

SECTION 1 GENERAL

Group 1 Safety hints	1-1
Group 2 Specifications	1-5
Group 3 Operational checkout record sheet	1-19

SECTION 2 REMOVAL & INSTALLATION OF UNIT

Group 1 Major components	2-1
Group 2 Removal and installation of unit	2-2

SECTION 3 POWER TRAIN SYSTEM

Group 1 Structure and operation	3-1
Group 2 Operation and maintenance	3-60
Group 3 Disassembly and assembly	3-73
Group 4 Adjustment	3-191

SECTION 4 BRAKE SYSTEM

Group 1 Structure and function	4-1
Group 2 Operational checks and troubleshooting	4-32
Group 3 Tests and adjustments	4-40
Group 4 Disassembly and assembly	4-43

SECTION 5 STEERING SYSTEM

Group 1 Structure and function	5-1
Group 2 Operational checks and troubleshooting	5-10
Group 3 Tests and adjustments	5-18
Group 4 Disassembly and assembly	5-22

SECTION 6 HYDRAULIC SYSTEM

Group 1 Structure and function	6-1
Group 2 Operational checks and troubleshooting	6-36
Group 3 Disassembly and assembly	6-41

SECTION 7 ELECTRICAL SYSTEM

Group 1 Component location	7-1
Group 2 Electrical circuit	7-3
Group 3 Cluster	7-23

Group 4	Transmission message display	7-54
Group 5	Switches	7-57
Group 6	Electrical component specification	7-65
Group 7	Connectors	7-79
Group 8	Troubleshooting	7-97

SECTION 8 MAST

Group 1	Structure	8-1
Group 2	Operational checks and troubleshooting	8-4
Group 3	Adjustment	8-7
Group 4	Removal and Installation	8-9

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

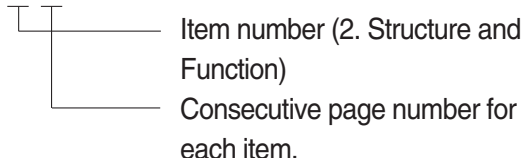
1. See the page number on the bottom of the page.

File the pages in correct order.

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

Example 1

2 - 3



3. Additional pages : Additional pages are indicated by a hyphen (-) and number after the page number. File as in the example.

7 - 4

7 - 4 - 1

7 - 4 - 2

7 - 5

Added pages

Revised edition mark (①②③...)

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

Revisions

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

Symbols

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

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

3. CONVERSION TABLE

Method of using the Conversion Table

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

Example

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

Convert 55 mm into inches.

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

(b)

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
(a) 50	1.969	2.008	2.047	2.087	2.126	(c) 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
 $1 \ell = 0.2642 \text{ U.S. Gal}$

	0	1	2	3	4	5	6	7	8	9
0		0.264	0.528	0.793	1.057	1.321	1.585	1.849	2.113	2.378
10	2.642	2.906	3.170	3.434	3.698	3.963	4.227	4.491	4.755	5.019
20	5.283	5.548	5.812	6.076	6.340	6.604	6.869	7.133	7.397	7.661
30	7.925	8.189	8.454	8.718	8.982	9.246	9.510	9.774	10.039	10.303
40	10.567	10.831	11.095	11.359	11.624	11.888	12.152	12.416	12.680	12.944
50	13.209	13.473	13.737	14.001	14.265	14.529	14.795	15.058	15.322	15.586
60	15.850	16.115	16.379	16.643	16.907	17.171	17.435	17.700	17.964	18.228
70	18.492	18.756	19.020	19.285	19.549	19.813	20.077	20.341	20.605	20.870
80	21.134	21.398	21.662	21.926	22.190	22.455	22.719	22.983	23.247	23.511
90	23.775	24.040	24.304	24.568	24.832	25.096	25.631	25.625	25.889	26.153

Liter to U.K. Gallon
 $1 \ell = 0.21997 \text{ U.K. Gal}$

	0	1	2	3	4	5	6	7	8	9
0		0.220	0.440	0.660	0.880	1.100	1.320	1.540	1.760	1.980
10	2.200	2.420	2.640	2.860	3.080	3.300	3.520	3.740	3.950	4.179
20	4.399	4.619	4.839	5.059	5.279	5.499	5.719	5.939	6.159	6.379
30	6.599	6.819	7.039	7.259	7.479	7.699	7.919	8.139	8.359	8.579
40	8.799	9.019	9.239	9.459	9.679	9.899	10.119	10.339	10.559	10.778
50	10.998	11.281	11.438	11.658	11.878	12.098	12.318	12.528	12.758	12.978
60	13.198	13.418	13.638	13.858	14.078	14.298	14.518	14.738	14.958	15.178
70	15.398	15.618	15.838	16.058	16.278	16.498	16.718	16.938	17.158	17.378
80	17.598	17.818	18.037	18.257	18.477	18.697	18.917	19.137	19.357	19.577
90	19.797	20.017	20.237	20.457	20.677	20.897	21.117	21.337	21.557	21.777

kgf · m to lbf · ft

1 kgf · m = 7.233 lbf · ft

	0	1	2	3	4	5	6	7	8	9
		7.2	14.5	21.7	28.9	36.2	43.4	50.6	57.9	65.1
10	72.3	79.6	86.8	94.0	101.3	108.5	115.7	123.0	130.2	137.4
20	144.7	151.9	159.1	166.4	173.6	180.8	188.1	195.3	202.5	209.8
30	217.0	224.2	231.5	238.7	245.9	253.2	260.4	267.6	274.9	282.1
40	289.3	296.6	303.8	311.0	318.3	325.5	332.7	340.0	347.2	354.4
50	361.7	368.9	376.1	383.4	390.6	397.8	405.1	412.3	419.5	426.8
60	434.0	441.2	448.5	455.7	462.9	470.2	477.4	484.6	491.8	499.1
70	506.3	513.5	520.8	528.0	535.2	542.5	549.7	556.9	564.2	571.4
80	578.6	585.9	593.1	600.3	607.6	614.8	622.0	629.3	636.5	643.7
90	651.0	658.2	665.4	672.7	679.9	687.1	694.4	701.6	708.8	716.1
100	723.3	730.5	737.8	745.0	752.2	759.5	766.7	773.9	781.2	788.4
110	795.6	802.9	810.1	817.3	824.6	831.8	839.0	846.3	853.5	860.7
120	868.0	875.2	882.4	889.7	896.9	904.1	911.4	918.6	925.8	933.1
130	940.3	947.5	954.8	962.0	969.2	976.5	983.7	990.9	998.2	10005.4
140	1012.6	1019.9	1027.1	1034.3	1041.5	1048.8	1056.0	1063.2	1070.5	1077.7
150	1084.9	1092.2	1099.4	1106.6	1113.9	1121.1	1128.3	1135.6	1142.8	1150.0
160	1157.3	1164.5	1171.7	1179.0	1186.2	1193.4	1200.7	1207.9	1215.1	1222.4
170	1129.6	1236.8	1244.1	1251.3	1258.5	1265.8	1273.0	1280.1	1287.5	1294.7
180	1301.9	1309.2	1316.4	1323.6	1330.9	1338.1	1345.3	1352.6	1359.8	1367.0
190	1374.3	1381.5	1388.7	1396.0	1403.2	1410.4	1417.7	1424.9	1432.1	1439.4

kgf/cm² to lbf/in²1 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

bar ↔ kgf/cm² ↔ psi ↔ MPa

bar 1	kgf/cm ² 1.02	psi 14.504	MPa 0.1
88	90	1280	9
90	91	1300	9
92	94	1340	9
98	100	1420	10
110	112	1600	11
118	120	1710	12
120	122	1740	12
122	124	1770	12
127	129	1840	13
130	133	1890	13
132	135	1920	13
135	138	1960	14
140	143	2030	14
145	148	2100	14
147	150	2130	15
150	153	2180	15
157	160	2280	16
160	163	2320	16
162	165	2350	16
165	168	2390	16
167	170	2420	17
170	174	2470	17
172	176	2500	17
175	179	2540	18
177	181	2570	18
180	183	2610	18
185	188	2680	18
187	191	2710	19
190	194	2760	19
195	199	2830	20
197	200	2850	20
207	211	3000	21
210	214	3050	21
217	221	3150	22
220	224	3190	22
234	239	3400	23
414	422	6000	41

TEMPERATURE

Fahrenheit-Centigrade Conversion.

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

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

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

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

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

SECTION 1 GENERAL

Group 1	Safety hints	1-1
Group 2	Specifications	1-5
Group 3	Operational checkout record sheet	1-19

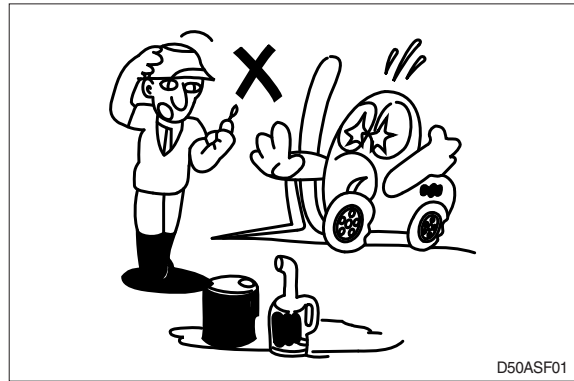
GROUP 1 SAFETY HINTS

Careless performing of the easy work may cause injuries.

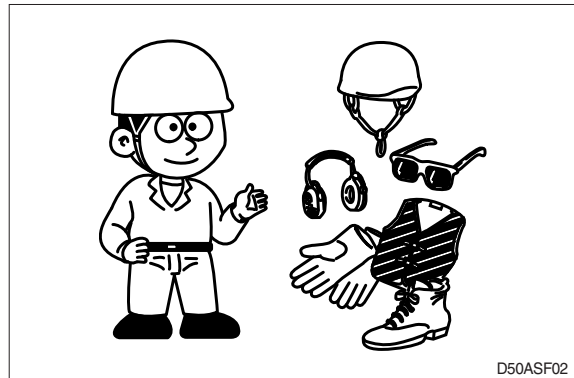
Take care to always perform work safely, at least observing the following.

- Oil is a dangerous substance. Never handle oil, grease or oily clothes in places where there is any fire of flame.

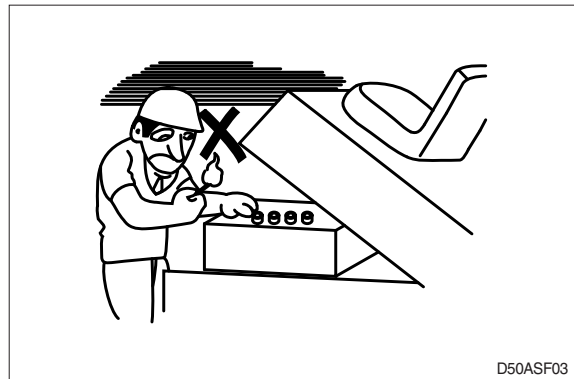
As preparation in case of fire, always know the location and directions for use of fire extinguishers and other fire fighting equipment.



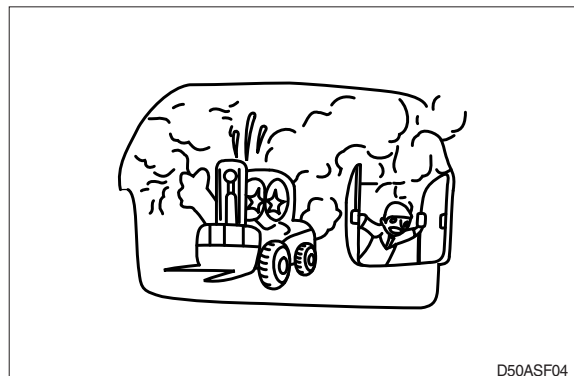
- Wear well-fitting helmet, safety shoes and working clothes. When drilling, grinding or hammering, always wear protective goggles. Always do up safety clothes properly so that they do not catch on protruding parts of machines. Do not wear oily clothes. When checking, always release battery plug.



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

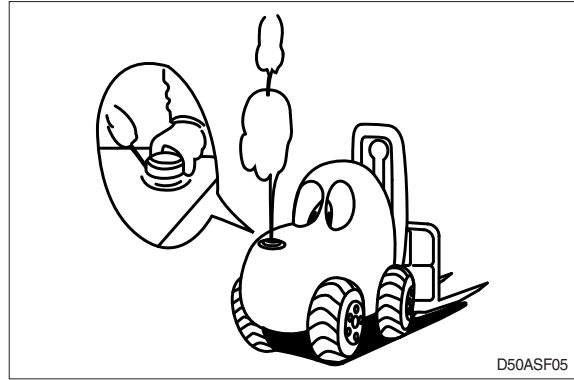


- Exhaust gas is dangerous. Provide adequate ventilation when working a closed space.



▲ 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.



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

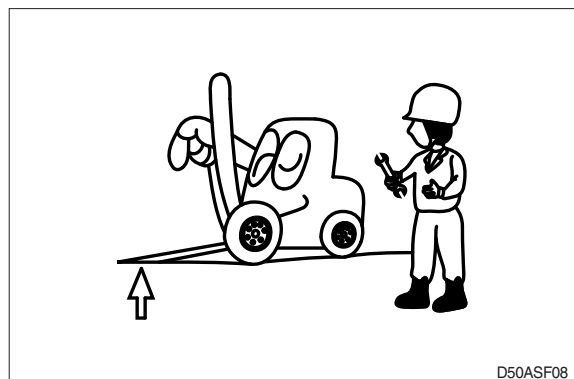


- Hand a caution sign in the operator's compartment (For example **Do not start** or **Maintenance in progress**). This will prevent anyone from starting or moving the machine by mistake.

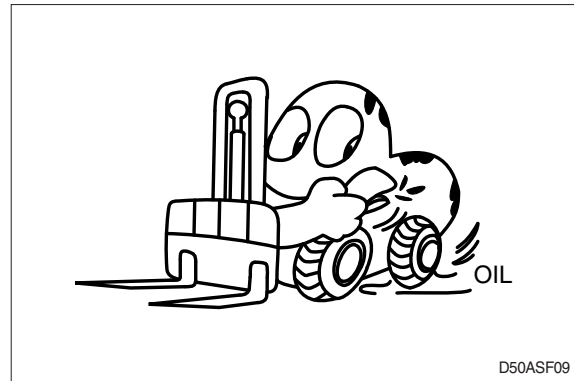


When inspecting running parts or near such parts, always stop the machine first. Before checking or servicing accumulator or piping, depress brake pedal repeatedly to release pressure.

- 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.

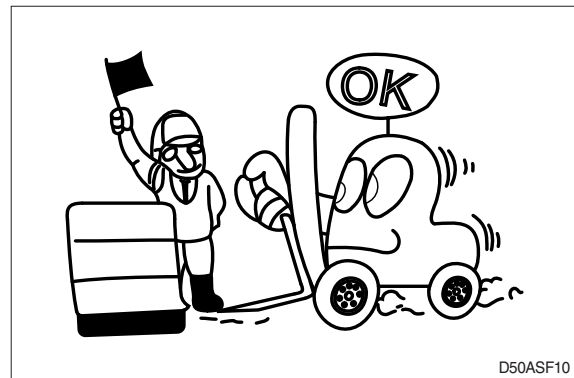


- Immediately remove any oil or grease on the floor of the operator's compartment, or on the handrail. It is very dangerous if someone slips while on the machine.



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

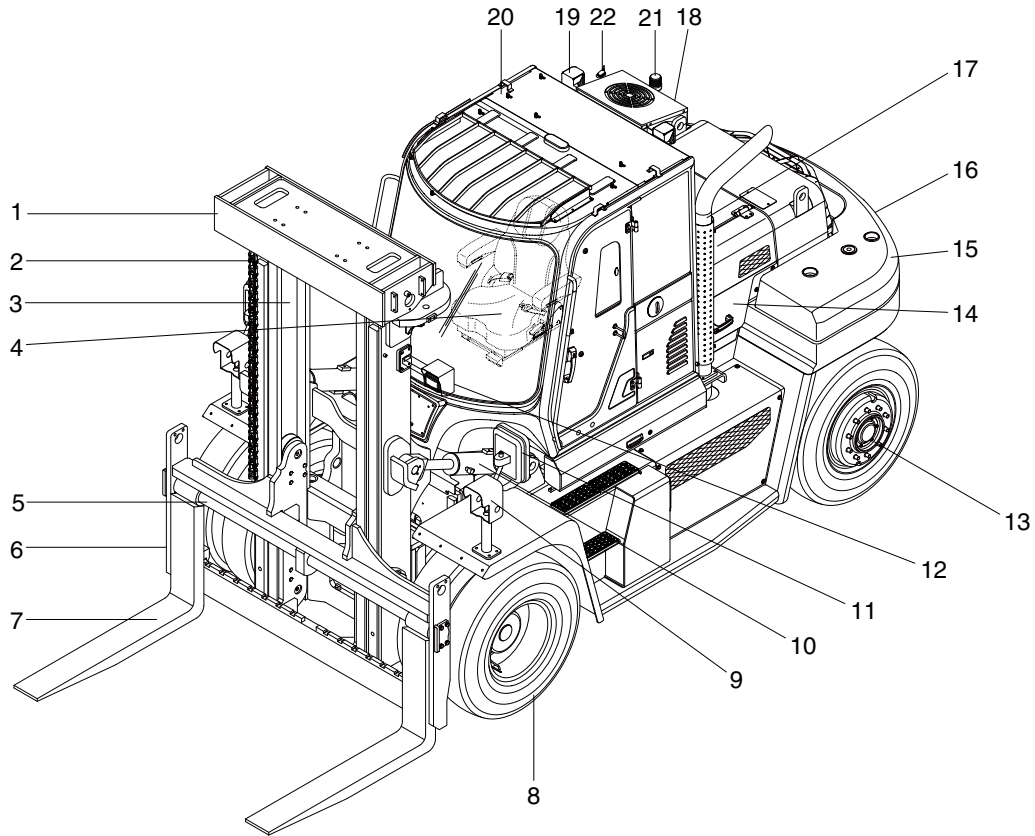
- Always remember that the hydraulic oil circuit is under pressure. When feeding or draining the oil or carrying out inspection and maintenance, release the pressure first.

- 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

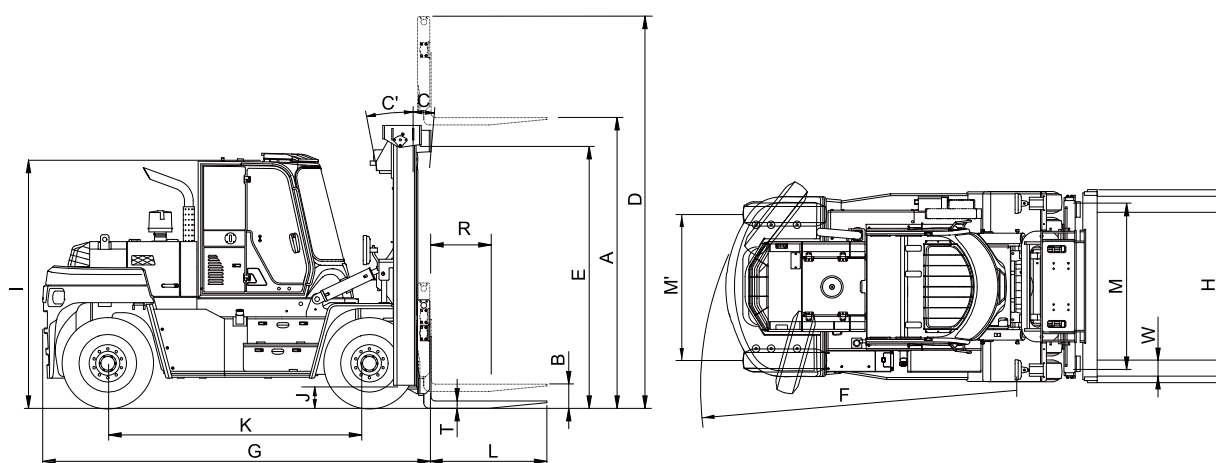
1. GENERAL LOCATIONS



160D9V3CD10

1 Mast	9 Head lamp-fender	17 Silencer
2 Lift chain	10 Tilt cylinder	18 Air conditioner (opt)
3 Lift cylinder	11 Rear view mirror	19 Rear work lamp
4 Operator's seat	12 Work lamp-mast	20 Cabin
5 Fork positioner cylinder	13 Rear wheel	21 Beacon lamp (opt)
6 Carriage	14 Bonnet	22 Mobile antenna (opt)
7 Forks	15 Counterweight	
8 Front wheel	16 Rear combination lamp	

2. SPECIFICATIONS



160D9VSP01

Model			Unit	120D-9V	130D-9V	160D-9V
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	500/480	←	420/390
	Lowering speed (Unload/Load)		mm/sec	500/550	←	450/550
	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	35.6	34.1	34.0
	Gradeability (Load)		%	45.7	42.8	43.9
	Min turning radius (Outside)	F	mm (ft·in)	4350 (14' 3")	←	4895 (16' 1")
ETC	System set pressure		kgf/cm ²	220	←	←
	Hydraulic oil tank		ℓ (USgal)	176 (46.5)	←	171 (45.2)
	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)	2980 (9' 8")	←	3018 (9' 11")
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)	12382 (27269)	12998 (28621)	15878 (34963)

2. SPECIFICATION FOR MAJOR COMPONENTS

1) 120/130D-9V

(1) ENGINE

Item	Unit	Specification
Model	—	Cummins B4.5
Type	—	4 cycle turbocharged, charger air cooled diesel engine
Cooling Method	—	Water cooling
Number of cylinders and arrangement	—	4 cylinders, In-line
Firing order	—	1-3-4-2
Combustion chamber type	—	Direct injection
Cylinder bore × stroke	mm (in)	107 × 124 mm (4.21" × 4.88")
Piston displacement	cc (cu in)	4500 (275.1)
Compression ratio	—	17.2 : 1
Rated gross horse power	ps/rpm	167.2/2200
Maximum gross torque at rpm	kgf · m/rpm	77.9/1200
Engine oil quantity	ℓ (U.S.gal)	11 (2.94)
Dry weight	kg (lb)	383 (844)
High idling speed	rpm	2230±50
Low idling speed	rpm	700~1200
Rated fuel consumption	g/ps.hr	155.9
Starting motor	V-kW	DENSO, 24-4.8
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	63+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
Lift section	Max flow	lpm	350
	Max pressure	bar	220
	Relief pressure	bar	220
Tilt section	Max flow	lpm	200
	Max pressure	bar	220
	Relief pressure	bar	220
Aux section	Max flow	lpm	220
	Relief pressure	bar	165

(4) STEERING UNIT

Item	Unit	Specification
Type	—	Load sensing/Non load reaction/Dynamic signal
Capacity	cc/rev	369

(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
		RR	1 : 5.647	2 : 2.404
Axle	Type	Front-wheel drive type, fixed location		
	Gear ratio	11.73 : 1		
	Gear	Ring & Pinion gear type		
Wheels	Q'ty (FR/RR)	Double : 4/2		
	Front (drive)	10.00-20-16 PR		
	Rear (steer)	10.00-20-16 PR		
Brakes	Travel	Front wheel, wet disc brake		
	Parking	Axle pinion, Caliper brake, hydraulic released		
Steering	Type	Full hydraulic, power steering		
	Steering angle	76° to both right and left angle, respectively		

2) 160D-9V
(1) ENGINE

Item	Unit	Specification
Model	—	Cummins 6.7
Type	—	4 cycle turbocharged, charger air cooled 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	175.4/2200
Maximum gross torque at rpm	kgf · m/rpm	114.3/1100
Engine oil quantity	ℓ (U.S.gal)	14.2 (3.8)
Dry weight	kg (lb)	583 (1282)
High idling speed	rpm	2230 ± 50
Low idling speed	rpm	700~1200
Rated fuel consumption	g/ps.hr	155.2
Starting motor	V-kW	DENSO, 24-4.8
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	63+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
Lift section	Max flow	lpm	300
	Max pressure	bar	400
	Relief pressure	bar	220
Tilt section	Max flow	lpm	200
	Max pressure	bar	380
	Relief pressure	bar	220
Aux section	Relief pressure	bar	165

(4) STEERING UNIT

Item	Unit	Specification
Type	—	Load sensing / Non load reaction / Dynamic signal
Capacity	cc/rev	369

(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	M12 × 1.75	14.7 ± 2.2	106 ± 15.9
6		Steering unit mounting bolt	M10 × 1.5	4.0 ± 0.5	28.9 ± 3.6
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)

Hose size	Thread (PF)	Hex. across flat (mm)	Tightening torque	
			kgf·m	lbf·ft
1/4"	1/4	19	4	28.9
3/8"	3/8	22	5	36.2
1/2"	1/2	27	9.5	68.7
3/4"	3/4	36	18	130.2
1"	1	41	21	151.9
1-1/4"	1-1/4	50	35	253.2

3) PIPE AND HOSE (ORFS TYPE)

Hose size	Thread (UN/UNF/UNS)	Hex. across flat (mm)	Tightening torque	
			kgf·m	lbf·ft
1/4"	9/16-18	19	3	21.7
3/8"	11/16-16	22	5	36.2
1/2"	13/16-16	24	7	50.6
5/8"	1-14	30	12	86.8
3/4"	1-3/16-12	36	18	130.2
1"	1-7/16-12	41	23	166.4
1-1/4"	1-11/16-12	50	28	202.5
1-1/2"	2-12	58	32	231.1

4) FITTING (O-RING SEAL TYPE)

Hose size	Thread (UN/UNF)	Hex. across flat (mm)	Tightening torque	
			kgf·m	lbf·ft
1/4"	7/16-20	17	2	14.5
3/8"	9/16-18	19	3	21.7
1/2"	3/4-16	22	4	28.9
		24	6	43.4
5/8"	7/8-14	27	10	72.3
		30	12	86.8
3/4"	1-1/16-12	32	15	108.5
		36	18	130.2
1"	1-5/16-12	41	23	166.4
1-1/4"	1-5/8-12	50	28	202.5
1-1/2"	1-7/8-12	55	32	231.5

5) BAND CLAMP

Tag No.	Hose size (mm)	Band width (mm)	Tightening torque	
			kgf·m	lbf·ft
S20-15	8 ~ 14	9	0.3	2.17
S20-17	11 ~ 17			
S20-22	13 ~ 20		0.35	2.53
S20-25	15 ~ 24			
S20-28	19 ~ 28			
S20-32	22 ~ 32	12	0.42	3.04
S20-40	26 ~ 38	9		
S20-45	32 ~ 44			

6) BAND CLAMP (IDEAL, FLEX GEAR TYPE)

Tag No.	Hose size (mm)	Band width (mm)	Tightening torque	
			kgf·m	lbf·ft
41-212	32 ~ 54	15.9	1.1	8.0
41-262	45 ~ 67			
41-312	57 ~ 79			
41-362	40 ~ 92			
41-412	83 ~ 105			
41-462	95 ~ 117			
41-512	108 ~ 130			

6. WRENCH AND SPANNER CHART

No.	Wrench & Spanner			Thread			PIPE AND HOSE	
	inch		mm	UNF/UN	M	PF/G	ORFS (UNF/UN)	FLARE (PF)
1	-	0.050	1.3	-	-	-	-	-
2	-	0.059	1.5	-	-	-	-	-
3	1/16	0.063	1.6	-	-	-	-	-
4	5/64	0.078	2	-	-	-	-	-
5	3/32	0.094	2.4	-	-	-	-	-
6	-	0.098	2.5	-	-	-	-	-
7	7/64	0.109	2.8	-	-	-	-	-
8	-	0.118	3	-	-	-	-	-
9	1/8	0.125	3.2	-	-	-	-	-
10	9/64	0.141	3.5	-	-	-	-	-
11	5/32	0.156	4	-	-	-	-	-
12	-	0.177	4.5	-	-	-	-	-
13	3/16	0.188	4.8	-	-	-	-	-
14	-	0.197	5	-	-	-	-	-
15	13/64	0.203	5.2	-	-	-	-	-
16	7/32	0.219	5.5	-	-	-	-	-
17	15/64	0.234	6	-	-	-	-	-
18	1/4	0.250	6.4	-	-	-	-	-
19	17/64	0.266	6.8	-	-	-	-	-
20	9/32	0.281	7	-	-	-	-	-
21	5/16	0.313	8	-	-	-	-	-
22	11/32	0.344	8.7	-	-	-	-	-
23	-	0.354	9	-	-	-	-	-
24	3/8	0.375	9.5	-	-	-	-	-
25	-	0.394	10	-	-	-	-	-
26	-	-	11	-	-	-	-	-
27	7/16	0.438	11.1	-	-	-	-	-
28	15/32	0.469	12	-	-	-	-	-
29	1/2	0.500	12.7	-	-	-	-	-
30	-	-	13	-	-	-	-	-
31	17/32	0.53	13.5	-	-	-	-	-
32	-	0.55	14	7/16-20	-	-	-	-
33	9/16	0.56	14.3	-	-	-	-	-
34	19/32	0.59	15	-	-	-	-	-
35	5/8	0.63	15.9	-	-	-	-	-
36	-	-	16	-	-	-	-	-
37	21/32	0.66	16.7	-	-	-	-	-

No.	Wrench & Spanner			Thread			PIPE AND HOSE	
	inch		mm	UNF/UN	M	PF/G	ORFS (UNF/UN)	FLARE (PF)
38	-	-	17	-	M12	-	-	-
39	11/16	0.69	17.5	-	-	-	-	-
40	-	-	18	-	-	-	-	-
41	3/4	0.75	19	9/16-18	M14	G1/4	9/16-18	PF1/4
42	25/32	0.78	19.8	-	-	-	-	-
43	-	-	20	-	-	-	-	-
44	13/16	0.81	20.6	-	-	-	-	-
45	-	-	21	-	-	-	-	-
46	-	-	22	-	M16	G3/8	11/16-16	PF3/8
47	7/8	0.88	22.2	-	-	-	-	-
48	29/32	0.91	23	-	-	-	-	-
49	15/16	0.94	23.8	-	-	-	-	-
50	-	-	24	3/4-16	M18	-	13/16-16	-
51	31/32	0.97	26.4	-	-	-	-	-
52	-	-	25	-	-	-	-	-
53	1	1.00	25.4	-	-	-	-	-
54	-	-	26	-	-	-	-	-
55	1 1/16	1.06	27	7/8-14	M22	G1/2	-	PF1/2
56	-	-	28	-	-	-	-	-
57	1 1/8	1.13	28.6	-	-	-	-	-
58	-	-	29	-	-	-	-	-
59	-	-	30	-	-	-	1-14	-
60	1 3/16	1.19	30.2	-	-	-	-	-
61	-	-	31	-	-	-	-	-
62	1 1/4	1.25	31.8	-	-	-	-	-
63	-	-	32	1-1/16-12	M24	G3/4	-	-
64	-	-	33	-	-	-	-	-
65	1 5/16	1.31	33.3	-	-	-	-	-
66	-	-	34	-	-	-	-	-
67	1 3/8	1.38	35	-	-	-	-	-
68	-	-	36	1-3/16-12	M27	G3/4	1-3/16-12	PF3/4
69	1 7/16	1.44	37	-	-	-	-	-
70	1 1/2	1.50	38	-	-	-	-	-
71	-	-	39	-	-	-	-	-
72	1 9/16	1.56	39.7	-	-	-	-	-
73	-	-	40	-	-	-	-	-
74	-	-	41	1-5/16-12	M33	G1	1-7/16-12	PF1
75	1 5/8	1.63	41.3	-	-	-	-	-

No.	Wrench & Spanner			Thread			PIPE AND HOSE	
	inch		mm	UNF/UN	M	PF/G	ORFS (UNF/UN)	FLARE (PF)
76	1 11/16	1.69	43	-	-	-	-	-
77	1 3/4	1.75	44	-	-	-	-	-
78	1 13/16	1.81	46	-	-	-	-	-
79	1 7/8	1.88	47.6	-	-	-	-	-
80	-	-	48	-	-	-	1-11/16-12	-
81	1 15/16	1.94	49.2	-	-	-	-	-
82	-	-	50	1-5/8-12	-	G1-1/4	-	PF1-1/4
83	2	2.00	50.8	-	-	-	-	-
84	-	-	51	-	-	-	-	-
85	2 1/8	2.13	54	-	-	-	-	-
86	-	-	55	1-7-8-12	-	G1-1/2	-	PF1-1/2
87	-	-	57	-	-	-	2-12	-
88	2 1/4	2.25	57.2	-	-	-	-	-
89	-	-	60	-	-	-	-	-

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)		Ambient temperature °C(°F)							
			120D-9V 130D-9V	160D-9V	-50 (-58)	-30 (-22)	-20 (-4)	-10 (14)	0 (32)	10 (50)	20 (68)	30 (86)
Engine oil pan	Engine oil		11 (2.94)	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		53.9 (14.4)		ISO 22241 (High-purity urea + deionized water (32.5:67.5))							
Torque converter transmission	Engine oil		16 (4.2)		SAE 10W-30							
					SAE 15W-40							
Drive axle	Gear oil	STD	19 (5.0)	SAE 80W-90/API GL-5								
		OPT 1	22.4 (5.9)									
		OPT 2	16.7 (4.4)									
Brake	Cooling oil		22 (5.8)		SHELL DONAX TD OR HYUNDAI OIL BANK XTEER THF 75W80							
Hydraulic tank	Hydraulic oil		176 (46.5)	171 (45.2)	★ISO VG 15							
					★ISO VG 32							
Cabin tilt hand pump	Hydraulic oil		0.7 (0.2)		ISO VG 46							
					ISO VG 68							
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		39 (10.4)	40 (10.7)	Ethylene glycol base permanent type							
					★Ethylene glycol base permanent type (60 : 40)							

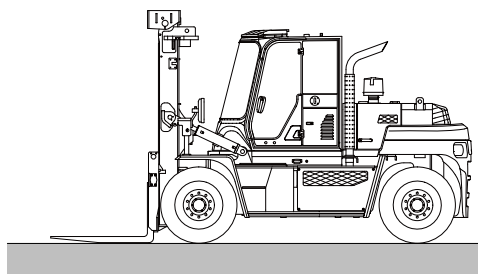
NOTES :

- 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 CK-4.
- ★¹ : Ultra low sulfur diesel ★ : Cold region
 - sulfur content ≤ 15 ppm 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.



160D9VGE02

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

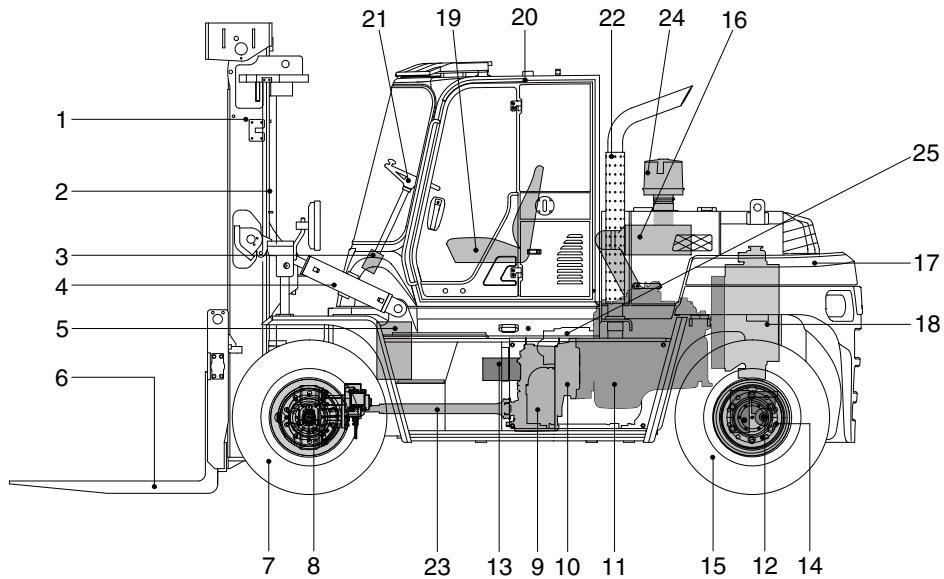
9. Cab components and vandal protection checks

- 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

Group 1	Major components	2-1
Group 2	Removal and installation of unit	2-2

GROUP 1 MAJOR COMPONENTS



160D9VOM21

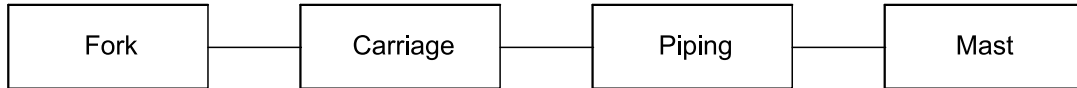
- | | | |
|----------------------|----------------------|--------------------------|
| 1 Mast | 10 Torque converter | 19 Seat |
| 2 Lift cylinder | 11 Engine | 20 Cabin |
| 3 Steering unit | 12 Steering cylinder | 21 Steering wheel |
| 4 Tilt cylinder | 13 Hydraulic pump | 22 Silencer |
| 5 Main control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

GROUP 2 REMOVAL AND INSTALLATION OF UNIT

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

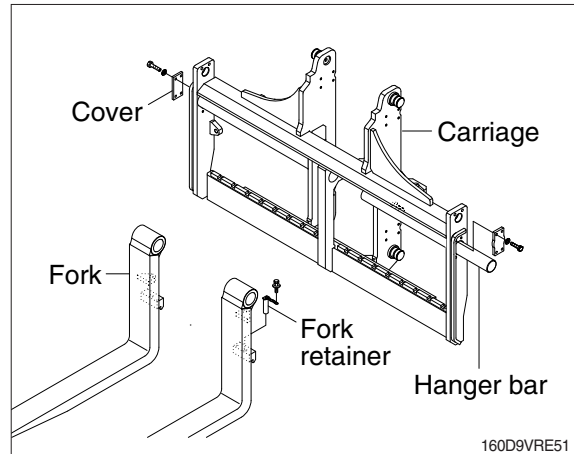
1. MAST

1) REMOVAL



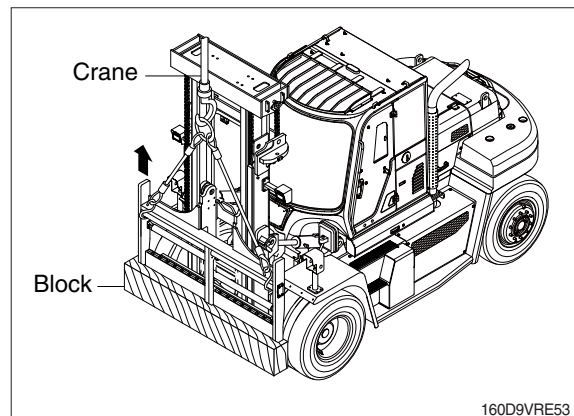
(1) Forks

- 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.

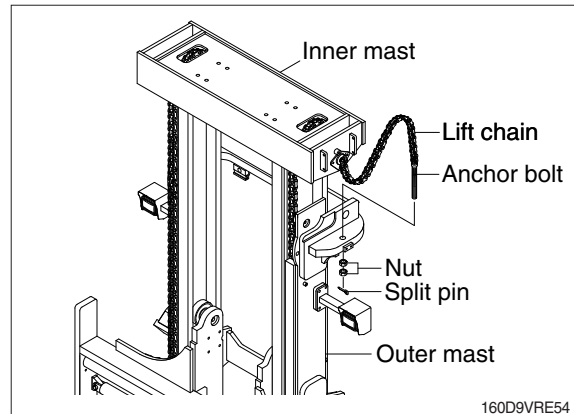


(2) Carriage

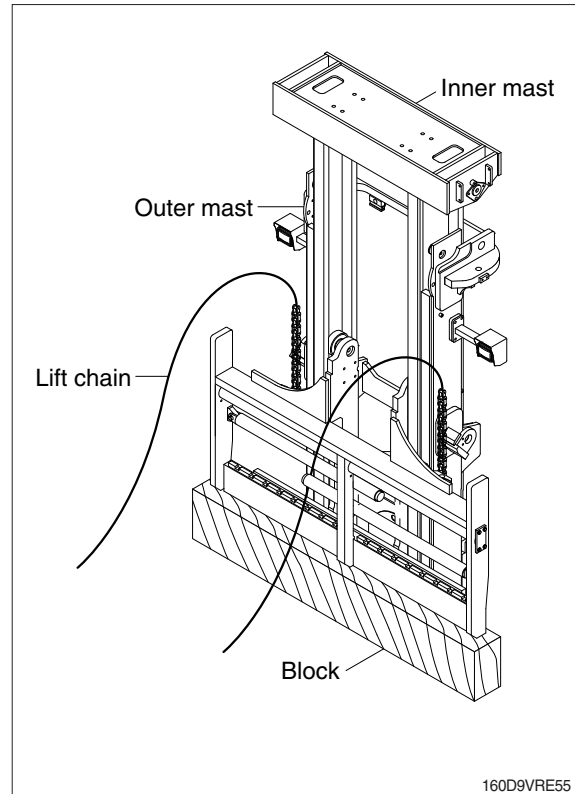
- ① With the mast vertical, raise the carriage high enough to place blocks under the load forks. This is done to create slack in the load chains when the carriage is lowered. Lower the carriage all the way down to the floor. Make sure the carriage is level, this will prevent any binding when the mast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



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



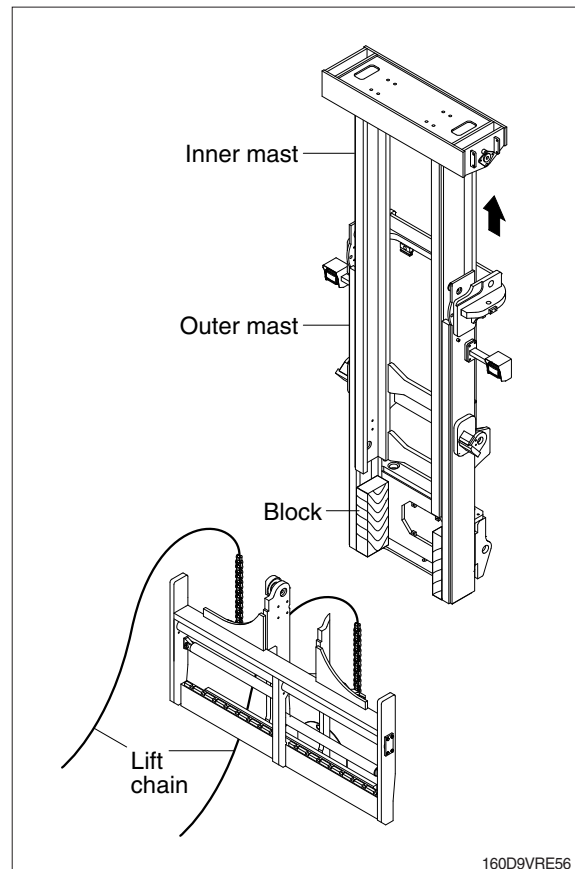
- ③ Pull the chains out of the sheaves and drape them over the front of the carriage.



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

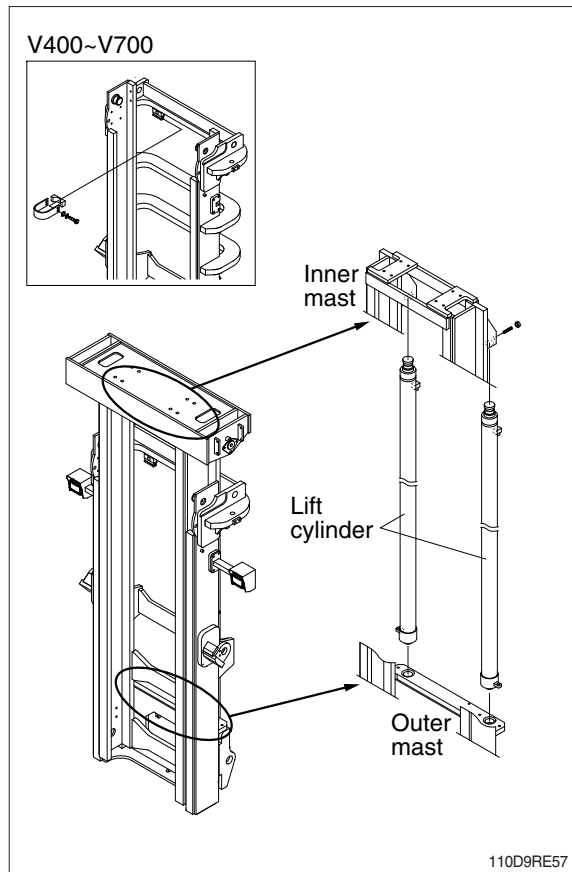
▲ Make sure that carriage remains on floor and does not bind while mast is being raised.

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

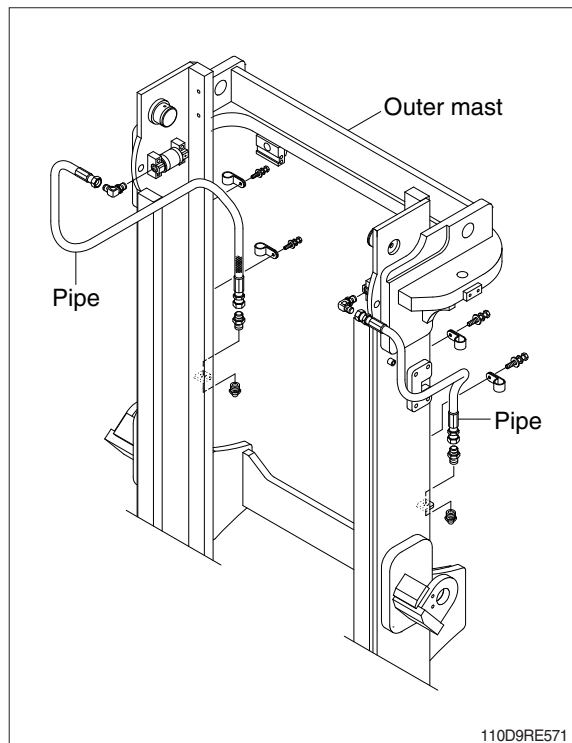


(3) Piping

- 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.

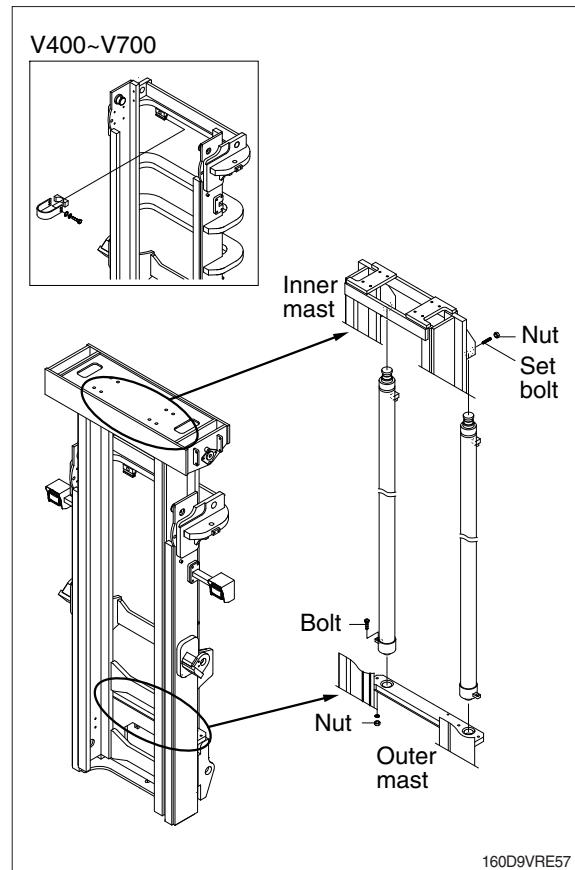


(4) Lift cylinder

- ① Loosen and remove set bolt and nuts 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.

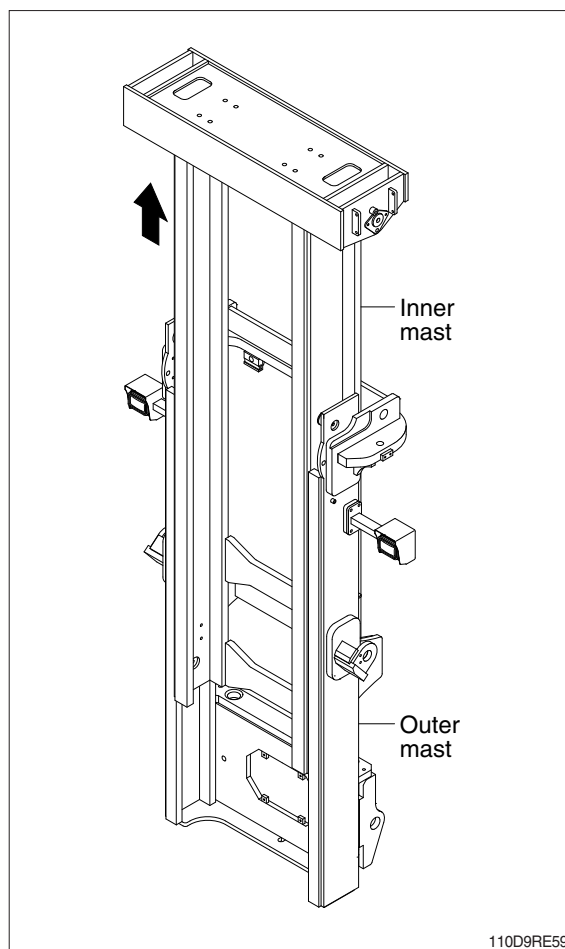
- ③ Loosen and remove hexagon bolts and nuts securing lift cylinders to outer mast.
- ④ Using an overhead hoist, slowly raise the inner mast high enough to clear lift cylinder.
- ⑤ Using an overhead hoist, draw out lift cylinder carefully and put down on the work floor.



(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

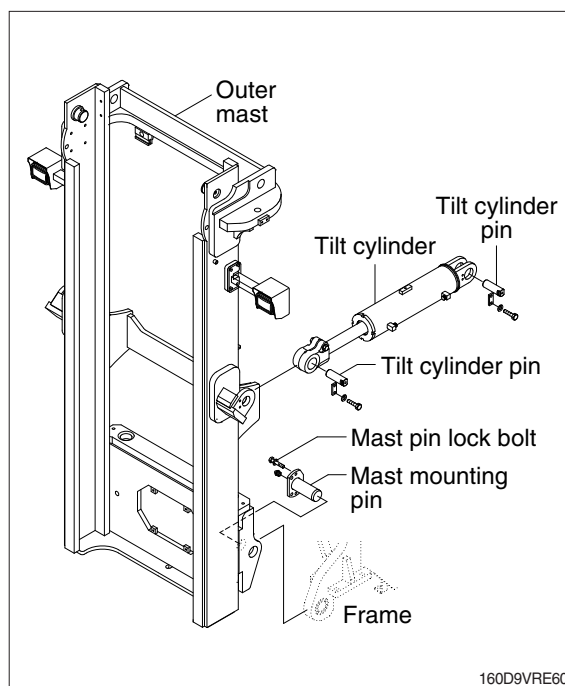
Loosen the bolt and remove the lock plate and tilt cylinder pin.

(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

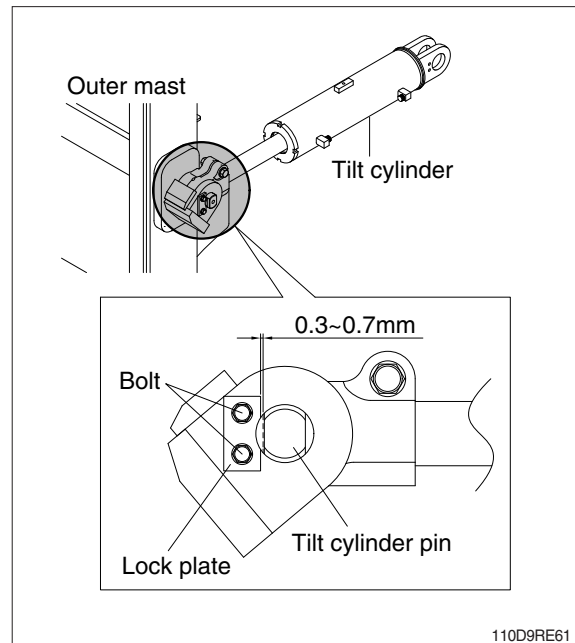
Check the mast mounting pins for wear, then install pins into the mast support bracket and main frame and tighten the mast pin lock bolts.

· 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

- 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.

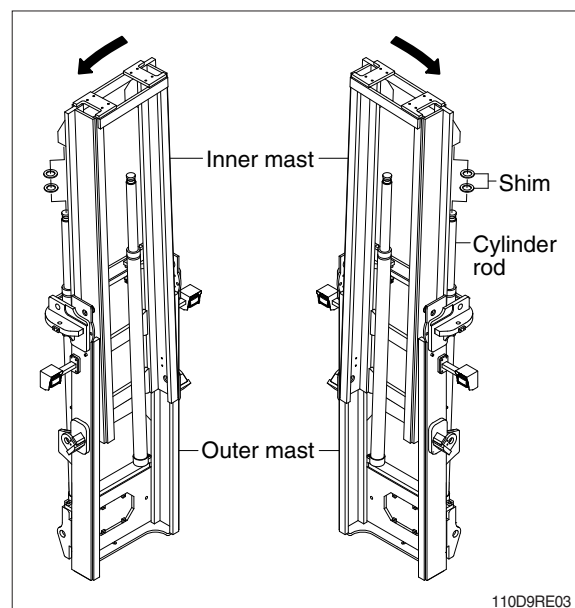
- ② Assemble the cylinder rod to the inner mast, and check the left-to-right play of the mast at the maximum lifting height.

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

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

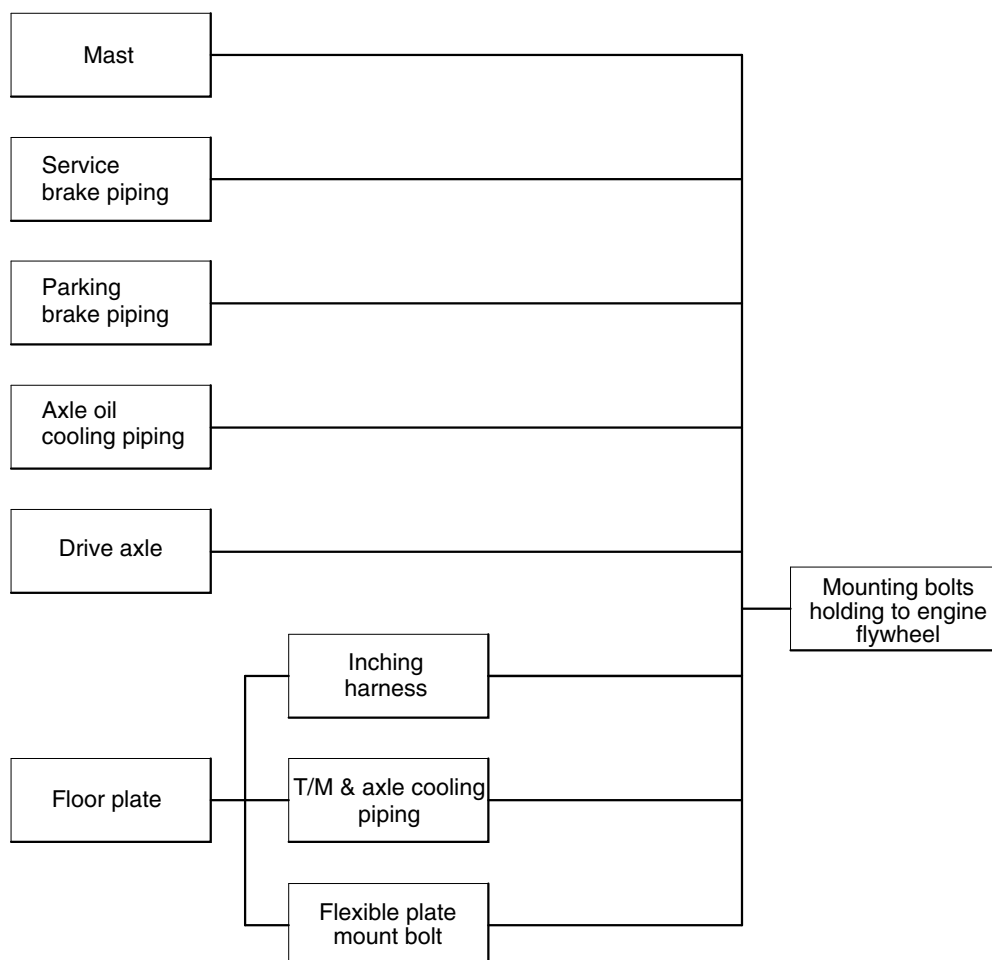
· Shim thickness : 1.0 mm (0.04 in)

※ Lubricate the grease into the nipple sufficiently.



2. POWER TRAIN ASSEMBLY

1) REMOVAL



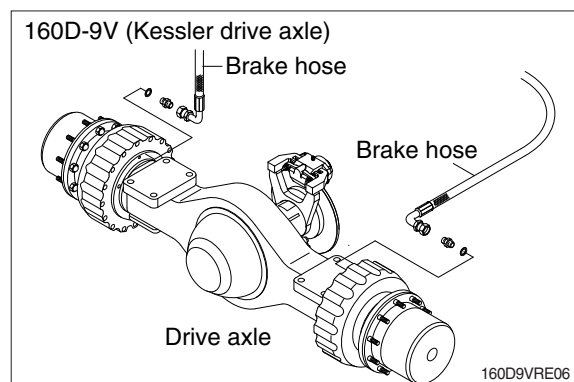
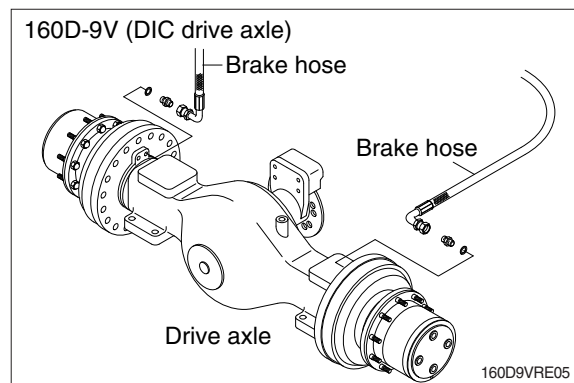
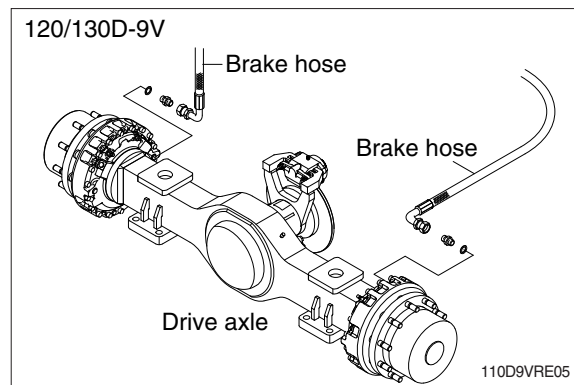
110D9RE04

(1) Mast

Refer to section on mast (Page 2-2)

(2) Service brake piping

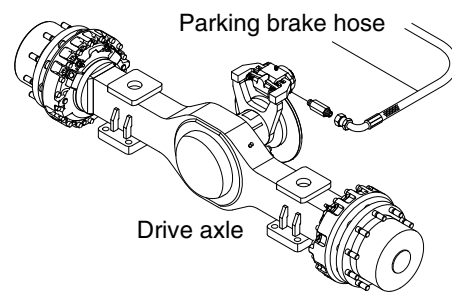
Disconnect the brake hydraulic hoses from the brake housing of drive axle assy.



(3) Parking brake piping

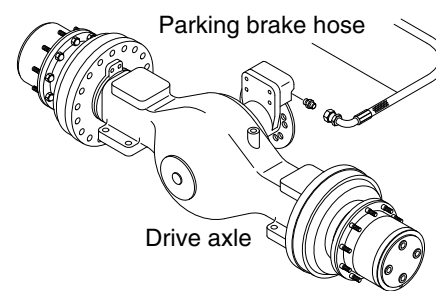
Disconnect the brake hydraulic hoses from the drive axle assy.

120/130D-9V



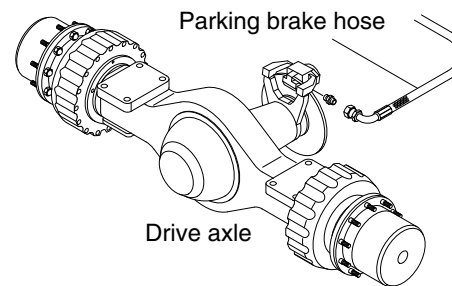
110D9VRE07

160D-9V (DIC drive axle)



160D9VRE07

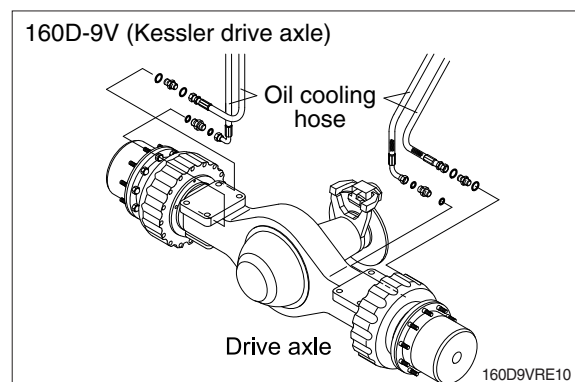
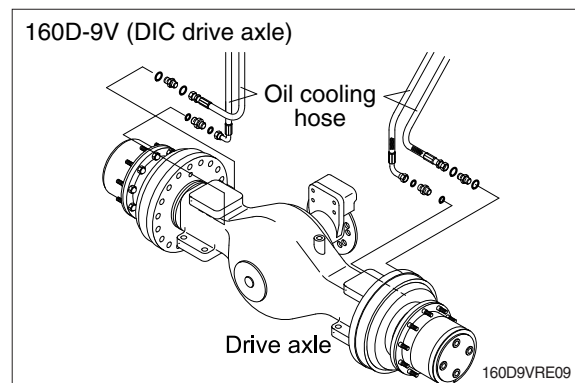
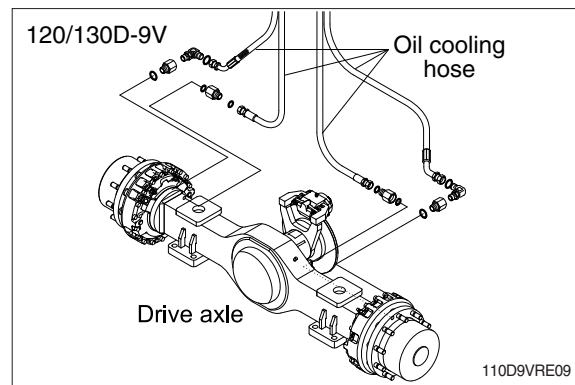
160D-9V (Kessler drive axle)



160D9VRE08

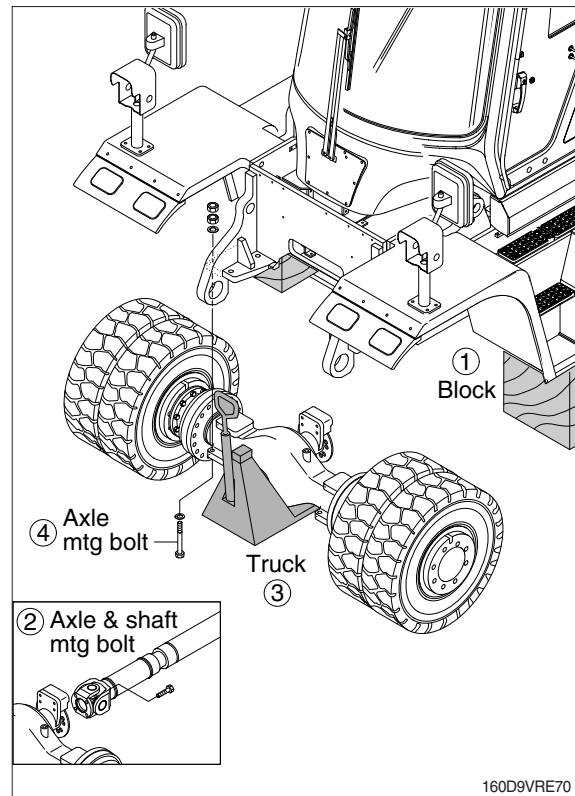
(4) Axle oil cooling piping

Disconnect the brake cooling piping from the drive axle.



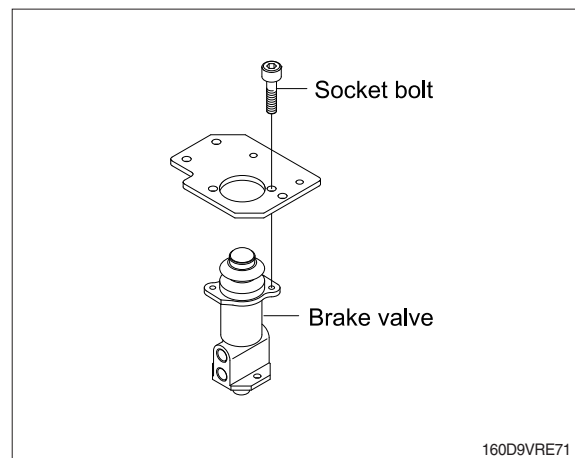
(5) Drive axle

- ※ 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.



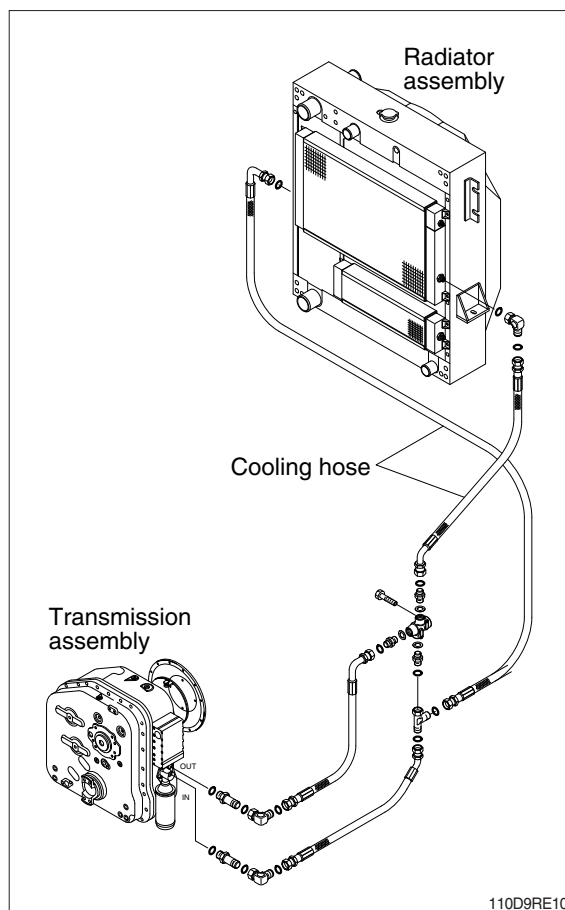
(6) Brake valve

- ① Loosen socket bolts and remove brake valve assembly.

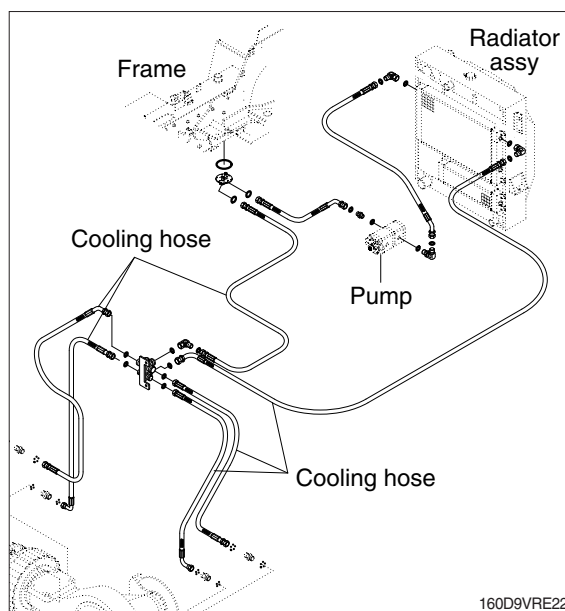


(7) Transmission and axle cooling piping

- ① Disconnect cooling hoses and connectors from the transmission.
- ※ Make sure that the coolant has been drained from the line.



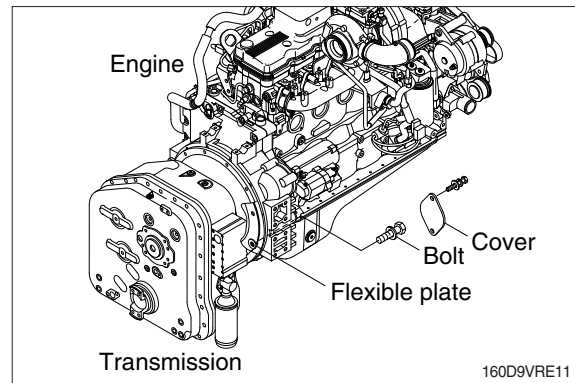
- ② Disconnect axle cooling hoses and connectors from the axle.
- ※ Make sure that the axle cooling oil has been drained from the line.



(8) Flexible plate

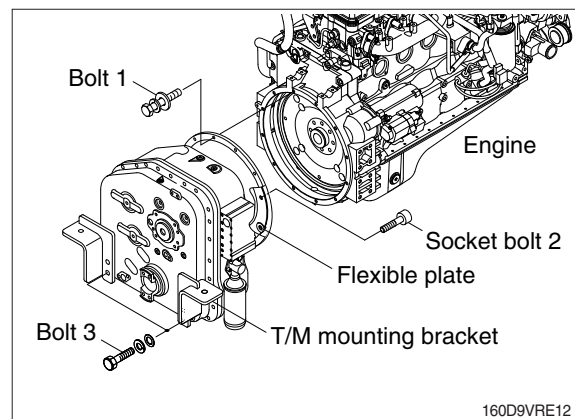
- ① Remove the cover on the left side of the flywheel housing then remove the 8 mounting bolts installed to the engine flywheel.

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.

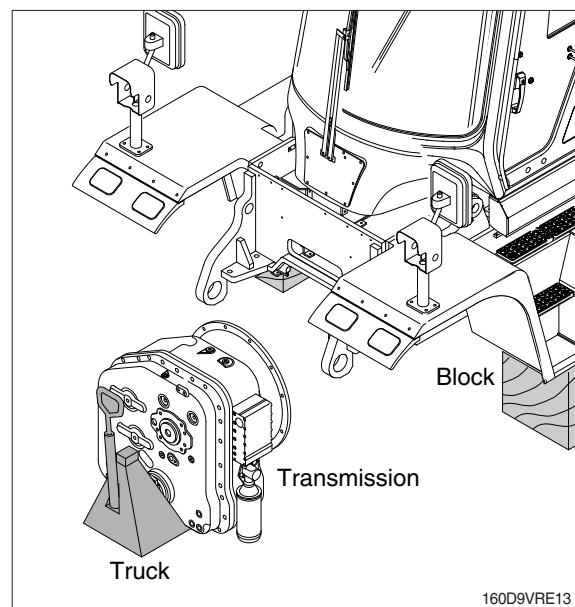


(9) Mounting bolts holding to flywheel housing

- 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.



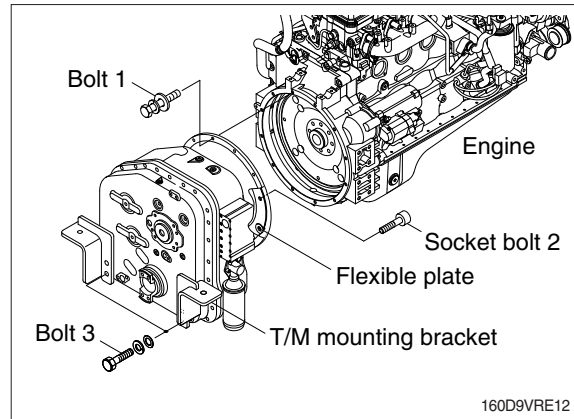
2) INSTALLATION

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 : 50~66 kgf·m (362~477 lbf·ft)

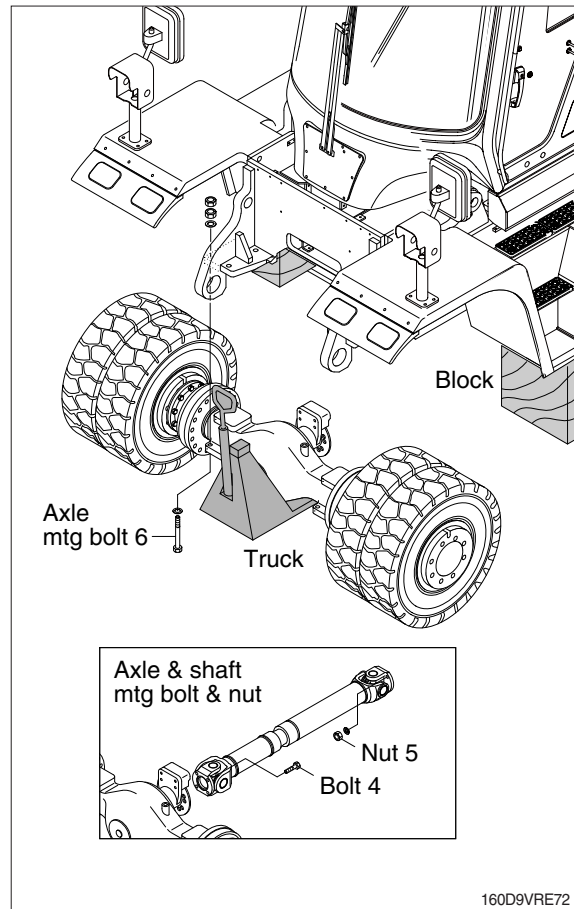
※ Apply loctite #277 on the thread before tightening the bolts.



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

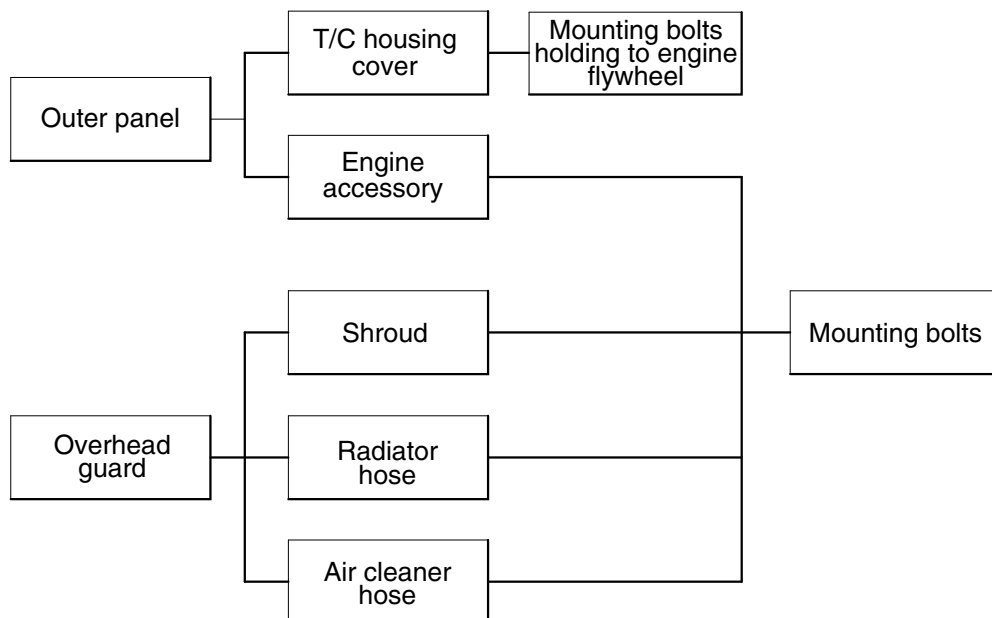
※ Apply loctite #277 on the thread before tightening the bolts.



3. ENGINE

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

1) REMOVAL

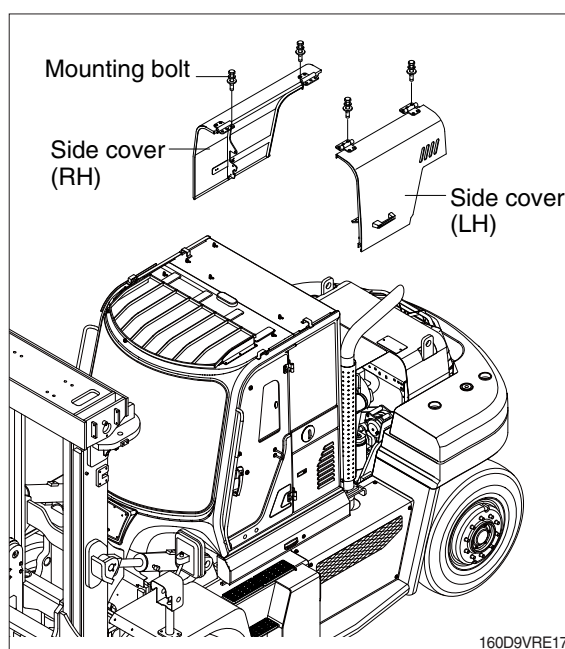


110D9RE25

(1) Outer panel

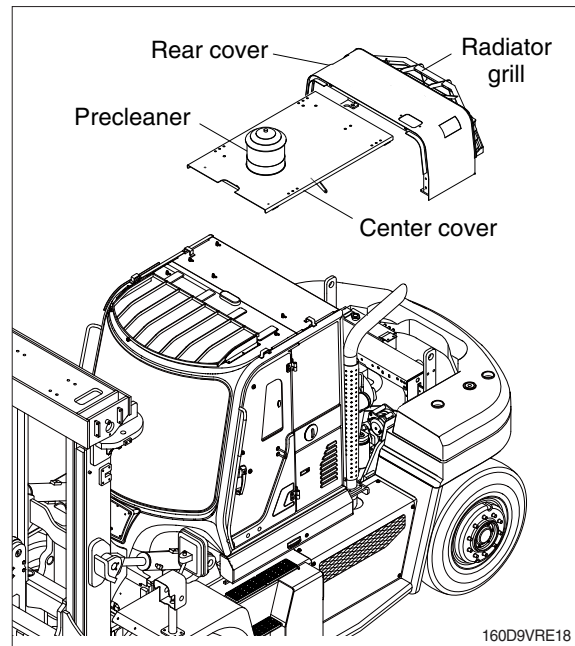
① Side door (LH, RH)

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

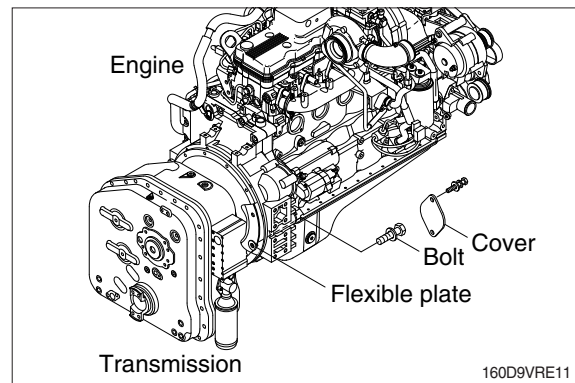


② Center cover

- 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.



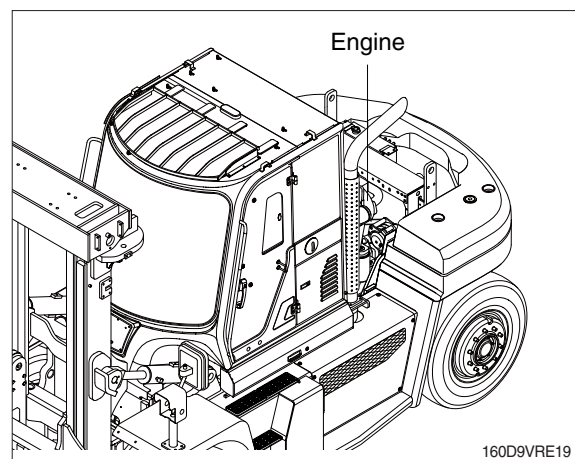
- (2) Flywheel housing cover and mounting bolts. See page 2-14.



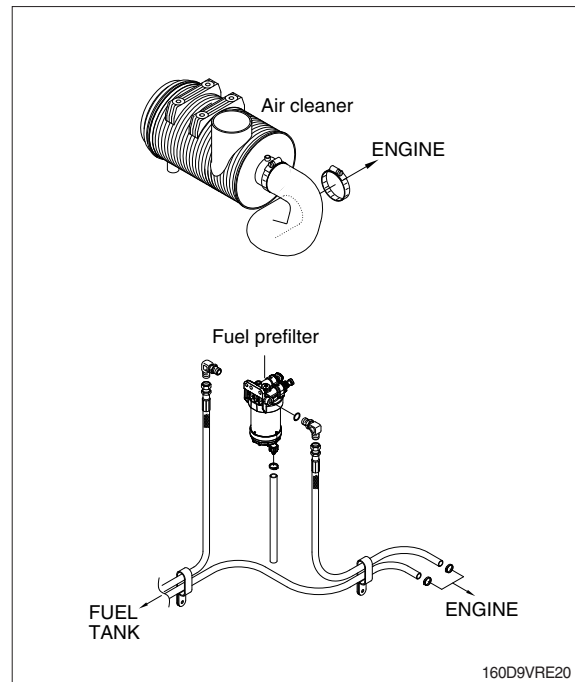
(3) Engine accessory

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

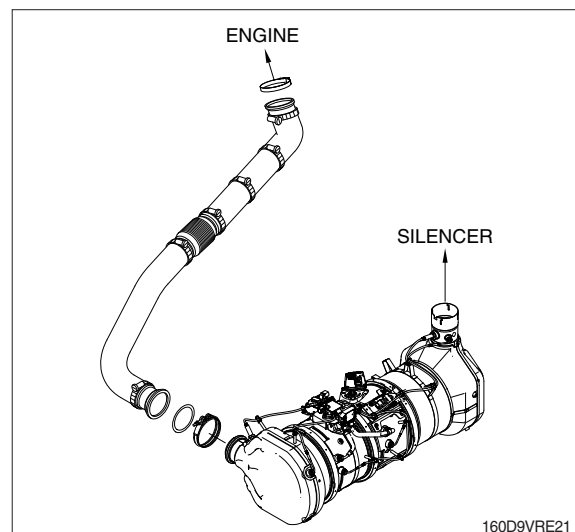
- ① Wiring harness to alternator and starter.
- ② Wiring harness for oil pressure and engine water temperature gauges.
- ③ Cables for meters, buttons and accelerator pedal.



- ④ Hoses to fuel tank and air cleaner.

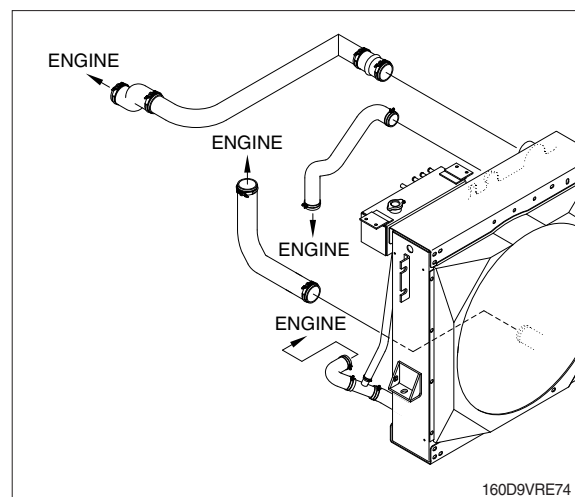


- ⑤ Exhaust pipe.



(4) Radiator hose

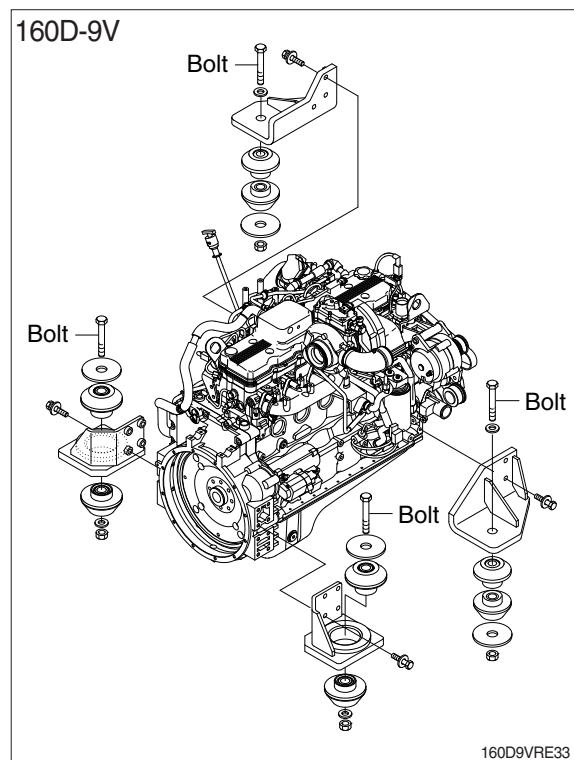
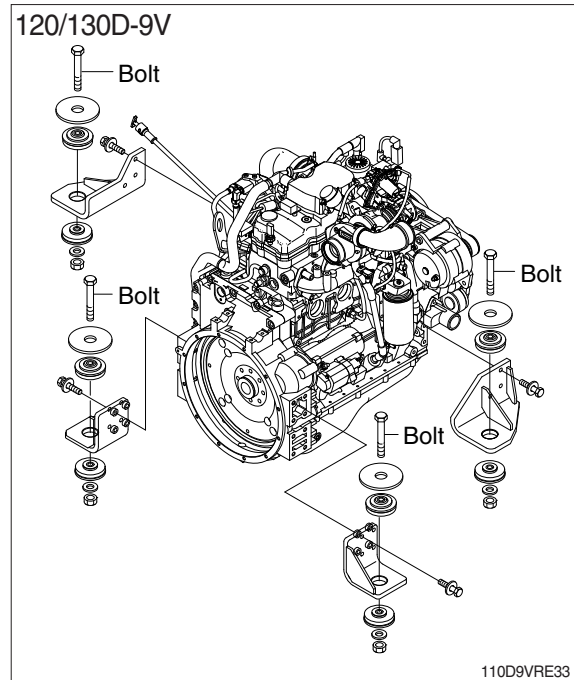
Open the drain valve of the radiator and drain the cooling water, then remove the radiator hose.



(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 (1).

- Tightening torque : 9.9~14.7 kgf·m
(71.6~106 lbf·ft)

※ 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 (2).

- Tightening torque : 25.2~34.2 kgf·m
(182~247 lbf·ft)

· Tightening torque

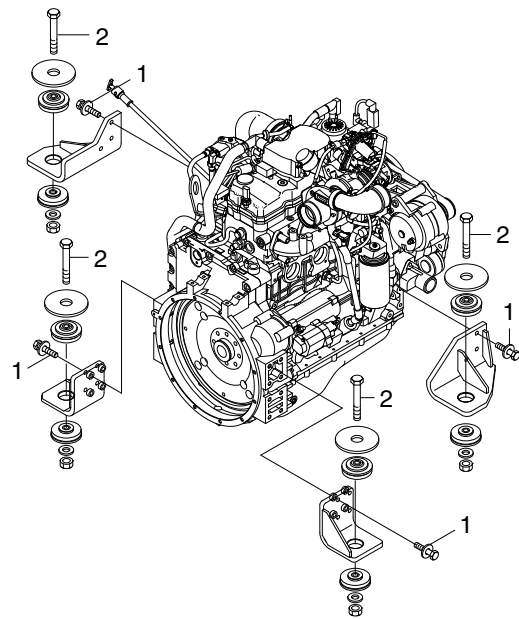
- Bolt (1)

9.9~14.7 kgf·m (71.6~106 lbf·ft)

- Bolt and nut (2)

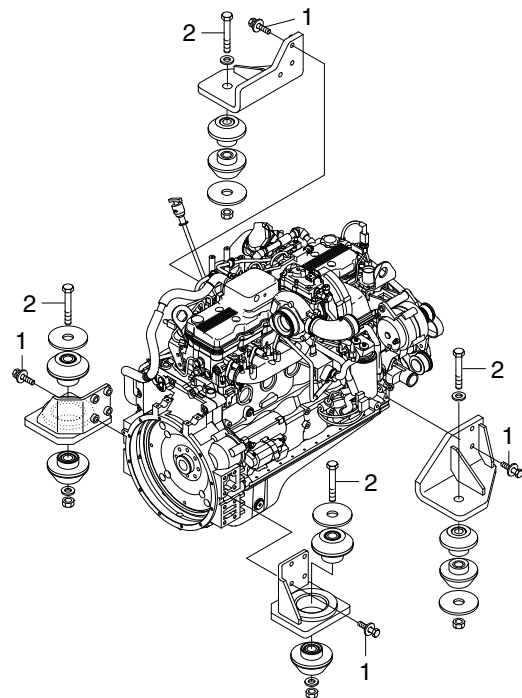
85~115 kgf·m (615~832 lbf·ft)

120/130D-9V



110D9VRE34

160D-9V

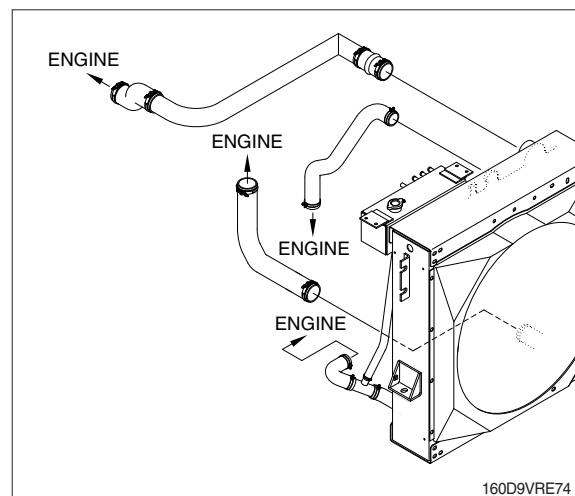


160D9VRE34

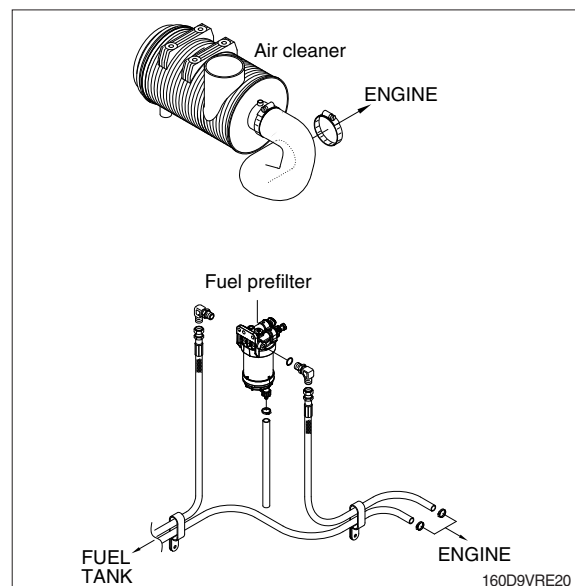
- (3) Tightening torque of mounting bolt installed to torque converter housing.
·See page 2-15, 2) **INSTALLATION**.

(4) Radiator hoses

Insert the radiator hoses securely and fit the clamps.

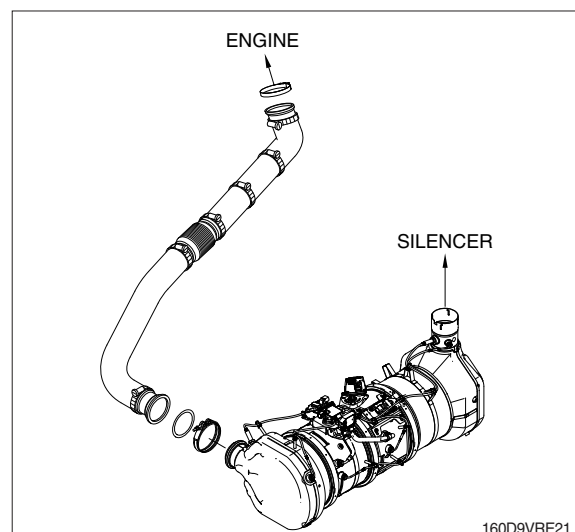


- (5) Air cleaner hose** Insert the air cleaner
① hose securely and fit a clamp.



(6) Exhaust pipe

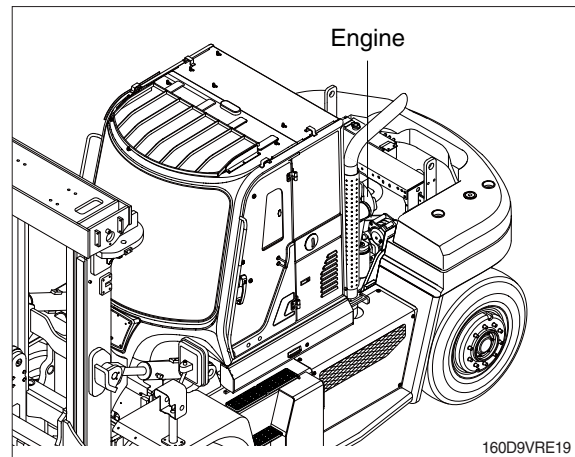
Insert the exhaust pipe to the engine securely and fit a clamp.



(7) Engine accessory

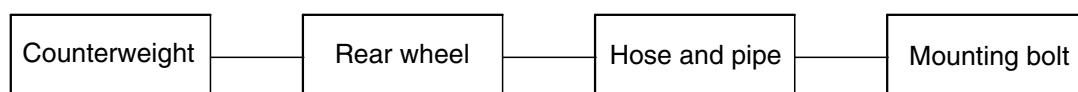
Install all wiring harnesses, cables and hoses around the engine, dashboard and frame.

- 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.

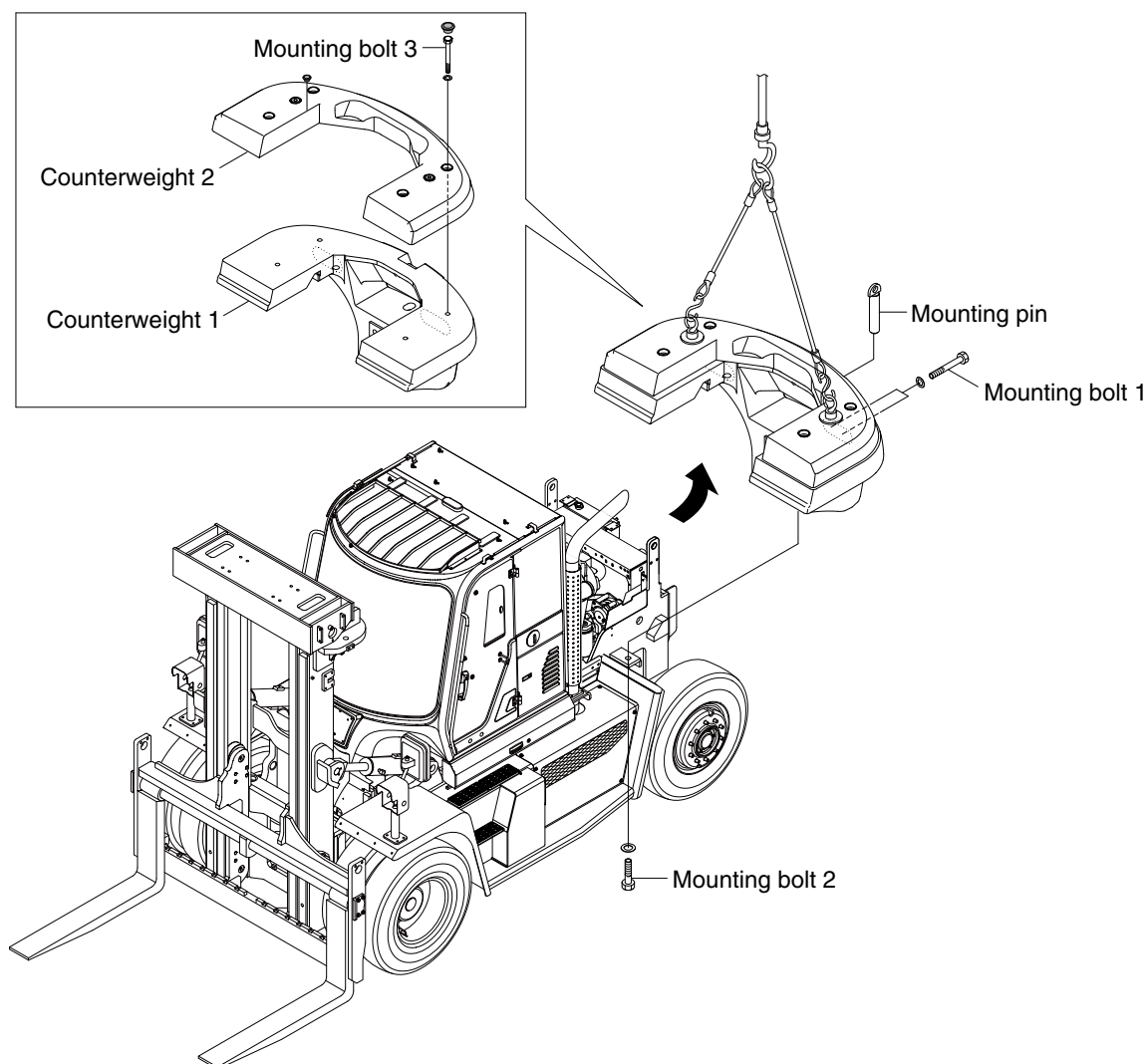


4. REAR AXLE

1) REMOVAL



110D9RE35



160D9VRE30

(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
120D-9V	2750 kg (6010 lb)	1390 kg (3065 lb)
130D-9V	3505 kg (7730 lb)	1390 kg (3065 lb)
160D-9V	4240 kg (9350 lb)	1850 kg (4080 lb)

· Tightening torque

- Mounting bolt 1 : 199 ± 29.9 kgf·m (1440 ± 216 lbf·ft)

- Mounting bolt 2, 3 : 100 kgf·m (722 lbf·ft)

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

(2) Rear wheel

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

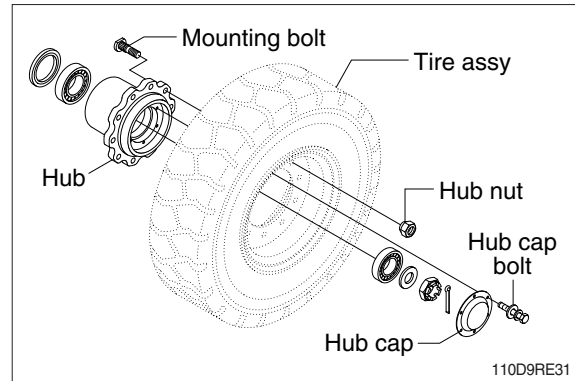
· Tightening torque

- Hub nut

$83.2 \pm 10 \text{ kgf}\cdot\text{m}$ ($602 \pm 72.3 \text{ lbf}\cdot\text{ft}$)

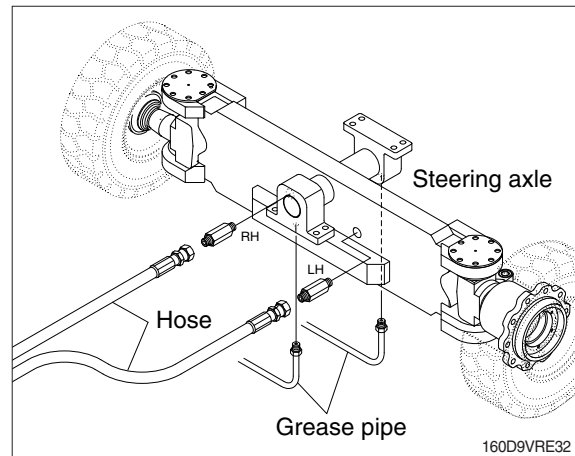
- Hub cap bolt

$2.5 \pm 0.5 \text{ kgf}\cdot\text{m}$ ($11.8 \pm 3.6 \text{ lbf}\cdot\text{ft}$)



(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

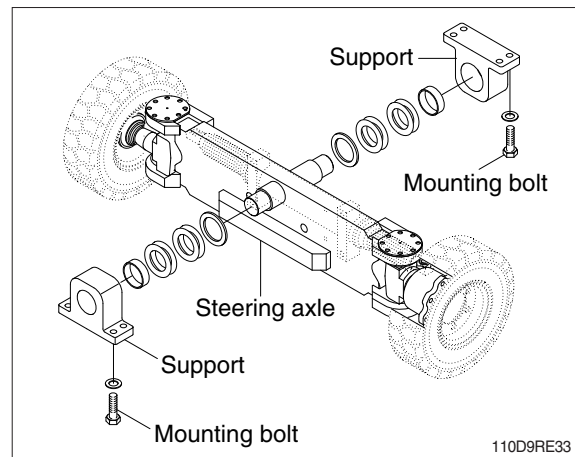
Put a block under the steering axle, support on a truck, and raise the frame with a crane. Remove the mounting bolts installing to the frame, and pull out to the rear.

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

· Mounting bolt tightening torque

$100 \pm 15 \text{ kgf}\cdot\text{m}$ ($723 \pm 72.3 \text{ lbf}\cdot\text{ft}$)

※ Apply loctite #277 on the thread before tightening.

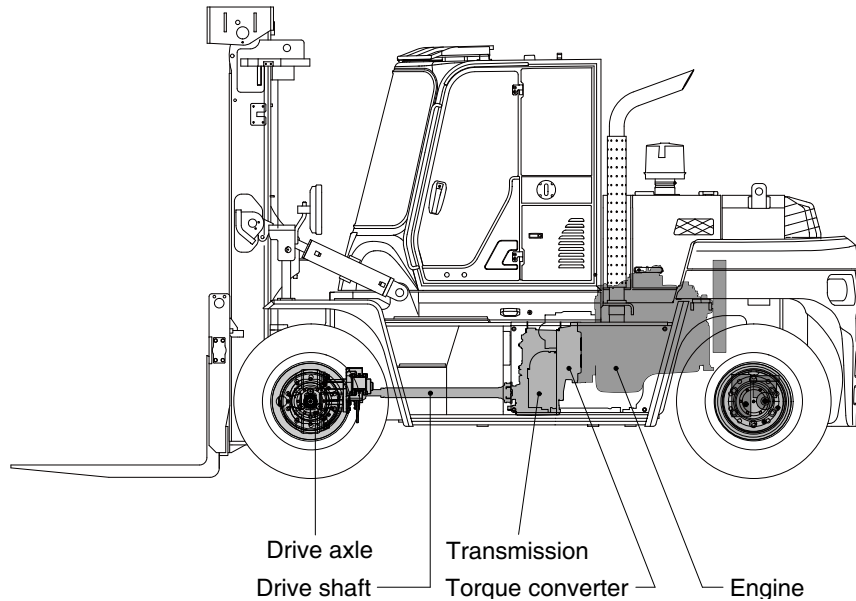


SECTION 3 POWER TRAIN SYSTEM

Group 1	Structure and operation	3-1
Group 2	Operation and maintenance	3-60
Group 3	Disassembly and assembly	3-73
Group 4	Adjustment	3-191

GROUP 1 STRUCTURE AND OPERATION

1. POWER TRAIN COMPONENT OVERVIEW



160D9VPT01

The power train consists of the following components :

- Torque converter
- Transmission
- Drive shaft
- Drive axle

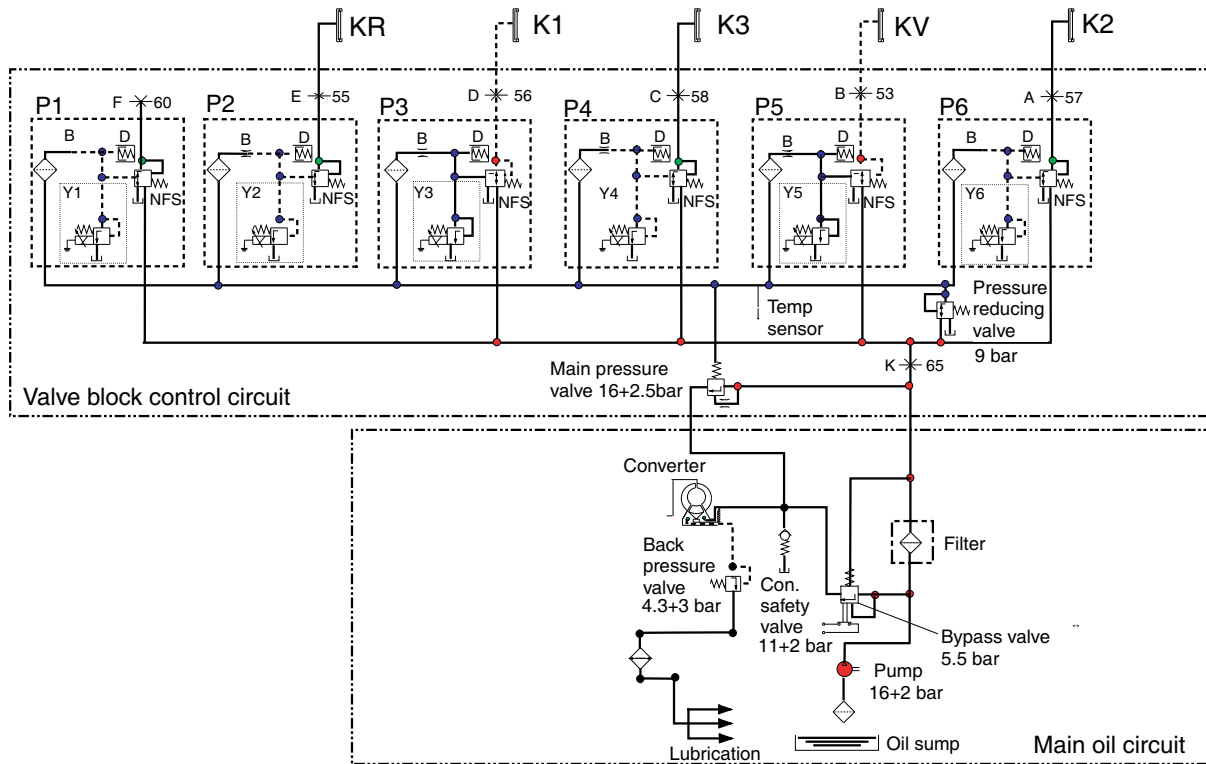
Engine power is transmitted to the transmission through the torque converter.

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

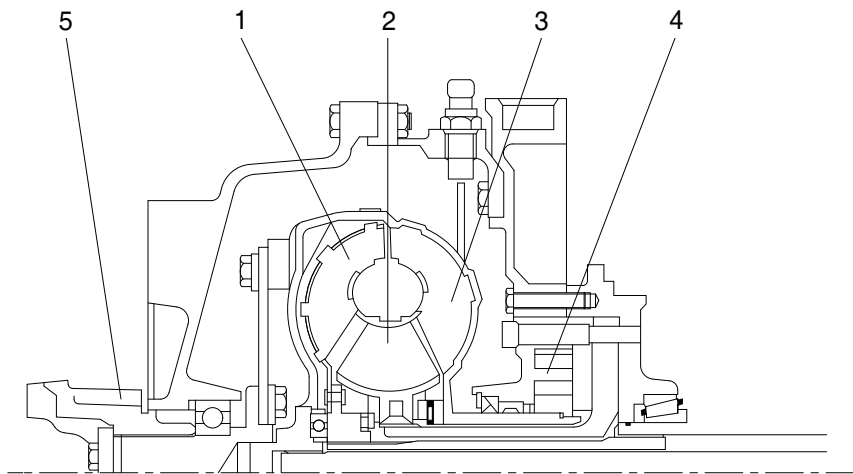
P4 Proportional valve K3

P5 Proportional valve KV

P6 Proportional valve K2

Y1~Y6 Pressure regulators

2. TORQUE CONVERTER



D503TM01

- | | | | | | |
|---|---------|---|-------------------|---|-------------|
| 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.

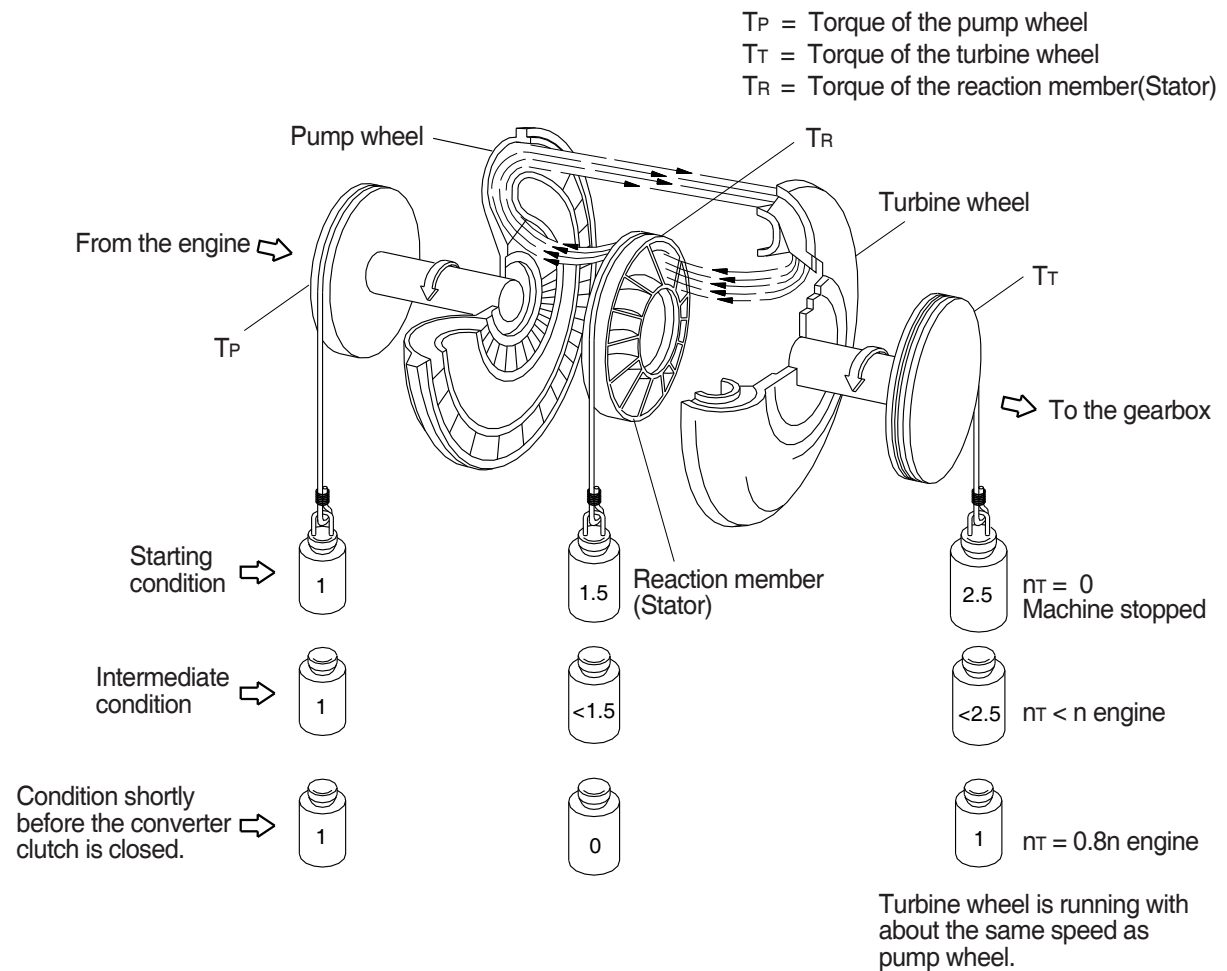
If the turbine speed is reaching about 80% of the pump speed, the conversion becomes 1.0 i.e. the turbine moment becomes equal to that of the pump moment.

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.

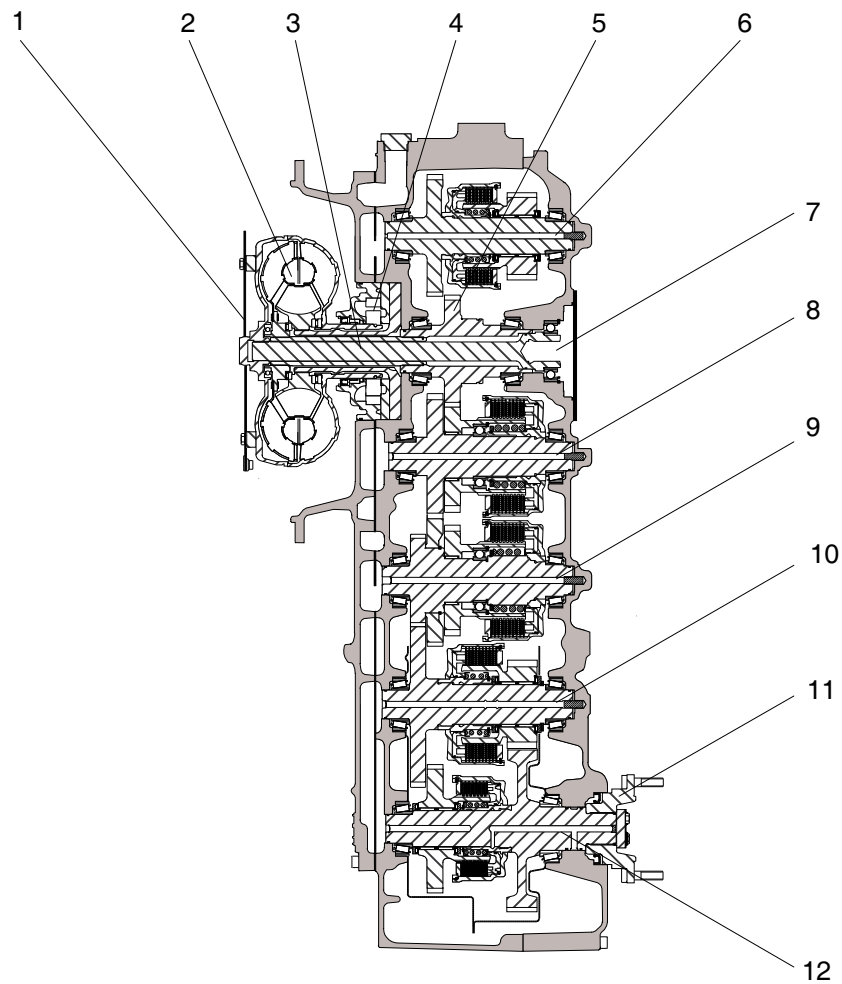
Function of a hydrodynamic torque converter (Schematic view)



D503TM02

3. TRANSMISSION

1) LAYOUT



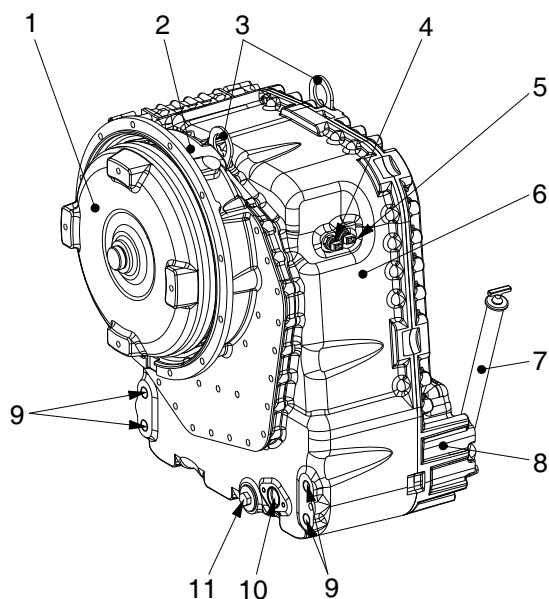
D507TM03

- 1 Engine connection
- 2 Converter
- 3 Input shaft
- 4 Transmission pump

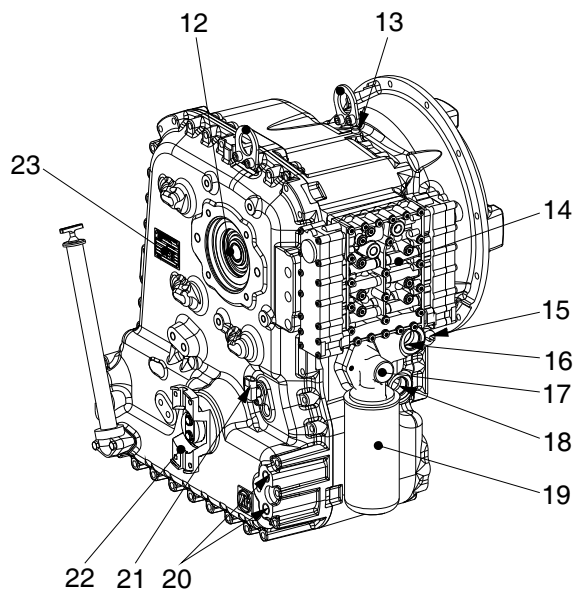
- 5 Input gear
- 6 Clutch shaft
- 7 Power take-off
- 8 Clutch shaft (KV)

- 9 Clutch shaft (KR)
- 10 Clutch shaft (K1)
- 11 Output flange
- 12 Clutch shaft (K3/output)

2) INSTALLATION VIEW



FRONT VIEW



REAR VIEW

110D9PT26

- 1 Converter
- 2 Converter bell
- 3 Lifting lugs
- 4 Inductive transmitter on central gear train
- 5 Inductive transmitter on 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 x 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 on 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.

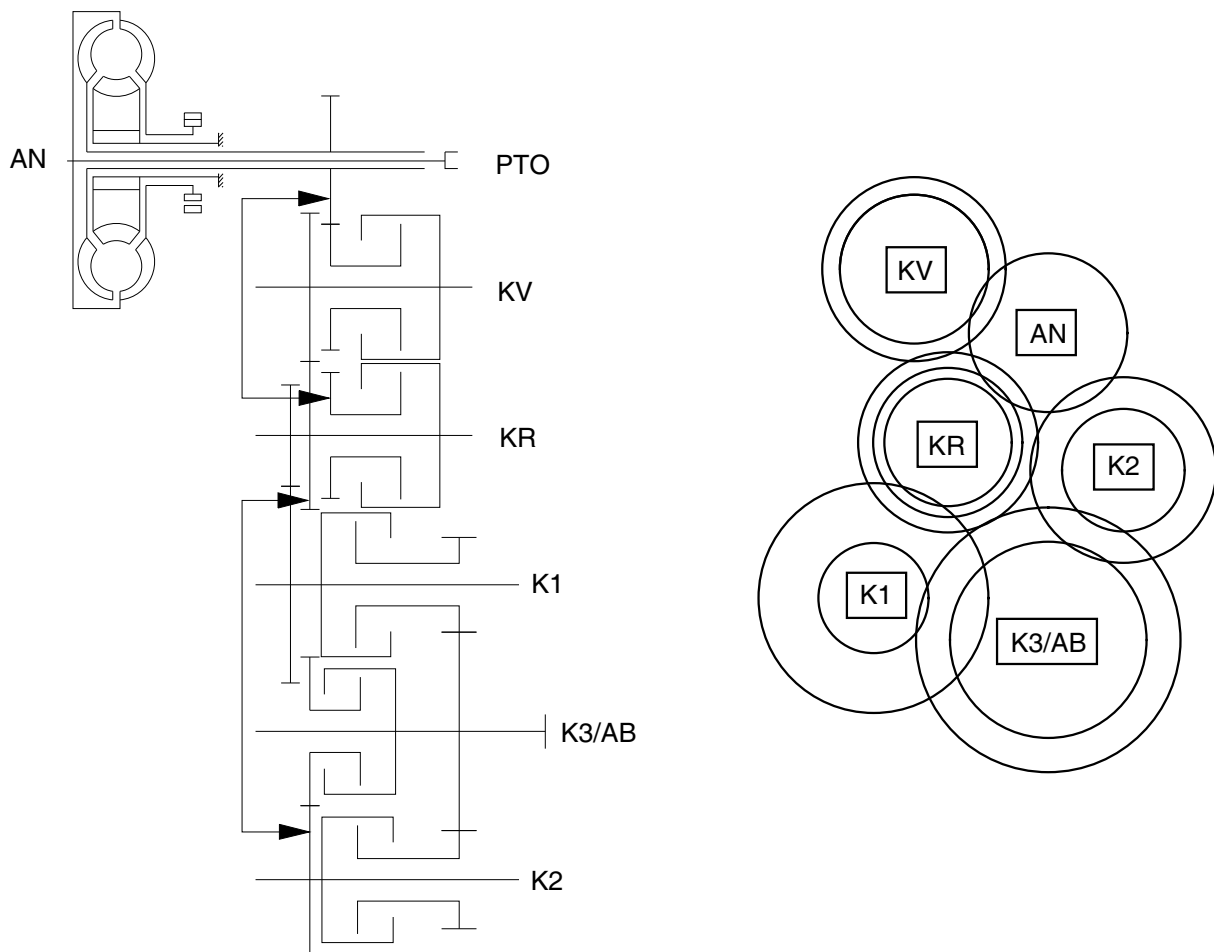
All gears are constantly meshing and carried on anti-friction bearings.

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 task 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

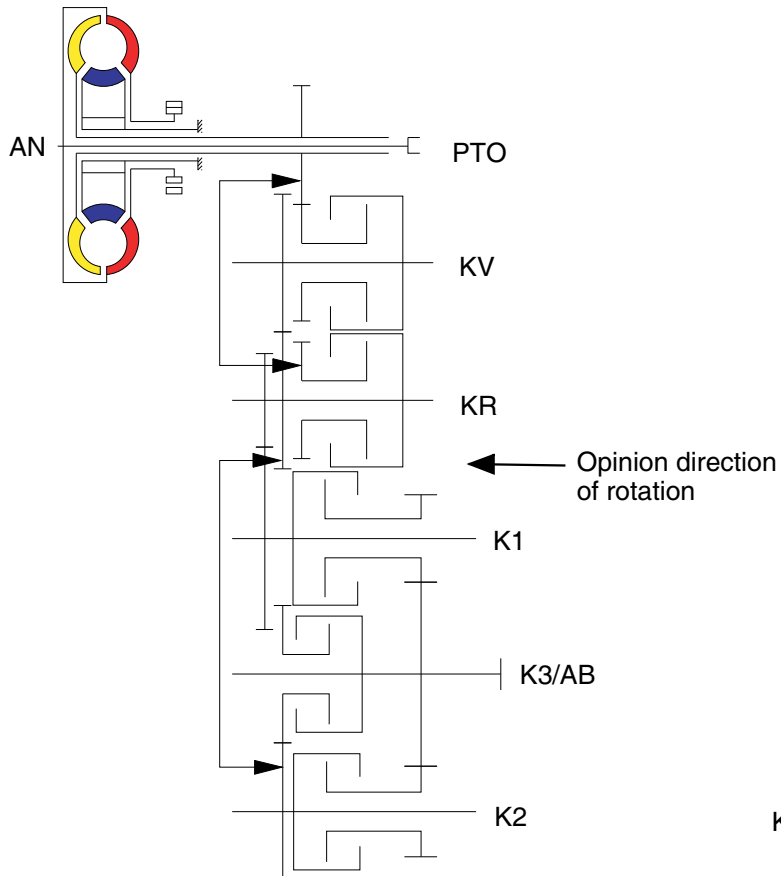
D507PT32

(2) Forward

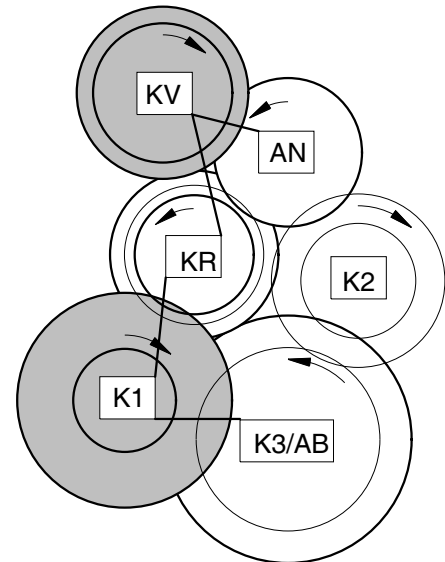
In forward, forward clutch and 1st, 2nd, 3rd clutch are engaged.

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

Transmission diagram



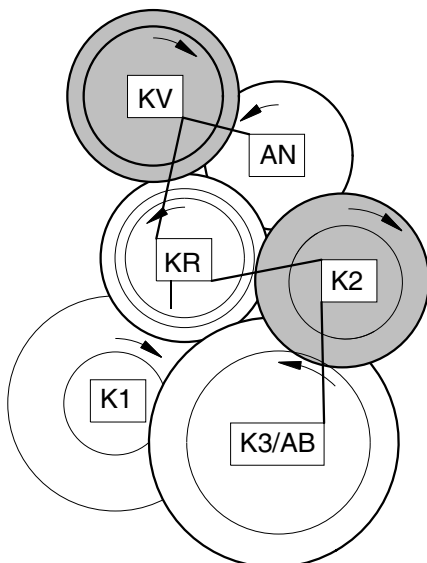
1st speed-forward



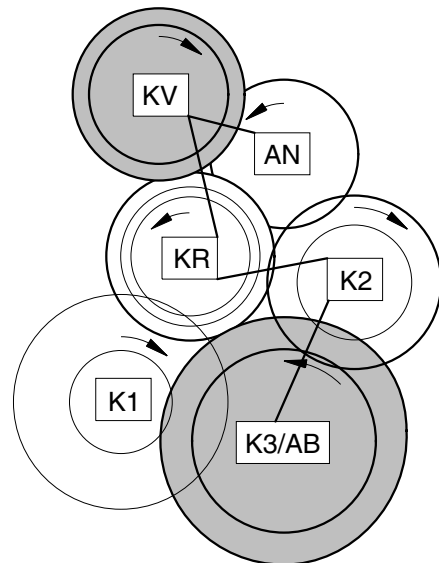
Legend:

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



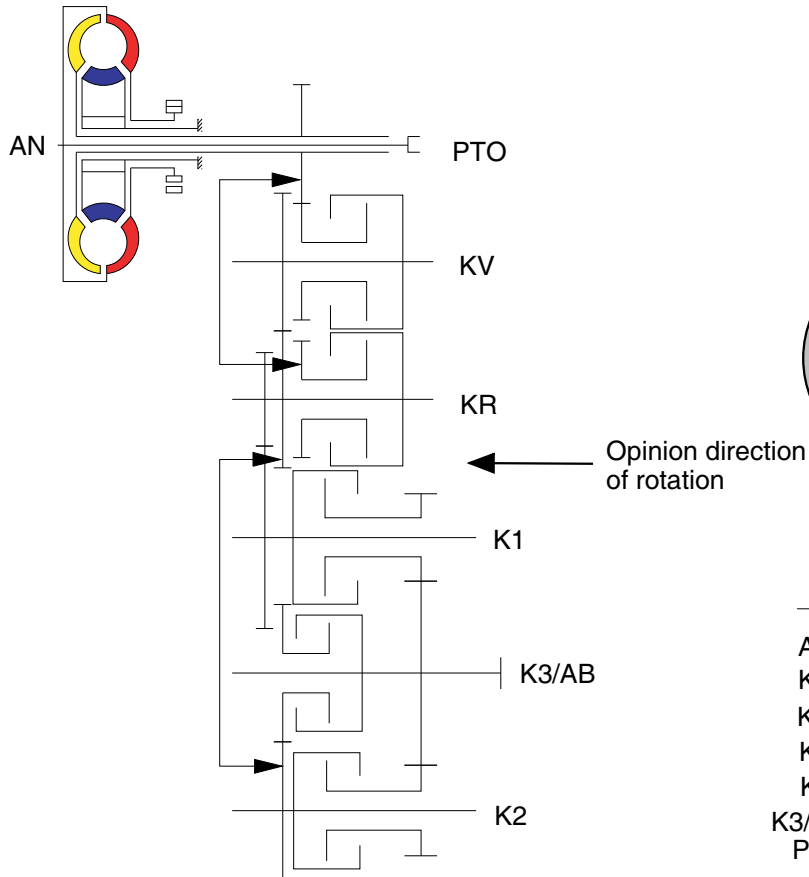
D503PT33

(3) Reverse

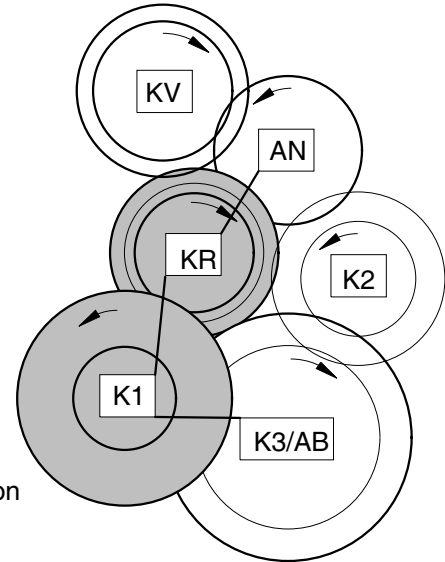
In reserve, reserve clutch and 1st, 2nd, 3rd clutch are engaged.

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

Transmission diagram



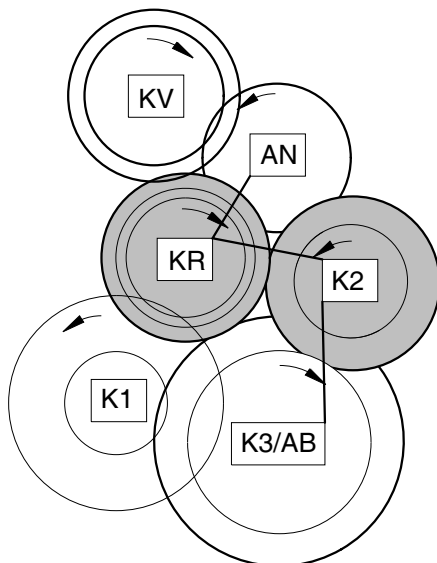
1st speed-reverse



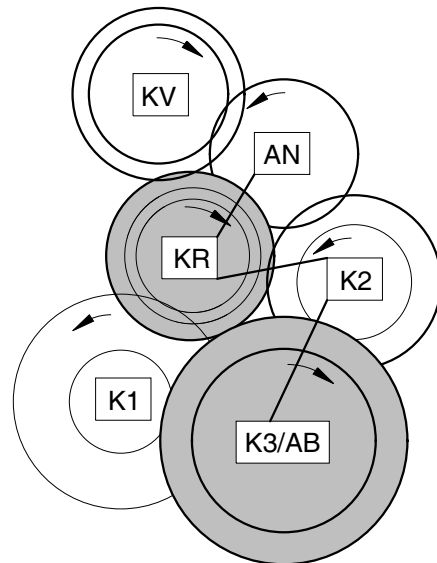
Legend:

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

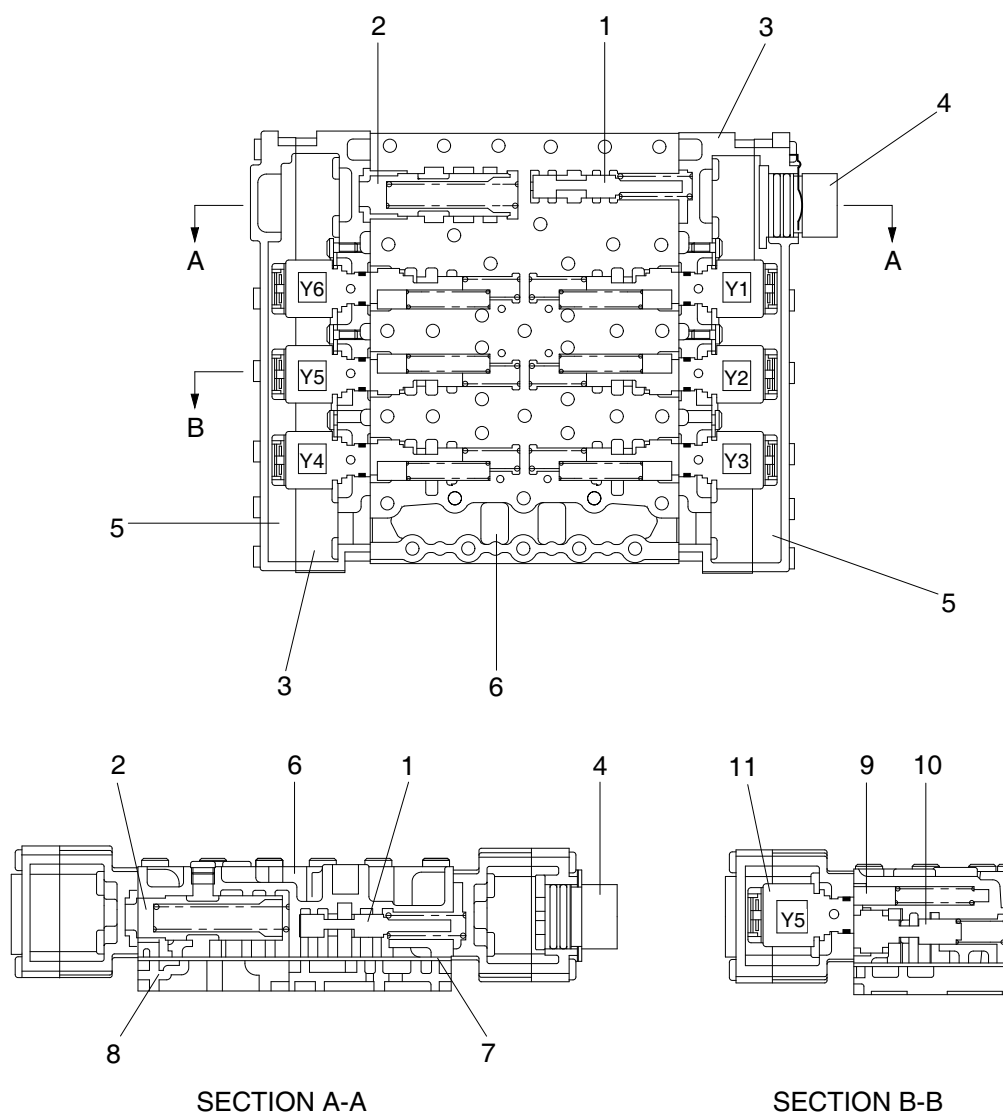


3rd speed-reverse



D507PT34

4) ELECTRO-HYDRAULIC SHIFT CONTROL WITH PROPORTIONAL VALVE



D507PT03

- | | | | |
|---|----------------------------------|----|--------------------|
| 1 | Pressure reducing valve (9 bar) | 7 | Intermediate plate |
| 2 | Main pressure valve (16 + 2 bar) | 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

$$Q = 85 \text{ l/min, at } n_{\text{Motor}} = 2000 \text{ min}^{-1}$$

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 $\Delta p = 5.5 \pm 3 \text{ bar}$) 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 ($16 \pm 2 \text{ bar}$) 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 $16 \pm 2.5 \text{ bar}$ 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 $11 \pm 2 \text{ bar}$).

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 $4.3 \pm 3 \text{ bar}$.

The oil, escaping out of the converter, is directed to the oil cooler.

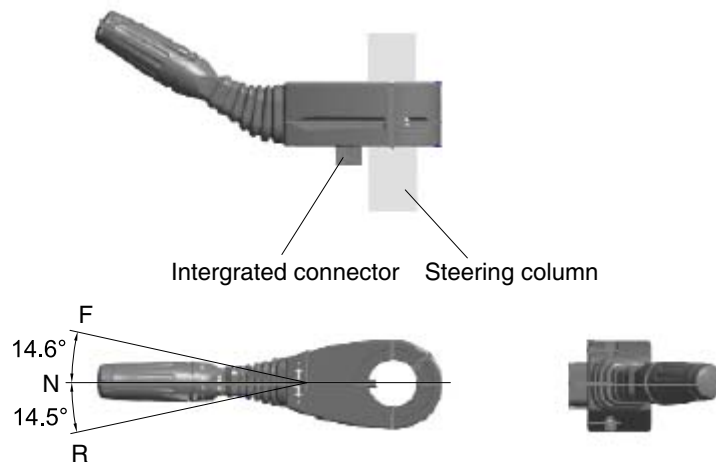
From the oil cooler, the oil is directed to the transmission and there to the lubricating oil circuit, so that all lubricating points are supplied with cooled oil.

In the electrohydraulic control unit are 6 pressure regulators installed.

5) GEAR SELECTOR (ES1C)

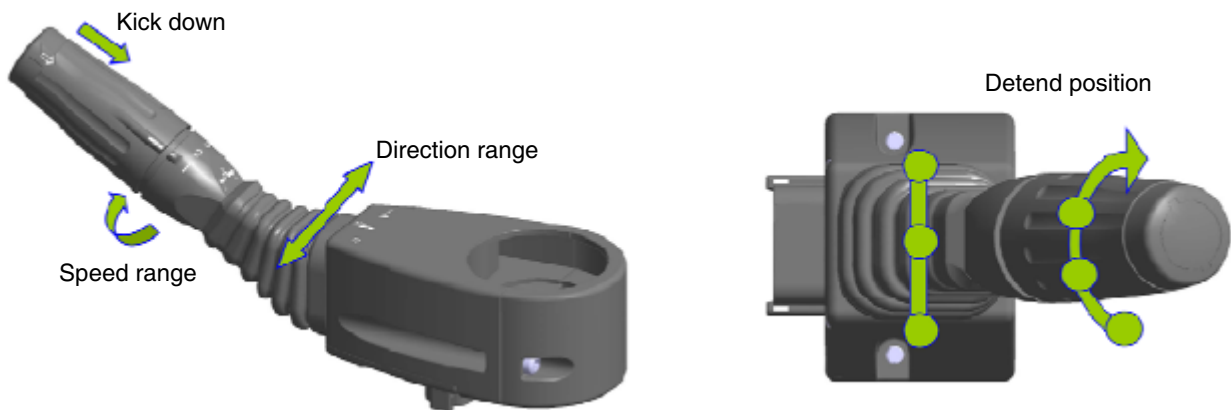
The gear selector is designed for the mounting on the steering column left side. By a rotative motion, the positions (speeds) 1 to 3 are selected by tilting the lever, the driving direction (Forward (F) - Neutral (N) - Reverse (R)).

The lever is operated by using the HALL IC with non-contact magnetic field switch method and the output signal sends with CAN bus.



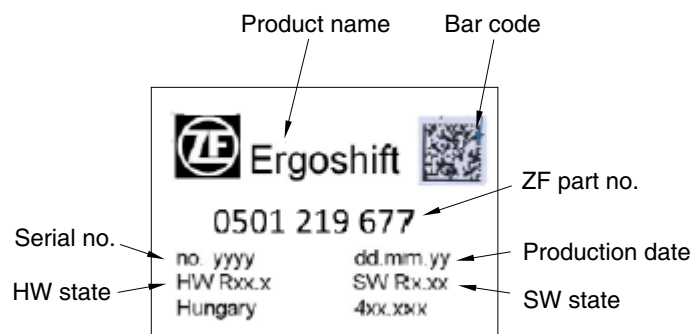
160D9VGS01

(1) Shift pattern



160D9VGS02

(2) Type plate



160D9VGS03

GEAR SELECTOR (ES1C)

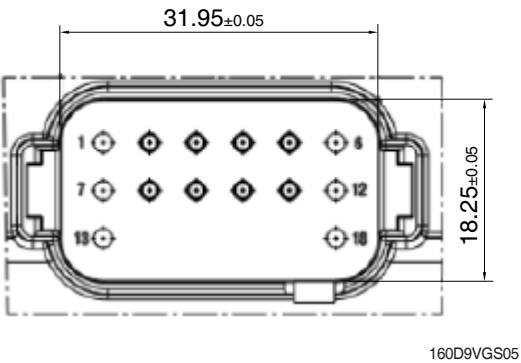
(3) Connector

All connections terminate in the 18-way Deutsch integrated connector.
Mating connector is DT16-18SA-K004.

Housing	Socket	Blind plug
18-way	Size 16, nickel plated Wire size : 0.5~1.0 mm ²	—
		
DT16-18SA-K004	0462-201-16141	0413-217-1605

(4) PINNING

Output connector	
Terminal	Designation
1	-
2	CAN_H
3	CAN_H*
4	CAN_T
5	KL15
6	-
7	-
8	CAN_L*
9	CAN_L
10	GND
11	KL30
12	-
13	-
14	-
15	-
16	-
17	-
18	-



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 ($1 \pm 0.1V$), After pedal operation ($3.5 \pm 0.1V$).
- 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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: <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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: <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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: <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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: <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 transmission sump temperature sensor input The measured voltage is too high: <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · Check the cable from TCU to the sensor · Check the connectors · Check the temperature sensor
26	S.C. to battery voltage or O.C. at transmission sump temperature sensor input The measured voltage is too low: <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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: <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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: <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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: <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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: <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · Cable/connector is defective and is contacted to vehicle ground · Speed sensor has an internal defect 	OP mode : Substitute clutch control	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · Cable/connector is defective and is contacted to vehicle ground · Speed sensor has an internal defect 	OP mode : Substitute clutch control	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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. <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · Cable/connector is defective and is contacted to battery voltage · Engine derating device has an internal defect 	No reaction OP mode : Normal	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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 	-	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · Cable or connectors are defective and are contacted to battery voltage · Display has an internal defect 	No reaction OP mode : Normal	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> · Cable or connectors are defective and are contacted to battery voltage · Display has an internal defect 	No reaction OP mode : Normal	<ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · Check Omron master · Check wire of DeviceNet-Bus · Check cable to Omron master
E5	DISPID1 timeout Timeout of CAN-massage DISPID1 from display controller <ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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

(2) Operation modes

① Normal

There is no failure detected in the transmission-system or the failure has no or slight effects on transmission control. TCU will work without or in special cases with little limitations.

② Substitute clutch control

TCU cannot change the gears or the direction under the control of the normal clutch modulation. TCU uses the substitute strategy for clutch control. All modulations are only time controlled.

③ Limp home

This mode is intended to allow the driver to leave area of work or area of danger. If an error is detected which error reaction is limp home, the transmission shifts to neutral. The driver can reengage the gear if he selects neutral with the shift lever. The first possible gear in the desired direction will be engaged on a driving request. The transmission is not able to shift into other gears in Limp Home mode. To perform reversals the driver has to shift to neutral and then to the opposite direction.

④ Transmission shutdown

This mode is intended to put the transmission into safe state if an error occurs which error reaction is transmission shutdown. The transmission shifts to neutral and no driving is possible as long as the failure is active. The driver has to shift to neutral to get into normal operation after the failure went inactive.

⑤ TCU shutdown

This mode is intended put the transmission into safe state if an error occurs which error reaction is TCU shutdown. In this operation mode no driving is possible. The driver has to shift to neutral and run a power off-on cycle to get into normal operation mode after the failure went inactive.

Error code		Description	Op mode	Cause	Possible step to repair
SPN	FMI				
523000	1	Battery low undervoltage	Trm shutdown	<p>The control unit detects a voltage of < 7.00 volt (12 V device) or < 9.00 volt (24 volt device) on the supply input of terminal 30.</p> <ol style="list-style-type: none"> 1 The alternator control unit has an internal defect. Vehicle battery not sufficiently charged. 3 Wiring or plug connection defective (supply or ground cable). 4 Control unit parameters incorrectly set. 	<p>The cause of the missing or insufficient voltage on terminal 30 must be located.</p> <ol style="list-style-type: none"> 1 Check the fuse of the terminal 30 control units. 2 If the error occurs after a (sluggish) vehicle start, check the vehicle battery. Recharge the battery to ensure that it is sufficiently charged. 3 Make sure that the control unit has a stable voltage supply. Check the stability of the voltage with Testman. 4 Check the wiring between the alternator and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. Pay special attention to the ground wiring. 5 Check the function of the alternator as well as the settings of the alternator control unit and replace both if necessary.
523000	3	Battery overvoltage	Trm shutdown	<p>The control unit detects a voltage of > 18.00 volt (12 volt device) or > 32.50 volt (24 volt device) on the supply input terminal 30.</p> <ol style="list-style-type: none"> 1 The alternator control unit has an internal defect. 2 Wiring or plug connection defective (supply or ground cable). 3 Control unit parameters incorrectly set. 	<p>The cause of the excessive voltage on terminal 30 must be located.</p> <ol style="list-style-type: none"> 1 Make sure that the control unit has a stable voltage supply. Check the voltage on the terminal tester with a voltmeter. <ul style="list-style-type: none"> · Target voltage ignition ON: Vehicle power supply. · Target voltage ignition OFF: Vehicle power supply. 2 With the ignition off, use a voltmeter to check the voltage on the connection of terminal 30 (steady plus) to terminal 31 (ground). The measured voltage must correspond to the vehicle power supply. 3 With the engine running, check the voltage in the same manner as described in the point above. The measured voltage must correspond to the vehicle power supply. 4 Check the wiring between the alternator and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. Pay special attention to the ground wiring. 5 Check the function of the alternator as well as the settings of the alternator control unit and replace both if necessary.

Error code		Description	Op mode	Cause	Possible step to repair
SPN	FMI				
523000	4	Battery undervoltage	Trm shutdown	<p>The control unit detects a voltage of < 9.00 volt (12 V device) or < 16.00 volt (24 volt device) on the supply input terminal 30.</p> <ol style="list-style-type: none"> 1 The alternator control unit has an internal defect. 2 Vehicle battery not sufficiently charged. 3 Wiring or plug connection defective (supply or ground cable). 4 Control unit parameters incorrectly set. 	<p>The cause of the missing or insufficient voltage on terminal 30 must be located.</p> <ol style="list-style-type: none"> 1 Check the fuse of the terminal 30 control units. 2 If the error occurs after a (sluggish) vehicle start, check the vehicle battery. Recharge the battery to ensure that it is sufficiently charged. 3 Make sure that the control unit has a stable voltage supply. Check the stability of the voltage with Testman. 4 Check the wiring between the alternator and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. Pay special attention to the ground wiring. 5 Check the function of the alternator as well as the settings of the alternator control unit and replace both if necessary.
523020	3	EC3: Supply for speed sensors (AU3) overvoltage	Trm shutdown	<p>The measured voltage is too high.</p> <ol style="list-style-type: none"> 1 Wiring or plug connection is defective. 2 Sensor has an internal defect. 3 Control unit has an internal defect. 	<p>The cause of the incorrect voltage must be located.</p> <ol style="list-style-type: none"> 1 Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2 Check the correct wiring of the pins. 3 Check the function of the sensor or replace the sensor. 4 Replace the control unit if the error continues to occur.
523020	4	EC3: Supply for speed sensors (AU3) undervoltage	Trm shutdown	<p>The measured voltage is too low.</p> <ol style="list-style-type: none"> 1 Wiring or plug connection is defective. 2 Sensor has an internal defect. 3 Control unit has an internal defect. 	<p>The cause of the incorrect voltage must be located.</p> <ol style="list-style-type: none"> 1 Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2 Check the correct wiring of the pins. 3 Check the function of the sensor or replace the sensor. 4 Replace the control unit if the error continues to occur.
523020	6	EC3: Supply for speed sensors (AU3) short to ground	Trm shutdown	<p>The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too low.</p> <ol style="list-style-type: none"> 1 Wiring or plug connection contacts vehicle ground. 2 Component has an internal defect. 3 Control unit has an internal defect. <p>Note : If this error occurs, calculations are partially being made with replacement values. The transmission functions are limited and the shifting quality is reduced.</p>	<ol style="list-style-type: none"> 1 Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 2 Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 3 Check the function of the connected component and replace it if needed. 4 Replace the control unit if the error continues to occur.

Error code		Description	Op mode	Cause	Possible step to repair
SPN	FMI				
523021	3	EC3 : Supply for temperature sensors and oil filter restriction switch (AU2) overvoltage EC4 : Supply for speed sensors (AU2) overvoltage	Trm shutdown	The measured voltage is too high. 1 Wiring or plug connection is defective. 2 Sensor has an internal defect. 3 Control unit has an internal defect.	The cause of the incorrect voltage must be located. 1 Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2 Check the correct wiring of the pins. 3 Check the function of the sensor or replace the sensor. 4 Replace the control unit if the error continues to occur.
523021	4	EC3 : Supply for temperature sensors and oil filter restriction switch (AU2) undervoltage EC4: Supply for speed sensors (AU2) undervoltage	Trm shutdown	The measured voltage is too low. 1 Wiring or plug connection is defective. 2 Sensor has an internal defect. 3 Control unit has an internal defect.	The cause of the incorrect voltage must be located. 1 Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2 Check the correct wiring of the pins. 3 Check the function of the sensor or replace the sensor. 4 Replace the control unit if the error continues to occur.
523021	6	EC3 : Supply for temperature sensors and oil filter restriction switch (AU2) short to ground EC4 : Supply for speed sensors (AU2) short to ground	Trm shutdown	The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too low. 1 Wiring or plug connection contacts vehicle ground. 2 Component has an internal defect. 3 Control unit has an internal defect. Note: If this error occurs, calculations are partially being made with replacement values. The transmission functions are limited and the shifting quality is reduced.	1 Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 2 Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 3 Check the function of the connected component and replace it if needed. 4 Replace the control unit if the error continues to occur.

Error code		Description	Op mode	Cause	Possible step to rapair
SPN	FMI				
523022	3	EC4: Supply for oil filter restriction switch (AU1) overvoltage	Limp home	The measured voltage is too high. 1 Wiring or plug connection is defective. 2 Sensor has an internal defect. 3 Control unit has an internal defect.	The cause of the incorrect voltage must be located. 1 Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2 Check the correct wiring of the pins. 3 Check the function of the sensor or replace the sensor. 4 Replace the control unit if the error continues to occur.
523022	4	EC4: Supply for oil filter restriction switch (AU1) undervoltage	Limp home	The measured voltage is too low. 1 Wiring or plug connection is defective. 2 Sensor has an internal defect. 3 Control unit has an internal defect.	The cause of the incorrect voltage must be located. 1 Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2 Check the correct wiring of the pins. 3 Check the function of the sensor or replace the sensor. 4 Replace the control unit if the error continues to occur.
523022	6	EC4: Supply for oil filter restriction switch (AU1) short to ground	Limp home	The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too low. 1 Wiring or plug connection contacts vehicle ground. 2 Component has an internal defect. 3 Control unit has an internal defect.	1 Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 2 Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 3 Check the function of the connected component and replace it if needed. 4 Replace the control unit if the error continues to occur.

Error code		Description	Op mode	Cause	Possible step to rapair
SPN	FMI				
523030	3	Propvalve power supply 1 (VPS1) overvoltage	TCU shutdown	<p>The measured voltage is too high.</p> <p>1 Wiring or plug connection is defective.</p> <p>2 Component has an internal defect.</p> <p>3 Control unit has an internal defect.</p>	<p>The cause of the incorrect voltage must be located.</p> <p>1 Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts.</p> <p>2 Check the correct wiring of the pins.</p> <p>3 Check the function of the connected component or replace the component.</p> <p>4 Replace the control unit if the error continues to occur.</p>
523031	3	Propvalve power supply 2 (VPS2) overvoltage	TCU shutdown	<p>The measured voltage is too high.</p> <p>1 Wiring or plug connection is defective.</p> <p>2 Component has an internal defect.</p> <p>3 Control unit has an internal defect.</p>	<p>The cause of the incorrect voltage must be located.</p> <p>1 Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts.</p> <p>2 Check the correct wiring of the pins.</p> <p>3 Check the function of the connected component or replace the component.</p> <p>4 Replace the control unit if the error continues to occur.</p>
523040	0	TCU overtemperature	TCU shutdown	<p>The measured temperature on the control unit of the transmission is too high.</p> <p>1 Overheating due to outside influences.</p> <p>2 Temperature sensor has an internal defect.</p>	<p>The cause of the increased temperature input in the control unit must be located.</p> <p>1 Check if outside influences have caused the excessive temperature.</p> <p>2 If the error continues to occur then the control unit needs to be replaced.</p>
523040	2	TCU temperature invalid value	TCU shutdown	<p>The measured temperature on the control unit of the transmission is invalid.</p> <p>1 Control unit has an internal defect.</p>	<p>1 Replace the control unit.</p>

Error code		Description	Op mode	Cause	Possible step to repair
SPN	FMI				
523044	12	Internal TCU Error 5	TCU shutdown	<p>There are 3 startup self-tests concerning power lines</p> <p>1 Watch dog cut-off test – WD chip allow VPS to be enabled only if it is activated (armed) and disable all VPSs before it resets MCU. The selftest check it.</p> <p>2 VPS cut off test – SW is able to control VPS via power supply manager component – self test check it</p> <p>3 OCG off test – it check if when VPS is on and OCG/AIM channels are disable (requested current = 0), there really is no current on the lines.</p>	<p>The cause of the incorrect behaviour must be located.</p> <p>1 Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts.</p> <p>2 Check the correct wiring of the pins.</p> <p>3 Check the function of the connected component or replace the component.</p> <p>4 Replace the control unit if the error continues to occur.</p>
523045	12	Internal TCU Error 1	TCU shutdown	The control unit detects an internal error.	Read out the operating data with Testman and send them to your ZF contact.
523046	12	Internal TCU Error 2	TCU shutdown	The control unit detects an internal error.	Read out the operating data with Testman and send them to your ZF contact.
523049	12	Unknown transmission controller hardware detected	TCU shutdown	Wrong TCU mounted. The TCU doesn't fit to the application.	Contact your ZF representative.
523100	3	Speed sensor input 1 (EF1) overvoltage: Turbine speed	Limp home	<p>The measured voltage at the input is too high.</p> <p>1 Wiring or plug connection is defective.</p> <p>2 Component has an internal defect.</p> <p>3 Control unit has an internal defect.</p>	<p>The cause of the incorrect voltage must be located.</p> <p>1 Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active.</p> <p>2 Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts.</p> <p>3 Check the correct wiring of the pins.</p> <p>4 Check the function of the connected component or replace the component.</p> <p>5 Replace the control unit if the error continues to occur.</p>

Error code		Description	Op mode	Cause	Possible step to rapair
SPN	FMI				
523100	6	Speed sensor input 1 (EF1) open or short to ground: Turbine speed	Limp home	<p>The measured line resistance between the connected component and the control unit is too high.</p> <p>1 Wiring or plug connection is defective.</p> <p>2 Component has an internal defect.</p> <p>3 Control unit has an internal defect.</p>	<p>1 Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester.</p> <p>2 Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts.</p> <p>3 Check the function of the connected component and replace it if needed.</p> <p>4 Replace the control unit if the error continues to occur.</p>
523100	8	Speed sensor input 1 (EF1) direction of rotation unknown: Turbine speed	Limp home	<p>The control unit does not recognize the rotational direction at the input.</p> <p>1 Wiring or plug connection is defective.</p> <p>2 Wiring or plug connection has a poor contact.</p> <p>3 Distance sensor–sensor ring too large.</p> <p>4 Sensor has an internal defect.</p>	<p>The cause of the unknown rotational direction must be located.</p> <p>1 Check the wiring from the sensor to the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts.</p> <p>2 Check the function of the sensor and, if necessary, replace it.</p>
523100	9	Speed sensor input 1 (EF1) speed unknown: Turbine speed	Limp home	<p>The control unit does not recognize the speed at the input.</p> <p>1 Wiring or plug connection is defective.</p> <p>2 Wiring or plug connection has a poor contact.</p> <p>3 Distance speed sensor–sensor ring too large.</p> <p>4 Speed sensor has an internal defect.</p>	<p>The cause of the unknown speed must be located.</p> <p>1 Check the wiring from the speed sensor to the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts.</p> <p>2 Check the function of the sensor and, if necessary, replace it.</p>

Error code		Description	Op mode	Cause	Possible step to repair
SPN	FMI				
523105	3	Speed sensor input 2 (EF2) overvoltage: Internal speed	Limp home	<p>The measured voltage at the input is too high.</p> <p>1 Wiring or plug connection is defective.</p> <p>2 Component has an internal defect.</p> <p>3 Control unit has an internal defect.</p>	<p>The cause of the incorrect voltage must be located.</p> <p>1 Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active.</p> <p>2 Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts.</p> <p>3 Check the correct wiring of the pins.</p> <p>4 Check the function of the connected component or replace the component.</p> <p>5 Replace the control unit if the error continues to occur.</p>
523105	6	Speed sensor input 2 (EF2) open or short to ground: Internal speed	Limp home	<p>The measured line resistance between the connected component and the control unit is too high.</p> <p>1 Wiring or plug connection is defective.</p> <p>2 Component has an internal defect.</p> <p>3 Control unit has an internal defect.</p>	<p>1 Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester.</p> <p>2 Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts.</p> <p>3 Check the function of the connected component and replace it if needed.</p> <p>4 Replace the control unit if the error continues to occur.</p>
523105	8	Speed sensor input 2 (EF2) direction of rotation unknown: Internal speed	Limp home	<p>The control unit does not recognize the rotational direction at the input.</p> <p>1 Wiring or plug connection is defective.</p> <p>2 Wiring or plug connection has a poor contact.</p> <p>3 Distance sensor–sensor ring too large.</p> <p>4 Sensor has an internal defect.</p>	<p>The cause of the unknown rotational direction must be located.</p> <p>1 Check the wiring from the sensor to the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts.</p> <p>2 Check the function of the sensor and, if necessary, replace it.</p>

Error code		Description	Op mode	Cause	Possible step to rapair
SPN	FMI				
523105	9	Speed sensor input 2 (EF2) speed unknown: Internal speed	Limp home	<p>The control unit does not recognize the speed at the input.</p> <ol style="list-style-type: none"> 1 Wiring or plug connection is defective. 2 Wiring or plug connection has a poor contact. 3 Distance speed sensor–sensor ring too large. 4 Speed sensor has an internal defect. 	<p>The cause of the unknown speed must be located.</p> <ol style="list-style-type: none"> 1 Check the wiring from the speed sensor to the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2 Check the function of the sensor and, if necessary, replace it.
523110	3	Speed sensor input 3 (EF3) overvoltage: Output speed	Limp home	<p>The measured voltage at the input is too high.</p> <ol style="list-style-type: none"> 1 Wiring or plug connection is defective. 2 Component has an internal defect. 3 Control unit has an internal defect. 	<p>The cause of the incorrect voltage must be located.</p> <ol style="list-style-type: none"> 1 Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2 Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 3 Check the correct wiring of the pins. 4 Check the function of the connected component or replace the component. 5 Replace the control unit if the error continues to occur.
523110	6	Speed sensor input 3 (EF3) open or short to ground: Output speed	Limp home	<p>The measured line resistance between the connected component and the control unit is too high.</p> <ol style="list-style-type: none"> 1 Wiring or plug connection is defective. 2 Component has an internal defect. 3 Control unit has an internal defect. 	<ol style="list-style-type: none"> 1 Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 2 Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 3 Check the function of the connected component and replace it if needed. 4 Replace the control unit if the error continues to occur.

Error code		Description	Op mode	Cause	Possible step to repair
SPN	FMI				
523110	8	Speed sensor input 3 (EF3) direction of rotation unknown: Output speed	Limp home	<p>The control unit does not recognize the rotational direction at the input.</p> <ol style="list-style-type: none"> 1 Wiring or plug connection is defective. 2 Wiring or plug connection has a poor contact. 3 Distance sensor – sensor ring too large. 4 Sensor has an internal defect. 	<p>The cause of the unknown rotational direction must be located.</p> <ol style="list-style-type: none"> 1 Check the wiring from the sensor to the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2 Check the function of the sensor and, if necessary, replace it.
523110	9	Speed sensor input 3 (EF3) speed unknown: Output speed	Limp home	<p>The control unit does not recognize the speed at the input.</p> <ol style="list-style-type: none"> 1 Wiring or plug connection is defective. 2 Wiring or plug connection has a poor contact. 3 Distance speed sensor – sensor ring too large. 4 Speed sensor has an internal defect. 	<p>The cause of the unknown speed must be located.</p> <ol style="list-style-type: none"> 1 Check the wiring from the speed sensor to the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2 Check the function of the sensor and, if necessary, replace it.
523115	3	Speed sensor input 4 (EF4) overvoltage: Engine speed	Limp home	<p>The measured voltage at the input is too high.</p> <ol style="list-style-type: none"> 1 Wiring or plug connection is defective. 2 Component has an internal defect. 3 Control unit has an internal defect. 	<p>The cause of the incorrect voltage must be located.</p> <ol style="list-style-type: none"> 1 Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2 Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 3 Check the correct wiring of the pins. 4 Check the function of the connected component or replace the component. 5 Replace the control unit if the error continues to occur.

Error code		Description	Op mode	Cause	Possible step to rapair
SPN	FMI				
523115	6	Speed sensor input 4 (EF4) open or short to ground: Engine speed	Limp home	<p>The measured line resistance between the connected component and the control unit is too high.</p> <p>1 Wiring or plug connection is defective.</p> <p>2 Component has an internal defect.</p> <p>3 Control unit has an internal defect.</p>	<p>1 Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester.</p> <p>2 Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts.</p> <p>3 Check the function of the connected component and replace it if needed.</p> <p>4 Replace the control unit if the error continues to occur.</p>
523115	8	Speed sensor input 4 (EF4) direction of rotation unknown: Engine speed	Limp home	<p>The control unit does not recognize the rotational direction at the input.</p> <p>1 Wiring or plug connection is defective.</p> <p>2 Wiring or plug connection has a poor contact.</p> <p>3 Distance sensor – sensor ring too large.</p> <p>4 Sensor has an internal defect.</p>	<p>The cause of the unknown rotational direction must be located.</p> <p>1 Check the wiring from the sensor to the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts.</p> <p>2 Check the function of the sensor and, if necessary, replace it.</p>
523115	9	Speed sensor input 4 (EF4) speed unknown: Engine speed	Limp home	<p>The control unit does not recognize the speed at the input.</p> <p>1 Wiring or plug connection is defective.</p> <p>2 Wiring or plug connection has a poor contact.</p> <p>3 Distance speed sensor – sensor ring too large.</p> <p>4 Speed sensor has an internal defect.</p>	<p>The cause of the unknown speed must be located.</p> <p>1 Check the wiring from the speed sensor to the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts.</p> <p>2 Check the function of the sensor and, if necessary, replace it.</p>

Error code		Description	Op mode	Cause	Possible step to rapair
SPN	FMI				
523140	3	Resistance sensor input 1 (ER1) open circuit or short to high source: Sump temperature	Normal	<p>The measured line resistance between the connected component and the control unit is too high.</p> <p>1 Wiring or plug connection is defective.</p> <p>2 Component has an internal defect.</p> <p>3 Control unit has an internal defect.</p>	<p>1 Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester.</p> <p>2 Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts.</p> <p>3 Check the function of the connected component and replace it if needed.</p> <p>4 Replace the control unit if the error continues to occur.</p>
523140	6	Resistance sensor input 1 (ER1) short to ground: Sump temperature	Normal	<p>The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too low.</p> <p>1 Wiring or plug connection contacts vehicle ground.</p> <p>2 Component has an internal defect.</p> <p>3 Control unit has an internal defect.</p>	<p>1 Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester.</p> <p>2 Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts.</p> <p>3 Check the function of the connected component and replace it if needed.</p> <p>4 Replace the control unit if the error continues to occur.</p>
523155	3	Current sensor input 2 (EI2) overvoltage: Oil Filter Restriction Switch	Normal	<p>The measured voltage at the input is too high.</p> <p>1 Wiring or plug connection is defective.</p> <p>2 Component has an internal defect.</p> <p>3 Control unit has an internal defect.</p>	<p>The cause of the incorrect voltage must be located.</p> <p>1 Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts.</p> <p>2 Check the correct wiring of the pins.</p> <p>3 Check the function of the connected component or replace the component.</p> <p>4 Replace the control unit if the error continues to occur.</p>

Error code		Description	Op mode	Cause	Possible step to repair
SPN	FMI				
523155	6	Current seonsr input 2 (EI2) open circuit or short to ground: Oil Filter Restriction Switch	Normal	The measured line resistance between the connected component and the control unit is too high. 1 Wiring or plug connection is defective. 2 Component has an internal defect. 3 Control unit has an internal defect.	1 Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 2 Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 3 Check the function of the connected component and replace it if needed. 4 Replace the control unit if the error continues to occur.
523160	3	Voltage sensor input 3 (EU3) overvoltage	TCU shutdown	The measured voltage at the sensor input 3 is too high: cable is defective and is contacted to battery voltage clutch cut off / inch pedal sensor has an internal defect connector pin is contacted to battery voltage.	1 check the cable from TCU to the sensor 2 check the connectors 3 check the sensor
523160	6	Voltage sensor input 3 (EU3) open or short to ground	TCU shutdown	The measured voltage at the sensor input 3 is too low: cable is defective and is contacted to vehicle ground cable has no connection to TCU clutch cut off / inch pedal sensor has an internal defect connector pin is contacted to vehicle ground or is broken.	1 check the cable from TCU to the sensor 2 check the connectors 3 check the sensor
523160	12	Voltage sensor input 3 (EU3) defect	TCU shutdown	The measured sensor voltage is out of the allowed thresholds.	check the cable from TCU to the sensor check the connectors check the sensor 4 Change the sensor
523165	3	Voltage sensor input 4 (EU4) overvoltage	Normal	The measured voltage at the sensor input 3 is too high: cable is defective and is contacted to battery voltage clutch cut off / inch pedal sensor has an internal defect connector pin is contacted to battery voltage.	1 check the cable from TCU to the sensor 2 check the connectors 3 check the sensor
523165	6	Voltage sensor input 4 (EU4) open or short to ground	Normal	The measured voltage at the sensor input 3 is too low: cable is defective and is contacted to vehicle ground cable has no connection to TCU clutch cut off / inch pedal sensor has an internal defect connector pin is contacted to vehicle ground or is broken.	1 check the cable from TCU to the sensor 2 check the connectors 3 check the sensor

Error code		Description	Op mode	Cause	Possible step to repair
SPN	FMI				
523165	12	Voltage sensor input 4	Normal	The measured sensor voltage is out of the allowed thresholds.	check the cable from TCU to the sensor check the connectors check the sensor 4 Change the sensor
523200	2	Current output driver 1 (AIM01) unknown electrical component	Trm shutdown	The measured line resistance between the connected component and the control unit is too high.	1 Using the circuit diagram, check if a component is assigned to the output. 2 Check the wiring, in particular that it is wired correctly. 3 Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts 4 Replace the control unit if the error continues to occur.
523200	3	Current output driver 1 (AIM01) short to battery	Limp home	The measured line resistance between the proportional valve and the control unit is too high or the voltage on the control unit output is too high. 1 Wiring or plug connection contacts battery voltage. 2 Proportional valve has an internal defect. 3 Control unit has an internal defect.	1 Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2 Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3 Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4 Check the function of the connected component and replace it if needed. 5 Replace the control unit if the error continues to occur.

Error code		Description	Op mode	Cause	Possible step to repair
SPN	FMI				
523200	5	Current output driver 1 (AIM01) open circuit	Limp home	<p>The measured line resistance between the connected component and the control unit is too high.</p> <p>1 Wiring or plug connection is defective.</p> <p>2 Component has an internal defect.</p> <p>3 Control unit has an internal defect.</p>	<p>1 Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active.</p> <p>2 Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester.</p> <p>3 Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts.</p> <p>4 Check the function of the connected component and replace it if needed.</p> <p>5 Replace the control unit if the error continues to occur.</p>
523200	6	Current output driver 1 (AIM01) short to ground	TCU shutdown	<p>The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too low.</p> <p>1 Wiring or plug connection contacts vehicle ground.</p> <p>2 Component has an internal defect.</p> <p>3 Control unit has an internal defect.</p>	<p>1 Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active.</p> <p>2 Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester.</p> <p>3 Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts.</p> <p>4 Check the function of the connected component and replace it if needed.</p> <p>5 Replace the control unit if the error continues to occur.</p>

Error code		Description	Op mode	Cause	Possible step to repair
SPN	FMI				
523200	8	Current output driver 1 (AIM01) short to another valve	TCU shutdown	<p>The measured line resistance between the proportional valve and the control unit is too high or the voltage on the control unit output is too low.</p> <p>1 Wiring or plug connection contacts another proportional valve.</p> <p>2 Proportional valve has an internal defect.</p> <p>3 Control unit has an internal defect.</p>	<p>1 Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active.</p> <p>2 Check if the error occurs with an additional proportional valve or with which valve the error is bypassed.</p> <p>3 Check the wiring between the proportional valve and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts.</p> <p>4 Switch the ignition off, unplug the control unit, and measure the resistance of the proportional valve using a terminal tester.</p> <p>5 Check the function of the proportional valve and replace it if needed.</p> <p>6 Replace the control unit if the error continues to occur.</p>
523205	2	Current output driver 2 (AIM02) unknown electrical component	TCU shutdown	<p>If this error occurs, then an electrical component has been connected at the output although the input should not be used.</p>	<p>1 Using the circuit diagram, check if a component is assigned to the output.</p> <p>2 Check the wiring, in particular that it is wired correctly.</p> <p>3 Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts</p> <p>4 Replace the control unit if the error continues to occur.</p>
523205	3	Current output driver 2 (AIM02) short to battery	Limp home	<p>The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too high.</p> <p>1 Wiring or plug connection contacts battery voltage.</p> <p>2 Component has an internal defect.</p> <p>3 Control unit has an internal defect.</p>	<p>1 Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active.</p> <p>2 Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester.</p> <p>3 Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts.</p> <p>4 Check the function of the connected component and replace it if needed.</p> <p>5 Replace the control unit if the error continues to occur.</p>

Error code		Description	Op mode	Cause	Possible step to repair
SPN	FMI				
523205	5	Current output driver 2 (AIM02) open circuit	Limp home	<p>The measured line resistance between the connected component and the control unit is too high.</p> <ol style="list-style-type: none"> 1 Wiring or plug connection is defective. 2 Component has an internal defect. 3 Control unit has an internal defect. 	<ol style="list-style-type: none"> 1 Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2 Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3 Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4 Check the function of the connected component and replace it if needed. 5 Replace the control unit if the error continues to occur.
523205	6	Current output driver 2 (AIM02) short to ground	TCU shutdown	<p>The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too low.</p> <ol style="list-style-type: none"> 1 Wiring or plug connection contacts vehicle ground. 2 Component has an internal defect. 3 Control unit has an internal defect. 	<ol style="list-style-type: none"> 1 Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2 Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3 Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4 Check the function of the connected component and replace it if needed. 5 Replace the control unit if the error continues to occur.

Error code		Description	Op mode	Cause	Possible step to repair
SPN	FMI				
523205	8	Current output driver 2 (AIM02) short circuit to another valve	TCU shutdown	<p>The measured line resistance between the proportional valve and the control unit is too high or the voltage on the control unit output is too low.</p> <p>1 Wiring or plug connection contacts another proportional valve.</p> <p>2 Proportional valve has an internal defect.</p> <p>3 Control unit has an internal defect.</p>	<p>1 Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active.</p> <p>2 Check if the error occurs with an additional proportional valve or with which valve the error is bypassed.</p> <p>3 Check the wiring between the proportional valve and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts.</p> <p>4 Switch the ignition off, unplug the control unit, and measure the resistance of the proportional valve using a terminal tester.</p> <p>5 Check the function of the proportional valve and replace it if needed.</p> <p>6 Replace the control unit if the error continues to occur.</p>
523210	2	Current output driver 3 (AIM03) unknown electrical component	TCU shutdown	<p>If this error occurs, then an electrical component has been connected at the output although the input should not be used.</p>	<p>1 Using the circuit diagram, check if a component is assigned to the output.</p> <p>2 Check the wiring, in particular that it is wired correctly.</p> <p>3 Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts</p> <p>4 Replace the control unit if the error continues to occur.</p>
523210	3	Current output driver 3 (AIM03) short to battery	Limp home	<p>The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too high.</p> <p>1 Wiring or plug connection contacts battery voltage.</p> <p>2 Component has an internal defect.</p> <p>3 Control unit has an internal defect.</p>	<p>1 Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active.</p> <p>2 Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester.</p> <p>3 Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts.</p> <p>4 Check the function of the connected component and replace it if needed.</p> <p>5 Replace the control unit if the error continues to occur.</p>

Error code		Description	Op mode	Cause	Possible step to repair
SPN	FMI				
523210	5	Current output driver 3 (AIM03) open circuit	Limp home	<p>The measured line resistance between the connected component and the control unit is too high.</p> <ol style="list-style-type: none"> 1 Wiring or plug connection is defective. 2 Component has an internal defect. 3 Control unit has an internal defect. 	<ol style="list-style-type: none"> 1 Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2 Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3 Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4 Check the function of the connected component and replace it if needed. 5 Replace the control unit if the error continues to occur.
523210	6	Current output driver 3 (AIM03) short to ground	TCU shutdown	<p>The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too low.</p> <ol style="list-style-type: none"> 1 Wiring or plug connection contacts vehicle ground. 2 Component has an internal defect. 3 Control unit has an internal defect. 	<ol style="list-style-type: none"> 1 Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2 Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3 Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4 Check the function of the connected component and replace it if needed. 5 Replace the control unit if the error continues to occur.

Error code		Description	Op mode	Cause	Possible step to repair
SPN	FMI				
523210	8	Current output driver 3 (AIM03) short circuit to another valve	Trm shutdown	<p>The measured line resistance between the proportional valve and the control unit is too high or the voltage on the control unit output is too low.</p> <p>1 Wiring or plug connection contacts another proportional valve.</p> <p>2 Proportional valve has an internal defect.</p> <p>3 Control unit has an internal defect.</p>	<p>1 Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active.</p> <p>2 Check if the error occurs with an additional proportional valve or with which valve the error is bypassed.</p> <p>3 Check the wiring between the proportional valve and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts.</p> <p>4 Switch the ignition off, unplug the control unit, and measure the resistance of the proportional valve using a terminal tester.</p> <p>5 Check the function of the proportional valve and replace it if needed.</p> <p>6 Replace the control unit if the error continues to occur.</p>
523215	2	Current output driver 4 (AIM04) unknown electrical component	Trm shutdown	<p>If this error occurs, then an electrical component has been connected at the output although the input should not be used.</p>	<p>1 Using the circuit diagram, check if a component is assigned to the output.</p> <p>2 Check the wiring, in particular that it is wired correctly.</p> <p>3 Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts</p> <p>4 Replace the control unit if the error continues to occur.</p>
523215	3	Current output driver 4 (AIM04) short to battery	Limp home	<p>The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too high.</p> <p>1 Wiring or plug connection contacts battery voltage.</p> <p>2 Component has an internal defect.</p> <p>3 Control unit has an internal defect.</p>	<p>1 Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active.</p> <p>2 Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester.</p> <p>3 Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts.</p> <p>4 Check the function of the connected component and replace it if needed.</p> <p>5 Replace the control unit if the error continues to occur.</p>

Error code		Description	Op mode	Cause	Possible step to rapair
SPN	FMI				
523215	5	Current output driver 4 (AIM04) open circuit	Limp home	<p>The measured line resistance between the connected component and the control unit is too high.</p> <ol style="list-style-type: none"> 1 Wiring or plug connection is defective. 2 Component has an internal defect. 3 Control unit has an internal defect. 	<ol style="list-style-type: none"> 1 Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2 Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3 Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4 Check the function of the connected component and replace it if needed. 5 Replace the control unit if the error continues to occur.
523215	6	Current output driver 4 (AIM04) short to ground	TCU shutdown	<p>The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too low.</p> <ol style="list-style-type: none"> 1 Wiring or plug connection contacts vehicle ground. 2 Component has an internal defect. 3 Control unit has an internal defect. 	<ol style="list-style-type: none"> 1 Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2 Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3 Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4 Check the function of the connected component and replace it if needed. 5 Replace the control unit if the error continues to occur.

Error code		Description	Op mode	Cause	Possible step to rapair
SPN	FMI				
523215	8	Current output driver 4 (AIM04) short circuit to another valve	Trm shutdown	<p>The measured line resistance between the proportional valve and the control unit is too high or the voltage on the control unit output is too low.</p> <p>1 Wiring or plug connection contacts another proportional valve.</p> <p>2 Proportional valve has an internal defect.</p> <p>3 Control unit has an internal defect.</p>	<p>1 Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active.</p> <p>2 Check if the error occurs with an additional proportional valve or with which valve the error is bypassed.</p> <p>3 Check the wiring between the proportional valve and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts.</p> <p>4 Switch the ignition off, unplug the control unit, and measure the resistance of the proportional valve using a terminal tester.</p> <p>5 Check the function of the proportional valve and replace it if needed.</p> <p>6 Replace the control unit if the error continues to occur.</p>
523220	2	Current output driver 5 (AIM05) unknown electrical component	Trm shutdown	<p>If this error occurs, then an electrical component has been connected at the output although the input should not be used.</p>	<p>1 Using the circuit diagram, check if a component is assigned to the output.</p> <p>2 Check the wiring, in particular that it is wired correctly.</p> <p>3 Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts</p> <p>4 Replace the control unit if the error continues to occur.</p>

Error code		Description	Op mode	Cause	Possible step to repair
SPN	FMI				
523220	3	Current output driver 5 (AIM05) short to battery	Limp home	<p>The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too high.</p> <p>1 Wiring or plug connection contacts battery voltage.</p> <p>2 Component has an internal defect.</p> <p>3 Control unit has an internal defect.</p>	<p>1 Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active.</p> <p>2 Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester.</p> <p>3 Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts.</p> <p>4 Check the function of the connected component and replace it if needed.</p> <p>5 Replace the control unit if the error continues to occur.</p>
523220	5	Current output driver 5 (AIM05) open circuit	Limp home	<p>The measured line resistance between the connected component and the control unit is too high.</p> <p>1 Wiring or plug connection is defective.</p> <p>2 Component has an internal defect.</p> <p>3 Control unit has an internal defect.</p>	<p>1 Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active.</p> <p>2 Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester.</p> <p>3 Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts.</p> <p>4 Check the function of the connected component and replace it if needed.</p> <p>5 Replace the control unit if the error continues to occur.</p>

Error code		Description	Op mode	Cause	Possible step to repair
SPN	FMI				
523220	6	Current output driver 5 (AIM05) short to ground	TCU shutdown	<p>The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too low.</p> <p>1 Wiring or plug connection contacts vehicle ground.</p> <p>2 Component has an internal defect.</p> <p>3 Control unit has an internal defect.</p>	<p>1 Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active.</p> <p>2 Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester.</p> <p>3 Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts.</p> <p>4 Check the function of the connected component and replace it if needed.</p> <p>5 Replace the control unit if the error continues to occur.</p>
523220	8	Current output driver 5 (AIM05) short circuit to another valve	Trm shutdown	<p>The measured line resistance between the proportional valve and the control unit is too high or the voltage on the control unit output is too low.</p> <p>1 Wiring or plug connection contacts another proportional valve.</p> <p>2 Proportional valve has an internal defect.</p> <p>3 Control unit has an internal defect.</p>	<p>1 Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active.</p> <p>2 Check if the error occurs with an additional proportional valve or with which valve the error is bypassed.</p> <p>3 Check the wiring between the proportional valve and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts.</p> <p>4 Switch the ignition off, unplug the control unit, and measure the resistance of the proportional valve using a terminal tester.</p> <p>5 Check the function of the proportional valve and replace it if needed.</p> <p>6 Replace the control unit if the error continues to occur.</p>

Error code		Description	Op mode	Cause	Possible step to repair
SPN	FMI				
523225	2	Current output driver 6 (AIM06) unknown electrical component	Trm shutdown	If this error occurs, then an electrical component has been connected at the output although the input should not be used.	<ol style="list-style-type: none"> 1 Using the circuit diagram, check if a component is assigned to the output. 2 Check the wiring, in particular that it is wired correctly. 3 Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts 4 Replace the control unit if the error continues to occur.
523225	3	Current output driver 6 (AIM06) short to battery	Limp home	<p>The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too high.</p> <ol style="list-style-type: none"> 1 Wiring or plug connection contacts battery voltage. 2 Component has an internal defect. 3 Control unit has an internal defect. 	<ol style="list-style-type: none"> 1 Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2 Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3 Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4 Check the function of the connected component and replace it if needed. 5 Replace the control unit if the error continues to occur.
523225	5	Current output driver 6 (AIM06) open circuit	Limp home	<p>The measured line resistance between the connected component and the control unit is too high.</p> <ol style="list-style-type: none"> 1 Wiring or plug connection is defective. 2 Component has an internal defect. 3 Control unit has an internal defect. 	<ol style="list-style-type: none"> 1 Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2 Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3 Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4 Check the function of the connected component and replace it if needed. 5 Replace the control unit if the error continues to occur.

Error code		Description	Op mode	Cause	Possible step to repair
SPN	FMI				
523225	6	Current output driver 6 (AIM06) short to ground	TCU shutdown	<p>The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too low.</p> <p>1 Wiring or plug connection contacts vehicle ground. 2 Component has an internal defect. 3 Control unit has an internal defect.</p>	<p>1 Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active.</p> <p>2 Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester.</p> <p>3 Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts.</p> <p>4 Check the function of the connected component and replace it if needed.</p> <p>5 Replace the control unit if the error continues to occur.</p>
523225	8	Current output driver 6 (AIM06) short circuit to another valve	Trm shutdown	<p>The measured line resistance between the proportional valve and the control unit is too high or the voltage on the control unit output is too low.</p> <p>1 Wiring or plug connection contacts another proportional valve. 2 Proportional valve has an internal defect. 3 Control unit has an internal defect.</p>	<p>1 Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active.</p> <p>2 Check if the error occurs with an additional proportional valve or with which valve the error is bypassed.</p> <p>3 Check the wiring between the proportional valve and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts.</p> <p>4 Switch the ignition off, unplug the control unit, and measure the resistance of the proportional valve using a terminal tester.</p> <p>5 Check the function of the proportional valve and replace it if needed.</p> <p>6 Replace the control unit if the error continues to occur.</p>

Error code		Description	Op mode	Cause	Possible step to repair
SPN	FMI				
523230	2	Current output driver 7 (AIM07) unknown electrical component	Trm shutdown	If this error occurs, then an electrical component has been connected at the output although the input should not be used.	<ol style="list-style-type: none"> 1 Using the circuit diagram, check if a component is assigned to the output. 2 Check the wiring, in particular that it is wired correctly. 3 Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts
523230	3	Current output driver 7 (AIM07) short to battery	Limp home	<p>The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too high.</p> <ol style="list-style-type: none"> 1 Wiring or plug connection contacts battery voltage. 2 Component has an internal defect. 3 Control unit has an internal defect. 	<ol style="list-style-type: none"> 1 Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2 Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3 Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4 Check the function of the connected component and replace it if needed. 5 Replace the control unit if the error continues to occur.
523230	5	Current output driver 7 (AIM07) open circuit	Limp home	<p>The measured line resistance between the connected component and the control unit is too high.</p> <ol style="list-style-type: none"> 1 Wiring or plug connection is defective. 2 Component has an internal defect. 3 Control unit has an internal defect. 	<ol style="list-style-type: none"> 1 Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2 Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3 Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4 Check the function of the connected component and replace it if needed. 5 Replace the control unit if the error continues to occur.

Error code		Description	Op mode	Cause	Possible step to repair
SPN	FMI				
523230	6	Current output driver 7 (AIM07) short to ground	TCU shutdown	<p>The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too low.</p> <p>1 Wiring or plug connection contacts vehicle ground.</p> <p>2 Component has an internal defect.</p> <p>3 Control unit has an internal defect.</p>	<p>1 Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active.</p> <p>2 Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester.</p> <p>3 Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts.</p> <p>4 Check the function of the connected component and replace it if needed.</p> <p>5 Replace the control unit if the error continues to occur.</p>
523230	8	Current output driver 7 (AIM07) short circuit to another valve	Trm shutdown	<p>The measured line resistance between the proportional valve and the control unit is too high or the voltage on the control unit output is too low.</p> <p>1 Wiring or plug connection contacts another proportional valve.</p> <p>2 Proportional valve has an internal defect.</p> <p>3 Control unit has an internal defect.</p>	<p>1 Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active.</p> <p>2 Check if the error occurs with an additional proportional valve or with which valve the error is bypassed.</p> <p>3 Check the wiring between the proportional valve and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts.</p> <p>4 Switch the ignition off, unplug the control unit, and measure the resistance of the proportional valve using a terminal tester.</p> <p>5 Check the function of the proportional valve and replace it if needed.</p> <p>6 Replace the control unit if the error continues to occur.</p>
523280	3	Digital current output driver 1 (ADM1) short to battery	Trm shutdown	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 device has an internal defect connector pin is contacted to battery voltage	check the cable from TCU to the device at ADM1 check the connectors check the resistance of the device at ADM1

Error code		Description	Op mode	Cause	Possible step to repair
SPN	FMI				
523280	5	Digital current output driver 1 (ADM1) open circuit	Trm shutdown	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 device has an internal defect connector has no connection to TCU	check the cable from TCU to the device at ADM1 check the connectors check the resistance of the device at ADM1
523280	6	Digital current output driver 1 (ADM1) short to ground	Trm shutdown	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 device has an internal defect connector pin is contacted to vehicle ground	check the cable from TCU to the device at ADM1 check the connectors check the resistance of the device at ADM1
523280	12	Digital current output driver 1 (ADM1) defect	Trm shutdown	TCU detected overtemperature or an internal error at the digital output	Change TCU
523281	3	Digital current output driver 2 (ADM2) short to battery	Trm shutdown	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 device has an internal defect connector pin is contacted to battery voltage	check the cable from TCU to the device at ADM2 check the connectors check the resistance of the device at ADM2
523281	5	Digital current output driver 2 (ADM2) open circuit	Trm shutdown	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 device has an internal defect connector has no connection to TCU	check the cable from TCU to the device at ADM2 check the connectors check the resistance of the device at ADM2
523281	6	Digital current output driver 2 (ADM2) short to ground	Trm shutdown	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 device has an internal defect connector pin is contacted to vehicle ground	check the cable from TCU to the device at ADM2 check the connectors check the resistance of the device at ADM2
523281	12	Digital current output driver 2 (ADM2) defect	Trm shutdown	TCU detected overtemperature or an internal error at the digital output	Change TCU

Error code		Description	Op mode	Cause	Possible step to repair
SPN	FMI				
523145	3	Resistance sensor input 2 (ER2) open circuit or short to high source: Torque converter temperature	Normal	<p>The measured line resistance between the connected component and the control unit is too high.</p> <ol style="list-style-type: none"> 1 Wiring or plug connection is defective. 2 Component has an internal defect. 3 Control unit has an internal defect. 	<ol style="list-style-type: none"> 1 Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 2 Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 3 Check the function of the connected component and replace it if needed. 4 Replace the control unit if the error continues to occur.
523145	6	Resistance sensor input 2 (ER2) short to ground: Torque converter temperature	Normal	<p>The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too low.</p> <ol style="list-style-type: none"> 1 Wiring or plug connection contacts vehicle ground. 2 Component has an internal defect. 3 Control unit has an internal defect. 	<ol style="list-style-type: none"> 1 Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 2 Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 3 Check the function of the connected component and replace it if needed. 4 Replace the control unit if the error continues to occur.
523125	3	Voltage sensor input 1 (EU1) overvoltage	Limp home	<p>The measured voltage at the sensor input 1 is too high.</p> <ol style="list-style-type: none"> 1 Cable is defective and is contacted to battery voltage 2 Clutch cut off / inch pedal sensor has an internal defect 3 Connector pin is contacted to battery voltage 	<ol style="list-style-type: none"> 1 check the cable from TCU to the sensor 2 check the connectors 3 check the sensor
523125	6	Voltage sensor input 1 (EU1) open or short to ground	Limp home	<p>The measured voltage at the sensor input 1 is too low.</p> <ol style="list-style-type: none"> 1 Cable is defective and is contacted to vehicle ground 2 Cable has no connection to TCU 3 Clutch cut off / inch pedal sensor has an internal defect 4 Connector pin is contacted to vehicle ground or is broken 	<ol style="list-style-type: none"> 1 check the cable from TCU to the sensor 2 check the connectors 3 check the sensor

Error code		Description	Op mode	Cause	Possible step to repair
SPN	FMI				
523125	12	Voltage sensor input 1 (EU1) defect	Limp home	The measured voltage from sensor output signal 1 and output signal 2 don't match or are out of range. 1 Cable is defective 2 Sensor has an internal defect	1 check the cable from TCU to the sensor 2 check the connectors 3 check the sensor
523023	3	Supply for temperature sensors (AU_ER) overvoltage	Limp home	The measured voltage is too high. 1 Wiring or plug connection is defective. 2 Sensor has an internal defect. 3 Control unit has an internal defect.	The cause of the incorrect voltage must be located. 1 Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2 Check the correct wiring of the pins. 3 Check the function of the sensor or replace the sensor. 4 Replace the control unit if the error continues to occur.
523023	4	Supply for temperature sensors (AU_ER) undervoltage	Limp home	The measured voltage is too low. 1 Wiring or plug connection is defective. 2 Sensor has an internal defect. 3 Control unit has an internal defect.	The cause of the incorrect voltage must be located. 1 Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2 Check the correct wiring of the pins. 3 Check the function of the sensor or replace the sensor. 4 Replace the control unit if the error continues to occur.
523130	3	Voltage sensor input 2 (EU2) overvoltage	Limp home	The measured voltage at the sensor input 2 is too high. 1 Cable is defective and is contacted to battery voltage 2 Clutch cut off / inch pedal sensor has an internal defect 3 Connector pin is contacted to battery voltage	1 check the cable from TCU to the sensor 2 check the connectors 3 check the sensor
523130	6	Voltage sensor input 2 (EU2) open or short to ground	Limp home	The measured voltage at the sensor input 2 is too low. 1 Cable is defective and is contacted to vehicle ground 2 Cable has no connection to TCU 3 Clutch cut off / inch pedal sensor has an internal defect 4 Connector pin is contacted to vehicle ground or is broken	1 Check the cable from TCU to the sensor 2 Check the connectors 3 Check the sensor

Error code		Description	Op mode	Cause	Possible step to rapair
SPN	FMI				
523130	12	Voltage sensor input 2 (EU2) defect	Limp home	The measured voltage from sensor output signal 1 and output signal 2 don't match or are out of range. 1 Cable is defective 2 Sensor has an internal defect	1 Check the cable from TCU to the sensor 2 Check the connectors 3 Check the sensor
523050	0	Internal TCU Error 6	TCU shutdown	-	-
523047	12	Internal TCU Error 3	TCU shutdown		Read out the operating data with Testman and send them to your ZF contact.
523300	0	Transmission sump oil most severe overtemperature	Normal	The measured temperature in the oil sump of the transmission is too high. 1 The oil level is incorrect. 2 The cooling system is faulty. 3 Load is permanently too high.	The cause of the increased temperature input in the transmission must be located. 1 Check the oil level and correct it as needed. 2 Check the function of the cooler fan. 3 Check the transmission oil cooler for contaminants and damage. 4 Check the connection lines from the transmission to the transmission oil cooler for damage. 5 Check the transmission oil temperature using the diagnosis unit. If the measured oil temperature does not drop when the vehicle is operated at idle even after a longer period of time, then the temperature sensor needs to be replaced.

Error code		Description	Op mode	Cause	Possible step to repair
SPN	FMI				
523300	16	Transmission sump oil moderately severe overtemperature	Normal	<p>The measured temperature in the oil sump of the transmission is too high.</p> <ol style="list-style-type: none"> 1 The oil level is incorrect. 2 The cooling system is faulty. 3 Load is permanently too high. 	<p>The cause of the increased temperature input in the transmission must be located.</p> <ol style="list-style-type: none"> 1 Check the oil level and correct it as needed. 2 Check the function of the cooler fan. 3 Check the transmission oil cooler for contaminants and damage. 4 Check the connection lines from the transmission to the transmission oil cooler for damage. 5 Check the transmission oil temperature using the diagnosis unit. If the measured oil temperature does not drop when the vehicle is operated at idle even after a longer period of time, then the temperature sensor needs to be replaced.
523305	0	Oil filter contaminated	Normal	<ol style="list-style-type: none"> 1 Filter clogged. 2 Sensor has an internal defect. 	<p>If this error occurs while driving, then remain at a standstill, switch the ignition off, then on again and wait another 40 seconds.</p> <ol style="list-style-type: none"> 1 Replace the filter. 2 Check the wiring of the switch, in particular with regard to defective plug connections such as corroded or damaged plug contacts.
523310	0	Transmission input torque too high	Normal	<p>The control unit receives a transmission input torque via the CAN bus that exceeds the permissible maximum.</p> <ol style="list-style-type: none"> 1 Engine torque too high. 2 CAN bus signal is faulty. 	<ol style="list-style-type: none"> 1 Reduce the applied engine torque. 2 If this error continues to occur, please contact your Hyundai dealer or A/S center.
523311	0	Transmission input power too high	Normal	TCU calculates an transmission input power above the defined thresholds	engine controller may ignore Torque or speedlimit command from TCU via TSC1 message
523320	15	Transmission output speed too high	Normal	The speed at the transmission output exceeds the permissible maximum.	The speed at the transmission output exceeds the permissible maximum.
523330	15	Transmission input speed too high	Trm shutdown	The speed at the transmission input exceeds the permissible maximum.	Reduce the engine speed. In order to prevent long-term damage, stay within the permissible speed range.

Error code		Description	Op mode	Cause	Possible step to repair
SPN	FMI				
523340	0	Transmission output torque too high	Trm shutdown	The control unit calculates a torque at the transmission output that exceeds the permissible maximum. 1 Engine torque too high.	Reduce the applied engine torque.
523360	9	Clutch djustment data invalid	Normal	The clutch calibration was not performed.	Perform the clutch calibration.
523361	13	Clutch calibration process failed	TCU shutdown	The clutch calibration did fail	Check oil level and run calibration again.
523400	9	Vehicle CAN failure	Trm shutdown	An electrical error exists on the vehicle CAN bus. 1 Malfunction on the CAN bus. 2 ZF control unit has an internal defect.	If the control unit resets the error itself, then this is a matter of a sporadically occurring error. Check the following points only when the error is active. 1 Check the CAN connection for interruptions, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2 Replace the ZF control unit. 3 Check the terminating resistor of the CAN connection (CAN 1). Using an ohmmeter, also determine the resistance on the control unit and on the adapter when the ignition is off. The resistance value must be 120 Ohm \pm 10 Ohm for each. 4 If this error continues to occur, please contact the Hyundai dealer or A/S center.
523402	9	ECU connection loss	Limp home	The control unit no longer transfers any information. 1 Engine control unit has an internal defect.	The cause of the missing connection must be located. 1 If error vehicle can failure occurs, then repair this first. 2 If this error continues to be active, please contact your Hyundai dealer or A/S center.
523403	9	VCU connection loss	Trm shutdown	No communication to the vehicle controller	Check CAN connection, check source adress of the VCU
523405	9	I/O-Extension connection loss	Trm shutdown	The extension no longer transfers any information. 1 I/O extension has an internal defect.	The cause of the missing connection must be located. 1 If error vehicle can failure occurs, then repair this first. 2 If this error continues to be active, please contact your appropriate ZF service partner.

Error code		Description	Op mode	Cause	Possible step to repair
SPN	FMI				
523411	9	Message ZFTC1 invalid or timeout	Trm shutdown	<p>The control unit does not receive the CAN message or the message contains faulty data.</p> <ol style="list-style-type: none"> 1 Sporadic electrical error. 2 CAN bus overloaded. 3 Sending control unit has an internal defect. 4 Receiving control unit has an internal defect. 	<p>If the control unit resets the error itself, then this is a matter of a sporadically occurring error or an excessive bus load.</p> <ol style="list-style-type: none"> 1 If error VCU Connection loss occurs, then repair this first. 2 If this error continues to be active, please contact your Hyundai dealer or A/S center.
523413	9	Message EEC1 invalid or timeout	Limp home	<p>The control unit does not receive the CAN message or the message contains faulty data.</p> <ol style="list-style-type: none"> 1 Sporadic electrical error. 2 CAN bus overloaded. 3 Sending control unit has an internal defect. 4 Receiving control unit has an internal defect. 	<p>If the control unit resets the error itself, then this is a matter of a sporadically occurring error or an excessive bus load.</p> <ol style="list-style-type: none"> 1 If error ECU Connection lost occurs, then repair this first. 2 If this error continues to be active, please contact your Hyundai dealer or A/S center.
523414	9	Message EEC2 invalid or timeout	Limp home	<p>The control unit does not receive the CAN message or the message contains faulty data.</p> <ol style="list-style-type: none"> 1 Sporadic electrical error. 2 CAN bus overloaded. 3 Sending control unit has an internal defect. 4 Receiving control unit has an internal defect. 	<p>If the control unit resets the error itself, then this is a matter of a sporadically occurring error or an excessive bus load.</p> <ol style="list-style-type: none"> 1 If error ECU Connection lost occurs, then repair this first. 2 If this error continues to be active, please contact your Hyundai dealer or A/S center.
523415	9	Message EEC3 invalid or timeout	Limp home	<p>The control unit does not receive the CAN message or the message contains faulty data.</p> <ol style="list-style-type: none"> 1 Sporadic electrical error. 2 CAN bus overloaded. 3 Sending control unit has an internal defect. 4 Receiving control unit has an internal defect. 	<p>If the control unit resets the error itself, then this is a matter of a sporadically occurring error or an excessive bus load.</p> <ol style="list-style-type: none"> 1 If error ECU Connection lost occurs, then repair this first. 2 If this error continues to be active, please contact your Hyundai dealer or A/S center.
523416	9	Message EC1 invalid or timeout	Limp home	<p>The control unit does not receive the CAN message or the message contains faulty data.</p> <ol style="list-style-type: none"> 1 Sporadic electrical error. 2 CAN bus overloaded. 3 Sending control unit has an internal defect. 4 Receiving control unit has an internal defect. 	<p>If the control unit resets the error itself, then this is a matter of a sporadically occurring error or an excessive bus load.</p> <ol style="list-style-type: none"> 1 If error ECU Connection lost occurs, then repair this first. 2 If this error continues to be active, please contact your Hyundai dealer or A/S center.

Error code		Description	Op mode	Cause	Possible step to repair
SPN	FMI				
523417	9	Message B invalid or timeout	Normal	<p>The control unit does not receive the CAN message or the message contains faulty data.</p> <ol style="list-style-type: none"> 1 Sporadic electrical error. 2 CAN bus overloaded. 3 Sending control unit has an internal defect. 4 Receiving control unit has an internal defect. 	<p>If the control unit resets the error itself, then this is a matter of a sporadically occurring error or an excessive bus load.</p> <ol style="list-style-type: none"> 1 If error VCU connection lost occurs, then repair this first. 2 If this error continues to be active, please contact your Hyundai dealer or A/S center.
523418	9	Message EBC1 invalid or timeout	Normal	<p>The control unit does not receive the CAN message or the message contains faulty data.</p> <ol style="list-style-type: none"> 1 Sporadic electrical error. 2 CAN bus overloaded. 3 Sending control unit has an internal defect. 4 Receiving control unit has an internal defect. 	<ol style="list-style-type: none"> 1 If error VCU connection lost occurs, then repair this first. 2 If this error continues to be active, please contact your Hyundai dealer or A/S center.
523419	9	Signal actual engine torque or signal engine speed (EEC1) are defective	Limp home	<p>One or more signals of the messages from engine controller contains faulty data.</p> <ol style="list-style-type: none"> 1 Incorrect software on the transmission control unit. 2 Incorrect software on the engine controller. 	<ol style="list-style-type: none"> 1 Check the software version of the transmission control unit and program the current software version if required. 2 If this error continues to occurs, please contact your Hyundai dealer or A/S center.
523420	9	Message CCVS invalid or timeout	Normal	<p>The control unit does not receive the CAN message or the message contains faulty data.</p> <ol style="list-style-type: none"> 1 Sporadic electrical error. 2 CAN bus overloaded. 3 Sending control unit has an internal defect. 4 Receiving control unit has an internal defect. 	<p>If the control unit resets the error itself, then this is a matter of a sporadically occurring error or an excessive bus load.</p> <ol style="list-style-type: none"> 1 If error Vehicle CAN error occurs, then repair this first. 2 If this error continues to be active, please contact your Hyundai dealer or A/S center.
523426	9	Message JBERC1 invalid or timeout	Limp home	<p>The control unit does not receive the CAN message or the message contains faulty data.</p> <ol style="list-style-type: none"> 1 Sporadic electrical error. 2 CAN bus overloaded. 3 Sending control unit has an internal defect. 4 Receiving control unit has an internal defect. 	<p>If the control unit resets the error itself, then this is a matter of a sporadically occurring error or an excessive bus load.</p> <ol style="list-style-type: none"> 1 If error Vehicle CAN error occurs, then repair this first. 2 If this error continues to be active, please contact your Hyundai dealer or A/S center.

Error code		Description	Op mode	Cause	Possible step to repair
SPN	FMI				
523427	9	Message JBRC invalid or timeout	Limp home	The control unit does not receive the CAN message or the message contains faulty data. 1 Sporadic electrical error. 2 CAN bus overloaded. 3 Sending control unit has an internal defect. 4 Receiving control unit has an internal defect.	If the control unit resets the error itself, then this is a matter of a sporadically occurring error or an excessive bus load. 1 If error Vehicle CAN error occurs, then repair this first. 2 If this error continues to be active, please contact your Hyundai dealer or A/S center.
523470	19	Operation Mode command invalid	Trm shutdown	The operating mode assigned by the vehicle control unit is invalid for the transmission. 1 Incorrect software on the transmission control unit. 2 Incorrect software on the vehicle computer.	1 Check the software version of the transmission control unit and program the current software version if required. 2 If this error continues to occurs, please contact your Hyundai dealer or A/S center.
523471	19	Transmission command invalid	Trm shutdown	The transmission mode assigned by the vehicle control unit is invalid for the transmission. 1 Incorrect software on the transmission control unit. 2 Incorrect software on the vehicle computer.	1 Check the software version of the transmission control unit and program the current software version if required. 2 If this error continues to occurs, please contact your Hyundai dealer or A/S center.
523480	9	Machine configuration invalid	TCU shutdown	The startup handshake has not been successful.	Check version of vehicle controller (it has to support handshaking).
523481	0	Testmode requested but conditions not complied	Trm shutdown	The conditions for Testmode are not fulfilled	Take back the test mode request, set the conditions to the allowed thresholds and request the Test Mode again
523500	0	Overspeed engine	Normal	The control unit receives an engine speed via the CAN bus that exceeds the permissible maximum. 1 Engine speed too high. 2 CAN bus signal is faulty.	1 Reduce the engine speed. 2 If this error continues to occur, please contact your Hyundai dealer or A/S center. Note: In order to prevent permanent damage, stay within the permissible speed range.
523501	0	Engine speed limit request does not take effect	Normal	The transmission control unit requires a limited engine speed; the engine does not maintain the limit;	If this error continues to be active, please contact your Hyundai dealer or A/S center.
523502	0	Engine speed control request does not take effect	Normal	The transmission control unit requires a certain engine speed; the engine controller does not set this speed;	If this error continues to be active, please contact your Hyundai dealer or A/S center.
523503	0	Engine torque limit request does not take effect	Normal	The transmission control unit requires a limited engine torque; the engine does not maintain the limit;	If this error continues to be active, please contact your Hyundai dealer or A/S center.

Error code		Description	Op mode	Cause	Possible step to repair
SPN	FMI				
523504	0	Engine torque control request does not take effect	Normal	The transmission control unit requires a certain engine torque;the engine controller does not set this torque;	If this error continues to be active, please contact your Hyundai dealer or A/S center.
523600	0	Protection related error detected	Trm shutdown	The control unit detects a safety-relevant error.	Read out the operating data with Testman and send them to your ZF contact.
523600	1	Protection Function 1 (SF01) Unwanted driveaway	TCU shutdown	Unexpected vehicle movement detected	Read out the operating data with Testman and send them to your ZF contact.
523600	2	Protection Function 2 (SF02) Unwanted driving direction	Trm shutdown	Driving in the wrong direction detected	Read out the operating data with Testman and send them to your ZF contact.
523600	3	Protection Function 3 (SF03) Safely limited acceleration (blocked Transmission)	Trm shutdown	Transmission blocking detected	Read out the operating data with Testman and send them to your ZF contact.
523600	4	Protection Function 4 (SF04) Safely limited acceleration (Downshift)	Trm shutdown	Unalowed speeds at transmission input detected	Read out the operating data with Testman and send them to your ZF contact.
523600	5	Protection Function 5 (SF05) Safe Output at reverse driving	Trm shutdown	Wrong reverse signal broadcasted	Read out the operating data with Testman and send them to your ZF contact.
523600	6	Protection Function 6 (SF06) Safely limited speed in Reverse	Trm shutdown	Unalowed speed or gear in Reverse detected	Read out the operating data with Testman and send them to your ZF contact.
523600	7	Protection Function 7 (SF07) Unwanted direction change	Trm shutdown	Unwanted change of driving direction detected	Read out the operating data with Testman and send them to your ZF contact.
523600	8	Protection Function 8 (SF08)	Trm shutdown	Safely limited torque	Read out the operating data with Testman and send them to your ZF contact.
523600	9	Protection Function 9 (SF09) Safely limited torque	Trm shutdown	Unalowed engine control request detected	Read out the operating data with Testman and send them to your ZF contact.

Error code		Description	Op mode	Cause	Possible step to repair
SPN	FMI				
523600	10	Protection Function 10 (SF10) Delayed gear engagement	Trm shutdown	Unallowed delayed get into gear detected	Read out the operating data with Testman and send them to your ZF contact.
523600	11	Protection Function 11 (SF11) Safe Difflock	Trm shutdown	Unallowed difflock acutation at too high speeds detected	Read out the operating data with Testman and send them to your ZF contact.
523600	16	Protection function 16 (SF16) safe inching exit	TCU shutdown	Safe inching exit	Read out the operating data with Testman and send them to your ZF contact.
523600	18	Protection function 18 (SF18) safe speedlimit	Trm shutdown	Unallowed speed limit overrun	Read out the operating data with Testman and send them to your ZF contact.
523601	0	Protection related error in transmission detected	TCU shutdown	The control unit detects a clutch shift although no gear change is requested. 1 Energization proportional valve faulty. 2 Proportional valve faulty. 3 Control unit has an internal defect.	1 Check the proportional valves. 2 If this error continues to occur, contact your ZF representative and give us the error code and the conditions under which the error occurs. Read out the operating data with Testman and send them to us.
523602	0	Protection related error in vehicle communication detected	TCU shutdown	The control unit detects a faulty check sum, a faulty message counter, or a faulty requirement from the vehicle control unit. 1 CAN bus message is faulty.	1 Check if the TC1 CAN bus message is present. In addition, create a CAN bus measurement on the vehicle CAN. 2 If this error continues to occur, please contact your Hyundai dealer or A/S center.
523603	0	Protection error reaction failed	TCU shutdown	The control unit requires that the internal supply voltage is switched off but this does not happen. 1 Control unit has an internal defect.	1 Replace the control unit.
523421	9	No response to request of Time and Date message	Normal	The control unit does not receive the CAN message or the message contains faulty data. 1 Sporadic electrical error. 2 CAN bus overloaded. 3 Sending control unit has an internal defect. 4 Receiving control unit has an internal defect.	If the control unit resets the error itself, then this is a matter of a sporadically occurring error or an excessive bus load. 1 If error vehicle CAN error occurs, then repair this first. 2 If this error continues to be active, please contact your Hyundai dealer or A/S center.

Error code		Description	Op mode	Cause	Possible step to repair
SPN	FMI				
523423	9	Message VehcCFG invalid or timeout	Trm shutdown	<p>The control unit does not receive the CAN message or the message contains faulty data.</p> <ol style="list-style-type: none"> 1 Sporadic electrical error. 2 CAN bus overloaded. 3 Sending control unit has an internal defect. 4 Receiving control unit has an internal defect. 	<p>If the control unit resets the error itself, then this is a matter of a sporadically occurring error or an excessive bus load.</p> <ol style="list-style-type: none"> 1 If error Vehicle CAN error occurs, then repair this first. 2 If this error continues to be active, please contact your Hyundai dealer or A/S center.
523424	9	Message CCSS or ZFCCSS invalid or timeout	Trm shutdown	<p>The control unit does not receive the CAN message or the message contains faulty data.</p> <ol style="list-style-type: none"> 1 Sporadic electrical error. 2 CAN bus overloaded. 3 Sending control unit has an internal defect. 4 Receiving control unit has an internal defect. 	<p>If the control unit resets the error itself, then this is a matter of a sporadically occurring error or an excessive bus load.</p> <ol style="list-style-type: none"> 1 If error Vehicle CAN error occurs, then repair this first. 2 If this error continues to be active, please contact your Hyundai dealer or A/S center.
523482	9	Application program verification failed	TCU shutdown	<p>The control unit does not receive the ZFVI or VI message or the message contains faulty data.</p>	<p>Read out the operating data with Testman and send them to your ZF contact.</p>
523100	7	EF1 speed does not match with other speeds	Trm shutdown	<p>The control unit measures a speed at the input which does not agree with the other speeds.</p> <ol style="list-style-type: none"> 1 Wiring or plug connection is defective. 2 Wiring or plug connection has a poor contact. 3 Distance speed sensor – sensor ring too large. 4 Speed sensor has an internal defect. 	<p>The cause of the different speeds must be located.</p> <ol style="list-style-type: none"> 1 Check the wiring from the speed sensor to the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2 Check the function of the sensor and, if necessary, replace it.
523100	11	EF1 direction of rotation does not match with other directions of rotation	Limp home	<p>The control unit recognizes a rotational direction at the input, which does not agree with the other rotational directions.</p> <ol style="list-style-type: none"> 1 Wiring or plug connection is defective. 2 Wiring or plug connection has a poor contact. 3 Distance speed sensor – sensor ring too large. 4 Speed sensor has an internal defect. 	<p>The cause of the different rotational directions must be located.</p> <ol style="list-style-type: none"> 1 Check the wiring from the sensor to the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2 Check the function of the sensor and, if necessary, replace it.

Error code		Description	Op mode	Cause	Possible step to rapair
SPN	FMI				
523105	7	EF2 speed does not match with other speeds	Limp shutdown	<p>The control unit measures a speed at the input which does not agree with the other speeds.</p> <ol style="list-style-type: none"> 1 Wiring or plug connection is defective. 2 Wiring or plug connection has a poor contact. 3 Distance speed sensor – sensor ring too large. 4 Speed sensor has an internal defect. 	<p>The cause of the different speeds must be located.</p> <ol style="list-style-type: none"> 1 Check the wiring from the speed sensor to the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2 Check the function of the sensor and, if necessary, replace it.
523105	11	EF2 direction of rotation does not match with other directions of rotation	Limp home	<p>The control unit recognizes a rotational direction at the input, which does not agree with the other rotational directions.</p> <ol style="list-style-type: none"> 1 Wiring or plug connection is defective. 2 Wiring or plug connection has a poor contact. 3 Distance speed sensor – sensor ring too large. 4 Speed sensor has an internal defect. 	<p>The cause of the different rotational directions must be located.</p> <ol style="list-style-type: none"> 1 Check the wiring from the sensor to the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2 Check the function of the sensor and, if necessary, replace it.
523110	7	EF3 speed does not match with other speeds	Limp shutdown	<p>The control unit measures a speed at the input which does not agree with the other speeds.</p> <ol style="list-style-type: none"> 1 Wiring or plug connection is defective. 2 Wiring or plug connection has a poor contact. 3 Distance speed sensor – sensor ring too large. 4 Speed sensor has an internal defect. 	<p>The cause of the different speeds must be located.</p> <ol style="list-style-type: none"> 1 Check the wiring from the speed sensor to the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2 Check the function of the sensor and, if necessary, replace it.
523110	11	EF3 direction of rotation does not match with other directions of rotation	Trm shutdown	<p>The control unit recognizes a rotational direction at the input, which does not agree with the other rotational directions.</p> <ol style="list-style-type: none"> 1 Wiring or plug connection is defective. 2 Wiring or plug connection has a poor contact. 3 Distance speed sensor – sensor ring too large. 4 Speed sensor has an internal defect. 	<p>The cause of the different rotational directions must be located.</p> <ol style="list-style-type: none"> 1 Check the wiring from the sensor to the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2 Check the function of the sensor and, if necessary, replace it.

Error code		Description	Op mode	Cause	Possible step to repair
SPN	FMI				
523115	7	EF4 speed does not match with other speeds	Limp home	<p>The control unit measures a speed at the input which does not agree with the other speeds.</p> <ol style="list-style-type: none"> 1 Wiring or plug connection is defective. 2 Wiring or plug connection has a poor contact. 3 Distance speed sensor – sensor ring too large. 4 Speed sensor has an internal defect. 	<p>The cause of the different speeds must be located.</p> <ol style="list-style-type: none"> 1 Check the wiring from the speed sensor to the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2 Check the function of the sensor and, if necessary, replace it.
523115	11	EF4 direction of rotation does not match with other directions of rotation	Normal	<p>The control unit recognizes a rotational direction at the input, which does not agree with the other rotational directions.</p> <ol style="list-style-type: none"> 1 Wiring or plug connection is defective. 2 Wiring or plug connection has a poor contact. 3 Distance speed sensor – sensor ring too large. 4 Speed sensor has an internal defect. 	<p>The cause of the different rotational directions must be located.</p> <ol style="list-style-type: none"> 1 Check the wiring from the sensor to the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2 Check the function of the sensor and, if necessary, replace it.
523302	0	Torque converter oil temperature critical	Normal	<p>The measured oil temperature at the converter is too high.</p> <ol style="list-style-type: none"> 1 The oil level is incorrect. 2 The cooling system is faulty. 3 Load is permanently too high. 	<p>The cause of the increased temperature at the converter must be located.</p> <ol style="list-style-type: none"> 1 Check the oil level and correct it as needed. 2 Check the function of the cooler fan. 3 Check the transmission oil cooler for contaminants and damage. 4 Check the connection lines from the transmission to the transmission oil cooler for damage. 5 Check the transmission oil temperature using the diagnosis unit. If the measured oil temperature does not drop when the vehicle is operated at idle even after a longer period of time, then the temperature sensor needs to be replaced.

Error code		Description	Op mode	Cause	Possible step to repair
SPN	FMI				
523302	16	Torque converter oil overtemperature	Normal	<p>The measured oil temperature at the converter is too high.</p> <ol style="list-style-type: none"> 1 The oil level is incorrect. 2 The cooling system is faulty. 3 Load is permanently too high. 	<p>The cause of the increased temperature at the converter must be located.</p> <ol style="list-style-type: none"> 1 Check the oil level and correct it as needed. 2 Check the function of the cooler fan. 3 Check the transmission oil cooler for contaminants and damage. 4 Check the connection lines from the transmission to the transmission oil cooler for damage. 5 Check the transmission oil temperature using the diagnosis unit. If the measured oil temperature does not drop when the vehicle is operated at idle even after a longer period of time, then the temperature sensor needs to be replaced.
523450	19	Engine reference torque signal invalid	Limp home	<p>Signal 'Engine Reference Torque' from engine controller contains faulty data.</p> <ol style="list-style-type: none"> 1 Incorrect software on the transmission control unit. 2 Incorrect software on the engine controller. 	<ol style="list-style-type: none"> 1 Check the software version of the transmission control unit and program the current software version if required. 2 If this error continues to occurs, please contact your Hyundai dealer or A/S center.
523451	19	Actual engine torque signal invalid	Limp home	<p>Signal 'Actual Engine Torque' from engine controller contains faulty data.</p> <ol style="list-style-type: none"> 1 Incorrect software on the transmission control unit. 2 Incorrect software on the engine controller. 	<ol style="list-style-type: none"> 1 Check the software version of the transmission control unit and program the current software version if required. 2 If this error continues to occurs, please contact your Hyundai dealer or A/S center.
523452	19	Engine nominal friction torque signal invalid	Normal	<p>Signal 'Engine Nominal Friction Torque' from engine controller contains faulty data.</p> <ol style="list-style-type: none"> 1 Incorrect software on the transmission control unit. 2 Incorrect software on the engine controller. 	<ol style="list-style-type: none"> 1 Check the software version of the transmission control unit and program the current software version if required. 2 If this error continues to occurs, please contact your Hyundai dealer or A/S center.
523454	19	Launch gear request invalid	Normal	<p>Signal 'Requested Launch Gear' from vehicle controller contains faulty data.</p> <ol style="list-style-type: none"> 1 Incorrect software on the transmission control unit. 2 Incorrect software on the vehicle controller. 	<ol style="list-style-type: none"> 1 Check the software version of the transmission control unit and program the current software version if required. 2 If this error continues to occurs, please contact your Hyundai dealer or A/S center.

Error code		Description	Op mode	Cause	Possible step to rapair
SPN	FMI				
523455	19	Message ZFSL1 invalid or timed out	Trm shutdown	Shift lever message is missing or provides wrong signals	Check CAN Bus, check shift lever
523456	19	Invalid FNR extension switches signal	Trm shutdown	Invalid output signals from FNR switch	Check Shift lever, FNR switch
523650	0	Neutral selected while vehicle moves with overspeed	Normal	Shift lever message is missing or provides wrong signals	Check CAN Bus, check shift lever
523700	0	Clutch K1 slipping unintendedly	Limp home	<p>The TCU calculates a speed difference although the clutch is closed. If this value is too high, it is interpreted as slip on the clutch.</p> <ol style="list-style-type: none"> 1 Insufficient pressure on the clutch. 2 Insufficient system pressure. 3 Filter clogged. 4 Clutch faulty. 5 Transmission input speed signal faulty. 6 Transmission output speed signal faulty. 7 Distance speed sensor – sensor ring too large. 8 Significant oscillation of the engine speed. 	<p>The cause of the occurring speed difference must be located.</p> <ol style="list-style-type: none"> 1 Check the existing system pressure. 2 Check the filter and replace it if needed (compare error 195). 3 Check the function of the clutch. 4 Check the function of the proportional valves and replace them if needed. 5 Check if all speeds are present and correct. 6 Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts.
523705	0	Clutch K2 slipping unintendedly	Limp home	<p>The TCU calculates a speed difference although the clutch is closed. If this value is too high, it is interpreted as slip on the clutch.</p> <ol style="list-style-type: none"> 1 Insufficient pressure on the clutch. 2 Insufficient system pressure. 3 Filter clogged. 4 Clutch faulty. 5 Transmission input speed signal faulty. 6 Transmission output speed signal faulty. 7 Distance speed sensor – sensor ring too large. 8 Significant oscillation of the engine speed. 	<p>The cause of the occurring speed difference must be located.</p> <ol style="list-style-type: none"> 1 Check the existing system pressure. 2 Check the filter and replace it if needed (compare error 195). 3 Check the function of the clutch. 4 Check the function of the proportional valves and replace them if needed. 5 Check if all speeds are present and correct. 6 Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts.

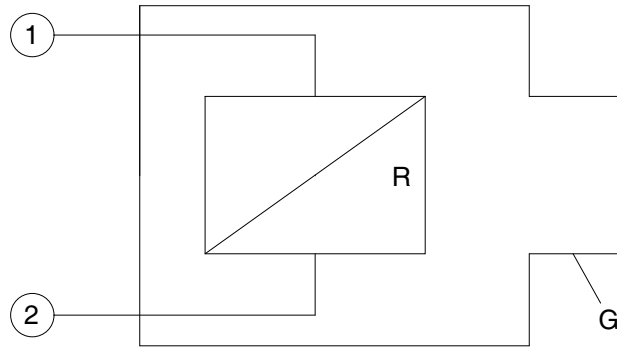
Error code		Description	Op mode	Cause	Possible step to repair
SPN	FMI				
523710	0	Clutch K3 slipping unintentionally	Limp home	<p>The TCU calculates a speed difference although the clutch is closed. If this value is too high, it is interpreted as slip on the clutch.</p> <ol style="list-style-type: none"> 1 Insufficient pressure on the clutch. 2 Insufficient system pressure. 3 Filter clogged. 4 Clutch faulty. 5 Transmission input speed signal faulty. 6 Transmission output speed signal faulty. 7 Distance speed sensor – sensor ring too large. 8 Significant oscillation of the engine speed. 	<p>The cause of the occurring speed difference must be located.</p> <ol style="list-style-type: none"> 1 Check the existing system pressure. 2 Check the filter and replace it if needed (compare error 195). 3 Check the function of the clutch. 4 Check the function of the proportional valves and replace them if needed. 5 Check if all speeds are present and correct. 6 Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts.
523715	0	Clutch KV slipping unintentionally	Limp home	<p>The TCU calculates a speed difference although the clutch is closed. If this value is too high, it is interpreted as slip on the clutch.</p> <ol style="list-style-type: none"> 1 Insufficient pressure on the clutch. 2 Insufficient system pressure. 3 Filter clogged. 4 Clutch faulty. 5 Transmission input speed signal faulty. 6 Transmission output speed signal faulty. 7 Distance speed sensor – sensor ring too large. 8 Significant oscillation of the engine speed. 	<p>The cause of the occurring speed difference must be located.</p> <ol style="list-style-type: none"> 1 Check the existing system pressure. 2 Check the filter and replace it if needed (compare error 195). 3 Check the function of the clutch. 4 Check the function of the proportional valves and replace them if needed. 5 Check if all speeds are present and correct. 6 Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts.
523720	0	Clutch K4 slipping unintentionally	Limp home	<p>The TCU calculates a speed difference although the clutch is closed. If this value is too high, it is interpreted as slip on the clutch.</p> <ol style="list-style-type: none"> 1 Insufficient pressure on the clutch. 2 Insufficient system pressure. 3 Filter clogged. 4 Clutch faulty. 5 Transmission input speed signal faulty. 6 Transmission output speed signal faulty. 7 Distance speed sensor – sensor ring too large. 8 Significant oscillation of the engine speed. 	<p>The cause of the occurring speed difference must be located.</p> <ol style="list-style-type: none"> 1 Check the existing system pressure. 2 Check the filter and replace it if needed (compare error 195). 3 Check the function of the clutch. 4 Check the function of the proportional valves and replace them if needed. 5 Check if all speeds are present and correct. 6 Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts.

Error code		Description	Op mode	Cause	Possible step to rapair
SPN	FMI				
523725	0	Clutch KR slipping unintendedly	Limp home	<p>The TCU calculates a speed difference although the clutch is closed. If this value is too high, it is interpreted as slip on the clutch.</p> <ol style="list-style-type: none"> 1 Insufficient pressure on the clutch. 2 Insufficient system pressure. 3 Filter clogged. 4 Clutch faulty. 5 Transmission input speed signal faulty. 6 Transmission output speed signal faulty. 7 Distance speed sensor – sensor ring too large. 8 Significant oscillation of the engine speed. 	<p>The cause of the occurring speed difference must be located.</p> <ol style="list-style-type: none"> 1 Check the existing system pressure. 2 Check the filter and replace it if needed (compare error 195). 3 Check the function of the clutch. 4 Check the function of the proportional valves and replace them if needed. 5 Check if all speeds are present and correct. 6 Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts.
523730	0	LUC slipping unintendedly	Normal	<p>The TCU calculates a speed difference although the clutch is closed. If this value is too high, it is interpreted as slip on the clutch.</p> <ol style="list-style-type: none"> 1 Insufficient pressure on the clutch. 2 Insufficient system pressure. 3 Filter clogged. 4 Clutch faulty. 5 Transmission input speed signal faulty. 6 Transmission output speed signal faulty. 7 Distance speed sensor – sensor ring too large. 8 Significant oscillation of the engine speed. 	<p>The cause of the occurring speed difference must be located.</p> <ol style="list-style-type: none"> 1 Check the existing system pressure. 2 Check the filter and replace it if needed (compare error 195). 3 Check the function of the clutch. 4 Check the function of the proportional valves and replace them if needed. 5 Check if all speeds are present and correct. 6 Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts.
523385	0	Upshift by engine overspeed not supported in limphome	Trm shutdown	Normally an upshift would have been necessary to protect the motor due to the increased motor speed. Since no shift can be performed in mode Limp Home, transmission shifts to neutral instead.	Do not overspeed engine in Limp Home. Use service brakes.
523355	0	Clutch KV temperature critical	Trm shutdown	Failure related to overheated clutch KV	<ol style="list-style-type: none"> 1 Wait for 20s to cool down clutches 2 Train operator to avoid unnecessary direction changes
523356	0	Clutch KR temperature critical	Trm shutdown	Failure related to overheated clutch KR	<ol style="list-style-type: none"> 1 Wait for 20s to cool down clutches 2 Train operator to avoid unnecessary direction changes

Error code		Description	Op mode	Cause	Possible step to rapair
SPN	FMI				
523171	12	CCO or inch pedal signals mismatch	Normal	The measured voltage of CCO and CCO2 signals don't match or are out of range. Or received signals via CAN do not correlate. 1 Cable is defective 2 Sensor has an internal defect	1 Check the cable from TCU to the sensor 2 Check connectors 3 Check sensor
523171	13	Inchpedal calibration failed	Normal	TCU was not able to read correct inchpedal adjustment parameters 1 Interference during saving data on non volatile memory 2 TCU is brand new, the inchpedal calibration was not performed	Perform the inchpedal calibration process.
523118	11	More than one internal speed sensors are defective	Trm shutdown	More than one internal speed sensor is not working properly. In this case limp home mode is not possible anymore.	1 Check transmission harness, cables between TCU and speed sensors 2 Check connectors 3 Check sensor
523431	19	Message ZFTC2 invalid or timed out	Trm shutdown	ZFTC2 message is missing or provides wrong signals.	1 Check CAN bus 2 Check the software version of the transmission control unit and program the current software version if required. 3 If this error continues to occurs, please contact your Hyundai dealer or A/S center.
523432	19	Message ZFSL1_FNR invalid or timed out	Trm shutdown	Shift lever message is missing or provides wrong signals.	1 Check CAN bus 2 Check shift lever 3 Check the software version of the transmission control unit and program the current software version if required. 4 If this error continues to occurs, please contact your Hyundai dealer or A/S center.
523171	11	CCO or inch pedal signal fault during CCO or inching	Limp home	A problem with the signals required for CCO or inching occured while the vehicle was in CCO or inching operation.	1 Check cable from TCU or the sensor 2 Check connectors 3 Check sensor

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

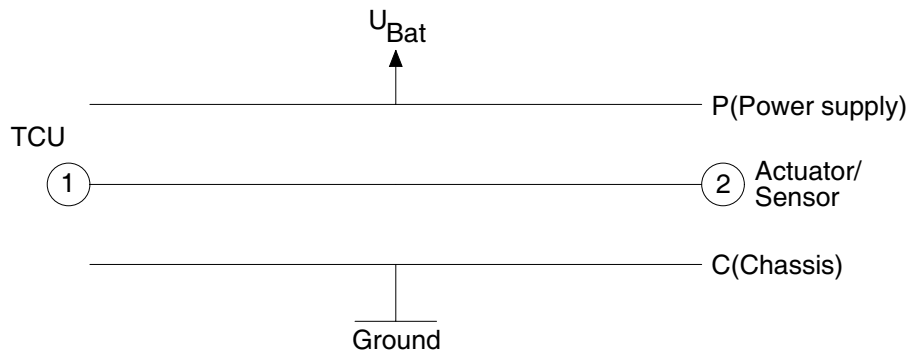
① Actuator



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

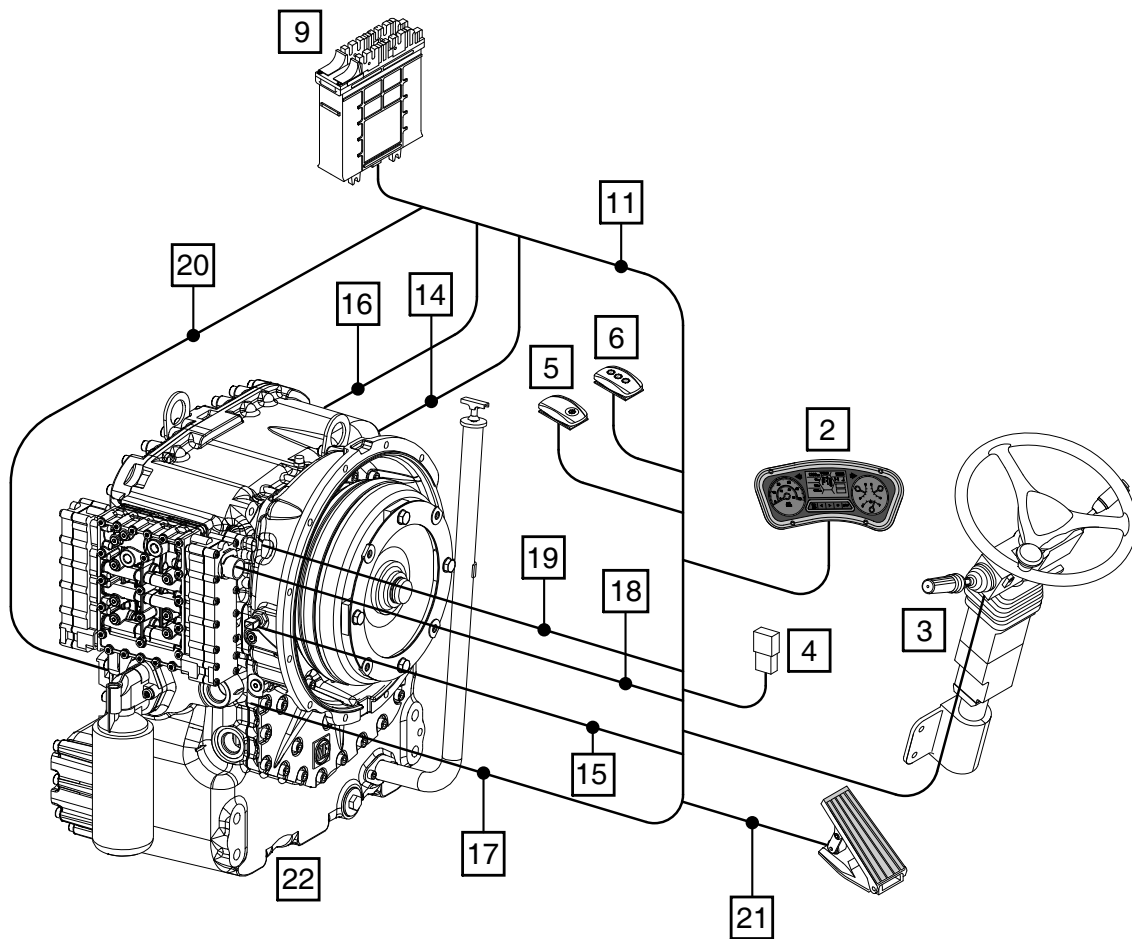
(1) Description of the basic functions

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 protection (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



(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 this way, the driver can move the vehicle very exactly to a determined position.

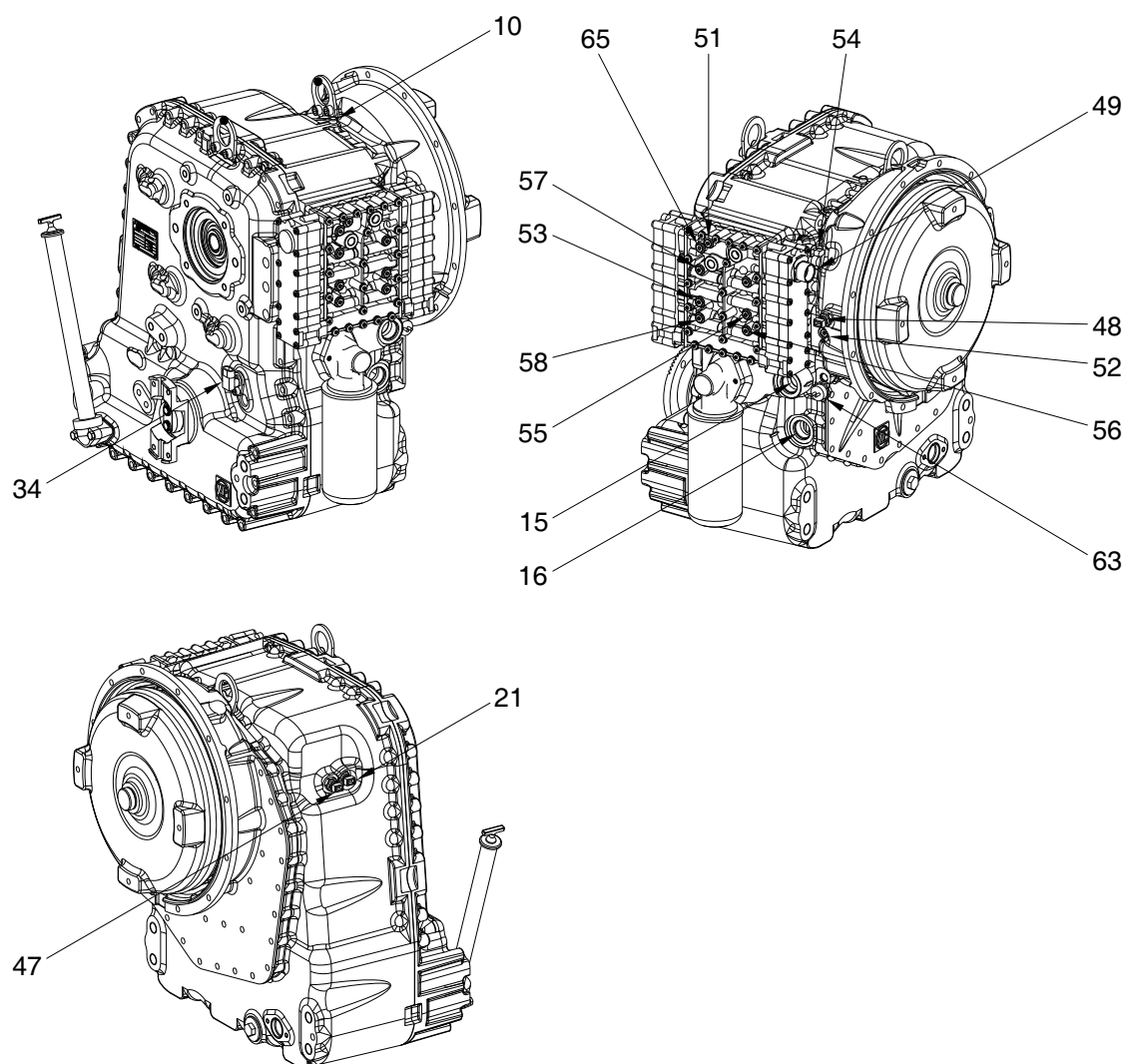
At the same time an important part of the engine power for the output of the hydraulic system is at disposal by the high engine speed.

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

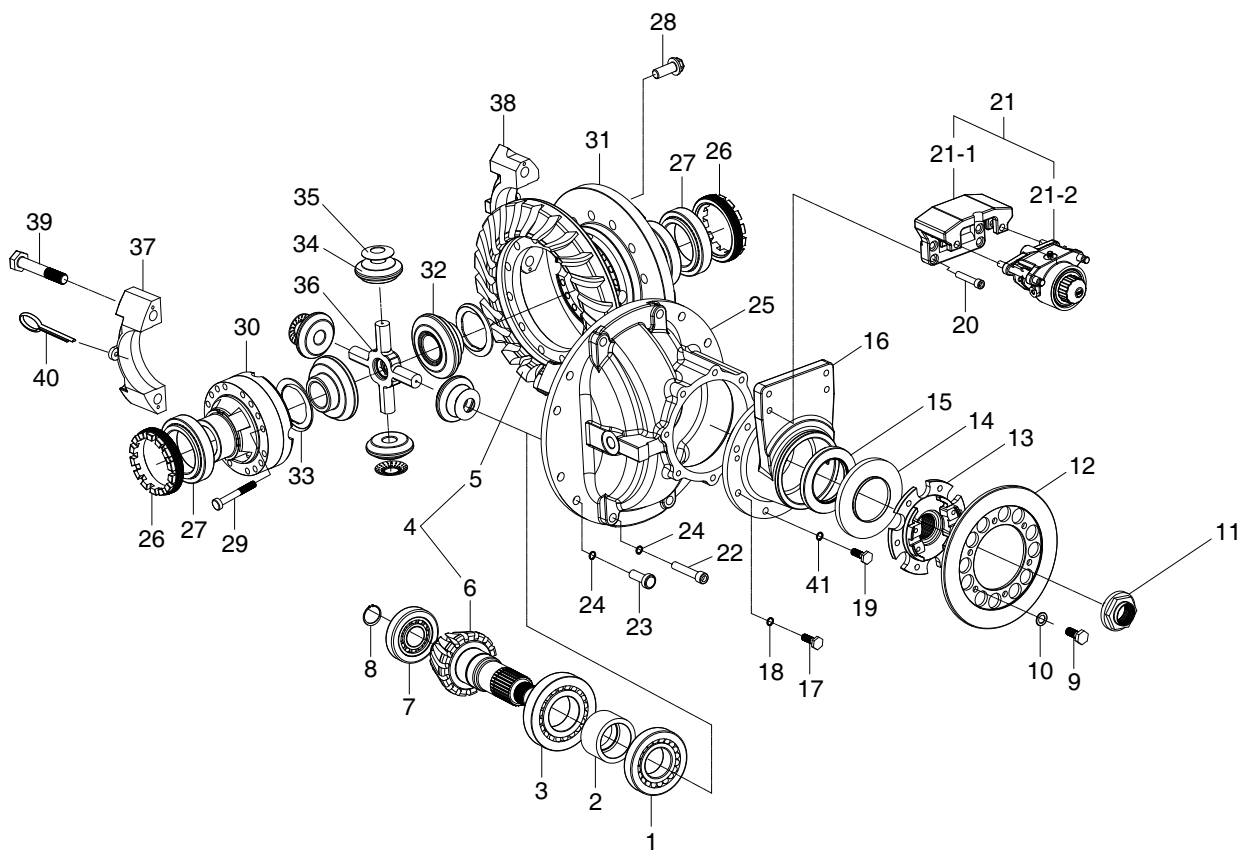
Port	Description	Size
21	Inductive transmitter n Turbine	M18×1.5
34	Speed transmitter n Output	-
47	Inductive transmitter n Internal speed input	M18×1.5
48	Inductive transmitter n Engine	M18×1.5
54	Differential pressure switch for pressure filter	M14x1.5

4) CONNECTIONS

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

5. DRIVE AXLE (DIC)

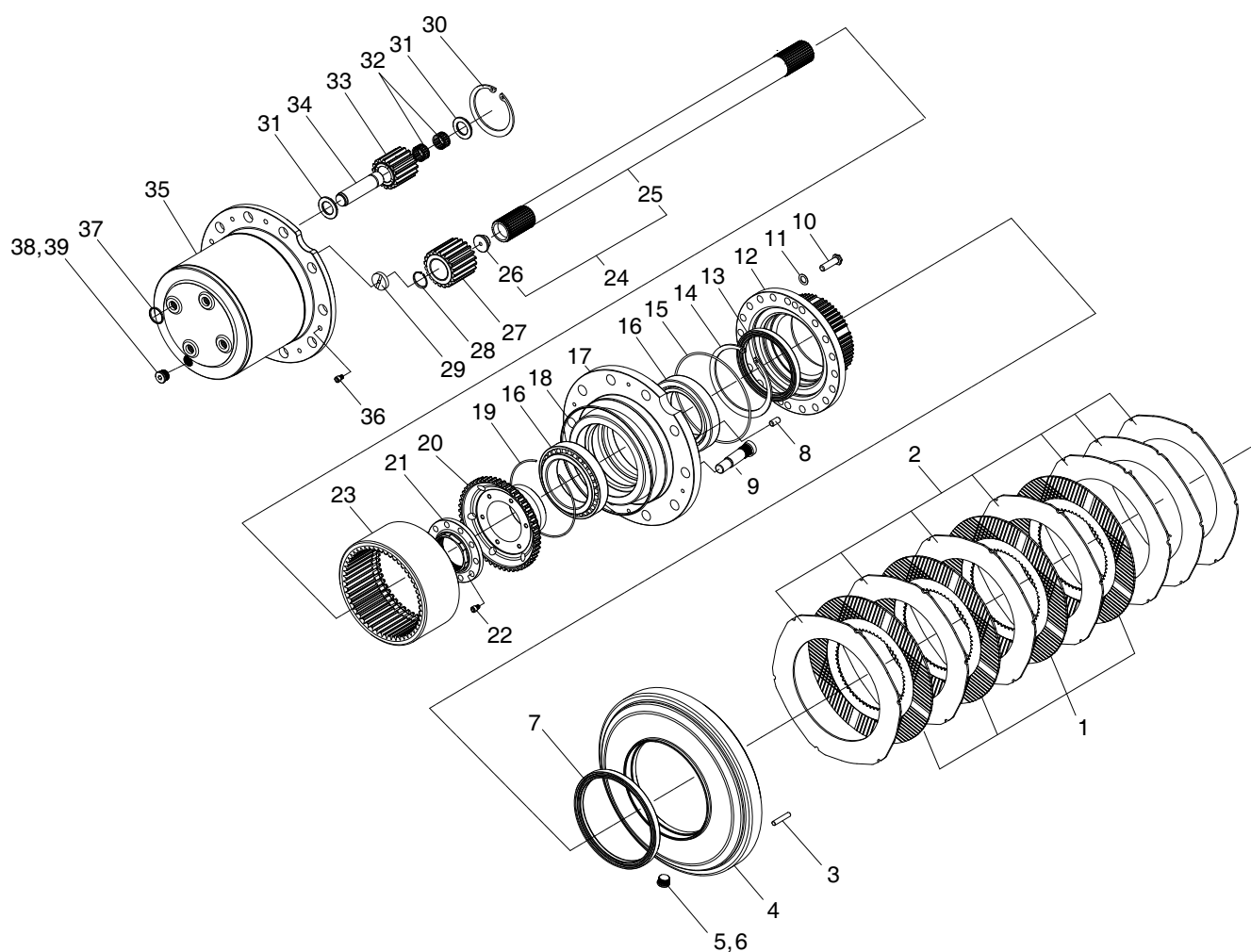
1) STRUCTURE (1/3)



110DED02

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

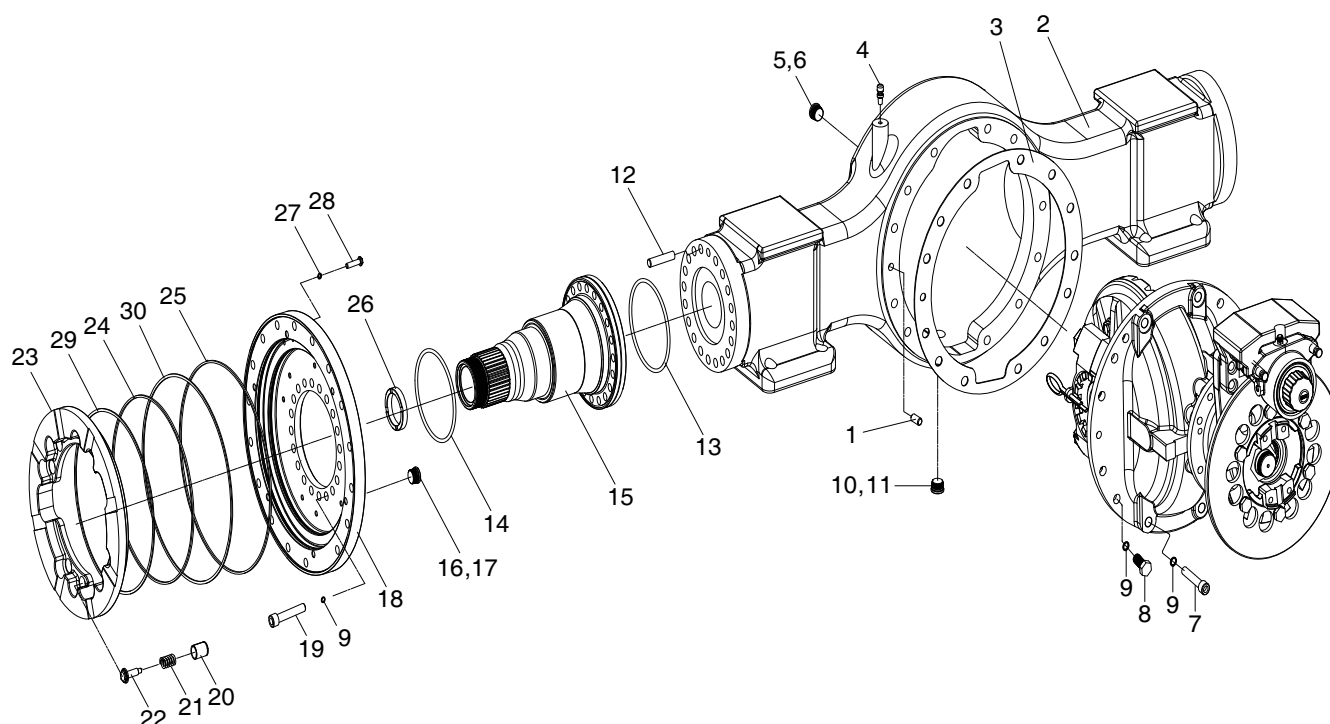
2) STRUCTURE (2/3)



110DED03

- | | | | | | |
|----|---------------|----|----------------------|----|-------------------|
| 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 | Axle hub | 25 | Shaft | 38 | Plug |
| 13 | Oil seal | 26 | Bushing | 39 | O-ring |

3) STRUCTURE (3/3)

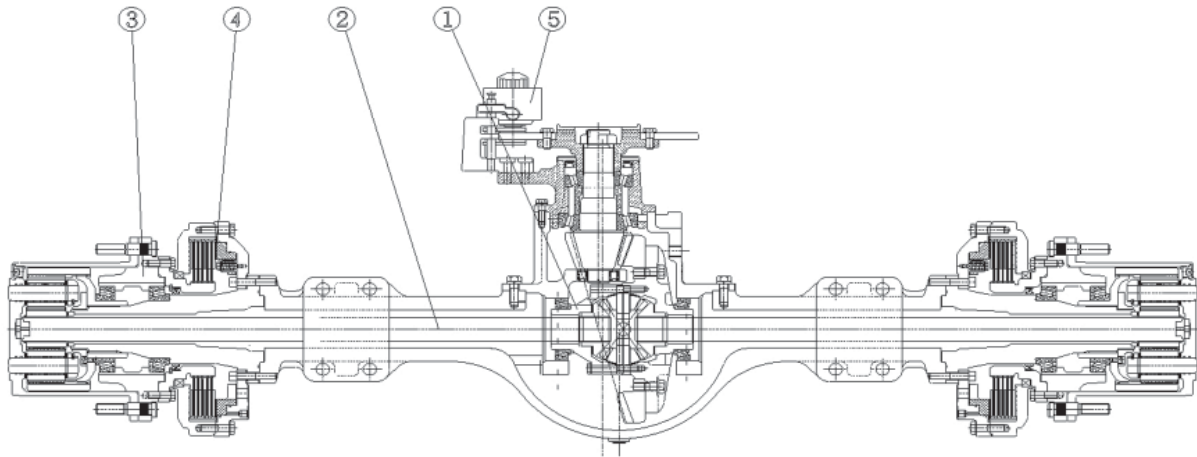


110DED04

- | | | |
|------------------|------------------|------------------|
| 1 Dowel pin | 11 O-ring | 22 Adjust bolt |
| 2 Axle housing | 12 Spacer | 23 Clutch 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.

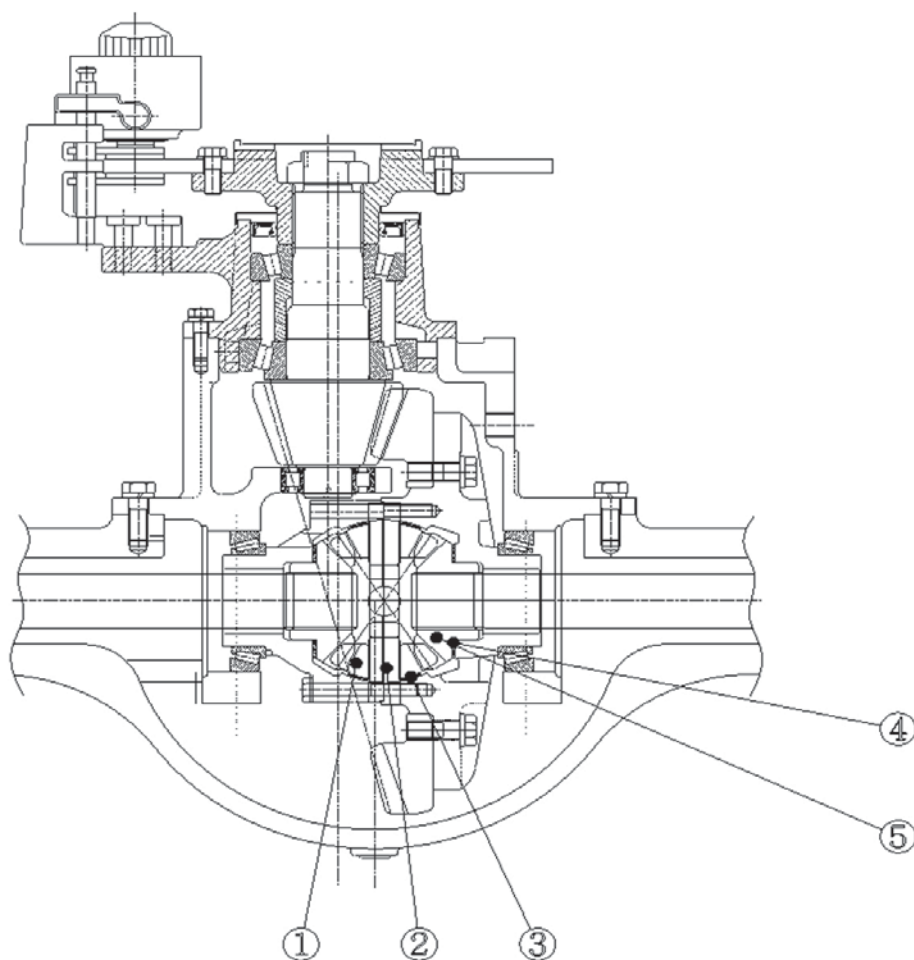
The power of transmission is transmitted to the spiral bevel gear through the output gear of the transmission.

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

(2) Powertrain specification

Classify			120/130D-9V		160D-9V	
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 DONAX TD or XTEER THF 75W-80	SAE 80W/90	Mobil 424 DONAX TD or XTEER THF 75W-80
	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	$\varnothing 27.110 \sim \varnothing 27.131$
2	Spider out diameter	$\varnothing 26.980 \sim \varnothing 26.959$
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)	$\varnothing 50.00 \sim \varnothing 50.04$

OPERATION

Differential transmits the power from the transmission to drive wheel.

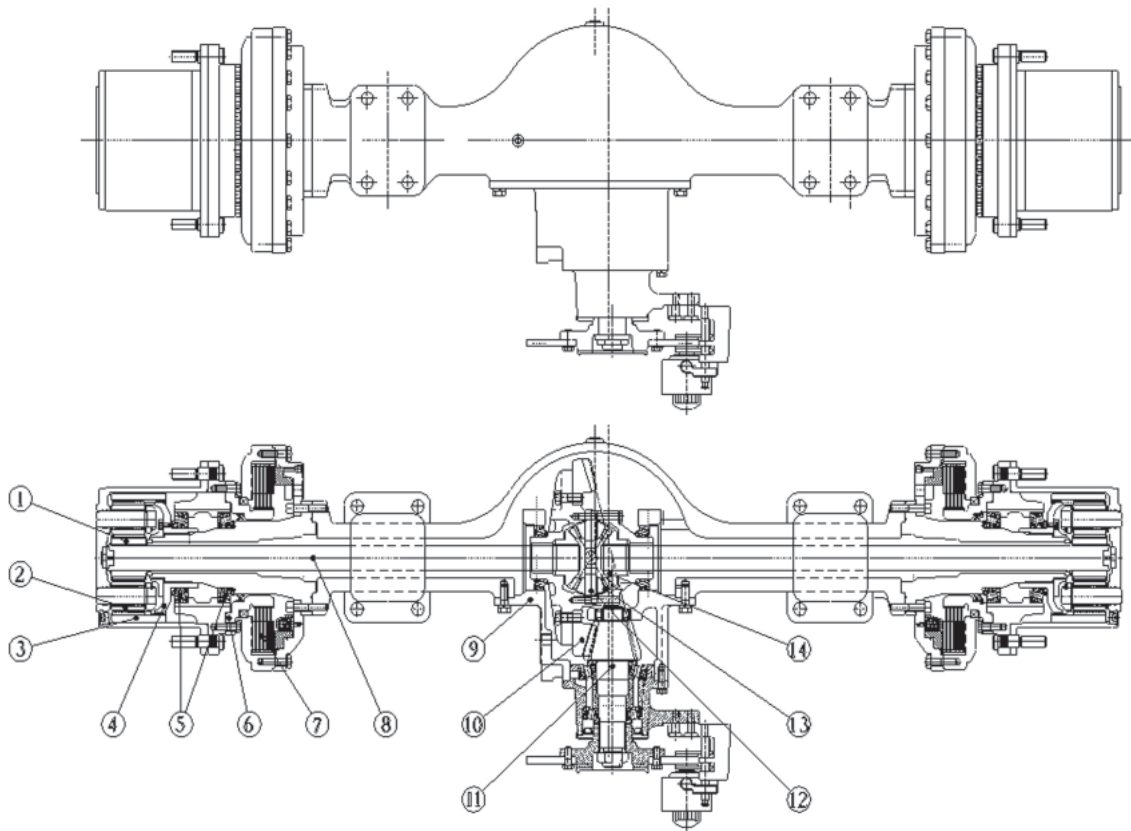
When the vehicle is running one side wheel rotates slower than the other side wheel.

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 Planetary 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

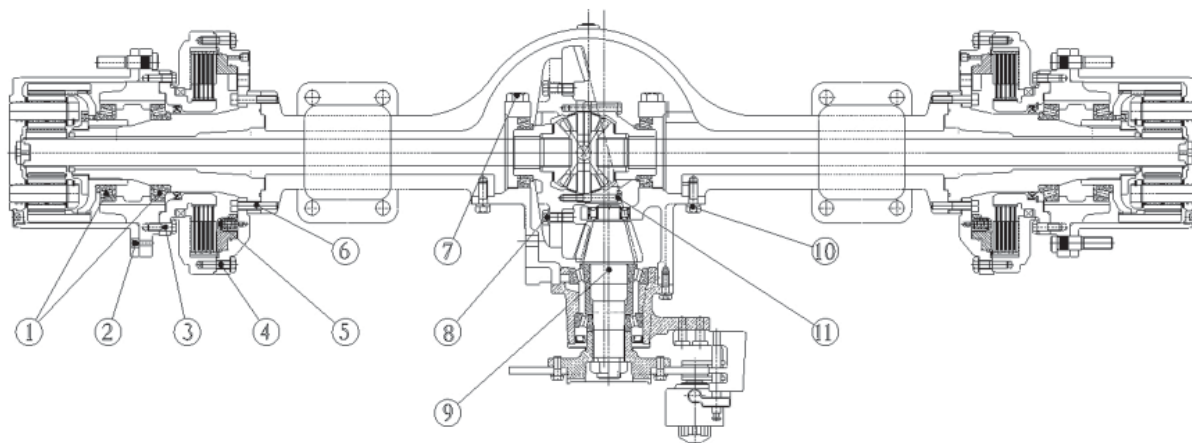
Drive axle which consists of differential carrier assembly (9), drive shaft (8) and hub assembly (6) transmits the drive force from transmission to the wheels.

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.

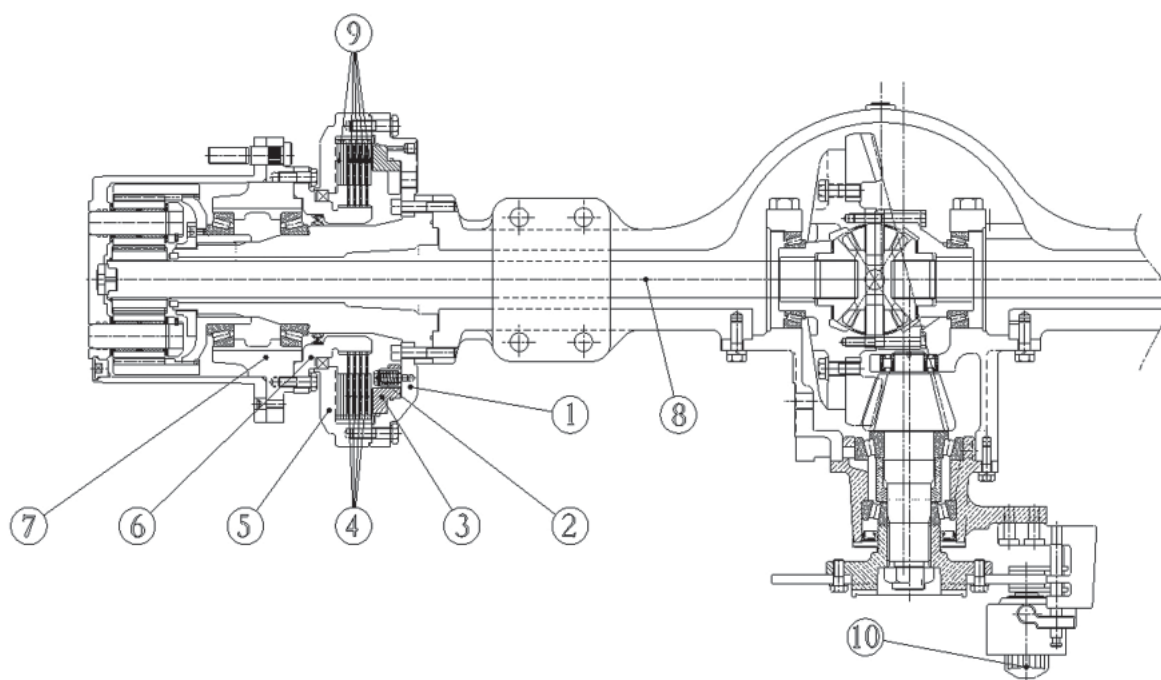
(2) Driving axle tightening torque specifications



110DEDA04

1	Wheel hub pre-load	330~400kg · cm
2	Planetary 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 (120/130D-9V)



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 |

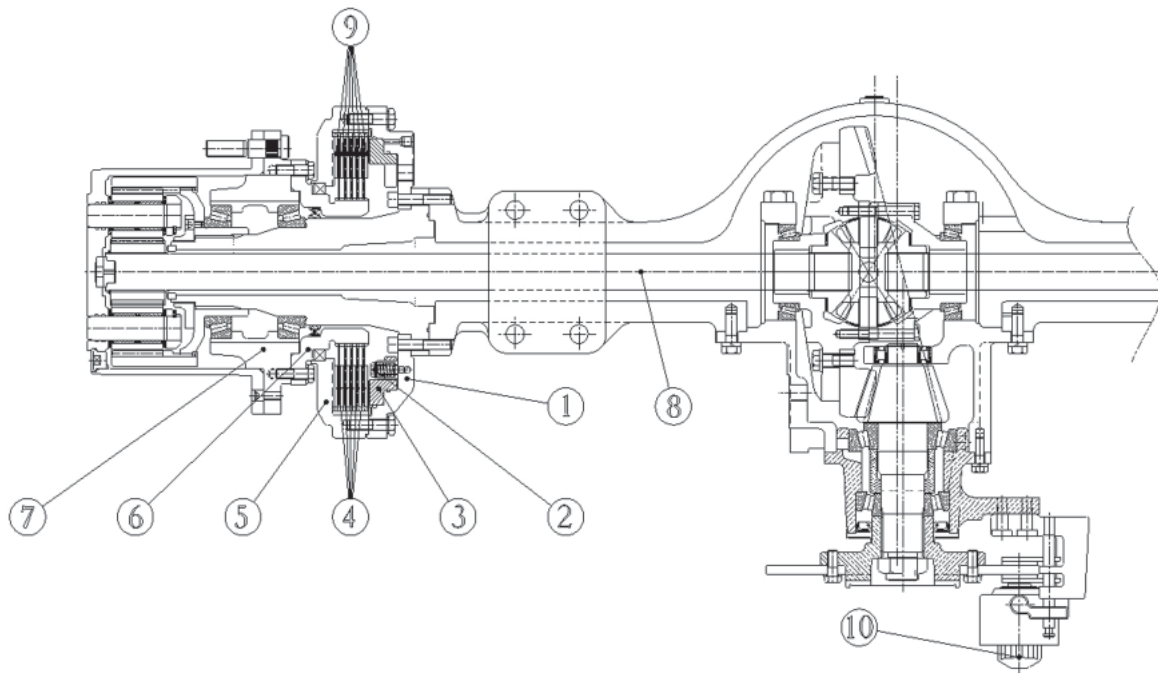
OPERATION

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-9V)



110DEDA06

- | | |
|------------------------|---------------------|
| 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

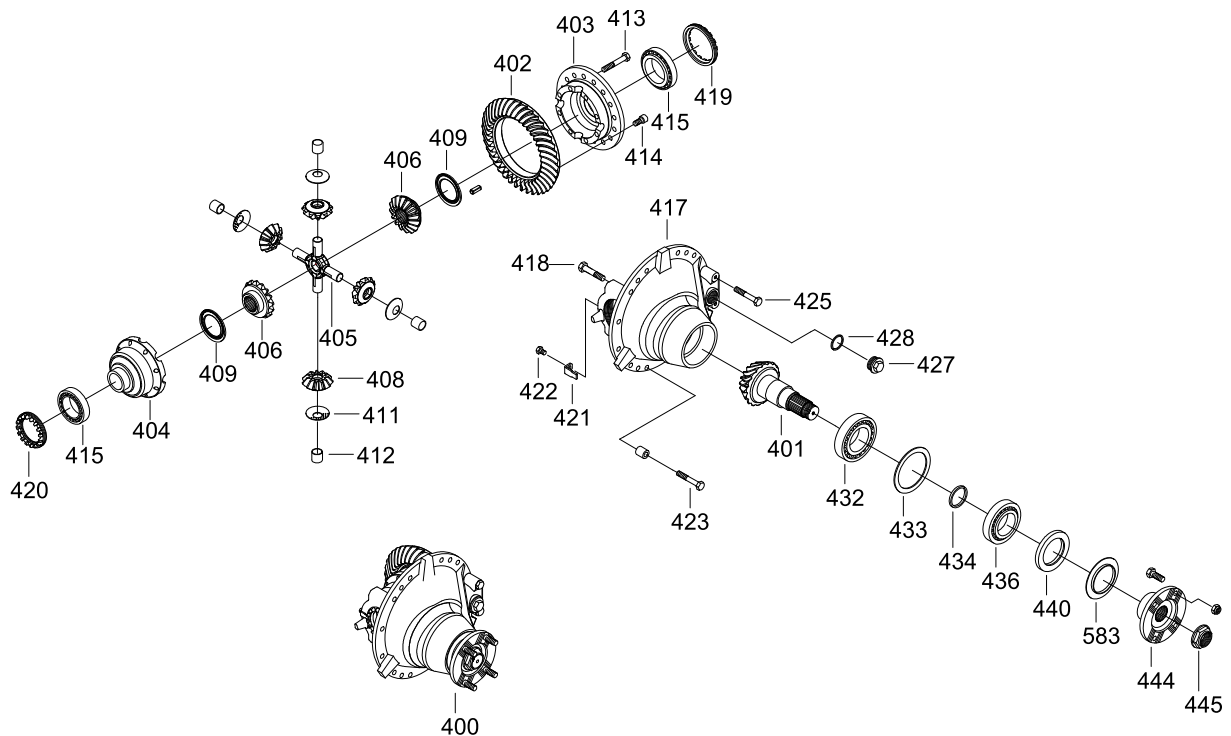
Sealed up structure of hydraulic multi-disk brake system secures good brake performance even in the high humid or dusty area.

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)

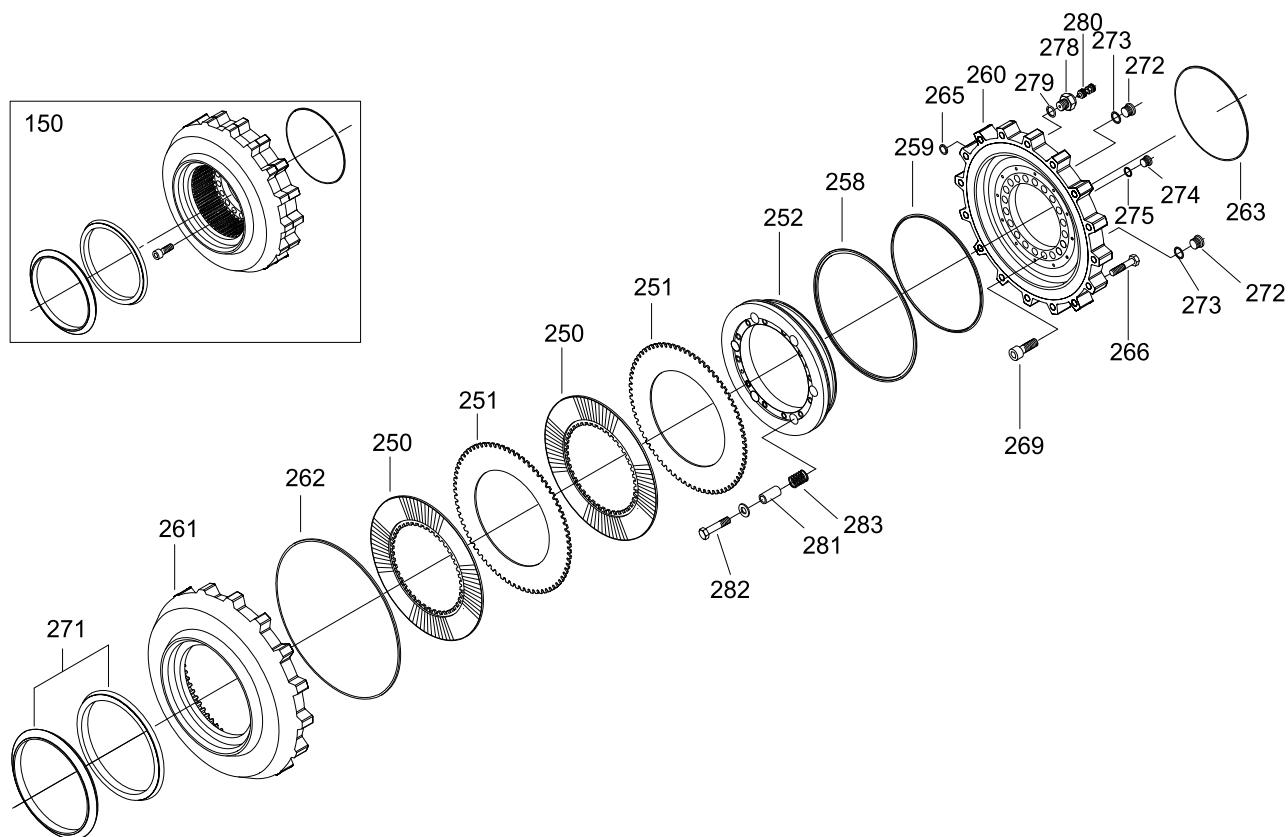
1) STRUCTURE (1/6)



160D9V/DR02

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	433	Thrust washer
405	Differential spider	418	Hexagon screw	434	Ring
406	Differential side gear	419	Setting ring	436	Tapered roller bearing
408	Differential pinion	420	Setting ring	440	Radial seal ring
409	Disk	421	Lock plate	444	Drive flange
411	Thrust washer	422	Hexagon screw	445	Adjusting nut
412	Bearing bushing	423	Hexagon screw	583	Drive plate

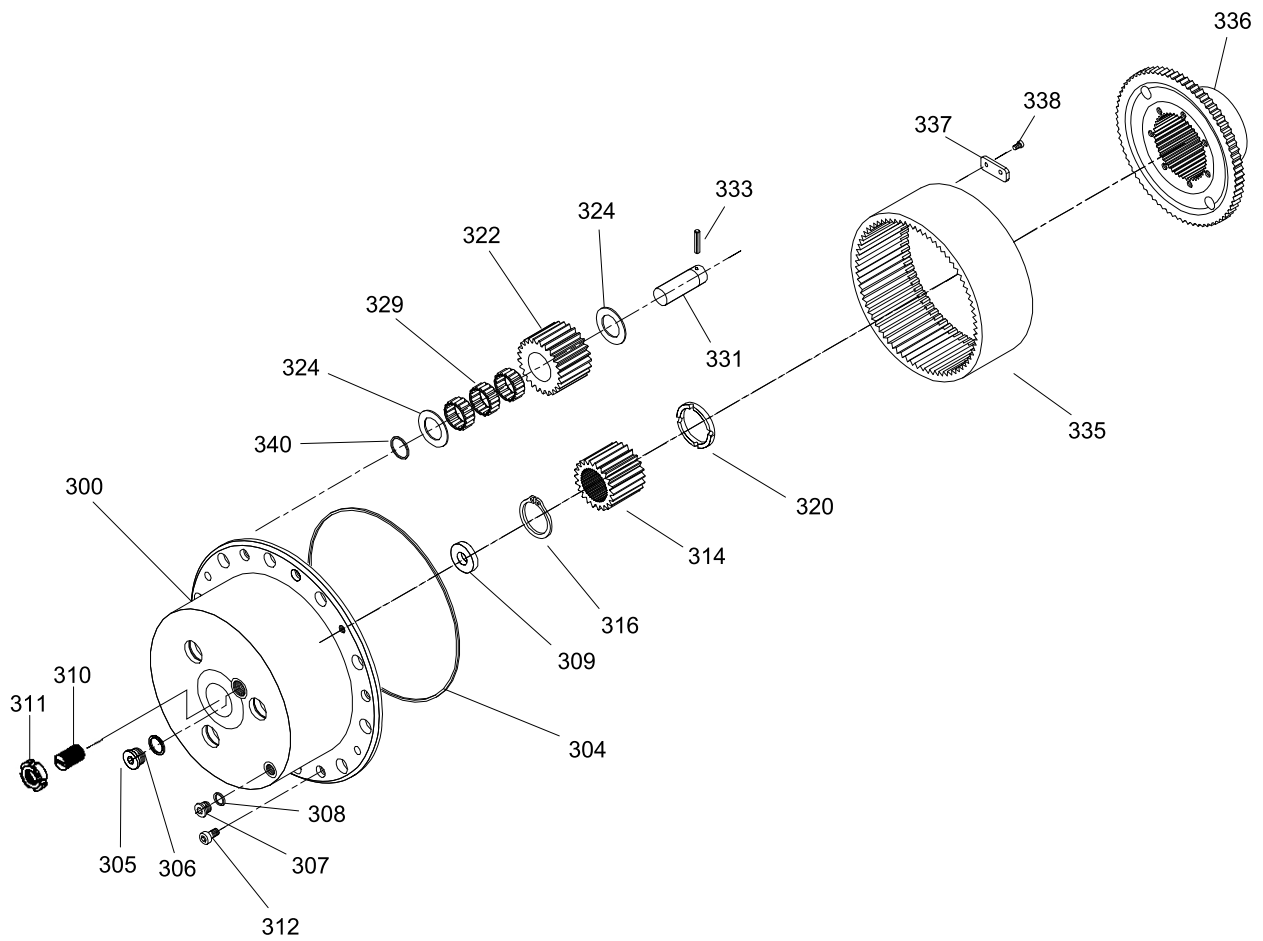
2) STRUCTURE (2/6)



160D9V/DR03

150	Brake (120/130D-9V)	262	O-ring	275	Seal (120/130D-9V)
250	Friction disc	263	O-ring	278	Bleeding socket
251	Steel disc	266	Hexagon screw	279	Sealing ring
252	Piston	269	Hex sockets crew	280	Bleeder valve
258	Gasket	271	Face seal	281	Pipe
259	Gasket	272	Screw plug	282	Hexagon screw with flange
260	Brake carrier	273	Sealing ring	283	Compression spring
261	Housing	274	Screw plug (120/130D-9V)		

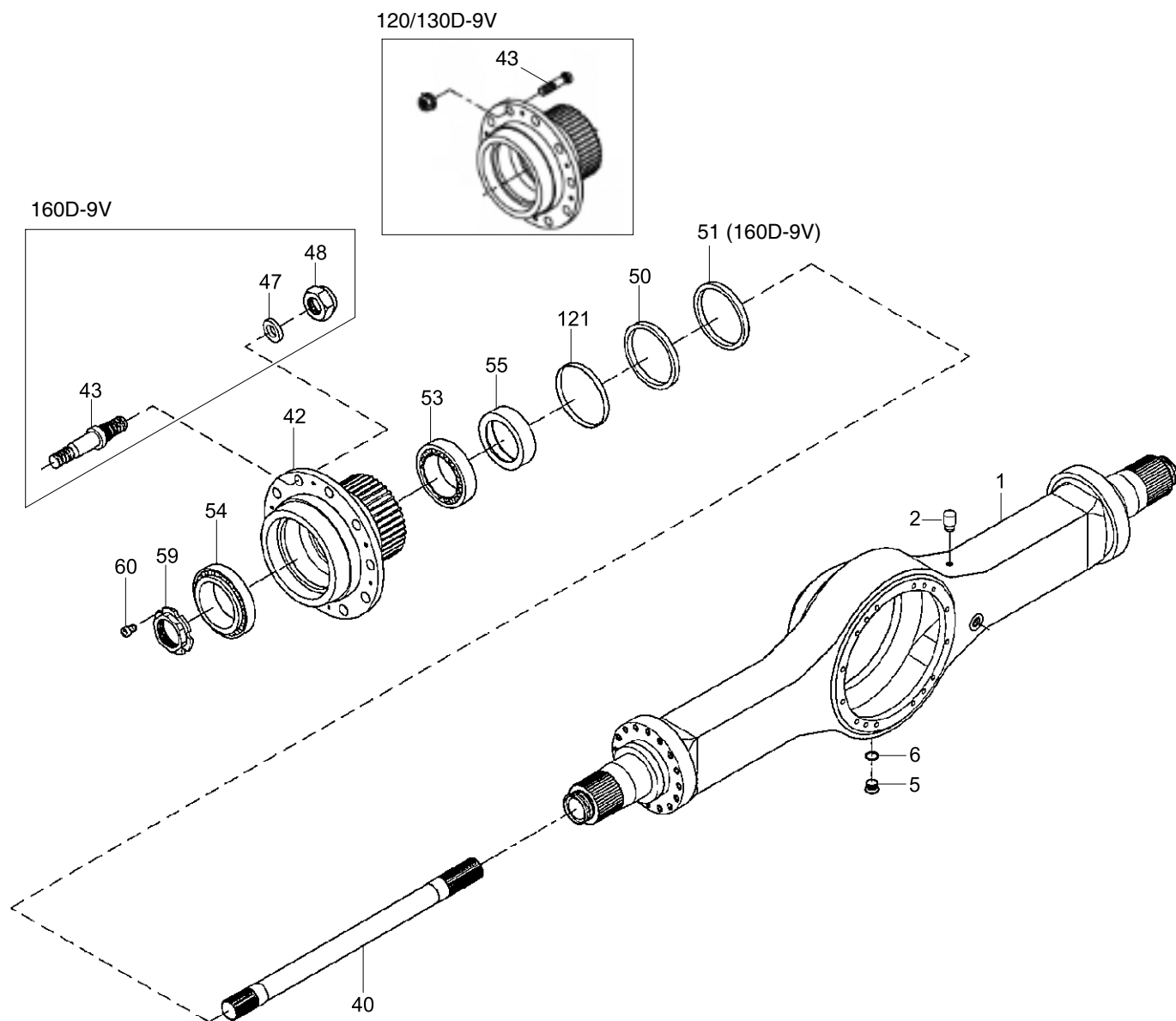
3) STRUCTURE (3/6)



160D9VDR04

300 Planetary housing	311 Slotted nut (160D-9V)	
304 O-ring	312 Hexagon socket screw	331 Planetary pin
305 Screw plug	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
309 Thrust washer (120/130D-9V)	324 Thrust washer	338 Hexagon socket screw
310 Adjusting screw (160D-9V)	329 Needle bearing	340 O-ring

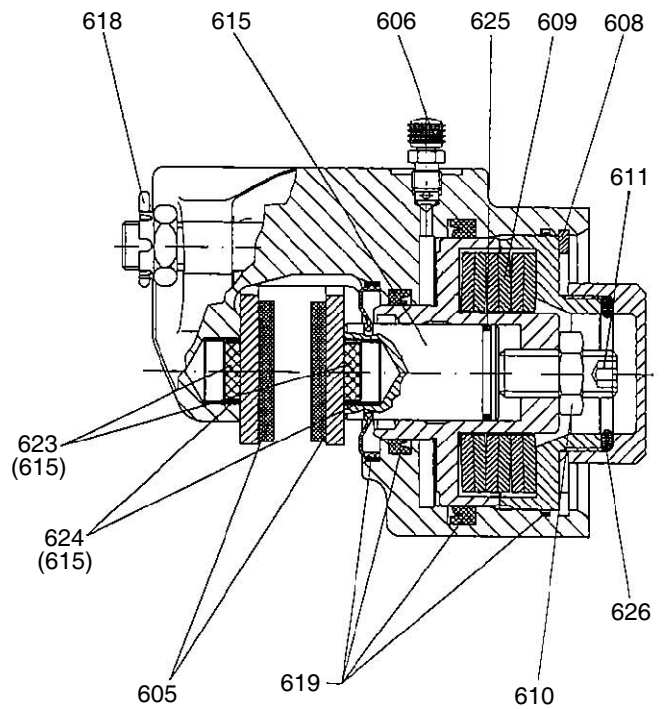
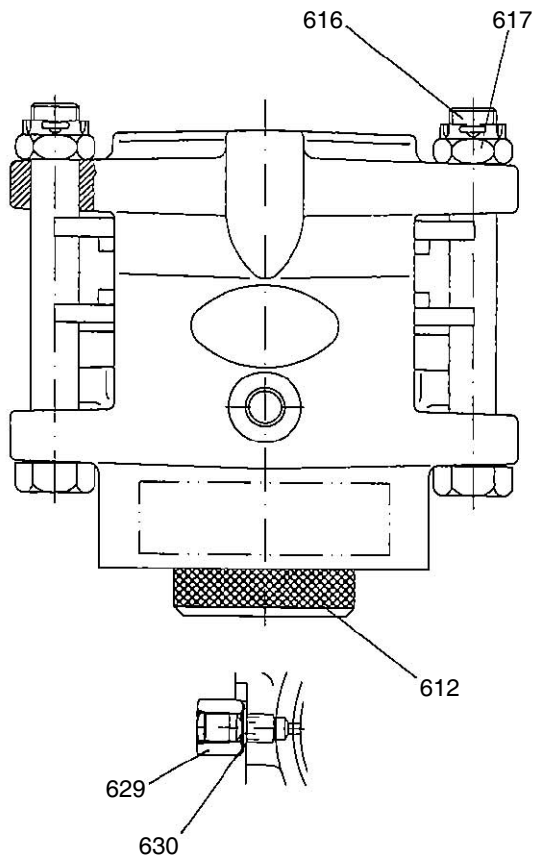
4) STRUCTURE (4/6)



160D9VDR05

- | | | | | | |
|----|--------------|----|----------------------|-----|----------------------|
| 1 | Axle housing | 43 | Stud bolt | 54 | Taper roller bearing |
| 2 | Breather | 47 | Wheel washer | 55 | Spacer ring |
| 5 | Plug | 48 | Hex nut | 59 | Nut |
| 6 | Seal | 50 | Radial seal ring | 60 | Socket screw |
| 40 | Axle shaft | 51 | Radial seal ring | 121 | Ring |
| 42 | Wheel hub | 53 | Taper roller bearing | | |

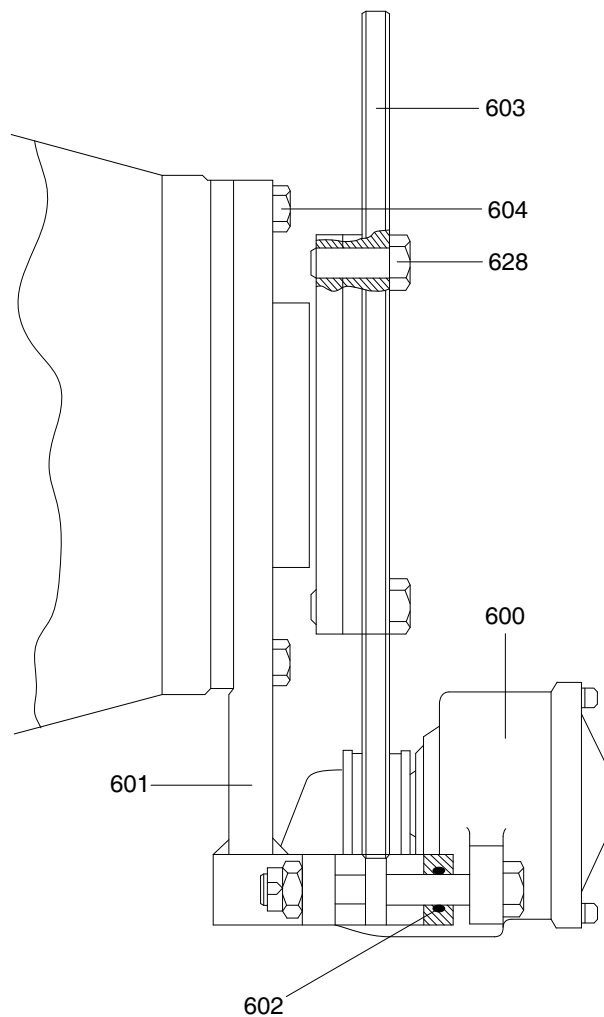
5) STRUCTURE (5/6)



110D9DR05

605	Lining set	612	Cap	623	Magnetic
606	Bleeder valve	615	Pressure bolt	624	Tolerance ring
608	Circlip	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

6) STRUCTURE (6/6)



110D9DR06

600 Parking brake
601 Brake carrier

602 O-ring
603 Brake disk

604 Hex screw
628 Hex screw

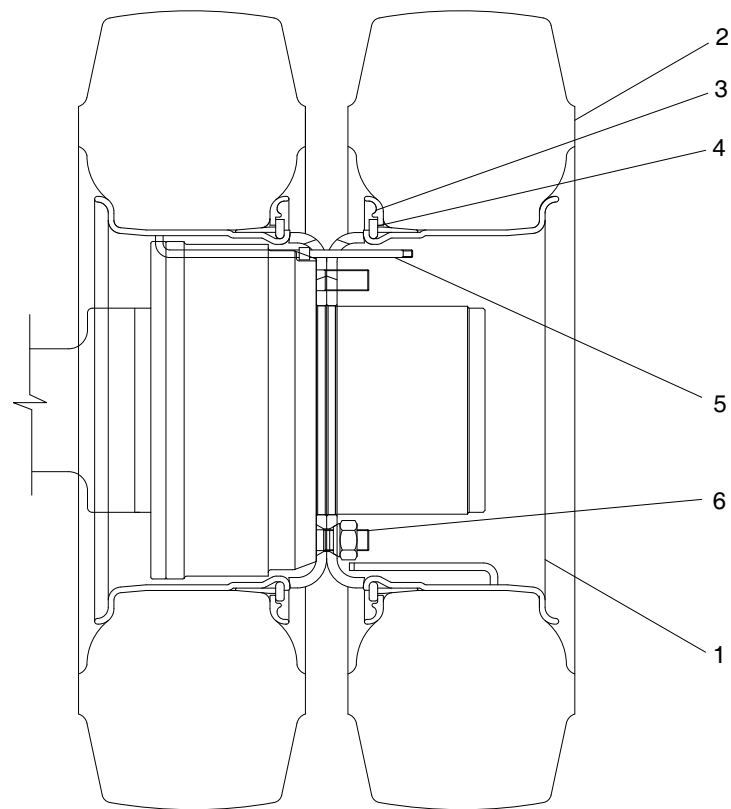
7) OPERATION

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 is 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



D507AX68

- | | | | | | |
|---|-----------|---|-----------|---|----------------|
| 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 $< -12^{\circ}\text{C}$, 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 $60^{\circ}\sim 90^{\circ}\text{C}$ 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 $1200\text{--}1500\text{ min}^{-1}$ 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 100 operating hours in service.

Every further oil change after 1000 operating 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 stream, 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.

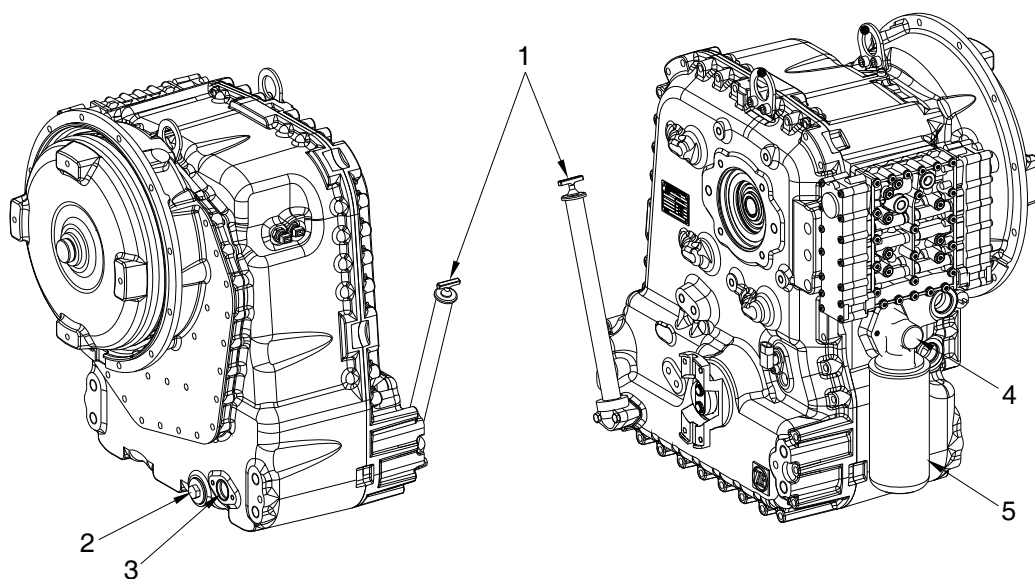
※ Treat the filter carefully at the installation, the transport and the storage.

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.

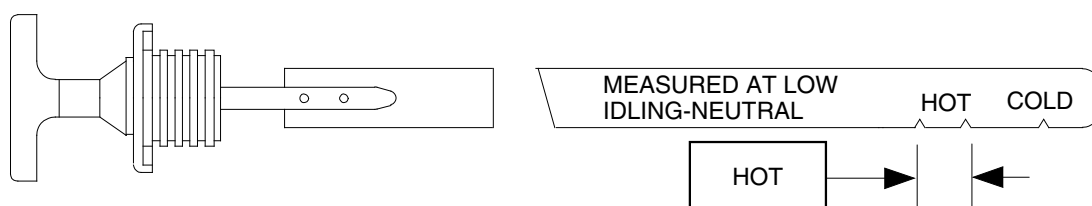


110D9PT19

Legend:

- 1 = Oil filter tube with oil dipstick
- 2 = Oil drain plug M38 × 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 rod.
- In case of signs of excessive heating, consult a brake specialist or the manufacturer.

(2) General lubrication instructions

① Lubrication points

See page 3-67 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

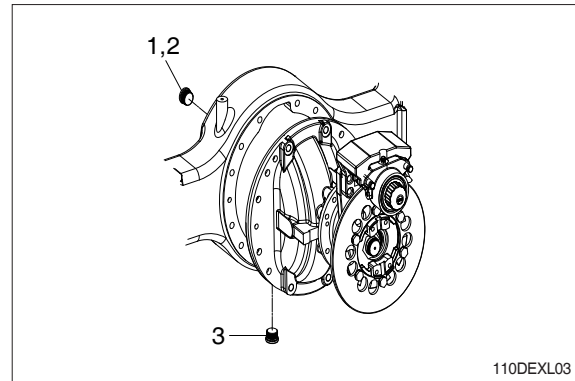
※ The position is dependent from the respective axle version.

※ 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

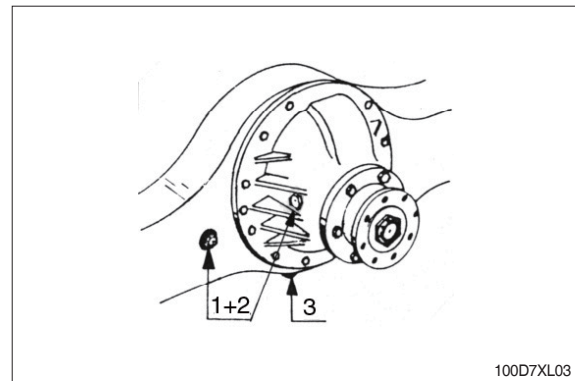
※ The position is dependent from the respective axle version.

※ 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. Disassemble, 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	<ol style="list-style-type: none"> 1. More than 1.4bar (20 psi) pressure applied when brakes released. 2. Damaged piston return spring assembly. 3. Piston not returning. 4. Wrong cooling and/or actuation fluid used. 5. Parking brake not adjusted properly. 	<ol style="list-style-type: none"> 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. Repair or replace piston return spring assembly. 3. Check piston seals for swelling or damage. Replace as necessary. 4. Check piston seals for swelling or damage. Purge system and use specified fluid. 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.	<ol style="list-style-type: none"> 1. Inadequate actuation fluid supply to brakes. 2. Inadequate pressure to apply brakes. 3. Worn or damaged discs. 4. Overheated seals and/or discs. 5. Dirty or contaminated cooling fluid. 	<ol style="list-style-type: none"> 1. Replenish fluid in brake system. Check for leakage and correct cause. 2. Check brakes apply system. Check for leakage in brake system or brakes, and correct cause. 3. Inspect and replace discs if necessary. ※ As disc wear occurs, make sure brake system can supply adequate fluid to fully apply brakes. 4. Inspect and replace discs and seals if necessary. 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.	<ol style="list-style-type: none"> 1. Empty fluid reservoir. 2. Damaged hydraulic system. 3. Leakage of brake actuation fluid. 	<ol style="list-style-type: none"> 1. Fill reservoir to correct level with specified fluid. 2. Repair hydraulic system. 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.	<ul style="list-style-type: none"> · Refueling lubricating oil · Exchange lubricating oil · Exchange bearing · Re-assemble · Exchange damaged gear · Exchange differential gear set · Exchange bearing · Exchange bearing
2	Noise at different intervals.	(1) Ring gear does not run even. <ul style="list-style-type: none"> a. Bolts on drive gear are not tightened correctly. b. Drive gear has a defect (warped) (2) Loose or broken differential bearings.	<ul style="list-style-type: none"> · Tighten bolts · Exchange damaged 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.	<ul style="list-style-type: none"> · 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 <ul style="list-style-type: none"> a. Too much oi b. Wrong kind of oil. c. Much restriction on air eather. (2) Leakage around pinion shaft. <ul style="list-style-type: none"> a. Too much oil. b. Wrong kind of oil. c. Much restriction on air eather. d. Oil seal worn or not installed correctly. 	<ul style="list-style-type: none"> · 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	<ul style="list-style-type: none"> · 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

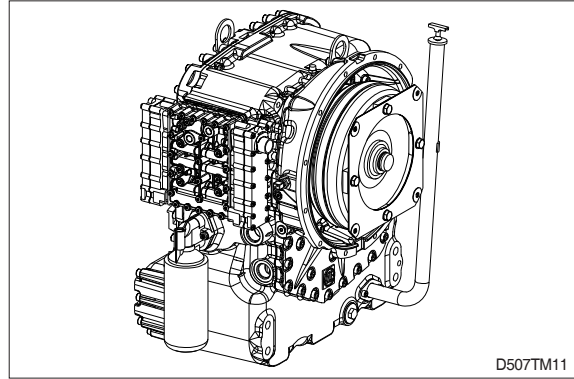
1) ELECTRO-HYDRAULIC CONTROL AND FILTER (EXCHANGE FILTER)

- ① Mount the transmission to the assembly truck.

(S) Assembly truck 5870 350 000

(S) Holding fixture 5870 350 124

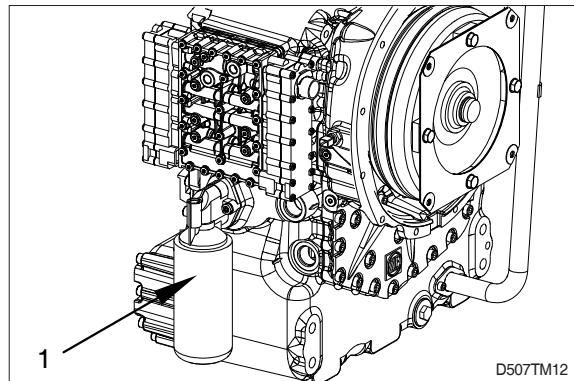
- ※ Prior to start the disassembly, drain the oil



(1) Removal of the filter

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

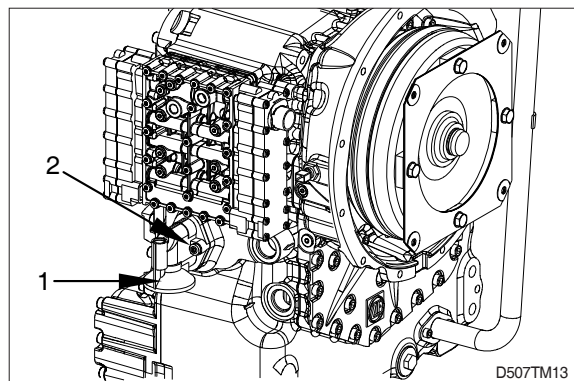
(S) Strap wrench 5870 105 005



- 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



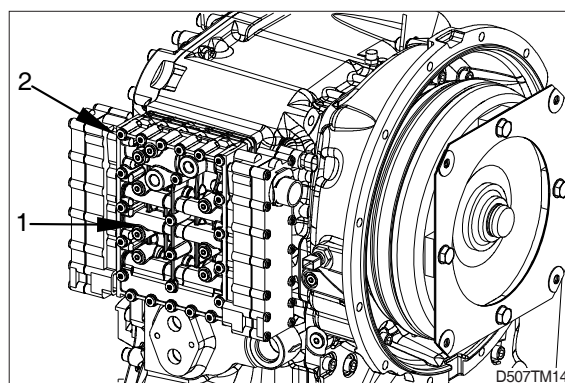
(2) Removal of the electric shift system

- ① Remove the shift system (1).

Loosen the Torx screws (2) and separate the gearshift housing from the intermediate sheet.

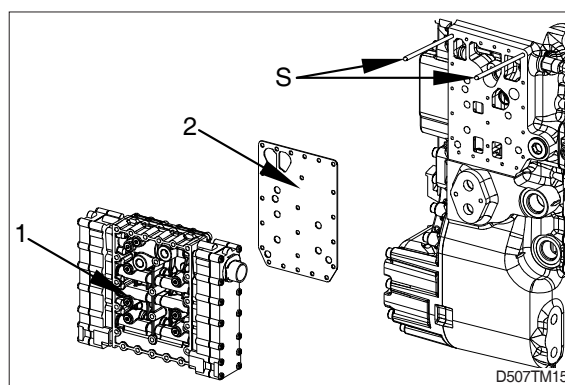
(S) Socket spanner TX-27 5873 042 002

(S) Adjusting screw M6 5870 204 063

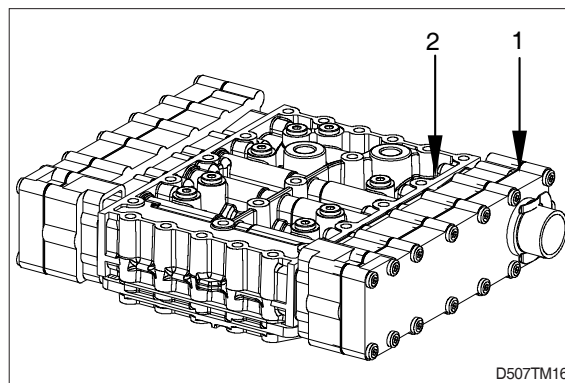


- ② Remove the complete shift system (1) and the intermediate shaft (2).

(S) Adjusting screw M6 5870 204 063

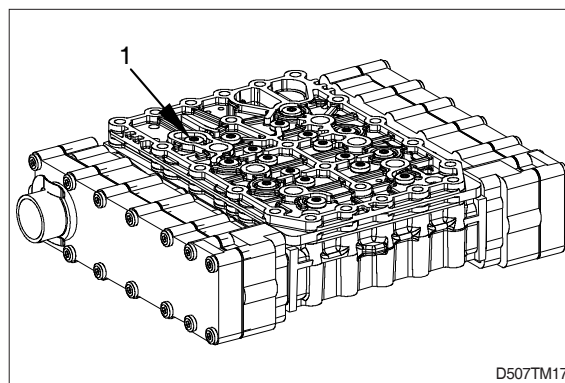


- ③ Mark the installation position of the cover (1) to the valve block (2).

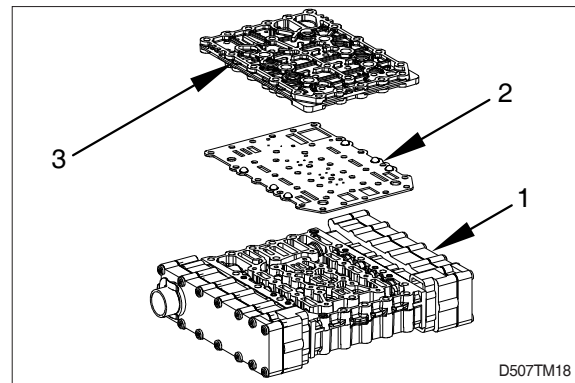


- ④ Loosen the Torx screws (1).

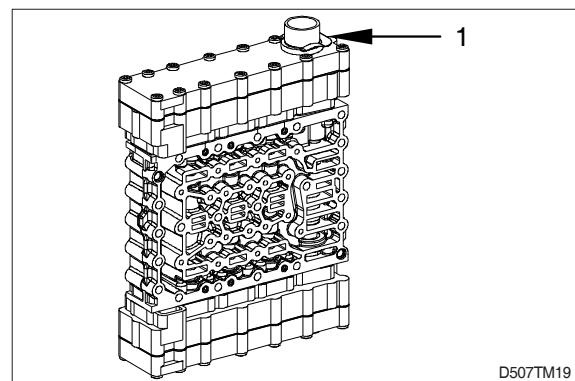
(S) Socket spanner TX-27 5873 042 002



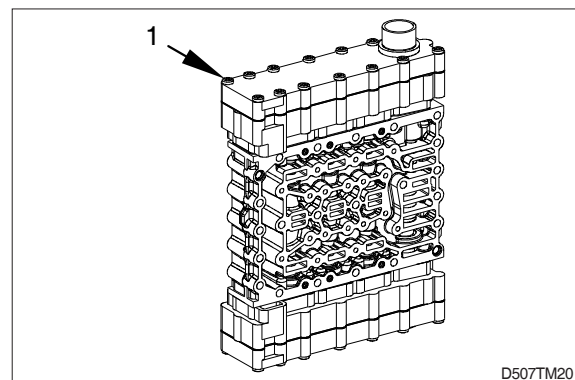
- ⑤ Separate the duct plate (3), and intermediate sheet (2) from the valve block (1).



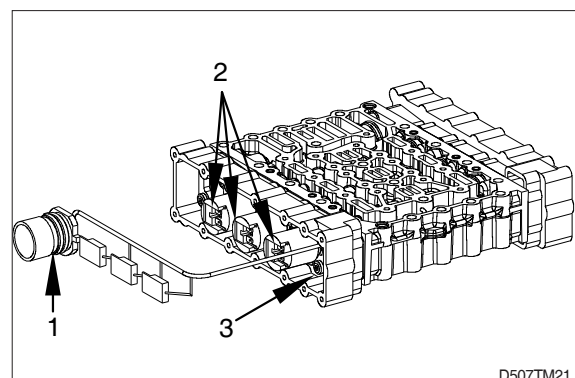
- ⑥ Remove the retaining clamp (1).



- ⑦ Loosen the cap screws (1) and remove the cover.
Remove the opposite cover.
(S) Socket spanner TX-27 5873 042 002

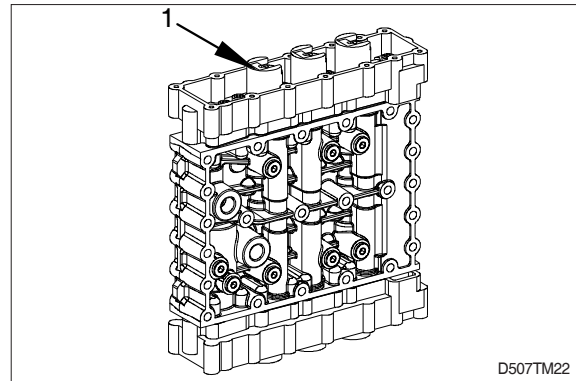


- ⑧ Remove the wiring harness (1).
Loosen the cap screws (3), remove the fixing plates and the pressure regulators (2).
(S) Socket spanner TX-27 5873 042 002



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

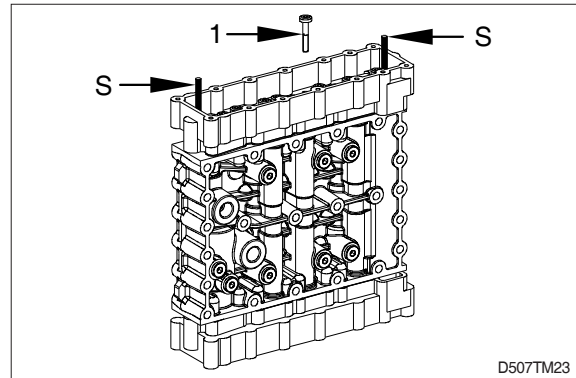
(S) Socket spanner TX-27 5873 042 002



- 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.

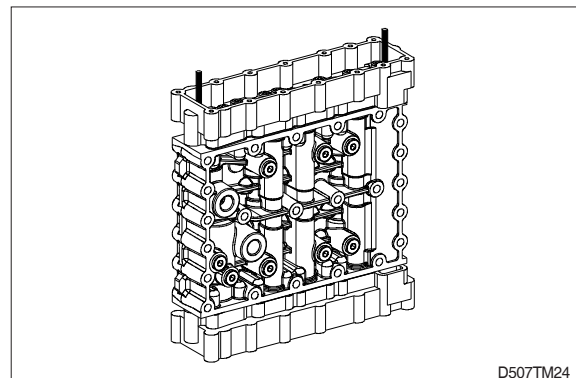
(S) Adjusting screws 5870 204 036

(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

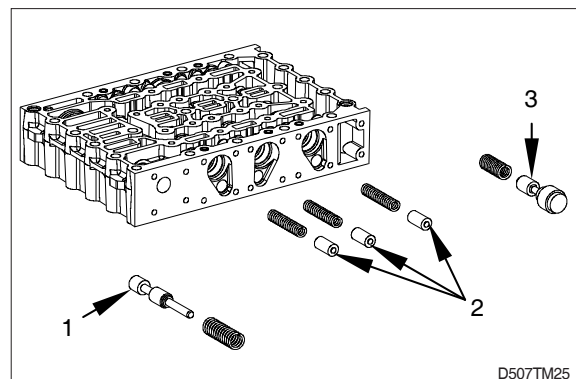


- ⑫ Remove the single parts:

1 = Pressure reducing valve

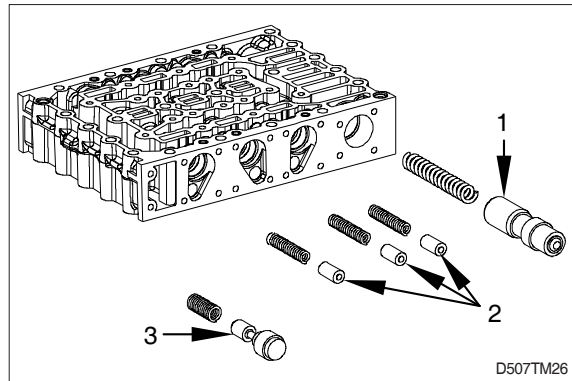
2 = Vibration damper

3 = Follow-on slide



- ⑬ Remove the single parts on the opposite side analogously:

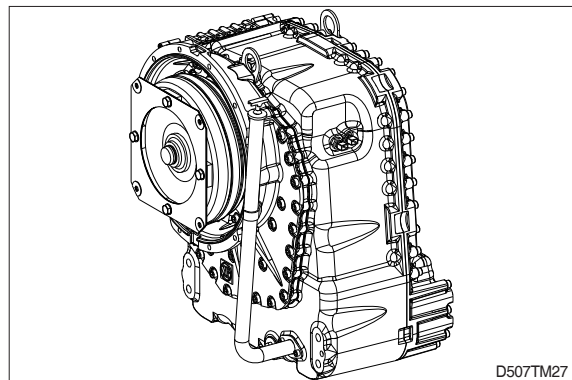
1 = Main pressure valve
2 = Vibration damper
3 = Follow-on slide



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

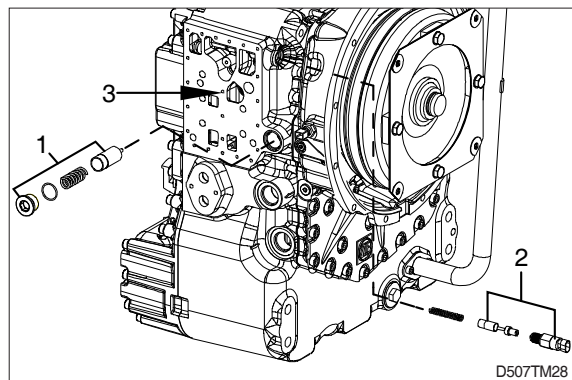
- ① Mount the transmission to the assembly truck.

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



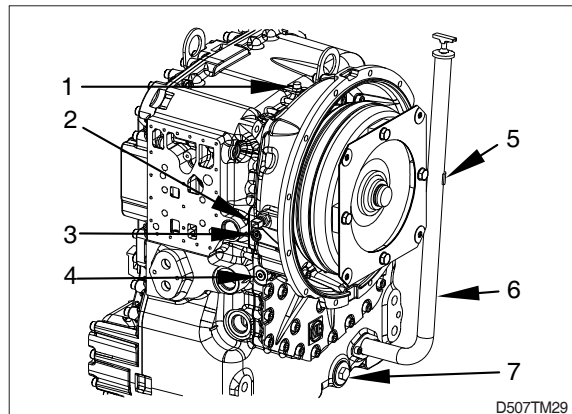
- ② Remove the converter pressure back-up valve (1) and differential pressure switch (3) for the filter (2).

※ Do not remove the pressure relief valve.



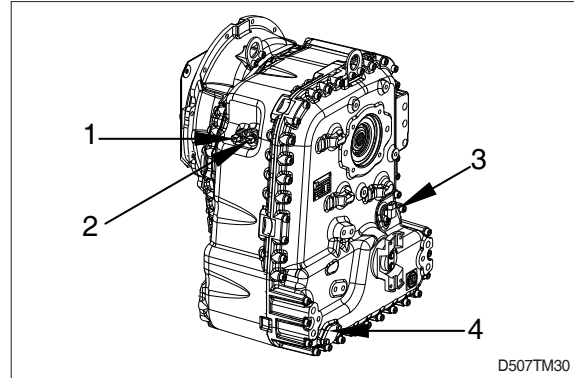
- ③ Remove the positioned parts.

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)

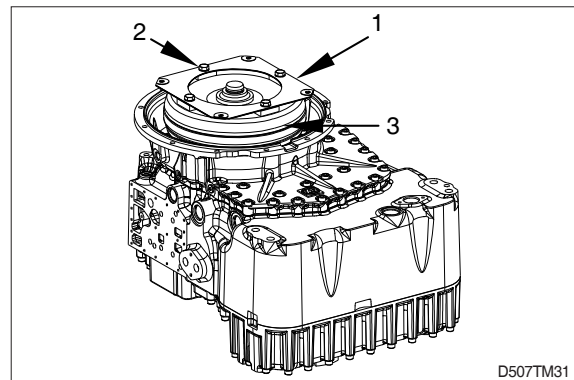


3) ENGINE CONNECTION, PRESSURE OIL PUMP AND REMOVAL OF THE CLUTCHES

① Mount the transmission to the assembly truck.

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

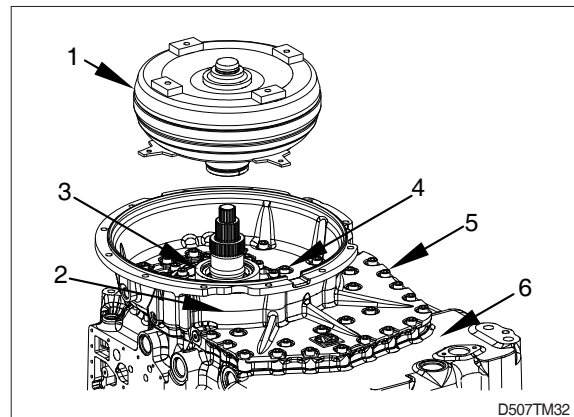
Loosen the hexagon screw (2) and separate the flexplate (1) from the converter (3).



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

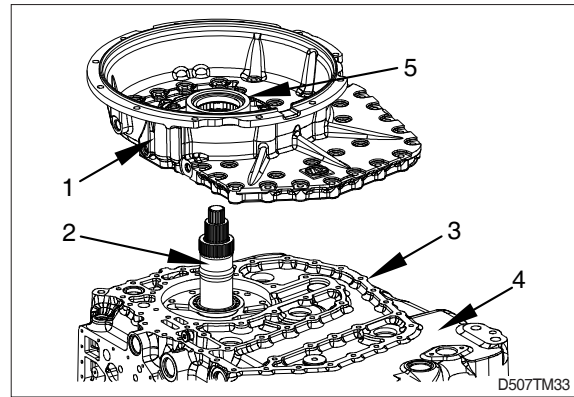
- (S) Eyebolts assortment 5870 204 002
- (S) Lifting chain 5870 281 047



- 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).

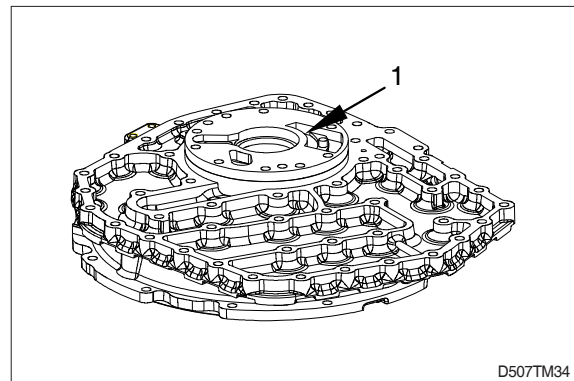
Remove the intermediate sheet (3) and the stator hollow shaft (2).

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



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

(S) Hammer 5870 280 004



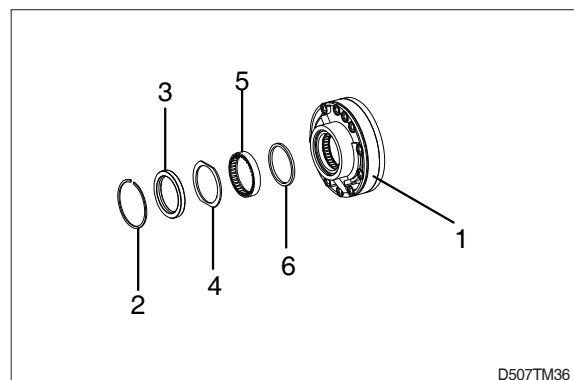
- ⑤ Loosen both cap screws and remove the cam disc.

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

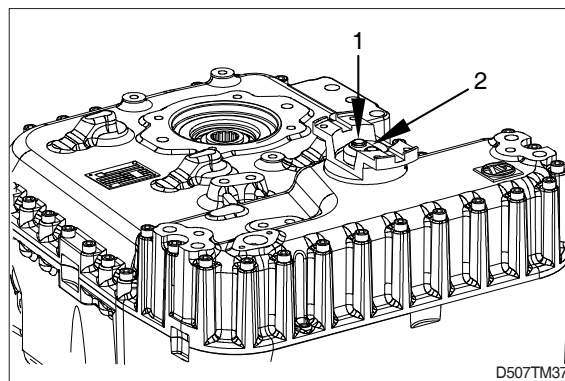


- ⑥ Squeeze out the snap ring (1) and remove the single parts.

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



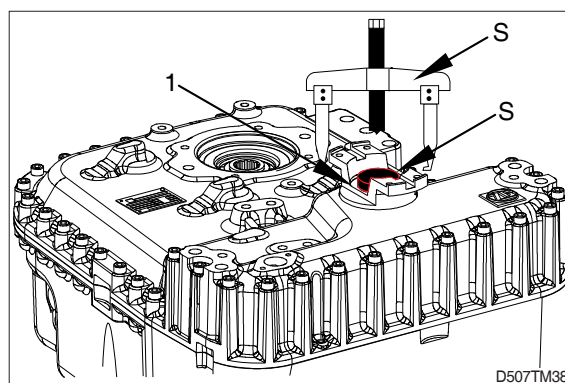
- ⑦ Remove the tab washer (2) and loosen the hexagon screws (1).



- ⑧ Pull off the input shaft (1).

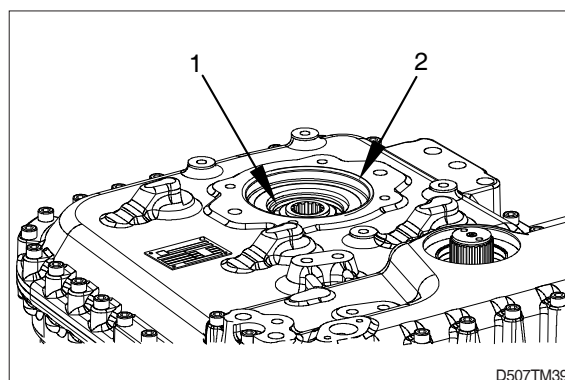
Remove the shaft seal.

(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

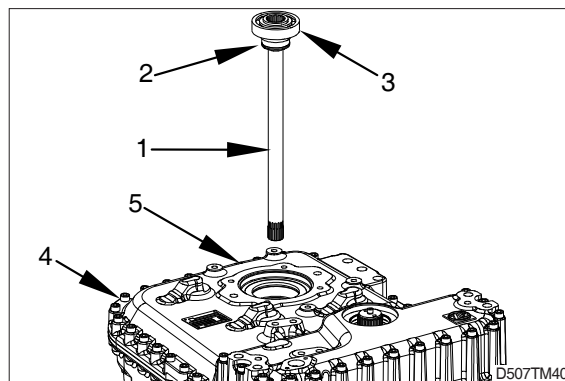


- ⑩ Pull the pump shaft (1) out of the housing bore.

Unsnap the rectangular ring (2).

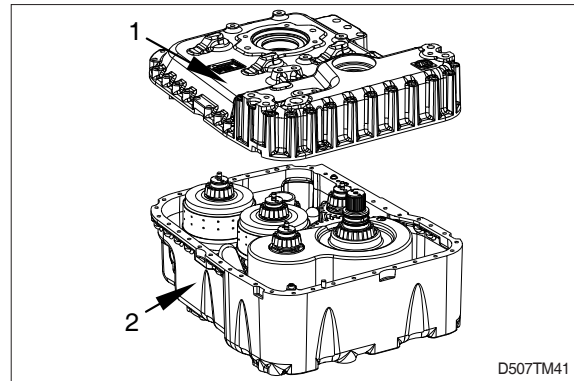
Press off the ball bearing (3) from the shaft.

Loosen the bolted connection (4) transmission housing rear section/transmission housing front section.

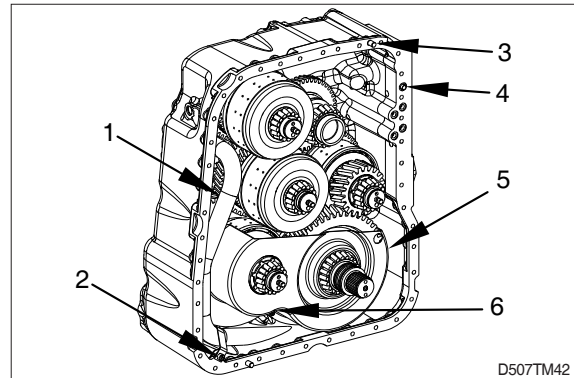


- ⑪ By means of the lifting equipment separate the transmission housing rear section (1) from the transmission housing front section (2).

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

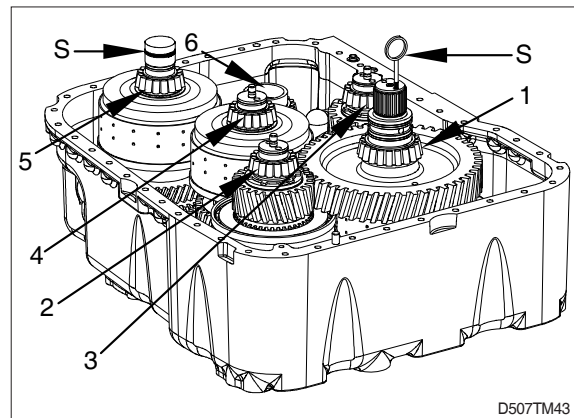


- ⑫ Loosen the cap screws (2) and remove the suction tube (1).
Remove the O-ring from the suction tube.
Loosen the cap screws (6) and remove the screen sheet (5).
Remove the pipes (4) with O-rings.



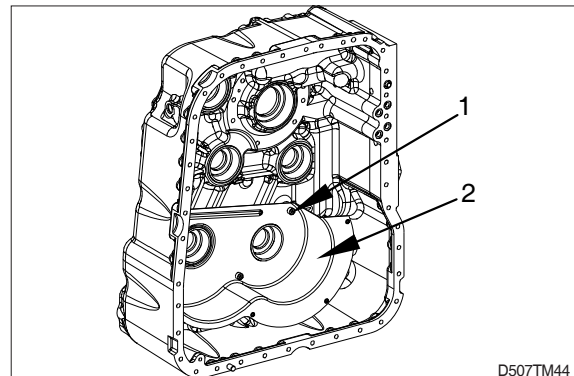
- ⑬ The clutch is to be removed from the transmission housing according to the sequence of numbers as described in the legend.

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).

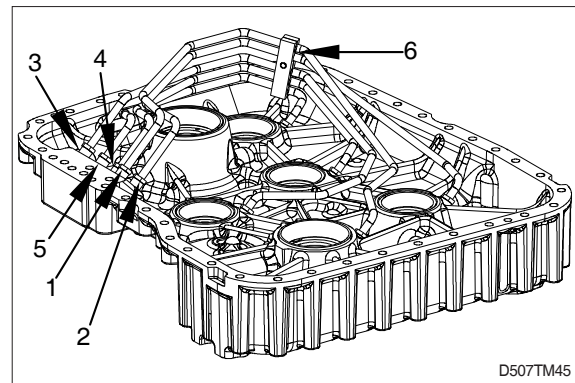


- ⑮ Remove the pipes (system pressure from the electro-hydraulic control to the respective clutch).

Remove the holding segment (6).

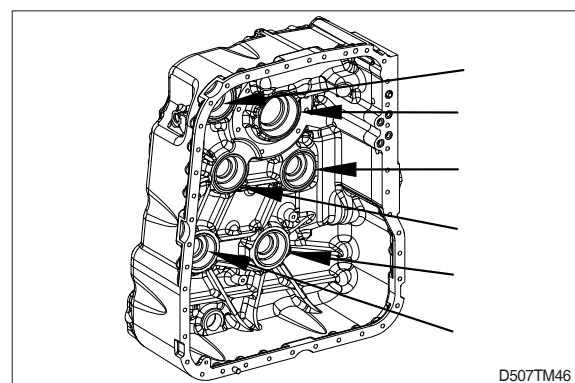
The pipes are to be disassembled in the following sequence:

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



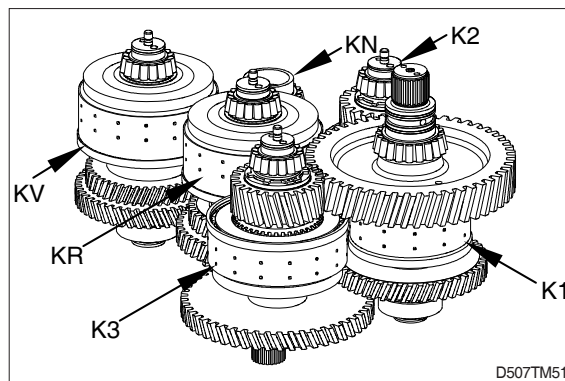
- ⑯ Remove all bearing outer rings (see arrows).

- ※ 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.



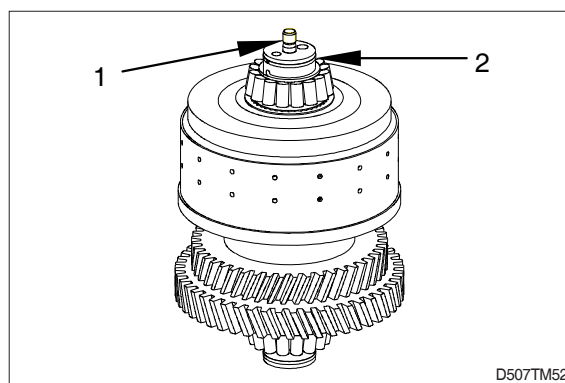
4) CLUTCHES KV/KR/K1/K2/K3 AND INPUT

See figure on the right.



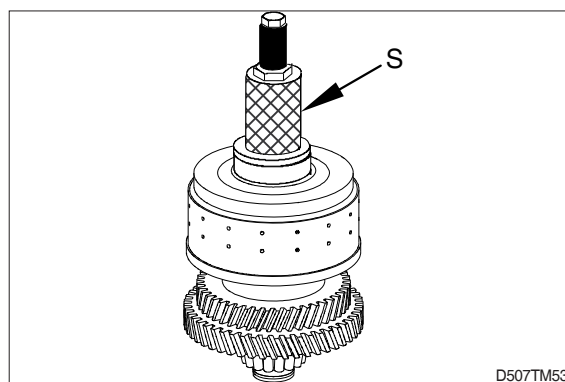
(1) Clutch KV

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



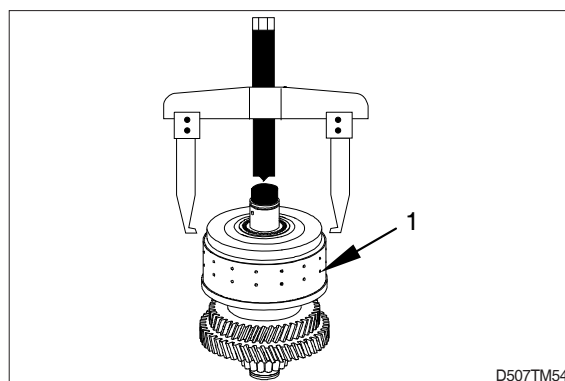
- ② Pull the taper roller bearing (inner ring) from the shaft.

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



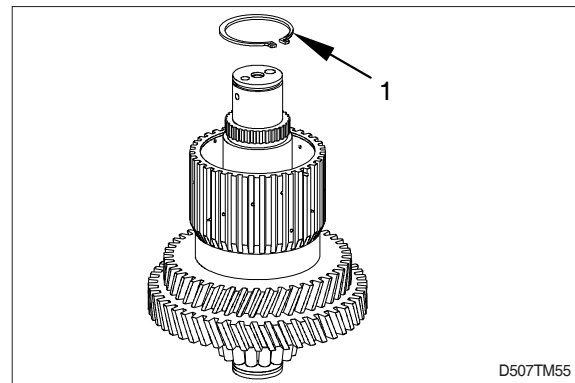
- ③ Pull the clutch (1) from the shaft.

(S) Two-armed puller	5870 970 003
----------------------	--------------



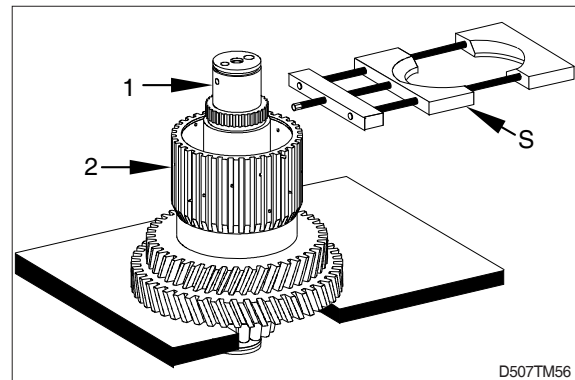
- ④ Unsnap the retaining ring (1).

(S) Set of external pliers 5870 900 015



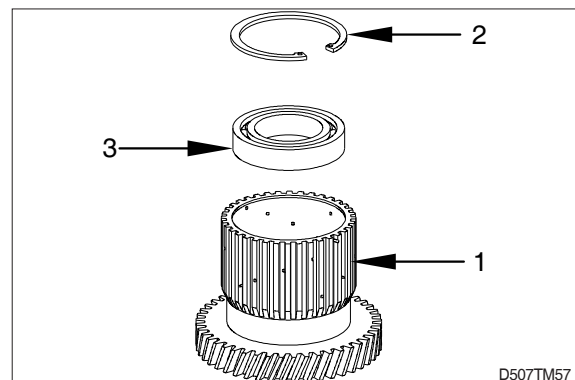
- ⑤ Press the clutch shaft (1) out of the idler (2).

(S) Parting tool 5870 300 028

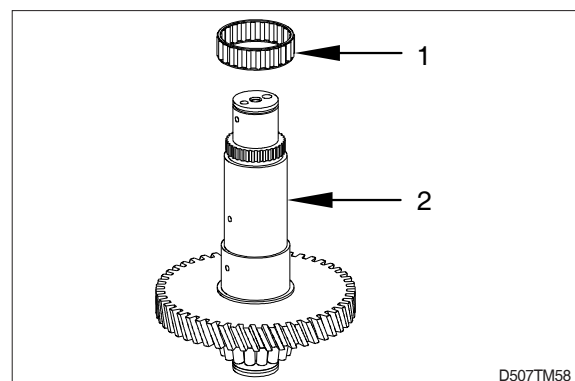


- ⑥ Unsnap the retaining ring (2) from the idler (1) and remove the ball bearing (3).

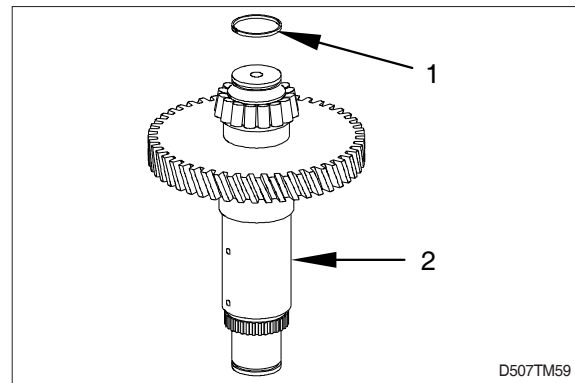
(S) Set of internal pliers 5870 900 013



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

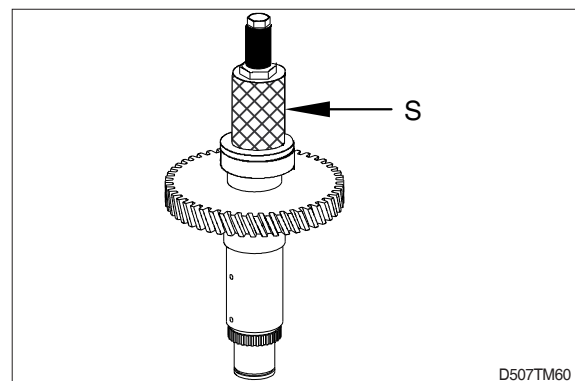


- ⑧ Rotate the shaft (2) by 180° and unsnap the piston ring (1).



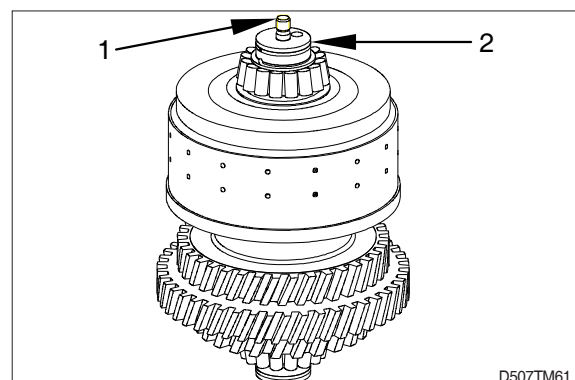
- ⑨ Pull the taper roller bearing (inner ring) from the shaft.

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



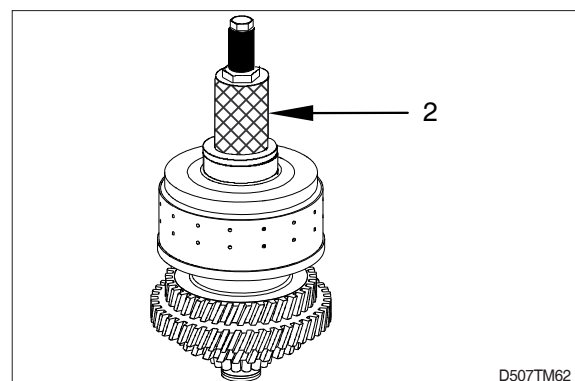
(2) Clutch KR

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



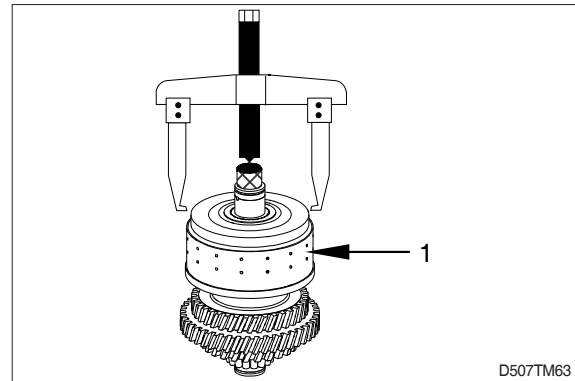
- ② Pull the taper roller bearing (inner ring) (2) from the shaft.

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



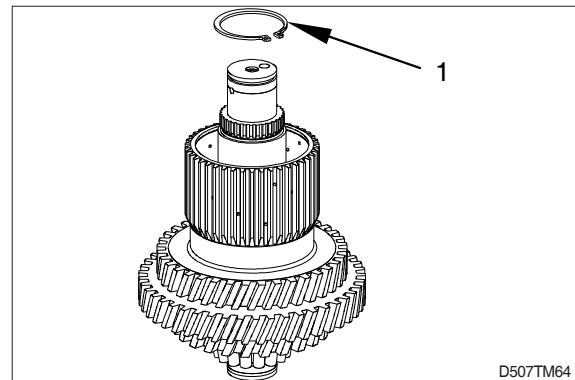
- ③ Pull the clutch (1) from the shaft.

(S)Two-armed puller 5870 970 003



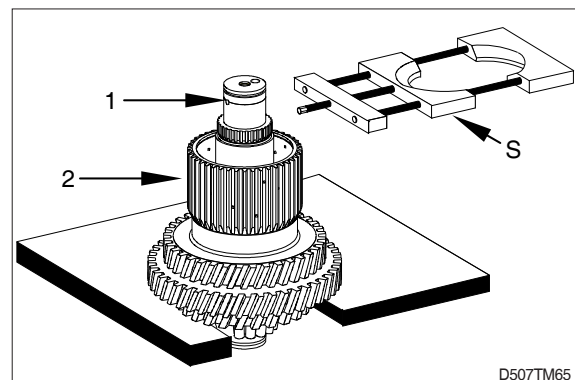
- ④ Unsnap the retaining ring (1).

(S)Set of external pliers 5870 900 015

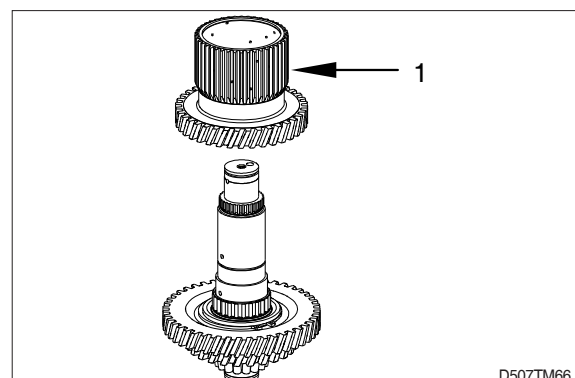


- ⑤ Press the clutch shaft (1) out of the idler (2).

(S)Parting tool 5870 300 028

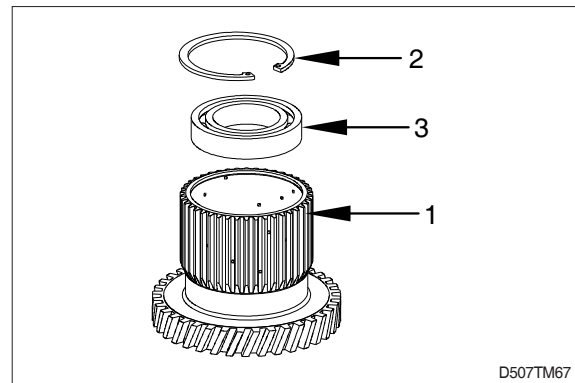


- ⑥ Disassemble the idler (1).

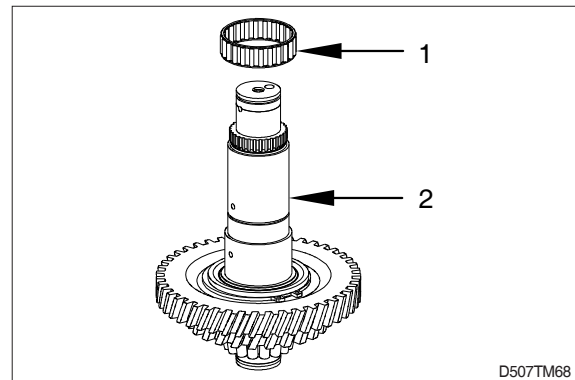


- ⑦ Unsnap the retaining ring (2) from the idler (1) and remove the ball bearing.

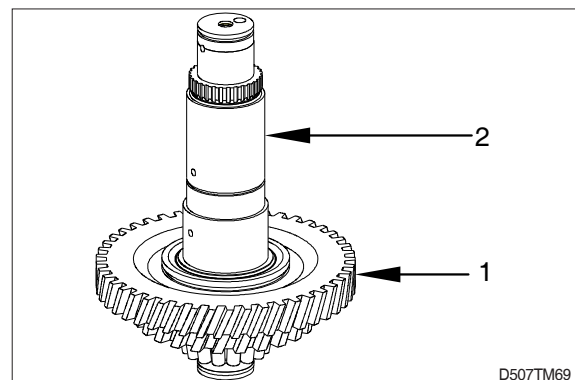
(S) Set of internal pliers 5870 900 013



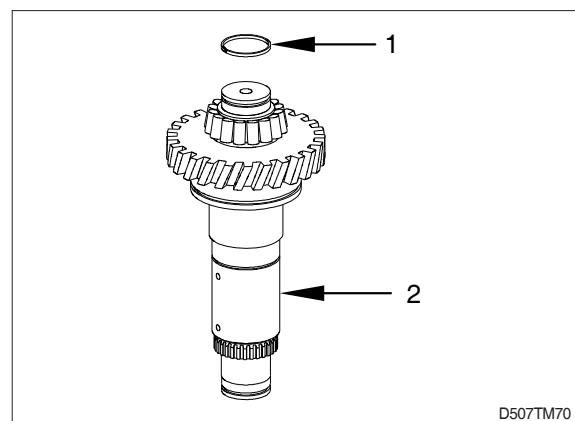
- ⑧ Remove the needle cage (1) from the shaft (2).



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

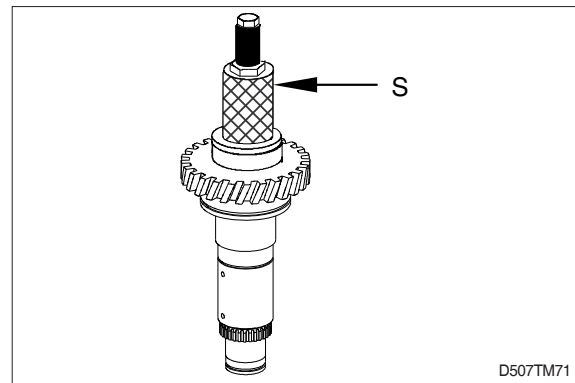


- ⑨ Rotated the shaft (2) by 180° and unsnap the piston ring (1).



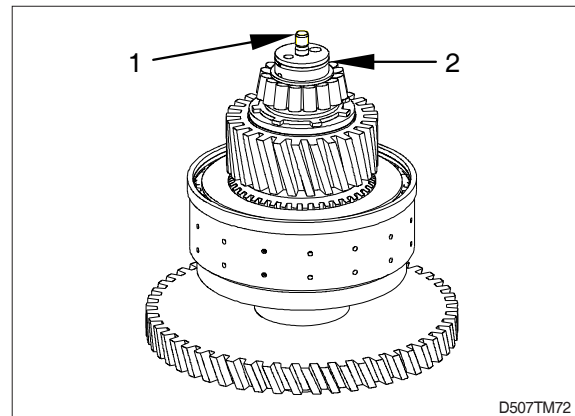
- ⑩ Pull the taper roller bearing (inner ring) from the shaft.

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



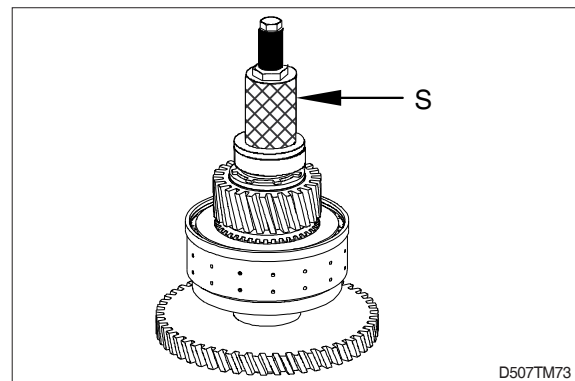
(3) Clutch K1

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



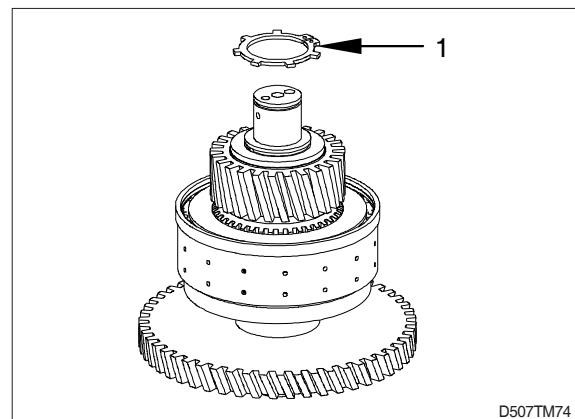
- ② Pull the taper roller bearing (inner ring) from the shaft.

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

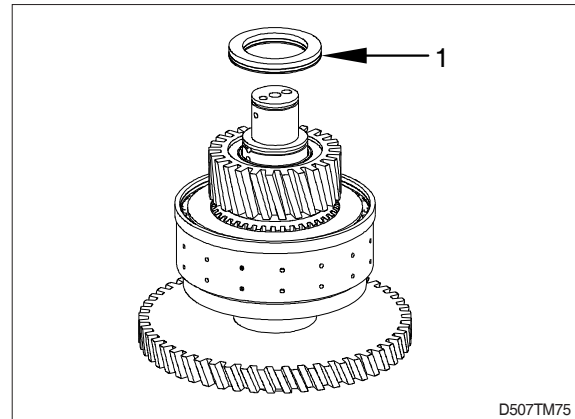


- ③ Unsnap the retaining ring (1).

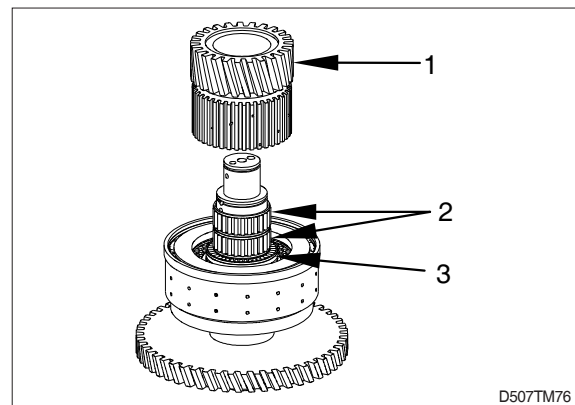
(S) Set of internal pliers 5870 900 013



- ④ Remove the complete axial bearing (1).

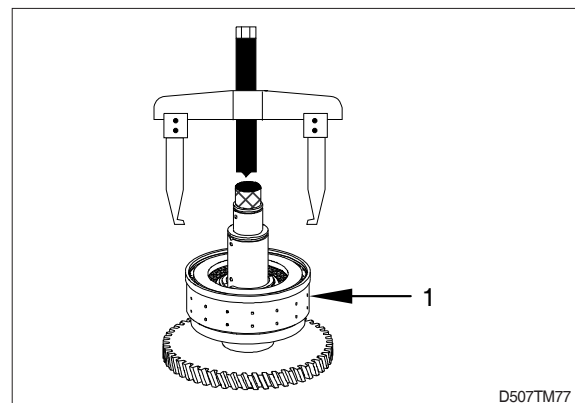


- ⑤ Take off idler (1), remove the needle cage (2) and the complete axial bearing (3).

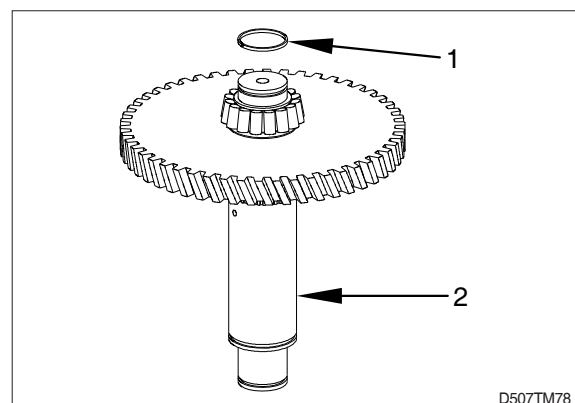


- ⑥ Pull the clutch (1) from the shaft.

(S)Two-armed puller 5870 970 003

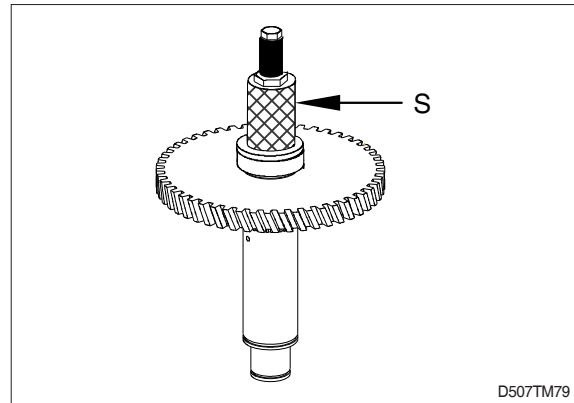


- ⑦ Rotated the shaft (2) by 180° and unsnap the piston ring (1).



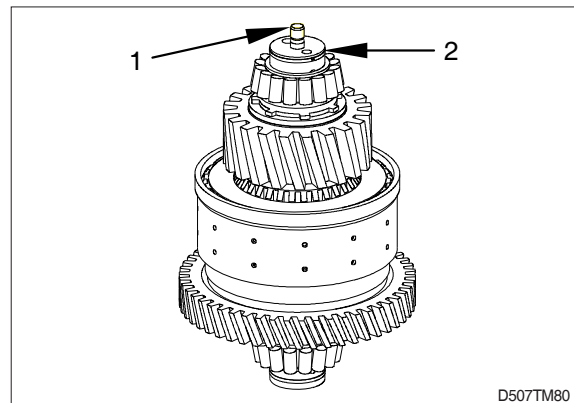
- ⑧ Pull the taper roller bearing (inner ring) from the shaft.

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



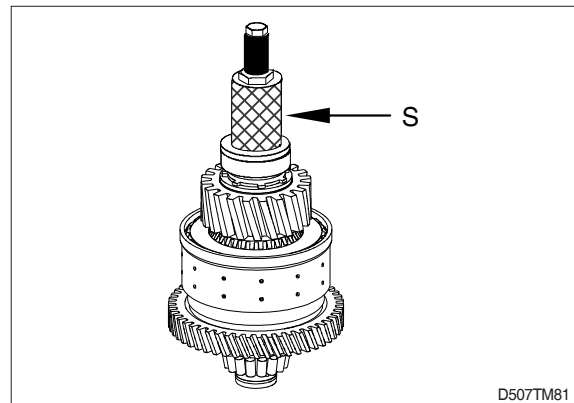
(4) Clutch K1

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



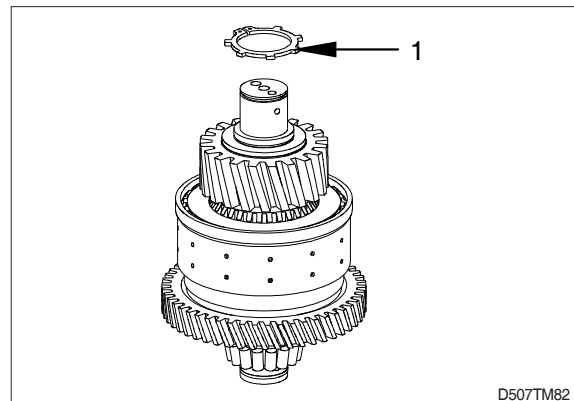
- ② Pull the taper roller bearing (inner ring) from the shaft.

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

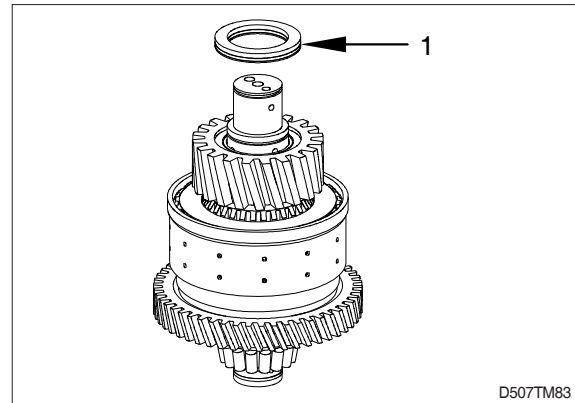


- ③ Unsnap the retaining ring (1).

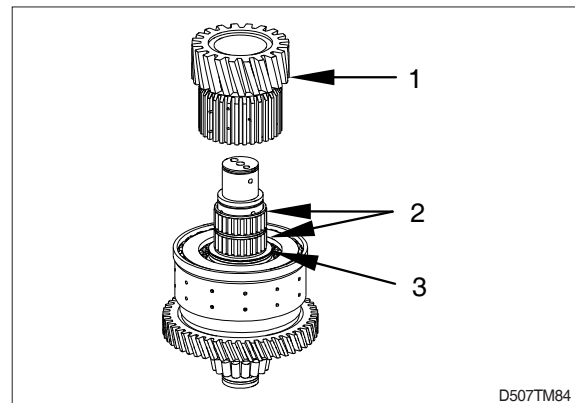
(S) Set of internal pliers	5870 900 015
----------------------------	--------------



- ④ Remove the complete axial bearing (1).

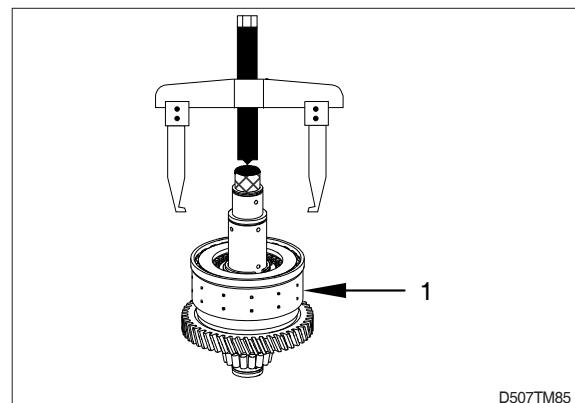


- ⑤ Take off idler (1), remove the needle cage (2) and the complete axial bearing (3).

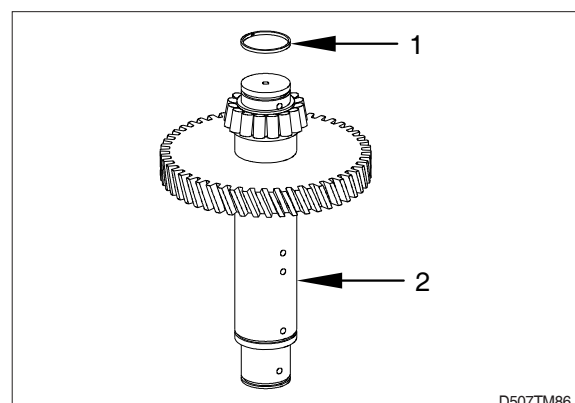


- ⑥ Pull the clutch (1), front the shaft.

(S) Two-armed puller 5870 970 003

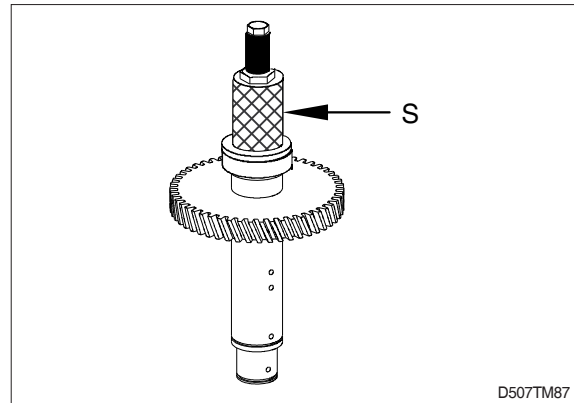


- ⑦ Rotated the shaft (2) by 180° and unsnap the piston ring (1).



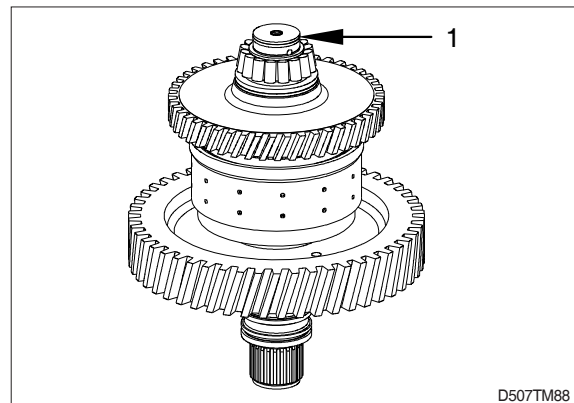
- ⑧ Pull the taper roller bearing (inner ring) from the shaft.

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



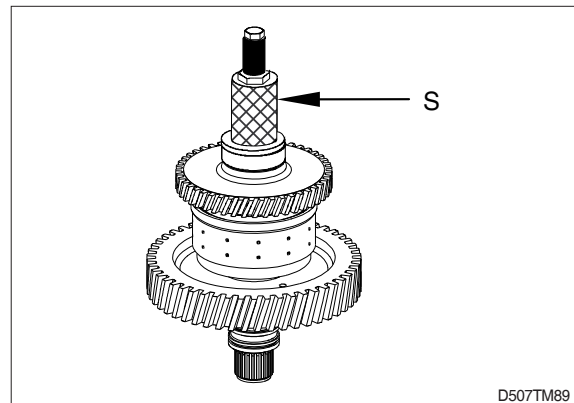
(5) Clutch K3

- ① Unsnap the piston ring (1).

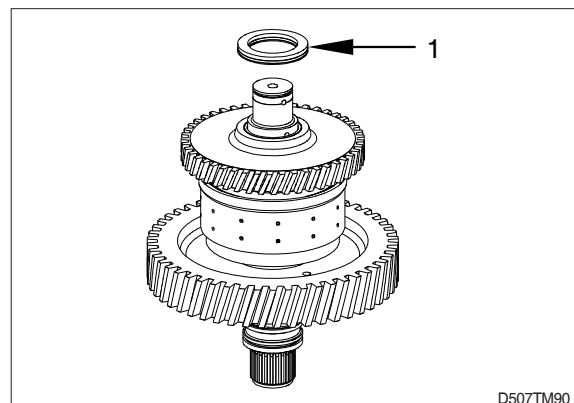


- ② Pull the taper roller bearing (inner ring) from the shaft.

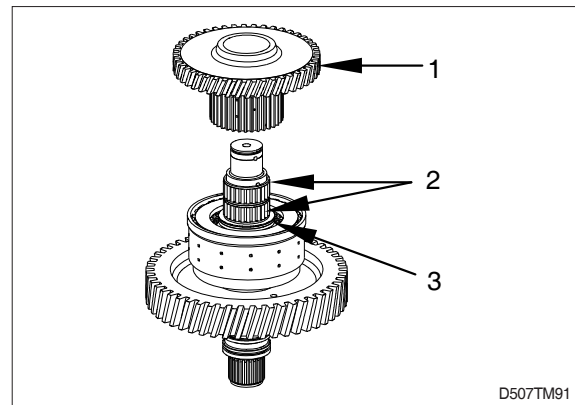
(S)Gripping insert	5873 001 057
(S)Back-off insert	5870 026 100
or	
(S)Rapid grip	5873 011 011



- ③ Remove the complete axial bearing (1).

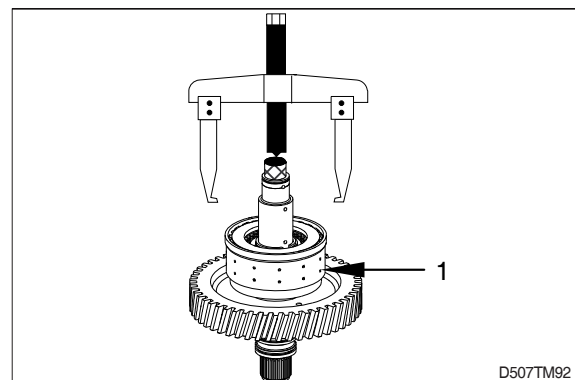


- ④ Take off idler (1), remove the needle cage (2) and the complete axial bearing (3).

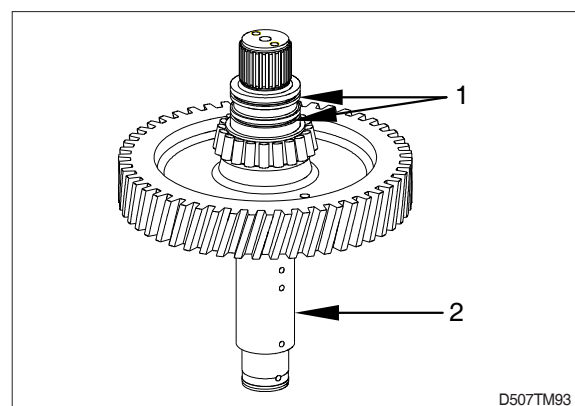


- ⑤ Pull the clutch (1) from the shaft.

(S) Two-armed puller 5870 970 003



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



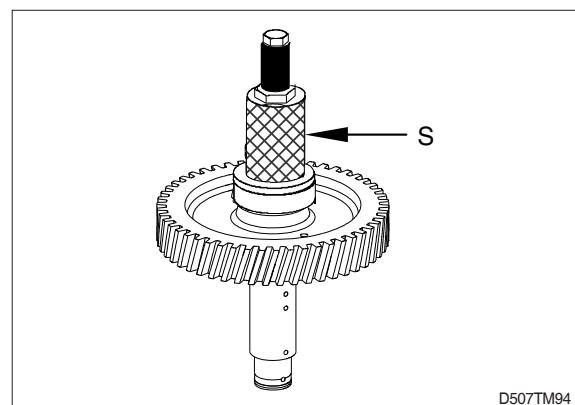
- ⑦ Pull the taper roller bearing (inner ring) from the shaft.

(S) Gripping insert 5873 001 058

(S) Back-off insert 5870 026 100

or

(S) Rapid grip 5873 011 014

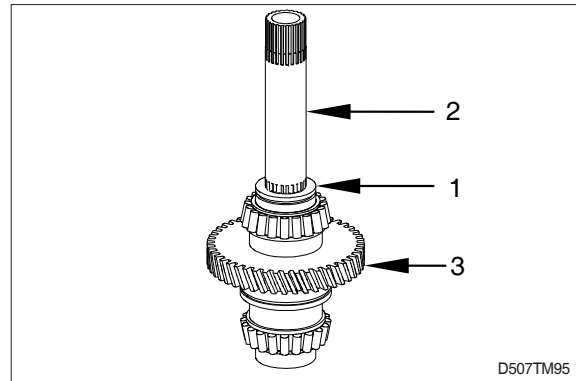


(6) Input

- 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



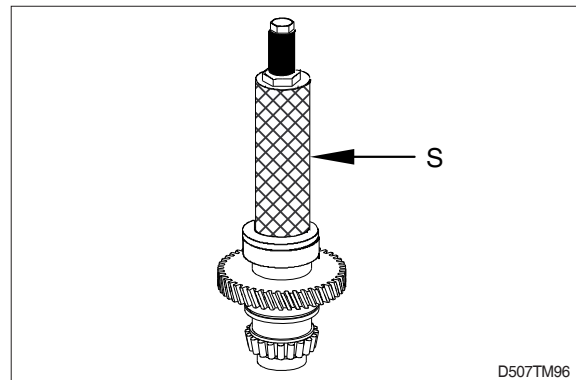
- ② Pull the taper roller bearing (inner ring) from the input gear.

(S) Gripping insert 5873 001 058

(S) Back-off insert 5870 026 100

or

(S) Rapid grip 5873 011 014



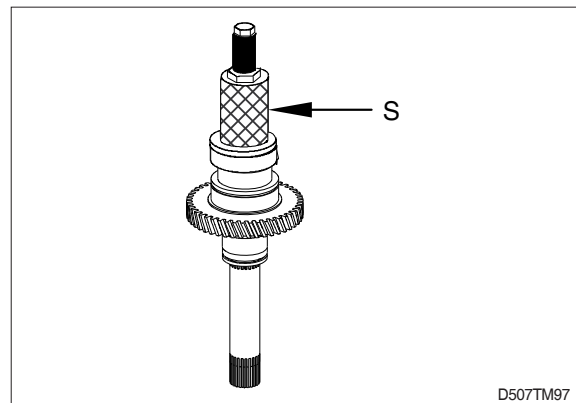
- ③ Pull the taper roller bearing (inner ring) from the input gear.

(S) Gripping insert 5873 001 058

(S) Back-off insert 5870 026 100

or

(S) Rapid grip 5873 011 011



2. TRANSMISSION ASSEMBLY

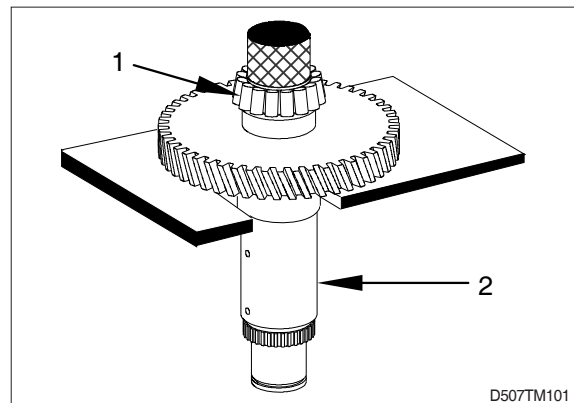
1) CLUTCHES KV/KR/K1/K2/K3 AND INPUT

※ 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.

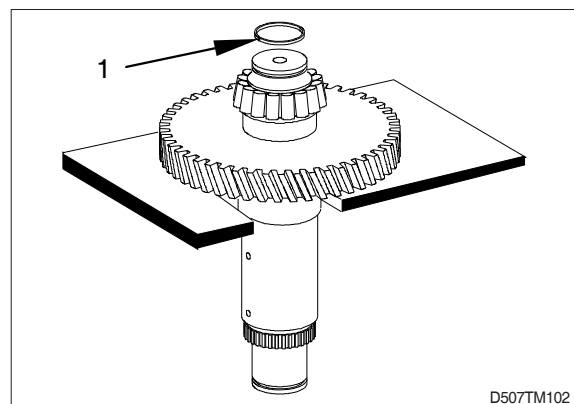
(1) Clutch KV

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



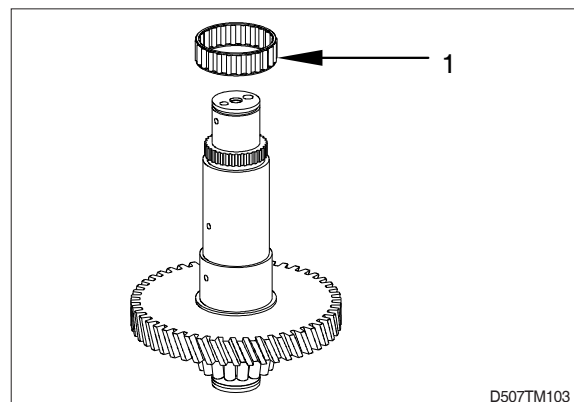
D507TM101

- ② Install the piston ring (1).



D507TM102

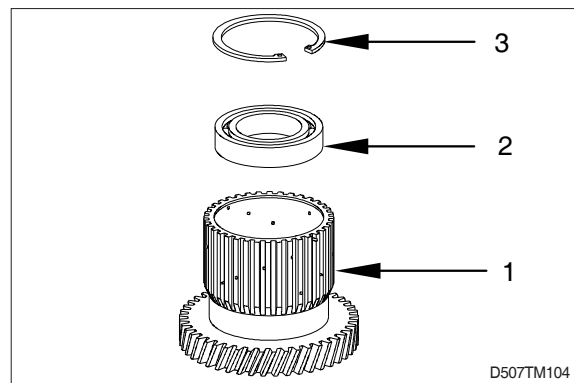
- ③ Mount the needle bearing (1) onto the shaft.



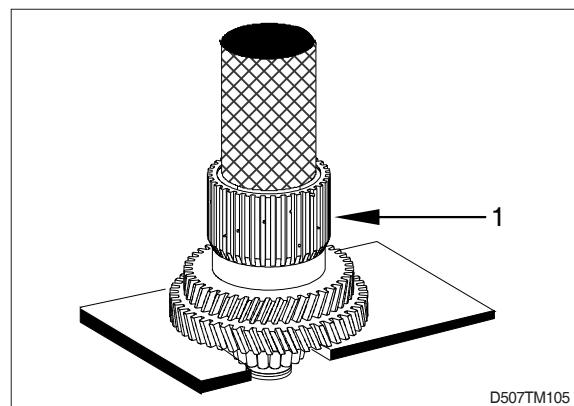
D507TM103

- 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

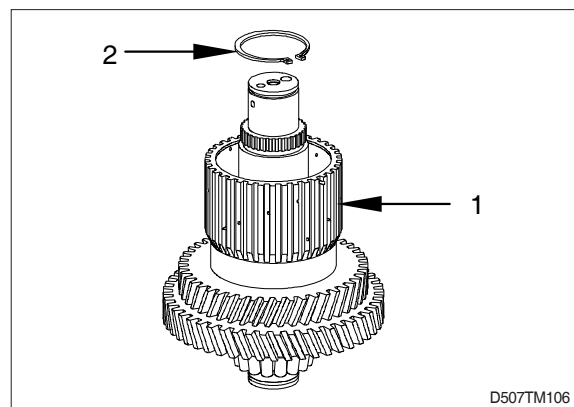


- ⑤ Press in preassembled idler (1) until contact.



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

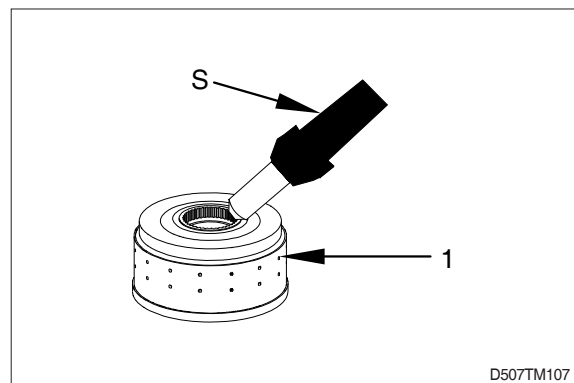
(S) Set of external pliers 5870 900 015



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

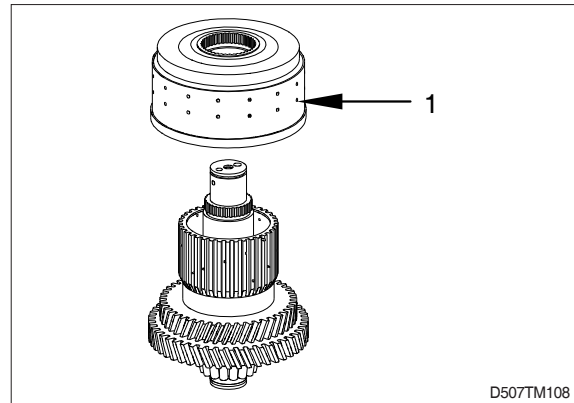
(S) Hot- air blower 220V 5870 221 500

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

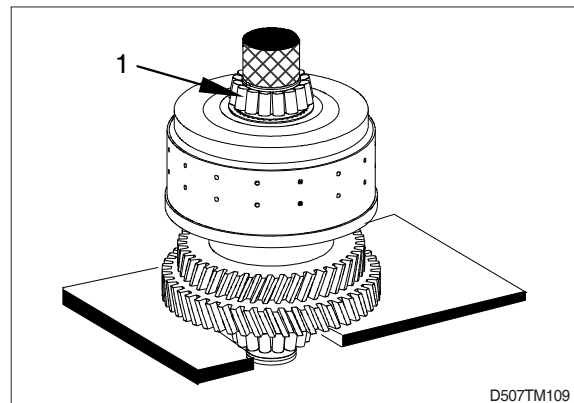


- ⑧ Mount the clutch (1) until contact is obtained.

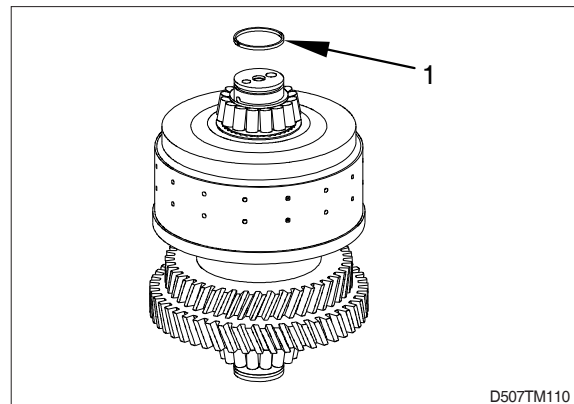
▲ Wear safety gloves.



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



- ⑩ Install the piston ring (1).

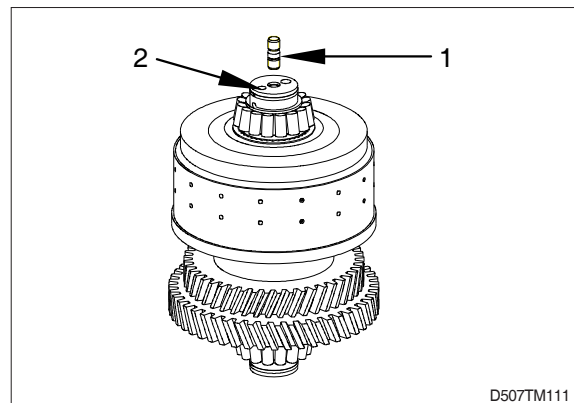


- ⑪ Install the stud (1).

Tightening torque $M_A = 1.7 \text{ kg} \cdot \text{m}$

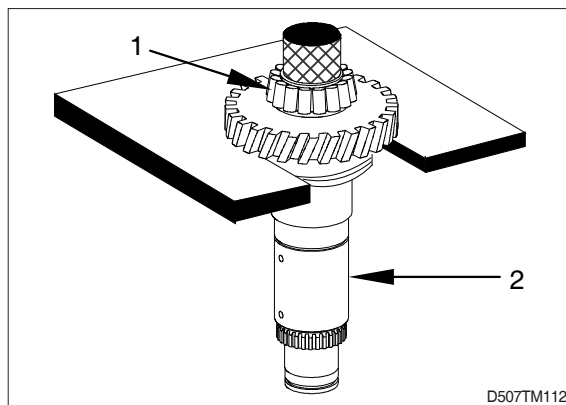
※ Check closing respective opening of the clutch by means of compressed air at the bore (2).

Closing respective opening of the clutch must be clearly audible.

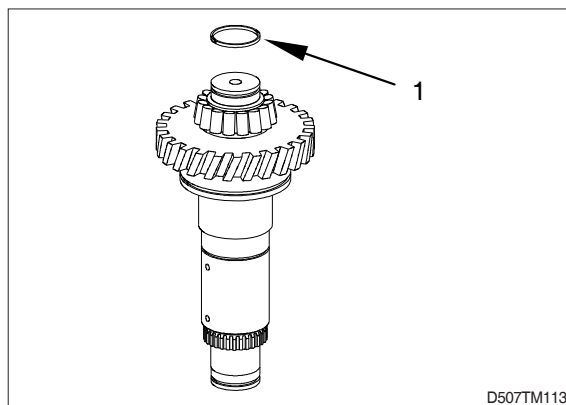


(2) Clutch KR

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



- ② Install the piston ring (1).

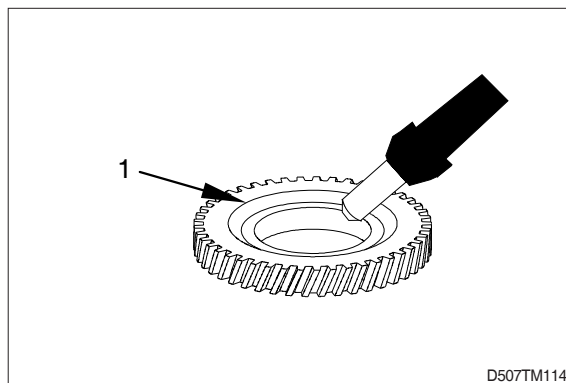


- ③ Heat up the inner diameter of the gear (1) (approx. 120°C).

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

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

▲ Wear safety gloves.

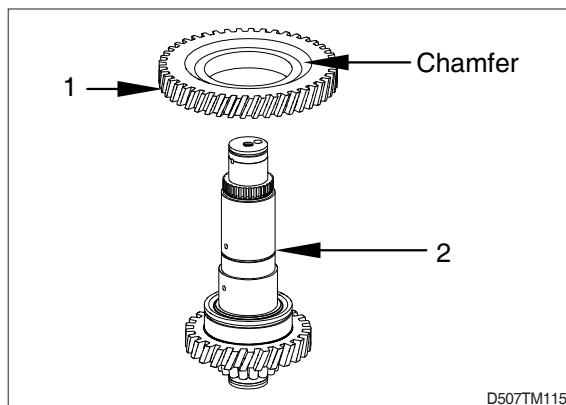


- ④ Undercool the shaft (2) (approx. 80°C).
Mount the gear until contact is obtained.

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

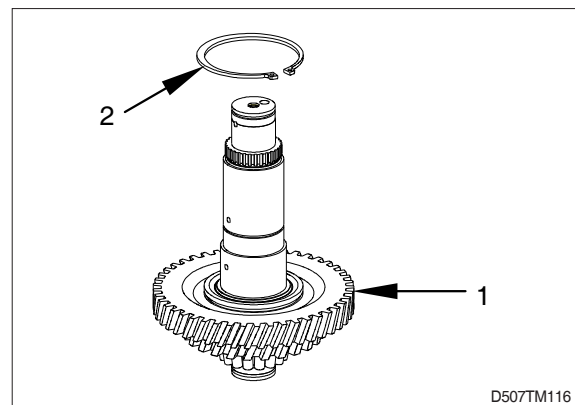
※ Observe the radial installation position.

▲ Wear safety gloves.

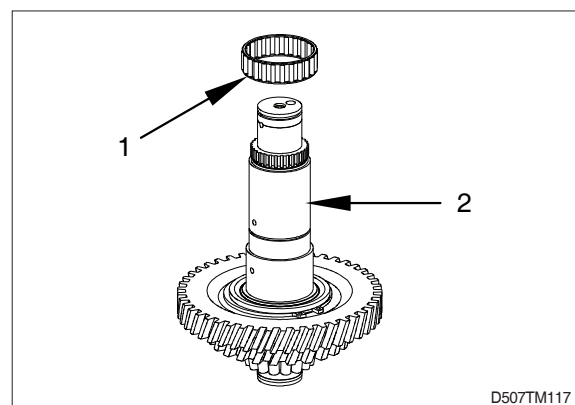


- ⑤ Fasten the gear (1) by means of retaining ring (2).

(S) Set of internal pliers 5870 900 015

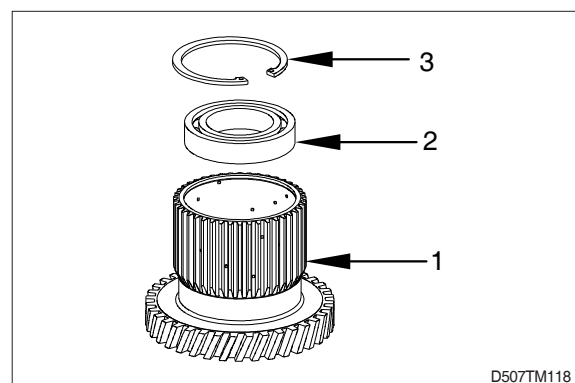


- ⑥ Mount the needle bearing (1) onto the shaft (2).

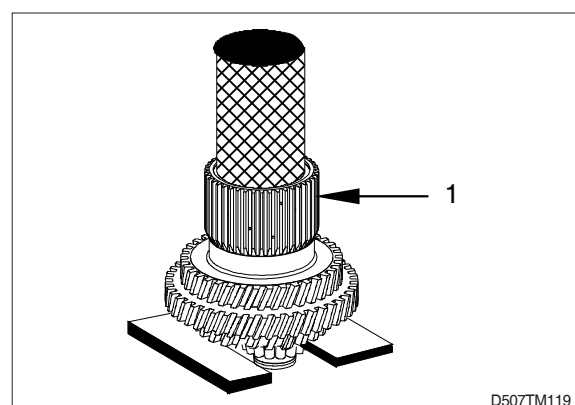


- ⑦ Put the ball bearing (2) into the idler (1) until contact is obtained and fasten it by means of retaining ring (3).

(S) Set of internal pliers 5870 900 013

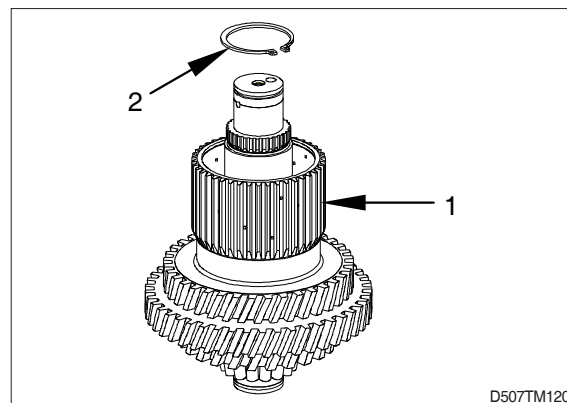


- ⑧ Press in the preassembled idler (1) until contact.



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

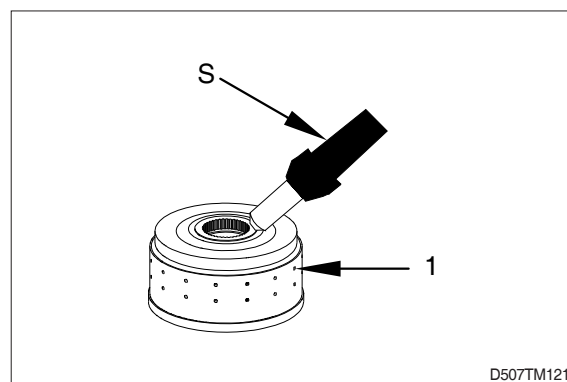
(S) Set of internal pliers 5870 900 015



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

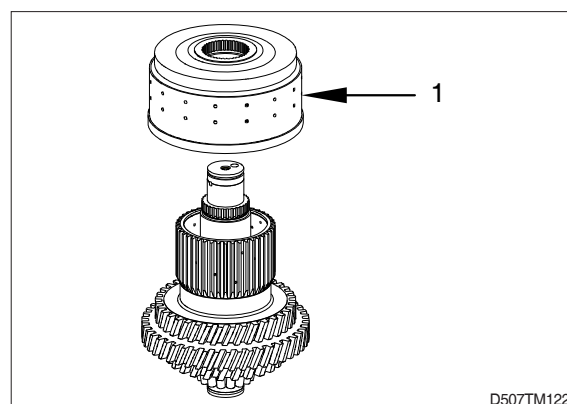
(S) Hot- air blower 220V 5870 221 500

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

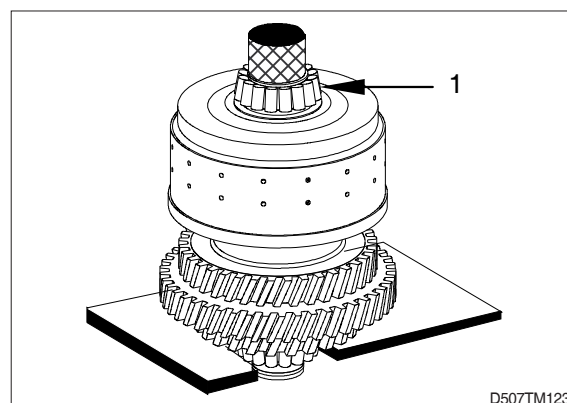


- ⑪ Mount the clutch (1) and press it until contact is obtained.

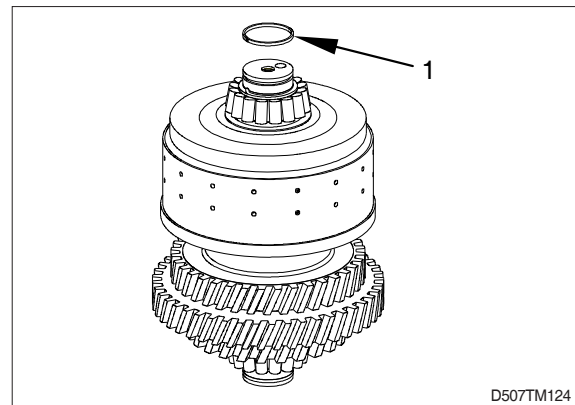
▲ Wear safety gloves.



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



- ⑬ Install the piston ring (1).

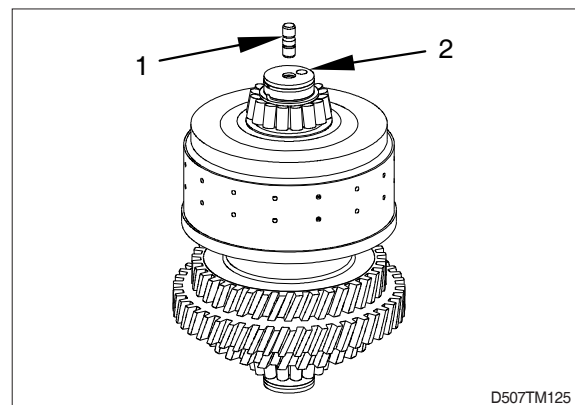


- ⑭ Install the stud (1).

Tightening torque $M_A = 1.7 \text{ kg} \cdot \text{m}$

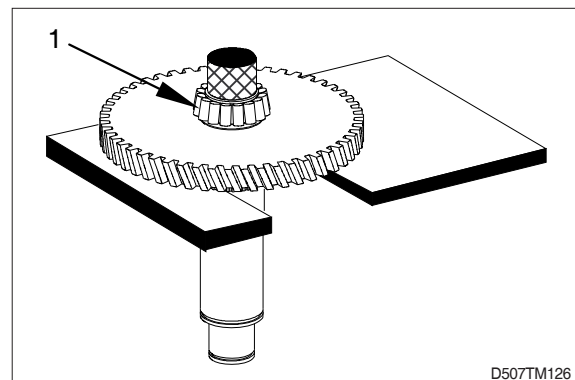
- ※ Check closing respective opening of the clutch by means of compressed air at the bore (2).

Closing respective opening of the clutch must be clearly audible.

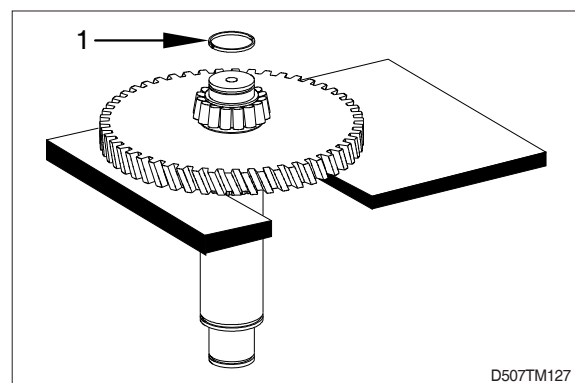


(3) Clutch K1

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

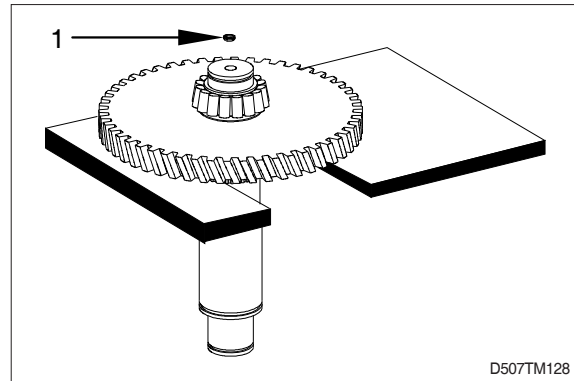


- ② Install the piston ring (1).



③ Install the sealing cap (1).

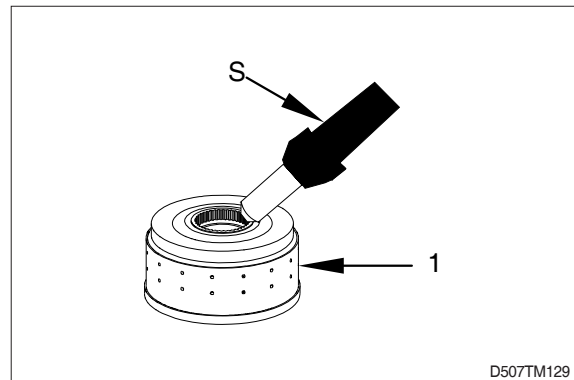
※ Wet the contact surface with (Loctite Type No. 262).



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

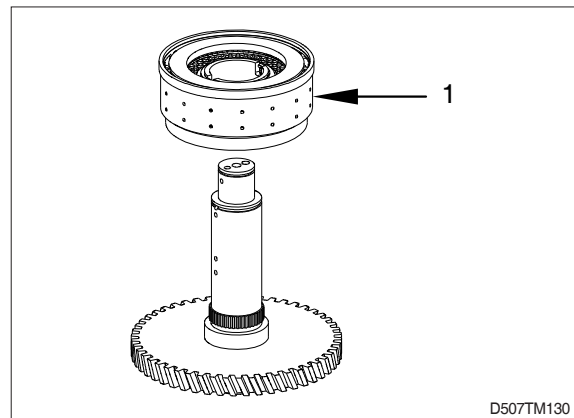
(S) Hot- air blower 220V 5870 221 500

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



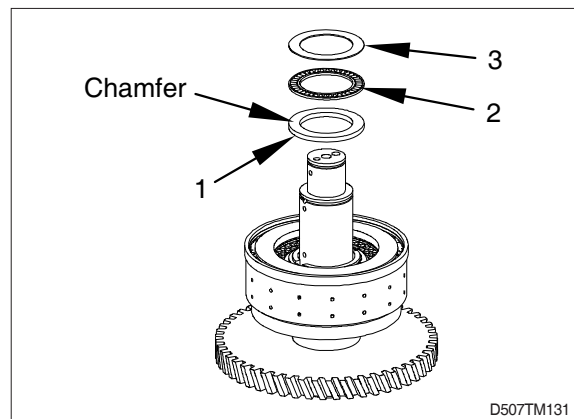
⑤ Mount the clutch (1) and press it until contact is obtained.

▲ Wear safety gloves.

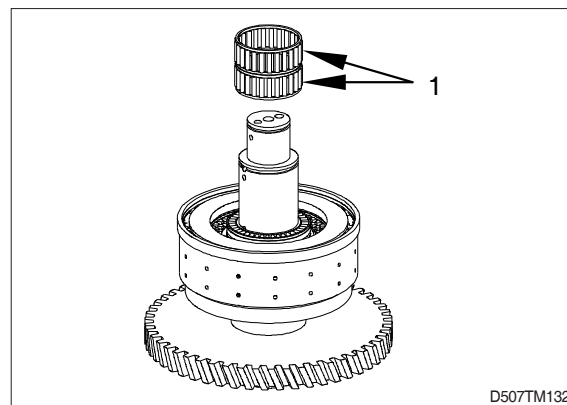


⑥ Mount the running disc (1), axial cage (2) and axial washer (3).

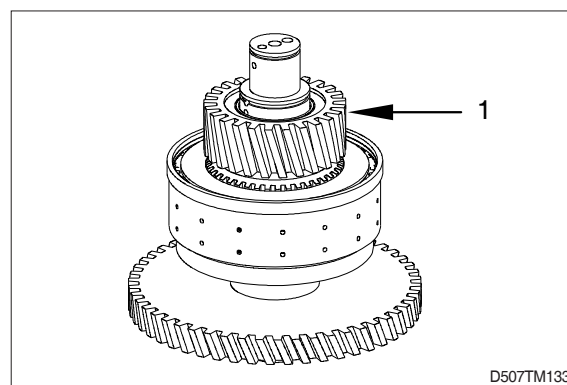
※ Install chamfer (see arrow) of the running disc (2) showing towards the axial cage.



⑦ Mount the needle cage (1).

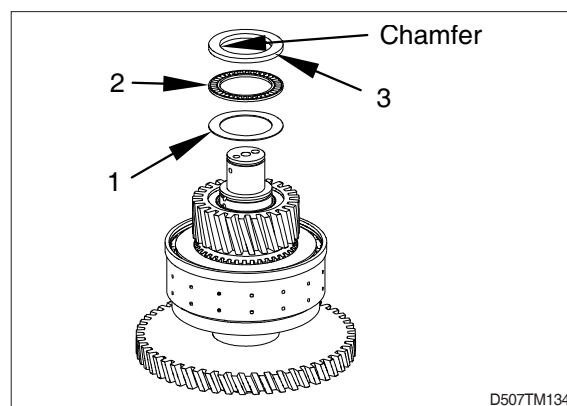


⑧ Install the idler (1).



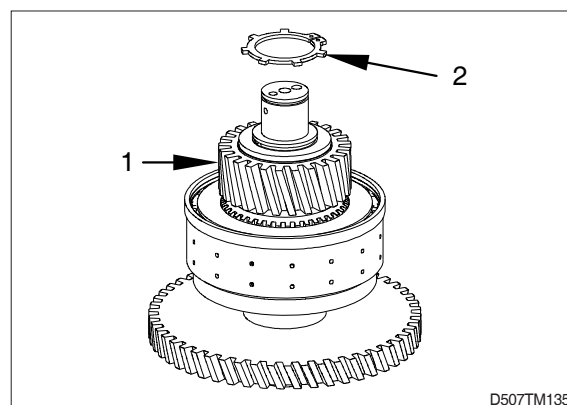
⑨ Mount the axial washer (1), axial cage (2) and running disc (3).

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

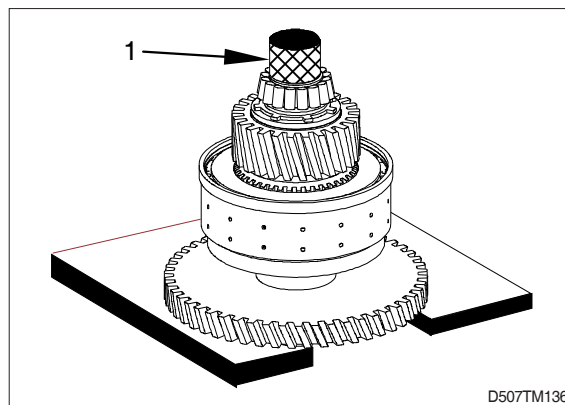


⑩ Fasten the idler (1) and the single parts by means of the retaining ring (2).

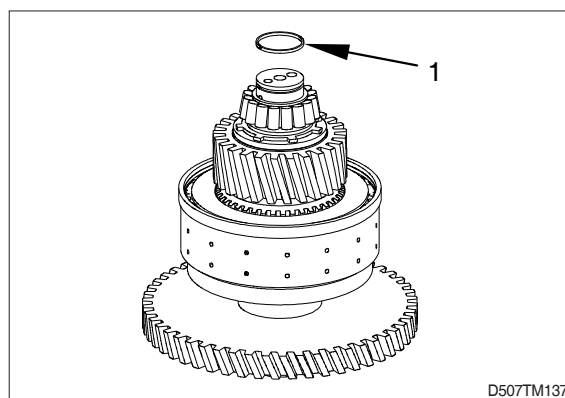
(S) Set of external pliers 5870 900 015



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



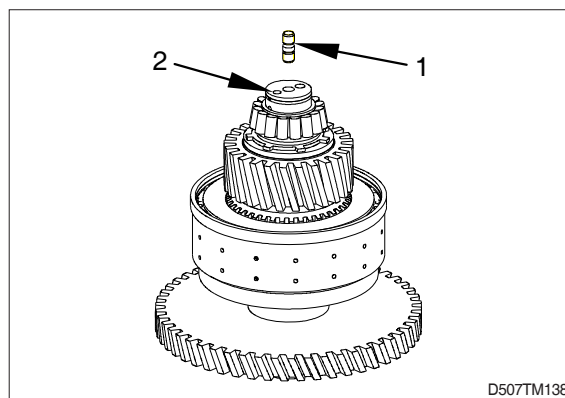
- ⑫ Install the piston ring (1).



- ⑬ Install the stud (1).

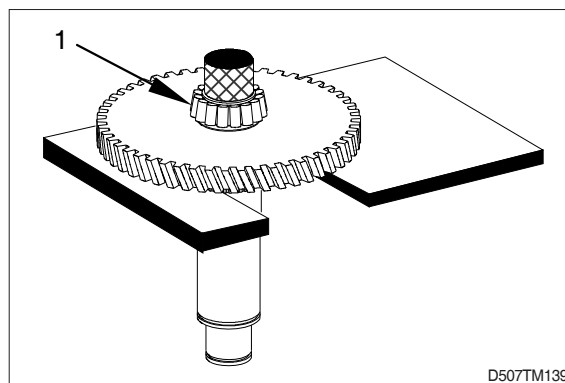
Tightening torque $M_A = 1.7 \text{ kg} \cdot \text{m}$

- ※ 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.

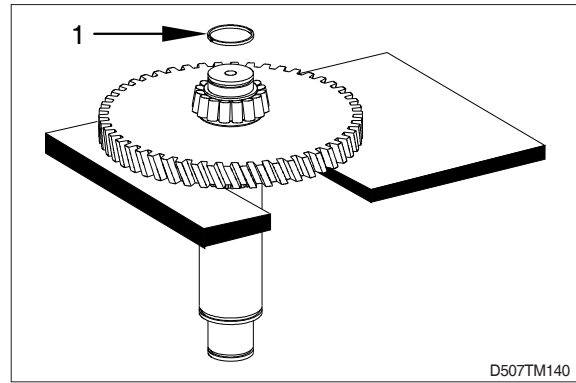


(4) Clutch K2

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



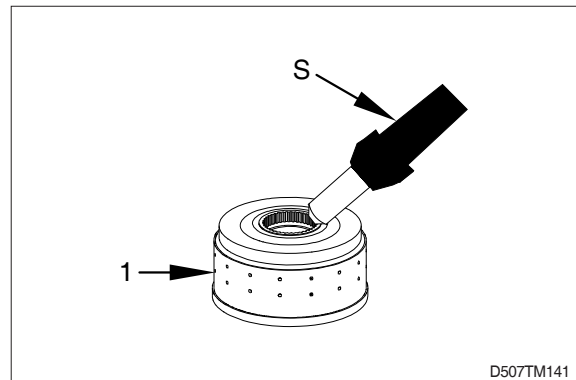
② Install the piston ring (1).



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

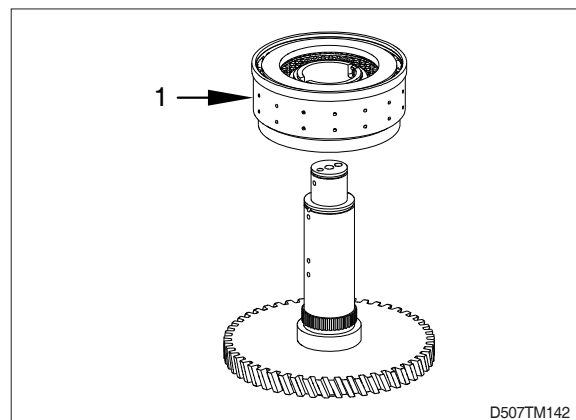
(S) Hot- air blower 220V 5870 221 500

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



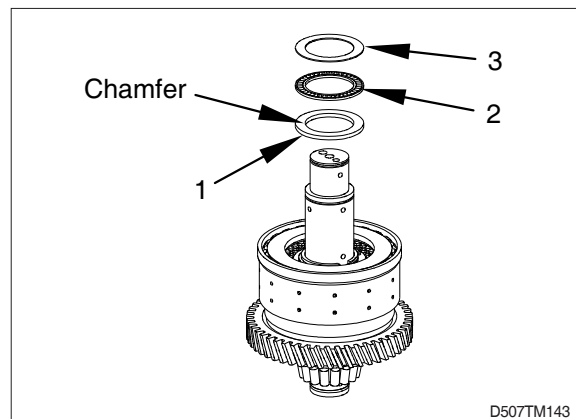
④ Mount the clutch (1) until contact is obtained.

▲ Wear safety gloves.

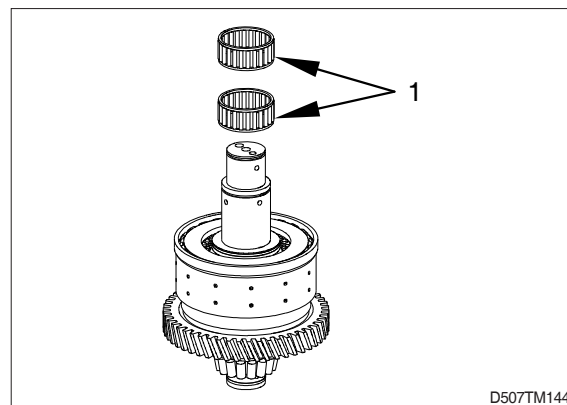


⑤ Mount the running disc (1), axial cage (2) and axial washer (3).

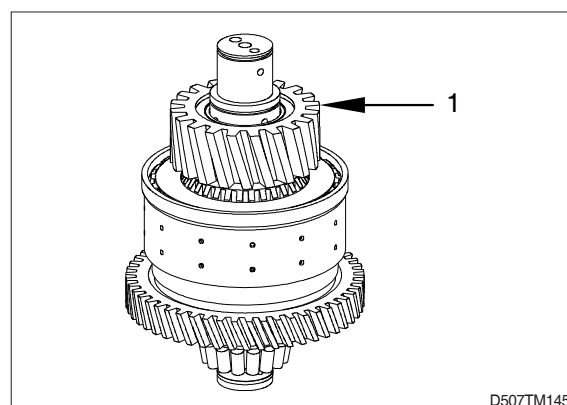
※ Install chamfer (see arrow) of the running disc (2) showing towards the axial cage.



⑥ Mount the needle cage (1).

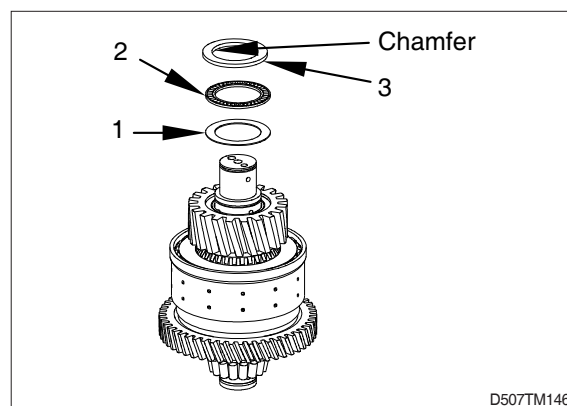


⑦ Install the idler (1).



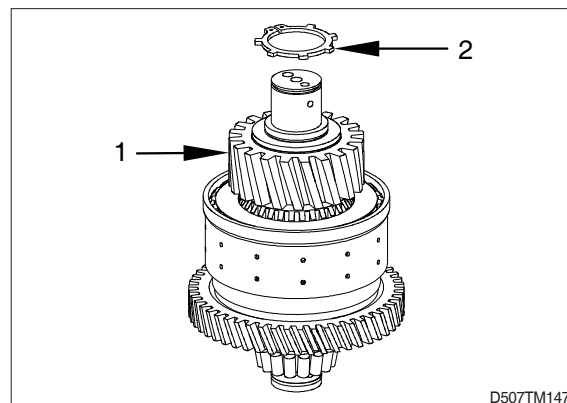
⑧ Mount the axial washer (1), axial cage (2) and running disc (3).

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

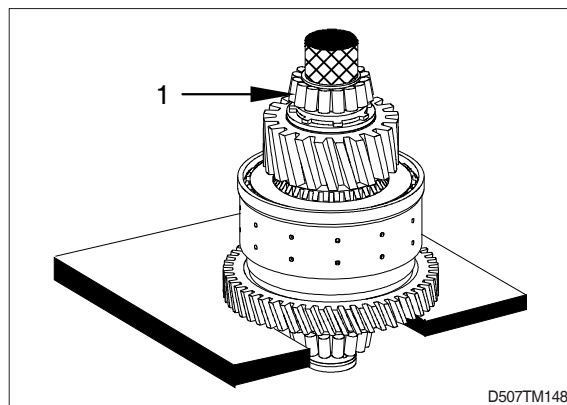


⑨ Fasten the idler (1) and the single parts by means of the retaining ring (2).

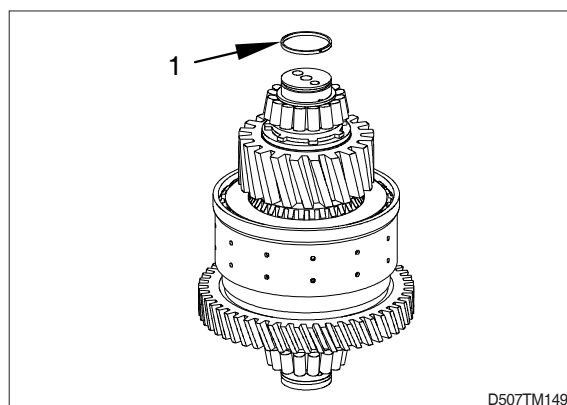
(S) Set of external pliers 5870 900 015



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



- ⑪ Install the piston ring (1).

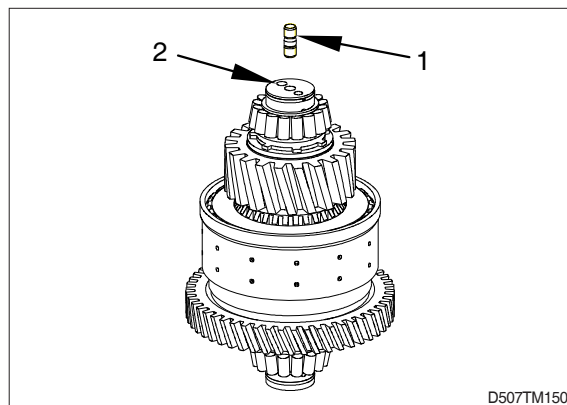


- ⑫ Install the stud (1).

Tightening torque $M_A = 1.7 \text{ kg} \cdot \text{m}$

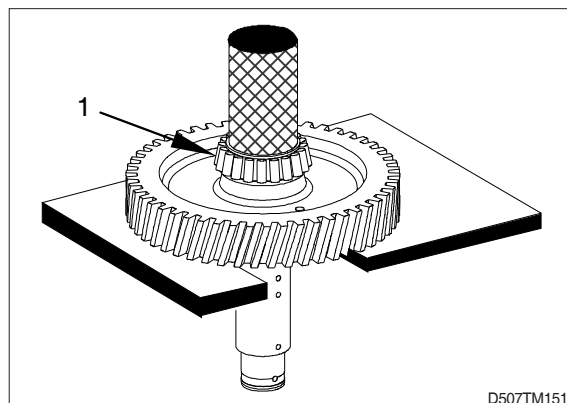
※ Check closing respective opening of the clutch by means of compressed air the bore(2).

Closing respective opening of the clutch must be clearly audible.

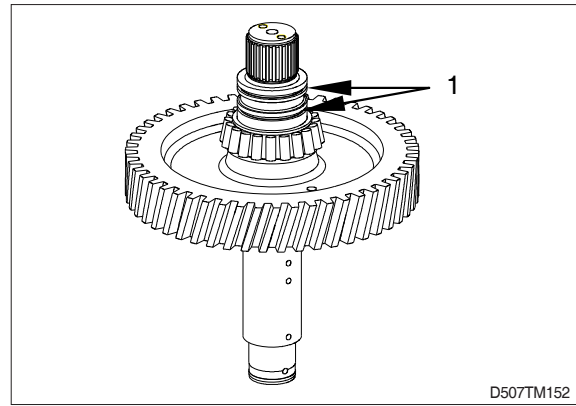


(5) Clutch K3

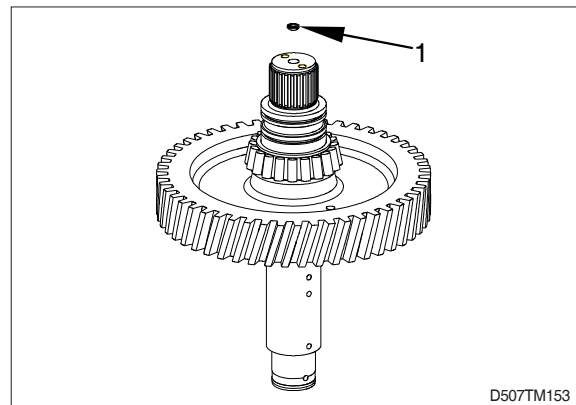
- ① Press the taper roller bearing (inner ring) (1) onto the shaft until contact.



② Install the piston ring (1).



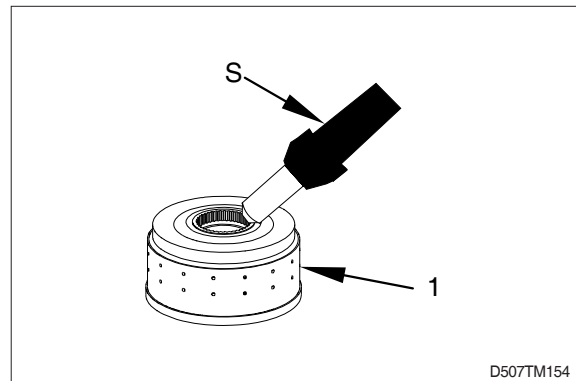
③ Install the sealing cap (1).
Wet the contact surface with loctite type No.262.



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

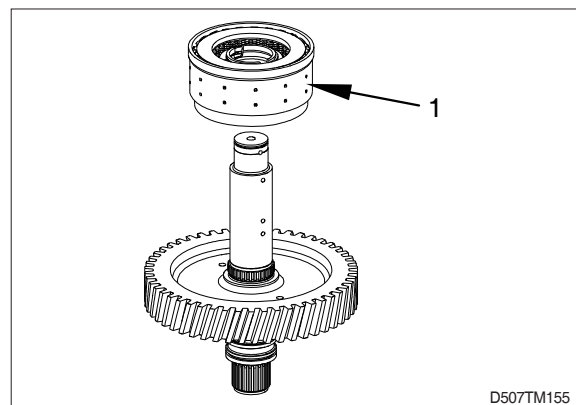
(S) Hot- air blower 220V 5870 221 500

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



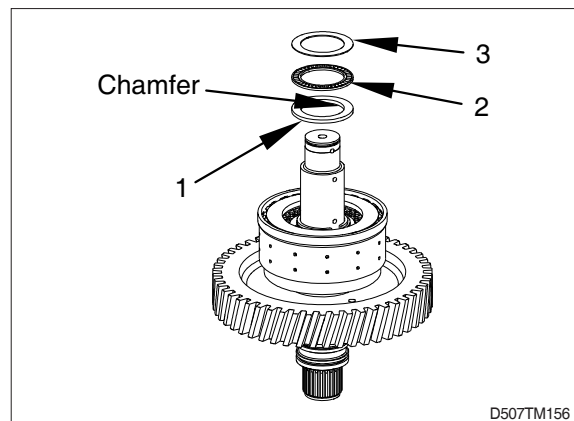
⑤ Mount the clutch (1) until contact is obtained.

▲ Wear safety gloves.

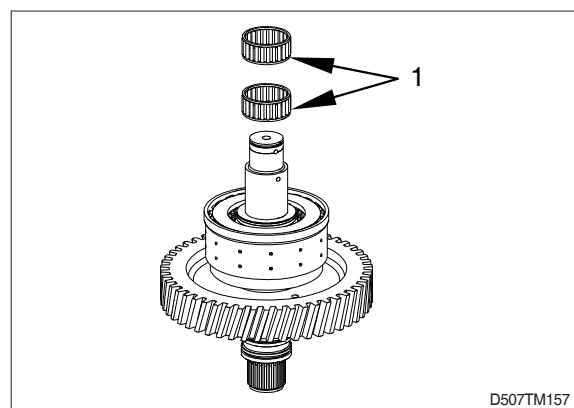


- ⑥ Mount the running disc (1), axial cage (2) and axial washer (3).

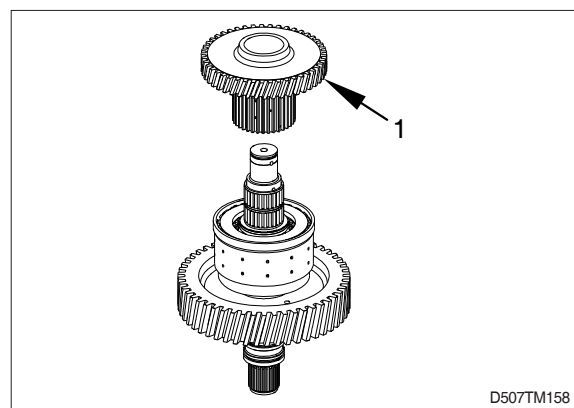
※ Install chamfer (see arrow) of the running disc (3) showing toward the axial cage.



- ⑦ Mount the needle cage (1).

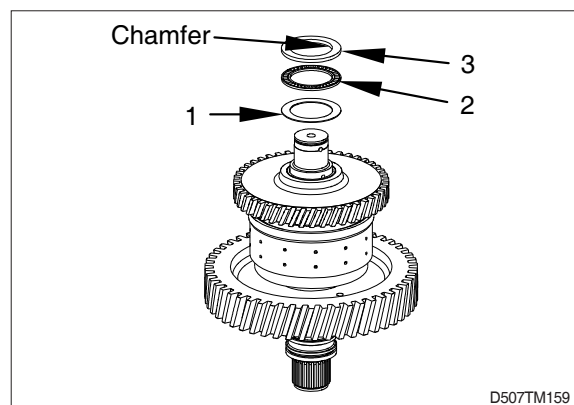


- ⑧ Install the idler (1).

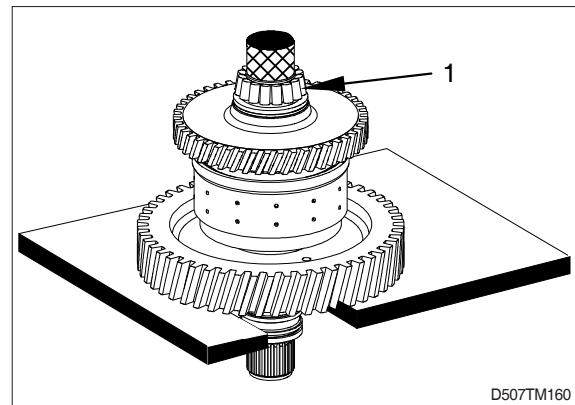


- ⑨ Mount the axial washer (1), axial cage (2) and running disc (3).

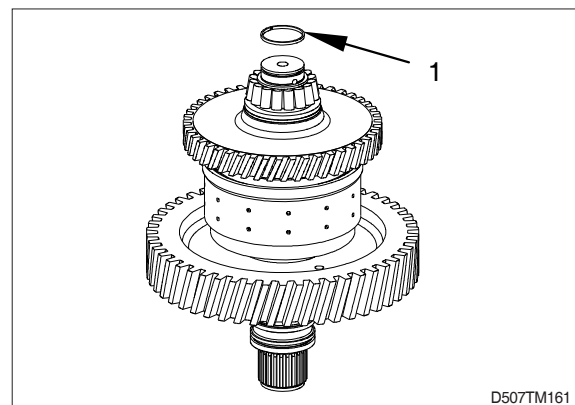
※ Install chamfer (see arrow) of the running disc (3) showing towards the axial cage.



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

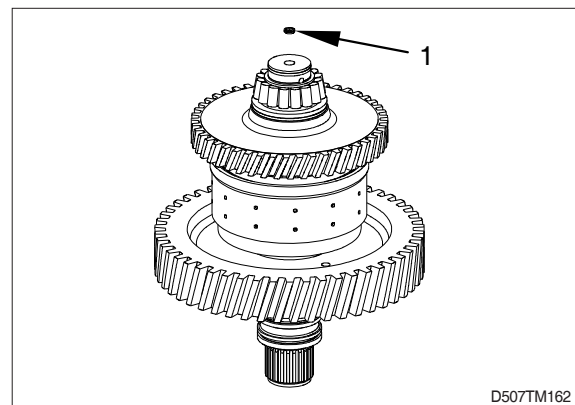


- ⑪ Install the piston ring (1).

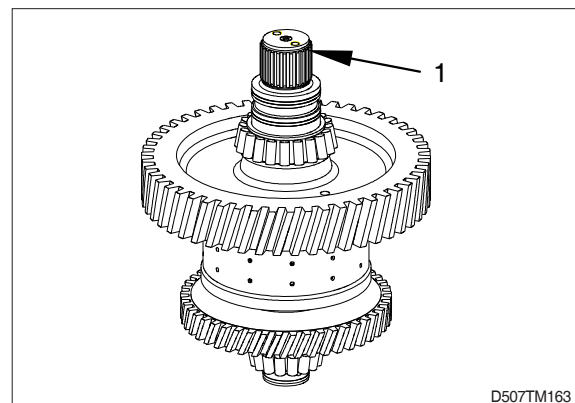


- ⑫ Install the screw plug (1).

(S) Lever riveting tongs 5870 320 016

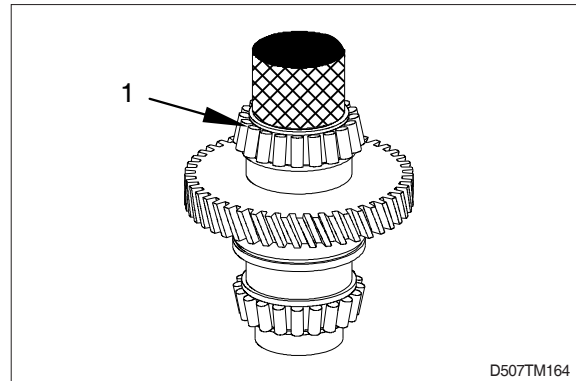


- ※ Check closing respective opening of the clutch by means of compressed air at the bore (1).
Closing respective opening of the clutch must be clearly audible.

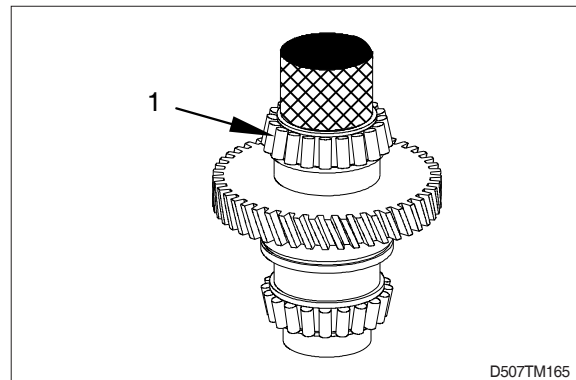


(6) Input

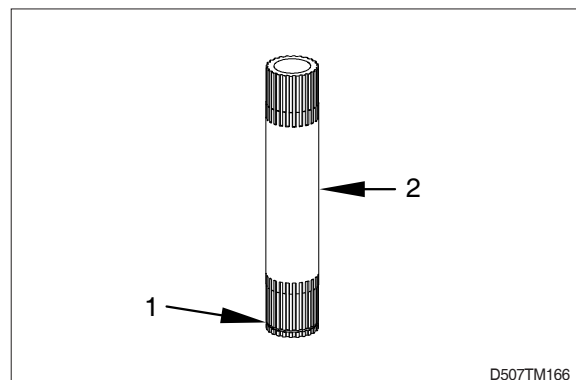
- ① Press the taper roller bearing (inner ring) (1) until contact is obtained.



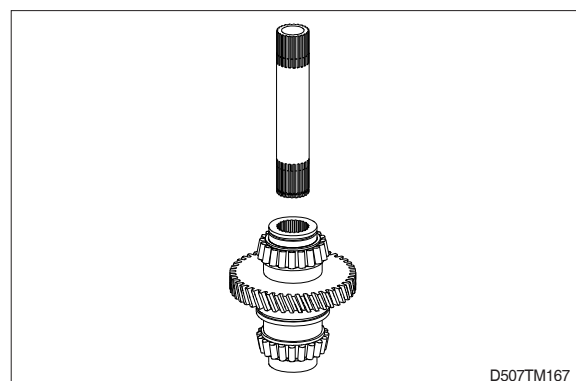
- ② Press the taper roller bearing (inner ring) (1) until contact is obtained.



- 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.



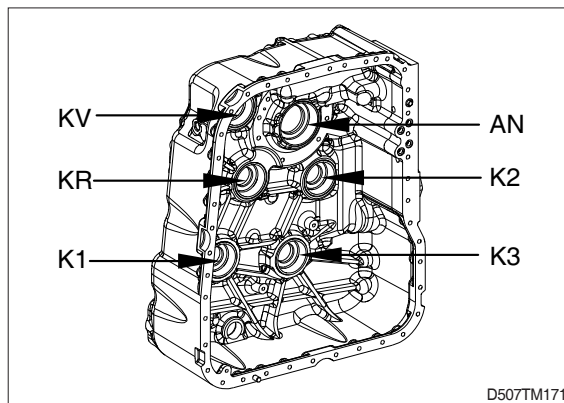
2) ENGINE CONNECTION, PRESSURE OIL PUMP AND INSTALLATION OF THE CLUTCHES

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.

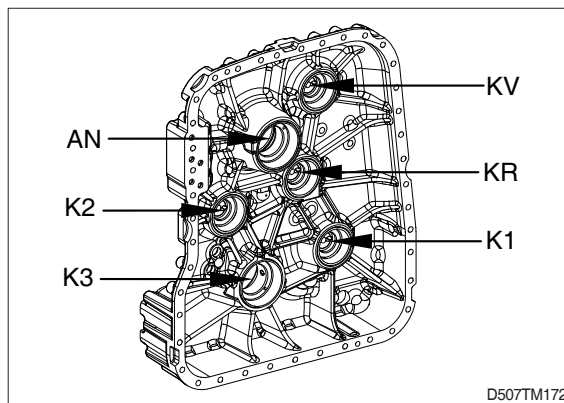
(1) Transmission housing front section

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



(2) Transmission housing rear section

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



- ① Install the pipe (system pressure from the electro-hydraulic control to the respective clutch).

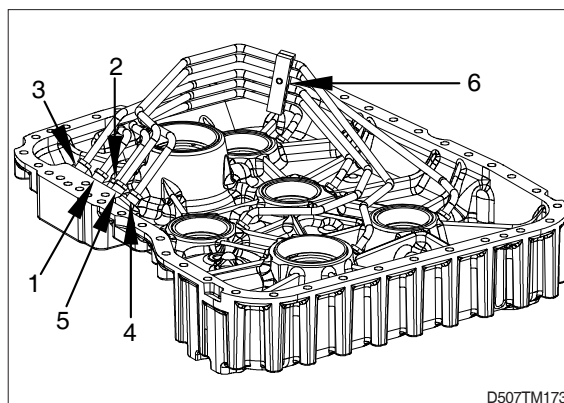
The pipes are to be installed in the following sequence:

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

Tightening torque $M_A = 4.3 \text{ kg} \cdot \text{m}$

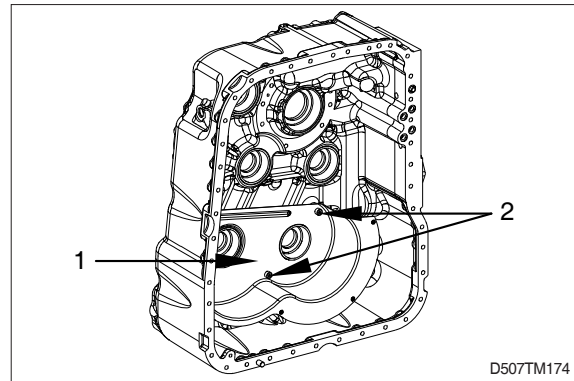
Install the holding segment (6)

Tightening torque (M8/8.8) .. $M_A = 2.3 \text{ kg} \cdot \text{m}$



- ② Fasten the screen sheet (1) by means of cap screws (2).

Tightening torque (M8/8.8) .. $M_A = 2.3 \text{ kg} \cdot \text{m}$



- 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

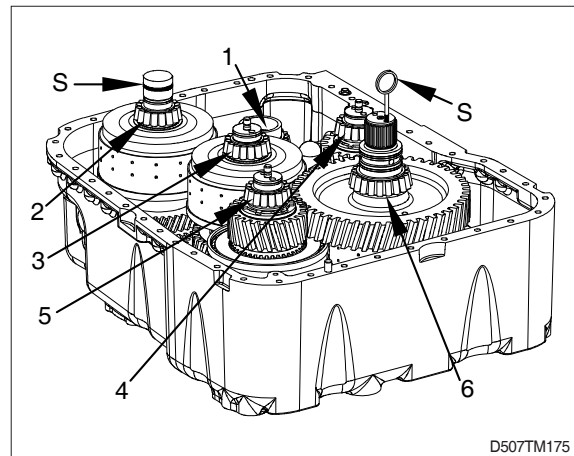
4 = Clutch K2

5 = Clutch K1

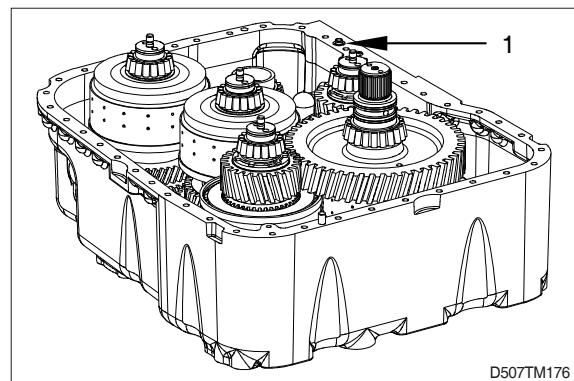
6 = Clutch K3

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

(S)Eyebolt 5870 204 002



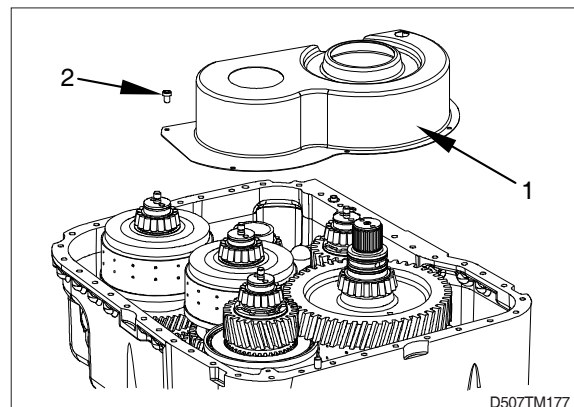
- ④ Put the pipes and O-rings into the bores and grease them.



- ⑤ Fasten the screen sheet (1) by means of cap screws (2).

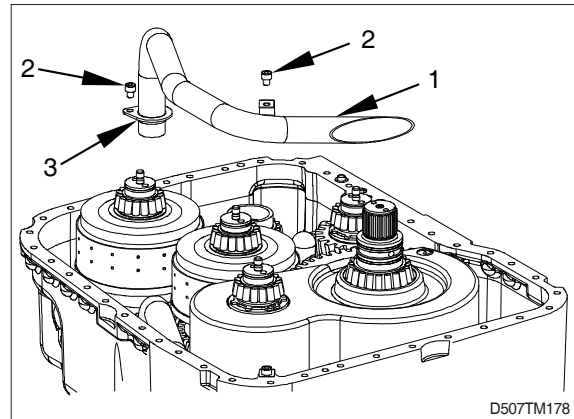
Tightening torque (M6/8.8)

..... $M_A = 0.97 \text{ kg} \cdot \text{m}$



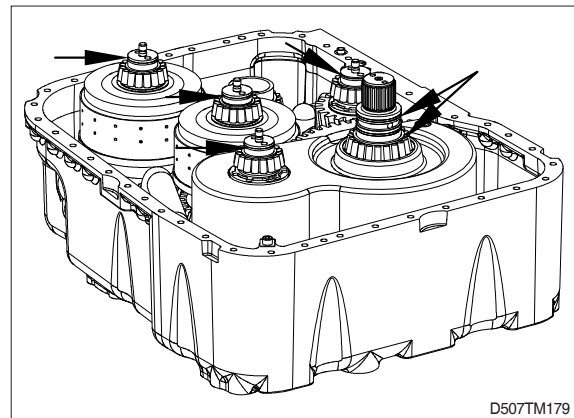
- ⑥ Install the O-rings (3) and fasten the suction pipe (1) by means of cap screws (2).

Tightening torque (M8/8.8) .. $M_A = 2.3 \text{ kg} \cdot \text{m}$



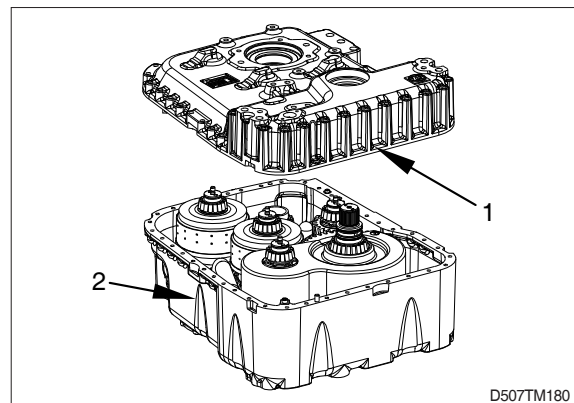
- ⑦ Grease the rectangular rings (see arrows) and align them, centrally.

※ 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

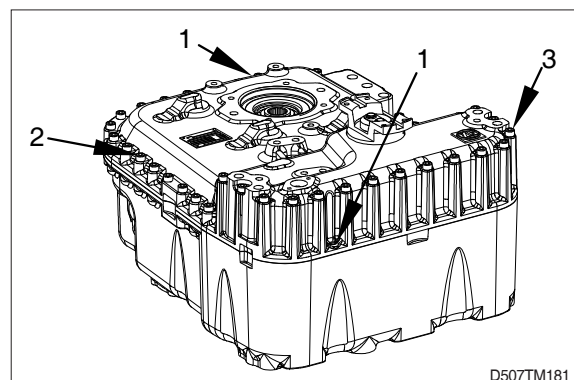


- ⑨ Install both cyl. pins (1) centrally to the mounting face.

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) $M_A = 4.7 \text{ kg} \cdot \text{m}$



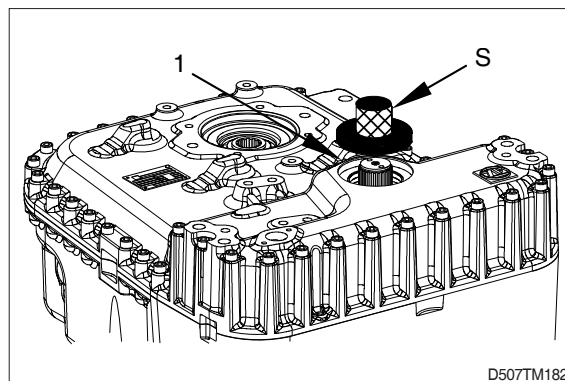
- ⑩ Install the shaft seal (1) with the sealing lip showing to the oil sump.

※ 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



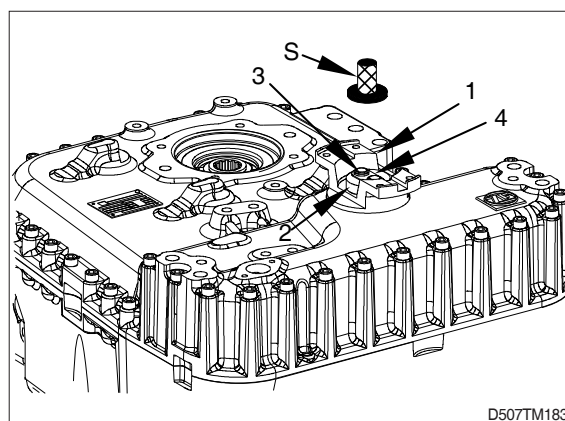
- ⑪ Insert the input flange (1) until contact and put in the O-ring. Fix the input flange (1) by means of washer (2) and hexagon screws (3).

Then fix the hexagon screws (3) with the tab washer (4) by means of the mounting tool (S).

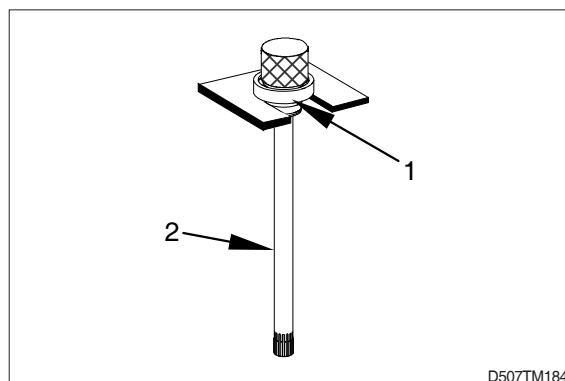
Tightening torque (M8/8.8) $\cdot M_A = 3.5 \text{ kg} \cdot \text{m}$

(S) Mounting tool 5870 057 011

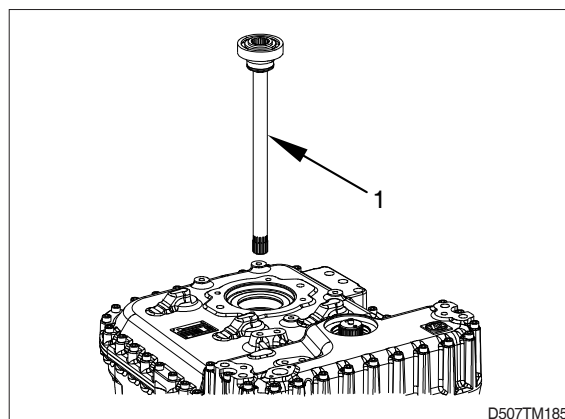
(S) Handle 5870 260 002



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

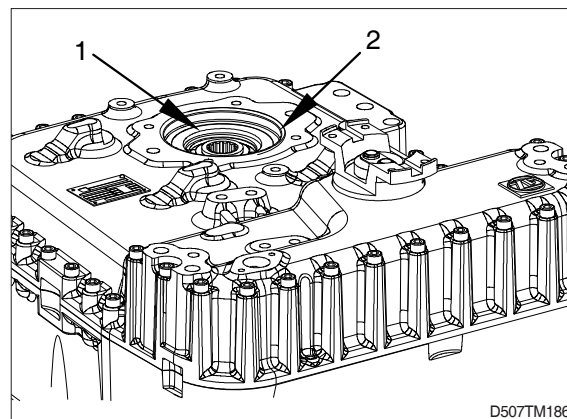


- ⑬ Install the pump shaft (1) until contact is obtained.



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

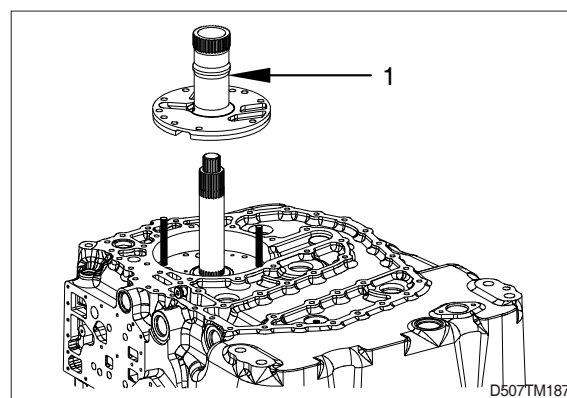
※ Grease the O-ring



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

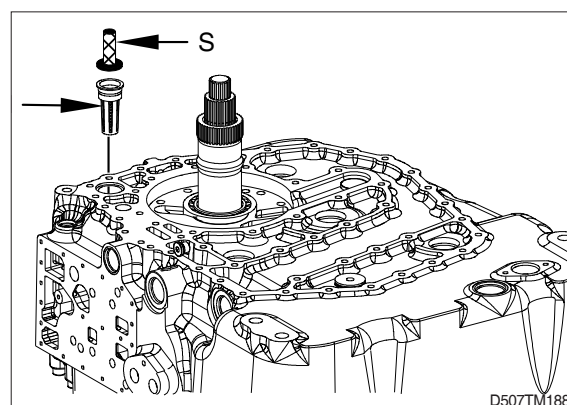
※ Observe the radial installation position.

(S) Adjusting screws 5870 204 007



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

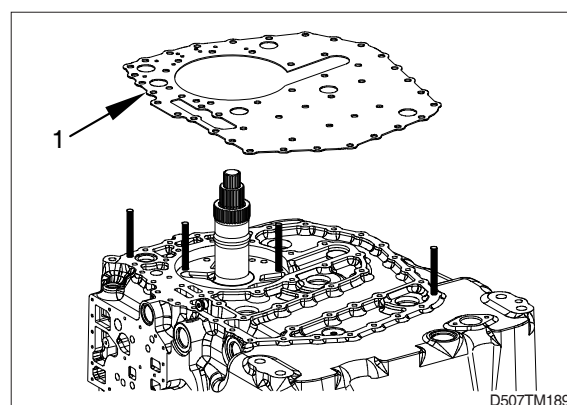
(S) Drive mandrel 5870 705 012



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

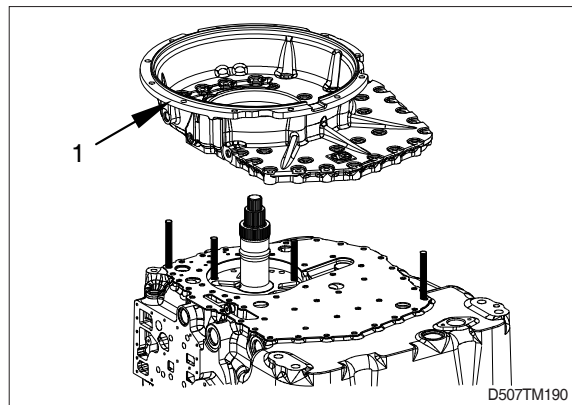
※ The intermediate sheet has always to be replaced.

(S) Adjusting screws 5870 204 007



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

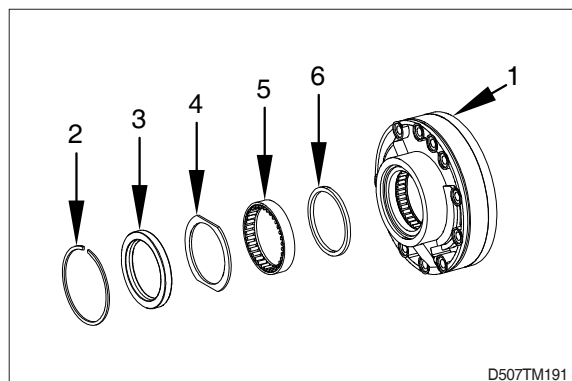
(S) Eyebolts assortment 5870 204 002
(S) Lifting chain 5870 281 047



(3) Pressure oil pump

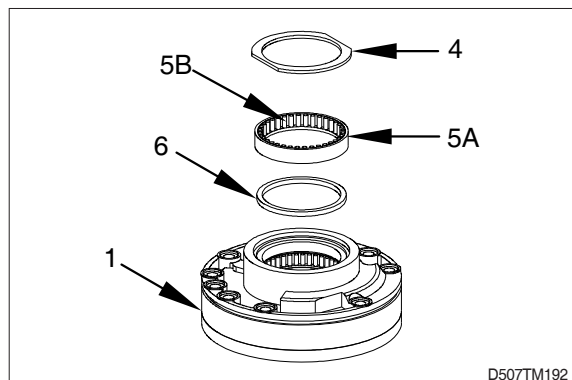
- ※ If running-in marks should be found in the pump housing or on the cam disc, the complete pump has to be replaced.
- ※ Item 1-6 are allowed to be replaced.

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



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

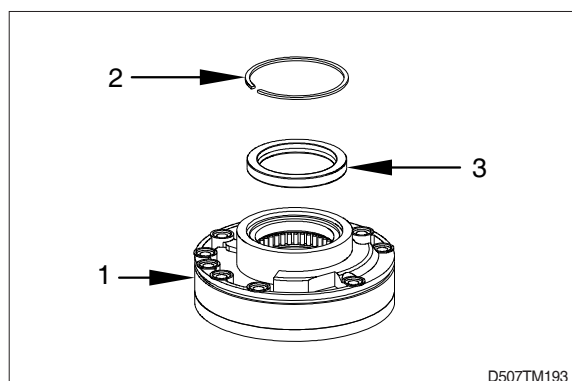
6 = Ring
5A = Bearing outer ring
5B = Needle cage
4 = Support shim



- 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).

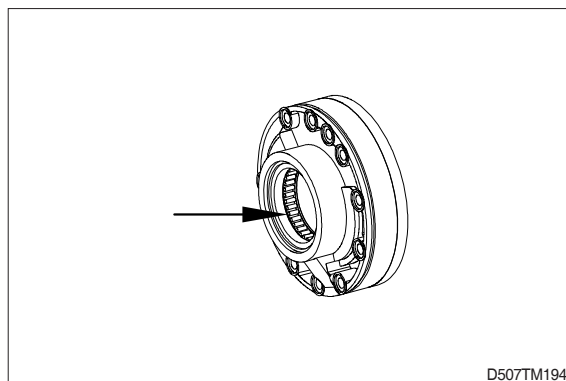
- ※ Wet the outer diameter of the shaft seal with spirit.

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

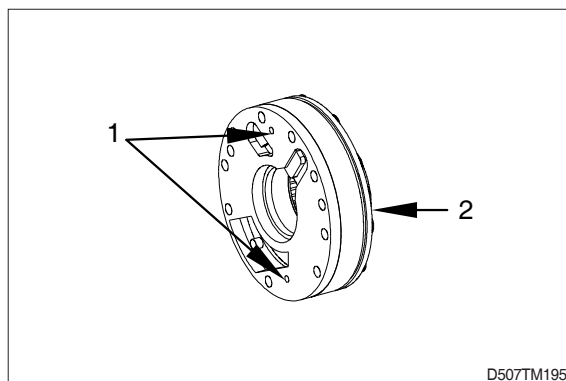


(4) Installation of the external and internal rotor

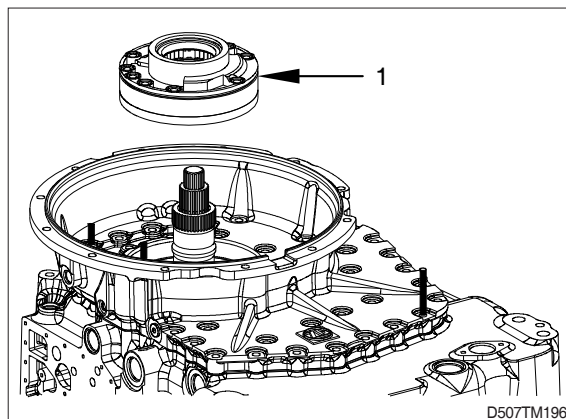
- ※ Install the external rotor.
Chamfer shows to the pump base (cannot be seen in the picture).
- ※ Install the internal rotor.
Gearing (arrow) shows downwards.



- 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 them 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.



- 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.



- 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.

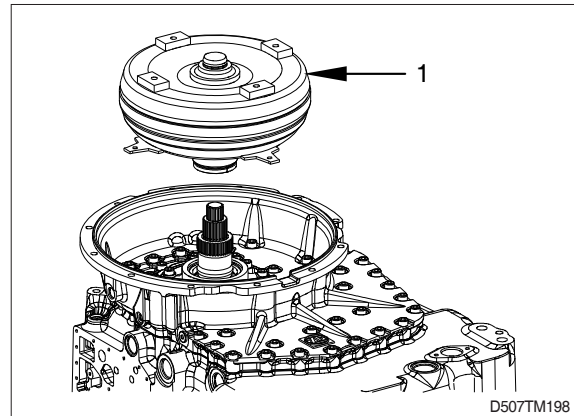
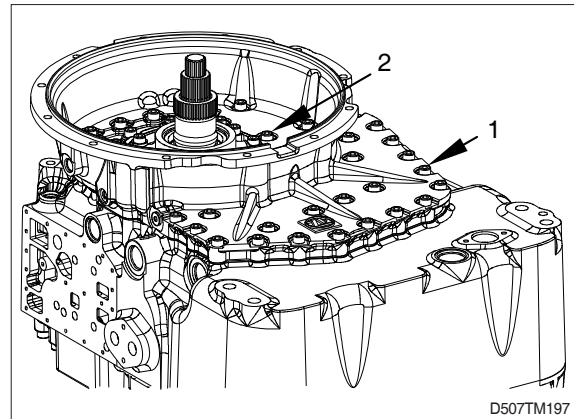
Tightening torque (M10/8.8)
..... $M_A = 4.7 \text{ kg} \cdot \text{m}$

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

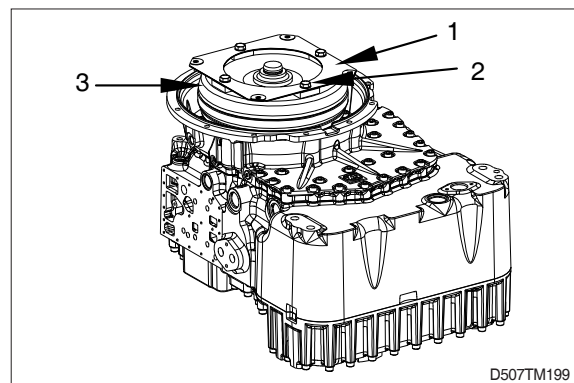


- ⑤ Fasten the flexplate (1) by means of hexagon screws (2).

※ 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)
..... $M_A = 11.7 \text{ kg} \cdot \text{m}$



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

① Install the converter pressure back-up valve.

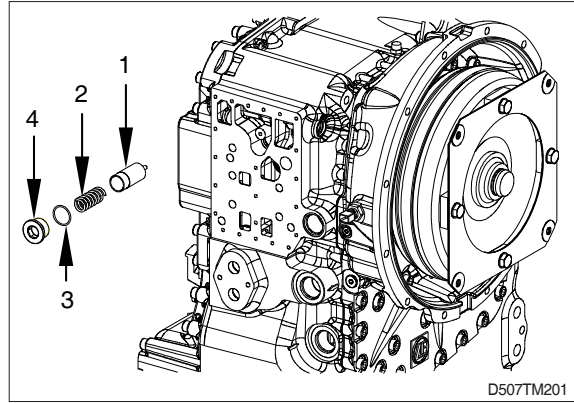
1 = Piston

2 = Compression spring

3 = O-ring (27 × 2)

4 = Screw plug (30 × 1.5)

※ Tightening torque $M_A = 10.2 \text{ kg} \cdot \text{m}$



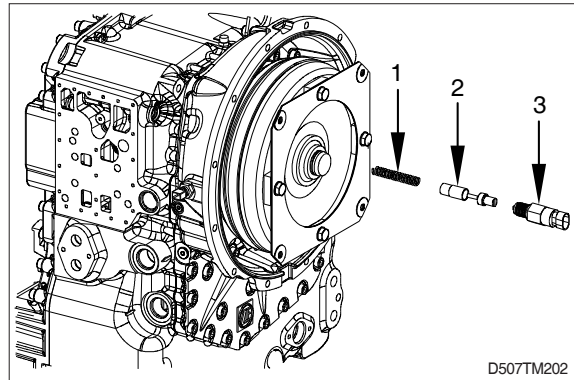
② Install the differential pressure switch for the pressure filter.

1 = Compression spring

2 = Piston

3 = Tappet switch

※ Tightening torque $M_A = 3.1 \text{ kg} \cdot \text{m}$



③ Installation of:

1 = Inductive transmitter - n Engine

2 = Screw plug M10 × 1.0

(measuring point pressure after converter)

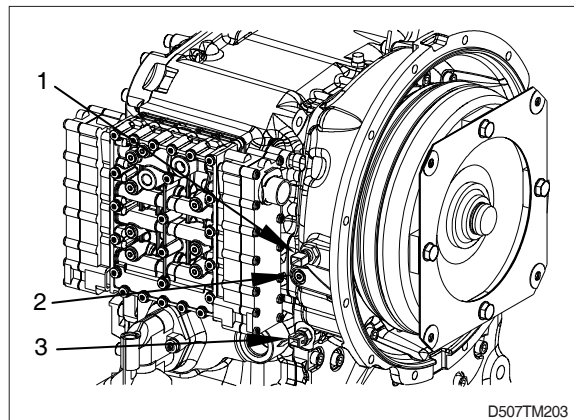
3 = Temperature transmitter M14 × 1.5

(measuring point temperature after converter)

※ Tightening torque (1) $M_A = 3.1 \text{ kg} \cdot \text{m}$

Tightening torque (2) $M_A = 0.97 \text{ kg} \cdot \text{m}$

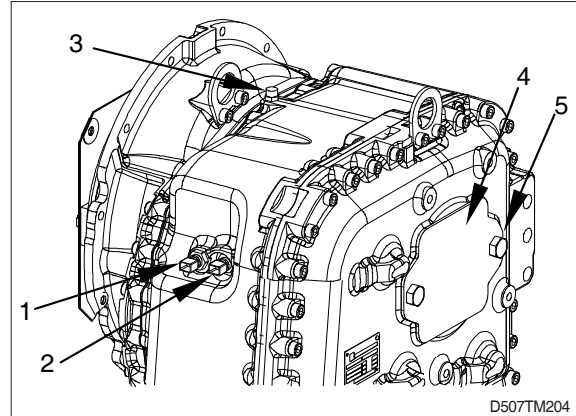
Tightening torque (3) $M_A = 2.6 \text{ kg} \cdot \text{m}$



④ Installation of:

- 1 = Inductive transmitter - n Internal speed input
- 2 = Inductive transmitter - n Turbine
- 3 = Breather

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

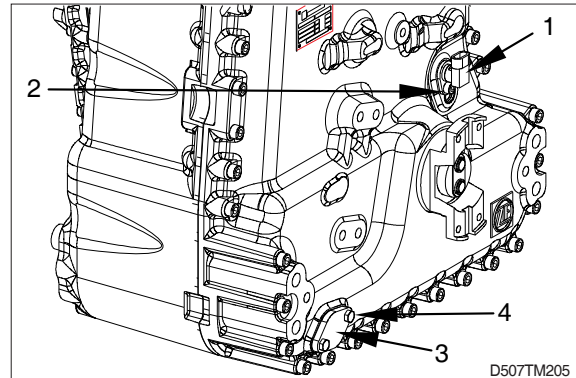


D507TM204

⑤ Installation of :

- 1 = Speed transmitter
- 2 = Cap screw

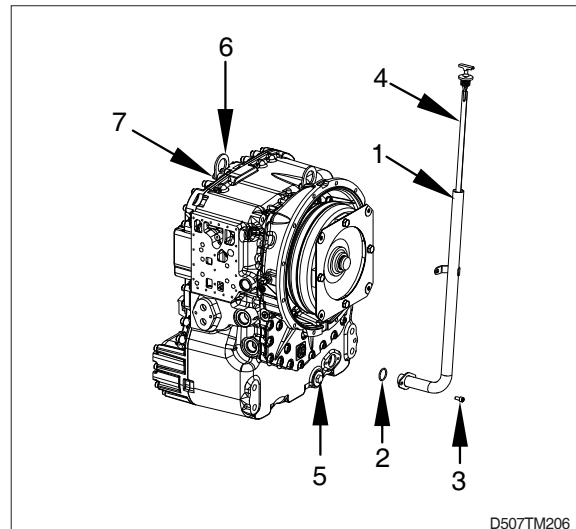
- ※ Tightening torque (2) (M8/8.8) · $M_A = 2.4 \text{ kg} \cdot \text{m}$
- 3 = Install the cove replate (3) with gasket.
- 4 = Hexagon screw
- ※ Tightening torque (2) (M8/8.8) $M_A = 2.4 \text{ kg} \cdot \text{m}$



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.

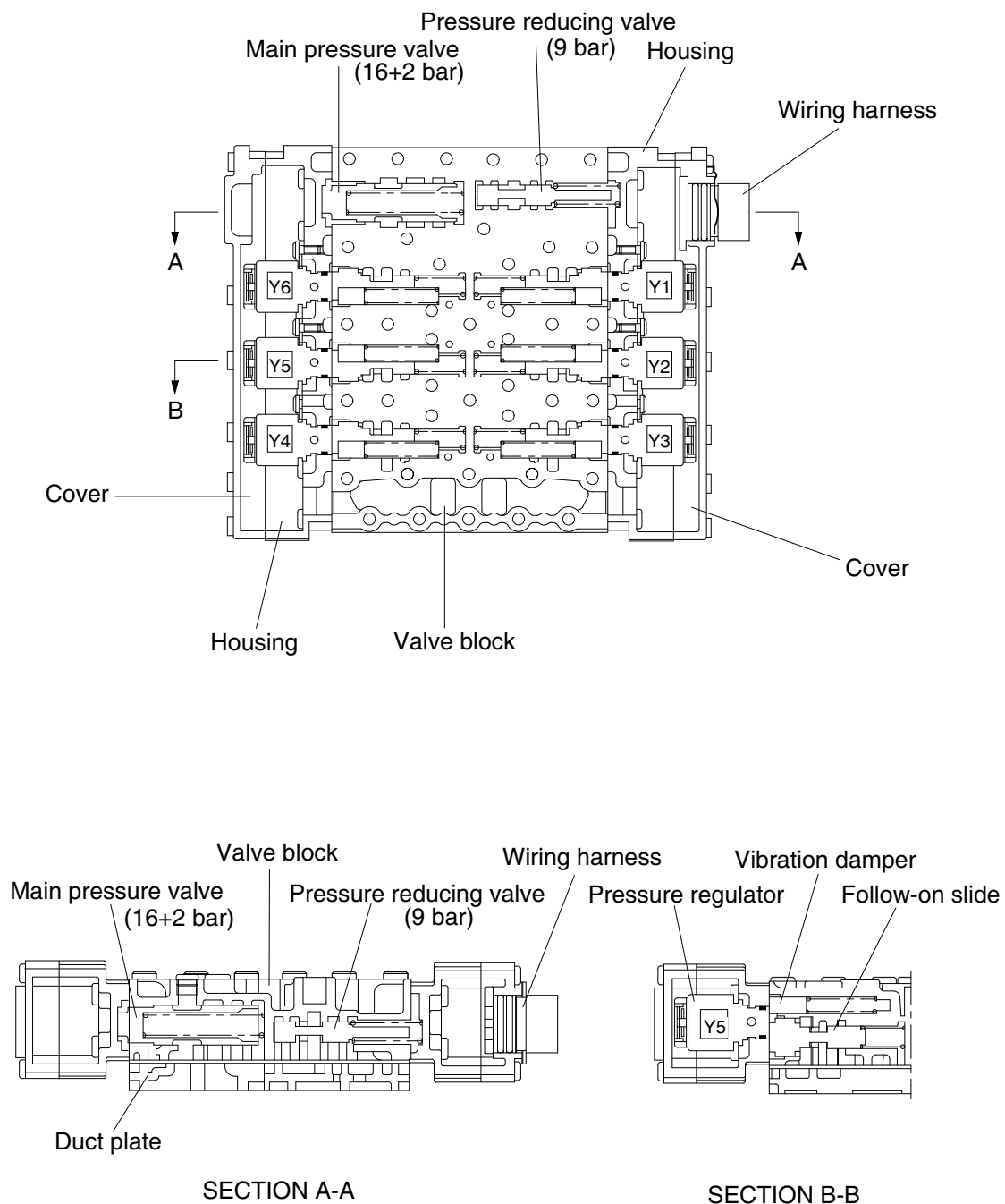
- ※ Tightening torque (2) (M8/8.8) $M_A = 2.4 \text{ kg} \cdot \text{m}$
- Install the oil drain plug (5) with the O-ring.
- ※ Tightening torque $M_A = 14.3 \text{ kg} \cdot \text{m}$
- Fasten the fixing plate (6) by means of cap screws (7)
- ※ Tightening torque (M10/8.8) · $M_A = 4.7 \text{ kg} \cdot \text{m}$



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.



D507TM211

(1) Mounting of the electric control unit

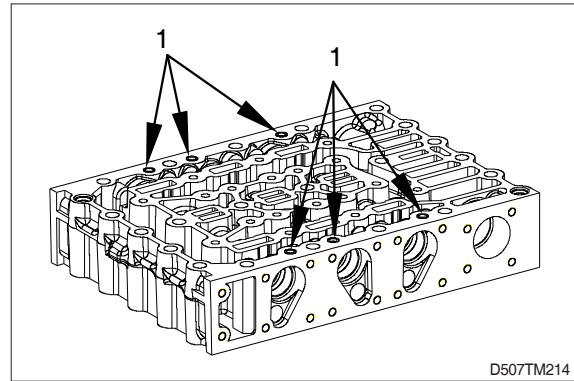
※ All single parts are to be checked for damaged and replaced, if required.

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

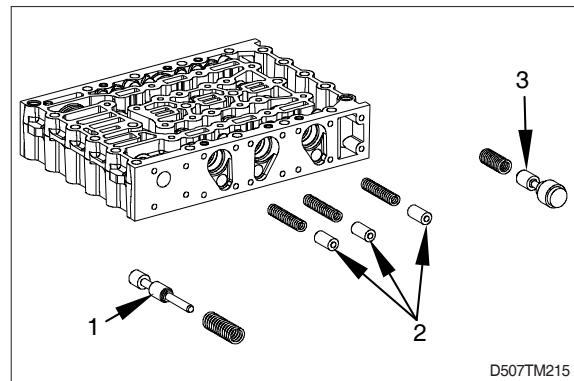
(1 ×, piston a. compr. spring)

2 = Vibration damper

(3 ×, piston a. compr. spring)

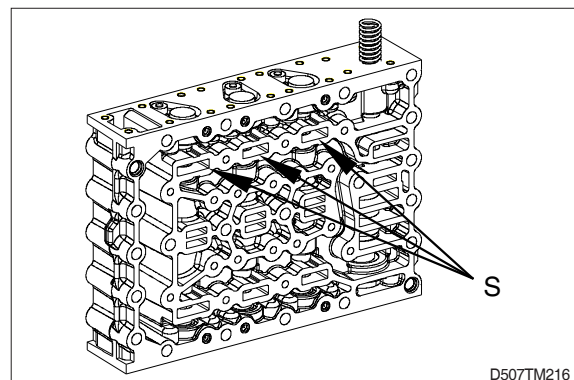
3 = Follow-on slide

(3 ×, piston a. compr. spring)



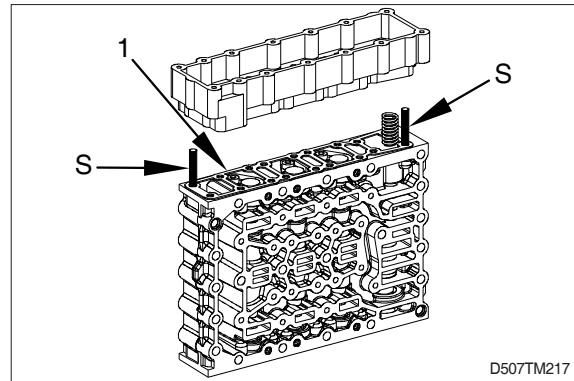
③ Install the single parts acc to right figure.

※ Preload the compression springs of the follow-on slides and fasten the piston preliminarily by means of cylindrical pins Ø5.0 mm (assembly aid), see arrows (s)

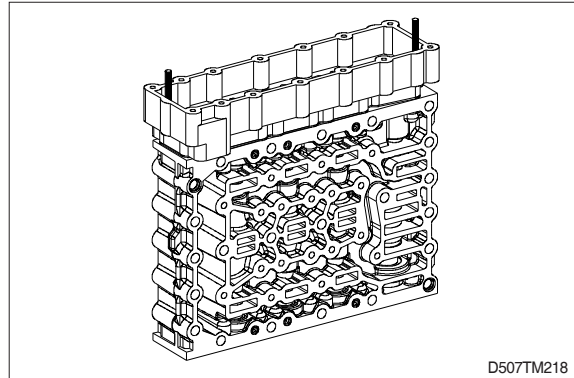


- ④ Install two adjusting screws.
 Assembly flat gasket (1) and housing cover.
 Then place the housing cover by means of adjusting screws equally until contact.

(S) Adjusting screws 5870 204 036



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



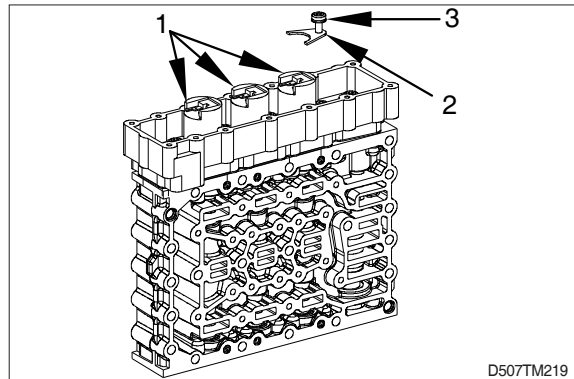
- ⑥ Fasten the housing cover by means of cap screws (1).

※ Tightening torque $M_A = 0.56 \text{ kg} \cdot \text{m}$

(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).

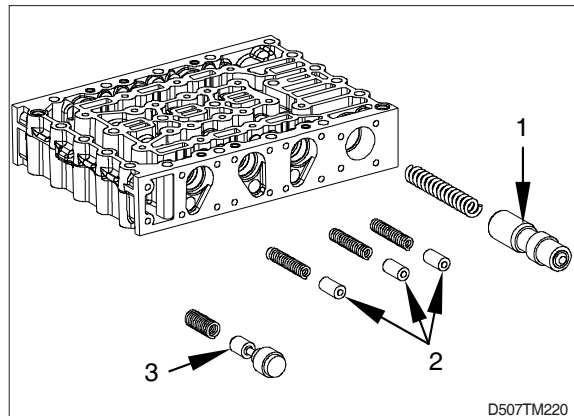
※ Install the fixing plate with the neck showing downwards
 Observe radial installation position of the pressure regulators.

Tightening torque $M_A = 0.56 \text{ kg} \cdot \text{m}$

(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

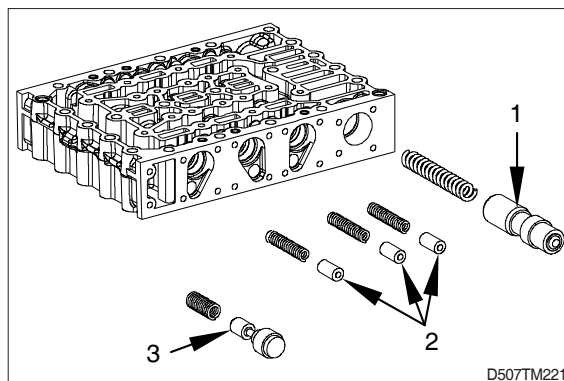
(1 ×, piston a. compr. spring)

2 = Vibration damper

(3 ×, piston a. compr. spring)

3 = Follow-on slide

(3 ×, piston a. compr. spring)



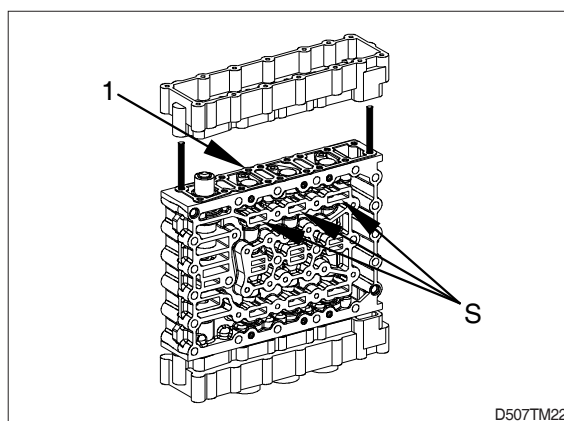
- ⑨ Install the single parts acc to right figure.

- ※ 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.



- 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).

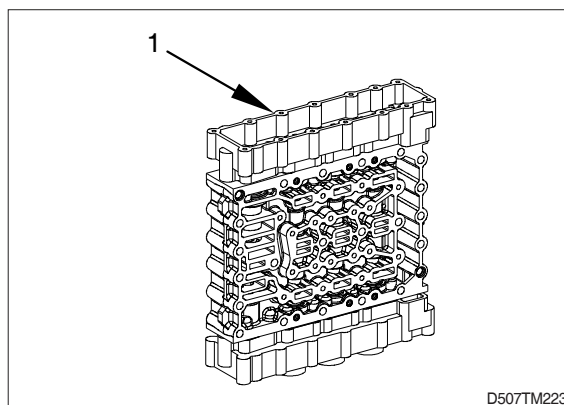
Tightening torque $M_A = 0.56 \text{ kg} \cdot \text{m}$

(S) Adjusting screws 5870 204 036

(S) Torque spanner 5870 203 031

(S) Reducer 5870 656 056

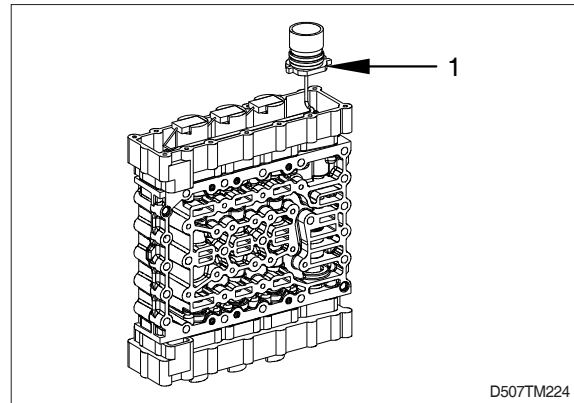
(S) Socket spanner TX-27 5873 042 002



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

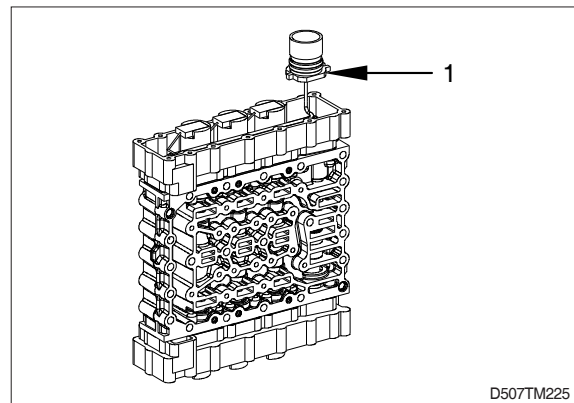
- ※ Install the fixing plate with the neck showing downwards
Observe radial installation position of the pressure regulators.

Tightening torque $M_A = 0.56 \text{ kg} \cdot \text{m}$



- 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.

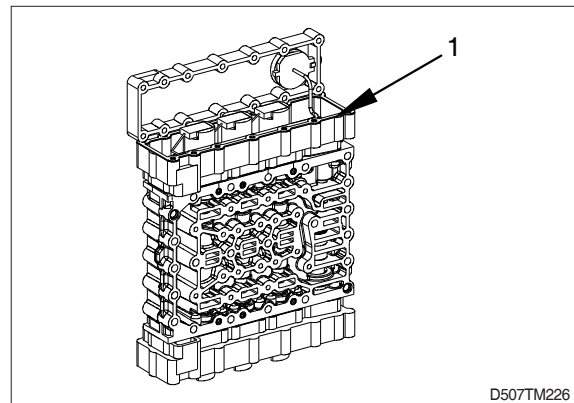


- ⑬ Put on the plate gasket (1).
Assemble the plug socket with the slot showing to the lug of the cover until contact.
Fasten the cover by means of cap screws.

Tightening torque $M_A = 0.56 \text{ kg} \cdot \text{m}$

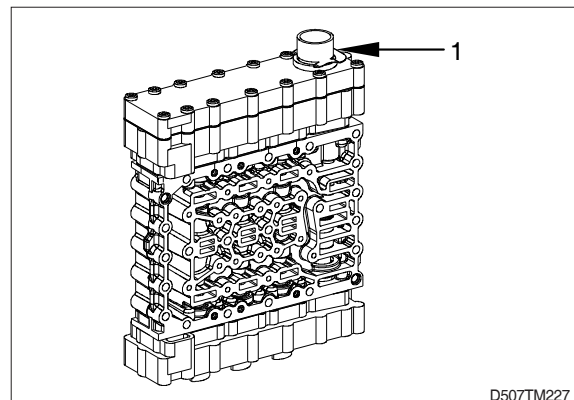
(S) Torque spanner 5870 203 031

(S) Socket spanner TX-27 5873 042 002



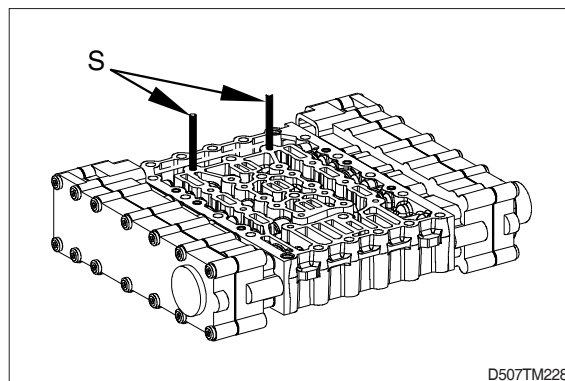
- ⑭ Fix the wiring harness by means of retaining clamp (1).

- ※ Install the opposite cover



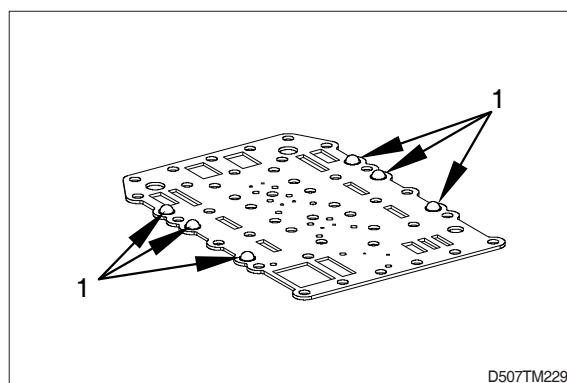
- ⑮ Install two adjusting screws.

(S) Adjusting screws 5870 204 063



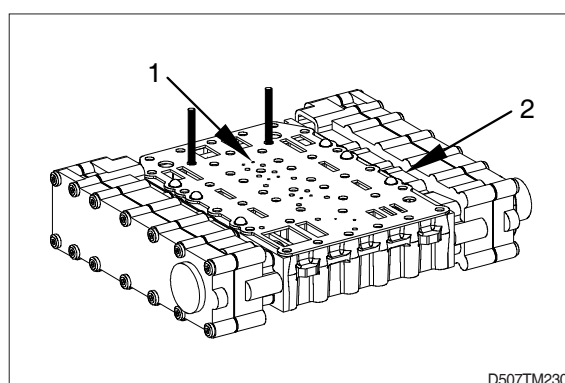
- ⑯ Screens (1) are to be flush mounted into the bores of the intermediate sheet, see arrows.

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



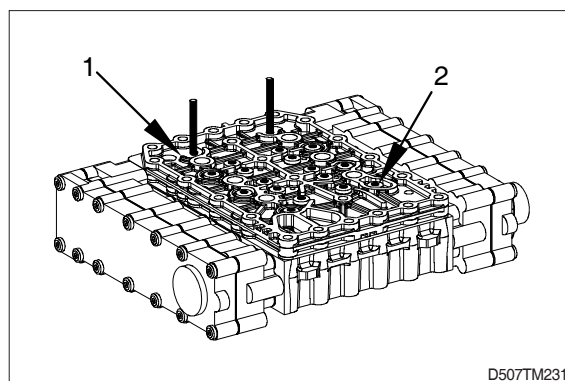
- ⑰ Put on the intermediate sheet (1)

※ Screens (2) must show upwards.



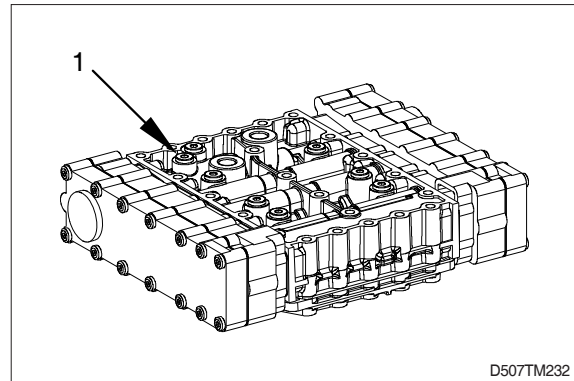
- ⑱ Put on the duct plate (1) and tighten it equally with torx screw (2).

※ Tightening torque $M_A = 0.97 \text{ kg} \cdot \text{m}$
 (S) Socket spanner TX-27 5873 042 002



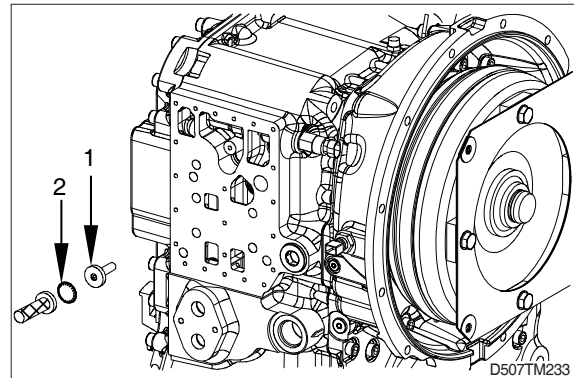
- ⑲ Provide the screw plugs (1) with new O-rings and install them.

※ Tightening torque $M_A = 0.61 \text{ kg} \cdot \text{m}$



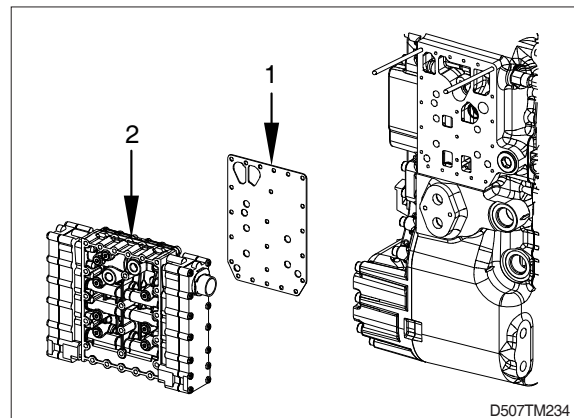
- ⑳ Insert the pressure relief valve (1) and lock it with the indented ring (2).

(S) Drive mandrel 5870 705 012



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

(S) Adjusting screws M6 5870 204 063



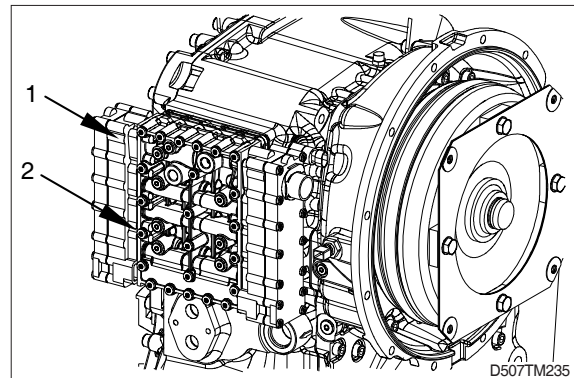
- ㉒ Fasten the electro-hydraulic control unit (1) equally by means of Torx screws (2).

※ Tightening torque $M_A = 0.56 \text{ kg} \cdot \text{m}$

(S) Torque spanner 5870 203 031

(S) Reducer 5870 656 056

(S) Socket spanner TX-27 5873 042 002



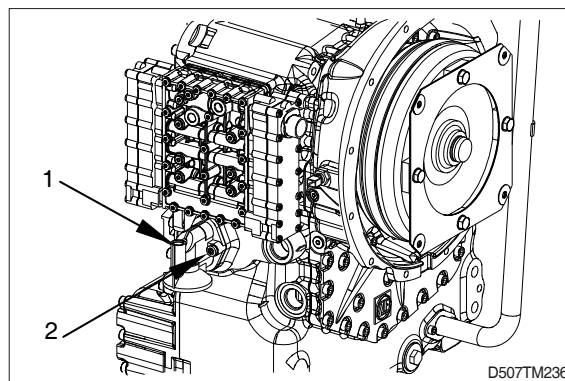
(2) Mounting of the filter (pressure filter)

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

Tightening torque(M8) $M_A = 2.4 \text{ kg} \cdot \text{m}$

(S) Torque spanner 5870 203 034

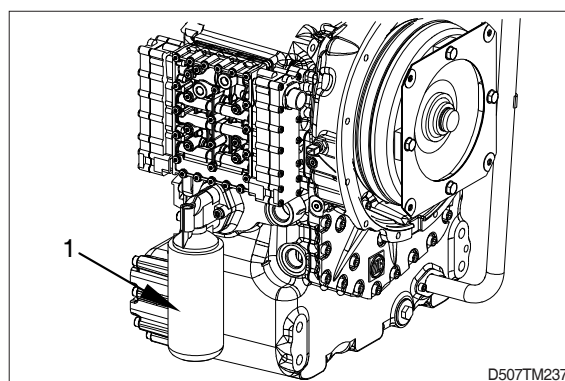
(S) Socket spanner TX-40 5870 042 004



▲ 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.



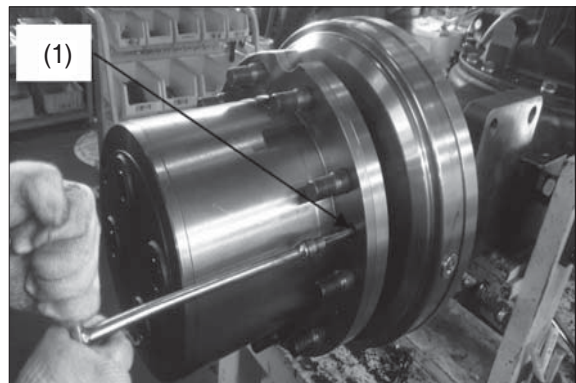
110DEDA10

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



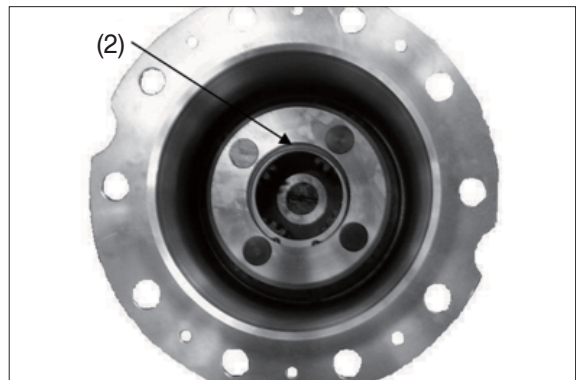
110DEDA11

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



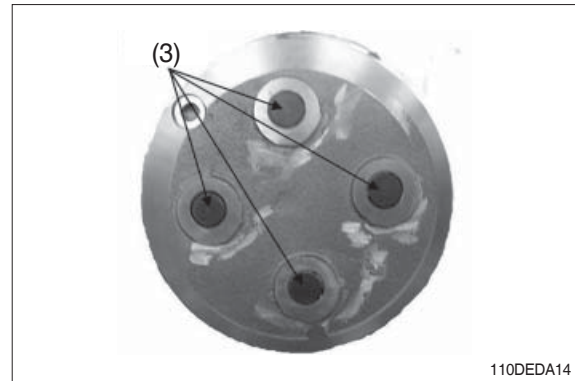
110DEDA12

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

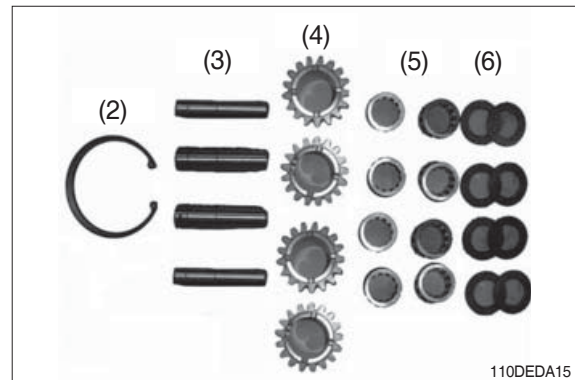


110DEDA13

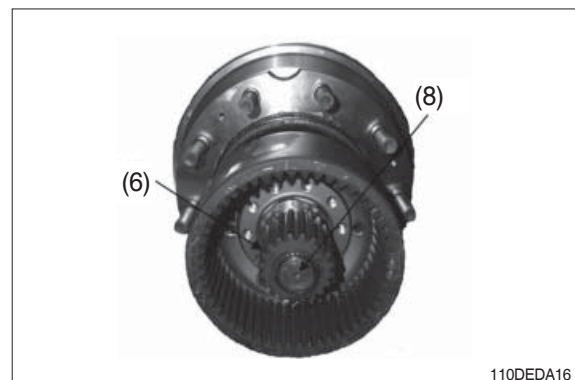
- (5) Disassemble four planetary pin (3) using the tool.



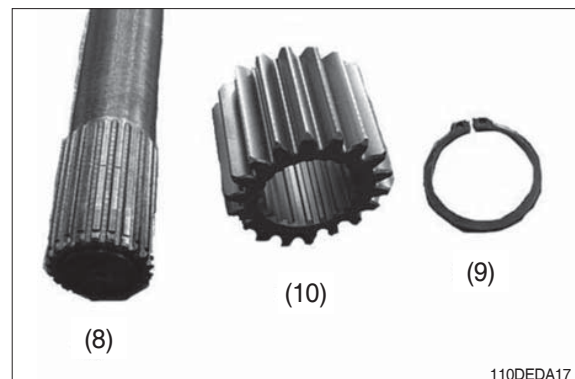
- (6) Disassemble planetary gear (4), needle bearing (5) and thrust washers (6).



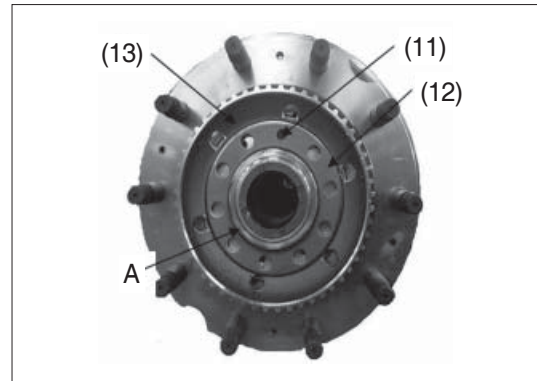
- (7) Disassemble drive shaft assembly (8) with sun gear (7).



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

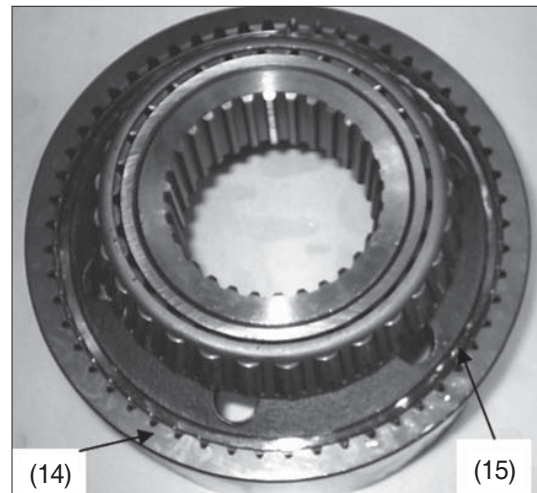


- (9) Loosen the bolts (11) and nut (12).
Disassemble the internal gear carrier assembly (13) from spindle (A).
Mark the installation position of the nut (12) and the internal gear carrier before disassembling. Check for position during assembly.



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.

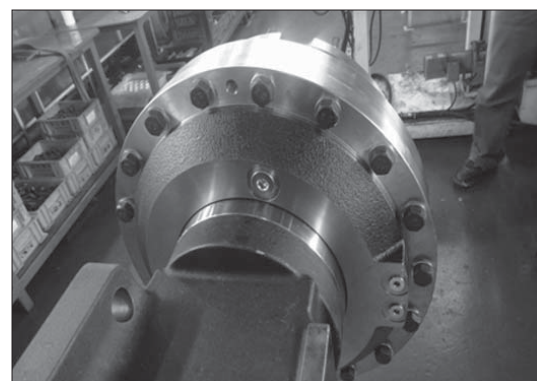


110DEDA19

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



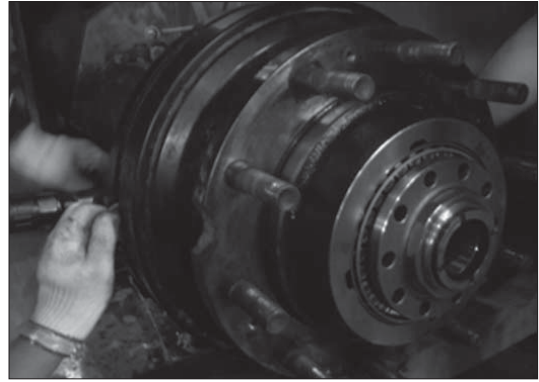
110DEDA20



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

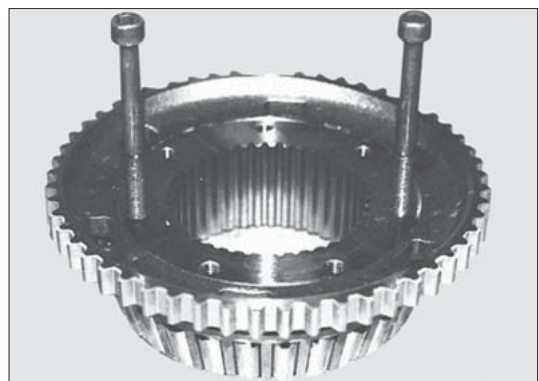


110DEDA23



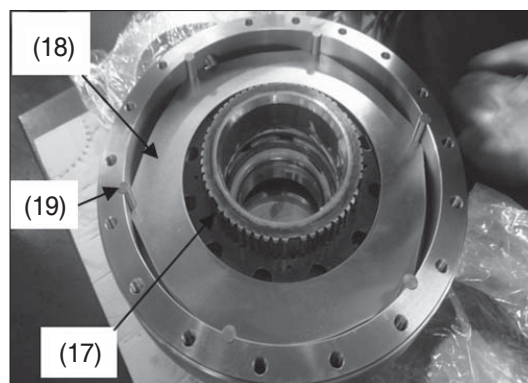
110DEDA24

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

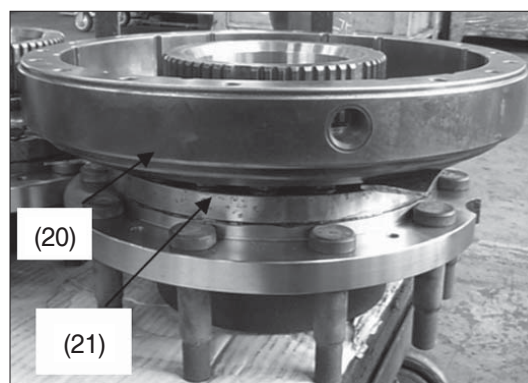


110DEDA25

- (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).



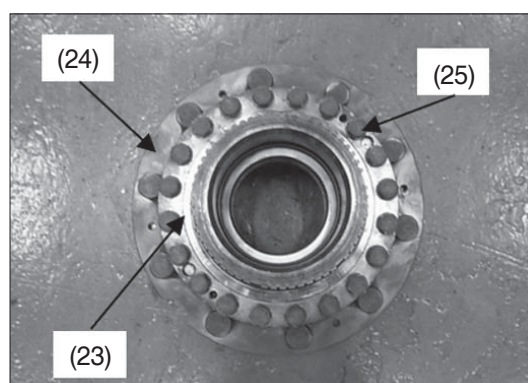
110DEDA26



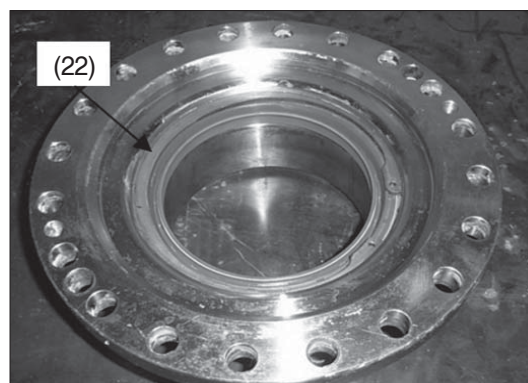
110DEDA27

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

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

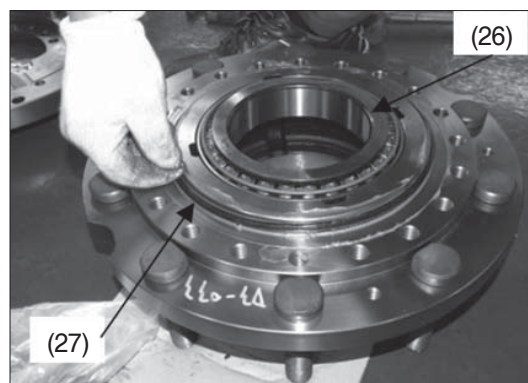


110DEDA28



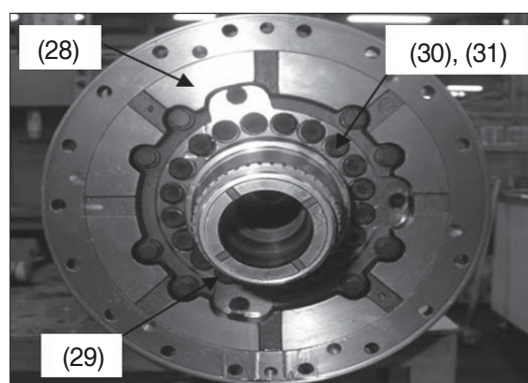
110DEDA29

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

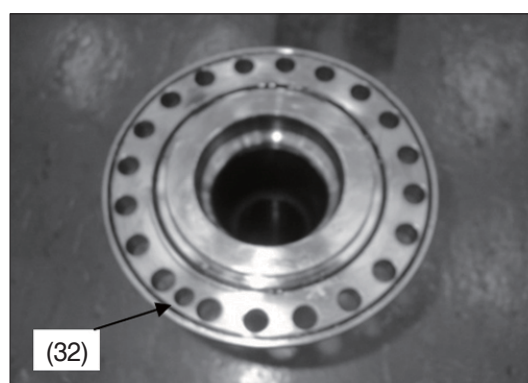


110DEDA30

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

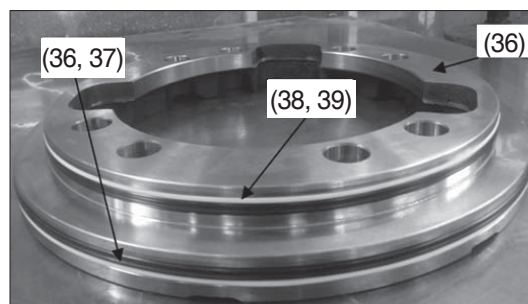


110DEDA31

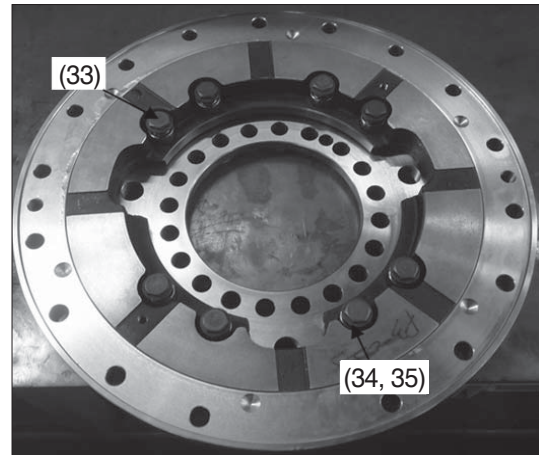


110DEDA32

- (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.



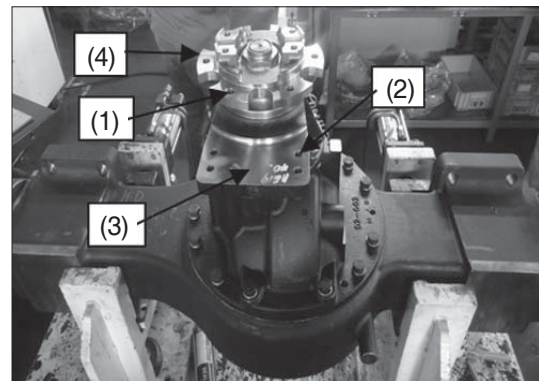
110DEDA33



110DEDA34

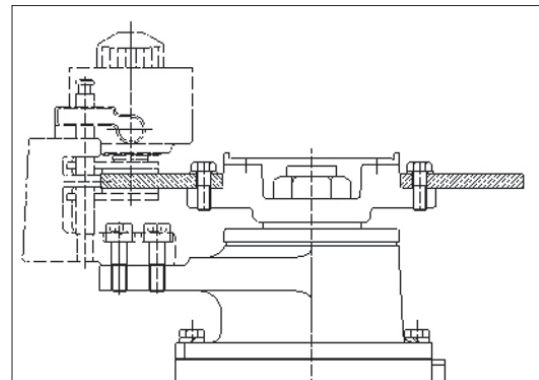
3) REMOVAL AND DISASSEMBLE THE CARRIER HOUSING ASSY

- (1) Disassemble parking disc (33) and brake assembly (4) after untightening six bolts (1) and four bolts (2).

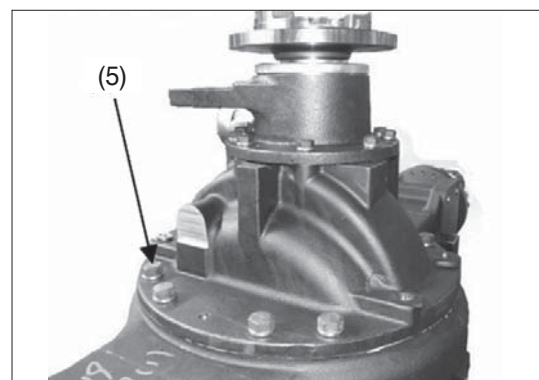


110DEDA35

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



110DEDA36

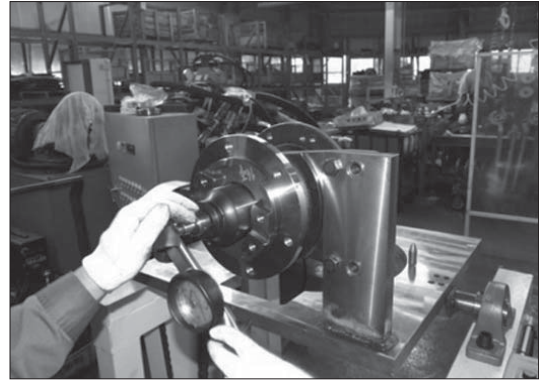


110DEDA37

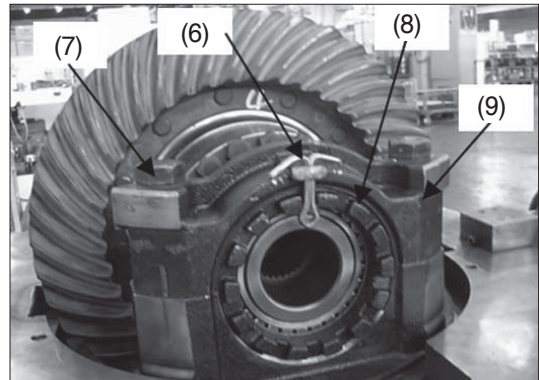
- (3) Check and record the rotational torque measurements of the carrier assy and then disassemble cotter pin (6).

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.

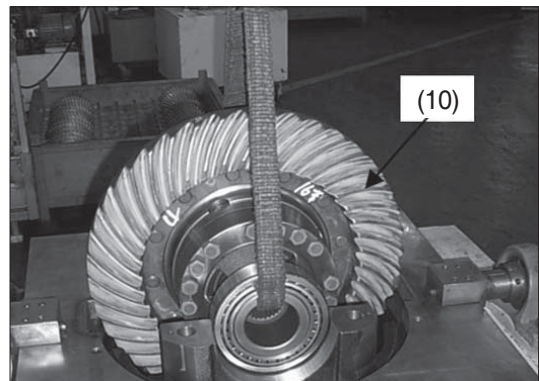


110DEDA38



110DEDA39

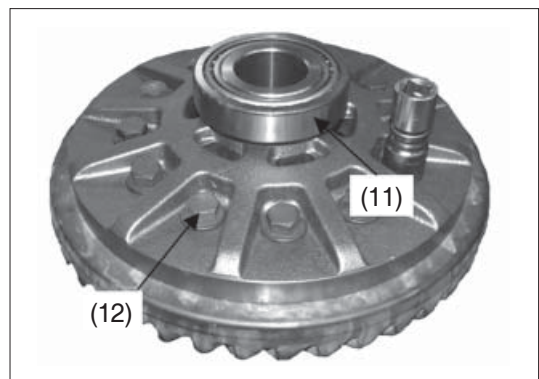
- (4) Disassembly ring gear assy (10) from carrier assembly.



110DEDA40

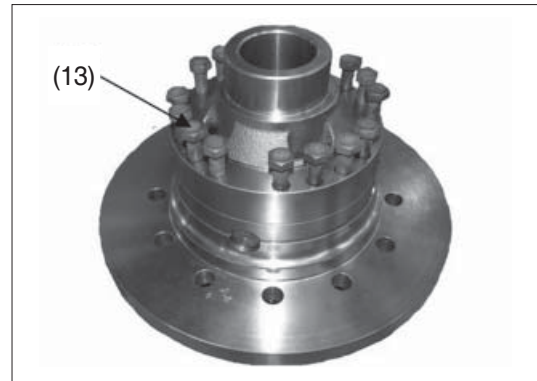
- (5) Disassemble both of two tapered roller bearings (11).

Loosen twelve bolt (12), then disassemble ring gear.



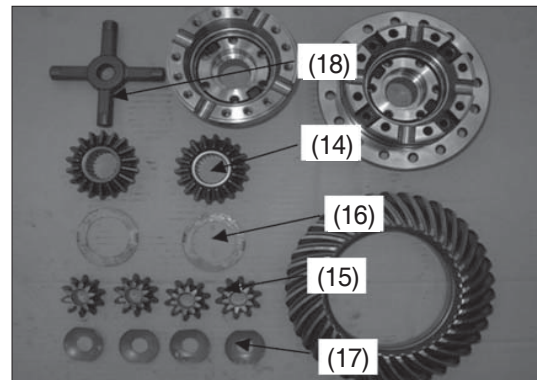
110DEDA41

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



110DEDA42

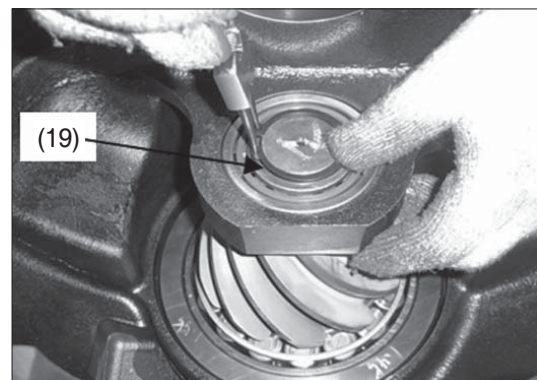
- (7) Disassemble side gear (14), pinion gear (15), thrust washers (16), (17) and spider (18) from differential assembly.



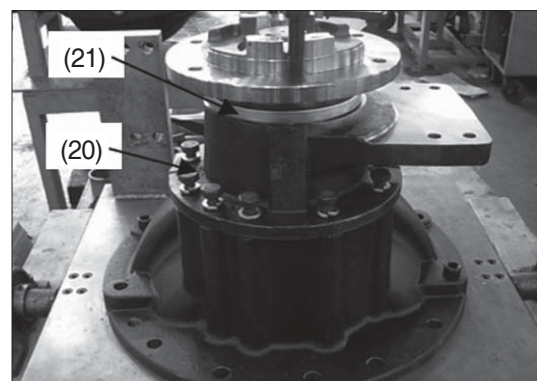
110DEDA43

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

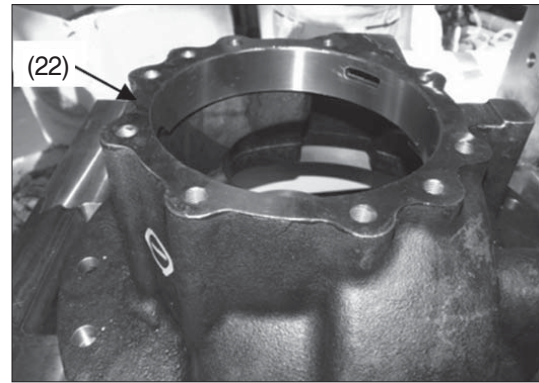
⚠ Do not reuse damaged shim.



110DEDA44

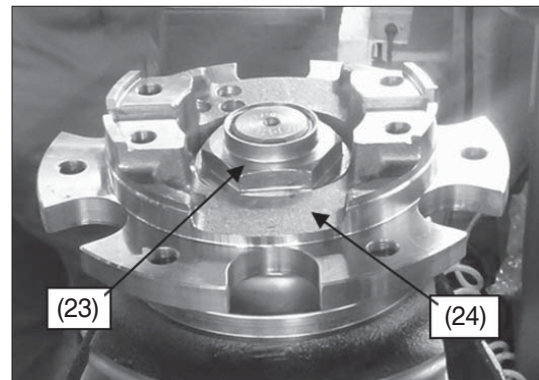


110DEDA45



110DEDA46

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



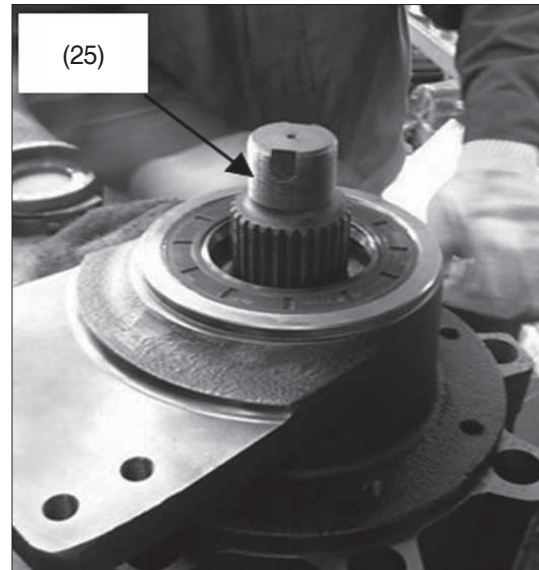
110DEDA47

- (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.



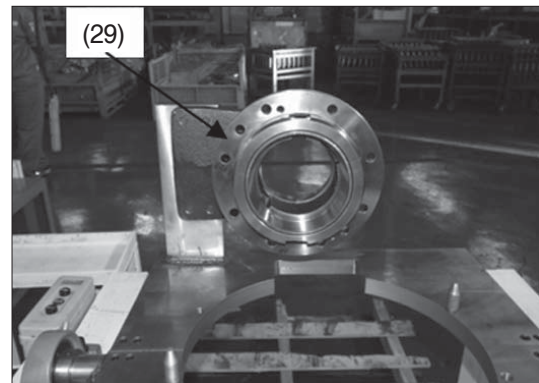
110DEDA48



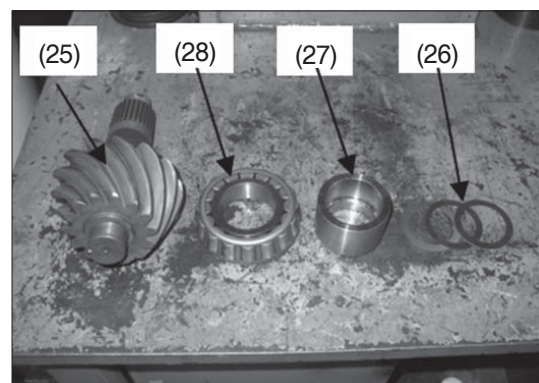
110DEDA49

- (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

(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.

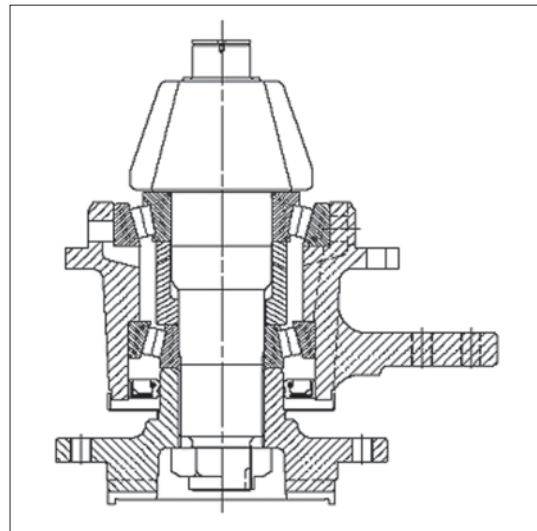
(3) Loosen the nut and remove the jig.

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.

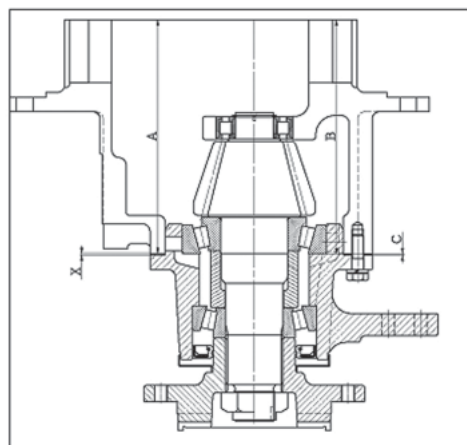
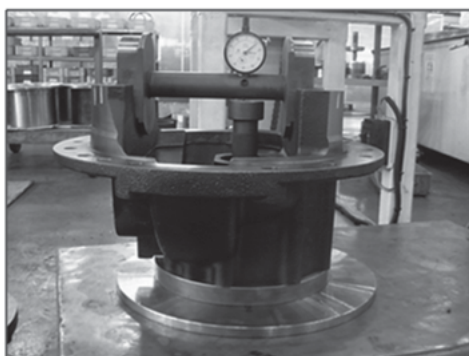
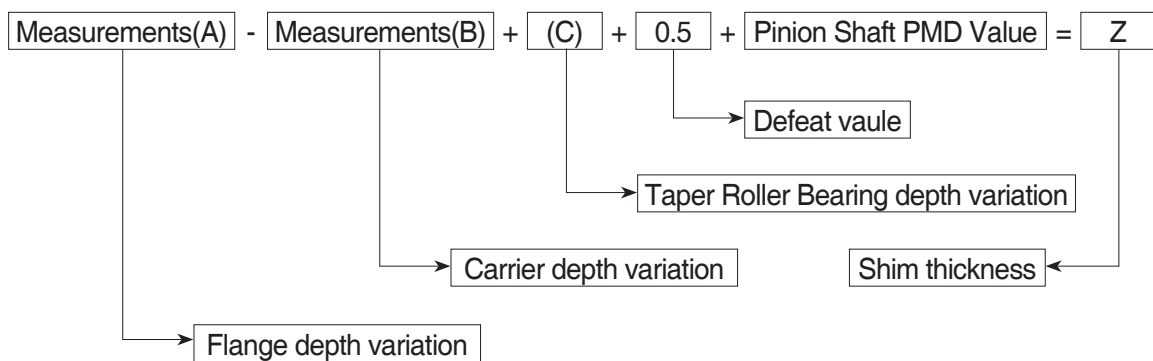
Apply loctite #271 on the thread and then tighten the nut.

- Tightening torque : 54.0~56.0 kgf · m



110DEDA52

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



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.

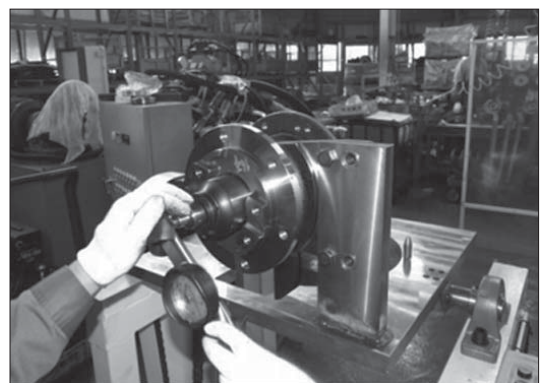
Assemble the bevel pinion shaft and set the preload with the ring and the shim.



110DEDA54



110DEDA55

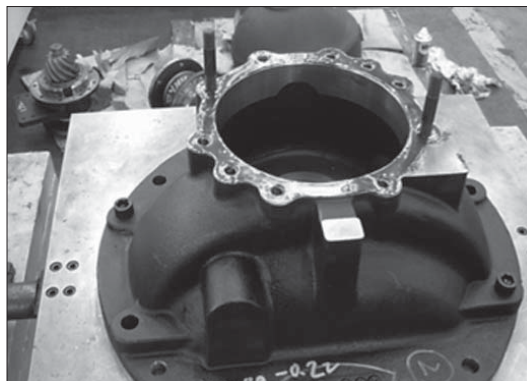


110DEDA56

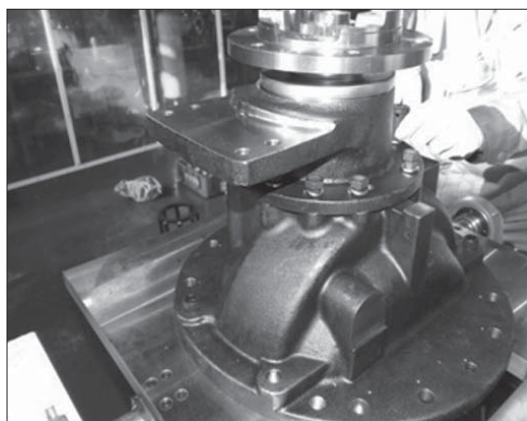
(2) Adjust the shim thickness by combinations of the different shims. Add the shims between the differential flange and differential carrier. Apply loctite on them and assemble the differential flange and differential carrier.

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

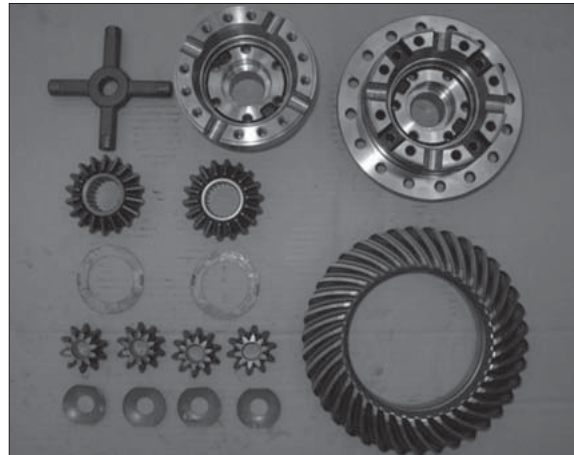


110DEDA58

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

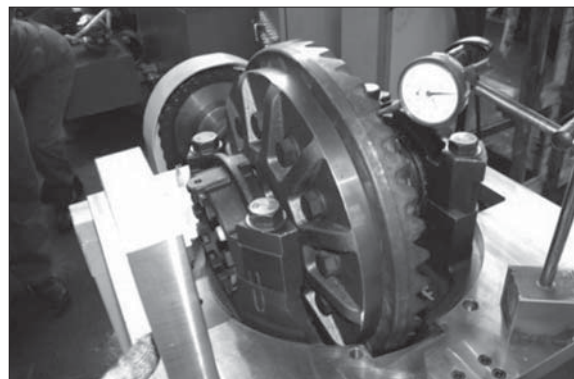
- (4) Assemble the ring gear by tighten 12 bolts.
· Tightening torque : 45.0~46.0 kgf · m
Be careful below notes when assembling the ring gear.

120/130D-9V	Ring-gear (41T)	Identification groove:1ea
160D-9V		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

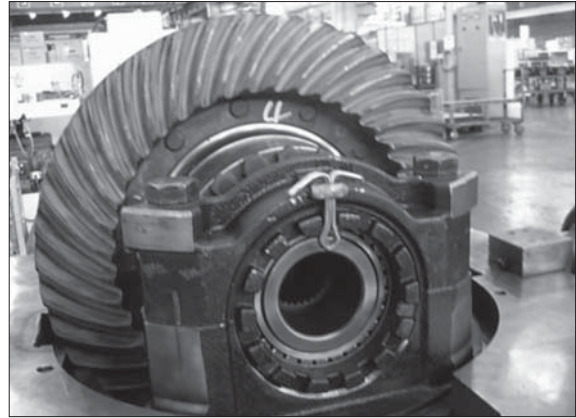
(6) Assemble the bearing cap.

※ 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 3-142) and the rolling resistance.



110DEDA63

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

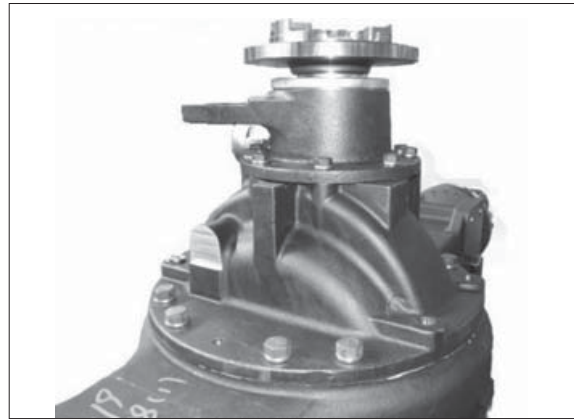
(8) Measure the rotation backlash once more after tighten the bearing cap completely and readjust the backlash with the screw if needed.

(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.

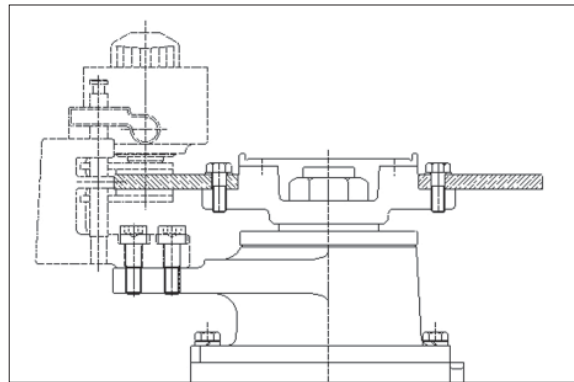
4) ASSEMBLE CARRIER TO AXLE HOUSING

- (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

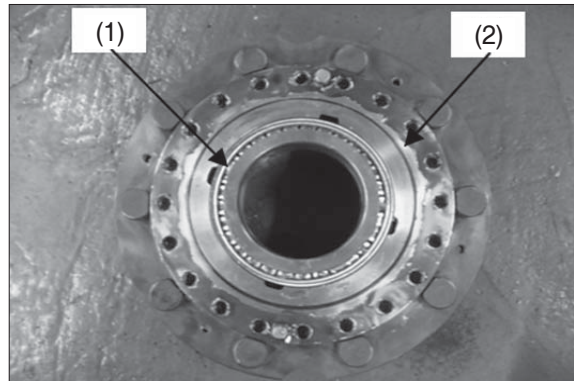
- (3) Assemble brake disc to yoke (1) with hex bolt.
Apply loctite #271 or #277 on the thread of the bolt and tighten them.
 - Tightening torque : 16.0~20.0 kgf · cm
- (4) Fix the parking brake support (3) with socket bolt and assemble parking brake (4).



110DEDA65

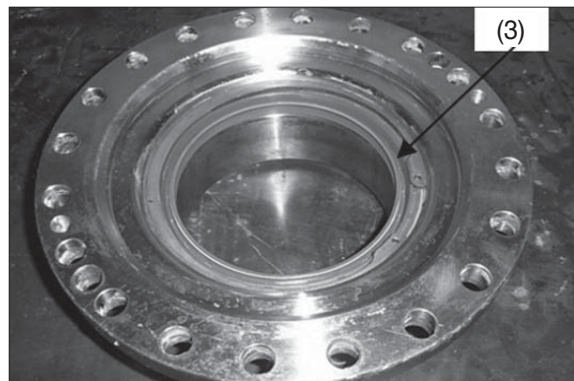
5) ASSEMBLE THE BRAKE AND HUB

- (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.

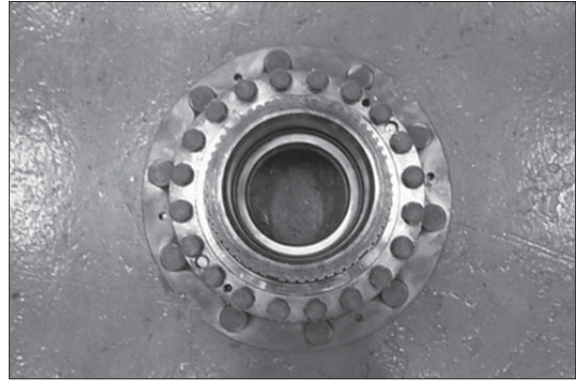


110DEDA66

- ※ 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



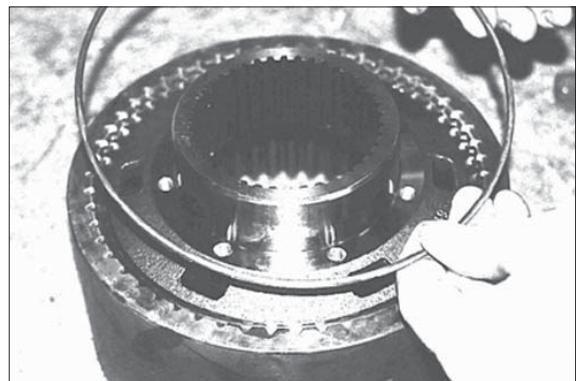
110DEDA68

- (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.



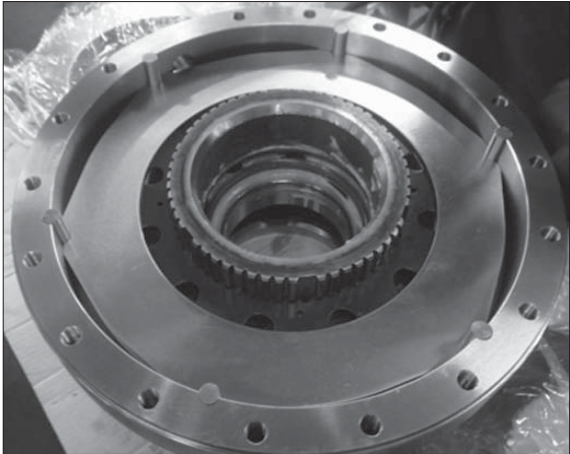
110DEDA70



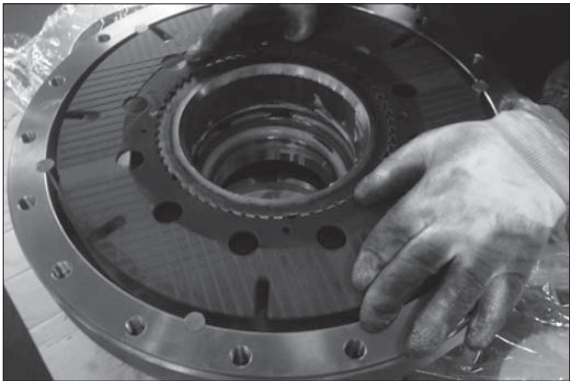
110DEDA71

(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.

120/130D-9V	Disc	4 piece
	Plate	7 piece
160D-9V	Disc	5 piece
	Plate	6 piece



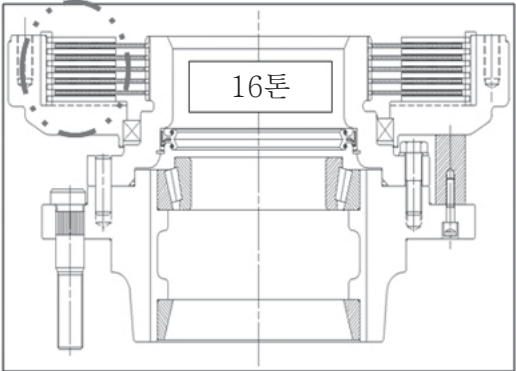
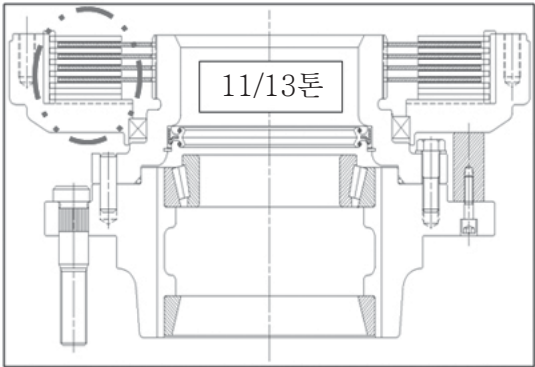
110DEDA72



110DEDA73



110DEDA74



110DEDA74-1

※ In case the 120/130D-9V, 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.

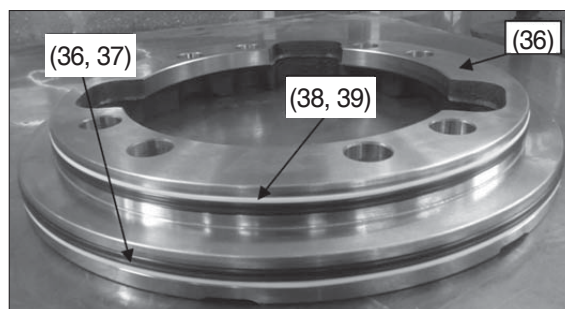
Assemble the bushing (35) into the piston (36) and assemble the piston into brake housing. At this time, align the tap hole of the housing and bushing hole of the piston.

Tighten the 8 bolts for the clearance adjustment.

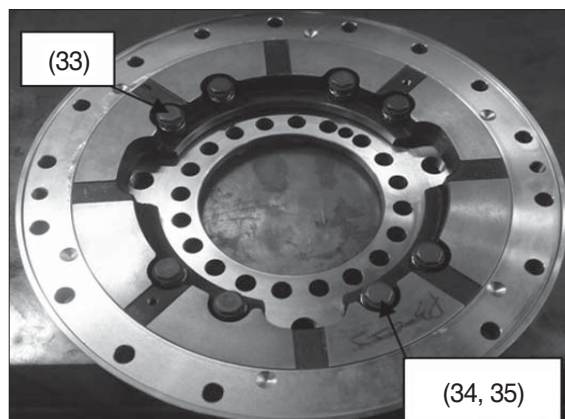
· Tightening torque : 3.0~3.5kgf · cm

- ※ 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.

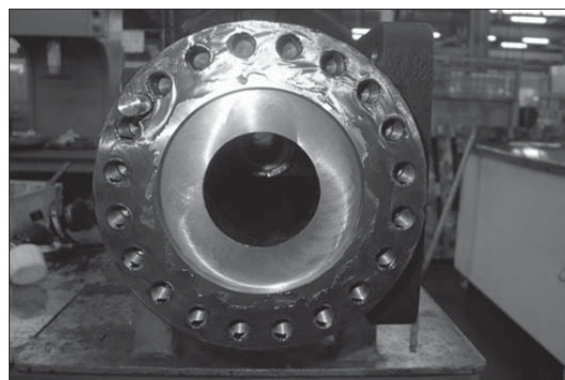


110DEDA75

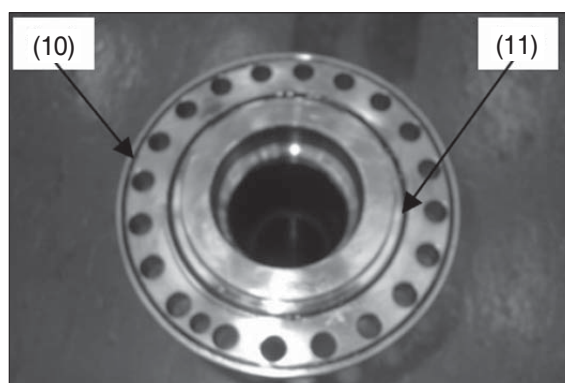


110DEDA76

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



110DEDA77



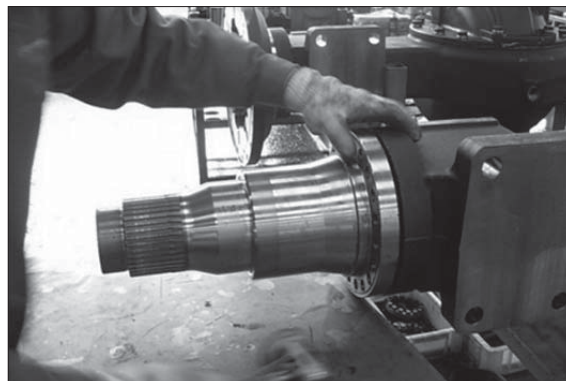
110DEDA78

- (7) Mount the axle tube into the axle housing and assemble the brake housing to axle housing.

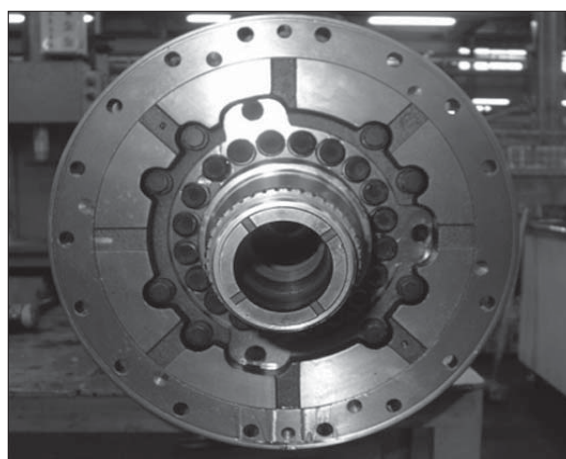
Tighten the 20 bolts.

· 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



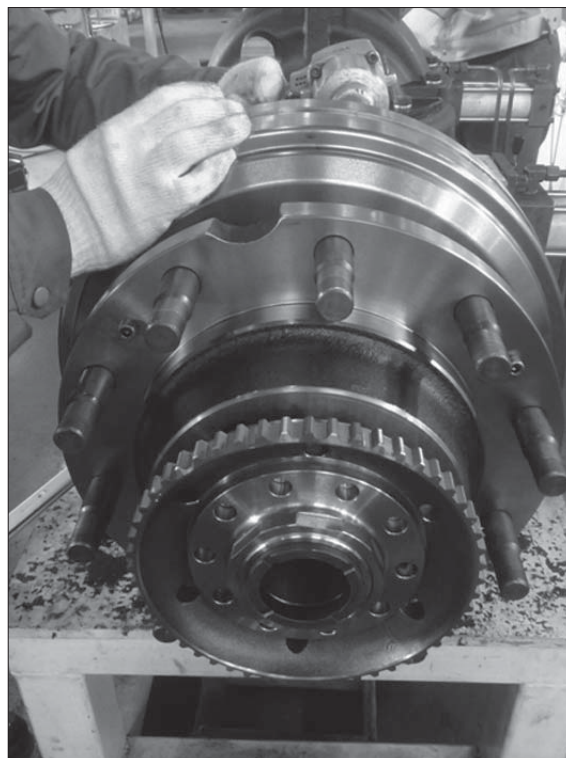
110DEDA80

- (8) Assemble the wheel hub assy into axle housing assy and tighten 24 bolts.

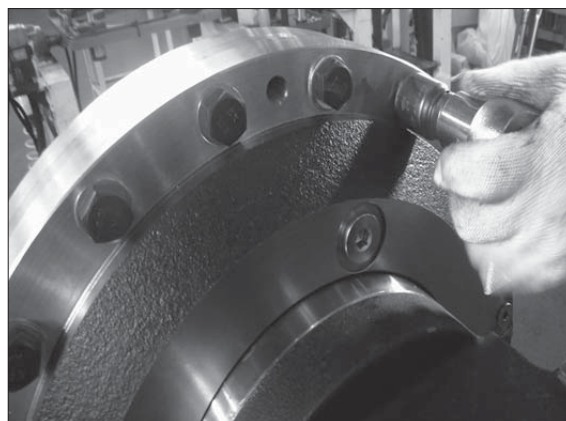
· Tightening torque : 20.5~51.54 kgf · cm

- ※ 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.

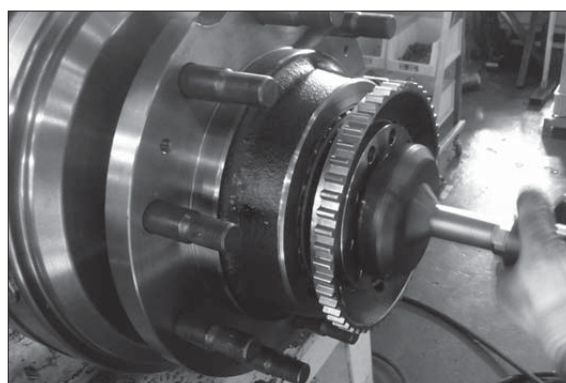


110DEDA81



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

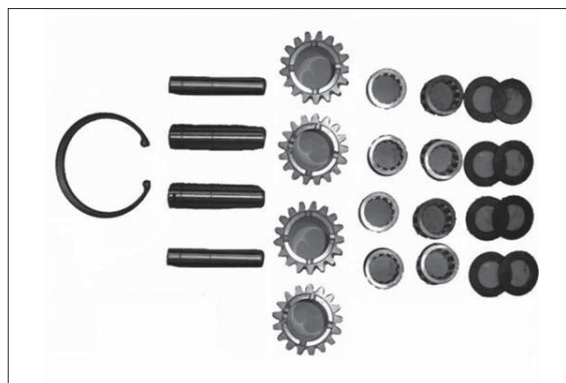
- (11) Assemble the sun gear to axle shaft and insert the stop ring.

Assemble the axle shaft assy into the axle housing assy.

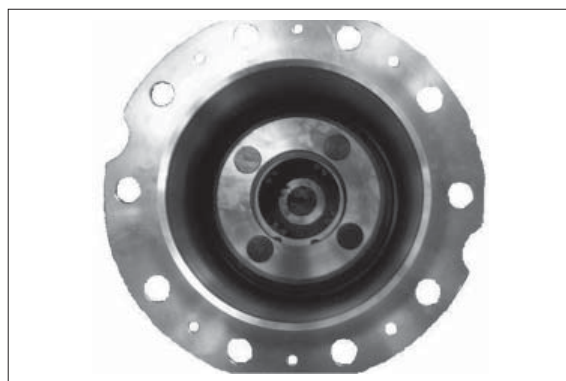


110DEDA85

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

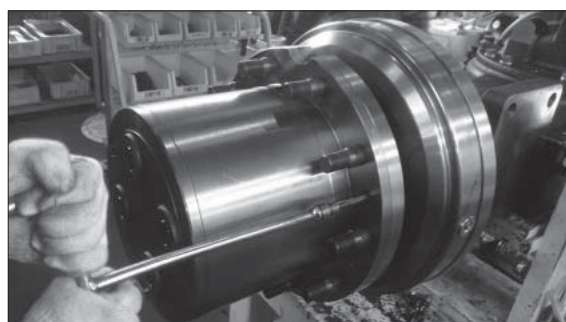


110DEDA86



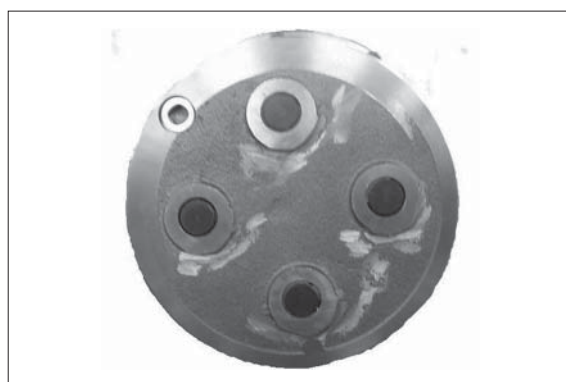
110DEDA87

- (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

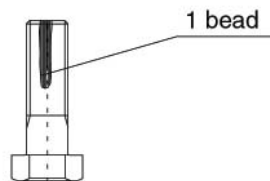
- (1) Disassembly and assembly are to be accomplished only by trained personnel.
- (2) The assembly can be made reverse to the respective disassembly instruction.
- (3) Drain oil before removing, check for presence of metal particles.
- (4) Mark the parts to each other before dismantle.
- (5) Never use 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 1 hour.
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	Screws	262	-
Track rod lever			-
Steering lever	Contact surface	270	-
Track rod lever			-
Wheel hub cover	Thread	572	-
Radial seal rings	Contact surface	572	-
Rubber casing			-
Radial seal rings	Contact surface	270	-
Steel casing			-
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

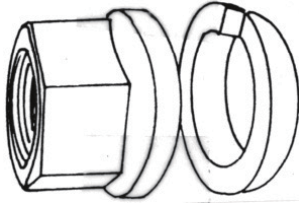
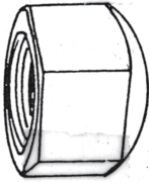
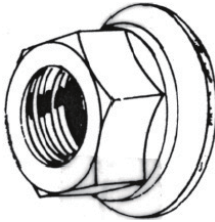
Metric standard thread						
Thread	Screw	Nut	Screw	Nut	Screw	Nut
	8.8	8	10.9	10	12.9	12
M4	3.0		4.4		5.1	
M5	5.9		8.7		10	
M6	10		15		18	
M8	25		36		43	
M10	49		72		84	
M12	85		125		145	
M14	135		200		235	
M16	210		310		365	
M8	300		430		500	
M20	425		610		710	
M22	580		830		970	
M24	730		1050		1220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

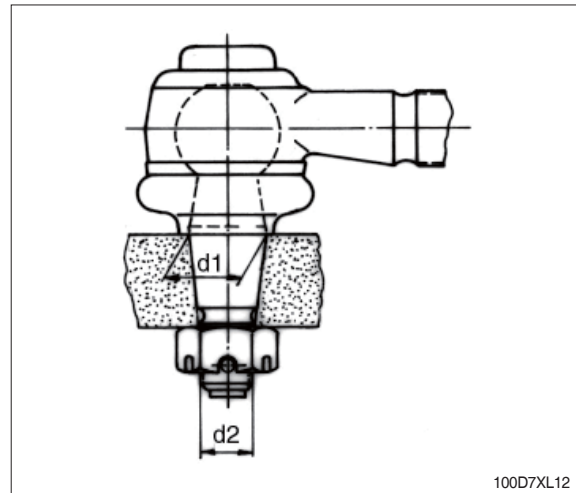
③ Wheel nut with clamp

Dimensions	Galvanized	
M18×2	350 Nm	

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

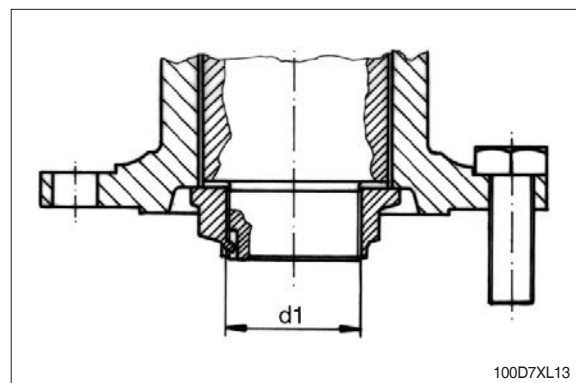
The tightening torques of the different thread dimensions of the joints are applicable for nuts of quality S6.

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.

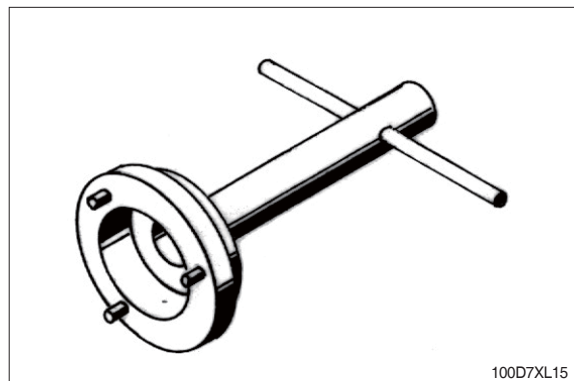
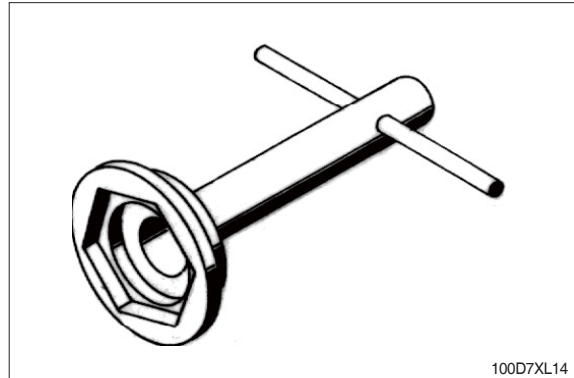
Thread d1 (mm)	Torque (Nm)
M20 × 1.5	360
M30 × 1.5	450
M36 × 1.5	540
M42 × 1.5	850
M45 × 1.5	850
M48 × 1.5	850
M52 × 1.5	950
M64 × 1.5	1050~1100



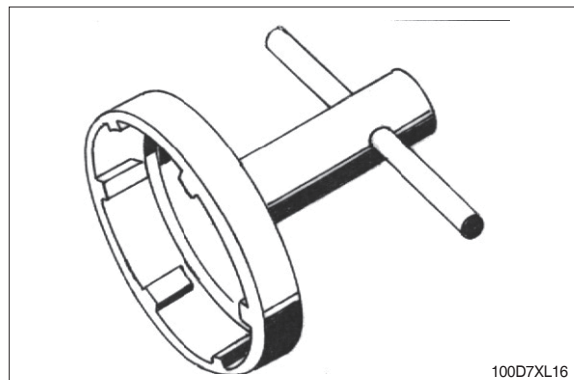
6) SERVICE TOOLS

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)

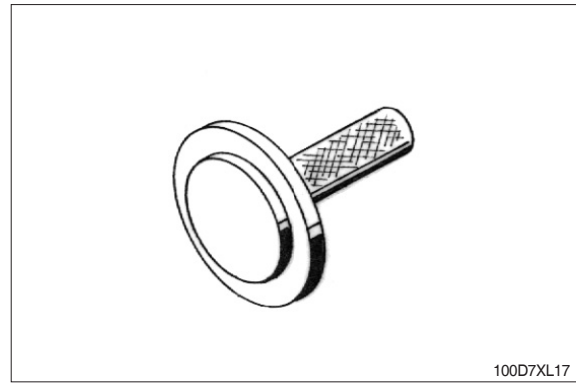
(1) Spanner for wheel safety nut



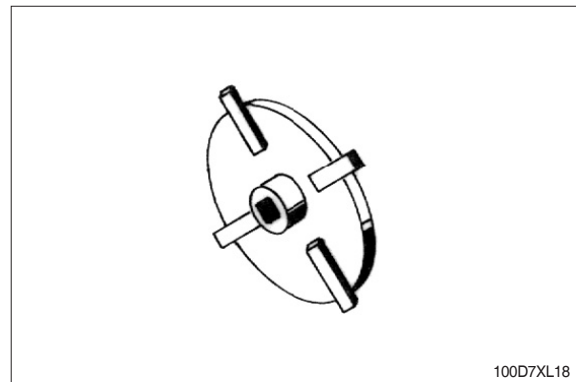
(2) Spanner for splined nut (hub assembly)



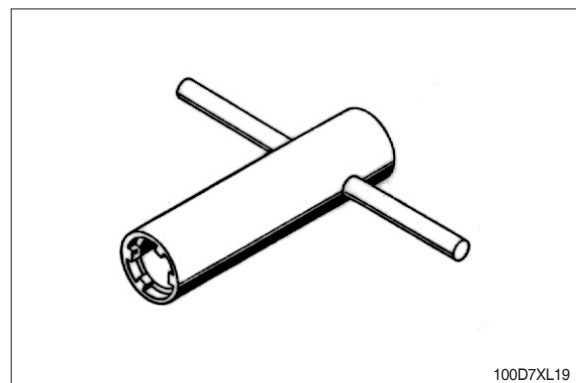
(3) Seal ring sleeve driver.



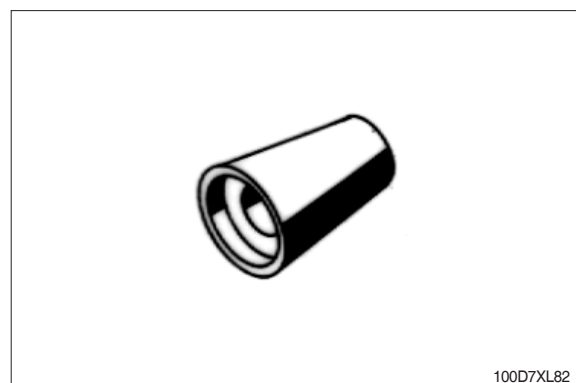
(4) Spanner for thread rings.
(Differential bearing)



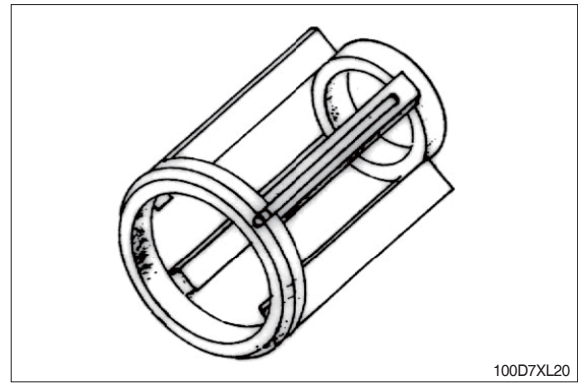
(5) Spanner for counter nut.
(Planetary gear drive)



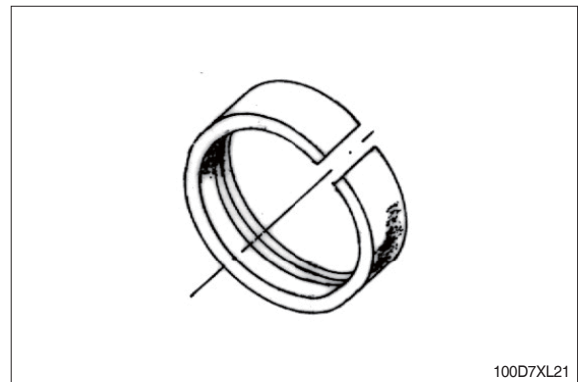
(6) Assembly cone for O-ring.
(Differential lock)



(7) Centering tool for discs.



(8) Installation tool for face seal.

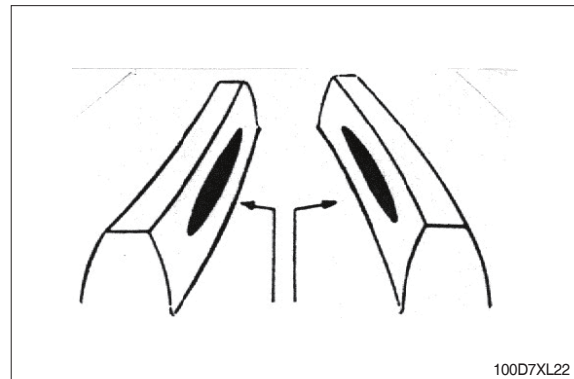


7) ASSEMBLY DRIVE ASSEMBLY

(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.

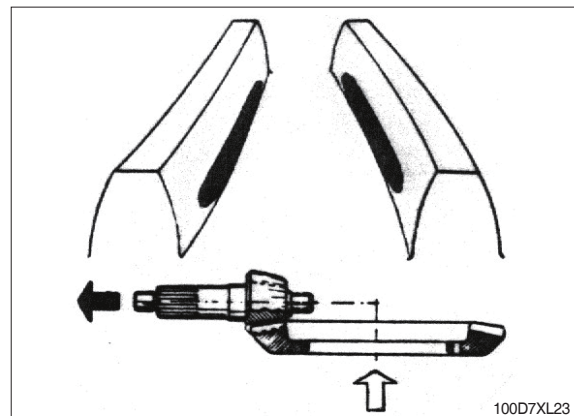


※ Improper gear meshing marks

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.

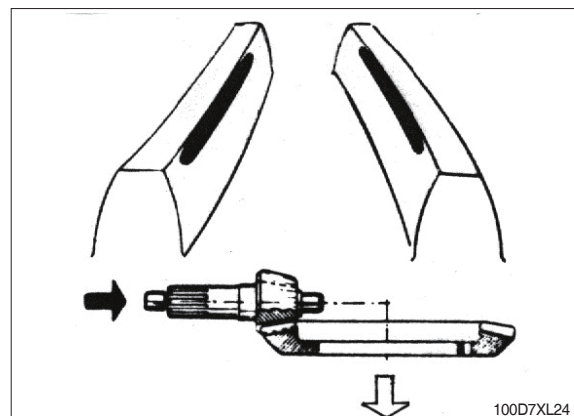
② Gear meshing to deep

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



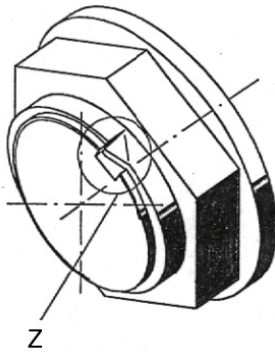
③ Gear meshing to high

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

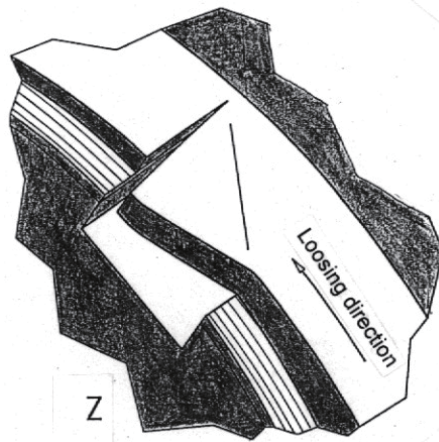


(2) Securing of the striking nut

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.

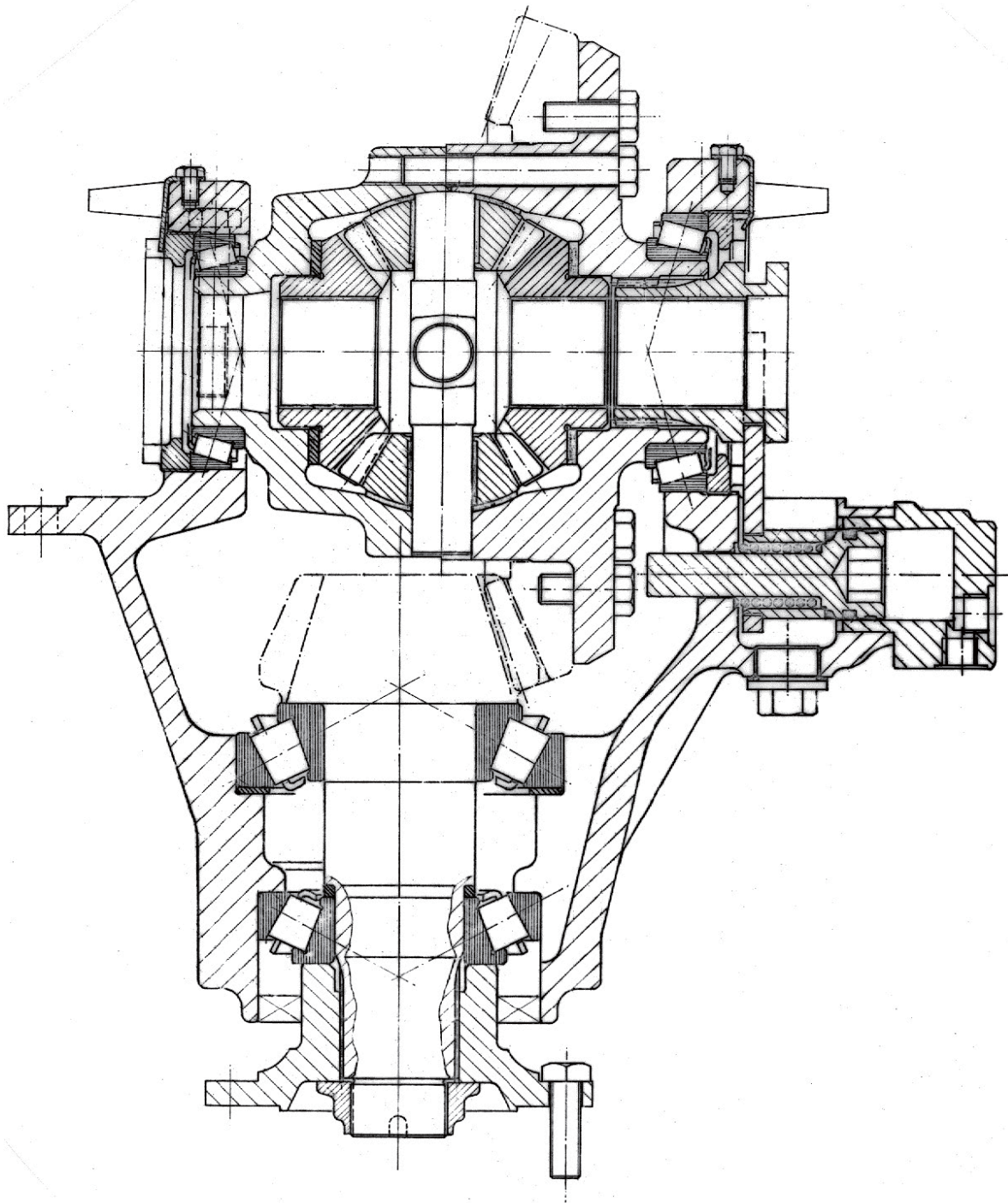
Striking nut at gear wheels, bearings etc.

- 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

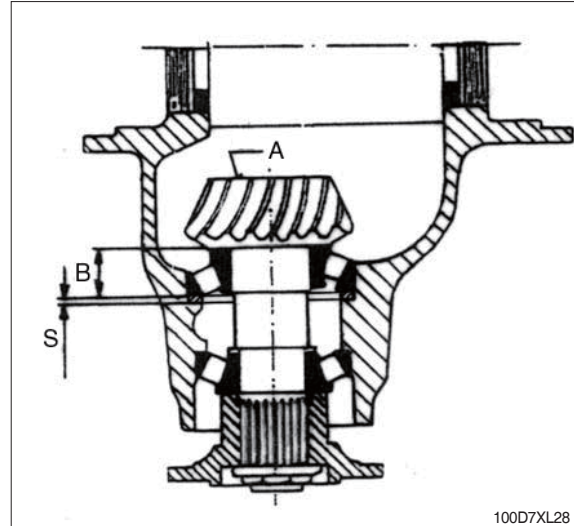


100D7XL27

(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")



- 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 :

$$A = + 0.10 ; B = 37.95$$

$$S = 3.00 \text{ mm (theorem)}$$

$$\begin{array}{l} + 0.05 \text{ mm} \rightarrow B = 0.05 \text{ mm smaller than B theorem.} \\ = 3.05 \text{ mm} \end{array}$$

$$\begin{array}{l} - 0.10 \text{ mm} \rightarrow \text{Drive pinion value A} \end{array}$$

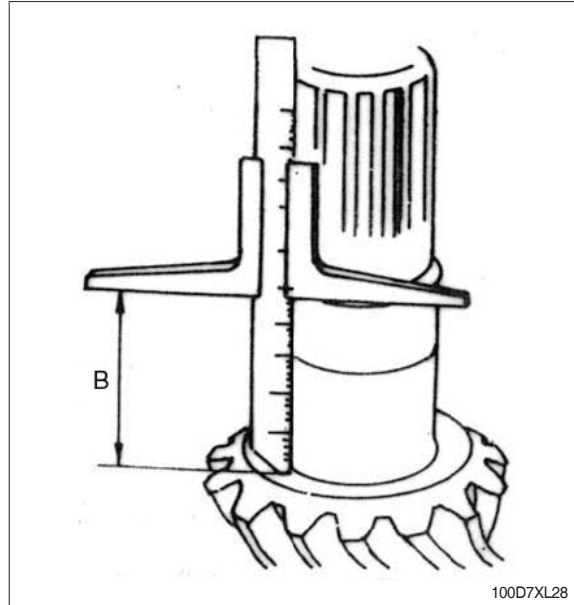
$$= \mathbf{2.95 \text{ mm}} \rightarrow \text{Necessary thickness of the adjustment disk}$$

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

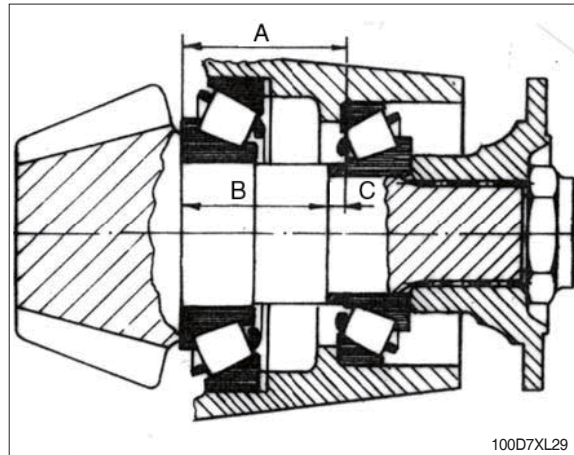
- ※ If value A is positive (f.e. +0.1) the adjustment disk has to be 0.1 mm thinner than theorem.
S. If value A is negative (f.e. -0.1) the adjustment disk has to be 0.1 mm thicker than theorem S.
- ※ If measure B is positive (f.e. 38.05) the adjustment disk has to be 0.05 mm thinner than theorem S.
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.

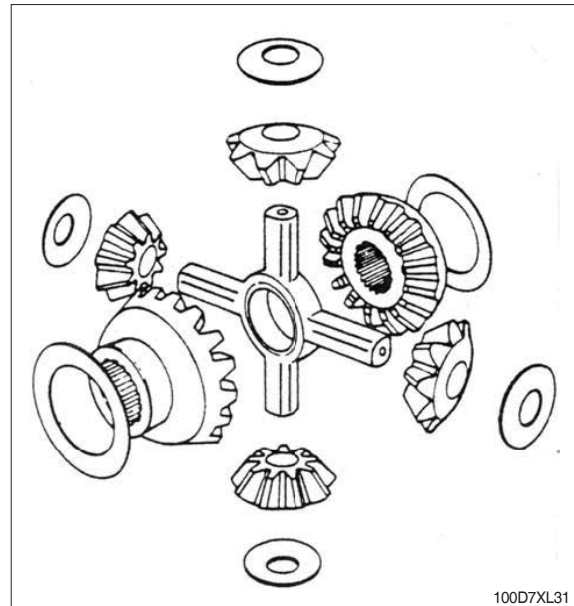


- ⑦ Measure the resistance of the bearings by using a torque wrench. If the measured value is not the prescribed 0.8 to 1.2 Nm, adjust the resistance by modification of the thickness of the spacer ring. After arriving at the adjustment of the bearing, back-off the safety nut and draw off the drive flange.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

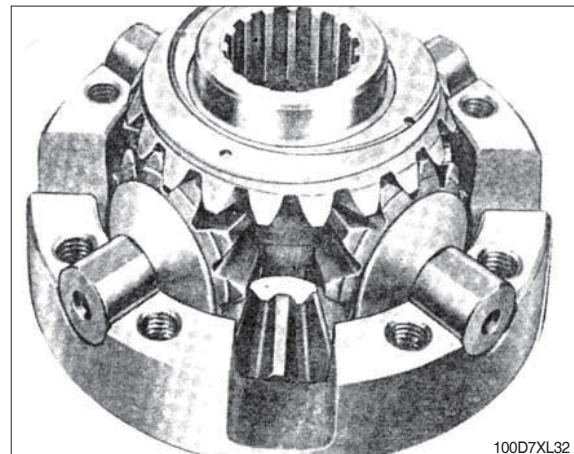
8) ASSEMBLY OF THE DIFFERENTIAL

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

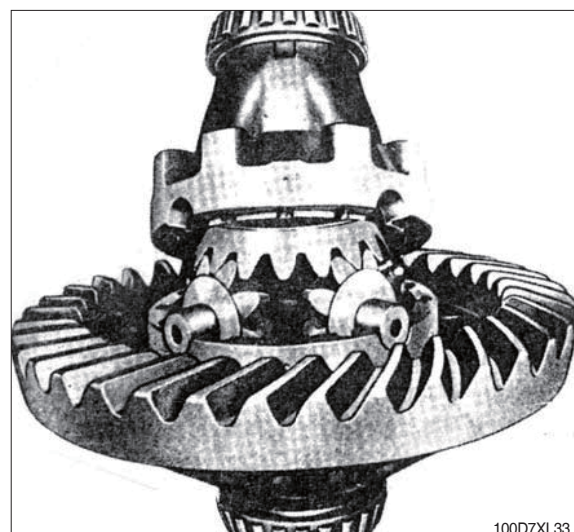
- (1) Place one differential side gear with the side gear thrust washer in the differential case.
- (2) Install the spider with differential gears and differential pinion thrust washers in the differential case.



- (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.

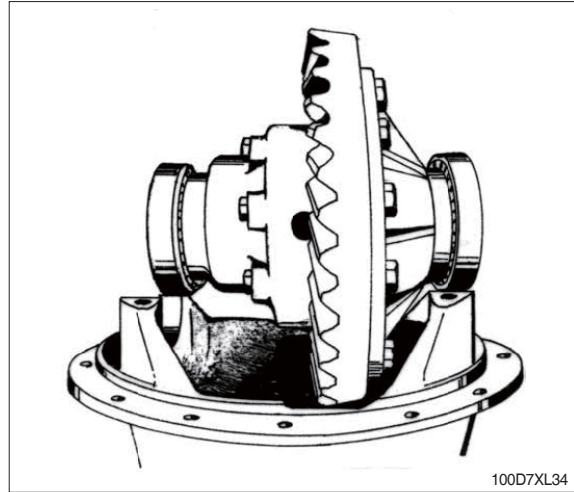


- (5) Check that all differential pinions can rotate easily.
- (6) Coat the contact surface of the ring gear with Loctite 270 and install the ring gear on the differential case by tapping lightly on the circumference. Tighten the ring gear bolts. Secure with Loctite 262.
- (7) Heat the two taper roller bearings to about 100°C and install them by using a sleeve.

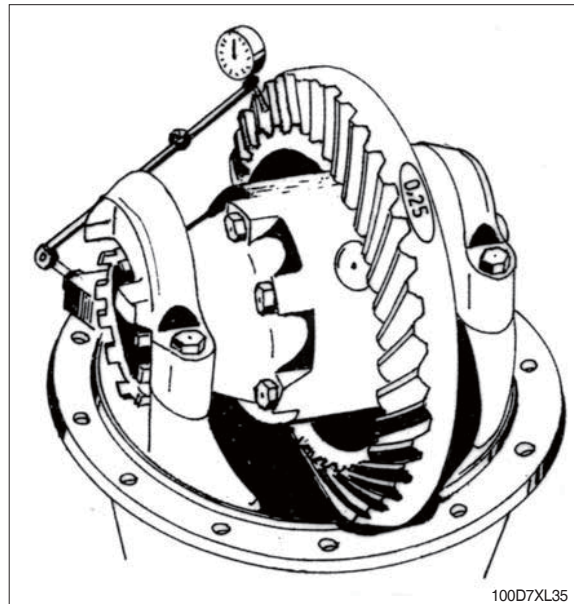


9) ASSEMBLY OF DRIVE ASSEMBLY

- (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)



- (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.



- (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.



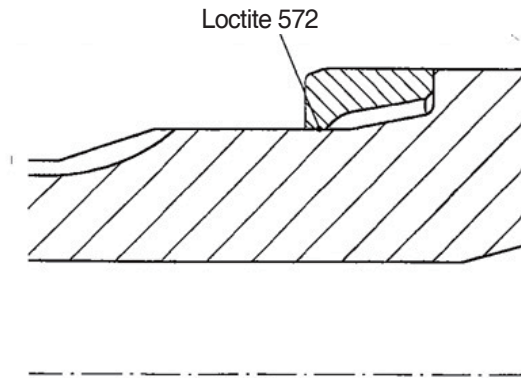
10) ASSEMBLY OF HUB ASSEMBLY

(1) Assembly of the spacer ring

Coat the seat of the spacer ring on the steering knuckle respective axle spindle with Loctite 572.

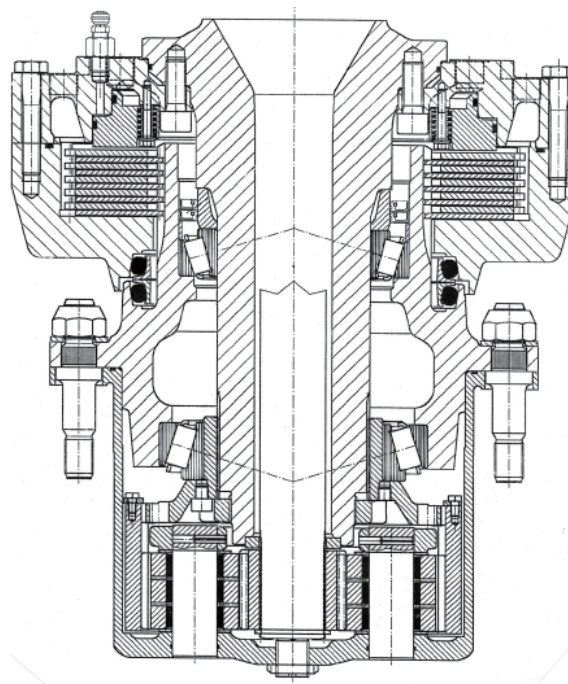
Heat the spacer ring to about 100°C and push it by gently striking onto the steering knuckle respective axle spindle. (The steering knuckle respective axle spindle must be free of corrosion)

Oil the seal ring tread onto the spacer ring.



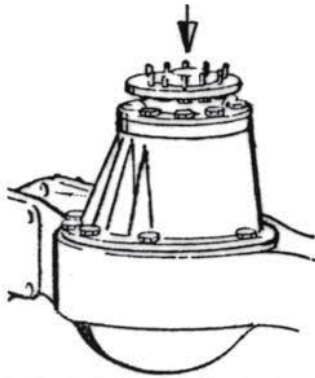
100D7XL37

(2) Drive axle hub assembly

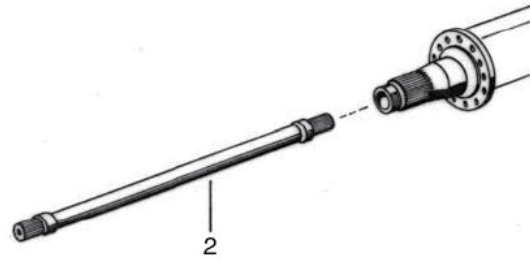


100D7XL38

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.

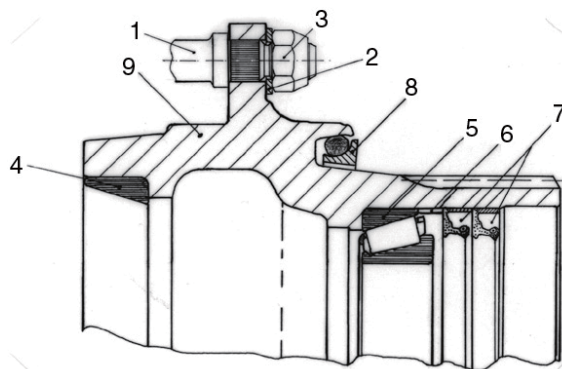
(6) Prepare wheel hub

- 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 :

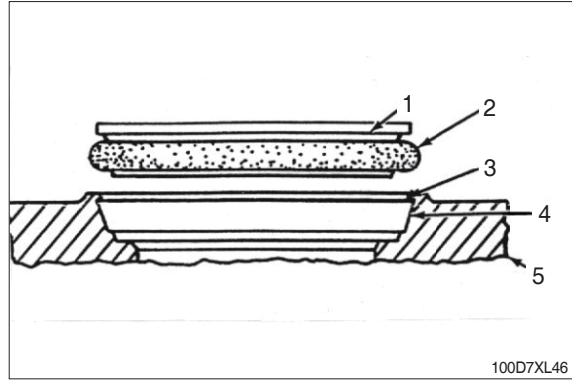
Screw on the wheel safety nut and tighten it with a 1.5 to 2 times higher tightening torque than the finish tightening torque. During the tightening, turn the wheel hub a few times and knock it with a plastic hammer. Untighten the wheel safety nut (about 180° back rotation), then tighten the wheel safety 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

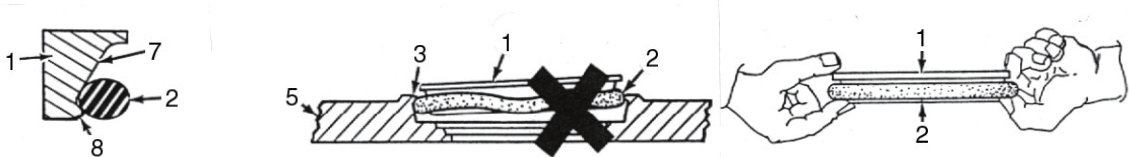
Designation	Version	Security / Remarks
Shaft nut with cheese head screw		Cheese head screw & Loctite 270

(9) Assembly of the face seal

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

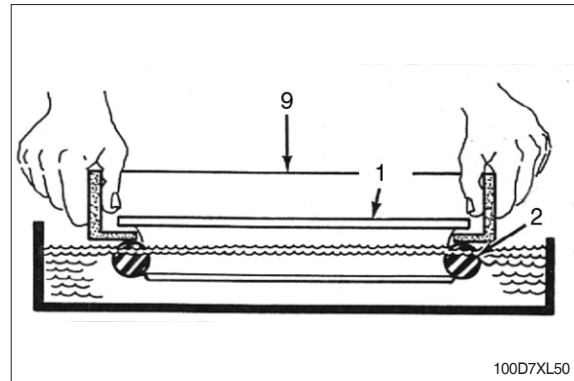


- ① Seal rings, torics, and housings must be clean and free of any oil film, dust, or other foreign matter. Use a solvent that evaporates quickly, leaves no residue, and is compatible with the rubber toric rings. The recommended solvent is Isopropanol. Ring and housings should be wiped with a solvent-soaked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

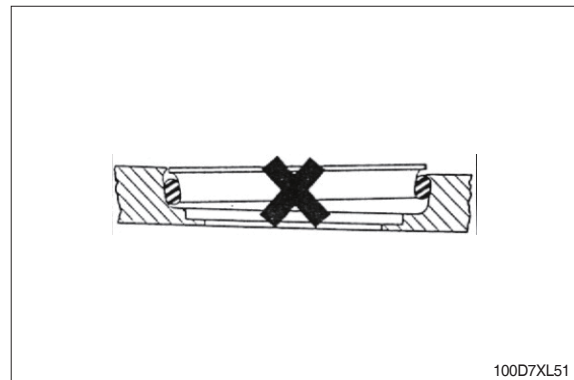


- ③ Put the toric ring (2) on seal ring (1), at the bottom of the seal ring ramp (7) and against the retaining lip (8).
- ④ The toric ring (2) can twist if it is not wet all around during installation or if there are burrs or fins on the retaining lip (3) of the housing (5).
- ⑤ Eliminate toric twist 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.

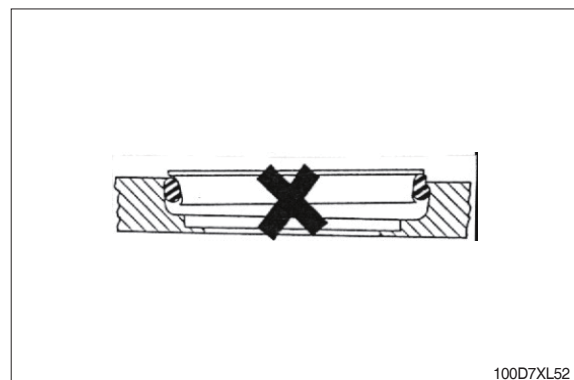
- ⑦ Put the installation tool (9) onto the seal ring (1) with toric ring (2).
Lower the rings into a container with Isopropanol until all surfaces of the toric (2) are wet.



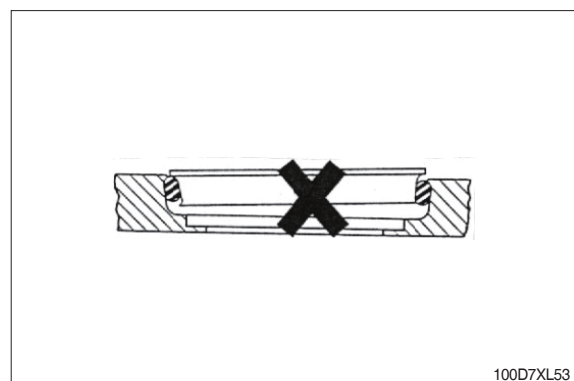
- ⑧ Toric sliding on retainer ramp.



- ⑨ Toric caught on housing retainer lip.

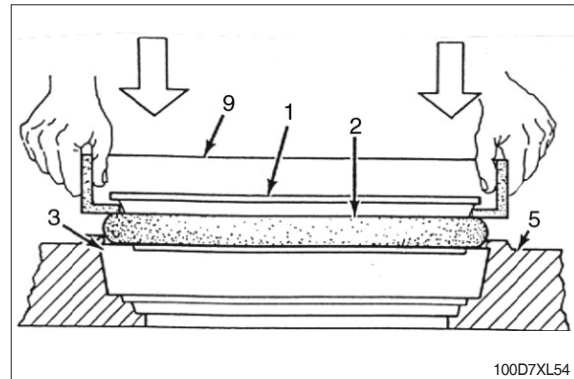


- ⑩ Toric sliding on seal ramp.



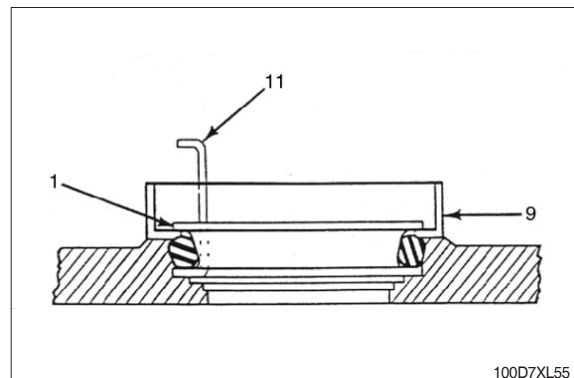
- ⑪ After dipping the seal assembly in the solvent, shake the excess solvent from the seal assembly and immediately "pop" the seal into the housing with a firm push of the installation tool. Remove the installation tool and check the seal standoff height at several places around the circumference of 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).

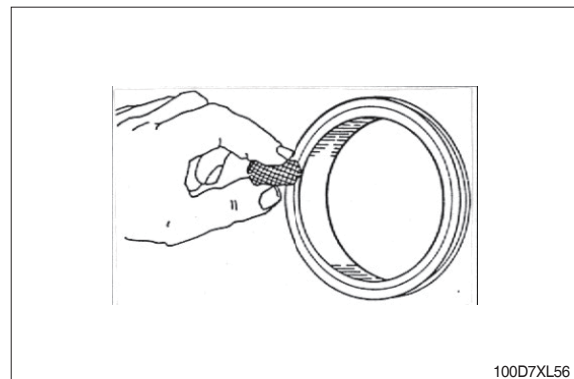


- ⑬ The seal can be adjusted by gently pushing the toric into position by hand or by using a fabricated adjustment hook.

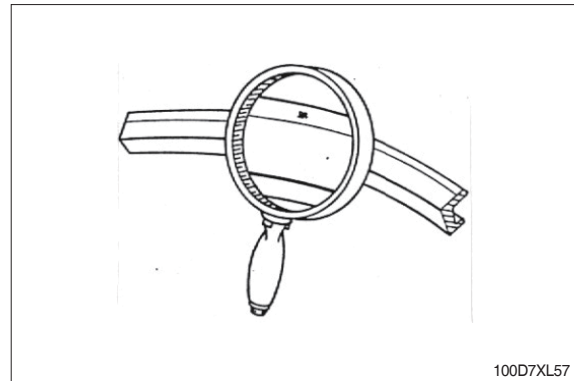
- ⑭ If small adjustments are necessary, do not push directly on the seal ring (1); use the installation tool (9) to push down or the adjustment tool (11) to pull up.



- 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.



- ⑩ 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.



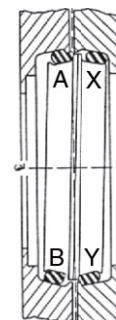
- ⑪ After successful installation, wait one minute for the Isopropanol to dry before assembling the two seal halves in the final loaded position. This delay is to allow any excess solvent to dry so that the torics roll, rather than slide, in the housing as the faceload is increased. If the torics slide, 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



Rotated 180°

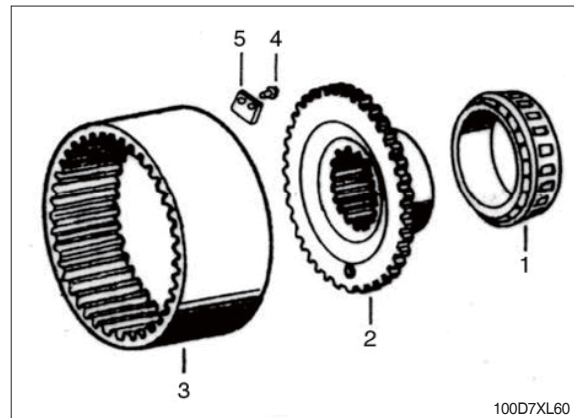


- ⑮ After the unit to be sealed is assembled, a post-assembly leakage test can be performed to insure the seal is properly installed. A vacuum check is recommended rather than a pressure check as vacuum checks are more sensitive. Many users find this an easy check to combine with a vacuum fill technique 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.
- ⑯ 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.



(2) Assembly of the ring gear carrier

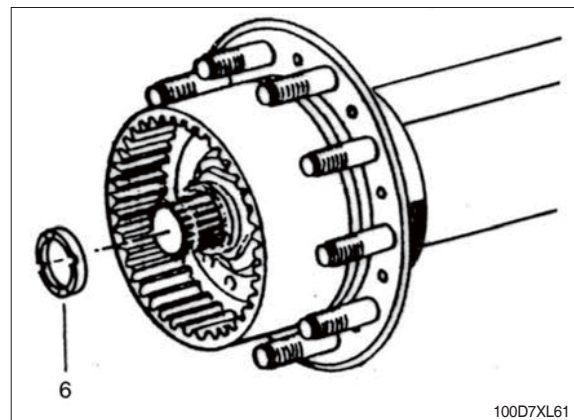
Install the ring gear carrier (2) with ring gear (3) into the wheel hub respective onto the steering knuckle respective axle spindle.

The oil compensating hole in the ring gear carrier must be on the bottom.

Subsequent adjust wheel bearings (see page 3-173).

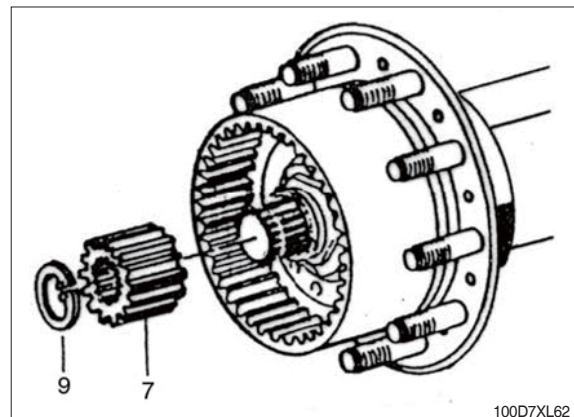
(3) Assembly of the thrust ring

Press the thrust ring (6) into the steering knuckle respective axle spindle. Secure with Loctite 270.



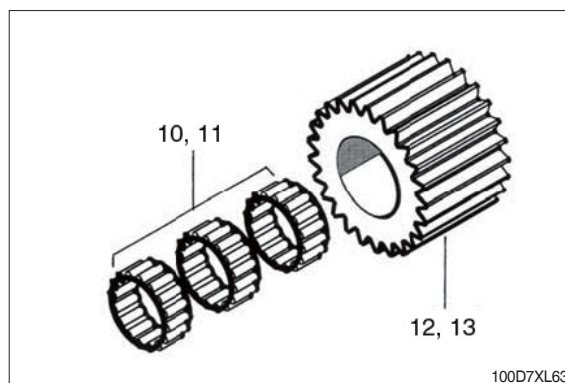
(4) Assembly of the sun gear

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.

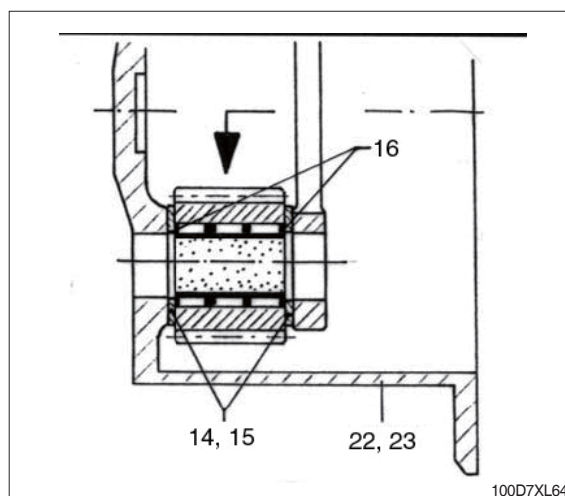


(5) Assembly of planetary gear

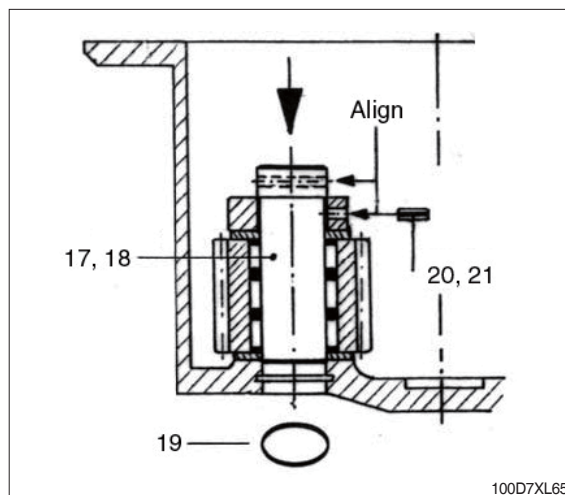
- ① Prepare planetary gear :
Install the needle bearing (10, 11) into the planetary gear (12, 13).



- 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).

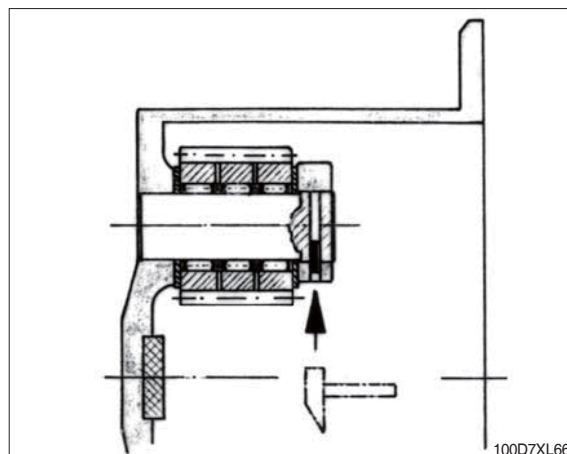


- ③ Place O-ring (19) into the slot of the planetary housing (22). Because of the difference of diameter of 0.1mm press the planetary pin (17, 18) in direction of arrow. Be sure, that the bore hole of the locking pin in the planetary pin and planetary housing are aligned. After inserting, secure the planetary pin with the locking pin (20, 21).



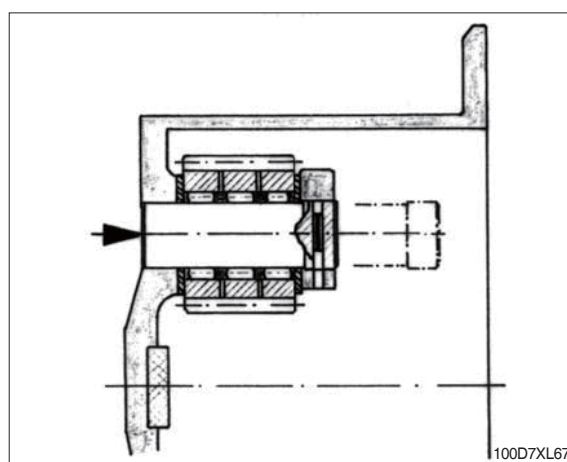
(6) Disassembly of planetary gear

- ① Knock the locking pin (20, 21) completely to the inner side of the planetary pin.

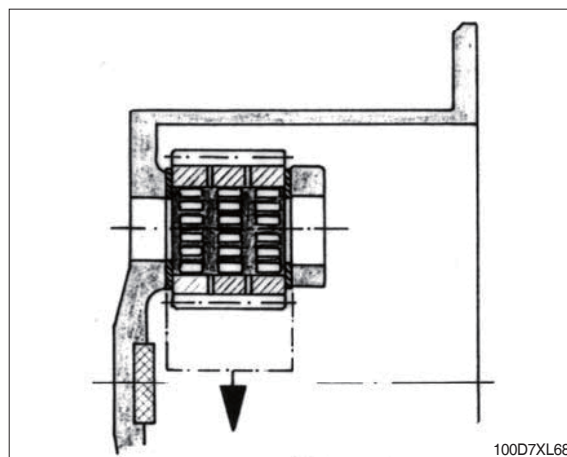


- ② Press the planetary pin in direction of arrow out of the planetary housing.

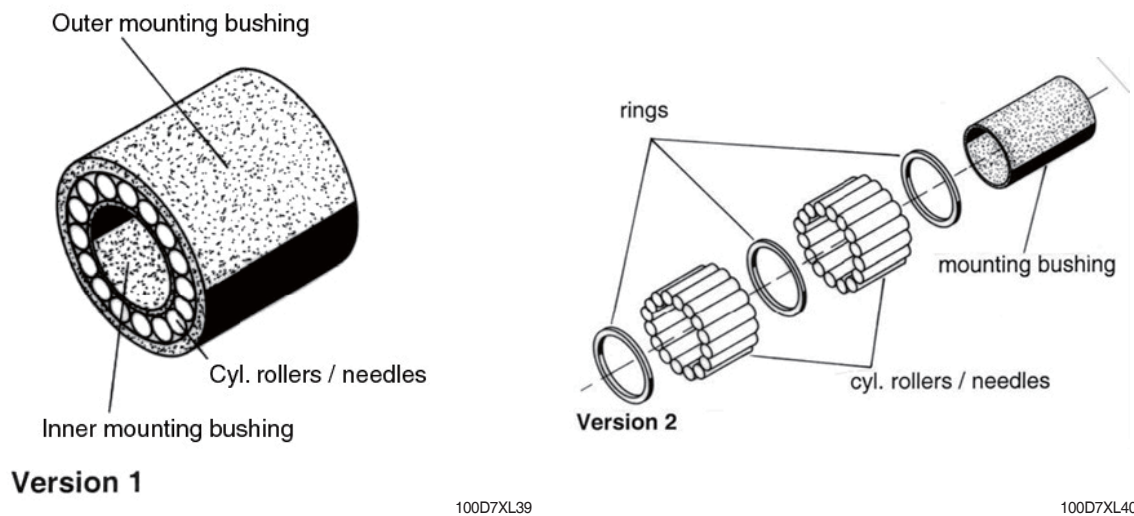
※ Because of the difference of diameter of 0.1 mm do not press the planetary pin against the direction of arrow out of the planetary housing, to prevent damaging the bore.



- ③ Remove the planetary gears with the thrust disks and needle bearings.



11) Assembly / disassembly cageless needle bearing(planetary gear bearing)



(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".

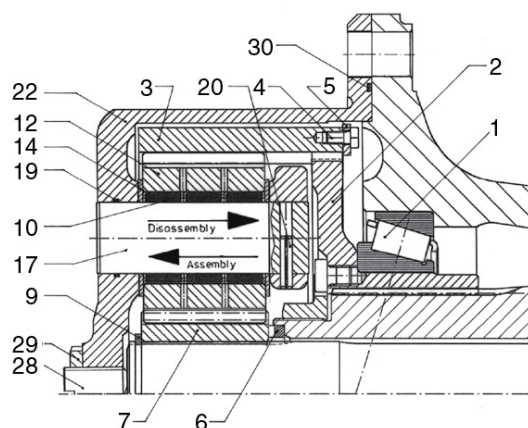
(2) Disassembly

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

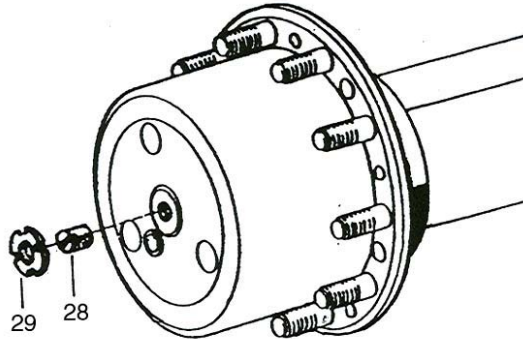


100D7XL71

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



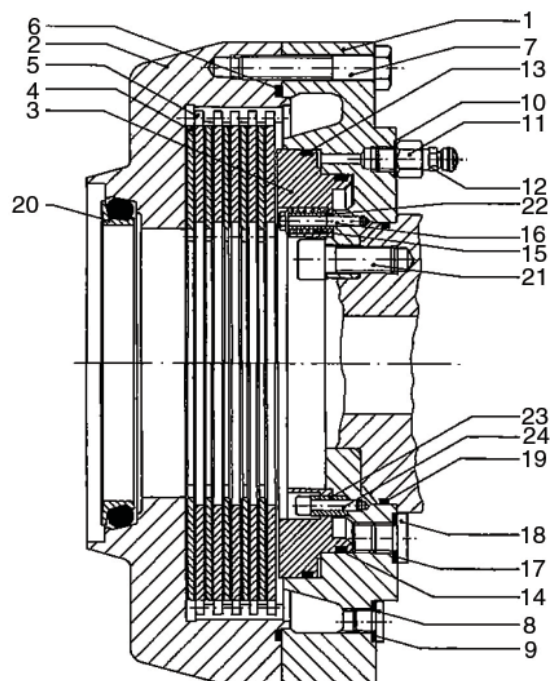
100D7XL72

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

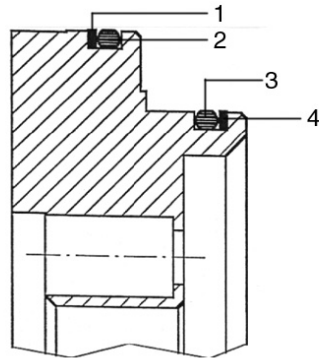
1	Brake carrier	9	Seal ring	17	Seal ring
2	Brake housing	10	Seal ring	18	Screw plug
3	Piston	11	Connection piece	19	O-ring
4	Inner disk	12	Breather	20	Face seal
5	Outer disk	13	Sealing ring	21	Screw
6	O-ring	14	Sealing ring	22	Tube
7	Screw	15	Spring	23	Bushing
8	Screw plug	16	Screw	24	Screw

(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.



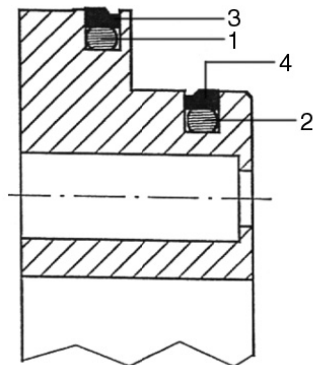
100D7XL73/84

- 1 Large supporting ring
- 2 Large O-ring

- 3 Small 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.

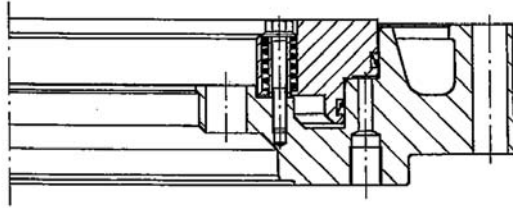


100D7XL74/85

- 1 Large O-ring
- 2 Small O-ring

- 3 Large supporting 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

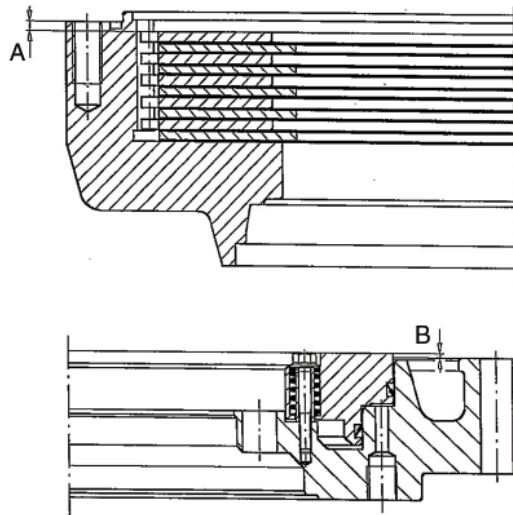
Press the piston equal by hand into the brake carrier (do not cant it).

※ 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.

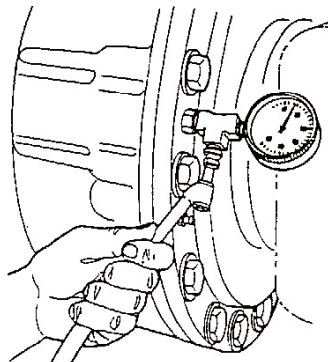
② Check cooling oil room for leaks

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.

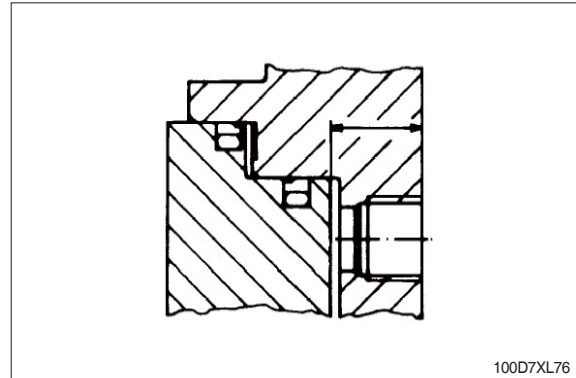
· Motor oil : SAE 80W-90

② Cooling fluid

· SAE 80W-90 LSP (Mobil lube LS85W-90)

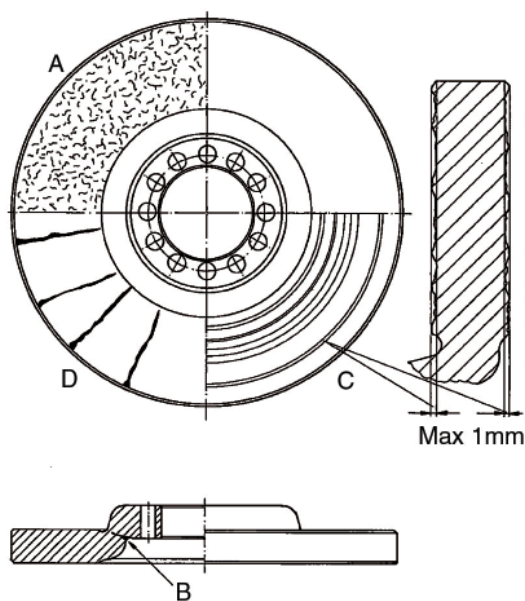
③ Check measure

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.



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 mm	admissible
D	Continuous cracks	not admissible

(10) Spring - loaded sliding caliper brakes

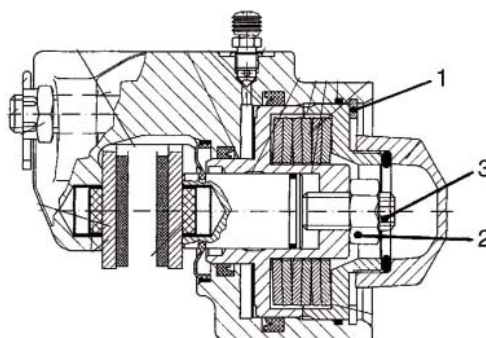
Safety notes :

· 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

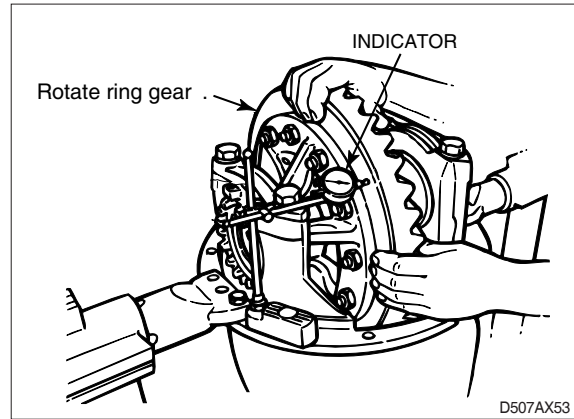
1. CHECKING THE RING GEAR BACKFACE RUNOUT

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.

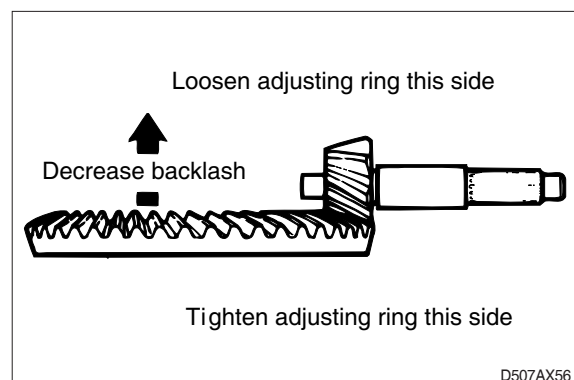
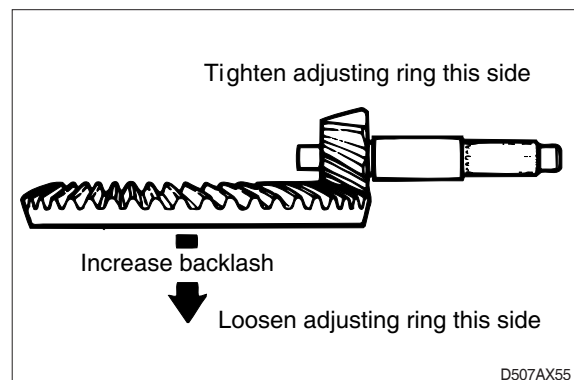
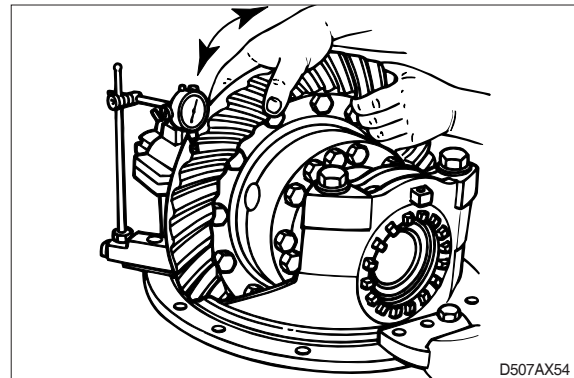
- 1) Attach a dial indicator on the mounting flange of the carrier.
- 2) Adjust the dial indicator so that the plunger or pointer is against the tooth surface, near the heel end of the gear tooth. Set the indicator dial to zero (0).
- 3) Hold the drive pinion in position.
- 4) Read the dial indicator, 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.

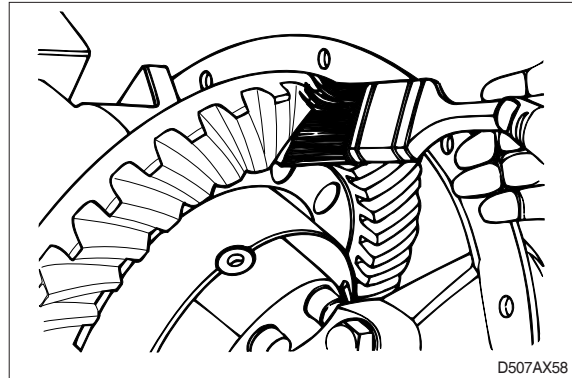
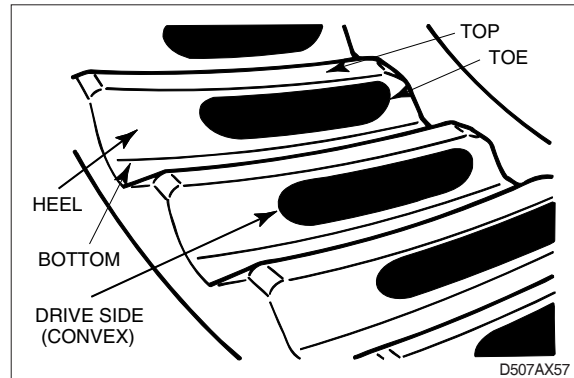
- 6) Loosen one bearing adjusting ring one notch, then tighten the opposite ring the same amount.



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.

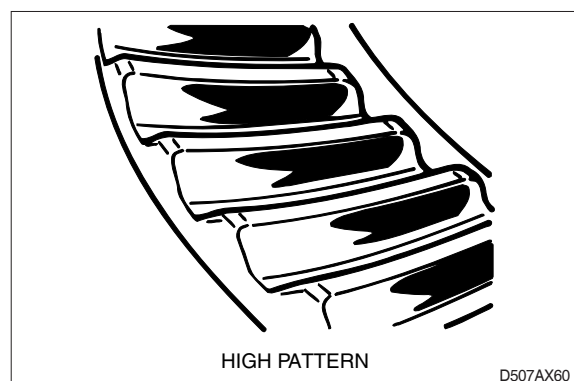
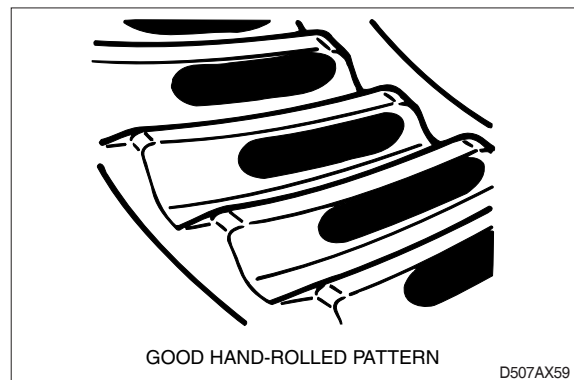
- 3) Compare the contact patterns.

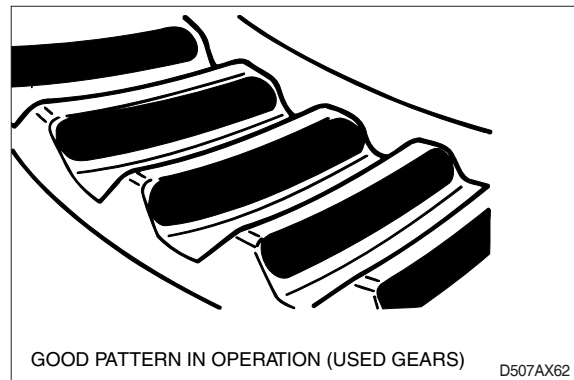
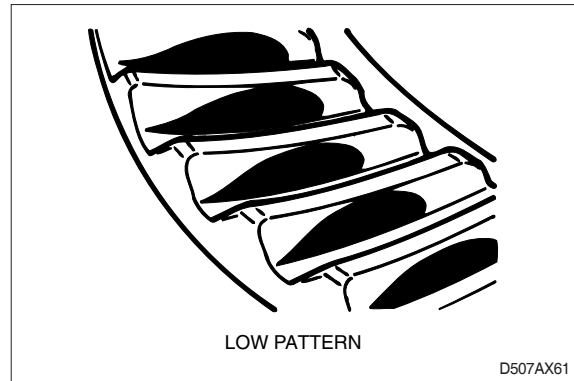
In new gearsets, a good contact pattern is toward the toe of the tooth, and centered between the top and bottom of the tooth.

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).

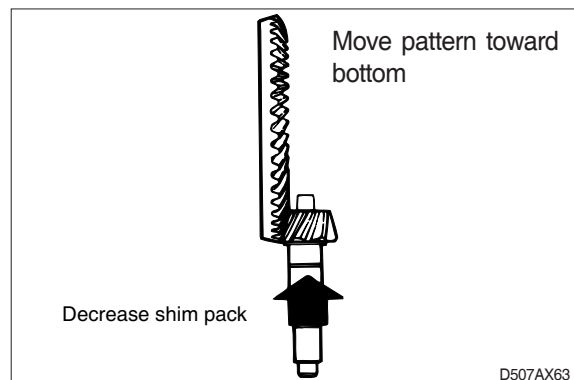
If the contact patterns requires adjustment along the length of tooth (toe/heel), follow step 6)-7).





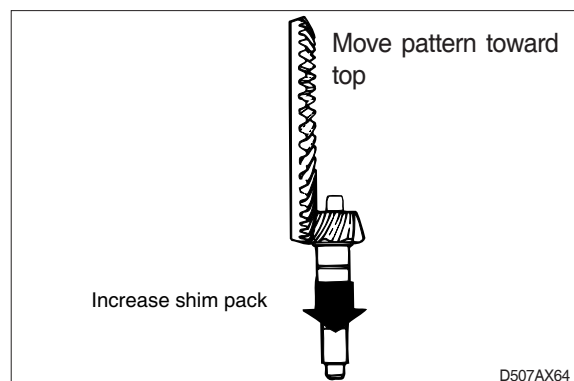
4) High pattern : A high contact pattern indicates that the pinion was installed too shallow into the carrier.

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".



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".



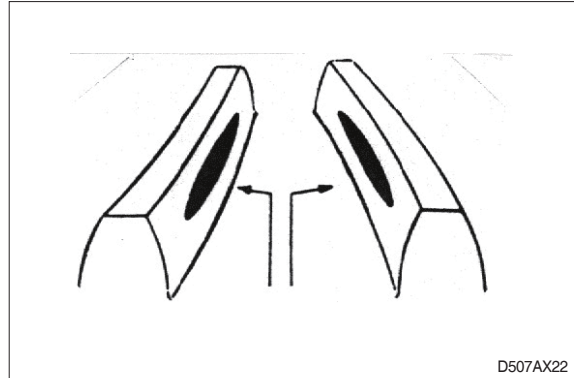
4. ADJUSTMENT OF GEAR MESHING OF GLEASON GEARS

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

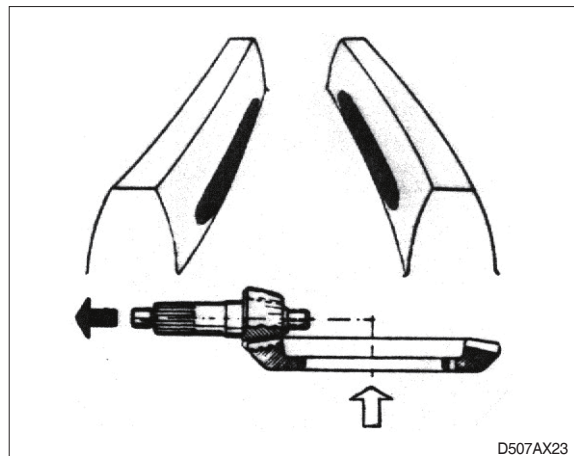
The following figures are showing improper gear meshing marks of the ring gear.

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 indicating the direction towards which the ring gear has to be moved, to get further more a correct backlash.



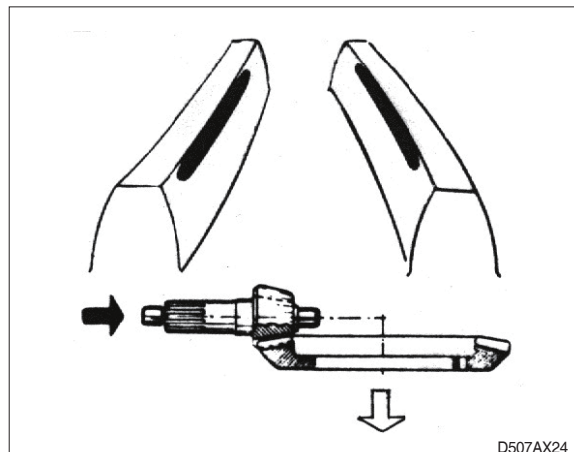
Gear meshing to deep

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



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.



SECTION 4 BRAKE SYSTEM

Group 1	Structure and function	4-1
Group 2	Operational checks and troubleshooting	4-32
Group 3	Tests and adjustments	4-40
Group 4	Disassembly and assembly	4-43

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

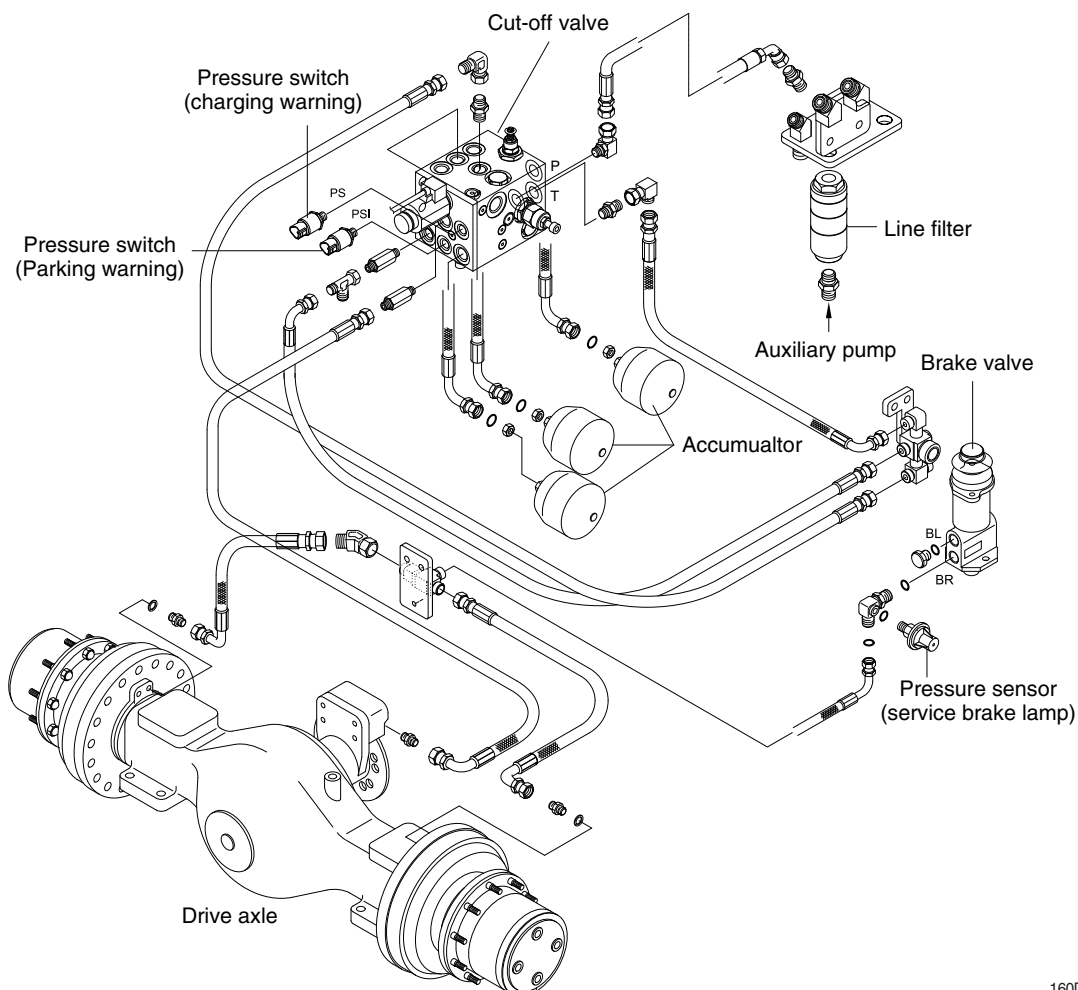
The fixed displacement brake pump supplies flow to the cut-off valve for service brake circuit and park brake circuits. It flows to three accumulator. The accumulator has a gas precharge and an inlet check valve to maintain a pressurized volume of oil for reserve brake applications.

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:

- Auxiliary pump
- Parking brake solenoid valve in cut off valve.
- Cut-off valve
- Brake valve
- Accumulators
- Pressure switches
- Line filter



160D9VBS100

FULL POWER HYDRAULIC BRAKE SYSTEM

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

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

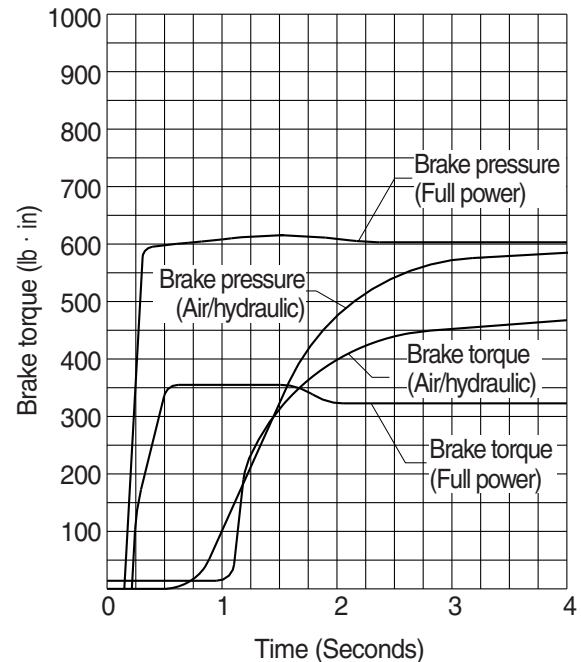
This is referred to as brake pressure modulation.

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

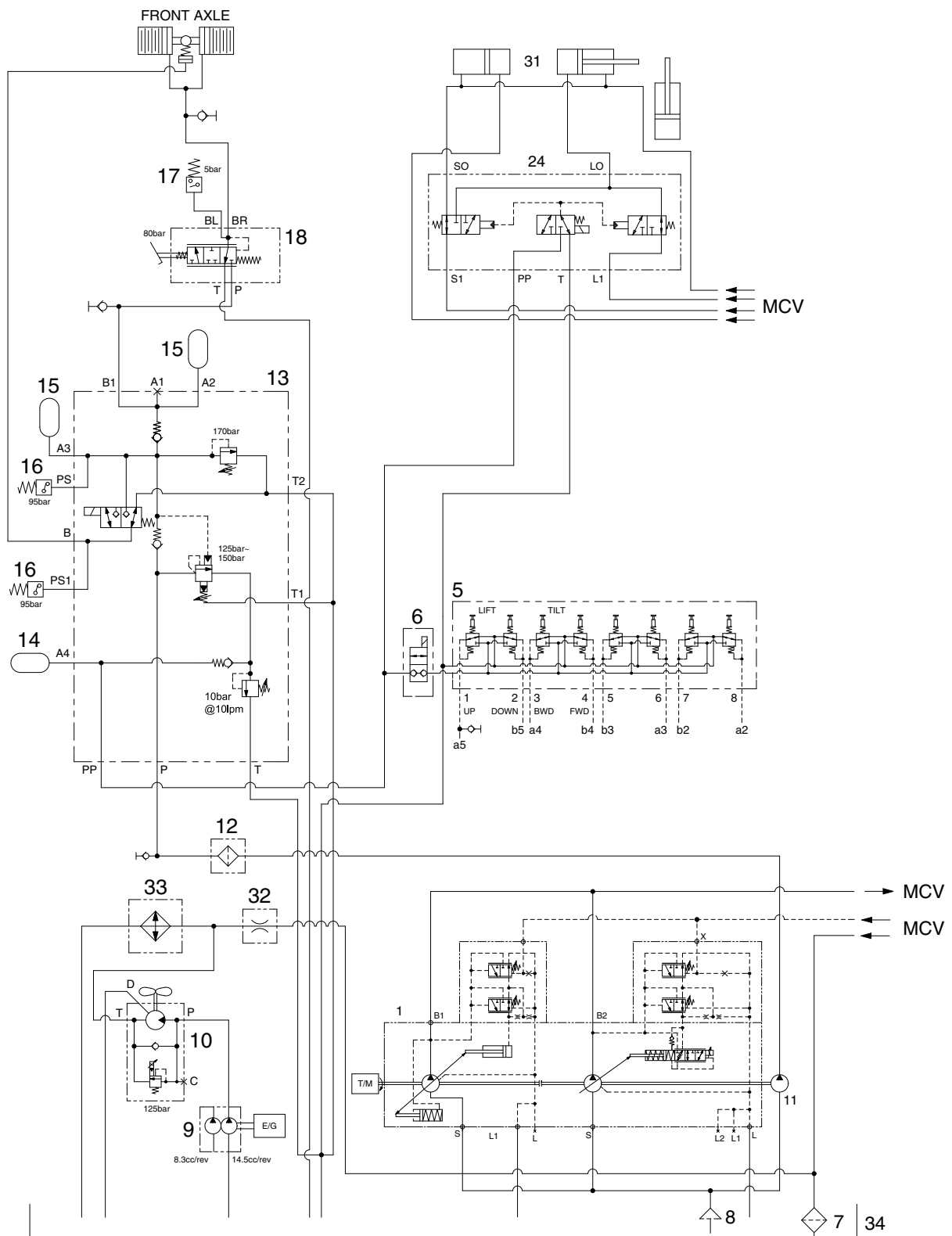
Because these systems are closed center, by using a properly sized accumulator, emergency power-off braking that is identical to power-on braking can be achieved. These systems can be either dedicated, where the brake system pump supplies only the demands of the brake system or non-dedicated, where the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

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

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



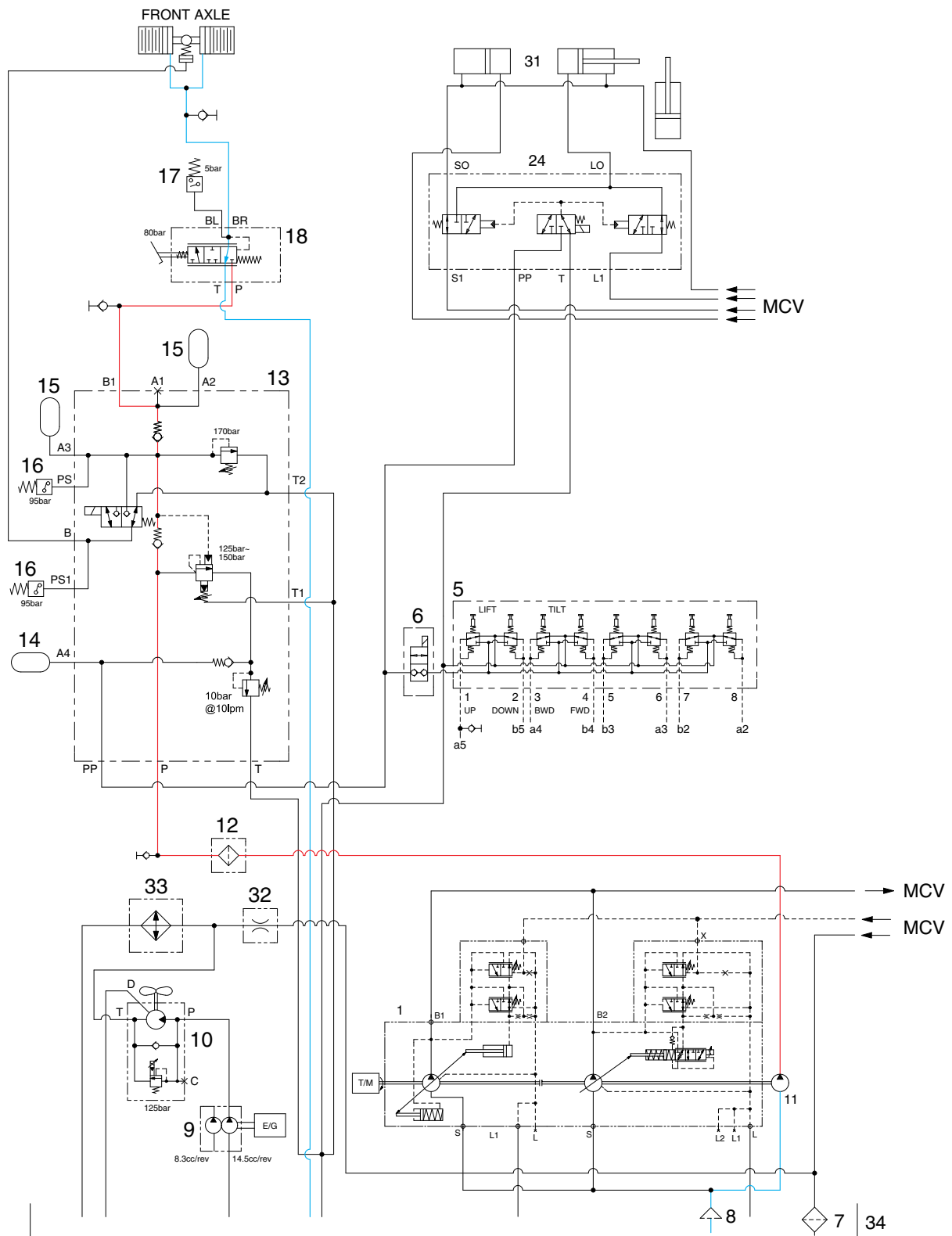
2. HYDRAULIC CIRCUIT



160D9VBS01

- | | | |
|-----------------------|--------------------|--|
| 1 Main pump | 10 Fan drive motor | 16 Pressure switch |
| 5 RCV | 11 Auxiliary pump | 17 Pressure switch |
| 6 OPSS solenoid valve | 12 Line filter | 18 Brake valve |
| 7 Return filter | 13 Cut-off valve | 24 Side shift solenoid valve (160D-9V) |
| 8 Suction strainer | 14 Accumulator | 31 Fork positioner cylinder |
| 9 Fan drive pump | 15 Accumulator | 34 Hydraulic oil tank |

1) SERVICE BRAKE RELEASED



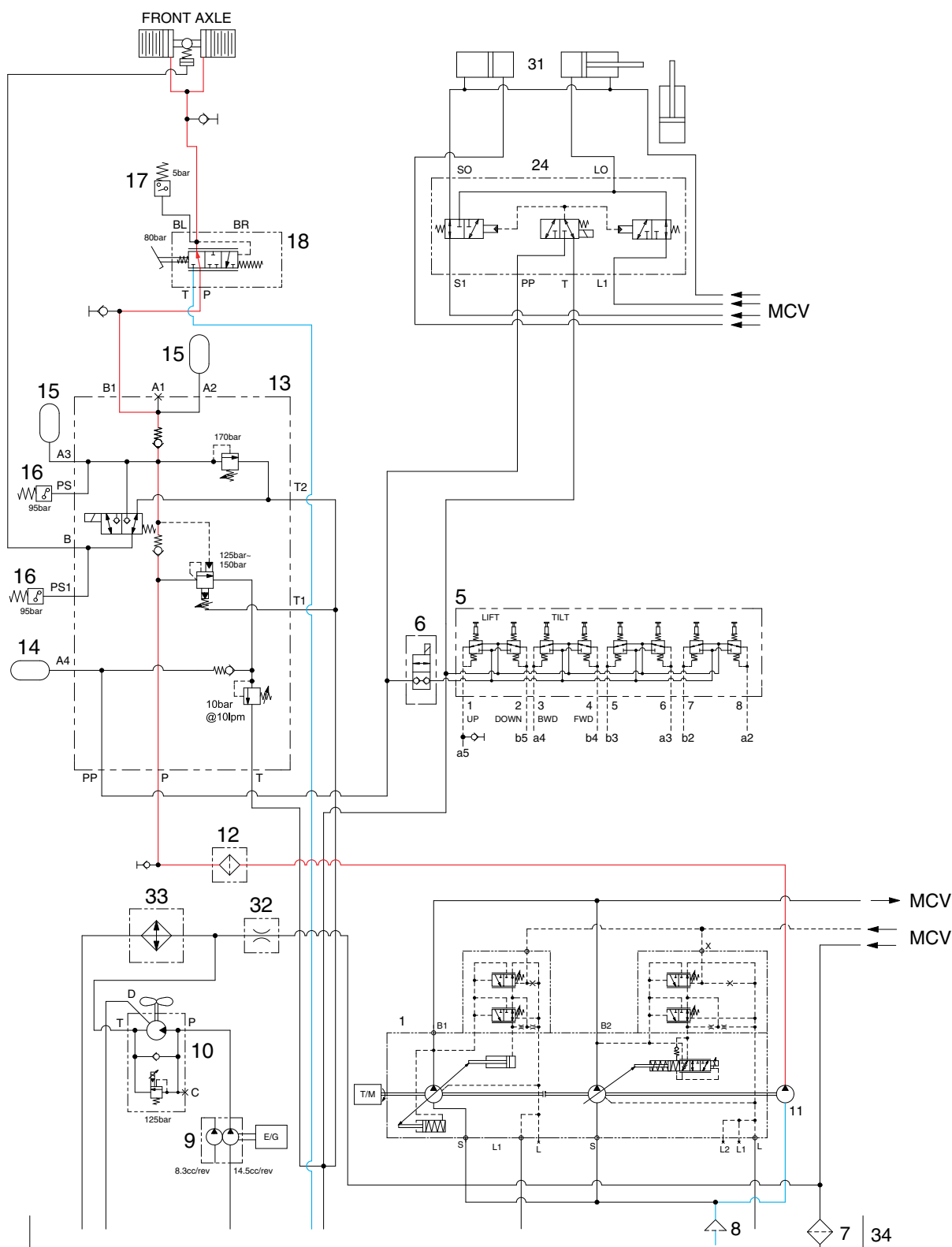
160D9VBS02

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



160D9VBS03

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.

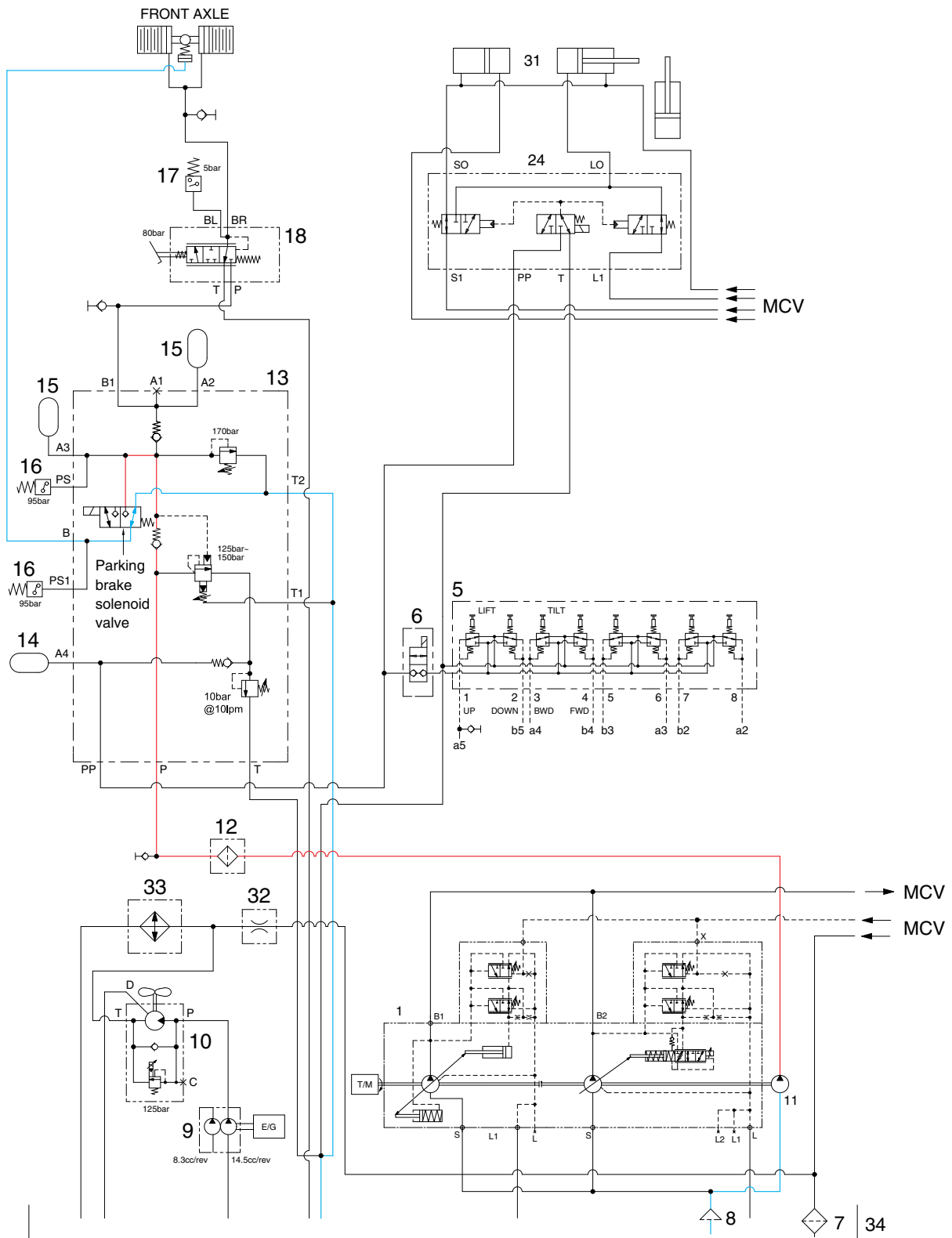
The diagram is a detailed hydraulic schematic for a vehicle system. It features several key components and connections:

- Front Axle:** Located at the top left, it includes a hydraulic cylinder and a valve assembly.
- Pressure Sensors (PS):** Multiple sensors are shown, labeled with values such as 5bar, 80bar, 95bar, 125bar, 150bar, and 170bar.
- Valves:** Various valves are depicted, including a "Parking brake solenoid valve" and several directional control valves (e.g., 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34).
- Hydraulic Lines:** The system is divided into different pressure zones, indicated by color-coded lines: red for high pressure (up to 170bar), blue for medium pressure (up to 125bar), and purple for low pressure (up to 10bar).
- MCV (Master Control Valve):** Two MCVs are shown on the right side of the diagram, connected to the main hydraulic lines.
- Other Components:** The diagram includes a "T/M" (Transmission/Motor) unit, a "T" (Tank) reservoir, and various other hydraulic components like accumulators and filters.

The schematic illustrates the flow of hydraulic fluid through the system, showing the interaction between the front axle, the parking brake solenoid valve, and the various hydraulic lines and valves. The color-coding helps to distinguish between different pressure levels and fluid paths.

4-6

4) PARKING BRAKE OPERATED



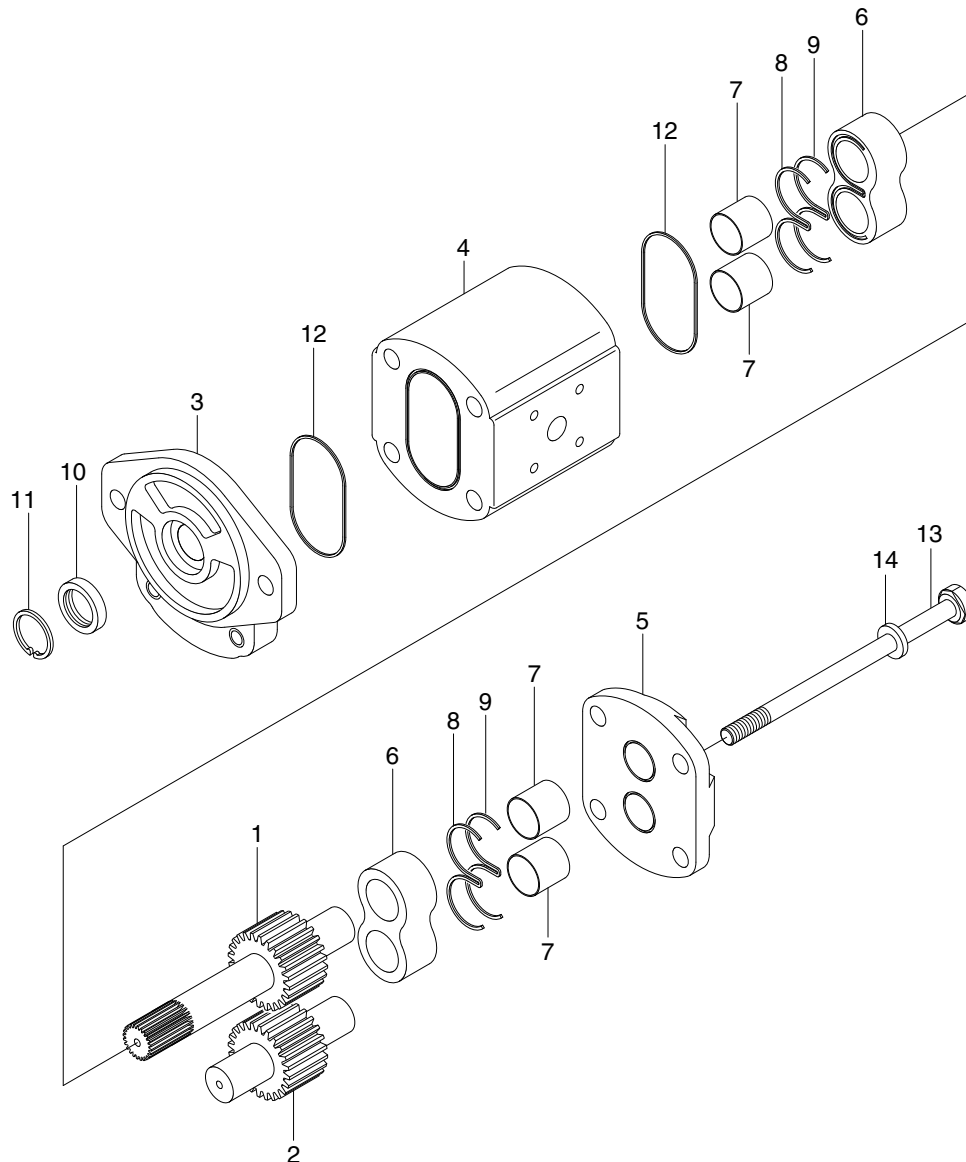
160D9VBS05

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. AUXILIARY PUMP

1) STRUCTURE



- | | | | |
|---|--------------|----|---------------|
| 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 |

180D7EBS06

This gear pump have a maximum delivery pressure of 200 kgf/cm².

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.

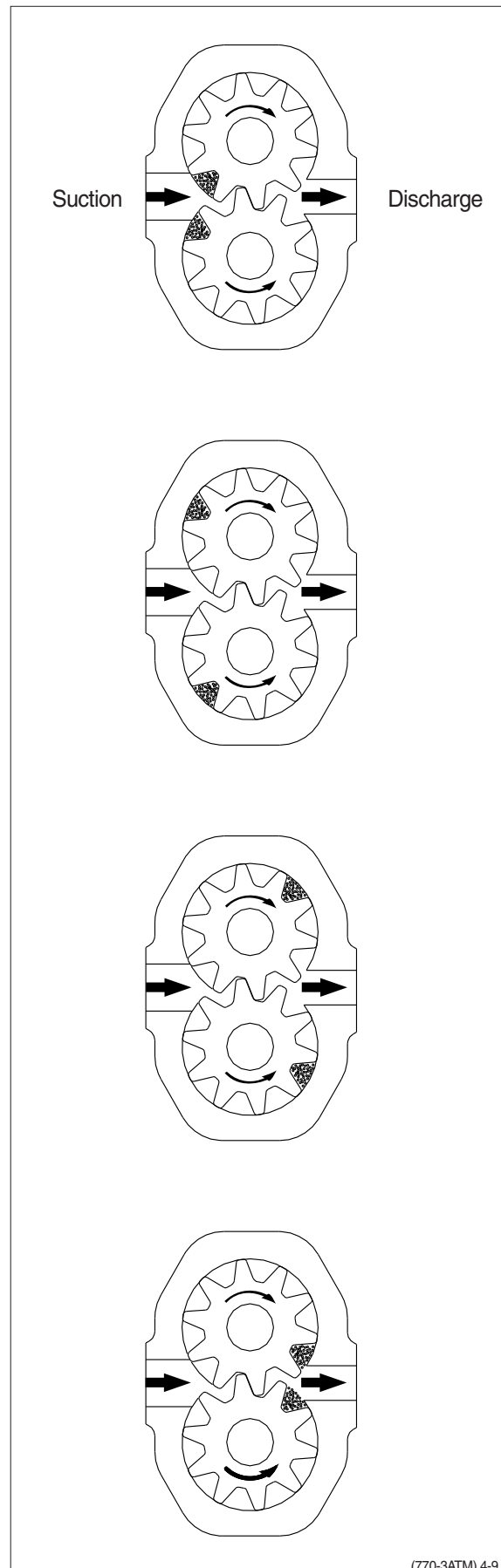
The amount of discharge increases with the speed of rotation of the gear.

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.



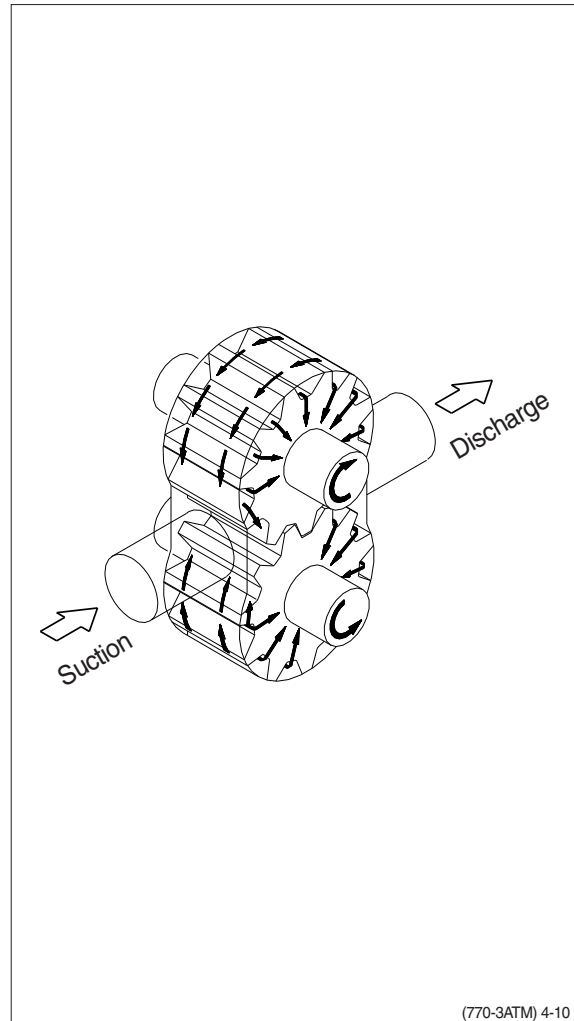
(2) Internal oil leakage

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.



(3) Forces acting on the gear

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

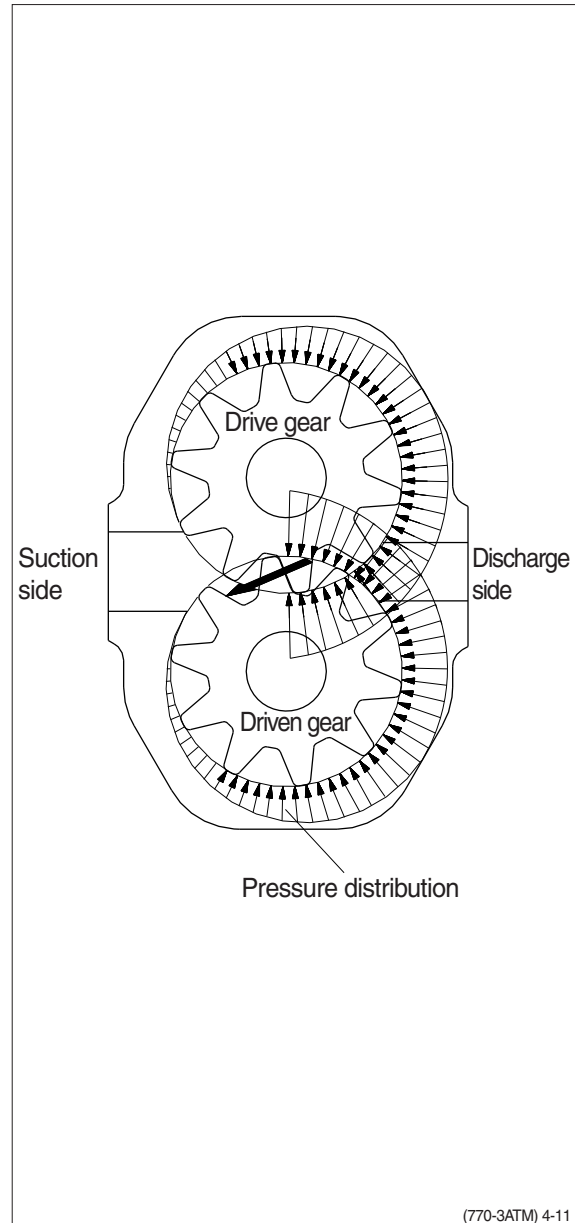
Due to the action of the delivery pressure, the oil pressure is higher on the delivery side of the pump, and due to suction pressure, is lower on the suction side. In the intermediate section, the pressure will gradually lower as the position moves from the delivery side to the suction side.

This phenomenon is shown in the drawing at right.

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

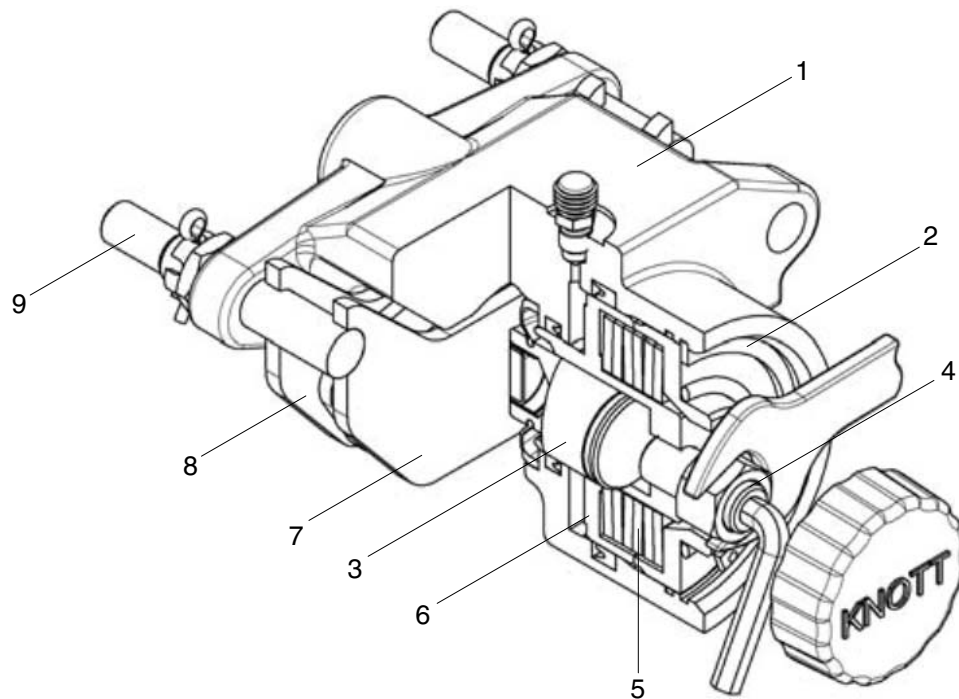
These forces pushing the gears toward the suction side are received by the bearings. Since the gears are pressed toward the suction side by these forces, the radial clearance becomes smaller on the suction side in the case. In some pumps, the clearance may become zero, thus allowing the gear teeth and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

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



4. 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 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.

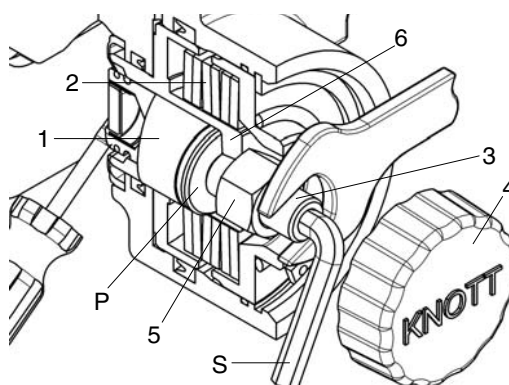
When the brake pad comes into contact with the brake disk, the reaction force shifts the housing onto the guide bolts until the brake pad is also pressed against the brake disk.

The brake is released by complete pre-tensioning of the bank of cup springs. During 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
120/130/160D-9V	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.

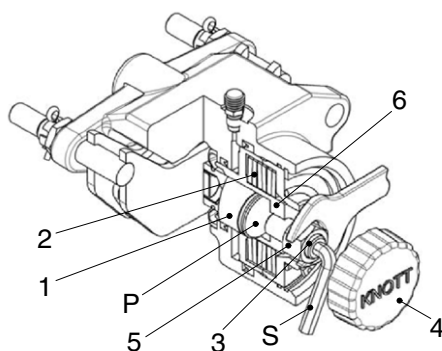
(3) ADJUSTING REGULATIONS

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".

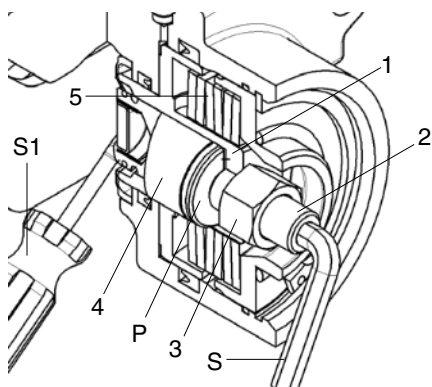
5) MAINTENANCE AND REPAIR WORK

(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 mm per lining pad (6 mm carrier plate thickness).

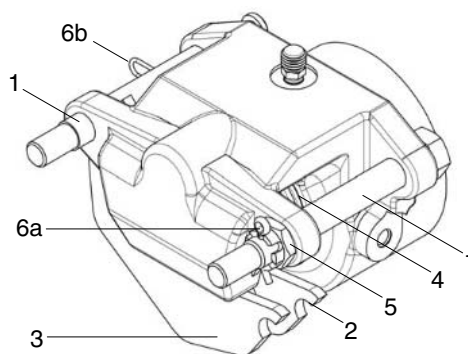


180D7EBS113

- | | | | |
|---|-----------------|----|----------------------|
| 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 too short, it must be unscrewed to remove the brake. Before the pressure hose can be released the brake must be emergency released.

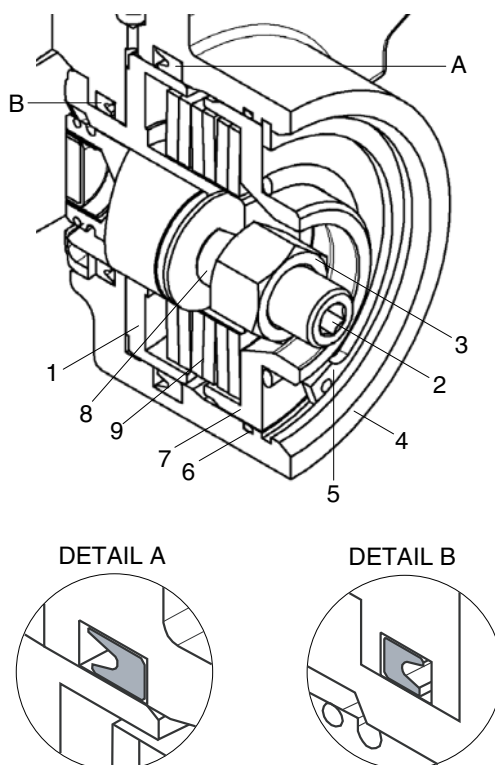
- ⑦ Exchange the brake pads and insert the guide bolts into the brake anchor plate. If you have removed the complete brake you have to amount the brake on both guide bolt again, now.

- 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 springs 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.

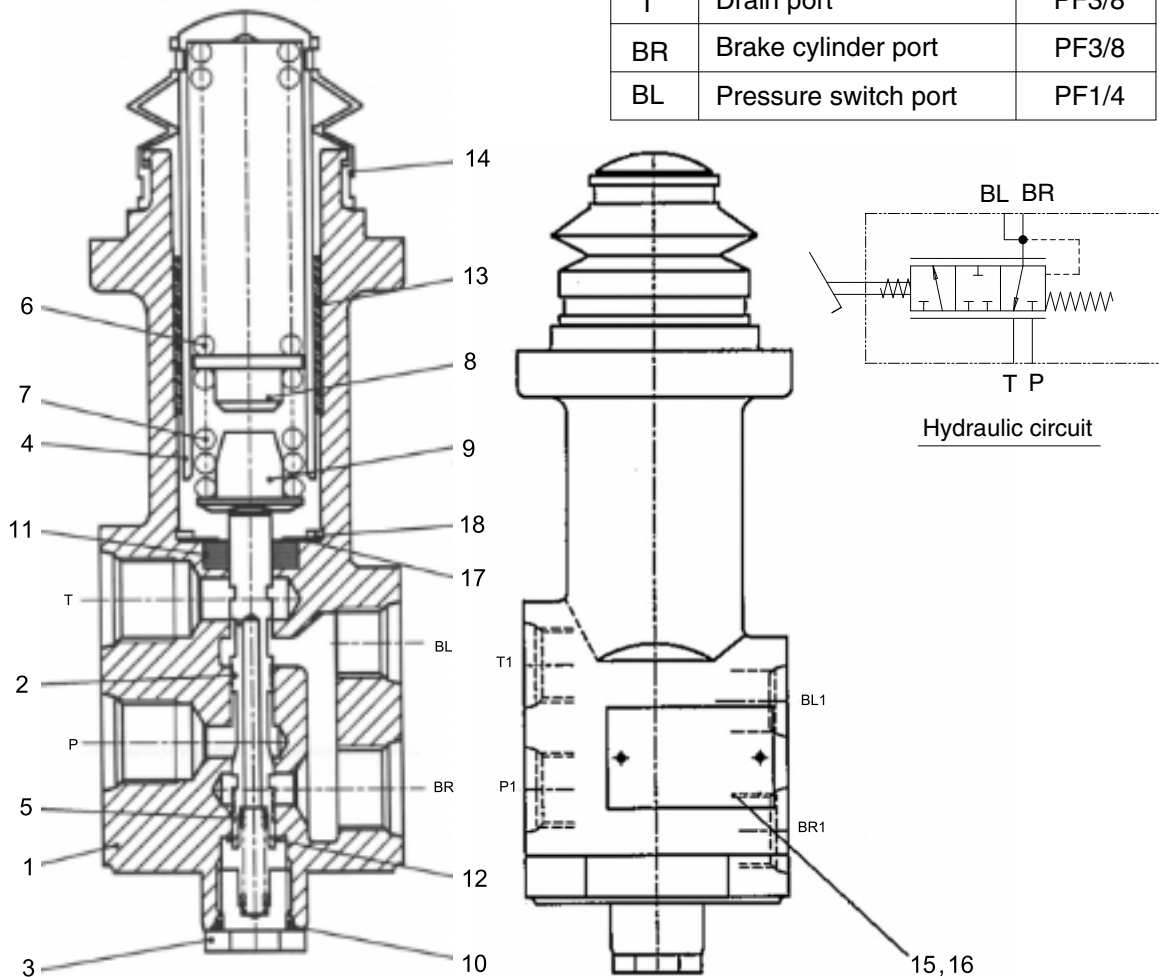
For any other information not contained in these instructions or for more detailed instructions, please contact Hyundai dealer.

5. BRAKE VALVE

1) STRUCTURE

(1) DIC drive axle

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

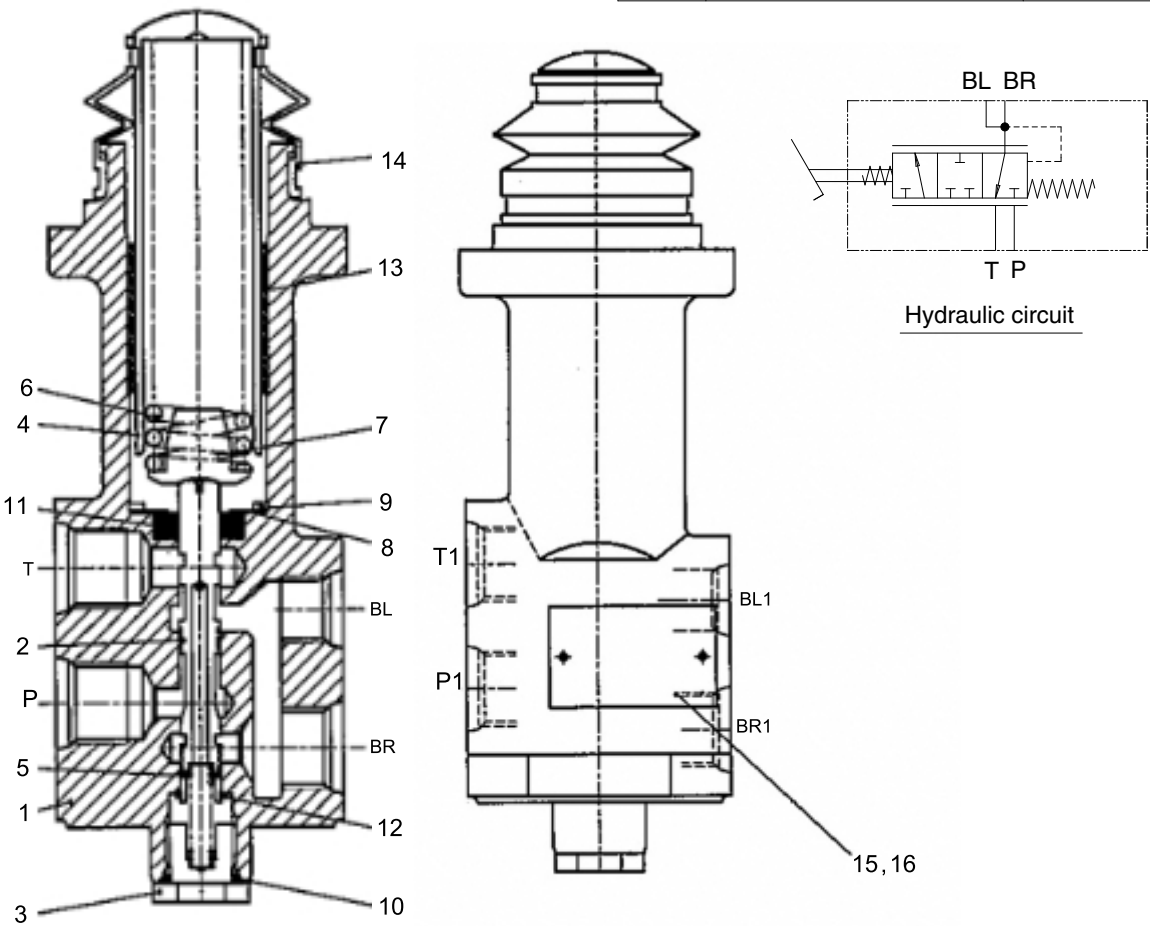


- | | | |
|----------------|-------------------|-----------------|
| 1 Valve body | 7 Main 100 spring | 13 DU bushing |
| 2 Spool | 8 Spring retainer | 14 Rubber cover |
| 3 Plug | 9 Spring retainer | 15 Name plate |
| 4 Brake holder | 10 O-ring | 16 Drive screw |
| 5 Lower spring | 11 Oil seal | 17 Plain washer |
| 6 Main spring | 12 Snap ring | 18 Snap ring |

160D9VBS06

(2) Kessler drive axle

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



- 1 Valve body
- 2 Spool
- 3 Plug
- 4 Brake holder
- 5 Lower spring
- 6 Main spring

- 7 Spring retainer
- 8 Plain washer
- 9 Snap ring
- 10 O-ring
- 11 Oil seal
- 12 Snap ring

- 13 DU bushing
- 14 Rubber cover
- 15 Name plate
- 16 Drive screw

160D9VBS07

2) OPERATION

(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) Installation requirements

Return lines (T) must be connected directly to the tank.

The connecting lines must be installed in such a way as to permit proper bleeding.

(6) 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.

(7) Repair work

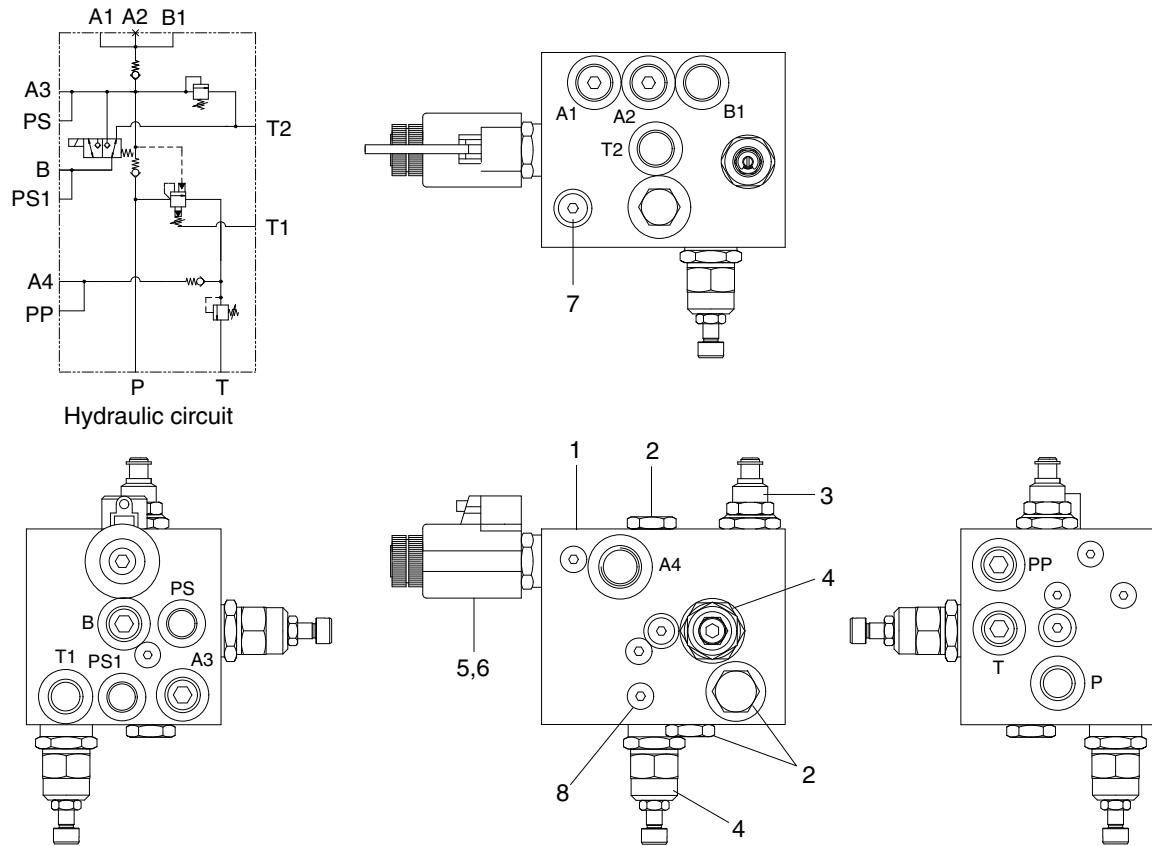
△ **When working on the braking system, always make sure that there is absolutely no pressure in the system. Even when the engine is switched off there will be some residual pressure in the system.**

※ **When doing repair work, make sure your environment is very clean.**

Immediately close all open ports on the components and on pipes using plugs.

6. CUT-OFF VALVE

1) STRUCTURE



31FT-05021

- | | | | |
|---|-----------------|---|----------------|
| 1 | Manifold | 5 | Solenoid valve |
| 2 | Check valve | 6 | Coil |
| 3 | Unloading valve | 7 | Plug |
| 4 | Relief valve | 8 | Plug |

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.

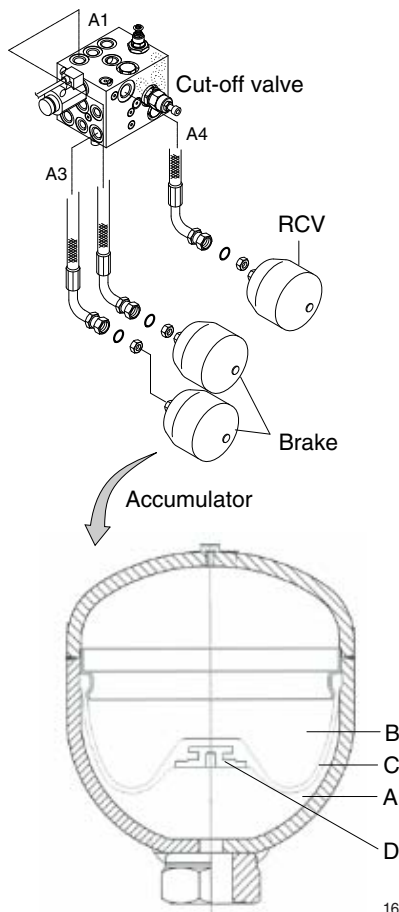
As the pressure on P line rises to 150 bar, the unloading valve (3) starts cut-offting and the oil in the P port is unloaded. The pressure on P line goes down 120 bar by the minute leakage from valve and other factors.

At this pressure, the unloading valve starts cutting.

This process is repeated in the regular period of 30~40 seconds.

7. BRAKE ACCUMULATOR

1) STRUCTURE



Item	31AC-10100 (Brake x 2EA)	31E3-3187 (RCV x 1EA)
Diameter	122 mm	90 mm
Mounting height	145 mm	120 mm
Nominal volume	0.75 ℓ	0.35 ℓ
Priming pressure	50 bar	15 bar
Operating medium	Oil	Oil
Operating pressure	Max 210 bar	Max 170 bar
Thread	M18×1.5	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

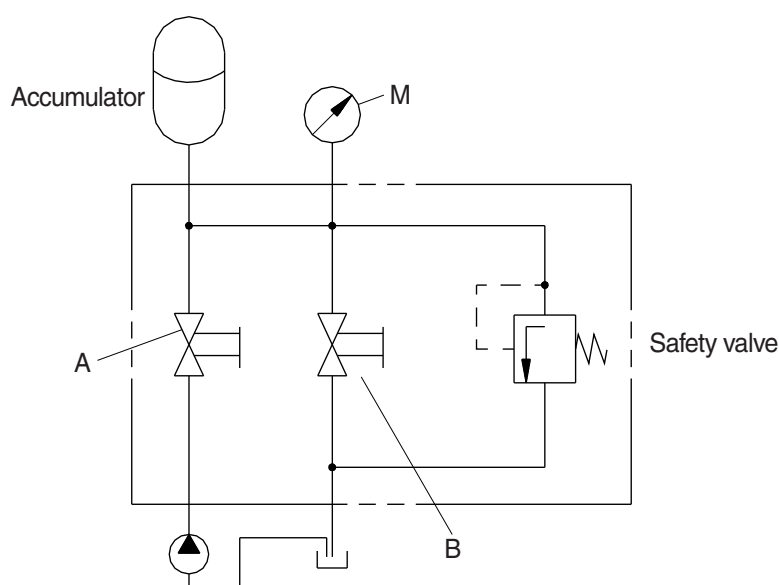
Before the accumulator is scrapped, its gas filling pressure must be reduced. For this purpose, drill a hole through gas chamber(B) using a drill approx. 3mm in diameter. The gas chamber is located on the side opposite the threaded port above the welding seam around the center of the accumulator.

※ 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**.

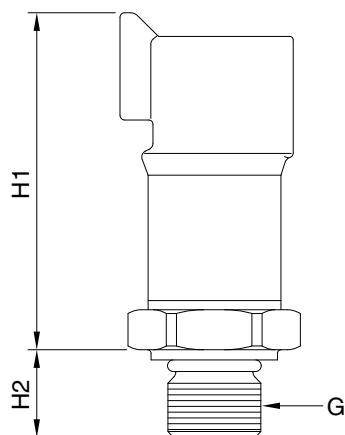


(7) Repair work

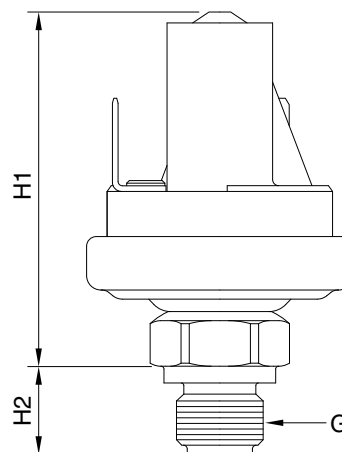
- △ **When working on the braking system, always make sure that there is absolutely no pressure in the system. Even when the engine is switched off there will be some residual pressure in the system.**
- ※ **When doing repair work, make sure your environment is very clean.
Immediately close all open ports on the components and on pipes using plugs.**
- △ **For safety reasons the 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 ± 5	Max 42
Charging	NC	Oil	PF 1/4	49.4	12.5	50 ~ 150	95 ± 5	Max 42
Brake stop	NO	Oil	PF 1/4	-	-	1~10	5 ± 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.

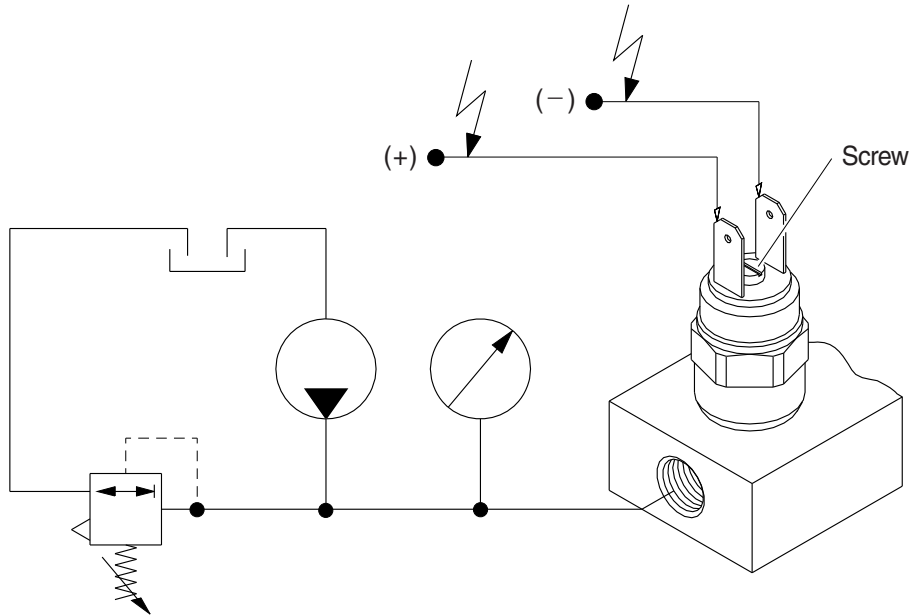
Immediately close all open ports on the components and on pipes using plugs.

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

(7) Adjusting and testing pressure switch

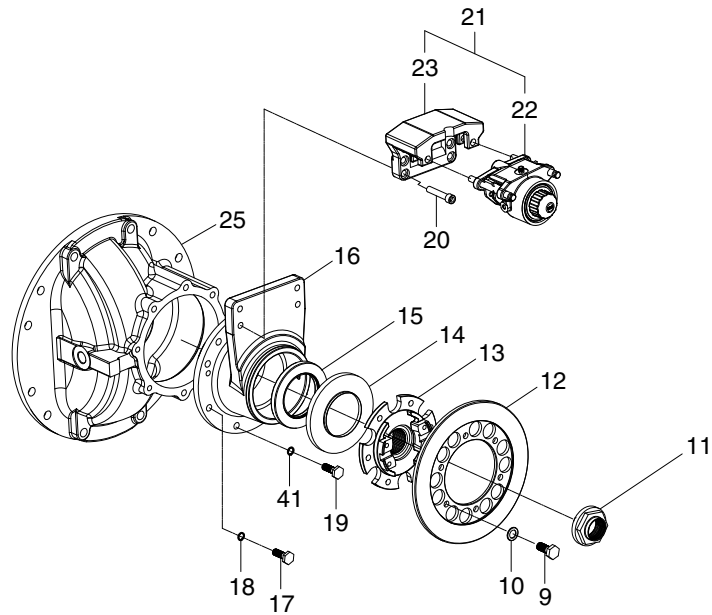
The adjusting screw located between the two contact plugs can be set to the desired value within a certain range. For adjusting range, please refer to the table **Technical data** on the previous page.

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



(770-3ATM) 4-25

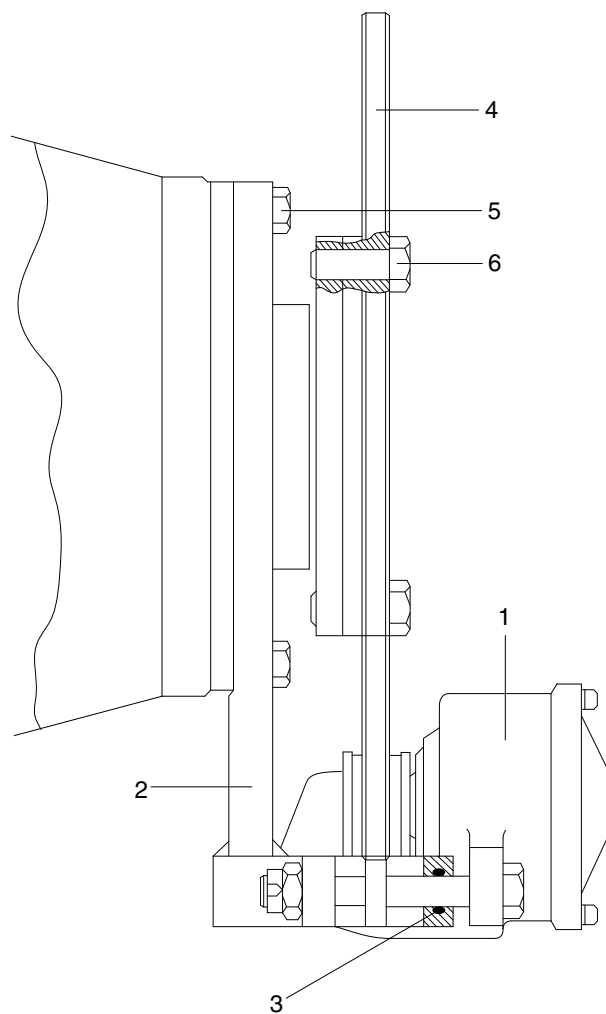
8. PARKING BRAKE (DIC)



110D9DA01

- | | |
|------------------------|--------------------------|
| 9 Hexagon bolt | 18 Spring 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 Parking brake
- 2 Brake carrier
- 3 O-ring

- 4 Brake disk
- 5 Hexagon screw
- 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.

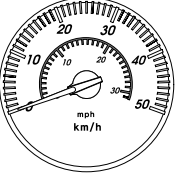
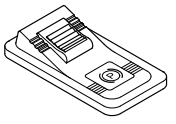
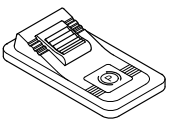
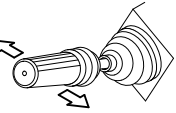
At the end of each check, if no problem is found (OK), that check is complete or an additional check is needed. If problem is indicated (NOT OK), you will be given repair required and group location.

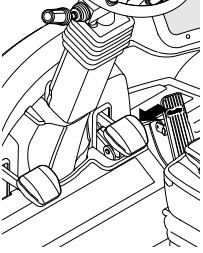

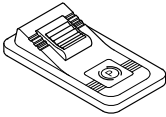
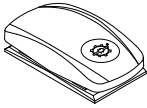
If verification is needed, you will be given next best source of information:



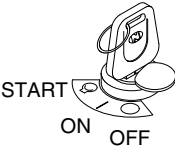

Chapter 2 : Troubleshooting

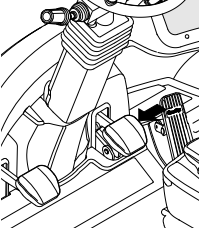
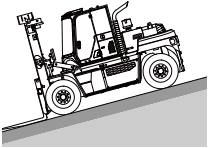
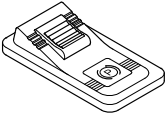
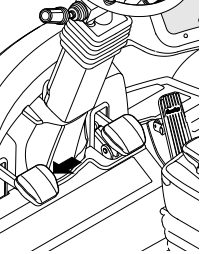
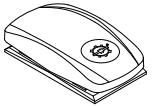
Group 3 : Tests and adjustments

※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.	 <p>Stop engine.</p> <p>Operate brake pedal approximately 20 times.</p> <p>Start engine and run at low idle.</p> <p>Record number of seconds required for low brake pressure indicator lamp to go out.</p> <p>LOOK : Indicator lamp must go out in less than 10 seconds from time engine starts.</p> <p>NOTE : Indicator will not come on approximately 1 second after starting engine.</p> 	<p>OK Check completed.</p> <p>NOT OK Check for brake circuit leakage.</p> <p>Go to next page.</p> <p>IF OK Install a cap on line connected to inlet of brake valve and repeat pump flow check.</p> <p>If time does not decrease, check for worn brake pump.</p>
Service brake capacity check Engine running.	 <p>Turn inching switch OFF.</p> <p>Apply service brakes, release park brake and put transmission in 2nd forward.</p> <p>Increase engine speed to high idle.</p> <p>LOOK : Machine may not move or move at a very slow speed.</p> <p>Repeat check three times to ensure accurate results.</p> 	<p>OK Check completed.</p> <p>NOT OK Check brake pressure in group 3.</p> <p>IF OK Inspect brake disk.</p>

Item	Description	Service action
Brake accumulator precharge check ※ The axles and hydraulic oil must be at operating temperature for this check.	 <p>Start and run engine for 30 seconds.</p> <p>Stop engine and turn start switch to ON and wait 5 seconds.</p> <p>NOTE : Engine oil pressure lamp will be on due to no engine oil pressure.</p>  <p>Count the number of times the brake pedal can be fully depressed before the low brake pressure warning lamp comes ON.</p> <p>LOOK : Warning lamp must come on over 20 times of applications.</p> <p>Start engine and operate at low idle.</p> <p>Observe cluster while applying brake pedal with maximum force.</p> <p>LOOK/LISTEN : Brake pressure indicator must not come ON.</p>	<p>OK Check completed.</p> <p>NOT OK Make sure brake pedal is not binding and keeping brakes partially engaged.</p> <p>Bleed brakes in group 3.</p> <p>Check brake system pressure.</p> <p>NOT OK If light comes on with engine running, accumulator has lost it's charge. Inspect and recharge accumulator.</p>
Brake system leakage check	 <p>Start engine and wait 30 seconds.</p> <p>Stop engine.</p> <p>Wait 2 minutes.</p> <p>Turn start switch to ON and wait 5 seconds.</p> <p>LOOK : Brake oil pressure warning lamp must not come on within 2 minutes after stopping engine.</p> 	<p>OK Check completed.</p> <p>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.</p> <p>Check individual component leakage.</p>

Item	Description	Service action
Service brake pedal check	 <p>Slowly depress brake pedal.</p> <p>Listen for a hissing noise that indicates oil is flowing to brake pistons.</p> <p>LISTEN/FEEL : A hissing noise must be heard when pedal is depressed.</p>	<p>OK Check completed.</p> <p>NOT OK Inspect for debris under brake pedal. Inspect clutch cut-off linkage.</p>
Service and parking brake system drag checks Engine running	 <p>Position machine on gradual slope.</p> <p>Lower fork approximately 50mm(2 in) from ground.</p> <p>Release parking and service brakes.</p> <p>LOOK : Machine must move or coast.</p> <p>NOTE : If machine does not move, check brake pedals to be sure they fully release when feet are removed from pedals.</p> 	<p>OK Check completed.</p> <p>NOT OK Adjust park brake, go to group 3.</p> <p>NOT OK Check floor mat interference to pedal or debris build-up.</p> <p>IF OK Check for brake pressure when brake is released.</p>
Inching check	 <p>Place inching switch in ON position.</p> <p>Release parking brake.</p> <p>Run engine at half speed in 1st forward.</p> <p>Depress inching pedal until machine stops with left foot.</p> <p>At this pedal angle, put on right foot on the brake pedal not to release.</p> <p>Release inching pedal.</p>  <p>LOOK : Machine must move.</p>	<p>OK Check completed.</p> <p>NOT OK Check inching sensor output voltage.</p>

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 Brake pump standby pressure low Brake pressure low Air in system Worn brake surface material Leakage in brake valve Leakage in brake piston seal	Do brake accumulator check. Do brake pump standby pressure test. Do brake valve pressure test. Bleed brakes. Inspect brake surface material. Do brake valve leakage test. 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 Clutch cut-off switch out of adjustment Brake valve malfunction Low oil level	Remove lines and components. Adjust switch. Disassemble and inspect. Check oil level.
Brakes drag	Brake pedal not returning properly Debris holding valve partially open in brake valve Warped brake disk Stuck brake piston	Inspect floor mat and pedal. Do brake valve pressure test. Inspect brake disk. Repair.
Brakes lock up	Brake valve malfunction	Clean or replace brake valve.

Problem	Cause	Remedy
Brakes chatter	Air in brake system Worn brake surface material Wrong oil in differential	Do brake bleed procedure. Inspect brake surface material. 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 Brake accumulator pressure too low Low brake pump standby pressure setting. Leakage in pressure reducing manifold block Leakage in brake system Worn brake pump Leakage in parking brake solenoid	Replace switch. Recharge accumulator. Do brake pump standby pressure test. Do pressure reducing valve manifold leakage test. Do brake system components leakage tests. Do brake pump flow test. 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.

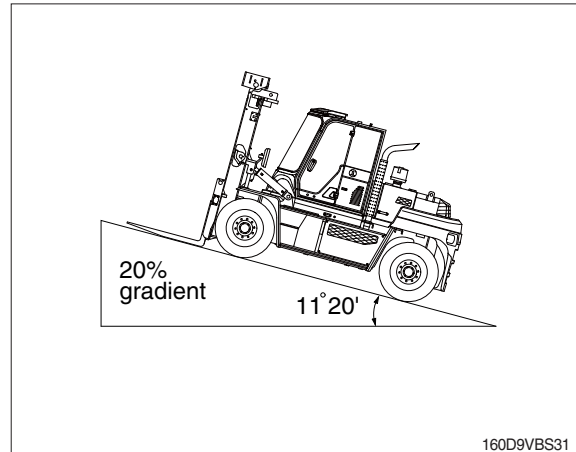
GROUP 3 TESTS AND ADJUSTMENTS

1. PARKING BRAKE PERFORMANCE

1) MEASUREMENT CONDITION

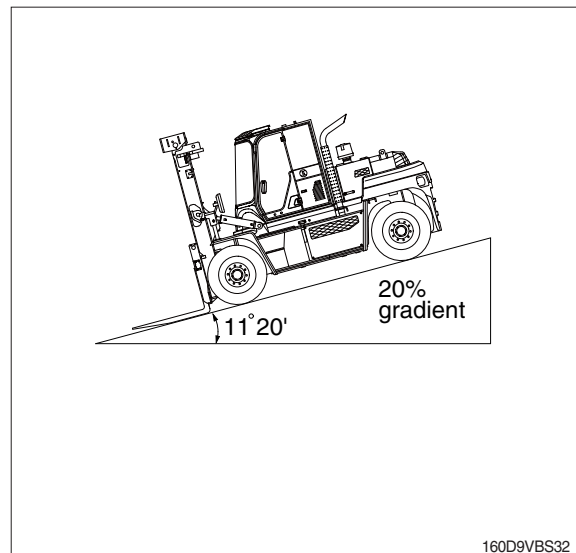
- (1) Tire inflation pressure: Specified pressure
- (2) Road surface: Flat, dry, paved surface with 1/5 (11°20') gradient.
- (3) Machine: In operating condition

Item	Standard value
Parking brake performance	Keep machine on 20% (11°20') gradient



2) MEASURING PROCEDURE

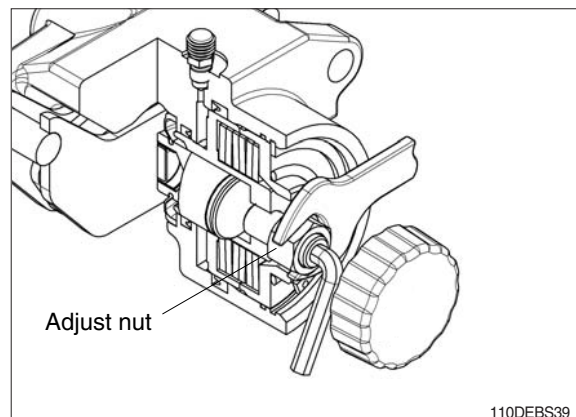
- (1) Start the engine and drive the machine straight up a 1/5 gradient with the fork unloaded.
 - (2) Depress the service brake, place the gear selector lever in neutral, then stop the engine.
 - (3) Turn the parking brake switch ON, then slowly release the service brake pedal and the machine must be kept stopped.
- ※ The measurement must be made with the machine facing either up or down the slope.



2. ADJUSTMENT OF BRAKE

1) EXTERNAL BRAKE INSPECTION (KESSLER)

- Inspect for wear of brake pad.



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
120D-9V	M16 (SW 8)	Min.	0.5	1/4
130D-9V		Clearance	1.0	1/2
160D-9V		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.

Release the lock nut (size 24 or 30) and turn the adjusting screw with socket wrench size 8 or 10

- (4) 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.

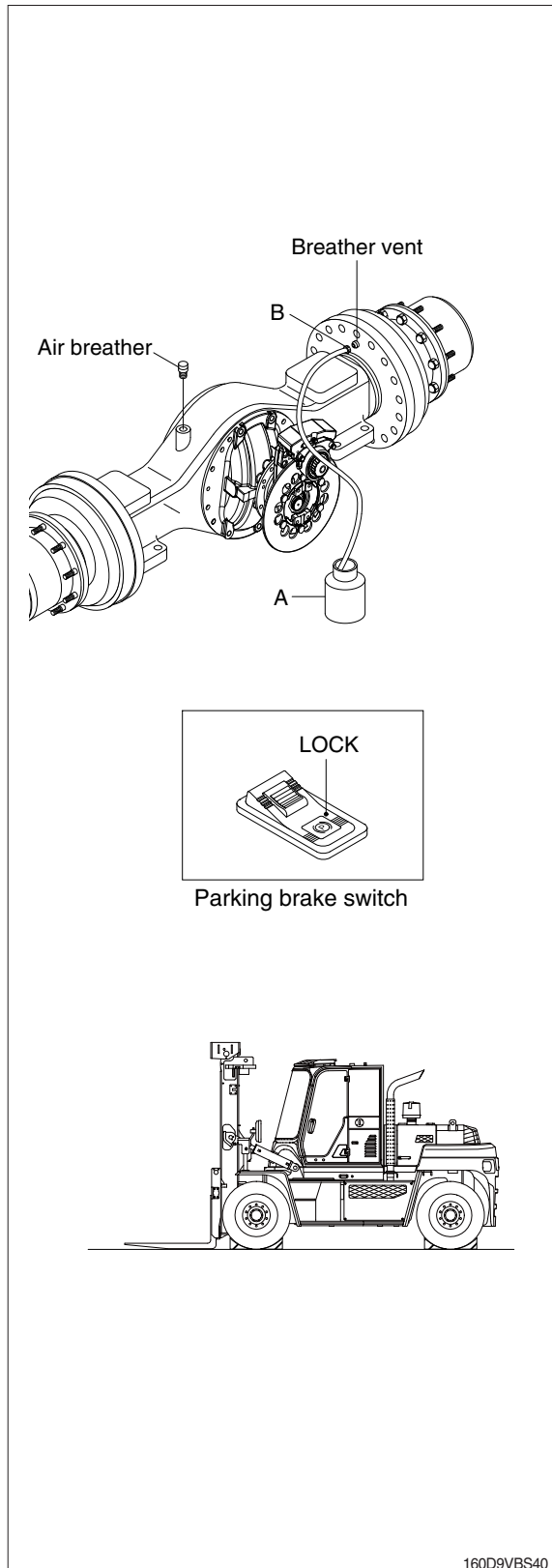
※ If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source.

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.

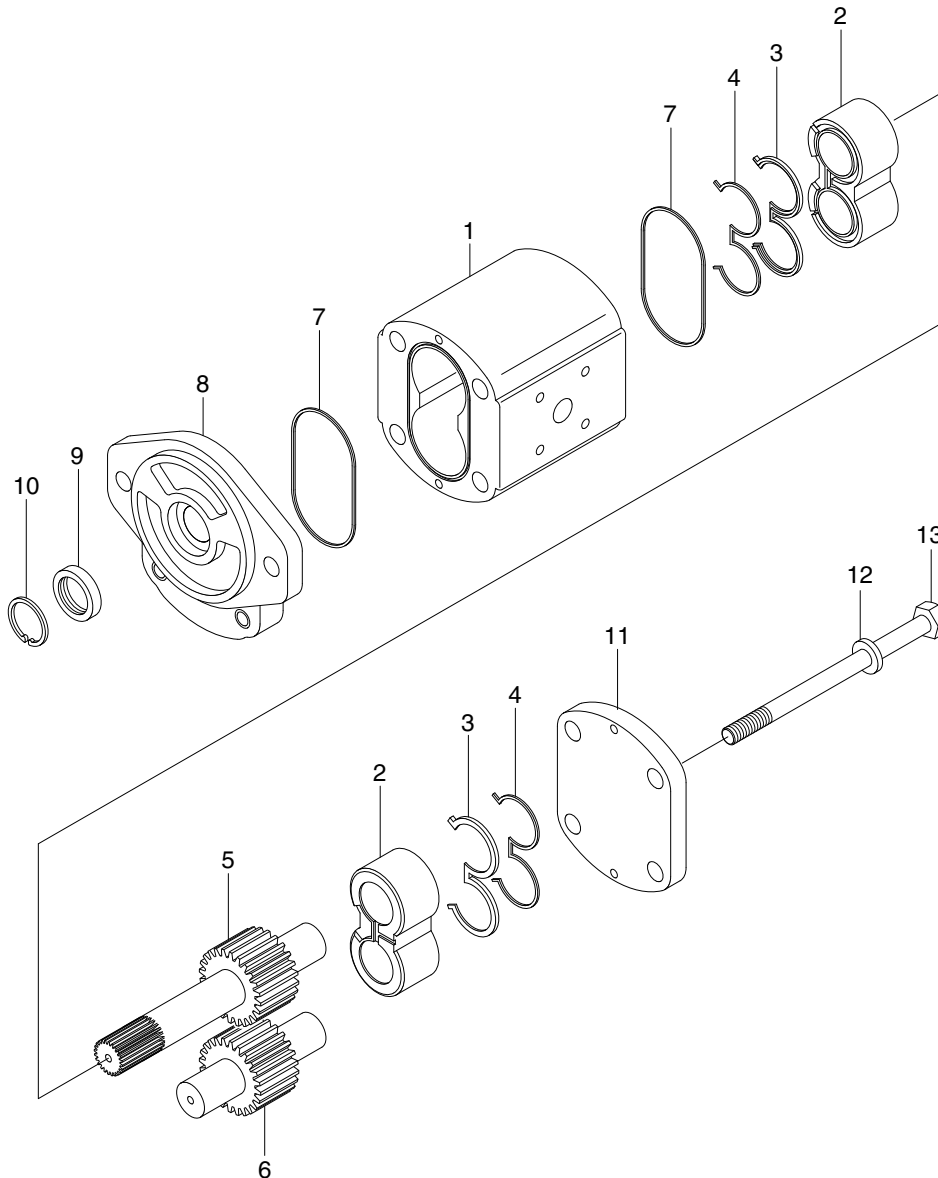
- 5) Open on bleed screw on differential and axle assembly until hydraulic oil starts to flow. Close bleed screw when oil is free of air. Release brake pedal.
- 6) Repeat steps 1-5 for each bleed screw.
- 7) Push either brake pedal and hold down.
- 8) Check hydraulic oil level.



GROUP 4 DISASSEMBLY AND ASSEMBLY

1. AUXILIARY PUMP

1) STRUCTURE



180D7EBP00

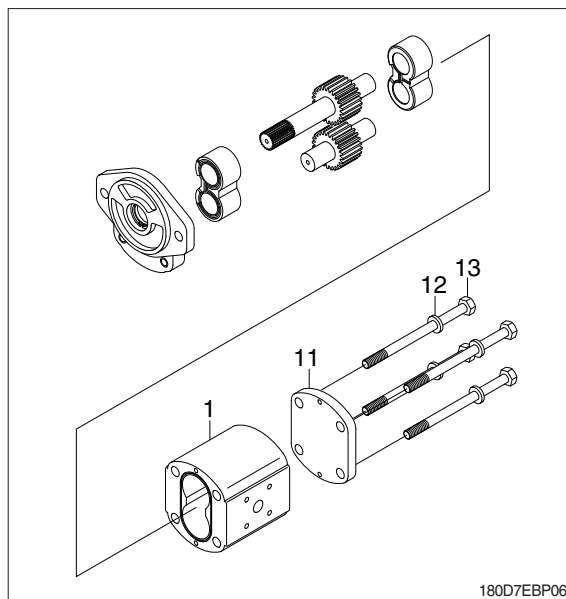
- | | | | |
|---|--------------|----|---------------|
| 1 | Housing | 8 | Front cover |
| 2 | Bush block | 9 | Retainer seal |
| 3 | Backup seal | 10 | Snap ring |
| 4 | Channel seal | 11 | Rear cover |
| 5 | Shaft gear | 12 | Washer |
| 6 | Driven gear | 13 | Bolt |
| 7 | O-ring | | |

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 or 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.

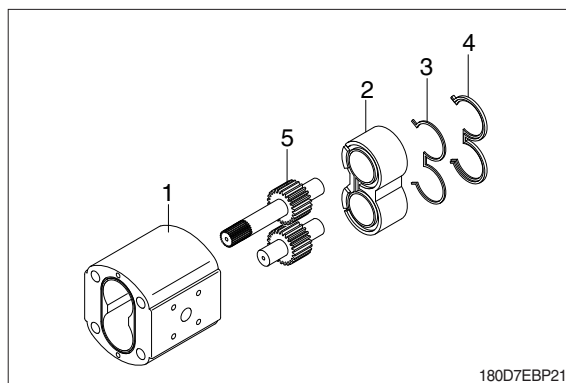
3) DISASSEMBLY

- (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).



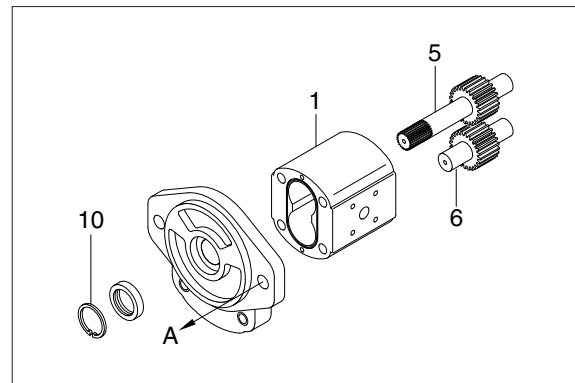
- (3) Disassemble the channel seal (4), back up seal (3) and bush block (2), from the housing (1).

※ 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.



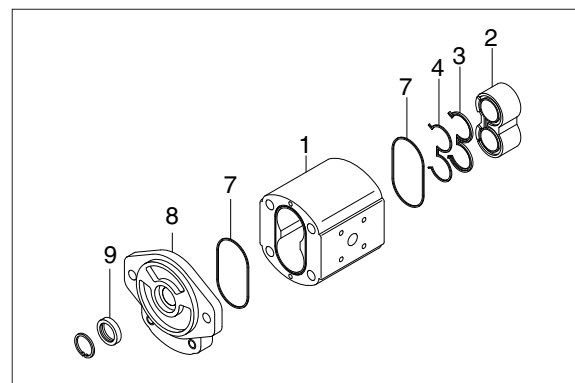
(4) After removing the snap ring (10), take out the shaft gear (5) and the drive gear (6) from the housing (1).

※ For the gear face of the shaft gear (5) and the driven gear (6), inspect for excessive wear, scoring or crack.



(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).



(6) Remove the retainer seal (9) from the front cover (8).

4) ASSEMBLY

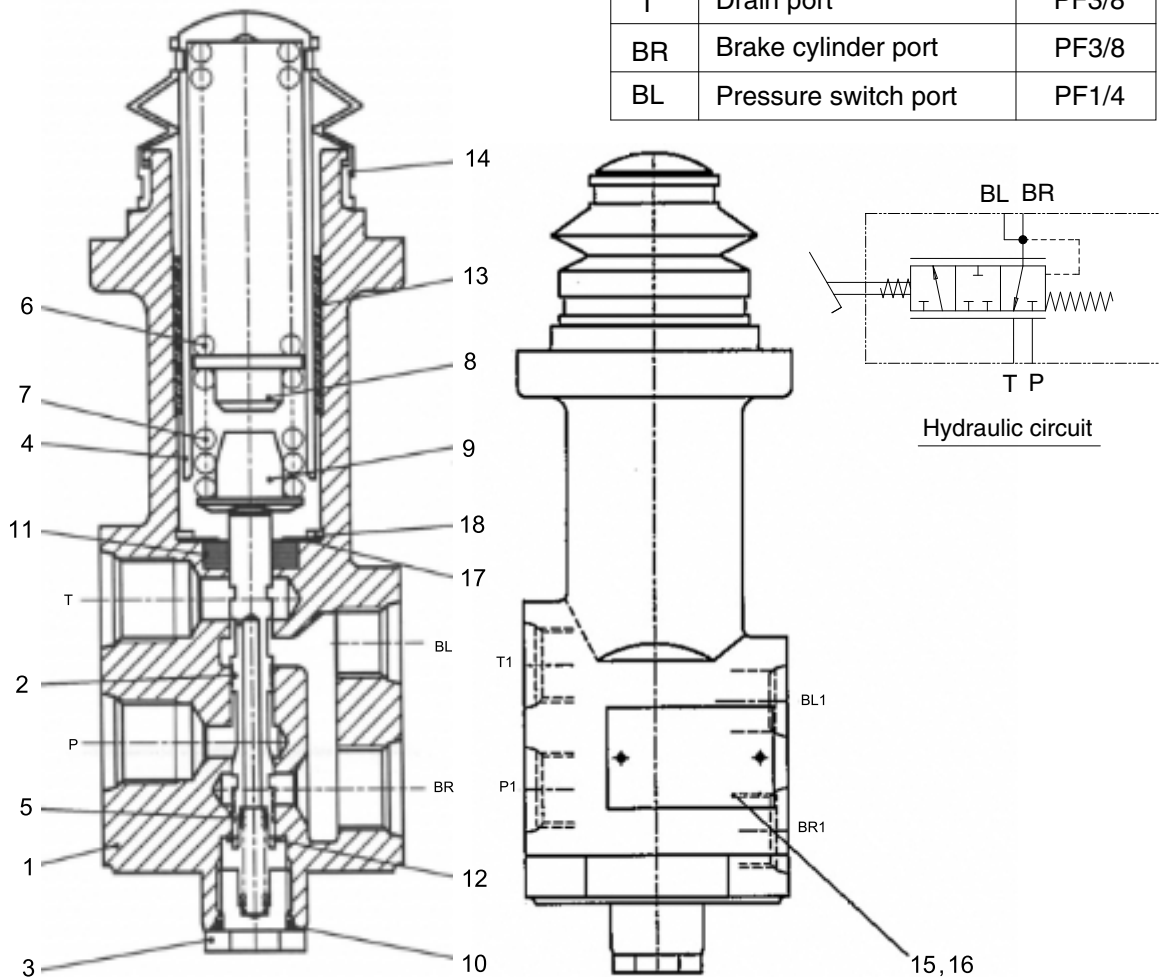
Assembly procedure of the pump is the reverse order of the disassembly procedure.

2. BRAKE VALVE

1) STRUCTURE

(1) DIC drive axle

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



- 1 Valve body
- 2 Spool
- 3 Plug
- 4 Brake holder
- 5 Lower spring
- 6 Main spring

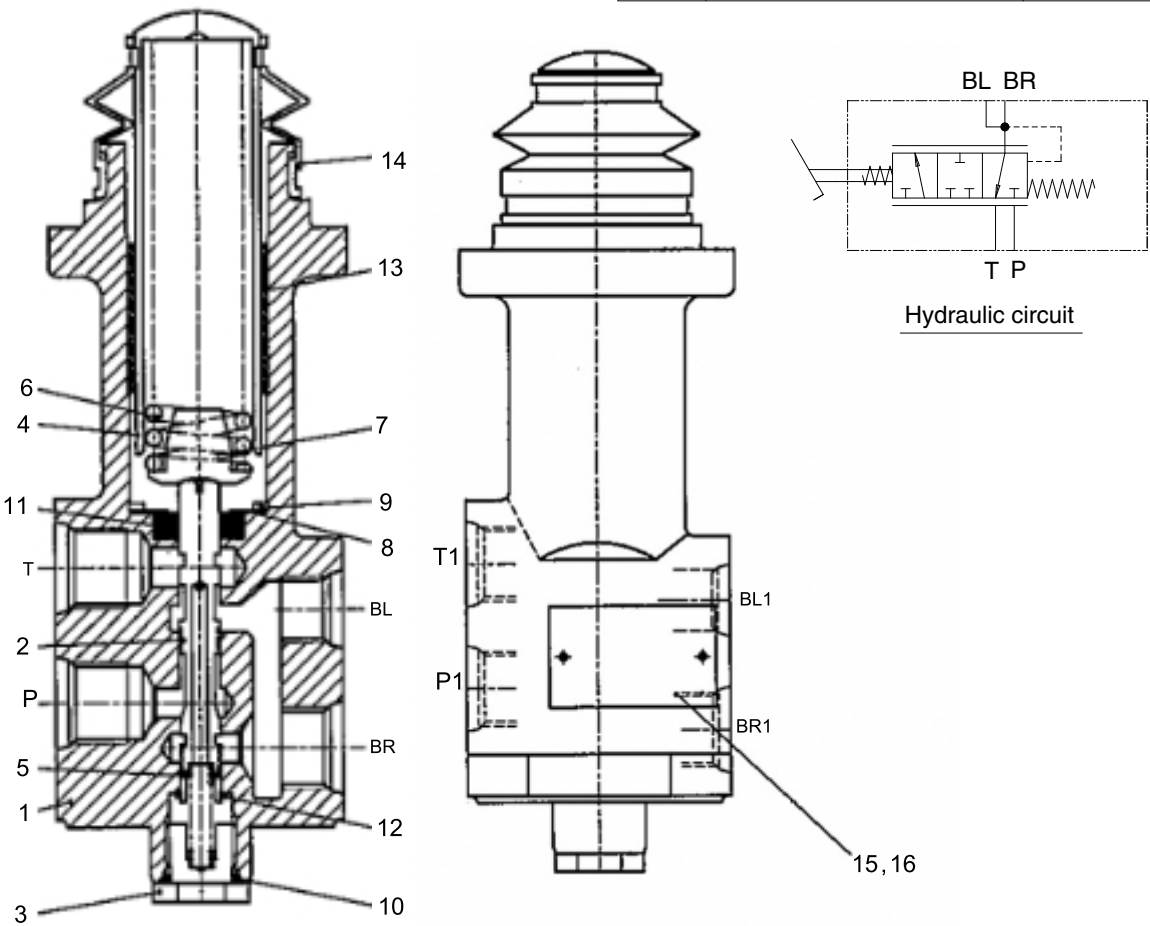
- 7 Main 100 spring
- 8 Spring retainer
- 9 Spring retainer
- 10 O-ring
- 11 Oil seal
- 12 Snap ring

- 13 DU bushing
- 14 Rubber cover
- 15 Name plate
- 16 Drive screw
- 17 Plain washer
- 18 Snap ring

160D9VBS06

(2) Kessler drive axle

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



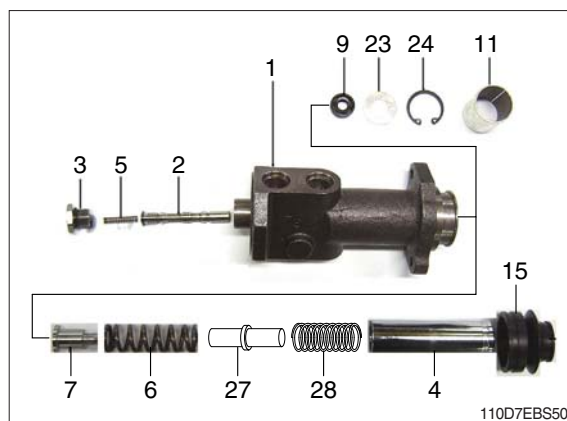
160D9VBS07

- | | | | | | |
|---|--------------|----|-----------------|----|--------------|
| 1 | Valve body | 7 | Spring retainer | 13 | DU bushing |
| 2 | Spool | 8 | Plate spring | 14 | Rubber cover |
| 3 | Plug | 9 | Snap ring | 15 | Name plate |
| 4 | Brake holder | 10 | O-ring | 16 | Drive screw |
| 5 | Lower spring | 11 | Oil seal | | |
| 6 | Main spring | 12 | Snap ring | | |

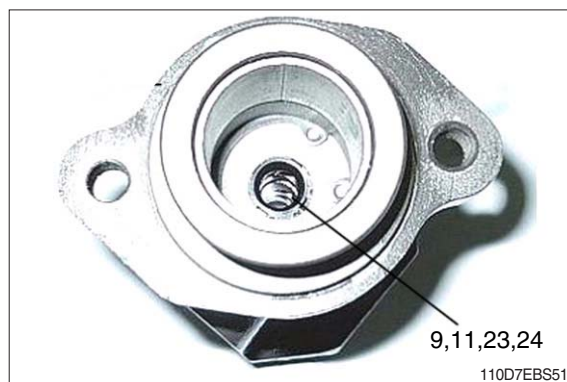
2) REASSEMBLY

(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 Snap ring
- 27 Spring retainer 2 (DIC axle)
- 28 Main spring 2 (DIC axle)



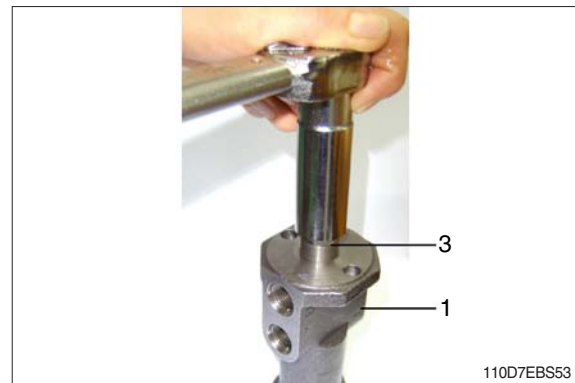
- ① Install oil seal (9), plain washer (23), snap ring (24), DU bushing (11).
- Tool : Jig for dry bearing, snap ring plier.



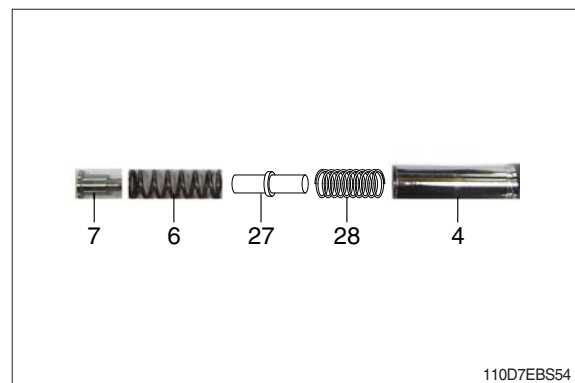
- ② Install spool (2) into body (1).



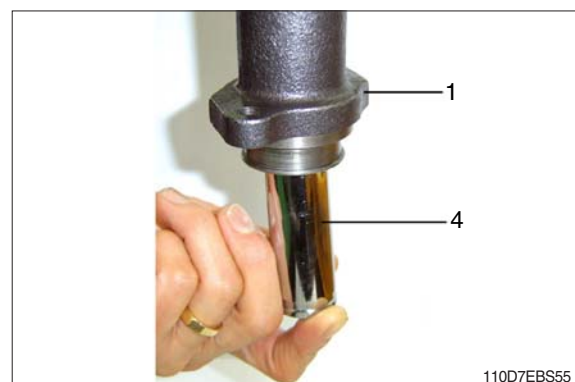
- ③ Tighten plug (3)
- Tool : 19mm spanner
 - Tightening torque : 14.0~16.5 kgf · m
- ※ Press-in the DU bushing (11) with a exclusive jig.
- ※ Be careful of dust and scrap after washing the parts.



- ④ Spring retainer (7, 28), main spring (6, 28) and holder (4).



- ⑤ Holder (4) → Body (1)



- ⑥ Rubber cover (15)

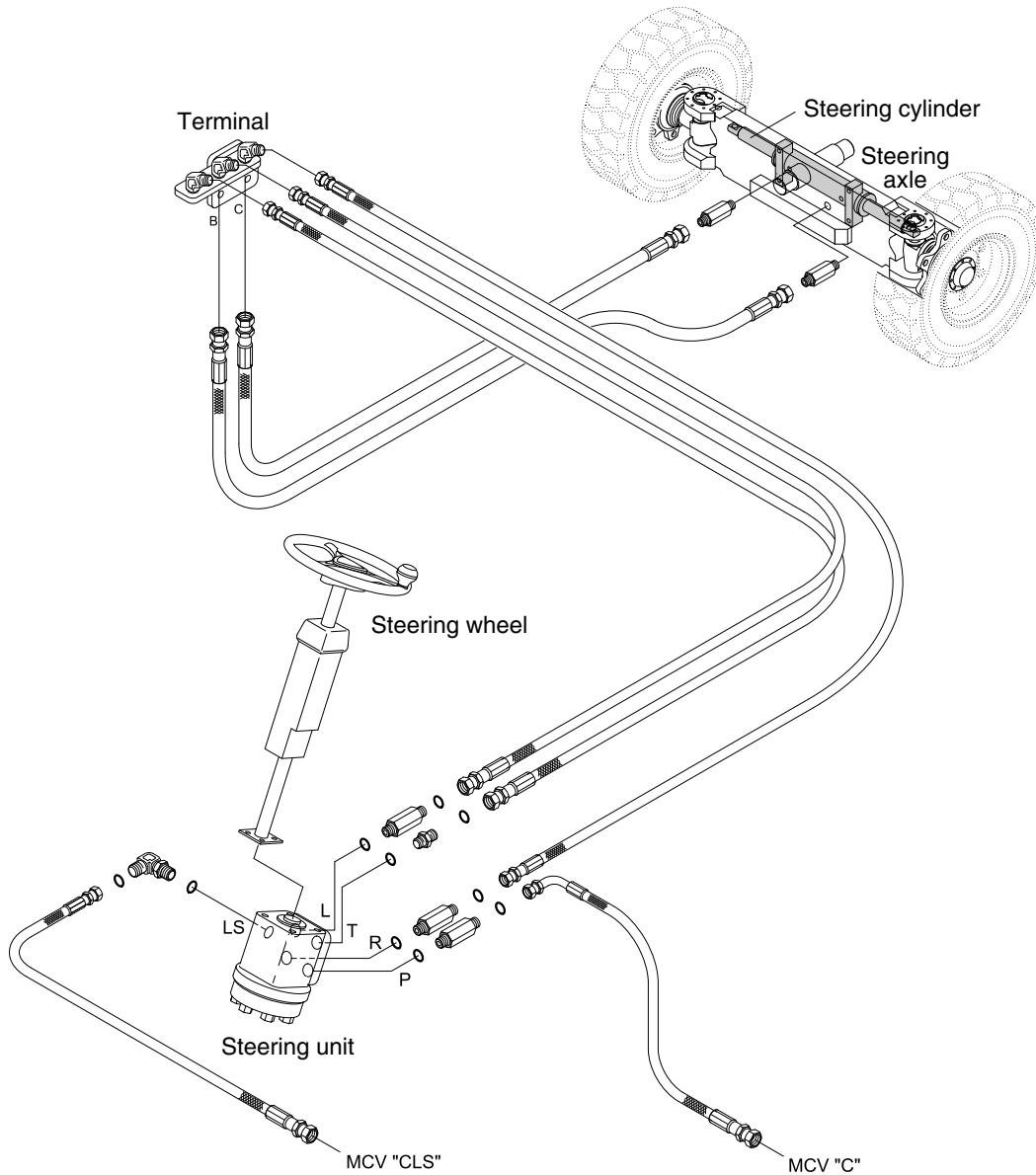


SECTION 5 STEERING SYSTEM

Group 1	Structure and function	5-1
Group 2	Operational checks and troubleshooting	5-10
Group 3	Tests and adjustments	5-18
Group 4	Disassembly and assembly	5-22

GROUP 1 STRUCTURE AND FUNCTION

1. OUTLINE

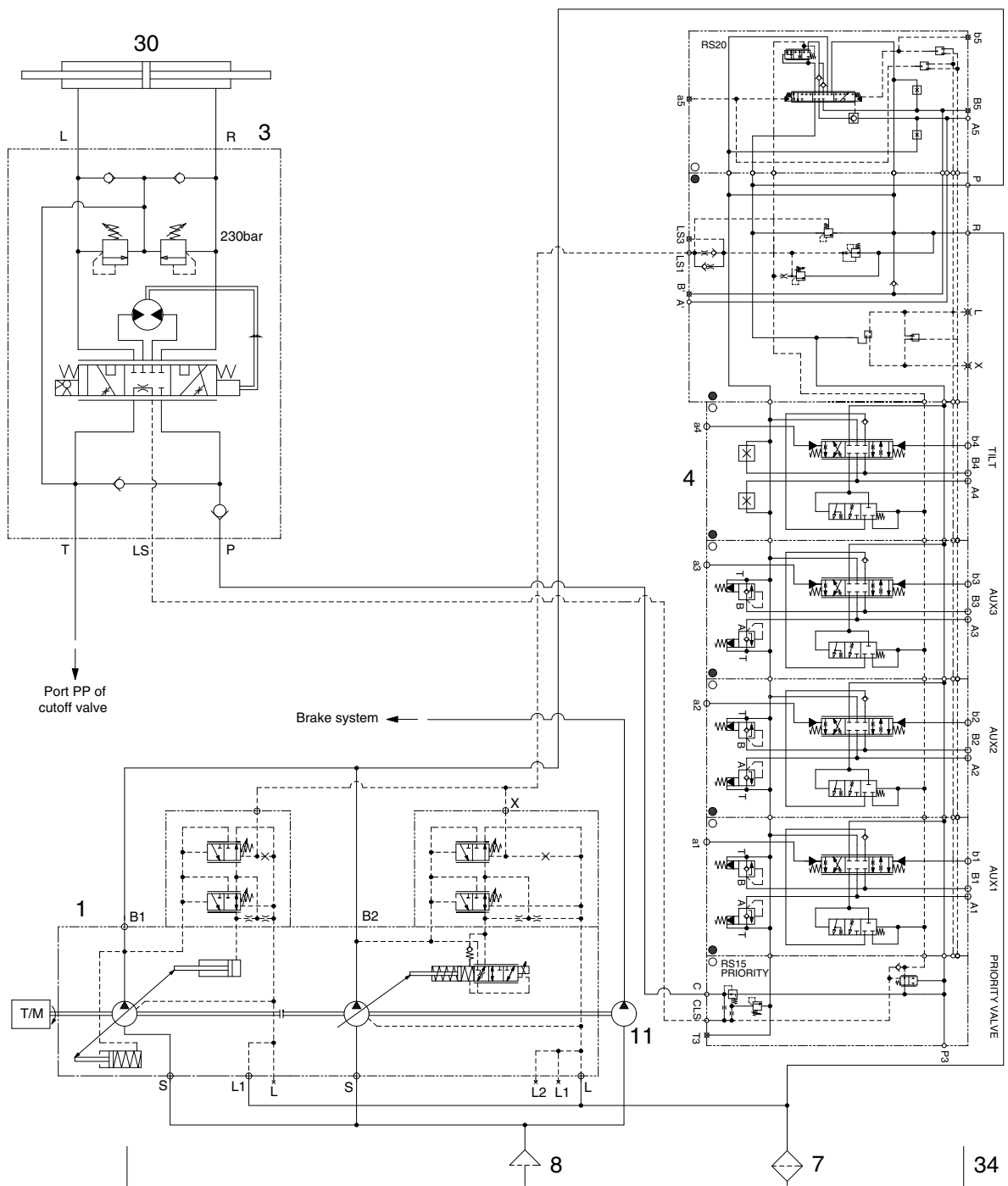


160D9VSS01

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.

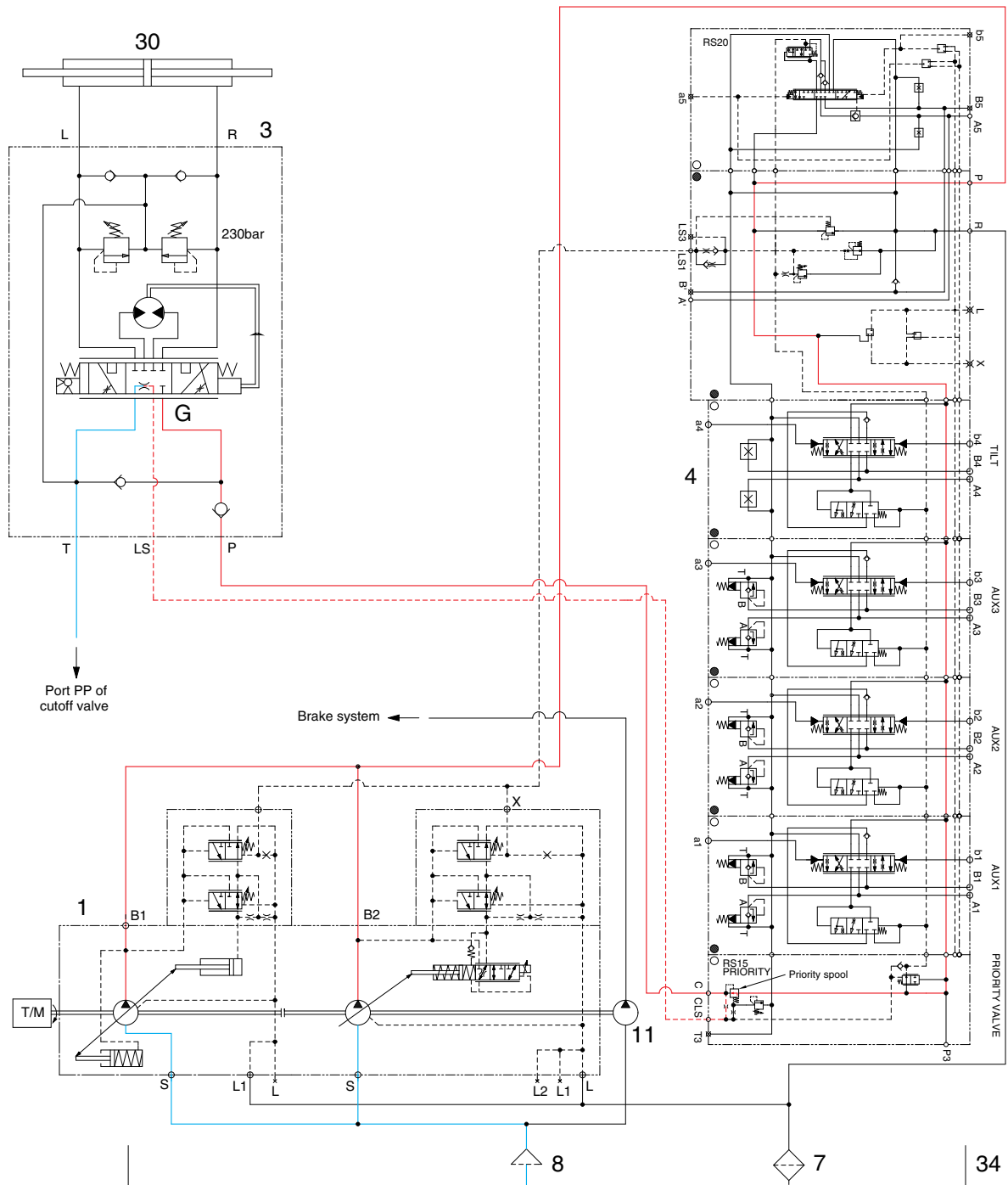
The axle body is unit structure having steering knuckles installed to its both ends by means of king pins. Hub and wheel are mounted through bearing to spindle of knuckle.

2. HYDRAULIC CIRCUIT



160D9VSS02

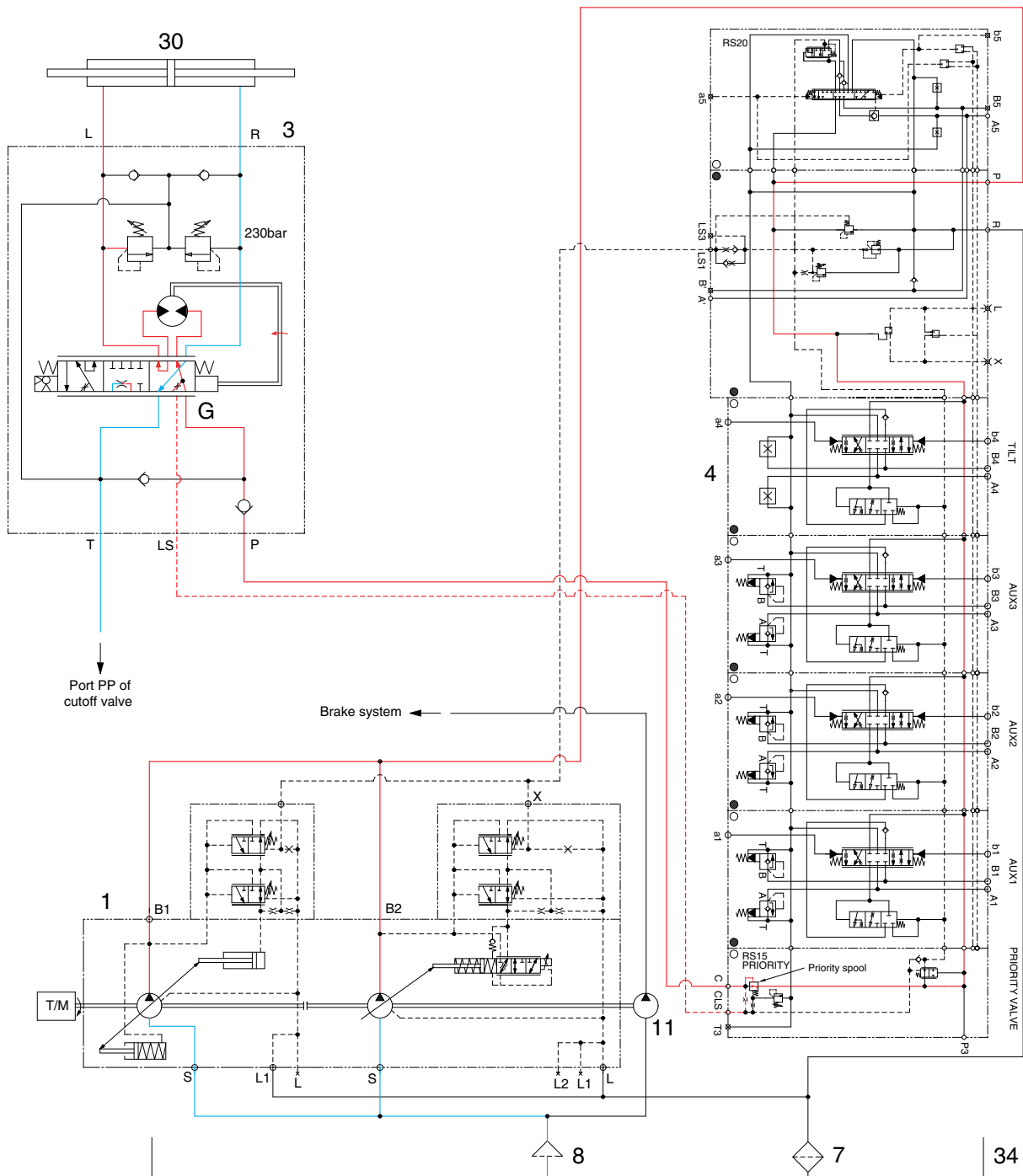
1) NEUTRAL



160D9VSS03

- 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).
- 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).

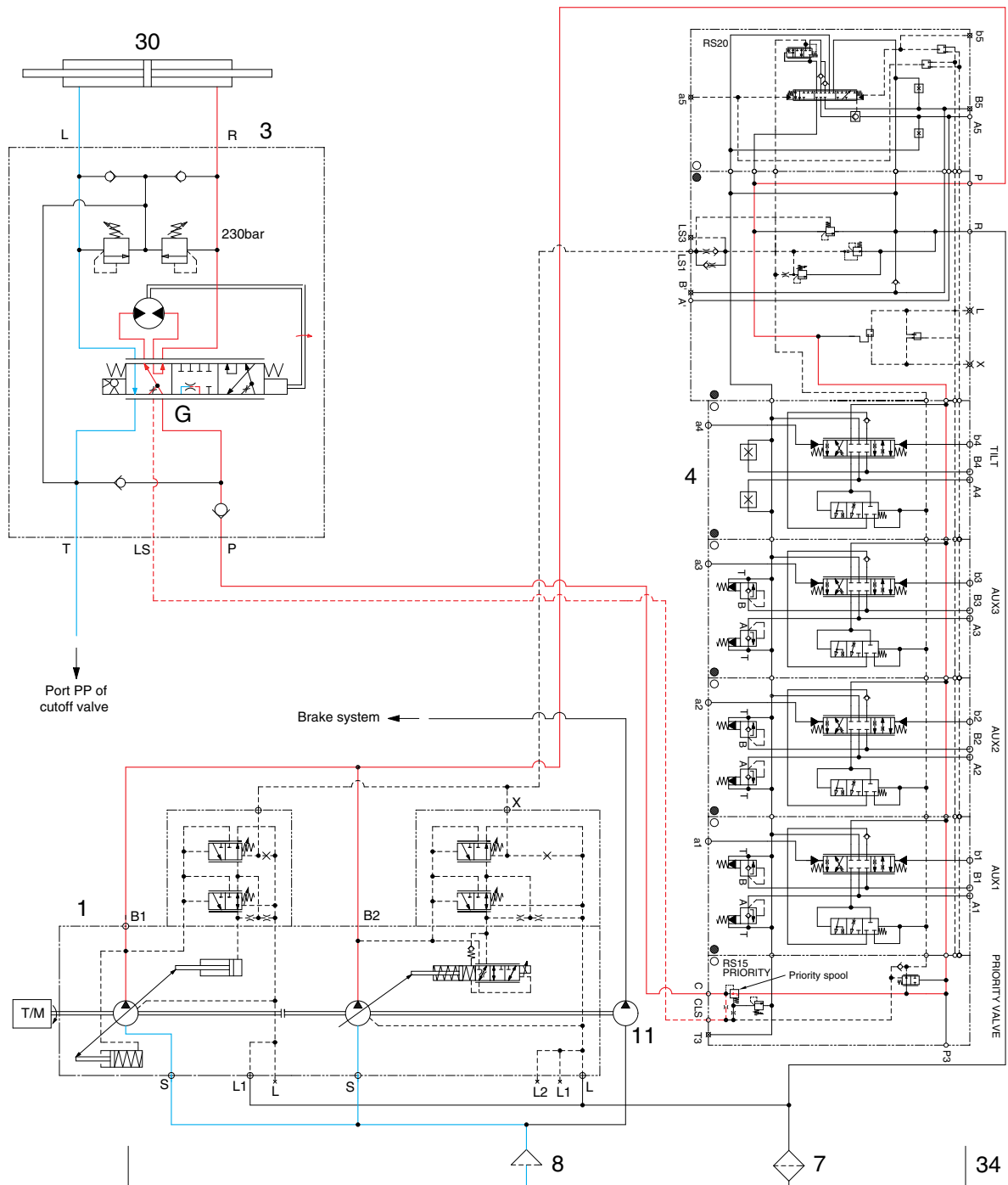
2) LEFT TURN



160D9VSS04

- 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

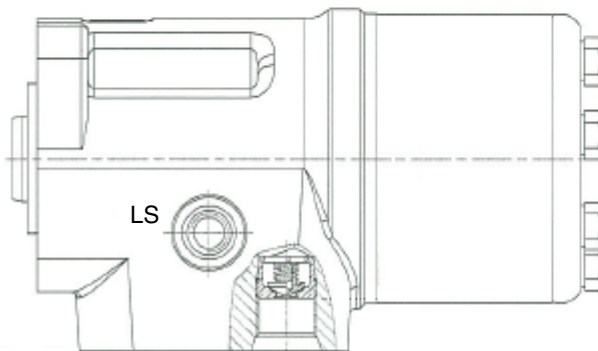
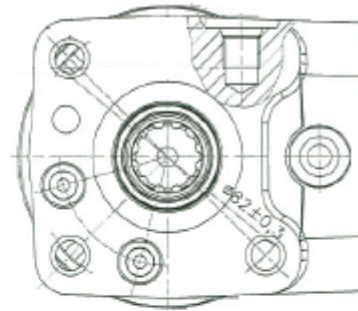
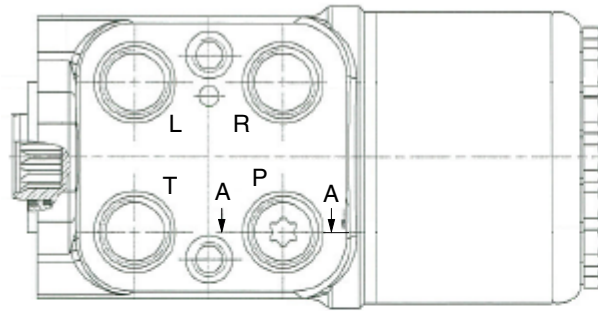


160D9VSS05

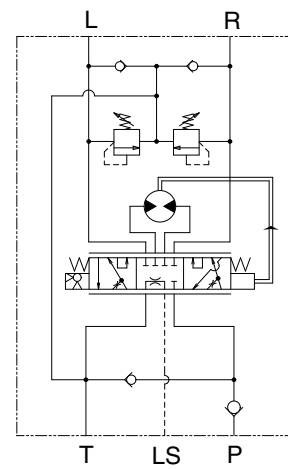
- When the steering wheel is turned to the right, the spool (G) within the steering unit (3) connected with steering column turns in right hand direction.
- At this time, the oil discharged from the main pump (1) flows into the spool (G) in the steering unit through the priority valve built in the MCV (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



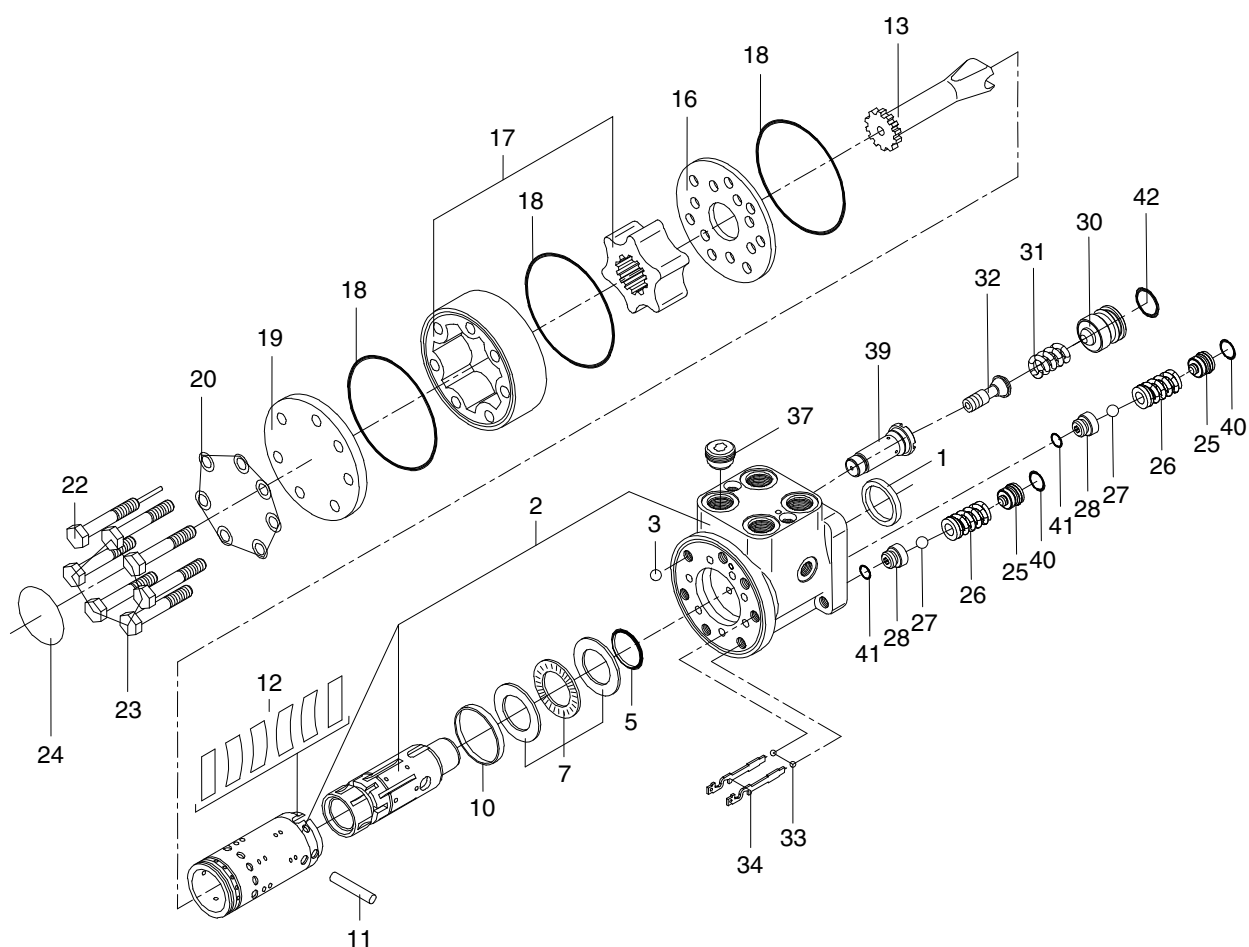
SECTION A-A



160D9VSU01

Port	Port name	Port size
P	Inlet port	PF 3/4 16 UNF
T	Tank port	PF 3/4 16 UNF
L	Left port	PF 3/4 16 UNF
R	Right port	PF 3/4 16 UNF
LS	Load sensing port	PF 7/16 20 UNF

2) PART LIST



160D9VSS10

1	Dust seal ring	18	O-ring	31	Spring
2	Housing and spool/sleeve	19	End cover	32	Piston
3	Ball	20	Washer	33	Ball
5	Shaft seal	22	Pin bolt screw	34	Bushing with pin
7	Bearing assembly	23	Screw	37	Check valve
10	Ring	24	Code label	39	PV cylinder
11	Cross pin	25	Adjusting screw	40	O-ring
12	Spring set	26	Spring with thrust pad	41	O-ring
13	Cardan shaft	27	Ball	42	Plug
16	Distribute plate	28	Seat		
17	Gear wheel set	30	Adjusting screw		

3) 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 (2-2) is connected directly to the drive shaft of steering wheel. It is connected to sleeve (2-3) by cross pin (11) (not in contact with the spool when the steering wheel is at neutral) and spring set (12).

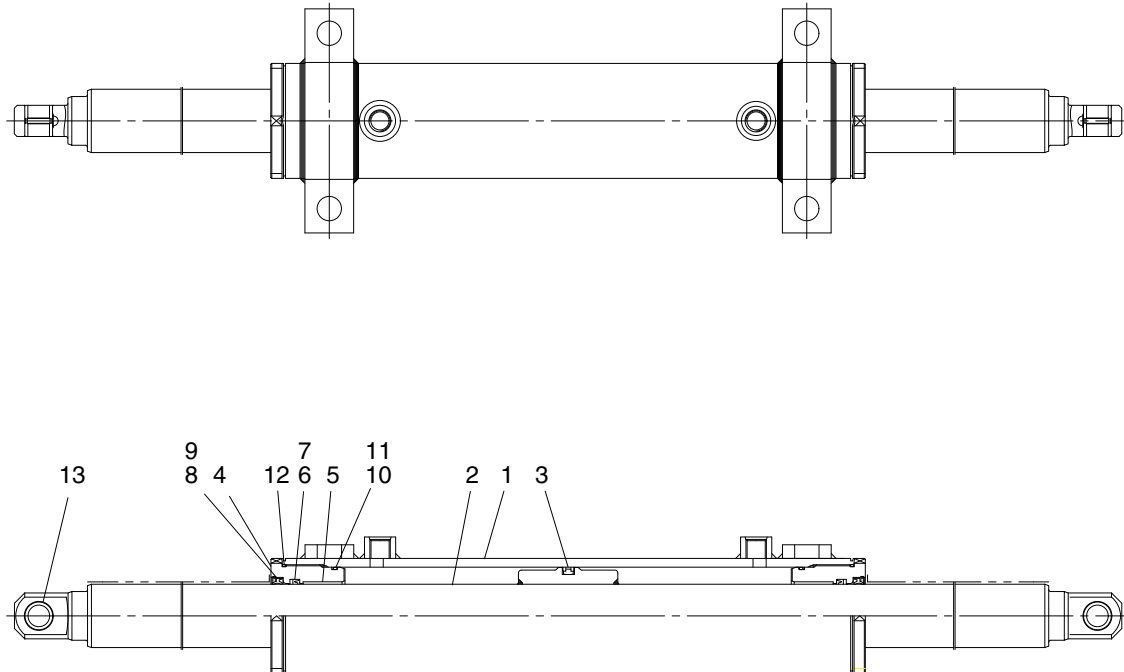
Cardan shaft (13) is meshed at the top with cross pin (11) and forms one unit with sleeve (2-3).

At the same time, it is meshed with gear wheel set (17) of the gerotor set by spline.

There are five ports in valve body. They are connected to the pump circuit, tank circuit, and the head, and left and right steering cylinder and load sensing circuit. 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 | U-packing | 11 | Back up ring |
| 2 | Rod assembly | 7 | Back up ring | 12 | O-ring |
| 3 | Piston seal | 8 | Dust wiper | 13 | Pin bushing |
| 4 | Rod cover | 9 | Stop ring | | |
| 5 | Pin bushing | 10 | O-ring | | |

2) OPERATION

This machine use to cross connected cylinder for steering operation.

The steering cylinder use a rod cover (4) to remove piston and sealed seals. Dust wiper (8) located on the inside of the rod cover 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 rod cover seals against the tube with two O-rings. The rod is sealed against the rod cover with a U-packing (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.

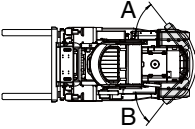
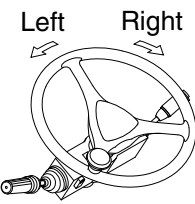
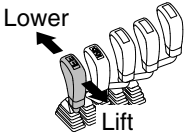
Locate system check in the left column and read completely, following this sequence from left to right.

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	 <p>Run engine at low idle.</p> <p>Turn steering wheel until frames are at maximum right (A) and then left (B) positions.</p> <p>LOOK : Frames must move smoothly in both directions.</p> <p>When steering wheel is stopped, tires must stop.</p> <p>FEEL : Excessive effort must not be required to turn steering wheel.</p> <p>NOTE : It is normal for steering to drift from stops when steering wheel is released.</p>	<p>OK Check completed.</p> <p>NOT OK Go to next check.</p>
Steering system leakage check Heat hydraulic oil to operating temperature. Run engine at high idle.	 <p>Turn steering wheel rapidly until frames are against stop.</p> <p>Hold approximately 2kg on steering wheel.</p> <p>Count steering wheel revolutions for 1 minute.</p> <p>Repeat test in opposite direction.</p> <p>LOOK : Steering wheel should rotate less than 3 rpm.</p> <p>NOTE : Use good judgment; Excessive steering wheel rpm does not mean steering will be affected.</p>	<p>OK Check completed.</p> <p>NOT OK Do steering system leakage test in group 3 to isolate the leakage.</p>
Priority valve low pressure check	<p>Park machine on a hard surface.</p> <p>Hold brake pedal down.</p> <p>Run engine at high idle.</p> <p>Steer machine to the right and left as far as possible.</p> <p>LOOK : Machine must turn at least half way to the right and left stops.</p>	<p>OK Check completed.</p> <p>NOT OK Do priority valve pressure test.</p>
Priority valve high pressure check Run engine at high idle.	 <p>Steer to steering stop and release steering wheel.</p> <p>Lift, tilt hold over relief and observe engine rpm.</p> <p>Turn steering wheel to steering stop and hold, observe engine rpm.</p> <p>LOOK : Steering stall engine rpm must be higher than hydraulic stall rpm.</p>	<p>OK Check completed.</p> <p>NOT OK Priority pressure is set too high. Do priority valve pressure test.</p>

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 Failed steering pump Failed main pump drive Stuck priority valve spool Broken priority valve spring Relief valve in steering valve stuck open.	Add recommended oil. Remove and inspect return filter for metal pump particles. Do main pump flow test. Remove and inspect priority valve spool. Remove and inspect spring. Do relief cartridge leakage test.
No hydraulic functions steering normal	Stuck open system relief valve Locked safety valve Plugged pilot line filter Failed hydraulic pump Low secondary pressure of RCV	Replace relief valve. Unlock safety valve. Inspect and replace. Remove and inspect the pump. Check the pressure and replace if necessary.

Problem	Cause	Remedy
Slow or hard steering	Too much friction in the mechanical parts of the machine Cold oil Low priority valve pressure setting Worn hydraulic pump Sticking priority valve spool Broken priority valve spring	Lubricate bearings and joints of steering column or repair if necessary. Check steering column installation. Warm the hydraulic oil. Do priority valve pressure test. Clean or replace cartridge in steering valve. Do hydraulic pump performance check. Remove and inspect. Remove and inspect.
Constant steering to maintain straight travel	Air in system Leakage in steering system Worn steering unit Leaf spring without spring force or broken Spring in double shock valve broken Gear wheel set worn Cylinder seized or piston seals worn	Check for foamy oil. Do steering system leakage check. Do steering system leakage check. Do steering unit neutral leakage test in group 3. Replace leaf springs. Replace shock valve. Replace gear wheel set. Replace defects parts.
Slow steering wheel movement will not cause any frame movement	Leakage in steering unit gerotor Worn steering unit gerotor	Do steering system leakage check. 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 Lack of oil in steering unit Leakage in steering system	Remove and inspect. Start engine and check steering operation. 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 or 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

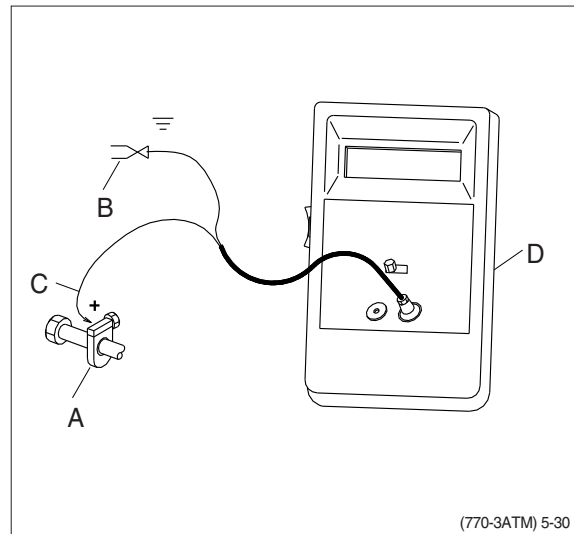
A : Clamp on tachometer.

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.



2) DIGITAL THERMOMETER INSTALLATION

- Service equipment and tools

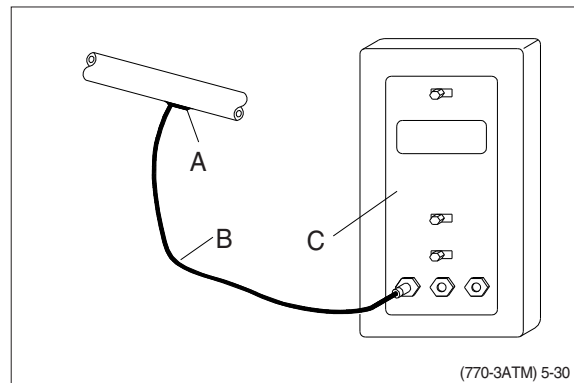
Digital thermometer

A : Temperature probe.

Fasten to a bare metal line using a tie band. Wrap with shop towel.

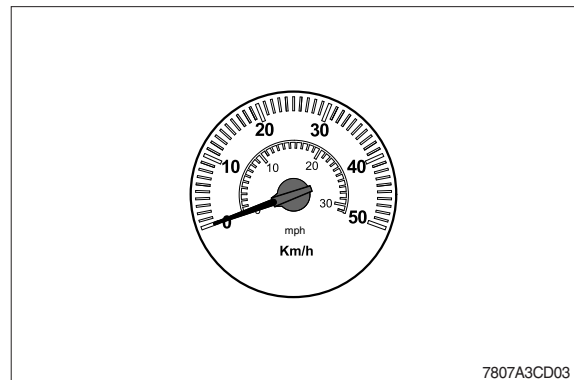
B : Cable.

C : Digital thermometer.



3) DISPLAY MONITOR TACHOMETER

The display monitor tachometer is accurate enough for test work.



3. STEERING UNIT LEAKAGE TEST

· SPECIFICATION

Oil temperature $45 \pm 5^{\circ}\text{C}$ ($113 \pm 9^{\circ}\text{F}$)

Engine speed High idle

Maximum leakage 7.5 l/min (2 gpm)

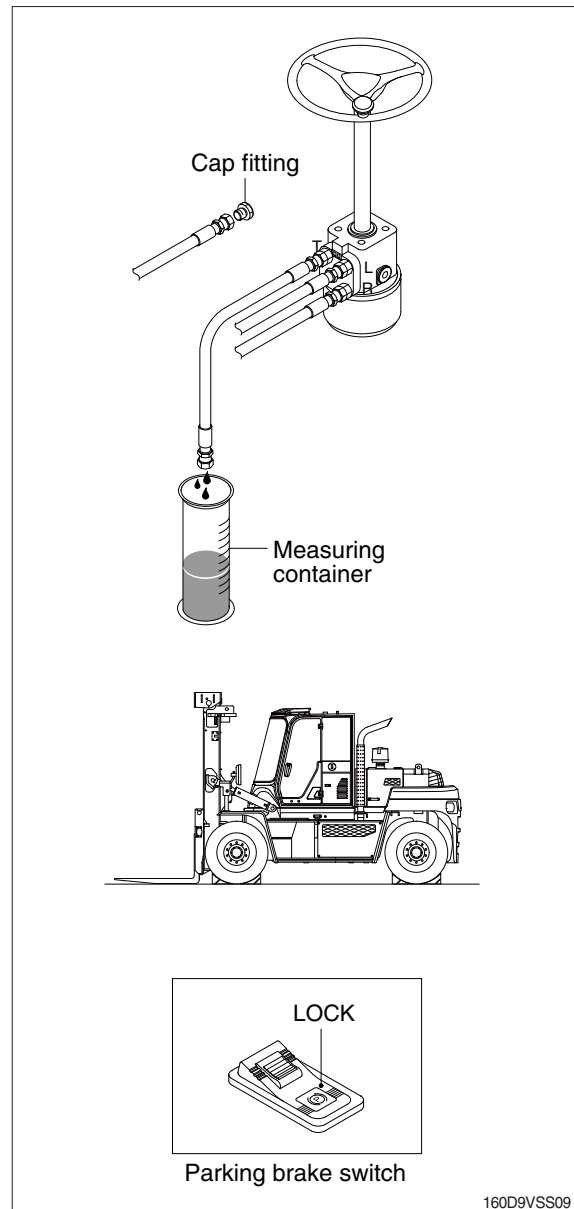
· GAUGE AND TOOL

Temperature reader

Measuring container (Approx. 20 l)

Stop watch

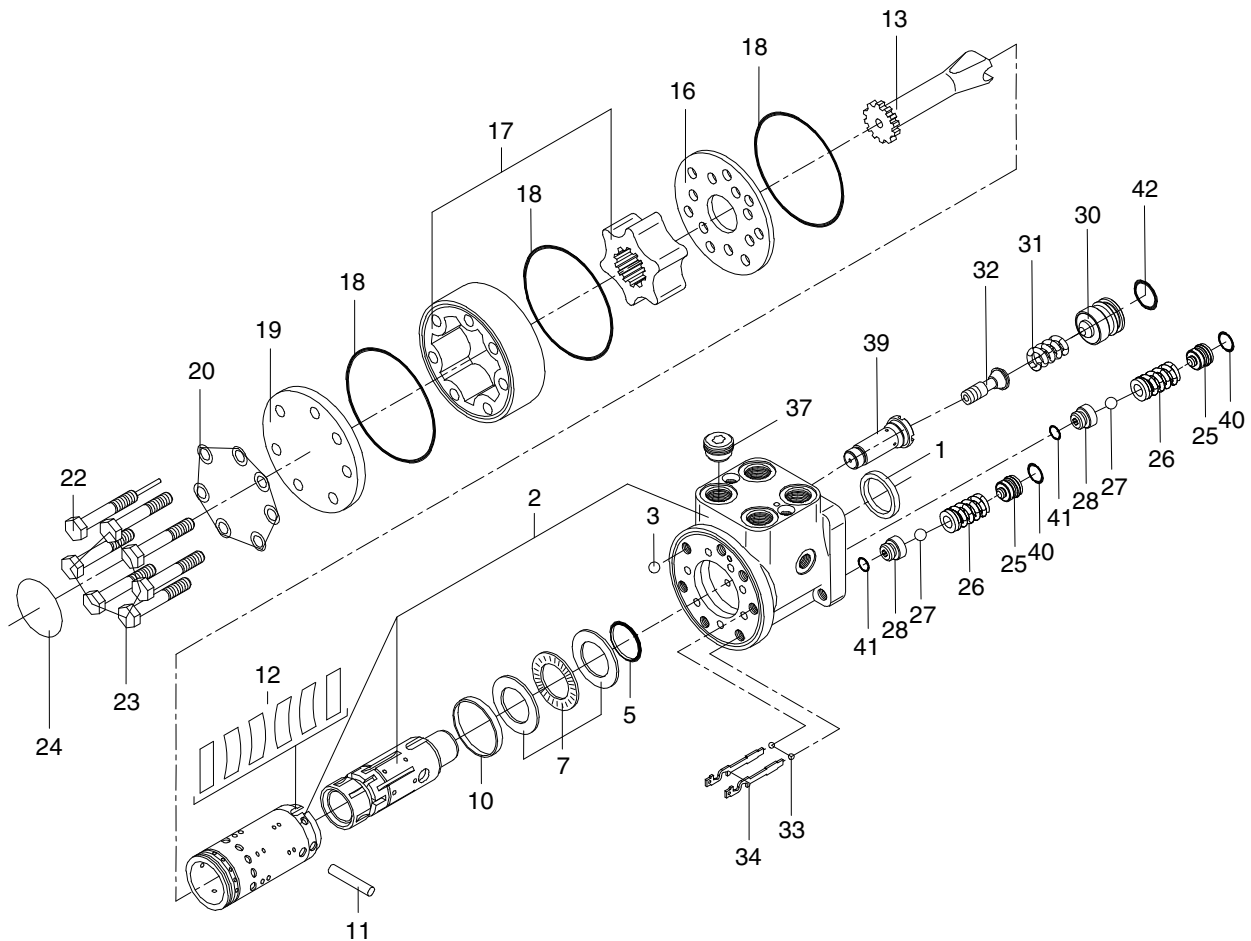
- 1) Install temperature reader.
(See temperature reader installation procedure in this group).
- 2) Heat hydraulic oil to specifications.
- 3) Disconnect return hose from fitting.
Install cap fitting.
- 4) Run engine at specifications. Rotate steering wheel completely to the right (or left) approximately $1.2 \text{ kgf} \cdot \text{m}$ of force.
Measure oil flow from return hose for 1 minute.
- 5) If leakage is greater than specifications, repair or replace steering unit.



GROUP 4 DISASSEMBLY AND ASSEMBLY

1. STEERING UNIT

1) STRUCTURE

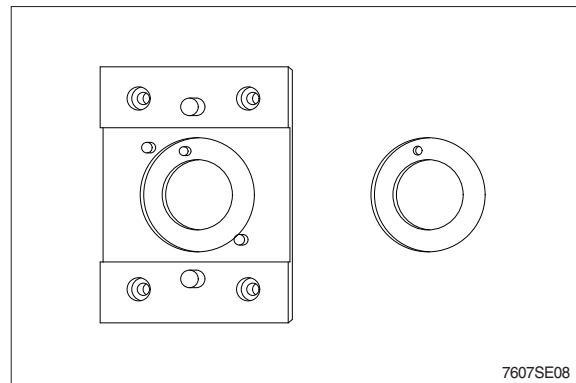


160D9VSS10

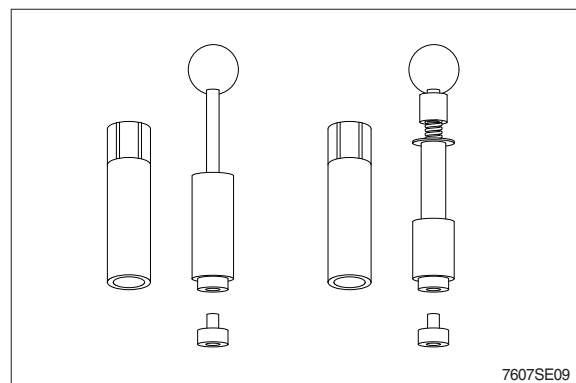
1	Dust seal ring	18	O-ring	31	Spring
2	Housing and spool/sleeve	19	End cover	32	Piston
3	Ball	20	Washer	33	Ball
5	Shaft seal	22	Pin bolt screw	34	Bushing with pin
7	Bearing assembly	23	Screw	37	Check valve
10	Ring	24	Code label	39	PV cylinder
11	Cross pin	25	Adjusting screw	40	O-ring
12	Spring set	26	Spring with thrust pad	41	O-ring
13	Cardan shaft	27	Ball	42	Plug
16	Distribute plate	28	Seat		
17	Gear wheel set	30	Adjusting screw		

2) TOOLS

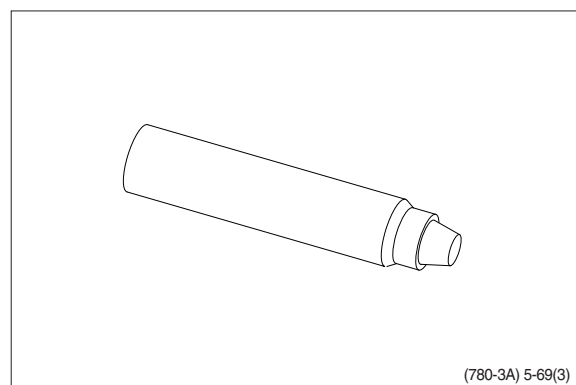
(1) Holding tool + Guide ring



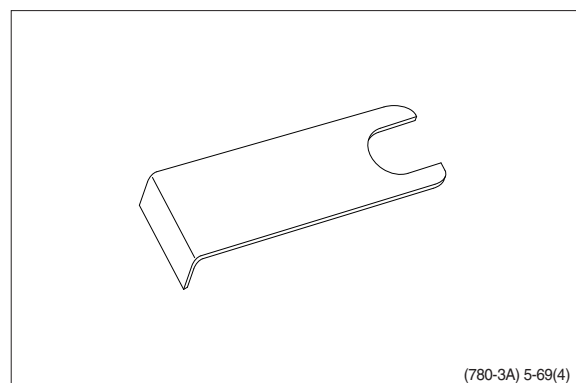
(2) Assembly tool for O-ring and kin-ring.



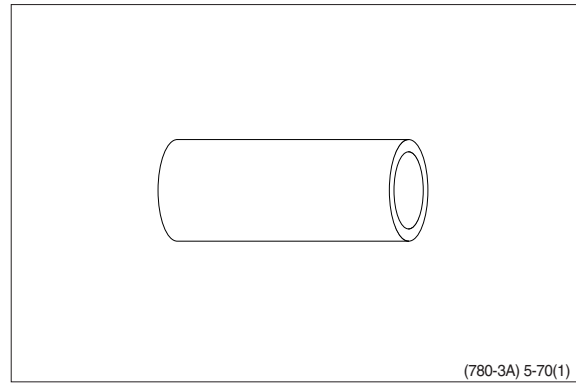
(3) Assembly tool for lip seal.



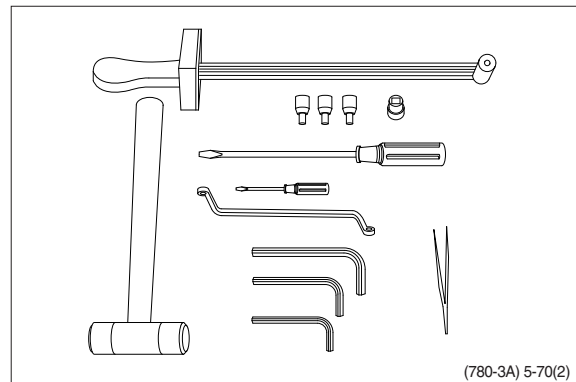
(4) Assembly tool for cardan shaft.



(5) Assembly tool for dust seal.

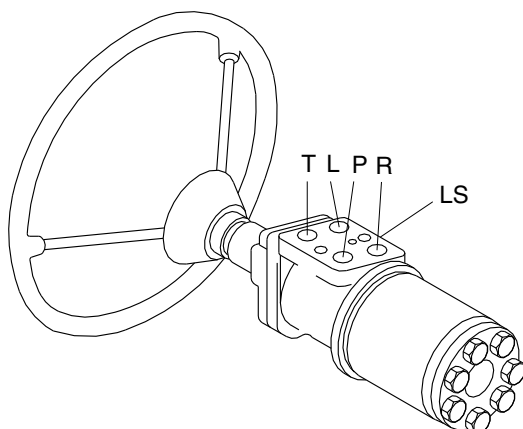


(6) Torque wrench 0~7.1 kgf · m
(0~54.4 lbf · ft)
13 mm socket spanner
6, 8 mm and 12 mm hexagon sockets
12 mm screwdriver
2 mm screwdriver
13 mm ring spanner
6, 8 and 12 mm hexagon socket spanners
Plastic hammer
Tweezers



3) TIGHTENING TORQUE AND HYDRAULIC CONNECTIONS

(1) Hydraulic connections



L : Left port
R : Right port
T : Tank port
P : Pump port
LS : Load sensing port

160D9VSU02

(2) Tightening torque

Screwed connection	Max. tightening torque [kgf·m (lbf·ft)]			
	With cutting edge	With copper washer	With aluminum washer	With O-ring
1/4 BSP.F	4.1 (29.7)	2.0 (14.5)	3.1 (22.4)	-
3/8 BSP.F	6.1 (44.1)	2.0 (14.5)	5.1 (36.9)	-
1/2 BSP.F	10.2 (73.8)	3.1 (22.4)	8.2 (59.3)	-
7/16-20 UNF	-	2.0 (14.5)	-	-
3/4-16 UNF	-	6.1 (44.1)	-	-
M 12×1.5	4.1 (29.7)	2.0 (14.5)	3.1 (22.4)	2.0 (14.5)
M 18×1.5	7.1 (51.4)	2.0 (14.5)	5.1 (36.9)	5.1 (36.9)
M 22×1.5	10.2 (73.8)	3.1 (22.4)	8.2 (59.3)	7.1 (51.4)

4) 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.

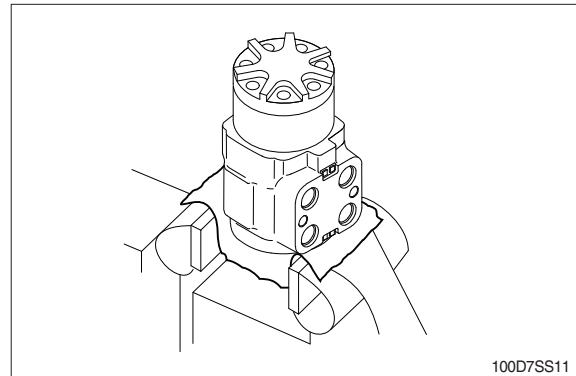
Cleanliness is extremely important for repairing. Work in a clean area. Before disconnecting the lines, clean port area of orbitrol thoroughly. Use a wire brush to remove foreign against flaw and nick by dropping down.

▲ Be careful not to get hurt by the machined edge of orbitrol.

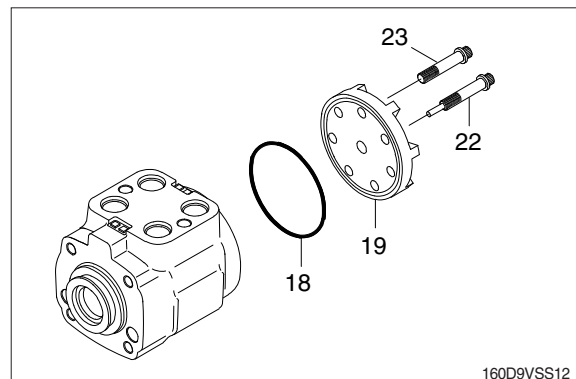
(1) Repair of backside

(Number) shows parts number of attached parts drawing and list, page 5-22.

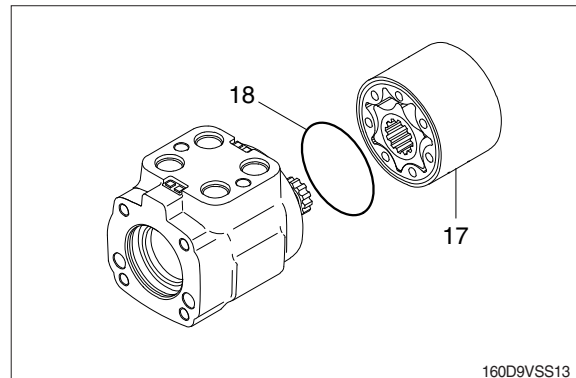
- ① Clamp orbitrol in vise with end cap to up.
Clamp lightly on edges of port face sides.
Use protective material on vise jaws. Do not over tighten jaws.



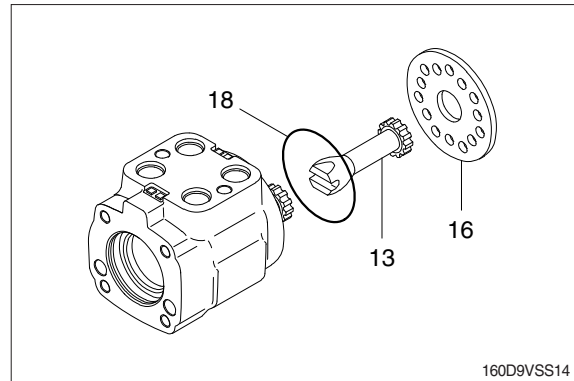
- ② Remove screw (23) and pin bolt screw (22).
- ③ Remove end cap (19).
- ④ Replace O-ring (18) with new one at end cap (19).



- ⑤ Remove spacer (s) (5).
Remove gear wheel set (17) and replace O-ring (18).

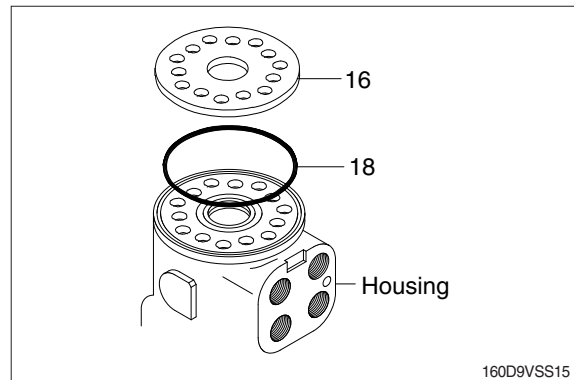


- ⑥ Remove cardan shaft (13).
- ⑦ Remove distribute plate (16).
- ⑧ Replace O-ring (18) in housing.



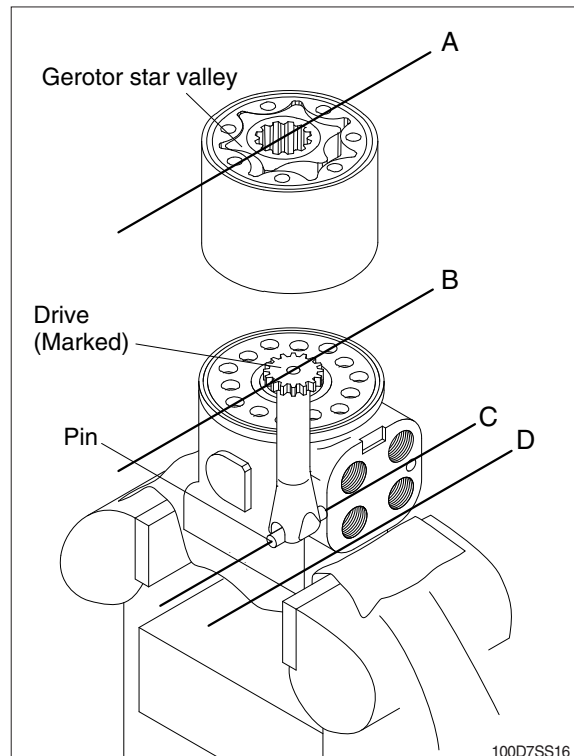
- ⑨ Put distribute plate (16) on housing (10). Align bolt holes in distribute plate (16) with tapped holes in housing.

※ Pitch dia. of bolt holes and oil holes in distribute plate (16) is different. (Larger pitch dia. is for bolt holes).



- ⑩ Install cardan shaft (13) and engage with cross pin (11).
- ⑪ Mark cardan shaft (13) spline end parallel to cross pin (11) to make sure relationship of cardan shaft (13) and cross pin (11). Refer right figure 6 line B and line C.
- ⑫ Align star valleys (right figure line A) with marked cardan shaft (13) (right figure line B). Star valleys must align with cross pin (11). 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.



- ⑬ Install end cover (19) on gear wheel set (17) aligning holes.

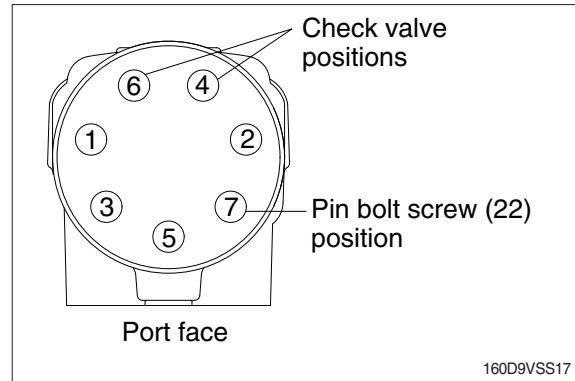
- ⑭ Install screw (23) and pin bolt screw (22) in end cover (19). Tighten screws to 15 N·m (1.5 kgf·m) in advance. Then tighten screws to tightening torque in sequence shown right figure.

Tightening torque (Standard type)

· Tightening torque : 30 ± 6 N·m
(3.1 ± 0.6 kgf·m)

- ⚠ If pin bolt screw (22) position is mistaken, it is possible to cause big trouble.

- ⑮ Install steering wheel to spool and make sure rotation smoothly.

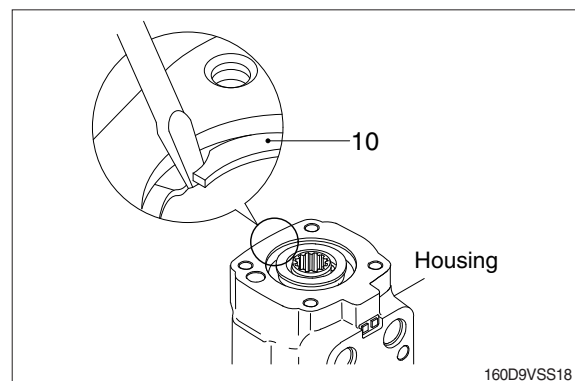


(2) Repair of front side

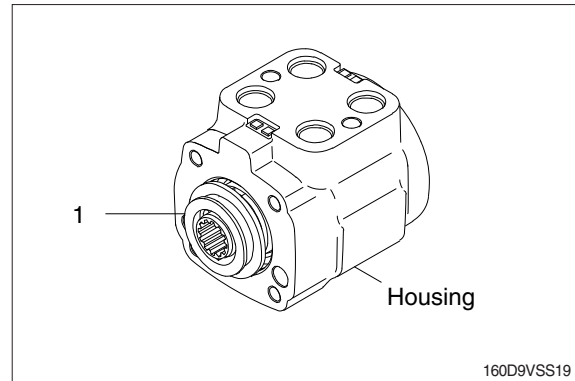
(Number) shows parts number of attached parts drawing and list page 5-22.

- ① Use a thin bladed screwdriver to pry retaining ring (10) from housing.

- ⚠ Retaining ring (10) may burst out from housing. Use goggles to protect your eyes.



- ② Remove dust seal ring (1) from housing.



- ③ Replace shaft seal (5) with new one.

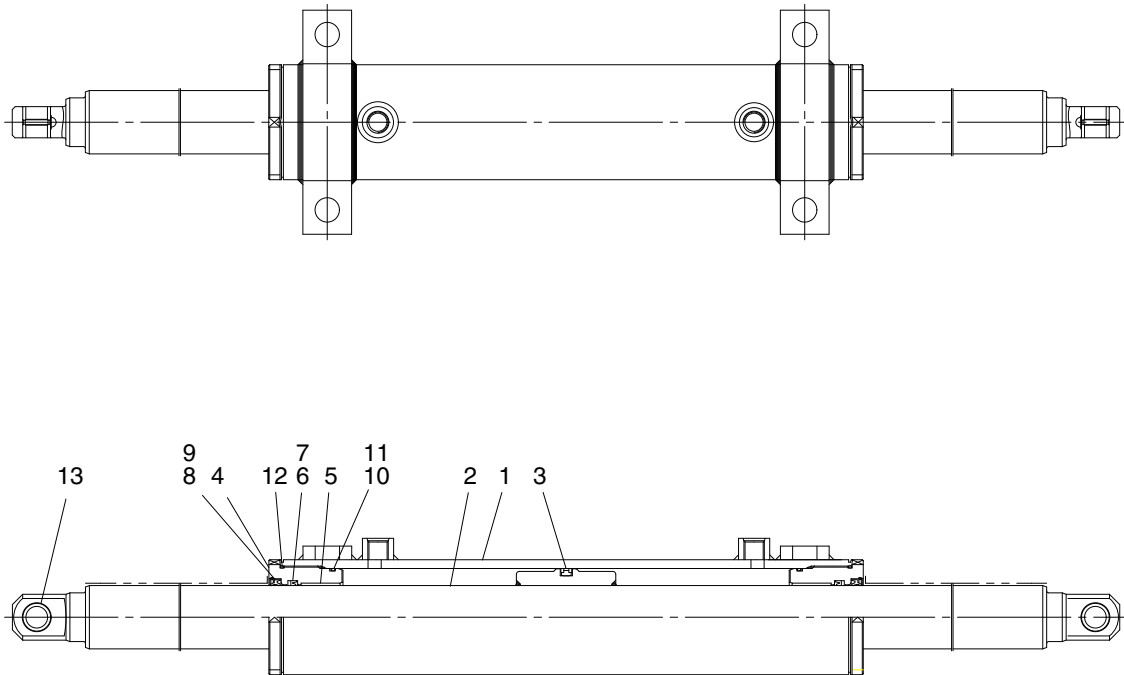
▲ Don't disassemble cylinder relief valve.
When the relief valve is disassembled by customer, the customer shall take responsibility for any trouble for relief valve.

▲ 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 N·m capacity)
 - 5/12" socket
 - Screw driver
 - Plastic hammer or rubber hammer
 - Grease
 - Vice
 - Marker pen

2. STEERING CYLINDER

1) STRUCTURE



100D7SS06

- | | | | | | |
|---|---------------|----|--------------|----|--------------|
| 1 | Tube assembly | 6 | U-packing | 11 | Back up ring |
| 2 | Rod assembly | 7 | Back up ring | 12 | O-ring |
| 3 | Piston seal | 8 | Dust wiper | 13 | Pin bushing |
| 4 | Rod cover | 9 | Stop ring | | |
| 5 | Pin 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 rod 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

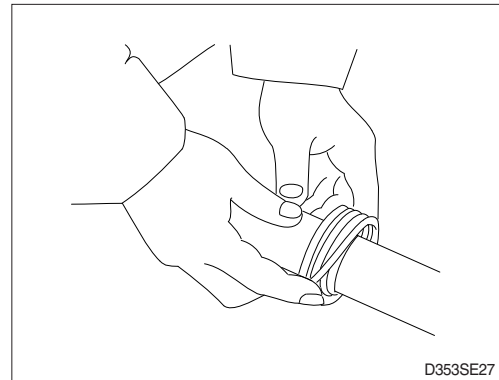
mm (in)

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

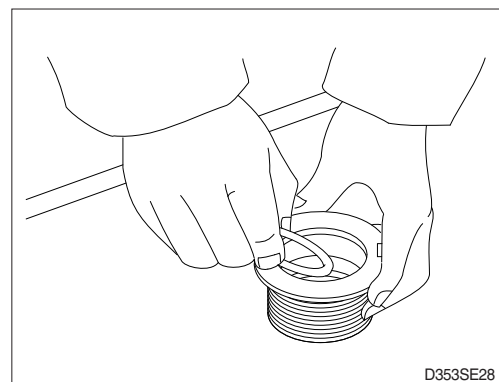
4) ASSEMBLY

- (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.

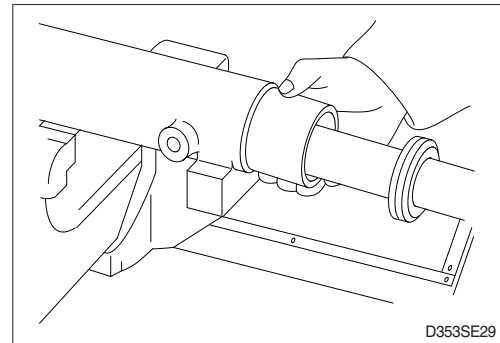


- (2) Install the rod seal to the position in the rod cover applying a slight coat with grease prior to install.

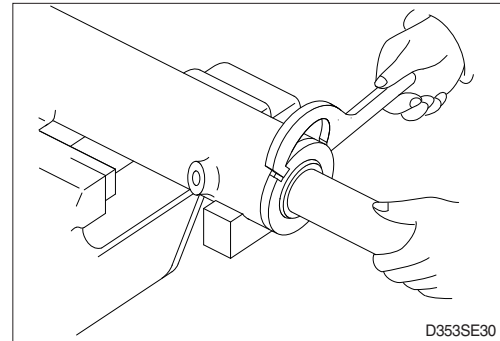


(3) Install the dust wiper to the rod cover using a special installing tool. Coat the dust wiper with grease slightly before installing.

(4) Using a special tool, install rod cover assembly into the cylinder tube.

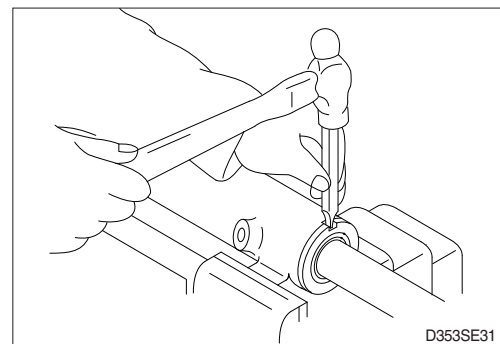


(5) Using a hook spanner, install the rod cover, and tighten it with torque $60 \pm 6 \text{ kgf} \cdot \text{m}$ ($434 \pm 43 \text{ lbf} \cdot \text{ft}$).



(6) After the rod cover was installed to the cylinder tube, calk at the tube end into the groove on the rod cover 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.

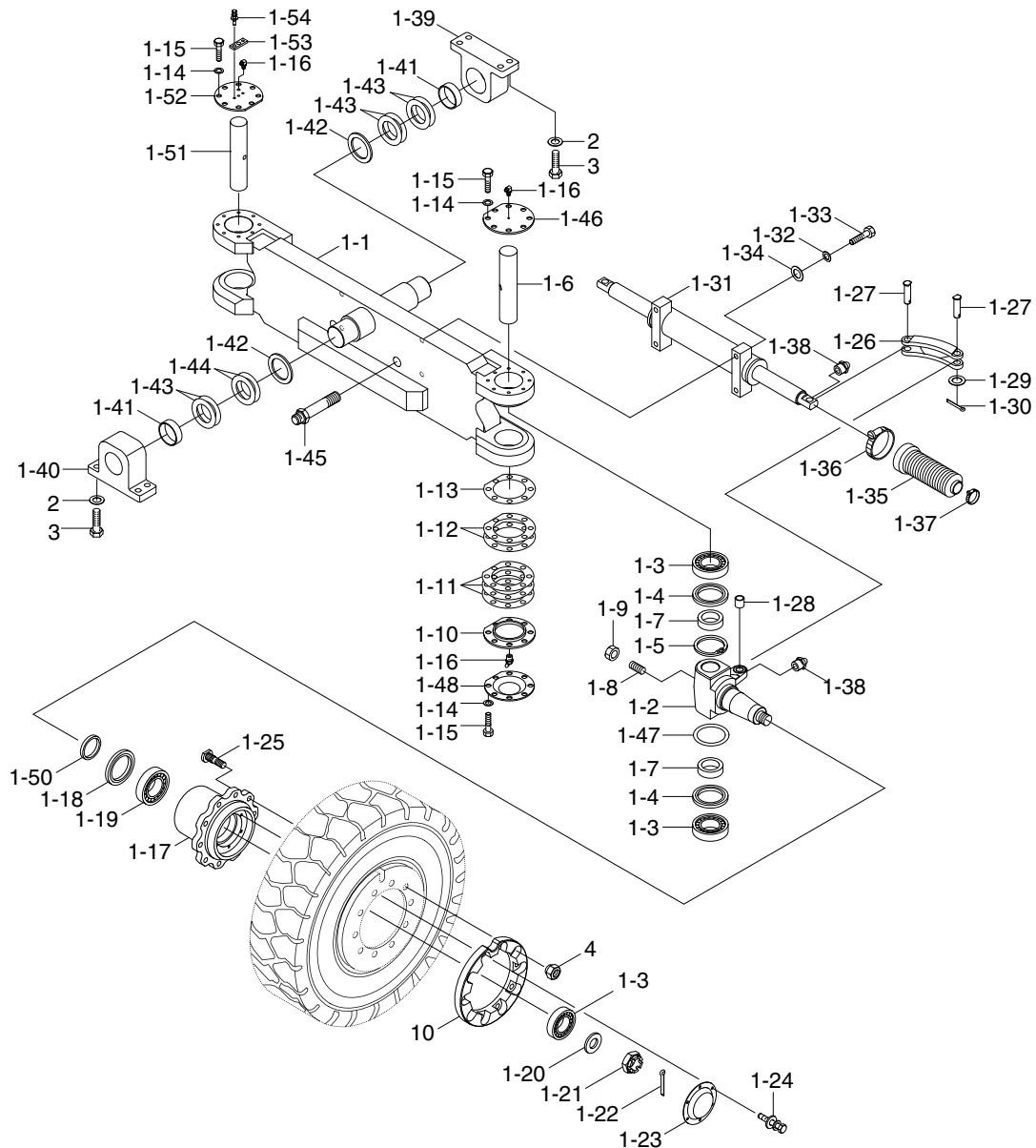
(9) While idling the engine with the rear wheels off the ground, operate the steering wheel left and right alternately.

※ 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

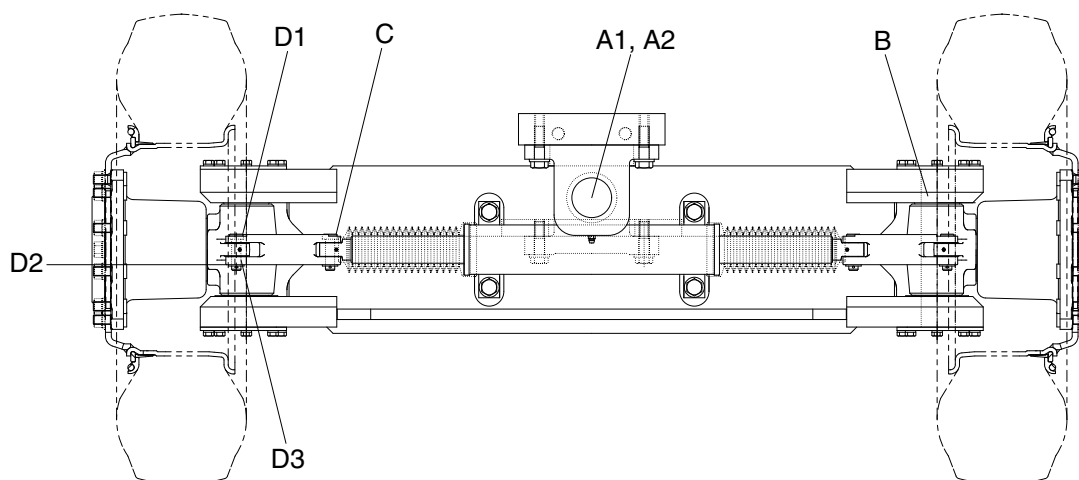
1) STRUCTURE



160D9VSS21

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 cylinder	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 Wheel 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 Wheel 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)	Adjust shim Replace
		D2	Vertical play	-	0.2(0.008)	
		D3	ID of bushing	22(0.9)	22.5(0.9)	

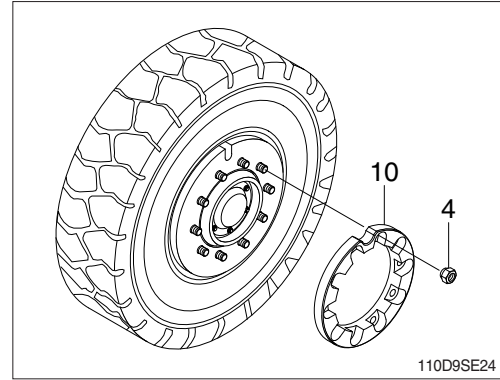
- OD : Outer diameter
- ID : Inner diameter

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 wheel 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, 1-19).

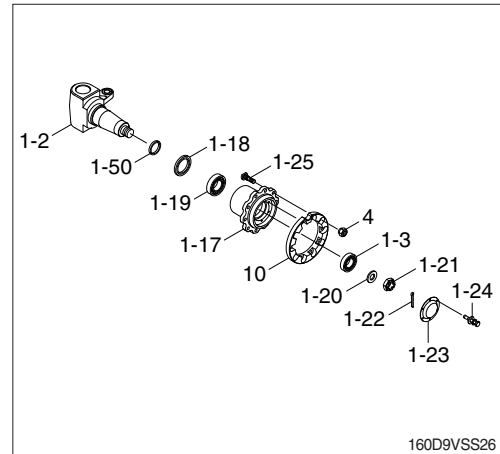
※ Be very careful because just before the hub comes off, tapered roller bearing will fall out.

- (5) After hub is removed take off the inner race of roller bearing (1-3, 1-19).

- (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).

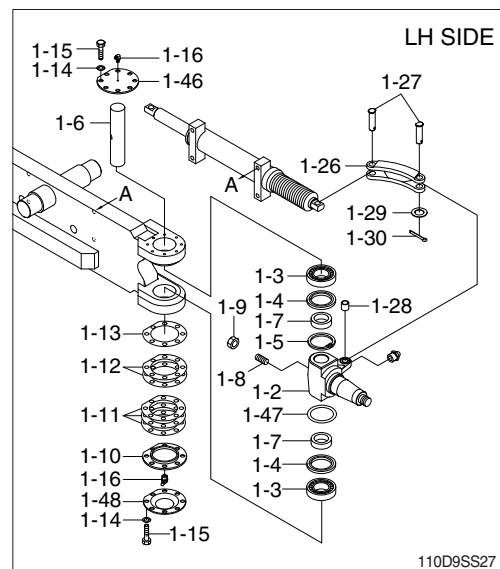
- (10) Push out the king pin (1-6) without damaging the knuckle arm (1-2).

- (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 split pin (1-30), special washer (1-29) and link pin (1-27).

※ Repeat the same procedure for the RH side.



4) ASSEMBLY

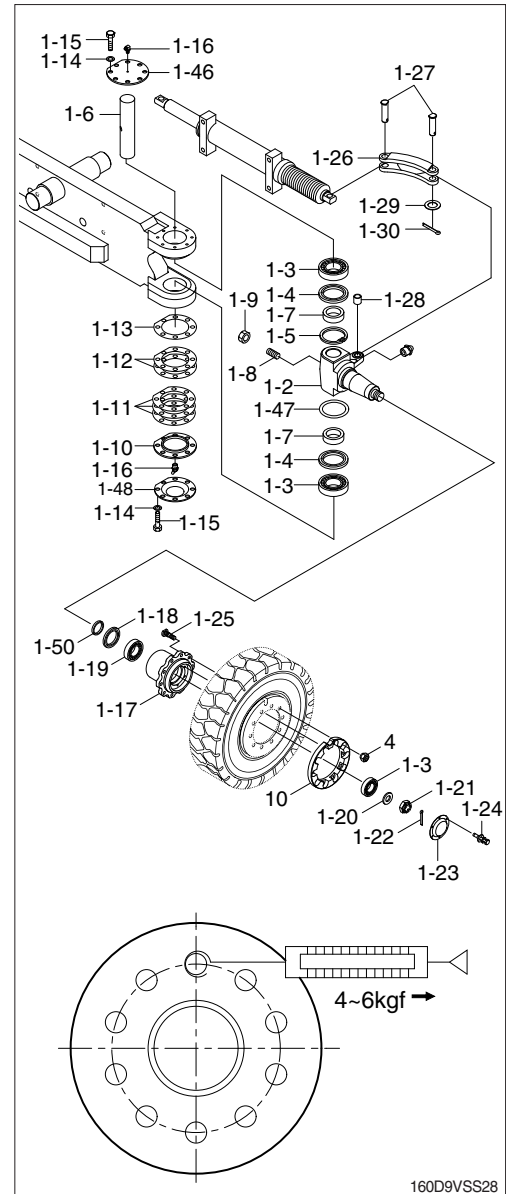
※ In reassembling, have all parts washed, grease applied to lubricating parts, and all expendable items such as oil seal and spring washers replaced by new ones.

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) 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

Group 1	Structure and function	6-1
Group 2	Operational checks and troubleshooting	6-36
Group 3	Disassembly and assembly	6-41

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
- Fingertip (EPPR valve, controller)

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 goes to accumulators for RCV. The cut-off valve flow either to the brake valve or to the remote control valve.

The remote control valve routes flow to either end of each spool valve section in the main control valve to control spool stroke.

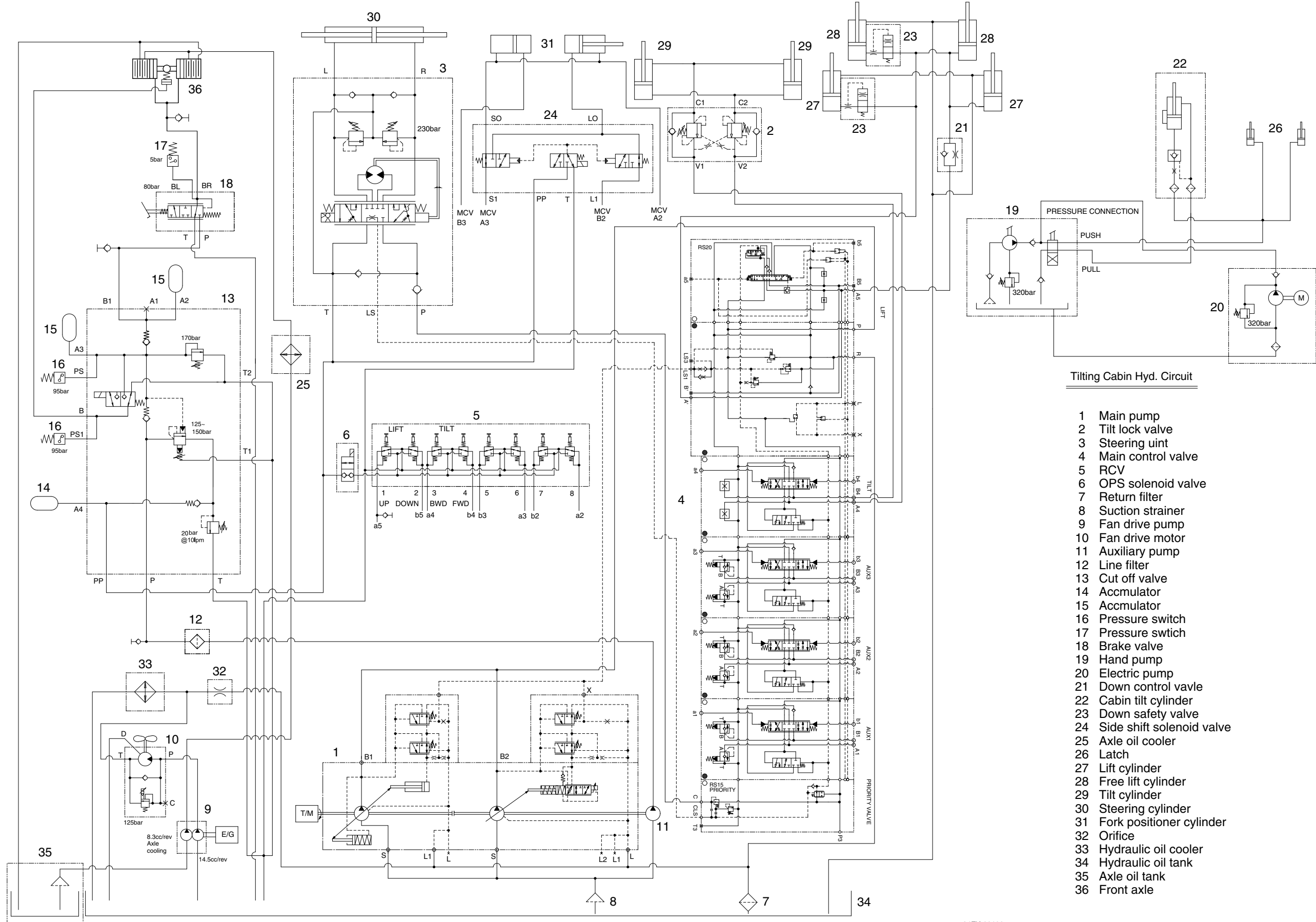
A accumulator mounted on the cut-off valve supplies a secondary pressure source to operate remote control valve so the mast can be lowered if the engine is off.

The return circuit for the main hydraulic system has a return filter inside the hydraulic tank.

The return filter uses a filter element and a bypass valve.

2. HYDRAULIC CIRCUIT

REMOTE CONTROL LEVER TYPE

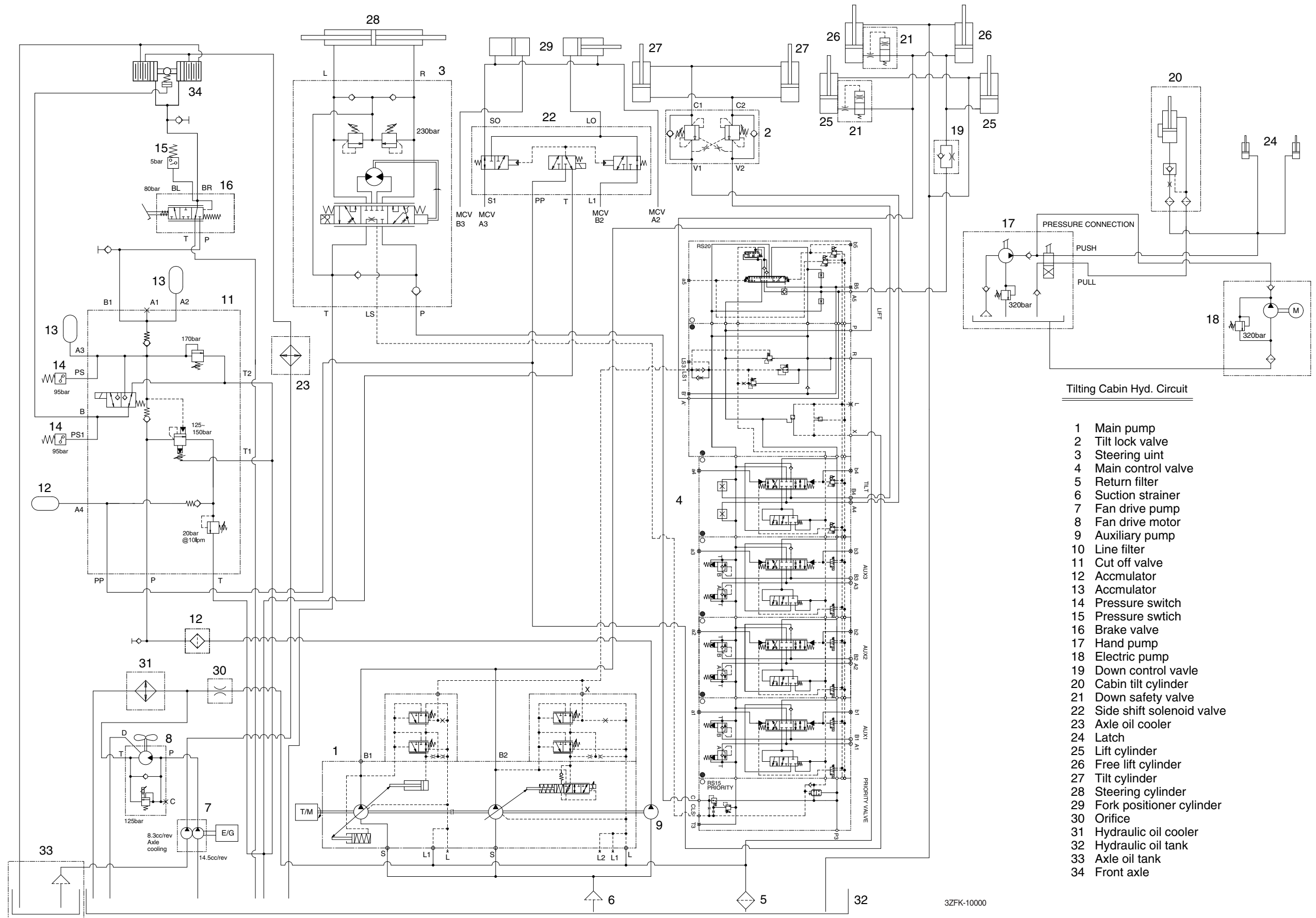


Tilting Cabin Hyd. Circuit

- 1 Main pump
- 2 Tilt lock valve
- 3 Steering unit
- 4 Main control valve
- 5 RCV
- 6 OPS solenoid valve
- 7 Return filter
- 8 Suction strainer
- 9 Fan drive pump
- 10 Fan drive motor
- 11 Auxiliary pump
- 12 Line filter
- 13 Cut off valve
- 14 Accumulator
- 15 Accumulator
- 16 Pressure switch
- 17 Pressure switch
- 18 Brake valve
- 19 Hand pump
- 20 Electric pump
- 21 Down control valve
- 22 Cabin tilt cylinder
- 23 Down safety valve
- 24 Side shift solenoid valve
- 25 Axle oil cooler
- 26 Latch
- 27 Lift cylinder
- 28 Free lift cylinder
- 29 Tilt cylinder
- 30 Steering cylinder
- 31 Fork positioner cylinder
- 32 Orifice
- 33 Hydraulic oil cooler
- 34 Hydraulic oil tank
- 35 Axle oil tank
- 36 Front axle

34FK-00100

FINGERTIP TYPE

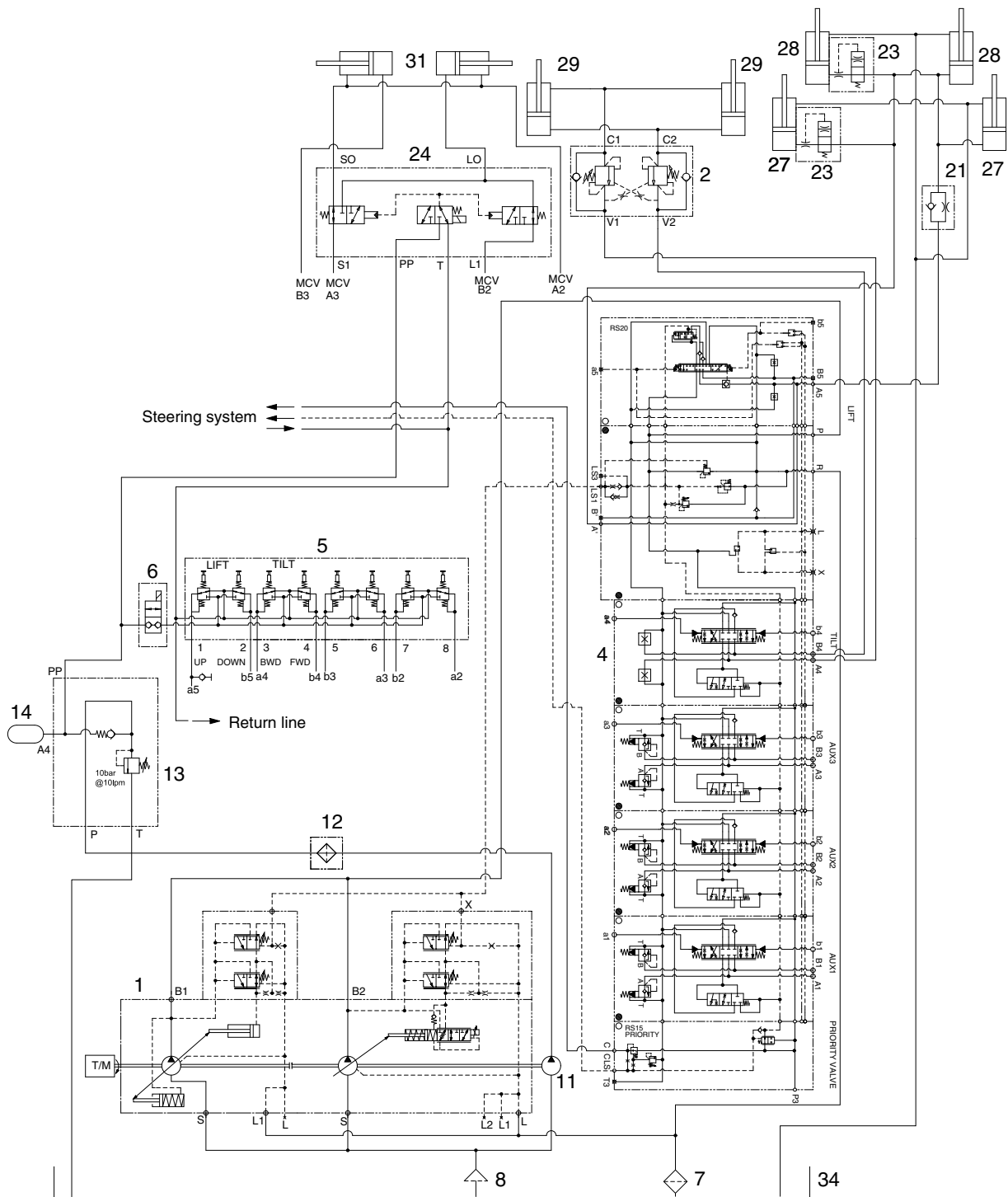


Tilting Cabin Hyd. Circuit

- 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 Auxiliary pump
- 10 Line filter
- 11 Cut off valve
- 12 Accumulator
- 13 Accumulator
- 14 Pressure switch
- 15 Pressure switch
- 16 Brake valve
- 17 Hand pump
- 18 Electric pump
- 19 Down control valve
- 20 Cabin tilt cylinder
- 21 Down safety valve
- 22 Side shift solenoid valve
- 23 Axle oil cooler
- 24 Latch
- 25 Lift cylinder
- 26 Free lift cylinder
- 27 Tilt cylinder
- 28 Steering cylinder
- 29 Fork positioner cylinder
- 30 Orifice
- 31 Hydraulic oil cooler
- 32 Hydraulic oil tank
- 33 Axle oil tank
- 34 Front axle

3. WORK EQUIPMENT HYDRAULIC CIRCUIT

※ The operating explain is based on the remote control lever type.



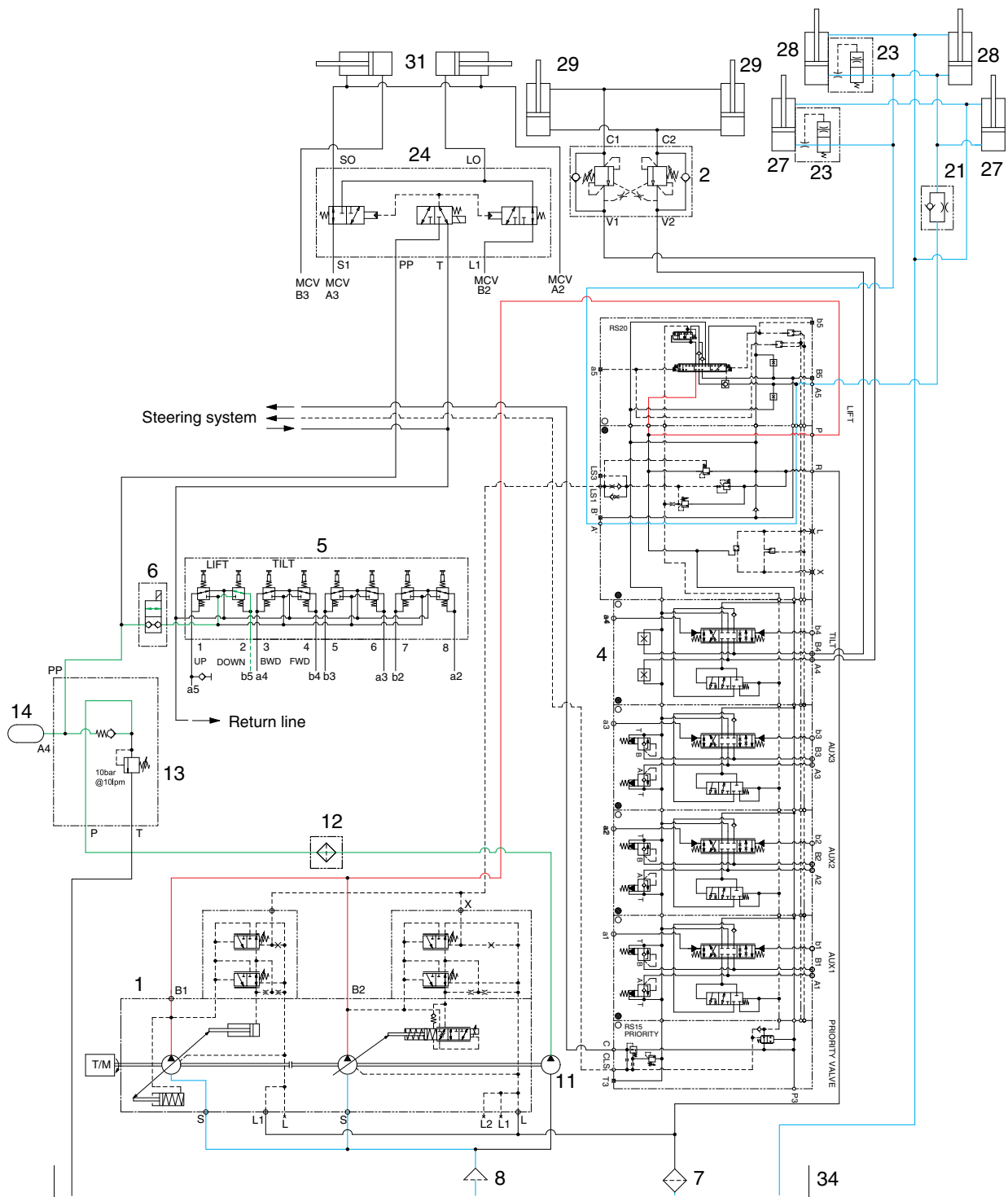
160D9VHS02

- | | | |
|------------------------|--|-----------------------------|
| 1 Main pump | 11 Auxiliary pump | 27 Lift cylinder |
| 2 Tilt lock valve | 12 Line filter | 28 Free lift cylinder |
| 4 Main control valve | 13 Cutoff valve | 29 Tilt cylinder |
| 5 Remote control valve | 14 Accumulator | 31 Fork positioner cylinder |
| 6 OPSS solenoid valve | 21 Down control valve | 34 Hydraulic oil tank |
| 7 Return filter | 23 Down safety valve | |
| 8 Suction strainer | 24 Side shift solenoid valve
(160D-9V only) | |

160D9VHS03

When this happens, the forks go up.

2) WHEN THE LIFT CONTROL LEVER IS IN THE LOWER POSITION

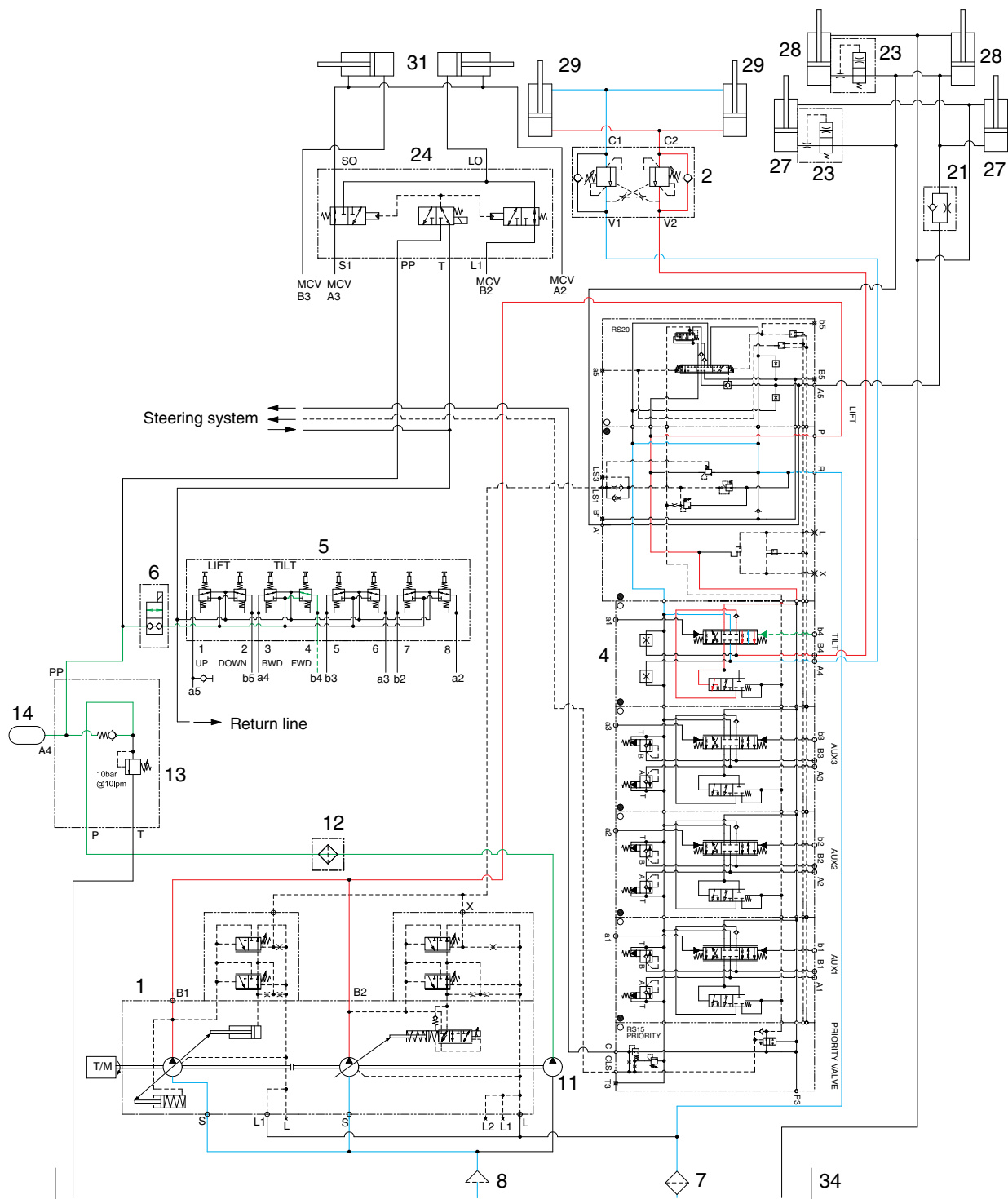


160D9VHS04

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.

3) WHEN THE TILT CONTROL LEVER IS IN THE FORWARD POSITION



160D9VHS05

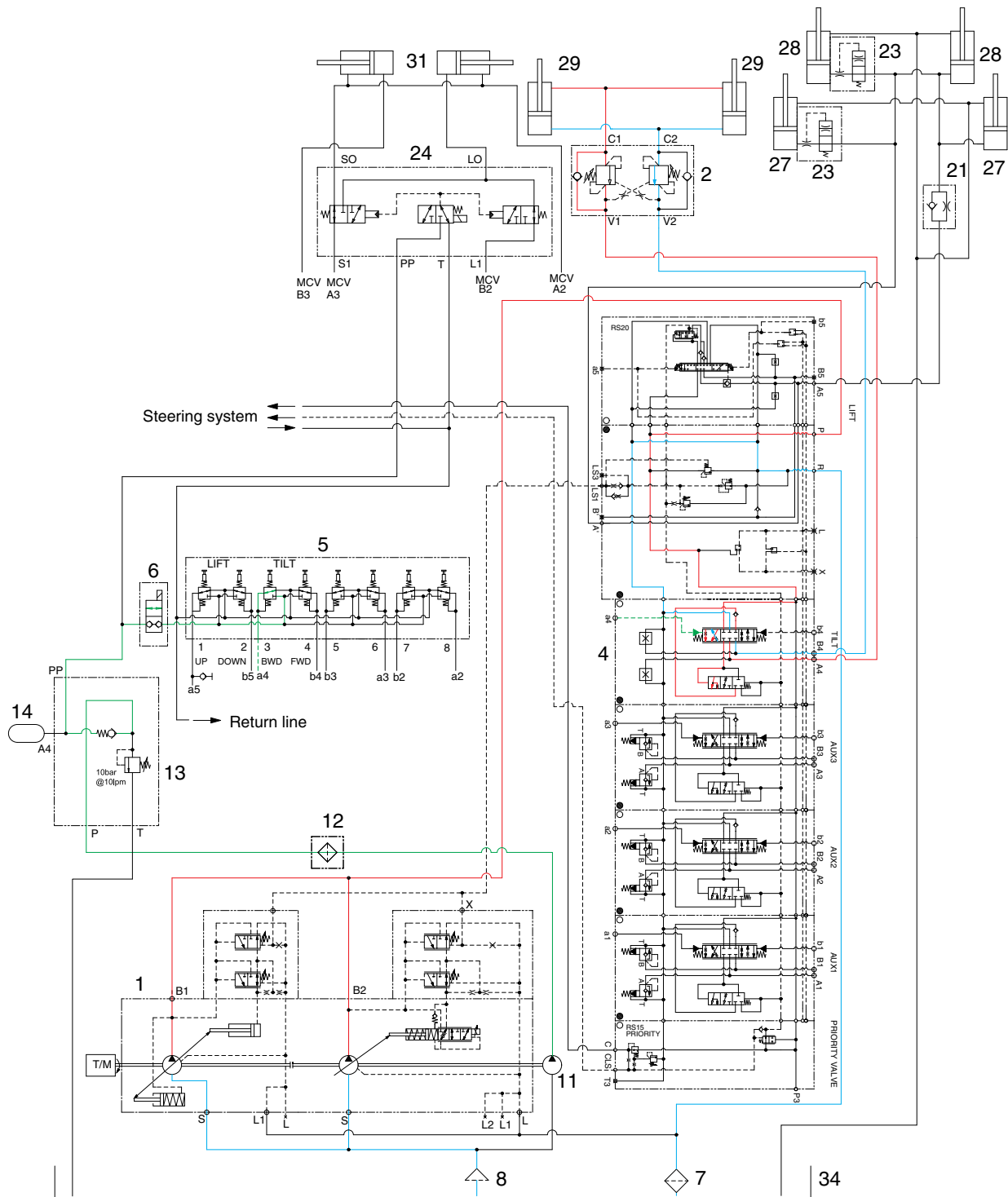
When the tilt control lever is pushed forward, the spool is moved to tilt forward position by the pilot oil pressure from the remote control valve (5).

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.

4) WHEN THE TILT CONTROL LEVER IS IN THE BACKWARD POSITION



160D9VHS06

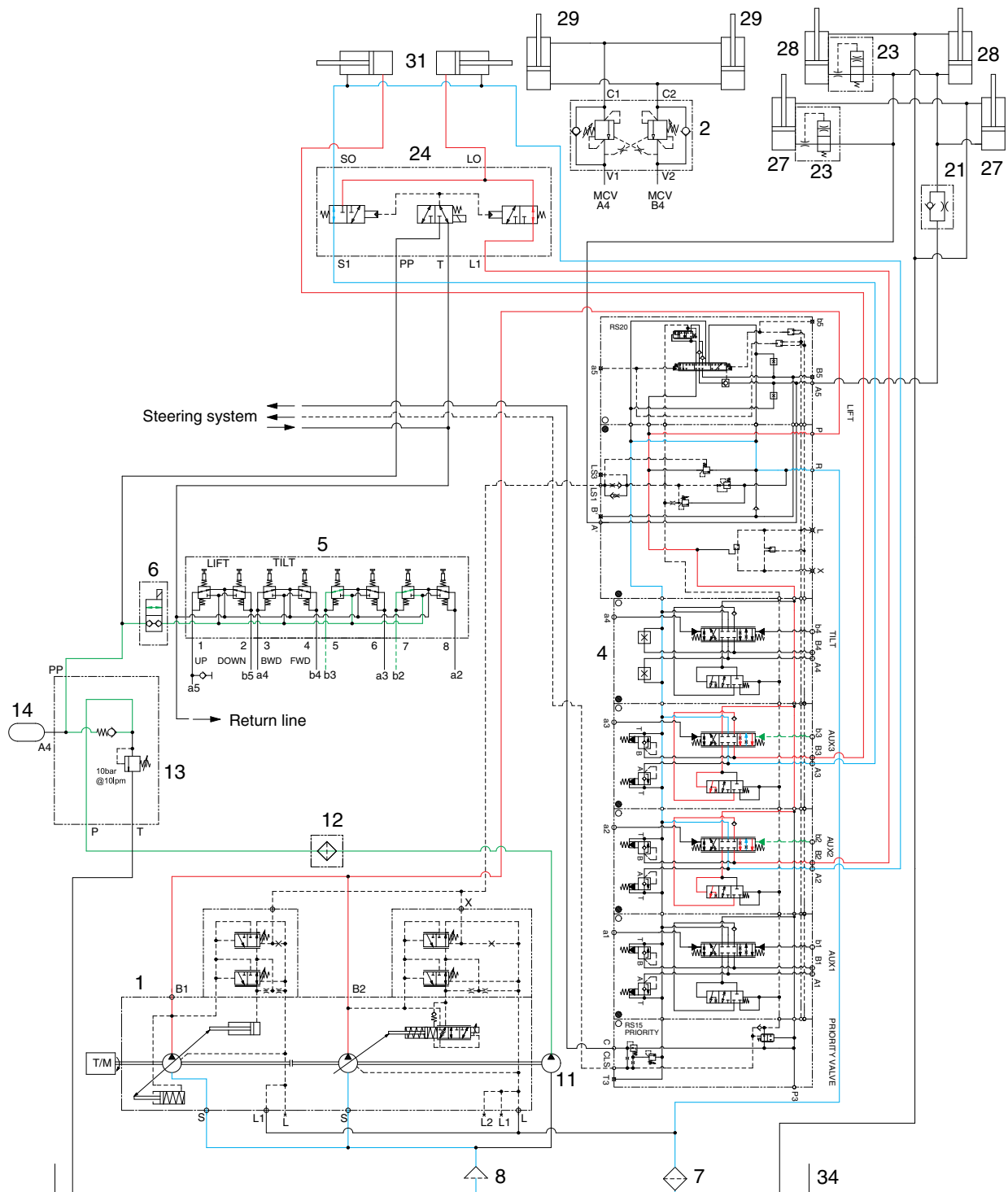
When the tilt control lever is pulled back, the spool is moved to tilt backward position by the pilot oil pressure from the remote control valve (5).

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.

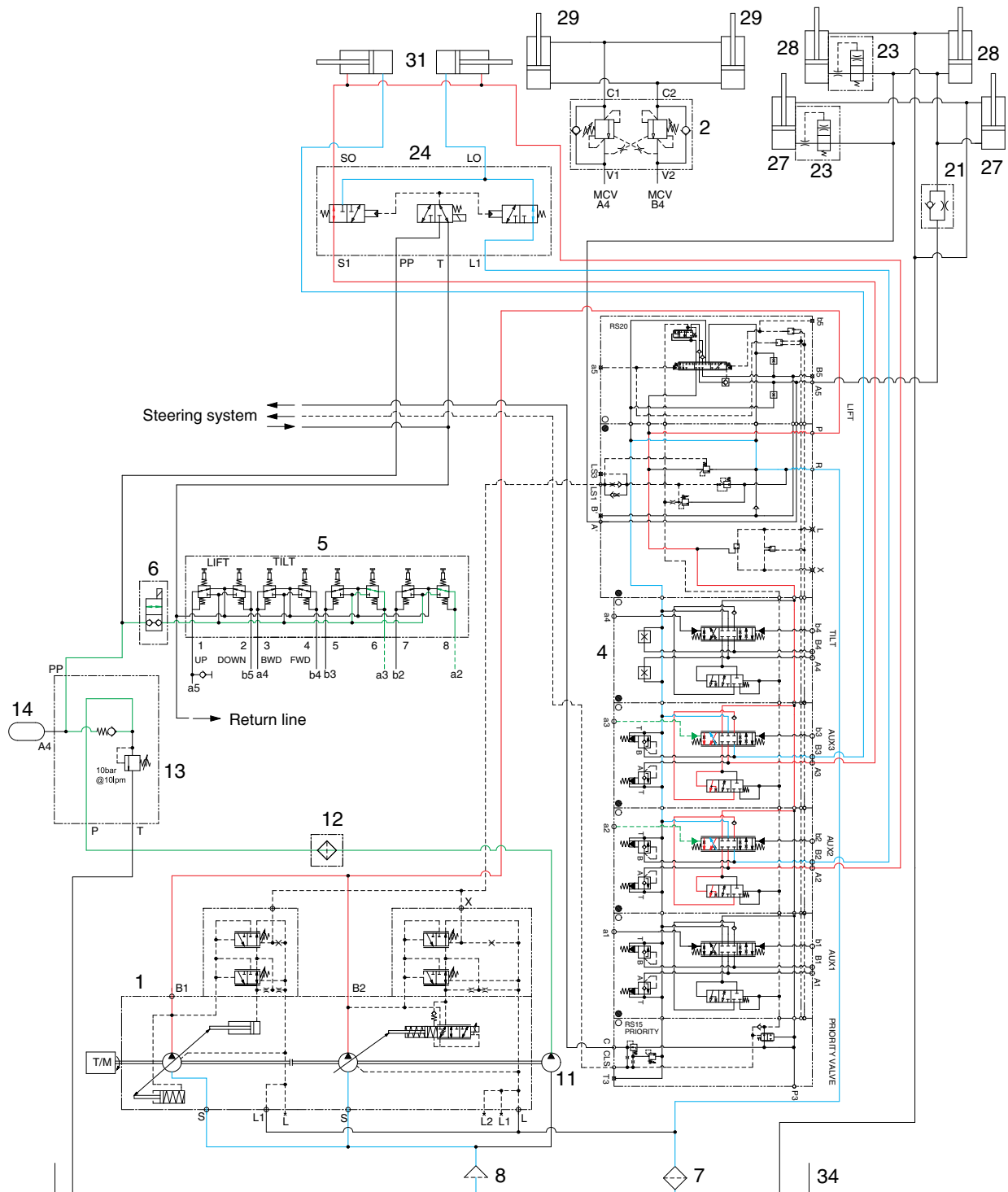
5) WHEN THE FORK POSITIONER LEVER IS IN THE SPREAD-OUT POSITION(OPTION)



160D9VHS07

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.

6) WHEN THE FORK POSITIONER LEVER IS IN THE CLOSE POSITION (OPTION)



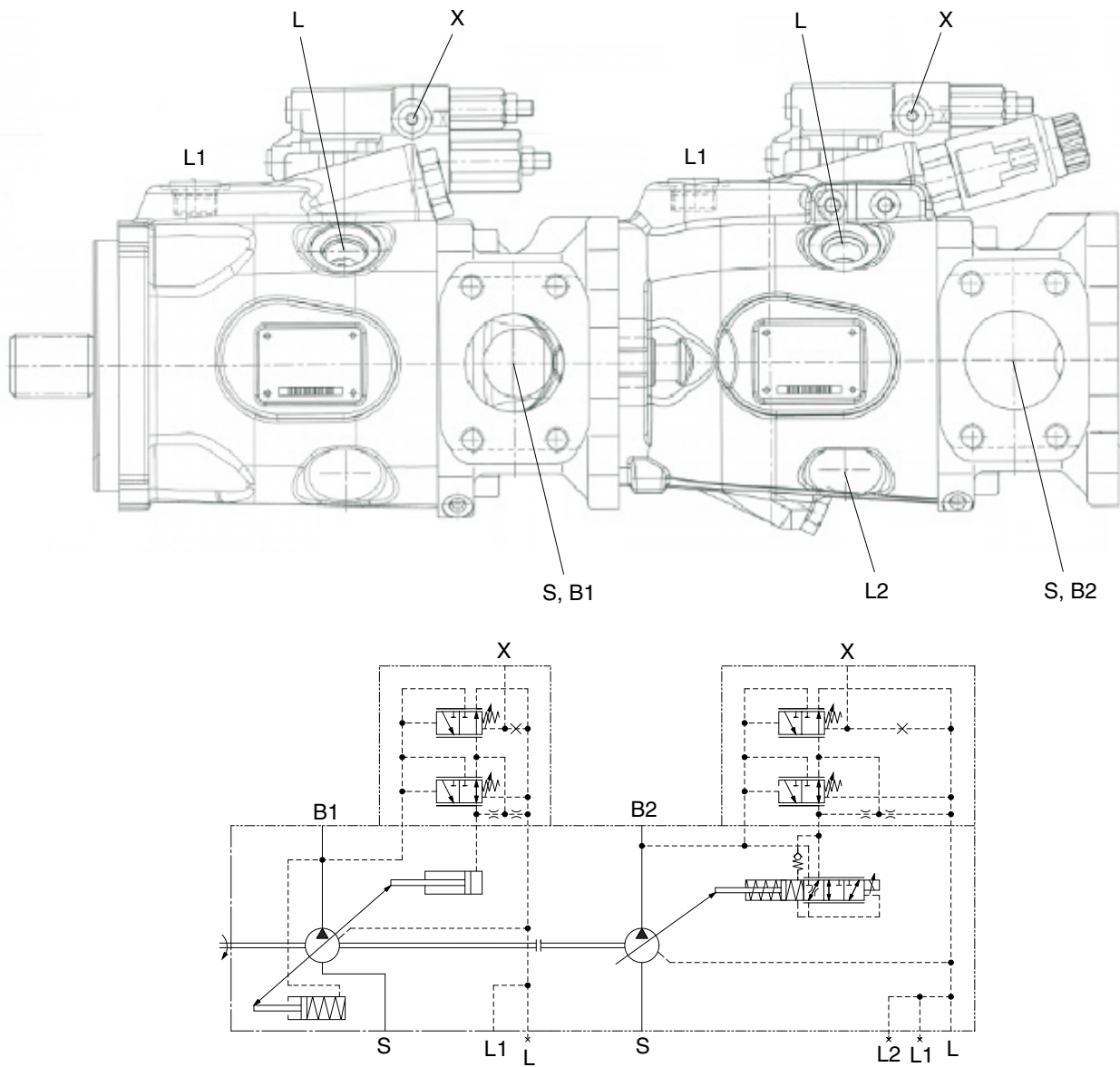
160D9VHS08

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.

4. MAIN PUMP

1) STRUCTURE (1/2)

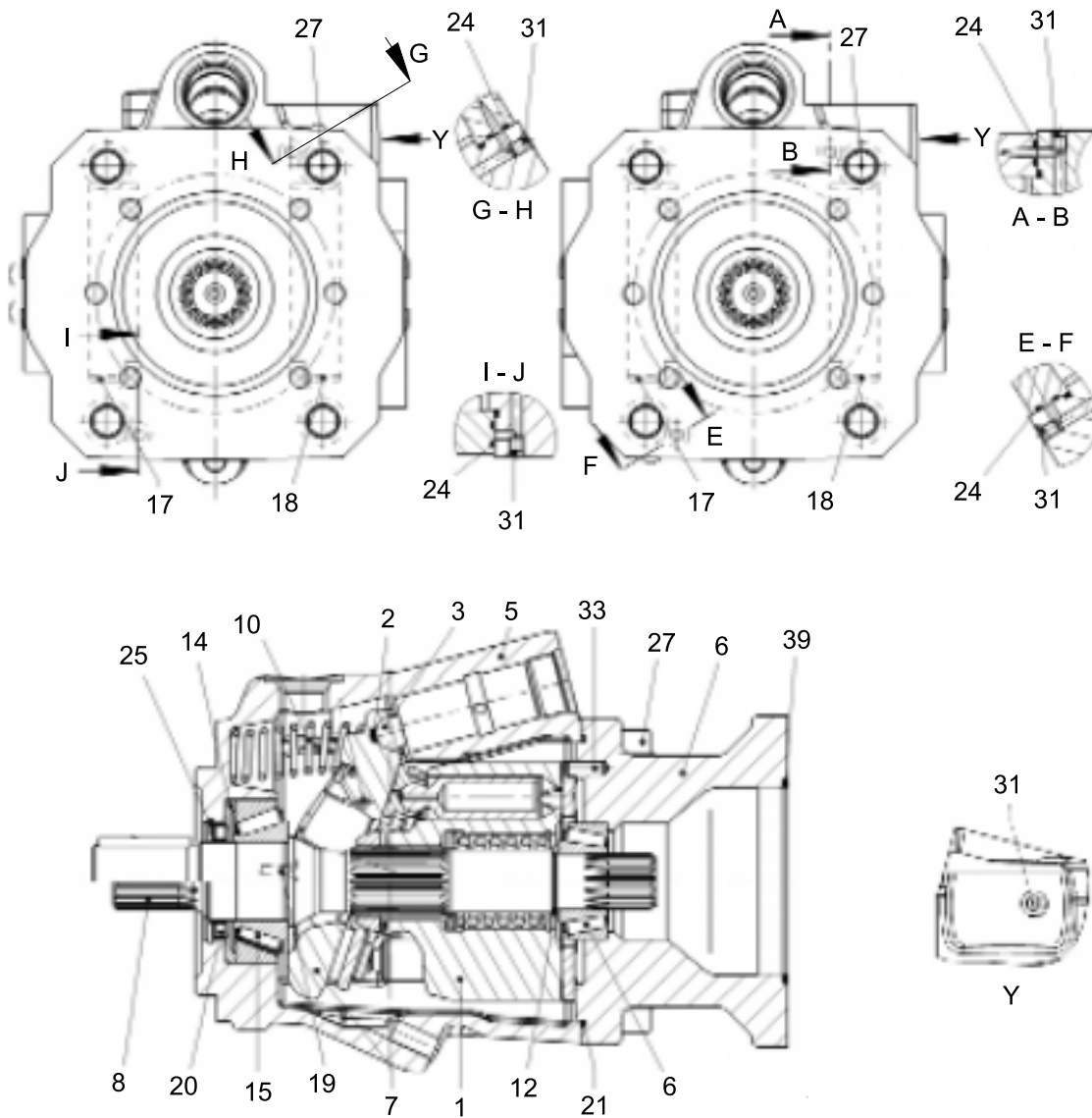
This variable displacement piston pump consists of steering pump and working pump.



160D9VMP04

Port	Port name	Size
B1	Pressure port	SAE 1"
B2	Pressure port	SAE 1"
S	Suction port	SAE 2"
L	Case drain port	7/8-14UNF-28
L1, L2	Case drain port	7/8-14UNF-28
X	Pilot pressure port	7/16-20UNF-28

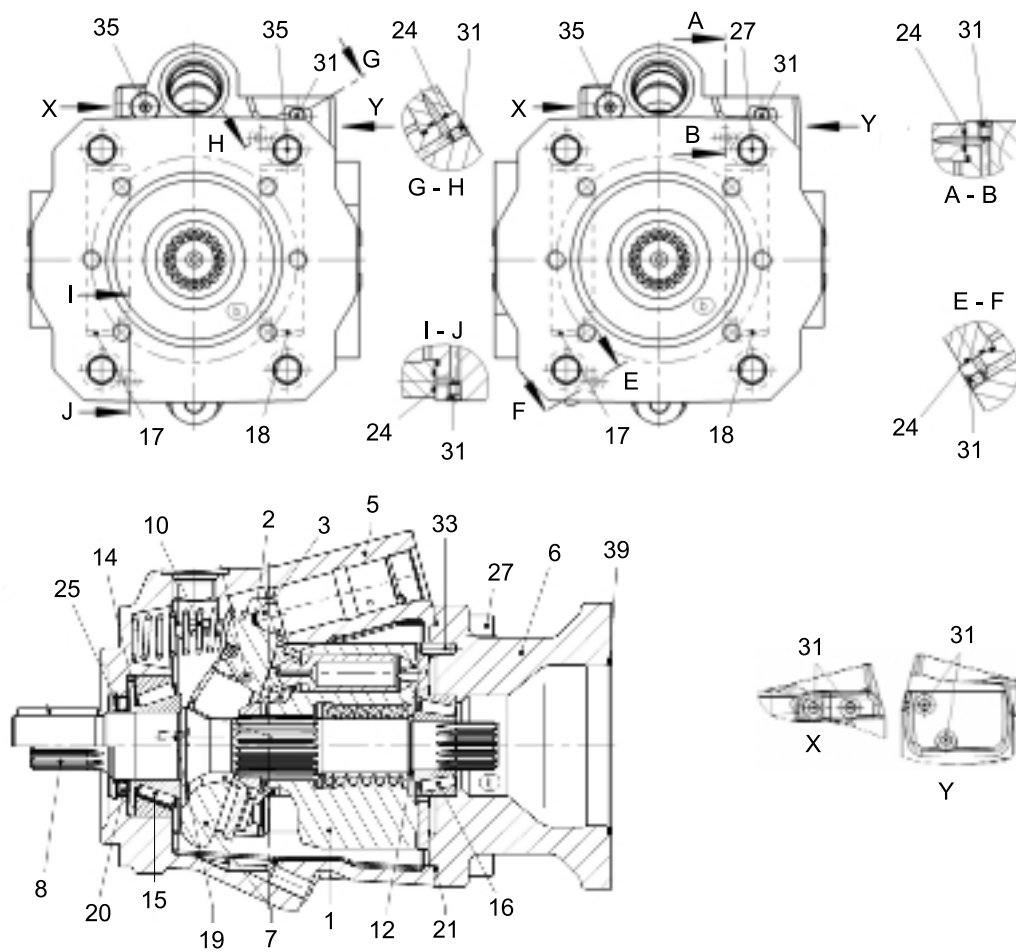
(1) Front pump



160D9VMP05

- | | | |
|--------------------|-------------------------|-------------------|
| 1 Rotary kit | 12 Shim | 21 O-ring |
| 2 Pressure spring | 14 Stop ring | 24 Seal |
| 3 Stopper | 15 Taper roller bearing | 25 Retaining ring |
| 5 Pump housing | 16 Taper roller bearing | 27 Socket screw |
| 6 Connection plate | 17 Bearing liner | 31 Pin |
| 7 Swash plate | 18 Bearing liner | 33 Straight pin |
| 8 Drive shaft | 19 Flat screw | 39 O-ring |
| 10 Spring | 20 Shaft seal | |

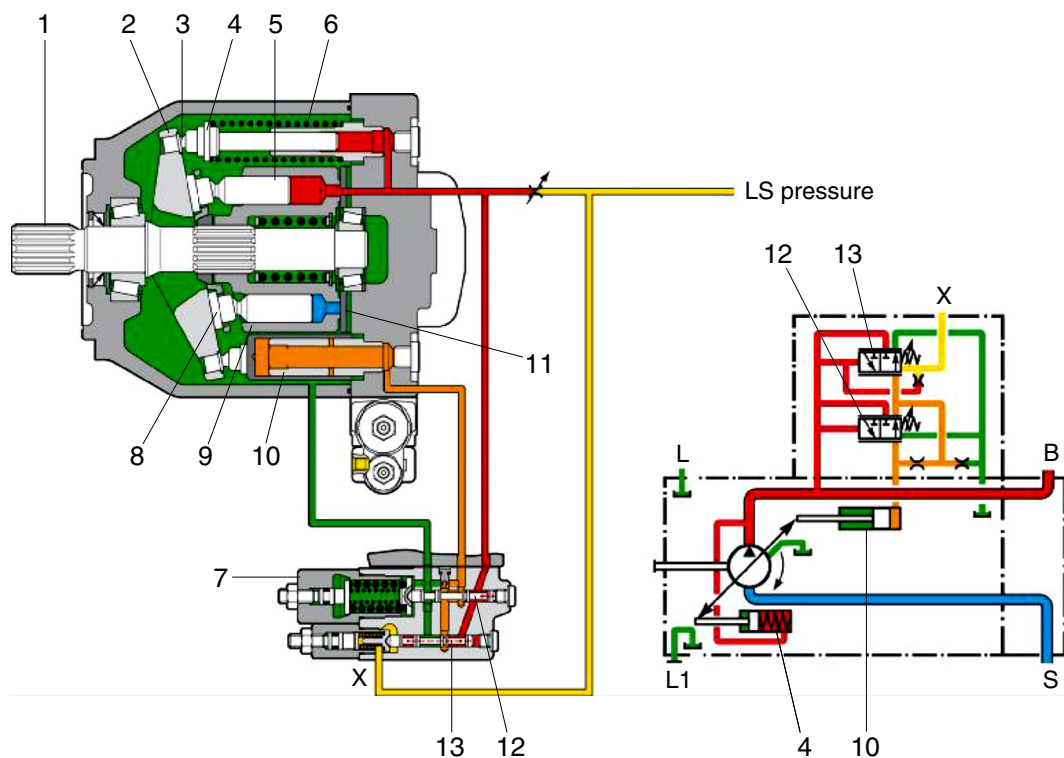
(2) Rear pump



160D9VMP06

- | | | |
|-------------------|-------------------------|-------------------|
| 1 Rotary kit | 12 Shim | 21 O-ring |
| 2 Pressure spring | 14 Stop ring | 24 Seal |
| 3 Stopper | 15 Taper roller bearing | 25 Retaining ring |
| 5 Pump housing | 16 Taper roller bearing | 27 Socket screw |
| 6 Port plate | 17 Bearing liner | 31 Pin |
| 7 Swash plate | 18 Bearing liner | 33 Straight pin |
| 8 Drive shaft | 19 Flat screw | 35 Locking screw |
| 10 Spring | 20 Shaft seal | 39 O-ring |

2) FUNCTION



75796WE33

- | | | |
|------------------|-------------------------------------|-------------------------------|
| 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.

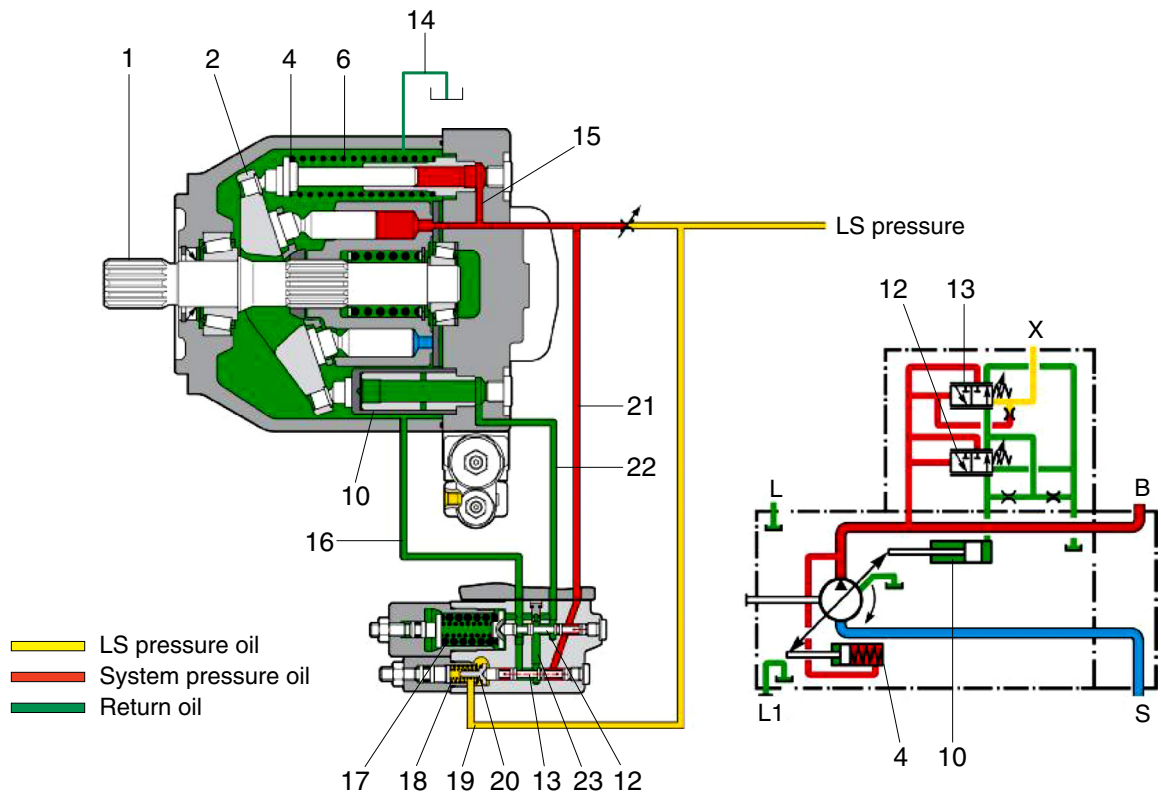
Control piston (10) has a larger area (diameter) than counter piston (4). Control piston (10) causes swash plate (2) to destroke the pump.

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 then causes the pump to destroke.

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.

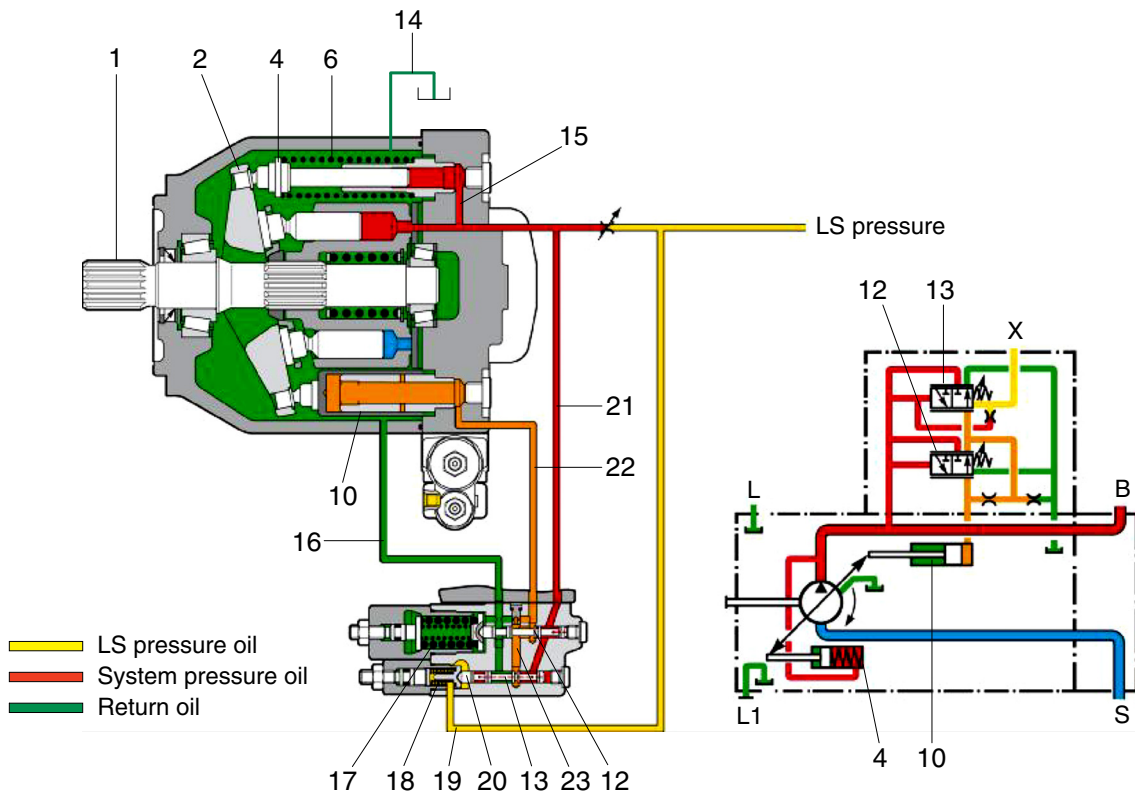
Supply oil flows through passage (15) to counter piston (4). The oil acts against counter piston (4).

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



75796WE34

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.

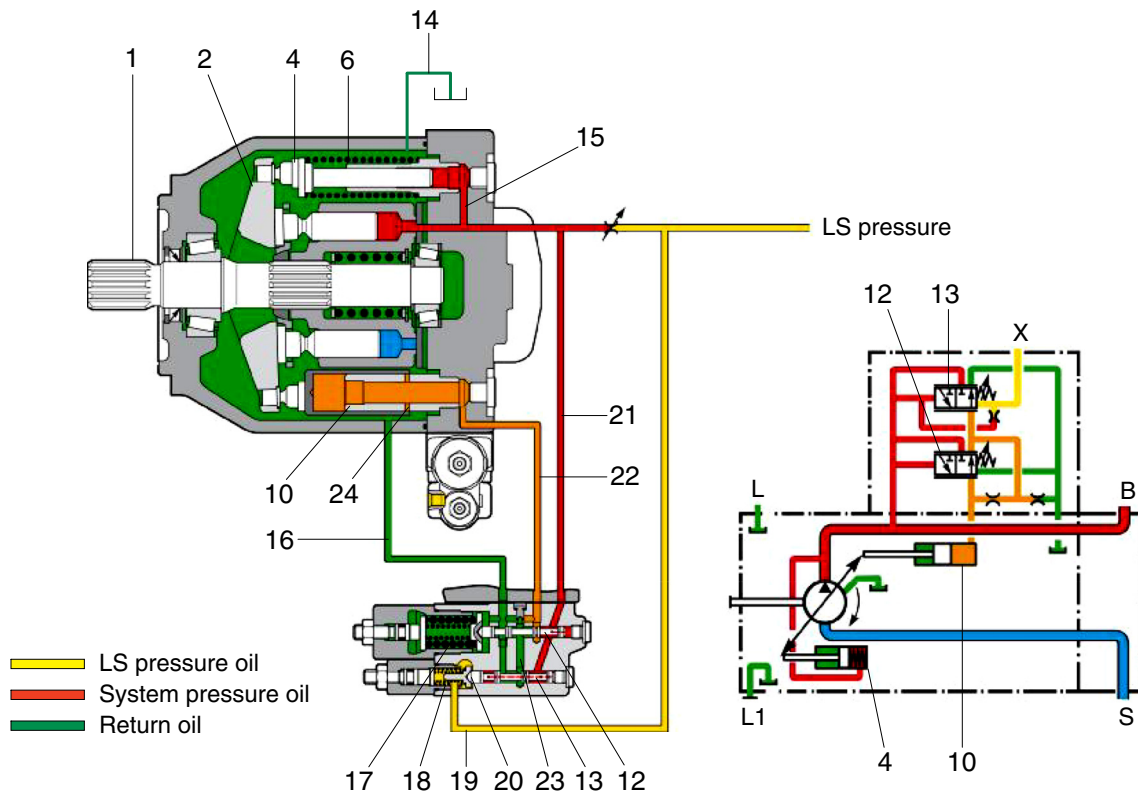
This decreases the pump output and the system pressure.

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



75796WE36

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).

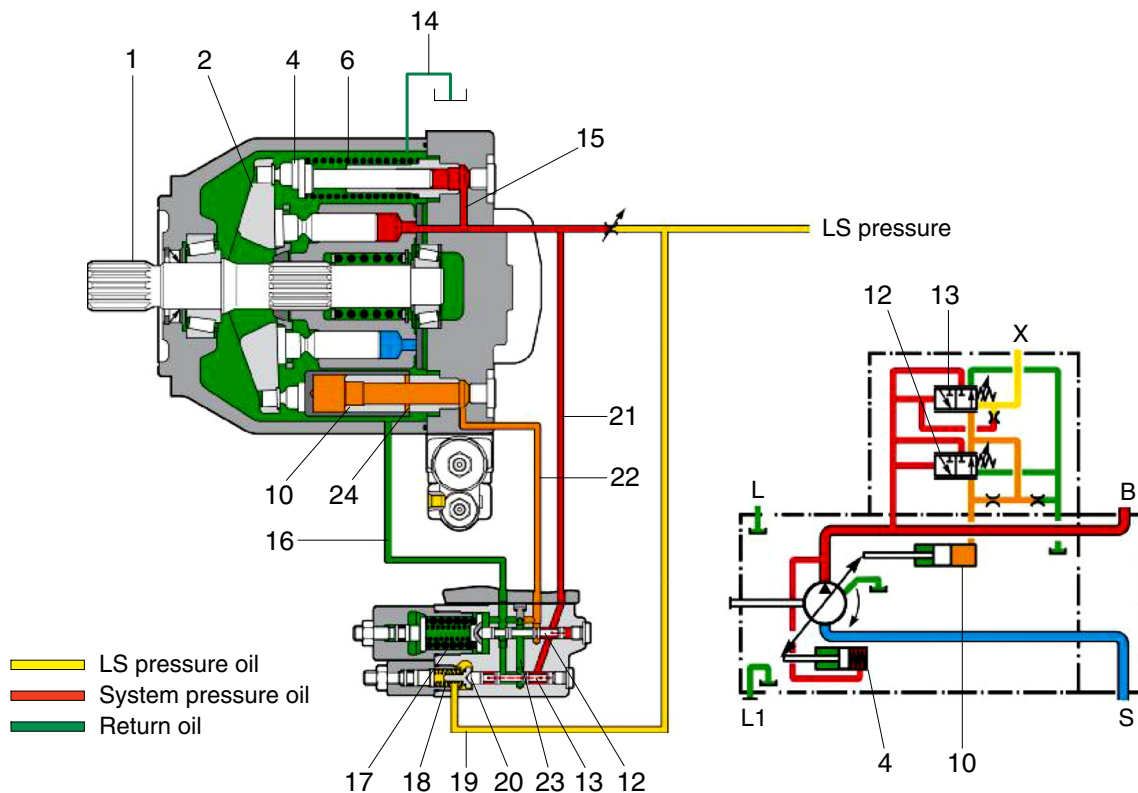
The oil acts against control piston (10) in order to overcome the force of counter spring (6). The oil causes control piston (10) to move to the left.

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



75796WE36

- | | | |
|-------------------------------|---------------------------|-----------------------------------|
| 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

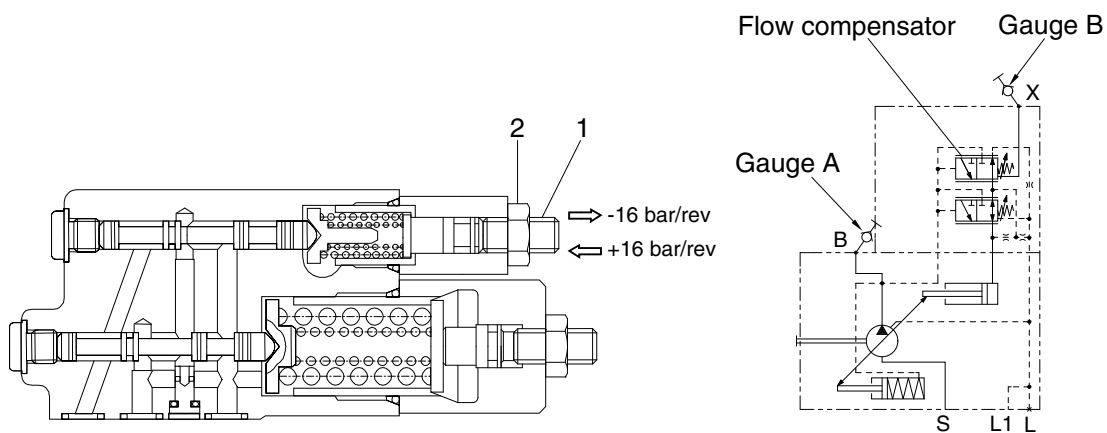
- Engine is running (at high or low idle).
- RCV is operated slowly (example : Mast up).
- Pressure gauges are installed.
- ※ Discharge pump flow should be less than max pump flow.

② Procedures

- Loosening the hexagon nut (2).
- Adjusting screw (1) of flow controller by tightening or loosening the screw (1).

Flow setting : P = Gauge A - Gauge B

Specification : Steering pump (29 bar) / Attachment pump (22 bar)



75796WE37

(6) Adjustment of pressure control

Pressure compensator setting must be carried out following procedures and conditions.

① Conditions

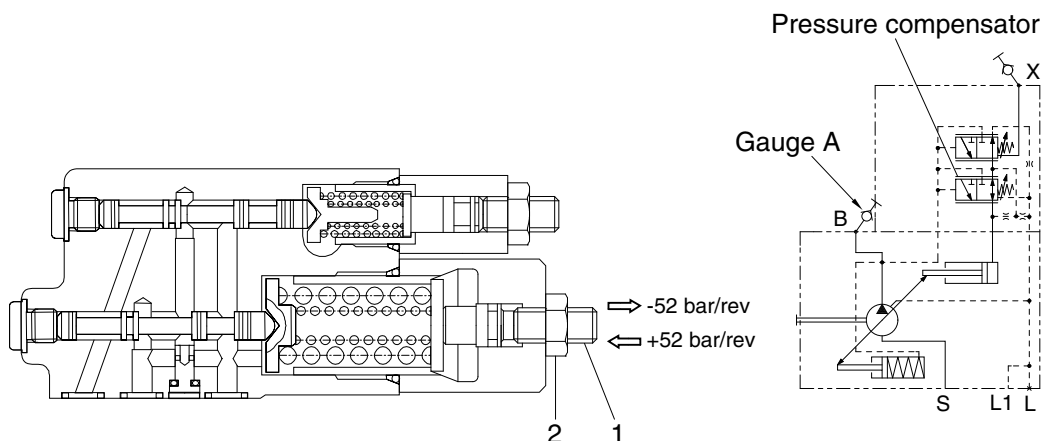
- Engine is running.
- System is at relief condition.

② Procedures

- Loosening the hexagon nut (2).
- Adjusting screw (1) of pressure controller by tightening or loosening the screw (1).

Maximum pressure setting = Gauge A

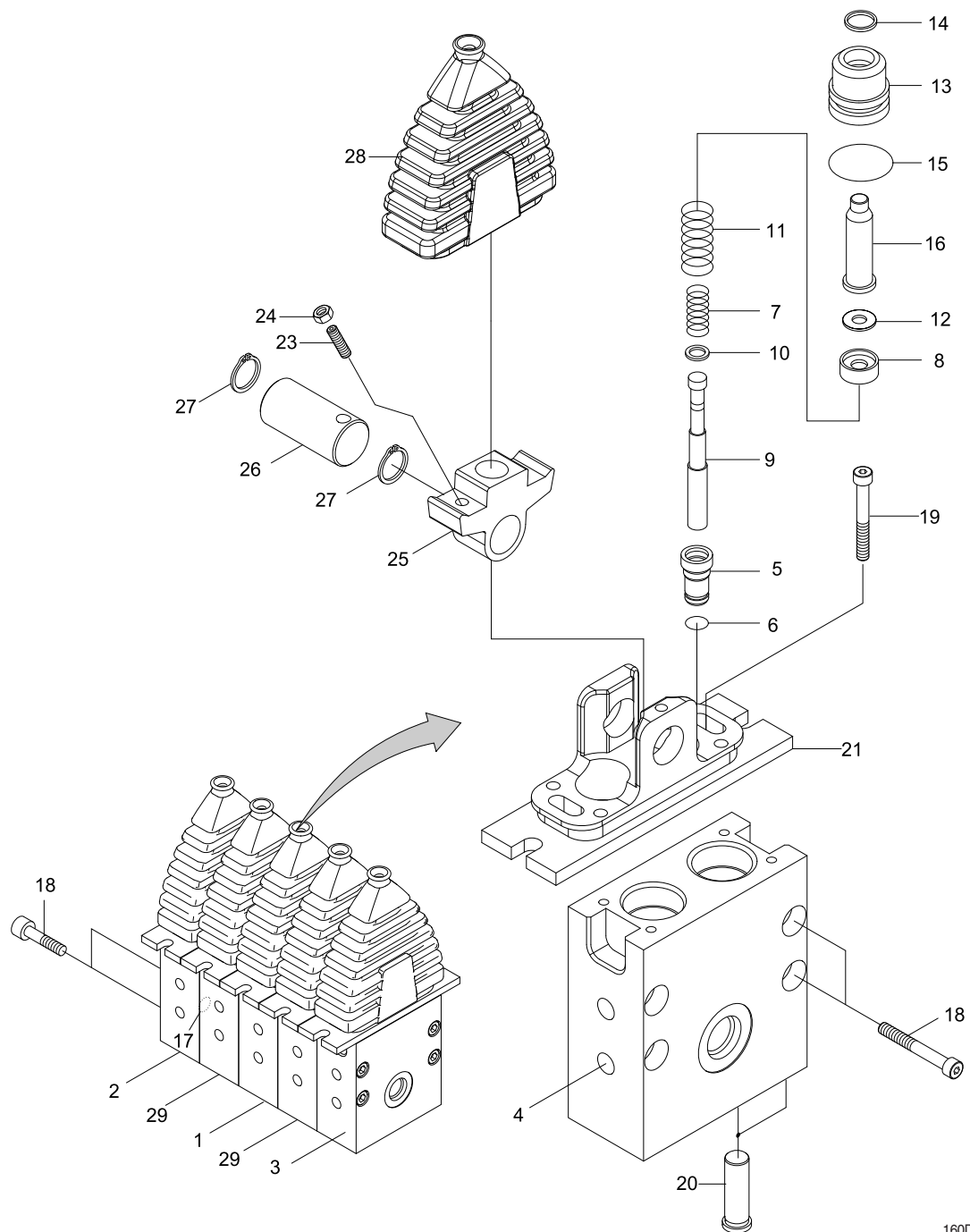
Specification : Steering pump (250 bar) / Attachment pump (300 bar)



75796WE38

5. REMOTE CONTROL VALVE

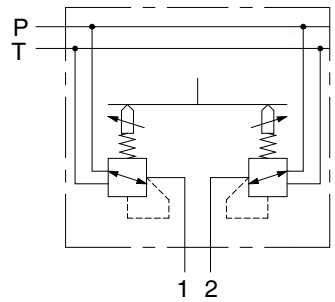
1) STRUCTURE



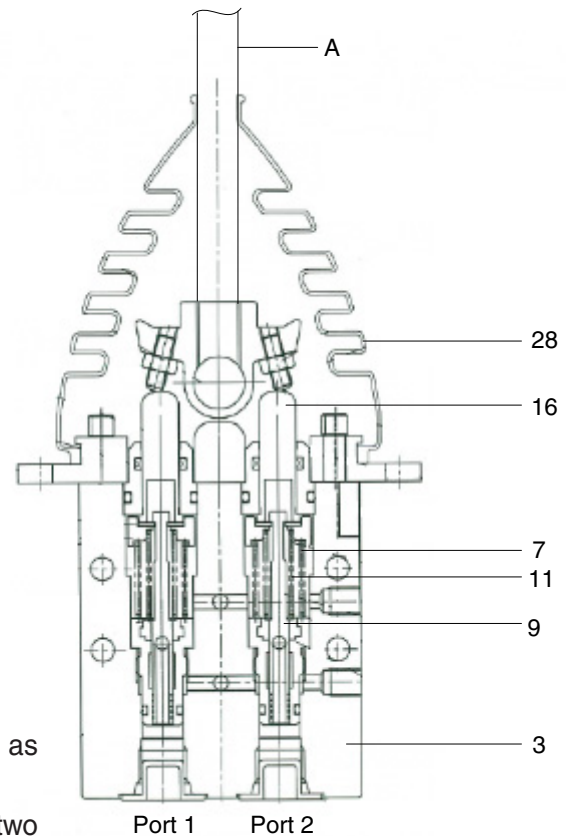
160D9VRV01

- | | | |
|---------------|----------------|----------------|
| 1 Body | 11 Spring | 21 Cover |
| 2 Body-L | 12 Stopper | 23 Socket bolt |
| 3 Body-R | 13 Plug | 24 Hex nut |
| 4 Plug | 14 Oil seal | 25 Guide |
| 5 Plug | 15 O-ring | 26 Pin |
| 6 O-ring | 16 Push rod | 27 Spring pin |
| 7 Spring | 17 O-ring | 28 Boot |
| 8 Spring seat | 18 Wrench bolt | 29 Body 2 |
| 9 Spool | 19 Wrench bolt | |
| 10 Shim | 20 Cap | |

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 push rod (16), a metering spring (7) and return 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, push rod (16) is pressed against return spring (11) and metering spring (7).

Metering spring (7) initially moves spool (9) 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 spool (9) 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 spool (9) and metering spring (7) the pressure in the relevant port is proportional to the stroke of push rod (16) 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.

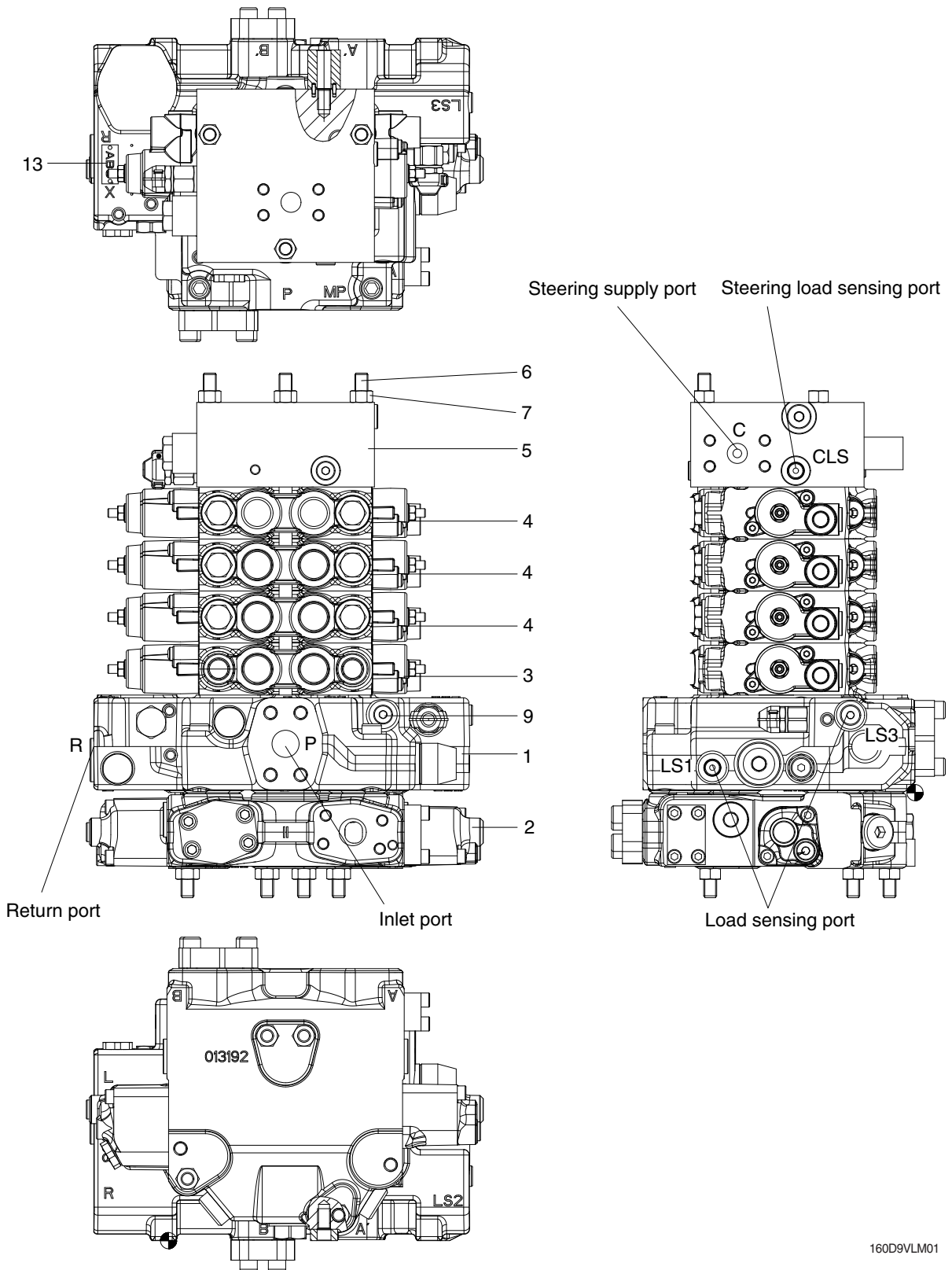
A rubber boot (28) protects the mechanical components in the housing from contamination.

160D9VRV02

6. MAIN CONTROL VALVE (LEVER TYPE)

1) RCV LEVER TYPE

(1) Structure (1/2)



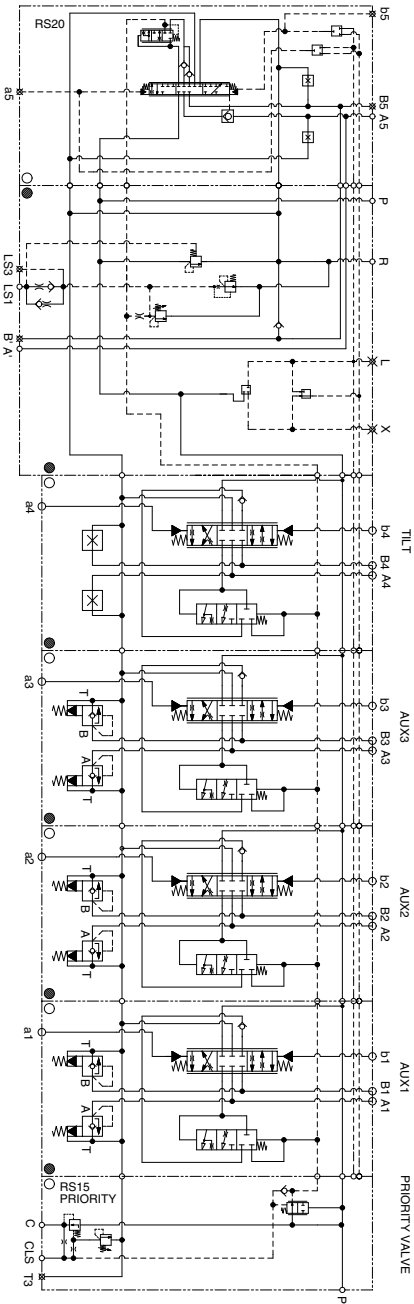
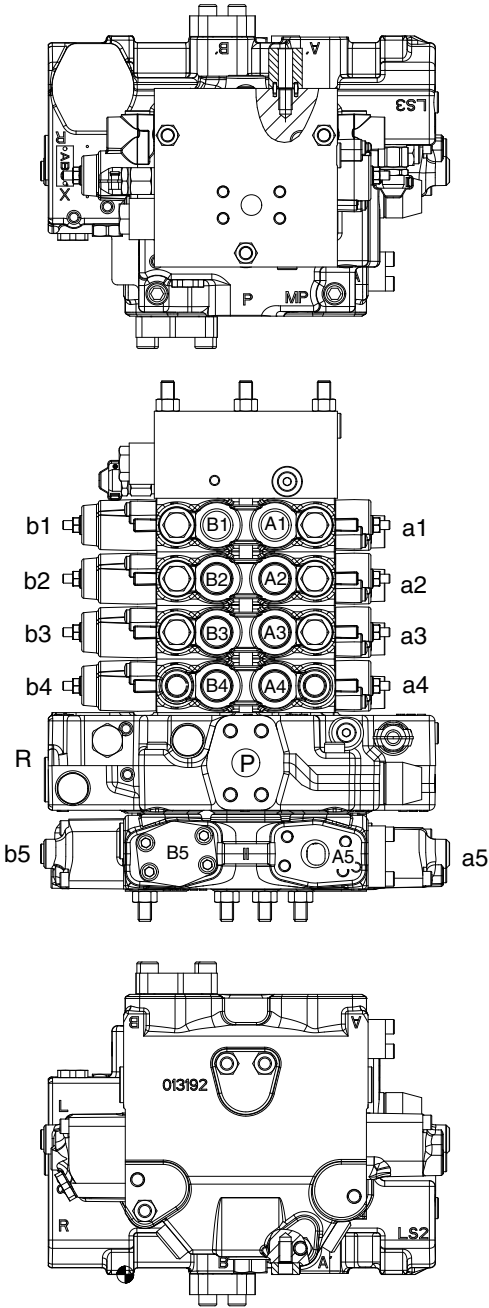
- 1 Inlet section
- 2 Lift section
- 3 Tilt section

- 4 Aux section
- 5 Priority valve section
- 6 Tie rod

- 7 Hexagon nut
- 9 Main relief valve
- 13 Name plate

160D9VLM01

Structure (2/2)

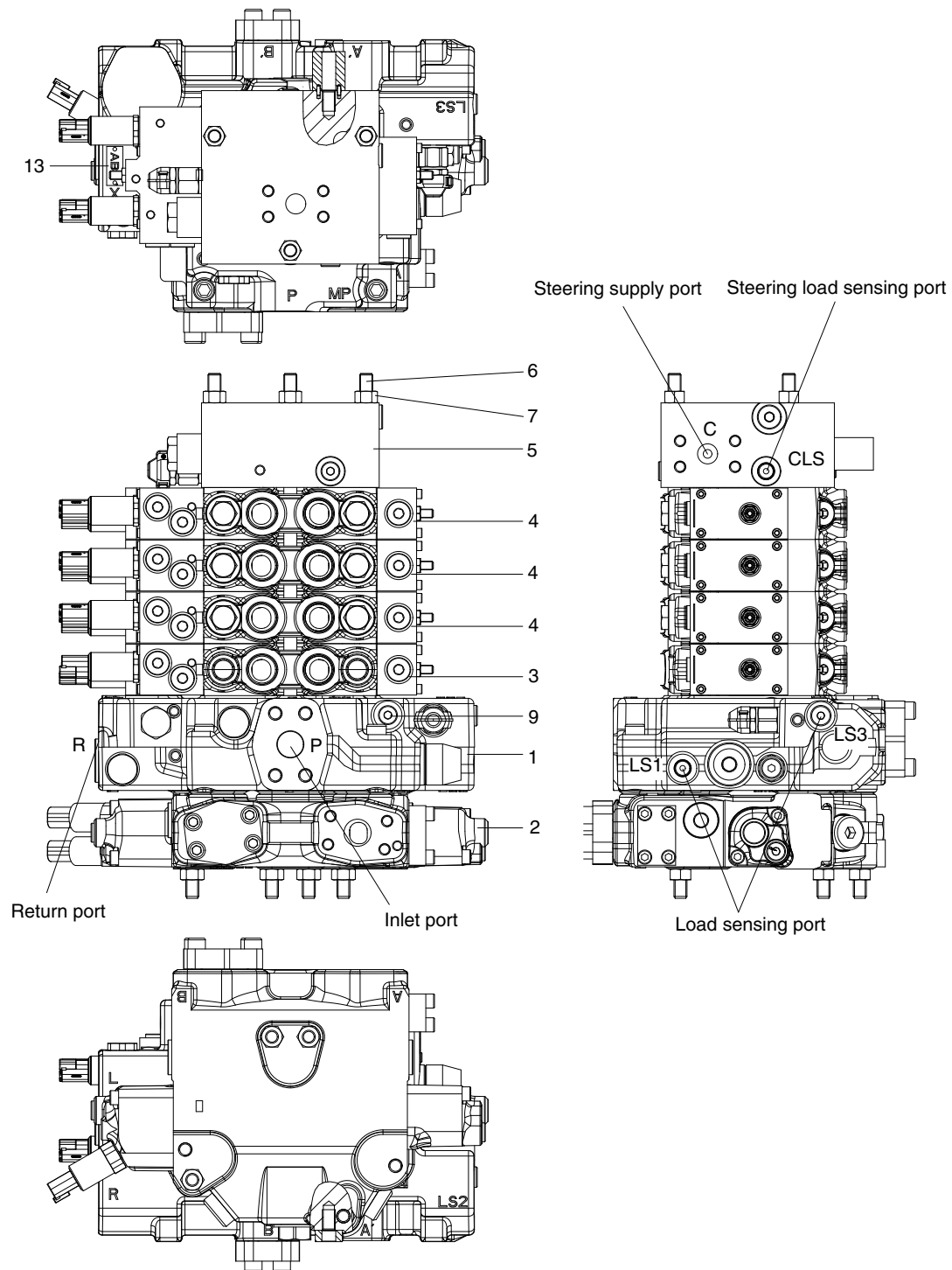


HYDRAULIC CIRCUIT 160D9VLM02

Port	Port name	Size	Port	Port name	Size
P	Inlet port	-	1A, 1B	To aux port	-
R	Outlet port	-	a5, b5	To lift pilot prot	-
5A, 5B	To lift cylinder port	-	a4,b4	To tilt pilot port	-
4A, 4B	To tilt cylinder port	-	a3, b3	To aux pilot port	-
3A, 3B	To aux cylinder port	-	a2, b2	To aux pilot port	-
2A, 2B	To aux cylinder port	-	a1, b1	To aux pilot port	-

2) FINGERTIP TYPE

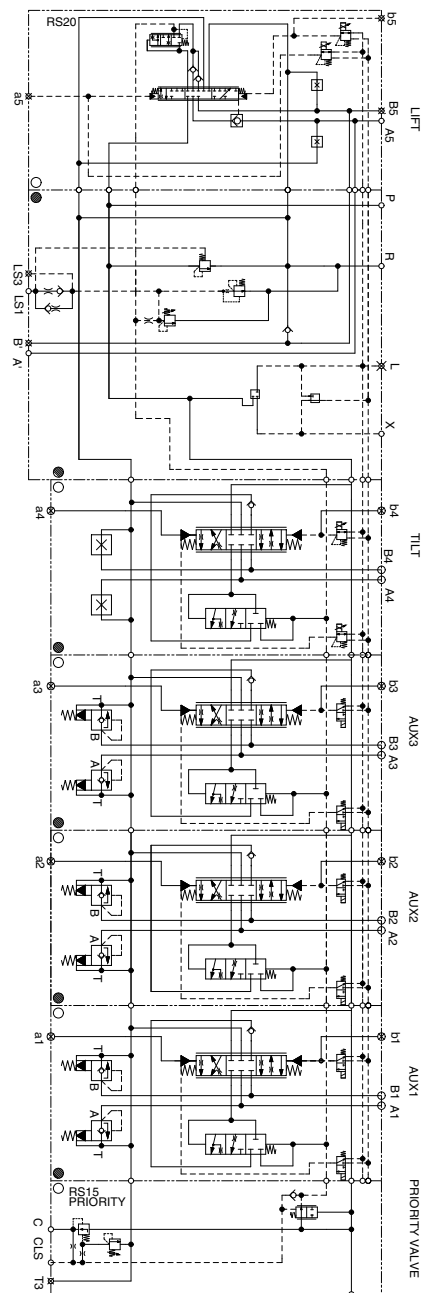
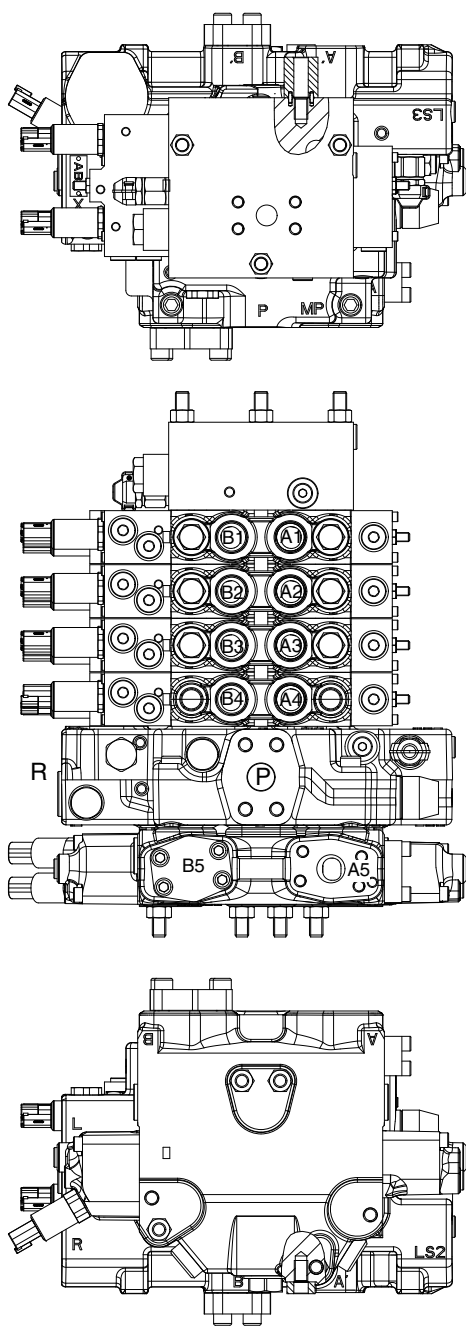
(1) Structure (1/2)



160D9VFM01

- | | | | | | |
|---|--------------------|---|------------------------|----|-------------------|
| 1 | Inlet section assy | 4 | Auxiliary section | 7 | Nut |
| 2 | Lift section | 5 | Priority valve section | 9 | Main relief valve |
| 3 | Tilt section | 6 | Tie rod | 13 | Name plate |

Structure (2/2)



HYDRAULIC CIRCUIT

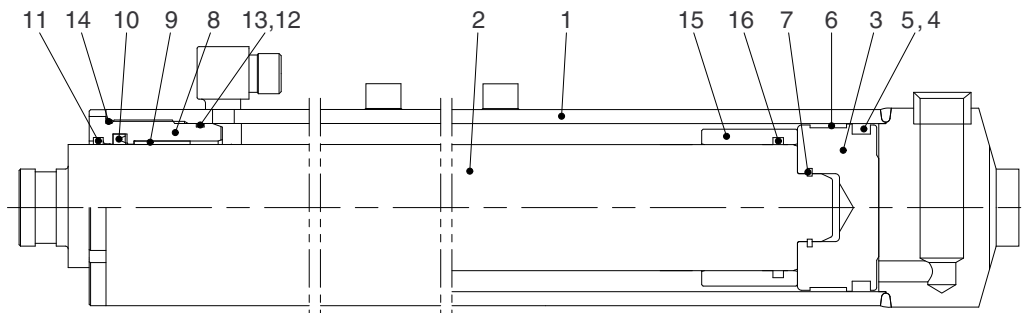
160D9VFM02

Port	Port name	Size
P	Inlet port	-
R	Outlet port	-
5A, 5B	To lift cylinder port	-
4A, 4B	To tilt cylinder port	-
3A, 3B	To tilt cylinder port	-
2A, 2B	To aux cylinder port	-
1A, 1B	To aux cylinder port	-

7. LIFT CYLINDER

1) V-MAST

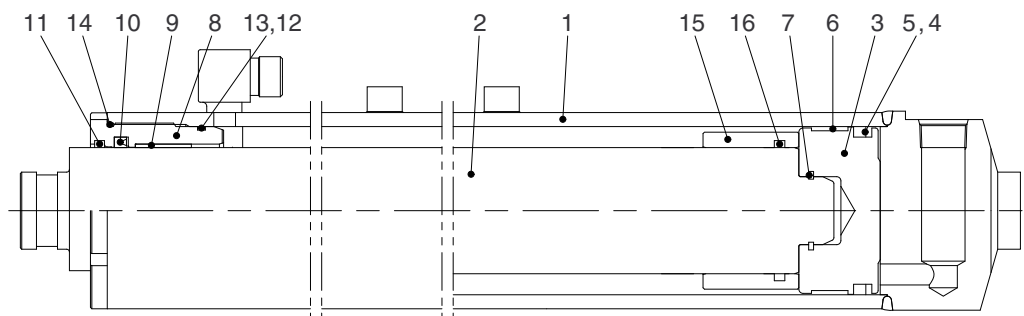
(1) 120/130D-9V



110D9CYL01

- | | | |
|-----------------|---------------|-----------------|
| 1 Tube assembly | 7 Stop ring | 13 Back up ring |
| 2 Rod assembly | 8 Rod cover | 14 O-ring |
| 3 Piston | 9 Rod bushing | 15 Spacer |
| 4 U-packing | 10 U-packing | 16 O-ring |
| 5 Back up ring | 11 Dust wiper | |
| 6 Wear ring | 12 O-ring | |

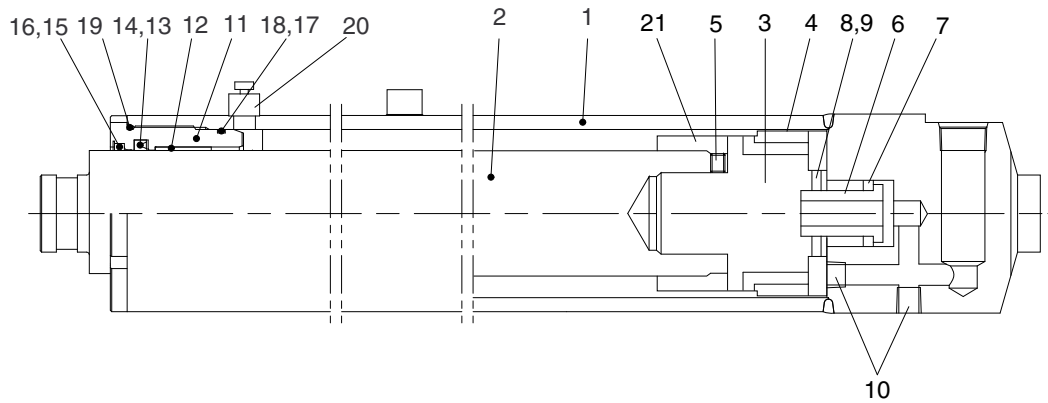
(2) 160D-9V



110D9CYL02

- | | | |
|-----------------|---------------|-----------------|
| 1 Tube assembly | 7 Stop ring | 13 Back up ring |
| 2 Rod | 8 Rod cover | 14 O-ring |
| 3 Piston | 9 Rod bushing | 15 Spacer |
| 4 U-packing | 10 U-packing | 16 O-ring |
| 5 Back up ring | 11 Dust wiper | |
| 6 Wear ring | 12 O-ring | |

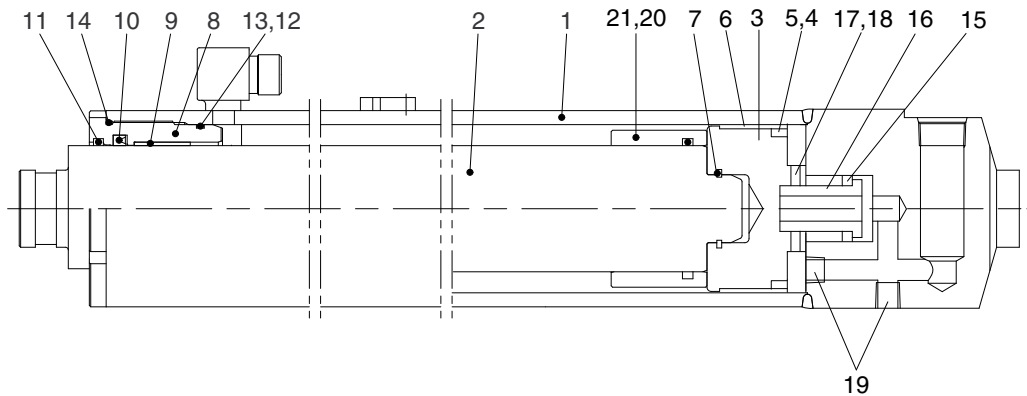
2) VS-MAST



3CFT-17011

1	Tube assembly	8	Set screw	15	Dust wiper
2	Rod	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

3) TS-MAST

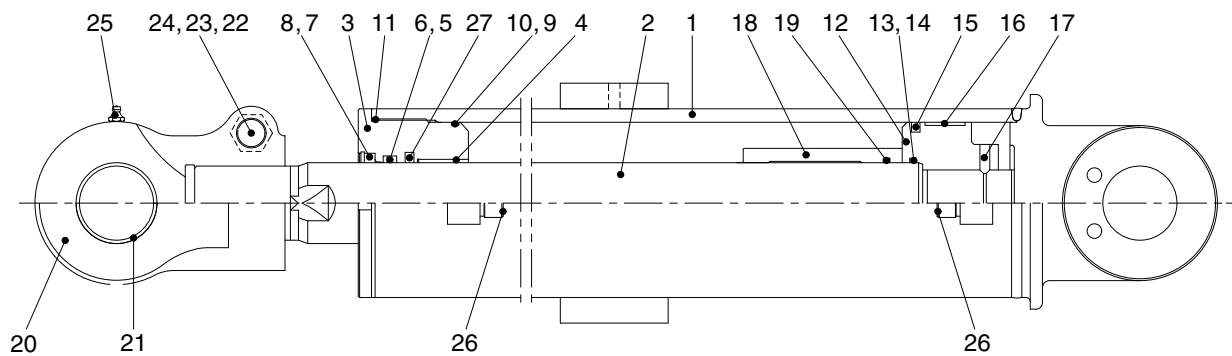


3DFT-17010

1	Tube assembly	8	Rod cover	15	Cushion ring
2	Rod	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

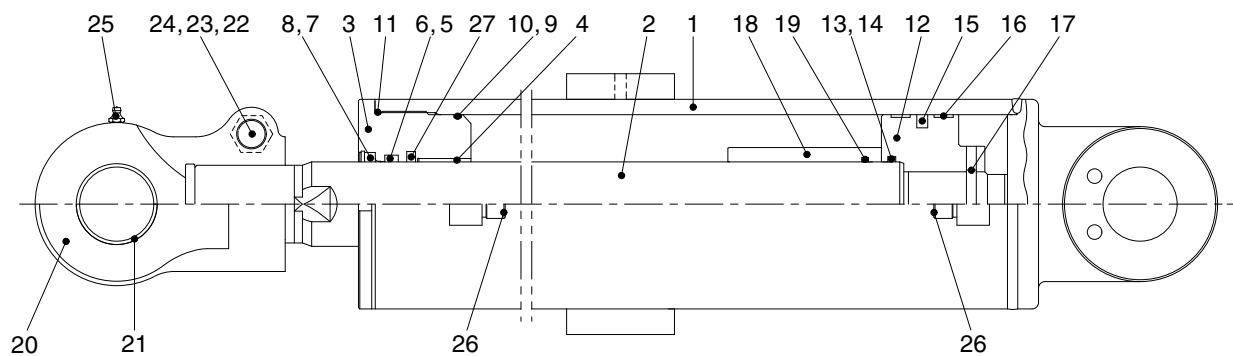
1) 120/130D-9V



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) | 27 Buffer ring |

2) 160D-9V

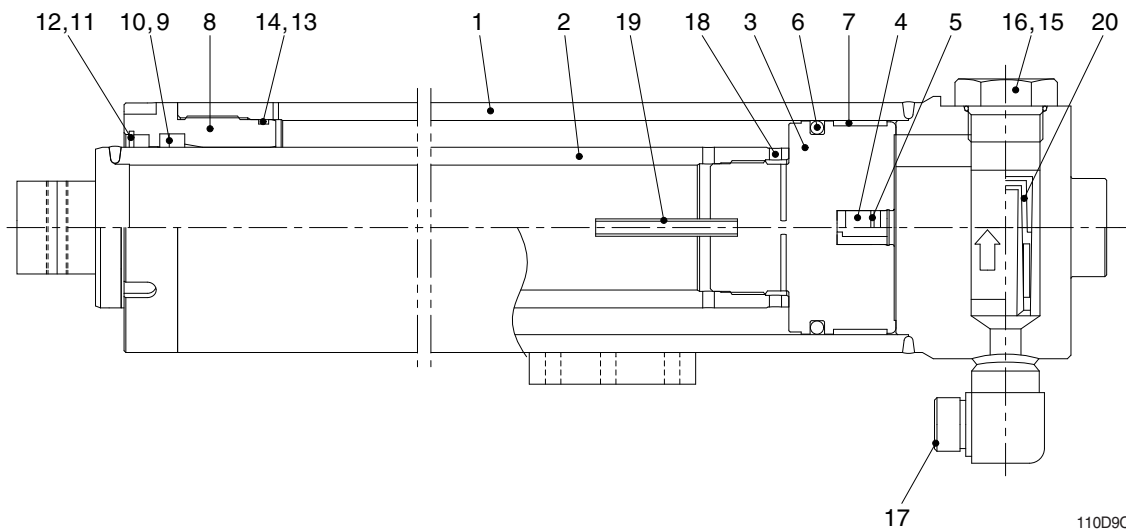


110D9CYL04

- | | | |
|-----------------|-----------------|------------------|
| 1 Tube assembly | 10 Back-up ring | 19 O-ring |
| 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 | 27 Buffer seal |

9. FREE CYLINDER

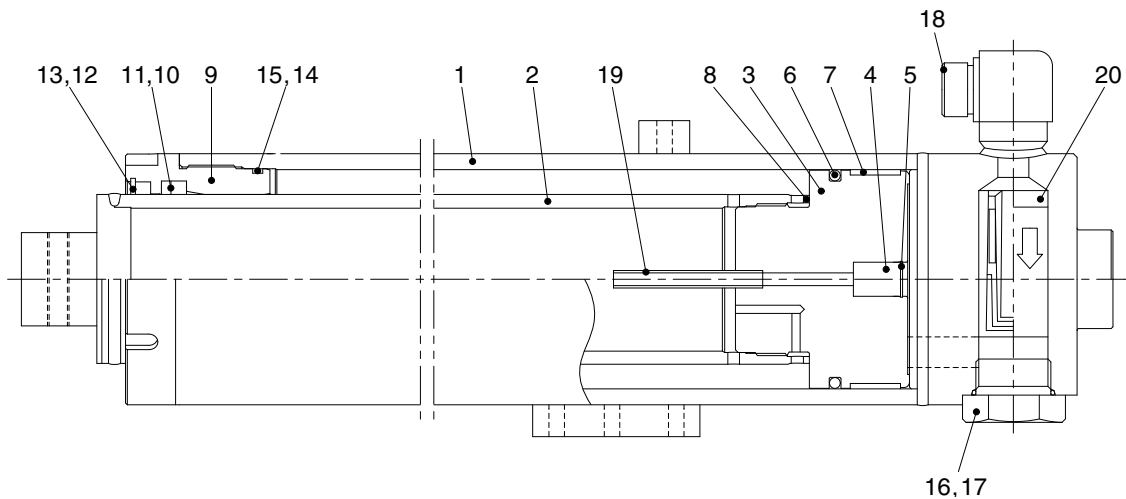
1) 120/130D-9V



110D9CYL05

- | | | |
|------------------|-------------------|----------------------|
| 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-9V



33FT-17221

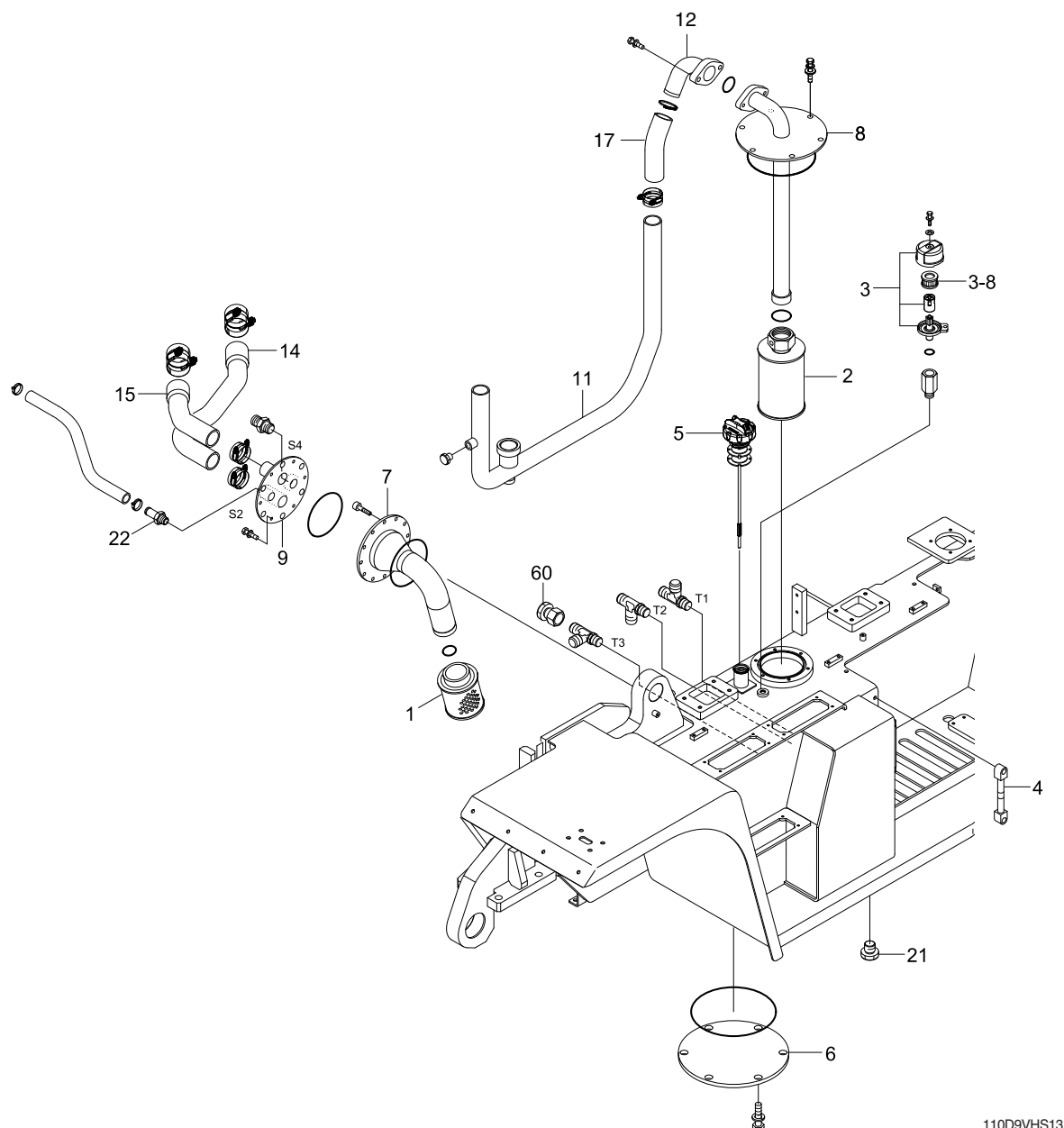
- | | | |
|------------------|-------------------|----------------------|
| 1 Tube assembly | 8 Set screw | 15 Back up ring |
| 2 Rod assembly | 9 Rod cover | 16 O-ring |
| 3 Piston | 10 U-packing | 17 Plug |
| 4 Check valve | 11 Back up ring | 18 O-ring |
| 5 Retaining ring | 12 Dust wiper | 19 Pipe assy |
| 6 Piston seal | 13 Retaining ring | 20 Down safety valve |
| 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.

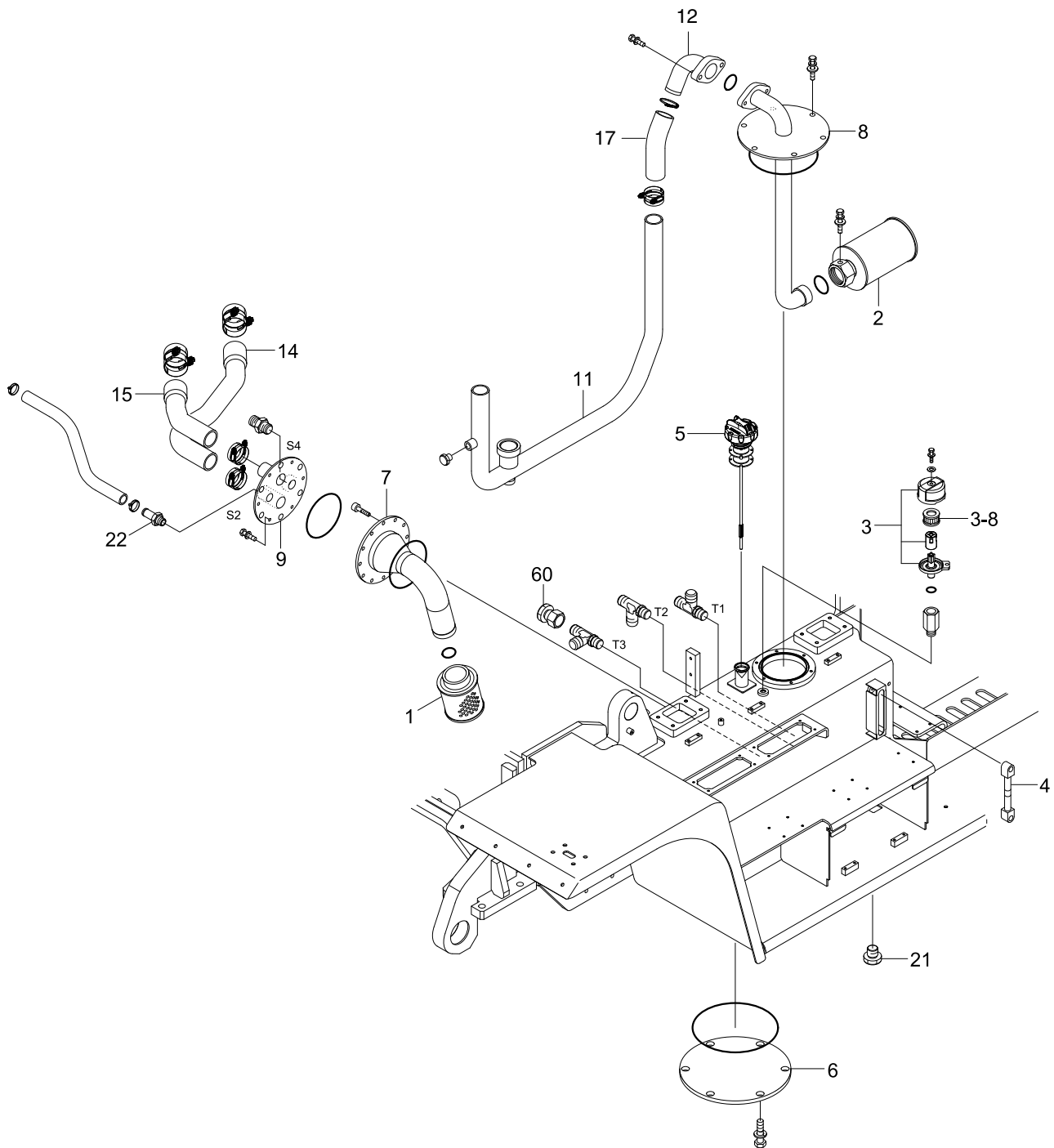
(1) 120/130D-9V



110D9VHS13

1	Suction strainer	6	Cover	14	Suction hose
2	Return filter element	7	Suction flange	15	Suction hose
3	Air breather assy	8	Return flange	17	Rubber hose
3-8	Element	9	Suction flange	21	Drain plug
4	Level gauge	11	Return pipe	22	Connector
5	Hydraulic tank cap	12	Pipe	60	Cap

(2) 160D-9V



160D9VHS13

- 1 Suction strainer
- 2 Return filter element
- 3 Air breather assy
- 3-8 Element
- 4 Level gauge
- 5 Hydraulic tank cap

- 6 Cover
- 7 Suction flange
- 8 Return flange
- 9 Suction flange
- 11 Return pipe
- 12 Pipe

- 14 Suction hose
- 15 Suction hose
- 17 Rubber hose
- 21 Drain plug
- 22 Connector
- 60 Cap

2) AIR BREATHER

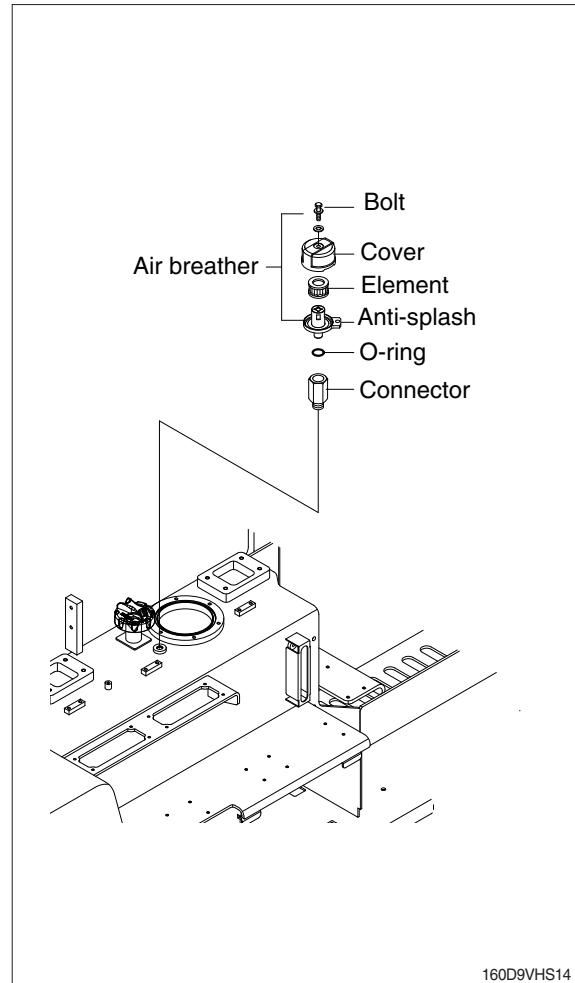
The air breather is equipped with the capacity to perform two functions simultaneously-as an air filter and as a breathing valve.

(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

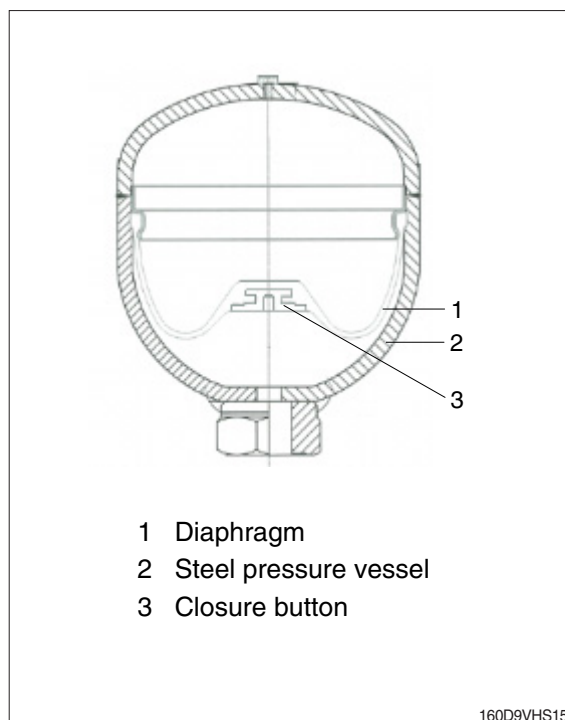
When the hydraulic cylinder is being used, the oil level in the hydraulic system increases and as temperature rises. If the hydraulic pressure rises above the set pressure, breather is actuated to release the hydraulic pressure inside the tank.



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.

Item	31E3-3187
Diameter (ϕ D)	90 mm
Mounting height (A)	120 mm
Norminal volume	0.35 ℓ
Priming pressure	15 bar
Operation medium	Oil
Operation pressure	Max 170 bar
Thread	PF 1/2
Priming gas	Nitrogen



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

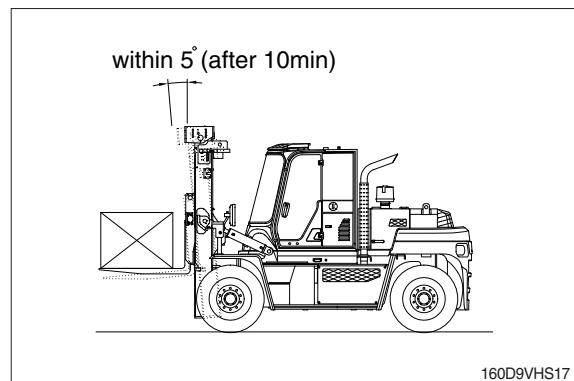
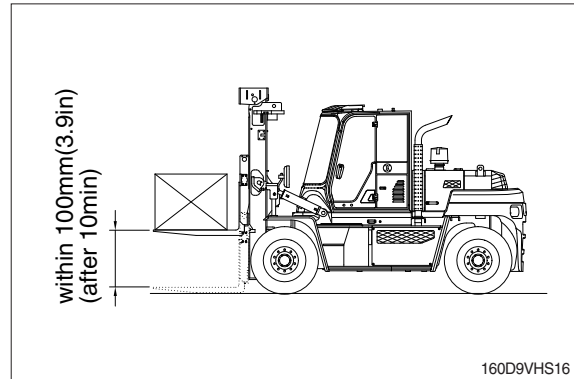
- Down (Downward movement of forks)
: Within 100 mm (3.9 in)
- Forward (Extension of tilt cylinder)
: Within 5°

- (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)
----------	------------------



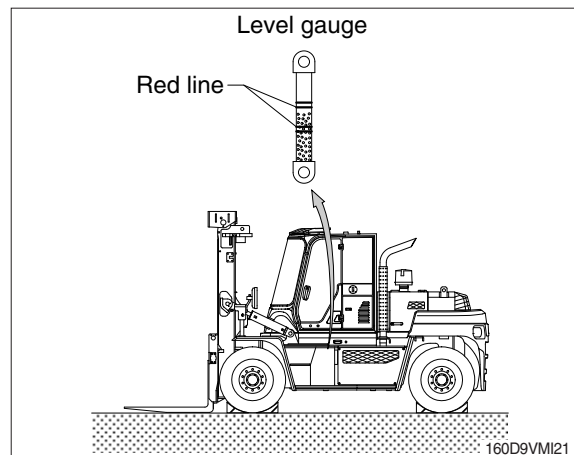
2) HYDRAULIC OIL

- (1) Using level gauge, measure oil level, and oil if necessary.
- (2) When changing hydraulic oil, clean suction strainer (screwed into outlet port pipe) (every one year or 2000 hours)

3) CONTROL VALVE

- (1) Raise forks to maximum height and measure oil pressure.

Check that oil pressure is 210 kgf/cm².
(2990 psi)



2. TROUBLESHOOTING

1) SYSTEM

Problem	Cause	Remedy
Large fork lowering speed.	<ul style="list-style-type: none"> Seal inside control valve defective. Oil leaks from joint or hose. Seal inside cylinder defective. 	<ul style="list-style-type: none"> Replace spool or valve body. Replace. Replace packing.
Large spontaneous tilt of mast.	<ul style="list-style-type: none"> Tilting backward : Check valve defective. Tilting forward : tilt lock valve defective. Oil leaks from joint or hose. Seal inside cylinder defective. 	<ul style="list-style-type: none"> Clean or replace. Clean or replace. Replace. Replace seal.
Slow fork lifting or slow mast tilting.	<ul style="list-style-type: none"> 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. 	<ul style="list-style-type: none"> 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.	<ul style="list-style-type: none"> Excessive restriction of oil flow pump suction side. Gear or bearing in hydraulic pump defective. 	<ul style="list-style-type: none"> Clean filter. Replace gear or bearing.
Control valve lever is locked	<ul style="list-style-type: none"> Foreign matter jammed between spool and valve body. Valve body defective. 	<ul style="list-style-type: none"> Clean. Tighten body mounting bolts uniformly.
High oil temperature.	<ul style="list-style-type: none"> Lack of hydraulic oil. High oil viscosity. Oil filter clogged. 	<ul style="list-style-type: none"> Add oil. Change to SAE10W, class CF engine oil. Clean filter.

Problem	Cause	Remedy
Actuator (cylinder or motor) works slowly or does not operate.	<ul style="list-style-type: none"> · Shortage of oil in oil tank. · Decrease of relief valve pressure. · Spool got stuck. · Shortage of oil flow to the valve. 	<ul style="list-style-type: none"> · 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.	<ul style="list-style-type: none"> · Internal leakage of cylinder happens frequently. · Excessive leakage from spool of the valve. · Spool got stuck. · Leakage in a part of the circuit. 	<ul style="list-style-type: none"> · 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.	<ul style="list-style-type: none"> · Defect of relief valve. · Leakage in a part of the circuit. 	<ul style="list-style-type: none"> · Check the relief valve. · Check the circuit. · Observe leakage from pipes.
Temperature rising of the hydraulic oil.	<ul style="list-style-type: none"> · 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. 	<ul style="list-style-type: none"> · 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 temperature. · Check the oil tank volume. · Check if the suction strainer is blocked.
Steering force is heavy.	<ul style="list-style-type: none"> · Defect of steering relief valve. 	<ul style="list-style-type: none"> · Check the steering relief valve.

2) HYDRAULIC PISTON PUMP

Problem	Cause	Remedy
Pump does not develop full pressure.	<ul style="list-style-type: none"> · System relief valve set too low or leaking. · Oil viscosity too low. · Pump is worn out. 	<ul style="list-style-type: none"> · Check system relief valve for proper setting. · Change to proper viscosity oil. · Repair or replace pump.
Pump will not pump oil.	<ul style="list-style-type: none"> · Reservoir low or empty. · Suction strainer clogged. 	<ul style="list-style-type: none"> · Fill reservoir to proper level. · Clean suction strainer.
Noisy pump caused by cavitation.	<ul style="list-style-type: none"> · Oil too thick. · Oil filter plugged. · Suction line plugged or too small. 	<ul style="list-style-type: none"> · Change to proper viscosity. · Clean filters. · Clean line and check for proper size.
Oil heating.	<ul style="list-style-type: none"> · Oil supply low. · Contaminated oil. · Setting of relief valve too high or too low. · Oil viscosity too low. 	<ul style="list-style-type: none"> · 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.	<ul style="list-style-type: none"> · Low oil level. · Air leaking into suction line. · Wrong kind of oil. 	<ul style="list-style-type: none"> · Fill reservoir to proper level. · Tighten fittings, check condition of line. · Drain reservoir, fill with non-foaming oil.
Shaft seal leakage.	<ul style="list-style-type: none"> · Worn shaft seal. · Worn shaft in seal area. 	<ul style="list-style-type: none"> · Replace shaft seal. · Replace drive shaft and seal.

3) MAIN RELIEF VALVE

Problem	Cause	Remedy
Can't get pressure	<ul style="list-style-type: none"> · Poppet stuck open or contamination under seat. 	<ul style="list-style-type: none"> · Check for foreign matter between puppets and their mating parts. Parts must slide freely.
Erratic pressure	<ul style="list-style-type: none"> · Pilot poppet seat damaged. 	<ul style="list-style-type: none"> · Replace the relief valve. · Clean and remove surface marks for free movement.
Pressure setting not correct	<ul style="list-style-type: none"> · Normal wear. Lock nut & adjust screw loose. 	<ul style="list-style-type: none"> · See *How to set pressure on work main relief.
Leaks	<ul style="list-style-type: none"> · Damaged seats. · Worn O-rings. · Parts sticking due to contamination. 	<ul style="list-style-type: none"> · 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

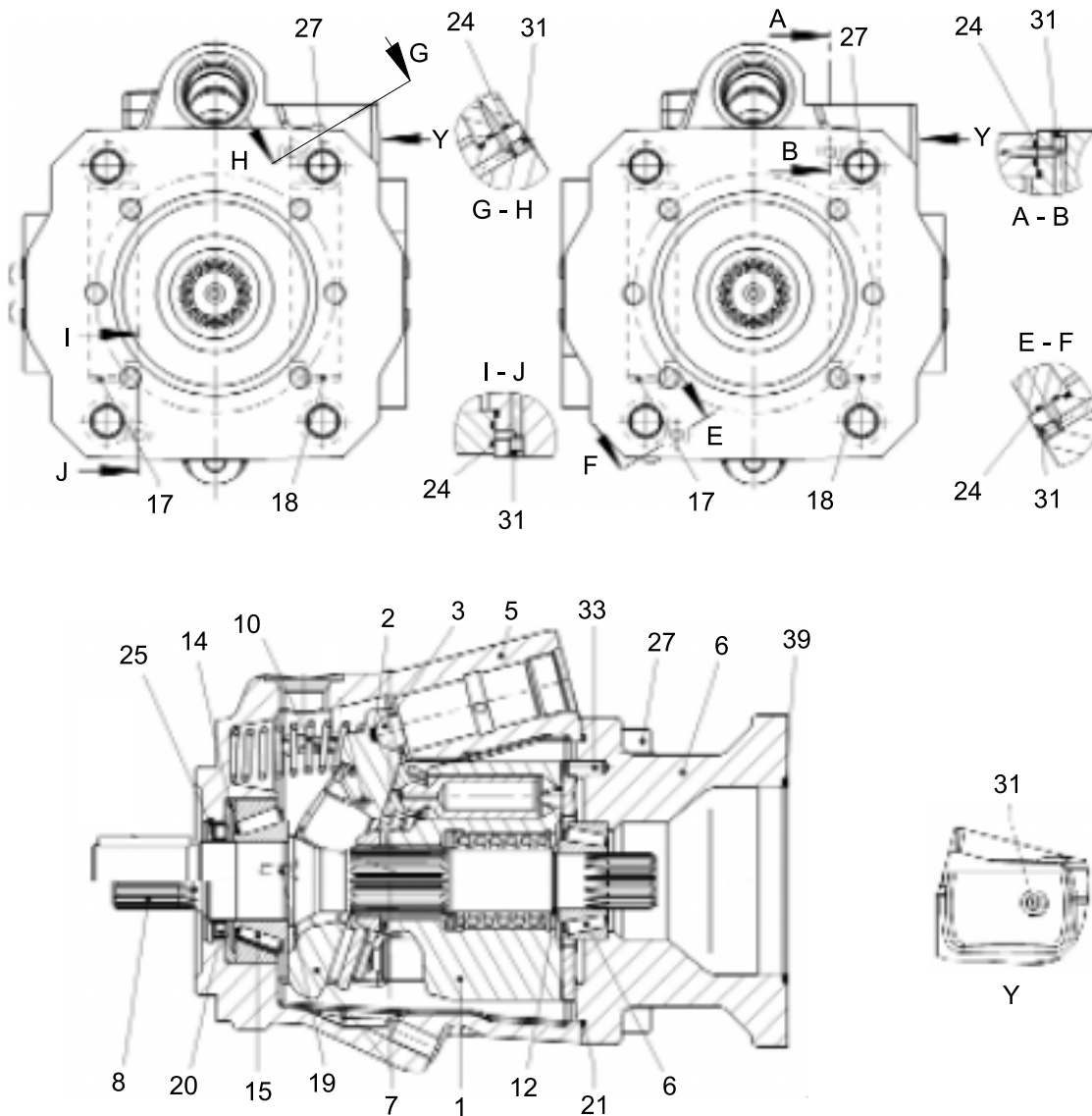
Problem	Cause	Remedy
Oil leaks out from gland through rod.	<ul style="list-style-type: none">· Foreign matters on packing.· Unallowable score on rod.· Unusual distortion of dust seal.· Chrome plating is striped.	<ul style="list-style-type: none">· Replace packing.· Smooth rod surface with an oil stone.· Replace dust seal.· Replace rod.
Oil leaks out from cylinder gland thread.	<ul style="list-style-type: none">· O-ring damaged.	<ul style="list-style-type: none">· Replace O-ring.
Rod spontaneously retract.	<ul style="list-style-type: none">· Scores on inner surface of tube.· Unallowable score on the inner surface of tube.· Foreign matters in piston seal.	<ul style="list-style-type: none">· Smooth rod surface with an oil stone.· Replace cylinder tube.· Replace piston seal.
Wear (clearance between cylinder tube and wear ring)	<ul style="list-style-type: none">· Excessive clearance between cylinder tube and wear ring.	<ul style="list-style-type: none">· Replace wear ring.
Abnormal noise is produced during tilting operation.	<ul style="list-style-type: none">· Insufficient lubrication of anchor pin or worn bushing and pin.· Bent tilt cylinder rod.	<ul style="list-style-type: none">· Lubricate or replace.· Replace.

GROUP 3 DISASSEMBLY AND ASSEMBLY

1. MAIN PUMP

1) STRUCTURE

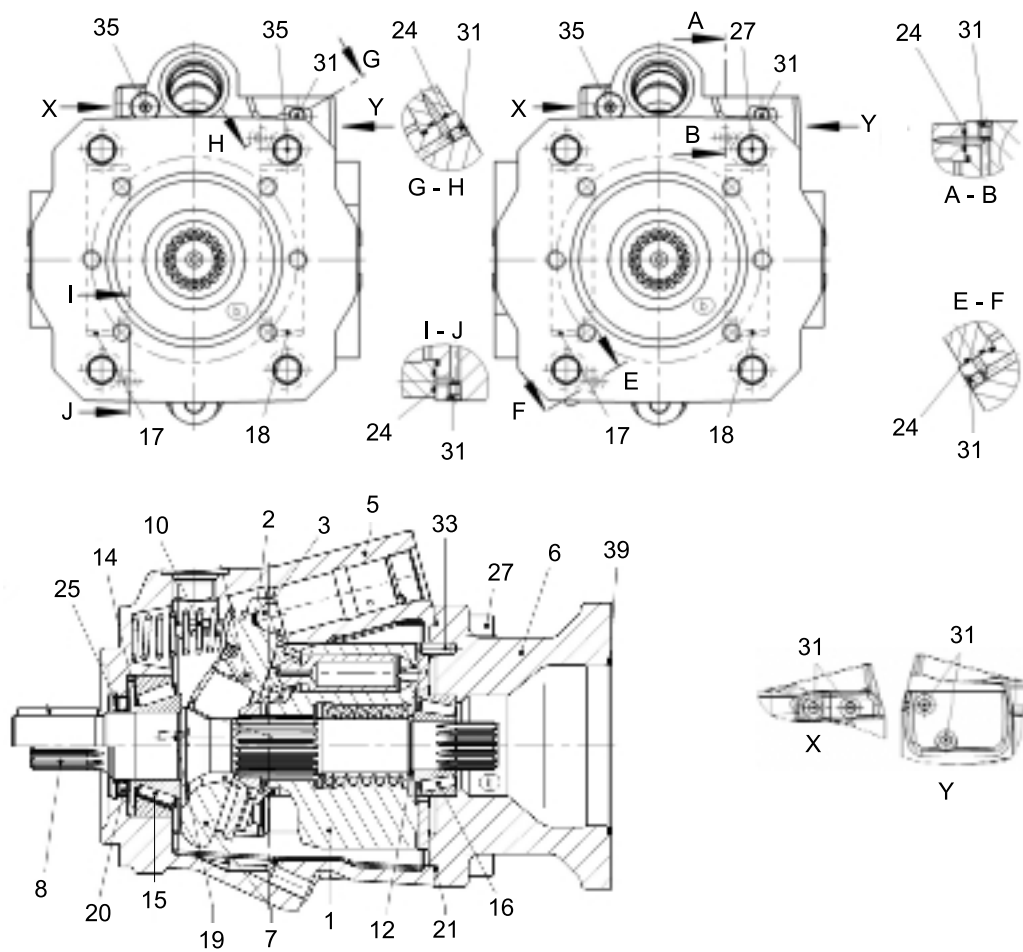
(1) Front



160D9VMP05

- | | | |
|--------------------|-------------------------|-------------------|
| 1 Rotary kit | 12 Shim | 21 O-ring |
| 2 Pressure spring | 14 Stop ring | 24 Seal |
| 3 Stopper | 15 Taper roller bearing | 25 Retaining ring |
| 5 Pump housing | 16 Taper roller bearing | 27 Socket screw |
| 6 Connection plate | 17 Bearing liner | 31 Pin |
| 7 Swash plate | 18 Bearing liner | 33 Straight pin |
| 8 Drive shaft | 19 Flat screw | 39 O-ring |
| 10 Spring | 20 Shaft seal | |

(2) Rear



160D9VMP06

- | | | |
|-------------------|-------------------------|-------------------|
| 1 Rotary kit | 12 Shim | 21 O-ring |
| 2 Pressure spring | 14 Stop ring | 24 Seal |
| 3 Stopper | 15 Taper roller bearing | 25 Retaining ring |
| 5 Pump housing | 16 Taper roller bearing | 27 Socket screw |
| 6 Port plate | 17 Bearing liner | 31 Pin |
| 7 Swash plate | 18 Bearing liner | 33 Straight pin |
| 8 Drive shaft | 19 Flat screw | 35 Locking screw |
| 10 Spring | 20 Shaft seal | 39 O-ring |

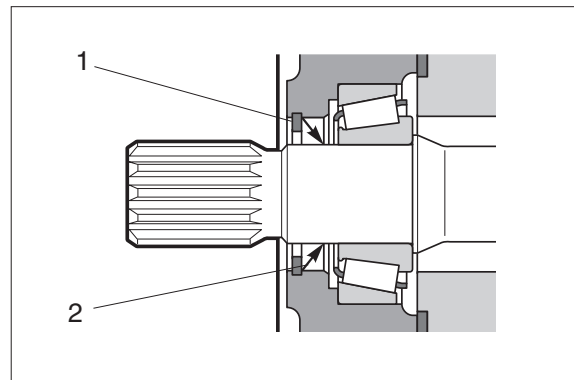
2) GENERAL REPAIR GUIDE LINES

- ※ 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.

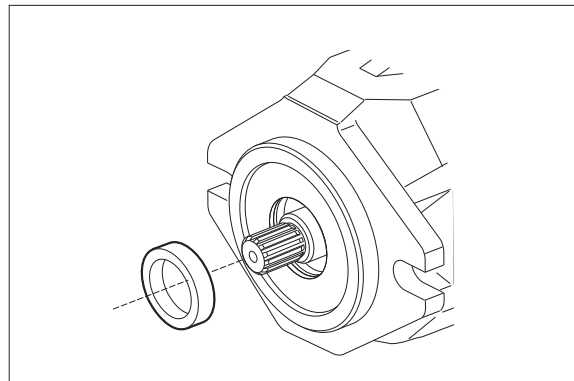
3) SEALING THE DRIVE SHAFT

- (1) Protect the drive shaft.
Remove the circlip.
Remove the shaft seal.

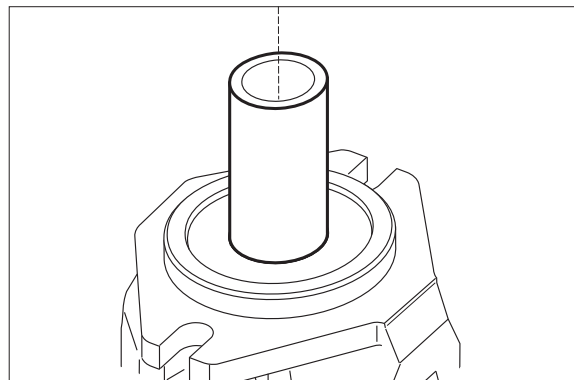
1 Circlip 2 Shaft seal



- (2) Change the shaft seal and check its sliding surface (drive shaft) and housing, grease the sealing ring.

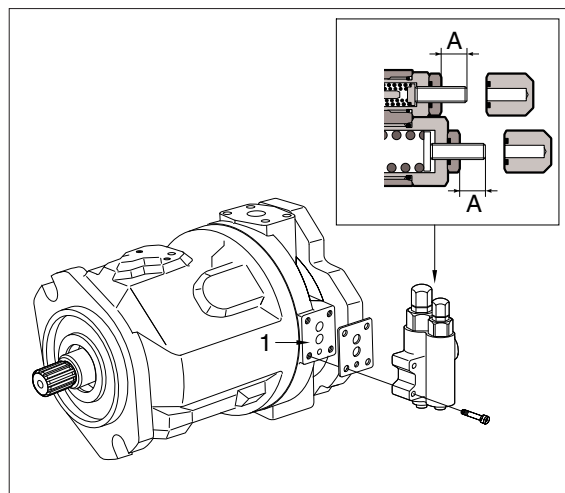


- (3) Assemble the sealing ring, fitting tool holds the correct position of the sealing ring in the pump housing.
Assemble the circlip in the correct position.



4) SEALING / CLEANING THE CONTROL VALVE

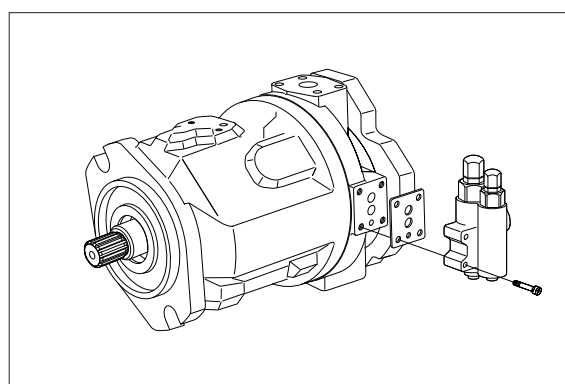
- (1) Disassemble the control valve.
- ※ Measure dimension A and note down.
- Check sealing surface (1).



75796WE62

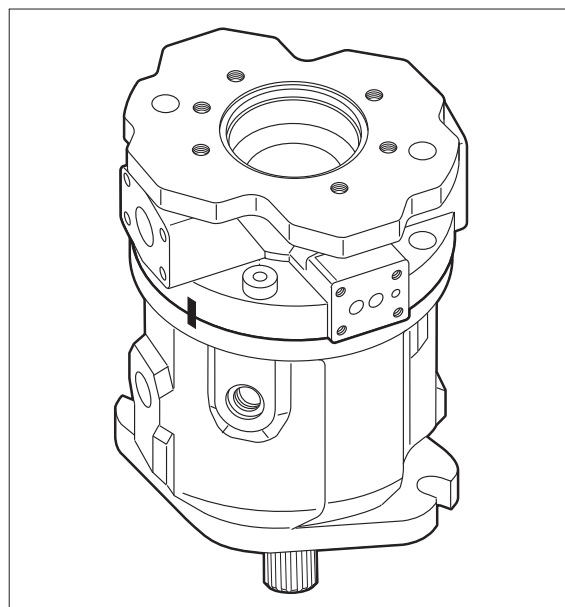
5) DISASSEMBLE THE PUMP

- (1) Remove the control valve.



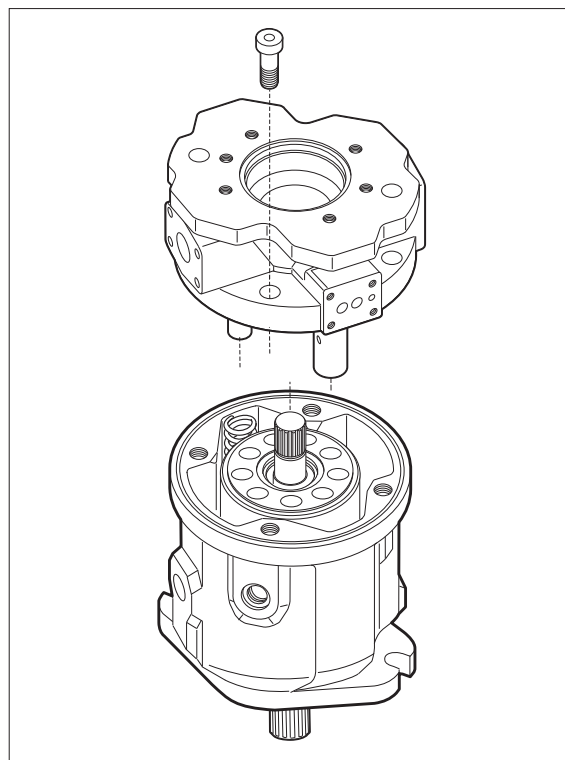
75796WE63

- (2) Mark the location of the connection plate on the housing.



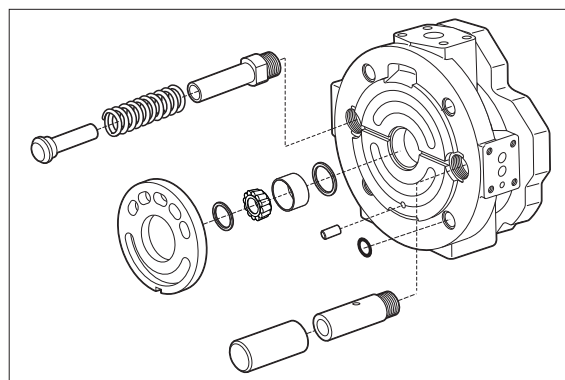
75796WE64

- (3) Remove the connection plate fixing bolts and the connection plate.
 ※ Distributor plate and adjustment piston can drop down.



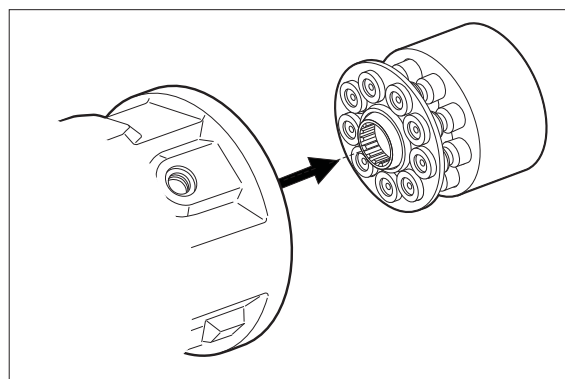
75796WE65

- (4) Remove distributor plate.
 Take note of the orientation.
 ※ Remove bearing with withdrawal tool.
 Do not damage the sealing surface.



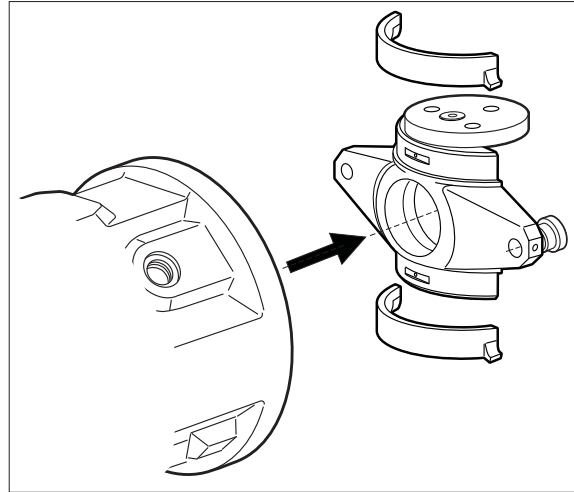
75796WE66

- (5) Remove the rotary group in a horizontal position.



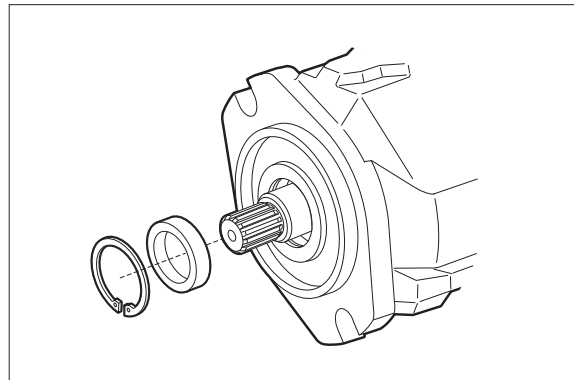
75796WE67

(6) Remove swash plate and bearing shells.



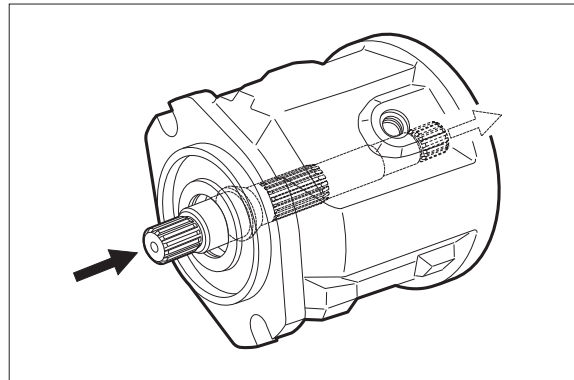
75796WE68

(7) Remove the circlip and the shaft seal.



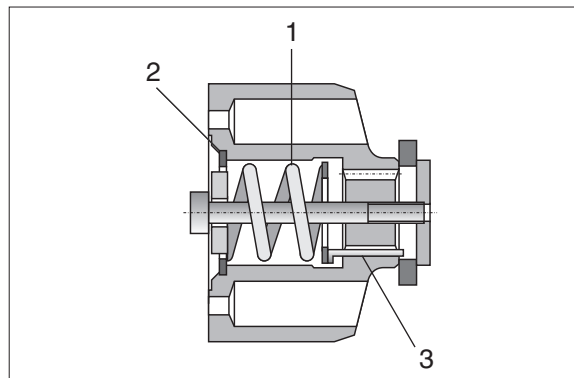
75796WE69

(8) Remove the drive shaft through rear side.



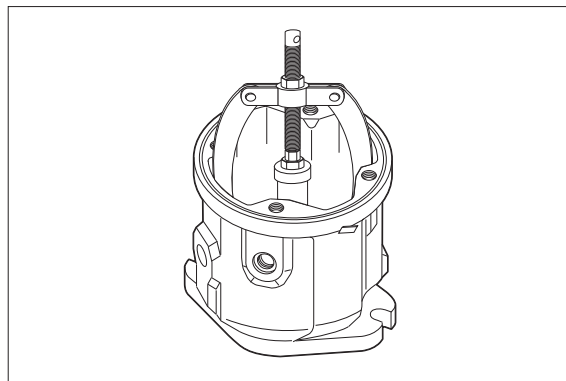
75796WE70

(9) Pre-tension the spring (1) using a suitable device.
Remove circlip (2).
Remove spring (1) and pressure pins (3).



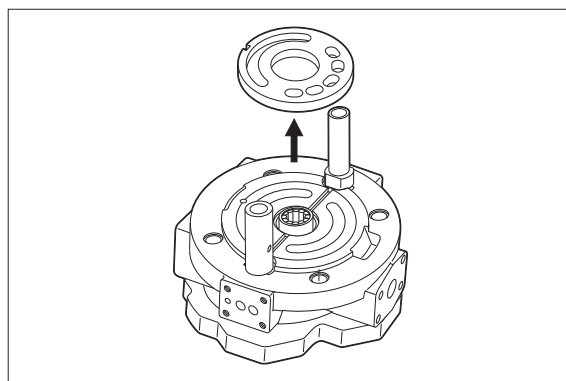
75796WE72

- (10) Use bearing puller to remove outer bearing race of front bearing out of housing press seat.



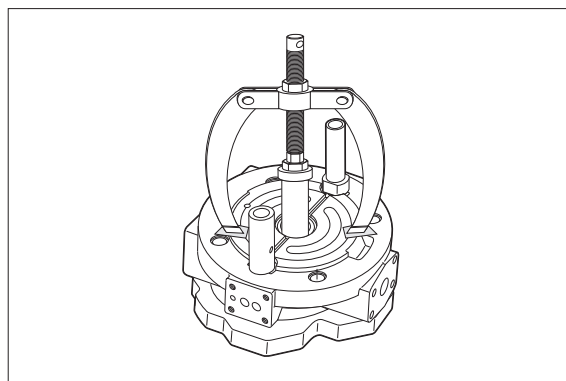
75796WE74

- (11) Remove the control plate.



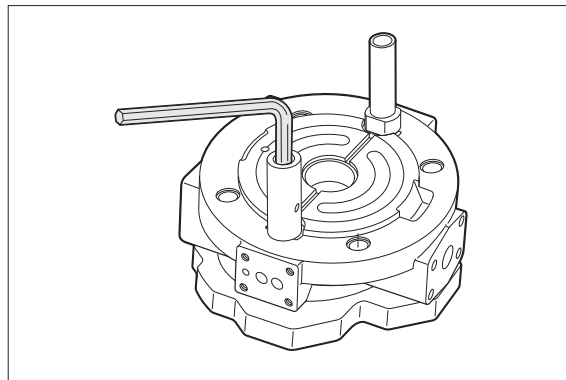
75796WE75

- (12) Use bearing puller to remove outer bearing race of rear bearing - press seat.



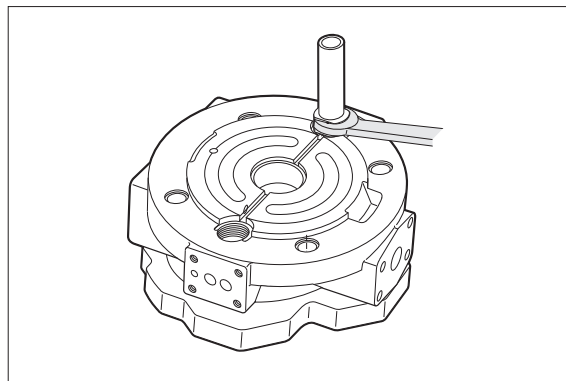
75796WE76

- (13) Disassemble the guide of control piston
(Mounting position: pilot valve side).



75796WE77

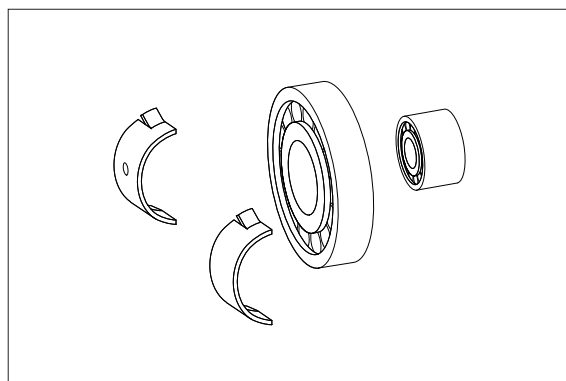
(14) Disassemble the guide of the opposite piston.



75796WE78

6) INSPECT HINTS

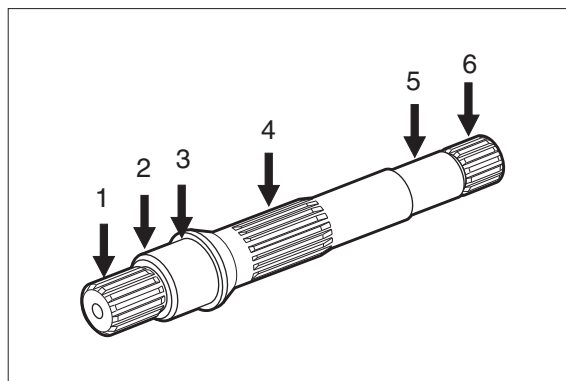
(1) Renew all bearings.



75796WE79

(2) Check :

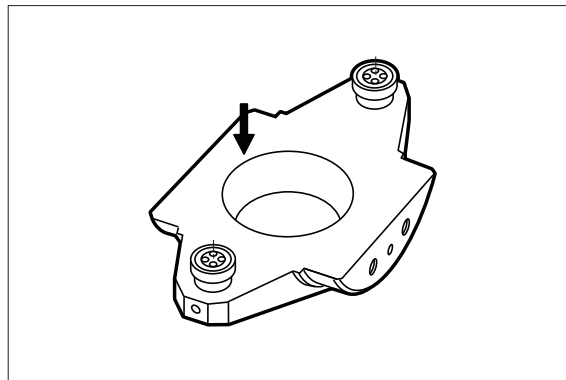
- 1 Wear on splines, rust
- 2 Drive shaft seal wear grooves
- 3 Bearing seat
- 4 Splines for cylinder drive
- 5 Bearing seat
- 6 Bearing seat



75796WE80

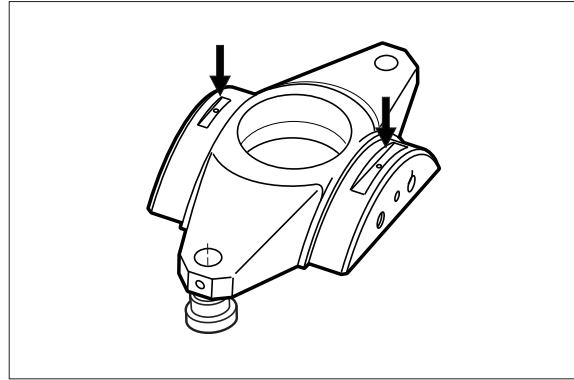
(3) Check :

Sliding surface free of grooves.



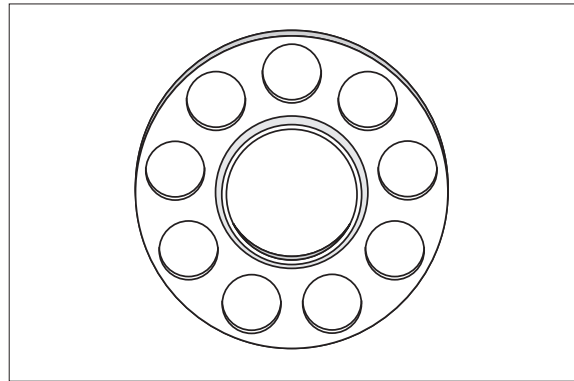
75796WE81

- (4) Check :
Bearing surfaces.



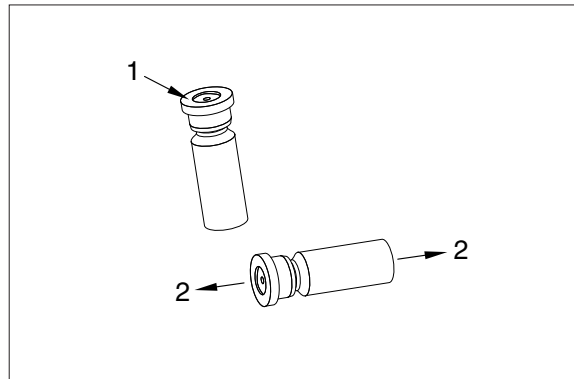
75796WE82

- (5) Check :
That the retaining plate is free of grooves
and that there is no wear in the slipper
pad area.



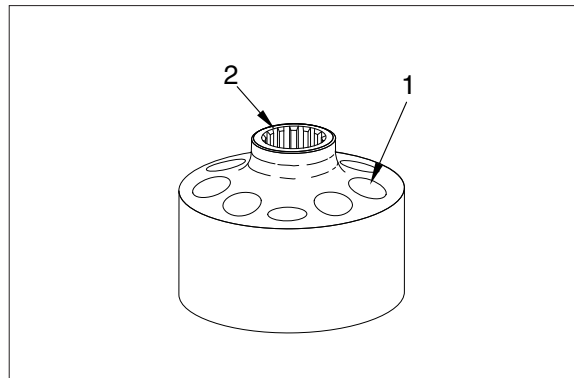
75796WE83

- (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).



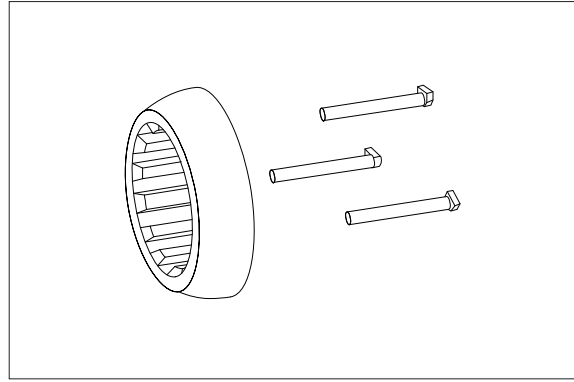
75796WE84

- (7) Check :
1 Cylinder bores
2 Splines



75796WE85

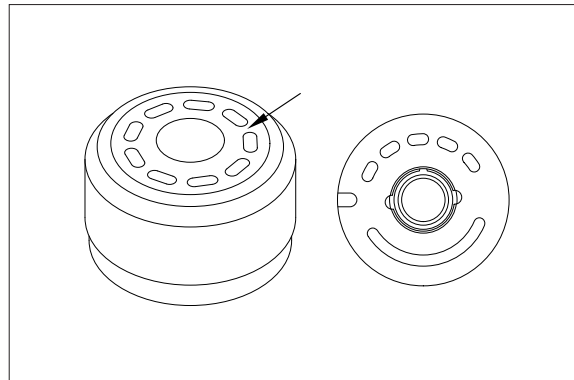
(8) Free of grooves, no signs of wear.



75796WE86

(9) Check :

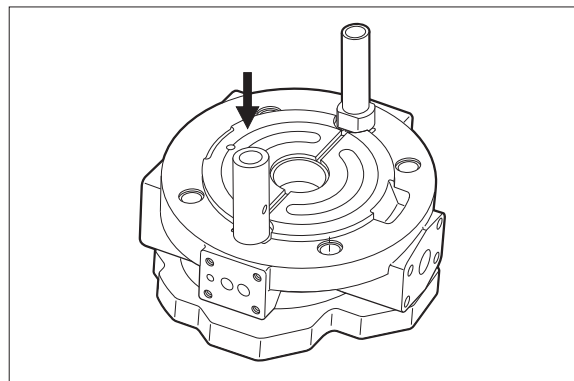
Cylinder sliding surface free of grooves, no wear, no embedded foreign particles. That there are no scratches on the control plate. (Only replace them as a set).



75796WE87

(10) Check :

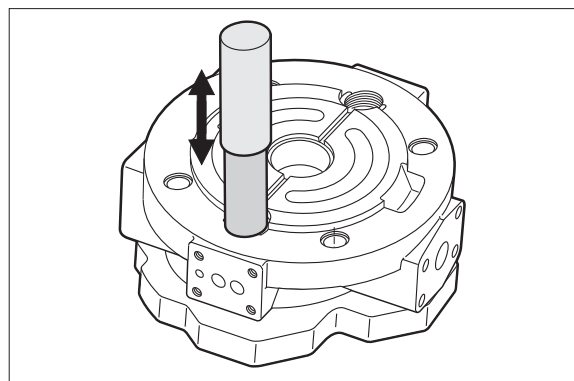
Mounting surface - control plate undamaged.



75796WE120

(11) Check :

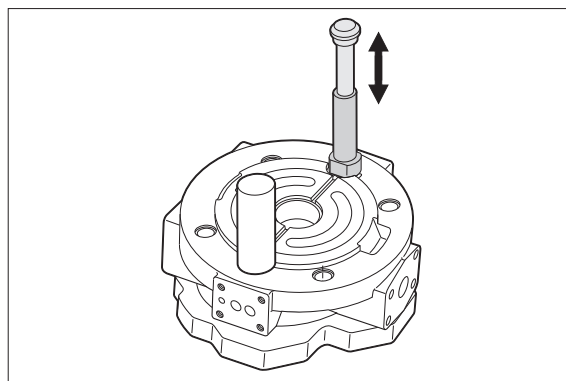
Check running conditions of the control piston.



75796WE89

(12) Check :

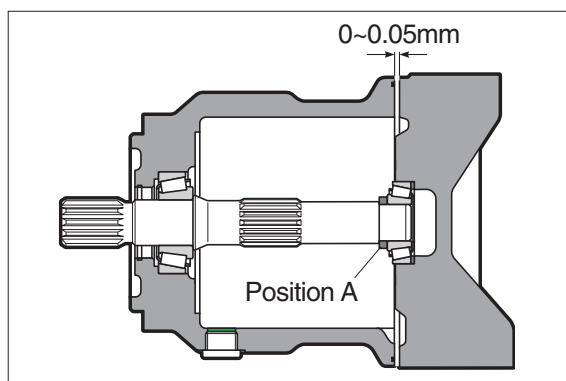
Check running conditions of the opposite piston.



75796WE90

7) ADJUSTMENT OF TAPER ROLLER BEARING SET

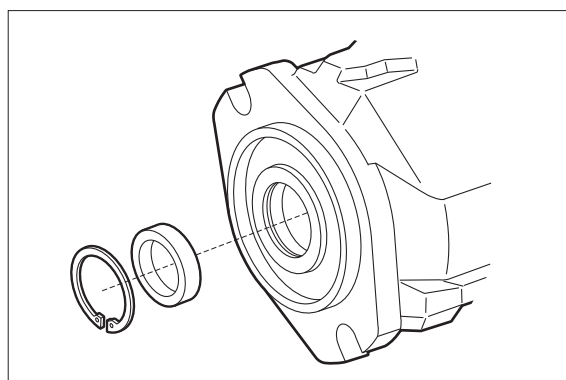
- (1) Cast iron housing must have initial tension of the bearings : 0~0,05 mm, grind position A if necessary.



75796WE91

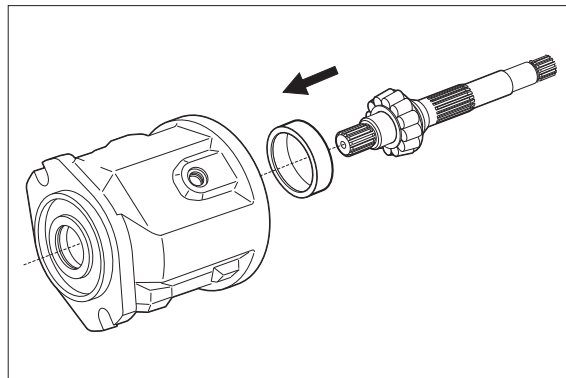
8) PUMP ASSEMBLY

- (1) Fit the seal into the housing.
Fit the circlip.



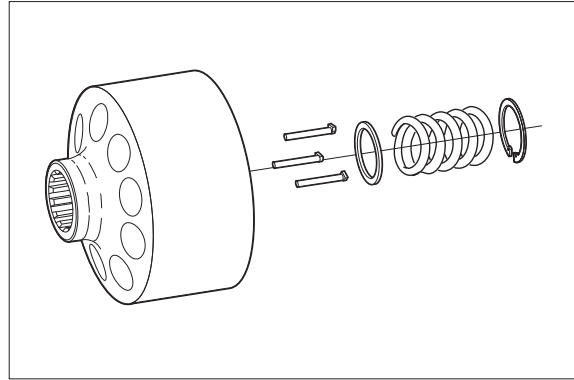
75796WE92

- (2) Fit the drive with bearing from rear end.
※ Do not touch seal lip with edge of keyway or spline.



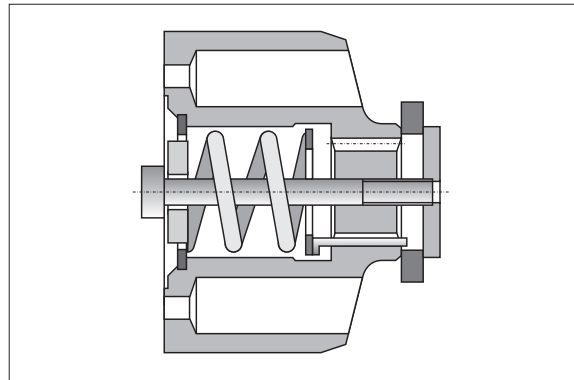
75796WE93

(3) Fit pressure pins using an assembly aid.



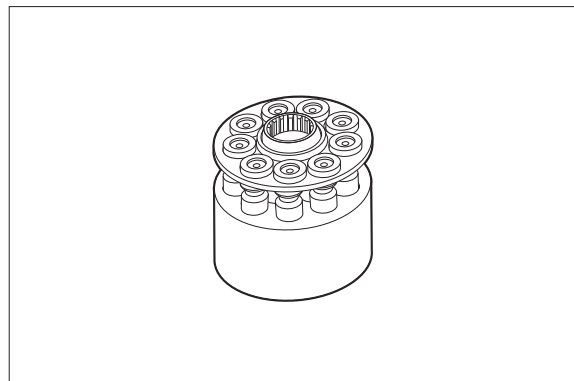
75796WE94

(4) Pre-tension the spring using a suitable device.



75796WE95

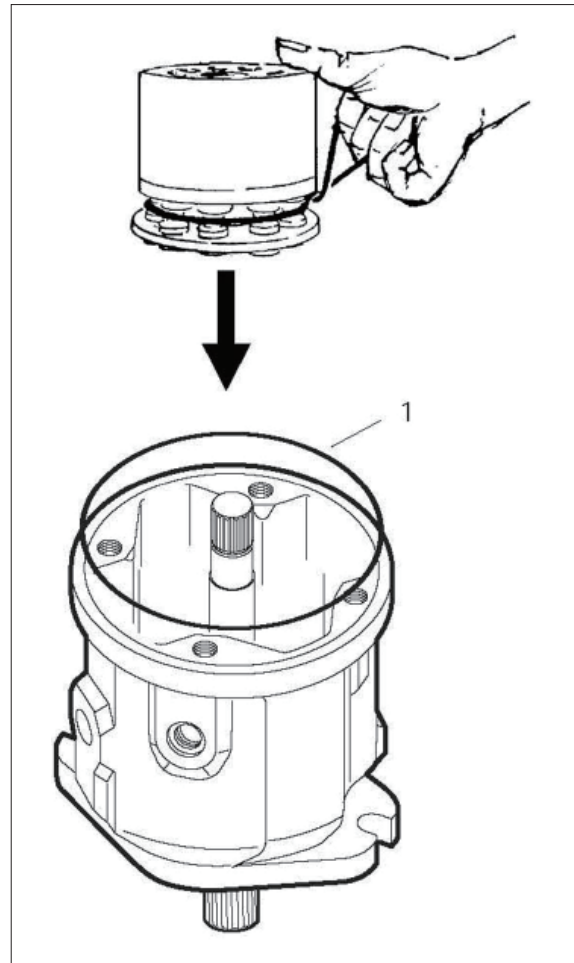
(5) Assemble piston with retaining plate.
※ Oil piston and slipper pad.



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 cylindrical pin (2).

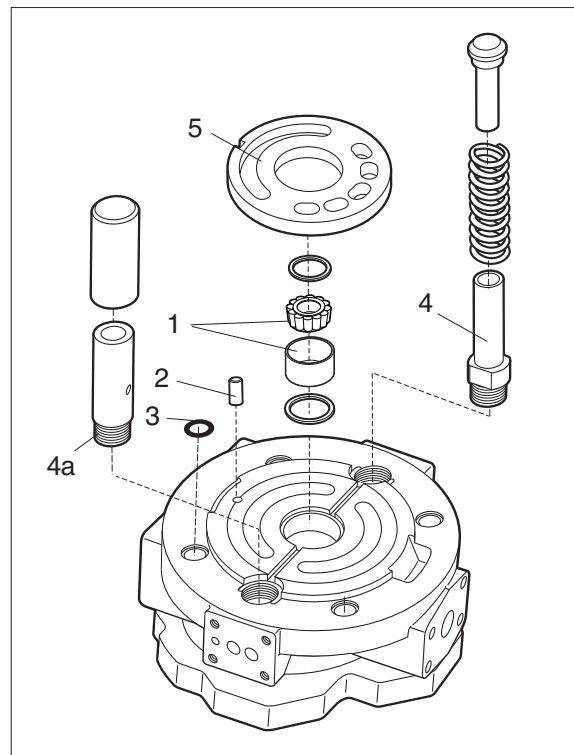
Fit O-rings (3) 4 pieces.

Fit adjustment spool (4) and guide piston (4a).

Fit distributor plate (5) (direction of rotation dependent)

※ Assembly.

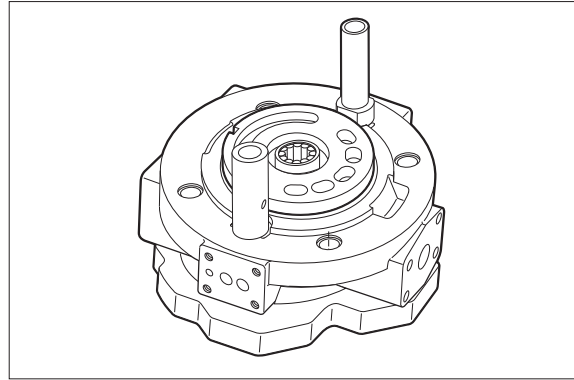
Hold the components in place with grease.



75796WE99

(8) Fit distributor plate.

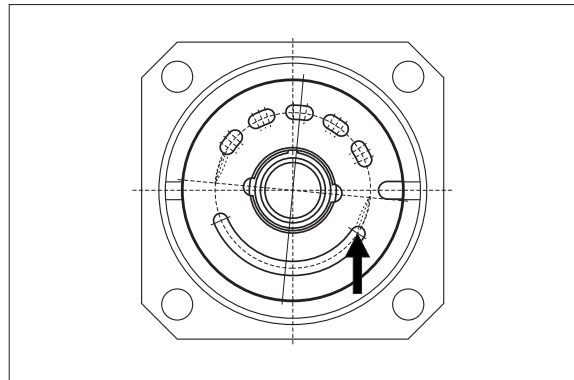
※ Assembly aid : Grease



75796WE100

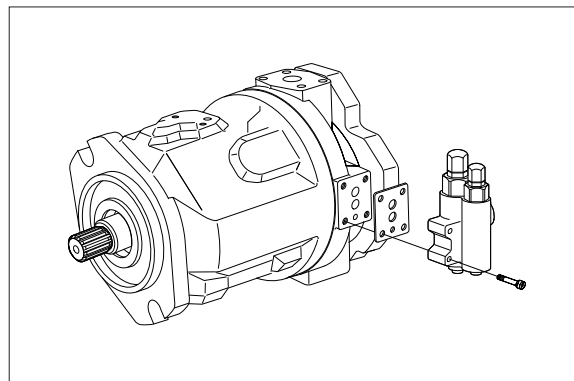
(9) For clockwise rotation pumps the distributor plate is off-set by 4 to the right from the centre position.

(Clockwise and anti-clockwise rotation distributor plates are not identical).



75796WE101

(10) Fit connection plate and control valve.



75796WE63

2. MAIN CONTROL VALVE (RCV LEVER TYPE)

1) VALVE SECTION DISASSEMBLY / REASSEMBLY INSTRUCTIONS

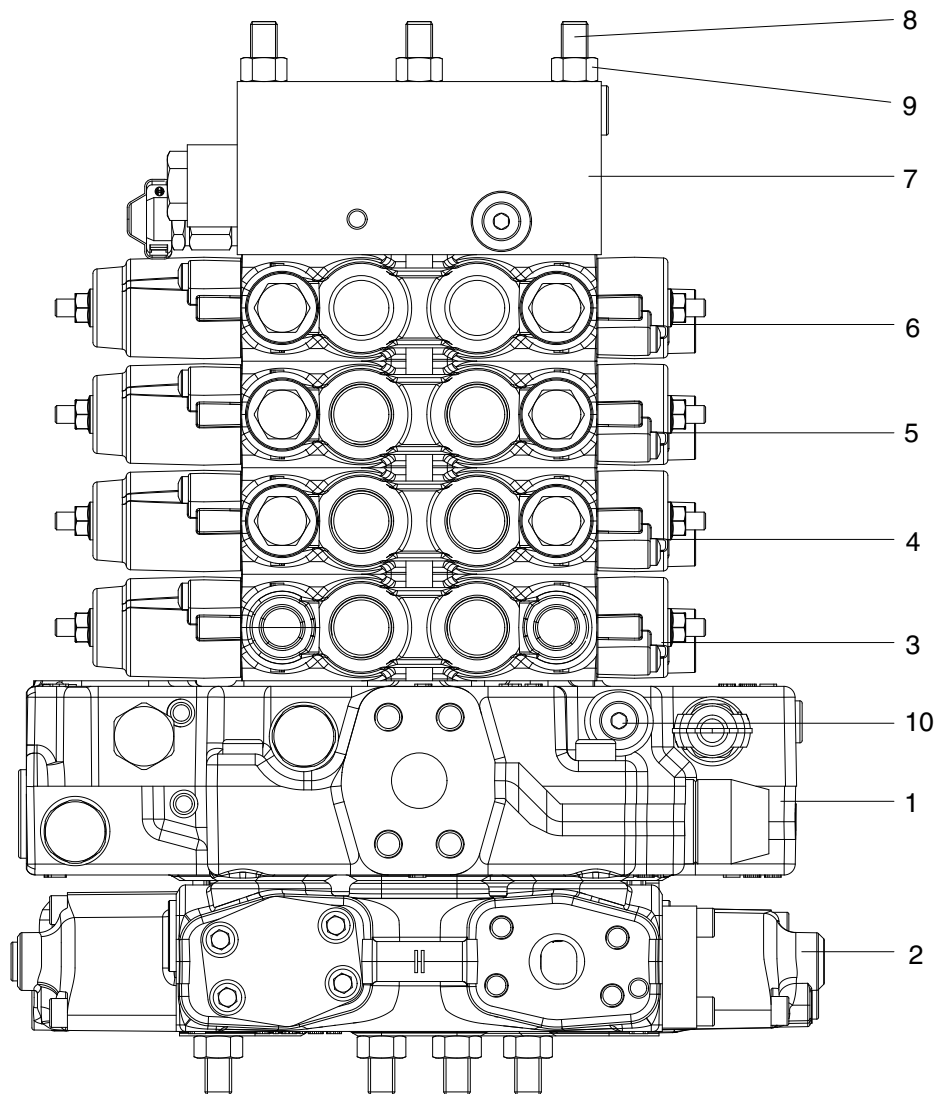
- (1) Clean valve assembly thoroughly to remove any dirt and debris.
- (2) Remove nuts (9) and tie rods (8) from control valve. Separate sections being careful not to lose section O-rings. Keep all components for each section together as a set.
- (3) Lay out valve components on a clean, flat working 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 following page. 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 (8) are threaded to different lengths on each end. Install nuts (9) fully onto the short thread end of each tie rod. Lay lift section (2) on its outside face with tie rods up. Install O-rings in grooves on lift section face. Slide spool section (1) over tie rods and install O-rings. Repeat for the remaining spool sections.

After stacking all spool sections and inlet / outlet sections onto tie rods (8) and nuts (9) 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; Tighten the 6 nuts (9).. Check for proper spool movement.
- (7) Install auxiliary valves and/or port plugs into all sections and torque to proper specifications.

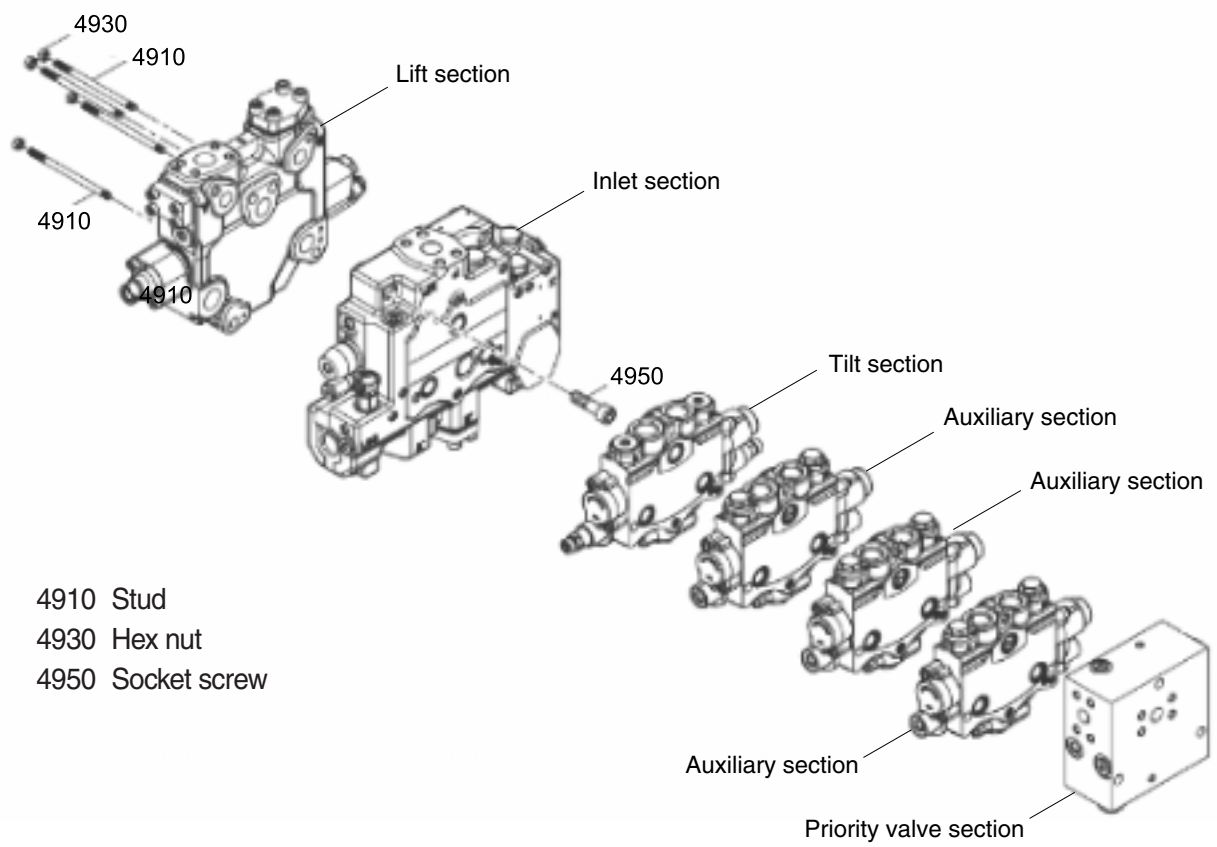
2) VALVE ASSEMBLY



160D9VLM10

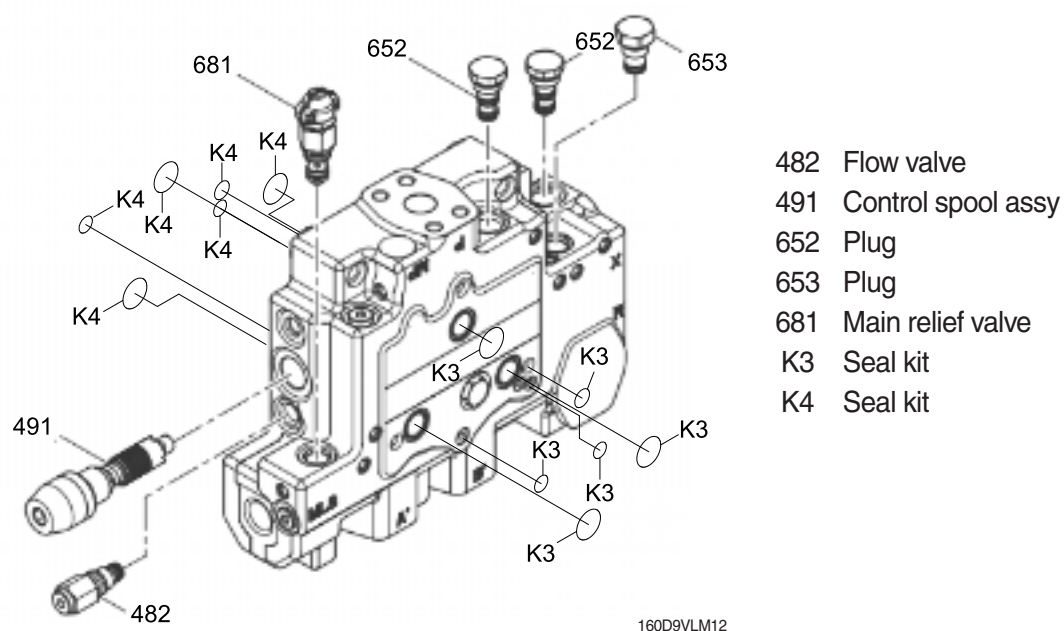
- | | | | | | |
|---|-------------------|---|-------------------|----|-------------------|
| 1 | Lift section | 5 | Auxiliary section | 9 | Nut |
| 2 | Inlet section | 6 | Auxiliary section | 10 | Main relief valve |
| 3 | Tilt section | 7 | Outlet section | | |
| 4 | Auxiliary section | 8 | Tie rod | | |

3) LAYOUT

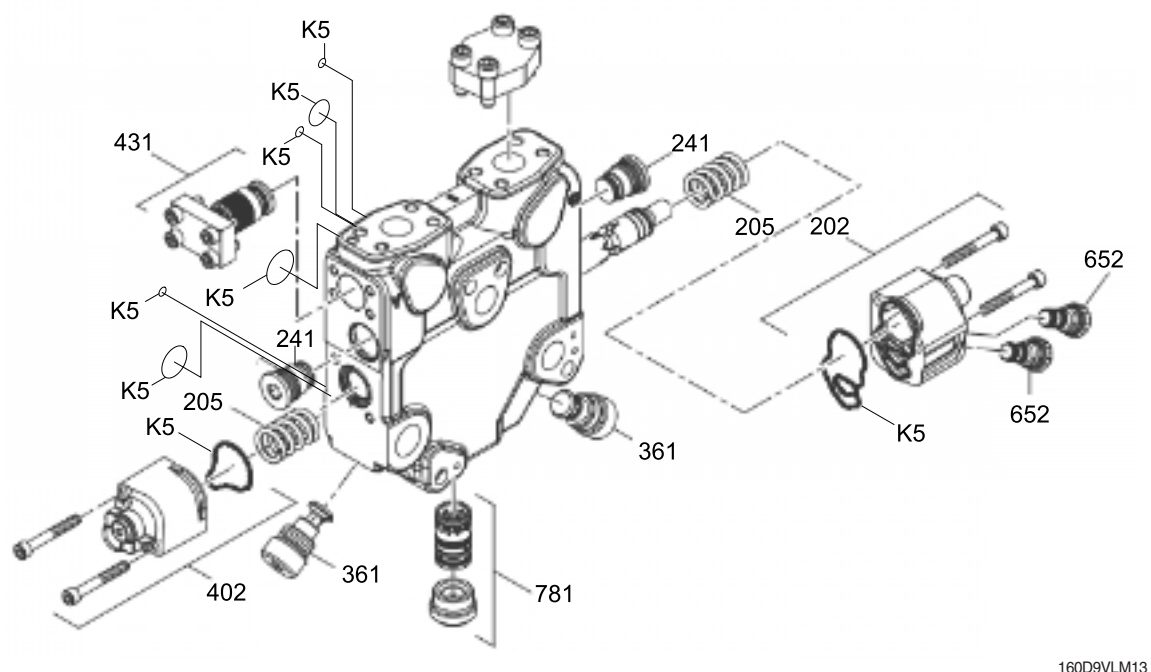


160D9VLM11

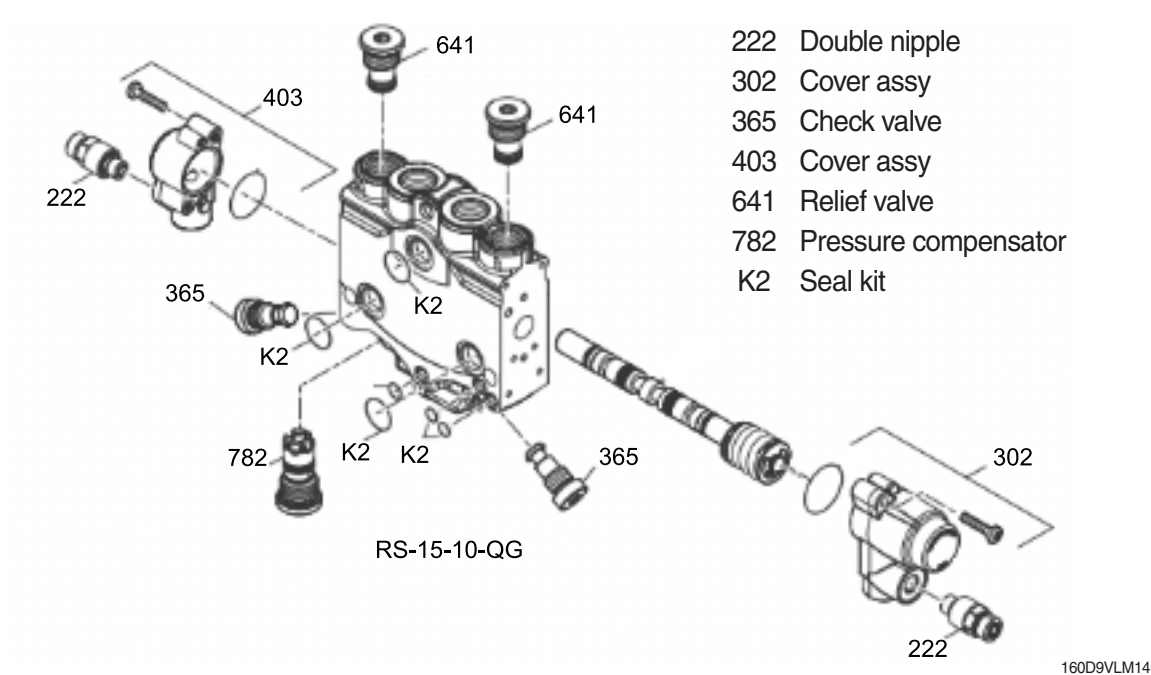
4) INLET SECTION



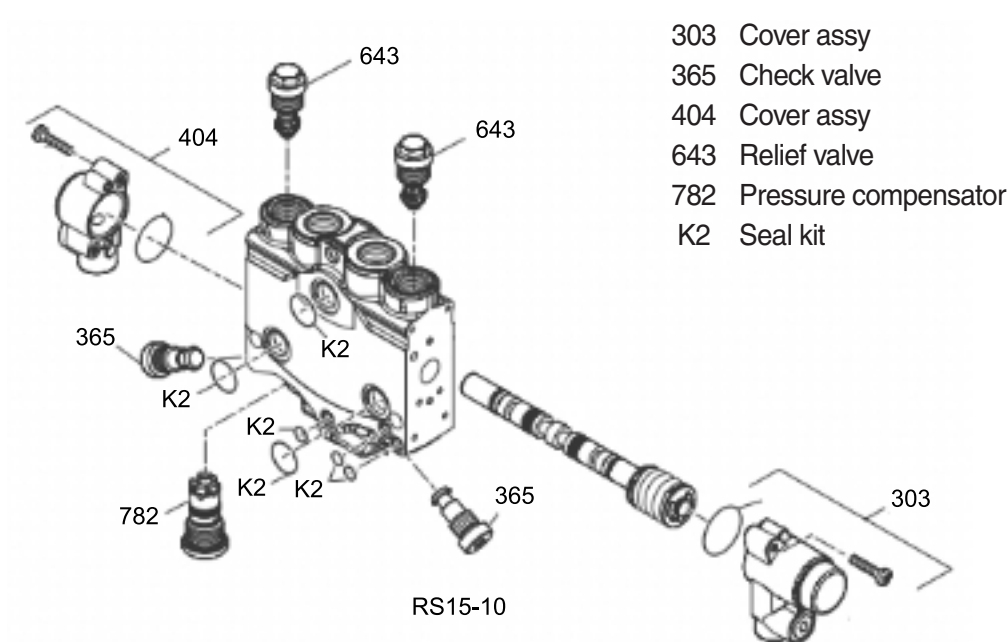
5) LIFT SECTION



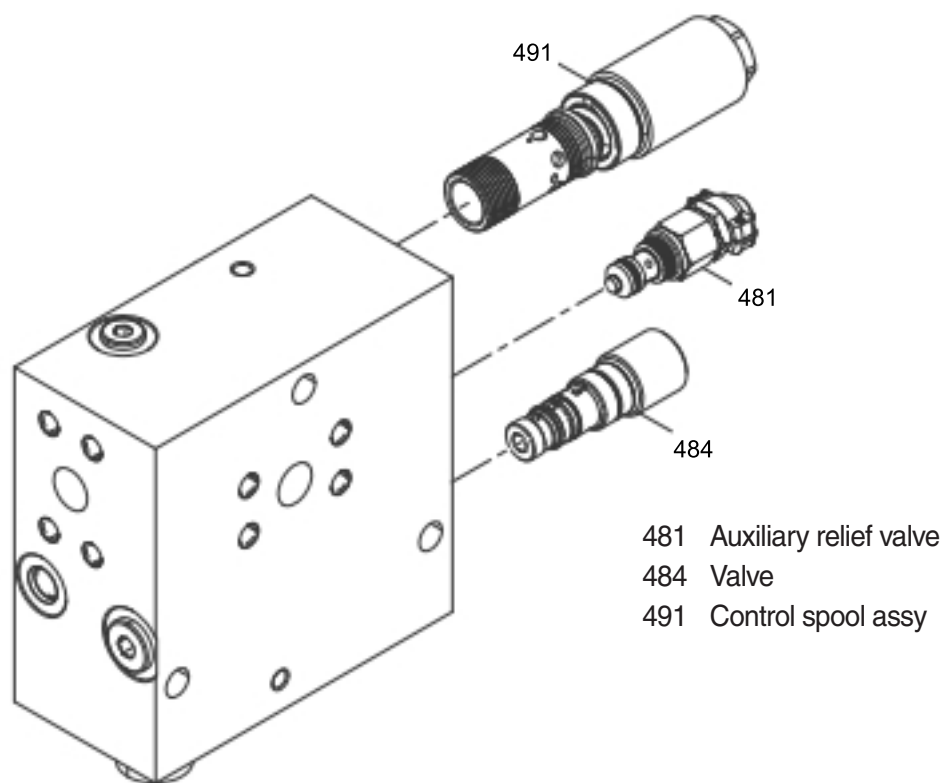
6) TILT SECTION



7) AUXILIARY SECTION



8) PRIORITY VALVE SECTION



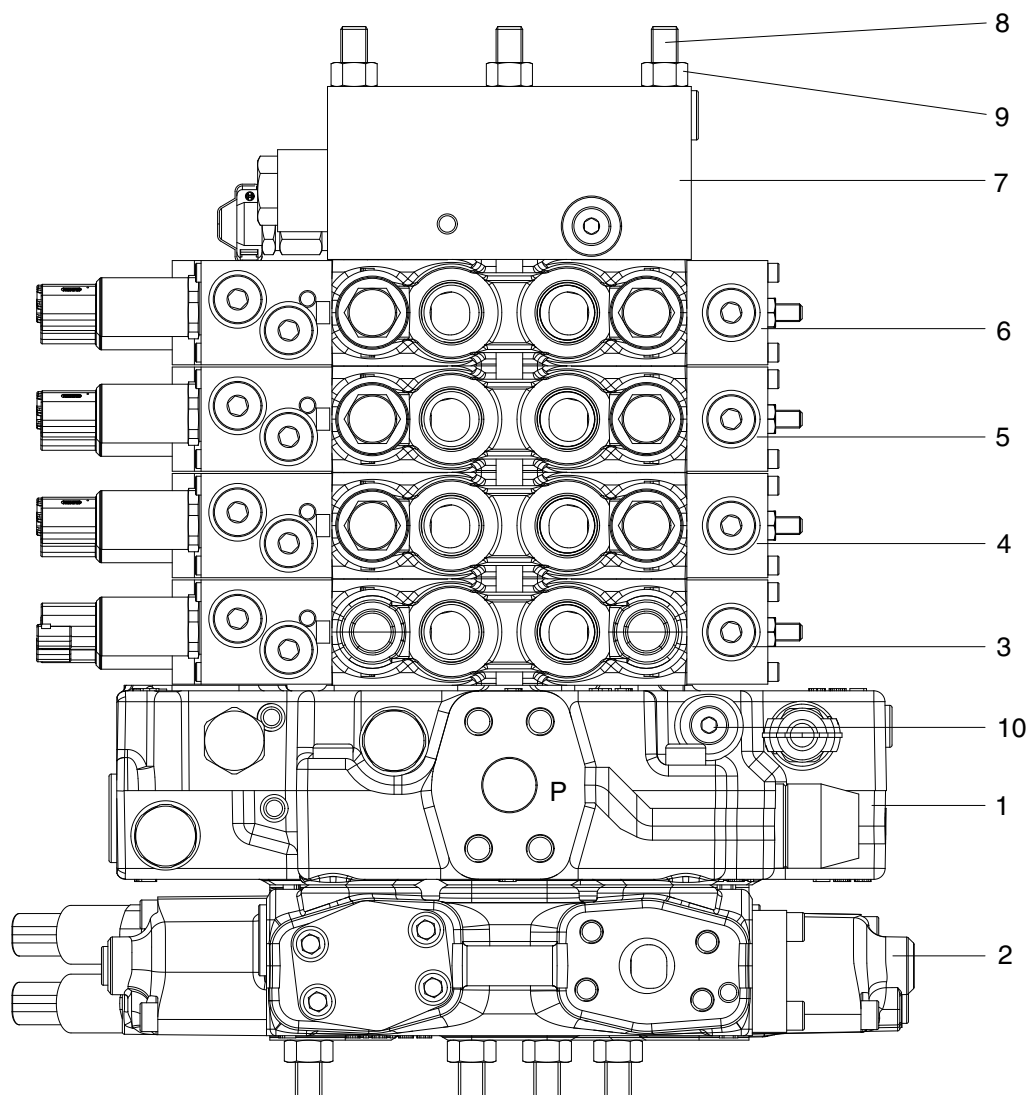
160D9VLM16

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 (9) and tie rods (8) from control valve. Separate sections being careful not to lose section O-rings. 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 following page. 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 (8) are threaded to different lengths on each end. Install nuts (9) fully onto the short thread end of each tie rod. Lay lift section (2) on its outside face with tie rods up. Install O-rings in grooves on lift section face. Slide spool section (1) over tie rods and install O-rings. Repeat for the remaining spool sections.
After stacking all spool sections and inlet / outlet sections onto tie rods (8) and nuts (9) 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; Tighten the 6 nuts (9).. Check for proper spool movement.
- (7) Install auxiliary valves and/or port plugs into all sections and torque to proper specifications.

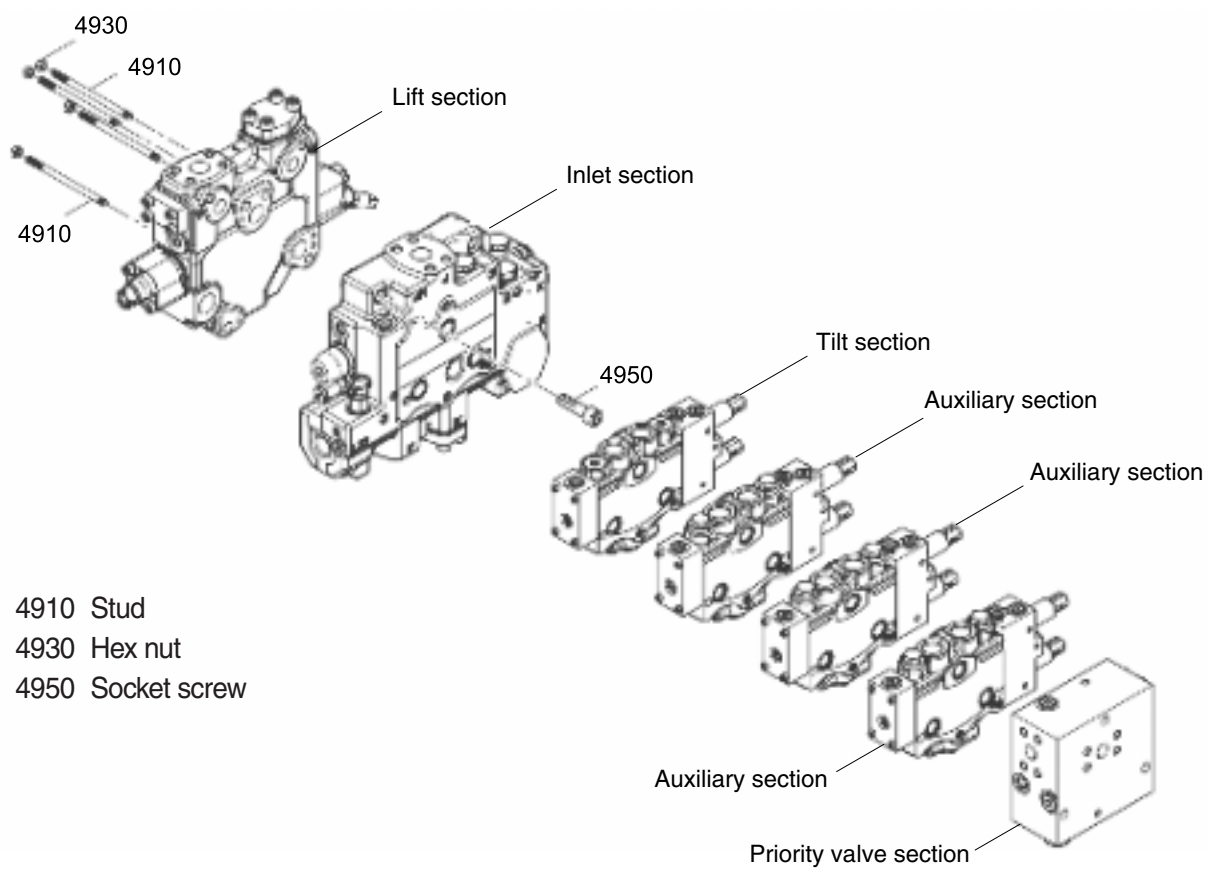
2) VALVE ASSEMBLY



160D9VFM10

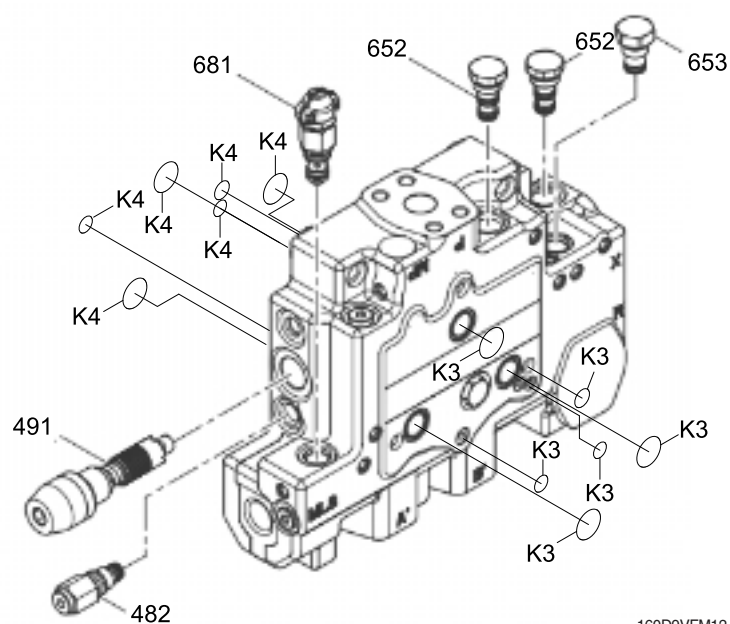
- | | | | | | |
|---|-------------------|---|-------------------|----|-------------------|
| 1 | Lift section | 5 | Auxiliary section | 9 | Nut |
| 2 | Inlet section | 6 | Auxiliary section | 10 | Main relief valve |
| 3 | Tilt section | 7 | Outlet section | | |
| 4 | Auxiliary section | 8 | Tie rod | | |

3) LAYOUT



160D9VFM11

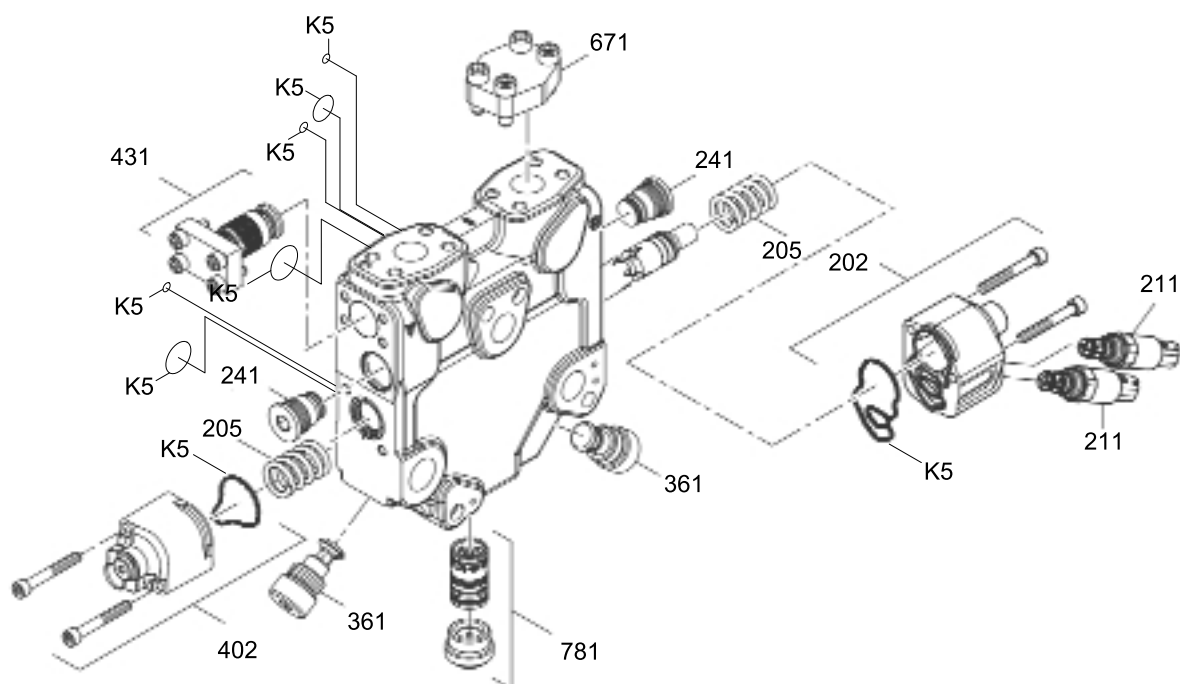
4) INLET SECTION



- 482 Flow valve
- 491 Control spool assy
- 652 Plug
- 653 Plug
- 681 Main relief valve
- K3 Seal kit
- K4 Seal kit

160D9VFM12

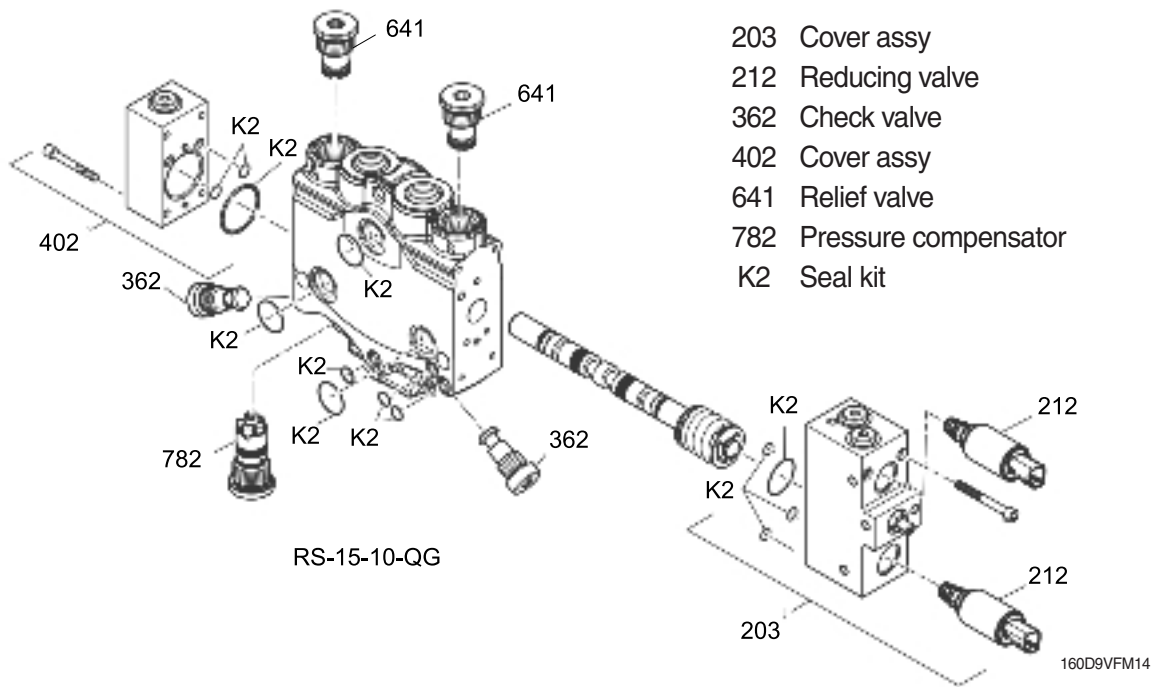
5) LIFT SECTION



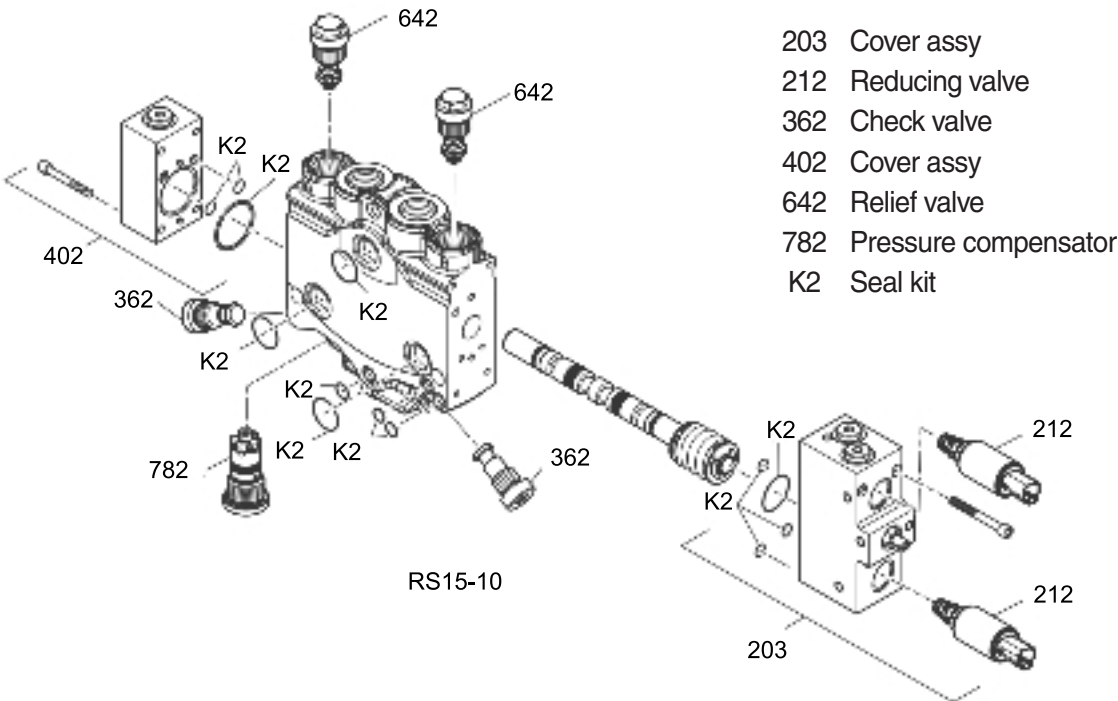
160D9VFM13

- | | | |
|--------------------|------------------|--------------------------|
| 202 Cover assy | 361 Spool assy | 781 Pressure compensator |
| 205 Spring | 402 Cover assy | K5 Seal kit |
| 211 Reducing valve | 431 Relief valve | |
| 241 Screw plug | 671 Flange | |

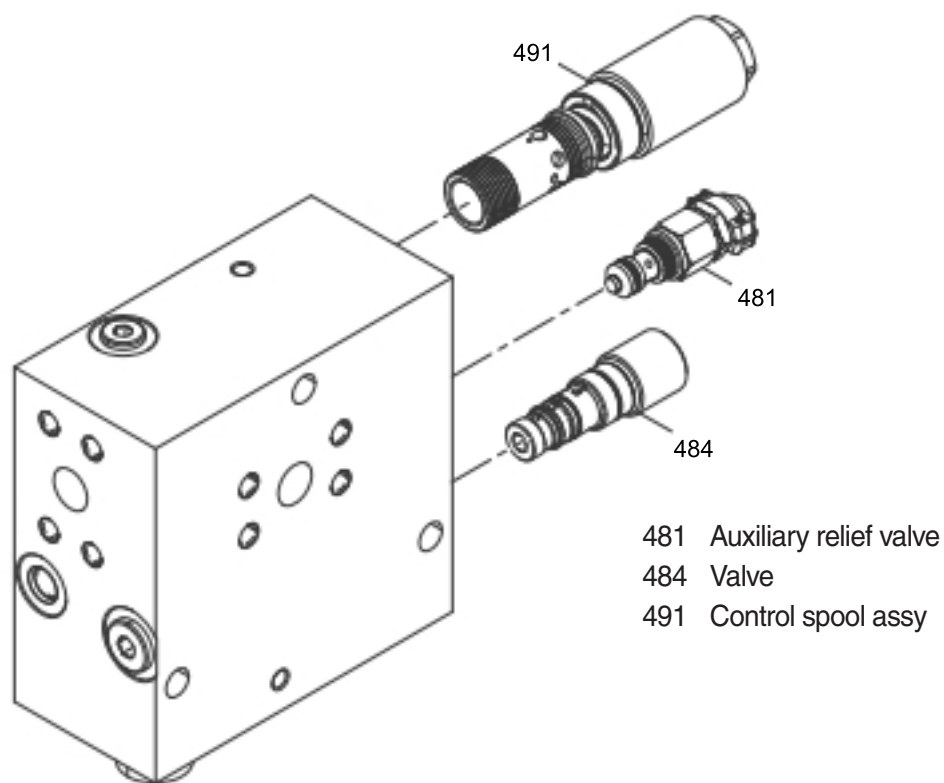
6) TILT SECTION



7) AUXILIARY SECTION



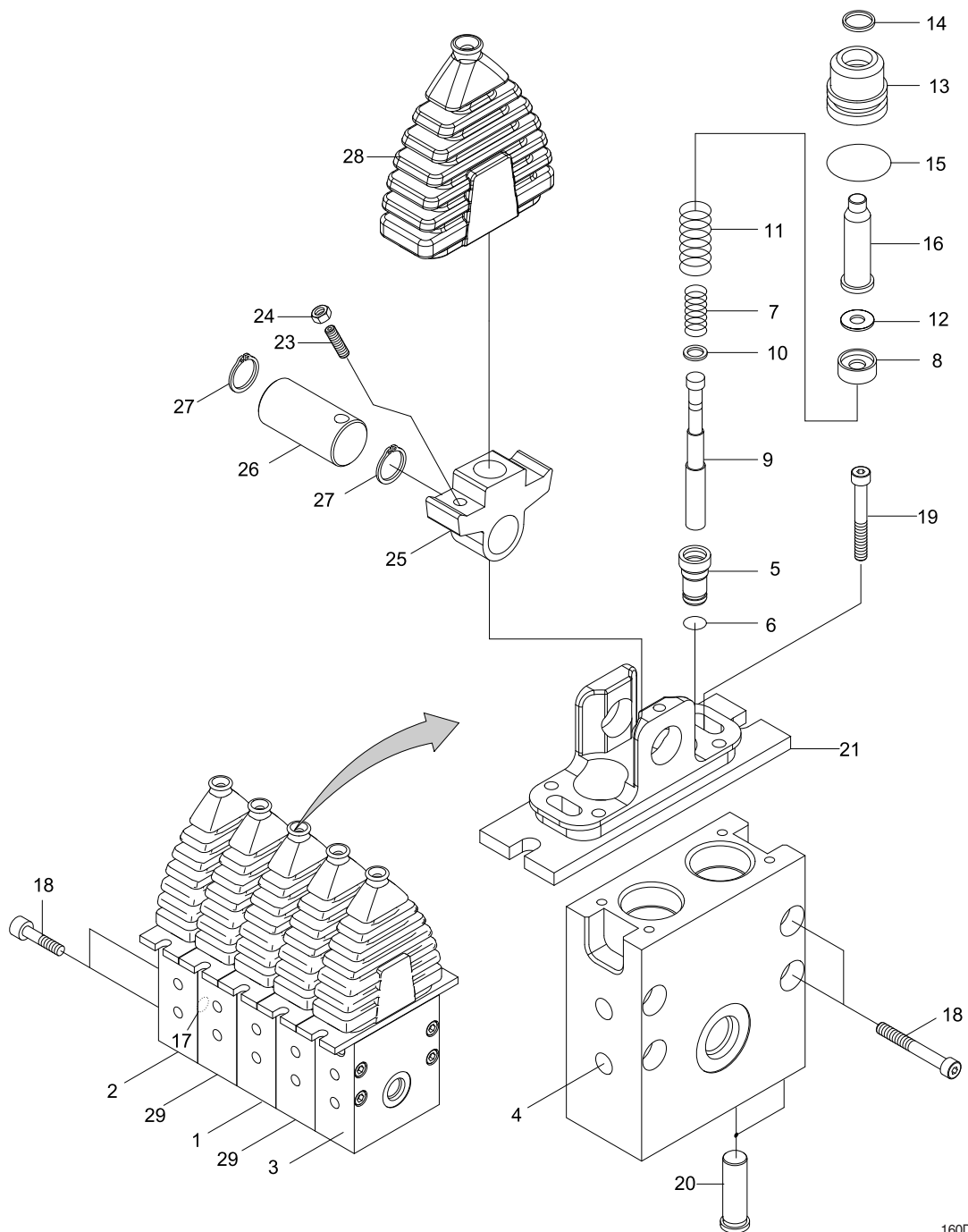
8) PRIORITY VALVE SECTION



160D9VFM16

3. REMOTE CONTROL VALVE

1) STRUCTURE



160D9VRV01

- | | | | | | |
|----|-------------|----|-------------|----|-------------|
| 1 | Body | 11 | Spring | 21 | Cover |
| 2 | Body-L | 12 | Stopper | 23 | Socket bolt |
| 3 | Body-R | 13 | Plug | 24 | Hex nut |
| 4 | Plug | 14 | Oil seal | 25 | Guide |
| 5 | Plug | 15 | O-ring | 26 | Pin |
| 6 | O-ring | 16 | Push rod | 27 | Spring pin |
| 7 | Spring | 17 | O-ring | 28 | Boot |
| 8 | Spring seat | 18 | Wrench bolt | 29 | Body 2 |
| 9 | Spool | 19 | Wrench bolt | | |
| 10 | Shim | 20 | Cap | | |

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

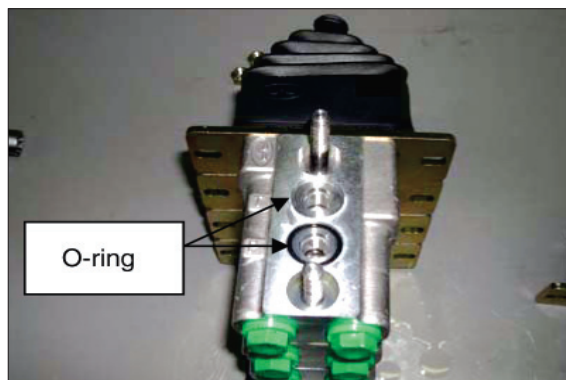
(1) Replacing complete working section

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 (22.1 lbf·ft).



100D7RCV04

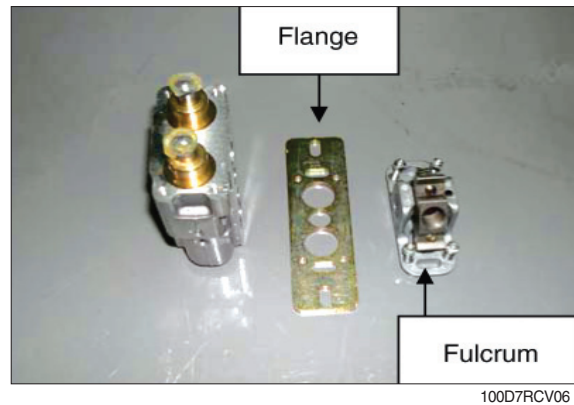
(2) Replacing pilot pressure spool

Loosen 4 screws holding upper part to the body with 3 mm wrench holding mounting plate no to spring up by return springs inside.

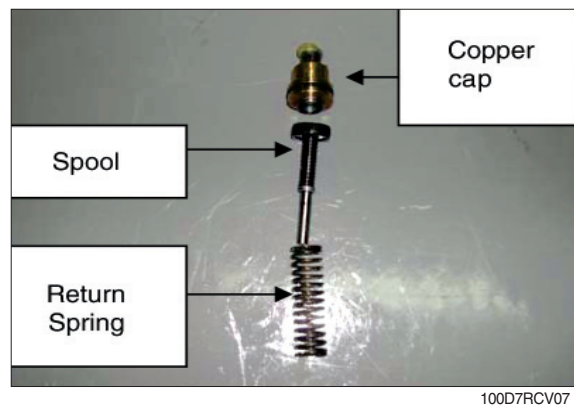


100D7RCV05

Take off the fulcrum and mounting flange very carefully keeping all components in their own positions.



Take out the spool, return spring from the body. And replace any component if it is needed.



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.



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.



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).



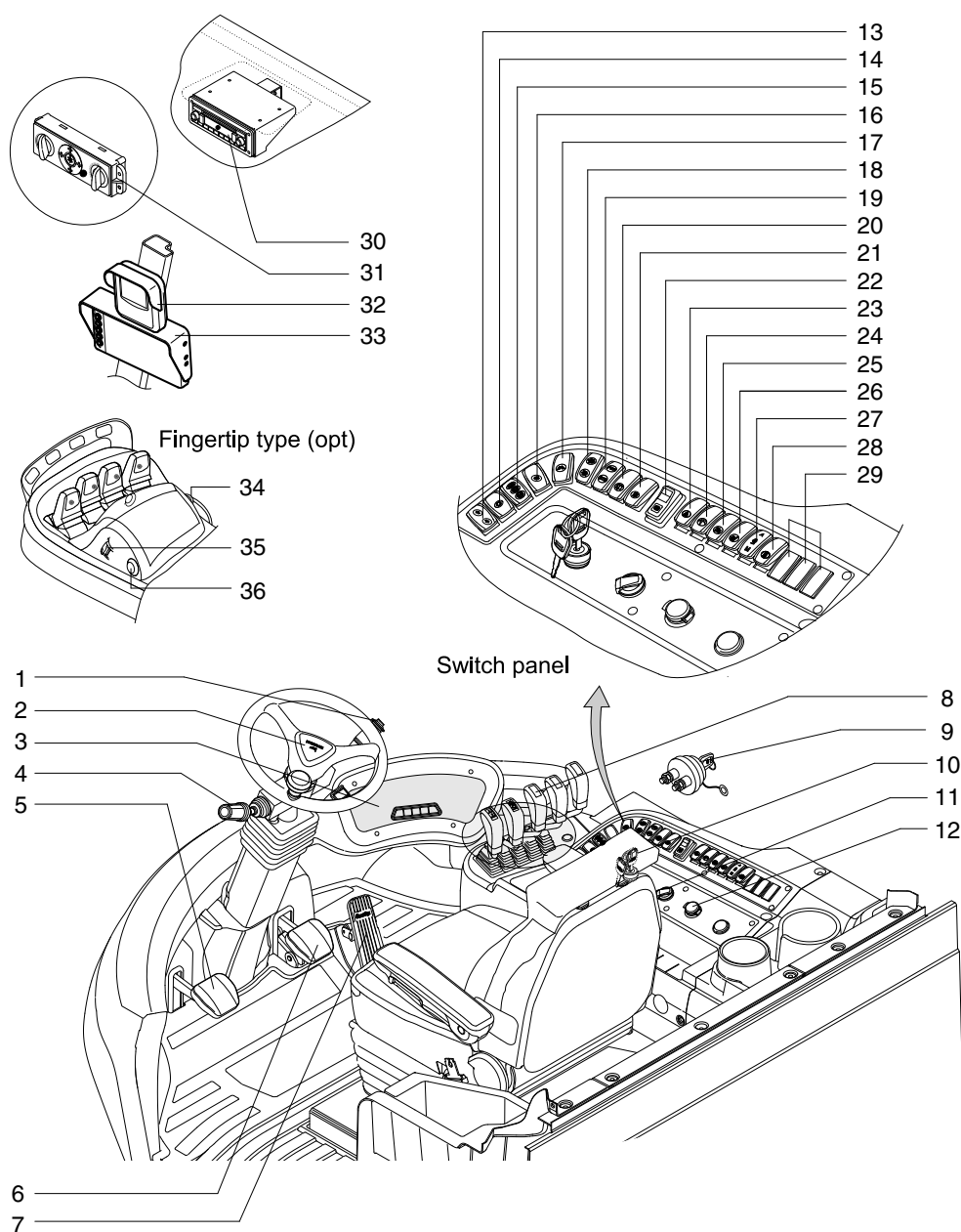
100D7RCV10

SECTION 7 ELECTRICAL SYSTEM

Group 1	Component location	7-1
Group 2	Electrical circuit	7-3
Group 3	Cluster	7-23
Group 4	Transmission message display	7-54
Group 5	Switches	7-57
Group 6	Electrical component specification	7-65
Group 7	Connectors	7-79
Group 8	Troubleshooting	7-97

GROUP 1 COMPONENT LOCATION

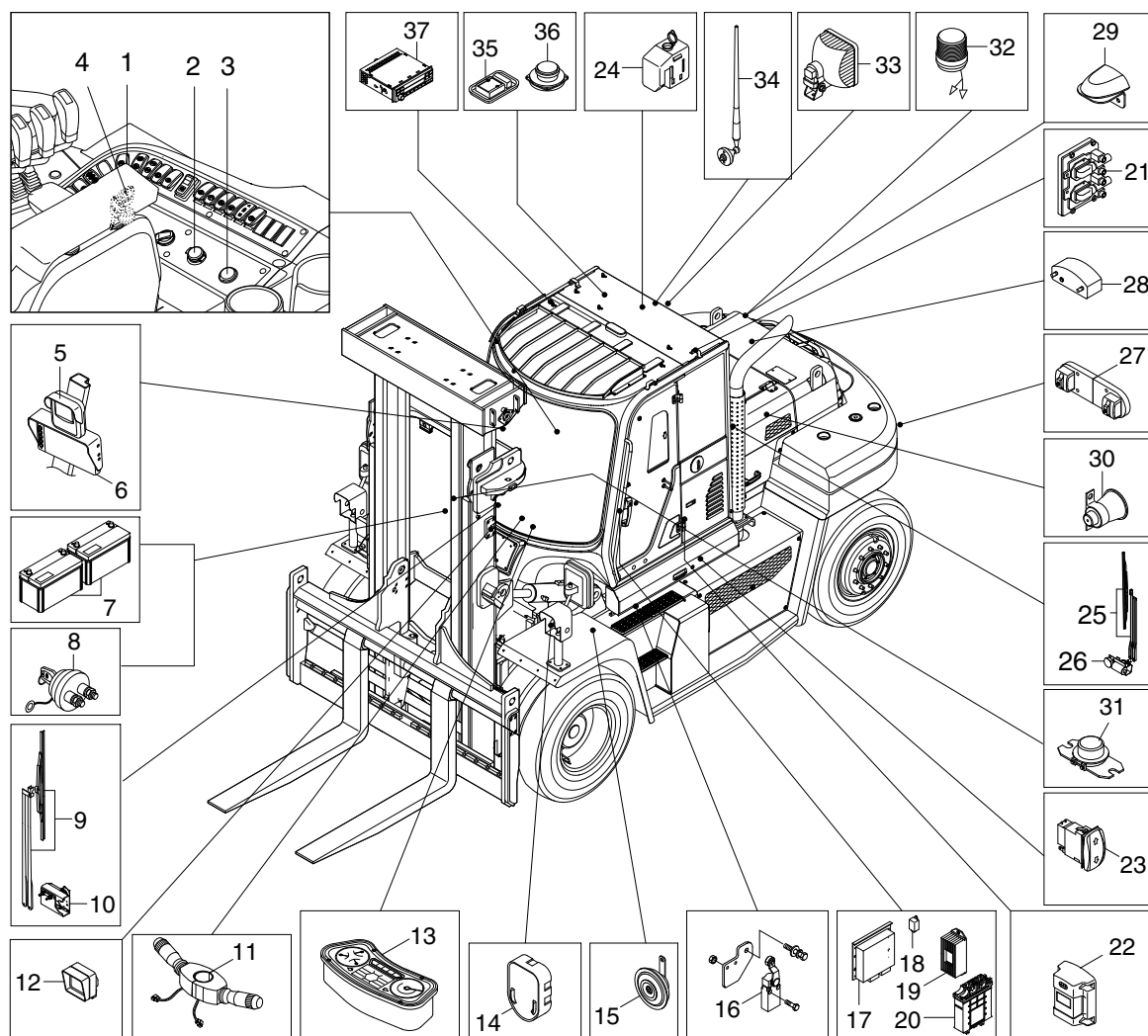
1. LOCATION 1



160D9VEL01

1	Multi function switch	13	Inc/decrease switch	25	Air compressor switch (opt)
2	Cluster	14	Main light switch	26	Seat heat switch (opt)
3	Horn button	15	Auto shift switch	27	Cooling fan control switch (opt)
4	Gear selector lever	16	Inching switch	28	Heated mirror switch (opt)
5	Inching pedal	17	Work lamp switch	29	Cover
6	Brake pedal	18	Exhaust system cleaning switch	30	Radio, USB, bluetooth player
7	Accelerator pedal	19	Engine mode switch	31	Air conditioner and heater switch
8	Remote control lever	20	Rear wiper/washer switch	32	Authentication device (opt)
9	Master switch (opt)	21	Fuel warmer switch	33	Monitor (opt)
10	Starting switch	22	Parking brake switch	34	FNR enable switch
11	USB charger	23	Hazard switch (opt)	35	FNR switch
12	12V socket	24	Top wiper/washer switch (opt)	36	Horn button

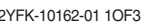
2. LOCATION 2



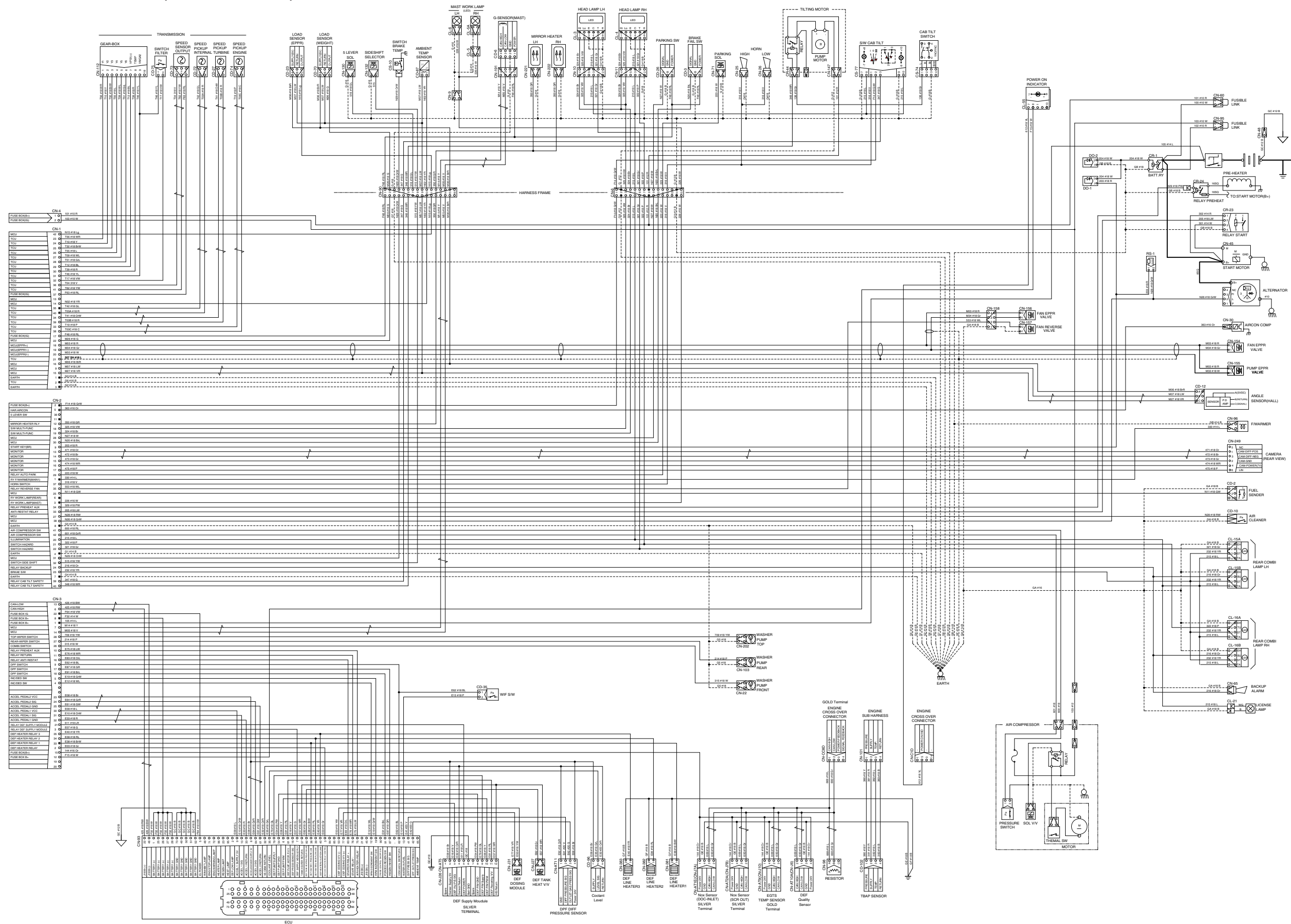
160D9VEL02

- | | | |
|-------------------------|--------------------------|---------------------------------|
| 1 Switch panel | 14 LED head/turn lamp | 27 Rear combination lamp |
| 2 USB charger | 15 Horn | 28 License lamp |
| 3 12V socket | 16 Tilt switch assembly | 29 Rear camera kit |
| 4 Start switch | 17 MCU | 30 Travel alarm buzzer |
| 5 Authentication | 18 Int wiper relay | 31 Battery relay |
| 6 Monitor | 19 DC-DC converter | 32 Beacon lamp |
| 7 Battery | 20 TCU | 33 Work lamp assembly |
| 8 Master switch | 21 ECU | 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, USB, bluetooth player |
| 12 Front work lamp | 25 Rear wiper assembly | |
| 13 Cluster | 26 Rear wiper motor | |

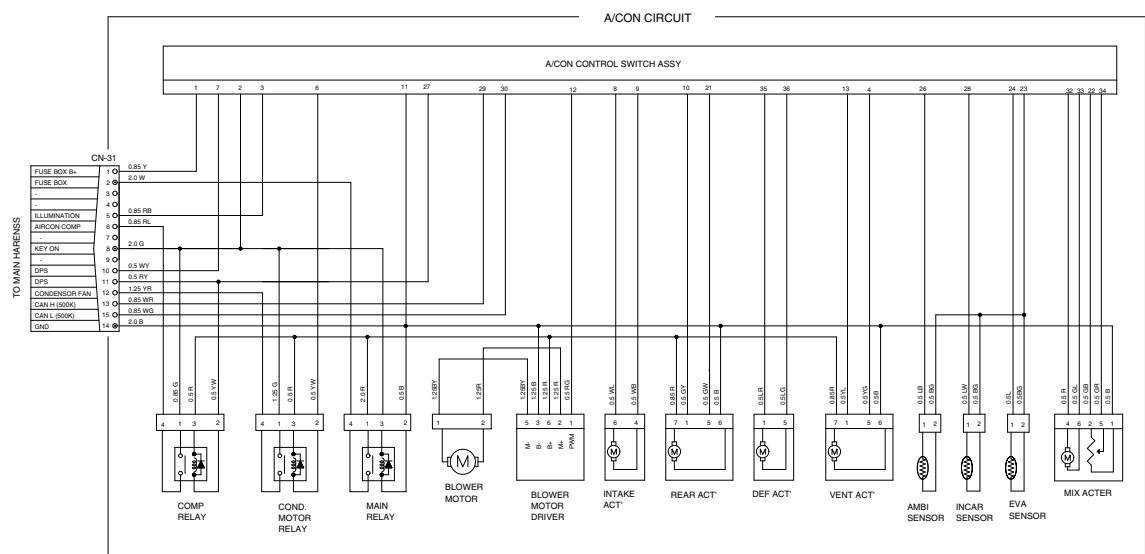
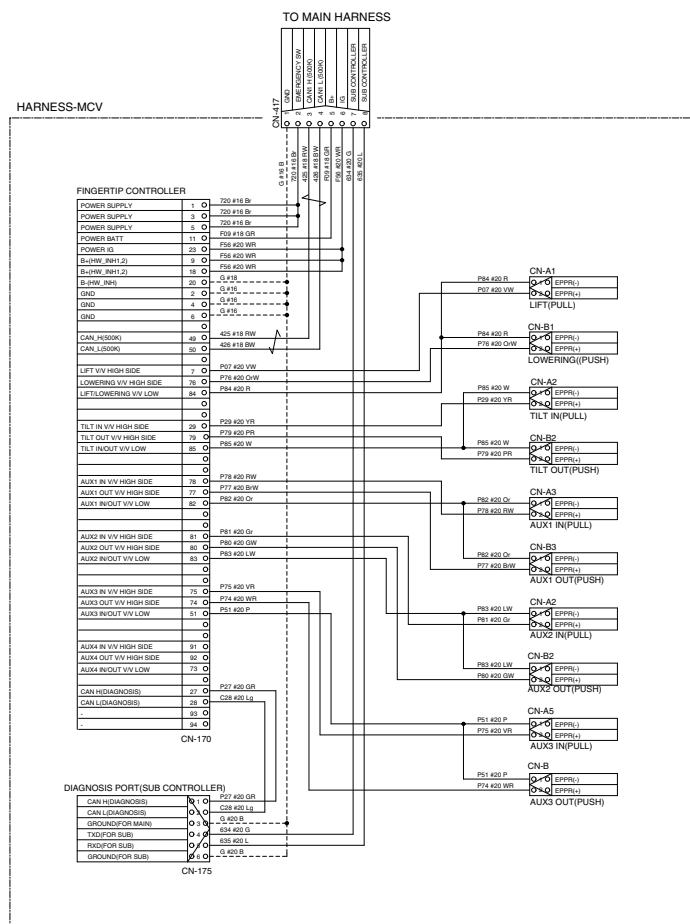
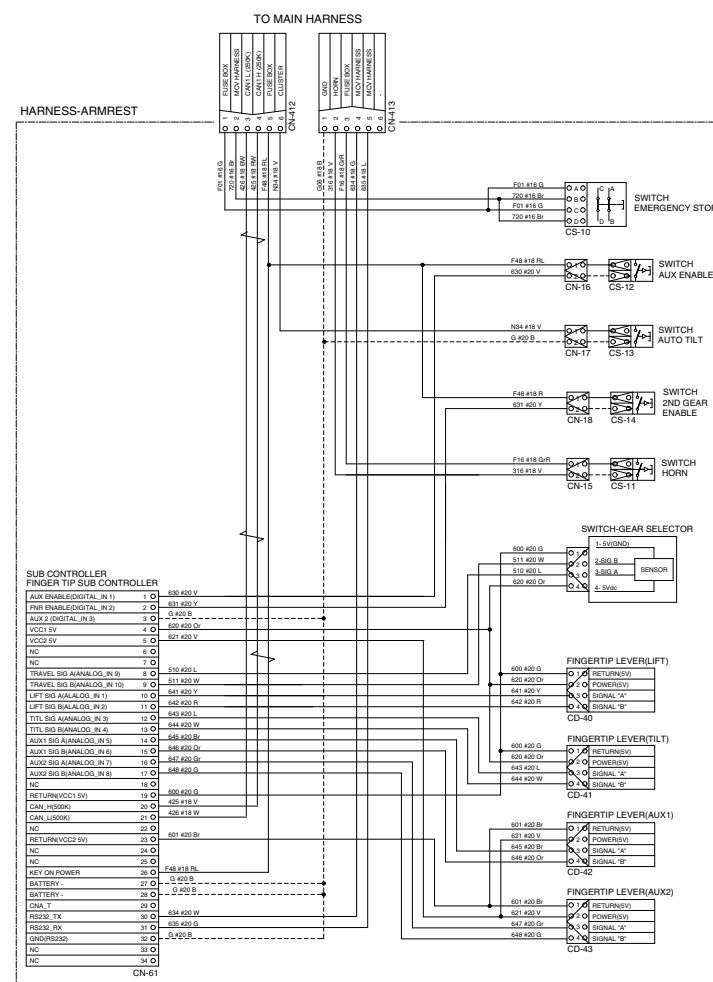
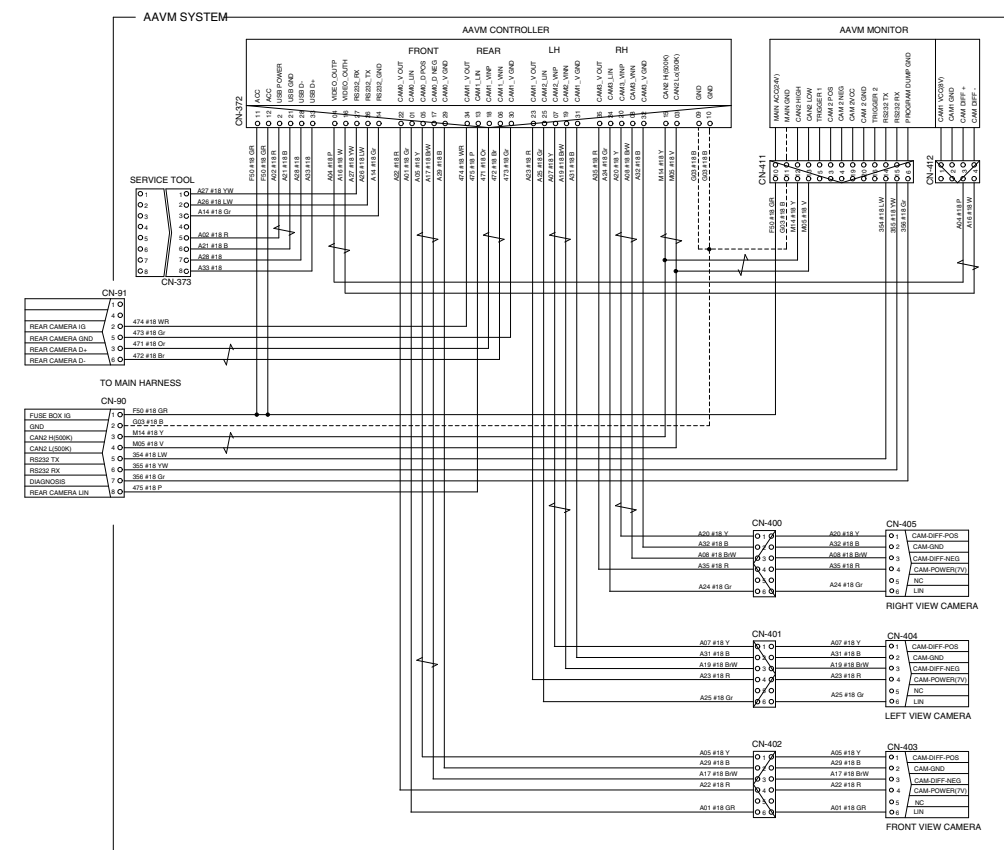
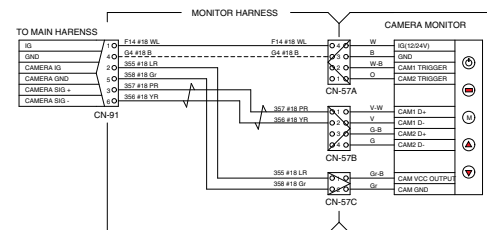
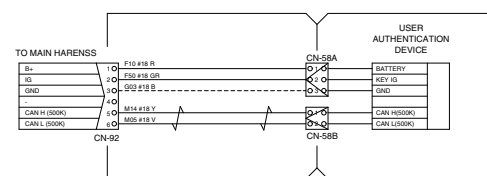
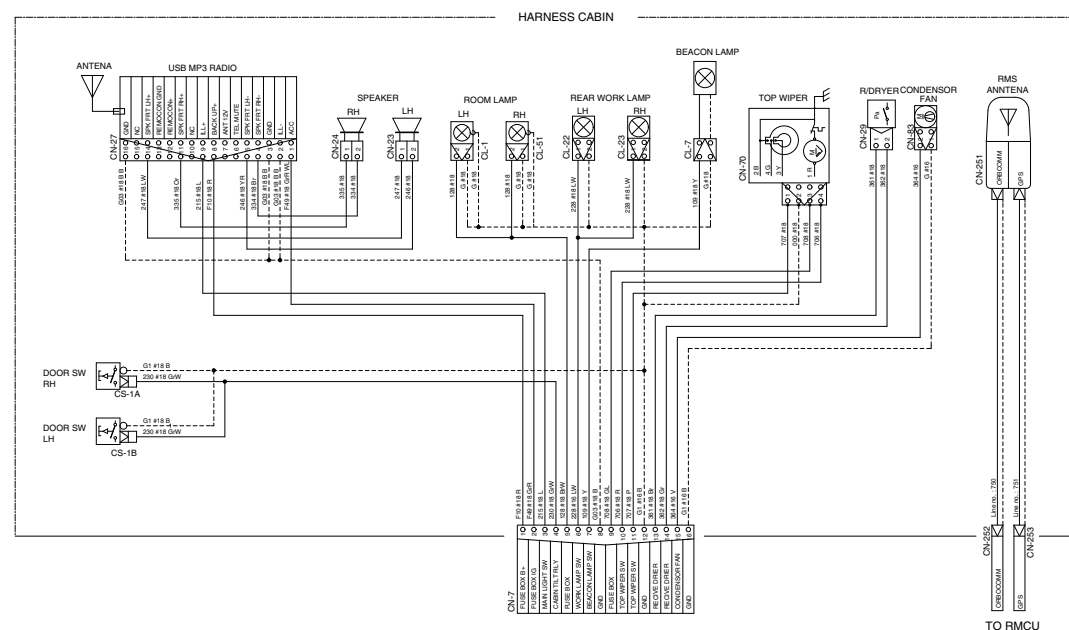
· ELECTRICAL CIRCUIT (1/3, 120/130D-9V)



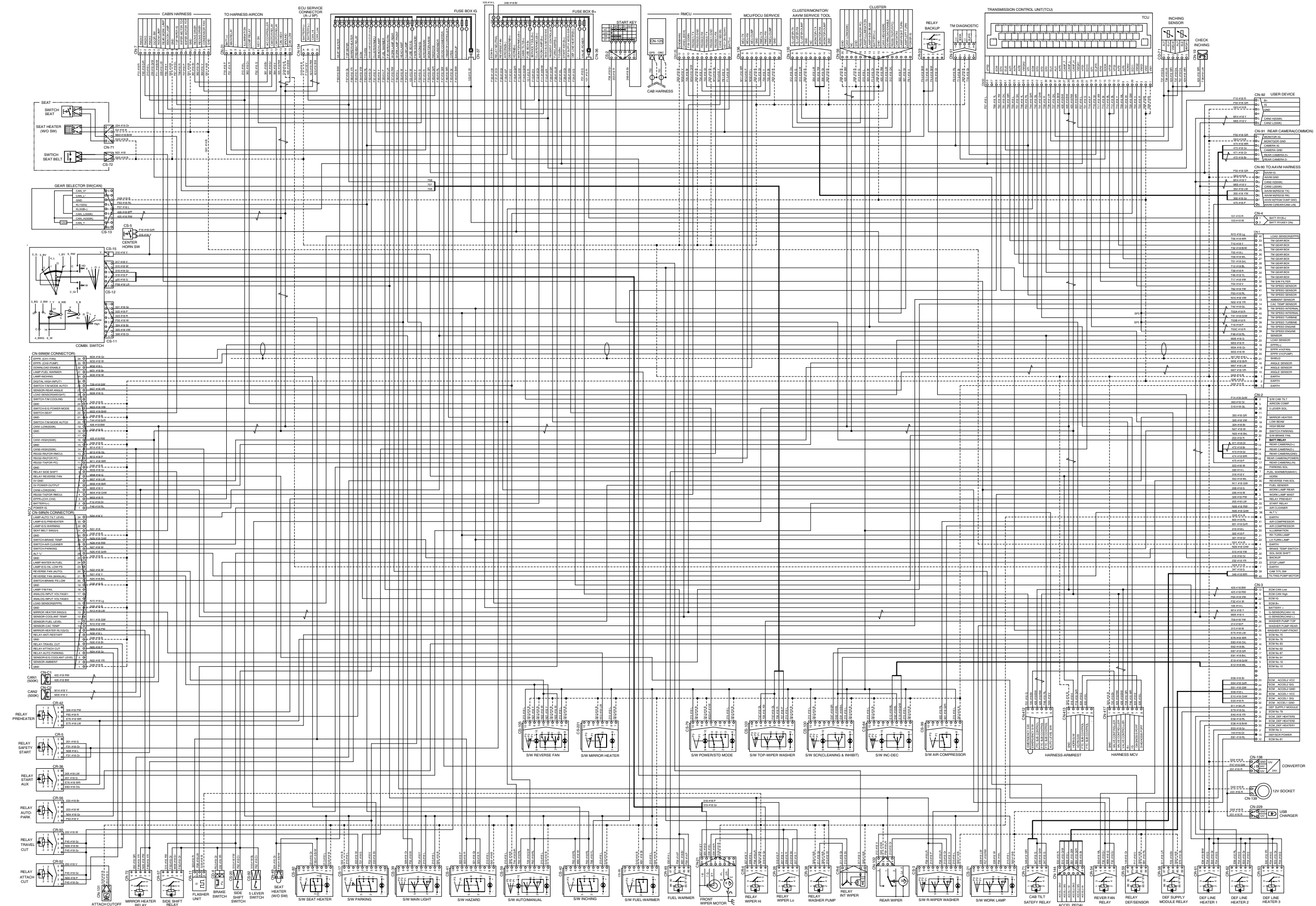
· ELECTRICAL CIRCUIT (2/3, 120/130D-9V)



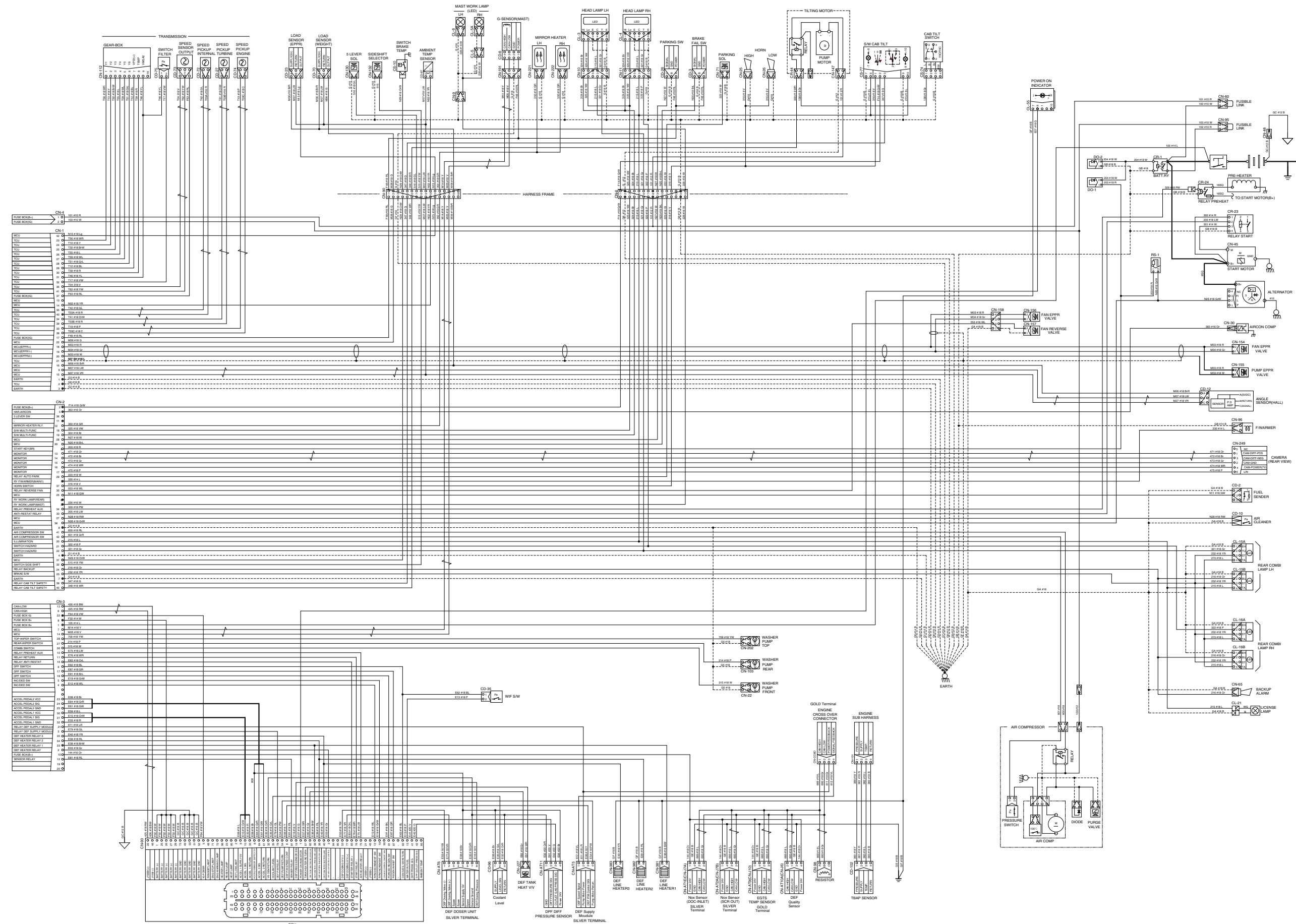
ELECTRICAL CIRCUIT (3/3, 120/130D-9V)



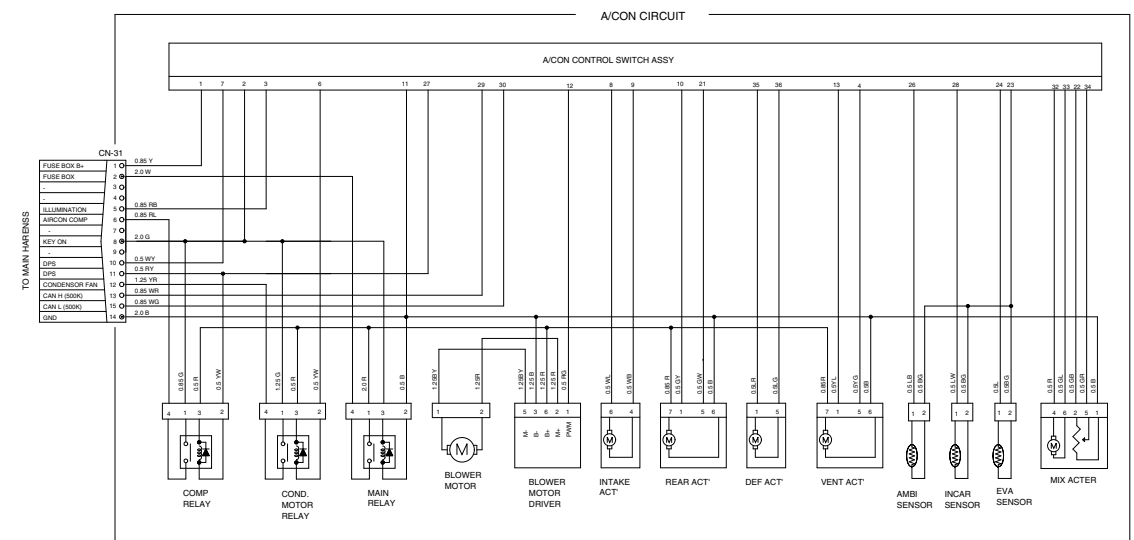
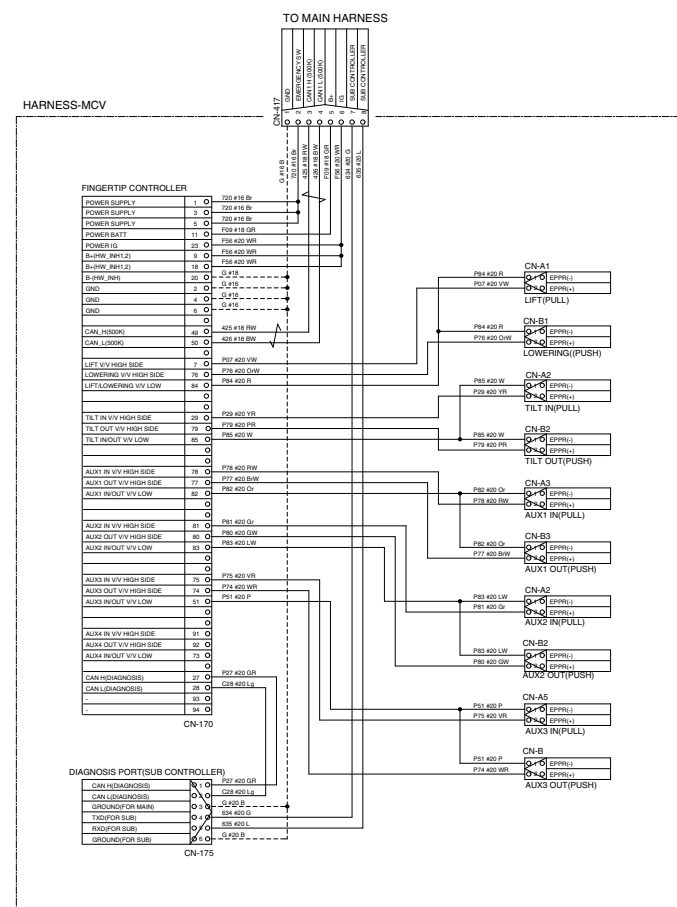
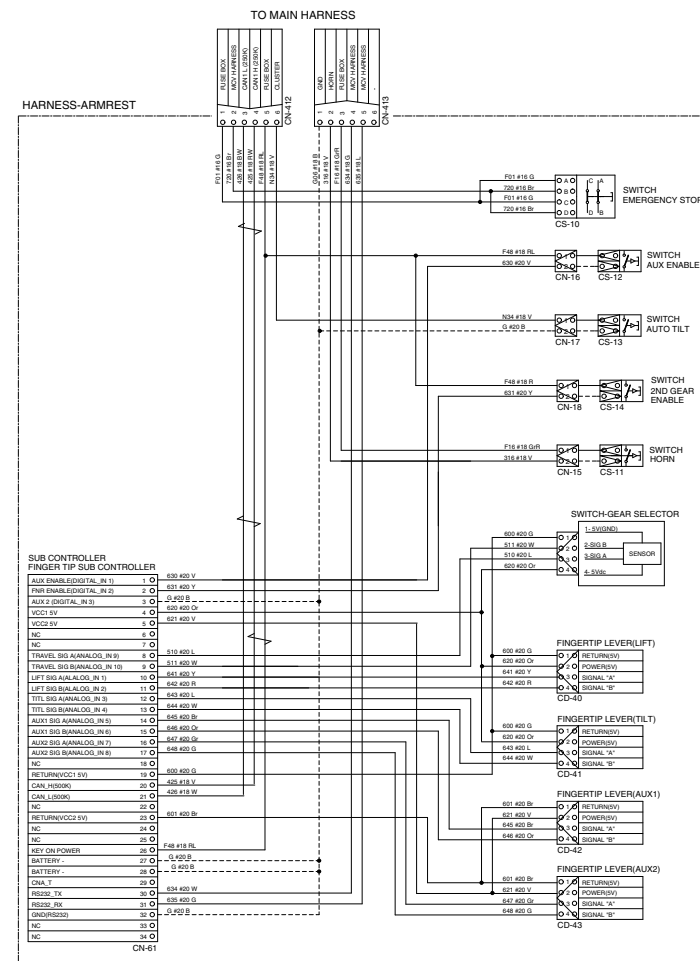
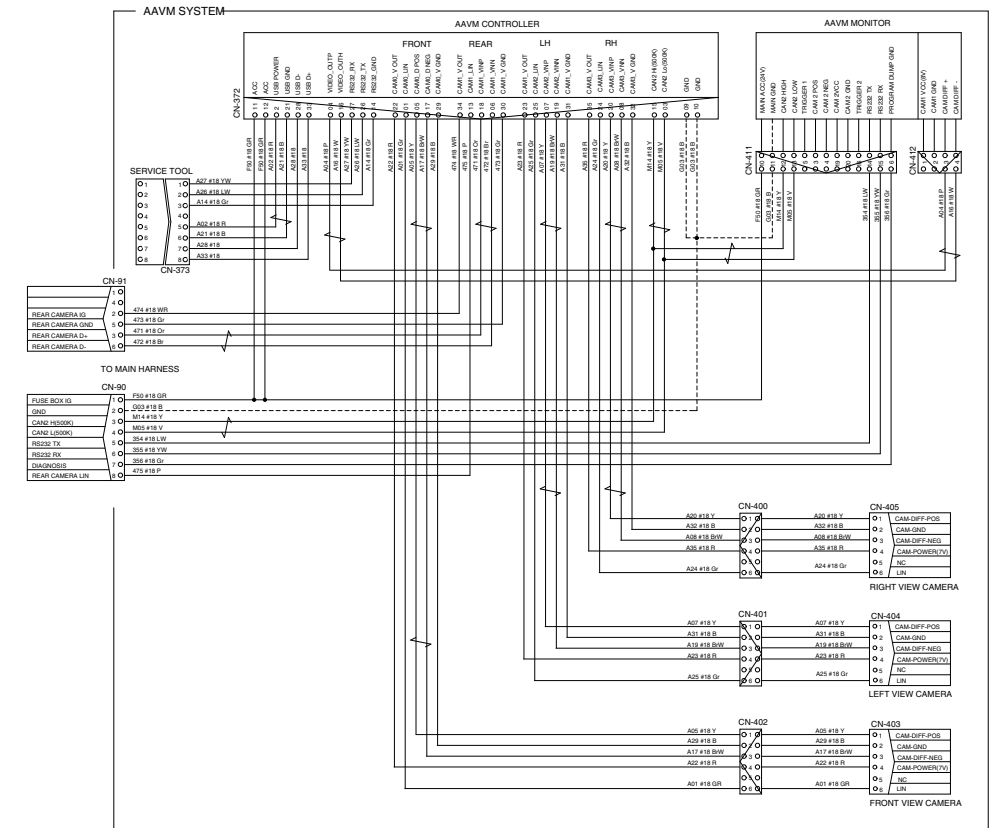
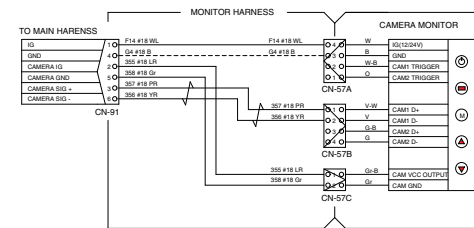
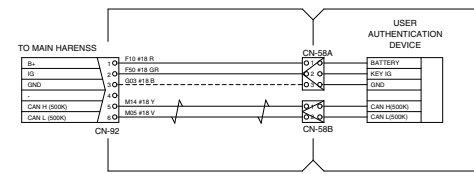
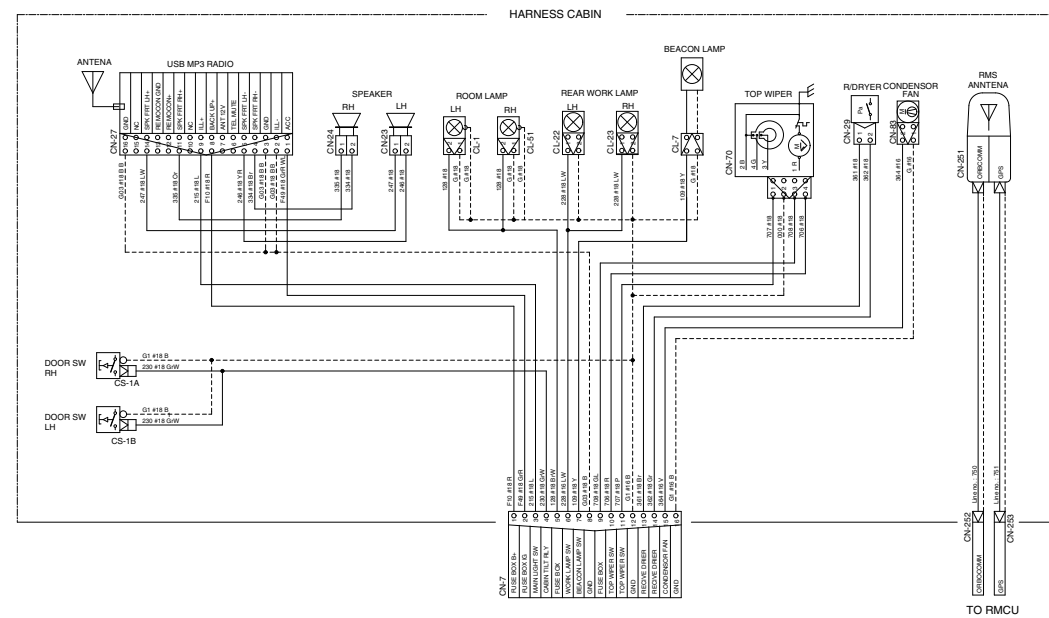
· ELECTRICAL CIRCUIT (1/3, 160D-9V)



· ELECTRICAL CIRCUIT (2/3, 160D-9V)



· ELECTRICAL CIRCUIT (3/3, 160D-9V)



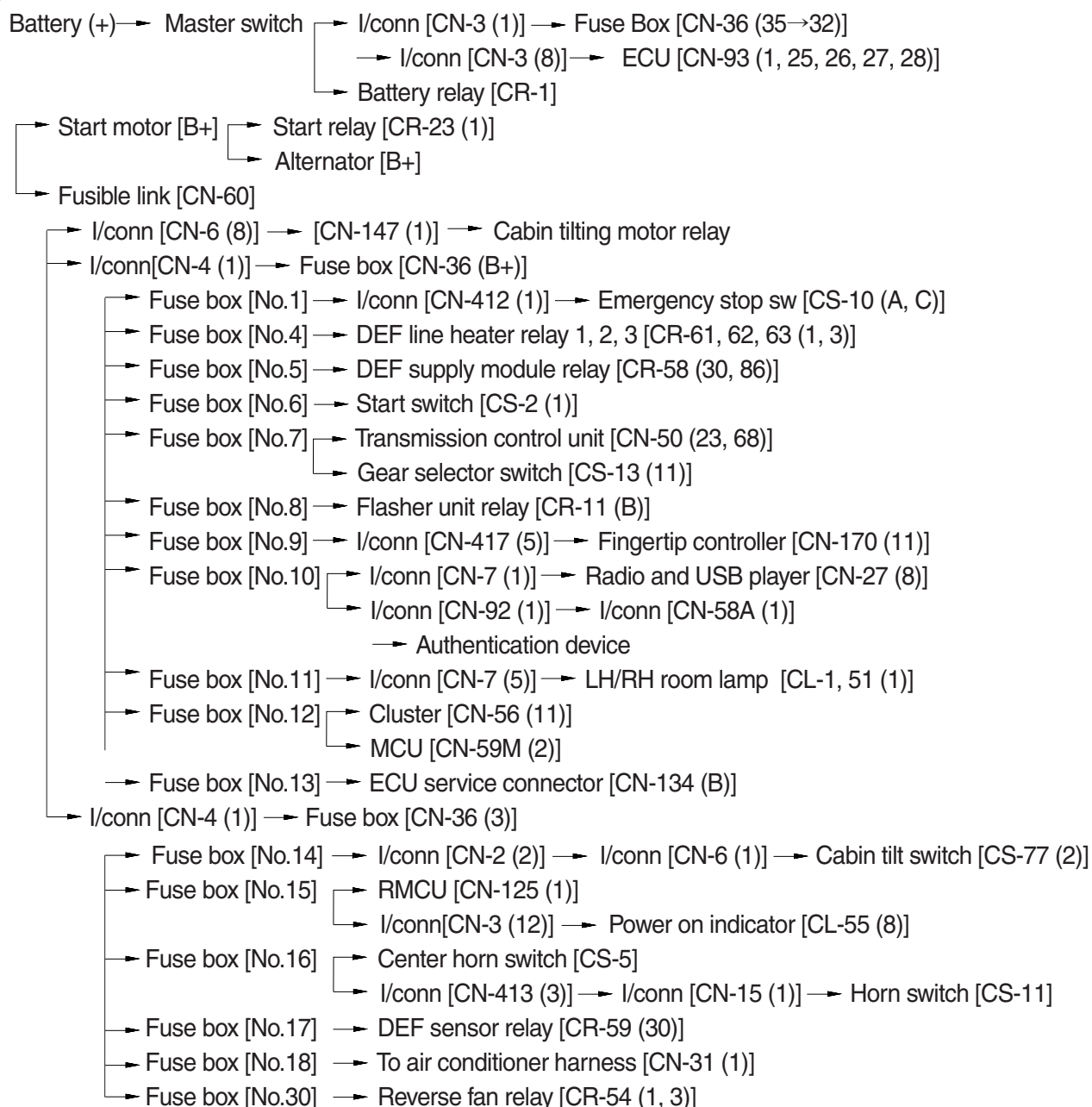
MEMORANDUM

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



2) CHECK POINT

Engine	Start switch	Check point	Voltage
STOP	OFF	① - GND (Battery (+)) ② - GND (Fusible link) ③ - GND (Fuse No. 32) ④ - GND (Fuse box B+) ⑤ - GND (Start switch)	24V

※ GND : Ground

7-11

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 gear selector lever is in neutral position.

(1) When start switch is in ON position

Start switch ON [CS-2 (2)] → I/conn [CN-2 (9)] → Diode [DO-1] → Battery relay [CR-1]

→ 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 switch is START position

Start switch START [CS-2 (5)] → Fuse box B+ [CN-36 (34→31)] → Safety start relay [CR-5 (3→4)]

→ Start aux relay [CR-36 (3→4)] → I/conn [CN-2 (33)] → Start relay [CR-23 (2→3)]

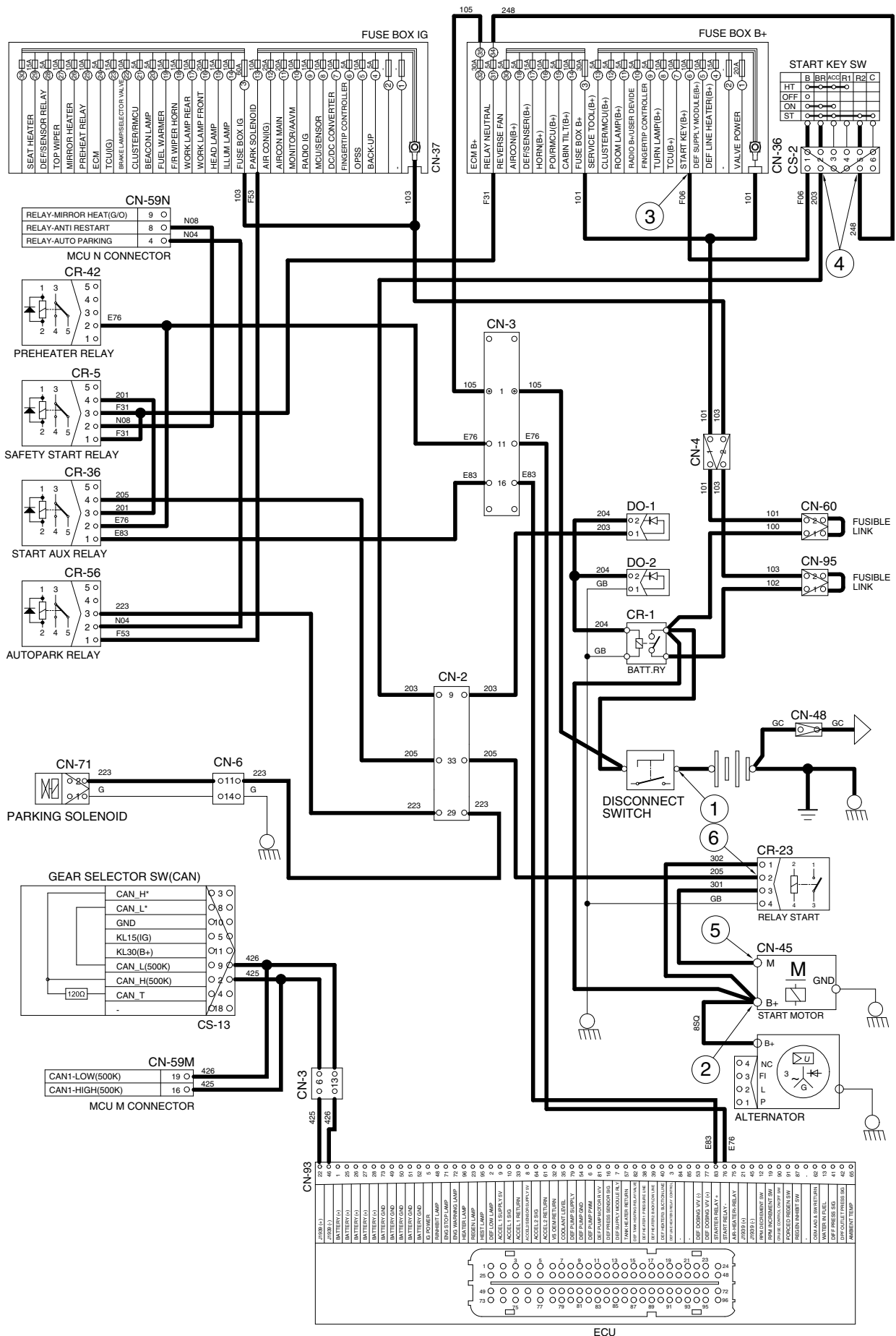
→ Start motor [CN-45 (M)] → Start motor operating

2) CHECK POINT

Engine	Start switch	Check point	Voltage
Running	ON	① - GND (Battery B+) ② - GND (Start motor B+) ③ - GND (Fuse box) ④ - GND (Start switch) ⑤ - GND (Start motor M) ⑥ - GND (Start relay)	24V

※ GND : Ground

STARTING CIRCUIT



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 relay [CR-1]
→ Master switch → Battery (+) terminal → Charging

2) CHECK POINT

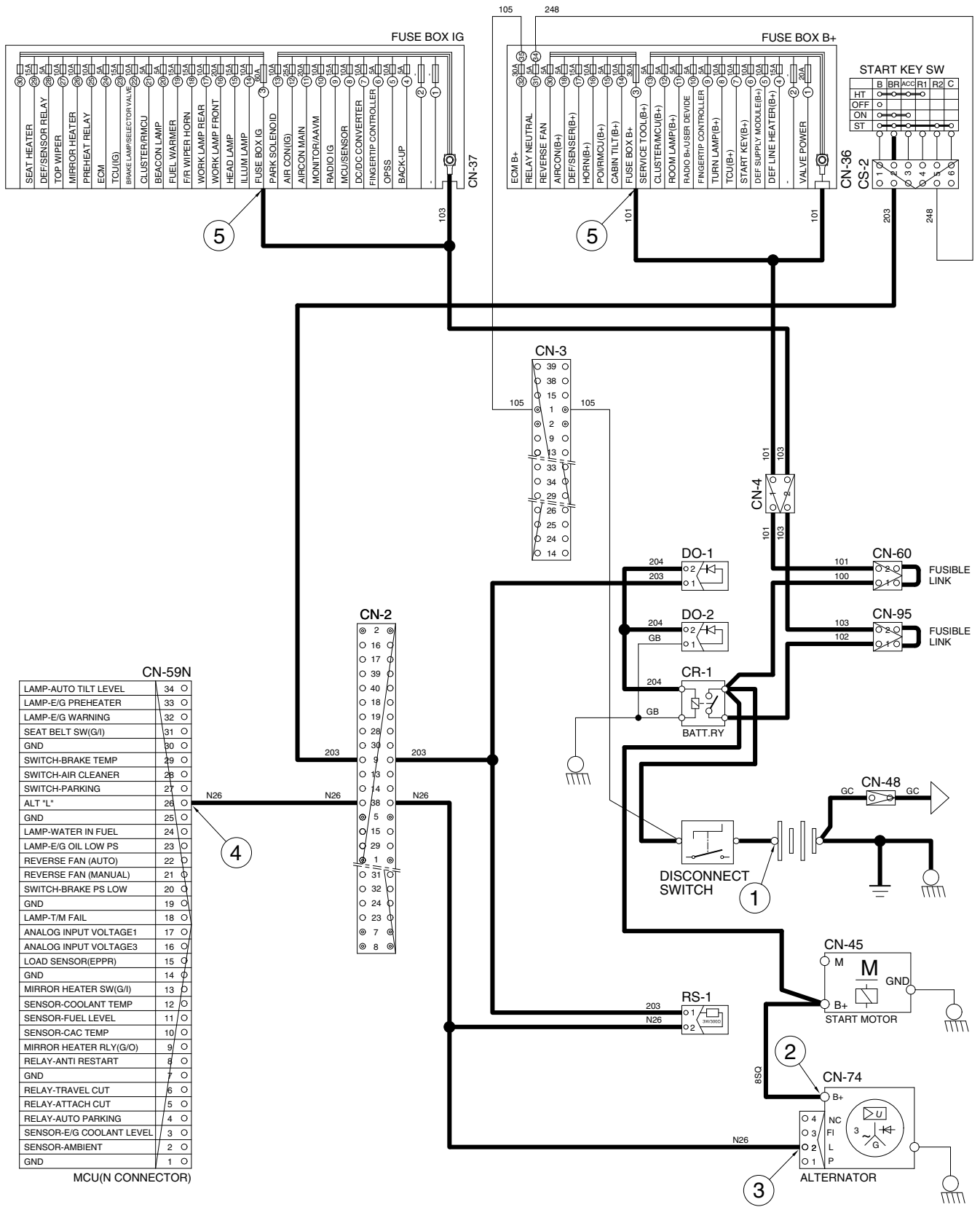
Engine	Start switch	Check point	Voltage
Running	ON	① - GND (Battery B+) ② - GND (Alternator B+) ③ - GND (Alternator 2) ④ - GND (MCU) ⑤ - GND (Fuse box)	24V

※ 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.

CHARGING CIRCUIT



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 preheat relay makes the preheater plugs operated and the preheater lamp of the cluster turned ON.

Start switch ON [CS-2 (2)]

→ MCU [CN-59M (31)] → Fuel warmer switch [CS-95 (2)] → Fuel warmer relay [CR-49 (85→87)]
→ I/conn [CN-2 (1)] → Fuel warmer [CN-96 (1)] → Fuel warmer operating
→ ECU [CN-93 (75)] → I/conn [CN-3 (10)] → Preheater relay [CR-42 (1→4)]
→ I/conn [CN-2 (34)] → Preheater relay [CR-24] → Preheater operating

2) CHECK POINT

Engine	Start switch	Check point	Voltage
STOP	ON	① - GND (Battery B+) ② - GND (Fusible link) ③ - GND (Start switch) ④ - GND (Fuse box) ⑤ - GND (Pre-heater relay) ⑥ - GND (Fuel warmer) ⑦ - GND (Fuel warmer switch)	24V

※ GND : Ground

The diagram illustrates the electrical system for a vehicle, showing the connection between the ECU (Electronic Control Unit) and various components. The ECU is connected to the battery via a disconnect switch and a fuse. The battery is connected to the ECU through a series of relays and fuses. The diagram also shows the connection to the start key and the fuel pump. A table of pinouts for the ECU is provided, along with a list of components connected to the ECU pins.

ECU Pinout Table:

Pin	Signal
1	BATTERY (+)
2	BATTERY (-)
3	BATTERY (+)
4	BATTERY (-)
5	BATTERY (+)
6	BATTERY (-)
7	BATTERY (+)
8	BATTERY (-)
9	BATTERY (+)
10	BATTERY (-)
11	BATTERY (+)
12	BATTERY (-)
13	BATTERY (+)
14	BATTERY (-)
15	BATTERY (+)
16	BATTERY (-)
17	BATTERY (+)
18	BATTERY (-)
19	BATTERY (+)
20	BATTERY (-)
21	BATTERY (+)
22	BATTERY (-)
23	BATTERY (+)
24	BATTERY (-)
25	BATTERY (+)
26	BATTERY (-)
27	BATTERY (+)
28	BATTERY (-)
29	BATTERY (+)
30	BATTERY (-)
31	BATTERY (+)
32	BATTERY (-)
33	BATTERY (+)
34	BATTERY (-)
35	BATTERY (+)
36	BATTERY (-)
37	BATTERY (+)
38	BATTERY (-)
39	BATTERY (+)
40	BATTERY (-)
41	BATTERY (+)
42	BATTERY (-)
43	BATTERY (+)
44	BATTERY (-)
45	BATTERY (+)
46	BATTERY (-)
47	BATTERY (+)
48	BATTERY (-)
49	BATTERY (+)
50	BATTERY (-)
51	BATTERY (+)
52	BATTERY (-)
53	BATTERY (+)
54	BATTERY (-)
55	BATTERY (+)
56	BATTERY (-)
57	BATTERY (+)
58	BATTERY (-)
59	BATTERY (+)
60	BATTERY (-)
61	BATTERY (+)
62	BATTERY (-)
63	BATTERY (+)
64	BATTERY (-)
65	BATTERY (+)
66	BATTERY (-)
67	BATTERY (+)
68	BATTERY (-)
69	BATTERY (+)
70	BATTERY (-)
71	BATTERY (+)
72	BATTERY (-)
73	BATTERY (+)
74	BATTERY (-)
75	BATTERY (+)
76	BATTERY (-)
77	BATTERY (+)
78	BATTERY (-)
79	BATTERY (+)
80	BATTERY (-)
81	BATTERY (+)
82	BATTERY (-)
83	BATTERY (+)
84	BATTERY (-)
85	BATTERY (+)
86	BATTERY (-)
87	BATTERY (+)
88	BATTERY (-)
89	BATTERY (+)
90	BATTERY (-)
91	BATTERY (+)
92	BATTERY (-)
93	BATTERY (+)
94	BATTERY (-)
95	BATTERY (+)
96	BATTERY (-)
97	BATTERY (+)
98	BATTERY (-)
99	BATTERY (+)
100	BATTERY (-)

ECU Component List:

- 101: ECU (+)
- 102: ECU (-)
- 103: ECU (+)
- 104: ECU (-)
- 105: ECU (+)
- 106: ECU (-)
- 107: ECU (+)
- 108: ECU (-)
- 109: ECU (+)
- 110: ECU (-)
- 111: ECU (+)
- 112: ECU (-)
- 113: ECU (+)
- 114: ECU (-)
- 115: ECU (+)
- 116: ECU (-)
- 117: ECU (+)
- 118: ECU (-)
- 119: ECU (+)
- 120: ECU (-)
- 121: ECU (+)
- 122: ECU (-)
- 123: ECU (+)
- 124: ECU (-)
- 125: ECU (+)
- 126: ECU (-)
- 127: ECU (+)
- 128: ECU (-)
- 129: ECU (+)
- 130: ECU (-)
- 131: ECU (+)
- 132: ECU (-)
- 133: ECU (+)
- 134: ECU (-)
- 135: ECU (+)
- 136: ECU (-)
- 137: ECU (+)
- 138: ECU (-)
- 139: ECU (+)
- 140: ECU (-)
- 141: ECU (+)
- 142: ECU (-)
- 143: ECU (+)
- 144: ECU (-)
- 145: ECU (+)
- 146: ECU (-)
- 147: ECU (+)
- 148: ECU (-)
- 149: ECU (+)
- 150: ECU (-)
- 151: ECU (+)
- 152: ECU (-)
- 153: ECU (+)
- 154: ECU (-)
- 155: ECU (+)
- 156: ECU (-)
- 157: ECU (+)
- 158: ECU (-)
- 159: ECU (+)
- 160: ECU (-)
- 161: ECU (+)
- 162: ECU (-)
- 163: ECU (+)
- 164: ECU (-)
- 165: ECU (+)
- 166: ECU (-)
- 167: ECU (+)
- 168: ECU (-)
- 169: ECU (+)
- 170: ECU (-)
- 171: ECU (+)
- 172: ECU (-)
- 173: ECU (+)
- 174: ECU (-)
- 175: ECU (+)
- 176: ECU (-)
- 177: ECU (+)
- 178: ECU (-)
- 179: ECU (+)
- 180: ECU (-)
- 181: ECU (+)
- 182: ECU (-)
- 183: ECU (+)
- 184: ECU (-)
- 185: ECU (+)
- 186: ECU (-)
- 187: ECU (+)
- 188: ECU (-)
- 189: ECU (+)
- 190: ECU (-)
- 191: ECU (+)
- 192: ECU (-)
- 193: ECU (+)
- 194: ECU (-)
- 195: ECU (+)
- 196: ECU (-)
- 197: ECU (+)
- 198: ECU (-)
- 199: ECU (+)
- 200: ECU (-)

5. HEAD LIGHT AND WORK LIGHT CIRCUIT

1) OPERATING FLOW

(1) Head light

Fuse box [CN-37 (No.55)] → 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)] → I/conn [CN-6 (3)]
 - I/conn [CN-10 (4)] → LH head light low beam ON [CL-3 (2)]
 - I/conn [CN-11 (4)] → RH head light low beam ON [CL-4 (2)]
- Multi function switch DOWN [CS-11 (6)]
 - Cluster high beam pilot lamp ON [CN-56 (13)]
 - I/conn [CN-2 (19)] → I/conn [CN-6 (4)]
 - I/conn [CN-10 (6)] → LH head light high beam ON [CL-3 (1)]
 - I/conn [CN-11 (6)] → RH head light high beam ON [CL-4 (1)]

(2) Front work lamp

Fuse box [CN-37 (No.56)] → Work light switch [CS-21 (2)] → Switch ON, 1nd step [CS-21 (3)]
 → I/conn [CN-2 (3)] → I/conn [CN-6 (15)] → I/conn [CN-9 (1)]

- Mast work light ON [CL-6 (1)]
- I/conn [CL-5 (1)] → Mast work light ON [CL-5A (1)]

(3) Rear work light

Fuse box [CN-37 (No.17)] → Work light switch [CS-21 (5)] → Switch ON, 2nd step [CS-21 (6)]
 → I/conn [CN-7 (6)]

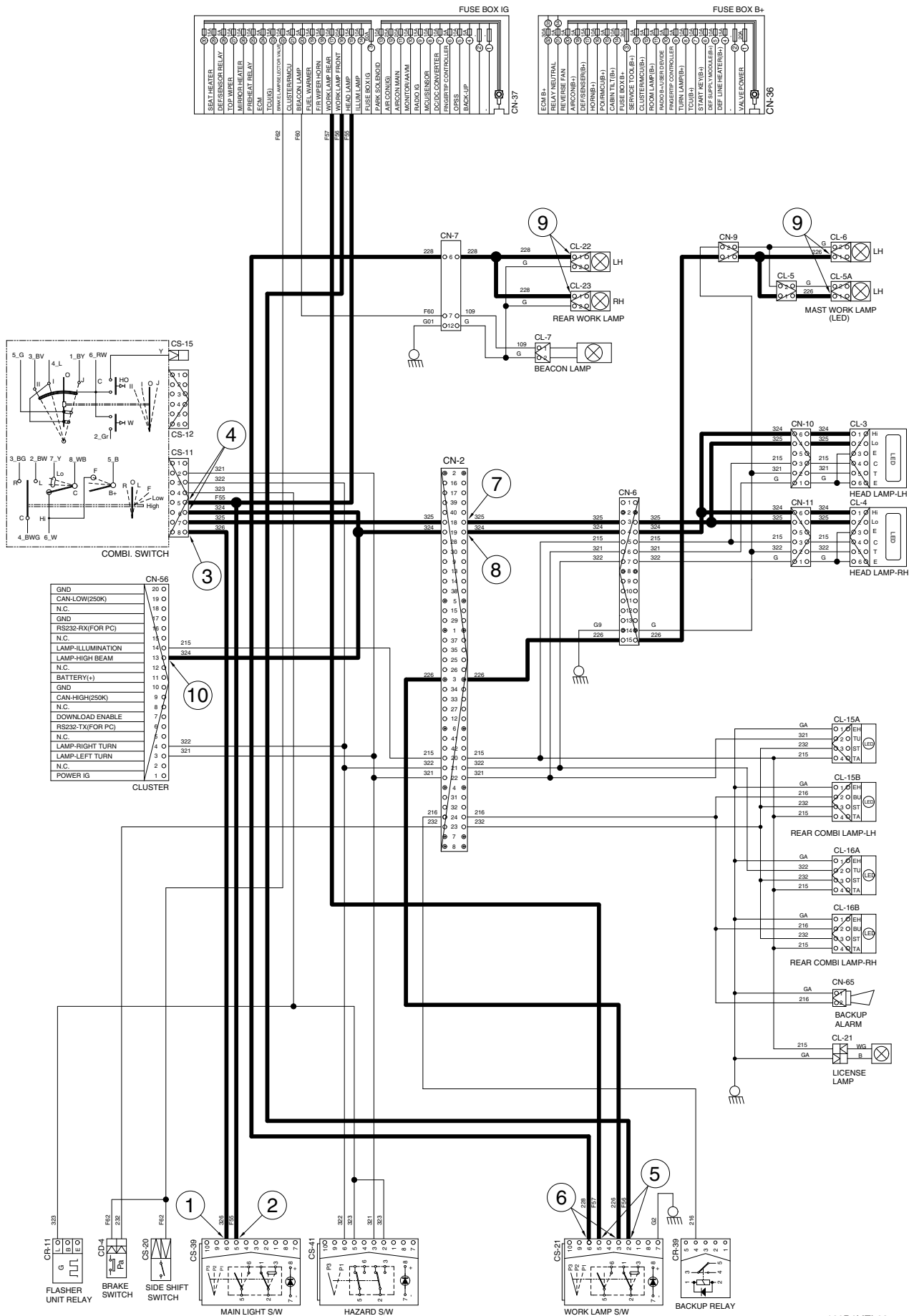
- LH rear work light ON [CL-22 (1)]
- RH rear work light ON [CL-23 (1)]

2) CHECK POINT

Engine	Start switch	Check point	Voltage
STOP	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

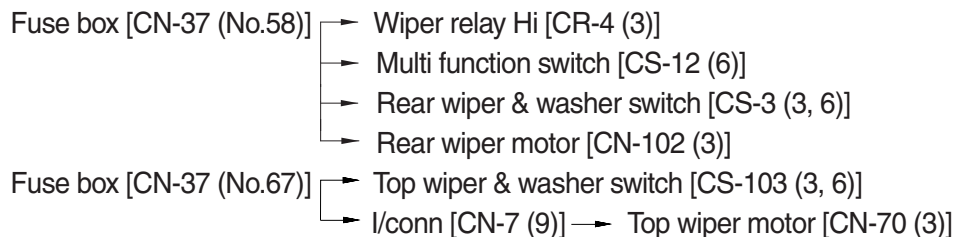
※ GND : Ground

HEAD LAMP AND WORK LIGHT CIRCUIT



6. WIPER AND WASHER CIRCUIT

1) OPERATING FLOW



(1) Front washer switch ON

- ① Washer switch ON [CS-12 (6)→(2)]
- I/conn [CN-3 (26)] → Washer tank [CN-22 (2)] → Front washer operating
 - Washer pump relay [CR-36 (1)→(3)] → 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)] →
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-26 (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-4 (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-26 (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 (27)] → 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

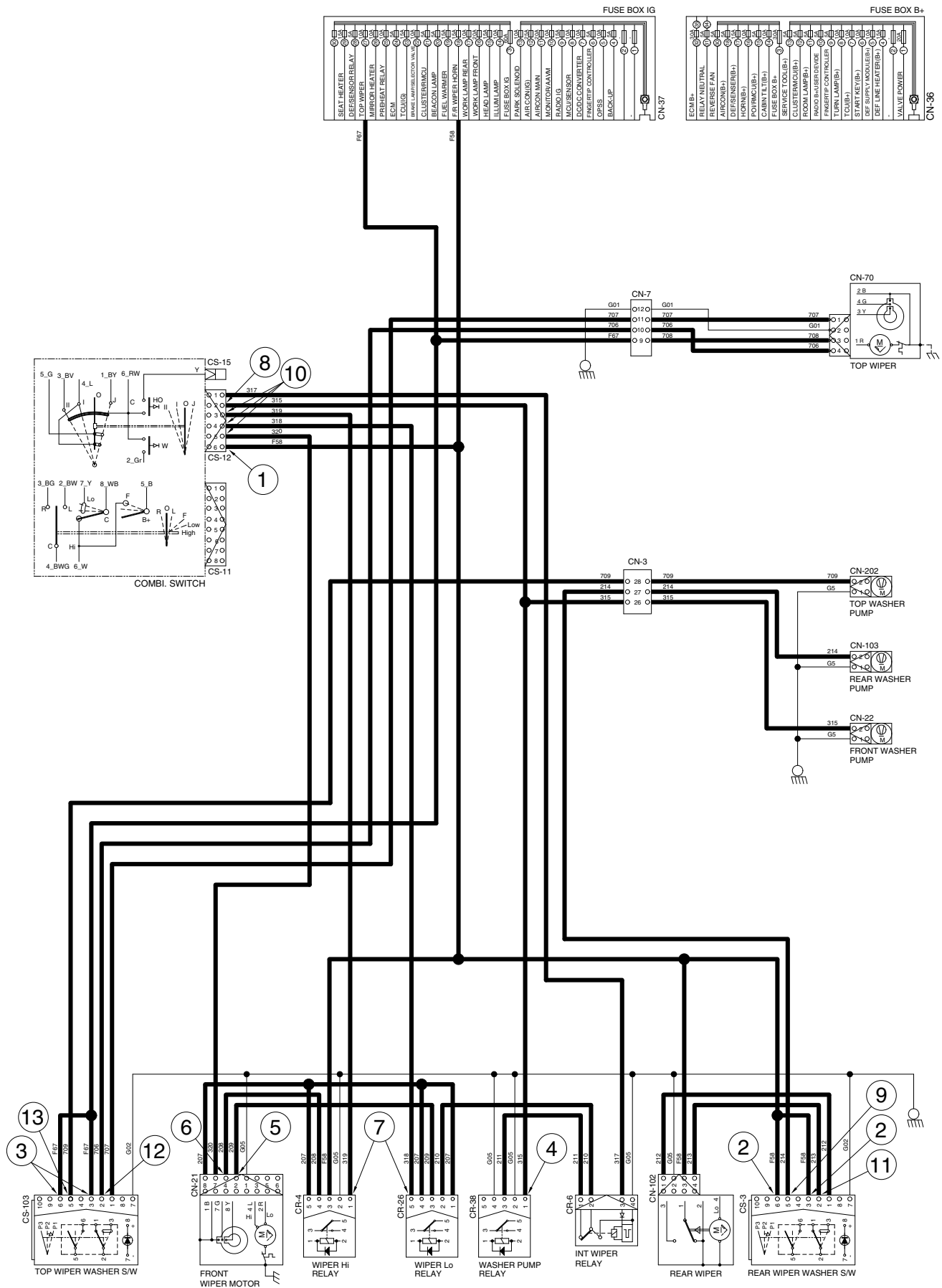
- ① Wiper switch ON (1st step)
- Wiper switch ON [CS-103 (3)→(2)] → I/conn [CN-7 (10)] → Top wiper motor [CN-70 (4)] →
Top wiper motor operating
- ② Washer switch ON (2nd step)
- Washer switch ON [CS-103 (6)→(5)] → I/conn [CN-3 (28)] → Top washer tank [CN-202 (2)] →
Washer operating
- Wiper switch ON [CS-103 (3)→(2)] → I/conn [CN-7 (10)] → Top wiper motor [CN-70 (4)] →
Top wiper motor operating

2) CHECK POINT

Engine	Start 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 wiper motor power output) ⑬ - GND (Top washer power output)	20~25V

※ GND : Ground

WIPER AND WASHER CIRCUIT



3. CLUSTER

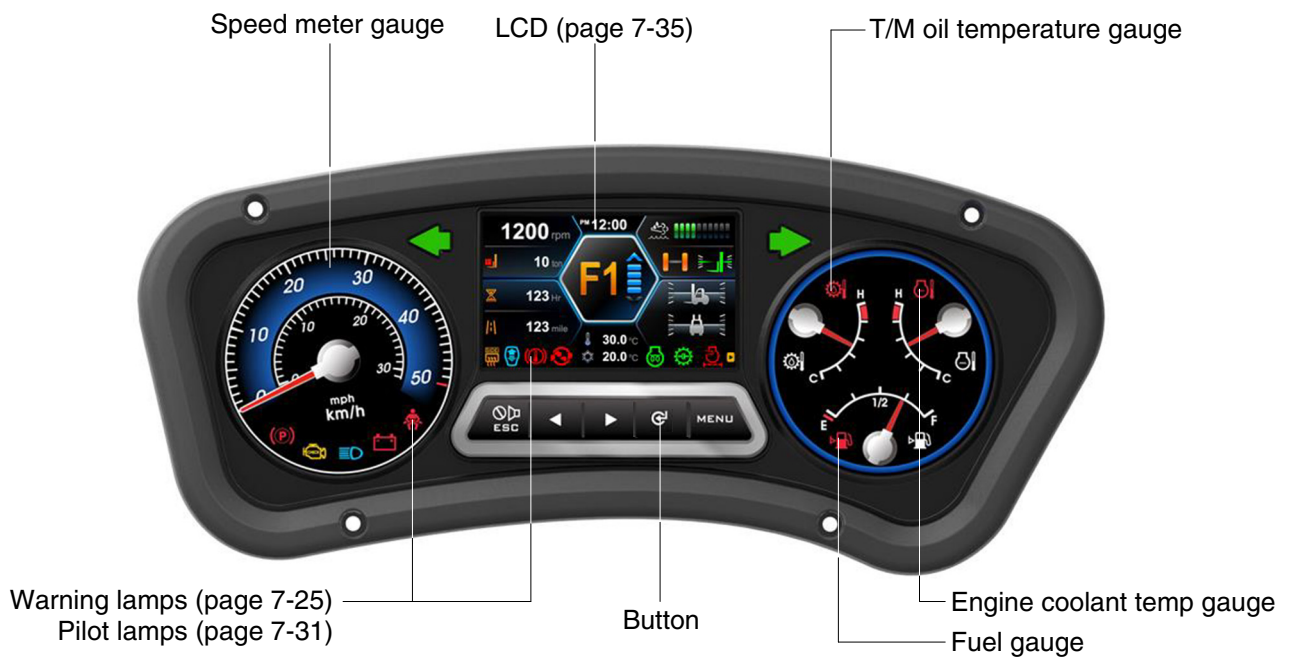
1) STRUCTURE

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 operator's manual chapter 7. **PLANNED MAINTENANCE AND LUBRICATION.**

※ When the cluster provides a warning immediately check the problem, and perform the required action.



160D9V7CD03

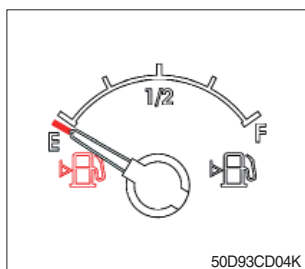
2) GAUGE

(1) Speed meter gauge



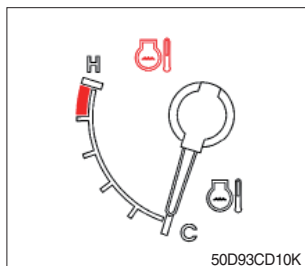
- ① The speed meter displays the speed of truck in mph and km/h.
 - 0~50 km/h
 - 0~31 mph

(2) Fuel gauge



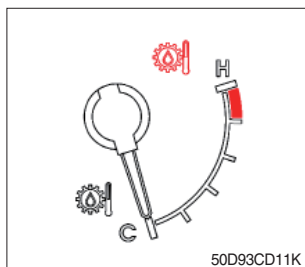
- ① This gauge indicates the amount of fuel in the fuel tank.
- ② Fill the fuel when the warning lamp lights ON or the indicator moves E point, refuel as soon as possible to avoid running out of fuel.
- ※ If the gauge indicates below E point even though the truck is on the normal condition, check the electric device as that can be caused by the poor connection of electricity or sensor.

(3) Engine coolant temperature gauge



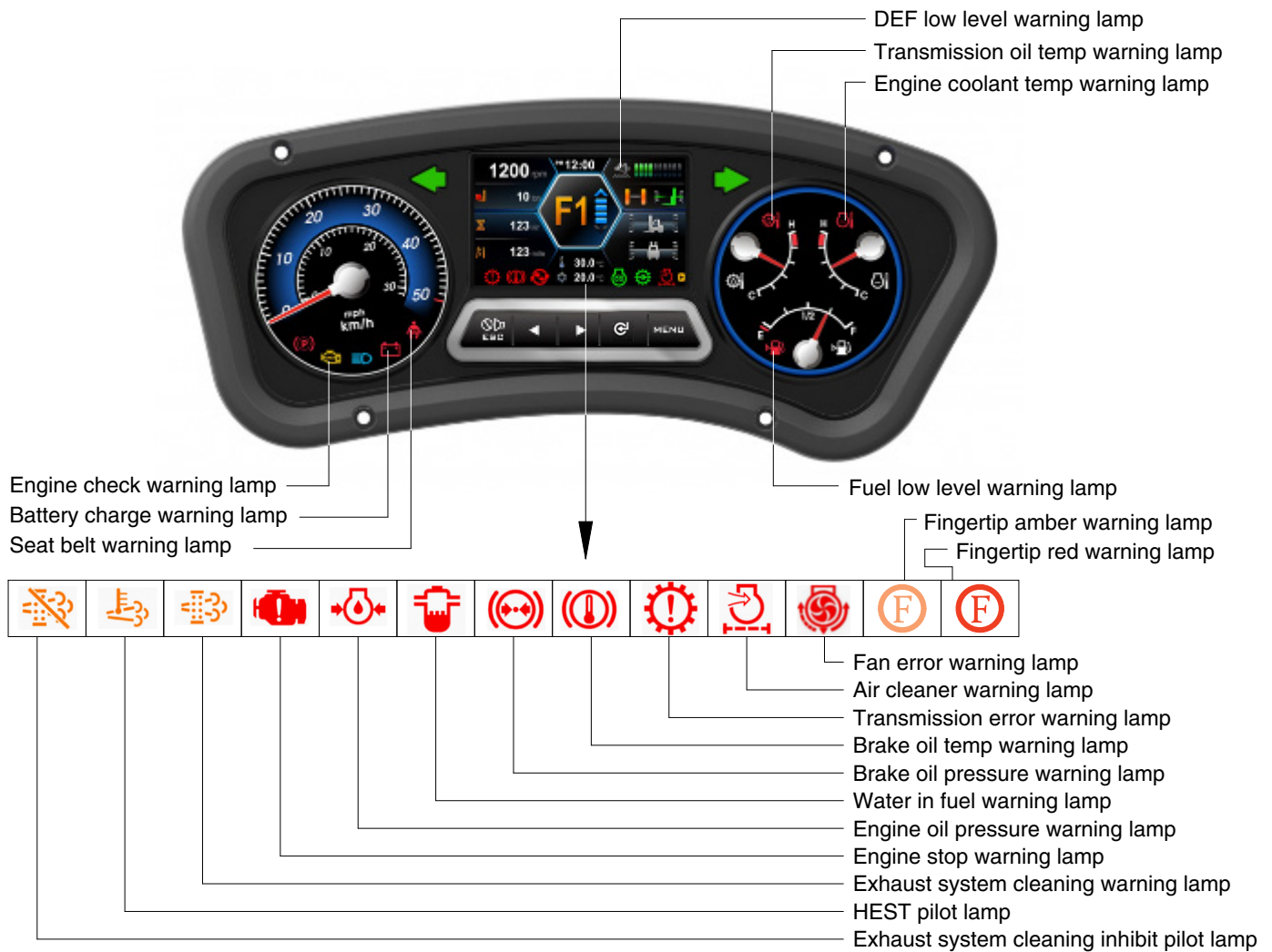
- ① This indicates the temperature of coolant.
 - White range : 40~107 °C (104~225 °F)
 - Red range : Above 107 °C (225 °F)
- ② Keep idling engine at low speed until the indicator is in the operating range.
- ③ If the indicator is in the red range, turn OFF the engine and check the radiator and engine.
- ※ 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



- 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



160D9V3CD04

※ When the warning and pilot lamps are illuminated more than display, you can display next lamps by push the button (▶).

(1) Engine check warning lamp



- ① This lamp lights ON during a nonfatal engine system error.
- ② The engine can still be run, but the fault should be corrected as soon as possible.

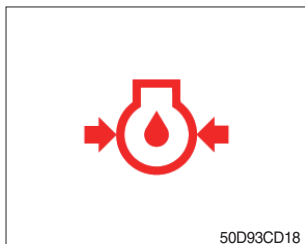
(2) Brake oil pressure warning lamp



- ① The lamp lights ON when the oil pressure of service brake drops below the normal range.
- ② When the lamp is ON, stop the engine and check for its cause.

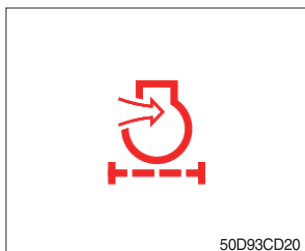
※ Do not operate until the problems are corrected.

(3) Engine oil pressure warning lamp



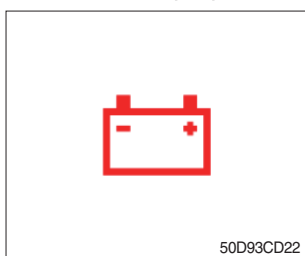
- ① This lamp comes ON for a while after starting the engine because of the low oil pressure.
- ② If the lamp comes ON during engine operation, shut OFF engine immediately. Check oil level.

(4) Air cleaner warning lamp



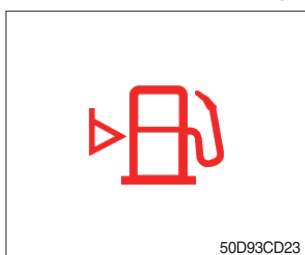
- ① This lamp operates by the vacuum caused inside when the filter of air cleaner is clogged.
- ② Check the filter and clean or replace it when the lamp is ON.

(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 Light up when water in fuel.
- ② Stop the engine and please drain the water of the fuel prefilter.

(8) Seat belt warning lamp



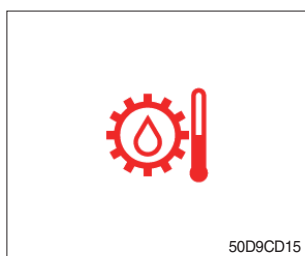
- ① This lamp lights ON for the first five seconds after starting the engine.

(9) Engine coolant temperature warning lamp



- ① This lamp is turned ON when the temperature of cooling water is over the normal temperature (108 °C, 226 °F).
- ② Check the cooling system when the lamp is ON.

(10) Transmission oil temperature warning lamp



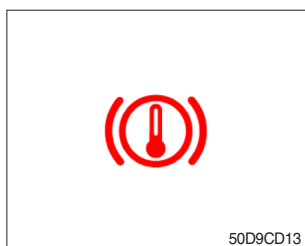
- ① This lamp informs the operator that transmission oil is above the specified temperature (107 °C, 225 °F).
 - Lamp ON : Abnormal
 - Lamp OFF : Normal
- ※ **When this lamp lights up during operation, stop the engine and check the truck.**

(11) Transmission error warning lamp



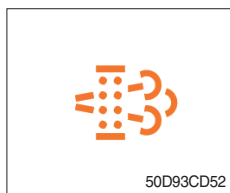
- ① This lamp lights ON and the information window of the LCD shows the error code when an error occur in the transmission.
 - ② Immediately pull the truck to a convenient stop. Stop the engine. Investigate the cause.
- ※ **Consult a HYUNDAI dealer to investigate the cause.**
- ※ **Do not operate until the cause has been corrected.**

(12) Brake oil 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.

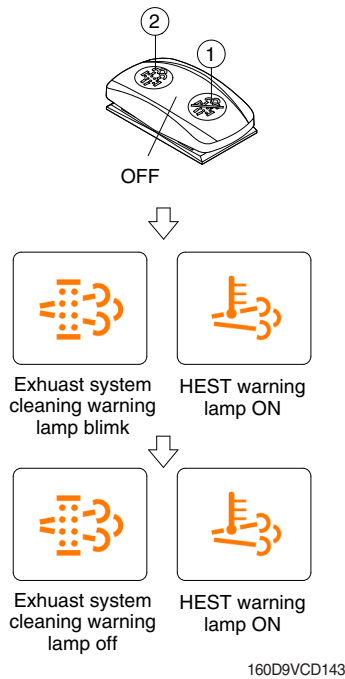
(13) Exhaust system cleaning warning lamp



① This warning lamp lights ON or flashes when exhaust system cleaning is needed as seen in the table below

Warning lamp				Remark
Exhaust warning lamp	DEF low lamp	Engine check lamp	Engine stop lamp	
				
On	-	-	-	1. Changing to a more challenging duty cycle. 2. Performing a manual (stationary) exhaust system cleaning.
On	-	On	-	1. The aftertreatment exhaust system needs to be cleaned immediately. 2. Engine power will be reduced automatically if action is not taken.
-	-	-	On	1 These lamps will be on when a manual (stationary) exhaust system cleaning is not performed 2. Stop the engine immediately 3. Please contact your hyundai service center or local dealer
Flash	-	-	-	The status of a manual (stationary) exhaust system cleaning when the exhaust system cleaning switch has been activated.
-	On	-	-	DEF level initial warning DEF level 10% (engine error code 3497)
-	Flash	-	-	DEF level critical warning DEF level 5% (engine error code 3498)
-	Flash	On	-	DEF level first derate warning DEF level 2.5% (engine error code 1673, 25% derate)
-	Flash	On	-	DEF level secondary derate warning DEF level 0% (error code 3547, 3714, 50% derate, 30 min)
-	Flash	On	On	DEF level final derate warning Engine error code 3712 Contact Hyundai Service center or dealer

※ Manual exhaust system cleaning



※ Manual exhaust system cleaning must be operated in a fireproof area.

※ To stop a manual exhaust system cleaning before it has completed, set to the exhaust system cleaning switch to the inhibit or turn OFF engine.

① Stop and park the truck.

② Push the switch to position ② to initiate the manual exhaust system cleaning.

※ Refer to the page 7-62 for the exhaust system cleaning switch operation.

※ The engine speed may increase during exhaust system cleaning and it will take approximately 20~60 minutes depending on condition.

③ The exhaust system cleaning warning lamp will flash and HEST warning lamp will light on during the exhaust system cleaning is operation.

④ The exhaust system cleaning and/or HEST warning lamp will light OFF when the exhaust system cleaning is completed.

(14) Exhaust system cleaning inhibit warning lamp



① This warning lamp lights ON when the exhaust system cleaning switch is pushed inhibit position, therefore automatic and manual exhaust system cleaning can not occur. It should inhibited, before caused fire due to the exhaust gas in high temperature.

※ Refer to the page 7-62 for the exhaust system cleaning switch.

(15) HEST (High exhaust system temperature) warning lamp



① This warning lamp indicates, when illuminated, that exhaust temperatures are high due to exhaust system cleaning.

② The lamp will also illuminate during a manual exhaust system 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 °C [1500 °F], which is hot enough to ignite or melt common materials, and to burn people.

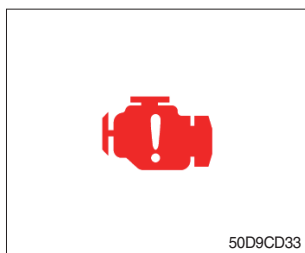
※ The lamp does not signify the need for any kind of equipment or engine service; It merely alerts the equipment operator to high exhaust temperatures. It will be common for the lamp to illuminate on and off during normal equipment operation as the engine completes the exhaust system cleaning.

(16) DEF (Diesel Exhaust Fluid) low warning lamp



- 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 7-28 for detail.**

(17) Engine stop warning lamp



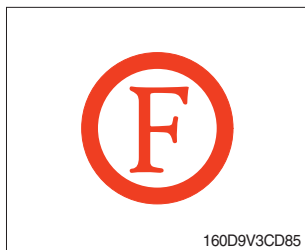
- ① When this warning lamp lights ON, stop the engine immediately and check the DEF level and related parts of the engine.
- ※ **Please contact your Hyundai service center or local dealer.**

(18) Fan error warning lamp



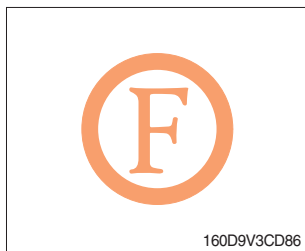
- ① This lamp is turned ON when the cooling fan error occurs.

(19) Fingertip red warning lamp



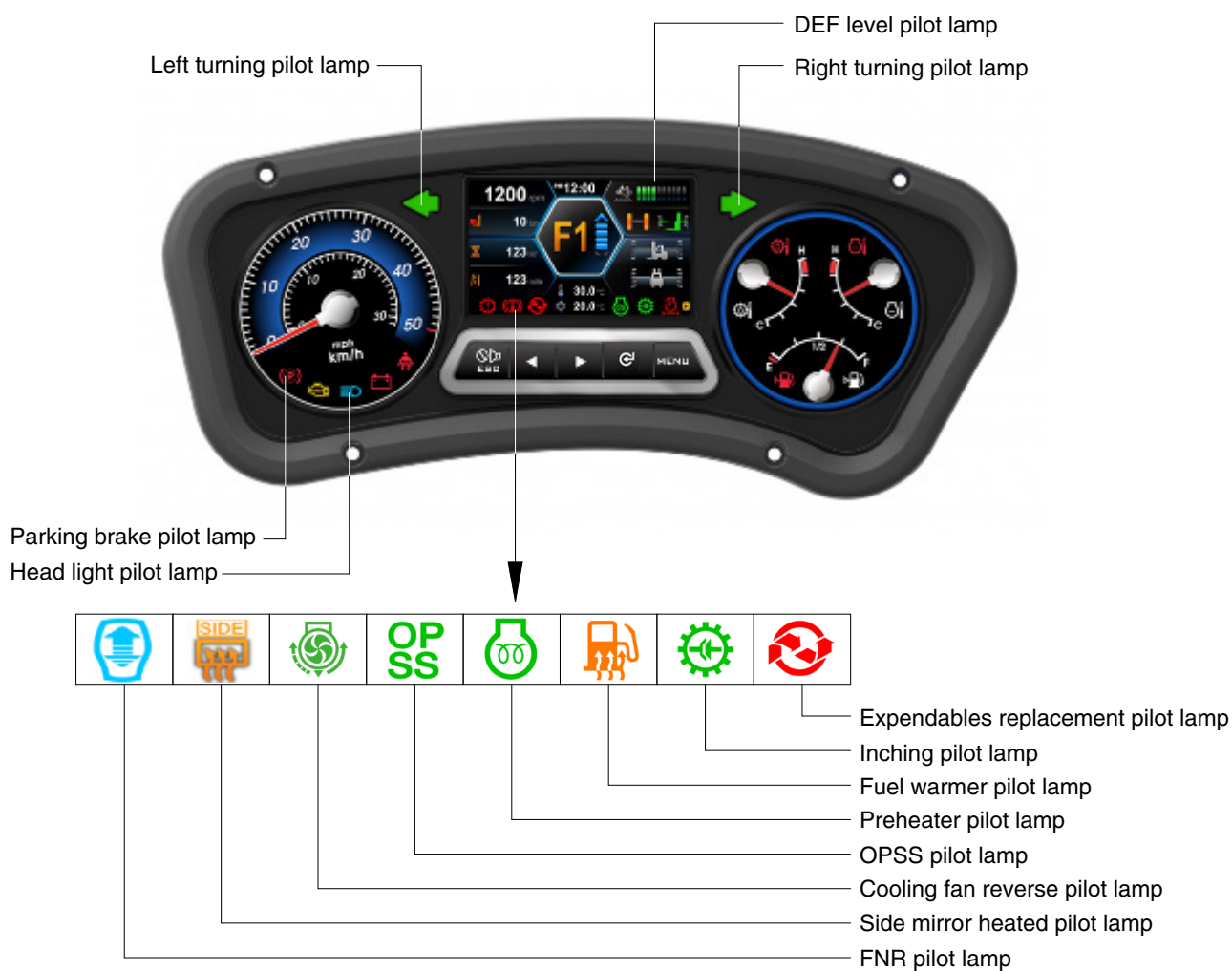
- ① This lamp lights ON when the forklift truck is in a condition that is serious enough to stop it.

(20) Fingertip amber warning lamp



- ① This lamp lights ON when there is a problem with the forklift truck system, but the vehicle does not need to be stopped immediately.

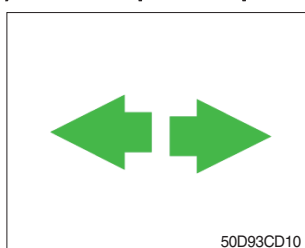
4) PILOT LAMPS



160D9V3CD05

※ When the warning and pilot lamps are illuminated more than display, you can display next lamps by push the button (▶).

(1) Direction pilot lamp



① This lamp flashes when the signal indicator lever is moved.

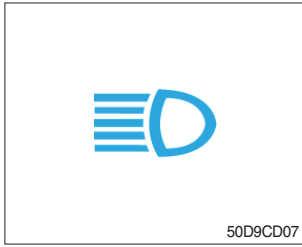
(2) Parking brake pilot lamp



① When the parking brake is actuated, the lamp lights ON.

※ Check the lamp is OFF before driving.

(3) Head light pilot lamp



- ① This lamp comes ON when the main light switch is operated to 2nd step.

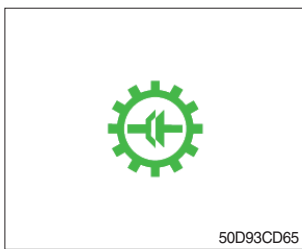
(4) Preheater pilot lamp



- 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 coolant temperature, indicating that preheating is completed.
- ② When the lamp goes out the operator should start cranking the engine.

※ Refer to operator's manual page 5-16.

(5) Inching pilot lamp



- ① When the inching switch is pressed, the lamp lights ON.

(6) Fuel warmer pilot lamp



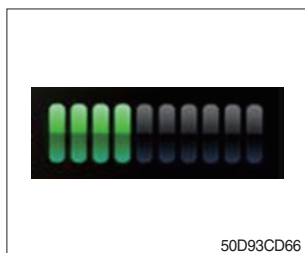
- ① Illuminates when the hydraulic fluid temperature is below 20 °C (68 °F) or engine coolant temperature is below 10 °C (50 °F).
- ② If the engine coolant temperature is above 60 °C (140 °F) or hydraulic fluid temperature is above 45 °C (113 °F) the start switch is in the ON position, automatic fuel heating is canceled.

(7) OPSS pilot lamp



- 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 gear selector lever must be cycled through neutral with the operator in the normal operating position to regain powered direction control.

(8) DEF (Diesel Exhaust Fluid) level pilot lamp



- ① This gauge indicates the level of DEF (10 steps).
- ② Fill the DEF when the level is low.

(9) Expendables replacement pilot lamp



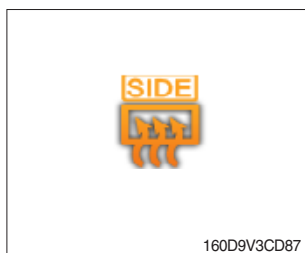
- ① This lamp lights ON if expendables which must be replaced are exist.
- ② The lamp will light up only 3 minutes since KEY ON, and then light off.
- ③ Please check the expendables management list in maintenance menu.

(10) Cooling fan reverse rotation pilot lamp



- ① This lamp lights ON when the cooling fan is operated to the reverse rotation.
- ※ Refer to page 7-63 for the operation of the cooling fan.

(11) Side mirror heated pilot lamp (option)



- ① When the heated mirror is operating, the lamp lights ON.

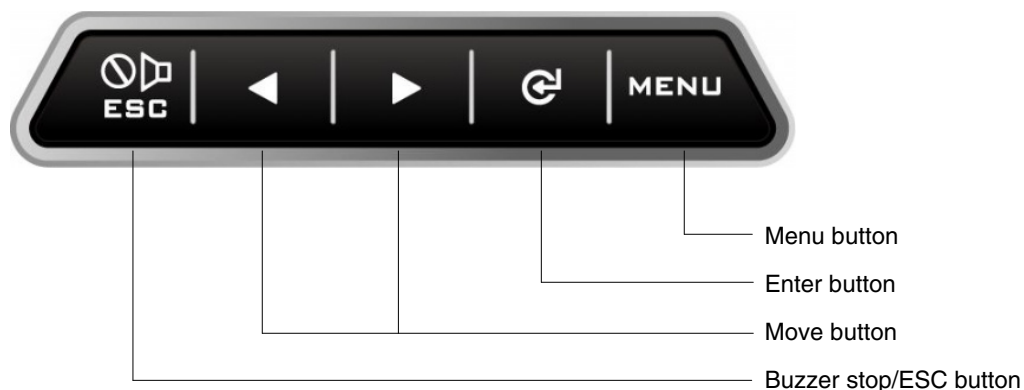
(12) FNR pilot lamp (option)



- ① This lamp lights ON when the 2nd FNR is activated.
- ② This function is optional.
- ※ Refer to page 7-64 for the FNR switch.

4) CLUSTER BUTTON

Each button has the following function.



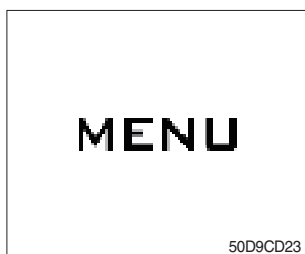
160D9VCD121

(1) Buzzer stop/ESC button



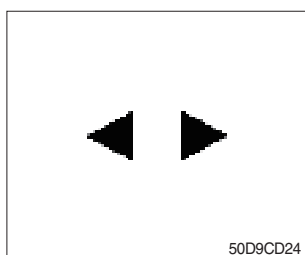
- ① This button is used to stop the buzzer sound.
- ② If another alarm condition occurs after this button has been pressed, the alarm buzzer will re-sound.

(2) Menu button



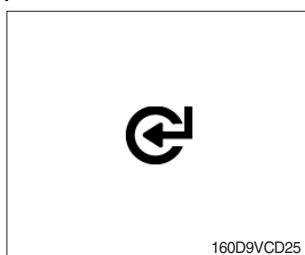
- ① Move in menu (left, up / right, down).

(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



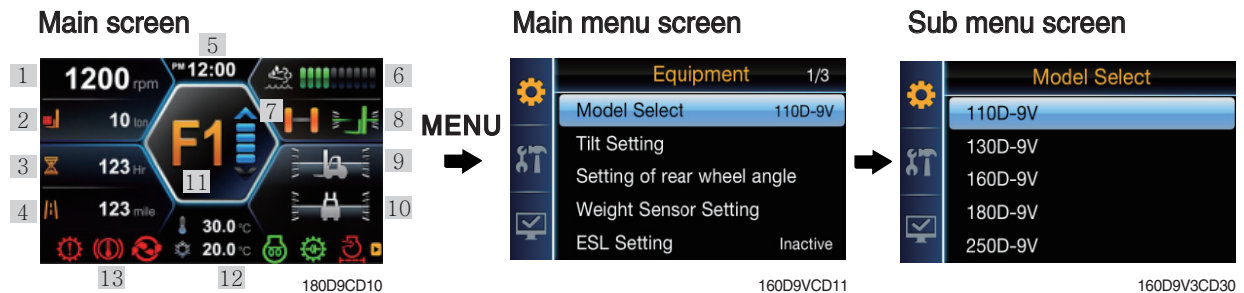
- ① This button is used to select menu.

5) LCD

(1) Main screen

※ You can select or set the menu by the button of the cluster.

※ Please refer to the page 3-34 for the selection and change of the menu and input value.



- 1 Engine rpm
- 2 Load indicator (opt)
- 3 Hour meter
- 4 Odometer
- 5 Current time
- 6 DEF level gauge
- 7 Rear wheel angle (opt)

- 8 Mast angle (opt)
- 9 Vehicle angle X
- 10 Vehicle angle Y
- 11 T/M info (error code, gear, warning)
- 12 Temperature (outdoor temp., setting temp)
- 13 Warning and pilot lamps

Communication error






※ Main screen when occurred communication error between the cluster and TCU/ MCU / ECU

Occurrence of the truck fault

While illuminates the engine, transmission or air conditioner warning lamp, when you press right button (▶) in the cluster button for about 4 seconds, it directly connected to the current failure screen.

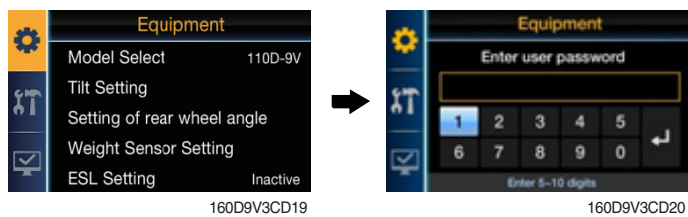
(Warning lamp : Engine (), Transmission ( and Air conditioner ().

(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 Cooling fan control Seat belt interlock (option) Finger tip setting (option)	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 Rotation direction, reverse interval and time Active, inactive Lever setting, valve setting
2	 Maintenance 50D9CD15K	Failure history Maintenance management Signal statue User password change Opening of communication	Current history, logged history and delete logged fault 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)

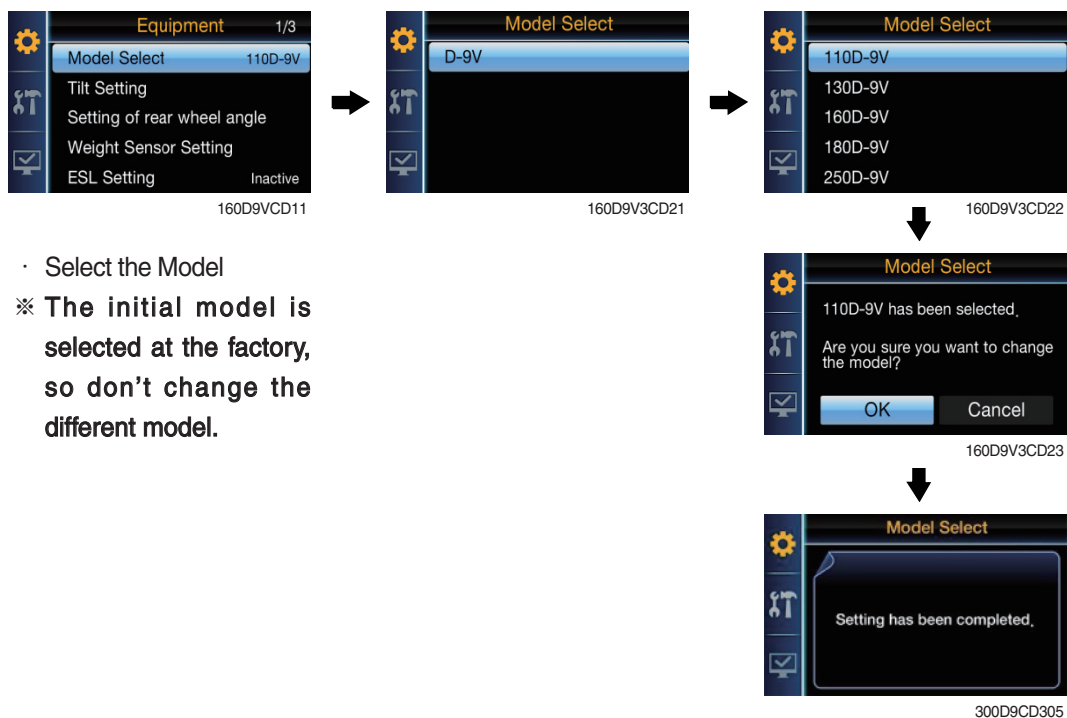
(3) Equipment

① Choose the equipment



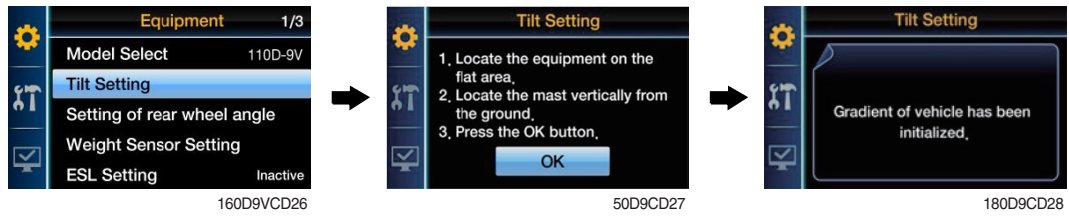
- To enter the menu, you must input user password.
- Default password is '00000'
- You should set password by five to ten digit.

② Model select



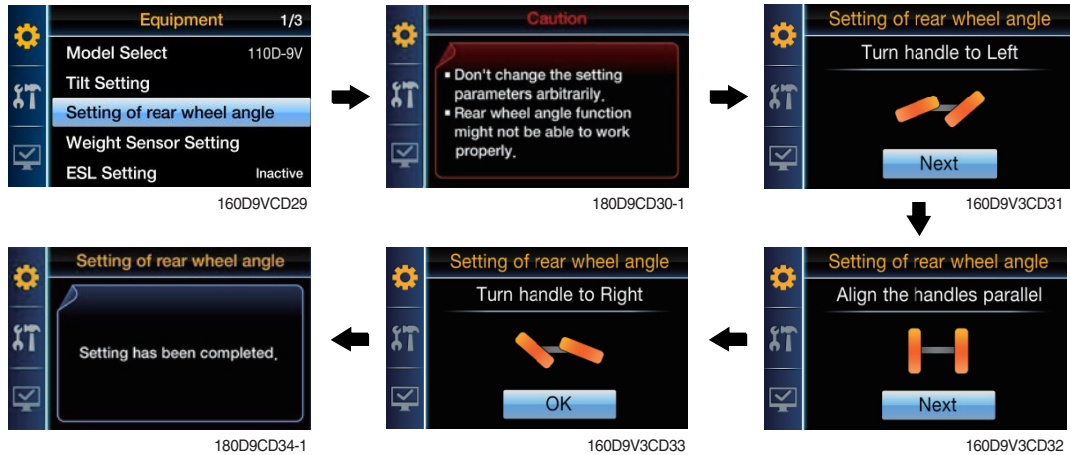
- Select the Model
- ※ **The initial model is selected at the factory, so don't change the different model.**

③ Tilt setting



- Set the offset about mast angle sensors and vehicle angle sensors.

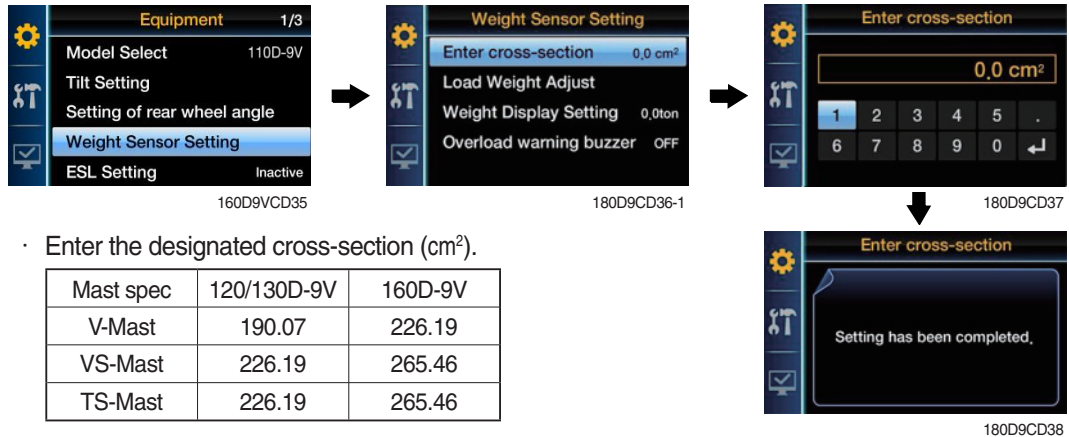
④ Setting for rear wheel angle



- 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



b. Load weight adjust

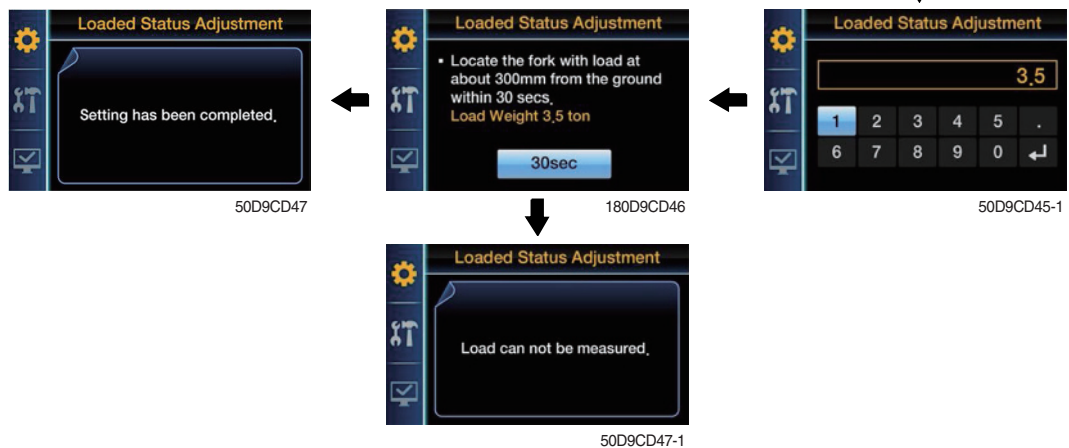
· Unloaded status adjustment

In the unloaded from the ground waiting 5 seconds after lift 30 cm, and tare ON.



· Loaded status adjustment

Loaded enter the weight.
 -> In the loaded from the ground waiting 5 seconds after lift 30 cm.
 -> Weight correction ON.





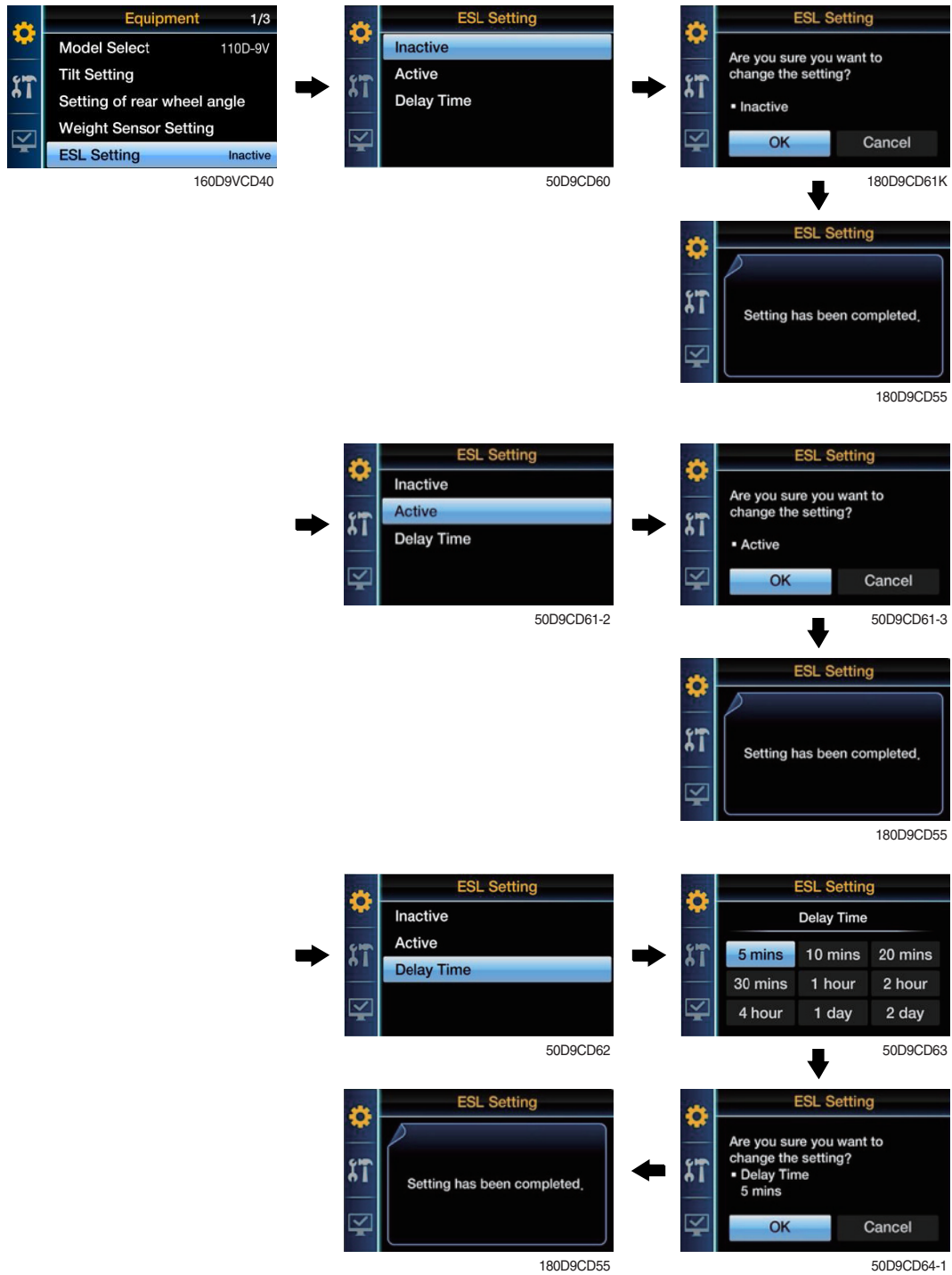
c. Weight display setting



d. Overload warning buzzer

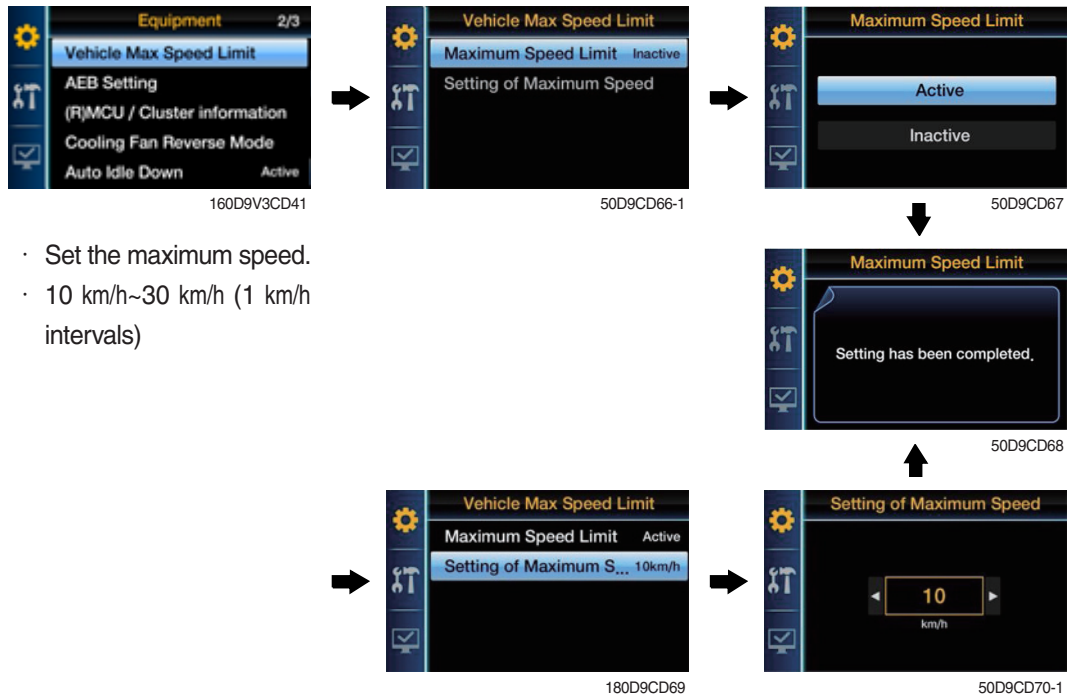


⑥ ESL setting



- 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



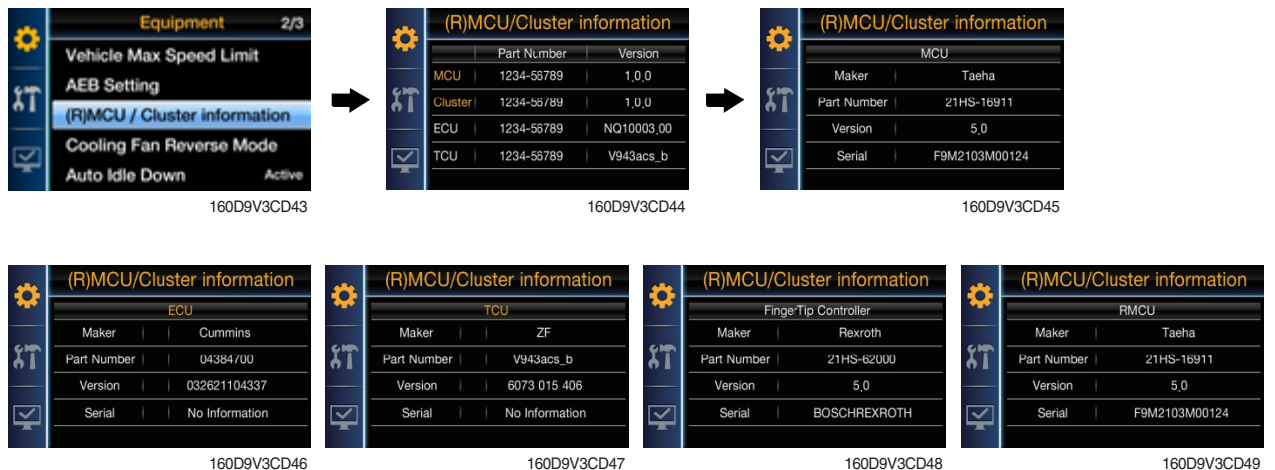
- Set the maximum speed.
- 10 km/h~30 km/h (1 km/h intervals)

⑧ AEB setting



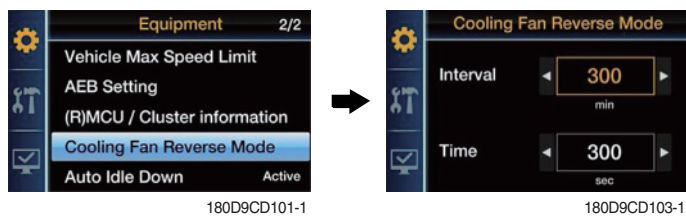
- Press OK button, then calibration will be started, for cancel, press Menu/ECS/Enter button.
- When it is finished (OK sign at gear box), Press Menu/ECS/Enter button.
- Start the engine : AEB start
- KEY ON : Brake pedal sensor calibration

⑨ (R) MCU / Cluster information



- Software version check for MCU/Cluster/RMCU.

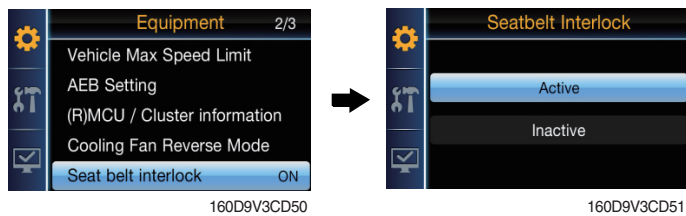
⑩ Cooling fan reverse mode



- Manual : The fan only rotate in reverse direction while you hold down the manual button.
- Automatic : The fan rotate in reverse direction at pre-set interval.
 - Interval : 30 minutes ~ 5 hours
 - Time : 30 seconds ~ 5 minutes

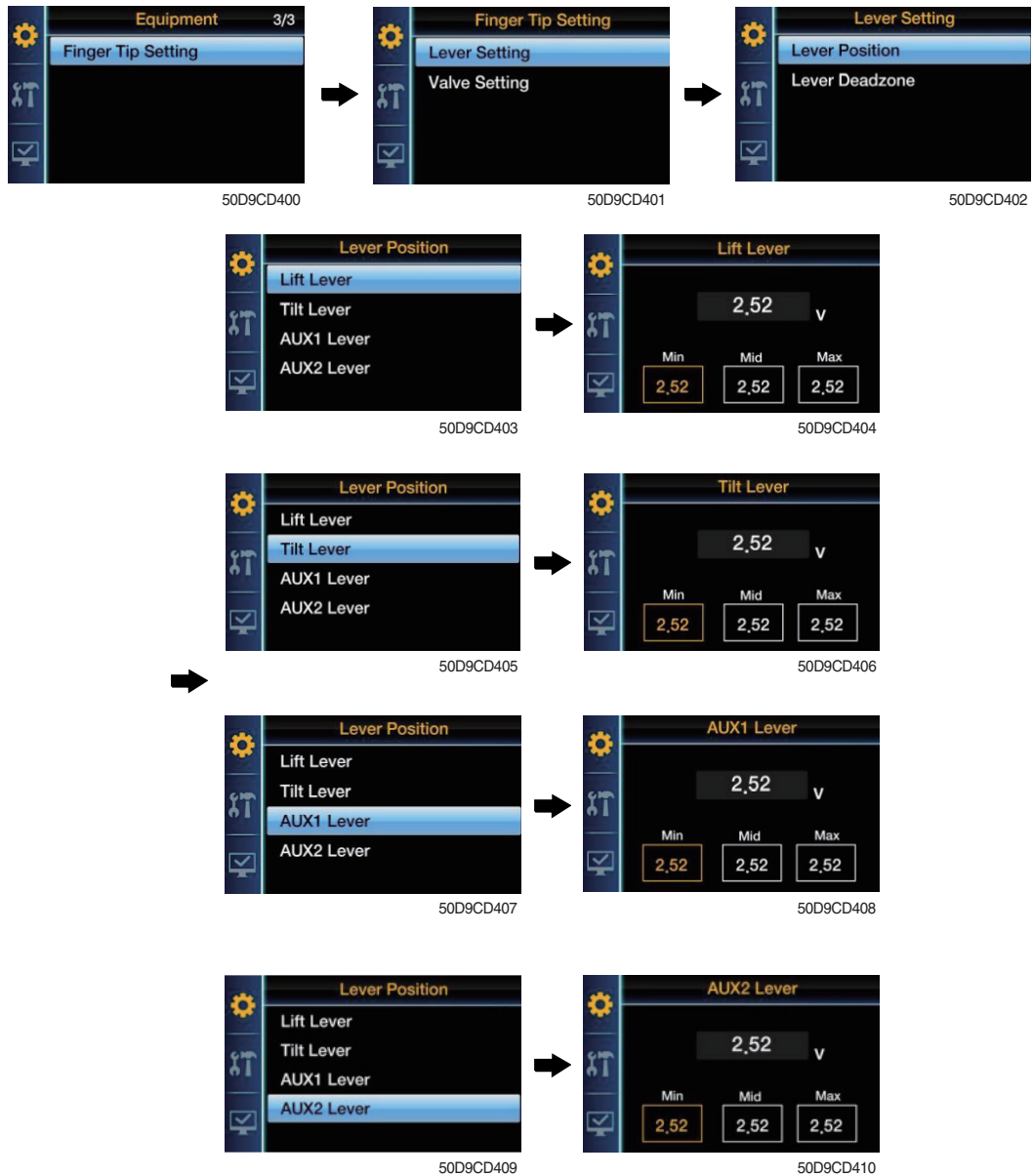
※ Refer to the page 7-63 for the cooling fan control switch.

⑪ Seat belt interlock (option)



- Turns on/off the seat belt interlock function.
- In the seat belt interlock option applied equipment, the menu is displayed only when the belt is fastened.

⑪ Finger tip setting (option)
a. Lever position setting



- Ability to set up the maximum Pull, Push (Min, Max) value and neutral value (Mid) of lever.
- Finger Tip lever set up about 0.5V~2.5V~4.5V.
You must be to move with actual Lever. (Unit V)
ex) Min 0.48, Mid 2.52, Max 4.52

b. Lever deadzone setting

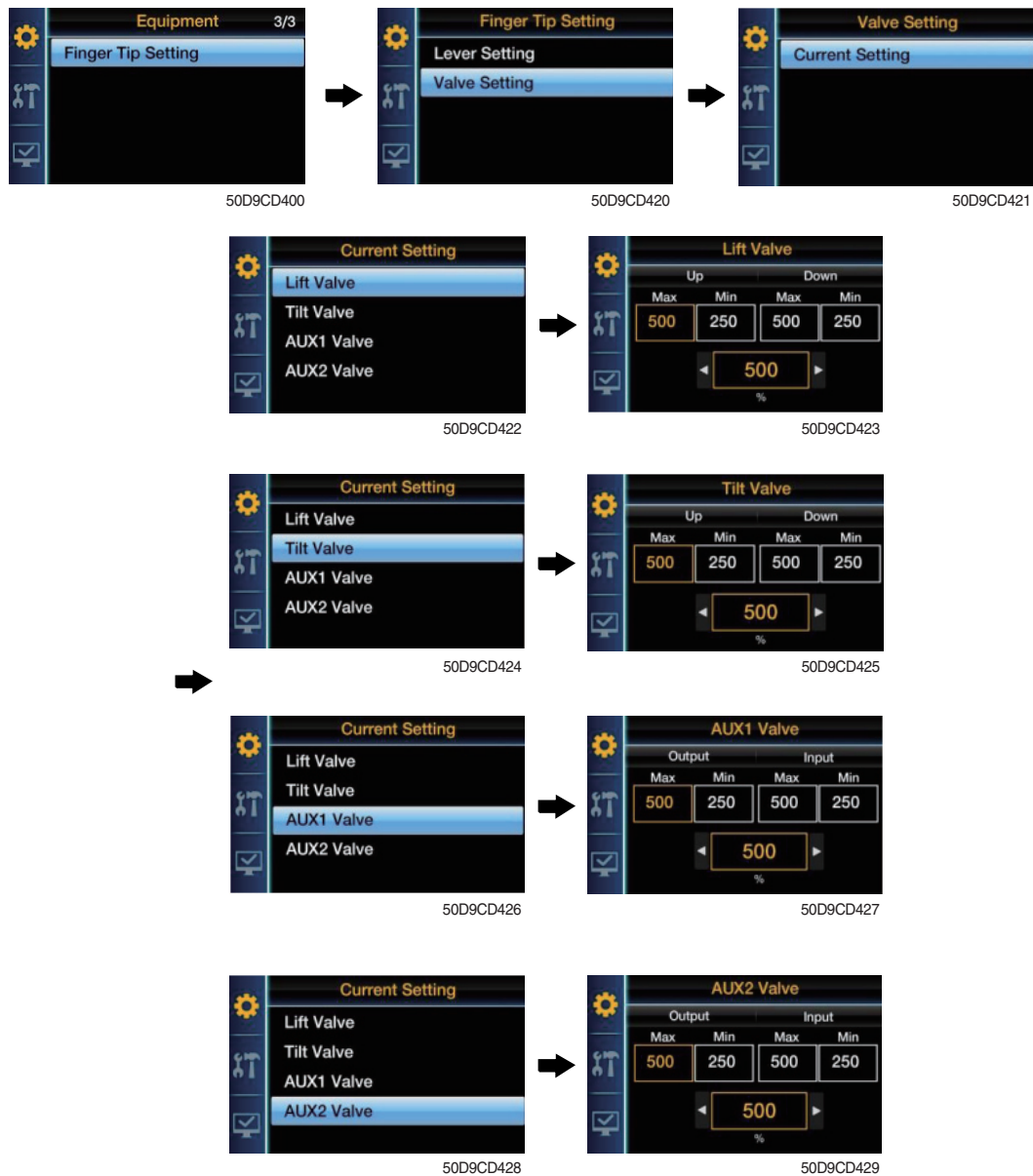


· Lever deadzone

- Ability to prevent the valve output due to a tiny error of the neutral Lever state (2.5V)
- It is not set below 0.20.

ex) If you set up the Upper : 0.26, Lower : 0.24, Lever operating range will be
 Upper zone : 2.76V (2.5+0.26) ~ 4.5V (Lever Max value)
 Lower zone : 2.26V (2.5-0.24) ~ 0.5V (Lever Min value)

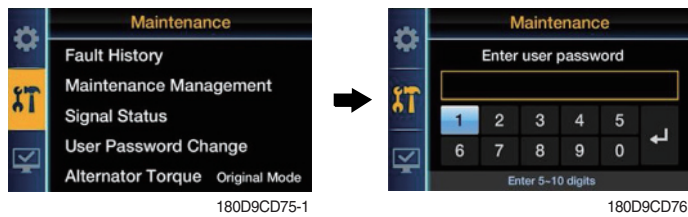
c. Valve setting



- Current Setting : Current setting for input each Valve Coil, it is to set up each maximum value of movements according to the current value (unit, %)
ex) If the Max value increase, the maximum speed will also increase.
If the Min value increase, the minimum speed will also increase.

(4) Maintenance

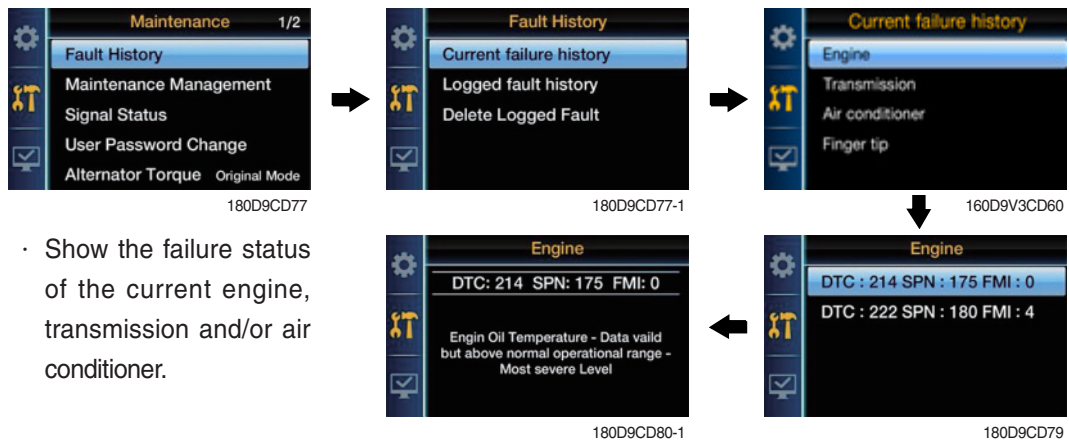
① Choose the maintenance



- To enter the Menu, you must input user password.
- Default password is '00000'
- You should set password by five to ten digit.

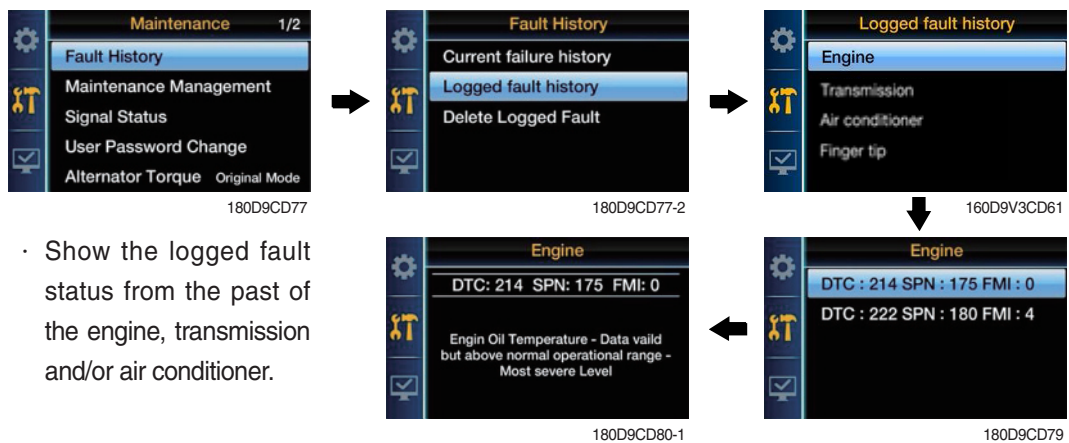
② Failure history

a. Current failure history



- Show the failure status of the current engine, transmission and/or air conditioner.

b. Logged fault history

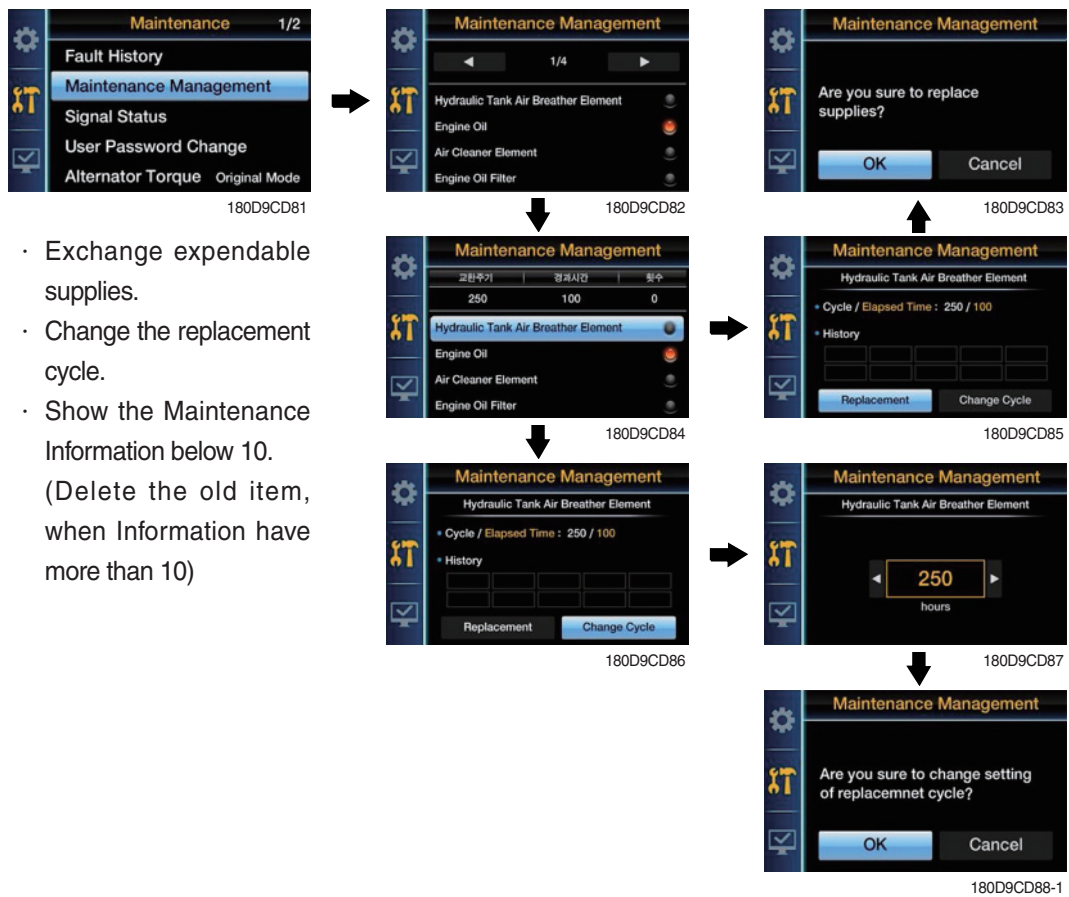


- Show the logged fault status from the past of the engine, transmission and/or air conditioner.

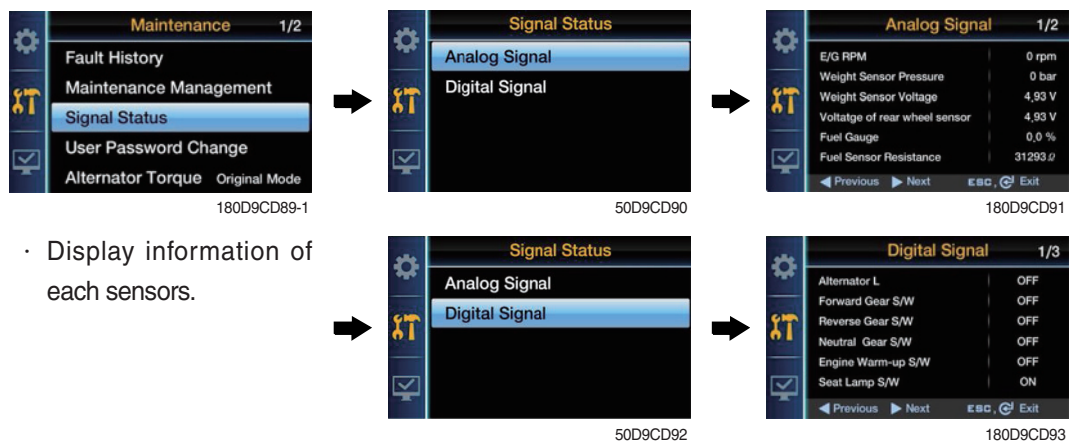
c. Delete logged fault



③ Maintenance management

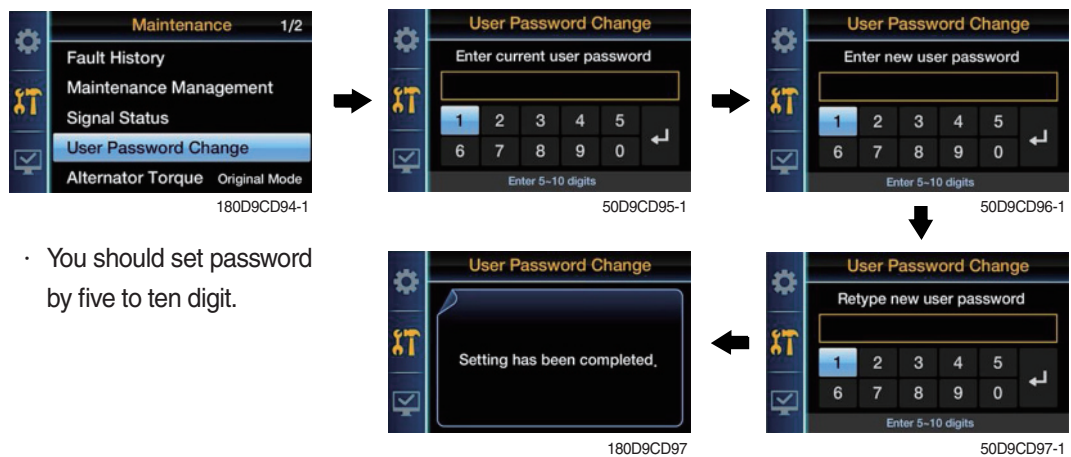


④ Signal status



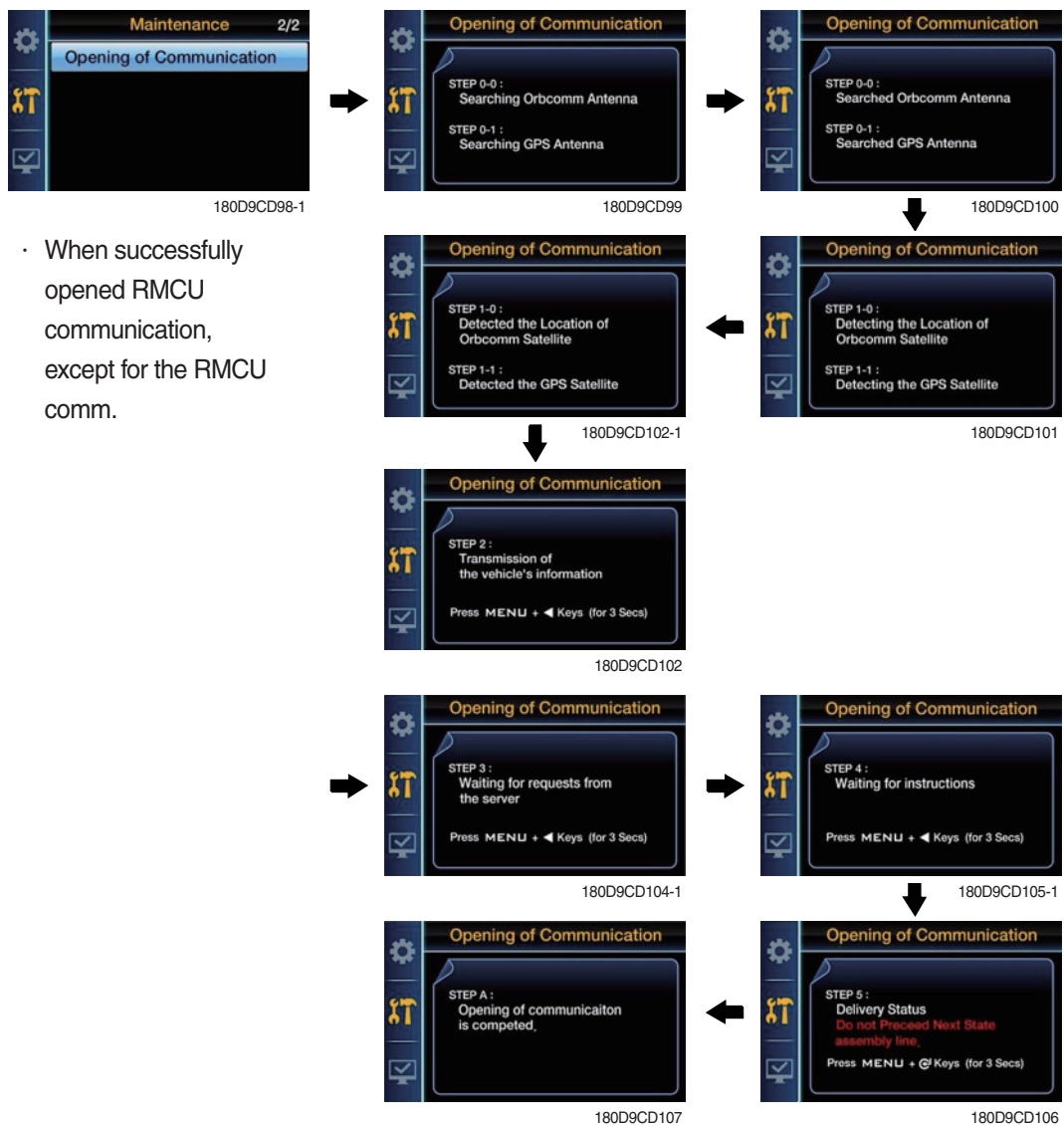
- Display information of each sensors.

⑤ User password change



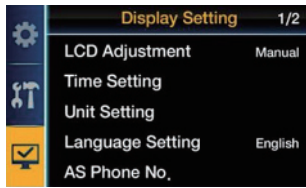
- You should set password by five to ten digit.

⑥ Opening of communication



(5) Display setting

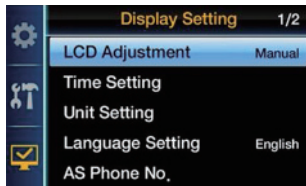
① Choose the display setting



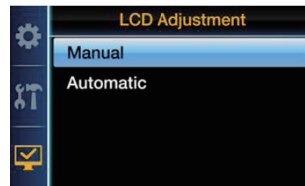
180D9CD108

- No password is required.

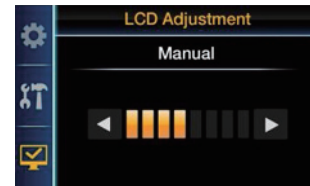
② LCD adjustment



180D9CD109



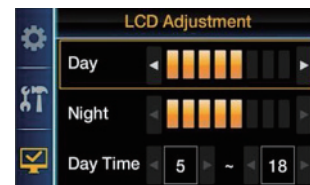
50D9CD110



180D9CD111

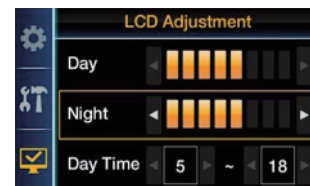


50D9CD112

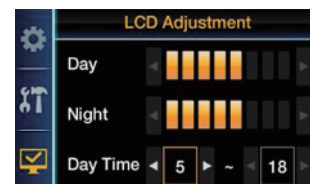


180D9CD113

- 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.)

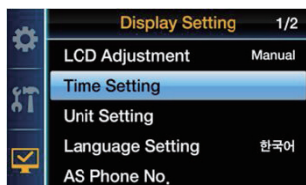


180D9CD114

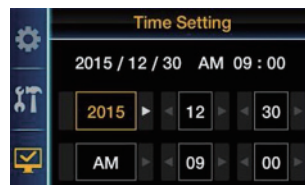


180D9CD115

③ Time setting



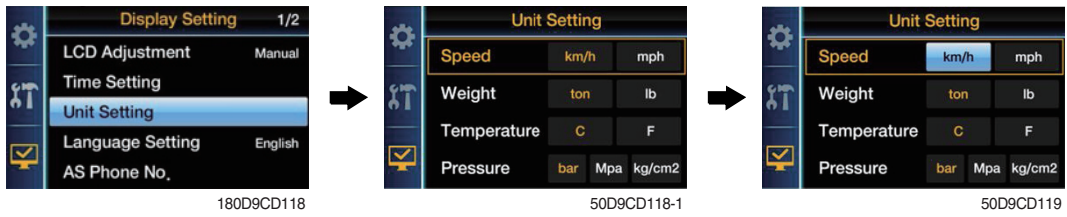
50D9CD116



180D9CD117

- Set the time (Year, Month, Day, Hour, Minute, AM/PM).

④ Unit setting



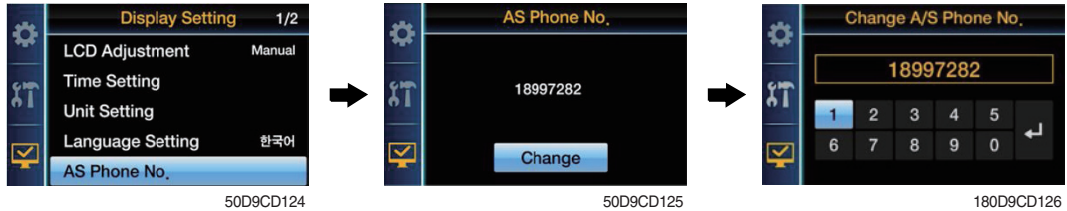
- Change units of temperature / speed / wight / pressure.

⑤ Language setting



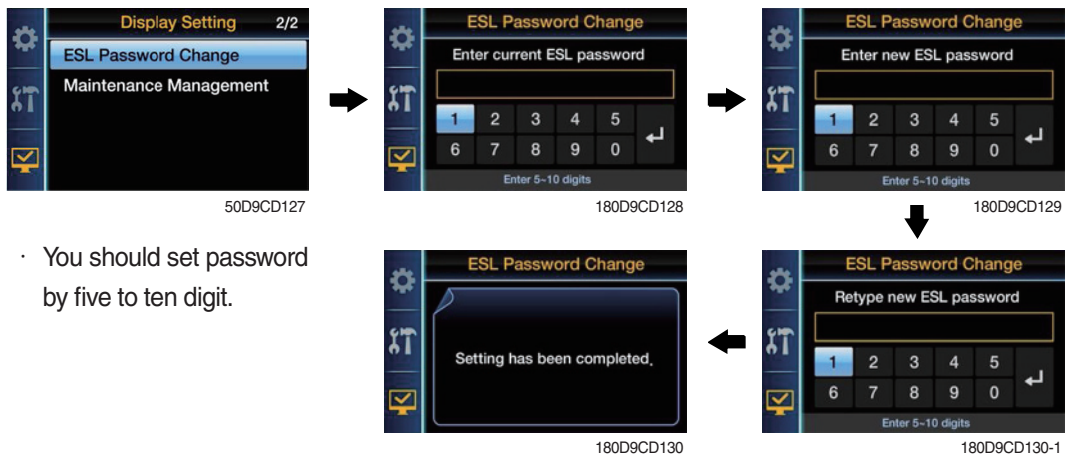
- Set the language used by your device.
(13 Multiple language)

⑥ A/S phone number



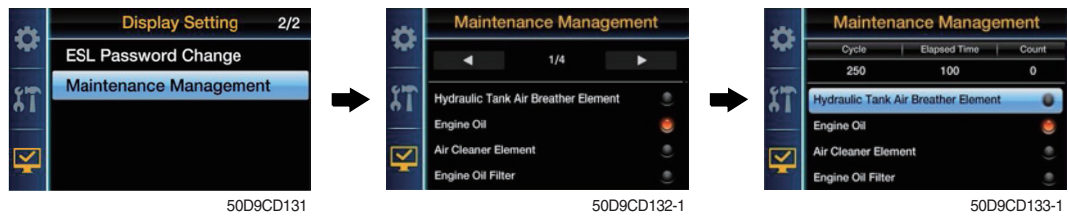
- Check and change of contact information for customer service.

⑦ ESL password change



- You should set password by five to ten digit.

⑧ Maintenance management



- 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



180D93ACD33

※ 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)

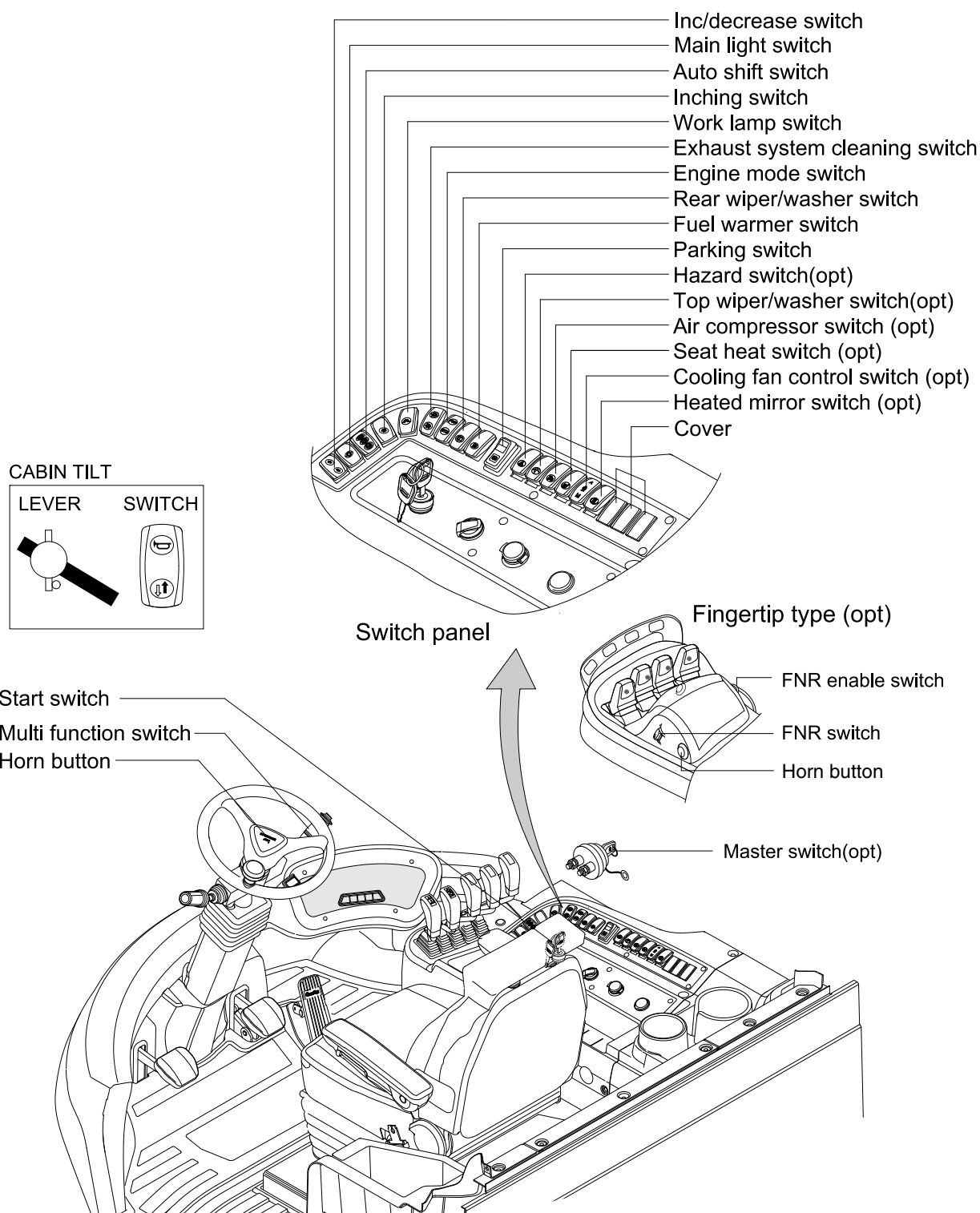
3) INITIALIZING THE INCHING SENSOR

- (1) Start engine after parking the truck on flat floor and blocking wheels.
- (2) Release parking brake and keep neutral gear shift.
- (3) Adjust the inching setting bolt so that the regular voltage is supplied to inching sensor when operating the pedal.
 - ※ Regular voltage : Before pedal operation ($1.0 \pm 0.3V$)
After pedal operation ($3.3 \pm 0.3V$)
- (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) Go into the AEB setting in the cluster menu. (refer to page 7-42)
- (7) Push OK button and execute as below.
- (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 truck again to repeat above.
 - ※ Above works are to be done with the parking brake released, so truck's wheels must be blocked for safety.

4) DISPLAY DURING INCHPEDAL CALIBRATION

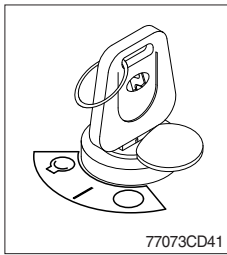
Symbol	Meaning	Remarks
▼IP	Push down the pedal slowly until endposition is reached and hold this position	
▲IP	Release the pedal slowly until endposition is reached	
IP blinkt	A problem occurred, release the pedal slowly until endposition is reached	If the expected endposition could not be reached, release 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



160D9V3CD06

1) START SWITCH



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

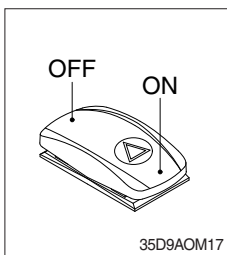
- ○ (OFF) : None of electrical circuits activate.
- | (ON) : All the systems of truck operate.
- ⦿ (START) : Use when starting the engine.

Release key immediately after starting.

※ **Before starting, set gear selector lever at NEUTRAL and place parking brake switch to LOCK position.**

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

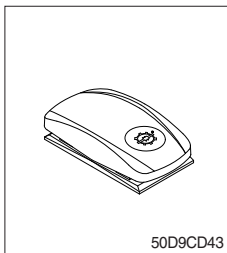
2) HAZARD SWITCH (OPTION)



(1) Use for parking, or loading truck.

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

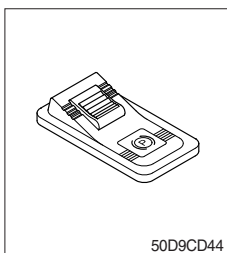
3) INCHING SWITCH



(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

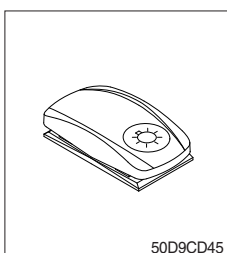


(1) This switch is used to parking brake lock or release.

(2) If this switch is pressed, the parking brake is applied and the warning lamp on the cluster will come 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



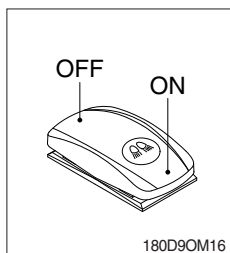
(1) This switch is used to operate the head light by one steps.

① First step : Clearance lamp and cluster illumination lamp come ON. Also, all of the pilot lamps of switches come ON.

② Second step : Head lamp comes ON.

※ **Refer to page 7-61 for head lamp.**

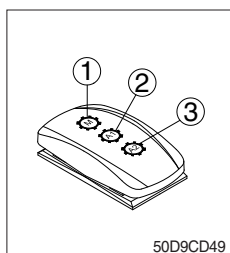
6) WORK LAMP SWITCH



(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 SHIFT 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.

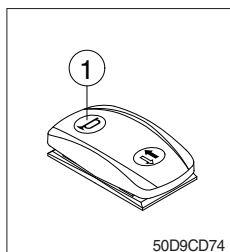
(2) Automatic 1st mode (②)

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.

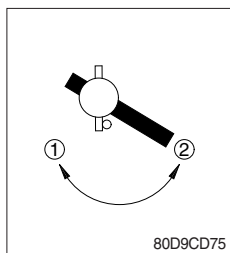
▲ Sound the horn to warn near by personnel, before tilting the cabin.

(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 operator's manual page 7-16 for the tilting method of the cabin.

9) HAND PUMP LEVER

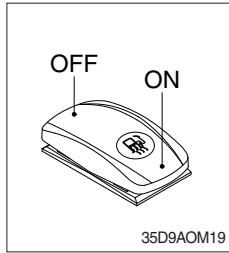


(1) This lever is used when tilting the cabin.

(2) Turn the hand pump lever to clockwise direction (①), the cabin shall be tilted to right side by the cabin tilt switch.

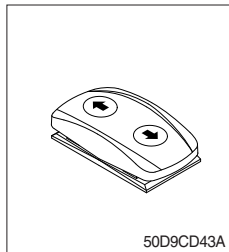
(3) Turn the hand pump lever to counterclockwise direction (②), the cabin shall be returned to original location by the cabin tilt switch.

10) FUEL WARMER SWITCH



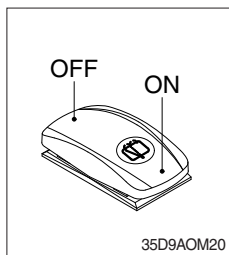
- (1) This switch is used to heat the fuel of pre-heater.

11) INC/DECREMENT SWITCH



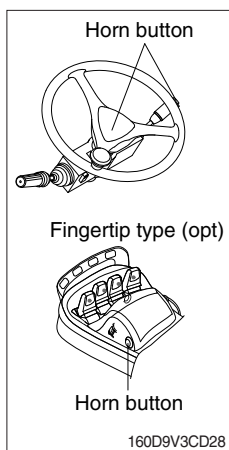
- (1) When engine running, the low idle rpm of engine increase or decrease by 25 rpm by operating this switch.
- (2) Engine low idle rpm returns to normal value when engine restarted.

12) TOP WIPER AND WASHER SWITCH (OPTION)



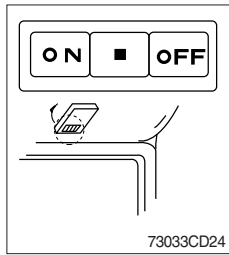
- (1) This switch is used to operate the wiper and washer on the top of the cab.
- (2) The washer liquid is sprayed and the wiper is operated only while pressing this switch.

13) HORN BUTTON



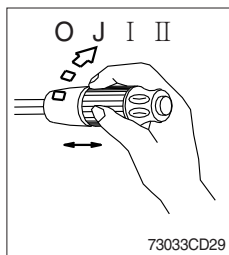
- (1) If you press the button on the top of the multifunction switch, the center of the steering wheel and the button on the fingertip body (option), the horn will sound.

14) CAB LAMP SWITCH



- (1) This switch turns ON the cab room lamp.

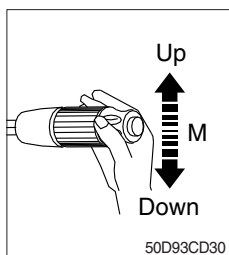
15) MULTI FUNCTION SWITCH



- (1) Front wiper and washer switch

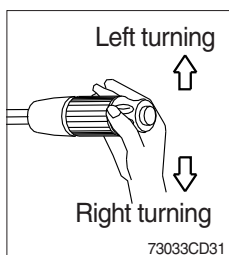
- ① When the switch is in J position, the wiper moves intermittently.
- ② When placed in I or II position, the wiper moves continuously.
- ③ If you push the grip of the lever, washer liquid will be sprayed and the wiper will be activated 2-3 times.

※ **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

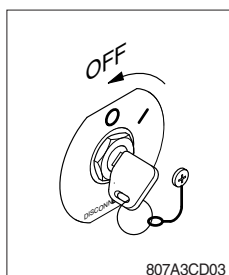
- ① This switch is used to turn the head light direction.
- ② Switch positions
 - Up : To flash for passing
 - Middle : Head light low beam ON
 - Down : Head light high beam ON
- ③ If you release the switch when it's in up position, the switch will return to middle.



- (3) Turning signal switch

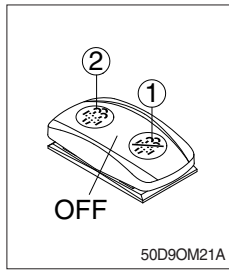
- ① This switch is used to warn or signal the turning direction of the truck to other vehicles or equipment.
- ② Push the lever up for turning left, pull the lever down for turning right.

16) MASTER SWITCH (OPTION)



- (1) This switch is used to shut off the entire electrical system.
When the truck 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.**

17) EXHAUST SYSTEM CLEANING SWITCH



(1) This switch is used to select the cleaning function of the exhaust system.

(2) Inhibit position (①)

- ① The inhibit position disallows any automatic or manual exhaust system cleaning.
- ② This may be used by operator to prevent exhaust system cleaning when the truck 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 initiate a automatic exhaust system cleaning when needed.

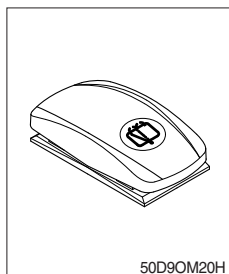
(4) Manual position (②)

- ① This position will only initiate a manual exhaust system cleaning and the exhaust system cleaning lamp is illuminated.
- ② HEST lamp will be illuminated during the entire exhaust system cleaning.

※ Refer to the page 7-29 for details.

※ This switch return to the OFF position when released the manual position (②).

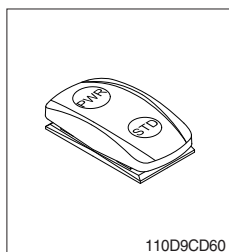
18) REAR WIPER/WASHER SWITCH



(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.

19) ENGINE MODE SWITCH



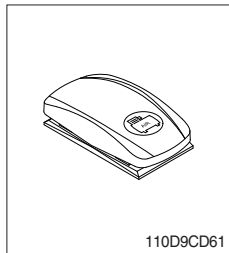
(1) This switch offers two selectable operating mode.

The operator can adjust the truck's performance with this selection switch.

(2) Function

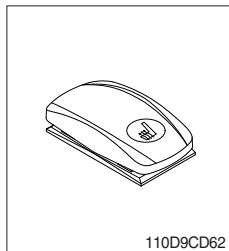
- ① STANDARD MODE : This mode provides maximum fuel efficiency for general loading.
- ② POWER MODE : This mode provides maximum power output for heavy loading or hill climb.

20) AIR COMPRESSOR SWITCH (option)



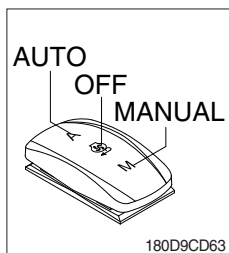
(1) This switch is used to activate the air compressor.

21) SEAT HEAT SWITCH (option)



(1) This switch is used to heat the seat.

22) COOLING FAN CONTROL SWITCH (option)



(1) This switch use to control the cooling fan.

(2) This switch has three positions.

- AUTO : The fan automatically work in reverse according to set up interval and time of the cooling fan reverse mode.

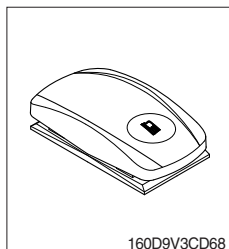
※ **Refer to page 7-43 to set of the cluster.**

- OFF : Only forward rotation is possible.
- MANUAL : The fan rotates reverse only while pressing this position.

(3) If release the switch, return to the OFF position.

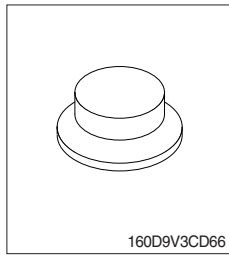
※ **The reverse rotation pilot lamp lights up on the area of the warning and pilot lamp of the LCD when the cooling fan is operated to the reverse rotation.**

23) HEATED MIRROR SWITCH (option)



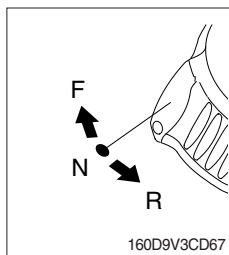
(1) This switch is used to heat the mirror.

24) FNR ENABLE SWITCH (option)




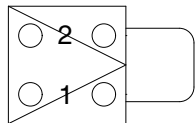
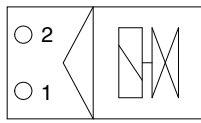
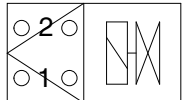
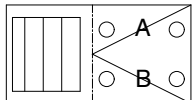
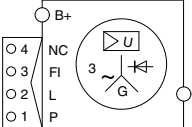
- (1) This switch makes FNR to enable when the fingertip is equipped as an option.

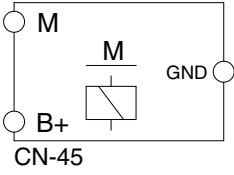
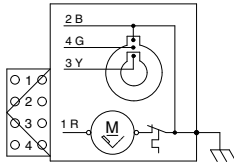
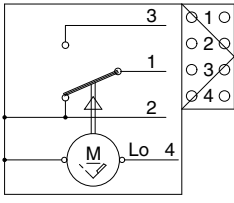
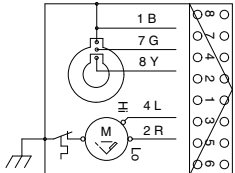
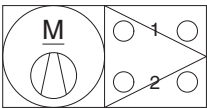
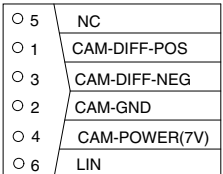
25) FNR SWITCH (option)



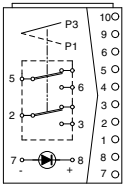
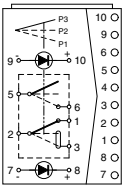
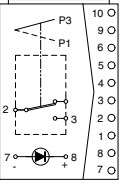
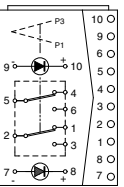
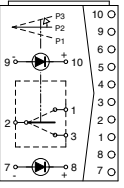
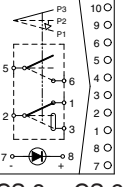
- (1) This switch changes travel direction of truck only when the FNR enable switch is selected ON.
- F : Truck moves forward
 - N : Neutral position
 - R : Truck moves backward

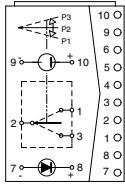
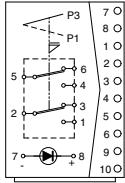
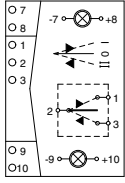
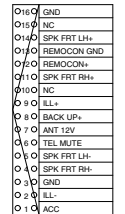
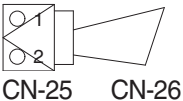
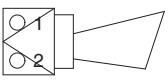
GROUP 6 ELECTRICAL COMPONENT SPECIFICATION

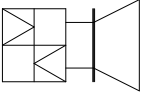
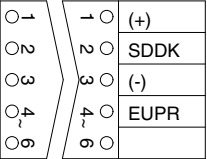
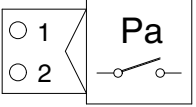
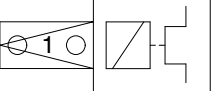
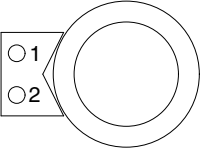
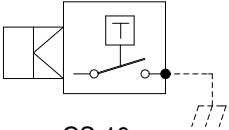
Part name	Symbol	Specifications	Check
Battery		12V × 100Ah (2EA)	※ When checking the battery charging indicator, Green : Normal condition Black : Discharge condition Transparency : Change
Fusible link	 CN-60 CN-95	CN-60 : 24V 27A CN-95 : 24V 45A	※ Check disconnection Normal : 0Ω (Connect ring terminal and check resistance between terminal 1 and 2)
EPPR valve (Pump, Fan)	 CN-154 CN-155 CN-156 CN-157	24V 300A	※ Check resistance About 24Ω
Solenoid valve (Parking, Attach cut off, Side shift selector, DEF tank heater, DEF dosing module)	 CN-71 CN-130 CN-131 CN-132 CN-J27 CN-J31	24V 1.2A	※ Check LED lamp. ※ Check resistance About 24Ω
Heater (Seat, DEF line heater 1, 2, 3)	 CN-381 CN-382 CN-383	24V	※ Check resistance Normal : About 200Ω (for terminal 1-3) 0Ω (for terminal 2-4)
Alternator	 CN-74	24V 70A	※ Check voltage Normal : 24~28V

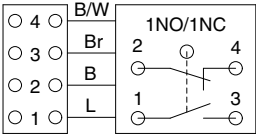
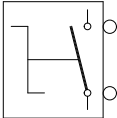
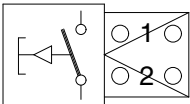
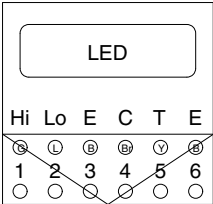
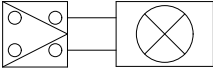
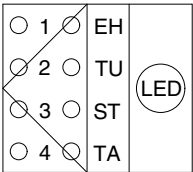
Part name	Symbol	Specifications	Check
Start motor	 <p>CN-45</p>	DENSO 24V 4.8kW	※ Operating or not
Top wiper motor	 <p>CN-70</p>	24V 1.5A 1-speed Auto parking	-
Rear wiper motor	 <p>CN-102</p>	24V 1A 1-speed Auto parking	-
Front wiper motor	 <p>CN-102</p>	24V 1A 2-speed Auto parking	-
Motor	 <p>CN-22 CN-83 CN-103 CN-202</p>	24V 2.5A	※ Check contact Normal : 26.4Ω (For terminal 1-2)
Camera	 <p>CN-249 CN-403 CN-404 CN-405</p>	24V 2.5W Signaling : NTSC Angle of view : 145°	-

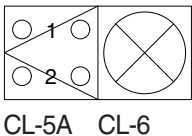
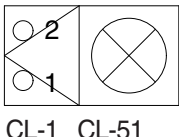
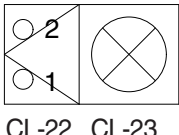
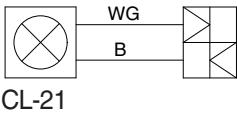
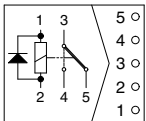
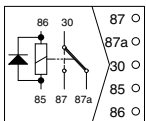
Part name	Symbol	Specifications	Check
Accel pedal	<p>CN-144</p>	5V, hall sensor	※ Check voltage 0.5~3.9V (2-1)
Resistor	<p>CN-98</p>	3W 300Ω	※ Check resistance Normal : 300Ω (A-B)
RMS antenna	<p>CN-251</p>	3.0~5.0V 20mA	-
Fuel warmer	<p>CN-96</p>	24V 15A	※ Check resistance Abnormal : ∞Ω
DC/DC converter	<p>CN-138</p>	24V 10A Output voltage : 13±1VDC	※ Check resistance Normal : A few Ω (1-2, 1-3)
Start switch	<p>CS-2</p>	DC 24V	※ Check contact OFF : ∞Ω (For each terminal) ON : 0Ω (For terminal 1-3) ∞Ω (For terminal 1-5) START : 0Ω (For terminal 1-3 and 1-5)

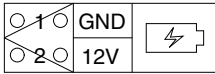
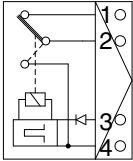
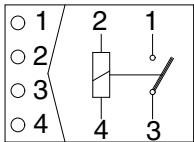
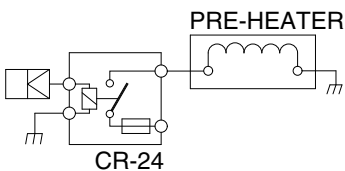
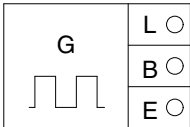
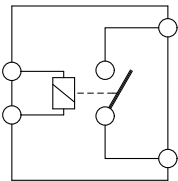
Part name	Symbol	Specifications	Check
Switch (Locking type)	 CS-41 CS-42 CS-82	24V 8A	※ Check contact OFF : $\infty \Omega$ (For terminal 2-3, 5-6)
Switch (Locking type)	 CS-59	24V 8A	※ Check contact OFF : $\infty \Omega$ (For terminal 2-3, 5-6)
Switch (Locking type)	 CS-99	24V 8A	※ Check contact OFF : $\infty \Omega$ (For terminal 2-3)
Switch (Locking type)	 CS-79	24V 8A	※ Check contact Normal ON : 0Ω (For terminal 2-3, 5-6) $\infty \Omega$ (For terminal 1-2, 4-5) OFF : $\infty \Omega$ (For terminal 2-3, 5-6) 0Ω (For terminal 1-2, 4-5)
Switch (Locking type)	 CS-100	24V 8A	※ Check contact OFF : $\infty \Omega$ (For terminal 2-1, 2-3)
Switch (Locking type)	 CS-3 CS-21 CS-39 CS-103	24V 8A	※ Check contact OFF : $\infty \Omega$ (For terminal 2-3, 5-6) 0Ω (For terminal 2-1)

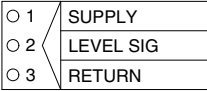
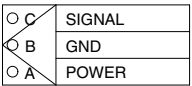
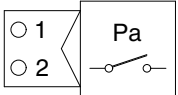
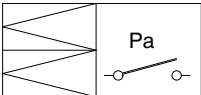
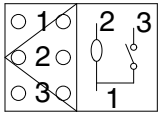
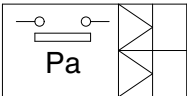
Part name	Symbol	Specifications	Check
Switch (Locking type)	 <p>CS-64</p>	24V 8A	※ Check contact OFF : $\infty \Omega$ (For terminal 2-1, 2-3)
Switch (Locking type)	 <p>CS-17</p>	24V 8A	※ Check contact Normal ON: 0Ω (For terminal 1-2, 4-5) $\infty \Omega$ (For terminal 2-3, 5-6) OFF: $\infty \Omega$ (For terminal 1-2, 4-5) 0Ω (For terminal 2-3, 5-6)
Cab tilt switch (Non-locking type)	 <p>CS-77</p>	24V 8A	※ Check contact OFF : $\infty \Omega$ (For terminal 2-1, 2-3)
Radio/USB player	 <p>CN-27</p>	24V 2A	※ Check voltage 20~25V (For terminal 1-3, 3-8)
Horn	 <p>CN-25 CN-26</p>	20~28V, 1.5A 100~115dB (at 25V, 2m)	※ Check operation Supply power (24V) to each terminal and connect ground.
Back up alarm	 <p>CN-65</p>	18~32V, 0.5A 115±3dB (at 1m)	※ Check operation Supply power (24V) to each terminal and connect ground.

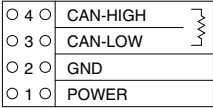
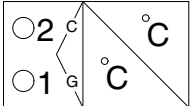
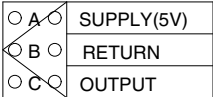
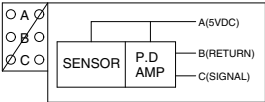
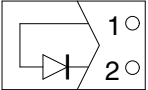
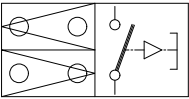
Part name	Symbol	Specifications	Check
Speaker	 CN-23(LH) CN-24(RH)	4Ω 20W	※ Check resistance Normal : 50Ω
TM diagoustic connector	 CN-51	-	-
Receiver dryer	 CN-29	N.O type	※ Check resistance Normal : Ω
Air conditioner compressor	 CN-30	24V 79W	※ Check contact Normal : 13.4Ω
12V socket	 CN-139	12V 10A Rated ampere	※ Check resistance Normal : A few Ω (1-2)
Brake temp switch	 CS-10	N.O type	※ Check resistance Normal : ∞Ω

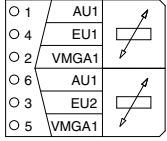
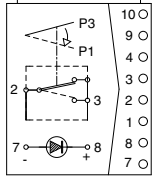
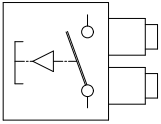
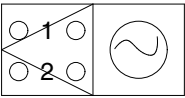
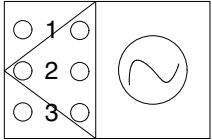
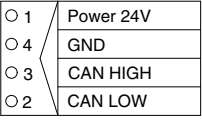
Part name	Symbol	Specifications	Check
Tilt switch	 <p>CS-74</p>	24V 8A	※ Check contact S/W open : $\infty \Omega$ (For terminal NO-COM) : 0Ω (For terminal NC-COM) S/W closed : 0Ω (For terminal NO-COM) : $\infty \Omega$ (For terminal NC-COM)
Master switch		Continuous Capacity : 180Amp Push in capacity : 1000Amp	※ Check contact OFF : $\infty \Omega$
Seat switch		24V 8A	※ Check contact OFF : $\infty \Omega$
Head lamp	 <p>CL-3 CL-4</p>	24V LED	※ Check disconnection Normal : $\infty \Omega$ (6-2, 4-2, 3-2, 1-2)
Beacon lamp	 <p>CL-7</p>	24V LED	※ Check disconnection Normal : A few Ω Abnormal : $\infty \Omega$
Rear combination lamp	 <p>CL-15A CL-16A</p>	24V LED 24V LED	※ Check disconnection Normal : A few Ω

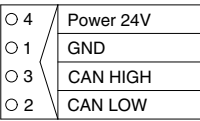
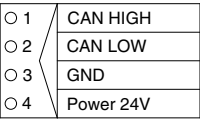
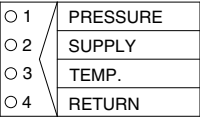
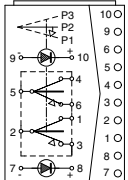
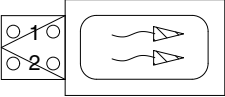
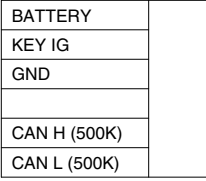
Part name	Symbol	Specifications	Check
Mast work lamp	 CL-5A CL-6	24V LED	※ Check disconnection Normal : A few Ω
Room lamp	 CL-1 CL-51	24V 10W	※ Check resistance Normal : A few Ω
Rear work lamp	 CL-22 CL-23	24V LED	※ Check resistance Normal : A few Ω
License lamp	 CL-21	24V 10W	※ Check resistance Normal : A few Ω
Relay (5 pin)	 CR-4 CR-5 CR-26 CR-36 CR-38 CR-39 CR-42 CR-50 CR-52 CR-54 CR-56 CR-57 CR-58 CR-61 CR-62 CR-63 CR-71 CR-72	24V 3-4 : 15A (85°C) 3-5 : 10A (85°C)	※ Check resistance Normal : 0 Ω (For terminal 3-4) : $\infty \Omega$ (For terminal 3-5)
Relay (5 pin)	 CR-49 CR-59	24V 30-87 : 20A 30-87a : 15A	※ Check resistance Normal : 0 Ω (For terminal 30-87a) : $\infty \Omega$ (For terminal 30-87)

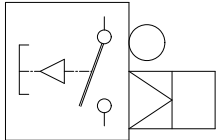
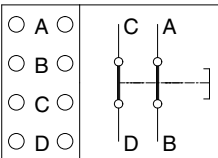
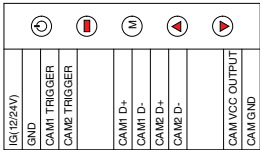
Part name	Symbol	Specifications	Check
USB charger	 CN-229	12V	—
Int wiper relay	 CR-6	24V 5A Operating time : 2.5 ± 1 sec	※ Check resistance Normal : 0Ω (FFor terminal 1-2) : $\infty \Omega$ (FFor terminal 1-3)
Start relay	 CR-23	24V 300A	※ Check resistance Normal : 10Ω (FFor terminal 2-4) : $\infty \Omega$ (FFor terminal 1-3)
Preheat relay	 CR-24	24V 200A Exciting current : 2.3A	※ Check resistance Normal : 10Ω (FFor terminal coil) : 0Ω (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 50Ω ※ Check contact Normal : $\infty \Omega$

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 : 0Ω (CLOSE)
Pressure switch	 CD-35 CD-75	N.O type	※ Check contact Normal : ∞Ω (OPEN)
Air cleaner pressure switch	 CD-10	Pressure : 635mmH ₂ O (N.O type)	※ Check contact Normal : ∞Ω
Fuel sender	 CD-2	Reed switch : Magnetic type	※ Check resistance Full : About 50Ω Low level : About 700Ω
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-87	-	-
Load sensor	 CD-23 CD-70	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	Diode spec : 1N5406	-
Switch	 CS-11 CS-12 CS-13 CS-14 CS-20 CS-92	24V (N.O type)	※ Check contact Normal : ∞ Ω

Part name	Symbol	Specifications	Check
Inching sensor	 <p>CD-71</p>	-	-
Mirror heater switch	 <p>CS-221</p>	24V 8A	※ Check contact OFF : $\infty \Omega$ (For terminal 2-3)
Center horn	 <p>CS-5</p>	24V	-
Transmission speed pick up sensor (Internal, Turbine, Engine)	 <p>CD-27 CD-74 CD-72</p>	-	-
Transmission speed sensor (output)	 <p>CD-73</p>	-	-
Engine sensor (NOx)	 <p>CN-ATIE CN-AT2A</p>	-	-

Part name	Symbol	Specifications	Check
Engine sensor (EGTS)	 CN-AT9A	-	-
DEF quality sensor	 CN-AT10A	-	-
TBAP sensor	 CD-102	-	-
Reverse fan switch	 CS-105	24V 8A	※ Check contact normal OFF : $\infty \Omega$ (For terminal 2-1, 2-3, 5-4, 5-6)
Mirror heater	 CN-221 CN-222	24V	-
User Authentication device		24V	-

Part name	Symbol	Specifications	Check
Door switch	 <p>CS-1A CS-1B</p>	N.O type	※ Check resistance Normal : $\infty \Omega$
Emergency stop switch	 <p>CS-10</p>	-	-
Camera monitor		-	-

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	36	I/conn(Engine harness-Main harness)	1743059-2	1743062-2
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-7	AMP	16	I/conn(Main harness-Cabin harness)	368047-1	368050-1
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-15	-	2	Horn harness-fingertip	-	-
CN-16	-	2	Aux enable harness-fingertip	-	-
CN-17	-	2	Auto tilt harness-fingertip	-	-
CN-18	-	2	2nd gear enable harness-fingertip	-	-
CN-19	KET	2	Inching potentiometer	MG610320	MG640322
CN-21	DEUTSCH	8	Front wiper	DT06-8S	-
CN-22	KET	2	Front washer pump	MG610043	-
CN-23	KET	2	Speaker LH	MG610070	-
CN-24	KET	2	Speaker RH	MG610070	-
CN-25	Molex	2	Horn	35825-0211	-
CN-26	Molex	2	Horn	35825-0211	-
CN-27	KUM	16	Radio & USB player	PK145-16017	-
CN-29	-	2	Receiver dryer	SMA-C-316R/V	-
CN-30	KUM	1	Compressor	PB625-01027	-
CN-31	AMP	15	Aircon harness	2-85262-1	-
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-47	AMP	8	Fingertip harness	174982-2	174984-2
CN-49	AMP	8	Seat cap	174352-2	174354-2
CN-50	AMP	68	Transmission control unit	963598-1	-
CN-51	AMP	6	Transmission control unit service tool	480704-0	926682-3
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	-

Connector number	Type	No. of pin	Destination	Connector part No.	
				Female	Male
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-83	-	2	Condensor fan	TNC-C-58	-
CN-90	AMP	16	I/conn (Engine harness-Frame harness)	368047-1	368050-1
CN-90	AMP	8	AAVM monitor	174982-2	174984-2
CN-91	AMP	6	Rear camera	174262-2	174264-2
CN-92	AMP	6	User authentic device	174262-2	174264-2
CN-93	DELPHI	96	ECU connector (J2)	13964572	-
CN-95	KET	2	Fusible link	-	MG620558
CN-96	DELPHI	2	Fuel warmer	15300027	-
CN-98	DEUTSCH	3	Resistor	DT06-3S-EP06	-
CN-101	SMITOMO	4	Engine TBAP sensor	-	6098-0144
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-130	DEUTSCH	2	5-lever solenoid	DT06-2S	DT04-2P
CN-131	DEUTSCH	2	Attachment cut off	DT06-2S	-
CN-132	DEUTSCH	2	Side shift select solenoid	DT06-2S	DT04-2P
CN-134	DEUTSCH	9	ECU service tool	-	HD10-9-1939P
CN-135	DEUTSCH	9	Cluster/Monitor service tool	-	HD10-9-96P
CN-136	DEUTSCH	9	MCU/RMCU service tool	-	HD10-9-96P
CN-138	KET	3	DC/DC connecter	MG610045	-
CN-139	KET	2	12V socket	MG610043	-
CN-144	-	6	Accel pedal	-	-
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-158	AMP	4	Fan harness	174257-2	174259-2
CN-160	DEUTSCH	2	Air compressor harness	DT06-2S	DT04-2P
CN-191	AMP	4	I/conn (Frame harness-G sensor)	174257-2	174259-2
CN-202	AMP	2	Top washer pump	2-967325-3	-
CN-221	DEUTSCH	2	Mirror heater-LH	DT06-2S	-
CN-222	DEUTSCH	2	Mirror heater-RH	DT06-2S	-
CN-229	AMP	2	USB charger	172864-2	-
CN-249	DEUTSCH	6	Rear camera	DT06-6S	DT04-6P

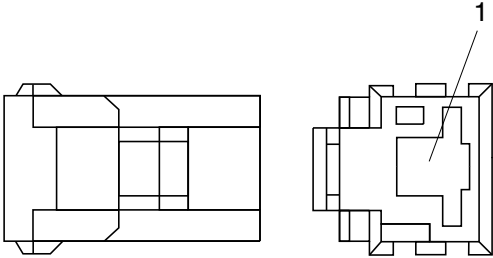
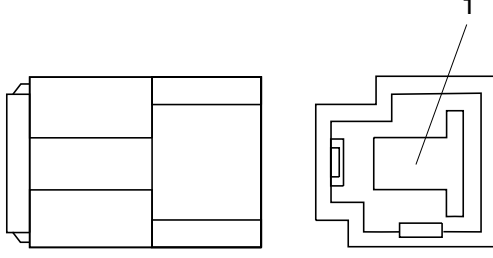
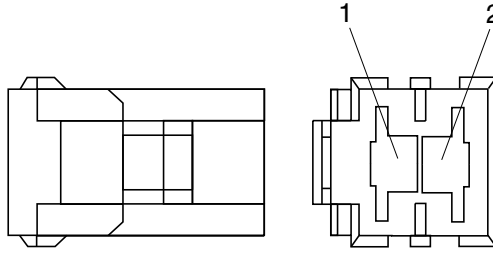
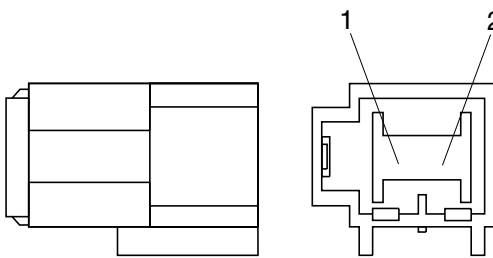
Connector number	Type	No. of pin	Destination	Connector part No.	
				Female	Male
CN-251	Ring term	-	RMS antenna	-	S820-106000
CN-252	-	1	ORBCOMM connector	TNJ-C-58	-
CN-253	-	1	GPS connector	SMA-C-316R/V	-
CN-381	DEUTSCH	2	DEF hose heating 1 (Pressure)	DT06-2S W2SB	-
CN-382	DEUTSCH	2	DEF hose heating 2 (Backflow)	DT06-2S W2SB	-
CN-383	DEUTSCH	2	DEF hose heating 3 (Suction line)	DT06-2S W2SB	-
CN-412	AMP	6	I/con (Fingertip harness - Main harness)	174262-2	174264-2
CN-413	AMP	6	I/con (Main harness - Fingertip harness)	174262-2	174264-2
CN-417	AMP	8	Fingertip harness	174982-2	174984-2
CN-AT1E	TYCO	4	DOC NOx sensor	2-1418390-1	-
CN-AT2A	AMP	4	SCR NOx sensor	1-1418390-1	-
CN-AT5	TYCO	12	DEF supply module	2-1703639-1	-
CN-AT9	TYCO	4	EGTS temperture sensor	4-1418390-1	-
CN-AT10A	DEUTSCH	4	DEF quality sensor	DT06-4S	-
CN-AT11	DELPHI	4	DPF diff pressure sensor	F715600	-
CN-C1	KET	2	CAN 1 harness	MG610320	MG640322
CN-C2	KET	2	CAN 2 harness	MG610320	MG640322
CN-C1D	DELPHI	14	Crossover connector	13533441	-
CN-C8D	DEUTSCH	4	Engine CAN connector	DT06-4S	-
CN-J27	TYCO	4	Coolant valve	1-967325-1	-
CN-J31	BOSCH	2	DEF dosing module	1-928405-522	-
Switch					
CS-1A	-	1	Door switch - RH	S822-014022	-
CS-1B	-	1	Door switch - LH	S822-014022	-
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-5B	Ring term	-	Center horn	-	S820-105000
CS-10	KET	1	Brake cooling switch	ST730018-3	-
CS-10	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-13	DEUTSCH	18	Gear slelctor (CAN)	DT16-18SA-K004	-
CS-14	-	2	2nd gear enable switch	-	-
CS-15	PACKARD	4	Gear selector switch	12015797	-
CS-15	KET	1	Gear selector switch	ST730018-3	-
CS-17	CARLING	10	Parking switch	21HN-56300	-
CS-20	KET	1	Side shift selector switch	ST730018-3	ST750036-3
CS-21	CARLING	10	Work lamp switch	21HN-56300	-
CS-39	CARLING	10	Main switch	21HN-56300	-

Connector number	Type	No. of pin	Destination	Connector part No.	
				Female	Male
CS-41	CARLING	10	Hazard switch	21HN-56300	-
CS-42	CARLING	10	Inching switch	21HN-56300	-
CS-59	CARLING	10	Auto/manual switch	21HN-56300	-
CS-64	CARLING	10	Inc/dec switch	21HN-56300	-
CS-72	DEUTSCH	2	Seat switch	DT06-2S	-
CS-74	CARLING	10	Fuel warmer switch	21HN-56300	-
CS-74	CARLING	10	Heated mirror switch	21HN-56300	-
CS-74	DEUTSCH	4	Tilt switch	-	DT04-4P
CS-77	CARLING	10	Tilt operation switch	21HN-56300	-
CS-79	CARLING	10	Engine mode switch	21HN-56300	-
CS-82	CARLING	10	Seat heat switch	21HN-56300	-
CS-92	KET	1	5-lever switch	ST730018-3	ST750036-3
CS-99	CARLING	10	Air compressor switch	21HN-56300	-
CS-100	CARLING	10	Exhaust system cleaning switch	21HN-56300	-
CS-103	CARLING	10	Top wiper switch	21HN-56300	-
CS-105	CARLING	10	Reverse fan switch	21HN-56300	-
Lamp					
CL-1	KET	2	Room lamp LH	MG610392	-
CL-3	DEUTSCH	6	Head lamp-LH	DT06-6S	-
CL-4	DEUTSCH	6	Head lamp-RH	DT06-6S	-
CL-5A	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	4	Rear combi lamp (Illum/stop, LH)	184050-2	-
CL-15B	AMP	4	Rear combi lamp (Turn/back up, LH)	184050-1	-
CL-16A	AMP	4	Rear combi lamp (Illum/stop, RH)	184050-2	-
CL-16B	AMP	4	Rear combi lamp (Turn/back up, RH)	184050-1	-
CL-21	KET	1	License lamp	ST730018-3	ST750036-3
CL-22	AMP	2	R/work lamp LH	174352-2	174354-2
CL-23	AMP	2	R/work lamp RH	174352-2	174354-2
CL-51	KET	2	Room lamp RH	MG610392	-
CL-55	CALRING	10	Power ON indicator	21HN-56300	-
Relay					
CR-1	KET	1	Battery relay coil	S820-308000	-
	KET	1	Battery relay coil	S820-104000	-
CR-4	AMP	5	Wiper high speed relay	VCFM-1002	-
CR-5	AMP	5	Safety start 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	-

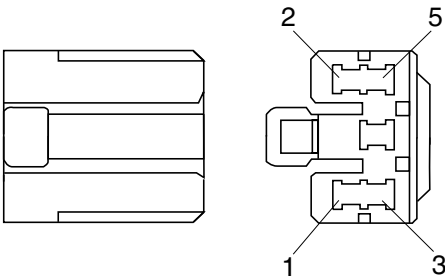
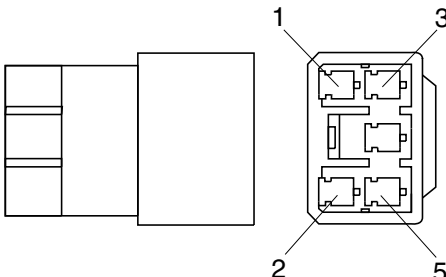
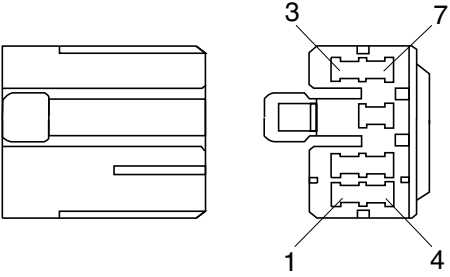
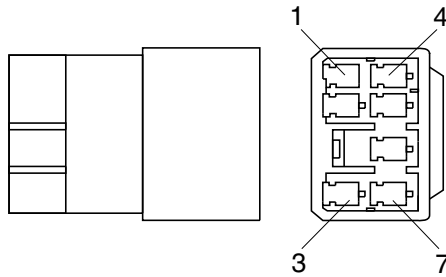
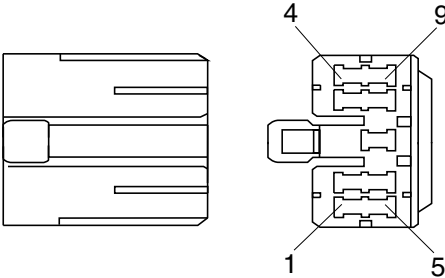
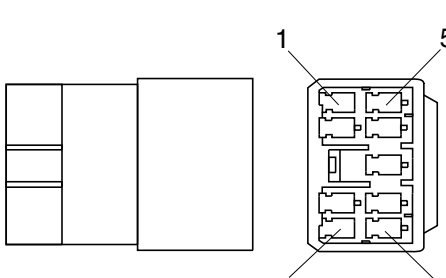
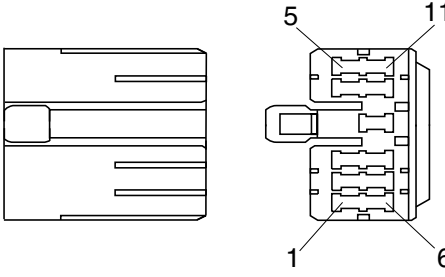
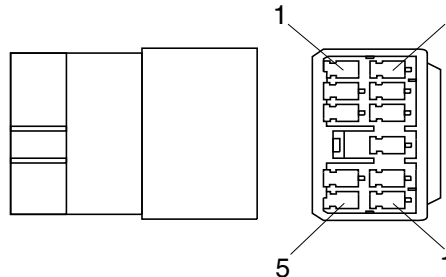
Connector number	Type	No. of pin	Destination	Connector part No.	
				Female	Male
CR-26	AMP	5	Wiper low speed relay	VCFM-1002	-
CR-36	AMP	5	Start aux relay	VCFM-1002	-
CR-38	AMP	5	Water pump relay	VCFM-1002	-
CR-39	AMP	5	Backup relay	VCFM-1002	-
CR-42	AMP	5	Preheat relay	VCFM-1002	-
CR-44	AMP	2	Cabin tilt relay	174352-2	-
CR-49	HELLA	5	Fuel warmer relay	8JA003536-001	-
CR-50	AMP	5	Travel cut relay	VCFM-1002	-
CR-52	AMP	5	Attach cut-off relay	VCFM-1002	-
CR-54	AMP	5	Reverse fan relay	VCFM-1002	-
CR-56	AMP	5	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	DEUTSCH	3	Fuel sender	DT06-3S-EP06	-
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-23	DEUTSCH	3	Load sensor (EPPR)	DT06-3S	-
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-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-87	KET	2	Ambient temp sensor	MG610320	-
CD-91	DEUTSCH	3	Loader sensor (weight)	DT06-3S	-
CD-96	PACKARD	3	Coolant level sensor	12110293	-
CD-102	FARMTIME	4	Engine TBAP sensor (Temp. Barometric Absolute Pressure)	54200415	-
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/QPL	2	Resistor (300Ω)	MG610043	21FT-10810

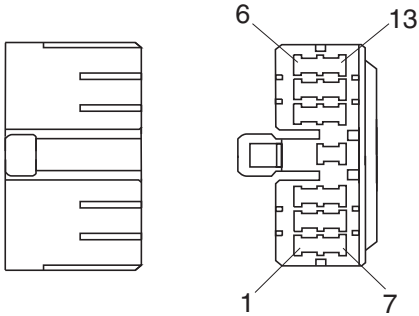
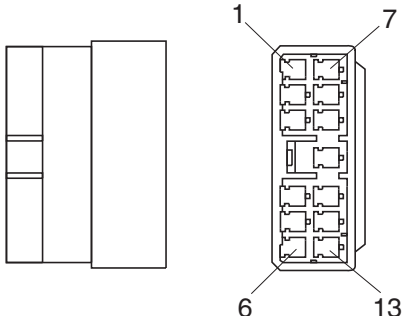
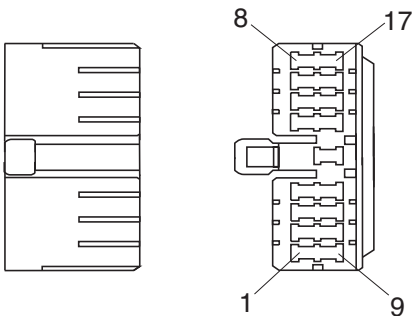
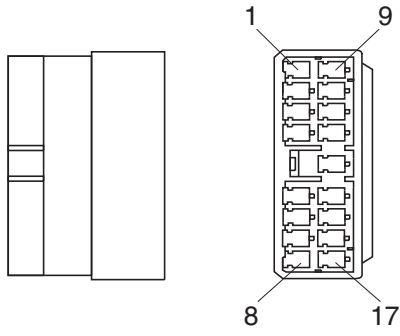
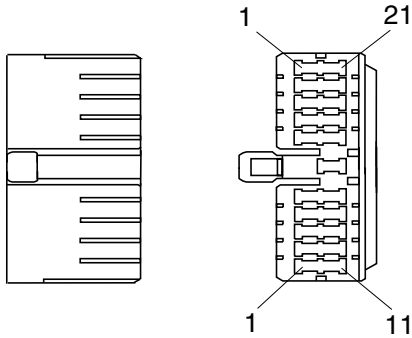
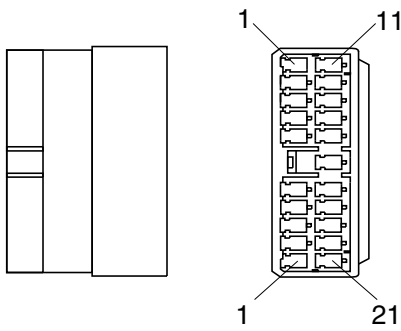
2. CONNECTION TABLE FOR CONNECTORS

1) 58-L TYPE CONNECTOR

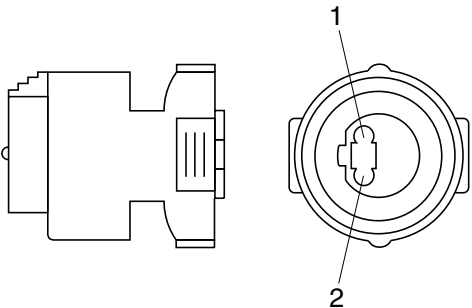
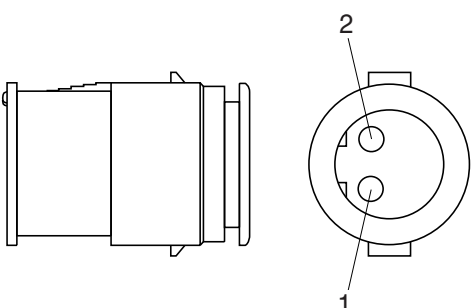
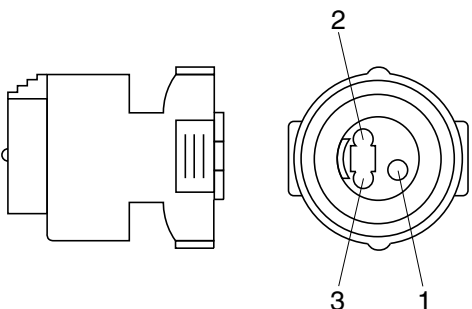
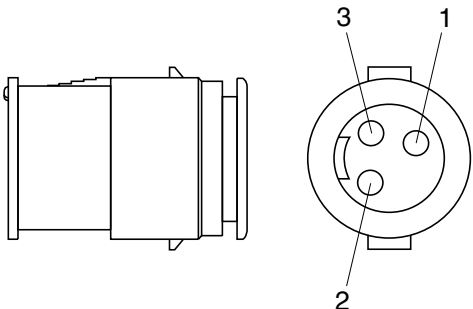
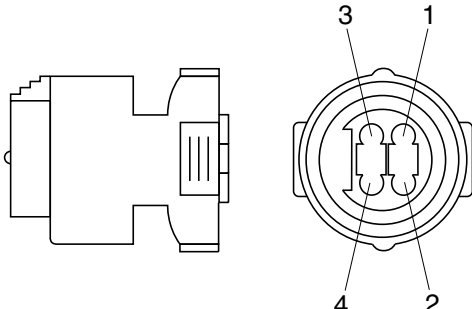
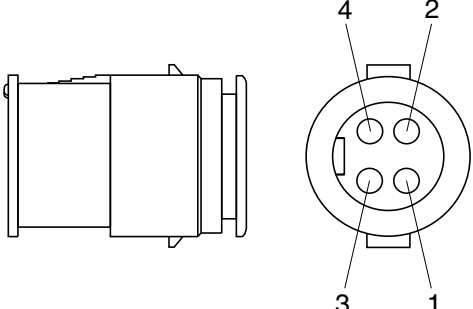
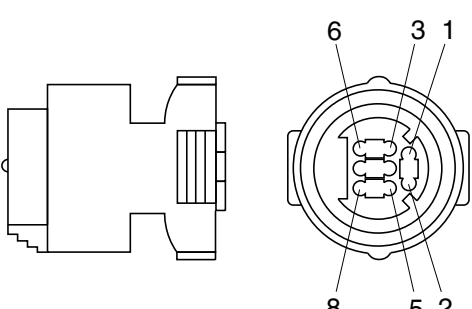
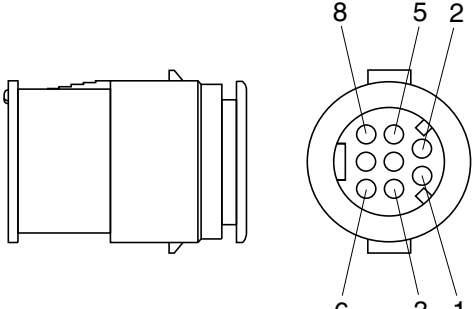
No. of pin	Receptacle connector (Female)	Plug connector (Male)
1	 S813-030100	 S813-130100
2	 S813-030200	 S813-130200

2) PA TYPE CONNECTOR

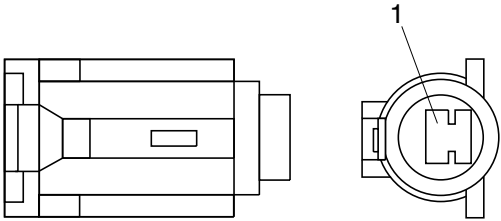
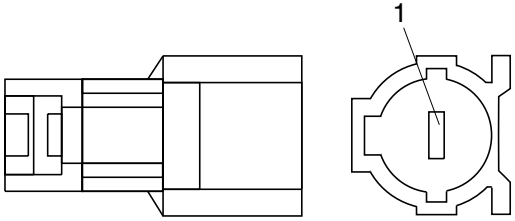
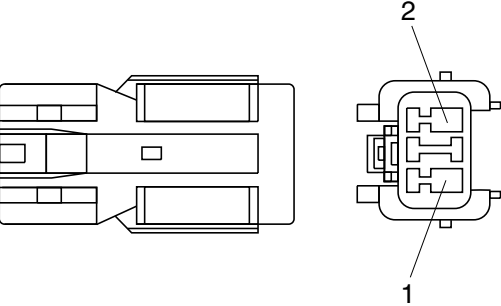
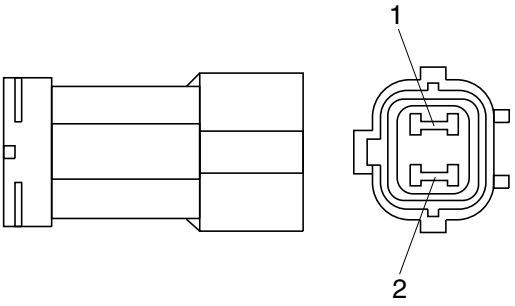
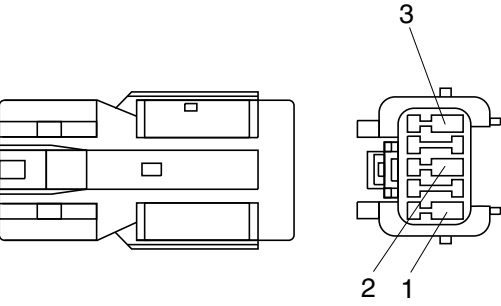
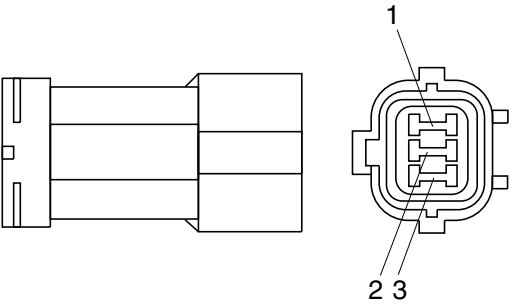
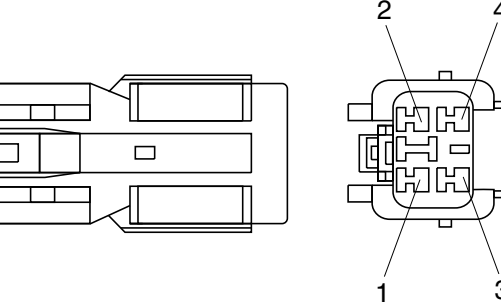
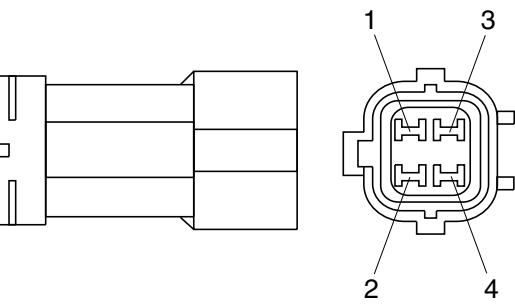
No. of pin	Receptacle connector (Female)	Plug connector (Male)
5	 <p>S811-005002</p>	 <p>S811-105002</p>
7	 <p>S811-007002</p>	 <p>S811-107002</p>
9	 <p>S811-009002</p>	 <p>S811-109002</p>
11	 <p>S811-011002</p>	 <p>S811-111002</p>

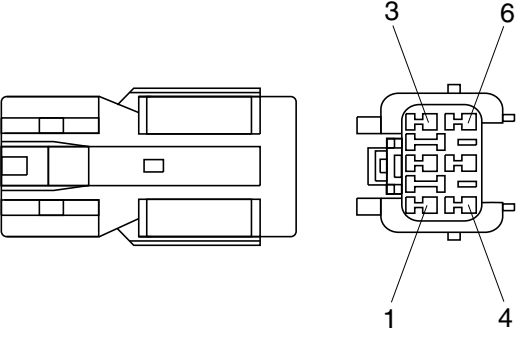
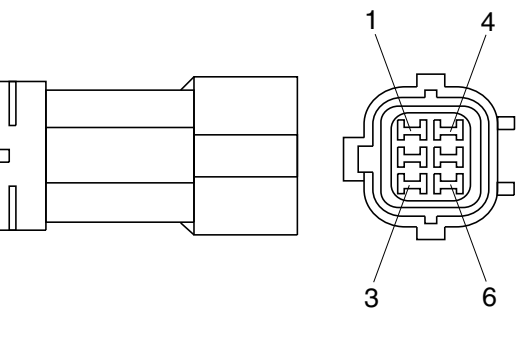
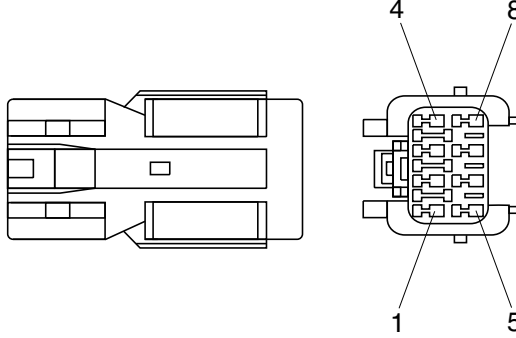
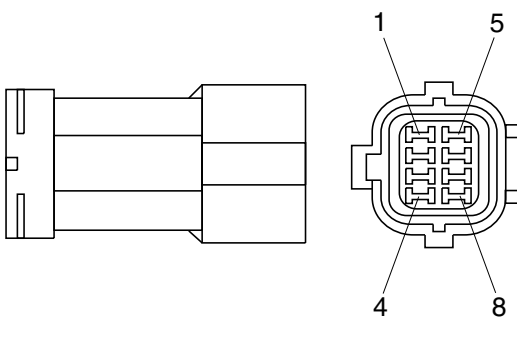
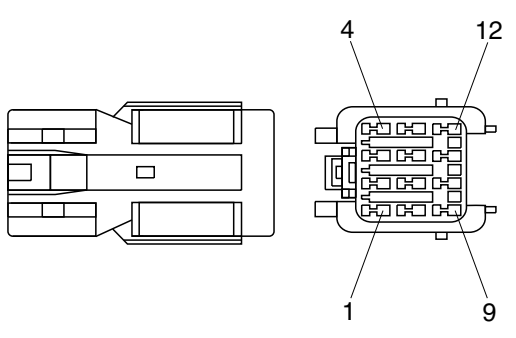
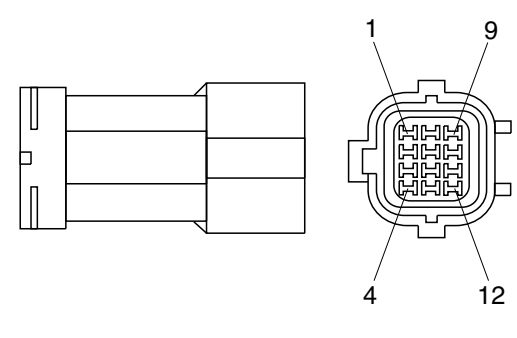
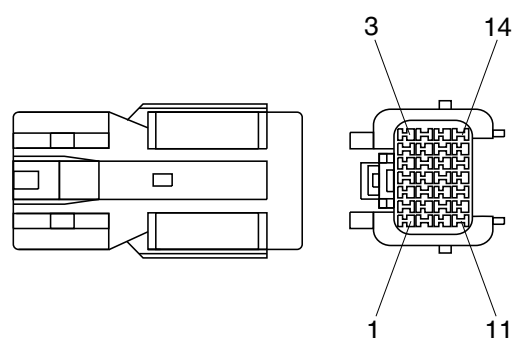
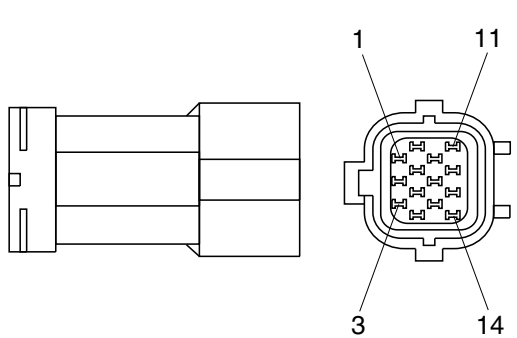
No. of pin	Receptacle connector (Female)	Plug connector (Male)
13	 <p>S811-013002</p>	 <p>S811-113002</p>
17	 <p>S811-017002</p>	 <p>S811-117002</p>
21	 <p>S811-021002</p>	 <p>S811-121002</p>

3) J TYPE CONNECTOR

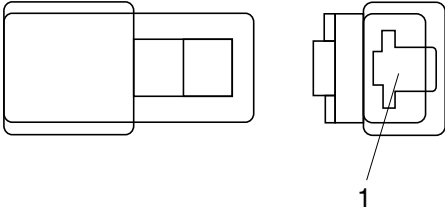
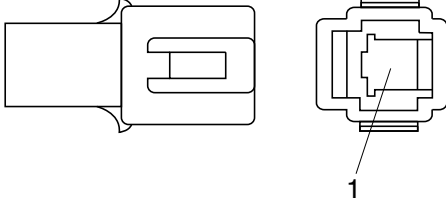
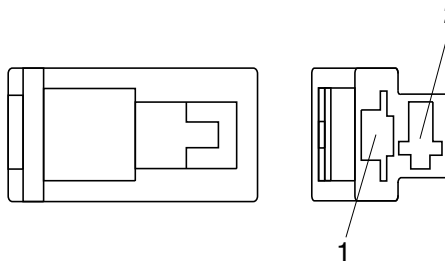
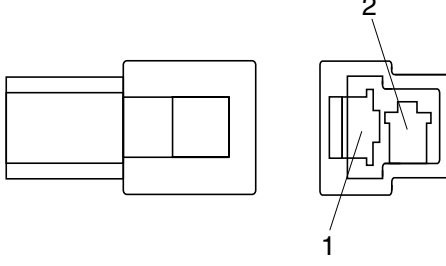
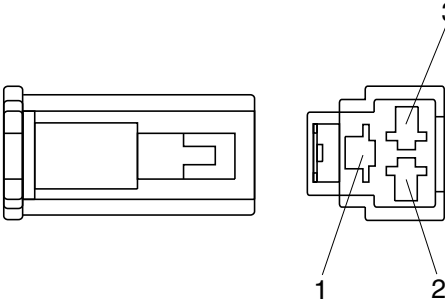
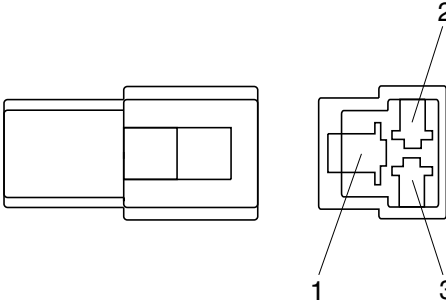
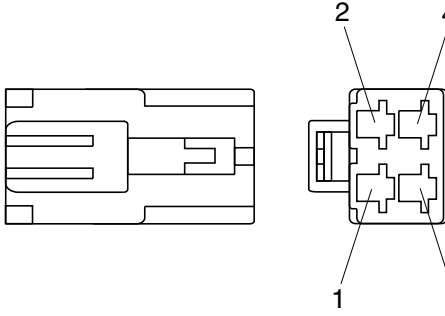
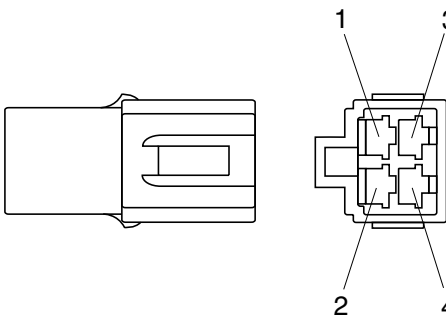
No. of pin	Receptacle connector (Female)	Plug connector (Male)
2	 <p>S816-002001</p>	 <p>S816-102001</p>
3	 <p>S816-003001</p>	 <p>S816-103001</p>
4	 <p>S816-004001</p>	 <p>S816-104001</p>
8	 <p>S816-008001</p>	 <p>S816-108001</p>

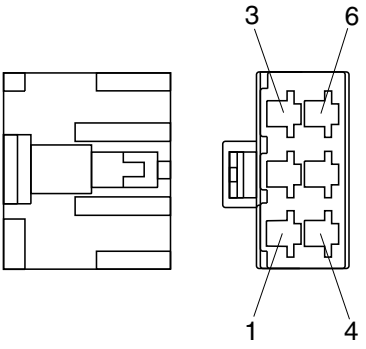
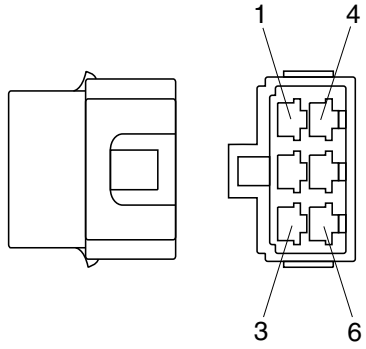
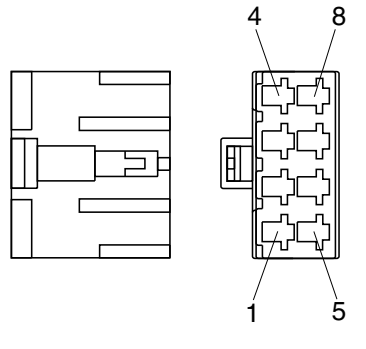
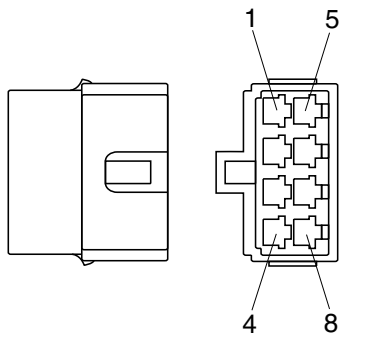
4) SWP TYPE CONNECTOR

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

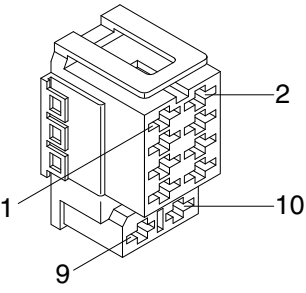
No. of pin	Receptacle connector (Female)	Plug connector (Male)
6	 <p data-bbox="686 627 837 660">S814-006000</p>	 <p data-bbox="1260 627 1412 660">S814-106000</p>
8	 <p data-bbox="686 1030 837 1064">S814-008000</p>	 <p data-bbox="1260 1030 1412 1064">S814-108000</p>
12	 <p data-bbox="686 1433 837 1467">S814-012000</p>	 <p data-bbox="1260 1433 1412 1467">S814-112000</p>
14	 <p data-bbox="686 1836 837 1870">S814-014000</p>	 <p data-bbox="1260 1836 1412 1870">S814-114000</p>

5) CN TYPE CONNECTOR

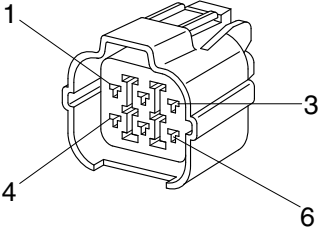
No. of pin	Receptacle connector (Female)	Plug connector (Male)
1	 <p>S810-001202</p>	 <p>S810-101202</p>
2	 <p>S810-002202</p>	 <p>S810-102202</p>
3	 <p>S810-003202</p>	 <p>S810-103202</p>
4	 <p>S810-004202</p>	 <p>S810-104202</p>

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

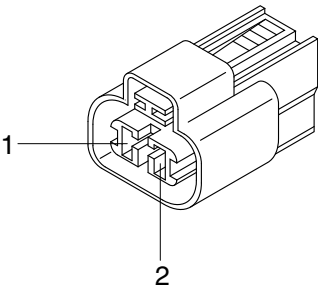
6) ITT SWF CONNECTOR

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	

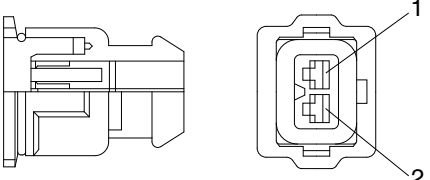
8) MWP02F-B CONNECTOR

No. of pin	Receptacle connector (Female)	Plug connector (Male)
2	 PH805-02028	

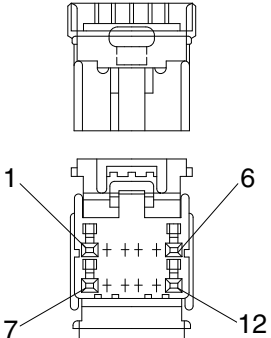
9) AMP ECONOSEAL CONNECTOR

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

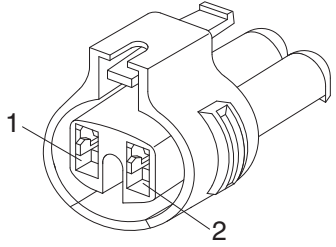
10) AMP TIMER CONNECTOR

No. of pin	Receptacle connector(Female)	Plug connector(Male)
2	 85202-1	

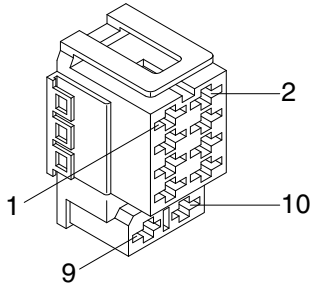
11) AMP 040 MULTILOCK CONNECTOR

No. of pin	Receptacle connector(Female)	Plug connector(Male)
12	 174045-2	

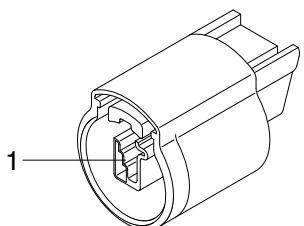
12)KET 090 WP CONNECTORS

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

13)ITT SWF CONNECTOR

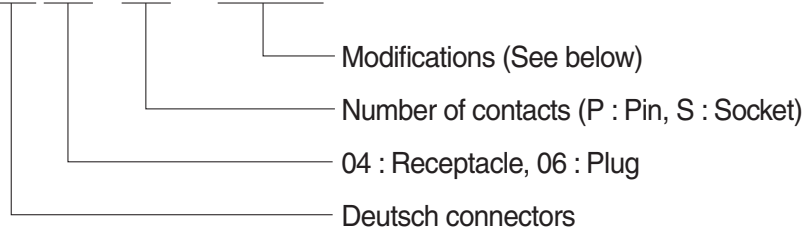
No. of pin	Receptacle connector (Female)	Plug connector (Male)
10	 <p>SWF593757</p>	

14)MWP NMWP CONNECTOR

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

15) DEUTSCH DT CONNECTORS

DT 06 - 3S - ★★★★★



※ Modification

E003 : Standard end cap - gray

E004 : Color of connector to be black

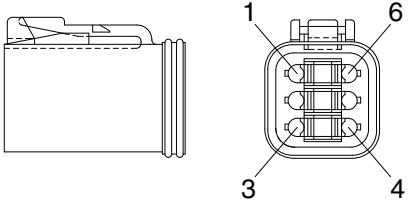
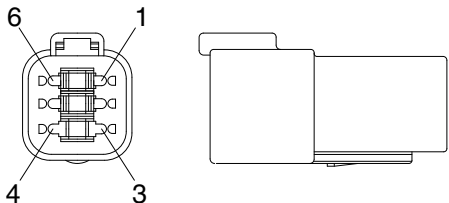
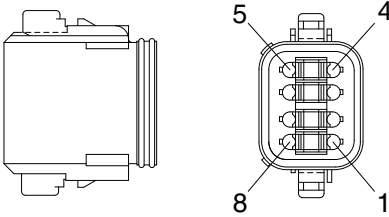
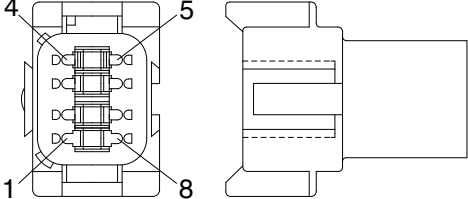
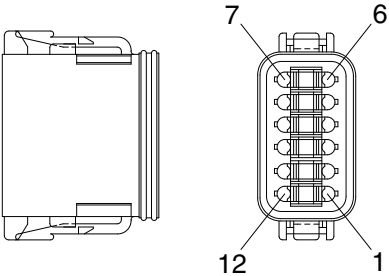
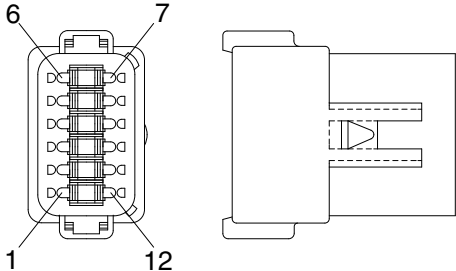
E005 : Combination - E004 & E003

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	<p>DT06-2S</p>	<p>DT04-2P</p>
3	<p>DT06-3S</p>	<p>DT04-3P</p>
4	<p>DT06-4S</p>	<p>DT04-4P</p>

No. of pin	Receptacle connector(Female)	Plug connector(Male)
6	 <p>DT06-6S</p>	 <p>DT04-6P</p>
8	 <p>DT06-8S</p>	 <p>DT04-8P</p>
12	 <p>DT06-12S</p>	 <p>DT04-12P</p>

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

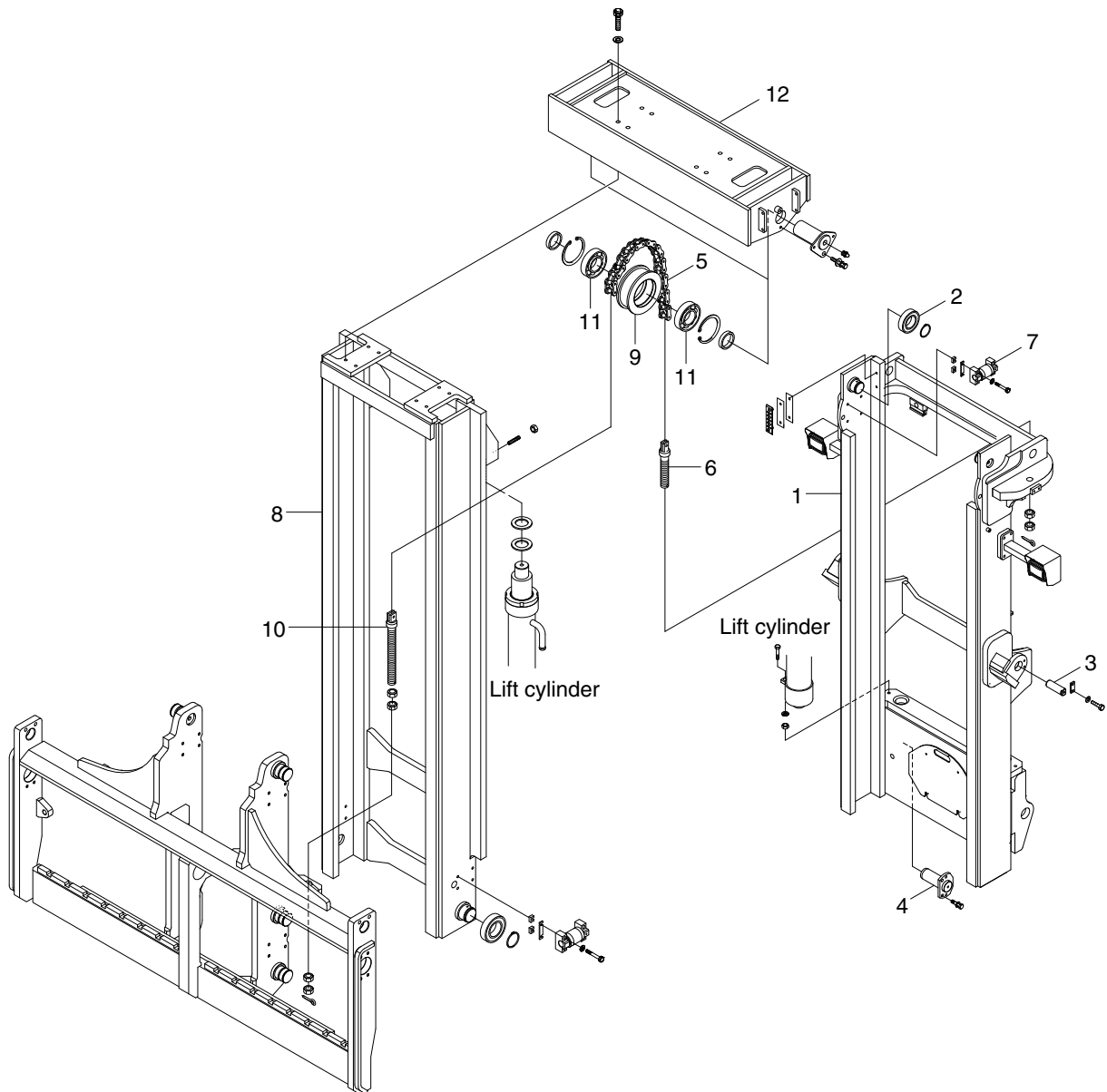
SECTION 8 MAST



Group 1 Structure	8-1
Group 2 Operational checks and troubleshooting	8-4
Group 3 Adjustment	8-7
Group 4 Removal and Installation	8-9

GROUP 1 STRUCTURE

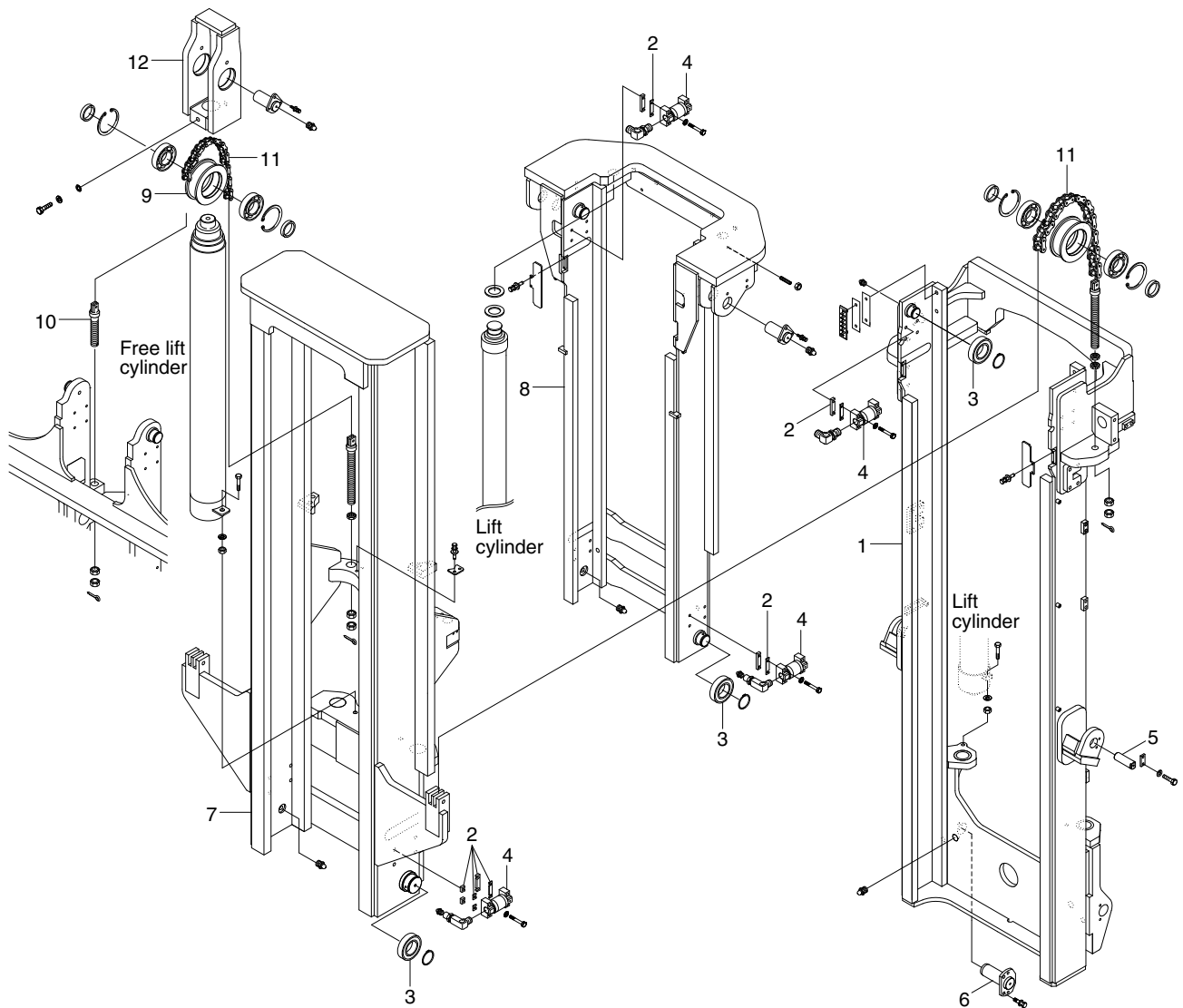
1. 2 STAGE MAST (V MAST)



160D9VMS01

- | | | | | | |
|---|-------------------|---|---------------------|----|----------------------|
| 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 | 12 | Cross member |

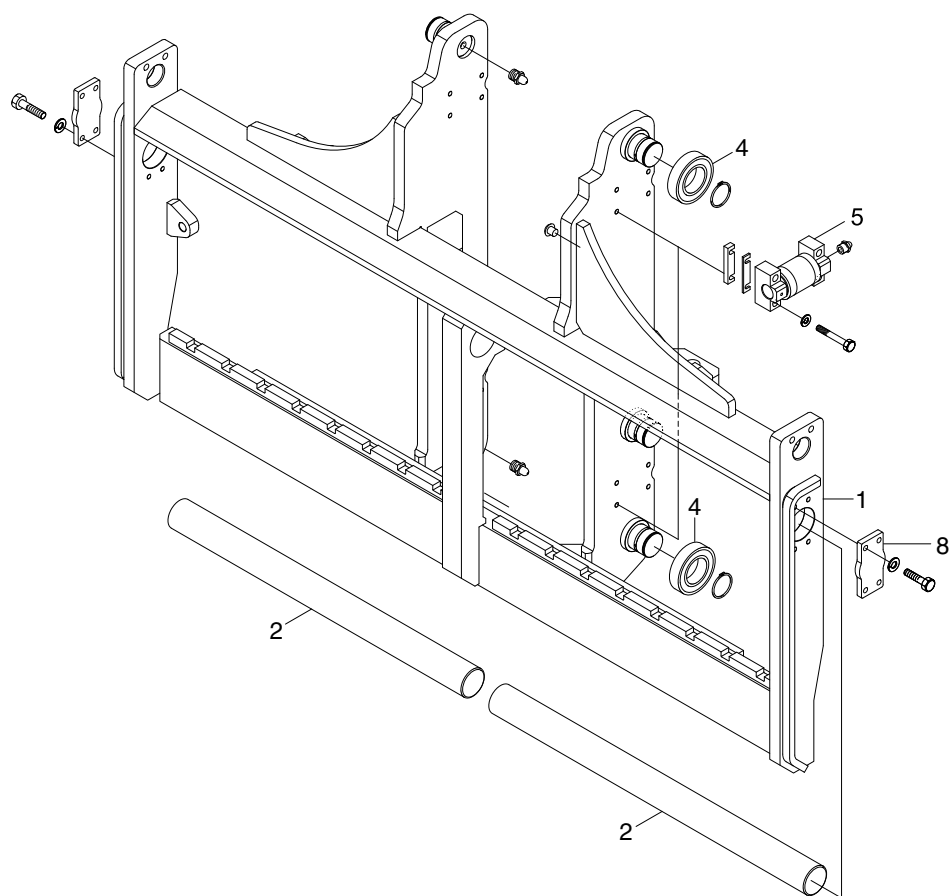
2. 3 STAGE MAST (TS MAST)



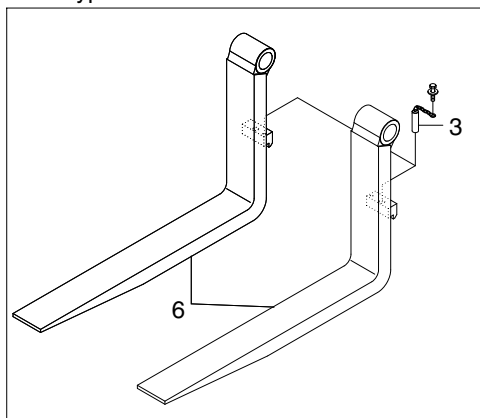
160D9VMS05

- | | | | | | |
|---|---------------------|---|-------------------|----|----------------|
| 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 |

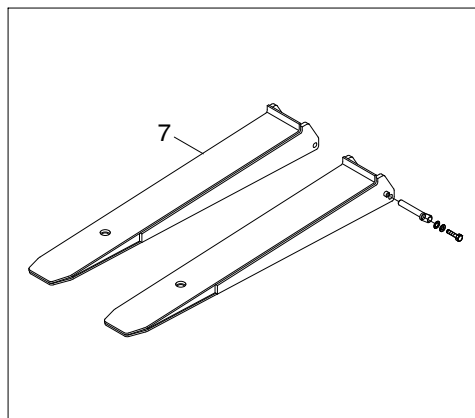
3. CARRIAGE, BACKREST AND FORK (SHAFT TYPE)



Shaft type fork



Extension fork



160D9VMS02

- 1 Carriage & backrest
- 2 Hanger bar
- 3 Fork retaining
- 4 Roller

- 5 Side roller
- 6 Fork
- 7 Extension fork
- 8 Cover

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

1. OPERATIONAL CHECKS

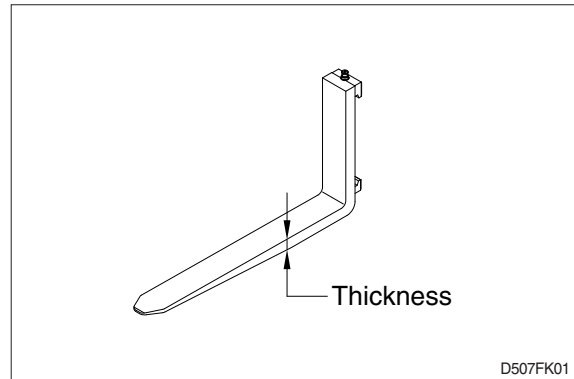
1) FORKS

- (1) Measure thickness of root of forks and check that it is more than specified value.

EX : $\ell = 1800$ mm (71 in)

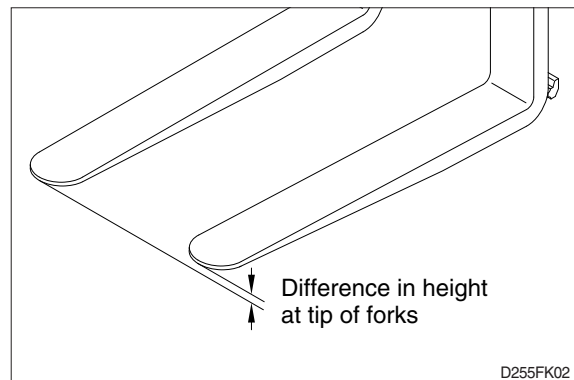
mm (in)

STD Fork assy	Applicable model	Standard	Limit
61FT-70342	120D-9V	75(3.0)	68(2.7)
61FT-71440	130D-9V	90(3.5)	80(3.2)
61FT-70143	160D-9V	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)
120D-9V 130D-9V 160D-9V	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 lowered.	· 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

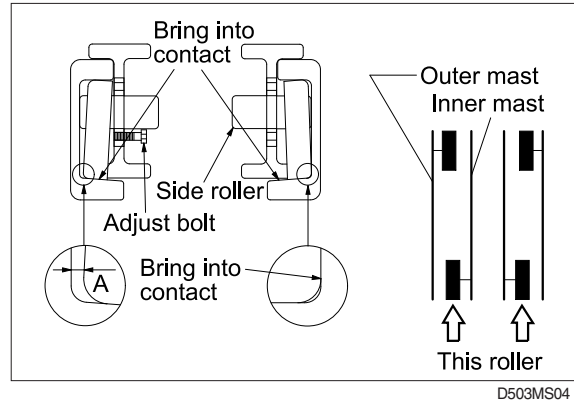
Problem	Cause	Remedy
Abrasion	<p>Long-time operations causes the fork to wear and reduces the thickness of the fork.</p> <p>Inspection for thickness is needed.</p> <ul style="list-style-type: none"> · Wear limit : Must be 90% of fork thickness 	If the measured value is below the wear limit, replace fork.
Distortion	<p>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.</p> <ul style="list-style-type: none"> · Difference in fork tip height : 15 mm · Difference in fork tip width : 35 mm 	If the measured value exceeds the allowance, replace fork.
Fatigue	<p>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.</p> <ul style="list-style-type: none"> · Crack on the fork heel. · Crack on the fork weldments. 	<p>Repair fork by expert.</p> <p>In case of excessive distortion, replace fork.</p>

GROUP 3 ADJUSTMENT

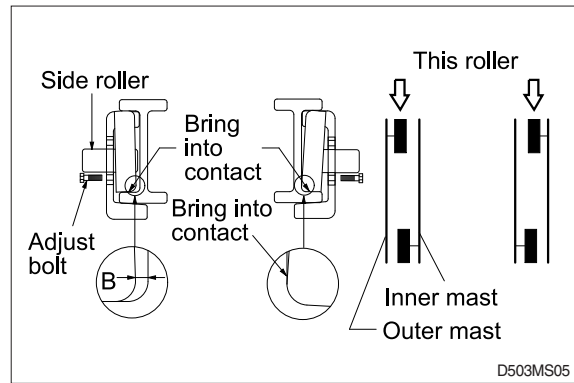
1. MAST LOAD ROLLER

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

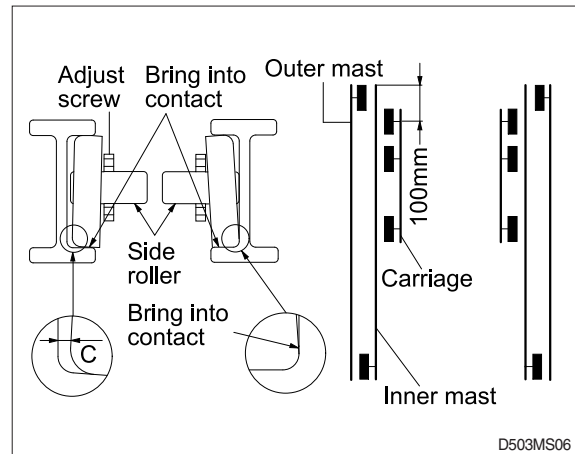


- (3) Distribute the roller clearance equally to the left and right roller.
- (4) After the adjustment, check that the inner mast moves smoothly in the outer mast.



2) CARRIAGE LOAD ROLLER

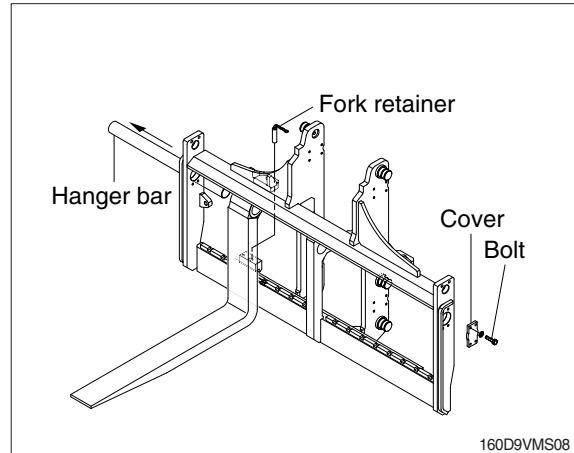
- (1) Measure the clearance when the center of the carriage upper roller is 100 mm from the top of the inner mast.
- (2) Measure the clearance at upper, middle and lower rollers after loosen the adjust screws from the side rollers. Shift the carriage to one side to bring the roller into contact with 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 $C = 0 \sim 0.6 \text{ mm}$
- (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)

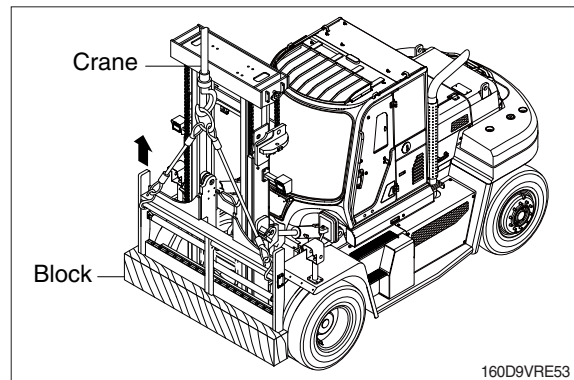
- (1) Lower the fork carriage until the forks are approximately 25 mm (1 in) from the floor.
- (2) Release fork anchor pins and slide one fork at a time toward the center of the carriage where a notch has been cut in the bottom plate for easy fork removal.
- (3) Remove only one fork at a time.
 - ※ On larger forks it may be necessary to use a block of wood.
- (4) Reverse the above procedure to install load forks.



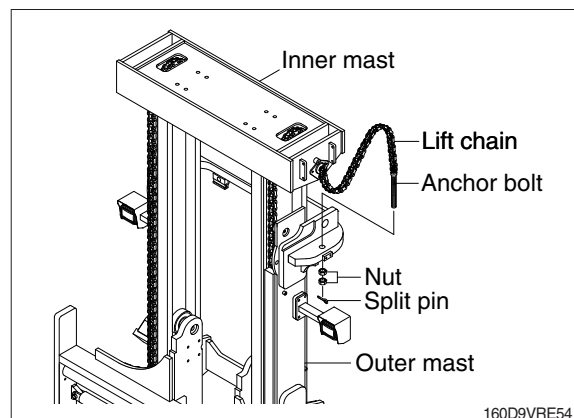
2. CARRIAGE ASSEMBLY

1) CARRIAGE

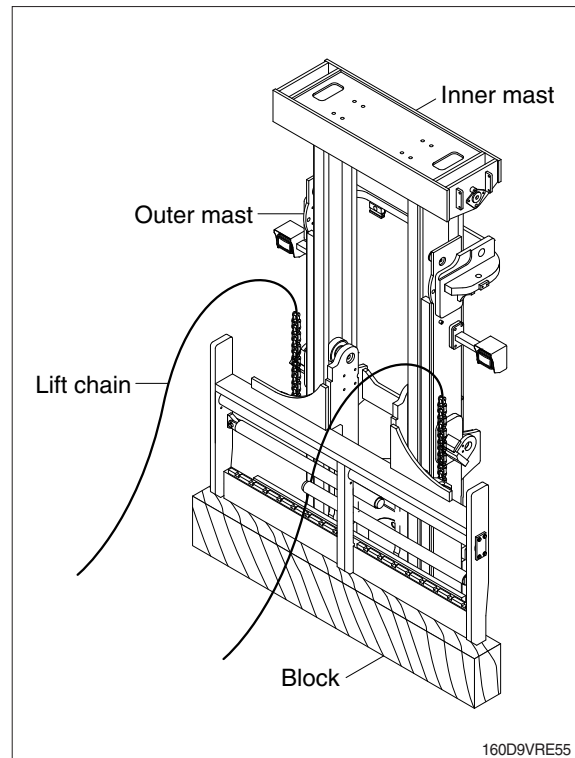
- (1) With the mast vertical, raise the carriage high enough to place blocks under the load forks. This is done to create slack in the load chains when the carriage is lowered. Lower the carriage all the way down to the floor. Make sure the carriage is level, this will prevent any binding when the mast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



- (2) While supporting lift chains, remove the split pin and slide out chain anchor pins from the chain anchors of stationary upright.



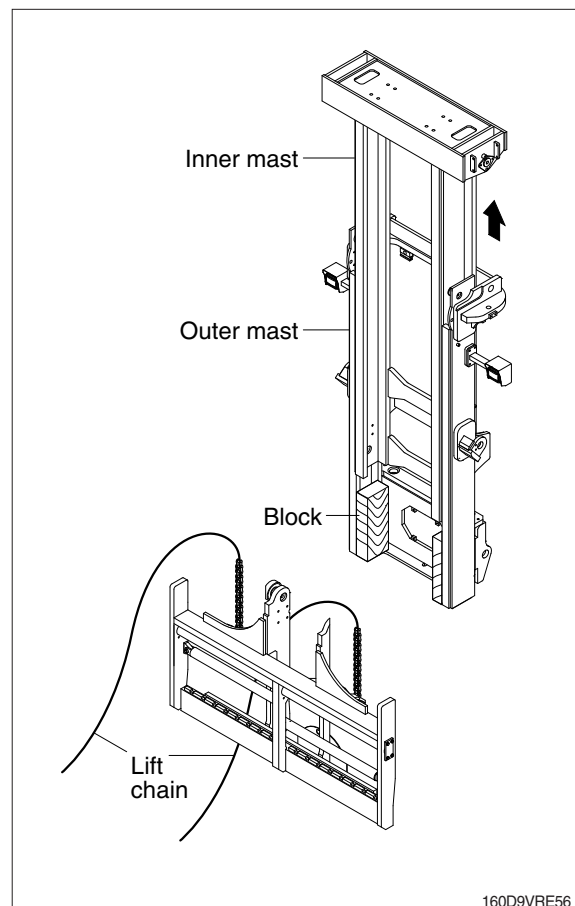
- (3) Pull the chains out of the sheaves and drape them over the front of the carriage.
- (4) Disconnect connector from the work lamp Assy.



- (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.

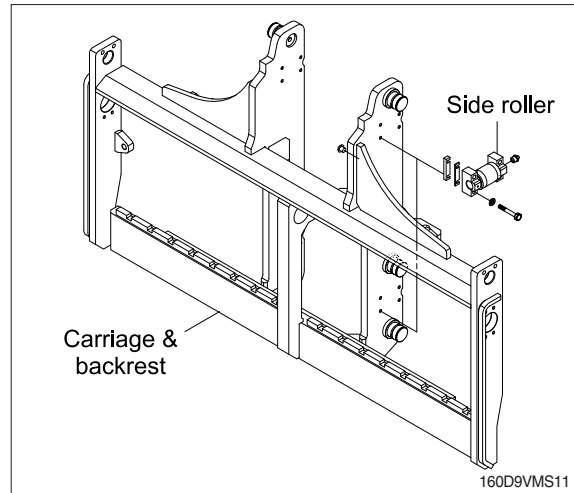


2) SIDE ROLLER

- (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.

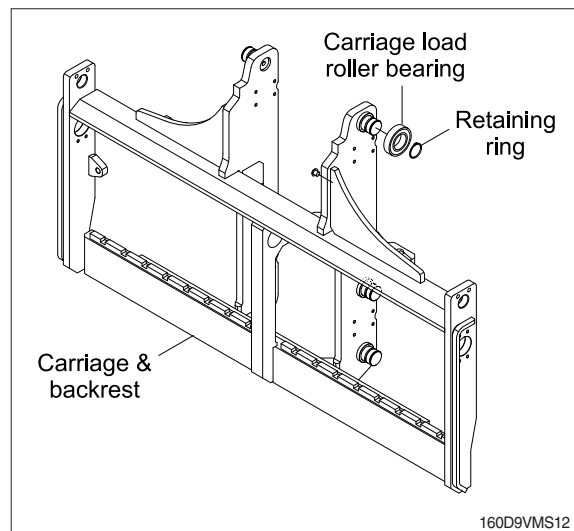
※ Adjustment

- 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 assembly. 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

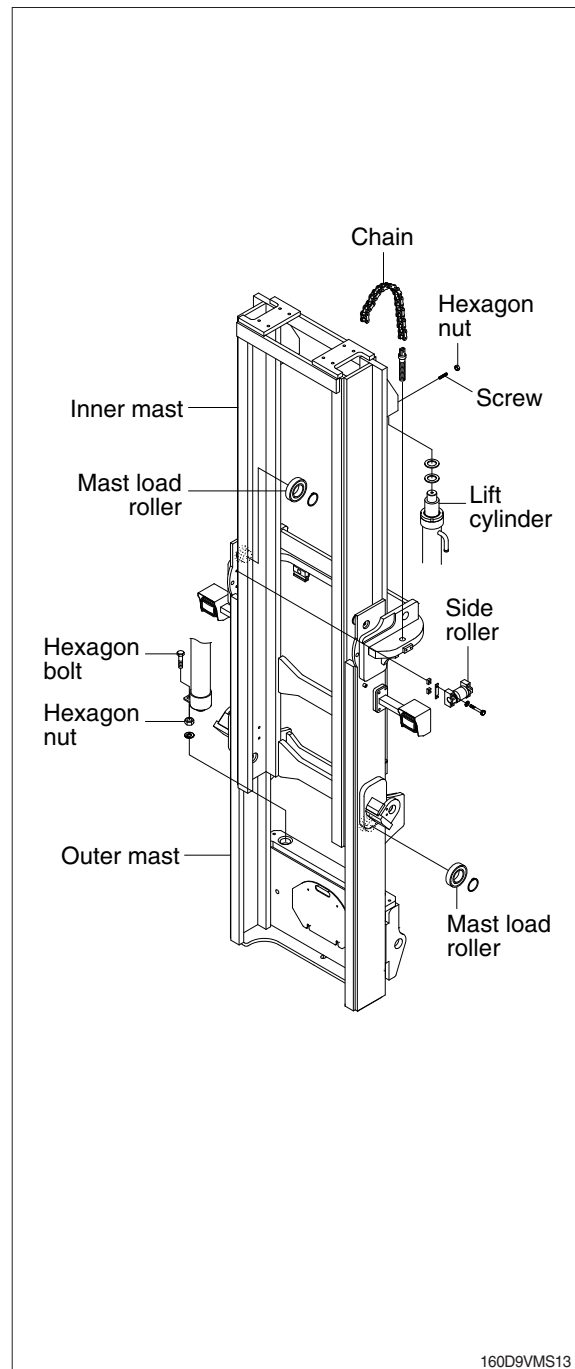
(10) paragraph.

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.

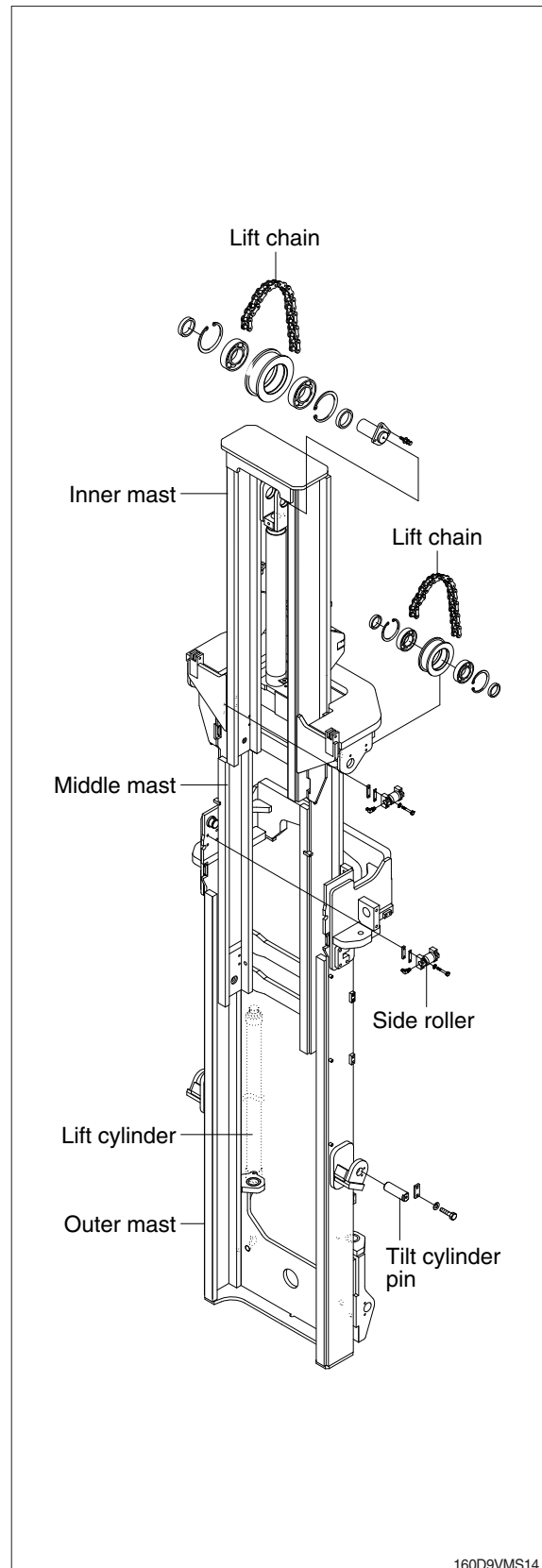
Make all necessary measurements and adjustments.



160D9VMS13

2) 3 STAGE MAST (TS 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 ADJ-USTMENT Paragraph.



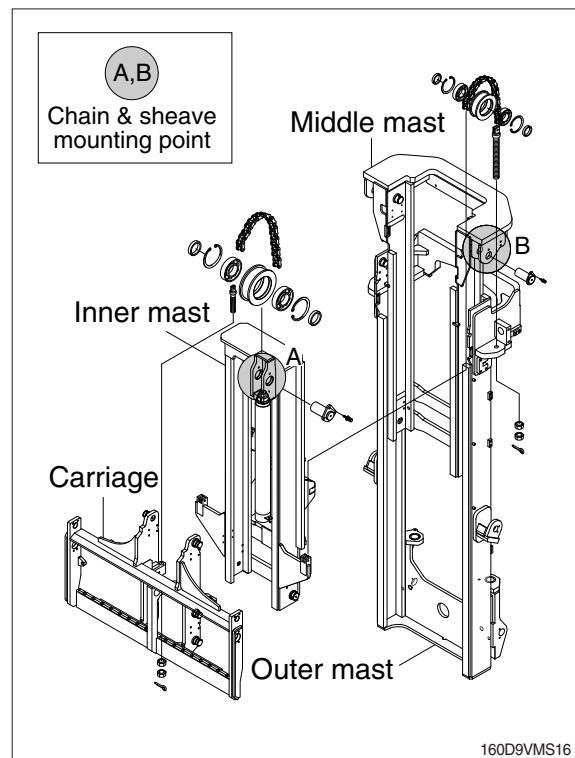
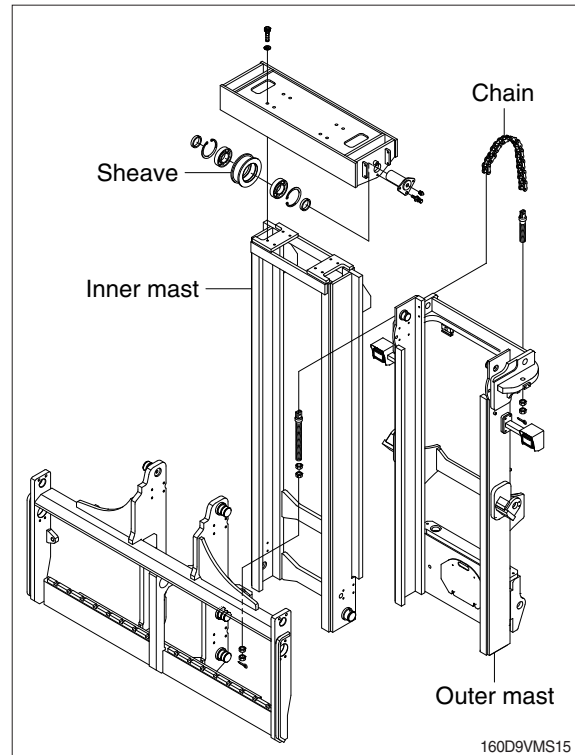
5. CHAIN

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.

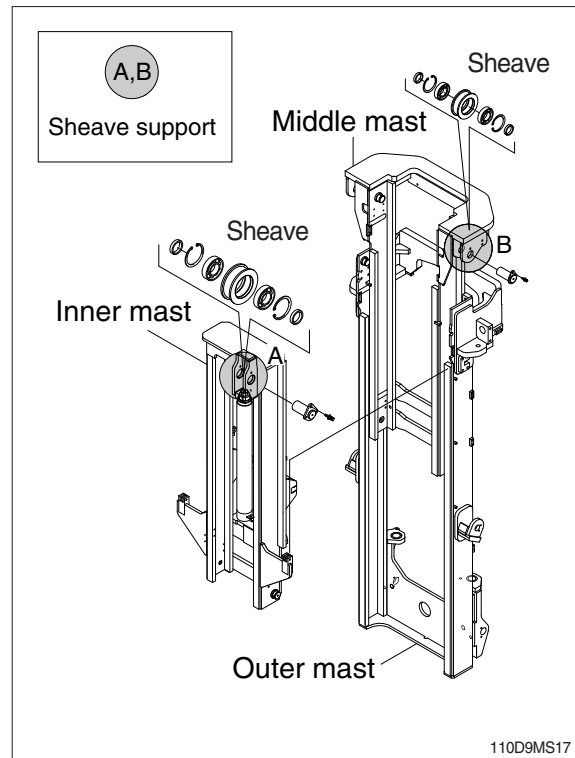
2) REAR CHAIN SHEAVE (TS MAST)

- (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.



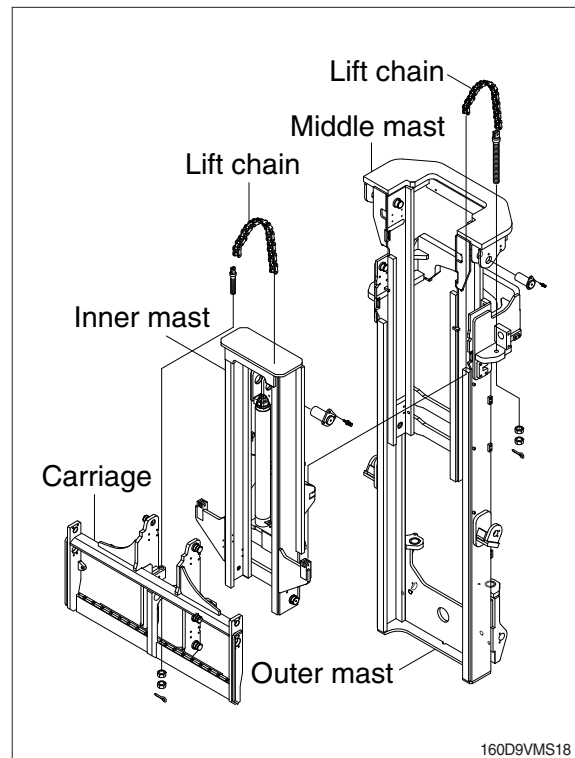
3) SHEAVE SUPPORT (TS MAST)

- (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.



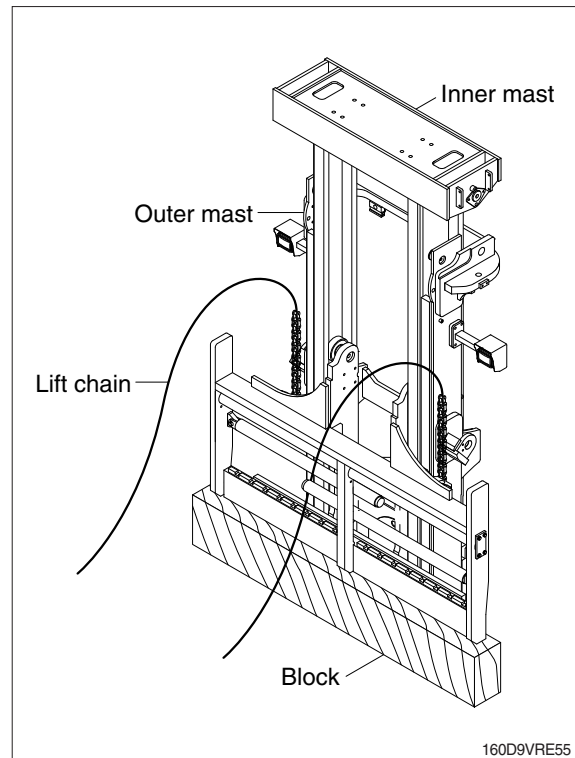
4) REAR CHAIN (TS MAST)

- (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 pins 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.



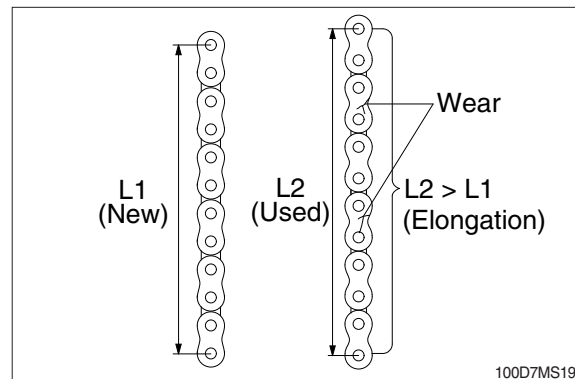
6) LOAD CHAIN INSPECTION AND MAINTENANCE

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.



(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 joints 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.