CONTENTS

1. STRUCTURE

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

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

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

SECTION 1 GENERAL

This section gives the general information of the machine and explains the safety hints for maintenance.

SECTION 2 REMOVAL & INSTALLATION OF UNIT

This section explains the procedures and techniques of removal and installation of each component.

SECTION 3 POWER TRAIN SYSTEM

This section explains the structure of the transmission as well as control valve and drive axle.

SECTION 4 BRAKE SYSTEM

This section explains the brake piping, each component and operation.

SECTION 5 STEERING SYSTEM

This section explains the structure of the steering unit, priority valve, trail axle as well as steering circuit and operation.

SECTION 6 HYDRAULIC SYSTEM

This section explains the structure of the gear pump, main control valve as well as work equipment circuit, each component and operation.

SECTION 7 ELECTRICAL SYSTEM

This section explains the electrical circuit and each component.

It serves not only to give an understanding electrical system, but also serves as reference material for troubleshooting.

SECTION 8 MAST

This section explains the structure of mast, carriage, backrest and forks.

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

2. HOW TO READ THE SERVICE MANUAL

Distribution and updating

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

Filing method

1. See the page number on the bottom of the page.
   File the pages in correct order.
2. Following examples shows how to read the page number.
   Example 1
   2 - 3
   Item number (2. Structure and Function)
   Consecutive page number for each item.
3. Additional pages : Additional pages are indicated by a hyphen (-) and number after the page number. File as in the example.
   10 - 4
   10 - 4 - 1
   10 - 4 - 2
   Added pages
   10 - 5

Revised edition mark (①②③…)

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

Revisions

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

Symbols

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

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

3. CONVERSION TABLE

Method of using the Conversion Table

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

Example

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

   Convert 55 mm into inches.

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

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

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

2. Convert 550 mm into inches.

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

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

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

Millimeters to inches

ⓑ

1 mm = 0.03937 in

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

Millimeters to inches

1 mm = 0.03937in

	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

1 kg = 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

kgf · m to lbf · ft

1 kgf · m = 7.233 lbf · ft

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

kgf/cm² to lbf/in²

1 kgf / cm² = 14.2233 lbf / in²

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

TEMPERATURE

Fahrenheit-Centigrade Conversion.
A simple way to convert a fahrenheit temperature reading into a centigrade temperature reading or vice verse is to enter the accompanying table in the center or boldface column of figures.
These figures refer to the temperature in either Fahrenheit or Centigrade degrees.
If it is desired to convert from Fahrenheit to Centigrade degrees, consider the center column as a table of Fahrenheit temperatures and read the corresponding Centigrade temperature in the column at the left.
If it is desired to convert from Centigrade to Fahrenheit degrees, consider the center column as a table of Centigrade values, and read the corresponding Fahrenheit temperature on the right.

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

SECTION 1 GENERAL

GROUP 1 SAFETY HINTS

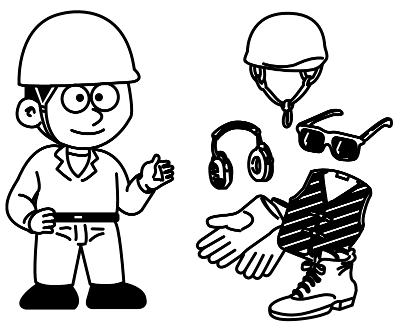
Careless performing of the easy work may cause injuries.

Take care to always perform work safely, at least observing the following.

- Oil is a dangerous substance. Never handle oil, grease or oily clothes in places where there is any fire of flame.
  As preparation in case of fire, always know the location and directions for use of fire extinguishers and other fire fighting equipment.

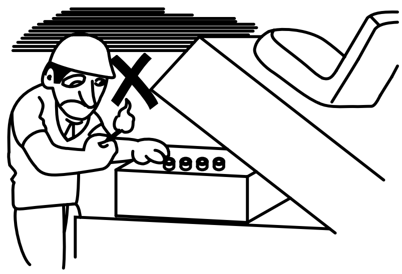
D50ASF01

- Wear well-fitting helmet, safety shoes and working clothes. When drilling, grinding or hammering, always wear protective goggles.
  Always do up safety clothes properly so that they do not catch on protruding parts of machines. Do not wear oily clothes.
  When checking, always release battery plug.



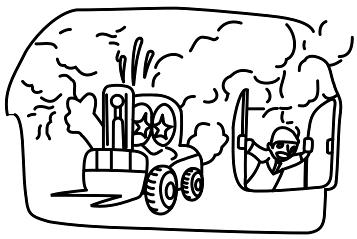
D50ASF02

- Flames should never be used instead of lamps. Never use a naked flame to check leaks or the level of oil or electrolyte.



D50ASF03

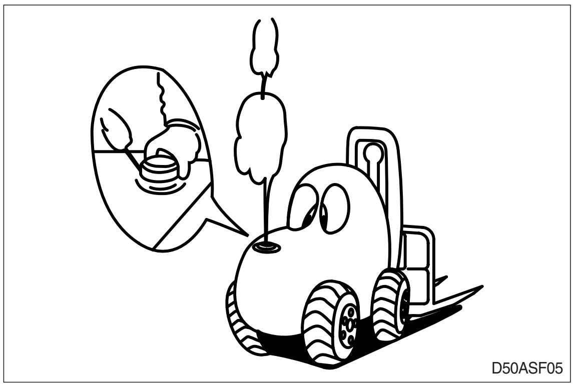
- Exhaust gas is dangerous. Provide adequate ventilation when working a closed space.



D50ASF04

⚠ **Be particularly careful when removing the radiator cap and the hydraulic oil tank filler cap, if this is done immediately after using the machine, there is a danger that boiled oil may spurt out.**

· The procedure for releasing the hydraulic pressure is as follows : lower the fork to the ground, and stop the engine(Motor), move the control levers to each position two or three times.

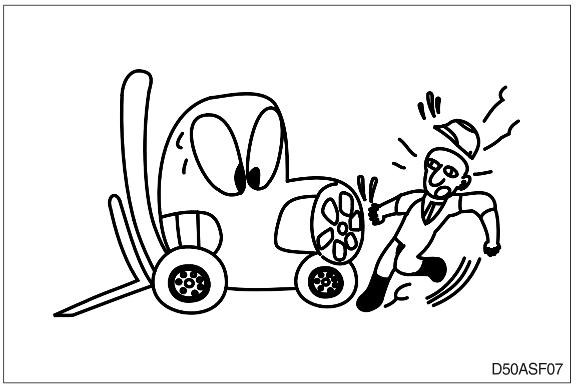


D50ASF05

· When working on top of the machine, be careful not to lose your balance and fall.

D50ASF06

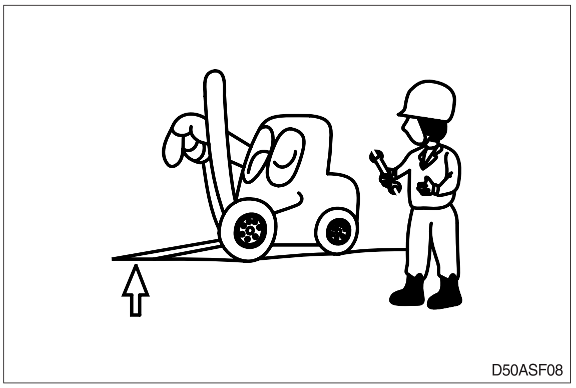
· Hand a caution sign in the operator's compartment (For example **Do not start** or **Maintenance in progress**).
  This will prevent anyone from starting or moving the machine by mistake.



D50ASF07

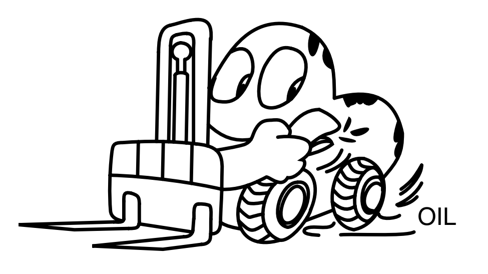
When inspecting running parts or near such parts, always stop the machine first.
Before checking or servicing accumulator or piping, depress brake pedal repeatedly to release pressure.

· Park the machine on firm, flat ground.
  Lower the fork to the ground and stop the engine.
  Return each lever to **NEUTRAL** and apply the brake lock.



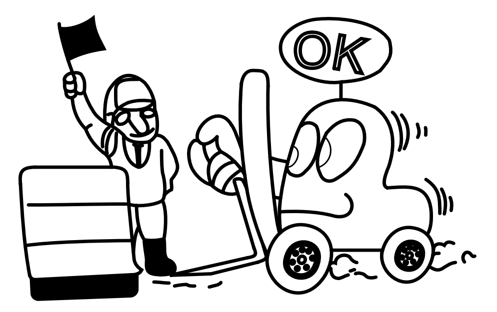
D50ASF08

· Immediately remove any oil or grease on the floor of the operator's compartment, or on the handrail. It is very dangerous if someone slips while on the machine.



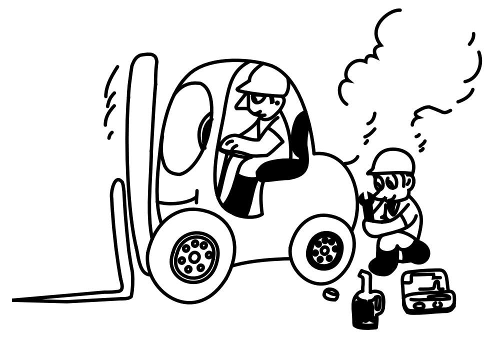
D50ASF09

· When working with others, choose a group leader and work according to his instructions. Do not perform any maintenance beyond the agreed work.



D50ASF10

· Unless you have special instructions to the contrary, maintenance should always be carried out with the engine stopped. If maintenance is carried out with the engine running, there must be two men present : one sitting in the operator's seat and the other one performing the maintenance. In such a case, never touch any moving part.



D50ASF11

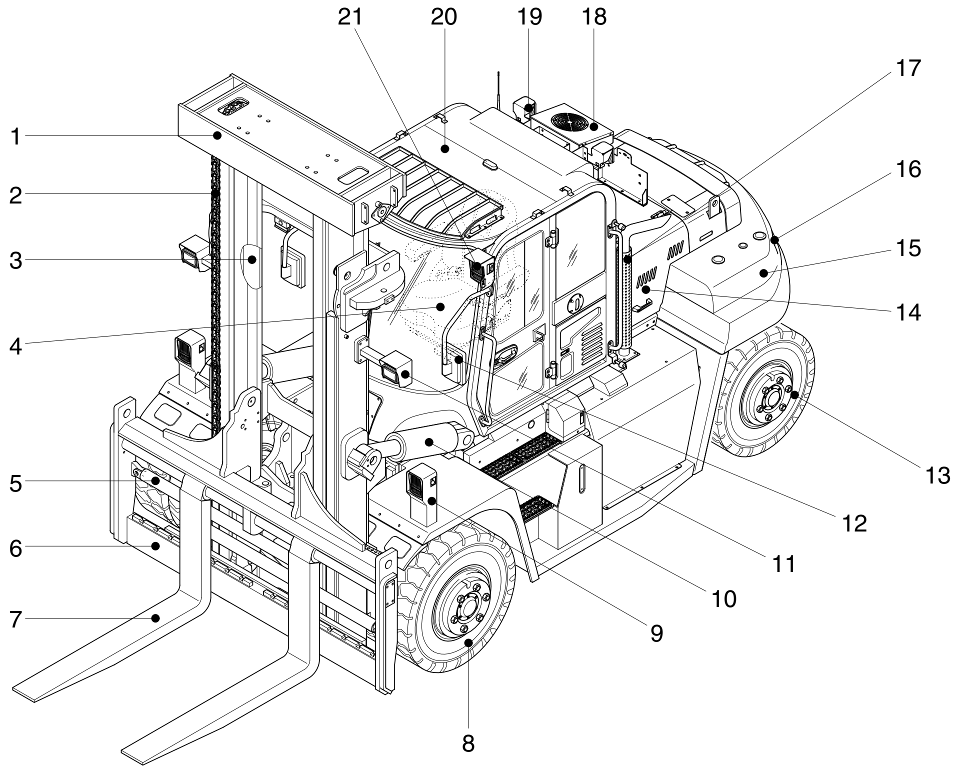
· Always remember that the hydraulic oil circuit is under pressure. When feeding or draining the oil or carrying out inspection and maintenance, release the pressure first.

- Thoroughly clean the machine. In particular, be careful to clean the filler caps, grease fittings and the area around the dipsticks. Be careful not to let any dirt or dust into the system.
- Always use HYUNDAI Forklift genuine parts for replacement.
- Always use the grades of grease and oil recommended by HYUNDAI Forklift.
  Choose the viscosity specified for the ambient temperature.
- Always use pure oil or grease, and be sure to use clean containers.
- When checking or changing the oil, do it in a place free of dust, and prevent any dirt from getting into the oil.
- Before draining the oil, warm it up to a temperature of 30 to 40° C.
- After replacing oil, filter element or strainer, bleed the air from circuit.
- When the strainer is located in the oil filler, the strainer must not be removed while adding oil.
- When changing the oil filter, check the drained oil and filter for any signs of excessive metal particles or other foreign materials.
- When removing parts containing O-ring, gaskets or seals, clean the mounting surface and replace with new sealing parts.
- After injecting grease, always wipe off the oil grease that was forced out.
- Do not handle electrical equipment while wearing wet places, as this can cause electric shock.
- During maintenance do not allow any unauthorized person to stand near the machine.
- Be sure you fully understand the contents of the operation. It is important to prepare necessary tools and parts and to keep the operating area clean.
- When checking an open gear case there is a risk of dropping things in. Before removing the covers to inspect such cases, empty everything from your pockets. Be particularly careful to remove wrenches and nuts.
- Way to use dipstick
  Push the dipstick fully into the guide, and then pull out.

  Carrying out other difficult maintenance work carelessly can cause unexpected accidents. If you consider the maintenance is too difficult, always request the HYUNDAI Forklift distributor to carry out it.

GROUP 2 SPECIFICATIONS

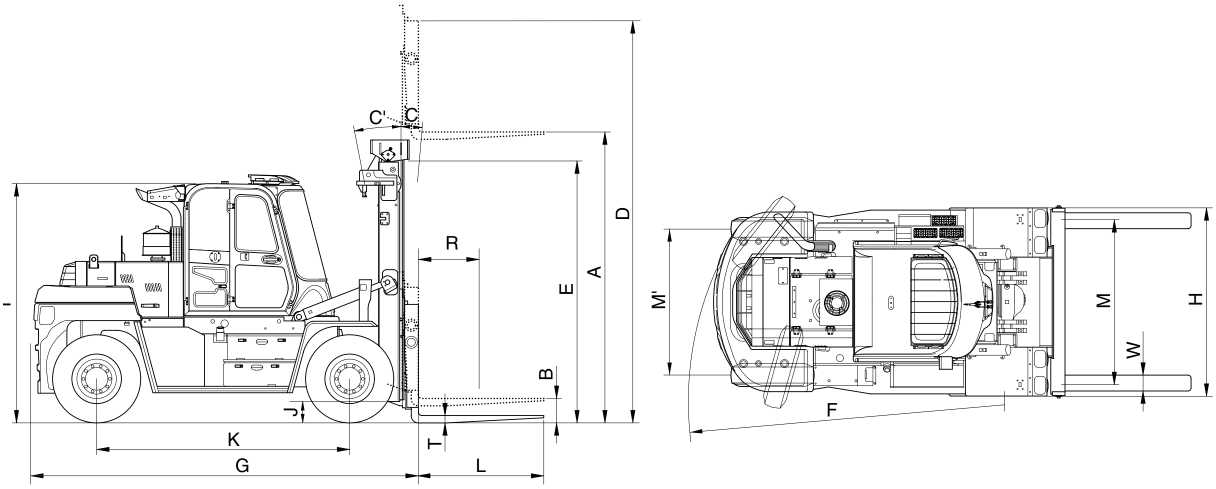
1. GENERAL LOCATIONS



110D9OM54

1	Mast	8	Front wheel	15	Counterweight
2	Lift chain	9	Head lamp-fender	16	Rear combination lamp
3	Lift cylinder	10	Tilt cylinder	17	Silencer
4	Operator's seat	11	Work lamp-mast	18	Air conditioner (opt)
5	Fork positioner cylinder	12	Rear view mirror	19	Rear work lamp
6	Carriage	13	Rear wheel	20	Cabin
7	Forks	14	Bonnet	21	Work lamp-cabin

2. SPECIFICATIONS



110D9SP011

Model			Unit	110D-9	130D-9	160D-9
Capacity			kg (lb)	11,000 (25000)	13,000 (29000)	16,000 (36000)
Load center		R	mm (in)	600 (24")	←	←
Weight(Unloaded)			kg	16274 (35880)	16991 (37460)	19842 (43740)
Fork	Lifting height	A	mm (ft·in)	3005 (9' 10")	3000 (9' 10")	3010 (9' 11")
	Free lift	B	mm (in)	0	←	←
	Lifting speed (Unload/Load)		mm/sec	510/440	510/430	450/350
	Lowering speed (Unload/Load)		mm/sec	460/510	←	410/430
	L×W×T	L,W,T	mm (in)	1350×200×75 (53.1×7.9×3.0)	1350×200×85 (53.1×7.9×3.3)	1350×200×90 (53.1×7.9×3.5)
Mast	Tilt angle (forward/backward)	C/C'	degree	15/12	←	←
	Max height	D	mm (ft·in)	4465 (14' 8")	←	4710 (15' 5")
	Min height	E	mm (ft·in)	3000 (9' 10")	←	3250 (10' 0")
Body	Travel speed (Unload)		km/h	39.5	←	33.3
	Gradeability (Load)		%	45.3	41.0	40.2
	Min turning radius (Outside)	F	mm (ft·in)	4350 (14' 3")	←	4895 (16' 1")
ETC	Max hydraulic pressure		kgf/cm^2	210	←	←
	Hydraulic oil tank		l (USgal)	115 (30.4)	←	124.3 (32.8)
	Fuel tank		l (USgal)	195 (51.5)	←	260 (68.7)
Overall length		G	mm (ft·in)	4570 (15' 0")	4580 (15' 0")	5080 (16' 8")
Overall width		H	mm (ft·in)	2777 (9' 1")	←	2497 (8' 2")
Cabin height		I	mm (ft·in)	2890 (9' 6")	←	2930 (9' 7")
Ground clearance		J	mm (in)	250 (9.8")	←	←
Wheel base		K	mm (ft·in)	3050 (10' 0")	←	3450 (11' 4")
Wheel tread front/rear		M/M'	mm (ft·in)	1842 / 1910 (6' 1" / 6' 3")	←	1842 / 1960 (6' 1" / 6' 5")
Drawbar pull			kg (lb)	12356 (27240)	12500 (27560)	13243 (29200)

3. SPECIFICATION FOR MAJOR COMPONENTS

1) 110/130D-9

(1) ENGINE

Item	Unit	Specification
Model	-	Cummins QSB6.7
Type	-	4 cycle turbocharged, Tier 4 final diesel engine
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
Cylinder bore × stroke	mm (in)	107 × 124 mm (4.21" × 4.88")
Piston displacement	cc (cu in)	6690 (409)
Compression ratio	-	17.3 : 1
Rated gross horse power	ps/rpm	165.8/2300
Maximum gross torque at rpm	kgf · m/rpm	74.7/1500
Engine oil quantity	l (U.S.gal)	14.2 (3.8)
Dry weight	kg (lb)	520 (1146)
High idling speed	rpm	2250 ± 50
Low idling speed	rpm	600~1200
Rated fuel consumption	g/ps.hr	168
Starting motor	V-kW	DENSO, 24-3.7
Alternator	V-A	24-70
Battery	V-AH	24-100

2) MAIN PUMP

Item	Unit	Specification
Type	-	Variable displacement axial piston pump
Capacity	cc/rev	74+63
Maximum operating pressure	bar	300
Rated speed (Max/Min)	rpm	2800/300

3) MAIN CONTROL VALVE

Item	Unit	Specification
Type	-	Sectional
Operating method	-	Hydraulic pilot
Main relief valve pressure	bar	210/165
Flow capacity	lpm	180

(4) STEERING UNIT

Item	Unit	Specification
Type	-	Load sensing/Non load reaction/Dynamic signal
Capacity	cc/rev	369
Rated flow	lpm	45.4

(5) POWER TRAIN DEVICES

<table>
<tr><th colspan="3">Item</th><th colspan="3">Specification</th></tr>
<tr><td rowspan="3">Torque converter</td><td colspan="2">Model</td><td colspan="3">05 W 340 (ZF SACH)</td></tr>
<tr><td colspan="2">Type</td><td colspan="3">3 Element, 1 stage, 2 phase</td></tr>
<tr><td colspan="2">Stall ratio</td><td colspan="3">2.362 : 1</td></tr>
<tr><td rowspan="5">Transmission</td><td colspan="2">Type</td><td colspan="3">Full auto, power shift</td></tr>
<tr><td colspan="2">Gear shift (FR/RR)</td><td colspan="3">3/3</td></tr>
<tr><td colspan="2">Adjustment</td><td colspan="3">Electrical single lever type</td></tr>
<tr><td rowspan="2">Overhaul ratio</td><td>FR</td><td>1 : 5.630</td><td>2 : 2.396</td><td>3 : 0.994</td></tr>
<tr><td>RR</td><td>1 : 5.647</td><td>2 : 2.404</td><td>3 : 0.997</td></tr>
<tr><td rowspan="3">Axle</td><td colspan="2">Type</td><td colspan="3">Front-wheel drive type, fixed location</td></tr>
<tr><td colspan="2">Gear ratio</td><td colspan="3">11.73 : 1</td></tr>
<tr><td colspan="2">Gear</td><td colspan="3">Ring & Pinion gear type</td></tr>
<tr><td rowspan="3">Wheels</td><td colspan="2">Q'ty (FR/RR)</td><td colspan="3">Double : 4/2</td></tr>
<tr><td colspan="2">Front (drive)</td><td colspan="3">10.00-20-16 PR</td></tr>
<tr><td colspan="2">Rear (steer)</td><td colspan="3">10.00-20-16 PR</td></tr>
<tr><td rowspan="2">Brakes</td><td colspan="2">Travel</td><td colspan="3">Front wheel, wet disc brake</td></tr>
<tr><td colspan="2">Parking</td><td colspan="3">Axle pinion, Caliper brake, hydraulic released</td></tr>
<tr><td rowspan="2">Steering</td><td colspan="2">Type</td><td colspan="3">Full hydraulic, power steering</td></tr>
<tr><td colspan="2">Steering angle</td><td colspan="3">76° to both right and left angle, respectively</td></tr>
</table>

2) 160D-9

(1) ENGINE

Item	Unit	Specification
Model	-	Cummins QSB6.7
Type	-	4 cycle turbocharged, Tier 4 final diesel engine
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
Cylinder bore × stroke	mm (in)	107 × 124 mm (4.21" × 4.88")
Piston displacement	cc (cu in)	6690 (409)
Compression ratio	-	17.3 : 1
Rated gross horse power	ps/rpm	165.8/2300
Maximum gross torque at rpm	kgf · m/rpm	74.7/1500
Engine oil quantity	l (U.S.gal)	14.2 (3.8)
Dry weight	kg (lb)	520 (1146)
High idling speed	rpm	2250 ± 50
Low idling speed	rpm	600~1200
Rated fuel consumption	g/ps.hr	168
Starting motor	V-kW	DENSO, 24-3.7
Alternator	V-A	24-70
Battery	V-AH	24-100

2) MAIN PUMP

Item	Unit	Specification
Type	-	Variable displacement axial piston pump
Capacity	cc/rev	74+63
Maximum operating pressure	bar	300
Rated speed (Max/Min)	rpm	2800/300

3) MAIN CONTROL VALVE

Item	Unit	Specification
Type	-	Sectional
Operating method	-	Hydraulic pilot
Main relief valve pressure	bar	210/165
Flow capacity	lpm	180

(4) STEERING UNIT

Item	Unit	Specification
Type	-	Load sensing / Non load reaction / Dynamic signal
Capacity	cc/rev	369
Rated flow	lpm	45.4

(5) POWER TRAIN DEVICES

Item			Specification		
Torque converter	Model		05 W 340 (ZF SACH)		
	Type		3 Element, 1 stage, 2 phase		
	Stall ratio		2.362 : 1		
Transmission	Type		Full auto, Power shift		
	Gear shift (FR / RR)		3/3		
	Adjustment		Electrical single lever type		
	Overhaul ratio	FR	1 : 5.630	2 : 2.396	3 : 0.994
		RR	1 : 5.647	2 : 2.404	3 : 0.997
Axle	Type		Front-wheel drive type, fixed location		
	Gear ratio		12.7 : 1		
	Gear		Ring & pinion gear type		
Wheels	Q'ty (FR / RR)		Double : 4/2		
	Front (drive)		12.00-20-18PR		
	Rear (steer)		12.00-20-18PR		
Brakes	Travel		Front wheel, Wet disk brake		
	Parking		Axle pinion, caliper brake, hydraulic released		
Steering	Type		Full hydraulic, power steering		
	Steering angle		76° to both right and left angle, respectively		

4. TIGHTENING TORQUE FOR MAJOR COMPONENTS

NO	Item		Size	kgf · m	lbf · ft
1	Engine	Engine mounting bolt, nut (bracket-frame)	M24 × 3.0	100 ± 15	723 ± 109
2		Engine mounting bolt (engine-bracket)	M12 × 1.75	12.3 ± 2.4	89.0 ± 17.4
3		Radiator mounting bolt, nut	M12 × 1.75	12.8 ± 3.0	92 ± 21.7
4	Hydraulic system	Hydraulic pump mounting bolt	M12 × 1.75	14.7 ± 2.2	106 ± 15.9
5		MCV mounting bolt	M10 × 1.5	6.9 ± 1.4	49.9 ± 10.1
6		Steering unit mounting bolt	M10 × 1.5	6.9 ± 1.4	49.9 ± 10.1
7		Tilt cylinder; rod-end bolt, nut	M20 × 2.5	57.9 ± 10	419 ± 72.3
8		Tilt cylinder pin; mounting bolt	M10 × 1.5	6.9 ± 1.4	50 ± 10.1
9	Power train system	Transmission mounting bolt, nut	M16 × 2.0	100 ± 15	723 ± 109
10		Torque converter mounting bolt	M10 × 1.5	4.5 ± 0.6	32.5 ± 4.3
11		Drive axle mounting bolt, nut	M24 × 2.0	100 ± 15	723 ± 109
12		Steering axle mounting bolt, nut	M24 × 3.0	100 ± 15	723 ± 109
13		Front and rear wheel mounting nut	M22 × 1.5	83.2 ± 10	602 ± 72.3
14		Propeller shaft (to T/M and D/Axle)	1/2-20UNF	15.0 ± 2.0	108 ± 14.5
15	Others	Counterweight mounting bolt 1	M30 × 3.5	199 ± 29.9	1440 ± 216
		Counterweight mounting bolt 2	M24 × 3.0	100 ± 15	723 ± 109
16		Operator's seat mounting nut	M8 × 1.25	3.4 ± 0.7	24.6 ± 5.1
17		Cabin mounting bolt	M16 × 2.0	7.5	54.2
18		Mast mounting bolt	M12 × 1.75	12.5 ± 1.3	90.4 ± 9.4

5. TORQUE CHART

Use following table for unspecified torque.

1) BOLT AND NUT

(1) Coarse thread

Bolt size	8T		10T	
	kg · m	lb · ft	kg · m	lb · ft
M 6 × 1.0	0.85 ~ 1.25	6.15 ~ 9.04	1.14 ~ 1.74	8.2 ~ 12.6
M 8 × 1.25	2.0 ~ 3.0	14.5 ~ 21.7	2.73 ~ 4.12	19.5 ~ 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 × 3.0	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	
	kg · m	lb · ft	kg · m	lb · 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

6. 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) 110D-9, 130D-9	Capacity l (U.S. gal) 160D-9	Ambient temperature °C (°F): -50 (-58), -30 (-22), -20 (-4), -10 (14), 0 (32), 10 (50), 20 (68), 30 (86), 40 (104)
Engine oil pan	Engine oil	14.2 (3.8)	14.2 (3.8)	★SAE 5W-40 SAE 30 SAE 10W SAE 10W-30 SAE 15W-40
DEF/ AdBlue® tank	Mixture of urea and deionized water	37.8 (10.0)	37.8 (10.0)	ISO 22241 (High-purity urea + deionized water (32.5:67.5))
Torque converter transmission	Engine oil	16 (4.2)	16 (4.2)	SAE 10W-30 SAE 15W-40
Axle brake	Gear oil	19 (5.0)	19 (5.0)	SAE 80W-90/API GL-5
	Cooling oil	22 (5.8)	22 (5.8)	DONAX TD
Hydraulic tank	Hydraulic oil	115 (30.4)	124.3 (32.8)	★ISO VG 15 ISO VG 46 ISO VG 68
Cabin tilt hand pump	Hydraulic oil	0.7 (0.2)	0.7 (0.2)	
Fuel tank	Diesel fuel★1	195 (51.5)	260 (68.7)	★ASTM D975 NO.1 ASTM D975 NO.2
Fitting (Grease nipple)	Grease	-	-	★NLGI NO.1 NLGI NO.2
Radiator	Antifreeze:Water 50:50	30 (7.9)	30 (7.9)	Ethylene glycol base permanent type ★Ethylene glycol base permanent type (60 : 40)

NOTES :

① SAE numbers given to engine oil should be selected according to ambient temperature.

② For engine oil used in engine oil pan, use SAE 10W oil when the temperature at the time of engine start up is below 0˚C, even if the ambient temperature in daytime is expected to rise to 10˚C or more.

③ Use engine oil of API service class CJ-4.

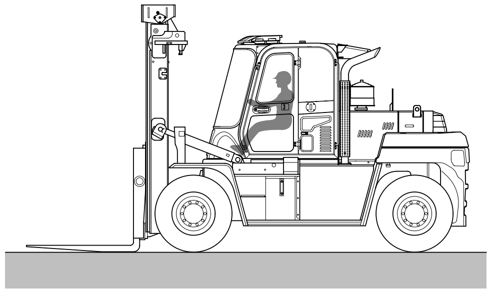
★1 : Ultra low sulfur diesel
- sulfur content ≤ 15 ppm

★ : Cold region
Russia, CIS, Mongolia

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.



110D9GE02

Item	OK	NOT OK	Comments

1. Monitor indicator and gauge checks (Engine OFF)

· Hour meter 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 ________________
· Engine speed control linkage check ________________

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 and 3rd 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 ____________
- Mast lift and lower check ____________
- Control valve lift check ____________
- Mast tilt check ____________
- Fork positioner check ____________
- Down safety valve leakage check ____________
- Lift, tilt and steering cylinder check ____________
- Side shift piping leakage check ____________
- Hydraulic oil cleanliness check ____________

7. Steering system checks

- Steering valve check ______________
- Steering system leakage check ______________
- Priority valve (built in MCV) ______________
  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 ______________
- Heater/Air conditioner blower check ______________
- Heater functional check ______________
- Air conditioner functional check ______________
- Start aid system check ______________

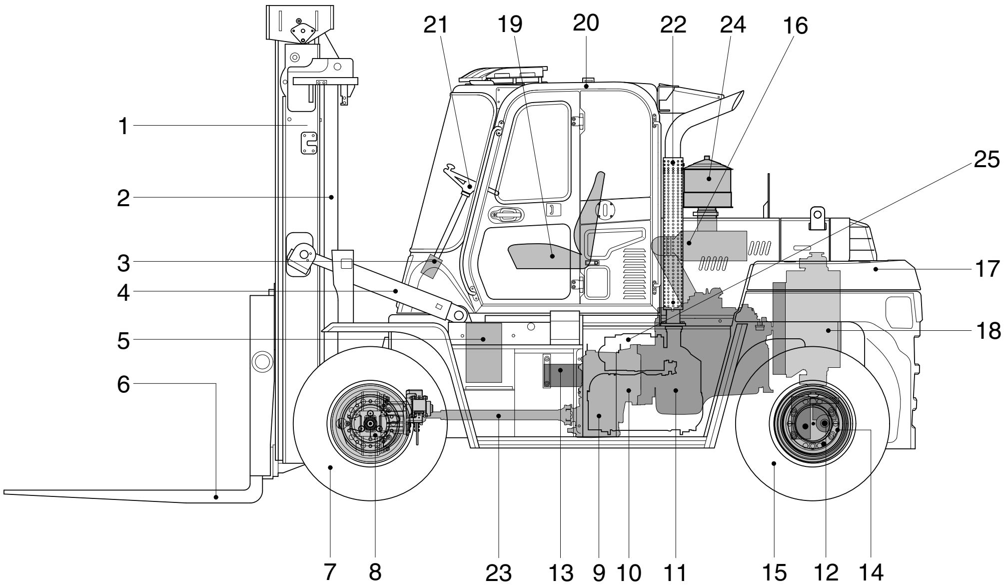
9. Cab components and vandal protection checks

- 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 ______________
- Service decal check ______________

SECTION 2 REMOVAL & INSTALLATION OF UNIT

SECTION 2 REMOVAL & INSTALLATION OF UNIT

GROUP 1 STRUCTURE



110D9OM21

1 Mast
2 Lift cylinder
3 Steering unit
4 Tilt cylinder
5 Main control valve
6 Fork
7 Front wheel
8 Drive axle
9 Transmission
10 Torque converter
11 Engine
12 Steering cylinder
13 Hydraulic pump
14 Steering axle
15 Rear wheel
16 Air cleaner
17 Counterweight
18 Radiator
19 Seat
20 Cabin
21 Steering wheel
22 Silencer
23 Drive shaft
24 Precleaner
25 Aftertreatment device

GROUP 2 REMOVAL AND INSTALLATION OF UNIT

Remove and install following units as explained in the flow chart.

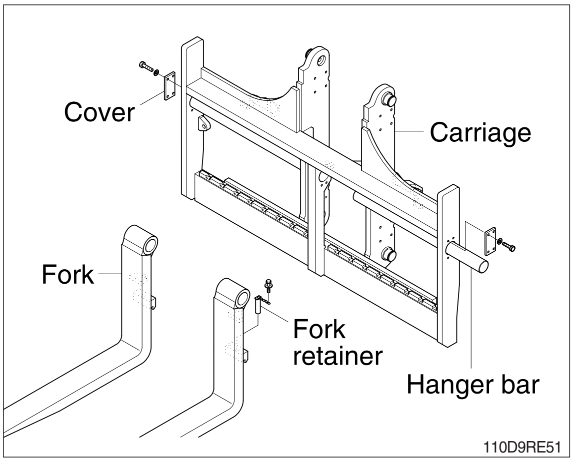
1. MAST

1) REMOVAL

Fork — Carriage — Piping — Mast

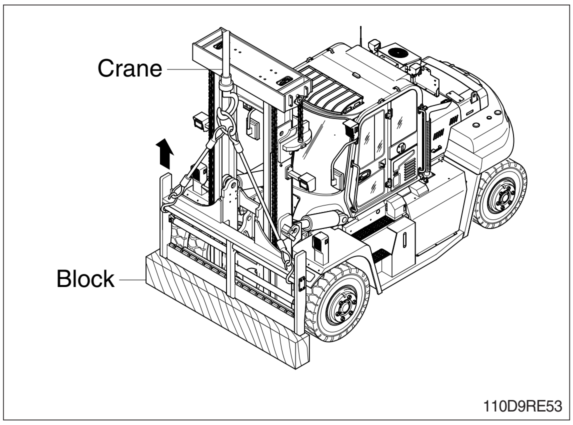
(1) Forks

① Lower the fork carriage until the forks are approximately 25 mm (1 in) from the floor.
② Release fork retainer and remove cover. Slide one hanger bar at a time out of carriage assembly.
③ Remove only one fork at a time.
※ On larger forks it may be necessary to use a block of wood.

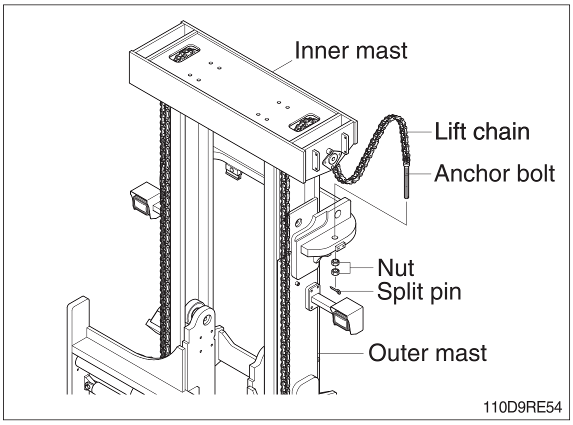


(2) Carriage

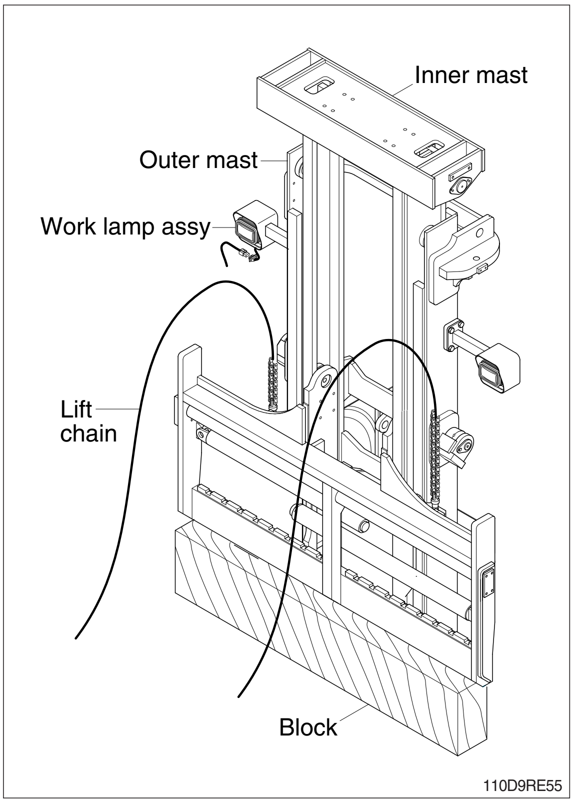
① With the mast vertical, raise the carriage high enough to place blocks under the load forks. This is done to create slack in the load chains when the carriage is lowered. Lower the carriage all the way down to the floor. Make sure the carriage is level, this will prevent any binding when the mast is raised.



② While supporting lift chains, remove nuts from the anchor bolt.



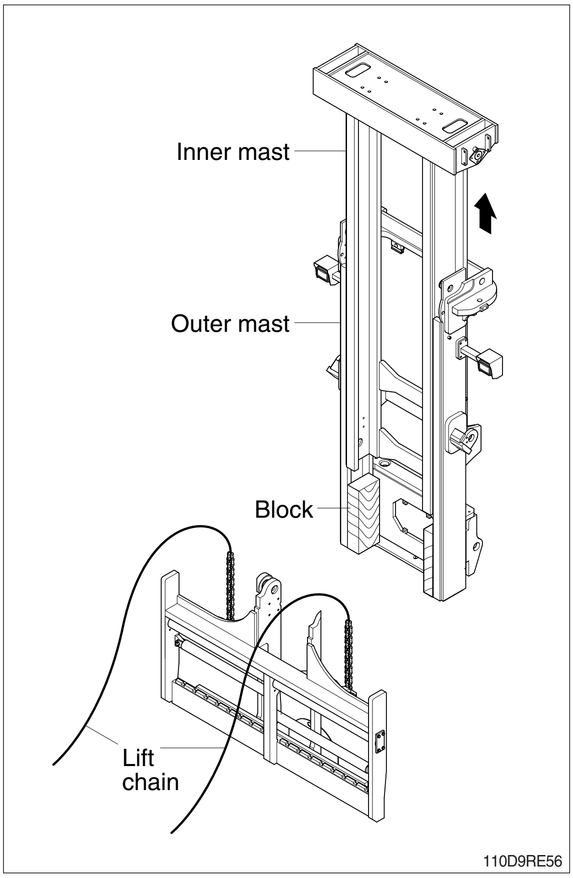
③ Pull the chains out of the sheaves and drape them over the front of the carriage.



④ Slowly raise inner mast upright until mast clears top of fork carriage. Move carriage to work area and lower the mast.

⚠ **Make sure that carriage remains on floor and does not bind while mast is being raised.**

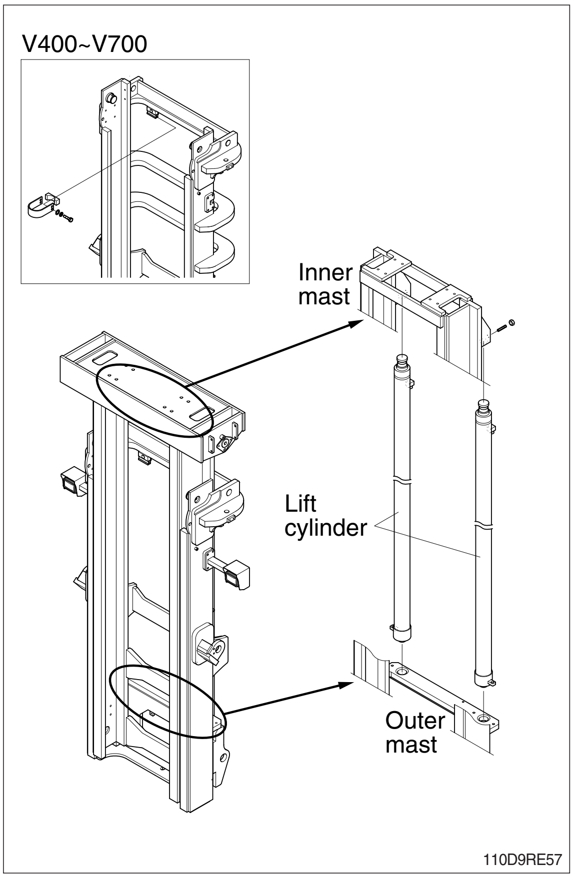
⑤ Inspect all parts for wear or damage. Replace all worn or damaged parts.



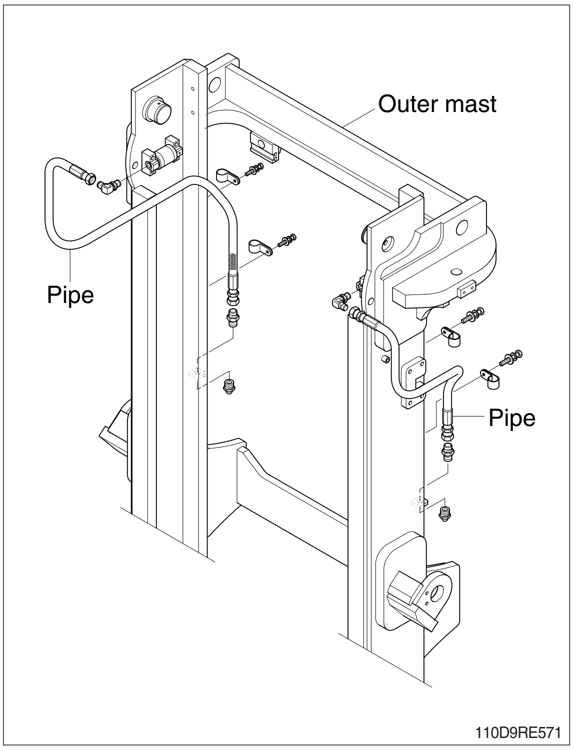
(3) Piping

① Remove the hoses and clamps attached to the cylinder.

※ Put blind plugs in the piping immediately after removing hoses.
This prevents the hydraulic oil from flowing out and also prevents dust and dirt from getting in.



③ Remove the lubrication pipes and clamps.



(4) Lift cylinder

① Loosen and remove hexagon bolts and washers securing lift cylinders to inner mast.

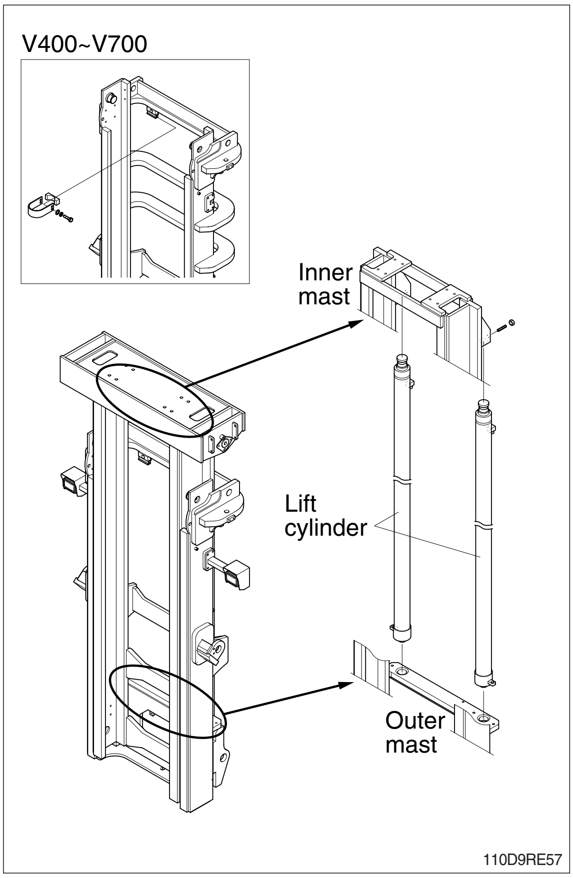
② Bind the lift cylinder with overhead hoist rope and pull up so that the rope has no slack or binding.

⚠ **Make sure the lift cylinder be tightened firmly for safety.**

③ Loosen and remove hexagon bolts and nuts securing lift cylinders to outer mast.

④ Using an overhead hoist, slowly raise the inner mast high enough to clear lift cylinder.

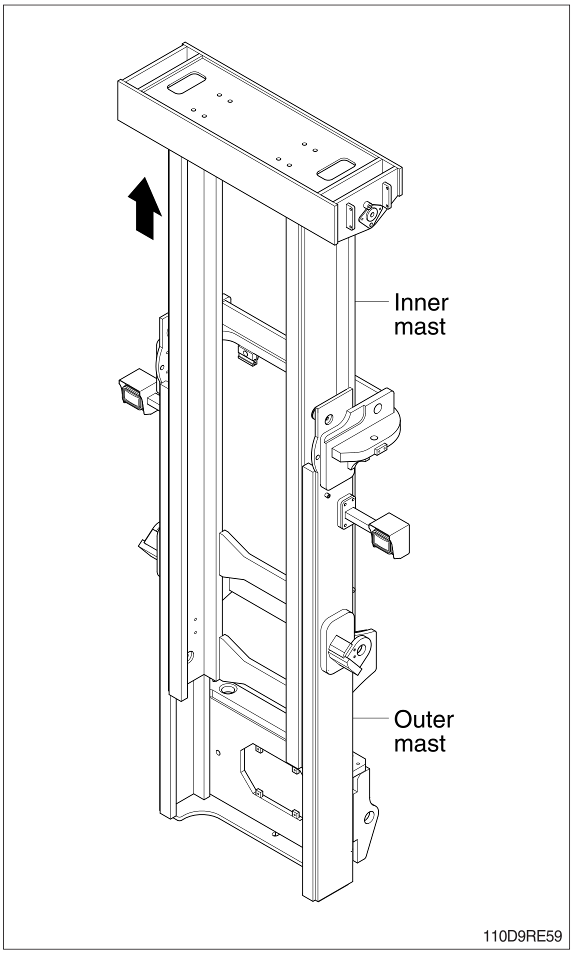
⑤ Using an overhead hoist, draw out lift cylinder carefully and put down on the work floor.



(5) Inner mast

① Using an overhead hoist raise the inner mast straight and carefully draw out of outer mast section.

⚠ Be careful the mast not to swing or fall.



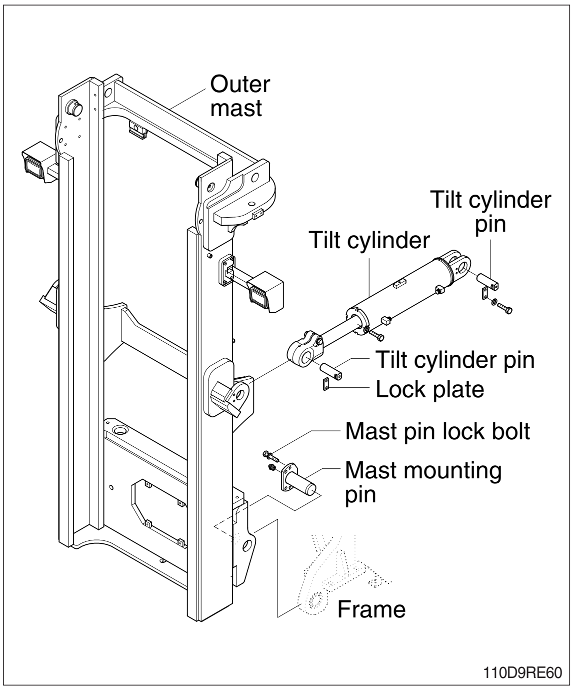
(6) Tilt cylinder pin

Loosen the bolt and remove the lock plate and tilt cylinder pin.

(7) Mast support pin

① Attach a crane to the stay at the top of the outer mast, and raise it. Loosen the pin lock bolts and remove the mounting pins from drive axle, then slowly raise outer mast the mast support bracket and main frame.

※ This operation is carried out under the machine, so use a pit, or if there is no pit, jack up the machine and loosen with an impact wrench.



2) INSTALLATION

After assembling mast components totally without piping connections, install mast assembly to the equipment.

※ Installation procedure for each of mast component is the reverse of the removal procedure.

(1) Mast support pin

Check the mast mounting pins for wear, then install pins into the mast support bracket and main frame and tighten the mast pin lock bolts.

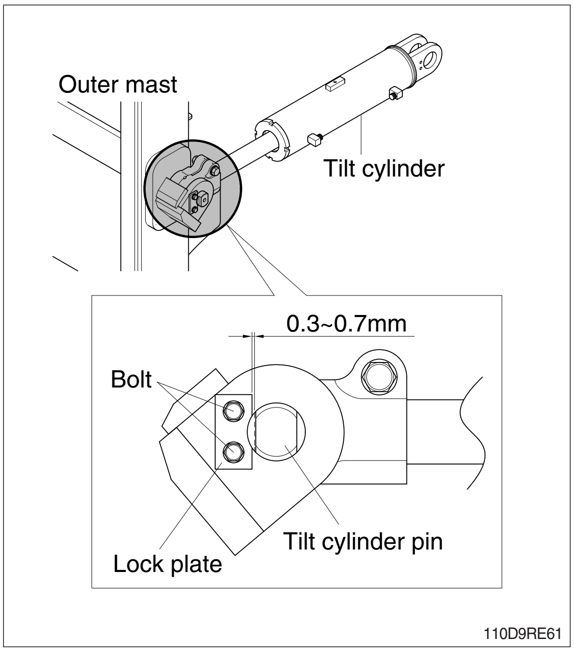
· Tightening torque : 12.5 kgf·m (90.4 lbf·ft)

(2) Tilt cylinder pin

Hold the mast with a crane, operate the tilt control lever and align the holes, then knock the pin and install the lock plate by the bolts.

· Tightening torque : 15.8 kgf·m (114 lbf·ft)

(3) Lift cylinder installation and adjustment



(3) Lift cylinder installation and adjustment

① Assemble the lift cylinder inside the outer mast, then tighten the stopper bolt. If the cylinder assembly has been replaced, adjust as follows so that the left and right cylinders are synchronized at the maximum lifting height.

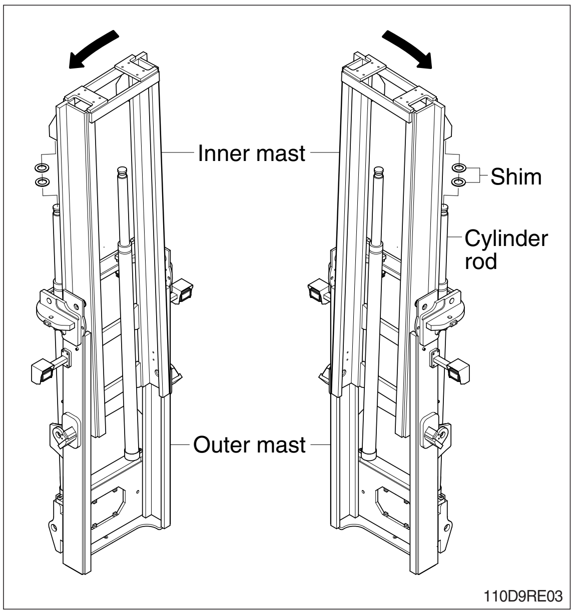
② Assemble the cylinder rod to the inner mast, and check the left-to-right play of the mast at the maximum lifting height.

※ If play is to LEFT, install adjustment shim to LEFT cylinder.

※ If play is to RIGHT, install adjustment shim to RIGHT cylinder.

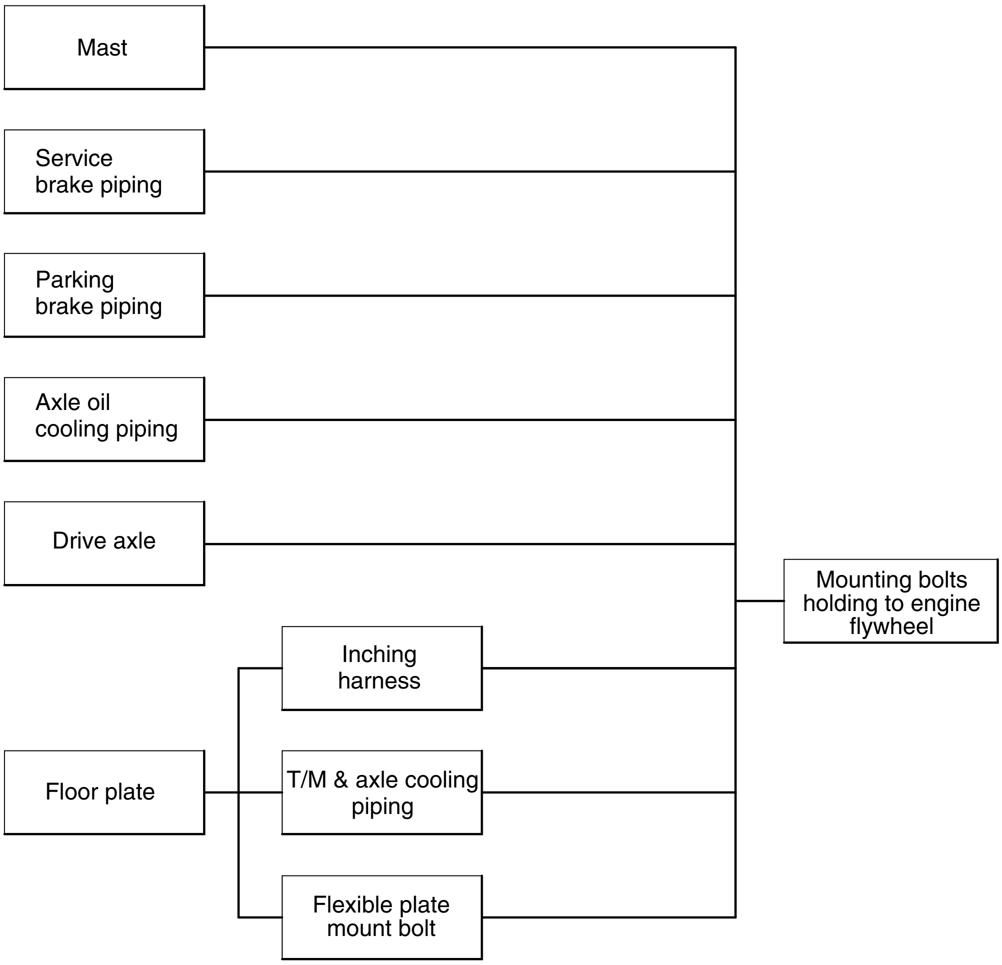
· Shim thickness : 1.0 mm (0.04 in)

※ Lubricate the grease into the nipple sufficiently.



2. POWER TRAIN ASSEMBLY

1) REMOVAL



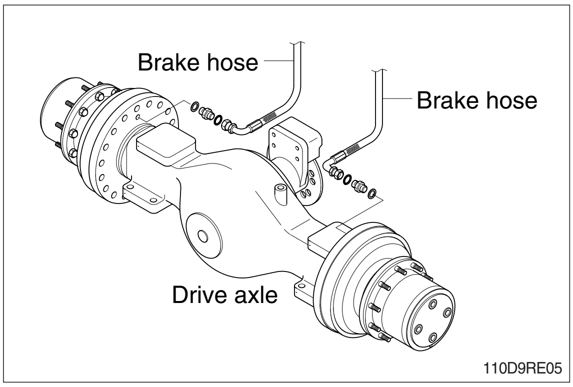
110D9RE04

(1) Mast

Refer to section on mast (Page 2-2)

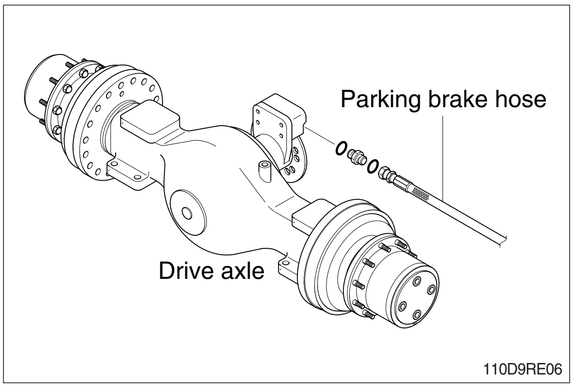
(2) Service brake piping

Disconnect the brake hydraulic hoses from the brake housing of drive axle assy.



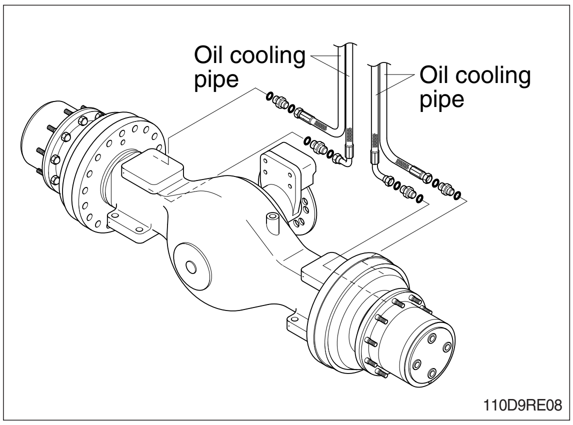
(3) Parking brake piping

Disconnect parking brake piping from the drive axle.



(4) Axle oil cooling piping

Disconnect the brake cooling piping from the drive axle.



(5) Drive axle

※ Before removing the drive axle assy, drain all of the oil from the axle.

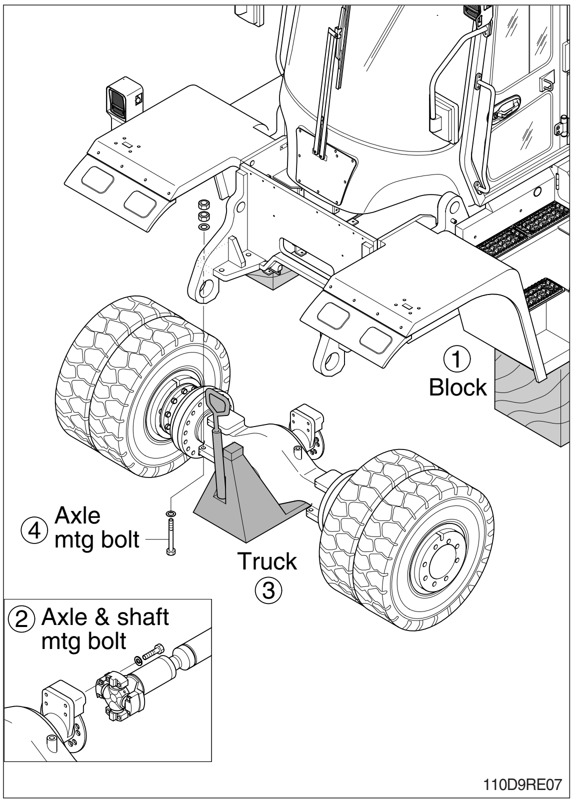
① Jack up the truck and then put the block under the frame.

※ If there is a pit, use the pit for safety.

② Loosen hexagonal bolts connecting drive axle to the drive shaft.

③ Prepare the truck under the drive axle unit to support it.

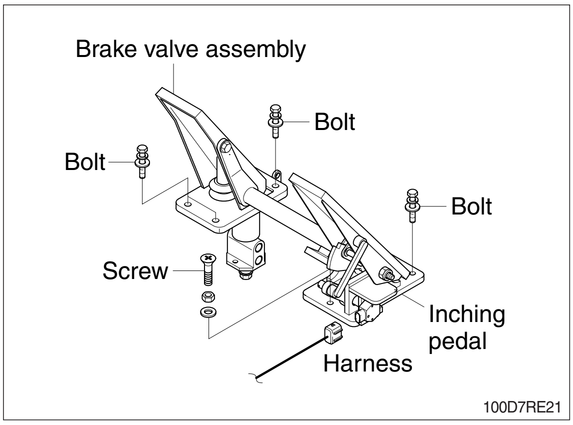
④ Remove mounting bolts fixing the axle to the frame and then carefully draw the truck out of the vehicle with the drive axle unit.



(6) Inching linkage

① Remove bolt and screw fixing the inching linkage assembly.

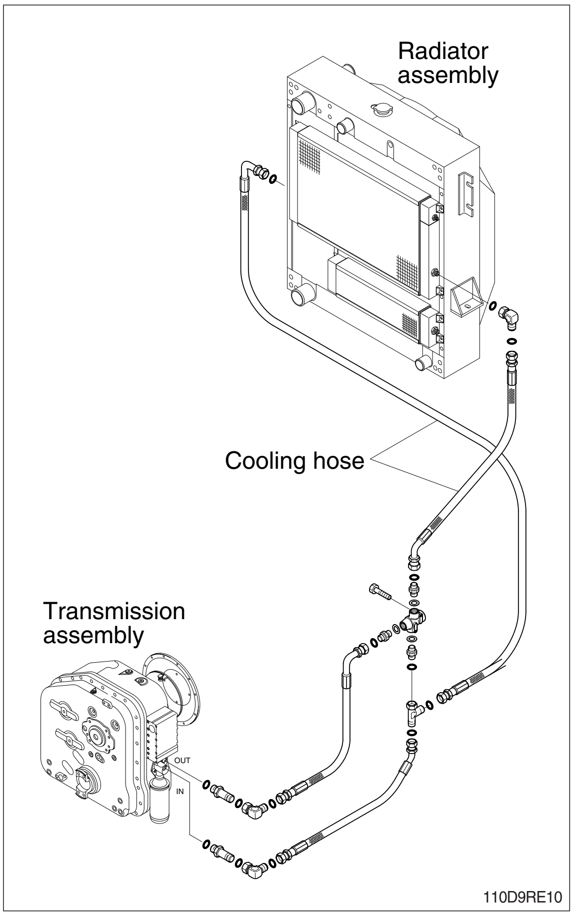
② Disconnect harness cable from the inching pedal assembly.



(7) Transmission and axle cooling piping

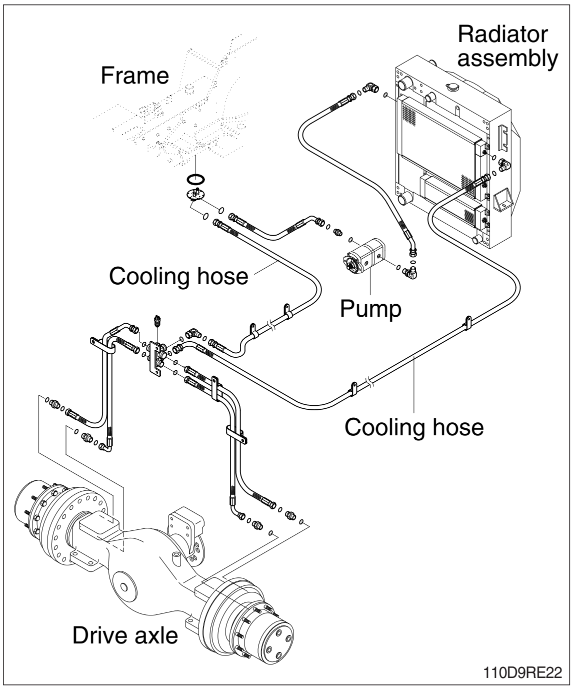
① Disconnect cooling hoses and connectors from the transmission.

※ Make sure that the coolant has been drained from the line.



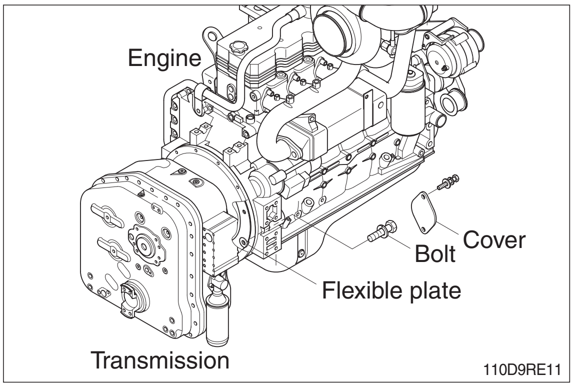
② Disconnect axle cooling hoses and connectors from the axle.

※ Make sure that the axle cooling oil has been drained from the line.



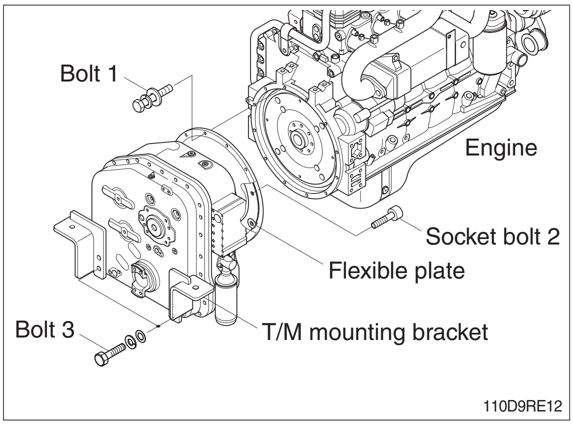
(8) Flexible plate

① Remove the cover on the left side of the flywheel housing then remove the 8 mounting bolts installed to the engine flywheel.
To rotate the flywheel, remove 1 mounting bolt, then insert a turning tool in the mounting hole. One man must turn the engine fan by hand while the other turns the flywheel.

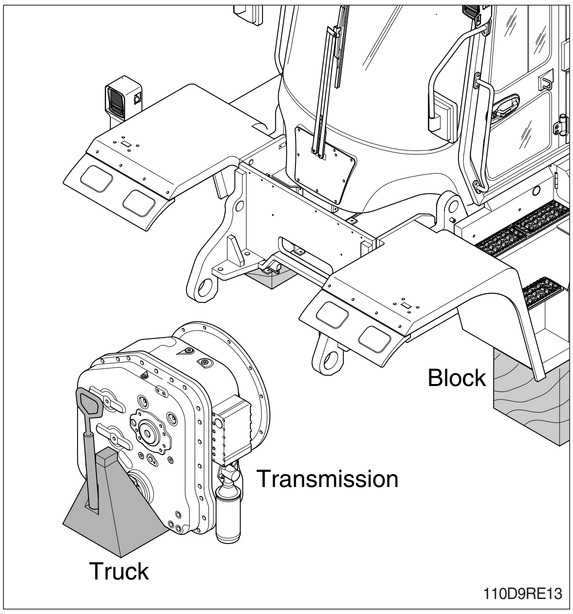


(9) Mounting bolts holding to flywheel housing

① Loosen the mounting bolt 1 to disconnect the transmission assembly from the torque converter housing.
② Loosen the socket bolts 2 to disconnect the flexible plate from the engine flywheel.
③ Loosen the mounting bolts 3 to disconnect the transmission assembly from the main frame.



④ Using a moving truck slowly pull out transmission assembly to the front.



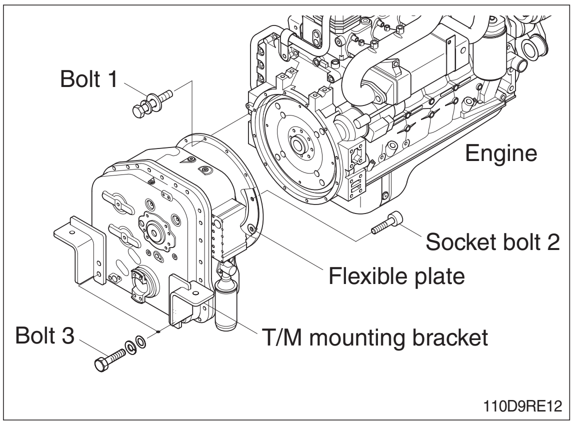
2) INSTALLATION

Installation is the reverse order to removal, but be careful of the following points.

(1) Tightening torque of the mounting bolts for the transmission.

① Bolt 1 : 5.5~8.3 kgf·m (39.8~60.0 lbf·ft)
② Bolt 2 : 3.9~5.1 kgf·m (28.1~36.9 lbf·ft)
③ Bolt 3 : 85~115 kgf·m (615~832 lbf·ft)

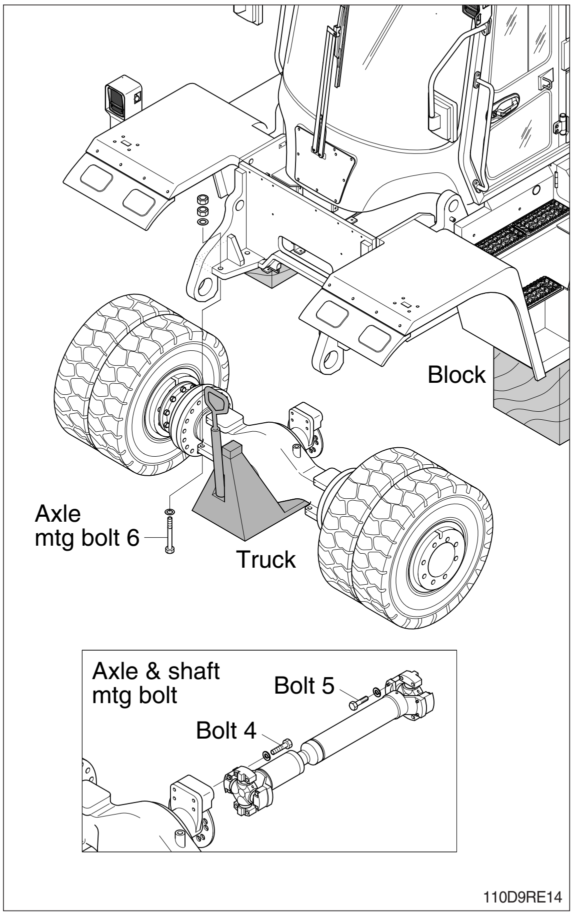
※ Apply loctite #277 on the thread before tightening the bolts 1 and 2.



(2) Tightening torque of the mounting bolts for the drive axle and shaft.

① Bolt 4 : 13~17 kgf·m (94.0~123 lbf·ft)
② Bolt 5 : 13~17 kgf·m (94.0~123 lbf·ft)
③ Bolt 6 : 85~115 kgf·m (615~832 lbf·ft)

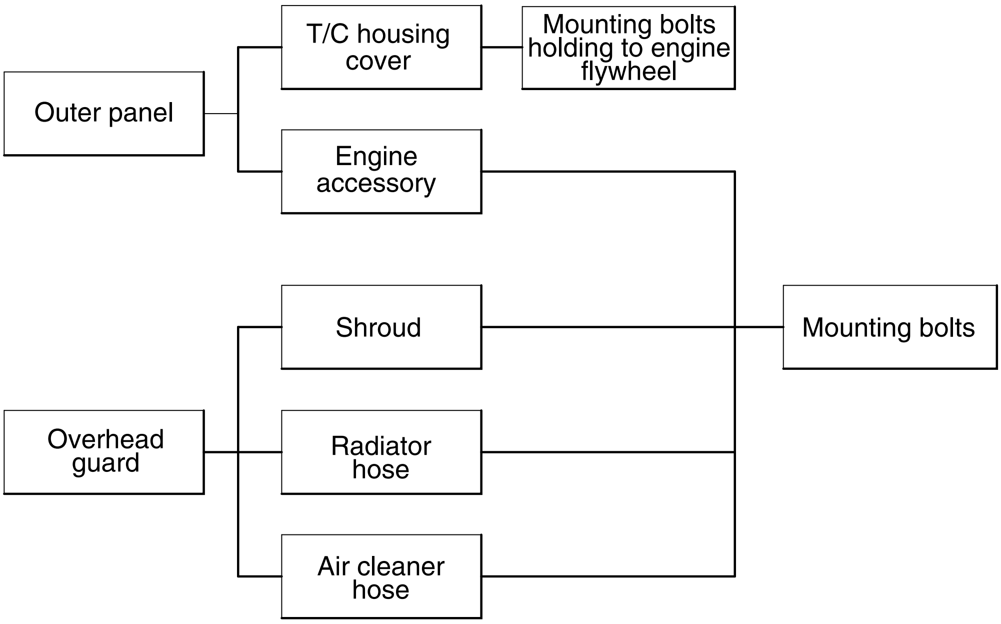
※ Apply loctite #277 on the thread before tightening the bolts.



3. ENGINE

Lever the torque converter, transmission and front axle inside the frame, then remove the engine assembly

1) REMOVAL

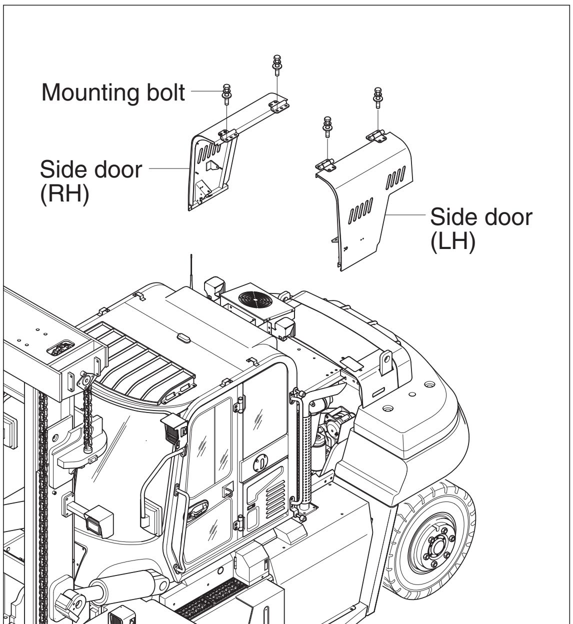


110D9RE25

(1) Outer panel

① **Side door (LH, RH)**

Remove side door (LH, RH) by loosening the mounting bolts.

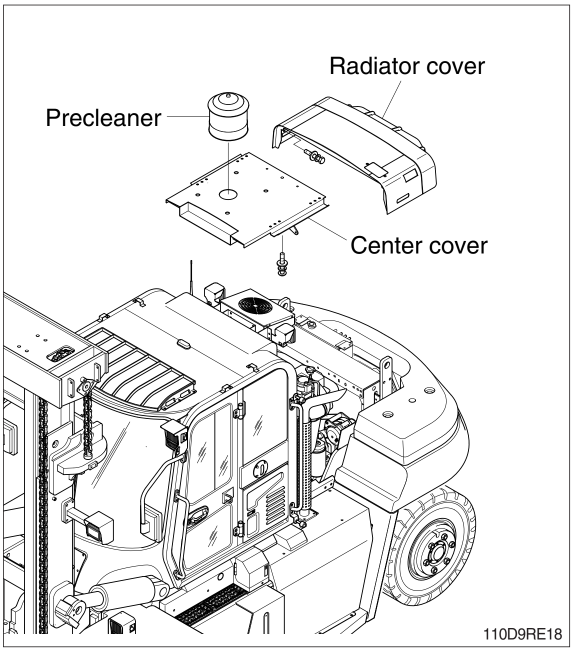


110D9RE17

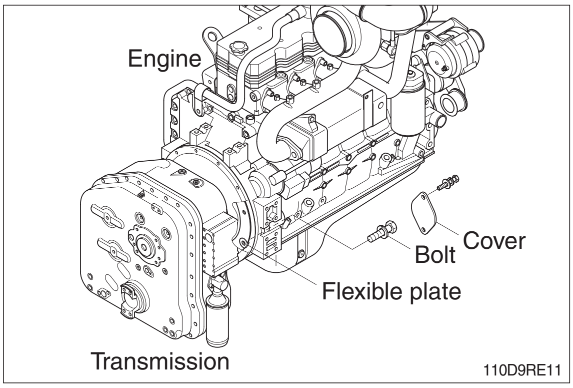
② Center cover

a. Pull upside the precleaner by loosening the clamp and seal in the air intake hole of air cleaner.

b. Remove center cover and radiator cover upward.



(2) Flywheel housing cover and mounting bolts. See page 2-12.



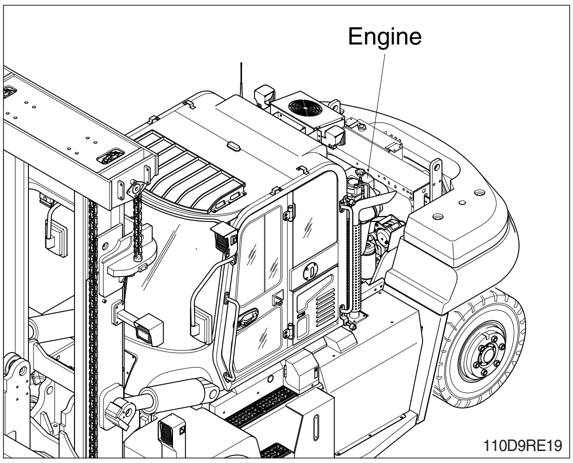
(3) Engine accessory

Remove all wiring harnesses, cables and hoses around the engine, dashboard and frame.

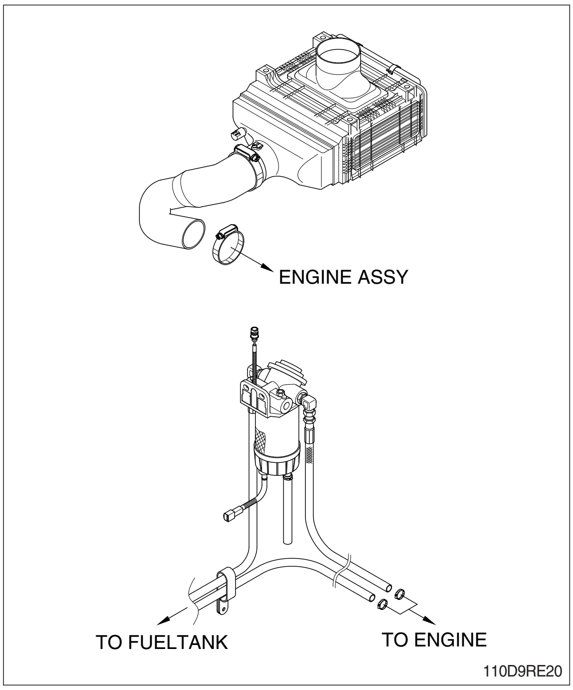
① Wiring harness to alternator and starter.

② Wiring harness for oil pressure and engine water temperature gauges.

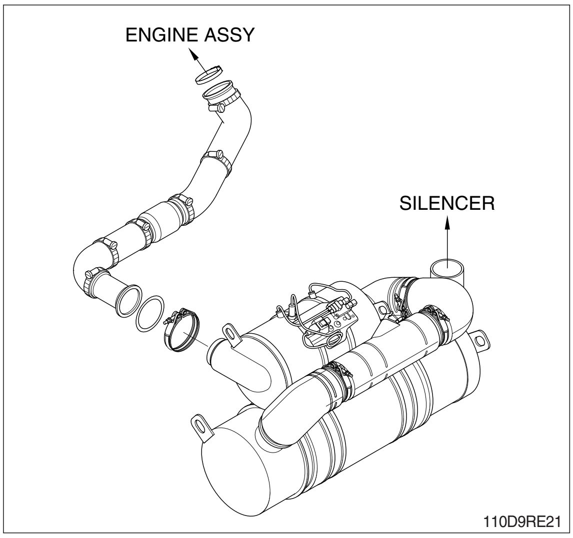
③ Cables for meters, buttons and accelerator pedal.



④ Hoses to fuel tank and air cleaner.

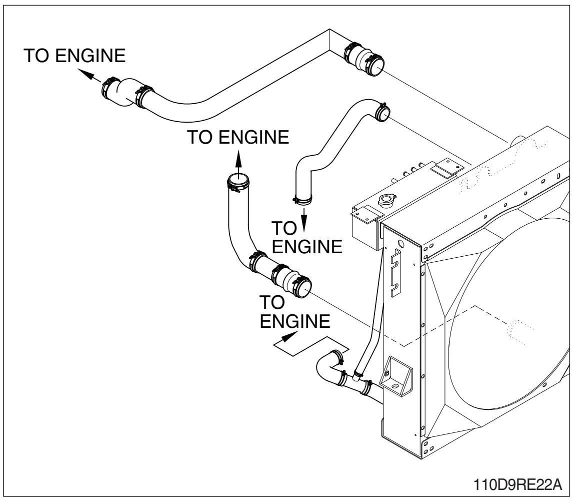


⑤ Exhaust pipe.



(4) Radiator hose

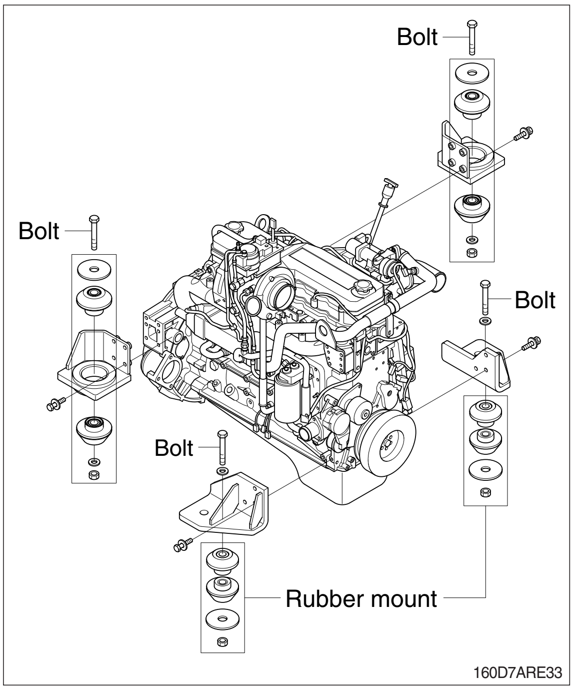
Open the drain valve of the radiator and drain the cooling water, then remove the radiator hose.



(5) Engine mounting bracket

Attach a crane to the engine hook and raise, then remove mounting bolts. Raise the engine slightly, slide towards the radiator, then lift up.

※ When sliding the engine, be careful of the collision of engine and radiator.



2) INSTALLATION

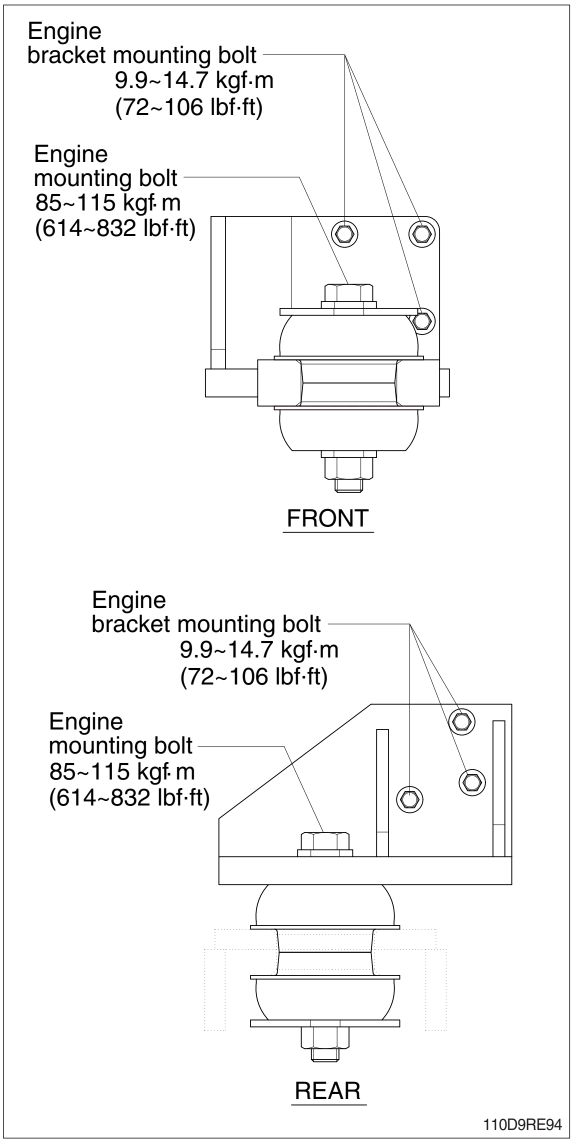
Installation is the reverse order to removal, but be careful of the following points.

(1) Tighten the engine bracket mounting bolts.

※ Do not remove the bolts unless necessary. Loctite is coated over the threads of bolt. So, once the bolts were removed, coat them with loctite(#277) when installing.

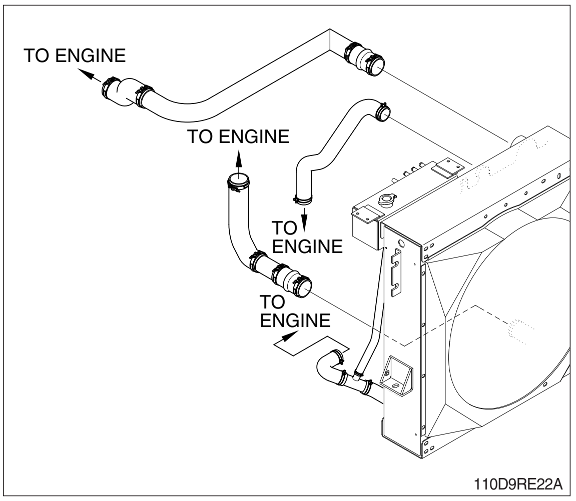
※ Before installing the bolts, loctite in the holes should be removed by a tap.

(2) Tighten the engine mounting bolts and nuts.



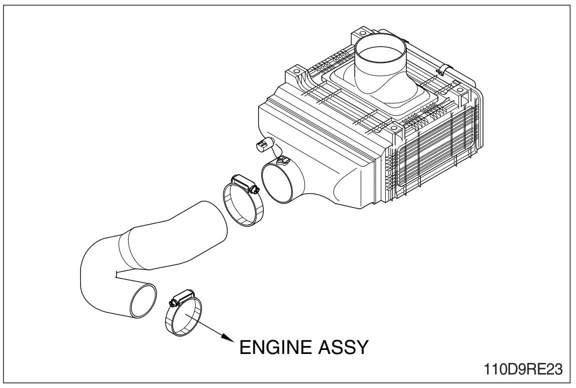
(3) Tightening torque of mounting bolt installed to torque converter housing.
·See page 2-13, 2) INSTALLATION.

(4) Radiator hoses
Insert the radiator hoses securely and fit the clamps.



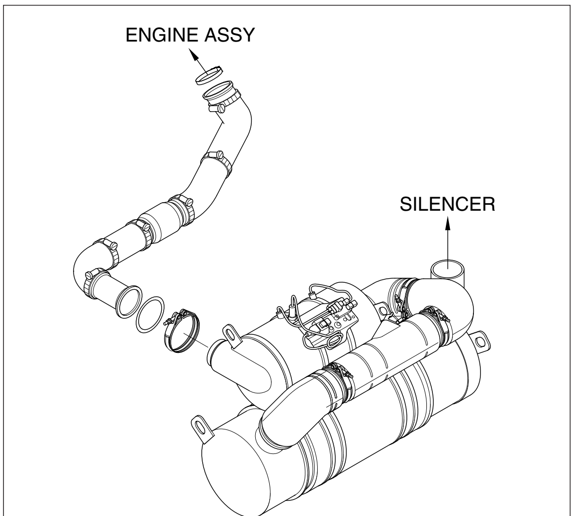
110D9RE22A

(5) Air cleaner hose
① Insert the air cleaner hose securely and fit a clamp.



110D9RE23

(6) Exhaust pipe
Insert the exhaust pipe to the engine securely and fit a clamp.



110D9RE21

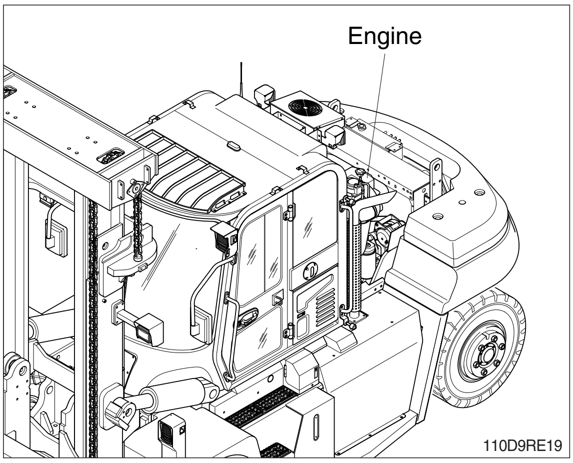
(7) Engine accessory

Install all wiring harnesses, cables and hoses around the engine, dashboard and frame.

① Wiring harness to alternator and starter.

② Wiring harness for oil pressure and engine water temperature gauges.

③ Cables for meters, buttons and accelerator pedal.

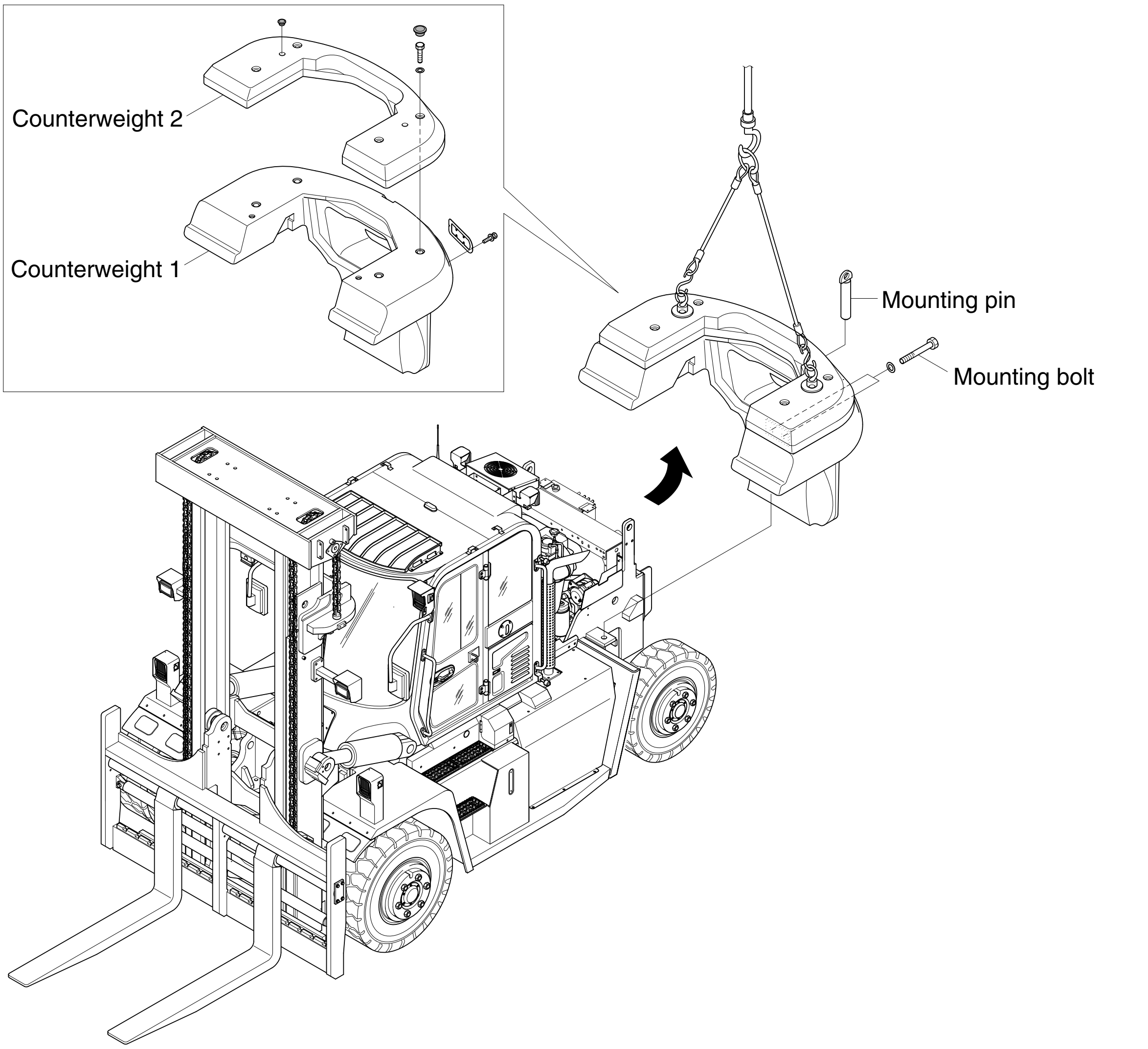


4. REAR AXLE

1) REMOVAL

Counterweight → Rear wheel → Hose and pipe → Mounting bolt

110D9RE35



110D9RE30

(1) Counterweight

Hold the counterweight with hoist bars, and raise it with a crane.

Remove the mounting bolts, raise slightly and move it slowly to rear side.

· Weight of counterweight (standard)

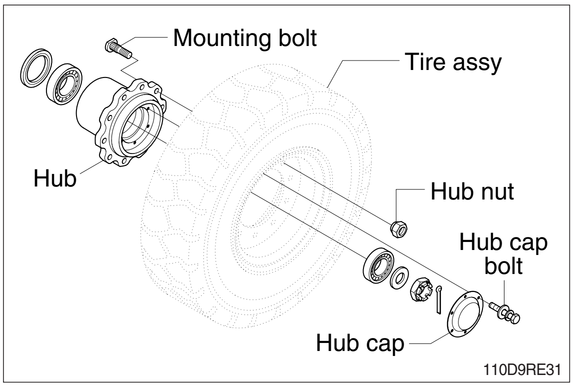
Mode	Counter weight 1	Counter weight 2
110D-9	2750 kg (6010 lb)	1390 kg (3065 lb)
130D-9	3505 kg (7730 lb)	1390 kg (3065 lb)
160D-9	4240 kg (9350 lb)	1850 kg (4080 lb)

· Tightening torque : 199±29.9 kgf · m (1440±216 lbf · ft)

(2) Rear wheel

Remove mounting bolt and hub nut with socket wrench and then carefully take out the tire assembly.

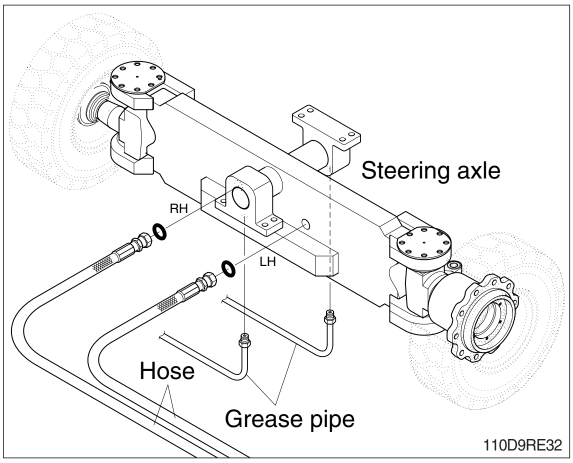
· Tightening torque
- Hub nut
  83.2±10 kgf·m (602±72.3 lbf·ft)
- Hub cap bolt
  2.5±0.5 kgf·m (11.8±3.6 lbf·ft)



(3) Hose and piping

① Disconnect the hoses from the steering axle and then drain out oil.

② Disconnect the pipes from the axle support.



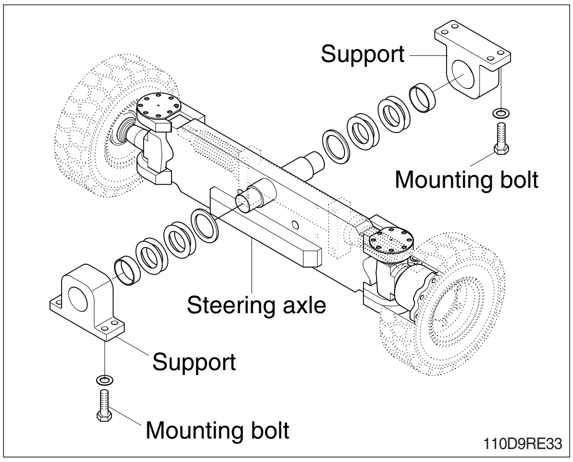
(4) Mounting bolt

Put a block under the steering axle, support on a truck, an raise the frame with a crane. Remove the mounting bolts installing to the frame, and pull out to the rear.

There are shims between the support and steering axle to prevent play.

· Mounting bolt tightening torque
  100±15 kgf·m (723±72.3 lbf·ft)

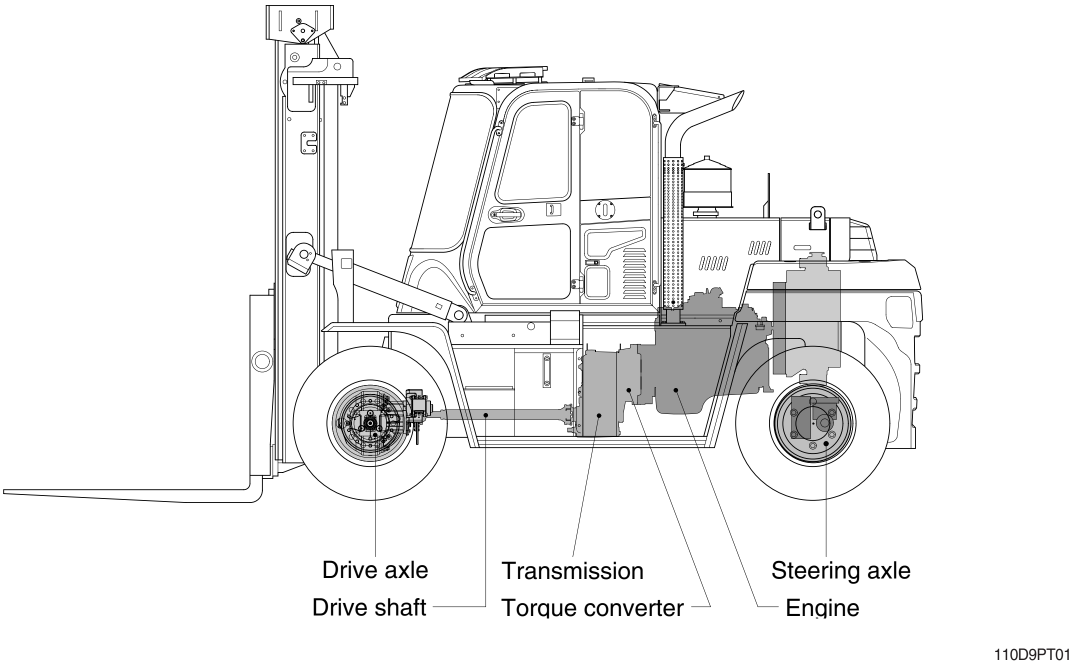
※ Apply loctite #277 on the thread before tightening.



SECTION 3 POWER TRAIN SYSTEM

GROUP 1 STRUCTURE AND OPERATION

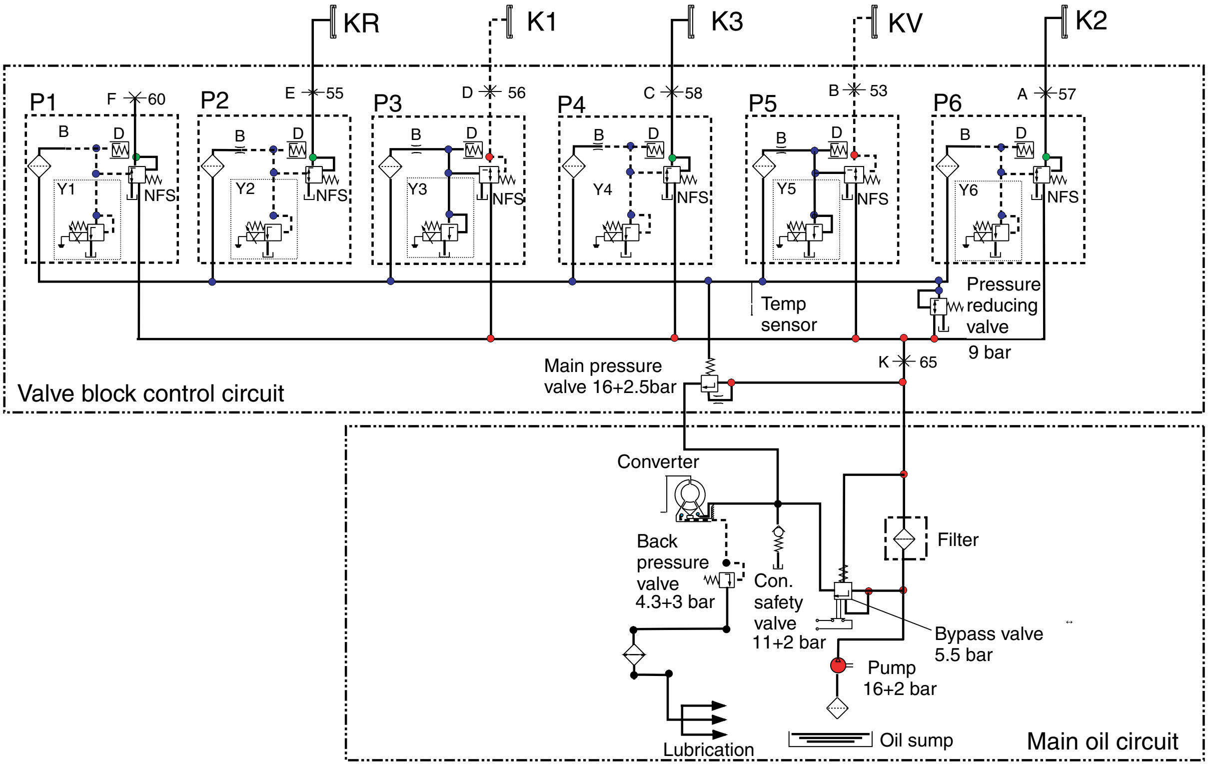
1. POWER TRAIN COMPONENT OVERVIEW



The power train consists of the following components :
- Torque converter
- Transmission
- Drive shaft
- Drive axle

Engine power is transmitted to the transmission through the torque converter.
The transmission is a hydraulically engaged three speed forward, three speed reverse power shift type transmission.
The transmission outputs through the universal joints of the drive shaft to drive axle assembly.
The power transmitted to front axle drives front wheels.

· Hydraulic circuit

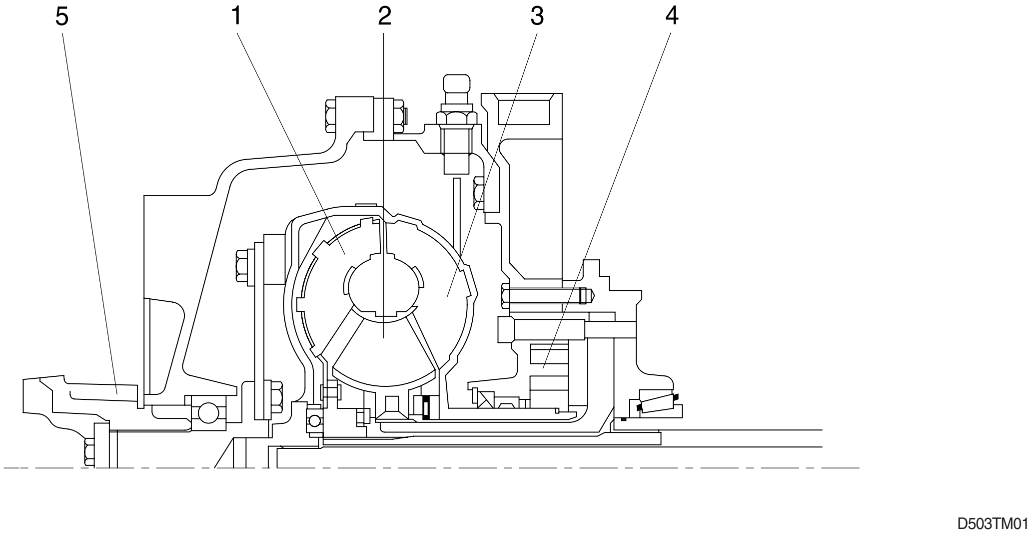


D507PT31

Speed	Forward			Reverse			Neutral	Positions on the valve block	No. of measuring points
	F1	F2	F3	R1	R2	R3			
Y1							-	F	60
Y2				●	●	●	-	E	55
Y3	●			●			-	D	56
Y4			●			●	-	C	58
Y5	●	●	●				-	B	53
Y6		●			●		-	A	57
Clutch engaged	KV, K1	KV, K2	KV, K3	KR, K1	KR, K2	KR, K3	-	-	-

NFS Follow-on slide
D Vibration damper
B Orifice
P1 Not used
P2 Proportional valve KR
P3 Proportional valve K1
P4 Proportional valve K3
P5 Proportional valve KV
P6 Proportional valve K2
Y1~Y6 Pressure regulators

2. TORQUE CONVERTER



1	Turbine	3	Pump	5	Input shaft
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.

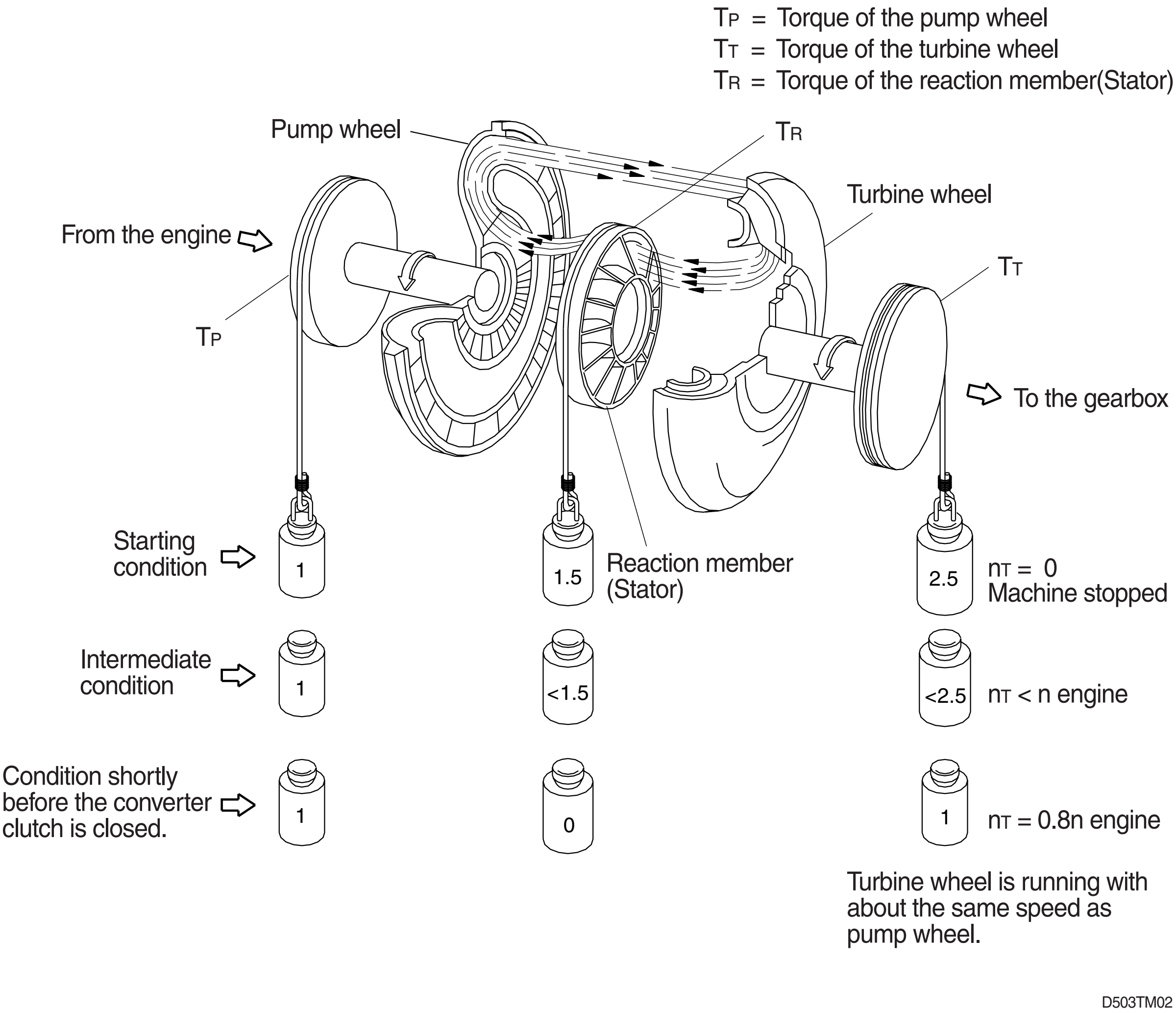
According to the rate of inversion, the turbine wheel and with it also the output shaft, receive a more or less high reaction moment. The stator (Reaction member), following the turbine, has the task to inverse again the oil which is escaping out of the turbine and to delivery it under the suitable discharge 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 adoption 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.

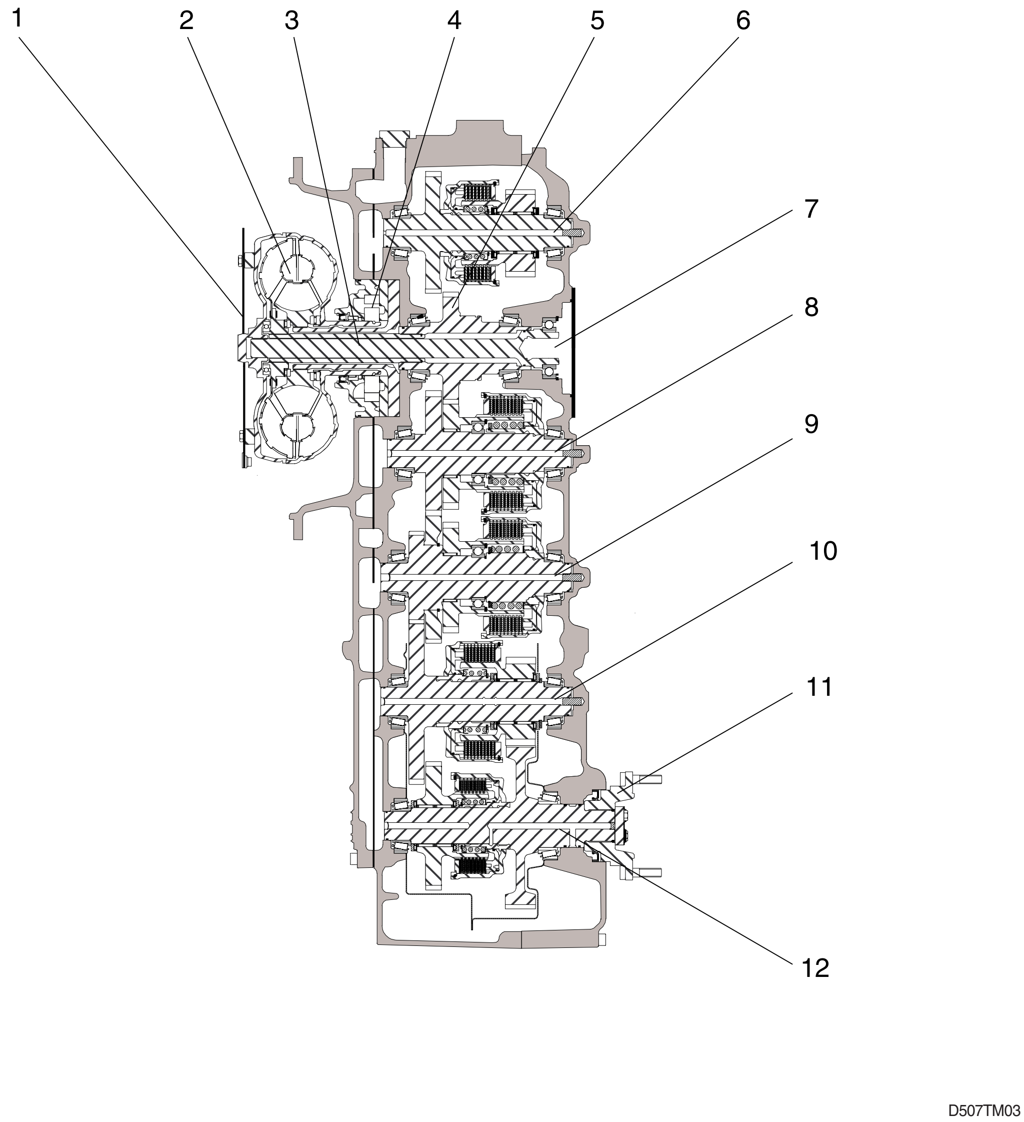
A stator freewheel serves to improve the efficiency in the upper driving range, it is backing up in the conversion range the moment upon the housing, and is released in the coupling range.
In this way, the stator can rotate freely.

Function of a hydrodynamic torque converter (Schematic view)



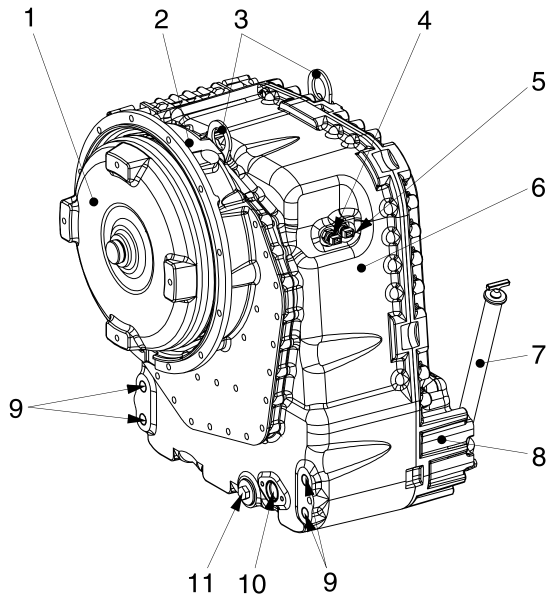
3. TRANSMISSION

1) LAYOUT

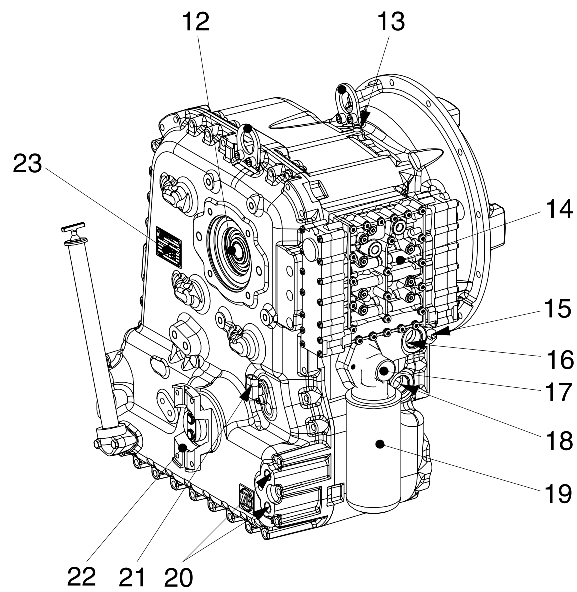


1	Engine connection	5	Input gear	9	Clutch shaft (KR)
2	Converter	6	Clutch shaft	10	Clutch shaft (K1)
3	Input shaft	7	Power take-off	11	Output flange
4	Transmission pump	8	Clutch shaft (KV)	12	Clutch shaft (K3/output)

2) INSTALLATION VIEW



FRONT VIEW



REAR VIEW

110D9PT26

1	Converter
2	Converter bell
3	Lifting lugs
4	Inductive transmitter n central gear train
5	Inductive transmitter n turbine
6	Gearbox housing - Front section
7	Oil level tube with oil dipstick
8	Gearbox housing - Rear section
9	Transmission suspension holes M20
10	Attachment possibility oil level tube with oil dipstick
11	Oil drain plug M38×1.5
12	Power take - off
13	Breather
14	Electro - hydraulic control
15	Temperature sensor behind the converter
16	Connection to the oil cooler
17	Filter head
18	Connection from the oil cooler
19	Exchange filter
20	Transmission suspension holes M20
21	Speed sensor n output
22	Output flange
23	Type plate

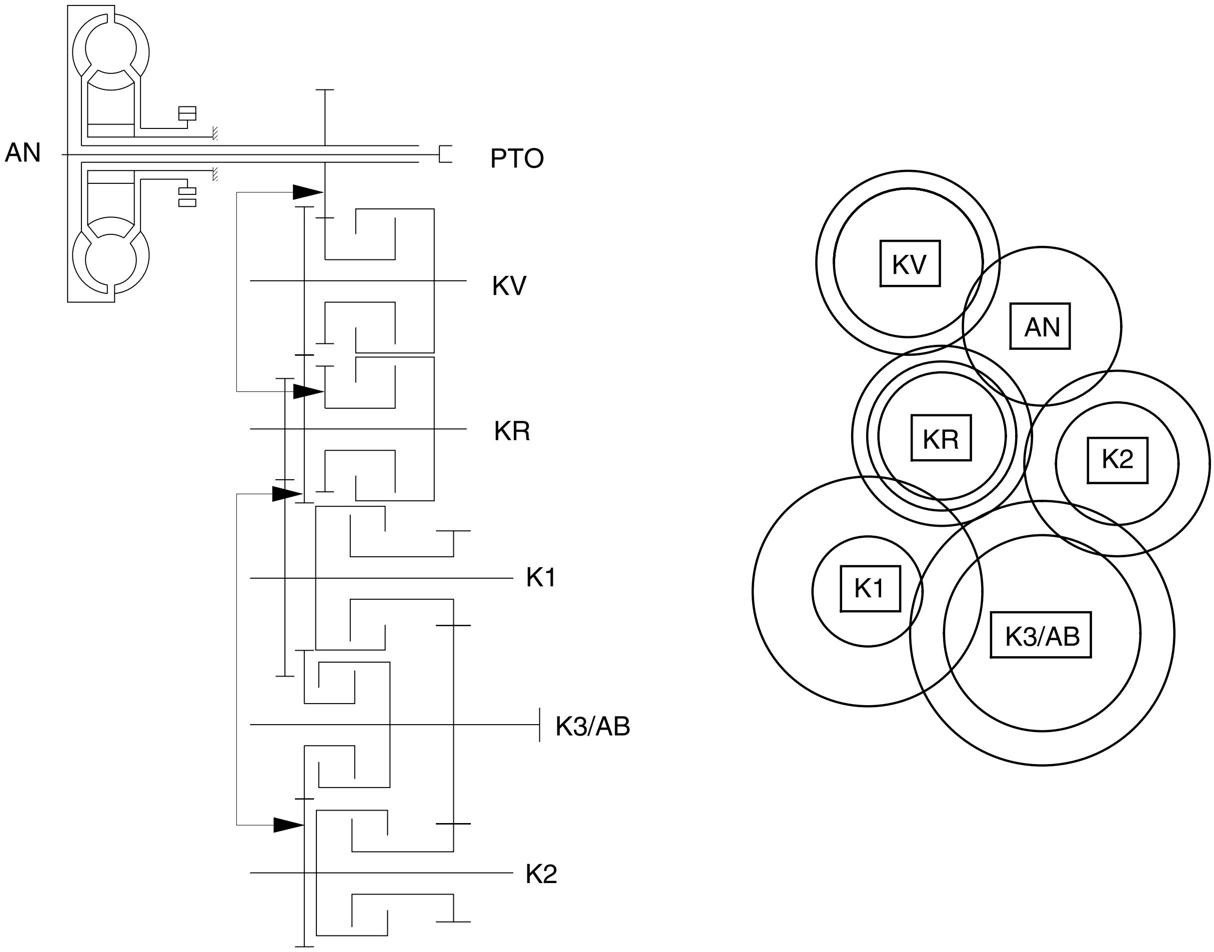
3) OPERATION OF TRANSMISSION

(1) Gearbox diagram

The multi-speed reversing transmission in counter shaft design is power shiftable by hydraulically actuated multi-disk clutches.

All gears are constantly meshing and carried on anti-friction bearings.
The gear wheels, bearings and clutches are cooled and lubricated with oil.
The 3-speed reversing transmission is equipped with 5 multi-disk clutches.
At the shifting, the actual plate pack is compressed by a piston, movable in axial direction, which is pressurized by pressure oil.

A compression spring takes over the pushing bask of the piston, thus the release of the plate pack. As to the layout of the transmission as well as the specifications of the closed clutches in the single speeds.



Legend:

AN = Input
KV = Clutch forward
KR = Clutch reverse
K1 = Clutch 1st speed
K2 = Clutch 2nd speed
K3 = Clutch 3rd speed/output
PTO = Power take-off

Diagram Clutches

Driving direction	Speed	Clutch
Forward	1	KV/K1
	2	KV/K2
	3	KV/K3
Reverse	1	KR/K1
	2	KR/K2
	3	KR/K3

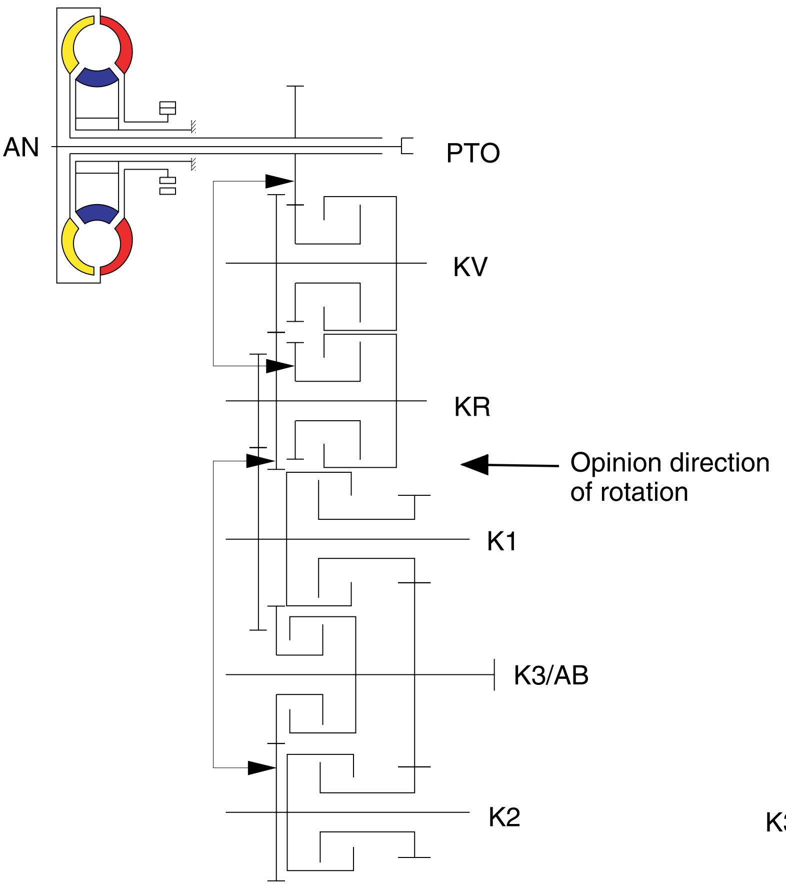
D507PT32

(2) Forward

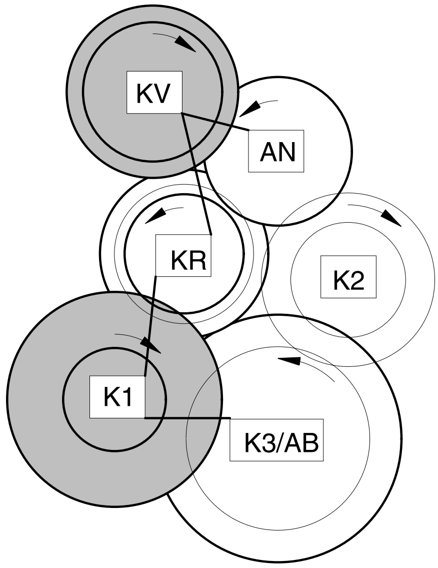
In forward, forward clutch and 1st, 2nd, 3rd clutch are engaged.

Forward clutch and 1st, 2nd, 3rd clutch are actuated by the hydraulic pressure applied to the clutch piston.

Transmission diagram



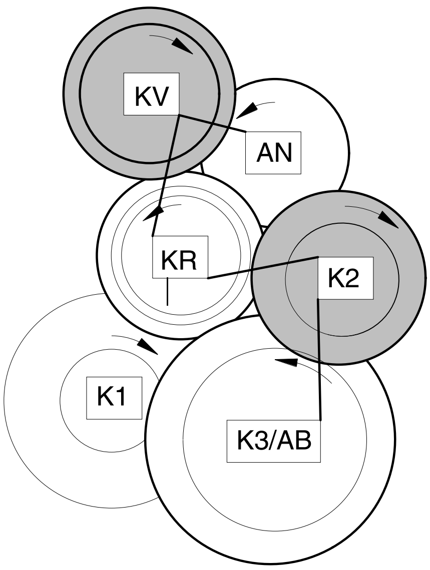
1st speed-forward



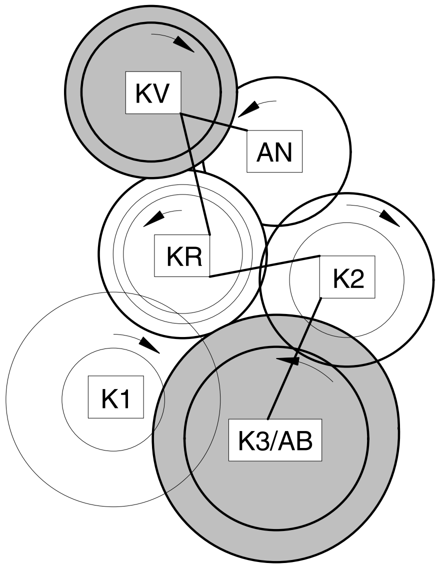
Legend:

AN = Input
KV = Clutch forward
KR = Clutch reverse
K1 = Clutch 1st speed
K2 = Clutch 2nd speed
K3/AB = Clutch 3rd speed/output
PTO = Power take-off

2nd speed-forward



3rd speed-forward



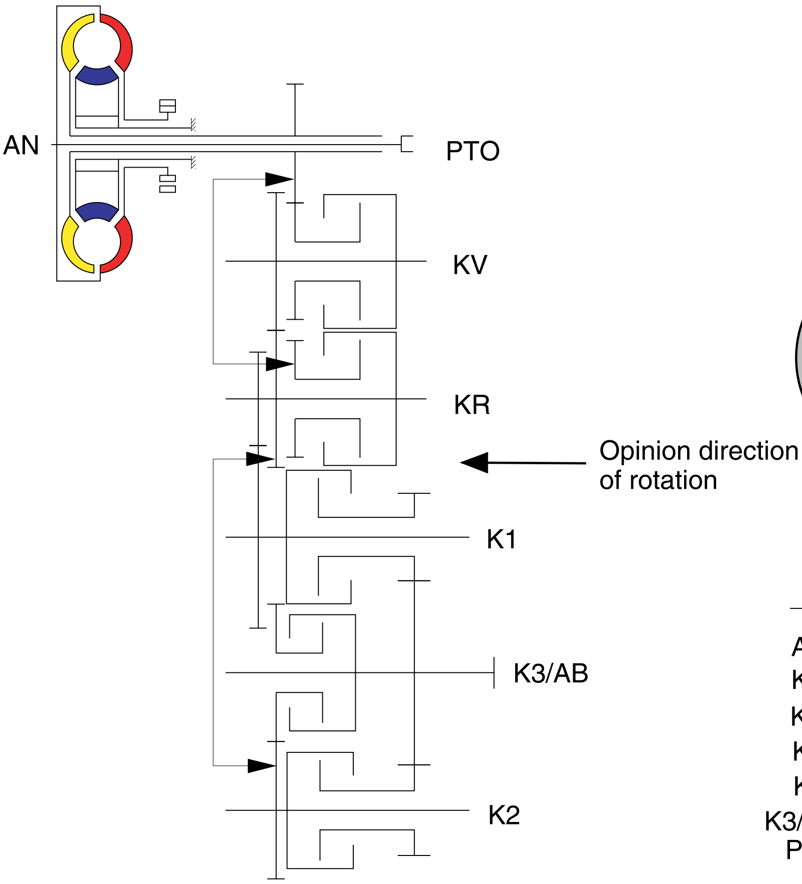
D503PT33

(3) Reverse

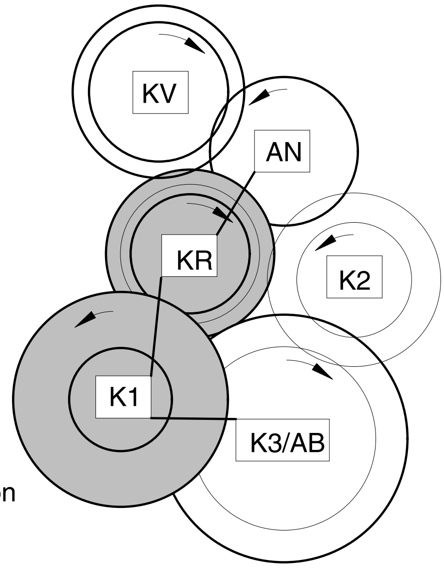
In reserve, reserve clutch and 1st, 2nd, 3rd clutch are engaged.

Reverse clutch and 1st, 2nd, 3rd are actuated by the hydraulic pressure applied to the clutch piston.

Transmission diagram



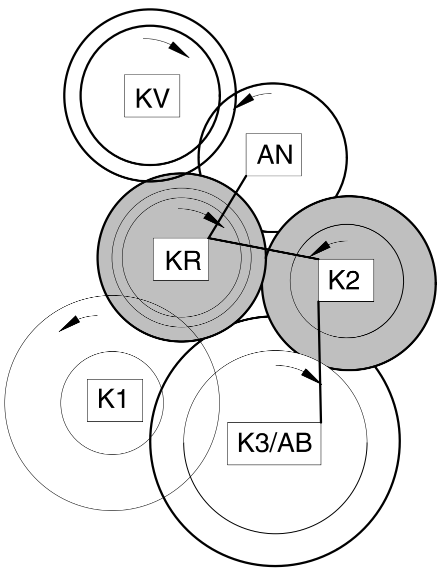
1st speed-reverse



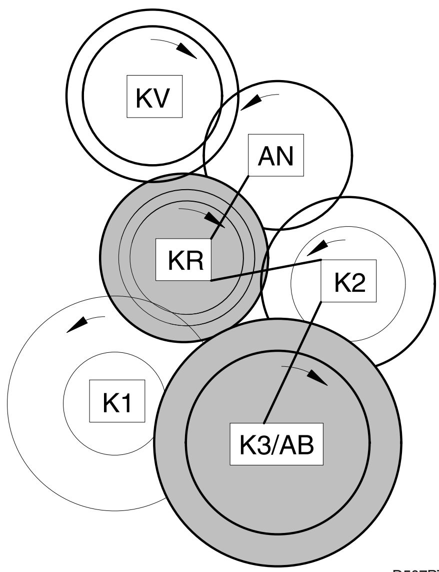
Legend:

AN = Input
KV = Clutch forward
KR = Clutch reverse
K1 = Clutch 1st speed
K2 = Clutch 2nd speed
K3/AB = Clutch 3rd speed/output
PTO = Power take-off

2nd speed-reverse

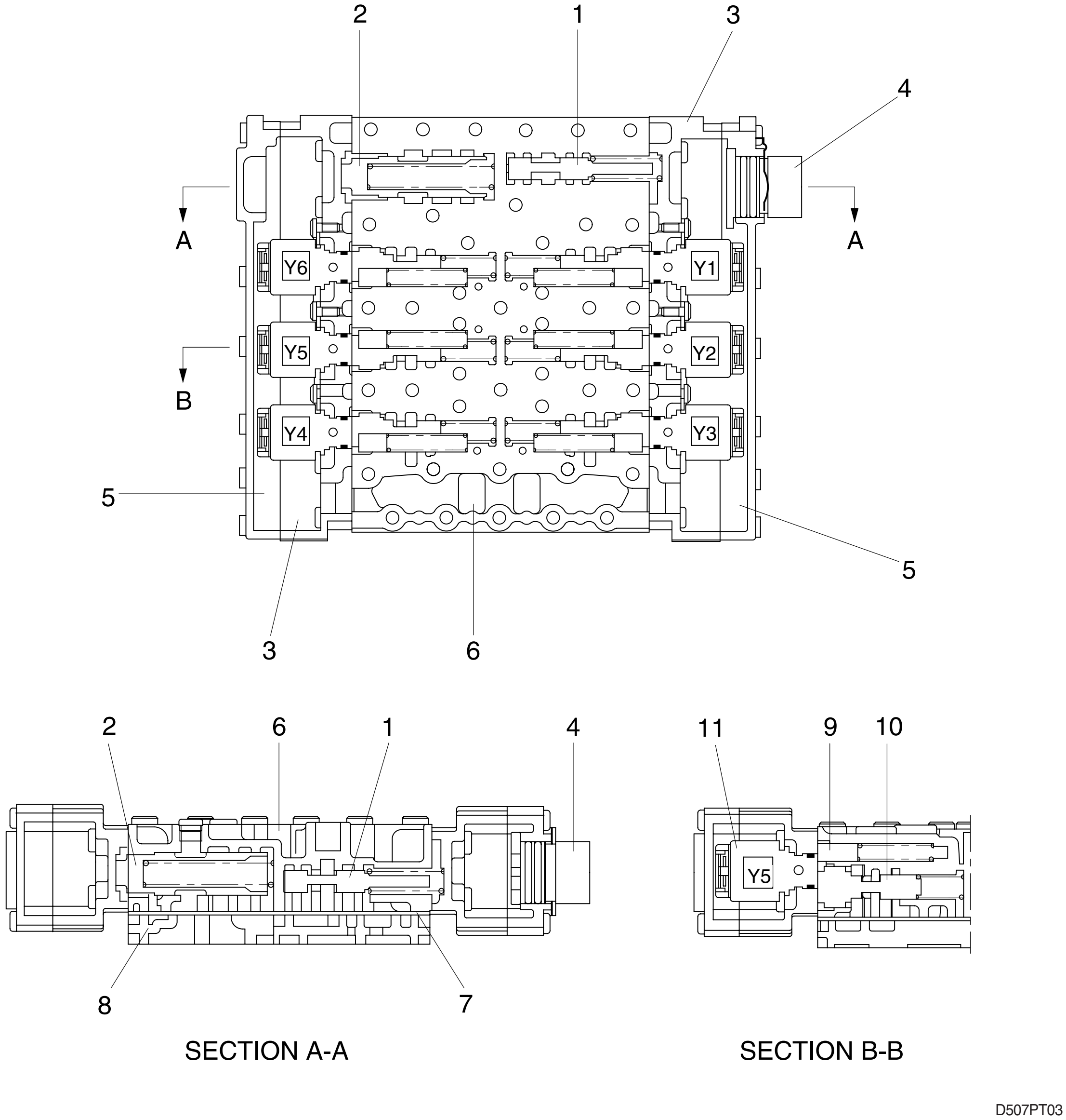


3rd speed-reverse



D507PT34

4) ELECTRO-HYDRAULIC SHIFT CONTROL WITH PROPORTIONAL VALVE



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

Transmission control, see schedule of measuring points, Oil circuit diagram and Electro-hydraulic control unit see page 3-2, 3-10.

The transmission pump, necessary for the oil supply of the converter, and for the transmission control, is sitting in the transmission on the engine-dependent input shaft.

The feed rate of the pump is
$Q = 85\ l$ /min, at $n_{Motor} = 2000\ min^{-1}$
This pump is sucking the oil via the coarse filter out of the oil sump and delivers it via the fine filter - the filter can also be fitted externally from the transmission - to the main pressure valve.

If because of contamination, respective damage, the through-flow through the fine filter is not ensured, the oil will be directly conducted via a filter differential pressure valve (bypass valve $\triangle p$ = 5.5+3bar) to the lubrication.
In this case, an error indication is shown on the display.

The five clutches of the transmission are selected via the 6 proportional valves P1 to P6 (P1 will not be under current at the 3-speed version, i.e. without function).
The proportional valve (pressure regulator unit) is composed of pressure regulator (e.g. Y6), follow-on slide and vibration damper.

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

Due to the direct proportional selection with separated pressure modulation for each clutch, the pressure to the clutches, which are engaged in the gear change, will be controlled. In this way, a hydraulic intersection of the clutches to be engaged and disengaged becomes possible.
This is creating spontaneous shiftings without traction force interruption.

At the shifting, the following criteria will be considered :
- Speed of engine, turbine, central gear train and output.
- Transmission temperature.
- Shifting mode (up-,down-, reverse shifting and speed engagement out of Neutral).
- Load condition (full and part load, traction, overrun inclusive consideration of load cycles during the shifting).

The main pressure valve is limiting the max. control pressure to 16+2.5bar and releases the main stream to the converter and lubrication circuit.
In the inlet to the converter, a converter safety valve is installed which protects the converter from high internal pressures (opening pressure 11+2bar).
Within the converter, the oil serves to transmit the power according to the well-known hydrodynamic principle (see Chapter torque converter page 3-3).
To avoid cavitation, the converter must be always completely filled with oil.

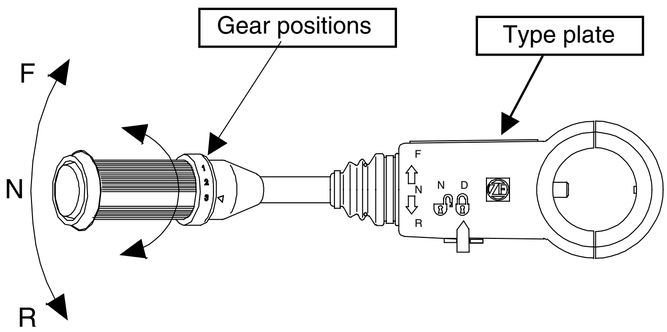
This is achieved by converter pressure back-up valve, rear-mounted to the converter, with an opening pressure of at least 4.3+3bar.
The oil, escaping out of the converter, is directed to the oil cooler.

From the oil cooler, the oil is directed to the transmission and there to the lubricating oil circuit, so that all lubricating points are supplied with cooled oil.
In the electrohydraulic control unit are 6 pressure regulators installed.

5) GEAR SELECTOR (DW-3)

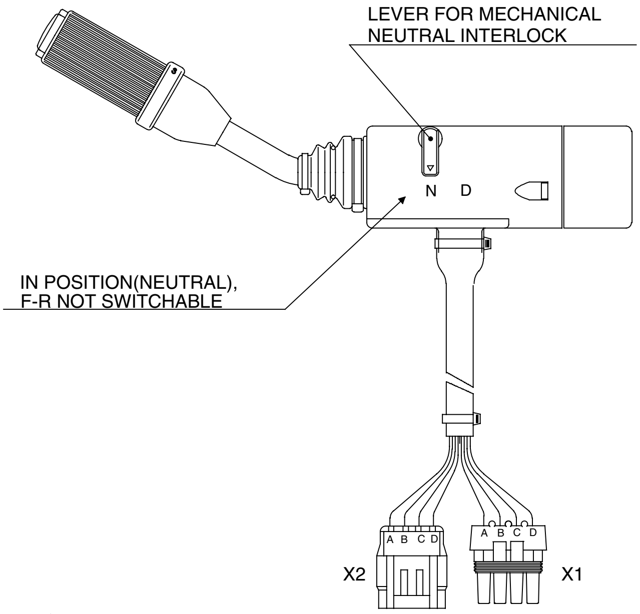
The gear selector is designed for the mounting on the steering column left side. By a rotative motion, the positions (speeds) 1 to 3 are selected by tilting the lever, the driving direction (Forward (F) - Neutral (N) - Reverse (R)).

For the protection from unintended start off, a neutral interlock is installed :
Position "N" - Controller lever blocked in this position
Position "D" - Driving



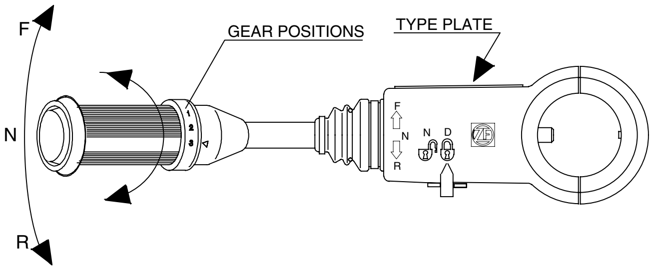
D507PT12

Gear selector (DW-3)



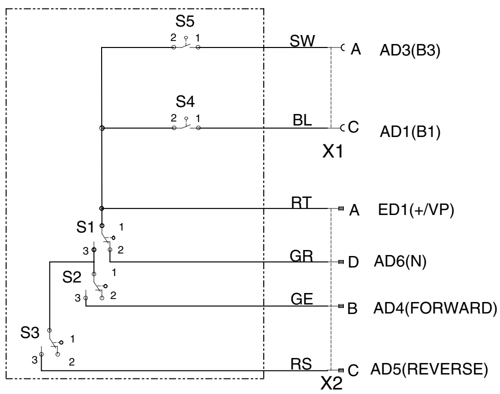
CODING GEAR SELECTOR

SPEED		OUTPUT								
		FORWARD			REVERSE			NEUTRAL		
		1	2	3	1	2	3	1	2	3
AD1	B1	●			●			●		
AD2	B2									
AD3	B3	●	●		●	●		●	●	
AD4	V	●	●	●						
AD5	R				●	●	●			
AD6	N							●	●	●

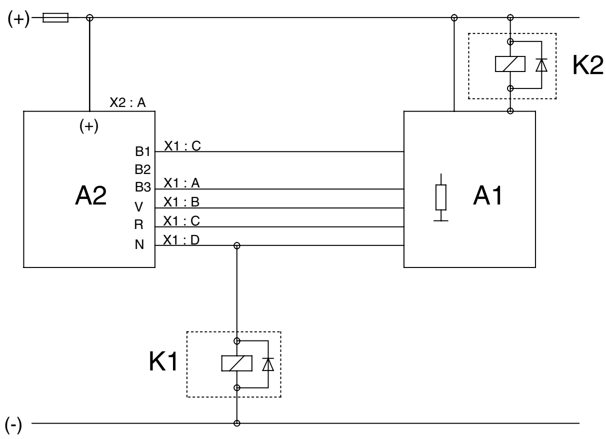


F = FORWARD
N = NEUTRAL
R = REVERSE
D = MECANICAL NEUTRAL INTERLOCK
1 = 1st SPEED
2 = 2nd SPEED
3 = 3rd SPEED

CIRCUIT DIAGRAM SELECTOR



CONNECTION DIAGRAM SELECTOR



K1 = RELAY STARTER INTERLOCK
K2 = RELAY REVERSE LIGHTS
A1 = TCU(Transmission Control Unit)
A2 = CONTROLLER

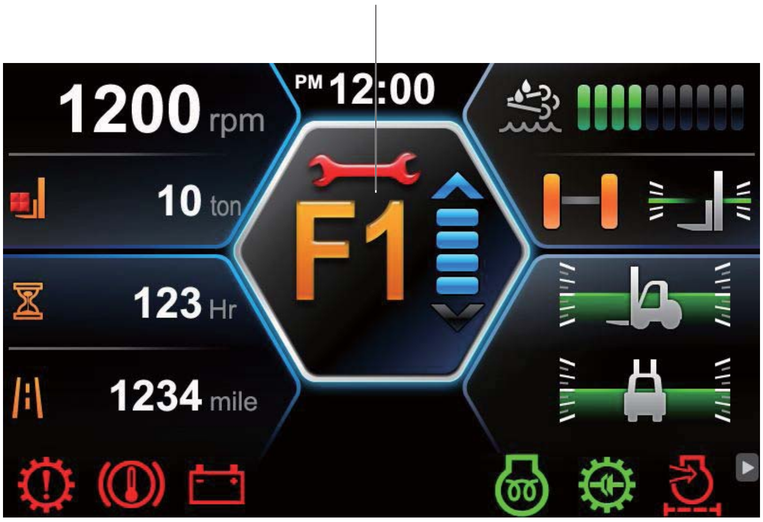
D507PT38

6) TRANSMISSION ERROR DISPLAY

(1) Function

The display can be used with the gear selector (DW-3). It indicates speed and driving direction. When driving in the automatic mode, a bar indicator gives additionally also information about the selected driving range; The automatic range is symbolized by arrows above and below the bar indicator. In case of possible errors in the system, a wrench appears on the display, combined with indication of the error number. Also sporadically occurring errors can be indicated.

Transmission message display



50D93ACD33

※ If it happens error codes, consult with Hyundai service center to repair the fault.

(2) Display during AEB-Mode

Symbol	Meaning	Remarks
K1......K3 KV, KR	Calibrating clutch K1...K3, KV or KR resp.	
_and Kx	Wait for start, initialization of clutch Kx, x : 1, 2, 3, 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) after removing AEB-Starter
STOP	AEB canceled(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 enging speed	
▽E	Engine speed too high → lower enging 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)
STOP	AEB-Starter was used incorrect or is defective. Wrong device or wrong cable used.	Transmission stays in neutral, you have to restart the TCU(ignition off/on)

(3) INITIALIZING THE INCHING SENSOR

① Start engine after parking the machine on flat floor and blocking wheels.
② Release parking brake and keep neutral gear shift.
③ Adjust the inching sensor linkage so that the regular voltage is supplied to inching sensor when operating the pedal.
※ Regular voltage ; Before pedal operation (1±0.1V), After pedal operation (3.5±0.1V).
④ Stop the engine and then just KEY ON. (Release parking brake, keep neutral gear)
⑤ Connect the AEB STARTER to the T/M controller.
⑥ Push AEB STARTER over 3 seconds.
⑦ If display shows "▼IP", Step on the pedal fully.
⑧ If display shows "▲IP", release "OK"
⑨ After the successful completion, it displays "OK".
⑩ In case of abnormal running, it may display "STOP" with the appropriate error code.
⑪ After troubleshooting, start the machine again to repeat above.
※ Above works are to be done with the parking brake released, so machine's wheels must be blocked for safety.

(4) DISPLAY DURING INCHPEDAL CALIBRATION

Symbol	Meaning	Remarks
▼IP	Push down the pedal slowly until endposition is reached and hold this position	
▲IP	Release the pedal slowly until endposition is reached	
IP blinkt	A problem occurred, release the pedal slowly until endposition is reached	If the expected endposition could not be reached, release the pedal and try again
OK	Finished inchpedal calibration successful	
FN and Stop	Shift lever not in Neutral position	Calibrations is aborted
FS and Stop	Sensor supply voltage AU1 is out of the specified range	Calibrations is aborted
FO and Stop	Outputspeed_not_zero	Calibrations is aborted
SL and Stop	Sensor voltage below specified range	Calibrations is aborted
SU and Stop	Sensor voltage below specified range	Calibrations is aborted
IL and Stop	Sensor position for released pedal out of specified range	Calibrations is aborted
IU and Stop	Sensor position for released pedal out of specified range	Calibrations is aborted
TO and Stop	Time-out calibration, pedal not moved after calibration start	Calibrations is aborted
DL and Stop	Angle between pedal positions released and pressed to small	Calibrations is aborted
DU and Stop	Angle between pedal positions released and pressed to small	Calibrations is aborted
FI and Stop	Sensor signal 1 and 2 don't match together	Calibrations is aborted

(5) Transmission error codes

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
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 elector 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
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

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
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
25	**S.C. to battery voltage or O.C. at transmi-ssion 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 transmi-ssion 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

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
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
29	**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
30	**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
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
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

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
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
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
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 page 3-37
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 page 3-37
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 page 3-37
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 page 3-37
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 page 3-37
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 page 3-37

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
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 page 3-37
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 page 3-37
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 page 3-37
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 * See page 3-37
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 page 3-37

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
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 page 3-37
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 page 3-37
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 page 3-37
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 page 3-37

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
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 page 3-37
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 page 3-37
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 page 3-37
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 page 3-37

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
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 page 3-37
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 page 3-37
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 page 3-37
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 page 3-37

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
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 page 3-37
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 page 3-37
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 page 3-37
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 page 3-37
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 page 3-37

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
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 page 3-37
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 page 3-37
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 page 3-37
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 page 3-37

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
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 page 3-37
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 page 3-37
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 page 3-37
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 page 3-37
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 page 3-37
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 page 3-37

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
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
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
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)

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
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
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 page 3-37
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 page 3-37
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 page 3-37

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
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 page 3-37
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 page 3-37
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 page 3-37

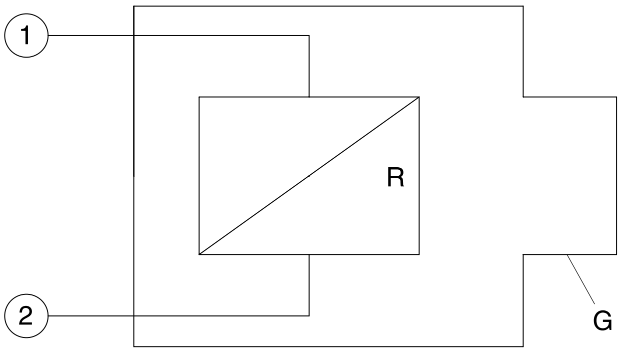
Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
D1	**S.C. to battery voltage at power supply for sensors** TCU measures more than 6V at the pin AU1 (5V sensor supply)	See fault codes No.21 to 2C	· Check cables and connectors 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
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
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
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

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

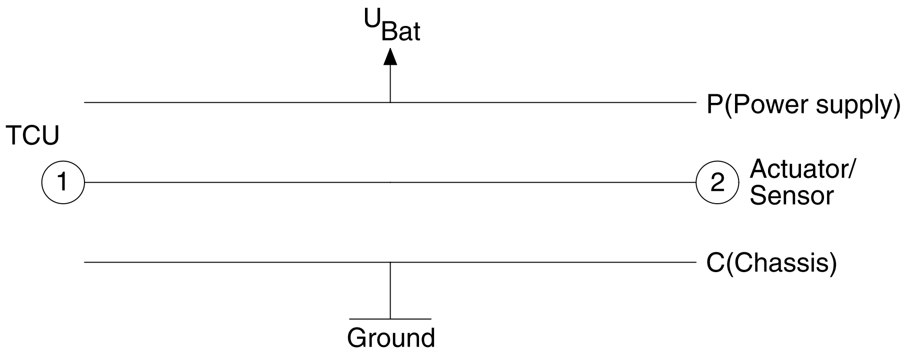
① Actuator



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) ELECTRONIC CONTROL FOR POWER TRANSMISSION

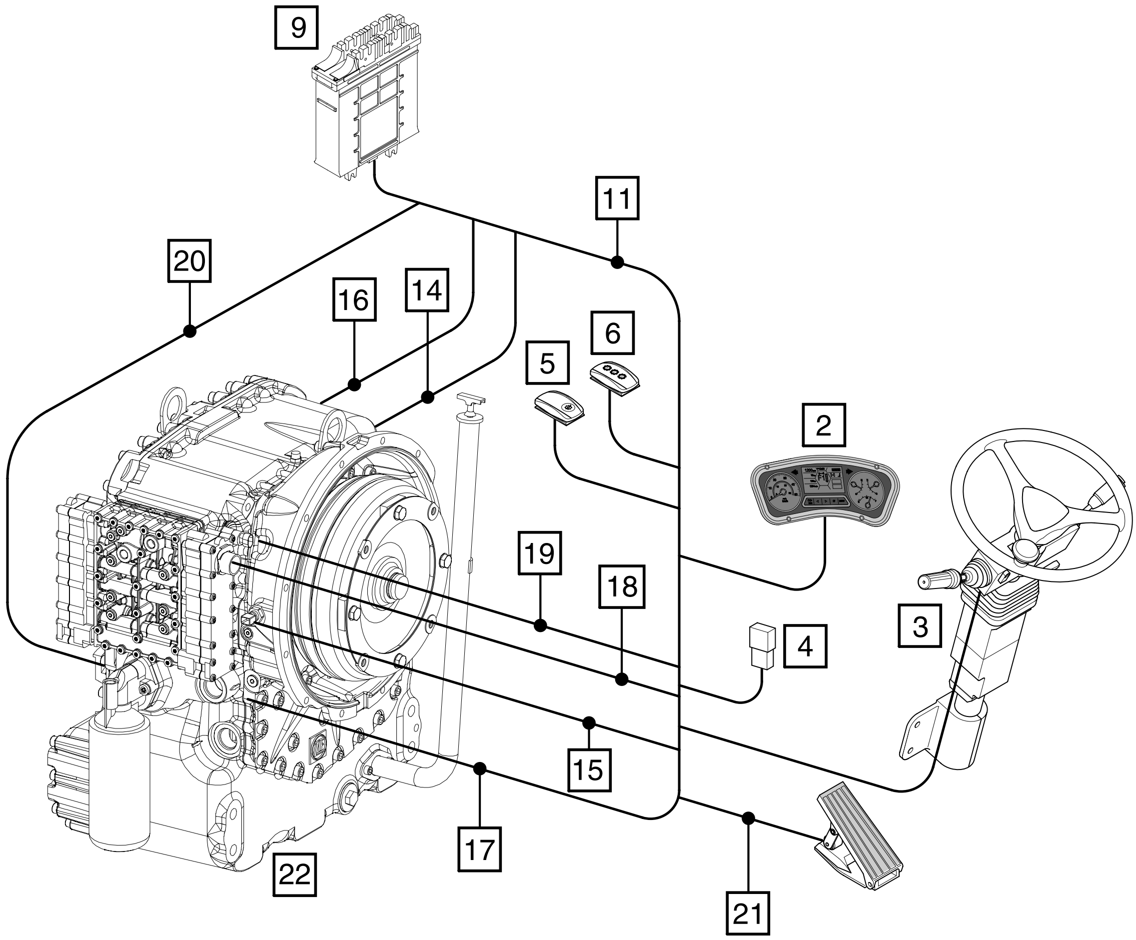
(1) Description of the basic functions

The powershift transmission is equipped with TCU.

- · The system is processing the desire of the driver according to the following criteria :
- · Gear determination depending on gear selector position, driving speed and load condition.
- · Protection from operating error as far as necessary, is possible via electronic protecttion (programming).
- · Protection from over-speeds (on the base of engine and turbine speed).
- · Electronic inching.

Legend

2 = Display
3 = Gear selector DW - 3
4 = Power supply connection
5 = Switch for enable inched (Option)
6 = Switch for driving program manual/Auto 1/Auto 2
9 = TCU (EST-37A)
11 = Wiring
14 = Cable to inductive transmitter speed central gear train
15 = Cable to inductive speed engine
16 = Cable to inductive transmitter speed turbine
17 = Cable to temperature measuring point behind the converter
18 = Cable to plug connection on the electrohydraulic control unit
19 = Cable to filter contamination switch
20 = Cable to speed sensor output
21 = Cable from angle sensor/inch-sensor
22 = Transmission



110D9PT17

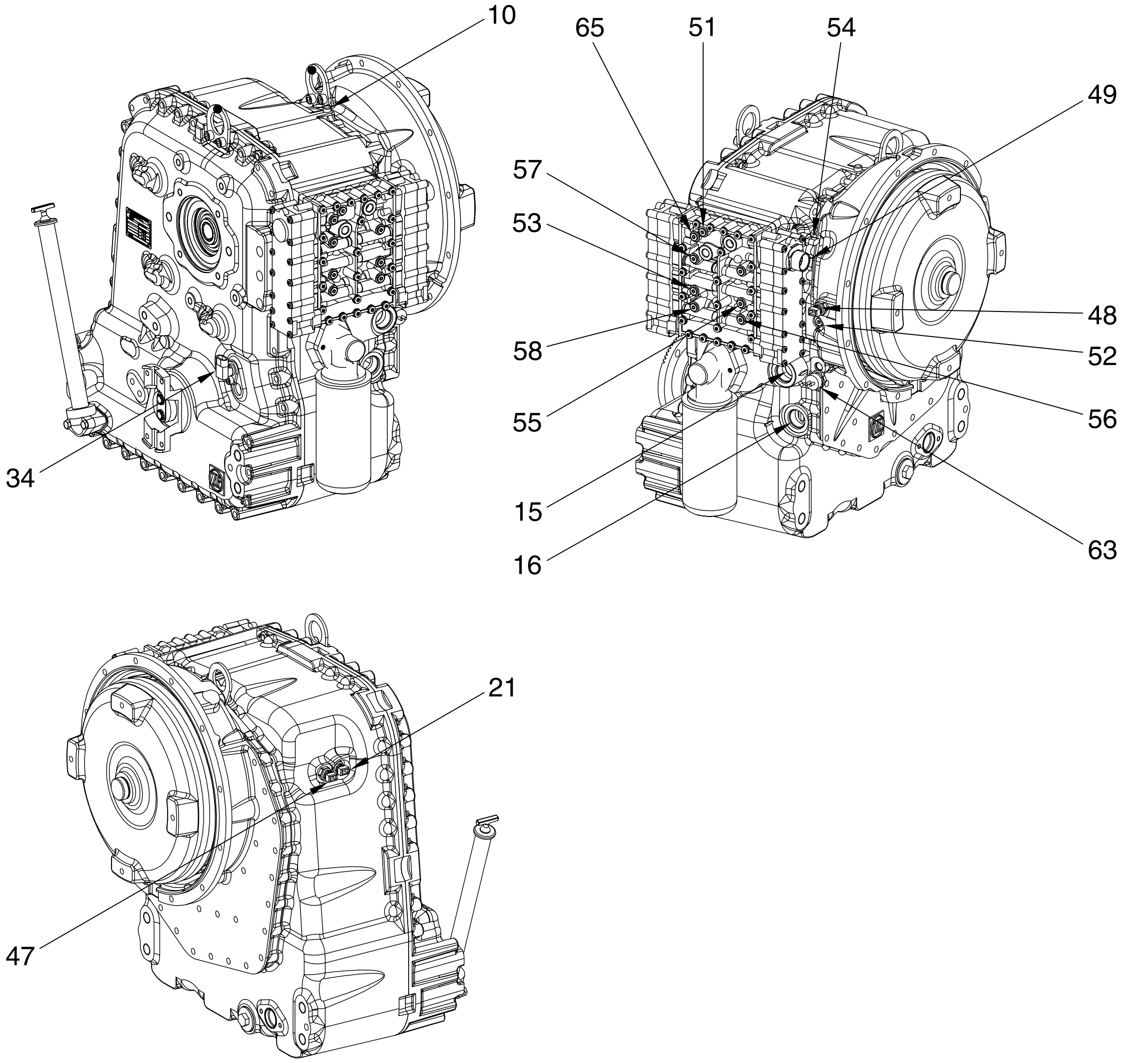
(2) Inching device

This function is especially suitable for lift trucks. It allows to reduce the driving speed infinitely variable without modification of the engine speed in such a way that driving with a very low speed will be possible. In his way, the driver can move the vehicle very exactly to a determined position.
At the same time and important part of the engine power for the output of the hydraulic system is at disposal by the high engine speed.

Operation is carried out by a separate inching pedal, where an angle of rotation sensor is mounted.
By means of the proportional valve technology the TCU regulates the pressure in the driving direction clutch in such a way that the driving speed is adjusted in accordance with the inch rotating angle sensor position. Clutch overloading is avoided thanks to the electronic protection.

4. TRANSMISSION MEASURING POINTS AND CONNECTIONS

The measurement have to be carried out with hot transmission (about 80~95˚C)



110D9TM04

1) OIL PRESSURE AND TEMPERATURE

Port	Description	Size
51	In front of converter - Opening pressure 11+2 bar	M10 × 1
52	Behind converter - Opening pressure 4.3 + 3 bar	M14 × 1.5
53	Clutch Forward 16 + 2 bar KV	M10 × 1
55	Clutch reverse 16 + 2 bar KR	M10 × 1
56	Clutch 16 + 2 bar K1	M10 × 1
57	Clutch 16 + 2 bar K2	M10 × 1
58	Clutch 16 + 2 bar K3	M10 × 1
63	Temperature sensor behind the converter	M14 × 1.5
65	System pressure 16 + 2.5 bar	M10 × 1

2) FLOW RATES

Port	Description	Size
15	Connection from oil cooler	1 $^{5}/_{16}$" - 12UN-2B
16	Connection to oil cooler	1 $^{5}/_{16}$" - 12UN-2B

3) TRANSMITTERS AND SWITCHES

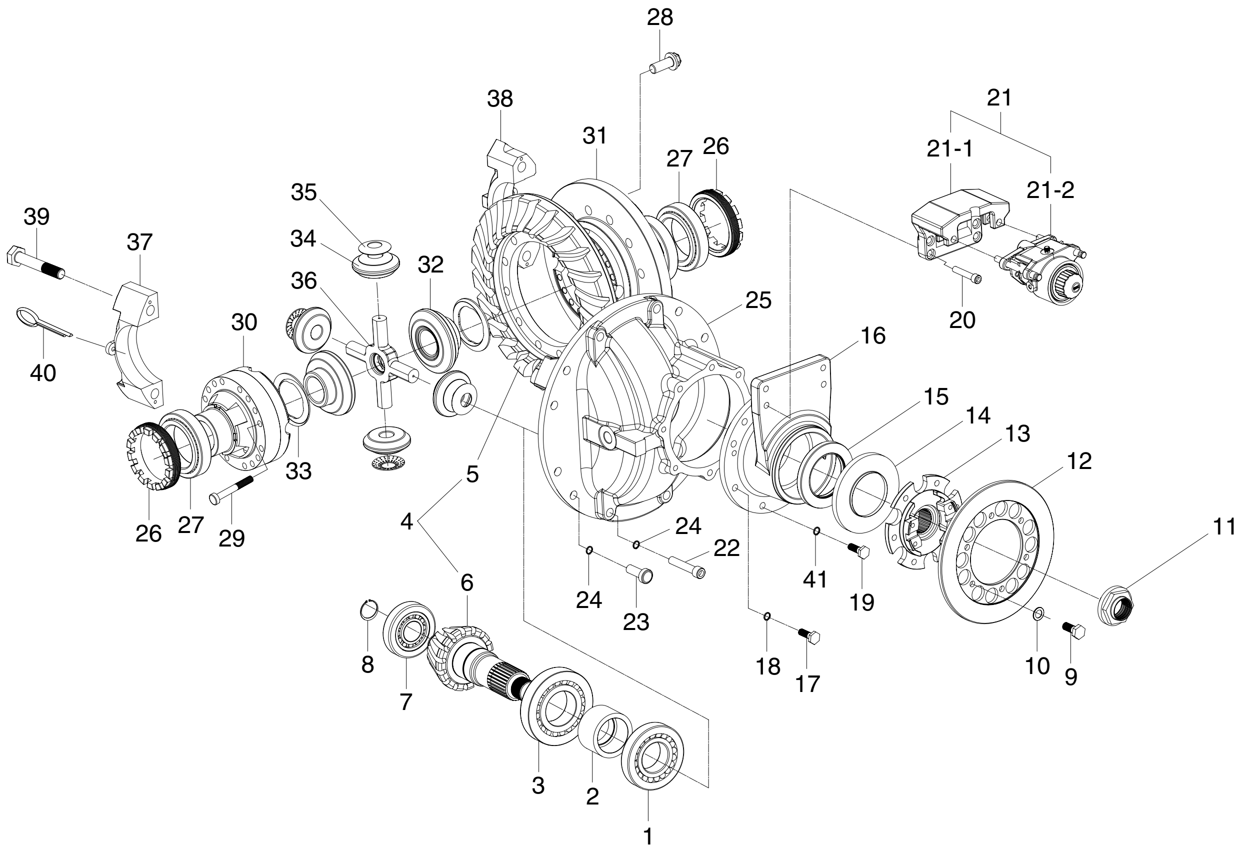
Port	Description	Size
21	Inductive transmitter n Turbine	M18 × 1.5
34	Speed transmitter n Output	-
47	Inductive transmitter n Internal speed input	M18 × 1.5
48	Inductive transmitter n Engine	M18 × 1.5
54	Differential pressure switch for pressure filter	M14x1.5

4) CONNECTIONS

Port	Description	Size
10	Breather	M10 × 1
49	Plug connection on electro-hydraulic control unit	

5. DRIVE AXLE (DIC)

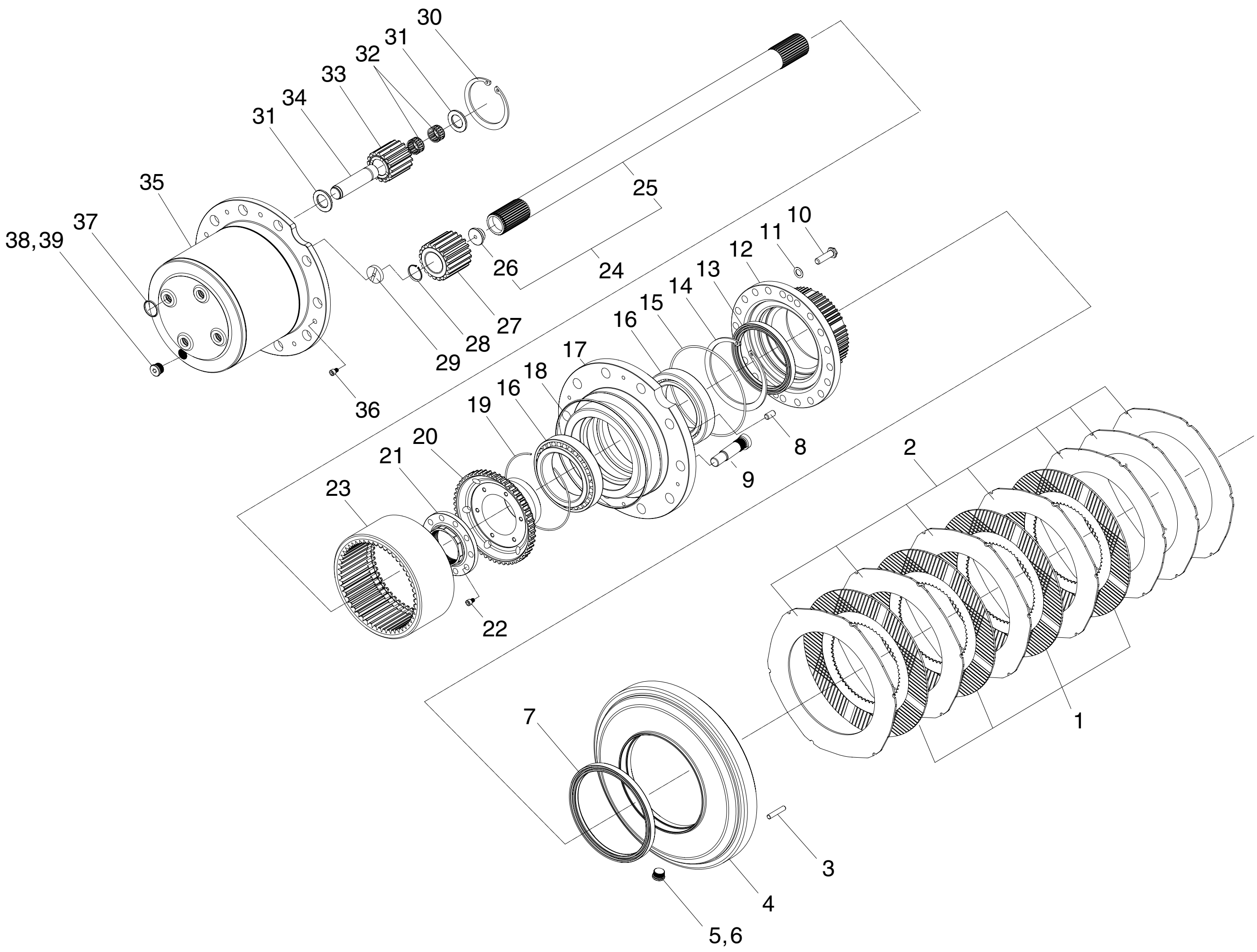
1) STRUCTURE 1



110DEDR02

1 Taper roller bearing
2 Spacer
3 Taper roller bearing
4 Bevel gear assy
5 Ring gear
6 Pinion shaft
7 Roller bearing
8 Snap ring
9 Hexagon bolt
10 Washer
11 Lock nut
12 Parking disc
13 Yoke
14 Dust cover
15 Oil seal
16 Differential flange
17 Hexagon bolt
18 Spring washer
19 Hexagon bolt
20 Socket bolt
21 Brake assy
22 Hexagon bolt
23 Hexagon bolt
24 Spring washer
25 Differential carrier
26 Adjusting nut
27 Taper roller bearing
28 Flange bolt
29 Hexagon bolt
30 Differential case-RH
31 Differential case-LH
32 Side gear
33 Thrust washer
34 Pinion gear
35 Thrust washer
36 Spider
37 Differential cap-RH
38 Differential cap-LH
39 Reamer bolt
40 Cotter pin
41 Washer

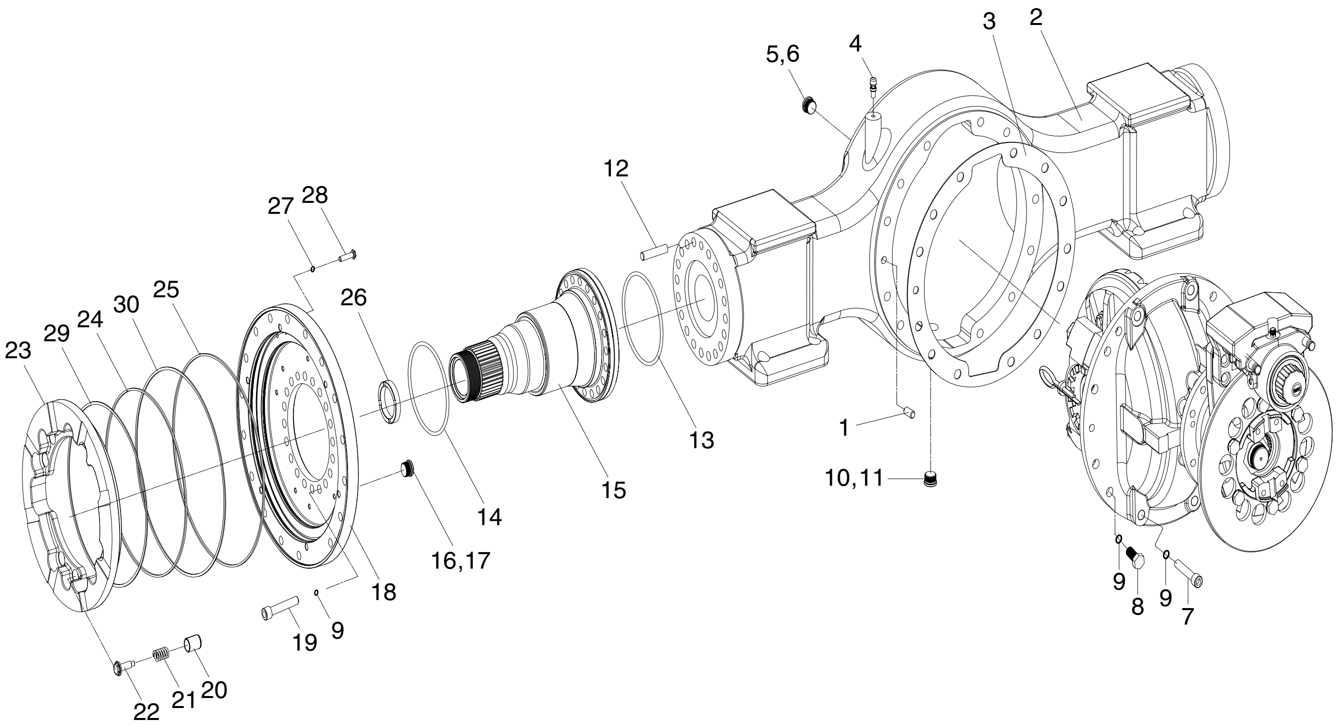
2) STRUCTURE 2



110DEDR03

1	Brake disc	14	Snap ring	27	Sun gear
2	Brake plate	15	O-ring	28	Snap ring
3	Pin	16	Taper roller bearing	29	Stopper
4	Brake cover	17	Wheel hub	30	Snap ring
5	Magnetic plug	18	O-ring	31	Thrust washer
6	O-ring	19	C-ring	32	Needle bearing
7	Oil seal	20	Carrier gear	33	Planetary gear
8	Pin	21	Nut	34	Planetary shaft
9	Wheel bolt	22	Hexagon bolt	35	Planetary housing
10	Hexagon bolt	23	Ring gear	36	Socke bolt
11	Washer	24	Shaft assy	37	O-ring
12	C/Spline hub	25	Shaft	38	Plug
13	Oil seal	26	Bushing	39	O-ring

3) STRUCTURE 3

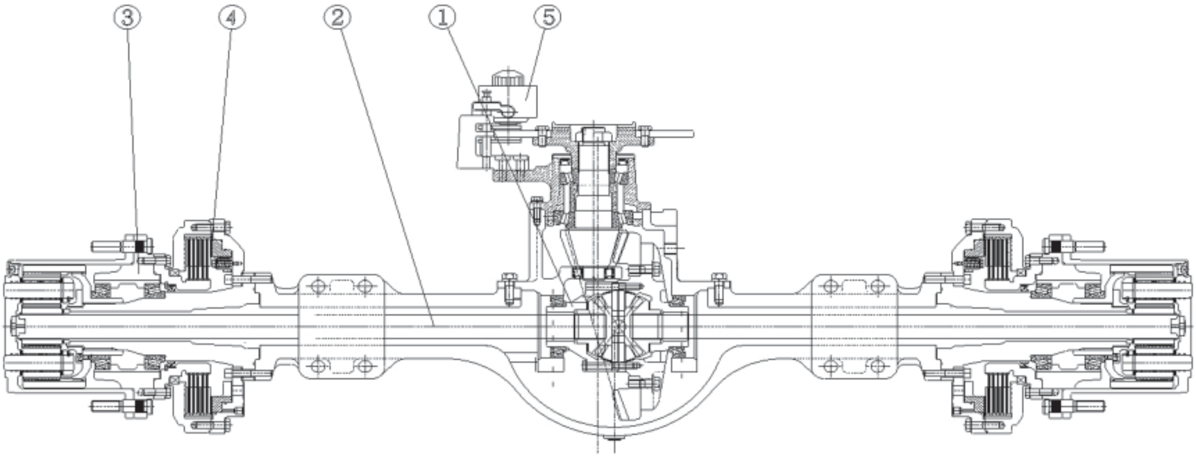


110DEDR04

1	Dowel pin	11	O-ring	22	Adjust bolt
2	Axle housing	12	Spacer	23	Piston
3	Gasket	13	O-ring	24	Quad ring
4	Air breather	15	Axle tube	25	Quad ring
5	Plug	16	Magnetic plug	26	Bushing
6	O-ring	17	O-ring	27	Washer
7	Hexagon bolt	18	Brake housing	28	Hexagon bolt
8	Hexagon bolt	19	Socket bolt	29	Back up ring
9	Spring washer	20	Bushing	30	Back up ring
10	Magnetic plug	21	Spring		

4) SYSTEM OPERATION

(1) General specification



110DEDA01

1	Differential	4	Service brake
2	Drive shaft	5	Parking brake
3	Drive wheel		

OPERATION

The drive axle is composed of differential carrier assy (1), drive shaft (2), and drive wheel (3).

The power is transmitted from the engine fly wheel to the transmission.

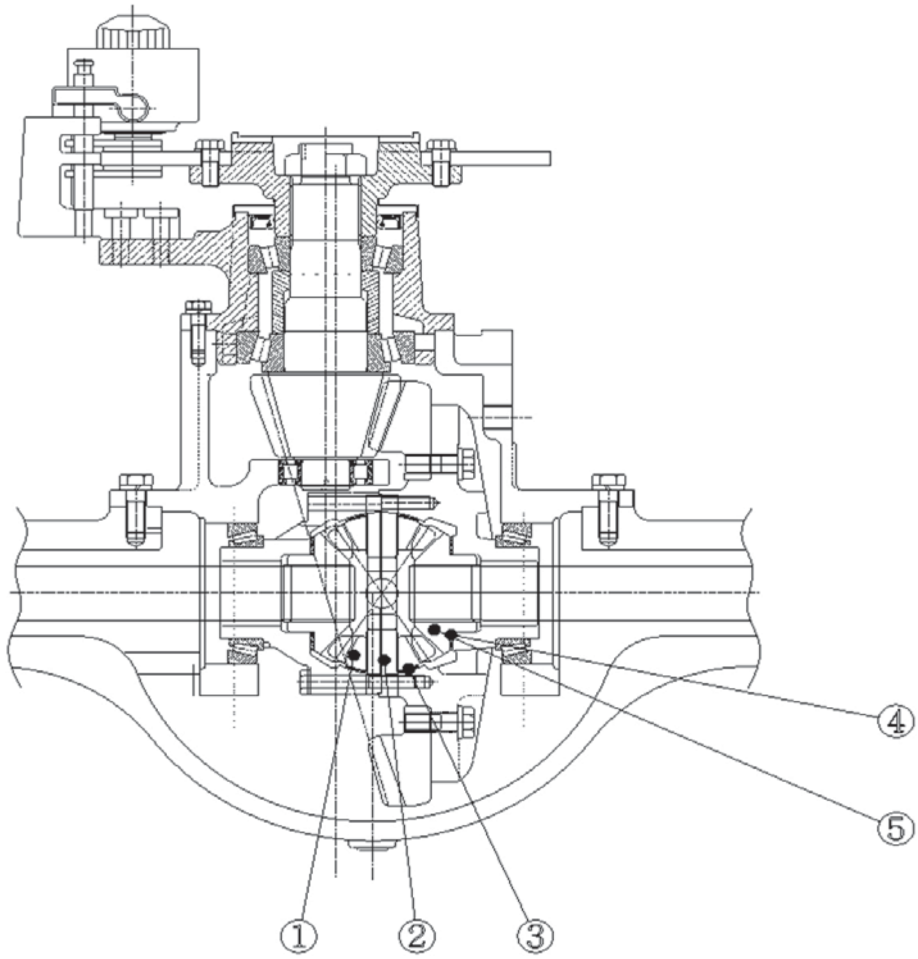
The power of transmission is transmitted to the spiral bevel gear through the output gear of the transmission.

Then the power of differential is transmitted to the wheel through the drive shaft.

(2) Powertrain specification

Classify			110/130D-9		160D-9	
Drive shaft	Reduction gear ratio	Differential	2.93 (41/11)		3.73 (41/11)	
		Plenatary gear	3.60 (52/20)			
		Sum	11.73		12.7	
	Axle oil		Differential	Cooling oil	Differential	Cooling oil
			SAE 80W/90	Mobil 424	SAE 80W/90	Mobil 424
	Oil capacity		15 ℓ	Circulating type	15 ℓ	Circulating type
Brake	Service brake		Wet disc brake			
	Brake oil		Hydraulic oil			
	Parking brake		Dry disc brakes with clip on type			
Differential	Gear type		Bevel gear			
	Differential type		4 pinion way			
U-joint			7C			

5) DIFFERENTIAL



110DEDA02

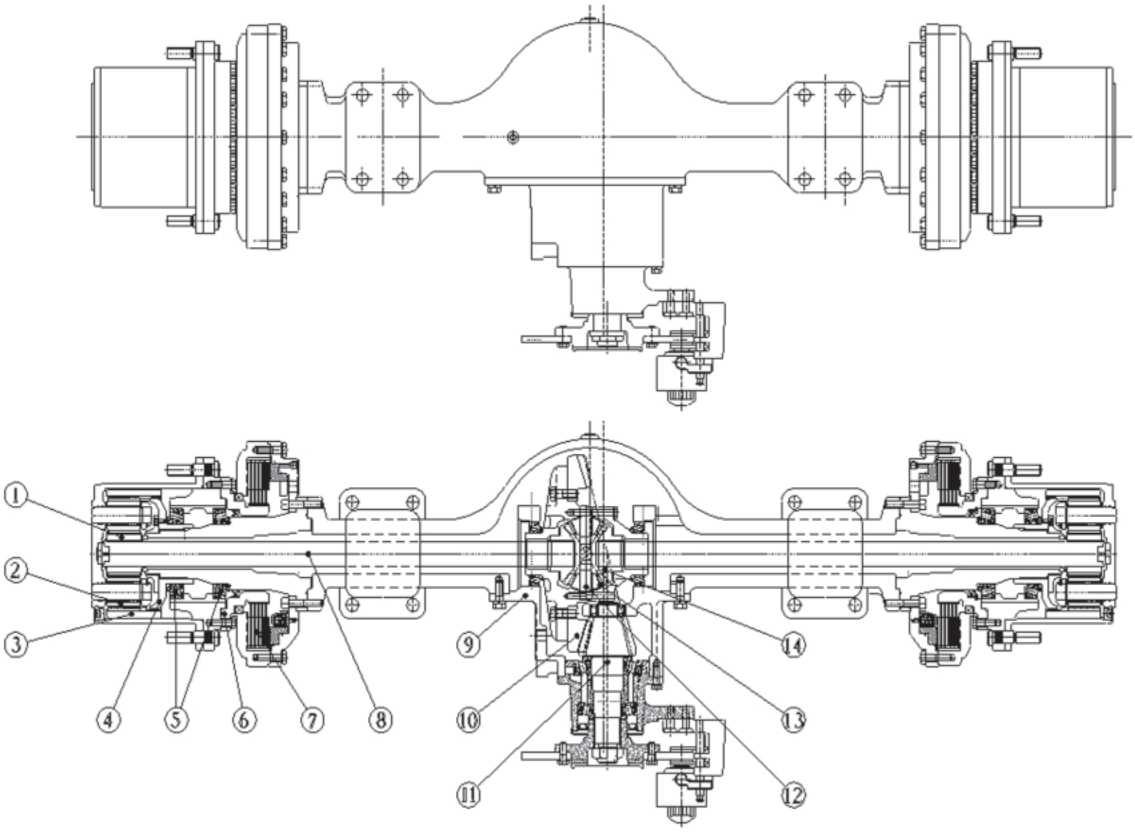
1	Differential pinion gear inner diameter	ø 27.110 ~ ø 27.131
2	Spider out diameter	ø 26.980 ~ ø 26.959
3	Pinion gear washer thickness	1.52 ~ 1.68 mm
4	Side gear washer thickness	2.94 ~ 3.06 mm
5	Side gear (Inner diameter)	ø 50.00 ~ ø 50.04

OPERATION

Differential transmits the power from the transmission to drive wheel.
When the vehicle is running one side wheel rotates slower than the other side wheel.
Differential is composed of 4 pinions (1), 2 side gears (5) and 1 spider (2).
The spider is meshed vertically between 4 pinions (1) and 2 side gear (5), so the engagement become a right angle.

6) DRIVE SHAFT

(1) General standards



110DEDA03

1	Sun gear	6	Hub assembly	11	Pinion shaft
2	Plenatary gear	7	Disc brake	12	Spider
3	Internal gear	8	Drive shaft	13	Pinion gear
4	Internal gear carrier	9	Differential carrier	14	Side gear
5	Taper roller bearing	10	Ring gear		

OPERATION

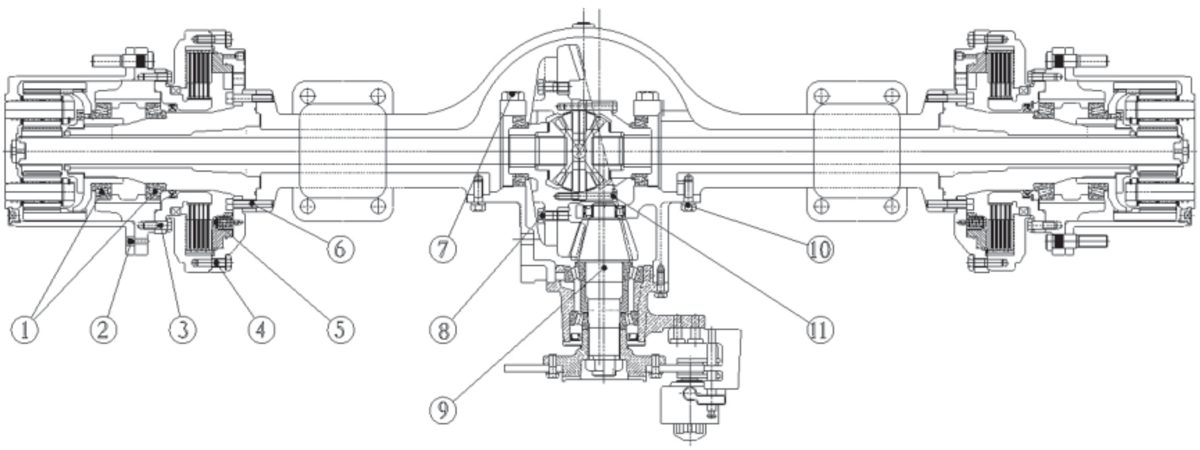
Drive axle which consists of differential carrier assembly (9), drive shaft (8) and hub assembly (6) transmits the drive force from transmission to the wheels.

Pinion shaft (11) is connected to transmission output through universal joint.

The power of transmission is transmitted to differential which consists of pinion shaft (11) and ring gear (10) and the differential rotates the drive shaft (8).

Side gear (14) and drive shaft (8) are connected with spline and the drive shaft (8) connect to planetary gear (2), inner hub (6) and finally drive wheels.

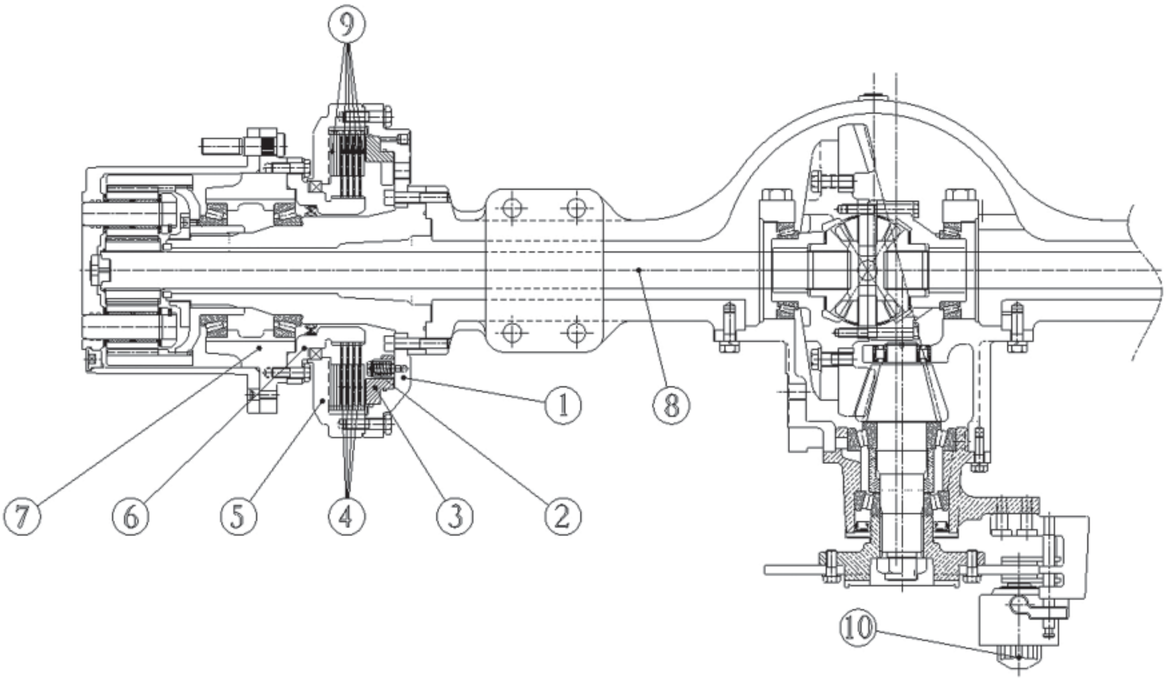
(2) Driving axle tightening torque specifications



110DEDA04

1	Wheel hub pre-load	330~400kg · cm
2	Plenatary housing tightening torque	250~400kg · cm
3	Spline hub tightening torque	3200±50kg · cm
4	Brake cover tightening torque	2100±50kg · cm
5	Self-adjust bolt tightening torque	300~350kg · cm
6	Axle tube tightening torque	3200±50kg · cm
7	Diff carrier cap tightening torque	5500±100kg · cm
8	Ring gear tightening torque	4500±100kg · cm
9	Pinion shaft pre-load tightening torque	Disassembly and assembly reference
10	Diff case tightening torque	2500±50kg · cm
11	Diff carrier assy tightening torque	1000±50kg · cm

(3) Disc brake (110/130D-9)



110DEDA05

1	Brake housing	6	Collar spline hub
2	Self adjust bolt	7	Wheel hub
3	Service brake piston	8	Drive shaft
4	Disc brake	9	Brake plate
5	Brake cover	10	Parking brake

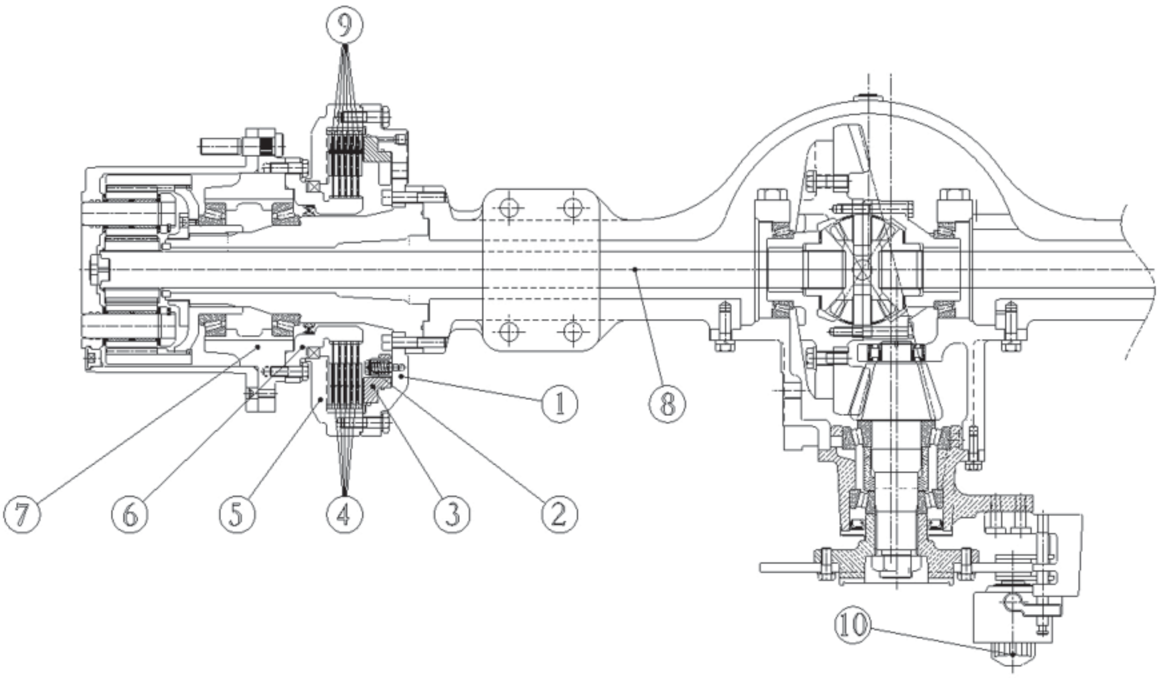
OPERATION

Sealed up structure of hydraulic multi-disk brake system secures good brake performance even in the high humid or dusty area.

Because it is possible to use the brake semi-permanently, there is no need to maintain its lining as drum type brake do. Also with self-adjust of friction plate clearance, it's easy to prevent the brake performance drop due to friction material wear.

Major components are 4 disk plates (4), 7 steel plates (9), service piston (3) and 8 piston adjust bolts (2). Braking take places when the discs and plates are pressed each other by the piston (3) which make rotation resistance to the collar (5) and the drive shaft (7).

(4) Disc brake (160D-9)



1	Brake housing	6	Collar spline hub
2	Self adjust bolt	7	Wheel hub
3	Service brake piston	8	Drive shaft
4	Disc brake	9	Brake plate
5	Brake cover	10	Parking brake

OPERATION

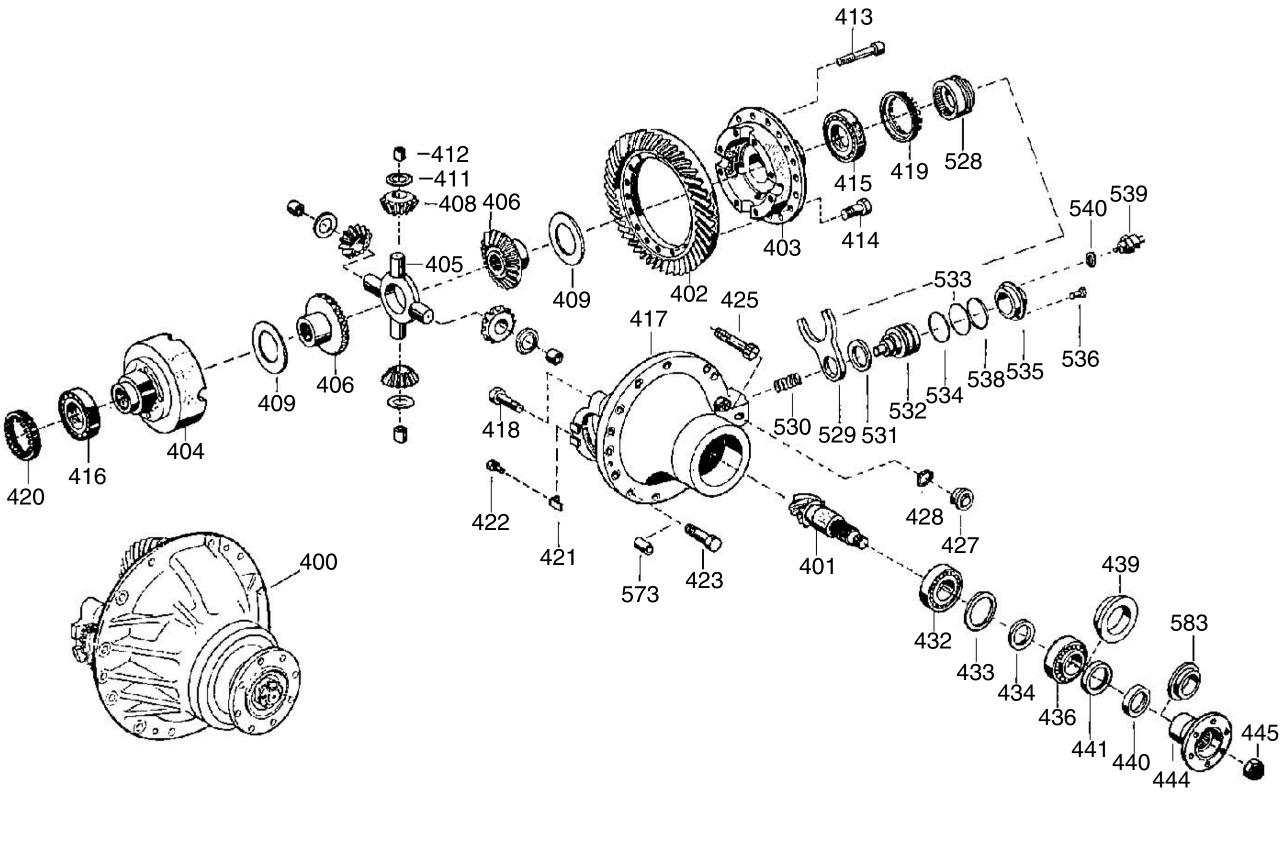
Sealed up structure of hydraulic multi-disk brake system secures good brake performance even in the high humid or dusty area.

Because it is possible to use the brake semi-permanently, there is no need to maintain its lining as drum type brake do. Also with self-adjust of friction plate clearance, it's easy to prevent the brake performance drop due to friction material wear.

Major components are 5 disk plates (4), 6 steel plates (9), service piston (3) and 8 piston adjust bolts (2). Braking take places when the discs and plates are pressed each other by the piston (3) which make rotation resistance to the collar (5) and the drive shaft (7).

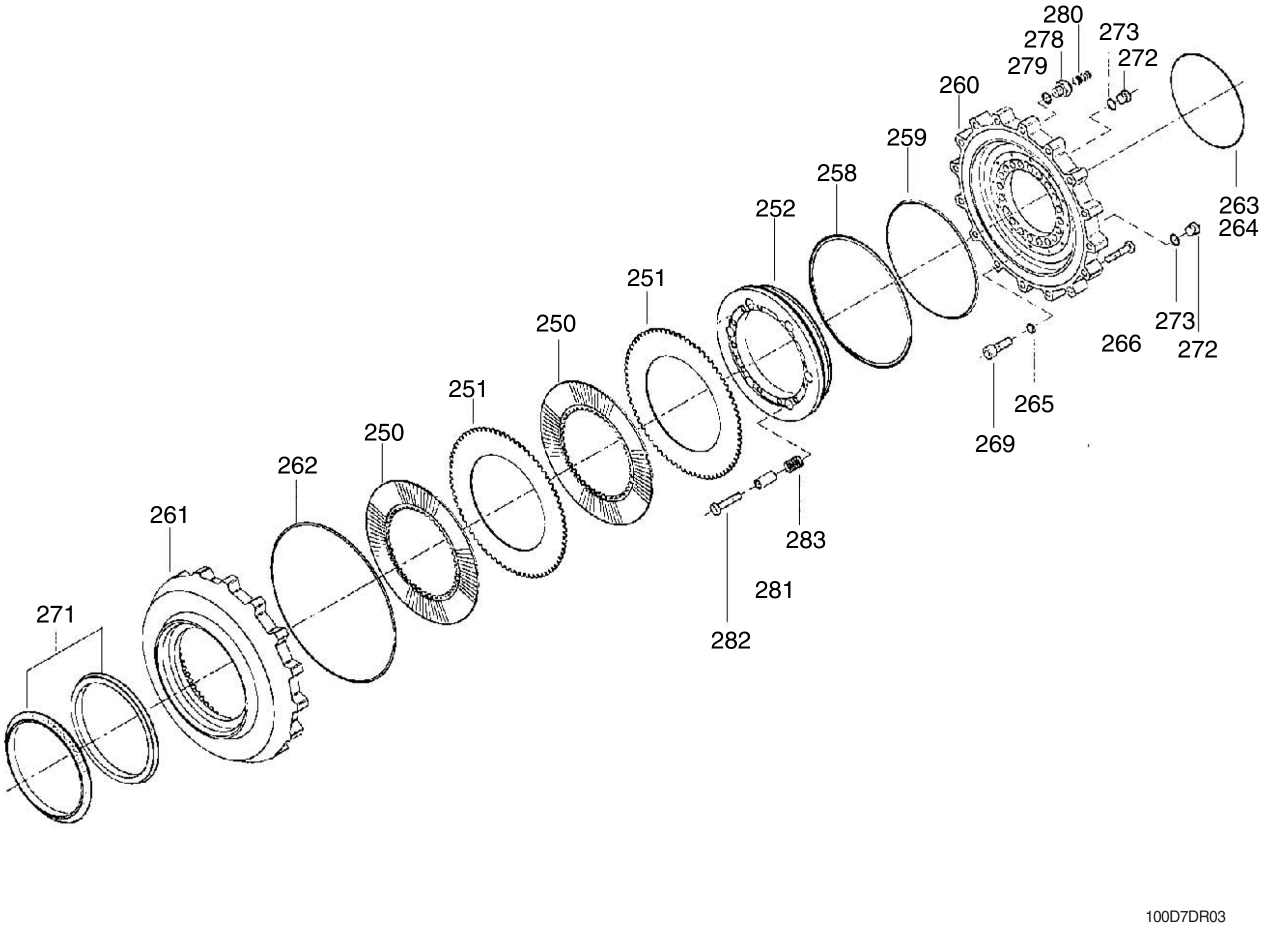
6. DRIVE AXLE (KESSLER)

1) STRUCTURE 1



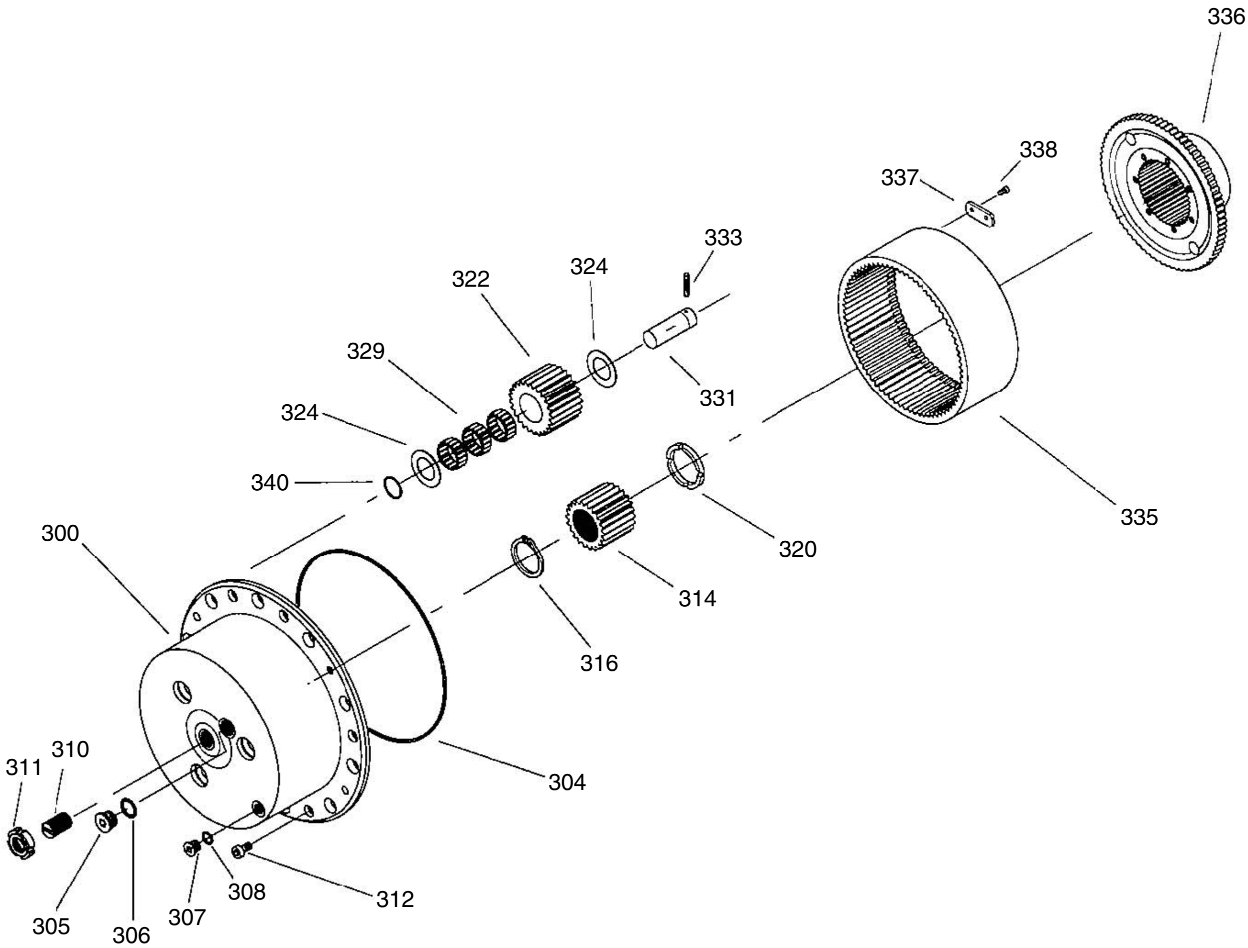
400	Differential & carrier assy	413	Hexagon screw	425	Hexagon screw
401	Drive pinion	414	Hexagon screw	427	Screw plug
402	Ring gear	415	Tapered roller bearing	428	Sealing ring
403	Differential housing	416	Tapered roller bearing	432	Tapered roller bearing
404	Differential housing	417	Differential carrier	436	Tapered roller bearing
405	Differential spider	418	Hexagon screw	440	Radial seal ring
406	Differential side gear	419	Setting ring	444	Drive flange
408	Differential pinion	420	Setting ring	445	Adjusting nut
409	Disk	421	Lock plate	583	Disk
411	Thrust washer	422	Hexagon screw		
412	Bearing bushing	423	Hexagon screw		

2) STRUCTURE 2



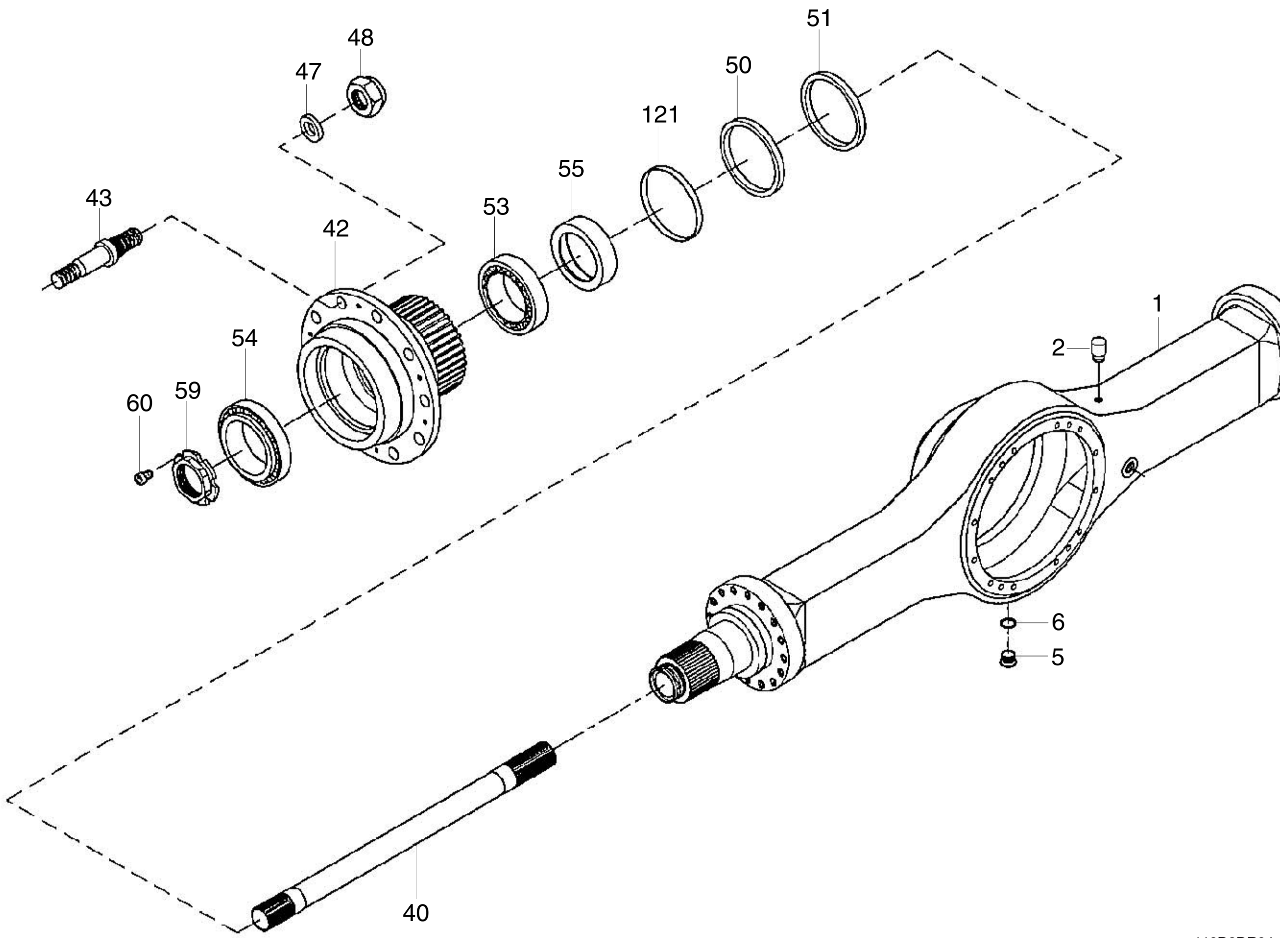
250	Inner disk	262	O-ring	278	Bleeding socket
251	Outer disk	263	O-ring	279	Sealing ring
252	Piston	266	Hexagon screw	280	Bleeder valve
258	Gasket	269	Hex sockets crew	281	Pipe
259	Gasket	271	Face seal	282	Hexagon screw with flange
260	Brake carrier	272	Screw plug	283	Compression spring
261	Housing	273	Sealing ring		

3) STRUCTURE 3



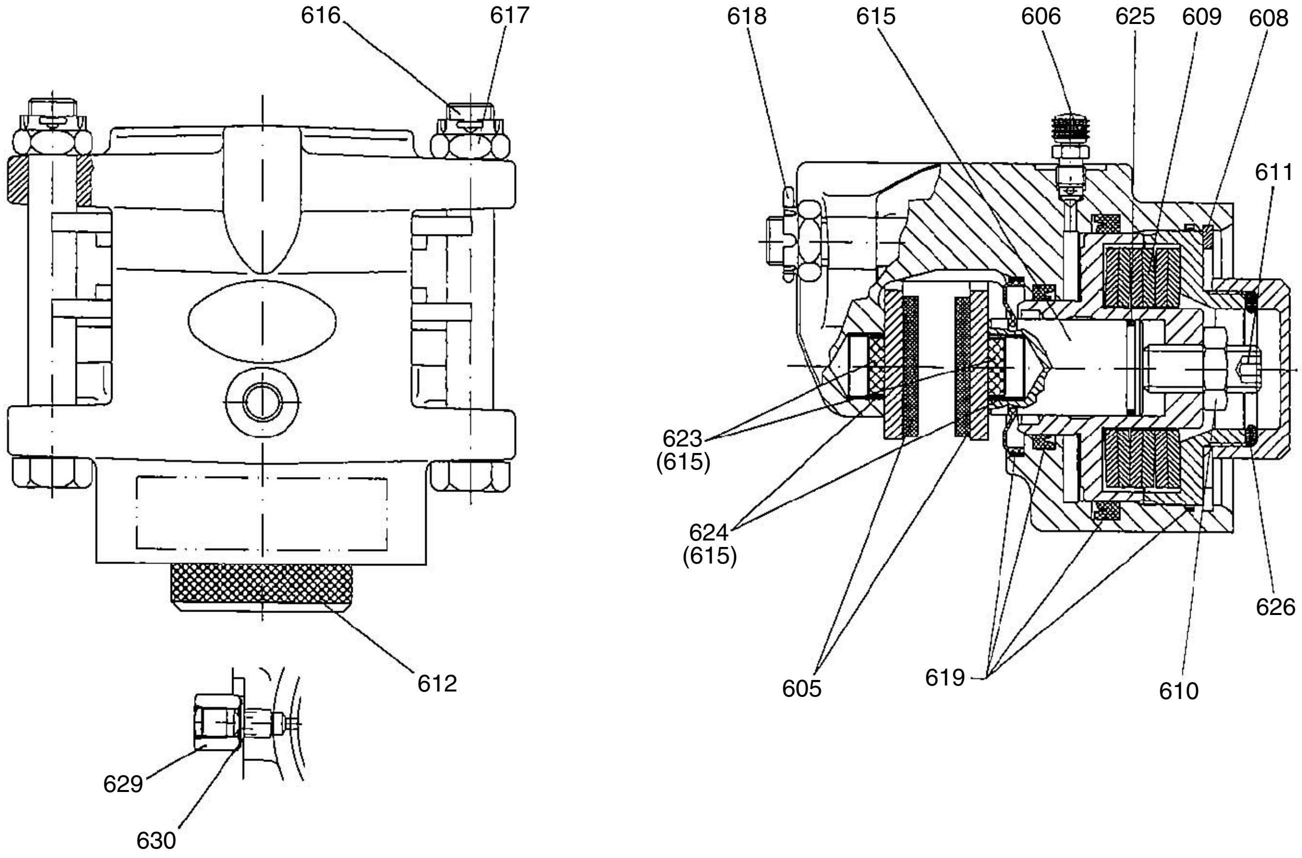
300	Planetary housing	312	Hexagon socket screw	331	Planetary pin
304	O-ring	314	Sun gear	333	Locking pin
306	Sealing ring	316	Circlip	335	Ring gear
307	Screw plug	320	Thrust ring	336	Ring gear carrier
308	Sealing ring	322	Planetary gear	337	Retainer
310	Adjusting screw	324	Thrust washer	338	Hexagon socket screw
311	Slotted nut	329	Needle bearing	340	O-ring

4) STRUCTURE 4



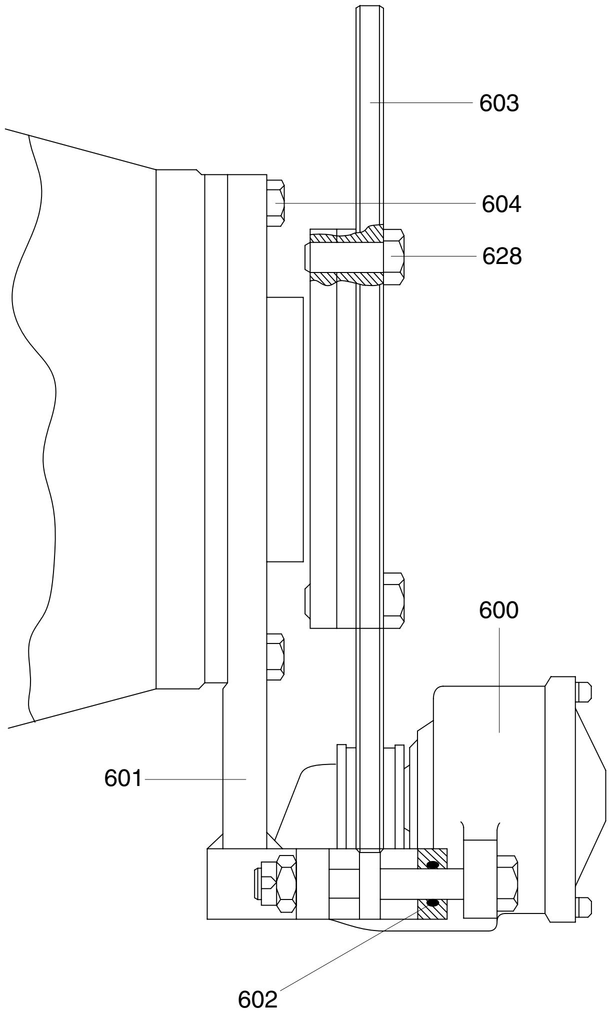
1	Axle housing	47	Disk	55	Spacer ring
2	Breather	48	Hex nut	59	Nut
5	Plug	50	Radial seal ring	60	Socket screw
40	Axle shaft	51	Radial seal ring	121	Ring
42	Wheel hub	53	Taper roller bearing		
43	Stud bolt	54	Taper roller bearing		

5) STRUCTURE 5



605	Lining set	615	Pressure bolt	624	Tolerance ring
606	Bleeder valve	616	Hex screw	625	O-ring
609	Dished plate spring	617	Castle nut	626	O-ring
610	Hex nut	618	Split pin	629	Socket screw
611	Set screw	619	Gasket	630	Sealing ring
612	Cap	623	Magetic		

6) STRUCTURE 6



600	Parking brake	602	O-ring	604	Hex screw
601	Brake carrier	603	Brake disk	628	Hex screw

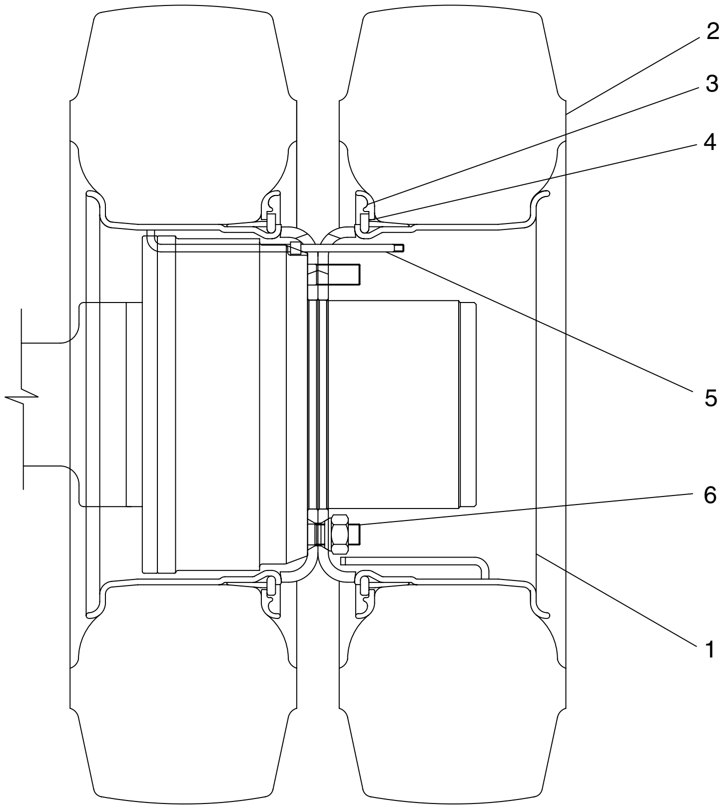
7) OPERATION

Both sides of the housing are supported by the frame and the center is mounted on the transmission case through propeller shaft.

The mast is installed on the front of the drive axle housing. The final deceleration and differential device built in the housing guarantee accurate rotation and smooth operation.

The power from the transmission in transferred through the hypoid pinion, hypoid gear, differential case, the pinion of the differential device and the side gear to the drive axle shaft by the side gear spline and to the hub and wheel mounted on the shaft by high tension bolts.

7. TIRE AND WHEEL



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

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.

GROUP 2 OPERATION AND MAINTENANCE

1. OPERATION

1) DRIVING PREPARATION AND MAINTENANCE

Prior to the commissioning of the transmission, take care that the prescribed oil grade will be filled in with the correct quantity. At the initial filling of the transmission has to be considered that the oil cooler, the pressure filters as well as the pipes must get filled with oil.

According to these cavities, the quantity of oil to be filled in, is greater than at the later oil fillings in the course of the usual maintenance service.

※ Because the converter and the oil cooler, installed in the vehicle, as well as the pipes can empty at standstill into the transmission, the **oil level check must be carried out at engine idling speed and operation temperature of the transmission.**

⚠ **At the oil level check, the vehicle has to be secured against rolling by blocks, articulated vehicles additionally against unintended turning-in.**

2) DRIVING AND SHIFTING

(1) Neutral position

Neutral position will be selected via the gear selector.

After the ignition is switched on, the electronics remains in the waiting state. By the position NEUTRAL of the gear selector, the TCU becomes ready for operation.

A gear can be engaged.

(2) Starting

The starting of the engine has always to be carried out in the NEUTRAL POSITION of the gear selector.

For safety reasons it is to recommend to brake the vehicle securely in position with the parking brake prior to start the engine.

After the starting of the engine and the preselection of the driving direction and the gear, the vehicle can be set in motion by acceleration.

At the start off, the converter takes over the function of a master clutch.

On a level road it is possible to start off also in higher gears.

- Upshifting under load.

Upshifting under load will be then realized if the vehicle can continue to accelerate by it.

- Downshifting under load.

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

- Upshifting in overrunning condition.
  In the overrunning mode, the upshifting will be suppressed by accelerator pedal idling position, if the speed of the vehicle on a downgrade should not be further increased.
- Downshifting in overrunning condition.
  Downshifting in overrunning mode will be then carried out if the vehicle should be related.

If the vehicle will be stopped and is standing with running engine and engaged transmission, the engine cannot be stalled. On a level and horizontal roadway it is possible that the vehicle begins to crawl, because the engine is creating at idling speed a slight drag torque via the converter.
It is convenient to brake the vehicle at very stop securely in position with the parking brake. At longer stops, the controller has to be shifted to the NEUTRAL POSITION.

At the start off, the parking brake has to be released. We know from experience that at a converter transmission it might not immediately be noted to have forgotten this quite normal operating step because a converter, due to its high ratio, can easily overcome the braking torque of the parking brake.
Temperature increases in the converter oil as well as overheated brakes will be the consequences to be find out later.
Neutral position of the selector switch at higher vehicle speed(above stepping speed) is not admissible.
Either a suitable gear is to be shifted immediately, or vehicle must be stopped at once.

3) COLD START

At an oil temperature in the shifting circuit <-12˚C, the transmission must be warmed-up for some minutes.
This must be carried out in neutral with an increased engine speed (about 1500 min^{-1}).
Until this oil temperature is reached, the electronics remains in neutral, and the symbol of the cold start phase will be indicated on the display.

Indication on the display:

After the indication on the display is extinguished, the full driving program can be utilized out of "NEUTRAL".

4) OIL TEMPERATURE

The oil temperature in the transmission sump is in the electrohydraulic control unit.

The service temperature in the sump of 60˚~90˚C must not be exceeded.
By overstepping results by 105˚C notice "WS" on the display.

At a trouble-free unit and an adequate driving mode, a higher temperature will not occur.
The notice "WS" results at the display, the vehicle has to be stopped and controlled for external oil loss and the engine must run with a speed of 1200-1500 min^{-1} at NEUTRAL POSITION of the transmission.

Now, the temperature must drop quickly (in about 2~3 minutes) to normal values. If this is not the case, there is a trouble pending, which must be eliminated prior to continue working.

The monitoring of the oil temperature(behind the converter) is additionally on the temperature gauge which is located on the dashboard.

Operating temperature behind the converter at least 65˚C and 100˚C in continuous operation, a short-time increase up to max. 120˚C is permitted.

The temperature is measured on the measuring point "63" (see schedule of measuring points-3-41)

2. MAINTENANCE

1) TRANSMISSION

(1) Oil level check

⚠ At the oil level check, the vehicle has to be secured against rolling with blocks.

The oil level check must be carried out as follows :

- Oil level check (weekly)
- At horizontally standing vehicle
- Transmission in neutral position "N"
- In the cold start phase, the engine must be running about 2~3 minutes at idling speed, and the marking on the oil dipstick must then be lying above the cold start mark "COLD"
- At operating temperature of the transmission(about 80˚~90˚C)
- At engine idling speed
- Loosen oil dipstick by counter-clock rotation, remove and clean it
- Insert oil dipstick slowly into the oil level tube until contact is obtained, and pull it out again.
- On the oil dipstick, the oil level must be lying in the zone "HOT"
- Insert the oil dipstick again, and tighten it by clockwise rotation

If the oil level has dropped in operating temperature condition below the "HOT" zone, it is absolutely necessary to replenish oil.
An oil level above the "HOT" marking, is leading to a too high oil temperature.

(2) Oil change and filter replacement intervals

※ First oil change after 100operating hours in service.
Every further oil change after 1000operating hours in service, however at least once a year.
At every oil change, the fine filter has to be replaced.

① Oil change and oil filling capacity

The oil change has to be carried out as follows. At operating temperature of the transmission, horizontally standing vehicle open the oil drain plug and drain the used oil.

- Clean oil drain plug with magnetic insert and surface on the housing and install again along with O-ring.
- Fill in oil (about 20 liters).
  (Sump capacity, external oil capacities e. g. in the heat exchanger, in the lines etc. are depended on the vehicle).
  The indicated value is a guide value.

※ It is imperative to pay attention to absolute cleanliness of oil and filter.
Binding is in any case the making on the oil dipstick.

- Start the engine-idling speed
- Transmission in neutral position "N"
- Top up oil up to the marking "COLD"
- Brake the vehicle securely in position and warm up the transmission
- Shift all controller positions through
- Check the oil level once more and top up oil once more if necessary
- On the oil dipstick, the oil level must be lying in the zone "HOT"
- Insert the oil dipstick again and tighten it by clockwise rotation

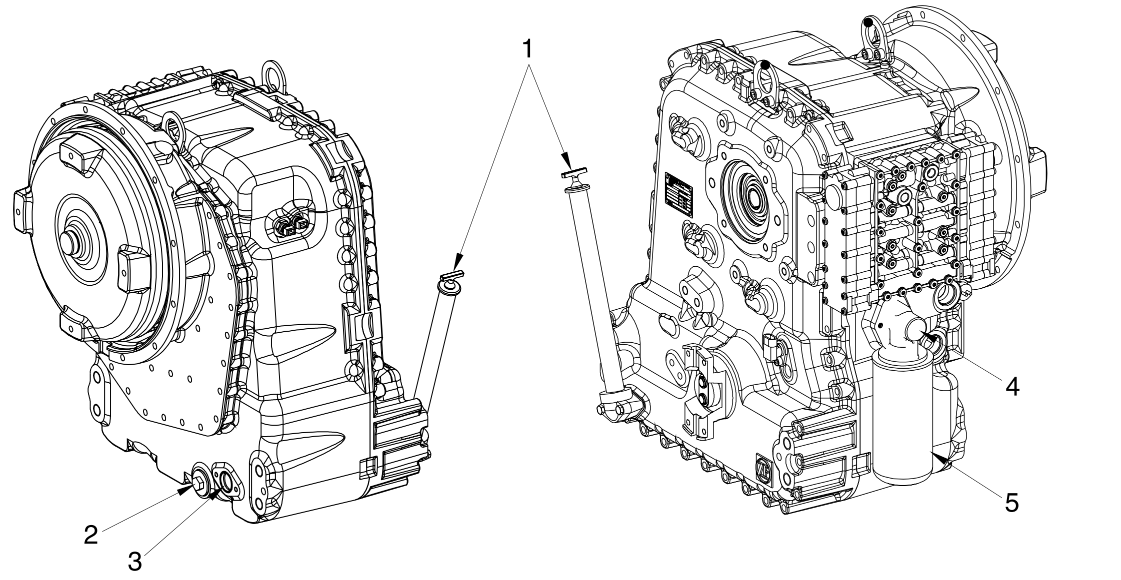
※ At the initial filling of the transmission has to be considered that the heat exchanger, the pressure filter as well as the pipes must get filled with oil.
According to these cavities, the oil capacity to be filled in is greater than at the later oil fillings in the course of the usual maintenance service.

② Filter replacement

At the replacement of the filter in the main oil steam, pay attention that no dirt or oil sludge can penetrate into the circuit.
At the mounting of the filter, any exertion of force has to be avoided.

※ Treat the filter carefully at the installation, the transport and the storage.
Damaged filters must no more be installed.
The mounting of the filter must be carried out as follows:

- Cover the gasket with a small amount of oil.
- Screw the filter in until contact with the sealing surface is obtained and tighten it now by hand about 1/3 to 1/2 turn.



110D9PT19

Legend:

1 = Oil filter tube with oil dipstick

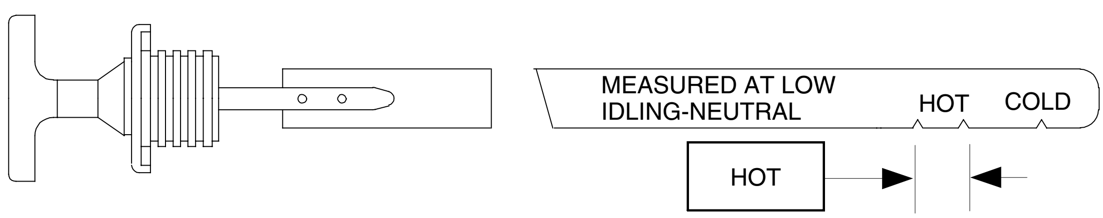
2 = Oil drain plug M38 $\times$ 1.5

3 = Attachment possibility oil level tube with oil dipstick(converter side)

4 = Filter head

5 = Fine filter

Oil dipstick



D507PT20

2) DRIVE AXLE

(1) Important remarks

① For safety reasons, the operator should verify and service at regular intervals all of the bolted assemblies and all of the important safety locks such as :
- Wheel nuts
- Nuts of axle mounting bolts
- Bolts on the steering components and the brake system parts : if the screws are tightable, the loctite contact breaks loose and remounting is necessary.
- Corrosion on the carrier elements (such as the axle spindle) is not acceptable for operational safety reasons.
- Verify seals, oil levels and lubrication at regular intervals.

② Brakes
- Inspect brake lining and brake drum/brake disk regularly as well as wear of brake system parts.
- Inspect the free movement of brake system rode.
- In case of signs of excessive heating, consult a brake specialist or the manufacturer.

(2) General lubrication instructions

① Lubrication points

See page 3-65 installation drawing.

② Fill levels

Are checked at the level control plugs.

③ Oil change

Place the vehicle in a horizontal position. Draining of the oil is to be accomplished only in warm condition. Clean all lubrication points before opening them. On the hub assemblies, the drain plug should be turned downward.

Replacement of the oil draining plugs.

Oil draining

Remove the oil filler plug as well as the oil level control plug on the carrier assembly, and on the planetary assembly. Drain the oil.

Oil filling

Supply oil into oil filler hole until it overflows.

Check the oil level at the oil level plug hole (Overflow control). Wait a few minutes. If the oil level falls, add oil until the level remains constant.

Clean the grease nipples before lubrication.

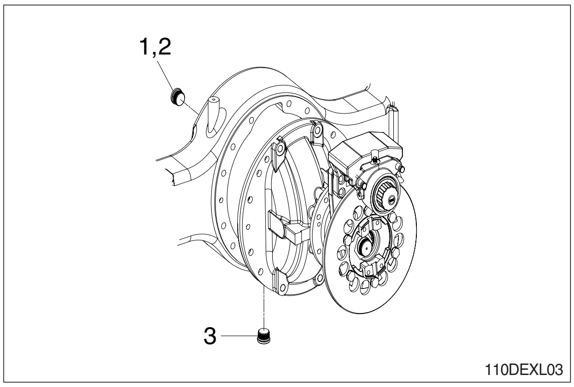
(3) Lubrication points (DIC)

The binding lubrication points has to be taken from the according installation drawing of the axle.

① Single drive assembly

※ The position is dependent from the respective axle version.

※ Legend
1 : Oil fill plug
2 : Oil level check plug
3 : Oil drain plug



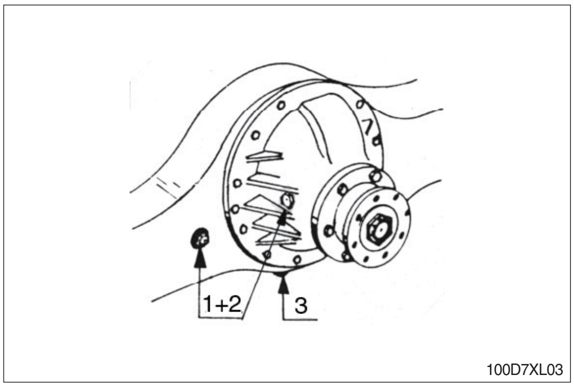
(4) Lubrication points (KESSLER)

The binding lubrication points has to be taken from the according installation drawing of the axle.

① Single drive assembly

※ The position is dependent from the respective axle version.

※ Legend
1 : Oil fill plug
2 : Oil level control plug
3 : Oil drain plug



3. TROUBLESHOOTING

1) BRAKE LEAKS ACTUATION FLUID

Condition	Possible cause	Correction
Internal leak : Fluid bypasses seals into axle and fills axle with fluid and blows out breather or empties brake fluid reservoir.	1. Worn or damaged piston seal. 2. Melted or extruded piston seals. 3. Corrosion, pitting, wear or other damage, marks, scratches to piston and/or brake housing bore in area of seal/sealing lips.	1. Replace piston seals. 2. Correct cause of overheating and replace seals. 3. Clean, smooth, rework or replace affected parts.
External leak	1. Loose bleeder screw. 2. Loose inlet fitting or plugs. 3. Damaged inlet fitting or plugs or damaged seats.	1. Tighten bleeder screw to 2.04~2.75kgf·m 2. Tighten inlet fitting to 3.47~4.79kgf·m 3. Replace inlet fitting or plug and O-ring if used.

2) BRAKE NOISE AND VIBRATION

Condition	Possible cause	Correction
Brakes product noise, chatter, vibration.	Incorrect axle fluid and/or friction material used.	1. Use only meritor specified or approved materials. 2. Drain and flush fluid from axle. Replace with approved fluid. 3. Replace all friction discs. Thoroughly clean or replace stationary discs.

3) BRAKE OVERHEATS

Condition	Possible cause	Correction
Overheating due to excessive duty cycle.	Inadequate coolant flow or heat exchange.	1. Install brake cooling system if not already installed on vehicle. 2. Re-analyze and re-size brake cooling system if necessary.
Inadequate coolant flow	Low pump output, blocked filter or coolant lines.	Check pump output at different operating modes. Replace filter and check lines.
Low or no coolant.	1. Improper fill or leaks. 2. Leaking face seal. 3. Loose or damaged plugs. 4. Deteriorated or inadequate sealant used at joint.	1. Check for proper fill level. 2. Replace or reinstall face seal assembly. 3. Tighten drain, fill or forced cooling plug. Replace if damaged. 4. Dissemble, clean, re-seal and re-assemble brake housing joint.
Brake drags.	1. More than 1.4bar(20psi) pressure applies when brakes released. 2. Damaged piston return spring assembly. 3. Piston not returning. 4. Wrong cooling and/or actuation fluid used. 5. Tight or damaged splines(eg. friction disc-to-hub driver).	1. Repair hydraulic system so pressure is less than 1.4bar(20psi) when brakes released and while machine is operating in any mode. 2. Repair or replace piston return spring assembly. 3. Check piston seals and seal separator. 4. Check piston seals and seal separator for swelling or damaged. Replace as necessary. Purge system and use correct fluid. 5. Repair or replace parts.

4) BRAKE DOES NOT APPLY

Condition	Possible cause	Correction
Low or no pressure to brake	1. Empty fluid reservoir. 2. Damaged hydraulic system. 3. Leaked of brake actuation fluid. 4. Parking brake not adjusted properly.	1. Fill reservoir to correct level with specified fluid. 2. Repair hydraulic system. 3. Refer to "Brake leaks actuation fluid" in this section. 4. Adjust parking brake lever as described in assembly of this manual.

5) BRAKE DOES NOT RELEASE

Condition	Possible cause	Correction
Vehicle does not move	Damaged hydraulic system.	Repair hydraulic system.
Brakes dragging	1. More than 1.4bar (20 psi) pressure applied when brakes released.	1. Repair hydraulic system so pressure is less than 1.4 bar (20 psi) when brakes released and while machine is operating in any mode.
	2. Damaged piston return spring assembly.	2. Repair or replace piston return spring assembly.
	3. Piston not returning.	3. Check piston seals for swelling or damage. Replace as necessary.
	4. Wrong cooling and/or actuation fluid used.	4. Check piston seals for swelling or damage. Purge system and use specified fluid.
	5. Parking brake not adjusted prope-rly.	5. Adjust parking brake lever as described in assembly of this manual.

6) BRAKING PERFORMANCE

Condition	Possible cause	Correction
Noticeable change or decrease in stopping performance.	1. Inadequate actuation fluid supply to brakes.	1. Replenish fluid in brake system. Check for leakage and correct cause.
	2. Inadequate pressure to apply brakes.	2. Check brakes apply system. Check for leakage in brake system or brakes, and correct cause.
	3. Worn or damaged discs.	3. Inspect and replace discs if necessary. ※ As disc wear occurs, make sure brake system can supply adequate fluid to fully apply brakes.
	4. Overheated seals and/or discs.	4. Inspect and replace discs and seals if necessary.
	5. Dirty or contaminated cooling fluid.	5. Drain and flush cooling fluid from brakes and entire brake system. Replace with approved fluid. In some cases, it may necessary to replace discs. Clean or replace filter.
Brake does not fully apply.	1. Empty fluid reservoir.	1. Fill reservoir to correct level with specified fluid.
	2. Damaged hydraulic system.	2. Repair hydraulic system.
	3. Leakage of brake actuation fluid.	3. Refer to "Brake leaks actuation fluid" in this section.
Brakes fell spongy/soft.	Brakes or brake system not properly bled.	Bleed brakes and brake system.

7) DIFFERENTIAL

No	Condition	Possible causes	Correction
1	Constant noise in differential.	(1) Oil is not enough(Replace interval : 50 hrs first, then every 500hrs). (2) Wrong kind of oil. (3) Wheel bearings out of adjustment or have a defect. (4) Drive gear and pinion not in adjustment for correct tooth contact. (5) Teeth of drive gear and pinion have been damage or worn. (6) Gear backlash is too much or too little. (7) Loose or worn on pinion bearings. (8) Loose or worn on side bearing.	· Refueling lubricating oil · Exchange lubricating oil · Exchange bearing · Re-assemble · Exchange dameged gear · Exchange differential gear set · Exchange bearing · Exchange bearing
2	Noise at different intervals.	(1) Ring gear does not run even. a. Bolts on drive gear are not tightened correctly. b. Drive gear has a defect (warped) (2) Loose or broken differential bearings.	· Tighten bolts · Exchange dameged drive gear set · Exchange bearing
3	Noise on turns only.	(1) Differential pinion gears are tight on the spider. (2) Side gears are tight in differential case. (3) Differential pinion or side gears have a defect. (4) Thrust washers worn or have a damage. (5) Too much clearance(backlash) between side gears and pinions.	· Exchange differential pinion gear or spider · Exchange differential side gear · Exchange differential gear set · Exchange differential washer · Exchange differential gear set
4	Leakage of the oil.	(1) Leakage through axle hub carrier a. Too much oi b. Wrong kind of oil. c. Much restriction on air eather. (2) Leakage around pinion shaft. a. Too much oil. b. Wrong kind of oil. c. Much restriction on air eather. d. Oil seal worn or not installed correctly.	· Adjust oil level · Exchange lubricating oil · Exchange air breather · Adjust oil level · Exchange lubricating oil · Exchange air breather · Exchange oil seal

No	Condition	Possible causes	Correction
5	Drive wheels do not rotate	(1) Broken axle shaft. a. Loose wheel bearings. b. Axle shaft too short. c. Loose flange studs or nuts. (2) Drive gear teeth have been damaged. (3) Side gear on differential damaged. (4) Differential pinion shaft or spider broken	 · Re-assemble wheel bearings. · Replace drive shaft · Tighten studs or nuts · Exchange damaged drive gear set · Exchange damaged gear · Exchange damaged gear

GROUP 3 DISASSEMBLY AND ASSEMBLY

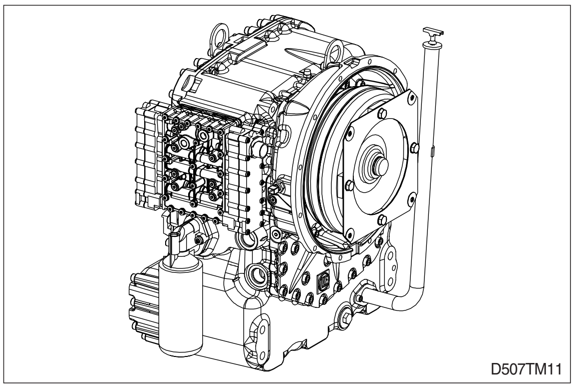
1. TRANSMISSION DISASSEMBLY

1) ELECTRO-HYDRAULIC CONTROL AND FILTER (EXCHANGE FILTER)

① Mount the transmission to the assembly truck.

(S) Assembly truck 5870 350 000
(S) Holding fixture 5870 350 124

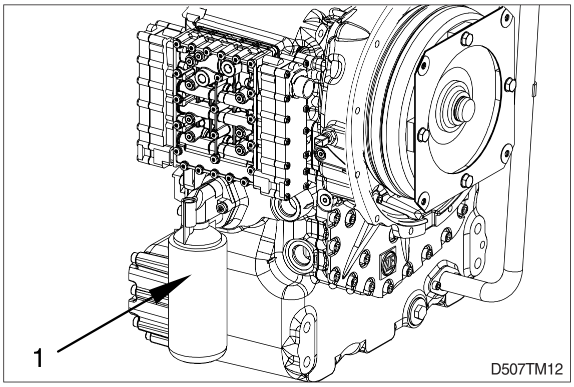
※ Prior to start the disassembly, drain the oil



(1) Removal of the filter

① By means of the strap wrench separate the filter (1) from the filter head.

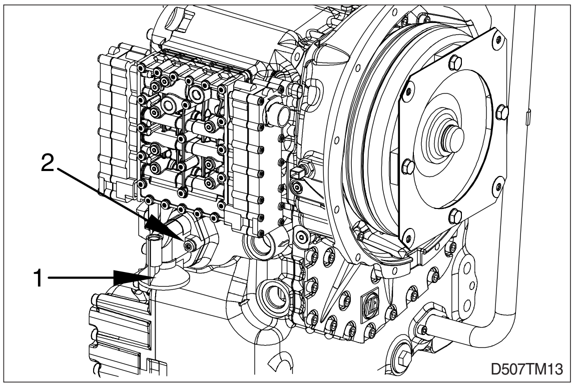
(S) Strap wrench 5870 105 005



② Loosen the cap screws (2) and separate the filter head (1) from the transmission housing.

※ Remove the O-ring

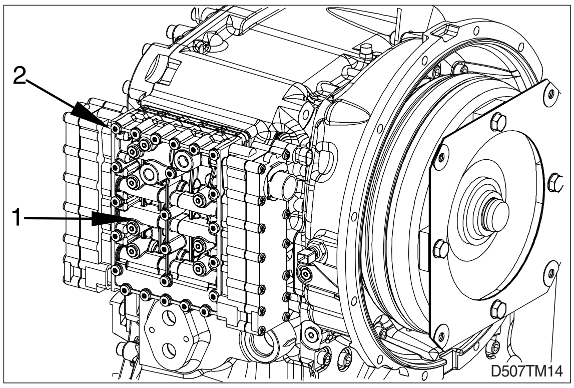
(S) Socket spanner 5873 042 004



(2) Removal of the electric shift system

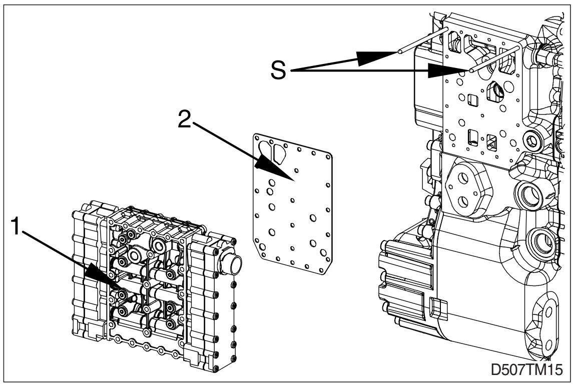
① Remove the shift system (1).
Loosen the Torx screws (2) and separate the gearshift housing from the intermedi-ate sheet.

(S) Socket spanner TX-27 5873 042 002
(S) Adjusting screw M6 5870 204 063

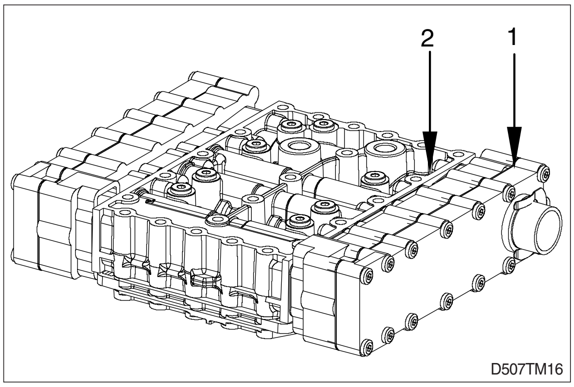


② Remove the complete shift system (1) and the intermediate shaft (2).

(S) Adjusting screw M6 5870 204 063

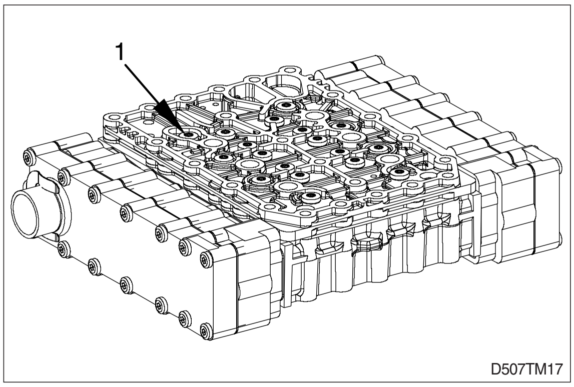


③ Mark the installation position of the cover (1) to the valve block (2).

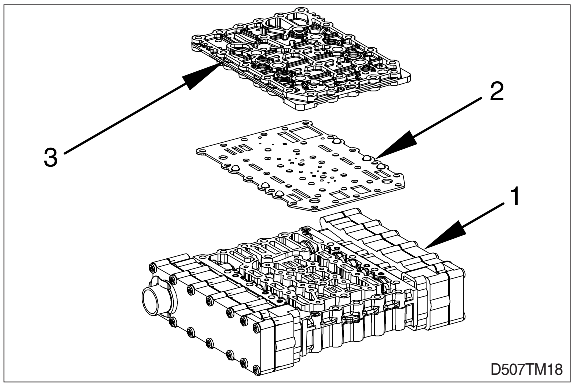


④ Loosen the Torx screws (1).

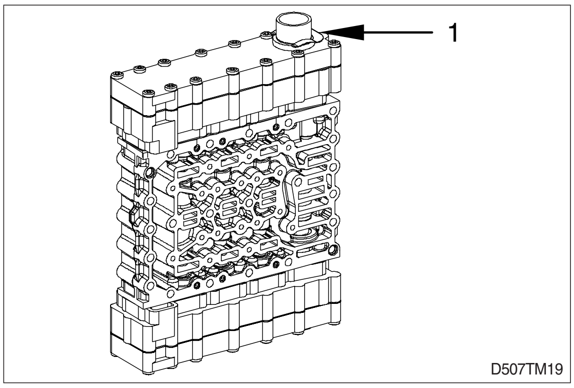
(S) Socket spanner TX-27 5873 042 002



⑤ Separate the duct plate (3), and intermediate sheet (2) from the valve block (1).

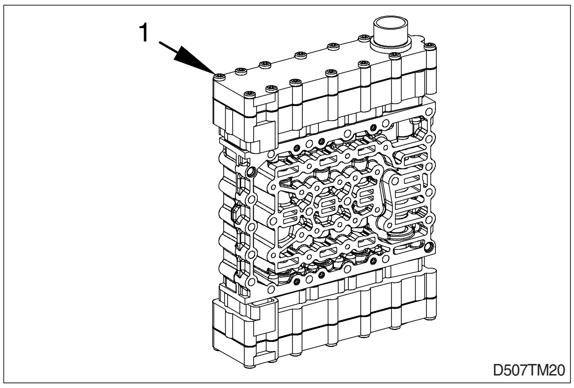


⑥ Remove the retaining clamp (1).



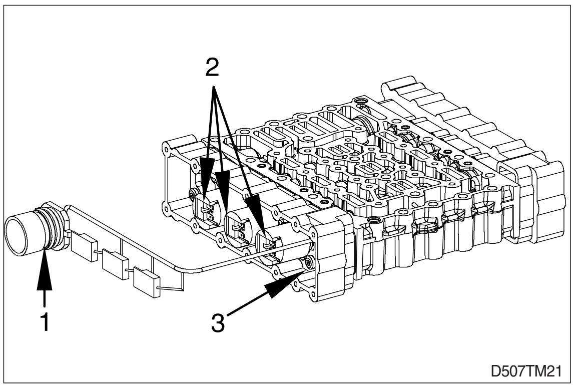
⑦ Loosen the cap screws (1) and remove the cover.
Remove the opposite cover.

(S) Socket spanner TX-27 5873 042 002



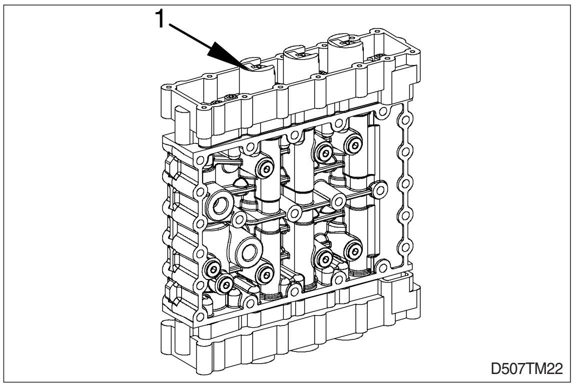
⑧ Remove the wiring harness (1).
Loosen the cap screws (3), remove the fixing plates and the pressure regul-ators (2).

(S) Socket spanner TX-27 5873 042 002



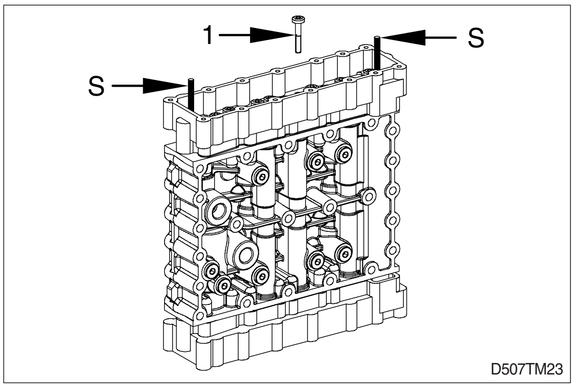
⑨ Loosen the cap screws, remove the fixing plates and the pressure regulators (1).

(S) Socket spanner TX-27 5873 042 002



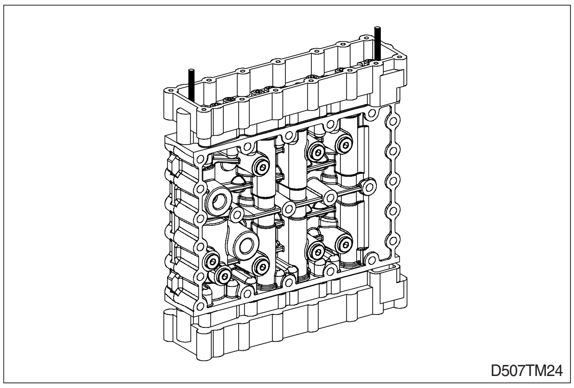
⑩ Loosen two cap screws (1) and fasten the adjusting screws (S) preliminarily (housing is spring-loaded). Following to this loosen the remaining cap screws.

(S) Adjusting screws	5870 204 036
(S) Socket spanner	5873 042 002



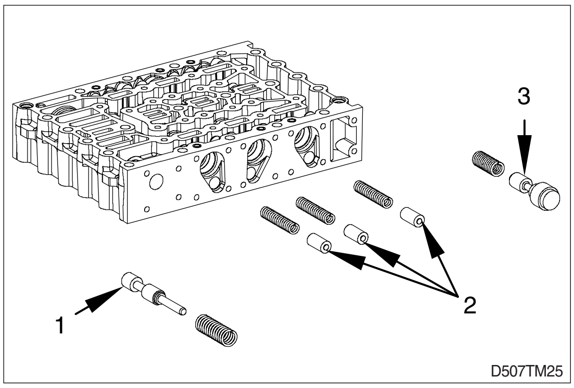
⑪ Separate the housing from the valve housing by loosening the adjusting screws equally.

(S) Adjusting screws 5870 204 036



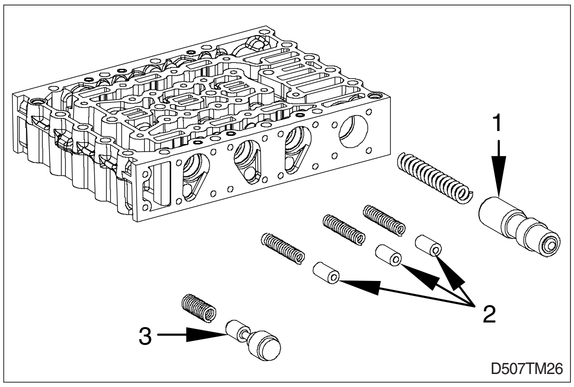
⑫ Remove the single parts:

1 = Pressure reducing valve
2 = Vibration damper
3 = Follow-on slide



⑬ Remove the single parts on the opposite side analogously:

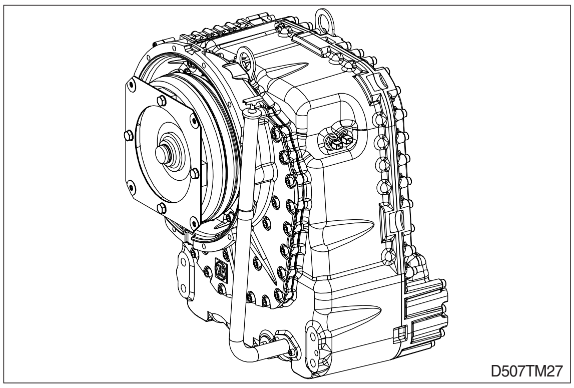
1 = Main pressure valve
2 = Vibration damper
3 = Follow-on slide



2) INDUCTIVE TRANSMITTERS, VALVES, OIL FILTER AND OIL DRAIN PLUG, SCREW PLUGS

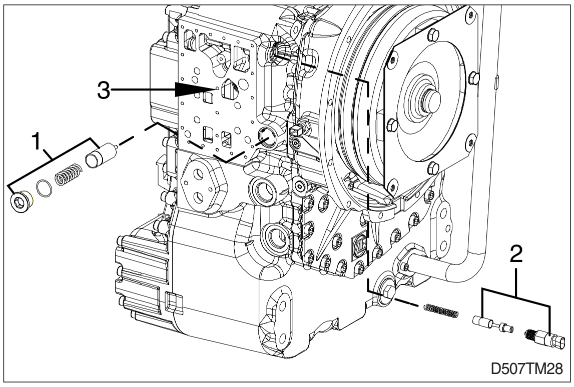
① Mount the transmission to the assembly truck.

(S) Assembly truck	5870 350 000
(S) Holding fixture	5870 350 124



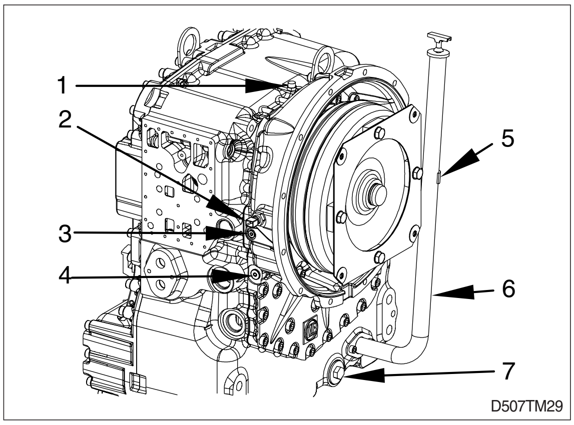
② Remove the converter pressure back-up valve (1) and differential pressure switch (3) for the filter (2).

※ Do not remove the pressure relief valve.



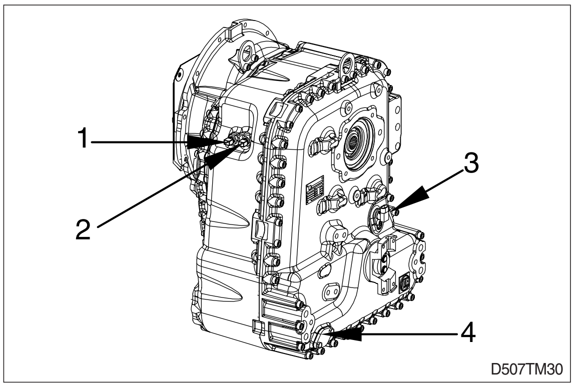
③ Remove the positioned parts.

1 = Breather
2 = Inductive transmitter-n engine
3 =Screw plug (measuring point after converter)
4 =Screw plug (option for temperature sensor)
5 = Fixing strap oil filter tube
6 = Oil filter tube with oil dipstick
7 = Screw plug (Oil drain bore)



④ Remove the positioned parts.

1 = Inductive transmitter n - Internal speed input
2 = Inductive transmitter n - Turbine
3 = Speed transmitter n - Output
4 = Cover (mounting possibility for oil filler tube)

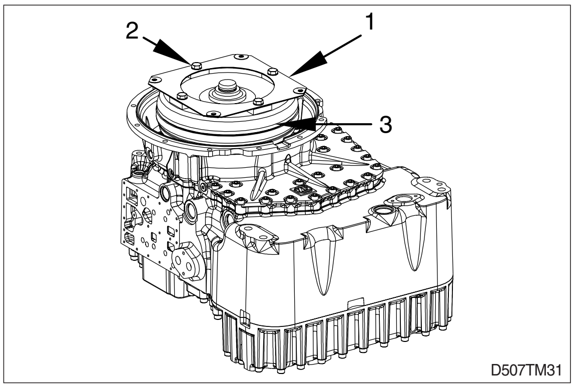


3) ENGINE CONNECTION, PRESSURE OIL PUMP AND REMOVAL OF THE CLUTCHES

① Mount the transmission to the assembly truck.

(S) Assembly truck 5870 350 000
(S) Holding fixture 5870 350 124

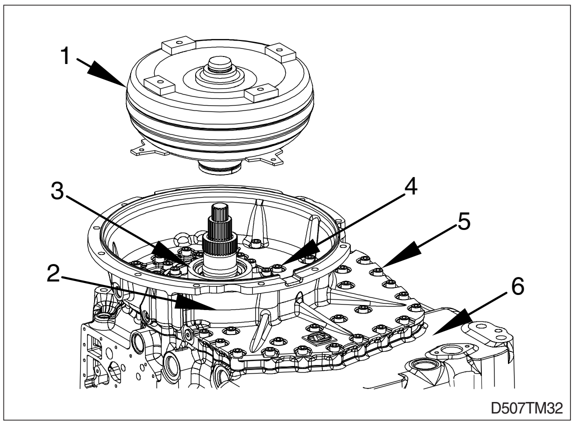
Loosen the hexagon screw (2) and separate the flexplate (1) from the converter (3).



② By means of the lifting equipment separate the converter (1) from the transmission. Loosen the bolted connection (4) and (5).

1 = Converter
2 = Converter bell
3 = Pressure oil pump
4 = Bolted connection converter bell/transmission housing rear section
5 = Bolted connect. pressure oil pump/transmission housing rear section
6 = Transmission housing rear section

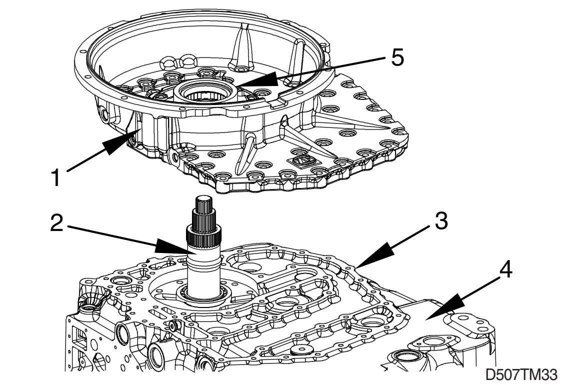
(S) Eyebolts assortment 5870 204 002
(S) Lifting chain 5870 281 047



③ By means of the lifting equipment the converter bell (1) with pressure oil pump (5) are commonly to be separated from the transmission housing rear section (4).

Remove the intermediate sheet (3) and the stator hollow shaft (2).

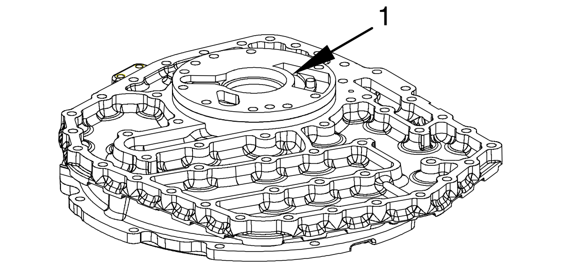
(S) Eyebolts assortment	5870 204 002
(S) Lifting chain	5870 281 047



D507TM33

④ Separate the pressure oil pump (1) from the converter bell.

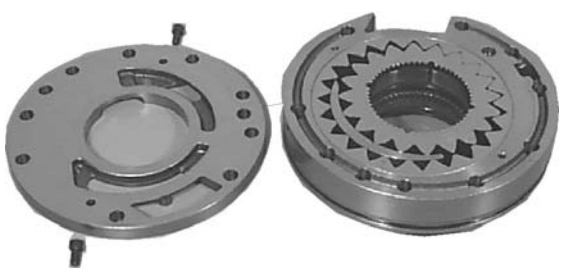
(S) Hammer	5870 280 004



D507TM34

⑤ Loosen both cap screws and remove the cam disc.

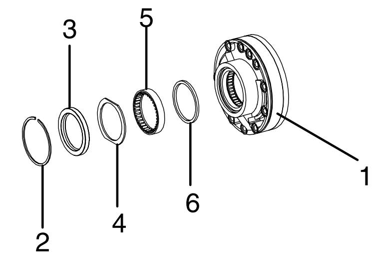
※ If running-in marks should be found in the pump housing or on the cam disc, the complete pump has to be replaced.



D507TM35

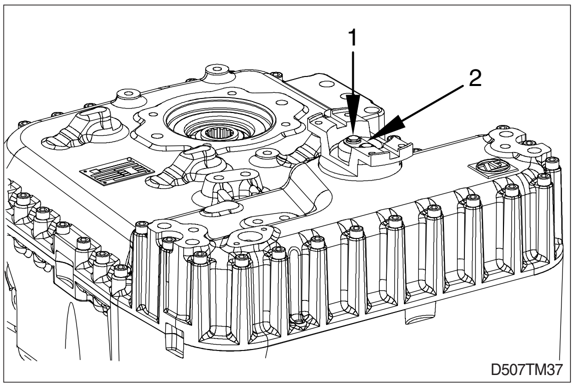
⑥ Squeeze out the snap ring (1) and remove the single parts.

1 = Pump housing with rotor
2 = Snap ring
3 = Shaft seal
4 = Support shim
5 = Needle bearing
6 = Ring



D507TM36

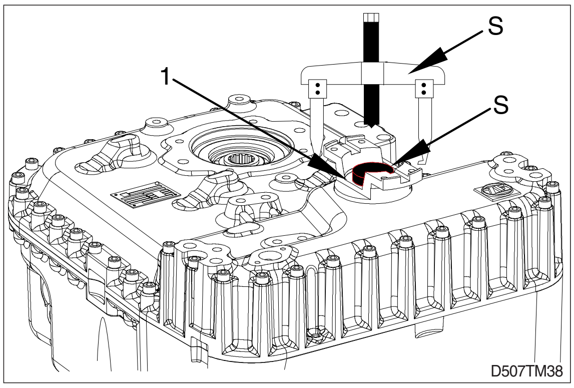
⑦ Remove the tab washer (2) and loosen the hexagon screws (1).



⑧ Pull off the input shaft (1).

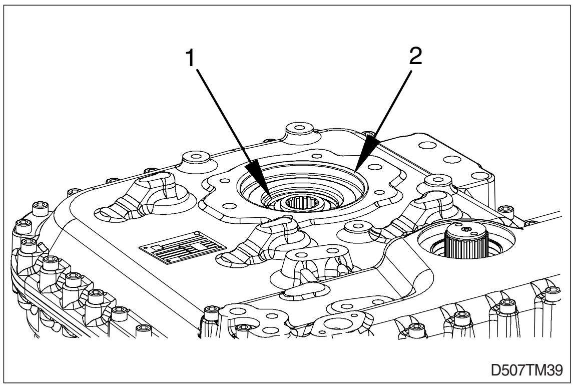
Remove the shaft seal.

(S) Two-armed puller 5870 970 003

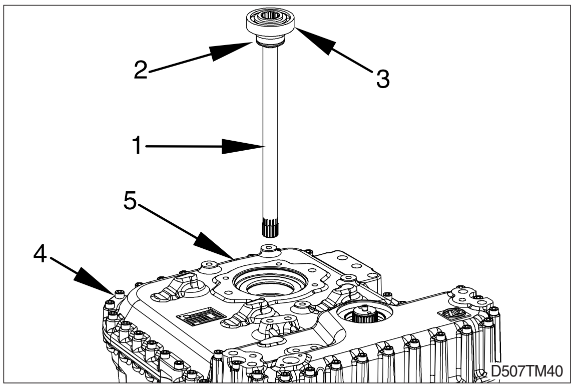


⑨ Unsnap the retaining ring (1) from the power take-off and remove the O-ring (2).

(S) Set of internal pliers 5870 900 013

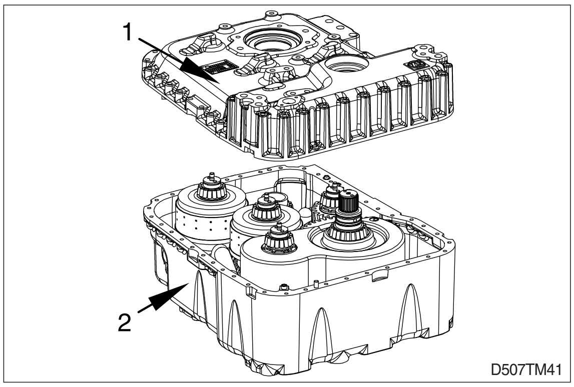


⑩ Pull the pump shaft (1) out of the housing bore.
Unsnap the rectangular ring (2).
Press off the ball bearing (3) from the shaft.
Loosen the bolted connection (4) transmission housing rear section/transmission housing front section.

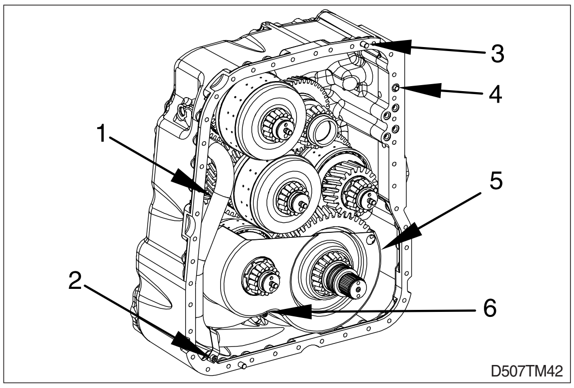


⑪ By means of the lifting equipment separate the transmission housing rear section (1) from the transmission housing front section (2).

(S) Eyebolts 2 × (M20)	0636 804 003
(S) Ring nut (M12)	0664 462 774
(S) Lifting chain	5870 281 047



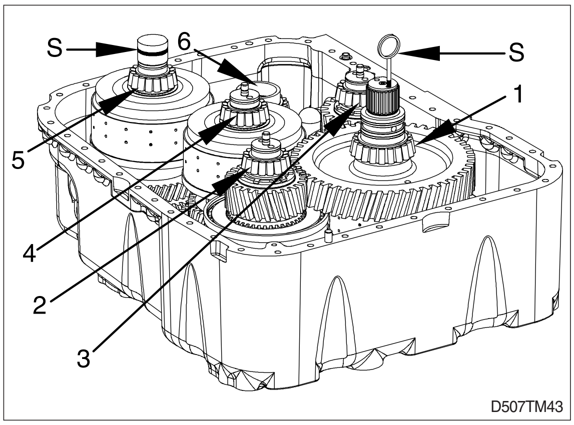
⑫ Loosen the cap screws (2) and remove the suction tube (1).
Remove the O-ring from the suction tube.
Loosen the cap screws (6) and remove the screen sheet (5).
Remove the pipes (4) with O-rings.



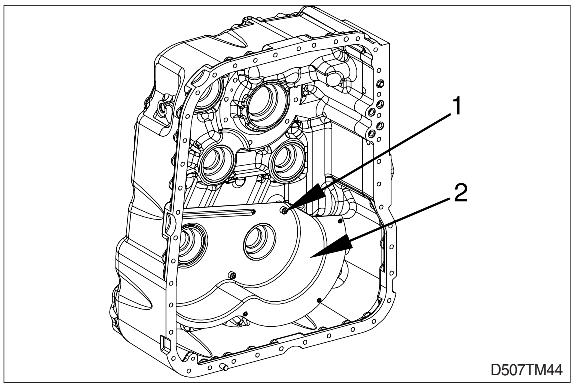
⑬ The clutch is to be removed from the transmission housing according to the sequence of numbers as described in the legend.

1 = Clutch K3
2 = Clutch K1
3 = Clutch K2
4 = Clutch KR
5 = Clutch KV
6 = Input shaft

(S) Handle 5870 260 014 (K1/K2/KV/KR)
(S) Eyebolt 5870 204 002 (K3)

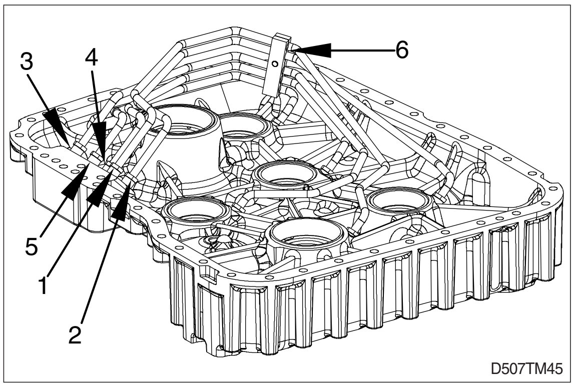


⑭ Loosen the cap screws (1) and remove the screen sheet (2).



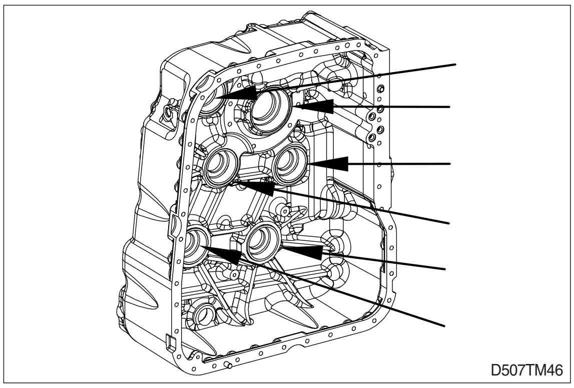
⑮ Remove the pipes (system pressure from the electro-hydraulic control to the respective clutch).
Remove the holding segment (6).
The pipes are to disassembled in the following sequence:

1 = Pipe	k3
2 = Pipe	k1
3 = Pipe	k2
4 = Pipe	kR
5 = Pipe	kV



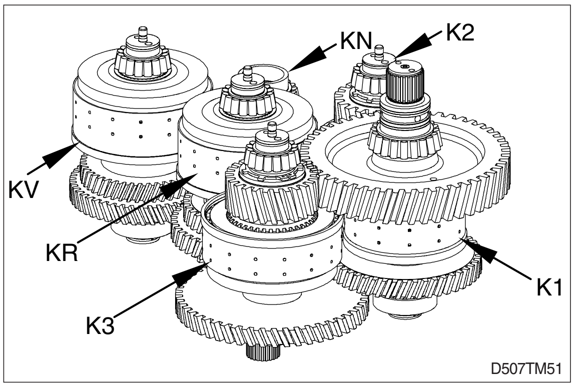
⑯ Remove all bearing outer rings (see arrows).

※ Should contrary to the recommendations the taper roller bearings of the clutches as well as of the input not be replaced the assignment (bearing inner and outer ring) has to be kept at least.
Mark the bearing inner and bearing outer rings to each other accordingly.



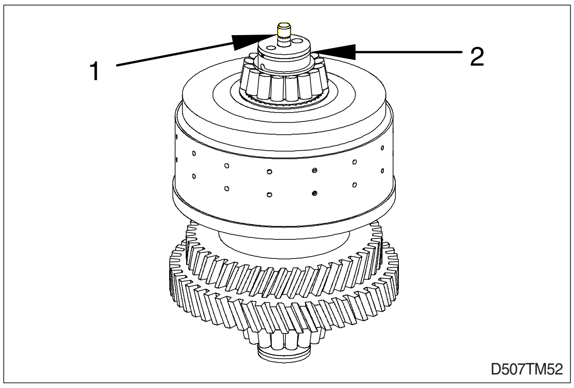
4) CLUTCHES KV/KR/K1/K2/K3 AND INPUT

See figure on the right.



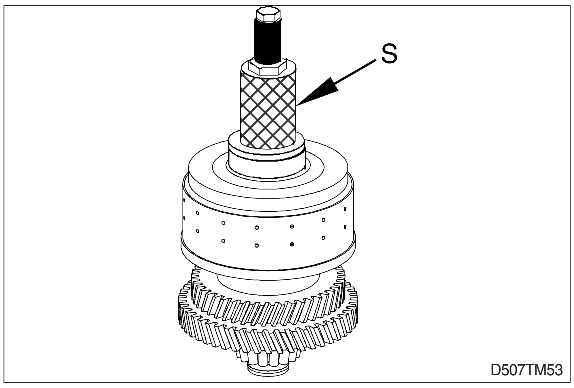
(1) Clutch KV

① Remove the stud (1) and unsnap the piston ring (2).



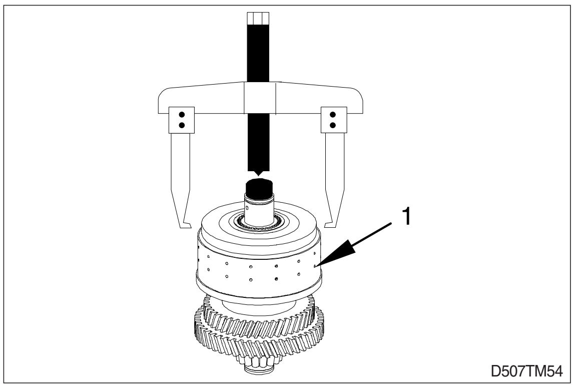
② Pull the taper roller bearing (inner ring) from the shaft.

(S)Gripping insert	5873 001 057
(S)Back-off insert	5870 026 100
or	
(S)Rapid grip	5873 001 011



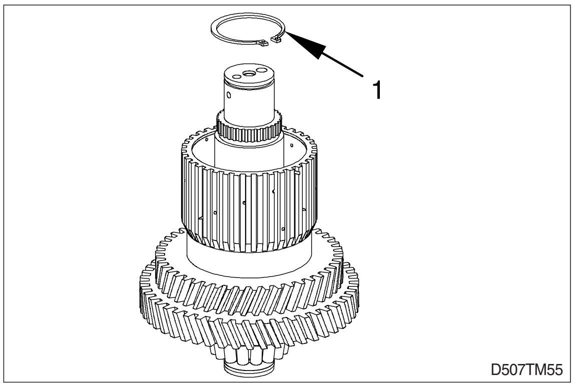
③ Pull the clutch (1) from the shaft.

(S) Two-armed puller 5870 970 003



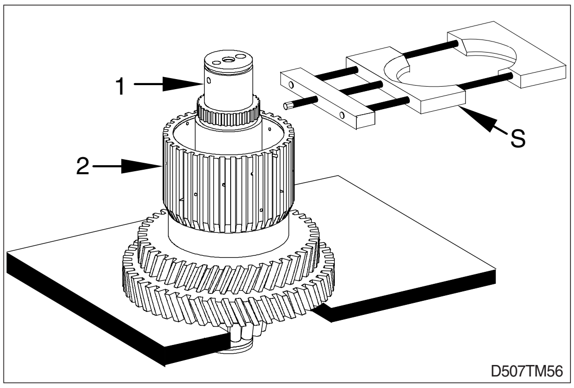
④ Unsnap the retaining ring (1).

(S) Set of external pliers 5870 900 015



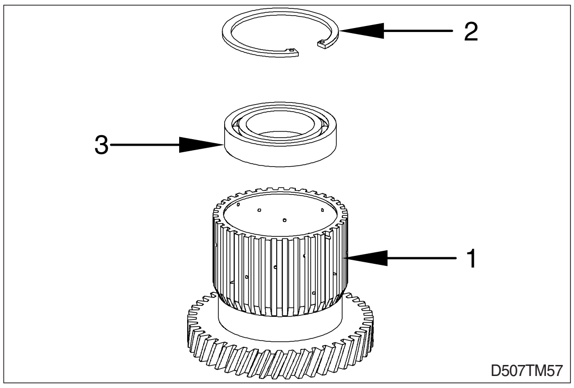
⑤ Press the clutch shaft (1) out of the idler (2).

(S) Parting tool 5870 300 028

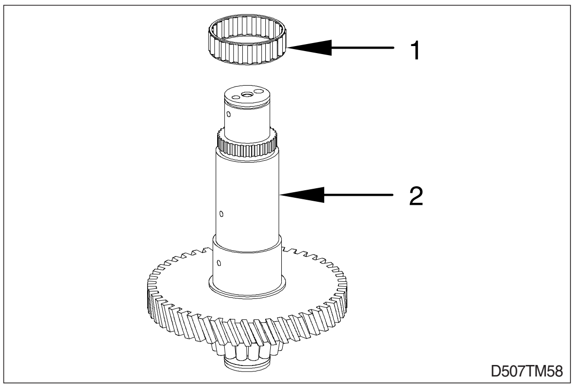


⑥ Unsnap the retaining ring (2) from the idler (1) and remove the ball bearing (3).

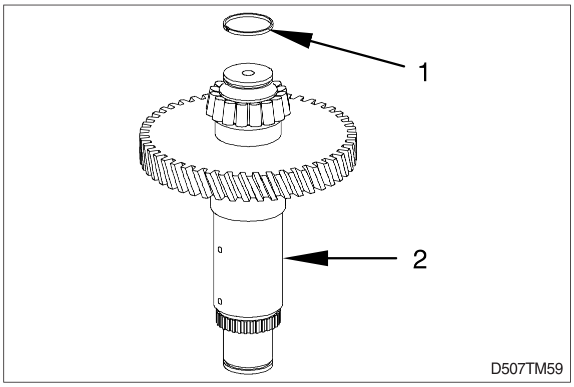
(S) Set of internal pliers 5870 900 013



⑦ Remove the needle cage (1) from the shaft (2).

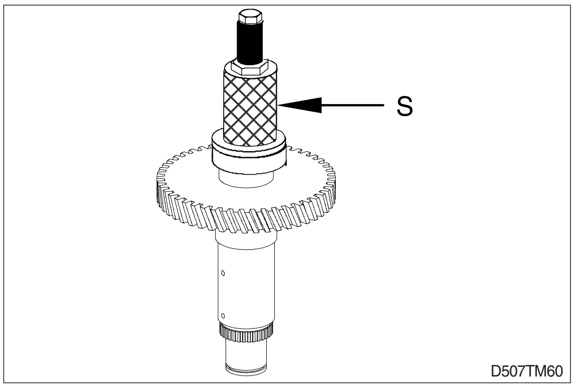


⑧ Rotate the shaft (2) by 180° and unsnap the piston ring (1).



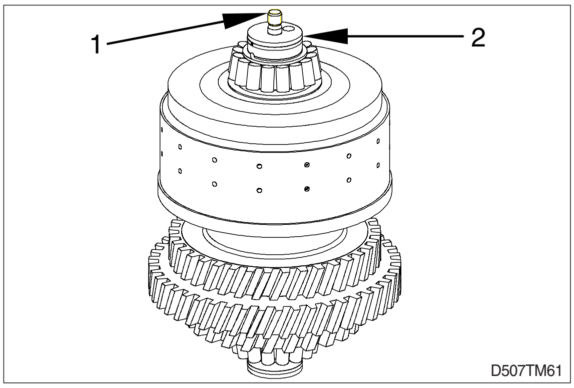
⑨ Pull the taper roller bearing (inner ring) from the shaft.

(S) Gripping insert 5873 001 057
(S) Back-off insert 5870 026 100
or
(S) Rapid grip 5873 011 011



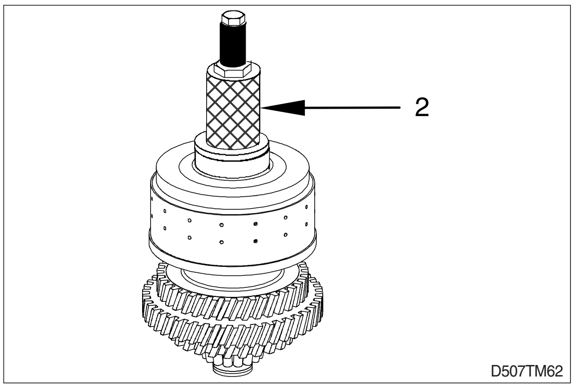
(2) Clutch KR

① Remove the stud (1) and unsnap the piston ring (2).



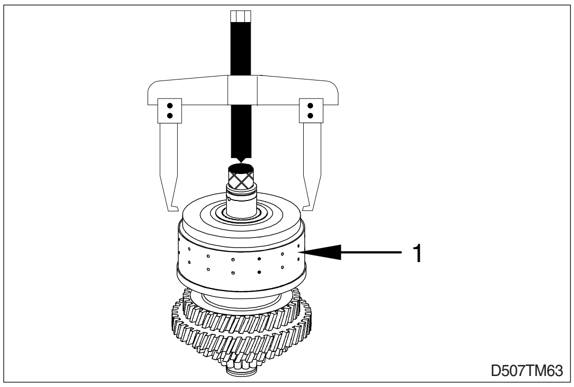
② Pull the taper roller bearing (inner ring) (2) from the shaft.

(S) Gripping insert 5873 001 057
(S) Bush 5870 026 016



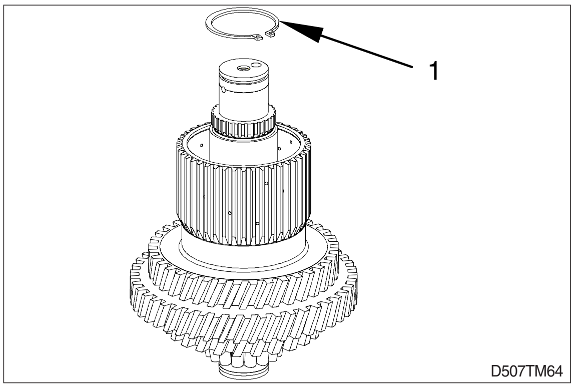
③ Pull the clutch (1) from the shaft.

(S)Two-armed puller 5870 970 003



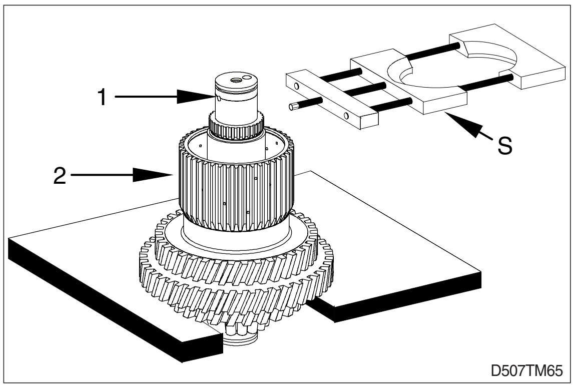
④ Unsnap the retaining ring (1).

(S)Set of external pliers 5870 900 015

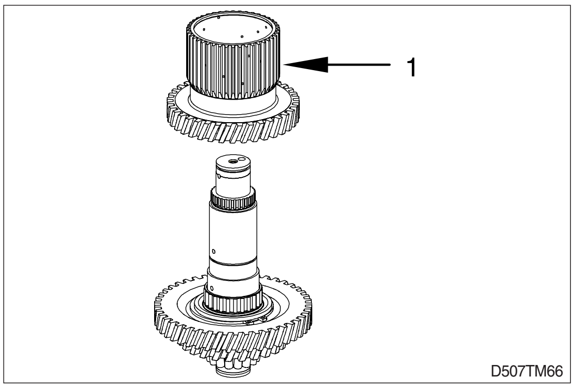


⑤ Press the clutch shaft (1) out of the idler (2).

(S)Parting tool 5870 300 028

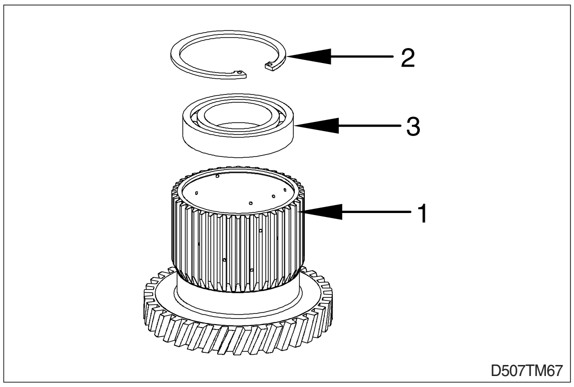


⑥ Disassemble the idler (1).

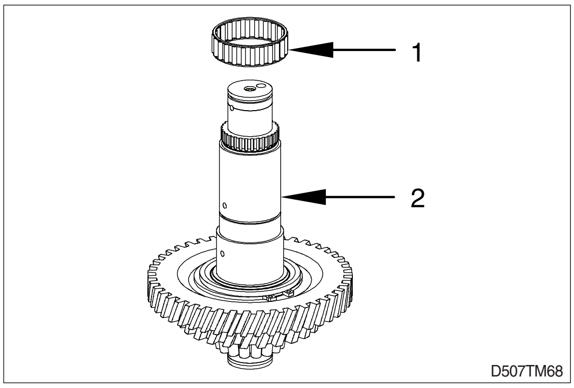


⑦ Unsnap the retaining ring (2) from the idler (1) and remove the ball bearing.

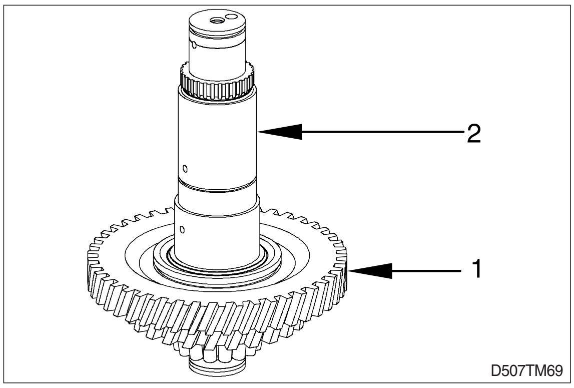
(S) Set of internal pliers 5870 900 013



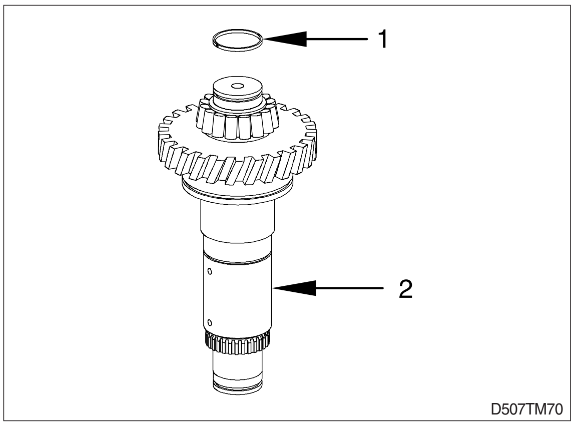
⑧ Remove the needle cage (1) from the shaft (2).



Shaft (2) and gear (1) cannot be separated (shrink fit).

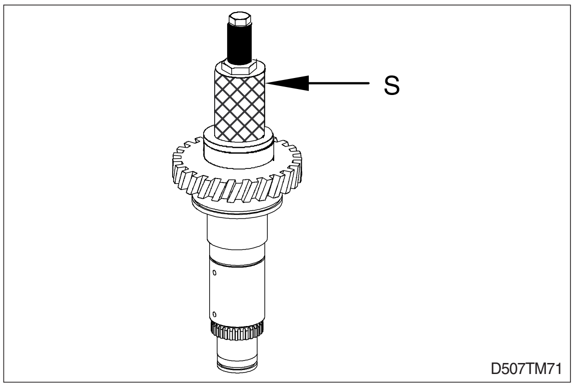


⑨ Rotated the shaft (2) by 180° and unsnap the piston ring (1).



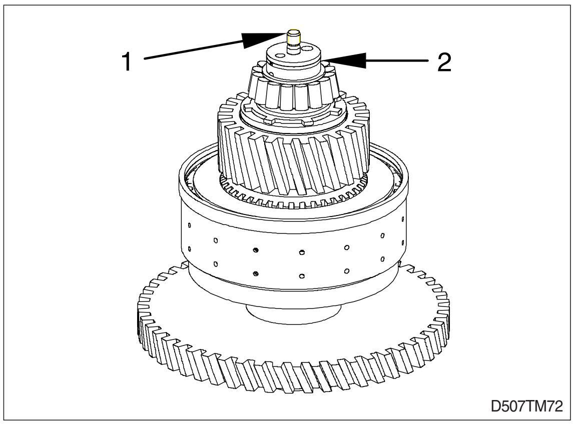
⑩ Pull the taper roller bearing (inner ring) from the shaft.

(S) Gripping insert	5873 001 057
(S) Back-off insert	5870 026 100
or	
(S) Rapid grip	5873 011 011



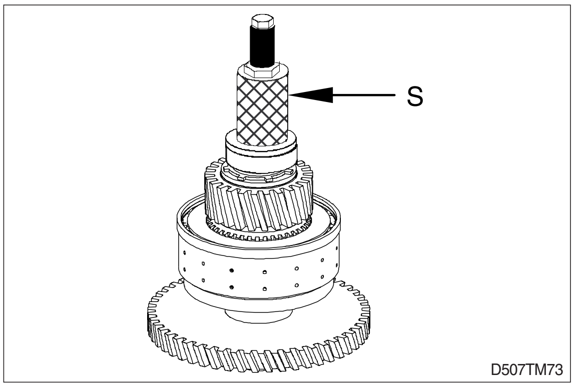
(3) Clutch K1

① Remove the stud (1) and unsnap the piston ring (2).



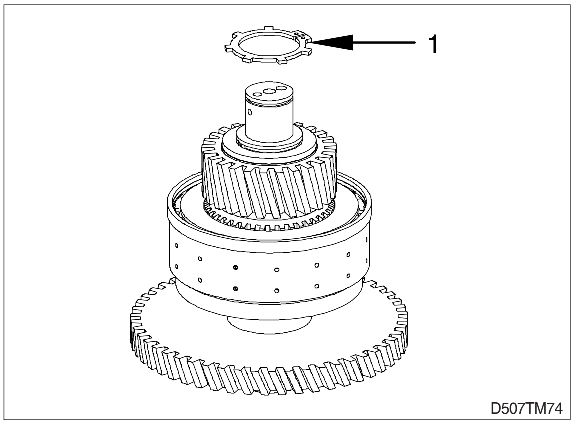
② Pull the taper roller bearing (inner ring) from the shaft.

(S) Gripping insert	5873 001 057
(S) Back-off insert	5870 026 100
or	
(S) Rapid grip	5873 011 011

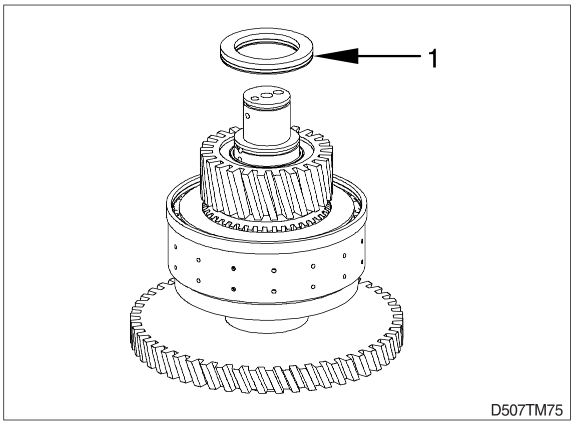


③ Unsnap the retaining ring (1).

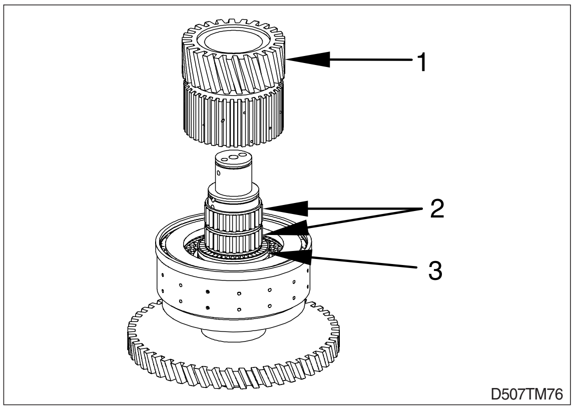
(S) Set of internal pliers 5870 900 013



④ Remove the complete axial bearing (1).

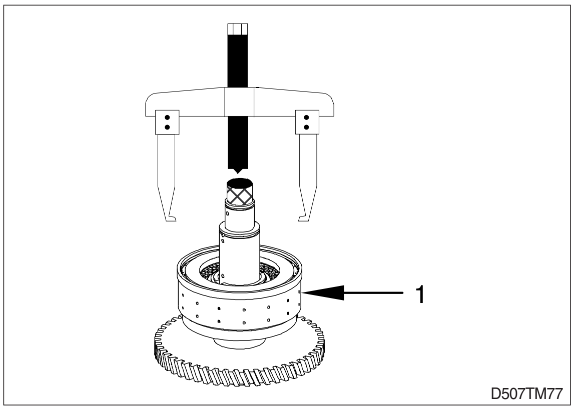


⑤ Take off idler (1), remove the needle cage (2) and the complete axial bea-ring (3).

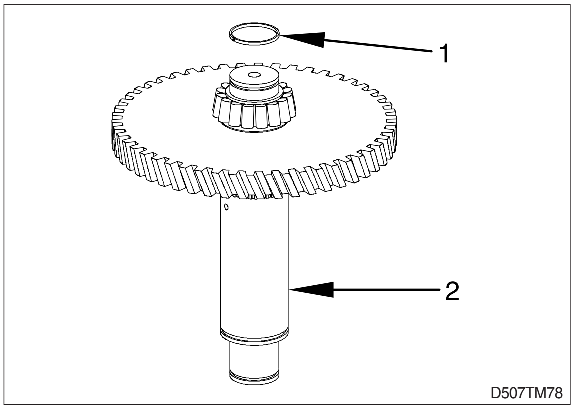


⑥ Pull the clutch (1) from the shaft.

(S)Two-armed puller 5870 970 003

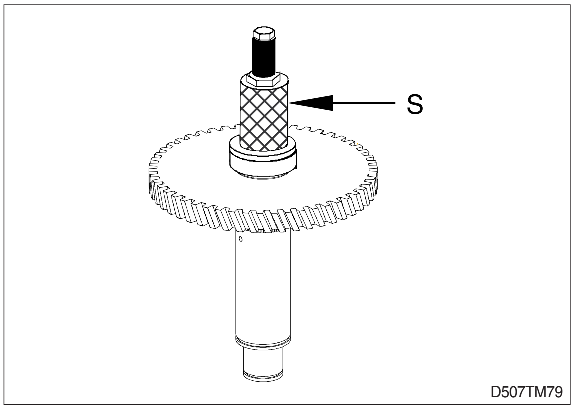


⑦ Rotated the shaft (2) by 180° and unsnap the piston ring (1).



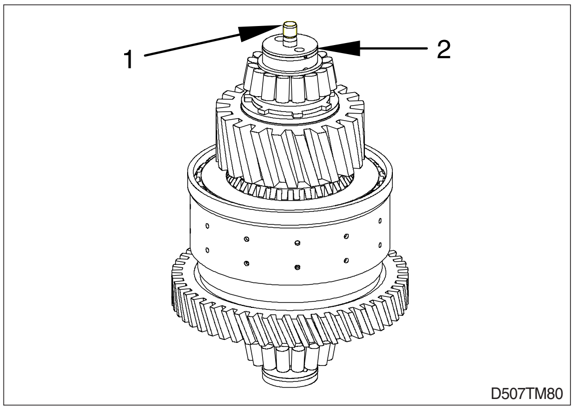
⑧ Pull the taper roller bearing (inner ring) from the shaft.

(S) Gripping insert	5873 001 057
(S) Back-off insert	5870 026 100
or	
(S) Rapid grip	5873 011 011



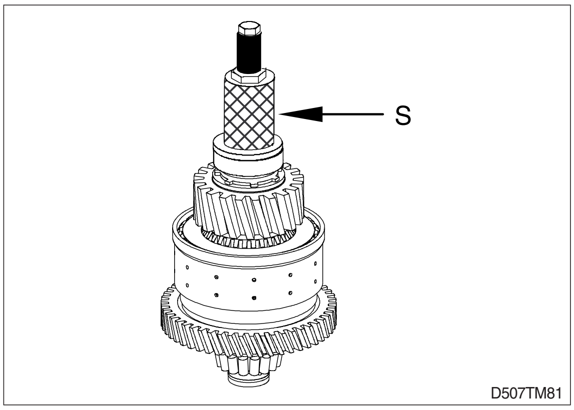
(4) Clutch K1

① Remove the stud (1) and unsnap the piston ring (2).



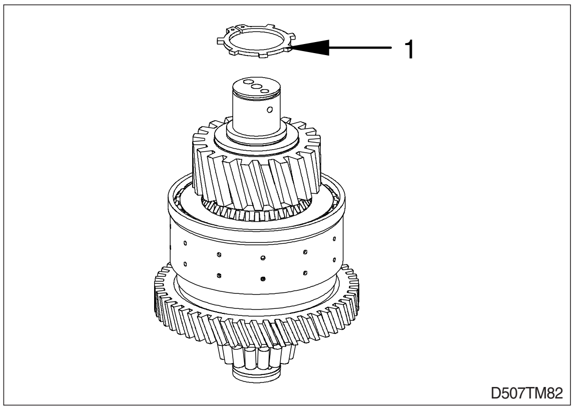
② Pull the taper roller bearing (inner ring) from the shaft.

(S) Gripping insert	5873 001 057
(S) Back-off insert	5870 026 100
or	
(S) Rapid grip	5873 011 011

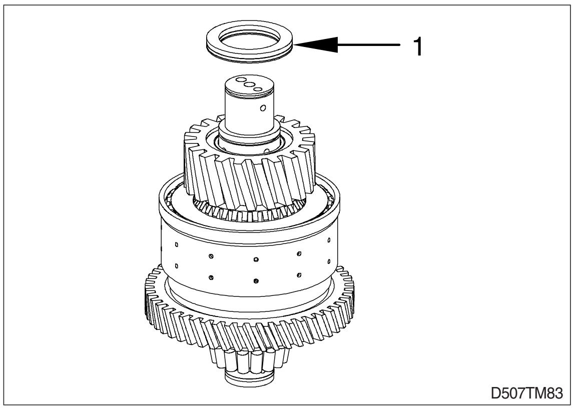


③ Unsnap the retaining ring (1).

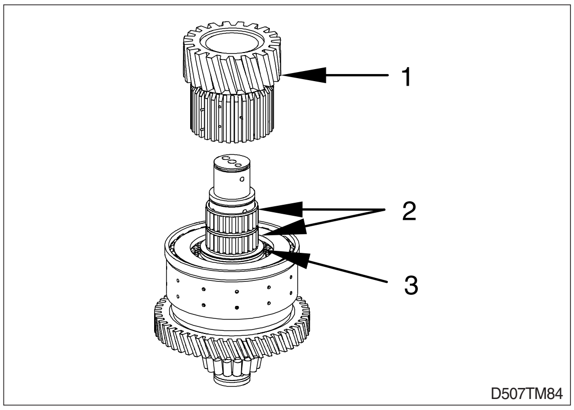
(S) Set of internal pliers 5870 900 015



④ Remove the complete axial bearing (1).

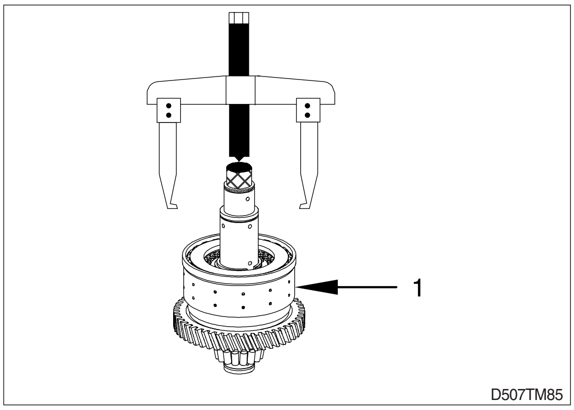


⑤ Take off idler (1), remove the needle cage (2) and the complete axial bea-ring (3).

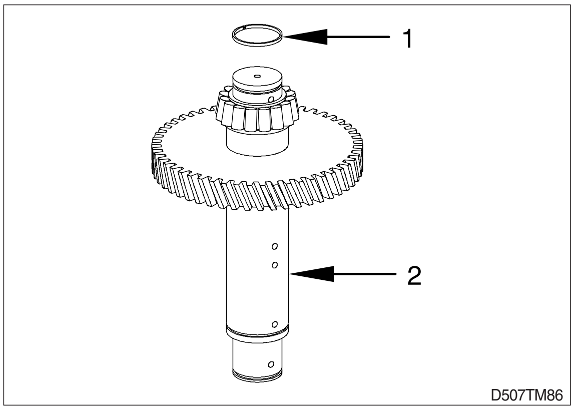


⑥ Pull the clutch (1), front the shaft.

(S) Two-armed puller 5870 970 003

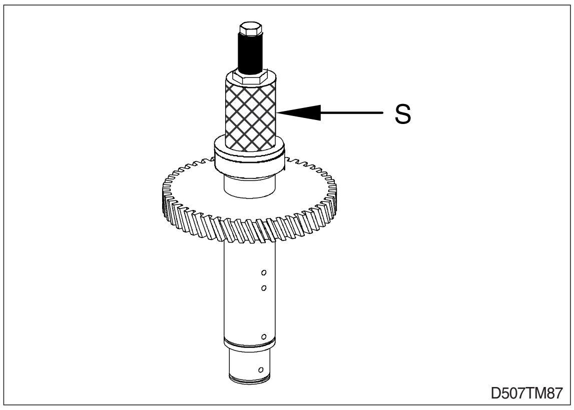


⑦ Rotated the shaft (2) by 180° and unsnap the piston ring (1).



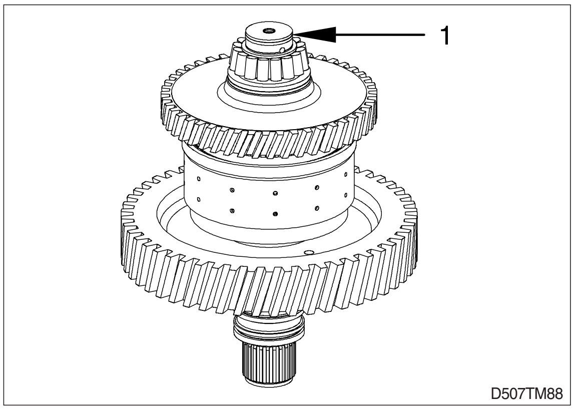
⑧ Pull the taper roller bearing (inner ring) from the shaft.

(S)Gripping insert	5873 001 057
(S)Back-off insert	5870 026 100
or	
(S)Rapid grip	5873 011 011



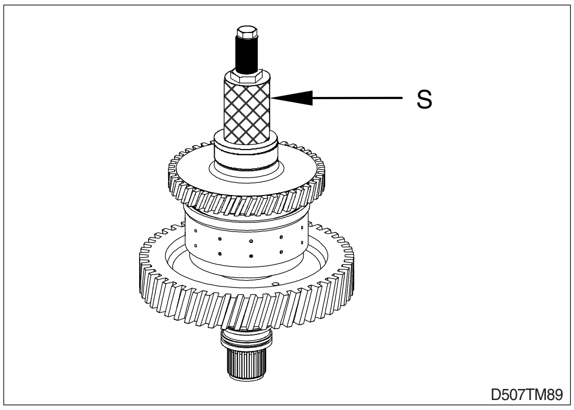
(5) Clutch K3

① Unsnap the piston ring (1).

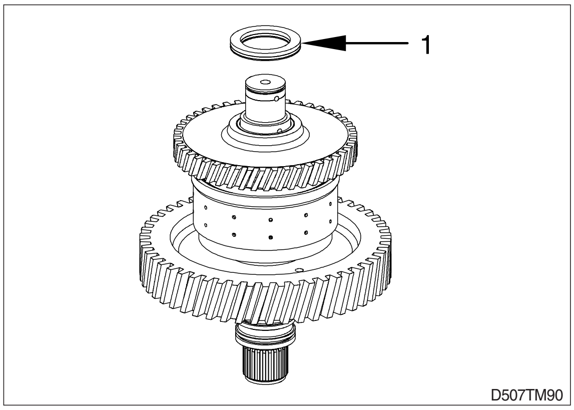


② Pull the taper roller bearing (inner ring) from the shaft.

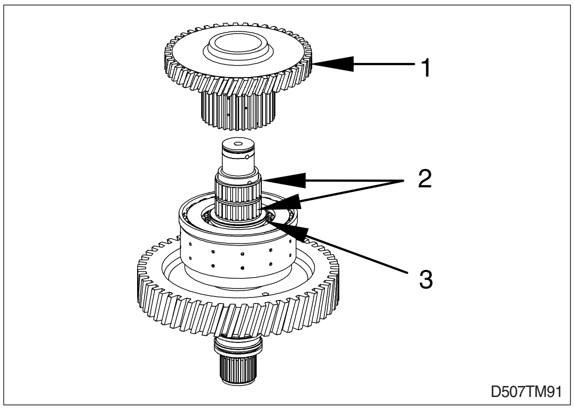
(S)Gripping insert	5873 001 057
(S)Back-off insert	5870 026 100
or	
(S)Rapid grip	5873 011 011



③ Remove the complete axial bearing (1).

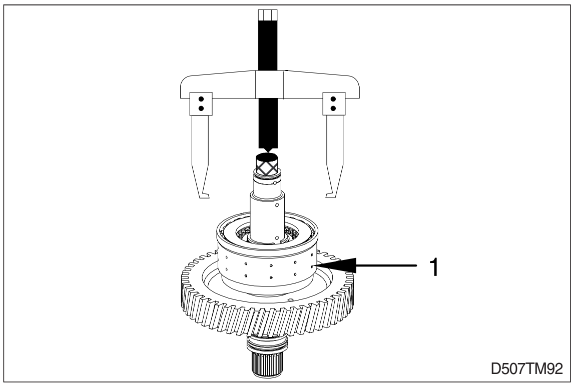


④ Take off idler (1), remove the needle cage (2) and the complete axial bea-ring (3).

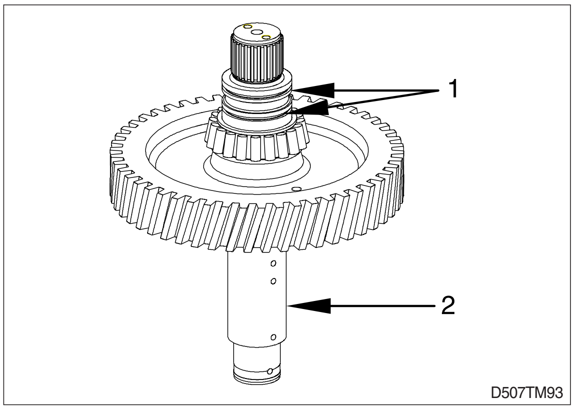


⑤ Pull the clutch (1) from the shaft.

(S) Two-armed puller 5870 970 003

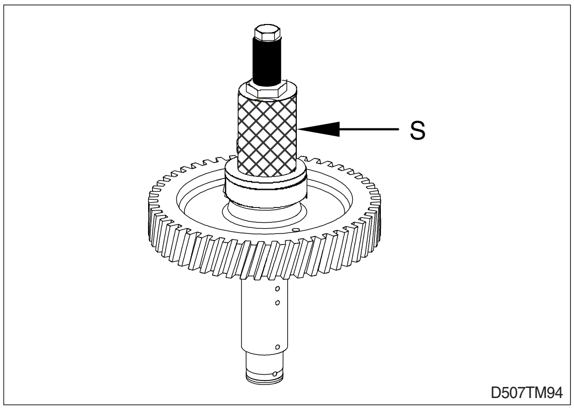


⑥ Rotated the shaft (2) by 180° and unsnap the piston ring (1).



⑦ Pull the taper roller bearing (inner ring) from the shaft.

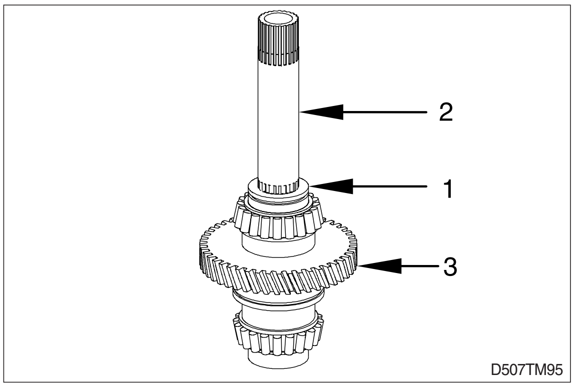
(S) Gripping insert 5873 001 058
(S) Back-off insert 5870 026 100
or
(S) Rapid grip 5873 011 014



(6) Input

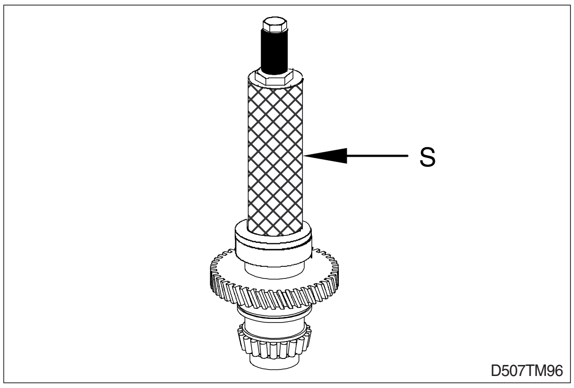
① Unsnap the piston ring (1).
The turbine wheel shaft (2) and the input gear (3) are attached with a snap ring.

※ The components are destroyed at separation



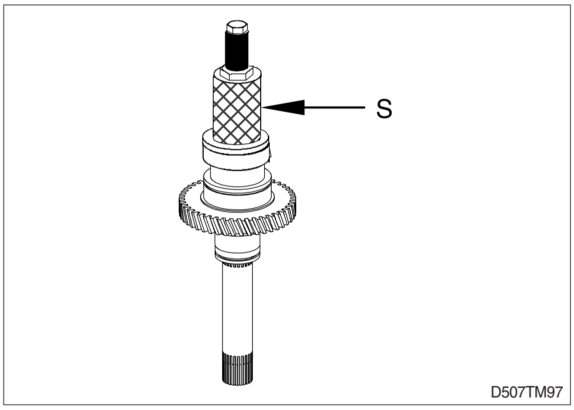
② Pull the taper roller bearing (inner ring) from the input gear.

(S) Gripping insert	5873 001 058
(S) Back-off insert	5870 026 100
or	
(S) Rapid grip	5873 011 014



③ Pull the taper roller bearing (inner ring) from the input gear.

(S) Gripping insert	5873 001 058
(S) Back-off insert	5870 026 100
or	
(S) Rapid grip	5873 011 011



2. TRANSMISSION ASSEMBLY

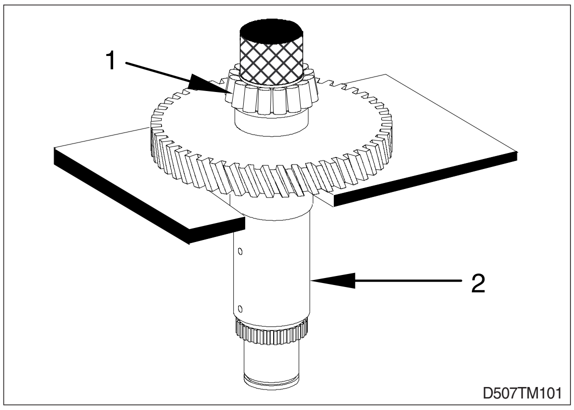
1) CLUTCHES KV/KR/K1/K2/K3 AND INPUT

※ In the EST-37A (electronic transmission control)the gear change (filling times and pressure level) are controlled via the drive program of the transmission electronics. Additionally, the EST-37A monitors the disc clearance (clearance) of the clutches and if exceeded, a fault message is given in the transmission error display.

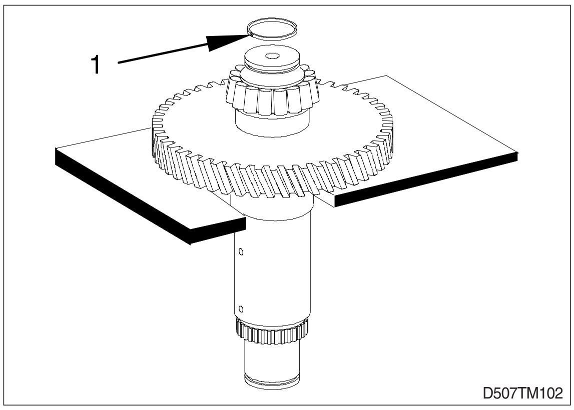
To ensure the shifting quality continuously, no repairs are allowed to be made on the clutches KV/KR/K1/K2/K3, which means that only the complete clutch is allowed to be replaced.

(1) Clutch KV

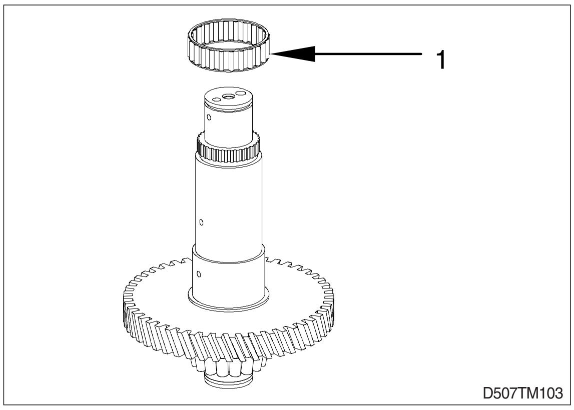
① Press the taper roller bearing (inner ring) (1) onto the shaft (2) until contact is obtained.



② Install the piston ring (1).

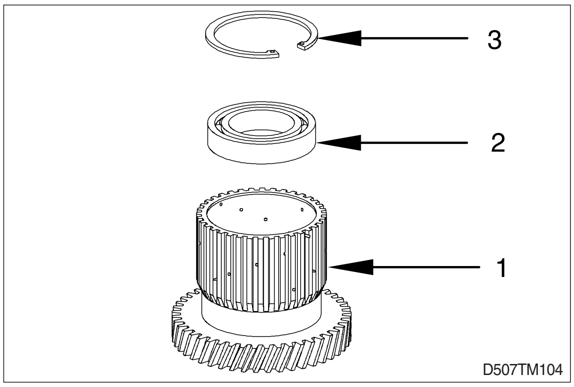


③ Mount the needle bearing (1) onto the shaft.

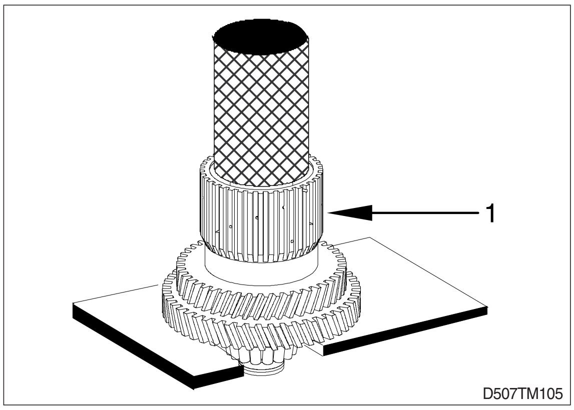


④ Put the ball bearing (2) into the idler (1) until contact is obtained and fasten it by means of retaining ring (3).

(S) Set of internal pliers

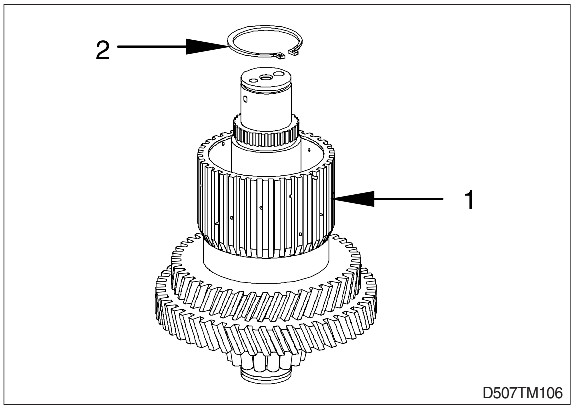


⑤ Press in preassembled idler (1) until contact.



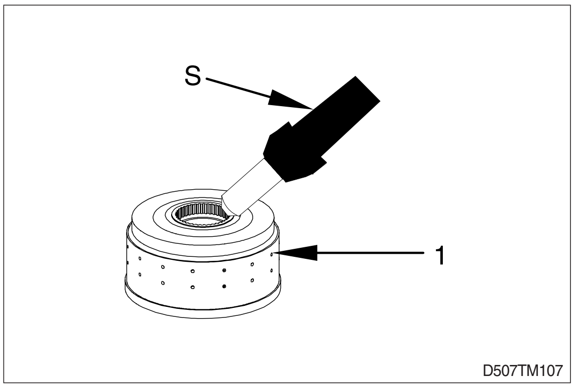
⑥ Fasten the idler (1) by means of retaining ring (2).

(S) Set of external pliers 5870 900 015



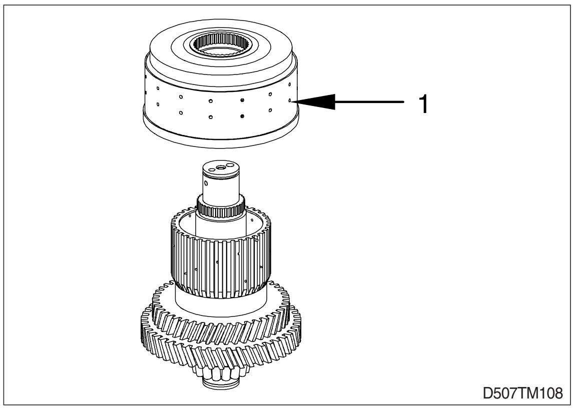
⑦ Heat up the inner diameter of the clutch (1) (approx. 120˚C).

(S) Hot- air blower 220V 5870 221 500
(S) Hot- air blower 110V 5870 221 501

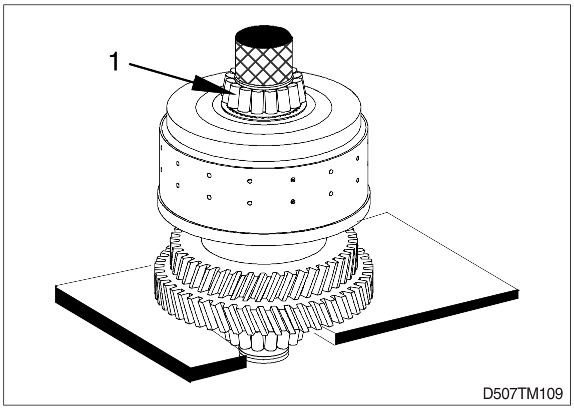


⑧ Mount the clutch (1) until contact is obtained.

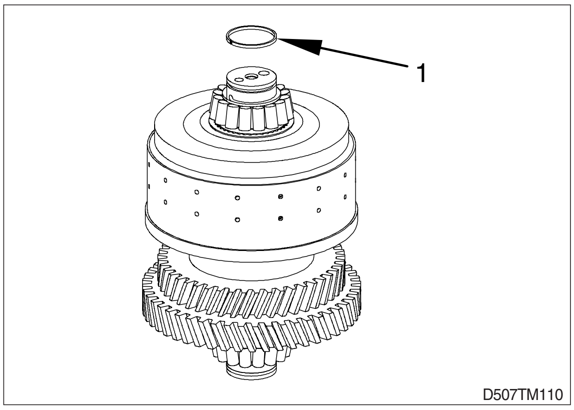
⚠ **Wear safety gloves.**



⑨ Press the taper roller bearing (inner ring) (1) until contact is obtained.



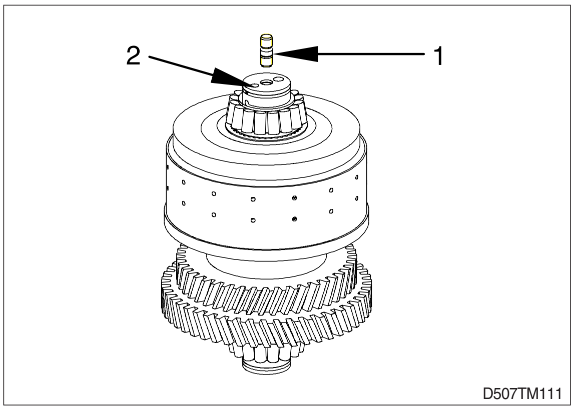
⑩ Install the piston ring (1).



⑪ Install the stud (1).

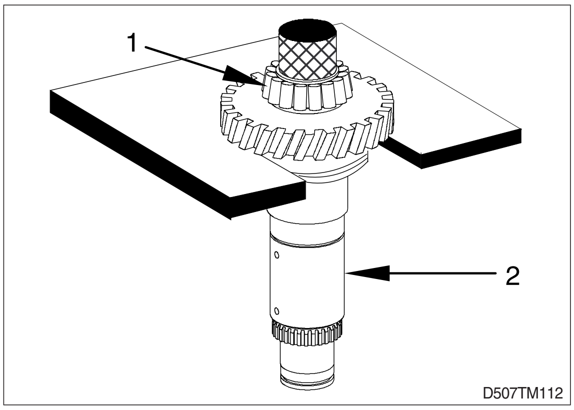
Tighteningtorque ·············· M_A=1.7 kg·m

※ Check closing respective opening of the clutch by means of compressed air at the bore (2).
Closing respective opening of the clutch must be clearly audible.



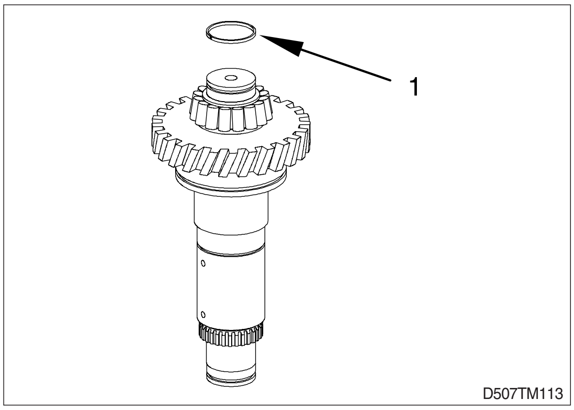
(2) Clutch KR

① Press the taper roller bearing (inner ring) (1) onto the shaft (2) until contact is obtained.



D507TM112

② Install the piston ring (1).

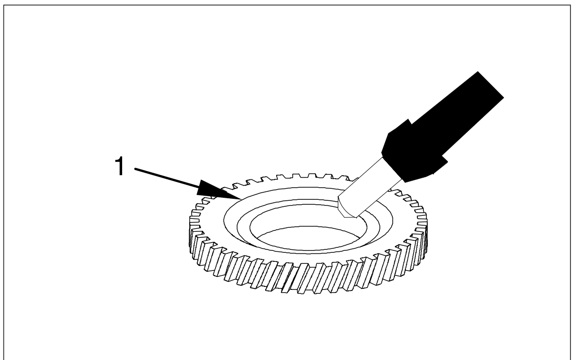


D507TM113

③ Heat up the inner diameter of the gear (1)(approx. 120˚C).

(S)Hot- air blower 220V 5870 221 500
(S)Hot- air blower 110V 5870 221 501

⚠ **Wear safety gloves.**



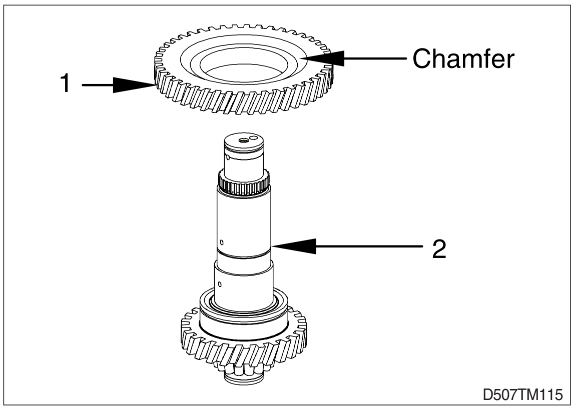
D507TM114

④ Undercool the shaft (2) (approx. 80˚C). Mount the gear until contact is obtained.

※ Install the chamfer of the gear (see arrow) showing upwards.

※ Observe the radial installation position.

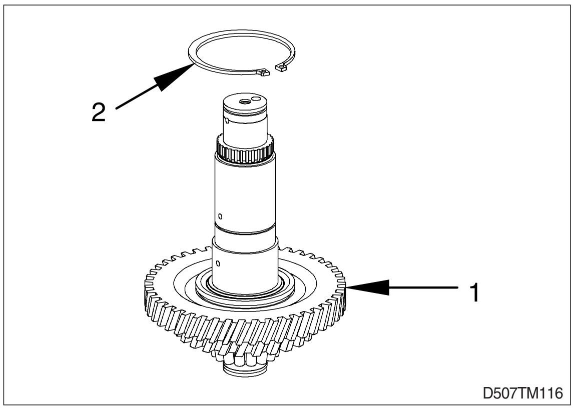
⚠ **Wear safety gloves.**



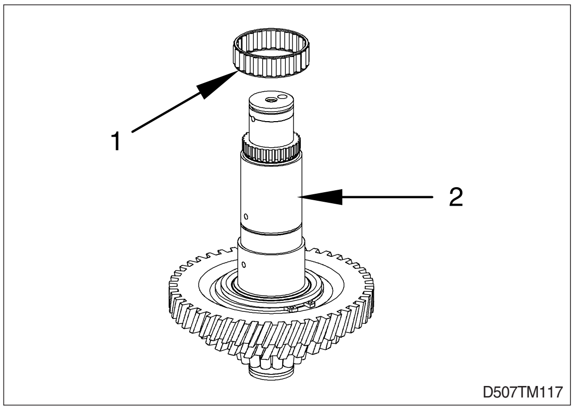
D507TM115

⑤ Fasten the gear (1) by means of retaining ring (2).

(S) Set of internal pliers 5870 900 015

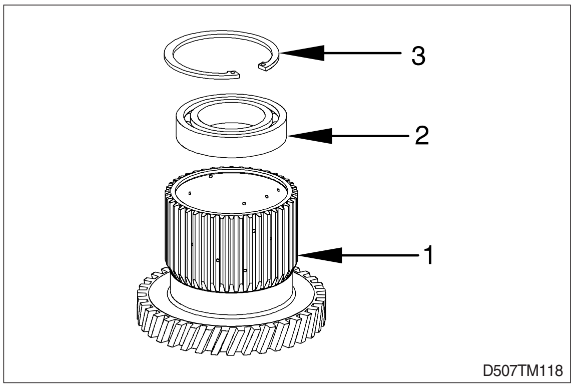


⑥ Mount the needle bearing (1) onto the shaft (2).

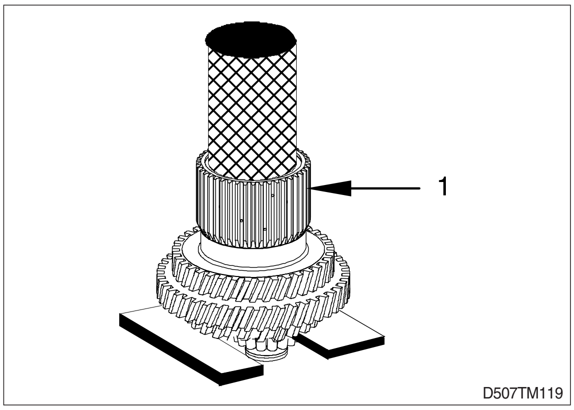


⑦ Put the ball bearing (2) into the idler (1) until contact is obtained and fasten it by means of retaining ring (3).

(S) Set of internal pliers 5870 900 013

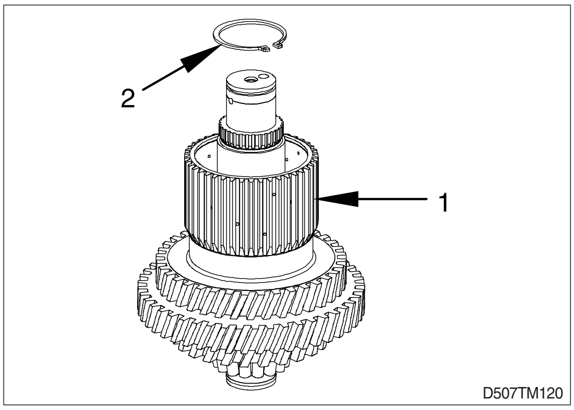


⑧ Press in the preassembled idler (1) until contact.



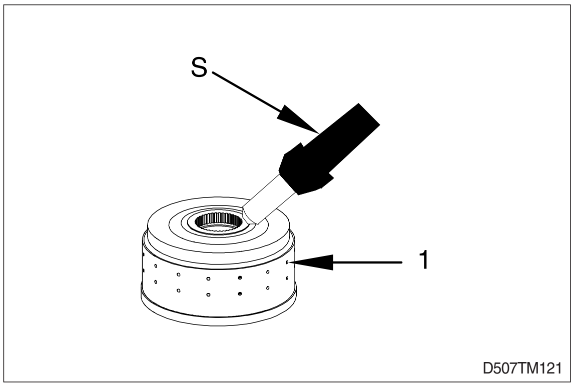
⑨ Fasten the idler (1) by means of retaining ring (2).

(S) Set of internal pliers 5870 900 015



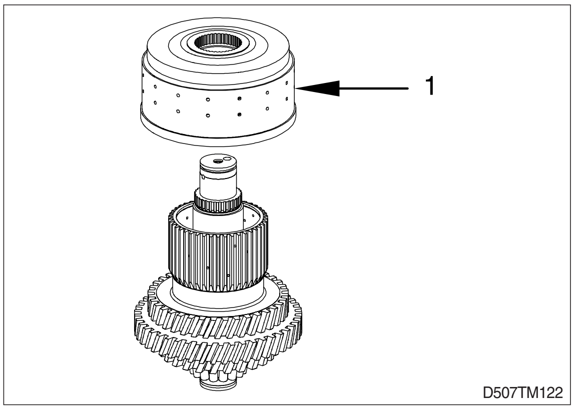
⑩ Heat up the inner diameter of the clutch (1) (approx. 120˚C).

(S) Hot- air blower 220V 5870 221 500
(S) Hot- air blower 110V 5870 221 501

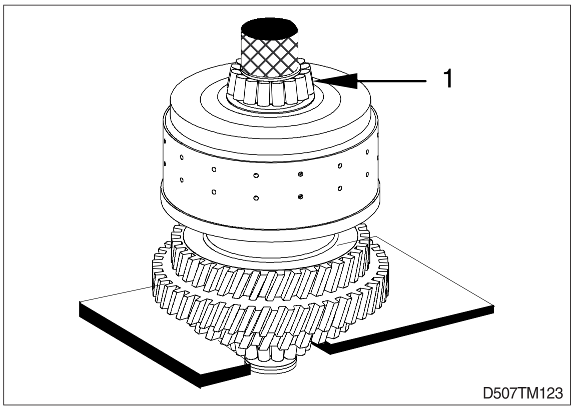


⑪ Mount the clutch (1) and press it until contact is obtained.

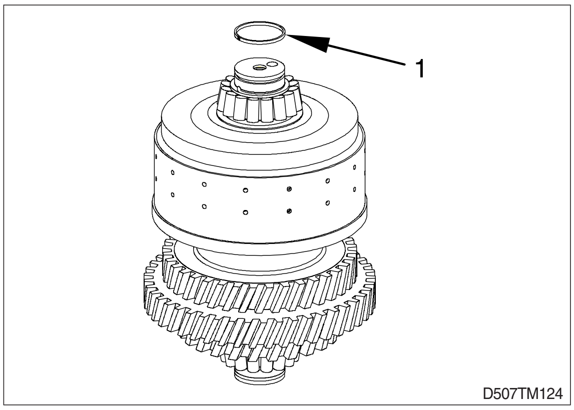
⚠ **Wear safety gloves.**



⑫ Press the taper roller bearing (inner ring) (1) until contact is obtained.

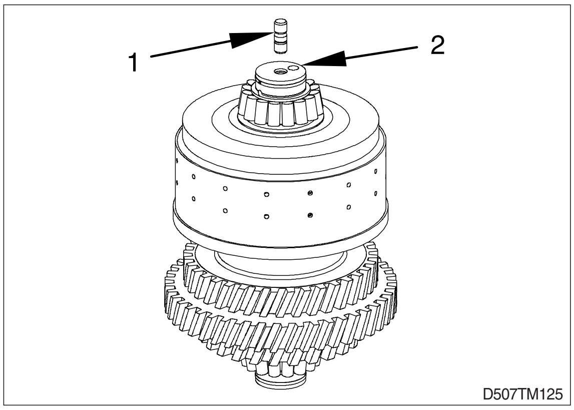


⑬ Install the piston ring (1).



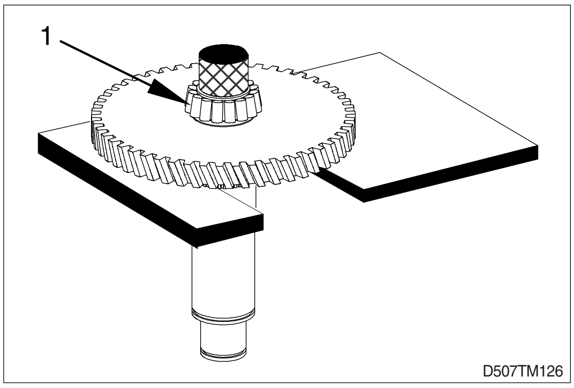
⑭ Install the stud (1).
Tightening torque ·············· M_A =1.7 kg·m

※ Check closing respective opening of the clutch by means of compressed air at the bore (2).
Closing respective opening of the clutch must be clearly audible.

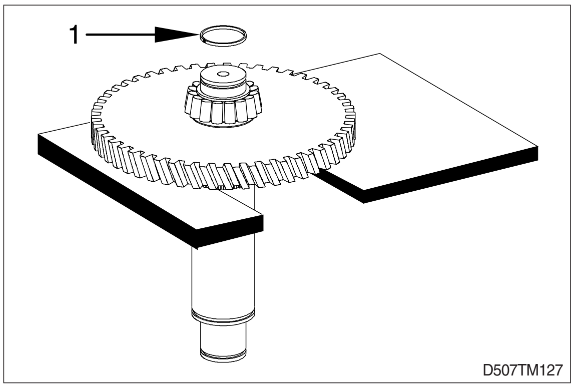


(3) Clutch K1

① Press the taper roller bearing (inner ring) (1) onto the shaft until contact.

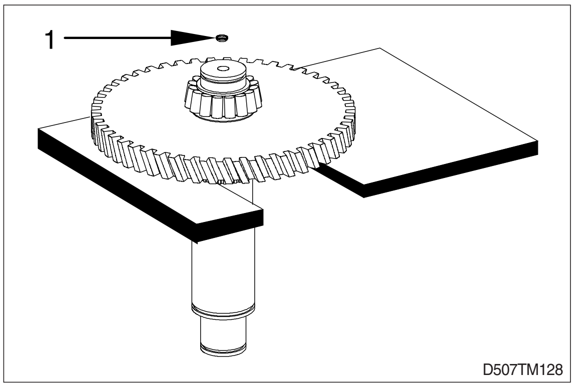


② Install the piston ring (1).



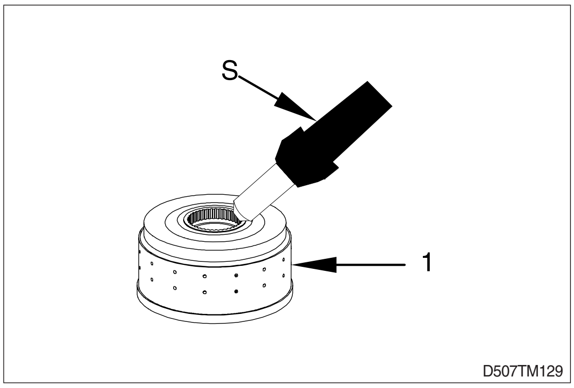
③ Install the sealing cap (1).

※ Wet the contact surface with (Loctite Type No. 262).



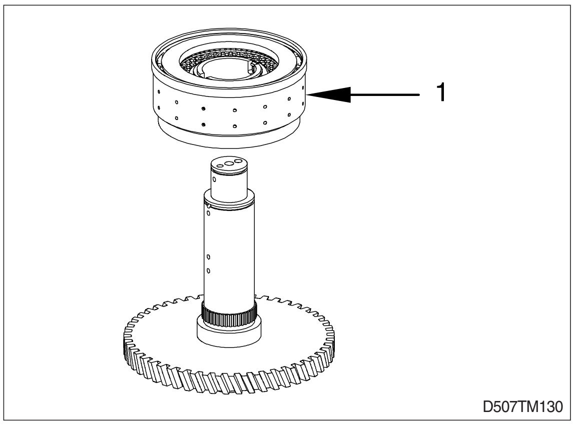
④ Heat up the inner diameter of the clutch (1) (approx. 120˚C).

(S) Hot- air blower 220V 5870 221 500
(S) Hot- air blower 110V 5870 221 501



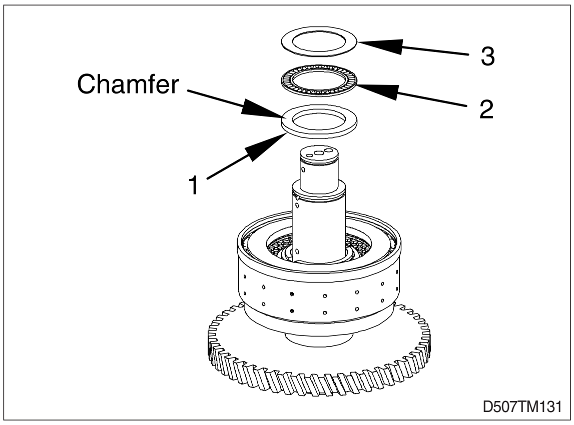
⑤ Mount the clutch (1) and press it until contact is obtained.

⚠ Wear safety gloves.

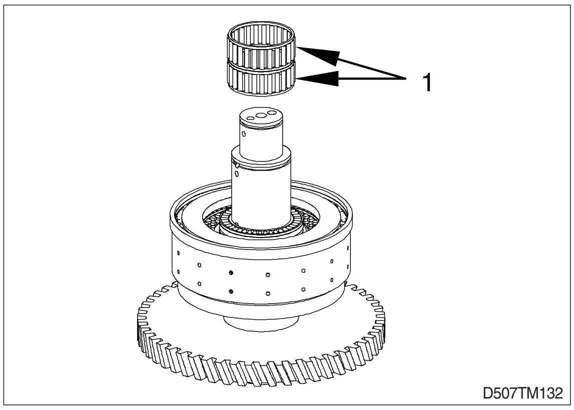


⑥ Mount the running disc (1), axial cage (2) and axial washer (3).

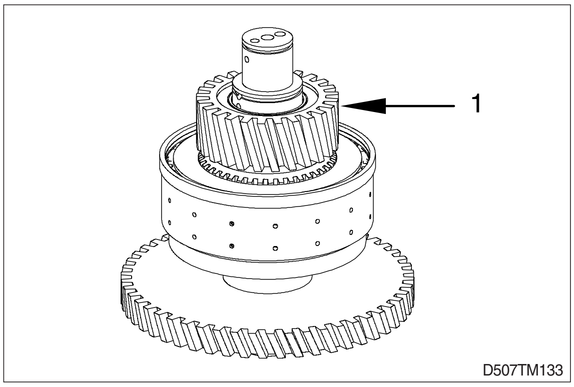
※ Install chamfer (see arrow) of the running disc (2) showing towards the axial cage.



⑦ Mount the needle cage (1).

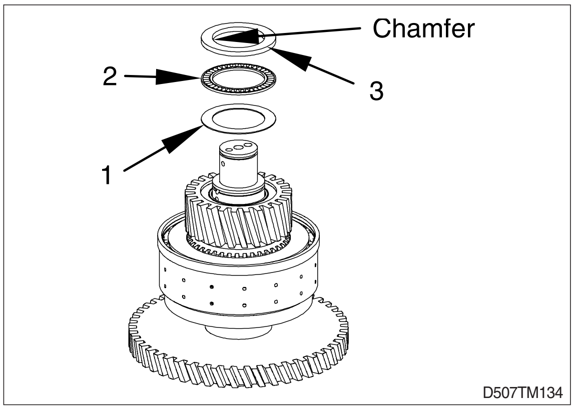


⑧ Install the idler (1).



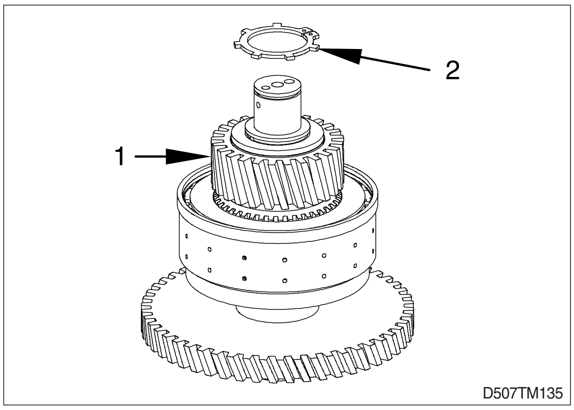
⑨ Mount the axial washer (1), axial cage (2) and running disc (3).

※ Install chamfer (see arrow) of the running disc (3) showing towards the axial cage

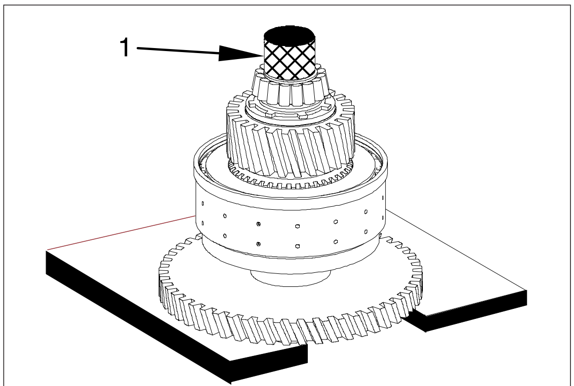


⑩ Fasten the idler (1) and the single parts by means of the retaining ring (2).

(S) Set of external pliers 5870 900 015

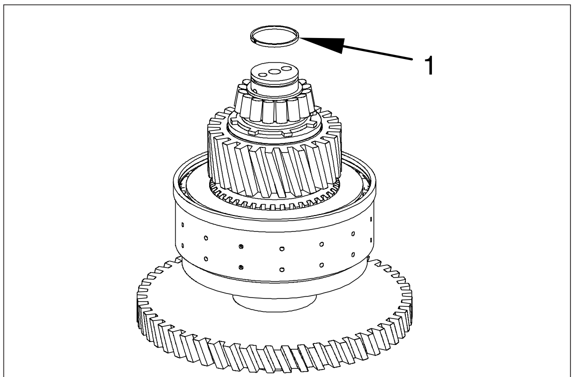


⑪ Press the taper roller bearing (inner ring) (1) until contact is obtained.



D507TM136

⑫ Install the piston ring (1).



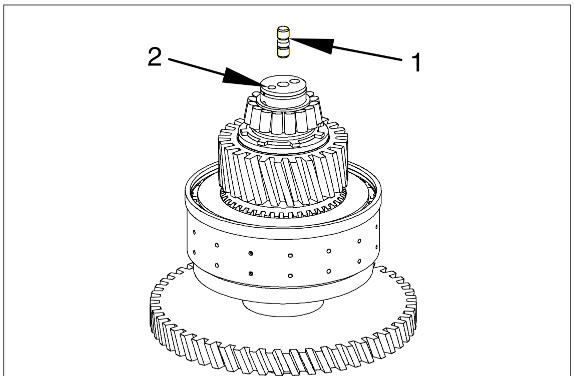
D507TM137

⑬ Install the stud (1).

Tightening torque ·············· M_A =1.7kg·m

※ Check closing respective opening of the clutch by means of compressed air at the bore (2).

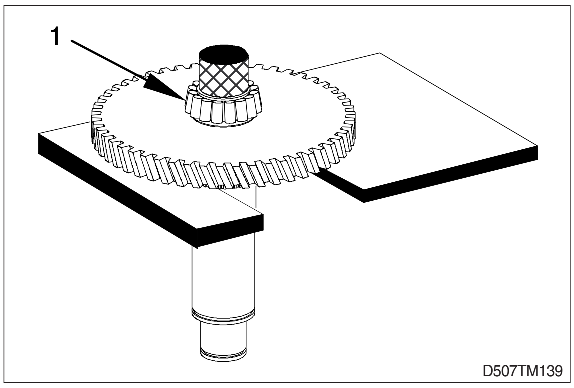
Closing respective opening of the clutch must be clearly audible.



D507TM138

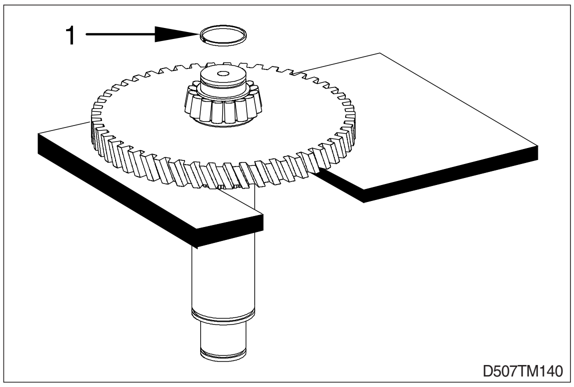
(4) Clutch K2

① Press the taper roller bearing (inner ring) (1) onto the shaft until contact.



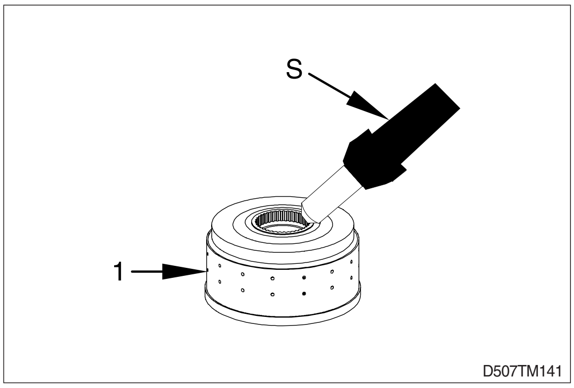
D507TM139

② Install the piston ring (1).



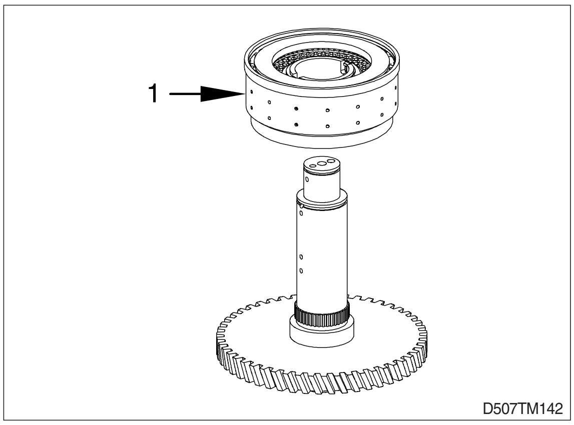
③ Heat up the inner diameter of the clutch (1) (approx. 120˚C).

(S) Hot- air blower 220V   5870 221 500
(S) Hot- air blower 110V   5870 221 501



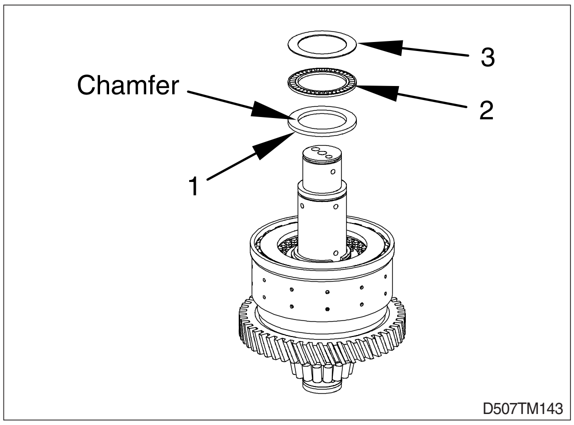
④ Mount the clutch (1) until contact is obtained.

⚠ Wear safety gloves.

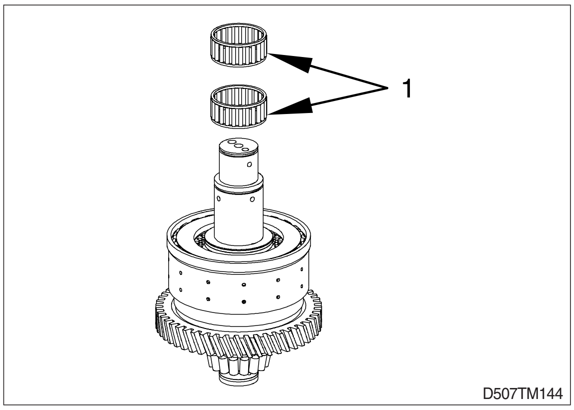


⑤ Mount the running disc (1), axial cage (2) and axial washer (3).

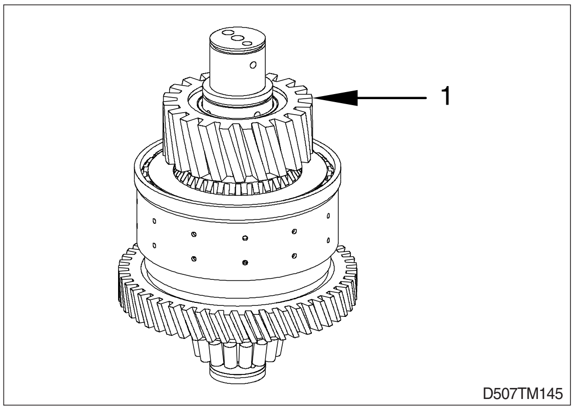
※ Install chamfer (see arrow) of the running disc (2) showing towards the axial cage.



⑥ Mount the needle cage (1).

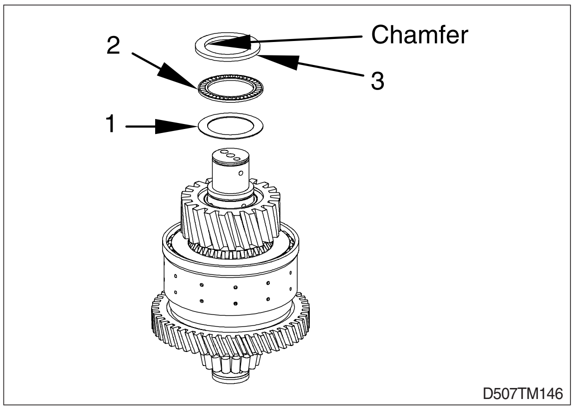


⑦ Install the idler (1).



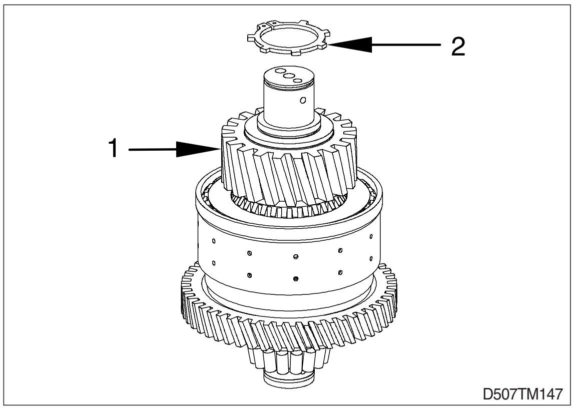
⑧ Mount the axial washer (1), axial cage (2) and running disc (3).

※ Install chamfer (see arrow) of the running disc (3) showing towards the axial cage.

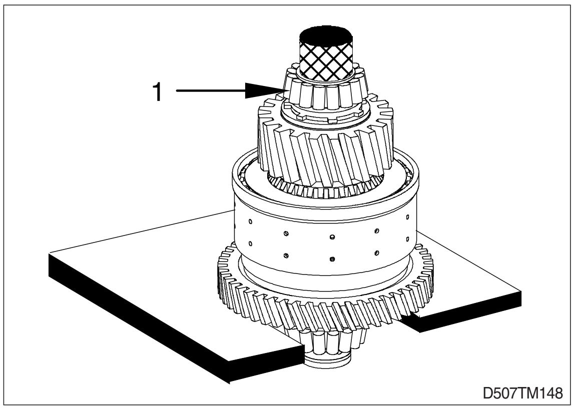


⑨ Fasten the idler (1) and the single parts by means of the retaining ring (2).

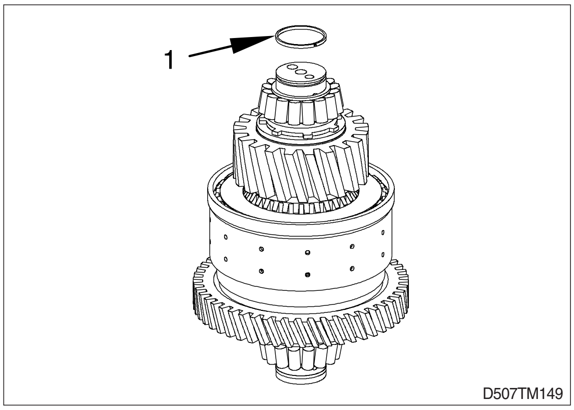
(S) Set of external pliers 5870 900 015



⑩ Press the taper roller bearing (inner ring) (1) until contact is obtained.

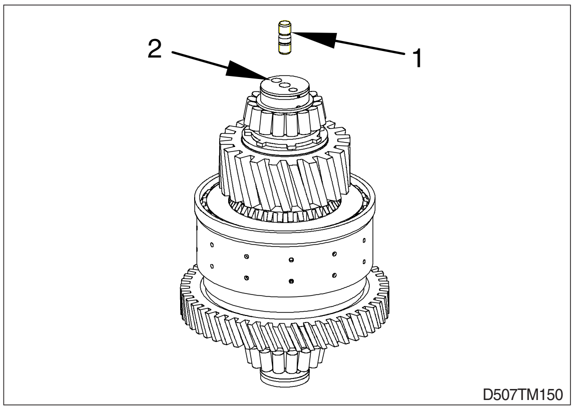


⑪ Install the piston ring (1).



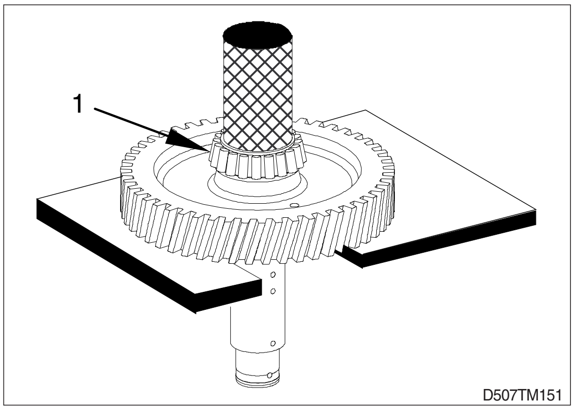
⑫ Install the stud (1).
Tightening torque ·············· M_A =1.7kg·m

※ Check closing respective opening of the clutch by means of compressed air the bore(2).
Closing respective opening of the clutch must be clearly audible.

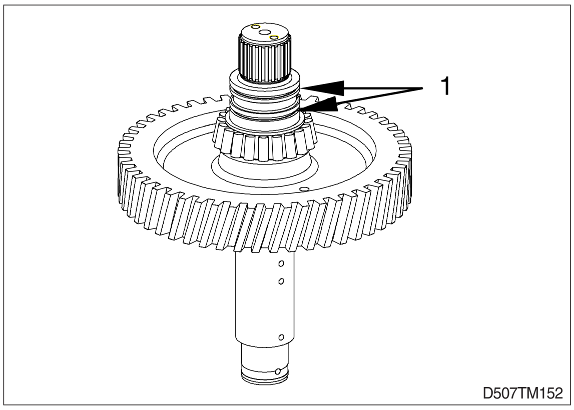


(5) Clutch K3

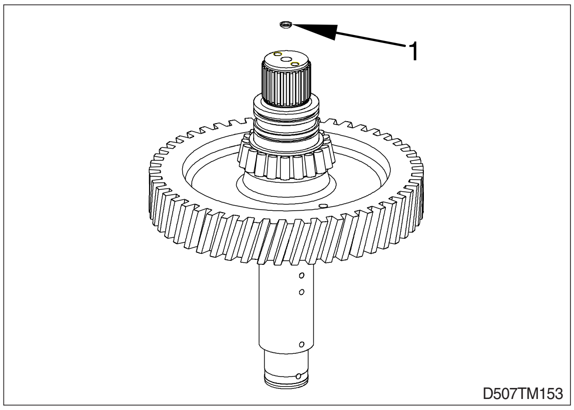
① Press the taper roller bearing (inner ring) (1) onto the shaft until contact.



② Install the piston ring (1).

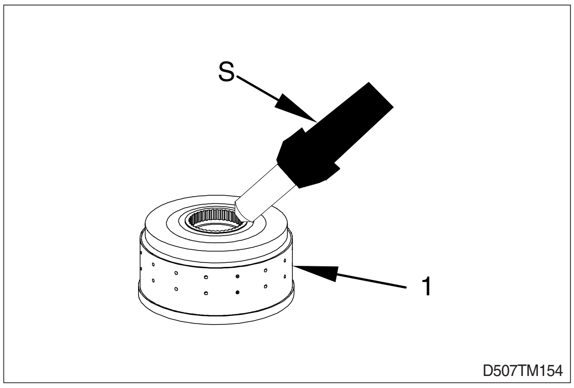


③ Install the sealing cap (1).
Wet the contact surface with loctite type No.262.



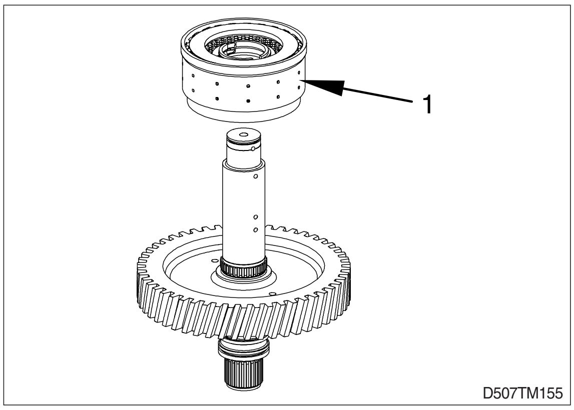
④ Heat up the inner diameter of the clutch (1) (approx. 120˚C).

(S) Hot- air blower 220V 5870 221 500
(S) Hot- air blower 110V 5870 221 501



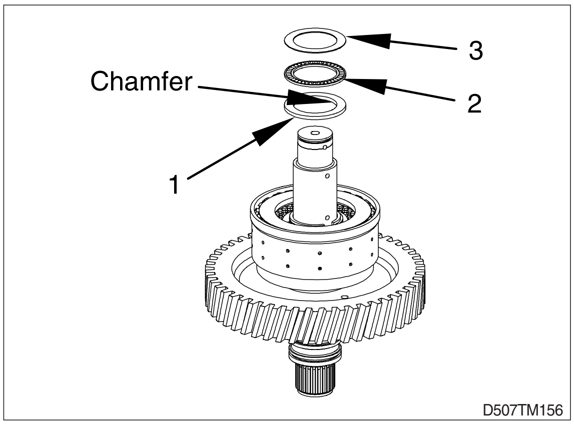
⑤ Mount the clutch (1) until contact is obtained.

⚠ **Wear safety gloves.**

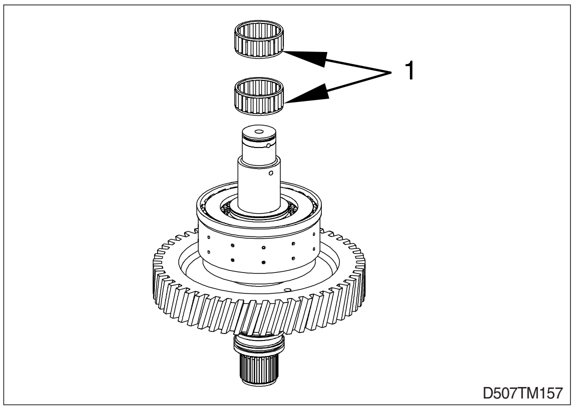


⑥ Mount the running disc (1), axial cage (2) and axial washer (3).

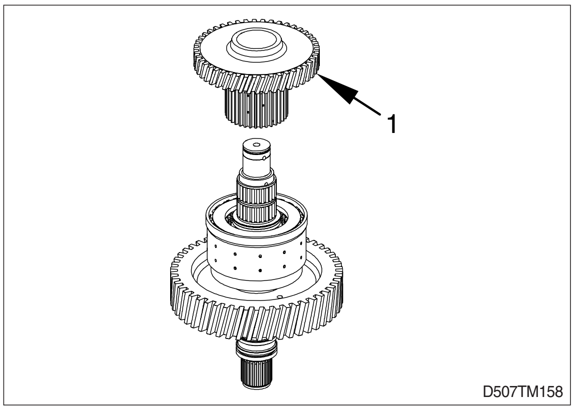
※ Install chamfer (see arrow) of the running disc (3) showing toward the axial cage.



⑦ Mount the needle cage (1).

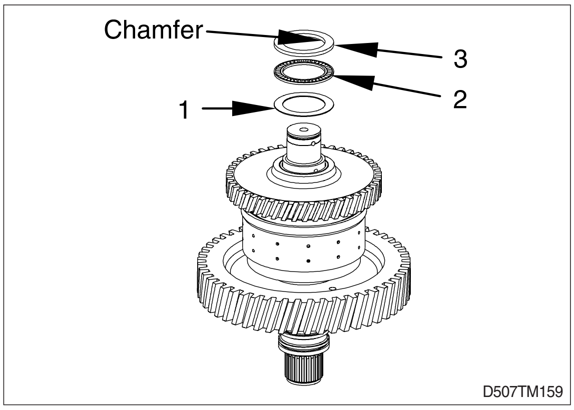


⑧ Install the idler (1).

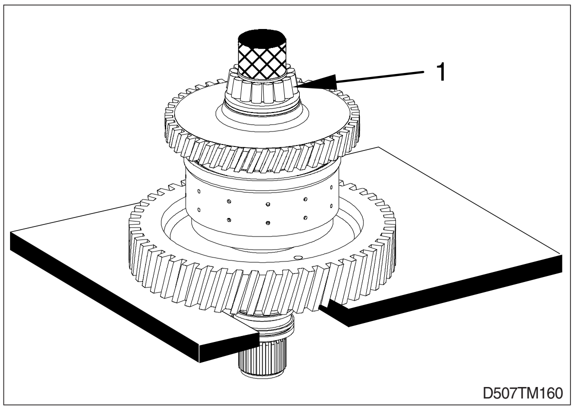


⑨ Mount the axial washer (1), axial cage (2) and running disc (3).

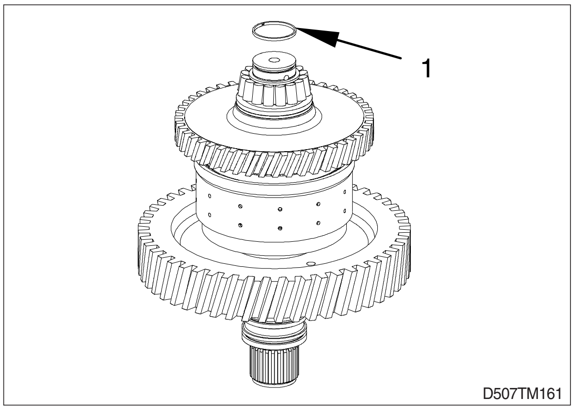
※ Install chamfer (see arrow) of the running disc (3) showing towards the axial cage.



⑩ Press the taper roller bearing (inner ring) (1) until contact is obtained.

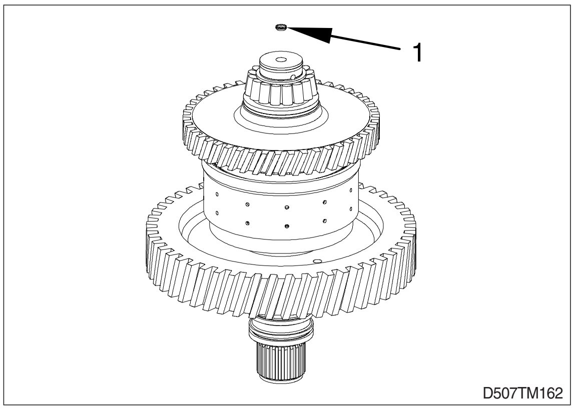


⑪ Install the piston ring (1).

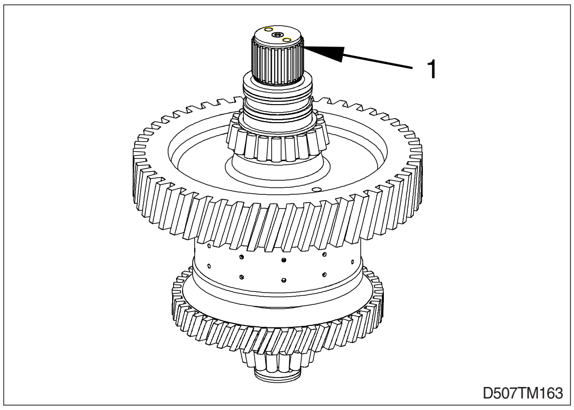


⑫ Install the screw plug (1).

(S) Lever riveting tongs 5870 320 016

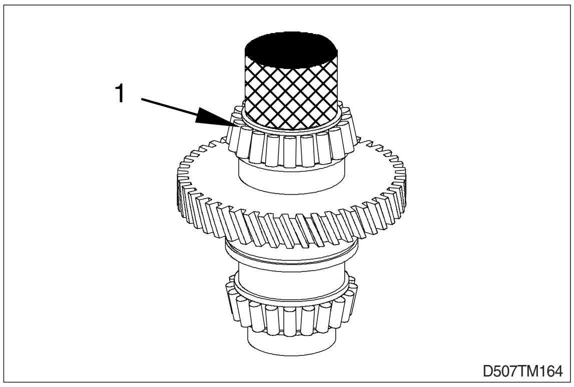


※ Check closing respective opening of the clutch by means of compressed air at the bore (1).
Closing respective opening of the clutch must be clearly audible.

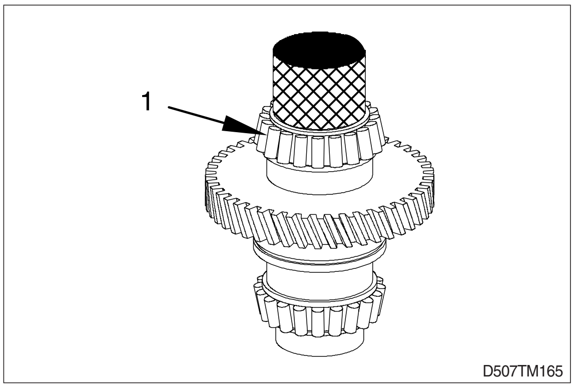


(6) Input

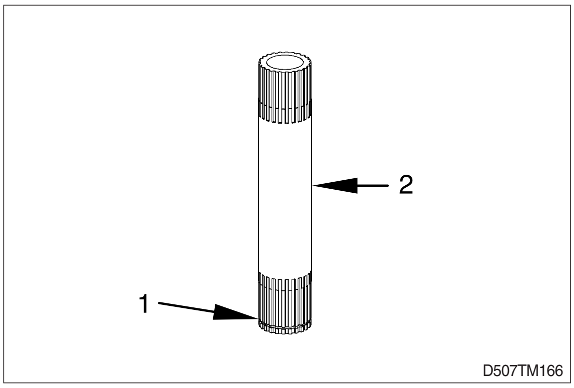
① Press the taper roller bearing (inner ring) (1) until contact is obtained.



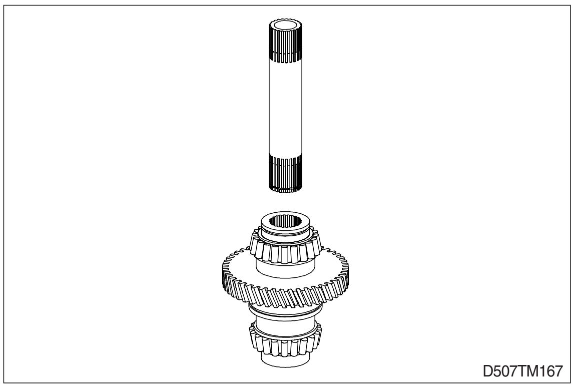
② Press the taper roller bearing (inner ring) (1) until contact is obtained.



③ Have the snap ring (1) engaged into the annular groove of the turbine wheel shaft (2).



④ Mount the turbine wheel shaft until the snap ring engages into the recess of the input gear-turbine wheel shaft is axially fixed.



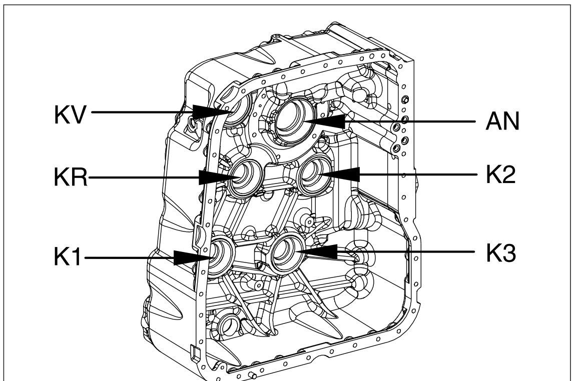
2) ENGINE CONNECTION, PRESSURE OIL PUMP AND INSTALLATION OF THE CLUTCHES

Install all bearing outer rings into the bearing bores of both transmission housing sections.

※ Should contrary to the recommendations the taper roller bearing of the clutches as well as of the input not be replaced, the assignment (bearing inner and outer rings) has to be kept at least .
Mark the bearing inner and bearing outer rings to each other accordingly.

(1) Transmission housing front section

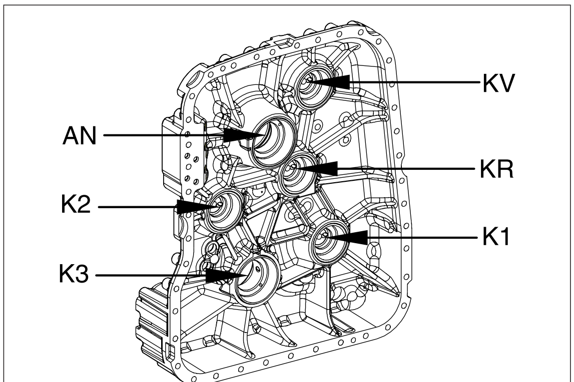
AN = Input
KV = Clutch - Forward
KR = Clutch - Reverse
K1 = Clutch - 1st gear
K2 = Clutch - 2nd gear
K3 = Clutch - 3rd gear



D507TM171

(2) Transmission housing rear section

※ Put the bearing outer rings with assembly grease into the bearing bores

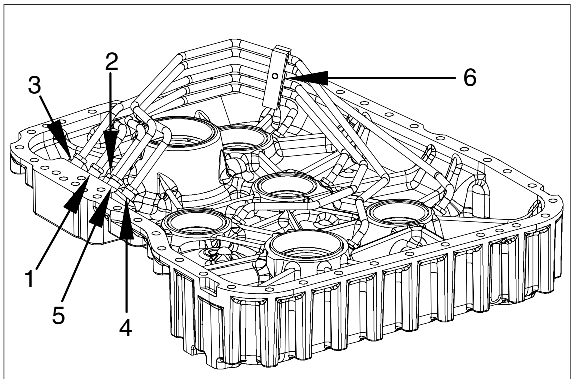


D507TM172

① Install the pipe (system pressure from the electro-hydraulic control to the respective clutch).
The pipes are to be installed in the following sequence:

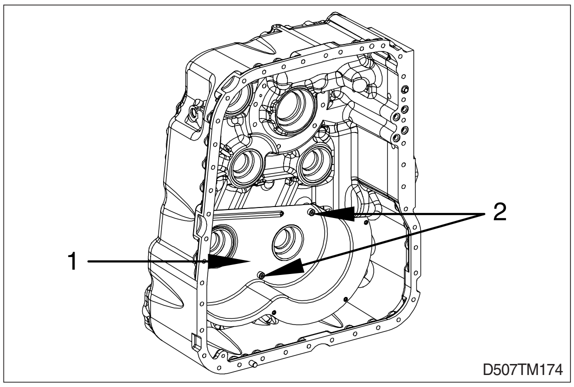
1 = Pipe	KV
2 = Pipe	KR
3 = Pipe	K2
4 = Pipe	K1
5 = Pipe	K3

Tightening torque ················· M_A =4.3kg·m
Install the holding segment (6)
Tightening torque (M8/8.8) ·· M_A =2.3 kg·m



D507TM173

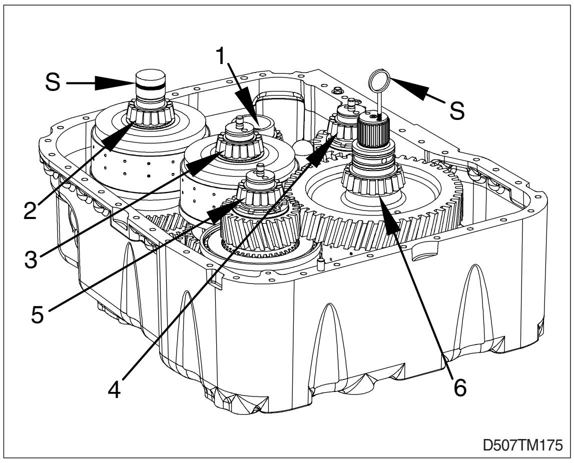
② Fasten the screen sheet (1) by means of cap screws (2).
Tightening torque (M8/8.8) ·· M_A =2.3 kg·m



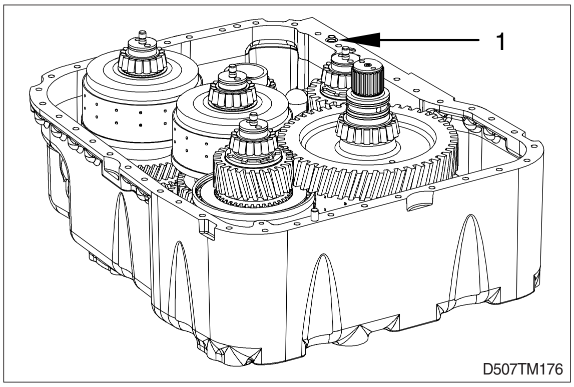
③ The clutch is to be put into the transmission housing front section as described in the legend.

1 = Input shaft
2 = Clutch KV
3 = Clutch KR
4 = Clutch K2
5 = Clutch K1
6 = Clutch K3

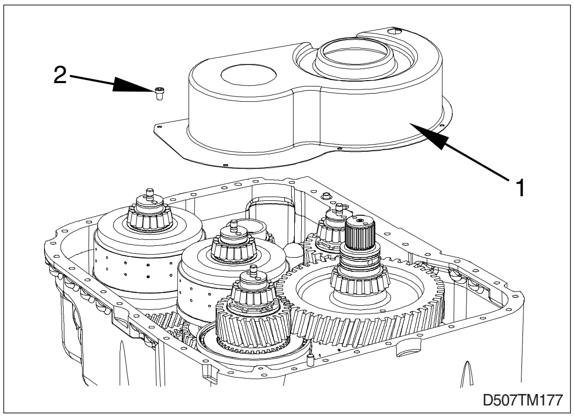
(S)Handle 5870 260 010 (K1/K2/KV/KR)
(S)Eyebolt 5870 204 002



④ Put the pipes and O-rings into the bores and grease them.

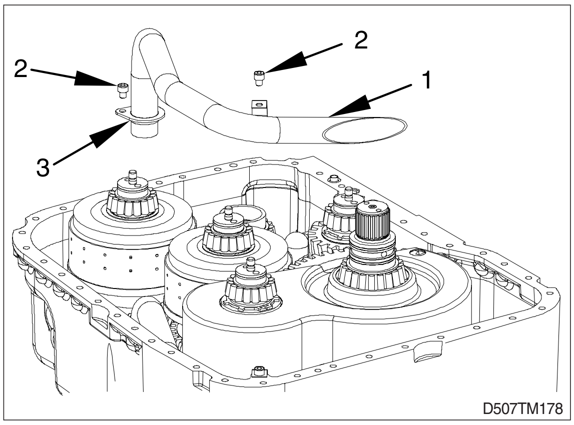


⑤ Fasten the screen sheet (1) by means of cap screws (2).
Tightening torque (M6/8.8) ··· M_A =0.97 kg·m



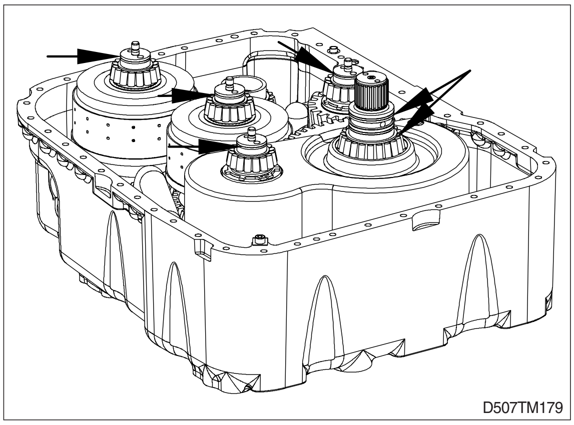
⑥ Install the O-rings (3) and fasten the suction pipe (1) by means of cap scre-ws (2).

Tightening torque (M8/8.8) ·· M_A =2.3 kg·m



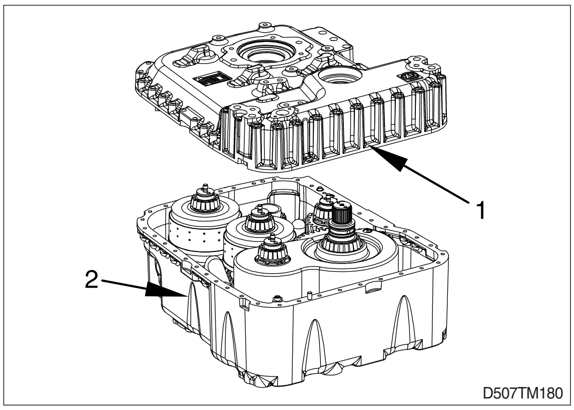
⑦ Grease the rectangular rings (see arrows) and align them, centrically.

※ Wet the mounting face with sealing compound loctite (Type No.574)



⑧ Cautiously place the transmission housing rear section (1) by means of the lifting equipment to the transmission housing front section (2) until contact is obtained.

(S) Eyebolts 2×(M20)	0636 804 003
(S) Ring nut(M12)	0664 462 774
(S) Lifting chain	5870 281 047

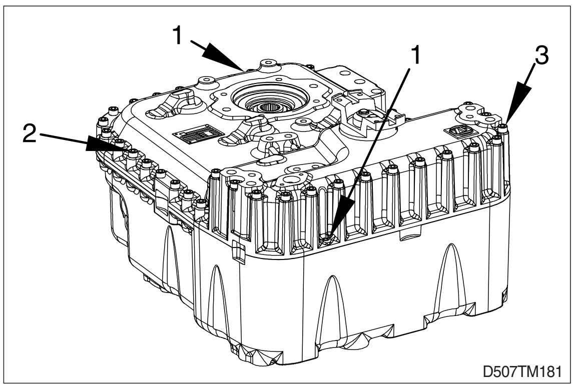


⑨ Install both cyl. pins (1) centrally to the mounting face.

By means of cap screws (2 and 3) fasten the transmission housing rear section to the transmission housing front section.

※ Cap screws with different lengths.

Tightening torque (M8/8) ······ M_A =4.7kg·m

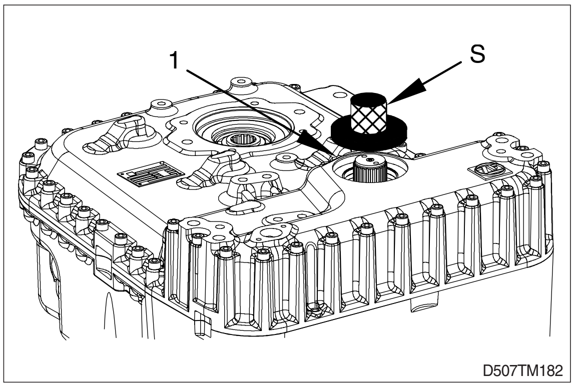


⑩ Install the shaft seal (1) with the sealing lip showing to the oil sump.

※ The exact installation position is obtained by using the specified mounting tool (S).

※ Fill the shaft seal between dust lip and sealing lip with grease.
Wet the outer diameter with spirit.

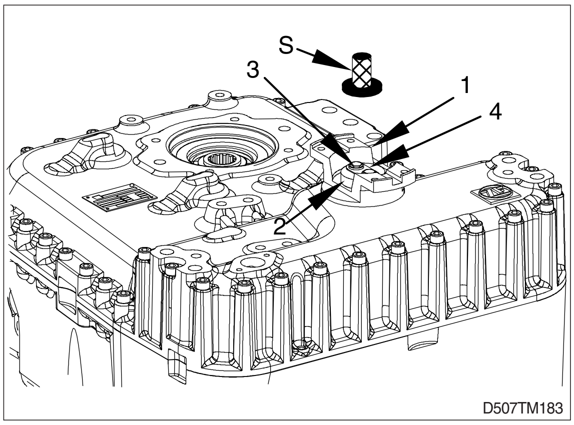
(S) Mounting tool 5870 048 057



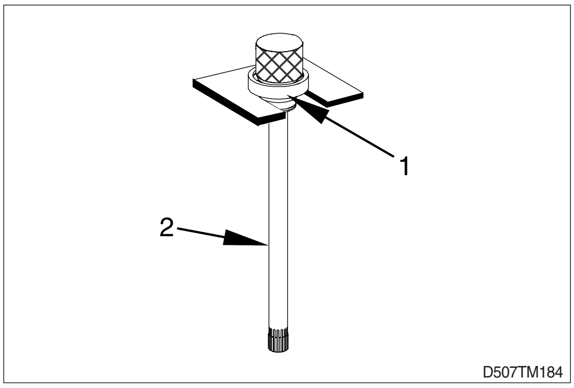
⑪ Insert the input flange (1) until contact and put in the O-ring. Fix the input flange (1) by means of washer (2) and hexagon screws (3).
Then fix the hexagon screws (3) with the tab washer (4) by means of the mounting tool (S).

Tightening torque (M8/8.8) ·· M_A =3.5 kg·m

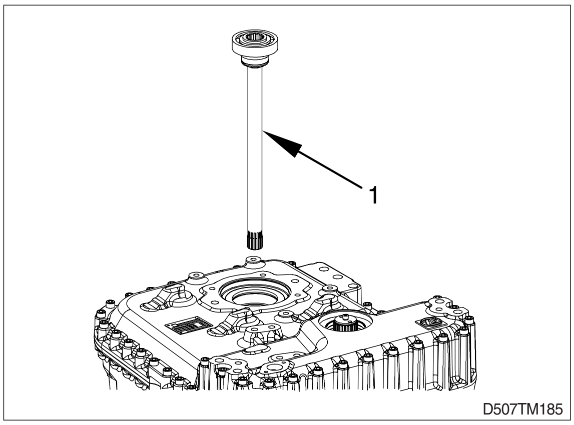
(S) Mounting tool 5870 057 011
(S) Handle 5870 260 002



⑫ Press the ball bearing (1) onto the pump shaft (2) until contact is obtained.

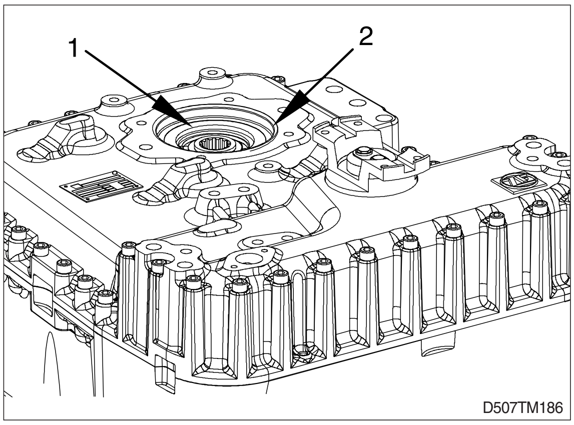


⑬ Install the pump shaft (1) until contact is obtained.



⑭ Install the retaining ring (1) and the O-ring (2).

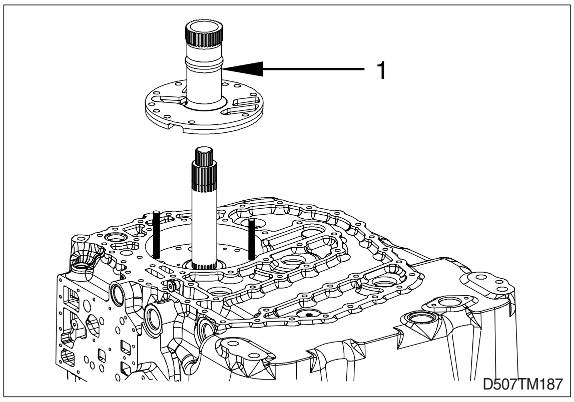
※ Grease the O-ring



⑮ Install two adjusting screws and mount the stator hollow shaft (1).

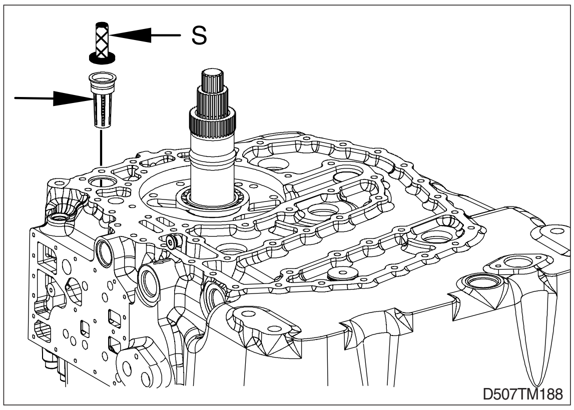
※ Observe the radial installation position.

(S) Adjusting screws 5870 204 007



⑯ Install the converter safety valve (1) until contact.

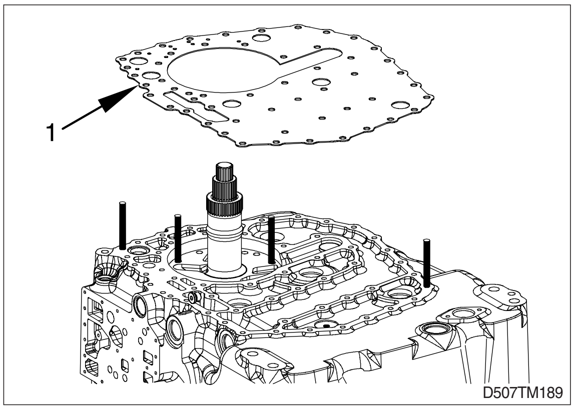
(S) Drive mandrel 5870 705 012



⑰ Install two adjusting screws and mount the intermediate sheet (1).

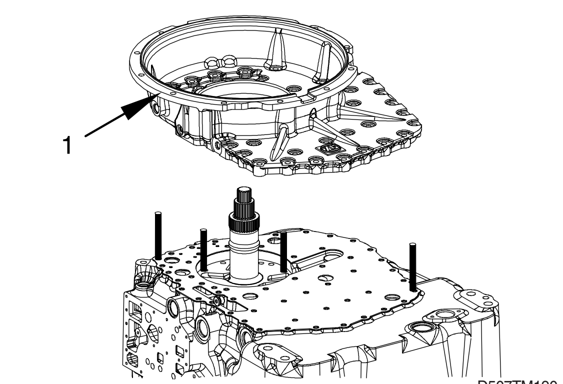
※ The intermediate sheet has always to be replaced.

(S) Adjusting screws 5870 204 007



⑱ Cautiously place the converter bell (1) by means of the lifting equipment to the tran-smission until contact is obtained.

(S) Eyebolts assortment 5870 204 002
(S) Lifting chain 5870 281 047

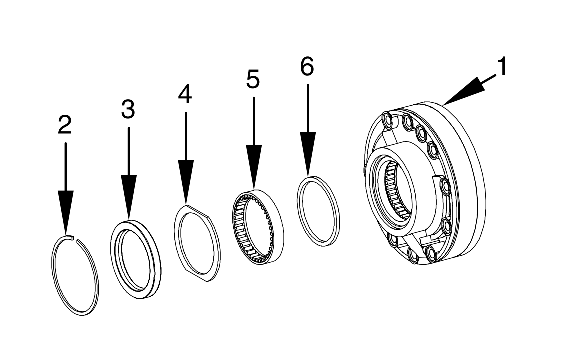


D507TM190

(3) Pressure oil pump

※ If running-in marks should be found in the pump housing or on the cam disc, the complete pump has to be replaced.
※ Item 1-6 are allowed to be replaced.

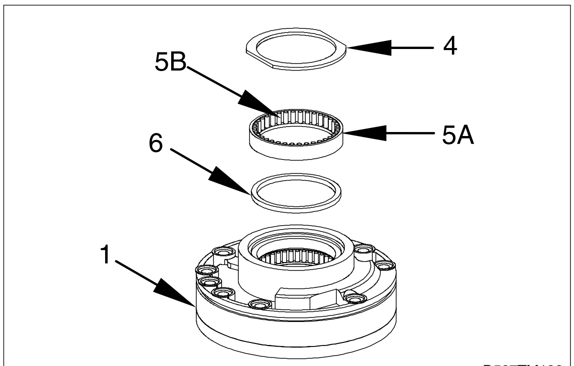
1 = Pump housing with rotor
2 = Snap ring
3 = Shaft seal
4 = Support shim
5 = Needle bearing cpl.(bearing outer ring and needle bearing)
6 = Ring



D507TM191

① Install the following parts into the pump housing (1).

6 = Ring
5A = Bearing outer ring
5B = Needle cage
4 = Support shim

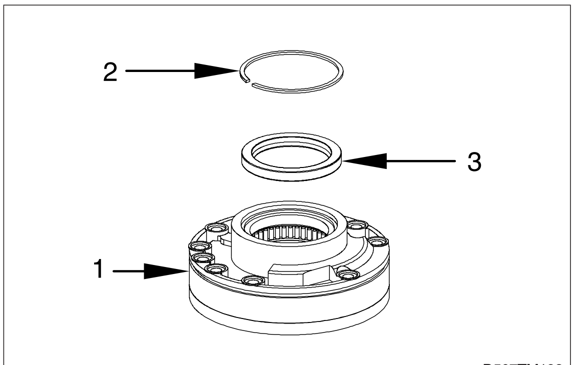


D507TM192

② Cautiously put the shaft seal (3) with the sealing lip showing downwards into the pump housing (1) until contact and fasten it by means of the snap spring (2).

※ Wet the outer diameter of the shaft seal with spirit.

(S) Mounting tool 5870 055 070
(S) Handle 5870 260 002

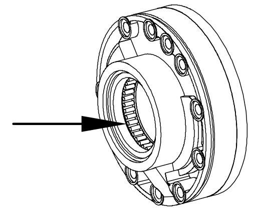


D507TM193

(4) Installation of the external and internal rotor

※ Install the external rotor.
Chamfer shows to the pump base (cannot be seen in the picture).

※ Install the internal rotor.
Gearing (arrow) shows downwards.

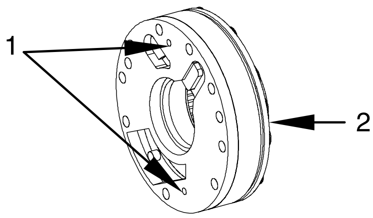


D507TM194

① Put on the cam disc and by means of two cap screws (1) fasten it radially.

※ Do not tighten the cap screws - just turn then in until contact is obtained and then make approx. 1/2 rotation back.
Observe the installation position of the cam disc.

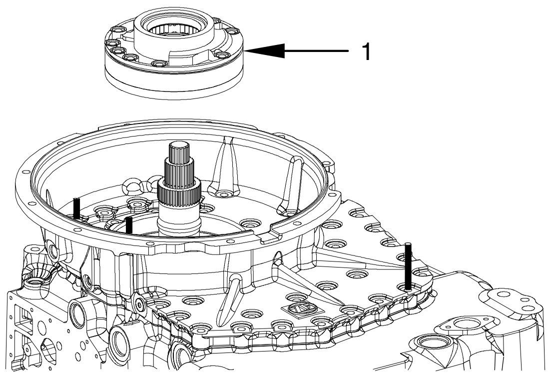
Put the O-ring (2) into the annular groove and oil it.



D507TM195

② Mount the preassembled pressure oil pump (1) and with the cap screws (3pcs.) first place it equally until contact is obtained.

※ Observe the radial installation position.
Then remove the cap screws again.



D507TM196

③ Fasten the converter bell, pressure oil pump and stator hollow shaft together by means of cap screws.

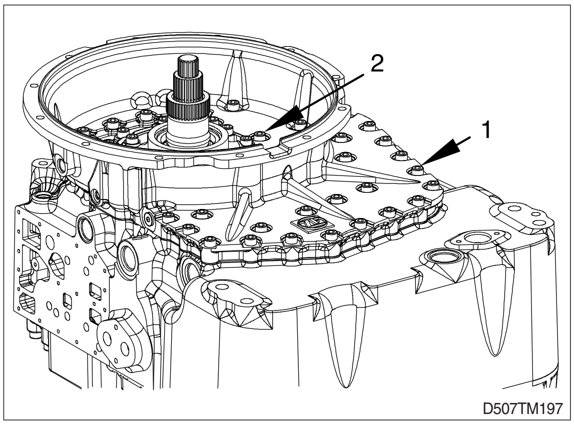
※ Different bolted connections.

1 = Bolted connection converter bell/transmission housing rear section.

Tightening torque (M10/8.8) ·· M_A =4.7 kg·m

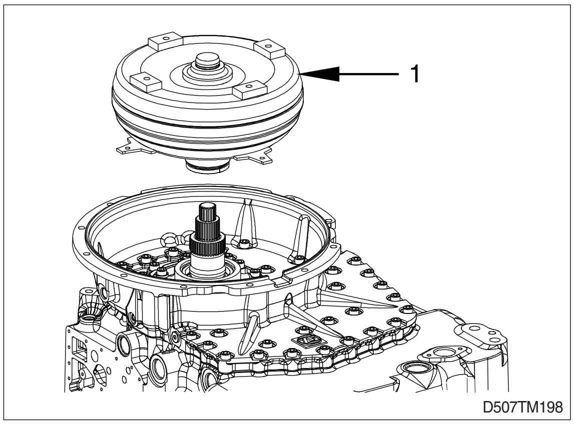
2 = Bolted connect. pressure oil pump/ stator hollow shaft transmission housing rear section.

※ Cap screws with O-rings.
Grease the O-rings.



④ Mount the converter (1) by means of lifting equipment until contact is obtained.

(S) Eyebolts assortment	5870 204 002
(S) Lifting chain	5870 281 047

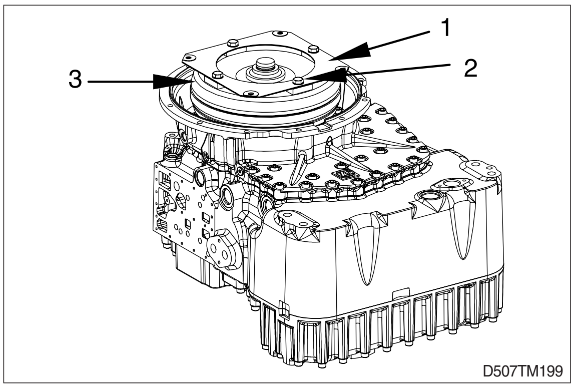


⑤ Fasten the flexplate (1) by means of hexagon screws (2).

※ Install washers between converter (3) and flexplate (1) under the hexagon screws.

※ Lock the hexagon screws with loctite (Type No.262).

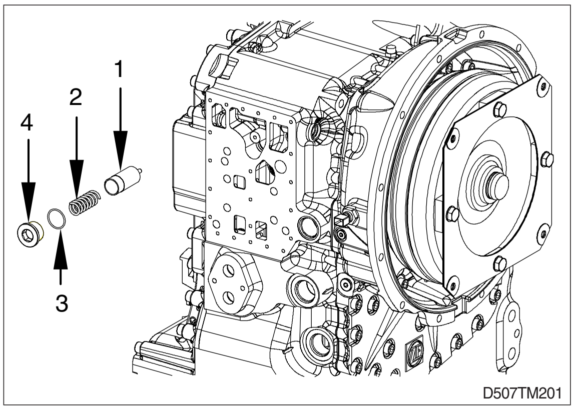
Tightening torque (M12/10.9)·· M_A =11.7 kg·m



3) INDUCTIVE TRANSMITTERS, VALVES, OIL FILTERS AND OIL DRAIN PLUG, SCREW PLUGS

① Install the converter pressure back-up valve.
1 = Piston
2 = Compression spring
3 = O-ring (27×2)
4 = Screw plug (30×1.5)

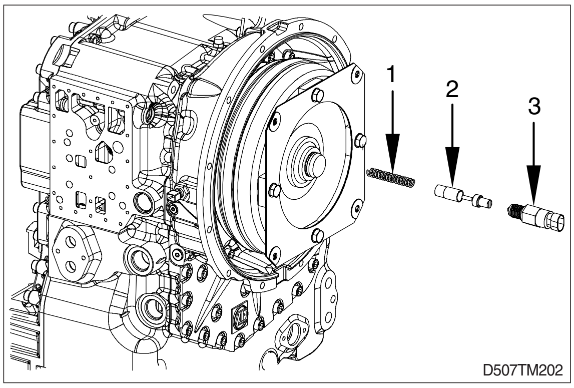
※ Tightening torque ·············· M_A=10.2 kg·m



D507TM201

② Install the differential pressure switch for the pressure filter.
1 = Compression spring
2 = Piston
3 = Tappet switch

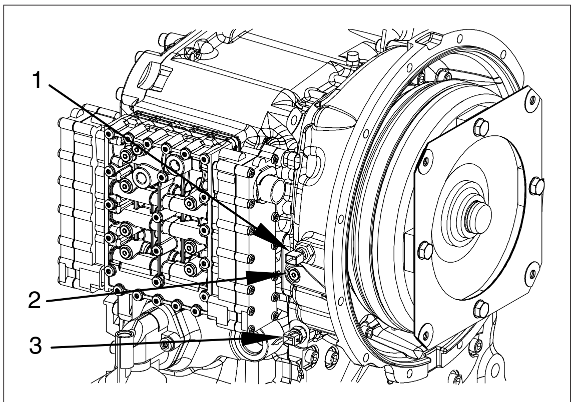
※ Tightening torque ··············· M_A=3.1kg·m



D507TM202

③ Installation of:
1 = Inductive transmitter - n Engine
2 = Screw plug M10×1.0
(measuring point pressure after converter)
3 = Temperature transmitter M14×1.5
(measuring point temperature after converter)

※ Tightening torque (1) ······· M_A=3.1 kg·m
Tightening torque (2) ······· M_A=0.97 kg·m
Tightening torque (3) ······· M_A=2.6 kg·m



D507TM203

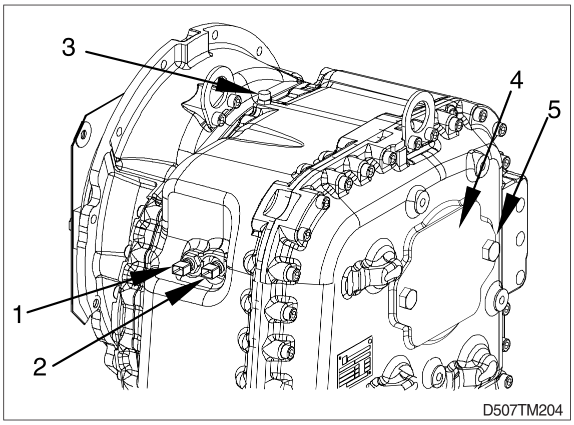
④ Installation of:

1 = Inductive transmitter - n Internal speed input

2 = Inductive transmitter - n Turbine

3 = Breather

※ Tightening torque (1 and 2) ·M_A =3.1 kg·m
Tightening torque (3) ·········· M_A =1.2 kg·m
Fasten the cove replate (4) by means of hexagon screws (5).
Tightening torque (M16/8.8) ······················
··· M_A =2.6 kg·m



D507TM204

⑤ Installation of :

1 = Speed transmitter

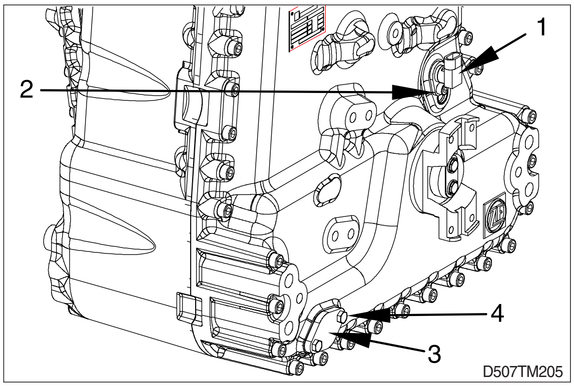
2 = Cap screw

※ Tightening torque(2)(M8/8.8) ·· M_A =2.4 kg·m

3 = Install the cove replate (3) with gasket.

4 = Hexagon screw

※ Tightening torque (2) (M8/8.8) ······················
·· M_A =2.4kg·m



D507TM205

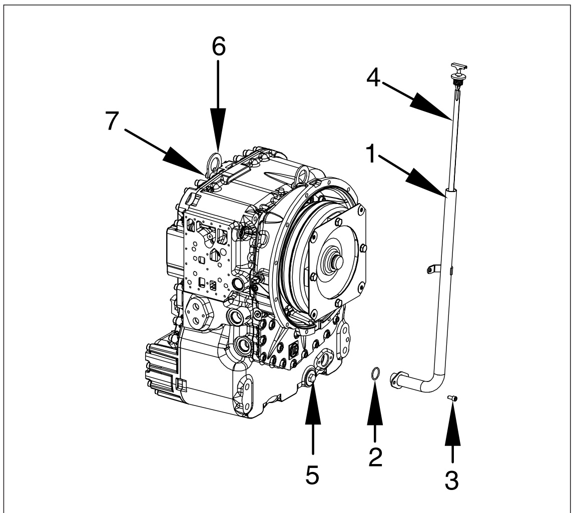
⑥ Fasten the oil filler tube (1) with O-ring (2) to the transmission housing by means of the hexagon screws (3).
Turn the oil dipstick (4) into the oil filler tube.

※ Tightening torque (2) (M8/8.8) ······················
··· M_A =2.4 kg·m

Install the oil drain plug (5) with the O-ring.

※ Tightening torque ·············· M_A =14.3 kg·m
Fasten the fixing plate (6) by means of cap screws (7)

※ Tightening torque (M10/8.8)· M_A =4.7 kg·m

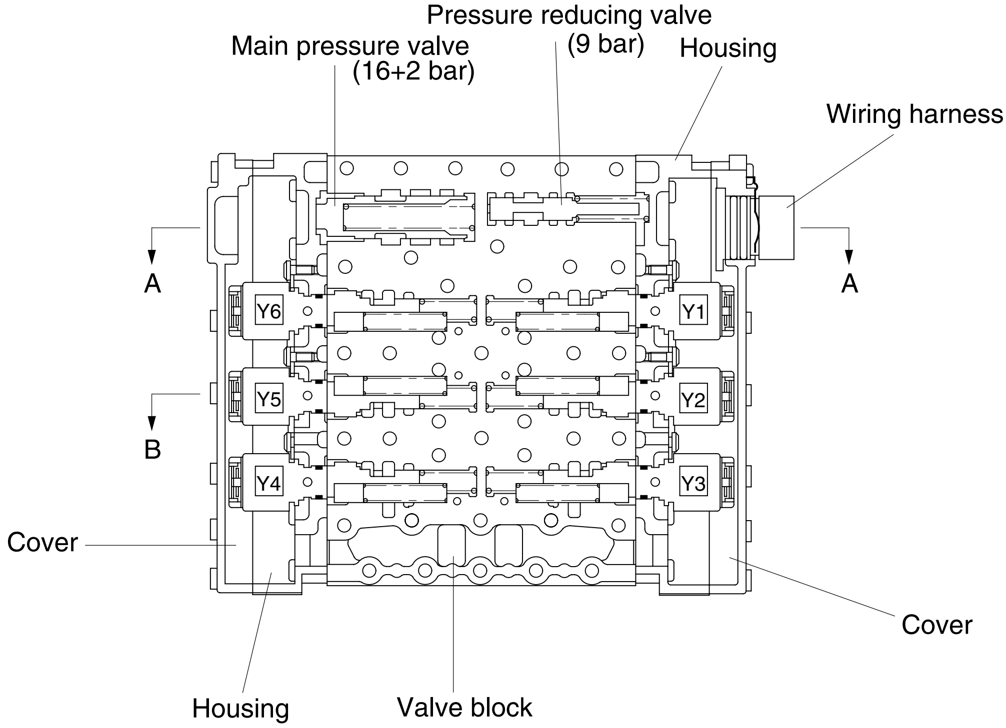


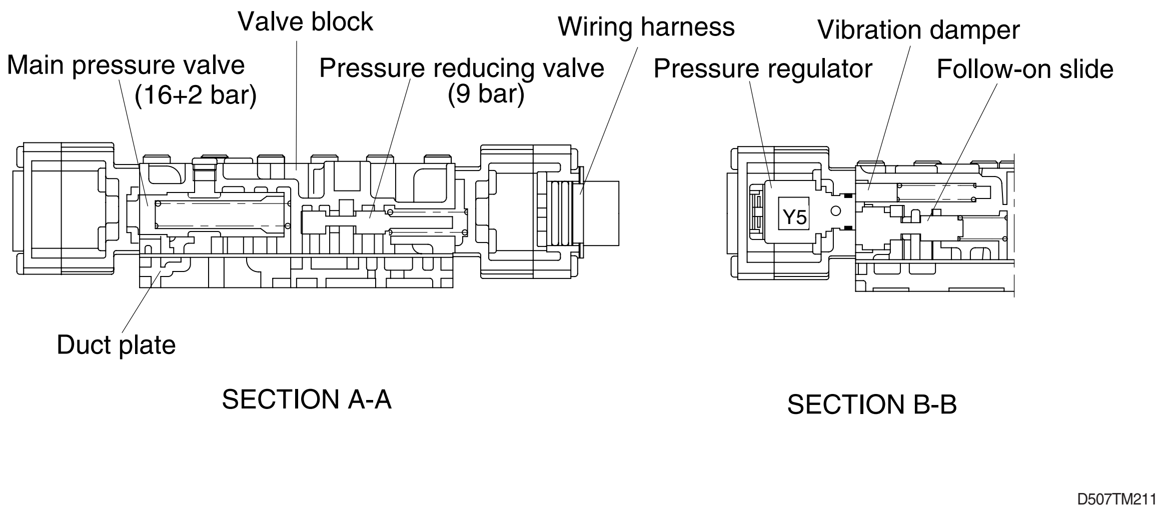
D507TM206

4) ELECTRO-HYDRAULIC CONTROL UNIT WITH PROPORTIONAL VALVES

※ Different versions as to the positions of the wiring harness are possible.

· The following sketches shows the sections of the electro-hydraulic control unit.



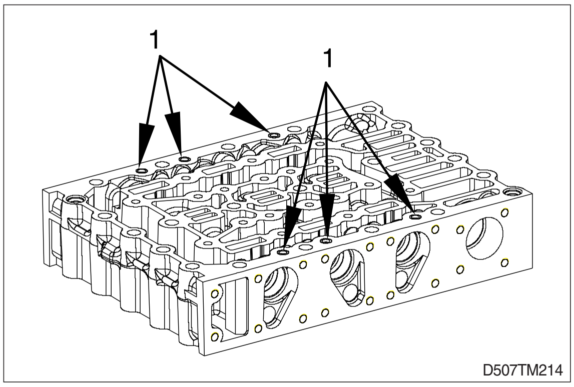


(1) Mounting of the electric control unit

※ All single parts are to be checked for damaged and replaced, if required.
Prior to installation check the mobile parts in the housing for functionality. Piston can be replaced individually.
Oil the single parts prior to installation acc. to the list of lubricants.

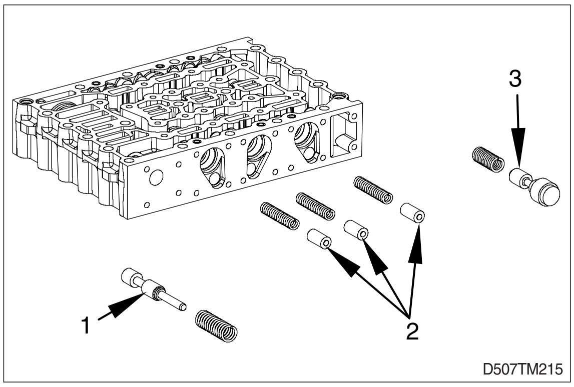
① Place the orifices (1) with the concave side showing upwards, until contact.

※ Installation position, see arrows.



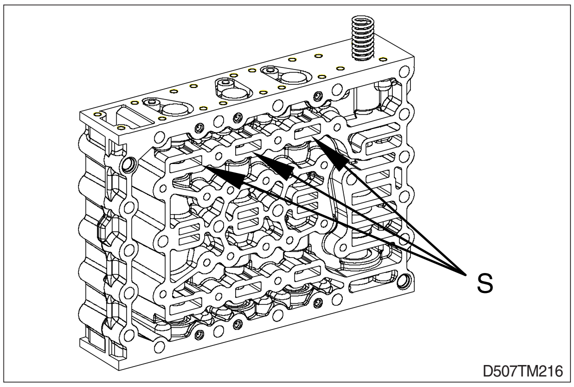
② The figure on the left shows the following single parts:

1 = Pressure reducing valve
(1 ×, piston a. compr. spring)
2 = Vibration damper
(3 ×, piston a. compr. spring)
3 = Follow-on slide
(3 ×, piston a. compr. spring)



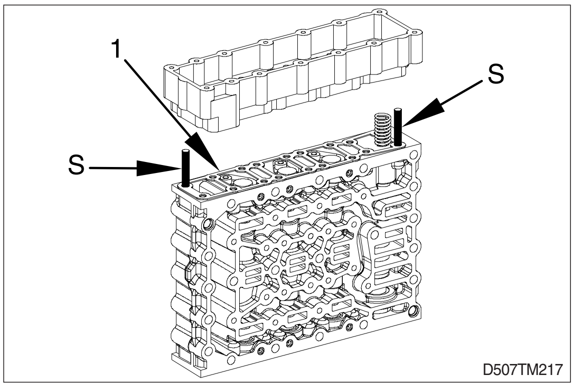
③ Install the single parts acc to right figure.

※ Preload the compression springs of the follow-on slides and fasten the piston preliminarily by means of cylindrical pins ø 5.0 mm (assembly aid), see arrows (s)

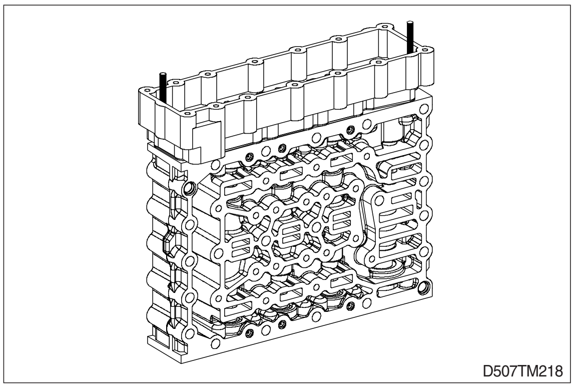


④ Install two adjusting screws.
Assembly flat gasket (1) and housing cover.
Then place the housing cover by means of adjusting screws equally until contact.

(S) Adjusting screws 5870 204 036



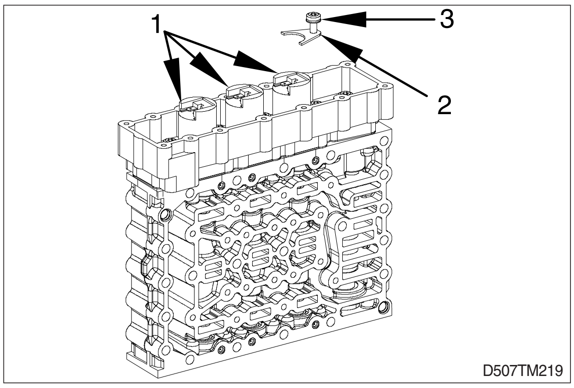
⑤ Preload the pistons with cap screws and remove the cyl. pins (assembly aid) again.



⑥ Fasten the housing cover by means of cap screws (1).

※ Tightening torque ············ M_A=0.56 kg·m

(S) Torque spanner 5870 203 031
(S) Reducer 5870 656 056
(S) Socket spanner TX-27 5873 042 002

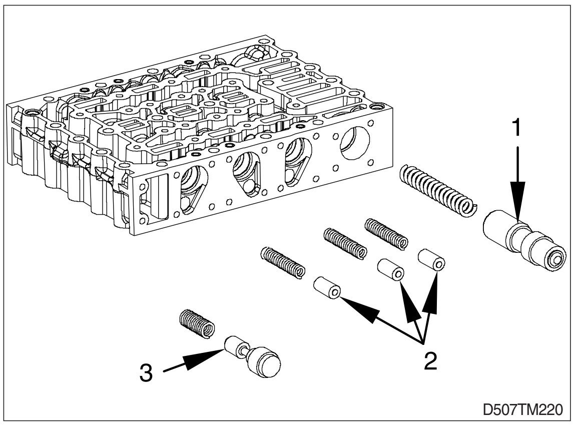


⑦ Mount the pressure regulators (1) and fasten them by means of fixing plates (2) and cap screws (3).

※ Install the fixing plate with the neck showing downwards
Observe radial installation position of the pressure regulators.

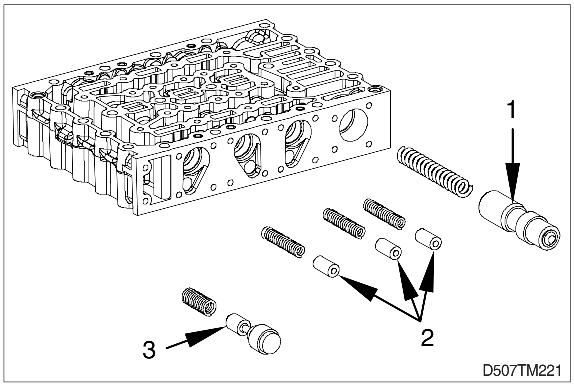
Tightening torque ············ M_A=0.56 kg·m

(S) Torque spanner 5870 203 031
(S) Reducer 5870 656 056
(S) Socket spanner TX-27 5873 042 002



· **Preassemble the opposite side**

⑧ The figure on the right shows the following single parts:
1 = Main pressure valve
(1 ×, piston a. compr. spring)
2 = Vibration damper
(3 ×, piston a. compr. spring)
3 = Follow-on slide
(3 ×, piston a. compr. spring)



D507TM221

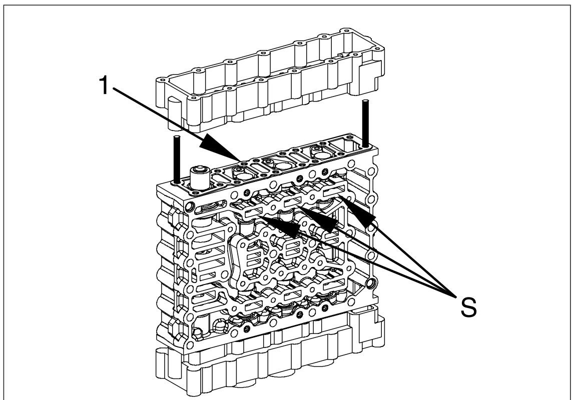
⑨ Install the single parts acc to right figure.

※ Preload the compression springs of the follow-on slides and fasten the pistons preliminarily by means of cylindrical pins (S) ø5.0 mm (assembly aid), see arrows (S).

Install two adjusting screws.

(S) Adjusting screws M5 5870 204 036

Assemble flat gasket (1) and housing cover. Then place the housing cover by means of adjusting screws equally until contact.

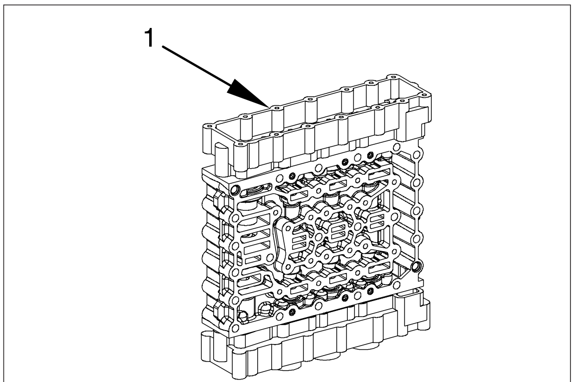


D507TM22

⑩ Preload the pistons with cap screws and remove the cyl. pins (assembly aid) again.
Then fasten the housing cover by means of cap screws (1).

Tightening torque ············ M_A=0.56 kg·m

(S) Adjusting screws	5870 204 036
(S) Torque spanner	5870 203 031
(S) Reducer	5870 656 056
(S) Socket spanner TX-27	5873 042 002

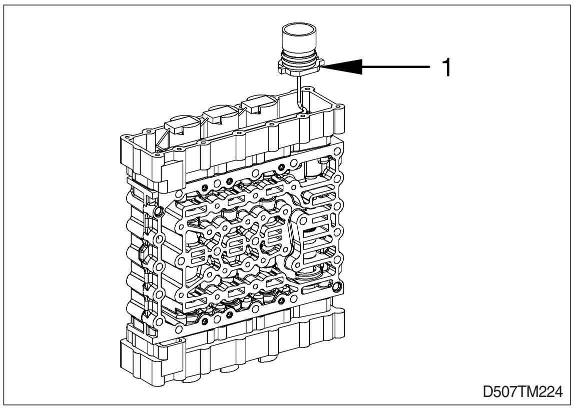


D507TM223

⑪ Mount the pressure regulators (1) and fasten them by means of fixing plates and cap screws.

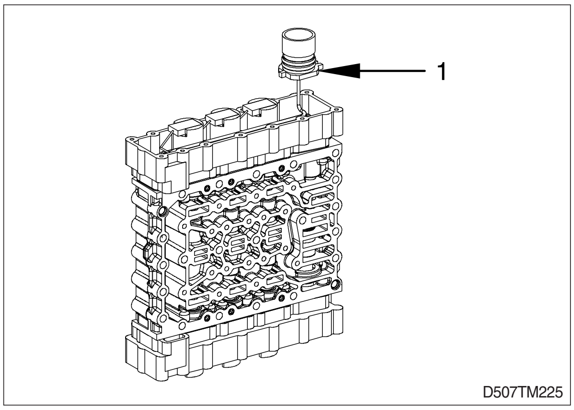
※ Install the fixing plate with the neck showing downwards
Observe radial installation position of the pressure regulators.

Tightening torque ············ M_A=0.56 kg·m



⑫ Assemble the wiring harness(1) and connect the pressure regulators (6×).

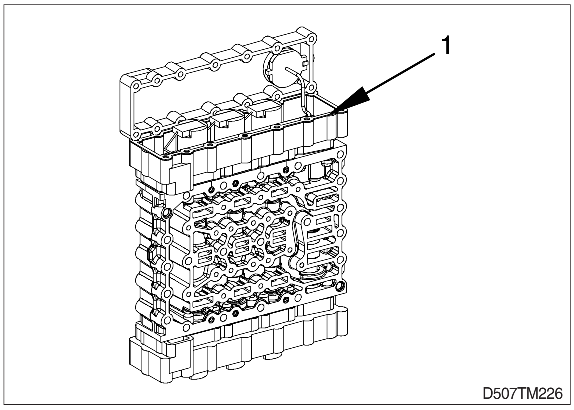
※ Installation position of pressure regulators.
※ Pay attention to the installation position of the wiring harness, also see markings ③ page 3-74.



⑬ Put on the plate gasket (1).
Assemble the plug socket with the slot showing to the lug of the cover until contact.
Fasten the cover by means of cap screws.

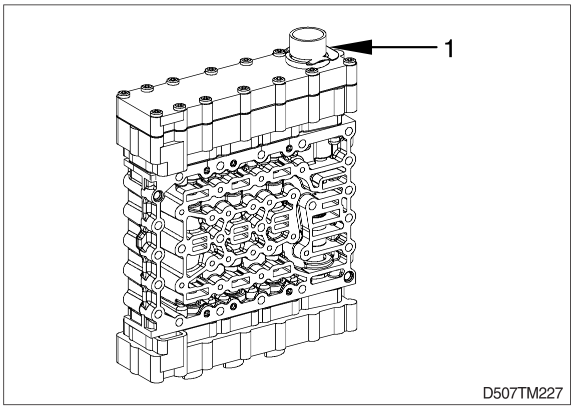
Tightening torque ············ M_A=0.56 kg·m

(S) Torque spanner 5870 203 031
(S) Socket spanner TX-27 5873 042 002



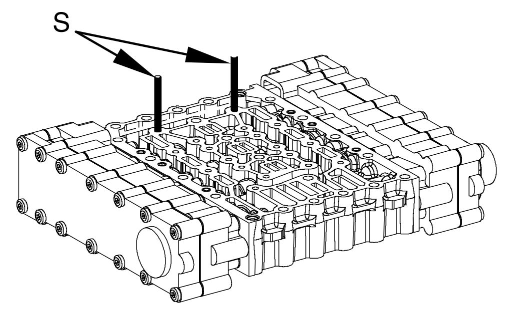
⑭ Fix the wiring harness by means of retaining clamp (1).

※ Install the opposite cover



⑮ Install two adjusting screws.

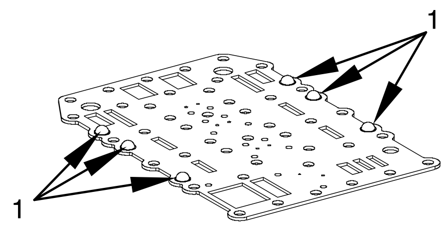
(S) Adjusting screws 5870 204 063



D507TM228

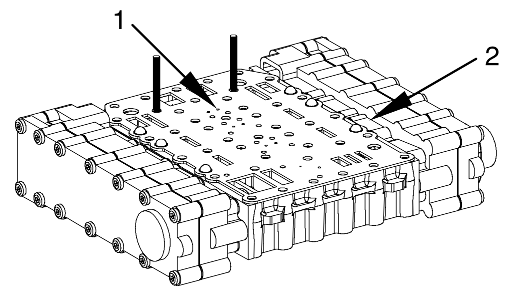
⑯ Screens (1) are to be flush mounted into the bores of the intermediate sheet, see arrows.

Observe the installation position-the screens are showing upwards (to the duct plate).



D507TM229

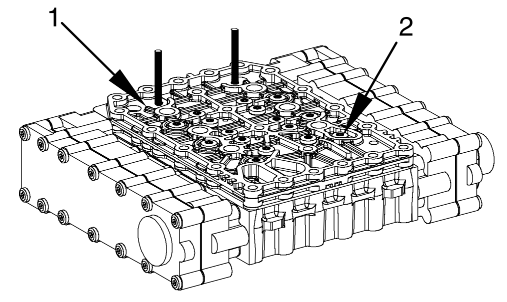
⑰ Put on the intermediate sheet (1)
※ Screens (2) must show upwards.



D507TM230

⑱ Put on the duct plate (1) and tighten it equally with torx screw (2).

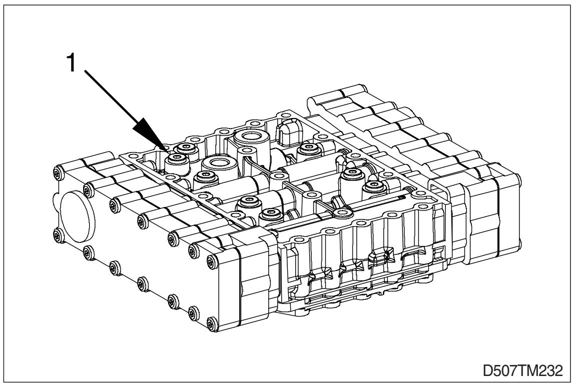
※ Tightening torque ············ M_A=0.97 kg·m
(S) Socket spanner TX-27 5873 042 002



D507TM231

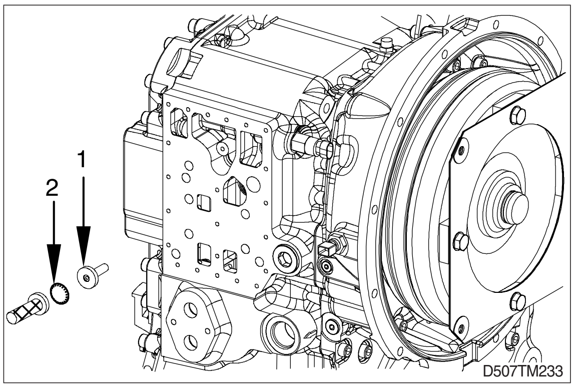
⑲ Provide the screw plugs (1) with new O-rings and install them.

※ Tightening torque ············ M_A =0.61 kg·m



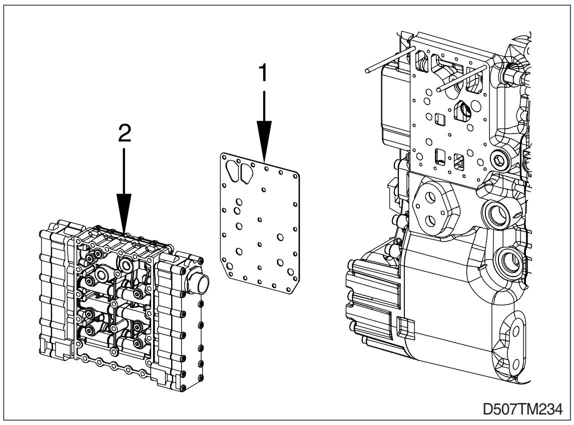
⑳ Insert the pressure relief valve (1) and lock it with the indented ring (2).

(S) Drive mandrel 5870 705 012



㉑ Mount the gasket (1) and the cpl. shift system (2).

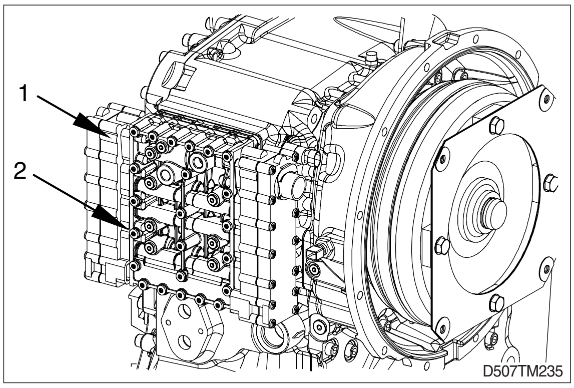
(S) Adjusting screws M6 5870 204 063



㉒ Fasten the electro-hydraulic control unit (1) equally by means of Torx screws (2).

※ Tightening torque ············ M_A =0.56 kg·m

(S) Torque spanner 5870 203 031
(S) Reducer 5870 656 056
(S) Socket spanner TX-27 5873 042 002

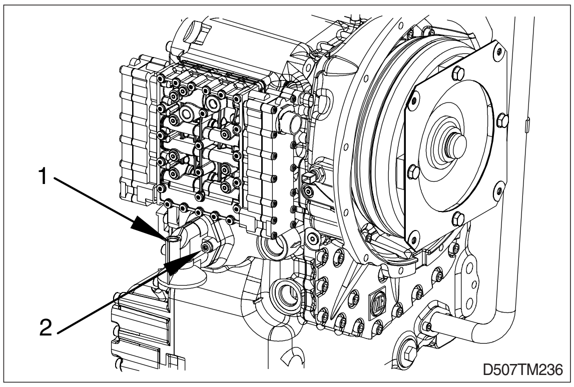


(2) Mounting of the filter (pressure filter)

① Fasten the filter head (1) with new O-rings by means of cap screws (2) to the trans-mission housing.

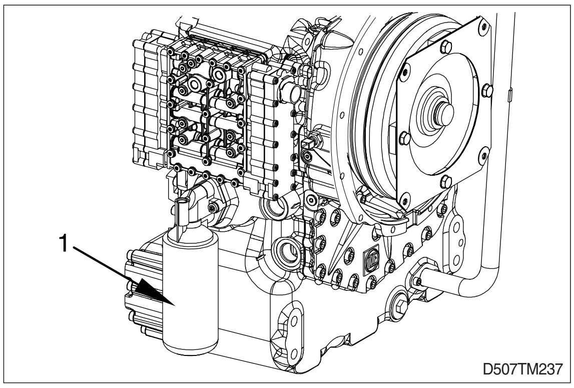
Tightening torque(M8) ······ M_A =2.4 kg·m

(S) Torque spanner 5870 203 034
(S) Socket spanner TX-40 5870 042 004



⚠ The filter is to be installed as follows:
- Oil the gasket slightly
- Turn in the filter until contact with the sealing surface is obtained and then tighten it by hand with an approx. 1/3 to 1/2 rotation.

Prior to initial operation of the transmission make the oil filling in accordance with the operating instructions.



3. DRIVE AXLE DISASSEMBLY (DIC)

1) GENERAL INSTRUCTIONS FOR CORRECT ASSEMBLY AND DISASSEMBLY

(1) Disassembly and assembly are to be accomplished only by trained personnel.

(2) The assembly can be made reverse to the respective disassembly instruction.

(3) Drain oil before removing, check for presence of metal particles.

(4) Mark the parts to each other before dismantle.

(5) Never use a hard object to separate tightly fitted assemblies. To remove bearings, drive flanges and similar parts, use the proper pullers.

(6) It is recommended that the special tools used for disassembly.

(7) Do not place parts on a dirty surface.

(8) Systematically replace used seals, O-rings and, if necessary, bearings on disassembly.

(9) Clean parts before reassembly.

(10) Replace or clean corroded parts.

(11) The cages of bearings rotating in oil are to be coated with oil at reassembly.

(12) Seal ring treads on flanges, shafts etc. must be preserved with SAE80W-90/API GL-5 before mounting.

(13) Oil seal rings and particularly the anti-dust lip seals must be filled with grease.

(14) The universal joint shafts and the axle shafts must not be force mounted(They must slide).

(15) At mounting of radial seal rings pay attention that there is suffice overlap to the housing bores. Pay attention for a plain alignment of the radial seal ring. The seal lips always must not be contacted with Loctite.

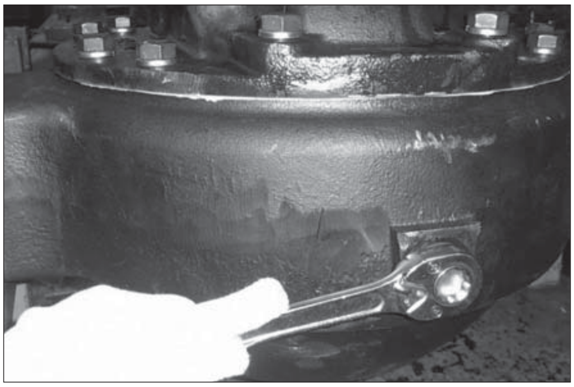
(16) The bolted or keyed assemblies safeties are to be checked according to instructions ; in case of doubt, consult Hyundai dealer.

(17) Refill the oil after assembly.

(18) Repair weldment is only allowed after consultation with Hyundai.

2) REMOVAL AND DISASSEMBLE THE WHEEL HUB

(1) Loosen the drain plug of the axle housing by using a torque wrench, and drain the oil.

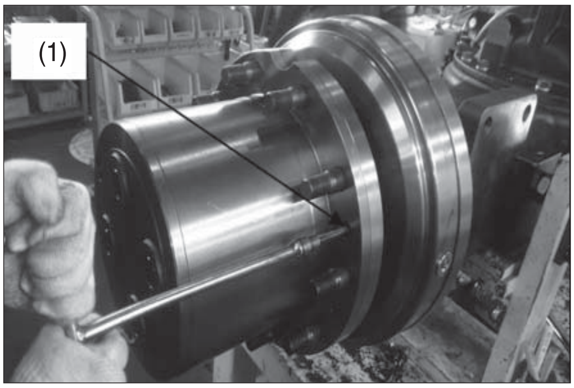


110DEDA10

(2) Loosen the drain plug of planetary housing, then drain the oil.

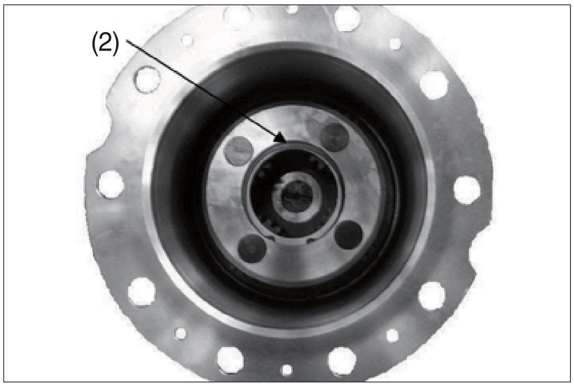
110DEDA11

(3) Loosen the four bolts (1) and disassemble the planetary housing.



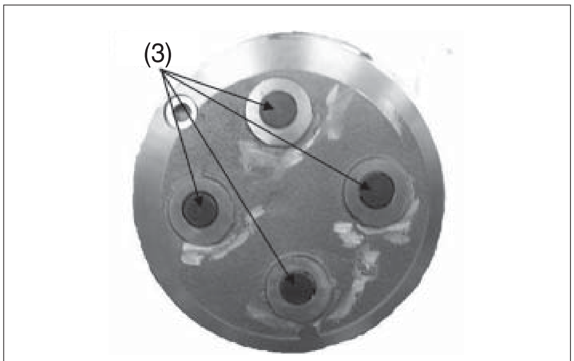
110DEDA12

(4) Disassemble the snap ring (2) in the planetary housing.



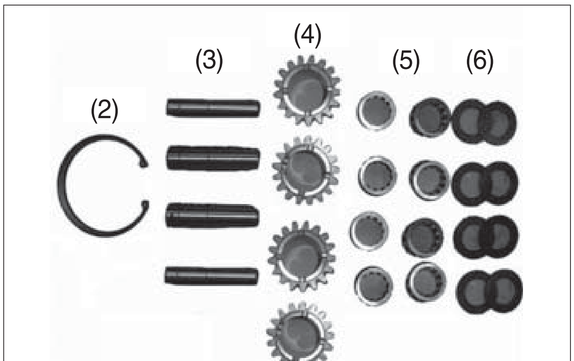
110DEDA13

(5) Disassemble four planetary pin (3) using the tool.



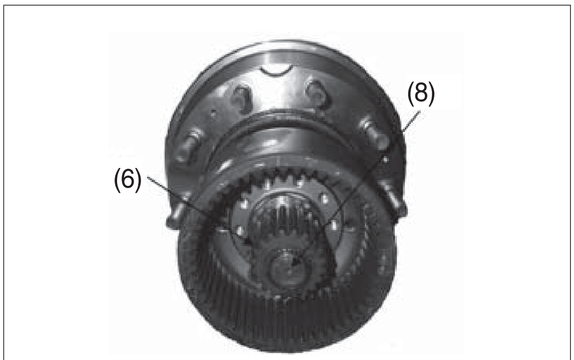
110DEDA14

(6) Disassemble planetary gear (4), needle bearing (5) and thrust washers (6).



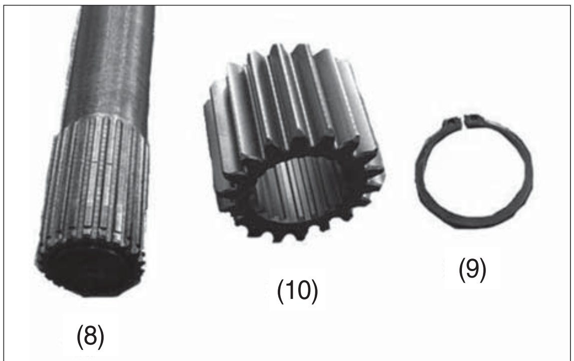
110DEDA15

(7) Disassemble drive shaft assembly (8) with sun gear (7).



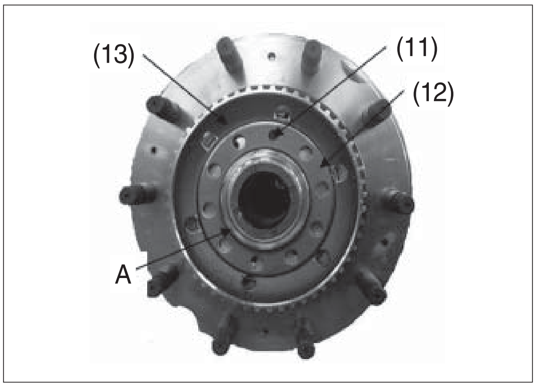
110DEDA16

(8) Disassemble retaining ring (9) by using tool and disassemble sun gear (10) from drive shaft (8).



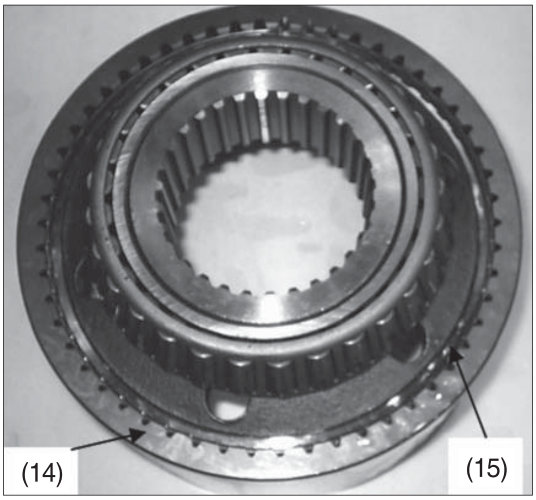
110DEDA17

(9) Loosen the bolts (11) and nut (12).
Disassemble the internal gear carrier assembly (13) from spindle (A).
Mark the installation position of the nut (12) and the internal gear carrier before disassembling. Check for position during assembly.



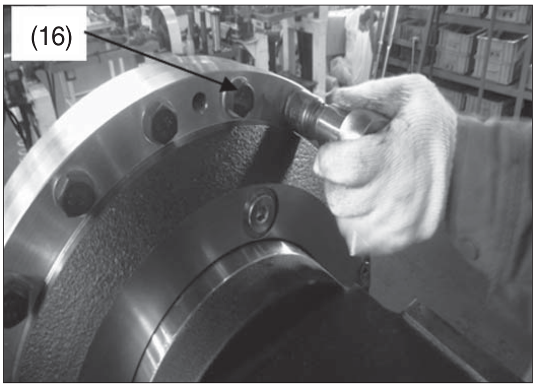
110DEDA18

(10) Disassemble the gear (15) from ring gear (14), and remove the internal gear carrier.
Assemble the internal gear carrier to spindle with a torque plate. To use disassembling wheel hub assembly.

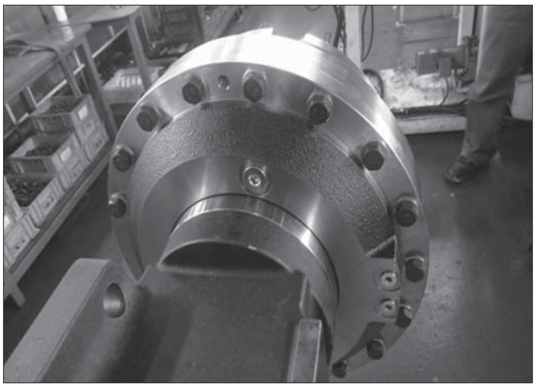


110DEDA19

(11) Disassemble seventeen bolt (16) that connects brake housing and brake cover.
Disassemble wheel hub assembly from the axle housing.

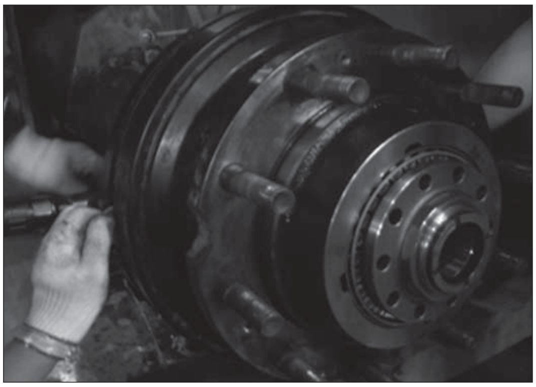


110DEDA20



110DEDA21

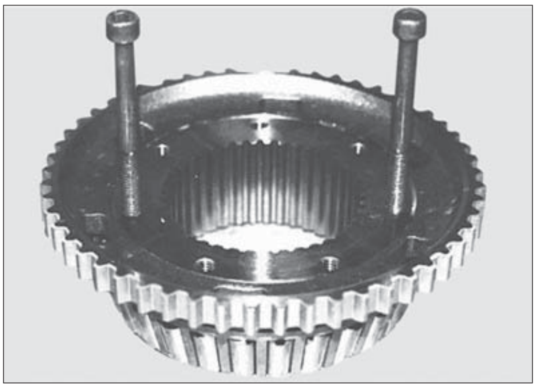
(12) Slowly disassemble the wheel hub assy and the internal gear carrier by using the extraction tab of the brake housing as loosen the nut.
A strong shock may be damaged the oil seal.


110DEDA22

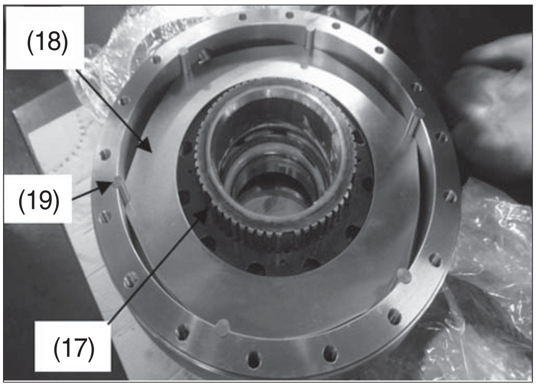

110DEDA23


110DEDA24

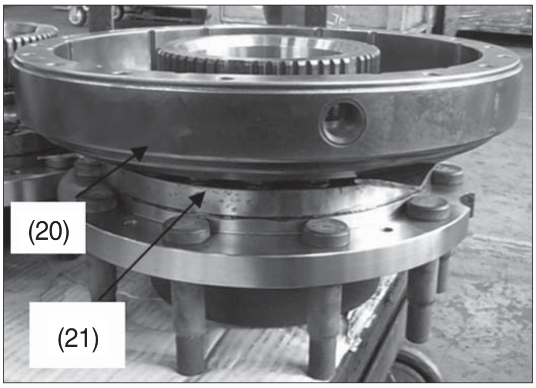
(13) Disassemble bearing of the carrier internal gear using two M8 bolts.


110DEDA25

(14) Disassemble disk (17) and plate (18) and then disassemble six brake pin (19) from the disassembled wheel hub assembly.
Disassemble the brake cover (20) and wheel hub assembly (21).



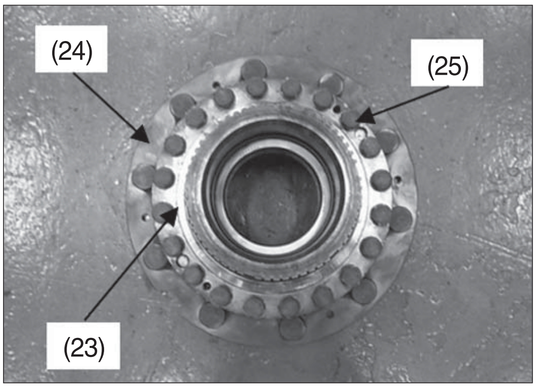
110DEDA26



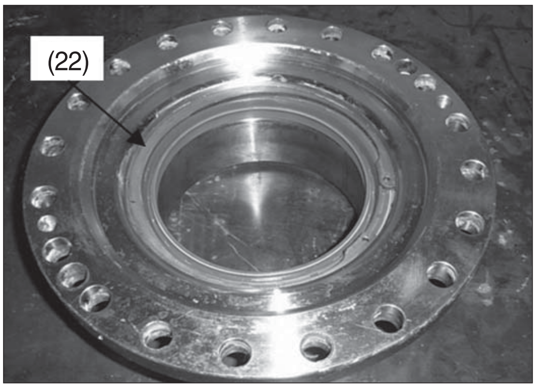
110DEDA27

(15) Disassemble hub spline (23) and wheel hub (24) after untightening tweenty bolts (25).

⚠ Check the oil seal (22) of the splined hub and replace if damaged.

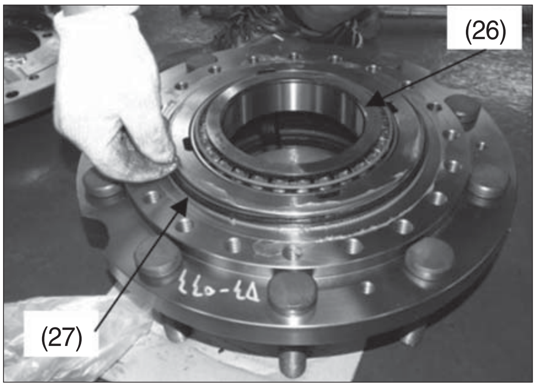


110DEDA28



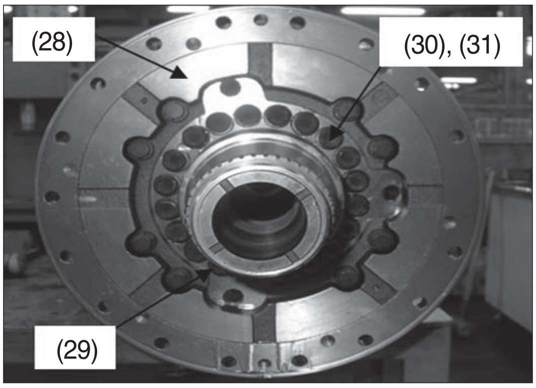
110DEDA29

(16) Disassemble bearing (26) and O-ring (27) from wheel hub.

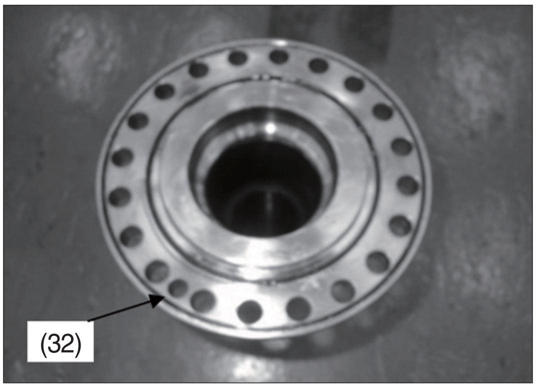


110DEDA30

(17) Disassemble brake housing assembly (28), axle tube (29), after untightening tweenty bolts that connect axle housing (30) and tweenty washers (31). Detach O-ring (32) on both joints sides of tube after disassemble brake housing and tube.

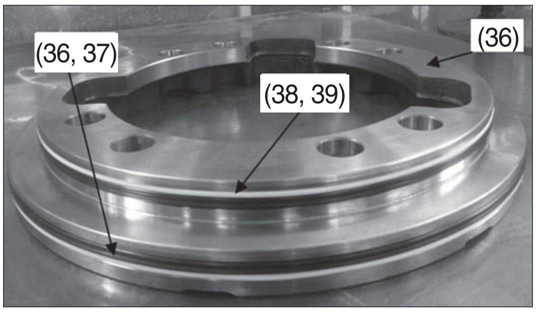


110DEDA31

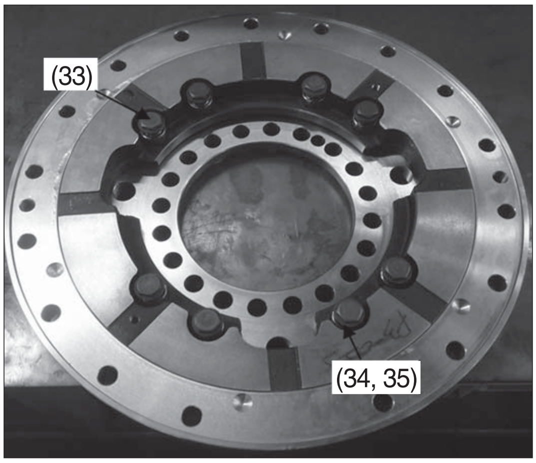


110DEDA32

(18) Disassemble piston (36) from brake housing assembly after untightening eight piston bolt (33) and then loosen eight spring (34) from eight bush (35). Disassemble the quad-ring (large) (36), quad-ring (small) (38), backup-ring(large) (37), backup-ring (small) (39) from piston disassembly.



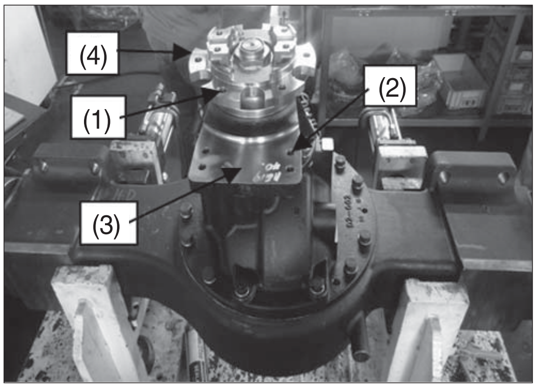
110DEDA33



110DEDA34

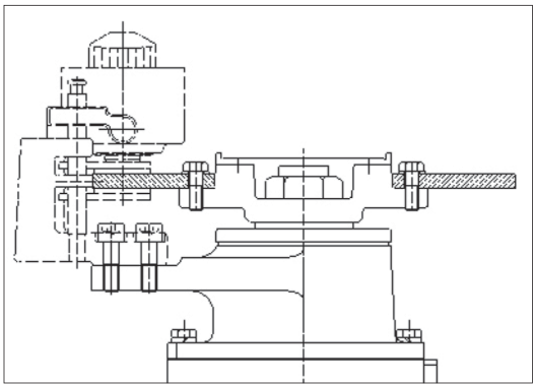
3) REMOVAL AND DISASSEMBLE THE CARRIER HOUSING ASSY

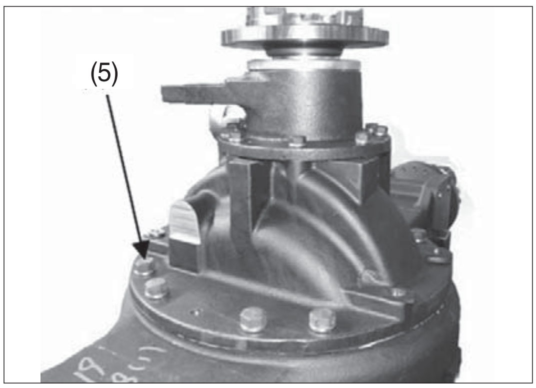
(1) Disassemble parking disc (3) and brake assembly (4) after untightening six bolts (1) and four bolts (2).



110DEDA35

(2) Loosen thirteen bolts (5) that connect the axle housing and the carrier housing and then disassemble the carrier from the axle housing.


110DEDA36

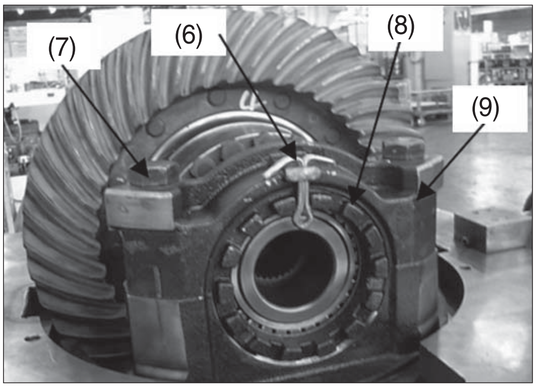


110DEDA37

(3) Check and record the rotational torque measurements of the carrier assy and then disassemble cotter pin (6).
Disassemble two nuts (8) and two differential caps (9), after untightening four bolts (7).

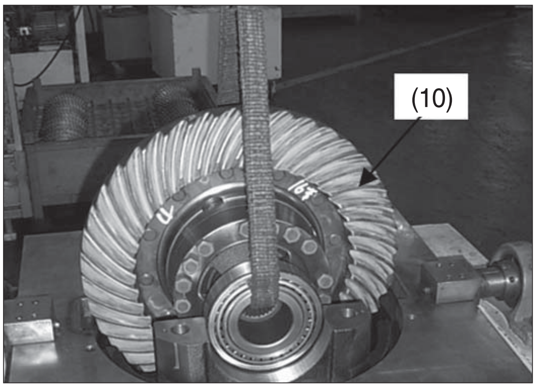
⚠ **Check and record the direction of the cap before removing bearing cup.**

110DEDA38



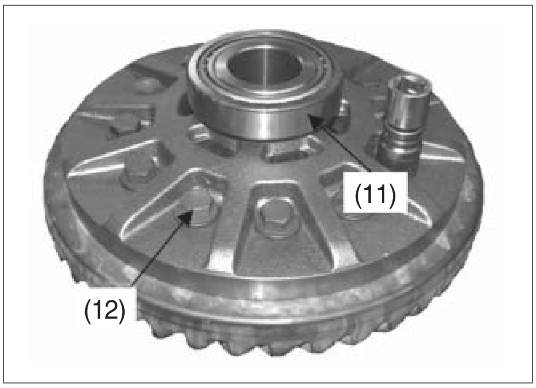
110DEDA39

(4) Disassembly ring gear assy (10) from carrier assembly.



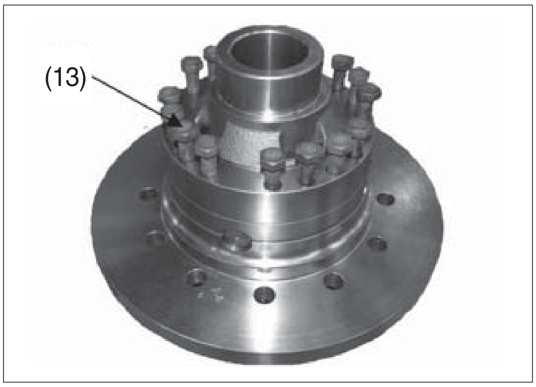
110DEDA40

(5) Disassemble both of two tapered roller bearings (11).
Loosen twelve bolt (12), then disassemble ring gear.



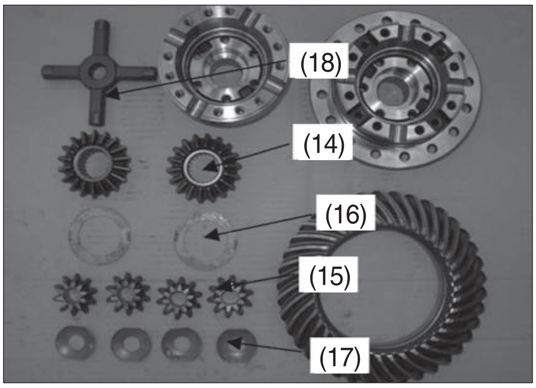
110DEDA41

(6) Loosen sixteen bolt (13) then disassemble differential assembly.



110DEDA42

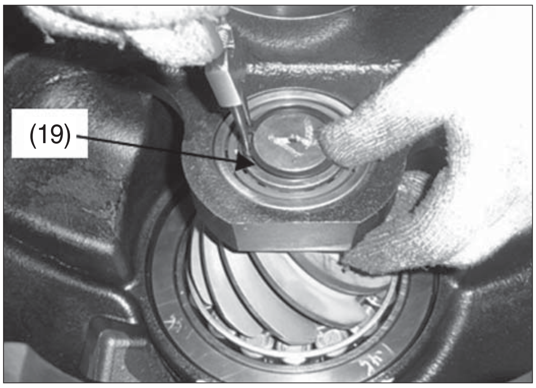
(7) Disassemble side gear (14), pinion gear (15), thrust washers (16), (17) and spider (18) from differential assembly.



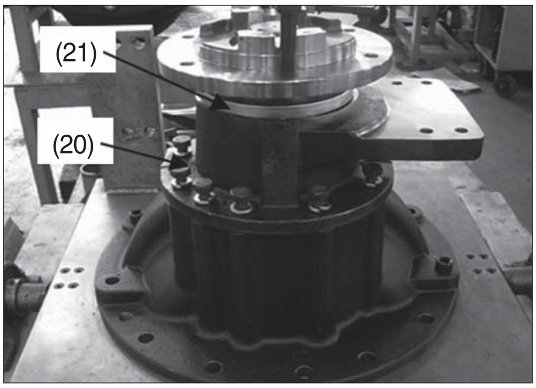
110DEDA43

(8) Disassemble differential flange assembly (21) and shim (22) from carrier housing after loosen snap ring (19) and ten bolts (20).

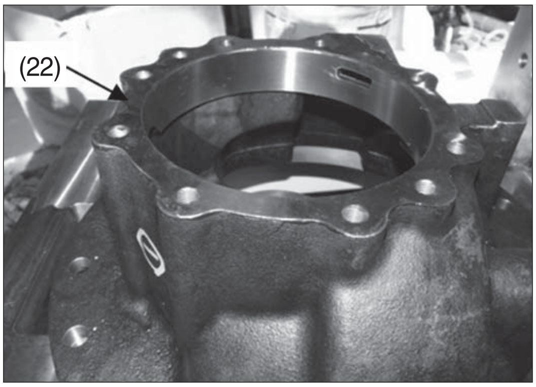
⚠ Do not reuse damaged shim.



110DEDA44

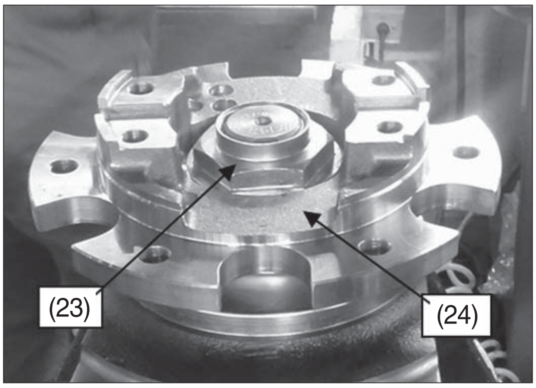


110DEDA45



110DEDA46

(9) Loosen nut (23) and disassemble the york (24) from differential flange assembly.

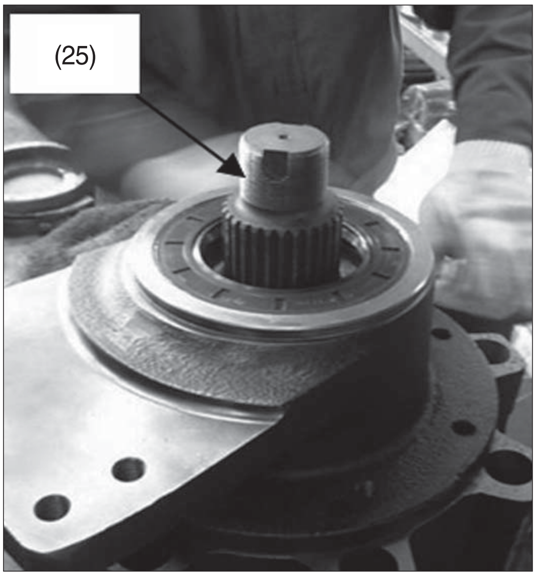


110DEDA47

(10) Disassemble the pinion shaft (25) from the differential flange (29) by using tools.

⚠ Be careful imprints on the pinion shaft and oil seal damage.

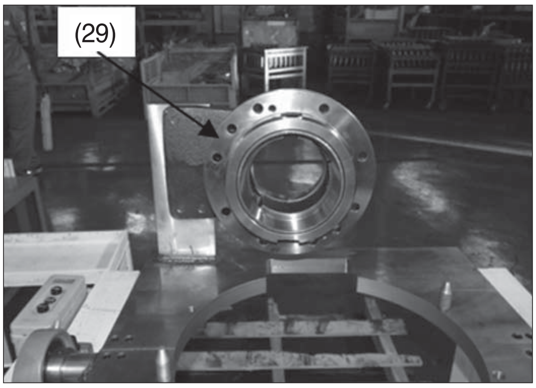
110DEDA48



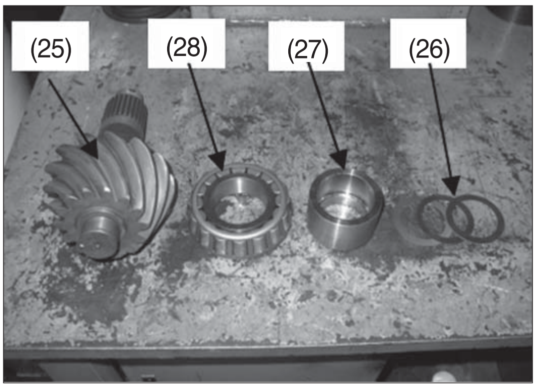
110DEDA49

(11) Disassemble shim (26) and spacer (27) from pinion shaft (25).
Disassemble both of tapered roller bearings (28) from the pinion shaft by using a bearing puller.

⚠ Do not reuse shim.



110DEDA50



110DEDA51

4. REASSEMBLY OF THE DRIVE AXLE

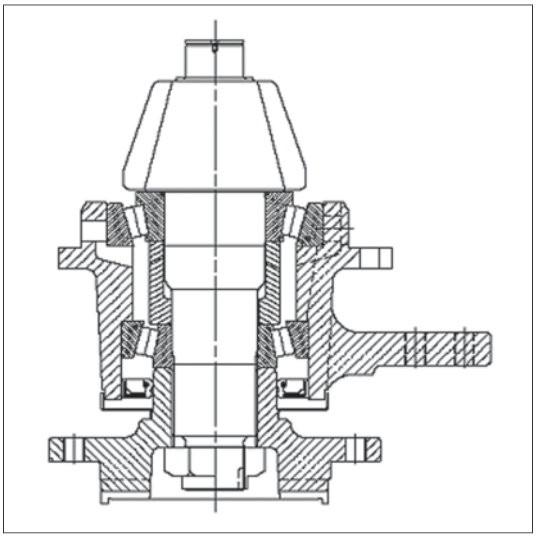
Clean every parts with cleaner and then remove remained loctite.

※ Be careful not to spill cleaner on your body.
Avoid drinking cleaner or breathing its fumes.
Wear protective clothing, glasses and gloves.
If spilled on the skin, flush your skin with water immediately.
If swallowed, get medical attention immediately.

· Check wear, damage or crack for all the parts and replace if needed.
· If the teeth of gear are damaged, replace it as a set.
· Replace damaged tapered roller bearing.
· Do not reuse deformed shims or worn thrust washers.
· Polish the surface on which seal contacted if needed.

1) DIFFERENTIAL FLANGE-AND-PINION SHAFT PRELOAD ADJUSTMENT METHODS

(1) Assemble the spacer and add shim (1) of 0.5 mm thickness (default value).
Fix the pinion shaft (2) not to rotate by a jig and tighten the nut (3).
· Tightening torque : 54.0 ~ 56.0 kgf · m



110DEDA52

(2) Measure the rotating torque (0.3~ 0.45 kgf · m) by a torque gauge. If the torque value is large, add shim or small, remove shim.

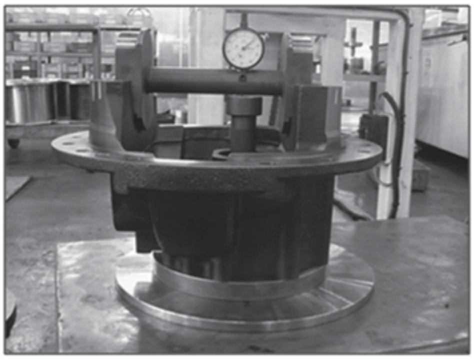
(3) Loosen the nut and remove the jig.
Apply TB #1102 on the outer surface of the oil seal (4) and assemble it to differential flange by using a assembling jig.

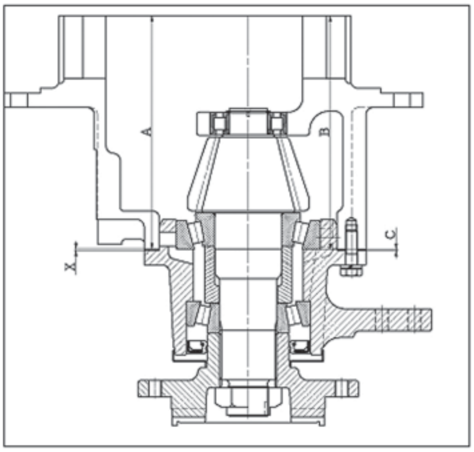
(4) Assemble the yoke (5) and fix the pinion shaft.
Apply loctite #271 on the thread and then tighten the nut.
· Tightening torque : 54.0~56.0 kgf · m

How to adjust the shim between differential carrier and the differential flange

Measurements(A) - Measurements(B) + (C) + 0.5 + Pinion Shaft PMD Value = Z

- Measurements(A): Flange depth variation
- Measurements(B): Carrier depth variation
- (C): Taper Roller Bearing depth variation
- 0.5: Defeat vaule
- Z: Shim thickness





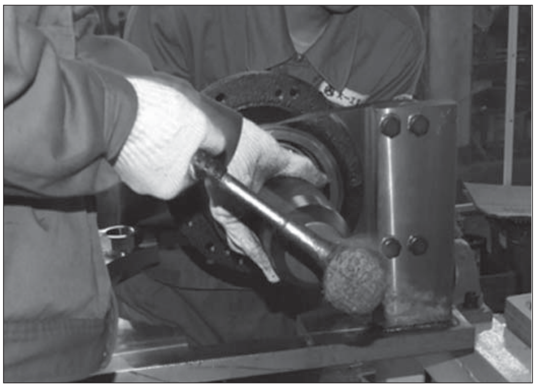
110DEDA53

※ If gear is damaged, replace a set of the bevel gear shaft and bevel gear.
Do not reuse deformed shim or damaged bearing.

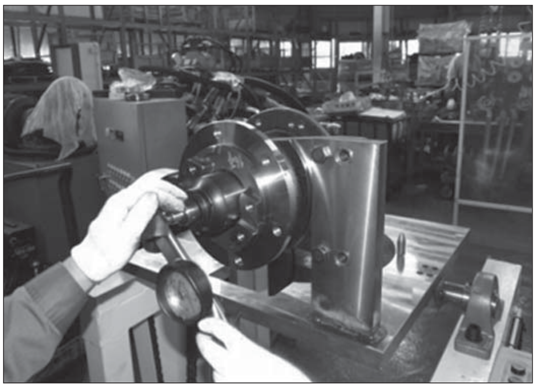
2) ASSEMBLY THE PINION SHAFT

(1) Inner ring of bearings should be heated up to 100˚C by a preheater.
Assemble the bevel pinion shaft and set the preload with the ring and the shim.

110DEDA54

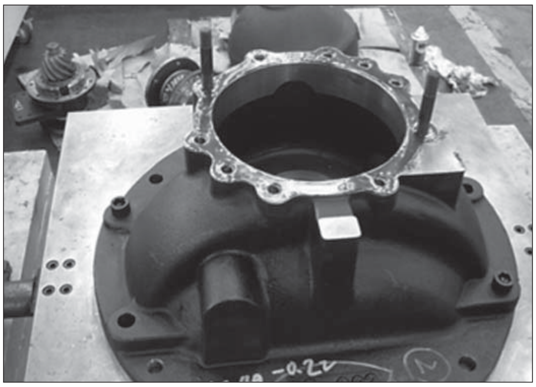


110DEDA55

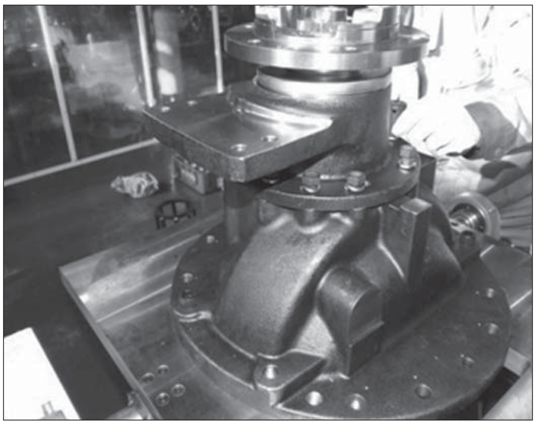


110DEDA56

(2) Adjust the shim thickness by combinations of the different shims. Add the shims between the differential flange and differential carrier. Apply loctite on them and assemble the differential flange and differential carrier.
The bolt tighten torque, see below.
· Short bolts (4ea) : 10.0~10.5 kgf · m
· Long bolts (6ea) : 12.0~12.5 kgf · m



110DEDA57

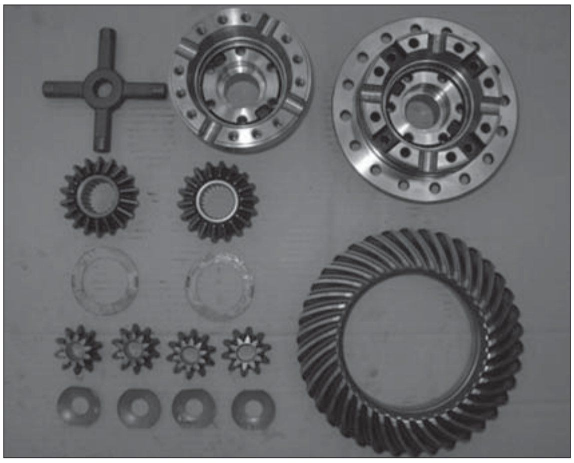

110DEDA58

3) ASSEMBLE THE DIFFERENTIAL ASSY

(1) Assemble the thrust washer, side gear and spider with gears and then install them to the differential housing.

(2) Assemble the differential housing.

⚠ Check marks on the differential assembly and housing. Match to marks at the same positions.



110DEDA59

(3) Tighten 12 bolts to the differential housing.

· Tightening torque : 10.0~10.5 kgf · m

⚠ Apply 80W/90 oil on the contact surface of the bevel gear and thrust washer and then assemble them.

110DEDA60

(4) Assemble the ring gear by tighten 12 bolts.

· Tightening torque : 45.0~46.0 kgf · m

Be careful below notes when assembling the ring gear.

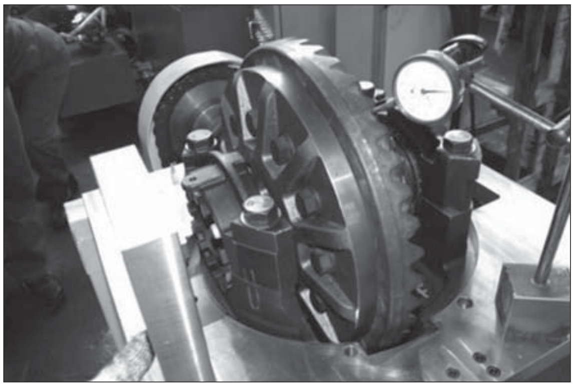
110/130D-9	Ring-gear (41T)	Identification groove:1ea
160D-9		Identification groove:none

110DEDA61

(5) Assemble the differential assy to the carrier. Assemble the bearing cup and screw to the housing. Adjust the rotation backlash by using the screw.

Install the dial gauge on the gear tooth and measure the backlash while rotating the bevel gear.

· Rotation backlash : 0.15~0.25 mm



110DEDA62

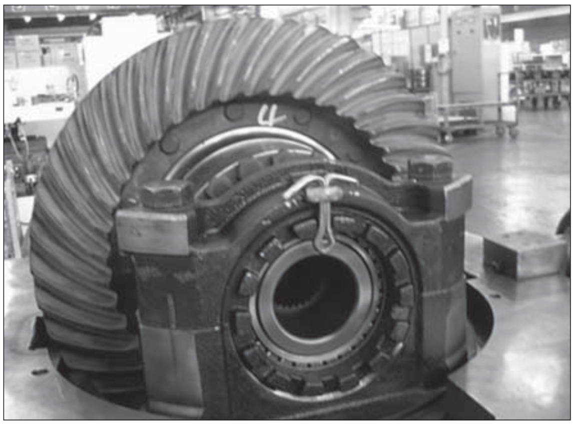
(6) Assemble the bearing cap.

※ Fix the bearing cap with hex bolt.

· Tightening torque : 50.0~65.0 kgf · cm

Measure the rolling resistance of the taper roller bearing.

The following table shows the relation between the preload of the bevel pinion shaft(measured at the adjustment, page 3-130) and the rolling resistance.



110DEDA63

(7) Confirm that the screw contacts to the bearing.

(8) Measure the rotation backlash once more after tighten the bearing cap completely and readjust the backlash with the screw if needed.

(9) Apply loctite # 271 on the thread of the bearing cap bolt and assemble it with tightening torque of 55.0 ~ 56.0 kgf · cm

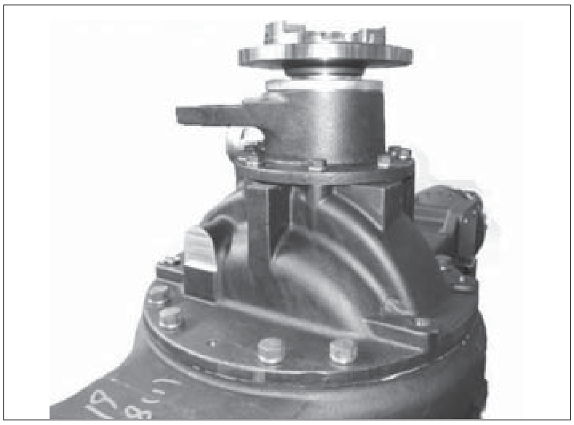
(10) Assemble the split pin to secure the screw not to move.

4) ASSEMBLE CARRIER TO AXLE HOUSING

(1) Assemble the carrier assy into axle housing.

(2) Fix the carrier assy to axle housing with the hex bolt.

· Tightening torque : 28.0~32.0 kgf · cm.

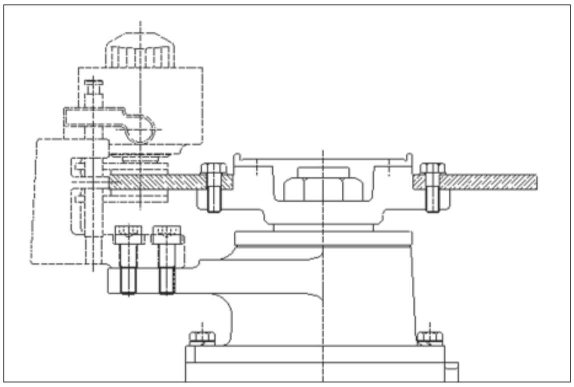


110DEDA64

(3) Assemble brake disc to yoke (1) with hex bolt.
Apply loctite #271 or #277 on the thread of the bolt and tighten them.

· Tightening torque : 16.0~20.0 kgf · cm

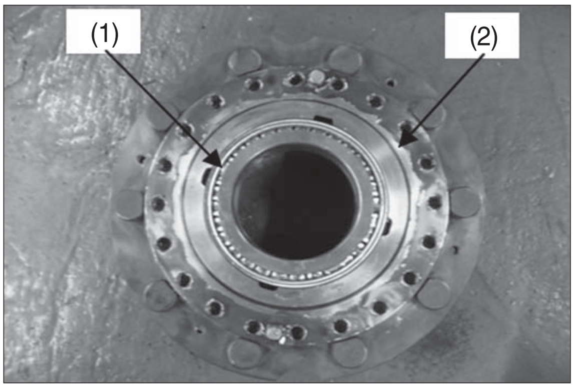
(4) Fix the parking brake support (3) with socket bolt and assemble parking brake (4).



110DEDA65

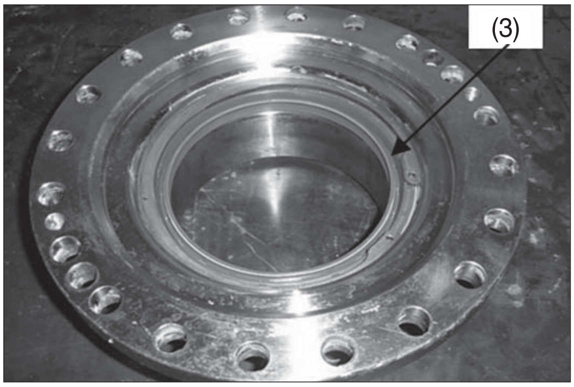
5) ASSEMBLE THE BRAKE AND HUB

(1) Assemble bearing (1) and O-ring (2) into wheel hub.
Confirm that the bearing and O-ring contact to wheel hub.
Apply loctite #5271 on the contact surface of the spline hub assy and assemble it.

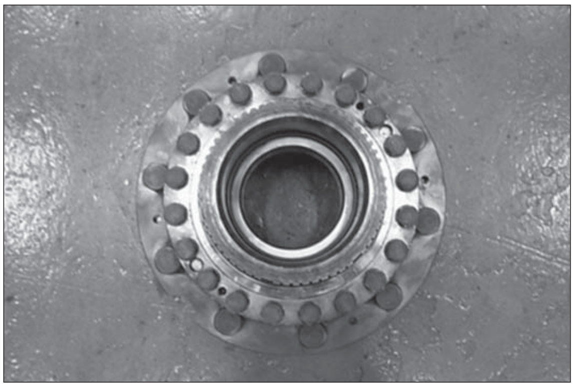


110DEDA66

※ Apply grease on the bearing and O-ring and then assemble them.
Check the statue of the oil seal (3) in the hub and assemble the spline hub.

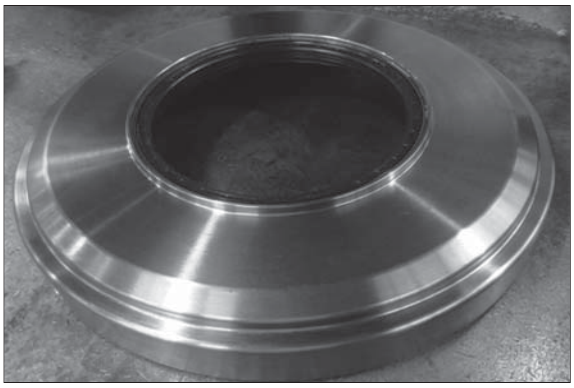


110DEDA67



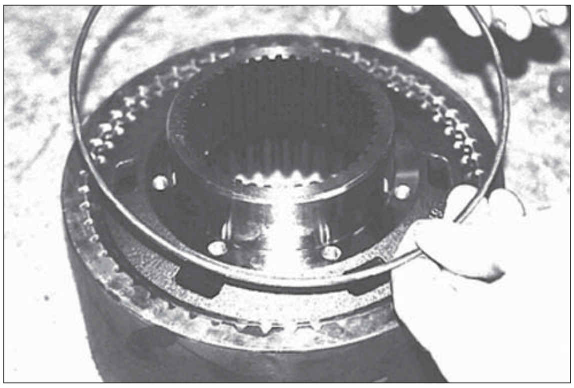
110DEDA68

(2) Assemble the oil seal into the brake cover.

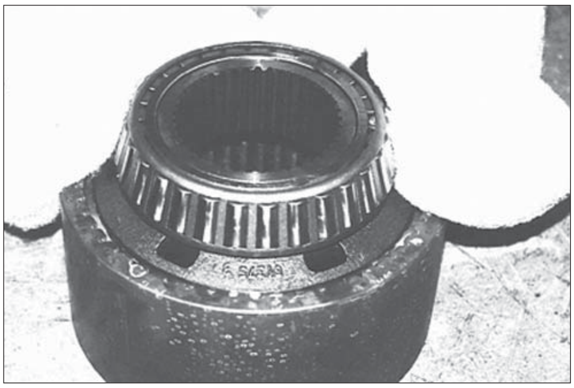


110DEDA69

(3) Assemble the internal gear carrier into the ring gear and fit the C-ring.
Heat the bearing and assemble it into the carrier. Cool down the bearing sufficiently and then assemble them into wheel hub.



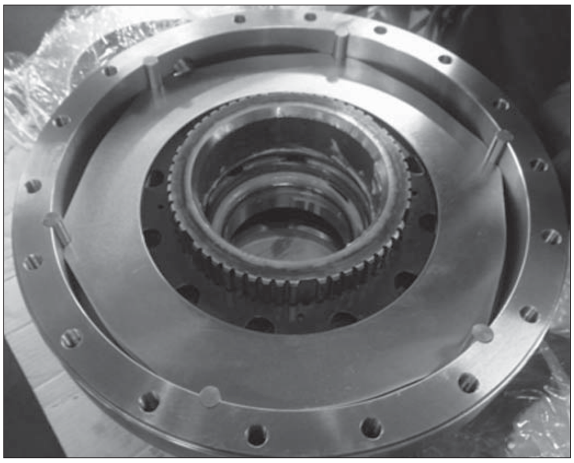
110DEDA70



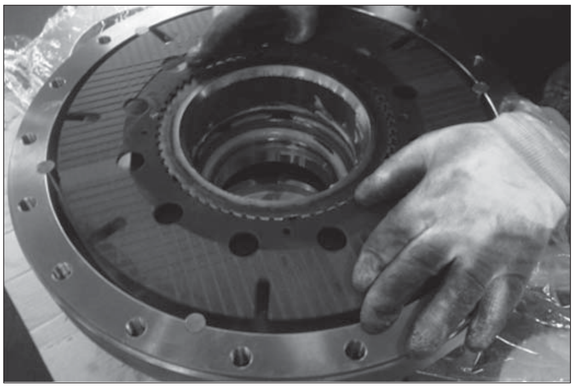
110DEDA71

(4) Assemble the preassembled wheel hub and spline collar with the brake cover assy. Assemble the disc, plate and 6 brake pins and apply loctite #5217 on the assemble surface.

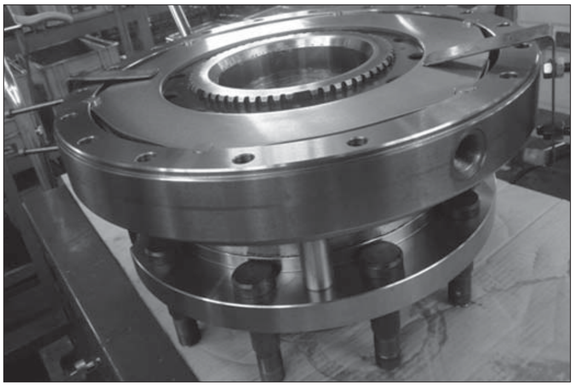
110/130D-9	Disc	4 piece
	Plate	7 piece
160D-9	Disc	5 piece
	Plate	6 piece



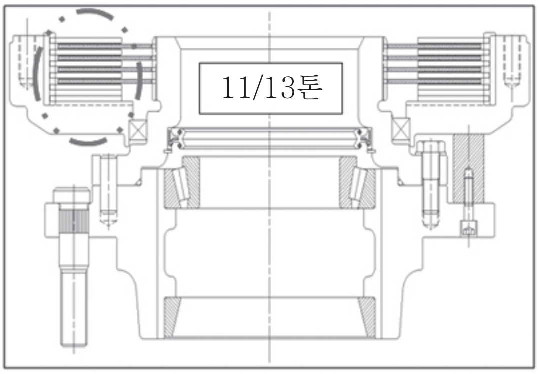
110DEDA72

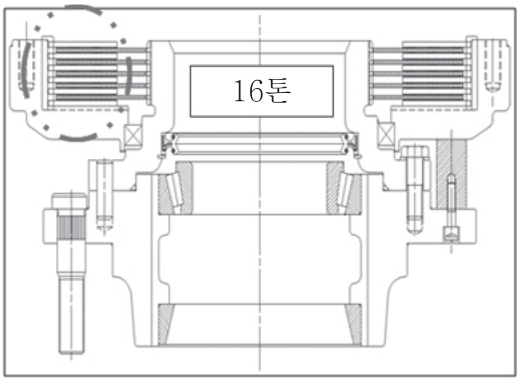


110DEDA73



110DEDA74



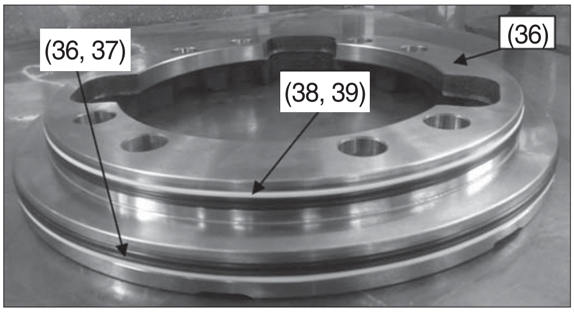


110DEDA74-1

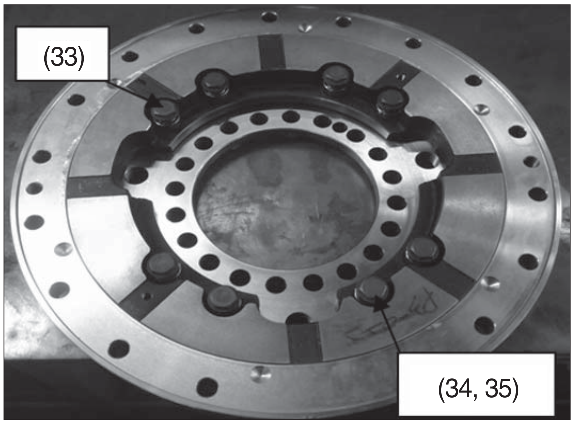
※ In case the 110/130D-9, assemble 3 piece plates on the bottom of the brake cover at first.

(5) Fit the square ring (large, 36), square ring (small, 38), backup ring (large, 37) and backup ring (small, 39) into the brake housing and apply oil (MOBIL #424) on them.
Assemble the bushing (35) into the piston (36) and assemble the piston into brake housing. At this time, align the tap hole of the housing and bushing hole of the piston.
Tighten the 8 bolts for the clearance adjustment.
· Tightening torque : 3.0~3.5kgf · cm

※ Check the square ring (2 kinds) and backup ring (2 kinds) and replace them if needed.
Be careful not to damage the square rings and backup rings when assembling the piston assy into the brake housing.

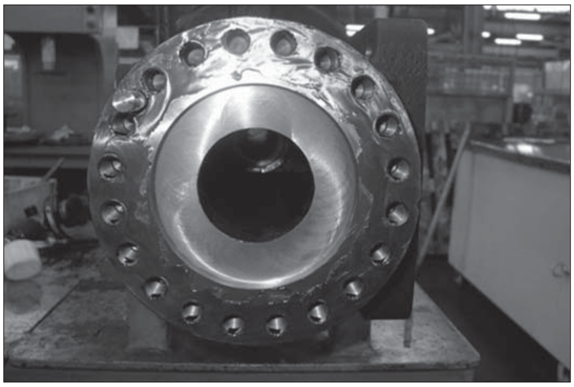


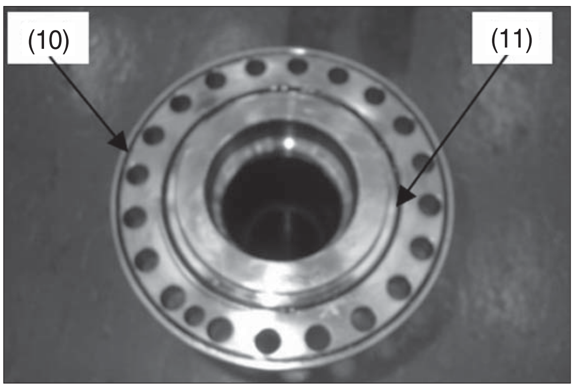
110DEDA75



110DEDA76

(6) Apply loctite #5127 on the assembling surface of the housing and assemble the O-ring (10) into the axle tube.

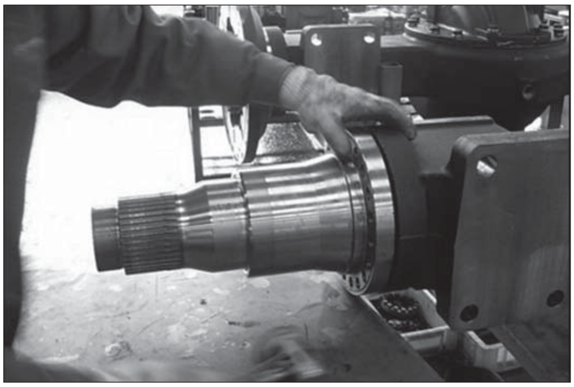

110DEDA77

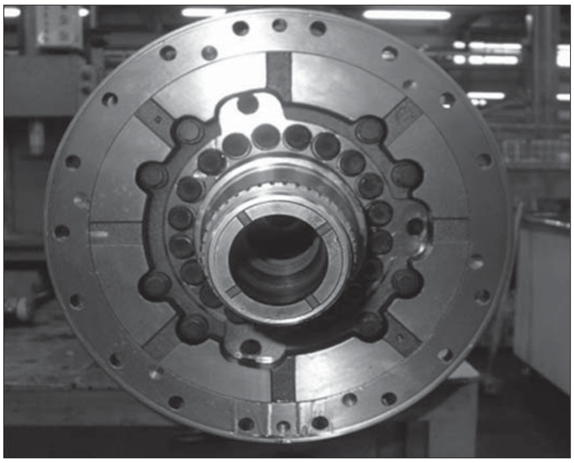


110DEDA78

(7) Mount the axle tube into the axle housing and assemble the brake housing to axle housing.
Tighten the 20 bolts.
· Tightening torque : 31.5~32.5 kgf · cm

※ Be careful not to damage the O-ring of the axle tube when assembling the brake housing.

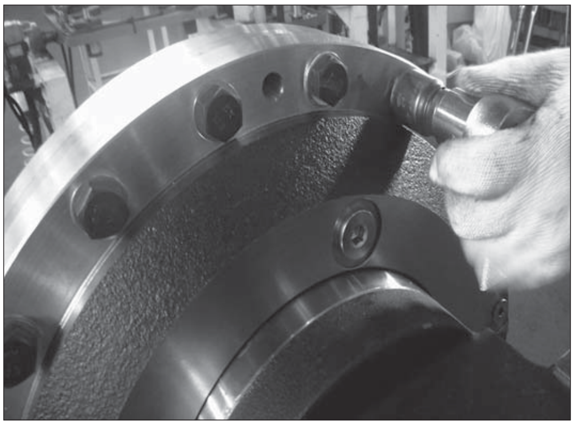

110DEDA79


110DEDA80

(8) Assemble the wheel hub assy into axle housing assy and tighten 24 bolts.
· Tightening torque : 20.5~51.54 kgf · cm

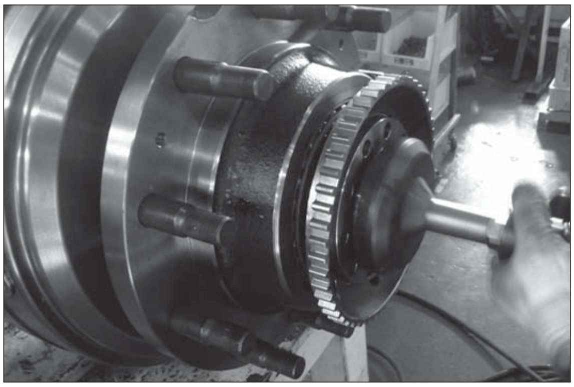
※ Be careful not to damage the oil seal and align the center exactly when assembling the wheel hub assy to the axle housing assy.
Do not reuse the damaged oil seal.


110DEDA81



110DEDA82

(9) Place the wheel hub to the axle tube until seated completely and tighten the nut.
Tighten the nut to the marks that marked when disassembling.



110DEDA83

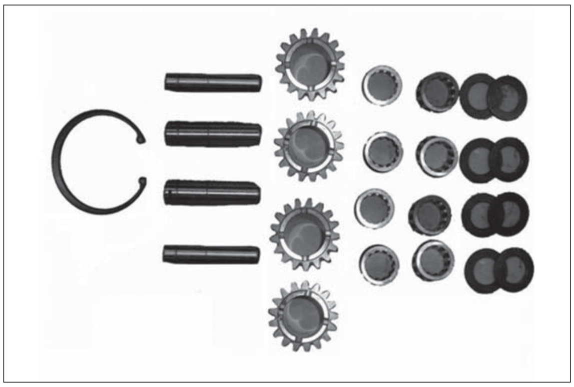
(10) Apply loctite #271 or #277 on the bolts and tighten them.
· Tightening torque : 1.8~2.0 kgf · cm
Assemble the ring gear and fix it with the C-ring.

110DEDA84

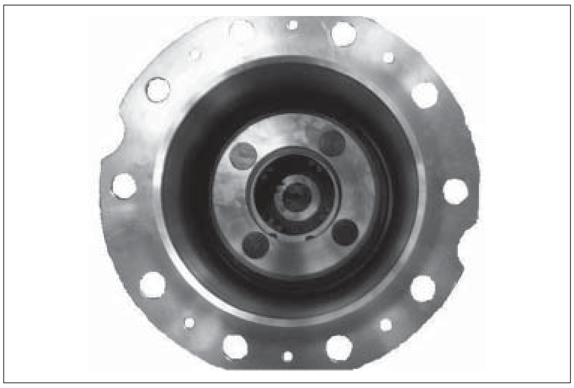
(11) Assemble the sun gear to axle shaft and insert the stop ring.
Assemble the axle shaft assy into the axle housing assy.

110DEDA85

(12) Assemble the internal components of the planetary carrier with the reverse order of disassembling.



110DEDA86

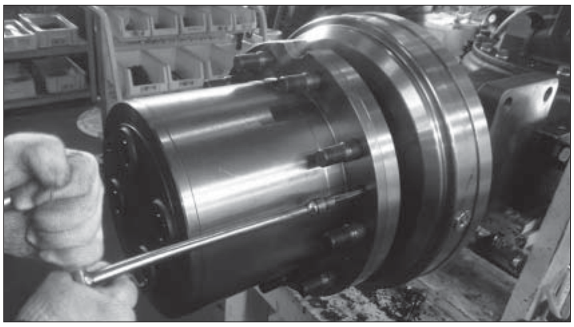


110DEDA87

(13) Assemble the planetary carrier assy to the wheel hub.

Tighten the bolts.

· Tightening torque : 2.5~4.0 kgf · cm



110DEDA88

(14) Assemble the wheel hub and tighten the plug (1).

· Tightening torque : 3.5~6.0 kgf · cm

110DEDA89

5. DRIVE AXLE DISASSEMBLY (KESSLER)

1) GENERAL INSTRUCTIONS FOR CORRECT ASSEMBLY AND DISASSEMBLY

(1) Disassembly and assembly are to be accomplished only by trained personnel.

(2) The assembly can be made reverse to the respective disassembly instruction.

(3) Drain oil before removing, check for presence of metal particles.

(4) Mark the parts to each other before dismantle.

(5) Never use a hard object to separate tightly fitted assemblies. To remove bearings, drive flanges and similar parts, use the proper pullers.

(6) It is recommended that the special tools according page 3-161 used for disassembly.

(7) Do not place parts on a dirty surface.

(8) Systematically replace used seals, O-rings and, if necessary, bearings on disassembly.

(9) Clean parts before reassembly.

(10) Replace or clean corroded parts.

(11) The cages of bearings rotating in oil are to be coated with oil at reassembly.

(12) Seal ring treads on flanges, shafts etc. must be preserved with SAE80W-90/API GL-5 before mounting.

(13) Oil seal rings and particularly the anti-dust lip seals must be filled with grease.

(14) The universal joint shafts and the axle shafts must not be force mounted (They must slide).

(15) At mounting of radial seal rings pay attention that there is suffice overlap to the housing bores.
Pay attention for a plain alignment of the radial seal ring. The seal lips always must not be contacted with Loctite.

(16) The bolted or keyed assemblies safeties are to be checked according to instructions ; in case of doubt, consult Hyundai dealer.

(17) Refill the oil after assembly.

(18) Repair weldment is only allowed after consultation with Hyundai.

2) USING OF LOCTITE AND OPERATING SUPPLIES

Kind	Type	Color	Application
Loctite	243	Blue	Lightly locked screws
	262	Red	Middle locked screws
	270	Green	Highly locked screws
	270	Green	Increased coefficient of friction in contact surfaces
	510	Orange	Surface gasket
	572	White	Special gasket
	638	Light-green	Glueing with big width of slit
Epple	33	Grey	Surface gasket
Dirko	-	Grey	Elastic gasket

3) REMARKS FOR WORKING UP LOCTITE AND OPERATING SUPPLIES

(1) Threads and surfaces have to be cleaned and free from color, oil and grease before applying loctite.

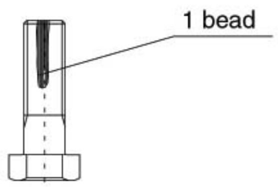
(2) Loctite will harden under following conditions :
① Exclusion of air
② Metal contact
③ Increased temperature

(3) Pre-assembly and control tightening has to be made in a short time (5 to 10 min).

(4) The time between glueing and mounting of the parts should be shorter than 1hour.
Exception : Parts made from nonferrous metal have to be glued within one minute.

(5) Assembled parts must remain unloaded for at least 24 hours.

(6) Loctite quantity :
- At screws :



100D7XL80

- At contact surfaces : Pay attention for a sufficient loctite application.

4) UTILIZATION OF LOCTITE AND OPERATING SUPPLIES

(1) Hub assembly

Safety blocked parts	Joint	Loctite	Operating supplies
Spacer ring	Contact surface	572	-
Axle spindle	Screws	562	-
Axle spindle	Contact surface	270	-
Grommet	In planetary housing	270	-
Disk	In axle spindle	270	-
Adjusting screw with nut	In planetary housing	270	-
Support	Screw	262	-
Ring gear retainer	Screws	270	-
Pol wheel	Contact surface	638	-
Steering lever Track rod lever	Screws	262	- -
Steering lever Track rod lever	Contact surface	270	- -
Wheel hub cover	Thread	572	-
Radial seal rings Rubber casing	Contact surface	572	- -
Radial seal rings Steel casing	Contact surface	270	- -
Wheel safety nut → See page 3-173 → Adjustment of wheel bearings			

(2) Drive assembly

Safety blocked parts	Joint	Loctite	Operating supplies
Drive flange	Nut surface	-	Epple 33
Diff-housing	Screws	262	-
Shifter cylinder(Diff-lock)	Contact surface	572	-
Diff. carrier(Through drive)	Contact surface	510	-
Drop gear housing	Contact surface	510	-
Diff. carrier	Contact surface	-	Epple 33
Through drive cover	Contact surface	510	-
Differential stap	Screws	262	-
Adjustment nut screw	Screw	270	-
Ring gear	Screw	262	-
Ring gear	Contact surface	270	-
Ring gear support	Cap	270	-
Ring gear support	Thread	-	Epple 33

5) TIGHTENING TORQUES

Unit : N·m

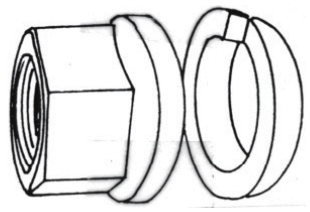
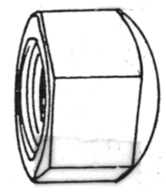
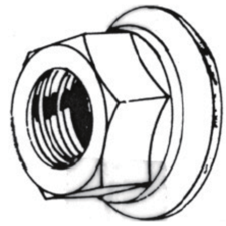
Metric standard thread						
Thread	Screw	Nut	Screw	Nut	Screw	Nut
	8.8	8	10.9	10	12.9	12
M4	3.0		4.4		5.1	
M5	5.9		8.7		10	
M6	10		15		18	
M8	25		36		43	
M10	49		72		84	
M12	85		125		145	
M14	135		200		235	
M16	210		310		365	
M8	300		430		500	
M20	425		610		710	
M22	580		830		970	
M24	730		1050		1220	
M27	1100		1550		1800	
M30	1450		2100		2450	

Unit : N·m

Metric fine thread						
Thread	Screw	Nut	Screw	Nut	Screw	Nut
	8.8	8	10.9	10	12.9	12
M 8×1	27		39		46	
M10×1	55		81		95	
M10×1.25	52		76		90	
M12×1.25	93		135		160	
M12×1.5	89		130		155	
M14×1.5	145		215		255	
M16×1.5	225		330		390	
M18×1.5	340		485		570	
M20×1.5	475		680		790	
M22×1.5	650		920		1050	
Brake caliper dowel screws (Greased)						
M20×1.5	400 + 100					
M27×2	900 + 100					
Nut for steering stop = 300 Nm						

Regard reduced tightening torque for galvanized bolts and nuts.

(1) Tightening torques of wheel nuts

		
Wheel nut with spring lock washer	Wheel nut with clamp (For clamp fixation)	Wheel nut with thrust collar (For rims with centering)

① Wheel nut with spring lock washer

Dimensions	Phosphorus darkened	Galvanized
M18×1.5	270 Nm	250 Nm
M22×1.5	450 Nm	350 Nm

② Wheel nut with thrust collar

Dimensions	Phosphorus darkened	
M22×1.5	650 Nm	

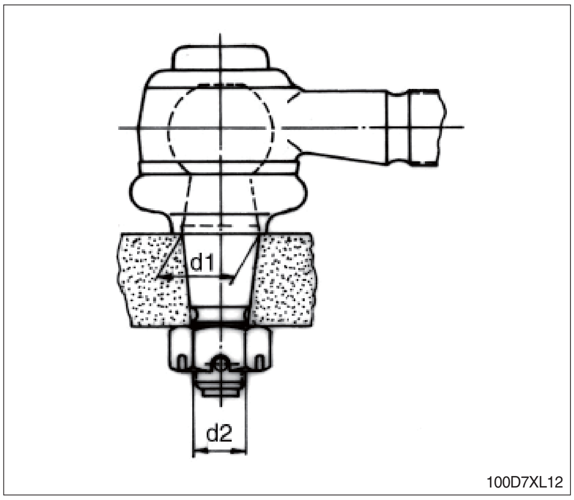
③ Wheel nut with clamp

Dimensions	Galvanized	
M18×2	350 Nm	

(2) Tightening torques for castle nuts on ball joints for track rods and ram cylinders

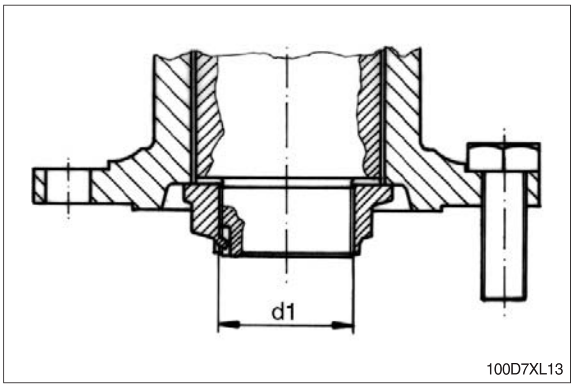
The tightening torques of the different thread dimensions of the joints are applicable for nuts of quality S6.

Cone size d1 (mm)	Thread d2 (mm)	Torque (Nm)
26	M20×1.5	200~220
30	M24×1.5	280~300
32	M27×1.5	290~320
38	M30×1.5	340~360
45	M39×1.5	410~430



(3) Tightening torque of the adjusting nut respective slotted nut at flanges respective gear wheels ect.

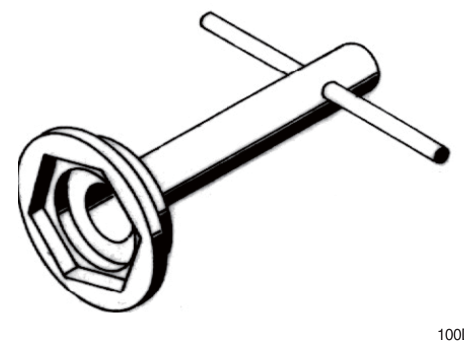
Thread d1 (mm)	Torque (Nm)
M20×1.5	360
M30×1.5	450
M36×1.5	540
M42×1.5	850
M45×1.5	850
M48×1.5	850
M52×1.5	950
M64×1.5	1050~1100



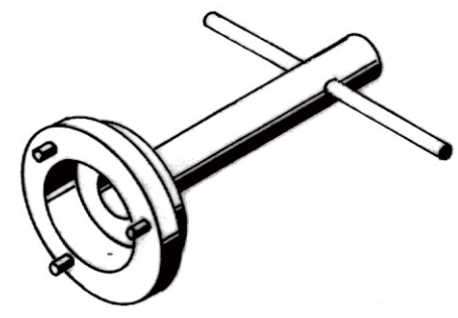
6) SERVICE TOOLS

When ordering service tools please provide order number (Installation drawing no), respective fabrication number→see identification plate. (The illustrations are not binding for the design)

(1) Spanner for wheel safety nut

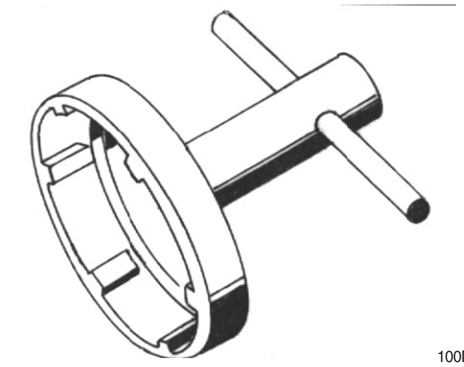


100D7XL14



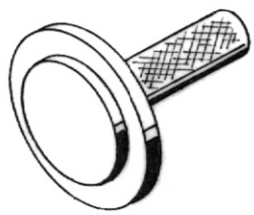
100D7XL15

(2) Spanner for splined nut (hub assembly)



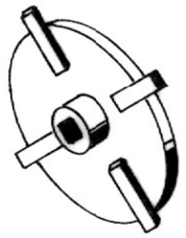
100D7XL16

(3) Seal ring sleeve driver.



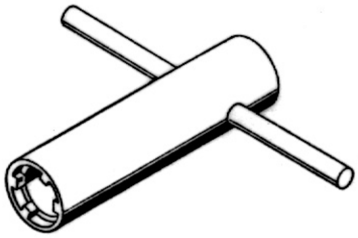
100D7XL17

(4) Spanner for thread rings.
(Differential bearing)



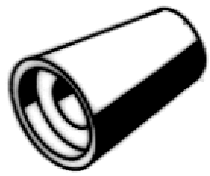
100D7XL18

(5) Spanner for counter nut.
(Planetary gear drive)



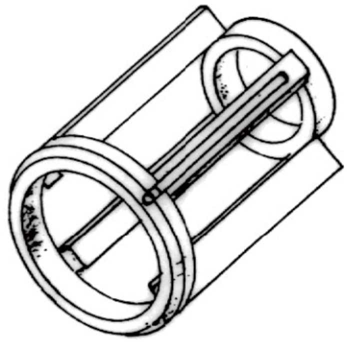
100D7XL19

(6) Assembly cone for O-ring.
(Differential lock)



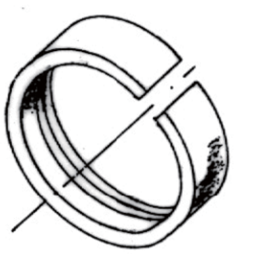
100D7XL82

(7) Centering tool for discs.



100D7XL20

(8) Installation tool for face seal.



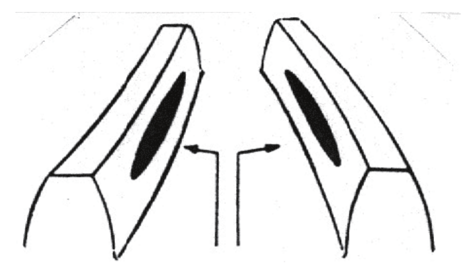
100D7XL21

7) ASSEMBLY DRIVE ASSEMBLY

(1) Adjustment of gear meshing of gleason gears

① Perfect marking

To become a perfect gear meshing is only possible, if the fabrication number of the drive pinion (marked on the end face) and the ring gear(marked on the circumference) are corresponding.



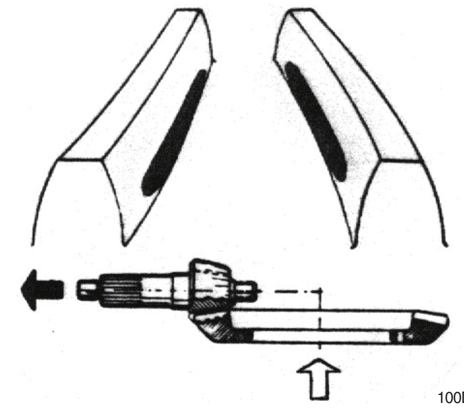
100D7XL22

※ Improper gear meshing marks

The following figures are showing improper gear meshing marks of the ring gear. The text alongside gives the corrections to obtain correct gear meshing. The dark colored arrows in the sketch of the drive pinion and ring gear are indicating the direction towards which the drive pinion has to be moved. The clear arrows are indicating the direction towards which the ring gear has to be moved, to get further more a correct backlash.

② Gear meshing to deep

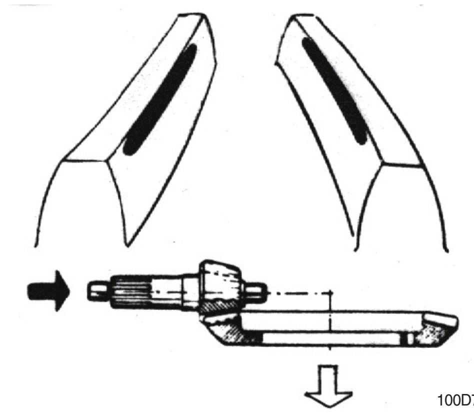
Increase the drive pinion distance by correction of the adjustment disk thickness. Regulate the backlash by inwards moving of the ring gear.



100D7XL23

③ Gear meshing to high

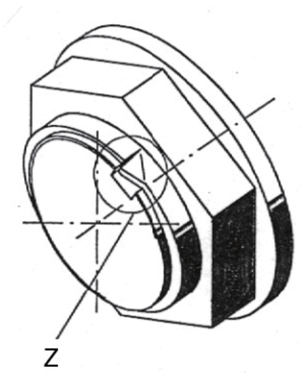
Decrease the drive pinion distance by correction of the adjustment disk thickness. Regulate the backlash by outwards moving of the ring gear.



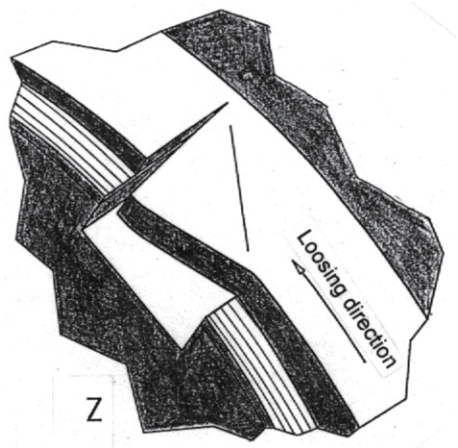
100D7XL24

(2) Securing of the striking nut

The brim of the striking nut has to be sheared only along the slot flank and the corner has to be bent on the slot ground.



100D7XL26



100D7XL25

① Using of Loctite and other operating supplies

a. Striking nut at drive flange
   - In thread : Assembly paste with MoS_2 (exception through drive pinion see point Z).
   - Front side contact surface : Sealing compound (Epple 33 or equivalent).

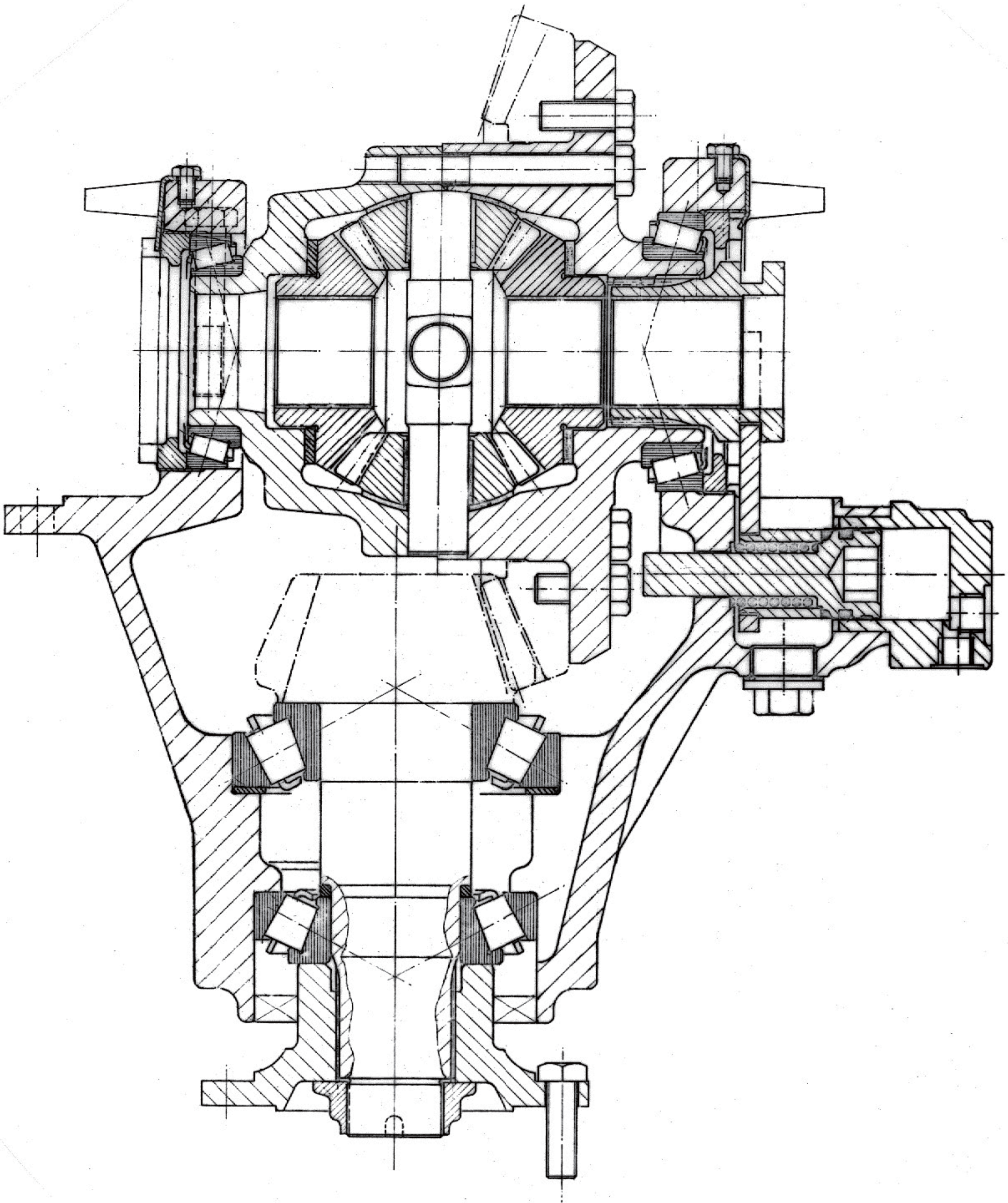
b. Striking nut at through drive pinion
   - In thread : Loctite 262.

   Striking nut at gear wheels, bearings etc.
   - In thread : Assembly paste with MoS_2.

② Removing of the striking nut

Bend away the nose and screw off the nut.

③ Drive assembly D 51



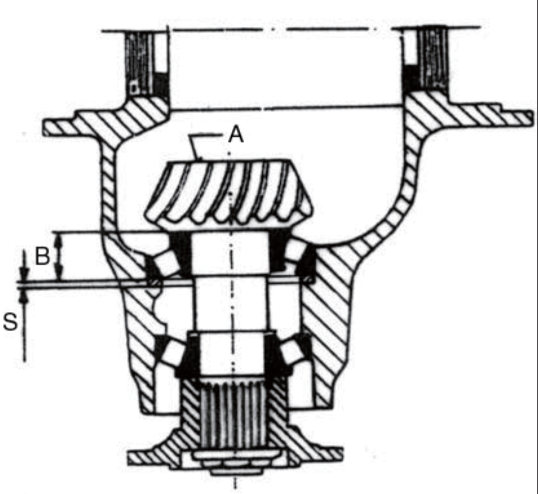
100D7XL27

(3) Adjustment drive pinion distance

To obtain the proper tooth flank contact, adjust the axial position of the drive pinion with the thickness of the adjustment disk.

The necessary thickness of the adjustment disk for first time assembly can be obtained by measurement (see calculation example).

The final thickness of the adjustment disk can be fixed during the checking of gear meshing at the assembled drive assembly (see page 3-164 "Adjustment of gear meshing of gleason gears")



100D7XL28

· A = Set value for correct pinion support. This dimension is written on the end face of the pinion in millimeter. It indicates the deviation from the theoretic distance(setpoint dimension).

· B = Measured width of the taper roller bearing.

※ Calculation example to ascertain the thickness S from the adjustment disk :

A = + 0.10 ; B = 37.95

S = 3.00 mm (theorem)

+ 0.05 mm → B = 0.05 mm smaller than B theorem.

= 3.05 mm

- 0.10 mm → Drive pinion value A

= **2.95 mm** → Necessary thickness of the adjustment disk

Fit corresponding disk and outer rings of the taper roller bearings.

※ If value A is positive (f.e. +0.1) the adjustment disk has to be 0.1 mm thinner than theorem. S. If value A is negative (f.e. -0.1) the adjustment disk has to be 0.1 mm thicker than theorem S.

※ If measure B is positive (f.e. 38.05) the adjustment disk has to be 0.05 mm thinner than theorem S.

If measure B is negative (f.e. 37.95) the adjustment disk has to be 0.05 mm thicker than theorem S.

(4) Assembly of drive pinion bearing

① Insert the two outer rings of the taper roller bearings into the differential carrier.

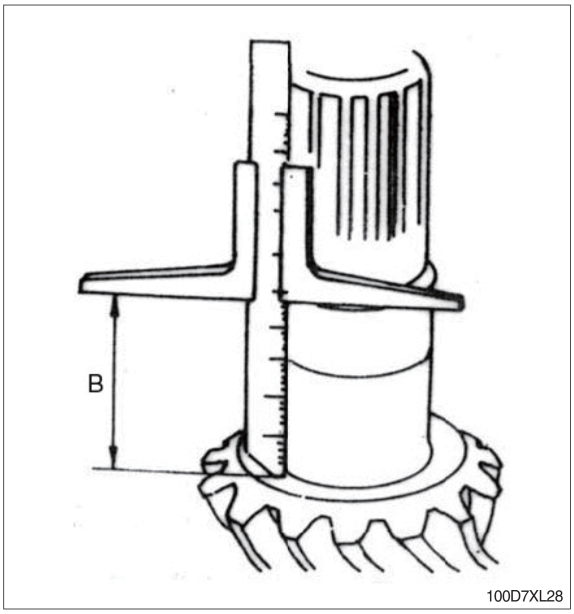
② Calculate the thickness C of the spacer ring.

  a. Place the two inner rings of the taper roller bearings in their outer rings. Measure A.

  b. Measure the dimension B of the drive pinion.

  c. Thickness of the spacer ring C = A-B.

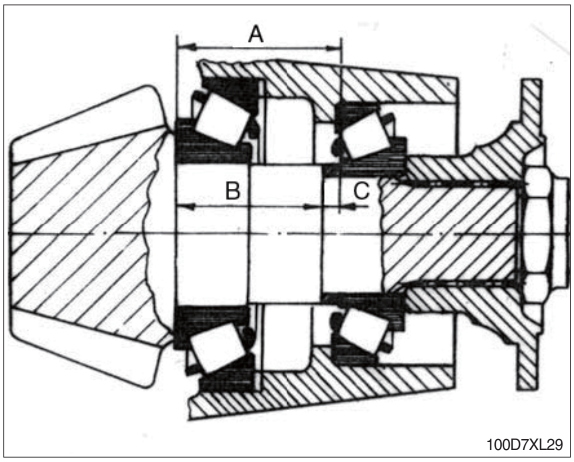
③ Heat the drive pinion side taper roller bearing to about 100˚C and install it on the drive pinion shaft.(Drive on completely after it cools)



④ Install the spacer ring on the pinion shaft.

⑤ Install the drive pinion into the differential carrier. Heat the taper roller bearing inner ring at undersize to about 100˚C and install it with a tube onto the drive pinion shaft.

⑥ Install the drive flange onto the drive pinion shaft. Tighten the safety nut according page 3-160. For tightening fix the differential carrier and block the drive flange.



⑦ Measure the resistance of the bearings by using a torque wrench. If the measured value is not the prescribed 0.8 to 1.2 Nm, adjust the resistance by modification of the thickness of the spacer ring. After arriving at the adjustment of the bearing, back-off the safety nut and draw off the drive flange.

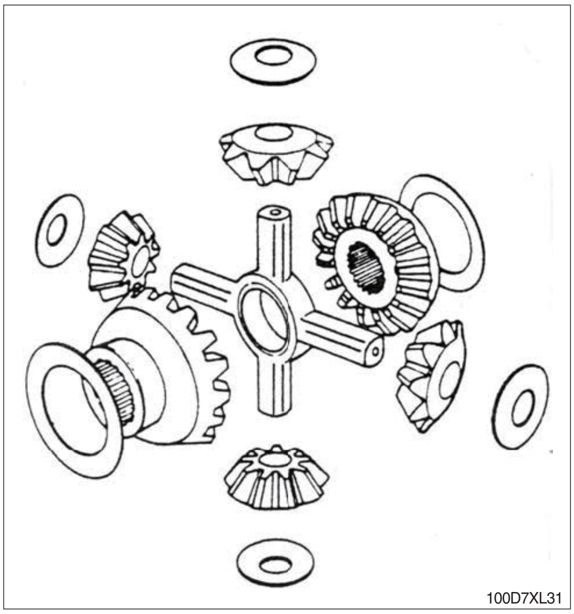
⑧ Install the radial seal ring with Loctite 572 applied. Fill the radial seal ring with bearing grease. Fit the carrier of the parking brake (if present) on the differential carrier and tighten the screws. Slip on the drive flange, screw on the safety nut with sealing compound between the contact surfaces. Tighten the safety nut according page 3-160. Lock the nut by striking the nut brim into the slot of the pinon.

8) ASSEMBLY OF THE DIFFERENTIAL

Before assembly all of the bevel gears and the thrust rings should be well oiled.

(1) Place one differential side gear with the side gear thrust washer in the differential case.

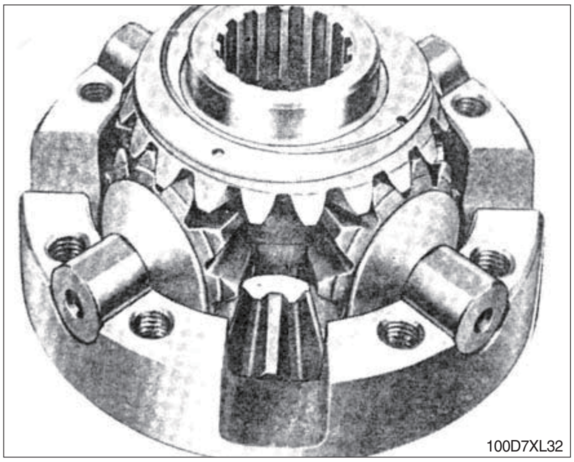
(2) Install the spider with differential gears and differential pinion thrust washers in the differential case.



100D7XL31

(3) Install the other differential side gear and side gear thrust washer. (At variants with nospin differential install the nospin diff. instead of the differential gears)

(4) Install the other half of the differential case over the assembly and observe the alignment marks, tighten the differential case bolts. Secure with Loctite 262.

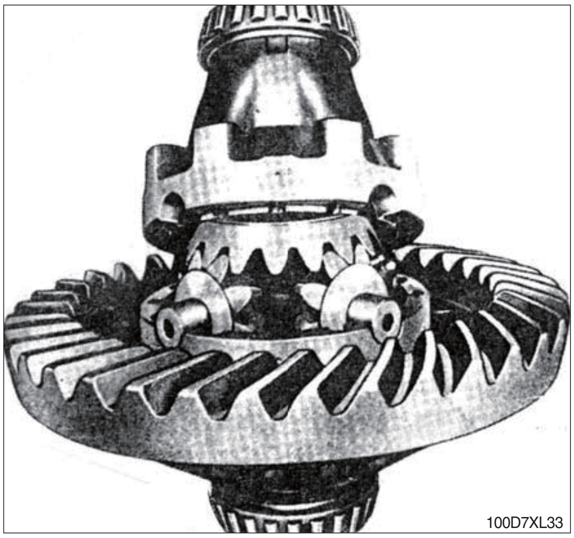


100D7XL32

(5) Check that all differential pinions can rotate easily.

(6) Coat the contact surface of the ring gear with Loctite 270 and install the ring gear on the differential case by tapping lightly on the circumference. Tighten the ring gear bolts. Secure with Loctite 262.

(7) Heat the two taper roller bearings to about 100˚C and install them by using a sleeve.



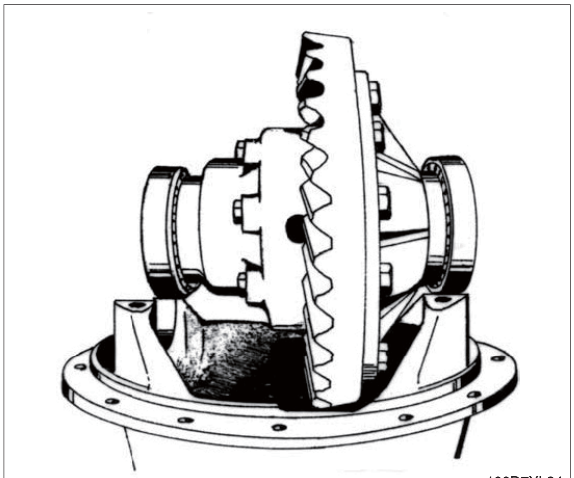
100D7XL33

9) ASSEMBLY OF DRIVE ASSEMBLY

(1) Place the differential with the outer rings of the taper roller bearings on the differential carrier which is in a vertical position, with mounted drive pinion.

(2) Mount the differential straps and align them with the thread rings.

(3) During this operation be careful of the alignment marks on the differential straps with respect to the differential carrier. (Do not interchange the differential straps)

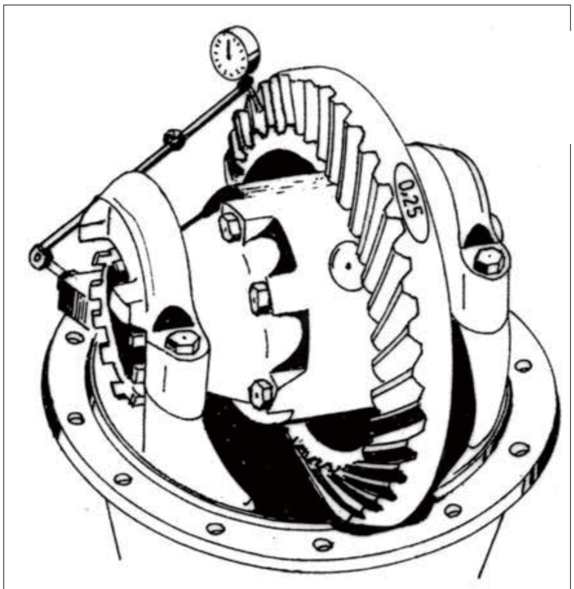


100D7XL34

(4) Hand tighten the differential strap bolts. By a counter rotation of the two thread rings, move the differential until the backlash is correct. (The smallest admissible value at the closest place is marked on the ring gear)

(5) Therefore hold the drive pinion at the drive flange. Check the backlash by careful forwards and rearwards rotating the ring gear. Use a dial indicator.

(6) Measure the backlash during a few times turns of the ring gear and if need correct the backlash, because of the smallest admissible value at the closest place must not be fall short of.



100D7XL35

(7) Adjust gear meshing according to page 3-164 "Adjustment of gear meshing of gleason gears".

(8) Tighten screws of the differential straps and lock them with Loctite 262.

(9) Adjust the bearing roll resistance through tightening of the thread rings. Set value : 2.0 to 3.0Nm. Check the value with a torque wrench. If measuring at the drive pinion/drive flange, take the ratio of the bevel wheel set into account.

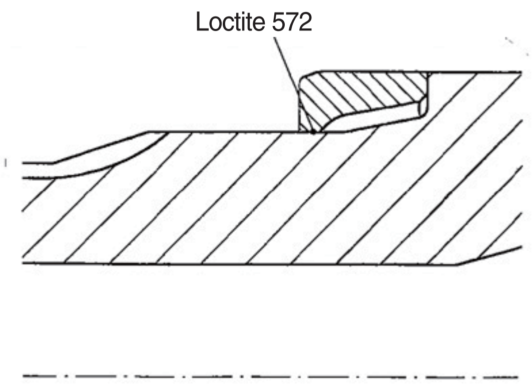
(10) Screw the lock plates for the thread rings and secure with Loctite 270, if need bend the lock plates.

100D7XL36

10) ASSEMBLY OF HUB ASSEMBLY

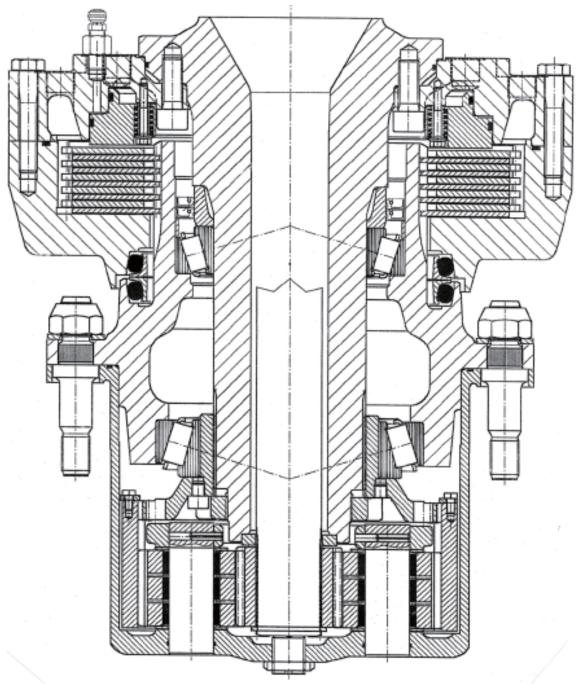
(1) Assembly of the spacer ring

Coat the seat of the spacer ring on the steering knuckle respective axle spindle with Loctite 572.
Heat the spacer ring to about 100˚C and push it by gently striking onto the steering knuckle respective axle spindle. (The steering knuckle respective axle spindle must be free of corrosion)
Oil the seal ring tread onto the spacer ring.



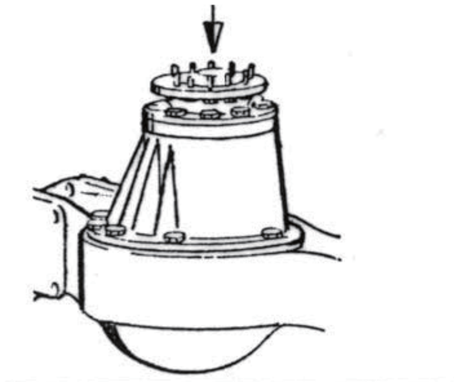
100D7XL37

(2) Drive axle hub assembly

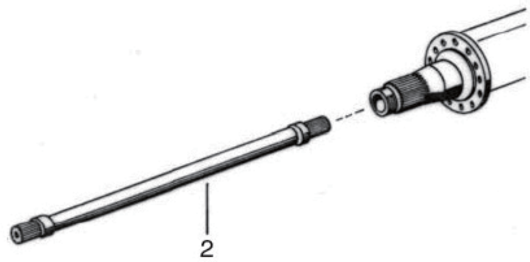


100D7XL38

11) ASSEMBLY OF THE DRIVE ASSEMBLY ONTO THE AXLE HOUSING



100D7XL39



100D7XL40

(1) Coat the contact surface of the axle housing with Epple 33 (at version through drive with Loctite 510), and mount the complete drive assembly. The axle housing being placed in a horizontal position, secure the screws with Loctite 262.

(2) Engage the axle shaft into the axle housing.

(3) The axle shaft should be able to be moved easily (by hand) in the toothing of the differential side gear.

(4) At version with differential lock on the outside (D71/D109) the differential lock must always be actuated when assemble or disassemble the axle shaft.

※ Actuating of the differential lock is necessary to prevent the sliding sleeve to drop out of the shifter fork into the axle housing when pulling out or sliding in the axle shaft. This would entail disassembly of the axle.

(5) Assembly hub assembly

① Assembly of the spacer ring (if present) see page 3-171.
② Install the brake onto the axle spindle, be careful of the brake control position and bolt it.
At version with disk brake install the brake carrier (if present), then mount the wheel hub with the brake disk, and after this operation install the brake.
③ Prepare and mount the wheel hub see page 3-173.
Attention : Hold the wheel hub with a hoist till the outer bearing with ring gear carrier is mounted.
④ Assembly of the planetary gear drive see page 3-179.
⑤ At version with drum brake mount the brake drum.

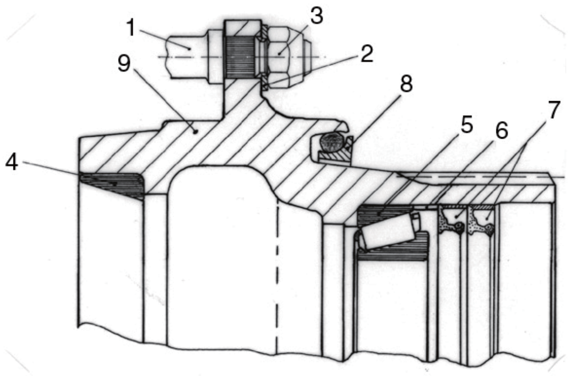
(6) Prepare wheel hub

① Install the wheel studs (1), attach the shim (2), screw on the nuts (3) with 800 Nm.
② Press in outer rings of taper roller bearings (4+5), do not hammer them.
③ Install inner ring of taper roller bearing (5).
④ Install the distance ring (6).
⑤ Press the radial seal rings (7) with Loctite 572 (rubber cage) respective Loctite 270 (steel cage) applied into the wheel hub (9). Fill the radial seal rings with bearing grease.
⑥ Install the face seal (8) into the wheel hub (9) (see page 3-174).

(7) Mount wheel hub

① Push the pre-assembled wheel hub (9) parallel onto the axle spindle respective steering knuckle.

※ Be carefully do not damage the seal rings.



100D7XL41

(8) Adjustment of wheel bearings

① Tightening torque of the wheel safety nut.

Series	Nm
81	450

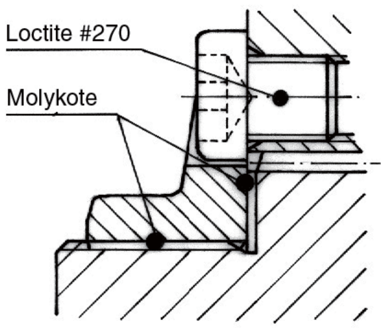
② Adjustment of wheel bearings

The temperature of the axle parts should be between 0 and +20˚C at the bearing adjustment.

Screw on the wheel safety nut (Loctite-respective Molykote-using see below) and adjust and secure as following described :

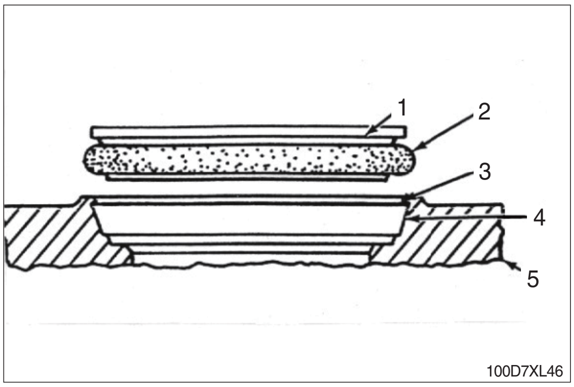
Screw on the wheel safety nut and tighten it with a 1.5 to 2 times higher tightening torque than the finish tightening torque. During the tightening, turn the wheel hub a few times and knock it with a plastic hammer. Untighten the wheel safety nut (about 180˚ back rotation), then tighten the wheel safety nut to the tightening torque according to the table. At this tightening turn the wheel hub also a few times, if there is no possibility for securing, the wheel safety nut has to be turned back to next securing possibility.

③ Wheel safety nut

Designation	Version	Security / Remarks
Shaft nut with cheese head screw		Cheese head screw & Loctite 270

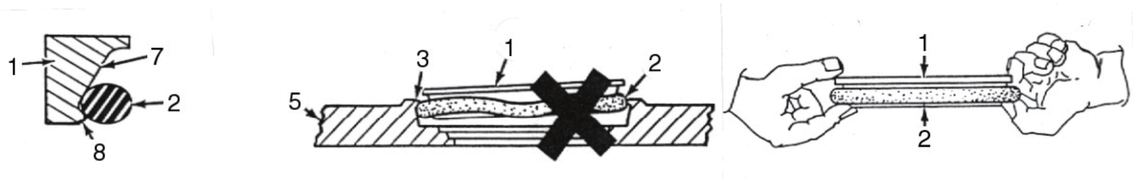
(9) Assembly of the face seal

1 Seal ring
2 Rubber toric ring
3 Housing retaining lip
4 Housing ramp
5 Seal ring housing



① Seal rings, torics, and housings must be clean and free of any oil film, dust, or other foreign matter. Use a solvent that evaporates quickly, leaves no residue, and is compatible with the rubber toric rings. The recommended solvent is Isopropanol. Ring and housings should be wiped with a solvent-soaked lint free cloth or paper towel.

② After all components have been wiped clean, the torics should be installed on the metal seal rings so that they rest in the radius on the tail of the metal ring. Insure that the torics are not twisted by inspecting the mold flash line on the outside diameter of the toric for true circumferential tracking around the seal. Twisted torics will case nonuniform face load that can result in leakage of lubricant and pumping of debris past the toric. If a twist is apparent, it can be eliminated by gently pulling a section of the toric radially away from the metal seal ring and letting it "snap" back. Repeating this in several places around the ring will eliminate any twist in the toric ring.



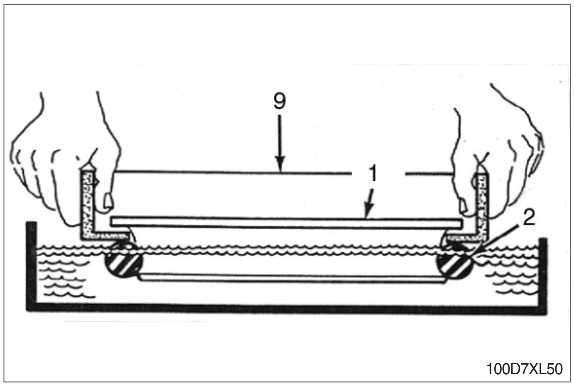
③ Put the toric ring (2) on seal ring (1), at the bottom of the seal ring ramp (7) and against the retaining lip (8).

④ The toric ring (2) can twist if it is not wet all around during installation or if there are burrs or fins on the retaining lip (3) of the housing (5).

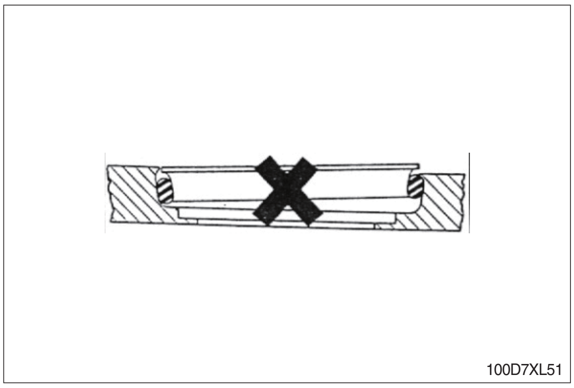
⑤ Eliminate toric twist by gently pulling a section of the toric (2) rapidly away from the seal ring (1) and letting it "snap" back.

⑥ Place the installation tool around the seal ring and dip the seal ring into a pan of Isopropanol solvent to lubricate the toric ring. It is essential to lubricate the toric with Isopropanol so that the toric will slip past the housing retaining lip and seal uniformly in the housing nose radius. Insufficient lubrication can cause poor seal performance due to nonuniform loading (twisted torics or cocked seals). Use of solvents other than Isopropanol can leave a residue on the toric or ramps and allow the toric to slide rather than roll in seat. This can also result in poor seal performance due to nonuniform loading.

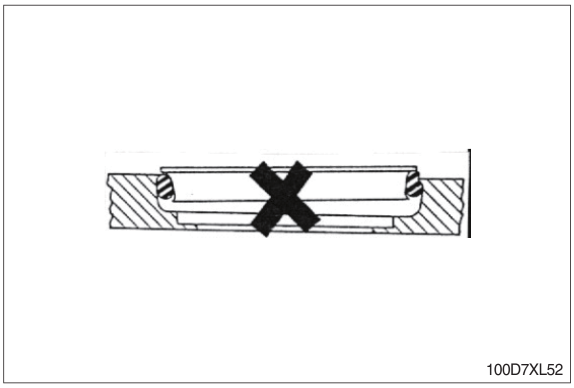
⑦ Put the installation tool (9) onto the seal ring (1) with toric ring (2).
Lower the rings into a container with Isopropanol until all surfaces of the toric (2) are wet.



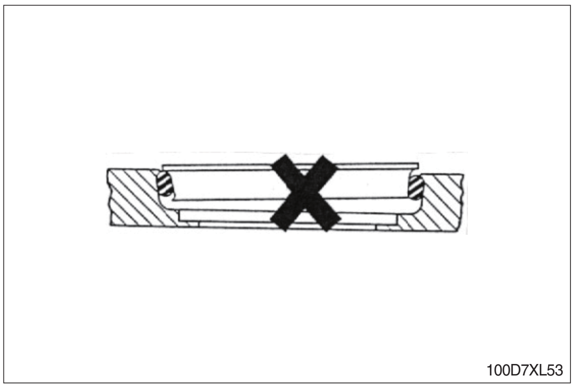
⑧ Toric sliding on retainer ramp.



⑨ Toric caught on housing retainer lip.

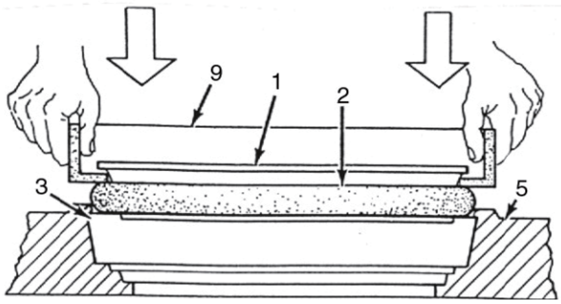


⑩ Toric sliding on seal ramp.



⑪ After dipping the seal assembly in the solvent, shake the excess solvent from the seal assembly and immediately "pop" the seal into the housing with a firm push of the installation tool. Remove the installation tool and check the seal standout height at several places around the circumference of the ring to verify an accurate installation. If the seal does not meet the height specification, inspect the toric for twists or obvious bulges.

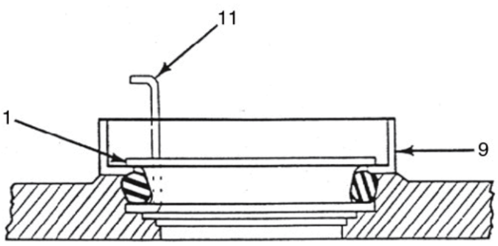
⑫ With all surfaces of the toric ring (2) wet with Isopropanol, use the installation tool (9) to position the seal ring (1) and the toric ring (2) squarely against the housing (5) as shown. Use sudden and even pressure to pop (push) the toric ring (2) under the retaining lip (3) of the housing (5).



100D7XL54

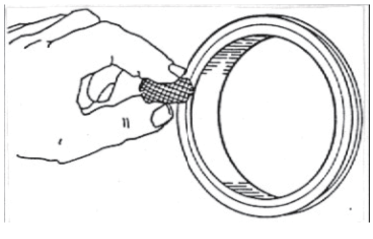
⑬ The seal can be adjusted by gently pushing the toric into position by hand or by using a fabricated adjustment hook.

⑭ If small adjustments are necessary, do not push directly on the seal ring (1) ; use the installation tool (9) to push down or the adjustment tool (11) to pull up.



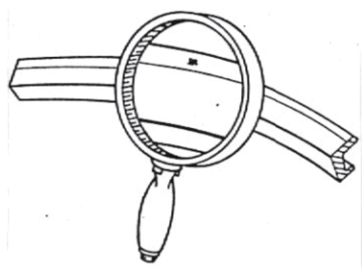
100D7XL55

⑮ A thin film of light oil should be applied to the seal faces prior to assembly. Use an applicator, a disposable tissue or a clean finger to distribute the oil evenly. Be careful not to get any oil on the rubber toric rings.



100D7XL56

⑯ Be sure there is no visible debris on either of the seal faces even a small piece of lint can hold the seal faces apart and cause leakage.

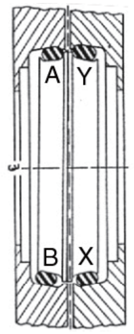


100D7XL57

⑰ After successful installation, wait one minute for the Isopropanol to dry before assembling the two seal halves in the final loaded position. This delay is to allow any excess solvent to dry so that the torics roll, rather than slide, in the housing as the faceload is increased. If the torics slide, this can produce a nonuniform load that can result in poor seal performance.

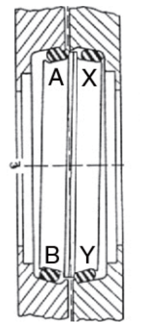
※ Results of incorrect assembly :
Point "A" and point "B" remain stationary.
Points "X" and "Y" rotate 180˚.
This causes high pressure at "A" and "Y" and possible galling.
When rotated, points "B" and "X" have low pressure and possible leakage.

Original assembled position



100D7XL58

Rotated 180˚



100D7XL59

⑱ After the unit to be sealed is assembled, a post-assembly leakage test can be performed to insure the seal is properly installed. A vacuum check is recommended rather than a pressure check as vacuum checks are more sensitive. Many users find this an easy check to combine with a vacuum fill technique for the lubricant. It is recommended the compartment be filled to the correct level with lubricant and then rotated slowly several revolutions to seat the seals.
A vacuum test will catch big seal damage such as broken seal rings or cut torics that may be caused in the last phases of assembly. The Duo-Cone seal is not designed to seal air, so some leakage can be expect using such a procedure.

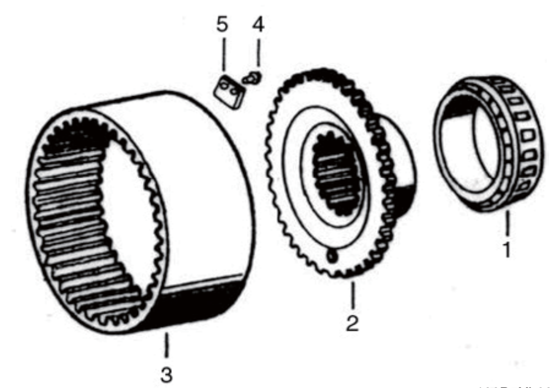
⑲ Following these guidelines and recommendations should insure optimum performance from the Duo-Cone-Seals.

10) ASSEMBLY OF PLANETARY GEAR DRIVE

(1) Prepare the ring gear and the ring gear carrier

Heat the taper roller bearing inner ring with cage (1) to about 100˚C and install it onto the ring gear carrier (2). Place the ring gear (3) onto the ring gear carrier.

Bolt the retainer (5) with the screws (4), secure the screws with Loctite 270.



100D7XL60

(2) Assembly of the ring gear carrier

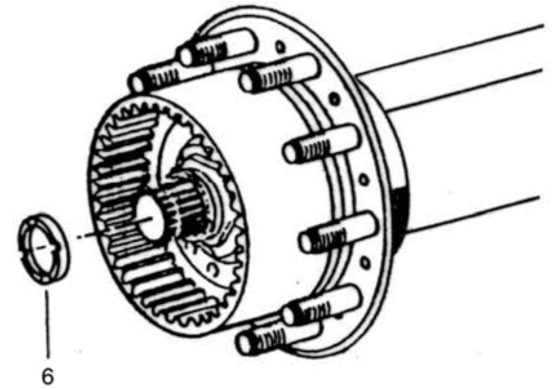
Install the ring gear carrier (2) with ring gear (3) into the wheel hub respective onto the steering knuckle respective axle spindle.

The oil compensating hole in the ring gear carrier must be on the bottom.

Subsequent adjust wheel bearings (see page 3-173).

(3) Assembly of the thrust ring

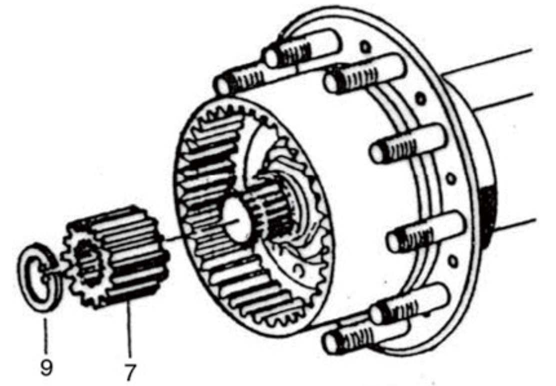
Press the thrust ring (6) into the steering knuckle respective axle spindle. Secure with Loctite 270.



100D7XL61

(4) Assembly of the sun gear

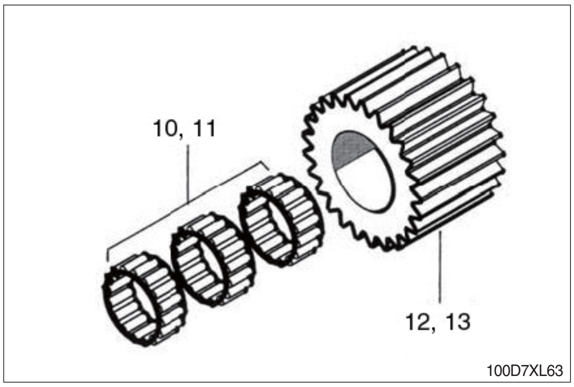
Slip the sun gear (7) onto the universal joint respective axle shaft, install the circlip (9) and push the universal joint respective axle shaft towards the inside until the circlip contacts to the sun gear and the sun gear contacts to the thrust ring.



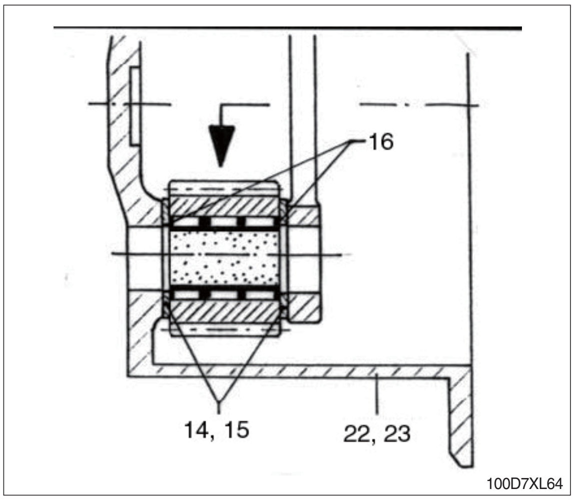
100D7XL62

(5) Assembly of planetary gear

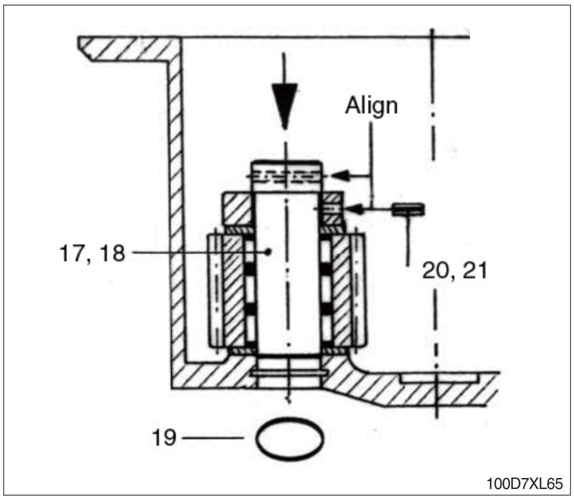
① Prepare planetary gear :
Install the needle bearing (10, 11) into the planetary gear (12, 13).



② Insert the preassembled planetary gears (12, 13) with needle bearings (10, 11), rings(16) (if present) and thrust disks (14 , 15) into the planetary housing (22, 23) (planetary housing in horizontal position).

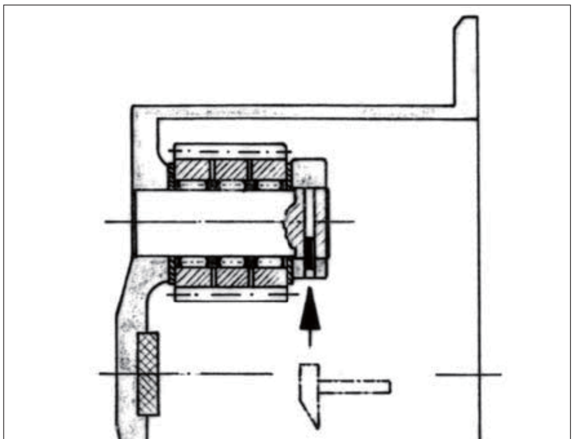


③ Place O-ring (19) into the slot of the planetary housing (22). Because of the difference of diameter of 0.1mm press the planetary pin (17, 18) in direction of arrow. Be sure, that the bore hole of the locking pin in the planetary pin and planetary housing are aligned. After inserting, secure the planetary pin with the locking pin (20, 21).



(6) Disassembly of planetary gear

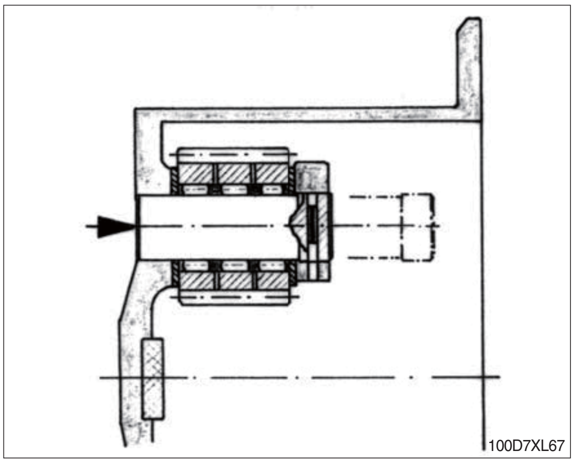
① Knock the locking pin (20, 21) completely to the inner side of the planetary pin.



100D7XL66

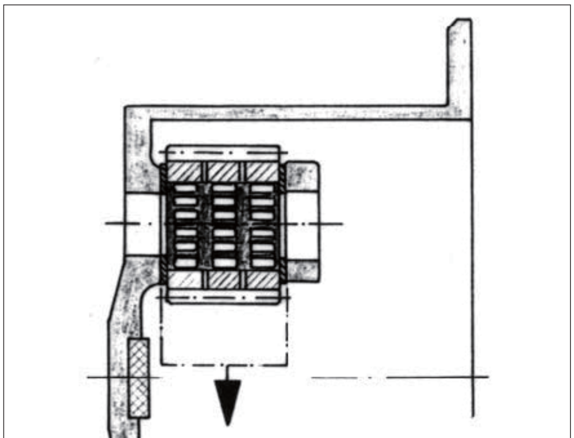
② Press the planetary pin in direction of arrow out of the planetary housing.

※ Because of the difference of diameter of 0.1 ㎜ do not press the planetary pin against the direction of arrow out of the planetary housing, to prevent damaging the bore.



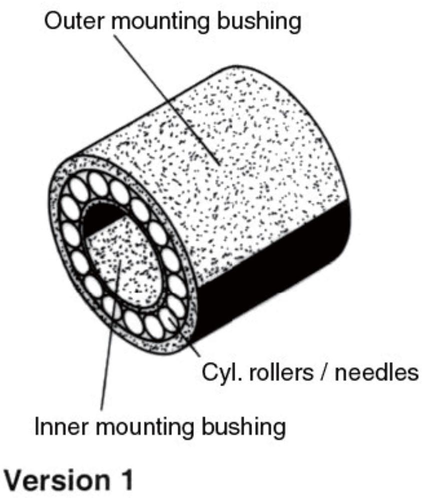
100D7XL67

③ Remove the planetary gears with the thrust disks and needle bearings.

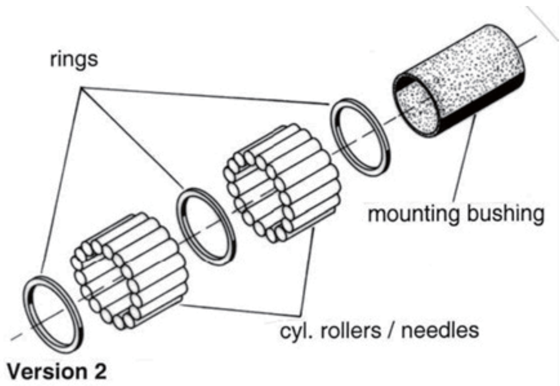


100D7XL68

11) Assembly / disassembly cageless needle bearing(planetary gear bearing)



100D7XL39



100D7XL40

(1) Assembly

① Version 1

Install the needle bearing with mounting bushings into the planetary gear, thereby the outer mounting bushing will be stripping. Insert the planetary gear with thrust disks into the planetary housing. Press in the planetary pin, thereby the inner mounting bushing will remove.

② Version 2

Place one thrust disk on the work bench, place on the planetary gear and insert the mounting bushing. Insert the cylindrical rollers/needles alternately with the rings (according to the design). Insert the planetary gear with thrust disks into the planetary housing.
Press in the planetary pin, thereby the mounting bushing will remove.

③ Hint

Note the passage "Assembly of the planetary gear".

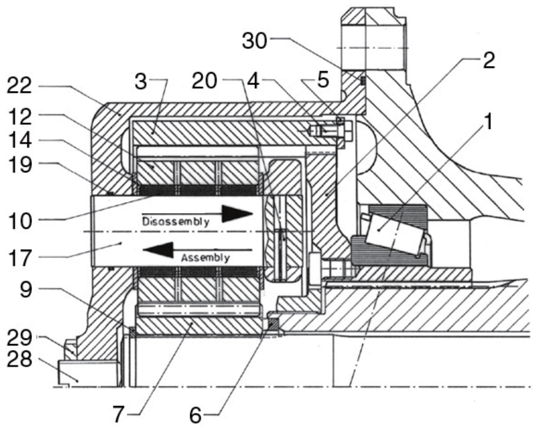
(2) Disassembly

At the disassembly of the planetary pin the cageless needle bearing will fall asunder, if not a mounting bushing will be pushing inwards at planetary pin removing.

① Hint

Note the passage "Disassembly of the planetary gear".

(3) Planetary gear drive

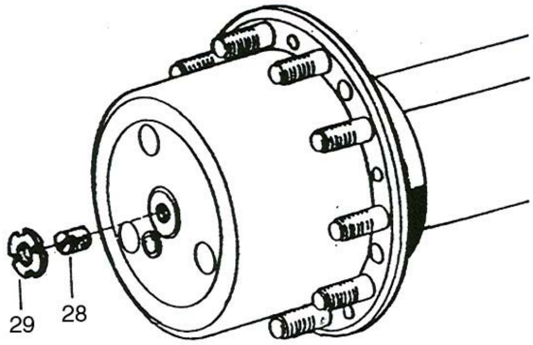


100D7XL71

12) Assembly of the planetary housing

Place O-ring (30) into the slot of the planetary housing. Install the planetary housing and bolt it.

13) Adjustment of the axial clearance



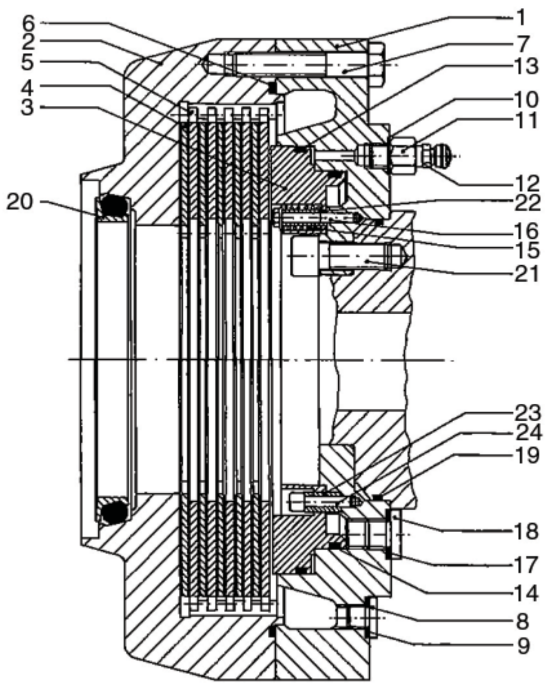
100D7XL72

The axial clearance between axle shaft respective universal joint and adjusting screw must be 0.3~0.7 mm. The adjustment has to be made by screwing in the adjusting screw until it touches the axle shaft respective universal joint. Back-off the adjusting screw 72~170˚ from the tightened position (this corresponds to about 0.3~0.7 mm axial clearance).

Secure the adjusting screw and the counter nut with Loctite 270.

※ When tightening the counter nut (29), hold the adjusting screw unconditional, to prevent turning of the adjusting screw.

14) Assembly of service brake



100D7XL83

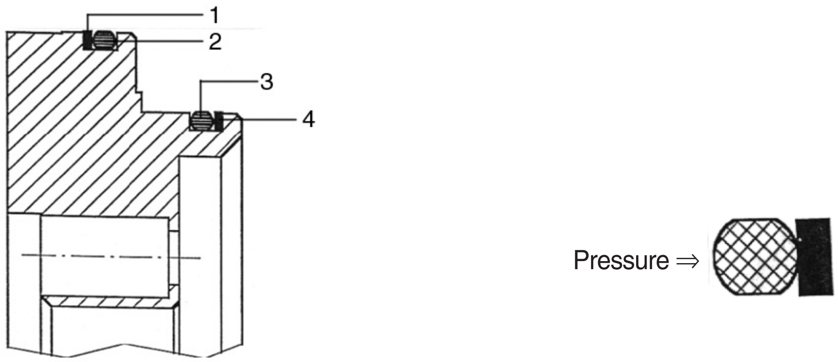
1	Brake carrier	9	Seal ring	17	Seal ring
2	Brake housing	10	Seal ring	18	Screw plug
3	Piston	11	Connection piece	19	O-ring
4	Inner disk	12	Breather	20	Face seal
5	Outer disk	13	Sealing ring	21	Screw
6	O-ring	14	Sealing ring	22	Tube
7	Screw	15	Spring	23	Bushing
8	Screw plug	16	Screw	24	Screw

(2) Assembly of the piston seals

Place piston with the larger diameter downwards. Note succession of the sealing parts at fitting.
Install O-rings free of torsion and loops.

(3) Assembly of O-ring and supporting ring

Install the supporting rings to the averting side of pressure.

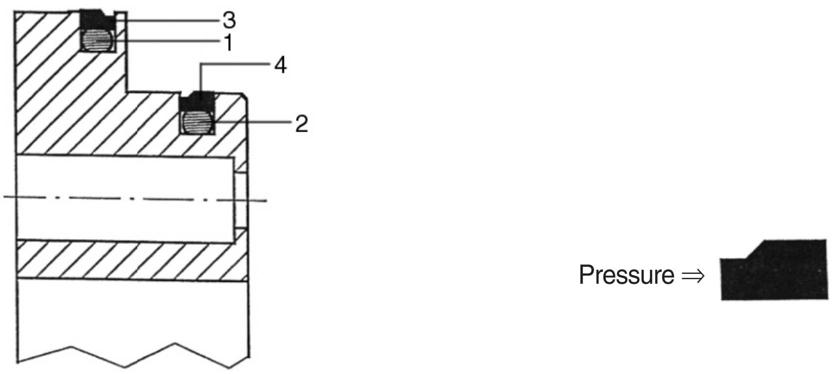


100D7XL73/84

1	Large supporting ring	3	Small O-ring
2	Large O-ring	4	Small supporting ring

(4) Assembly of the Omegat seal kit

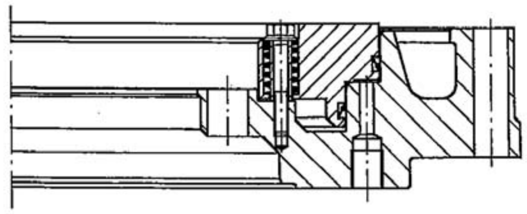
Install the PTFE-profile rings with small diameter to pressure side.
For assembly there can be used mounting tapes from Merkel company.



100D7XL74/85

1	Large O-ring	3	Large supporting ring
2	Small O-ring	4	Small supporting ring

(5) Assembly of the piston



100D7XL86

Lubricate cylinder bore, apply the thread holes at wet disk brakes of dimension X270 and X340 with Loctite 243, at wet disk brakes of dimension X460 and X650 with Loctite 262 and install and screw the bushing (if present). Place the piston onto the brake carrier (do not cant it).

※ Wet disk brakes of dimension X270 and X340

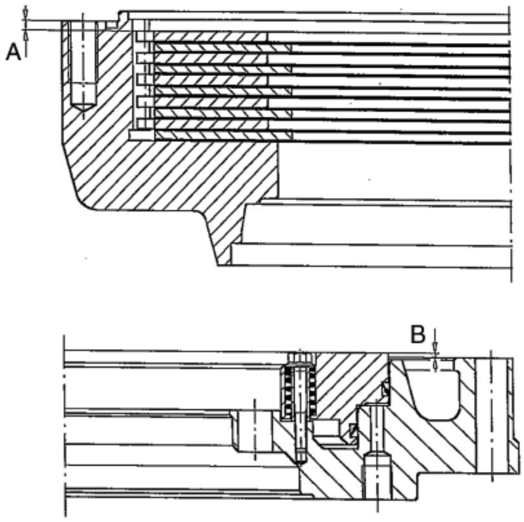
Press the piston equal by hand into the brake carrier (do not cant it).

※ Wet disk brakes of dimension X460 abd X650

Press the piston equal with mounting screws into the brake carrier (do not cant it).

If necessary adjust the piston with easy hammer taps to the thread holes. Install first the spring, then the tubes in the bore holes of the piston. Screw in the hexagon head screws with flange.

① Prepare housing and check the air gap



100D7XL87

Lay discs into the housing.

② Check the air gap

Air gap = measure A-measure B (measured without pressure)

Rated size about 0.5 mm smaller than the air gap pressurized (see table).

Install O-ring (brake housing / brake carrier) free of torsion and loops.

③ Air gap and wear dimension

Brake type	Air gap sL new (Pressurized) (mm)	Wear dimension (mm)
5340	2.4±0.9	2.0

(6) Finish assembly

Place the brake carrier onto the brake housing and bolt it. Mount breather with connection piece and seal ring, screw plugs with seal rings.
Check brake hydraulic system for leaks (see tightness checking instruction).
Install O-ring (Brake carrier / axle spindle respective steering knuckle) free of torsion and loops.

① Check the air gap (pressurized)

Measure through the check hole the distance from brake carrier to the piston end face, while non actuated brake, actuate the brake and repeat the measure operation-the difference of the measured distances gives the air gap sL (pressurized), rated size sL see table.
Measure through the check hole the distance from brake carrier to the piston end face, while actuating the brake and knock the measured value with marking punches into the brake carrier.
Install the complete brake on the axle (coat the contact surface with Loctite 270).
Mount face seal see page 3-174.

② Alignment of the discs

Wet disk brake dimension X270 and X340 :
The alignment of the discs has to be made at mounting of the wheel hub by itself.
Wet disk brake dimension X460 and X650 :
The alignment of the discs has to be made by a mounting device (see page 3-161). Clamp the discs by actuating the brake (hydraulic or air pressure).

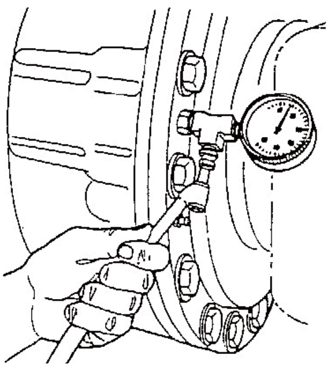
(7) Tightness checking instruction for brake hydraulic system and cooling oil room

① Check brake hydraulic system for leaks

Before conducting the test, bleed the brake hydraulic system.
The pressure drop after applying 120bar for a period of 15minutes must not exceed 2% (leaving 117.5 bar).
Test medium : Motor oil SAE 10W corresponding to MIL-L2104.

② Check cooling oil room for leaks

Brake with external cooling :
After assembly of the wheel hub with the face seal and adjusting of the wheel bearings check the tightness of the cooling oil room. Install a air pressure gauge with shutoff valve.
Beload the hub assembly with 1.5bar pressure air. Turn the hub assembly several times.
The pressure drop after a period of 10minutes must not exceed 0.1bar.



100D7XL75

(8) Permissible oil for brake with external cooling

① Actuation fluid

Do not use brake fluid any time.

Use a mineral oil base hydraulic oil type fluid only.

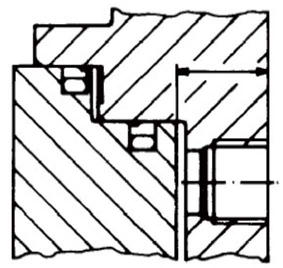
· Motor oil : SAE 80W-90

② Cooling fluid

· SAE 80W-90 LSP (Mobil lube LS85W-90)

③ Check measure

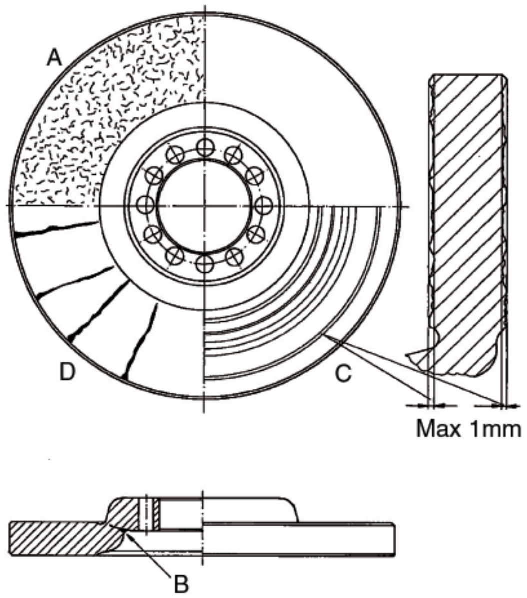
It is measured through the check hole, while actuating the brake. The check measure, new, is marked in the housing below the hole. Is the measured dimension bigger than the marked dimension and max. wear dimension, unconditional consult Hyundai dealer.



100D7XL76

After working at the brake, bleed the brake hydraulic system and check for tightness.

(9) Brake disk



100D7XL78

A	Network - like formation of cracks	admissible
B	Radially shaped crack	not admissible
C	Uneven brake surface characteristics below 1.0 ㎜	admissible
D	Continuous cracks	not admissible

(10) Spring - loaded sliding caliper brakes

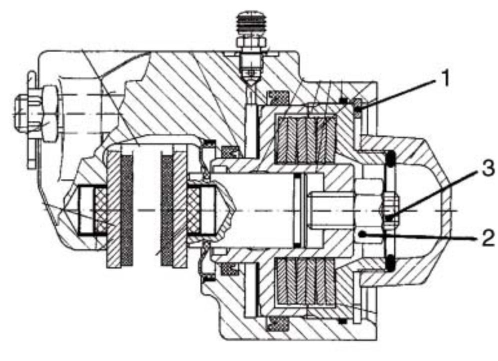
Safety notes :

· Warning

Before commencing work on the parking brake, ensure that no unintended machine movement can happen when the braking effect is removed.

· Danger

The parking brake is under spring tension. Parts could become loose and fly out suddenly if improper brake opening. Therefore release the lock nut (2) and turn the adjusting screw (3) counter - clockwise until the spring set is released before disassembly of the circlip (1).



100D7XL79

GROUP 4 ADJUSTMENT

1. CHECKING THE RING GEAR BACKFACE RUNOUT

Runout specification : 0.20 mm (0.008-inch) maximum

1) Attach a dial indicator on the mounting flange of the carrier.

2) Adjust the dial indicator so that the plunger or pointer is against the back surface of the ring gear.

3) Set the dial indicator to zero (0).

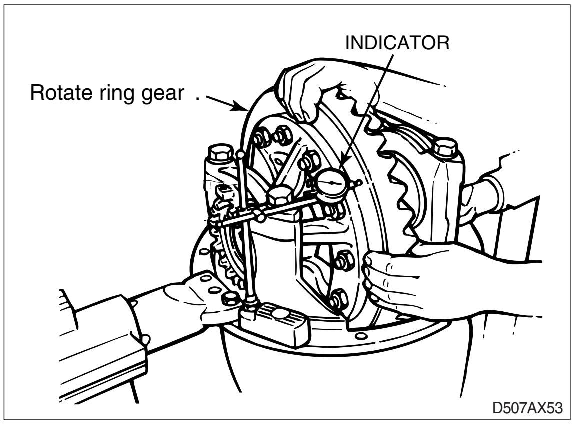
4) Rotate the ring gear and read the dial indicator. The runout must not exceed 0.20 mm (0.008 inch).

   If runout exceeds specification, remove the differential and ring gear assembly from the carrier. Refer to "Assembly of the differential".

5) Check the differential parts, including the carrier, for problems that may cause the ring gear runout to exceed specifications. Repair or replace parts.

6) Re-install the differential and ring gear into the carrier. Refer to "Assembling the differential case".

7) Repeat the preload adjustment of the differential bearings.



2. ADJUSTING THE GEARSET BACKLASH

Backlash specification : 0.13~0.18 mm
(0.005-0.007 inch)

If the old gearset is installed, adjust the backlash to the setting that was measured before the carrier was disassembled.

If a new gearset is installed, adjust the backlash to the correct specification for new gearsets.

1) Attach a dial indicator on the mounting flange of the carrier.

2) Adjust the dial indicator so that the plunger or pointer is against the tooth surface, near the heel end of the gear tooth. Set the indicator dial to zero (0).

3) Hold the drive pinion in position.

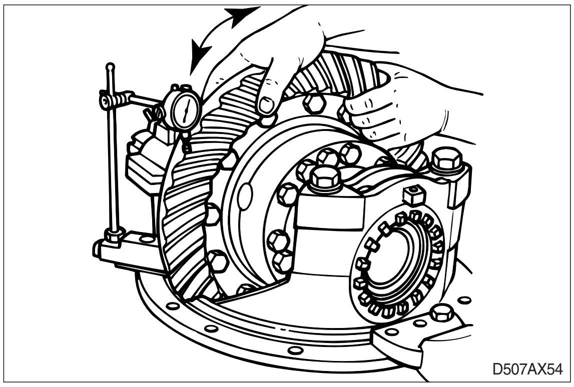
4) Read the dial indicator, while rotating the ring gear a small amount in both directions, against the drive pinion teeth.

※ When you adjust backlash, move the ring gear ONLY. DO NOT move the drive pinion.

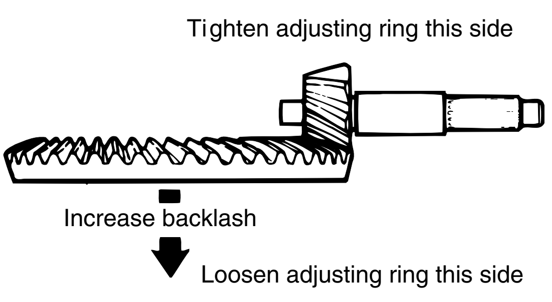
5) If the backlash reading is within specification, continue checking tooth contact patterns.
Otherwise, adjust backlash. Refer to step 6), and check, following steps 1)-4).

※ Backlash is increased by moving the ring gear away from the drive pinion. Backlash is decreased by moving the ring gear toward the drive pinion.

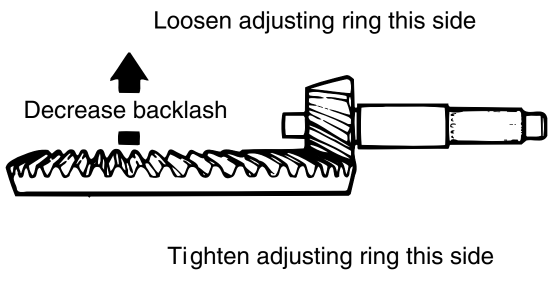
6) Loosen one bearing adjusting ring one notch, then tighten the opposite ring the same amount.



D507AX54



D507AX55

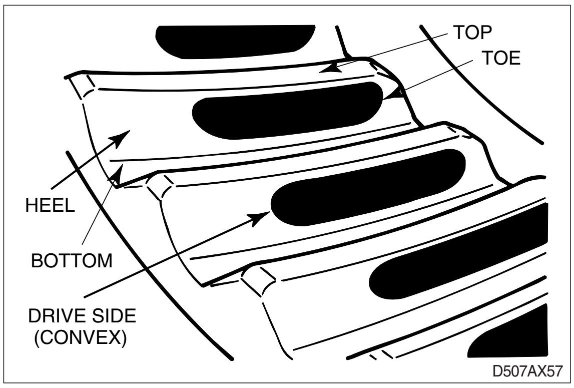


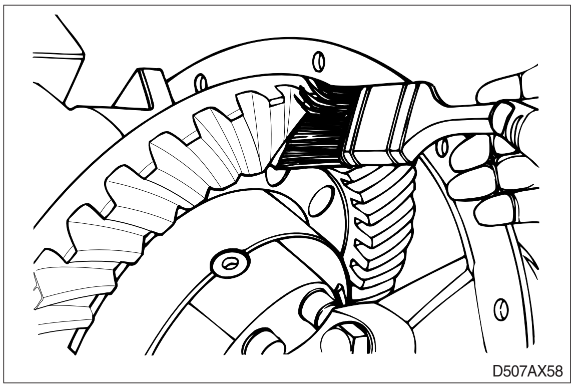
D507AX56

3. ADJUSTING TOOTH CONTACT PATTERN OF THE GEARSET

Always check tooth contact pattern on the drive side of the gear teeth.

1) Apply marking compound to approximately 12 teeth of the ring gear.





2) Rotate ring gear forward and backward so that the 12 marked teeth go past the drive pinion six times to get a good contact pattern.

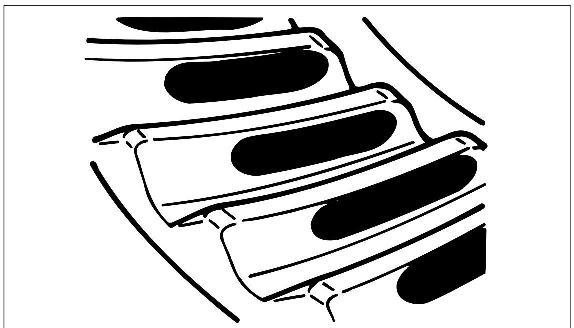
3) Compare the contact patterns.

In new gearsets, a good contact pattern is toward the toe of the tooth, and centered between the top and bottom of the tooth.

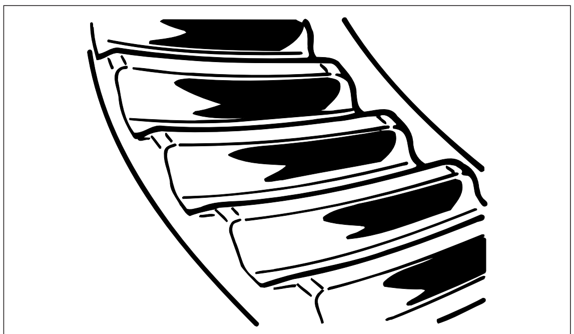
In used gearsets, a good contact pattern fills approximately the full length of the tooth. The top of the pattern is near the top of the tooth. The location should match the wear pattern on the tooth.

If the contact patterns require adjustment along the width of tooth (top/bottom), follow steps 4)-5).

If the contact patterns requires adjustment along the length of tooth (toe/heel), follow step 6)-7).

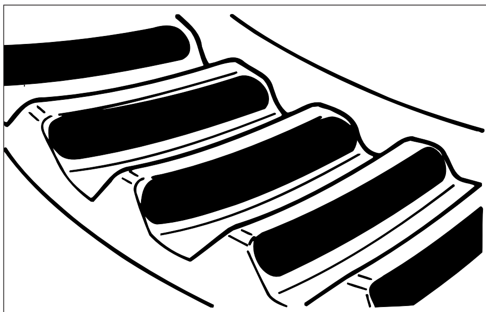


GOOD HAND-ROLLED PATTERN



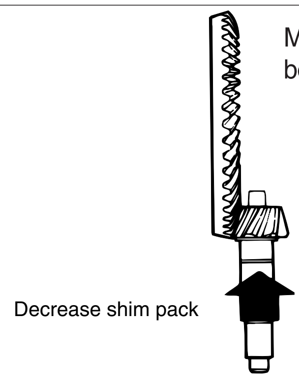
HIGH PATTERN


LOW PATTERN
D507AX61


GOOD PATTERN IN OPERATION (USED GEARS)
D507AX62

4) High pattern : A high contact pattern indicates that the pinion was installed too shallow into the carrier.

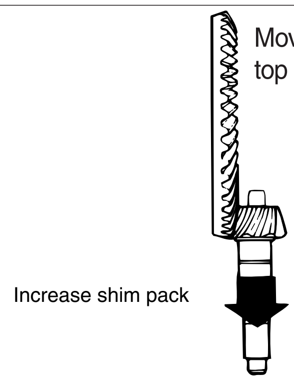
To correct, move the pinion toward the ring gear by decreasing the shim pack between pinion spigot and inner bearing cone. Refer to "Assembling the pinion bearing cage".



D507AX63

5) Low pattern : A low contact pattern indicates that the pinion was installed too deep into the carrier.

To correct, move the pinion away from the ring gear by increasing the shim pack between pinion spigot and inner bearing cone. Refer to "Assembling the pinion bearing cage".



D507AX64

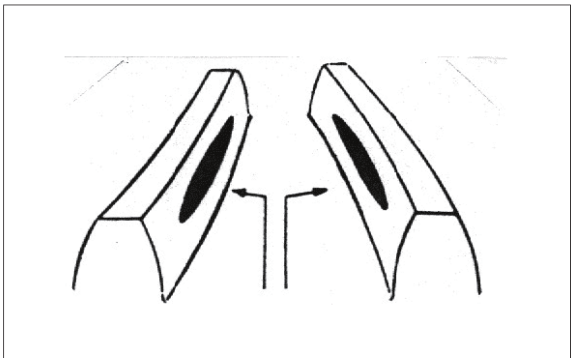
4. ADJUSTMENT OF GEAR MESHING OF GLEASON GEARS

To become a perfect gear meshing is only possible, if the fabrication number of the drive pinion (marked on the end face) and the ring gear (marked on the circumference) are corresponding.

Perfect marking

The following figures are showing improper gear meshing marks of the ring gear.

The text alongside gives the corrections to obtain correct gear meshing. The dark colored arrows in the sketch of the drive pinion and ring gear are indicating the direction towards which the drive pinion has to be moved. The clear arrows are indicat-ing the direction towards which the ring gear has to be moved, to get further more a correct backlash.

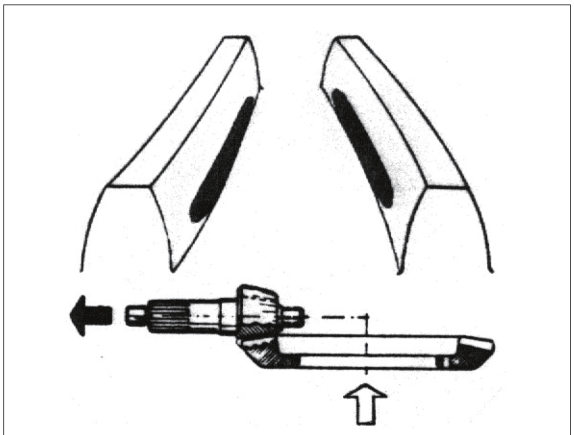


D507AX22

Gear meshing to deep

Increase the drive pinion distance by correction of the adjustment disk thickness.

Regulate the backlash by inwards moving of the ring gear.

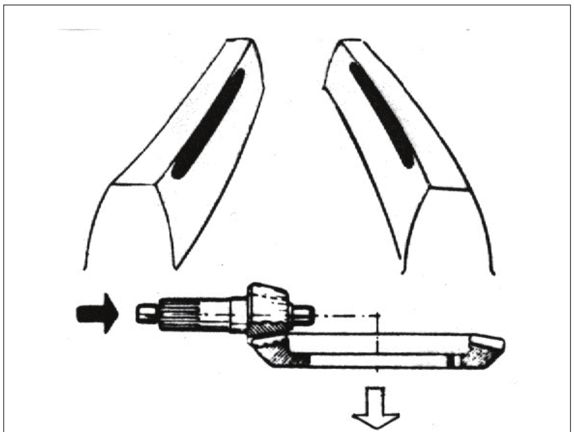


D507AX23

Gear meshing to high

Decrease the drive pinion distance by correction of the adjustment disk thickness.

Regulate the backlash by outwards moving of the ring gear.



D507AX24

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.

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

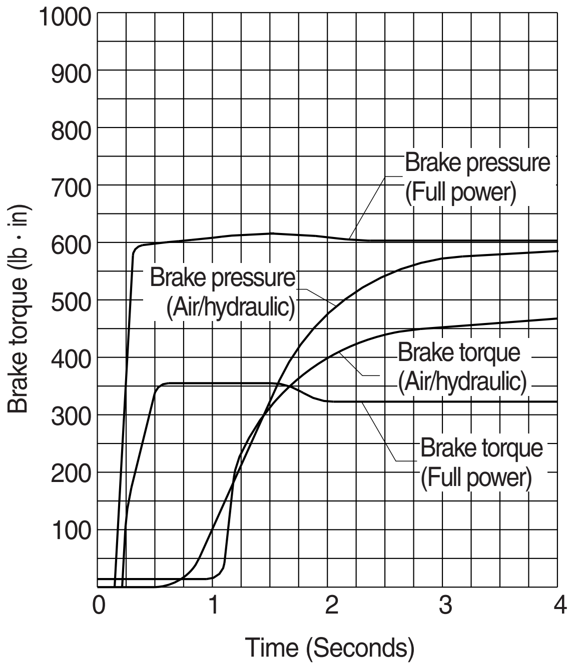
FULL POWER HYDRAULIC BRAKE SYSTEM

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.

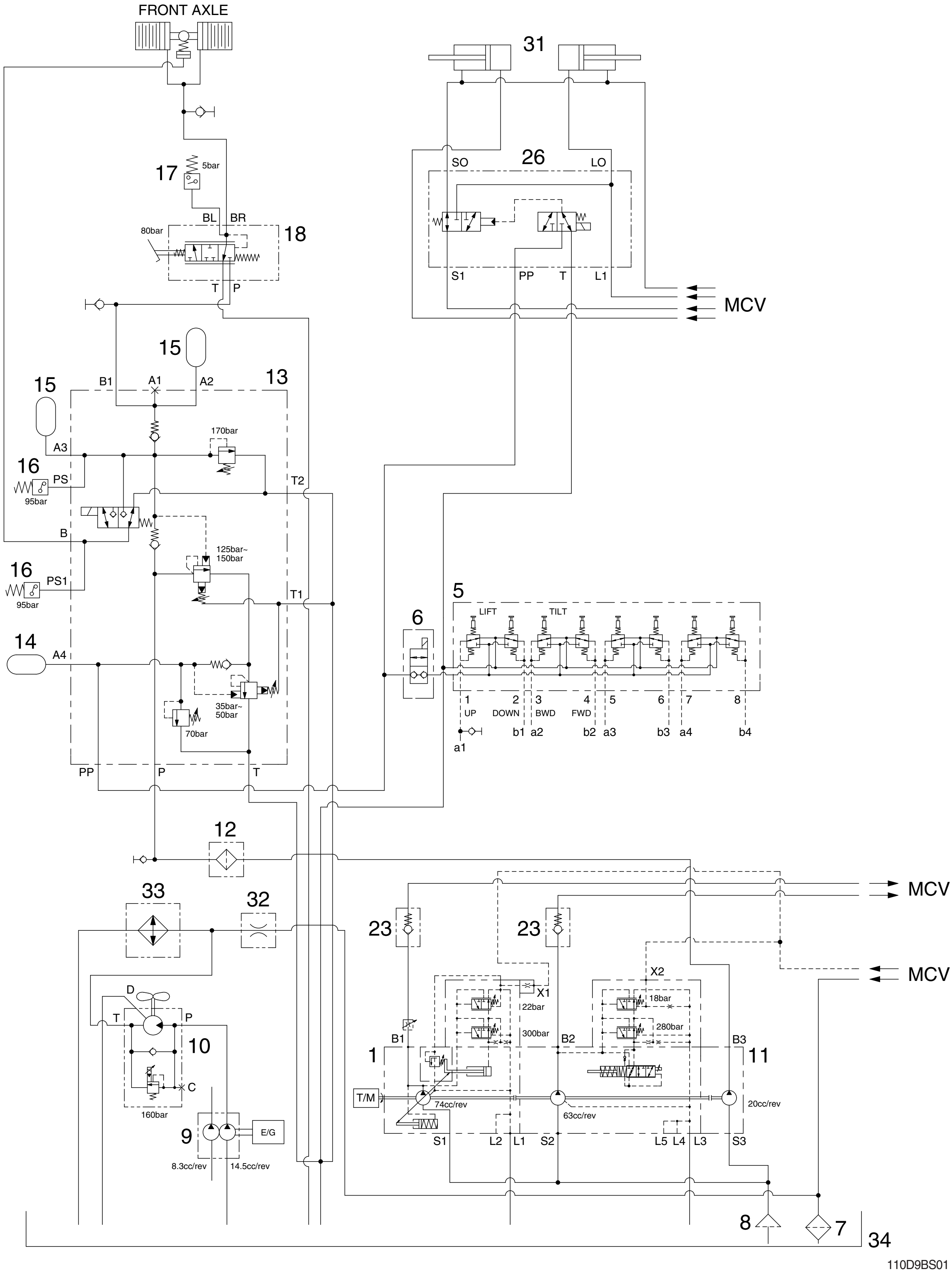
Full power systems can supply significantly higher brake pressures with relatively low reactive pedal forces. The reactive pedal force felt by the operator will be proportional to the brake line pressure being generated.
This is referred to as brake pressure modulation.
Another key design feature of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

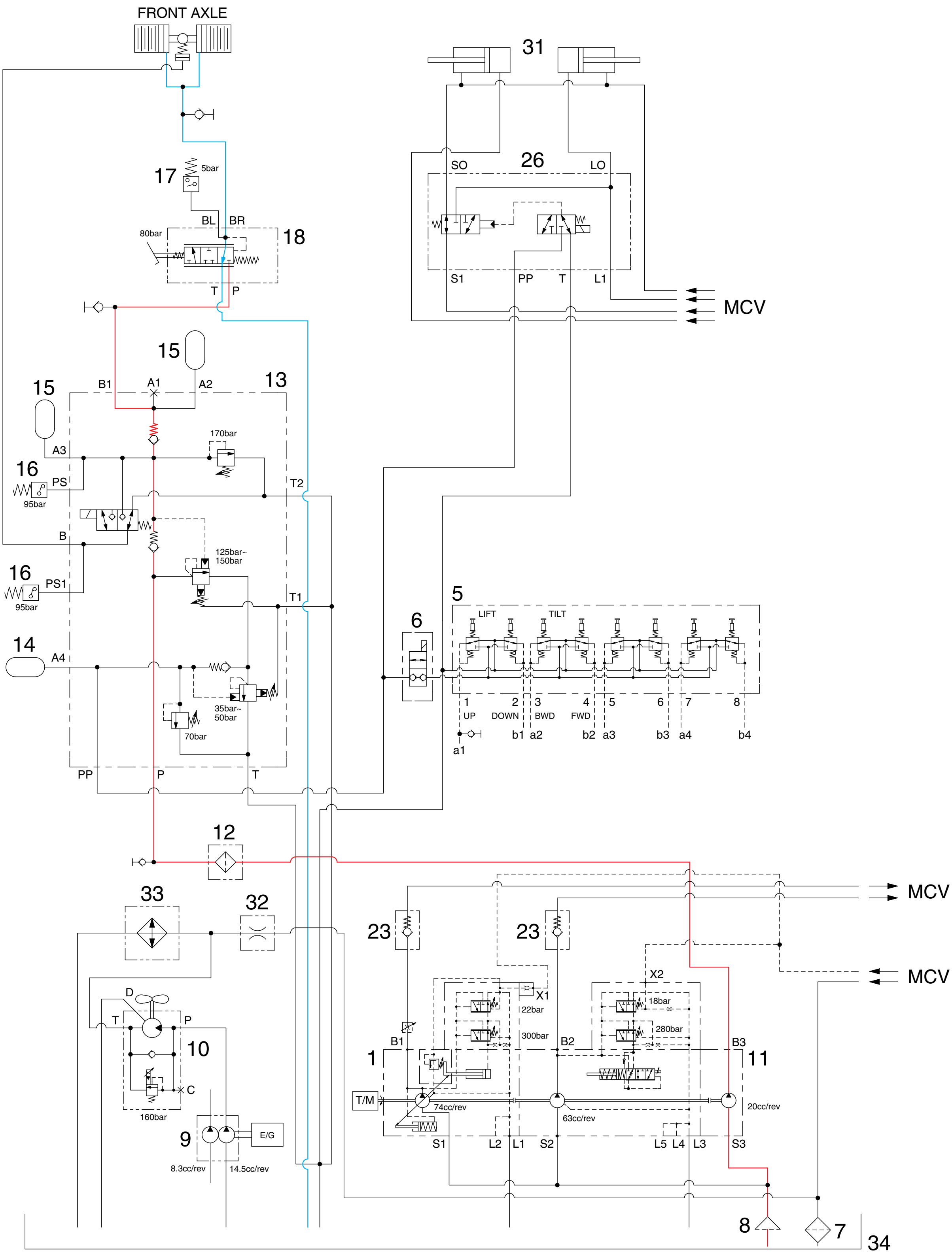


2. HYDRAULIC CIRCUIT



1 Main pump
5 RCV
6 OPSS solenoid valve
7 Return filter
8 Suction strainer
9 Fan drive pump
10 Fan drive motor
11 Brake pump
12 Line filter
13 Cut-off valve
14 Accumulator
15 Accumulator
16 Pressure switch
17 Pressure switch
18 Brake valve
26 Side shift solenoid valve (160D-9 only)
34 Hydraulic oil tank

1) SERVICE BRAKE RELEASED



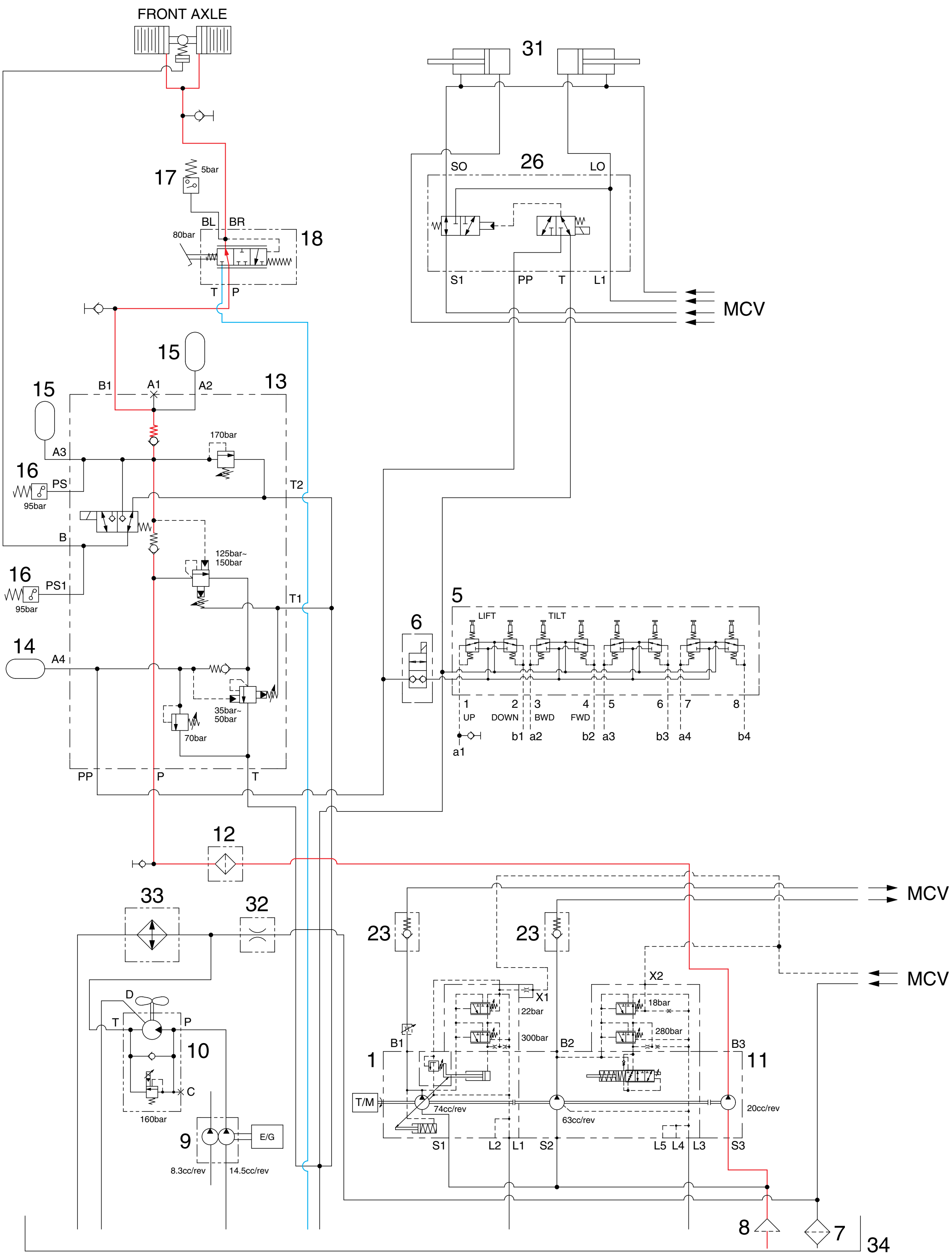
110D9BS02

When the pedal of brake valve (18) 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 (34).

Therefore, the service brake is kept released.

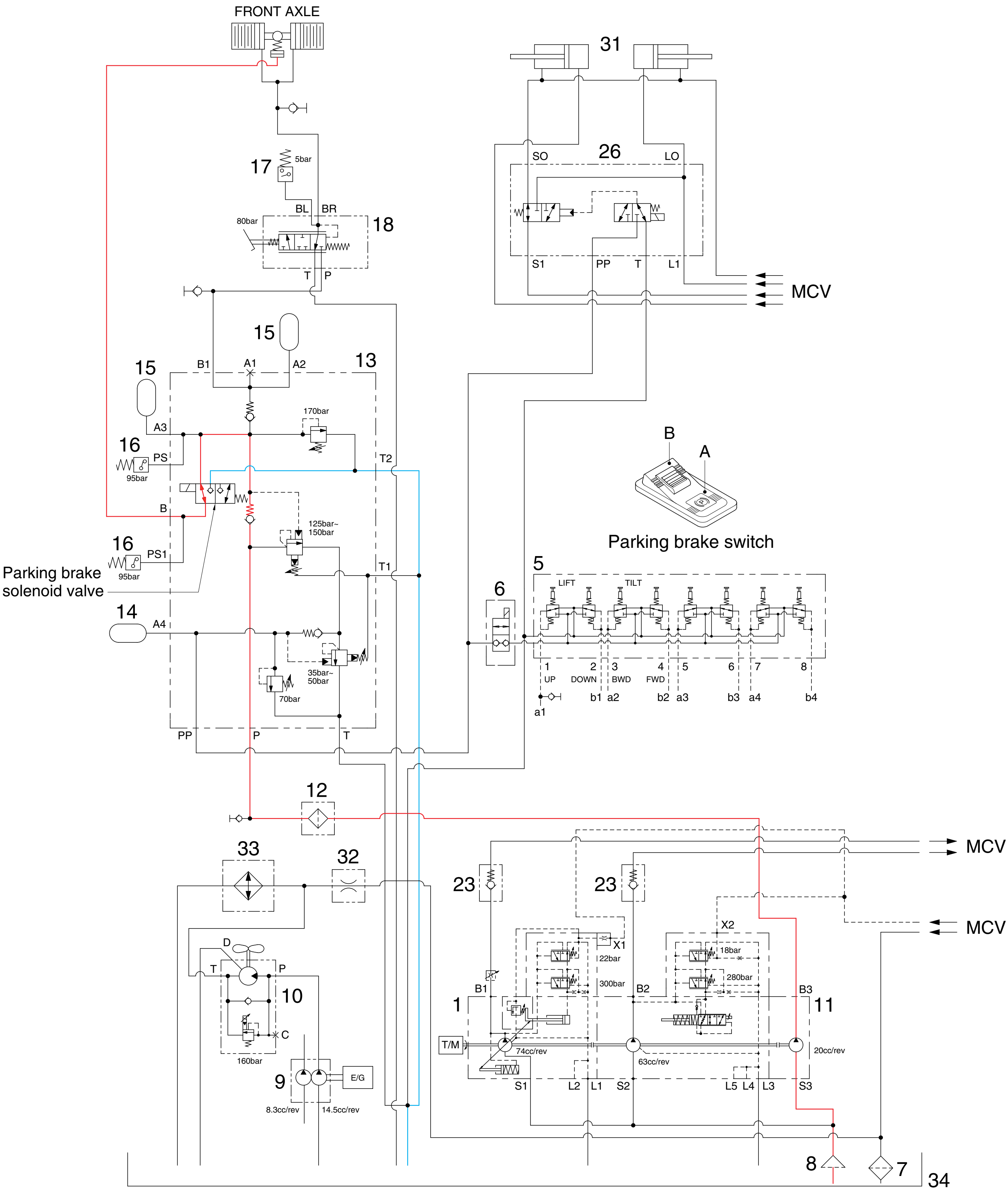
2) SERVICE BRAKE OPERATED



110D9BS03

When the pedal of brake valve (18) 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 (13) enters the piston in the drive axles. Therefore, the service brake is applied.

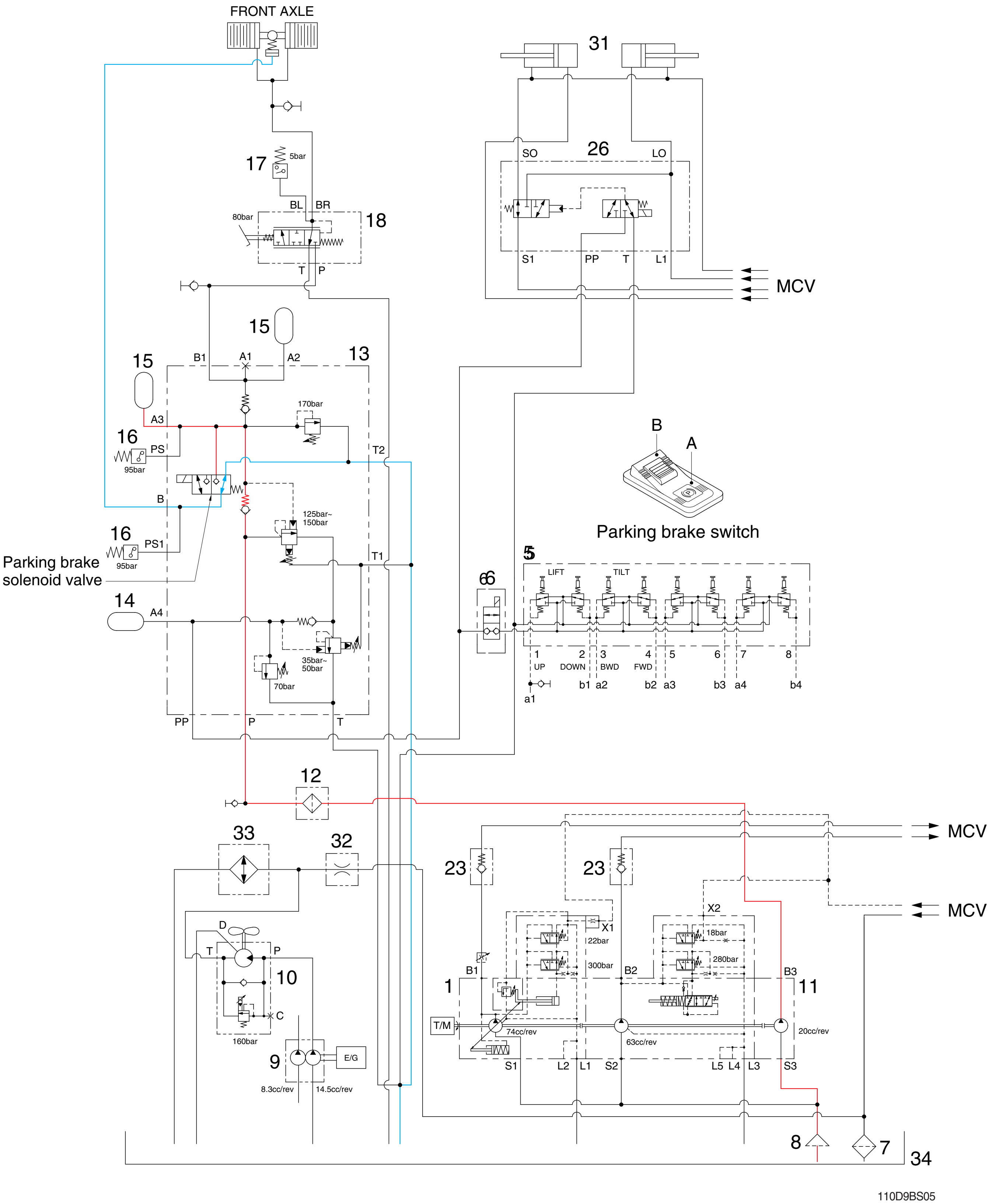
3) PARKING BRAKE RELEASED



110D9BS04

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 (13) 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

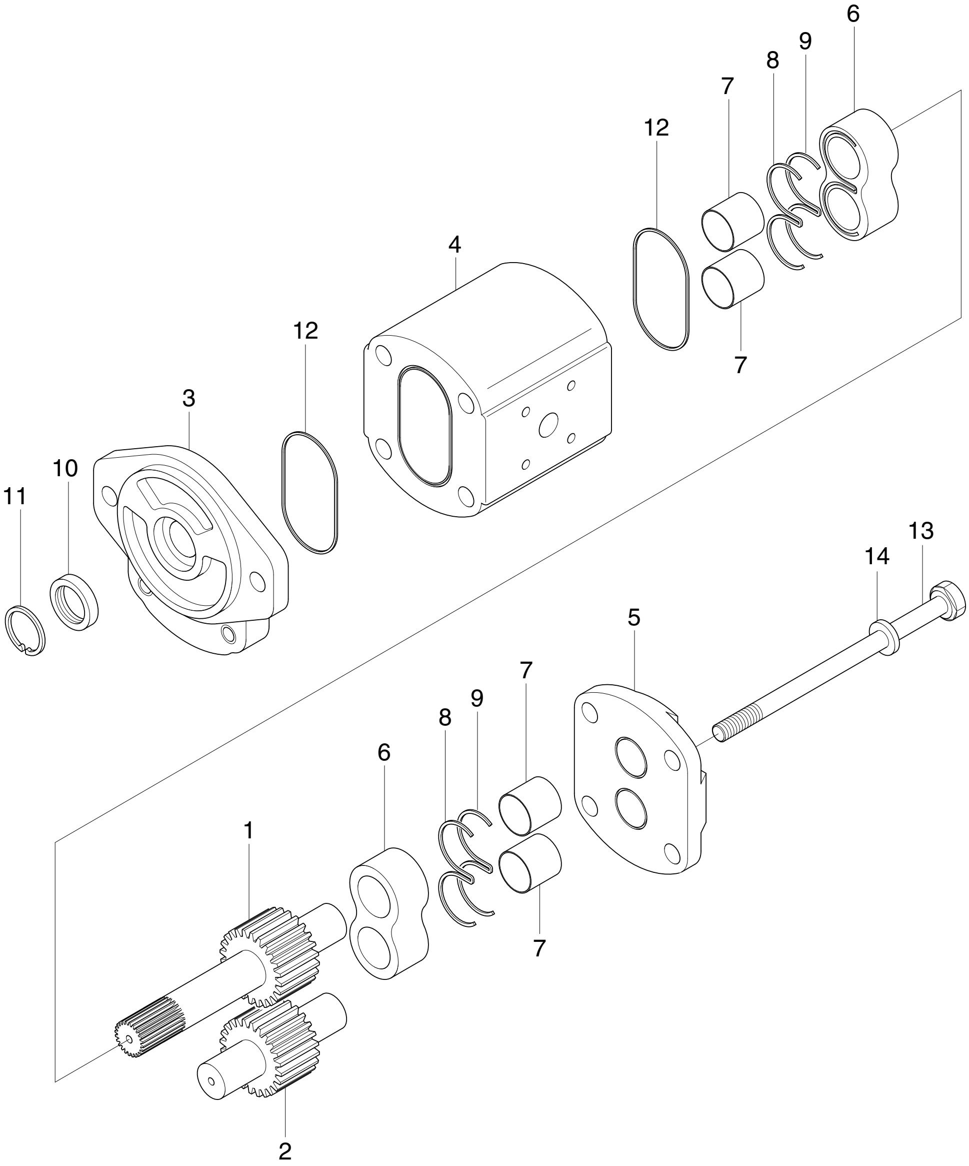


When the parking brake switch is pressed A position, the solenoid valve is deenergized and the valve open the drain port.

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

1) STRUCTURE



180D7EBS06

1	Shaft gear	8	Seal
2	Driven gear	9	Back up seal
3	Front cover	10	Retainer seal
4	Gear housing	11	Snap ring
5	Rear cover	12	O-ring
6	Bush block	13	Bolt
7	Bush	14	Spring washer

This gear pump have a maximum delivery pressure of 200 kgf/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.

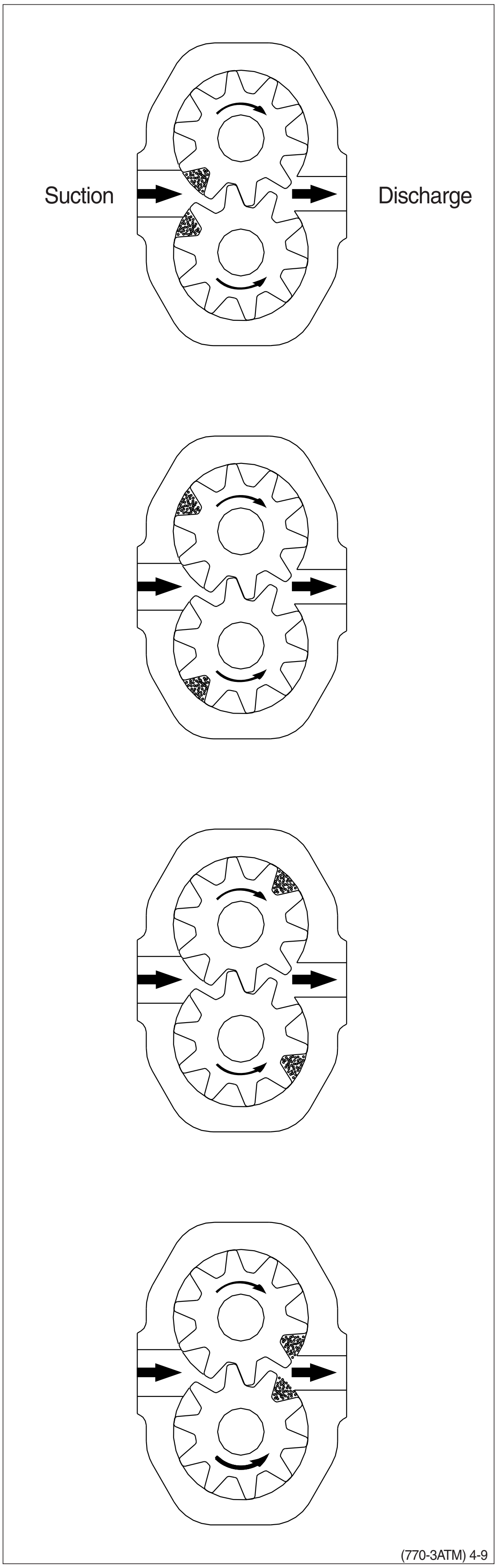
The amount of discharge increases with the speed of rotation of the gear.

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.



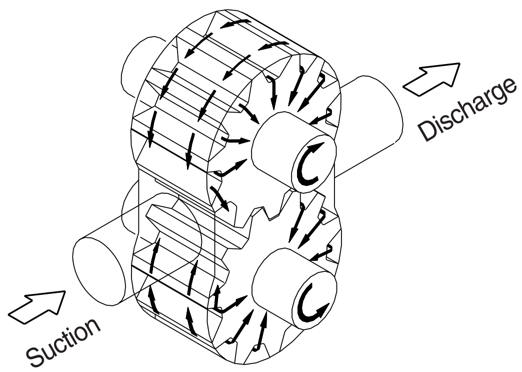
(2) Internal oil leakage

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.

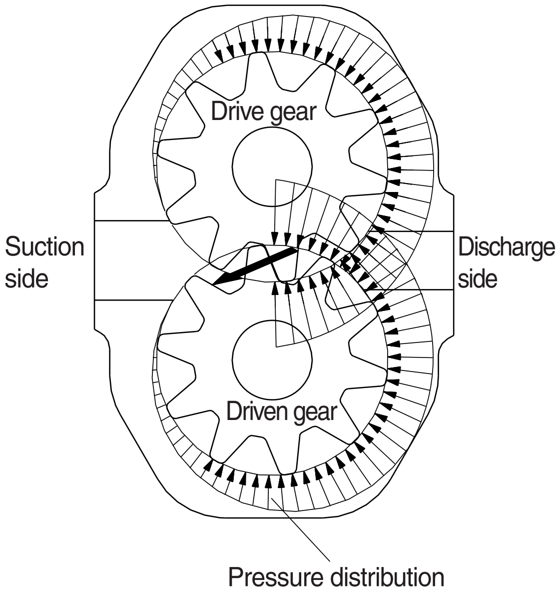
Due to the action of the delivery pressure, the oil pressure in higher on the delivery side of the pump, and due to suction pressure, is lower on the suction side. In the intermediate section, the pressure will gradually lower as the position moves from the delivery side to the suction side.

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.

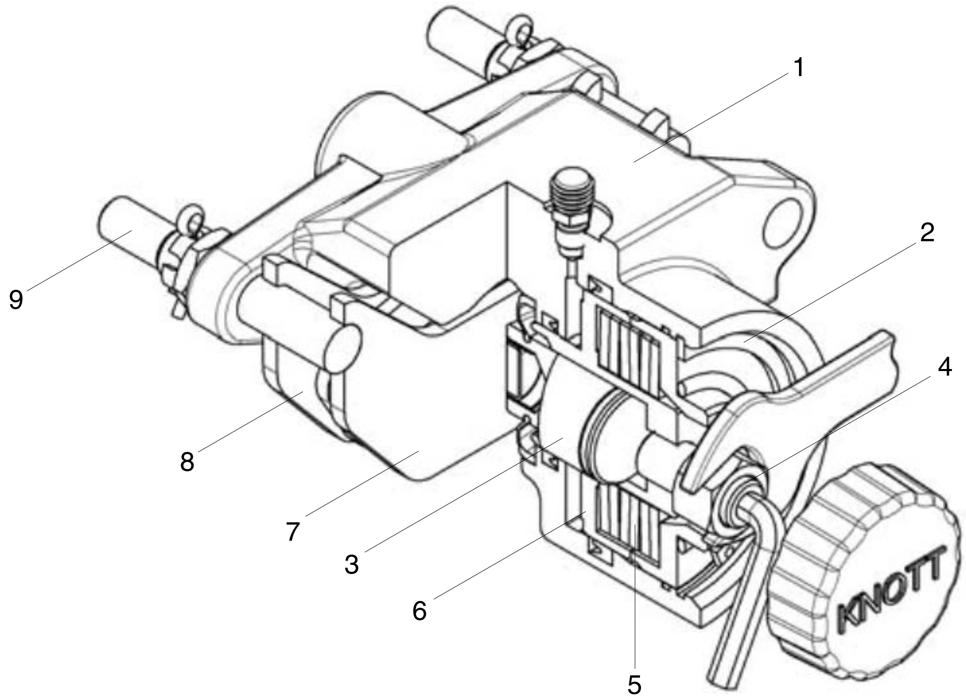
For this reason, an excessive increase in the delivery pressure must be avoided, since it will produce a large force which will act on the gears, placing an overload on the bearings, and resulting in a shortened service life of the bearing or interference of the gear with the case.



(770-3ATM) 4-11

4. PARKING BRAKE SYSTEM (KESSLER)

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.

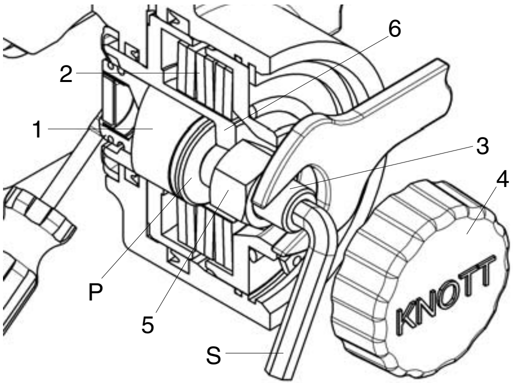
When the brake pad comes into contact with the brake disk, the reaction force shifts the housing onto the guide bolts until the brake pad is also pressed against the brake disk.

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.

Model	Adjusting screw	Clearance (mm)		Turns
110/130/160D-9	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.

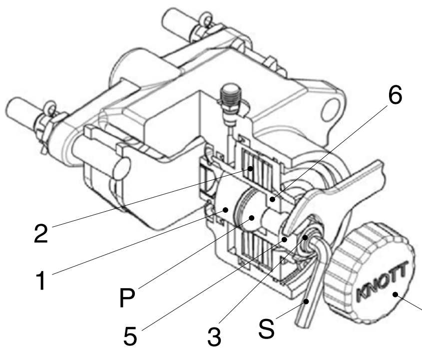
⑥ Hold the adjusting screw in position with the hexagonal socket wrench and lock with the lock nut.

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".**

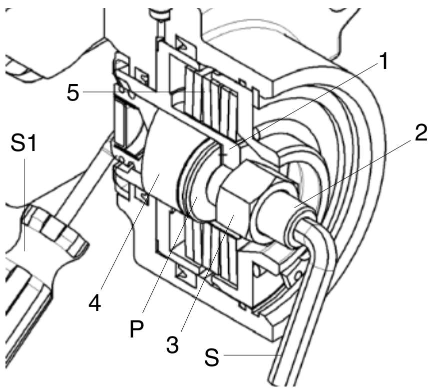
5) MAINTENANCE AND REPAIR WORK

(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).

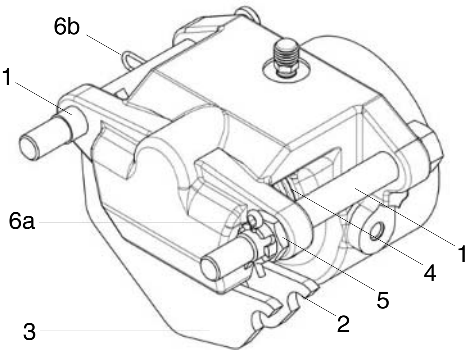


180D7EBS113

1	Piston	5	Bank of cup spring
2	Adjusting screw	S	Socket wrench
3	Lock nut	S1	Screwdriver
4	Thrust bolt	P	Inside of the piston

※ 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.**

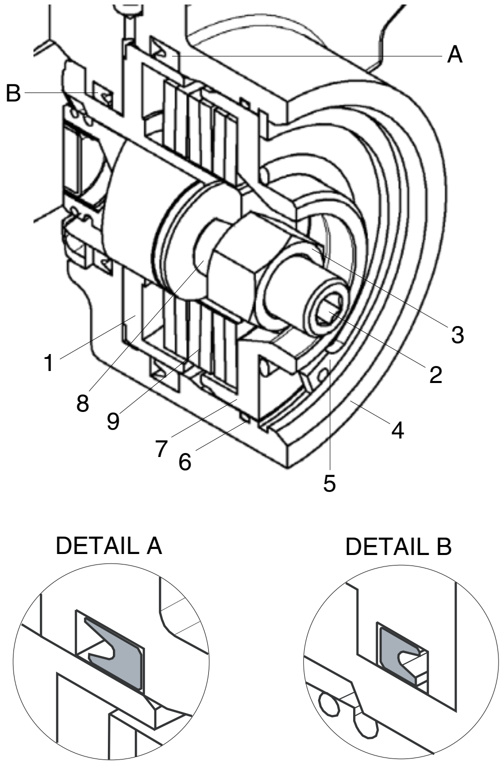
⑦ Exchange the brake pads and insert the guide bolts into the brake anchor plate. If you have removed the complete brake you have to amount the brake on both guide bolt again, now.

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.

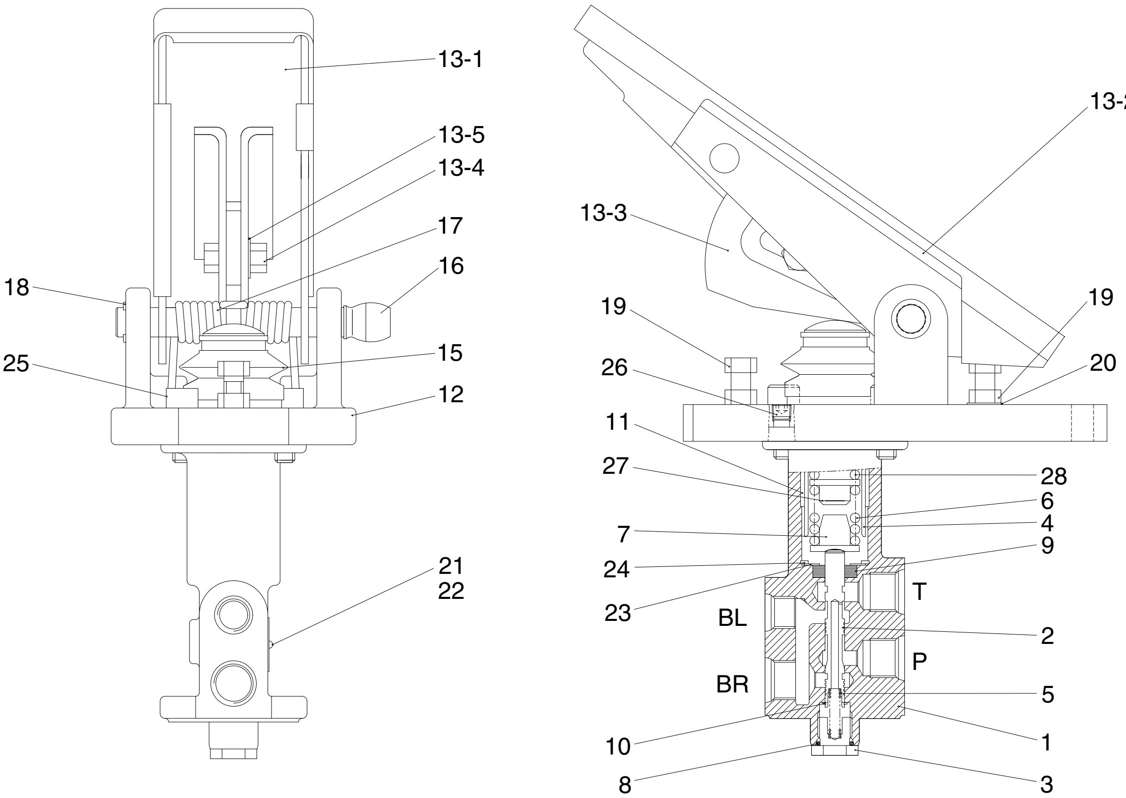
(2) General

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.

5. BRAKE VALVE

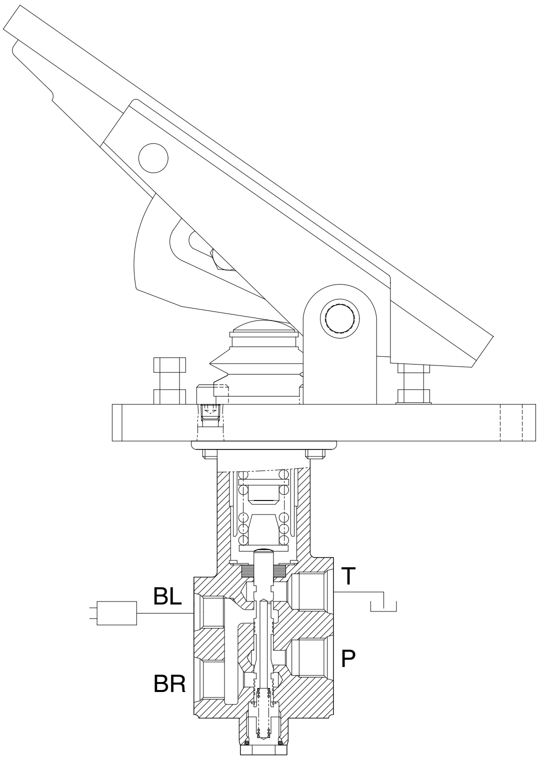
1) STRUCTURE

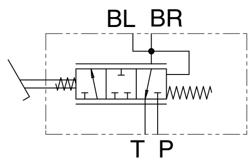


160D7ABS07

1	Body	12	Pedal plate	19	Hexagon bolt
2	Spool	13	Pedal assembly	20	Hexagon nut
3	Plug	13-1	Pedal	21	Name plate
4	Holder	13-2	Pedal rubber	22	Drive screw
5	Lower spring	13-3	Lock plate	23	Plain washer
6	Main spring 1	13-4	Hexagon bolt	24	Snap ring
7	Spring retainer 1	13-5	Plate washer	25	Socket bolt
8	O-ring	15	Bellows	26	Taper plug
9	Oil seal	16	Lock pin 1	27	Spring retainer 2 (DIC axle)
10	Snap ring	17	Torsion spring	28	Main spring 2 (DIC axle)
11	DU bushing	18	Snap ring		

2) OPERATION





Hydraulic circuit

Port	Port name	Port size
P	Main pressure port	PF3/8
T	Drain port	PF3/8
BR	Brake cylinder port	PF3/8
BL	Pressure switch port	PF1/4

160D7ABS08

(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

A connection is established between ports (BR) and ports (T) so that the wheel brakes ports (BR) are pressureless via the returns ports (T).

(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 main spring (6) beneath pedal plate (12) 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 spool (2) is mechanically actuated via main spring (6). As spool (2) move downward, they will first close returns (T) via the control edges, thus establishing a connection between accumulator ports (P) and ports (BR) for the wheel brake cylinders. The foot force applied now determines the output braking pressure. The control spool (2) is held in the control position by the force applied (Spring assembly above the spool).
After output of the braking pressure, spool (2) is in a partial braking position, causing ports (P) and ports (T) to close and holding the pressure in ports (BR).

(4) Full braking position

When pedal is fully actuated, end position of the brakes is reached and a connection established between accumulator ports (P) and brake cylinder ports (BR). Returns (T) are closed at this point.

When the braking process is ended, a connection is once again established between brake cylinder ports (BR) and return ports (T), closing accumulator ports (P).

(5) Limiting the braking pressure

Pedal restriction bolt (19) on base plate below pedal is used to limit the braking pressure.

(6) Installation requirements

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

(7) 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.**

(8) 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.

(9) Replacing the pedal cover

Pedal cover (13-2) is simply pulled of by hand. The new pedal cover is pushed over pedal (13-1) and tightened manually. Fasten the bellows with the strap retainers.

(10) 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 main spring (6) does not fall out. When installing the new actuating mechanism, make sure that main spring (6) is fitted in the right order.

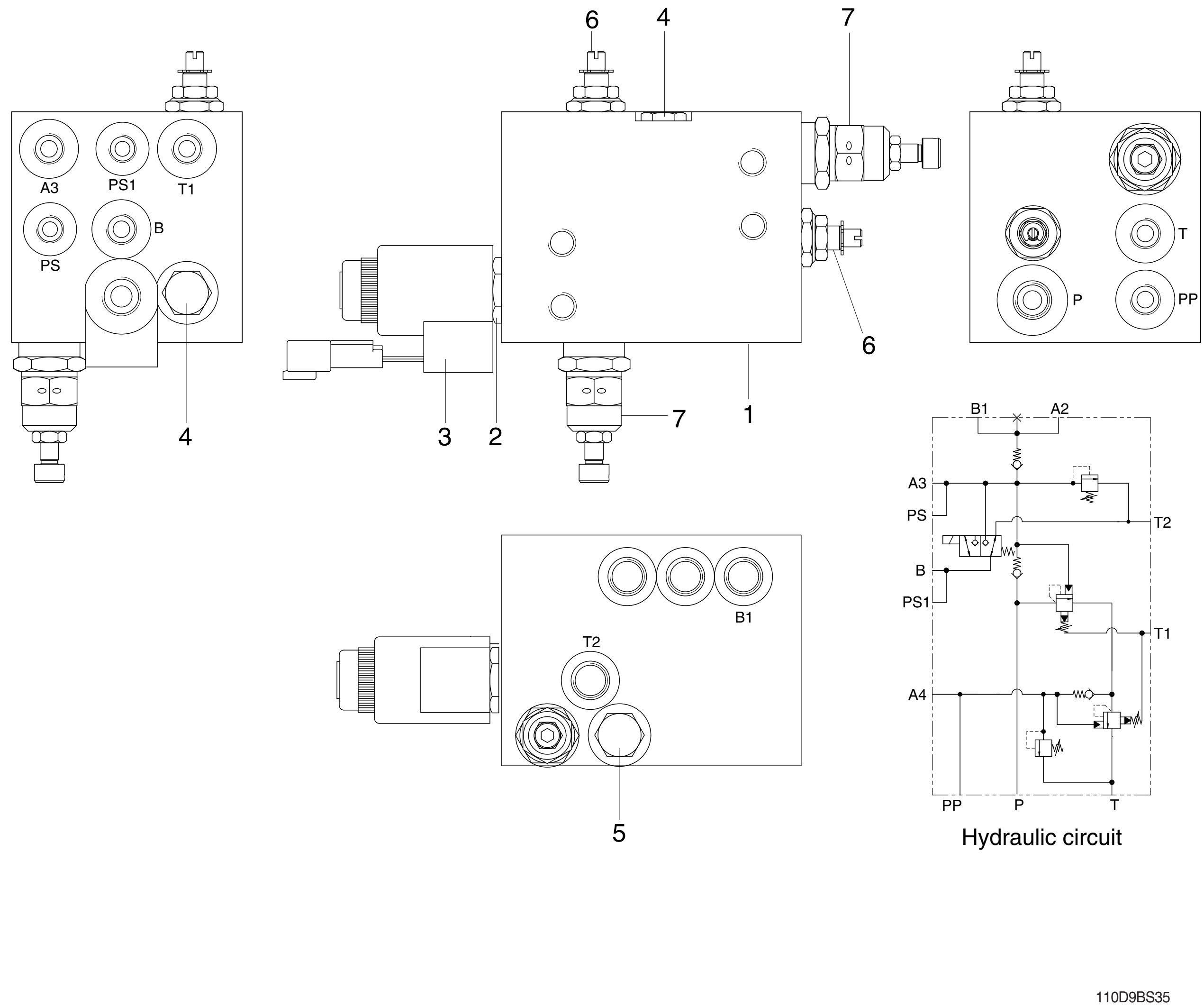
(11) Replacing the bellows

To change bellows (15) it is advisable to remove pedal (13). For this purpose, loosen retaining ring (18) and knock out pin 1 (16) 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 (13) and bellows (15).

Now fit the new bellows and proceed in reverse order as described above. The upper portion of bellows is fastened to piston (4), its lower portion to pedal plate (12) secure the bellows using clamps.

6. CUT-OFF VALVE

1) STRUCTURE



1	Manifold	5	Check valve
2	Solenoid valve	6	Cut-off valve
3	Coil	7	Relief valve
4	Check 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.

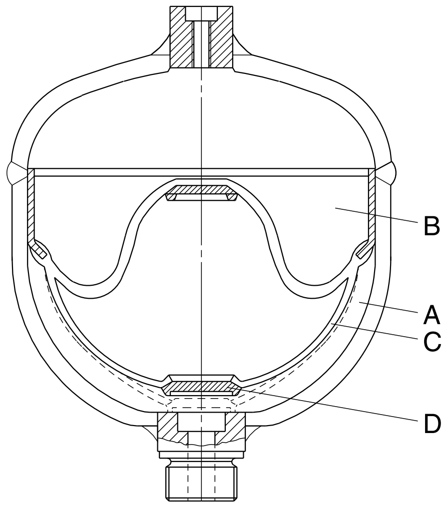
As the pressure on P line rises to 150 bar, the cut off valve (6) starts cut-offing and the oil in the P port is unloaded. The pressure on P line goes down 120 bar by the minute leakage from valve and other factors.

At this pressure, the cut-off valve starts cuting.

This process is repeated in the regular period of 30~40 seconds.

7. BRAKE ACCUMULATOR

1) STRUCTURE



110D9BA01

Item	81L1-0003	31E3-3187
Diameter	138 mm	90 mm
Mounting height	187 mm	140 mm
Nominal volume	1.0 l	0.35 l
Priming pressure	50 kgf/cm^2	15 kgf/cm^2
Operating medium	Oil	Oil
Operating pressure	Max 150 kgf/cm^2	Max 170 kgf/cm^2
Thread	M22 $\times$ 1.5	PF1/2
Priming gas	Nitrogen	Nitrogen

A Fluid portion C Diaphragm
B Gas portion 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

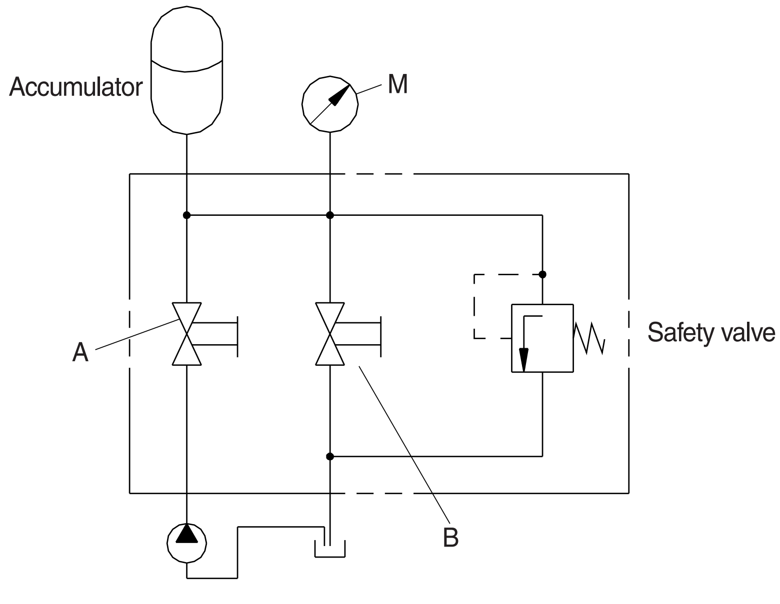
Before the accumulator is scrapped, its gas filling pressure must be reduced. For this purpose, drill a hole through gas chamber(B) using a drill approx. 3mm in diameter. The gas chamber is located on the side opposite the threaded port above the welding seam around the center of the accumulator.

※ 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.



(770-3ATM) 4-23

(7) Repair work

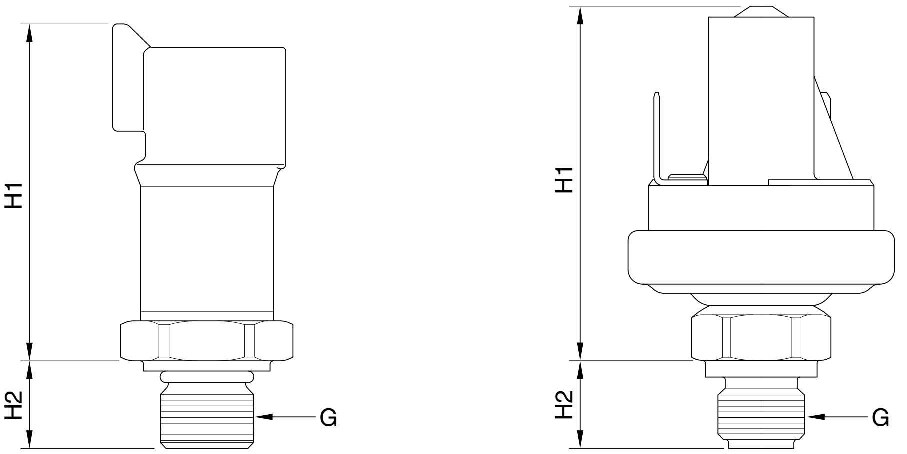
△ When working on the braking system, always make sure that there is absolutely no pressure in the system. Even when the engine in switched off there will be some residual pressure in the system.

※ 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.

8. PRESSURE SWITCHES

1) STRUCTURE



Parking and charging

Brake stop

110D9BS20

· Technical data

Item	Type	Medium	G	H1 mm	H2 mm	Adjusting range kgf/cm^2	Adjusting pressure kgf/cm^2	Voltage V
Parking	NC	Oil	PF 1/4	49.4	12.5	50 ~ 150	95 $\pm$ 5	Max 42
Charging	NC	Oil	PF 1/4	49.4	12.5	50 ~ 150	95 $\pm$ 5	Max 42
Brake stop	NO	Oil	PF 1/4	-	-	1~10	5 $\pm$ 1	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.**

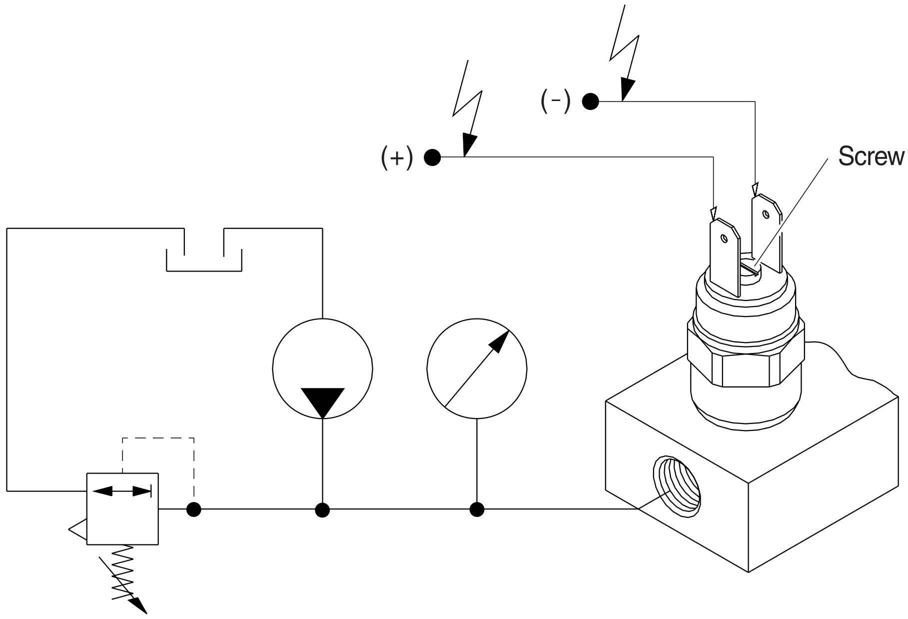
※ When doing repair work, make sure your environment is very clean.
Immediately close all open ports on the components and on pipes using plugs.

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

(7) Adjusting and testing pressure switch

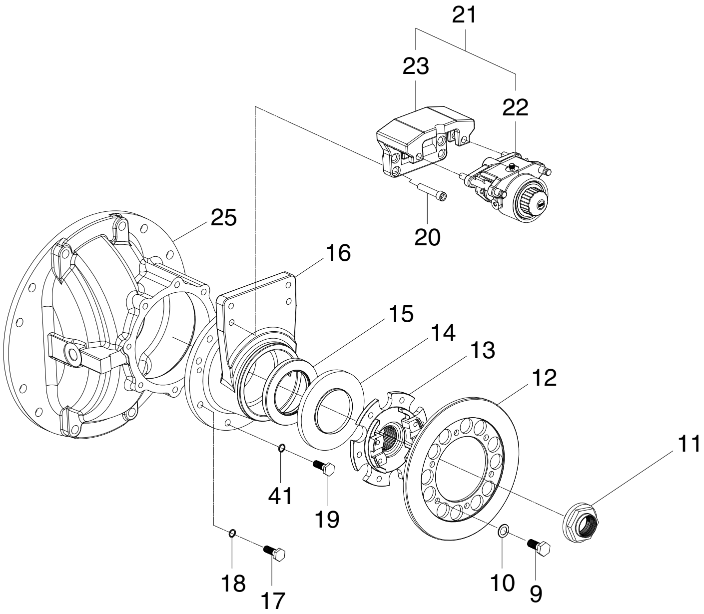
The adjusting screw located between the two contact plugs can be set to the desired value within a certain range. For adjusting range, please refer to the table **Technical data** on the previous page.

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



(770-3ATM) 4-25

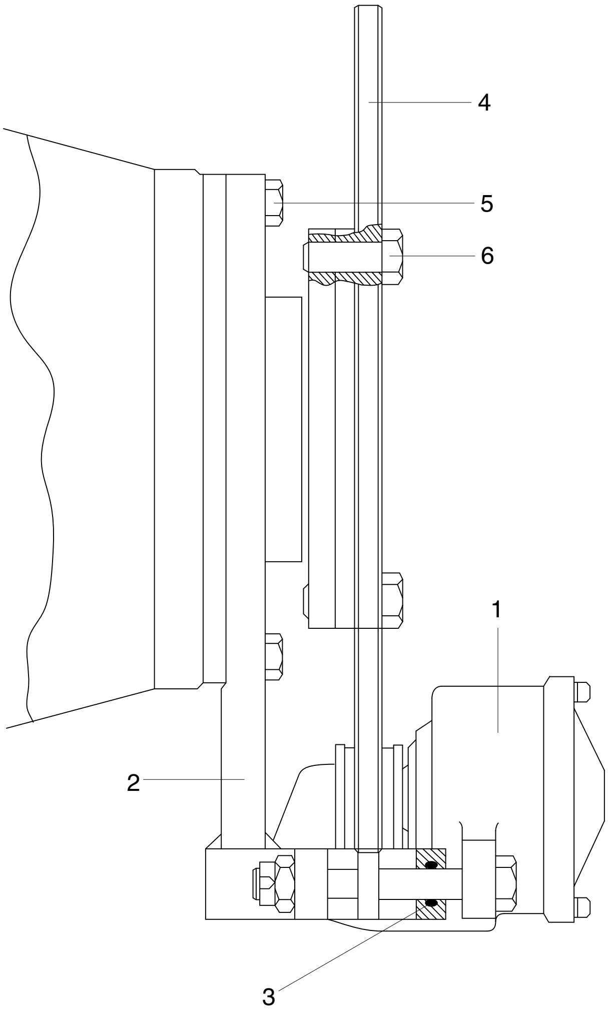
8. PARKING BRAKE (DIC)



110D9DA01

9	Hexagon bolt	18	Washer
10	Washer	19	Hexagon bolt
11	Lock nut	20	Socket bolt
12	Parking disc	21	Parking brake assy
13	Yoke	22	Parking brake
14	Dust cover	23	Parking brake support
15	Oil seal	25	Differential carrier
16	Differential flange	41	Washer
17	Hexagon bolt		

PARKING BRAKE (KESSLER)



100D7BS109

1	Brake	4	Brake disk
2	Brake carrier	5	Hexagon screw
3	O-ring	6	Hexagon screw

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.

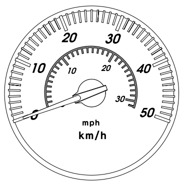
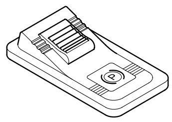
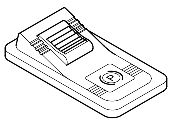
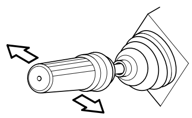
The engine and all other major components must be at operating temperature for some checks.

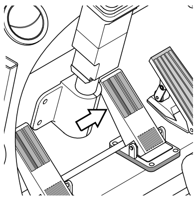
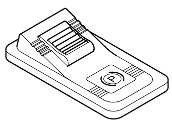
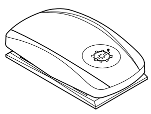
Locate system check in the left column and read completely, following the sequence from left to right.
Read each check completely before performing.

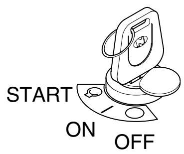
At the end of each check, if no problem is found (OK), that check is complete or an additional check is needed. If problem is indicated (NOT OK), you will be given repair required and group location.
If verification is needed, you will be given next best source of information:

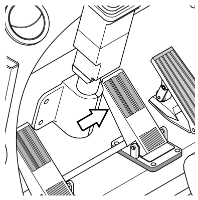
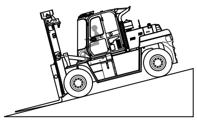
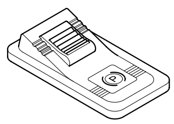
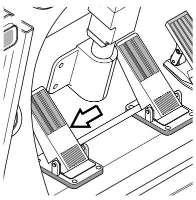
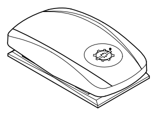
Chapter 2 : Troubleshooting
Group 3 : Tests and adjustments

※ Hydraulic oil must be at operating temperature for these checks.

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 10 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.
Service brake capacity check Engine running.	 	Turn inching 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.

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 over 20 times of 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. NOT OK If light comes on with engine running, accumulator has lost it's charge. Inspect and recharge accumulator.
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 fork 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.	**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.
Inching check	  Place inching switch in ON position. Release parking brake. Run engine at half speed in 1st forward. Depress inching pedal until machine stops with left foot. At this pedal angle, put on right foot on the brake pedal not to release. Release inching pedal. **LOOK** : Machine must move.	**OK** Check completed. **NOT OK** Check inching sensor output voltage.

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 Malfunctioning parking brake solenoid Worn brake disk and / or brake pads Brake piston hangs up in bore	Adjust parking brake. Inspect and replace. Disassemble, inspect, repair. Remove and inspect. Repair.
Brake disk overheats	Pads out of adjustment Brake not released	Adjust parking brake. 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 Malfunctioning wiring, switch, or solenoid Restriction between brake valve and brake	Adjust parking brake. Check electric circuit. Remove hose and inspect. Replace.

GROUP 3 TESTS AND ADJUSTMENTS

1. PARKING BRAKE PERFORMANCE

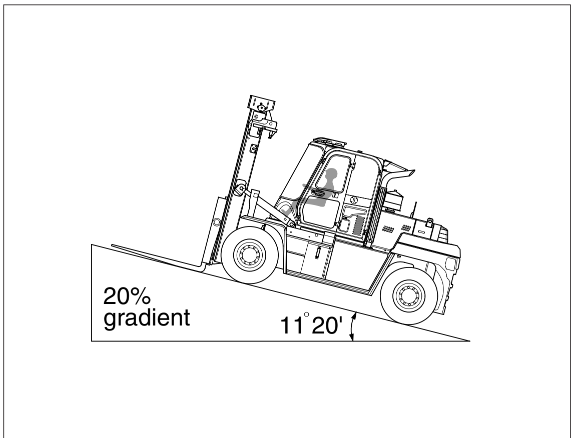
1) MEASUREMENT CONDITION

(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 value
Parking brake performance	Keep machine on 20% (11˚20') gradient



110D9BS33

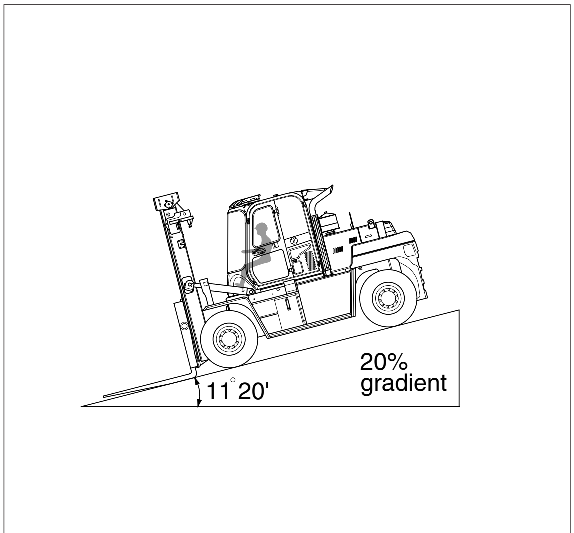
2) MEASURING PROCEDURE

(1) Start the engine and drive the machine straight up a 1/5 gradient with the fork 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.

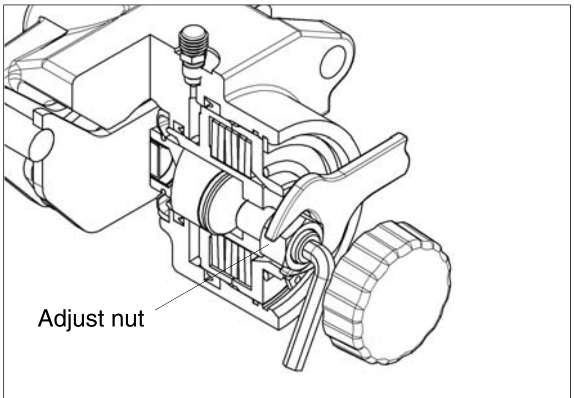


110D9BS32

2. ADJUSTMENT OF BRAKE

1) EXTERNAL BRAKE INSPECTION (KESSLER)

· Inspect for wear of brake pad.



110DEBS39

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.

Model	Adjusting screw	Clearance (mm)		Turns
110D-9 130D-9 160D-9	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.

3. HYDRAULIC BRAKE BLEEDING PROCEDURE

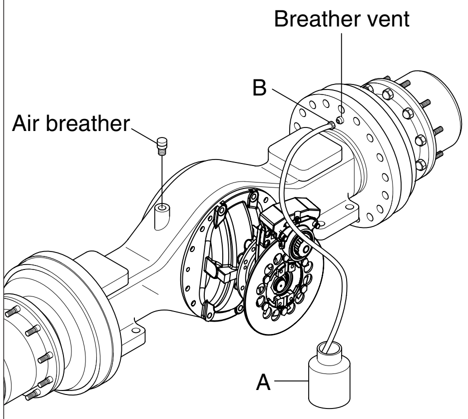
⚠ Escaping fluid under pressure can penetrate the skin causing serious injury. Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Search for leaks with a piece of cardboard. Protect hands and body from high pressure fluids.

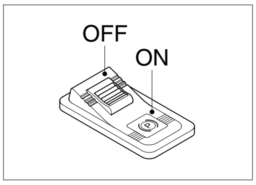
※ If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source. Two people are required to bleed brake system oil, one to operate brake valve and other to open and close bleed screws.

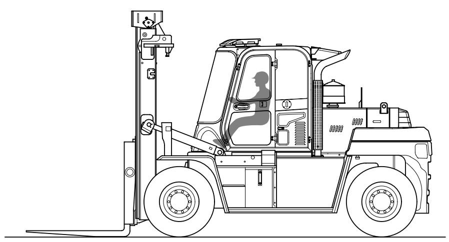
1) Engage parking brake and block the tire.
2) Put a clear plastic tube on bleed screw (B) to route low to hydraulic reservoir filler tube or container (A).
3) Start engine and run at low idle.
4) Push and hold brake pedal down until brake bleeding procedure is complete.

※ 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.





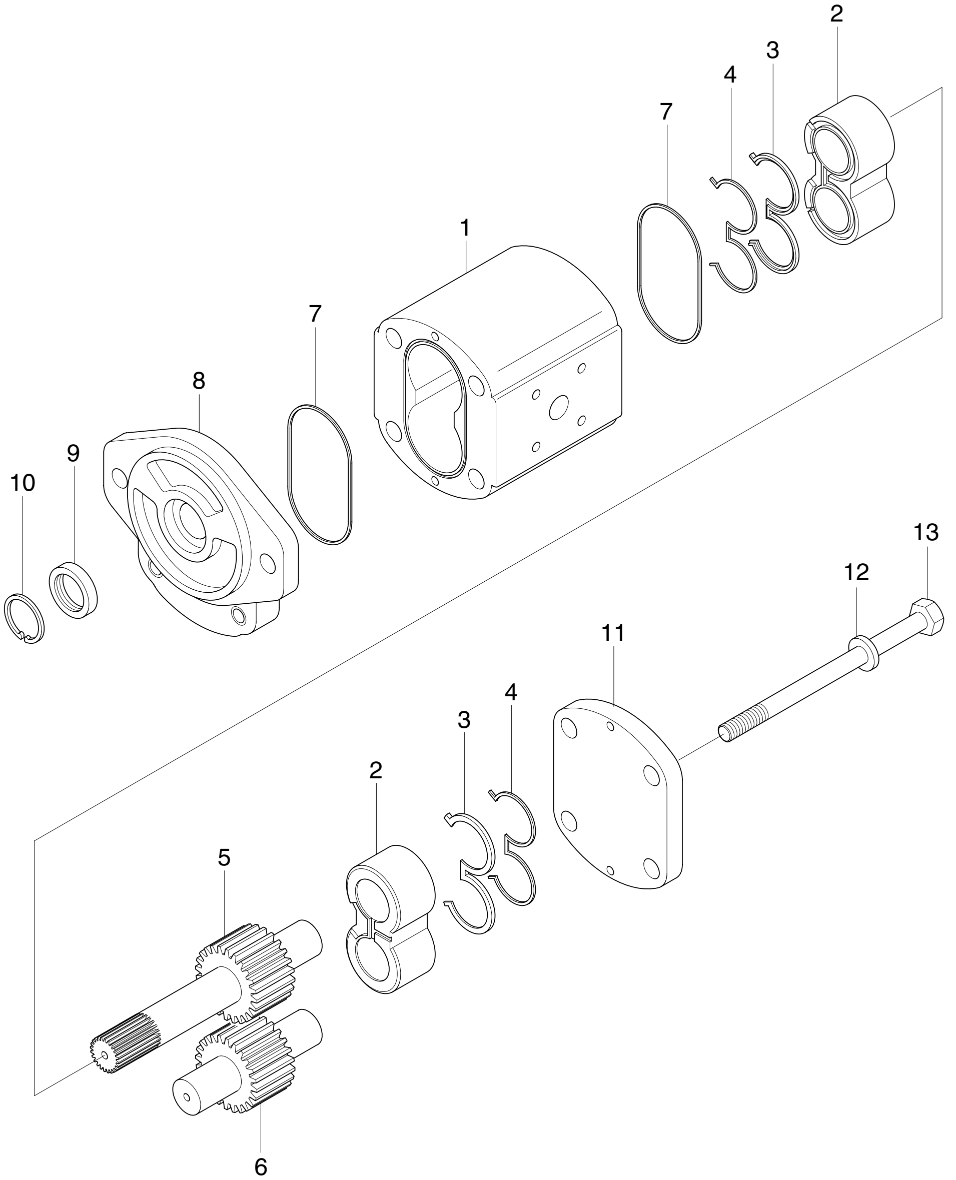


110D9BS40

GROUP 4 DISASSEMBLY AND ASSEMBLY

1. BRAKE PUMP

1) STRUCTURE



180D7EBP00

1	Housing	8	Front cover
2	Bush block	9	Retainer seal
3	Backup seal	10	Snap ring
4	Channel seal	11	Rear cover
5	Shaft gear	12	Washer
6	Driven gear	13	Bolt
7	O-ring		

2) GENERAL INSTRUCTION

(1) Always work in a clean environment.

(2) Wash all components in solvent and blow dry with compressed air before refitting.

(3) Take care not to damage rubber seals.

(4) Avoid damaging precision machined surfaces.

(5) Components should fit into their housings without excessive force. If force is necessary, this normally means that the component does not have the correct dimensional tolerances of is aligned incorrectly.

(6) When hand pressure is insufficient, only use presses or rubber hammer to fit components.

(7) Never strike components with steel hammers.

(8) Steel bush must be fitted only with a suitable press.

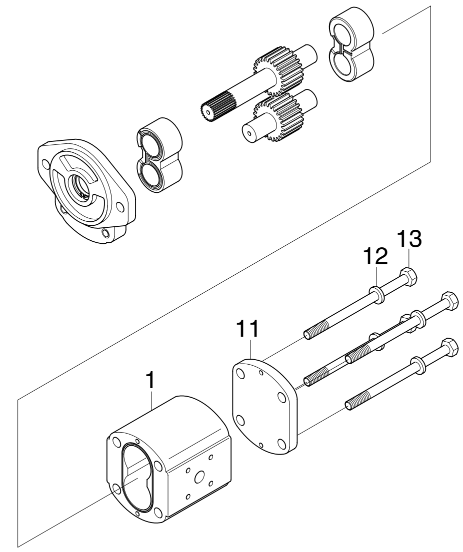
(9) Do not use hammers to fit bearings.

(10) Always respect the direction of rotation when assembling components.

3) DISASSEMBLY

(1) Loosen and remove the bolts (13) with washers (12) from the rear cover (11).

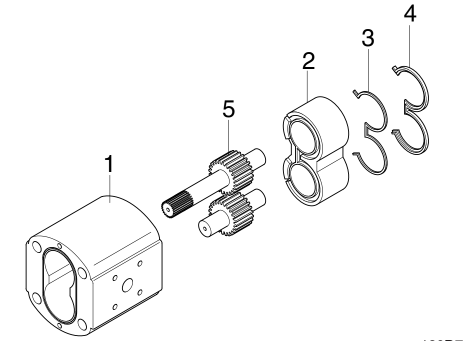
(2) Remove the rear cover (11) from the housing (1).



180D7EBP06

(3) Disassemble the channel seal (4), back up seal (3) and bush block (2), from the housing (1).

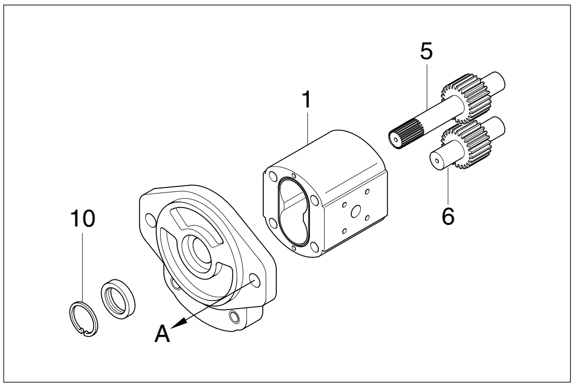
※ After removing the bush block (2) from the housing (1), clean the contacting surface of the bush block (2) with the journal of the shaft gear (5) and the drive gear (1), inspect for excessive wear, scoring or crack.



180D7EBP21

(4) After removing the snap ring (10), take out the shaft gear (5) and the drive gear (6) from the housing (1).

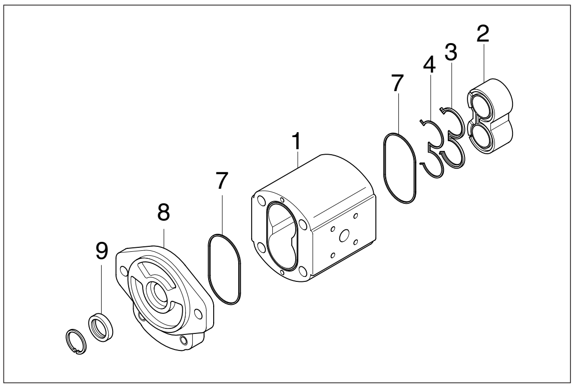
※ For the gear face of the shaft gear (5) and the driven gear (6), inspect for excessive wear, scoring or crack.



180D7EBP51

(5) Remove bush block (2), back up seal (3), channel seal (4) and O-ring (7) from the housing (1).

※ After removing the bush block (2) from the housing (1), inspect whether it is happened scratch or damage for inner surface of the housing (1).



180D7EBP52

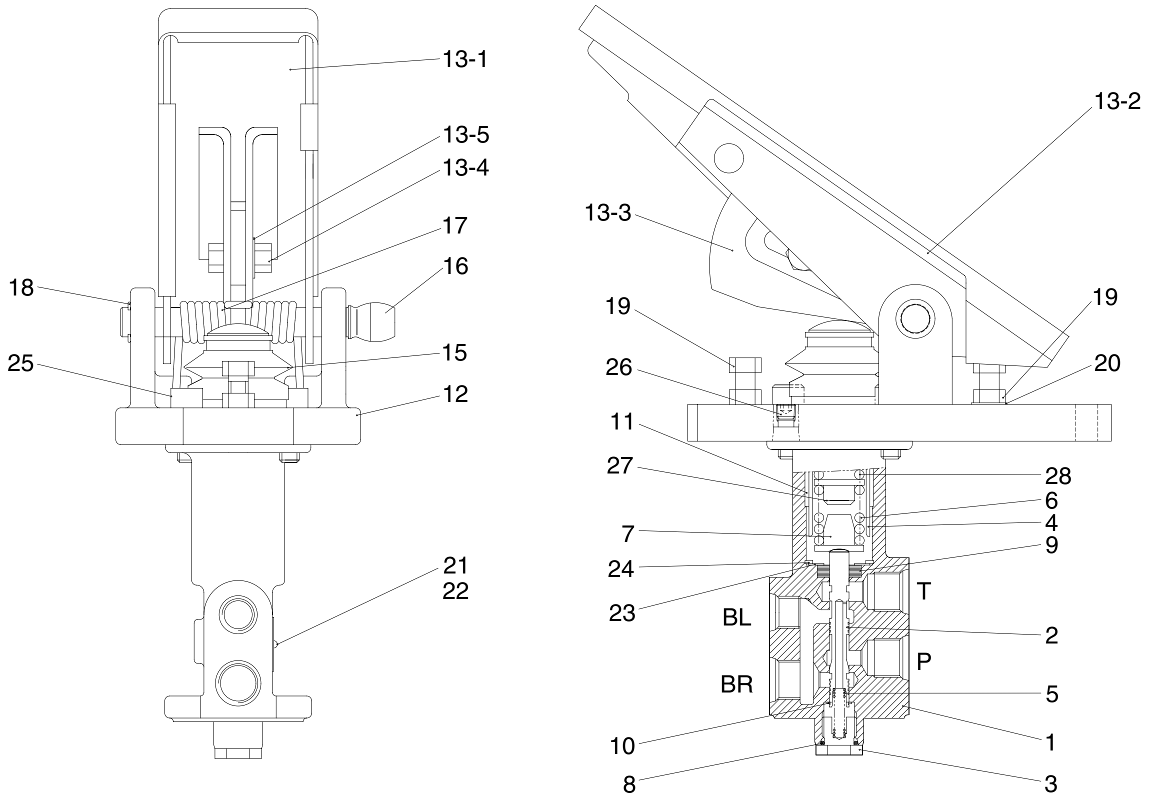
(6) Remove the retainer seal (9) from the front cover (8).

4) ASSEMBLY

Assembly procedure of the pump is the reverse order of the disassembly procedure.

2. BRAKE VALVE

1) STRUCTURE



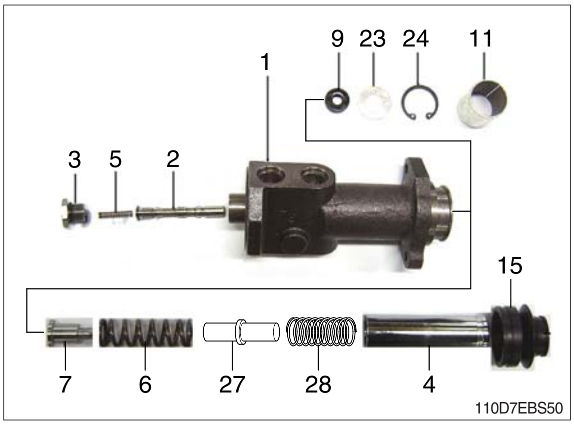
160D7ABS07

1	Body	12	Pedal plate	19	Hexagon bolt
2	Spool	13	Pedal assembly	20	Hexagon nut
3	Plug	13-1	Pedal	21	Name plate
4	Holder	13-2	Pedal rubber	22	Drive screw
5	Lower spring	13-3	Lock plate	23	Plain washer
6	Main spring 1	13-4	Hexagon bolt	24	Snap ring
7	Spring retainer 1	13-5	Plate washer	25	Socket bolt
8	O-ring	15	Bellows	26	Taper plug
9	Oil seal	16	Lock pin 1	27	Spring retainer 2 (DIC axle)
10	Snap ring	17	Torsion spring	28	Main spring 2 (DIC axle)
11	DU bushing	18	Snap ring		

2) REASSEMBLY

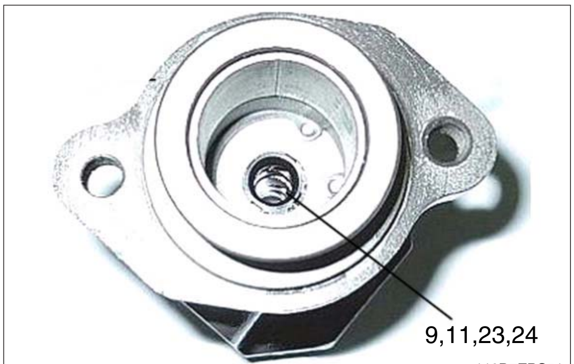
(1) Body assembly

1	Body
2	Spool
3	Plug
4	Holder
5	Spring
6	Main spring 1
7	Spring retainer 1
9	Oil seal
11	DU bushing
15	Rubber cover
23	Plain washer
24	Stop ring
27	Spring retainer 2 (DIC axle)
28	Main spring 2 (DIC axle)



110D7EBS50

① Install oil seal (9), plain washer (23), stop ring (24), DU bushing (11).
- Tool : Jig for dry bearing, snap ring plier.



110D7EBS51

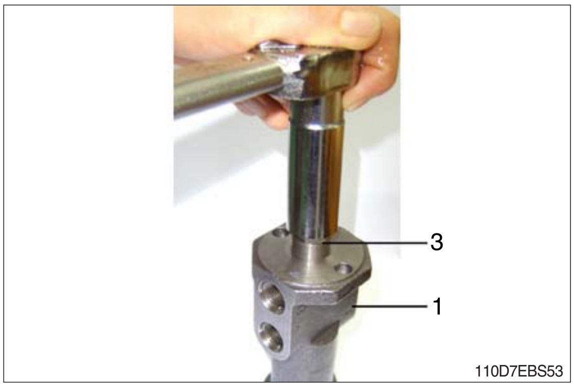
② Install spool (2) into body (1).

110D7EBS52

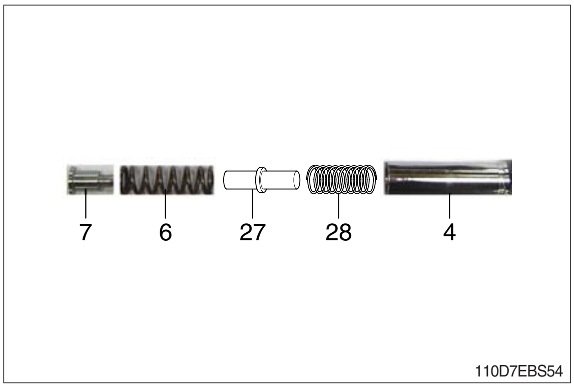
③ Tighten plug (3)
- Tool : 19mm spanner
- Tightening torque : 14.0~16.5 kgf · m

⚠ Press-in the DU bushing (11) with a exclusive jig.

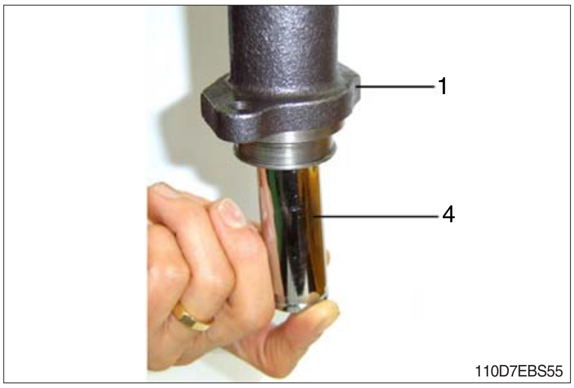
⚠ Be careful of dust and scrap after washing the parts.



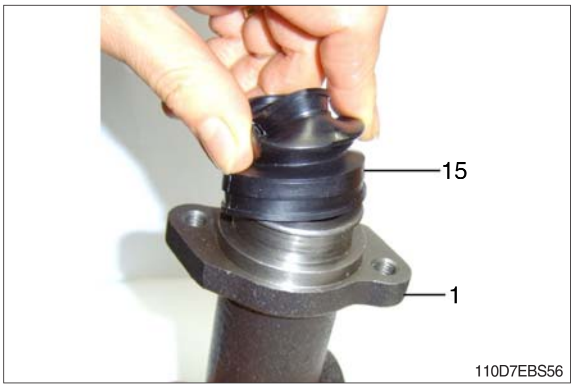
④ Spring retainer (7, 28), main spring (6, 28) and holder (4).



⑤ Holder (4) → Body (1)

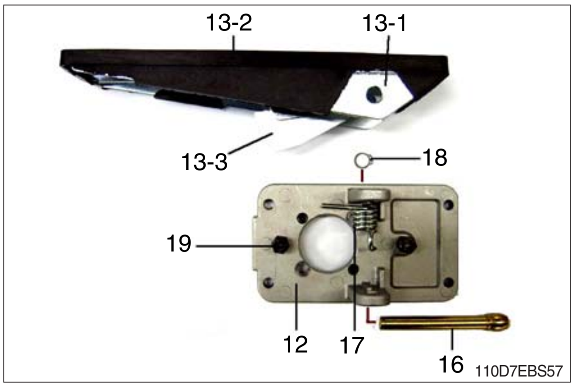


⑥ Rubber cover (15)



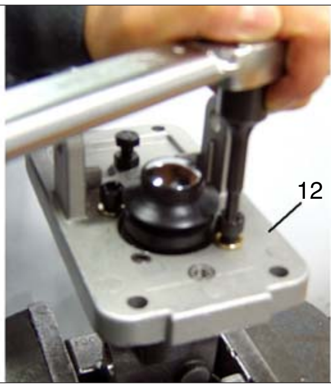
(2) Pedal plate assembly

12	Pedal plate
13-1	Pedal
13-2	Pedal cover
13-3	Lock plate
16	Lock pin (pedal)
17	Torsion spring
18	Stop ring
19	Hexagon bolt



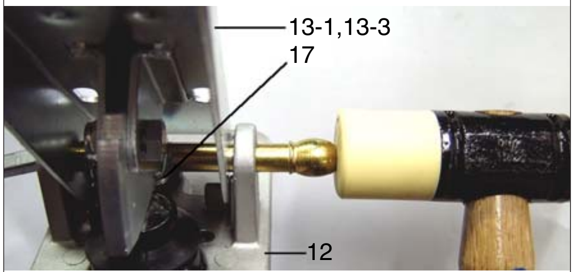
110D7EBS57

① Pedal plate (12) assembly
- Tool : 6 ㎜ torque wrench
- Tightening torque : 2.5~3.0 kgf · m



110D7EBS58

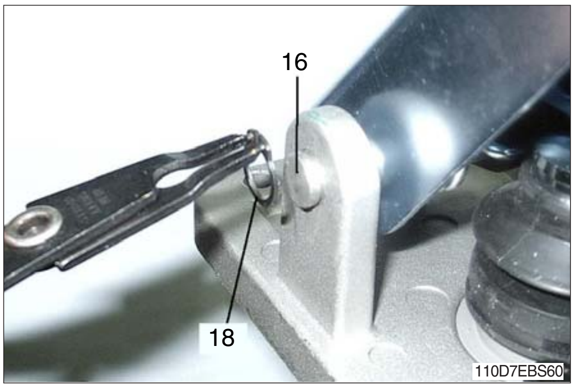
② Pre-assemble pedal assembly (13-1, 13-3) and torsion spring (17) on the pedal plate (12) with a bar of ø12 and then push the bar with a plastic hammer.
- Tool : ø12 bar, plastic hammer.



110D7EBS59

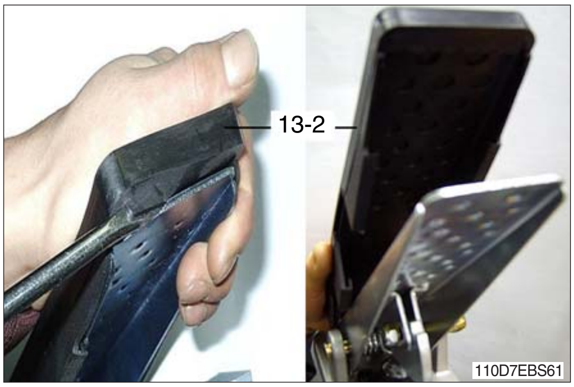
③ Lock pin (pedal) (16), stop ring (18).
- Tool : Snap ring plier for axis.

⚠ To prevent pedal plate from being damaged stop ring (18) must be removed before removing lock pin (16).

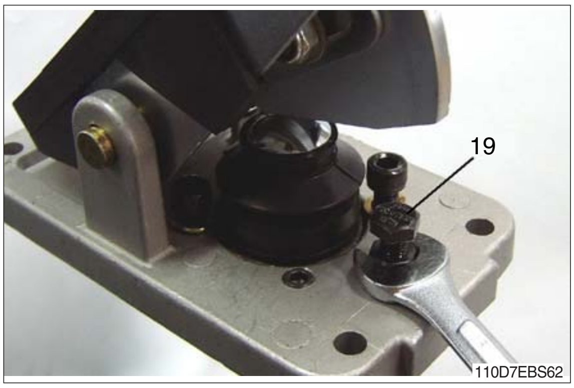


110D7EBS60

④ Rubber cover (13-2)



⑤ Hexagon bolt (19)
- Tool : 13 mm spanner
- Tightening torque : 2.0 kgf · m



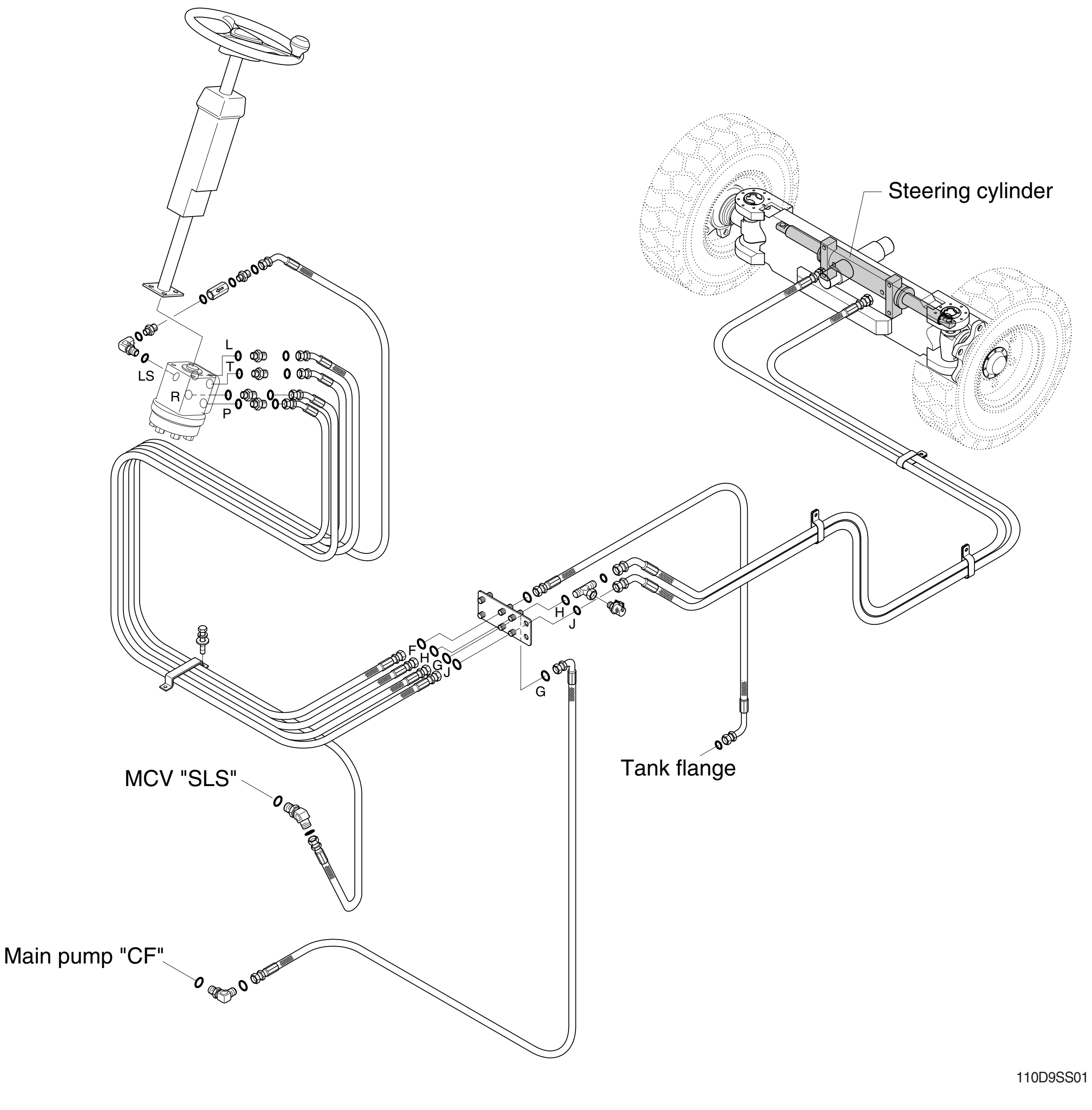
⚠ Never remove the hexagon bolt.
(Pressure setting valve deviation occurs)

SECTION 5 STEERING SYSTEM

SECTION 5 STEERING SYSTEM

GROUP 1 STRUCTURE AND FUNCTION

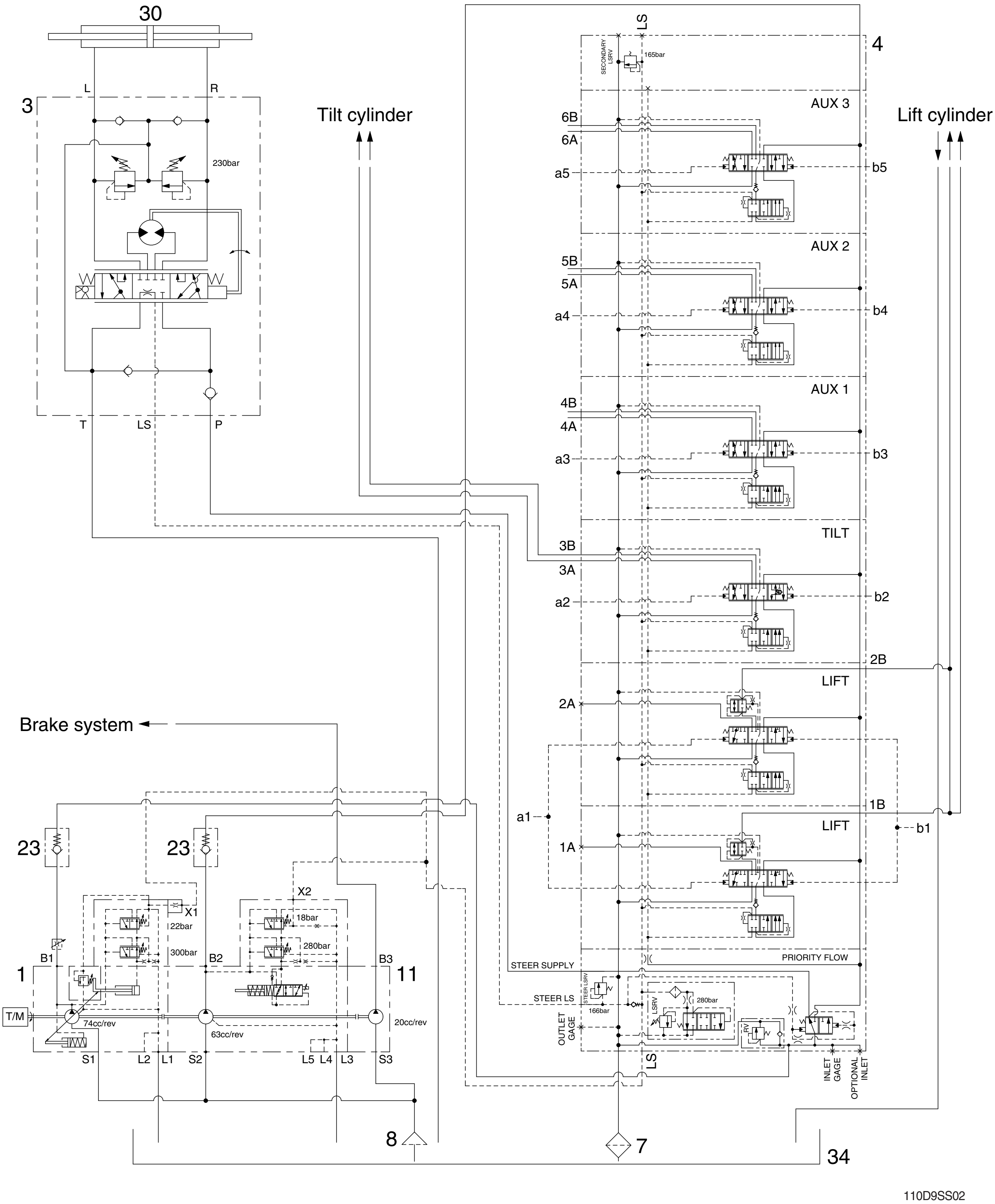
1. OUTLINE



The steering system for this machine is composed of steering wheel assembly, steering unit, steering cylinder, steering axle and piping. The steering force given to the steering wheel enters the steering unit through the steering column. The required oil flow is sensed by the function of the control section of the unit, and pressurized oil delivered from the hydraulic pump is fed to the steering cylinder. The force produced by the steering cylinder moves the knuckle of steering tires through the intermediate link.

The axle body is unit structure having steering knuckles installed to its both ends by means of king pins. Hub and wheel are mounted through bearing to spindle of knuckle.

2. HYDRAULIC CIRCUIT



1 Main pump

3 Steering unit

4 Main control valve

7 Return filter

8 Suction strainer

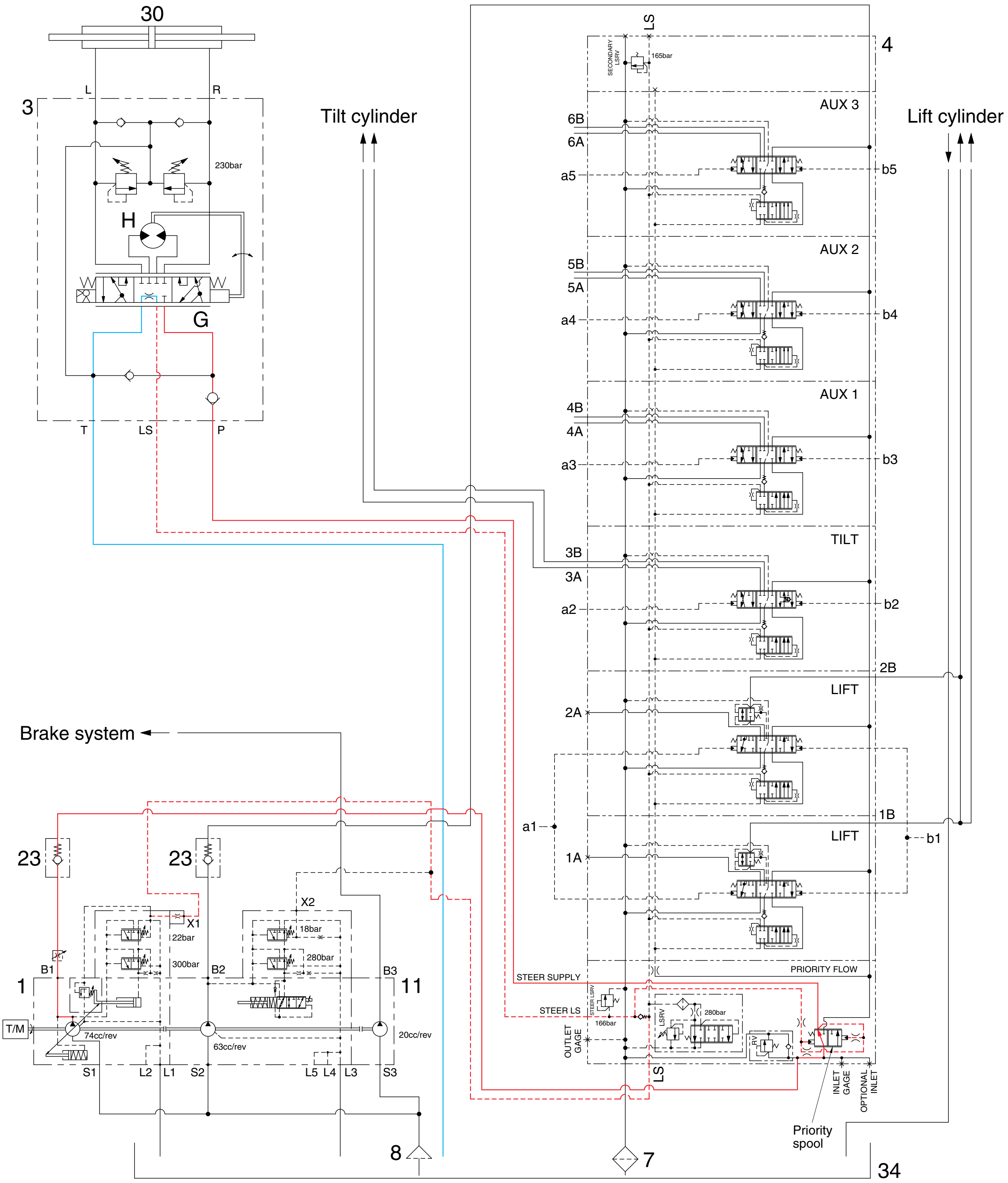
11 Brake pump

23 Check valve

30 Steering cylinder

34 Hydraulic tank

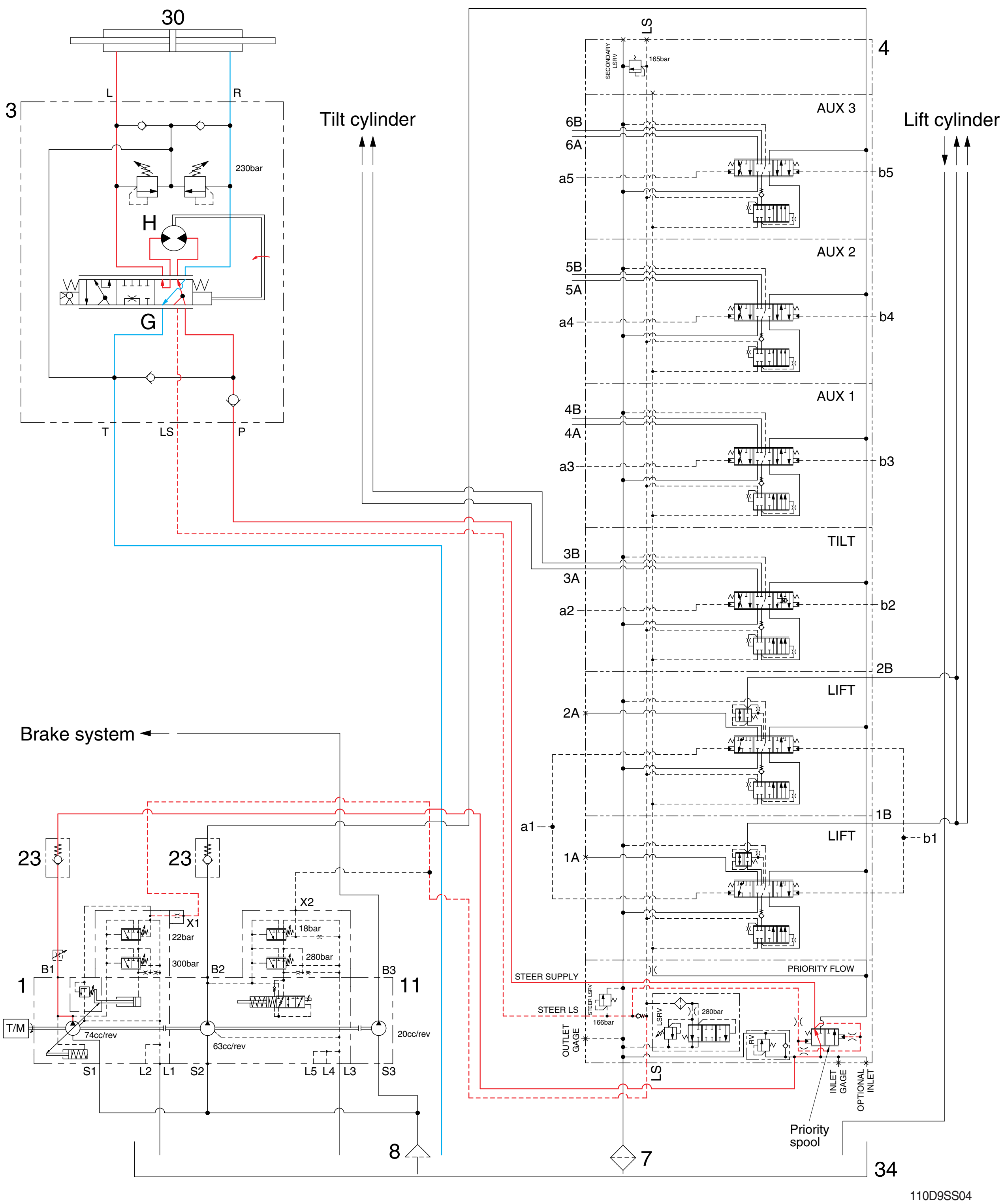
1) NEUTRAL



110D9SS03

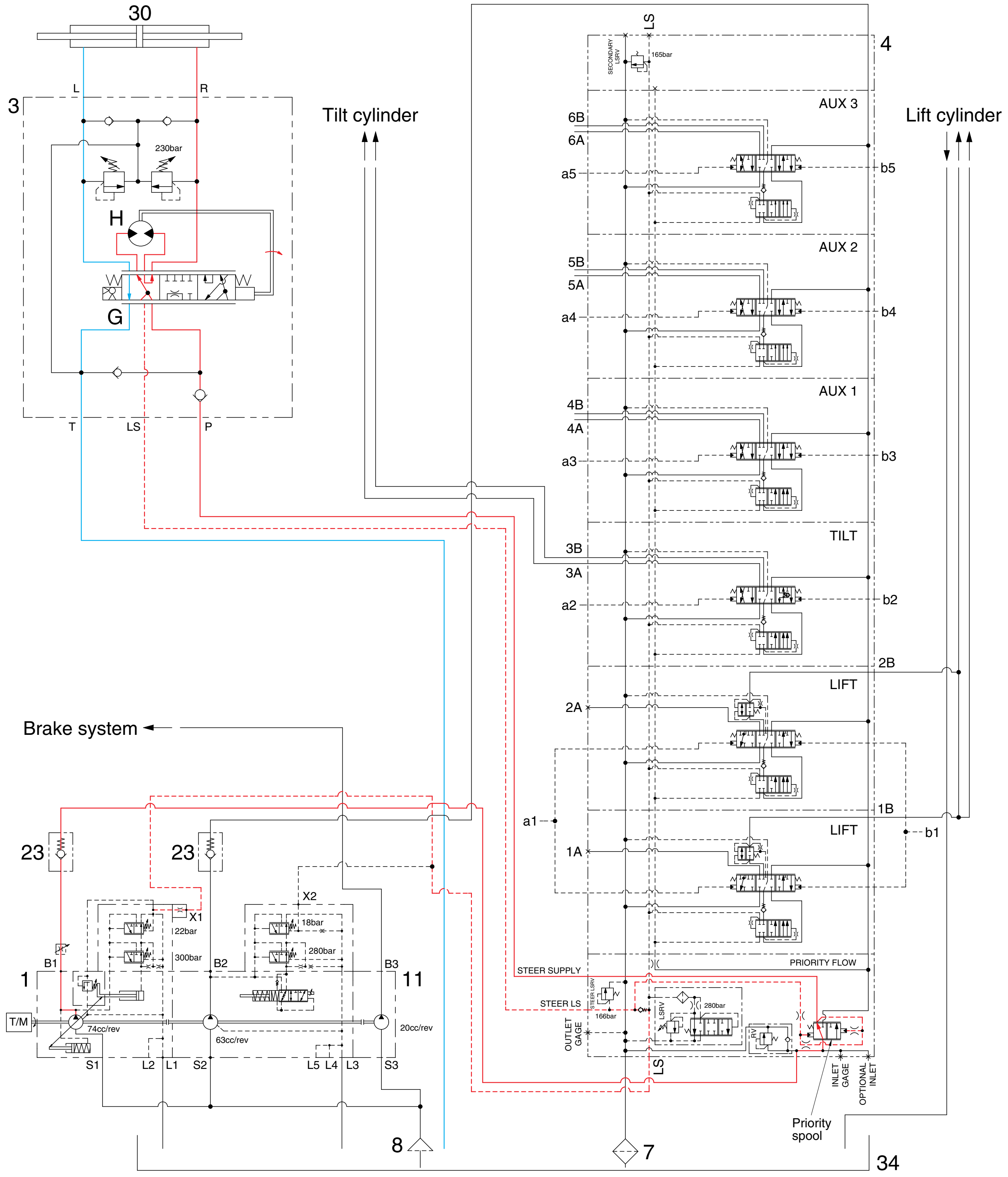
- The steering wheel is not being operated so control spool (G) does not move.
- The oil from the main pump (1) enters port P of steering unit (3) and the inlet pressure oil moves the priority spool built in the MCV (4) to the left.
- Almost all of pump flow goes to the main control valve through the priority spool in the MCV (4) and partly flows into the hydraulic tank (34) through the spool (G).

2) LEFT TURN



- When the steering wheel is turned to the left, the spool (G) within the steering unit (3) connected with steering column turns in left hand direction.
- At this time, the oil discharged from the main pump (1) flows into the spool (G) in the steering unit through the priority valve built in the MCV (4) and flows the gerotor (H).
- Oil flow from the gerotor (H) flows back into the spool (G) where it is directed out the left work port (L).
- Oil returned from cylinder returns to hydraulic tank (34).
- When the above operation is completed, the machine turns to the left.

3) RIGHT TURN

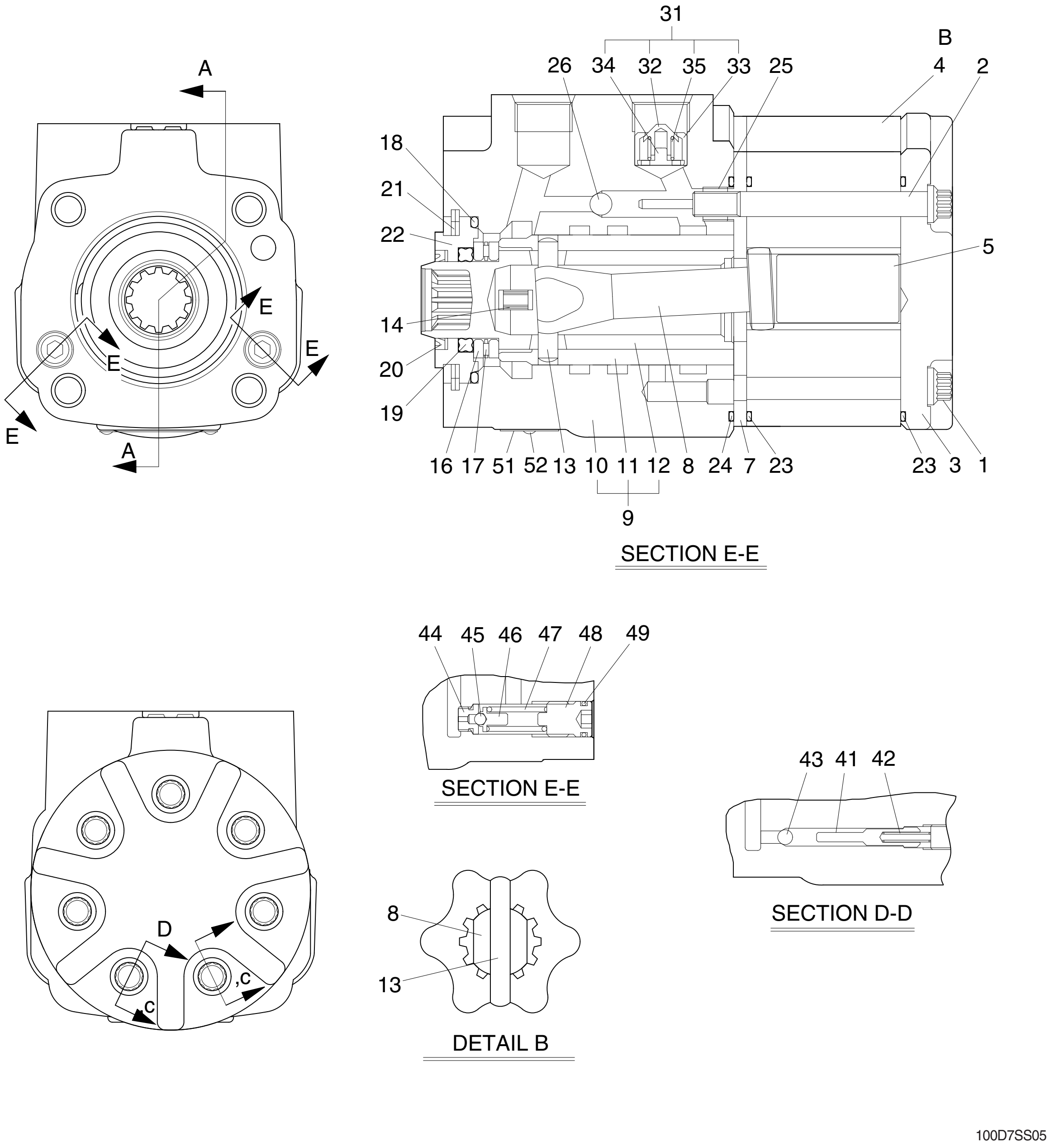


110D9SS05

- When the steering wheel is turned to the right, the spool (G) within the steering unit (3) connected with steering column turns in right hand direction.
- At this time, the oil discharged from the main pump (1) flows into the spool (G) in the steering unit through the priority valve built in the MCV (4) and flows the gerotor (H).
- Oil flow from the gerotor (H) flows back into the spool (G) where it is directed out the right work port (R).
- Oil returned from cylinder returns to hydraulic tank (34).
- When the above operation is completed, the machine turns to the right.

3. STEERING UNIT

1) STRUCTURE



1	Cap screw	12	Spool	23	O-ring	42	Spring
2	Retainer screw	13	Pin	24	O-ring	43	Ball
3	Cap end	14	Centering spring	25	Adopt screw	44	Seat
4	Gerotor	16	Spacer bearing	26	Ball	45	Ball
5	Spacer	17	Needle bearing	31	Check valve sub assy	46	Holder
7	Spacer plate	18	O-ring	32	Poppet	47	Spring
8	Drive	19	Seal	33	Body	48	Plug
9	Control parts assembly	20	Dust seal	34	Guide	49	O-ring
20	Housing	21	Retaining ring	35	Spring	51	Name plate
11	Sleeve	22	Bushing	41	Retainer plug	52	Rivet

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 (12) is connected directly to the drive shaft of steering wheel. It is connected to sleeve (11) by cross pin (13) (not in contact with the spool when the steering wheel is at neutral) and center spring (14).

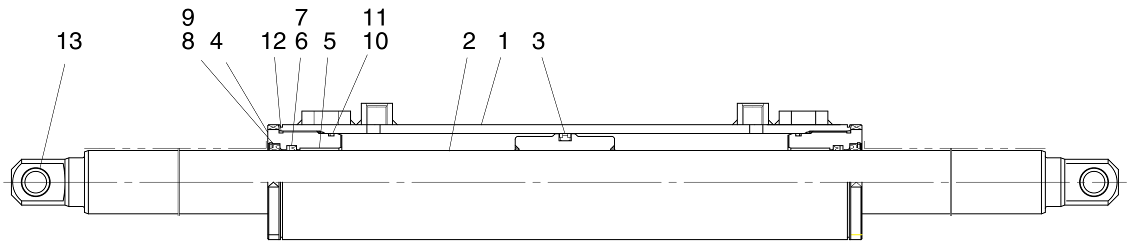
Cardan shaft (8) is meshed at the top with cross pin (13) and forms one unit with sleeve (11).

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.

4. STEERING CYLINDER

1) STRUCTURE



100D7SS06

1	Tube assembly	6	Rod seal	11	Back up ring
2	Rod assembly	7	Back up ring	12	O-ring
3	Piston seal	8	Dust wiper	13	Pin bushing
4	Gland	9	Snap ring		
5	Du bushing	10	O-ring		

2) OPERATION

This machine use to cross connected cylinder for steering operation.
The steering cylinder use a gland (4) 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 is fastened to the rod (2) by weld.

The piston uses a single piston seal (3) 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 (6).

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, refer to structure and function in group 1.

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

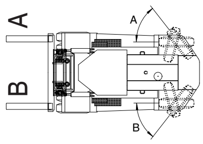
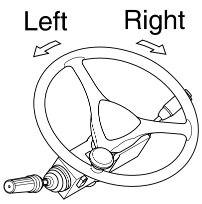
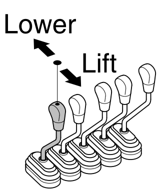
The engine and all other major components must be at operating temperature for some checks.

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.

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, tires 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 3 rpm. **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 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.
Priority valve high pressure check Run engine at high idle.	 Steer to steering stop and release steering wheel. Lift, tilt 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.

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.
No hydraulic functions steering normal	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 secondary 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. 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 Low oil level Sticking priority valve spool Loose cylinder piston Damaged steering unit	Check for foamy oil. Add recommended oil. Remove and inspect spool. Remove rod to inspect piston. Remove and inspect.
Spongy or soft steering	Air in oil Low oil level	Check for foamy oil. Add recommended oil.
Free play at steering wheel	Loose steering wheel nut Worn or damaged splines on steering column or unit	Tighten. Inspect.
Steering unit binding or steering wheel does not immediately return to neutral when released	Binding in steering column or misalignment of column High return pressure Contamination in steering unit Large particles of contamination in steering unit	Inspect. Check for a pinched or damaged return line. Inspect hydraulic filter for contamination. Repair cause of contamination. Flush hydraulic system. 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.
Neutral position of steering wheel cannot be obtained, i.e. there is a tendency towards "motoring"	Steering column and steering unit out of line Too little or no play between steering column and steering unit input shaft Pinching between inner and outer spools	Align the steering column with steering unit. Adjust the play and, if necessary, shorten the splines journal. 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 Leaf springs without spring force or broken Worn splines on the steering column	Replace cardan shaft. Replace leaf springs. Replace steering column.
"Shimmy" effect. The steered wheels vibrate. (Rough tread on tires gives vibrations)	Air in the steering cylinder Mechanical connections or wheel bearings worn High priority valve setting pressure	Bleed cylinder. Find and remove the reason for air collection. Replace worn parts. 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 Relief valve setting too low Relief valve sticking owing to dirt Spool in priority valve sticking owing to dirt. Too weak spring in priority valve	Replace pump or increase number of revolutions. Adjust valve to correct setting. Clean the valve. Clean the valve, check that spool moves easily without spring. 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 Clogged orifices in LS side in priority valve Oil is too thick(Cold)	Replace spring by a stronger. Clean orifices in spool and in connecting plugs for LS. 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 3658 mm (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 115 l (30.4U.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. 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

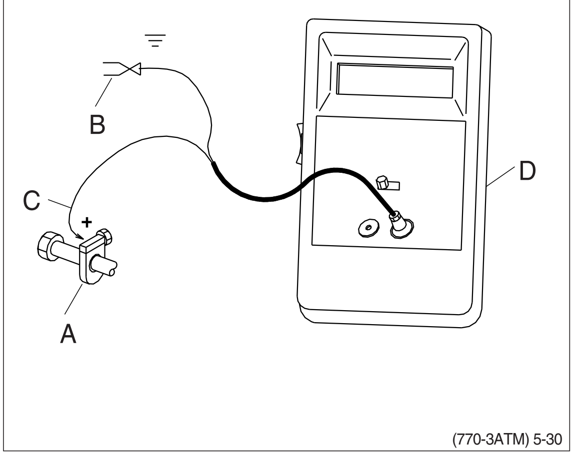
  A : Clamp on tachometer.

  Remove paint using emery cloth and connect to a straight section of injection line within 100 mm (4 in) 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.



(770-3ATM) 5-30

2) DIGITAL THERMOMETER INSTALLATION

- Service equipment and tools

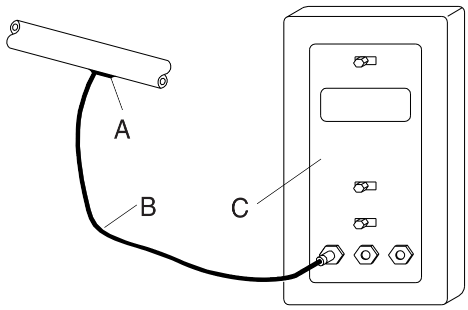
  Digital thermometer

  A : Temperature probe.

  Fasten to a bare metal line using a tie band. Wrap with shop towel.

  B : Cable.

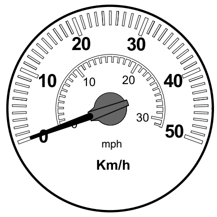
  C : Digital thermometer.



(770-3ATM) 5-30

3) DISPLAY MONITOR TACHOMETER

The display monitor tachometer is accurate enough for test work.



7807A3CD03

3. STEERING UNIT LEAKAGE TEST

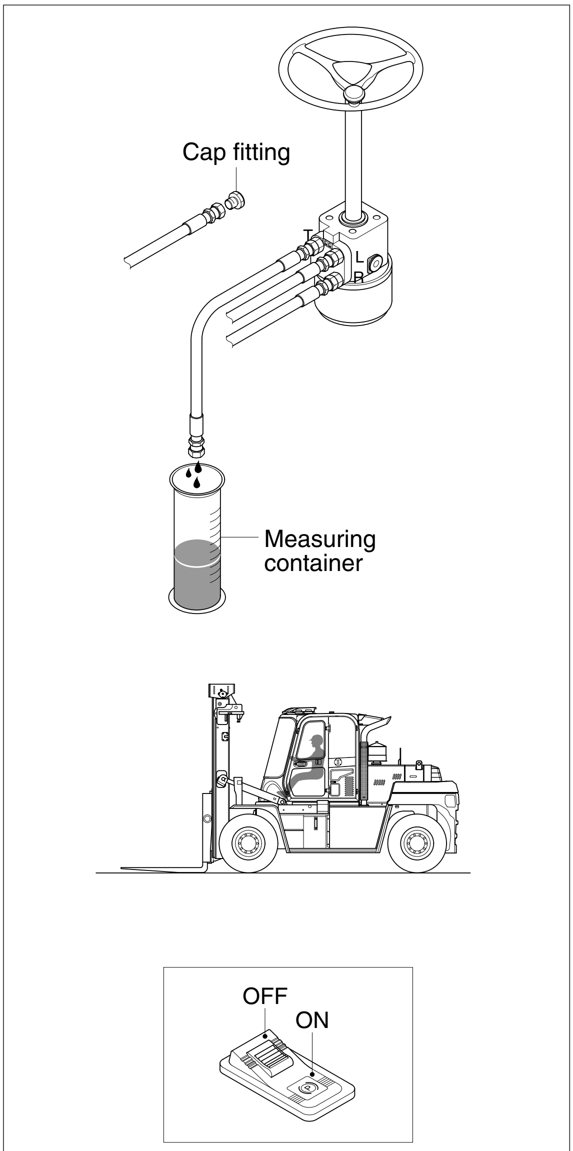
· SPECIFICATION

Oil temperature	45±5˚C(113±9˚F)
Engine speed	High idle
Maximum leakage	7.5 ℓ/min (2 gpm)

· GAUGE AND TOOL

Temperature reader
Measuring container (Approx. 20 ℓ)
Stop watch

1) Install temperature reader.
   (See temperature reader installation procedure in this group).
2) Heat hydraulic oil to specifications.
3) Disconnect return hose from fitting.
   Install cap fitting.
4) Run engine at specifications. Rotate steering wheel completely to the right (or left) approximately 1.2 kgf · m of force.
   Measure oil flow from return hose for 1 minute.
5) If leakage is greater than specifications, repair or replace steering unit.

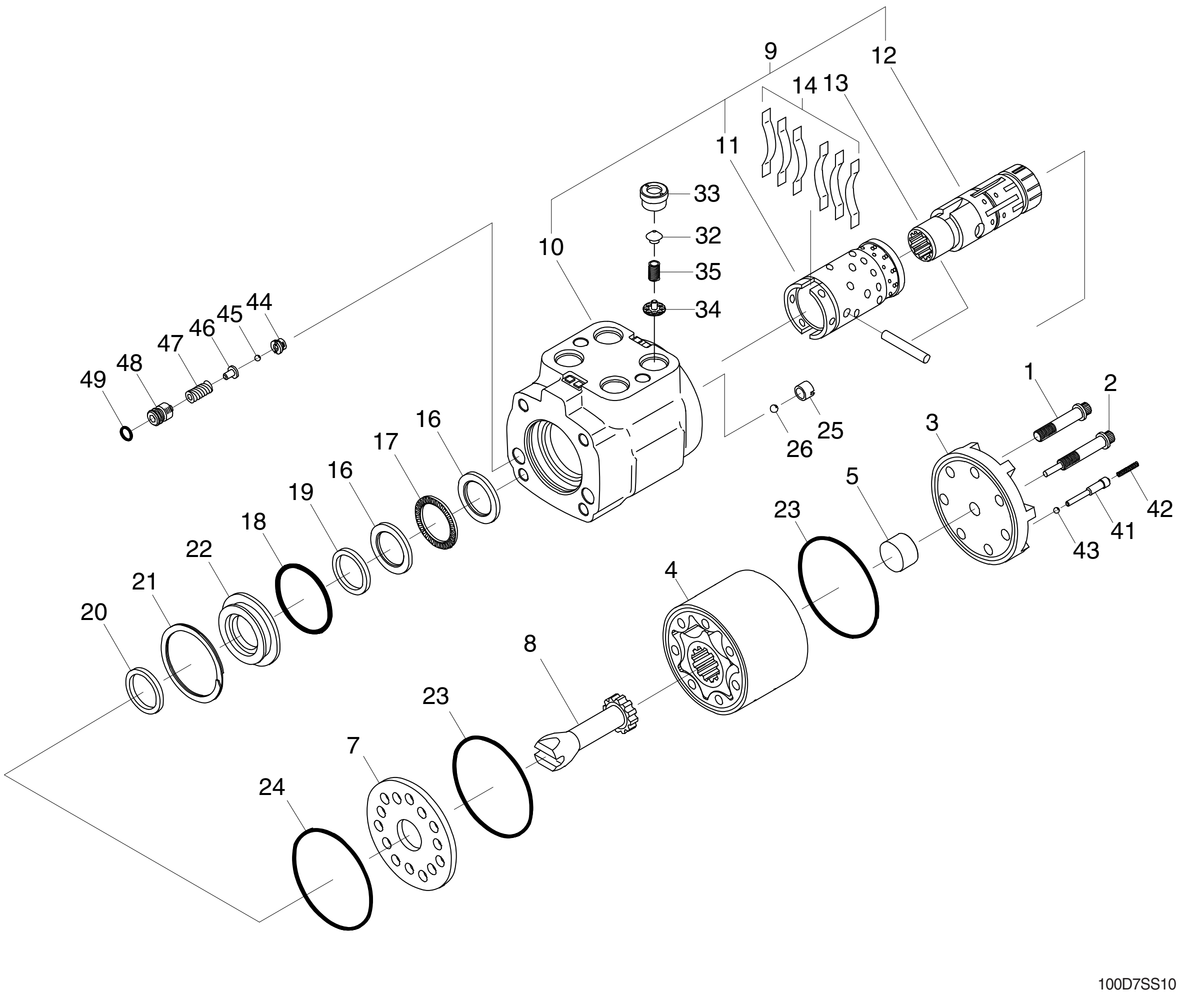


110D9SS09

GROUP 4 DISASSEMBLY AND ASSEMBLY

1. STEERING UNIT

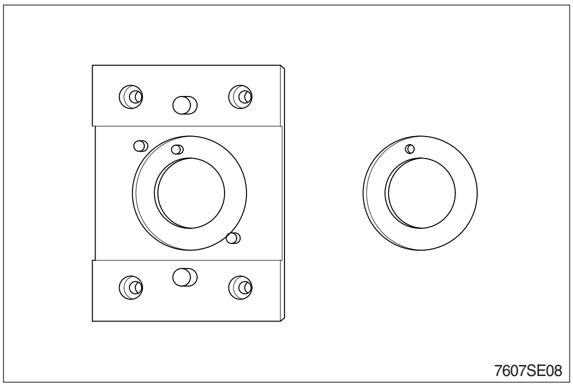
1) STRUCTURE



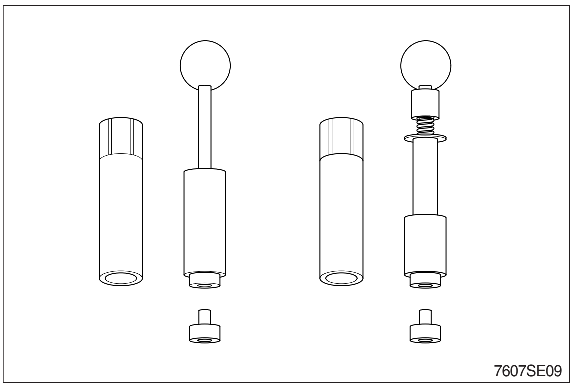
1	Cap screw	17	Needle bearing	35	Spring
2	Retainer screw	18	O-ring	41	Retainer plug
3	Cap end	19	Seal	42	Spring
4	Gerotor	20	Dust seal	43	Ball
5	Spacer plate	21	Retaining ring	44	Seat
7	Spacer plate	22	Bushing	45	Ball
8	Cardan shaft	23	O-ring	46	Holder
9	Control parts assembly	24	O-ring	47	Spring
10	Housing	25	Adopt screw	48	Plug
11	Sleeve	26	Ball	49	O-ring
12	Spool	31	Check valve sub assy	51	Name plate
13	Pin	32	Poppet	52	Rivet
14	Centering spring	33	Body		
16	Spacer bearing	34	Guide		

2) TOOLS

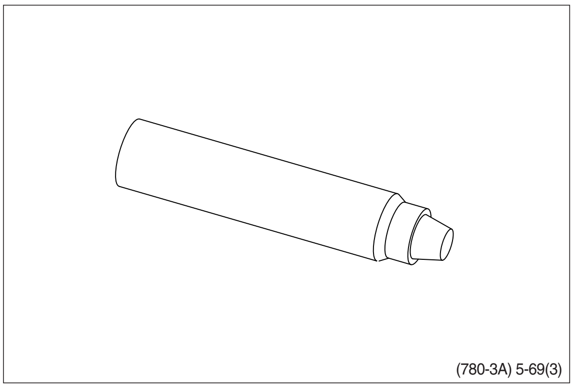
(1) Holding tool + Guide ring



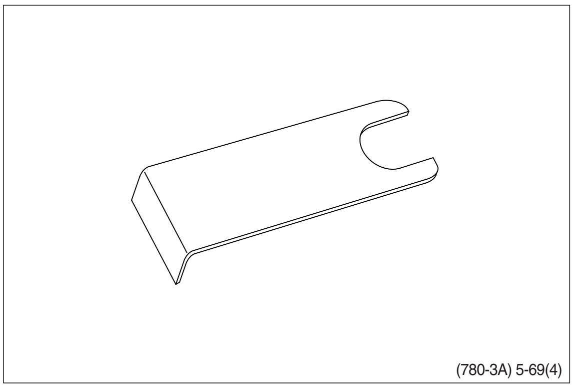
(2) Assembly tool for O-ring and kin-ring.



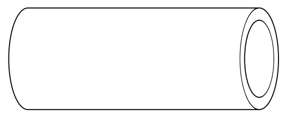
(3) Assembly tool for lip seal.



(4) Assembly tool for cardan shaft.

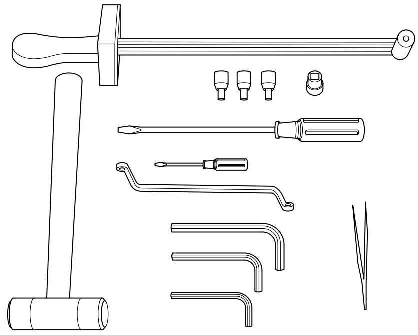


(5) Assembly tool for dust seal.



(780-3A) 5-70(1)

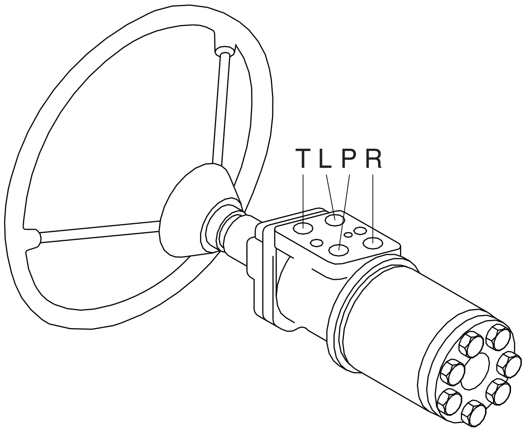
(6) Torque wrench 0~7.1 kgf · m
(0~54.4 lbf · ft)
13 mm socket spanner
6, 8 mm and 12 mm hexagon sockets
12 mm screwdriver
2 mm screwdriver
13 mm ring spanner
6, 8 and 12 mm hexagon socket spanners
Plastic hammer
Tweezers



(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 $\times$ 1.5	4.1 (29.7)	2.0 (14.5)	3.1 (22.4)	2.0 (14.5)
M 18 $\times$ 1.5	7.1 (51.4)	2.0 (14.5)	5.1 (36.9)	5.1 (36.9)
M 22 $\times$ 1.5	10.2 (73.8)	3.1 (22.4)	8.2 (59.3)	7.1 (51.4)

4) REPLACEMENT OF SEAL PARTS

When repairing orbitrol, refer to parts manual.

⚠ **We cannot assure any troubles of orbitrol repaired by customers, so we commend sending back to our Hyundai dealer when repairing.**

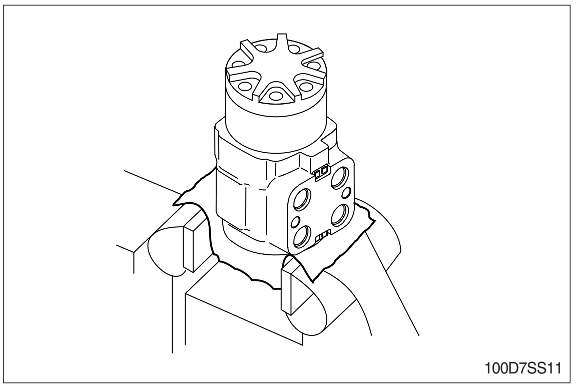
Cleanliness is extremely important for repairing. Work in a clean area. Before disconnecting the lines, clean port area of orbitrol thoroughly. Use a wire brush to remove foreign against flaw and nick by dropping down.

⚠ **Be careful not to get hurt by the machined edge of orbitrol.**

(1) Repair of backside

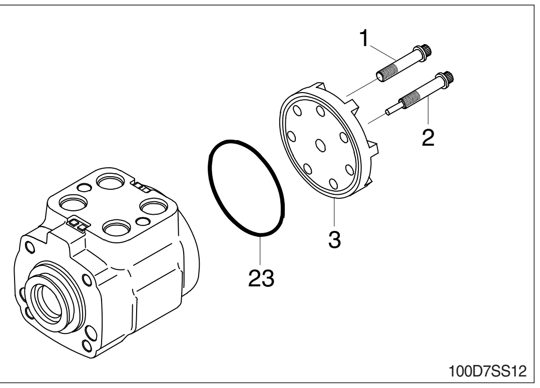
(Number) shows parts number of attached parts drawing and list, page 5-21.

① Clamp orbitrol in vise with end cap to up. Clamp lightly on edges of port face sides.
Use protective material on vise jaws. Do not over tighten jaws.



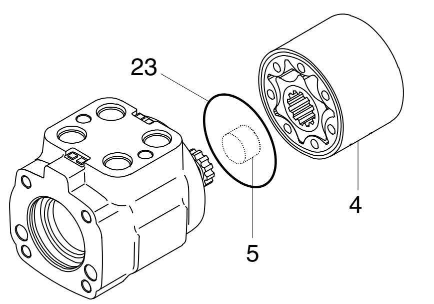
100D7SS11

② Remove cap screw (1) and retainer screw assy (2).
③ Remove end cap (3).
④ Replace O-ring (23) with new one at end cap (3).



100D7SS12

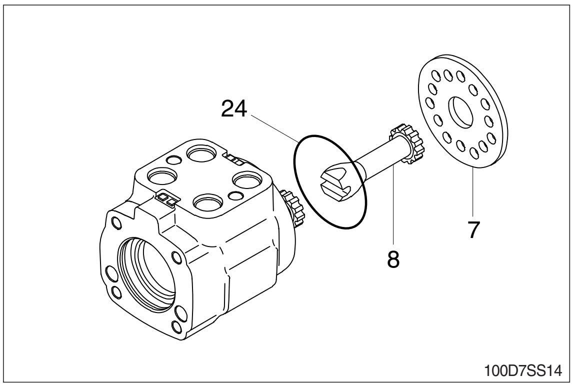
⑤ Remove spacer (s) (5).
⑥ Remove gerotor (4) and replace O-ring (23).



100D7SS13

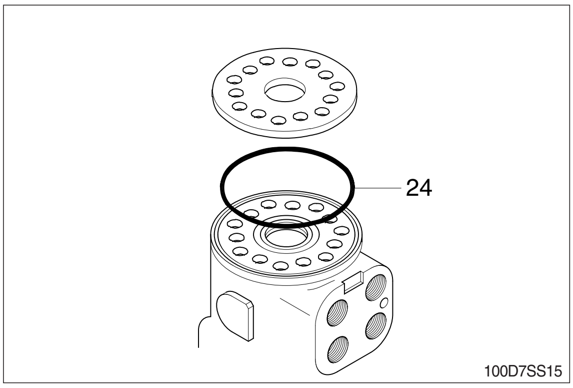
⑦ Remove drive (8).
⑧ Remove spacer plate (7).
⑨ Replace O-ring (24) in housing (10).

※ Be careful that O-ring size (23) and (24) is different.



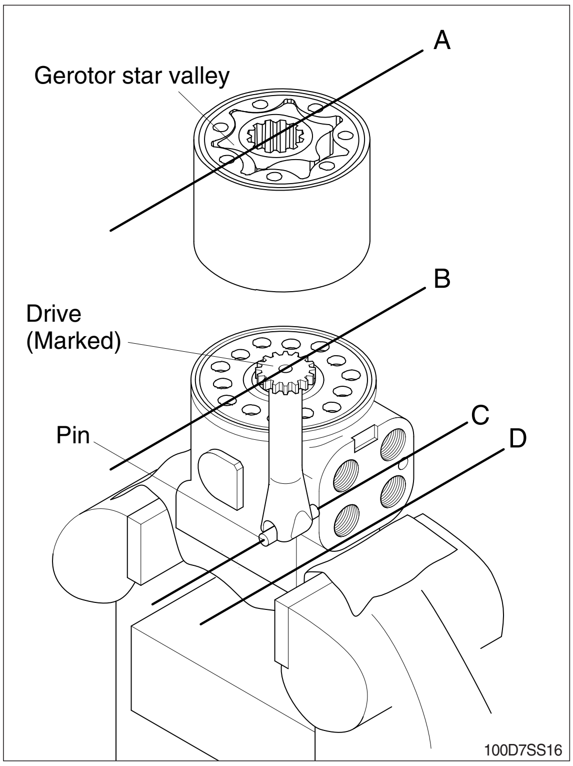
⑩ Put spacer plate (7) on housing (10). Align bolt holes in spacer plate (7) with tapped holes in housing (10).

※ Pich dia. of bolt holes and oil holes in spacer plate (7) is different. (Larger pitch dia. is for bolt holes).



⑪ Install drive (8) and engage with pin (13).
⑫ Mark drive (8) spline end parallel to pin (13) to make sure relationship of drive (8) and pin (13). Refer right figure 6 line B and line C.
⑬ Align star valleys (right figure line A) with marked drive (8) (right figure line B). Star valleys must align with pin (13). Note parallel relationship of lines A, B and C in right figure.

⚠ Make sure relationship of parts.
If relationship is mistaken, it is possible to cause big trouble for steering.

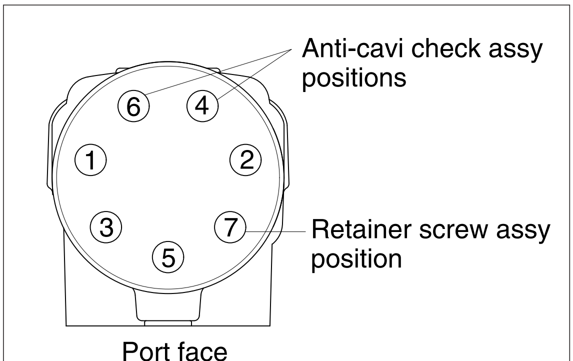


⑭ Install spacer (s) (5) in gerotor (4).

⑮ Install end cap (3) on gerotor (4) aligning holes.

⑯ Install cap screw (1) and retainer screw assy (2) in end cap (3). Tighten screws to 15 Nm (1.5 kgf · m) in advance.
Then tighten screws to tightening torque in sequence shown right figure.

Tightening torque (Standard type)
· Tightening torque : 28N.M (2.9 kgf · m)
· Displacement : 369 cc/rev



100D7SS17

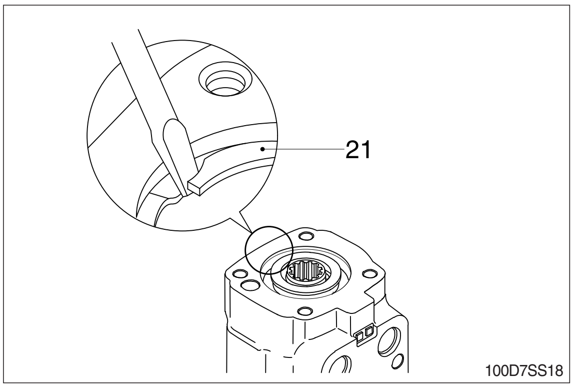
⚠ **If retainer screw assy (2) position is mistaken, it is possible to cause big trouble.**

⑰ Install steering wheel to spool(12) and make sure rotation smoothly.

(2) Repair of front side
(Number) shows parts number of attached parts drawing and list page 5-21.

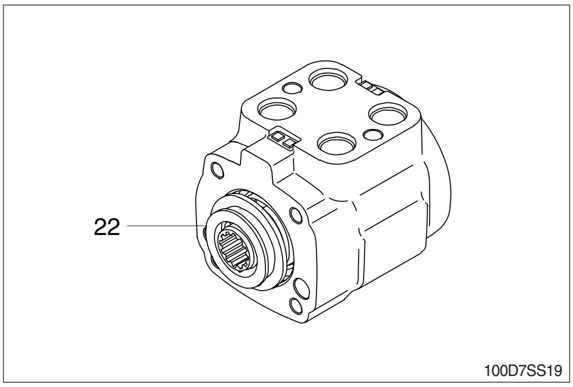
① Use a thin bladed screwdriver to pry retaining ring (21) from housing (10).

⚠ Retaining ring (21) may burst out from housing (10). Use goggles to protect your eyes.



100D7SS18

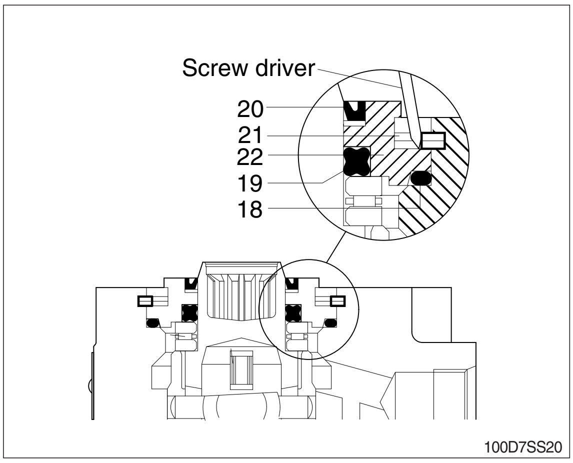
② Remove seal gland bushing (22) from housing (10).



③ Replace O-ring (18) with new one.

④ Remove oil seal (19) from seal gland bushing (22) and replace oil seal (19) with new one.

※ When installing oil seal (19) in seal gland bushing (22), be careful not to twist and deform oil seal.



⑤ Install dust seal (20) in seal gland bushing (22).

※ Install dust seal (20) until bottom of groove with tapping by a rubber hummer.

⑥ Install retaining ring (21) in housing (10).

※ Pry retaining ring (21) with screw driver to install entire circumference of it in hosing (10) groove completely.

⚠ Retaining ring (21) may burst out from housing (10). Use goggles to protect your eyes.

⚠ Don't disassemble cylinder relief valve. When the relief valve is disassembled by customer, the customer shall take responsibility for any trouble for relief valve.

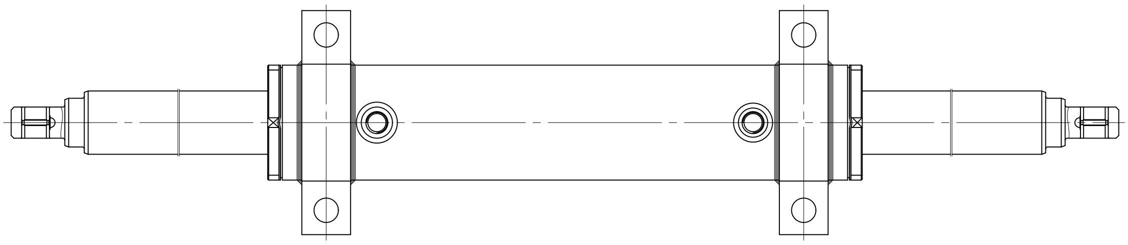
⚠ Don't disassemble spool/sleeve assy from housing. When these are disassembled from housing by customer, the customer shall take responsibility for it.

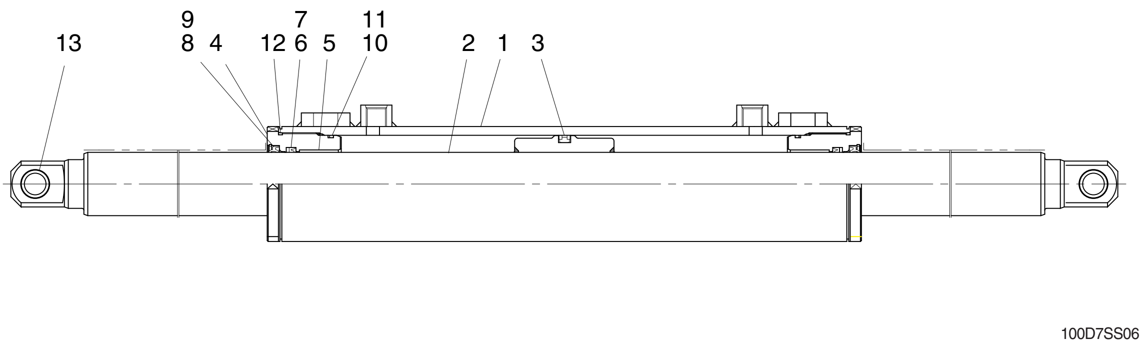
· **Tools required for repair**

- Torque wrench (50 Nm capacity)
- 5/12" socket
- Screw driver
- Plastic hammer or rubber hammer
- Grease
- Vice
- Marker pen

2. STEERING CYLINDER

1) STRUCTURE





1	Tube assembly	6	Rod seal	11	Back up ring
2	Rod assembly	7	Back up ring	12	O-ring
3	Piston seal	8	Dust wiper	13	Pin bushing
4	Gland	9	Snap ring		
5	DU bushing	10	O-ring		

2) DISASSEMBLY

※ Before disassembling steering cylinder, release oil in the cylinder first.

(1) Put wooden blocks against the cylinder tube, then hold in & vice.

(2) Remove the cover by hook a wrench in the notch of cylinder head and turn counter-clockwise.

(3) Remove the cylinder rod and piston from the tube.

(4) Check wear condition of the sealing parts (O-ring, oil seal, dust seal, U-packing, bush). If there are some damage, replace with new parts.

3) CHECK AND INSPECTION

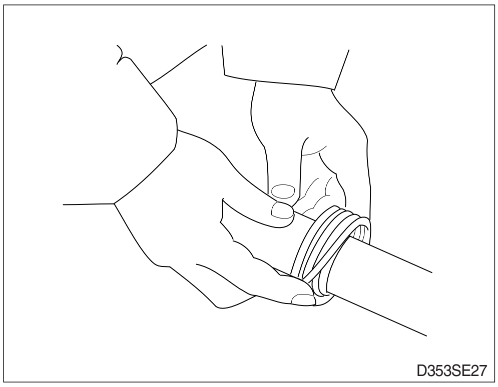
mm (in)

Check item	Criteria		
	Standard size	Repair limit	Remarks
Clearance between piston & cylinder tube	0.05~0.25 (0.002~0.01)	0.4 (0.02)	Replace piston seal
Clearance between cylinder rod & bushing	0.05~0.18 (0.002~0.007)	0.3 (0.01)	Replace bushing
Seals, O-ring	Damage		Replace
Cylinder rod	Dents		Replace
Cylinder tube	Biting		Replace

4) ASSEMBLY

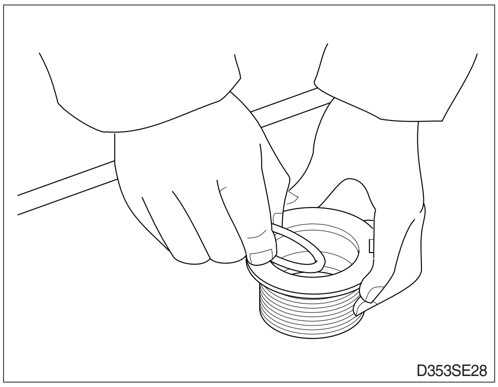
(1) Install a new piston seal around the groove on the piston.

※ Be careful not to scratch the seal too much during installation or it could not be seated properly.



D353SE27

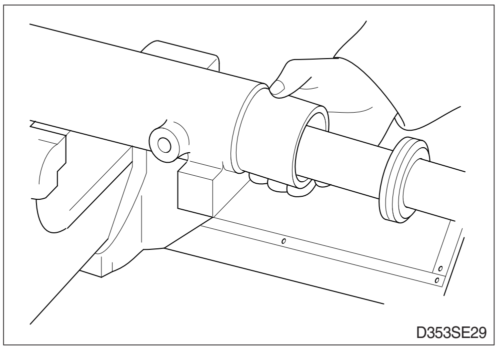
(2) Install the rod seal to the position in the gland applying a slight coat with grease prior to install.



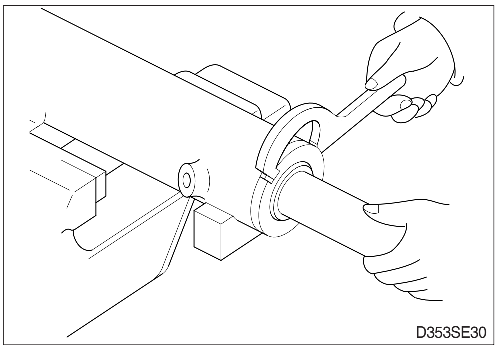
D353SE28

(3) Install the dust wiper to the gland using a special installing tool. Coat the dust wiper with grease slightly before installing.

(4) Using a special tool, install gland assembly into the cylinder tube.

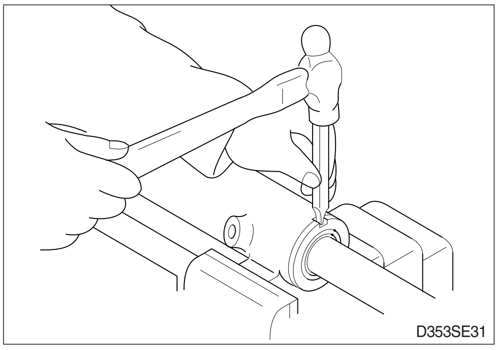


(5) Using a hook spanner, install the gland assembly, and tighten it with torque 60±6 kgf · m (434±43 lbf · ft).



(6) After the gland assembly was installed to the cylinder tube, calk at the tube end into the groove on the gland to prevent screw loosening.

※ If it is needed to calk again, never calk on the same place.



(7) Move the piston rod back and forth several times for the full distance of its stroke. This helps to seat the ring and seals before applying full hydraulic pressure to the cylinder.

(8) Install cylinder into trail axle.

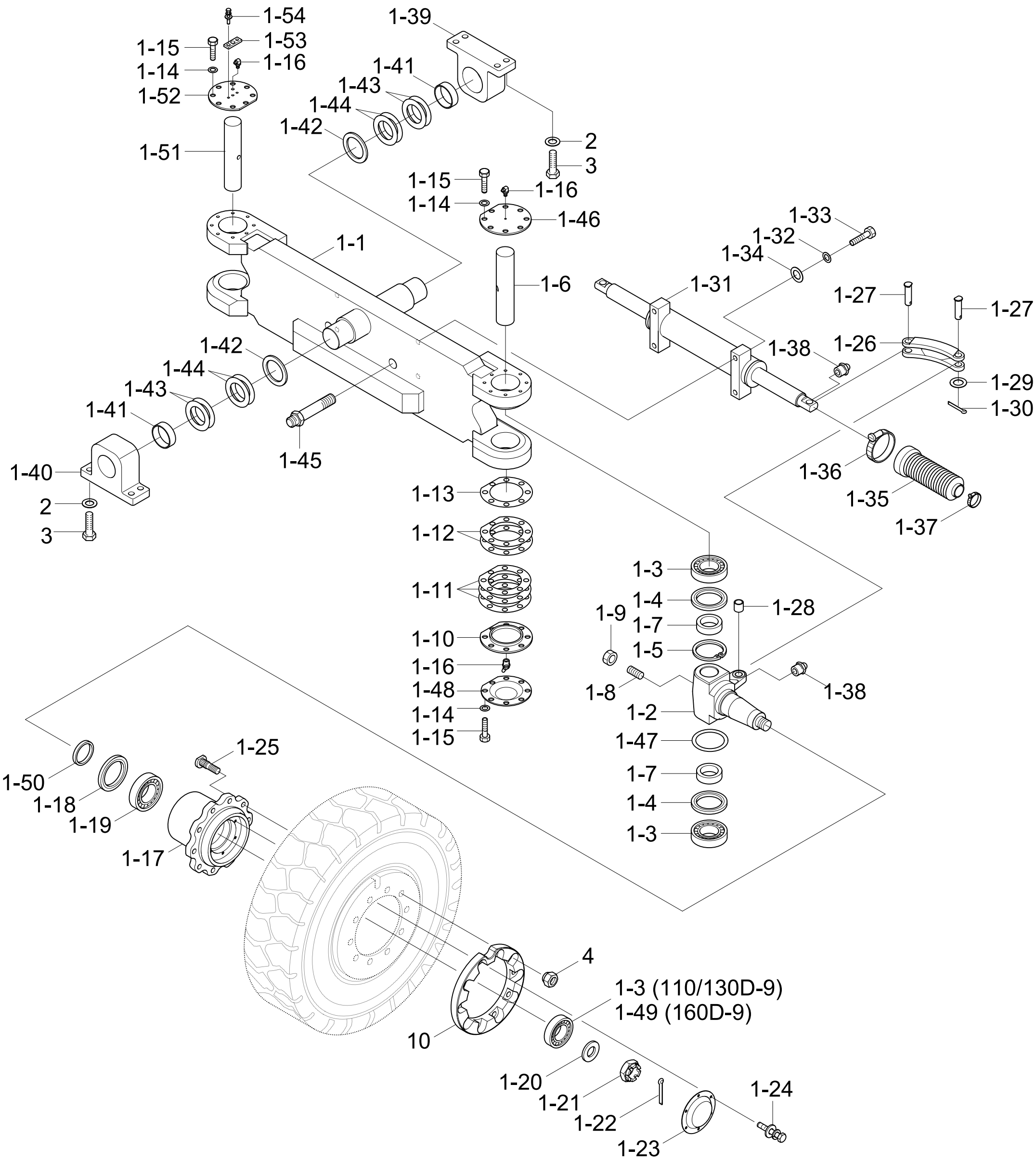
(9) While idling the engine with the rear wheels off the ground, operate the steering wheel left and right alternately.

※ Then, repeat the above operation at gradually increasing engine rpm. This releases air from the system and completes preparation for operation.

(10) Stop the engine, lower the floating rear wheels, and check pump joints for oil leaks and looseness and retighten, them as required.

3. STEERING AXLE

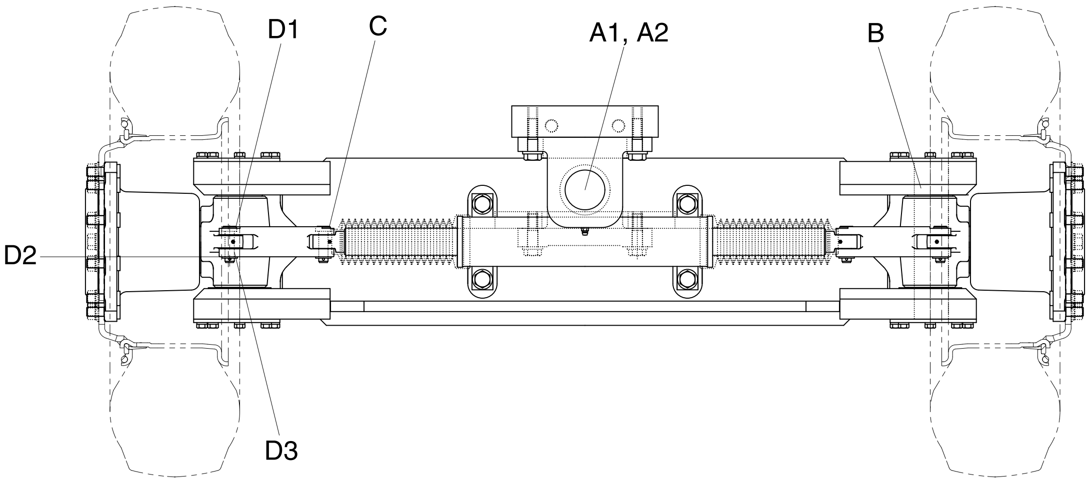
1) STRUCTURE



110D9SS21

1	Steering axle assembly	1-15	Hexagon bolt	1-30	Split pin	1-45	Connector
1-1	Steering axle	1-16	Grease nipple	1-31	Steering axle	1-46	Cover (LH)
1-2	Knuckle	1-17	Hub	1-32	Hardened washer	1-47	Spacer
1-3	Taper roller bearing	1-18	Oil seal	1-33	Hexagon bolt	1-48	Plate
1-4	Oil seal	1-19	Taper roller bearing	1-34	Shim (0.2 t)	1-49	Taper roller bearing
1-5	Retaining ring	1-20	Special washer	1-35	Boots	1-50	Spacer
1-6	King pin (LH)	1-21	Lock nut	1-36	Hose clamp	1-51	King pin (RH)
1-7	Spacer	1-22	Split pin	1-37	Hose clamp	1-52	Cover (RH)
1-8	Hexagon socket setscrew	1-23	Cap	1-38	Grease nipple	1-53	Plate (RH)
1-9	Hexagon nut	1-24	Bolt with washer	1-39	Rear support	1-54	Bolt with washer
1-10	Cover	1-25	Hub bolt	1-40	Front support	2	Hardened washer
1-11	Shim (0.1t)	1-26	Link	1-41	Bushing	3	Hexagon bolt
1-12	Shim (0.2 t)	1-27	Link pin	1-42	Spacer	4	Hub nut
1-13	Shim (0.5 t)	1-28	Bushing	1-43	Shim (0.2 t)	10	Protector (opt)
1-14	Hardened washer	1-29	Special washer	1-44	Shim (0.5 t)		

2) CHECK AND INSPECTION



100D7SS22

unit : mm (in)

No.	Check item			Criteria		Remarks
				Standard size	Repair limit	
A	Shaft	A1	OD of shaft	100(3.94)	99(3.90)	Replace
		A2	ID of bushing	100(3.94)	99(3.90)	
B	OD of king pin			80(3.2)	79.5(3.1)	
C	OD of steering cylinder pin			22(0.9)	21.9(0.9)	
D	Knuckle	D1	OD of pin	22(0.9)	21.9(0.9)	
		D2	Vertical play	-	0.2(0.008)	Adjust shim
		D3	ID of bushing	22(0.9)	22.5(0.9)	Replace

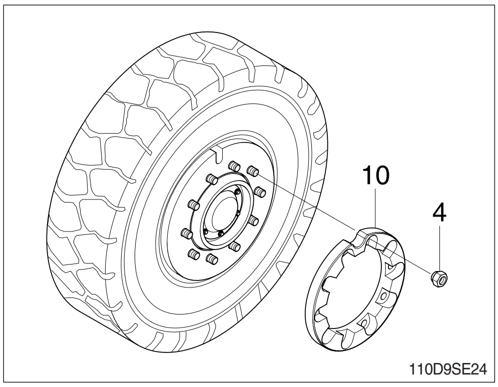
· OD : Outer diameter
· ID : Inner diameter

3) DISASSEMBLY

※ Servicing work on the knuckle part can be carried out without removing the axle assy from chassis. The work can be done by jacking up the balance weight part of the truck.

(1) Loosen the hub nut (4) and take off the steering wheel tire.

※ Remove the protector (10) if equipped.



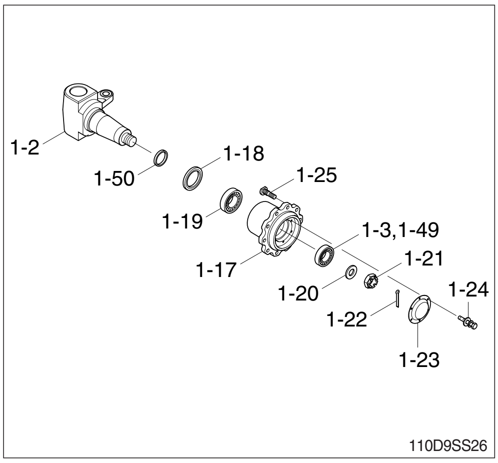
(2) Loosen the bolt (1-24) and remove hub cap (1-23).

(3) Pull out split pin (1-22) and remove lock nut (1-21), washer (1-20).

(4) Using the puller, take off the hub (1-17) together with the roller bearing (1-3/1-49, 1-19).

※ Be very careful because just before the hub comes off, tapered roller bearing will fall out.

(5) After hub is removed take off the inner race of roller bearing (1-3/1-49, 1-19).



(6) Pull out oil seal (1-18).

※ Don't use same oil seal twice.

(7) Repeat the same procedure for the other side. Moreover, when disassembling is completed, part the lock nut in the knuckle to protect the threaded portion.

(8) Loosen set screw (1-8) and nut (1-9).

(9) Loosen with washer bolt (1-15) and remove cover (1-10, 1-48), shim (1-11, 1-12, 1-13). Remove grease nipple (1-16).

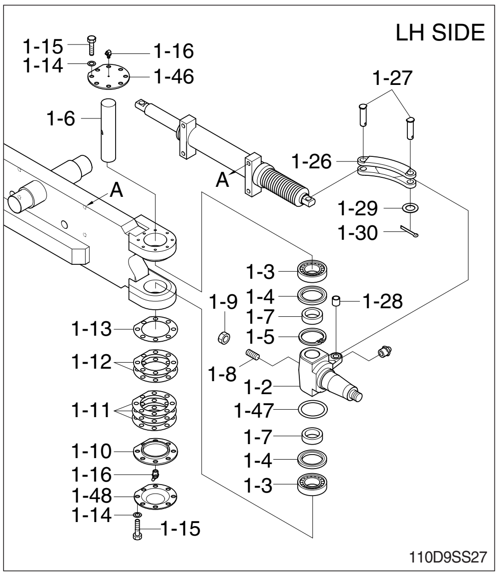
(10) Push out the king pin (1-6) without damaging the knuckle arm (1-2).

(11) At the same time the king pin is removed, pull out the oil seal (1-4).

(12) If defect is observed in taper roller bearing (1-3), pull it out by using extractor.

(13) Remove spilt pin (1-30), special washer (1-29) and link pin (1-27).

※ Repeat the same procedure for the RH side.



4) ASSEMBLY

※ In reassembling, have all parts washed, grease applied to lubricating parts, and all expendable items such as oil seal and spring washers replaced by new ones.

Perform the disassembly in reverse order.

(1) Tighten the set screw (1-8) of king pin (1-6).

(2) There is a notch in the middle of the king pin (1-6), make sure that this notch is on the set screw side.

(3) Do not hammer to drive in taper roller bearing (1-3) because it will break.
Always use drive-in tool.

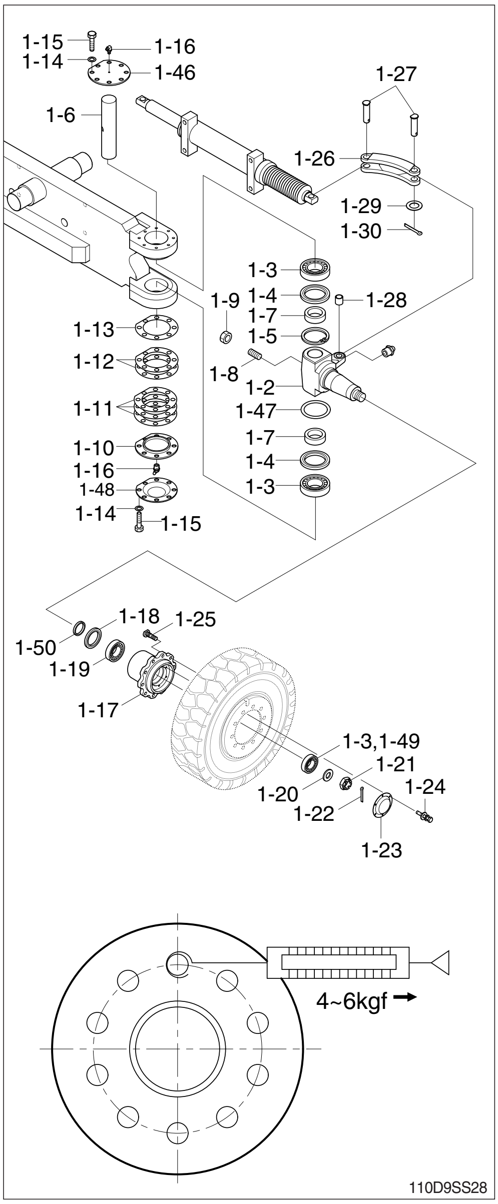
(4) Hub

① Mount spacer (1-50), oil seal (1-18) and inner race of tapered roller bearing (1-19) on the knuckle.
The bearing should be well greased before assembling.

② Install hub (1-17), outer race of the bearing (1-3, 1-49) in the wheel center and assemble to the knuckle.

③ Put washer (1-20) in place, tighten with nut (1-21) and locked with split pin (1-22). In locking with split pin, locate the hole for the split pin by turning the nut back 1/6 of a turn. Adjust the preload of bearing.

④ Mount the hub cap (1-23).
Bearing should be well greased before assembling.



SECTION 6 HYDRAULIC SYSTEM

SECTION 6 HYDRAULIC SYSTEM

GROUP 1 STRUCTURE AND FUNCTION

1. HYDRAULIC SYSTEM OUTLINE

The hydraulic system is a pilot operated, closed center system which is supplied with flow from the variable displacement main hydraulic pump.
The pilot control system is a low pressure, system which is supplied with flow from the auxiliary pump.

The attachment system components are :

· Main pump
· Auxiliary pump
· Main control valve
· Lift cylinders
· Tilt cylinders
· Remote control valve (Pilot control valve)
· OPSS solenoid valve
· Cut-off valve

The oil from the B2 main pump via the priority spool built in the main control valve is combined with oil from the B1 main pump by parallel passage and flows the main control valve.

The main control valve is a parallel circuit type, closed center valve which routes flow to the lift, tilt and or auxiliary cylinders when the respective spools are shifted.

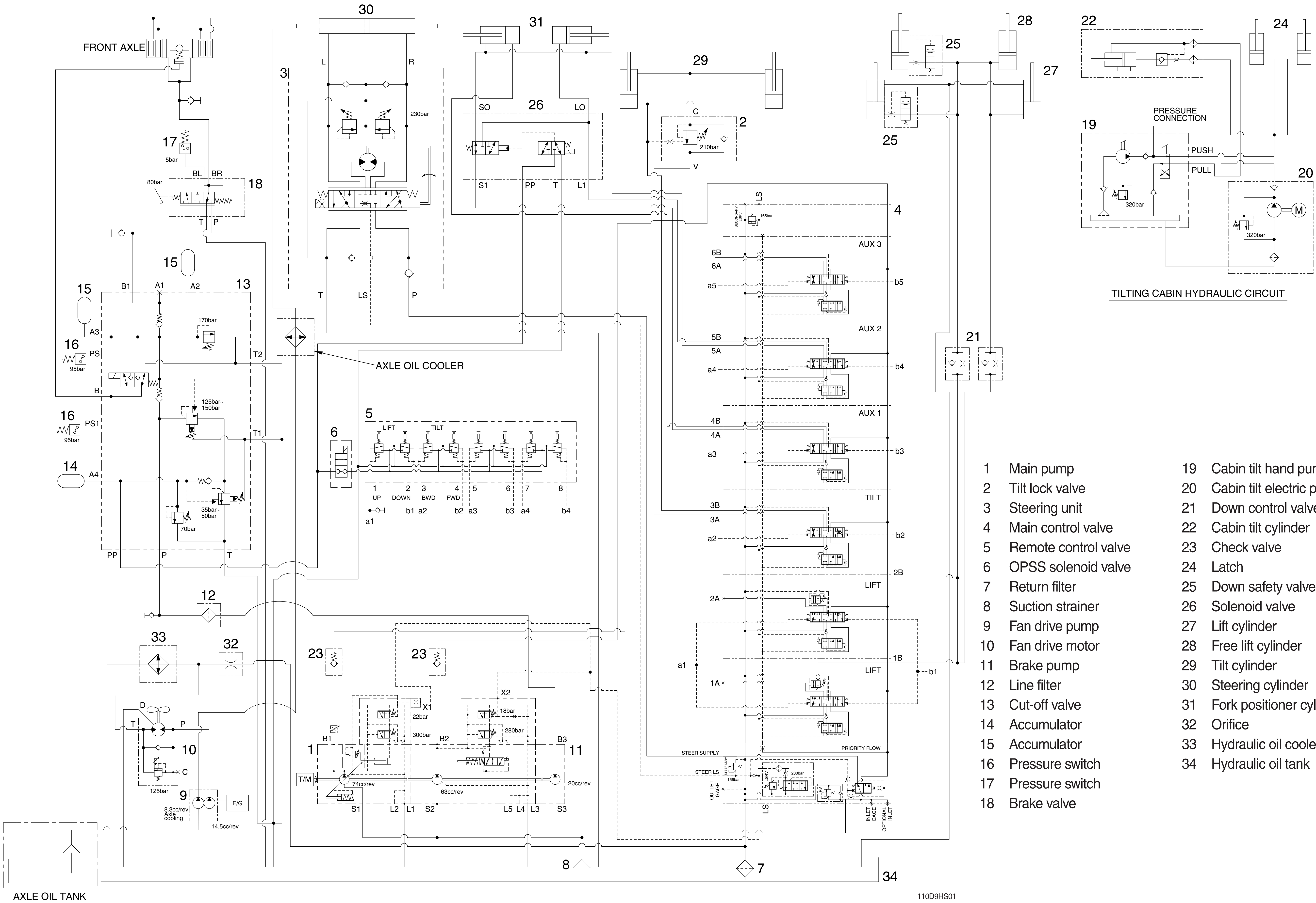
Flow from the brake pump is routed to the cut-off valve that charges the pressure in accumulators. After charging the pressure in accumulators for braking, the flow gose to accumulators for RCV. The cut-off valve flow either to the brake valve or to the remote control valve.
The remote control valve routed flow to either end of each spool valve section in the main control valve to control spool stroke.

A accumulator mounted on the cut-off valve supplies a secondary pressure source to operate remote control valve so the mast 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.

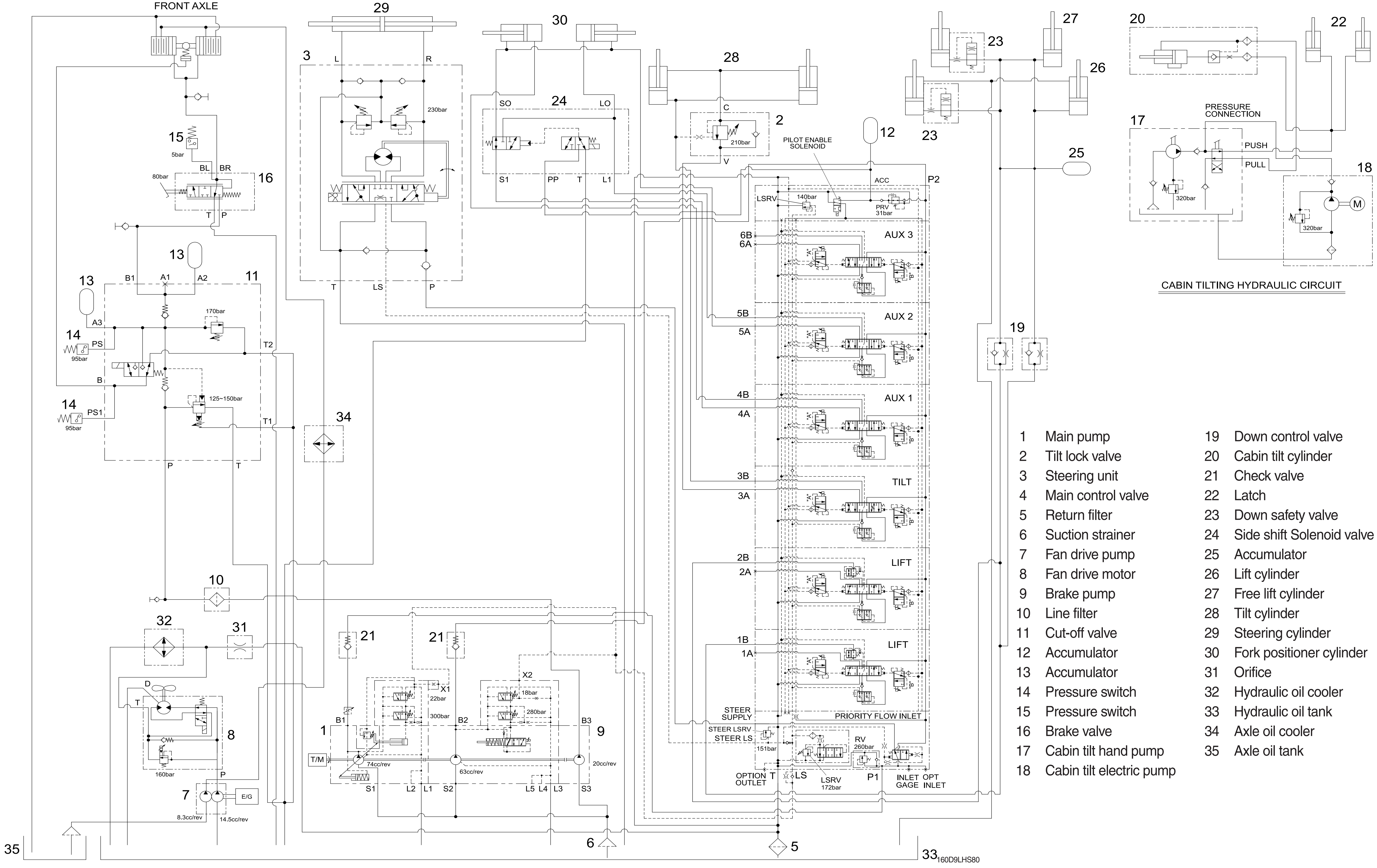
2. HYDRAULIC CIRCUIT

· REMOTE CONTROL LEVER TYPE



1 Main pump	19 Cabin tilt hand pump
2 Tilt lock valve	20 Cabin tilt electric pump
3 Steering unit	21 Down control valve
4 Main control valve	22 Cabin tilt cylinder
5 Remote control valve	23 Check valve
6 OPSS solenoid valve	24 Latch
7 Return filter	25 Down safety valve
8 Suction strainer	26 Solenoid valve
9 Fan drive pump	27 Lift cylinder
10 Fan drive motor	28 Free lift cylinder
11 Brake pump	29 Tilt cylinder
12 Line filter	30 Steering cylinder
13 Cut-off valve	31 Fork positioner cylinder
14 Accumulator	32 Orifice
15 Accumulator	33 Hydraulic oil cooler
16 Pressure switch	34 Hydraulic oil tank
17 Pressure switch	
18 Brake valve	

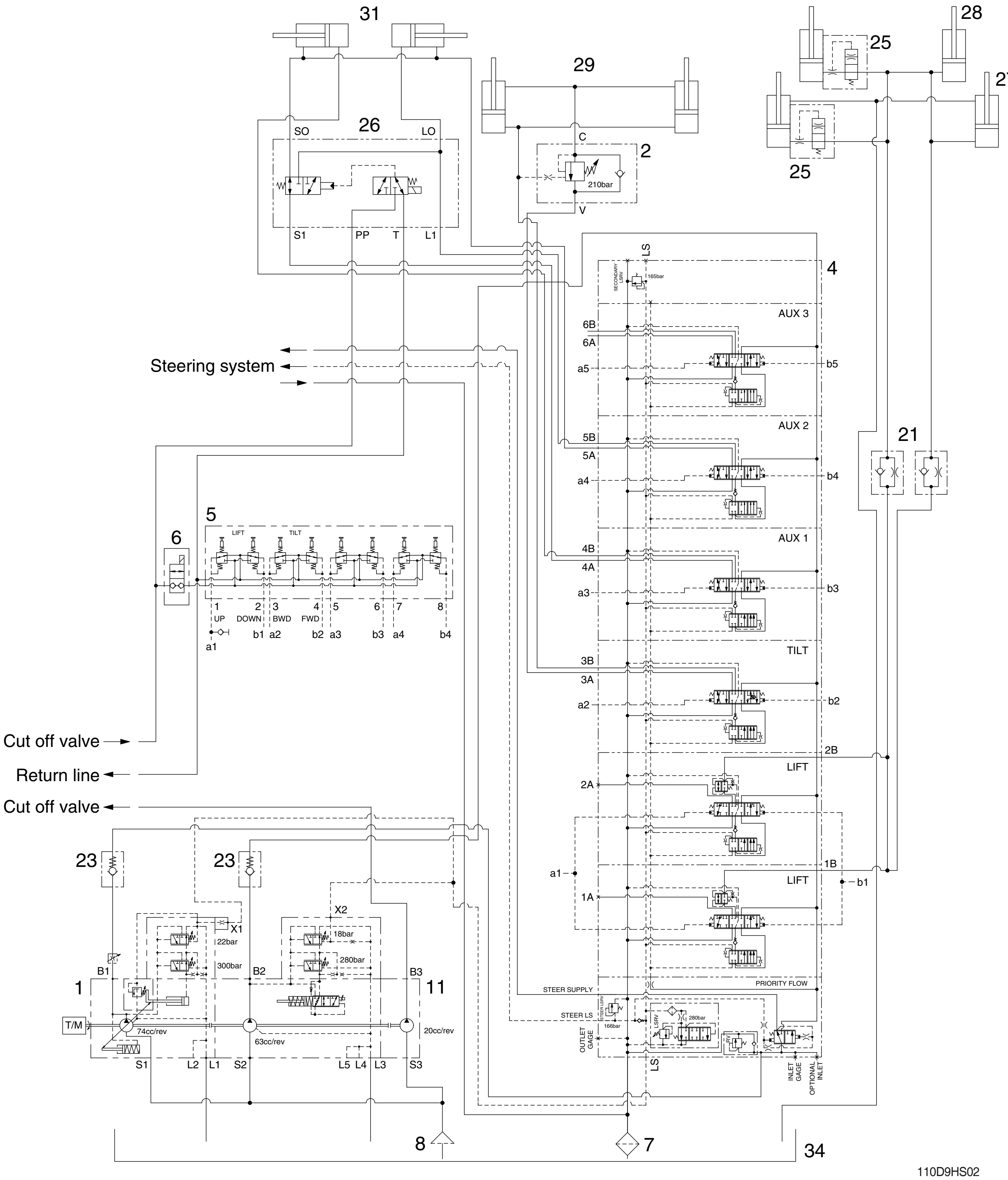
· FINGERTIP TYPE



1 Main pump
2 Tilt lock valve
3 Steering unit
4 Main control valve
5 Return filter
6 Suction strainer
7 Fan drive pump
8 Fan drive motor
9 Brake pump
10 Line filter
11 Cut-off valve
12 Accumulator
13 Accumulator
14 Pressure switch
15 Pressure switch
16 Brake valve
17 Cabin tilt hand pump
18 Cabin tilt electric pump
19 Down control valve
20 Cabin tilt cylinder
21 Check valve
22 Latch
23 Down safety valve
24 Side shift Solenoid valve
25 Accumulator
26 Lift cylinder
27 Free lift cylinder
28 Tilt cylinder
29 Steering cylinder
30 Fork positioner cylinder
31 Orifice
32 Hydraulic oil cooler
33 Hydraulic oil tank
34 Axle oil cooler
35 Axle oil tank

3. WORK EQUIPMENT HYDRAULIC CIRCUIT

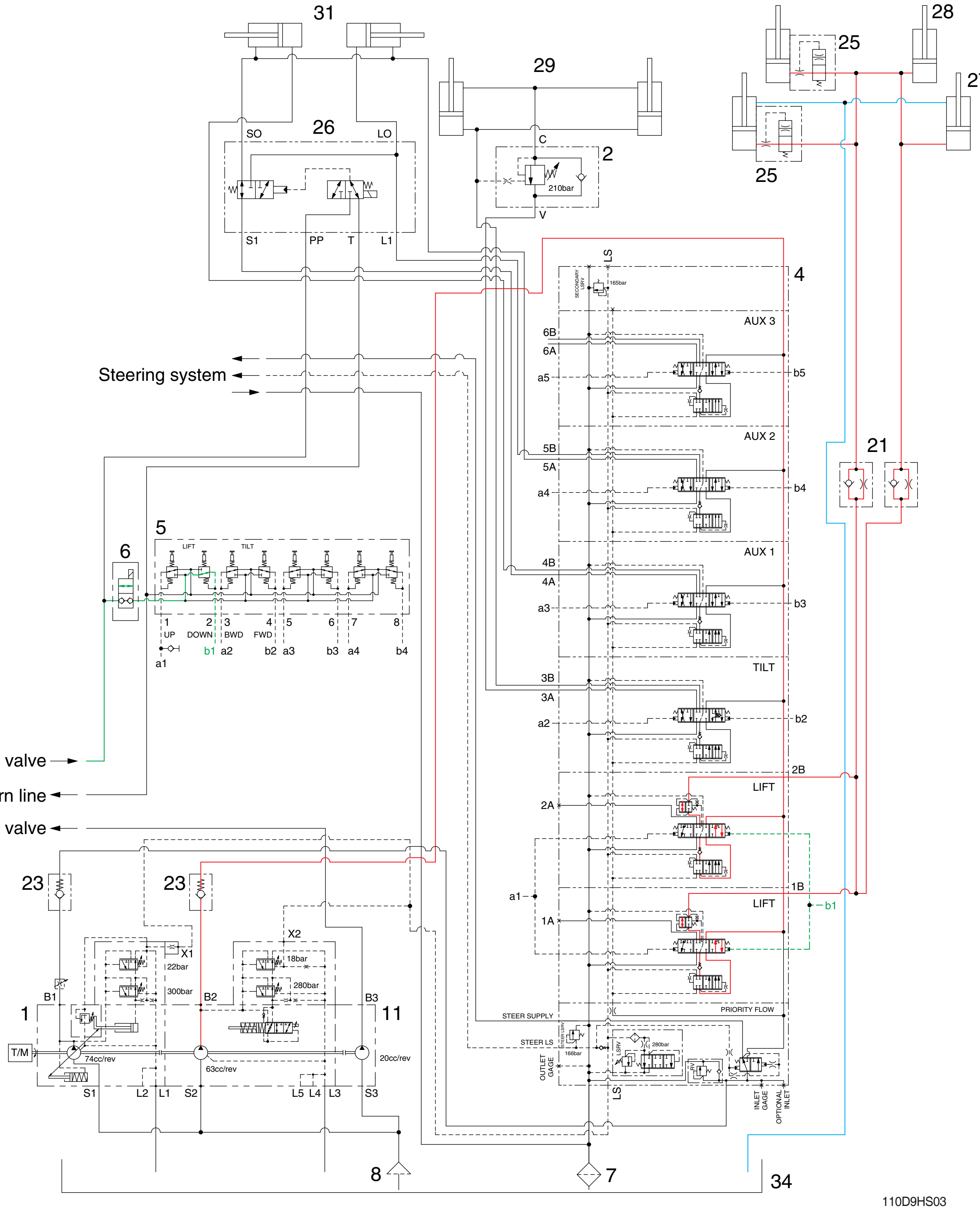
※ The operating explain is based on the remote control lever type.



1	Main pump	11	Brake pump	27	Lift cylinder
2	Tilt lock valve	21	Down control valve	28	Free lift cylinder
4	Main control valve	23	Check valve	29	Tilt cylinder
5	Remote control valve	25	Down safety valve	31	Fork positioner cylinder
6	OPSS solenoid valve	26	Side shift solenoid valve (160D-9 only)	34	Hydraulic oil tank
7	Return filter				
8	Suction strainer				

※ The circuit diagram may differ from the equipment, so please check before a repair.

1) WHEN THE LIFT CONTROL LEVER IS IN THE LIFT POSITION



When the lift control lever is pulled back, the spool is moves to lift position by the pilot oil pressure from the remote control valve (5).

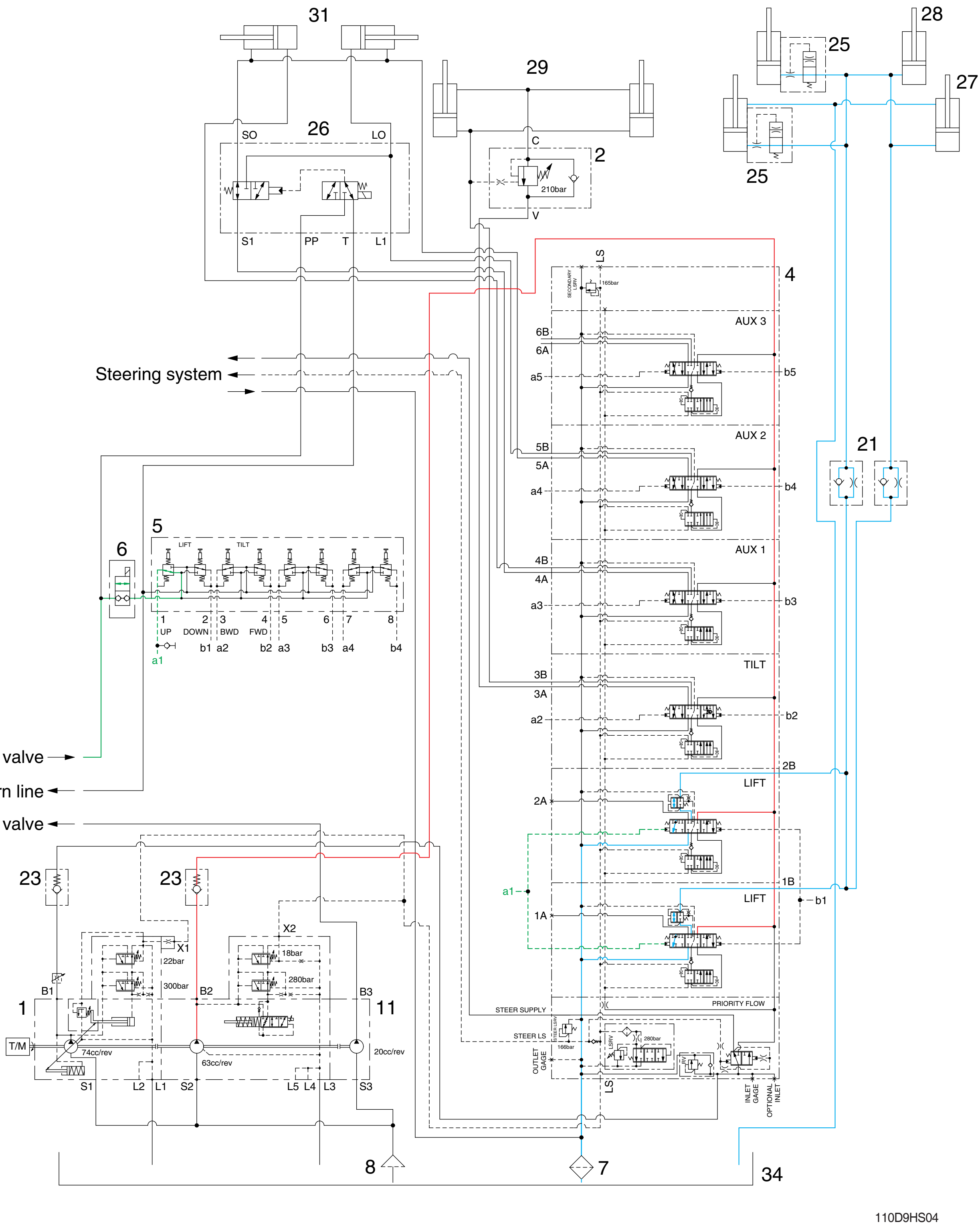
The oil from hydraulic main pump (1) flows into main control valve (4) and then goes to the large chamber of lift cylinder (27) by pushing the load check valve of the spool.

The oil from the small chamber of lift cylinder (27) returns to hydraulic oil tank (34) at the same time.

When this happens, the forks go up.

※ The circuit diagram may differ from the equipment, so please check before a repair.

2) WHEN THE LIFT CONTROL LEVER IS IN THE LOWER POSITION

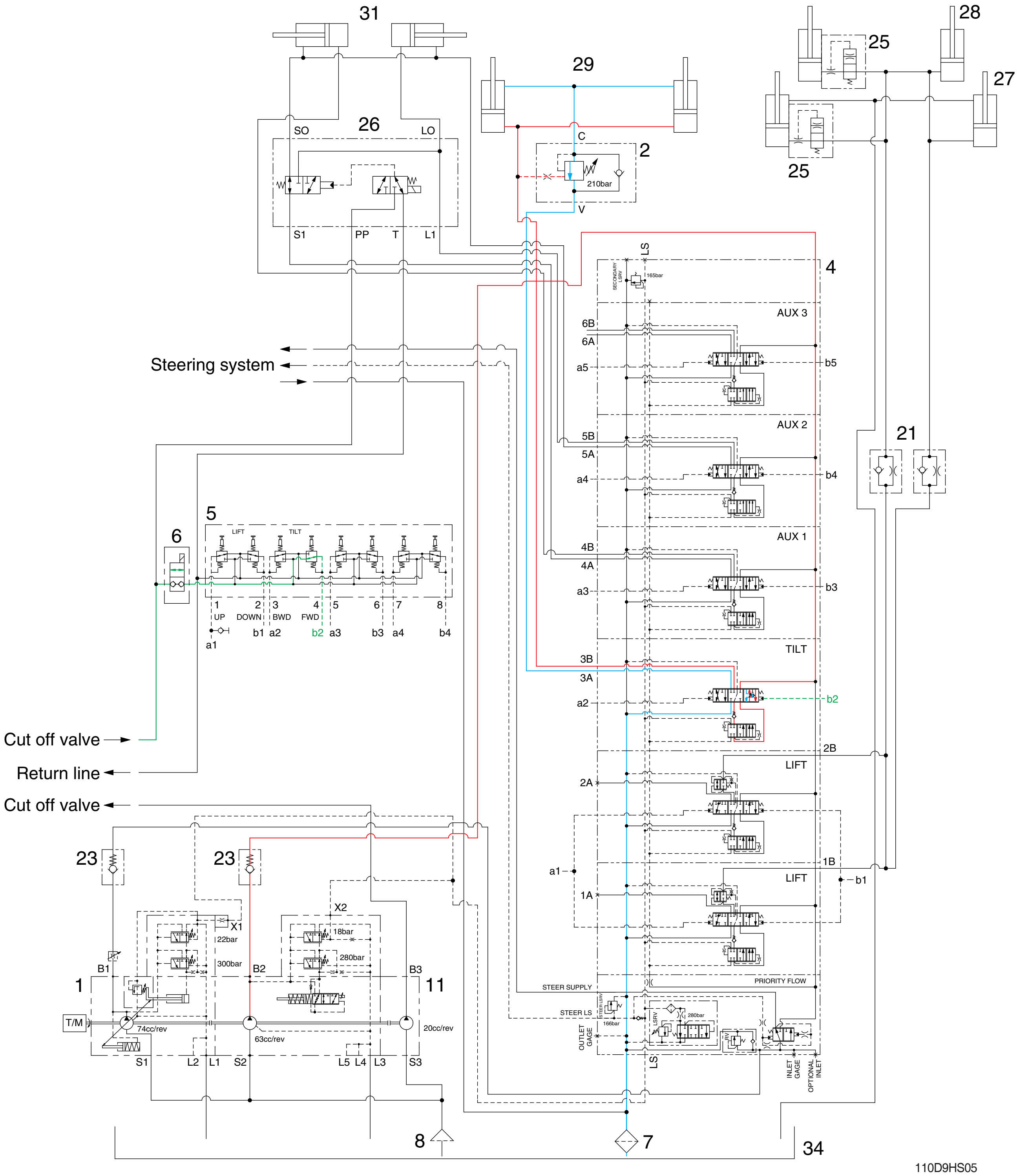


When the lift control is pushed forward, the spool is moved to lower position by the pilot oil pressure from the remote control valve (5).

The work ports (1B, 2B) and the small chamber and the large chamber are connected to the return passage, so the lift will be lowered due to its own weight.

※ The circuit diagram may differ from the equipment, so please check before a repair.

3) WHEN THE TILT CONTROL LEVER IS IN THE FORWARD POSITION



When the tilt control lever is pushed forward, the spool is moved to tilt forward position by the pilot oil pressure from the remote control valve (5).

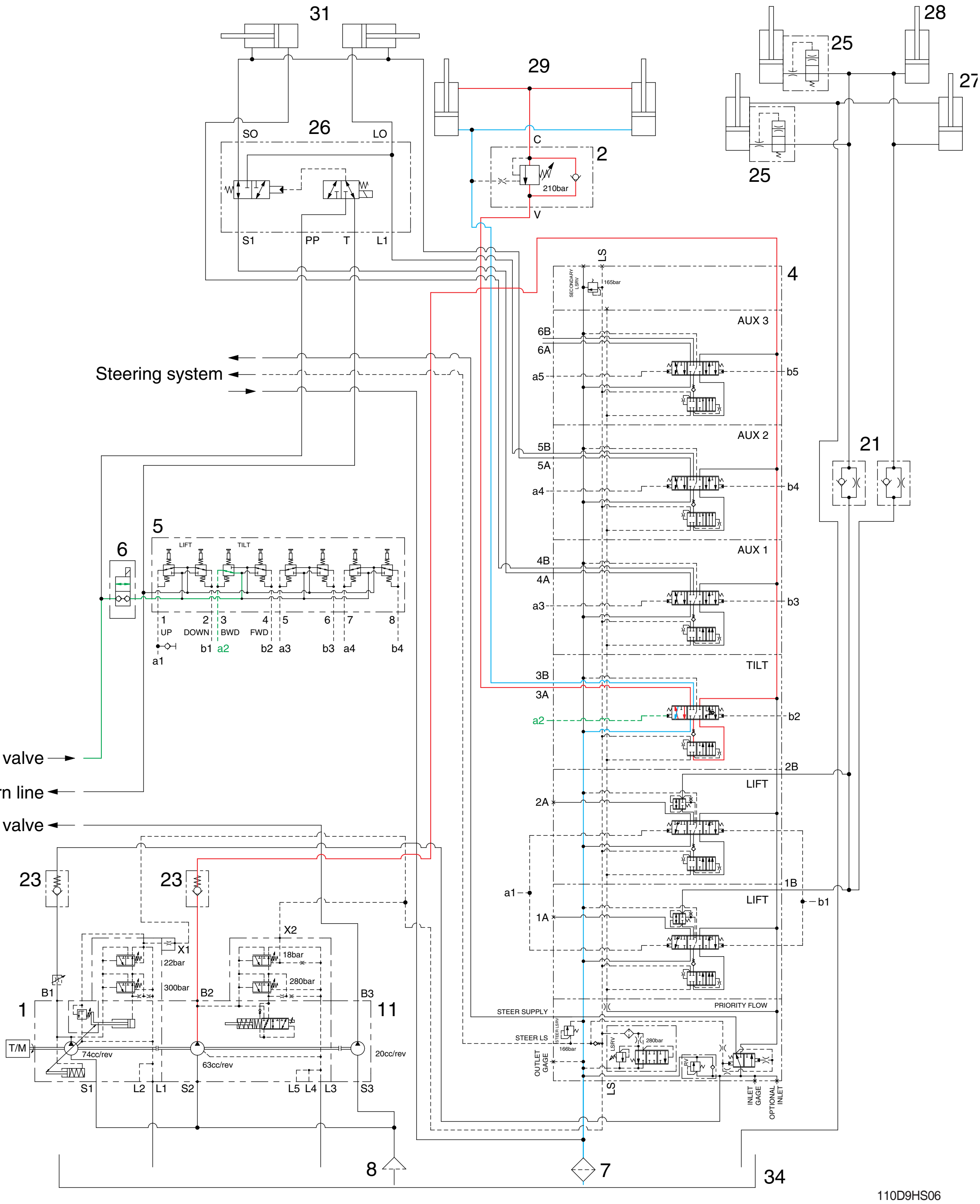
The oil from hydraulic main pump (1) flows into main control valve (4) and then goes to the large chamber of tilt cylinder (29) by pushing the load check valve of the spool.

The oil at the small chamber of tilt cylinder (29) returns to hydraulic tank (34) at the same time.

When this happens, the mast tilt forward.

※ The circuit diagram may differ from the equipment, so please check before a repair.

4) WHEN THE TILT CONTROL LEVER IS IN THE BACKWARD POSITION



When the tilt control lever is pulled back, the spool is moved to tilt backward position by the pilot oil pressure from the remote control valve (5).

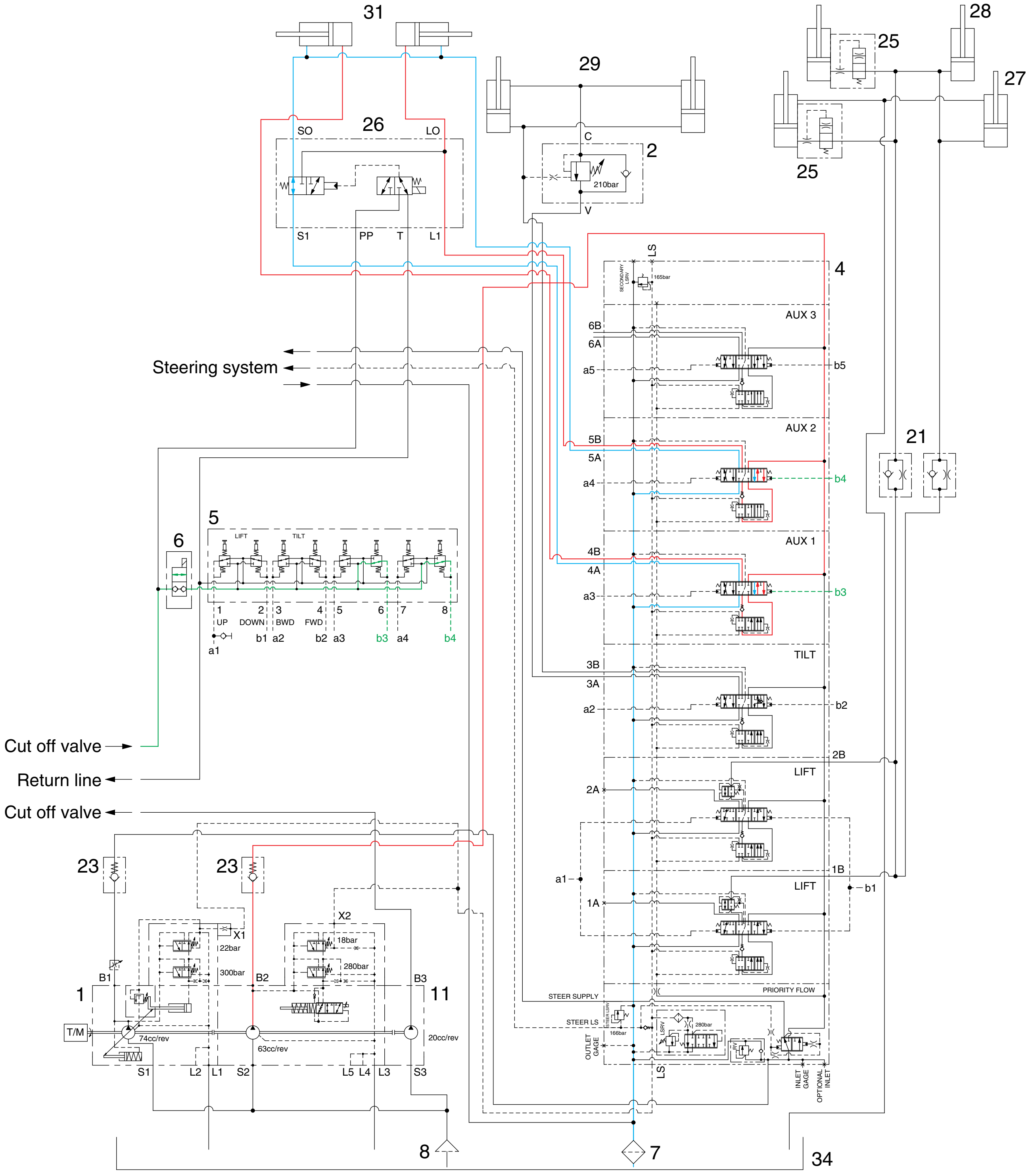
The oil from hydraulic main pump (1) flows into main control valve (4) and then goes to the small chamber of tilt cylinder (29) by pushing the load check valve of spool.

The oil at the large chamber of tilt cylinder (29) returns to hydraulic tank (34) at the same time.

When this happens, the mast tilt backward.

※ The circuit diagram may differ from the equipment, so please check before a repair.

5) WHEN THE FORK POSITIONER LEVER IS IN THE SPREAD-OUT POSITION(OPTION)

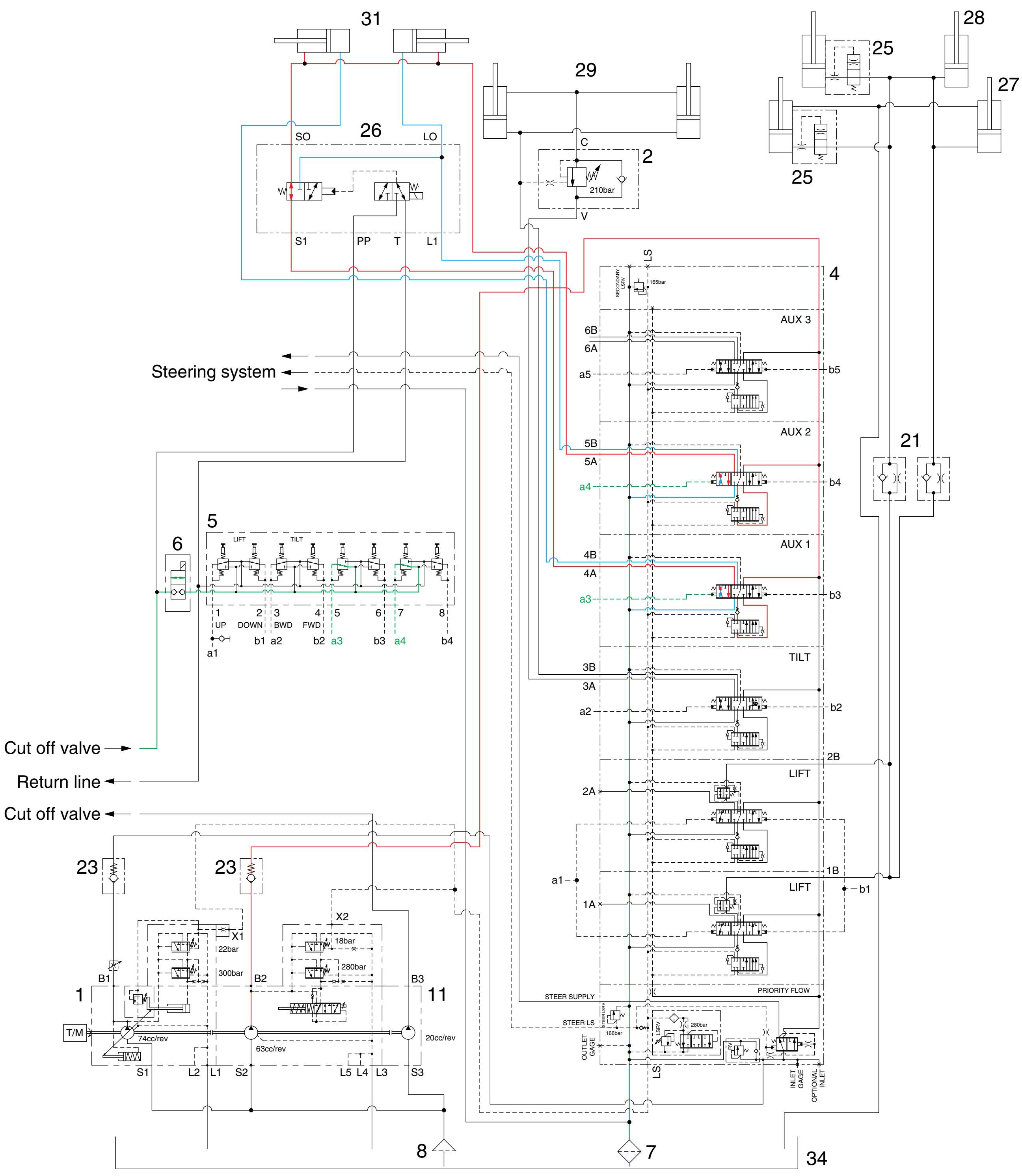


110D9HS07

When the fork positioner lever is pulled back, the spool is moved to fork spread-out position by the pilot oil pressure from the remote control valve (5). The oil from hydraulic main pump (1) flows into main control valve (4) and then goes to the large chamber of fork positioner cylinder (31) by pushing the load check valve of the spool. The oil from small chamber of the cylinder (31) returns to hydraulic oil tank (34) at the same time. When this happens the forks are spread out.

※ The circuit diagram may differ from the equipment, so please check before a repair.

6) WHEN THE FORK POSITIONER LEVER IS IN THE CLOSE POSITION (OPTION)



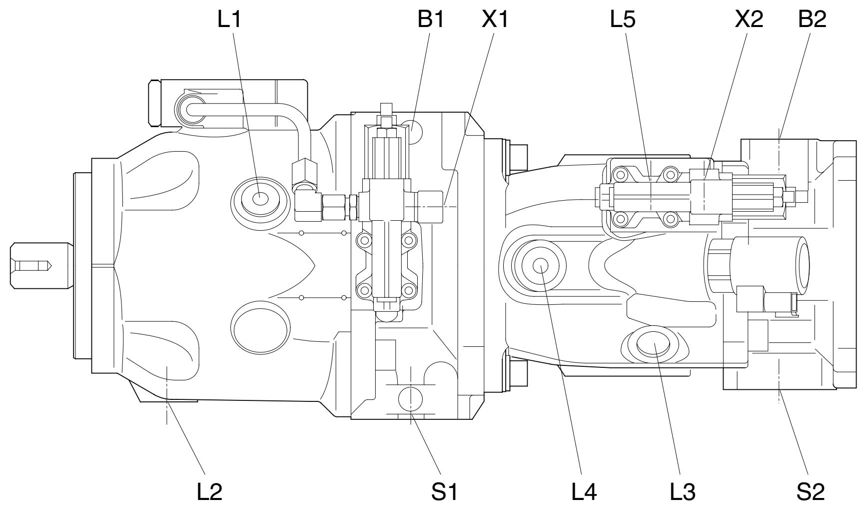
When the fork positioner lever is pushed forward, the spool is moved to fork close position by the pilot oil pressure from the remote control valve (5). The oil from hydraulic main pump (1) flows into main control valve (4) and then goes to the small chamber of fork positioner cylinder (31) by pushing the load check valve of the spool. The oil from large chamber of the cylinder (31) returns to hydraulic oil tank (34) at the same time. When this happens, the forks are close each other.

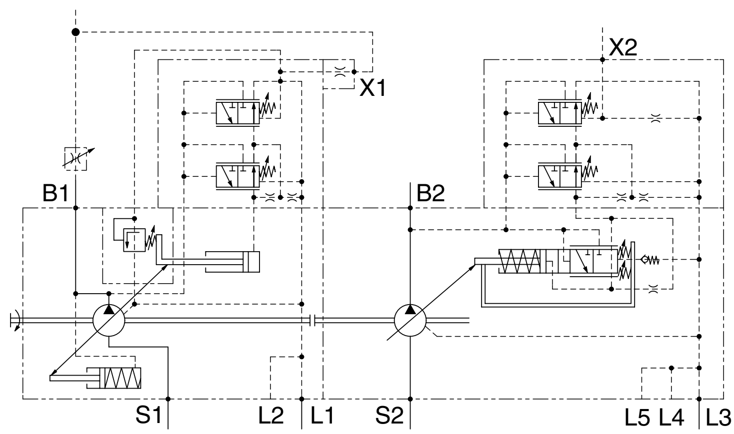
※ The circuit diagram may differ from the equipment, so please check before a repair.

4. MAIN PUMP

1) STRUCTURE (1/2)

This variable displacement piston pump consists of steering pump and working pump.

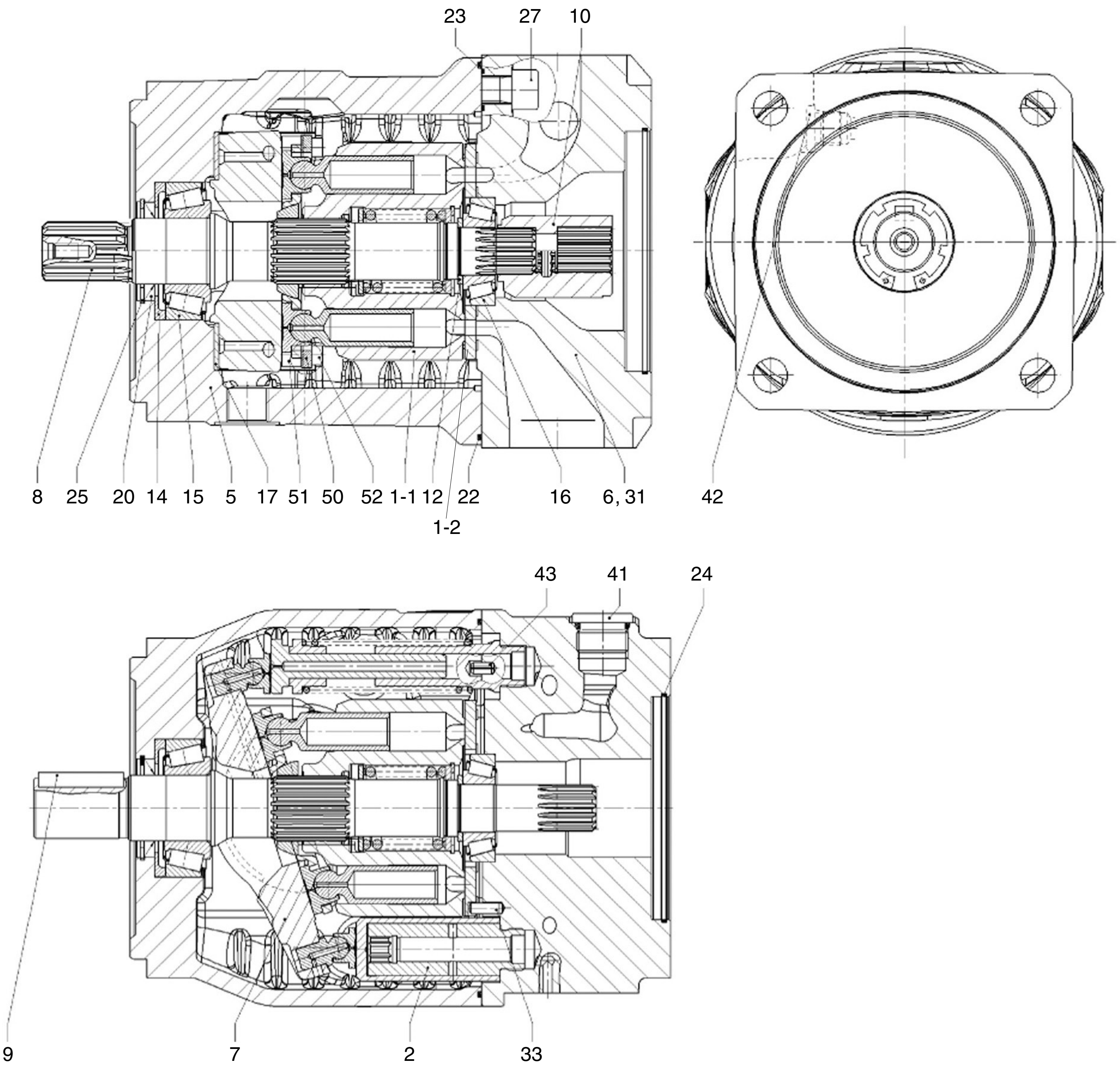




110D9MP04

Port	Port name	Size
B1	Pressure port	SAE 1"
B2	Pressure port	SAE 1"
S1	Suction port	SAE 2"
S2	Suction port	SAE 2"
L1, L2	Case drain port	7/8-14UNF-28
L3, L4	Case drain port	7/8-14UNF-28
X1, X2	Pilot pressure port	7/16-20UNF-28

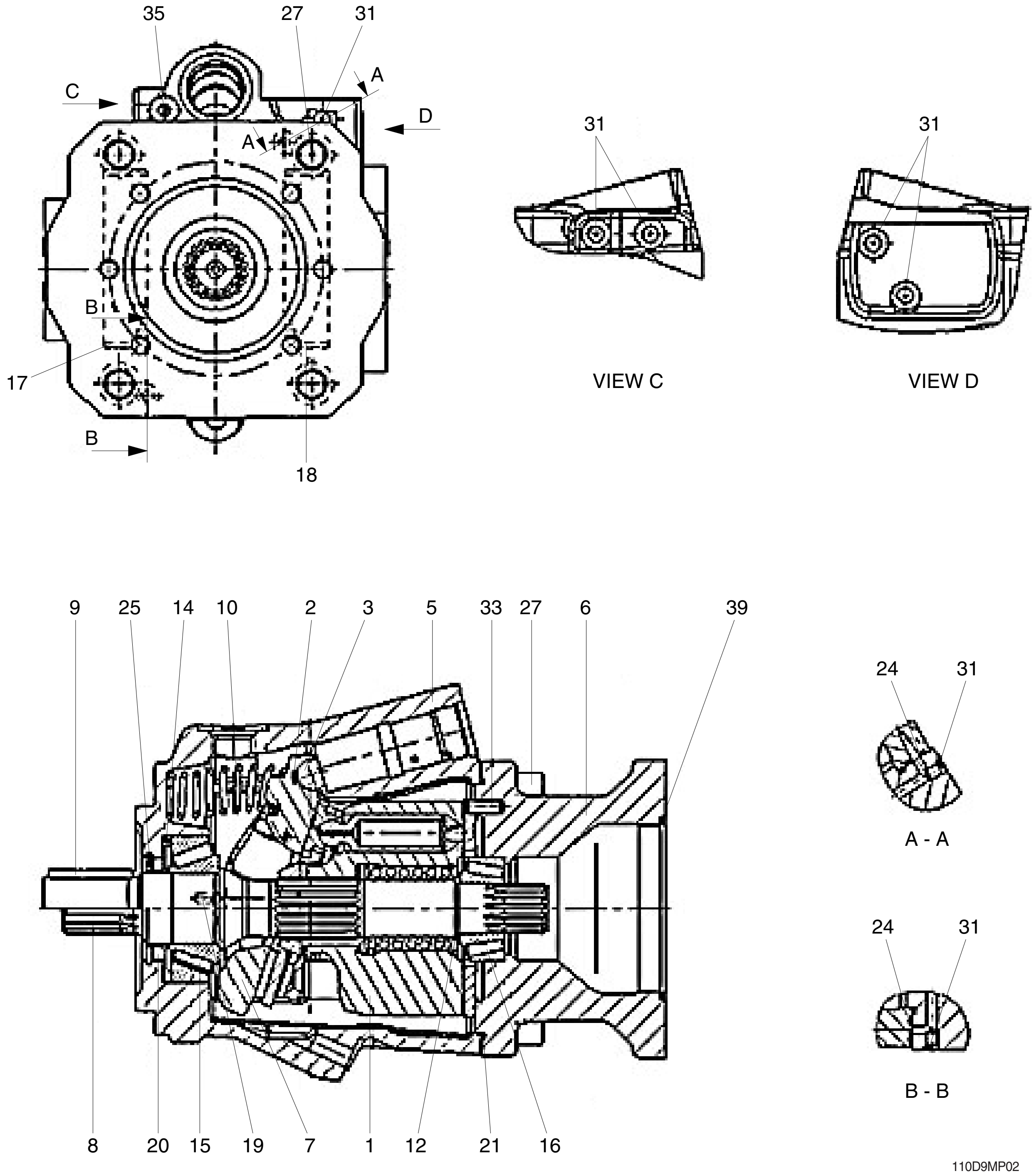
· FRONT PUMP



110DEMP01

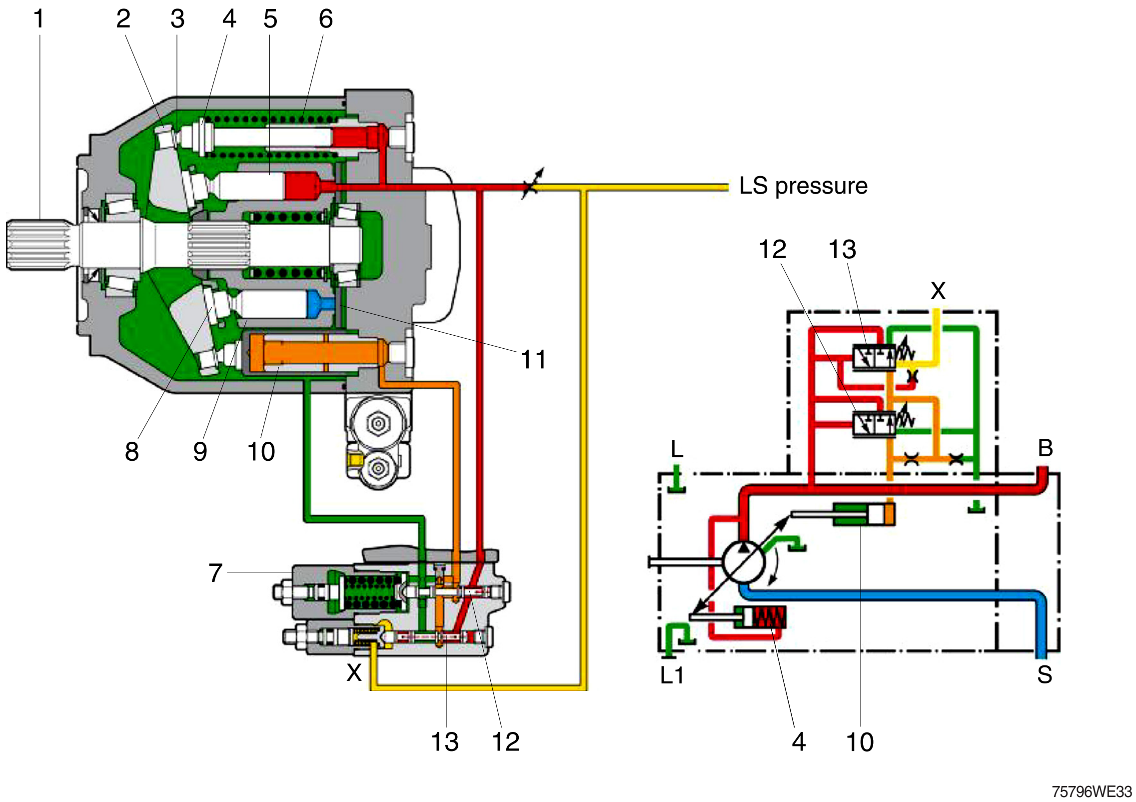
1-1	Rotary group	14	Stop ring	31	Double break off pin
1-2	Control plate	15	Taper roller bearing	33	Cylinder pin
2	Adjusting piece	16	Taper roller bearing	41	Plug
5	Pump housing	17	Bearing liner	42	Plug
6	Port plate	20	Shaft seal ring	43	Plug
7	Swash plate	22	O-ring	50	Segment
8	Drive shaft	23	O-ring	51	Spacer sleeve
9	Key	24	O-ring	52	Socket screw
10	Splined hub	25	Retaining ring		
12	Shim	27	Socket screw		

· REAR PUMP



1	Rotary group	12	Shim	21	O-ring
2	Pressure spring	14	Stop ring	24	Seal ring
3	Stop	15	Taper roller bearing	25	Retaining ring
5	Pump housing	16	Taper roller bearing	27	Socket screw
6	Port plate	17	Bearing liner	31	Double break off pin
7	Swash plate	18	Bearing liner	33	Cylinder pin
8	Drive shaft	19	Socket screw	35	Locking screw
10	Spring	20	Shaft seal ring	39	O-ring

2) FUNCTION



1	Drive shaft	6	Counter spring	11	Control plate
2	Swash plate	7	Pressure & flow compensator valve	12	Pressure compensator spool
3	Shoe plate	8	Piston shoe	13	Flow compensator spool
4	Counter piston	9	Cylinder		
5	Piston	10	Control piston		

The steering pump and attachment pump are variable displacement piston pump. The steering pump and attachment pump are flow controlled by LS signal. When the steering and attachment are not being used, the pumps are at low pressure standby.

The load sensing pressure that is sensed from steering and attachment hydraulic systems flows to flow compensator spool (13). This spool keeps the pump output at a level that is necessary to fulfill the requirements for the system flow and for the pressure.

The pressure compensator spool (12) also limits maximum system pressure. The pressure compensator spool (12) prevents damage to the steering and attachment hydraulic components from excessive pressure.

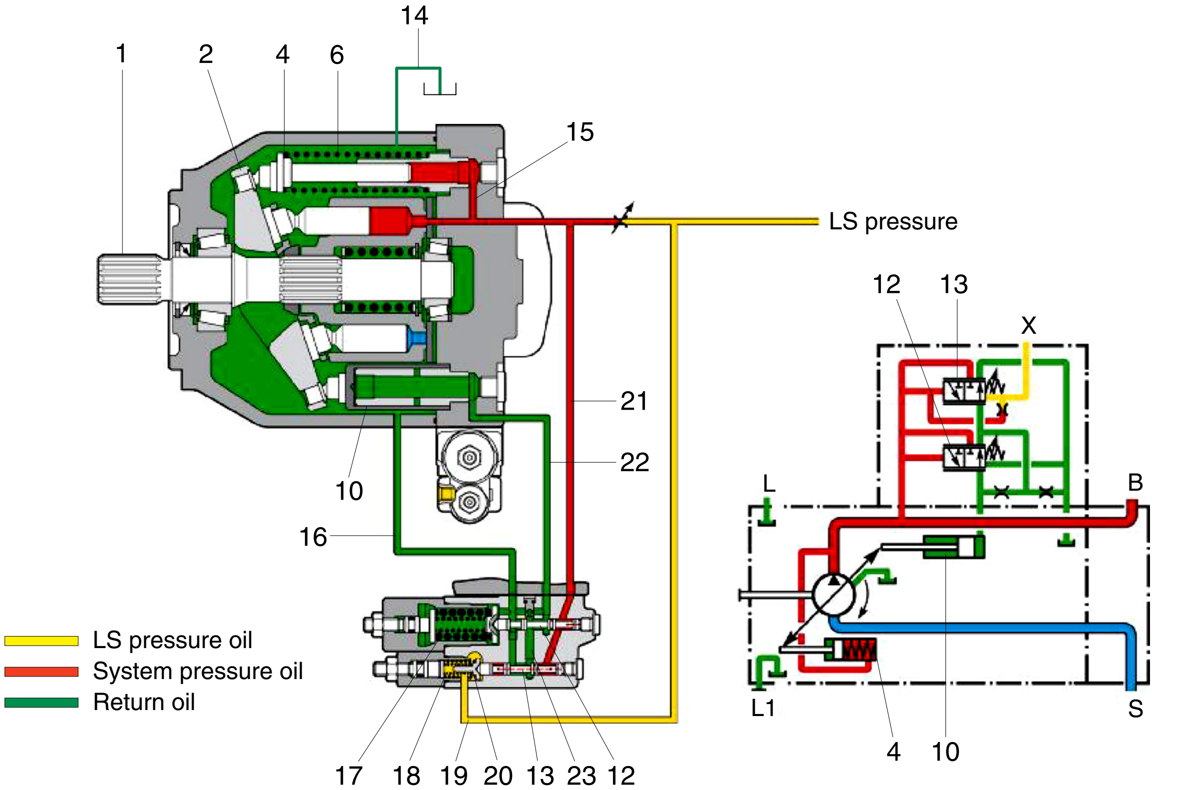
The swivel angle of the pumps is controlled by counter piston (4) and control piston (10). Counter spring (6) cause swash plate (2) to move at maximum displacement or causes swash plate (2) to upstroke.

Control piston (10) has a larger area (diameter) than counter piston (4). Control piston (10) causes swash plate (2) to destroke the pump.
Flow compensator spool (13) and/or pressure compensator spool (12) changes pump output by regulating the pump discharge pressure that is acting on control piston (10).

Control piston (10) diameter is larger than counter piston (4) diameter, the oil pressure that is acting against control piston (10) overcomes the force of counter spring (6). The oil pressure than causes the pump to destoke.

Pressure and flow compensator valve (7) also controls the maximum output of pump pressure.
When steering and loader pressure rises above pressure compensator setting, pressure compensator spool (12) overrides flow compensator spool (13). This causes the pump to destroke.

(1) Upstroking



75796WE35

1	Drive shaft	13	Flow compensator spool	19	LS line from the metering pump
2	Swash plate	14	Case drain	20	Cavity
4	Counter piston	15	Passage	21	Passage
6	Counter spring	16	Passage	22	Passage
10	Control piston	17	Spring	23	Cavity
12	Pressure compensator spool	18	Spring		

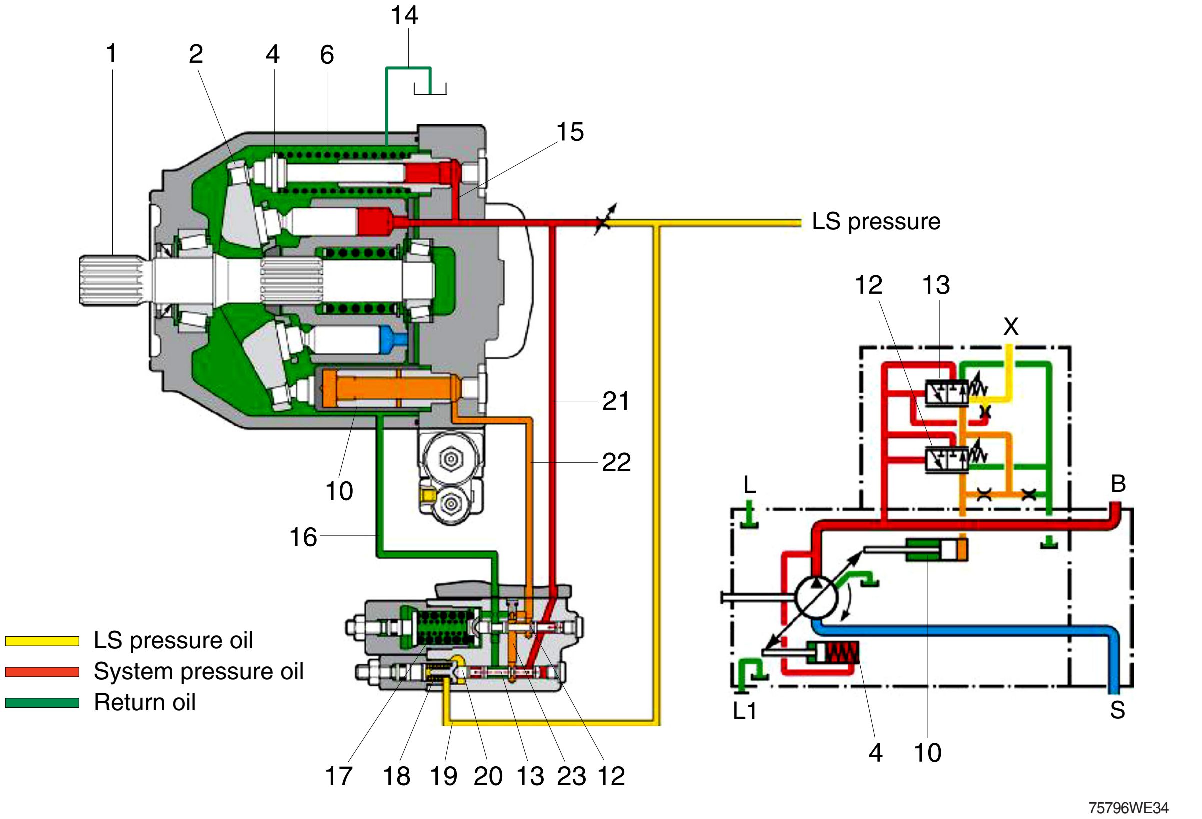
Upstroking of the pump occurs as flow demand from attachment and steering system.
The increased flow demand causes a LS pressure in LS line (19). The LS pressure in LS line (19) combines with the force of spring (18) in cavity (20).
The force of spring (18) causes pump pressure to be higher than the LS pressure (19).
If the combination of LS pressure and of spring force is greater than the pump discharge pressure, this difference pressure causes spool (13) to move right. As spool (13) moves right, the spool (13) blocks the flow of supply oil to control piston (10). Pump swash plate (2) is controlled by pressure and flow as much as hydraulic system requests.

When the oil flow to control piston (10) is blocked, the pilot oil in passage (22) drains to passage (23). The oil then flows past pressure compensator spool (12) and through passage (16) into the housing and via the drain line (14) to tank.

Supply oil flows through passage (15) to counter piston (4). The oil acts against counter piston (4).
The oil combines with the force of counter spring (6). This causes swash plate (2) to upstroke.

This also causes the pump flow to increase. As flow requirements are satisfied, the pump output pressure increase. The pressure increases until the pressure in passage (15) moves flow compensator spool (13) up to be satisfied with system requirement for pressure and flow.
¡¤Pump discharge pressure = force of spring (18) + LS pressure (19)

(2) Destroking



1	Drive shaft	13	Flow compensator spool	19	LS line from the metering pump
2	Swash plate	14	Case drain	20	Cavity
4	Counter piston	15	Passage	21	Passage
6	Counter spring	16	Passage	22	Passage
10	Control piston	17	Spring	23	Cavity
12	Pressure compensator spool	18	Spring		

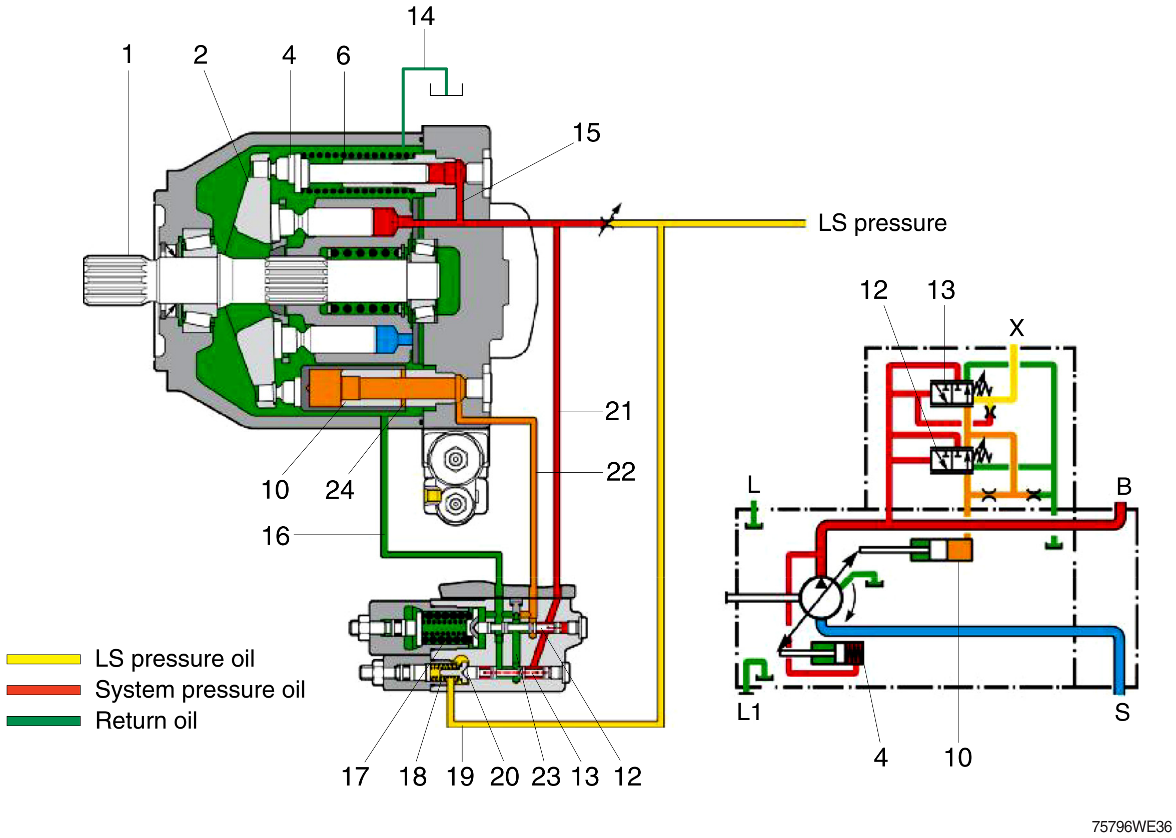
The decreased flow demand causes a LS pressure in line (19). The LS pressure in line (19) combines with the force of spring (18) in cavity (20).
This combination of LS pressure and of spring force is less than the pump pressure in passage (21). This causes flow compensator spool (13) to move left.
Pump oil now flows through passage (15). The oil then flows past flow compensator spool (13), through passage (22), and then to control piston (10).

The pump pressure behind control piston (10) is now greater than the combined force of counter piston(4) and of counter spring (6). The angle of swash plate (2) decreases.
This decreases the pump output and the system pressure.

When the lower flow requirements are met, flow compensator spool (13) moves right up to the balanced position. Swash plate (2) maintains an angle that is sufficient to provide the lower required pressure. If the operator does not turn the steering wheel and does not move RCV, then the pump will return to low pressure standby.

※ Control piston ¡æ Changes pump displacement ; influenced by controller.
Counter piston ¡æ Helps to change pump displacement but no possible to control this piston.

(3) Low pressure standby



1	Drive shaft	13	Flow compensator spool	19	LS line from the metering pump
2	Swash plate	14	Case drain	20	Cavity
4	Counter piston	15	Passage	21	Passage
6	Counter spring	16	Passage	22	Passage
10	Control piston	17	Spring	23	Cavity
12	Pressure compensator spool	18	Spring	24	Cross-drilled hole

Low pressure standby constitutes the following condition: a running engine and inactive steering and attachment. There are no flow demands on the pump or pressure demands on the pump. Therefore, there is no LS pressure in line (19).
Before you start the engine, counter spring (6) holds swash plate (2) at the maximum angle. As the pump begins to turn, oil begins to flow and pressure increases in the system.
Because of close centered steering control valve and close centered loader hydraulic system.

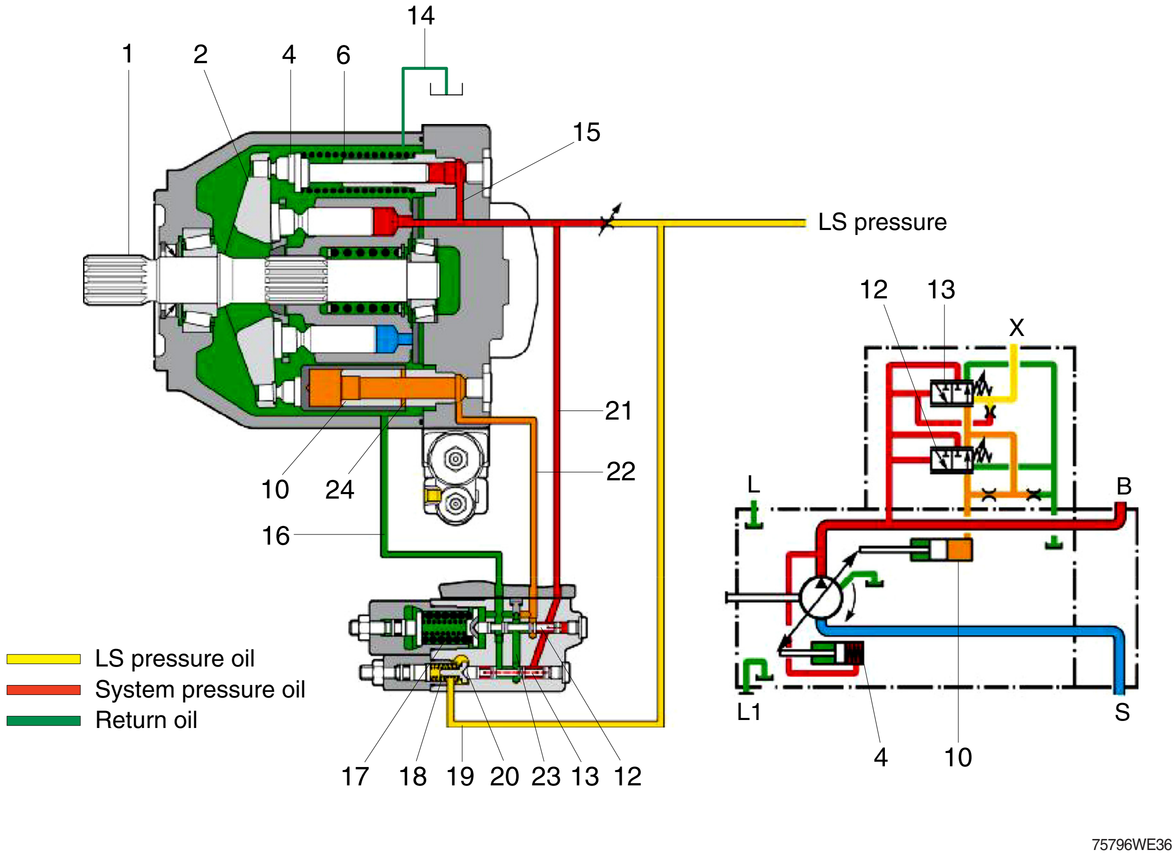
As this pressure increase, the pressure pushes flow compensator spool (13) against spring (18). This causes flow compensator spool (13) to move left. This opens passage (23) in order to allow pressure oil to flow to control piston (10).

The oil acts against control piston (10) in order to overcome the force of counter spring (6). The oil causes control piston (10) to move to the left.
When control piston (10) moves to the left, the piston moves swash plate (2) toward the minimum angle. Control piston (10) continues to move to the left until cross-drilled hole (24) allows the oil to drain to the case.

Cross-drilled hole (24) limits the maximum travel of control piston (10) to the left. The pump supplies a sufficient amount of flow that compensates for system leakage. The pump also supplies a sufficient of flow that compensates for leakage to the pump case. The leakage to the pump case is a result of the cross-drilled hole. The pump maintains low pressure standby. Low pressure standby pressure should not exceed 40 bar (580 psi).

※ Low pressure standby will vary in the same pump as the system leakage or the pump leakage increases. The pump will upstroke slightly in order to compensate for the increasing leakage. Control piston (10) will cover more of the cross-drilled hole.

(4) High pressure stall



1	Drive shaft	13	Flow compensator spool	19	LS line from the metering pump
2	Swash plate	14	Case drain	20	Cavity
4	Counter piston	15	Passage	21	Passage
6	Counter spring	16	Passage	22	Passage
10	Control piston	17	Spring	23	Cavity
12	Pressure compensator spool	18	Spring		

When the hydraulic system stalls under load or when the cylinders reach the end of the stroke, the main system pressure increases. But LS pressure (19) is regulated by LS relief valve on steering system and attachment system. The pressure difference between discharged pump and LS pressure equal to spring (18). It means no flow is necessary. Therefore, discharged pressure push flow compensator spool (13) left . Supply oil now flows past flow compensator spool (13) and through passage (23). The oil flows past flow compensator spool (13) and into passage (22). The oil then flows to control piston (10).
Pump swash plate (2) will be minimum displacement if the operator does not turn the steering wheel and RCV, then the pump will return to low pressure standby.

(5) Adjustment of flow control

Flow compensator setting must be carried out following procedures and conditions.

① Conditions

- Engine is running (at high or low idle).
- RCV is operated slowly (example : Boom up).
- Pressure gauges are installed.

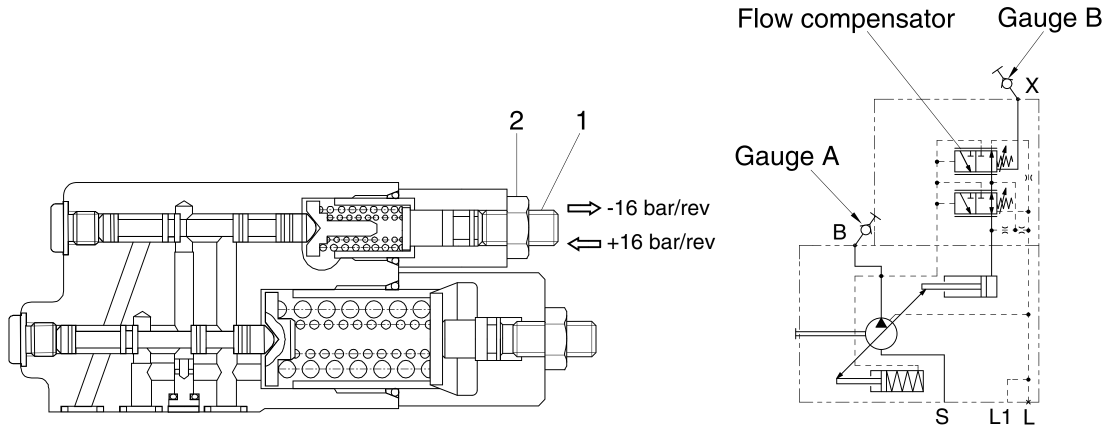
※ Discharge pump flow should be less than max pump flow.

② Procedures

- Loosening the hexagon nut (2).
- Adjusting screw (1) of flow controller by tightening or loosing the screw (1).

Flow setting : P = Gauge A - Gauge B

Specification : Steering pump (22 bar) / Attachment pump (18 bar)



75796WE37

(6) Adjustment of pressure control

Pressure compensator setting must be carried out following procedures and conditions.

① Conditions

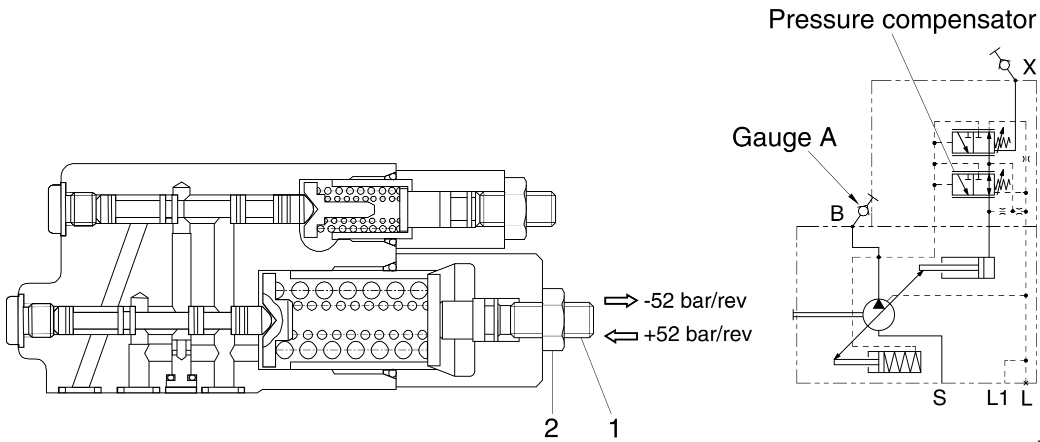
- Engine is running.
- System is at relief condition.

② Procedures

- Loosening the hexagon nut (2).
- Adjusting screw (1) of pressure controller by tightening or loosing the screw (1).

Maximum pressure setting = Gauge A

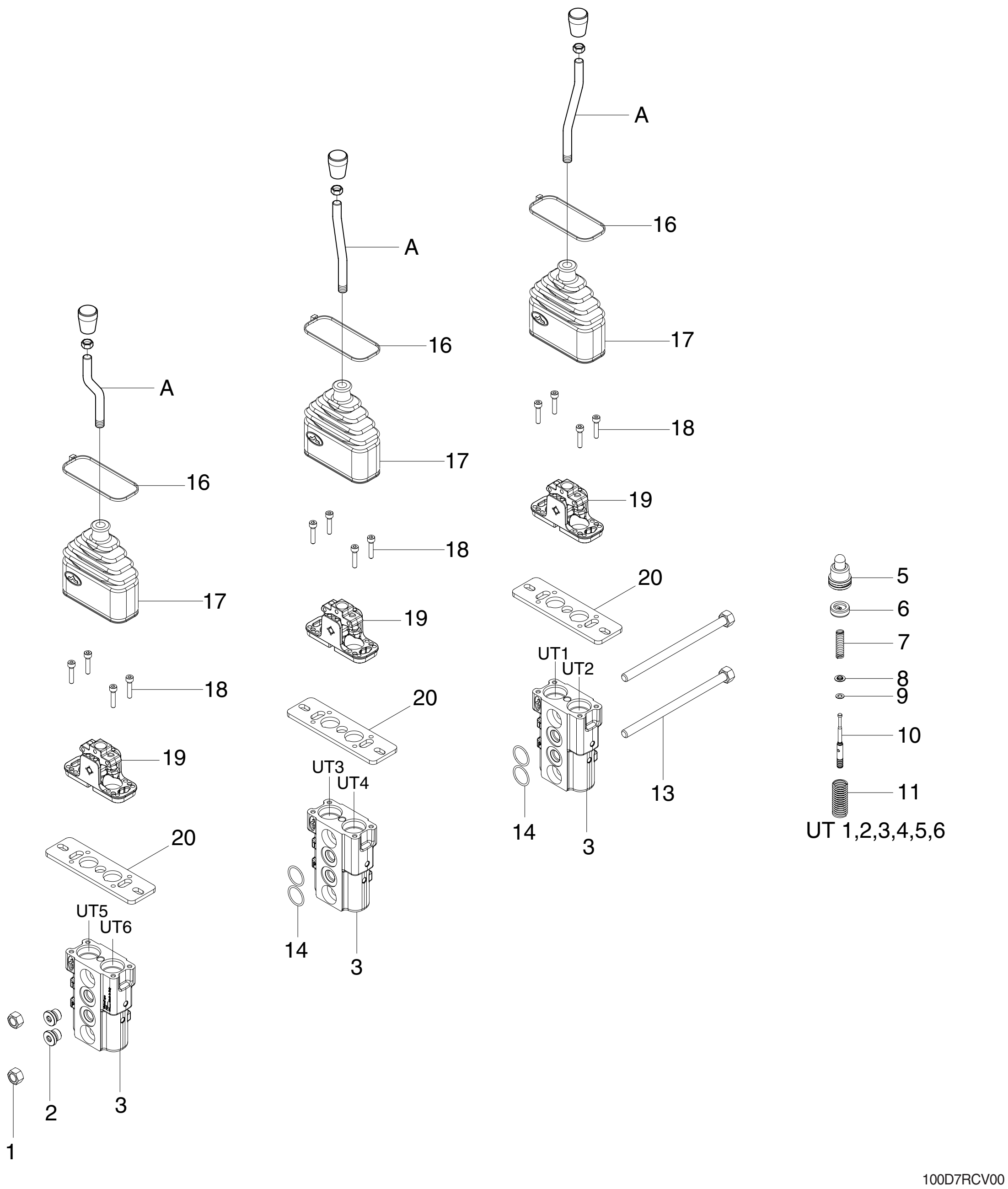
Specification : Steering pump (300 bar) / Attachment pump (280 bar)



75796WE38

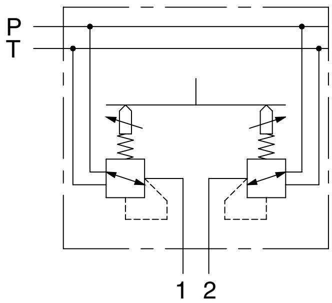
5. REMOTE CONTROL VALVE

1) STRUCTURE

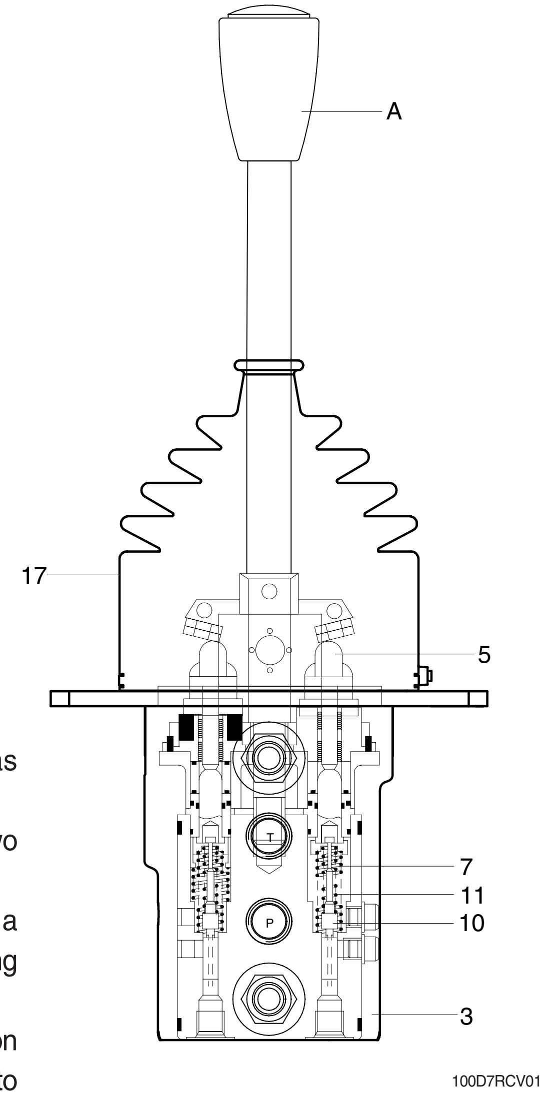


A	Lever	7	Metering spring	14	O-ring
1	Nut	8	Seeger ring	15	Kit 3
2	Plug	9	Seeger ring	16	Clamp
3	Body	10	Docking rod	17	Rubber bellows
4	Kit 1	11	Spring	18	Screw
5	Plunger kit	12	Kit 2	19	Support kit
6	Spring guide	13	Tie rod with nut	20	Flange

2) OPERATION



HYDRAULIC CIRCUIT



(1) Hydraulic functional principle

Pilot devices with end position locks operate as direct operated pressure reducing valves.

They basically comprise of control lever (A), two pressure reducing valves, body (3) and locks.

Each pressure reducing valve comprises of a plunger kit (5), a metering spring (7) and a spring (11).

At rest, control lever (A) is held in its neutral position by return springs (11). Ports (1, 2) are connected to tank port T.

When control lever (A) is deflected, plunger kit (5) is pressed against return spring(11) and metering spring (7).

Metering spring (7) initially moves docking rod (10) 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. The control phase starts as soon as docking rod (10) finds its balance between the force from metering spring (7) and the force, which results from the hydraulic pressure in the relevant port (ports 1, 2).

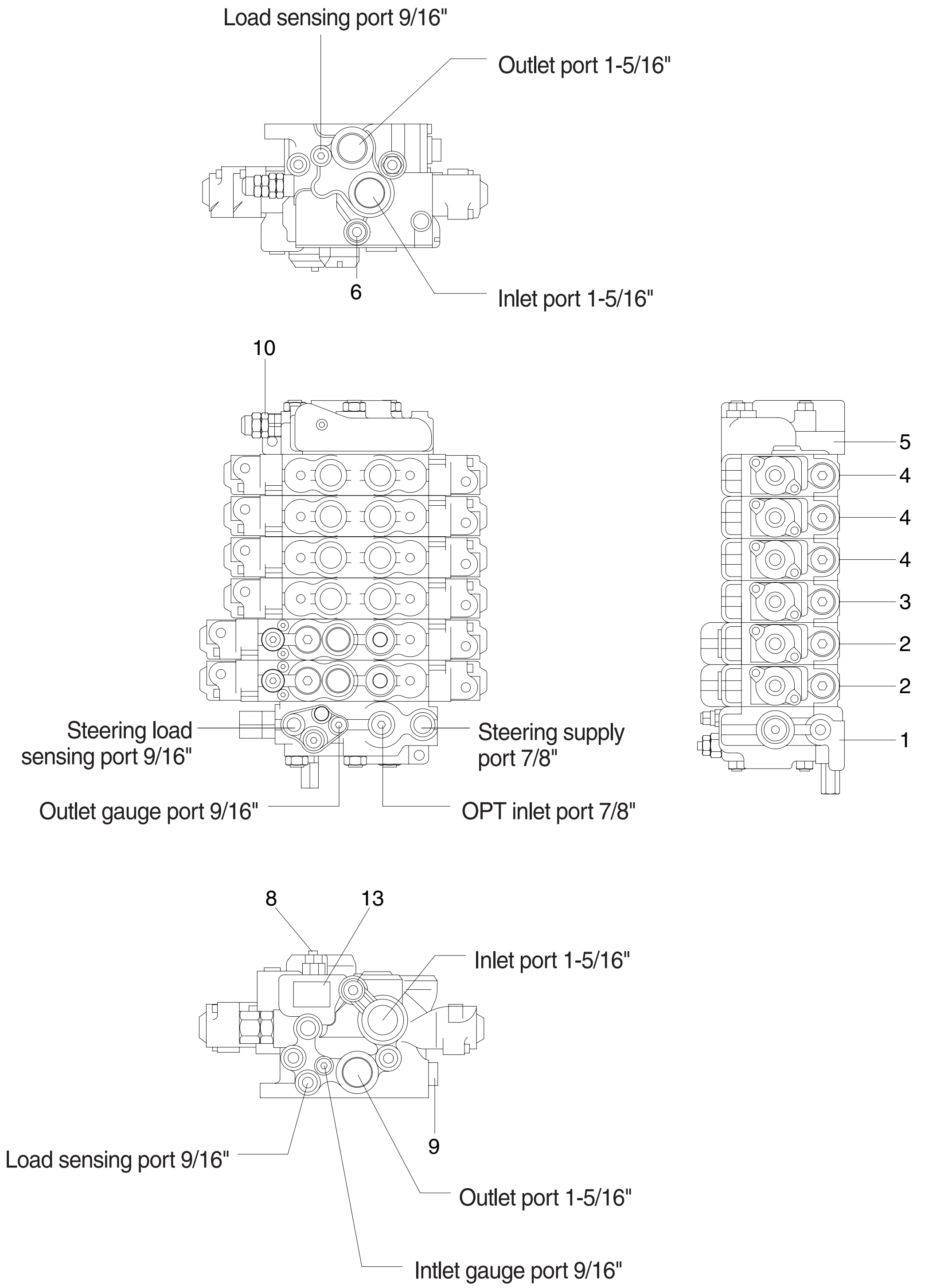
Due to the interaction between docking rod (10) and metering spring (7) the pressure in the relevant port is proportional to the stroke of plunger (5) and hence to the position of control lever (A).

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 (17) protects the mechanical components in the housing from contamination.

6. MAIN CONTROL VALVE (LEVER TYPE)

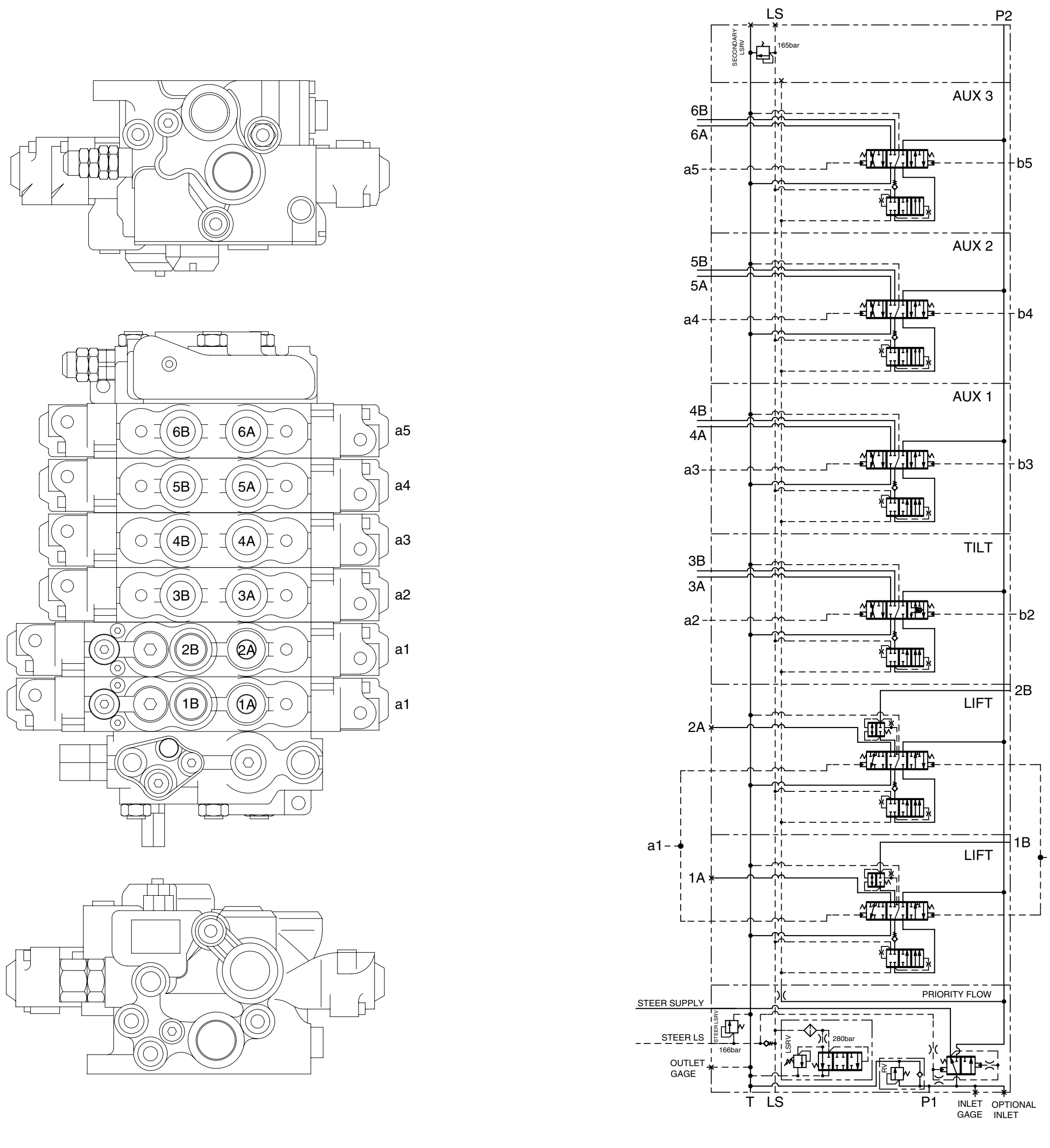
1) STRUCTURE



110DEHS09

1 Inlet section
2 Lift section
3 Tilt section
4 Aux section
5 Outle section
6 Tie rod
8 Drain regulator
9 Main relief Valve
10 Aux relief Valve
13 Name plat

STRUCTURE

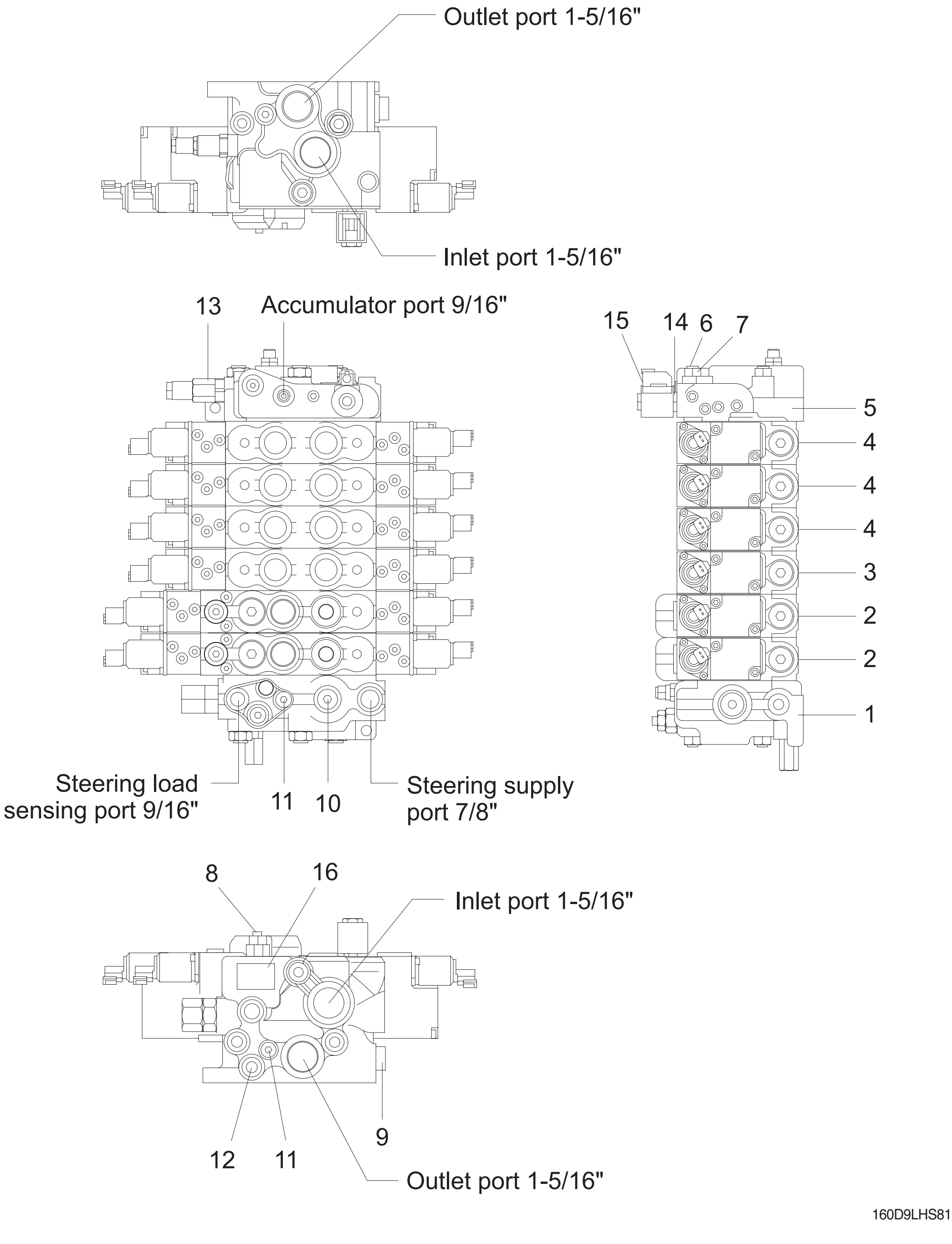


110D9HS10

Port	Port name	Size	Port	Port name	Size
P1, P2	Inlet port	1 5/16" - 12UNF	6A, 6B	To aux port	1 1/16" - 12UNF
T	Outlet port	1 5/16" - 12UNF	a1, b1	To lift pilot prot	9/16" - 18UNF
1A, 2B	To lift cylinder port	1 1/16" - 12UNF	a2, b2	To tilt pilot port	9/16" - 18UNF
3A, 3B	To tilt cylinder port	1 1/16" - 12UNF	a3, b3	To aux pilot port	9/16" - 18UNF
4A, 4B	To aux cylinder port	1 1/16" - 12UNF	a4, b4	To aux pilot port	9/16" - 18UNF
5A, 5B	To aux cylinder port	1 1/16" - 12UNF	a5, b5	To aux pilot port	9/16" - 18UNF

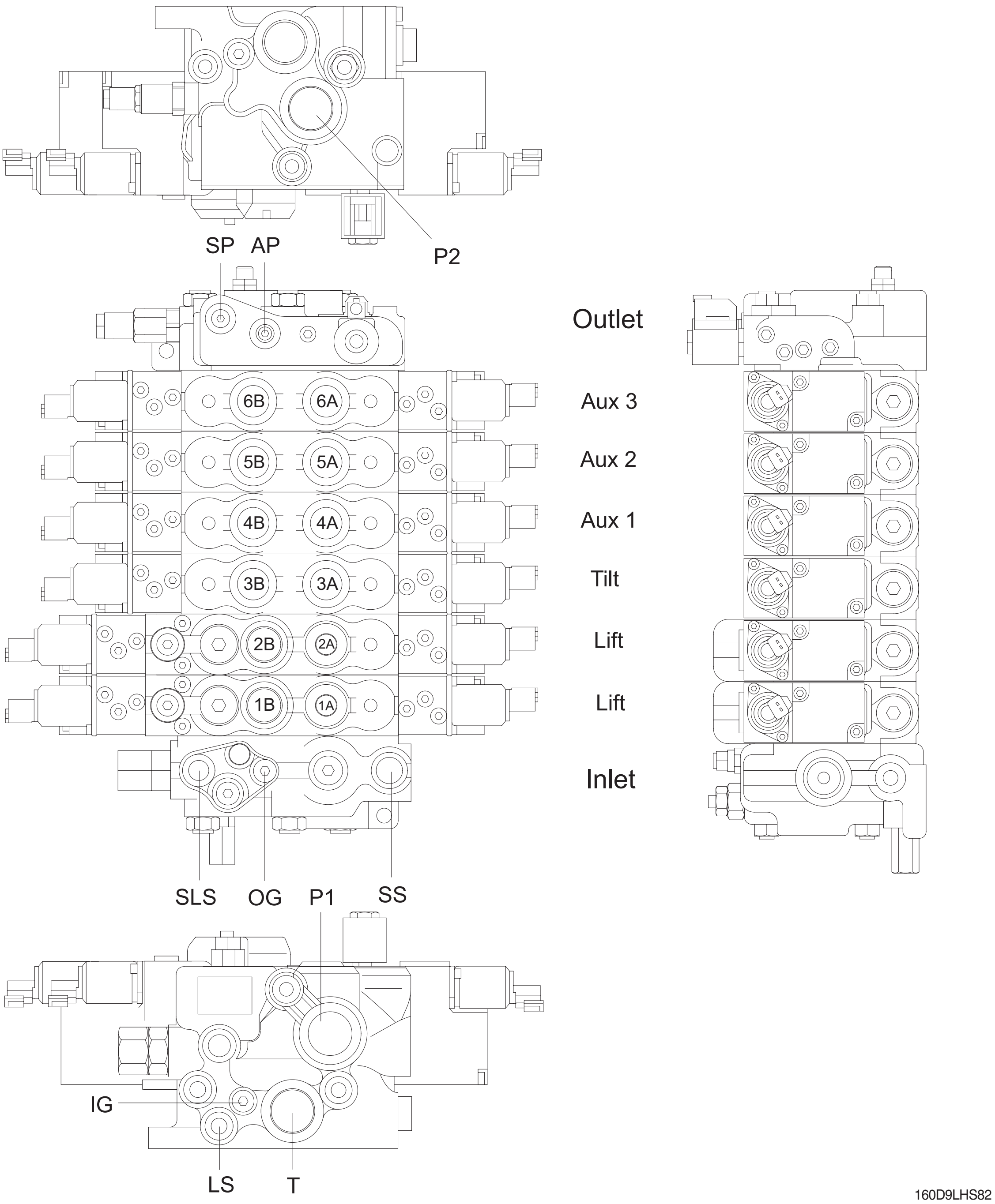
7. MAIN CONTROL VALVE (FINGERTIP)

1) STRUCTURE (1/2)



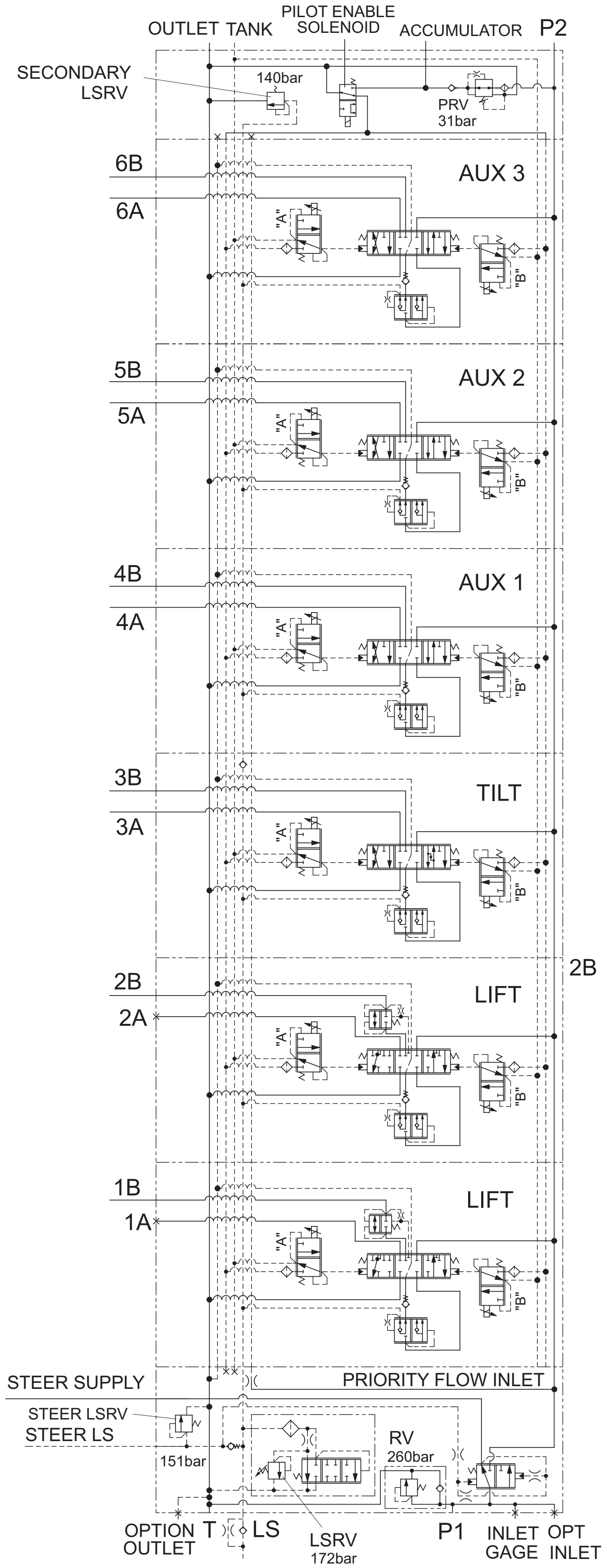
1	Inlet section assy	7	Nut	13	Pressure regulator valve assy
2	Spool section assy	8	Drain regulator assy	14	Solenoid body assy
3	Spool section assy	9	Relief valve assy	15	Solenoid coil
4	Spool section assy	10	Plug assy	16	Name plate
5	Outlet section assy	11	Plug assy		
6	Tie rod	12	Check valve assy		

STRUCTURE (2/2)



Port	Port name	Size	Port	Port name	Size
P1, P2	Inlet port	1-5/16" - 12UN-2B	SP	Tank port	9/16" - 18UNF-2B
T	Outlet port	1-5/16" - 12UN-2B	AP	Accumulator port	9/16" - 18UNF-2B
1A, 1B	To lift cylinder port	1-1/16" - 12UN-2B	LS	Load sense port	9/16" - 18UNF-2B
2A, 2B	To tilt cylinder port	1-1/16" - 12UN-2B	SS	Steer supply port	7/8" - 14UNF-2B
3A, 3B	To tilt cylinder port	1-1/16" - 12UN-2B	SLS	Steer load sense port	9/16" - 18UNF-2B
4A, 4B	To aux cylinder port	1-1/16" - 12UN-2B	IG	Inlet gauge port	9/16" - 18UNF-2B
5A, 5B	To aux cylinder port	1-1/16" - 12UN-2B	OG	Outlet gauge port	9/16" - 18UNF-2B
6A, 6B	To aux cylinder port	1-1/16" - 12UN-2B	-	-	-

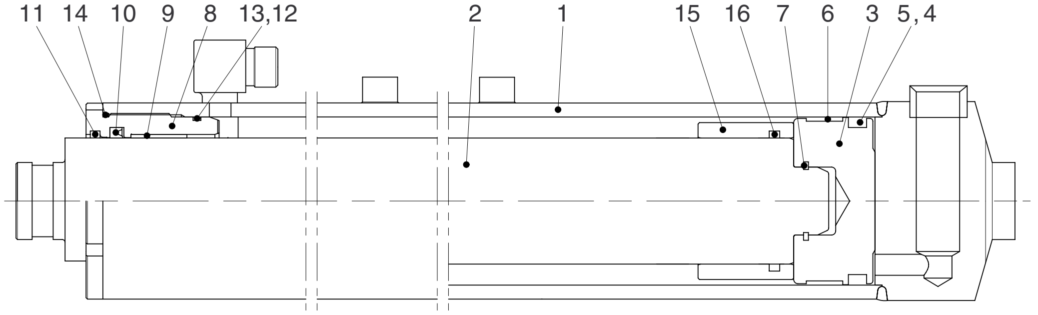
2) HYDRAULIC CIRCUIT



160D9LHS83

7. LIFT CYLINDER

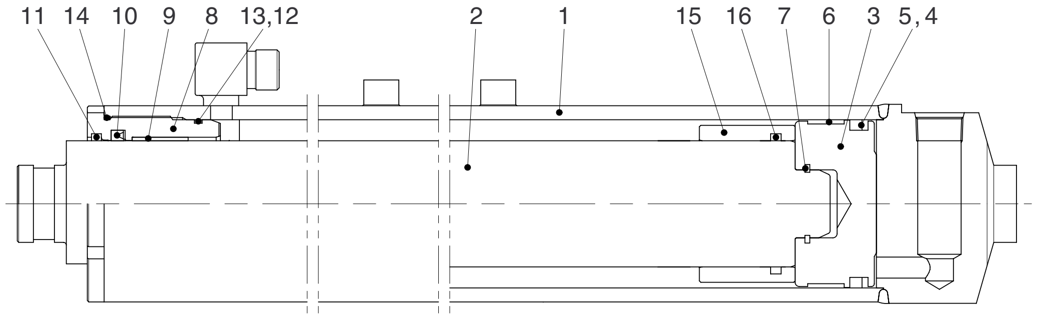
1) 110/130D-9



110D9CYL01

1	Tube assembly	8	Set screw	15	Dust wiper
2	Rod assembly	9	Set screw	16	Retaining ring
3	Piston	10	Plug	17	O-ring
4	Wear ring	11	Rod cover	18	Back up ring
5	Set screw	12	Rod bushing	19	O-ring
6	Guide	13	U-packing	20	Bleeder
7	Cushion ring	14	Back up ring	21	Spacer

2) 160D-9

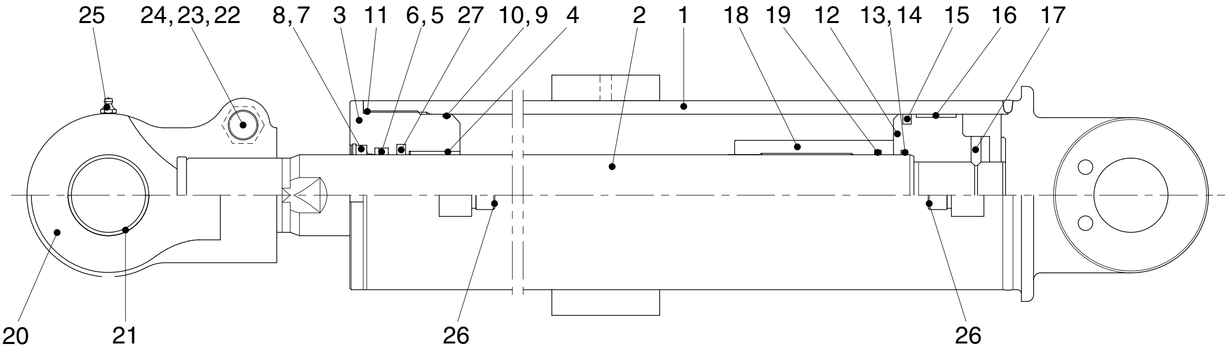


110D9CYL02

1	Tube assembly	8	Rod cover	15	Cushion ring
2	Rod assembly	9	Rod bushing	16	Guide
3	Piston	10	U-packing	17	Set screw
4	U-packing	11	Dust wiper	18	Set screw
5	Back up ring	12	O-ring	19	Plug
6	Wear ring	13	Back up ring	20	Spacer
7	Stop ring	14	O-ring	21	O-ring

8. TILT CYLINDER

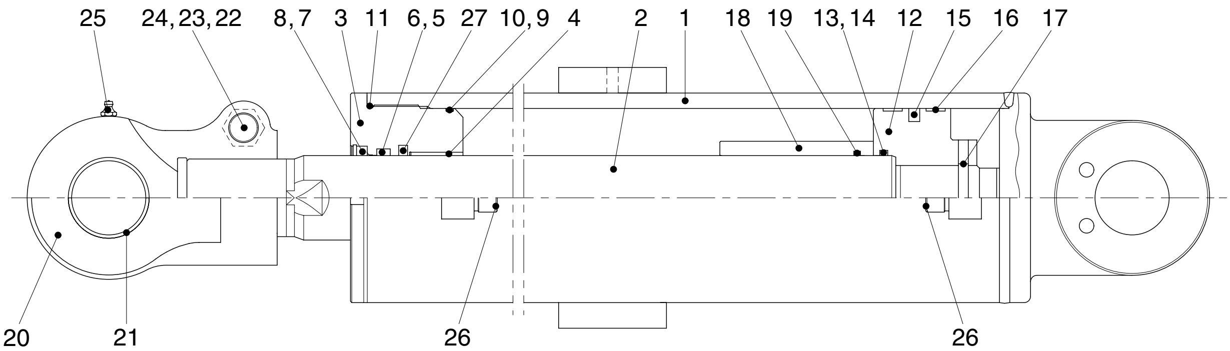
1) 110/130D-9



110D9CYL03

1	Tube assembly	10	Back-up ring	19	O-ring (10/10° only)
2	Rod	11	O-ring	20	Eye
3	Rod cover	12	Piston	21	Rod bushing
4	Rod bushing	13	O-ring	22	Hexagon bolt
5	U-packing	14	Back-up ring	23	Hexagon nut
6	Back up ring	15	Piston seal	24	Spring washer
7	Dust wiper	16	Wear ring	25	Grease nipple
8	Stop ring	17	Set screw	26	O-ring
9	O-ring	18	Spacer (10/10° only)		

2) 160D-9

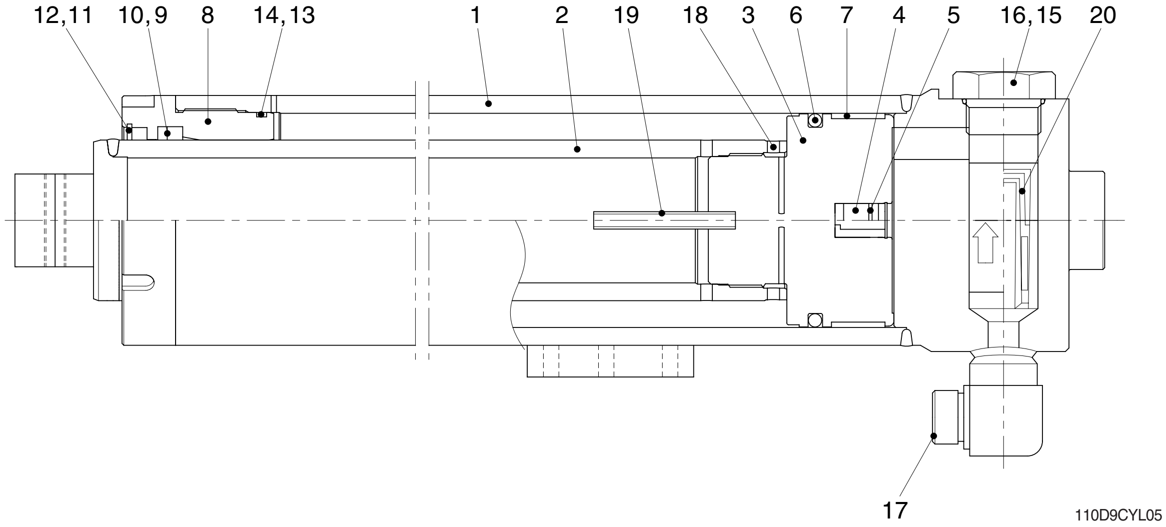


110D9CYL04

1	Tube assembly	10	Back-up ring	19	O-ring (10/10° only)
2	Rod	11	O-ring	20	Eye
3	Rod cover	12	Piston	21	Rod bushing
4	Rod bushing	13	O-ring	22	Hexagon bolt
5	U-packing	14	Back-up ring	23	Hexagon nut
6	Back up ring	15	Piston seal	24	Spring washer
7	Dust wiper	16	Wear ring	25	Grease nipple
8	Stop ring	17	Set screw	26	O-ring
9	O-ring	18	Spacer (10/10° only)	27	Buffer seal

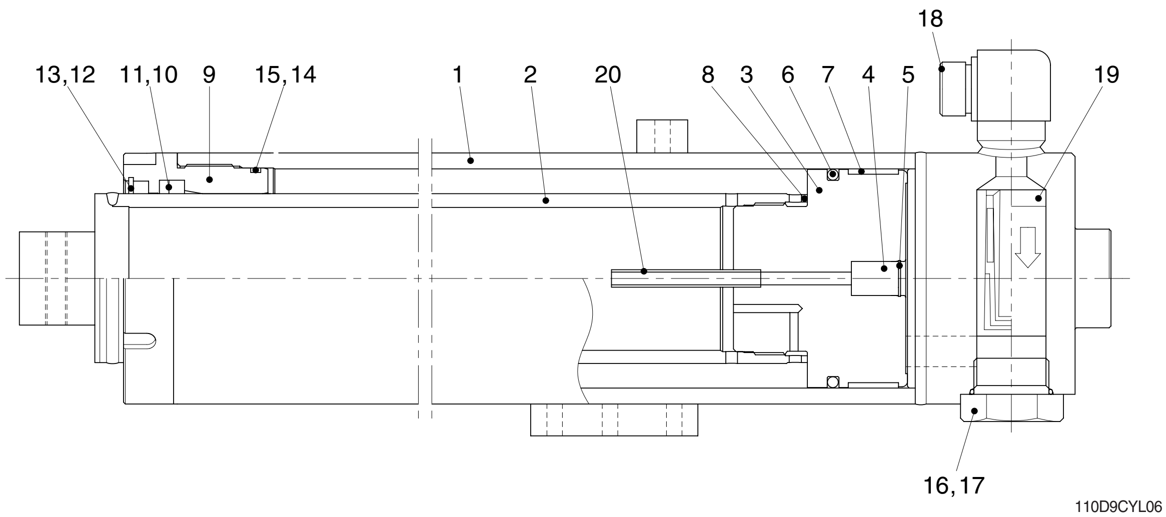
9. FREE CYLINDER

1) 110/130D-9



1	Tube assembly	8	Rod cover	15	Plug
2	Rod assembly	9	U-packing	16	O-ring
3	Piston	10	Back up ring	17	O-ring
4	Check valve	11	Dust wiper	18	Set screw
5	Retaining ring	12	Retaining ring	19	Pipe
6	Piston seal	13	O-ring	20	Down safety valve
7	Wear ring	14	Back up ring		

2) 160D-9

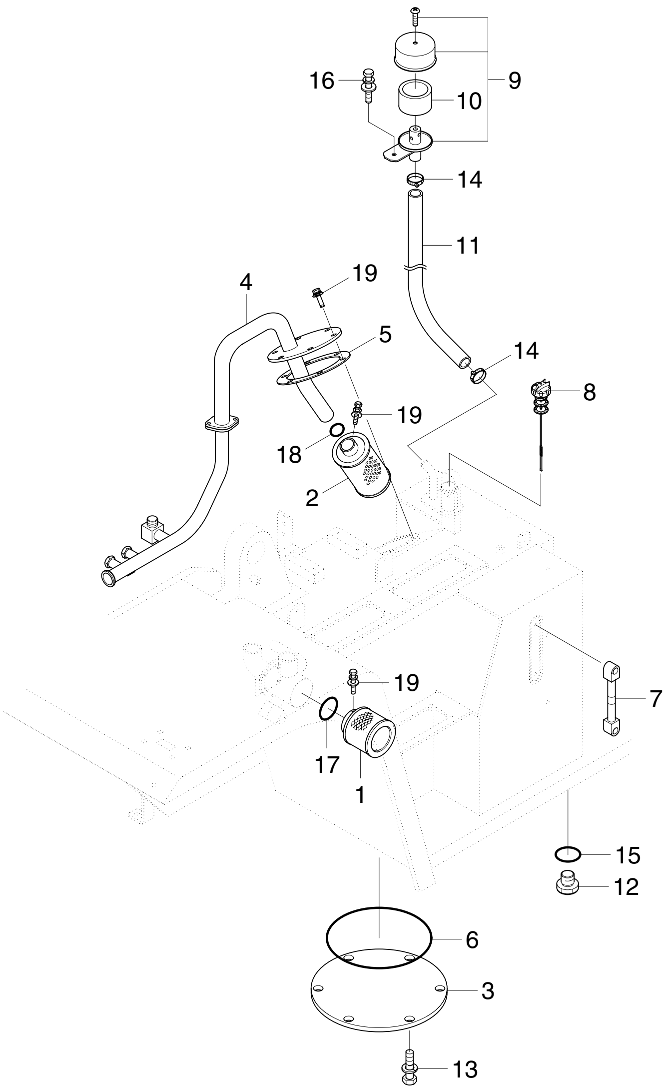


1	Tube assembly	8	Set screw	15	Back up ring
2	Rod assembly	9	Rod cover	16	O-ring
3	Piston	10	U-packing	17	Plug
4	Check valve	11	Back up ring	18	O-ring
5	Retaining ring	12	Dust wiper	19	Down safety valve
6	Piston seal	13	Retaining ring	20	Pipe
7	Wear ring	14	O-ring		

10. 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.



110D9HS13

1	Suction filter	8	Hydraulic oil cap	15	O-ring
2	Return filter	9	Air breather cap	16	Hexagon bolt
3	Suction flange	10	Air breather filter	17	O-ring
4	Return flange	11	Rubber hose	18	O-ring
5	Gasket	12	Magnet plug	19	Hexagon bolt
6	O-ring	13	Bolt with washer		
7	Level gauge	14	Clamp		

2) AIR BREATHER

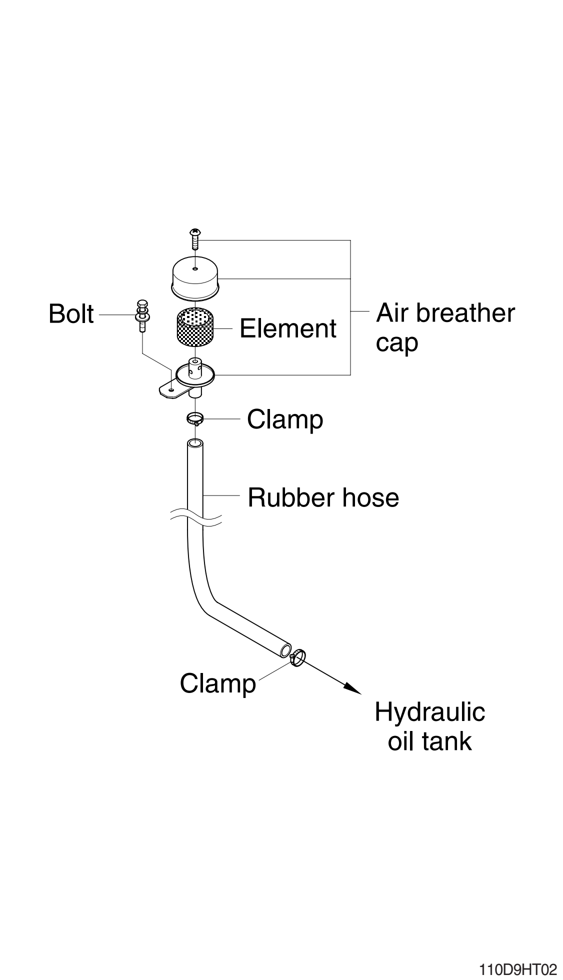
The air breather is equipped with the capacity to perform two functions simultaneously-as an air filter and as a breathing valve.

(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 puppet in the breather, and air from the outside is let into the tank or prevent negative pressure.

(2) Preventing excessive pressure inside the tank

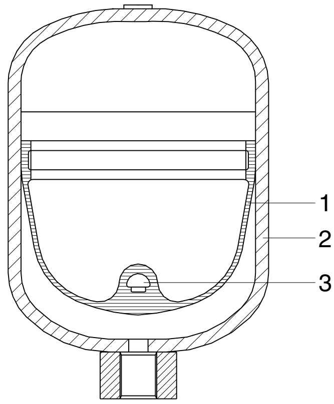
When the hydraulic cylinder is being used, the oil level in the hydraulic system increases and as temperature rises. If the hydraulic pressure rises above the set pressure, breather is actuated to release the hydraulic pressure inside the tank.



11. ACCUMULATOR

The accumulator is installed at the cut off valve. When the mast 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	0.35 ℓ (0.1 U.S.gal)
Charging pressure of gas	15kg/cm^2 (213psi)
Max actuating pressure	170kg/cm^2 (2420psi)



1 Diaphragm
2 Steel pressure vessel
3 Closure button

7803AWE56

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

1. OPERATIONAL CHECKS

1) CHECK ITEM

(1) Check visually for deformation, cracks or damage of rod.

(2) Set mast vertical and raise 1 m from ground. Wait for 10 minutes and measure hydraulic drift (amount forks move down and amount mast tilts forward).

· Check condition

- Hydraulic oil : Normal operating temp
- Mast substantially vertical.
- Rated capacity load.

· Hydraulic drift

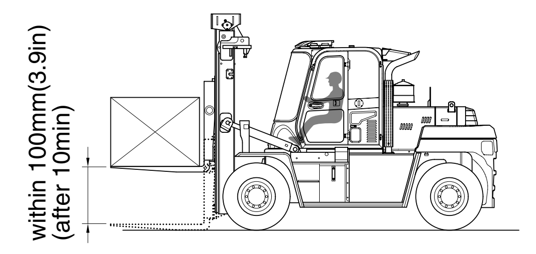
- Down (Downward movement of forks)
  : Within 100 mm (3.9 in)
- Forward (Extension of tilt cylinder)
  : Within 5˚

(3) If the hydraulic drift is more than the specified value, replace the control valve or cylinder packing.

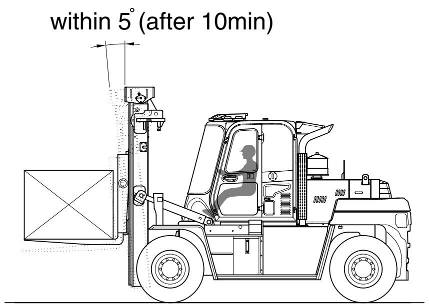
Check that clearance between tilt cylinder bushing and mounting pin is within standard range.

mm (in)

Standard	Under 0.6 (0.02)



110D9HS14

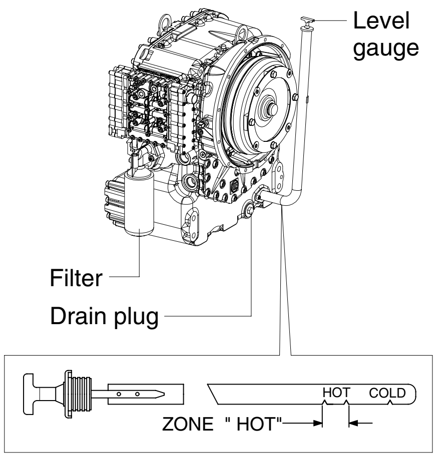


110D9HS15

2) HYDRAULIC OIL

(1) Using dipstick, measure oil level, and oil if necessary.

(2) When changing hydraulic oil, clean suction strainer (screwed into outlet port pipe) and line filter (screwed into inlet pipe). Line filter uses paper element, so replace periodically (every 6 months or 1000 hours)



110D9HS18

3) CONTROL VALVE

(1) Raise forks to maximum height and measure oil pressure.

Check that oil pressure is 210 kgf/cm^2.
(2990 psi)

2. TROUBLESHOOTING

1) SYSTEM

Problem	Cause	Remedy
Large fork lowering speed.	· Seal inside control valve defective. · Oil leaks from joint or hose. · Seal inside cylinder defective.	· Replace spool or valve body. · Replace. · Replace packing.
Large spontaneous tilt of mast.	· Tilting backward : Check valve defective. · Tilting forward : tilt lock valve defective. · Oil leaks from joint or hose. · Seal inside cylinder defective.	· Clean or replace. · Clean or replace. · Replace. · Replace seal.
Slow fork lifting or slow mast tilting.	· Lack of hydraulic oil. · Hydraulic oil mixed with air. · Oil leaks from joint or hose. · Excessive restriction of oil flow on pump suction side. · Relief valve fails to keep specified pressure. · Poor sealing inside cylinder. · High hydraulic oil viscosity. · Mast fails to move smoothly. · Oil leaks from lift control valve spool. · Oil leaks from tilt control valve spool.	· Add oil. · Bleed air. · Replace. · Clean filter. · Adjust relief valve. · Replace packing. · Change to SAE10W, class CF engine oil. · Adjust roll to rail clearance. · Replace spool or valve body. · Replace spool or valve body.
Hydraulic system makes abnormal sounds.	· Excessive restriction of oil flow pump suction side. · Gear or bearing in hydraulic pump defective.	· Clean filter. · Replace gear or bearing.
Control valve lever is locked	· Foreign matter jammed between spool and valve body. · Valve body defective.	· Clean. · Tighten body mounting bolts uniformly.
High oil temperature.	· Lack of hydraulic oil. · High oil viscosity. · Oil filter clogged.	· Add oil. · Change to SAE10W, class CF engine oil. · Clean filter.

Problem	Cause	Remedy
Actuator (cylinder or motor) works slowly or does not operate.	· Shortage of oil in oil tank. · Decrease of relief valve pressure. · Spool got stuck. · Shortage of oil flow to the valve.	· Check the oil level in the oil tank. · Install pressure gauge on the circuit, and check the pressure with it by handling the lever. · Check that manual lever moves smoothly. · Check that lever stroke is enough. · Check that oil flow of the pump is within specified rate.
Cylinder lowers considerably under normal circumstance.	· Internal leakage of cylinder happens frequently. · Excessive leakage from spool of the valve. · Spool got stuck. · Leakage in a part of the circuit.	· Fit the stop valve on the pipe between valve and cylinder, observe the internal leakage of cylinder. · Check the oil viscosity is not too low. · Check that manual lever moves smoothly. · Check the circuit. · Observe leakage from pipes.
Pressure does not increase sufficiently.	· Defect of relief valve. · Leakage in a part of the circuit.	· Check the relief valve. · Check the circuit. · Observe leakage from pipes.
Temperature rising of the hydraulic oil.	· Working with higher pressure than rated pressure. · Low viscosity of oil. · Leakage from a part of the circuit. · Oil leakage in the pump. · Insufficient suction of the pump.	· Check the flow pressure. · Check the sort of oil and viscosity. · Check if the circuit is relieved at all times. · Check if the temperature of pump surface higher 30°C than oil tempera-ture. · Check the oil tank volume. · Check if the suction strainer is blocked.
Steering force is heavy.	· Defect of steering relief valve.	· Check the steering relief valve.

2) HYDRAULIC PISTON PUMP

Problem	Cause	Remedy
Pump does not develop full pressure.	· System relief valve set too low or leaking. · Oil viscosity too low. · Pump is worn out.	· Check system relief valve for proper setting. · Change to proper viscosity oil. · Repair or replace pump.
Pump will not pump oil.	· Reservoir low or empty. · Suction strainer clogged.	· Fill reservoir to proper level. · Clean suction strainer.
Noisy pump caused by cavitation.	· Oil too thick. · Oil filter plugged. · Suction line plugged or too small.	· Change to proper viscosity. · Clean filters. · Clean line and check for proper size.
Oil heating.	· Oil supply low. · Contaminated oil. · Setting of relief valve too high or too low. · Oil viscosity too low.	· Fill reservoir to proper level. · Drain reservoir and refill with clean oil. · Set to correct pressure. · Drain reservoir and fill with proper viscosity.
Foaming oil.	· Low oil level. · Air leaking into suction line. · Wrong kind of oil.	· Fill reservoir to proper level. · Tighten fittings, check condition of line. · Drain reservoir, fill with non-foaming oil.
Shaft seal leakage.	· Worn shaft seal. · Worn shaft in seal area.	· Replace shaft seal. · Replace drive shaft and seal.

3) MAIN RELIEF VALVE

Problem	Cause	Remedy
Can't get pressure	· Poppet stuck open or contamination under seat.	· Check for foreign matter between puppets and their mating parts. Parts must slide freely.
Erratic pressure	· Pilot poppet seat damaged.	· Replace the relief valve. · Clean and remove surface marks for free movement.
Pressure setting not correct	· Normal wear. Lock nut & adjust screw loose.	· See *How to set pressure on work main relief.
Leaks	· Damaged seats. · Worn O-rings. · Parts sticking due to contamination.	· Replace the relief valve. · Install seal and spring kit. · Disassemble and clean.

★ A good pressure gauge must be installed in the line which is in communication with the main relief. A load must be applied in a manner to reach the set pressure of the main relief unit.
Then, follow these steps:

· Loosen lock nut.
· Set adjusting nut to desired pressure setting.
· If desired pressure setting cannot be achieved, add or remove shims as required.
· Tighten lock nut.
· Retest in similar manner as above.

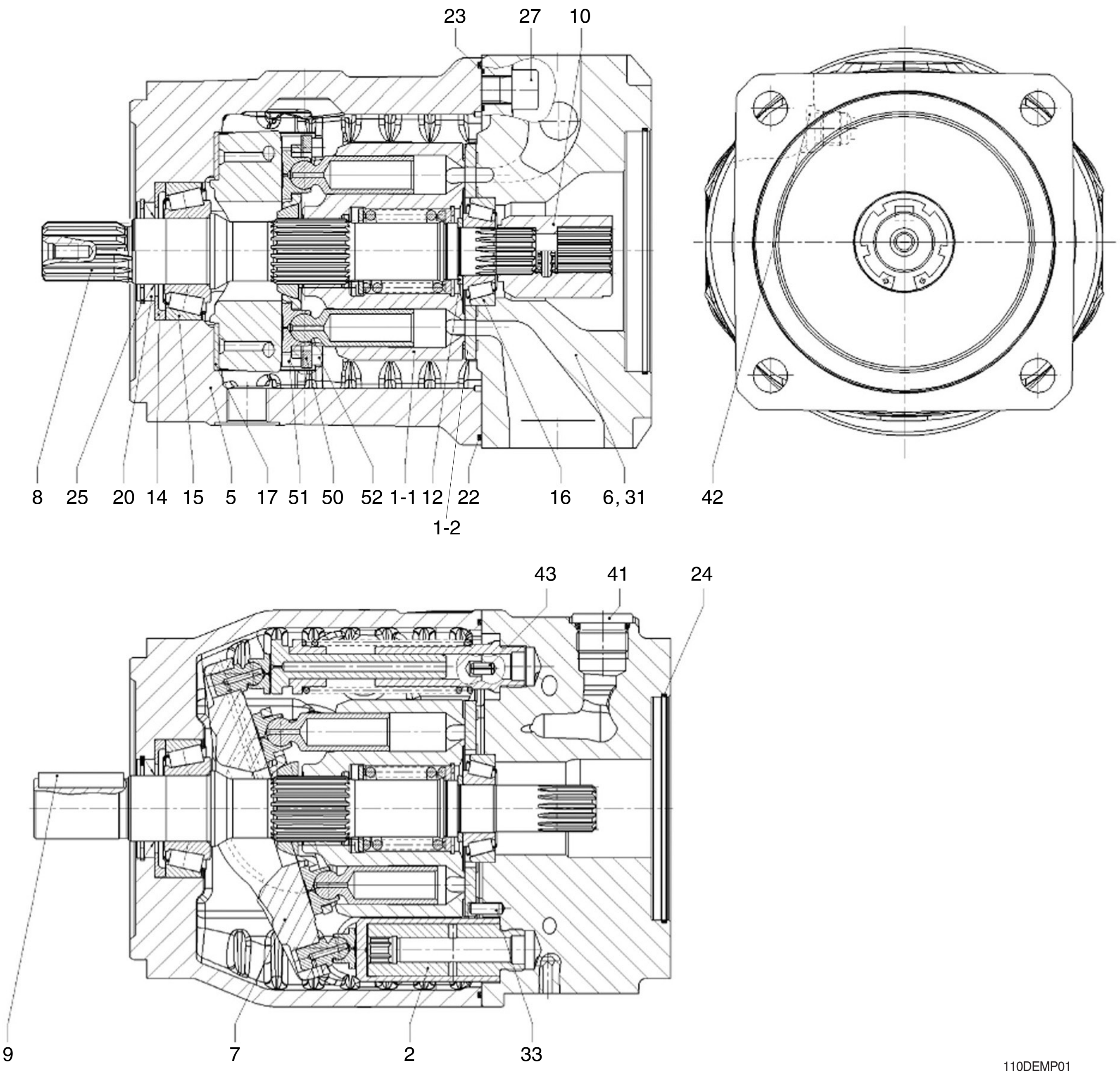
4) CYLINDER

Problem	Cause	Remedy
Oil leaks out from gland through rod.	· Foreign matters on packing. · Unallowable score on rod. · Unusual distortion of dust seal. · Chrome plating is striped.	· Replace packing. · Smooth rod surface with an oil stone. · Replace dust seal. · Replace rod.
Oil leaks out from cylinder gland thread.	· O-ring damaged.	· Replace O-ring.
Rod spontaneously retract.	· Scores on inner surface of tube. · Unallowable score on the inner surface of tube. · Foreign matters in piston seal.	· Smooth rod surface with an oil stone. · Replace cylinder tube. · Replace piston seal.
Wear (clearance between cylinder tube and wear ring)	· Excessive clearance between cylinder tube and wear ring.	· Replace wear ring.
Abnormal noise is produced during tilting operation.	· Insufficient lubrication of anchor pin or worn bushing and pin. · Bent tilt cylinder rod.	· Lubricate or replace. · Replace.

GROUP 3 DISASSEMBLY AND ASSEMBLY

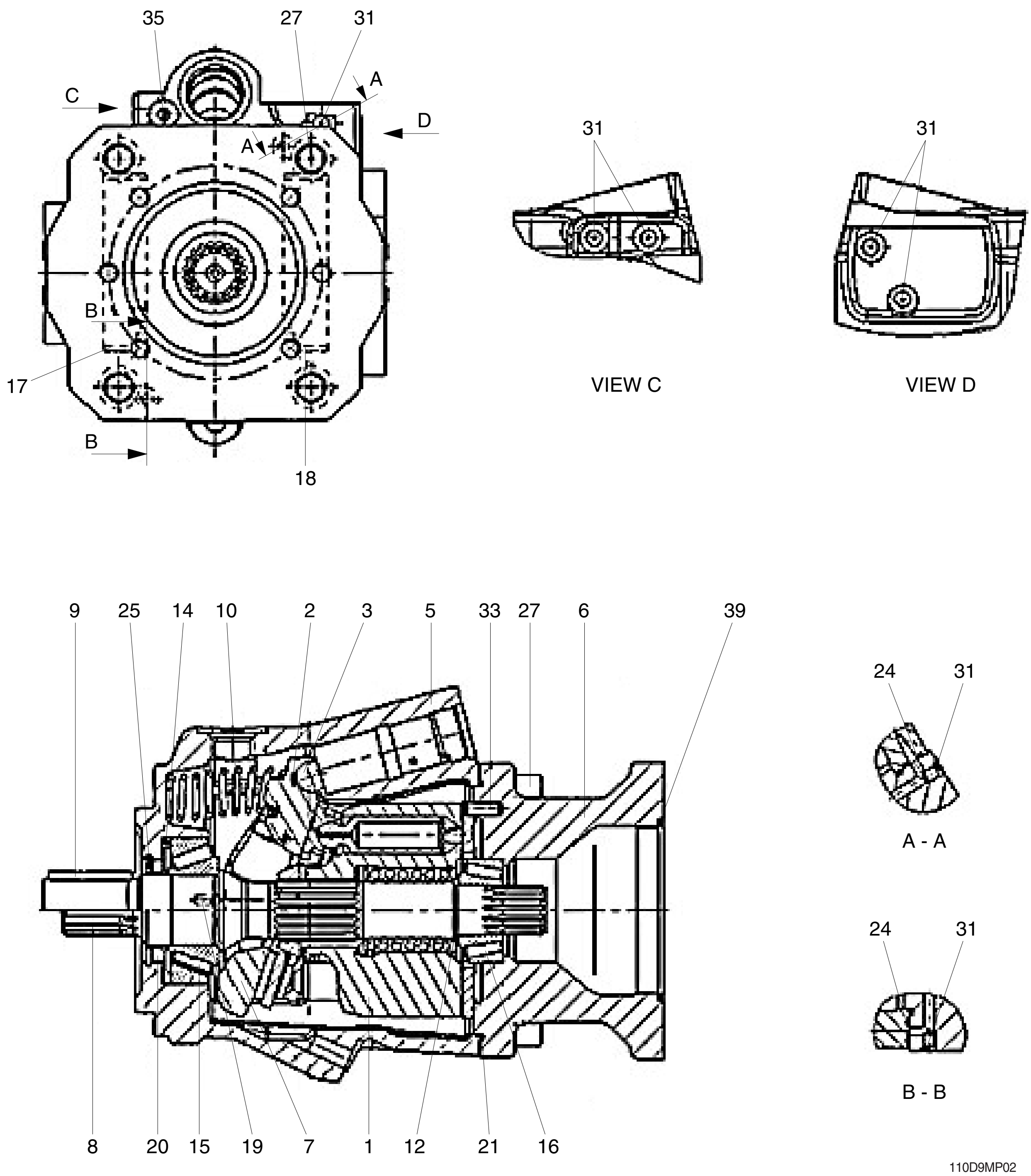
1. MAIN PUMP

1) STRUCTURE (front)



110DEMP01

1-1	Rotary group	14	Stop ring	31	Double break off pin
1-2	Control plate	15	Taper roller bearing	33	Cylinder pin
2	Adjusting piece	16	Taper roller bearing	41	Plug
5	Pump housing	17	Bearing liner	42	Plug
6	Port plate	20	Shaft seal ring	43	Plug
7	Swash plate	22	O-ring	50	Segment
8	Drive shaft	23	O-ring	51	Spacer sleeve
9	Key	24	O-ring	52	Socket screw
10	Splined hub	25	Retaining ring		
12	Shim	27	Socket screw		



1 Rotary group
2 Pressure spring
3 Stop
5 Pump housing
6 Port plate
7 Swash plate
8 Drive shaft
10 Spring
12 Shim
14 Stop ring
15 Taper roller bearing
16 Taper roller bearing
17 Bearing liner
18 Bearing liner
19 Socket screw
20 Shaft seal ring
21 O-ring
24 Seal ring
25 Retaining ring
27 Socket screw
31 Double break off pin
33 Cylinder pin
35 Locking screw
39 O-ring

2) GENERAL REPAIR GUIDE LINES

※ Observe the following guidelines when carrying out repairs on hydraulic pumps.

(1) Close off all openings of the hydraulic unit.

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

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

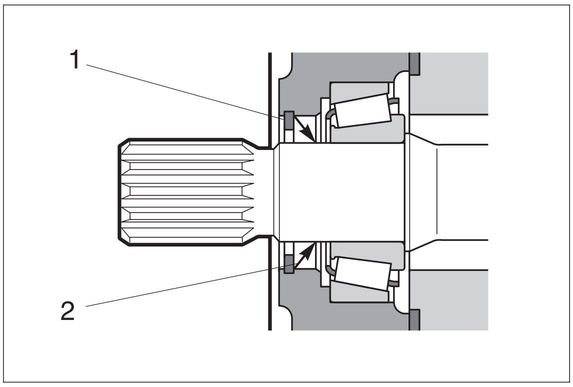
※ Re-work of the sliding surfaces by using, for example abrasive paper, can damage the surface.

(4) Fill the hydraulic pump with hydraulic oil before commissioning.

3) SEALING THE DRIVE SHAFT

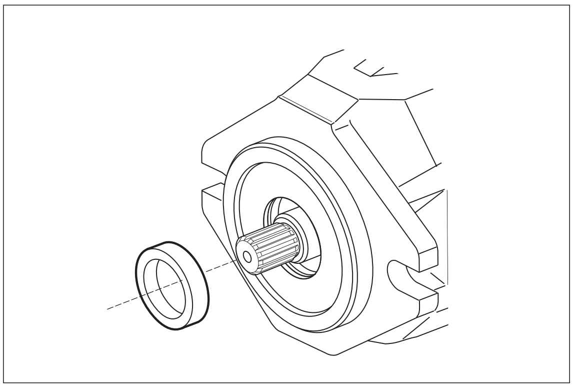
(1) Protect the drive shaft.
Remove the circlip.
Remove the shaft seal.

1 Circlip 2 Shaft seal



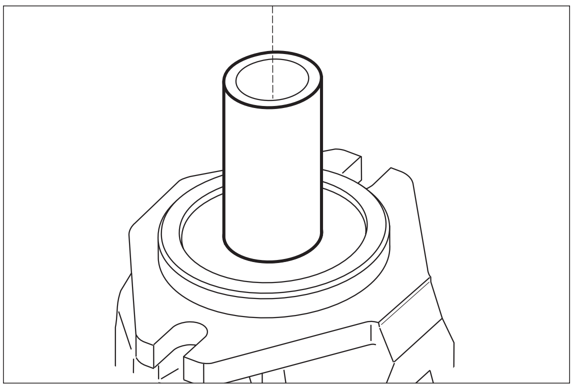
75796WE60

(2) Change the shaft seal and check its sliding surface (drive shaft) and housing, grease the sealing ring.



75796WE58

(3) Assemble the sealing ring, fitting tool holds the correct position of the sealing ring in the pump housing.
Assemble the circlip in the correct position.

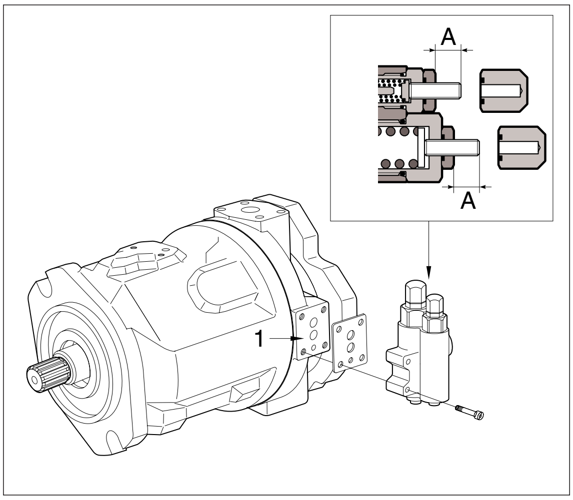


75796WE59

4) SEALING / CLEANING THE CONTROL VALVE

(1) Disassemble the control valve.

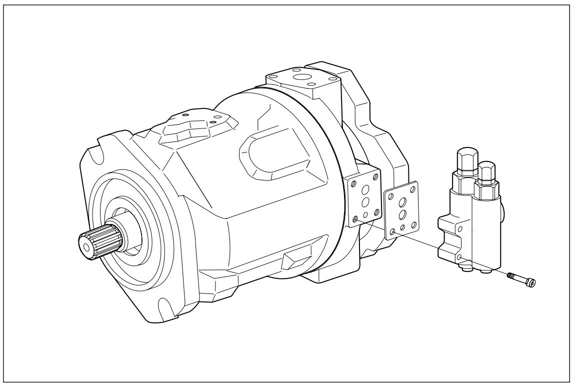
※ Measure dimension A and note down. Check sealing surface (1).



75796WE62

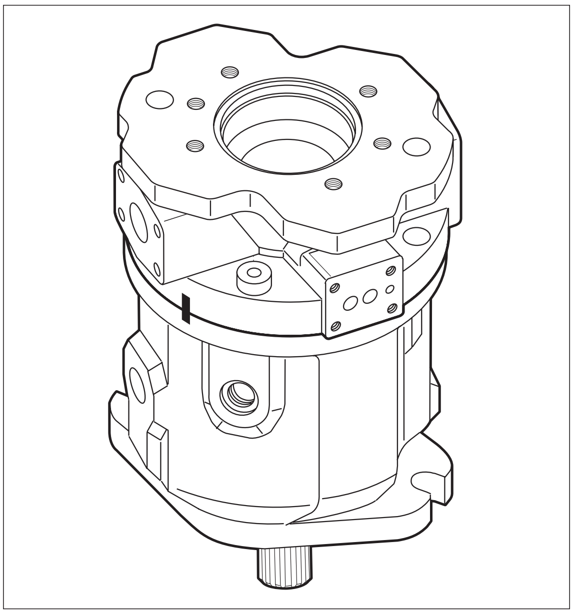
5) DISASSEMBLE THE PUMP

(1) Remove the control valve.



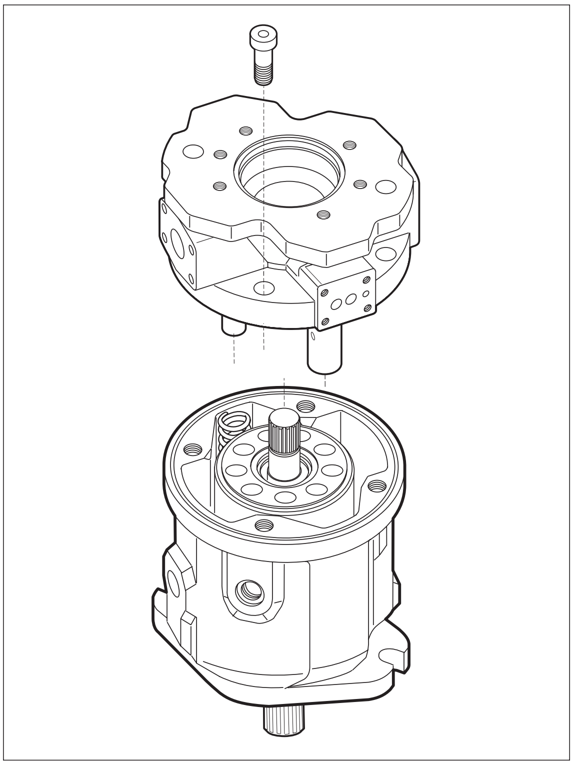
75796WE63

(2) Mark the location of the connection plate on the housing.



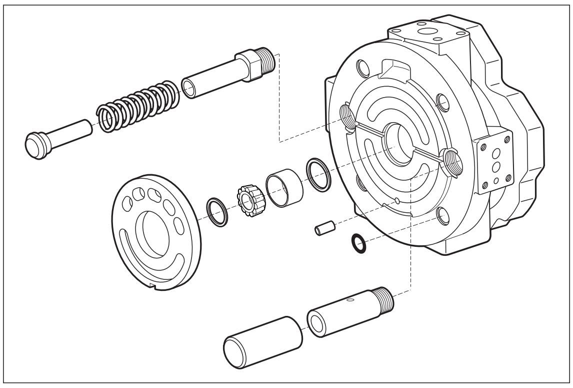
75796WE64

(3) Remove the connection plate fixing bolts and the connection plate.
※ Distributor plate and adjustment piston can drop down.



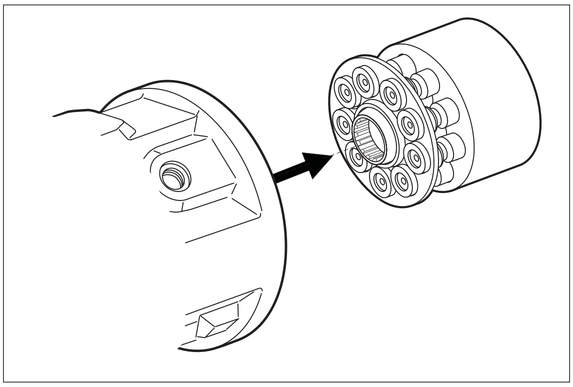
75796WE65

(4) Remove distributor plate.
Take note of the orientation.
※ Remove bearing with withdrawal tool.
Do not damage the sealing surface.



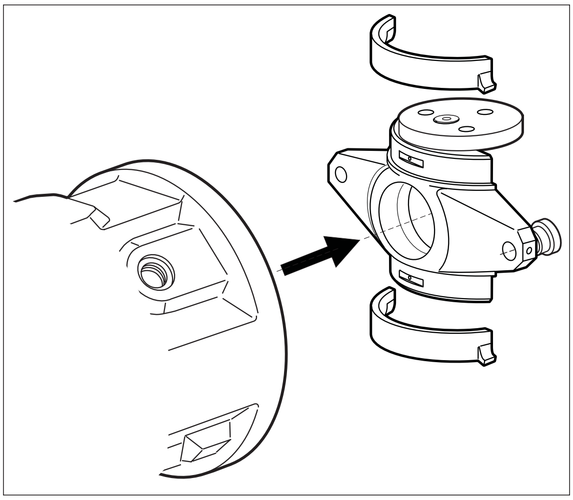
75796WE66

(5) Remove the rotary group in a horizontal position.

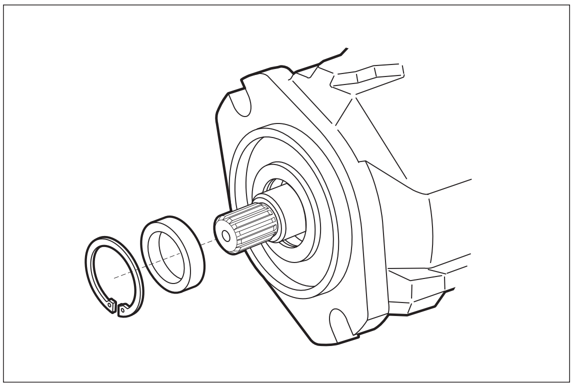


75796WE67

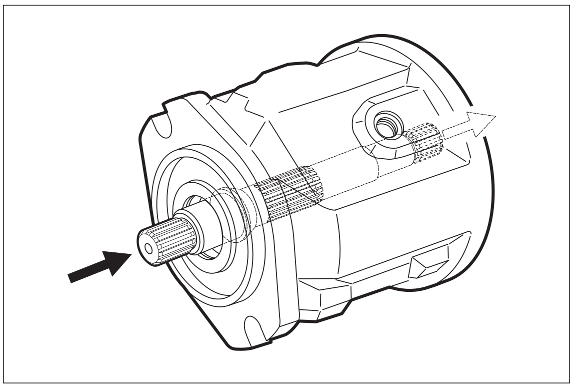
(6) Remove swash plate and bearing shells.


75796WE68

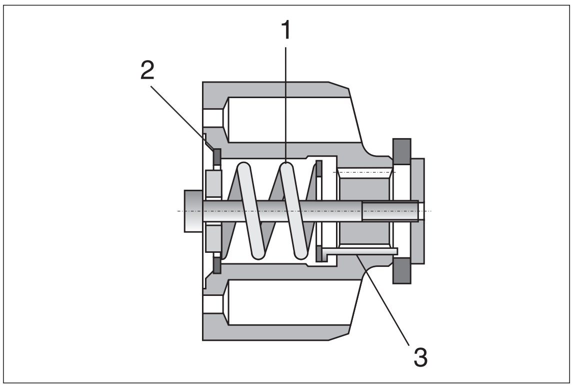
(7) Remove the circlip and the shaft seal.


75796WE69

(8) Remove the drive shaft through rear side.

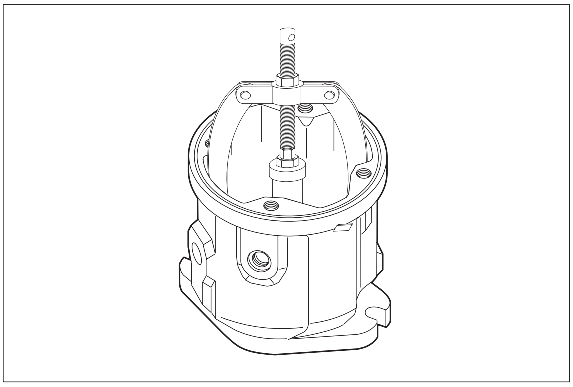

75796WE70

(9) Pre-tension the spring (1) using a suitable device.
Remove circlip (2).
Remove spring (1) and pressure pins (3).



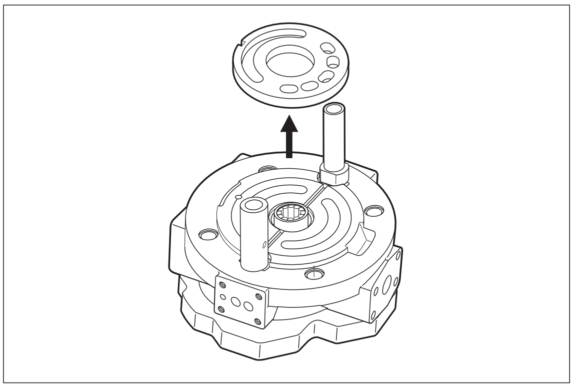
75796WE72

(10) Use bearing puller to remove outer bearing race of front bearing out of housing press seat.



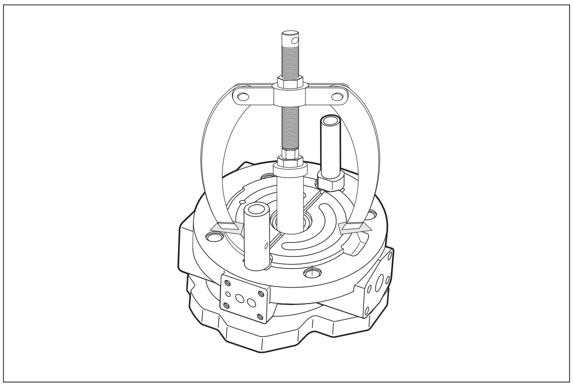
75796WE74

(11) Remove the control plate.



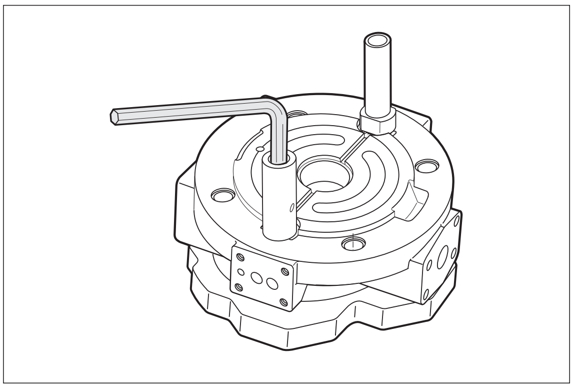
75796WE75

(12) Use bearing puller to remove outer bearing race of rear bearing - press seat.



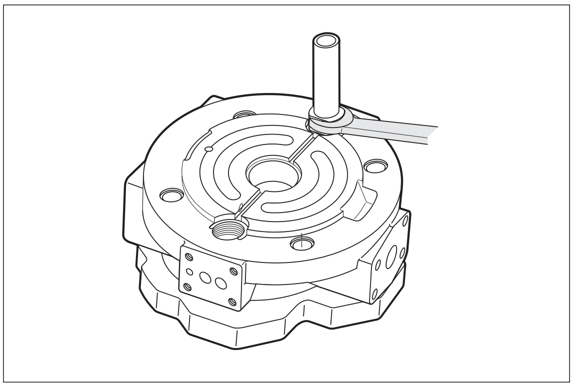
75796WE76

(13) Disassemble the guide of control piston (Mounting position: pilot valve side).



75796WE77

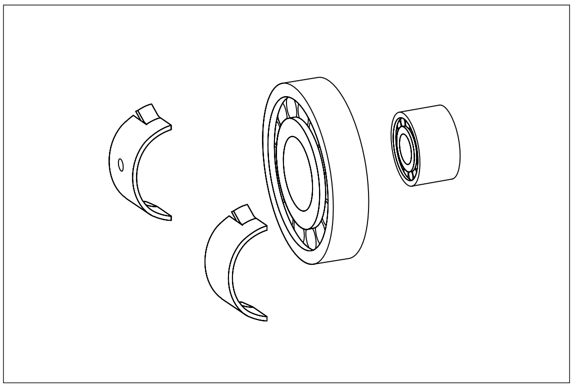
(14) Disassemble the guide of the opposite piston.



75796WE78

6) INSPECT HINTS

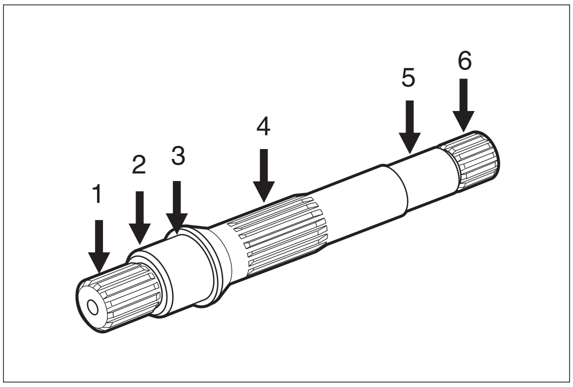
(1) Renew all bearings.



75796WE79

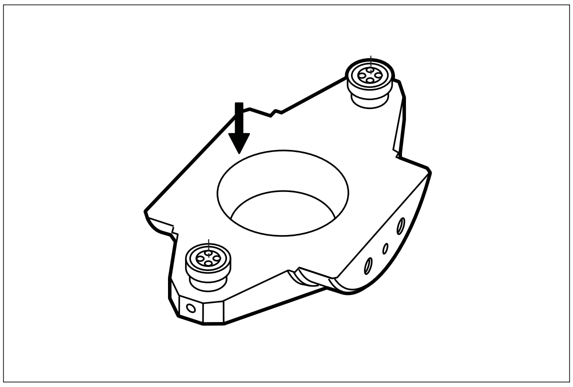
(2) Check :

1 Wear on splines, rust
2 Drive shaft seal wear grooves
3 Bearing seat
4 Splines for cylinder drive
5 Bearing seat



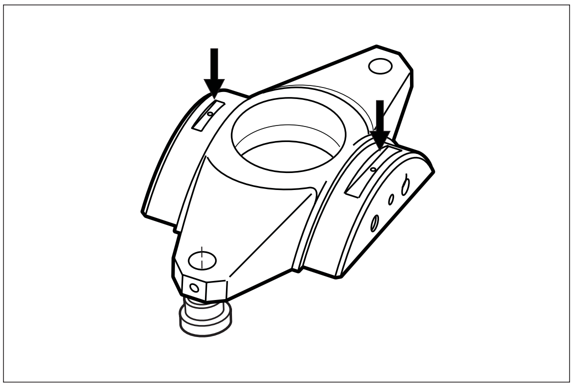
75796WE80

(3) Check :
Sliding surface free of grooves.



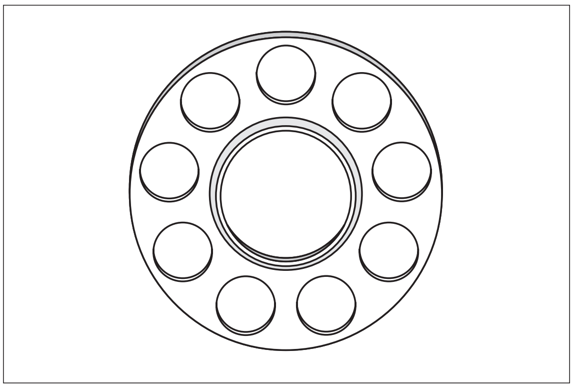
75796WE81

(4) Check :
Bearing surfaces.



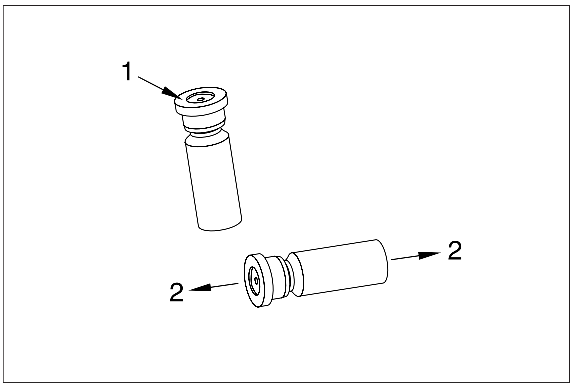
75796WE82

(5) Check :
That the retaining plate is free of grooves and that there is no wear in the slipper pad area.



75796WE83

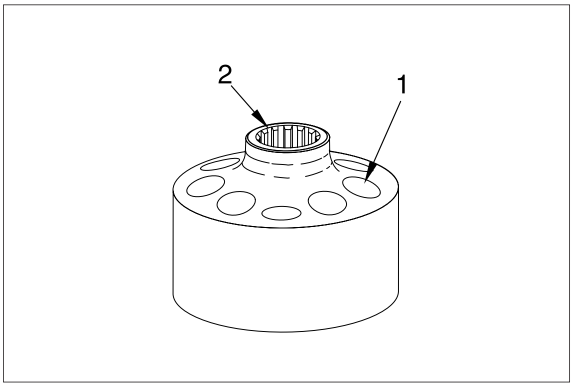
(6) Check :
Check to see that there are no scratches or metal deposits on the sliding surface (1) and that there is no axial play (2) (Pistons must only be replaced as a set).



75796WE84

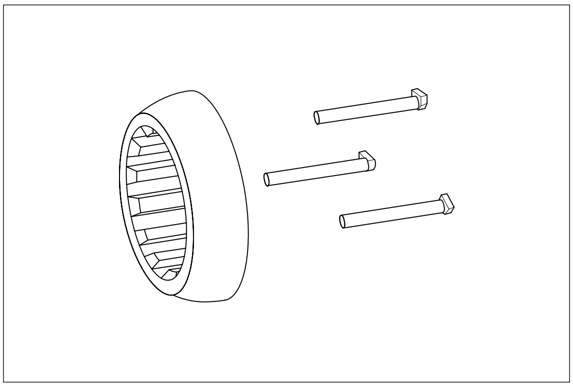
(7) Check :

1 Cylinder bores
2 Splines



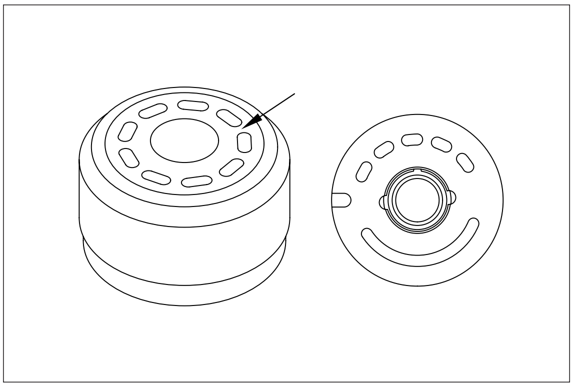
75796WE85

(8) Free of grooves, no signs of wear.



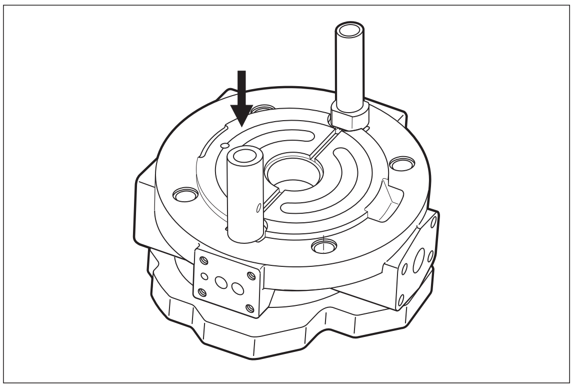
75796WE86

(9) Check :
Cylinder sliding surface free of grooves, no wear, no embedded foreign particles. That there are no scratches on the control plate. (Only replace them as a set).



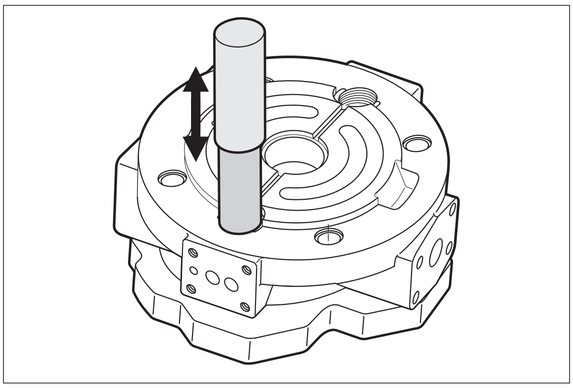
75796WE87

(10) Check :
Mounting surface - control plate undamaged.



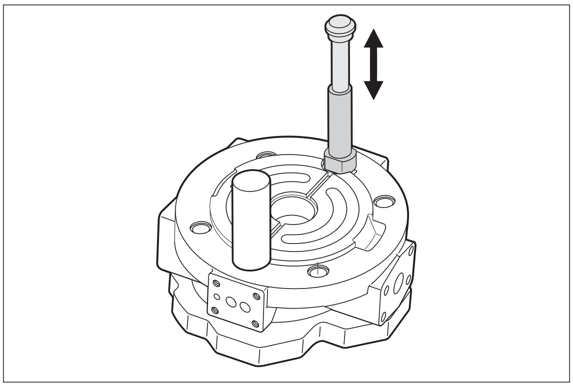
75796WE120

(11) Check :
Check running conditions of the control piston.



75796WE89

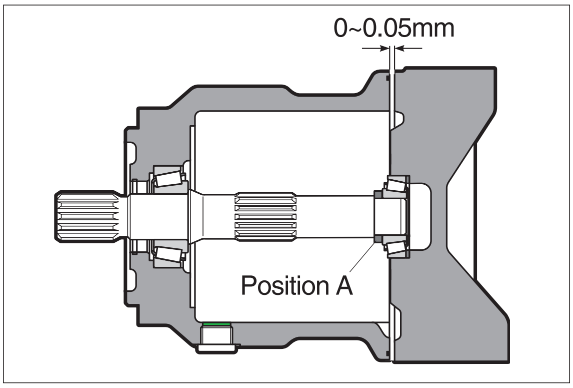
(12) Check :
Check running conditions of the opposite piston.



75796WE90

7) ADJUSTMENT OF TAPER ROLLER BEARING SET

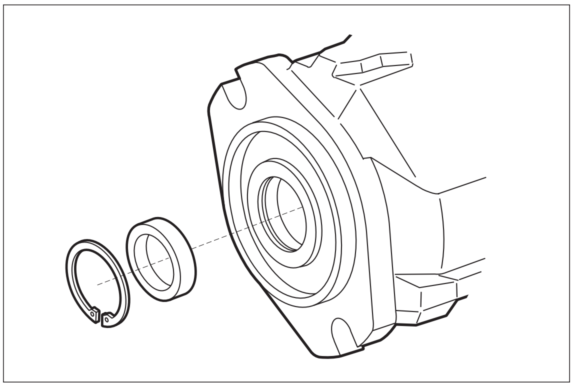
(1) Cast iron housing must have initial tension of the bearings : 0~0,05 mm, grind position A if necessary.



75796WE91

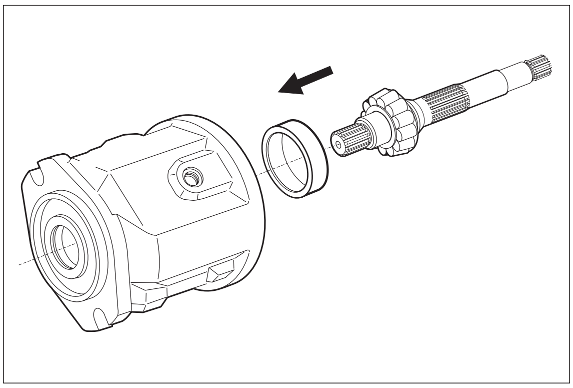
8) PUMP ASSEMBLY

(1) Fit the seal into the housing.
Fit the circlip.



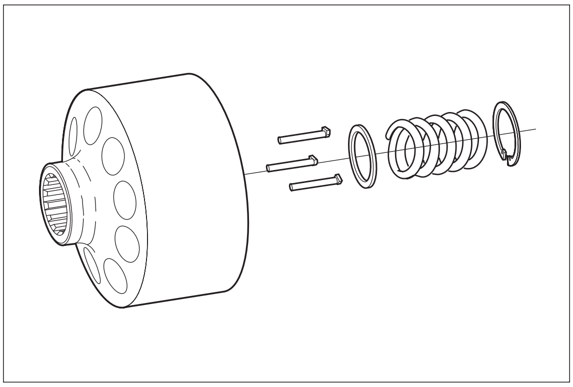
75796WE92

(2) Fit the drive with bearing from rear end.
※ Do not touch seal lip with edge of keyway or spline.



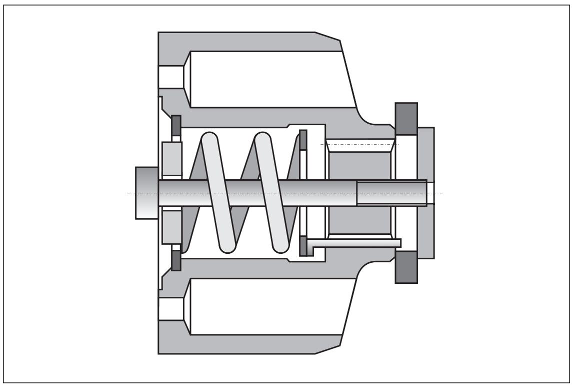
75796WE93

(3) Fit pressure pins using an assembly aid.



75796WE94

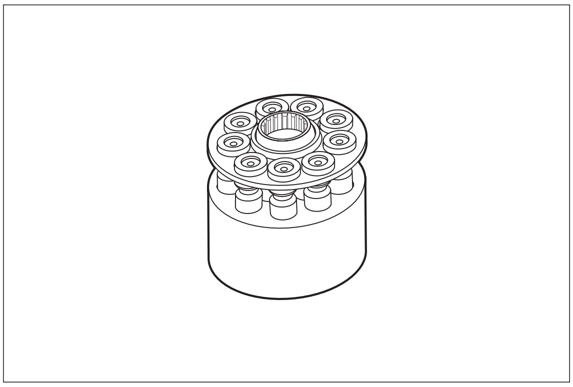
(4) Pre-tension the spring using a suitable device.



75796WE95

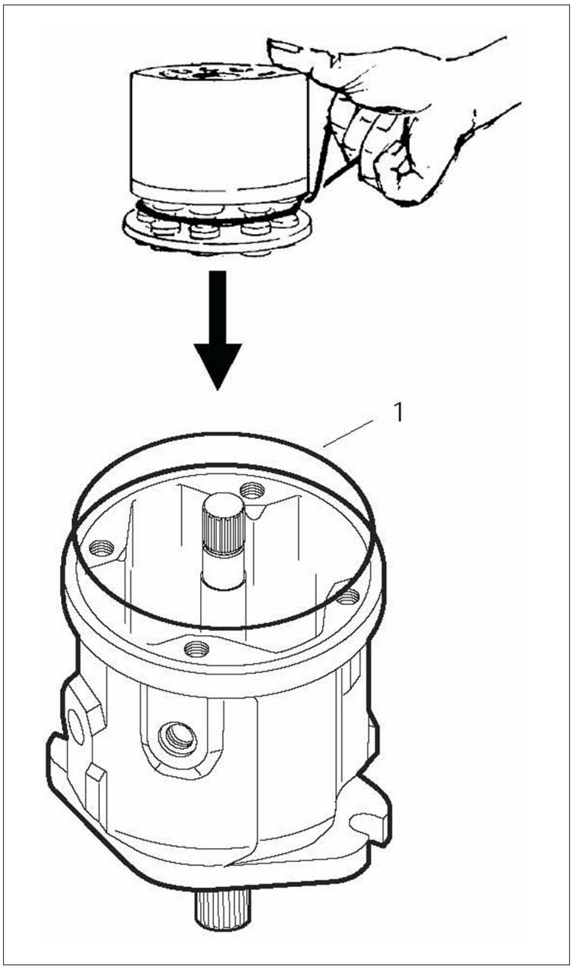
(5) Assemble piston with retaining plate.

※ Oil piston and slipper pad.



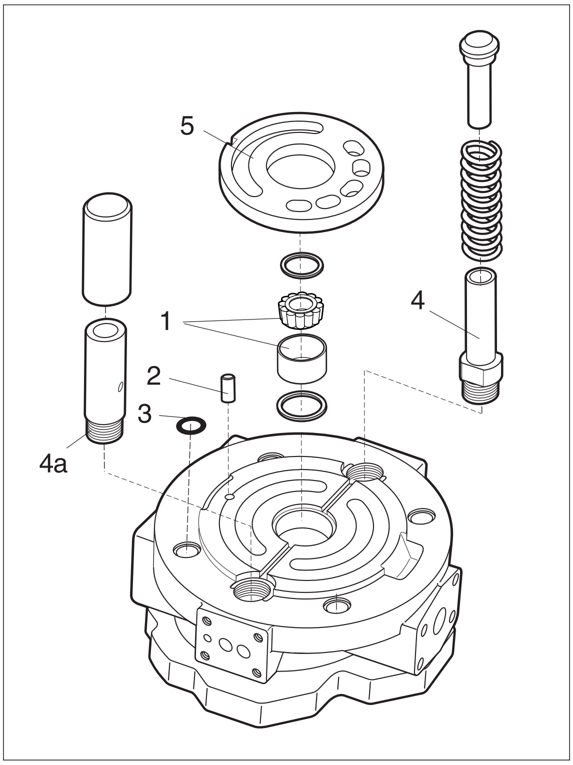
75796WE97

(6) Fit rotary group.
※ Hold the piston by using an O-ring.
Fit O-ring (1).



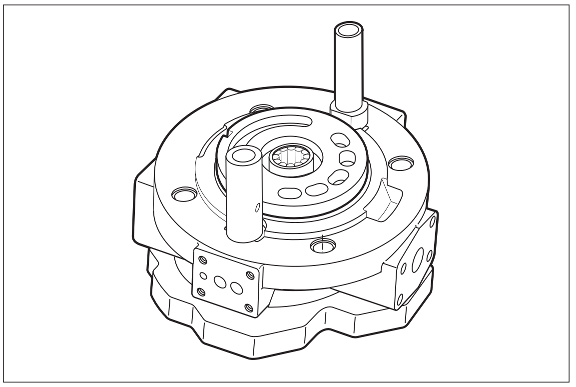
75796WE98

(7) Fit bearing (1) in connection plate.
Fit cyilindrical pin (2).
Fit O-rings (3) 4 pieces.
Fit adjustment spool (4) and guide piston (4a).
Fit distributor plate (5) (direction of rotation dependent)
※ Assembly.
Hold the components in place with grease.



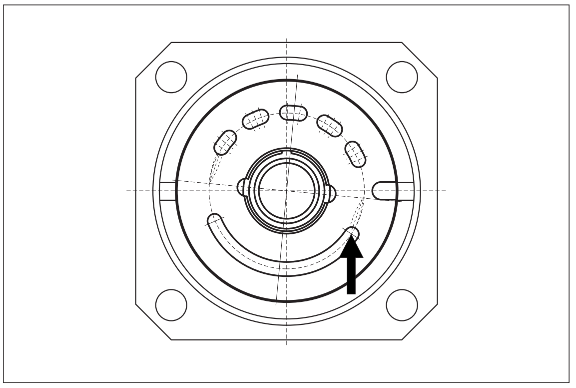
75796WE99

(8) Fit distributor plate.
※ Assembly aid : Grease



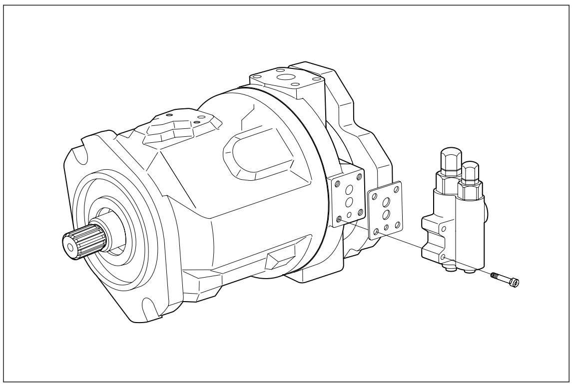
75796WE100

(9) For clockwise rotation pumps the distributor plate is off-set by 4 to the right from the centre position.
(Clockwise and anti-clockwise rotation distributor plates are not identical).



75796WE101

(10) Fit connection plate and control valve.



75796WE63

2. MAIN CONTROL VALVE (LEVER TYPE)

1) VALVE SECTION DISASSEMBLY / REASSEMBLY INSTRUCTIONS

(1) Clean valve assembly thoroughly to remove any dirt and debris.

(2) Remove nuts (10) and tie rods (9) from control valve (see Figure #4). Separate sections being careful not to lose section O-rings (A and B , Figure #1-3). Keep all components for each section together as a set.

(3) Lay out valve components on a clean, flat working surface. The inlet assembly will include o-rings, and the spool section(s) will include o-rings. Tools required for basic valve assembly include 19mm open or box end wrench and a torque wrench with thin wall sockets.

(4) Inspect parts for wear or damage. Replace as necessary.

(5) Restack valve as shown in Figure #4. Care should be taken to assure that the mating section surfaces are absolutely free of contamination (dirt, paint, paint chips, etc.). Care should be taken to not pinch the section O-ring when restacking the valve.
Using the following procedure for stacking the valve assembly will help eliminate the possibility of damaged seals and will allow easy examination of the surfaces for debris.
Tie rods (9) are threaded to different lengths on each end. Install nuts (10) fully onto the short thread end of each tie rod. Lay inlet section on its outside face with tie rods up. Install O-rings (A and B) in grooves on inlet face. Slide spool section (2) over tie rods and install O-rings (A and B, Figure #1). Repeat for the remaining spool sections.
After stacking all spool sections and inlet / outlet sections onto tie rods (9) and nuts (10) onto tie rods and hand tighten so valve assembly can be placed on its mounting feet before torquing tie rods.

(6) Position valve assembly with the mounting pads of the end sections on a flat surface. To obtain proper alignment of end sections relative to the spool sections apply downward pressure to the end sections; snug tie rod ends to approximately 1.38 kgf·m (10 lbf·ft). Final torque the six 19 mm nuts (10) to 9.3 kgf·m (67 lbf·ft). Check for proper spool movement.

(7) Install auxiliary valves and/or port plugs into all sections and torque to proper specifications.

2) SPOOL SECTION

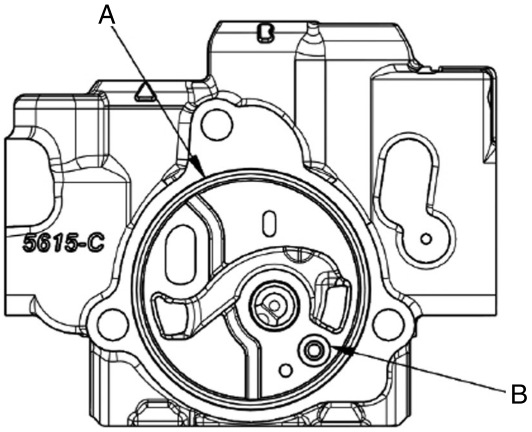


FIGURE #1 - SPOOL SECTION VIEW
A - Large O-ring
B - Small O-ring

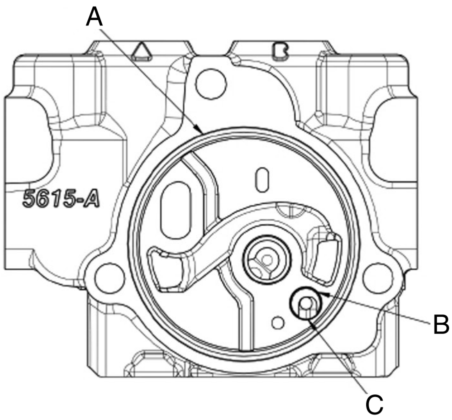


FIGURE #2 - SPOOL SECTION VIEW
A - Large O-ring
B - Seat assy (CV Valve)
C - Small O-ring

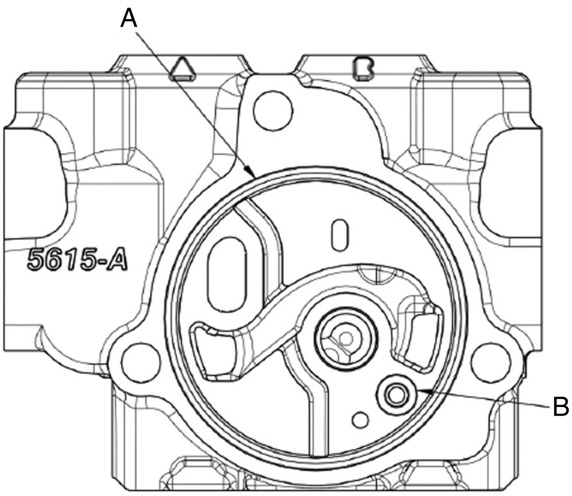


FIGURE #3 - SPOOL SECTION VIEW
A - Large O-ring
B - Small O-ring

110DEMCV01

3) VALVE ASSEMBLY

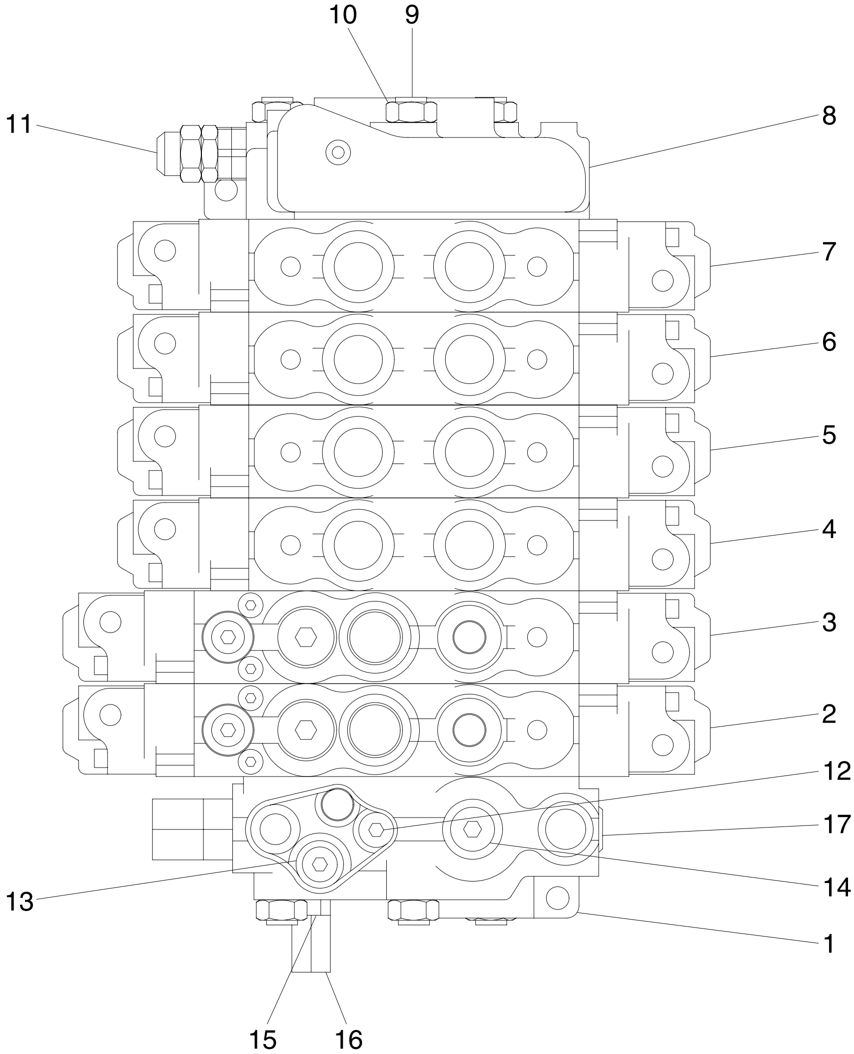
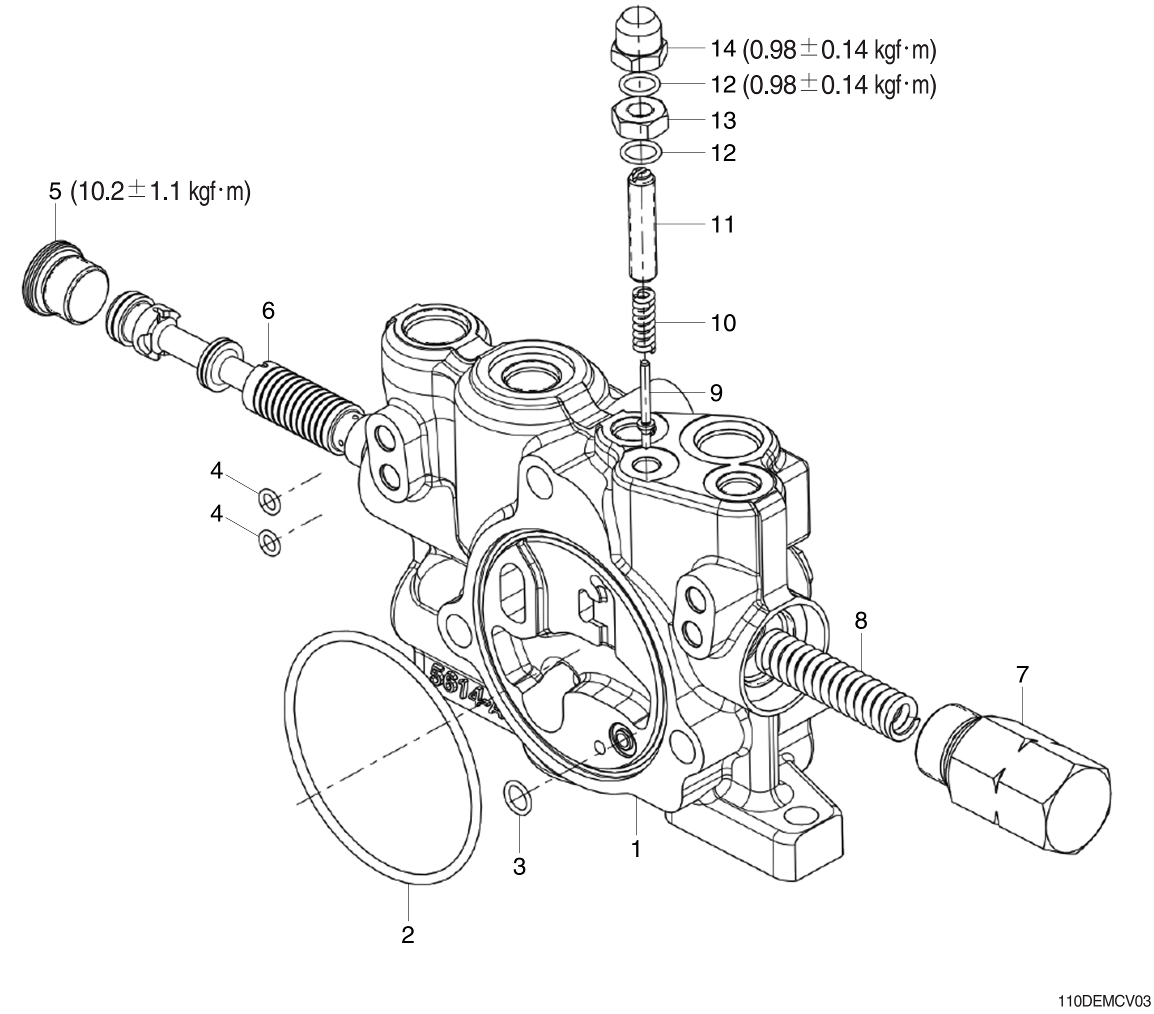


FIGURE #4 - VALVE ASSEMBLY

110DEMCV02

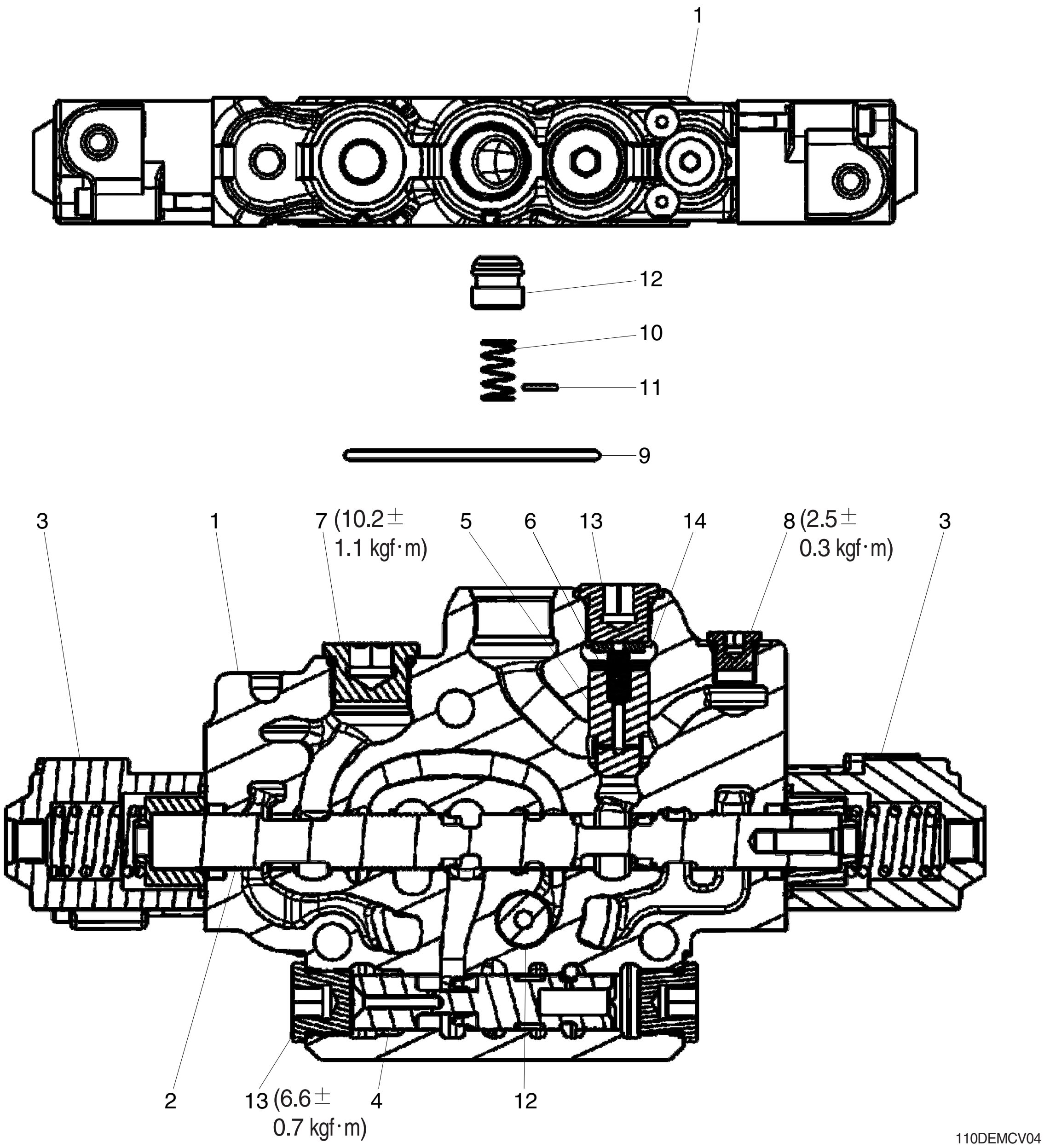
1	Inlet section	7	Aux section	13	LSRV
2	Lift section	8	Outlet section	14	Plug
3	Lift section	9	Tie rod(3)	15	Plug
4	Tilt section	10	Special nut(6)	16	Check valve
5	Aux section	11	Relief valve	17	Relief valve
6	Aux section	12	Plug		

4) INLET SECTION



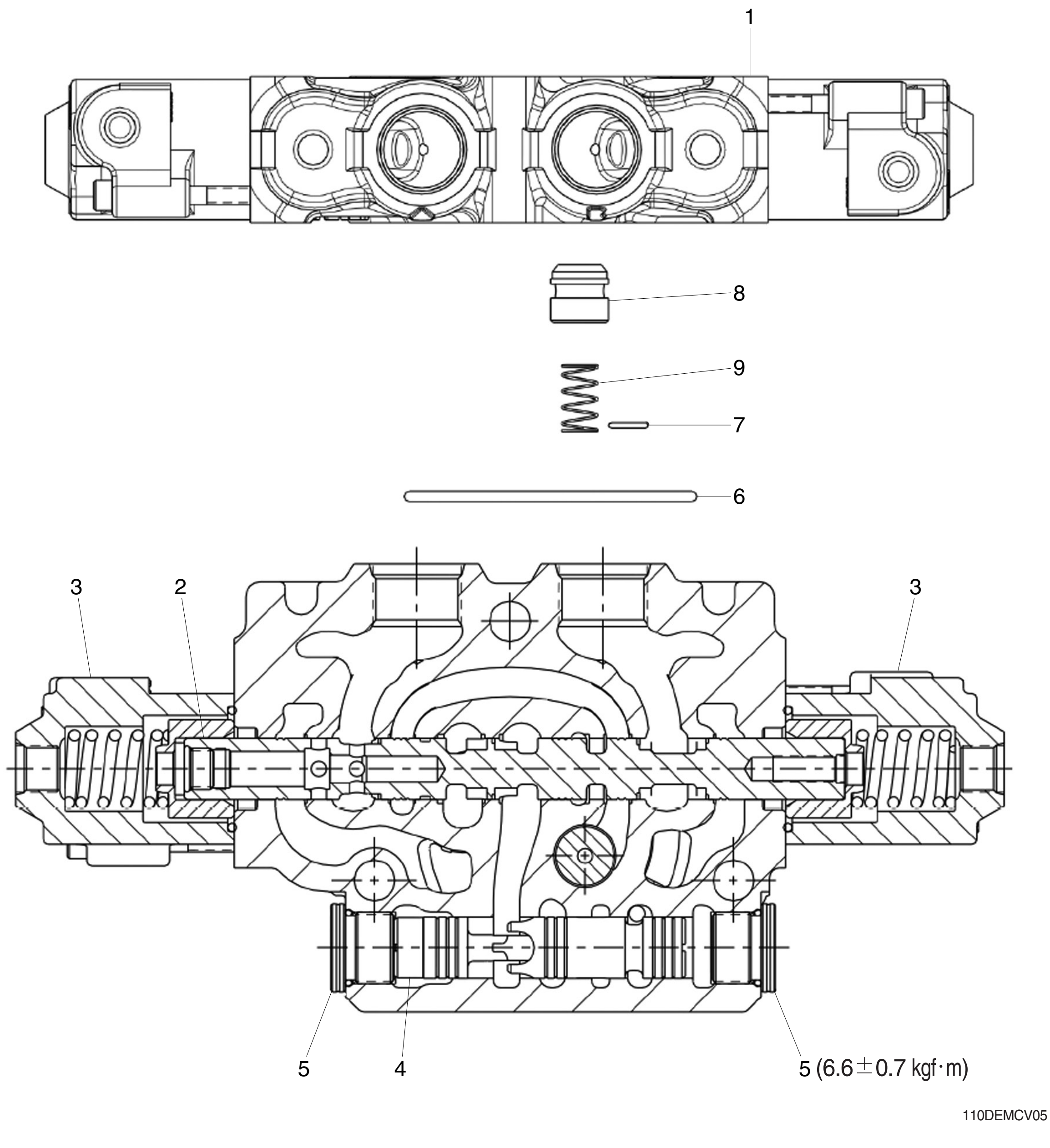
1	Inlet housing	6	Spool	11	Adjust screw
2	O-ring	7	Cap	12	O-ring
3	O-ring	8	Spring	13	Special nut
4	O-ring	9	Poppet	14	Special nut
5	Plug	10	Spring		

5) LIFT SECTION



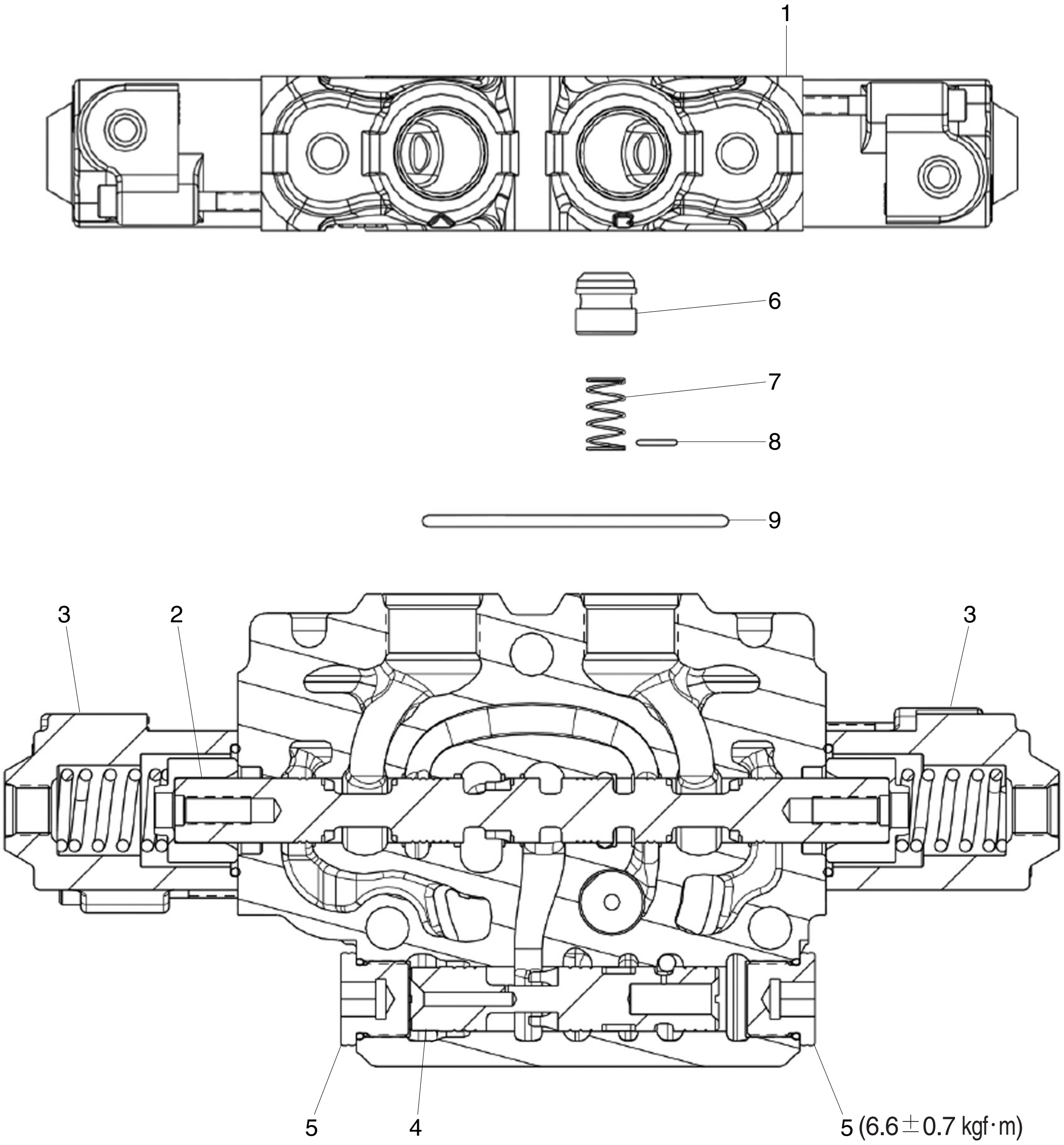
1	Lift spool housing	6	Spring	11	O-ring
2	Spool	7	Plug	12	Poppet
3	End cap	8	Plug	13	Plug
4	Spool	9	O-ring	14	Washer
5	Lockout valve poppet	10	Spring		

6) TILT SECTION



1	Tilt spool housing	4	Spool	7	O-ring
2	Spool	5	Plug	8	Poppet
3	End cap	6	O-ring	9	Spring

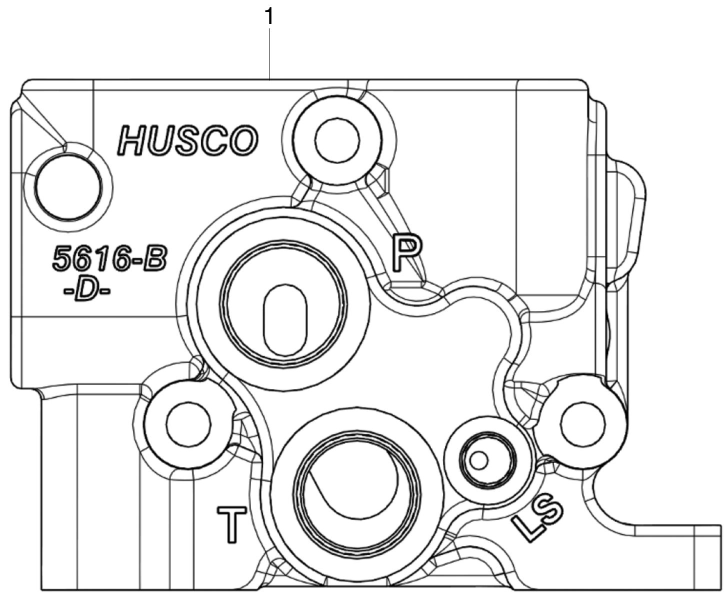
7) AUX SECTION



110DEMCV06

1	Aux spool housing	4	Spool	7	Spring
2	Spool	5	Plug	8	O-ring
3	End cap	6	Poppet	9	O-ring

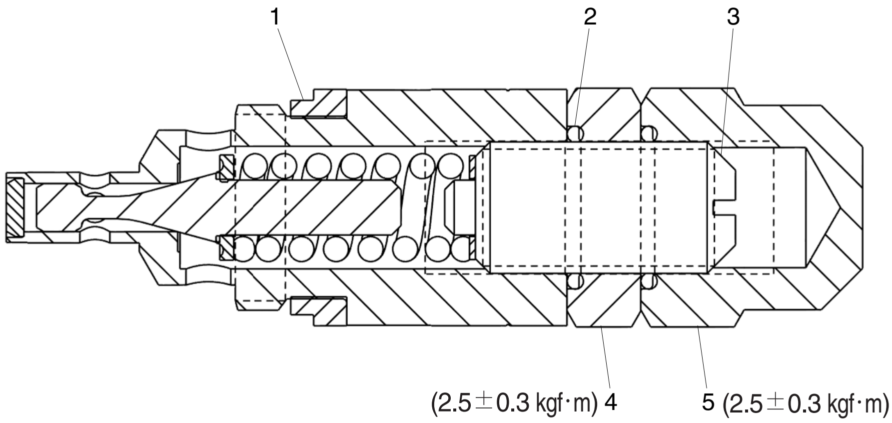
8) OUTLET SECTION



110DEMCV07

1 Outlet housing

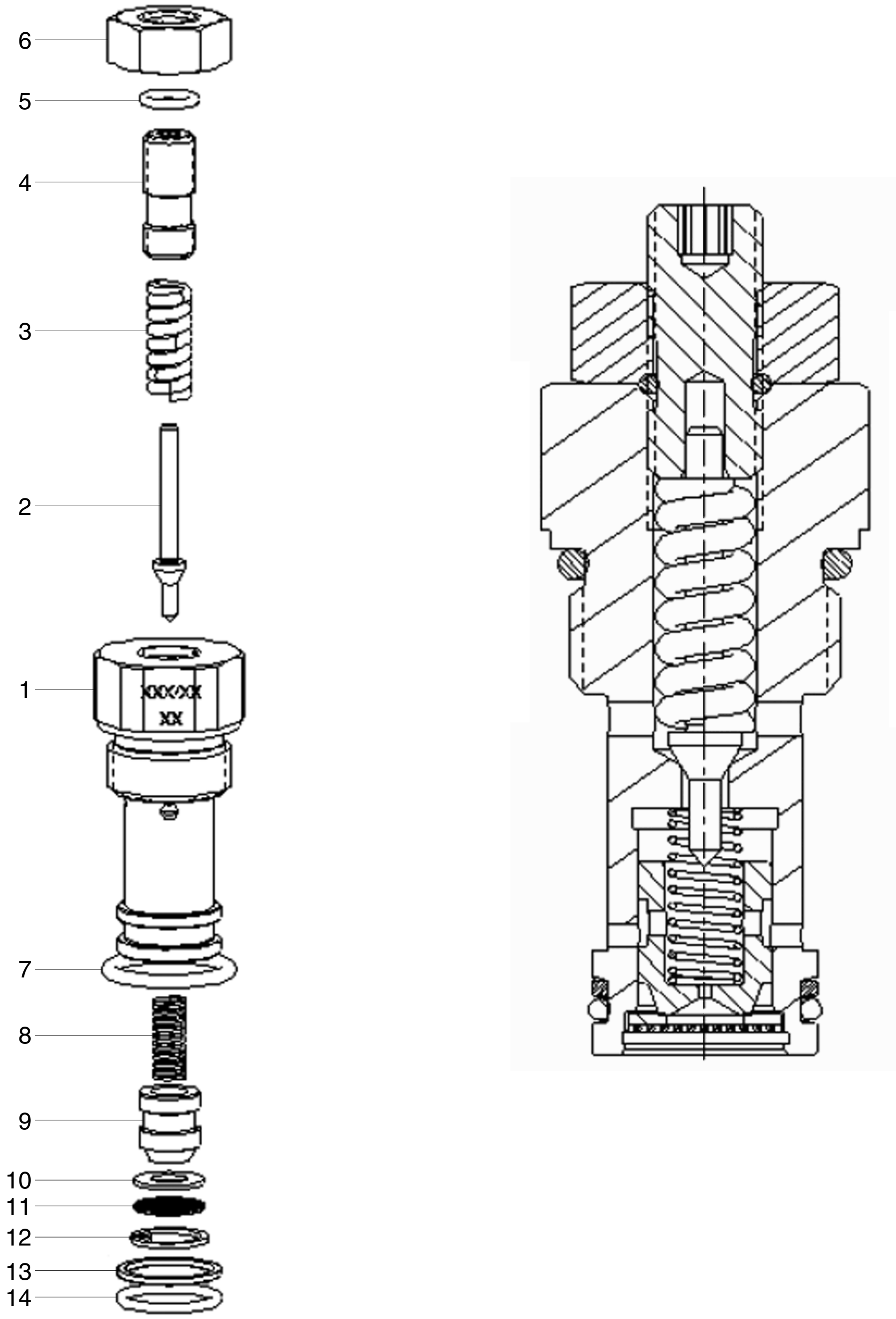
9) RELIEF VALVE



110DEMCV08

1	Special seal	3	Adjust screw	5	Special nut
2	O-ring	4	Jam nut		

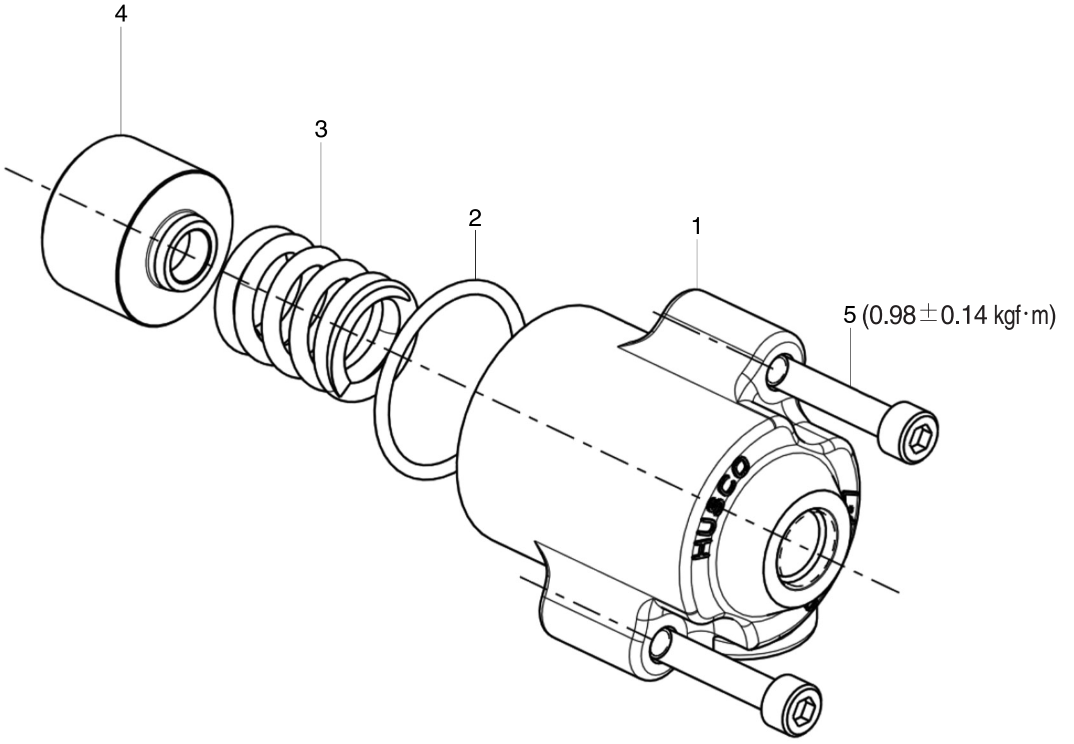
10) DRAIN REGULATOR



110DEMCV09

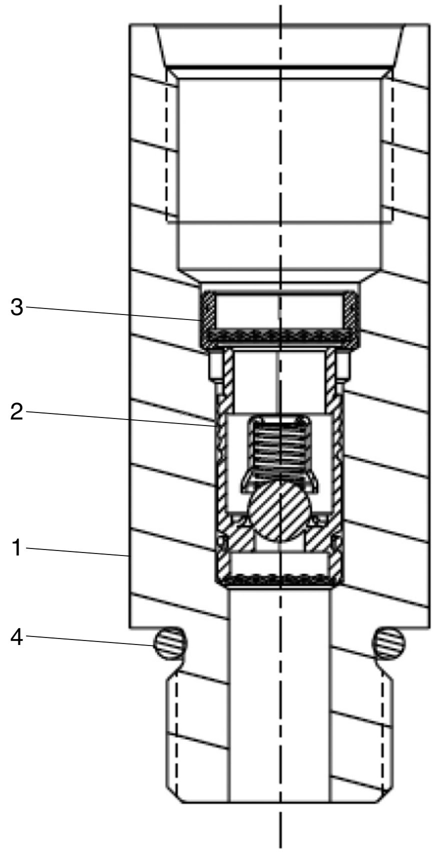
1	Body	6	Special nut	11	Filter
2	Poppet	7	O-ring	12	Retaining ring
3	Spring	8	Spring	13	Backup ring
4	Adjust screw	9	Piston	14	O-ring
5	O-ring	10	Washer		

11) END CAP



1	Spool cap	3	Spring	5	Cap screw
2	O-ring	4	Spring seat		

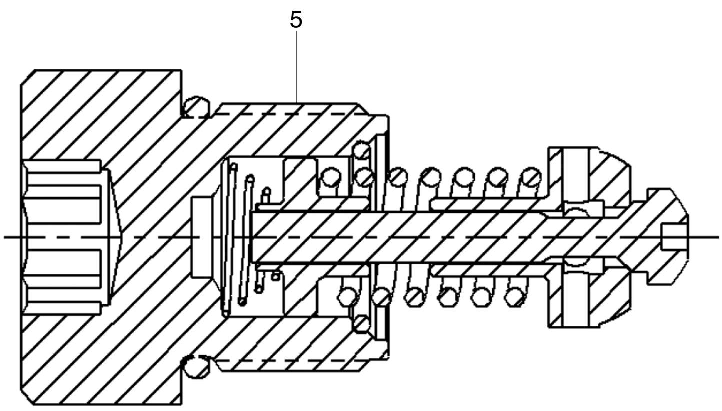
12) CHECK VALVE



110DEMCV11

1 Body
2 Flow control
3 Filter
4 O-ring

13) RELIEF VALVE



110DEMCV12

5 O-ring

3. MAIN CONTROL VALVE (FINGERTIP TYPE)

1) VALVE SECTION DISASSEMBLY / REASSEMBLY INSTRUCTIONS

(1) Clean valve assembly thoroughly to remove any dirt and debris.

(2) Remove nuts (10) and tie rods (9) from control valve (see Figure #4). Separate sections being careful not to lose section O-rings (A, B, C and D , Figure #1-3). Keep all components for each section together as a set.

(3) Lay out valve components on a clean, flat working surface. The inlet assembly will include O-rings, and the spool section(s) will include O-rings. Tools required for basic valve assembly include 19 mm open or box end wrench and a torque wrench with thin wall sockets.

(4) Inspect parts for wear or damage. Replace as necessary.

(5) Restack valve as shown in Figure #4. Care should be taken to assure that the mating section surfaces are absolutely free of contamination (dirt, paint, paint chips, etc.). Care should be taken to not pinch the section O-ring when restacking the valve.
Using the following procedure for stacking the valve assembly will help eliminate the possibility of damaged seals and will allow easy examination of the surfaces for debris.
Tie rods (9) are threaded to different lengths on each end. Install nuts (10) fully onto the short thread end of each tie rod. Lay inlet section on its outside face with tie rods up. Install O-rings (A, B and C) in grooves on inlet face. Slide spool section (2) over tie rods and install O-rings (A, B and C, Figure #1). Repeat for the remaining spool sections.
After stacking all spool sections and inlet / outlet sections onto tie rods (9) and nuts (10) onto tie rods and hand tighten so valve assembly can be placed on its mounting feet before torquing tie rods.

(6) Position valve assembly with the mounting pads of the end sections on a flat surface. To obtain proper alignment of end sections relative to the spool sections apply downward pressure to the end sections; snug tie rod ends to approximately 1.4 kgf·m (10 lbf·ft). Final torque the six 19 mm nuts (10) to 9.3 kgf·m (67 lbf·ft). Check for proper spool movement.

(7) Install auxiliary valves and/or port plugs into all sections and torque to proper specifications.

2) SPOOL SECTION

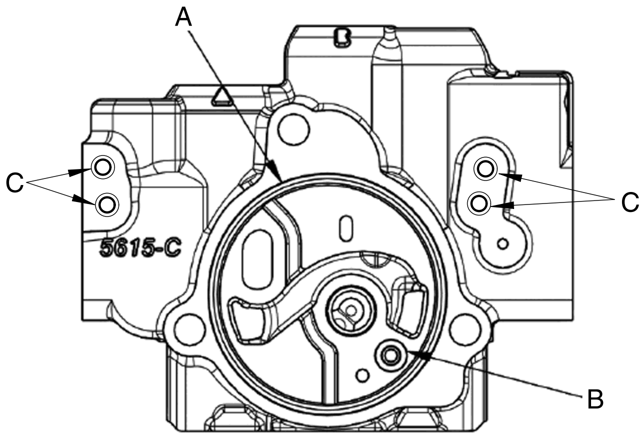


Figure #1 Spool section view

A Large O-ring
B Medium O-ring
C Small O-ring

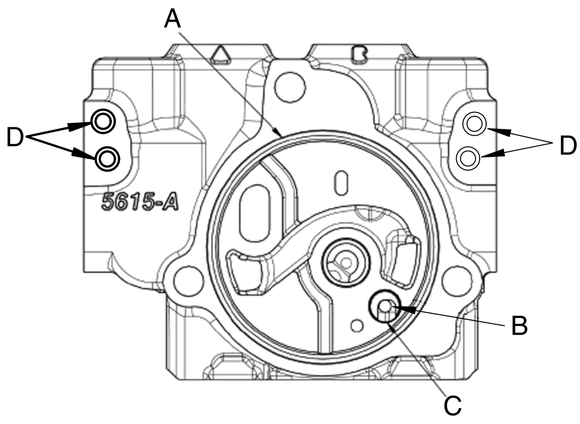


Figure #2 Spool section view

A Large O-ring
B Seat assy (CV valve)
C Medium O-ring
D Small O-ring

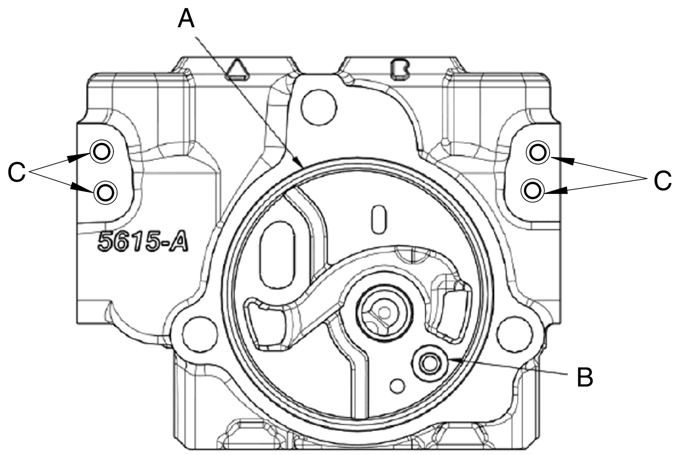


Figure #3 Spool section view

A Large O-ring
B Medium O-ring
C Small O-ring

160D9LMCV01

3) VALVE ASSEMBLY

※ The valve assembly pictured below is the 5 spool.

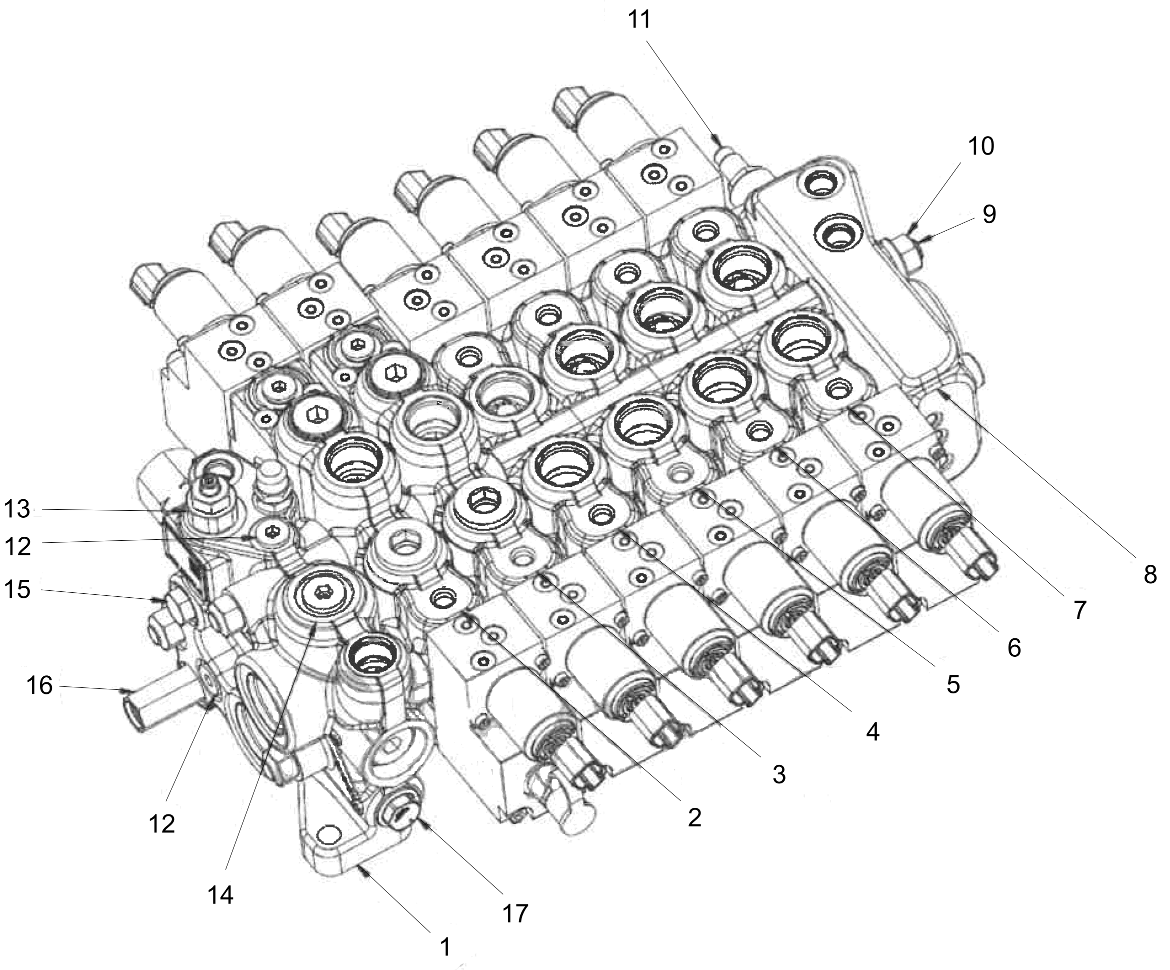


FIGURE #4 - VALVE ASSEMBLY

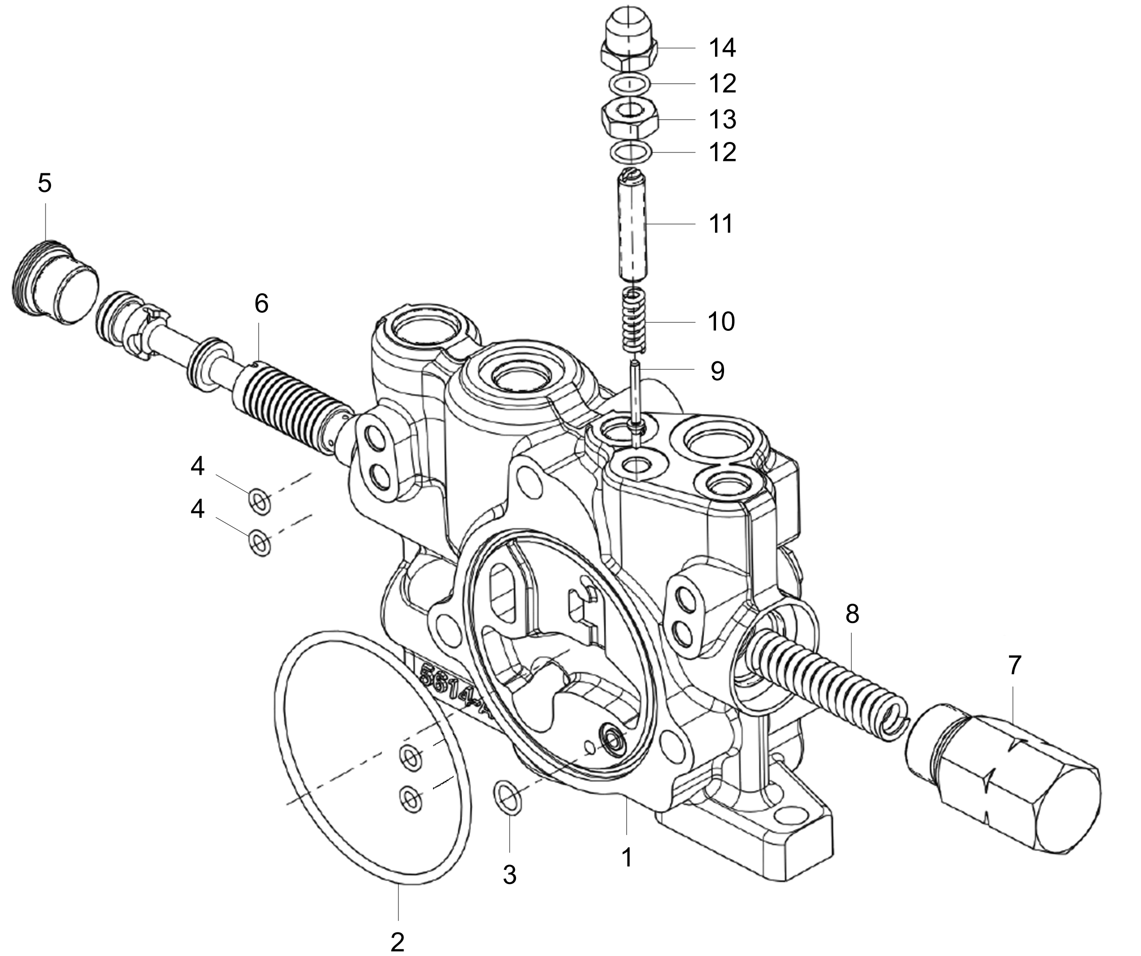
160D9LMCV02

※ Tightening torque

Item	Torque	Item	Torque
10	9.3 ± 0.7 kgf·m (67 ± 5 lbf·ft)	14	2.5 ± 0.3 kgf·ft (18 ± 2 lbf·ft)
11	2.5 ± 0.3 kgf·ft (18 ± 2 lbf·ft)	15	2.5 ± 0.3 kgf·ft (18 ± 2 lbf·ft)
12	4.6 ± 0.5 kgf·ft (33 ± 3.5 lbf·ft)	16	4.6 ± 0.5 kgf·ft (33 ± 3.5 lbf·ft)
13	4.6 ± 0.5 kgf·ft (33 ± 3.5 lbf·ft)	17	3.5 ± 0.35 kgf·ft (25 ± 2.5 lbf·ft)

1 Inlet section
2 Lift section 1
3 Lift section 2 (option)
4 Tilt section
5 Aux section
6 Aux section
7 Aux section
8 Outlet section
9 Tie rod
10 Special nut
11 Auxiliary relief valve assy
12 Plug
13 Load sensing relief valve (option)
14 Plug
15 Plug
16 Check valve assy
17 Main relief valve assy

4) INLET SECTION

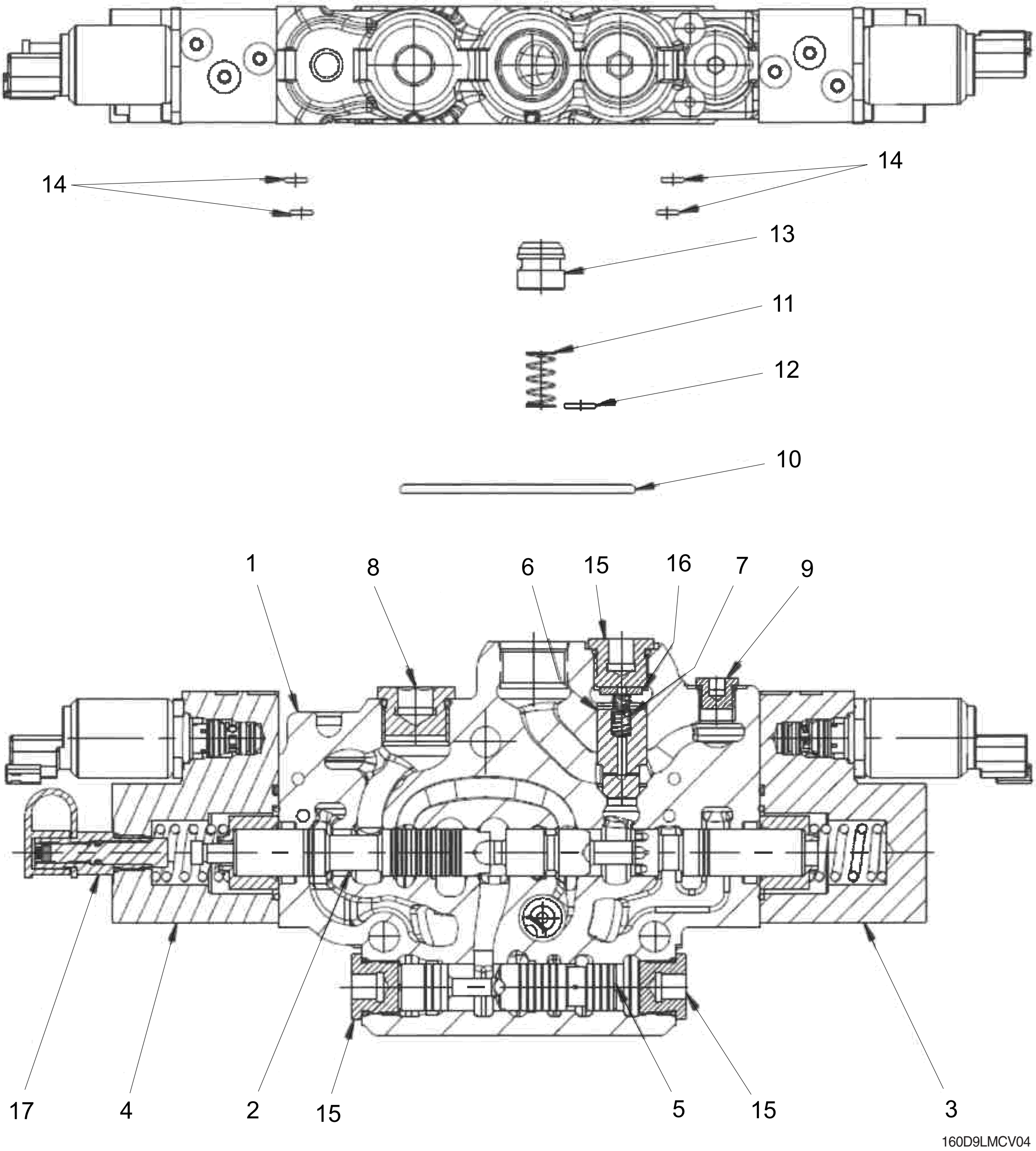


※ Tightening torque

Item	Torque	Item	Torque
5	6.6 ± 0.7 kgf·m (48 ± 5 lbf·ft)	14	0.97 ± 0.14 kgf·m (7 ± 1 lbf·ft)
7	10.2 ± 1.1 kgf·ft (74 ± 8 lbf·ft)	17	2.5 ± 0.3 kgf·m (18 ± 2 lbf·ft)
13	0.97 ± 0.14 kgf·m (7 ± 1 lbf·ft)	-	-

1	Inlet housing	7	Cap assy	13	Special nut
2	O-ring	8	Spring	14	Special nut
3	O-ring	9	RV poppet	15	CV poppet (not shown)
4	O-ring	10	Spring	16	Spring (not shown)
5	Plug assy	11	Adjust screw	17	Plug assy (not shown)
6	Spool	12	O-ring		

5) LIFT SECTION 1

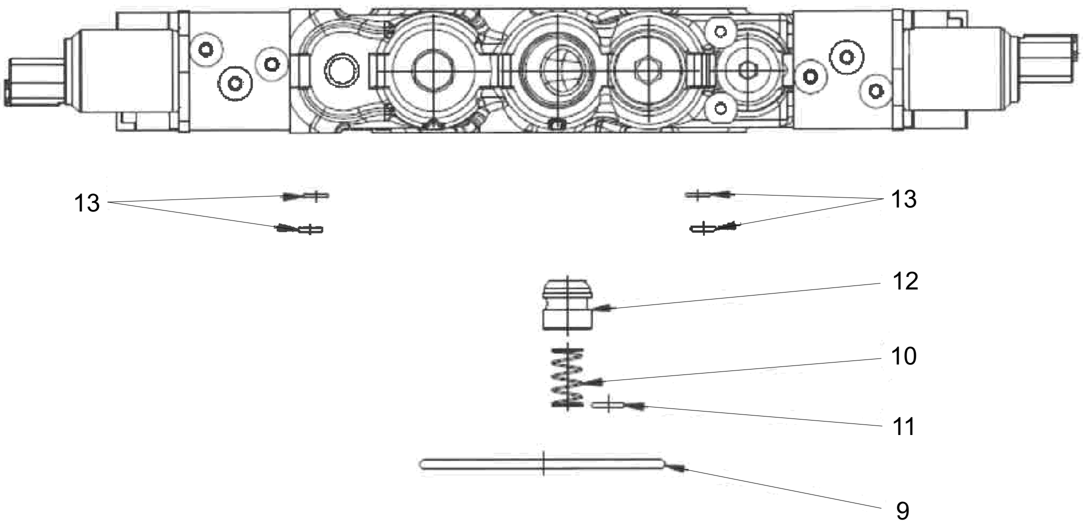


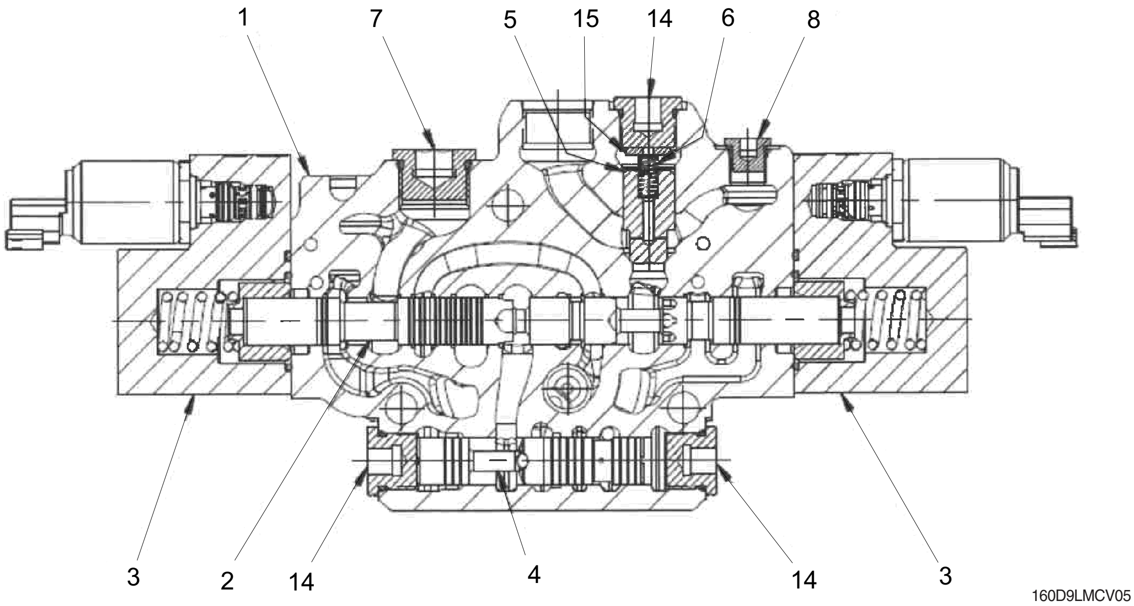
※ Tightening torque

Item	Torque	Item	Torque
8	10.2 ± 1.1 kgf·ft (74 ± 8 lbf·ft)	15	6.6 ± 0.7 kgf·m (48 ± 5 lbf·ft)
9	2.5 ± 0.3 kgf·m (18 ± 2 lbf·ft)	17	2.5 ± 0.3 kgf·m (18 ± 2 lbf·ft)

1 Lift spool housing
2 Spool assy
3 End cap assy
4 End cap assy
5 Spool assy
6 Lockout valve poppet
7 Spring
8 Plug assy
9 Plug assy
10 O-ring
11 Spring
12 O-ring
13 CV poppet
14 O-ring
15 Plug assy
16 Flat washer
17 Adjust plug assy

6) LIFT SECTION 2 (OPTION)



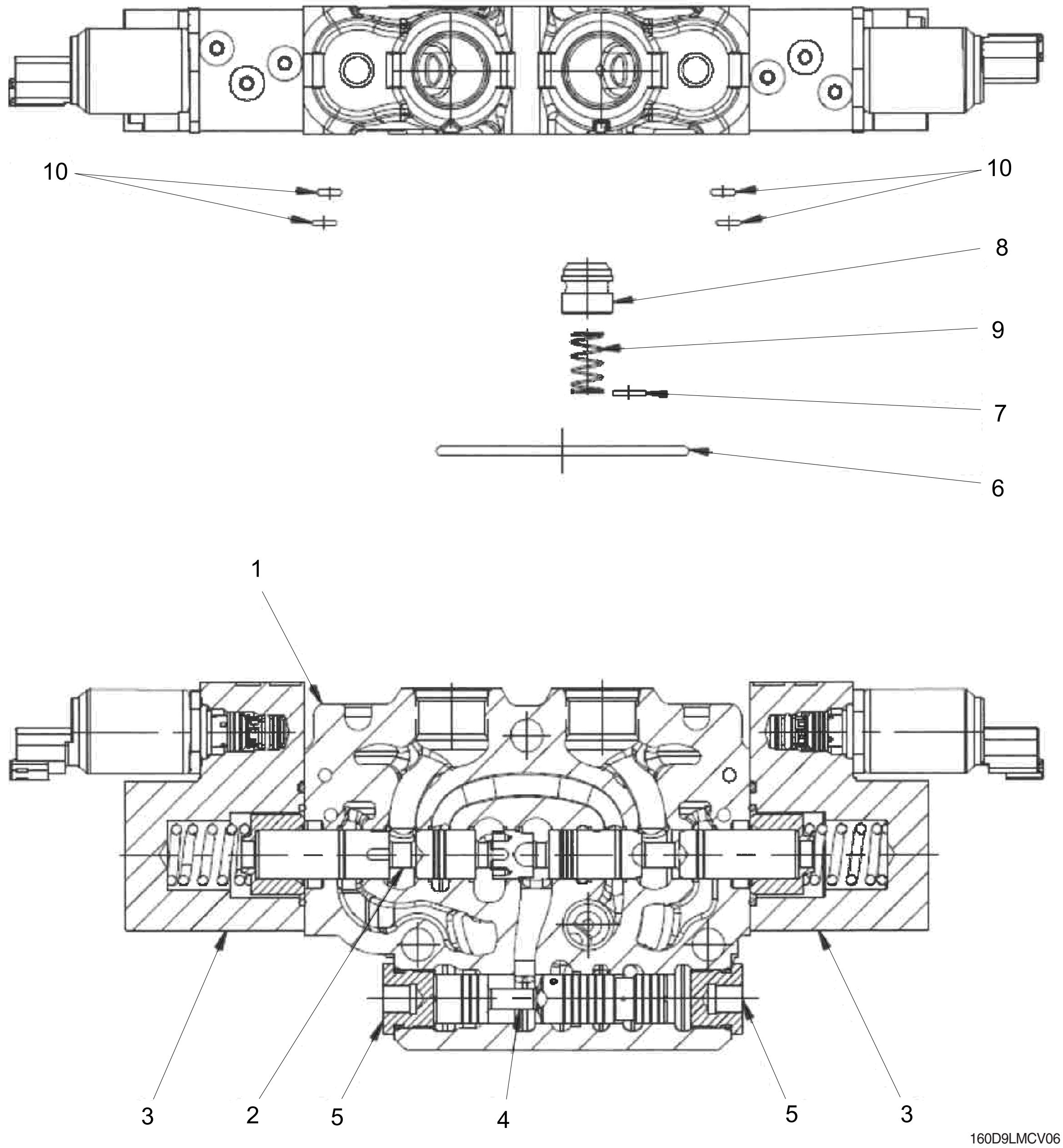


※ Tightening torque

Item	Torque	Item	Torque
7	10.2 ± 1.1 kgf·ft (74 ± 8 lbf·ft)	14	6.6 ± 0.7 kgf·m (48 ± 5 lbf·ft)
8	2.5 ± 0.3 kgf·m (18 ± 2 lbf·ft)	-	-

1 Lift spool housing
2 Spool
3 End cap assy
4 Compensator spool assy
5 Lockout valve poppet
6 Spring
7 Plug assy
8 Plug assy
9 O-ring
10 Spring
11 O-ring
12 CV poppet
13 O-ring
14 Plug assy
15 Flat washer

7) TILT SECTION

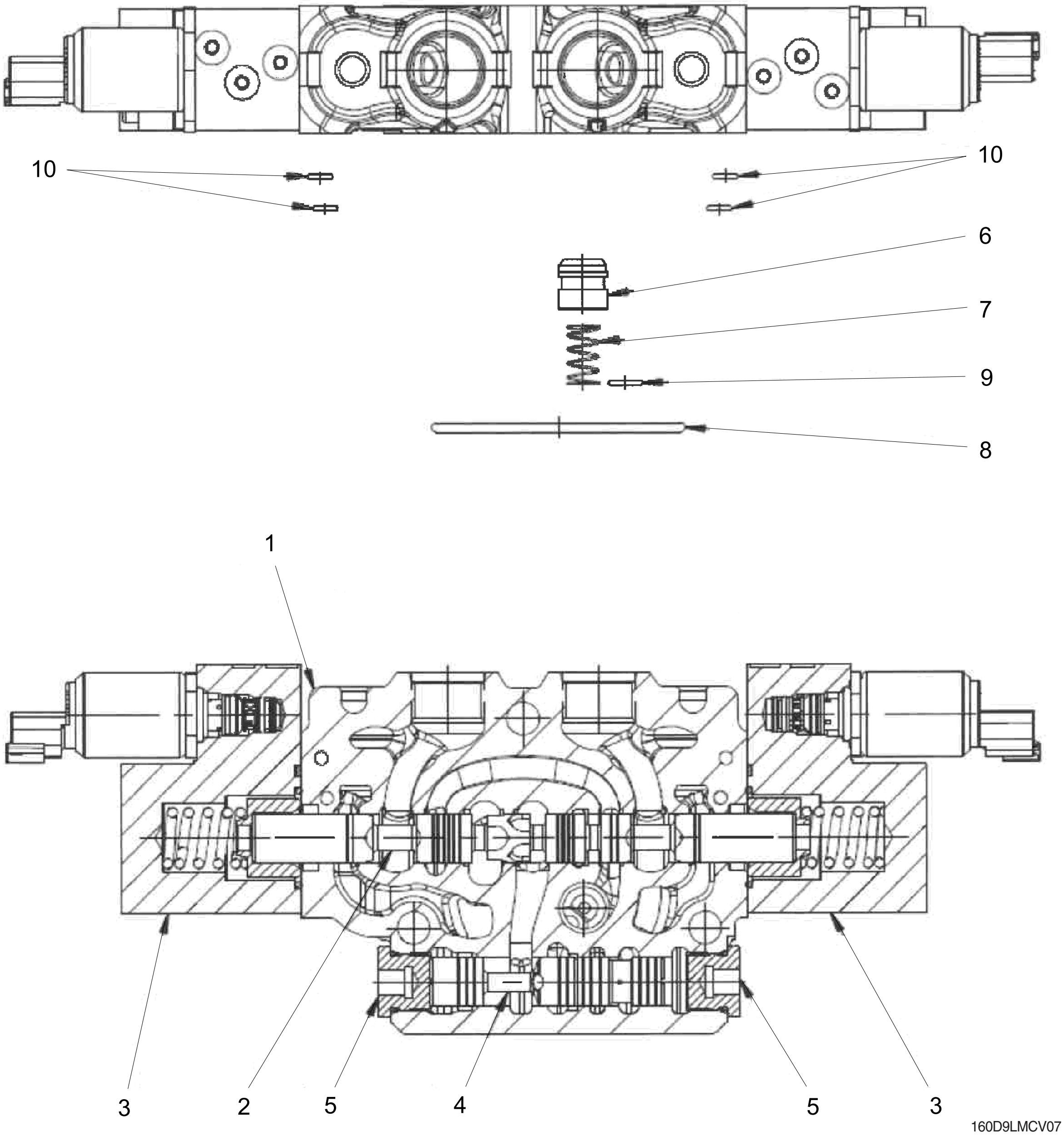


※ Tightening torque

Item	Torque
5	6.6 ± 0.7 kgf·m (48 ± 5 lbf·ft)

1 Tilt spool housing
2 Spool
3 End cap assy
4 Compensator spool assy
5 Plug assy
6 O-ring
7 O-ring
8 CV poppet
9 Spring
10 O-ring

8) AUX SECTION

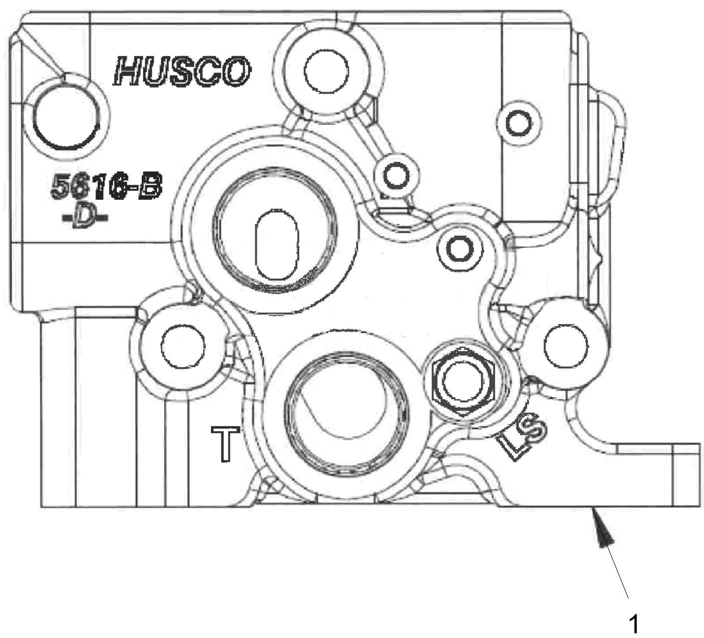


※ Tightening torque

Item	Torque
5	6.6 ± 0.7 kgf·m (48 ± 5 lbf·ft)

1 Aux spool housing
2 Spool
3 End cap assy
4 Compensator spool assy
5 Plug assy
6 CV poppet
7 Spring
8 O-ring
9 O-ring
10 O-ring

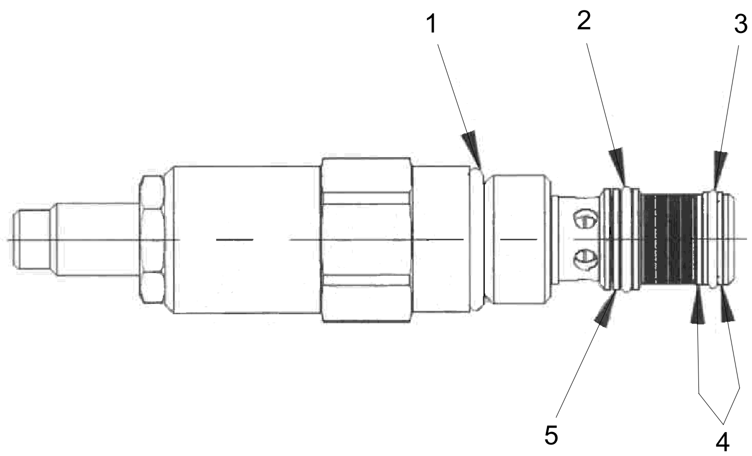
9) OUTLET SECTION



160D9LMCV08

1 Outlet housing

10) MAIN RELIEF VALVE ASSY (OPTION)

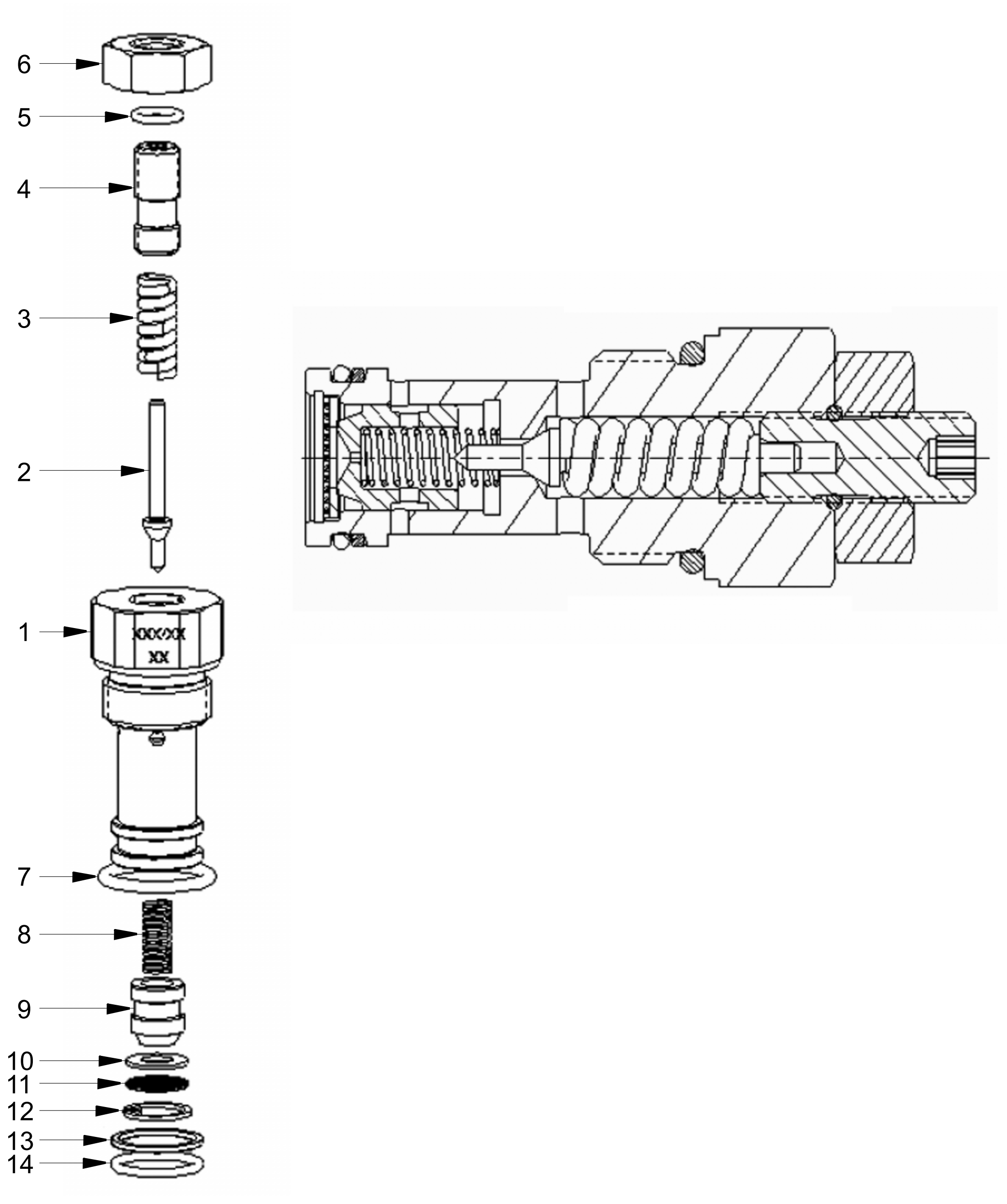


160D9LMCV09

※ If service other than external seal replacement is required replace entire assembly.

1	O-ring	3	O-ring	5	Back up ring
2	O-ring	4	Back up ring		

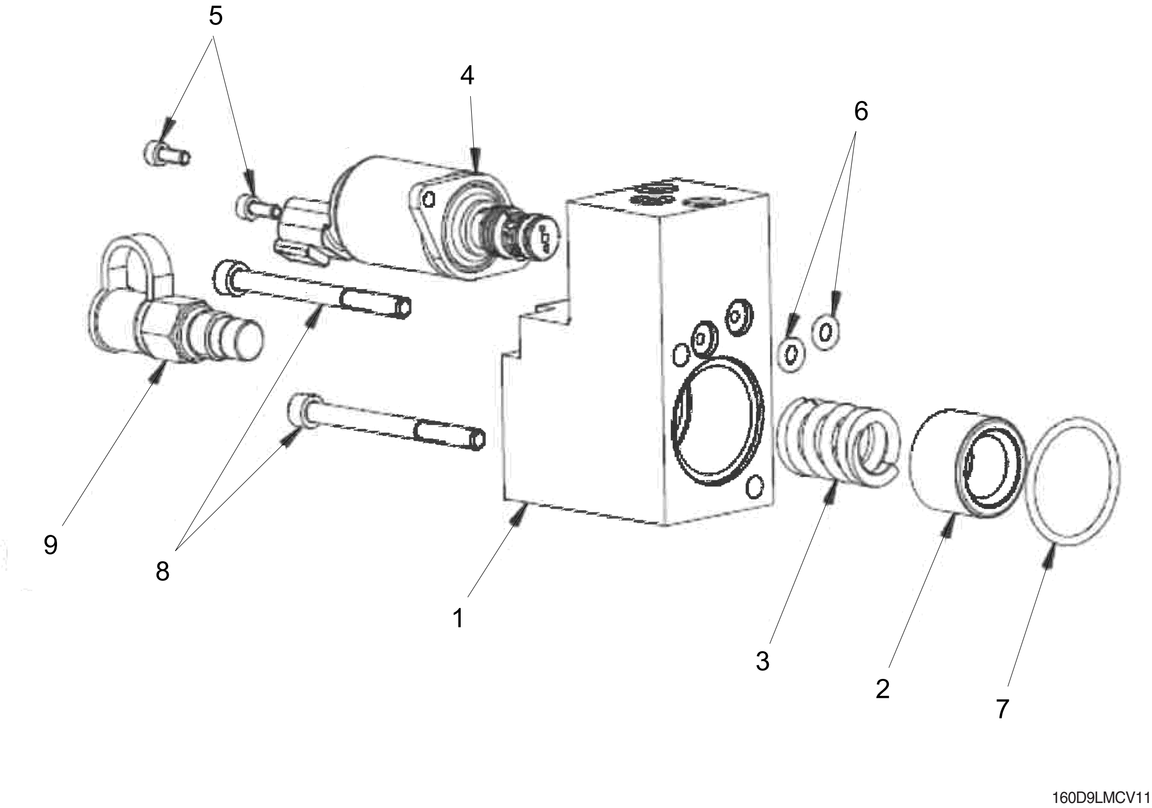
11) DRAIN REGULATOR ASSEMBLY



160D9LMCV10

1	Relief valve body	6	Special nut	11	Filter
2	Relief valve poppet	7	O-ring	12	Retaining ring
3	Spring	8	Spring	13	Backup ring
4	Adjust screw	9	Piston	14	O-ring
5	O-ring	10	Washer		

12) END CAP ASSEMBLY (OPTION)

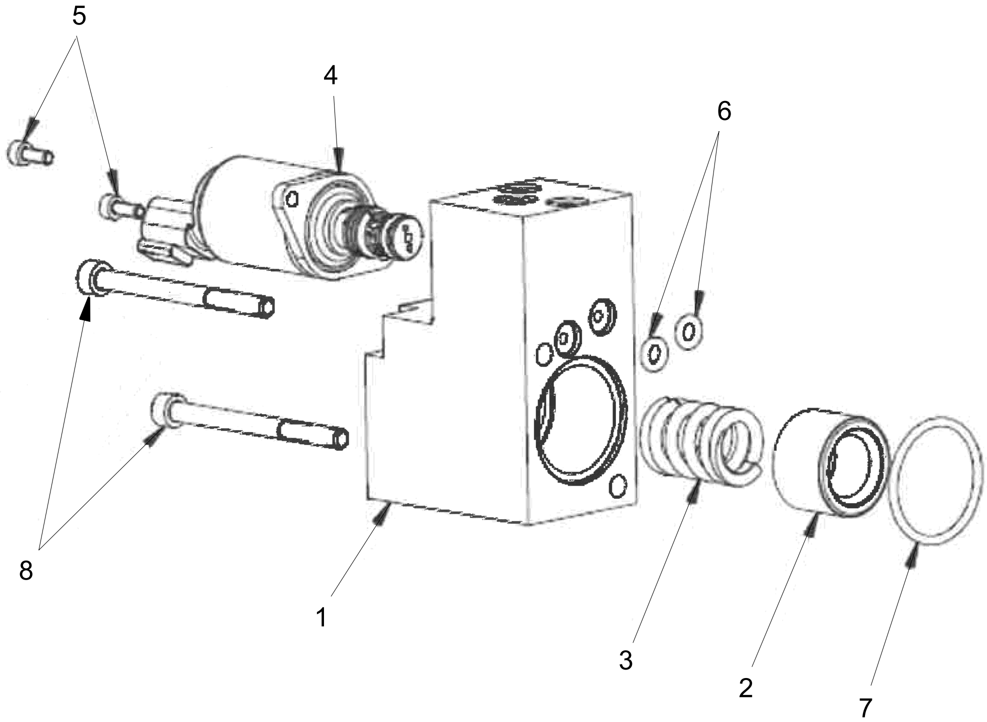


※ Tightening torque

Item	Torque	Item	Torque
5	0.21 ± 0.03 kgf·m (1.5 ± 0.2 lbf·ft)	9	2.5 ± 0.3 kgf·m (18 ± 2 lbf·ft)
8	1.4 ± 0.14 kgf·m (10 ± 1 lbf·ft)	-	-

1 Solenoid spool cap assy
2 Spring seat
3 Spring
4 Solenoid cartridge valve
5 Socket head cap screw
6 O-ring
7 O-ring
8 Socket head cap screw
9 Adjust plug assy

13) END CAP ASSEMBLY



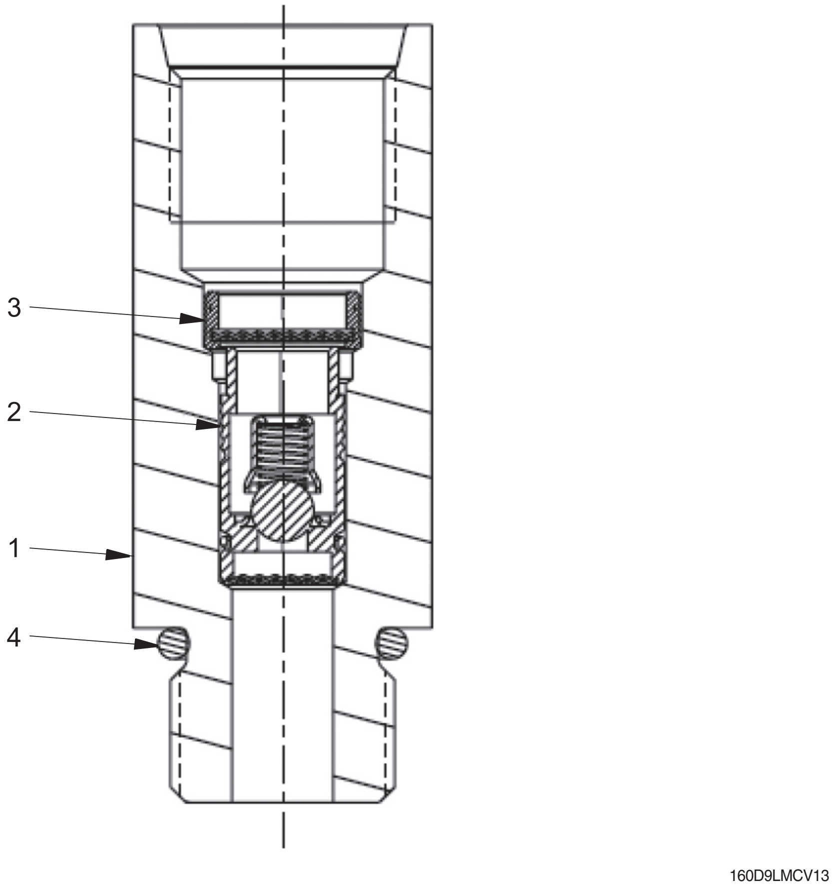
160D9LMCV12

※ Tightening torque

Item	Torque	Item	Torque
5	0.21 ± 0.03 kgf·ft (1.5 ± 0.2 lbf·ft)	8	1.4 ± 0.14 kgf·m (10 ± 1 lbf·ft)

1 Solenoid spool cap assy
2 Spring seat
3 Spring
4 Solenoid cartridge valve
5 Socket head cap screw
6 O-ring
7 O-ring
8 Socket head cap screw

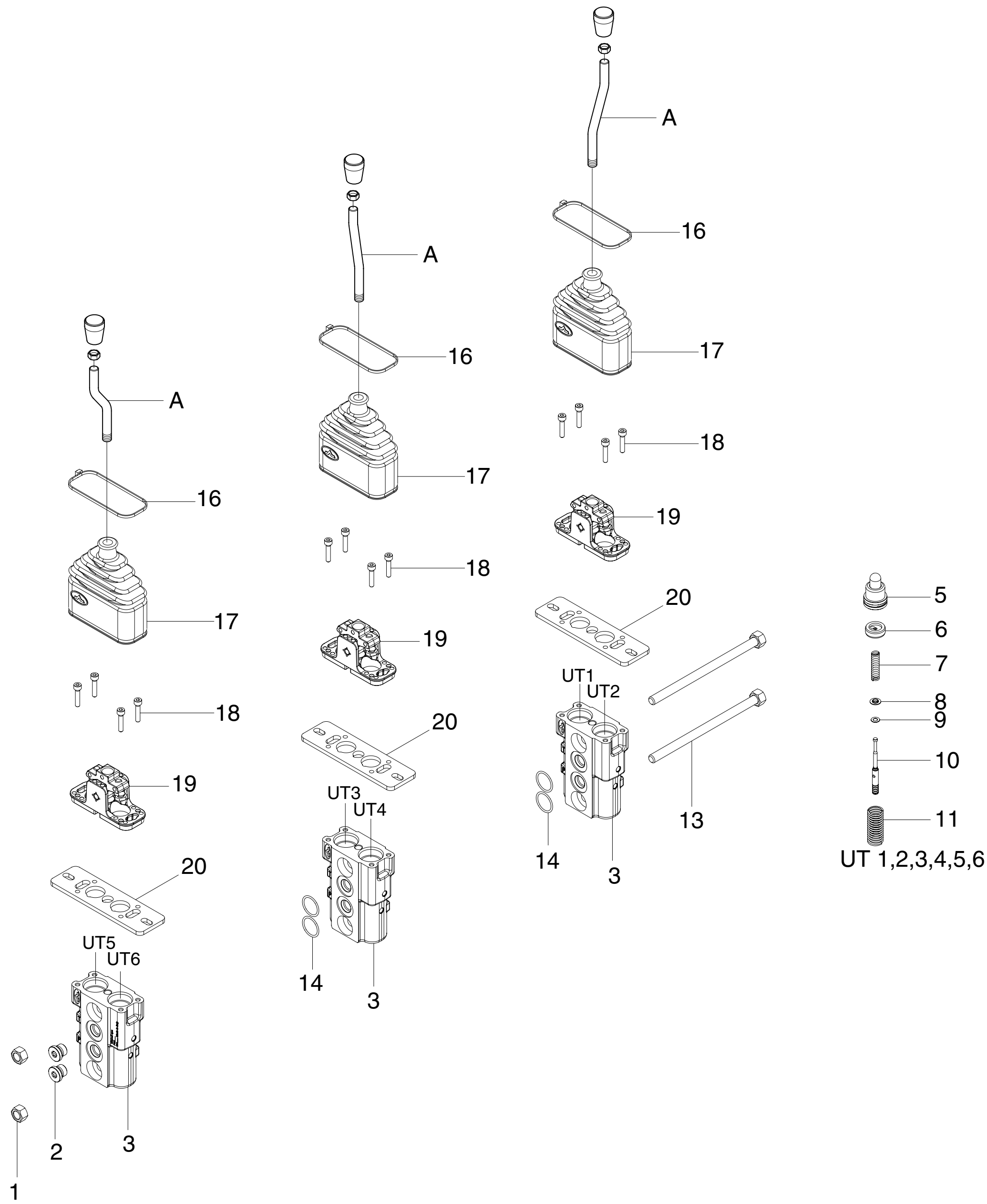
14) CHECK VALVE ASSEMBLY



1	CV body	3	Filter
2	Flow control assy	4	O-ring

3. REMOTE CONTROL VALVE

1) STRUCTURE



100D7RCV00

A	Lever	7	Metering spring	14	O-ring
1	Nut	8	Seeger ring	15	Kit 3
2	Plug	9	Seeger ring	16	Clamp
3	Body	10	Docking rod	17	Rubber bellow
4	Kit 1	11	Spring	18	Screw
5	Plunger kit	12	Kit 2	19	Support kit
6	Spring guide	13	Tie rod with nut	20	Flange

2) GENERAL PRECAUTIONS

(1) In the system, all of the pipes must be carefully cleaned before installation in order to remove dirt, rust, and deposits.
(2) The following cleaning procedures are recommended: Sanding, brushing, pickling, and flushing with a solvent to remove contaminating particles.
(3) The use of Teflon tape, hemp, or other "fillers" for joints is PROHIBITED
(4) Verify that the pipes, fittings and connections are not subjected to mechanical stress.
(5) Make sure that the pipes are not wound and that there are no abrasions on the surface.

3) PRECAUTION FOR DISASSEMBLY AND ASSEMBLY

(1) Valve piping joint should be tightened with the specified torque value. When piping, care should be taken not to apply excess pressure to the valve. If valve is installed with incorrect torque values, it might cause defect of spool operation, noise or vibration.
Recommended tightening torque of SAE 4 (7/16-20UNF) is 1.0 kgf·m (7.2 lbf·ft).
(2) Care must be taken not to damage the seals by excess temperature or spatter of welding, when welding near by the valve.
(3) During the installation, care must be taken not to damage spool. It might cause defect of operation such as the spool getting stuck in valve body.
(4) Fit the rubber hosepipe for the machine, which expected vibration.
(5) Until piping, don't remove the blinds from each port.

4) PRECAUTION FOR OPERATION

(1) Max input pressure range should be less than 30~100 bar (435~1450 psi).
(2) Back pressure of tank port should be less than 3 bar (43.5 psi).
(3) The oil temperature should be between -10~80˚C. And ambient temperature should be from -40 ~60˚C. because that very high viscosity of oil will be cause defect of spool operation, warm up the machine to avoid it.
(4) 15/12- ISO4406 level of filtration is required in the hydraulic circuit for long life cycle of each components without mechanical trouble.

5) SPECIAL TOOL

(1) 3 mm wrench.
(2) 13 mm socket spanner.
(3) Torque wrench adjustable from 1.02 ~ 3.06 kgf·m (7.4 ~ 22.1 lbf·ft).

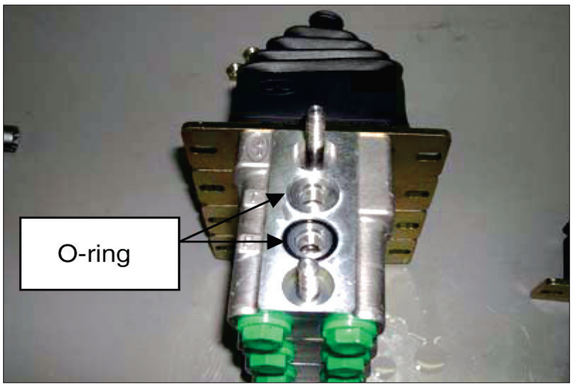
6) DISASSEMBLY & ASSEMBLY

(1) Replacing complete working section

Loosen two tightening bolts with 13 mm spanner.

100D7RCV02

Taking out the damaged section and insert new one. Pay attention 2 O-rings on the internal passage to be in right position.



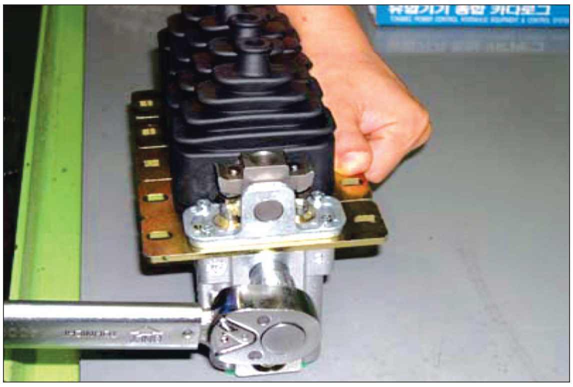
100D7RCV03

Tight M13 nut with proper torque 3.06 kgf·m (22.1lbf·ft).

100D7RCV04

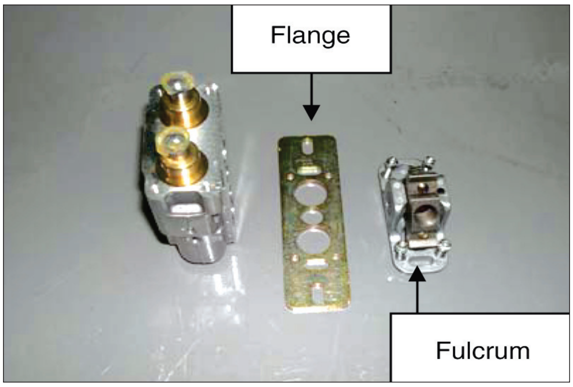
(2) Replacing pilot pressure spool

Loosen 4 screws holding upper part to the body with 3 mm wrench holding mounting plate no to spring up by return springs inside.



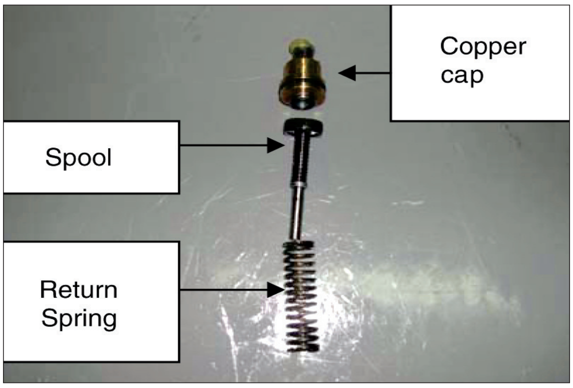
100D7RCV05

Take off the fulcrum and mounting flange very carefully keeping all components in their own positions.



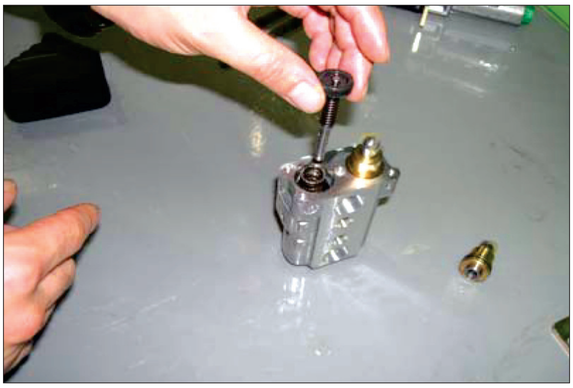
100D7RCV06

Take out the spool, return spring from the body. And replace any component if it is needed.



100D7RCV07

Reassemble the spool in opposite order mentioned above.
Insert spool as straight as possible not to give any damaged on it while inserting it into body.


100D7RCV08

Prepare copper cap in clean.
Apply some clean grease around the O-ring on the copper cap, in order to avoid any damage of O-ring while fitting it into body.


100D7RCV09

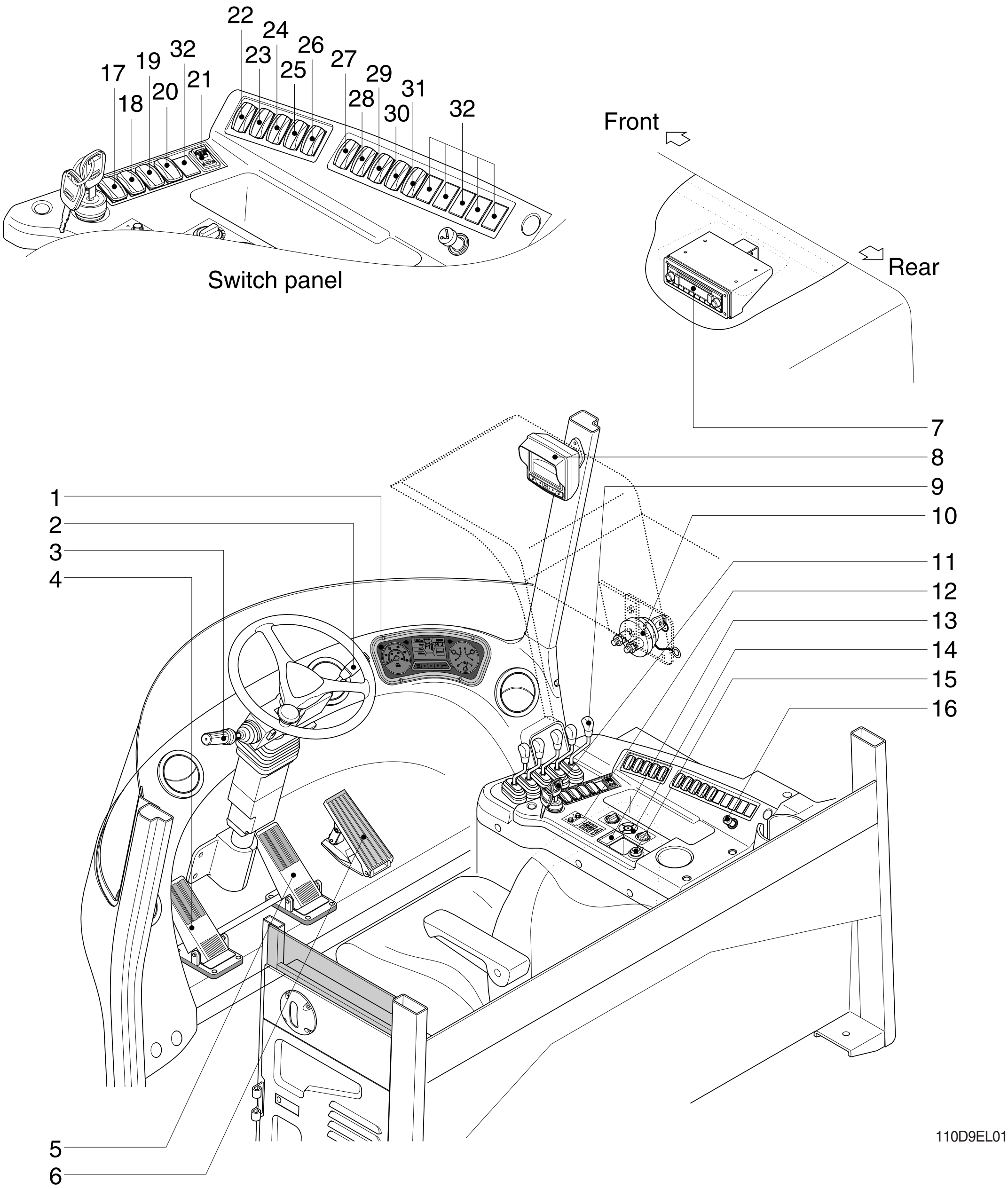
Hold tightly mounting flange and lay fulcrum on the flange and screw in clamp bolts in a crisscross pattern.
Clamp torque is 0.67 kgf·m (4.9 lbf·ft).


100D7RCV10

SECTION 7 ELECTRICAL SYSTEM

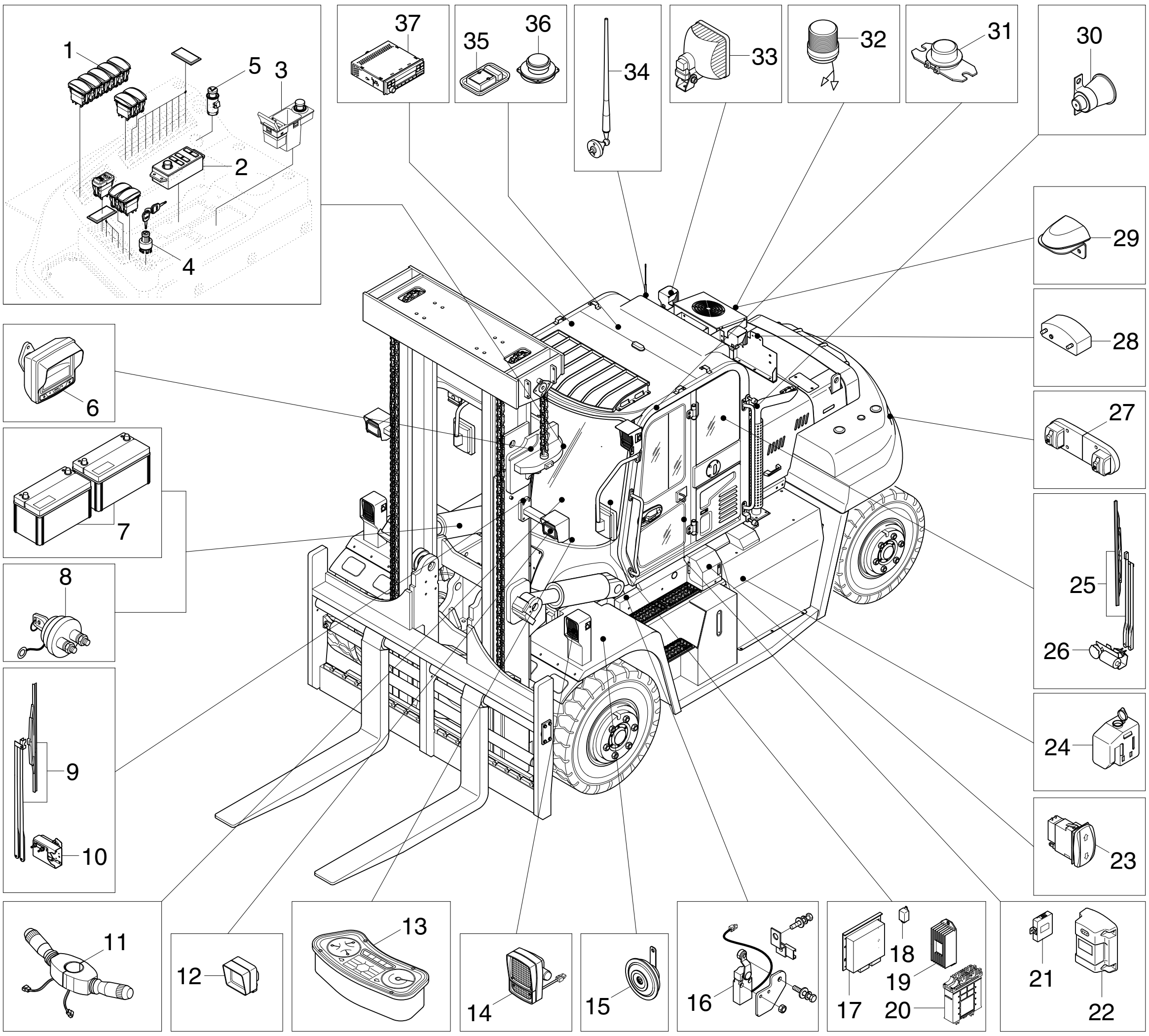
GROUP 1 COMPONENT LOCATION

1. LOCATION 1



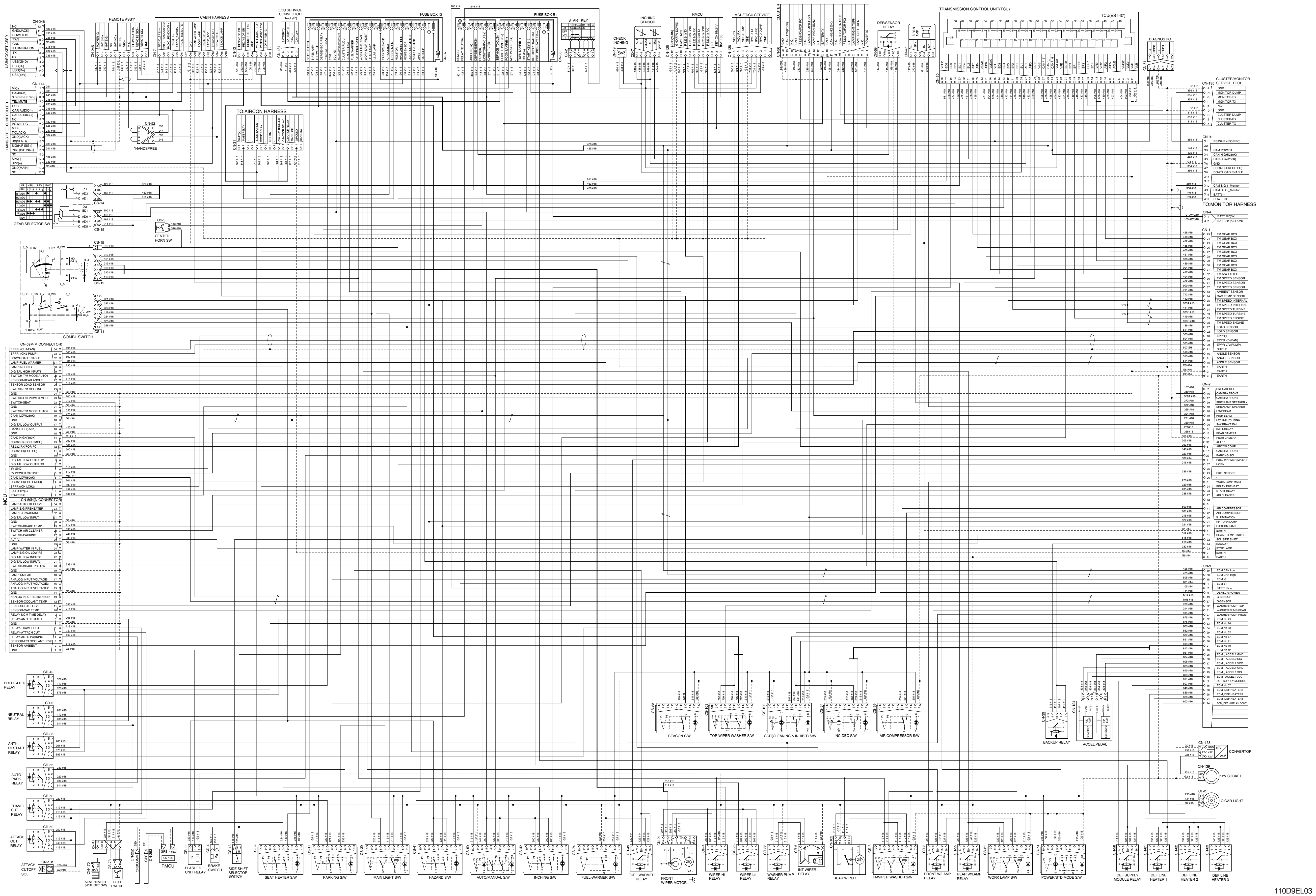
1	Cluster	12	Remote controller (opt)	23	Inching switch
2	Multi function switch	13	Handsfree (opt)	24	Fuel heater switch
3	Gear selector lever	14	Aircon & heater switch	25	Inc/Dec switch
4	Inching pedal	15	USB socket	26	SCR cleaning switch
5	Brake pedal	16	Cigar lighter	27	Power/standard switch
6	Accelerator pedal	17	Main light switch	28	Rear wiper/washer switch
7	Radio and USB player	18	Work lamp swich	29	Top wiper/washer switch (opt)
8	Monitor (opt)	19	Hazard switch	30	Air compressor switch (opt)
9	Remote control lever	20	Beacon lamp switch (opt)	31	Seat heat switch
10	Master switch (opt)	21	Parking brake switch	32	Cover
11	Starting switch	22	Auto/Manual select switch		

2. LOCATION 2



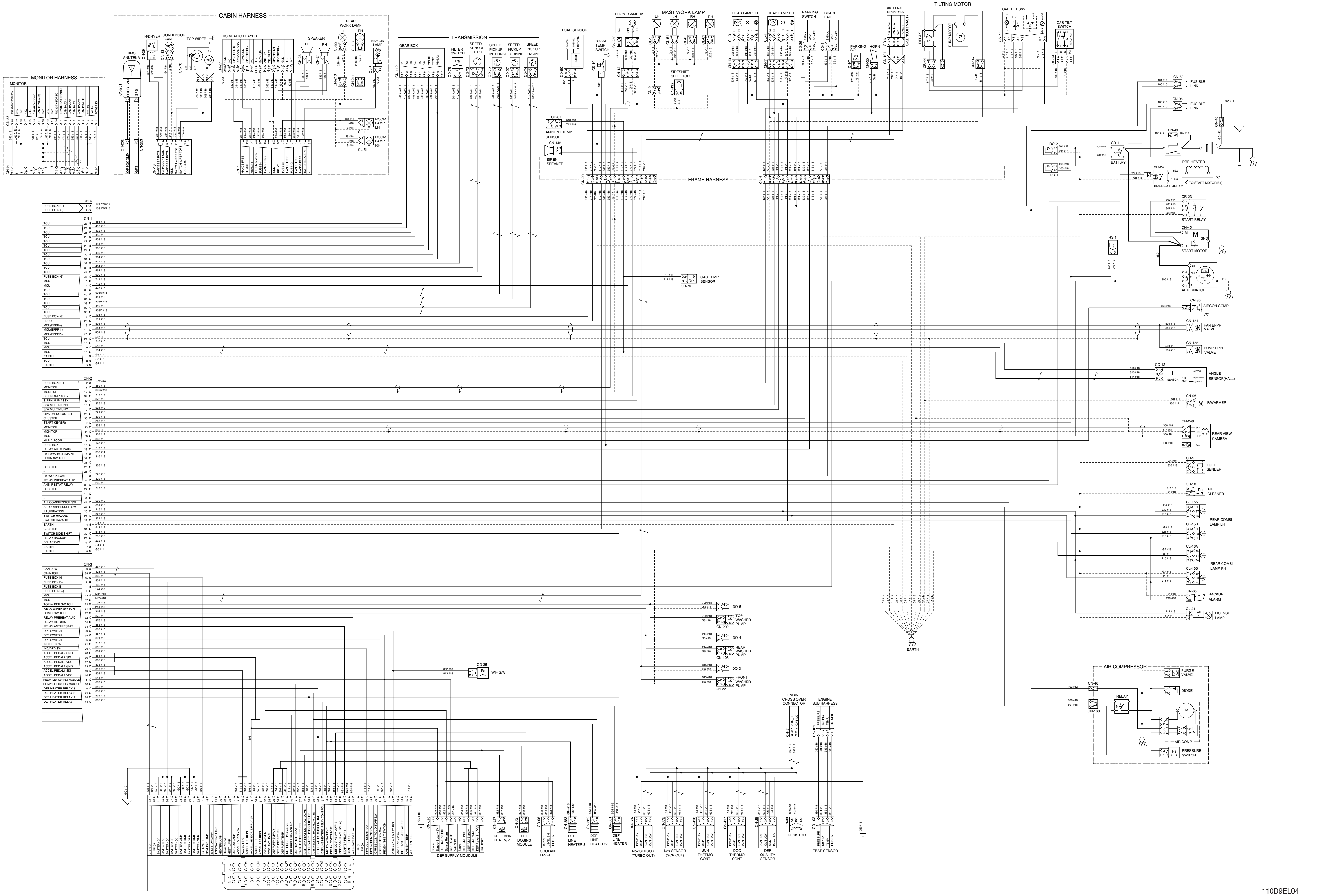
1	Switch panel	14	Head lamp	27	Rear combination lamp
2	Remote controller	15	Horn	28	License lamp
3	USB & socket assembly	16	Tilt switch	29	Rear camera kit
4	Start switch	17	MCU	30	Travel alarm buzzer
5	Cigar lighter	18	Int wiper relay	31	Heater relay
6	Monitor assembly	19	DC-DC converter	32	Beacon lamp
7	Battery	20	TCU	33	Work lamp assembly
8	Master switch	21	Bluetooth handsfree	34	Antenna
9	Wiper assembly	22	RMCU	35	Room lamp
10	Wiper motor	23	Cabin tilt switch	36	Speaker assembly
11	Multifunction switch	24	Washer reservoir tank	37	Radio and USB player
12	Front turn lamp	25	Rear wiper assembly		
13	Cluster	26	Rear wiper motor		

· ELECTRICAL CIRCUIT (1/12, 110D-9 : #0001-0008, 130D-9 : #0001-0004, 160D-9 : #0001-0067)



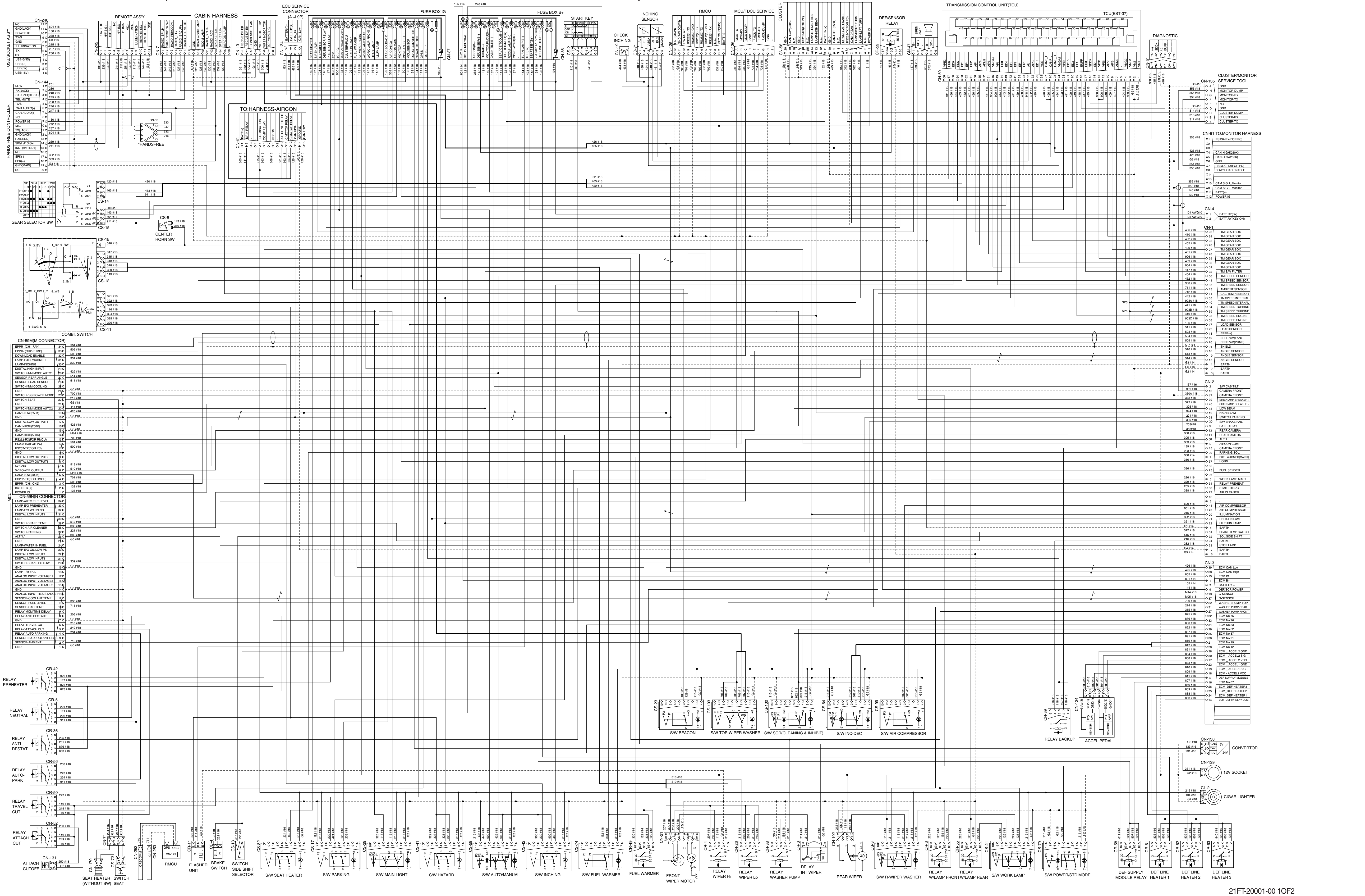
110D9EL03

· ELECTRICAL CIRCUIT (2/12, 110D-9 : #0001-0008, 130D-9 : #0001-0004, 160D-9 : #0001-0067)



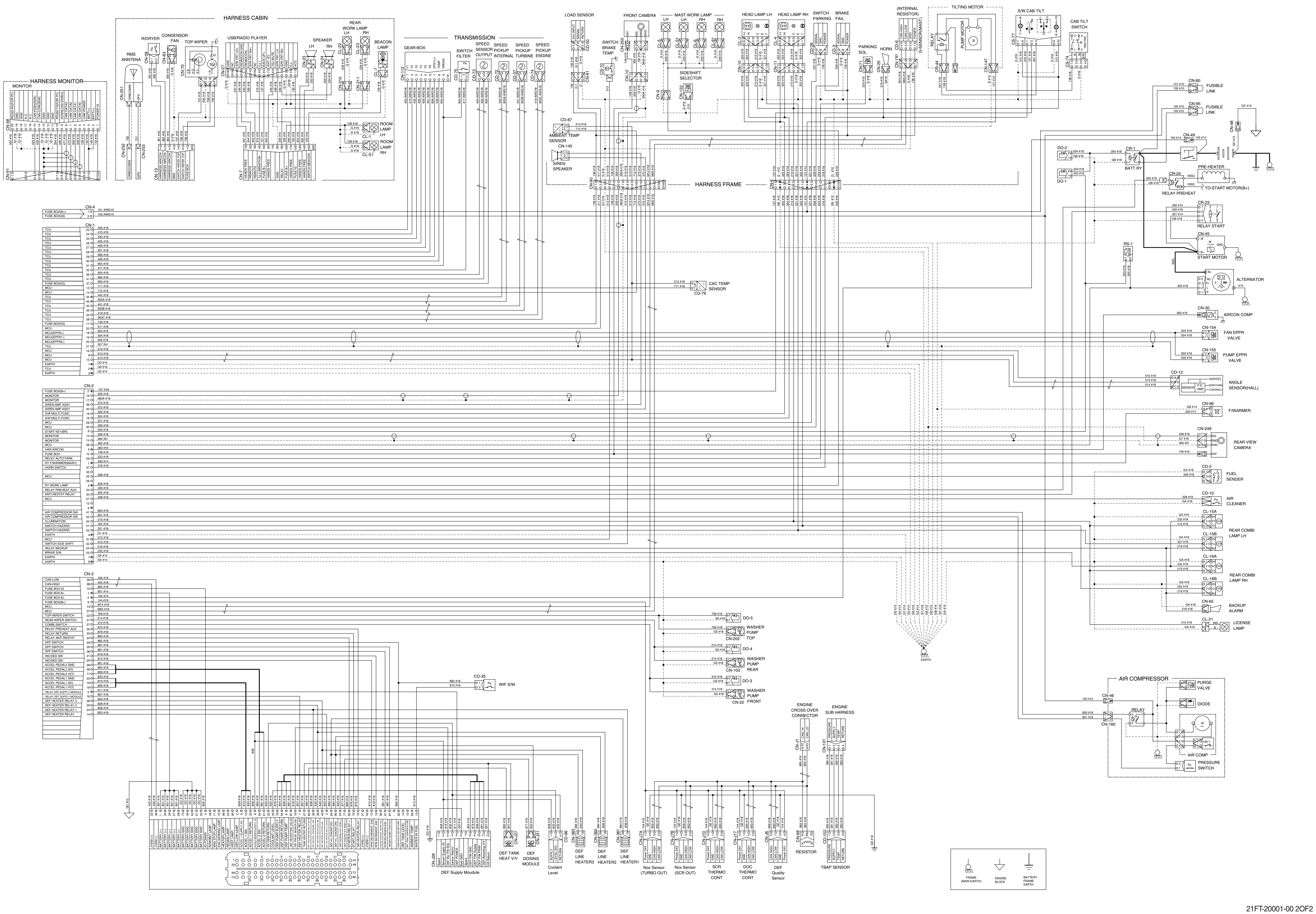
110D9EL04

· ELECTRICAL CIRCUIT (3/12, 110D-9 : #0009-0024, 130D-9 : #0005-0022, 160D-9 : #0068-0127)

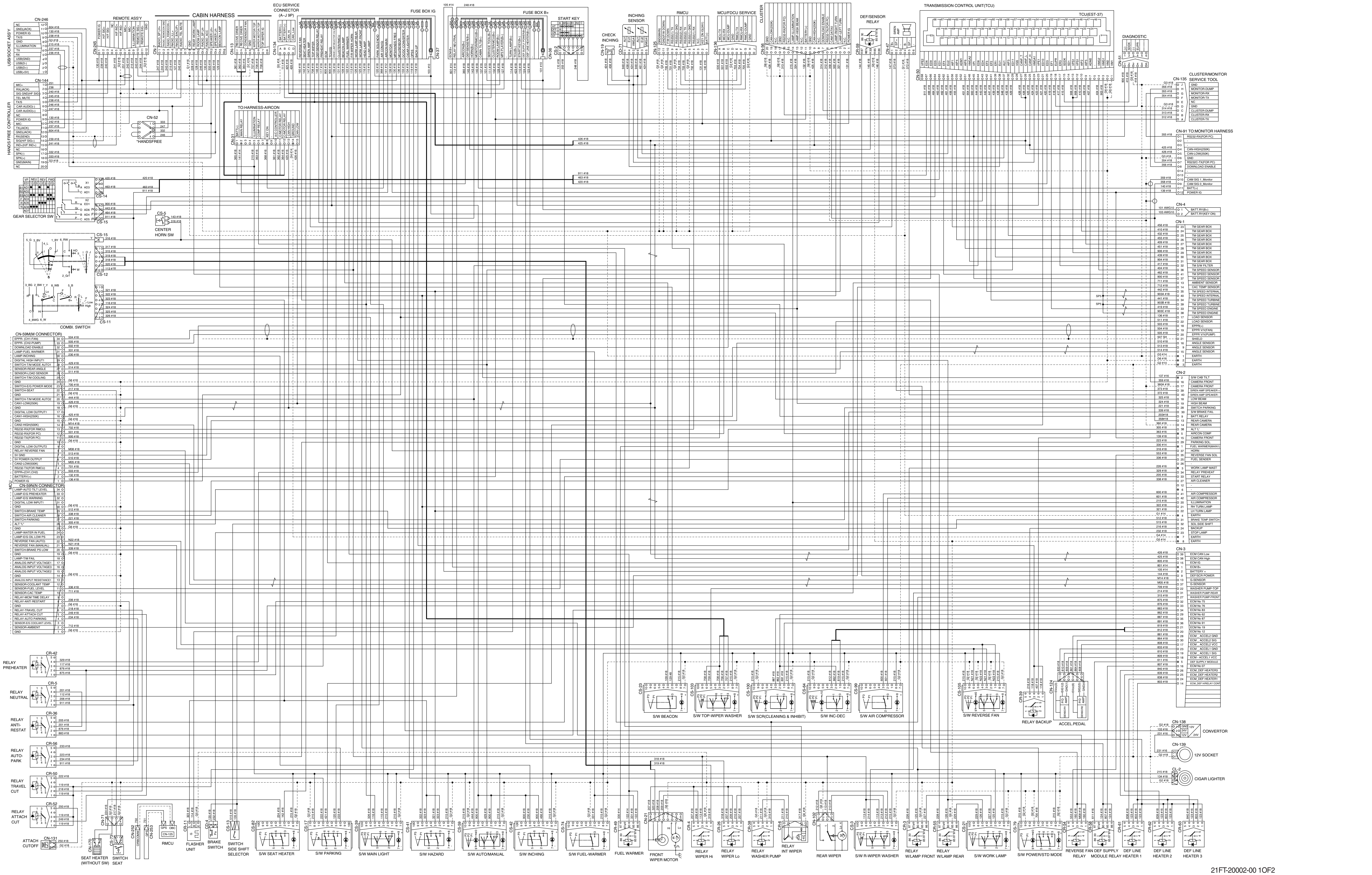


21FT-20001-00 1OF2

· ELECTRICAL CIRCUIT (4/12, 110D-9 : #0009-0024, 130D-9 : #0005-0022, 160D-9 : #0068-0127)

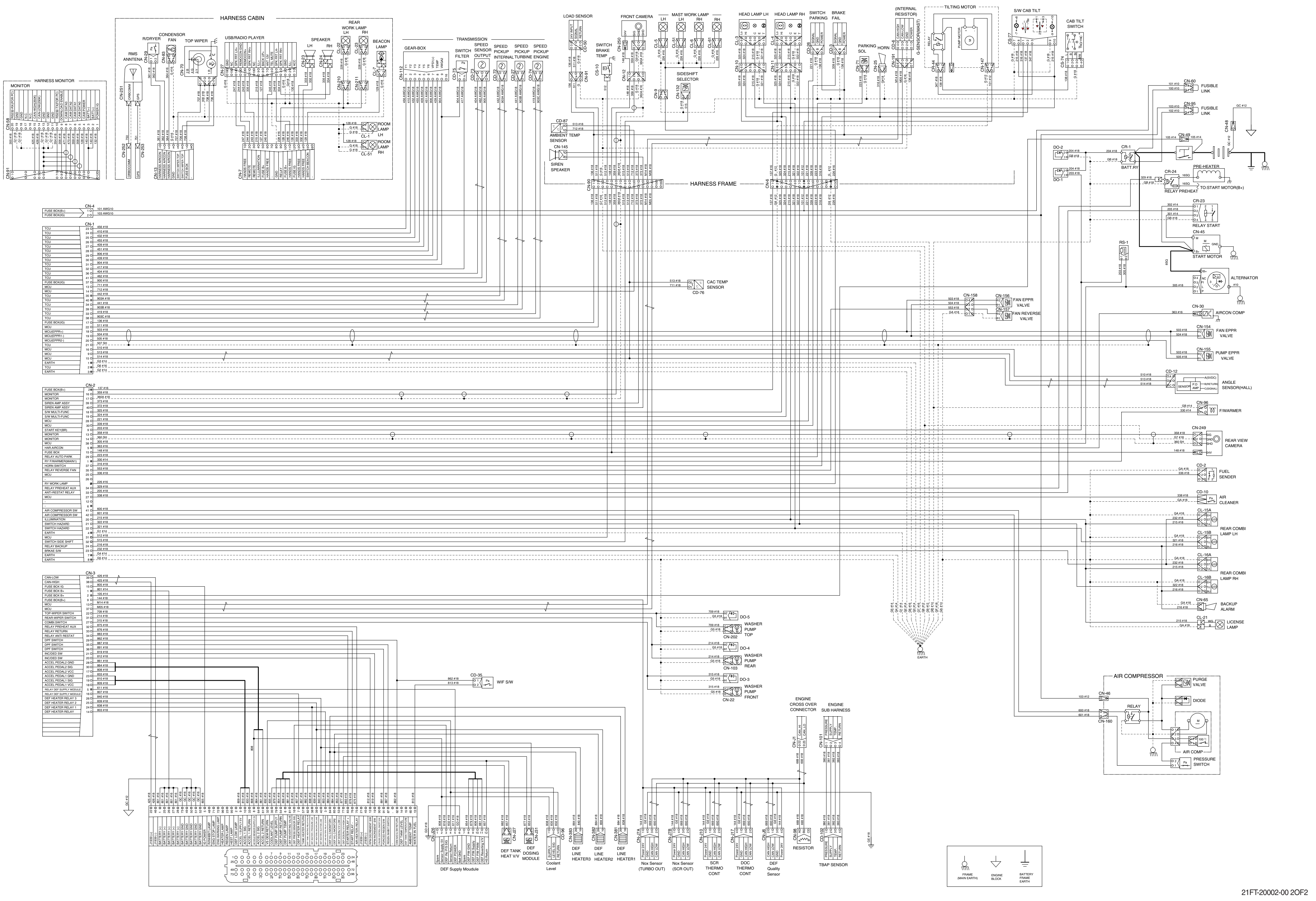


· ELECTRICAL CIRCUIT (5/12, 110D-9 : #0025-0067, 130D-9 : #0023-0024, 160D-9 : #0128-0137)

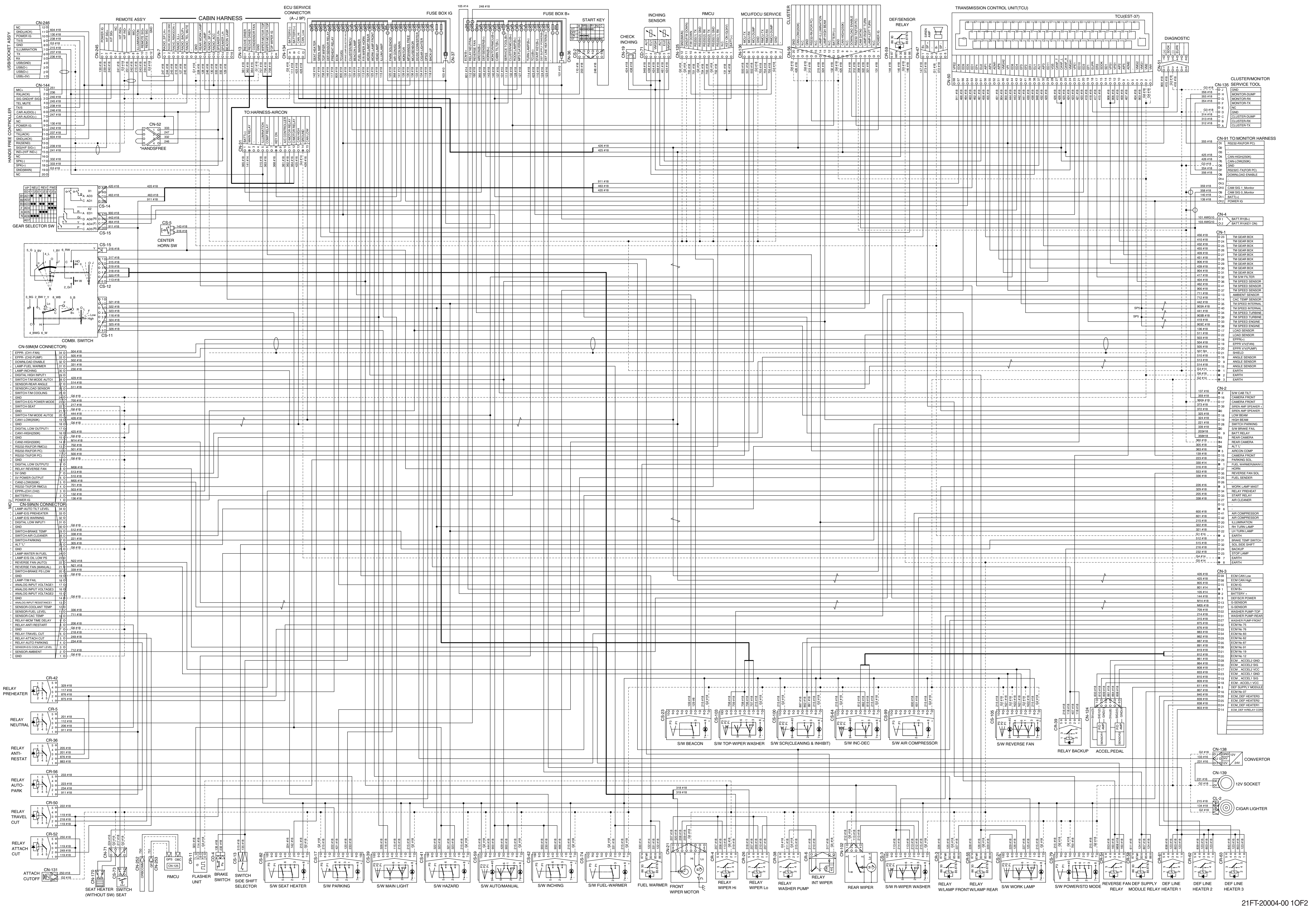


21FT-20002-00 1OF2

· ELECTRICAL CIRCUIT (6/12, 110D-9 : #0025-0067, 130D-9 : #0023-0024, 160D-9 : #0128-0137)

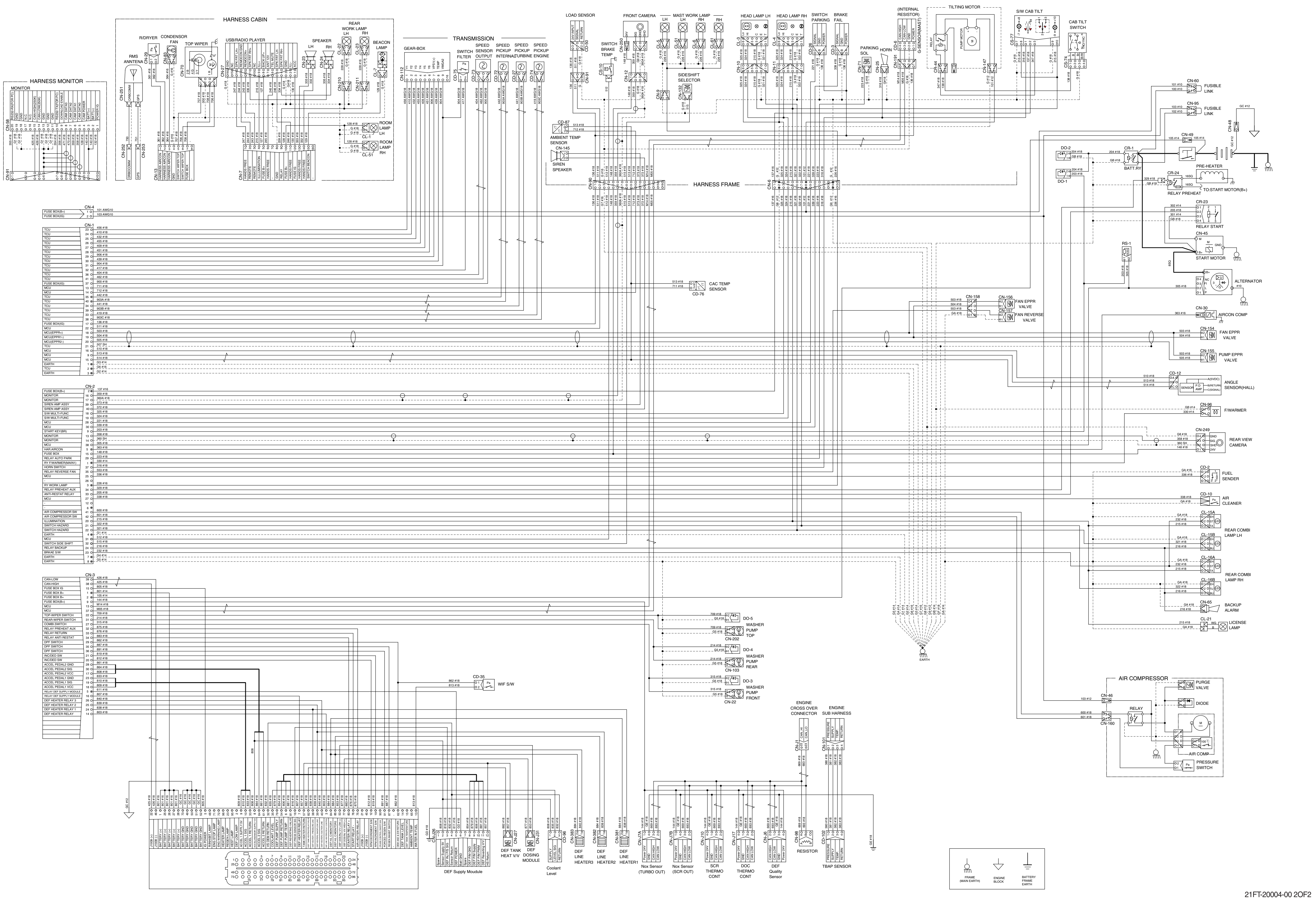


· ELECTRICAL CIRCUIT (7/12, 110D-9 : #0068-0108, 130D-9 : #0025-0048, 160D-9 : #0138-0187)

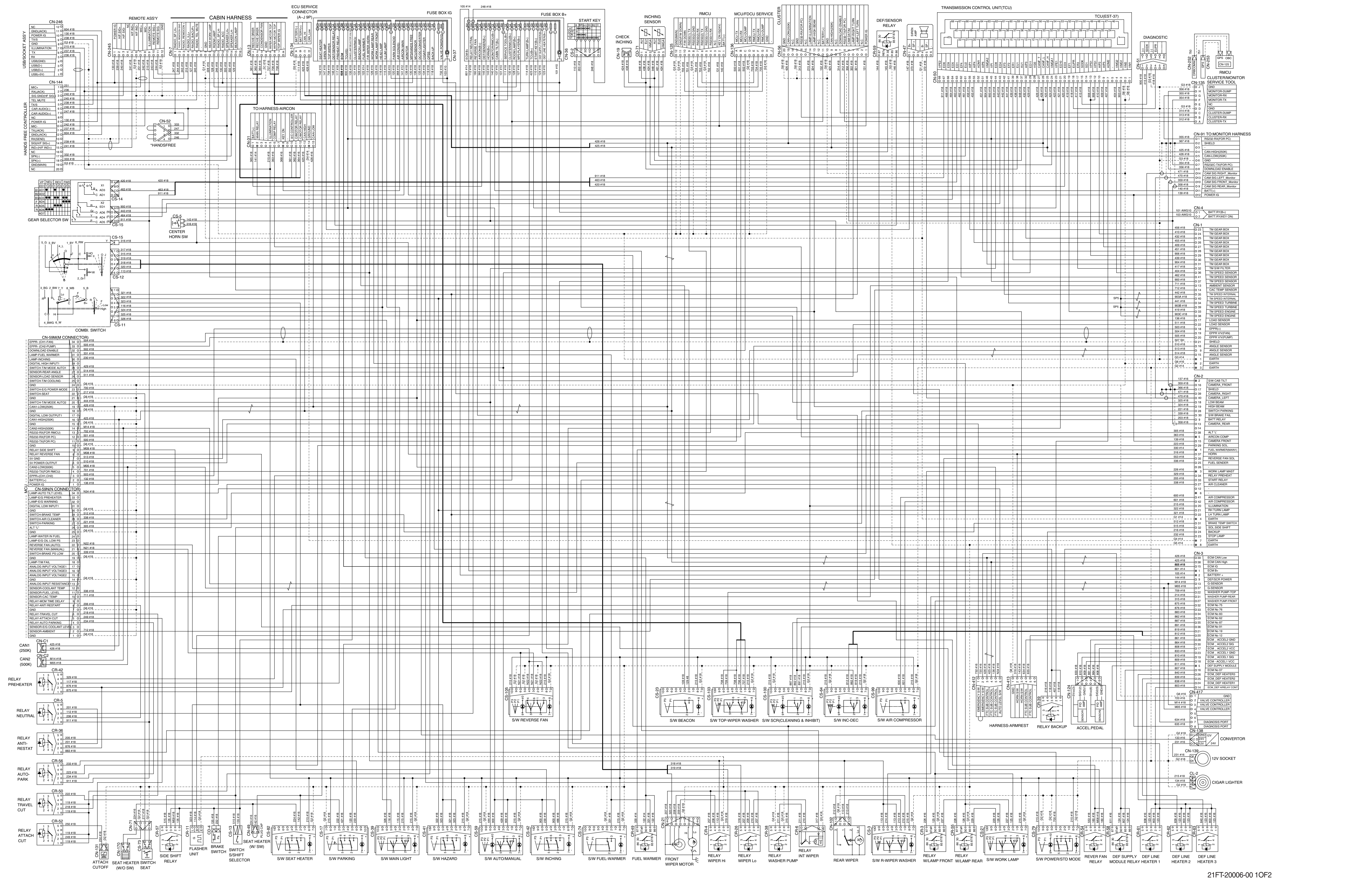


21FT-20004-00 1OF2

· ELECTRICAL CIRCUIT (8/12, 110D-9 : #0068-0108, 130D-9 : #0025-0048, 160D-9 : #0138-0187)

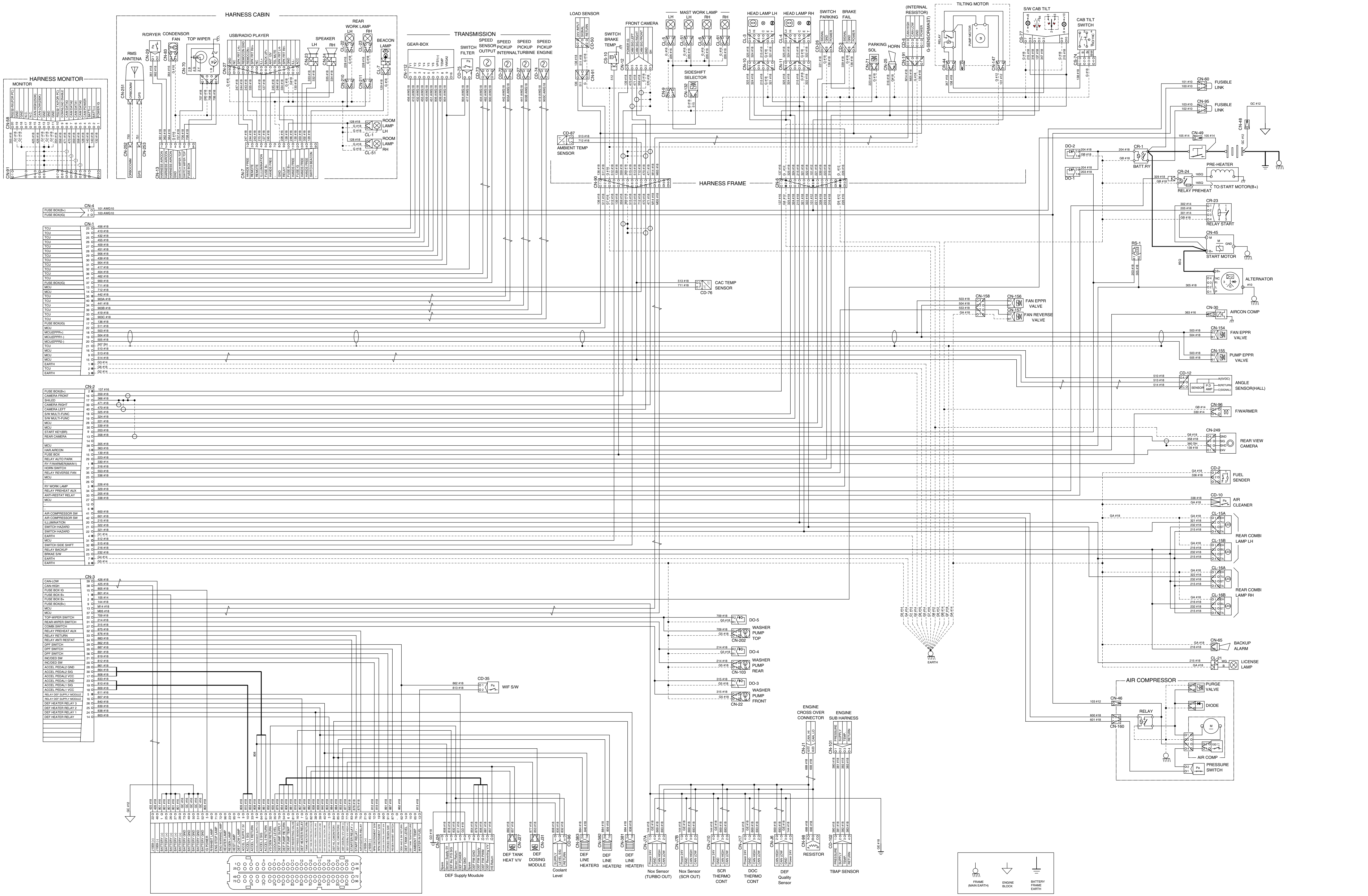


· ELECTRICAL CIRCUIT (9/12, 110D-9 : #0109-, 130D-9 : #0049-, 160D-9 : #0188-)



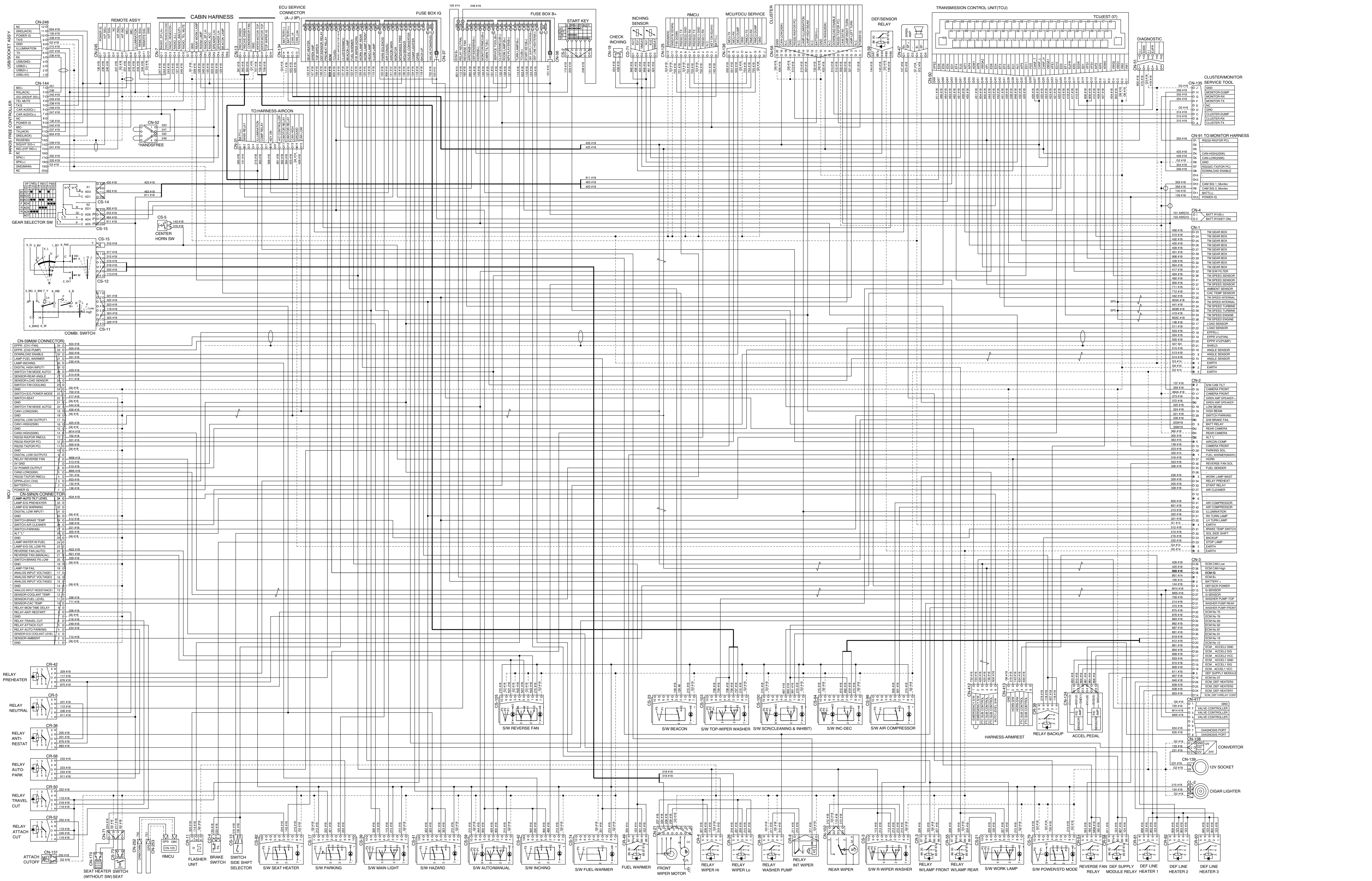
21FT-20006-00 1OF2

· ELECTRICAL CIRCUIT (10/12, 110D-9 : #0109-, 130D-9 : #0049-, 160D-9 : #0188-)



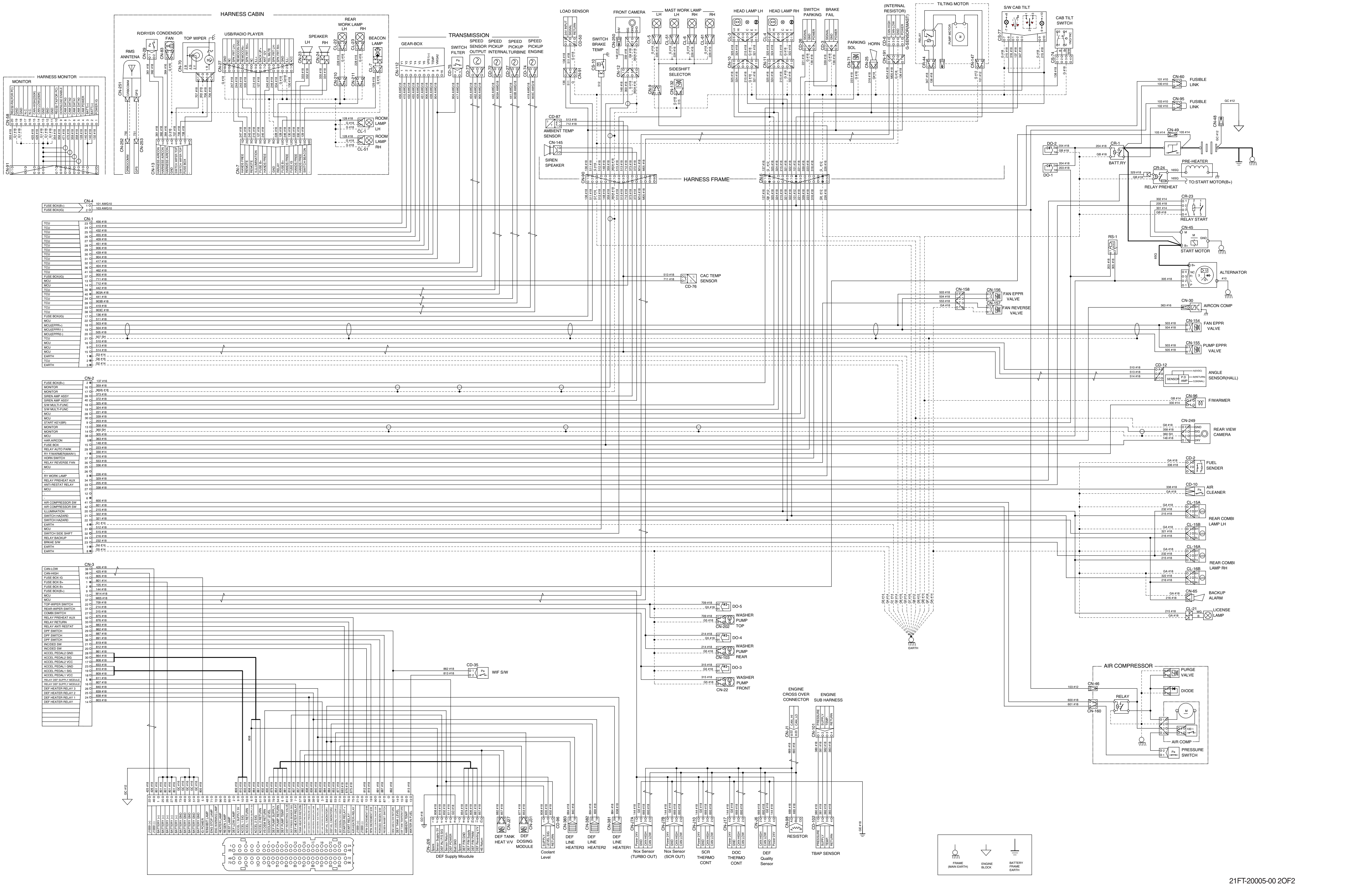
21FT-20006-00 2OF2

· ELECTRICAL CIRCUIT (11/12, FINGERTIP, 110D-9 : #0079-, 130D-9 : #0029-, 160D-9 : #0156-)



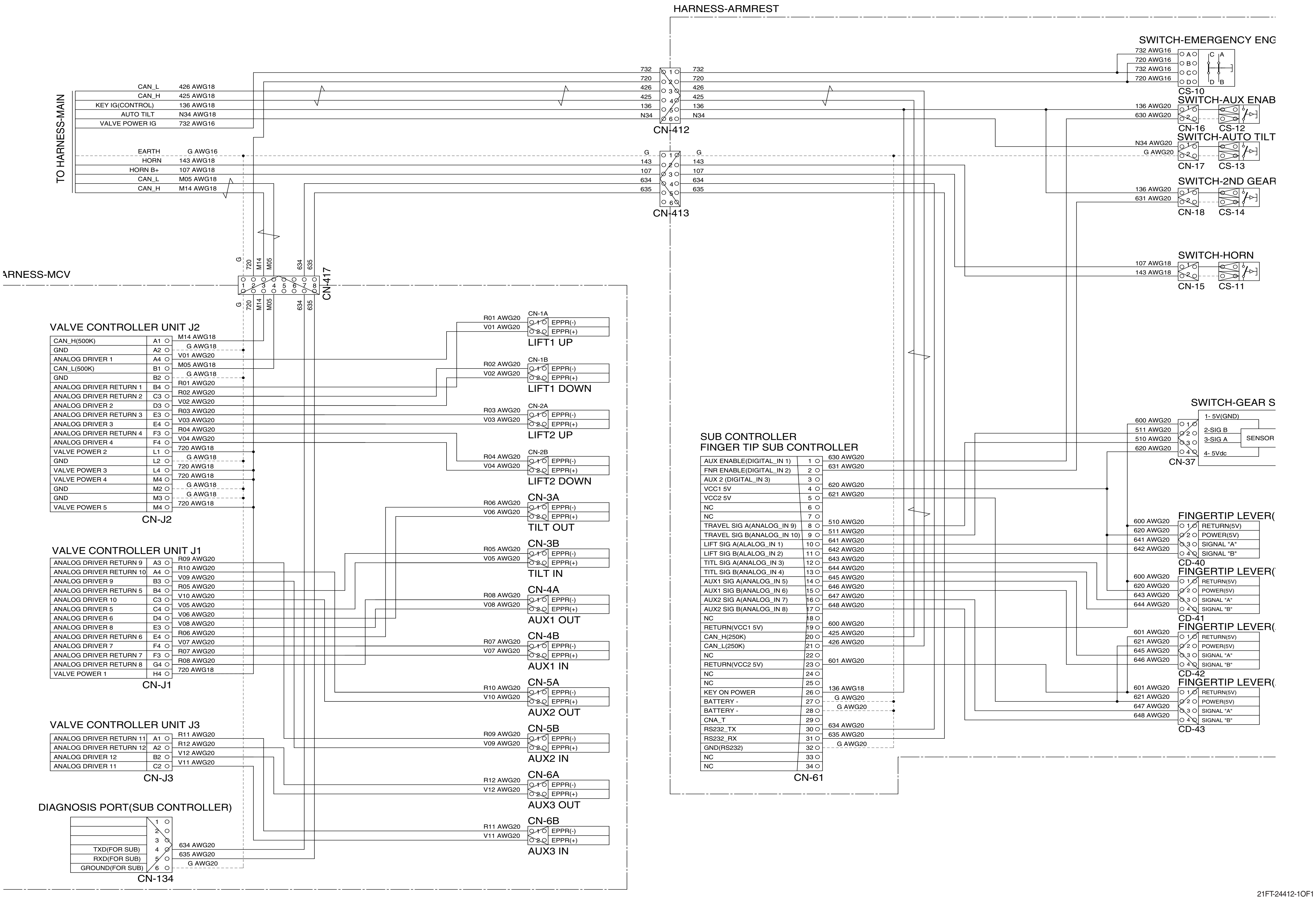
21FT-20005-00 1OF2

· ELECTRICAL CIRCUIT (12/12, FINGERTIP, 110D-9 : #0079-, 130D-9 : #0029-, 160D-9 : #0156-)



21FT-20005-00 2OF2

· ELECTRICAL CIRCUIT (FINGERTIP, 110D-9 : #0079-, 130D-9 : #0029-, 160D-9 : #0156-)



MEMORANDUM

HYUNDAI HEAVY INDUSTRIES CO., LTD.
CONSTRUCTION EQUIPMENT DIV.

1. POWER CIRCUIT

The negative terminal of the battery is grounded to the machine chassis.
When the start switch is in the off position, the current flows from the positive battery terminal.

1) OPERATING FLOW

Battery(+) → I/conn [CN-49] → I/conn [CN-3 (2)] → Fuse box [CN-36 (35)]
→ I/conn [CN-3 (1)] → ECM [CN-93 (1, 25, 26, 27, 28)]
→ Master switch → Battery relay [CR-1]
→ Start motor [B+] → Start relay [CR-23 (1)]
→ Alternator [(2)]
→ Fusible link [CN-60]
→ I/conn [CN-6 (8)] → [CN-147 (1)] → Cabin tilting motor relay
→ Fuse box (B+) → Fuse box [No.4] → DEF line heater relay 1, 2, 3 [CR-61, 62, 63)]
→ Fuse box [No.5] → DEF supply module relay [CR-58 (30, 86)]
→ Fuse box [No.6] → Start key switch [CS-2 (1)]
→ Fuse box [No.7] → Transmission control unit [CN-50 (23)]
→ Fuse box [No.8] → Flasher unit relay [CR-11 (B)]
→ Fuse box [No.10] → I/conn [CN-7 (5)] → Radio and USB player [CN-27 (8)]
→ Fuse box [No.11] → I/conn [CN-7 (10)] → LH/RH room lamp [CL-1, 51 (1)]
→ Fuse box [No.12] → Cluster [CN-56 (11)]
→ MCU [CN-59M (2)]
→ Fuse box [No.13] → ECU service connector [CN-134 (B)]
→ Fuse box (3) → Fuse box [No.14] → I/conn [CN-2 (2)] → I/conn [CN-6 (1)]
→ Cabin tilt switch [CS-77 (2)]
→ Fuse box [No.15] → RMCU [CN-125 (1)]
To monitor harness [CN-91 (1)]
→ Fuse box [No.16] → Center horn switch [CS-5]
→ Fuse box [No.17] → DEF sensor relay [CR-59 (30)]
→ Fuse box [No.18] → To air conditioner harness [CN-6 (1)]

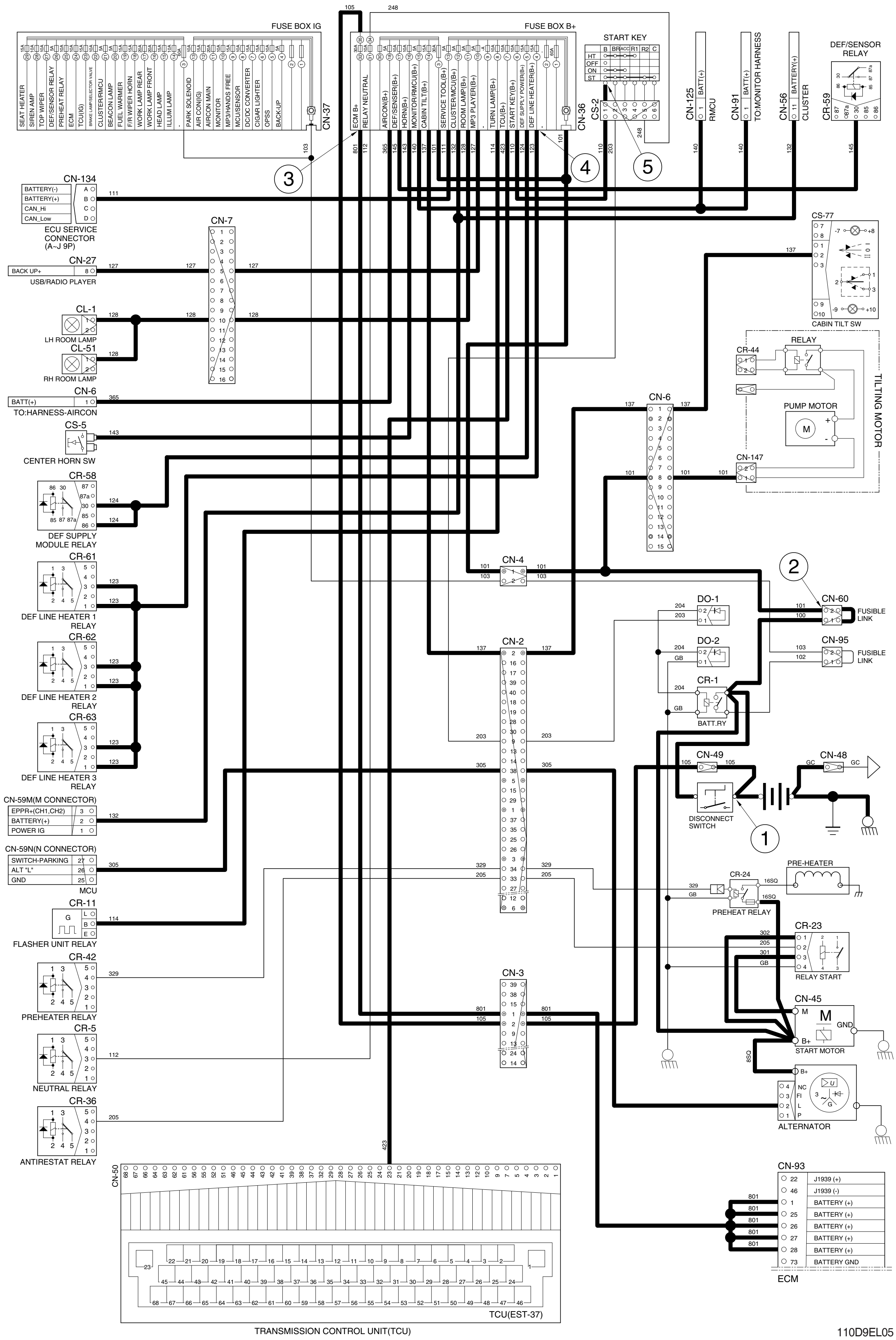
2) CHECK POINT

Engine	Key switch	Check point	Voltage
OFF	OFF	① - GND (Battery(+)) ② - GND (Fusible link) ③ - GND (Fuse No. 32) ④ - GND (Fuse box B+) ⑤ - GND (Start key)	24V

※ GND : Ground

※ The circuit diagram may differ from the equipment, so please check before a repair.

POWER CIRCUIT



※ The circuit diagram may differ from the equipment, so please check before a repair.

2. STARTING CIRCUIT

1) OPERATING FLOW

Battery(+) terminal → Master Switch → Battery relay[CR-1]
→ Fusible link [CN-60] → I/conn [CN-4 (1)] → Fuse box [B+→(6)] → Start switch [CS-2 (1)]
→ Start motor [CN-45 (B+)] → Start relay [CR-23 (1)]

※ The engine can be started only when the gearshift is in neutral position.

(1) When start key switch is in ON position

Start switch ON [CS-2 (2)] → I/conn [CN-2 (9)] → Battery relay → Fusible link [CN-95]
→ I/conn [CN-4 (2)] → Fuse box [CN-37 (IG, No.3)]
→ Power is supply with the electric components.

(2) When start key switch is START position

Start switch START [CS-2(6)] → Fuse box B+ [CN-36 (34→31)] → Neutral relay [CR-5 (3→4)
→ Anti start relay [CR-36 (3→4)] → I/conn [CN-2 (3)] → Start relay [CR-23 (2→3)]
→ Start motor [CN-45 (M)] → Start motor operating

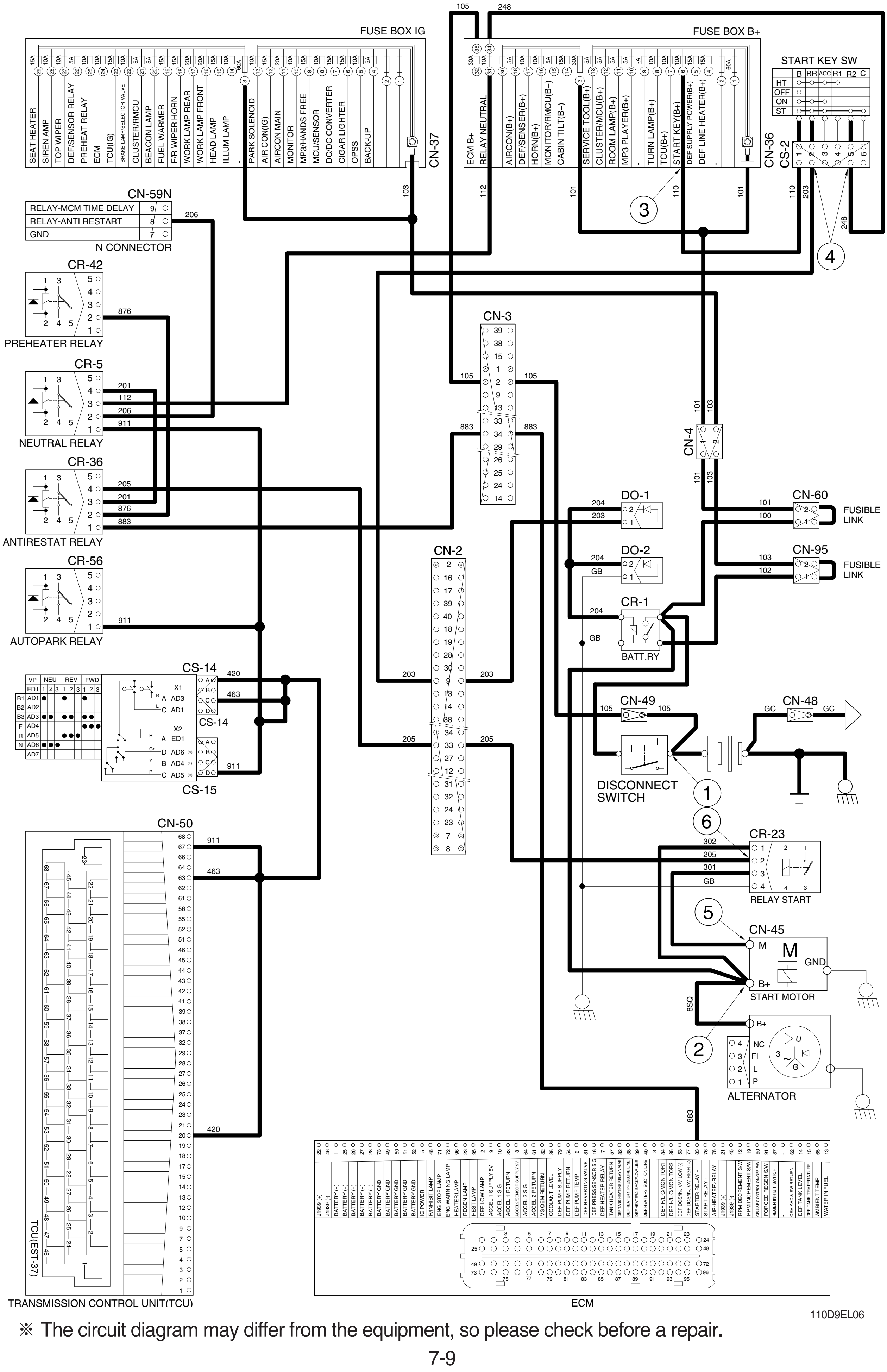
2) CHECK POINT

Engine	Key switch	Check point	Voltage
Running	ON	① - GND (Battery B+) ② - GND (Start motor B+) ③ - GND (Fuse box) ④ - GND (Start key) ⑤ - GND (Start motor M) ⑥ - GND (Start relay)	24V

※ GND : Ground

※ The circuit diagram may differ from the equipment, so please check before a repair.

STARTING CIRCUIT



※ The circuit diagram may differ from the equipment, so please check before a repair.

3. CHARGING CIRCUIT

When the starter is activated and the engine is started, the operator release the start switch to the ON position. Charging current generated by operating alternator flows into the battery.
The current also flows from alternator to each electrical component through the fusible link(CN-60) and the fuse box.

1) OPERATING FLOW

(1) Warning flow

Alternator [CN-74 (2)] → I/conn [CN-2 (38)] → MCU alternator level [CN-59N (26)]
→ Cluster charging warning lamp (via CAN interface)

(2) Charging flow

Alternator [CN-74 (B+)] → Start motor [CN-45 (B+)] → Battery ralay [CR-1]
→ Master switch → Battery (+) terminal → Charging
→ Fusible link [CN-60] → I/conn [CN-4 (1)] → Fuse box B+ [CN-36]
→ Fusible link [CN-95] → I/conn [CN-4 (2)] → Fuse box IG [CN-37]

2) CHECK POINT

Engine	Key switch	Check point	Voltage
ON	ON	① - GND (Battery B+) ② - GND (ALT B+) ③ - GND (ALT 2) ④ - GND (MCU) ⑤ - GND (Fuse box)	24V

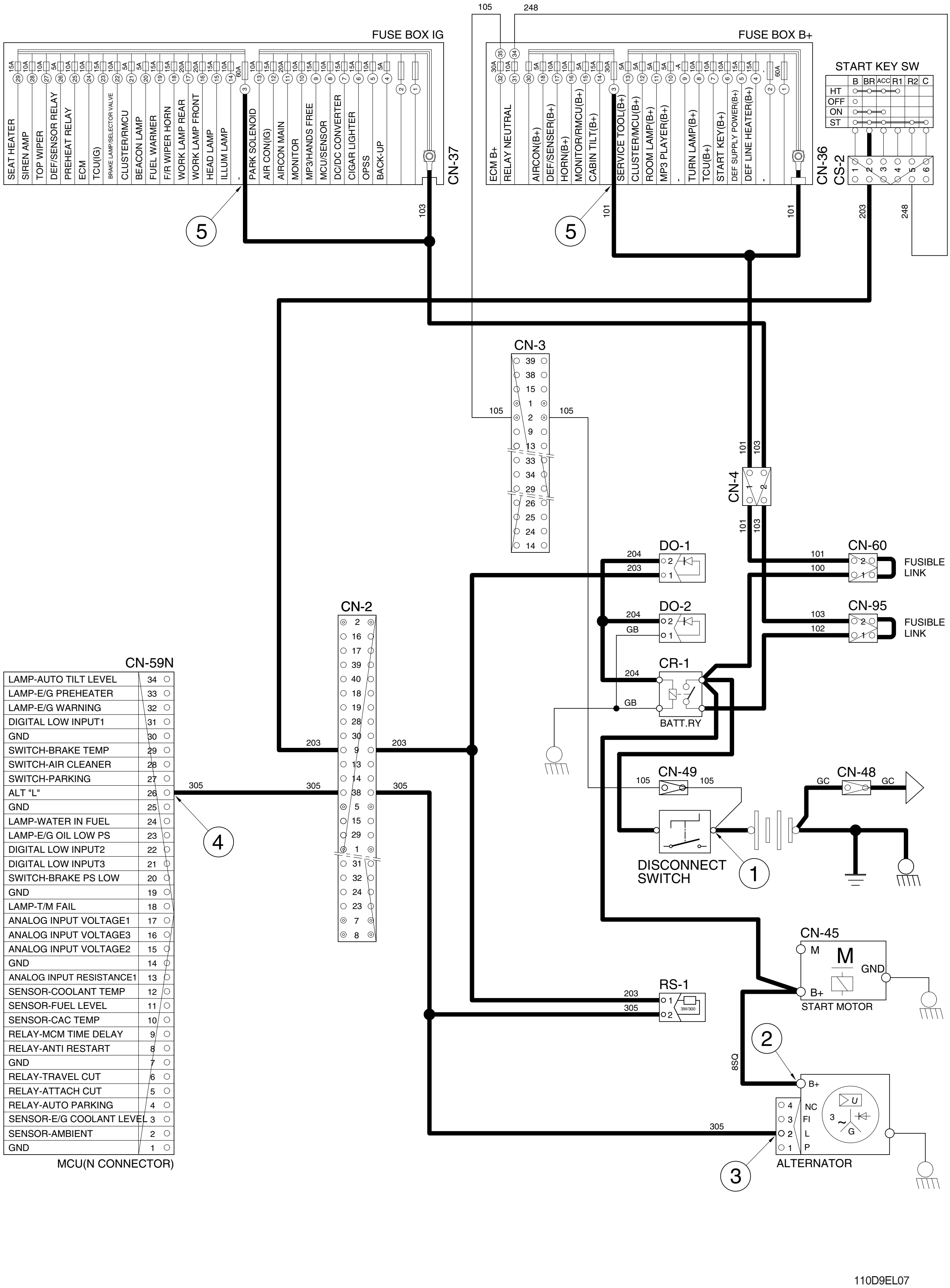
※GND : Ground

※Cautions

1. When using an arc welder, always disconnect the ground lead from the battery to prevent alternator or battery damage.
2. Attach the welding ground clamp as close to the weld area as possible to prevent welding current from damaging the bearings of the alternator.
3. Do not disconnect the battery when the engine is running. The voltage surge can damage the diode and resistors in the electrical system.
4. Do not disconnect an electric wire before the engine is stopped and the switches are OFF.

※ The circuit diagram may differ from the equipment, so please check before a repair.

CHARGING CIRCUIT



※ The circuit diagram may differ from the equipment, so please check before a repair.

4. PREHEATING CIRCUIT

Combustion chamber glow plugs are used in order to give satisfactory starting of low ambient temperatures.

1) OPERATING FLOW

Battery (+) terminal → Master Switch → Battery relay [CR-1] → Start motor [CN-45 (B+)]
→ Preheater relay [CR-24]

※ When you turn the start switch to the ON position, the glow relay makes the glow plugs operated and the glow lamp of the cluster turned ON.

Start switch ON [CS-2 (2)]
→ Fuse box IG [No.19] → Fuel warmer switch [CS-10] → Fuel warmer relay [CR-49 (30→87)]
→ I/conn [CN-2 (1)] → Fuel warmer [CN-96 (1)] → Fuel warmer operating
→ ECM [75] → I/conn [CN-3 (32)] → Preheater relay [CR-42 (1→4)] → I/conn [CN-2 (34)]
→ Preheater relay [CR-24] → Preheater operating

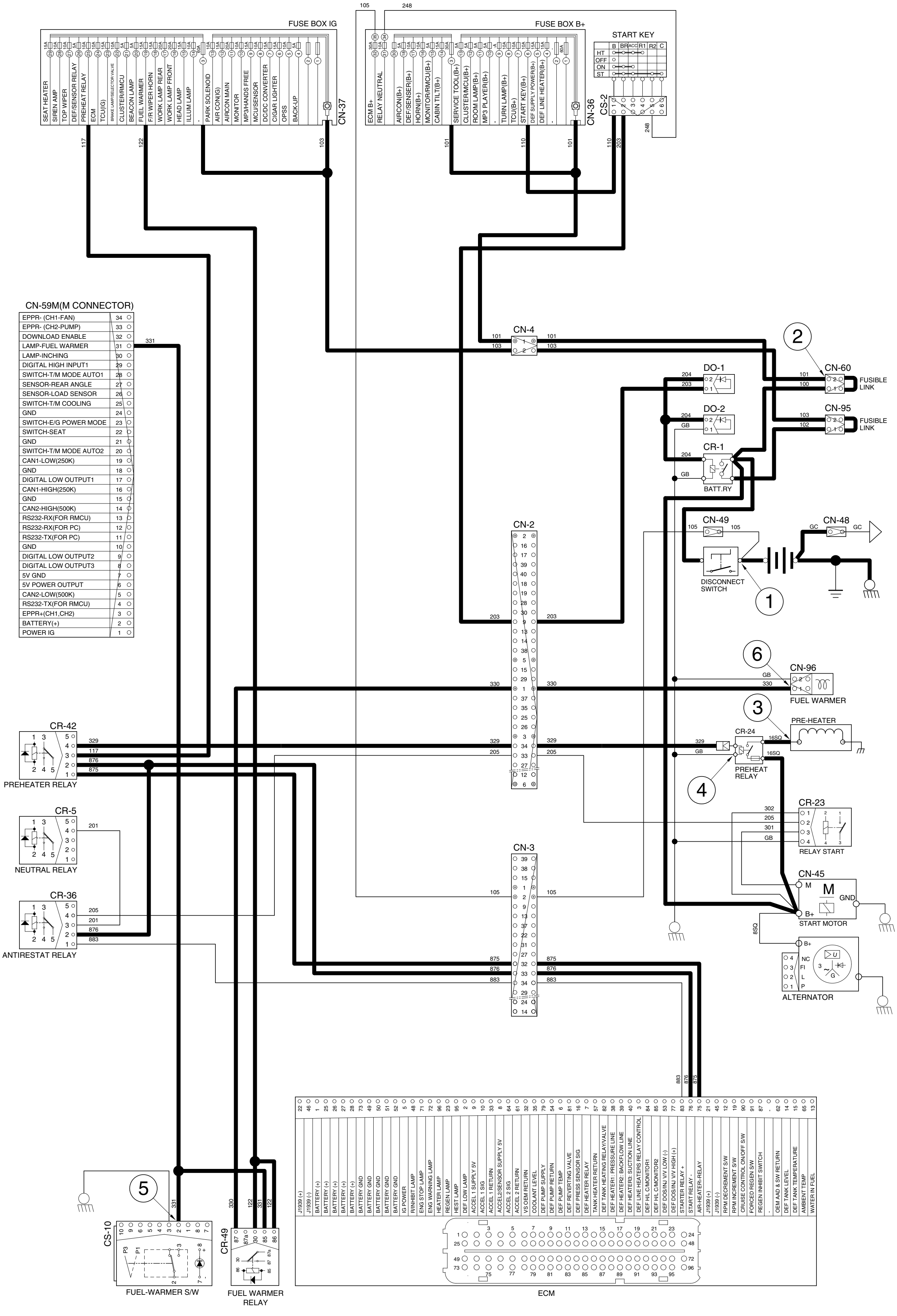
2) CHECK POINT

Engine	Key switch	Check point	Voltage
Stop	HEAT	① - GND (Battery B+) ② - GND (Fusible link) ③ - GND (Start switch) ④ - GND (Fuse box) ⑤ - GND (Pre-heater relay) ⑥ - GND (ECU)	10 ~ 13V

※ GND : Ground

※ The circuit diagram may differ from the equipment, so please check before a repair.

PREHEATING CIRCUIT



110D9EL08

※ The circuit diagram may differ from the equipment, so please check before a repair.

5. HEAD LIGHT AND WORK LIGHT CIRCUIT

1) OPERATING FLOW

(1) Head light

Fuse box (No.16) → Main light switch [CS-39 (5)] → Switch ON, 2nd step [CS-39 (6)]
→ Multi function switch [CS-11 (8)]
→ Multi function switch MIDDLE [CS-11 (7)] → I/conn [CN-2 (18)]
→ LH Head light low beam ON [CL-3 (6)]
→ RH Head light low beam ON [CL-4 (6)]
→ Multi function switch DOWN [CS-11 (6)]
→ Cluster high beam pilot lamp ON [CN-56 (13)]
→ I/conn [CN-2 (9)] → I/conn [CN-6 (4)]
→ LH Head light high beam ON [CL-3 (4)]
→ RH Head light high beam ON [CL-4 (4)]

(2) Front work lamp

Fuse box (No.16) → Work light switch [CS-21 (2)] → Switch ON, 1nd step [CS-21 (3)]
→ Front work lamp relay [CR-3 (86→87)] → I/conn [CN-2 (3)] → I/conn [CN-6 (15)]
→ I/conn [CN-9 (1)] → Mast work light ON [CL-5, 6, 51, 61 (2)]

(3) Rear work light

Fuse box (No.17) → Work light switch [CS-21 (5)] → Switch ON, 2nd step [CS-21 (6)]
→ Rear work lamp relay [CR-55 (86→87)] → I/conn [CN-7 (9)]
→ I/conn [CN-210 (1)] → LH rear work light ON [CL-22 (2)]
→ I/conn [CN-211 (1)] → RH rear work light ON [CL-23 (2)]

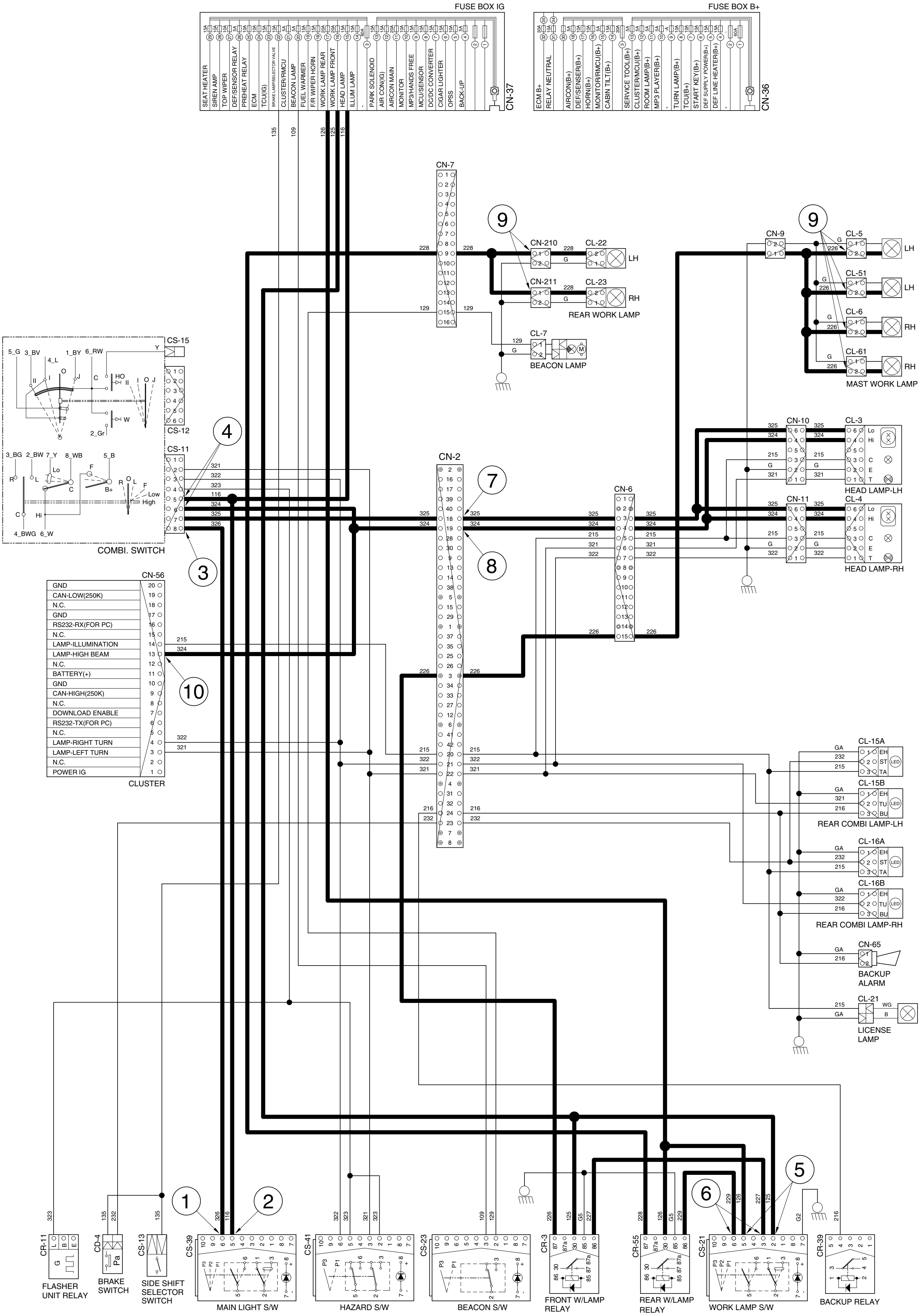
2) CHECK POINT

Engine	Key switch	Check point	Voltage
OFF	ON	① - GND (Main light switch input) ② - GND (Main light switch output) ③ - GND (Multifunction switch input) ④ - GND (Multifunction switch output) ⑤ - GND (Work light switch input) ⑥ - GND (Work light switch output) ⑦ - GND (Low beam) ⑧ - GND (High beam) ⑨ - GND (Work light) ⑩ - GND (Cluster high beam pilot lamp input)	20~25V

※ GND : Ground

※ The circuit diagram may differ from the equipment, so please check before a repair.

HEAD LAMP AND WORK LIGHT CIRCUIT



110D9EL09

※ The circuit diagram may differ from the equipment, so please check before a repair.

6. WIPER AND WASHER CIRCUIT

1) OPERATING FLOW

Fuse box [No.18] → Wiper relay Hi [CR-4 (3)]
→ Multi function switch [CS-12 (6)]
→ Rear wiper & washer switch [CS-3 (3, 6)]
→ Rear wiper motor [CN-102 (3)]

Fuse box [No.27] → Top wiper & washer switch [CS-103 (3, 6)]
→ I/conn [CN-7 (7)] → Top wiper motor [CN-70 (3)]

(1) Front washer switch ON

① Washer switch ON [CS-12 (6)→(2)]
→ I/conn [CN-3 (27)] → Washer tank [CN-22 (2)] → Front washer operating
→ Washer pump relay [CR-36 (1)→(4)] → Int wiper relay Lo [CR-6 (1)→(2)]
→ Wiper relay Lo [CR-26 (2)→(3)] → Front wiper motor [CN-21 (2)]
→ Wiper motor operating (low)

(2) Front wiper switch ON

① **INT position**
Wiper switch ON [CS-12 (6)→(1)] → Int wiper relay [CR-6 (3)] →]
Front wiper relay Lo [CR-4 (3)→(2)] → Wiper relay Lo [CR-26 (2)→(3)] →
Front wiper motor [CN-21 (2)] → Front wiper motor intermittently operating

② **Lo position**
Wiper switch ON [CS-12 (6)→(4)] → Wiper relay Lo [CR-4 (5)→(3)] →
Front wiper motor [CN-21 (2)] → Front wiper motor operating (low)

③ **Hi position**
Wiper switch ON [CS-12 (6)→(3)] → Wiper relay Hi [CR-39 (1)→(4)] →
Front wiper motor [CN-21 (4)] → Front wiper motor operating (high)

(3) Auto-parking (when switch OFF)
Switch OFF [CS-12 (4)] → Wiper relay Lo [CR-4 (5)→(3)] → Front wiper motor [CN-21 (2)] →
Wiper motor stop

(4) Rear wiper and washer switch

① **Wiper switch ON** (1st step)
Wiper switch ON [CS-3 (3)→(2)] → Rear wiper motor [CN-102 (4)] → Rear wiper motor operating

② **Washer switch ON** (2nd step)
Washer switch ON [CS-3 (6)→(5)] → I/conn [CN-3 (31)] → Rear washer tank [CN-103 (2)] →
Washer operating
Wiper switch ON [CS-3 (3)→(2)] → Rear wiper motor [CN-102 (4)] → Rear wiper motor operating

(5) Top wiper and washer switch

① **Wiper switch ON** (1st step)
Wiper switch ON [CS-103 (3)→(2)] → I/conn [CN-7 (6)] → Top wiper motor [CN-70 (4)] →
Top wiper motor operating

② **Washer switch ON** (2nd step)
Washer switch ON [CS-103 (6)→(5)] → I/conn [CN-3 (22)] → Top washer tank [CN-202 (2)] →
Washer operating
Wiper switch ON [CS-103 (3)→(2)] → I/conn [CN-7 (6)] → Top wiper motor [CN-70 (4)] →
Top wiper motor operating

※ The circuit diagram may differ from the equipment, so please check before a repair.

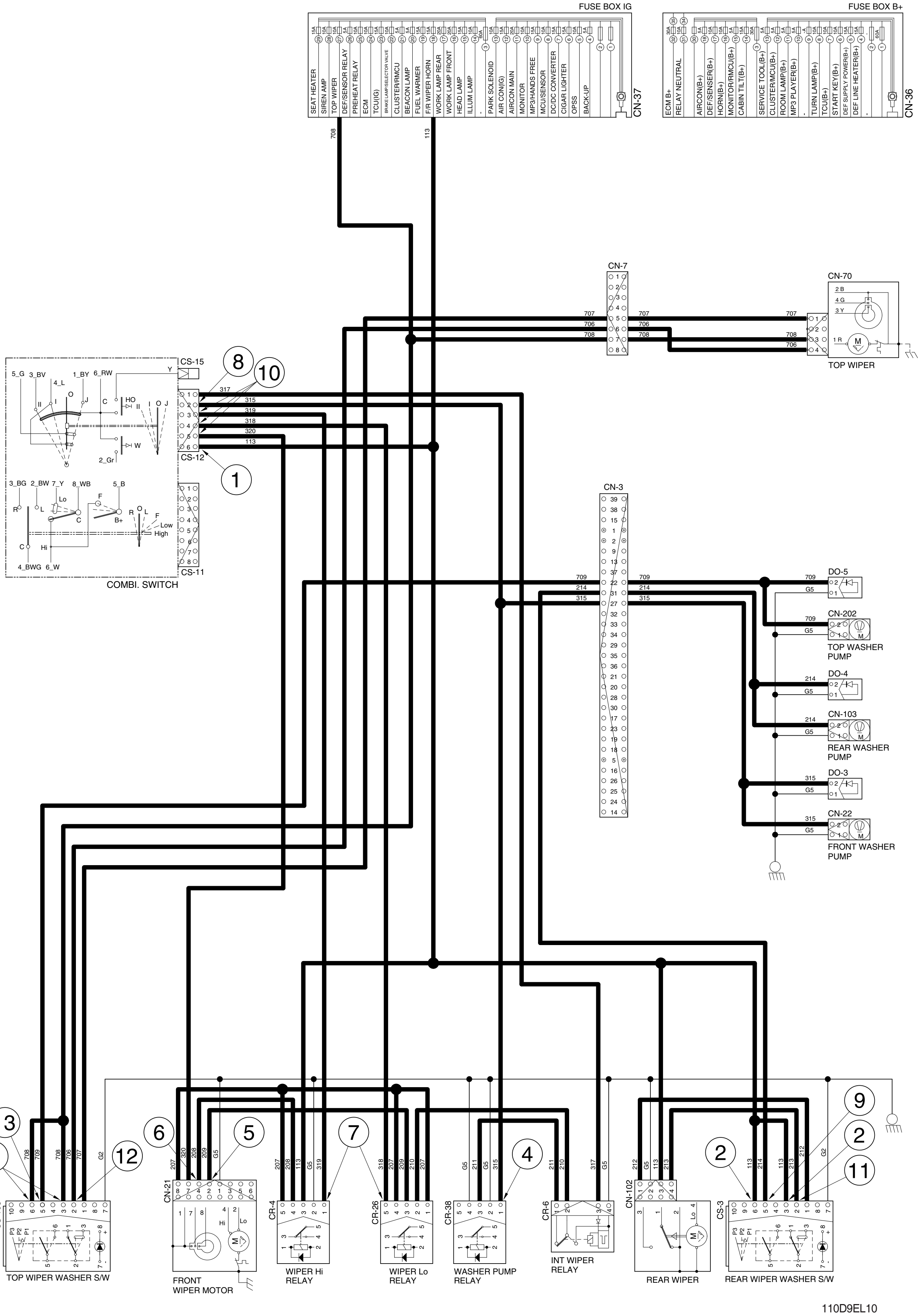
2) CHECK POINT

Engine	Key switch	Check point	Voltage
Stop	ON	① - GND (Front wiper switch power input) ② - GND (Rear wiper switch power input) ③ - GND (Top wiper switch power input) ④ - GND (Washer pump relay power input) ⑤ - GND (Front wiper motor Lo power input) ⑥ - GND (Front wiper motor High power input) ⑦ - GND (Wiper relay power input) ⑧ - GND (Front washer power output) ⑨ - GND (Rear washer power output) ⑩ - GND (Front wiper motor power output) ⑪ - GND (Rear wiper motor power output) ⑫ - GND (Top washer power output) ⑬ - GND (Top wiper motor power output)	20~25V

※ GND : Ground

※ The circuit diagram may differ from the equipment, so please check before a repair.

WIPER AND WASHER CIRCUIT



※ The circuit diagram may differ from the equipment, so please check before a repair.

3. CLUSTER

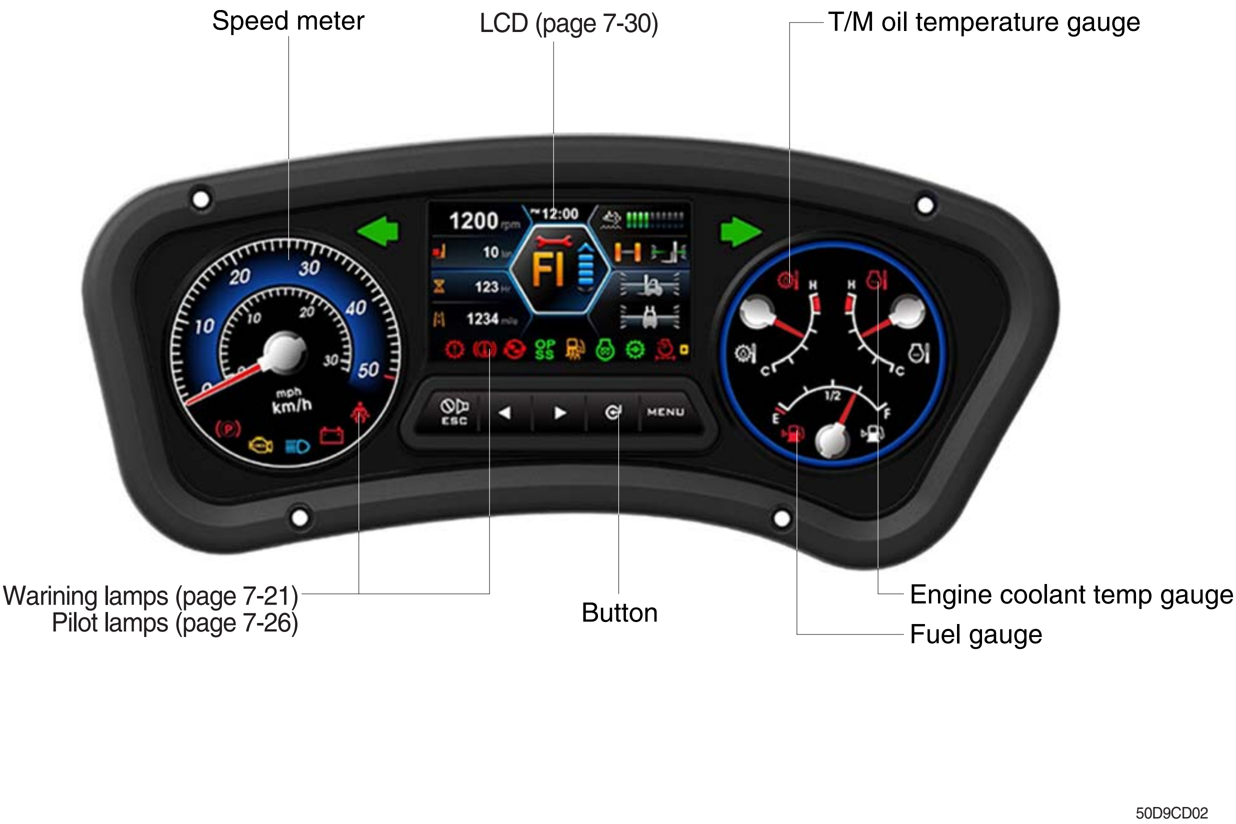
1) STRUCTURE

The cluster consists of gauges, lamps, buttons and LCD as shown below, to warn the operator in case of abnormal truck operation or conditions for the appropriate operation and inspection.

- Gauges : Indicate operating status of the truck.
- Warning lamps : Indicate abnormality of the truck.
- Pilot lamps : Indicate operating status of the truck.
- LCD : Display the truck model, error code and engine speed etc.
- Buttons : Select the truck model, error code and engine speed etc and stop the buzzer sound.

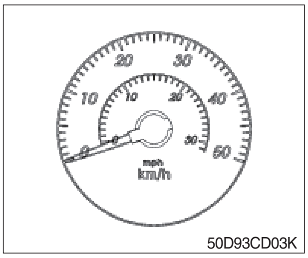
※ **The cluster installed on this truck does not entirely guarantee the condition of the truck. Daily inspection should be performed according to chapter 7. PLANNED MAINTENANCE AND LUBRICATION.**

※ **When the cluster provides a warning immediately check the problem, and perform the required action.**



2) GAUGE

(1) Speed meter

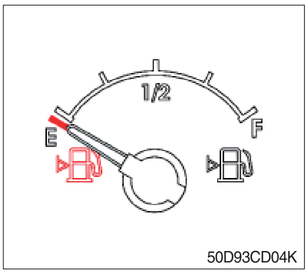


50D93CD03K

① The speed meter displays the speed of truck in mph and km/h.

- 0~50 km/h
- 0~31 mph

(2) Fuel gauge



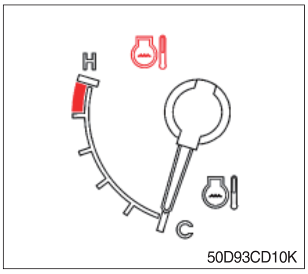
50D93CD04K

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 truck 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



50D93CD10K

① This indicates the temperature of coolant.

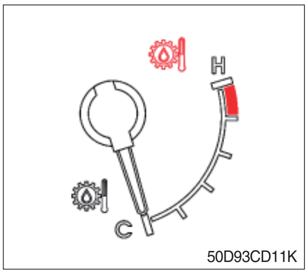
· White range : 40~115˚C (104~239˚F)
· Red range : Above 115˚C (239˚F)

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 and check the radiator and engine.

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

(4) Transmission oil temperature gauge



50D93CD11K

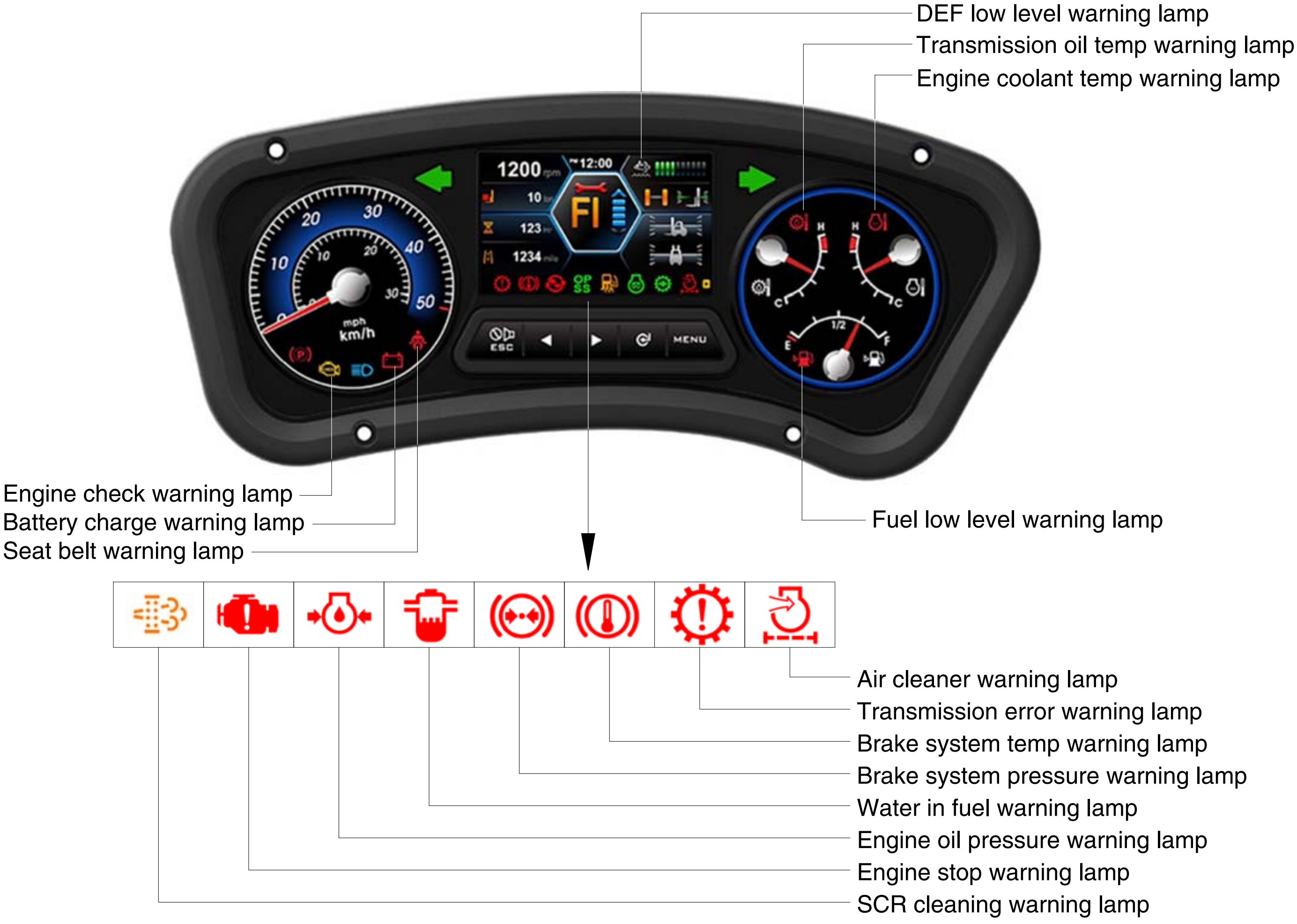
① This range indicates the temperature of transmission oil.

· White range : 40~107˚C (104~225˚F)
· 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.

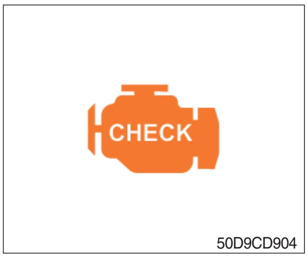
3) WARNING LAMPS



50D9CD02-1

※ When the warning and pilot lamps are illuminated more than display, you can display next lamps by push the button (▶).

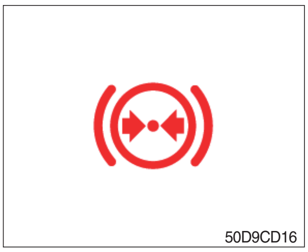
(1) Engine check lamp



50D9CD904

① This lamp lights ON during a nonfatal engine system error. The engine can still be run, but the fault should be corrected as soon as possible.

(2) Brake fail warning lamp



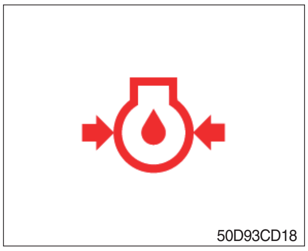
50D9CD16

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 the problems are corrected.

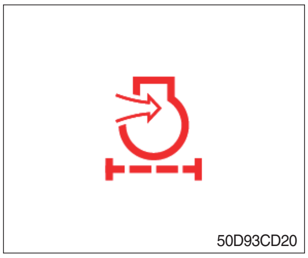
(3) Engine oil pressure warning lamp



① This lamp comes ON for a while after starting the engine because of the low oil pressure.

② If the lamp comes ON during engine operation, shut OFF engine immediately. Check oil level.

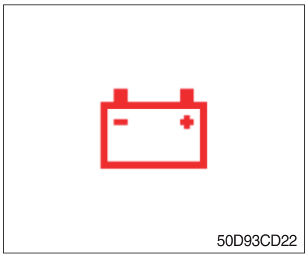
(4) Air cleaner warning lamp



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.

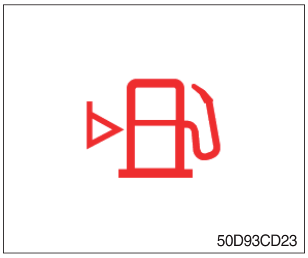
(5) Battery charging warning lamp



① This lamp is ON after key switch is turned ON, it is turned OFF after starting the engine.

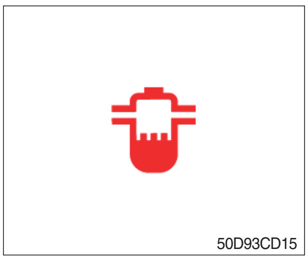
② Check the battery charging circuit when this lamp comes ON during engine operation.

(6) Fuel low level warning lamp



① Fill the fuel immediately when the lamp is turned ON.

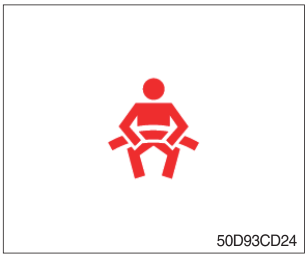
(7) Water in fuel warning lamp



① This lamp lights up when the prefilter is filled with water or malfunctioning.

※ **When this lamp lights up, stop the truck and spill water out of the prefilter.**

(8) Seat belt warning lamp

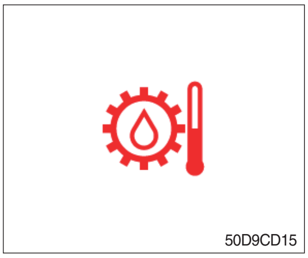


① This lamp lights ON for the first five seconds after starting the engine.

(9) Engine coolant temperature warning lamp

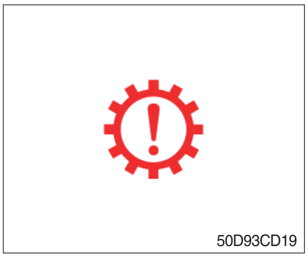
① This lamp is turned ON when the temperature of cooling water is over the normal temperature (115°C, 239°F).
② Check the cooling system when the lamp is ON.

(10) Transmission oil temperature warning lamp



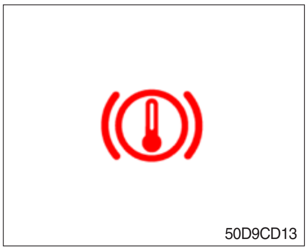
① This lamp informs the operator that transmission oil is above the specified temperature (107˚C, 225˚F).
· Lamp ON : Abnormal
· Lamp OFF : Normal
※ When this lamp lights up during operation, stop the engine and check the truck.

(11) Transmission error warning lamp



① This lamp lights ON and the information window of the LCD shows the error code when an error occur in the transmission.
② Immediately pull the truck 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.

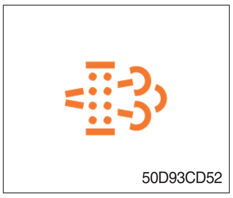
(12) Brake system temperature warning lamp



① This lamp is turned ON when the brake oil temperature is too high.

② When the lamp is ON, stop the engine and check for its cause.

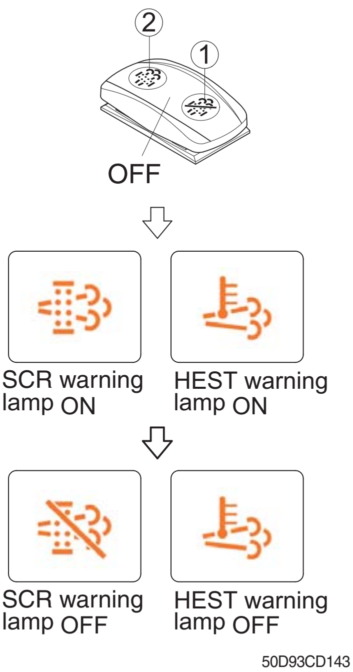
(13) SCR (Selective Catalytic Reduction) CLEANING WARNING LAMP



① This lamp lights ON when the SCR cleaning is needed and lamp flashes when manual SCR cleaning is activeted as table below.

Condition	Warning lamp				Remark
	SCR cleaning lamp	DEF Low Lamp	Engine Check Lamp	Engine Stop Lamp	
SCR needs to be cleaned	On	-	-	-	1. Change to a more challenging duty cycle. 2. Perform manual SCR cleaning.
SCR needs to be cleaned immediately	On	-	On	-	Manual SCR cleaning is required.
Stationary SCR cleaning status	Flash	-	-	-	-
DEF level initial warning	-	On	-	-	DEF level 10% Engine error code 3497
DEF level critical warning	-	Flash	-	-	DEF level 5% Engine error code 3498
DEF level initial warning	-	Flash	On	-	DEF level 2.5% Engine error code 1673, 25% derate
DEF level secondary derate warning	-	Flash	On	-	DEF level 0% Engine error code 3547,3714 50% derate, 30 min.
DEF level final derate warning	-	Flash	On	On	Engine error code 3712 Contact Hyundai service center or dealer.

※ Manual SCR cleaning method



※ **Manual SCR cleaning applies if the machine is in a fireproof area and there is no plan to turn off the machine during the SCR cleaning.**

① Stop and park the machine.

② Push the switch to position ② to initiate the manual SCR cleaning.

※ **Refer to the page 7-49 for the switch operation.**

※ **The engine speed may increase during SCR cleaning and it will take approximately 20~60 minutes depending on condition.**

③ The SCR cleaning lamp flash and HEST warning lamp will light on during the manual SCR cleaning function is operating.

④ The SCR cleaning and/or HEST warning lamp will light OFF when the SCR cleaning function is completed.

(14) DEF (Diesel Exhaust Fluid) low warning lamp

50D9CD32

① This warning lamp indicates, when illuminated or flashing, that the diesel exhaust fluid level is low.

※ Add the diesel exhaust fluid into DEF tank.

※ Refer to the page 7-24 for detail.

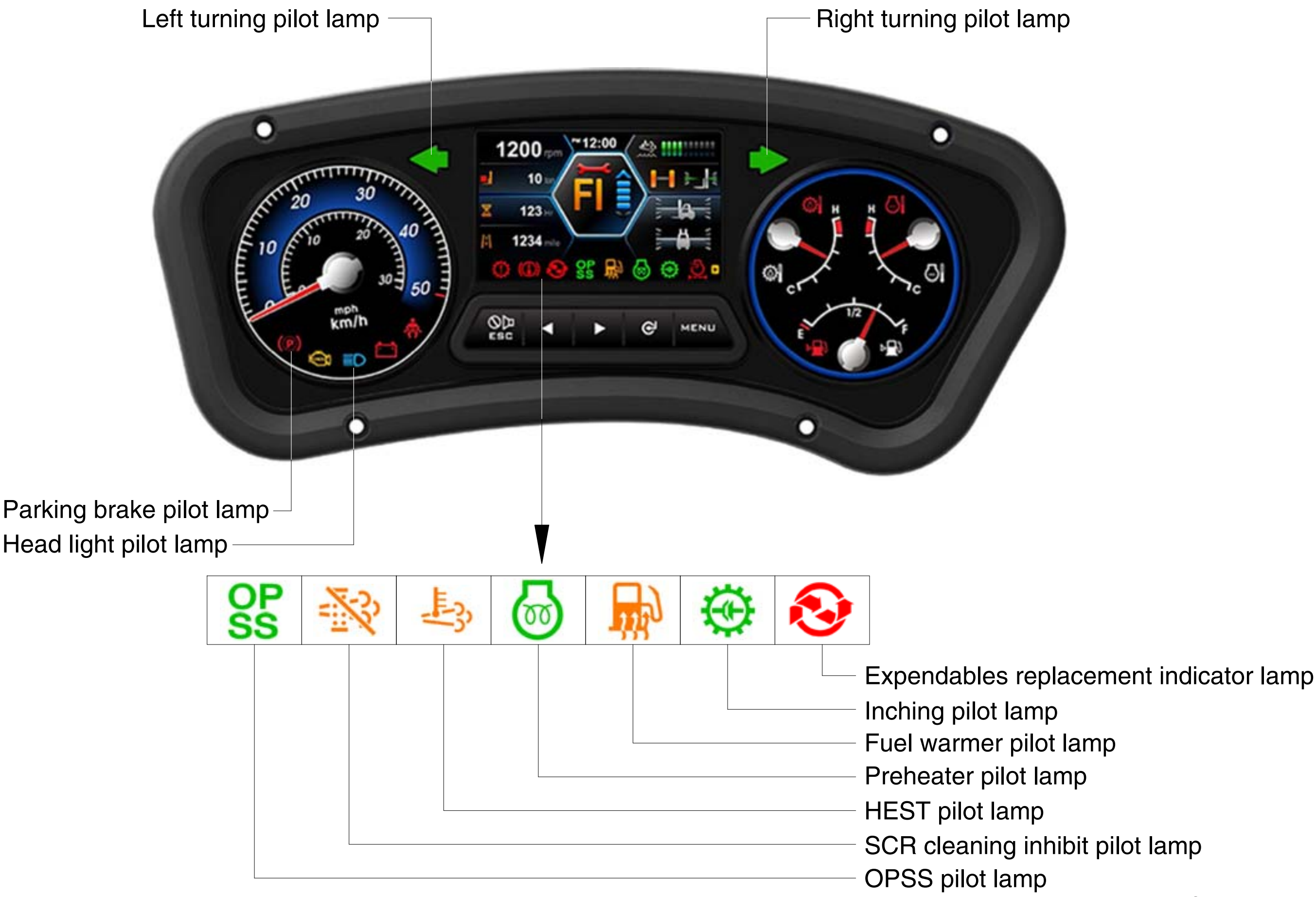
(15) Engine stop warning lamp

50D9CD33

① When this warning lamp lights ON, stop the engine immediately and and check the DEF level and related parts of the engine.

※ Please contact your Hyundai service center or local dealer.

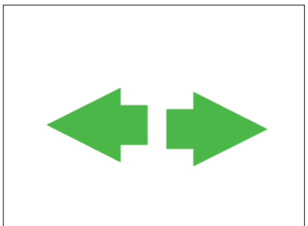
4) PILOT LAMPS



50D9CD02-2

※ When the warning and pilot lamps are illuminated more than display, you can display next lamps by push the button (▶).

(1) Direction pilot lamp



50D93CD10

① This lamp flashes when the signal indicator lever is moved.

(2) Parking brake pilot lamp

50D93CD11

① When the parking brake is actuated, the lamp lights ON.

※ Check the lamp is OFF before driving.

(3) Head light pilot lamp

50D9CD07

① This lamp comes ON when the main light switch is operated to 2nd step.

(4) Preheater pilot lamp

50D93CD14

① This lamp lights ON when start switch is turned clockwise to the ON position. Light will turn off after approximately 15~45 seconds, depending on engine temperature, indicating that preheating is completed.

② When the lamp goes out the operator should start cranking the engine.

※ **Refer to page 5-12 of the operator's manual.**

(5) Inching pilot lamp

50D93CD65

① When the inching switch is pressed, the lamp lights ON.

(6) Fuel warmer pilot lamp

50D93CD43

① This lamp lights ON when the fuel warmer switch is pressed.

(7) OPSS pilot lamp

50D9CD14

① This signal lamp lights ON when the operator leaves the seat.

② Powered travel movement of the truck shall be possible only if the operator is in the normal operating position. Transmission will automatically shift to neutral upon the exiting of the operator.

③ The forward/reverse lever must be cycled through neutral with the operator in the normal operating position to regain powered direction control.

(8) SCR cleaning inhibit pilot lamp

50D93CD30

① This pilot lamp lights ON when the SCR cleaning switch is pushed inhibit position, therefore automatic and manual SCR cleaning can not occur. It should inhibited, before caused fire due to the exhaust gas in high temperature.

※ Refer to the page 7-49 for the SCR cleaning switch.

(9) HEST (High exhaust system temperature) pilot lamp

50D9CL003

① This warning lamp indicates, when illuminated, that exhaust temperatures are high due to SCR cleaning.
② The lamp will also illuminate during a manual SCR cleaning.
③ When this lamp is illuminated, be sure the exhaust pipe outlet is not directed at any surface or material that can melt, burn, or explode.

⚠ When this lamp is illuminated, the exhaust gas temperature could reach 800℃ [1500℉], which is hot enough to ignite or melt common materials, and to burn people.

※ The lamp does not signify the need for any kind of equipment or engine service; It merely alerts the equipment operator to high exhaust temperatures. It will be common for the lamp to illuminate on and off during normal equipment operation as the engine completes the SCR cleaning.

(10) DEF (Diesel Exhaust Fluid) level pilot lamp

50D93CD66

① This gauge indicates the level of DEF (10 steps).
② Fill the DEF when the level is low.

(11) Expendables replacement indicator lamp

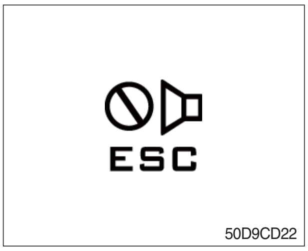
50D93CD31

① This lamp lights ON if expendables which must be replaced are exist.
② The lamp will light up only 3 minutes since KEY ON, and then light off.
③ Please check the expendables management list in maintenance menu.

4) CLUSTER BUTTON

Each button has the following function.

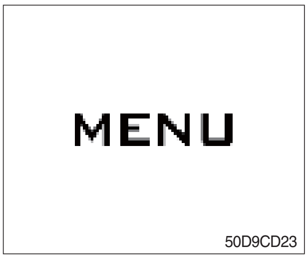
(1) Buzzer stop/ESC button



① This button is used to stop the buzzer sound.

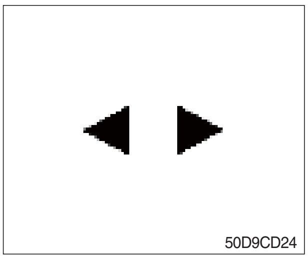
② If another alarm condition occurs after this button has been pressed, the alarm buzzer will re-sound.

(2) Menu button



① Move in menu (left, up / right, down).

(3) Move button

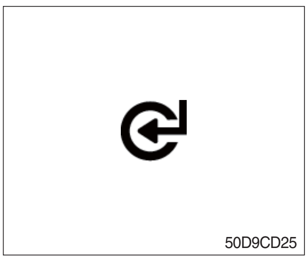


① Move in menu (left, up / right, down).

② Decrease / Increase input value.

③ When the warning and pilot lamps occur over six, you can display next lamps by push the button (▶).

(4) Enter button



① This button is used to select menu.

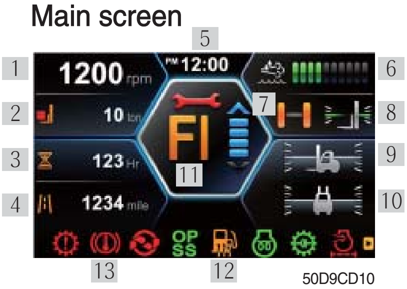
5) LCD

(1) Main screen

※ You can select or set the menu by the button of the cluster.

※ Please refer to the page 7-29 for the selection and change of the menu and input value.

Main screen



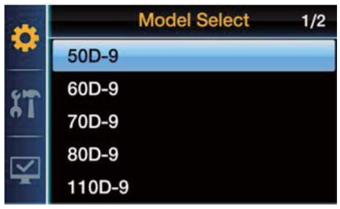
50D9CD10

MENU

Main menu screen

50D9CD11

Sub menu screen



50D9CD12

Communication error

50D9CD13

※ Main screen when occurred communication error between the cluster and TCU/ MCU / ECU

1	Engine rpm	8	Mast angle (opt)
2	Load indicator (opt)	9	Vehicle angle X (opt)
3	Hour meter	10	Vehicle angle Y (opt)
4	Odometer	11	T/M info (error code, gear, warning)
5	Current time	12	Temperature (outdoor temp., setting temp, cabin opt)
6	DEF level gauge	13	Warning and pilot lamps
7	Rear wheel angle (opt)		

(2) Main menu

No.	Main menu	Sub menu	Description
1	 Equipment 50D9CD14K	Model select Tilt setting Rear angle setting Weight sensor setting ESL setting Vehicle max speed limit AEB setting (R) MCU/cluster information	Model select Tilt setting (mast and vehicle angle) Rear angle setting Cross-section, load weight adjust, weight display setting, load indicator buzzer ESL setting Vehicle max speed limit (10~30 km) AEB setting (R)MCU/cluster information
2	 Maintenance 50D9CD15K	Current failure history Maintenance management Signal statue User password change RMCU comm	Display failure status (engine, transmission) Replacement, Change interval oils and filters Display information of sensors User password change (5~10 digit) Orbcomm, GPS antenna
3	 Display setting 50D9CD16K	LCD adjustment Time setting Unit setting Language setting AS phone number ESL password change Maintenance management	LCD brightness setting Time setting Unit setting (temp, speed, weight, pressure) Language setting (13 languages) Check and change AS phone number ESL password change (5~10 digit) Maintenance information (cycle, elapsed time, change count, alarm info)

(3) Equipment

① Choose the equipment

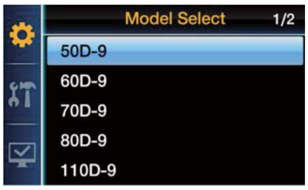
50D9CD20

50D9CD21

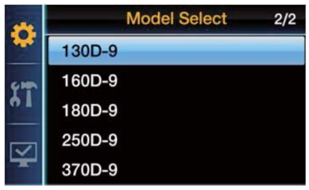
· To enter the menu, you must input user password.
· Default password is ‘00000’
· You should set password by five to ten digit.

② Model select

50D9CD22



50D9CD23



50D9CD24

· Select the Model
※ The initial model is selected at the factory, so don’t change the different model.

50D9CD25

50D9CD24-1

③ Tilt setting

50D9CD26

50D9CD27

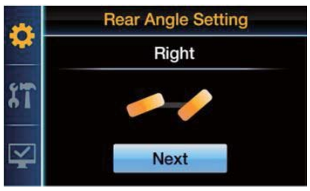
50D9CD28

· Set the offset about mast angle sensors and vehicle angle sensors.

④ Rear angle setting

50D9CD29

50D9CD30



50D9CD31

50D9CD34

50D9CD33

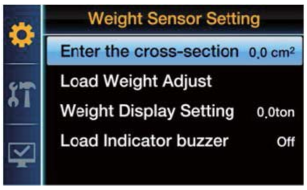
50D9CD32

· The user revises a forklift truck steering angle.
· Display set to approve a condition.
- Right set rear wheel calibration.
- Center set rear wheel calibration.
- Left set rear wheel calibration.

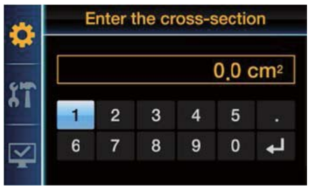
⑤ Weight sensor setting

a. Cross-section

50D9CD35



50D9CD36



50D9CD37

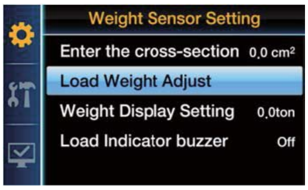
50D9CD38

· Enter the designated cross-section (cm²).

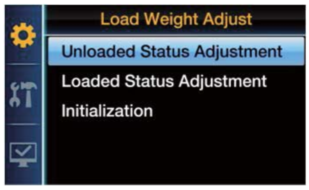
Mast spec	110/130D-9	160D-9
V mast	190.07	226.19
VS mast	226.19	265.46
TS mast	226.19	265.46

b. Load weight adjust

· Unloaded status adjustment
In the unloaded from the ground waiting 5 seconds after lift 30 cm, and tare ON.



50D9CD39

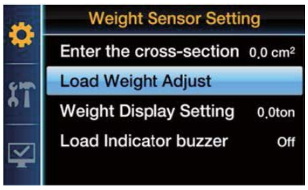


50D9CD40

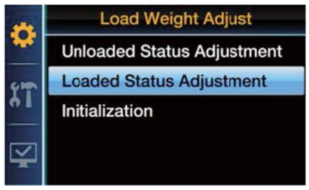
50D9CD42

50D9CD41

· Loaded status adjustment
Loaded enter the weight.
-> In the loaded from the ground waiting 5 seconds after lift 30 cm.
-> Weight correction ON.



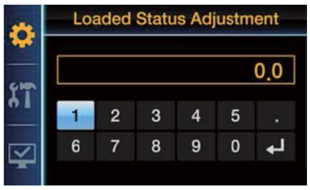
50D9CD39



50D9CD44

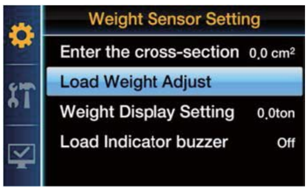
50D9CD47

50D9CD46

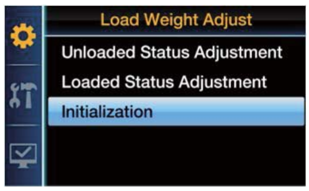


50D9CD45

· Initialization
It is initialized loaded status and unloaded status.



50D9CD39



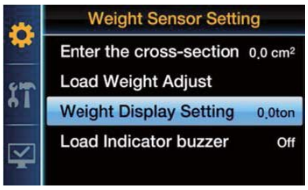
50D9CD49

50D9CD51

50D9CD50

c. Weight display setting

50D9CD35



50D9CD53

50D9CD54

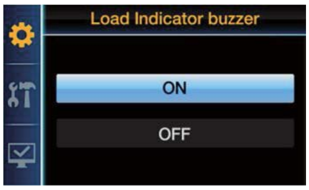
50D9CD55

· Select the number of points of weight value display.

d. Load indicator buzzer

50D9CD35

50D9CD57



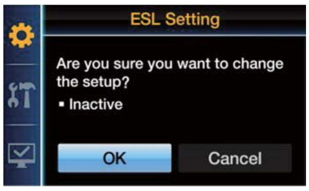
50D9CD58

· Choose using buzzer when over weight.

⑥ ESL setting

50D9CD59

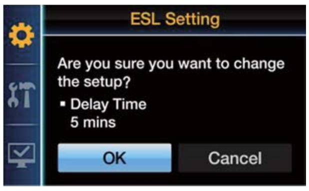
50D9CD60



50D9CD61

50D9CD62

50D9CD63

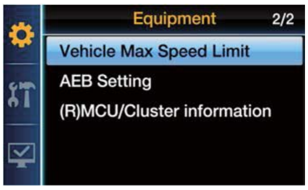


50D9CD64

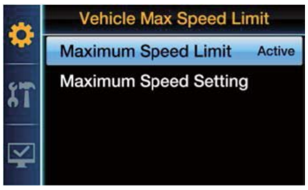
· Set ON/OFF function for using limitation of ignition and time for starting.

· Set time 5 minutes for starting :
In 5 minutes you can restart without password, but after 5 minutes, you should input password for starting.

⑦ Vehicle max speed limit



50D9CD65

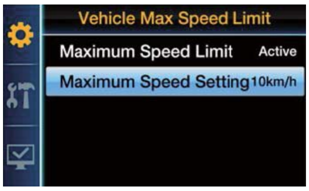


50D9CD66

50D9CD67

50D9CD68

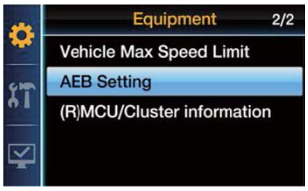
- Set the maximum speed.
- 10 km/h~30 km/h (1 km/h intervals)



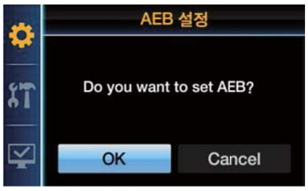
50D9CD69

50D9CD70

⑧ AEB setting



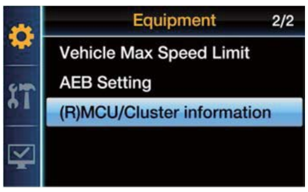
50D9CD71



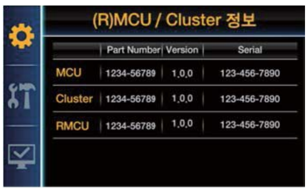
50D9CD72

- Press OK button, then calibration will be started, for cancel, press Menu/ECS/Enter button.
- When it is finished (OK sign at gear box), Press Menu/ECS/Enter button.
- Start the engine : AEB start
- KEY ON : Brake pedal sensor calibration

⑨ (R) MCU / Cluster information



50D9CD73

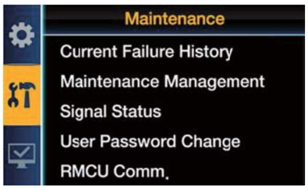


50D9CD74

- Software version check for MCU/Cluster/RMCU.

(4) Maintenance

① Choose the maintenance



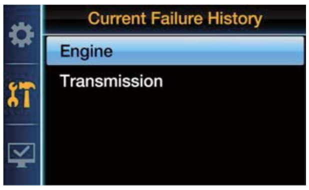
50D9CD75

50D9CD76

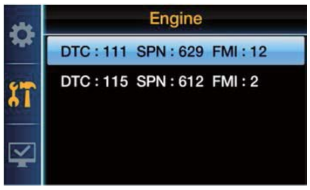
- To enter the Menu, you must input user password.
- Default password is '00000'
- You should set password by five to ten digit.

② Current failure history

50D9CD77



50D9CD78



50D9CD79

50D9CD80

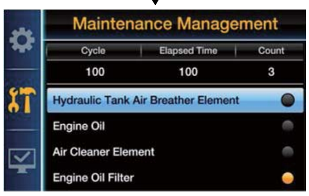
- Show the failure status of engine / transmission / air conditioner.

③ Maintenance management

50D9CD81

50D9CD82

50D9CD83



50D9CD84

50D9CD85

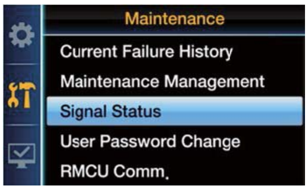
50D9CD86

50D9CD87

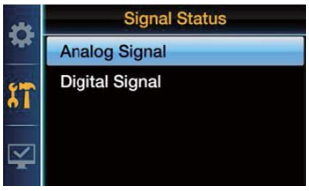
50D9CD88

- Exchange expendable supplies.
- Change the replacement cycle.
- Show the Maintenance Information below 10. (Delete the old item, when Information have more than 10)

④ Signal status



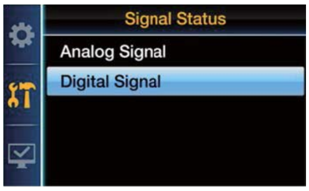
50D9CD89



50D9CD90

50D9CD91

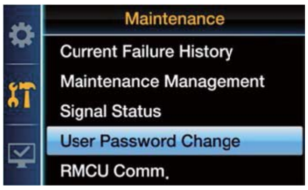
- Display information of each sensors.



50D9CD92

50D9CD93

⑤ User password change



50D9CD94

50D9CD95

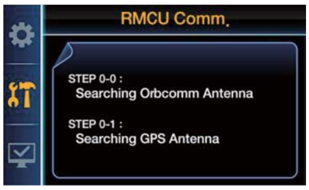
50D9CD96

- You should set password by five to ten digit.

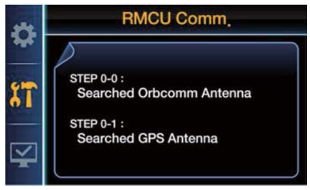
50D9CD97

⑥ RMCU Comm

50D9CD98

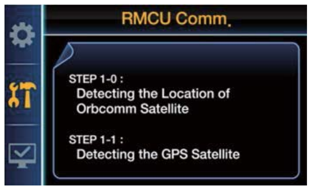


50D9CD99

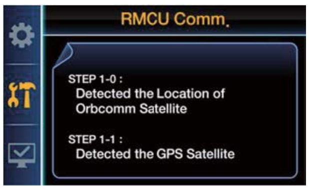


50D9CD100

- When successfully opened RMCU communication, Except for the RMCU Comm.

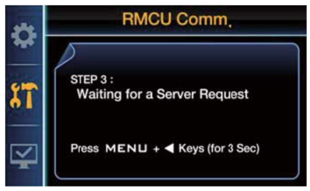


50D9CD101



50D9CD102

50D9CD103



50D9CD104

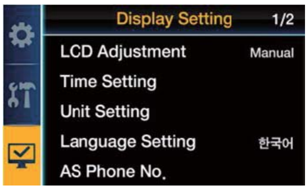
50D9CD105

50D9CD106

50D9CD107

(5) Display setting

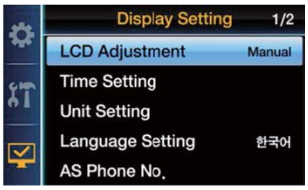
① Choose the display setting



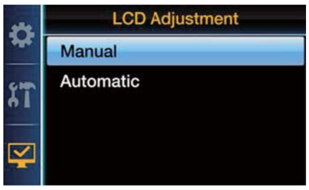
50D9CD108

- No password is required.

② LCD adjustment

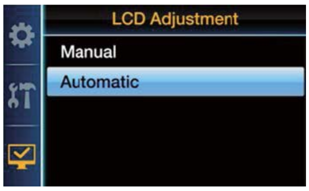


50D9CD109



50D9CD110

50D9CD111



50D9CD112

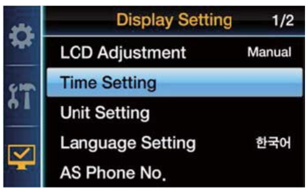
50D9CD113

50D9CD114

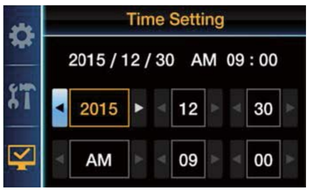
50D9CD115

- Manual : Manual setting for LCD brightness.
- Automatic : Automatic control of LCD brightness as set level of Day/Night.
- Setting day time : Set the time for daylight.
  (If you set the time for daylight, the rest time will be night.)

③ Time setting



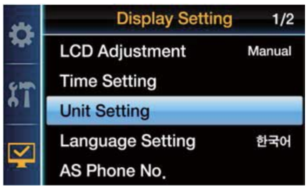
50D9CD116



50D9CD117

- Set the time (Year, Month, Day, Hour, Minute, AM/PM).

④ Unit setting



50D9CD118

50D9CD118-1

50D9CD119

- Change units of temperature / speed / wight / pressure.

⑤ Language setting

50D9CD120

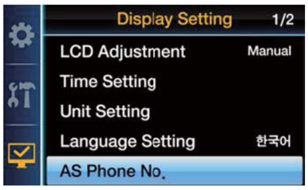
50D9CD121

50D9CD122

50D9CD123

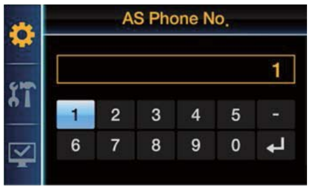
- Set the language used by your device.
  (13 Multiple language)

⑥ A/S phone number



50D9CD124

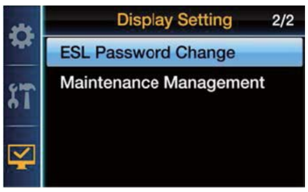
50D9CD125



50D9CD126

- Check and change of contact information for customer service.

⑦ ESL password change



50D9CD127

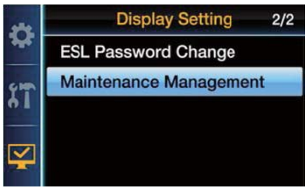
50D9CD128

50D9CD129

50D9CD130

- You should set password by five to ten digit.

⑧ Maintenance management



50D9CD131

50D9CD132

50D9CD133

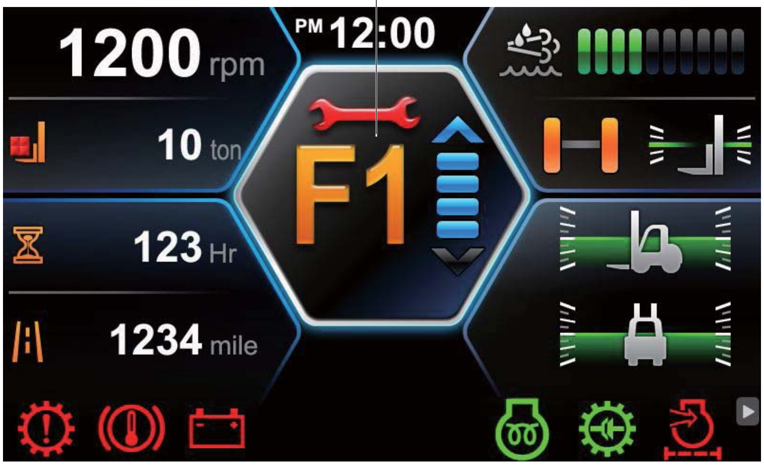
· Show the maintenance information (replacement cycle, elapsed time, change count, alarm information).

4.TRANSMISSION MESSAGE DISPLAY

1) FUNCTION

The display can be used with the gear selector (DW-3). It indicates speed and driving direction. When driving in the automatic mode, a bar indicator gives additionally also information about the selected driving range; The automatic range is symbolized by arrows above and below the bar indicator. In case of possible errors in the system, a wrench appears on the display, combined with indication of the error number. Also sporadically occurring errors can be indicated.

Transmission message display



50D93ACD33

If it happens error codes, consult with Hyundai service center to repair the fault.

2) DISPLAY DURING AEB-MODE

Symbol	Meaning	Remarks
K1......K3 KV, KR	Calibrating clutch K1...K3, KV or KR resp.	
_and Kx	Wait for start, initialization of clutch Kx, x : 1, 2, 3, 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) after removing AEB-Starter
STOP	AEB canceled(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 enging speed	
▽E	Engine speed too high → lower enging 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)
STOP	AEB-Starter was used incorrect or is defective. Wrong device or wrong cable used.	Transmission stays in neutral, you have to restart the TCU(ignition off/on)

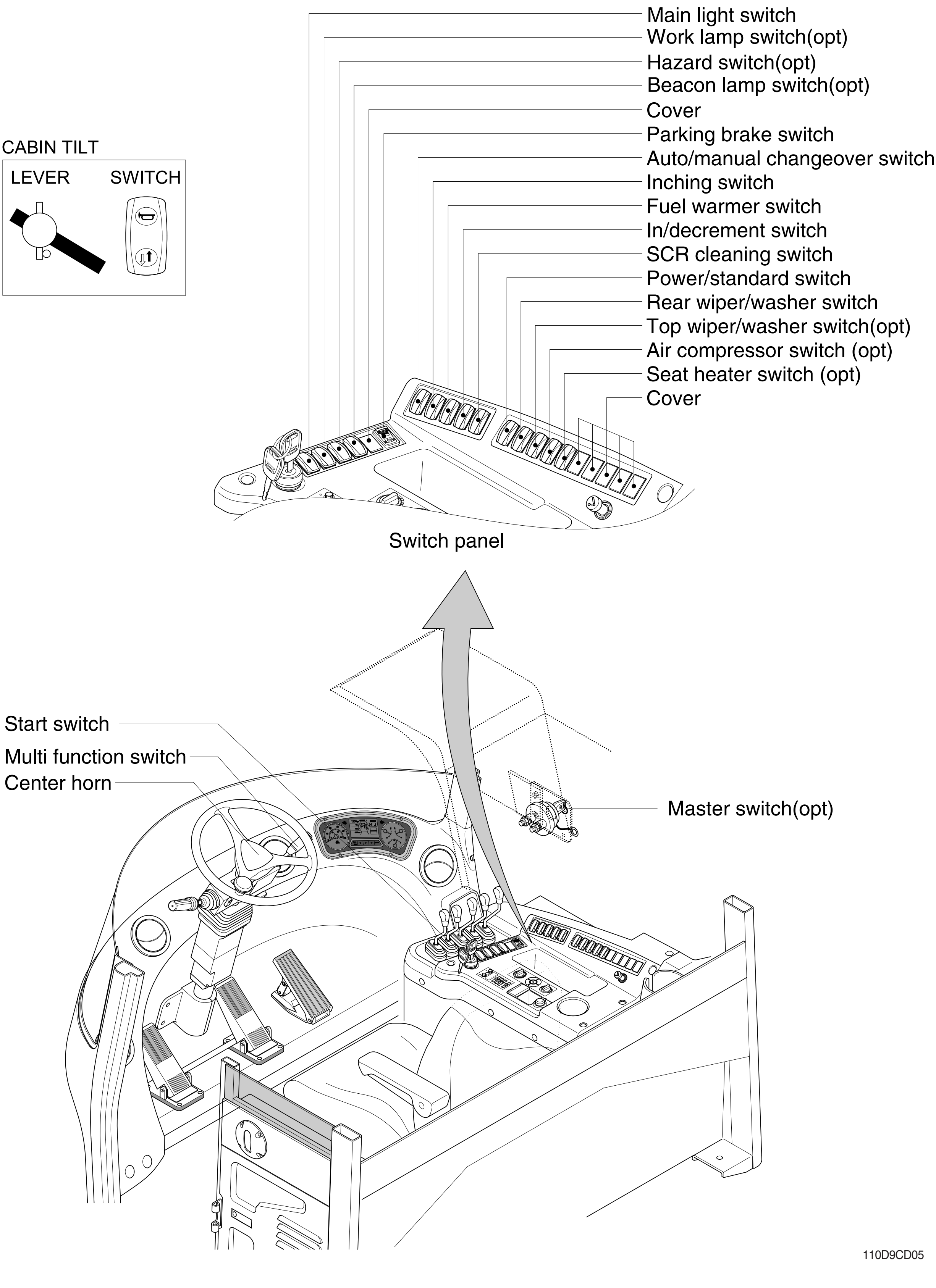
3) INITIALIZING THE INCHING SENSOR

(1) Start engine after parking the machine on flat floor and blocking wheels.
(2) Release parking brake and keep neutral gear shift.
(3) Adjust the inching sensor linkage so that the regular voltage is supplied to inching sensor when operating the pedal.
※ Regular voltage ; Before pedal operation (1±0.1V), After pedal operation (3.5±0.1V).
(4) Stop the engine and then just KEY ON. (Release parking brake, keep neutral gear)
(5) Connect the AEB STARTER to the T/M controller.
(6) Push AEB STARTER over 3 seconds.
(7) If display shows "IP", Step on the pedal fully.
(8) If display shows "IP", release "OK"
(9) After the successful completion, it displays "OK".
(10) In case of abnormal running, it may display "STOP" with the appropriate error code.
(11) After troubleshooting, start the machine again to repeat above.
※ Above works are to be done with the parking brake released, so machine's wheels must be blocked for safety.

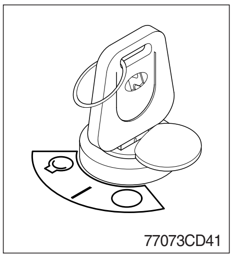
4) DISPLAY DURING INCHPEDAL CALIBRATION

Symbol	Meaning	Remarks
▼IP	Push down the pedal slowly until endposition is reached and hold this position	
▲IP	Release the pedal slowly until endposition is reached	
IP blinkt	A problem occurred, release the pedal slowly until endposition is reached	If the expected endposition could not be reached, release the pedal and try again
OK	Finished inchpedal calibration successful	
FN and Stop	Shift lever not in Neutral position	Calibrations is aborted
FS and Stop	Sensor supply voltage AU1 is out of the specified range	Calibrations is aborted
FO and Stop	Outputspeed_not_zero	Calibrations is aborted
SL and Stop	Sensor voltage below specified range	Calibrations is aborted
SU and Stop	Sensor voltage below specified range	Calibrations is aborted
IL and Stop	Sensor position for released pedal out of specified range	Calibrations is aborted
IU and Stop	Sensor position for released pedal out of specified range	Calibrations is aborted
TO and Stop	Time-out calibration, pedal not moved after calibration start	Calibrations is aborted
DL and Stop	Angle between pedal positions released and pressed to small	Calibrations is aborted
DU and Stop	Angle between pedal positions released and pressed to small	Calibrations is aborted
FI and Stop	Sensor signal 1 and 2 don't match together	Calibrations is aborted

5. SWITCHES

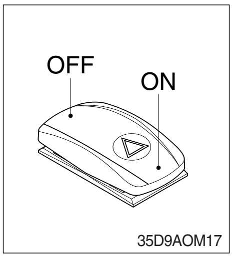

CABIN TILT
LEVER
SWITCH
Main light switch
Work lamp switch(opt)
Hazard switch(opt)
Beacon lamp switch(opt)
Cover
Parking brake switch
Auto/manual changeover switch
Inching switch
Fuel warmer switch
In/decrement switch
SCR cleaning switch
Power/standard switch
Rear wiper/washer switch
Top wiper/washer switch(opt)
Air compressor switch (opt)
Seat heater switch (opt)
Cover
Switch panel
Start switch
Multi function switch
Center horn
Master switch(opt)
110D9CD05

1) START SWITCH



(1) There are three positions, OFF, ON and START.
- ○ (OFF) : None of electrical circuits activate.
- | (ON) : All the systems of truck operate.
- (START) : Use when starting the engine. Release key immediately after starting.

2) HAZARD SWITCH (OPTION)



(1) Use for parking, or loading truck.

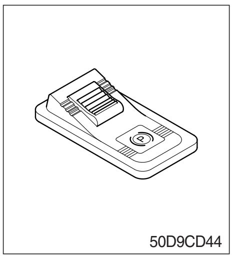
※ **If the switch is left ON for a long time, the battery may be discharged.**

3) INCHING SWITCH

(1) If this switch is pressed, inching operation is applied to inching pedal.

(2) Also, inching lamp on the cluster is illuminated.

4) PARKING BRAKE SWITCH

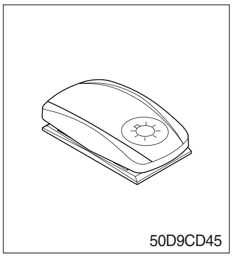


(1) This switch is used to parking brake lock or release.

(2) If this switch is pressed, the parking brake is applied and the warning lamp on the cluster will comes ON.

※ **When operating the gear selector lever, be sure to release the parking brake. If the truck 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



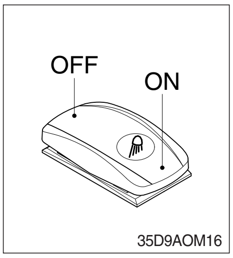
(1) This switch is used to operate the clearance lamp, cluster illumination lamp and head light by two steps.

① First step : Clearance lamp and cluster illumination lamp comes ON. Also, all of the pilot lamps of switches come ON.

② Second step : Head light low beam comes ON.

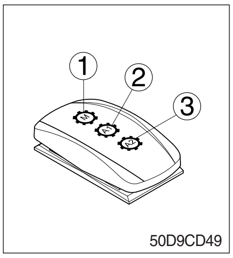
※ **Refer to the page 7-48 for the head light.**

6) WORK LAMP SWITCH (OPTION)



(1) This switch is used to operate the work lamps by two steps.
① First step : Front work lamp comes ON.
② Second step : Rear work lamp comes ON.

7) AUTO/MANUAL CHANGEOVER SWITCH

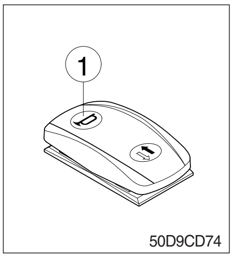


(1) Manual mode (①)
Press the top of the switch for the manual mode of the autoshift function. The operator selects the desired speed and the desired direction in the manual mode with the gear selector lever.

(2) Automatic 1st mode (②)
Place the switch in the middle position for the autoshift function changing from 1st to 3rd gear shift mode.

(3) Automatic 2nd mode (③)
Press the bottom of the switch fully for the autoshift function changing from 2nd to 3rd gear shift mode.

8) CABIN TILT SWITCH



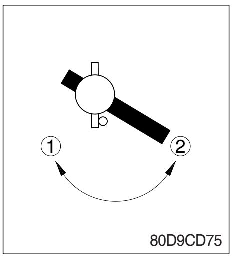
(1) Horn ( )
By pressing position ①, the horn sounds and by releasing, the horn stops.

⚠ **Sound the horn to warn near by personnel, before tilting the cabin.**

(2) Tilting of the cabin (⬆ , ⬇)
Press the cabin tilt switch in order to tilt the cabin to right side or return to original location.

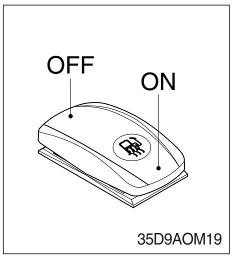
※ **Refer to page 7-18 of the operator's manual for the tilting method of the cabin.**

9) HAND PUMP LEVER



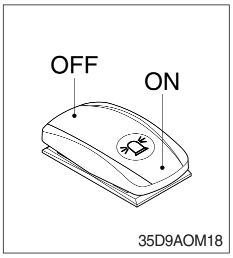
(1) This lever is used when tilting the cabin.
(2) Turn the hand pump lever to counterclockwise direction (①), the cabin shall be tilted to right side by the cabin tilt switch.
(3) Turn the hand pump lever to clockwise direction (②), the cabin shall be returned to original location by the cabin tilt switch.

10) FUEL WARMER SWITCH



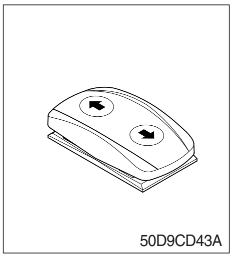
(1) This switch is used to heat the fuel of pre-heater.

11) BEACON SWITCH (OPTION)



(1) This switch turn ON the strobe light.

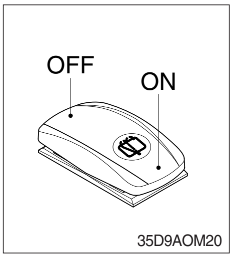
12) INC/DECREMENT SWITCH



(1) When engine running, the low rpm of engine increase or decrease by 25 rpm by operating this switch.

(2) Engine low rpm returns to normal value when engine restarted.

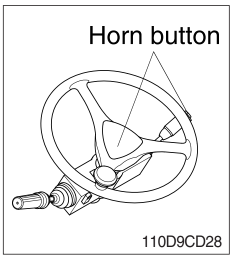
13) TOP WIPER AND WASHER SWITCH (OPTION)



(1) This switch is used to operate the wiper and washer on the top of the cab.

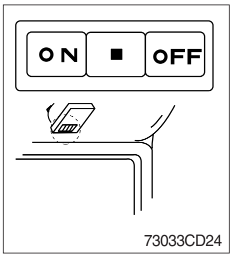
(2) The washer liquid is sprayed and the wiper is operated only while pressing this switch.

14) HORN BUTTON



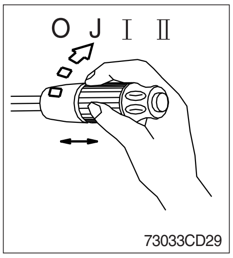
(1) If you press the button on the top of the multifunction switch and the center of the steering wheel, the horn will sound.

15) CAB LAMP SWITCH



(1) This switch turns ON the cab room lamp.

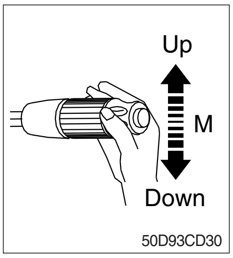
16) MULTI FUNCTION SWITCH



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

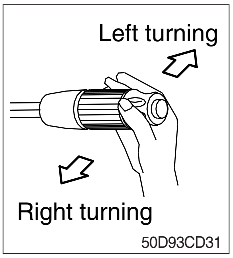
※ **Check the quantity of washer liquid in the tank. If the level of the washer liquid is LOW, add the washer liquid (In cold, winter days) or water. The capacity of the tank is 1 liter.**



(2) Dimmer switch

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

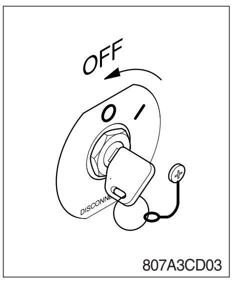
③ If you release the switch when it's in up position, the switch will return to middle.



(3) Turning switch

① This switch is used to warn or signal the turning direction of the truck to other vehicles or equipment.
② Push the lever up for turning left, pull the lever down for turning right.

17) MASTER SWITCH (OPTION)

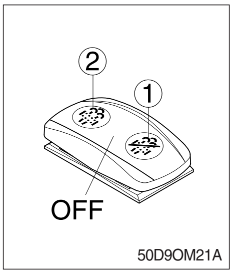


(1) This switch is used to shut off the entire electrical system.
When the machine is not operated for a long time, turn OFF the master switch for the safety purpose.

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

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

18) SCR (Selective Catalytic Reduction) CLEANING SWITCH



(1) This switch is used to select the cleaning function of the SCR.

(2) Inhibit position (①)

① The inhibit position disallows any automatic or manual SCR cleaning.

② This may be used by operator to prevent SCR cleaning when the machine is operating in a hazardous environment is concerned about high temperature.

③ It is strongly recommended that the this position is only activated when high temperatures may cause a hazardous condition.

(3) OFF position

This position will initate a automatic SCR cleaning when needed.

(4) Manual SCR cleaning position (②)

① This position will only initate a manual SCR cleaning and the SCR cleaning lamp is illuminated.

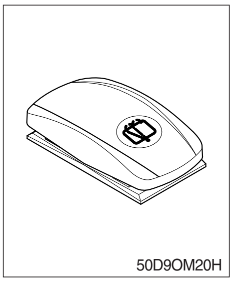
② HEST lamp will be illuminated during the entire SCR cleaning.

※ **Refer to the page 7-28 for details.**

※ **This switch can be move to the manual SCR cleaning position (②) only when the safety button is pulled to backward.**

※ **Also, this switch return to the OFF position when released the manual SCR cleaning position (②).**

19) REAR WIPER/WASHER SWITCH



(1) This switch is used to operate the wiper and washer on the rear of the cab.

(2) The washer liquid is sprayed and the wiper is operated only while pressing this switch.

20) ENGINE MODE SWITCH

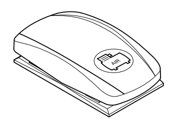
(1) This switch offers two selectable operating mode.
The operator can adjust the machine's performance with this selection switch.

(2) Function

① STANDARD MODE : This mode provides maximum fuel efficiency for general loading.

② POWER MODE : This mode provides maximum power output for heavy loading or hill climb.

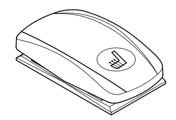
21) AIR COMPRESSOR SWITCH (option)



110D9CD61

(1) This switch is used to activate the air compressor.

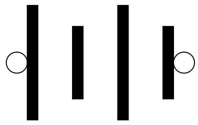
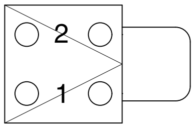
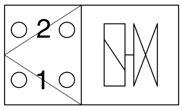
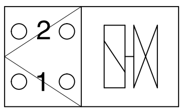
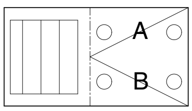
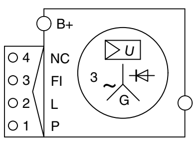
22) SEAT HEAT SWITCH

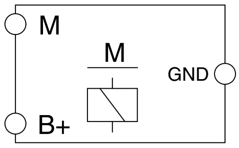
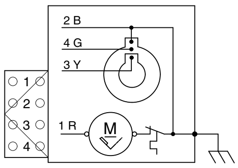
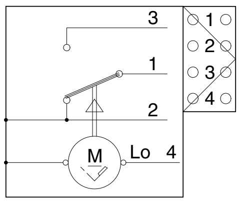
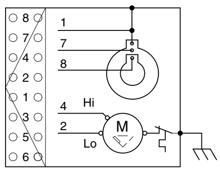
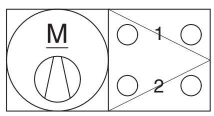
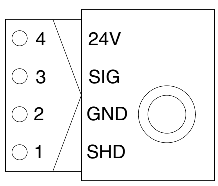


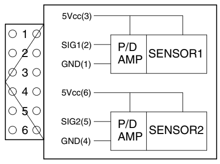
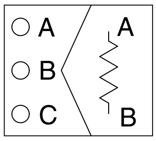
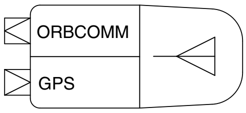
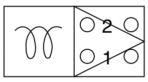
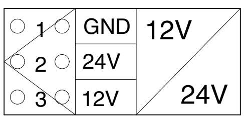
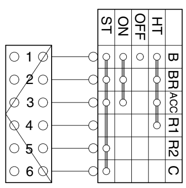
110D9CD62

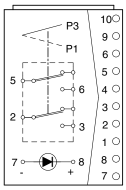
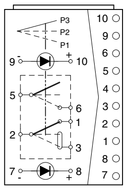
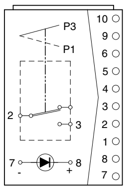
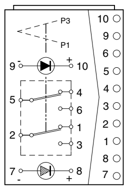
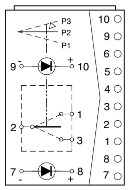
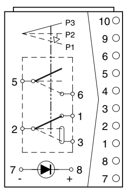
(1) This switch is used to heat the seat.

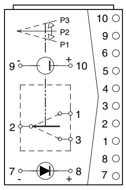
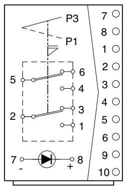
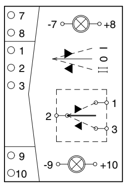
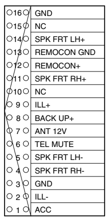
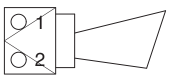
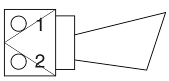
GROUP 6 ELECTRICAL COMPONENT SPECIFICATION

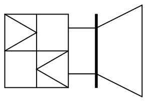
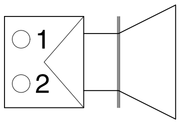
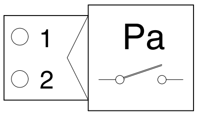
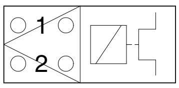
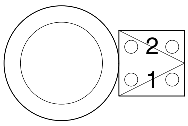
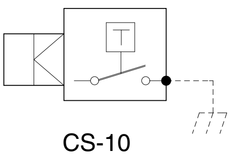
Part name	Symbol	Specifications	Check
Battery		12V × 100Ah (2EA)	※ When checking the battery charging indicator, Green : Normal condition Black : Discharge condition Transparency : Change
Fusible link	 CN-60 CN-95	CN-60 : 24V 27A CN-95 : 24V 45A	※ Check disconnection Normal : 0 Ω (Connect ring terminal and check resistance between terminal 1 and 2)
EPPR valve (Pump, Fan)	 CN-154 CN-155	24V 300A	※ Check resistance About 24 Ω
Solenoid valve (Parking, Attach cut off, Side shift selector, DEF tank heater, DEF dosing module)	 CN-71 CN-131 CN-132 CN-J27 CN-J31	24V 1.2A	※ Check LED lamp. ※ Check resistance About 24 Ω
Heater (Seat, DEF line heater 1, 2, 3)	 CN-170 CN-381 CN-382 CN-383	24V	※ Check resistance Normal : About 200 Ω (for terminal 1-3) 0 Ω (for terminal 2-4)
Alternator	 CN-74	Delco Remy 24SI 24V 70A	※ Check voltage Normal : 24~28V

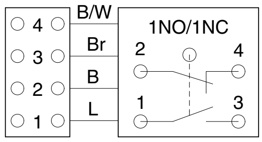
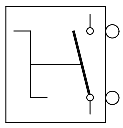
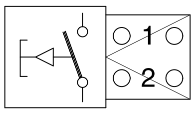
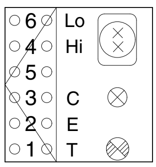
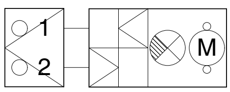
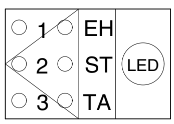
Part name	Symbol	Specifications	Check
Start motor	 CN-45	DENSO 24V 3.7kW	※ Operating or not
Top wiper motor	 CN-70	24V 1.5A 1-speed Auto parking	-
Rear wiper motor	 CN-102	24V 1A 1-speed Auto parking	-
Front wiper motor	 CN-21	24V 1A 2-speed Auto parking	-
Motor	 CN-22 CN-83 CN-103 CN-202	24V 2.5A	※ Check contact Normal : 26.4 Ω (For terminal 1-2)
Camera	 CN-249 CN-250	24V 2.5W Signaling : NTSC Angle of view : 145°	-

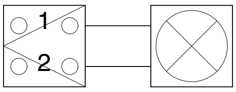
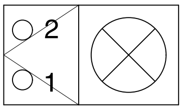
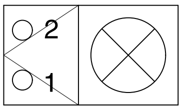
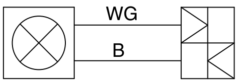
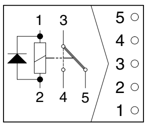
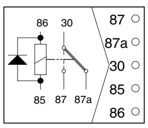
Part name	Symbol	Specifications	Check
Accel pedal	 CN-124	5V, hall sensor	※ Check voltage 0.5~3.9V (2-1)
Resistor	 CN-98	3W 300 Ω	※ Check resistance Normal : 300 Ω (A-B)
RMS antena	 CN-251	3.0~5.0V 20mA	-
Fuel warmer	 CN-96	24V 15A	※ Check resistance Abnormal : ∞ Ω
DC/DC converter	 CN-138	24V 10A Output voltage : 13±1VDC	※ Check resistance Normal : A few Ω (1-2, 1-3)
Start key	 CS-2	DC 24V	※ 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)

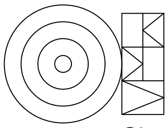
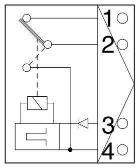
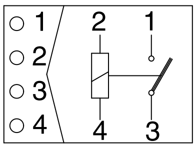
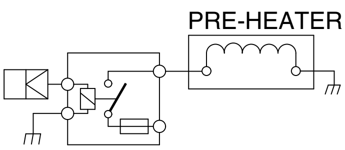
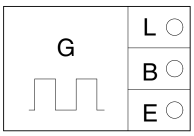
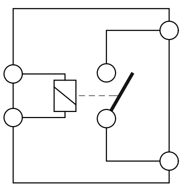
Part name	Symbol	Specifications	Check
Switch (Locking type)	 CS-41 CS-42 CS-82	24V 8A	※ Check contact OFF : ∞ Ω (For terminal 2-3, 5-6)
Switch (Locking type)	 CS-59	24V 8A	※ Check contact OFF : ∞ Ω (For terminal 2-3, 5-6)
Switch (Locking type)	 CS-23 CS-74 CS-99	24V 8A	※ Check contact OFF : ∞ Ω (For terminal 2-3)
Switch (Locking type)	 CS-79	24V 8A	※ Check contact Normal ON: 0 Ω (For terminal 2-3, 5-6) ∞ Ω (For terminal 1-2, 4-5) OFF: ∞ Ω (For terminal 2-3, 5-6) 0 Ω (For terminal 1-2, 4-5)
Switch (Locking type)	 CS-100	24V 8A	※ Check contact OFF : ∞ Ω (For terminal 2-1, 2-3)
Switch (Locking type)	 CS-3 CS-21 CS-39 CS-103	24V 8A	※ Check contact OFF : ∞ Ω (For terminal 2-3, 5-6) 0 Ω (For terminal 2-1)

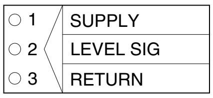
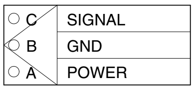
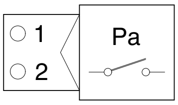
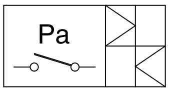
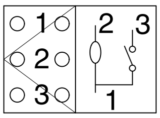
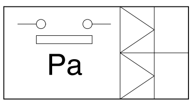
Part name	Symbol	Specifications	Check
Switch (Locking type)	 CS-64	24V 8A	※ Check contact OFF : ∞ Ω (For terminal 2-1, 2-3)
Switch (Locking type)	 CS-17	24V 8A	※ Check contact Normal ON: 0 Ω (For terminal 1-2, 4-5) ∞ Ω (For terminal 2-3, 5-6) OFF: ∞ Ω (For terminal 1-2, 4-5) 0 Ω (For terminal 2-3, 5-6)
Cab tilt switch (Non-locking type)	 CS-77	24V 8A	※ Check contact OFF : ∞ Ω (For terminal 2-1, 2-3)
Radio/USB player	 CN-27	24V 2A	※ Check voltage 20~25V (For terminal 1-3, 3-8)
Horn	 CN-25	20~28V, 1.5A 100~115dB (at 25V, 2m)	※ Check operation Supply power (24V) to each terminal and connect ground.
Back up alarm	 CN-65	18~32V, 0.5A 115±3dB (at 1m)	※ Check operation Supply power (24V) to each terminal and connect ground.

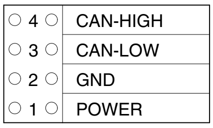
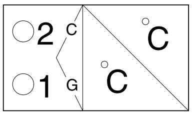
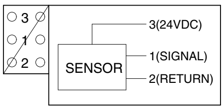
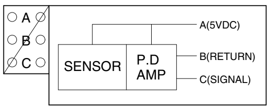
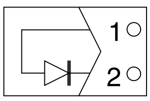
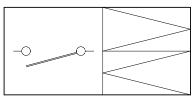
Part name	Symbol	Specifications	Check
Speaker	 CN-23(LH) CN-24(RH)	4Ω 20W	※ Check resistance Normal : 50 Ω
Siren speaker	 CN-145	24V	-
Receiver dryer	 CN-29	N.O type	※ Check resistance Normal : Ω
Air conditioner compressor	 CN-30	24V 79W	※ Check contact Normal : 13.4 Ω
12V socket	 CN-139	12V 10A Rated ampere	※ Check resistance Normal : A few Ω (1-2)
Brake temp switch	 CS-10	N.O type	※ Check resistance Normal : ∞ Ω

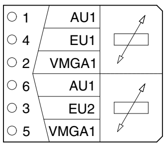
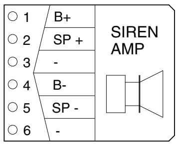
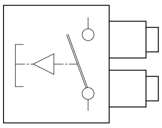
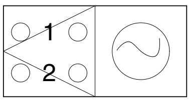
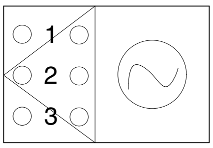
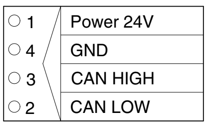
Part name	Symbol	Specifications	Check
Tilt switch	 CS-74	24V 8A	※ Check contact S/W open : ∞ Ω (For terminal NO-COM) : 0 Ω (For terminal NC-COM) S/W closed : 0 Ω (For terminal NO-COM) : ∞ Ω (For terminal NC-COM)
Master switch		Continuous Capacity : 180Amp Push in capacity : 1000Amp	※ Check contact OFF : ∞ Ω
Seat switch	 CS-73	24V 8A	※ Check contact OFF : ∞ Ω
Head lamp	 CL-3 CL-4	24V 75/70W H4 bulb	※ Check disconnection Normal : ∞ Ω (6-2, 4-2, 3-2, 1-2)
Beacon lamp	 CL-7	24V 0.8A (Strobe type)	※ Check disconnection Normal : A few Ω Abnormal : ∞ Ω
Rear combination lamp	 CL-15A CL-15B CL-16A CL-16B	24V 10W (tail) 24V 21/5W (turn)	※ Check disconnection Normal : A few Ω

Part name	Symbol	Specifications	Check
Mast work lamp	 CL-5 CL-6 CL-51 CL-61	24V 70W H3 bulb	※ Check disconnection Normal : A few Ω
Room lamp	 CL-1 CL-22	24V 10W	※ Check resistance Normal : A few Ω
Rear work lamp	 CL-23 CL-51	24V 70W	※ Check resistance Normal : A few Ω
License lamp	 CL-21	24V 3W × 2	※ Check resistance Normal : A few Ω
Relay (5pin)	 CR-5 CR-39 CR-52 CR-62 CR-26 CR-42 CR-56 CR-63 CR-36 CR-45 CR-58 CR-38 CR-50 CR-61	24V 3-4 : 15A (85˚C) 3-5 : 10A (85˚C)	※ Check resistance Normal : 0 Ω (For terminal 3-4) : ∞ Ω (For terminal 3-5)
Relay (5pin)	 CR-3 CR-55 CR-49 CR-59	24V 30-87 : 20A 30-87a : 15A	※ Check resistance Normal : 0 Ω (For terminal 30-87a) : ∞ Ω (For terminal 30-87)

Part name	Symbol	Specifications	Check
Cigar lighter	 CL-2	24V 5A	※ Check coil resistance Normal : About 1M Ω ※ Operating time : 5~15 sec
Int wiper relay	 CR-6	24V 5A Operating time : 2.5±1 sec	※ Check resistance Normal : 0 Ω (For terminal 1-2) : ∞ Ω (For terminal 1-3)
Start relay	 CR-23	24V 300A	※ Check resistance Normal : 10 Ω (For terminal 2-4) : ∞ Ω (For terminal 1-3)
Preheat relay	 CR-24	24V 200A Exciting current : 2.3A	※ Check resistance Normal : 10 Ω (For terminal coil) : 0 Ω (Between ring term)
Flasher unit	 CR-11	24V 85±10 C/M 50dB	-
Battery relay	 CR-1	Rated load 24V 100A (continuity) 1000A (30 seconds)	※ Check coil resistance (M4 to M4) Normal : About 50 Ω ※ Check contact Normal : ∞ Ω

Part name	Symbol	Specifications	Check
Coolant level pressure switch	 CD-96	4.75~5.25V 12.5mA	-
Pressure switch	 CD-3 CD-26	N.C TYPE	※ Check contact Normal : 0 Ω (CLOSE)
Pressure switch	 CD-35 CD-75	N.O TYPE	※ Check contact Normal : ∞ Ω (OPEN)
Air cleaner pressure switch	 CD-10	Pressure : 635mmH_2O (N.O TYPE)	※ Check contact Normal : ∞ Ω
Fuel sender	 CD-2	Reed switch : Magnetic type	※ Check resistance Full : About 50 Ω Low level : About 700 Ω
Brake switch	 CD-4	N.O type	※ Check resistance Normal : ∞ Ω

Part name	Symbol	Specifications	Check
G-sensor	 CD-6	24V, 5W	-
Temperature sensor (Ambient, cac)	 CD-76 CD-87	-	-
Load sensor	 CD-50	24V, hall sensor	※ Check voltage 0.5~4.5 VDC (1-2)
Angle sensor	 CD-12	5V, hall sensor	※ Check voltage 0.4~4.5 VDC (B-C)
Diode	 DO-1 DO-2 DO-3 DO-4 DO-5	Diode spec : 1N5406	-
Side shift selector switch	 CS-13	24V	※ Check contact Normal : ∞ Ω

Part name	Symbol	Specifications	Check
Inching sensor	 CD-71	-	-
Siren amp	 CN-47	24V	-
Center horn	 CS-5	24V	-
Transmission speed pick up sensor (Internal, Turbine, Engine)	 CD-27 CD-74 CD-72	-	-
Transmission speed sensor (output)	 CD-73	-	-
Engine sensor (NOx)	 CN-J7A CN-J7B	-	-

Part name	Symbol	Specifications	Check
Engine sensor (SCR, DOC)	○ 4 Power 24V ○ 1 GND ○ 3 CAN HIGH ○ 2 CAN LOW CN-J17	-	-
DEF quality sensor	○ 1 CAN HIGH ○ 2 CAN LOW ○ 3 GND ○ 4 Power 24V CN-J6	-	-
TBAP sensor	○ 1 PRESSURE ○ 2 SUPPLY ○ 3 TEMP. ○ 4 RETURN CD-102	-	-

GROUP 7 CONNECTORS

1. CONNECTOR DESTINATION

Connector number	Type	No. of pin	Destination	Connector part No.	
				Female	Male
CN-1	AMP	42	I/conn(Engine harness-Main harness)	936421	936429
CN-2	AMP	42	I/conn(Main harness-Engine harness)	936421	936429
CN-3	AMP	42	I/conn(Engine harness-Main harness)	936421	936429
CN-4	KET	2	I/conn(Engine harness-Main harness)	MG642928	MG652934-5
CN-6	AMP	15	I/conn(Engine harness-Frame harness)	2-85262-1	368301-1
CN-6	AMP	15	I/conn(Main harness-A/C harness)	2-85262-1	-
CN-7	AMP	16	I/conn(Main harness-Cabin harness)	368047-1	368050-1
CN-8	KET	14	I/conn(Main harness-Monitor harness)	MG610350	MG640352
CN-9	DEUTSCH	2	I/conn(Mast w/lamp harness-Frame harness)	-	DT04-2P
CN-10	DEUTSCH	6	I/conn(Fender harness-Frame harness)-LH	DT06-6S	DT04-6P
CN-11	DEUTSCH	6	I/conn(Fender harness-Frame harness)-RH	DT06-6S	DT04-6P
CN-12	AMP	4	To front camera harness	DT06-4S	DT04-4P
CN-13	AMP	6	I/conn(Main harness-Cabin harness)	174982-2	174984-2
CN-14	KET	8	Cabin harness	MG610049	MG620048
CN-15	KET	6	Aircon harness	MG610049	-
CN-16	DEUTSCH	2	Mast work lamp harness	DT06-2S	DT04-2P
CN-17	DEUTSCH	2	Mast lamp harness	DT06-2S	-
CN-19	KET	2	Inching potentiometer	MG610329	MG640322
CN-21	DEUTSCH	8	Front wiper	DT06-8S	-
CN-22	KET	2	Front washer pump	MG610320	-
CN-23	KET	2	Speaker LH	MG610070	-
CN-24	KET	2	Speaker RH	MG610070	-
CN-25	Molex	2	Horn	35825-0211	-
CN-27	KUM	16	Radio & USB player	PK145-16017	-
CN-29	KET	2	Receiver dryer	MG640795	
CN-30	KUM	1	Compressor	PB625-01027	-
CN-31	AMP	2	Aircon harness	-	174354-2
CN-32	AMP	2	Aircon harness	-	176146-2
CN-33	AMP	6	Aircon harness	-	174264-2
CN-36	QPL	1	Fuse box	21HN-55010	-
CN-37	QPL	1	Fuse box	21HN-55010	-
CN-45	Ring term	1	Start motor (M)	S820-205000	-
		1	Start motor (B+)	S820-312000	-
CN-46	KET	1	Air compressor harness	MG640944-5	MG650943-5
CN-47	KET	1	Battery (+)	MG640944-5	MG650943-5
	KET	1	Master switch (B+)	S820-312000	-
CN-50	AMP	68	Transmission control unit	963598-1	-
CN-51	AMP	6	Transmission control unit service tool	480704-0	926682-3
CN-52	KET	4	Handsfree controller	MG610331	21FT-36150

Connector number	Type	No. of pin	Destination	Connector part No.	
				Female	Male
CN-55	KET	14	OPSS unit	MG610350	
CN-56	AMP	20	Cluster	174047-2	-
CN-59M	AMP	34	MCU (Machine control unit)	4-1437290-0	-
CN-59N	AMP	34	MCU (Machine control unit)	4-1437290-1	-
CN-60	KET	2	Fusible link	-	MG620558
CN-65	DEUTSCH	2	Back-up buzzer	DT06-2S	-
CN-70	AMP	4	Top wiper motor	180900	-
CN-71	DEUTSCH	2	Parking solenoid	DT06-2S	-
CN-71	DEUTSCH	4	Seat switch	-	DT04-4P
CN-74	PACKARD	4	Alternator	12186568	-
CN-75	KET	1	Battery (-) terminal	MG640944-5	-
CN-82	KET	2	Seat harness	MG610043	-
CN-83	KUM	2	Condensor fan	PB625-02027	-
CN-90	AMP	16	I/conn (Engine harness-Frame harness)	368047-1	368050-1
CN-90	KET	14	Monitor	MG610350	MG640352
CN-91	DEUTSCH	3	Load sensor	DT06-3S	DT04-3P
CN-93	DELPHI	96	ECM connector (J2)	13964577	-
CN-94	FRAMATOME	24	Alternate droop	F934000	-
CN-94	DEUTSCH	4	Mast camera	DT06-4S	DT04-4P
CN-95	KET	2	Fusible link	-	MG620558
CN-96	AMP	4	Fuel warmer	2-967325-3	-
CN-100	KET	4	Harness relay	MG610047	-
CN-101	FRAMTIME	4	Engine TBAP	-	54200415
CN-102	AMP	4	Rear wiper motor	180900	-
CN-103	KET	2	Rear washer pump	MG610320	-
CN-112	ZF	16	Gear box	21L7-60290	-
CN-124	AMP	6	Accel pedal	174262-2	-
CN-125	DEUTSCH	12	RMCU (Remote control unit)	DT06-12S	DT04-12P
CN-131	DEUTSCH	2	Attachment cut	DT06-2S	-
CN-132	DEUTSCH	2	Side shift select solenoid	DT06-2S	-
CN-134	DEUTSCH	9	ECM service tool	-	HD10-9-1939P
CN-135	DEUTSCH	9	Cluster/Monitor service tool	-	HD10-9-96P
CN-136	DEUTSCH	9	MCU/FDCU service tool	-	HD10-9-96P
CN-138	KET	3	DC/DC connecter	MG610045	-
CN-139	KET	2	12V socket	MG610043	-
CN-144	KET	20	Handsfree controller	MG610240	-
CN-145	AMP	2	Amp speaker	S816-002002	S816-102002
CN-147	KET	2	Cabin tilt (Pump motor)	MG640188-4	-
CN-154	DEUTSCH	2	Fan motor EPPR valve	DT06-2S	-
CN-155	DEUTSCH	2	Pump EPPR valve	DT06-2S	-
CN-160	DEUTSCH	2	Air compressor harness	DT06-2S	-
CN-191	AMP	4	I/conn (Frame harness-G sensor)	174257-2	174259-2

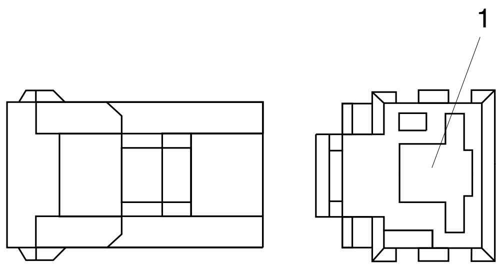
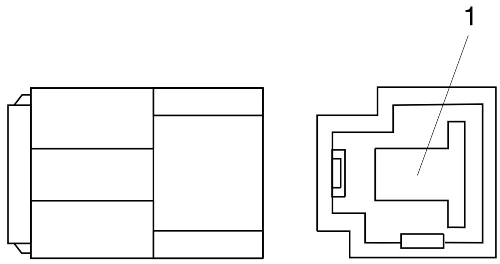
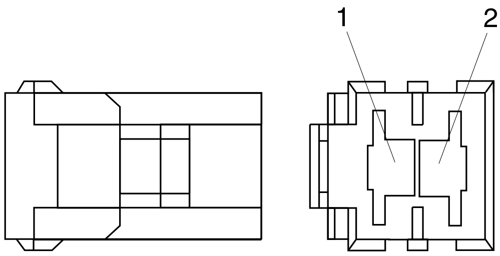
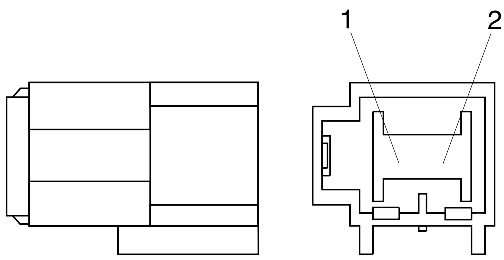
Connector number	Type	No. of pin	Destination	Connector part No.	
				Female	Male
CN-202	AMP	4	Top washer pump	2-967325-3	-
CN-245	AMP	12	Remote controller assy	368542	-
CN-246	AMP	12	USB & Socket assy	174045-2	-
CN-249	AMP	3	Rear camera	174357-2	174359-2
		1	Rear camera	174877-2	174879-2
CN-381	DEUTSCH	2	DEF hose heating 1 (Pressure)	DT06-2S W2SB	-
CN-382	DEUTSCH	2	DEF hose heating 2 (Backflow)	DT06-2S W2SB	-
CN-383	DEUTSCH	2	DEF hose heating 3 (Suction line)	DT06-2S W2SB	-
CN-J1	FCI	24	Alternate droop breakout connector	F254000	-
CN-J6	DEUTSCH	4	DEF quality sensor	DT06-4S	-
CN-J7A	AMP	4	DOC NOx sensor	2-1418390-1	-
CN-J7B	AMP	4	SCR NOx sensor	1-1418390-1	-
CN-J10	AMP	4	SCR thermistor	3-1418390-1	-
CN-J17	AMP	4	DOC thermistor	4-1418390-1	-
CN-J26	AMP	12	DEF supply module	2-1703639-1	-
CN-J27	AMP	4	Coolant valve	1-967325-1	-
CN-J31	AMP	2	DEF dosing module inj vlv-LO/HI	936059-1	-
Switch					
CS-2	KET	4	Start key	MG610335	-
CS-3	CARLING	10	Rear wiper switch	21HN-56300	-
CS-5	KET	2	Center horn	-	MG640322
CS-5A	KET	2	Center horn	MG610320	-
CS-10	KET	1	Brake cooling switch	ST730018-3	-
	CARLING	10	Fuel warmer switch	21HN-56300	-
CS-11	KET	8	Multifunction switch	MG610339	-
CS-12	KET	6	Multifunction switch	MG610335	-
CS-13	KET	1	Sideshift selector switch	ST730018-3	ST750036-3
CS-14	PACKARD	4	Gear selector switch	-	12010974
CS-15	PACKARD	4	Gear selector switch	12015797	-
	KET	1	Gear selector switch	ST730018-3	-
CS-17	CARLING	10	Parking switch	21HN-56300	-
CS-21	CARLING	10	Work lamp switch	21HN-56300	-
CS-23	CARLING	10	Beacon switch	21HN-56300	-
CS-39	CARLING	10	Main switch	21HN-56300	-
CS-41	CARLING	10	Hazard switch	21HN-56300	-
CS-42	CARLING	10	Inching switch	21HN-56300	-
CS-54	CARLING	10	Aircon switch	21HN-56300	-
CS-59	CARLING	10	Auto/manual switch	21HN-56300	-
CS-64	CARLING	10	Inc/dec switch	21HN-56300	-
CS-74	DEUTSCH	4	Tilt switch	-	DT04-4P
CS-77	CARLING	10	Tilt operation switch	21HN-56300	-
		10	Air compressor switch	21HN-56300	-

Connector number	Type	No. of pin	Destination	Connector part No.	
				Female	Male
CS-79	CARLING	10	Engine mode switch	21HN-56300	-
CS-82	CARLING	10	Seat heat switch	21HN-56300	-
CS-100	CARLING	10	SCR cleaning switch	21HN-56300	-
CS-103	CARLING	10	Top wiper switch	21HN-56300	-
Lamp					
CL-1	KET	2	Room lamp LH	MG610392	-
CL-2	KET	1	Cigar lighter	ST730018-3	ST750036-3
	AMP	1	Cigar lighter	172128-1	-
CL-3	DEUTSCH	6	Head lamp	DT06-6S	-
CL-5	DEUTSCH	2	Work lamp (Mast, RH)	-	DT04-2P
CL-6	DEUTSCH	2	Work lamp (Mast, LH)	-	DT04-2P
CL-7	DEUTSCH	2	Beacon lamp	DT06-2S	DT04-2P
CL-15A	AMP	3	Rear combi lamp (Illum/stop, LH)	282087-1	-
CL-15B	AMP	3	Rear combi lamp (Turn/back up, LH)	282087-1	-
CL-16A	AMP	3	Rear combi lamp (Illum/stop, RH)	282087-1	-
CL-16B	AMP	3	Rear combi lamp (Turn/back up, RH)	282087-1	-
CL-21	KET	1	License lamp	ST730018-3	ST750036-3
CL-22	AMP	2	R/work lamp LH	174352	174354-2
CL-23	AMP	2	R/work lamp RH	174352	174354-2
CL-51	KET	2	Room lamp RH	MG610392	-
Relay					
CR-1	-	1	Battery relay coil	S820-308000	-
		1	Battery relay coil	S820-104000	-
CR-3	HELLA	5	Front work lamp relay	8JA003526-001	-
CR-4	AMP	-	Wiper high speed relay	VCFM-1002	-
CR-5	AMP	-	Netural relay	VCFM-1002	-
CR-6	KET	4	Internal wiper relay	MG610047	-
CR-11	HELLA	5	Flasher unit relay	8JA003526-001	21LM-01600
CR-23	KET	4	Start relay	MG610047	-
CR-24	Ring term	1	Preheat relay	-	S832-106000
	KET	1	Preheat relay	ST730018-3	-
CR-26	AMP	-	Wiper low speed relay	VCFM-1002	-
CR-38	AMP	-	Water pump relay	VCFM-1002	-
CR-39	AMP	-	Backup relay	VCFM-1002	-
CR-42	AMP	-	Preheat relay	VCFM-1002	-
CR-44	AMP	2	Cabin tilt relay	174352-2	-
CR-45	HELLA	5	Engine control module relay	8JA003536-001	-
CR-46	HELLA	5	Engine preheat relay	8JA003536-001	-
CR-49	HELLA	5	Fuel warmer relay	8JA003536-001	-
CR-50	AMP	-	Travel cut relay	VCFM-1002	-
CR-51	AMP	-	Start lock relay	VCFM-1002	-
CR-52	AMP	-	Attach cut-off relay	VCFM-1002	-

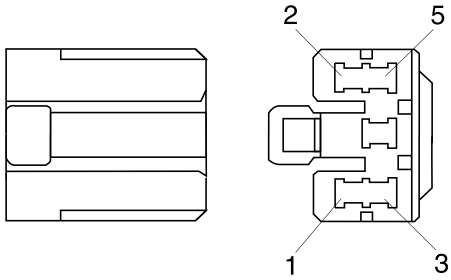
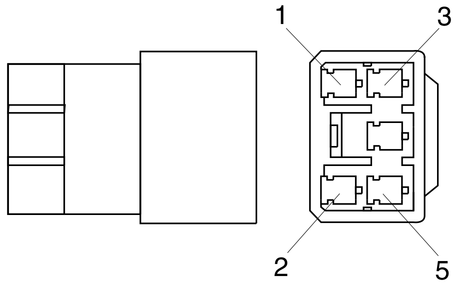
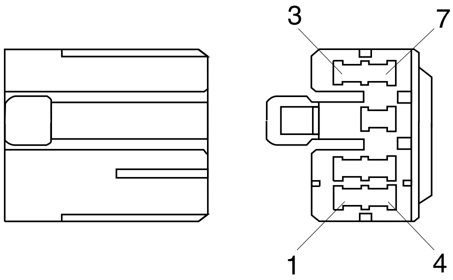
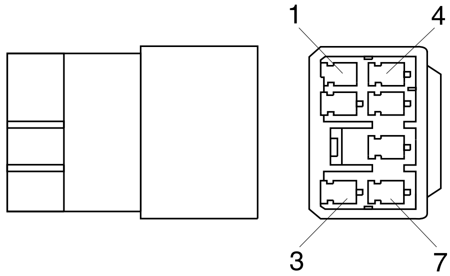
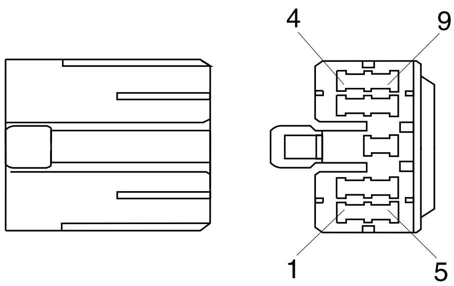
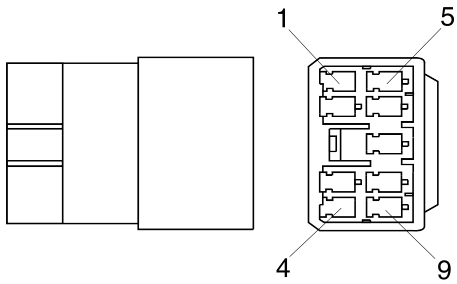
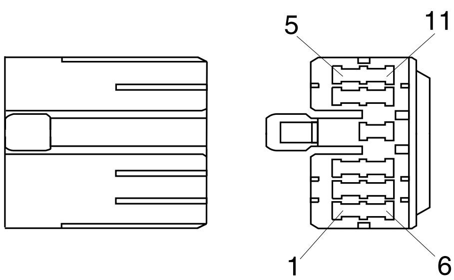
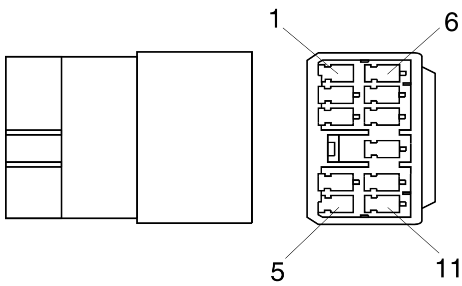
Connector number	Type	No. of pin	Destination	Connector part No.	
				Female	Male
CR-54	AMP	-	Brake switch relay	VCFM-1002	-
CR-55	HELLA	5	Rear work lamp relay	8JA003526-001	-
CR-56	AMP	-	Auto park relay	VCFM-1002	-
CR-58	HELLA	5	DEF supply module relay	8JA003526-001	-
CR-59	HELLA	5	DEF sensor relay	8JA003526-001	-
Sensor and pressure switch					
CD-2	KET	3	Fuel sender	MG610045	-
CD-3	DEUTSCH	3	Accumulator fail switch	DT06-3S	-
CD-4	AMP	1	Brake switch	171809-2	-
CD-6	DEUTSCH	4	G-sensor	DT06-4S	-
CD-10	KET	1	Air cleaner switch	ST730057-2	-
CD-12	DEUTSCH	3	Angle sensor	DT06-3S	DT04-3P
CD-26	DEUTSCH	3	Parking pressure switch	DT06-3S	-
CD-27	AMP	2	Turbine speed pick-up	963040-2	-
CD-35	DEUTSCH	2	Water in fuel switch	DT06-2S	-
CD-50	DEUTSCH	3	Load sensor	DT06-3S	DT04-3P
CD-71	AMP	6	Inching sensor	1-967616-1	-
CD-72	AMP	2	Internal speed pick-up	963040-3	-
CD-73	AMP	3	Output speed sensor	282087-1	-
CD-74	AMP	2	Engine speed pick-up	963040-3	-
CD-75	AMP	2	Filter switch	282080-1	-
CD-76	AMP	2	Air temp sensor	963040-3	-
CD-87	KET	2	Ambient temp sensor	MG610320	-
CD-96	PACKARD	3	Coolant level sensor	12110293	-
CD-101	SUMITOMO	4	TBAP sensor	-	54200415
CD-102	SUMITOMO	4	Engine TBAP sensor (Temp. Barometric Absolute Pressure)	6098-0144	-
Diode					
DO-1	AMP	2	Diode	174352-2	21EA-50550
DO-2	AMP	2	Diode	174352-2	21EA-50550
DO-3	AMP	2	Diode	174352-2	21EA-50550
DO-4	AMP	2	Diode	174352-2	21EA-50550
DO-5	AMP	2	Diode	174352-2	21EA-50550
Resistor					
RS-1	KET	2	Resistor (300 Ω)	MG610043	21FT-10810
RS-2	KET	2	Resistor (120 Ω)	MG610043	21FH-15030

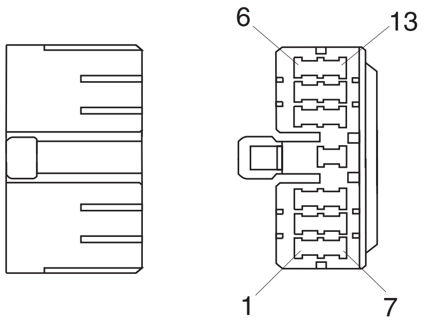
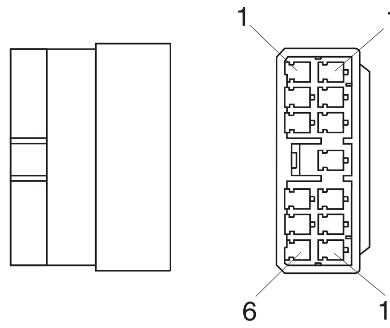
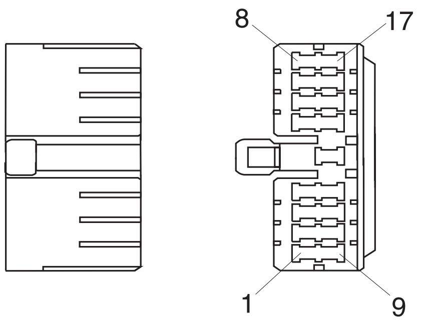
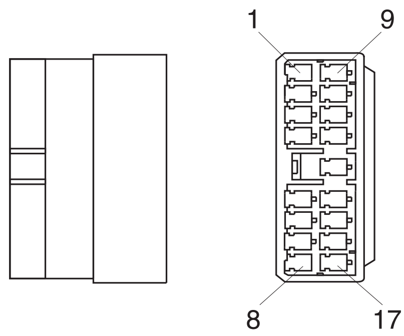
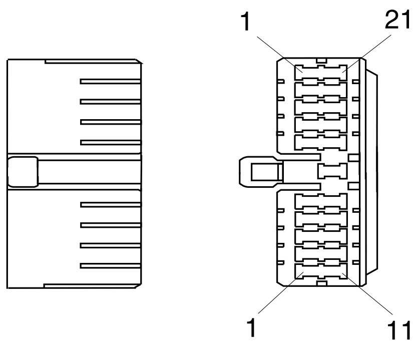
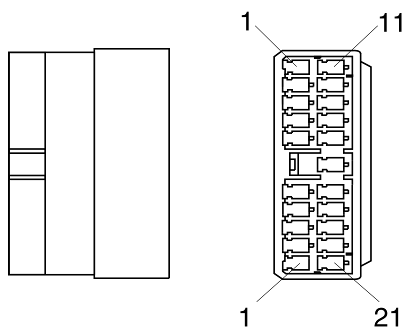
2. CONNECTION TABLE FOR CONNECTORS

1) 58-L TYPE CONNECTOR

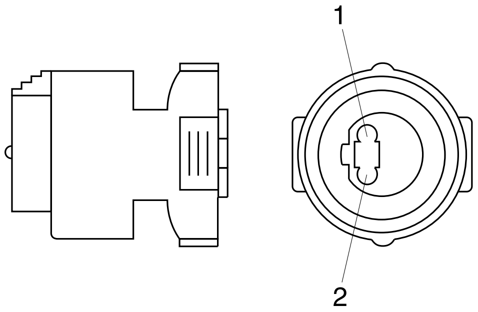
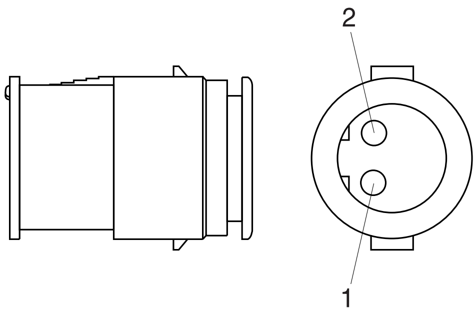
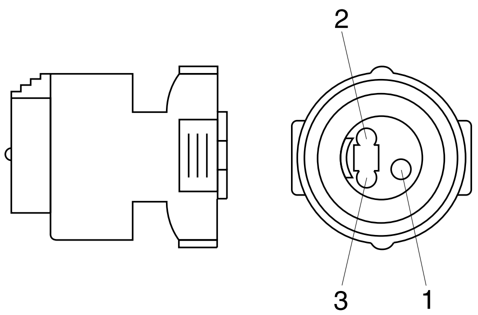
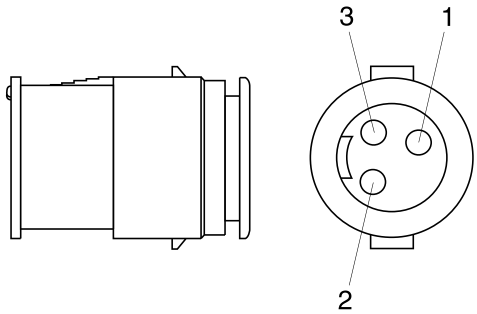
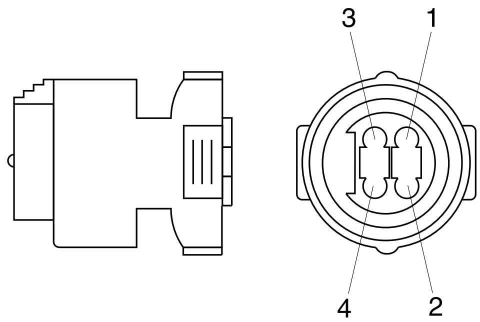
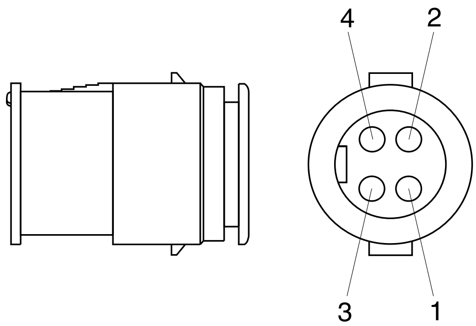
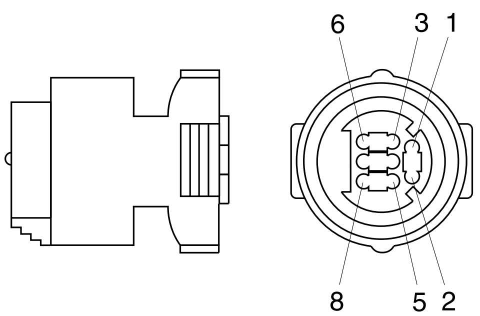
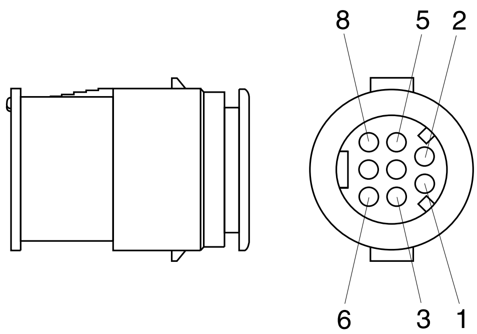
No. of pin	Receptacle connector (Female)	Plug connector (Male)
1	 S813-030100	 S813-130100
2	 S813-030200	 S813-130200

2) PA TYPE CONNECTOR

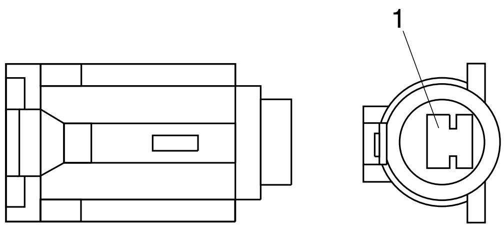
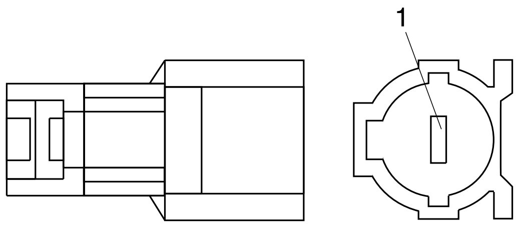
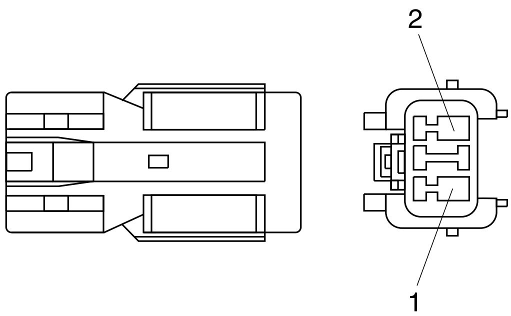
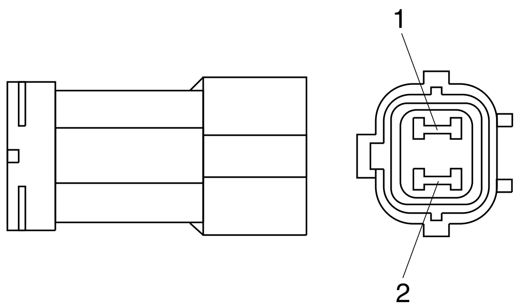
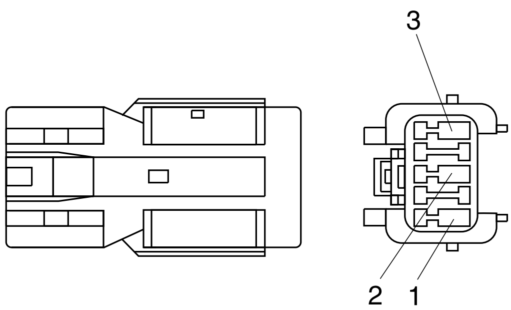
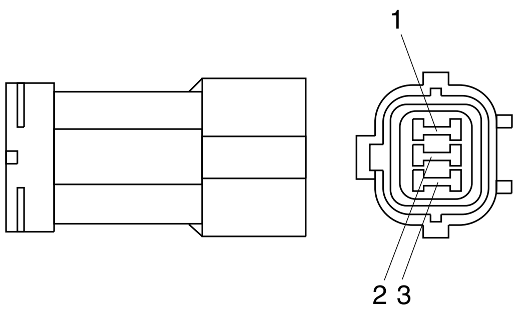
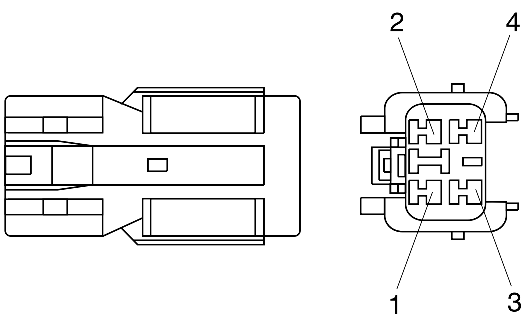
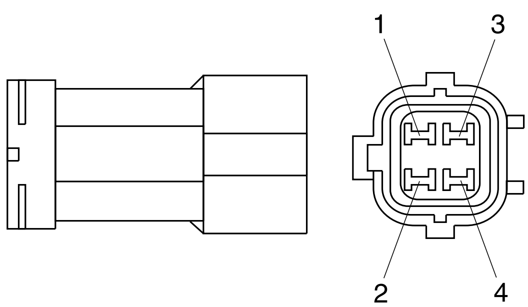
No. of pin	Receptacle connector (Female)	Plug connector (Male)
5	 S811-005002	 S811-105002
7	 S811-007002	 S811-107002
9	 S811-009002	 S811-109002
11	 S811-011002	 S811-111002

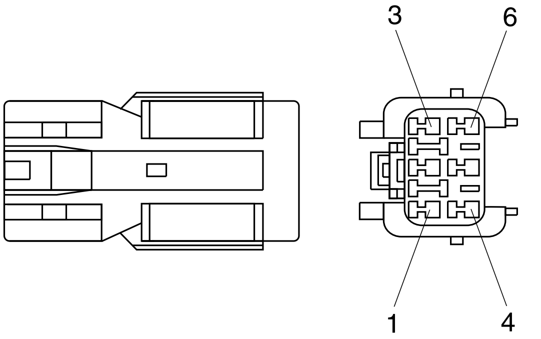
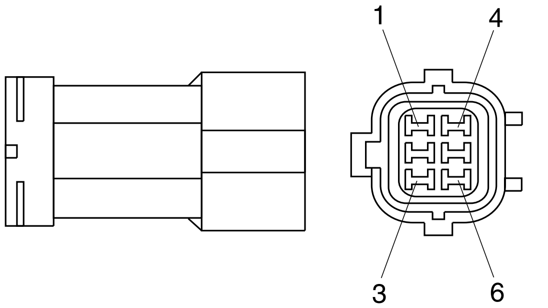
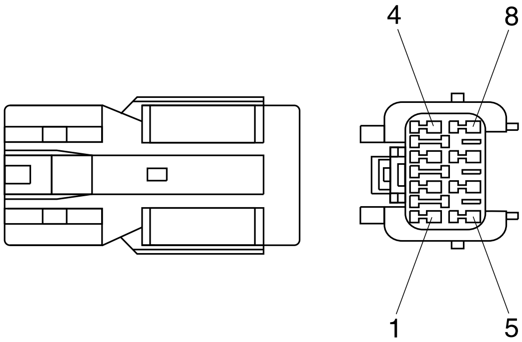
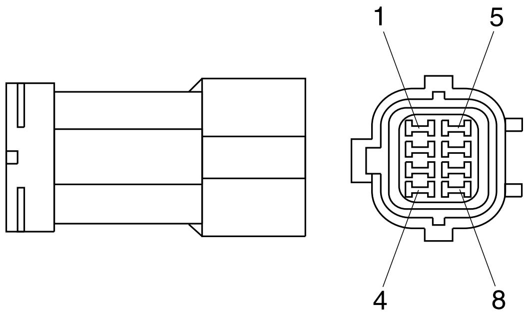
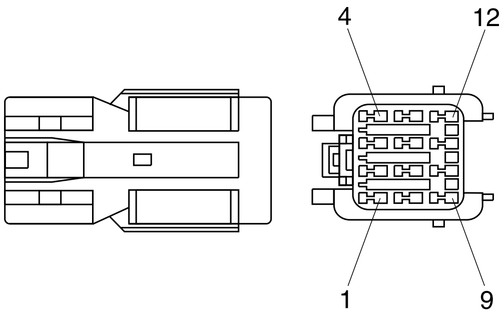
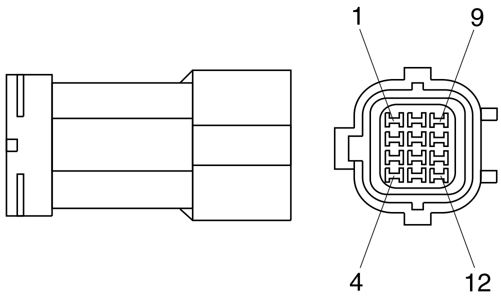
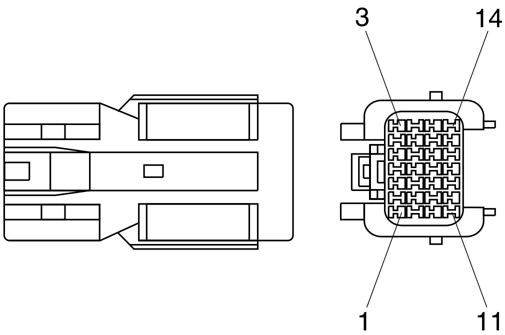
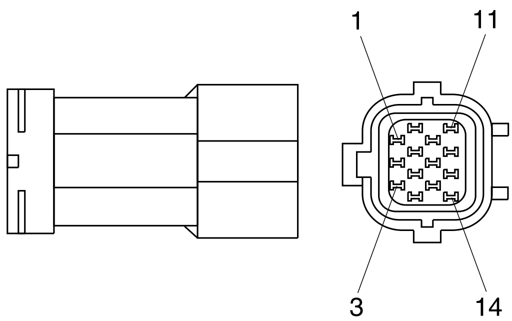
No. of pin	Receptacle connector (Female)	Plug connector (Male)
13	 S811-013002	 S811-113002
17	 S811-017002	 S811-117002
21	 S811-021002	 S811-121002

3) J TYPE CONNECTOR

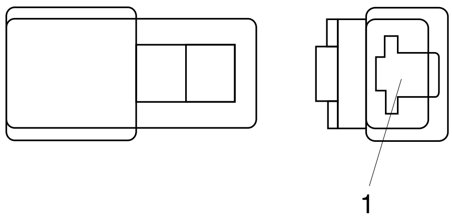
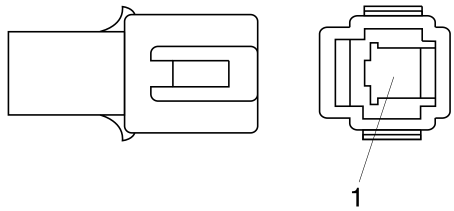
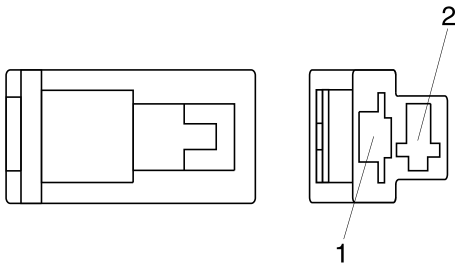
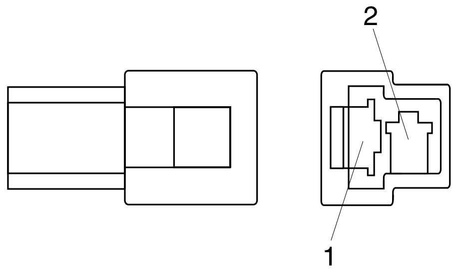
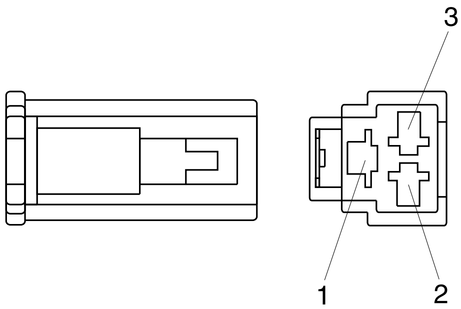
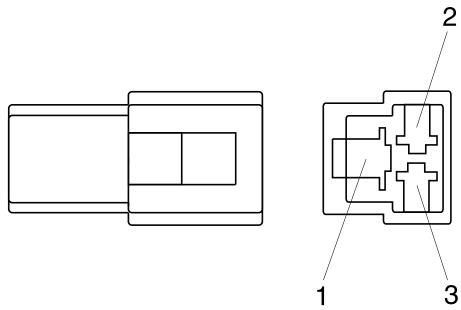
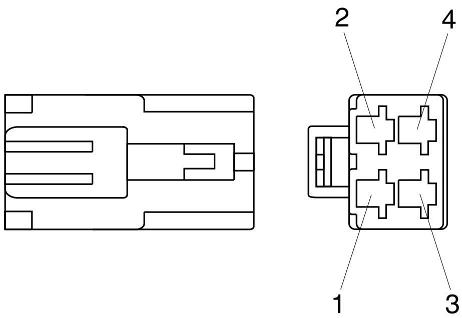
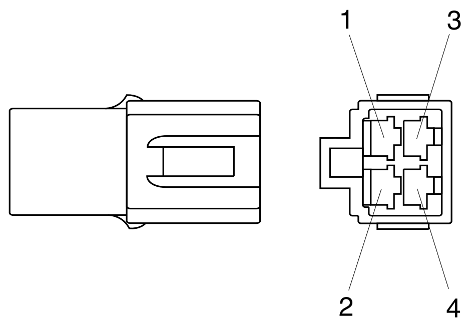
No. of pin	Receptacle connector (Female)	Plug connector (Male)
2	 S816-002001	 S816-102001
3	 S816-003001	 S816-103001
4	 S816-004001	 S816-104001
8	 S816-008001	 S816-108001

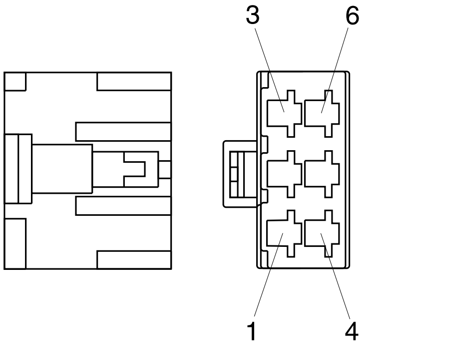
4) SWP TYPE CONNECTOR

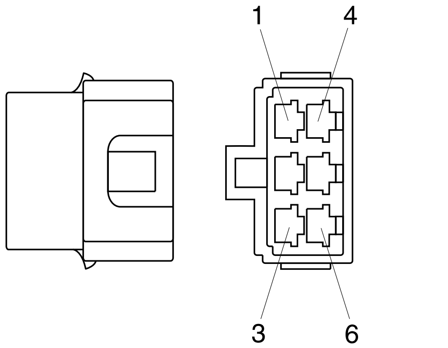
No. of pin	Receptacle connector (Female)	Plug connector (Male)
1	 S814-001000	 S814-101000
2	 S814-002000	 S814-102000
3	 S814-003000	 S814-103000
4	 S814-004000	 S814-104000

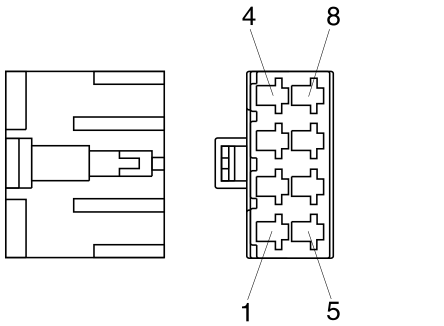
No. of pin	Receptacle connector (Female)	Plug connector (Male)
6	 S814-006000	 S814-106000
8	 S814-008000	 S814-108000
12	 S814-012000	 S814-112000
14	 S814-014000	 S814-114000

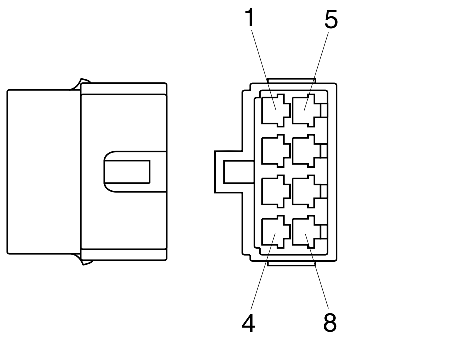
5) CN TYPE CONNECTOR

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

<table>
<tr><th>No. of pin</th><th>Receptacle connector (Female)</th><th>Plug connector (Male)</th></tr>
<tr><td>6</td><td>


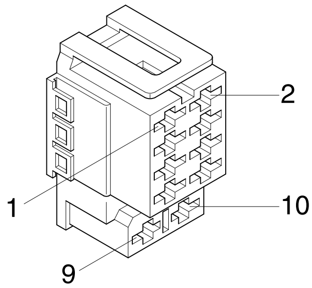
S810-006202</td><td>


S810-106202</td></tr>
<tr><td>8</td><td>


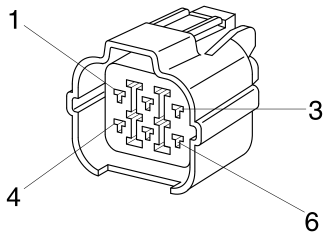
S810-008202</td><td>


S810-108202</td></tr>
</table>

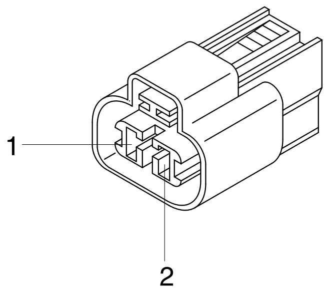
6) ITT SWF CONNECTOR

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	

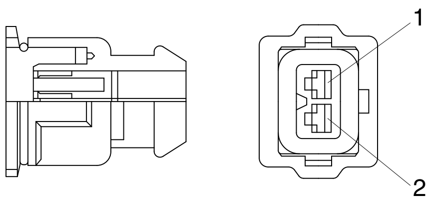
8) MWP02F-B CONNECTOR

No. of pin	Receptacle connector (Female)	Plug connector (Male)
2	 PH805-02028	

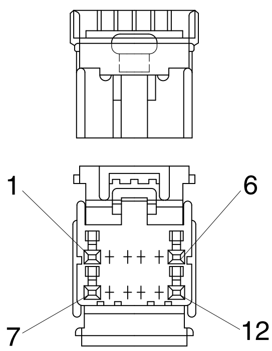
9) AMP ECONOSEAL CONNECTOR

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

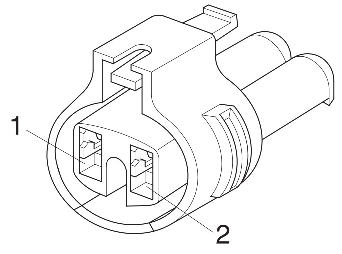
10) AMP TIMER CONNECTOR

No. of pin	Receptacle connector(Female)	Plug connector(Male)
2	 85202-1	

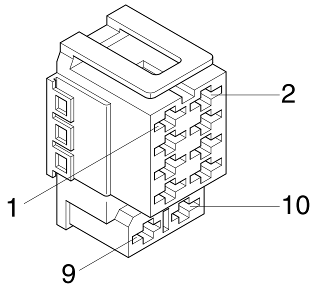
11) AMP 040 MULTILOCK CONNECTOR

No. of pin	Receptacle connector(Female)	Plug connector(Male)
12	 174045-2	

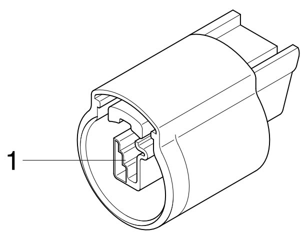
12) KET 090 WP CONNECTORS

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	

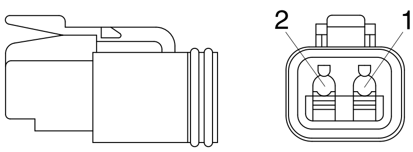
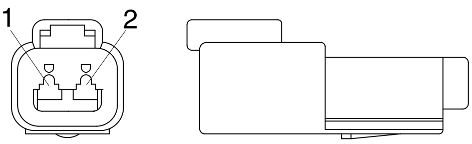
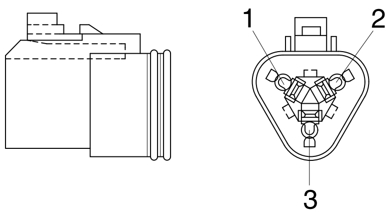
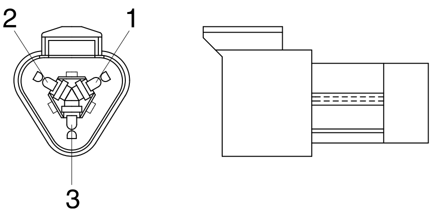
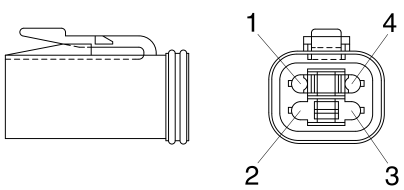
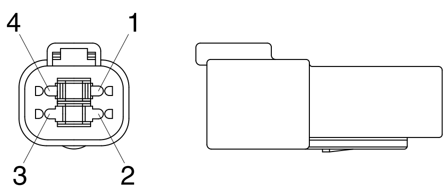
15) DEUTSCH DT CONNECTORS

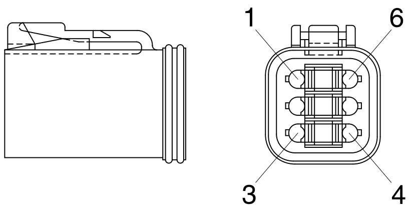
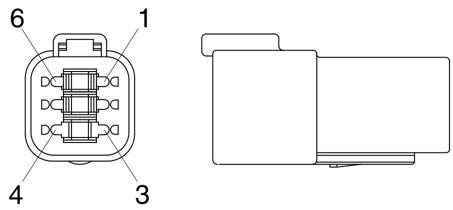
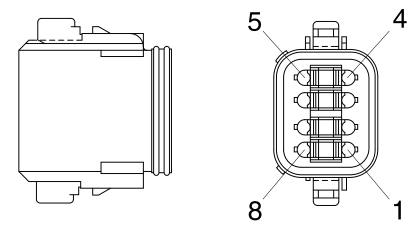
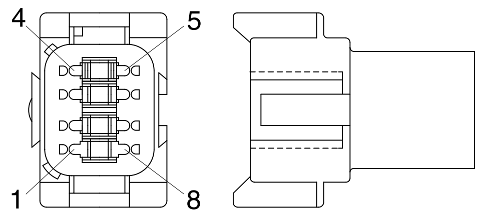
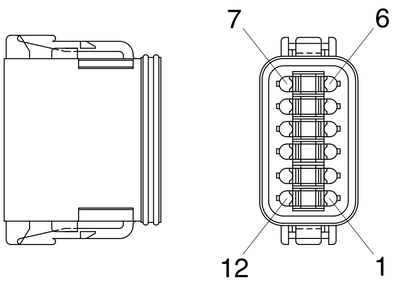
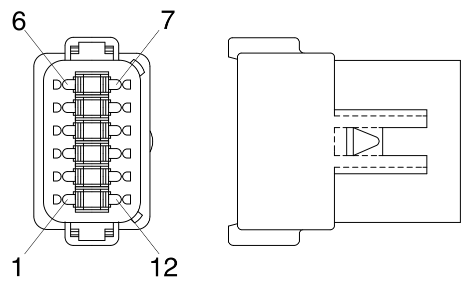
DT 06 - 3S - ★★★★

- ★★★★ : Modifications (See below)
- 3S : Number of contacts (P : Pin, S : Socket)
- 06 : 04 : Receptacle, 06 : Plug
- DT : Deutsch connectors

※ 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

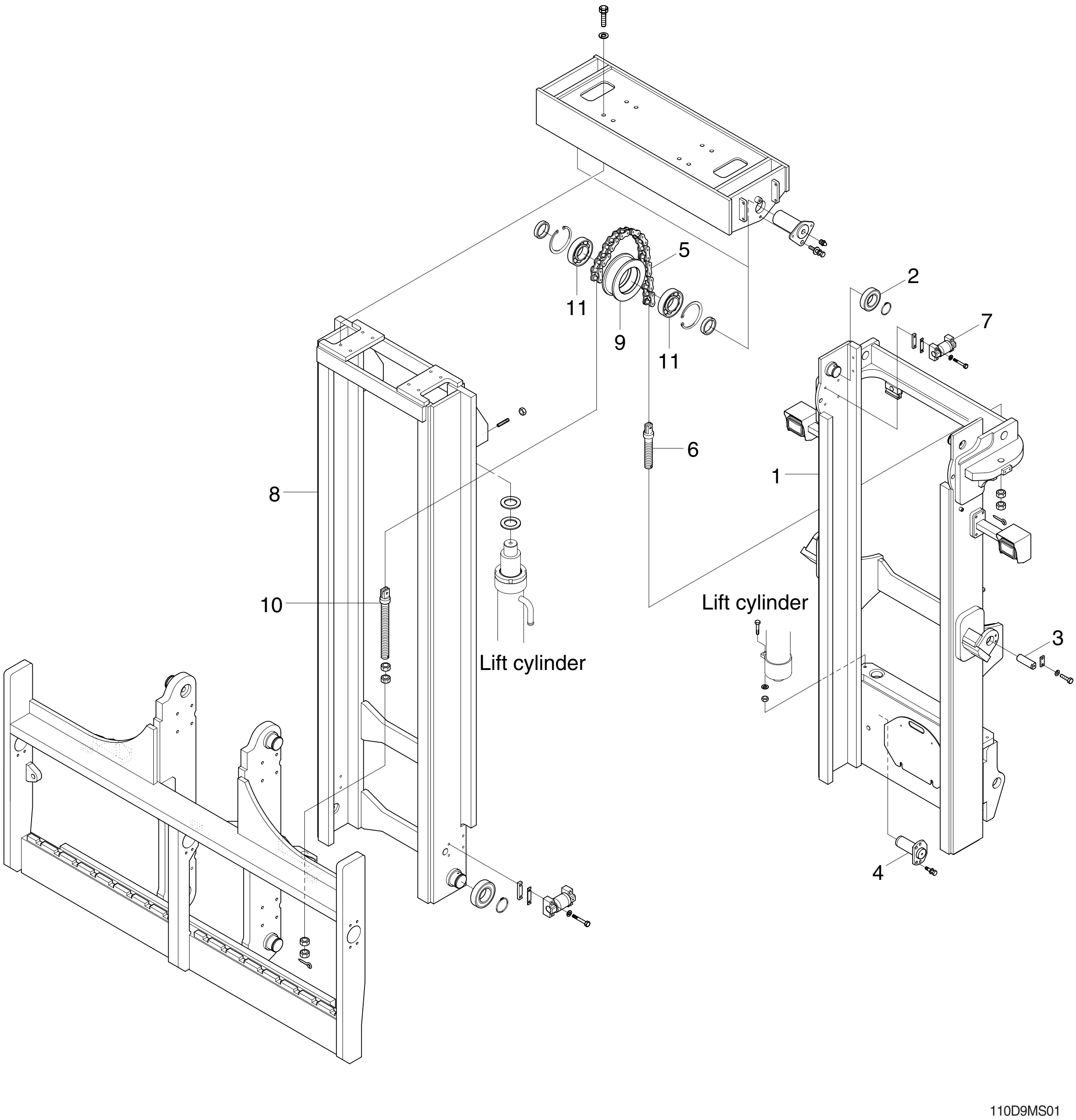
GROUP 8 TROUBLESHOOTING

Trouble symptom	Probable cause	Remedy
Lamps dimming even at maximum engine speed.	· Faulty wiring.	· Check for loose terminal and disconnected wire.
Lamps flicker during engine operation.	· Improper belt tension.	· Adjust belt tension.
Charge lamp does not light during normal engine oper.	· Charge lamp defective. · Faulty wiring.	· Replace. · Check and repair.
Alternator makes abnormal sounds.	· Alternator defective.	· Replace
Starting motor fails to run.	· Faulty wiring. · Insufficient battery voltage.	· Check and repair. · Recharge battery.
Starting motor pinion repeats going in and out.	· Insufficient battery voltage.	· Recharge battery.
Excessively low starting motor speed.	· Insufficient battery voltage. · Starting motor defective.	· Recharge battery. · Replace
Starting motor comes to a stop before engine starts up.	· Faulty wiring. · Insufficient battery voltage.	· Check and repair. · Recharge battery.
Heater signal does not become red.	· Faulty wiring. · Glow plug damaged.	· Check and repair. · Replace
Engine oil pressure caution lamp does not light when engine is stopped (with starting switch left in"ON" position).	· Caution lamp defective. · Caution lamp switch defective.	· Replace · Replace

SECTION 8 MAST

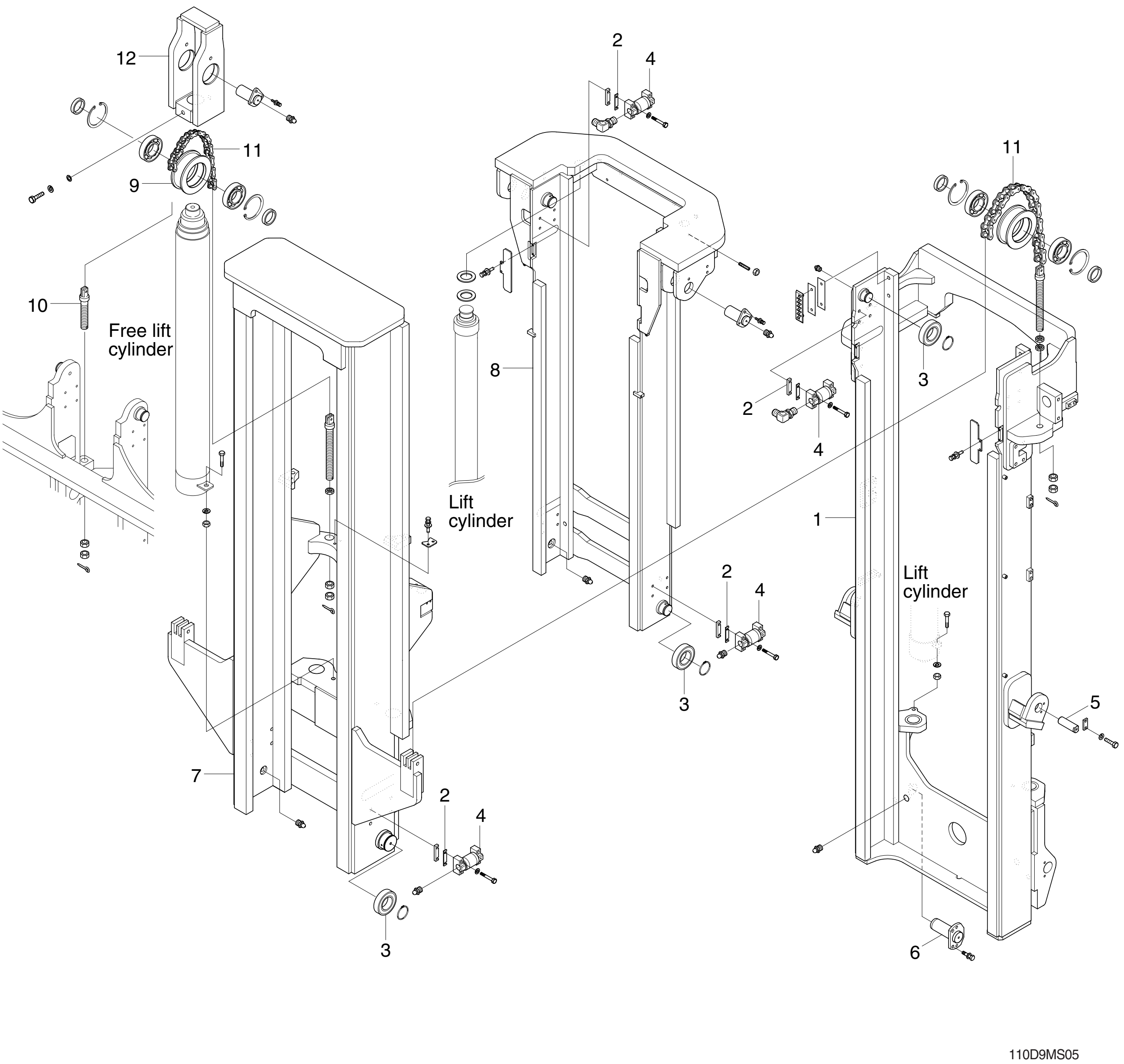
GROUP 1 STRUCTURE

1. 2 STAGE MAST (V MAST)



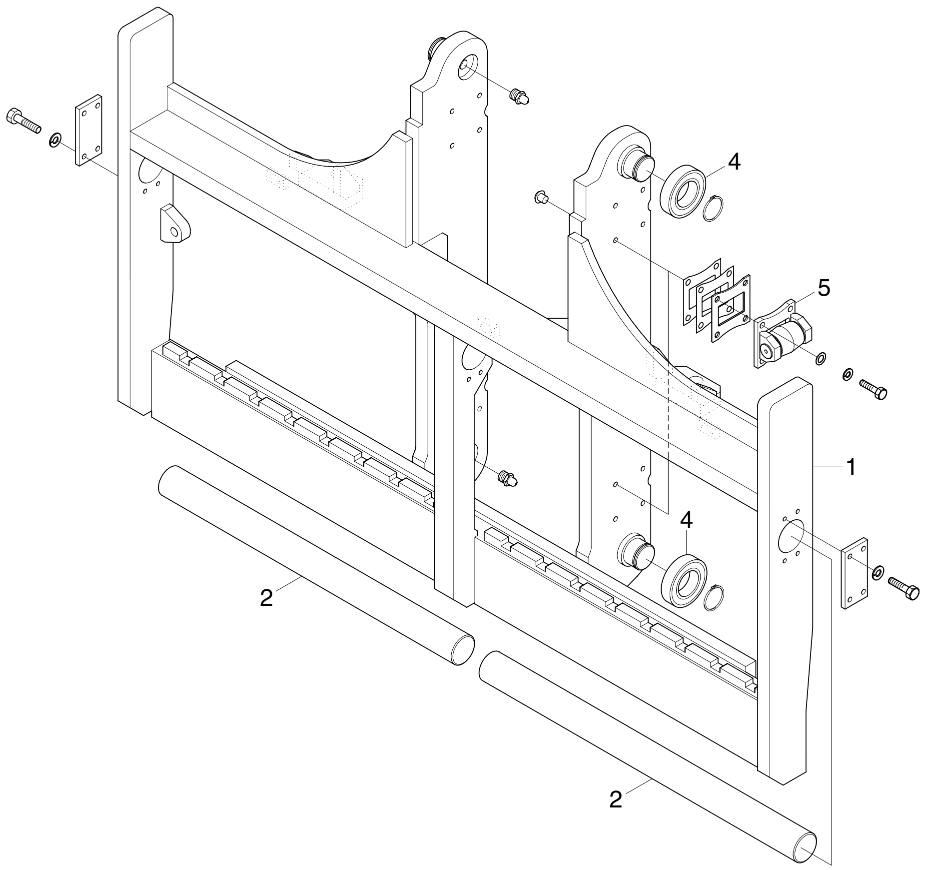
1	Outer mast	5	Lift chain	9	Chain sheave bearing
2	Roller bearing	6	Anchor bolt	10	Anchor bolt
3	Tilt cylinder pin	7	Side roller bearing	11	Roller bearing
4	Mast mounting pin	8	Inner mast		

2. 3 STAGE MAST (TS MAST)

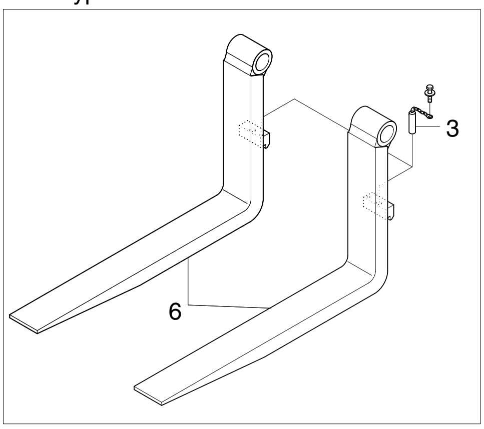


1	Outer mast	5	Tilt cylinder pin	9	Sheave
2	Shim	6	Mast mounting pin	10	Anchor bolt
3	Roller bearing	7	Inner mast	11	Chain
4	Side roller bearing	8	Middle mast	12	Sheave bracket

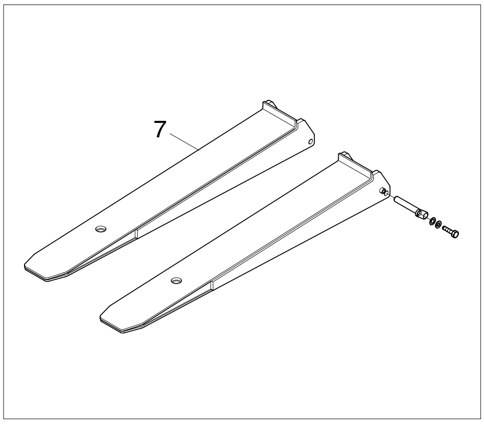
3. CARRIAGE, BACKREST AND FORK (SHAFT TYPE)



Shaft type fork



Extension fork



110D9MS02

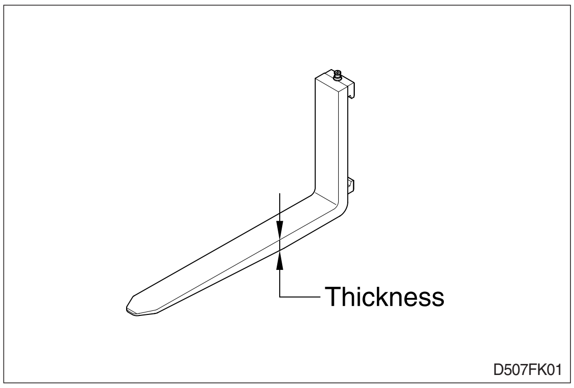
1	Carriage & backrest	5	Side roller
2	Hanger bar	6	Fork
3	Fork retaining	7	Extension fork
4	Roller		

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

1. OPERATIONAL CHECKS

1) FORKS

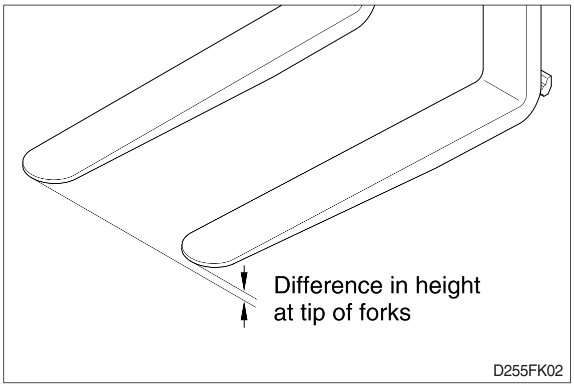
(1) Measure thickness of root of forks and check that it is more than specified value.
EX : l =1800 mm (71 in)



mm (in)

STD Fork assy	Applicable model	Standard	Limit
61FT-70342	110D-9	75(3.0)	68(2.7)
61FT-71440	130D-9	90(3.5)	80(3.2)
61FT-70143	160D-9	95(3.7)	85(3.3)

2) Set forks in middle and measure out of parallel and difference in height at the top of forks.



Model	Fork length (mm)	Height difference (mm)
110D-9 130D-9 160D-9	below 1500	3
	equal or above 1500	6

3) Most force is concentrated at root of fork and at hook, so use crack detection method to check cracks.

2. MAST

1) Check for cracks at mast stay, tilt cylinder bracket, guide bar, fork carriage and roller shaft weld. Check visually or use crack detection method. Repair any abnormality.
2) Set mast vertical, raise forks about 10cm from ground and check front-to-rear clearance and left-to-right clearance between inner mast and fork carriage, and between outer mast and inner mast. Use these figures to judge if there is any play at roller or rail.
   · Front-to-rear clearance : Within 2.0 mm (0.08 in)
   · Left-to-right clearance : Within 2.5 mm (0.10 in)
3) Check that there is an oil groove in bushing at mast support.
4) Set mast vertical, raise forks about 10cm from ground, and push center of lift chain with finger to check for difference in tension.
   If there is any difference in tension, adjust chain stopper bolt.
5) Check visually for abnormalities at thread of chain anchor bolt, and at contact surface between chain wheel and chain.
   Rotate chain wheel by hand and check for any play of bearing.

2. TROUBLESHOOTING

1) MAST

Problem	Cause	Remedy
Forks fail to lower.	· Deformed mast or carriage.	· Disassemble, repair or replace.
Fork fails to elevate.	· Faulty hydraulic equipment. · Deformed mast assembly.	· See troubleshooting hydraulic pump and cylinders in section 6, hydraulic system. · Disassemble mast and replace damaged parts or replace complete mast assembly.
Slow lifting speed and insufficient handling capacity.	· Faulty hydraulic equipment. · Deformed mast assembly.	· See troubleshooting hydraulic pump and Cylinders in section 6, hydraulic system. · Disassemble mast and replace damaged parts or replace complete mast assembly.
Mast fails to lift smoothly.	· Deformed masts or carriage. · Faulty hydraulic equipment. · Damaged load and side rollers. · Unequal chain tension between LH & RH sides. · LH & RH mast inclination angles are unequal. (Mast assembly is twisted when tilted)	· Disassembly, repair or replace. · See Troubleshooting Hydraulic Cylinders pump and control valve in section 6, hydraulic system. · Replace. · Adjust chains. · Adjust tilt cylinder rods.
Abnormal noise is produced when mast is lifted and lower-ed.	· Broken load roller bearings. · Broken side roller bearings. · Deformed masts. · Bent lift cylinder rod. · Deformed carriage. · Broken sheave bearing.	· Replace. · Replace. · Disassemble, repair or replace. · Replace. · Replace. · Replace.
Abnormal noise is produced during tilting operation.	· Insufficient lubrication of anchor pin, or worn bushing and pin. · Bent tilt cylinder rod.	· Lubricate or replace. · Replace.

2) FORKS

Problem	Cause	Remedy
Abrasion	Long-time operations causes the fork to wear and reduces the thickness of the fork. Inspection for thickness is needed. · Wear limit : Must be 90% of fork thickness	If the measured value is below the wear limit, replace fork.
Distortion	Forks are bent out of shape by a number of reasons such as overloading, glancing blows against walls and objects, and picking up load unevenly. · Difference in fork tip height : 15 mm · Difference in fork tip width : 35 mm	If the measured value exceeds the allowance, replace fork.
Fatigue	Fatigue failure may result from the fatigue crack even though the stress to fork is below the static strength of the fork. Therefore, a daily inspection should be done. · Crack on the fork heel. · Crack on the fork weldments.	Repair fork by expert. In case of excessive distortion, replace fork.

GROUP 3 ADJUSTMENT

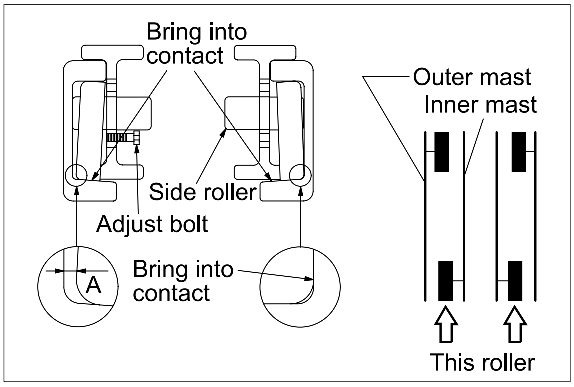
1. MAST LOAD ROLLER

1) INNER/OUTER MAST ROLLER CLEARANCE ADJUSTMENT

(1) Measure the clearance with the mast overlap at near 480 mm (19 in).

(2) Shift the inner mast to one side to bring the roller into contact with the outer mast, and adjust the clearance between the roller side face and mast at the closest position on the opposite side to the following value by adjust bolt.

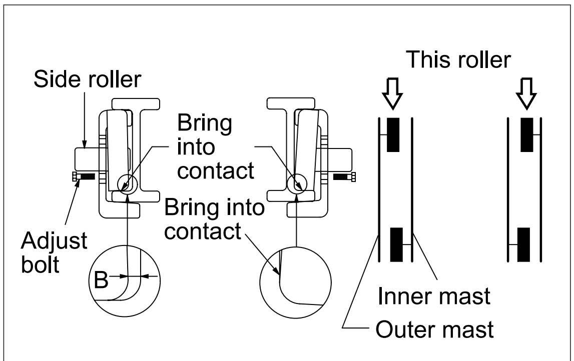
- Standard clearance A, B = 0~0.6 mm



D503MS04

(3) Distribute the roller clearance equally to the left and right roller.

(4) After the adjustment, check that the inner mast moves smoothly in the outer mast.



D503MS05

2) CARRIAGE LOAD ROLLER

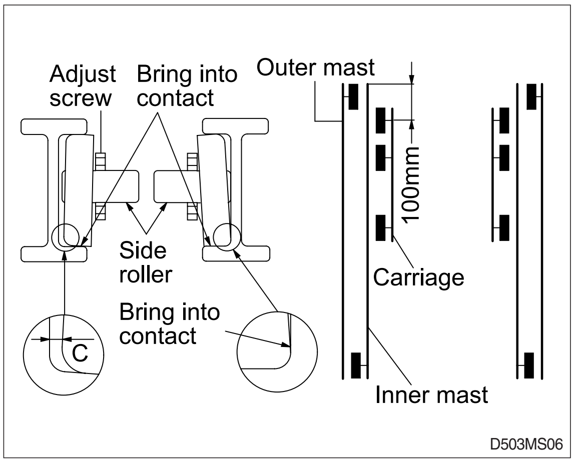
(1) Measure the clearance when the center of the carriage upper roller is 100 mm from the top of the inner mast.

(2) Measure the clearance at upper, middle and lower rollers after loosen the adjust screws from the side rollers. Shift the carriage to one side to bring the roller into contact with the inner mast, and measure the clearance between the roller side face and mast at the closest position on the opposite side to the following value by adjust screw.

· Standard clearance C = 0~0.6 mm

(3) Distribute the roller clearance equally to the left and right roller.

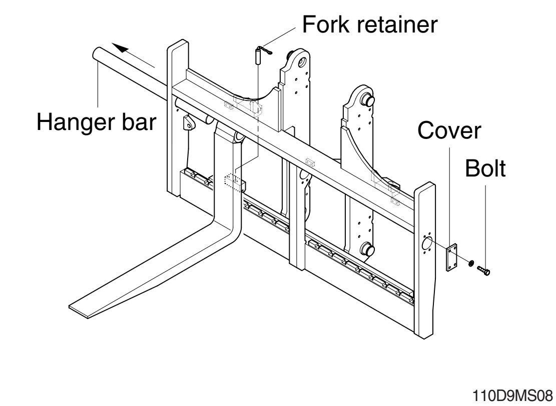
(4) After the adjustment, the carriage should move smoothly along the overall mast length.



GROUP 4 REMOVAL AND INSTALLATION

1. FORKS (SHAFT TYPE)

(1) Lower the fork carriage until the forks are approximately 25 mm (1 in) from the floor.
(2) Release fork anchor pins and slide one fork at a time toward the center of the carriage where a notch has been cut in the bottom plate for easy fork removal.
(3) Remove only one fork at a time.
※ On larger forks it may be necessary to use a block of wood.
(4) Reverse the above procedure to install load forks.

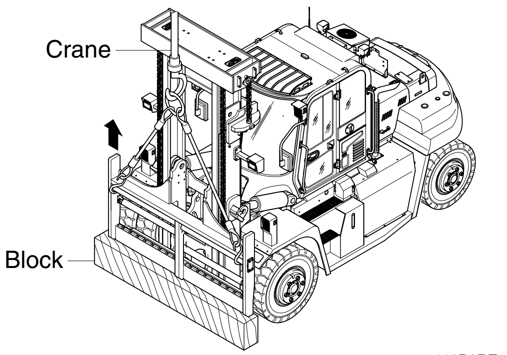


110D9MS08

2. CARRIAGE ASSEMBLY

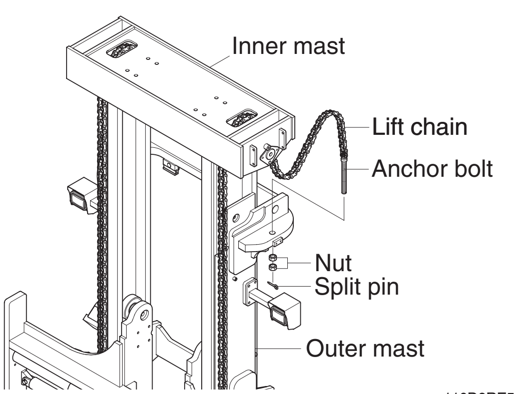
1) CARRIAGE

(1) With the mast vertical, raise the carriage high enough to place blocks under the load forks. This is done to create slack in the load chains when the carriage is lowered. Lower the carriage all the way down to the floor. Make sure the carriage is level, this will prevent any binding when the mast is raised.



110D9RE53

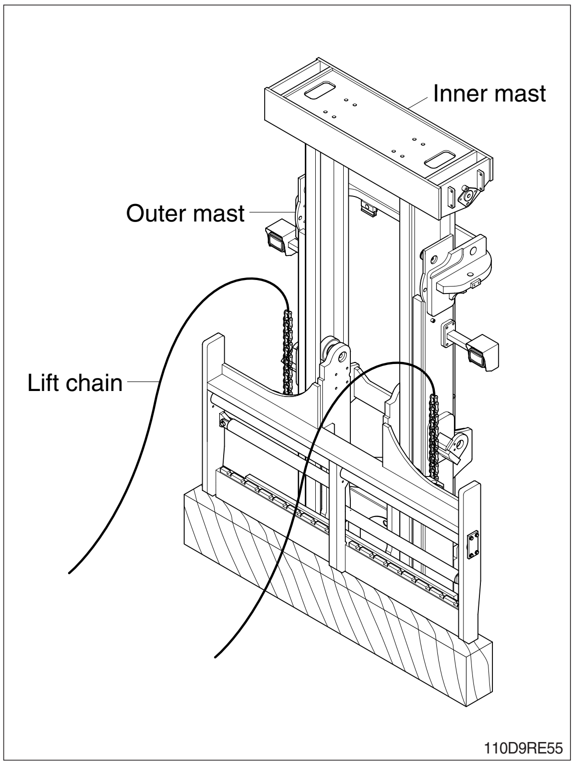
(2) While supporting lift chains, remove the split pin and slide out chain anchor pins from the chain anchors of stationary upright.



110D9RE54

(3) Pull the chains out of the sheaves and drape them over the front of the carriage.

(4) Disconnect connector from the work lamp assy.

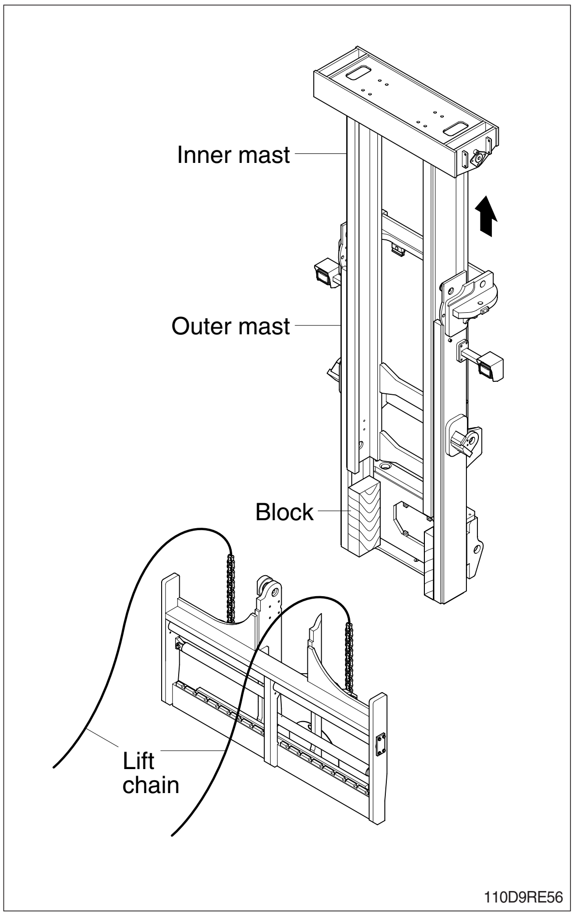


(5) Slowly raise inner mast upright until mast clears top of fork carriage. Move carriage to work area and lower mast.

⚠ **Make sure that carriage remains on floor and does not bind while mast is being raised.**

※ Inspect all parts for wear or damage. Replace all worn or damaged parts.

※ Reverse the above steps to reinstall.

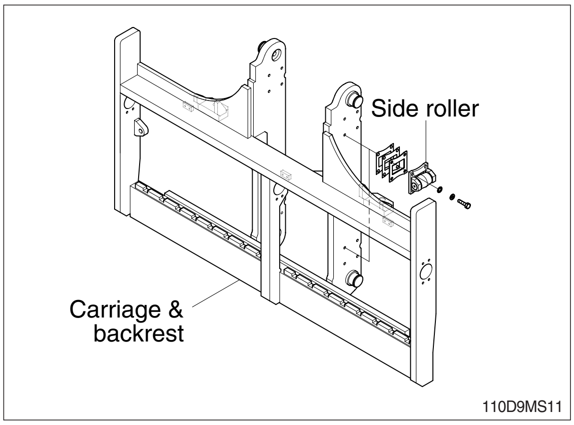


2) SIDE ROLLER

(1) Remove carriage as outlined in the carriage removal paragraph.
(2) Loosen and remove nuts, adjust screws and side rollers from carriage side plate.
(3) Thoroughly clean, inspect and replace all worn or damaged parts.
(4) Reverse the above procedure to assembly.

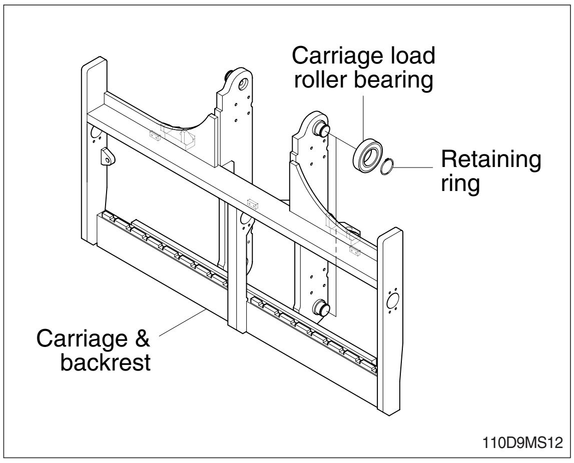
※ Adjustment

- Once carriage is properly installed, loosen nuts and adjust screws, (if not already done) allowing carriage to be centered in the inner mast.
- Adjust side roller by tightening screw until side roller just makes contact with mast. Back off approximately 1/10 turn on screw and tighten nut to lock screw in place.
- Run carriage up and down along the inner mast to be sure the carriage has free movement and does not stick. Also, make sure chains are properly adjusted. Refer to chain adjustment paragraph. Make adjustment when necessary and recheck operation of carriage.



3) CARRIAGE LOAD ROLLER BEARING

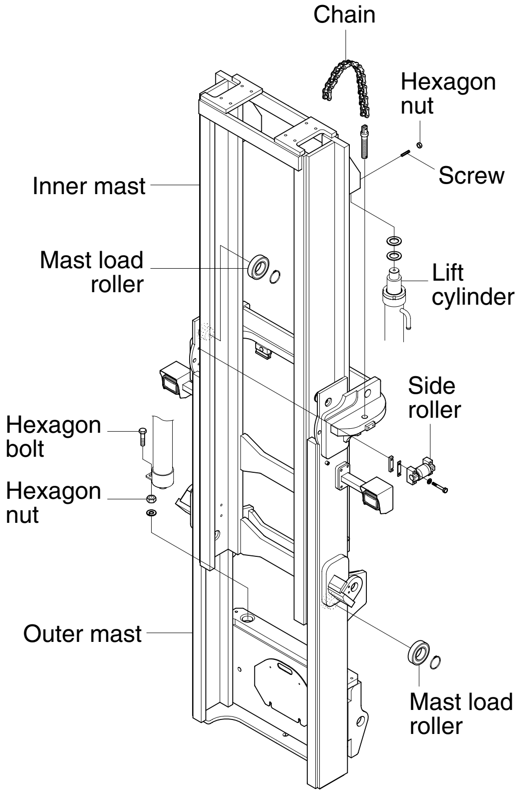
(1) Remove carriage as outlined in the carriage removal paragraph.
(2) Using the plier, remove retaining rings from load roller bearing bracket.
(3) Using a plier, remove load roller bearings from load roller bearing bracket.
(4) Reverse the above procedure to assemble. Refer to MAST ROLLER ADJUSTMENT paragraph.



4. MAST LOAD ROLLER

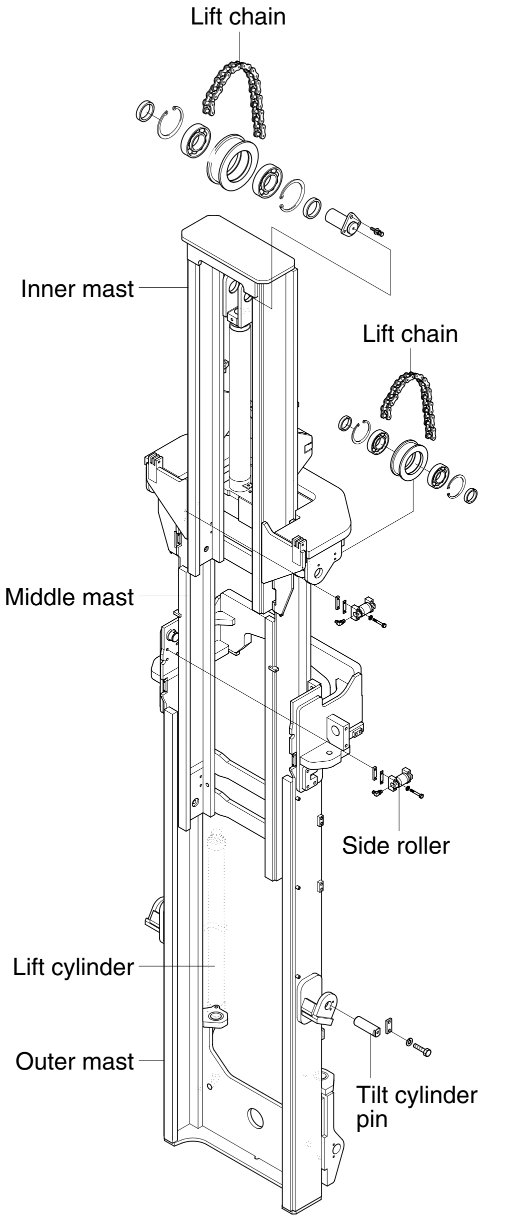
1) 2 STAGE MAST (V MAST)

(1) Remove the carriage assembly and move them to one side.
(2) Loosen and remove hexagon nuts and screws securing lift cylinders to inner mast.
(3) Loosen and remove hexagon bolts and nuts securing lift cylinders to outer mast.
(4) Attach chains or sling to the inner mast section at top crossmember. Using an overhead hoist, slowly raise the inner mast high enough to clear lift cylinder.
(5) After lowering the lift cylinder rods, and disconnecting lift cylinder hose, tilt the lift cylinders (LH and RH) with ropes to the outer mast.
(6) Using the overhead hoist, lower inner mast until top and bottom rollers are exposed.
(7) Using a plier, remove load rollers from load roller bracket. Remove side rollers.
(8) Thoroughly clean, inspect and replace all worn or damaged parts.
(9) Reverse the above procedure to assemble.
Refer to MAST ROLLER ADJUSTMENT
(10) paragraph.
After completing all necessary steps for load rollers removal, use an overhead hoist to remove sling or chain around upper crossmember of the inner mast section.
(11) Lift inner mast upright straight up and out of outer mast section.
(12) Replace and reverse above procedure to install.
Make all necessary measurements and adjustments.



2) 3 STAGE MAST(TF MAST)

(1) Remove the carriage assembly and move it to one side.
(2) Loosen and remove hexagon bolt securing bottom cylinder from outer mast.
(3) Loosen and remove set screws and nuts securing lift cylinders to middle mast.
(4) Attach chains or sling to the inner and middle mast section at top crossmember. Using an overhead hoist, slowly raise the uprights high enough to clear lift cylinder.
(5) After lowering the lift cylinder rods, and disconnecting lift cylinder hose, tilt the lift cylinders LH and RH and tie them with ropes to the outer mast.
(6) Using the overhead hoist raise inner and middle masts. Place 4inch block of wood under the free lift cylinder bracket of the inner mast then lower mast sections (this will create slack in the chains).
(7) Remove retaining rings securing chain sheaves to sheave support brackets while supporting chains, remove chain sheaves and let chains hang free.
The upper outer and lower middle mast rollers and back up liners are now exposed.
(8) Using a plier, remove load rollers from load bracket. Remove side rollers from mast.
(9) Attach chains or sling to the middle mast section at top crossmember. Using an overhead hoist, slowly raise the middle mast until top and bottom rollers are exposed.
(10) Using a plier, remove load rollers from roller bracket.
(11) Thoroughly clean, inspect and replace all worn or damaged parts.
(12) Reverse the above procedure to assemble. Refer to MAST LOAD ROLLER ADJUSTMENT Paragraph.



5. CHAIN

1) CHAIN SHEAVE

(1) Place a sling around carriage and attach to an overhead hoist. Lift carriage high enough so that the tension on the chain over sheaves is relieved after the carriage is blocked. Position wooden blocks under the carriage and lower it.

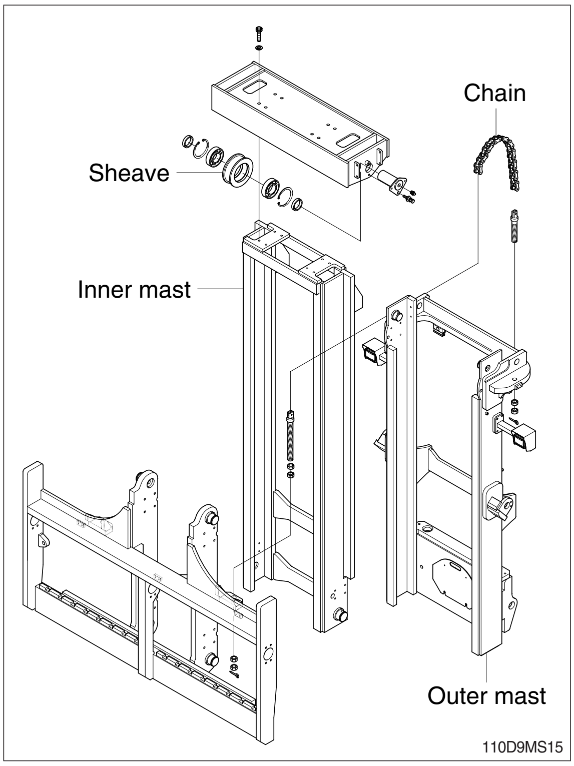
(2) Remove the split pin securing the chain anchor pins and discard. While supporting the chains, remove the chain anchor pins and drape the chain over the carriage.

(3) Remove retaining ring securing sheaves to sheave support. Remove sheaves with bearings.

(4) Remove bearing retaining ring from sheave and press bearings from sheaves.

(5) Thoroughly clean, inspect and replace all worn or damaged parts.

(6) Reverse the above to assemble and install. Use new split pins in chain anchor pins.



2) REAR CHAIN SHEAVE (TF MAST)

(1) Raise and securely block carriage and inner mast section.

(2) Remove the split pin securing the chain anchor pins and discard.

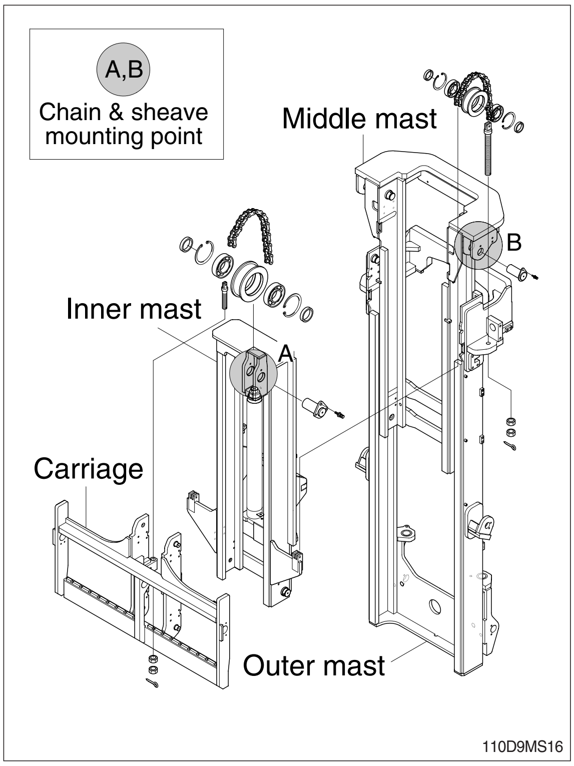
(3) Remove chains.

(4) Remove retaining ring securing chain sheaves to sheave support. Pry off sheaves with bearings.

(5) Remove bearing retaining ring from sheave and press bearings from sheaves.

(6) Thoroughly clean, inspect and replace all worn or damaged parts.

(7) Reverse the above procedure to assemble and install. Use new split pins in chain anchor pins.



3) SHEAVE SUPPORT (TF MAST)

(1) Remove the carriage assembly and move to one side.

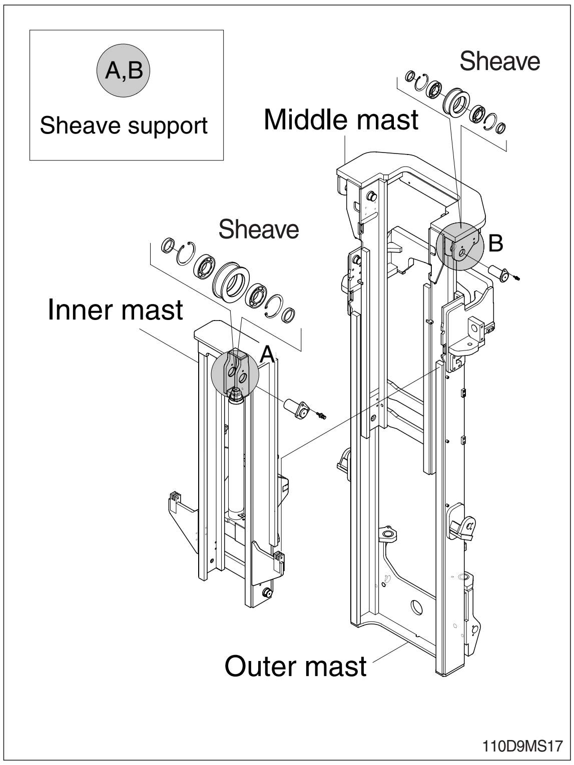
(2) After removing bolt to securing sheave support assembly to free lift cylinder.
Attach a sling to the sheave support assembly. Using an overhead hoist, lift support assembly straight up and off of free lift cylinder. Move assembly to work area.

(3) Remove retaining ring securing sheave to sheave support.

(4) Remove bearing retaining ring from sheave and press bearings from sheaves.

(5) Thoroughly clean, inspect and replace all worn or damaged parts.

(6) Reverse the above procedure to install.



4) REAR CHAIN (TF MAST)

(1) Remove the carriage assembly and move to one side. Refer to carriage removal and installation.

(2) Raise and securely block truck approximately 6 inches from the floor.

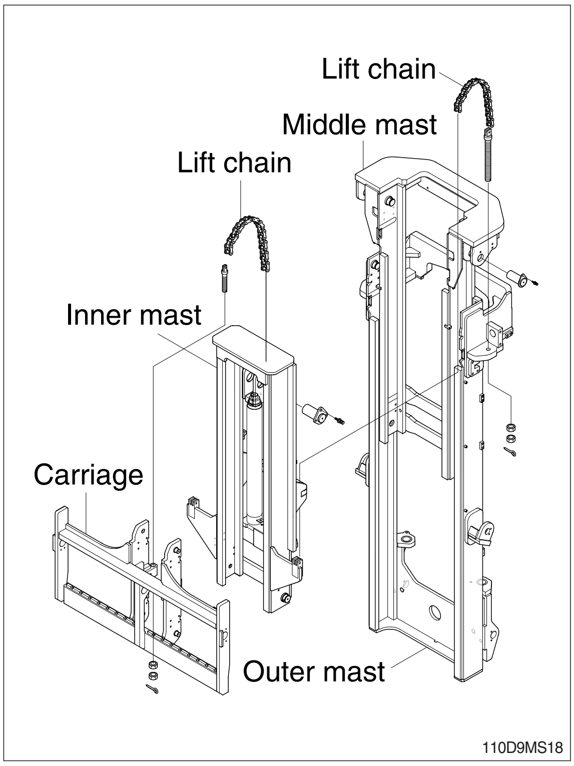
(3) Using a sling or chain around inner mast section attached to an overhead hoist, slowly raise inner mast until there is enough slack in the chains to remove them. Block inner mast section.

(4) Remove split pins and chain anchor pins securing chains to chain anchor (part of inner mast).

(5) While supporting the chains, remove split and chain anchor pins securing chains to chain anchors attached to outer mast section.

(6) Remove chains.

(7) Reverse the above to assemble and install. Use new split pins in chain anchor pins. Refer to this section for Load chain lubrication and adjustment.



5) CARRIAGE CHAIN

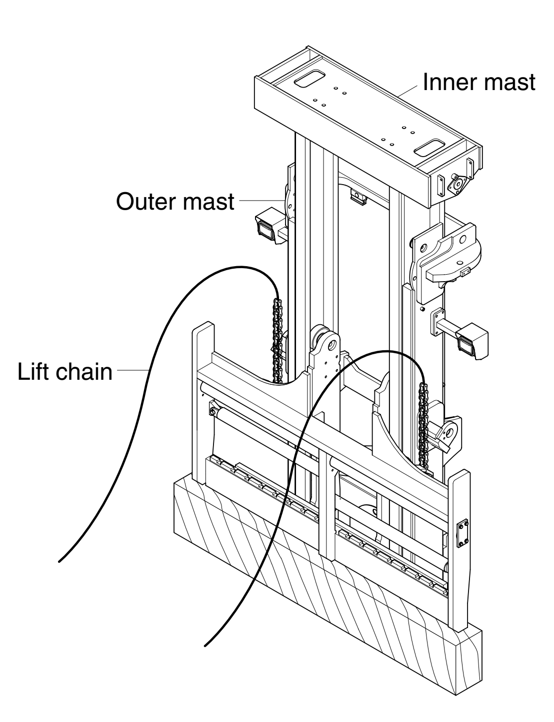
(1) Place a sling around carriage front plate and attach to an overhead hoist. Lift and secure carriage high enough so that split and chain anchor pins on carriage can be easily be removed. Remove chain anchor pins from carriage and drape chains out over carriage.

(2) Place a wooden block under the carriage and lower the carriage on the block.

(3) While supporting the chains, remove split pins and chain anchor pins from chain anchors.

(4) Remove chains and wash them with solvent. Refer to this section for Load chain inspection and maintenance.

(5) Reverse the above procedure to assemble and install. Use new split pins in chain anchor pins.
Refer to this section for Load chain lubrication and adjustment.



110D9RE55

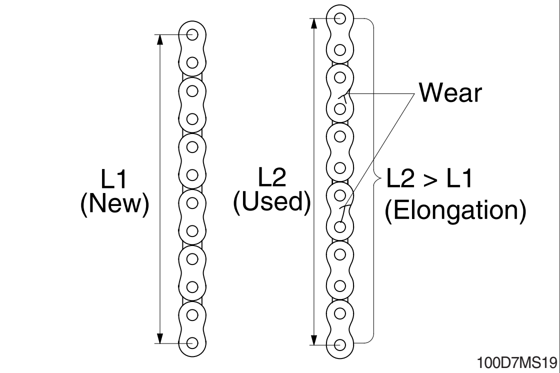
6) LOAD CHAIN INSPECTION AND MAINTENANCE

After every 200 hours of truck operation, lift chains should be inspected and lubricated inspect for the following chain conditions :

(1) Wear

As the chain flexes on and off the sheaves, the joints very gradually wear. The stretch a chain develops in service is due to material being worn off pin outer diameter and pitch hole inner diameter on the inside plate.

Chain wear can be measured using a wear scale or steel tape. When chains have elongated 3%, they should be discarded. When checking chain wear, be sure to measure a segment of chain that operates over a sheave. Do not repair chains by cutting out the worn section and splicing in a new piece. If part of the chain is worn, replace all the chains on the truck.



100D7MS19

(2) Rust and corrosion

Chains used on lift trucks are highly stressed precision components. It is very important that the s-manufactured ultimate strength and fatigue strength be maintained throughout the chain service life. Corrosion will cause a major reduction in the load-carrying capacity of lift chain or roller chain because corrosion causes side plate cracking.

(3) Cracked plate

The most common cause of plate cracking is fatigue failure. Fatigue is a phenomenon that affects most metals and many plastics. After many repeated heavy loads, the plates may crack and the chains will eventually break. Fatigue cracks are almost always found through the pitch holes perpendicular to the pitch line. Contrast this failure mode to the random failures caused by stress-corrosion cracking. If cracks are present, replace all the chain on the truck. Noise in the chain indicates that the plate is on the verge of cracking and will be failed before long.

(4) Tight joints

All joints in lift chain should flex freely. Tight joints resist flexure, increase internal friction, thus increasing chain tension required to lift a given load. Increased tension accelerates wear and fatigue problems.

Tight joints in lift chains can be caused by :

· Bent pins or plates.
· Rusty joints.
· Peened plate edges.

Oil rusty chains and replace chains with bent or peened components.

(5) Protruding or turned pins

Heavily loaded chains operating with lube generate tremendous friction between pins and plates. In extreme cases, the frictional torque in the joint can actually turn pins in the press-fit outside plates. If chain is allowed to operate in this condition, the pins slowly work out of the chain causing chain failure. Turned pins can be quickly spotted because the flats on the V heads are no longer in line. Chains with turned or protruding pins should be replaced immediately. Do not attempt to repair the chain by driving pins back into the chain.

(6) Chain side wear

A wear pattern on pin heads and outside plates indicates misalignment. This condition damages chain and sheaves as well as increasing internal friction in the chain system.

(7) Chain anchors and sheaves

An inspection of the chain system includes a close examination of chain anchors and sheaves. Check chain anchors for wear, breakage and misalignment. Anchors with worn or broken fingers should be replaced. Anchors should be adjusted to eliminate twisting or other misalignment in the chain. When chain is misaligned, load is not distributed uniformly between the plates. Prolonged operation will result in premature fatigue failure. Sheaves with badly worn flanges and outside diameter should be replaced. Heavy flange wear indicates chain misalignment.

(8) Chain wear scale

The chain can be checked for wear or stretching with the use of a chain wear scale. Stretching of a chain is due to the elongation of the pitch holes and wearing of the pin O.D. The greatest amount of stretching occurs at the areas of the chain that flex over the sheaves most frequently. Check the chain at this point with a scale. The wear scale has instructions printed on the sides for use in determining chain stretch and are as follows :

· Determine pitch length of chain using 6 inch scale on one side of wear scale.
· If pitch is 1/2 (12.7 mm), 3/4 (19.05 mm), 1 (25.4 mm), 1-1/2 (38.1 mm), 2 (50.8 mm), use side A of scale.
· If pitch is 5/8 (15.875 mm), 1-1/4 (31.75 mm) or 2 (50.8 mm), use side B.
· Align point A or B to center of a pin and note position of the opposite A or B point.
· If other point also lines up with a pin, the chain is worn and should be replaced.

If any of the above conditions exists (cracked plates, turned pins, stretching etc), the chains should be replaced in pairs as a complete assembly. Order chains by part number to insure the correct chain length, pitch and material specifications.

7) LOAD CHAIN LUBRICATION AND ADJUSTMENT

(1) Lubrication

The most important consideration in field maintenance of lift chains is lubrication. Hard working, heavily loaded chains cannot be expected to give satisfactory wear life without scheduled periodic re-lubrication. Like all bearing surfaces, the precision manufactured, hardened steel, joint-wearing surfaces require a film of oil between mating parts to prevent rapid wear. Oil must penetrate the chain joint to prevent wear. Applying oil to external surfaces will prevent rust, but oil must flow into the live bearing surfaces for maximum wear life. Frequency of re-lube will vary with operating conditions and environment, the best estimate of lube period is 200 hours. Trucks parked outdoors or trucks in extremely severe service, may require more frequent re-lube to maintain an oil film on all chain surface.

· Wipe off the old oil with a clean cloth and blow out the remaining dirt with compressed air.

⚠ Wear eye protection.

· With a clean brush, apply EP-140 extreme pressure lubricant or heavy motor oil (40W).

(2) Replacement

Replace chains as a pair. It will be virtually impossible to maintain uniform loading between the strands if a new chain is put into service opposite an old chain. The jonts in the old chain will be greater than that on the new chain, greatly complicating the problem of maintaining equal chain tension. The new chain will wear more slowly causing it to bear the major portion of the load resulting in premature wear and fatigue failure. Don't steam clean or decrease new chains.
The manufacturer's grease is effective in reducing wear and corrosion. If the original factory lube is dried out or wiped off, soak the new chain in heavy engine oil for at 1/2 hour prior to installing on truck. After the old chains have been stripped from the mast, very carefully inspect chain anchors and sheaves. Broken, cracked or worn anchor must be replaced using the new anchor pin and split pin. Do not paint newly replaced chain after it has been installed.

(3) Adjustment

Chain adjustments are important for the following reasons :

· Equal loading of chain.
· Proper sequencing of mast.
· Prevent over-stretching of chains.
· Prevent chains from jumping off sheaves if they are too loose.

(4) Adjustment procedure

· With mast in its fully collapsed and vertical position, lower the fork to the floor.
· Adjust the chain length by loosening or tightening nut on the chain anchor.
· After making adjustment on the mast, be sure to tighten the nut.