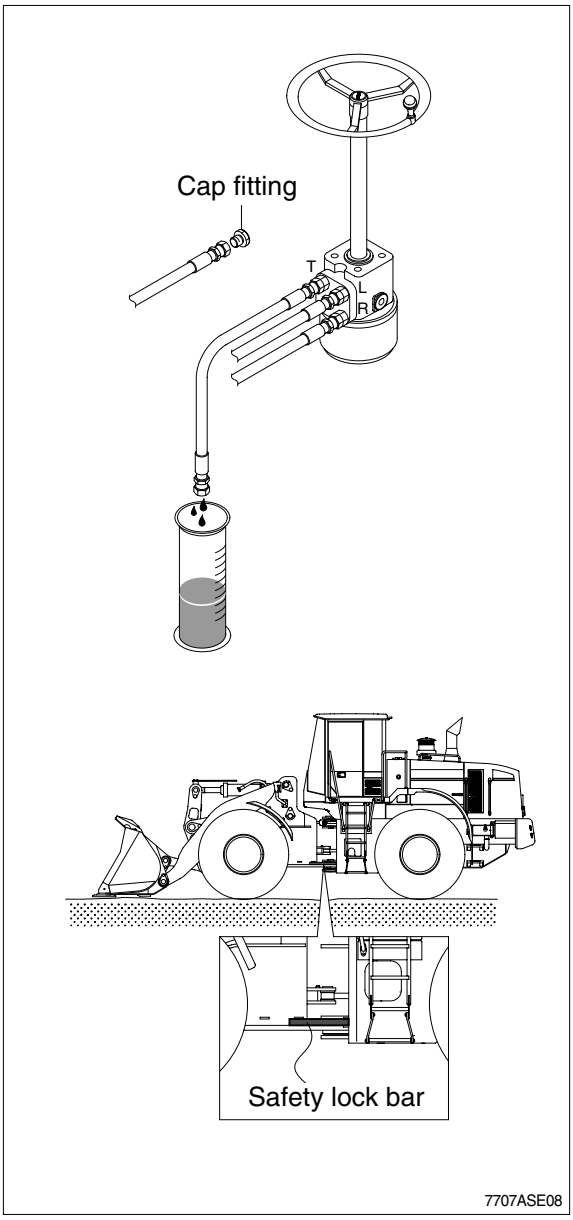
- **SPECIFICATION**

  Oil temperature 45±5℃(113±9℉)
  Engine speed High idle
  Maximum leakage 7.5 ℓ/min(2gpm)

- **GAUGE AND TOOL**

  Temperature reader
  Measuring container(Approx. 20 ℓ)
  Stop watch

1) Install frame locking bar to prevent machine from turning.
2) Install temperature reader.
   (See temperature reader installation procedure in this group).
3) Heat hydraulic oil to specifications.
   (See hydraulic oil warm up procedure at page 6-50).
4) Disconnect return hose from fitting.
   Install cap fitting.
5) Run engine at specifications. Rotate steering wheel against locking bar using approximately 1.2kgf · m of force.
   Measure oil flow from return hose for 1 minute.
6) Leakage is greater than specifications, repair or replace steering unit.



5. STEERING VALVE(EHPS) PRESSURE TEST

- **SPECIFICATION**

  Oil temperature 45±5°C(113±9°F)
  Engine speed High idle
  Oil pressure 20.1~21.1MPa
  (205~215bar, 2900~3100psi)

- **GAUGE AND TOOL**

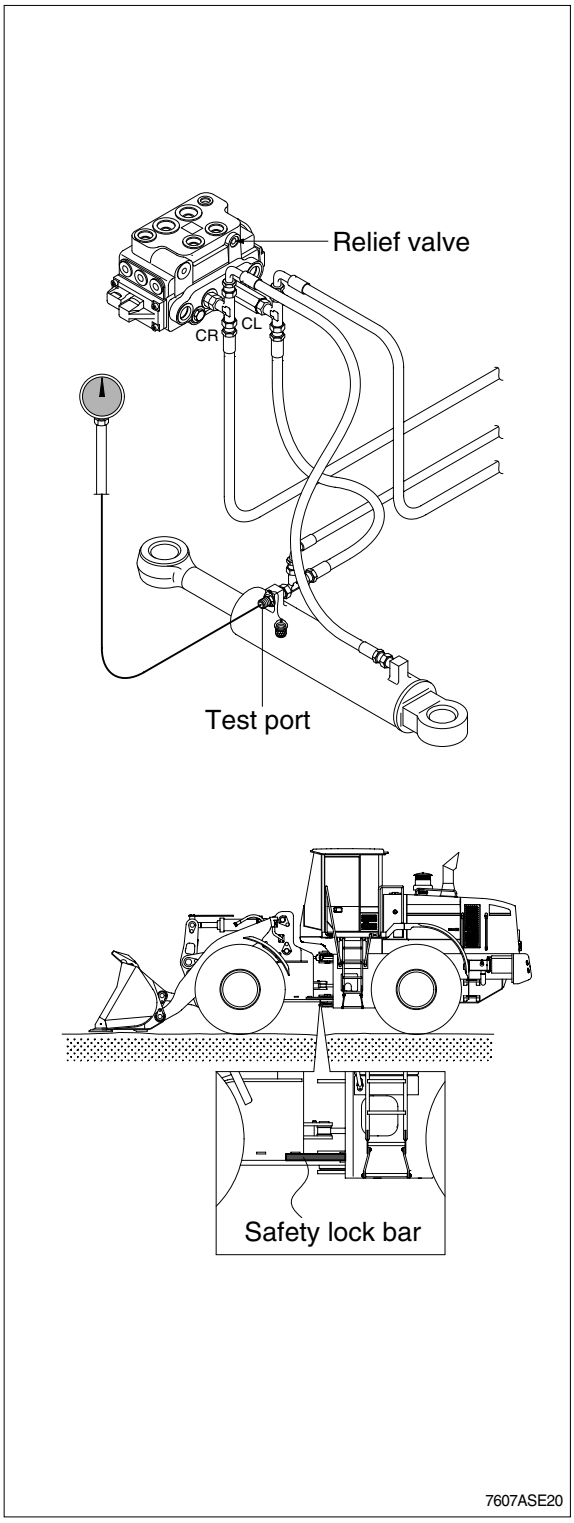
  Gauge 0~35MPa(0~350bar, 0~5000psi)
  Temperature reader

1) Connect gauge to test port.
2) Install temperature reader(See installation procedure in this group).
3) Install frame locking bar.
4) Heat hydraulic oil to specifications(See hydraulic oil warm up procedure at page 6-50).
5) Run engine at specifications and turn steering wheel rapidly hold approximately 22N(5lb force) pressure on wheel with frames locked.

※ **If steering wheel is turned slowly, it will continue to with the frames locked.**
This will give an incorrect pressure reading.
If steering wheel continues to turn rapidly with the frames locked, steering system leakage is indicated.

6) Read pressure gauge. This is the steering valve relief pressure.
7) If pressure in not to specification, turn adjusting screw in relief cartridge using a hex head wrench to adjust pressure.

   If pressure cannot be adjusted to specification, disassemble and inspect steering valve.



6. STEERING VALVE(EHPS) RELIEF CARTRIDGE LEAKAGE TEST

· **SPECIFICATION**

Oil temperature 45±5℃(113±9℉)
Engine speed High idle
Maximum leakage 1m ℓ /min(16 drops per min)

· **GAUGE AND TOOL**

Temperature reader
Measuring container
Stop watch

1) Install temperature reader.
(See temperature reader installation procedure in this group).

2) Heat hydraulic oil to specifications.
(See hydraulic oil warm up procedure at page 6-50).

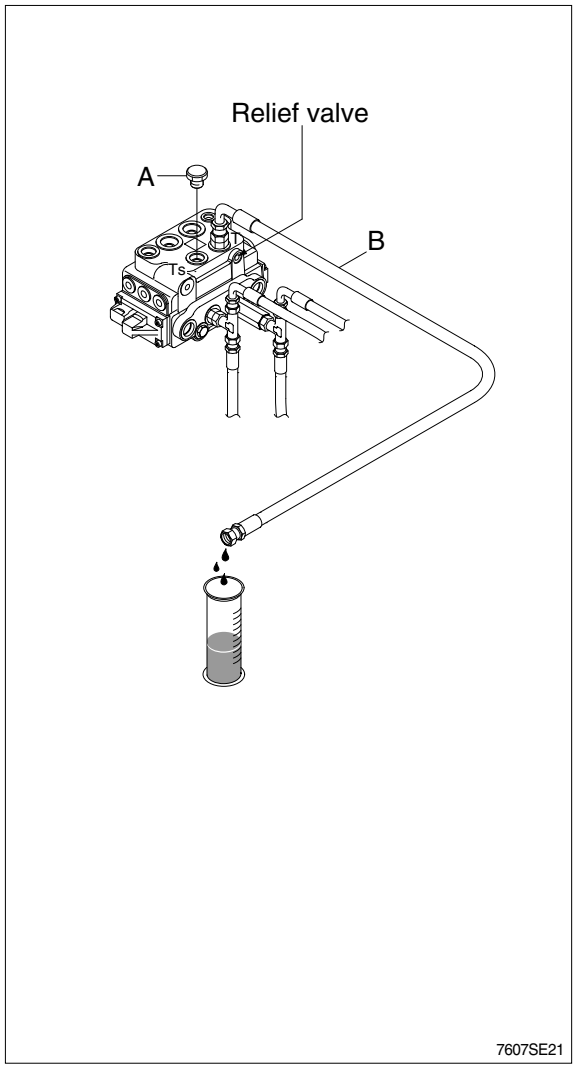
3) Install plug(A) in Ts port.
Disconnect line from T port on steering valve. Install plug in line.

4) Connect line(B) to steering valve.

5) Start engine and run at specification.

6) Measure oil leakage from T port.

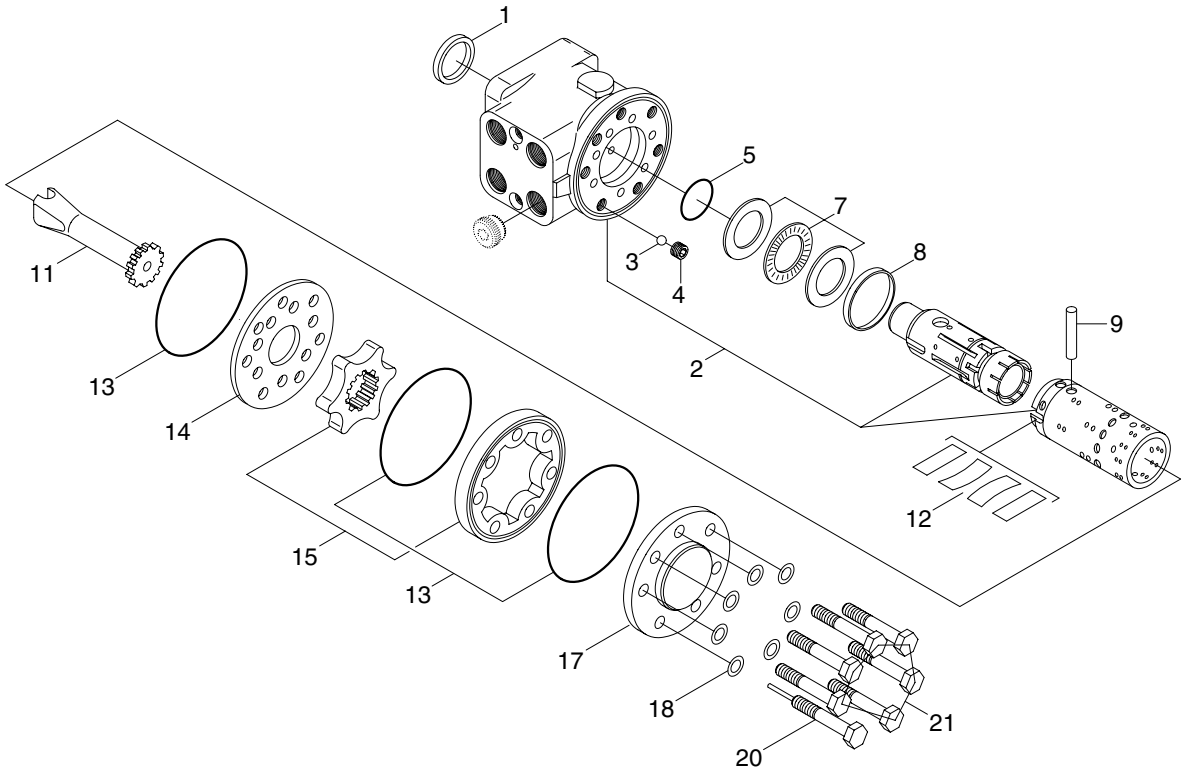
7) If leakage is more than specification, disassemble and inspect relief cartridge for damage or debris.



GROUP 4 DISASSEMBLY AND ASSEMBLY

1. STEERING UNIT

1) STRUCTURE

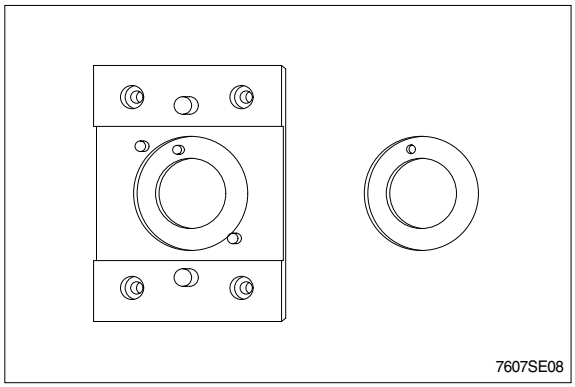


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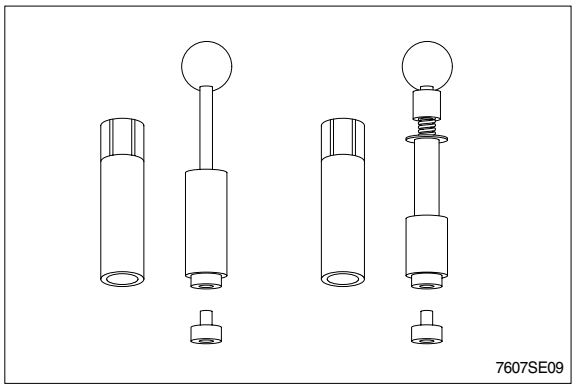
1	Dust seal	8	Ring	15	Gearwheel set
2	Housing, spool, sleeve	9	Cross pin	17	End cover
3	Ball	11	Cardan shaft	18	Washer
4	Thread bushing	12	Set of springs	20	Screw with pin
5	O-ring	13	O-ring	21	Screw
7	Bearing assembly	14	Distributor plate		

2) TOOLS

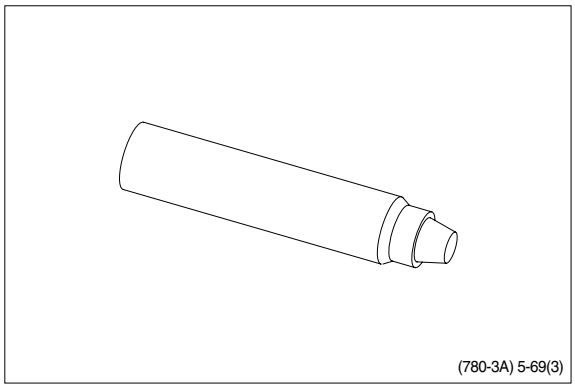
(1) Holding tool + Guide ring



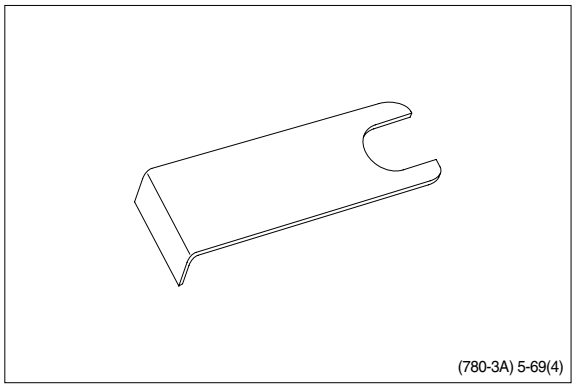
(2) Assembly tool for O-ring and kin-ring.



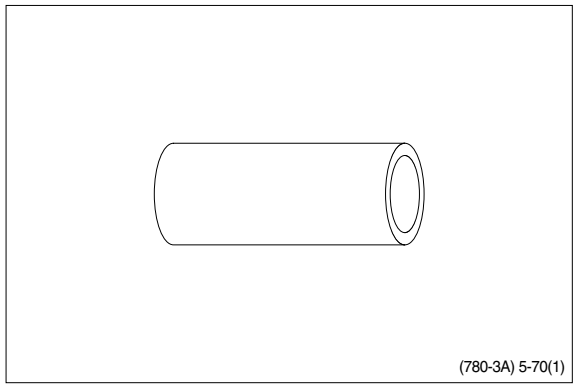
(3) Assembly tool for lip seal.



(4) Assembly tool for cardan shaft.

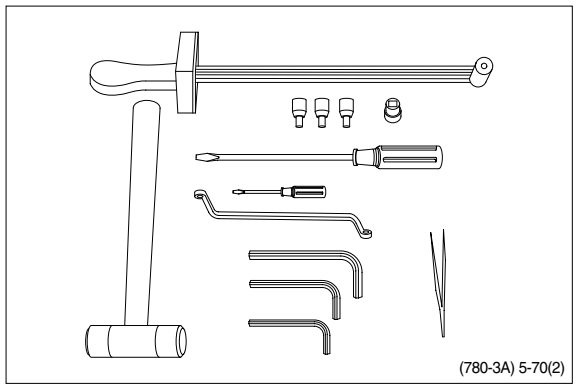


(5) Assembly tool for dust seal.



(780-3A) 5-70(1)

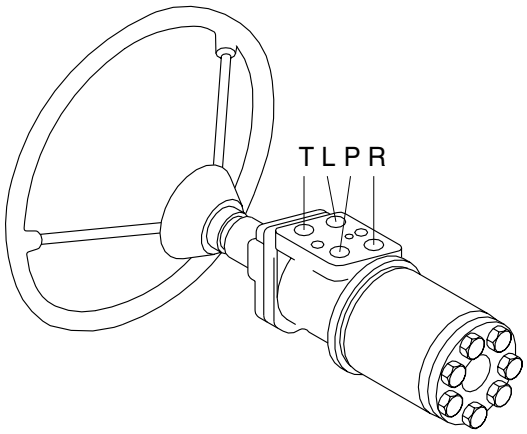
(6) Torque wrench 0~7.1kgf · m
(0~54.4lbf · ft)
13mm socket spanner
6, 8mm and 12 mm hexagon sockets
12mm screwdriver
2mm screwdriver
13mm ring spanner
6, 8 and 12mm hexagon socket spanners
Plastic hammer
Tweezers



(780-3A) 5-70(2)

3) TIGHTENING TORQUE AND HYDRAULIC CONNECTIONS

(1) Hydraulic connections



L : Left port
R : Right port
T : Tank
P : Pump

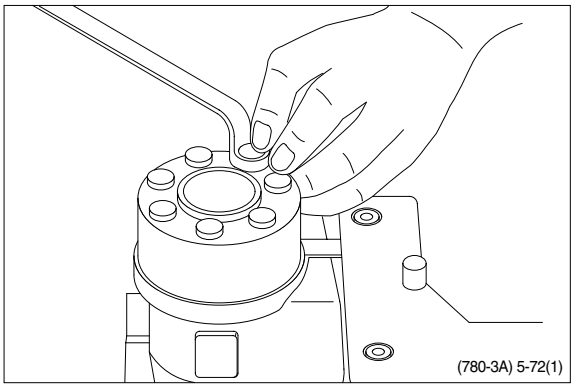
(780-3A) 5-71

(2) Tightening torque

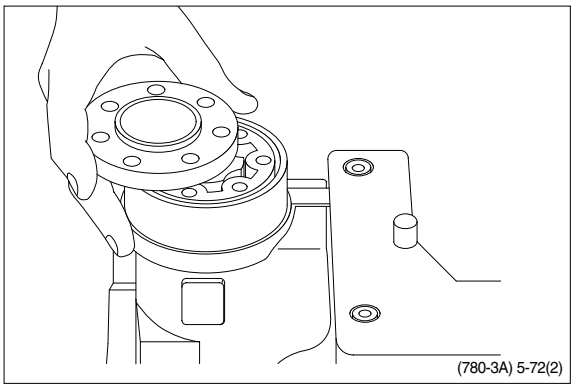
Screwed connection	Max. tightening torque [kgf · m(lbf · ft)]			
	With cutting edge	With copper washer	With aluminum washer	With O - ring
1/4 BSP.F	4.1(29.7)	2.0(14.5)	3.1(22.4)	-
3/8 BSP.F	6.1(44.1)	2.0(14.5)	5.1(36.9)	-
1/2 BSP.F	10.2(73.8)	3.1(22.4)	8.2(59.3)	-
7/16-20 UNF	-	2.0(14.5)	-	-
3/4-16 UNF	-	6.1(44.1)	-	-
M 12×1.5	4.1(29.7)	2.0(14.5)	3.1(22.4)	2.0(14.5)
M 18×1.5	7.1(51.4)	2.0(14.5)	5.1(36.9)	5.1(36.9)
M 22×1.5	10.2(73.8)	3.1(22.4)	8.2(59.3)	7.1(51.4)

4) DISASSEMBLY

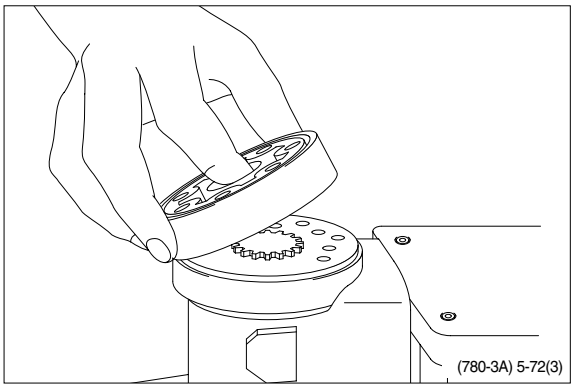
(1) Disassemble steering column from steering unit and place the steering unit in the holding tool.
Screw out the screws in the end cover(6-off plus one special screw).


(780-3A) 5-72(1)

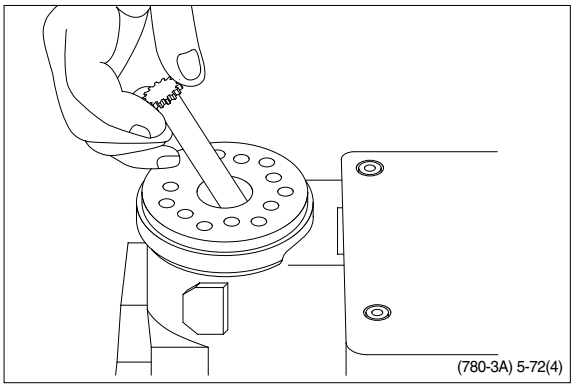
(2) Remove the end cover, sideways.


(780-3A) 5-72(2)

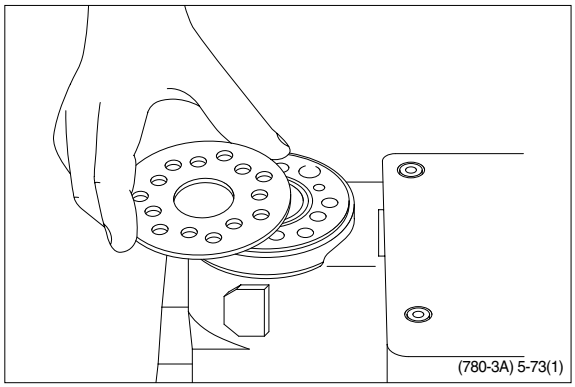
(3) Lift the gearwheel set (With spacer if fitted) off the unit.
Take out the two O-rings.


(780-3A) 5-72(3)

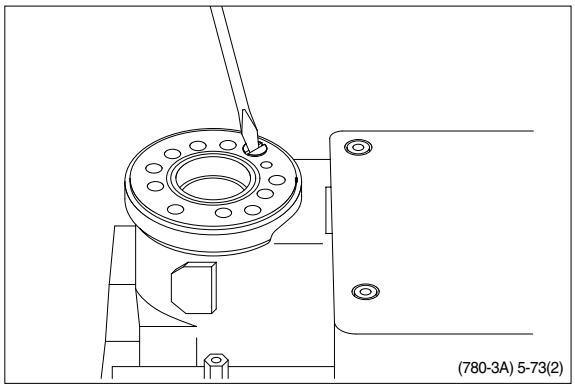
(4) Remove cardan shaft.


(780-3A) 5-72(4)

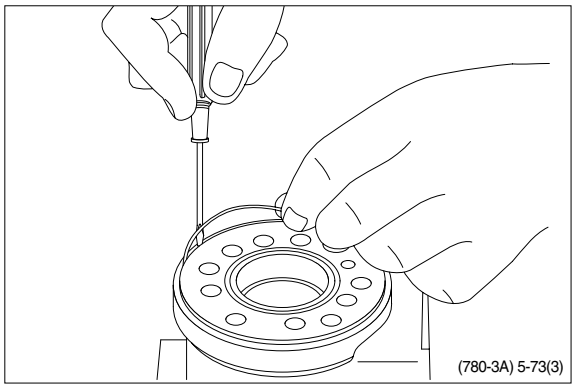
(5) Remove distributor plate.


(780-3A) 5-73(1)

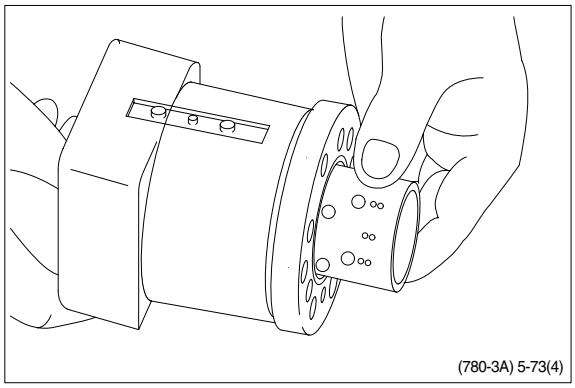
(6) Screw out the threaded bush over the check valve.


(780-3A) 5-73(2)

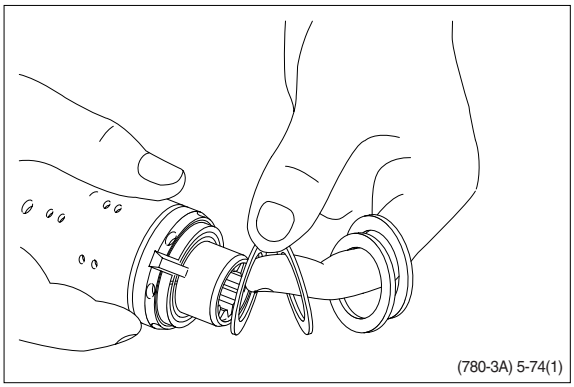
(7) Remove O-ring.


(780-3A) 5-73(3)

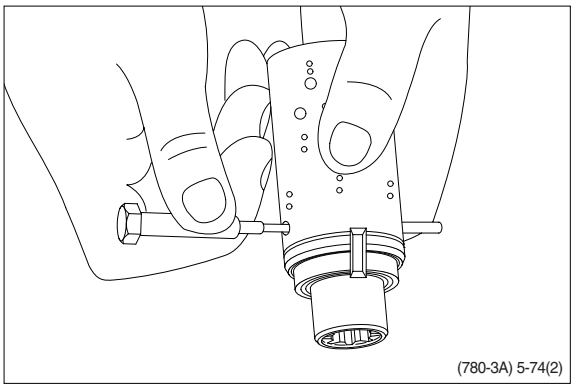
(8) Take care to keep the cross pin in the sleeve and spool horizontal. The pin can be seen through the open end of the spool. Press the spool inwards and the sleeve, ring, bearing races and needle bearing will be pushed out of the housing together.


(780-3A) 5-73(4)

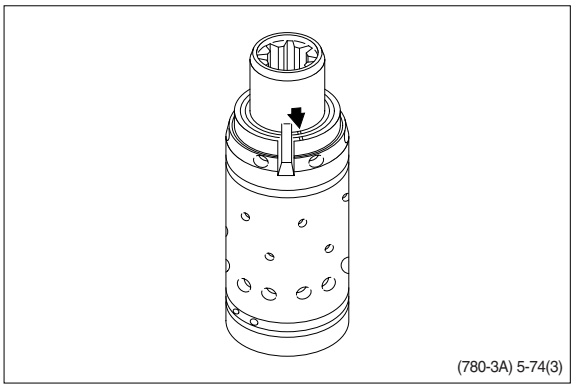
(9) Take ring, bearing races and needle bearing from sleeve and spool. The outer (Thin) bearing race can sometimes "stick" in the housing, therefore check that it has come out.


(780-3A) 5-74(1)

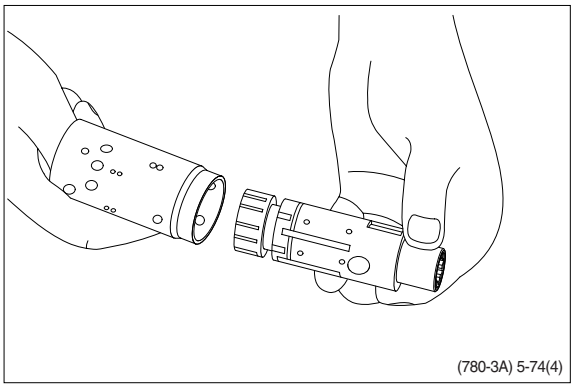
(10) Press out the cross pin. Use the special screw from the end cover.


(780-3A) 5-74(2)

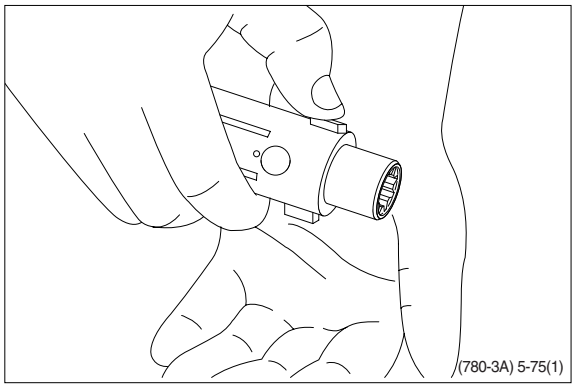
※ A small mark has been made with a pumice stone on both spool and sleeve close to one of the slots for the neutral position springs (See drawing).
If the mark is not visible, remember to leave a mark of your own on sleeve and spool before the neutral position springs are disassembled.


(780-3A) 5-74(3)

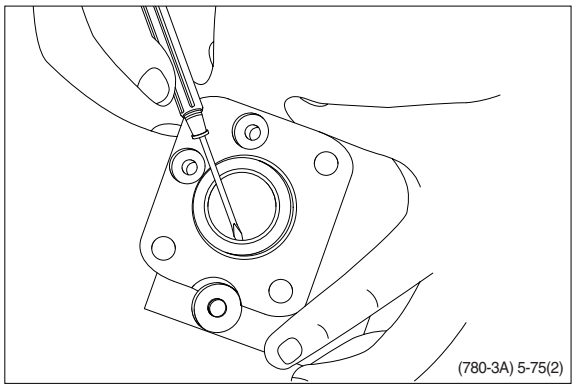
(11) Carefully press the spool out of the sleeve.


(780-3A) 5-74(4)

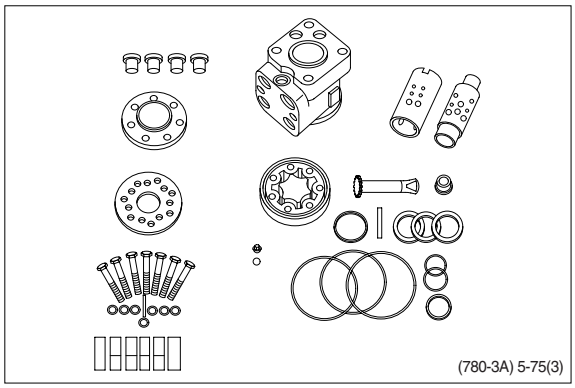
(12) Press the neutral position springs out of their slots in the spool.


(780-3A) 5-75(1)

(13) Remove dust seal and O-ring.


(780-3A) 5-75(2)

(14) The steering unit is now completely disassembled.

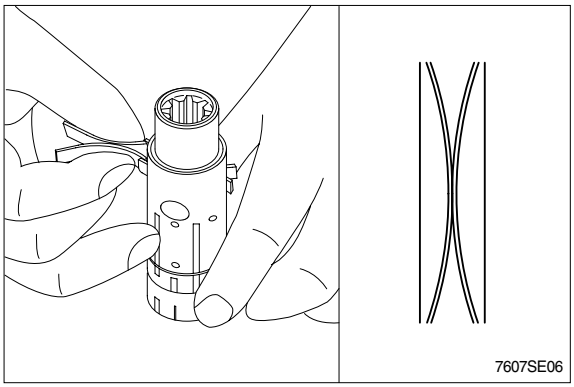

(780-3A) 5-75(3)

※ **Cleaning**
Clean all parts carefully in Shellsol K or the like.

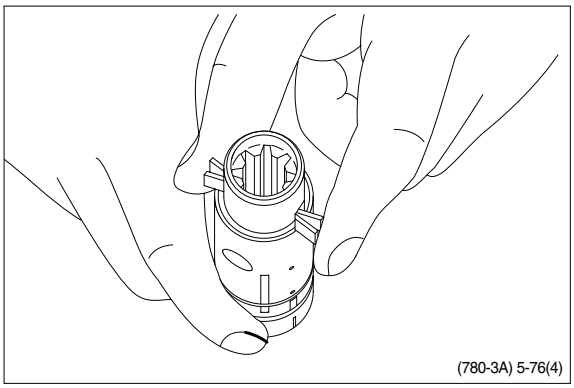
※ **Inspection and replacement**
Replace all seals and washers. Check all parts carefully and make any replacements necessary.

※ **Lubrication**
Before assembly, lubricate all parts with hydraulic oil.

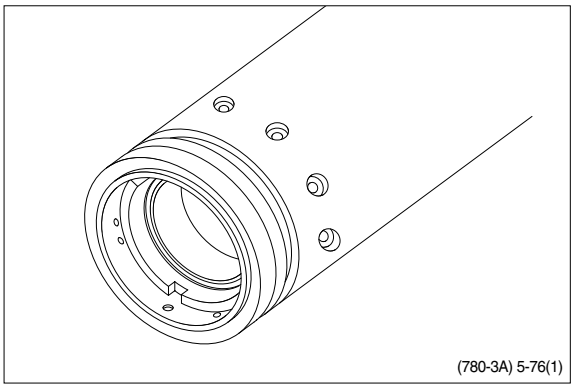
(1) Place the two flat neutral position springs in the slot.
Place the curved springs between the flat ones and press them into place.



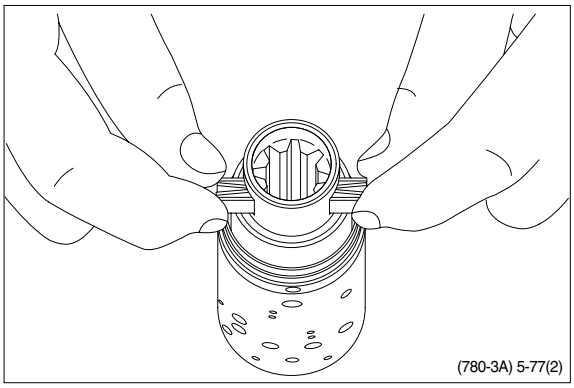
(2) Line up the spring set.



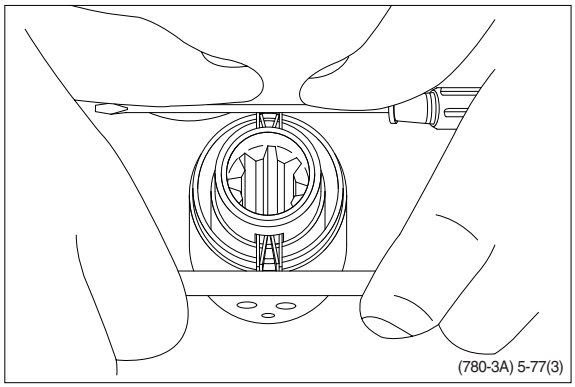
(3) Assemble the spool/sleeve and make sure the marks on spool and sleeve are opposite each other(see drawing page 5-36).



(4) Press the springs together and push the neutral position springs into place in the sleeve.

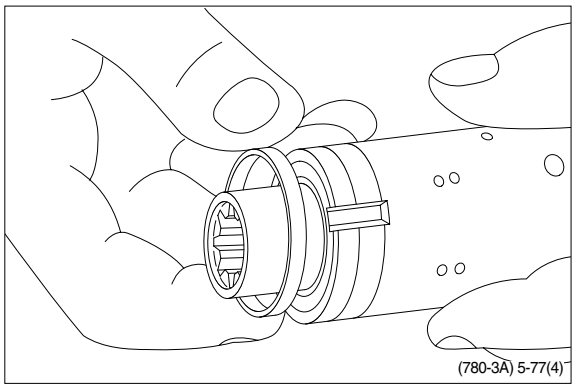


(5) Line up the springs and center them.

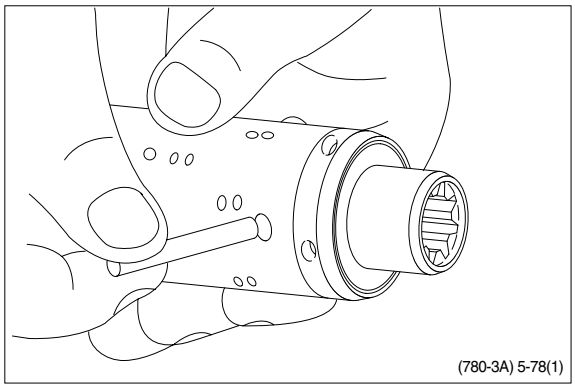

(780-3A) 5-77(3)

(6) Guide the ring down over the sleeve.

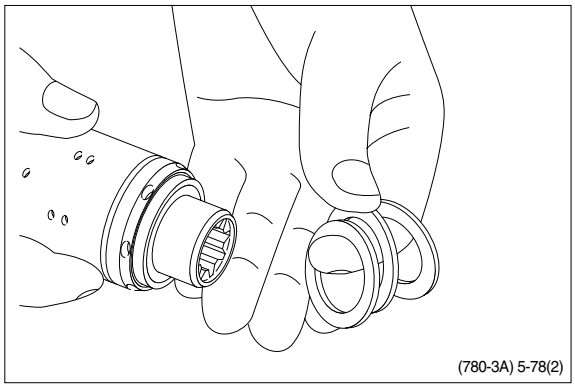
※ The ring should be able to move-free of the springs.


(780-3A) 5-77(4)

(7) Fit the cross pin into the spool / sleeve.


(780-3A) 5-78(1)

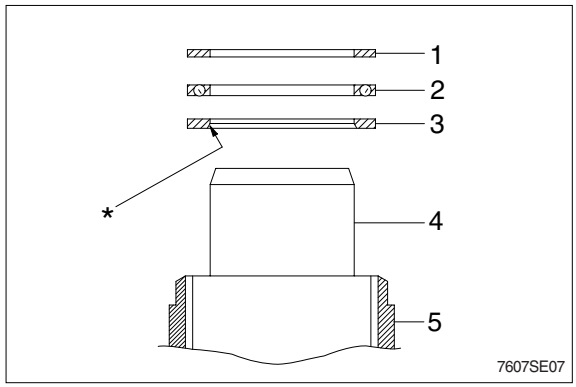
(8) Fit bearing races and needle bearing.
(See the next page)


(780-3A) 5-78(2)

※ **Assembly pattern for standard bearings**

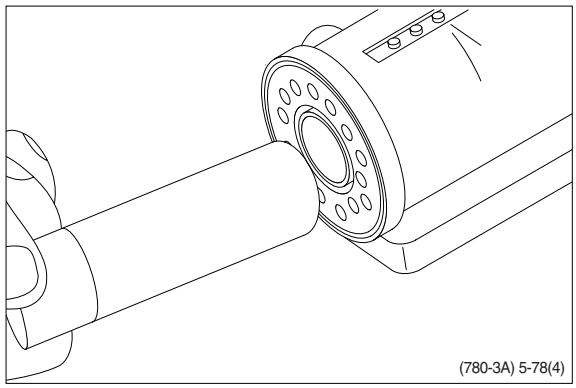
1 Outer bearing race
2 Needle bearing
3 Inner bearing race
4 Spool
5 Sleeve

* **The inside chamfer on the inner bearing race must face the inner spool.**

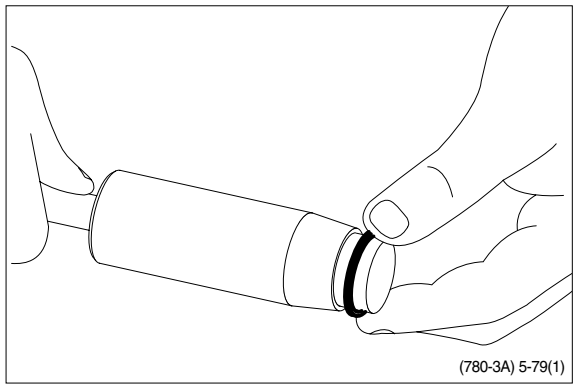


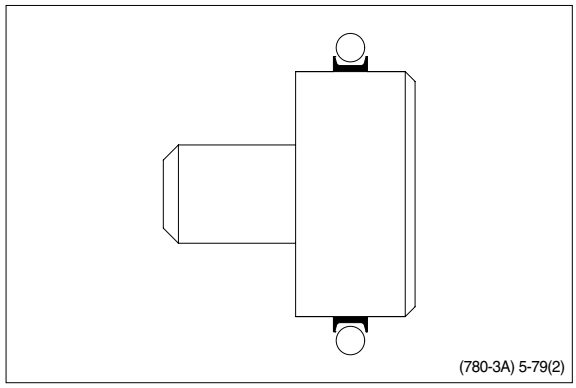
Installation instruction for O-ring

(9) Turn the steering unit until the bore is horizontal. Guide the outer part of the assembly tool into the bore for the spool / sleeve.

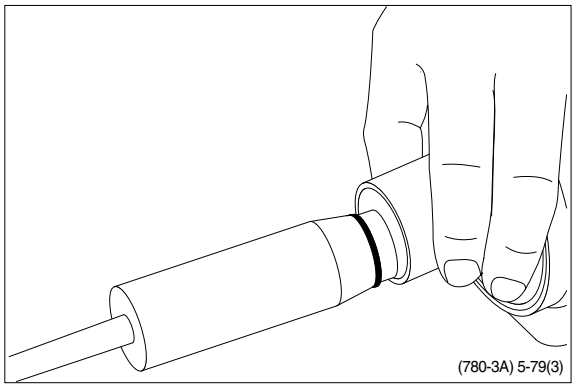


(10) Grease O-ring with hydraulic oil and place them on the tool.

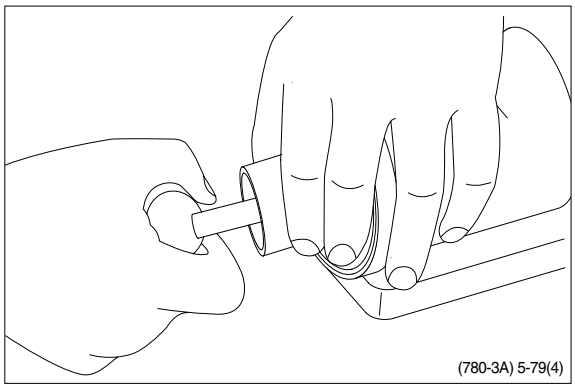




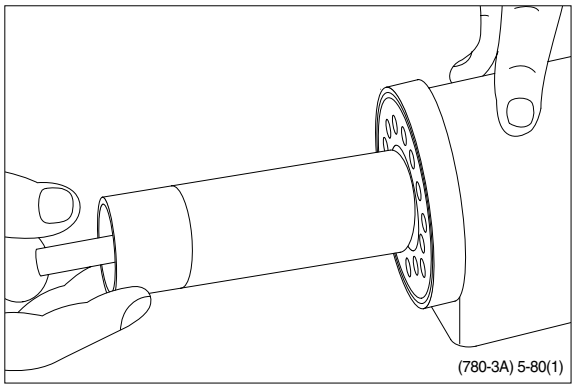
(11) Hold the outer part of the assembly tool in the bottom of the steering unit housing and guide the inner part of the tool right to the bottom.


(780-3A) 5-79(3)

(12) Press and turn the O-ring into position in the housing.

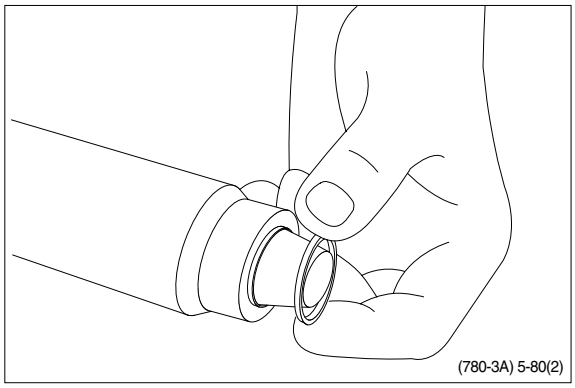

(780-3A) 5-79(4)

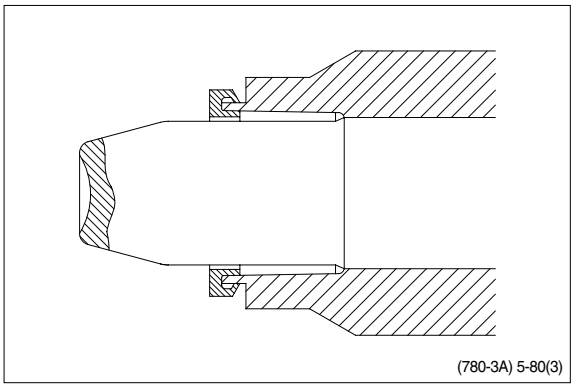
(13) Draw the inner and outer parts of the assembly tool out of the steering unit bore, leaving the guide from the inner part in the bore.


(780-3A) 5-80(1)

Installation instructions for lip seal

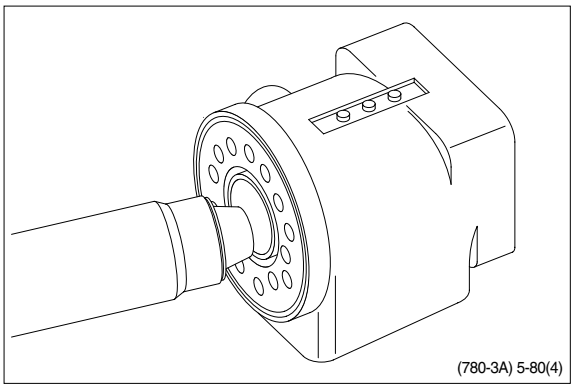
(14) Lubricate the lip seal with hydraulic oil and place it on the assembly tool.


(780-3A) 5-80(2)



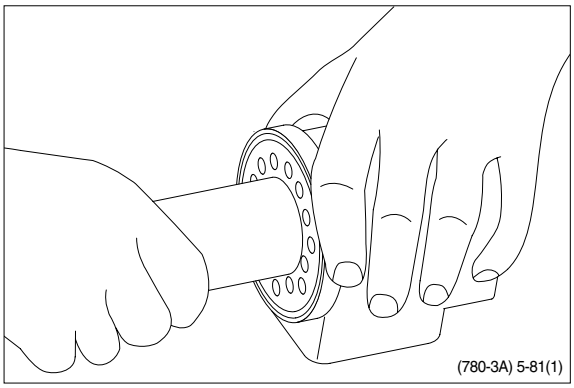
(780-3A) 5-80(3)

(15) Guide the assembly tool right to the bottom.



(780-3A) 5-80(4)

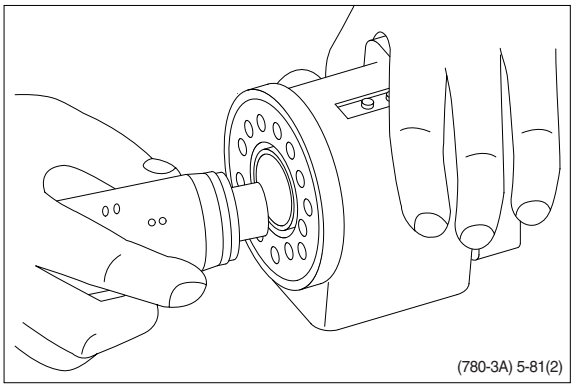
(16) Press and turn the lip seal into place in the housing.



(780-3A) 5-81(1)

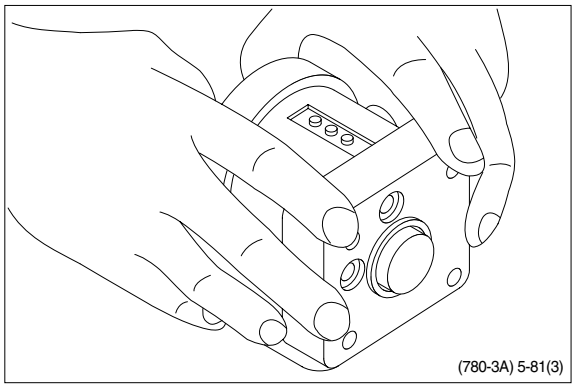
(17) With a light turning movement, guide the spool and sleeve into the bore.

※ Fit the spool set holding the cross pin horizontal.

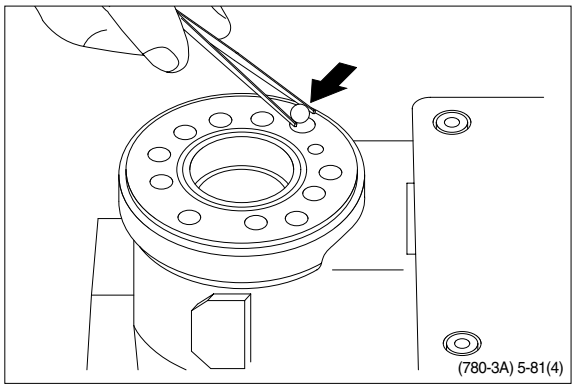


(780-3A) 5-81(2)

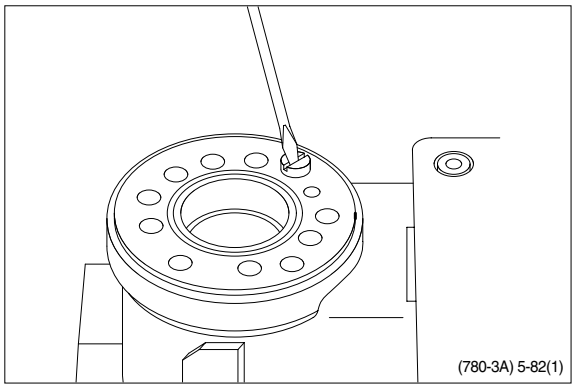
(18) The spool set will push out the assembly tool guide. The O-ring are now in position.


(780-3A) 5-81(3)

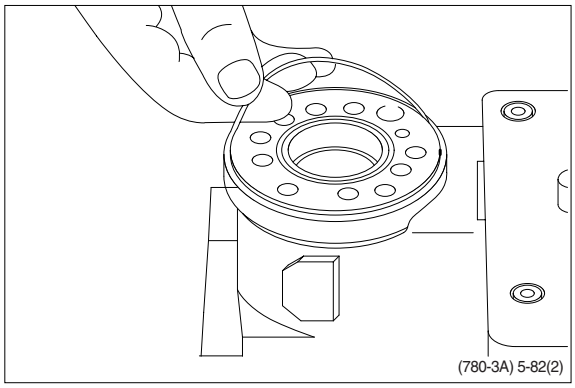
(19) Turn the steering unit until the bore is vertical again. Put the check valve ball into the hole indicated by the arrow.


(780-3A) 5-81(4)

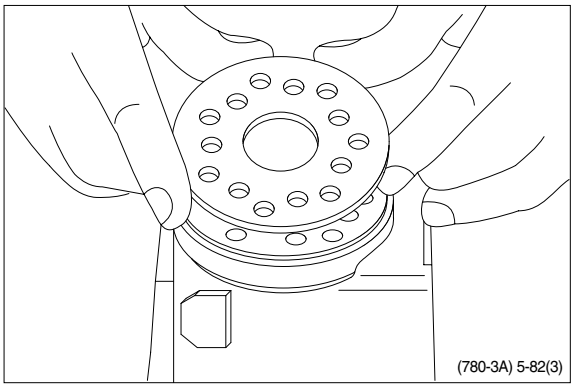
(20) Screw the threaded bush lightly into the check valve bore. The top of the bush must lie just below the surface of the housing.


(780-3A) 5-82(1)

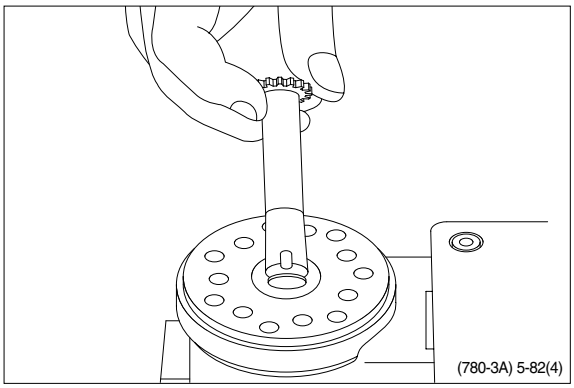
(21) Grease the O-ring with mineral oil approx. viscosity 500 cSt at 20°C.


(780-3A) 5-82(2)

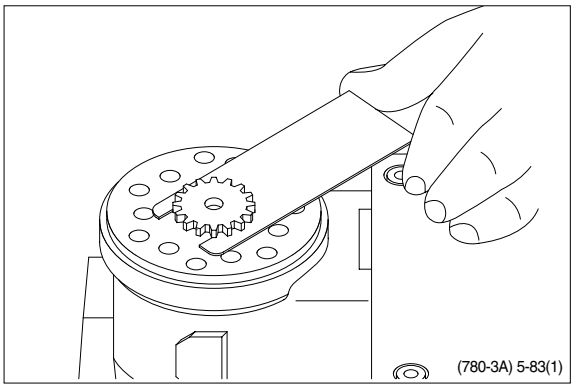
(22) Place the distributor plate so that the channel holes match the holes in the housing.



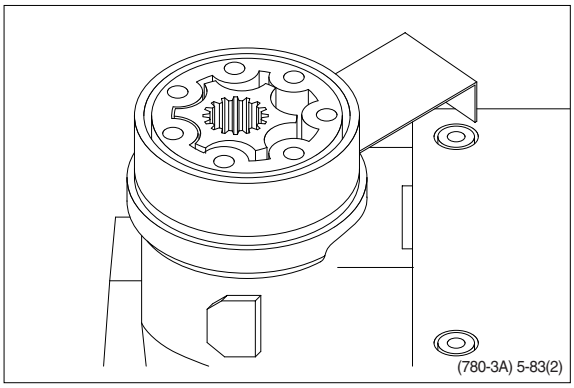
(23) Guide the cardan shaft down into the bore so that the slot is parallel with the connection flange.



(24) Place the cardan shaft as shown - so that it is held in position by the mounting fork.



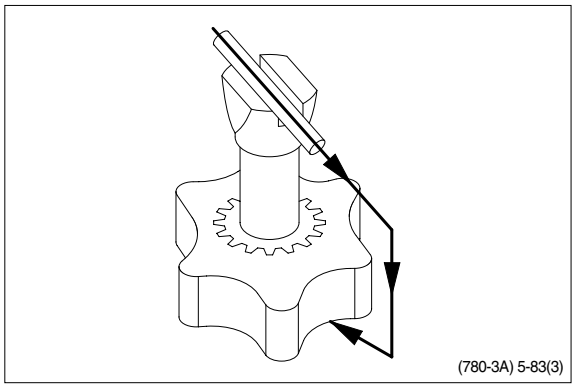
(25) Grease the two O-rings with mineral oil approx. viscosity 500 cSt at 20°C and place them in the two grooves in the gear rim. Fit the gearwheel and rim on the cardan shaft.



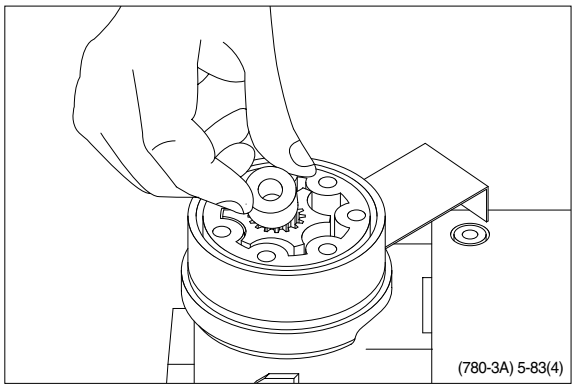
(26) Important

Fit the gearwheel (Rotor) and cardan shaft so that a tooth base in the rotor is positioned in relation to the shaft slot as shown.

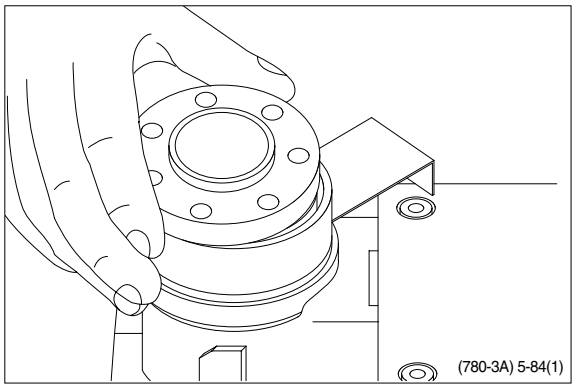
Turn the gear rim so that the seven through holes match the holes in the housing.


(780-3A) 5-83(3)

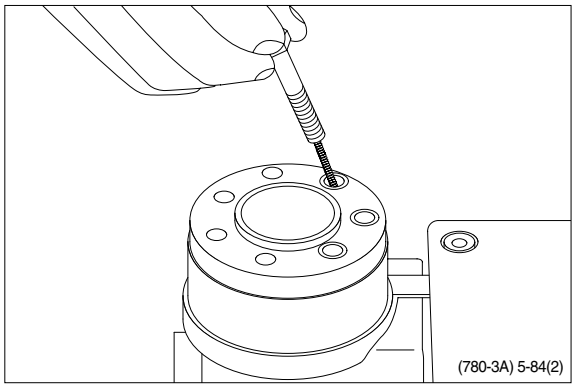
(27) Fit the spacer, if any.


(780-3A) 5-83(4)

(28) Place the end cover in position.

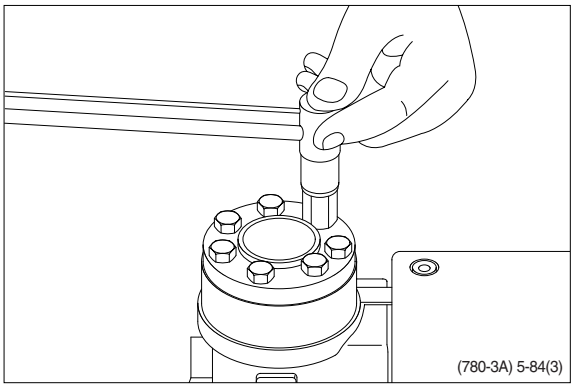

(780-3A) 5-84(1)

(29) Fit the special screw with washer and place it in the hole shown.

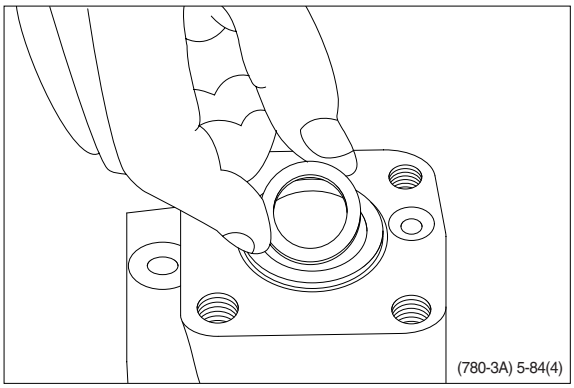

(780-3A) 5-84(2)

(30) Fit the six screws with washers and insert them. Cross-tighten all the screws and the rolled pin.

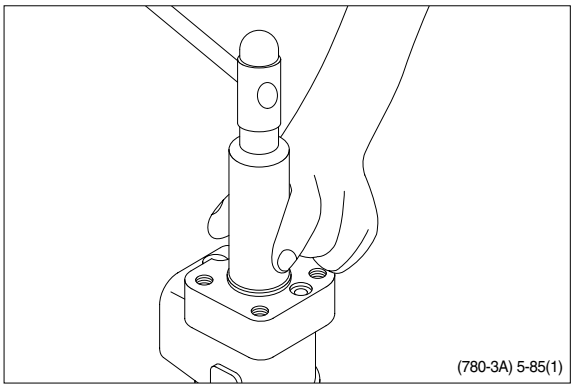
· Tightening torque : 3.1±0.6kgf · m
(22.4±4.3lbf · ft)


(780-3A) 5-84(3)

(31) Place the dust seal ring in the housing.

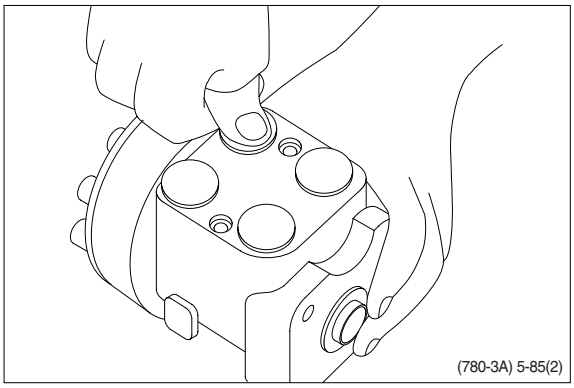

(780-3A) 5-84(4)

(32) Fit the dust seal ring in the housing using special tool and a plastic hammer.


(780-3A) 5-85(1)

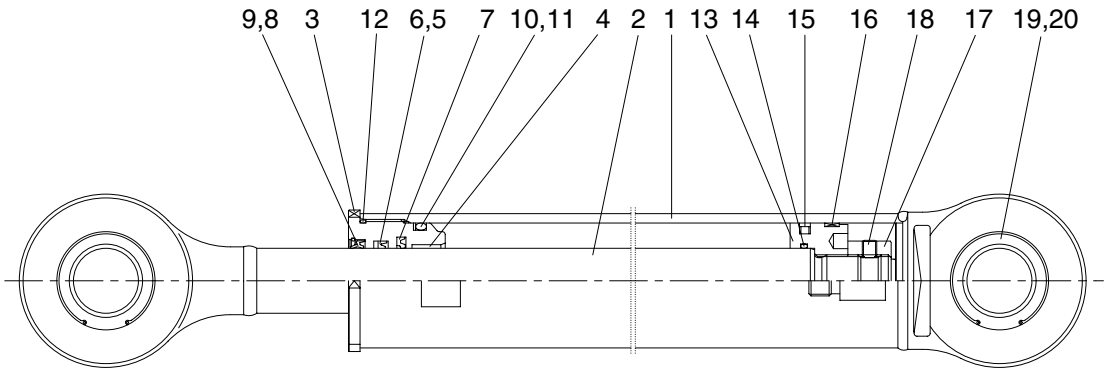
(33) Press the plastic plugs into the connection ports.

※ Do not use a hammer!


(780-3A) 5-85(2)

2. STEERING CYLINDER

1) STRUCTURE

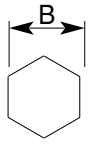


7607SE05

1	Tube assembly	8	Dust wiper	15	Piston seal
2	Rod assembly	9	Snap ring	16	Wear ring
3	Gland	10	O-ring	17	Piston nut
4	Bushing	11	Back up ring	18	Set serew
5	Rod seal	12	O-ring	19	Spherical bearing
6	Back up ring	13	Piston	20	Retaining ring
7	Buffer ring	14	O-ring		

2) TOOLS AND TIGHTENING TORQUE

(1) Tools

Tool name	B	Remark
L-wrench	5	
Spanner	36	
Wrench	For gland	
(-) 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	3	M85×3	75±8	542±58
Piston	13	M36×3	50±5	362±36
Piston nut	17	M36×3	75±8	542±58
Set screw	18	M10×1.5	5.4±0.5	39±3.6

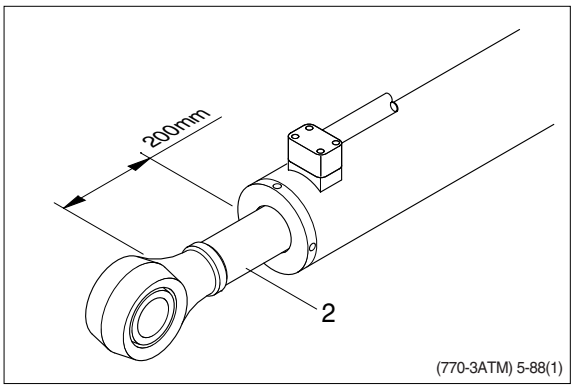
3) DISASSEMBLY

(1) Remove cylinder head and piston rod

① Hold the clevis section of the tube in a vise.

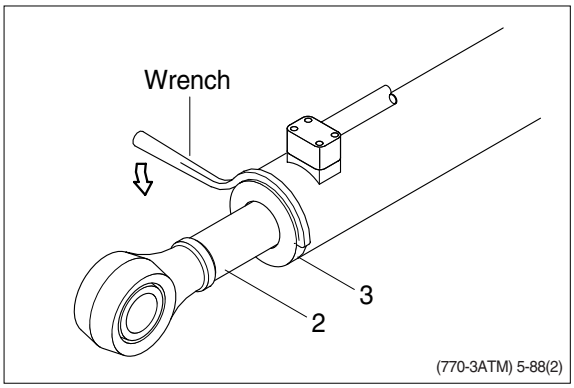
※ Use mouth pieces so as not to damage the machined surface of the cylinder tube. Do not make use of the outside piping as a locking means.

② Pull out piston rod(2) about 200mm (7.8in). Because the piston rod is rather heavy, finish extending it with air pressure after the oil draining operation.



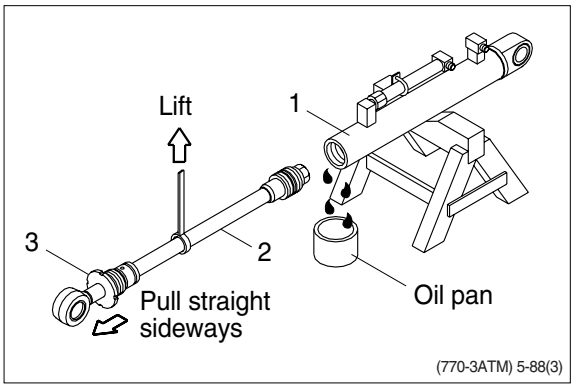
③ Loosen and remove the gland(3).

※ Cover the extracted piston rod(2) with rag to prevent it from being accidentally damaged during operation.



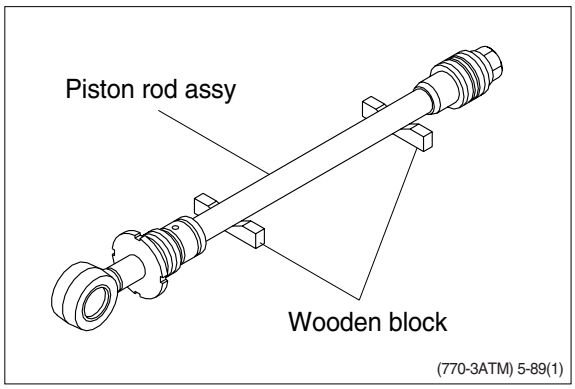
④ Draw out gland(3) and piston rod (2) assembly together from cylinder tube(1).

※ Since the piston rod assembly is heavy in this case, lift the tip of the piston rod(2) with a crane or some means and draw it out. However, when piston rod(2) has been drawn out to approximately two thirds of its length, lift it in its center to draw it completely.



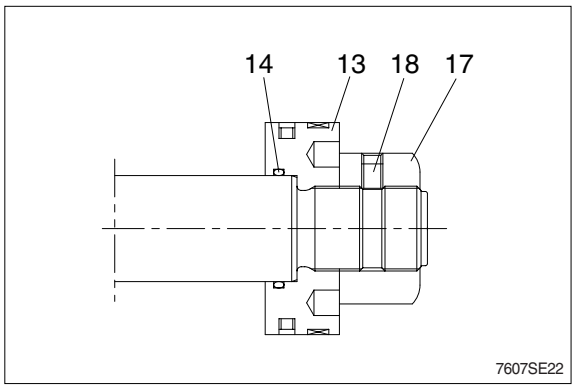
※ Note that the plated surface of piston rod(2) is to be lifted. For this reason, do not use a wire sling and others that may damage it, but use a strong cloth belt or a rope.

⑤ Place the removed piston rod assembly on a wooden V-block that is set level.
※ Cover a V-block with soft rag.

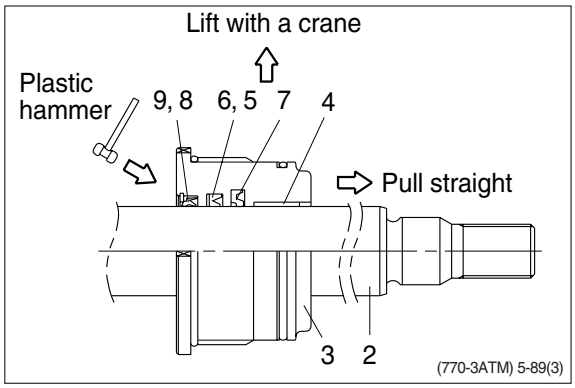


(2) Remove piston and gland assembly

① Remove the set screw(18).
② Remove the piston nut(17).
③ Remove piston assembly(13) and O-ring (14).



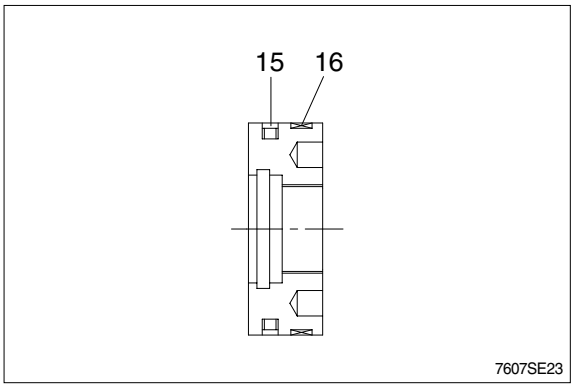
③ Remove the gland(3) assembly from piston rod(2).
※ If it is too heavy to move, move it by striking the flanged part of gland(3) with a plastic hammer.
※ Pull it straight with gland assembly lifted with a crane.
Exercise care so as not to damage the lip of rod bushing(4) and packing (5,6,7,8,9) by the threads of piston rod(2).



(3) Disassemble the piston assembly

① Remove wear ring(16).
Remove piston seal(15).

※ Exercise care in this operation not to damage the grooves.



(4) Disassemble gland assembly

① Remove back up ring(11), and O-ring (10).

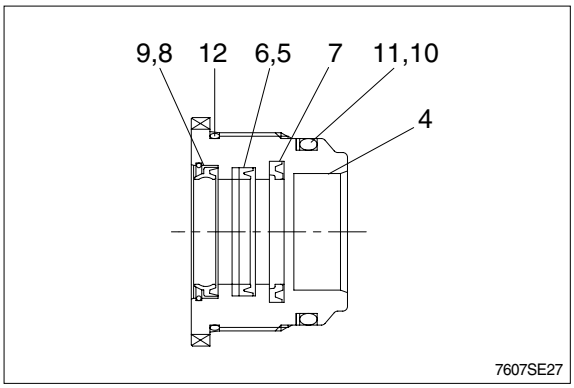
② Remove O-ring (12).

③ Remove snap ring(9) and dust wiper(8).

④ Remove back up ring(6), rod seal(5) and buffer ring(7).

※ Exercise care in this operation not to damage the grooves.

※ Do not remove seal and ring, if does not damaged.

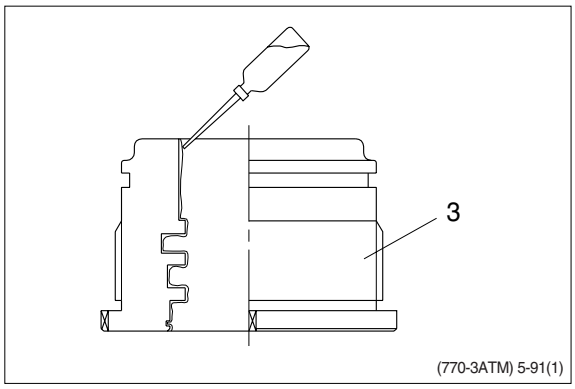


4) ASSEMBLY

(1) Assemble gland assembly

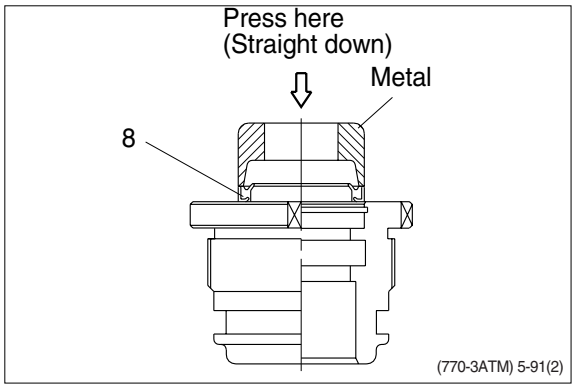
※ Check for scratches or rough surfaces if found smooth with an oil stone.

① Coat the inner face of gland(3) with hydraulic oil.



② Coat dust wiper(8) with grease and fit dust wiper(8) to the bottom of the hole of dust wiper.
At this time, press a pad metal to the metal ring of dust seal.

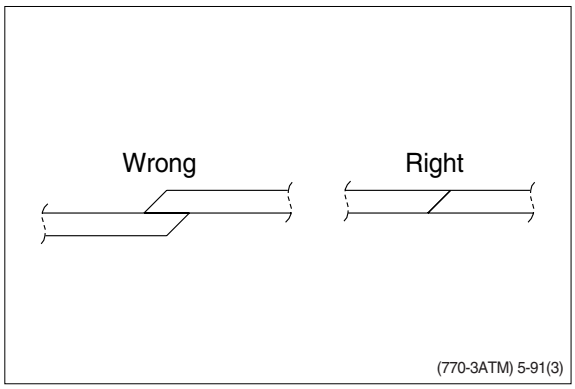
③ Fit snap ring(9) to the stop face.



④ Fit back up ring(6) and rod seal(5), and buffer ring(7) to corresponding grooves, in that order.

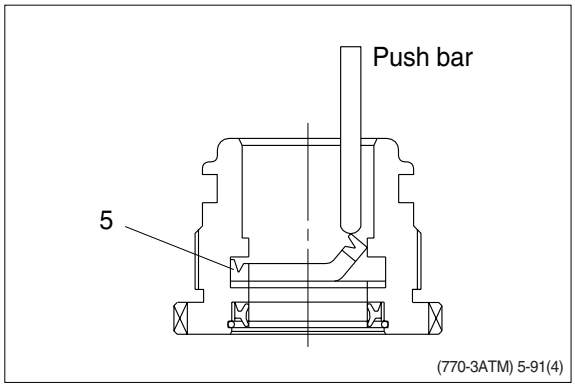
※ Coat each packing with hydraulic oil before fitting it.

※ Insert the backup ring until onside of it is inserted into groove.



※ Rod seal(5) has its own fitting direction. Therefore, confirm it before fitting them.

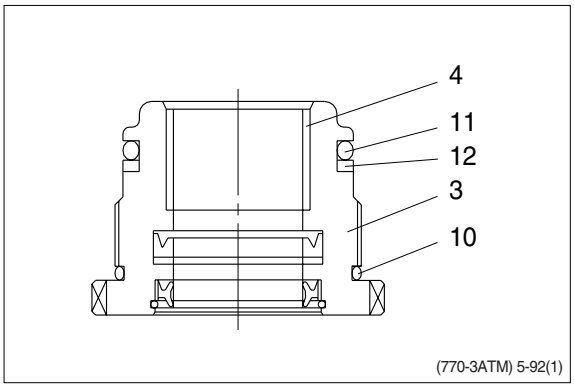
※ Fitting rod seal(5) up side down may damage its lip. Therefore check the correct direction that is shown in figure.



⑤ Fit back up ring(11) to gland (3).

※ Put the backup ring in the warm water of 30~50℃.

⑥ Fit O-ring(10) to gland(3).

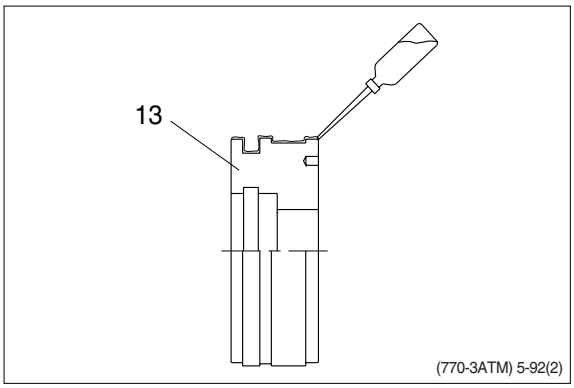


(770-3ATM) 5-92(1)

(2) Assemble piston assembly

※ Check for scratches or rough surfaces.

① If found smooth with an oil stone.
Coat the outer face of piston(13) with hydraulic oil.

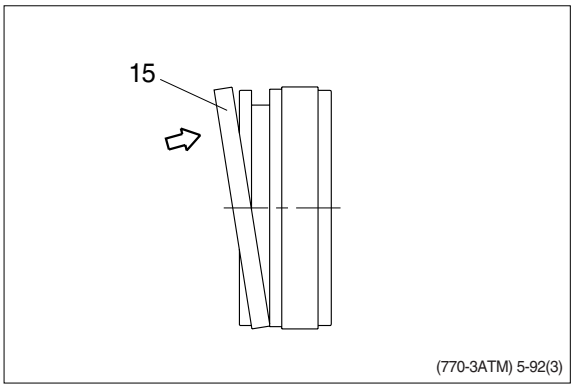


(770-3ATM) 5-92(2)

② Fit piston seal(15) to piston.

※ Put the piston seal in the warm water of 60~100℃ for more than 5 minutes.

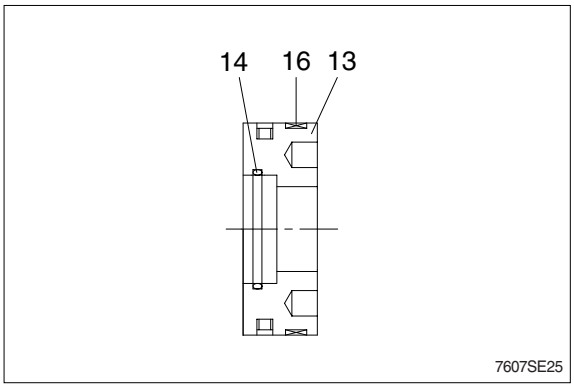
※ After assembling the piston seal, press its outer diameter to fit in.



(770-3ATM) 5-92(3)

③ Fit wear ring(16) to piston(13).

④ Fit O-ring(14) to piston(13).



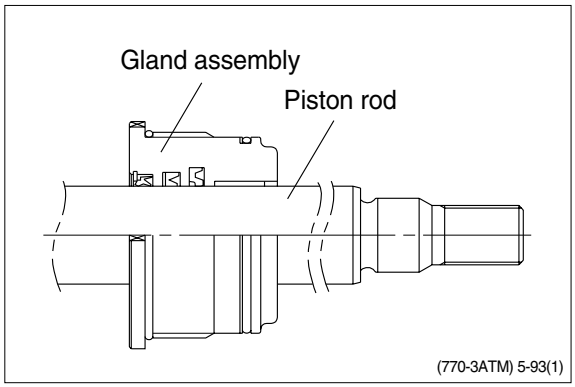
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(3) Install piston and gland assembly

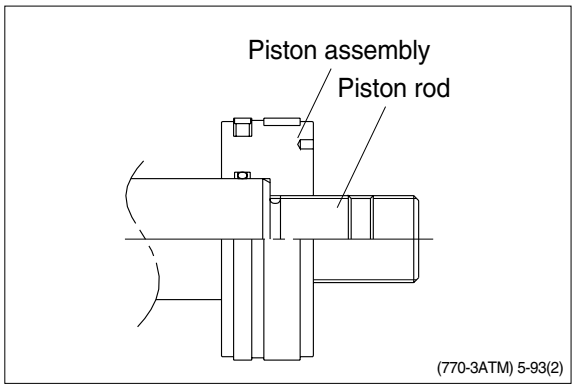
① Fix the piston rod assembly to the work bench.

② Apply hydraulic oil to the outer surface of piston rod(2), the inner surface of piston and gland.

③ Insert gland assembly to piston rod(2).



④ Fit piston assembly to piston rod.

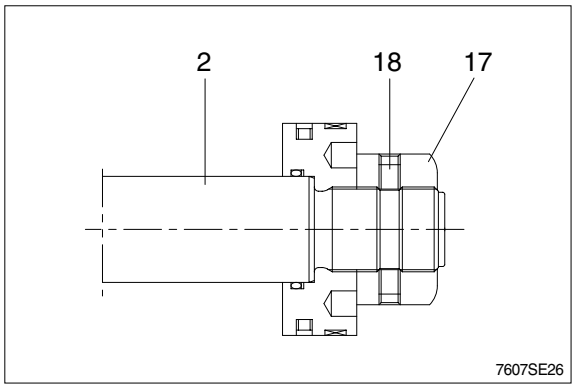


⑤ Tighten piston nut(17) to piston rod(2).

· Tightening torque : 75±8kgf · m
(542±58lbf · ft)

Tighten set screw(18) to piston nut(17).

· Tightening torque : 5.4±0.5kgf · m
(39±3.6lbf · ft)



(4) Overall assemble

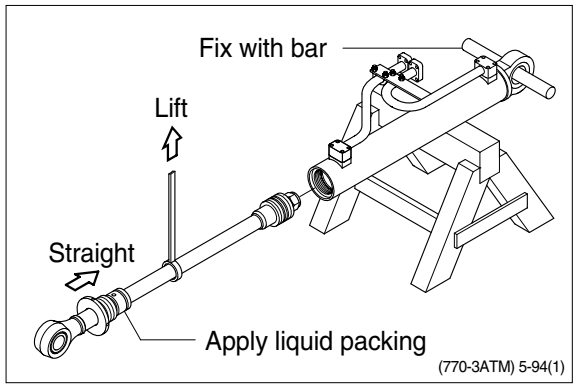
① Place a V-block on a rigid work bench. Mount the cylinder tube assembly(1) on it and fix the assembly by passing a bar through the clevis pin hole to lock the assembly.

② Insert the piston rod assembly in to the cylinder tube assembly, while lifting and moving the piston rod assembly with a crane.

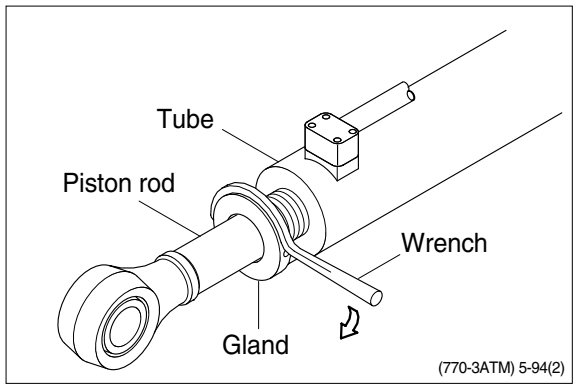
※ Be careful not to damage piston seal by thread of cylinder tube.

③ Match the bolts holes in the cylinder head flange to the tapped holes in the cylinder tube assembly and tighten socket bolts to a specified torque.

※ Refer to the table of tightening torque.



(770-3ATM) 5-94(1)

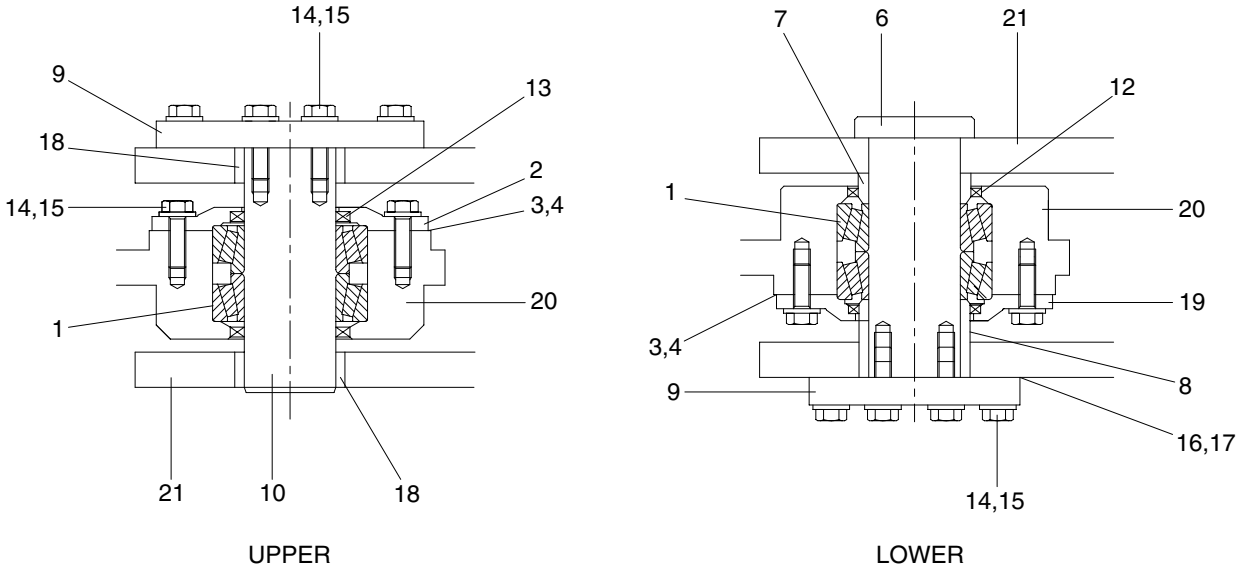


(770-3ATM) 5-94(2)

6. CENTER PIVOT PIN

1) CONSTRUCTION

Figure shows the construction of the center pivot pin assembly. This assembly serves to connect the front frame with the rear frame; two sets of assemblies are provided, one each for the upper and lower parts. The numbers in parentheses following the parts name denote the item numbers shown in the figure in the disassembly and assembly procedures.



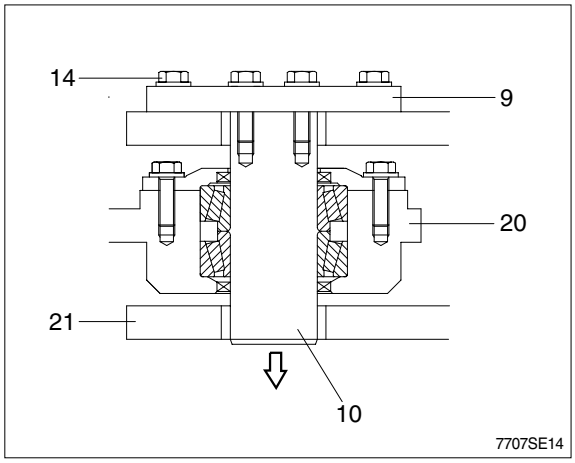
1	Bearing	9	Plate	16	Shim(0.1T)
2	Cover	10	Pin	17	Shim(0.5T)
3	Shim(0.1T)	12	Seal	18	Bushing
4	Shim(0.5T)	13	Seal	19	Cover
6	Pin	14	Hexagon bolt	20	Front frame
7	Collar	15	Hardened washer	21	Rear frame
8	Collar				

2) DISASSEMBLY

After supporting the front frame and the rear frame as horizontally as possible using wood blocks and jacks, disassemble as follows: In order to facilitate the disassembly/assembly of the center pivot pins, remove the drive shaft, hydraulic line and steering cylinder first.

(1) Maintain the horizontal level of front frame(20) and rear frame(21), and then remove hexagon bolt(14) and plate(9).

(2) Take out upper pin(10) to the downside using a metal punch.



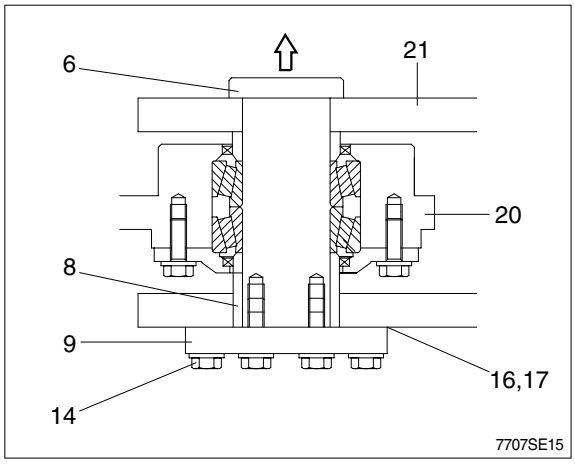
(3) Maintain the front frame horizontal level, remove hexagon bolts(14) and then remove the plate(9) and shims(16,17).

(4) Take out lower pin(6) to the upside using a metal punch carefully.

(5) Jack up or lifting the front frame(20) slightly, the collar(8) protrudes over the rear frame.
Remove the collar(8).

(6) Lift the frame by passing the slinging wire rope at four positions of front frame, in order to separate it from the rear frame.

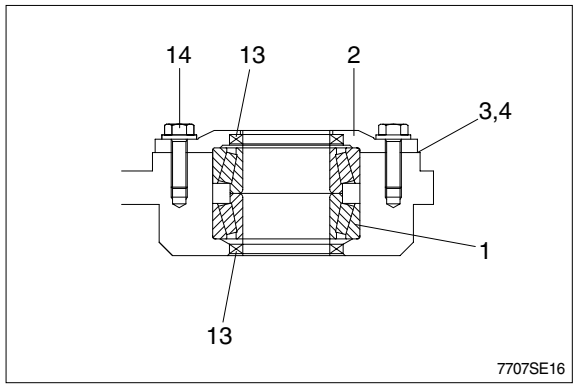
(7) Support the front frame safely.



(8) Remove bolt(14) and then take out cover(2) and shims(3,4).

(9) Take out dust seal(13) from the cover(2).

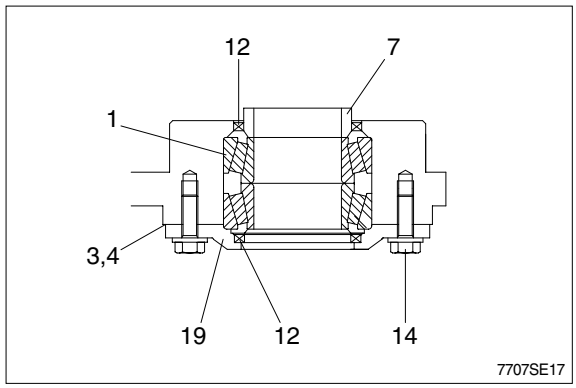
(10) Remove the bearing(1), and dust seal(13).



(11) Remove bolt(14) and then take out cover(19) and shims(3,4).

(12) Take out the dust seal(12) from the cover(19).

(13) Remove the bearing(1), collar(7) and dust seal(12).



3) INSPECTION

(1) Check the bearing sliding surface for excessive wear, scorching or scratches; replace if necessary.

(2) Replace all dust seals(12,13) with new ones.

(3) Grind any pins(6, 10) dented with an oilstone or replace any pins abrasive excessively.

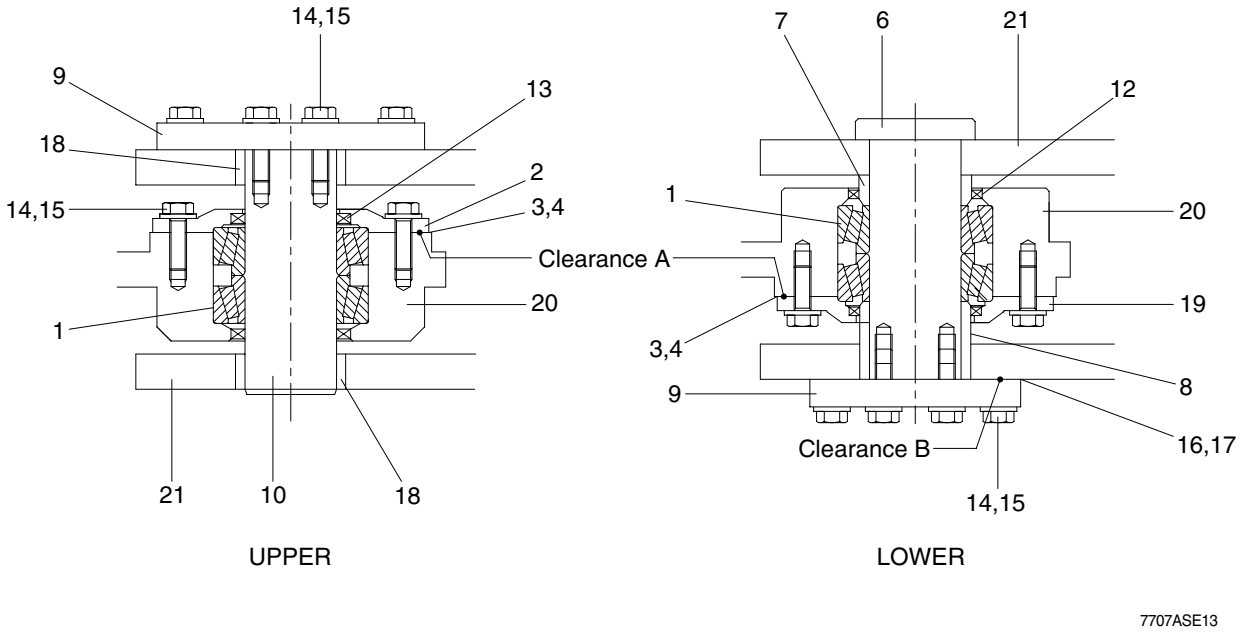
(4) Check inside cover(2, 19) and collar(7, 8) for dents or scratches; if any damage is found, correct with a grinder or replace.

(5) The serviceable limit of pins and bushings is shown in the table below.

Unit : mm

Item No.	Name	Std dimension	Serviceable limit			Remedy
			Outer dia	Inner dia	Clearance	
6, 10	Pin	90	89.5		0.8	Replace
1	Tapered roller bearing			90.5		
7, 8	Collar			90.5		
12, 13	Dust seal	When removed				Replace

4) ASSEMBLY



Assemble the center pivot group by reversing the order of disassembly while paying close attention to the following.(Assembly position, see page 5-93)

(1) Put the dust seal(12,13) into cover(2, 19) and front frame(20).

※ Apply grease to the lip of the dust seal. Insert the dust seal so that the dust seal lip faces out and punch four places on the outer circumference of the seal to lock it.

(2) Lower the temperature of the lower bearing cup to -75±5°C (-103±9°F) and install it to front frame until it contacts the bottom of the frame.

(3) Coat lightly with oil and install lower bearing in bore in front frame. Coat lightly with oil and install upper bearing in bore in upper front frame.

(4) Position the cover(2, 19) and hold in place with bolt(14). At this time, adjust shims(3,4) to press the shoulder of bearing(1) against retainer.

· Adjustment method of clearance A

① Install bearing and cover without shim(3, 4)
Install four of bolt(14) so that each bolt is seperated by 90 degrees.
· Tightenig torque : 1.5~1.7kgf · m(10.8~12.3lbf · ft)

② Adjust shims in order to control the clearance A.
· Clearance A : Below 0.1mm
· Shim thickness : 0.1mm, 0.5mm

(5) Apply grease to lower collar(8) and insert it to the lower of roller bearing.

(6) After setting the bearing so that its upper surface is horizontal, tighten the all the bolt(14).
After tightening, confirm that tapered roller bearing moves lightly ; if does not move smoothly, add shims(3,4).
- Tightening Torque : 25.4~34.2kgf · m(184~247lbf · ft)
- Apply loctite #243.

(7) Move the front frame and join it to the rear frame so that match the pin hole at the center.

(8) Apply grease to pin(10), bushing(18) and insert it into tapered roller bearing(1).

(9) Apply grease to lower collar(8) and insert it to the lower of roller bearing through rear frame(21).

(10) Apply grease to pin(6) and insert it into tapered roller bearing(1).

(11) Before tightening bolt(14), adjust shims(16,17) in order to control the clearance between the plate(9) and rear frame(21).
- **Adjustment method of clearance B**

① Install pin(6) and plate(9) without shim(16, 17).
Install four of bolt(14) so that each bolt is seperated by 90 degrees.
- Tighting torque : 1.5~1.7kgf · m(10.8~12.3lbf · ft)

② Adjust shims in order to control the clearance B.
- Clearance B : 0.1~0.2mm
- Shim thickness : 0.1mm, 0.5mm

(12) Tighten the all the bolts(14).
- Tightening Torque : 25.4~34.2kgf · m(184~247lbf · ft)
- Apply loctite #243.

5) TROUBLESHOOTING

Trouble	Probable cause	Remedy
Shock is felt when steering	Capscrew for fixing steering valve is loose	Retighten
	Faulty center pivot pin mounting bolts	Retighten
	Center pivot pins have worn out	Readjust or replace
	Faulty hydraulic system	See hydraulic system
Shock is felt when moving backward or forward	Fault fixing of connecting capscrews	Retighten
	Center pins have worn out	Readjust or replace
	Bearings of support unit have worn out	Retighten
	Drive shaft damaged	See drive system
	Faulty transmission	See transmission system

SECTION 6 WORK EQUIPMENT

Group 1 Structure and Function ····· 6-1
Group 2 Operational Checks and Troubleshooting ····· 6-35
Group 3 Tests and Adjustments ····· 6-46
Group 4 Disassembly and Assembly ····· 6-62

GROUP 1 STRUCTURE AND FUNCTION

1. HYDRAULIC SYSTEM OUTLINE

The loader hydraulic system is a pilot operated, open center system which is supplied with flow from the fixed displacement main hydraulic pump.
The pilot control system is a low pressure, closed center hydraulic system which is supplied with flow from the first(Steering) pump.

The loader system components are :

- Main pump
- Main control valve
- Bucket cylinder
- Boom cylinders
- Pilot supply unit
- Remote control valve(Pilot control valve)
- Safety valve

The pilot supply unit consists of the pressure reducing valve, relief valve and accumulator.

Flow from the main hydraulic pump not used by the steering system leaves the steering valve(EHPS) EF port.
It flows to the inlet port plate of a mono block type main control valve.

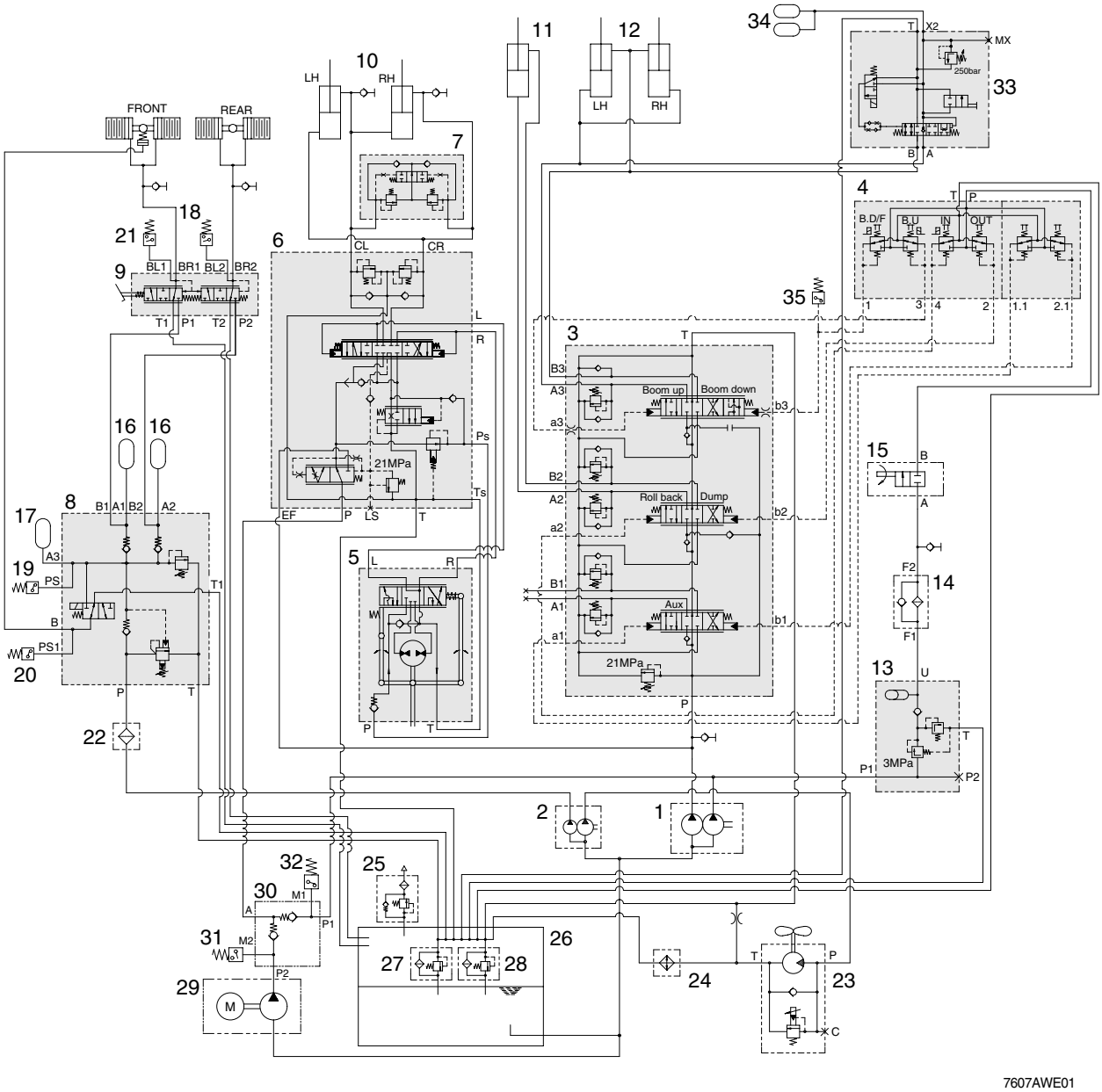
The main control valve is a tandem version spool type, open center valve which routes flow to the boom, bucket or auxiliary cylinders(Not shown) when the respective spools are shifted.

Flow from the steering pump is routed to the pilot supply unit where the steering pump outlet pressure is reduced to pilot circuit pressure. The pilot supply unit flow to the remote control valve.
The remote control valve routed flow to either end of each spool valve section in the main control valve to control spool stroke.

A accumulator mounted on pilot supply unit supplies a secondary pressure source to operated remote control valve so the boom can be lowered if the engine is off.

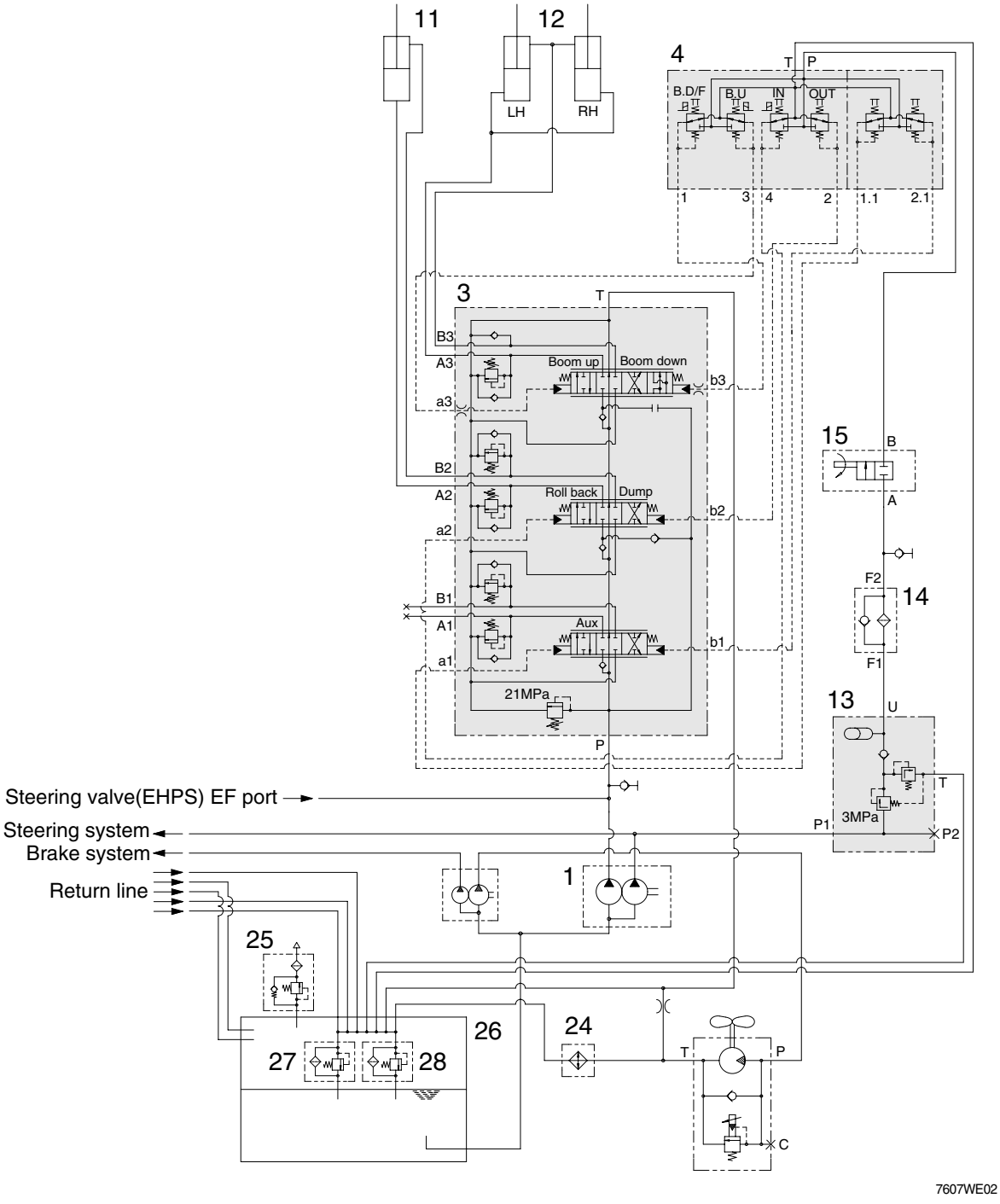
The return circuit for the main hydraulic system have return filter inside the hydraulic tank. The return filter uses a filter element and a bypass valve. The bypass valve is located in the upside of filter.

2. HYDRAULIC CIRCUIT



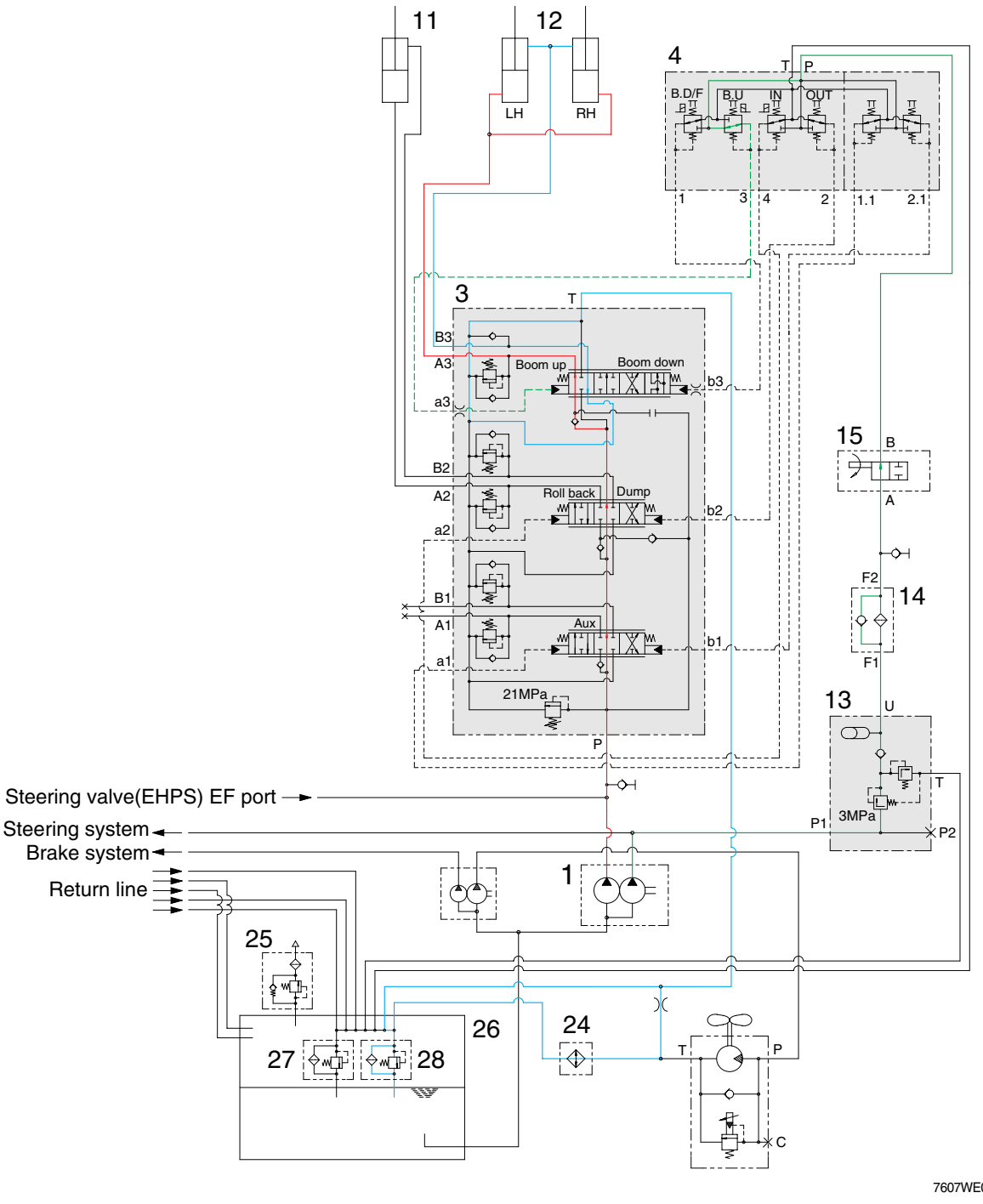
1	Main pump	13	Pilot supply unit	25	Air breather
2	Fan & brake pump	14	Line filter	26	Hydraulic tank
3	Main control valve	15	Safety valve	27	Return filter
4	Remote control valve	16	Accumulator	28	Bypass valve
5	Steering unit	17	Accumulator	29	Pump motor(Option)
6	Steering valve(EHPS)	18	Pressure switch	30	Check valve(Option)
7	Cushion valve	19	Pressure switch	31	Pressure switch(Option)
8	Cut off valve	20	Pressure switch	32	Pressure switch(Option)
9	Brake valve	21	Pressure switch	33	Ride control valve(Option)
10	Steering cylinder	22	Line filter	34	Accumulator(Option)
11	Bucket cylinder	23	Fan motor	35	Pressure switch(Option)
12	Boom cylinder	24	Oil cooler		

3. WORK EQUIPMENT HYDRAULIC CIRCUIT



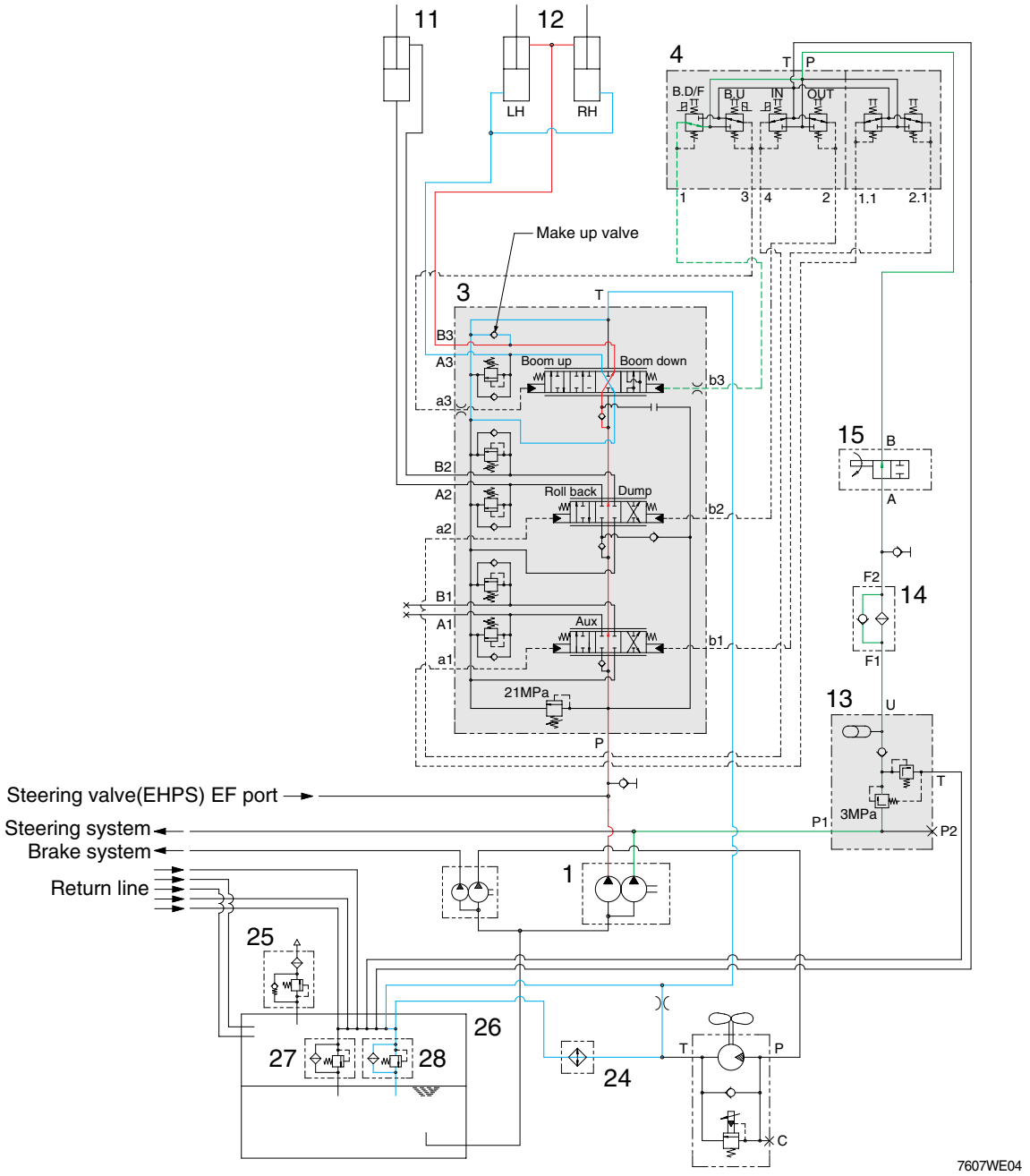
1	Main pump	13	Pilot supply unit	25	Air breather
3	Main control valve	14	Line filter	26	Hydraulic tank
4	Remote control valve	15	Safety valve	27	Return filter
11	Bucket cylinder	24	Oil cooler	28	Bypass valve
12	Boom cylinder				

1) WHEN THE RCV LEVER IS IN THE RAISE POSITION



- When the RCV lever(4) is pulled back, the boom spool is moved to raise position by pilot oil pressure from port 3 of RCV.
- The oil from main pump(1) flows into main control valve(3) and then goes to the large chamber of boom cylinder (12) by pushing the load check valve of the boom spool through center bypass circuit of the bucket spool.
- The oil from the small chamber of boom cylinder(12) returns to hydraulic oil tank(26) through the boom spool at the same time.
- When this happens, the boom goes up.

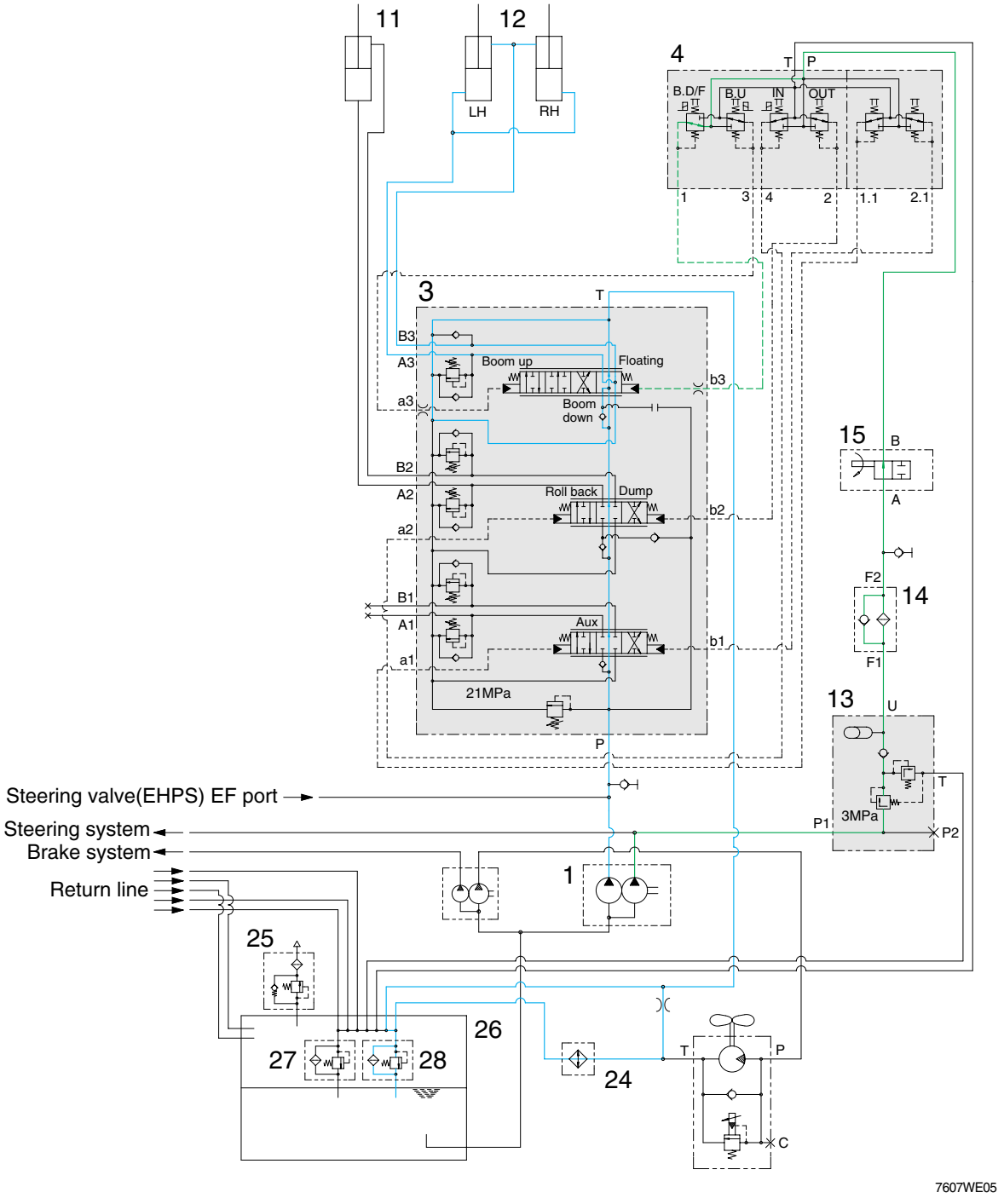
2) WHEN THE RCV LEVER IS IN THE LOWER POSITION



- When the RCV lever(4) is pushed forward, the boom spool is moved to lower position by pilot pressure.
- The oil from main pump(1) flows into main control valve(3) and then goes to small chamber of boom cylinder(12) by pushing the load check valve of the boom spool through center bypass circuit of the bucket spool.
- The oil returned from large chamber of boom cylinder(12) returns to hydraulic tank(26) through the boom spool at the same time.
- When the lowering speed of boom is faster, the return oil from the large chamber of boom cylinder combines with the oil from the pump through the make up valve, and flows into the small chamber of the cylinder.

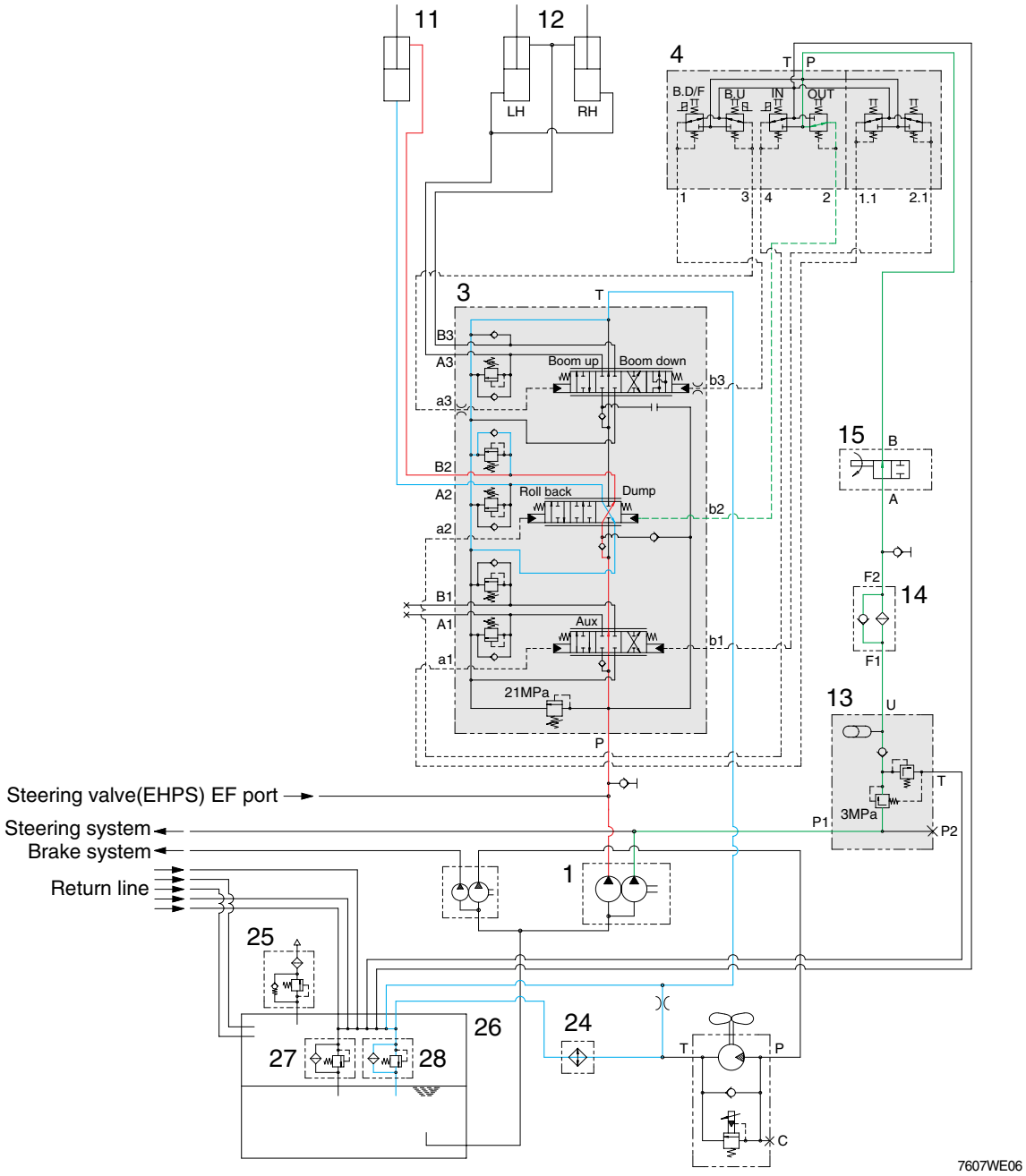
  This prevents cylinder cavitation by the negative pressure when the pump flow cannot match the boom down speed.

3) WHEN THE RCV LEVER IS IN THE FLOAT POSITION



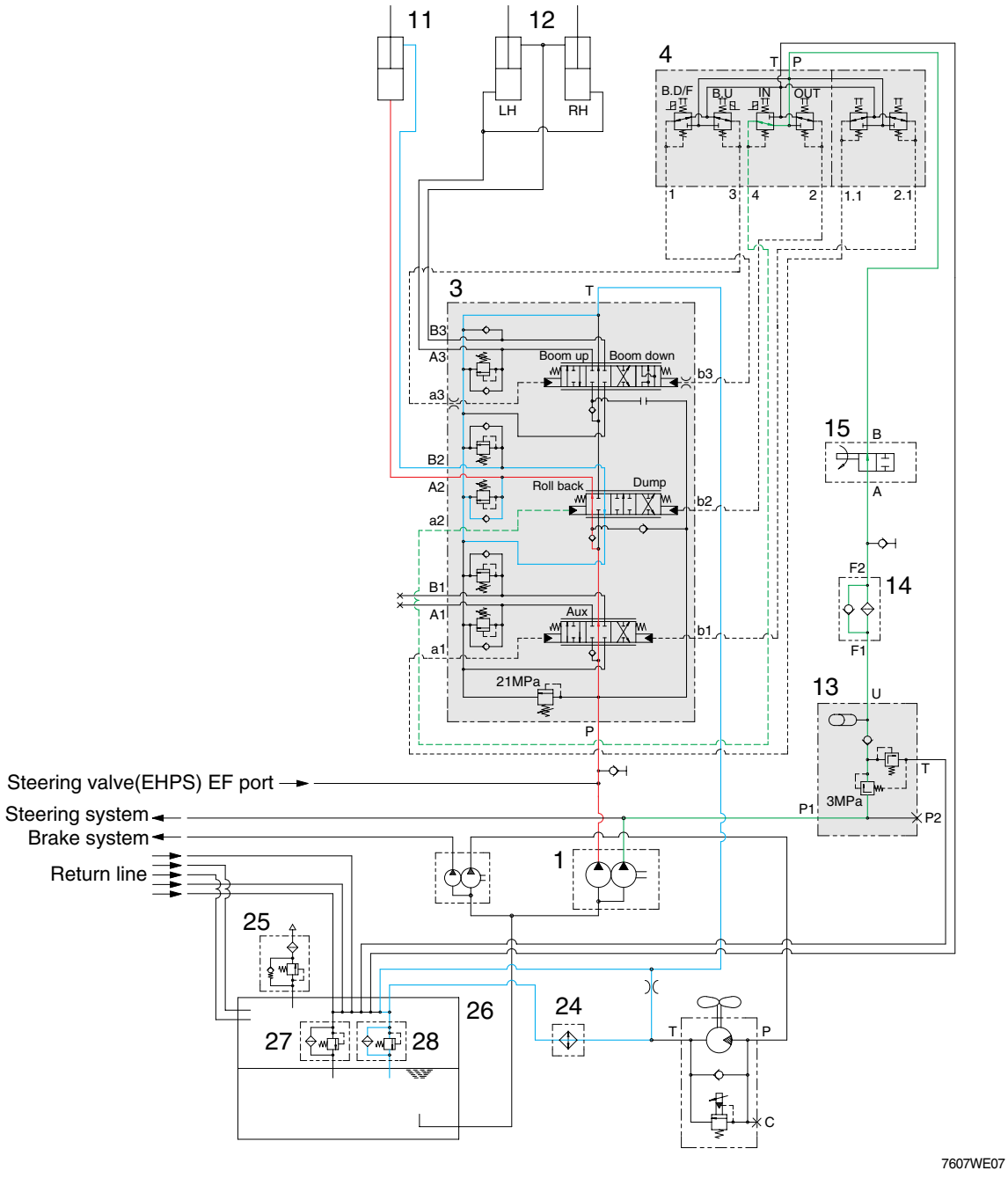
- When the RCV lever(4) is pushed further forward from the lower position, the pitot pressure reaches to 13~15bar, then the boom spool is moved to floating position.
- The work ports(A3), (B3) and the small chamber and the large chamber are connected to the return passage, so the boom will be lowered due to it's own weight.
- In this condition, when the bucket is in contact with the ground, it can be move up and down in accordance with the shape of the ground.

4) WHEN THE RCV LEVER IS IN THE DUMP POSITION



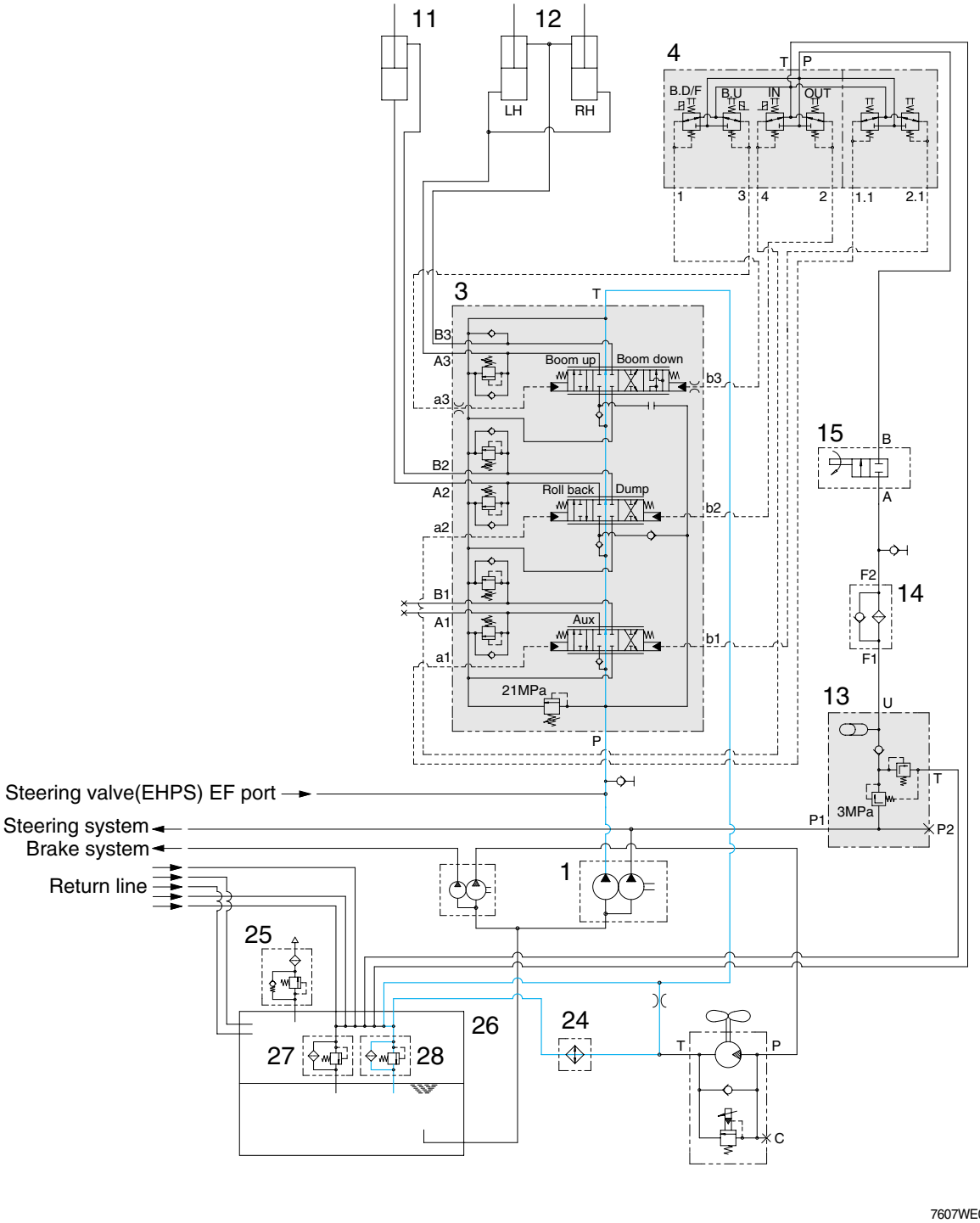
- If the RCV lever(4) is pushed right, the bucket spool is moved to dump position by pilot oil pressure from port 2 of RCV.
- The oil from main pump(1) flows into main control valve(3) and then goes to the small chamber of bucket cylinder(11) by pushing the load check valve of the bucket spool.
- The oil at the large chamber of bucket cylinder(11) returns to hydraulic tank(26) through the bucket spool.
- When this happens, the bucket is dumped.
- When the dumping speed of bucket is faster, the oil returned from the large chamber of bucket cylinder combines with the oil from the pump, and flows into the small chamber of the cylinder.
  This prevents cylinder cavitation by the negative pressure when the pump flow cannot match the bucket dump speed.

5) WHEN THE RCV LEVER IS IN THE ROLL BACK(retract) POSITION



- If the RCV lever(4) is pulled left, the bucket spool is moved to roll back position by pilot oil pressure from port 4 of RCV.
- The oil from main pump(1) flows into main control valve(3) and then goes to the large chamber of bucket cylinder by pushing the load check valve of the bucket spool.
- The oil at the chamber of bucket cylinder(11) returns to hydraulic tank(26) through the bucket spool.
- When this happens, the bucket roll back.
- When the rolling speed of bucket is faster, the return oil from the small chamber of bucket cylinder combines with the oil from the pump, and flows into the large chamber of the cylinder.
  This prevents cylinder cavitation by the negative pressure when the pump flow cannot match the bucket rolling speed.

6) WHEN THE RCV LEVER IS IN THE HOLD POSITION

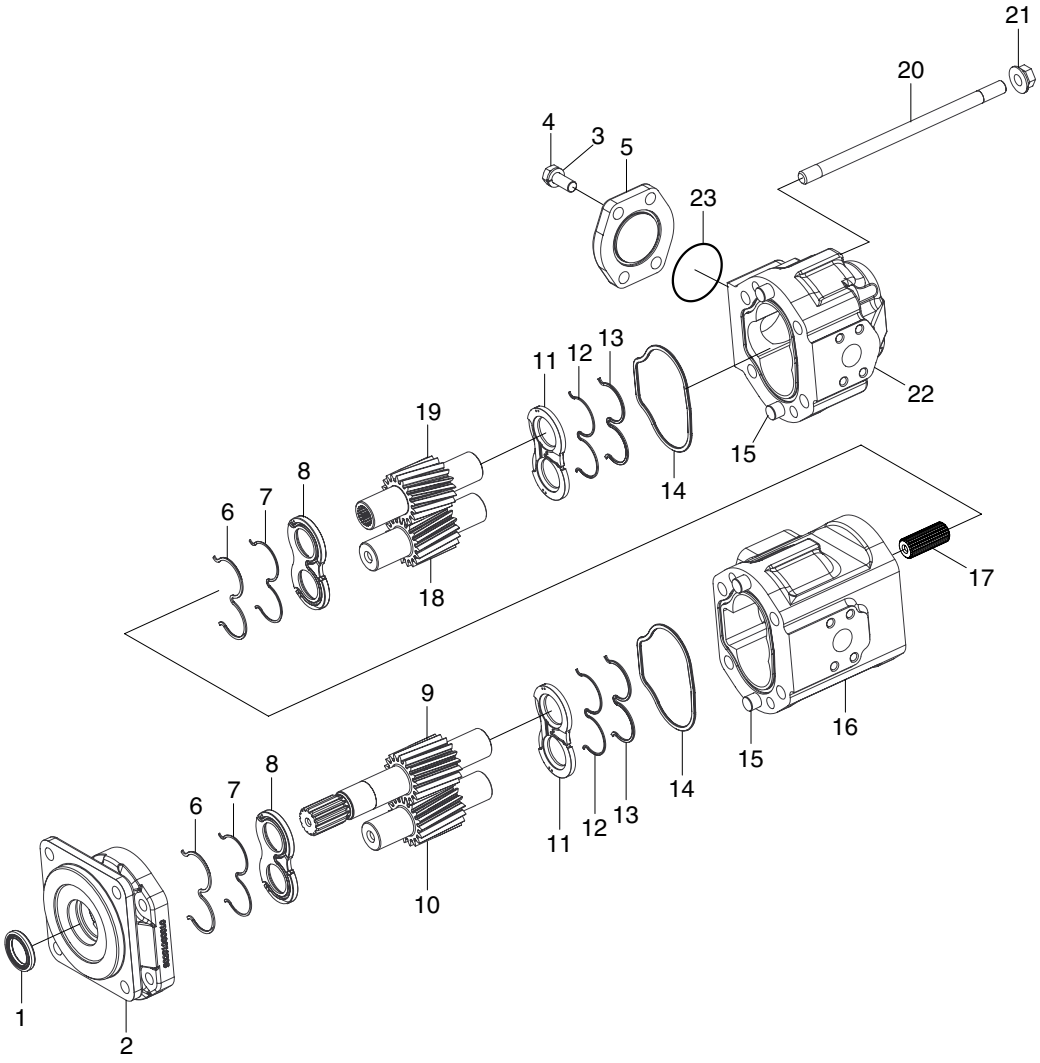


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- The oil from main pump(1) flows into main control valve(3).
- In this time, the bucket spool, the boom spool and the boom float spool are in neutral position, then the oil supplied to main control valve(3) returns into hydraulic tank(26) through center bypass circuit of each spool.
- In this condition, each cylinder keeps the neutral position, so the boom and the bucket is holded.

4. MAIN PUMP

1) STRUCTURE



7607WE33

1	Shaft seal	9	Front drive gear	17	Spline coupling
2	Adapter	10	Front driven gear	18	Rear driven gear
3	Washer	11	Wearplate	19	Rear drive gear
4	Bolt	12	O-ring seal	20	Stud
5	Flange	13	Back up seal	21	Flanged nut
6	Back up seal	14	Interface seal	22	Rear body
7	O-ring seal	15	Dowel	23	O-ring
8	Wearplate	16	Front body		

2) OPERATION

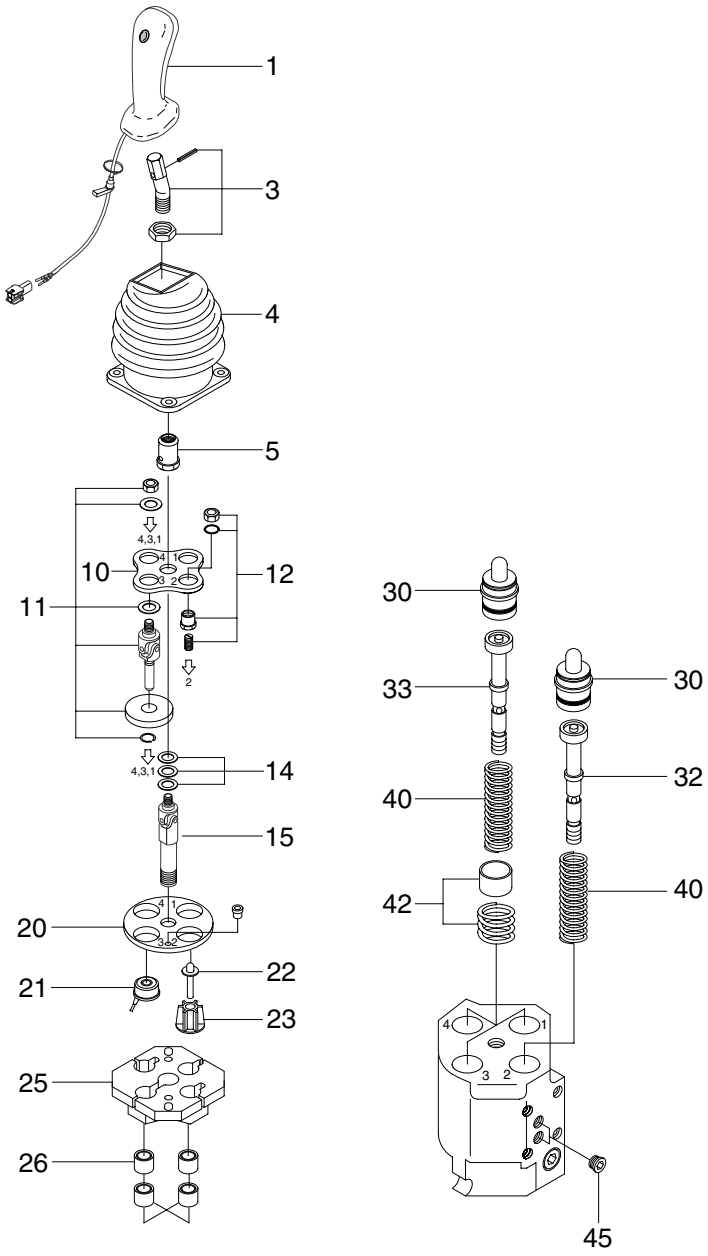
The main hydraulic pump is a fixed displacement gear type pump. The pump is drive at engine speed by the transmission. The pump shafts are supported by shaft seal(1) adapter(2), front body(16) and rear body(22). The wearplate(8, 11) are located between the gear surface and adapter(1), rear body(22) and front body(16).

As the drive gear(9) and (19) turns the idler gears(10, 18), the gear teeth come out of mesh. Oil flows from the hydraulic tank through the inlet into the cavity between the gear teeth. As the gears continue to rotate, the oil becomes trapped between the gear teeth and front body(16).
The trapped oil is then carried to the pump outlet. Oil is forced out the outlet to supply the hydraulic function. As the gears re-mesh, they form a seal to prevent oil from flowing between the gears and back to the inlet.

The pump uses outlet pressure oil to load the wearplate(8, 11) against the gear faces. This controls internal leakage to maintain pump displacement.
Outlet pressure fills the area bounded by the pressure balance moulded seals(6, 7) to force the wearplate against the high pressure area or the gear faces.

5. REMOTE CONTROL VALVE

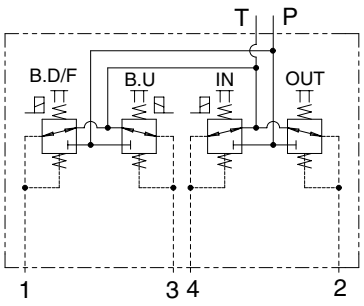
1) STRUCTURE



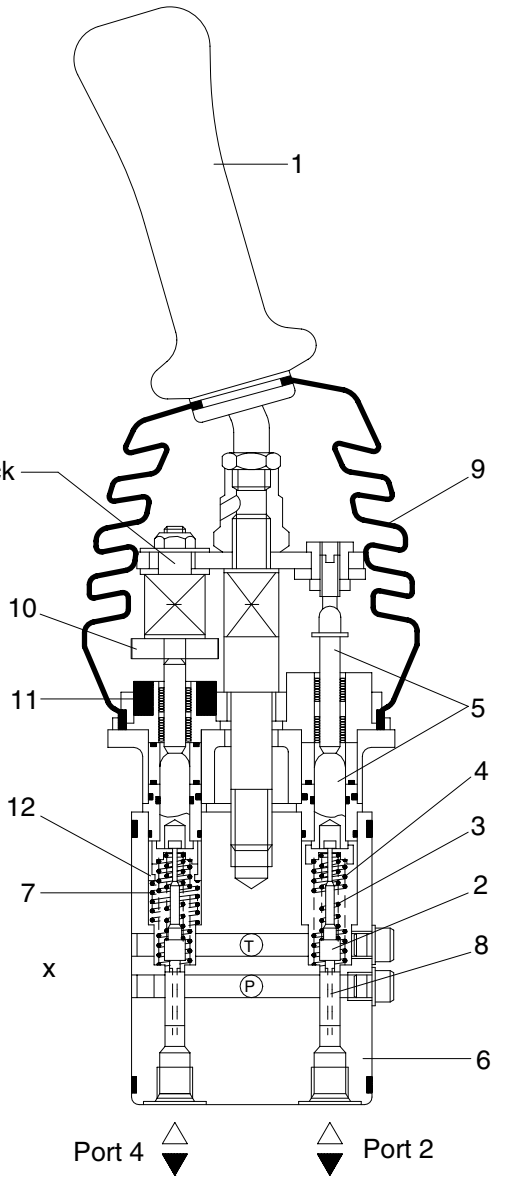
7707WE11

1	Handle	14	Shim set	26	Bushing kit
3	Lever kit	15	Joint	30	Plunger kit
4	Bellows	20	Flange	32	Regulating unit
5	Nut	21	Solenoid complete	33	Regulating unit
10	Bracket	22	Plunger kit	40	Spring set
11	Detent kit	23	Plunger guide	42	Prefeel point kit
12	Plunger kit	25	Electric bracket	45	Plug set

2) OPERATION



HYDRAULIC CIRCUIT
(3 Electromagnetic locks)



(1) Hydraulic functional principle

Pilot devices with end position locks operate as direct operated pressure reducing valves.

They basically comprise of control lever(1), four pressure reducing valves, housing(6) and locks.

Each pressure reducing valve comprises of a control spool(2), a control spring(3), a return spring(4) a plunger(5).

At rest, control lever(1) is held in its neutral position by return springs(4). Ports(1, 2, 3, 4) are connected to tank port T via drilling(8).

When control lever(1) is deflected, plunger(5) is pressed against return spring(4) and control spring(3).

Control spring(3) initially moves control spool(2) downwards and closes the connection between the relevant port and tank port T. At the same time the relevant port is connected to port P via drilling(8). The control phase starts as soon as control spool(2) finds its balance between the force from control spring(3) and the force, which results from the hydraulic pressure in the relevant port(ports 1, 2, 3 or 4).

Due to the interaction between control spool(2) and control spring(3) the pressure in the relevant port is proportional to the stroke of plunger(5) and hence to the position of control lever(1).

This pressure control which is dependent on the position of the control lever and the characteristics of the control spring permits the proportional hydraulic control of the main directional valves and high response valves for hydraulic pumps.

A rubber bellows(9) protects the mechanical components in the housing from contamination.

(2) End position lock

Only those control ports, for which it is necessary to hold the control lever in a deflected position are equipped with end position locks.

Electromagnetic lock

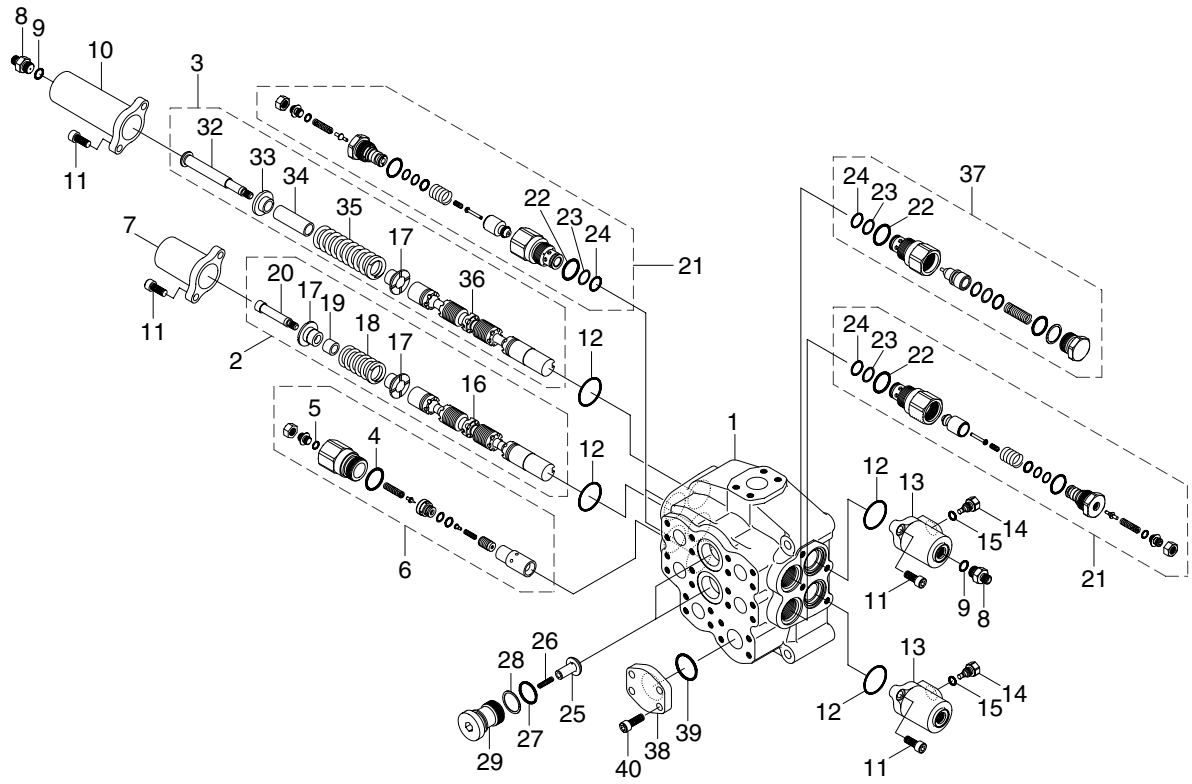
An additional spring(7), which is fitted below an additional plate(12) warns, by means of an increased force, which is required for compressing this spring, that the plunger(5) and the control lever(1) have almost reached their end position.

When this threshold is overcome, a ring(10) contacts the solenoid armature(11); if the solenoid is energized, then control lever(1) is held in its end position by magnetic force.

This lock is released automatically when the solenoid is deenergized.

6. MAIN CONTROL VALVE

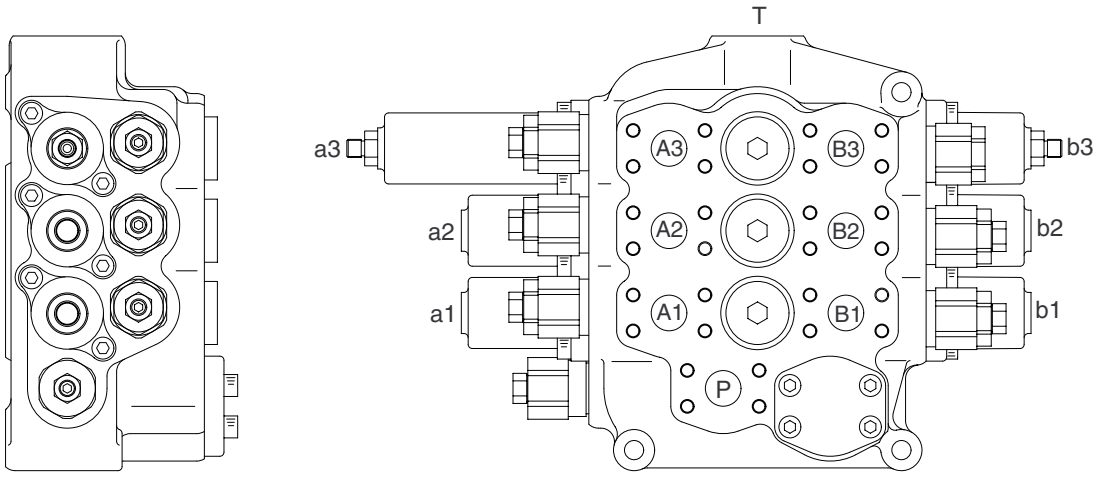
1) STRUCTURE

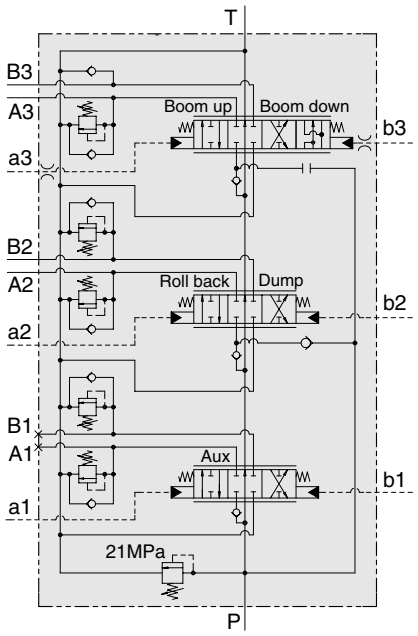


7607WE09

1	Housing assembly	14	Plug	27	O-ring
2	Plunger assembly	15	O-ring	28	Back up ring
3	Plunger assembly	16	Plunger	29	Cap
4	O-ring	17	Guide	32	Cap
5	O-ring	18	Spring	33	Guide
6	Main relief assembly	19	Spacer	34	Spacer
7	Cover	20	Nipple	35	Spring
8	Nipple	21	Port relief assembly	36	Plunger
9	O-ring	22	O-ring	37	Make up assembly
10	Cover	23	Back up ring	38	Cover
11	Socket bolt	24	O-ring	39	O-ring
12	O-ring	25	Check	40	Bolt
13	cover	26	Spring		

STRUCTURE





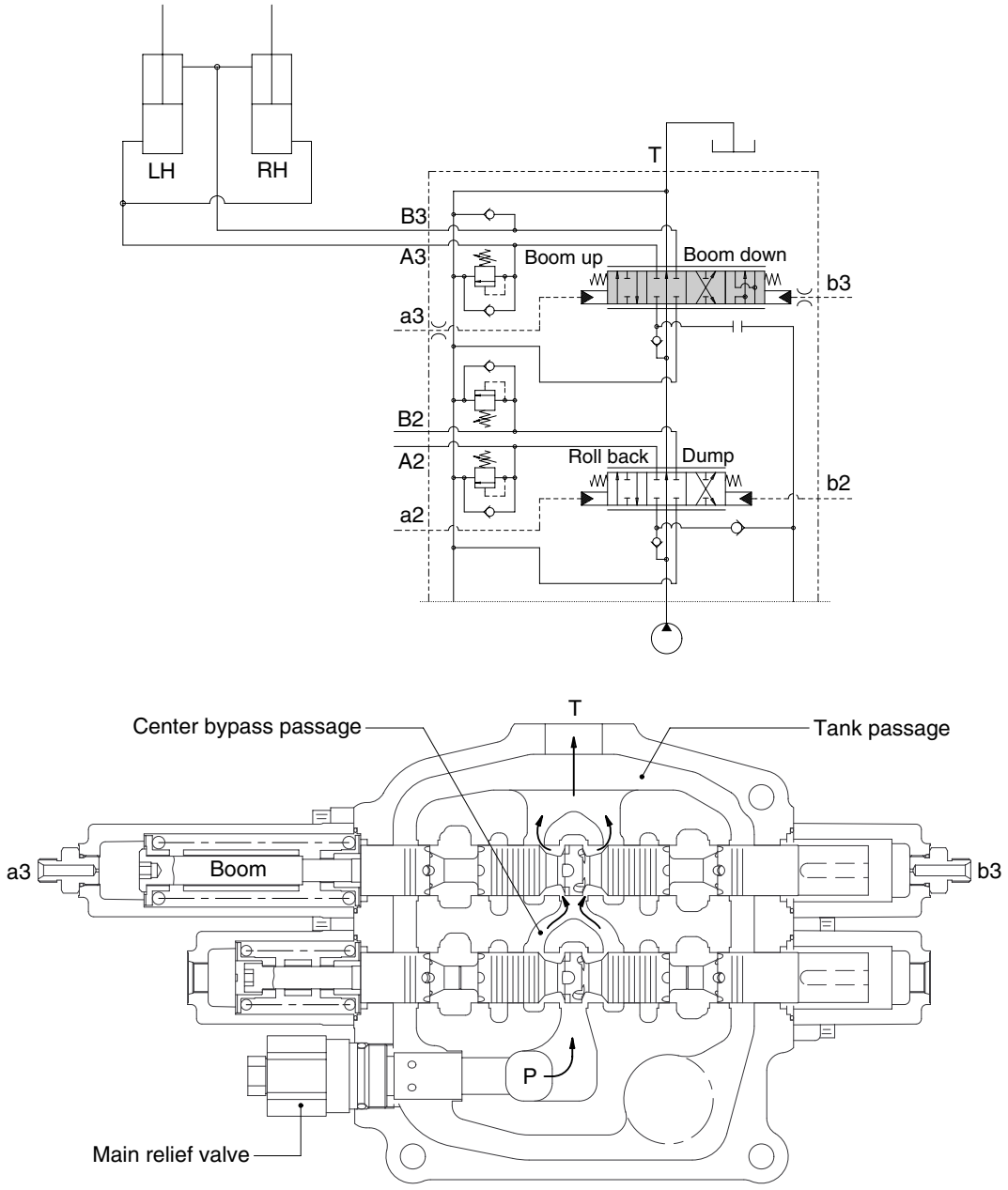
Hydraulic circuit

7607WE10

Port	Port name	Port size
P	From main pump	1″ Split flange
T	To hydraulic tank	1-1/4″ Split flange
A2, B2	To bucket cylinder port	1″ Split flange
A3, B3	To boom cylinder port	1″ Split flange
a3, b3	Boom pilot port	PF 3/8″ Fitting
a2, b2	Bucket pilot port	PF 3/8 O-ring boss

2) BOOM SECTION OPERATION

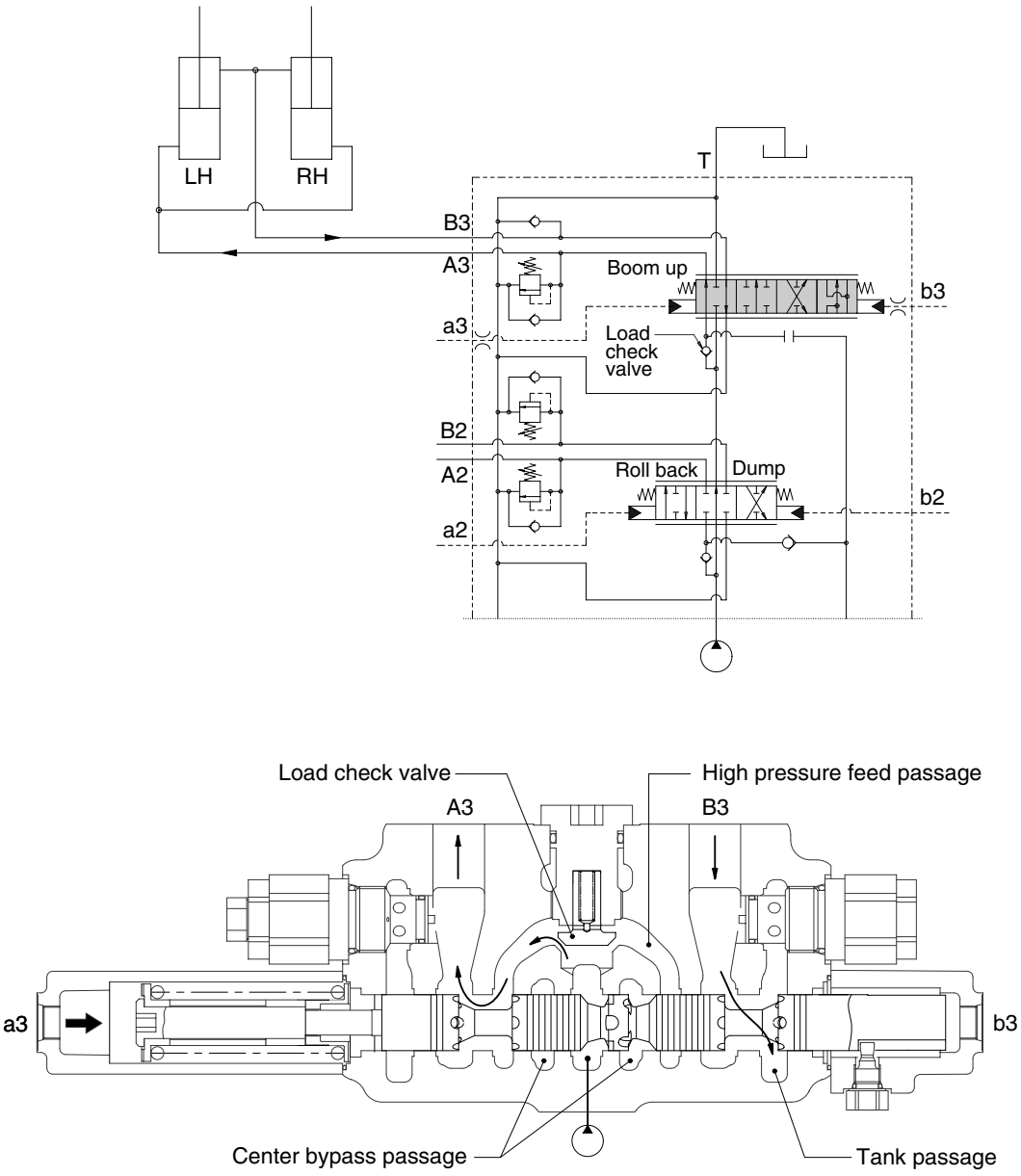
(1) Spool in neutral



When the boom plunger is in neutral position, oil from the pump flows to the tank through the center bypass line.

The cylinder port(A3, B3) are shut off from the high pressure feed passage and tank passage by the boom plunger.

(2) Boom raise position



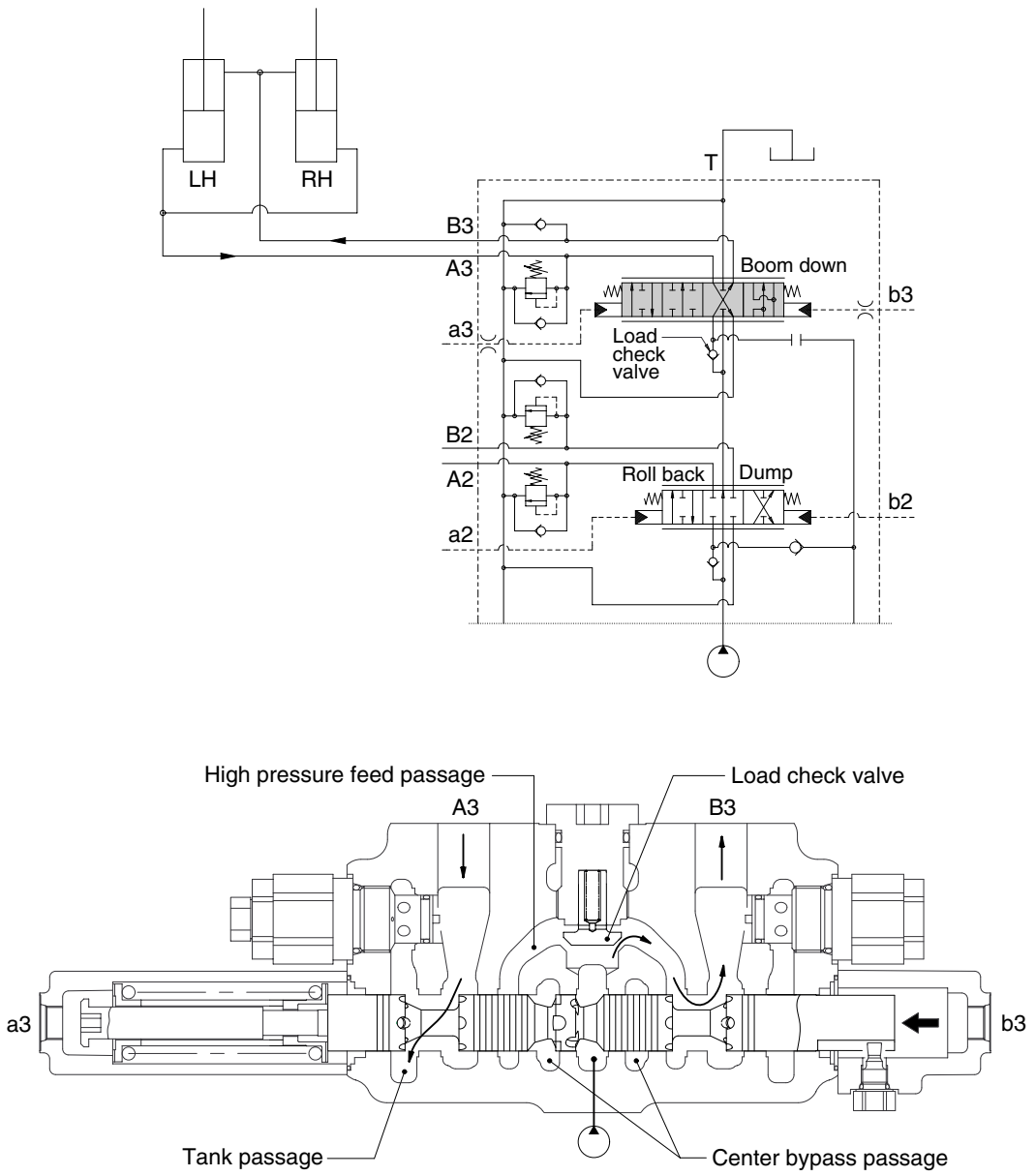
When the pilot pressure is led to the port(a3), the boom plunger is switched, and shut off center bypass passage.

Oil from the pump flows to the cylinder port(A3) through the load check valve and oil from the cylinder flows into the tank passage through the cylinder port(B3).

※ **Load check valve**

When the load pressure is higher than the pump pressure, the load check shuts off the passage between the high pressure feed passage and the center bypass passage and prevents the reverse flow from the cylinder.

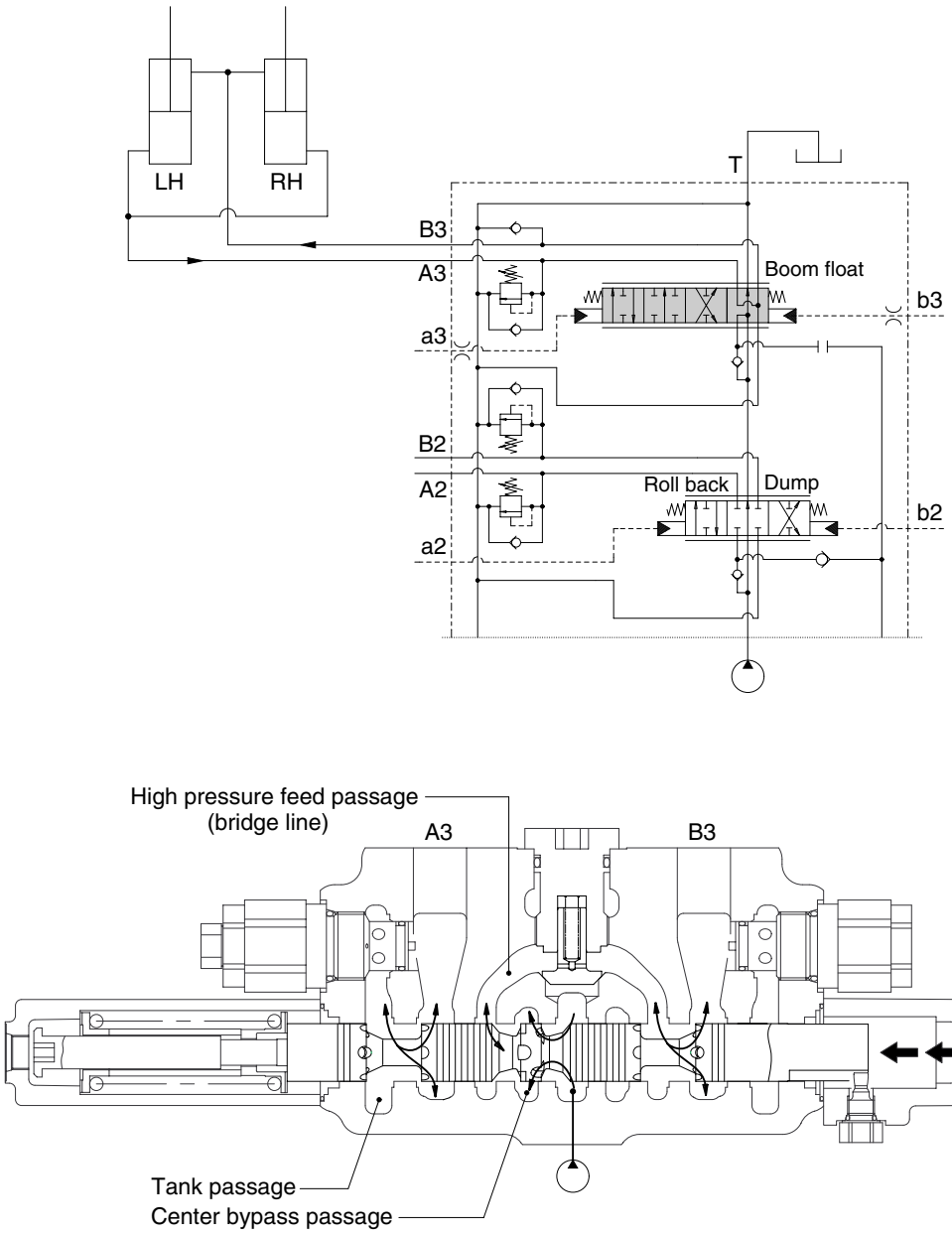
(3) Boom lower position



7607WE13

When the pilot pressure is led to the port(b3), the boom plunger is switched, and shut off center bypass passage. Oil from the pump flows to the cylinder port(B3), through the load check valve and oil from the cylinder flows into the tank passage through the cylinder port(A3).

(4) Boom float position



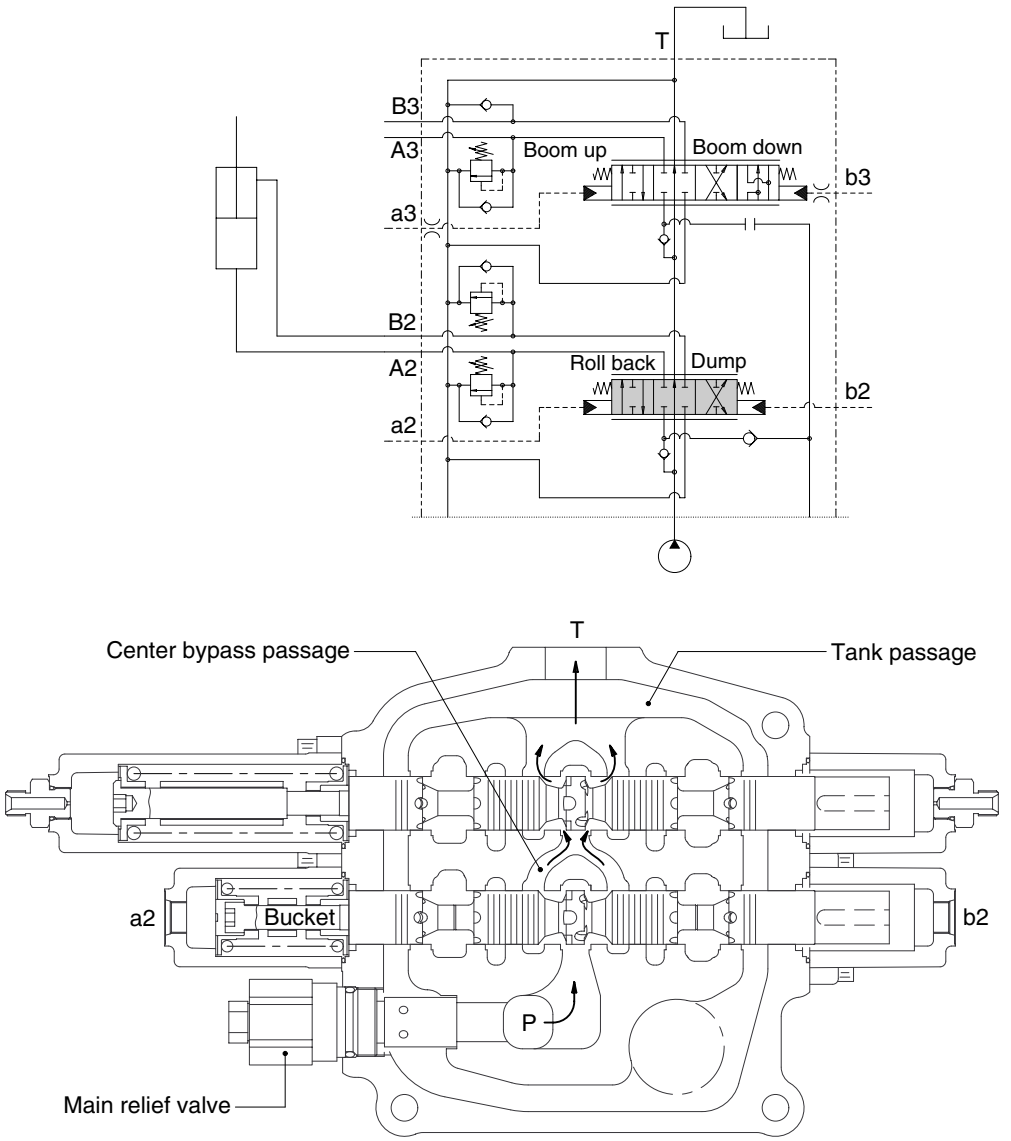
7607WE14

When the boom plunger is located in float position, the oil from the pump flows to the tank through the center bypass line.

The cylinder port(A3) is connected to the tank passage, and the cylinder port(B3) is connected to the tank passage, and the cylinder port(B3) is connected to the tank passage through the bridge line. And then the both cylinder port is in float condition.

3) BUCKET SECTION OPERATION

(1) Spool in neutral

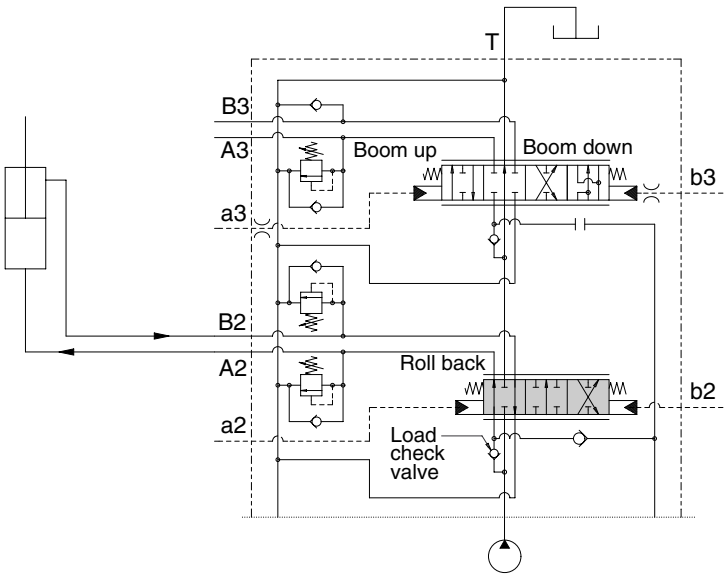


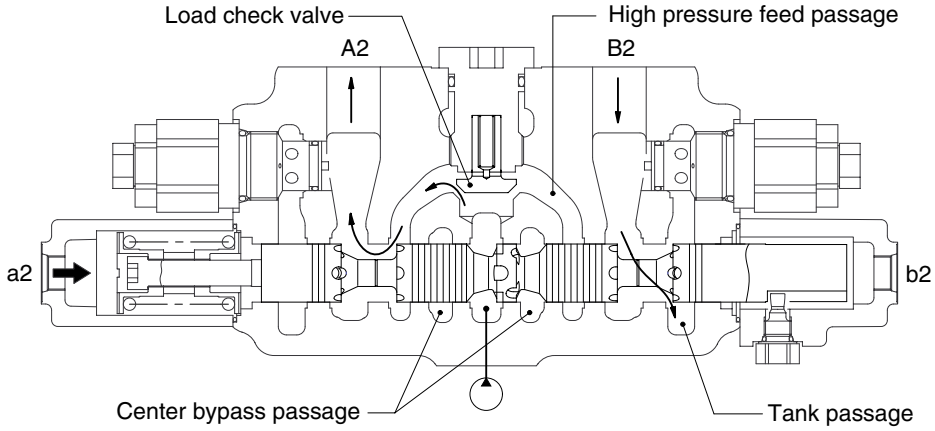
7607WE15

When the bucket plunger is in neutral position, oil from the pump flows to the tank through the center bypass line.

To cylinder port(A2, B2) are shut off from the high pressure feed passage and tank passage by the bucket plunger.

(2) Bucket rollback position





7607WE16

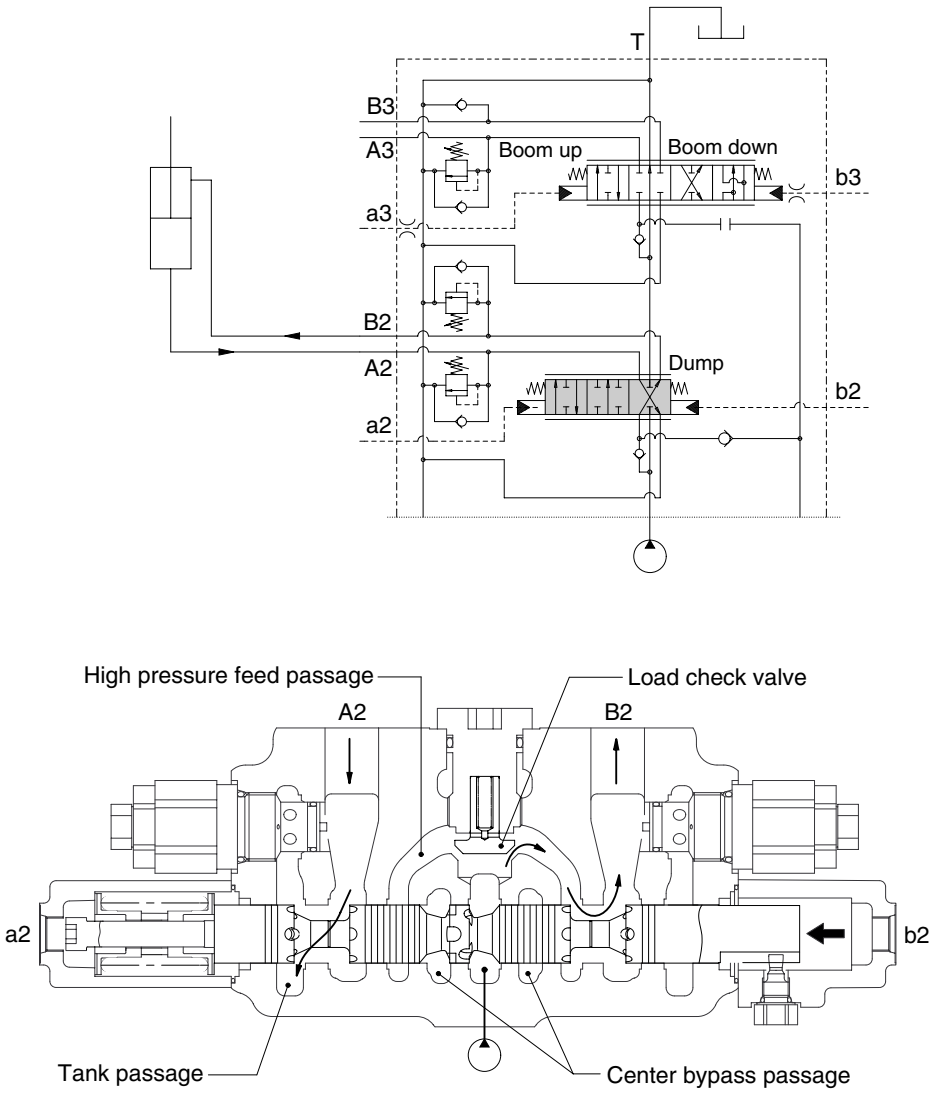
When the pilot pressure is led to the port(a2), the bucket plunger is switched, and shut off center bypass passage.

Oil from the pump flows to the cylinder port(A2) through the load check valve and oil from the cylinder flows into the tank passage through the cylinder port(B2).

※ Load check valve

When the load pressure is higher than the pump pressure, the load check shuts off the passage between the high pressure feed passage and the center bypass passage and prevents the reverse flow from the cylinder.

(3) Bucket dump position

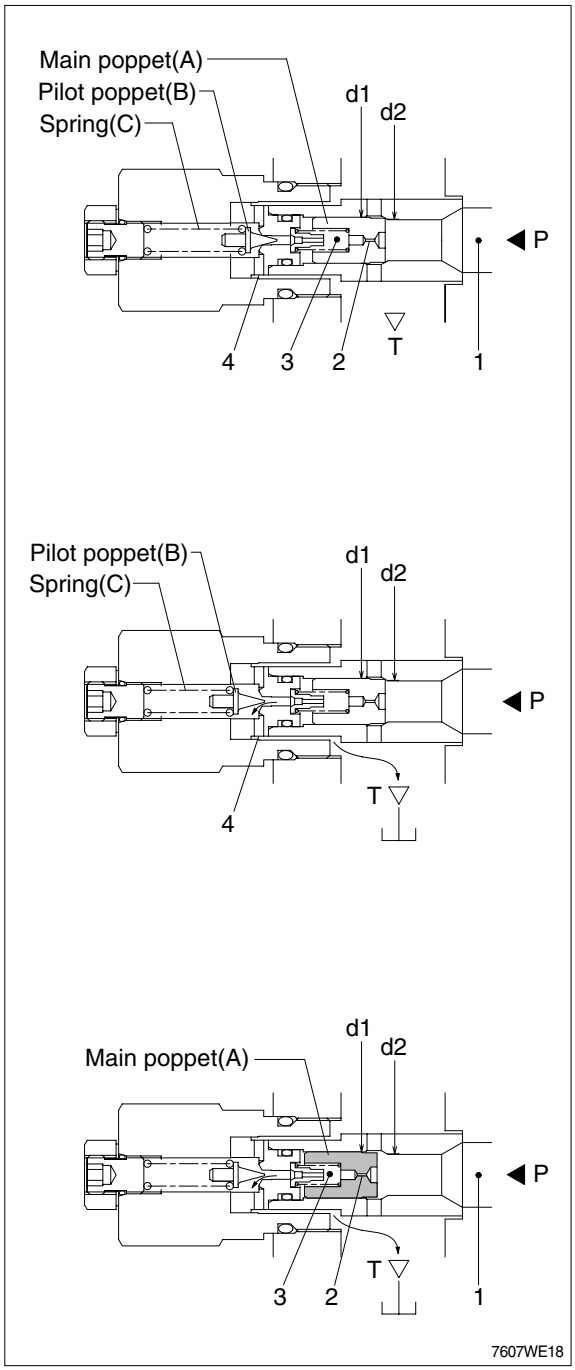


7607WE17

When the pilot pressure is led to the port(b2), the bucket plunger is switched, and shut off center bypass passage.
Oil from the pump flows to the cylinder port(B2) through the load check valve and oil from the cylinder flows into the tank passage through the cylinder port(A2).

4) MAIN RELIEF VALVE

- The relief valve is installed between pump circuit and tank circuit in the main control valve housing and keeps system pressure to setting pressure.
- Oil from the pump port(P) enters into the chamber(3) through the orifice(2) of the main poppet(A).
  As d2<d1, main poppet(A) is securely seated.



- When the pressure reaches the preset force of the spring(C), the pilot poppet(B) opens. Oil flow around pilot poppet(B) and flows into the tank passage(T) through the side hole(4).

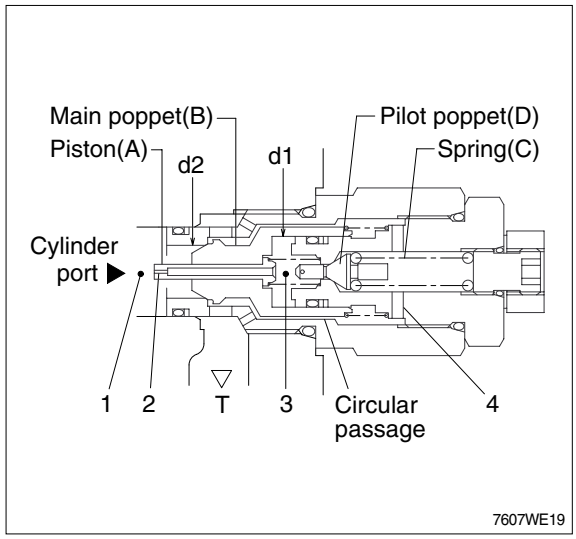
- As oil flows from the pump port(P) to the tank passage(T) through the orifice(2) of the main poppet(A), the pressure of the chamber(3) comes to lower than that of the pump port.
  Then the main poppet(A) is lifted and pressured oil flows into the tank passage.

5) PORT RELIEF VALVE

The port relief valve is installed between cylinder port and tank passage.

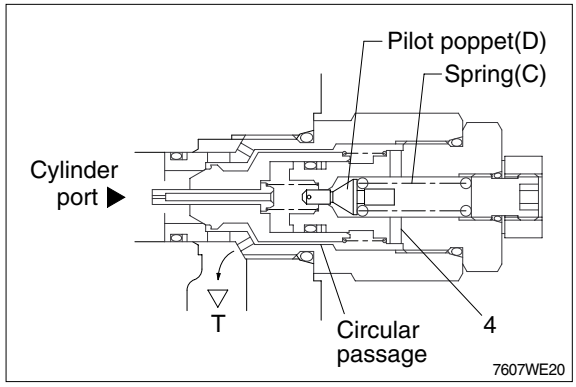
It protects the actuator from abnormal pressure, due to outer force or sudden block of cylinder pressure.

The port relief valve is the type of built-in make-up function.



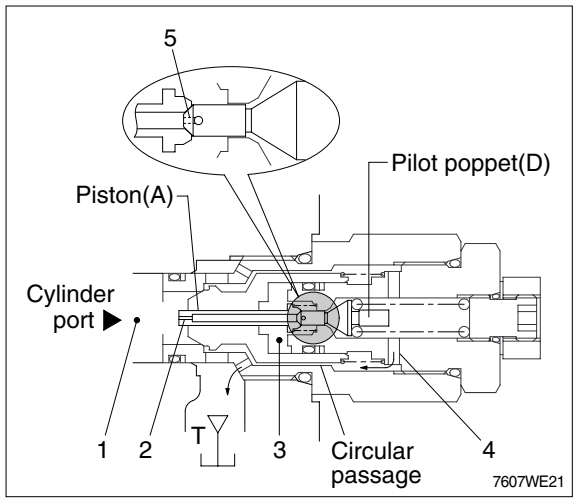
(1) Overload relief function

① When the pressure reaches the preset force of the spring(C), the pilot poppet(D) is lifted and pressured oil flows into the tank passage.

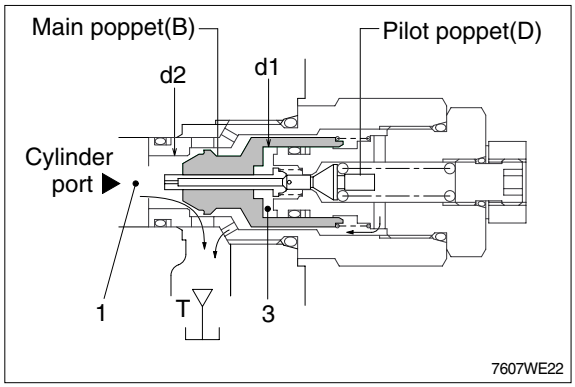


② As oil flows from the cylinder port to the tank passage through the orifice(2) of the piston(A), the pressure of the chamber(3) comes to lower than that of the cylinder port. Then the piston(A) is lifted and seated to the pilot poppet(D).

Oil from the cylinder port flows to the tank passage through the orifice(5) of the pilot poppet(D), side hole(4) and the circular passage.

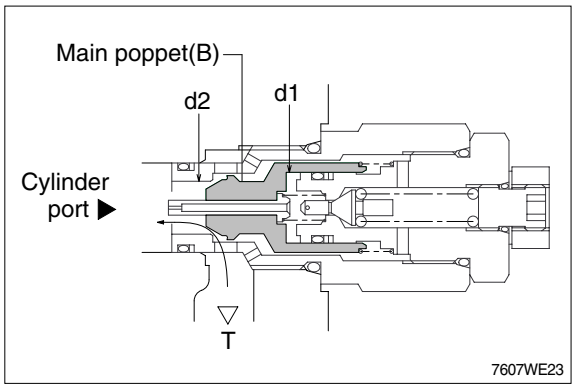


③ Oil from the cylinder port flows to the tank passage. As the pressure of the chamber(3) comes to lower still more, the main poppet(B) is lifted and pressured oil flows into the tank possage.



(2) Make-up function

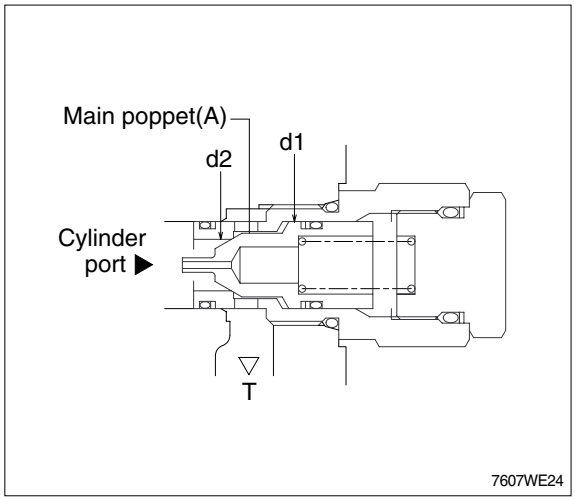
As the cylinder port pressure is normally higher than the tank passage pressure and d2<d1, the poppet(B) is securely seated. When the cylinder port pressure comes to lower than the tank passage pressure (closer to negative pressure), the poppet(B) opens receiving the tank passage pressure for the difference in area between d2 and d1 oil from the tank passage flows to the cylinder port in order to prevent cavitation.



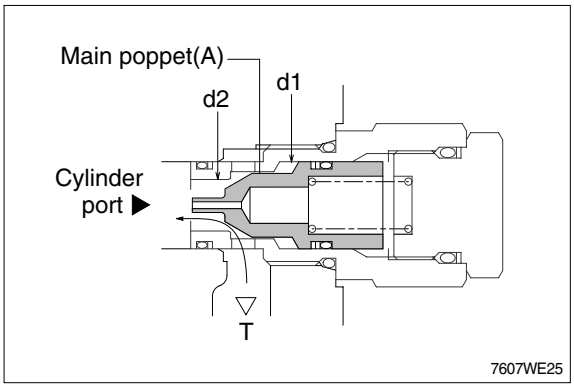
6) MAKE UP VALVE

The make-up valve is installed between the cylinder port and the tank passage. When the cylinder port pressure comes to lower than the tank passage pressure, then make-up valve supplies the oil to the cylinder port from the tank passage, and prevents cavitation.

(1) As the cylinder port pressure is normally higher than the tank passage pressure and d2<d1, the poppet(A) is securely seated.

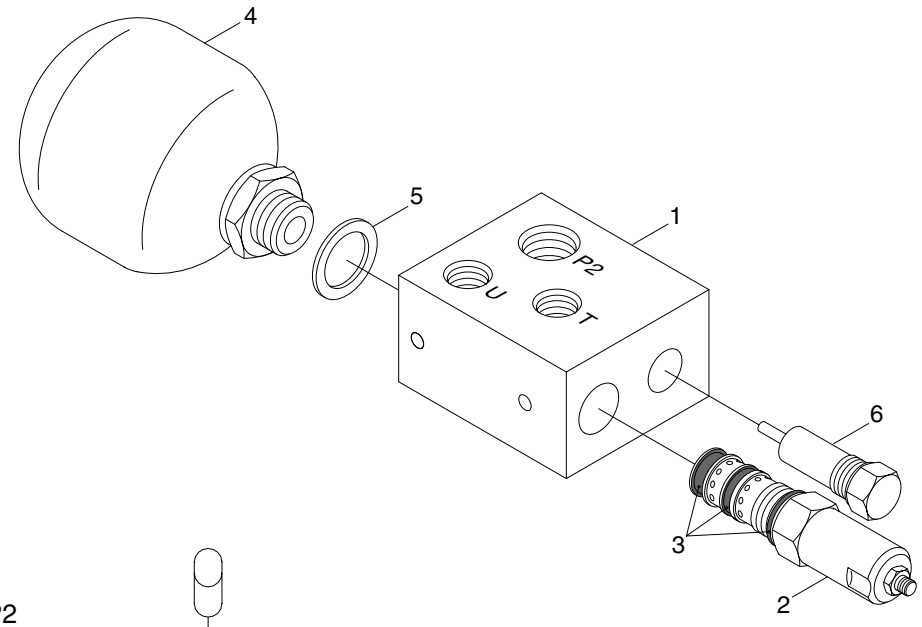


(2) When the cylinder port pressure comes to lower than the tank passage pressure (closer to negative pressure), the poppet (A) opens receiving the tank passage pressure for the difference in area between d2 and d1. Oil from the tank passage flows to the cylinder port in order to prevent cavitation.

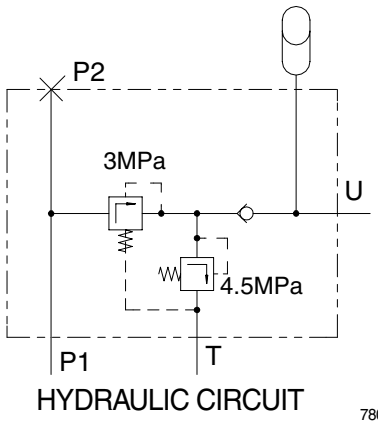


7. PILOT OIL SUPPLY UNIT

1) STRUCTURE



PILOT SUPPLY UNIT



HYDRAULIC CIRCUIT

7807AWE49

Port	Port name	Port size
P1	From steering pump	3/4-16UNF
P2	Pluging	3/4-16UNF
U	Supply to RCV lever	9/16-18UNF
T	To hydraulic tank	9/16-18UNF

1 Manifold complete
2 Reducing valve
3 Seal kit
4 Accumulator
5 Gasket
6 Relife valve

(2) OPERATION

The pilot supply manifold reduces the pressure from the high pressure circuit to a low pressure circuit in order to supply the remote control valve.

The accumulator satisfies short term peak power demands and is a source of emergency power in case of main circuit pressure failures.

The unit consists of the housing, the accumulator(4), the relief valve(6), the check valve and the reducing valve(2).

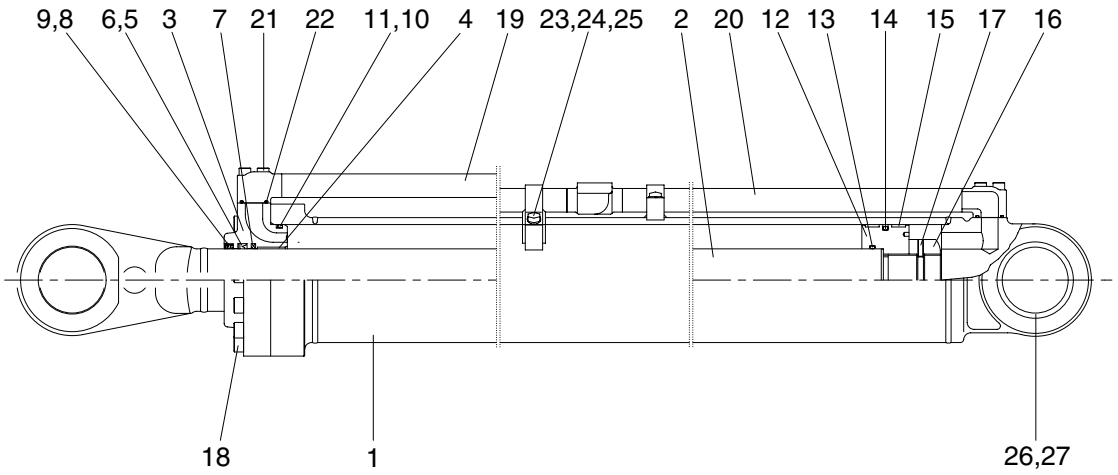
The flow path is from the high pressure circuit through port P2 to the pressure reducing valve(2). The pressure is reduced in the reducing valve(2) and oil passes the check valve into the accumulator(4) and to the port U, which is connected with the remote control valve.

The pressure relief valve(6) protects the pilot circuit in case of the reducing valve(2) failures or external increase of pressure.

8. BOOM AND BUCKET CYLINDER

The boom cylinders are two unit and the bucket cylinder is one unit. They use a bolt on rod guide.
The piston(12) threads on to the rod(2) and is retained by a nut(16) and set screw(17).
The piston seals against the tube(1) with piston seal(14). Two wear rings(15) are located on each side of the piston seal.
The gland(3, the rod guide) seals against the tube with an O-ring(10). The cylinder thread seals against the rod with a lip type buffer ring(7) and a rod seal(5). A dust wiper(8) cleans the rod when it is retracted.

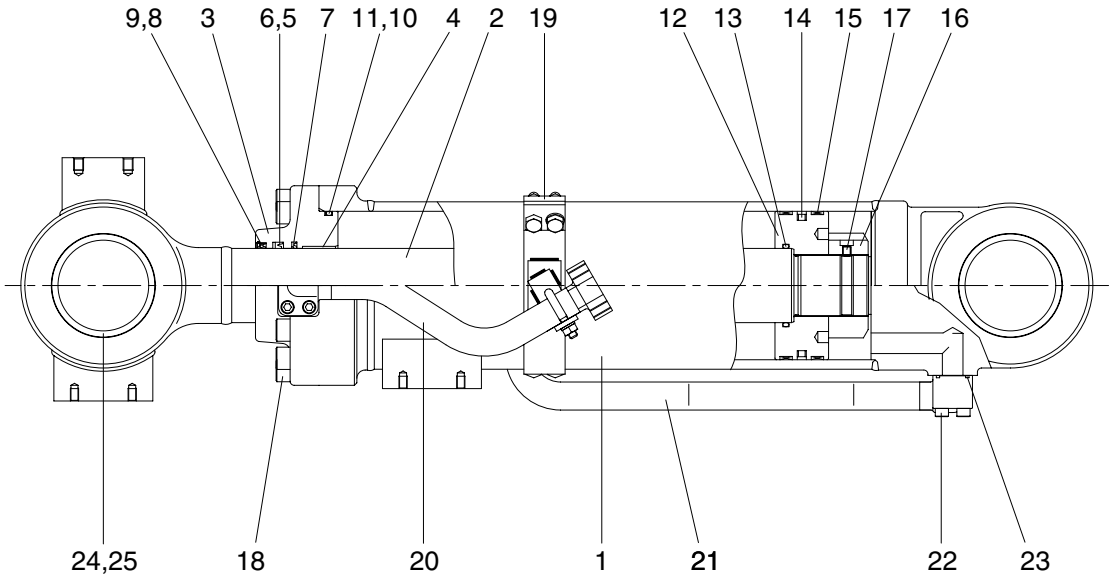
1) BOOM CYLINDER



7607WE26

1	Tube assembly	11	Back up ring	20	Pipe assembly
2	Rod assembly	12	Piston	21	Bolt
3	Gland	13	O-ring	22	O-ring
4	Bushing	14	Piston seal	23	Spring washer
5	Rod seal	15	Wear ring	24	Bolt
6	Back up ring	16	Piston nut	25	Pipe clamp
7	Buffer ring	17	Set screw	26	Bushing
8	Dust wiper	18	Bolt	27	Dust seal
9	Snap ring	19	Pipe assembly		
10	O-ring				

2) BUCKET CYLINDER



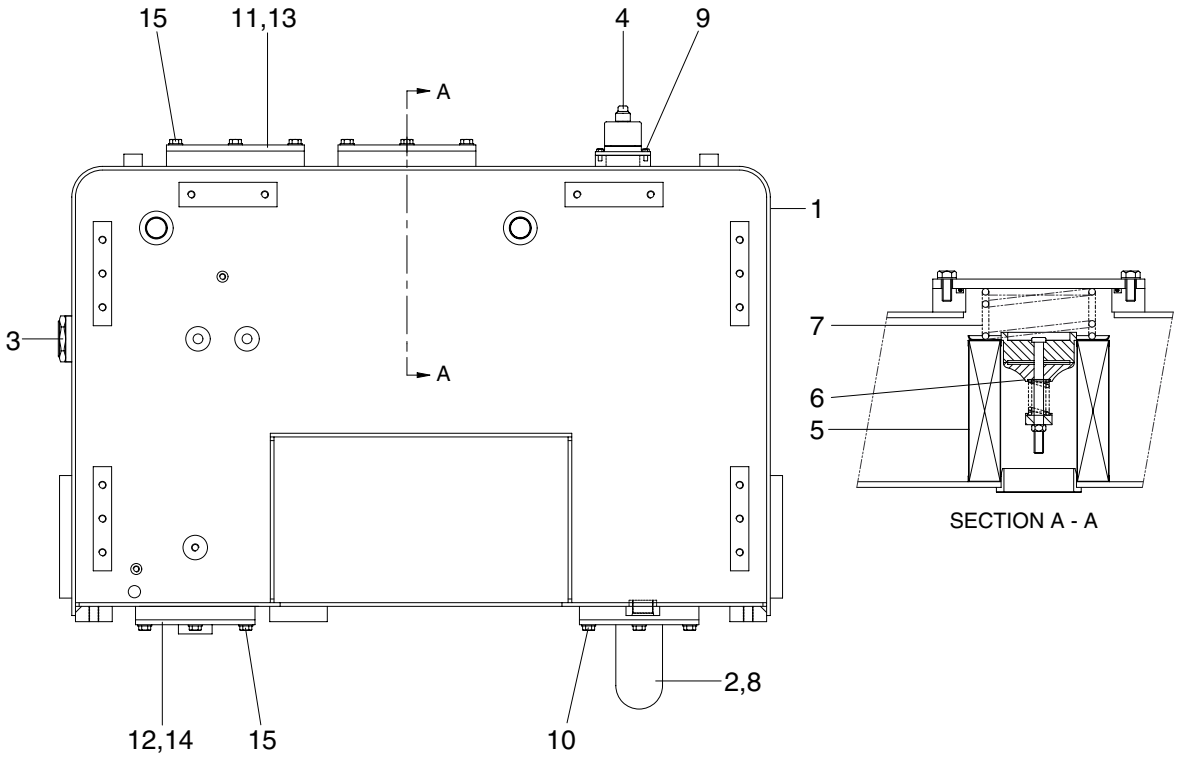
7607WE27

1	Tube assembly	10	O-ring	18	Bolt
2	Rod assembly	11	Back up ring	19	Band assembly
3	Gland	12	Piston	20	Pipe assembly
4	Bushing	13	O-ring	21	Pipe assembly
5	Rod seal	14	Piston seal	22	Bolt
6	Back up ring	15	Wear ring	23	O-ring
7	Buffer ring	16	Piston nut	24	Bushing
8	Dust wiper	17	Set screw	25	Dust seal
9	Snap ring				

9. HYDRAULIC OIL TANK

1) STRUCTURE

- The oil from the hydraulic tank is sent from the pump through main control valve to the cylinders. In the return circuit, the oil from various parts merges.
- A part of oil is cooled in the oil cooler, passes through the hydraulic filter and returns to the hydraulic tank(1).
- If the hydraulic return oil filter becomes clogged, return filter bypass valve(6) acts to allow the oil to return directly to the hydraulic tank(1). This prevents damage to the hydraulic filter(5). The bypass valve(6) is also actuated when negative pressure is generated in the circuit.



7607WE28

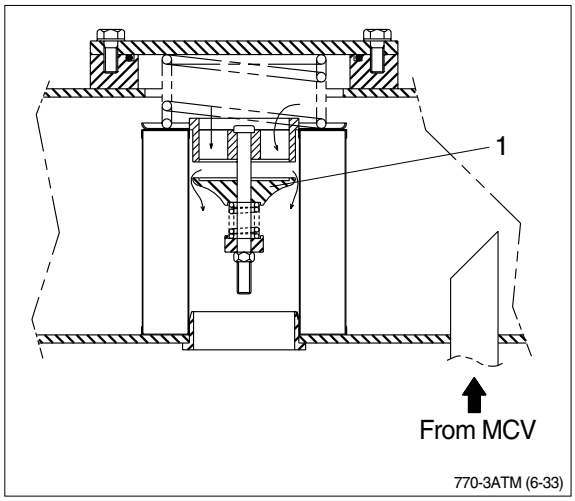
1	Hydraulic tank wa	9	Socket bolt
2	Pipe wa	10	Bolt
3	Sight gauge	11	Cover
4	Air breather	12	Cover
5	Element assembly	13	O-ring
6	Bypass valve	14	O-ring
7	Spring	15	Bolt
8	O-ring		

2) RETURN OIL FILTER BYPASS VALVE

(1) When the filter is clogged

Bypass valve(1) is opened and the oil returns directly to the tank without passing through the filter.

· Bypass valve set pressure : 1.36kg/cm^2 (19.3psi)



3) AIR BREATHER

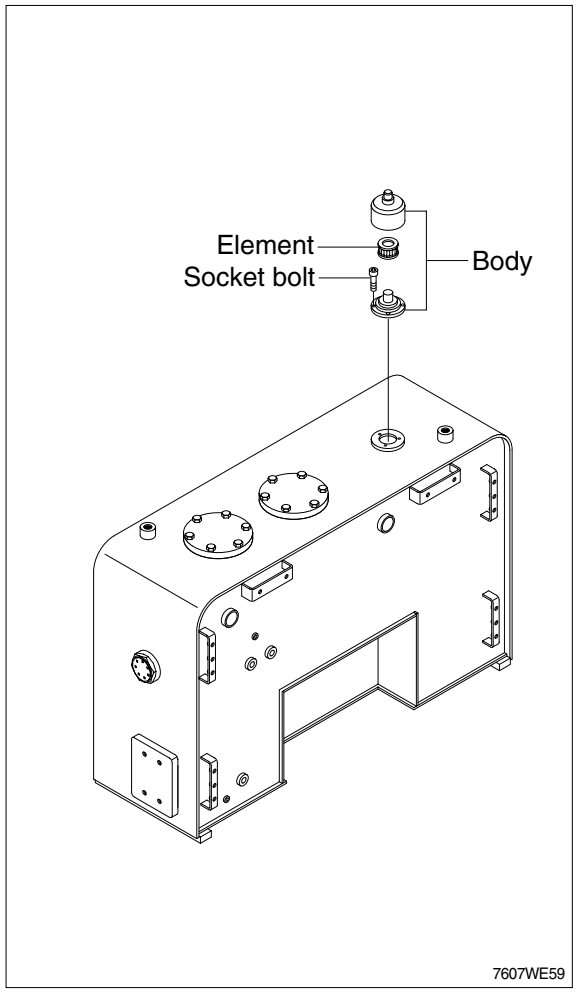
The air breather is equipped with the capacity to perform three functions simultaneously-as an air filter, breathing valve, and as a lubrication opening.

(1) Preventing negative pressure inside the tank

The tank is a pressurized sealed type, so negative pressure is formed inside the hydraulic tank when the oil level drops during operations. When this happens, the difference in pressure between the tank and the outside atmospheric pressure opens the poppet in the breather, and air from the outside is let into the tank or prevent negative pressure.

(2) Preventing excessive pressure inside the tank

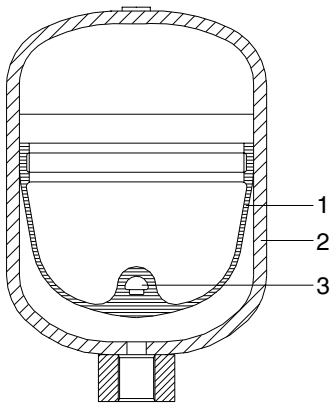
When the hydraulic cylinder is being used, the oil level in the hydraulic system increases and as temperature rises. If the hydraulic pressure rises above the set pressure, breather is actuated to release the hydraulic pressure inside the tank.



10. ACCUMULATOR

The accumulator is installed at the pilot oil supply unit. When the boom is left the raised position, and the control levers are operated with the engine stopped the pressure of the compressed nitrogen gas inside the accumulator sends pilot pressure to the control valve to actuate it and allow the boom and bucket to come down under their own weight.

Type of gas	Nitrogen gas(N_2)
Volume of gas	0.75 ℓ (0.2 U.S.gal)
Charging pressure of gas	16kg/cm²(228psi)
Max actuating pressure	128kg/cm²(1820psi)



1 Diaphragm
2 Steel pressure vessel
3 Closure button

7803AWE56

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

1. OPERATIONAL CHECKS

This procedure is designed so the mechanic can make a quick check of the system using a minimum amount of diagnostic equipment. If you need additional information, read **structure and function**, Group 1.
A location will be required which is level and has adequate space to complete the checks.

The engine and all other major components must be at operating temperature for some checks.

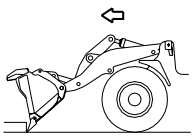
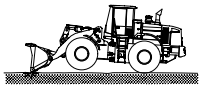
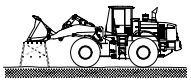
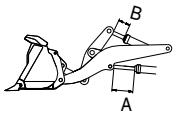
Locate system check in the left column and read completely, following the sequence from left to right. Read each check completely before performing.

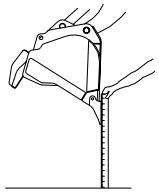
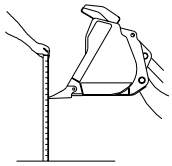
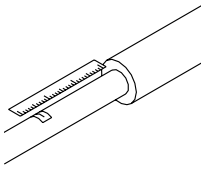
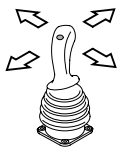
At the end of each check, if no problem is found(OK), that check is complete or an additional check is needed. If problem is indicated(NOT OK), you will be given repair required and group location.
If verification is needed, you will be given next best source of information:

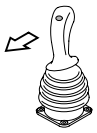
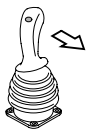
- Chapter 2 : Troubleshooting
- Group 3 : Tests and adjustments

※ **Hydraulic oil must be at operating temperature for these checks(Refer to page 6-50).**

Item		Description	Service action
Hydraulic system warm-up procedure Run engine at high idle. Refer to page 6-50.		Hold a hydraulic function over relief to heat oil.(Don't keep relief condition over 5 seconds at a time) Periodically cycle all hydraulic functions to distribute warm oil. Repeat procedure until oil is at operating temperature. **FEEL :** Hydraulic reservoir must be uncomfortable to hold your hand against. (approximately 40 ~50℃)	**OK** Check completed.
Hydraulic pump performance check Heat hydraulic oil to operating temperature. Run engine at high idle.		With bucket flat on ground, actuate boom raise. Time how long it takes to raise boom to full height. **LOOK :** Boom must raise to full height in less than 7 seconds.	**OK** Check completed. **NOT OK** Go to priority valve(in steering valve) high pressure check at page 5-28. **IF OK** Do steering system leakage check at page 5-29. **IF OK** Do main hydraulic pump flow test at page 6-51.
Control valve lift check Run machine at low idle.		With bucket partially dumped, lower boom to raise front of machine. Slowly move boom control lever(RCV lever) to boom lower position. Slowly move bucket control lever to bucket dump position. **LOOK :** Boom must not raise before moving down. Bucket must not rollback before dumping.	**OK** Check complete. **NOT OK** Repair lift checks in loader control valve.

Item	Description	Service action
Bucket rollback circuit relief valve check	 Position bucket at a 45° angle against an immovable object. Engage transmission in 3rd speed forward. **LOOK :** Bucket angle must not change.	**OK** Check complete. **NOT OK** Replace boom lower check valve.
Bucket dump circuit relief valve low pressure check	 Raise front of machine which bucket at 45° angle. Backdrag with bucket while observing bucket angle. **LOOK :** Bucket must not rollback	**OK** Go to next check. **NOT OK** Do loader system and circuit relief valve test at page 6-52.
Pilot control valve float check Run engine at low idle.	  With the bucket partially dumped, lower boom to raise front of machine. Push control lever to the float detent position and release lever. **LOOK** : Front of machine lower to the ground and valve must remain in float position when lever is released.	**OK** Check complete. **NOT OK** Do pilot control valve pressure test in group 3.
Boom cylinder and bucket cylinder drift check Heat hydraulic oil to operating temperature.	  Set the boom and bucket horizontal, then stop the engine. Stop the engine, wait for 5 minutes, then start measuring. Measure the amount the lift and dump cylinder rods retract during 15 minutes.(Unloaded bucket) A : Retraction of boom cylinder rod B : Retraction of bucket cylinder rod Boom cylinder must drift less than 40mm Bucket cylinder must drift less than 50mm	**OK** Check complete. **NOT OK** Go to next check.

Item	Description	Service action
Boom cylinder leakage check Heat hydraulic oil to operating temperature.	 Dump bucket until teeth or cutting edge is perpendicular to the ground. Raise boom until cutting edge is about 1m(3ft) above ground. Stop engine. Measure drift from tooth or cutting edge to ground for 1 minute. Wait 10 minutes. Measure drift from tooth or cutting edge to ground for 1 minute. **LOOK :** Compare the drift rate between the first measurement and the second measurement.	**OK** Drift is approximately the same between first and second measurement. Repair loader control valve or circuit relief valve. **NOT OK** If drift is considerably less on second measurement, repair cylinder.
Bucket cylinder leakage check Heat hydraulic oil to operating temperature.	 Raise bucket about 1m(3ft) off ground with bucket level. Stop engine. Place a support under boom. Measure drift from tooth or cutting edge to ground for 1 minute. Wait 10 minutes. Measure drift from tooth or cutting edge to ground for 1 minute. **LOOK :** Compare the drift rates between the first measurement and the second measurement.	**OK** Drift is approximately the same between first and second measurement. Repair loader control valve or circuit relief valve at page 6-52. **NOT OK** Drift is considerably less on second measurement. Repair cylinder.
Check valve of safety valve leakage check Heat hydraulic oil to operating temperature.	 Put bucket level and position about 1.2m(4ft) above ground. Place a piece of tape on cylinder rod at least 51mm(2in) from rod guide. Run engine at low idle in safety-release position. **LOOK :** Bucket must not drift up.	**OK** Check complete. **NOT OK** Check or replace safety valve.
Pilot control valve (RCV lever) check	 Stop engine. Turn key switch to OFF position. Move control lever to all positions and then release. **LOOK :** Lever must return to neutral when released from all positions.	**OK** Check completed. **NOT OK** Repair pilot control valve.

Item	Description		Service action
Bucket leveler (Positioner) check Run engine at low idle.		Position bucket fully dumped just above ground level. Move control lever to bucket leveler detent position and release. **LOOK** : Bucket must rollback to the level position and control lever must return to neutral. If bucket is in a rolled back position when key is turned ON, control lever must be returned to neutral manually if placed in the bucket leveler detent position. After bucket is dumped once, bucket leveler will work normally.	**OK** Check complete. **NOT OK** Do bucket leveler checks in group 3.
Boom height kickout check Run engine at low idle.		Position bucket flat on ground. Move control lever to boom raise detent position and release. **LOOK** : Boom must raise to the set height and stop. Control lever must return to neutral.	**OK** Check complete. **NOT OK** Do boom height kickout check in group 3.
Cycle time check Heat hydraulic oil to operating temperature. Run engine at high idle.	Function Boom raise Boom lower(Float) Bucket dump Bucket rollback Steering(No. of turns)	Operating condition. Bucket flat on ground to full height. Full height to level ground. Boom at full height. Boom at full height. Frame stop to frame stop.	Maximum cycle time 6.7sec 3.5sec 1.7sec 2.4sec 2.7sec(4 turns) **OK** Check complete. **NOT OK** Go to slow hydraulic functions in group 3.

※ MEASURING BOOM AND BUCKET CYCLE TIME

1. MEASUREMENT CONDITION

- Coolant temperature : Inside operating range
- Steering position : Neutral
- Hydraulic temperature : 40~50°C
- Bucket : Unloaded
- Engine speed : High idling

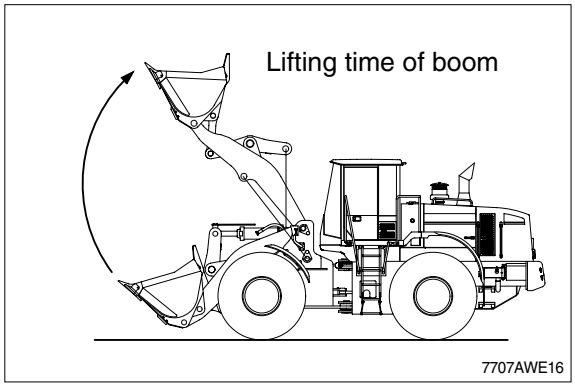
2. MEASURING TOOL

- Stop watch(1EA)

3. MEASURING PROCEDURE

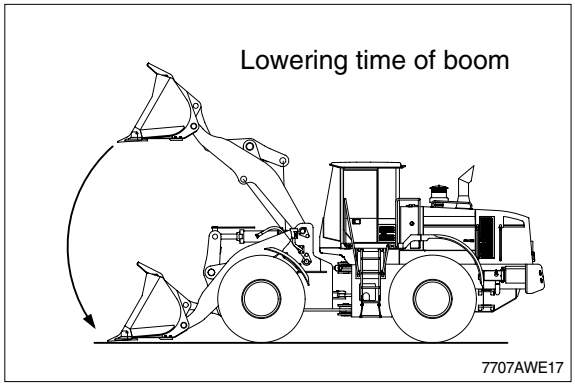
1) LIFTING TIME OF BOOM

Set the bucket near the maximum tilt back position and at the lowest position on the ground. Raise the bucket and measure the time taken for bucket to reach the maximum height of the boom.



2) LOWERING TIME OF BOOM

Set the bucket horizontal with the boom at the maximum height, lower the bucket and measure the taken for the bucket to reach the lowest position on the ground.

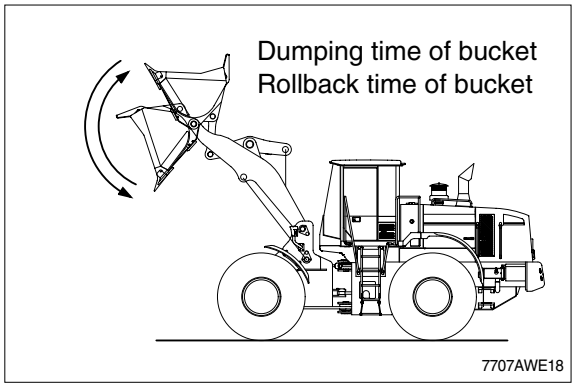


3) DUMPING TIME OF BUCKET

Raise the boom to the maximum height and measure the time taken for the bucket to move from the maximum tilt back position to the maximum dump position

4) ROLL BACK TIME OF BUCKET

Raise the boom to the maximum height and measure the time taken for the bucket to reach the maximum tilt back position.



2. TROUBLESHOOTING

※ **Diagnose malfunction charts are arranged from most probable and simplest to verify, to least likely, more difficult to verify. Remember the following steps when troubleshooting a problem :**

Step 1. Operational check out procedure (see section 1)
Step 2. Operational checks (see group 2)
Step 3. Troubleshooting
Step 4. Tests and adjustments (see group 3)

Problem	Cause	Remedy
Noisy hydraulic pump	Low oil supply or wrong viscosity	Fill reservoir with recommended oil.
	Plugged or pinched suction line	Clean or replace line.
	Air in oil	Check for foamy oil. Tighten connections. Replace O-rings and or lines.
	Plugged suction strainer	Inspect and clean strainer in reservoir.
	Loose or missing hydraulic line clamps	Tighten or replace clamps.
	Hydraulic lines in contract with frame	Inspect and repair.
	Worn or damaged pump	Do hydraulic pump performance check in group 2. Do hydraulic pump flow test in group 3.
No or Slow hydraulic functions	Failed or worn hydrualic pump	Do performance check.
	Cold oil	Warm oil up.
	Slow engine speed	Adjust engine speed. Check high idle speed.
	Suction line air leak	Check for foamy oil.
	Low oil supply	Add recommended oil.
	Wrong oil viscosity	Use recommended oil.
	Oil leaking past cylinders or control valve	Check cylinder drift in group 2.
	Blocked or damaged line	Inspect lines.
	Faulty or misadjusted pilot oil supply unit	Do pilot oil supply unit pressure test in group 3.
	Faulty pilot control valve(RCV)	Do pilot control valve(RCV) pressure test in group 3.
	Binding loader control valve(MCV) spool	Inspect valve.
	Faulty steering valve(EHPS)	Check priority valve, orifice of steering valve(EHPS) specification

Item	Cause	Remedy
No steering or hydraulic function	Low oil level	Add recommended oil.
	Failed hydraulic pump	Remove and inspect return filter for metal pump particles.
	Failed main hydraulic pump drive	Remove main hydraulic pump and inspect drive gear.
No hydraulic functions steering normal	Failed hydraulic pump	Remove and inspect return filter for metal pump particles, or replace the pump.
	Failed line filter	Remove and inspect line filter for RCV.
	Faulty safety valve	Safety valve leakage test or ON, OFF function test.
	Stuck open port relief valve	Replace relief valve.
Boom float function does not work	Low pilot control pressure	Do pressure reducing valve pressure test in group 3.
	Faulty pilot control valve(RCV)	Replace relief valve.
	Loader control valve(MCV) spool binding in bore	Do pressure reducing valve pressure test in group 3.
One hydraulic function does not work.	Faulty pilot control valve(RCV)	Do pilot control valve pressure test. Inspect and repair valve.
	Stuck open port relief valve	Replace relief valve.
	Oil leaking past cylinder packings	Do boom and bucket cylinder leakage test in group 3.
	Blockage in oil lines or valve	Inspect lines for damage. Disconnect and inspect lines for internal blockage.
	Loader control valve(MCV) spool stuck in bore	Inspect and repair valve.
Low hydraulic power	Leakage within work circuit	Do cylinder drift check in group 2.
	Low system relief valve(main relief valve) setting	Do loader system and port relief valve pressure test in group 3.
	Low port relief valve setting	Do loader system and port relief valve pressure test in group 3.
	Faulty or misadjusted pilot oil supply unit	Do pilot oil supply unit pressure test in group 3.
	Leaking system relief valve	Remove and inspect valve.
	Worn hydraulic pump	Do hydraulic pump performance check in group 2.
	Faulty pilot control valve(RCV)	Do pilot control valve pressure test in group 3.

Item	Cause	Remedy
Function drifts down	Leaking cylinders	Do cylinder leakage checks in group 2.
	Leaking seals in circuit relief valve(port relief valve) or valve stuck open	Inspect seals. Replace relief valve.
	Leaking loader control valve(MCV)	Repair or replace valve section.
Boom drifts up	Leakage in boom down spool	Remove and inspect boom down spool.
Boom down does not work(Engine off)	Safety valve not operated	Operate valve.
	Stuck pilot control valve	Inspect.
	Faulty line filter	Remove and inspect filter.
	Accumulation not operated.	Inspect.
	MCV spool stuck	Inspect and repair valve.
Oil overheats	Low oil viscosity in hot weather	Use recommended oil.
	Excessive load	Reduce load.
	Holding hydraulic system over relief	Reduce load.
	Leakage in work circuit	Do boom and bucket cylinder leakage test in group 3.
	Plugged fins in oil cooler	Inspect and clean oil cooler.
	Internally plugged oil cooler	Do hydraulic oil cooler restriction test in group 3.
	Incorrect system or circuit relief valve setting	Do loader system and circuit relief valve pressure test in group 3.
	Restriction in oil lines or loader control valve(MCV)	Inspect for dented or kinked lines. Do hydraulic system restriction test in group 3.
	Malfunctioning steering valve	Do hydraulic system restriction test in group 3.
	Leaking system main relief valve	Remove and inspect valve and seals.
	Worn hydraulic pump(internal leakage)	Do hydraulic pump performance check in group 2.
Function drops before raising when valve is activated	Stuck open lift check valve	Do control valve lift check in group 2.

Problem	Cause	Remedy
Hydraulic oil foams	Low oil level	Add recommended oil.
	Wrong oil	Change to recommended oil.
	Water in oil	Change oil.
	Loose or faulty suction lines (air leak in system)	Tighten or install new lines.
Remote control valve (RCV) leaking	Leaking plunger seals	Remove, inspect and replace plunger seals.

※ **Followings are general precautions for the hydraulic system and equipment.**

1) Every structure has its limit of strength and durability. The relief valve is installed to limit the pressure on the hydraulic equipment and protect various parts of the wheel loader from possible damage. Therefore, never change the preset pressure of the relief valve unless absolutely necessary.

2) Since the hydraulic equipment is built with precision, the presence of only the slightest amount of dust and / or other particles in the hydraulic circuit might cause wear and/or damage, resulting in unstable functions and/or damage, resulting in unstable functions and/or unexpected accidents. Therefore, always keep hydraulic oil clean. Periodically, check the filter in the return circuit and replace the element as necessary.

3) Extract about 200cc of hydraulic oil from the tank as a sample every 6 months. If possible, have it analyzed by a specialist to confirm that the oil can still be used. Never extract the oil for sampling until the oil temperature has become the normal operating temperature. Since the replacement period varies depending on operating conditions, refer to **Operator's Manual** and change oil.

4) Should the equipment get damaged due to the presence of metal particles and/or foreign matter in the circuit drain out the hydraulic oil and carry out flushing. Also, replace the filter element and clean the hydraulic tank. Change the hydraulic oil entirely.

5) When checking the filter, if found metal particles in the element, drain out the hydraulic oil entirely, flush the whole circuit, and then fill with new oil. The presence of metal particles may indicate internal damage to the equipment. In such a case, check carefully before flushing, and repair or replace as required.

6) To add and/or change the hydraulic oil, always use recommended oil.(Refer to the list of recommended oils and lubricants at page 1-22, **Recommended lubricants**.) Never mix oil of different makes of kinds.

7) To change the hydraulic oil, use a clean vessel and funnel for pouring it into the tank. Never use cloth because it might cause the presence of lint in the circuit.

8) When removing the hydraulic equipment, be sure to put plugs or caps on hoses, tube lines and ports. Also, enter mating marks for later identification.

9) Disassemble and/or assemble the hydraulic equipment only in a clean place free of dust. When disassembling, be careful about the interchangeability of parts, and clean the disassembled parts with pure and clean mineral cleansing oil. Clean the internal passages as well. After the parts have dried, wipe them off with a clean lint-free cloth.

10) When overhauling the hydraulic equipment replace all O-rings, backup rings, etc. with new ones. Assemble O-rings with grease or vaseline applied.

11) After installing the equipment, add more hydraulic oil to make up for that lost during disassembly.

12) Tighten joints correctly. Loose joints will cause the hydraulic oil to leak. If the oil leaks, the tank oil level drops and air gets sucked in, so the pump will break down. Also loose joints in suction lines will take air in and might cause abnormal noise, malfunction or damage to pumps.

1. HYDRAULIC OIL CLEAN UP PROCEDURE USING PORTABLE FILTER CADDY

※ **Service equipment and tool**

- Portable filter caddy
- Two 4000mm × 1in 100R1 Hoses
- Quick disconnect fittings.
- Discharge wand
- Various size fittings.

※ **Brake system uses oil from hydraulic oil tank. Flush all lines in the brake, pilot, steering system and cut off system. Disassemble and clean major components for brake and steering system. Remove and clean pilot caps from main control valve.**
Brake and steering components may fail if brake and steering system is not cleaned after hydraulic oil tank contamination.

1) If hydraulic system is contaminated due to a major component failure, remove and disassemble steering cylinders to clean debris from cylinders.

2) Install a new return filter element. Inspect filter housing before installing new element.

※ **For a failure that creates a lot of debris, remove access cover from hydraulic oil tank. Drain and clean hydraulic oil tank of fill the specified oil to hydraulic oil tank through upper cover.**

3) To minimize oil loss, pull a vacuum in hydraulic oil tank using a vacuum pump. Connect filter caddy suction line to drain port at bottom of hydraulic oil tank using connector. Check to be sure debris has not closed drain port.

4) Put filter caddy discharge line into hydraulic oil tank filler hole so end is as far away from drain port as possible to obtain a thorough cleaning of oil.

5) Start the filter caddy. Check to be sure oil is flowing through the filters.
   Operate filter caddy approximately 10 minutes so oil in hydraulic oil tank is circulated through filter a minimum of four times.

※ **Hydraulic oil tank capacity : 150 ℓ (39.7U.S. gal)**
   Leave filter caddy operation for the next steps.

6) Start the engine and run it at high idle.

※ **For the most effective results, cleaning procedure must start with the smallest capacity circuit then proceed to the next largest capacity circuit.**

7) Operate all functions, one at a time, through a complete cycle in the following order: Clam, steering, bucket, and boom. Also include all auxiliary hydraulic functions.
   Repeat procedure until the total system capacity has circulated through filter caddy seven times, approximately 30 minutes.
   Each function must go through a minimum of three complete cycles for a through cleaning for oil.

※ **Filtering time for machines with auxiliary hydraulic functions must be increased because system capacity is larger.**

8) Stop the engine. Remove the filter caddy.

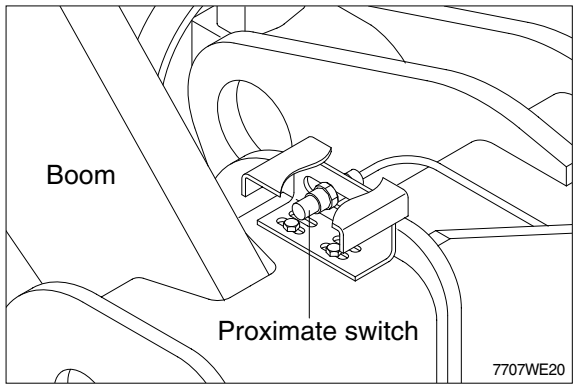
9) Install a new return filter element.

10) Check oil level in reservoir; Add oil if necessary.

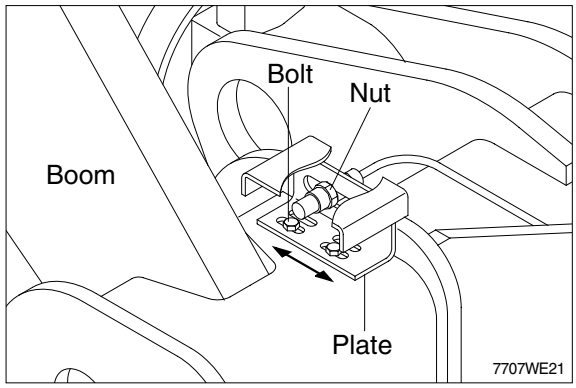
2. BOOM HEIGHT KICKOUT ADJUSTMENT

1) Lift the boom up to a desired height, set the boom control lever at hold, then stop the engine.

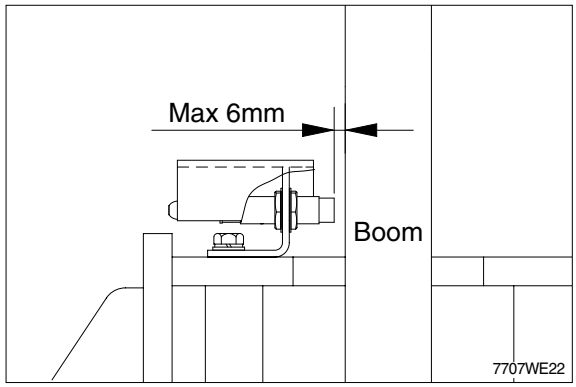
⚠ **Be careful lest work equipment fall down. Put the hydraulic safety lock lever in the LOCK position.**



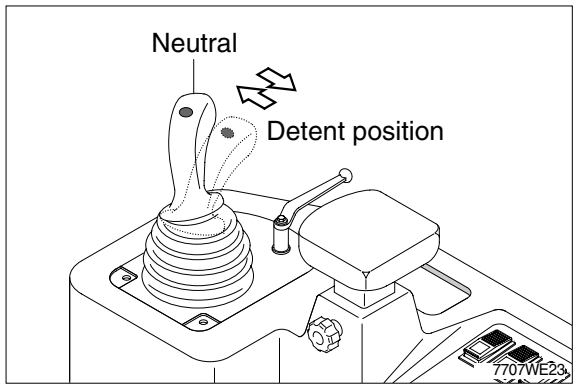
2) Loosen nuts and bolts then tighten them after adjusting the plate or proximate switch so that it comes in contact with the center of the probe of the proximate switch.



3) Loosen the nuts so that a clearance between the plate and the probe of the proximate switch are maximum 6㎜.



4) Start the engine. Position the bucket on the ground. Then lift the bucket to a desired height by using the control lever and release the hand.
Confirm the lever automatically returns to the neutral position and the boom(the bucket) stop at the adjusted position.



3. TEST TOOLS

1) CLAMP-ON ELECTRONIC TACHOMETER INSTALLATION

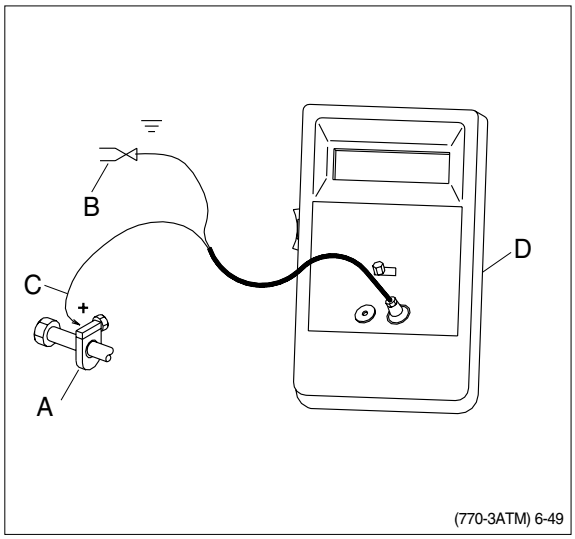
· Service equipment and tools
Tachometer

A : Clamp on tachometer.
Remove paint using emery cloth and connect to a straight section of injection line within 100mm(4in) of pump. Finger Tighten only-do not over tighten.

B : Black clip(-). Connect to main frame.

C : Red clip(+). Connect to transducer.

D : Tachometer readout. Install cable.



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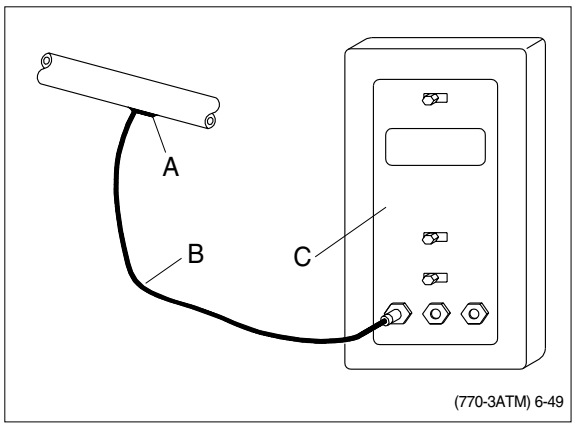
2) DIGITAL THERMOMETER INSTALLATION

· Service equipment and tools
Digital thermometer

A : Temperature probe.
Fasten to a bare metal line using a tie band. Wrap with shop towel.

B : Cable.

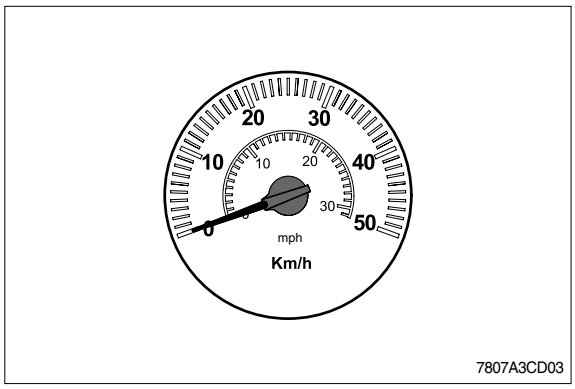
C : Digital thermometer.



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3) DISPLAY MONITOR TACHOMETER

The display monitor tachometer is accurate enough for test work.



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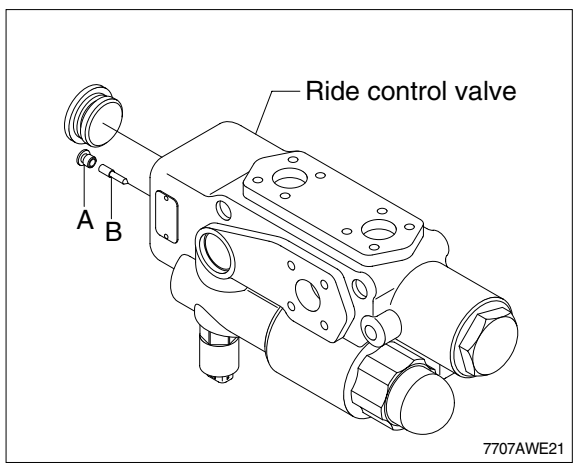
4. HYDRAULIC OIL WARM UP PROCEDURE

1) Install temperature reader(See temperature reader installation procedure in this group).
2) Run engine at high idle.
3) Hold a hydraulic function over relief to heat the oil.
4) Periodically cycle all hydraulic functions to distribute warm oil.
5) Heat oil to test specification(Approx. 45℃).

※ **Ride control system(Option)**

⚠ **Attention**

1) Before carrying out any maintenance work the accumulators must be unloaded(Zero pressure).
2) For this, unscrew the plug(A) then rotate the drain screw(B), located under the plug(A), 2 turns anti-clockwise with 3mm L-wrench.
3) The lifting system must firstly be secured against lowering.
4) After carrying out maintenance work, screw the plug(A) and drain screw(B).
   · Tightening torque
   A : 0.71kgf · m(5.16lbf · ft)
   B : 0.36kgf · m(2.58lbf · ft)



5. MAIN HYDRAULIC PUMP FLOW TEST

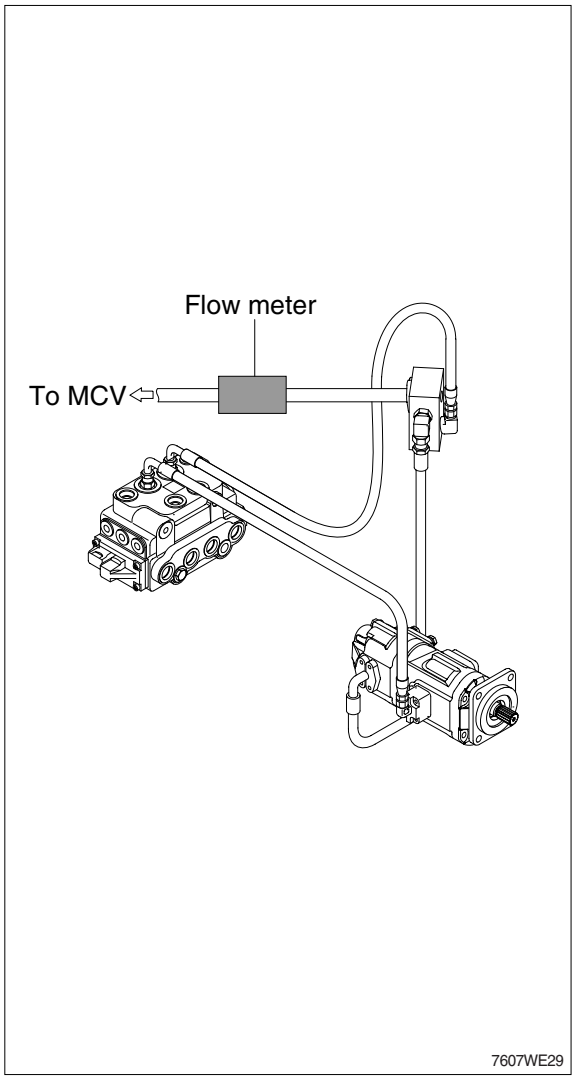
· **SPECIFICATION**

Oil temperature	45±5℃(113±9°F)
Engine speed	2100±25rpm
Test pressure	210±5bar(2990psi)
Maximum pump flow	280 ℓ/min(74.0gpm)

· **FLOW METER GAUGE AND TOOL**

Gauge 0~35MPa(0~350bar, 0~5000psi)
Temperature reader

1) Make test connections.
2) Install temperature reader.
   (See temperature reader installation procedure in this group)
3) Heat hydraulic oil to specifications.
   (See hydraulic oil warm up procedure in this group)
4) Run engine at test specifications.
5) Close flow meter loading valve to increase pressure to test specifications.
6) Read flow meter.
7) If flow is below specifications, check suction line and suction pressure for abnormality before removing pump.



6. LOADER SYSTEM AND PORT RELIEF VALVE PRESSURE TEST

· **SPECIFICATION**

Oil temperature (40~50°C)

Relief valve	Engine speed	Relief pressure
System(M)	High	210±5kg/cm² (2987±70psi)
Boom raise(U)	Low	240±5kg/cm² (3414±70psi)
Bucket rollback(R)	Low	240±5kg/cm² (3414±70psi)
Bucket dump(D)	Low	240±5kg/cm² (3414±70psi)

· **Gauge and tool**

Gauge 0~35MPa(0~350bar, 0~5000psi)

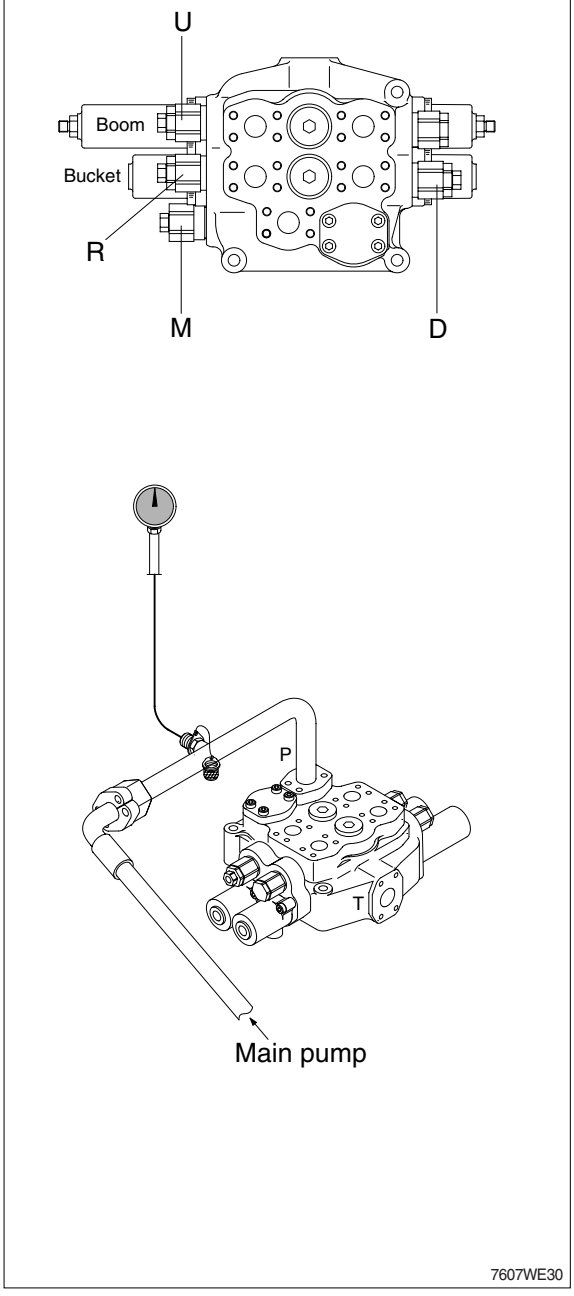
M : System(Main) relief valve

R : Bucket rollback relief

D : Bucket dump relief

U : Boom raise relief

1) Install fitting and pressure gauge to test port in pump delivery line.
2) Install temperature reader.
   (See temperature reader installation procedure in this group)
3) Heat hydraulic oil to specifications.
   (See hydraulic oil warm up procedure in this group)
4) To check the system relief(M), run engine at high idle. Lower boom to bottomed position.
   Slowly activate boom down function while watching pressure gauge. If pressure is not to specification, loosen lock nut on system relief valve(M) and adjust to specification.



※ **Do not adjust the system relief valve above 250kg/cm²(3560psi). Damage to the pump will result from excessive pressure settings.**

5) To check the bucket dump, bucket rollback, and boom raise, adjust the system relief valve to 250kg/cm²(3560psi).

Run engine to maintain 800 ~ 850rpm when hydraulic function is activated over relief.
Activate the function to be checked with the cylinder bottomed. Read the pressure gauge.

If pressure is not to specification cycle relief valve over relief 10 times to flush.
Read pressure gauge again. Turn screw to adjust valve to specification.

※ **Do not work machine with system relief adjusted above specification or structural damage may occur.**

6) Adjust system relief valve to specification.

7. HYDRAULIC SYSTEM RESTRICTION TEST

· **SPECIFICATION**

Oil temperature 45±5°C(113±9°F)
Engine speed High idle
Maximum pressure 2MPa(20bar, 285psi) at steering valve(EHPS).
Maximum pressure at main control valve 1MPa(10bar, 145psi)

· **GAUGE AND TOOL**

Gauge 0~7MPa(0~70bar, 0~1000psi) 2EA

This test will check for restrictions in the hydraulic system which can cause overheating of hydraulic oil.

1) Install temperature reader.
(See temperature reader installation procedure in this group)

2) Heat hydraulic oil to specifications.
(See hydraulic oil warm up procedure in this group)

3) Connect fitting and gauge to steering valve.

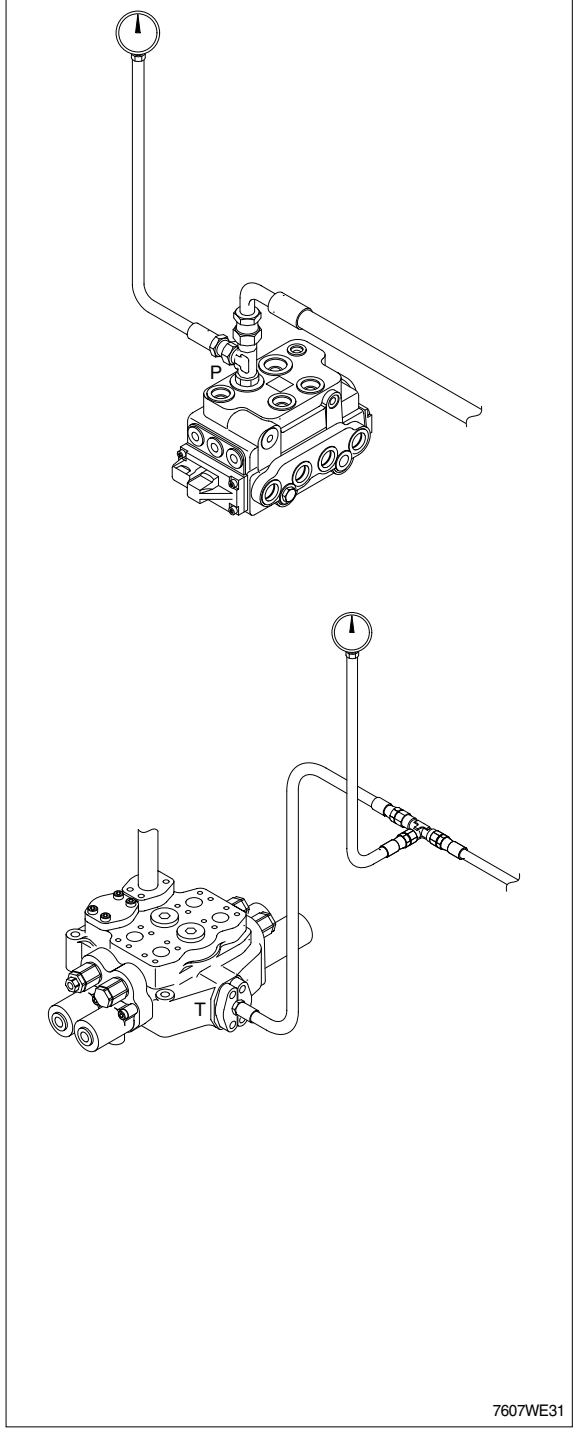
4) Connect fitting and gauge to main control valve.

⚠ **Do not operate steering or loader functions or test gauge may be damaged.**

5) Run engine at specification and read pressure gauges.

If pressure is more than specification at the loader control valve, check for a kinked, dented or obstructed hydraulic line. Check loader control valve for a binding spool.

If pressure is more than specification at the steering unit, inspect neutral condition of the steering unit and steering valve for a stuck spool. Make sure orifice plugs are installed in ends of priority valve spool.
Check for plugged orifice in priority valve and dynamic signal orifice on steering valve body.



8. LOADER CYLINDER DRIFT TEST

· **SPECIFICATION**

Oil temperature 45±5°C(113±9°F)
Boom horizontal
Bucket horizontal
Bucket unloaded

Item	Standard value
Retraction of boom cylinder rod	40mm
Retraction of bucket cylinder rod	50mm

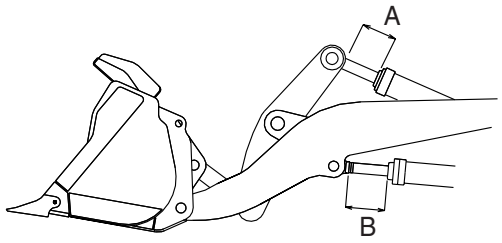
· **GAUGE AND TOOL**

Stop watch
Temperature reader

⚠ **Put the safety lock lever in the lock position.**

⚠ **Do not go under the work equipment.**

1) Set the boom and bucket horizontal, then stop the engine.
2) Stop the engine, wait for 5 minutes, then start measuring.
3) Measure the amount the boom and bucket cylinder rods retract during 15 minutes.



A : Retraction of bucket cylinder rod
B : Retraction of boom cylinder rod

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9. BOOM AND BUCKET CYLINDER LEAKAGE TEST

· **SPECIFICATION**

Oil temperature	45±5°C(113±9°F)
Engine speed	Low idle
Maximum leakage	15 ㎖/min(1/2 oz/min)

· **GAUGE AND TOOL**

Temperature reader
Stop watch
Measuring container

1) Fasten temperature sensor to head end port of cylinder to be tested. Cover sensor with a shop towel.

2) Heat hydraulic oil to specifications(See hydraulic oil warm up procedure in this group).

⚠ **Never work under raised equipment unless it is supported with a hoist or support stands.**

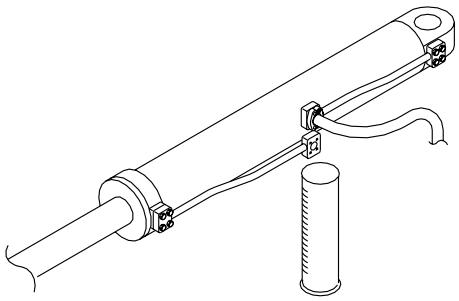
3) Full extend the cylinder to be tested. If testing the boom cylinders, restrain boom in the fully raised position using a hoist or a stand.

※ **Check cylinders for leakage in the fully extended position only. In the retracted position contacts the end of the cylinder and seals off piston seal leakage.**

4) Remove and plug cylinder rod end hose or line.

5) Run engine at slow idle. Activate control lever to extend cylinder for 1 minute over relief while measuring leakage for open port.

If leakage is within specification, excessive cylinder drift is caused by leakage in the loader control valve or circuit relief valve.



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10. PILOT CONTROL VALVE PRESSURE TEST

· **SPECIFICATION**

Oil temperature	45±5°C(113±9°F)
Engine speed	Low idle
Begin metering	1/4" of lever travel
Pressure in detent :	
Boom float detent	1.9MPa(19bar)
Pressure at feel position :	
Boom power down	19~22bar
Boom raise	19~22bar
Bucket rollback	19~22bar
Bucket dump	19~22bar

· **GAUGE AND TOOL**

Gauge 0~7MPa(0~70bar, 0~1000psi)

As the control lever is moved from neutral, the pilot pressure will suddenly jump up to approximately 5.8bar at 1/4in. travel. The pressure should then increase smoothly to the specification at the FEEL position(Or 3/4 lever travel), and then jump up about 430psi as the lever is moved into detent.

This test will determine if adequate pilot pressure is available to move the loader control valve spools.

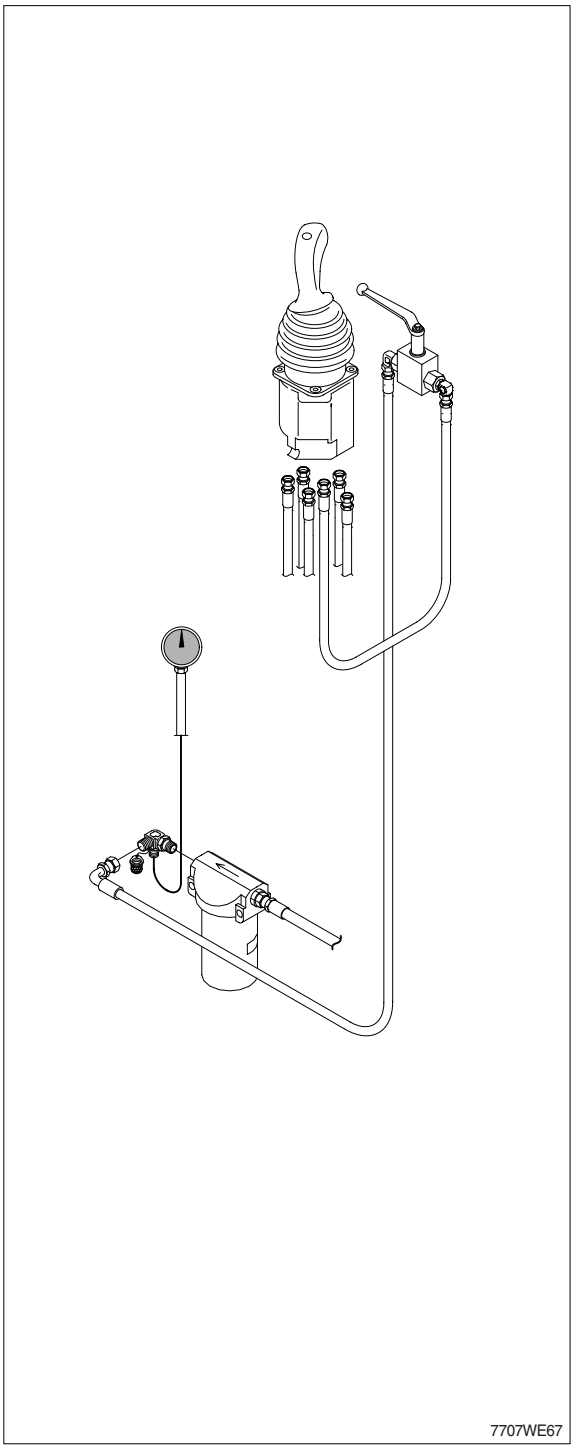
※ **The FEEL position is when lever is moved to feel the ramp of the detent before lever passes into detent position.**

1) Lower boom to ground.

2) Connect gauge to the pilot pressure port of function to be checked.

3) Install temperature reader(See temperature reader installation procedure in this group).

4) Heat hydraulic oil to specification(See hydraulic oil warm up procedure in this group).



5) Run engine at specification. Activate function to be checked and record pressure reading.

※ **If boom raise or bucket rollback FEEL positions are not operation due to boom or bucket position, plug boom float detent wires into bucket leveler solenoid or boom height kickout solenoid. This will provide a feel position on the control lever.**

11. PILOT OIL SUPPLY UNIT PRESSURE TEST

· **SPECIFICATION**

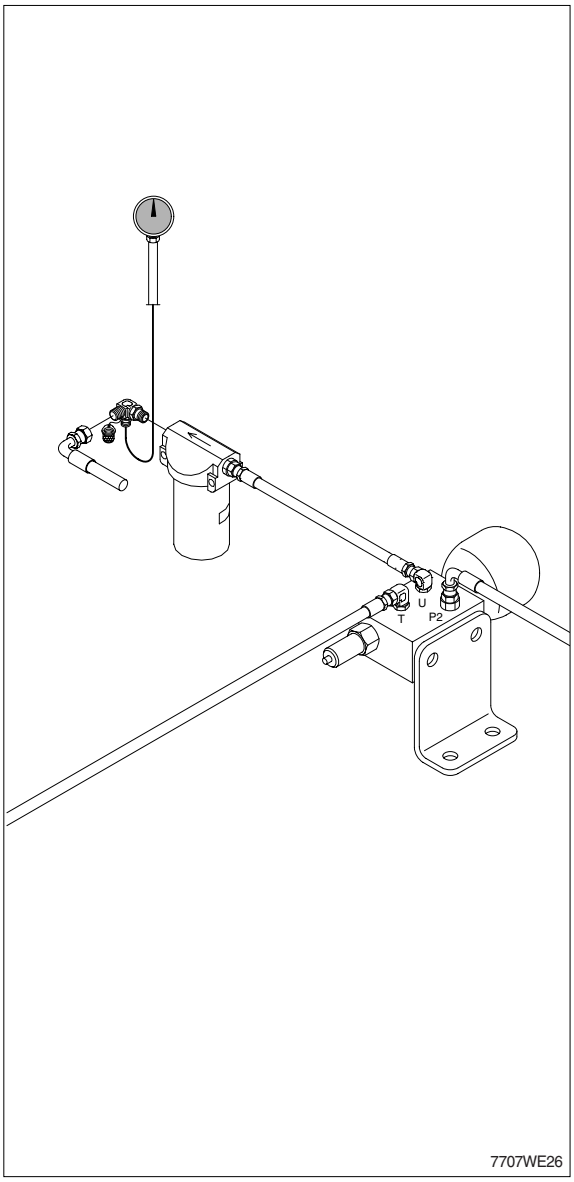
Oil temperature	45±5°C(113±9°F)
Engine speed	Low idle and stop
Pilot pressure setting	
30~35bar(430~500psi)	
Relief valve setting pressure	45bar
Accumulator precharging pressure	16bar

· **GAUGE AND TOOL**

Gauge 0~7MPa(0~70bar, 0~1000psi)

The pilot supply unit consist of the pressure reducing valve, the relief valve and an accumulator. This regulates pressure to the pilot control circuit.

1) Connect gauge to test port on the screw coupling.
2) Install temperature reader(See temperature reader installation procedure in this group).
3) Heat hydraulic oil to specification(See hydraulic oil warm up procedure in this group).
4) Run engine at low idle for 1 minute and stop engine, wait for 5 minutes. Then start measuring.
5) If pressure in not within specifications, replace valve.



12. CYCLE TIME TEST

· **SPECIFICATION**

Oil temperature ····· 45±5°C(113±9°F)

Engine speed ····· High idle

Function	Operating conditions	Maximum cycle time(seconds)
Boom raise	Bucket flat on ground to full height	6.7
Boom lower(float)	Full height to ground level	3.5
Bucket dump	Boom at full height	1.7
Bucket rollback	Boom at full height	2.4
Steering(Number of turns)	Frame stop to stop	2.7(4 turns)

Hydraulic pump performance cycle time.

Function	Operating conditions	Maximum cycle time(seconds)
Boom raise	Bucket flat on ground to full height while holding steering over relief	8.0

13. HYDRAULIC OIL FILTER INSPECTION PROCEDURE

1) Lower the bucket to the ground, stop the engine, move the control lever back and forth several times, and clean all over the upper surface of the hydraulic oil tank.

2) Remove the bolts(1) and take out the filter case cover(2) and O-ring(3).

3) Remove the spring(4) and bypass valve(5).

4) Remove the filter element(6) from the tank.

5) Check the element and the filter case bottom for debris. Excessive amounts of brass and steel particles can indicate a failed hydraulic pump or a pump failure in process. A rubber type of material can indicated cylinder packing or other packing failure.

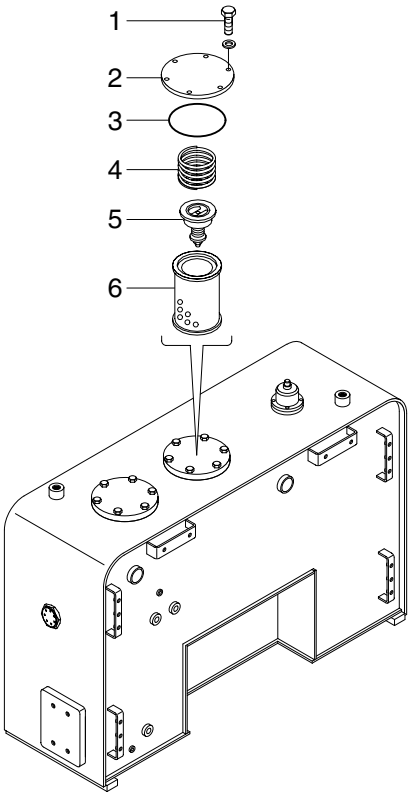
※ **The hydraulic oil filter in the filter case of the hydraulic oil tank should be replaced every 250 operating hours or more often. When the filter element is replaced, please keep as follows.**

(1) Clean the inside of the filter case.

(2) Place new element in the proper positions inside the filter case.

(3) Install the bypass valve and spring. Make sure the element stand upright, and check for complete contact of the element bottom with the filter case bottom.

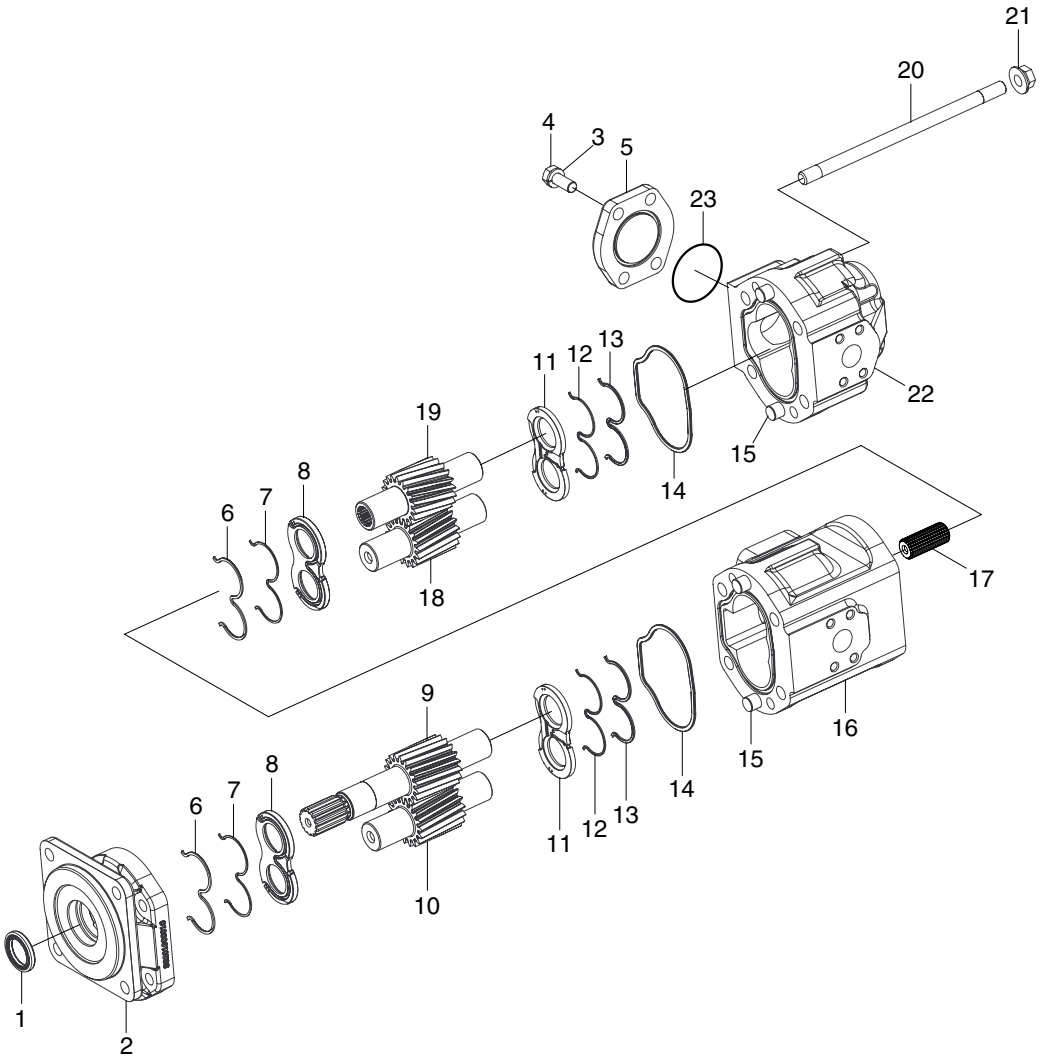
(4) Install the O-ring and filter case covers. Tighten them with bolt. Replace the O-ring with new one if damaged.sa



7607WE32

1. MAIN PUMP

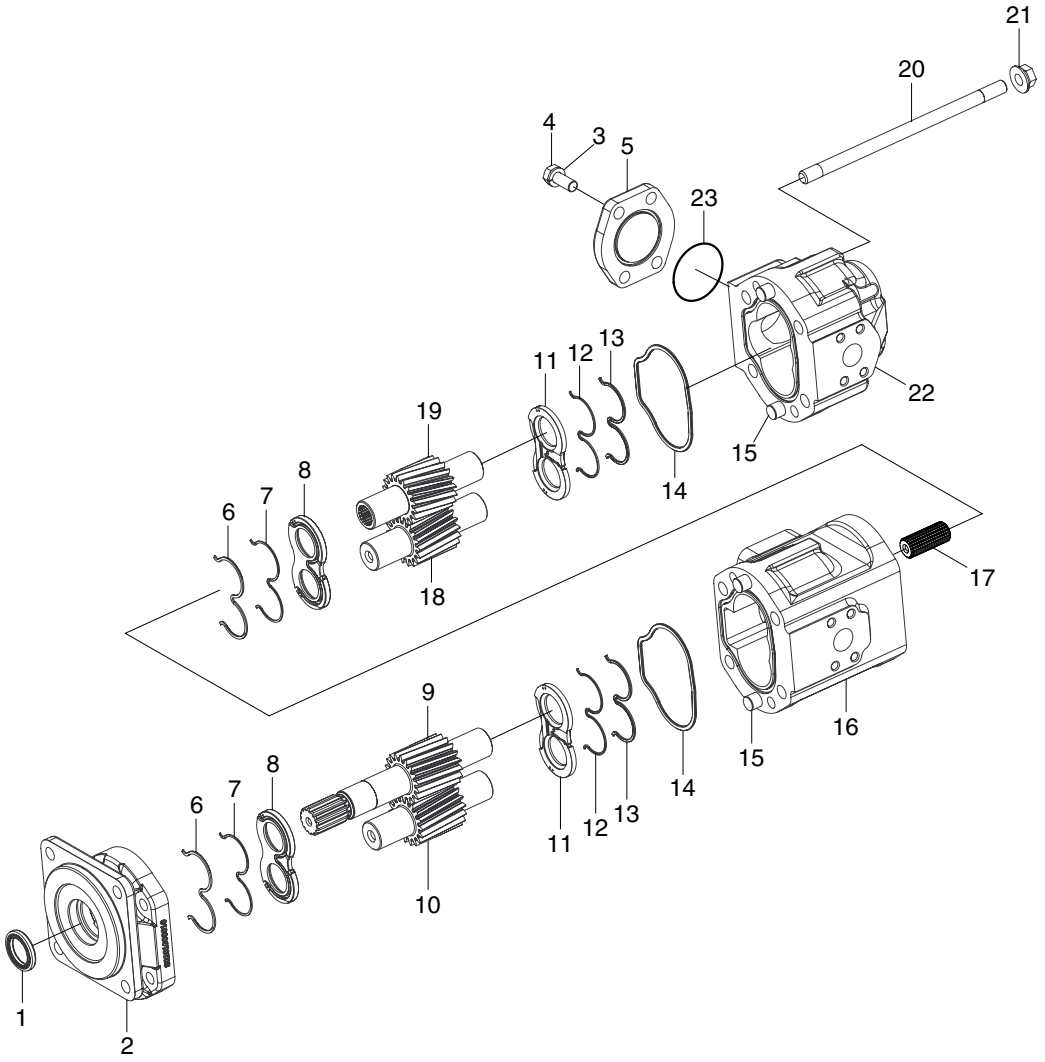
1) STRUCTURE



7607WE33

1	Shaft seal	9	Front drive gear	17	Spline coupling
2	Adapter	10	Front driven gear	18	Rear driven gear
3	Washer	11	Wearplate	19	Rear drive gear
4	Bolt	12	O-ring seal	20	Stud
5	Flange	13	Back up seal	21	Flanged nut
6	Back up seal	14	Interface seal	22	Rear body
7	O-ring seal	15	Dowel	23	O-ring
8	Wearplate	16	Front body		

2) DISASSEMBLY



7607WE33

※ Plug all ports prior to cleaning and disassembling pump to prevent ingress of debris or contamination.

※ Clean the pump thoroughly with a solvent, ensuring no loose debris or contamination remains on the unit.

※ Mark each interface and then separate into individual pump sections.

(1) Securely clamp pump horizontally on one port face, ensuring that no damage is sustained to the port face and remove the stud(20) and nut(21).

(2) Remove the front adaptor(2) from the body(16) using a pulling tool centred on the drive shaft(9).

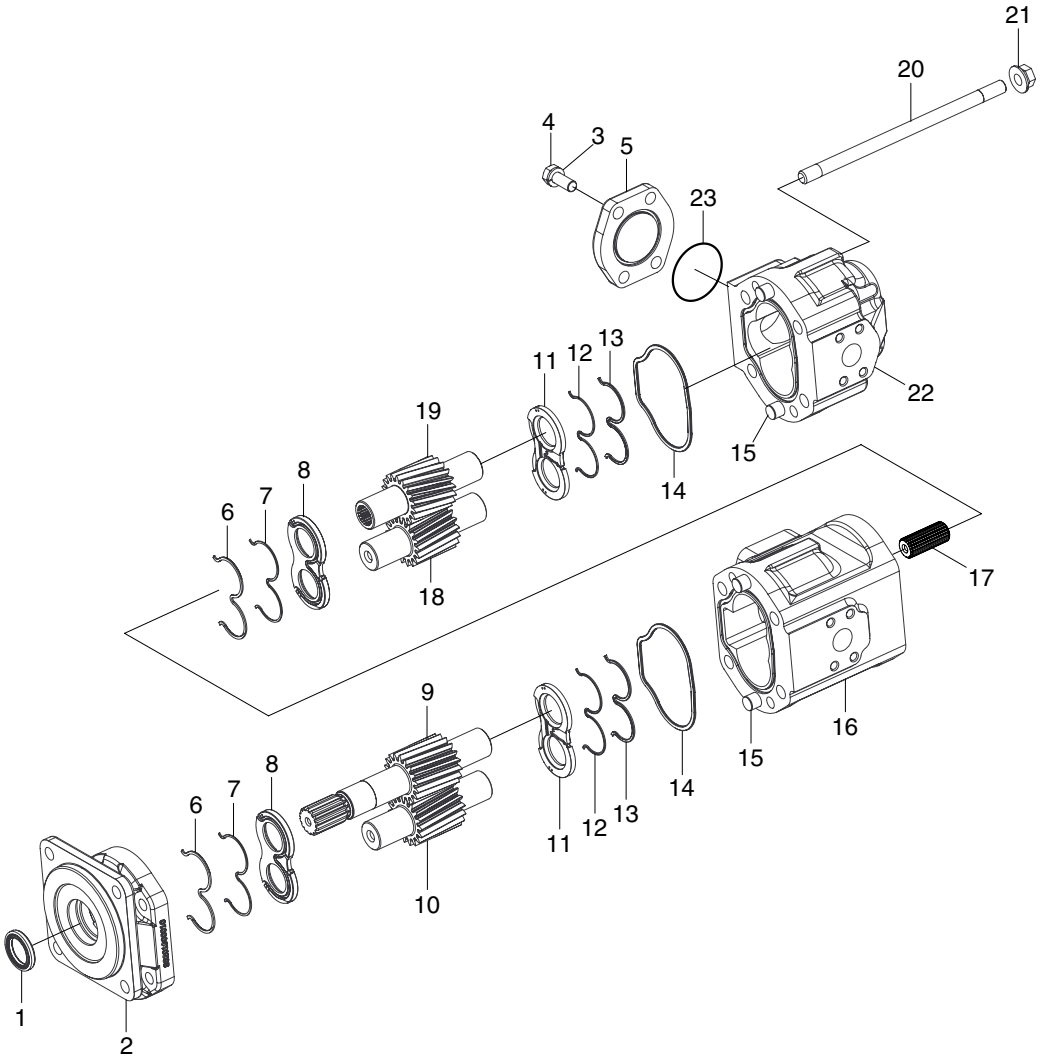
※ Under **NO** circumstances attempt to prise or chisel cover from body as such action could damage the machined sealing faces.

(3) Remove and discard the shaft seal(1) from adaptor making sure that no damage is sustained to the surface of the seal bore.

(4) Unclamp pump and place it vertically with drive shaft up.

(5) Before removing wearplate from the body mark it using a soft pencil or a felt-tip pen to ensure correct reassembly. Remove wearplate(8) complete with O-ring seal(7) and back up seal(6).

DISASSEMBLY



7607WE33

(6) Mark the gears using a soft pencil or felt-tip pen to ensure assembly in the same relative position, see figure on the right, then withdraw the drive shaft/gear(9) and driven gear(10) separately to prevent jamming.



7607WE34

(7) Again, to ensure correct assembly, mark remaining wearplate(11) using a soft pencil or a felt-tip pen. Remove wearplate from body complete with O-ring seal(12) and back up seal(13).

(8) Discard interface seal(14).

(9) Having separated into individual pumps, proceed as per paragraph (1)~(7).

3) MANDATORY REPLACEMENT PARTS

Discard all seals including interface seals, shaft seals, wear plate seals and back up seals. Fit new seals on reassembly. Wearplates should also be replaced with new items from seal kit.

4) HANDLING/STORAGE

While disassembling pump, ensure no surfaces are scored or marked in any way. A rubber surfaced table will be beneficial. All components must be placed in a clean, dry and safe area. Leakage will be created by scratches on components. If parts are to be left for any period ensure they are not exposed to dirt, dust and corrosion. Keep gears separate from each other in protective boxes.

5) INSPECTION OF PARTS

Wash all parts in a solvent and dry.

(1) Adaptor housing and cover

The pump must be replaced if the damage listed is present.

Feature	Damage
Surfaces	Corrosion, nicks or burrs(slight burrs can be removed using and india stone)
Machined sealing Interfaces	Scores, cracks or corrosion
Bearing	Loose

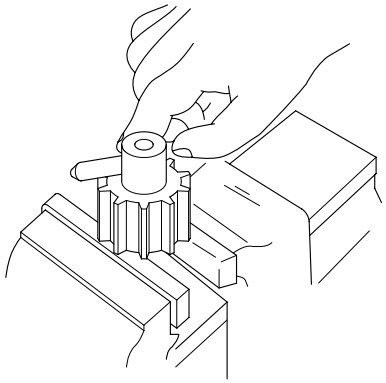
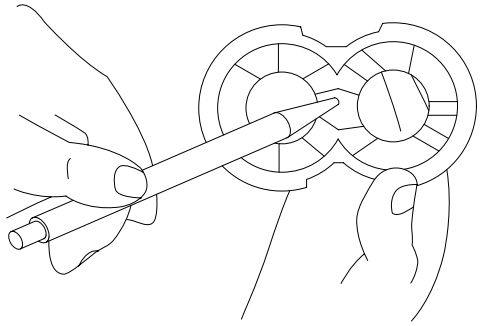
(2) Gears

The pump must be replaced if the damage listed is present.

Feature	Damage
Surfaces	Corrosion, nicks or burrs(slight burrs can be removed using an Indian stone). Wear due to seal(s)
Journals	Pitting, wear, sufficient wear to change outside diameter
Tooth	Cracks or heavy scoring or chipped
Splines/keyways	Distortion of wear
End faces	Wear, cracks

(3) Floating wear plates

The pump must be replaced if the damage listed is present.

Feature	Damage
Surfaces	Corrosion, nicks or burrs, amounts of scoring,erosion or any cracks, discoloration caused by overheating
 Removing burrs or minor scoring from end faces and teeth of the gears.	 Scoring of wear plate.

(4) Bolts/Studs

The pump should be replaced if the damage listed is present.

Feature	Damage
Surfaces	Corrosion, nicks or burrs(slight burrs can be removed using an India stone), cracks or scoring, distortion or damage to thread form

(5) Plain bearings

The pump must be replaced if the damage listed is present.

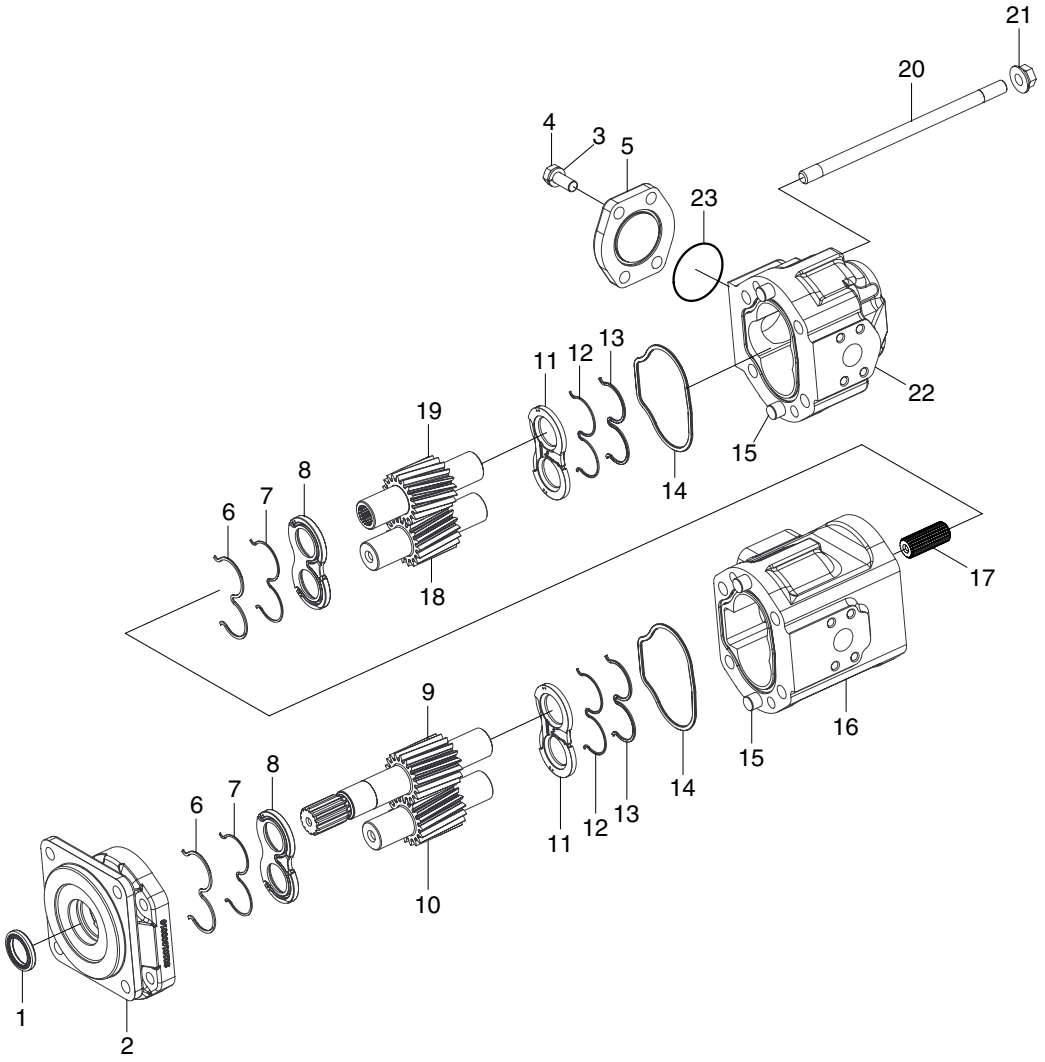
Feature	Damage
Surfaces	Cracks or socring
PTEF Coating	Worn-bronze, sub-layer showing
Bearing	Loose in housing/cover

(6) Coupling

This must be replaced if damage listed is present.

Feature	Damage
Surfaces	Corrosion, nicks or burrs, erosion, cracks or pitting
Splines	Distorted or badly worn

6) ASSEMBLY



7607WE33

※ It is critical that the wearplates are assembled into the pump with regard to the following:
-The seal side of the wearplate must be adjacent to the adaptor or body.
-The high pressure side of the wearplate must be adjacent to the outlet port.

※ This must take place in a clean dry area, ensuring that all parts are clean and free from contamination or loose particles. Lightly oil all surfaces.

(1) Place body vertically with gear pockets upper most.

(2) Slide wearplate(11) complete with O-ring seal(12) and back up seal(13) down through the housing to the bottom of the gear pockets.

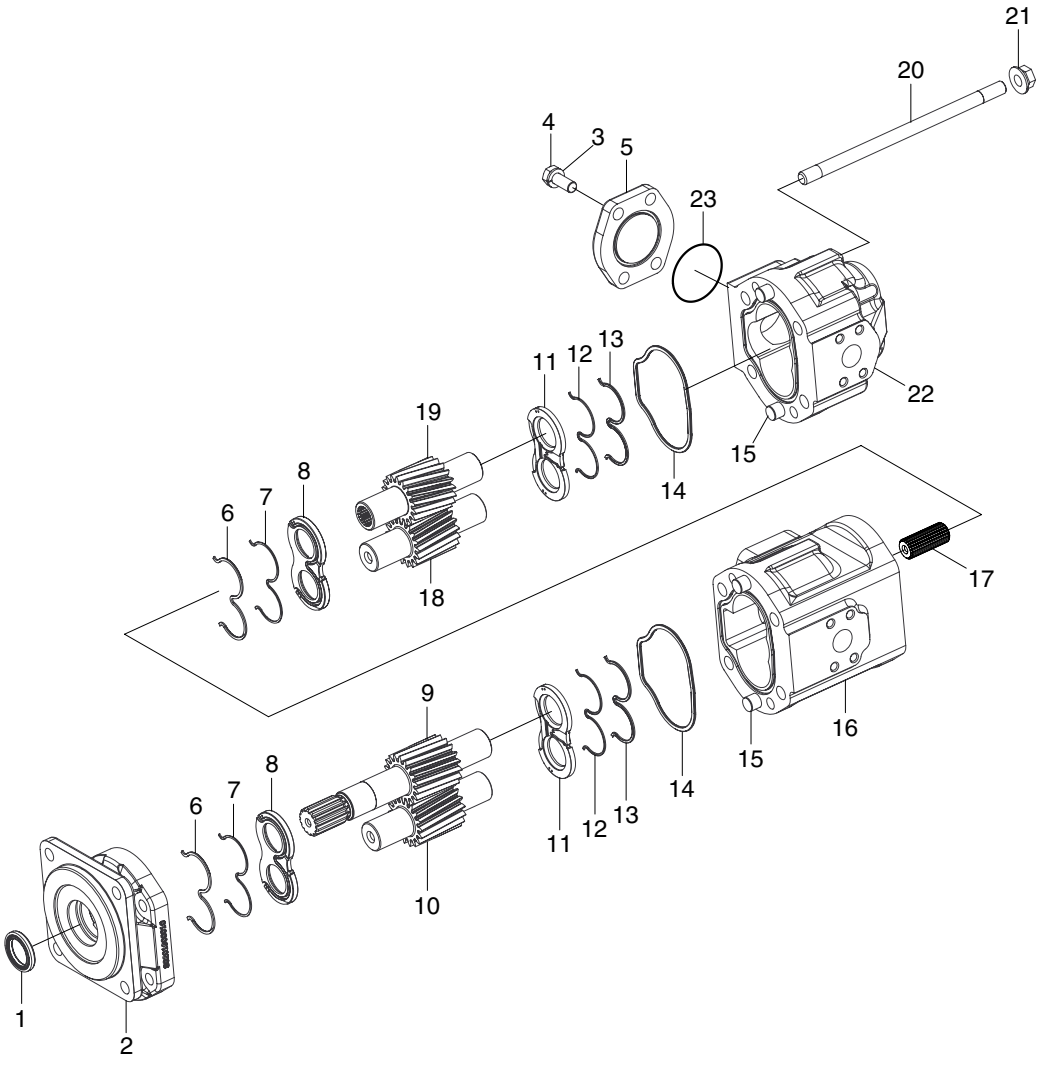
※ Be sure to refit the wearplate the same as that marked from this position during disassembly.

(3) Fit the gears(18,19) within the housing taking care to replace as marked, with the teeth reassembled to their original related position.

(4) Fit the wearplate(8) complete with O-ring seal(7) and back up seal(6).

※ Be sure to refit the wearplate the same as that marked from this position during disassembly.

ASSEMBLY



7607WE33

(5) Fit new interface seal(14) into groove in body.

(6) Proceed as per paragraph(1)~(5).

(7) Fit adaptor(2) over the drive gear(9) and fit stud(22).

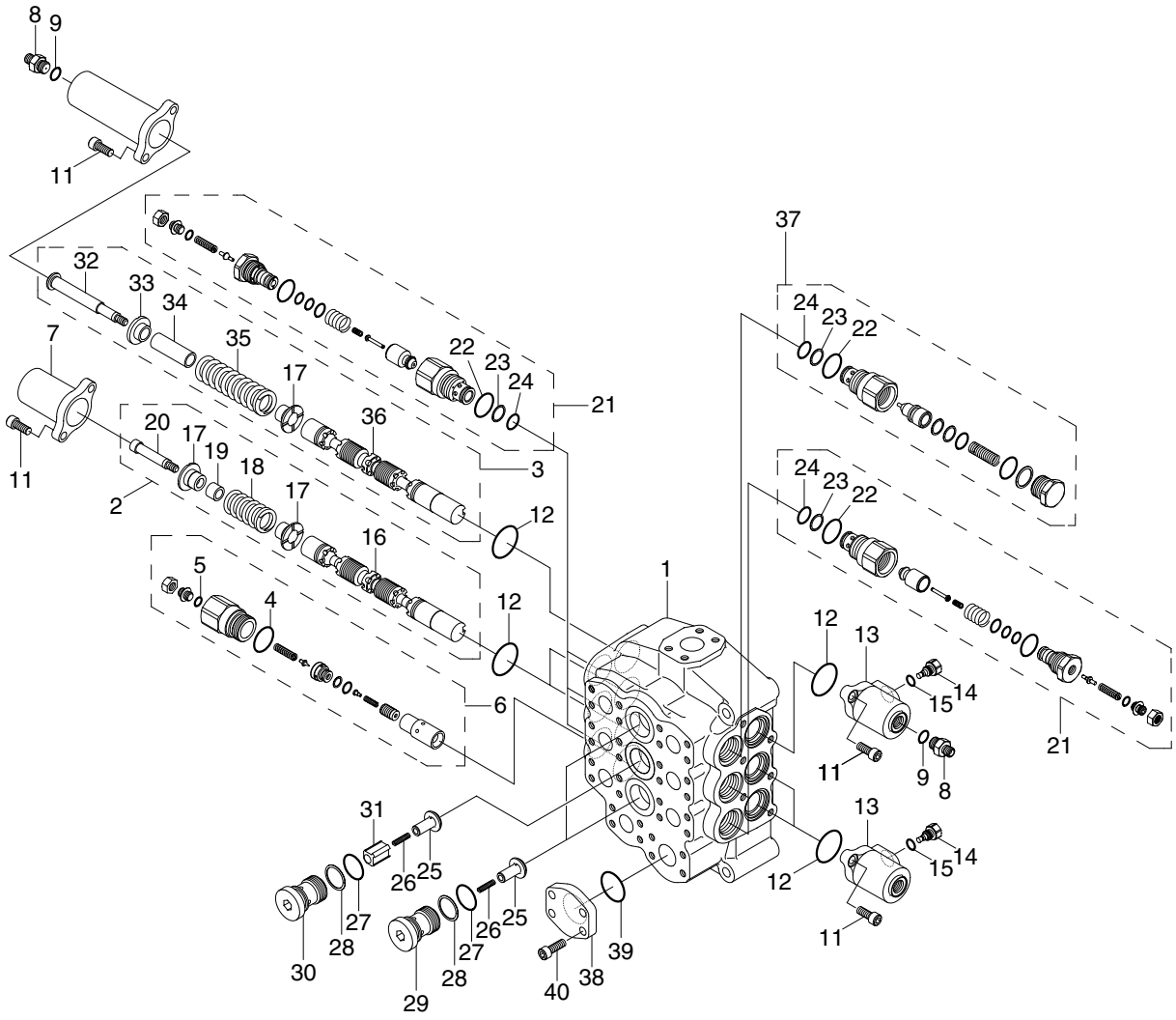
(8) Securely clamp unit and tighten nut(21) to half torque and then full torque.
- Tightening torque : 23.2kgf · m(168lbf · ft)

(9) Fit shaft seal(1) using appropriate tooling, in correct position and orientation.

(10) Pour a little clean hydraulic oil into the ports.

2. MAIN CONTROL VALVE

1) STRUCTURE



7607WE35

1	Housing assembly	15	O-ring	28	Back up ring
2	Plunger assembly	16	Plunger	29	Cap
3	Plunger assembly	17	Guide	30	Cap
4	O-ring	18	Spring	31	Check
5	O-ring	19	Spacer	32	Cap
6	Main relief assembly	20	Nipple	33	Guide
7	Cover	21	Port relief assembly	34	Spacer
8	Nipple	22	O-ring	35	Spring
9	O-ring	23	Back up ring	36	Plunger
10	Cover	24	O-ring	37	Make up assembly
11	Socket bolt	25	Check	38	Cover
12	O-ring	26	Spring	39	O-ring
13	Cover	27	O-ring	40	Bolt
14	Plug				

2) GENERAL PRECAUTIONS

(1) Clean room with no dust is recommended for maintenance. Because hydraulic components are precision, and have minute clearance. Tool and wash-oil must be clean, too. Handle them carefully.
(2) At removing control valve from the machine, wash around the piping port, and neither dust nor water should go into inside with plugging. It is same at attaching the machine.
(3) Prepare the required parts by checking structure figure before assembly. There are parts which are supplied with only sub-assembly part, so check the parts list before assembly.

3) PRECAUTIONS FOR DISASSEMBLY

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

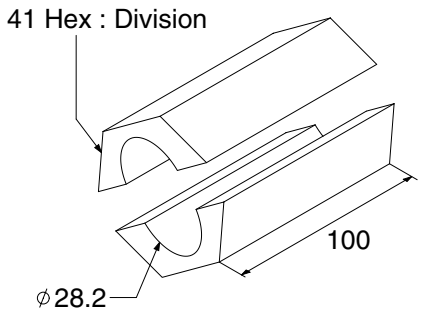
4) PRECAUTIONS FOR REASSEMBLY

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

5) SPECIAL TOOL

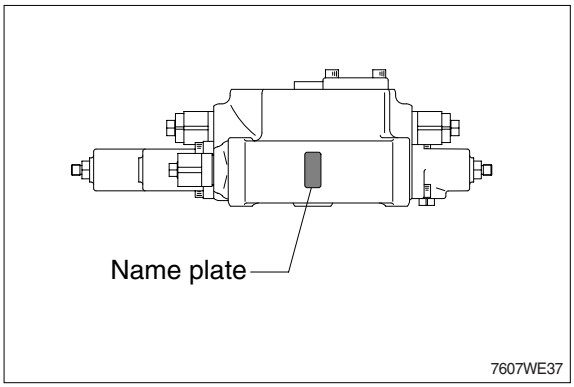
· HOLDER

Material : copper



7607WE36

※ **Regarding to change the main plunger**
We can not supply the main plunger, because the plunger is fit for valve housing.
So, do not change the plunger at the field.
If changing plunger must be needed, then tell us model name of control valve and serial number written at its nameplate.

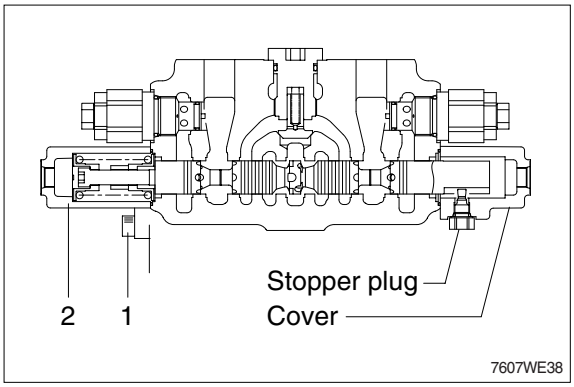


6) BUCKET PLUNGER AND ACCESSORY PLUNGER

※ Reassemble in the opposite order to disassemble.
※ To reassemble correctly, attach an identification tag immediately after parts are removed.

(1) Remove hexagon socket bolts(1) then remove cover(2).
- Hexagon socket bolt
  Width across flat : 8mm
  Tightening torque : 5.1kgf · m(36.8lbf · ft)

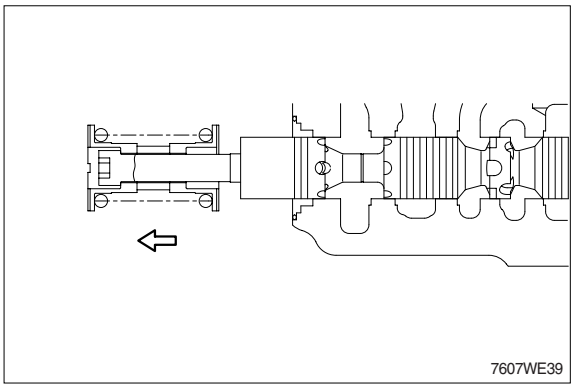
※ Reassembly
Install cover(2), after making sure that O-ring is placed on the edge of the housing hole.



(2) Pull out spool assembly from housing.

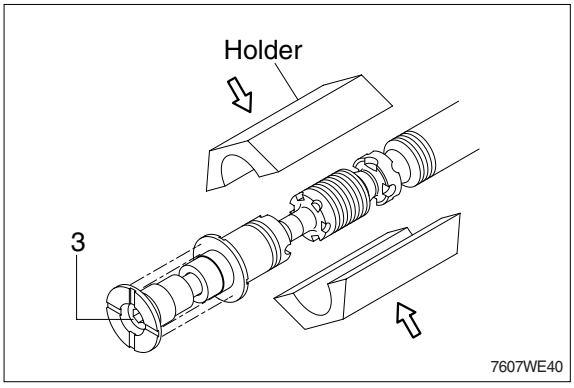
※ Do not pull out the spool all at once.
Pull slowly while fitting in the housing hole.

※ Reassembly
Set the key groove of the plunger with the stopper plug of the cover.



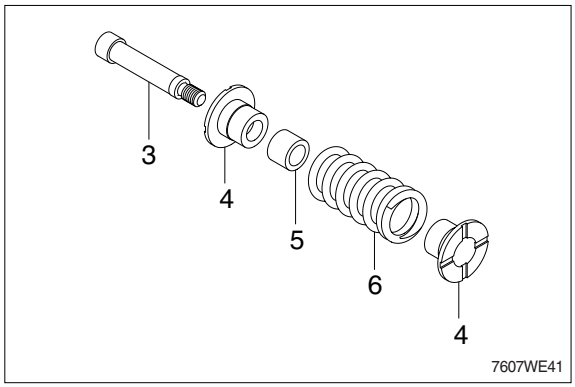
(3) Set the spool between holders and loosen plunger cap(3) by using vise.
- Plunger cap
  Width across flat : 8mm
  Tightening torque : 6.1kgf · m(44.2lbf · ft)

※ Set the spool between holders and clamp them by a vise after degreasing the spool and holders as a special tool.



(4) Remove the plunger cap(3), spring guide (4), spring(5) and sleeve(6).

※ Spring is different from boom section spring.

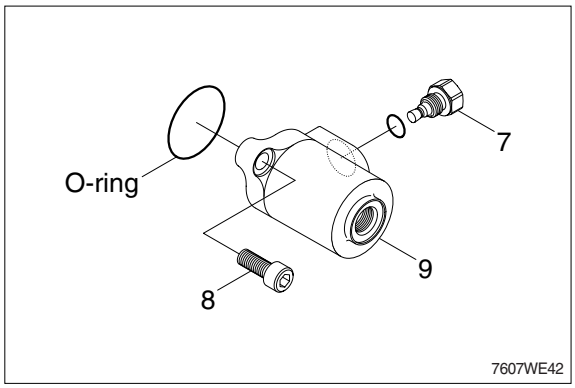


(5) Remove hexagon socket bolts(8) then remove cover(9) after remove plug(7).

· Plug(7)
Width across flat : 19mm
Tightening torque : 8.2kgf · m(59.0lbf · ft)

· Hexagon socket bolt(8)
Width across flat : 8mm
Tightening torque : 5.1kgf · m(36.8lbf · ft)

※ Make sure that O-ring is on the face of housing.

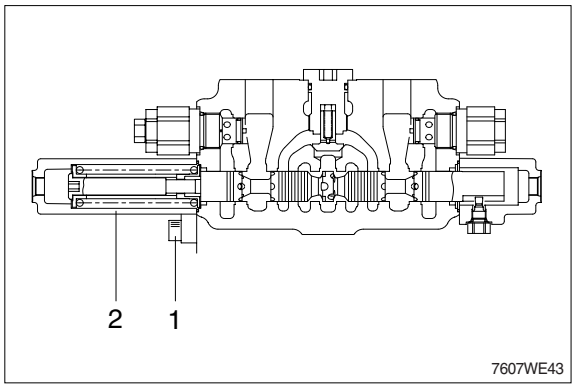


7) BOOM PLUNGER

(1) Remove hexagon socket bolts(1) then remove cover(2).

· Hexagon socket bolt
Width across flat : 8mm
Tightening torque : 5.1kgf · m(36.8lbf · ft)

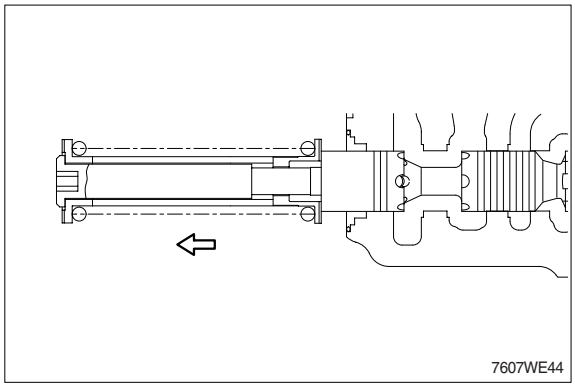
※ Reassembly
Install cover(2), after making sure that O-ring is placed on the edge of the housing hole.



(2) Pull out spool assembly from housing.

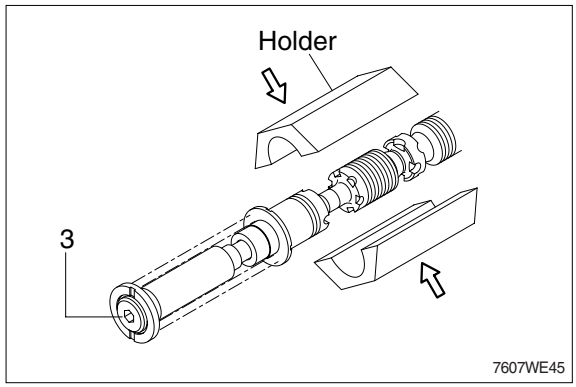
※ Do not pull out the spool all at once.
Pull slowly while fitting in the housing hole.

※ Reassembly
Set the key way of the plunger to the stopper plug of the cover.



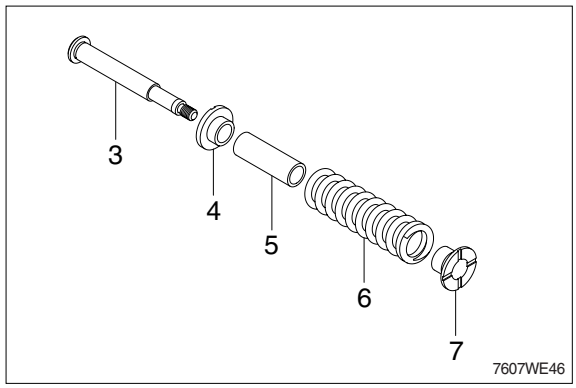
(3) Set the spool between holders and loosen plunger cap(3) by using vise.
- Plunger cap
  Width across flat : 8mm
  Tightening torque : 6.1kgf · m(44.2lbf · ft)

※ Set the spool between holders and clamp them by a vise after degreasing the spool and holders as a special tool.



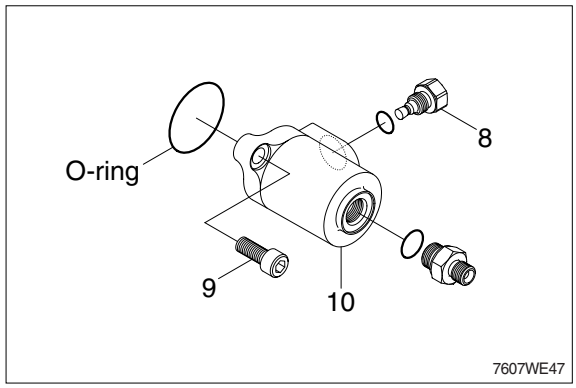
(4) Remove the plunger cap(3), spring guide (4), spring(5), sleeve(6) and spring guide (7).

※ Spring is different from the other section spring.



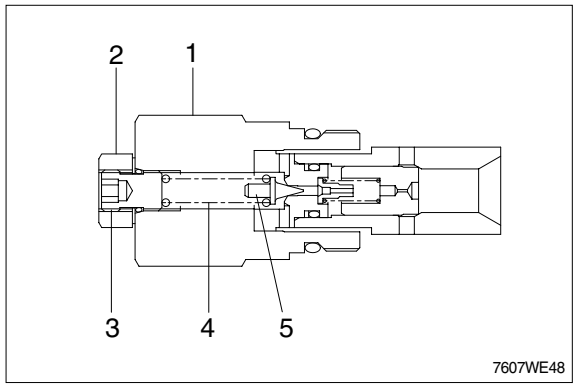
(5) Remove hexagon socket bolts(8) then remove cover(9) after remove plug(7).
- Plug(7)
  Width across flat : 19mm
  Tightening torque : 8.2kgf · m(59.0lbf · ft)
- Hexagon socket bolt(8)
  Width across flat : 8mm
  Tightening torque : 5.1kgf · m(36.8lbf · ft)

※ Confirm that O-ring is put to end face of housing.

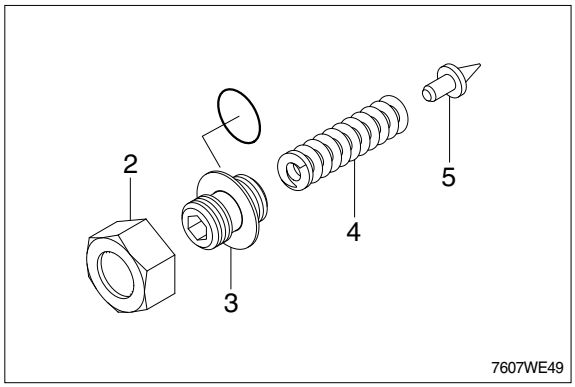


8) MAIN RELIEF VALVE

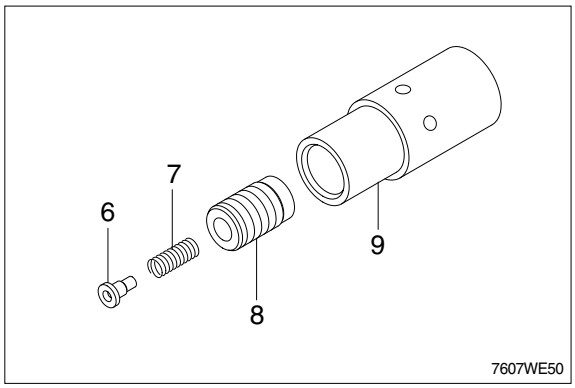
(1) Loosen cap(1) and remove the main relief cartridge from the body.
- Cap(1)
  Width across flat : 41mm
  Tightening torque : 10.2kgf · m(73.8lbf · ft)



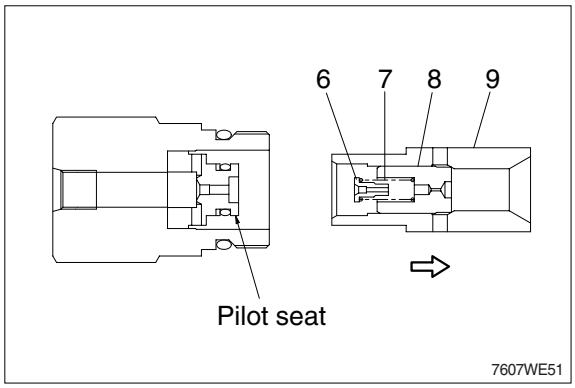
(2) Loosen hex nut(2), and remove adjust screw(3), spring(4) and pilot poppet(5).
- Hex nut(2)
  Width across flat : 19mm
  Tightening torque : 3.3kgf · m(23.6lbf · ft)
- Adjust screw(3)
  Width across flat : 22mm



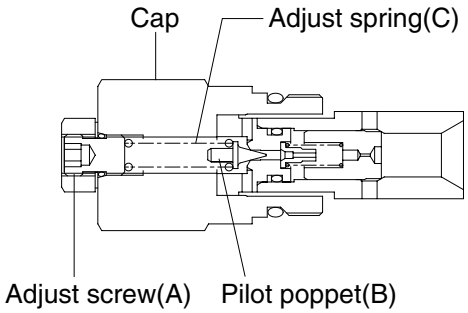
(3) Pull out sleeve(9), and remove orifice(6), spring(7) and main poppet(8).



※ Do not disassemble pilot seat, because the pilot seat is assembled with pressure.



(5) RESETTING THE RELIEF PRESSURE



7607WE52

※ If setting pressure is mistaken, hydraulic unit may be destroyed and danger may be caused.
Do not raise by any means more than the pressure decided for every model.

Tempolary assembly and setting

① Check the position of setting pressure 0 MPa.
Set adjusting screw(A) temporarily in the position that pilot poppet(B) contacts to pilot seat.
Then pressure adjusting spring(C) begins to be effective.

② Install the main relief valve which is set temporarily to main body.
Tighten cap with torque wrench.
· Tightning torque : 10.2kgf · m(73.8lbf · ft)

To set pressure

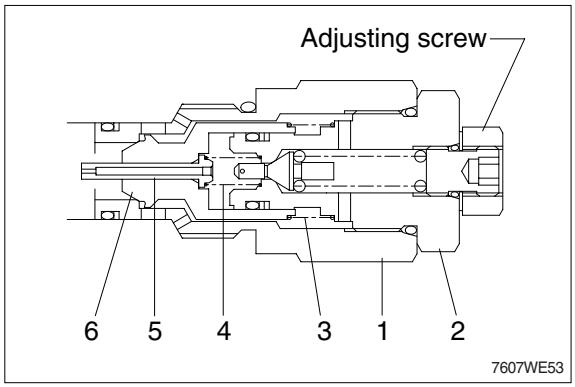
① Attach exact pressure gauge at exit of pump or gauge port of control valve.
② Operate the pump with rated speed.
③ Operate plunger either boom or bucket at full stroke and check the pressure.
④ Turn adjusting screw(A) (right turn) and set pressure with checking pressure gauge.
· One quarter turn of adjusting screw(A) equals about 4 MPa.
· Setting pressure 20.6MPa(210kgf/cm^2) at 220 ℓ /min.
· Relief is very sensitivity. So, do not turn adjusting screw(A) suddenly.
⑤ Tighten lock nut with torque wrench holding adjusting screw.
· Tightning torque : 3.3kgf · m(23.6lbf · ft)
※ Operate plunger and check the setting pressure, again.

9) PORT RELIEF VALVE

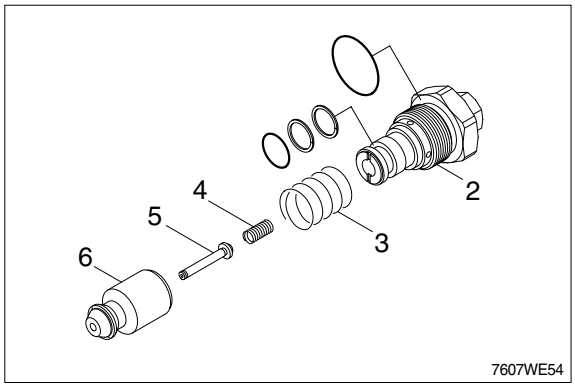
※ Do not disassemble adjusting screw.
It's impossible to readjust setting pressure exactly on the machine.

(1) Loosen sleeve(1) and remove relief valve.
- Sleeve(1)
  Width across flat : 41mm
  Tightening torque : 10.2kgf · m(73.8lbf · ft)

※ Install to original position.

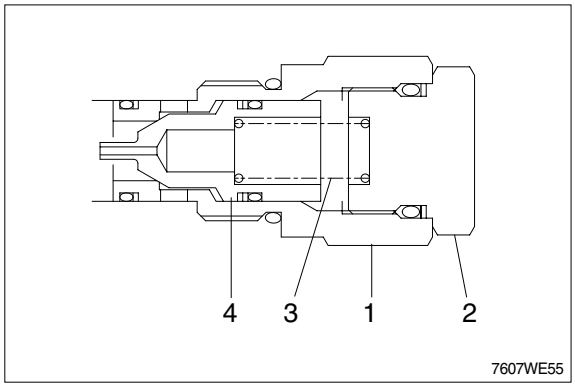


(2) Loosen and remove relief seat sub-assembly(2). And remove spring(3),(4) piston(5), and main poppet(6).
- Relief seat(2)
  Width across flat : 36mm
  Tightening torque : 10.2kgf · m(73.8lbf · ft)

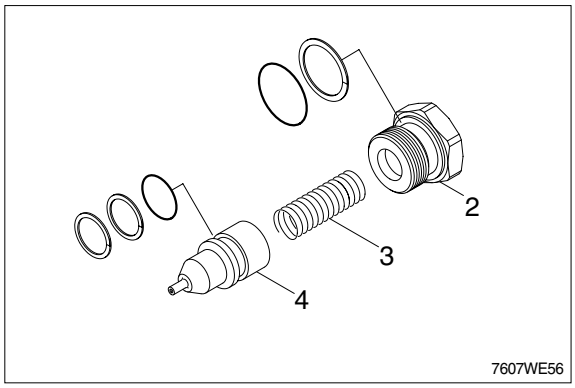


10) MAKE UP VALVE

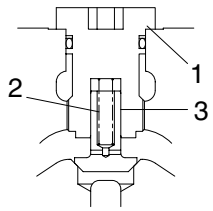
(1) Loosen sleeve(1) and remove relief valve.
- Sleeve(1)
  Width across flat : 41mm
  Tightening torque : 10.2kgf · m(73.8lbf · ft)



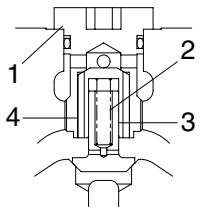
(2) Remove cap(2) and pull out spring(3), poppet(4).
- Cap(2)
  Width across flat : 36mm
  Tightening torque : 10.2kgf · m(73.8lbf · ft)



11) LOAD CHECK VALVE



- Bucket for 2-spools valve
- Aux for 3-spools valve
- Boom for 2 & 3-spools valve



- Bucket for 3-spools valve

7607WE57

Example for explanation : Bucket section of 3-spools valve(double check)

(1) Remove cap(1) pull out spring(2), check (3) and (4)

· Cap(2)

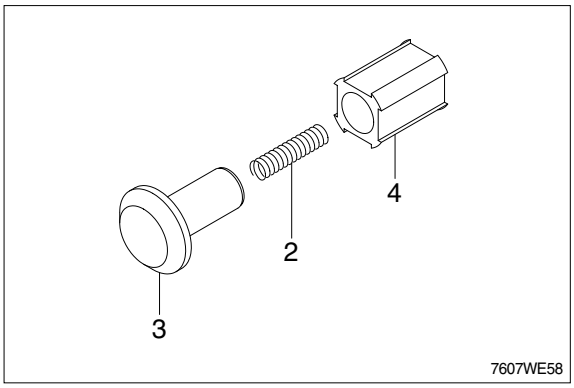
Width across flat : 36mm

Tightening torque : 25.5kgf · m(184lbf · ft)

※ When reassembly ;

Be careful for the back-up ring not to protrude.

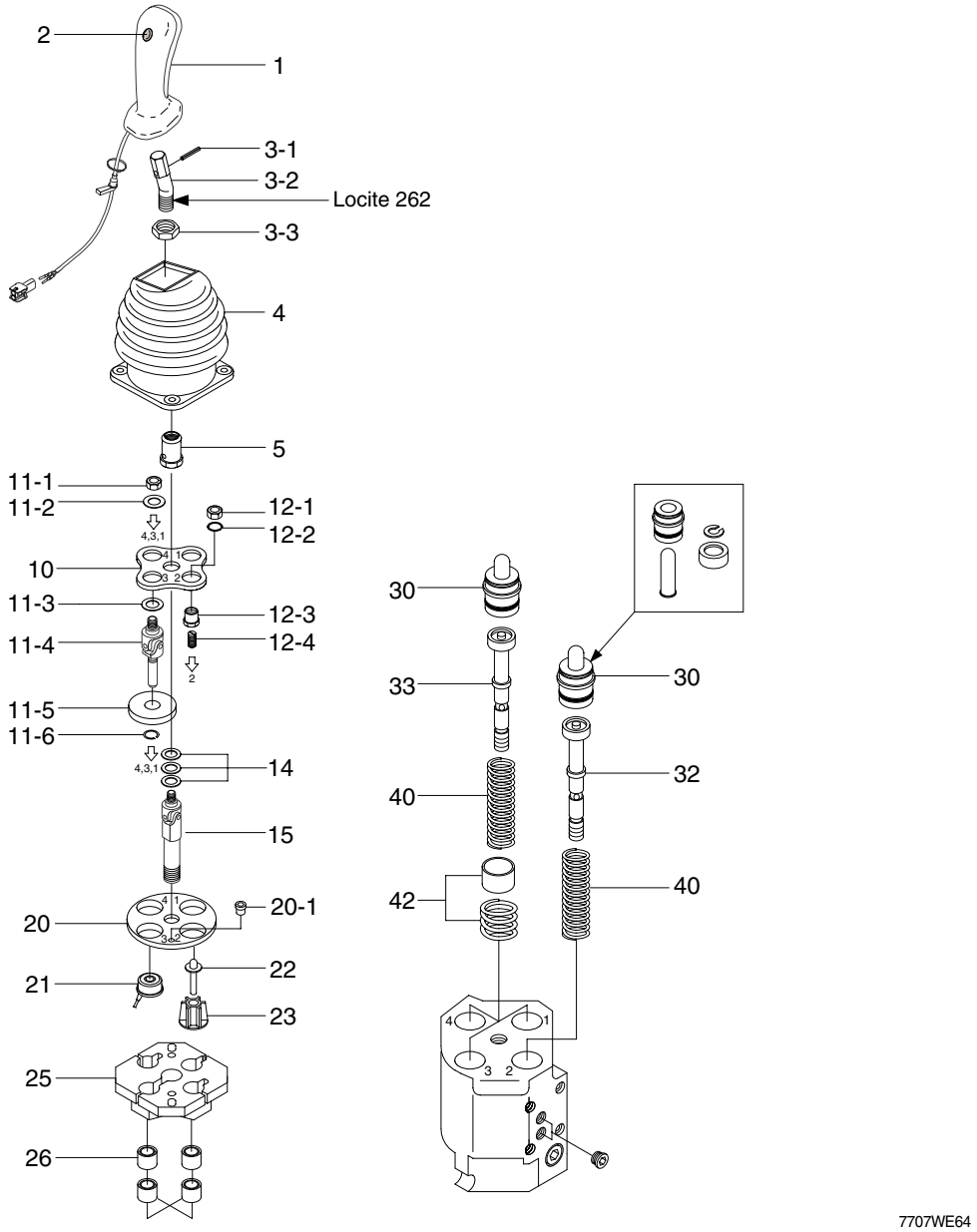
※ Only Bucket section has double check.



7607WE58

3. REMOTE CONTROL VALVE

1) STRUCTURE



1	Handle	11-4	Cardan	22	Intermediary plunger kit
2	Push button	11-5	Armature	23	Intermediary plunger guide
3-1	Locking pin	11-6	Spring ring	25	Electric bracket
3-2	Bent lever	12-1	Counter nut	26	Bushing
3-3	Nut	12-2	Spring ring	30	Plunger kit
4	Rubber boot	12-3	Switch plate screw	32	Regulation unit
5	Locking nut	12-4	Press screw	33	Regulation unit
10	Cardan bracket	14	Shims(0.1, 0.2, 0.5㎜)	40	Return spring
11-1	Self-locking nut	15	Cardan	42	Prefeeling point kit
11-2	Washer	20	Flange		
11-3	Washer	21	Solenoid		

2) DISASSEMBLY AND ASSEMBLY

(1) PUSH BUTTEN

※ The remote control valve does not need to be removed from the machine to perfom this operation.
Remove worn pushbutton using a small screwdriver.
The installation of new elements is performed without any special tools; the parts are simply pressed into place.

(2) RUBBER BOOT

① Remove the remote control valve from the machine or free the valve by unscrewing the 4 screws fixing the plate in order to release the electrical cable.
· Assembly
Torque : 1.02kgf · m(7.4lbf · ft)
Hold the remote control valve using a vice or a vice-grip wrench(clamp onto the body).

※ The pilot unit does not need to be removed from the machine to release the cable. However, it is recommended to lift the control unit by undoing the 4 fixing screws on the arm rest.

※ It is unnecessary to remove the units with no electrical functions.

② Lift and turn the boot inside out.
③ Remove the grommet(7) from its emplacement to free the cable.
④ Loosen the handle mounting nut(3-3) using a 19㎜ open-end wrench.
· Assembly : torque 4.08kgf · m(29.5lbf · ft)
⑤ Unscrew and remove the handle(1).
· Assembly
- Add loctite 262 onto the lever thread
- Torque : 4.08kgf · m(29.5lbf · ft)
⑥ Replace the faulty rubber boot(4) with a new one.
⑦ Replace the handle(1) following the disassembly instructions in reverse order.

(3) HANDLE

① Clamp the threaded section of the lever(3-2) in a vice fitted with V-shaped vice clamp.
② Remove the pin(3-1) using a 5㎜ pin driver.
③ Replace the lever(3-2) onto the new handle(1) and secure it with the pin(3-1) using a 5㎜ pin driver.

※ Respect the position of the curved lever to ensure that the handle is correctly oriented as indicated by the machine's technical specifications.

④ Replace the nut(3-3) on the threaded section and replace the boot(4).

(4) DETENT CARDAN BRACKET KIT

※ Remove the 2 grommets(20-1) from the flange (20).

※ Place centering sleeves V & W to avoid damaging the cardan knuckles while loosening the nuts.

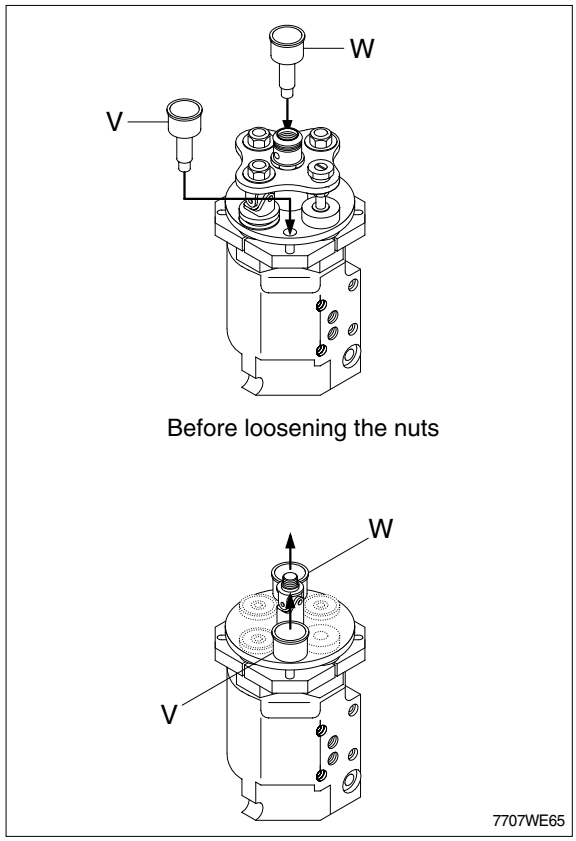
※ Unscrew the locking nut(5) using a 23mm open-end wrench.

· Assembly : Torque 4.08±0.4kgf · m (29.5±2.9lbf · ft)

① Unscrew the self-locking nut(11-1) using a 13㎜ open-end wrench.

· Assembly
- Torque 1.02kgf · m(7.4lbf · ft)
- Place centering sleeves(V-W) to avoid damaging the cardan knuckles while screwing the nuts.

② Remove : - Friction washer(11-2)
- Friction washer(11-3)
- Cardan/armature assembly (11-4 ~ 11-6)



(5) NON-DETENT PLUNGER KIT

① Unscrew the self-locking nut(12-1) using a 13㎜ open-end wrench.

· Reassembly : - Torque 1.02kgf · m(7.4lbf · ft)
- Place centering sleeves(V-W) to avoid damaging the cardan knuckles while screwing the nuts.

② Undo the snap ring(12-2) using a flat-end screwdriver.

③ Remove the screw assembly(12-3, 12-4)

(6) CARDAN

① Remove the centering sleeves **V** & **W**.

② Remove the cardan bracket(10) and the shims(14).

③ Unscrew the cardan(15) using a 17㎜ open-end wrench.

· Reassembly : - Ungrease the cardan threads
- Add loctite 262 onto the cardan threads(both end)
- Torque 4.08kgf · m(29.5lbf · ft)

(7) SOLENOID AND CONNECTOR

※ It is advised to mount the connector onto the solenoid cable once the remote control valve is assembled.

① Remove the flange(20) and the electrical bracket(25),

② Remove the protecting bushes(26) from the electrical bracket(25).

③ Undo the solenoid(21) from the electric bracket(25).

④ Replace the solenoid.

※ Clean the polar face using a piece of cloth and pay attention not to hit them.

⑤ Assembly : Place the solenoid cable in its emplacement on the electric bracket before fitting the protection bushes.

(8) INTERMEDIARY PLUNGER KIT

① Undo the intermediary plunger guide(23).

② Remove and replace the intermediary plunger kit assembly(22).

(9) GUIDE / PLUNGER AND REGULATION UNIT

※ Beware of the plungers that might jump out due to the spring return.

① Remove : - Guide/plunger assembly(30).
- Regulation unit(32/33).
- Return spring(40).
- Pre-feeling point kit(42).

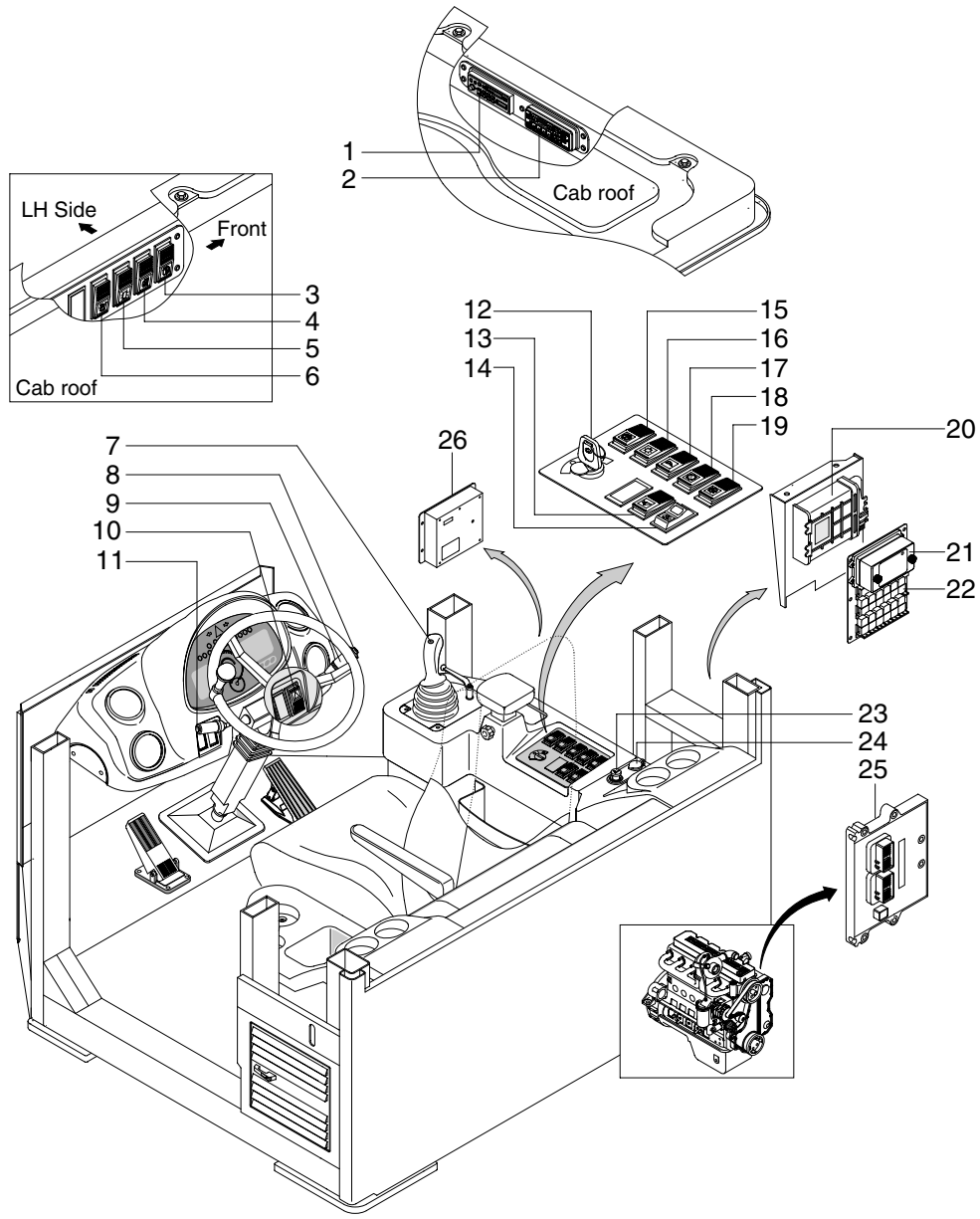
② The remote control valve is now totally disassembled.
Assemble in reverse order following the torque specification.

SECTION 7 ELECTRICAL SYSTEM

Group 1 Component Location ····· 7-1
Group 2 Electrical Circuit ····· 7-3
Group 3 Monitoring System ····· 7-21
Group 4 Electrical Component Specification ····· 7-38
Group 5 Connectors ····· 7-45
Group 6 Troubleshooting ····· 7-65

GROUP 1 COMPONENT LOCATION

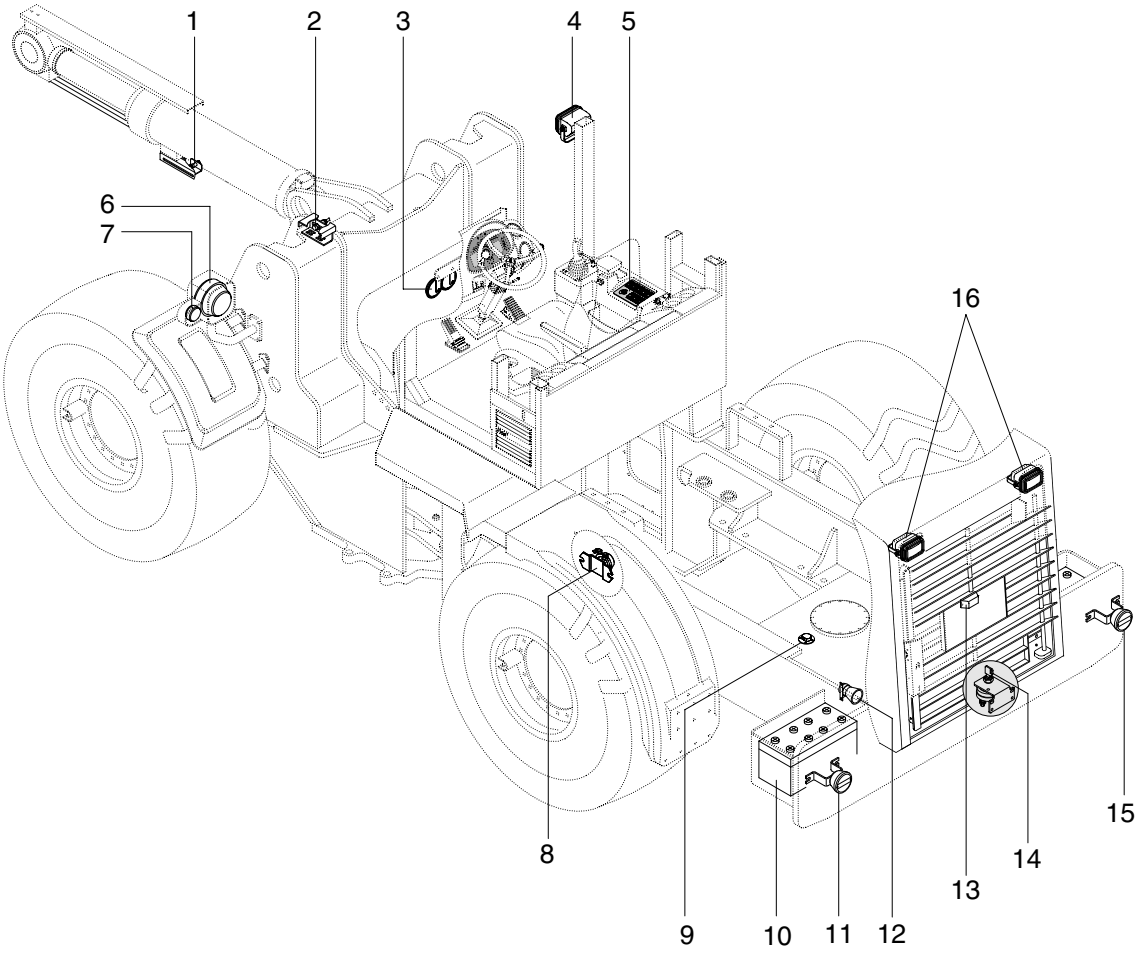
1. LOCATION 1



7607AEL02

1	Radio & cassette(STD) Radio & CD player(OPT)	9	Multi function switch	18	Auto select switch
		10	Hazard switch	19	Clutch cut off switch
2	Aircon & heater switch	11	Kick down switch	20	Transmission control unit(TCU)
3	Rear wiper/washer switch	12	Starting switch	21	Fuse box
4	Mirror defrost switch(Option)	13	Ride control switch(Option)	22	Relay board
5	Beacon switch(Option)	14	Pump motor switch(Option)	23	Cigar lighter
6	Heated seat switch(Option)	15	Parking brake switch	24	12V socket
7	Kick down switch	16	Main light switch	25	Engine control module(ECM)
8	Horn button	17	Work lamp switch	26	Machine control unit(MCU)

2. LOCATION 2

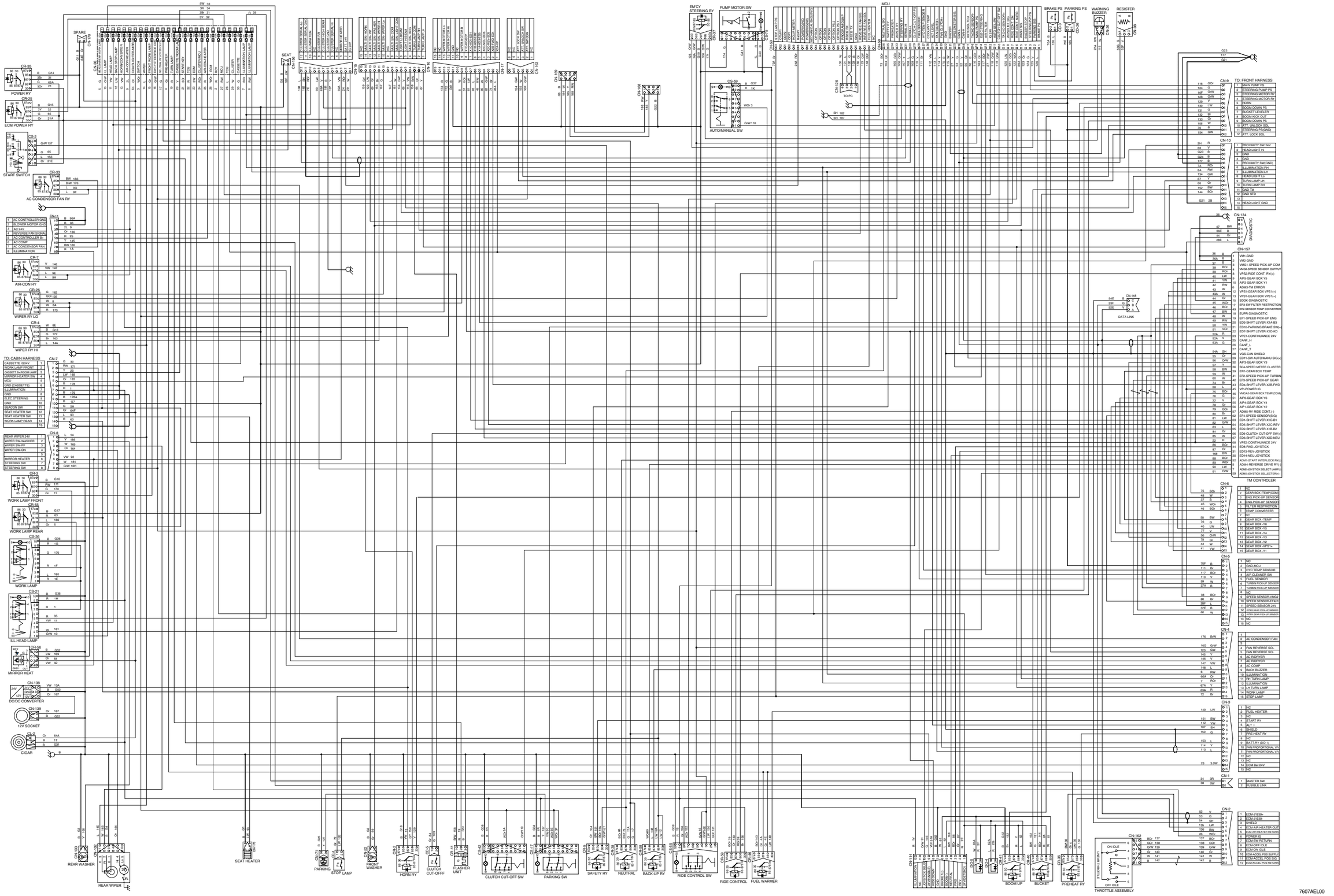


7707AEL02-1

1	Proximity switch	7	Front turn lamp	12	Back up buzzer
2	Proximity switch	8	Start relay	13	Number plate lamp
3	Horn	9	Fuel sender	14	Master switch
4	Work lamp	10	Battery	15	Rear combi lamp
5	Switch panel	11	Rear combi lamp	16	Work lamp
6	Head lamp				

MEMORANDUM


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HYUNDAI HEAVY INDUSTRIES CO., LTD.
CONSTRUCTION EQUIPMENT DIV.


POWER RY
ECM POWER RY
START SWITCH
AC CONDENSOR FAN RY
AIR-CON RY
WIPER RY LO
WIPER RY HI
WORK LAMP FRONT
WORK LAMP REAR
WORK LAMP
ILL HEAD LAMP
MIRROR HEAT
DC/DC CONVERTER
12V SOCKET
CIGAR
REAR WASHER
REAR WIPER
SEAT HEATER
PARKING
STOP LAMP
FRONT WASHER
HORN RY
CLUTCH CUT-OFFF
FLASHER UNIT
CLUTCH CUT-OFF SW
PARKING SW
SAFETY RY
NEUTRAL
BACK-UP RY
RIDE CONTROL SW
RIDE CONTROL
FUEL WARMER
EM'CY STEERING RY
PUMP MOTOR SW
AUTO/MANUAL SW
MCU
BRAKE PS
PARKING PS
WARNING BUZZER
RESISTER
BOOM UP
BUCKET
PREHEAT RY
THROTTLE ASSEMBLY
DATA LINK
TM CONTROLER
TO: CABIN HARNESS
TO: FRONT HARNESS
DIAGNOSTIC

7607AEL00

FRAME HARNESS

ENGINE HARNESS

CAB HARNESS

AC & HEATER CONTROLLER

JOY STICK

CAB HARNESS-FRONT

TRANSMISSION

RIDE CONTROL

EMERGENCY STEERING

FRONT HARNESS

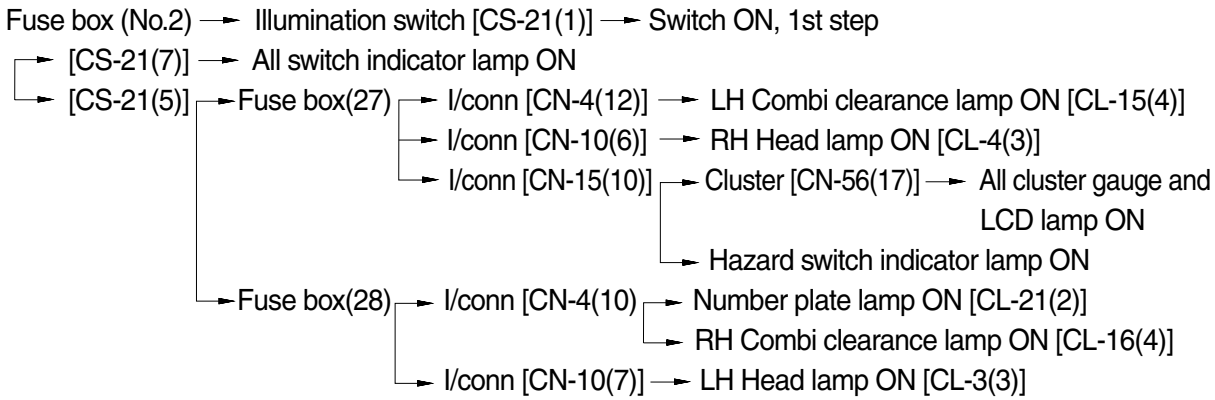
7607AEL01

MEMORANDUM


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HYUNDAI HEAVY INDUSTRIES CO., LTD.
CONSTRUCTION EQUIPMENT DIV.

1. ILLUMINATION CIRCUIT

1) OPERATING FLOW

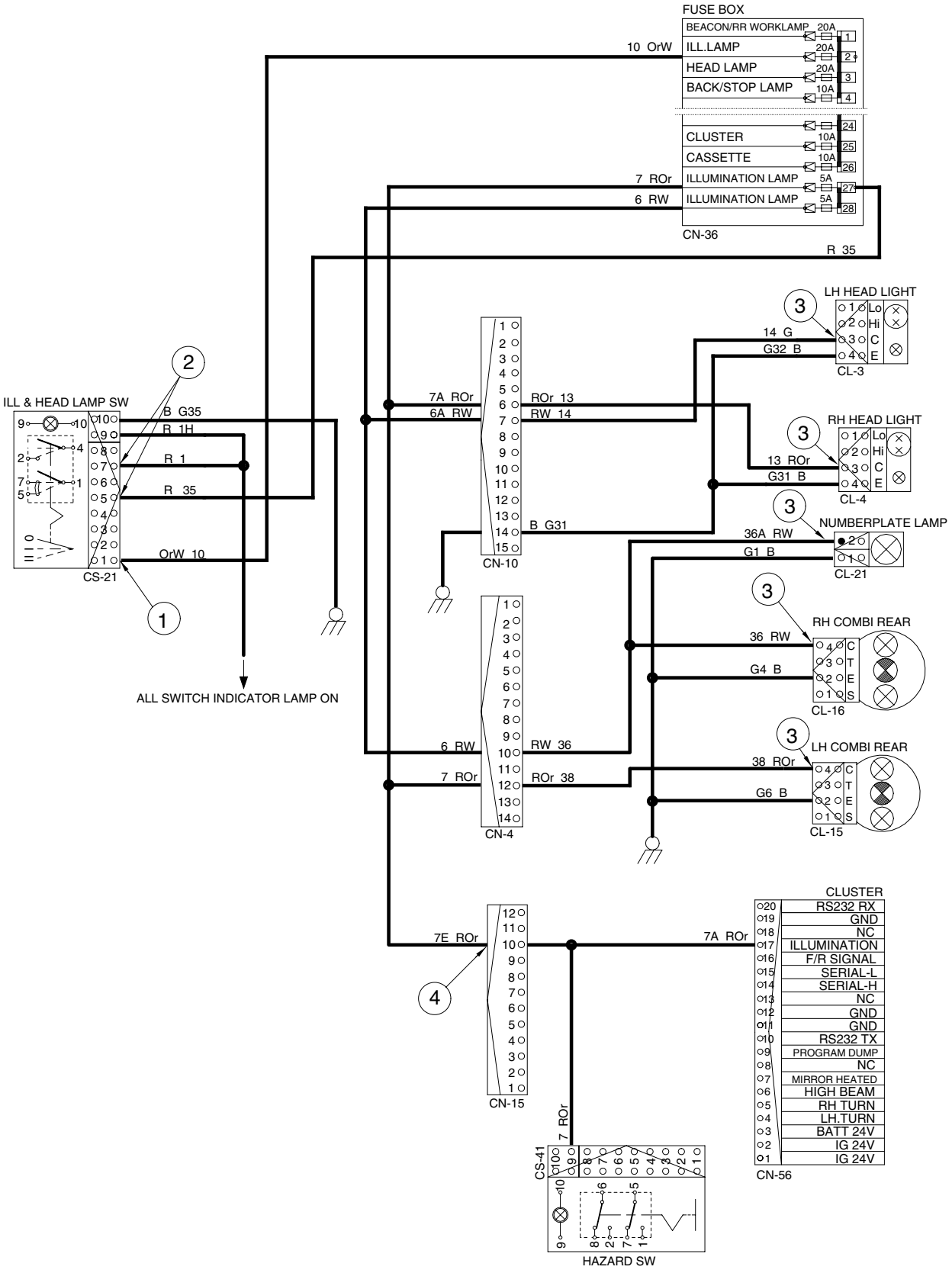


2) CHECK POINT

Engine	Key switch	Check point	Voltage
OFF	ON	① - GND (Switch input) ② - GND (Switch output) ③ - GND (To light) ④ - GND (To cluster)	20~25V

※ GND : Ground

ILLUMINATION CIRCUIT



7607AEL03

2. HEAD LIGHT CIRCUIT

1) OPERATING FLOW

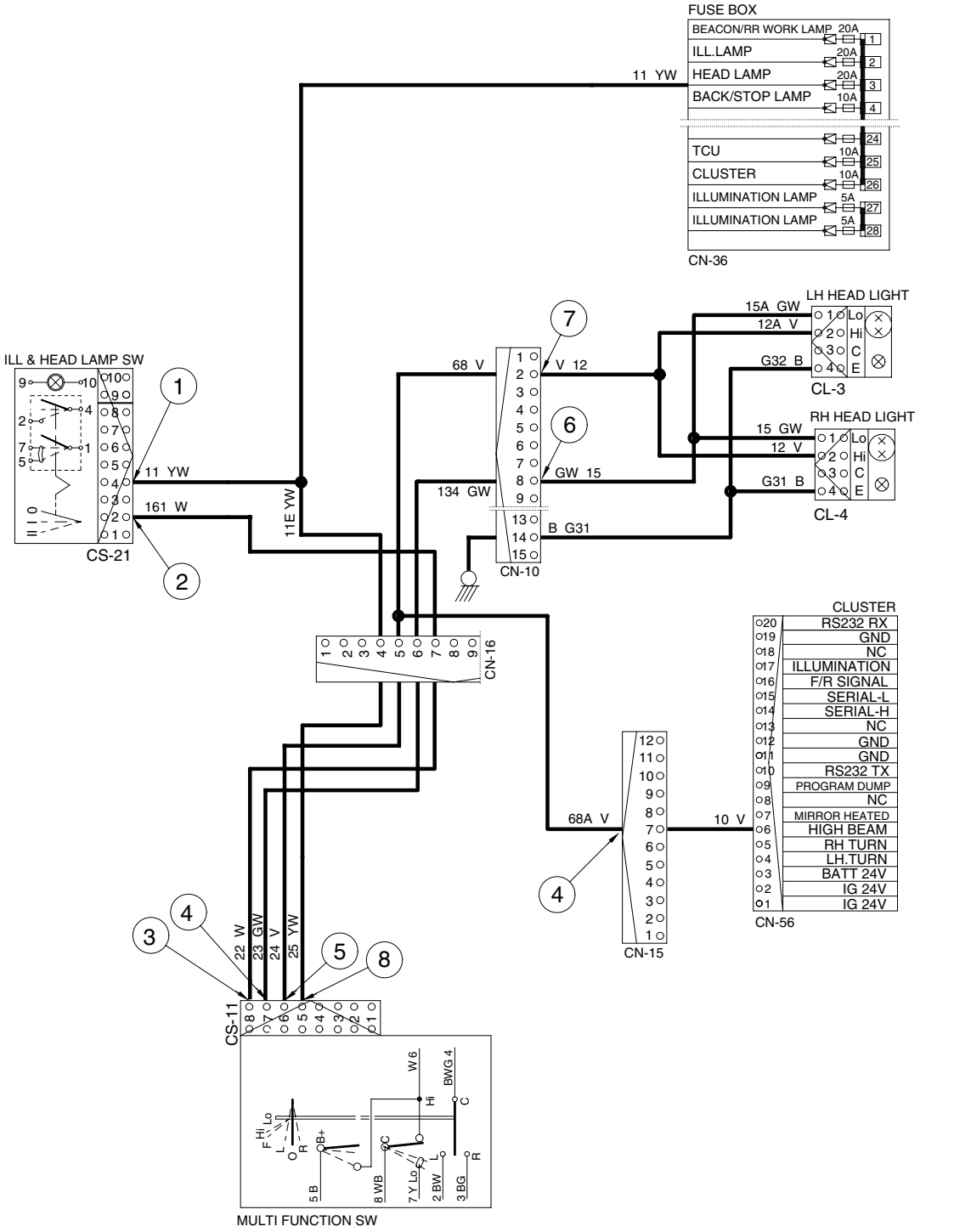
Fuse box(No.3) → Head light switch [CS-21(4)] → Light switch ON, 2nd step [CS-21(2)]
→ I/conn [CN-16(7)] → Multi function switch [CS-11(8)]
- → Multi function switch MIDDLE [CS-11(7)] → I/conn [CN-16(6)] → I/conn [CN-10(8)]
  - → LH Head light low beam ON [CL-3(1)]
  - → RH Head light low beam ON [CL-4(1)]
- → Multi function switch DOWN [CS-11(6)] → I/conn [CN-16(5)]
  - → I/conn [CN-10(2)]
    - → LH Head light high beam ON [CL-3(2)]
    - → RH Head light high beam ON [CL-4(2)]
  - → I/conn [CN-15(7)]
    - → Cluster high beam pilot lamp ON [CN-56(6)]

2) CHECK POINT

Engine	Key switch	Check point	Voltage
OFF	ON	① - GND (Switch input) ② - GND (Switch output) ③ - GND (Multi function input) ④ - GND (Multi function output) ⑤ - GND (Multi function output) ⑥ - GND (Low beam) ⑦ - GND (High beam) ⑧ - GND (Passing B^+)	20~25V

※ GND : Ground

HEAD LIGHT CIRCUIT



7707AEL04

3. WORK LIGHT SWITCH

1) OPERATING FLOW

※ Illumination switch : ON position

(1) Work lamp switch ON (1st step)

ILL & head lamp switch [CS-21(7)] → Work lamp switch indicate lamp ON
→ Work lamp switch [CS-36(1)→(7)] →
Front work lamp relay[CR-3(30)→(87)] → I/conn [CN-7(2)]
→ RH Front work lamp ON [CL-5(2)]
→ LH Front work lamp ON [CL-6(2)]

(2) Work lamp switch (2nd step)

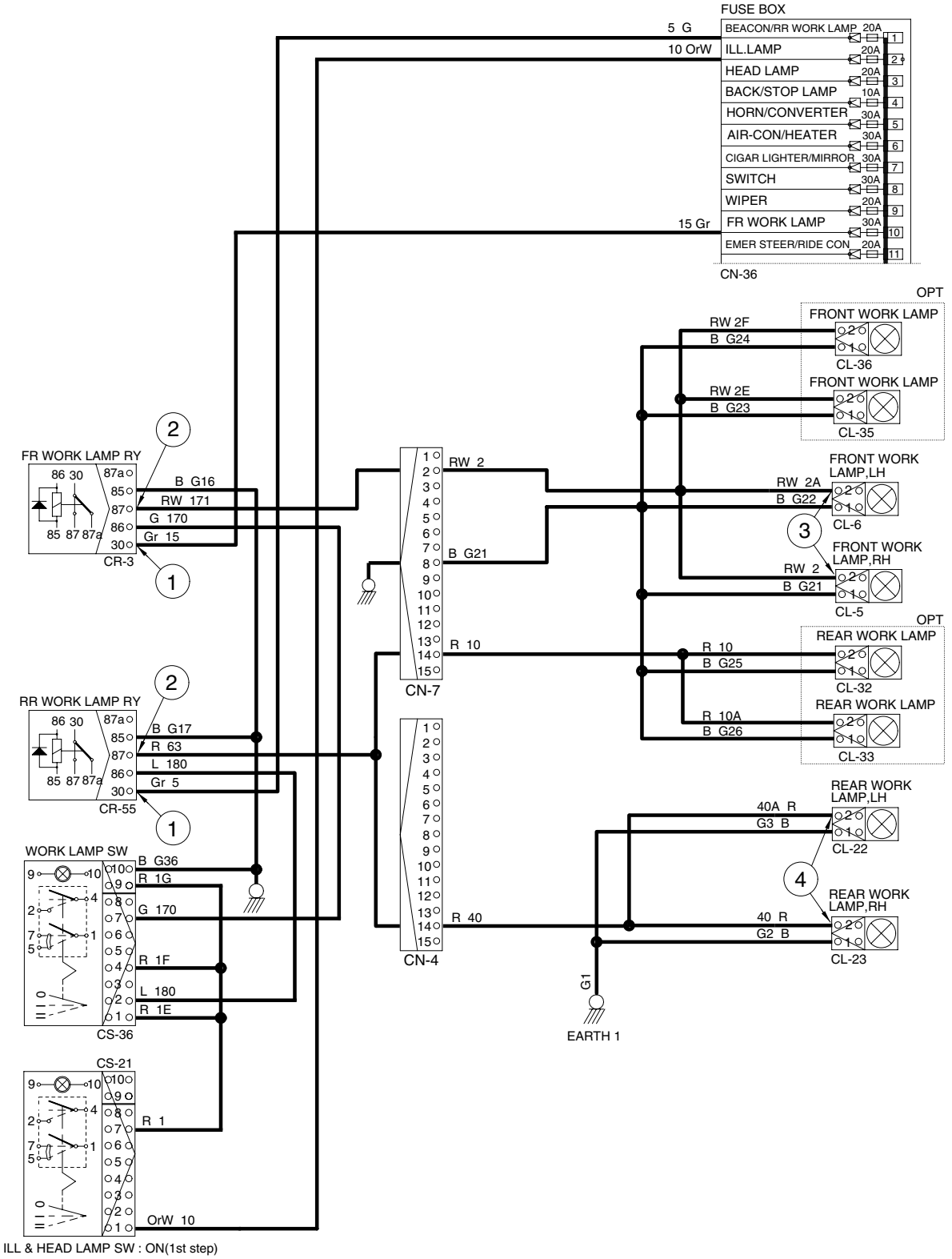
Work lamp switch [CS-36(4)→(2)] → Rear work lamp relay [CR-55(30)→(87)] →
I/conn [CN-4(14)] → LH Rear work lamp ON [CL-22(2)]
→ RH Rear work lamp ON [CN-23(2)]

2) CHECK POINT

Engine	Key switch	Check point	Voltage
OFF	ON	① - GND (Work lamp power input) ② - GND (Work lamp power output) ③ - GND (Front work lamp) ④ - GND (Rear work lamp)	20~25V

※ GND : Ground

WORK LIGHT SWITCH



7807AEL5

4. STARTING CIRCUIT

1) OPERATING FLOW

Battery(+) terminal → Fusible link [CN-60(1)→(2)] → Master switch [CS-74]
→ I/conn [CN-1(1)] → Fuse box (No.15) → Start switch [CS-2(1)]
→ ECM power relay [CR-25(30)]
→ Power relay [CR-35(30)]

※ The gear selector lever is neutral position. It is necessary condition before the starting.
The gear selector has an output signal which is activated whenever the shift lever is in the neutral position. This signal can be used to control a relay and prevent engine from starting whenever the shift lever is not in the neutral position.

(1) When start key switch is in ON position

Start switch ON → Start switch [CS-2(2)] → I/conn [CN-3(9)] → Battery relay [CR-1]
→ Battery relay operating(All power is supplied with the electric component)
→ Start switch [CS-2(3)] → ECM power relay [CR-25(30)→(87)] → Fuse box[No.21]
→ I/conn [CN-2(6)] → I/conn [CN-12(10)] →
ECM port 50P[CN-93(39)]
→ Power relay[CR-35(30)→(87)] → Fuse box[No.23]
→ MCU[CN-58(12)]

(2) When start key switch is in START position

Start switch START [CS-2(5)] → Start safety relay [CR-5(30)→(87)] → I/conn [CN-3(4)]
→ [CN-13(7)] → Start relay [CR-23(2)] → Starter(Terminal B^+ and M connector of start motor)

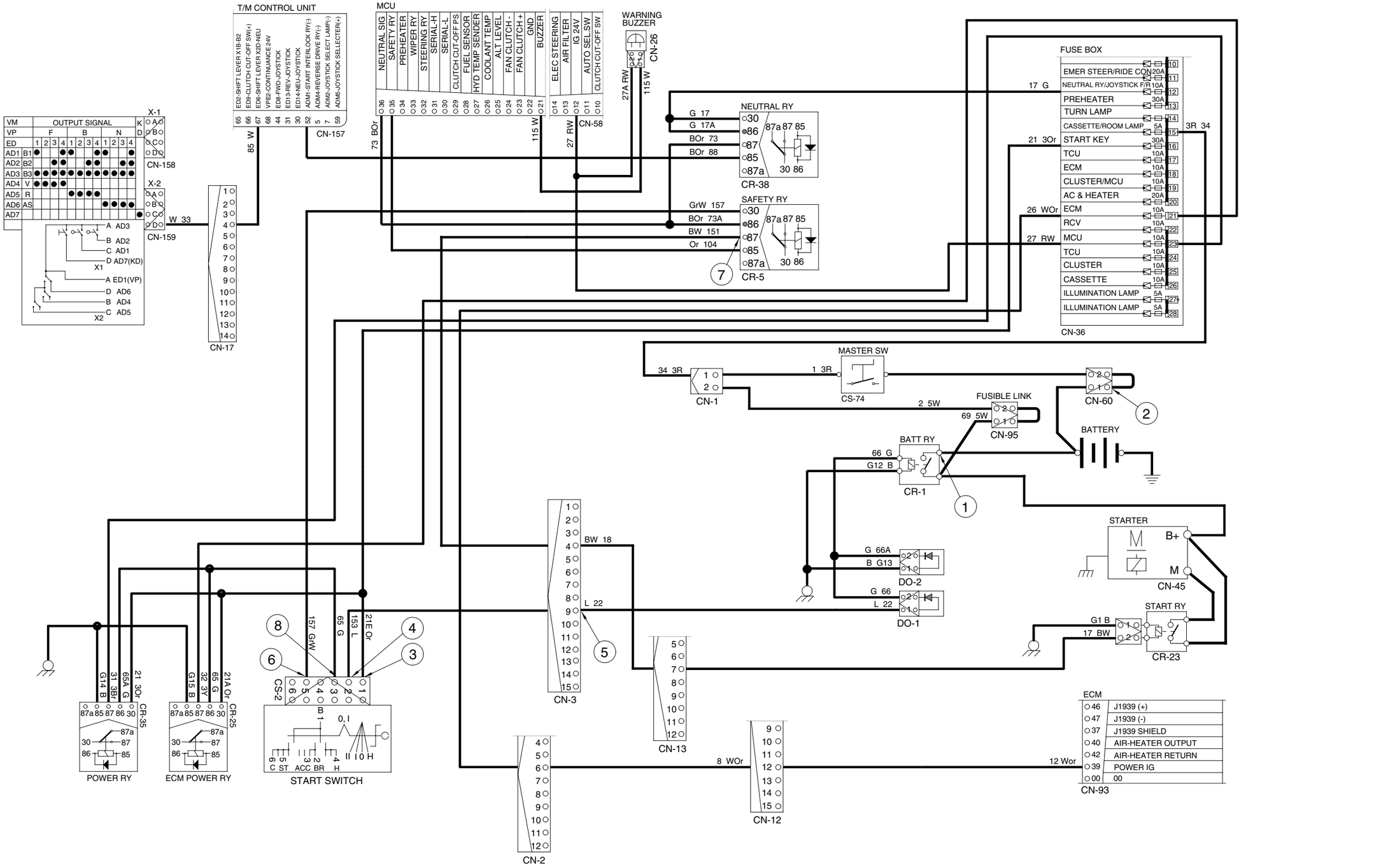
2) CHECK POINT

Engine	Key switch	Check point	Voltage
Running	ON	① - GND (Battery B^+) ② - GND (Fusible link) ③ - GND (Start key B terminal) ④ - GND (Start key BR terminal) ⑤ - GND (I/conn CN-3(9)) ⑥ - GND (Start key ST terminal) ⑦ - GND (Start safety relay output) ⑧ - GND (Start key ACC terminal)	20~25V

※ GND : Ground

※ ECM : Electronic control module

STARTING CIRCUIT



7607AEL06

5. 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

Altermator [CN-74(2)] → I/conn [CN-13(8)] → I/conn [CN-3(5)] → MCU[CN-58(25)]
→ Cluster charge warning lamp ON

(2) Charging flow

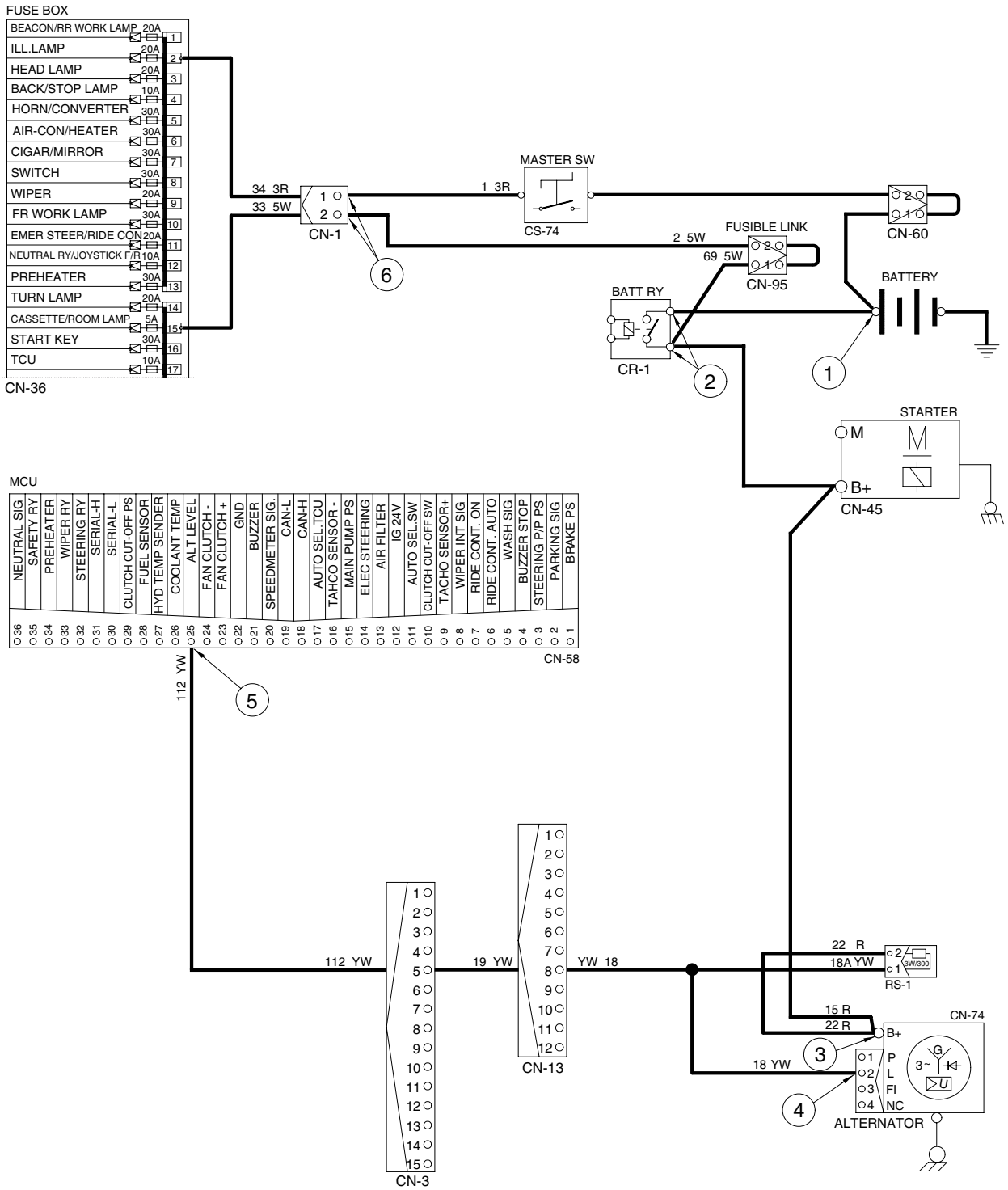
Alternator → Starter [CN-45(B^+)] → Battery relay [CR-1]
→ Battery(+) terminal → Charging
→ Fusible link [CN-95(1)→(2)] → I/conn [CN-1(2)] → Fuse box

2) CHECK POINT

Engine	Key switch	Check point	Voltage
Running	ON	① - GND (Battery) ② - GND (Battery relay) ③ - GND (ALT B^+) ④ - GND (ALT 2) ⑤ - GND (MCU) ⑥ - GND (Fuse box)	20~28V

※ GND : Ground

CHARGING CIRCUIT



7607AEL07

6. ELECTRIC PARKING, DECLUTCH CIRCUIT

1) OPERATING FLOW

(1) Parking OFF

Fuse box (No.8) → Parking switch OFF [CS-17(6)→(8)] → Parking solenoid ON (Activated) → Parking brake released (By hydraulic pressure)

(2) Parking ON

Fuse box (No.8) → Parking switch ON → Parking solenoid [CN-71] OFF → Parking brake applied [By spring force]

Parking switch ON → [CS-17(5)→(7)] → T/M control unit [CN-157(21)] → T/M declutch

(3) Declutch ON

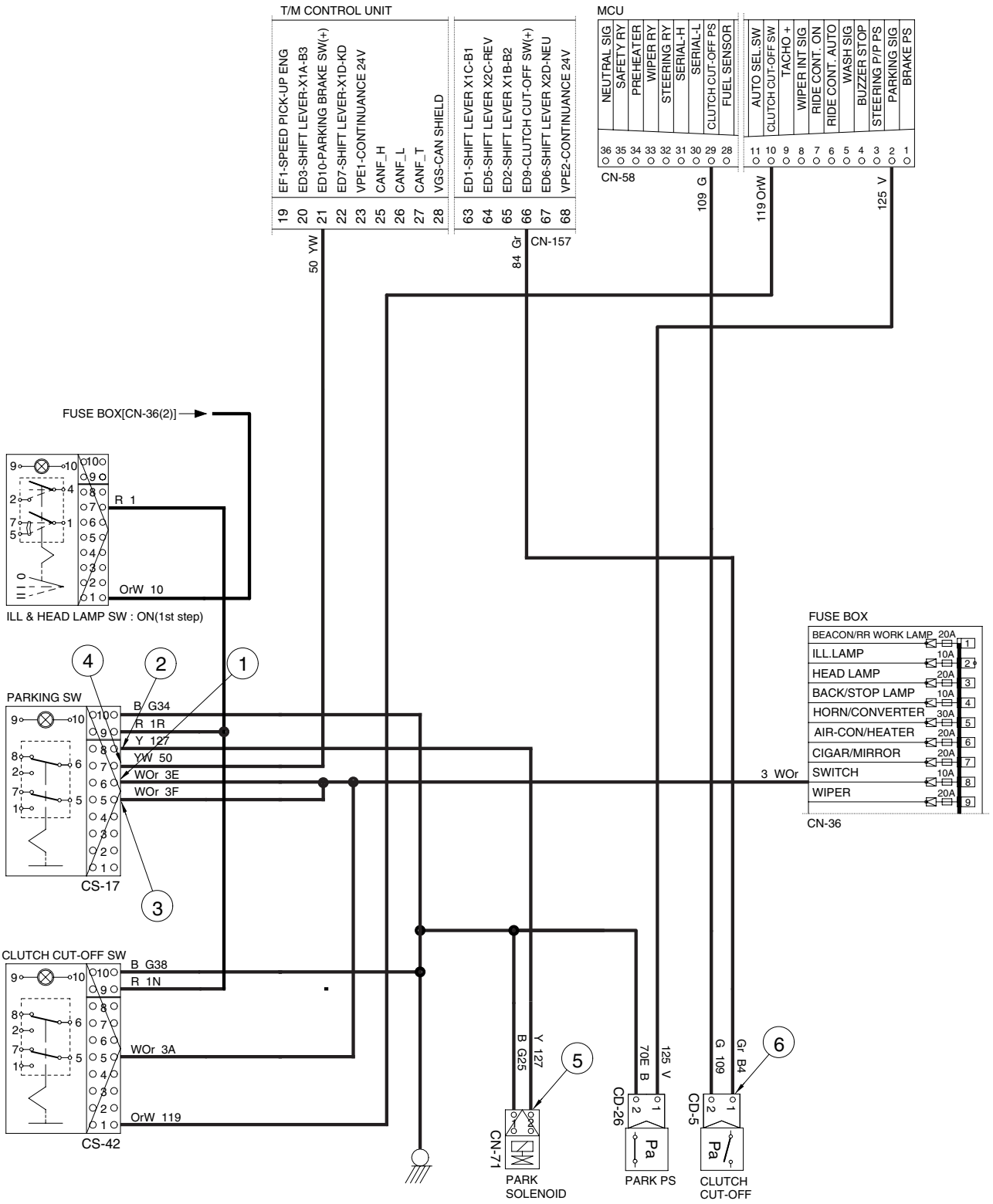
Fuse box (No.8) → Clutch cut-off switch ON → Clutch cut-off switch [CS-42(5)→(1)] → MCU [CN-58(10)→(29)] → Service brake applied → Service brake pressure switch ON [CD-5] → T/M control unit [CN-157(66)] → Declutch

2) CHECK POINT

Engine	Key switch	Check point	Voltage
Running	ON	① - GND (Parking switch input) ② - GND (Parking switch output) ③ - GND (Parking switch input) ④ - GND (Parking switch output) ⑤ - GND (Parking solenoid) ⑥ - GND (Pressure switch clutch cut-off)	20~25V

※ GND : Ground

ELECTRIC PARKING, DECLUTCH CIRCUIT



7807AEL08

7. WIPER AND WASHER CIRCUIT

1) OPERATING FLOW

Fuse box (No.9) → Wiper relay [CR-4(30)→(87a)] → I/conn [CN-17(9)] → Front wiper motor [CN-21(1)]
Wiper relay [CR-4(30)→(87a)] → Wiper relay Lo [CR-26(86), (87)]
Fuse box (No.9) → I/conn [CN-16(8)] → Multi function switch [CS-12(6)]
Fuse box (No.9) → I/conn [CN-8(1)] → Rear wiper & washer switch [CS-35(1)]
Fuse box (No.9) → Rear wiper motor [CN-102(1)]

(1) Front washer switch ON

① Washer switch ON [CS-12(6)→(2)] → Washer tank [CN-16(12)] → Washer operating
Washer switch ON [CS-12(6)→(2)] → MCU [CN-58(5)→(33)] → Front wiper relay Lo [CR-26(87)→(30)] → I/conn [CN-17(13)] → Front wiper motor [CN-21(5)] → Wiper motor operating(Low)

(2) Front wiper switch ON

① **INT position**

Wiper switch ON [CS-12(6)→(1)] → I/conn [CN-16(13)] → MCU [CN-58(8)→(33)] → Wiper relay Lo [CR-26(87)→(30)] → I/conn [CN-17(13)] → Front wiper motor [CN-21(5)] → Front wiper motor intermittently operating

② **Lo position**

Wiper switch ON [CS-12(6)→(4)] → I/conn [CN-16(10)] → Wiper relay Lo [CR-26(87a)→(30)] → I/conn [CN-17(13)] → Front wiper motor [CN-21(5)] → Front wiper motor operating (Low)

③ **Hi position**

Wiper switch ON [CS-12(6)→(3)] → I/conn [CN-16(11)] → Wiper relay Hi [CR-4(30)→(87)] → I/conn [CN-17(12)] → Front wiper motor [CN-21(4)] → Front wiper motor operating(High)

(3) Auto-parking(When switch OFF)

Switch OFF → Fuse box (No.9) → Wiper relay Hi [CR-4(30)→(87a)] → I/conn [CN-17(9)] → Front wiper motor [CN-21(1)→(2)] → Multi function switch [CS-12(5)→(4)] → I/conn [CN-16(10)] → Wiper relay Lo [CR-26(87a)→(30)] → I/conn [CN-17(13)] → Front wiper motor [CN-21(5)] → Wiper motor stop

(4) Rear wiper and washer switch

① **Wiper switch ON**(1st step)

Wiper switch ON [CS-35(1)→(6)] → I/conn [CN-8(4)] → Rear wiper motor [CN-102(5)] → Rear wiper motor operating

② **Washer switch ON**(2nd step)

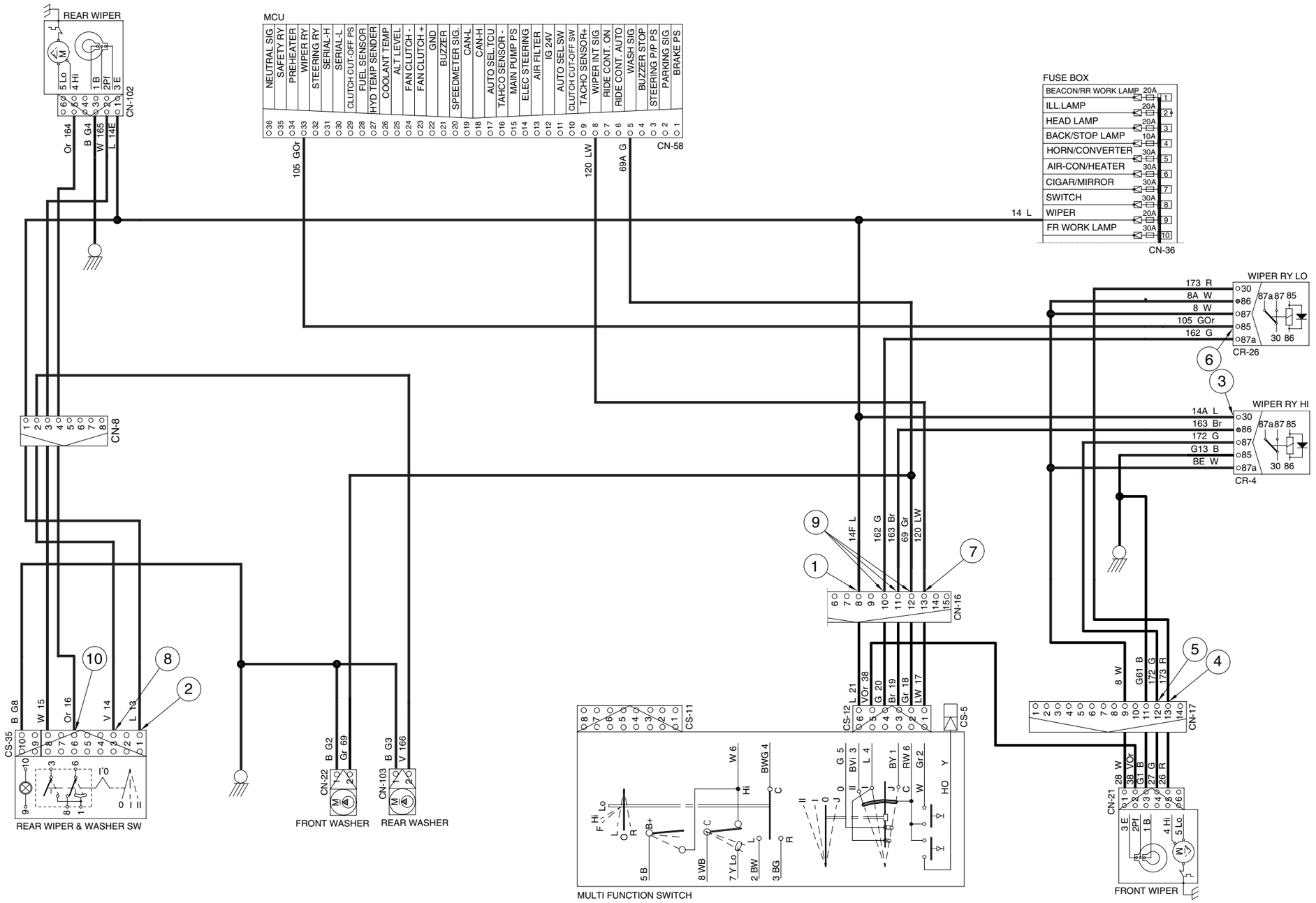
Washer switch ON [CS-35(1)→(3)] → I/conn [CN-8(2)] → Rear washer tank [CN-103(2)] → Washer operating

2) CHECK POINT

Condition	Check point	
Engine : Stop Key switch : ON Voltage : 20~25V	① - GND (Front wiper switch power input)	⑥ - GND (Wiper relay power input)
	② - GND (Rear wiper switch power input)	⑦ - GND (Front washer power output)
	③ - GND (Wiper relay power input)	⑧ - GND (Rear washer power output)
	④ - GND (Front wiper motor Lo power input)	⑨ - GND (Front wiper motor power output)
	⑤ - GND (Front wiper motor High power input)	⑩ - GND (Rear wiper motor power output)

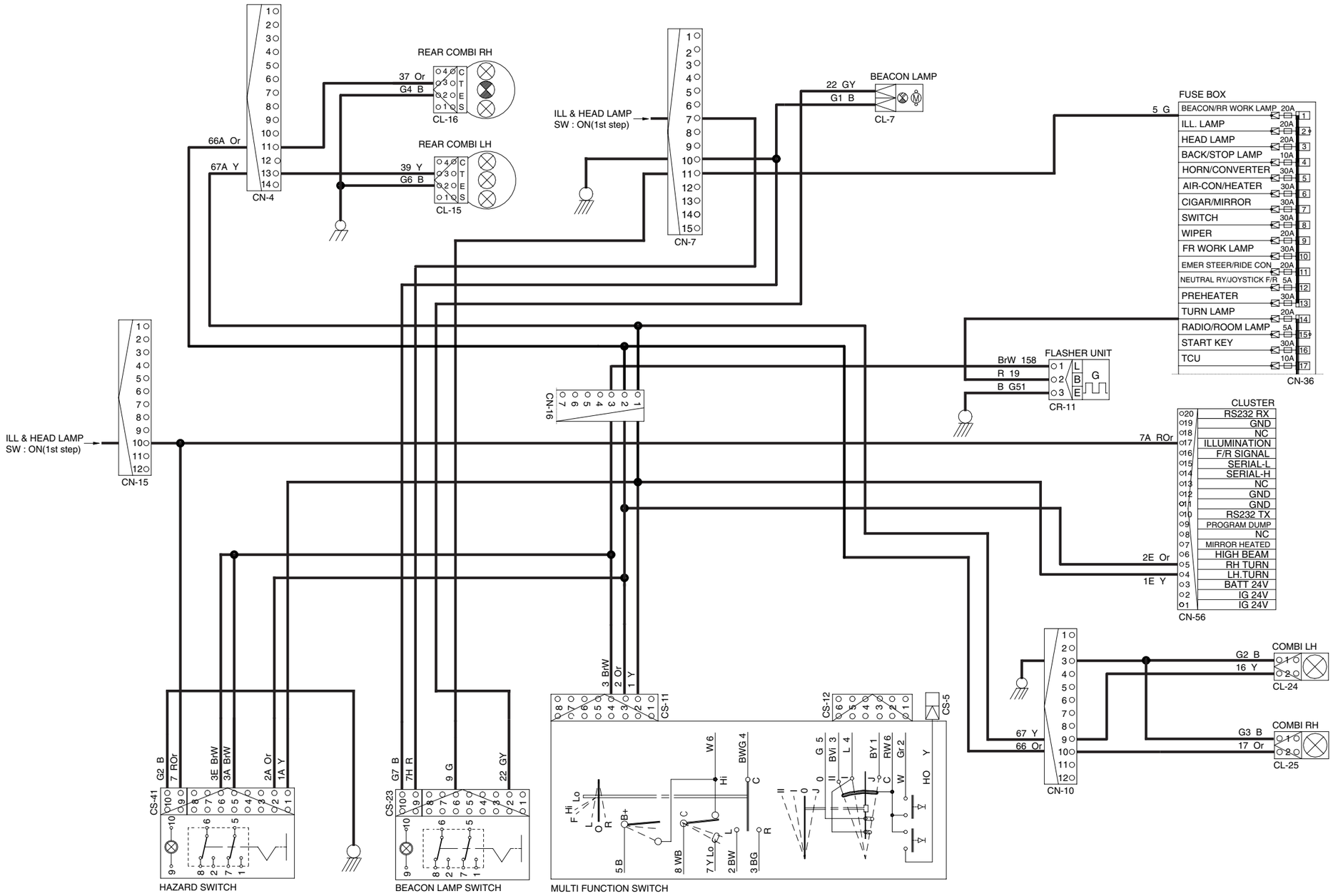
※ GND : Ground

WIPER AND WASHER CIRCUIT



7707AEL09

HAZARD, TURN AND ROTARY CIRCUIT



7607AEL10

GROUP 3 MONITORING SYSTEM

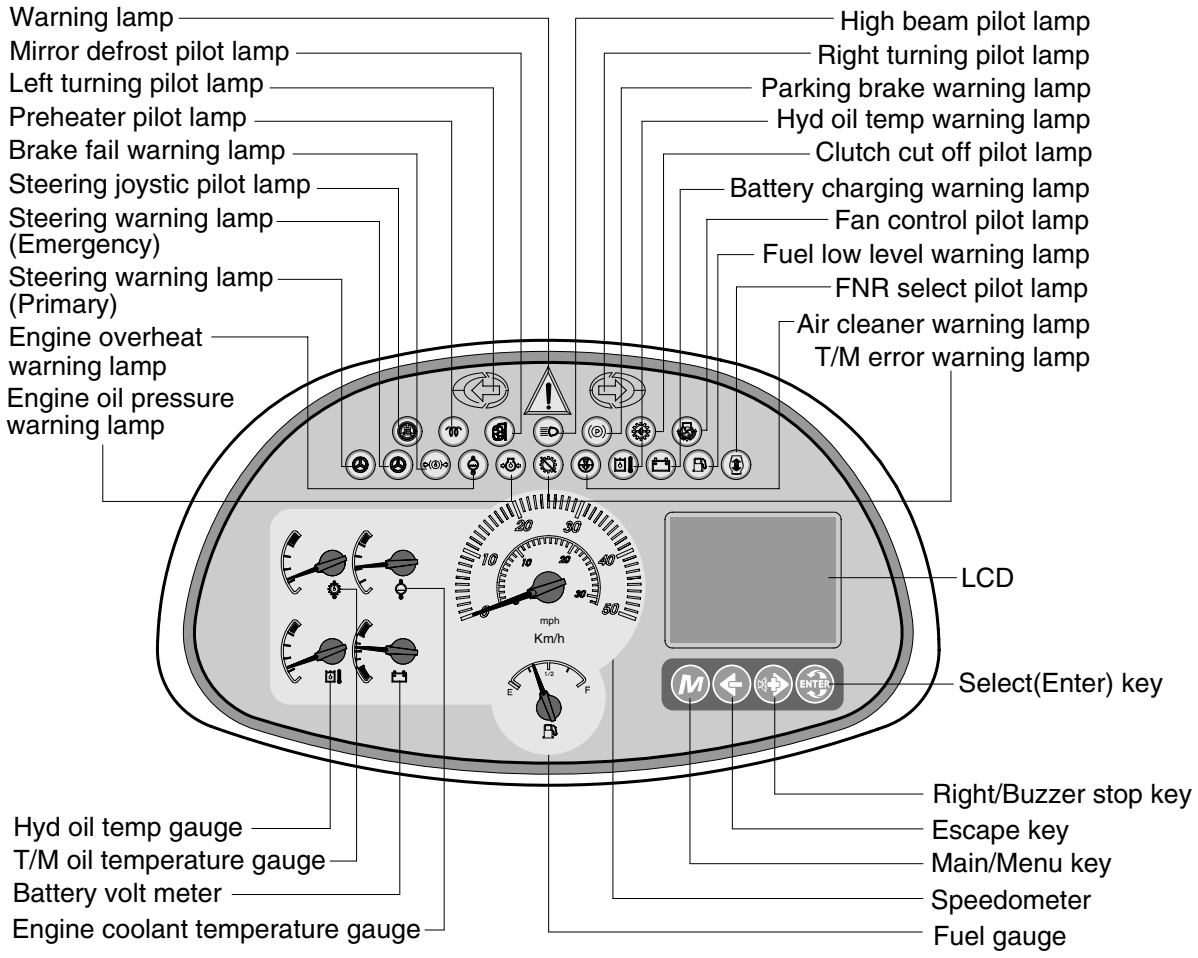
1. CLUSTER

The gauges panel consists of gauges and monitors as shown below, to warn the operator in case of abnormal machine operation or conditions for the appropriate operation and inspection.

- Gauges : Indicate operating status of the machine.
- Warning lamp : Indicate abnormality of the machine.
- Pilot lamp : Indicate operating status of the machine.

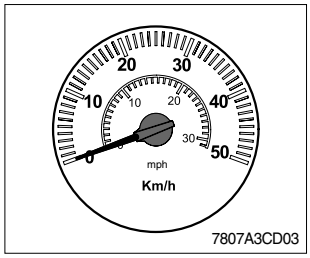
※ **The monitor installed on this machine does not entirely guarantee the condition of the machine. Daily inspection should be performed according to chapter 6, MAINTENANCE.**

※ **When the monitor provides a warning immediately check the problem, and perform the required action.**



7707A3CD02

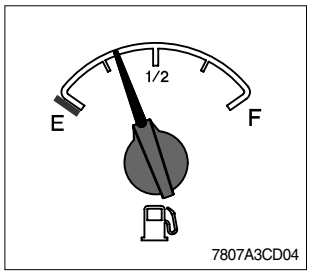
1) SPEEDOMETER



7807A3CD03

(1) The speedometer displays the speed of machine in mph and km/h.

2) FUEL GAUGE

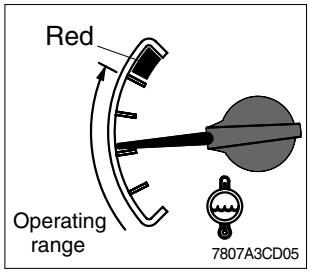


(1) This gauge indicates the amount of fuel in the fuel tank.

(2) Fill the fuel when the indicator moves **E** point, refuel as soon as possible to avoid running out of fuel.

※ **If the gauge indicates below E point 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) ENGINE COOLANT TEMPERATURE GAUGE

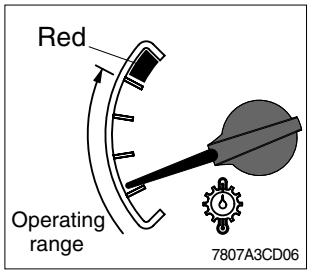


(1) This indicates the temperature of coolant.
- Red range : Above 104°C (219°F)

(2) Keep idling engine at low speed until the indicator is in the operating range.

(3) If the indicator is in the red range, turn OFF the engine, check the radiator and engine.

4) TRANSMISSION OIL TEMPERATURE GAUGE

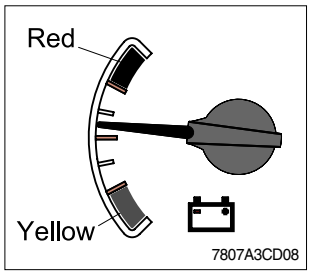


(1) This range indicates the temperature of transmission oil.
- Red range : Above 107°C (225°F)

(2) Keep idling engine at low speed until the indicator is in the operating range.

(3) If the indicator is in the red range, it means the transmission is overheated. Be careful that the indicator does not move into the red range.

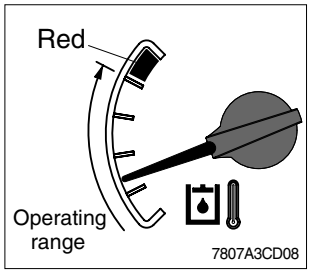
5) BATTERY VOLT METER



(1) This gauge indicates the voltage in the charging system when the engine is running.

(2) If the indicator is below 24V(Yellow range), it means that the electricity is being discharged. If the indicator is above 30V(Red range), an unusually high voltage may damage the alternator. Check the charging system in both cases.

6) HYD OIL TEMPERATURE GAUGE



(1) This range indicates the temperature of hydraulic oil.
- Red range : Above 105°C (221°F)

(2) Keep idling engine at low speed until the indicator is in the operating range.

(3) If the indicator is in the red range, reduce the load on the system. If the gauge stays in the red range, stop the machine and check the cause of the problem.

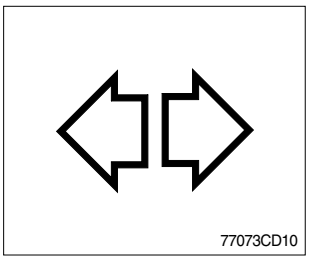
7) WARNING LAMP



(1) When all warning lamp or fault codes are being displayed, this warning lamp will flash.

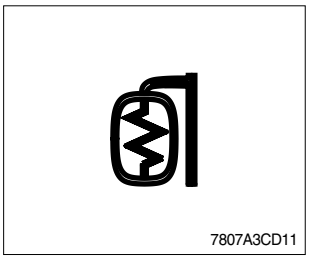
(2) When this warning lamp flashes, machine must be checked or serviced as soon as possible.

8) DIRECTION PILOT LAMP



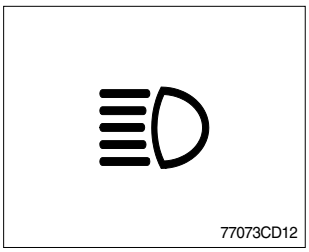
(1) This lamp flashes when the signal indicator lever is moved.

9) MIRROR DEFROST PILOT LAMP(Option)



(1) This lamp comes ON when mirror defrost switch is pressed.

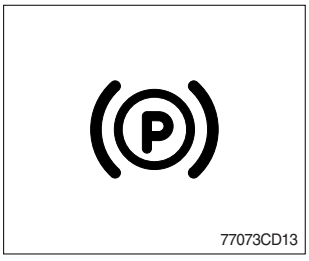
10) HIGH BEAM PILOT LAMP



(1) This lamp works when the illuminating direction is upward.

(2) This lamp comes ON when the dimmer switch is operated, e.g., when passing another vehicle.

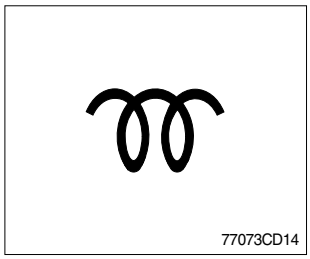
11) PARKING BRAKE WARNING LAMP



(1) When the parking brake is actuated, the lamp lights ON.

※ **Check the lamp is OFF before driving.**

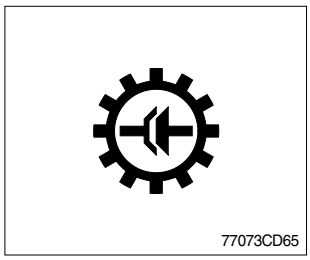
12) PREHEATER PILOT LAMP



(1) This lamp lights ON when start switch is turned clockwise to the ON position. Light will turn off after approximately 5~45 seconds, depending on engine temperature, indicating that preheating is completed.

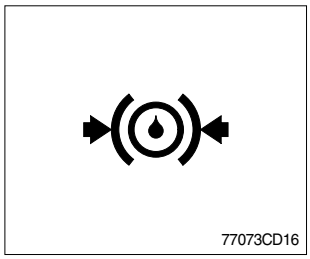
(2) When the lamp goes out the operator should start cranking the engine.

13) CLUTCH CUT OFF PILOT LAMP



(1) When the clutch cut off switch is pressed, the lamp lights ON.

14) BRAKE FAIL WARNING LAMP

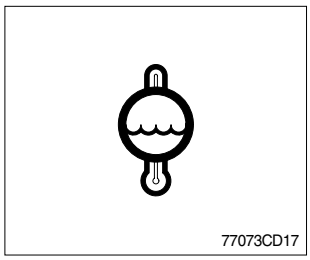


(1) The lamp lights ON when the oil pressure of service brake drops below the normal range.

(2) When the lamp is ON, stop the engine and check for its cause.

※ **Do not operate until any problems are corrected.**

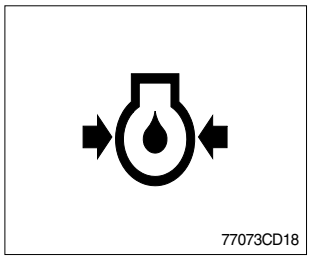
15) ENGINE OVERHEAT WARNING LAMP



(1) This lamp is turned ON when the temperature of cooling water is over the normal temperature(104℃, 219℉).

(2) Check the cooling system when the lamp is ON.

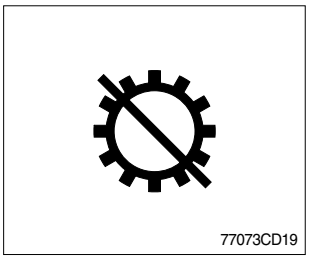
16) ENGINE OIL PRESSURE WARNING LAMP



(1) This lamp is comes ON after starting the engine because of the low engine oil pressure.

(2) If the lamp comes ON during engine operation, shut OFF engine immediately. Check engine oil level.

17) TRANSMISSION ERROR WARNING LAMP



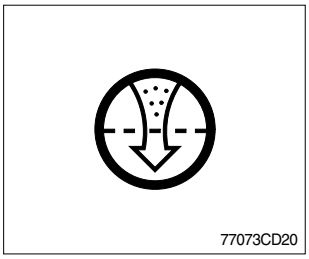
(1) This lamp lights ON and the LCD display show the error codes when an error occurs in the transmission.

(2) Immediately pull the machine to a convenient stop. Stop the engine. Investigate the cause.

※ **Consult a HYUNDAI dealer to investigate the cause.**

※ **Do not operate until the cause has been corrected.**

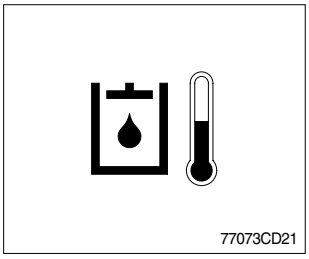
18) AIR CLEANER WARNING LAMP



(1) This lamp operates by the vacuum caused inside when the filter of air cleaner is clogged.

(2) Check the filter and clean or replace it when the lamp is ON.

19) HYD OIL TEMPERATURE WARNING LAMP

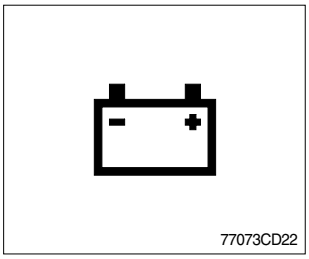


(1) This warning lamp operates and the buzzer sounds when the temperature of hydraulic oil is over 105°C(221°F).

(2) Check the hydraulic oil level when the lamp is turned ON.

(3) Check for debris between oil cooler and radiator.

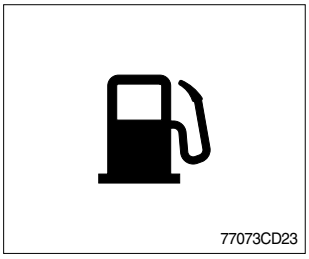
20) BATTERY CHARGING WARNING LAMP



(1) This lamp is ON when key ON, it is turned OFF after starting the engine.

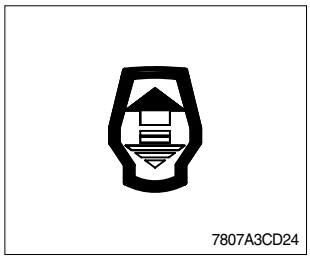
(2) Check the battery charging circuit when this lamp comes ON, during engine operation.

21) FUEL LOW LEVEL WARNING LAMP



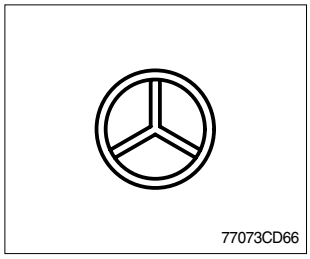
(1) Fill the fuel immediately when the lamp is turned ON.

22) FNR SELECT PILOT LAMP(Option)



(1) The lamp comes ON when FNR select button on the optional FNR remote control lever is pressed.

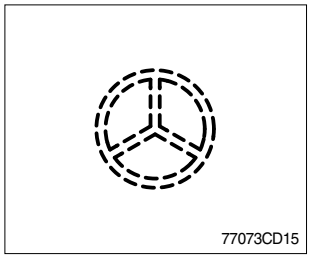
23) STEERING WARNING LAMP(Option)



(1) Primary

This lamp indicates that the primary steering has failed. When the indicators come on and the action alarm sounds, steer the machine immediately to a convenient location and stop the machine. Stop the engine and investigate the cause.

※ **Do not operate the machine until the cause has been corrected.**



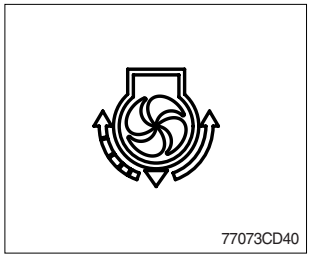
(2) Emergency

This lamp indicates the emergency steering system is active.

※ **Immediately pull the machine to a convenient stop and stop the engine.**

※ **The emergency steering system can be manually tested. Refer to page 7-36.**

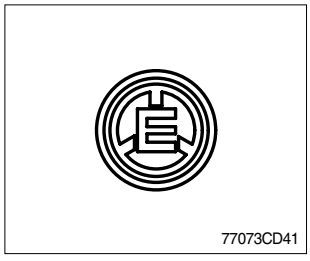
24) FAN CONTROL PILOT LAMP(Option)



(1) This lamp lights ON when cooling fan is selected to reverse mode.

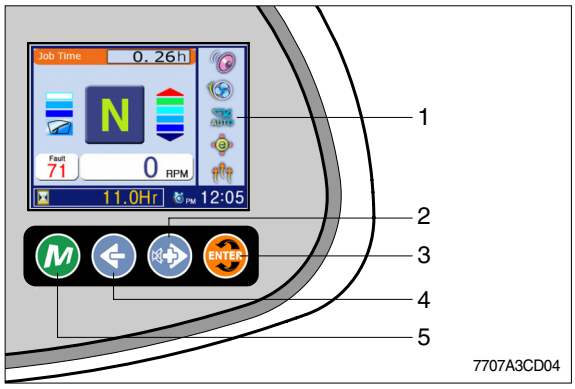
※ **Refer to page 7-28.**

25) STEERING JOYSTIC PILOT LAMP(Option)



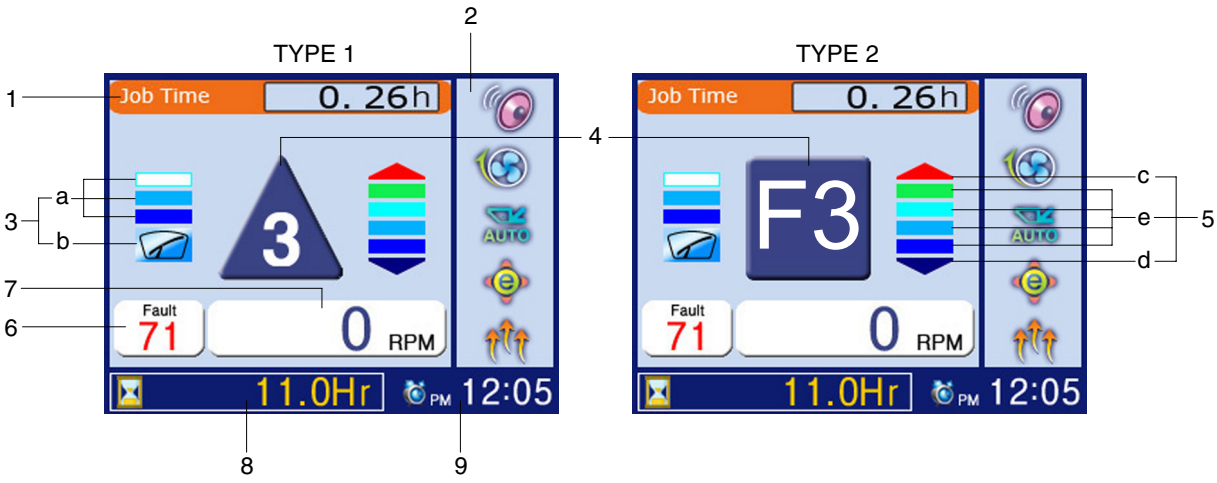
(1) This lamp lights ON when steering joystic is operated.

26) LCD



1 LCD
2 ( ) Right, Buzzer stop
Move to the next selection
3 ( ) Select(Enter)
Activate the currently chosen item
4 ( ) Escape
Return to the previous menu
5 ( ) Main, Menu
- Display menu
- Return to the main display

(1) Main display

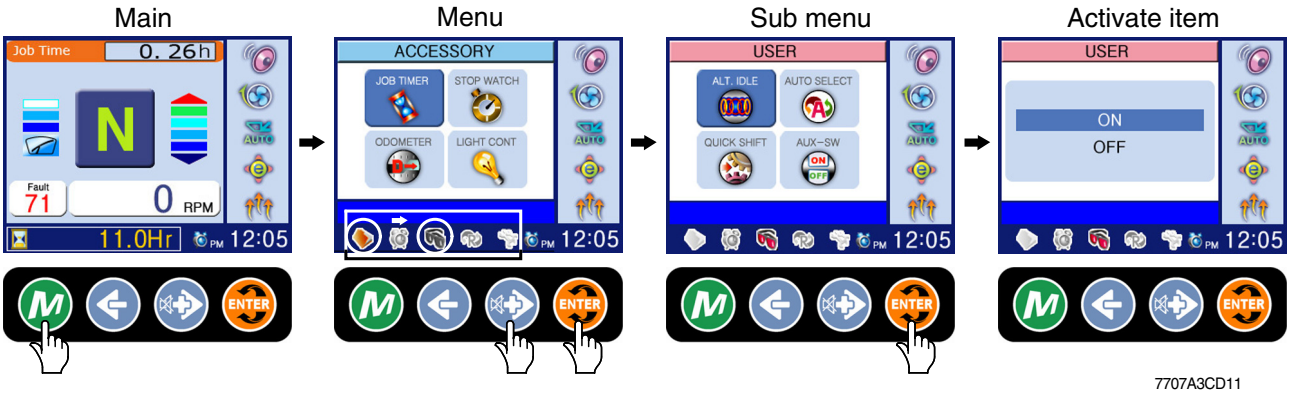


7707A3CD10

No	Symbol	Meaning	Remark		
1	Job Time 1.26h	Monitoring information	Job timer, Odometer, Hydraulic temperature, Battery voltage, Coolant temperature, T/M oil temperature.		
2	AUTO	State information	Buzzer, Fan state, Ride state(option), Steering joystic(option), Warming up		
3	a	Wiper display	When operating intermittently, it shows an operating time interval		
	b		Wiper motor intermittently operating		
4	△, ▽, □	Actual gear display	Forward, reverse, neutral	LCD type 1	
	F, R, N		Forward, reverse, neutral	LCD type 2	
	1, 2, 3, 4		Actual gear		
	P		Parking brake mode active		
5	c, d	Select gear display	Up and down shifting	c: Forward, d: Reverse	Automatic mode
	e		Pre-selected gear		
6	Fault 71	Fault code display	Fault code state display		
7	0 RPM	Engine rpm display	Now engine rpm state display		
8	11.0Hr	Hour meter display	Hour meter state display		
9	PM 12:05	Timer & alarm display	Now time & alarm state display		

※ Both type1 and type2 are LCD modes and they can be changed each other by operator's selection.
(Adjustment/Display, see page 7-29)

(2) Display map



7707A3CD11

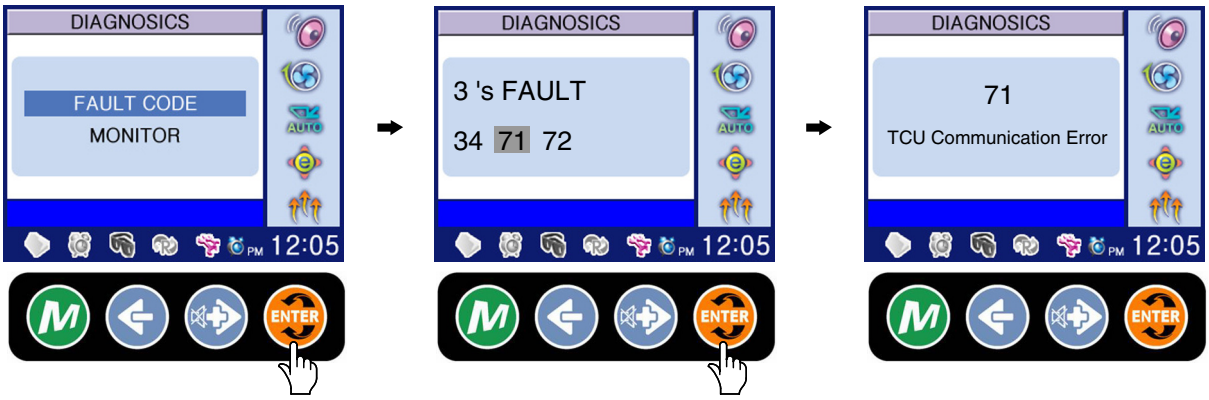
Main group	Sub group		Meaning	Display on LCD
Accessory	Job timer		· Measure the various job time. · Press ENTER : Display ON, OFF or RESET	Job Time 1.26h
	Stop watch		· Measures time in seconds. · Press ENTER : Start. Press ENTER again : Stop.	-
	Odometer	Latest	· Distance until recent times.	Latest 20.5 Km
		Total	· Total distance.	Total 30.5 Km
	Light control		· Control of LCD display luminosity. · Brightness control : ◀▶ .	-
Clock	Time set		· When 12H or 24H is selected, the current hour appears. · ◀▶ : input, ENTER : setting.	PM 22:05
	Clock ON/OFF		· ENTER : Clock display ON or OFF.	
	Alarm	1	· Alarm setting. It is possible to set 3 alarms. · Stop alarming : ◀▶	
		2		
		3		
User	Alternate idle	ON	· Raise the idle rpm to 1200rpm automatically to warm up the engine.	-
		OFF		
	Auto select	Mode 1 (1st-4th)	· Automatic travelling speed is applied from 1st to 4th gear.	-
		Mode 2 (2nd-4th)	· Automatic travelling speed is applied from 2nd to 4th gear.	-
	Quick shift	Mode 1 (Down/Up)	· Press button once : Shift down, press button again ; shift up.	-
		Mode 2 (Down only)	· Press button every time : Shift to lower gear respectively.	-
	Aux-sw	Auto select	· ON : Transmission auto condition. · OFF : Transmission semi-auto condition.	
		Clutch cut-off	· ON : Clutch cut-off is activated. · OFF : Clutch cut-off is cancelled.	-
	Fan control	Forward	· Forward active	
		Reverse	· Reverse active★	

★Reverse mode cleans out quickly dirt and dust on radiator and cooler by reverse rotation of cooling fan.

Main group	Sub group		Meaning	Display on LCD
Adjustment	Unit	MKS ENG	· Choose between metric and inch unit display.	Total 50.7 Km Total 31.5 Mile
	Wiper Intermittence		· When using the intermittent function of wiper motor, it regulates operation time.	
	Alternate RPM		· Regulate idle rpm. · Press : Adjust idle rpm increments (or decrement) by 25rpm.	-
	Pulse		· Press : Modification.	-
	AEB		· It controls the disk interval of the transmission, automatically.	ST
	Model		· It is set at the factory, so there's no need to change.	-
	ENG/KOR		· English : Display in English. · Korean : Display in Korean.	-
	Display 1/2		· Type 1 : Indicate with the symbol. · Type 2 : Indicate with a letter.	3 , F3
Diagnostics	Machine	Fault code	· Error code display. · Refer to page 7-30.	-
		Monitor	· Hydraulic temperature and battery voltage display. · Press : Display ON or OFF.	HYD temp 100.6℃ Bat Volt 27.5 V
	Engine	Fault code	· Error code display. · Consult a Hyundai dealer to error code.	-
		Monitor	· Engine coolant temperature display. · Press : Display ON or OFF.	Coolant Temp 57.6℃
	Transmis-sion	Fault code	· Error code display. · Consult a Hyundai dealer to error code.	-
		Monitor	Transmission oil temperature display. · Press : Display ON or OFF.	Oil Temp 37.6℃
	Version		· Display the controller(MCU) and cluster version.	-

(3) Machine fault code

When selecting the fault code menu, it shows all of the fault codes which mean abnormal conditions of present time.



7707A3CD36

※ To go out from fault explanation window, press button.
(Press , to go out to main.)

※ **No error** will be indicated in case that there's no fault.

Description	Code	Meaning	Remark
Electrical system	010	Power input voltage low	Below 18V
	011	Power input voltage high	Above 38V
	012	Alternator voltage low	Below 5V
	013	Alternator voltage high	Above 36V
	014	Buzzer circuit open or short to ground	
	015	Buzzer circuit short to power	
Hydraulic system	020	Hydraulic oil temperature sensor open or short to power	
	021	Hydraulic oil temperature sensor short to ground	
Engine system	030	Fuel level sensor open or short to power	
	031	Fuel level sensor short to ground	
	034	Cooling fan driving valve open or short to ground	
	035	Cooling fan driving valve short to power	
T/M system	050	Auto select switch supply power open or short to power	
	051	Auto select switch supply power short to ground	
	052	Clutch cutoff supply power open or short to power	
	053	Clutch cutoff supply power short to ground	
Steering system	060	Emergency steering relay open or short to ground	Option
	061	Emergency steering relay short to power	Option
Communication	070	MCU communication error	
	071	TCU communication error	
	072	ECM communication error	

MCU : Machine control unit TCU : Transmission control unit ECM : Engine control module

(4) Transmission warning

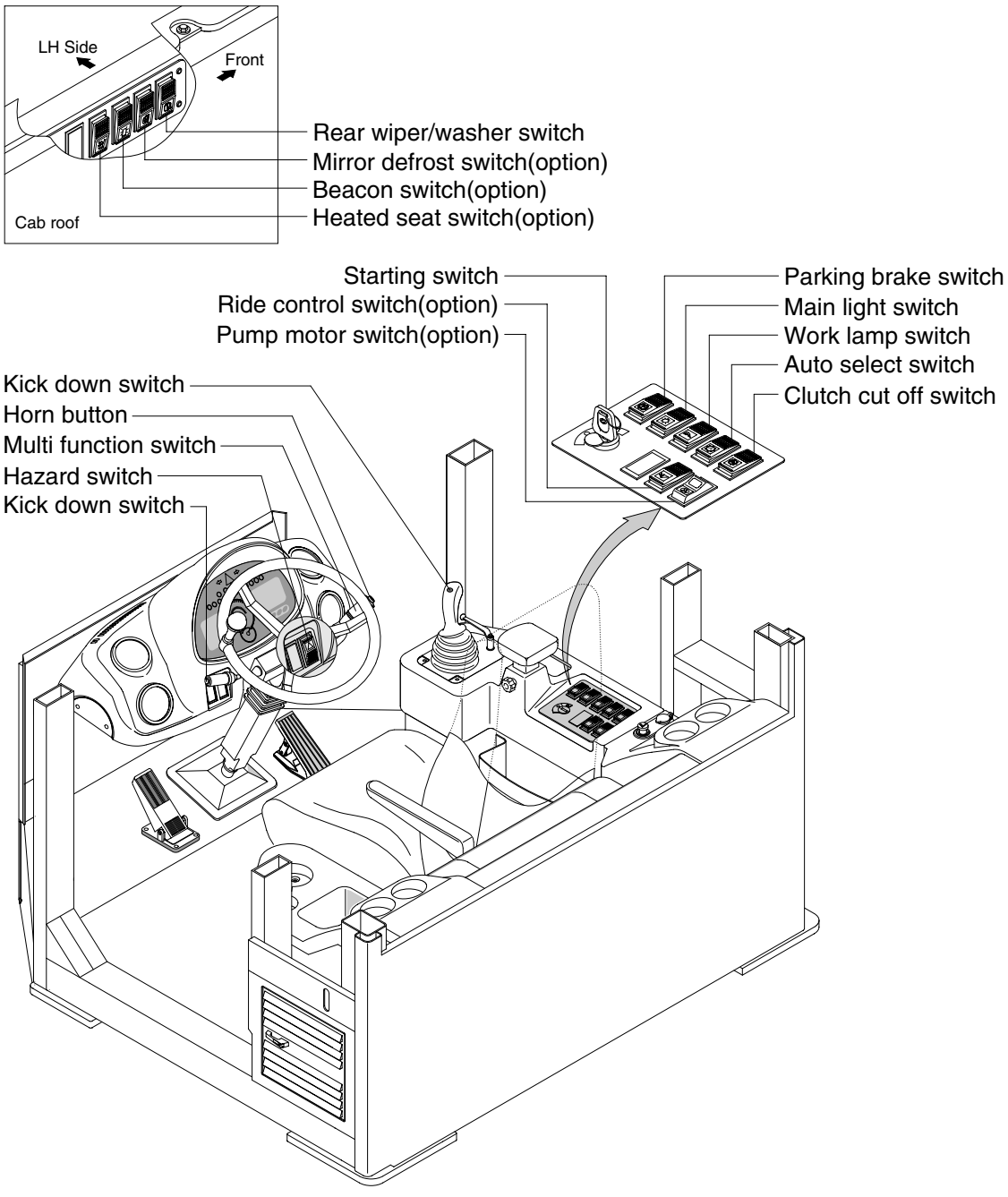
Symbol	Meaning	Remarks
LF, LR	Limp home gear	-
F/R/△/▽ flashing	Direction F or R selected while turbine speed is too high, CAUTION gear will engage if turbine speed drops	-
	Oil temperature too low, no gear available	Warm up engine / transmission
WS	Warning sump temperature	Changes between actual gear/direction while driving, in neutral only displayed if no fault is detected
WT	Warning torque converter temperature	Changes between actual gear/direction while driving, in neutral only displayed if no fault is detected
WE	Warning high engine speed	Changes between actual gear/direction while driving, in neutral only displayed if no fault is detected

(5) Display during AEB mode

Symbol	Meaning	Remarks
K1~K4, KV, KR	Calibrating clutch K1~K4, KV or KR respectively	
- And Kx	Wait for start, initialization of clutch Kx, x : 1, 2, 3, 4, V, R	
And Kx	Fast fill time determination of clutch Kx	
= And Kx	Compensating pressure determination of clutch Kx	
OK	Calibration for all clutches finished	Transmission stays in neutral, you have to restart the TCU(Ignition off/on)
STOP	AEB cancled(Activation stopped)	Transmission stays in neutral, you have to restart the TCU(Ignition off/on)
STOP and Kx	AEB stopped, clutch Kx can't be calibrated	Transmission stays in neutral, you have to restart the TCU(Ignition off/on)
Spanner and Kx	Kx couldn't be calibrated, AEB finished	Transmission stays in neutral, you have to restart the TCU(Ignition off/on)
△E	Engine speed too low, - Raise engine speed	
▽E	Engine speed too high, - Lower engine speed	
△T	Transmission oil temperature too low, - Heat up transmission	
▽T	Transmission oil temperature too high, - Cool down transmission	
FT	Transmission temperature not in defined range during calibration	Transmission stays in neutral, you have to restart the TCU(Ignition off/on)
FB	Operating mode not NORMAL or transmission temperature sensor defective or storing of calibrated values to EEPROM has failed	Transmission stays in neutral, you have to restart the TCU(Ignition off/on)
FO	Output speed not zero	Transmission stays in neutral, you have to restart the TCU(Ignition off/on)
FN	Shift lever not in neutral position	Transmission stays in neutral, you have to restart the TCU(Ignition off/on)
FP	Park brake not applied	Transmission stays in neutral, you have to restart the TCU(Ignition off/on)

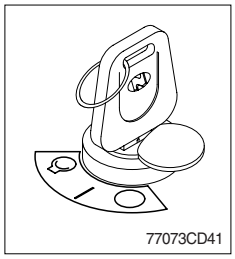
※ **AEB mode :** It controls the disk internal of the transmission, automatically.

2. SWITCHES



7707A3CD29

1) STARTING SWITCH

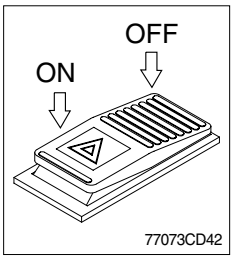


(1) There are three positions, OFF, ON and START.

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

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

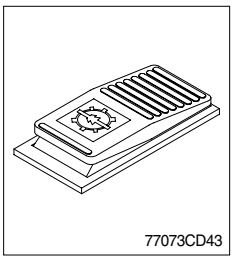
2) HAZARD SWITCH



(1) Use for parking, or roading machine.

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

3) CLUTCH CUT OFF SWITCH



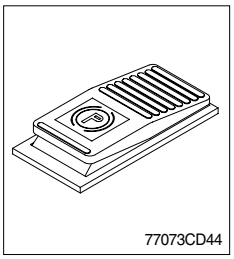
(1) This switch is pressed, it will cut off the clutch when brake operates.

※ **Be careful not to use this switch when driving on a slope.**

(2) When the switch failure occurs, it will be able to operate a clutch off function from LCD.

※ **Refer to page 7-28.**

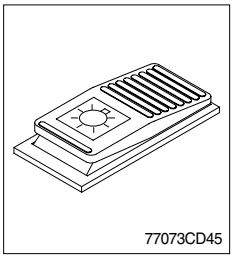
4) PARKING BRAKE SWITCH



(1) This switch is pressed, the parking brake will start to operate and the gauge panel warning lamp will comes ON.

※ **When operating the gear selector lever, be sure to release the parking brake. If the machine is operated with the parking brake engaged, the brake will overheat and may cause the brake system to go out of order.**

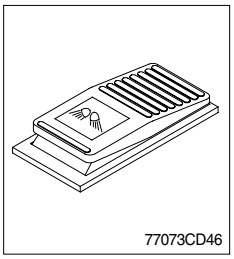
5) MAIN LIGHT SWITCH



(1) This switch use to operates the clearance lamp and head light by two step.

- **First step** : Clearance lamp and cluster illumination lamp comes ON. Also, all indicator lamp of switches come ON.
- **Second step** : Head light comes ON.

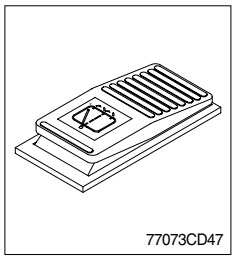
6) WORK LAMP SWITCH



(1) This switch use to operates the front and rear work lamps by two step.

- **First step** : Front work lamp located on the cab comes ON.
- **Second step** : Rear work lamp located on the cowl comes ON.

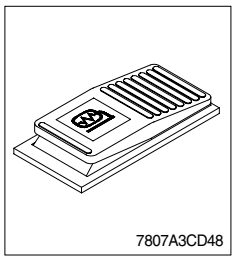
7) REAR WIPER AND WASHER SWITCH



(1) The switch use to operates the rear wiper and washer by two step.

- **First step** : The rear wiper operates.
- **Second step** : The washer liquid is sprayed and the rear wiper is operated only while pressing. If release the switch, return to the first step position.

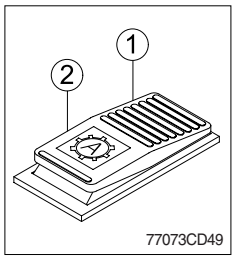
8) MIRROR DEFROST SWITCH(Option)



(1) If the mirror defrost switch is pressed in condition of key ON, it operates for 15 minutes. After 15 minutes, the defrost function stops automatically.

(2) One more pressing the switch in operation also stops defrost function.

9) AUTO SELECT SWITCH



(1) Manual mode(①)

Press the top of the switch for the manual mode of the autoshift function. The operator selects the desired speed and the desired direction in the manual mode with the gear selector lever.

(2) Automatic mode(②)

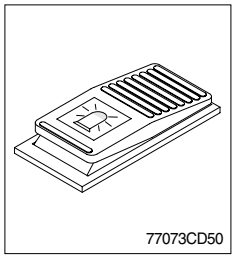
Press the bottom of the switch for the autoshift function in the automatic mode. Press the bottom of the switch prior to shifting the transmission into forward or reverse in order to activate the autoshift function.

※ **The operator can select two kinds of automatic modes. (1st ↔ 4th, 2nd ↔ 4th)**

※ **When the switch failure occurs, it will be able to operate a auto select function from LCD.**

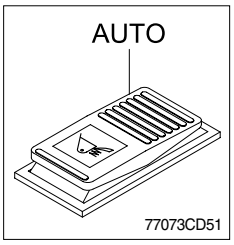
※ **Refer to page 7-28.**

10) BEACON SWITCH (Option)



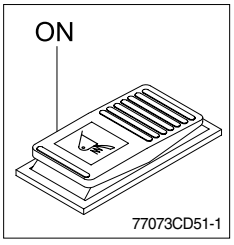
(1) This switch turns ON the rotary light on the cab.

11) RIDE CONTROL SWITCH (Option)



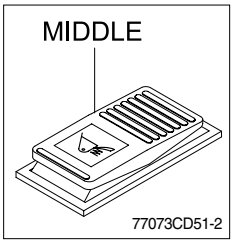
(1) AUTO position

Push in the top of the ride control switch in order to turn on the automatic ride control. The automatic ride control automatically turns on when the travel speed exceeds a preset speed of approximately 9.5km/h. The automatic ride control automatically shuts off during low speed 8km/h travel mode.



(2) ON position

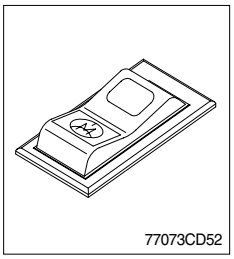
Push in the bottom of the ride control switch in order to turn on the system for ride control regardless speed. The ride control will smooth the ride of the machine during travel.



(3) MIDDLE position

Push the ride control switch to the middle position in order to turn off the system for the ride control.

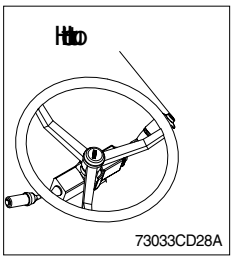
12) PUMP MOTOR SWITCH (option)



(1) The emergency steering system can be manually tested. Push the pump motor switch in order to determine if the emergency steering and the emergency steering lamp are functional.

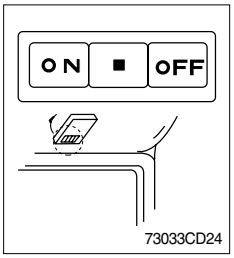
(2) When the switch is pushed, the emergency steering pump motor will run. The emergency steering lamp will light. If the emergency steering lamp does not light, do not operate the machine.

13) HORN BUTTON



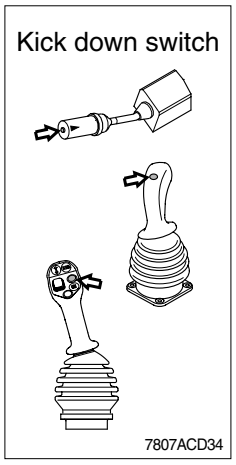
(1) If you press the button on the top of the multifunction switch, the horn will sound.

14) CAB LAMP SWITCH



(1) This switch turns ON the cab room lamp.

15) KICK DOWN SWITCH



(1) Manual mode

It is effective 2nd speed to 1st speed only and recover to 2nd speed quickly when push the switch one more time.

(2) Automatic mode

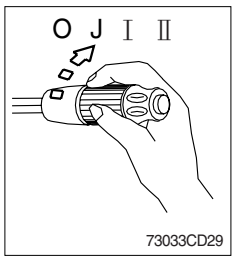
① Mode 1(Down/Up)

It shifts down quickly from current gear to one step lower speed by pushing the switch and recover to original speed quickly when push the switch one more time.

② Mode 2(Down)

It shifts down from current gear to one step lower speed when push the switch every time. **Refer to page 7-28.**

16) MULTI FUNCTION SWITCH



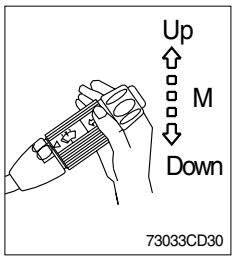
(1) Front wiper and washer switch

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

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

③ If you press a button at the end of the lever, washer liquid will be sprayed and the wiper will be activated 2-3 times.

※ **Check the quantity of washer liquid in the tank. If the level of the washer liquid is LOW, add the washer liquid (In cold, winter days) or water. The capacity of the tank is 1 liter.**



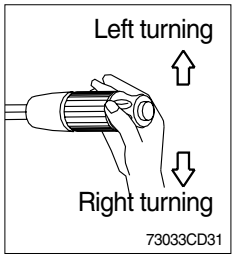
(2) Dimmer switch

① This switch is used to turn the head lights direction.

② Switch positions

- Up : To flash for passing
- Middle : Head lights low beam ON
- Down : Head lights high beam ON

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

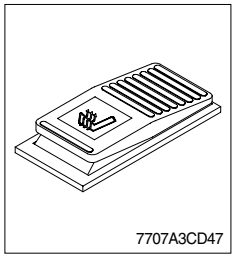


(3) Turning switch

① This switch is used to warn or signal the turning direction of the machine to other vehicles or equipment.

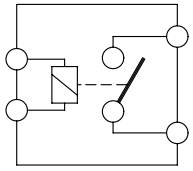
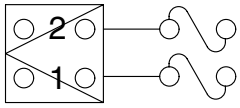
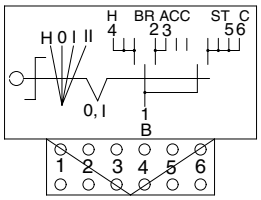
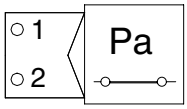
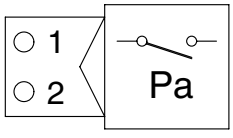
② Push the lever up for turning left, pull the lever down for turning right.

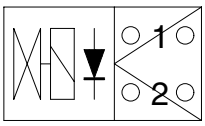
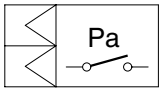
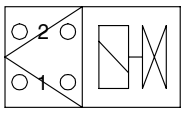
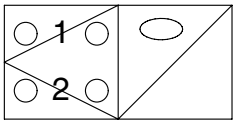
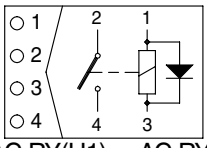
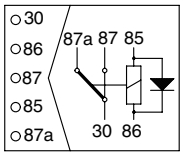
17) HEATED SEAT SWITCH(Option)

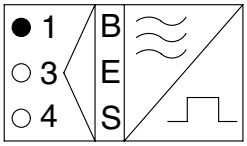
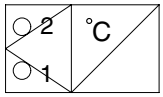
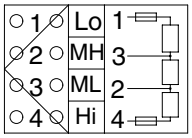
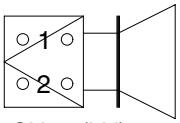
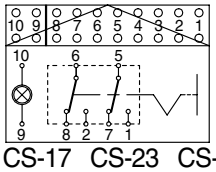
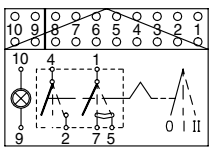


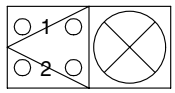
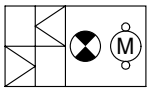
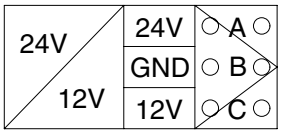
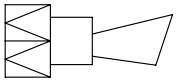
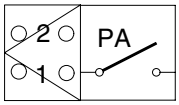
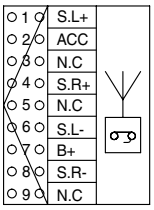
(1) This switch is used to heat the seat.

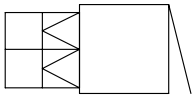
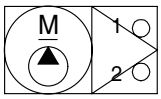
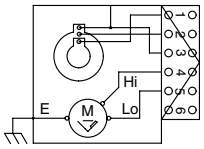
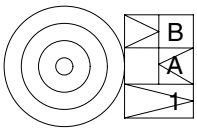
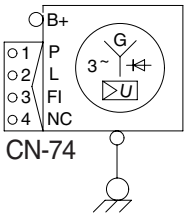
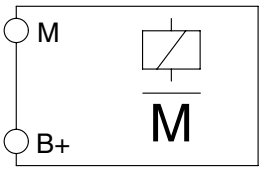
GROUP 4 ELECTRICAL COMPONENT SPECIFICATION

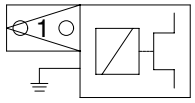
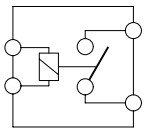
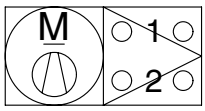
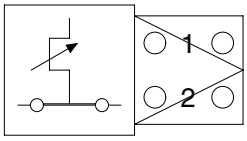
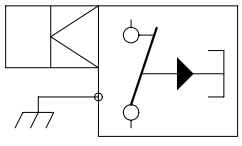
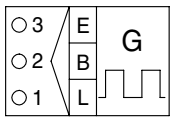
Part name	Symbol	Specifications	Check
Battery		12V × 160Ah (2EA)	※ Check specific gravity 1.280 over : Over charged 1.280 ~ 1.250 : Normal 1.250 below : Recharging
Battery relay	 CR-1	Rated load : 24V 100A(Continuity) 1000A(30seconds)	※ Check coil resistance Normal : About 50 Ω ※ Check contact Normal : ∞ Ω
Fusible link	 CN-60 CN-95	24V 60A	※ Check disconnection Normal : 0 Ω (Connect ring terminal and check resistance between terminal 1 and 2)
Start key	 CS-2	-	※ Check contact OFF : ∞ Ω (For each terminal) ON : 0 Ω (For terminal 1-3) ∞ Ω (For terminal 1-5) START : 0 Ω (For terminal 1-3 and 1-5)
Pressure switch	 CD-3 CD-26 CD-39 CD-41	N.C TYPE	※ Check contact Normal : 0 Ω (CLOSE)
Pressure switch	 CD-4 CD-40 CD-5 CD-48	N.O TYPE	※ Check contact Normal : ∞ Ω (OPEN)

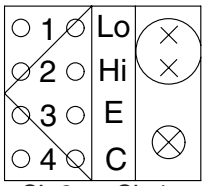
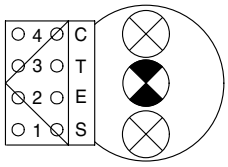
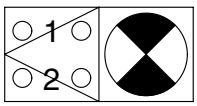
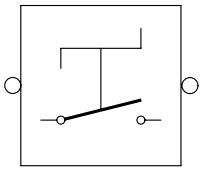
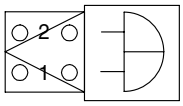
Part name	Symbol	Specifications	Check
Parking brake/ Ride control solenoid	 CN-71 CN-137	24V 1A	※ Check resistance Normal : 15~25 Ω (For terminal 1-2)
Air cleaner pressure switch	 CD-10	Pressure : 635mmH₂O (N.O TYPE)	※ Check contact Normal : ∞ Ω
Ride control valve / Fan solenoid	 CN-136 CN-154 CN-155	24V 1.2A	※ Check LED lamp ※ Check Resistance About 24 Ω
Fuel sender	 CD-2	Reed switch : Magnetic type	※ Check resistance Full : About 30 Ω Low level : About 300 Ω
Relay (4pin)	 AC RY(H1) AC RY(M2)	24V 20A	※ Check resistance Normal : About 200 Ω (For terminal 1-3) : ∞ Ω (For terminal 2-4)
Relay (5pin)	 CR-2 CR-3 CR-4 CR-5 CR-7 CR-25 CR-26 CR-33 CR-35 CR-36 CR-37 CR-38 CR-40 CR-41 CR-46 CR-55 CR-58 CR-59	24V 20A	※ Check resistance Normal : About 160 Ω (For terminal 2-6) : 0 Ω (For terminal 1-3) : ∞ Ω (For terminal 1-3)

Part name	Symbol	Specifications	Check
Proximate switch	 CN-100 CN-101	24V 400mA	
Hydraulic temperature	 CD-1		※ Check resistance Normal : ∞ Ω 105℃ over : 0 Ω
Aircon resistor			※ Check contact Normal : 1.12 Ω (For terminal 2-4) : 2.07 Ω (For terminal 3-4) : 3.17 Ω (For terminal 4-1)
Speaker	 CN-23(LH) CN-24(RH)	4 Ω 20W	※ Check resistance Normal : 50 Ω
Switch (Locking type)	 CS-17 CS-23 CS-41 CS-42 CS-59 CS-80 CS-82	24V 8A	※ Check contact OFF : ∞ Ω (for terminal 1-5, 2-6) : 0 Ω (for terminal 5-7, 6-8)
Switch (Non-locking type)	 CS-21 CS-35 CS-36	24V 8A	※ Check contact OFF : ∞ Ω (for terminal 2-4, 1-7)

Part name	Symbol	Specifications	Check
Work lamp, Room lamp, Number plate lamp	 CL-1 CL-6 CL-22 CL-5 CL-21 CL-23 CL-24 CL-25 CL-30	Work lamp 24V 70W Number plate lamp Room lamp 24V 10W	※ Check disconnection Normal : A few Ω
Beacon lamp	 CL-7	24V 70W (H1 TYPE)	※ Check disconnection Normal : A few Ω
DC/DC Converter		12V 3A	※ 24V (A-B) 12V (B-C)
Horn	 CN-20 CN-25	22-28V 2A 110dB	※ Check operation Supply power(24V) to each terminal and connect ground
Receiver dryer	 CN-29	24V 2.5A	※ Check contact Normal : ∞ Ω
Cassette radio	 CN-27	24V 20W+20W	※ Check resistance Power ON : 4 Ω +4 Ω (for terminal 1-6, 4-8)

Part name	Symbol	Specifications	Check
Back up buzzer	 CN-65	24V 0.5A 110dB	-
Washer pump	 CN-103 CN-22	24V 2.5A	※ Check contact Normal : 26.4 Ω (for terminal 1-2)
Wiper motor	 CN-102 CN-21	24V 1.5A 2-speed Auto parking	-
Cigar lighter	 CL-2	24V 5A	-
Alternator	 CN-74	24V 70A	※ Check voltage Normal : 24~28V
Starter	 CN-45	Delco Remy 28MT 24V	※ Operating or not

Part name	Symbol	Specifications	Check
Aircon compressor	 CN-28	24V 79W	※ Check contact Normal : 13.4 Ω
Start relay	 CR-23	24V 200A	※ Check contact Normal : 11.3 Ω
Blower		24V 9A 2900±150rpm	-
Duct sensor		1°C OFF 4°C ON	※ Check resistance Normal : 0 Ω (for terminal 1-2), the atmosphere temp: over 4°C
Door switch	 CS-1 CS-55	24V 2W	※ Check resistance Normal : About 5M Ω
Flasher unit	 CR-11	24V 85 ~ 190 C/M 50dB	-

Part name	Symbol	Specifications	Check
Head lamp	 CL-3 CL-4	24V 75W/70W (H4 TYPE) 24V 4W (T4W)	※ Check disconnection Normal : A few Ω
Combi lamp	 CL-15 CL-16	24V 5W (R5W) 2×24V 21W (P21W)	-
Turn lamp	 CL-24 CL-25	24V 21W (P21W)	-
Master switch	 CS-74	Continuous capacity : 180Amp Push in capacity : 1000Amp	-
Warning buzzer	 CN-26	24V 200mA 90±5dB(ℓm)	-

GROUP 5 CONNECTORS

1. CONNECTOR DESTINATION

Connector number	Type	No. of pin	Destination	Connector part No.	
				Female	Male
CN-1	58	2	I/conn(Frame harness-Main harness)	S813-030200	S813-130200
CN-2	Econoseal J	12	I/conn(Main harness-Frame harness)	S816-012002	S816-112002
CN-3	AMP	15	I/conn(Frame harness-Main harness)	2-85262-1	368301-1
CN-4	AMP	15	I/conn(Main harness-Frame harness)	2-85262-1	368301-1
CN-5	AMP	15	I/conn(Frame harness-Main harness)	2-85262-1	368301-1
CN-6	AMP	15	I/conn(Main harness-Frame harness)	2-85262-1	368301-1
CN-7	AMP	15	I/conn(Main harness-Cab harness)	2-85262-1	368301-1
CN-8	Econoseal J	8	I/conn(Main harness-Cab harness)	S816-008002	S816-108002
CN-9	Econoseal J	12	I/conn(Main harness-Front harness)	S816-012002	S816-112002
CN-10	AMP	15	I/conn(Main harness-Front harness)	2-85262-1	368301-1
CN-11	DEUTSCH	8	I/conn(Main harness-Aircon harness)	DT06-8S	-
CN-12	AMP	15	I/conn(Frame harness-Engine harness)	2-85262-1	368301-1
CN-13	Econoseal J	15	I/conn(Frame harness-Engine harness)	S816-012002	S816-112002
CN-18	Econoseal J	4	I/conn(Ride control harness-Front harness)	S816-004002	S816-104002
CN-20	Molex	2	Horn	36825-0211	-
CN-21	HW090 sealed	6	Front wiper motor	6189-0133	-
CN-22	SWP	2	Front washer tank	S814-002000	-
CN-23	KET	2	Speaker(LH)	7123-1520	-
CN-24	KET	2	Speaker(RH)	7123-1520	-
CN-25	Molex	2	Horn	36825-0211	-
CN-26	250	2	Warning buzzer	S810-002202	-
CN-27	PA	9	Cassette and radio	S811-009003	-
CN-28	MWP	1	Comp(Air-con)	NMWP01F-B	-
CN-29	KET	2	Receiver drier	MG640795	-
CN-45	Ring term	-	Starter	S820-414000	-
CN-56	AMP	20	Cluster	174047-2	-
CN-58	Econoseal III	36	Controller	344111-1	-
CN-59	AMP	23	Controller	770680-1	-
CN-65	DEUTSCH	2	Back up buzzer	DT06-2S-EP06	-
CN-71	DEUTSCH	2	Parking solenoid	DT06-2S-EP06	-
CN-74	PACKARD	4	Alternator	1218-6568	-
CN-83	NMWP	2	Aircon fan	PB625-02027	-
CN-93	DEUTSCH	50	ECM	DRC26-50S-04	-
CN-94	DEUTSCH	4	ECM power	DTP06-4S-EP06	-

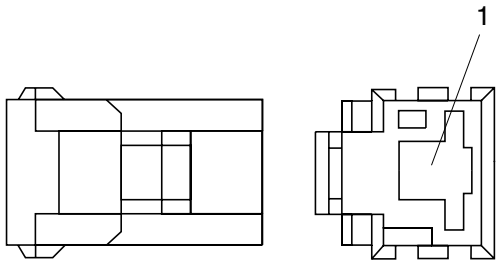
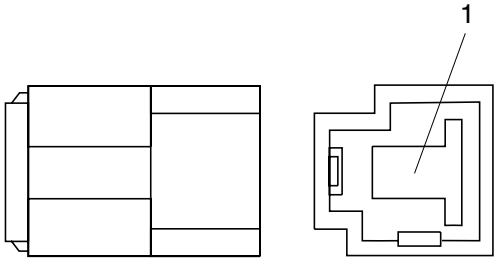
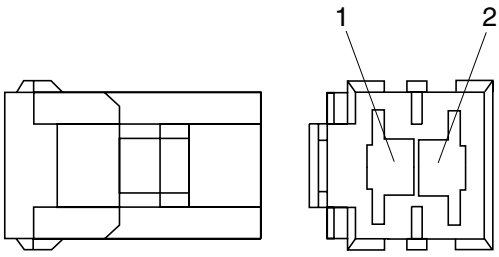
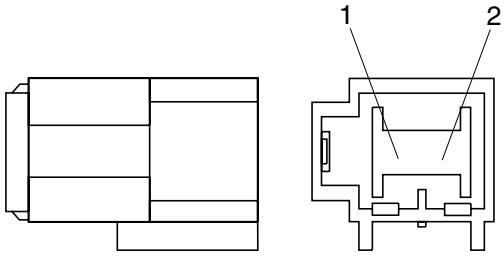
Connector number	Type	No. of pin	Destination	Connector part No.	
				Female	Male
CN-96	PACKARD	4	Fuel heater	2-967325-3	-
CN-99	DEUTSCH	2	Resister	DT04-3P-EP10	-
CN-100	Autonics	-	Boom kick out	21L6-20020	-
CN-101	Autonics	-	Bucket leveler	21L6-20020	-
CN-102	HW090 sealed	6	Rear wiper motor	6189-01330	-
CN-103	SWP	2	Rear washer tank	S814-002000	-
CN-112	-	16	Gear box	21L7-60290	-
CN-114	Econoseal J	12	Joy stick	-	S816-112002
CN-136	DEUTSCH	2	Ride control solenoid	DT06-2S-EP06	-
CN-137	DEUTSCH	2	Control valve solenoid	DT06-2S-EP06	-
CN-138	DEUTSCH	3	DC/DC Converter	DT06-3S-EP06	-
CN-139	DEUTSCH	2	12V socket	-	DT04-2P
CN-154	AMP	2	Fan clutch	85202-1	-
CN-157	AMP	68	T/M control unit	962175	-
CN-158	PACKARD	4	Gear shift lever	-	1201-0974
CN-159	PACKARD	4	Gear shift lever	1201-5797	-
CN-162	Econoseal J	6	Pedal	S816-006002	-
Relay					
CR-1	Ring term	-	Battery relay	S820-104000	-
CR-2	250	4	Horn relay	S810-004202	-
CR-3	250	4	Front work lamp relay	S810-004202	-
CR-4	250	6	Wiper relay(Hi)	S810-006202	-
CR-5	250	2	Safety relay	S810-006202	-
CR-7	250	4	Aircon relay	S810-004202	-
CR-11	250	3	Flasher unit	S810-003702	-
CR-23	SWP	2	Start relay	-	S814-102001
CR-24	Shur	1	Preheater relay	S822-014000	-
CR-36	250	4	Preheater relay	S810-004202	-
CR-46	250	4	Fuel warmer relay	S810-004202	-
CR-55	250	4	Rear work lamp relay	S810-004202	-
CR-58	250	1	Back up relay	S810-004202	-
Switch					
CS-1	Shur	1	Door switch	S822-014004	-
CS-2	SWP	6	Start key switch	S814-006000	-
CS-5	Shur	1	Horn switch	S822-014000	-
CS-11	SWP	8	Multi function switch	S814-008000	-
CS-12	SWP	6	Multi function switch	S814-006000	-

Connector number	Type	No. of pin	Destination	Connector part No.	
				Female	Male
CS-17	SWF	10	Parking switch	593757	-
CS-21	SWF	10	Main light switch	593757	-
CS-23	SWF	10	Beacon switch	593757	-
CS-35	SWF	10	Rear wiper	593757	-
CS-36	SWF	10	Work lamp switch	593757	-
CS-41	SWF	10	Hazard switch	593757	-
CS-42	SWF	10	Clutch cut off switch	593757	-
CS-55	SWF	10	Ride control switch	593757	-
CS-59	SWF	10	Auto/manual switch	593757	-
CS-74	Ring term	1	Master switch	S820-210002	-
CS-75	SWF	10	Steering pump switch	593757	-
CS-76	SWF	10	Mirror heater	593757	-
CS-82	SWF	10	Seat heater	593757	-
Light					
CL-2	250	3	Cigar lighter	S810-003202	-
CL-3	DEUTSCH	4	Head light	DT04-4P-E005	-
CL-4	DEUTSCH	4	Head light	DT04-4P-E005	-
CL-5	DEUTSCH	2	Work light(LH)	-	DT04-2P-E005
CL-6	DEUTSCH	2	Work light(RH)	-	DT04-2P-E005
CL-7	AMP	2	Beacon lamp	S822-014004	S822-114004
CL-15	SWP	4	Combi lamp(RR, LH)	S814-004000	-
CL-16	SWP	4	Combi lamp(RR, RH)	S814-004000	-
CL-21	SWP	2	Numberplate lamp	S814-002000	-
CL-22	DEUTSCH	2	Work light(LH)	-	DT04-2P-E005
CL-23	DEUTSCH	2	Work light(RH)	-	DT04-2P-E005
CL-24	SWP	2	Turn lamp(LH)	S814-002000	-
CL-25	SWP	2	Turn lamp(RH)	S814-002000	-
CL-30	KET	2	Room lamp	MG610392	-
CL-32	DEUTSCH	2	Rear work light(RH)	-	DT04-2P-E005
CL-33	DEUTSCH	2	Rear work light(LH)	-	DT04-2P-E005
Sensor, sender					
CD-1	AMP	2	Hyduaulic oil temo sendor	85202-1	-
CD-2	SWP	2	Fuel sendor	S814-002000	-
CD-3	Rubber cap	-	Brake fail pressure switch	21EA-003100	-
CD-4	Rubber cap	-	Stop lamp pressure switch	21EA-003100	-
CD-5	Rubber cap	-	Clutch cut off pressure switch	21EA-003100	-
CD-10	Ring term	2	Air cleaner switch	S820-105000	-

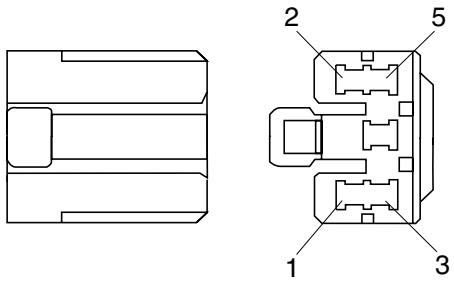
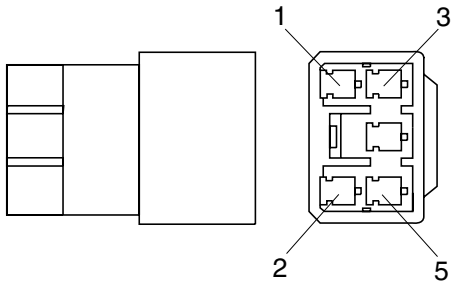
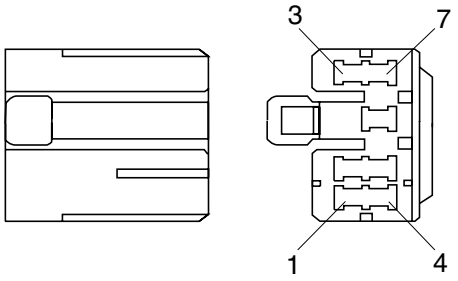
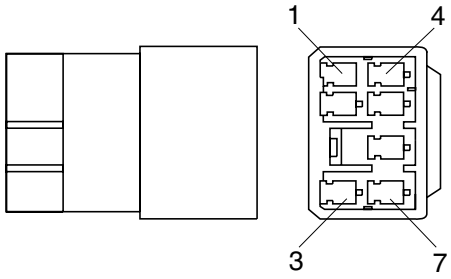
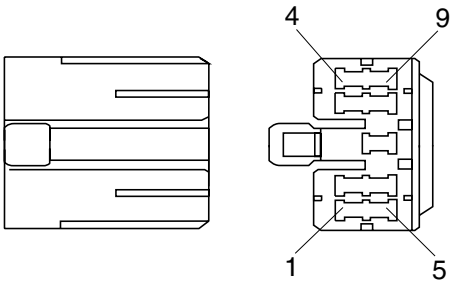
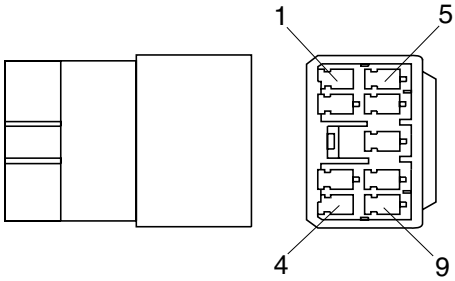
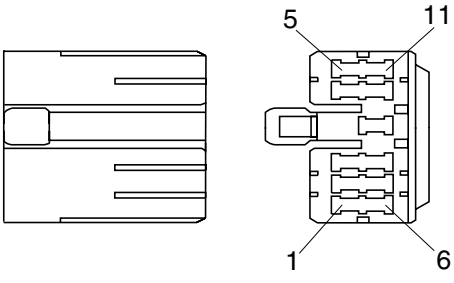
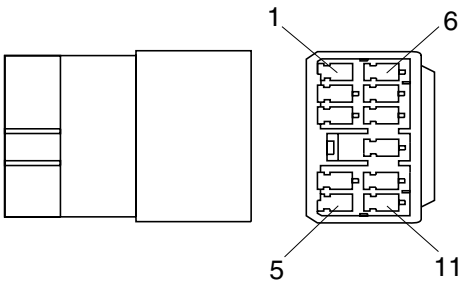
Connector number	Type	No. of pin	Destination	Connector part No.	
				Female	Male
CD-17	AMP	2	Engine pick-up sensor	85202-1	-
CD-26	Rubber cap	-	Parking pressure switch	21EA-003100	-
CD-27	AMP	2	Turbin pick up sensor	85202-5	-
CD-35	PACKARD	2	Fuel filter	1204-0753	-
CD-39	Rubber cap	2	Main pump pressure switch	21EA-00310	-
CD-40	Rubber cap	2	Steering pump pressure switch	21EA-00310	-
CD-41	Rubber cap	2	Boom down pressure switch	21EA-00310	-
CD-46	AMP	3	Output speed sensor	282087	-
CD-47	AMP	2	Gear chain senser	85202-1	-
CD-48	AMP	2	Oil filter	282080	-
CD-49	AMP	2	Converter sensor	85202-1	-

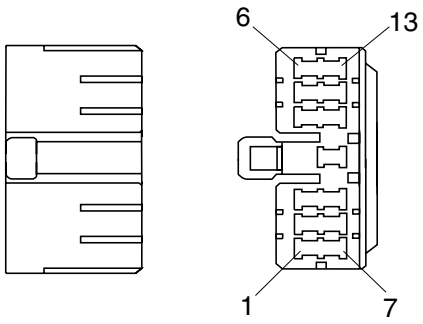
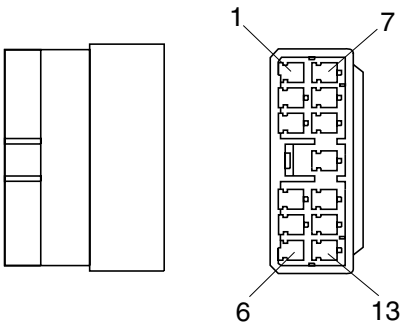
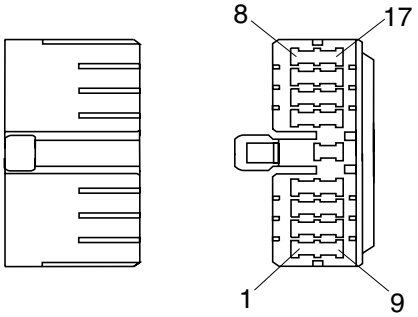
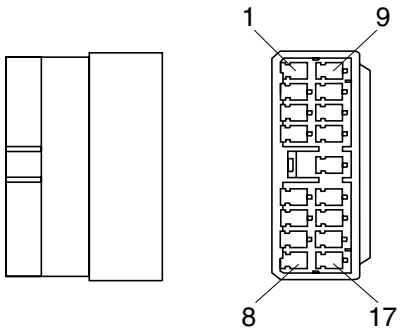
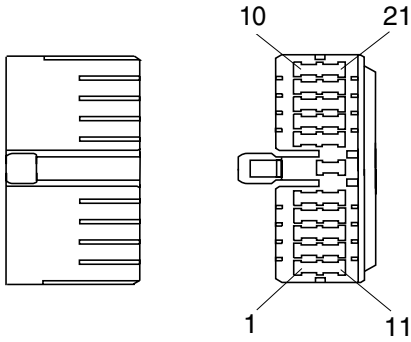
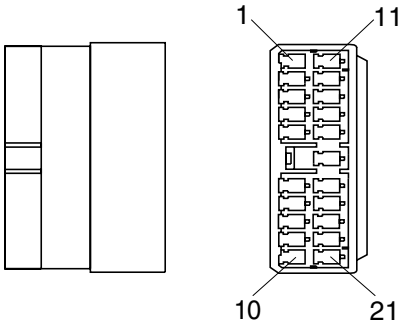
2. CONNECTION TABLE FOR CONNECTORS

1) 58-L TYPE CONNECTOR

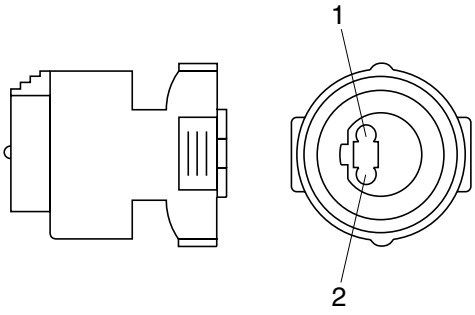
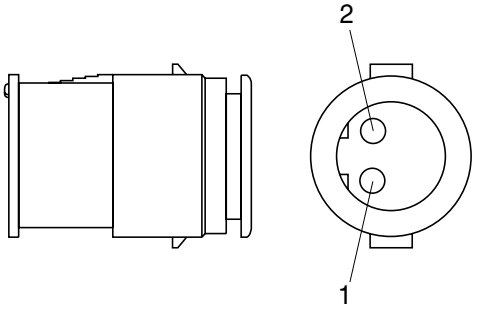
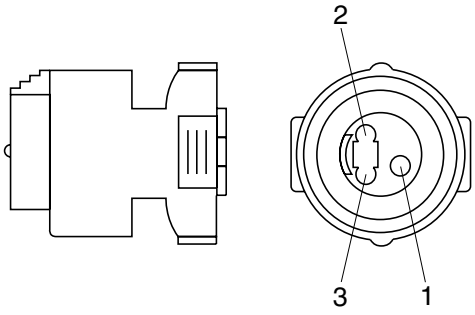
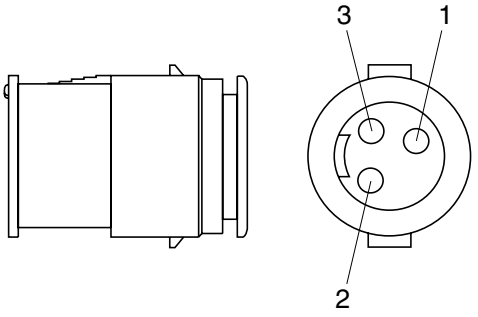
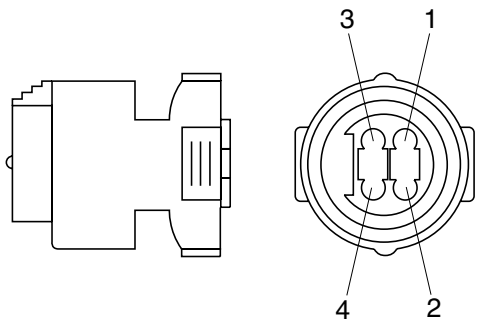
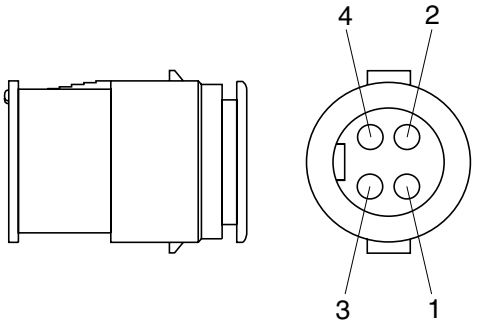
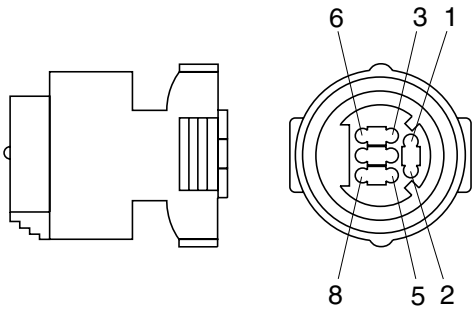
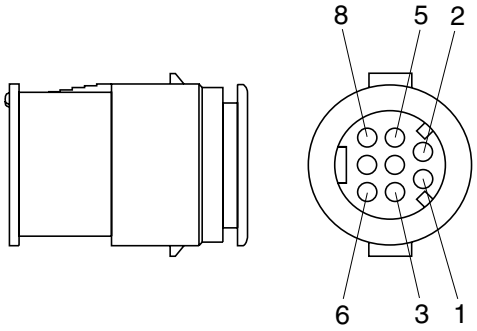
No. of pin	Receptacle connector(Female)	Plug connector(Male)
1	 S813-030100	 S813-130100
2	 S813-030200	 S813-130200

2) PA TYPE CONNECTOR

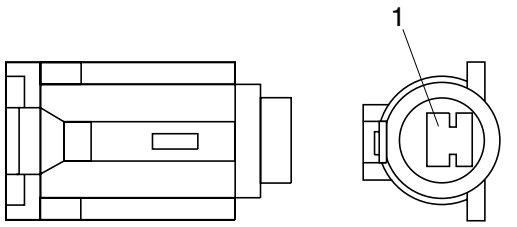
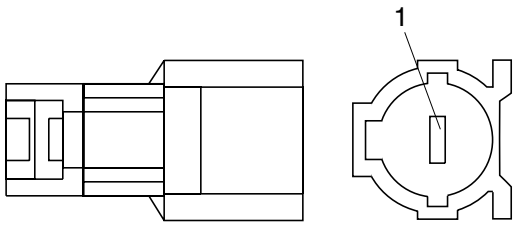
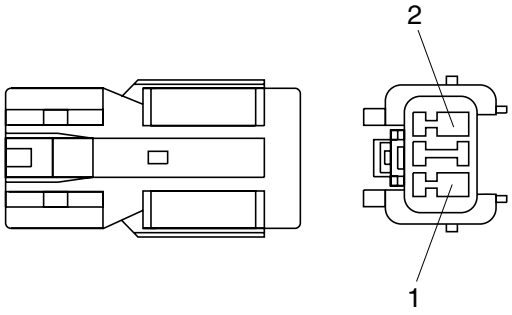
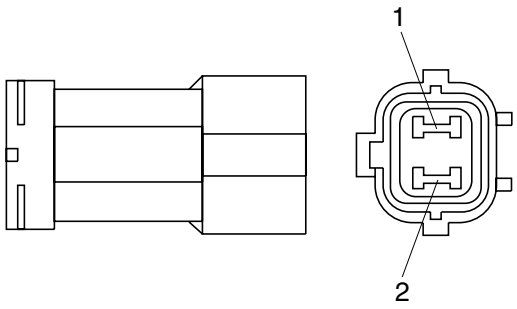
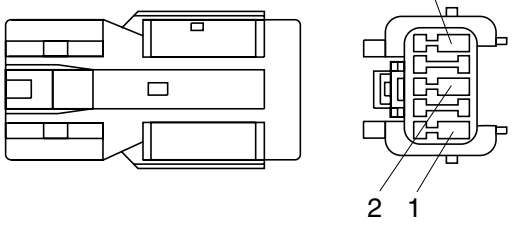
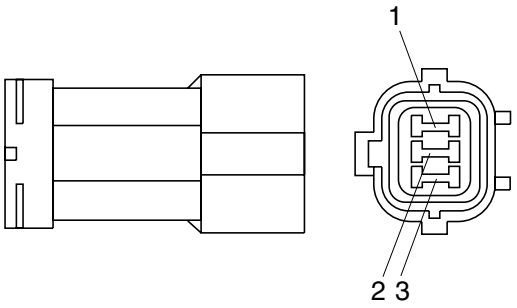
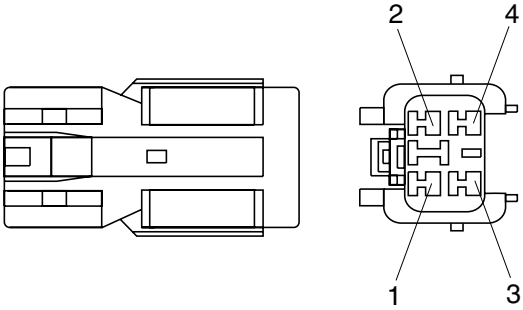
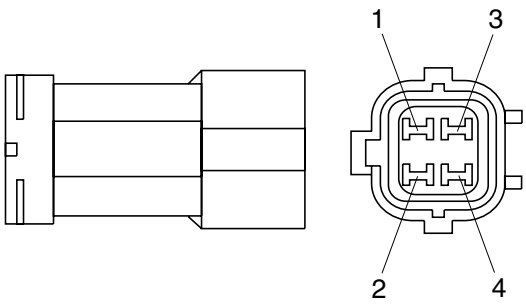
No. of pin	Receptacle connector(Female)	Plug connector(Male)
5	 S811-005002	 S811-105002
7	 S811-007002	 S811-107002
9	 S811-009002	 S811-109002
11	 S811-011002	 S811-111002

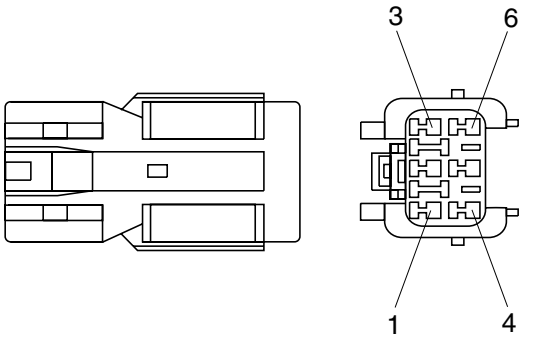
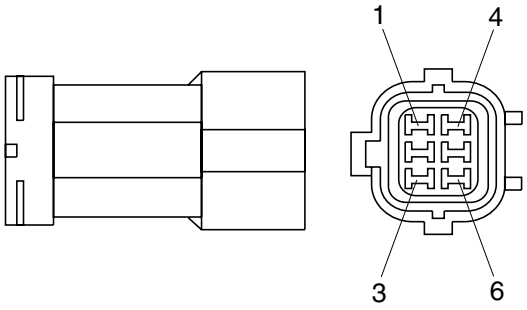
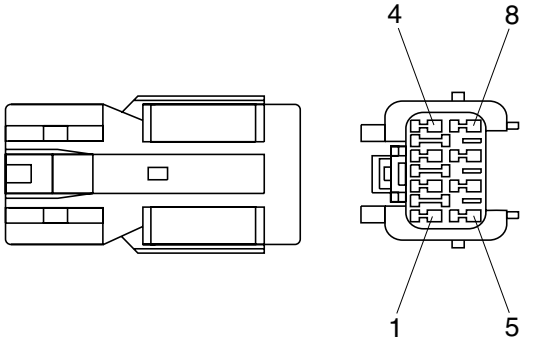
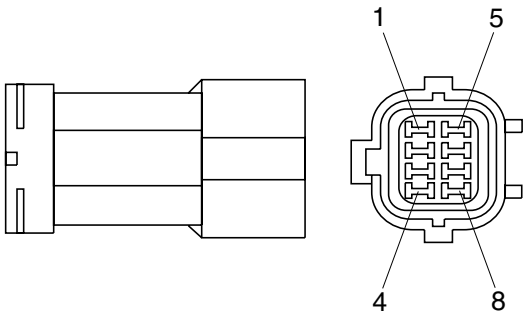
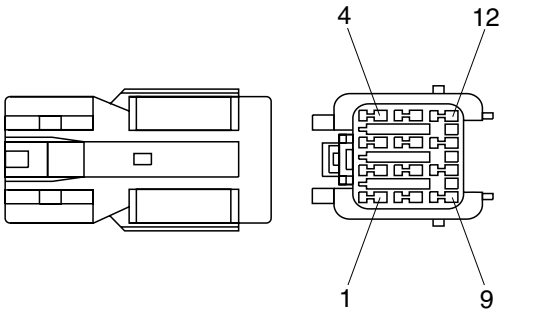
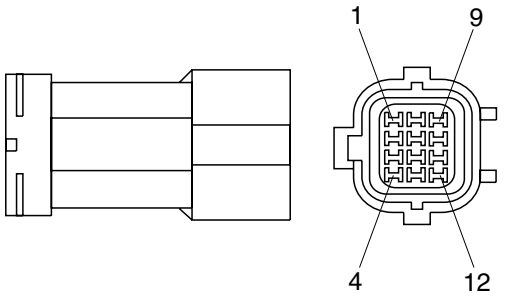
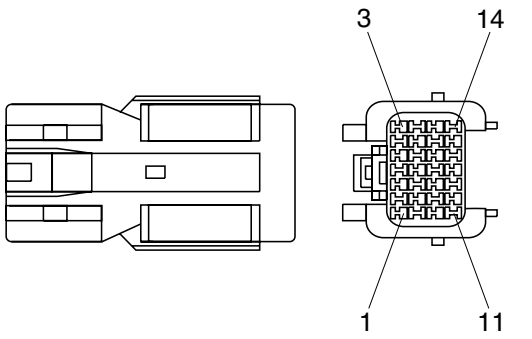
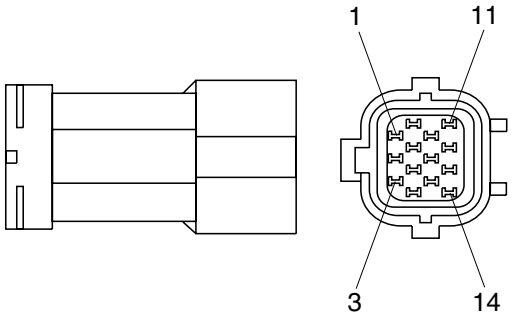
No. of pin	Receptacle connector(Female)	Plug connector(Male)
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17	 S811-017002	 S811-117002
21	 S811-021002	 S811-121002

3) J TYPE CONNECTOR

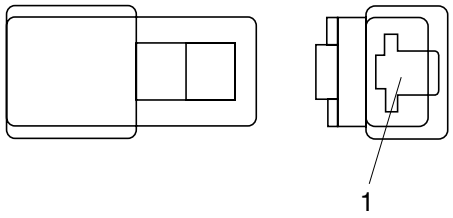
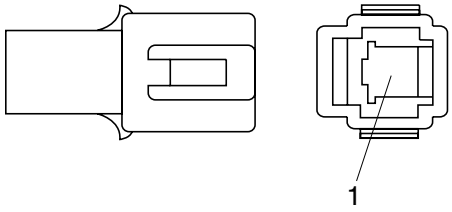
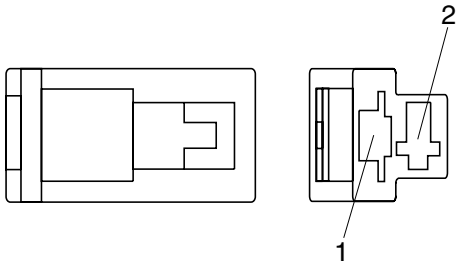
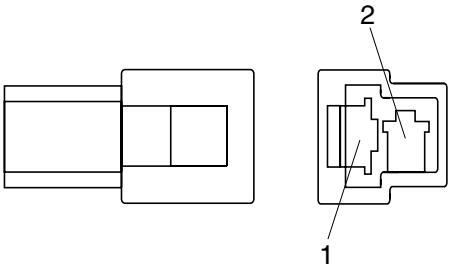
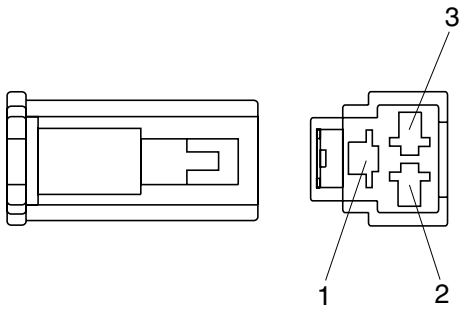
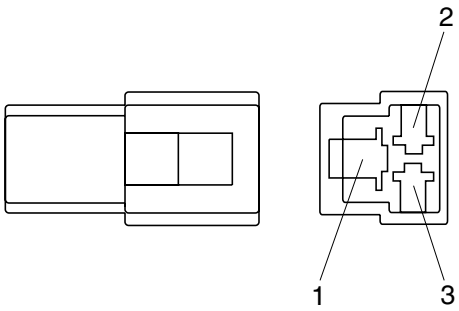
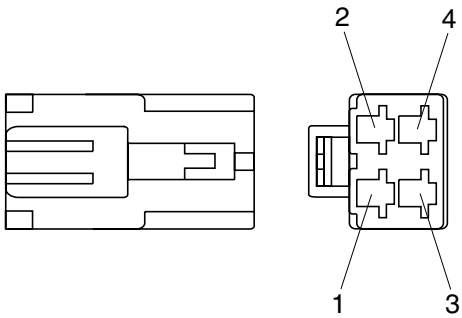
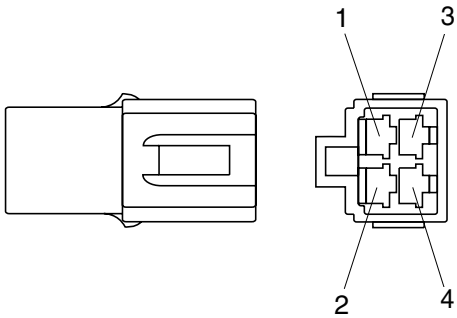
No. of pin	Receptacle connector(Female)	Plug connector(Male)
2	 S816-002001	 S816-102001
3	 S816-003001	 S816-103001
4	 S816-004001	 S816-104001
8	 S816-008001	 S816-108001

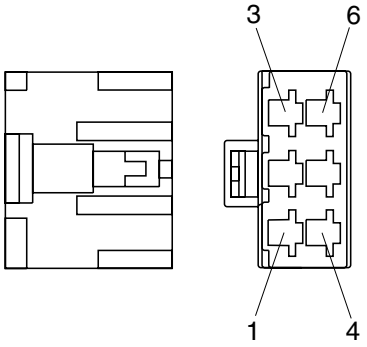
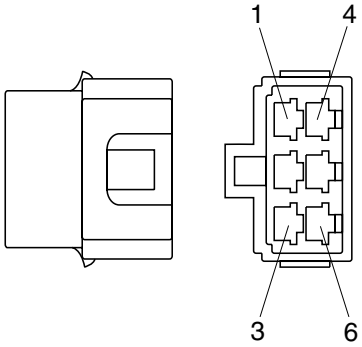
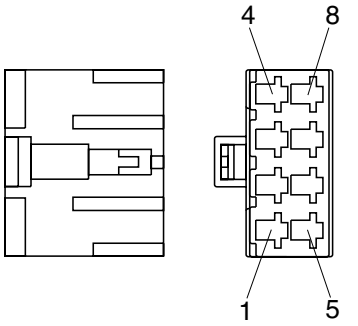
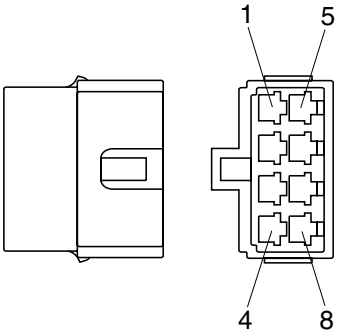
4) SWP TYPE CONNECTOR

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

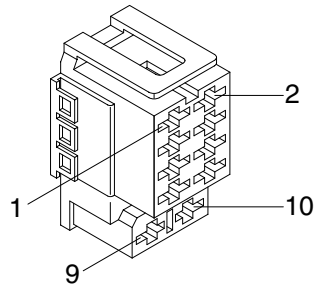
No. of pin	Receptacle connector(Female)	Plug connector(Male)
6	 S814-006000	 S814-106000
8	 S814-008000	 S814-108000
12	 S814-012000	 S814-112000
14	 S814-014000	 S814-114000

5) CN TYPE CONNECTOR

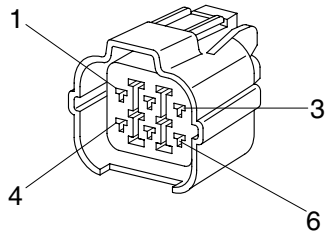
No. of pin	Receptacle connector(Female)	Plug connector(Male)
1	 S810-001202	 S810-101202
2	 S810-002202	 S810-102202
3	 S810-003202	 S810-103202
4	 S810-004202	 S810-104202

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

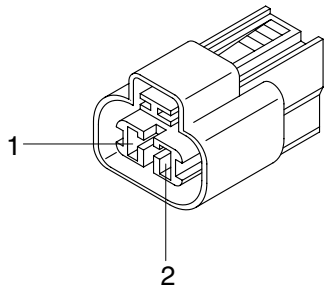
6) ITT SWF CONNECTOR

No. of pin	Receptacle connector(Female)	Plug connector(Male)
10	 SWF593757	

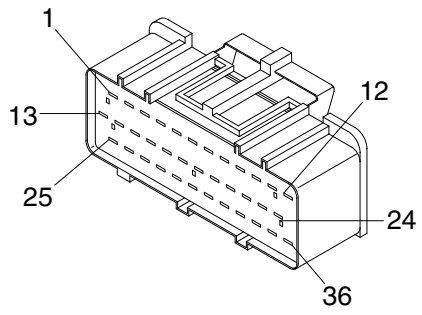
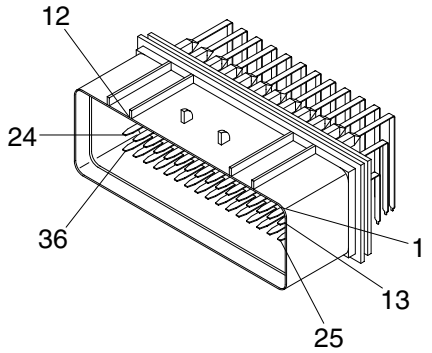
7) HW090 SEALED CONNECTOR

No. of pin	Receptacle connector(Female)	Plug connector(Male)
6	 6189-0133	

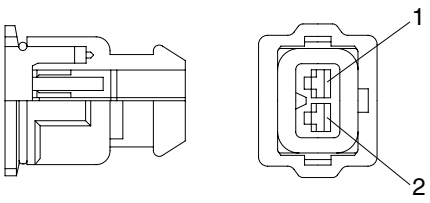
8) MWP02F-B CONNECTOR

No. of pin	Receptacle connector(Female)	Plug connector(Male)
2	 PH805-02028	

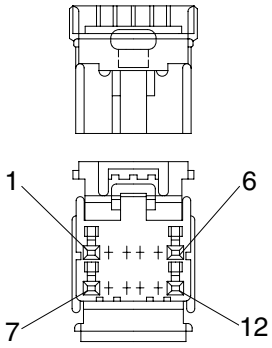
9) AMP ECONOSEAL CONNECTOR

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

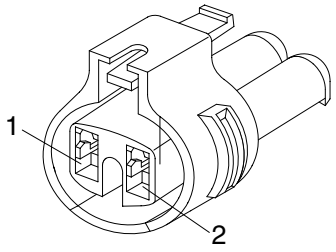
10) AMP TIMER CONNECTOR

No. of pin	Receptacle connector(Female)	Plug connector(Male)
2	 85202-1	

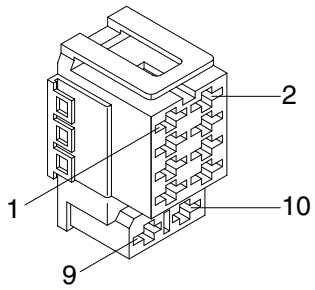
11) AMP 040 MULTILOCK CONNECTOR

No. of pin	Receptacle connector(Female)	Plug connector(Male)
12	 174045-2	

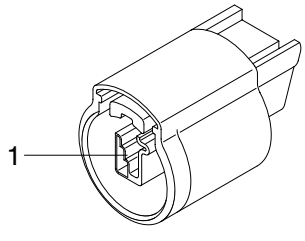
12) KET 090 WP CONNECTORS

No. of pin	Receptacle connector(Female)	Plug connector(Male)
2	 MG640795	

13) ITT SWF CONNECTOR

No. of pin	Receptacle connector(Female)	Plug connector(Male)
10	 SWF593757	

14) MWP NMWP CONNECTOR

No. of pin	Receptacle connector(Female)	Plug connector(Male)
1	 NMWP01F-B	

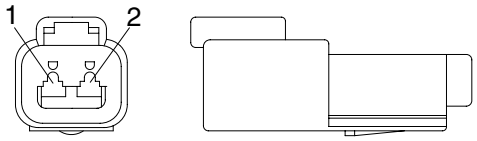
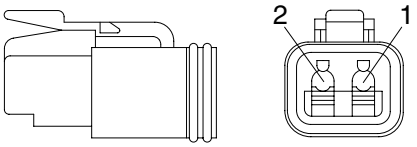
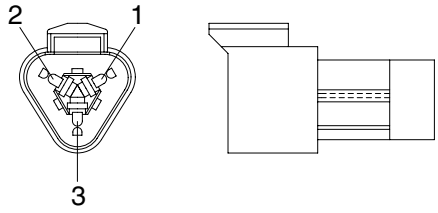
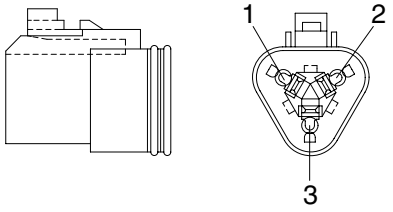
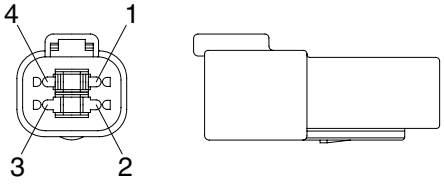
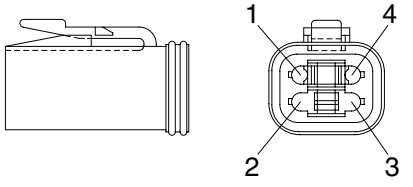
15) DEUTSCH DT CONNECTORS

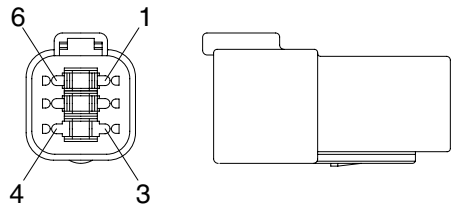
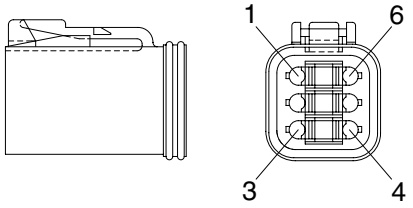
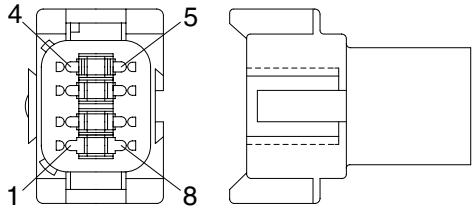
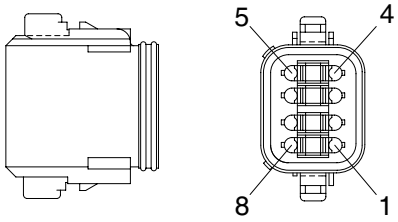
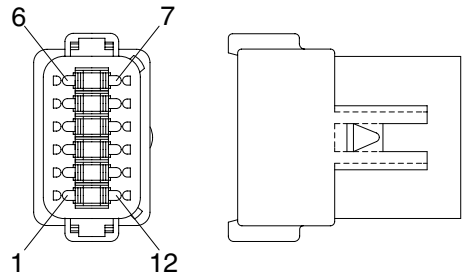
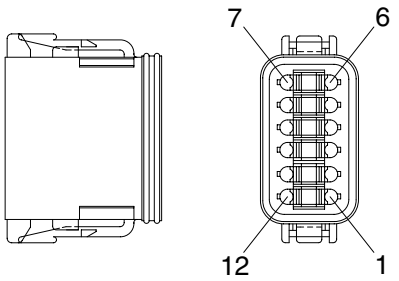
DT 06 - 3S - ★★★★

- ★★★★ : Modifications(See below)
- 3S : Number of contacts(P : Pin, S : Socket)
- 06 : 04 : Receptacle, 06 : Plug
- DT : Deutsch connetors

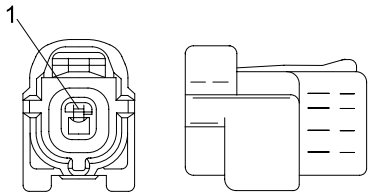
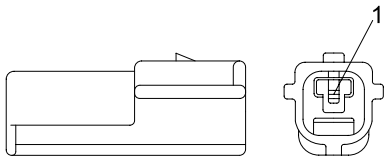
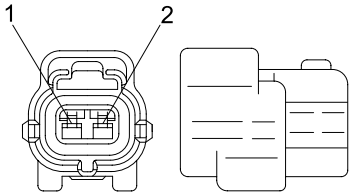
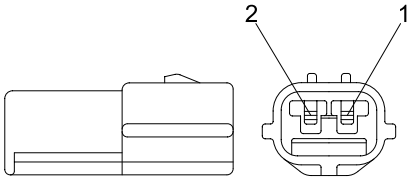
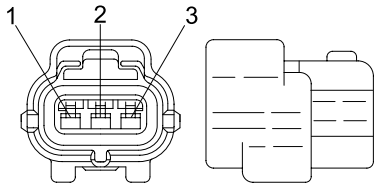
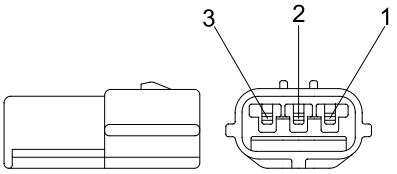
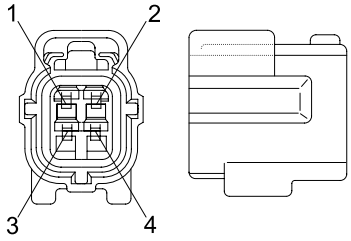
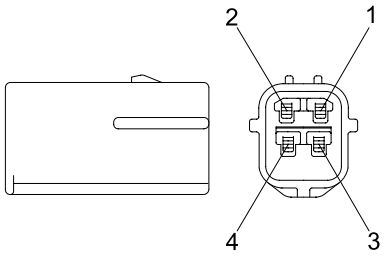
※ Modification

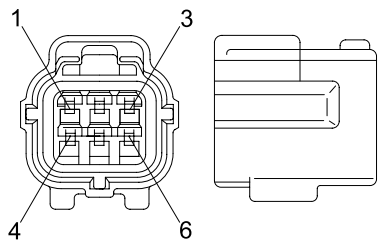
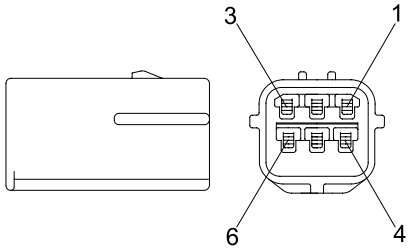
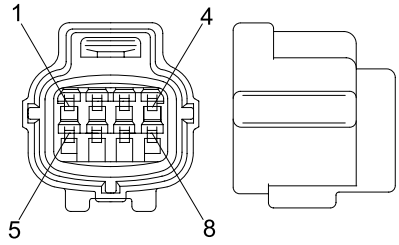
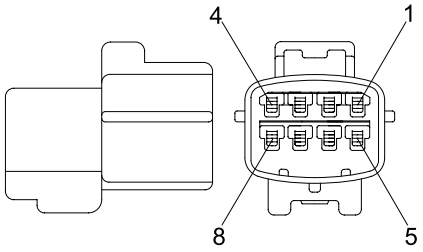
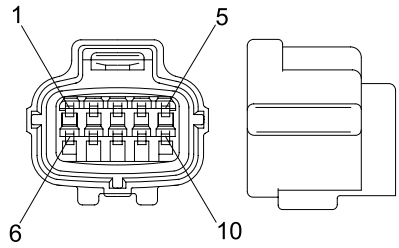
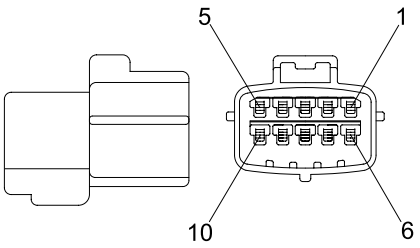
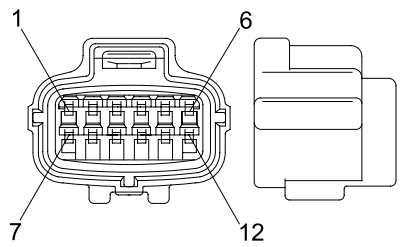
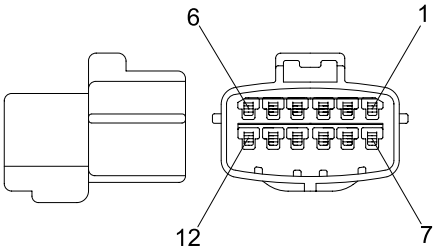
E003 : Standard end cap - gray
E004 : Color of connector to be black
E005 : Combination - E004 & E003
EP04 : End cap
EP06 : Combination P012 & EP04
P012 : Front seal enhancement - connectors color to black for 2, 3, 4 & 6pin

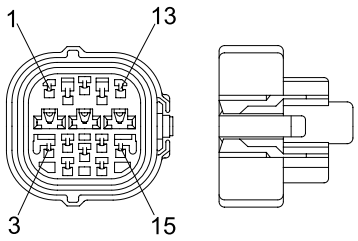
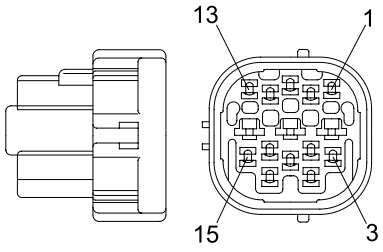
No. of pin	Receptacle connector(Female)	Plug connector(Male)
2	 DT06-2S	 DT04-2P
3	 DT06-3S	 DT04-3P
4	 DT06-4S	 DT04-4P

No. of pin	Receptacle connector(Female)	Plug connector(Male)
6	 DT06-6S	 DT04-6P
8	 DT06-8S	 DT04-8P
12	 DT06-12S	 DT04-12P

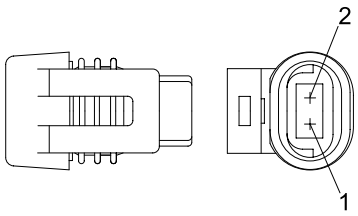
16) ECONOSEAL J TYPE CONNECTORS

No. of pin	Receptacle connector(Female)	Plug connector(Male)
1	 S816-001002	 S816-101002
2	 S816-002002	 S816-102002
3	 S816-003002	 S816-103002
4	 S816-004002	 S816-104002

No. of pin	Receptacle connector(Female)	Plug connector(Male)
6	 S816-006002	 S816-106002
8	 S816-008002	 S816-108002
10	 S816-010002	 S816-110002
12	 S816-012002	 S816-112002

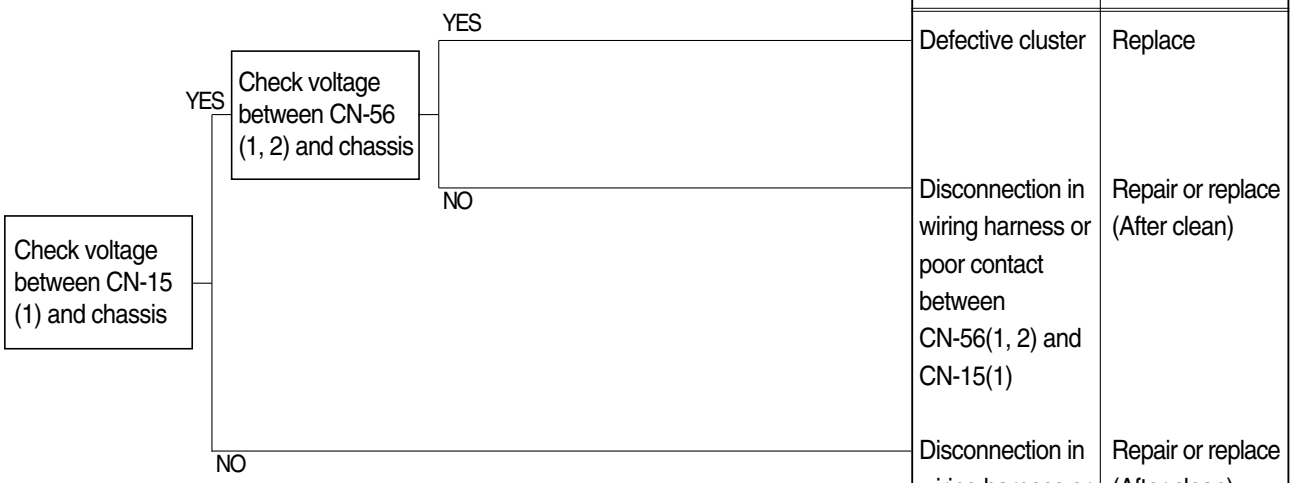
No. of pin	Receptacle connector(Female)	Plug connector(Male)
15	 368301-1	 2-85262-1

17) METRI-PACK TYPE CONNECTOR

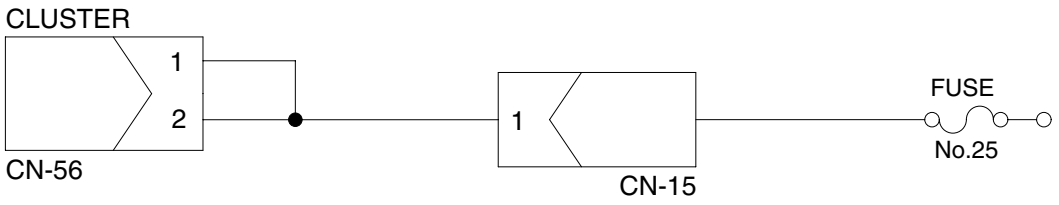
No. of pin	Receptacle connector(Female)	Plug connector(Male)
2	 12040753	

1. WHEN STARTING SWITCH IS TURNED ON, CLUSTER LAMP DOES NOT LIGHT UP

- Before carrying out below procedure, check all the related connectors are properly inserted and the fuse No.25 is not blown out and ON/OFF of bulb.
- After checking, connect the disconnected connectors again immediately unless otherwise specified.



Cause	Remedy
Defective cluster	Replace
Disconnection in wiring harness or poor contact between CN-56(1, 2) and CN-15(1)	Repair or replace (After clean)
Disconnection in wiring harness or poor contact between CN-15(1) and fuse No.25	Repair or replace (After clean)



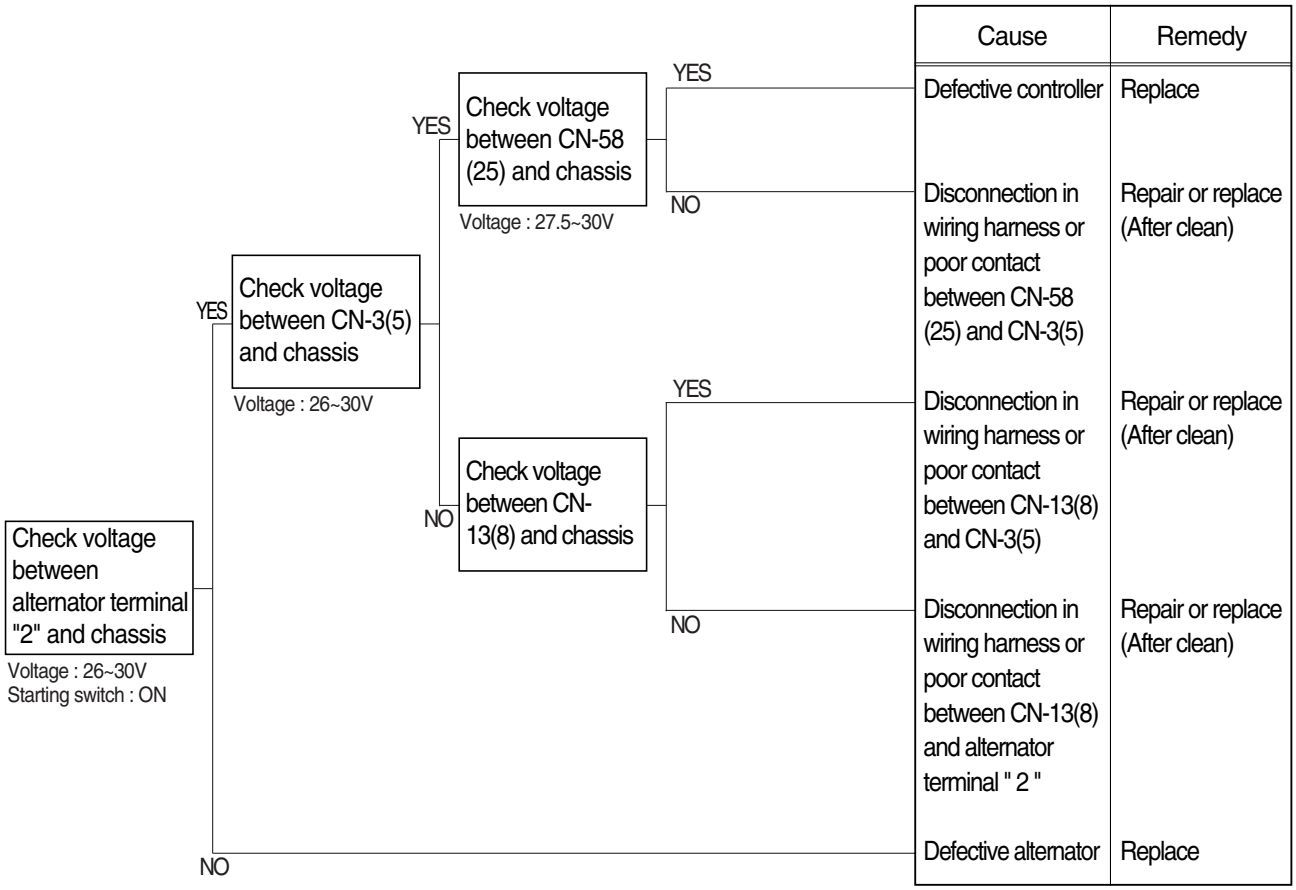
Check voltage

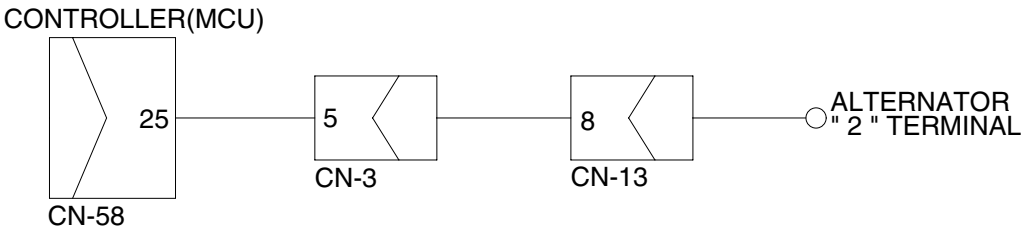
YES	20 ~ 30V
NO	0V

7807AEL15

2. WHEN BATTERY LAMP LIGHTS UP(Engine is started)

· Before carrying out below procedure, check all the related connectors are properly inserted.
· After checking, connect the disconnected connectors again immediately unless otherwise specified.





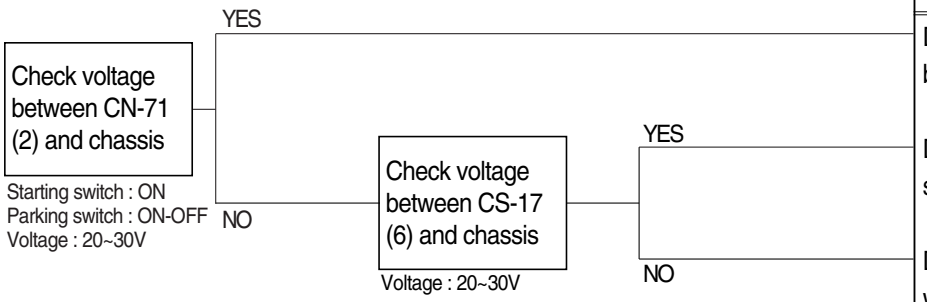
Check valtage

YES	20 ~ 30V
NO	0V

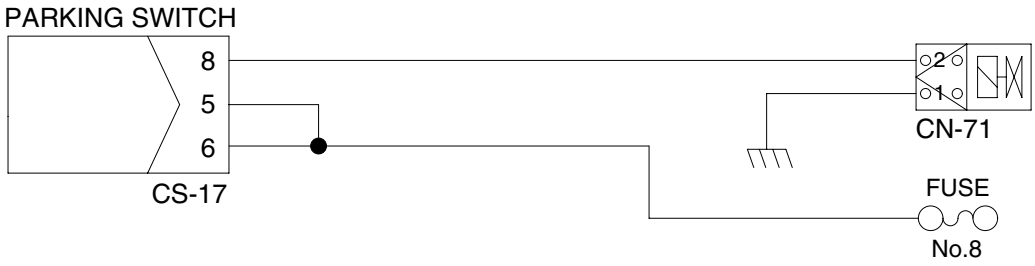
7707AEL16

3. WHEN PARKING SOLENOID DOES NOT WORK

- Before carrying out below procedure, check all the related connectors are properly inserted and the fuse No.8 is not blown out.
- After checking, connect the disconnected connectors again immediately unless otherwise specified.



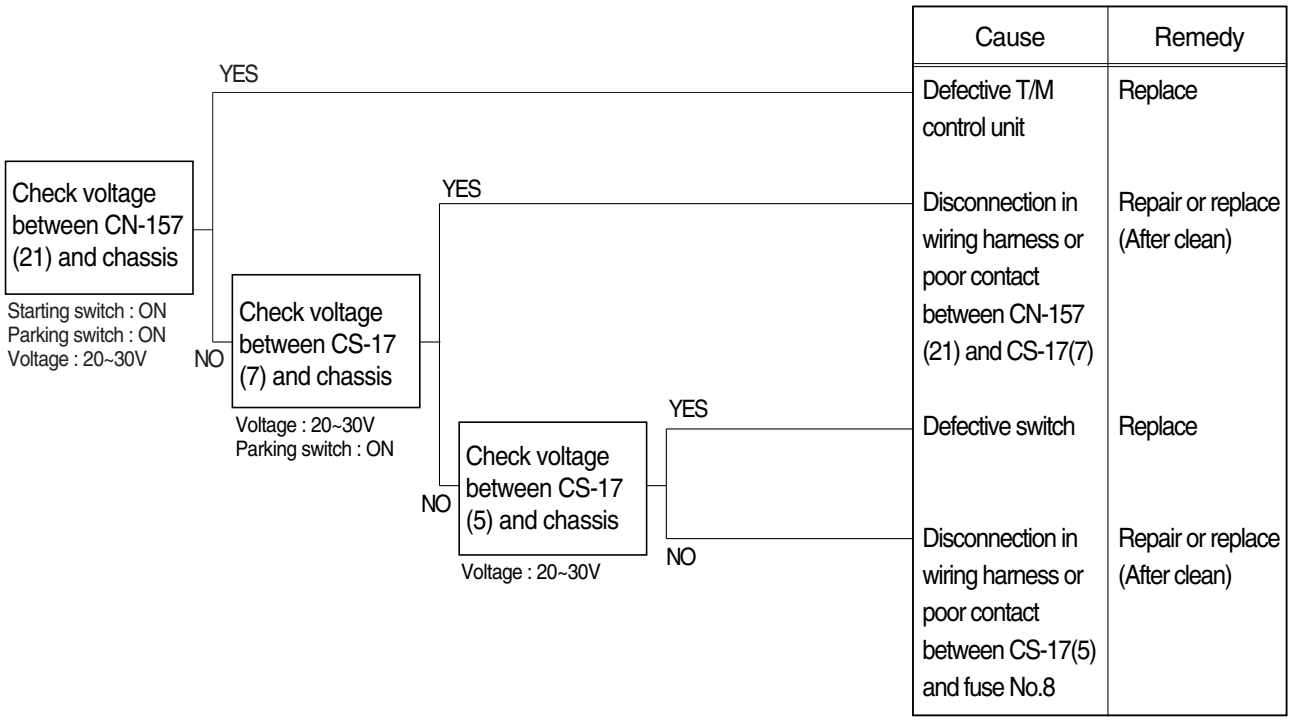
Cause	Remedy
Defective parking brake solenoid	Replace
Defective parking switch	Replace
Disconnection in wiring harness or poor contact between CS-17 (6) and Fuse No.8	Repair or replace (After clean)



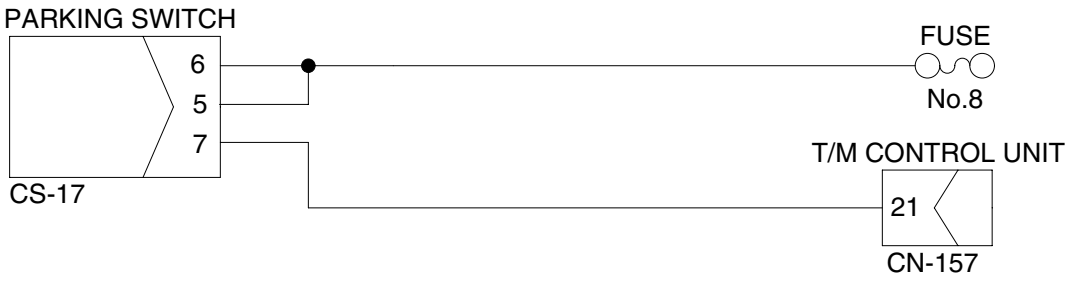
7707EL24

4. TRANSMISSION IS NOT RETURNED TO NEUTRAL WHEN PARKING BRAKE IS APPLIED

- Before carrying out below procedure, check all the related connectors are properly inserted and the fuse No.17(T/M control unit) and No.8 are not blown out.
- After checking, connect the disconnected connectors again immediately unless otherwise specified.



Cause	Remedy
Defective T/M control unit	Replace
Disconnection in wiring harness or poor contact between CN-157 (21) and CS-17(7)	Repair or replace (After clean)
Defective switch	Replace
Disconnection in wiring harness or poor contact between CS-17(5) and fuse No.8	Repair or replace (After clean)



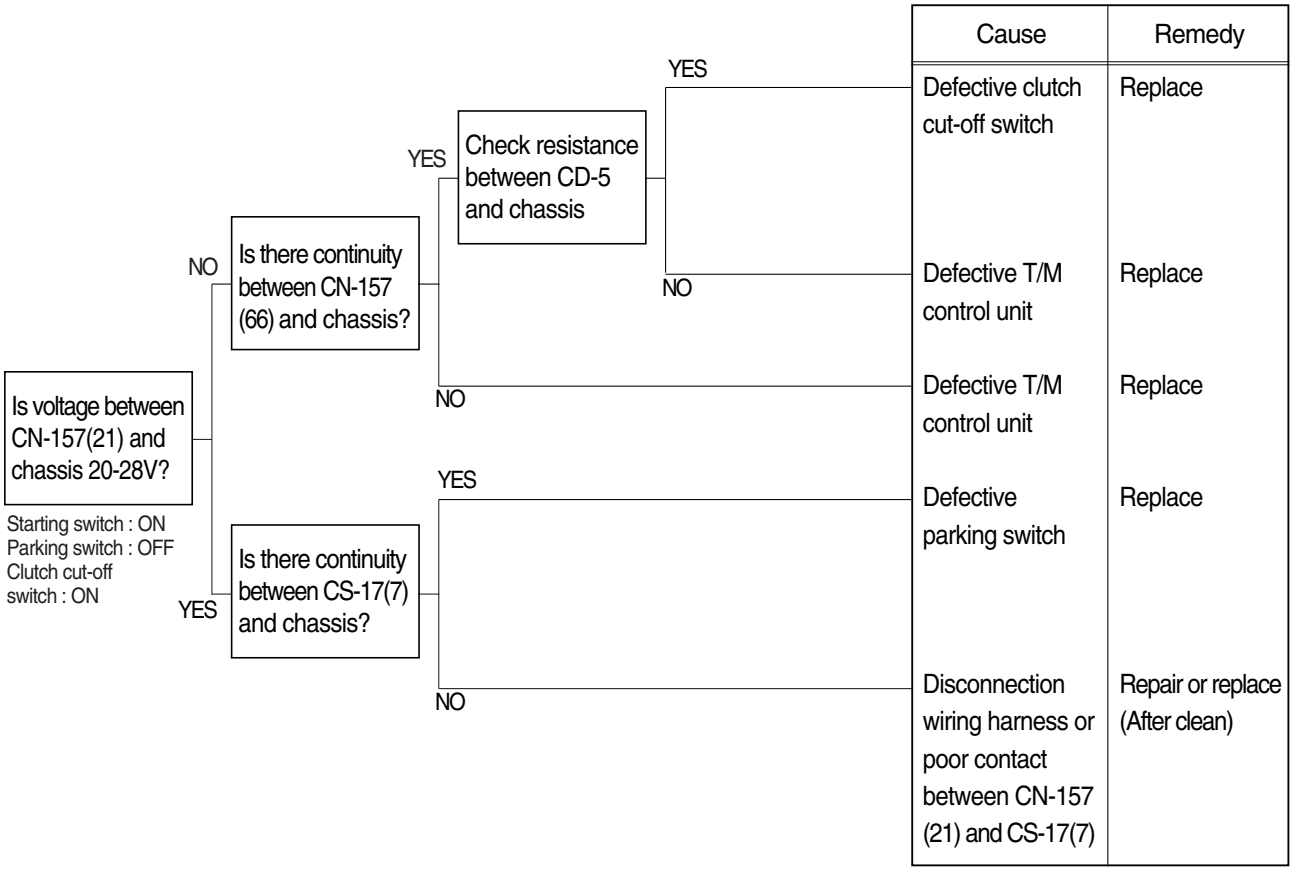
Check resistance

YES	MAX 1 Ω
NO	MIN 1M Ω

7807AEL17

5. MACHINE DOES NOT TRAVEL

- Before carrying out below procedure, check all the related connectors are properly inserted and the fuse No.17(Transmission controller) is not blown out.
- After checking, connect the disconnected connectors again immediately unless otherwise specified.
- Wiring diagram : **See page 7-17.**

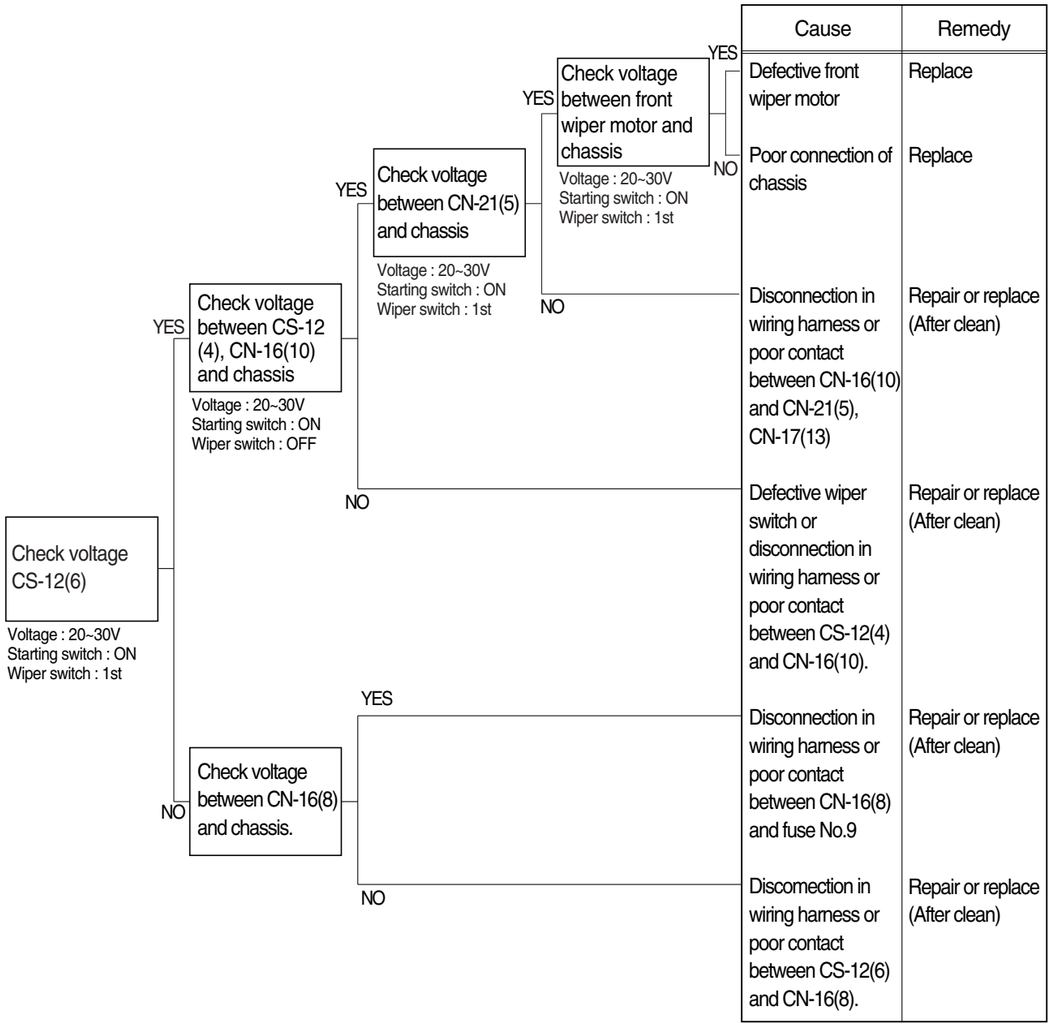


Check resistance

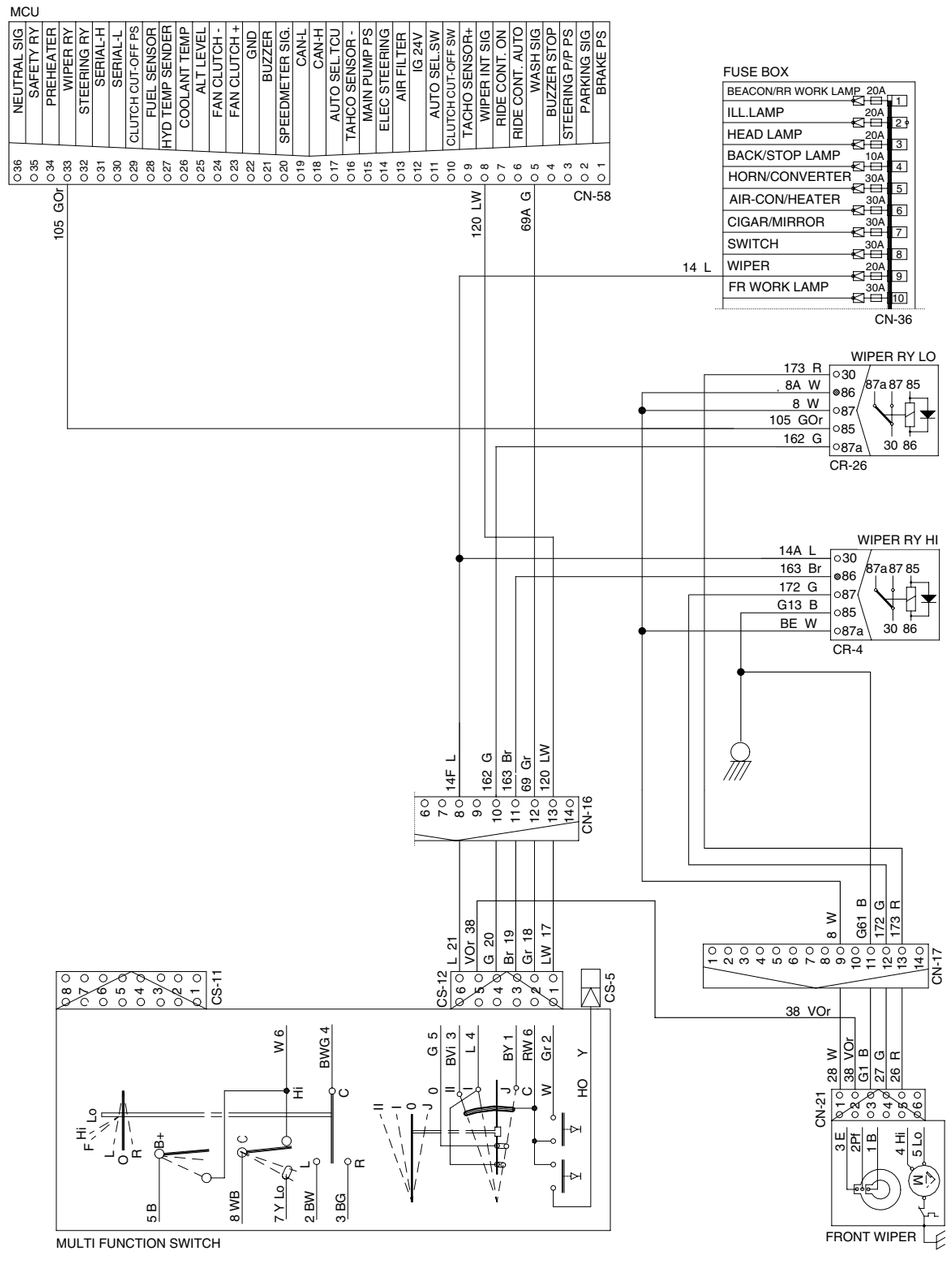
YES	MAX 1 Ω
NO	MIN 1M Ω

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

- Before carrying out below procedure, check all the related connectors are properly inserted and the fuse No.9 is not blown out.
- After checking, connect the disconnected connectors again immediately unless otherwise specified.



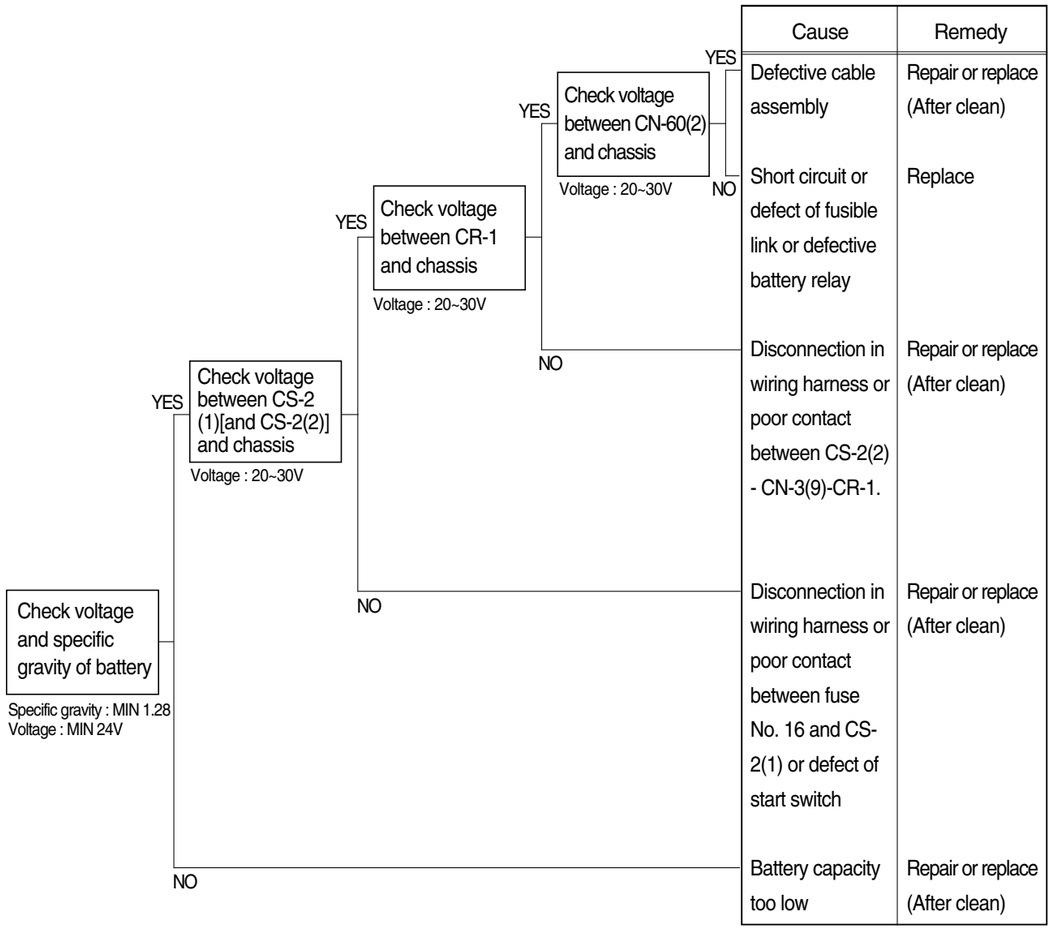
Cause	Remedy
Defective front wiper motor	Replace
Poor connection of chassis	Replace
Disconnection in wiring harness or poor contact between CN-16(10) and CN-21(5), CN-17(13)	Repair or replace (After clean)
Defective wiper switch or disconnection in wiring harness or poor contact between CS-12(4) and CN-16(10).	Repair or replace (After clean)
Disconnection in wiring harness or poor contact between CN-16(8) and fuse No.9	Repair or replace (After clean)
Disconnection in wiring harness or poor contact between CS-12(6) and CN-16(8).	Repair or replace (After clean)



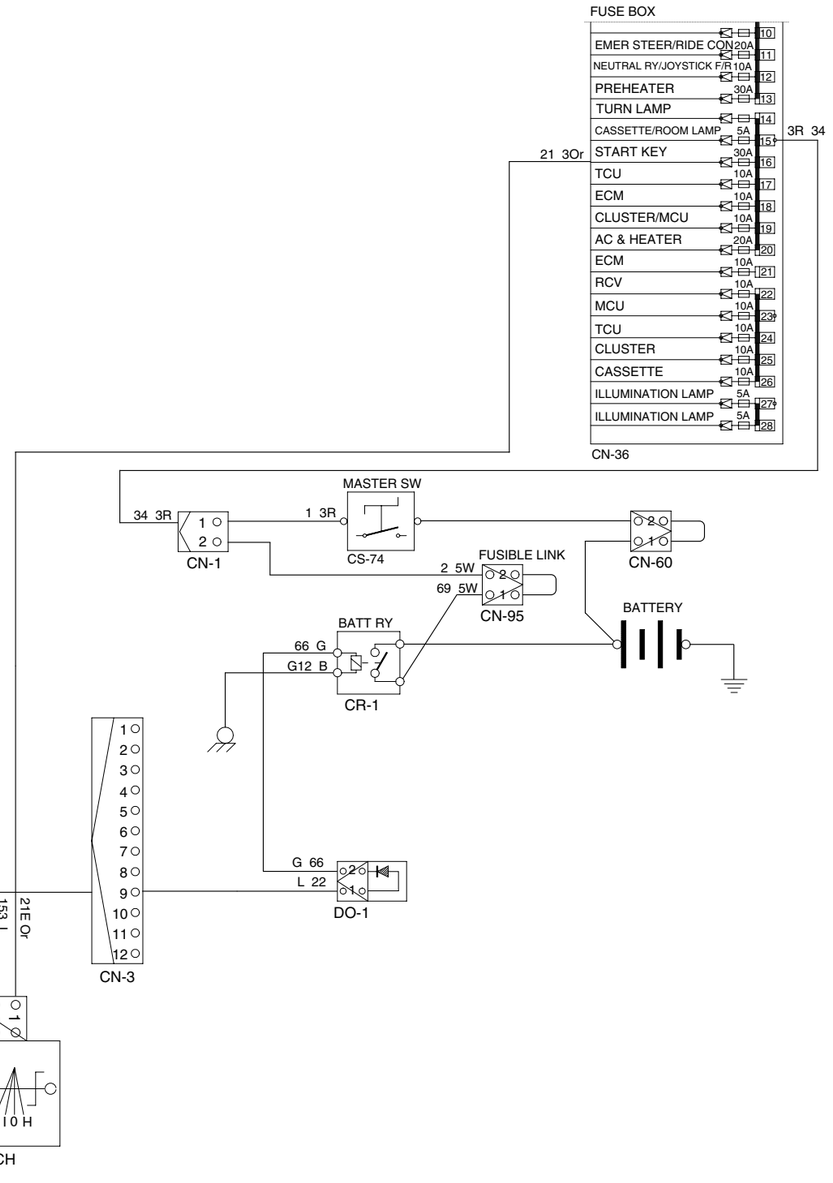
7707AEL18

7. WHEN STARTING SWITCH "ON" DOES NOT OPERATE

- Before carrying out below procedure, check all the related connectors are properly inserted and and the fuse No.16 is not blown out.
- After checking, connect the disconnected connectors again immediately unless otherwise specified.



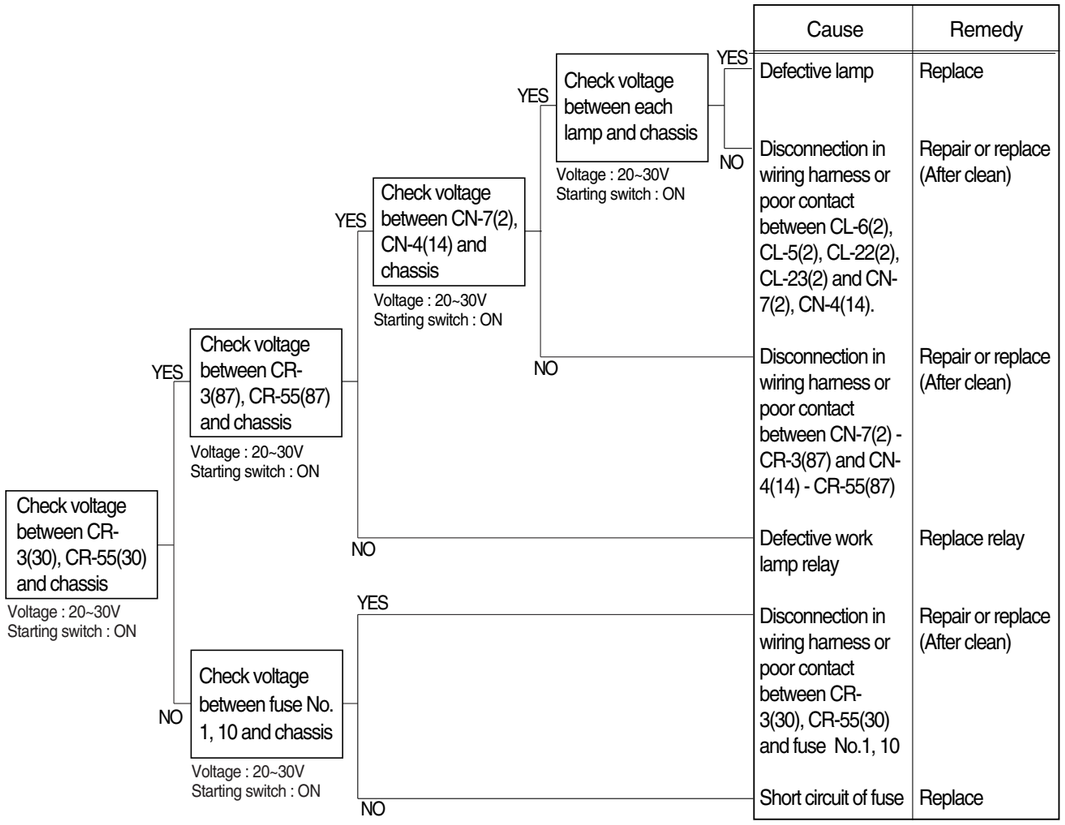
Cause	Remedy
Defective cable assembly	Repair or replace (After clean)
Short circuit or defect of fusible link or defective battery relay	Replace
Disconnection in wiring harness or poor contact between CS-2(2) - CN-3(9)-CR-1.	Repair or replace (After clean)
Disconnection in wiring harness or poor contact between fuse No. 16 and CS-2(1) or defect of start switch	Repair or replace (After clean)
Battery capacity too low	Repair or replace (After clean)



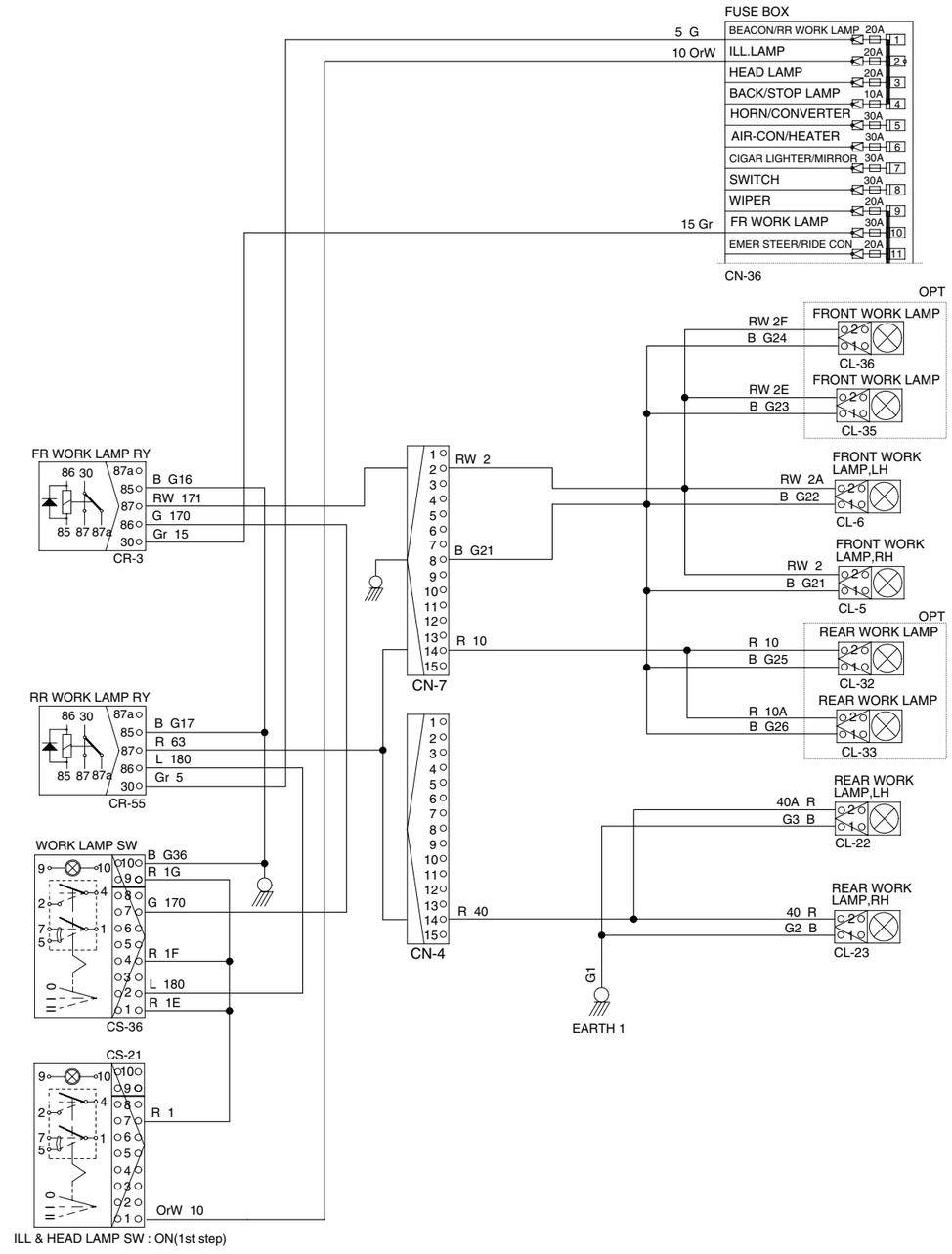
7607AEL19

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

- Before carrying out below procedure, check all the related connectors are properly inserted, and the fuse No.1, 10 is not blown out.
- After checking, connect the disconnected connectors again immediately unless otherwise specified.



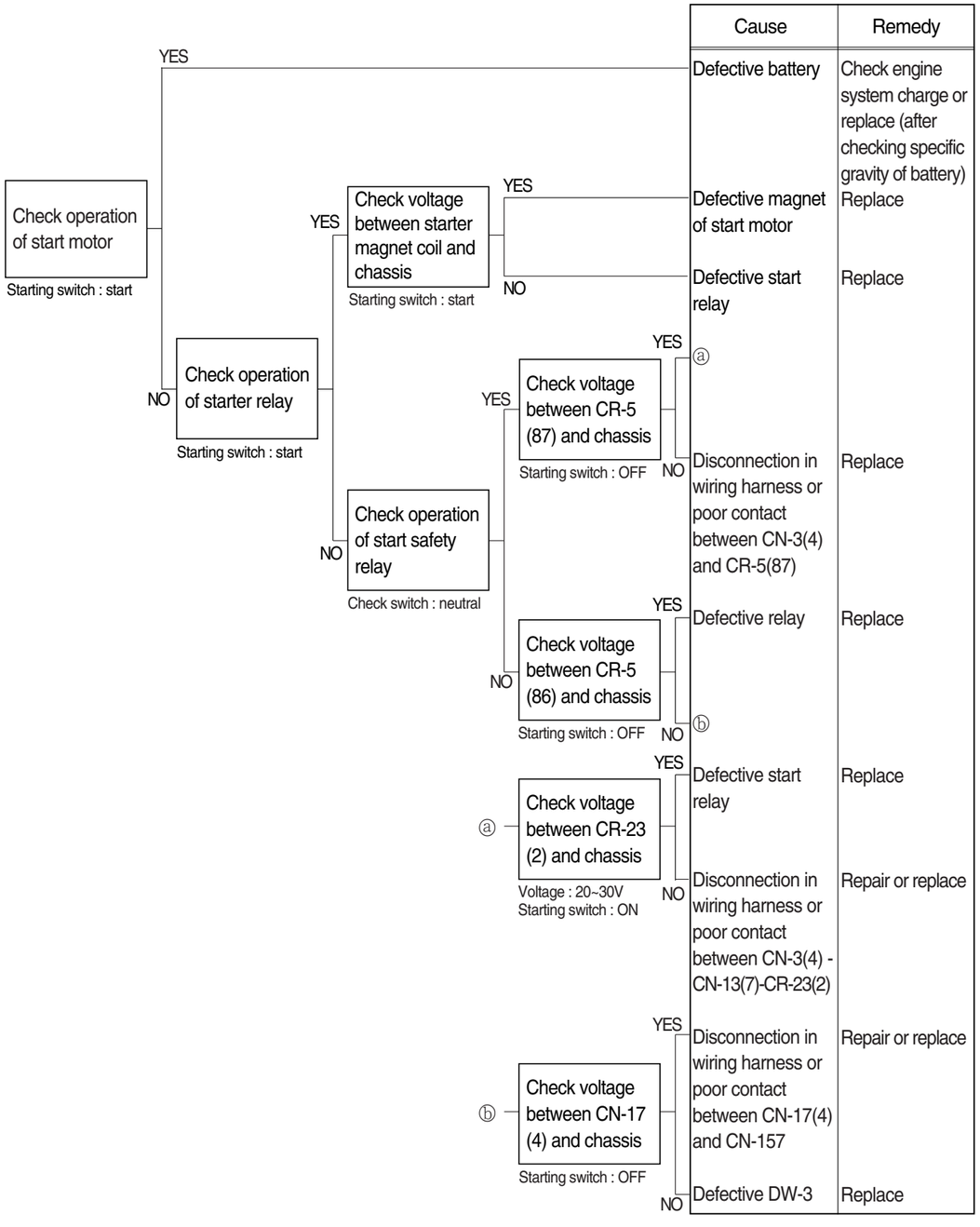
Cause	Remedy
Defective lamp	Replace
Disconnection in wiring harness or poor contact between CL-6(2), CL-5(2), CL-22(2), CL-23(2) and CN-7(2), CN-4(14).	Repair or replace (After clean)
Disconnection in wiring harness or poor contact between CN-7(2) - CR-3(87) and CN-4(14) - CR-55(87)	Repair or replace (After clean)
Defective work lamp relay	Replace relay
Disconnection in wiring harness or poor contact between CR-3(30), CR-55(30) and fuse No.1, 10	Repair or replace (After clean)
Short circuit of fuse	Replace

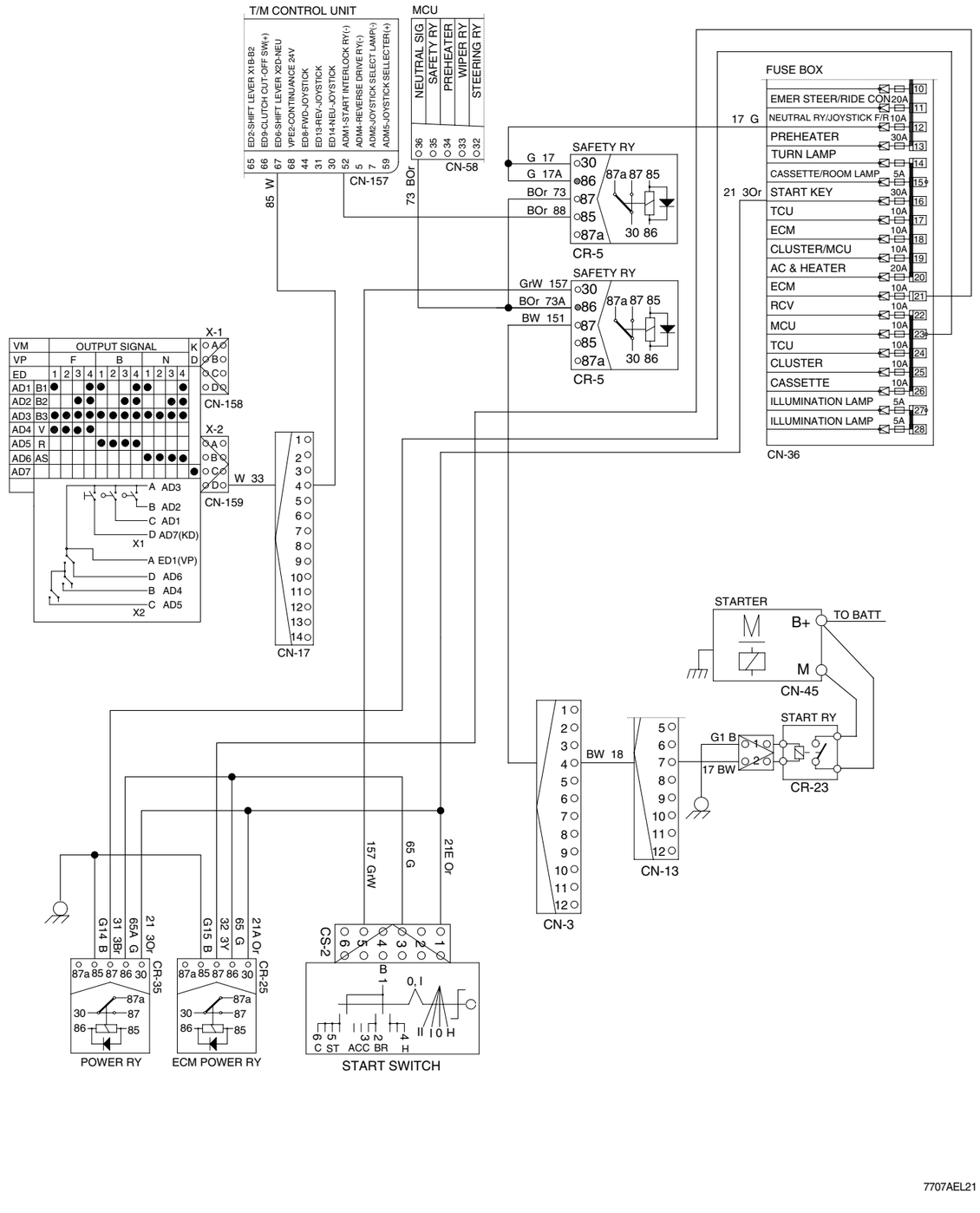


7807AEL20

9. WHEN ENGINE DOES NOT START

- Check supply of the power at engine stop solenoid while starting switch is ON.
- Before carrying out below procedure, check all the related connectors are properly inserted.
- After checking, connect the disconnected connectors again immediately unless other wise specified.
- Check forward reverse switch at neutral position.





7707AEL21