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1. STRUCTURE

This service manual has been prepared as an aid to improve the quality of repairs by giving the serviceman an accurate understanding of the product and by showing him the correct way to perform repairs and make judgements. Make sure you understand the contents of this manual and use it to full effect at every opportunity.
This service manual mainly contains the necessary technical information for operations performed in a service workshop.
For ease of understanding, the manual is divided into the following sections.

SECTION 1 GENERAL
This section gives the general information of the machine and explains the safety hints for maintenance.

SECTION 2 REMOVAL & INSTALLATION OF UNIT
This section explains the procedures and techniques of removal and installation of each component.

SECTION 3 POWER TRAIN SYSTEM
This section explains the structure of the transmission as well as control valve and drive axle.

SECTION 4 BRAKE SYSTEM
This section explains the brake piping, each component and operation.

SECTION 5 STEERING SYSTEM
This section explains the structure of the steering unit, priority valve, trail axle as well as steering circuit and operation.

SECTION 6 HYDRAULIC SYSTEM
This section explains the structure of the gear pump, main control valve as well as work equipment circuit, each component and operation.

SECTION 7 ELECTRICAL SYSTEM
This section explains the electrical circuit and each component.
It serves not only to give an understanding electrical system, but also serves as reference material for troubleshooting.

SECTION 8 MAST
This section explains the structure of mast, carriage, backrest and forks.

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

2. HOW TO READ THE SERVICE MANUAL

Distribution and updating

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

Filing method

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

Revised edition mark(①②③…)

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

Revisions

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

Symbols

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

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

3. CONVERSION TABLE

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

Example

1. Method of using the Conversion Table to convert from millimeters to inches
   Convert 55mm into inches.

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

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

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

2. Convert 550mm into inches.

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

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

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

Millimeters to inches ⓑ 1mm = 0.03937 in

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

Millimeters to inches

1mm = 0.03937in

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

Kilogram to Pound

1kg = 2.2046lb

	0	1	2	3	4	5	6	7	8	9
0		2.20	4.41	6.61	8.82	11.02	13.23	15.43	17.64	19.84
10	22.05	24.25	26.46	28.66	30.86	33.07	35.27	37.48	39.68	41.89
20	44.09	46.30	48.50	50.71	51.91	55.12	57.32	59.5.	61.73	63.93
30	66.14	68.34	70.55	72.75	74.96	77.16	79.37	81.57	83.78	85.98
40	88.18	90.39	92.59	94.80	97.00	99.21	101.41	103.62	105.82	108.03
50	110.23	112.44	114.64	116.85	119.05	121.25	123.46	125.66	127.87	130.07
60	132.28	134.48	136.69	138.89	141.10	143.30	145.51	147.71	149.91	152.12
70	154.32	156.53	158.73	160.94	163.14	165.35	167.55	169.76	171.96	174.17
80	176.37	178.57	180.78	182.98	185.19	187.39	189.60	191.80	194.01	196.21
90	198.42	200.62	202.83	205.03	207.24	209.44	211.64	213.85	216.05	218.26

Liter to U.S. Gallon

1 l = 0.2642 U.S.Gal

	0	1	2	3	4	5	6	7	8	9
0		0.264	0.528	0.793	1.057	1.321	1.585	1.849	2.113	2.378
10	2.642	2.906	3.170	3.434	3.698	3.963	4.227	4.491	4.755	5.019
20	5.283	5.548	5.812	6.6076	6.340	6.604	6.869	7.133	7.397	7.661
30	7.925	8.189	8.454	8.718	8.982	9.246	9.510	9.774	10.039	10.303
40	10.567	10.831	11.095	11.359	11.624	11.888	12.152	12.416	12.680	12.944
50	13.209	13.473	13.737	14.001	14.265	14.529	14.795	15.058	15.322	15.586
60	15.850	16.115	16.379	16.643	16.907	17.171	17.435	17.700	17.964	18.228
70	18.492	18.756	19.020	19.285	19.549	19.813	20.077	20.341	20.605	20.870
80	21.134	21.398	21.662	21.926	22.190	22.455	22.719	22.983	23.247	23.511
90	23.775	24.040	24.304	24.568	24.832	25.096	25.631	25.625	25.889	26.153

Liter to U.K. Gallon

1 l = 0.21997 U.K.Gal

	0	1	2	3	4	5	6	7	8	9
0		0.220	0.440	0.660	0.880	1.100	1.320	1.540	1.760	1.980
10	2.200	2.420	2.640	2.860	3.080	3.300	3.520	3.740	3.950	4.179
20	4.399	4.619	4.839	5.059	5.279	5.499	5.719	5.939	6.159	6.379
30	6.599	6.819	7.039	7.259	7.479	7.969	7.919	8.139	8.359	8.579
40	8.799	9.019	9.239	9.459	9.679	9.899	10.119	10.339	10.559	10.778
50	10.998	11.281	11.438	11.658	11.878	12.098	12.318	12.528	12.758	12.978
60	13.198	13.418	13.638	13.858	14.078	14.298	14.518	14.738	14.958	15.178
70	15.398	15.618	15.838	16.058	16.278	16.498	16.718	16.938	17.158	17.378
80	17.598	17.818	18.037	18.257	18.477	18.697	18.917	19.137	19.357	19.577
90	19.797	20.017	20.237	20.457	20.677	20.897	21.117	21.337	21.557	21.777

kgf · m to lbf · ft

1kgf · m = 7.233lbf · ft

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

kgf/cm^2 to lbf/in^2

1kgf / cm^2 = 14.2233lbf / in^2

	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

TEMPERATURE

Fahrenheit-Centigrade Conversion.

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

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

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

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

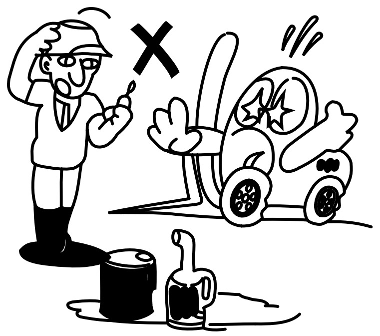
°C		°F	°C		°F	°C		°F	°C		°F
-40.4	-40	-40.0	-11.7	11	51.8	7.8	46	114.8	27.2	81	117.8
-37.2	-35	-31.0	-11.1	12	53.6	8.3	47	116.6	27.8	82	179.6
-34.4	-30	-22.0	-10.6	13	55.4	8.9	48	118.4	28.3	83	181.4
-31.7	-25	-13.0	-10.0	14	57.2	9.4	49	120.2	28.9	84	183.2
-28.9	-20	-4.0	-9.4	15	59.0	10.0	50	122.0	29.4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

SECTION 1 GENERAL

GROUP 1 SAFETY HINTS

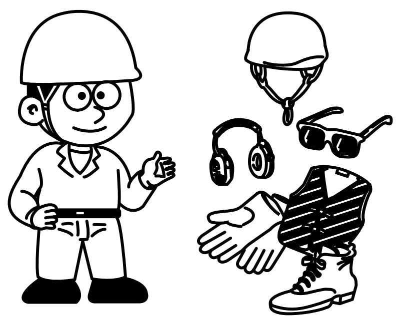
Careless performing of the easy work may cause injuries.
Take care to always perform work safely, at least observing the following.

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



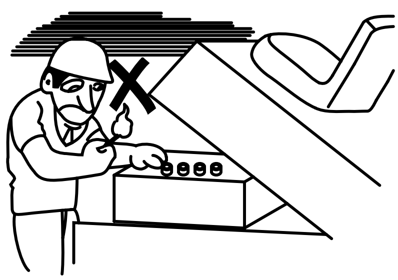
D50ASF01

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



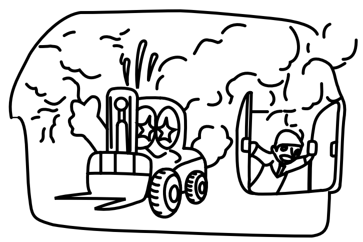
D50ASF02

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



D50ASF03

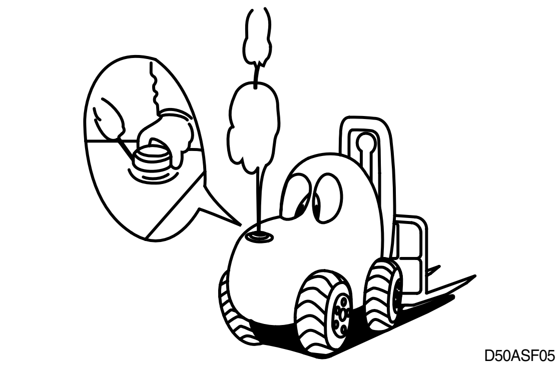
- Exhaust gas is dangerous. Provide adequate ventilation when working a closed space.



D50ASF04

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

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



D50ASF05

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

D50ASF06

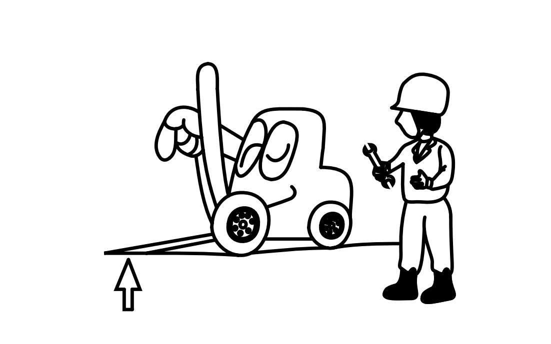
· Hand a caution sign in the operator's compartment (For example **Do not start** or **Maintenance in progress**).
This will prevent anyone from starting or moving the machine by mistake.

⚠ **It is extremely dangerous to try to check the fan belt tension while he engine is running.**

D50ASF07

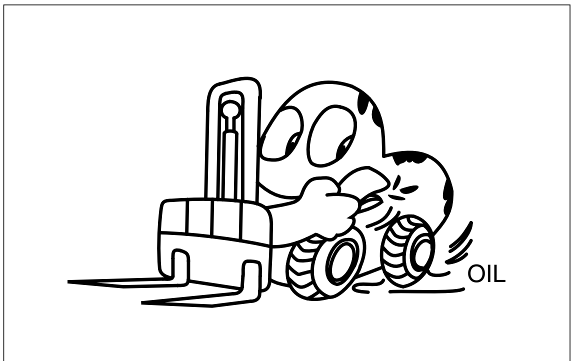
When inspecting the engine is running parts, or near such parts, always stop the engine first.
Before checking or servicing accumulator or piping, depress brake pedal repeatedly to release pressure.

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



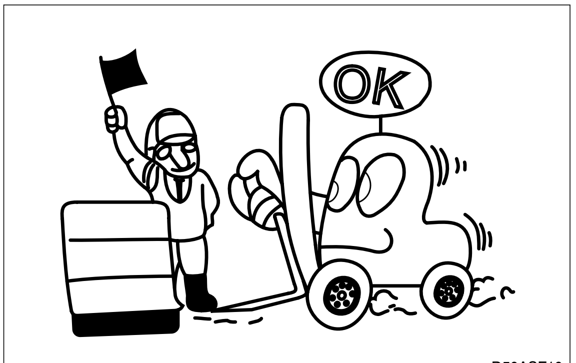
D50ASF08

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



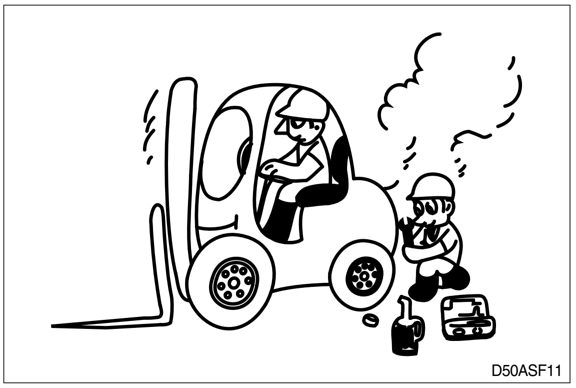
D50ASF09

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



D50ASF10

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



D50ASF11

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

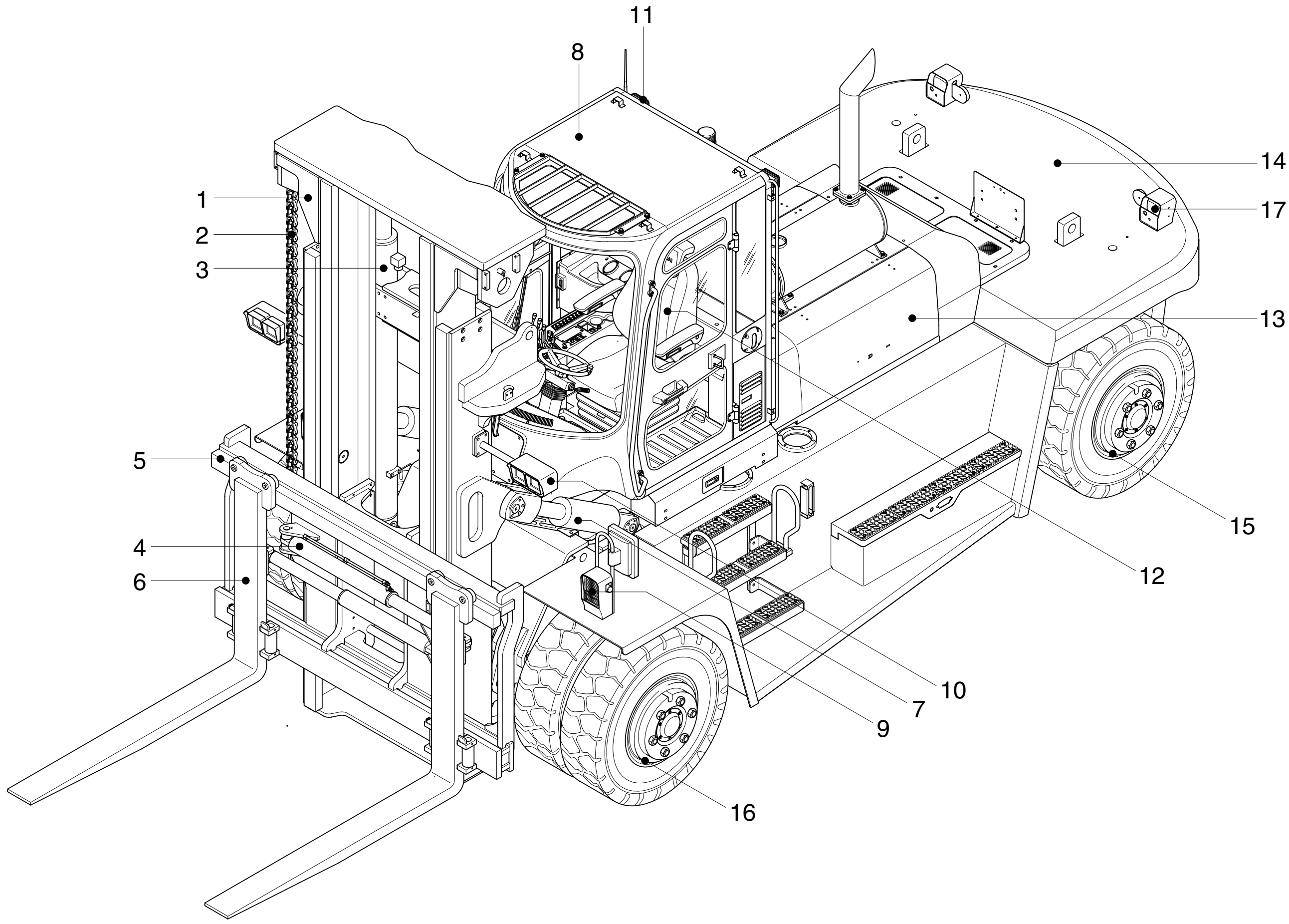
- Thoroughly clean the machine. In particular, be careful to clean the filler caps, grease fittings and the area around the dipsticks. Be careful not to let any dirt or dust into the system.
- Always use HYUNDAI Forklift genuine parts for replacement.
- Always use the grades of grease and oil recommended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

160D7ESP01

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

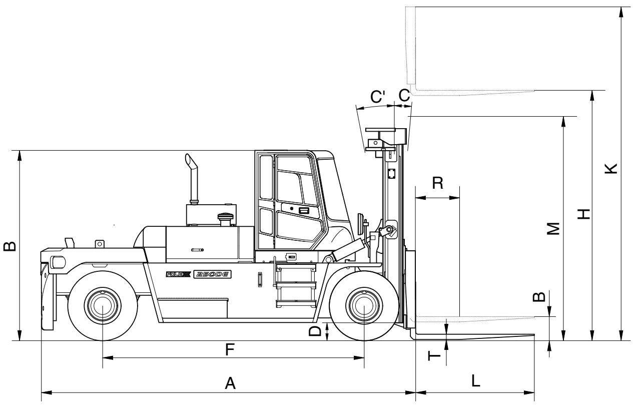
1. MAJOR COMPONENTS

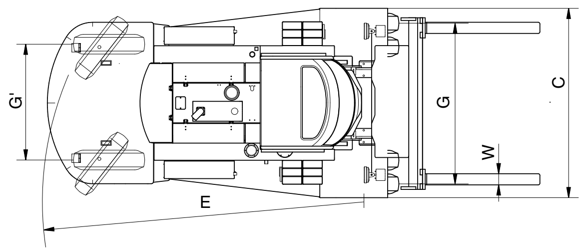


250D7EOM54

1	Mast	7	Tilt cylinder	13	Bonnet
2	Lift chain	8	Cabin	14	Counterweight
3	Lift cylinder	9	Head light-fender	15	Rear wheel
4	Fork positioner cylinder	10	Work lamp-mast	16	Front wheel
5	Carriage	11	Work lamp-cabin rear	17	Rear combination lamp
6	Forks	12	Operator's seat		

2. SPECIFICATIONS





Model			Unit	250D-7E
Capacity			kg	25000
Load center		R	mm	1200
Weight(Unloaded)			kg	37020
Fork	Lifting height	H	mm	4030
	Free lift	B	mm	0
	Lifting speed (Unload/Load)		mm/sec	280/250
	Lowering speed (Unload/Load)		mm/sec	300/400
	L×W×T	L,W,T	mm	2450×250×110
Mast	Tilt angle (forward/backward)	C/C	degree	12/10
	Max height	K	mm	5837
	Min height	M	mm	3877
Body	Travel speed (Unload/Load)		km/h	31.7/28.3
	Gradeability		degree	15.7 (28.2%)
	Min turning radius (Outside)	E	mm	5800
ETC	Max hydraulic pressure		kgf/cm^2	210
	Hydraulic oil tank		l	268
	Fuel tank		l	531
Overall length		A	mm	6362
Overall width		C	mm	3050
Cabin height		B	mm	3223
Ground clearance (Mast)		D	mm	300
Wheel base		F	mm	4250
Wheel tread front/rear		G/G'	mm	2212/2140

3. SPECIFICATIONS FOR MAJOR COMPONENTS

(1) ENGINE

Item	Unit	Specification
Model	-	CUMMINS QSC
Type	-	4 cycle turbocharged and inter cooled 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 X stroke	mm(in)	114×135mm (4.49"×5.31")
Piston displacement	cc(cu in)	8300 (510)
Compression ratio	-	17.5 : 1
Rated gross horse power	ps/rpm	264/2200
Maximum gross torque at rpm	kgf · m/rpm	120.4/1500
Engine oil quantity	l (U.S.gal)	20 (5.3)
Dry weight	kg(lb)	723 (1594)
High idling speed	rpm	2350
Low idling speed	rpm	750
Rated fuel consumption	g/ps.hr	165
Starting motor	V-kW	DENSO, 24-7.5
Alternator	V-A	24-70
Battery	V-AH	24-100

(2) MAIN PUMP

Item	Unit	Specification
Type	-	Axial piston variable pump
Capacity	cc/rev	74+74
Maximum operating pressure	bar	300
Rated speed (Max/Min)	rpm	2550/500

(3) MAIN CONTROL VALVE

Item	Unit	Specification
Type	-	Sectional
Operating method	-	Hydraulic pilot
Main relief valve pressure	bar	210/165
Flow capacity	lpm	400

(4) STEERING UNIT

Item	Unit	Specification
Type	-	Load sensing/Non load reaction/Dynamic signal
Capacity	cc/rev	630
Rated flow	lpm	52

(5) POWER TRAIN DEVICES

Item			Specification
Torque converter	Model		W340, 1.773/271 (ZF SACH)
	Type		3 Element, 1 stage, 2 phase
	Stall ratio		1.773 : 1
Transmission	Type		Full auto, power shift
	Gear shift(FR/RR)		3/3
	Adjustment		Electrical single lever type
	Overhaul ratio	FR	1 : 5.683 2 : 2.304 3 : 0.963
		RR	1 : 5.041 2 : 2.044 3 : 0.854
Axle	Type		Front-wheel drive type, fixed location
	Gear ratio		17.52 : 1
	Gear		Ring & Pinion gear type
Wheels	Q'ty(FR/RR)		Double : 4/2
	Front(drive)		14.00-24-28 PR
	Rear(steer)		14.00-24-28 PR
Brakes	Travel		Front wheel, wet disc brake
	Parking		Front wheel, hydraulic released brake
Steering	Type		Full hydraulic, power steering
	Steering angle		71.9° 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	M24 × 3.0	100 ± 15	723 ± 109
2		Radiator mounting bolt, nut	M12 × 1.75	12.8 ± 3.0	93 ± 22
3	Hydraulic system	Hydraulic pump mounting bolt	M12 × 1.75	12.8 ± 3.0	93 ± 22
4		MCV mounting bolt, nut	M16 × 2.0	29.7 ± 4.5	215 ± 32
5		Steering unit mounting bolt	M10 × 1.5	6.9 ± 1.4	50 ± 10
6		Tilt cylinder; rod-end bolt, nut	M20 × 2.5	37 ± 4.0	268 ± 28.9
7	Power train system	Transmission mounting bolt, nut	M20 × 2.5	57.9 ± 8.7	419 ± 63
8		Torque converter mounting bolt	M10 × 1.5	6.9 ± 1.4	49.9 ± 10
9		Drive axle mounting bolt, nut	M30 × 3.5	115 ± 10	831 ± 72
10		Steering axle mounting bolt, nut	M48 × 5.0	199 ± 30	1440 ± 217
11		Front wheel mounting nut	M18 × 2.0	35 ± 2	253 ± 14.5
12		Rear wheel mounting nut	M22 × 1.5	84 ± 12	608 ± 87
13		Propeller shaft(To T/M)	M12 × 1.5	15 ± 2	109 ± 14.5
		Propeller shaft (To D/Axle)	M12 × 1.75	12.3 ± 2.5	89 ± 18
14	Others	Counterweight mounting bolt 1	M30 × 3.5	199 ± 29.9	1439 ± 216
		Counterweight mounting bolt 2	M24 × 3.0	100 ± 15	723 ± 109
15		Operator's seat mounting nut	M8 × 1.25	3.4 ± 0.7	24.6 ± 5
16		Cab mounting nut	M16 × 2.0	29.7 ± 4.5	215 ± 32
17		Mast mounting bolt	M14 × 2.0	19.6 ± 2.9	144 ± 23

5. TORQUE CHART

Use following table for unspecified torque.

1) BOLT AND NUT - Coarse thread

Bolt size	8T		10T	
	kgf · m	lbf · ft	kgf · m	lbf · ft
M 6 × 1.0	0.85 ~ 1.25	6.15 ~ 9.04	1.14 ~ 1.74	8.2 ~ 12.6
M 8 × 1.25	2.0 ~ 3.0	14.5 ~ 21.7	2.7 ~ 4.1	19.5 ~ 29.7
M10 × 1.5	4.0 ~ 6.0	28.9 ~ 43.4	5.5 ~ 8.3	39.8 ~ 60.0
M12 × 1.75	7.4 ~ 11.2	53.5 ~ 81.0	9.8 ~ 15.8	70.9 ~ 114
M14 × 2.0	12.2 ~ 16.6	88.2 ~ 120	16.7 ~ 22.5	121 ~ 163
M16 × 2.0	18.6 ~ 25.2	135 ~ 182	25.2 ~ 34.2	182 ~ 247
M18 × 2.0	25.8 ~ 35.0	187 ~ 253	35.1 ~ 47.5	254 ~ 344
M20 × 2.5	36.2 ~ 49.0	262 ~ 354	49.2 ~ 66.6	356 ~ 482
M22 × 2.5	48.3 ~ 63.3	349 ~ 458	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 ~ 1656
M36 × 4.0	174 ~ 236	1261 ~ 1704	250 ~ 310	1808 ~ 2242

(1) Fine thread

Bolt size	8T		10T	
	kgf · m	lbf · ft	kgf · m	lbf · ft
M 8 × 1.0	2.2 ~ 3.4	15.9 ~ 24.6	3.0 ~ 4.4	21.7 ~ 31.8
M10 × 1.2	4.5 ~ 6.7	32.5 ~ 48.5	5.9 ~ 8.9	42.7 ~ 64.4
M12 × 1.25	7.8 ~ 11.6	56.4 ~ 83.9	10.6 ~ 16.0	76.7 ~ 116
M14 × 1.5	13.3 ~ 18.1	96.2 ~ 131	17.9 ~ 24.1	130 ~ 174
M16 × 1.5	19.9 ~ 26.9	144 ~ 195	26.6 ~ 36.0	192 ~ 260
M18 × 1.5	28.6 ~ 43.6	207 ~ 315	38.4 ~ 52.0	278 ~ 376
M20 × 1.5	40.0 ~ 54.0	289 ~ 391	53.4 ~ 72.2	386 ~ 522
M22 × 1.5	52.7 ~ 71.3	381 ~ 516	70.7 ~ 95.7	511 ~ 692
M24 × 2.0	67.9 ~ 91.9	491 ~ 665	90.9 ~ 123	658 ~ 890
M30 × 2.0	137 ~ 185	990 ~ 1339	182 ~ 248	1314 ~ 1796
M36 × 3.0	192 ~ 260	1390 ~ 1880	262 ~ 354	1894 ~ 2562

2) PIPE AND HOSE(FLARE TYPE)

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

3) PIPE AND HOSE(ORFS TYPE)

Thread size(PF)	Width across flat(mm)	kgf · m	lbf · ft
9/16-18	19	4	28.9
11/16-16	22	5	36.2
13/16-16	27	9.5	68.7
1-3/16-12	36	18	130.2
1-7/16-12	41	21	151.9
1-11/16-12	50	35	253.2

4) FITTING

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

6. RECOMMENDED LUBRICANTS

Service point	Kind of fluid	Capacity ℓ (U.S.gal)	Ambient temperature °C (°F) -20 (-4), -10 (14), 0 (32), 10 (50), 20 (68), 30 (86), 40 (104)
Engine oil pan	Engine oil	20 (5.3)	SAE 30 SAE 10W SAE 10W-30 SAE 15W-40
Torque converter transmission	Engine oil	27 (7.1)	SAE 10W-30 SAE 15W-40
Axle brake	Gear oil	27.5+2×3.2 (7.3+2×0.8)	SAE 80W-90/API GL-5
	Cooling oil	33 (8.7)	DONAX TD
Hydraulic tank	Hydraulic oil	268 (71)	ISO VG32 ISO VG46 ISO VG68
Fuel tank	Diesel fuel	531 (139.7)	ASTM D975 No.1 ASTM D975 No.2
Fitting (Grease nipple)	Grease	-	NLGI No.1 NLGI No.2
Radiator	Antifreeze:Water 50:50	30.6 (8.08)	Ethylene glycol base permanent type

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 If any engine oil of API service class CF is used instead of class CH4 engine oil, the

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.

100D7GE02

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

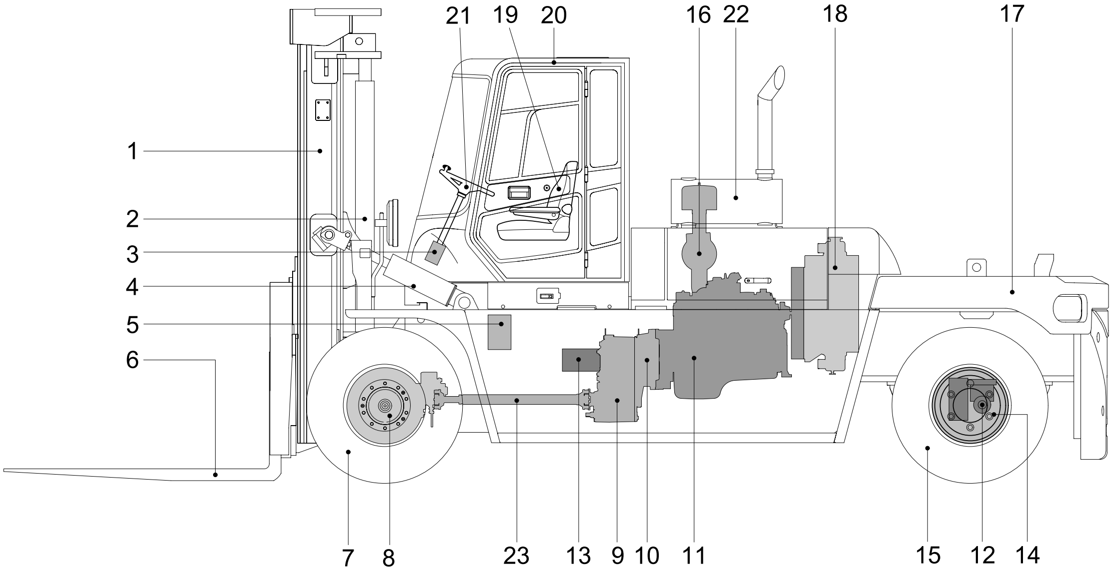
- · Operating lights check ____________
- · Work light check ____________
- · Brake light check ____________
- · Cab light check ____________
- · Horn circuit check ____________
- · Windshield washer and wiper check ____________
- · Heater/Air conditioner blower check ____________
- · Heater functional 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 STRUCTURE



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

GROUP 2 REMOVAL AND INSTALLATION OF UNIT

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

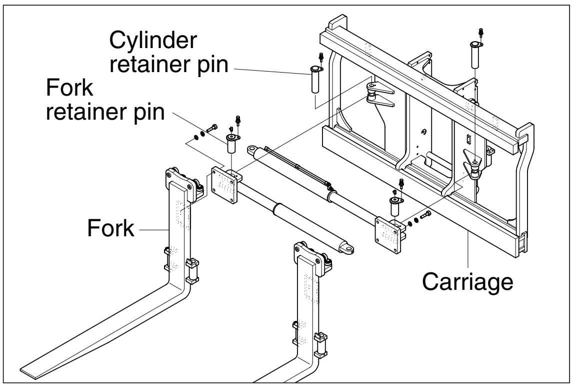
1. MAST

1) REMOVAL

Fork	Carriage	Piping	Mast

(1) FORKS

① Lower the fork carriage until the forks are approximately 25mm(1in) from the floor.
② Release fork retainer by removing the fork retainer pin.
Remove the cylinders 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.



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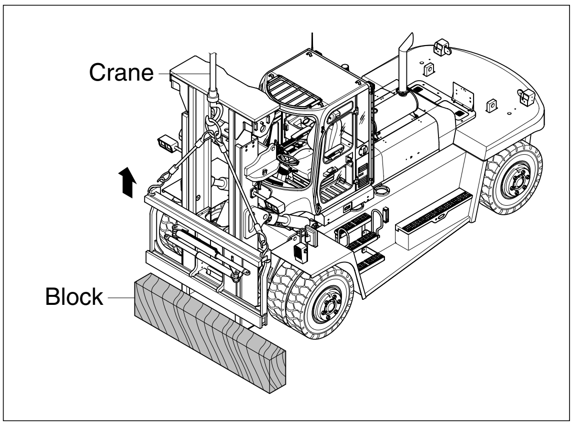
(2) CARRIAGE

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.



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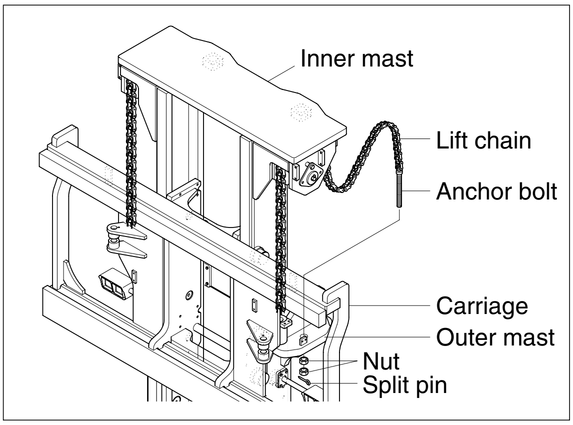
② While supporting lift chains, remove nuts from the anchor bolt.



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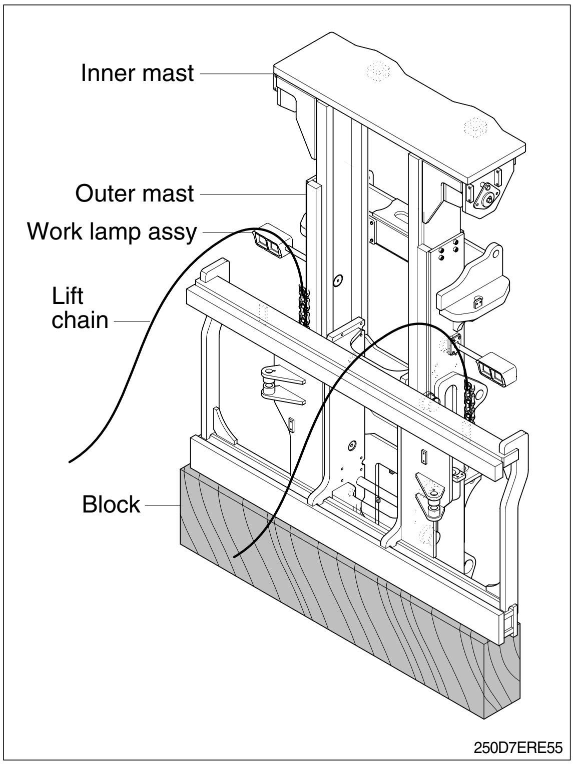
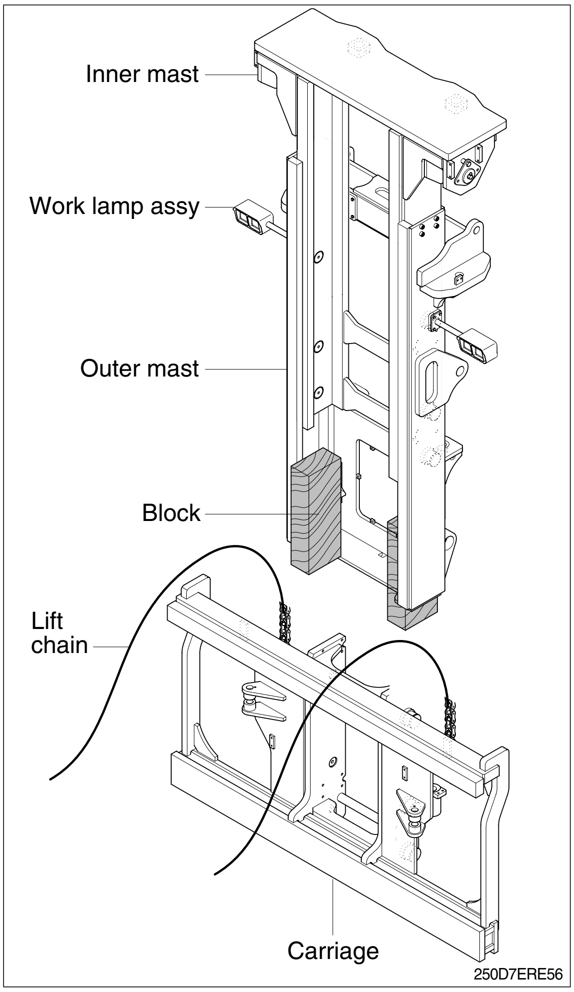
③ Pull the chains out of the sheaves and drape them over the front of the carriage.



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.**

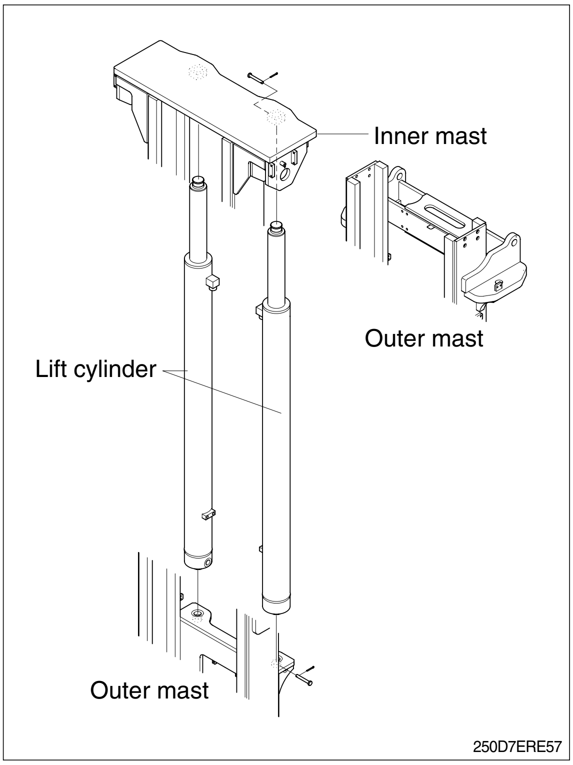
※ Inspect all parts for wear or damage. Replace all worn or damaged parts.



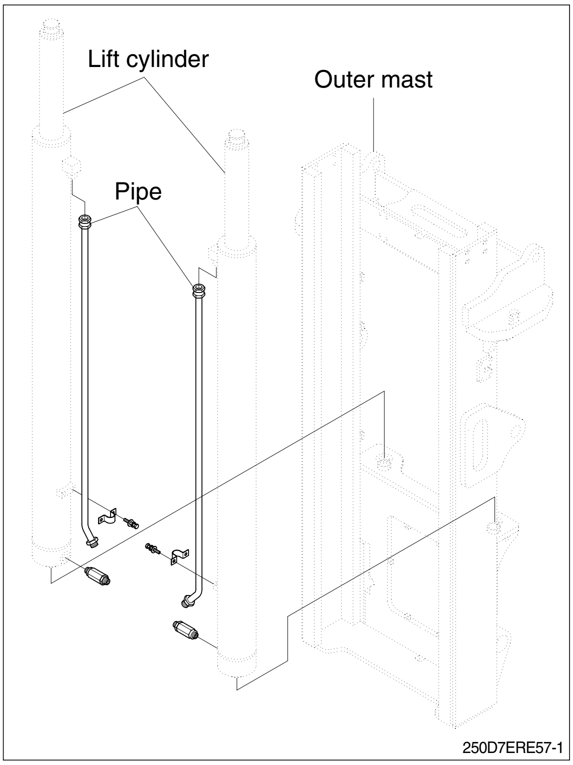
(3) PIPING

① Remove the hoses and clamps attached to the cylinder.

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



③ Remove the lubrication pipes and clamps.



(4) LIFT CYLINDER

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

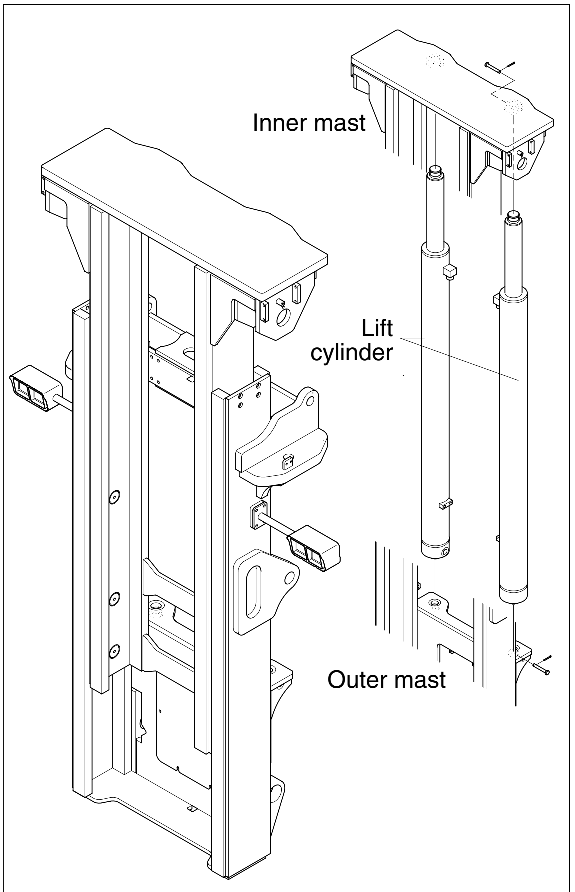
② Bind the lift cylinder with overhead hoist rope and pull up so that the rope has no slack or binding.

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

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

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

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



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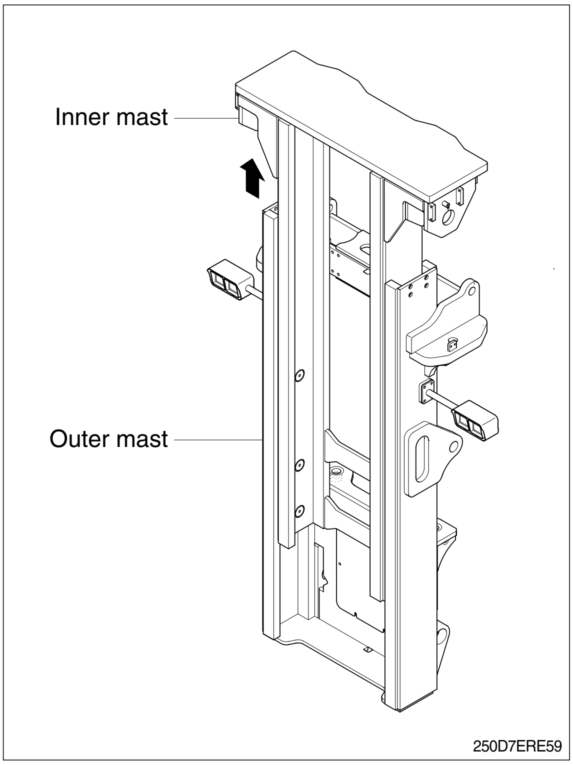
(5) INNER MAST

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.

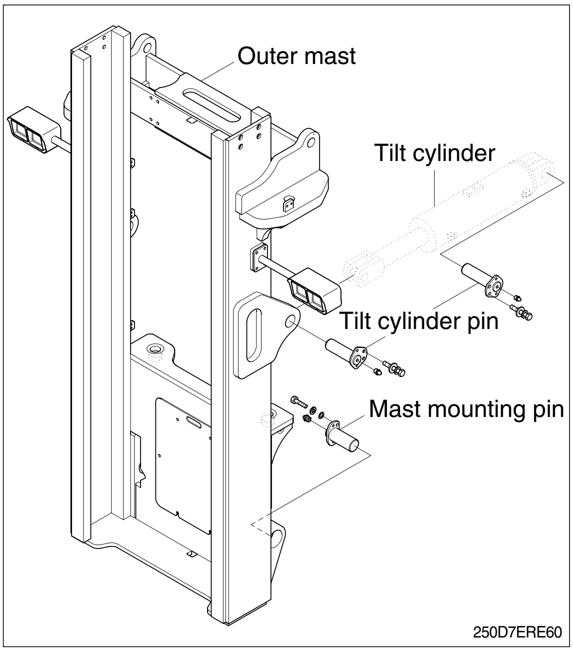


(6) TILT CYLINDER PIN

(7) MAST SUPPORT PIN

Attach a crane to the stay at the top of the outer mast, and raise it.
Remove the mounting bolts and pins from drive axle, then slowly raise outer mast.

※ 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 support pins for wear, then install pins into the mast support bracket and drive axle.

(2) TILT CYLINDER PIN

Hold the mast with a crane, operate the tilt control lever and align the holes, then knock the pin.

(3) LIFT CYLINDER INSTALLATION AND ADJUSTMENT

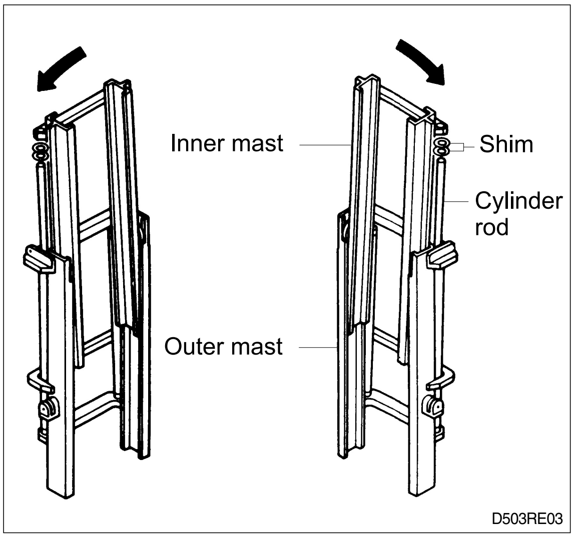
① Assemble the lift cylinder inside the outer mast, then tighten the stopper bolt. If the cylinder assembly has been replaced, adjust as follows so that the left and right cylinders are synchronized at the maximum lifting height.

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.

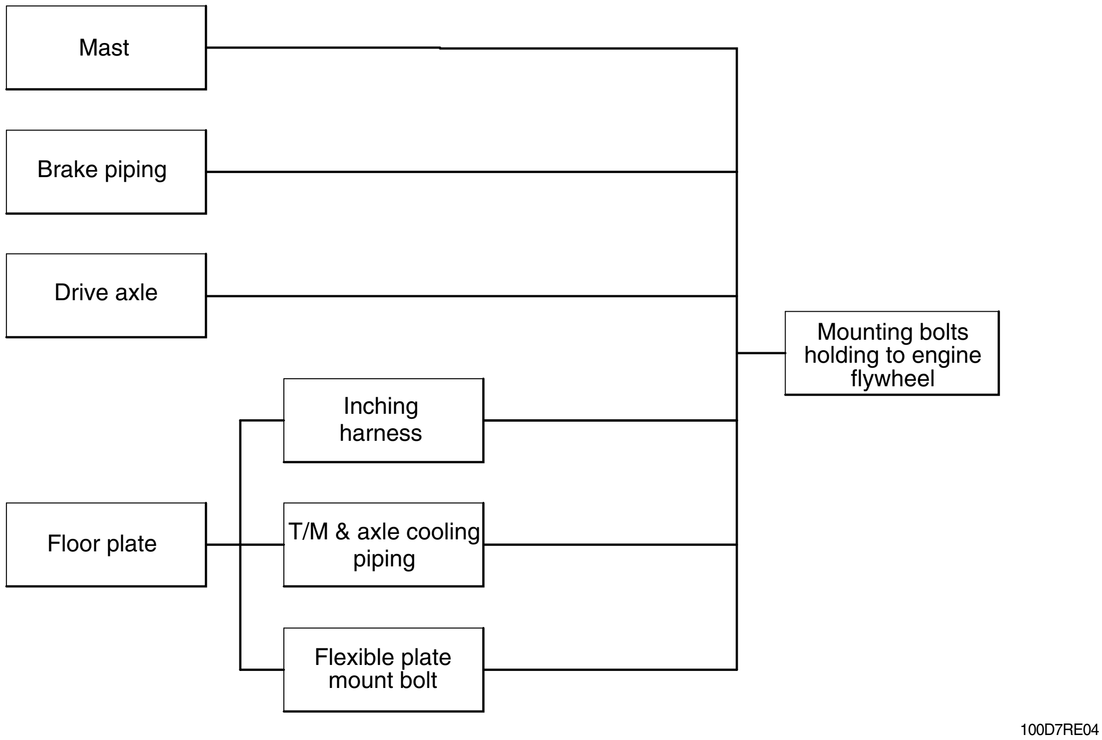
※ If play is to RIGHT, install adjustment shim to RIGHT cylinder.

· Shim thickness : 1.0mm(0.04in)



2. POWER TRAIN ASSEMBLY

1) REMOVAL



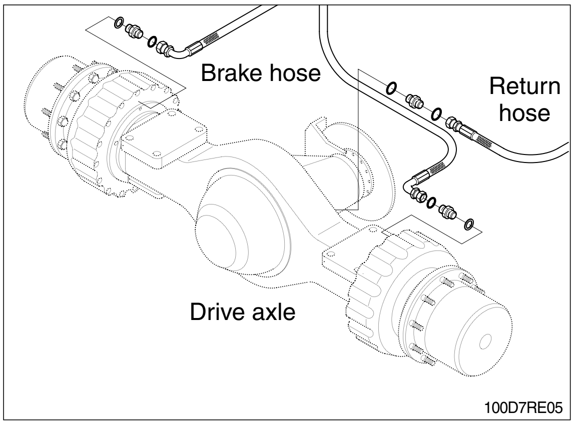
(1) Mast

Refer to section on mast(Page 2-2)

(2) Brake piping

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

▲ **When disconnecting the brake hydraulic hoses, take care that oil should not be spilt on the floor.**
If someone slips due to oil spillage, it can cause to do him severe injuries.
In case of spilling out of the oil on the floor, wipe it off immediately in order to prevent someone from unexpected accident.



(3) Drive axle

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

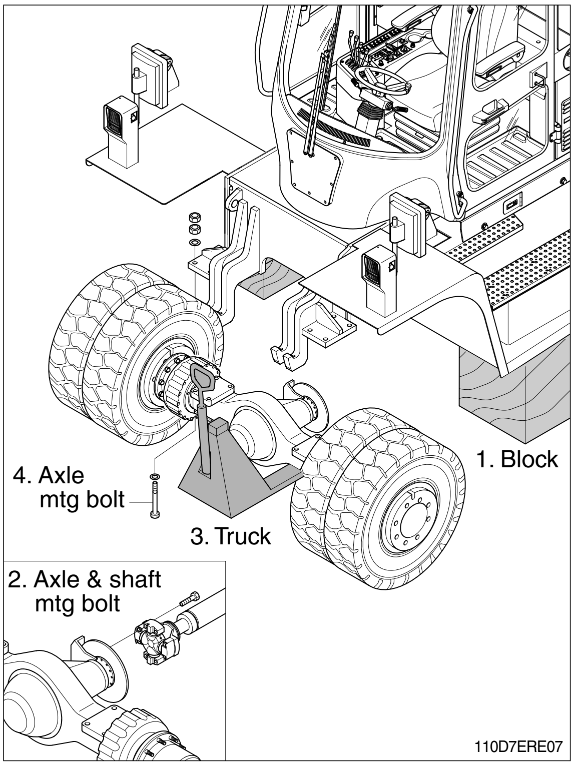
① Jack up the machine and then put the block under the frame.

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

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

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

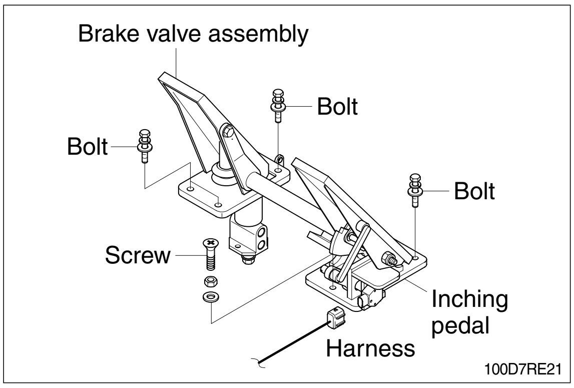
④ Remove mounting bolts fixing the axle to the frame and then carefully draw the truck out of the vehicle with the drive axle unit.



(4) Inching linkage

① Remove bolt and screw fixing the inching linkage assembly.

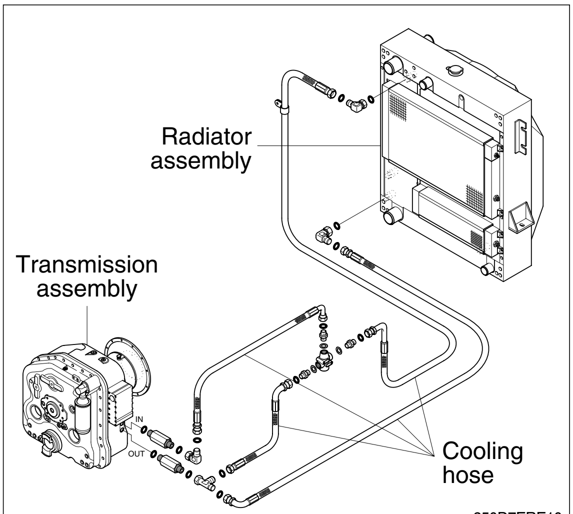
② Disconnect harness cable from the inching pedal assembly.



(5) Transmission and axle cooling piping

① Disconnect cooling hose and connector from the transmission.

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

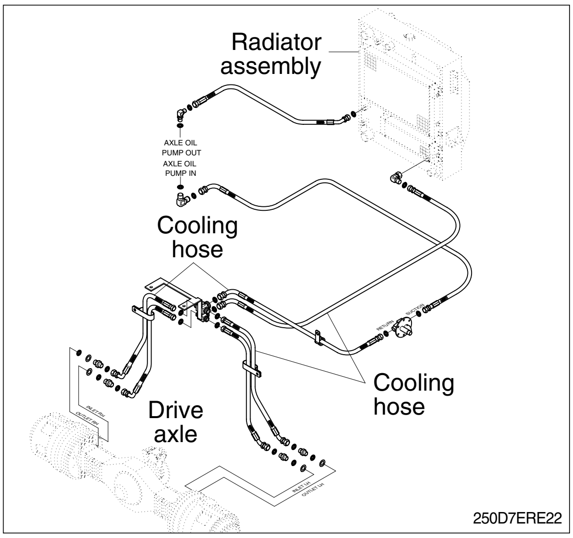


250D7ERE10

② Disconnect axle cooling hose and connector from the axle.

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

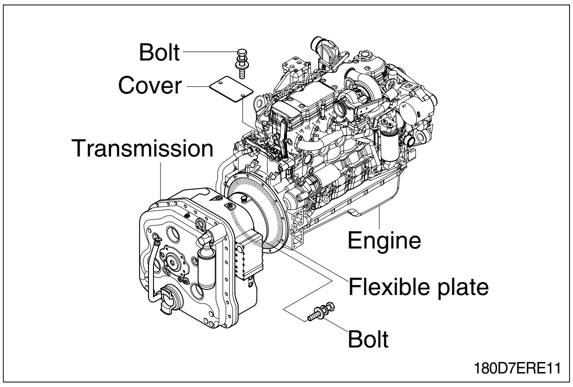
⚠ **When disconnecting the oil cooling hoses, take care that oil should not be spilt on the floor.**
If someone slips due to oil spillage, it can cause to do him severe injuries.
In case of spilling out of the oil on the floor, wipe away immediately it in order to prevent someone from unexpected accident.



250D7ERE22

(6) Flexible plate

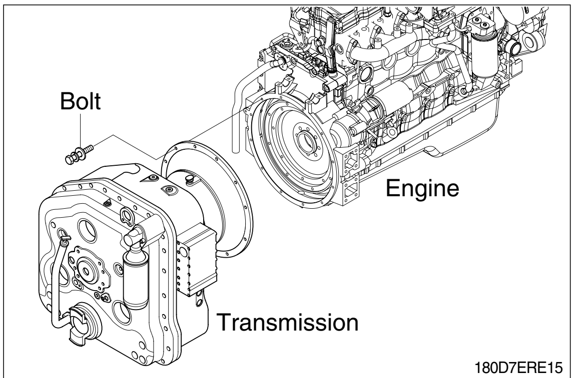
① Remove the cover on the right side of flywheel housing then remove 4 pieces of the mounting bolts installed to the engine flywheel.
To rotate the flywheel, rotate the crank shaft at the end of the engine.



180D7ERE11

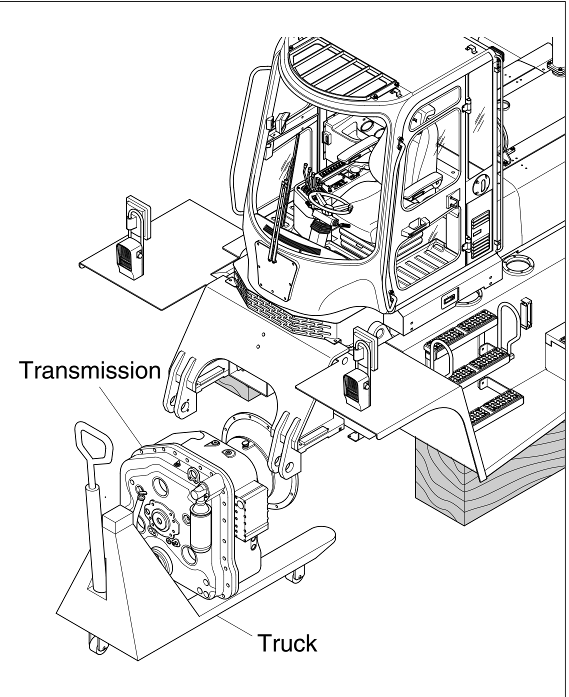
(7) Mounting bolts holding to flywheel housing

① Remove the transmission assembly from engine by loosen-ing 12 pieces of the mounting bolts.(Bolt②)



180D7ERE15

② Using a moving truck slowly pull out transmission assembly to the front.



250D7ERE13

2) INSTALLATION

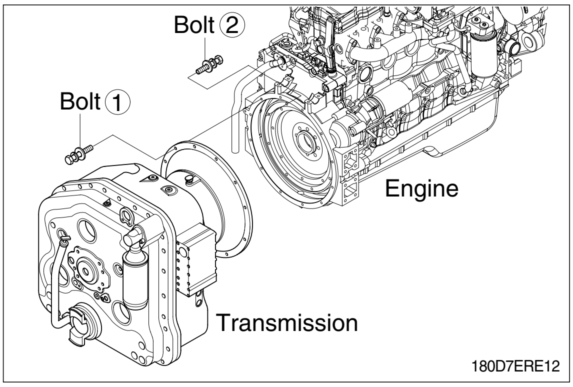
Installation is the reverse order to removal, but be careful of the following points.

(1) Tightening torque of mounting bolts ① to flywheel housing.

① : 5.5~8.3kgf · m (39.8~60.0lbf · ft)

(2) Tightening torque of mounting bolts ② to the flywheel for flexible plate.

② : 3.9~5.1kgf · m (28.2~36.9lbf · ft)



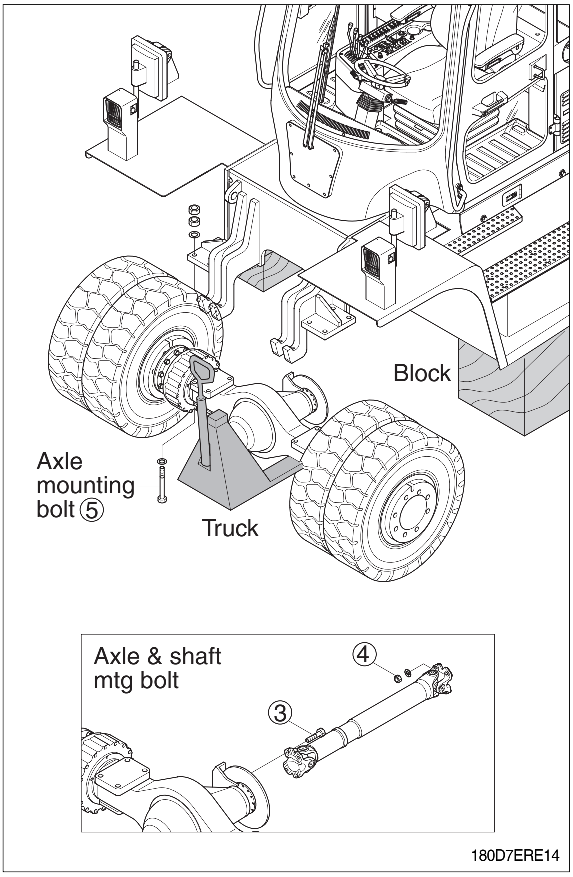
(3) Tightening torque of mounting bolts ③ and nut ④ for propeller shaft.

③ : 9.8~14.8kgf · m (70.9~107lbf · ft)

④ : 13~17kgf · m (94~123lbf · ft)

(4) Tightening torque of mounting bolts ⑤ for drive axle.

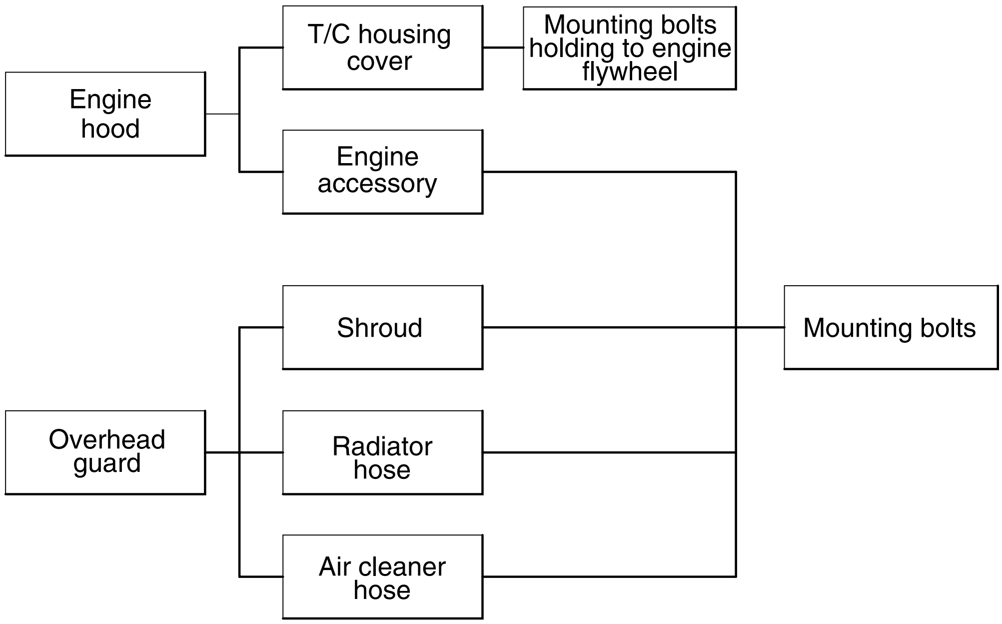
⑤ : 85~115kgf · m (615~832lbf · ft)



3. ENGINE

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

1) REMOVAL

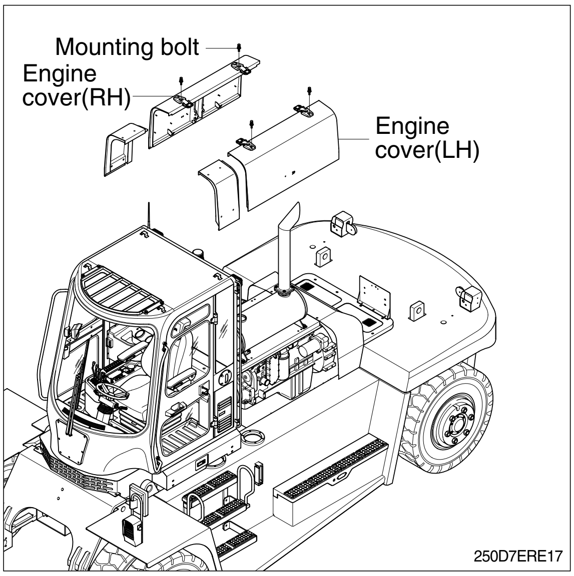


100D7RE25

(1) Engine hood

① **Engine cover (LH, RH)**

Remove engine cover by loosening the mounting bolts.

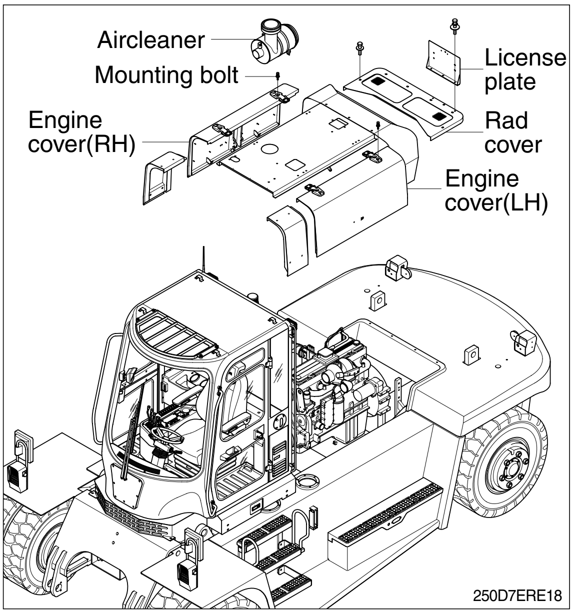


250D7ERE17

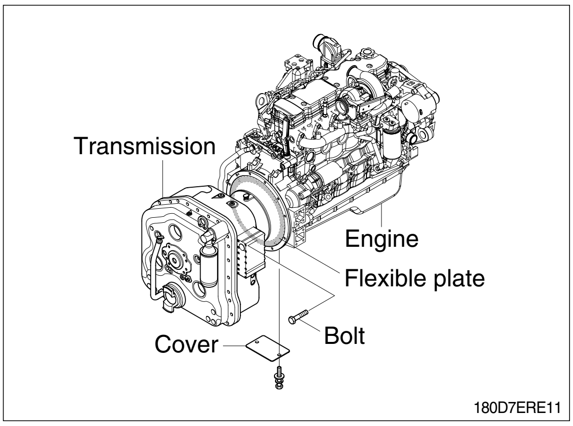
② **Engine cover(center)**

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

b. Remove engine cover and radiator cover upward.



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



(3) Engine accessory

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

① Wiring harness to alternator and starter.

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

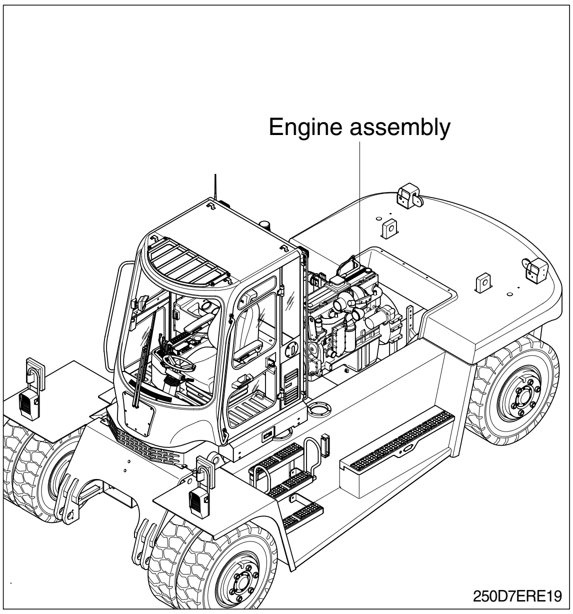
③ Cables for meters, buttons and accelerator pedal.

④ Hoses to fuel tank and air cleaner.

⑤ Exhaust pipe.

(4) Radiator hose

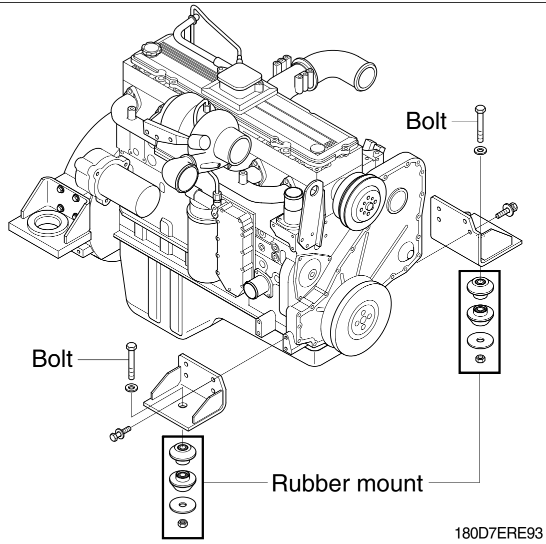
Open the drain valve of the radiator and drain the cooling water, then remove the radiator hose.



(5) Engine mounting bracket

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

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



180D7ERE93

2) INSTALLATION

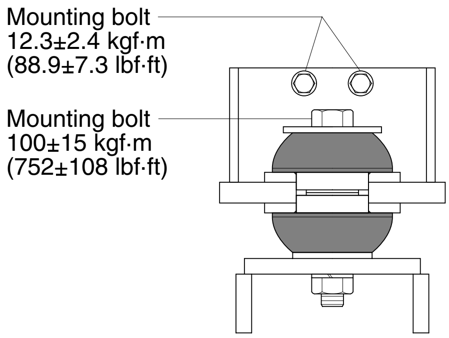
Installation is the reverse order to removal, but be careful of the following points.

(1) Tighten the engine mounting bolts and nuts.

(2) Tighten the engine mounting bracket bolts.

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

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



250D7ERE94

(3) Tightening torque of mounting bolt installed to torque converter housing.

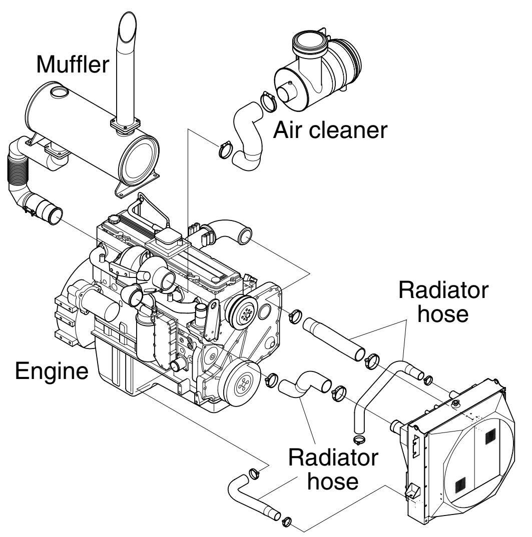
· See page 2-12, **2) INSTALLATION**.

(4) Radiator hoses

· Distance to insert hose : 80mm(3.1in)

(5) Air cleaner hose

Insert the air cleaner hose securely and fit a clamp.

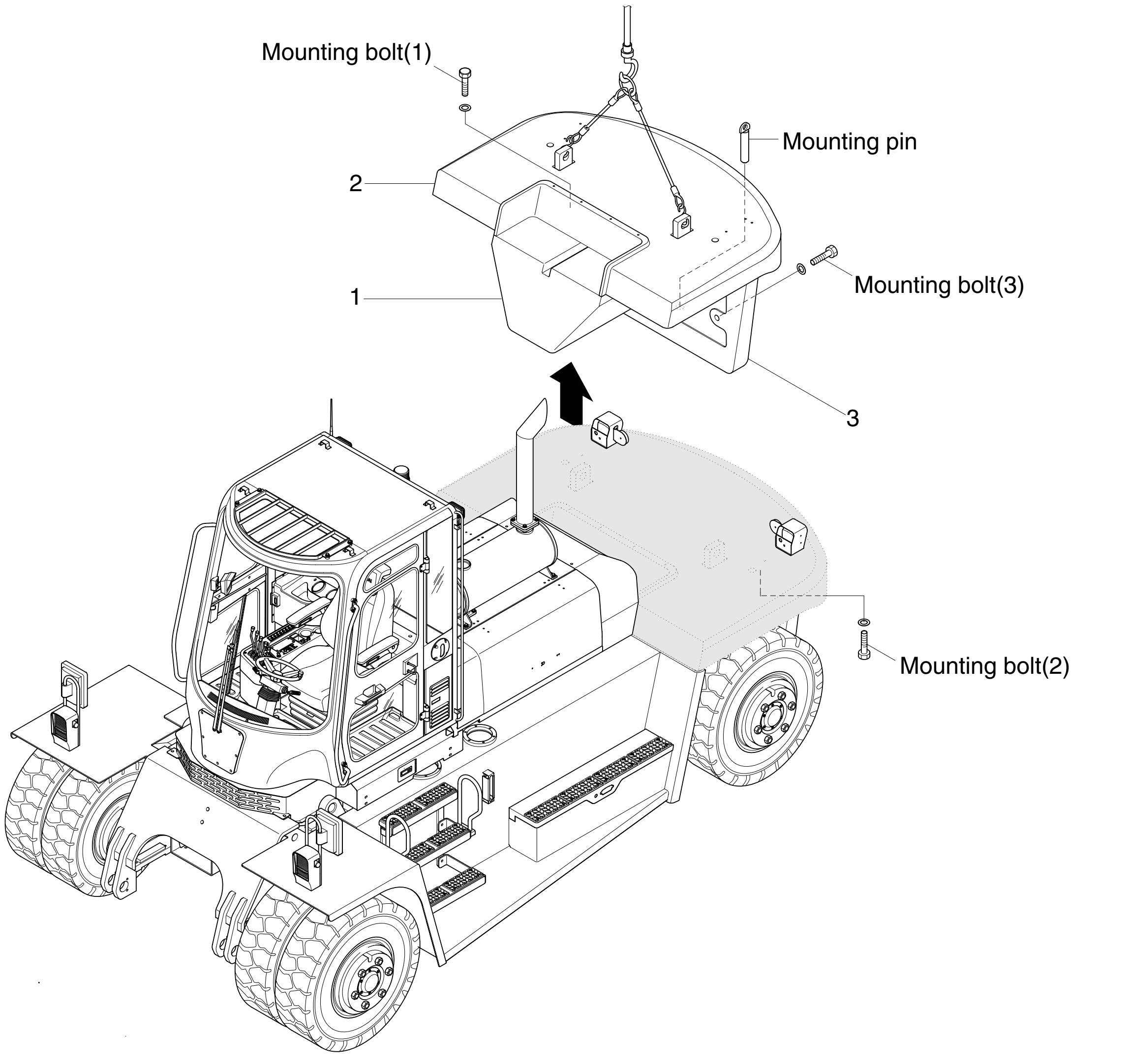


250D7ERE95

4. REAR AXLE

1) REMOVAL

Counter weight	Rear wheel	Hose	Mounting bolt



(1) Counterweight

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

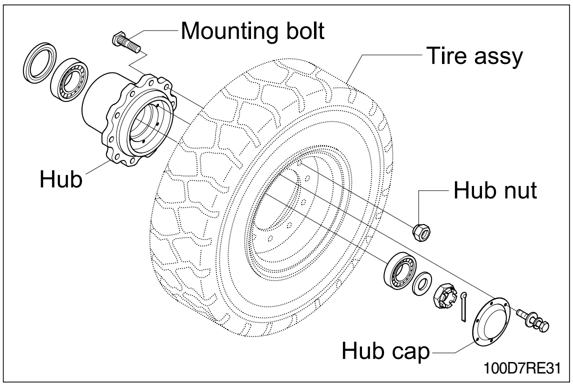
Remove the mounting bolts, raise slightly and move it slowly to rear side.

· Weight of counterweight (standard)

Description	Weight	Tightening torque
Counter weight (1)	2560kg (5640lb)	199±30kgf · m (1440±217 lbf · ft)
Counter weight-upper (2)	5970kg (13160lb)	199±30kgf · m (1440±217 lbf · ft)
Counter weight-lower (3)	1430kg (3150lb)	100±15kgf · m (723±108 lbf · ft)

(2) Rear wheel

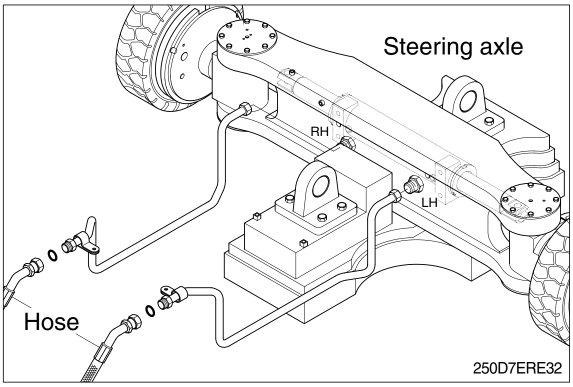
Remove mounting bolt and hub nut with socket wrench and then carefully take out the tire assembly.



(3) Hose

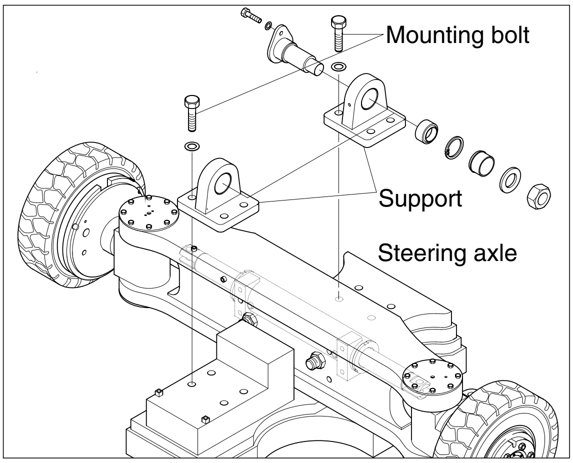
Disconnect the hose from the steering axle and then drain out oil from the hoses.

⚠ **When disconnecting the hoses, take care that oil should not be spilt on the floor.**
If someone slips due to oil spillage, it can cause to do him severe injuries.
In case of spilling out of the oil on the floor, wipe away immediately it in order to prevent someone from unexpected accident.



(4) Mounting bolt

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



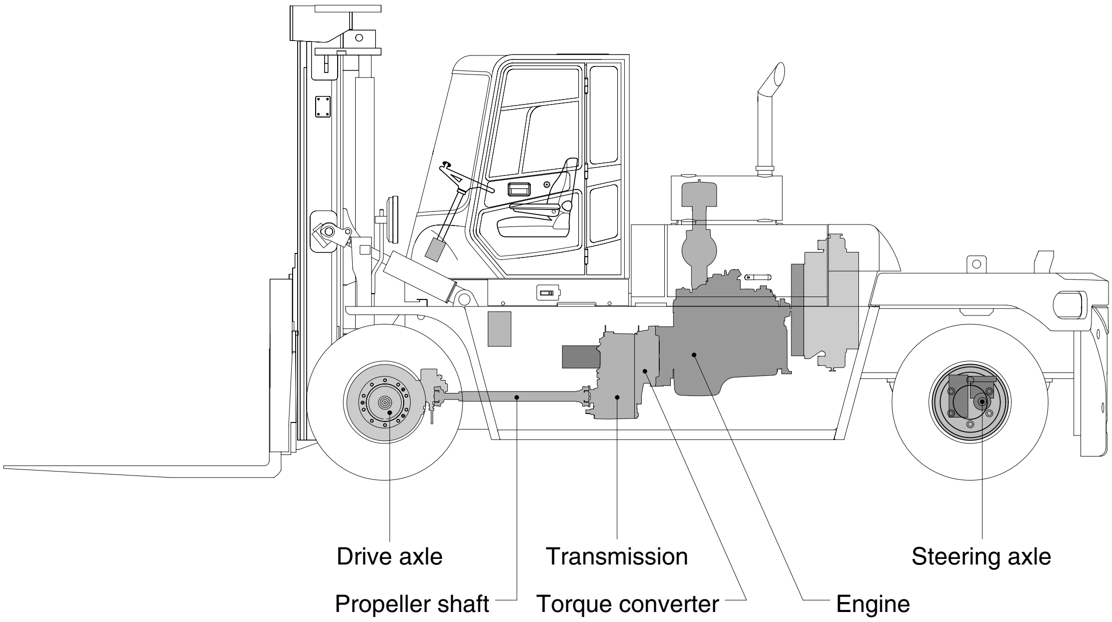
250D7ERE33

SECTION 3 POWER TRAIN SYSTEM

SECTION 3 POWER TRAIN SYSTEM

GROUP 1 STRUCTURE AND OPERATION

1. POWER TRAIN COMPONENT OVERVIEW



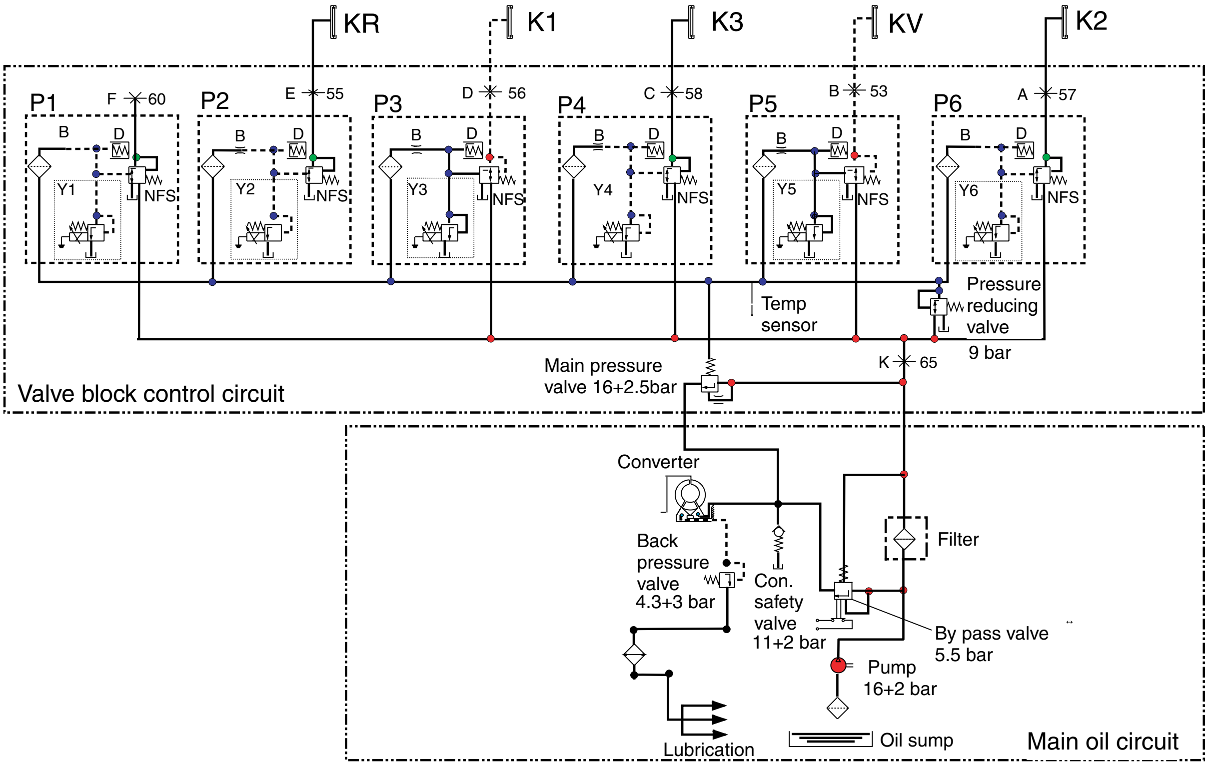
250D7EPT01

The power train consists of the following components :

· Torque converter
· Transmission
· Propeller 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 universal joints to drive axle assembly.
The power transmitted to front axle drives front wheels.

· **Hydraulic circuit**

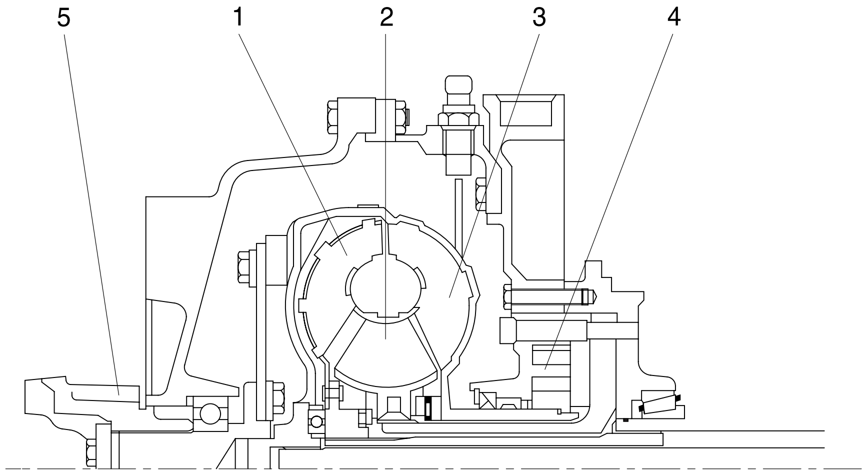


D507PT31

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.

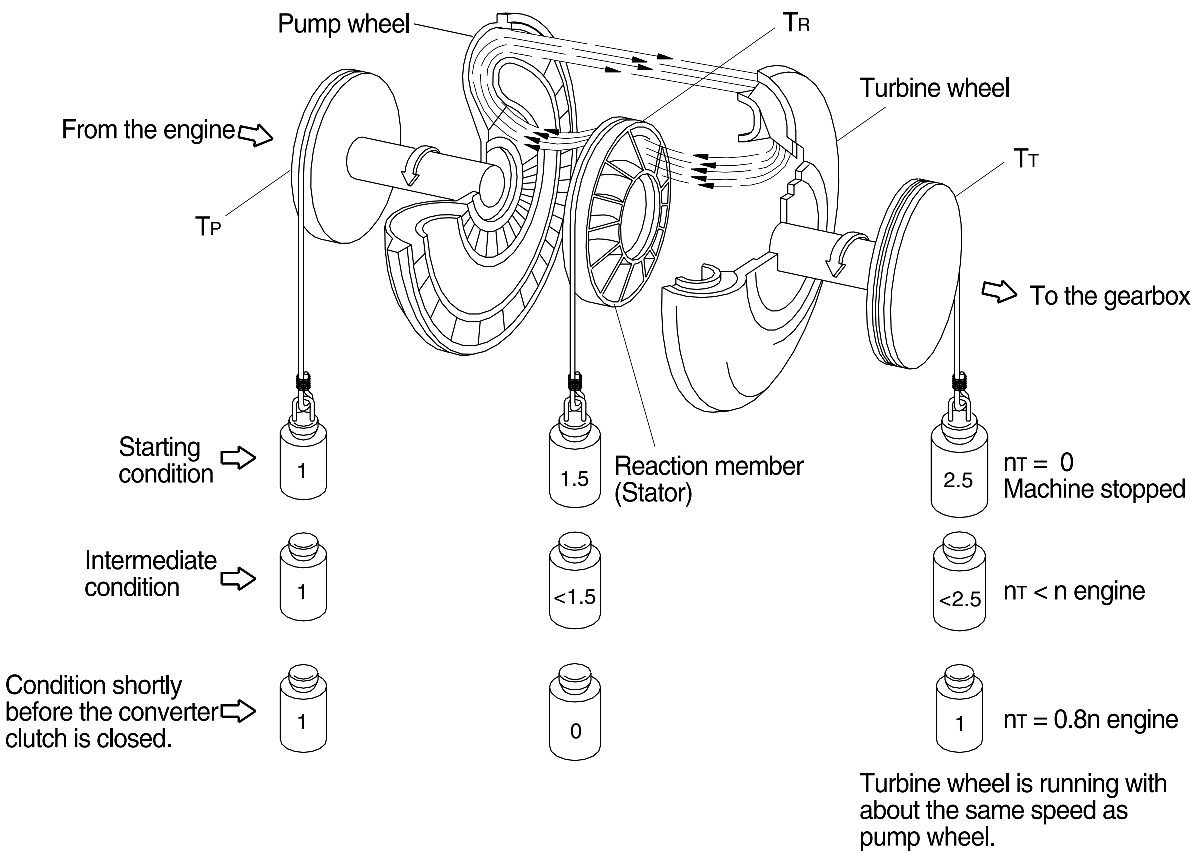
Therefore, the maximum conversion is created at standing turbine wheel.
With increasing output speed, the torque conversion is decreasing. The adoption of the output speed to a certain required output moment is infinitely variable and automatically achieved by the torque converter.

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)

T_P = Torque of the pump wheel
T_T = Torque of the turbine wheel
T_R = Torque of the reaction member(Stator)

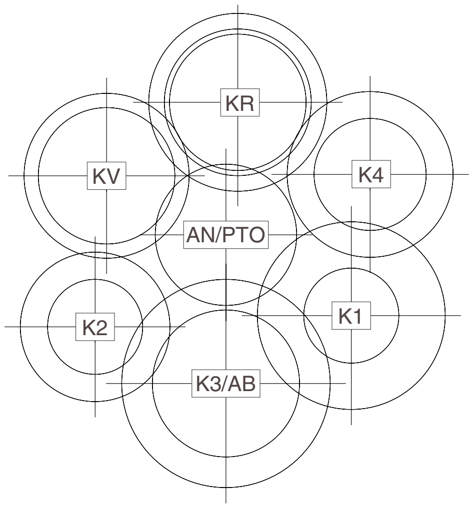


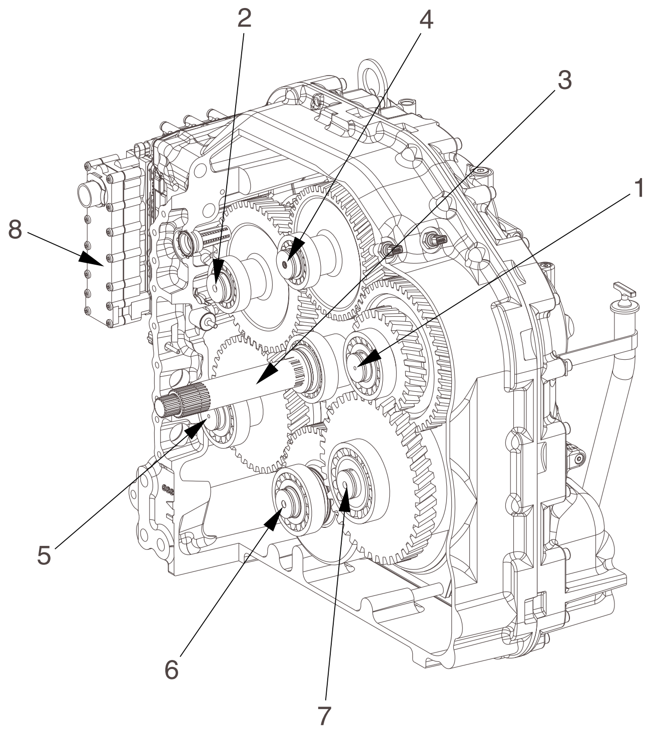
D503TM02

3. TRANSMISSION

1) LAYOUT

Gearbox diagram

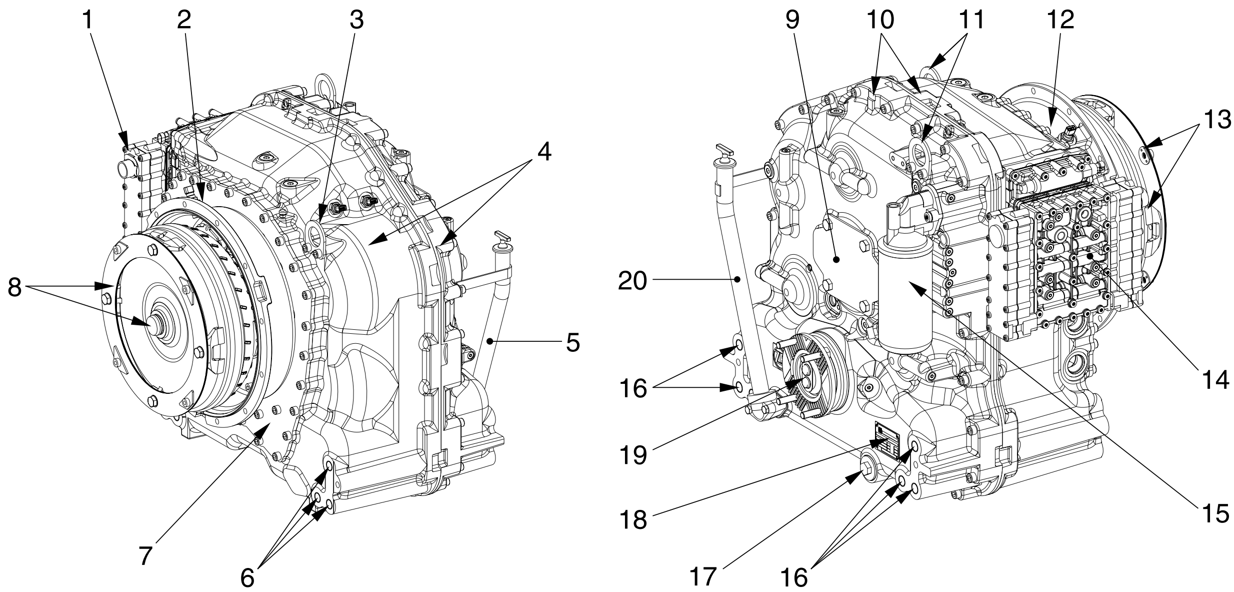




180D7ETM03

1 Clutch shaft (lay shaft, K4)
2 Clutch shaft (KV)
3 Input shaft / Power take-off (AN/PTO)
4 Clutch shaft (KR)
5 Clutch shaft (KZ)
6 Clutch shaft / Output (K3/AB)
7 Clutch shaft (K1)
8 Electro-hydraulic control

2) INSTALLATION VIEW



180D7EPT26

1	Electro - hydraulic control	11	Lifting lugs
2	Converter bell	12	Converter bell
3	Lifting lugs	13	Converter with diaphragm - direct mounting
4	Gearbox housing front and rear section	14	Converter with diaphragm
5	Oil level tube with oil dipstick (rear side)	15	Exchange filter with filter head
6	Transmission suspension holes M20	16	Transmission suspension holes M20
7	Plate	17	Oil drain plug M38 $\times$ 1.5
8	Converter with diaphragm - direct mounting	18	Type plate
9	Power take - off; coaxial, engine - dependent	19	Output flange
10	Gearbox housing front and rear section	20	Oil level tube with oil dipstick (rear side)

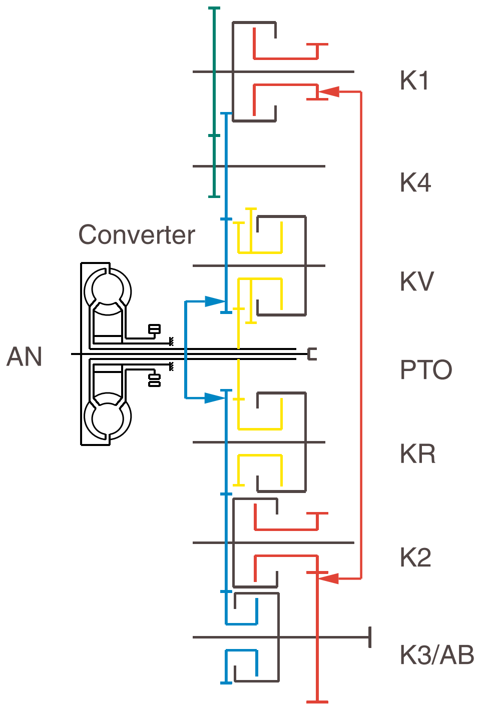
3) OPERATION OF TRANSMISSION

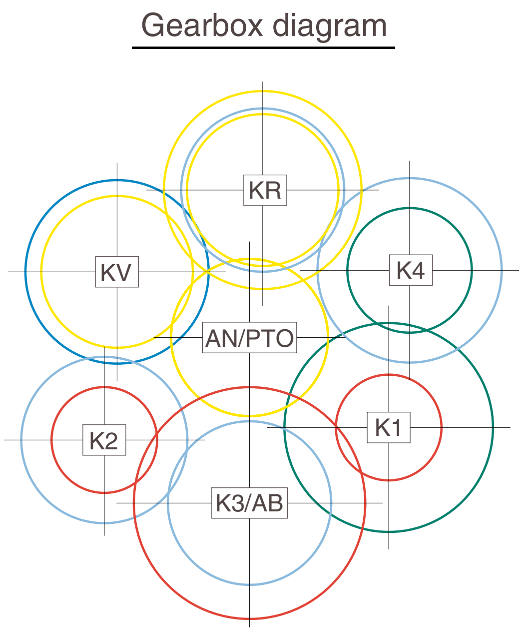
(1) Gearbox diagram

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

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

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





Legend

KV = Clutch forward
KR = Clutch reverse
K1 = Clutch 1st speed
K2 = Clutch 2nd speed
K3/AB = Clutch 3rd speed / output
K4 = Clutch 4th speed(layshaft)
AN/PTO = INPUT / 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

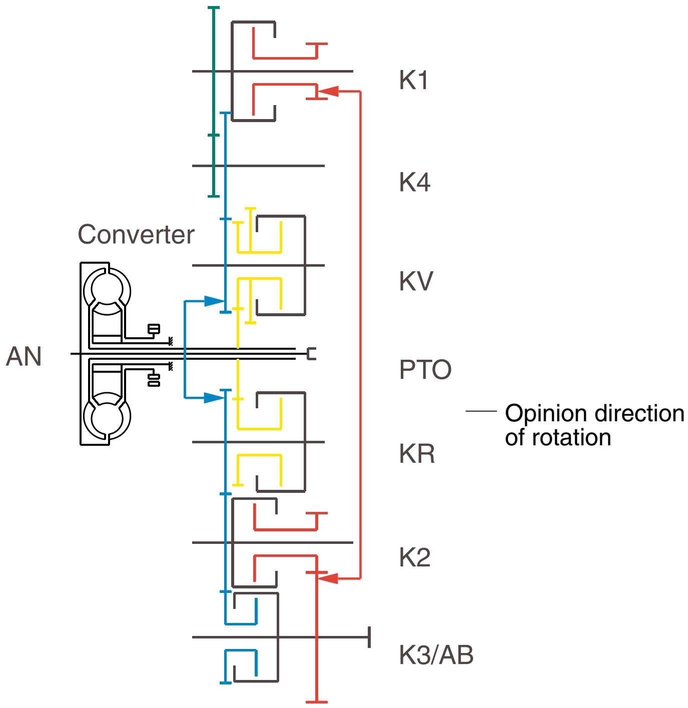
180D7EPT32

(2) Forward

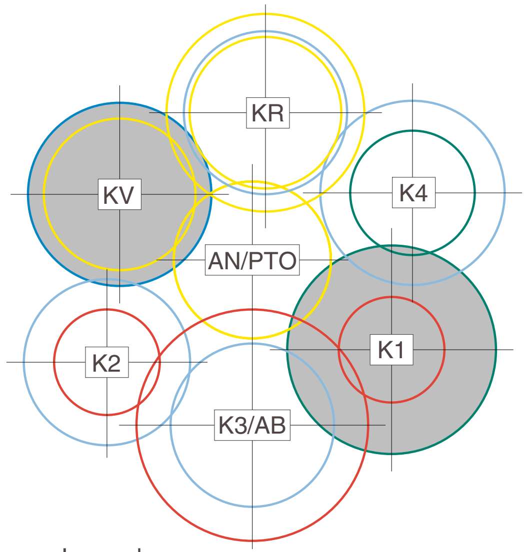
In forward, forward clutch and 1st, 2nd, 3rd clutch are engaged.

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

Transmission diagram



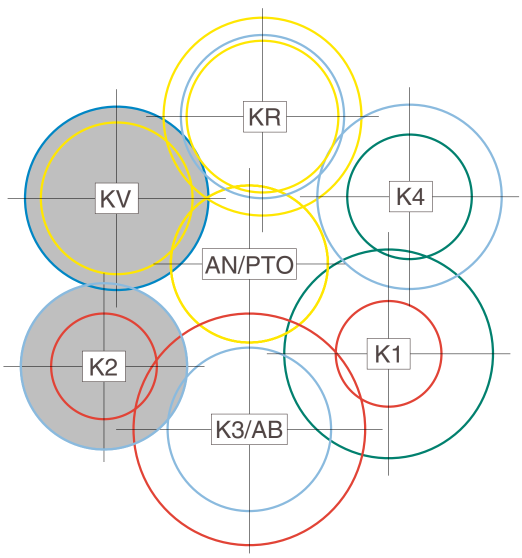
1st speed-reverse



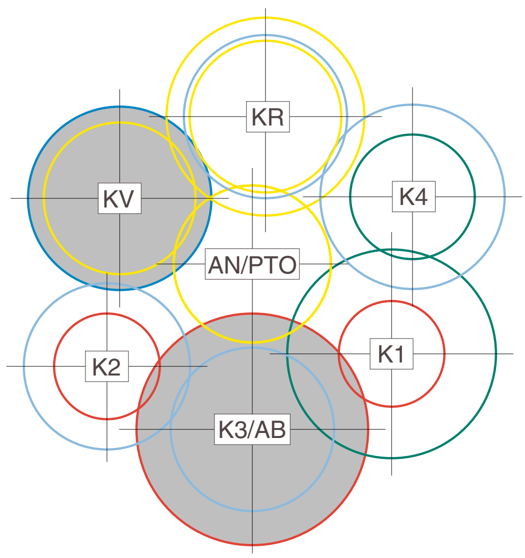
Legend

KV	= Clutch forward
KR	= Clutch reverse
K1	= Clutch 1st speed
K2	= Clutch 2nd speed
K3/AB	= Clutch 3rd speed / output
K4	= Clutch 4th speed(layshaft)
AN/PTO	= INPUT / Power take-off

2nd speed-reverse



3rd speed-reverse

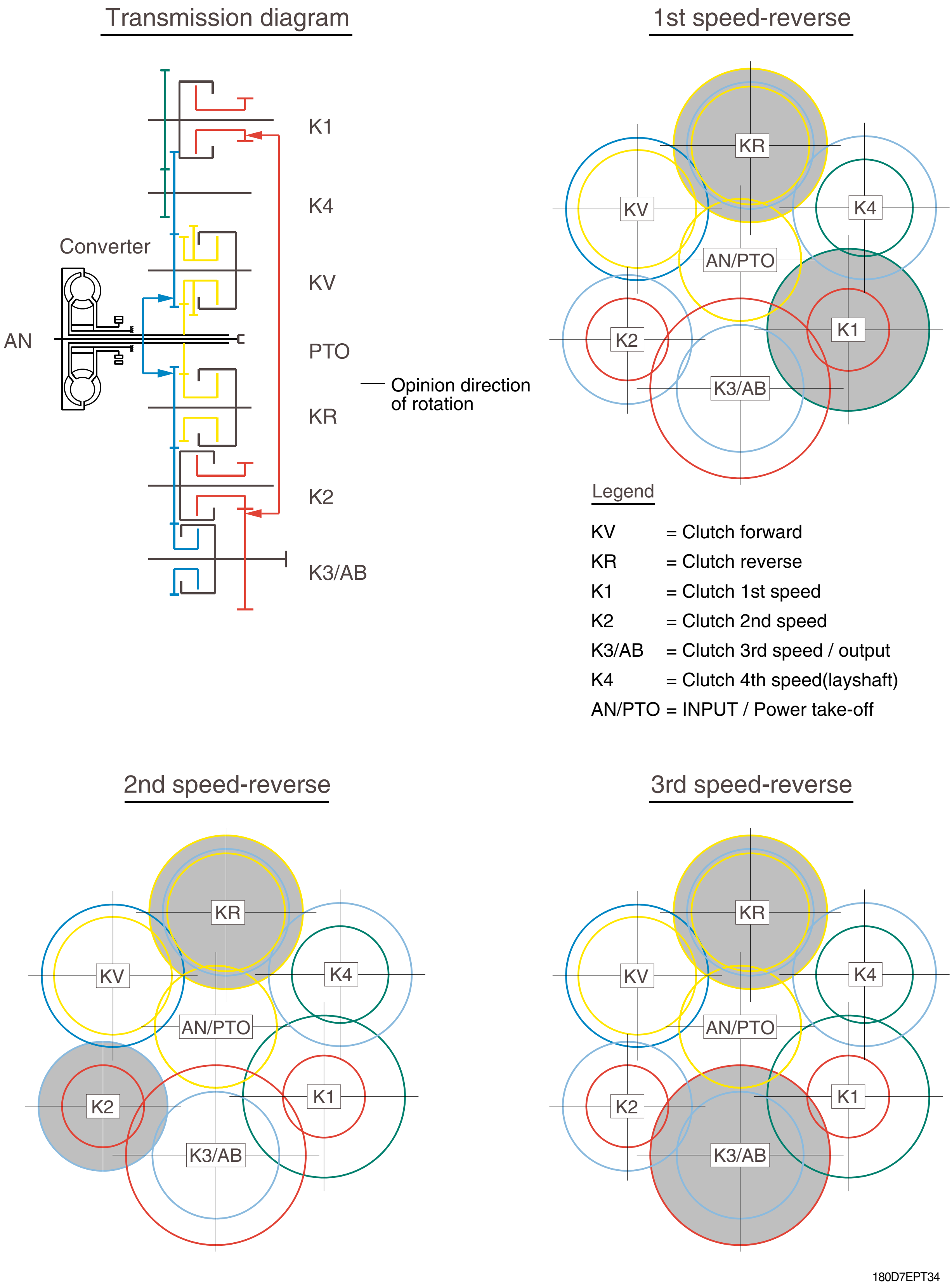


180D7EPT33

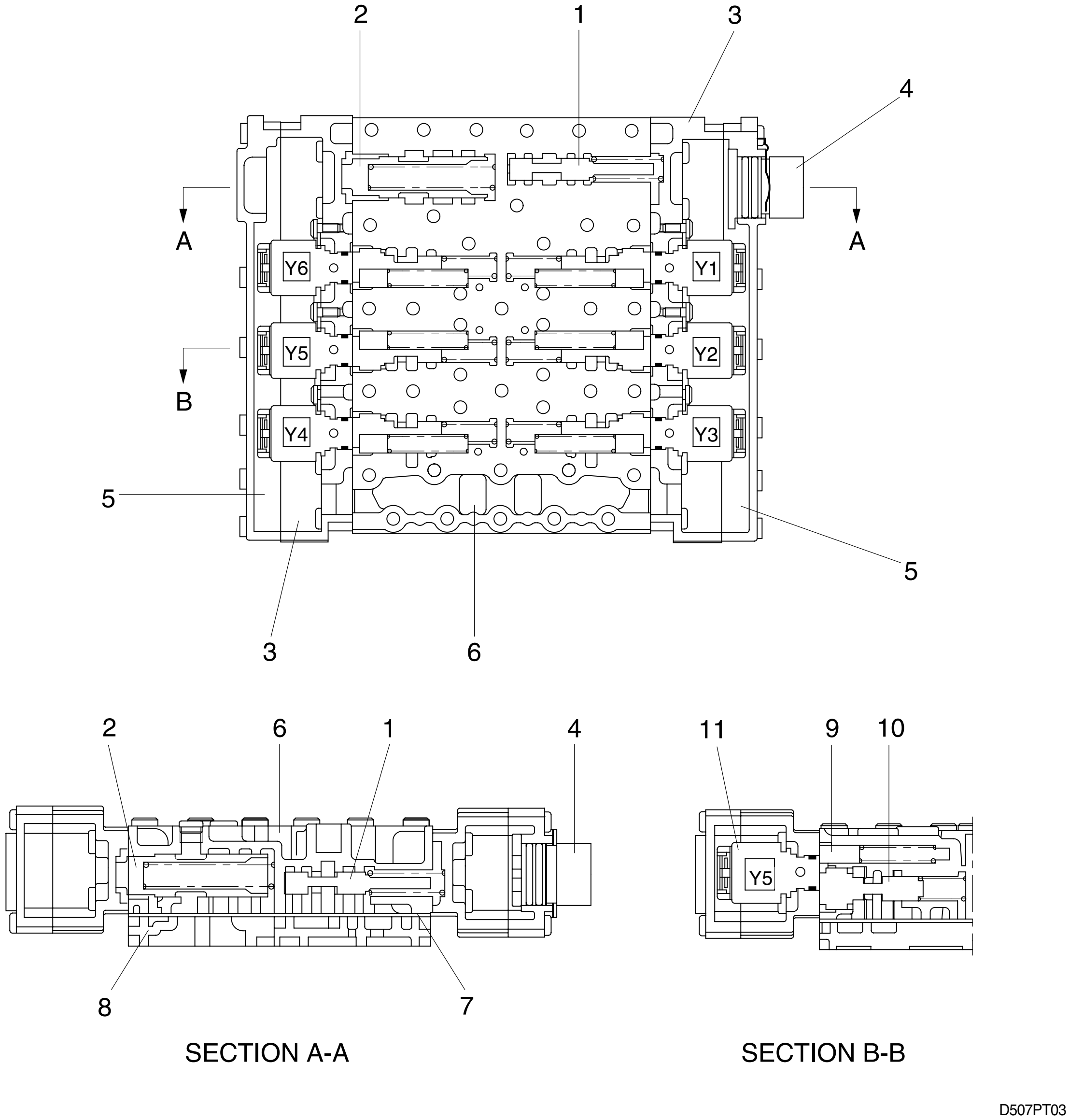
(3) Reverse

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.



4) ELECTRO-HYDRAULIC SHIFT CONTROL WITH PROPORTIONAL VALVE



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

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

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

The feed rate of the pump is
$Q = 105\ l$ /min, at $n_{Engine} = 2000\ min^{-1}$
This pump is sucking the oil via the coarse filter out of the oil sump and delivers it via the fine filter - the filter can also be fitted externally from the transmission - to the main pressure valve.

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

The five clutches of the transmission are selected via the 5 proportional valves P2 to P6.
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+0.5bar for the actuation of the follow-on slides is created by pressure reducing valve. The pressure oil(16+2bar) is directed via the follow-on slide to the respective clutch.

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

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

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

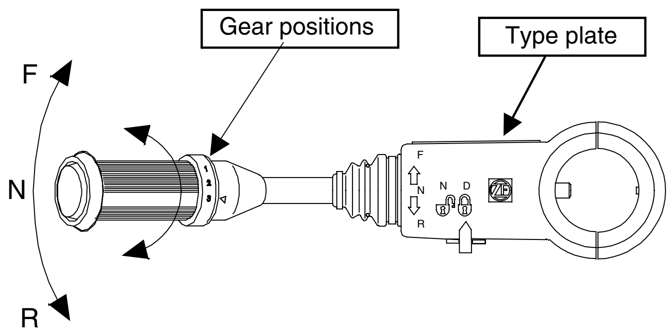
This is achieved by converter pressure back-up valve, rear-mounted to the converter, with an opening pressure of at least 4.3+3bar.
The oil, escaping out of the converter, is directed to the oil cooler.

From the oil cooler, the oil is directed to the transmission and there to the lubricating oil circuit, so that all lubricating points are supplied with cooled oil.
In the electrohydraulic control unit are 5 pressure regulators installed.

5) GEAR SELECTOR(DW-3)

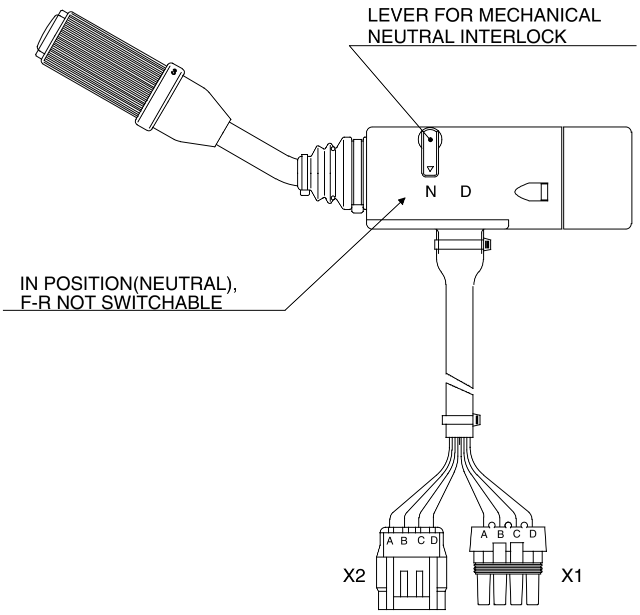
The gear selector is designed for the mounting on the steering column left side. By a rotative motion, the positions(speeds) 1 to 3 are selected by tilting the lever, the driving direction(Forward (F) - Neutral(N) - Reverse(R)).

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



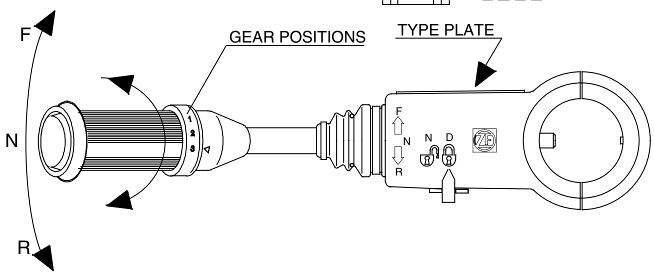
D507PT12

Gear selector(DW-3)



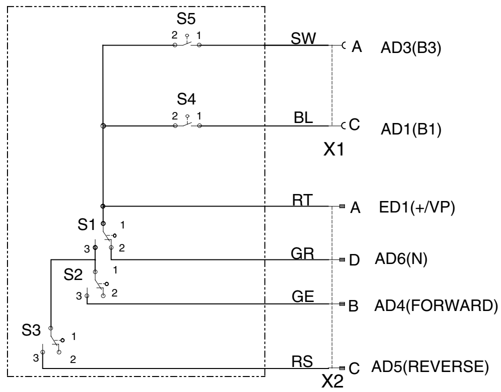
CODING GEAR SELECTOR

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

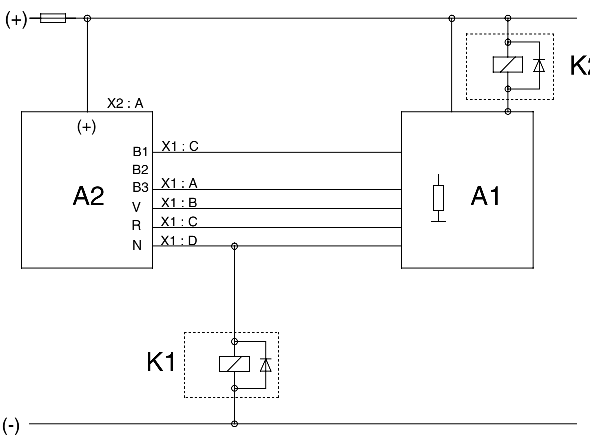


F = FORWARD
N = NEUTRAL
R = REVERSE
D = MECANICAL NEUTRAL INTERLOCK
1 = 1st SPEED
2 = 2nd SPEED
3 = 3rd SPEED

CIRCUIT DIAGRAM SELECTOR



CONNECTION DIAGRAM SELECTOR



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

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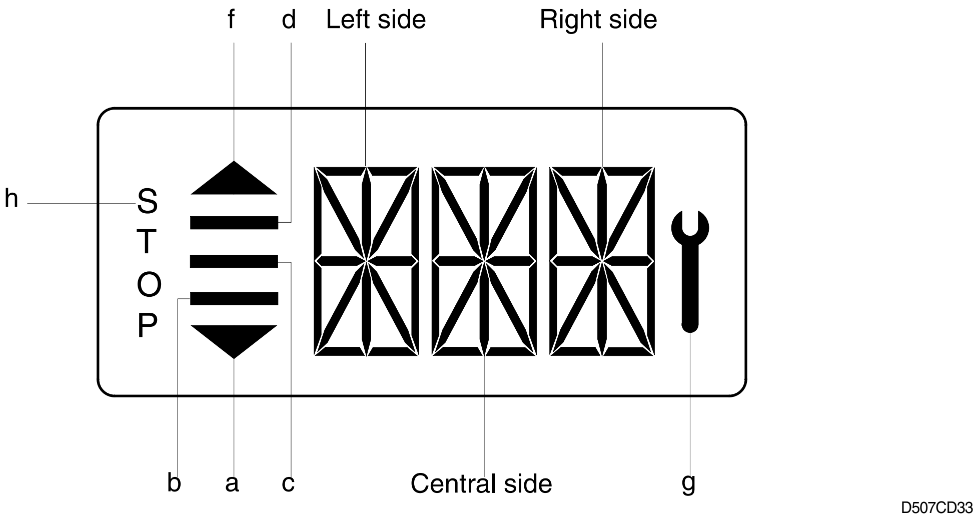
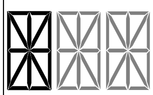
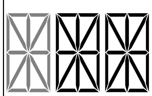
6) TRANSMISSION ERROR DISPLAY

(1) Function

The display can be used with the gear selector. It indicates speed and driving direction as well as the activated inching.

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.



1	Bars	a, f	Automatic range(up and down shifting)
		b, c, d,	Preselected gear
2	Left side		For the moment still without function
3	Central and Right side		On the two alphanumeric 16-segment display, the electric control unit issues the actual state of gear and driving direction. Besides, a two digit error code will be indicated via these two segment
4	Spanner	g	Electronic control unit recognized an error, is flashing
5	Letters **STOP**	h	Immediate stop is required(At the moment not activated)

(2) Abbreviations

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

(3) Display during operation

Symbol	Meaning	Remarks
F, N, R 1, 2, 3	Actual gear and direction Central side shows actual gear Right side shows actual direction	
NN (Central and right side)	Not neutral, waiting for neutral after power up or a reverse fault	To engage a gear, first move shift selector to neutral position and again to F to R position
1 bar	Manual mode lst gear	
2 bar	Manual mode 2nd gear	
3 bar	Manual mode 3nd gear	
3bars and 2 arrows	Automatic mode	a, f
**	Transmission neutral	Cold start phase
Spanner flashing	At least on fault active	Select neutral to get fault code displayed
WT	Warning torque converter temperature	Changes between actual gear/direction while driving, in neutral only displayed if no fault is detected(spanner)
WS	Warning sump temperature	Changes between actual gear/direction while driving, in neutral only displayed if no fault is detected(spanner)
WE	Warning high engine speed	Changes between actual gear/direction while driving, in neutral only displayed if no fault is detected(spanner)
PN	Direction F or R selected while parking brake engaged	Transmission in neutral until parking brake is released. ※ Machine starts to move after release of parking brake.
F or R flashing	Direction F or R selected while turbine speed is to high	※ Gear will engage when turbine speed drops
EE flashing (central and right side)	No communication with display	

(4) Transmission error codes

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

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
23	**S.C. to battery voltage at load sensor input** The measured voltage is too high: · Cable is defective and is contacted to battery voltage · Load sensor has an internal defect · Connector pin is contacted to battery voltage	Retarder function is affected TCU uses default load OP mode : Normal	· Check the cable from TCU to the sensor · Check the connectors · Check the load sensor · Check the assembly tolerances of load sensor ※ Availability of retarder depends on default load
24	**S.C. to ground or O.C. at load sensor input** The measured voltage is too low: · Cable is defective and is contacted to vehicle ground · Cable has no connection to TCU · Load sensor has as internal defect · Connector pin is contacted to vehicle ground or is broken	Retarder function is affected TCU use default load OP mode : Normal	· Check the cable from TCU to the sensor · Check the connectors · Check the load sensor · Check the assembly tolerances of load sensor ※ Availability of retarder depends on default load
25	**S.C. to battery voltage or O.C. at transmi-ssion sump temperature sensor input** The measured voltage is too high: · Cable is defective and is contacted to battery voltage · Cable has no connection to TCU · Temperature sensor has an internal defect · Connector pin is contacted to battery voltage or is broken	No reaction, TCU use default temperature OP mode : Normal	· Check the cable from TCU to the sensor · Check the connectors · Check the temperature sensor
26	**S.C. to battery voltage or O.C. at transmi-ssion sump temperature sensor input** The measured voltage is too low: · Cable is defective and is contacted to vehicle ground · Temperature sensor has an internal defect · Connector pin is contacted to vehicle ground	No reaction, TCU uses default temperature OP mode : Normal	· Check the cable from TCU to the sensor · Check the connectors · Check the temperature sensor
27	**S.C. to battery voltage or O.C. at retarder temperature sensor input** The measured voltage is too high: · Cable is defective and is contacted to battery voltage · Cable has no connection to TCU · Temperature sensor has an internal defect · Connector pin is contacted to battery voltage or is broken	No reaction, TCU uses default temperature OP mode : Normal	· Check the cable from TCU to the sensor · Check the connectors · Check the temperature sensor

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

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

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
39	**Logical error at internal speed input** TCU measures a internal speed over a threshold and at the next moment the measured speed is zero · Cable/connector is defective and has bad contact · Speed sensor has an internal defect · Sensor gap has the wrong size	OP mode : Substitute clutch control	· Check the cable from TCU to the sensor · Check the connectors · Check the speed sensor · Check the sensor gap ※ This fault is reset after power up of TCU
3A	**S.C. to battery voltage or O.C. at output speed input** TCU measures a voltage higher than 12.5V at speed input pin · Cable is defective and is contacted to battery voltage · Cable has no connection to TCU · Speed sensor has an internal defect · Connector pin is contacted to battery voltage or has no contact	Special mode for gear selection OP mode : Substitute clutch control If a failure is existing at turbine speed, TCU shifts to neutral OP mode : lamp home	· Check the cable from TCU to the sensor · Check the connectors · Check the speed sensor
3B	**S.C. to ground at output speed input** TCU measures a voltage less than 1.00V at speed input pin · Cable/connector is defective and is contacted to vehicle ground · Speed sensor has an internal defect	Special mode for gear selection OP mode : Substitute clutch control If a failure is existing at turbine speed, TCU shifts to neutral OP mode : lamp home	· Check the cable from TCU to the sensor · Check the connectors · Check the speed sensor
3C	**Logical error at output speed input** TCU measures a turbine speed over a threshold and at the next moment the measured speed is zero · Cable/connector is defective and has bad contact · Speed sensor has an internal defect · Sensor gap has the wrong size	Special mode for gear selection OP mode : Substitute clutch control If a failure is existing at turbine speed, TCU shifts to neutral OP mode : lamp home	· Check the cable from TCU to the sensor · Check the connectors · Check the speed sensor · Check the sensor gap ※ This fault is reset after power up of TCU
3D	**Turbine speed zero doesn't fit to other speed signals**	-	※ Not used
3E	**Output speed zero doesn't fit to other speed signals** If transmission is not neutral and the shifting has finished, TCU measures output speed zero and turbine speed or internal speed not equal to zero. · Speed sensor has an internal defect · Sensor gap has the wrong size	Special mode for gear selection OP mode : Substitute clutch control If a failure is existing at turbine speed, TCU shifts to neutral OP mode : lamp home	· Check the sensor signal of output speed sensor · Check the sensor gap of output speed sensor · Check the cable from TCU to the sensor ※ This fault is reset after power up of TCU

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
71	**S.C. to battery voltage at clutch K1** The measured resistance value of the valve is out of limit, the voltage at K1 valve is too high · Cable/connector is defective and has contact to battery voltage · Cable/connector is defective and has contact to another regulator output of the TCU · Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	· Check the cable from TCU to the gearbox · Check the connectors from TCU to the gearbox · Check the regulator resistance* · Check internal wire harness of the gearbox * See page 3-36
72	**S.C. to ground at clutch K1** The measured resistance value of the valve is out of limit, the voltage at K1 valve is too low · Cable/connector is defective and has contact to vehicle ground · Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	· Check the cable from TCU to the gearbox · Check the connectors from gearbox to TCU · Check the regulator resistance* · Check internal wire harness of the gearbox * See page 3-36
73	**O.C. at clutch K1** The measured resistance value of the valve is out of limit · Cable/connector is defective and has no contact to TCU · Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	· Check the cable from TCU to the gearbox · Check the connectors from gearbox to TCU · Check the regulator resistance* · Check internal wire harness of the gearbox * See page 3-36
74	**S.C. to battery voltage at clutch K2** The measured resistance value of the valve is out of limit, the voltage at K2 valve is too high · Cable/connector is defective and has contact to battery voltage · Cable/connector is defective and has contact to another regulator output of the TCU · Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	· Check the cable from TCU to the gearbox · Check the connectors from gearbox to TCU · Check the regulator resistance* · Check internal wire harness of the gearbox * See page 3-36
75	**S.C. to ground at clutch K2** The measured resistance value of the valve is out of limit, the voltage at K2 valve is too low · Cable/connector is defective and has contact to vehicle ground · Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	· Check the cable from TCU to the gearbox · Check the connectors from gearbox to TCU · Check the regulator resistance* · Check internal wire harness of the gearbox * See page 3-36
76	**O.C. at clutch K2** The measured resistance value of the valve is out of limit · Cable/connector is defective and has no contact to TCU · Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	· Check the cable from TCU to the gearbox · Check the connectors from gearbox to TCU · Check the regulator resistance* · Check internal wire harness of the gearbox * See page 3-36

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
77	**S.C. to battery voltage at clutch K3** The measured resistance value of the valve is out of limit, the voltage at K3 valve is too high · Cable/connector is defective and has contact to battery voltage · Cable/connector is defective and has contact to another regulator output of the TCU · Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	· Check the cable from TCU to the gearbox · Check the connectors from gearbox to TCU · Check the regulator resistance* · Check internal wire harness of the gearbox * See page 3-36
78	**S.C. to ground at clutch K3** The measured resistance value of the valve is out of limit, the voltage at K3 valve is too low · Cable/connector is defective and has contact to vehicle ground · Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	· Check the cable from TCU to the gearbox · Check the connectors from gearbox to TCU · Check the regulator resistance* · Check internal wire harness of the gearbox * See page 3-36
79	**O.C. at clutch K2** The measured resistance value of the valve is out of limit Cable/connector is defective and has no contact to TCU Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	· Check the cable from TCU to the gearbox · Check the connectors from gearbox to TCU · Check the regulator resistance* · Check internal wire harness of the gearbox * See page 3-36
7A	**S.C. to battery voltage at converter clutch**	-	-
7B	**S.C. to ground at converter clutch**	-	-
7C	**O.C. at converter clutch**	-	※ Not used
7D	**S.C. ground at engine derating device** · Cable is defective and is contacted to vehicle ground · Engine derating device has an internal defect · Connector pin is contacted to vehicle ground	Engine derating will be on until TCU power down even if fault vanishes(Loose connection) OP mode : Normal	· Check the cable from TCU to the engine derating device · Check the connectors from engine derating device to TCU · Check the resistance* of engine derating device ※ Not used * See page 3-36
7E	**S.C. battery voltage at engine derating device** · Cable/connector is defective and is contacted to battery voltage · Engine derating device has an internal defect	No reaction OP mode : Normal	· Check the cable from TCU to the engine derating device · Check the connectors from backup alarm device to TCU · Check the resistance* of backup alarm device * See page 3-36

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
7F	**O.C. at engine derating device** TCU detected a wrong voltage at the output pin, that looks like a O.C. for this output pin · Cable is defective and has no connection to TCU · Engine derating device has an internal defect · Connector has no connection to TCU	No reaction OP mode : Normal	· Check the cable from TCU to the engine derating device · Check the connectors from engine derating device to TCU · Check the resistance* of engine derating device * See page 3-36
85	**S.C. to ground at clutch KV** The measured resistance value of the valve is out of limit, the voltage at K4 valve is too low · Cable/connector is defective and has contact to vehicle ground · Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	· Check the cable from TCU to the gearbox · Check the connectors from gearbox to TCU · Check the regulator resistance* · Check internal wire harness of the gearbox * See page 3-36
86	**O.C. at clutch KV** The measured resistance value of the valve is out of limit · Cable/connector is defective and has contact to TCU · Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	· Check the cable from TCU to the gearbox · Check the connectors from gearbox to TCU · Check the regulator resistance* · Check internal wire harness of the gearbox * See page 3-36
87	**S.C. to battery voltage at clutch KR** The measured resistance value of the valve is out of limit, the voltage at KR valve is too high · Cable/connector is defective and has contact to battery voltage · Cable/connector is defective and has contact to another regulator output of the TCU · Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	· Check the cable from TCU to the gearbox · Check the connectors from gearbox to TCU · Check the regulator resistance* · Check internal wire harness of the gearbox * See page 3-36

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
88	**S.C. to ground at clutch KR** The measured resistance value of the valve is out of limit, the voltage at KR valve is too low · Cable/connector is defective and has contact to vehicle ground · Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	· Check the cable from TCU to the gearbox · Check the connectors from gearbox to TCU · Check the regulator resistance* · Check internal wire harness of the gearbox * See page 3-36
89	**O.C. at clutch KR** The measured resistance value of the valve is out of limit · Cable/connector is defective and has no contact to TCU · Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	· Check the cable from TCU to the gearbox · Check the connectors from gearbox to TCU · Check the regulator resistance* · Check internal wire harness of the gearbox * See page 3-36
91	**S.C. to ground at relay reverse warning alarm** TCU detected a wrong voltage at the output pin, that looks like a S.C. to vehicle ground · Cable is defective and is contact to vehicle ground · Backup alarm device has an internal defect · Connector pin is contacted to vehicle ground	Backup alarm will be on until TCU power down even if fault vanishes(Loose connection) OP mode : Normal	· Check the cable from TCU to the backup alarm device · Check the connectors from backup alarm device to TCU · Check the resistance* of backup alarm device * See page 3-36
92	**S.C. to battery voltage at relay reverse warning alarm** TCU detected a wrong voltage at the output pin, that looks like a S.C. to battery voltage · Cable is defective and is contacted to battery voltage · Backup alarm device has an internal defect · Connector pin is contacted to battery voltage	No reaction OP mode : Normal	· Check the cable from TCU to the backup alarm device · Check the connectors from backup alarm device to TCU · Check the resistance* of backup alarm device * See page 3-36

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
93	**O.C. at relay reverse warning alarm** TCU detected a wrong voltage at the output pin, that looks like a O.C. for this output pin · Cable is defective and has no connection to TCU · Backup alarm device has an internal defect · Connector has no connection to TCU	No reaction OP mode : Normal	· Check the cable from TCU to the backup alarm device · Check the connectors from backup alarm device to TCU · Check the resistance* of backup alarm device * See page 3-36
94	**S.C. to ground at relay starter interlock** TCU detected a wrong voltage at the output pin, that looks like a S.C. to vehicle ground · Cable is defective and is connection to vehicle ground · Starter interlock relay has an internal defect · Connector pin is contacted to vehicle ground	No reaction OP mode : Normal	· Check the cable from TCU to the stater interlock relay · Check the connectors from starter interlock relay to TCU · Check the resistance* of starter interlock relay * See page 3-36
95	**S.C. to battery voltage at relay starter interlock** TCU detected a wrong voltage at the output pin, that looks like a S.C. to battery voltage · Cable is defective and has no connection to battery voltage · Starter interlock relay has an internal defect · Connector pin is contacted to battery voltage	No reaction OP mode : Normal	. Check the cable from TCU to the starter interlock relay . Check the connectors from starter interlock relay to TCU . Check the resistance* of starter interlock relay * See page 3-36
96	**O.C. at relay starter interlock** TCU detected a wrong voltage at the output pin, that looks like a O.C. for this output pin · Cable is defective and has no connection to TCU · Starter interlock relay has an internal defect · Connector has no connection to TCU	No reaction OP mode : Normal	· Check the cable from TCU to the starter interlock relay · Check the connectors from starter interlock relay to TCU · Check the resistance* of starter interlock relay * See page 3-36

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
97	**S.C. to ground at park brake solenoid** TCU detected a wrong voltage at the output pin, that looks like a S.C. to vehicle ground · Cable is defective and is connection to vehicle ground · Park brake solenoid has an internal defect · Connector pin is contacted to vehicle ground	No reaction OP mode : Normal	· Check the cable from TCU to the park brake solenoid · Check the connectors from park brake solenoid to TCU · Check the resistance* of park brake solenoid * See page 3-36
98	**S.C. to battery voltage at park brake solenoid** TCU detected a wrong voltage at the output pin, that looks like a S.C. to battery voltage · Cable is defective and is connection to battery voltage · Park brake solenoid has an internal defect · Connector pin is contacted to battery voltage	No reaction Optional : (Some customers) TCU shifts to neutral caused by park brake feed back OP mode : Normal	· Check the cable from TCU to the park brake solenoid · Check the connectors from park brake solenoid to TCU · Check the resistance* of park brake solenoid * See page 3-36
99	**O.C. at park brake solenoid** TCU detected a wrong voltage at the output pin, that looks like a O.C. for this output pin · Cable is defective and has no connection to TCU · Park brake solenoid has an internal defect · Connector has no connection to TCU	No reaction Optional : Some customers TCU shifts to neutral caused by park brake feed back OP mode : Normal	· Check the cable from TCU to the park brake solenoid · Check the connectors from park brake solenoid to TCU · Check the resistance* of park brake solenoid * See page 3-36
9A	**S.C. to ground at converter lock up clutch solenoid** TCU detected a wrong voltage at the output pin, that looks like a S.C. to vehicle ground · Cable is defective and is contacted to vehicle ground · Converter clutch solenoid has an internal defect · Connector pin is contacted to vehicle ground	No reaction OP mode : Normal	· Check the cable from TCU to the converter clutch solenoid · Check the connectors from converter clutch solenoid to TCU · Check the resistance* of park brake solenoid * See page 3-36
9B	**O.C. at converter lock up clutch solenoid** TCU detected a wrong voltage at the output pin, that looks like a O.C. for this output pin · Cable is defective and has no connection to TCU · Converter clutch solenoid has an internal defect · Connector has no connection to TCU	Converter clutch always open, retarder not available OP mode : Normal	· Check the cable from TCU to the converter clutch solenoid · Check the connectors from converter clutch solenoid to TCU · Check the resistance* of park brake solenoid * See page 3-36

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
9C	**S.C. to battery voltage at converter lock up clutch solenoid** TCU detected a wrong voltage at the output pin, that looks like a S.C. to battery voltage · Cable is defective and has no contacted to battery voltage · Converter clutch solenoid has an internal defect · Connector pin is contacted to battery voltage	No reaction OP mode : Normal	· Check the cable from TCU to the converter clutch solenoid · Check the connectors from converter clutch solenoid to TCU · Check the resistance* of converter clutch solenoid * See page 3-36
9D	**S.C. to ground at retarder solenoid** TCU detected a wrong voltage at the output pin, that looks like a S.C. to vehicle ground · Cable is defective and is contacted to vehicle ground · Retarder solenoid has an internal defect · Connector pin is contacted to vehicle ground	No reaction OP mode : Normal	· Check the cable from TCU to the retarder solenoid · Check the connectors from retarder solenoid to TCU · Check the resistance* of retarder solenoid * See page 3-36
9E	**O.C. at retarder solenoid** TCU detected a wrong voltage at the output pin, that looks like a O.C. for this output pin · Cable is defective and has no connection to TCU · Retarder solenoid has an internal defect · Connector has no connection to TCU	No reaction OP mode : Normal	· Check the cable from TCU to the retarder solenoid · Check the connectors from retarder solenoid to TCU · Check the resistance* of retarder solenoid * See page 3-36
9F	**S.C. to battery voltage at retarder solenoid** TCU detected a wrong voltage at the output pin, that looks like a S.C. to battery voltage · Cable is defective and has no connection to battery voltage · Retarder solenoid has an internal defect · Connector pin is contacted to battery voltage	No reaction OP mode : Normal	· Check the cable from TCU to the retarder solenoid · Check the connectors from retarder solenoid to TCU · Check the resistance* of retarder solenoid * See page 3-36

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
A1	**S.C. to ground at difflock or axle connection solenoid** TCU detected a wrong voltage at the output pin, that looks like a S.C. to vehicle ground · Cable is defective and is contacted to vehicle ground · Difflock solenoid has an internal defect · Connector pin is contacted to vehicle ground	No reaction OP mode : Normal	· Check the cable from TCU to the difflock solenoid · Check the connectors from difflock solenoid to TCU · Check the resistance* of difflock solenoid * See page 3-36
A2	**S.C. to battery voltage at difflock or axle connection solenoid** TCU detected a wrong voltage at the output pin, that looks like a S.C. to battery voltage · Cable is defective and has no connection to battery voltage · Difflock solenoid has an internal defect · Connector pin is contacted to battery voltage	No reaction OP mode : Normal	· Check the cable from TCU to the difflock solenoid · Check the connectors from difflock solenoid to TCU · Check the resistance* of difflock solenoid * See page 3-36
A3	**O.C. at difflock or axle connection solenoid** TCU detected a wrong voltage at the output pin, that looks like a O.C. for this output pin · Cable is defective and has no connection to TCU · Difflock solenoid has an internal defect · Connector has no connection to TCU	No reaction OP mode : Normal	· Check the cable from TCU to the difflock solenoid · Check the connectors from difflock solenoid to TCU · Check the resistance* of difflock solenoid * See page 3-36
A4	**S.C. to ground at warning signal output** TCU detected a wrong voltage at the output pin, that looks like a S.C. to vehicle ground · Cable is defective and is contacted to vehicle ground · Warning device has an internal defect · Connector pin is contacted to vehicle ground	No reaction OP mode : Normal	· Check the cable from TCU to the warning device · Check the connectors from warning device to TCU · Check the resistance* of warning device * See page 3-36
A5	**O.C. voltage at warning signal output** TCU detected a wrong voltage at the output pin, that looks like a O.C. for this output pin · Cable is defective and has no connection to TCU · Warning device has an internal defect · Connector has no connection to TCU	No reaction OP mode : Normal	· Check the cable from TCU to the warning device · Check the connectors from warning device to TCU · Check the resistance* of warning device * See page 3-36
A6	**S.C. to battery voltage at warning signal output** TCU detected a wrong voltage at the output pin, that looks like a S.C. to battery voltage · Cable is defective and has is contacted to battery voltage · Warning device has an internal defect · Connector pin is contacted to battery voltage	No reaction OP mode : Normal	· Check the cable from TCU to the warning device · Check the connectors from warning device to TCU · Check the resistance* of warning device * See page 3-36

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

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
B5	**Slippage at clutch KV** TCU calculates a differential speed at closed clutch KV. If this calculated value is out of range, TCU interprets this as slipping clutch · Low pressure at clutch KV · Low main pressure · Wrong signal at internal speed sensor · Wrong signal at turbine speed sensor · Wrong size of the sensor gap · Clutch is defective	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	· Check pressure at clutch KV · Check main pressure in the system · Check sensor gap at internal speed sensor · Check sensor gap at turbine speed sensor · Check signal at internal speed sensor · Check signal at turbine speed sensor · Replace clutch
B6	**Slippage at clutch KR** TCU calculates a differential speed at closed clutch KR. If this calculated value is out of range, TCU interprets this as slipping clutch · Low pressure at clutch KR · Low main pressure · Wrong signal at internal speed sensor · Wrong signal at turbine speed sensor · Wrong size of the sensor gap · Clutch is defective	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	· Check pressure at clutch KR · Check main pressure in the system · Check sensor gap at internal speed sensor · Check sensor gap at turbine speed sensor · Check signal at internal speed sensor · Check signal at turbine speed sensor · Replace clutch
B7	**Overtemp sump** TCU measured a temperature in the oil sump that is over the allowed threshold.	No reaction OP mode : Normal	· Cool down machine · Check oil level · Check temperature sensor
B8	**Overtemp retarder** TCU measured a temperature in the retarder oil that is over the allowed threshold	TCU disables retarder OP mode : Normal	· Cool down machine · Check oil level · Check temperature sensor
B9	**Overspend engine**	Retarder applies OP mode : Normal	-
BA	**Differential pressure oil filter** TCU measured a voltage at differential pressure switch out of the allowed range · Oil filter is polluted · Cable/connector is broken or cable/ connector is contacted to battery voltage or vehicle ground · Differential pressure switch is defective	No reaction OP mode : Normal	· Check oil filter · Check wiring from TCU to differential pressure switch · Check differential pressure switch(Measure resistance)

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
BB	**Slippage at converter lockup clutch** TCU calculates a differential speed at closed converter lockup clutch. If this calculated value is out of range, TCU interprets this as slipping clutch · Low pressure at converter lockup clutch · Low main pressure · Wrong signal at engine speed sensor · Wrong signal at turbine speed sensor · Wrong size of the sensor gap · Clutch is defective	-	· Check pressure at converter lockup clutch · Check main pressure in the system · Check sensor gap at engine speed sensor · Check sensor gap at turbine speed sensor · Check signal at engine speed sensor · Check signal at turbine speed sensor · Replace clutch
BD	**S.C. to ground at engine brake solenoid** TCU detected a wrong voltage at the output pin, that looks like a S.C. to vehicle ground · Cable is defective and is contacted to vehicle ground · Engine brake solenoid has an internal defect · Connector pin is contacted to vehicle ground	No reaction OP mode : Normal	· Check the cable from TCU to engine brake solenoid · Check the connectors from engine brake solenoid to TCU · Check the resistance* of engine brake solenoid * See page 3-36
BE	**S.C. to battery voltage at engine brake** TCU detected a wrong voltage at the output pin, that looks like a S.C. to battery voltage · Cable is defective and is contacted to battery voltage · Engine brake solenoid has an internal defect · Connector pin is contacted to battery voltage	No reaction OP mode : Normal	· Check the cable from TCU to the engine brake solenoid · Check the connectors from engine brake solenoid to TCU · Check the resistance* of engine brake solenoid * See page 3-36
BF	**O.C. at engine brake** TCU detected a wrong voltage at the output pin, that looks like a O.C. for this output pin · Cable is defective and has no connection to TCU · Engine brake solenoid has an internal defect · Connector has no connection to TCU	No reaction OP mode : Normal	· Check the cable from TCU to the engine brake solenoid · Check the connectors from engine brake solenoid to TCU · Check the resistance* of engine brake solenoid * See page 3-36

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
C3	**Overtemp converter output** TCU measured a oil temperature at the converter output that is the allowed threshold	No reaction OP mode : Normal	· Cool down machine · Check oil level · Check temperature sensor
C4	**S.C. to ground at joystick status indicator** TCU detected a wrong voltage at the output pin, that looks like a S.C. to vehicle ground · Cable is defective and is contacted to vehicle ground · Joystick status indicator has an internal defect · Connector pin is contacted to vehicle ground	No reaction OP mode : Normal	· Check the cable from TCU to joystick status indicator · Check the connectors from joystick status indicator to TCU · Check the resistance* of joystick status indicator * See page 3-36
C5	**S.C. to battery voltage at joystick status indicator** TCU detected a wrong voltage at the output pin, that looks like a S.C. to battery voltage · Cable is defective and is contacted to battery voltage · Joystick status indicator has an internal defect · Connector pin is contacted to battery voltage	No reaction OP mode : Normal	· Check the cable from TCU to joystick status indicator · Check the connectors from joystick status indicator to TCU · Check the resistance* of joystick status indicator * See page 3-36
C6	**O.C. at joystick status indicator** TCU detected a wrong voltage at the output pin, that looks like a O.C. for this output pin · Cable is defective and has no connection to TCU · Joystick status indicator has an internal defect · Connector pin has no connection to TCU	No reaction OP mode : Normal	· Check the cable from TCU to joystick status indicator · Check the connectors from joystick status indicator to TCU · Check the resistance* of joystick status indicator * See page 3-36

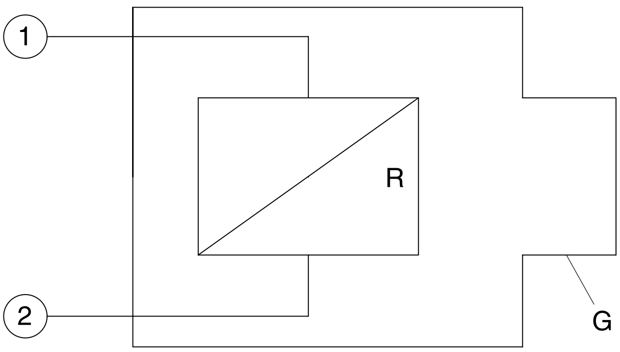
Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
D1	**S.C. to battery voltage at power supply for sensors** TCU measures more than 6V at the pin AU1 (5V sensor supply)	See fault codes No.21 to 2C	· Check cables and connectors to sensors, which are supplied from AU1 · Check the power supply at the pin AU1(Should be appx. 5V) ※ Fault codes No.21 to No.2C may be reaction of this fault
D2	**S.C. to ground at power supply for sensors** TCU measures less than 4V at the pin AU1 (5V sensor supply)	See fault codes No.21 to 2C	· Check cables and connectors to sensors, which are supplied from AU1 · Check the power supply at the pin AU1(Should be appx. 5V) ※ Fault codes No.21 to No.2C may be reaction of this fault
D3	**Low voltage at battery** Measured voltage at power supply is lower than 18V(24V device)	Shift to neutral OP mode : TCU shutdown	· Check power supply battery · Check cables from batteries to TCU · Check connectors from batteries to TCU
D4	**High voltage at battery** Measured voltage at power supply is higher than 32.5V(24V device)	Shift to neutral OP mode : TCU shutdown	· Check power supply battery · Check cables from batteries to TCU · Check connectors from batteries to TCU
D5	**Error at valve power supply VPS1** TCU switched on VPS1 and measured VPS1 is off or TCU switched off VPS1 and measured VPS1 is still on · Cable or connectors are defect and are contacted to battery voltage · Cable or connectors are defect and are contacted to vehicle ground · Permanent power supply KL30 missing · TCU has an internal defect	Shift to neutral OP mode : TCU shutdown	· Check fuse · Check cables from gearbox to TCU · Check connectors from gearbox to TCU · Replace TCU
D6	**Error at valve power supply VPS2** TCU switched on VPS2 and measured VPS2 is off or TCU switched off VPS2 and measured VPS2 is still on · Cable or connectors are defect and are contacted to battery voltage · Cable or connectors are defect and are contacted to vehicle ground · Permanent power supply KL30 missing · TCU has an internal defect	Shift to neutral OP mode : TCU shutdown	· Check fuse · Check cables from gearbox to TCU · Check connectors from gearbox to TCU · Replace TCU

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

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

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

① Actuator



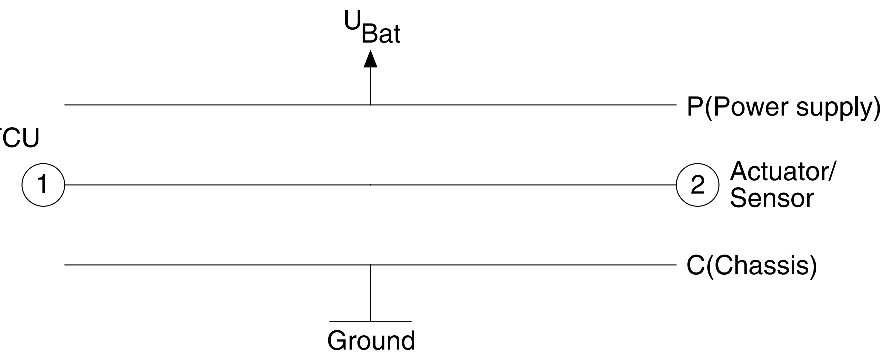
76043PT19

Open circuit $R_{12} = R_{1G} = R_{2G} = \infty$

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

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

② Cable



76043PT20

Open circuit $R_{12} = R_{1P} = R_{1C} = R_{2P} = R_{2C} = \infty$

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

Short cut to battery $R_{12} = 0$; $R_{1C} = R_{2C} = 0$, $R_{1P} = R_{2P} = 0$

7) ELECTRONIC CONTROL FOR POWER TRANSMISSION

(1) Description of the basic functions

The powershift transmission is equipped with TCU.

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

(2) Automatic calibration of the shifting elements (AEB)

The AEB serves to compensate tolerances (plate clearance and pressure level), which are in fluencing the filling procedure of the clutches. For each clutch, the correct filling parameters for

* Period of the rapid - filling time
* Level of the filling equalizing pressure are defined in a test cycle.

The filling parameters are stored, together with the ABE-program and the driving program in the transmission electronics. Because the electronics will be separately supplied, the AEB-cycle must be started only after the installation of both components in the vehicle, thus ensuring the correct mating (transmission and electronics).

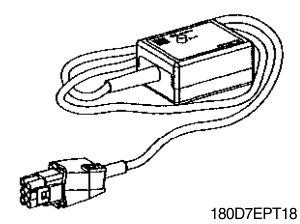
※ At any rate, the AEB - cycle must be carried out at the vehicle manufacturer prior to the commissioning of the vehicles.
It is imperative, to respect the following test conditions :
- Shifting position neutral
- Engine in idling speed
- Praking brake applied
- Transmission in operating temperature

※ After a replacement of the transmission the electrohydraulic control or the TCU in the vehicle the AEB-cycle must be as well carried out again.

The AEB-cycle continues for about 3 to 4 minutes. The determined filling parameters are stored in the EEPROM of the electronics. In this way, the error message F6 shown on the display will be cancelled also at non - performed AEB.

※ For the start of the AEB-cycle there are principally two possibilities :

① Start of the AEB by separate tools which are connected on the diagnostic port of the wiring.
Following tools for the AEB start will be offered by the ZF service ;
- Testmann (see Diagnostic systems)
- AEB Starter
Order - No. : ZGAQ-03870
The Special tool developped by the ZF can be used only for the starting of the AEB.


180D7EPT18

② Start AEB by operating elements on the vehicle.
For it a CAN-communication between transmission and vehicle electronics is necessary.

※ Due to the operation of the transmission the paper friction linings installed in the ergopower transmissions are settling, i.e. the plate clearance becomes greater.
Because these settling appearances can interfere the shifting quality, ZF recommends to repeat the AEB-cycle at the Maintenance intervals.

※ The ZF recommends likewise at a reduced shifting quality as first measure to repeat the AEB-cycle.

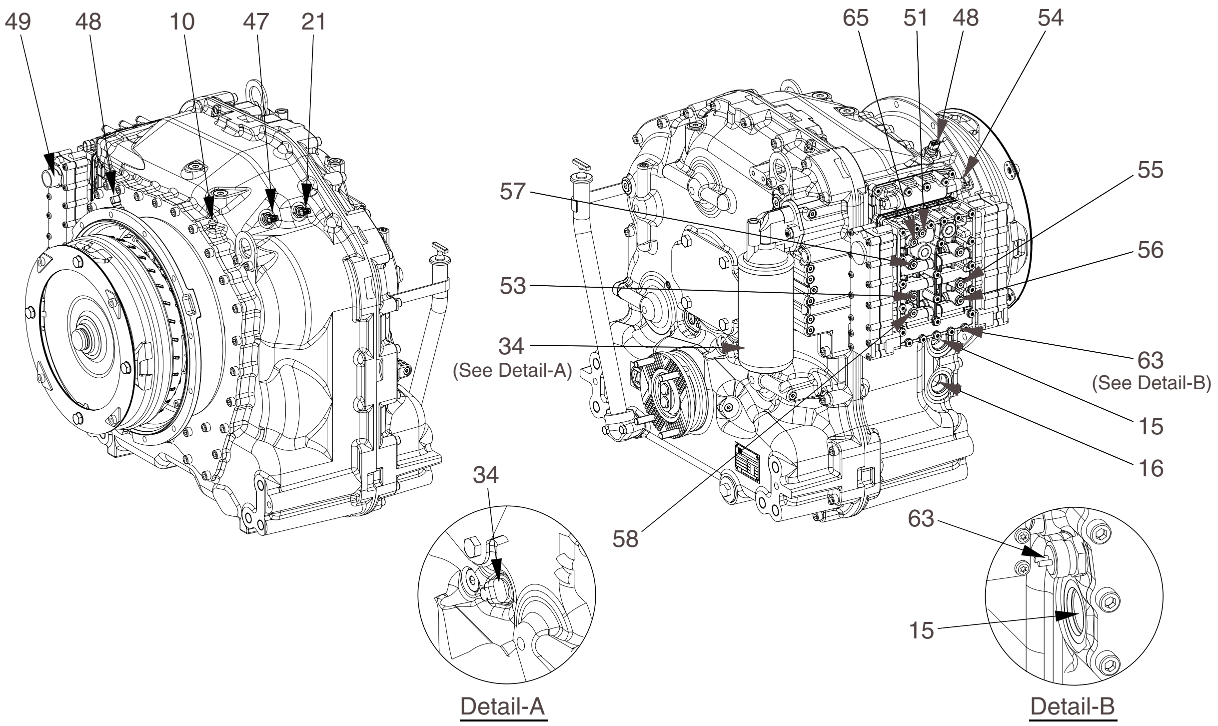
(3) Inching device

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

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

4. TRANSMISSION MEASURING POINTS AND CONNECTIONS

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



180D7ETM04

		· Pressure regulator under voltage					Engaged clutch	
Driving direction	Speed	Y2	Y3	Y4	Y5	Y6		
Forward	1		●		●		K1	KV
	2				●	●	KV	K2
	3			●	●		K3	KV
	1	●	●				KR	K1
Reverse	2	●				●	KR	K2
	3	●		●			KR	K3
Neutral								
Engaged clutch		KR	K1	K3	KV	K2		
Position on valve block		E	D	C	B	A		
Consec. No. Of measuring points		55	56	58	53	57		

1) OIL PRESSURE AND TEMPERATURE

Port	Description			Size
51	In front of converter - Opening pressure 11+2 bar			M10x1
53	Clutch Forward	16 + 2 bar	KV	M10x1
55	Clutch reverse	16 + 2 bar	KR	M10x1
56	Clutch	16 + 2 bar	K1	M10x1
57	Clutch	16 + 2 bar	K2	M10x1
58	Clutch	16 + 2 bar	K3	M10x1
63	Temperature sensor behind the converter			M14x1.5
65	System pressure	16 + 2.5 bar		M10x1

2) MEASURING POINTS FOR DELIVERY RATES

Port	Description	Size
15	Connection to the oil cooler	M33x2
16	Connection from the oil cooler	M33x2

3) INDUCTIVE TRANSMITTER - IMPURSE - SPEED SENSOR AND SWITCH

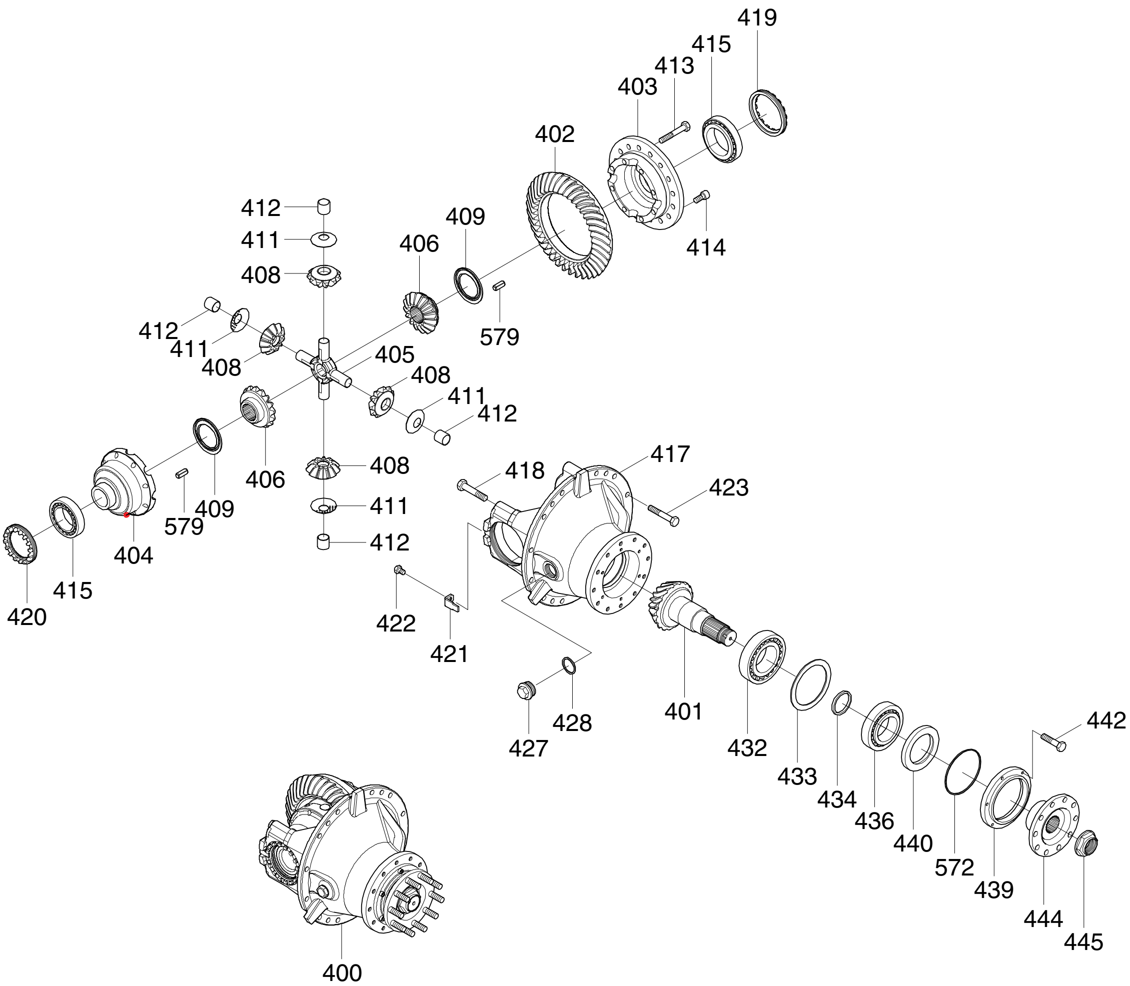
Port	Description		Size
21	Inductive transmitter	n Turbine	M18x1.5
34	Speed sensor	n Output an speedometer	-
47	Inductive transmitter	n Central gear train	M18x1.5
48	Inductive transmitter	n Engine	M18x1.5
54	Filter contamination switch		M14x1.5

4) CONNECTIONS

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

5. DRIVE AXLE

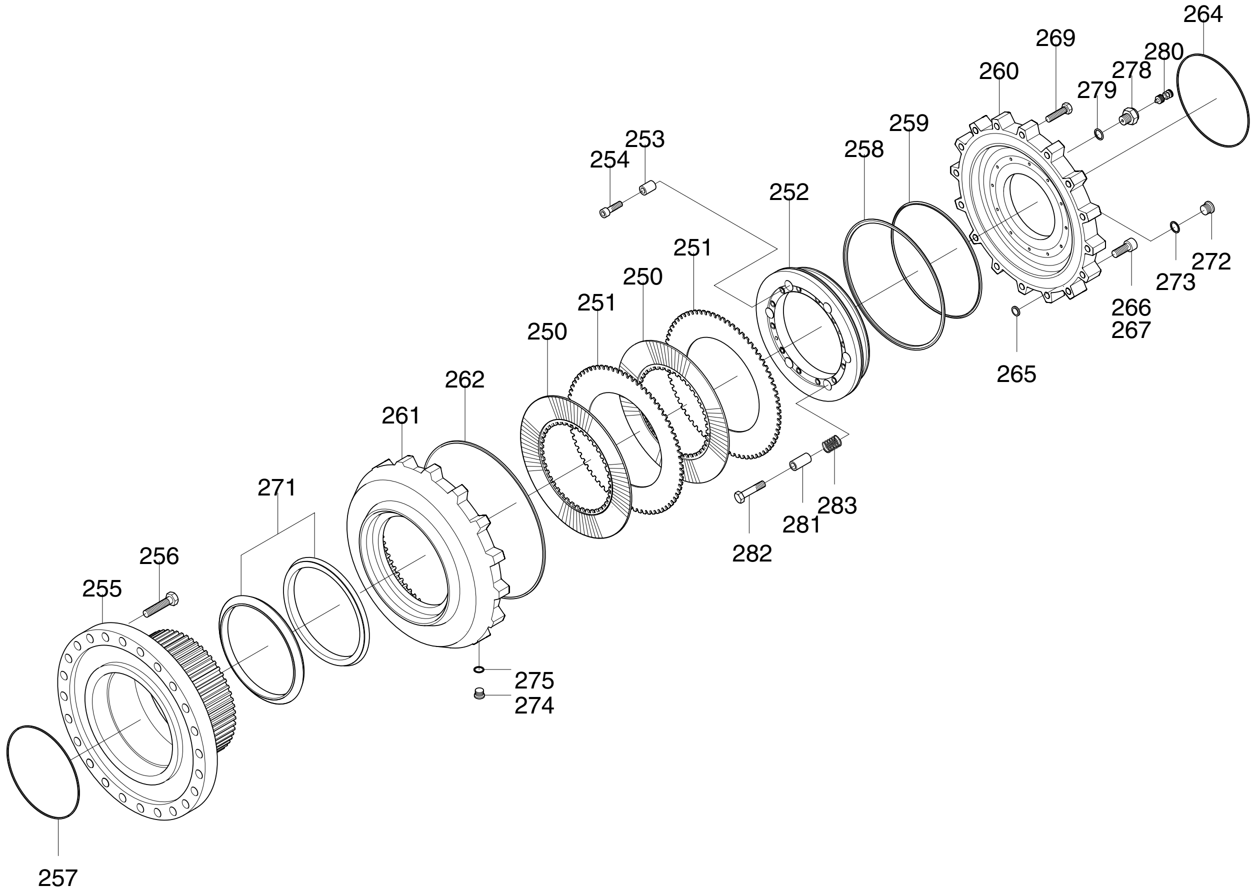
1) STRUCTURE 1



250D7EDR02

400	Differential & carrier	413	Hexagon socket screw	428	Sealing ring
401	Drive pinion	414	Hexagon screw	432	Tapered roller bearing
402	Ring gear	415	Tapered roller bearing	433	Thrust washer
403	Differential housing	417	Differential carrier housing	436	Tapered roller bearing
404	Differential housing	418	Hexagon screw	439	Cover
405	Differential spider	419	Setting ring	440	Radial seal ring
406	Differential side gear	420	Setting ring	442	Hexagon socket screw
408	Differential pinion	421	Lock plate	444	Drive flange
409	Disk	422	Hexagon screw	445	Adjusting nut
411	Thrust washer	423	Hexagon screw	572	O-ring
412	Bearing bushing	427	Screw plug	579	Lock pin

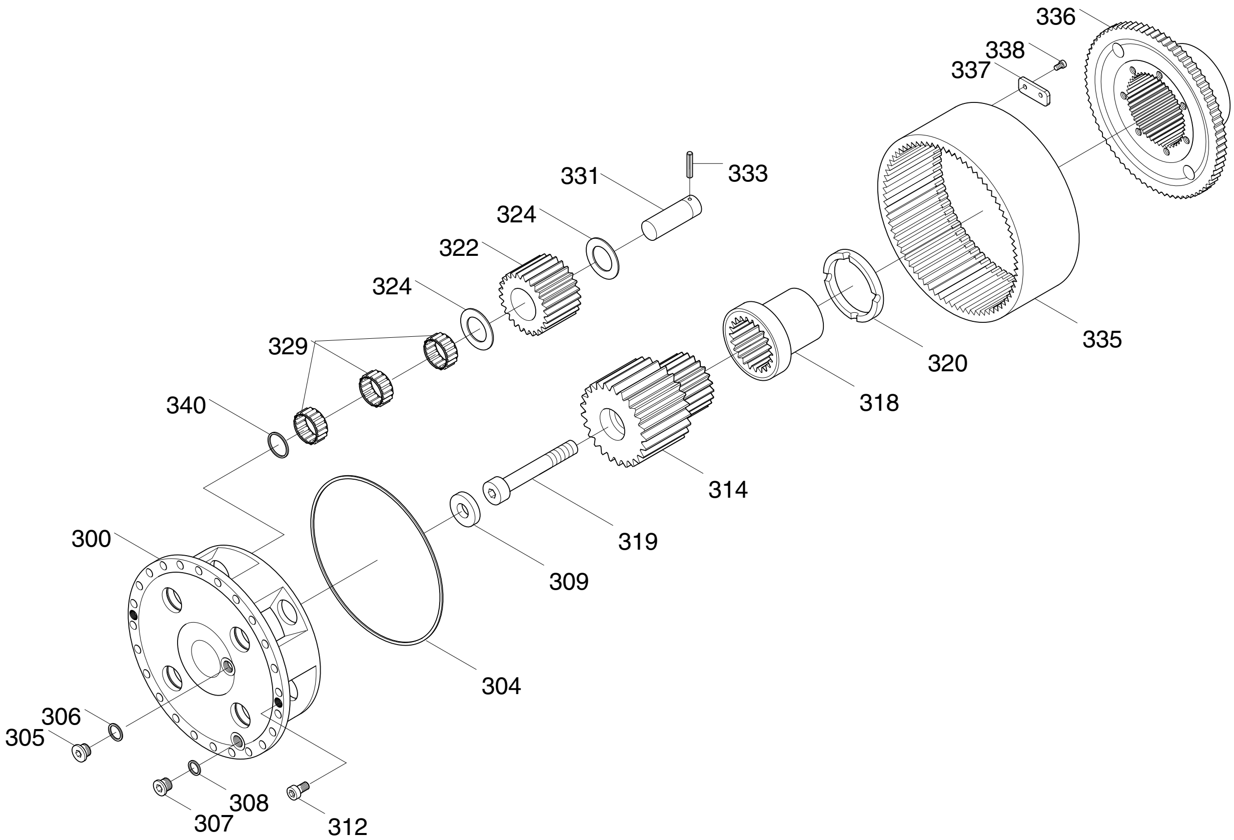
2) STRUCTURE 2



250D7EDR03

250	Inner disk	261	Brake housing	274	Screw plug
251	Outer disk	262	O-ring	275	Sealing ring
252	Piston	264	O-ring	278	Bleeding socket
253	Bushing	265	O-ring	279	Sealing ring
254	Hex socket screw	266	Hex socket screw	280	Bleeder valve
255	Disk carrier	267	Hex socket screw	281	Pipe
256	Hex socket screw	269	Hex screw	282	Hexagon screw with flange
258	Gasket	271	Face seal	283	Compression spring
259	Gasket	272	Screw plug		
260	Brake carrier	273	Sealing ring		

3) STRUCTURE 3



300	Planetary housing	314	Sun gear	331	Planetary pin
304	O-ring	318	Sleeve	333	Locking pin
305	Screw plug	319	Hexagon socket screw	335	Ring gear
306	Sealing ring	320	Thrust ring	336	Ring gear carrier
307	Screw plug	322	Planetary gear	337	Retainer
308	Sealing ring	324	Thrust washer	338	Hexagon screw
309	Thrust washer	329	Needle bearing	340	O-ring
312	Hexagon socket screw				

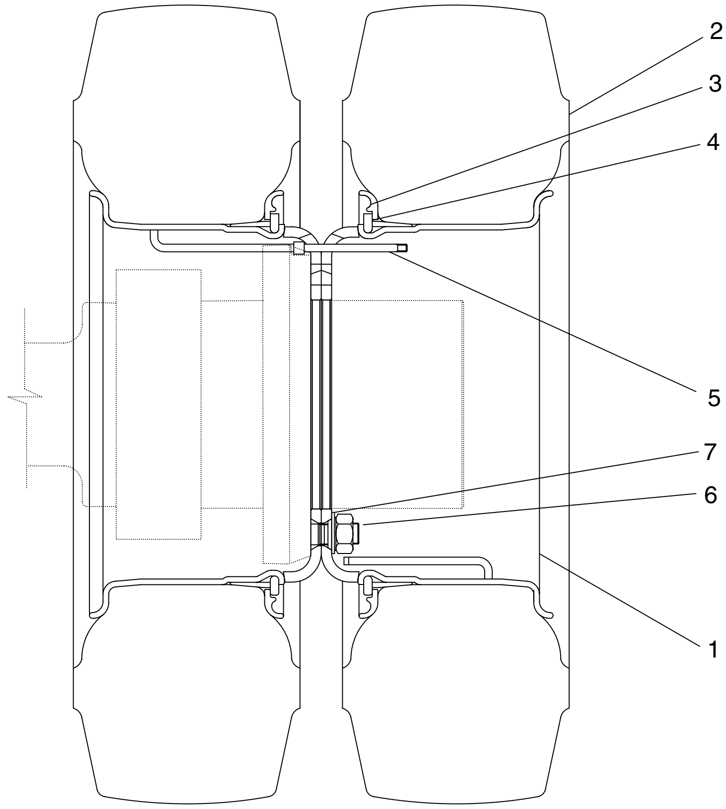
4) OPERATION

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 frame. The final deceleration and differential device built in the housing guarantee accurate rotation and smooth operation.

The power from the transmission in transferred through the pinion, ring 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.

6. TIRE AND WHEEL



250D7EAX68

1	Wheel rim	4	Side ring	7	Harden washer
2	Tire	5	Extension valve		
3	Lock ring	6	Hub nut		

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

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

GROUP 2 OPERATION AND MAINTENANCE

1. OPERATION

1) DRIVING PREPARATION AND MAINTENANCE

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

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

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

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

2) DRIVING AND SHIFTING

(1) Neutral position

Neutral position will be selected via the gear selector.

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

A gear can be engaged.

(2) Starting

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

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

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

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

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

- **Upshifting under load.**
  Upshifting under load will be then realized if the vehicle can continue to accelerate by it.
- **Downshifting under load.**
  Downshifting under load will be then realized if more traction force is needed.

- Upshifting in overrunning condition.

In the overrunning mode, the upshifting will be suppressed by accelerator pedal idling position, if the speed of the vehicle on a downgrade should not be further increased.

- Downshifting in overrunning condition.

Downshifting in overrunning mode will be then carried out if the vehicle should be related.

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

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

3) COLD START

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

Indication on the display:

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

4) OIL TEMPERATURE

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

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

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

Now, the temperature must drop quickly(in about 2-3minutes) 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-3-40)

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 2-3minutes at idling speed, and the marking on the oil dipstick must then be lying above the cold start mark "COLD"
- At operating temperature of the transmission(about 80°-90°C)
- At engine idling speed
- Loosen oil dipstick by counter-clock rotation, remove and clean it
- Insert oil dipstick slowly into the oil level tube until contact is obtained, and pull it out again.
- On the oil dipstick, the oil level must be lying in the zone "HOT"
- Insert the oil dipstick again, and tighten it by clockwise rotation

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

(2) Oil change and filter replacement intervals

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

① Oil change and oil filling capacity

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

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

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

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

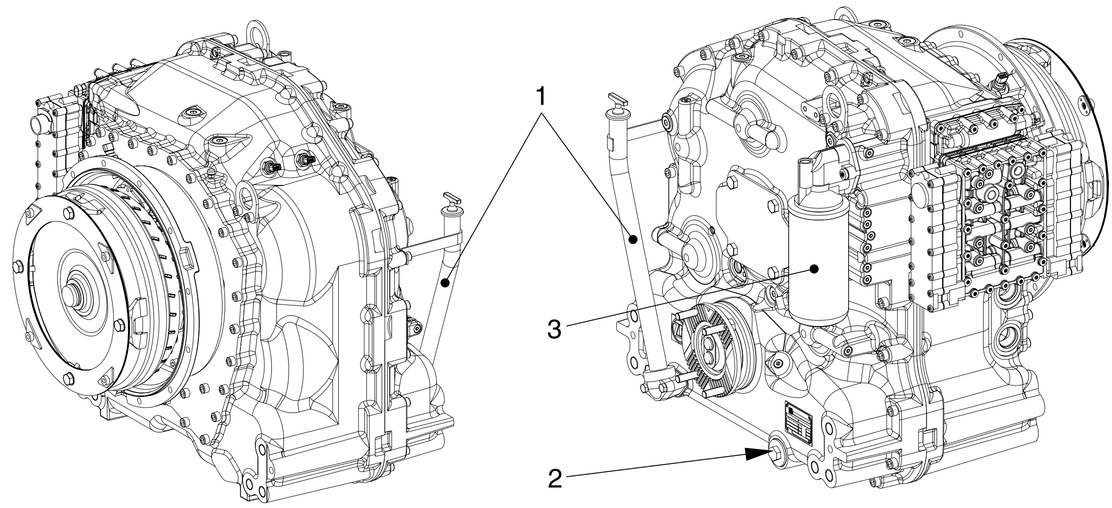
※ At the initial filling of the transmission has to be considered that the heat exchanger, the pressure filter as well as the pipes must get filled with oil.
According to these cavities, the oil capacity to be filled in is greater than at the later oil fillings in the course of the usual maintenance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

② Filter replacement

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

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

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



180D7EPT19

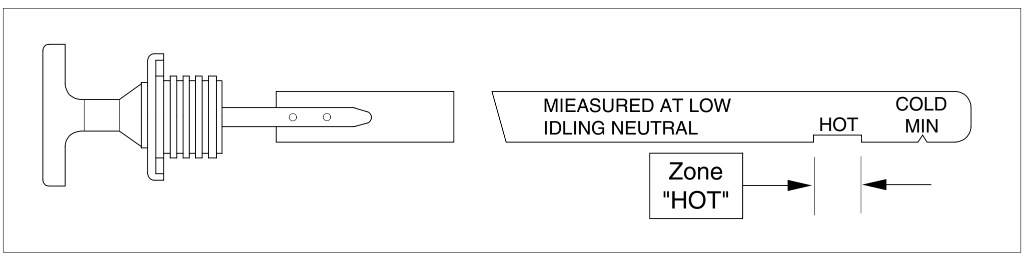
Legend:

1 = Oil filter tube with oil dipstick

2 = Oil drain plug M38 × 1.5

3 = Fine filter

Oil dipstick



180D7EPT20

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 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 disk regularly as well as wear of brake system parts.
- In case of signs of excessive heating, consult the dealer or the manufacturer.

(2) General lubrication instructions

① **Lubrication points**

See page 3-53 installation drawing.

② **Fill levels**

Check 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.

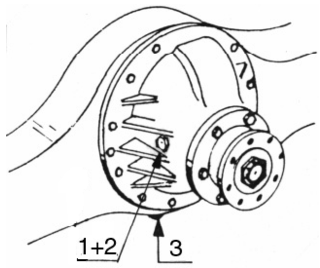
(3) Lubrication points

※ Legend

1 : Oil fill plug

2 : Oil level control plug

3 : Oil drain plug



250D7EXL03

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 2.0~2.7kgf · m(15-20 lb-ft) 2. Tighten inlet fitting to 3.4~4.8kgf · m(25-35 lb-ft) 3. Replace inlet fitting or plug and O-ring if used.

2) BRAKE NOISE AND VIBRATION

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

3) BRAKE OVERHEATS

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

4) BRAKE DOES NOT APPLY

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

5) BRAKE DOES NOT RELEASE

Condition	Possible cause	Correction
Vehicle does not move	Damaged hydraulic system.	Repair hydraulic system.
Brakes dragging	1. More than 1.4bar(20psi) 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.	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 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.	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.	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.	1. Empty fluid reservoir. 2. Damaged hydraulic system. 3. Leakage of brake actuation fluid.	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.

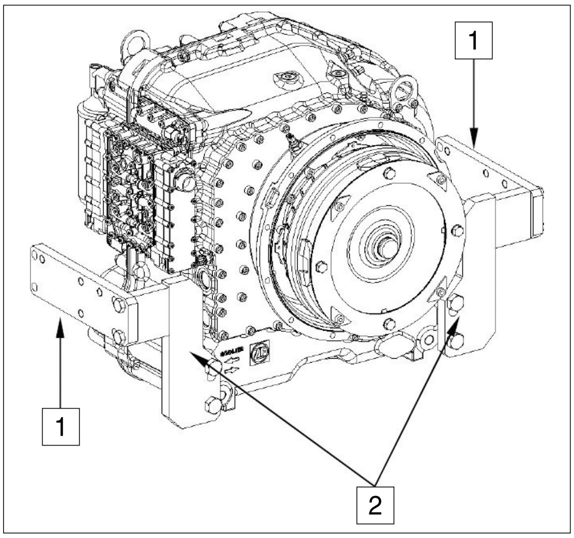
GROUP 3 DISASSEMBLY AND ASSEMBLY

1. TRANSMISSION DISASSEMBLY

1) ELECTRO-HYDRAULIC CONTROL UNIT AND FINE FILTER

① Fix transmission on assembly truck.

(S)Assembly truck	5870 350 000
(S)Holding fixtures (1)	5870 350 063
(S)Clamping Angle (2)	5870 350 124

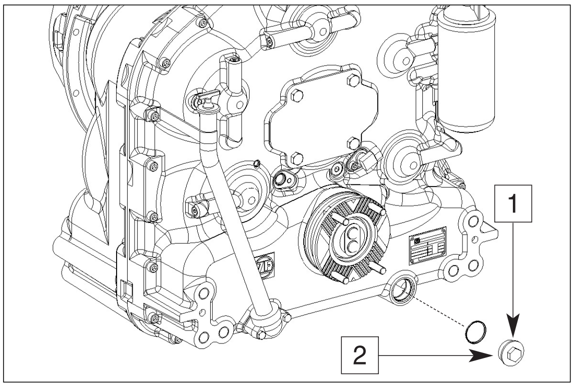


180DTM011

(1) Remove oil drain plug and oil filler tube

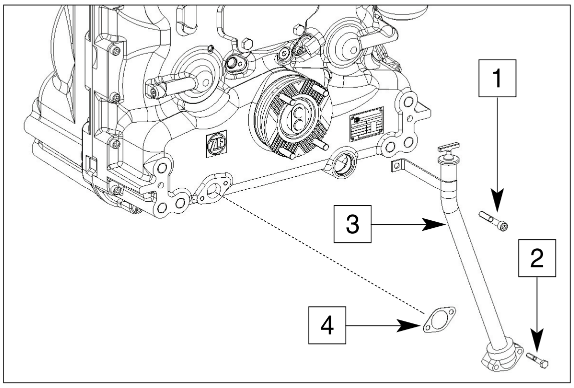
Drain oil before starting disassembly

① Loosen screw plug (1) and remove seal ring (2).



180DTM012

② Loosen hex screw (1) from tab and hex screws (2) from oil level tube and remove oil level tube (3) with sealing (4).

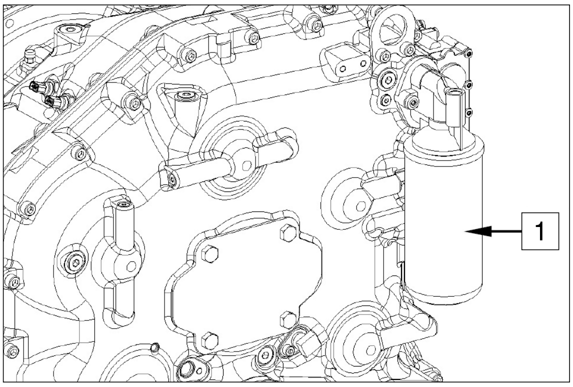


180DTM013

(2) Dismounting of filter

① Separate fine filter (1) from filter head by belt wrench.

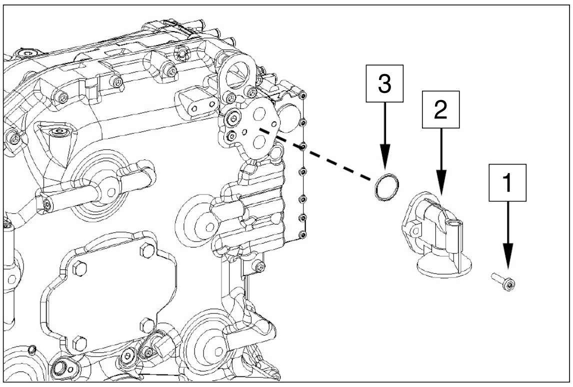
(S)Belt wrench 5870 105 005



180DTM014

② Loosen torx screws (1), separate filter head (2) from transmission housing and remove O-rings (3).

(S)Socket wrench TX 40 5873 042 004



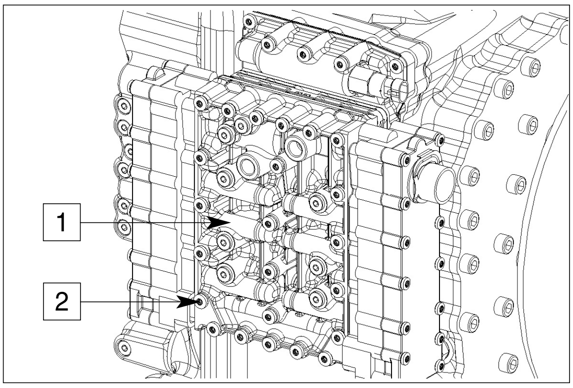
180DTM015

(3) Dismounting of electric control unit

① Dismantle control unit (1).

Loosen torx screws (2).

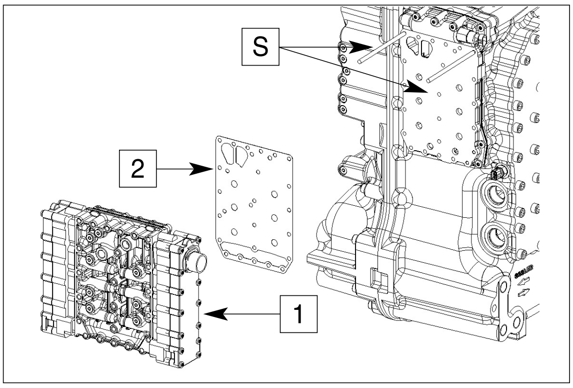
(S)Socket wrench TX-27 5873 042 002
(S)Adjusting screws M6 5870 204 063



180DTM016

② Remove cpl control unit (1) and sealing plate (2).

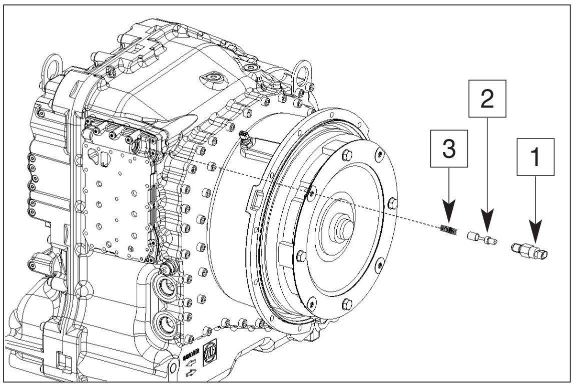
(S)Adjusting screws M6 5870 204 063



180DTM017

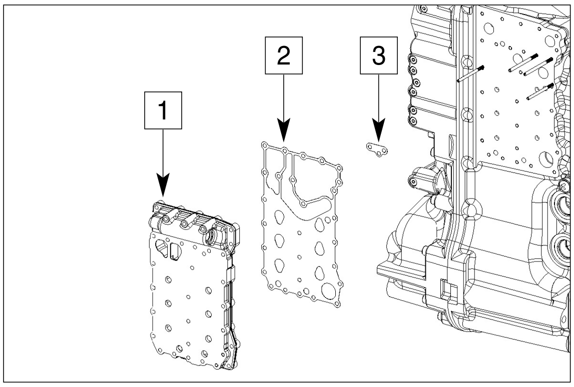
③ Remove differential pressure switch for fine filter from the duct plate.

1 = Switch with O-ring
2 = Piston
3 = Compression spring



180DTM018

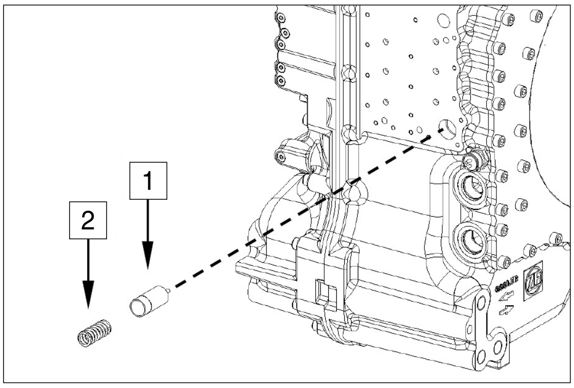
④ Loosen torx screws and separate duct plate (1) and seals (2 and 3) from housing front part.



180DTM019

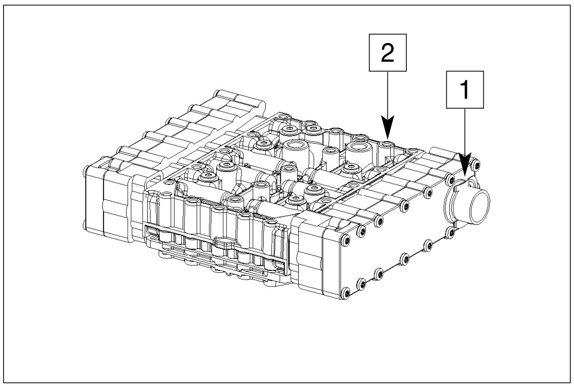
⑤ Pull converter safety valve out of housing hole.

1 = Piston
2 = Compression spring



180DTM020

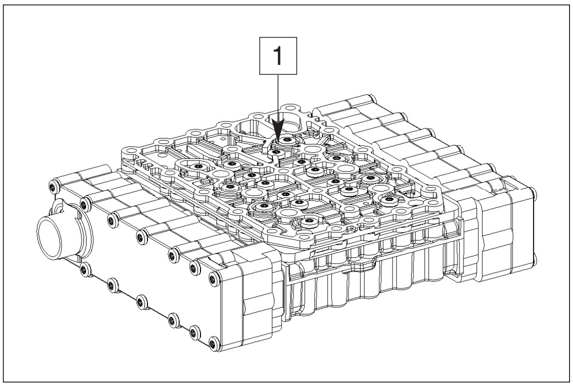
⑥ Mark installation position of wiring harness (1) towards valve block (2).



180DTM021

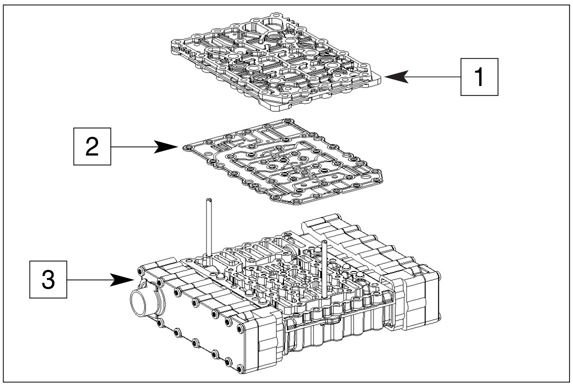
⑦ Loosen torx screws (1).

(S)Socket wrench TX-27　5873 042 002



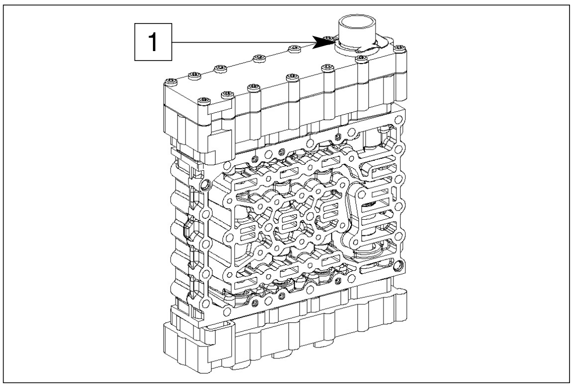
180DTM022

⑧ Separate duct plate (1) and sealing plate plate (2) from valve block (3).



180DTM023

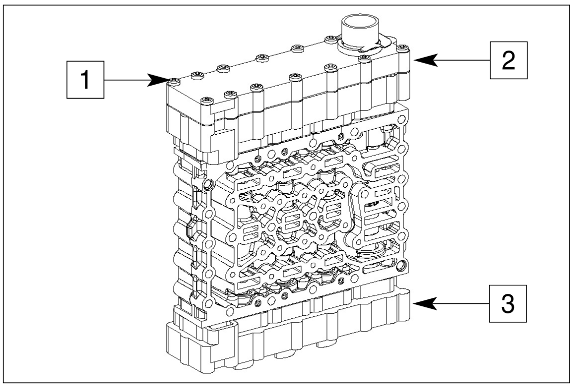
⑨ Remove retaining clamp (1).



180DTM024

⑩ Loosen torx screws (1) and remove lid (2).
Remove opposite cover (3) in the same way.

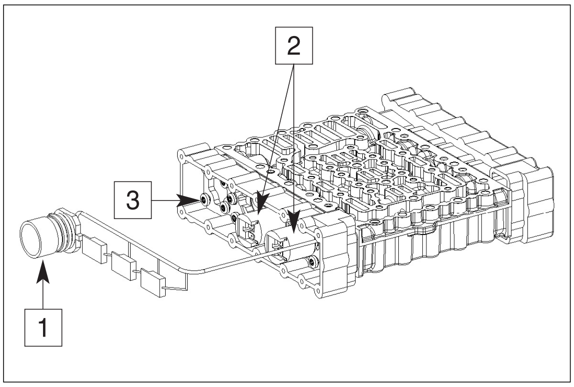
(S)Socket wrench TX-27　5873 042 002



180DTM025

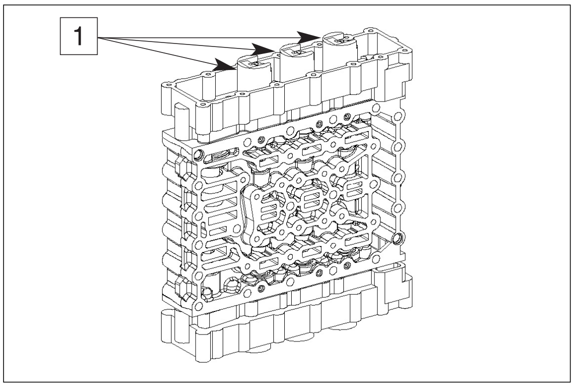
⑪ Remove wiring harness (1).

Loosen cyl screws (3), remove fixing plates and dismount pressure controllers (2).



180DTM026

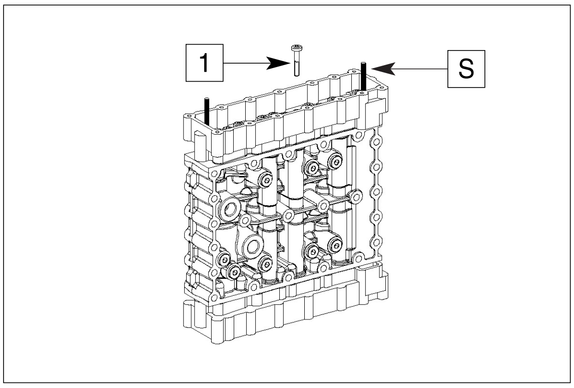
⑫ Loosen cyl screws on opposite side, remove fixing plates and dismount pressure controllers (1).



180DTM027

⑬ Loosen two torx screws (1) and temporarily fix housing by means of adjusting screws (S).
Then loosen remaining torx screws (Housing is spring-loaded).

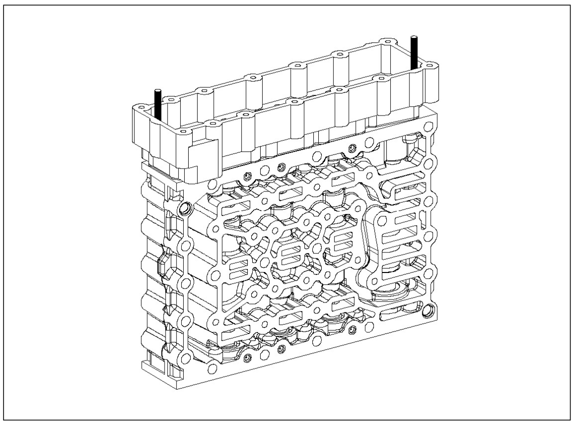
(S)Adjusting screws 5870 204 036



180DTM028

⑭ Separate housing from valve housing by evenly loosening the adjusting screws.

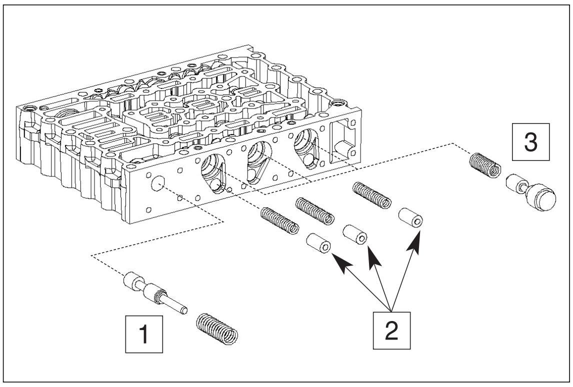
(S)Adjusting screws 5870 204 036



180DTM029

⑮ Remove single components :

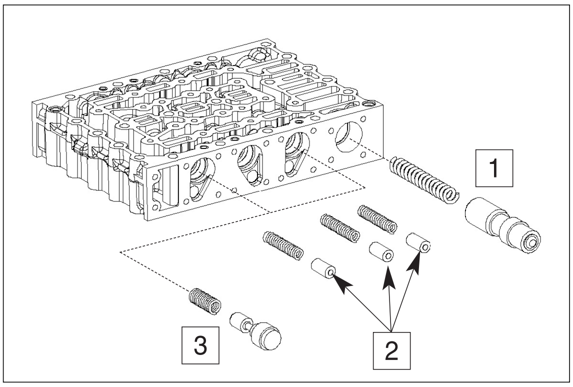
1 = Pressure reducing valve
2 = Vibration damper
3 = Follow-on slide



180DTM030

⑯ Remove single components of the opposite side analogously :

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

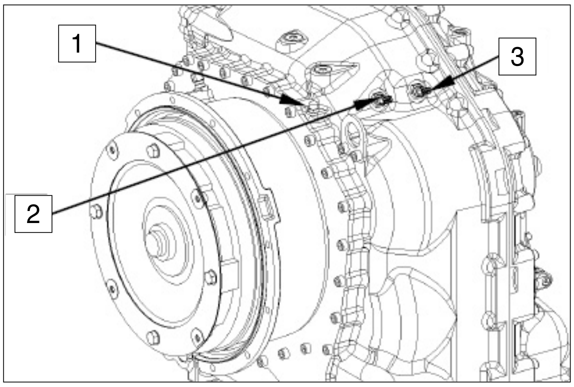


180DTM031

2) INDUCTIVE SENSOR, HALL SENSOR, BREATHER AND TEMPERATURE SENSOR

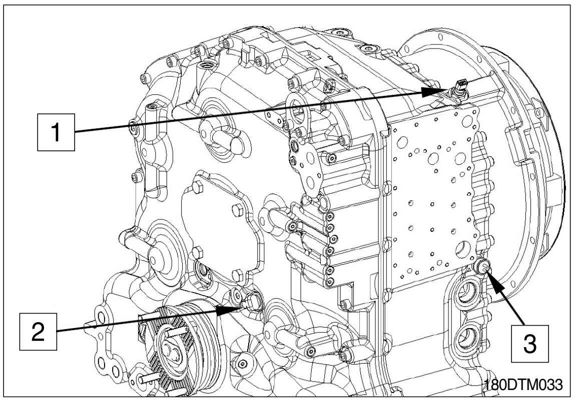
① Dismantle positioned parts.

1 = Breather
2 = Inductive sensor-n central gear chain
3 = Inductive sensor-n turbine



180DTM032

② Dismantle inductive sensor - n engine (1) and temperature sensor (3)
Loosen cyl screw and remove speed sensor (2).
Remove O-ring.
1 = Inductive sensor - n engine (1)
2 = Speed sensor - n output (Hall sensor)
3 =Temperature sensor measuring point "63" after converter

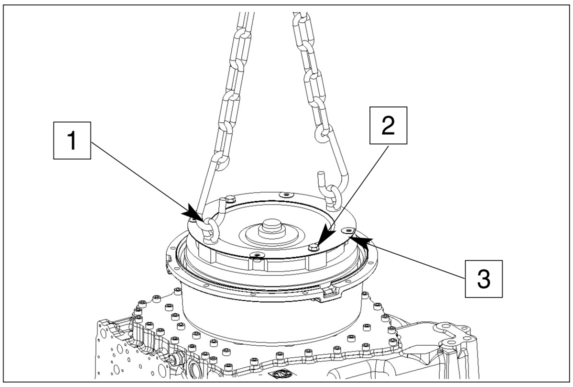


180DTM033

3) ENGINE CONNECTION AND OIL PRESSURE PUMP

(1) Engine connection

Loosen two hex screws (2), fit eye bolts (1) and pull off converter by means of lifting device.

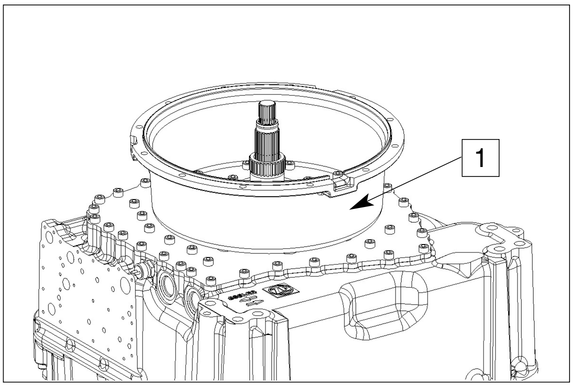


180DTM034

① Separate flexplate (3) from converter.

(S)Eye bolts assortment	5870 204 002
(S)Lifting chain	5870 281 047

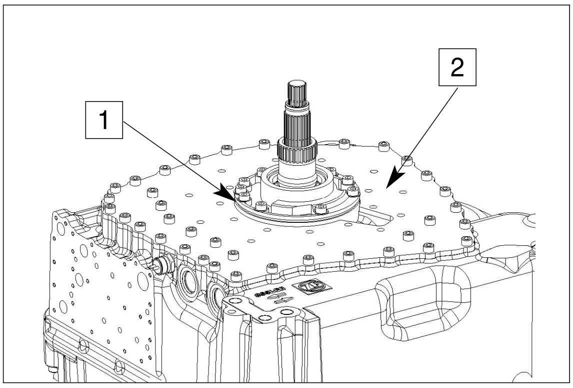
② Loosen threaded connection converter bell-housing/transmission housing and remove converter bell-housing (1).



180DTM035

③ Remove O-ring (1).

Loosen threaded connection plate/ transmission housing and oil pressure pump/transmission housing, then remove plate (2).

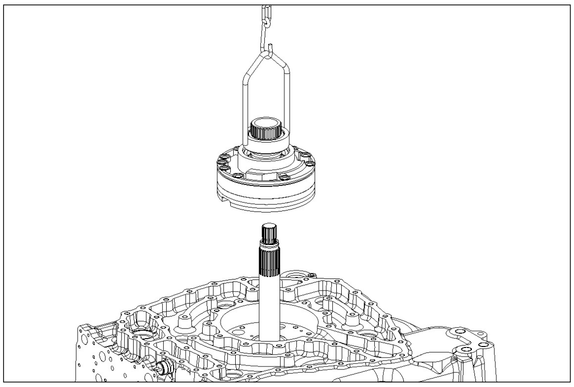


180DTM036

(2) Oil pressure pump

① Pull off stator hollow shaft/oil pressure pump by means of puller and lifting device.

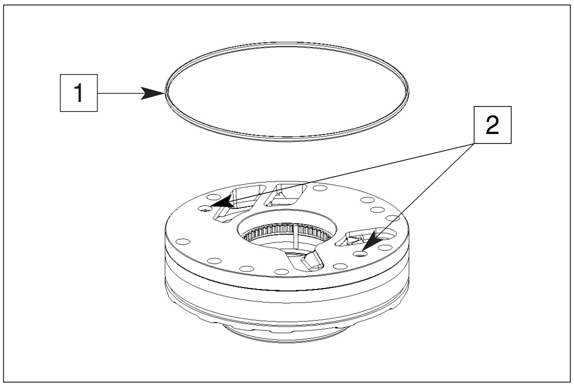
(S)Puller 5870 000 107



180DTM037

② Remove O-ring (1).

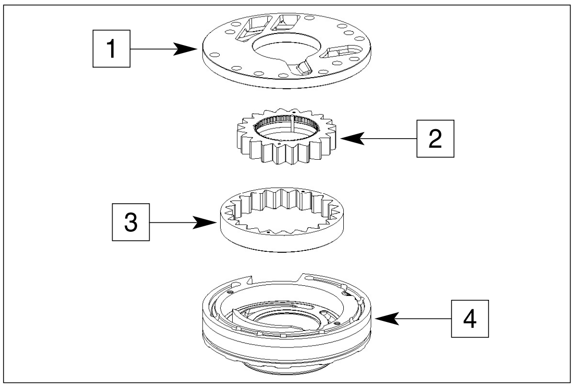
Loosen cylindrical screws (2).



180DTM038

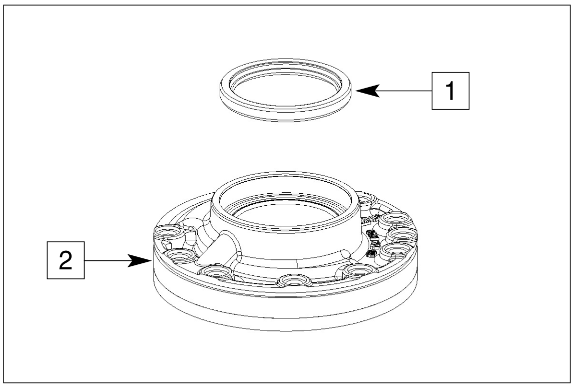
※ Check oil gear pump :
In case of wear marks in the pump housing, cover or on the inner and outer rotor, the complete oil pressure pump is to be replaced.

1 = Cover
2 = Inner rotor
3 = Outer rotor
4 = Pump housing



180DTM039

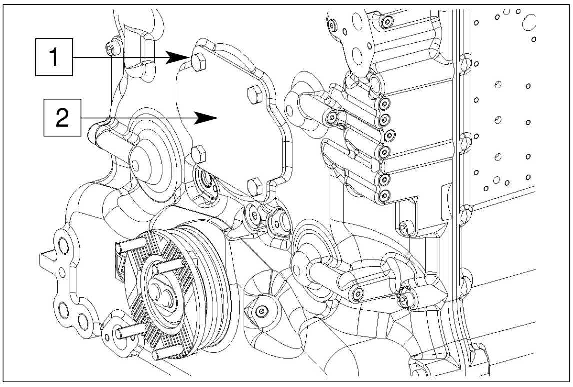
④ Remove shaft seal (1) from the pump housing (2).



180DTM040

4) DISASSEMBLY PTO

① Loosen hex screws (1) and remove lid (2).

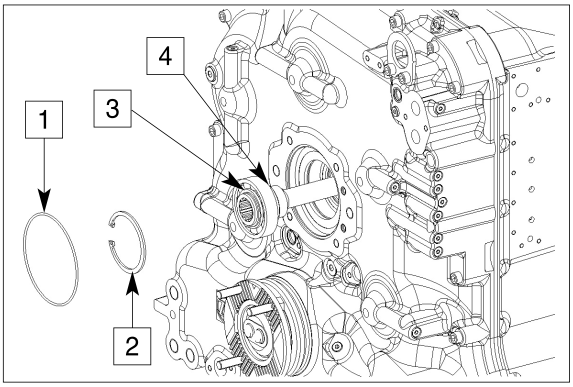


180DTM041

② Take O-ring (1) out of lid, unsnap and remove retaining ring (2).

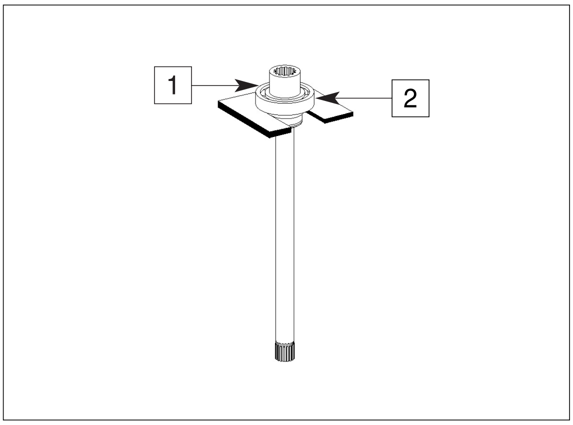
Pull pump shaft (3) out of housing hole.

Unsnap rectangular ring (4).



180DTM042

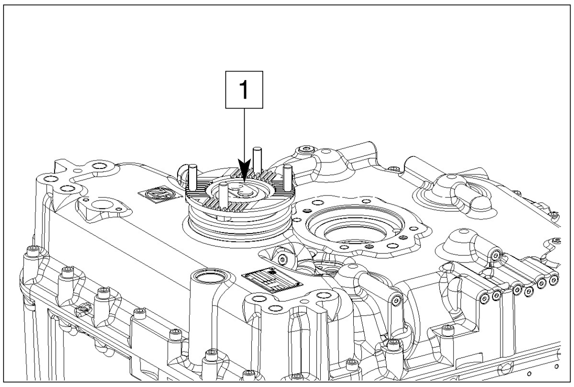
③ Snap out retaining ring (1) and press ball bearing (2) off the pump shaft.



180DTM043

5) REMOVAL OF INPUT SHAFT AND CLUTCHES

① Loosen hex Screws (1), remove disc and O-ring.

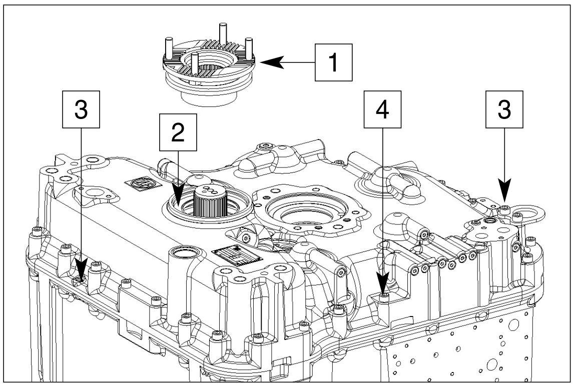


180DTM044

② Pull-off output flange (1) and remove shaft seal (2).

Force out both cylindrical pins (3).

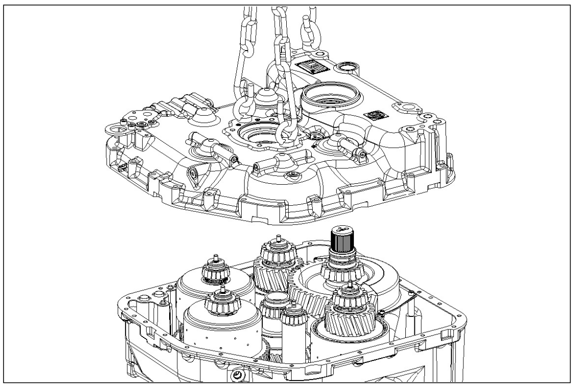
Loosen threaded connection (4) housing front and rear part.



180DTM045

③ Separate housing rear part by means of lifting device.

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

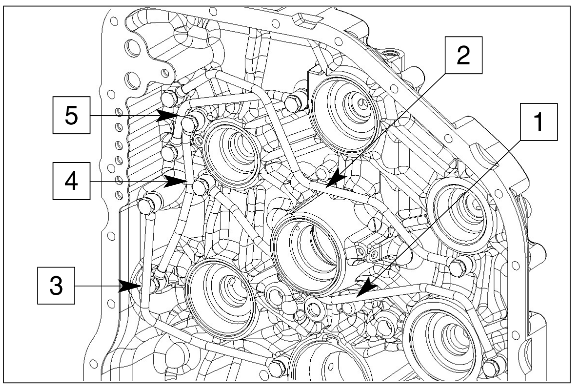


180DTM046

④ Dismantle pipes (system pressure from the electro-hydraulic control unit to the corresponding clutch).

Keep the following order to dismantle the pipes :

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



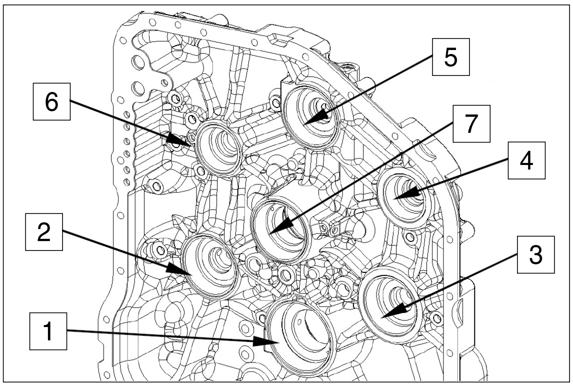
180DTM047

⑤ Dismantle bearing outer rings from housing front part.

※ Legend: see figure TM050.

※ If, contrary to the ZF recommendation, the tapered roller bearings of clutches and input are not replaced, it is imperative to ensure the previous pairing (bearing outer ring/bearing inner ring).

※ Bearing outer ring and bearing inner ring must be marked.

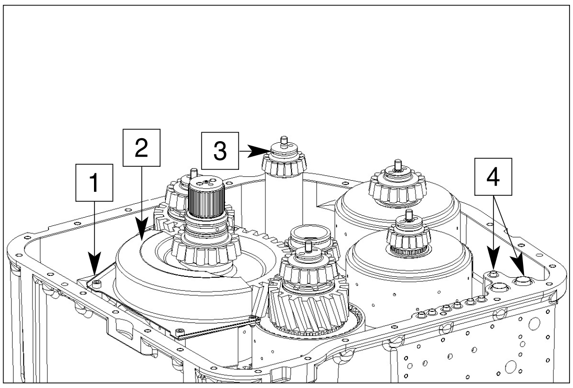


180DTM048

⑥ Loosen cylinder screws (1), remove upper screen sheet (2) and sleeves.

Remove all rectangular rings (3) from clutches KV, KR, K1, K2, K3, K4 and input shaft.

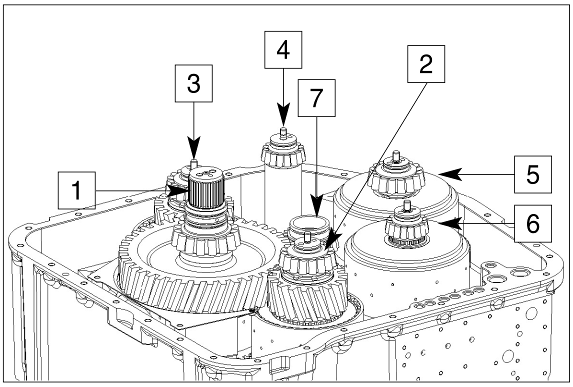
Remove tubes (4) with O-rings.



180DTM049

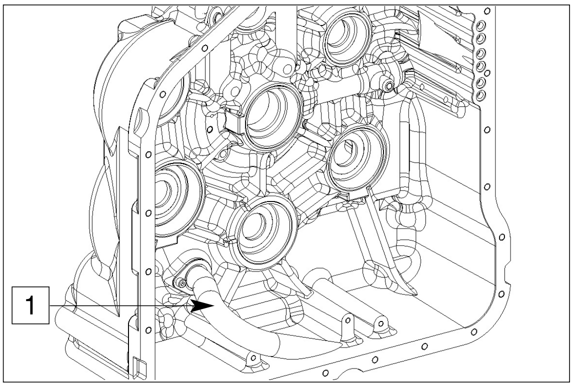
⑦ Lift clutches out of the housing following the numeric order, as described in the legend.

1 = Clutch K3 / Output
2 = Clutch K2
3 = Clutch K1
4 = Clutch K4 (Intermediate shaft)
5 = Clutch KR
6 = Clutch KV
7 = Input shaft



180DTM050

⑧ Loosen and remove cyl screws of suction tube (1) in the housing front part.



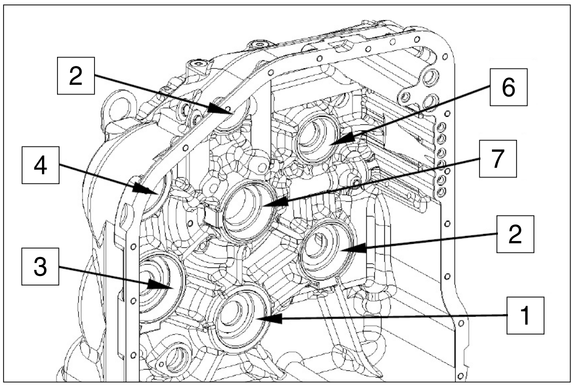
180DTM051

⑨ Dismantle bearing outer rings from housing rear part.

※ Legend : see figure TM050.

※ If, contrary to the recommendation, the tapered roller bearings of clutches and input are not replaced, it is imperative to ensure the previous pairing (bearing outer ring/bearing inner ring).

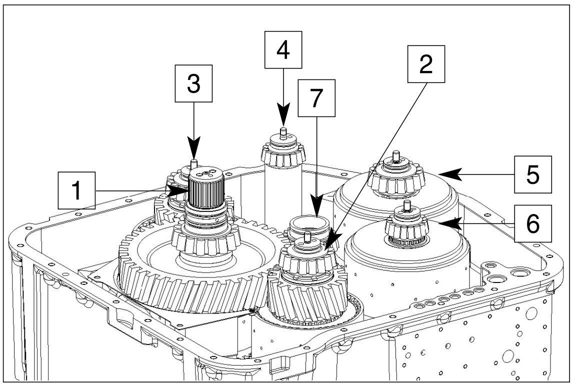
Bearing outer ring and bearing inner ring must be marked.



180DTM052

6) CLUTCHES KV/KR/K1/K2/K3/K4 INPUT SHAFT

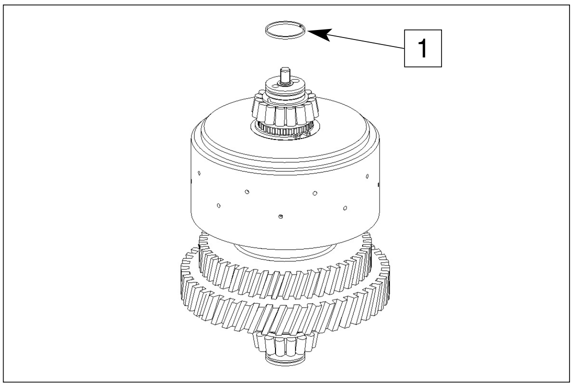
1 = Clutch K3 / Output
2 = Clutch K2
3 = Clutch K1
4 = Clutch K4 (Intermediate shaft)
5 = Clutch KR
6 = Clutch KV
7 = Input shaft



180DTM050

(1) Clutch KV

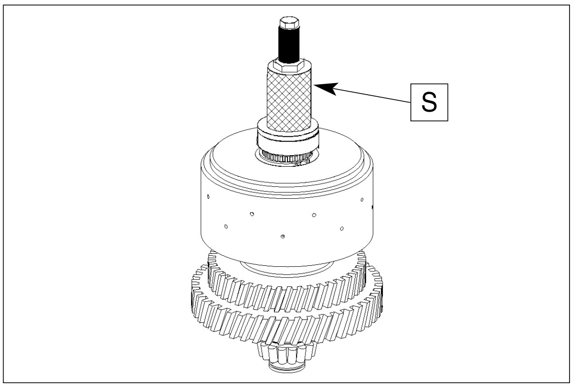
① Unsnap piston ring (1).



180DTM053

② Pull tapered roller bearing (internal ring) off the shaft.

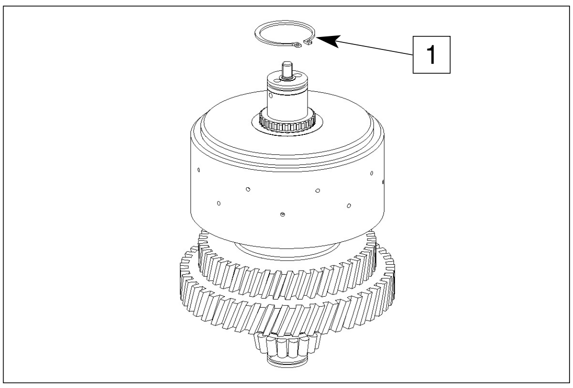
(S)Forcing device 5870 026 100
(S)Grab sleeve 5873 001 057
or
(S)Rapid grip 5873 011 011



180DTM054

③ Unsnap retaining ring (1).

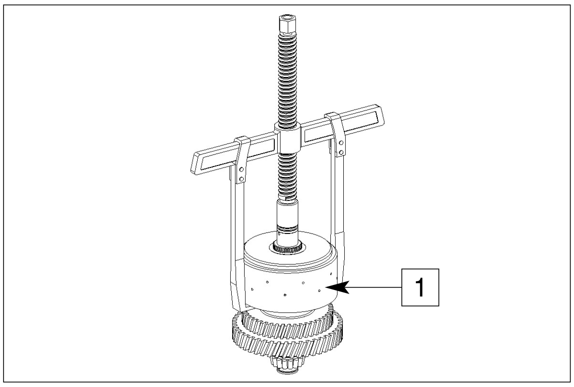
(S)Set of external pliers 5870 900 015



180DTM055

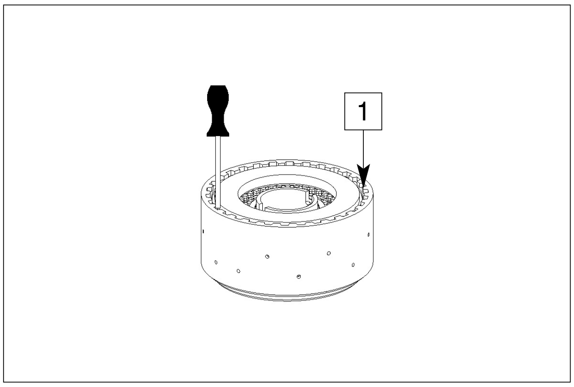
④ Pull clutch (1) off the shaft.

(S)Two-armed puller 5870 970 004



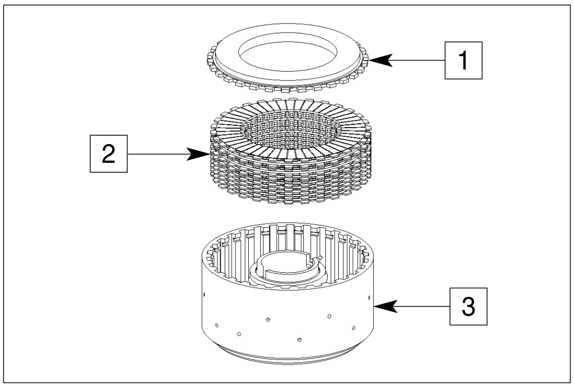
180DTM056

⑤ Remove snap ring (1).



180DTM057

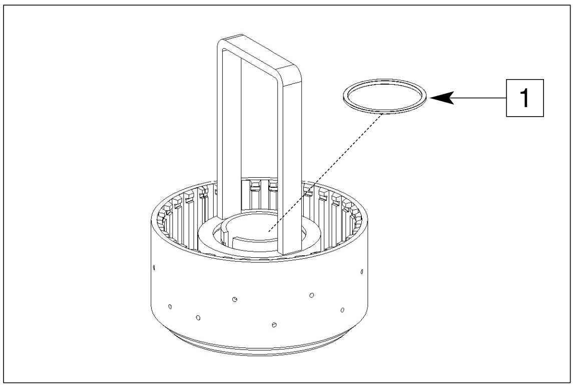
⑥ Remove end plate (1) and disc package (2) from disc carrier (3).



180DTM058

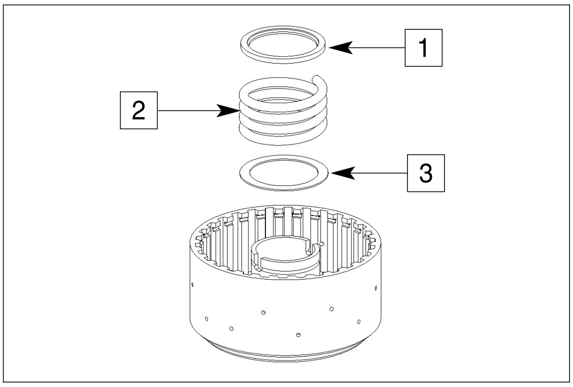
⑦ Preload compression spring and remove L-ring (1).

(S)Assembly aid 5870 345 088



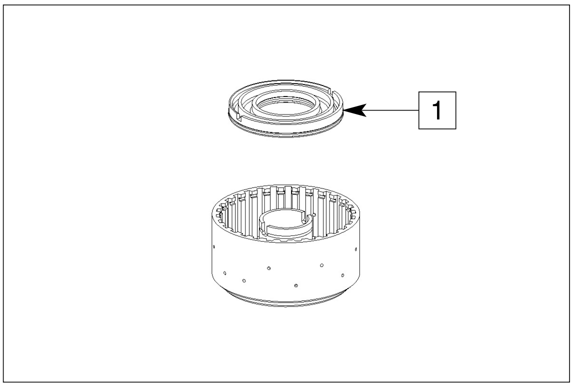
180DTM059

⑧ Remove guide ring (1), compression spring (2) and disc (3).



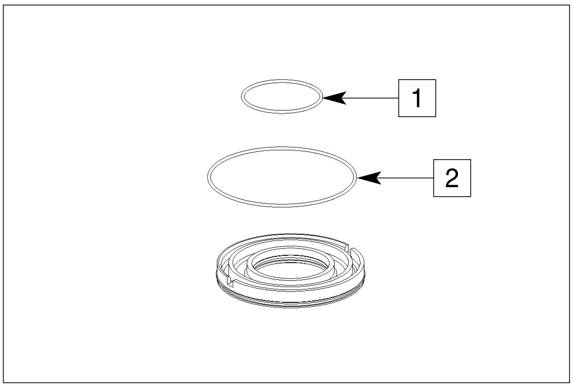
180DTM060

⑨ Lift piston (1) off the disc package by compressed air out of hole, and remove it.



180DTM061

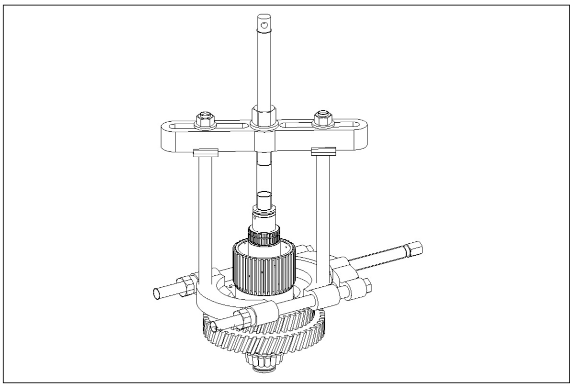
⑩ Remove both O-rings (1 and 2).



180DTM062

⑪ Pull spur gear off the shaft.

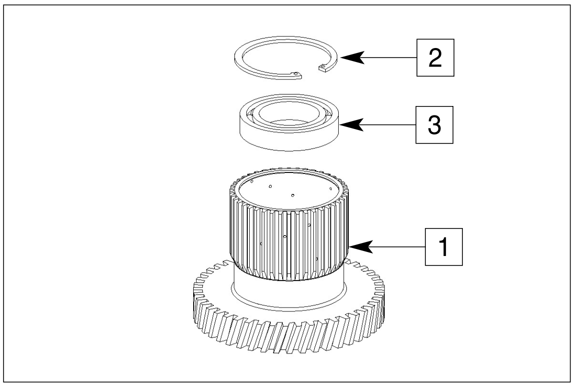
(S)Cut-off device	5870 300 024
(S)Puller	5870 300 033



180DTM063

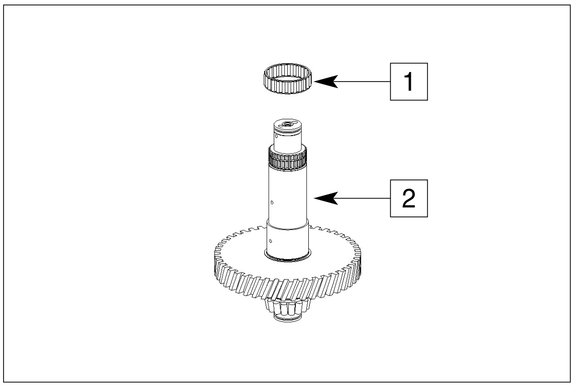
⑫ Unsnap retaining ring (2) out of idler gear (1) and remove ball bearing (3).

(S)Set of internal pliers 5870 900 013



180DTM064

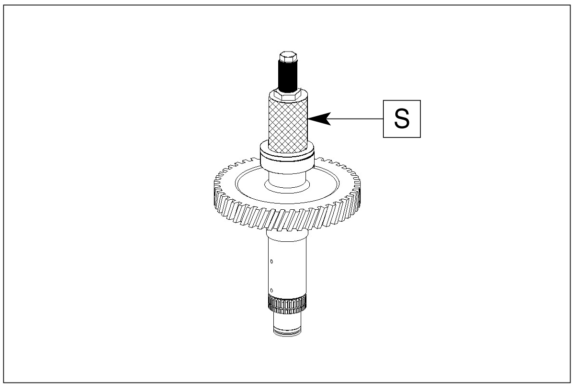
⑬ Pull needle cage (1) off the shaft (2).



180DTM065

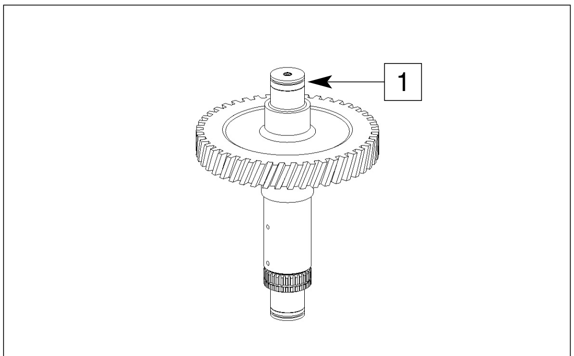
⑭ Pull tapered roller bearing (internal ring) off the shaft.

(S)Forcing device 5870 026 100
(S)Grab sleeve 5873 001 057
or
(S)Rapid grip 5873 011 011



180DTM066

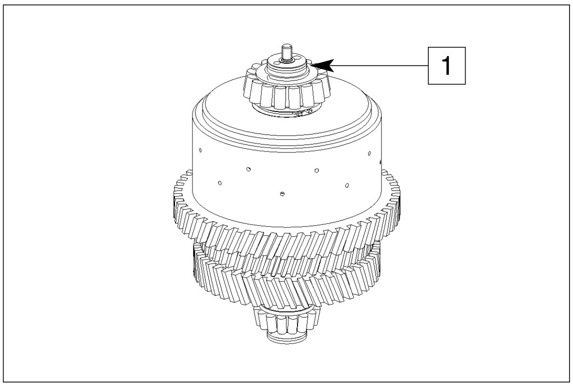
⑮ Unsnap piston ring (1).



180DTM067

(2) Clutch KR

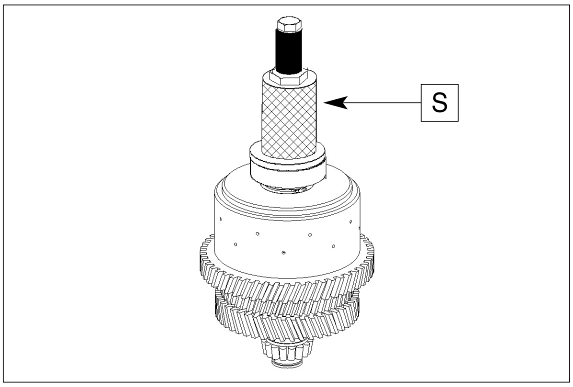
① Unsnap piston ring (1).



180DTM068

② Pull tapered roller bearing (internal ring) off the shaft.

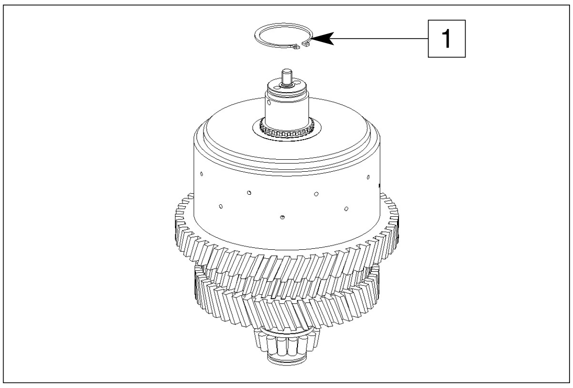
(S)Forcing device 5870 026 100
(S)Grab sleeve 5873 001 059



180DTM069

③ Unsnap retaining ring (1).

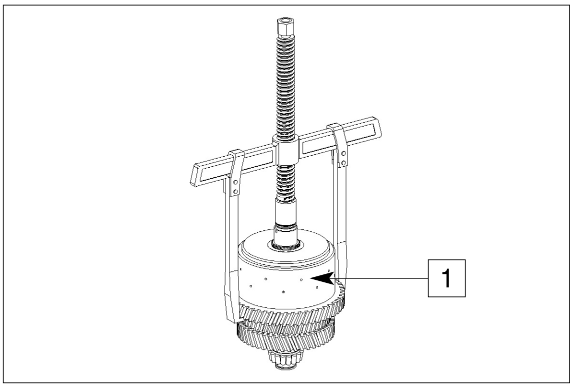
(S)Set of external pliers 5870 900 015



180DTM070

④ Pull clutch (1) together with spur gear off the shaft.

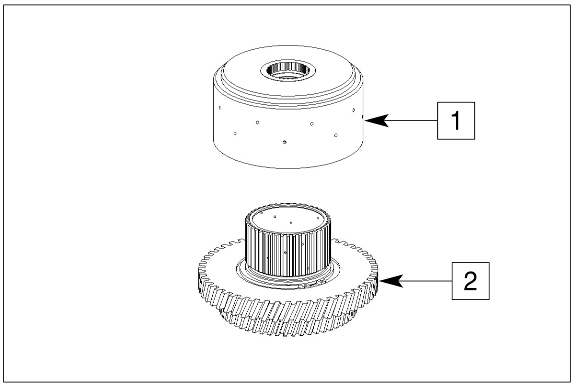
(S)Two-armed puller 5870 970 004



180DTM071

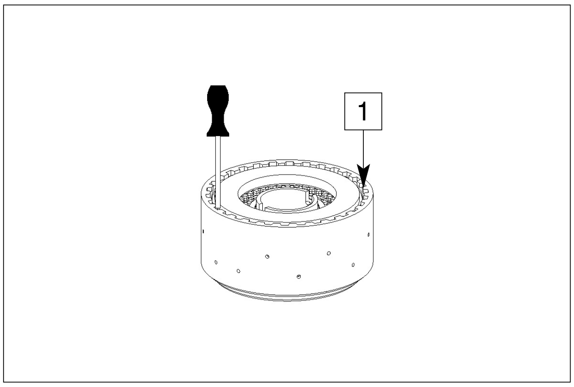
⑤ Pull clutch (1) off the spur gear (2).

※ No further disassembly of spur gear (2) is possible.



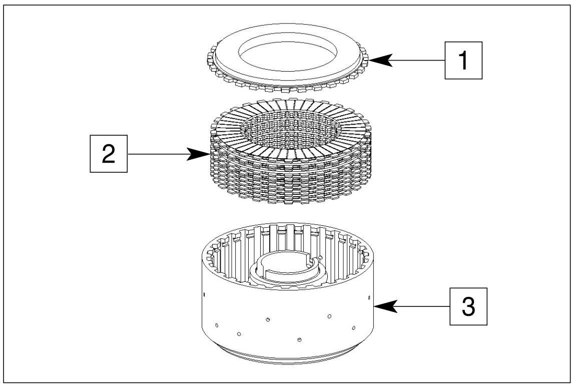
180DTM072

⑥ Remove snap ring (1).



180DTM057

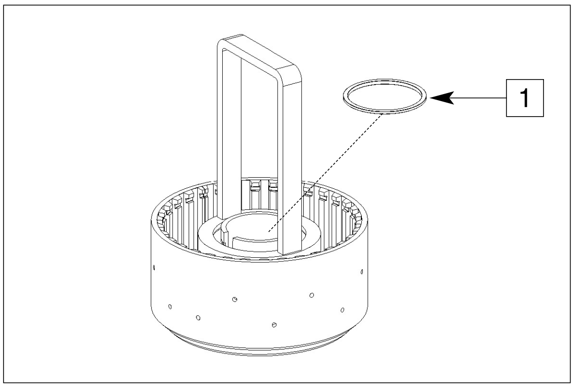
⑦ Remove end plate (1) and disc package (2) from disc carrier.



180DTM058

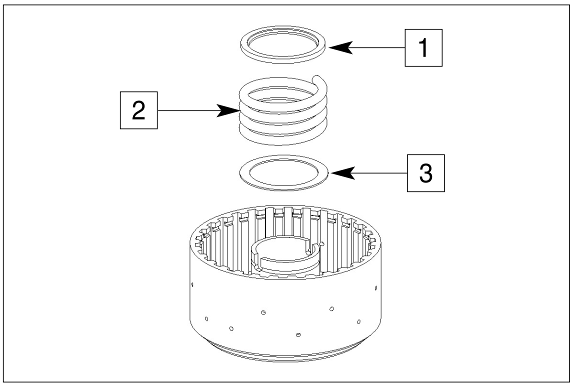
⑧ Preload compression spring and remove L-ring (1).

(S)Assembly aid 5870 345 088



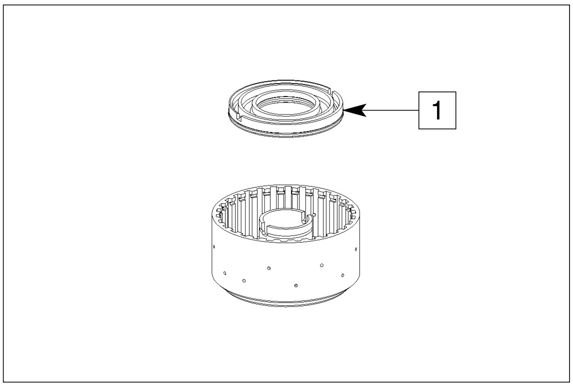
180DTM059

⑨ Remove guide ring (1), compression spring (2) and disc (3).



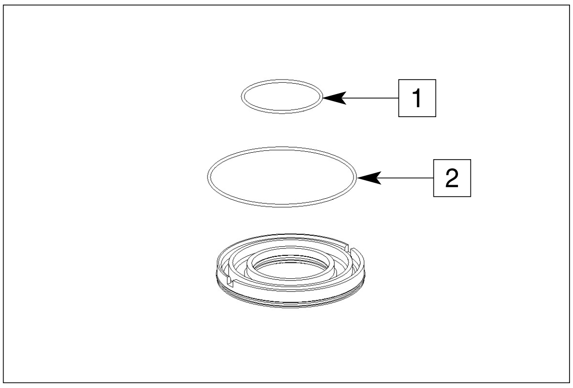
180DTM060

⑩ Lift piston (1) off the disc carrier by compressed air out of hole, and remove it.



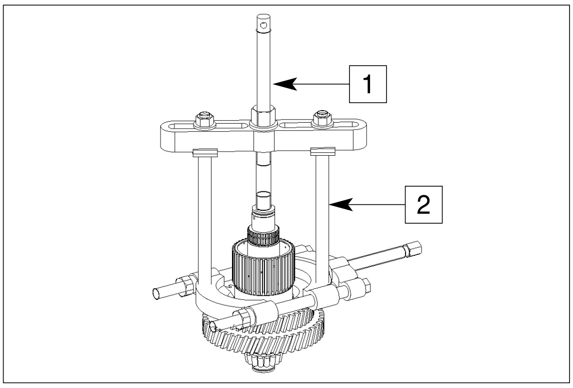
180DTM061

⑪ Remove both O-rings (1 and 2).



180DTM062

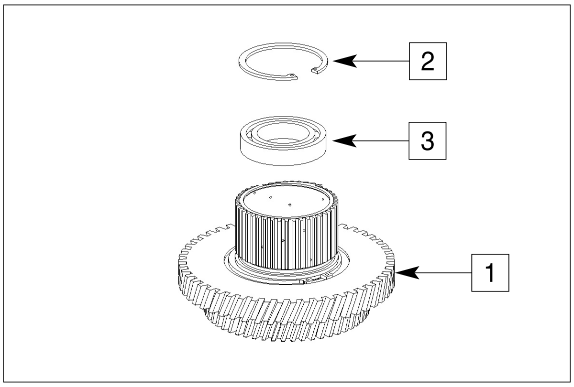
⑫ Pull off needle cage (1) off the shaft (2).



180DTM073

⑬ Unsnap retaining ring (2) from idler gear (1) and dismount ball bearing (3).

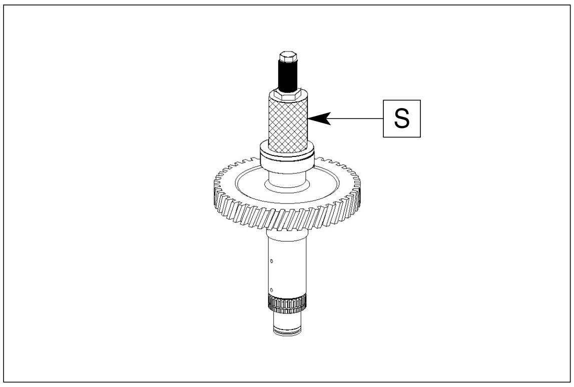
(S)Set of internal pliers 5870 900 013



180DTM074

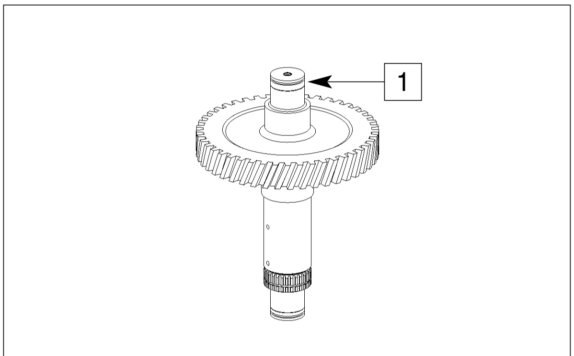
⑭ Pull tapered roller bearing (internal ring) off the shaft.

(S)Forcing device	5870 026 100
(S)Grab sleeve	5873 001 057
or	
(S)Rapid grip	5873 011 011



180DTM066

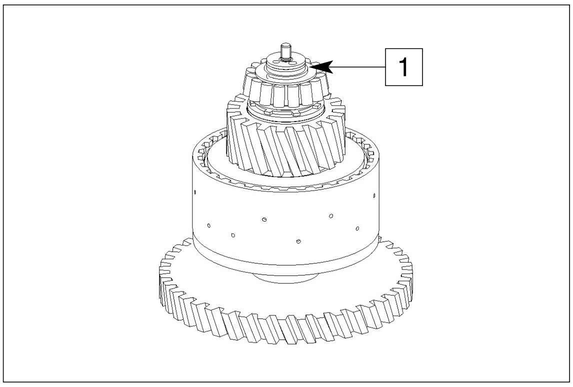
⑮ Unsnap piston ring (1).



180DTM067

(3) Clutch K1

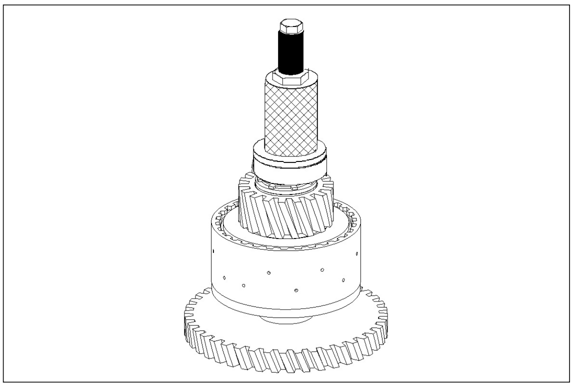
① Unsnap piston ring (1).



180DTM075

② Pull tapered roller bearing (internal ring) off the shaft.

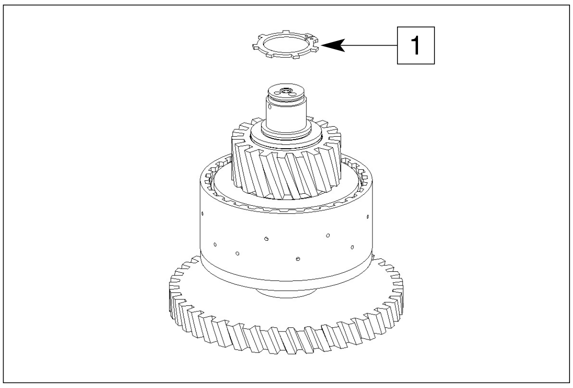
(S)Forcing device 5870 026 100
(S)Grab sleeve 5873 001 059



180DTM076

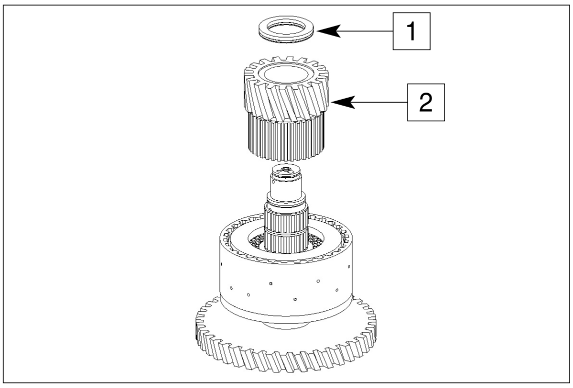
③ Unsnap retaining ring (1).

(S)Set of external pliers 5870 900 015



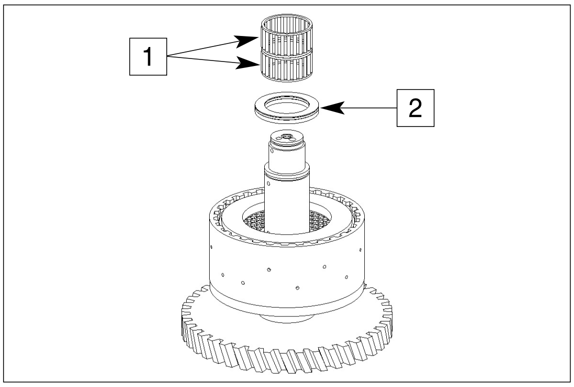
180DTM077

④ Remove cpl axial bearing (1) and idler gear (2).



180DTM078

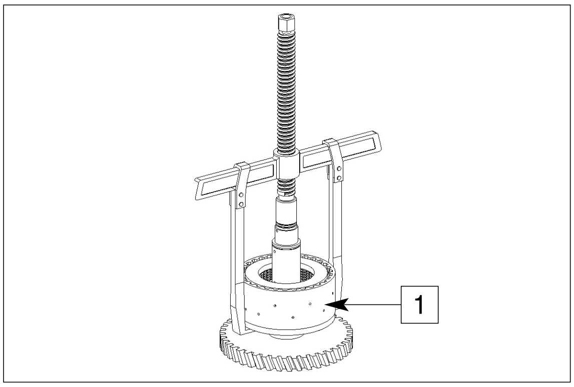
⑤ Remove needle cage (1) and cpl axial bearing (2).



180DTM079

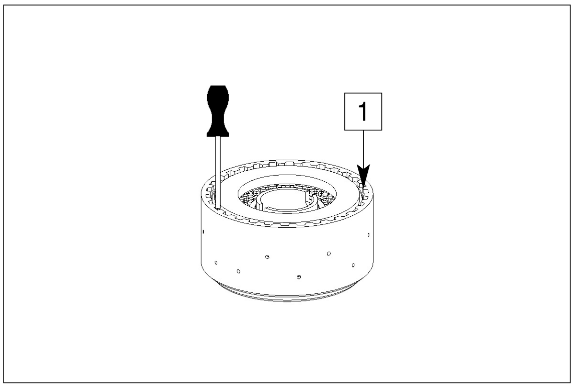
⑥ Pull clutch (1) off the shaft.

(S)Two-armed puller 5870 970 004



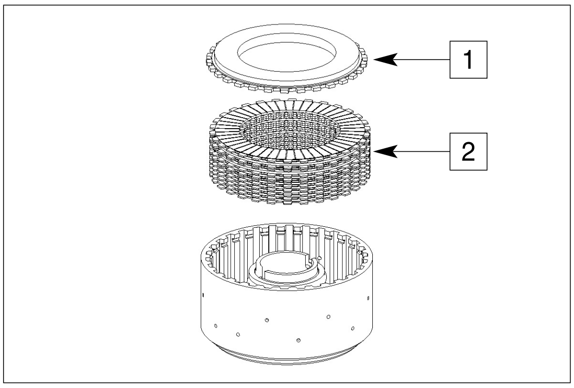
180DTM080

⑦ Remove snap ring (1).



180DTM057

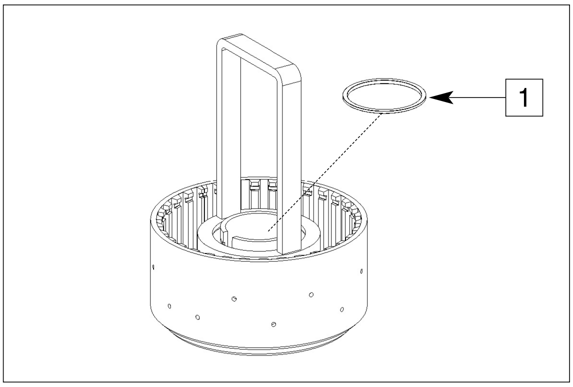
⑧ Remove end plate (1) and disc package (2) from disc carrier.



180DTM081

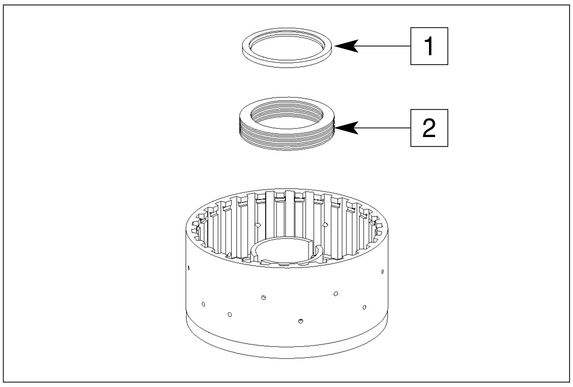
⑨ Preload cup springs and remove L-ring (1).

(S)Assembly aid 5870 345 088



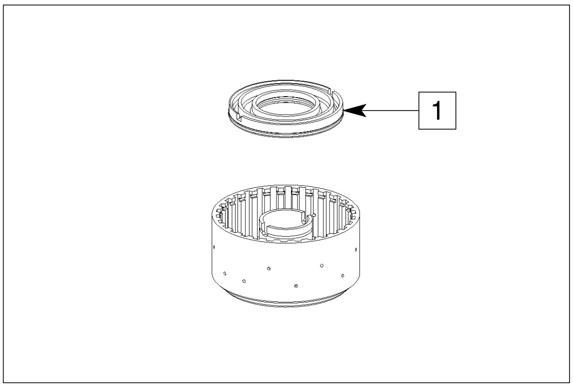
180DTM059

⑩ Remove guide ring (1) and cup spring package (2).

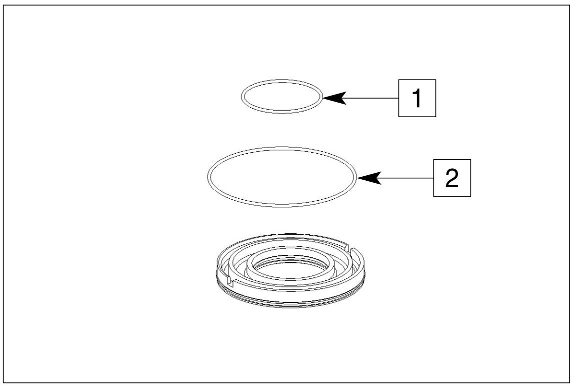


180DTM082

⑪ Lift piston (1) off the disc carrier by compressed air out of hole, and remove it.

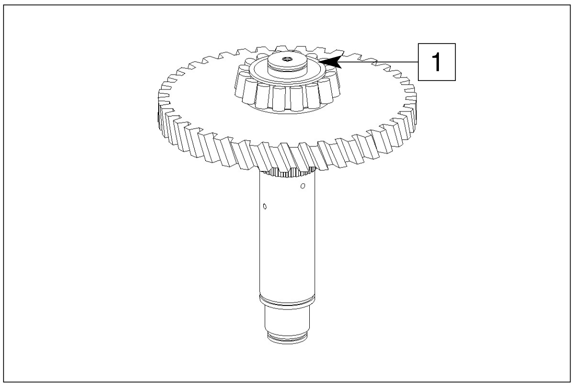


180DTM061



180DTM062

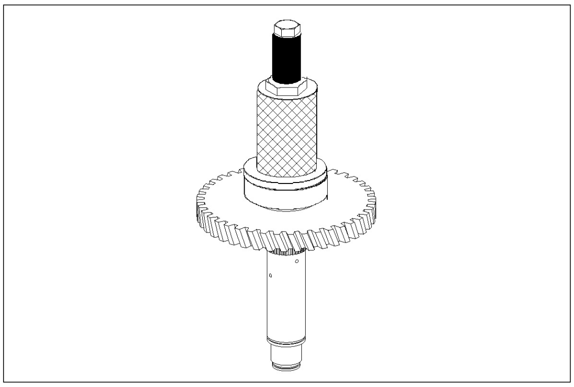
⑫ Unsnap piston ring (1).



180DTM083

⑬ Pull tapered roller bearing (internal ring) off the shaft.

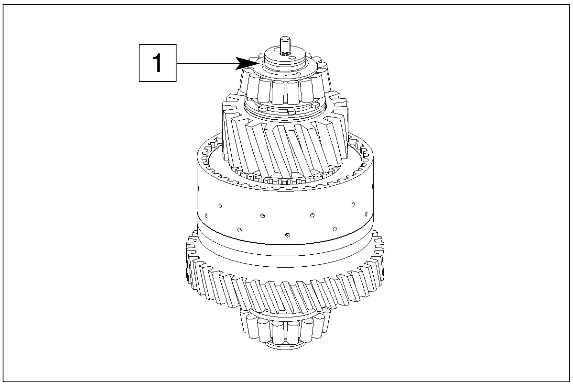
(S)Basic tool	5873 002 001
(S)Grab sleeve	5873 002 038



180DTM084

(4) Clutch K2

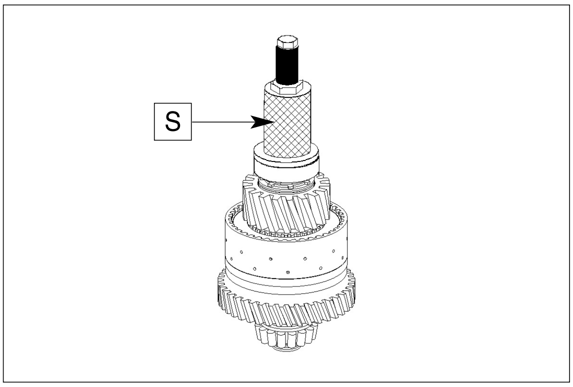
① Unsnap piston ring (1).



180DTM085

② Pull tapered roller bearing (internal ring) off the shaft.

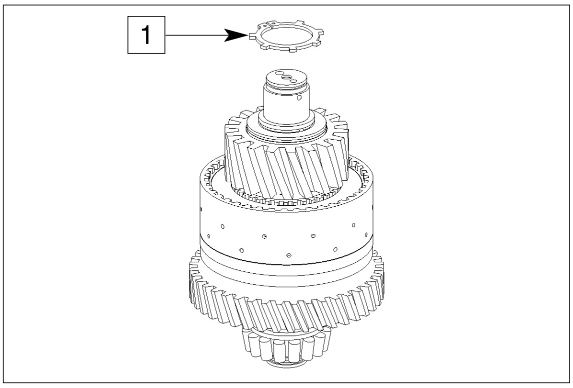
(S)Forcing device	5870 026 100
(S)Grab sleeve	5873 001 059



180DTM086

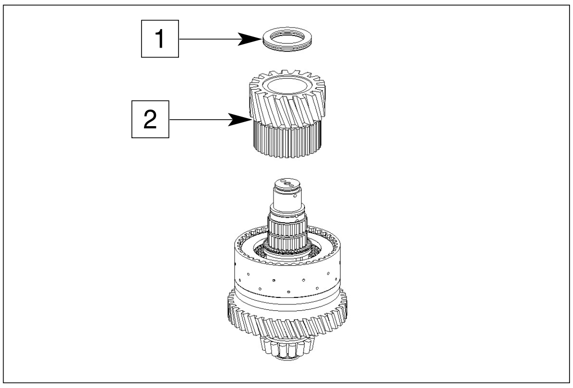
③ Unsnap retaining ring (1).

(S)Set of external pliers 5870 900 015



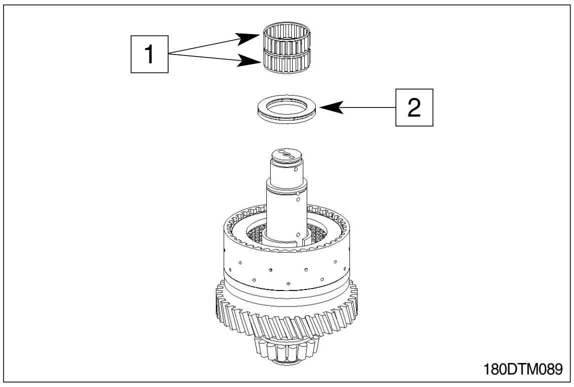
180DTM087

④ Remove cpl axial bearing (1) and idler gear (2).



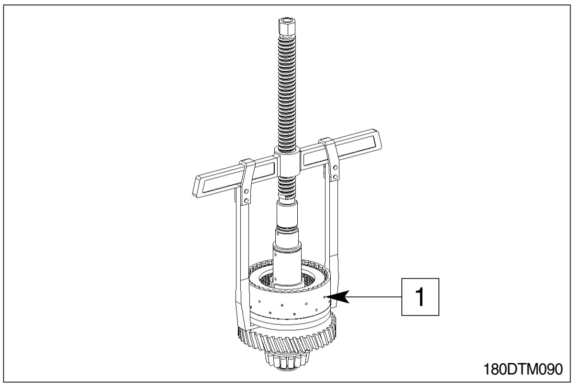
180DTM088

⑤ Remove needle cage (1) and cpl axial bearing (2).

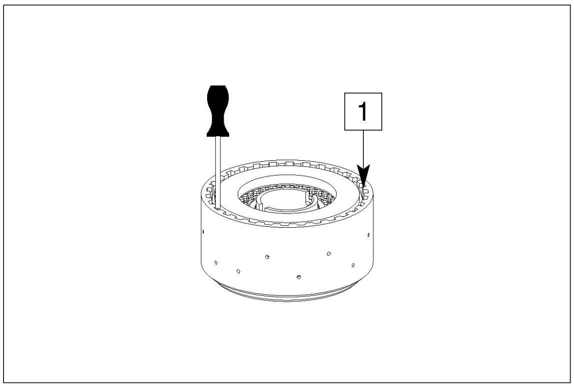


⑥ Pull clutch (1) off the shaft.

(S)Two-armed puller 5870 970 004

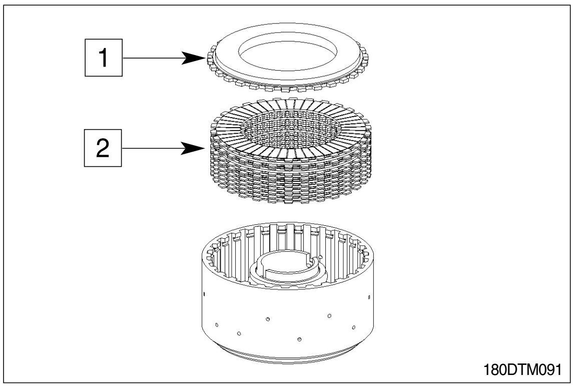


⑦ Remove snap ring (1).



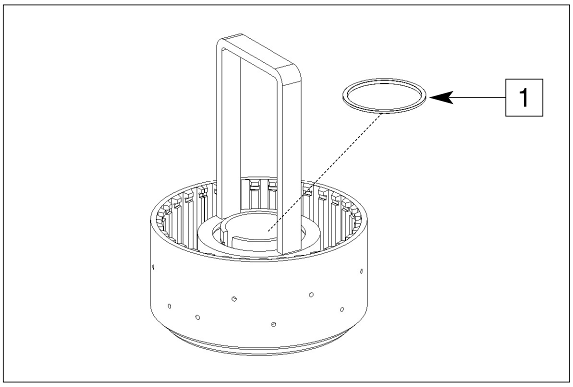
180DTM057

⑧ Remove end plate (1) and disc package (2) from disc carrier.



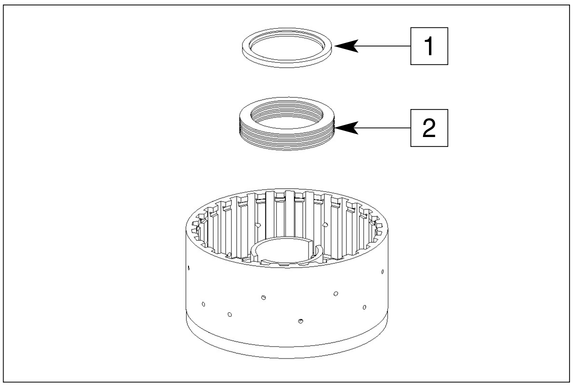
⑨ Preload cup springs and remove L-ring (1).

(S)Assembly aid 5870 345 088



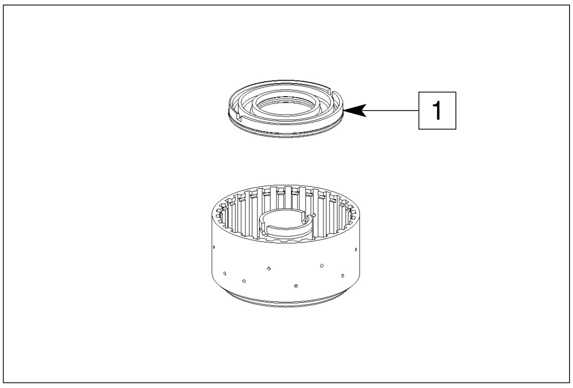
180DTM059

⑩ Remove guide ring (1) and cup spring package (2).



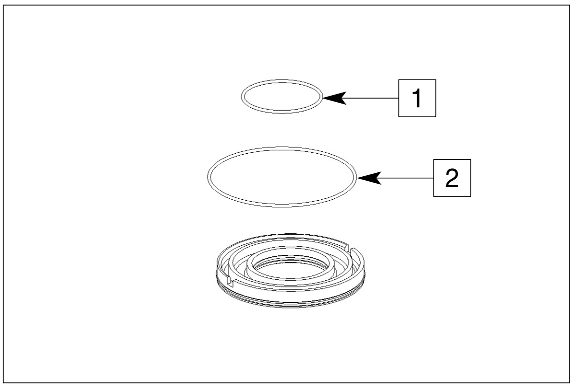
180DTM082

⑪ Lift piston (1) off the disc carrier by compressed air out of hole, and remove it.



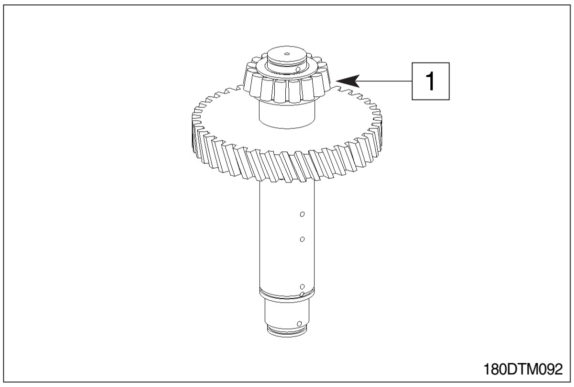
180DTM061

⑫ Remove both O-rings (1 and 2).



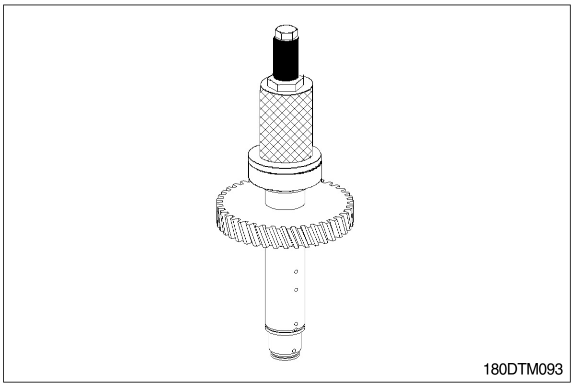
180DTM062

⑬ Unsnap piston ring (1).



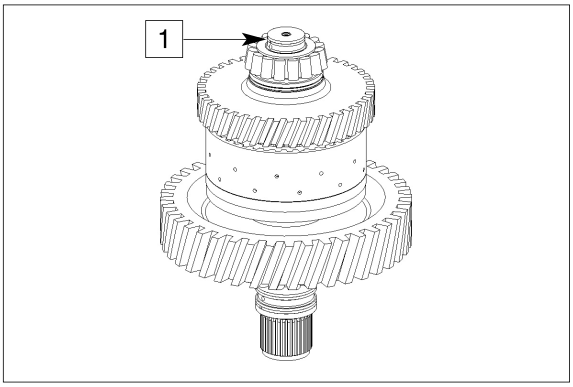
⑭ Pull tapered roller bearing (internal ring) off the shaft.

(S)Forcing device	5870 026 100
(S)Grab sleeve	5873 001 059



(5) Clutch K3

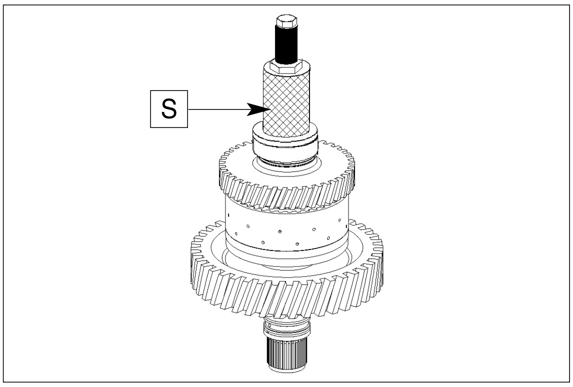
① Unsnap piston ring (1).



180DTM094

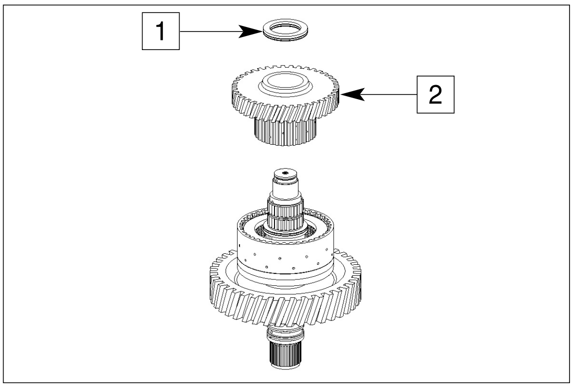
② Pull tapered roller bearing (internal ring) off the shaft.

(S)Forcing device	5870 026 100
(S)Grab sleeve	5873 001 059



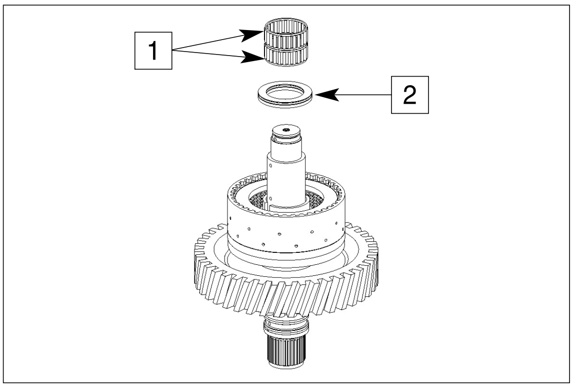
180DTM095

③ Remove cpl axial bearing (1) and idler gear (2).



180DTM096

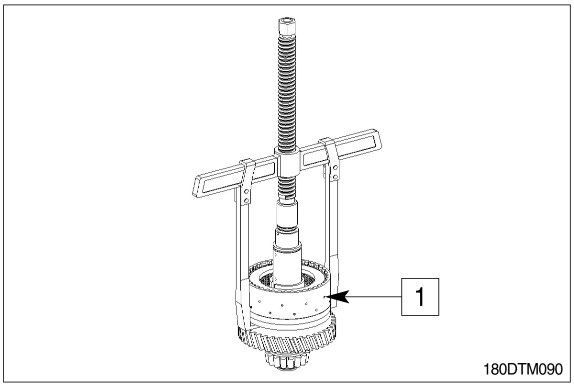
④ Remove needle cage (1) and cpl axial bearing (2).



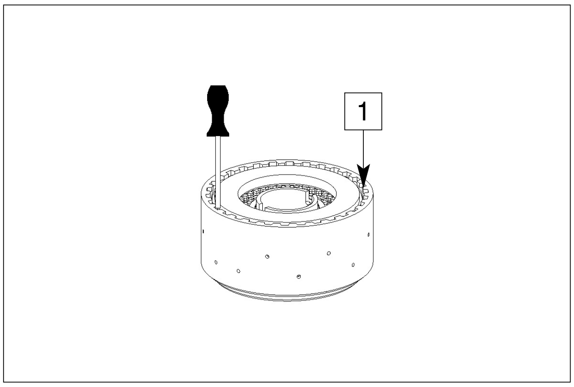
180DTM097

⑤ Pull clutch (1) off the shaft.

(S)Two-armed puller 5870 970 004

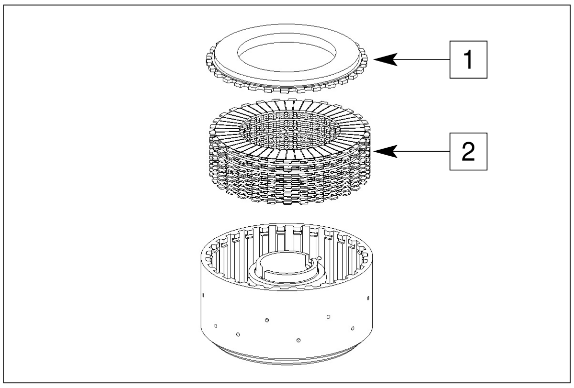


⑥ Remove snap ring (1).



180DTM057

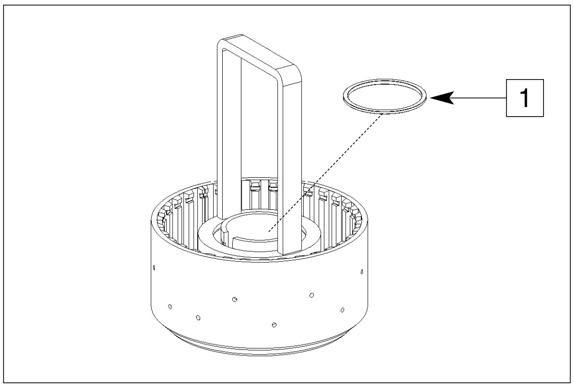
⑦ Remove end plate (1) and disc package (2) from disc carrier.



180DTM081

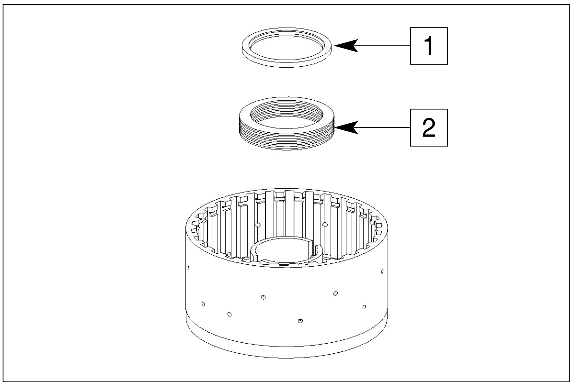
⑧ Preload cup springs and remove L-ring (1).

(S)Assembly aid 5870 345 088



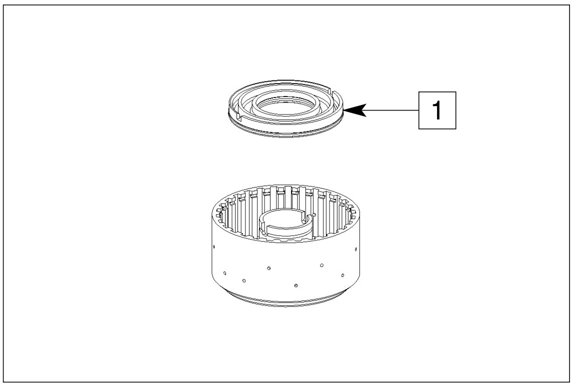
180DTM059

⑨ Remove guide ring (1) and cup spring package (2).



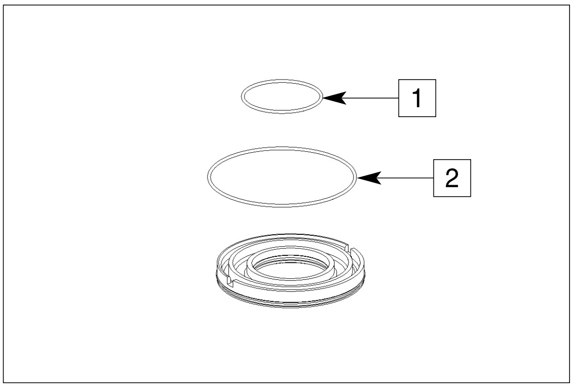
180DTM082

⑩ Lift piston (1) off the disc carrier by compressed air out of hole, and remove it.



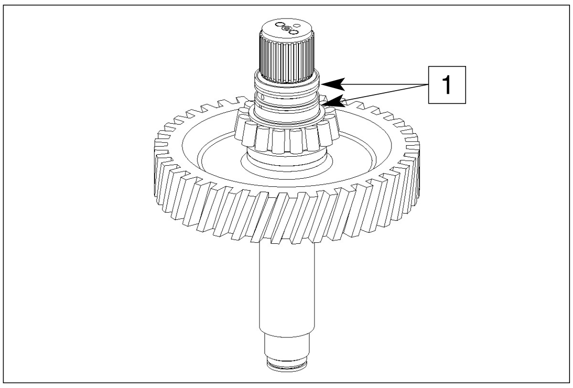
180DTM061

⑪ Remove both O-rings (1 and 2).



180DTM062

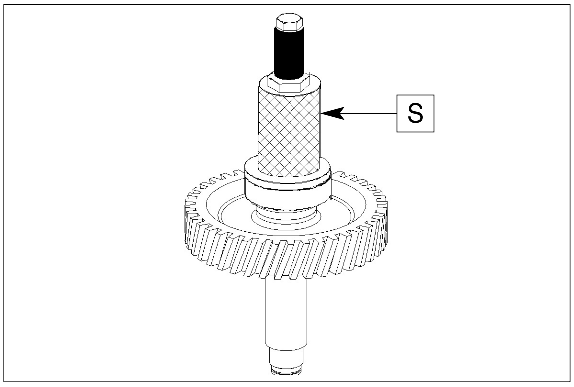
⑫ Unsnap piston rings (1).



180DTM098

⑬ Pull tapered roller bearing (internal ring) off the shaft.

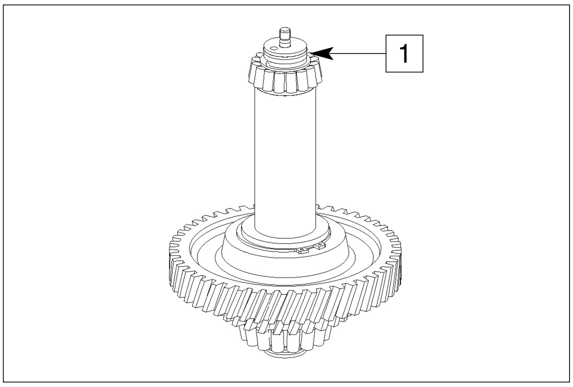
(S) Basic tool 5873 002 001
(S) Grab sleeve 5873 002 038



180DTM099

(6) Clutch K4 (Intermediate shaft)

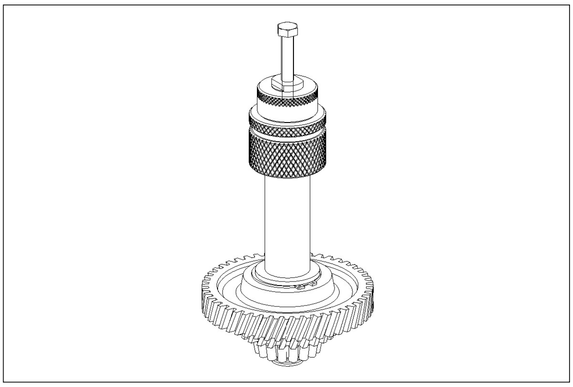
① Unsnap piston ring (1).



180DTM100

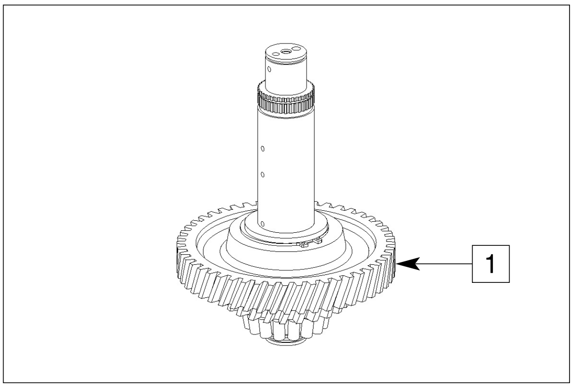
② Pull tapered roller bearing (internal ring) off the shaft.

(S)Forcing device	5870 026 100
(S)Grab sleeve	5873 001 057
or	
(S)Rapid grip	5873 011 011



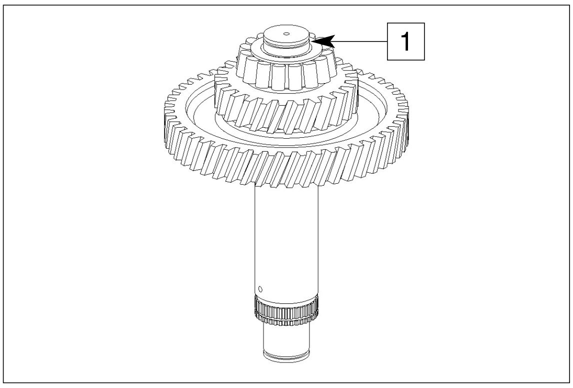
180DTM101

※ The gear (3) cannot be removed (shrink fit).



180DTM102

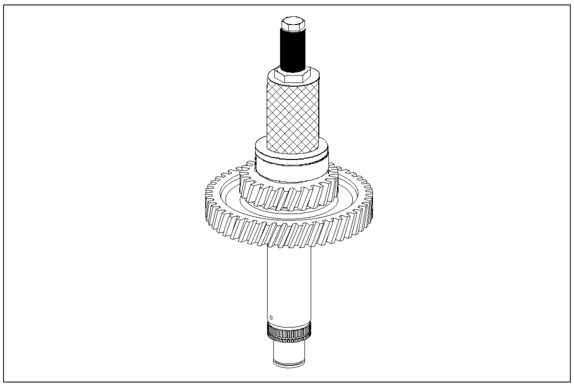
③ Unsnap piston rings (1).



180DTM103

④ Pull tapered roller bearing (internal ring) off the shaft.

(S)Forcing device	5870 026 100
(S)Grab sleeve	5873 001 059



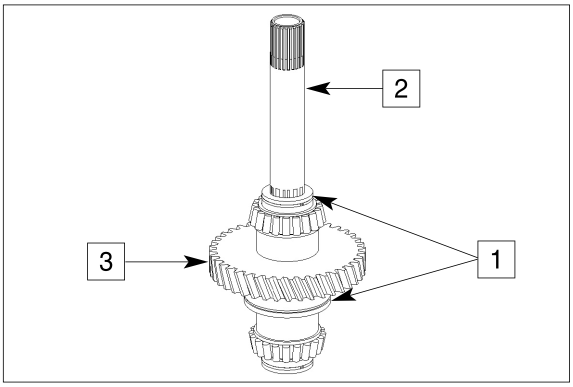
180DTM104

(7) Input shaft

① Unsnap piston rings (1).

Turbine wheel shaft (2) and drive gear (3) are fixed by means of a snap ring.

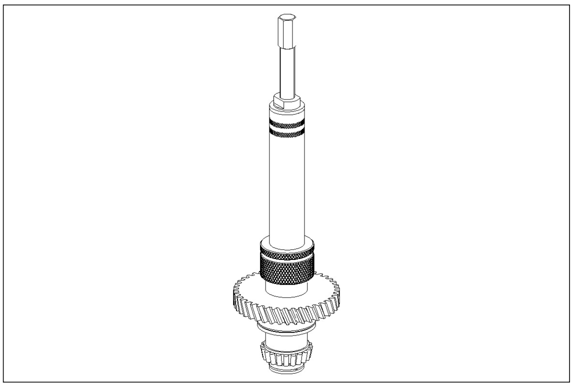
※ When separated, the components will be destroyed.



180DTM105

② Pull tapered roller bearing (internal ring) off the drive gear.

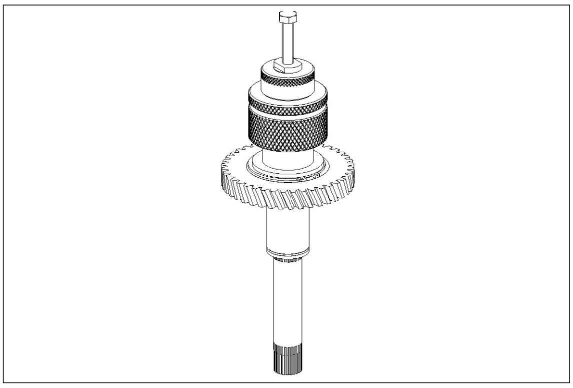
(S)Basic tool	5873 001 000
(S)Rapid grip	5873 011 014
or	
(S)Grab sleeve	5873 001 058



180DTM106

③ Pull tapered roller bearing (internal ring) off the drive gear.

(S)Forcing device	5870 026 100
(S)Rapid grip	5873 011 014

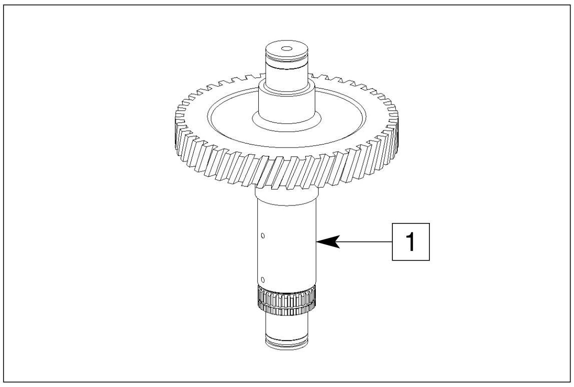


180DTM107

7) REASSEMBLY OF CLUTCHES

(1) Clutch KV

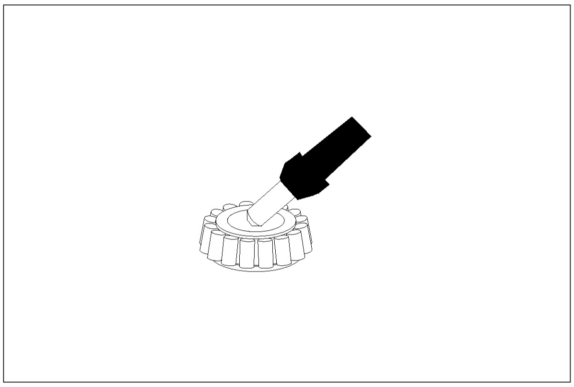
① Shaft - clutch shaft KV- (1).



180DTM108

② Heat up bearing inner ring (app. 120˚C).

(S)Hot air blower 230 V 5870 221 500
(S)Hot air blower 115 V 5870 221 501



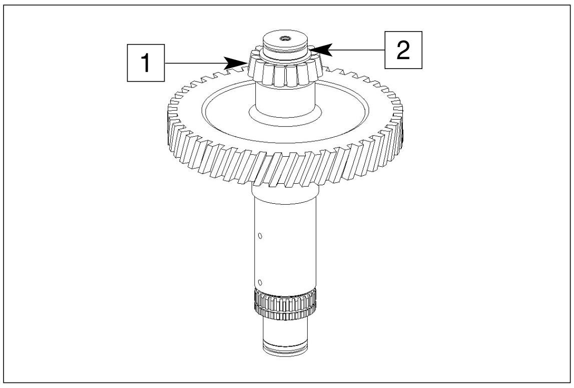
180DTM109

③ Mount bearing inner ring (1) until contact.

Mount piston ring (2).

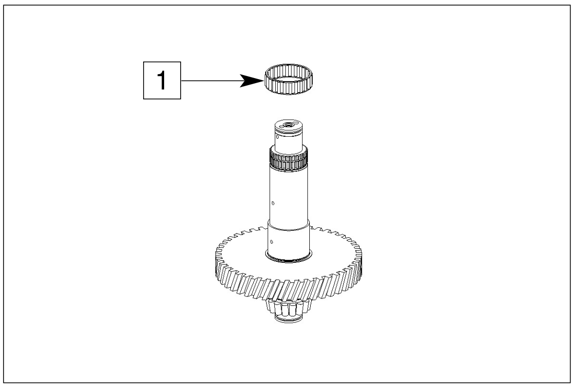
⚠ **Wear protective gloves.**

※ Readjust bearing inner ring after cooling down.



180DTM110

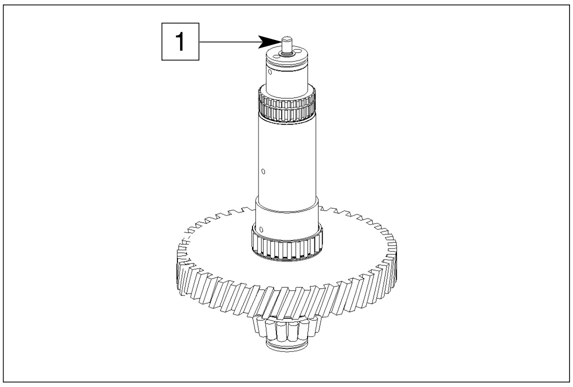
④ Mount needle cage 60×68×20 (1) on shaft and oil it.



180DTM111

⑤ Mount stud bolt (1).

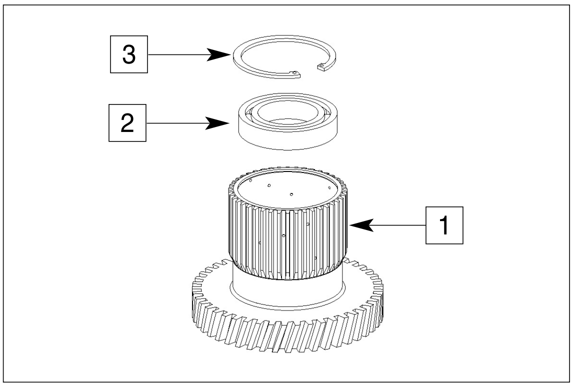
Tightening torque (M10/8.8×16) ·············
··· M_A =1.7 Nm



180DTM112

⑥ Insert ball bearing 55×90×18 (2) into idler gear (1) until contact is obtained and fix it by means of retaining ring (3) 90×3.

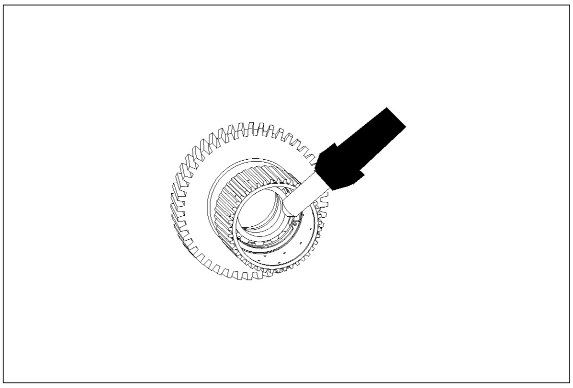
(S)Set of internal pliers 5870 900 013



180DTM113

⑦ Heat up ball bearing (app. 120°C).

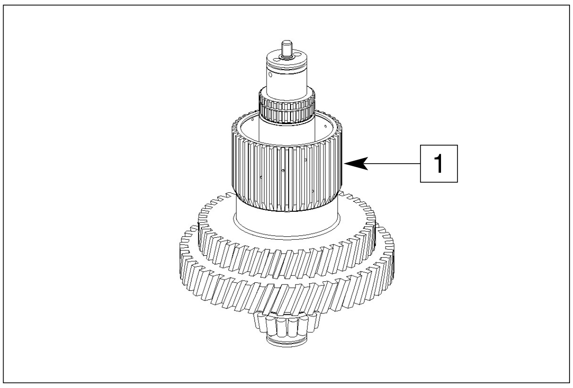
(S)Hot air blower 230 V 5870 221 500
(S)Hot air blower 115 V 5870 221 501



180DTM114

⑧ Mount pre-assembled idler gear (1) until contact.

⚠ **Wear protective gloves.**

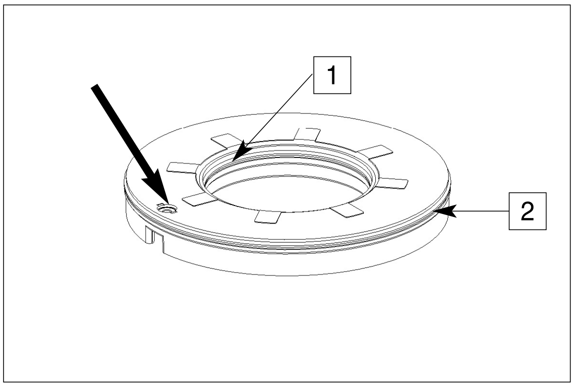


180DTM115

⑨ Insert both O-rings (1 and 2) into piston grooves and oil them.

1 = 75×3
2 = 142×3

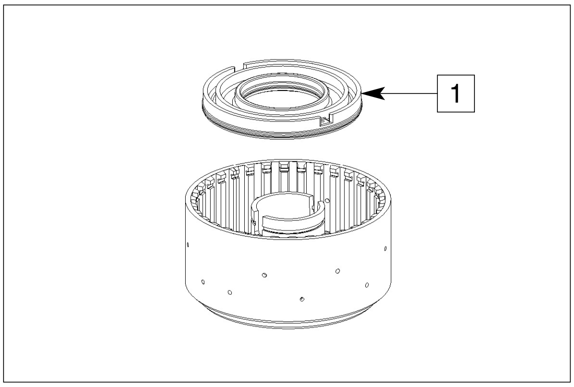
※ Check function of the drain valve (see arrow) - there must be no jamming of the ball.



180DTM116

⑩ Insert piston (1) into disc carrier.

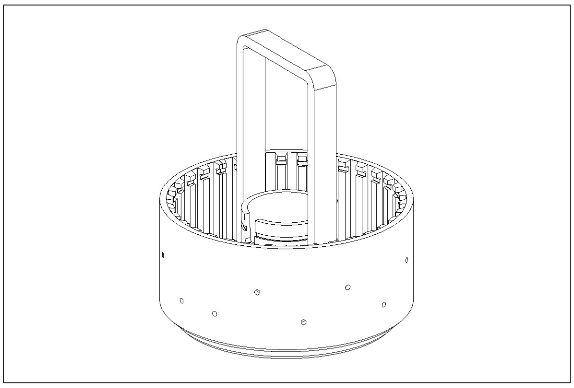
※ Observe installation position, see figure.



180DTM117

⑪ Use a hand-operated press to place piston into the disc carrier by means of the assembly aid.

(S)Assembly aid 5870 345 088



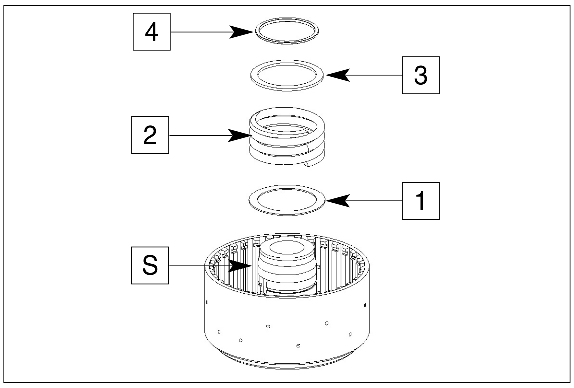
180DTM118

⑫ Mount inner installer (S) onto the disk carrier.

Install disk (1), compression spring (2), support shim (3) and L-ring (4).

※ Installation position support shim and L-ring see figure TM121.

(S)Inner installer → see figure TM120.

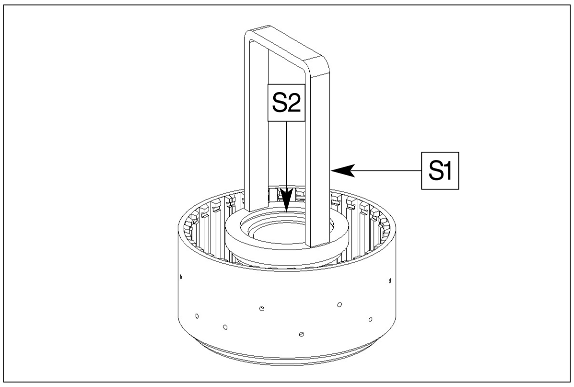


180DTM119

⑬ Preload compression spring by means of assembly aid (S1) and pressure piece (S2), until L-ring has engaged into the annular groove.

(S) Assembly aid 5870 345 088
(S) Assembly fixture 5870 345 124
(Inner installer and pressure piece)

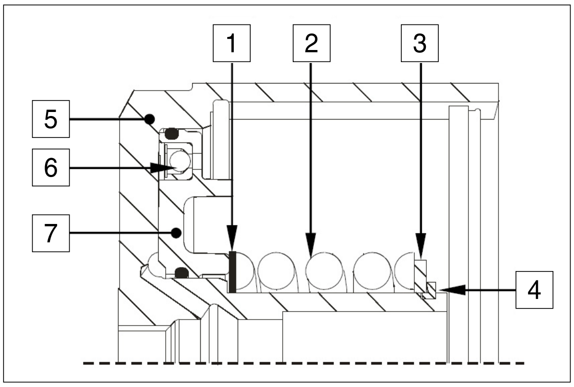
※ It is always necessary to mount a new L-ring.



180DTM120

⑭ Disk carrier with piston retraction :

Legend :
1 = Washer
2 = Compression spring
3 = Support shim
4 = L-ring
5 = Disk carrier
6 = Drain valve (piston)
7 = Piston with O-rings

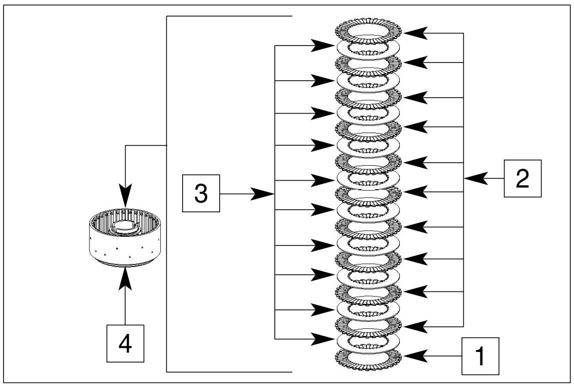


180DTM121

⑮ Install outer and inner disks alternately into the disk carrier (4) as personated in figure TM122.

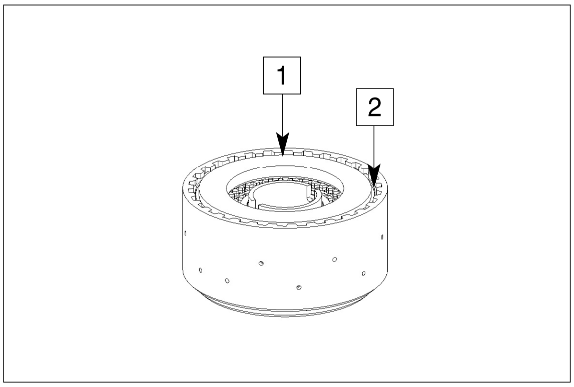
Legend :
1 = Friction disk-coated on one side (1 pcs)
2 = Outer disks (10 pcs)
3 = Inner disks (10 pcs)

※ Take care that the uncoated (blank) side of the friction disk (1) is showing towards the piston.
Number of friction surfaces : 20.



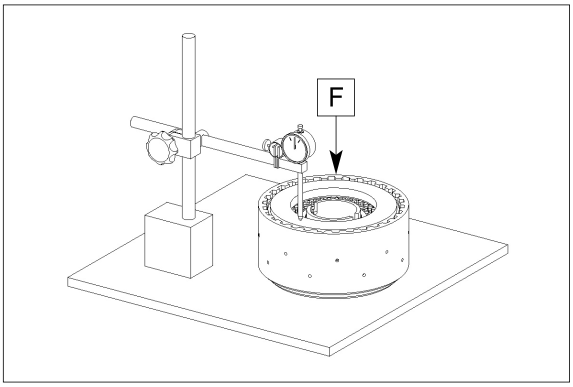
180DTM122

⑯ Mount end plate (1) and fix disk package by means of snap ring (2) (e.g. thickness = 2.65 mm / recommended value).



180DTM123

⑰ Press on end plate with F (approx. 100 N = 10 kg) and set dial indicator to "zero".

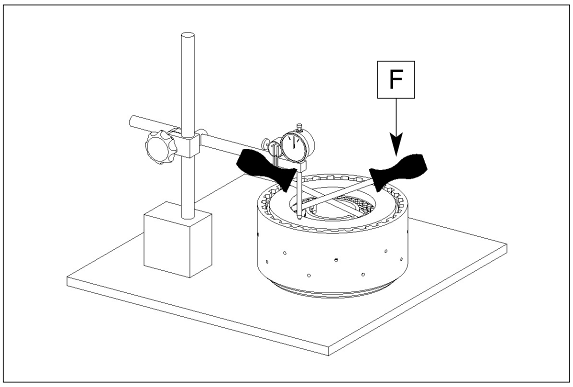


180DTM124

⑱ Then press end plate against the snap ring (upwards) and read disk clearance.

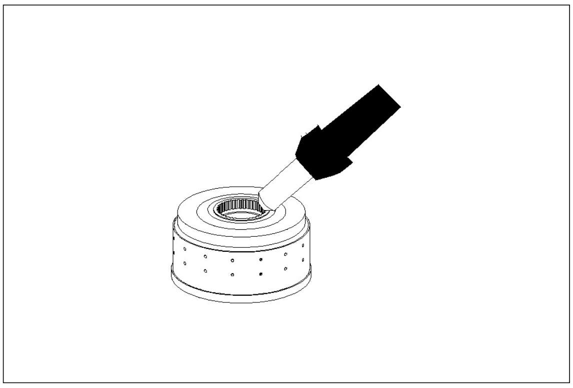
※ Disk clearance : 2.65 ~ 2.95 mm

※ In case of deviations, the disk clearance must be corrected with an appropriate snap ring (optional thicknesses = 2.1~4.2 mm).



180DTM125

⑲ Heat up clutch inner diameter (approx. 120˚C).

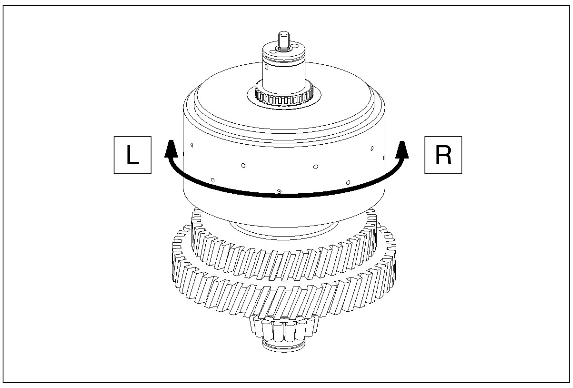


180DTM126

⑳ Install clutch until contact is obtained.

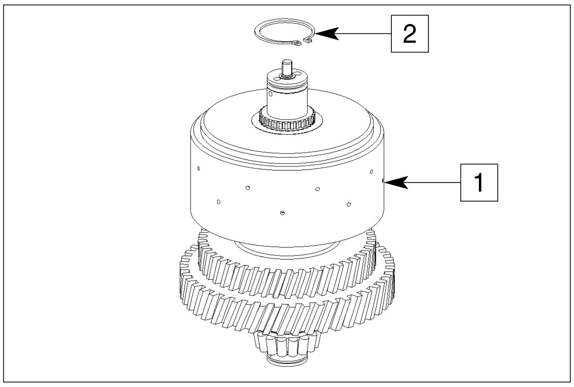
Mount inner disks onto the inner disk carrier by means of short left/right rotations.

⚠ **Wear protective gloves.**



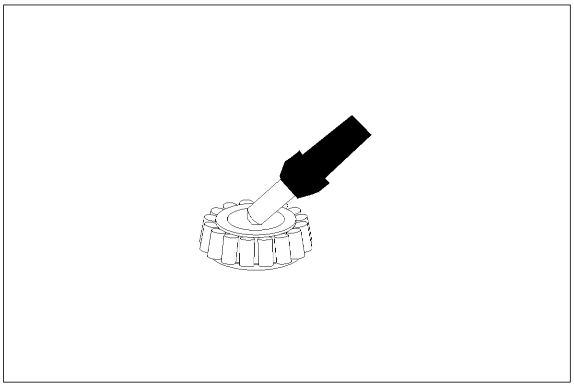
180DTM127

㉑ Fix clutch (1) by means of retaining ring 55×2 (2).



180DTM128

㉒ Heat up bearing inner ring (approx. 120˚C)



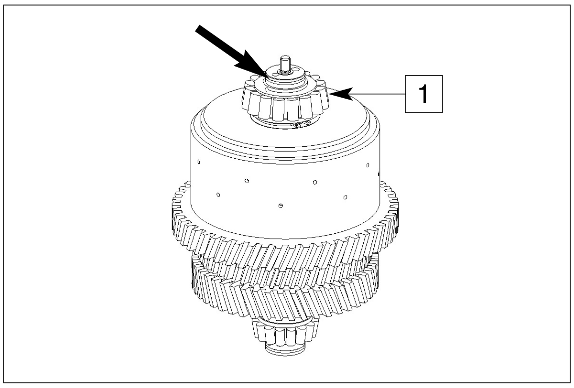
180DTM129

㉓ Mount bearing inner ring (1) until contact is obtained.

⚠ Wear protective gloves.

※ Adjust bearing inner ring after cooling-down.

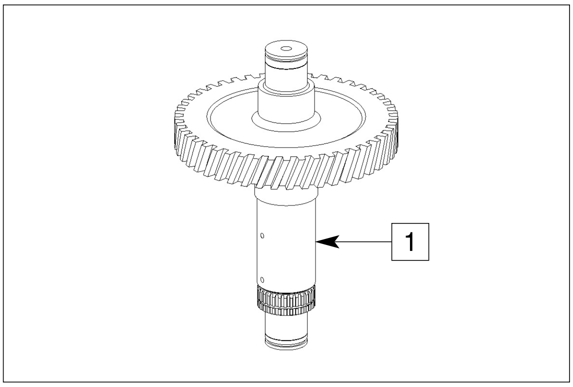
Check closing and opening of the clutch by means of compressed air at the hole (see arrow).
Closing and opening of the clutch must be clearly audible.



180DTM130

(2) Clutch KR

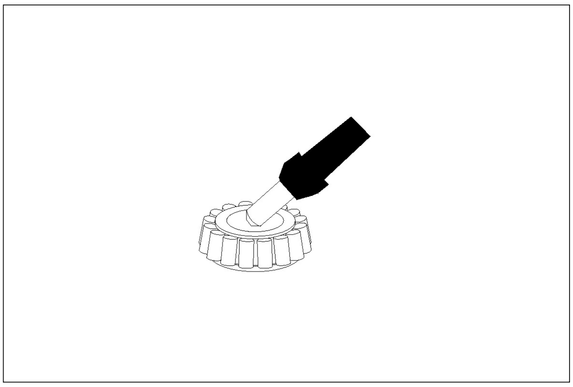
① Shaft - clutch shaft KR- (1).



180DTM108

② Heat up bearing inner ring (app. 120°C).

(S)Hot air blower 230 V   5870 221 500
(S)Hot air blower 115 V   5870 221 501



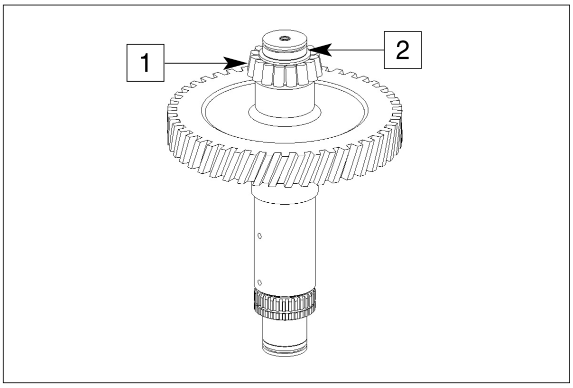
180DTM109

③ Mount bearing inner ring (1) until contact.

Mount piston ring (2).

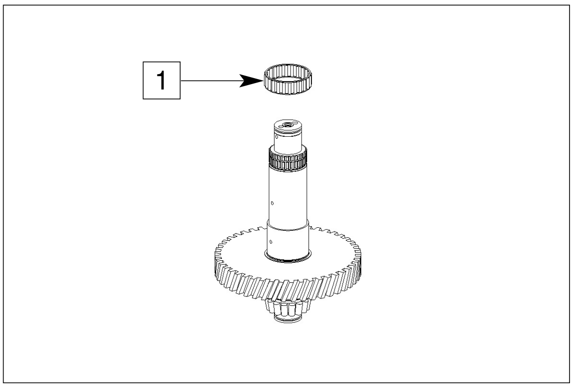
⚠ Wear protective gloves.

※ Readjust bearing inner ring after cooling down.



180DTM110

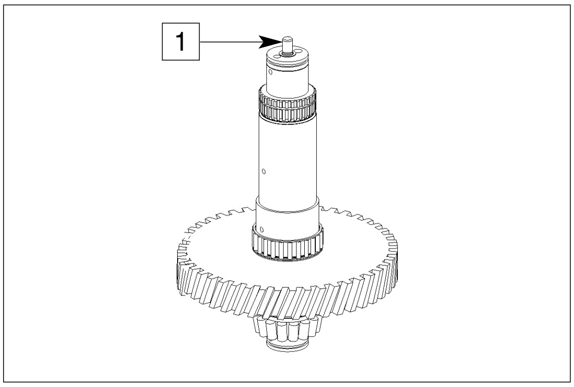
④ Mount needle cage 60×68×20 (1) on shaft and oil it.



180DTM111

⑤ Mount stud bolt (1).

Tightening torque (M10/8.8×16) ··· M_A = 17 Nm

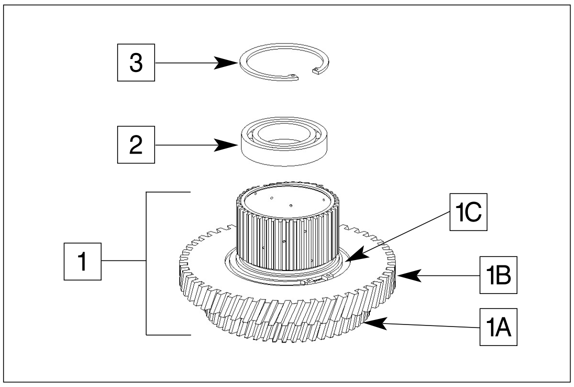


180DTM112

⑥ Insert ball bearing 55x90x18 (2) into idler gear (1) until contact is obtained and fix it by means of retaining ring (3) 90×3.

(S)Set of internal pliers 5870 900 013

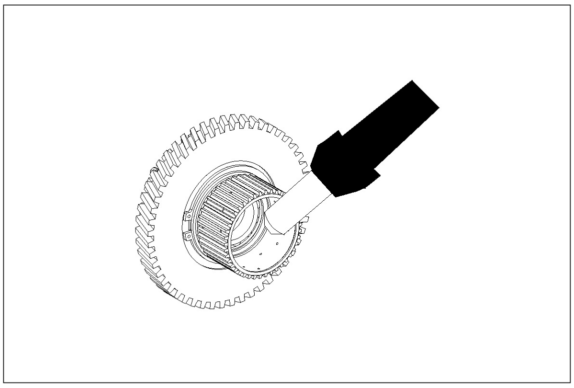
※ The idler gear (1) is only available as a complete assy in spare parts service.
Consisting of :
1A = Idler gear
1B = Spur gear
1C = Retaining ring 110x4



180DTM131

⑦ Heat up ball bearing (app. 120°C).

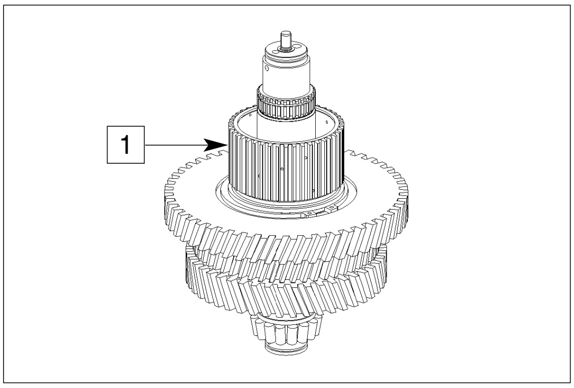
(S)Hot air blower 230 V 5870 221 500
(S)Hot air blower 115 V 5870 221 501



180DTM132

⑧ Mount pre-assembled idler gear (1) until contact.

⚠ **Wear protective gloves.**

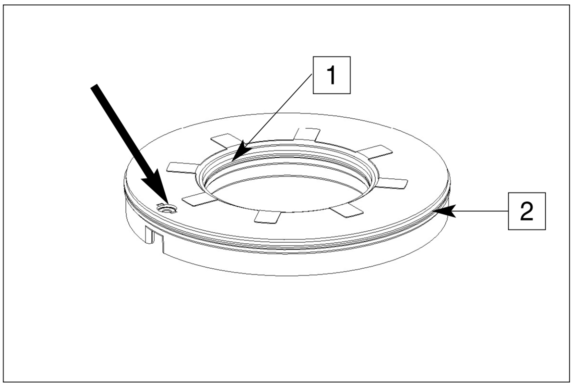


180DTM133

⑨ Insert both O-rings (1 and 2) into piston grooves and oil them.

1 = 75×3
2 = 142×3

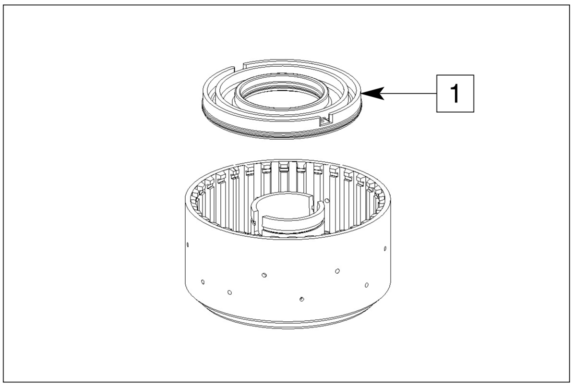
※ Check function of the drain valve (see arrow) - there must be no jamming of the ball.



180DTM116

⑩ Insert piston (1) into disc carrier.

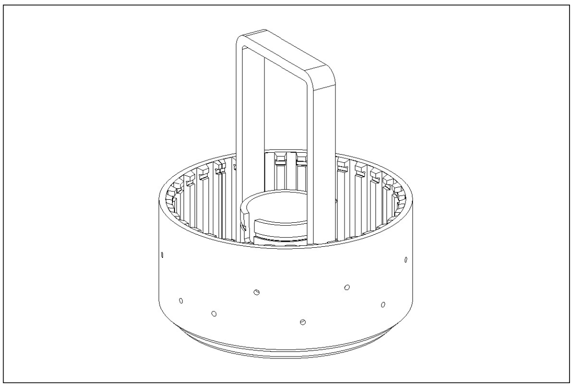
※ Observe installation position, see figure.



180DTM117

⑪ Use a hand-operated press to place piston into the disc carrier by means of the assembly aid.

(S)Assembly aid 5870 345 088



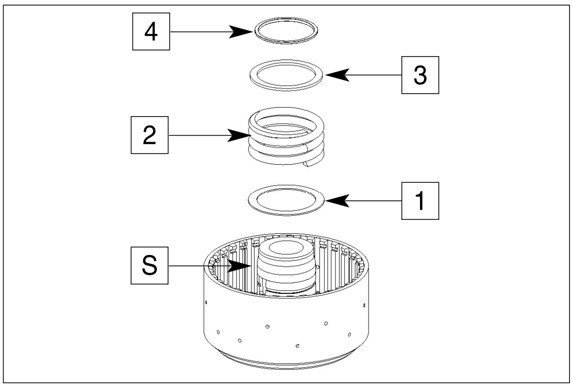
180DTM118

⑫ Mount inner installer (S) onto the disk carrier.

Install disk (1), compression spring (2), support shim (3) and L-ring (4).

※ Installation position support shim and L-ring see figure TM121.

(S)Inner installer → see figure TM120.

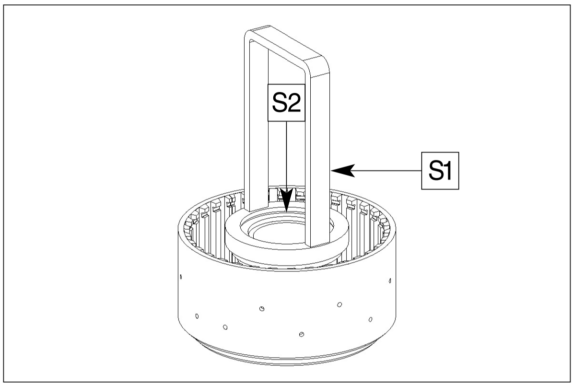


180DTM119

⑬ Preload compression spring by means of assembly aid (S1) and pressure piece (S2), until L-ring has engaged into the annular groove.

(S)Assembly aid 5870 345 088
(S)Assembly fixture 5870 345 124
(Inner installer and pressure piece)

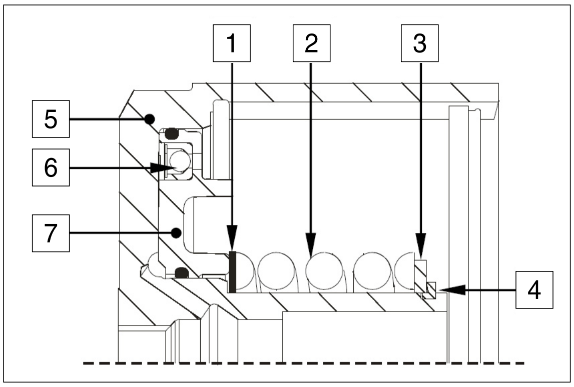
※ It is always necessary to mount a new L-ring.



180DTM120

⑭ Disk carrier with piston retraction :

Legend :
1 = Washer
2 = Compression spring
3 = Support shim
4 = L-ring
5 = Disk carrier
6 = Drain valve (piston)
7 = Piston with O-rings

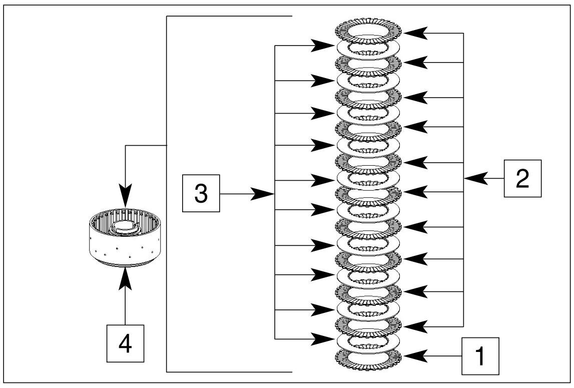


180DTM121

⑮ Install outer and inner disks alternately into the disk carrier (4) as personated in figure TM122.

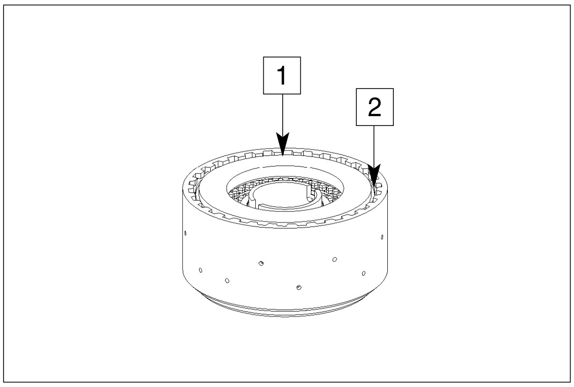
Legend :
1 = Friction disk-coated on one side (1 pcs)
2 = Outer disks (10 pcs)
3 = Inner disks (10 pcs)

Take care that the uncoated (blank) side of the friction disk (1) is showing towards the piston.
Number of friction surfaces : 20.



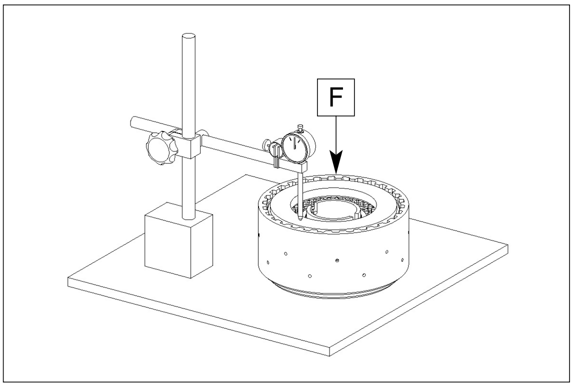
180DTM122

⑯ Mount end plate (1) and fix disk package by means of snap ring (2) (e.g. thickness = 2.65 mm / recommended value).



180DTM123

⑰ Press on end plate with F (approx. 100 N = 10 ㎏) and set dial indicator to "zero".

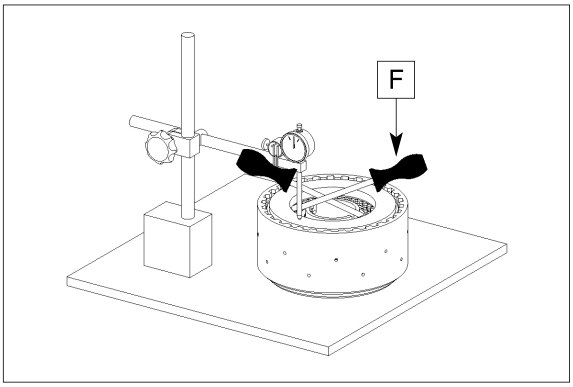


180DTM124

⑱ Then press end plate against the snap ring (upwards) and read disk clearance.

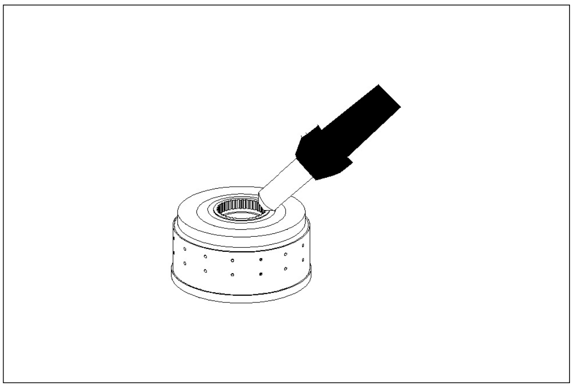
※ Disk clearance : 2.65 ~ 2.95 ㎜

※ In case of deviations, the disk clearance must be corrected with an appropriate snap ring (optional thicknesses = 2.1~4.2 ㎜).



180DTM125

⑲ Heat up clutch inner diameter (approx. 120˚C).

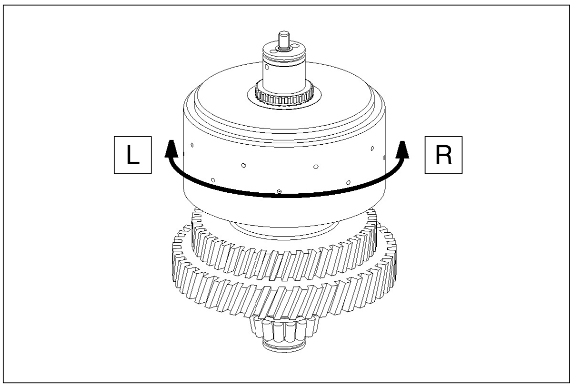


180DTM126

⑳ Install clutch until contact is obtained.

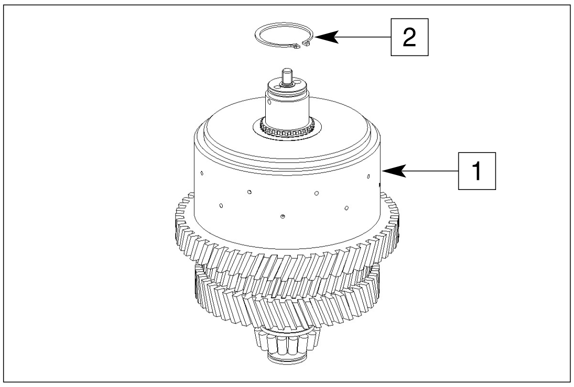
Mount inner disks onto the inner disk carrier by means of short left/right rotations.

⚠ **Wear protective gloves.**



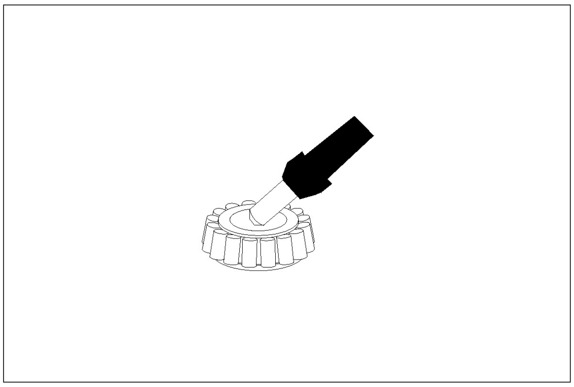
180DTM127

㉑ Fix clutch (1) by means of retaining ring 55×2 (2).



180DTM134

㉒ Heat up bearing inner ring (approx. 120°C).

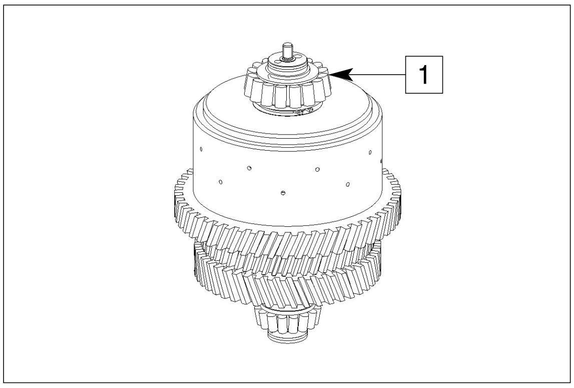

180DTM135

㉓ Mount bearing inner ring (1) until contact is obtained.

⚠ Wear protective gloves.

※ Adjust bearing inner ring after cooling-down.

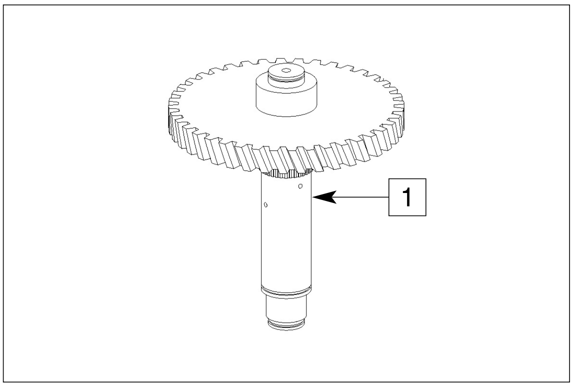
Check closing and opening of the clutch by means of compressed air at the hole (see arrow).
Closing and opening of the clutch must be clearly audible.



180DTM136

(3) Clutch K1

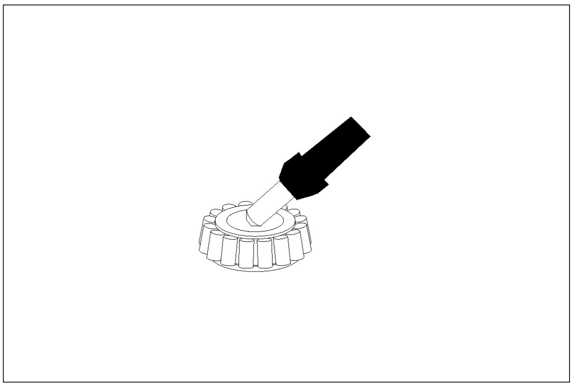
① Shaft - clutch shaft K1- (1).



180DTM137

② Heat up bearing inner ring (app. 120˚C).

(S)Hot air blower 230 V 5870 221 500
(S)Hot air blower 115 V 5870 221 501



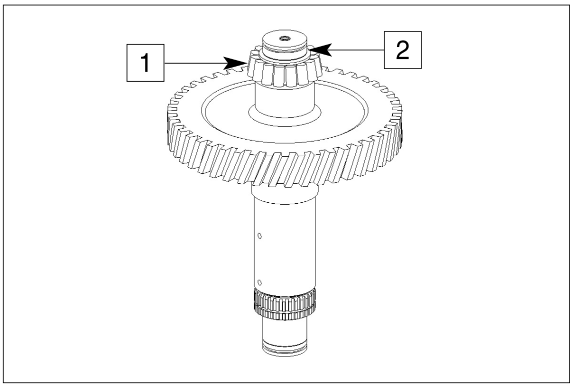
180DTM109

③ Mount bearing inner ring (1) until contact.

Mount piston ring (2).

⚠ **Wear protective gloves.**

※ Readjust bearing inner ring after cooling down.

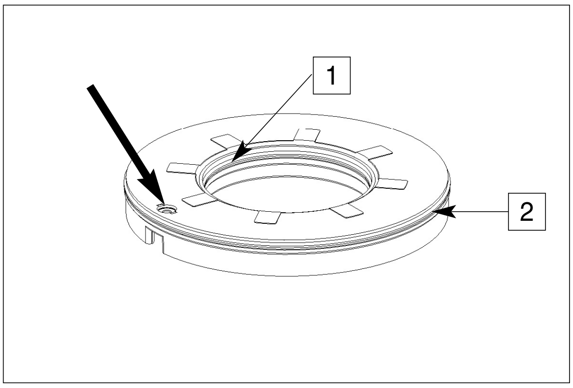


180DTM110

④ Insert both O-rings (1 and 2) into piston grooves and oil them.

1 = 75×3
2 = 158×3

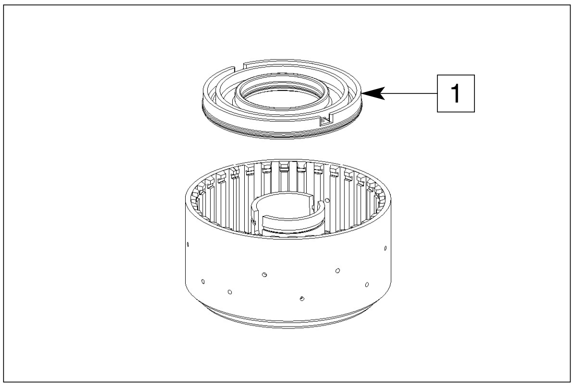
※ Check function of the drain valve (see arrow) - there must be no jamming of the ball.



180DTM116

⑤ Insert piston (1) into disc carrier.

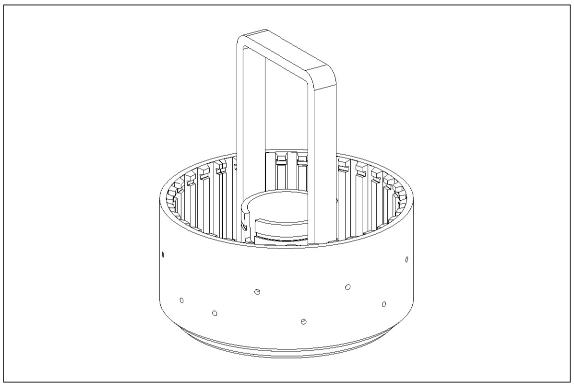
※ Observe installation position, see figure.



180DTM117

⑥ Use a hand-operated press to place piston into the disc carrier by means of the assembly aid.

(S) Assembly aid 5870 345 088



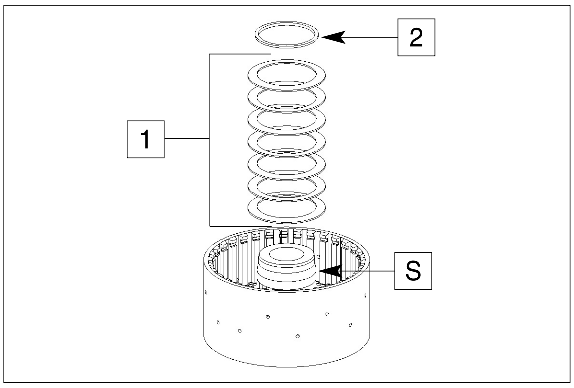
180DTM118

⑦ Mount inner installer (S) onto the disk carrier.

Install cup spring package (1) and L-ring (2).

※ Installation position cup spring package and L-ring see figure TM139.

(S) Inner installer → see figure TM120.

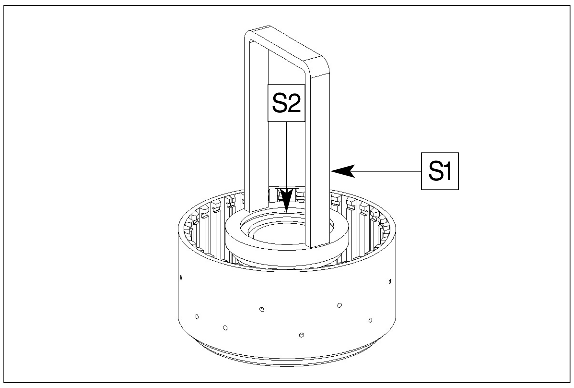


180DTM138

⑧ Preload cup spring package by means of assembly aid (S1) and pressure piece (S2), until L-ring has engaged into the annular groove.

(S) Assembly aid 5870 345 088
(S) Assembly fixture 5870 345 124
(Inner installer and pressure piece)

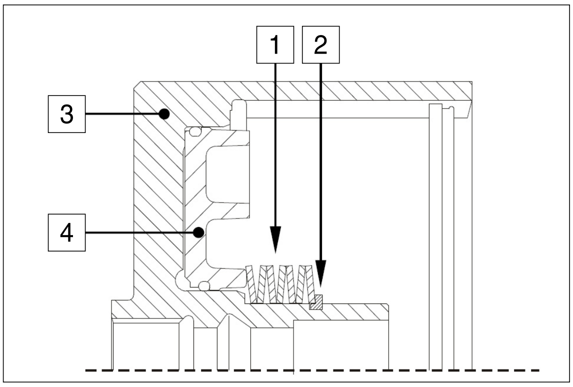
It is always necessary to mount a new L-ring.



180DTM120

⑨ Disk carrier with piston retraction :

Legend :
1 = Cup spring package
2 = L-ring
3 = Disk carrier
4 = Piston with O-rings

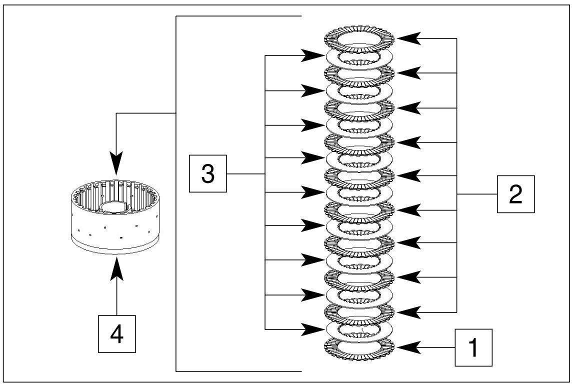


180DTM139

⑩ Install outer and inner clutch discs alternately into disc carrier (4) as described in figure.

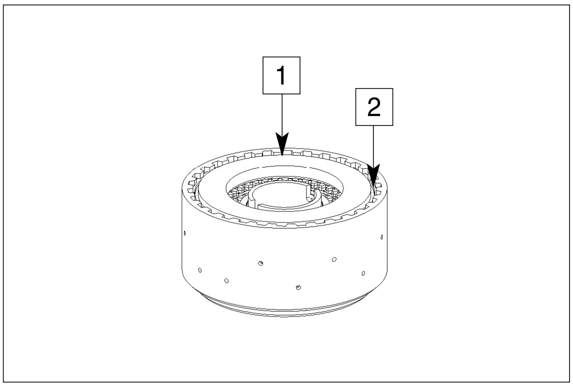
Legend :
1 = Friction disc - coated on one side (1pc)
2 = Outer discs (9 pcs)
3 = Inner discs (9 pcs)

※ When mounting the friction disc (1) ensure that its uncoated (bare) side shows towards the piston.
Number of friction surfaces : 18.



180DTM140

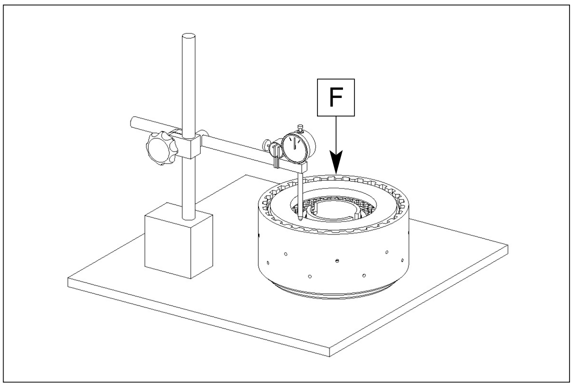
⑪ Mount end plate (1) and fix disc package by means of snap ring (2) (e.g. s = 2.65 mm / experience value).



180DTM123

⑫ Press on end plate with F (app. 100 N = 10 kg) and set dial indicator to "zero".

(S) Magnetic stand	5870 200 055
(S) Dial indicator	5870 200 057

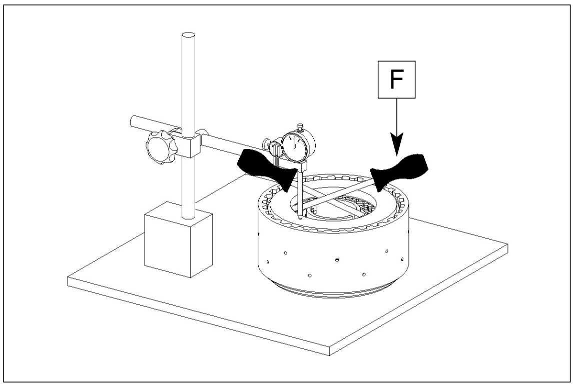


180DTM124

⑬ Then press end plate against snap ring (upwards) and read disc clearance.

※ Disc clearance : 2.35 ~ 2.65 ㎜

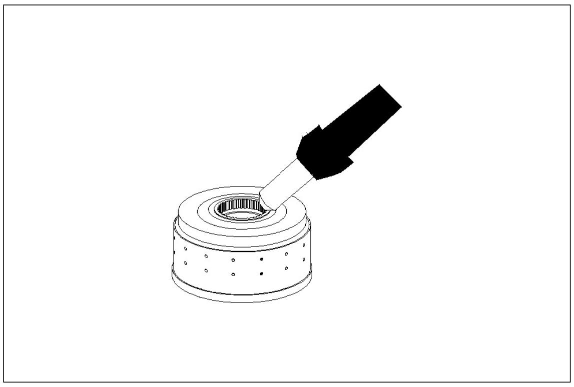
※ Any deviation demands a correction of the disc clearance by a suitable snap ring (optional s = 2.1~4.2 ㎜).



180DTM125

⑭ Heat up internal diameter of clutch (app. 120 ˚C).

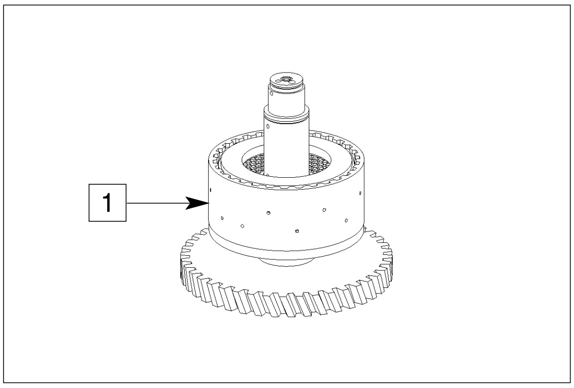
(S) Hot air blower 230 V 5870 221 500
(S) Hot air blower 115 V 5870 221 501



180DTM126

⑮ Mount clutch (1) until contact is obtained.

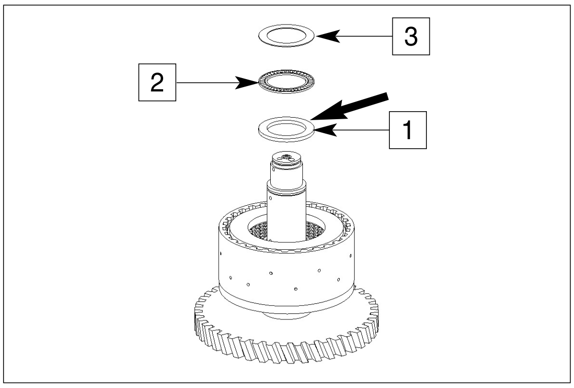
⚠ **Wear protective gloves.**



180DTM141

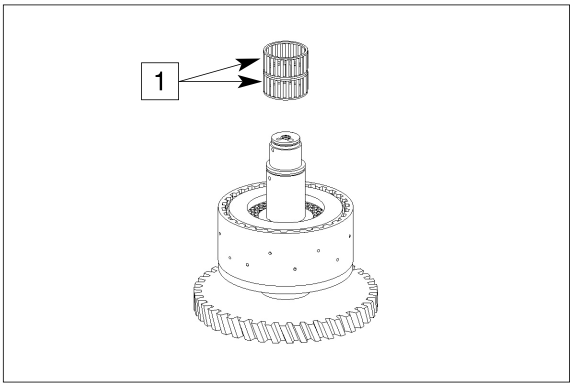
⑯ Mount and oil running disc 55×78×5 (1), axial cage (2) and axial washer 55×78×1 (3).

※ Install running disc (1) with chamfer (see arrow) showing towards the axial cage.



180DTM142

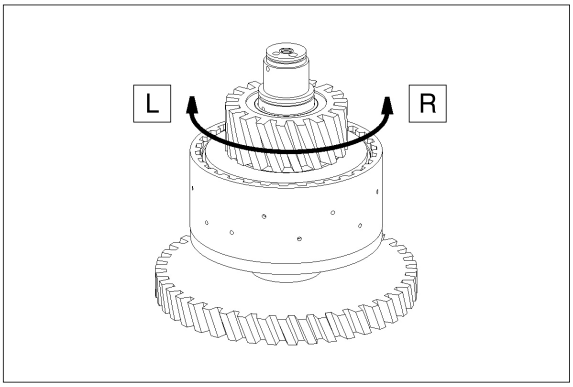
⑰ Mount needle cage 55×63×64 (1) on shaft and oil it.



180DTM143

⑱ Install idler gear.

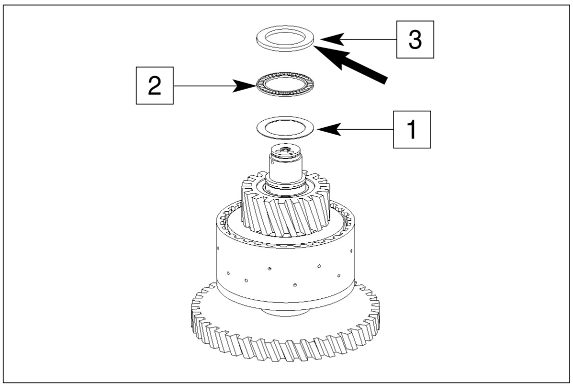
Install inner discs on inner disc carrier (idler gear) by shortly rotating them cw/ccw.



180DTM144

⑲ Mount and oil axial washer 55×78×1 (1), axial cage (2) and running disc 55×78×5 (3).

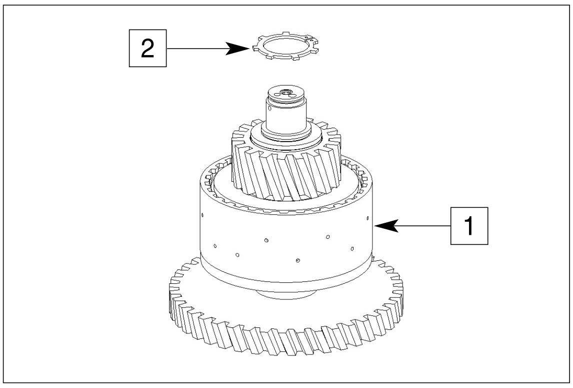
※ Install running disc (3) with chamfer (see arrow) showing towards the axial cage.



180DTM145

⑳ Fix clutch (1) with retaining ring (2) 50×3.

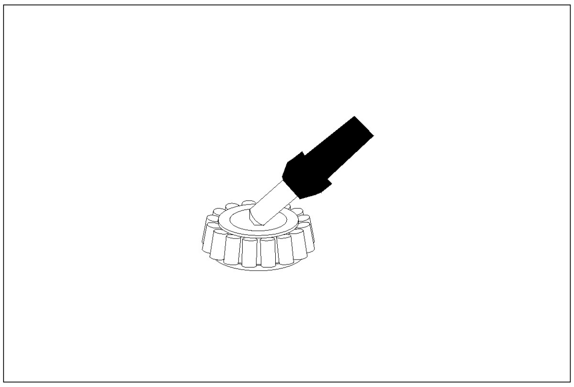
(S)Set of external pliers 5870 900 015



180DTM146

㉑ Heat up bearing inner ring (app. 120 °C).

(S)Hot air blower 230 V 5870 221 500
(S)Hot air blower 115 V 5870 221 501



180DTM135

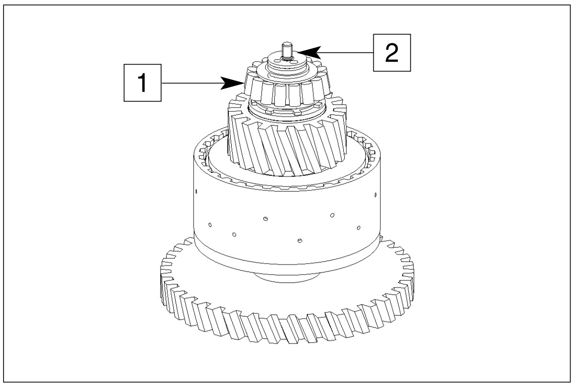
㉒ Mount bearing inner ring (1) until contact.

Mount stud bolt (1).

Tightening torque (M10/8.8 × 16) ....
.... M_A = 17 Nm

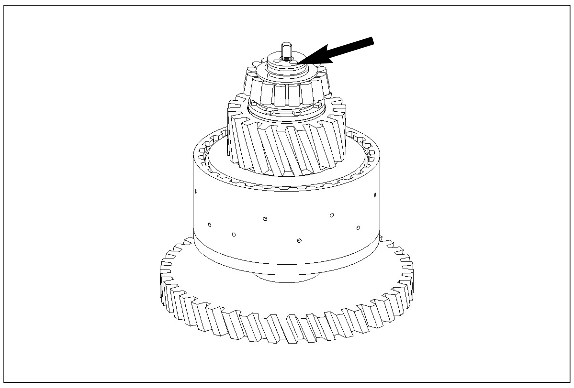
⚠ **Wear protective gloves.**

※ Readjust bearing inner ring after cooling down.



180DTM147

※ Check closing and opening of the clutch by means of compressed air at the hole (see arrow).
Closing and opening of the clutch must be clearly audible.

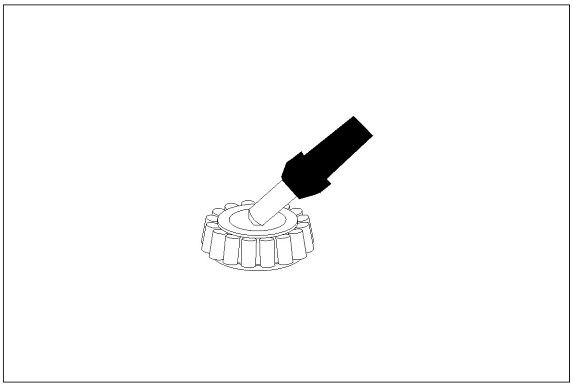


180DTM148

(4) Clutch K2

① Heat up bearing inner ring (app. 120°C).

(S) Hot air blower 230 V 5870 221 500
(S) Hot air blower 115 V 5870 221 501



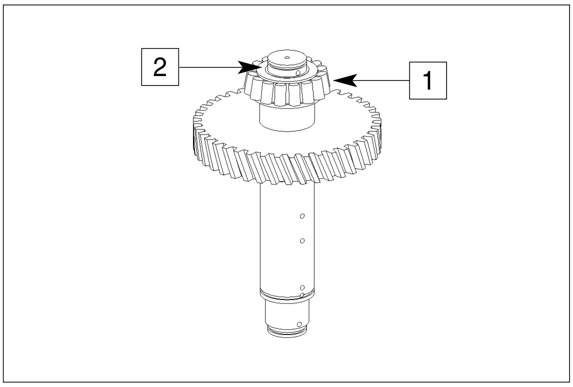
180DTM135

② Mount bearing inner ring (1) until contact.

Mount piston ring (2).

⚠ **Wear protective gloves.**

※ Readjust bearing inner ring after cooling down.

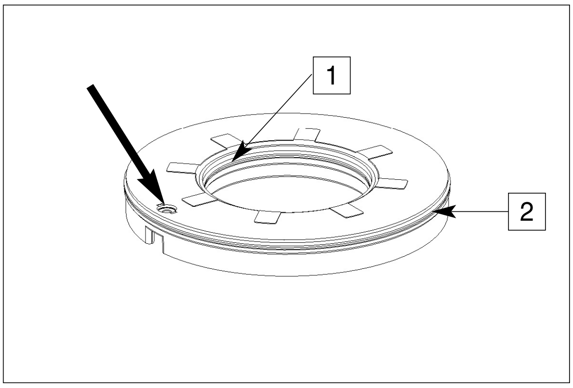


180DTM149

③ Insert both O-rings (1 and 2) into piston grooves and oil them.

1 = 75 × 3
2 = 142 × 3

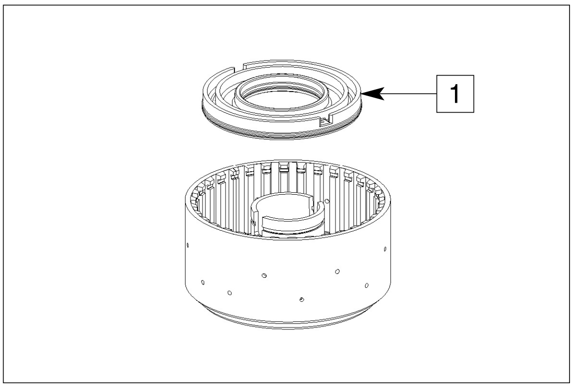
※ Check function of the drain valve (see arrow) - there must be no jamming of the ball.



180DTM116

④ Insert piston (1) into disc carrier.

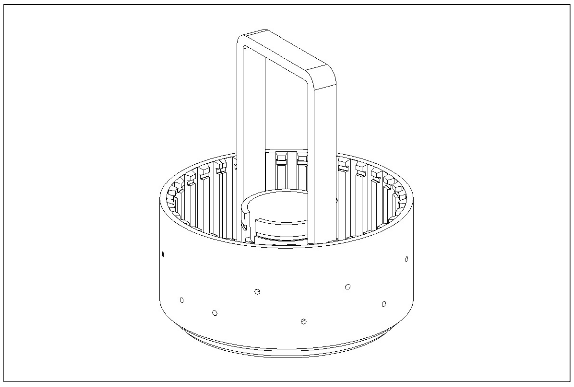
※ Observe installation position, see figure.



180DTM117

⑤ Use a hand-operated press to place piston into the disc carrier by means of the assembly aid.

(S)Assembly aid 5870 345 088



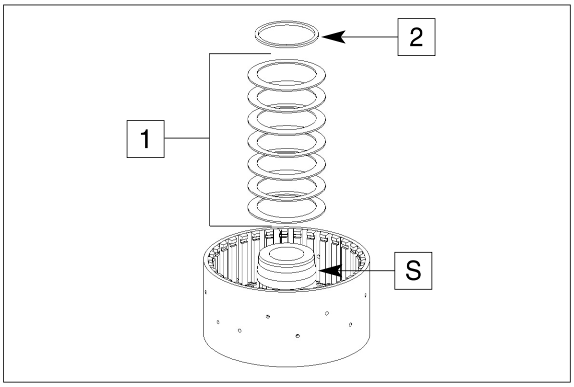
180DTM118

⑥ Mount inner installer (S) onto the disk carrier.

Install cup spring package (1) and L-ring (2).

※ Installation position cup spring package and L-ring see figure TM139.

(S) Inner installer → see figure TM120.

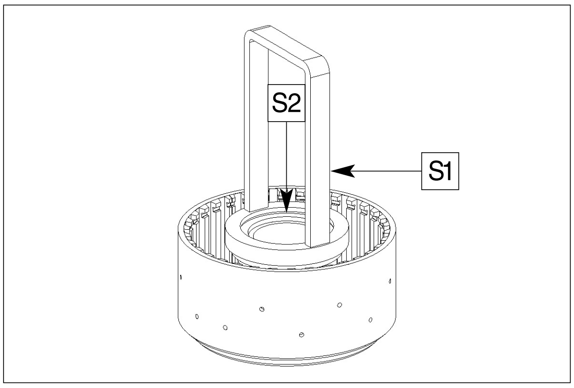


180DTM138

⑦ Preload cup spring package by means of assembly aid (S1) and pressure piece (S2), until L-ring has engaged into the annular groove.

(S) Assembly aid 5870 345 088
(S) Assembly fixture 5870 345 124
(Inner installer and pressure piece)

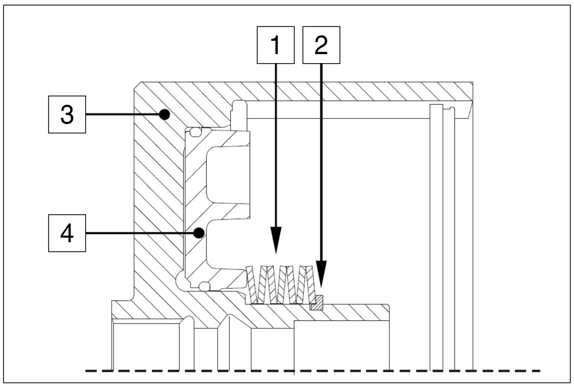
※ It is always necessary to mount a new L-ring.



180DTM120

⑧ Disk carrier with piston retraction :

Legend :
1 = Cup spring package
2 = L-ring
3 = Disk carrier
4 = Piston with O-rings

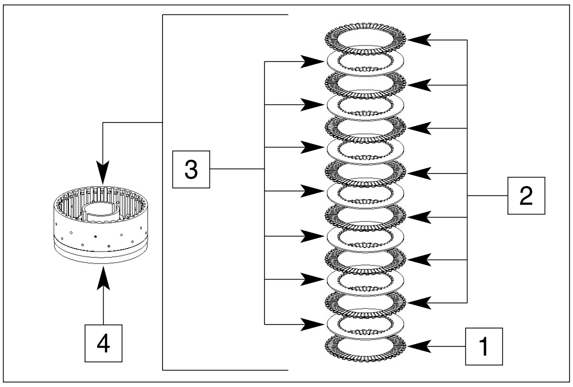


180DTM139

⑨ Install outer and inner clutch discs alternately into disc carrier (4) as described in figure TM150.

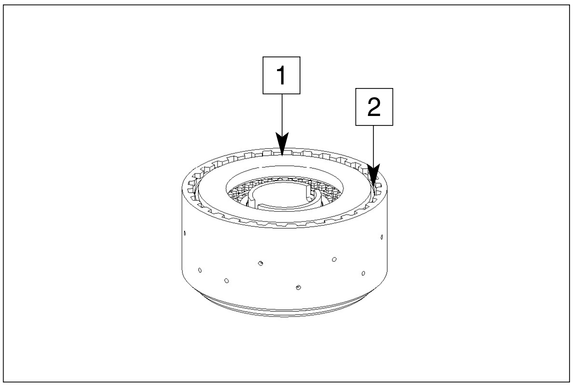
Legend :
1 = Friction disc- coated on one side (1 pc)
2 = Outer discs (7 pcs)
3 = Inner discs (7 pcs)

※ When mounting the friction disc (1) ensure that its uncoated (bare) side shows towards the piston.
Number of friction surfaces : 14



180DTM150

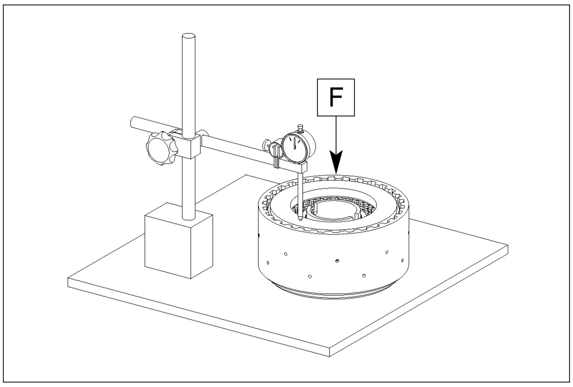
⑩ Mount end plate (1) and fix disc package by means of snap ring (2) (e.g. s = 2.65 ㎜ / experience value).



180DTM123

⑪ Press on end plate with F (app. 100 N = 10 ㎏) and set dial indicator to "zero".

(S) Magnetic stand 5870 200 055
(S) Dial indicator 5870 200 057

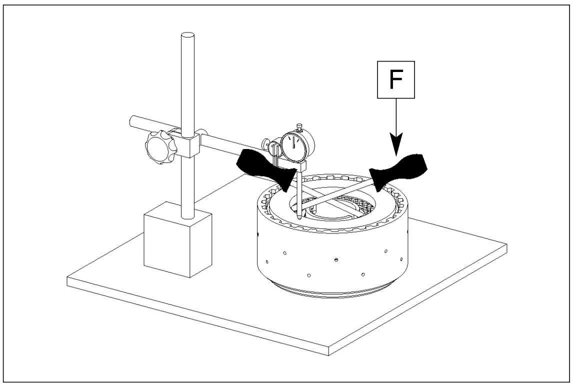


180DTM124

⑫ Then press end plate against snap ring (upwards) and read disc clearance.

※ Disc clearance : 1.75 ~ 2.05 ㎜

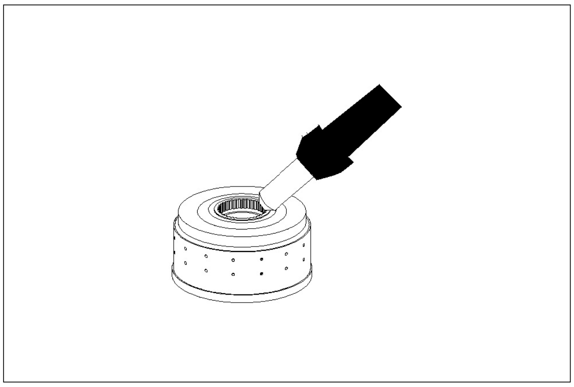
※ Any deviation demands a correction of the disc clearance by a suitable snap ring (optional s = 2.1 ~ 4.2 ㎜).



180DTM125

⑬ Heat up internal diameter of clutch (app. 120 ˚C).

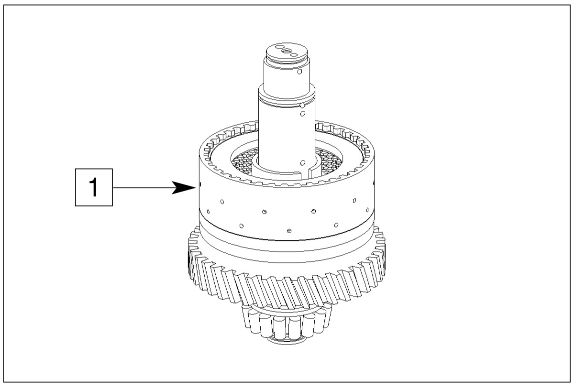
(S) Hot air blower 230 V 5870 221 500
(S) Hot air blower 115 V 5870 221 501



180DTM126

⑭ Mount clutch until contact is obtained.

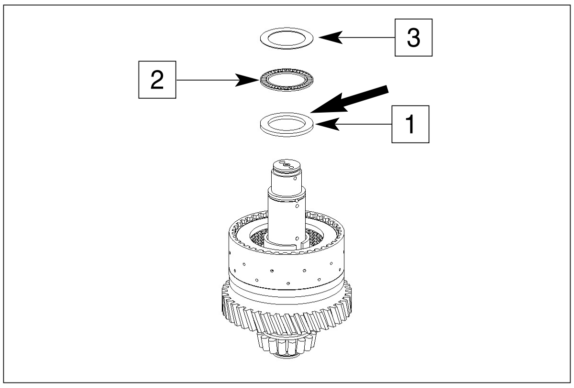
⚠ **Wear protective gloves.**



180DTM151

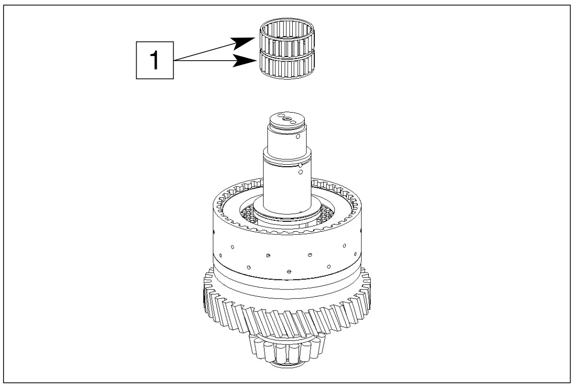
⑮ Mount and oil running disc $55 \times 78 \times 5$ (1), axial cage (2) and axial washer $55 \times 78 \times 1$ (3).

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



180DTM152

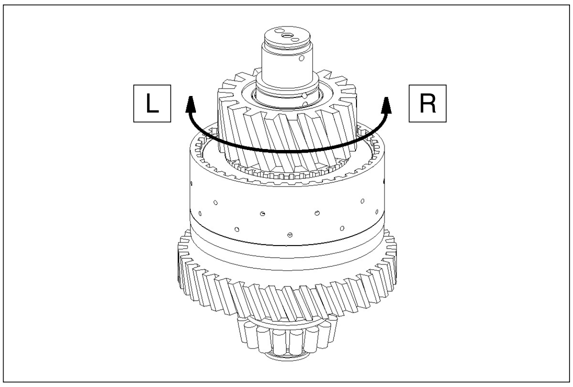
⑯ Mount needle cage $55 \times 63 \times 50$ (1) on shaft and oil it.



180DTM153

⑰ Install idler gear.

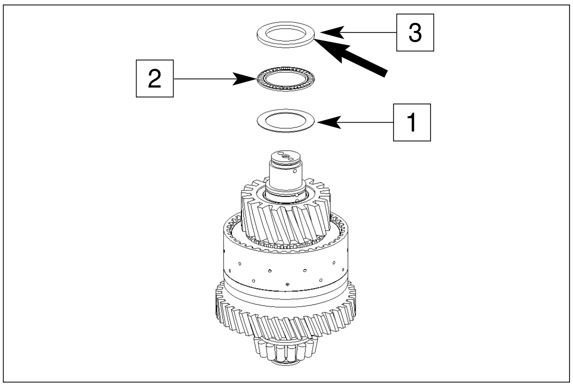
Install inner discs on inner disc carrier (idler gear) by shortly rotating them cw/ccw.



180DTM154

⑱ Mount axial washer 55×78×1 (1), axial cage (2) and running disc 55×78×5 (3) and oil them.

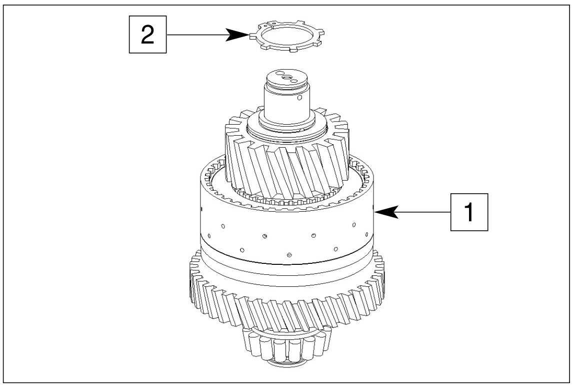
Install running disc (arrow) with chamfer (see arrow) showing towards the axial cage.



180DTM155

⑲ Fix clutch (1) with retaining ring (2) 50x3.

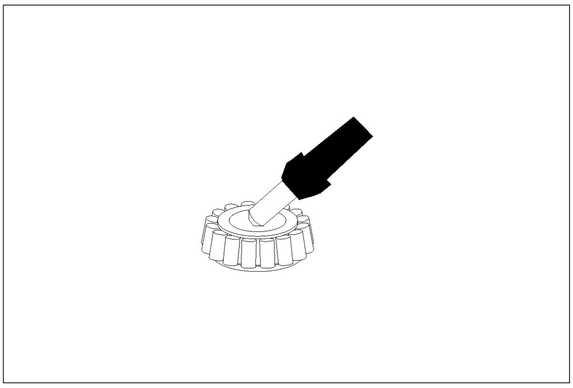
※ (S)Set of external pliers 5870 900 015



180DTM156

⑳ Heat up bearing inner ring (app. 120°C).

(S)Hot air blower 230 V 5870 221 500
(S)Hot air blower 115 V 5870 221 501



180DTM135

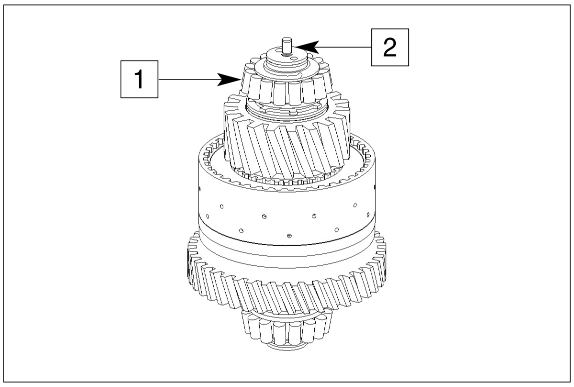
㉑ Mount bearing inner ring (1) until contact.

Mount stud bolt (1).

Tightening torque (M10/8.8 × 16) .... M_A = 17 Nm

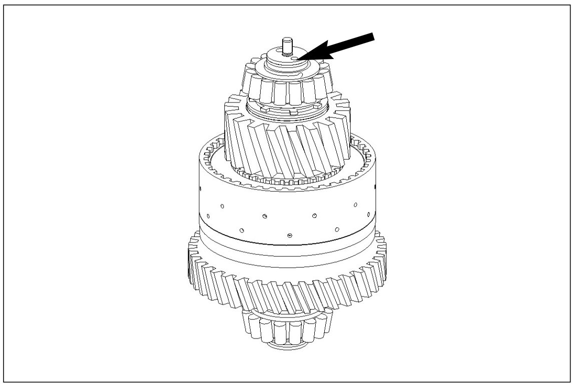
⚠ **Wear protective gloves.**

※ Readjust bearing inner ring after cooling down.



180DTM157

※ Check closing and opening of the clutch by means of compressed air at the hole (see arrow).
Closing and opening of the clutch must be clearly audible.

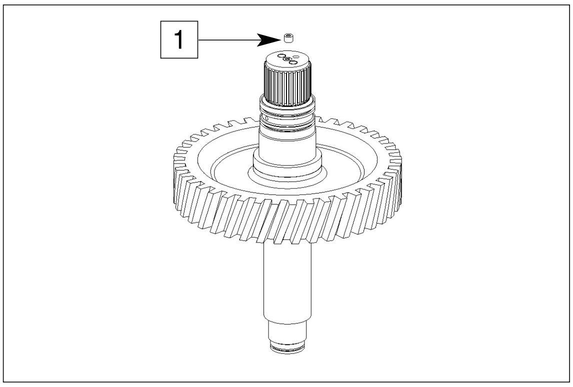


180DTM158

(5) Clutch K3

① Close machining aperture of the oil supply hole by means of plug (1).

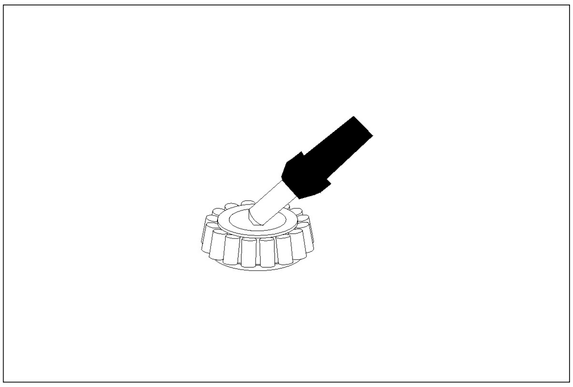
(S)Lever riveting pliers 5870 320 016



180DTM159

② Heat up bearing inner ring (app. 120°C).

(S)Hot air blower 230 V 5870 221 500
(S)Hot air blower 115 V 5870 221 501



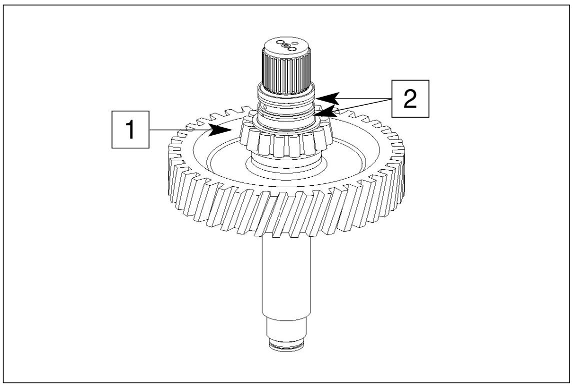
180DTM135

③ Mount bearing inner ring (1) until contact.

Install rectangular rings 65×2 (2).

⚠ Wear protective gloves.

※ Readjust bearing inner ring after cooling down.

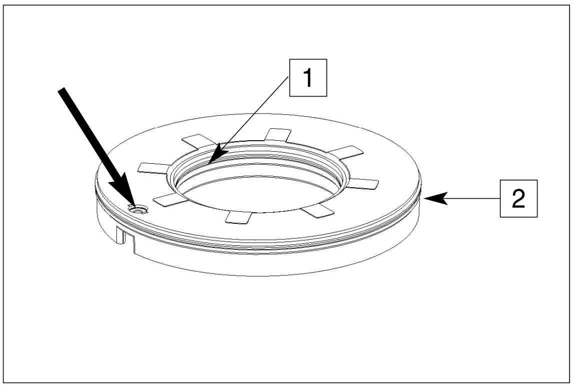


180DTM160

④ Insert both O-rings (1 and 2) into piston grooves and oil them.

1 = 75×3
2 = 142×3

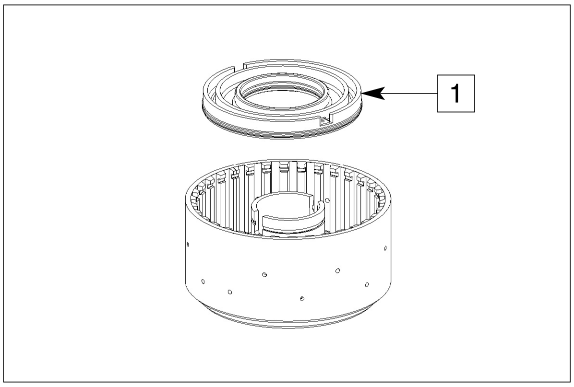
※ Check function of the drain valve (see arrow) - there must be no jamming of the ball.



180DTM161

⑤ Insert piston (1) into disc carrier.

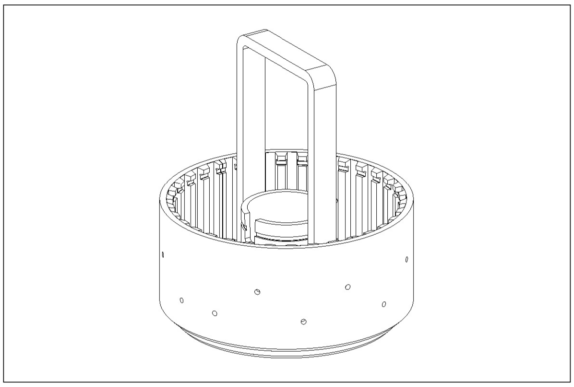
※ Observe installation position, see figure.



180DTM117

⑥ Use a hand-operated press to place piston into the disc carrier by means of the assembly aid.

(S) Assembly aid 5870 345 088



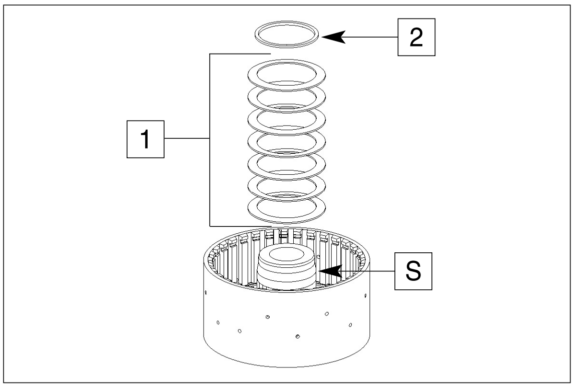
180DTM118

⑦ Mount inner installer (S) onto the disk carrier.

Install cup spring package (1) and L-ring (2).

Installation position cup spring package and L-ring see figure TM139.

※ (S) Inner installer → see figure TM120.

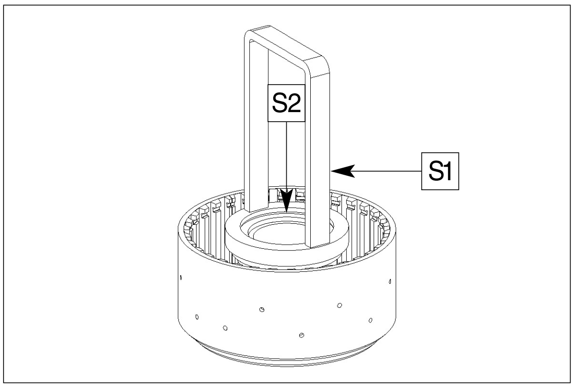


180DTM138

⑧ Preload cup spring package by means of assembly aid (S1) and pressure piece (S2), until L-ring has engaged into the annular groove.

(S) Assembly aid 5870 345 088
(S) Assembly fixture 5870 345 124
(Inner installer and pressure piece)

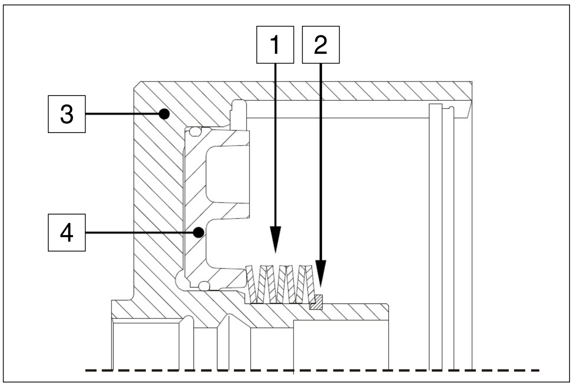
※ It is always necessary to mount a new L-ring.



180DTM120

⑨ Disk carrier with piston retraction :

Legend :
1 = Cup spring package
2 = L-ring
3 = Disk carrier
4 = Piston with O-rings

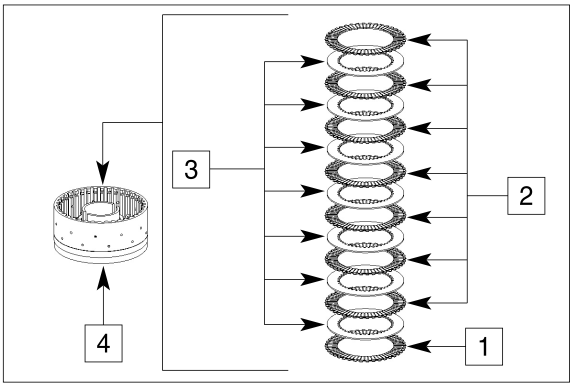


180DTM139

⑩ Install outer and inner clutch discs alternately into disc carrier (4) as described in figure TM150.

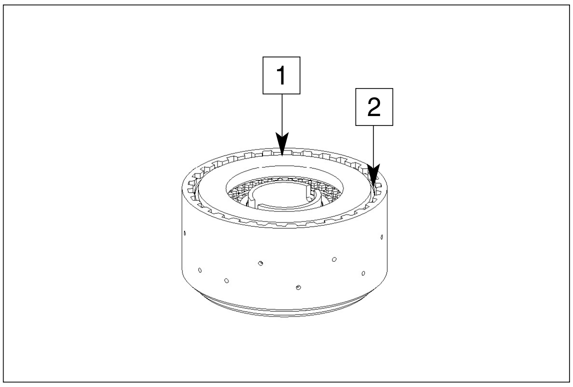
Legend :
1 = Friction disc-coated on one side (1 pc)
2 = Outer discs (7 pcs)
3 = Inner discs (7 pcs)

※ When mounting the friction disc (1) ensure that its uncoated (bare) side shows towards the piston.
Number of friction surfaces : 14.



180DTM150

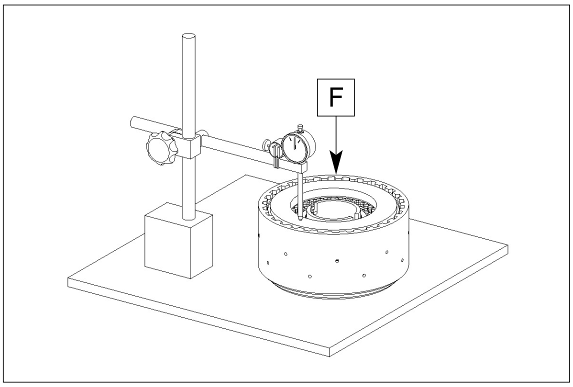
⑪ Mount end plate (1) and fix disc package by means of snap ring (2) (e.g. s = 2.65 mm / experience value).



180DTM123

⑫ Press on end plate with F (app. 100 N = 10 kg) and set dial indicator to "zero".

(S) Magnetic stand	5870 200 055
(S) Dial indicator	5870 200 057

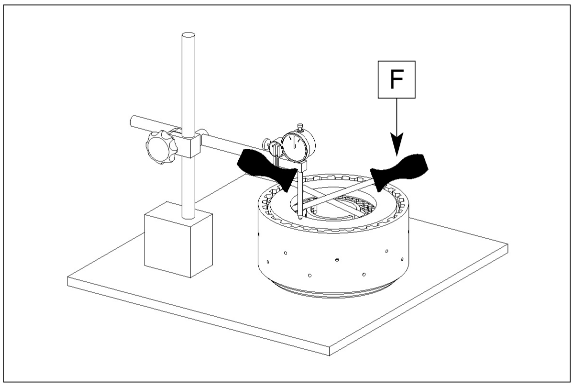


180DTM124

⑬ Then press end plate against snap ring (upwards) and read disc clearance.

Disc clearance : 1.75 ~ 2.05 mm

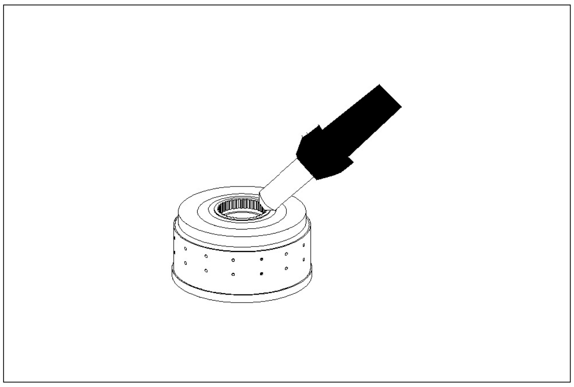
Any deviation demands a correction of the disc clearance by a suitable snap ring (optional s = 2.1 ~ 4.2 mm).



180DTM125

⑭ Heat up internal diameter of clutch (app. 120˚C).

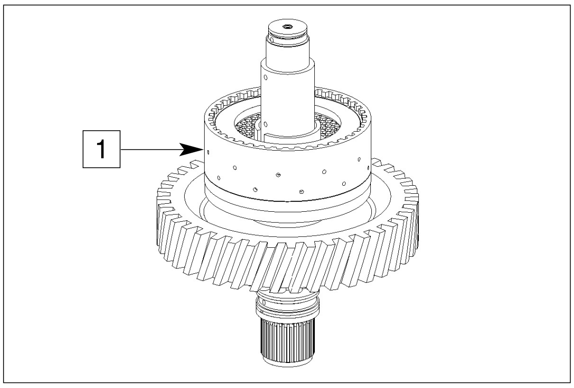
(S)Hot air blower 230 V 5870 221 500
(S)Hot air blower 115 V 5870 221 501



180DTM126

⑮ Mount clutch (1) until contact is obtained.

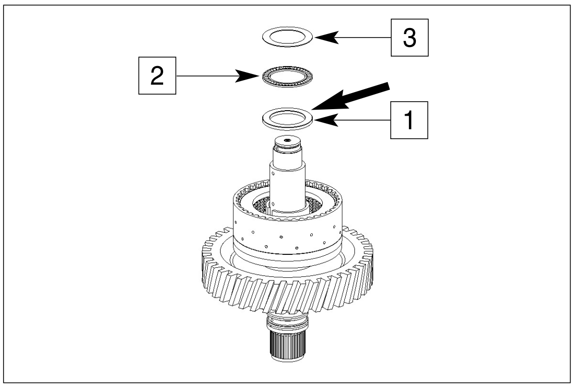
⚠ **Wear protective gloves.**



180DTM162

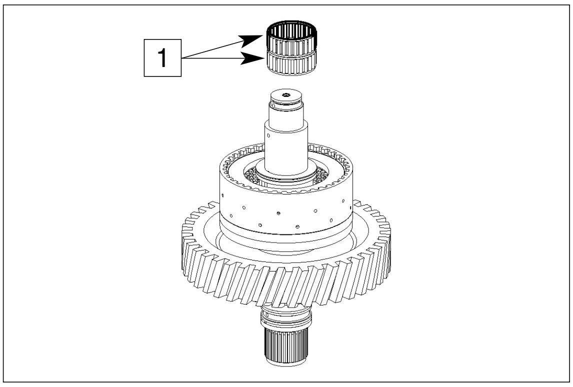
⑯ Mount and oil running disc 55×78×5 (1), axial cage (2) and axial washer 55×78×1 (3).

※ Install running disc (1) with chamfer (see arrow) showing towards the axial cage.



180DTM163

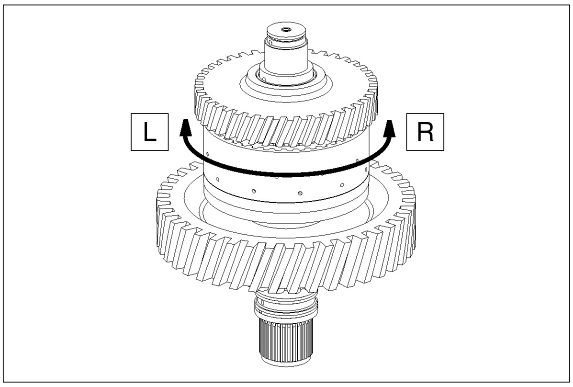
⑰ Mount needle cage 55×63×50 (1) on shaft and oil it.



180DTM164

⑱ Install idler gear.

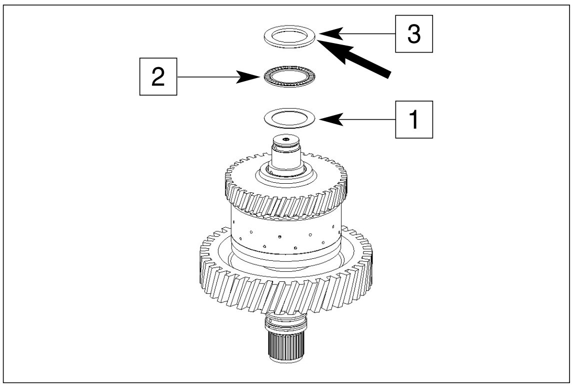
Install inner discs on inner disc carrier (idler gear) by shortly rotating them cw/ccw.



180DTM165

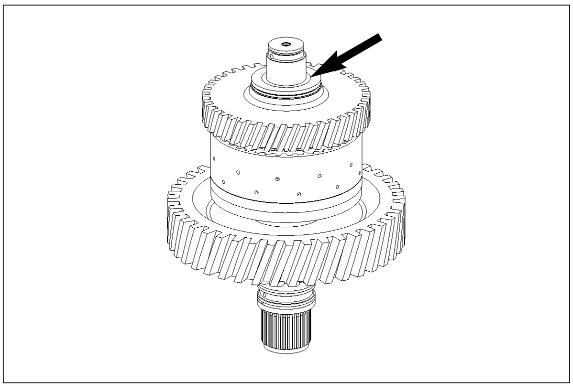
⑲ Mount and oil axial washer 55×78×1 (1), axial cage (2) and running disc 55×78×5 (3).

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



180DTM166

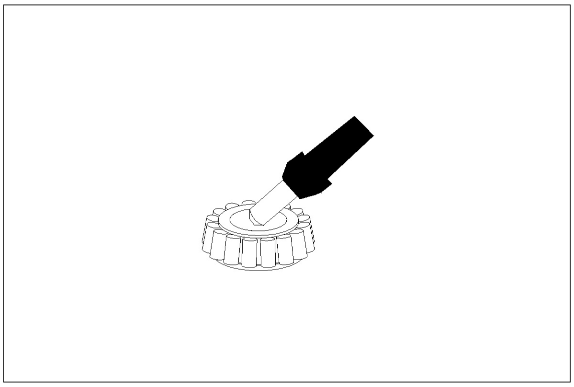
※ Pay attention that the running disc (see arrow) is flush with the shaft collar to ensure that all inner discs are mounted on the idler gear teeth.



180DTM167

⑳ Heat up bearing inner ring (app. 120 °C).

(S)Hot air blower 230 V   5870 221 500
(S)Hot air blower 115 V   5870 221 501

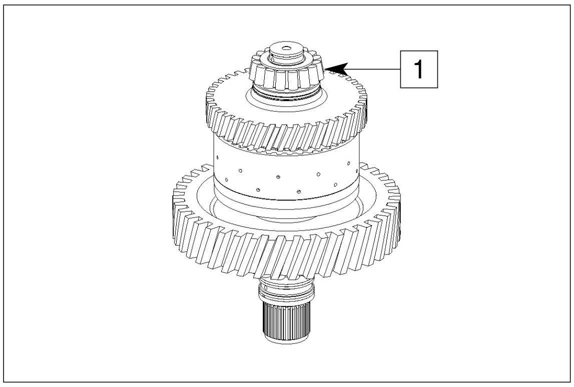


180DTM135

㉑ Mount bearing inner ring (1) until contact.

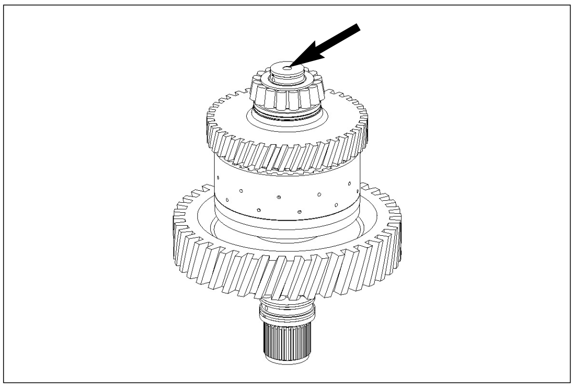
⚠ **Wear protective gloves.**

※ Readjust bearing inner ring after cooling down.



180DTM168

※ Check closing and opening of the clutch by means of compressed air at the hole (seer arrow).
Closing and opening of the clutch must be clearly audible.

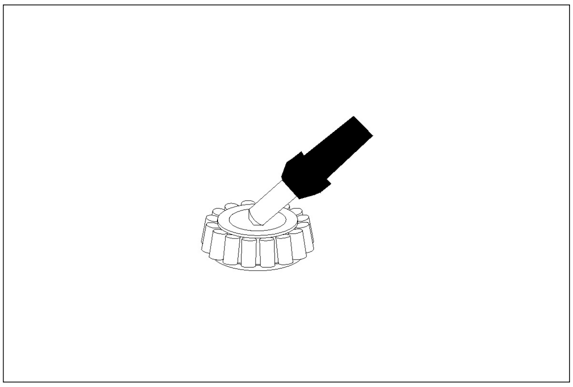


180DTM169

(6) Clutch K4

① Heat up bearing inner ring (app. 120°C).

(S) Hot air blower 230 V 5870 221 500
(S) Hot air blower 115 V 5870 221 501



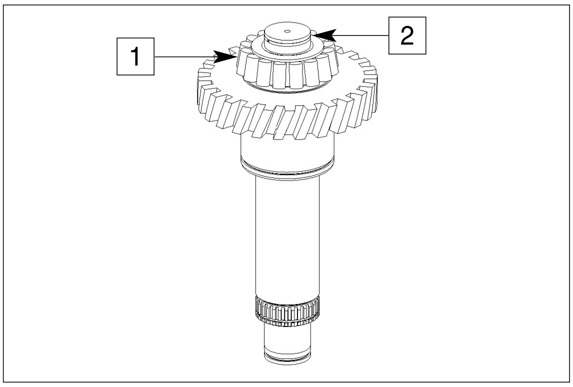
180DTM135

② Mount bearing inner ring (1) until contact.

Mount piston ring (2).

⚠ **Wear protective gloves.**

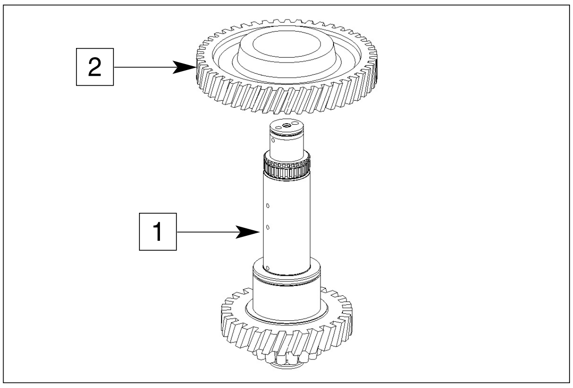
※ Readjust bearing inner ring after cooling down.



180DTM170

③ Undercool shaft (1) (app. -80°C), heat up gear (2) (app. +120°C) and mount until contact is obtained.

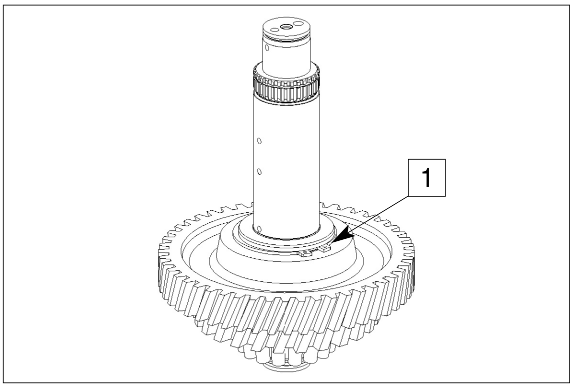
⚠ **Wear protective gloves.**



180DTM171

④ Secure gear by means of retaining ring 80×2.5 (1).

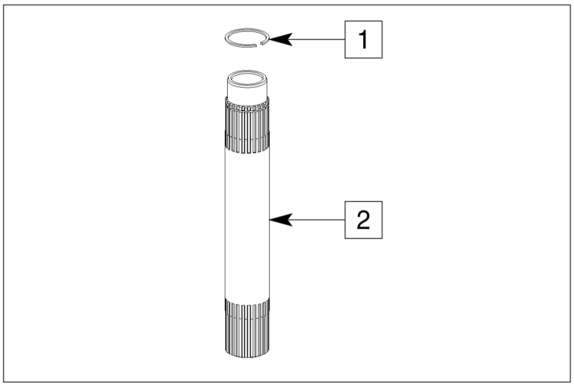
※ (S)Set of external pliers 5870 900 015



180DTM172

(7) Input shaft

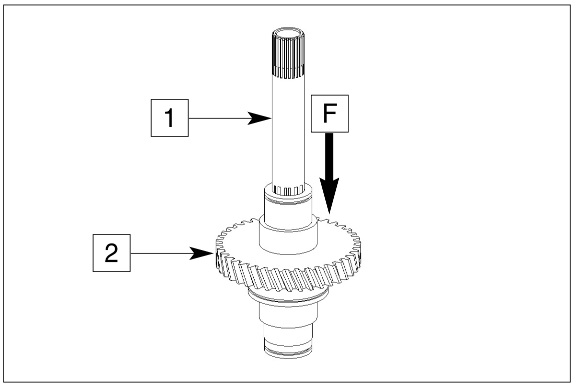
① Install snap ring SB-38 (1) into annular groove of turbine shaft (2).



180DTM173

② Press turbine shaft (1) into the input shaft (2) under a handoperated press until snap ring engages into the groove.

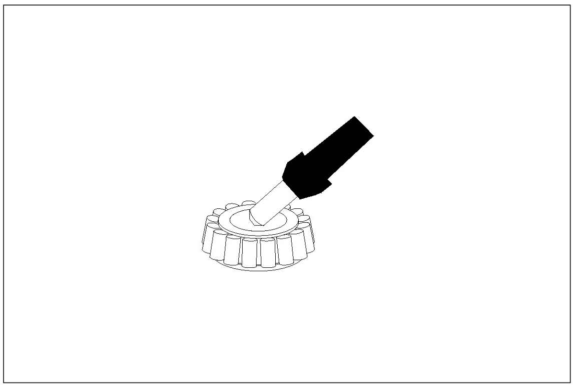
※ Axial fixture of turbine shaft.



180DTM174

③ Heat up both bearing inner rings (app. 120°C).

(S) Hot air blower 230 V 5870 221 500
(S) Hot air blower 115 V 5870 221 501



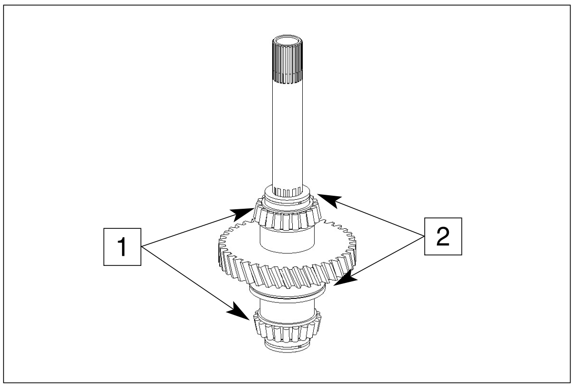
180DTM135

④ Mount bearing inner rings (1) until contact.

Install rectangular ring (2) 60 × 3.

⚠ Wear protective gloves.

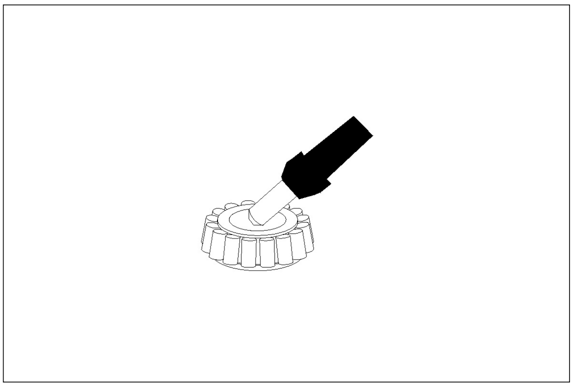
※ Readjust bearing inner ring after cooling down.



180DTM175

⑤ Heat up bearing inner ring (app. 120°C).

(S) Hot air blower 230 V 5870 221 500
(S) Hot air blower 115 V 5870 221 501



180DTM135

⑥ Mount bearing inner ring (1) until contact is obtained.

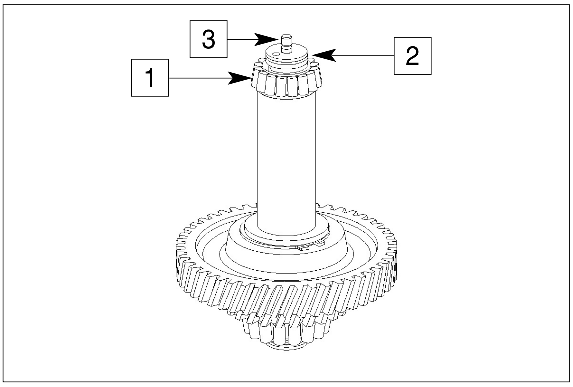
Fit rectangular ring 40×2.5 (2).

▲ **Wear protective gloves.**

※ Adjust bearing inner ring after cooling-down.

Mount stud bolt (3).

Tightening torque (M10/8.8×16) .... M_A = 17 Nm



180DTM176

8) INSTALLATION OF INPUT SHAFT AND CLUTCHES

(1) Preassembly of front and rear transmission housing

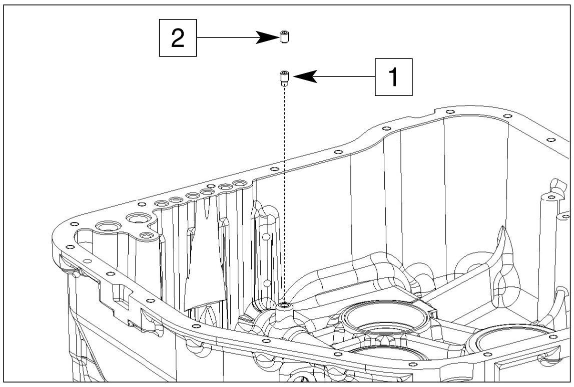
① Stop for converter outlet pressure valve.

Fit threaded pin M10×16 (1) with pin.

Tightening torque .... M_A = 10 Nm

Fit threaded pin M10×12 (2).

Tightening torque .... M_A = 23 Nm



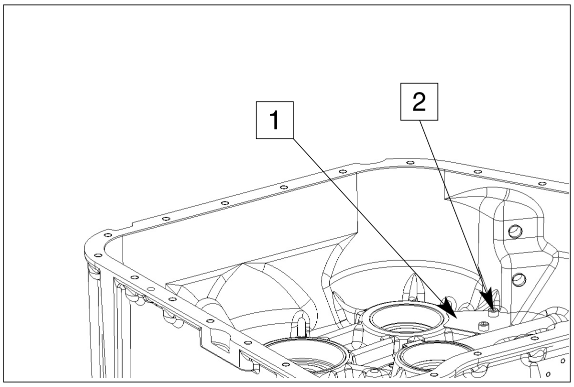
180DTM177

② Fix screen sheet (1) by means of cyl screws (2) in the transmission housing.

Oil cylinder screws before the assembly.

Tightening torque M8/8.8×12 .... M_A = 23 Nm

※ It is always necessary to use new cylinder screws.



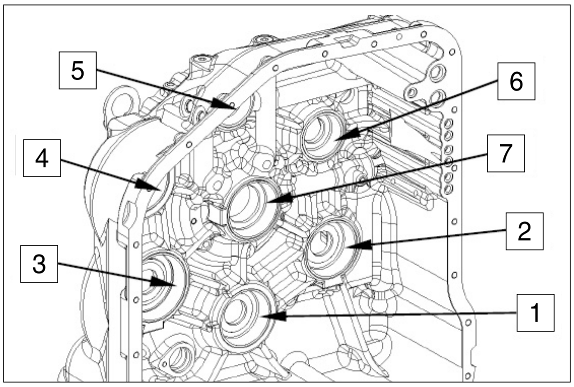
180DTM178

③ Insert all bearing outer rings into bearing holes of both housing parts.

Housing front part :

1 = "K3" Clutch - 3rd gear
2 = "K2" Clutch - 2nd gear
3 = "K1" Clutch - 1st gear
4 = "K4" Clutch - Intermediate shaft
5 = "KR" Clutch - reverse
6 = "KV" Clutch - forward
7 = "An" Input

※ K4/K2/K3 and "An" have got the same outer diameter, but merely K4/K2/K3 are fitted with the same bearings. Risk of confusing.



180DTM179

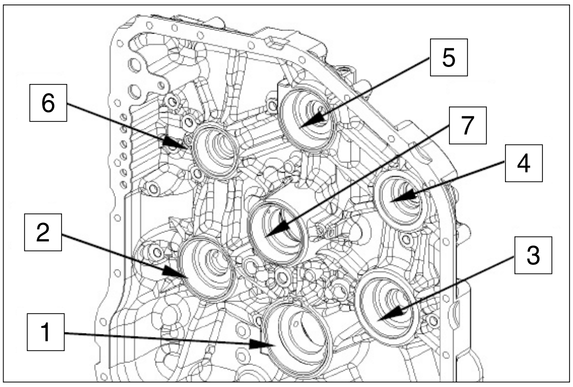
Housing rear part :

Legend see figure TM179.

※ Insert bearing outer rings into bearing holes with assembly grease.

※ If, contrary to the recommendation, the tapered roller bearings of clutches and the input are not replaced, it is imperative to ensure the previous pairing (bearing inner ring/bearing outer ring) - see chapter 5) figure TM048 and TM052.

※ K1/K2/KR and "An" have got the same outer diameter, but merely K1/K2/KR are fitted with the same bearings. Risk of confusing.



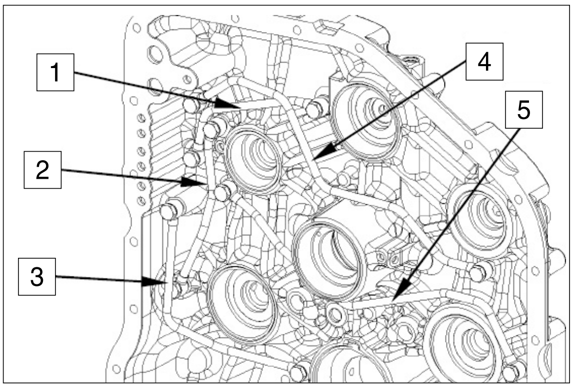
180DTM180

④ Install pipes (system pressure from electro-hydraulic control unit to the corresponding clutch).

Keep the following order to install the pipes with hollow screws and seal rings A14×18:

1 = Pipe	KR
2 = Pipe	K2
3 = Pipe	K3
4 = Pipe	K4 - Intermediate shaft -
5 = Pipe	K1

Tightening torque .... M_A = 40 Nm



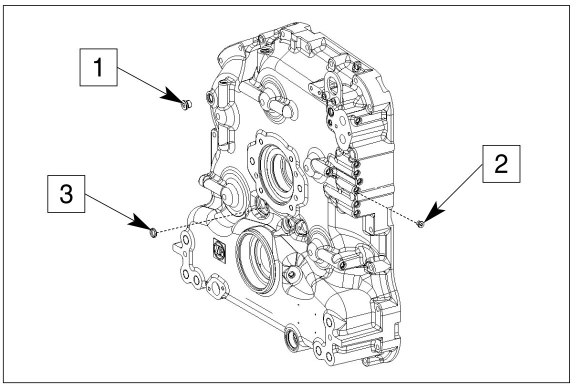
180DTM181

⑤ Install various screw plugs and place closing covers until contact is obtained.

1 = Screw plug M16×1.5 with O-ring 13×2 (1×)
2 = Screw plug M10×1 with O-ring 8×1.5 (14×)
3 = Closing cover 12 (3×)

Tightening torque (item. 1) ... M_A = 40 Nm
Tightening torque (Item. 2) ... M_A = 25 Nm

※ Wet contact face of closing covers (3) with Loctite (type no. 262).



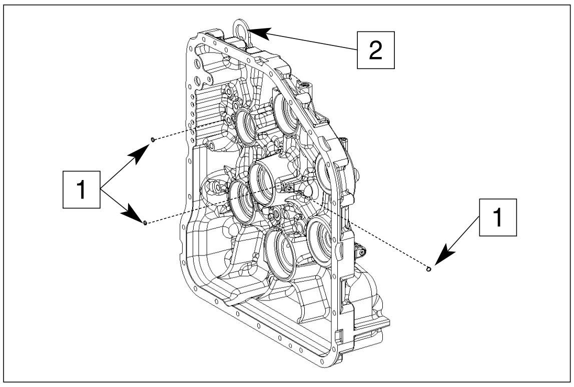
180DTM182

⑥ Place closing covers (1) until contact and fasten fixing plate (2) with cyl screws on the transmission housing rear part.

1 = Closing cover
2 = Fixing plate with cyl screw

Tightening torque (item. 2) M10/8.8×20 .... M_A = 46 Nm

※ Wet contact face of closing covers (1) with Loctite (type no. 262).

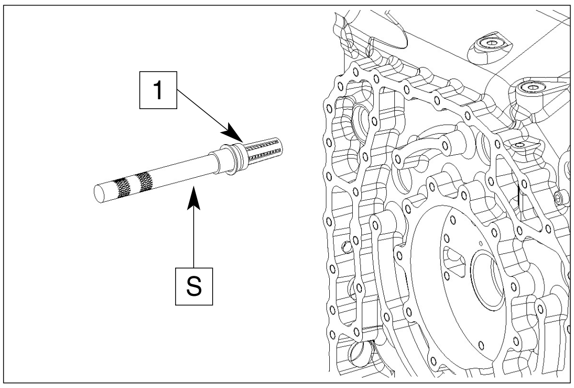


180DTM183

(2) Installation of converter outlet pressure valve

① Insert valve (1) into transmission housing front part by means of drift (S) until contact is obtained.

(S)Drift 5870 705 012



180DTM184

② Place indented ring (1) into transmission housing front part by means of press-fit mandrel (S).

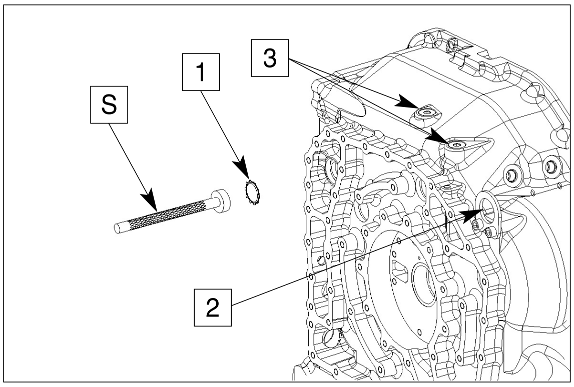
(S)Press-fit mandrel 5870 705 015

Fasten fixing plate (2) on transmission housing front part by means of cyl screws.

Tightening torque M10/8.8×20 .... M_A = 46 Nm

Install screw plug M22×1.5 (3) with O-ring 19×2

Tightening torque M10/8.8×20 .... M_A = 60 Nm

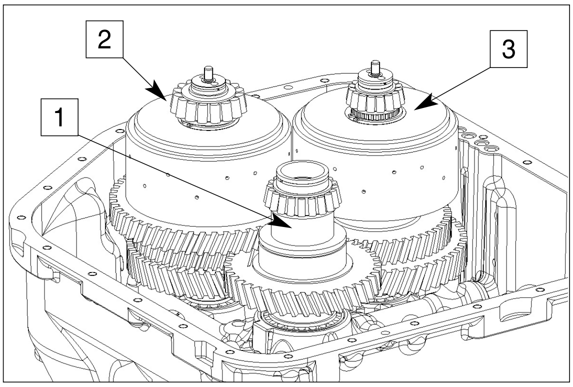


180DTM185

(3) Insert clutches into transmission housing front part

① Install piston rings in clutches KV and KR, as well as rectangular ring 60×3 into input shaft, align and grease them.

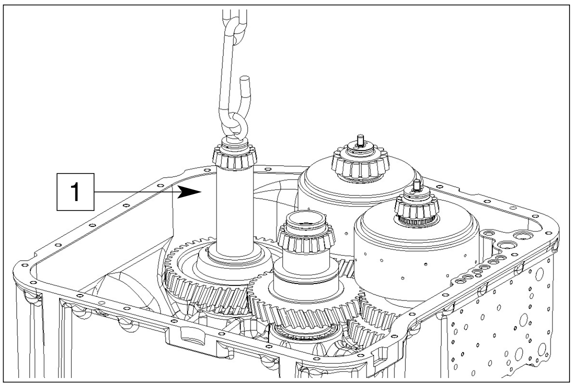
Insert clutch KR (2), clutch KV (3) and input shaft (1) jointly into bearing outer rings.



180DTM186

② Install piston ring into clutch K4 - Intermediate shaft-, align and grease it.

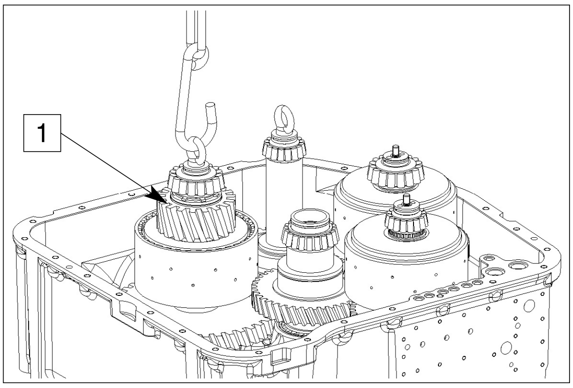
Bring clutch K4 - Intermediate shaft - (1) into proper position.



180DTM187

③ Install piston ring in clutch K1 (1), align and grease it.

Bring clutch K1 (1) into proper position.



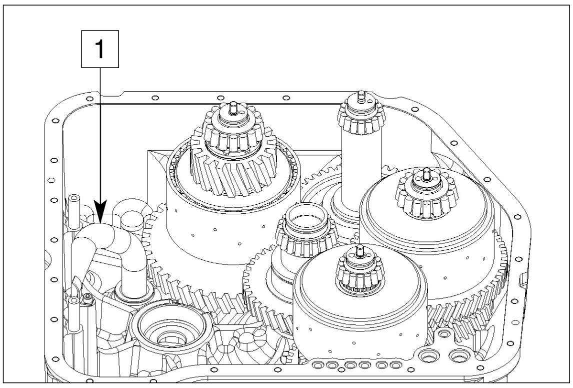
180DTM188

④ Mount O-ring 35×3 on suction tube (1), grease it and then fix it in the transmission housing front part with cyl screws M8×12.

Oil cylinder screws before the assembly.

Tightening torque M8/8.8×12 .... M_A = 23 Nm

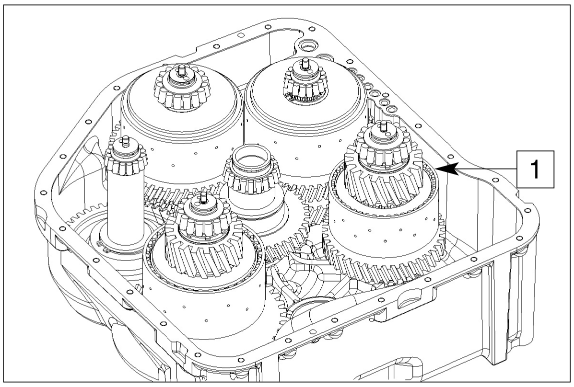
※ It is always necessary to use new cylinder screws.



180DTM189

⑤ Mount piston ring into clutch K2, align and grease it.

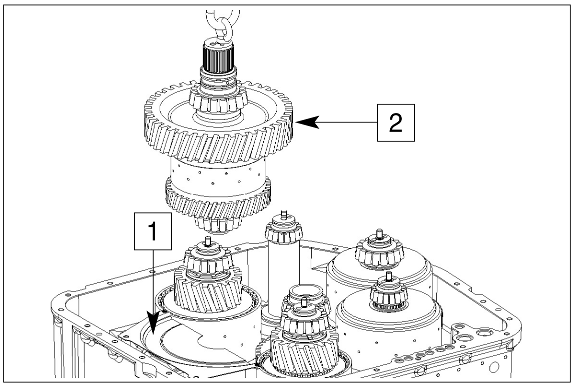
Bring clutch K2 (1) into proper position.



180DTM190

⑥ Mount piston ring into clutch K3, align and grease it.

Place screen sheet (1) and bring clutch K3 (2) into proper position.

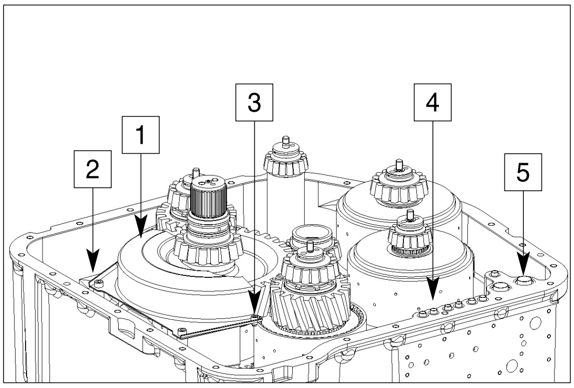


180DTM191

⑦ Place screen sheet (1) and fix it with cyl screws (2) with sleeves and with cyl screws (3).
Oil cylinder screws before the assembly.

Tightening torque M6/8.8×10 ....
.... M_A = 9.5 Nm
Tightening torque M8/8.8×65 ....
.... M_A = 23 Nm

Insert tubes . guide tubes - (4 and 5) into connecting holes of transmission housing front part with O-rings.
O-ring 24×3 (2×)
O-ring 12×2.5 (7×)



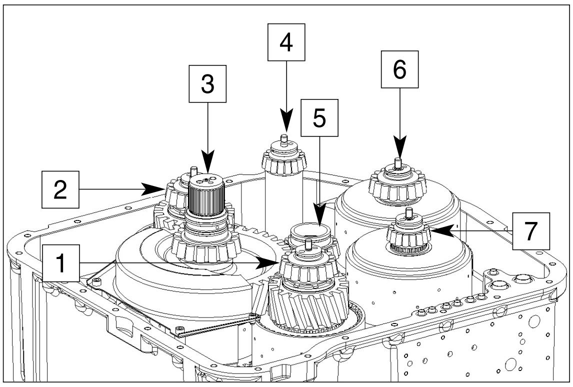
180DTM192

※ It is always necessary to use new cylinder screws.

※ Wet tubes (4 and 5) on outer diameter with Loctite (type no. 262) and insert into hole.

⑧ Install piston rings on clutches KV, KR, K1, K2, K4, and rectangular ring 65×3 on clutch K3 and rectangular ring 60×3 on input shaft, align and grease them.

1 = Clutch K2
2 = Clutch K1
3 = Clutch K3
4 = Clutch K4 - Intermediate shaft -
5 = Input shaft
6 = Clutch KR
7 = Clutch KV

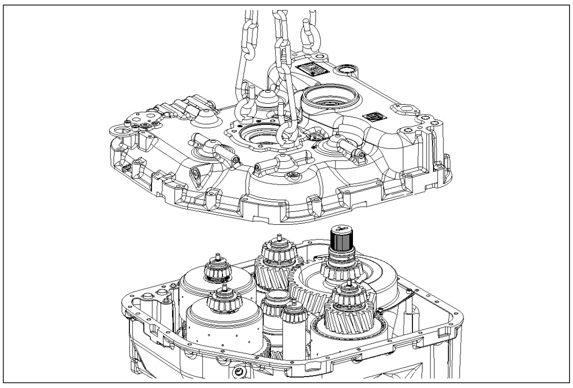


180DTM193

⑨ Carefully bring transmission housing rear part into contact position by means of lifting device.

※ Ensure an exact alignment of the tubes.

※ Wet mounting face with Loctite (type no. 574).

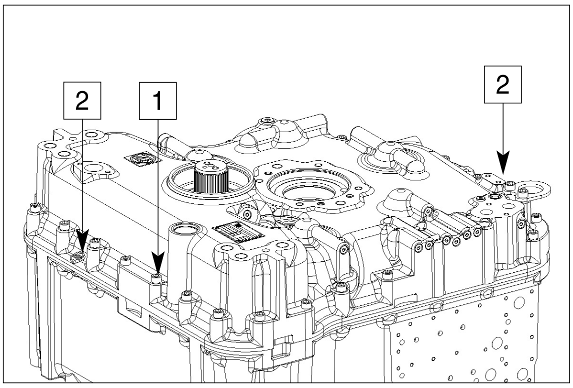

180DTM194

⑩ Fix transmission housings with 2 cyl screws (1) crosswise by hand.

Fit both cylindrical pins (2) 10×26 centrically to the mounting face.

Fix transmission housing front and rear part by means of cylinder screws (1).

Tightening torque M10/8.8×65 ....
.... M_A = 46 Nm



180DTM195

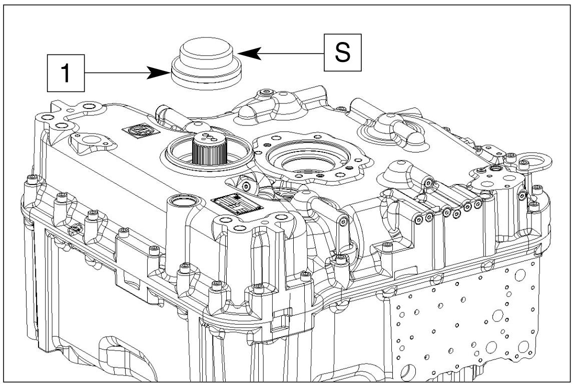
(4) Install output flange

① Mount shaft seal 90×120×13 (1) by means of driver tool, with the sealing lip showing to the oil sump.

(S)Driver tool 5870 048 237

※ Use the specified driver tool (S), to obtain the exact installation position.

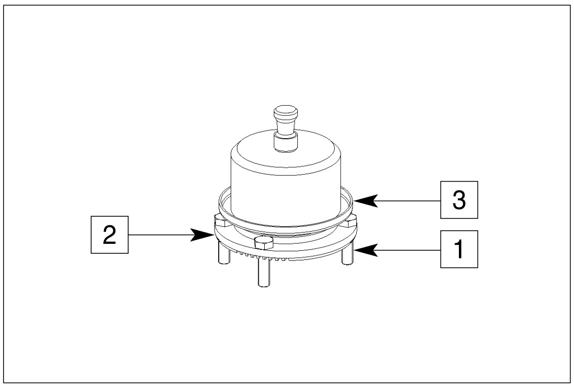
※ Fill space between sealing lip and dust lip with grease.
Wet outer diameter (rubber-coated) with spirit.



180DTM196

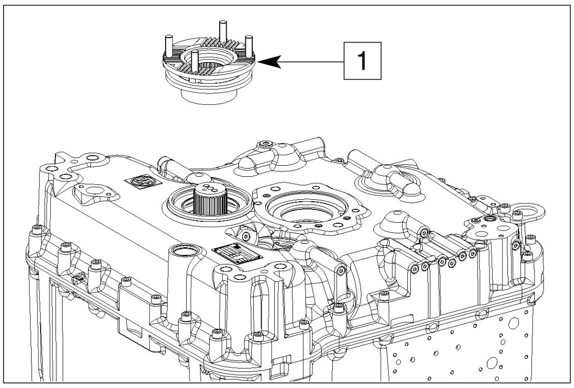
② Install hex screws (1) M12×1.5×45 into holes of output flange (2) and press screen sheet (3) into flush position.

(S) Pressure sleeve 5870 506 142



180DTM197

③ Mount pre-assembled output flange (1) on output shaft.



180DTM198

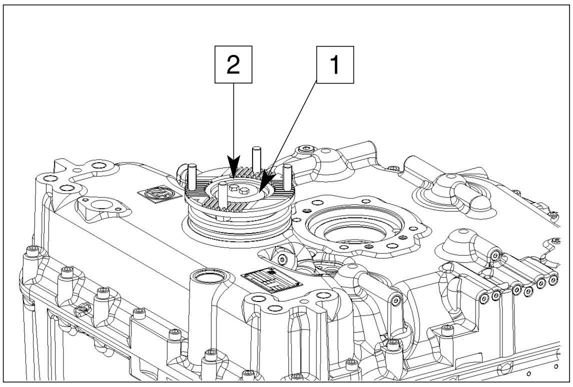
④ Insert O-ring 48 × 4 into the space between output flange and shaft.

Fix output flange with washer (1) and hex screws (2).

Oil hexagon screws before the assembly.

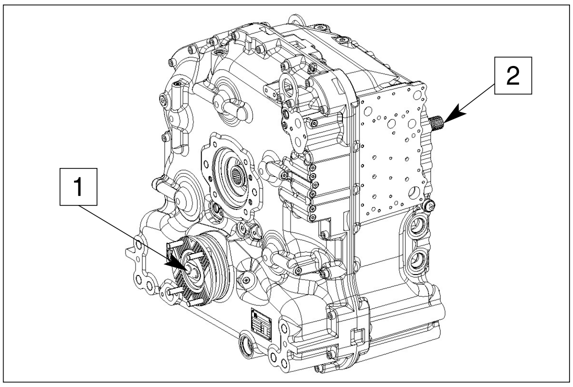
Tightening torque M10/8.8 × 30 .... M_A = 46 Nm

It is always necessary to use new hexagon screws.



180DTM199

⑤ Check clearance of gear drive train and output gears by rotating the output flange (1) and turbine shaft (2).



180DTM200

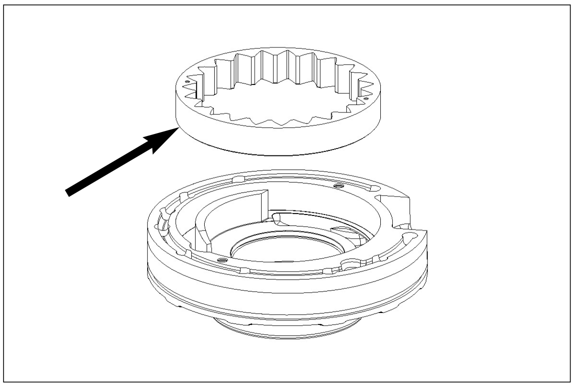
9) REASSEMBLY ENGINE CONNECTION AND OIL PRESSURE PUMP

(1) Oil pressure pump :

※ In case of wear marks in the pump housing or on the control disk, the pump assy must be replaced.

① Install outer rotor.

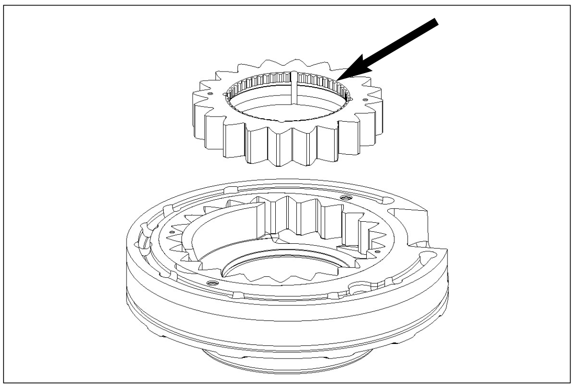
※ Chamfer (see arrow) to show downwards.



180DTM201

② Install inner rotor.

※ Teeth (see arrow) to show upwards.

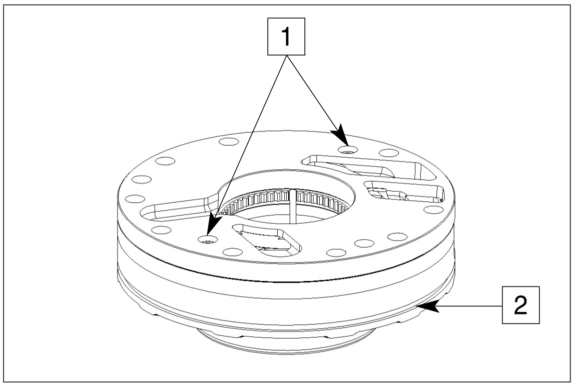


180DTM202

③ Place control disk and fix it radially by means of two cylindrical screws M6×12 (1).

※ Do not tighten the cylindrical screws-just turn them in until contact is obtained and then turn them back by approx 1/2 rotation.
Pay attention to the installation position of the control disk, see figure.

Place O-ring 182×3 (2) into the annular groove and oil it.

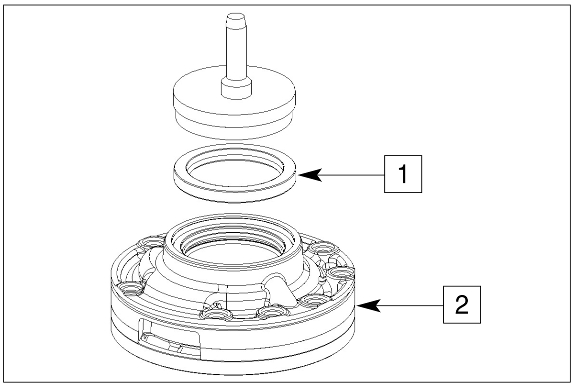


180DTM203

④ With the sealing lip showing downwards, carefully insert the shaft seal 75×905×10 (1) into the pump housing (2) until contact is obtained.

※ Wet outer diameter of shaft seal with spirit.

(S)Driver	5870 055 070
(S)Handle	5870 260 002



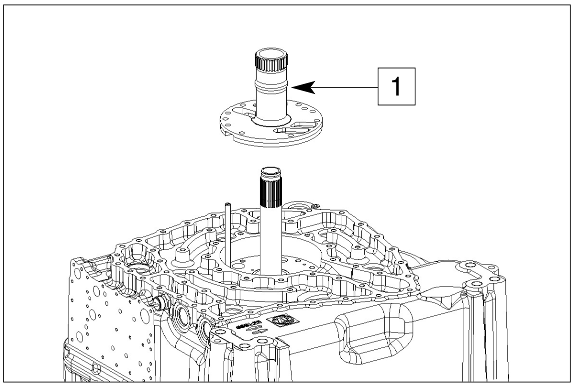
180DTM204

⑤ Install two adjusting screws and mount stator shaft (1).

※ Pay attention to hole pattern.

(S)Adjusting screws (M10)

5870 204 007

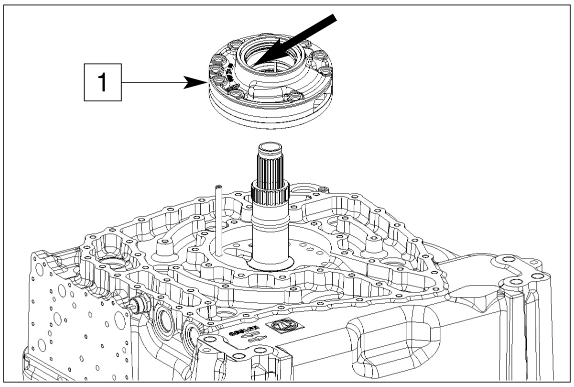


180DTM205

※ Oil sliding bearing (see arrow) before the assembly.

⑥ Mount pre-assembled pump (1).

※ Pay attention to hole pattern.



180DTM206

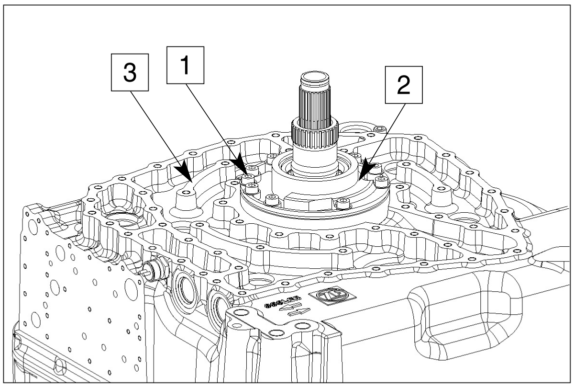
⑦ Provide cylinder screws with O-rings 9.5 ×1.6.

※ Grease O-rings.

Fix transmission pump (2) by means of cyl screws (1).

Tightening torque (M10/8.8×75) .... M_A = 46 Nm

※ Wet mounting faces - duct ribs - (3) with Loctite (type no. 574).



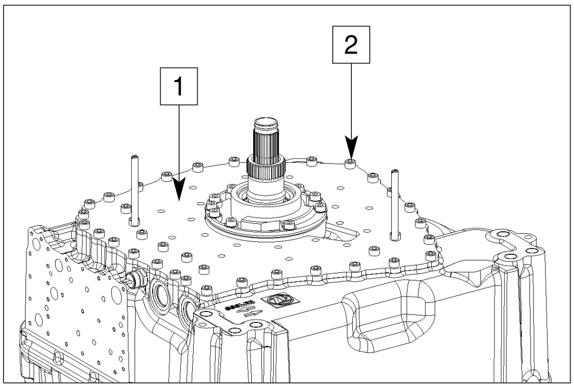
180DTM207

⑧ Mount two adjusting screws and place plate (1), and fix with cylinder screws (2).

(S)Adjusting screws (M10)

5870 204 007

Tightening torque (M10/8.8×20) .... M_A = 46 Nm



180DTM208

(2) Converter connection :

① Install two adjusting screws and place converter bell-housing (1), and bring into contact position evenly with 3 cylinder screws (3×180 offset).

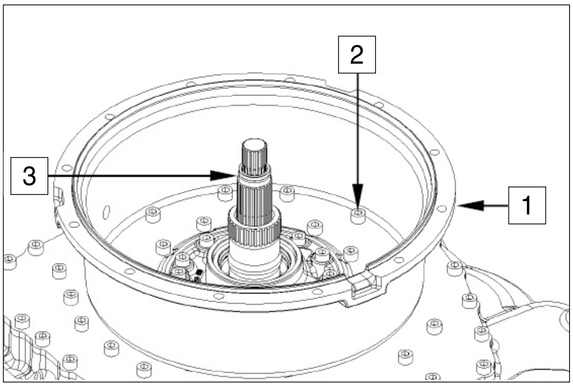
※ Make sure that O-ring will not be damaged (sheared off).

Fix converter bell-housing with cylinder screws (2).

Tightening torque (M10/8.8×30) .... M_A = 46 Nm

Mount, align and grease rectangular ring 36×2.5 (3) .

※ Wet mounting face with Loctite (type no 574).

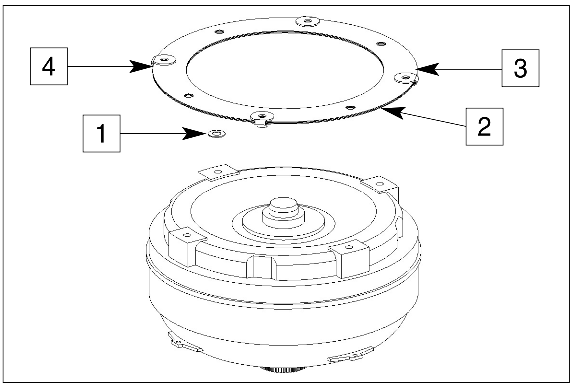


180DTM209

② Always position 1 disk 4×(1) onto the flexplate mounting web (4×).

Install flexplate set (2)

Flexplate set consisting of :
3 = flexplates (3 pieces)
4 = clamps (4 pieces)



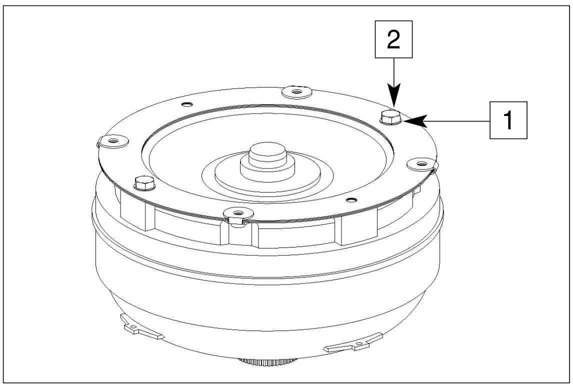
180DTM210

③ Mount disk (1) onto the hexagon screw M10x16 (2) and fix flexplates.

Mount eyebolts

Tightening torque (M12/10.9×18) .... M_A = 115 Nm

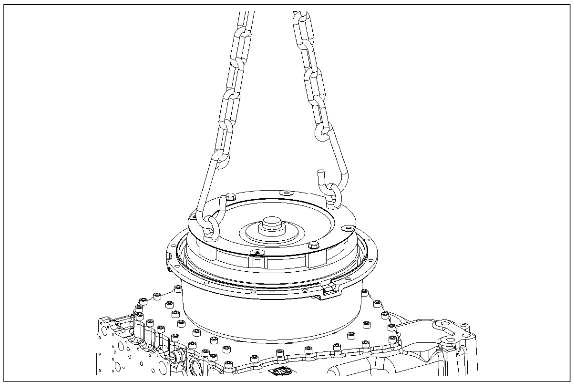
※ Wet the thread with Loctite (Type no. 262).



180DTM211

④ Insert the converter by using the lifting device until contact is obtained.

Remove the eyebolts and fix the flexplates with hexagon screws (see figure TM211).

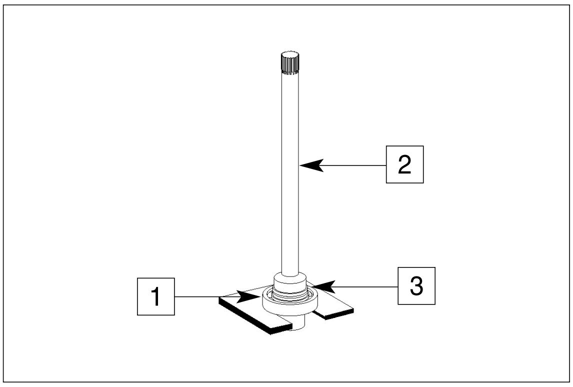


180DTM212

10) REASSEMBLY PTO

(1) Press ball bearing (1) on pump shaft (2) until contact is obtained.

Mount, align and grease rectangular ring (4) 60$\times$3.

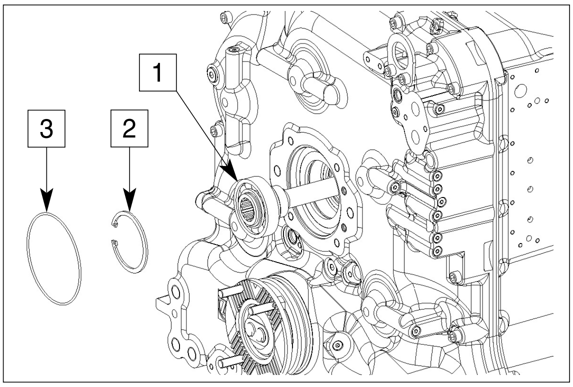


180DTM213

(2) Mount pump shaft (1) into turbine wheel of converter until contact is obtained and fix with retaining ring (2) 85$\times$3.

Grease O-ring (3) 180$\times$3 and insert it into hole.

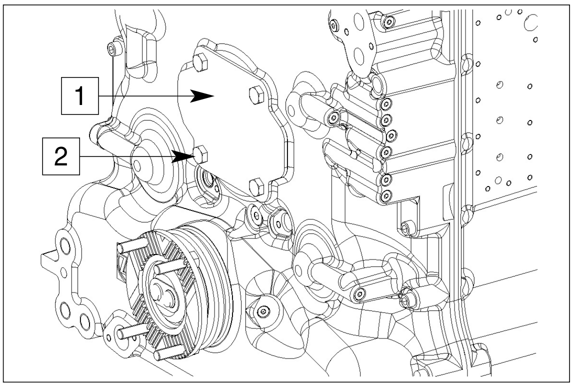
⚠ **When mounting the pump shaft make sure that the converter will not be forced out of the converter bell-housing.**
Fix converter axially.
Risk of injury.



180DTM214

(3) Fix cover plate (1) with hex screws (2).

Tightening torque (M12/10.9$\times$18) ....
.... M_A = 115 Nm

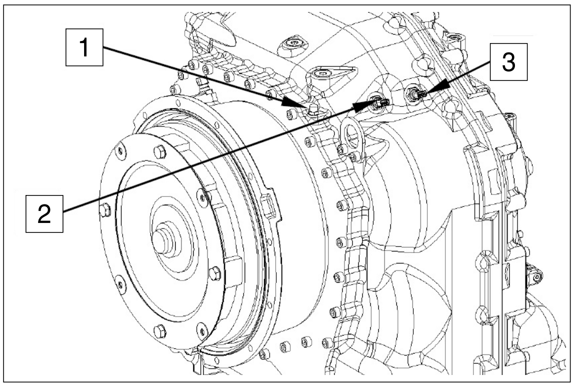


180DTM215

11) REASSEMBLY INDUCTIVE SENSOR, HALL SENSOR, BREATHER AND TEMPERATURE SENSOR

(1) Mount positioned parts.

1 = Breather
Tightening torque .... M_A = 12 Nm
2 = Inductive sensor with O-ring 15.5×2.6
(n central gear chain)
Tightening torque .... M_A = 30 Nm
3 = Inductive sensor with O-ring 15.5×2.6
(n turbine)
Tightening torque .... M_A = 30 Nm

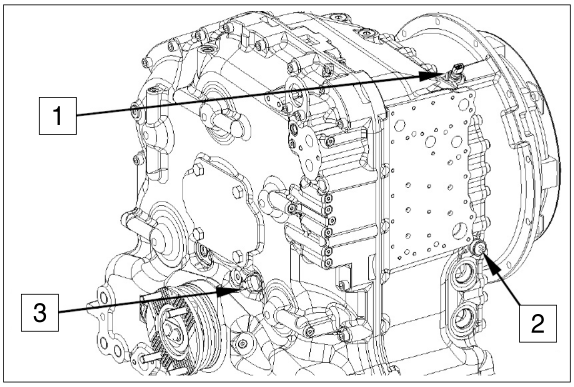


180DTM216

(2) Mount inductive sensor (1), temperature sensor (2) and speed sensor (3).

1 = Inductive sensor with O-ring 15.5×2.6
(n engine)
Tightening torque .... M_A = 30 Nm
2 = temperature sensor with O-ring 11×3
(Measuring point "63" after converter)
Tightening torque .... M_A = 25 Nm
3 = Speed sensor with O-ring 15.5×2.6
(n output Hall sensor)
Fix with cyl screws

Tightening torque (M8/8.8× 16)
.... M_A = 23 Nm



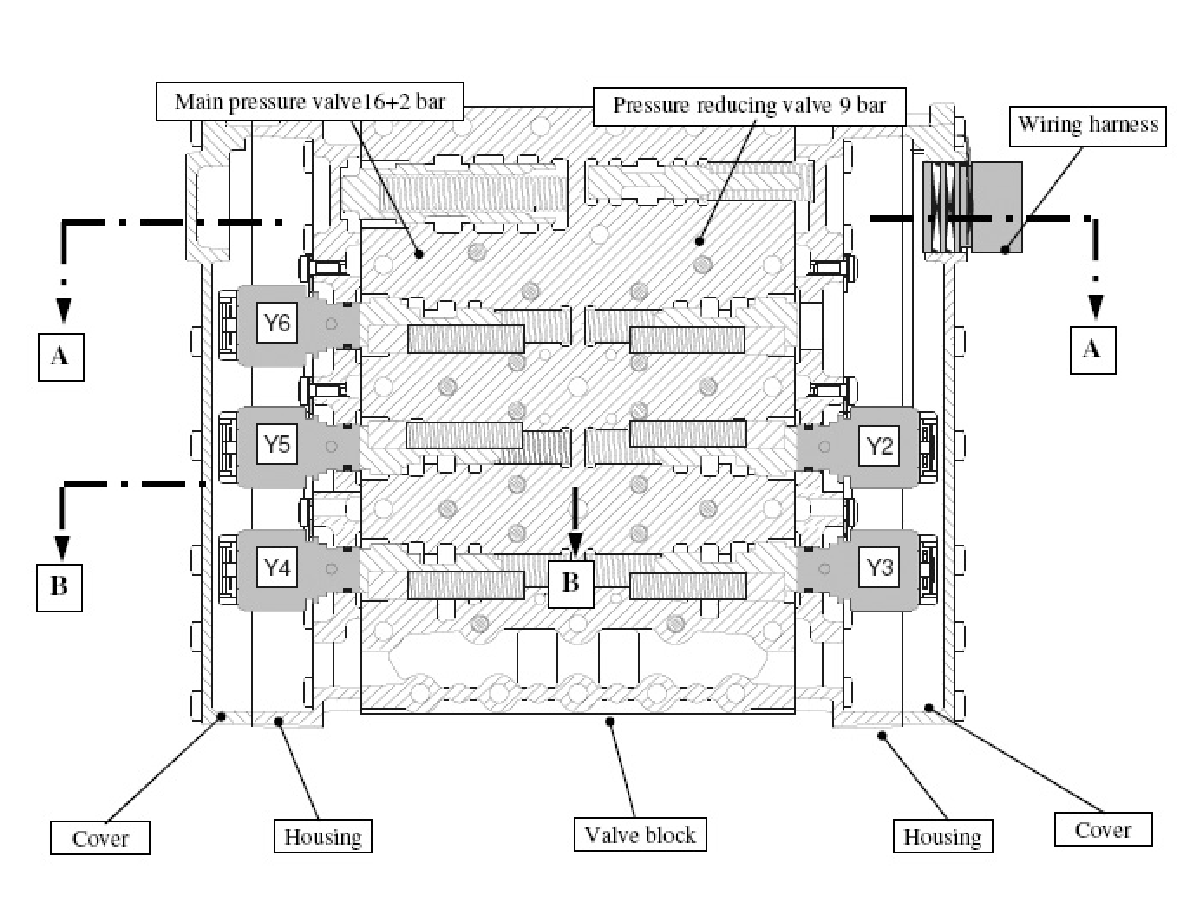
180DTM217

12) REASSEMBLY

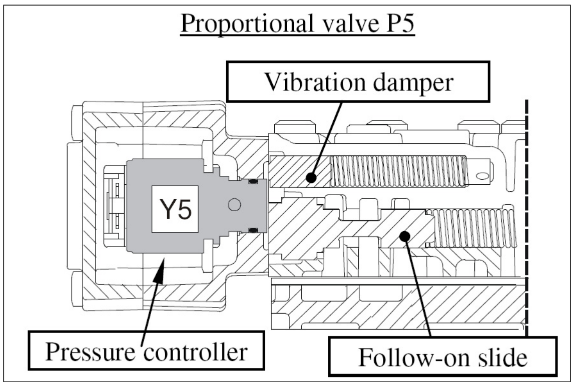
Electro-hydraulic control with proportional valves :

※ Different versions regarding the wiring harness position are possible.

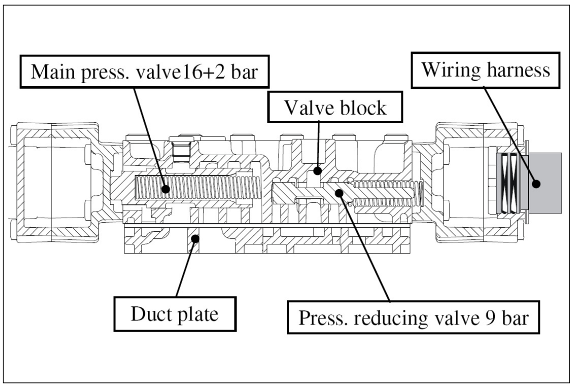
The following sketches show the sectional views of the electro-hydraulic control.



180DTM218



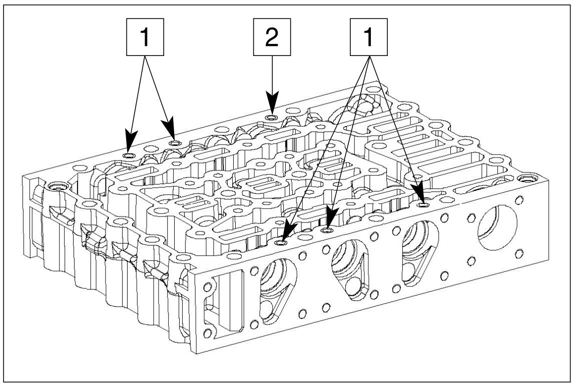
180DTM219



180DTM220

(1) Fitting of electric control

※ All single parts are to be checked for damage and replaced, if required.
Ensure free travel of the moving parts in the valve block prior to installation.
Pistons can be exchanged individually.
Prior to the installation, oil single parts.

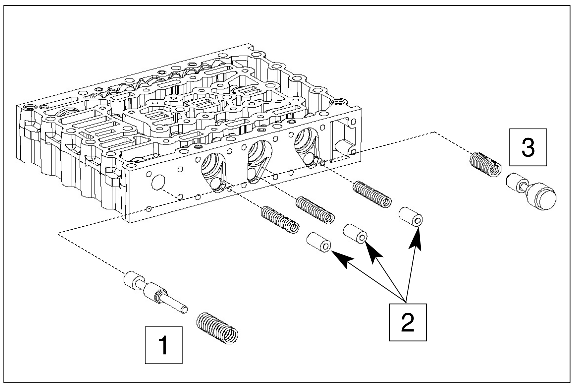


180DTM221

① With the concave side showing upwards, insert orifice (1 and 2) until contact is obtained.

※ See arrows for installation position.
Orifice - cover plate - (2) without through-hole.

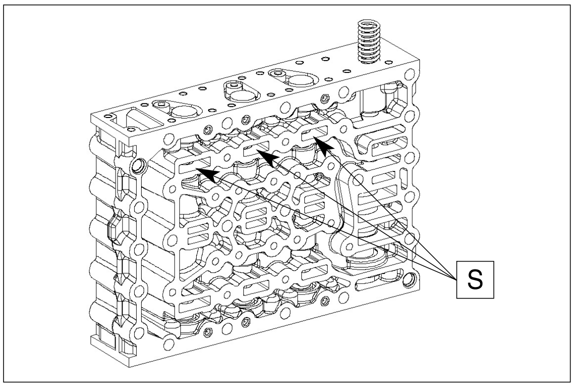
The opposite figure shows the following single parts :
1 = pressure reducing valve
(1×, piston and compr spring)
2 = vibration damper
(3×, piston and compr spring)
3 = follow-on slide
(3×, piston and compr spring)



180DTM222

② Install the single parts acc to figure TM222.

※ Preload compression springs of the follow-on slides and preliminarily fix pistons by means of cylindrical pins ø 5.0 mm (assembly aid), see arrows (S).

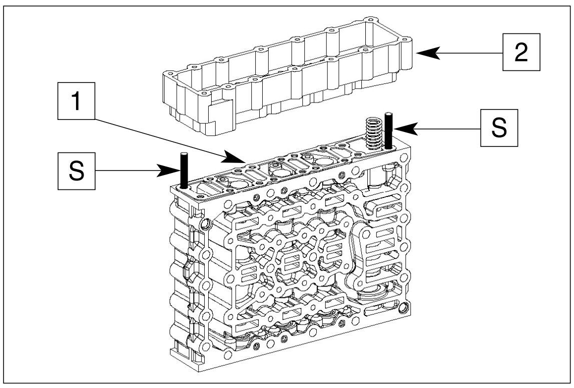


180DTM223

③ Fit two adjusting screws.

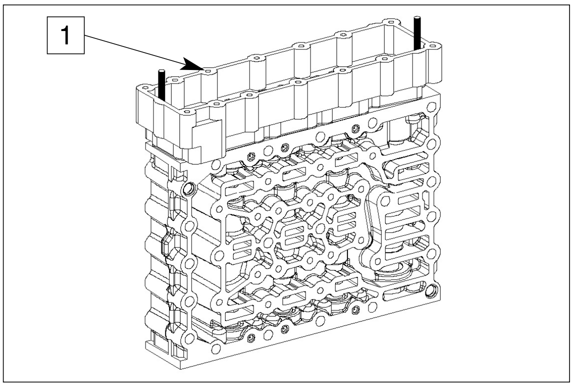
Mount seal (1) and housing (2).
Then position housing equally by means of adjusting screws until contact is obtained.

(S)Adjusting screws 5870 204 036



180DTM224

④ Bring housing (1) into contact position by means of the Torx screws. This will preload the pistons, and you can remove the cylindrical pins (assembly aid).

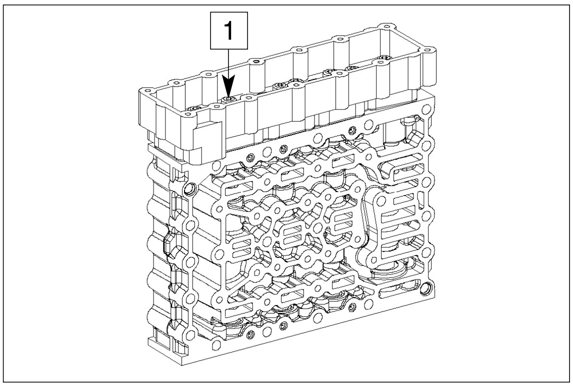


180DTM225

⑤ Fix housing by means of Torx screws (1).

Tightening torque (M5/10.9×30) ....
.... M_A = 5.5 Nm

(S)Reducing adapter 5870 656 056
(S)Socket wrench TX-27 5873 042 002

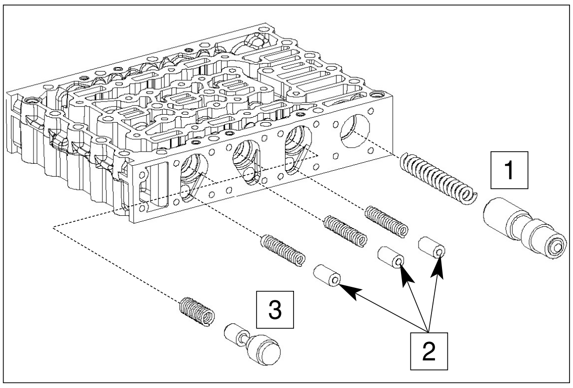


180DTM226

⑥ **Preassemble the opposite side**

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)



180DTM227

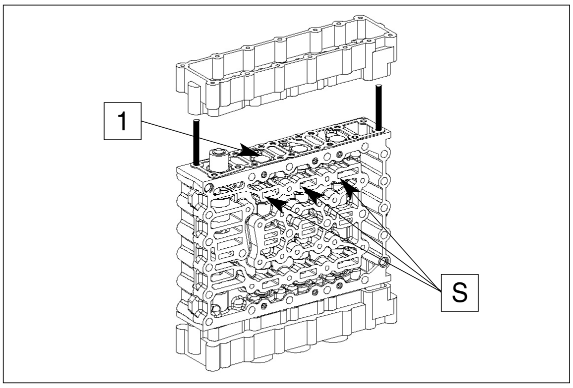
⑦ Install the single parts acc. to figure TM228.

※ Preload the compression springs of the follow-on slides and fasten the pistons preliminarily by means of cylindrical pins (S) ø 5.0 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.



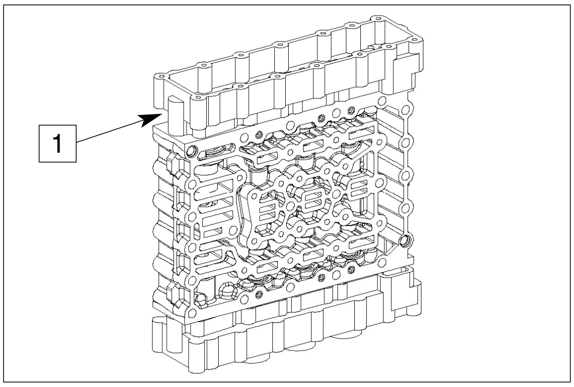
180DTM228

⑧ Preload the pistons with Torx screws and remove the cyl pins (assembly aid) again.

Then fasten the housing cover by means of cap screws (1).

Tightening torque (M5/10.9×30) .... M_A = 5.5 Nm

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



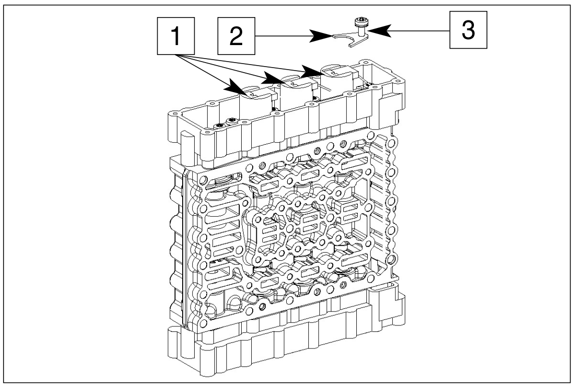
180DTM229

⑨ Mount pressure controllers with O-ring 13.5×2 (1) and fasten them by means of fixing plates (2) and Torx screws (3).

※ Install fixing plate, with the claw showing downwards.
Pay attention to the radial installation position of pressure controllers, see figure.

Tightening torque (M5/8.8×12) .... M_A = 5.5 Nm

(S)Reducing adapter 5870 656 056
(S)Socket wrench TX-27 5873 042 002



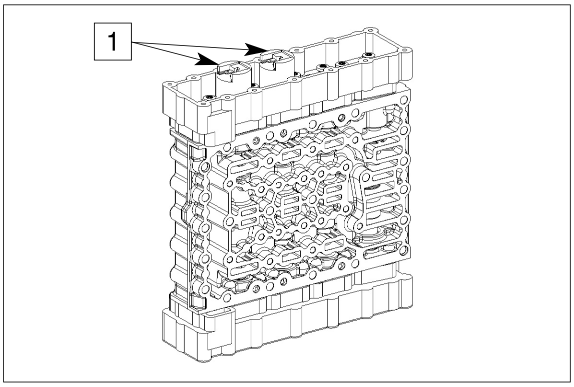
180DTM230

⑩ Mount the pressure regulators (1) and fasten them by means of fixing plates and Torx screws.

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

Tightening torque (M5/8.8×12) .... M_A = 5.5 Nm

(S)Reducing adapter 5870 656 056
(S)Socket wrench TX-27 5873 042 002

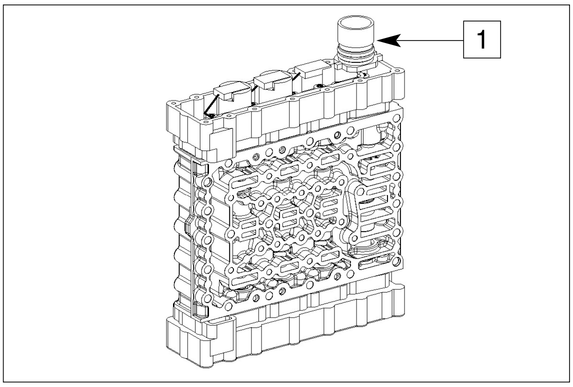


180DTM231

⑪ Assemble the wiring harness (1) and connect the pressure regulators (5×).

※ See figure TM218, page 3-142 for installation position of pressure regulators.

※ Pay attention to the installation position of the wiring harness, also see markings (Chapter 1) figure TM019).



180DTM232

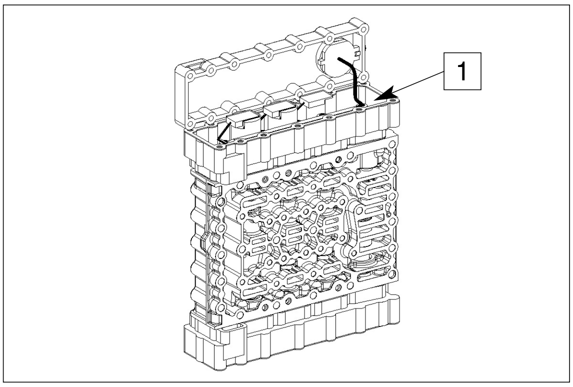
⑫ Put on the flat gasket (1).

Assemble the plug socket with the slot showing to the lug of the cover until contact.

Fasten the cover by means of Torx screws.

Tightening torque (M5/10.9×30) .... M_A = 5.5 Nm

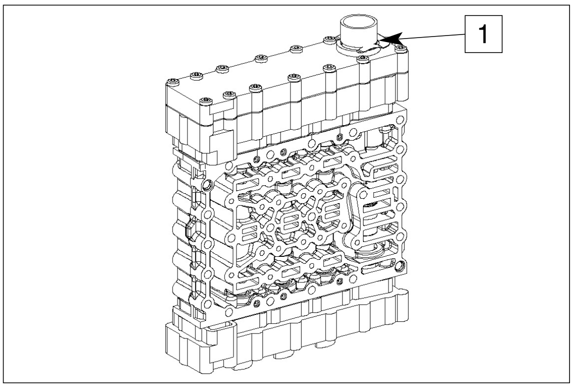
(S)Socket spanner TX-27 5873 042 002



180DTM233

⑬ Fix the wiring harness by means of retaining clamp (1).

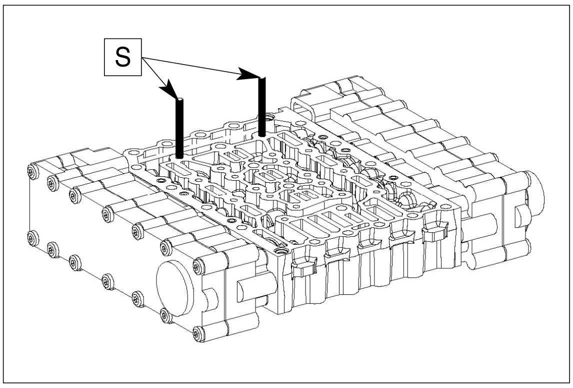
※ Install the opposite cover.



180DTM234

⑭ Install two adjusting screws.

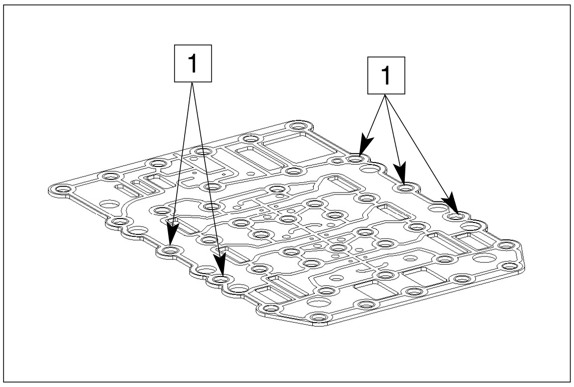
(S) Adjusting screws 5870 204 063



180DTM235

⑮ Flush-mount screens (1) into the holes of the sealing plate, see arrows.

※ Pay attention to the installation position - screens to show upwards (towards the duct plate).

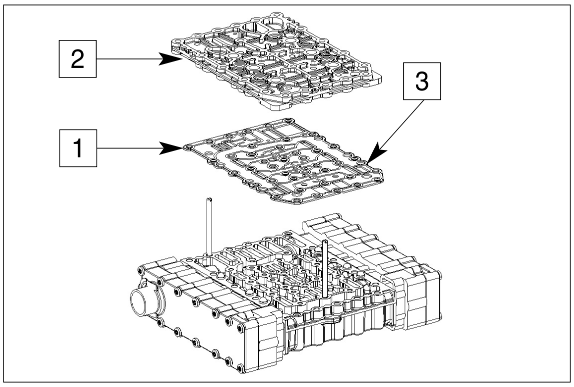


180DTM236

⑯ Put on sealing plate (1) and duct plate (2).

※ Screens (3) to show upwards.

※ It is not permitted to re-assemble the seal plate after opening the threaded joint shift unit/duct plate.
In case of repair it is always necessary to mount a new seal plate.

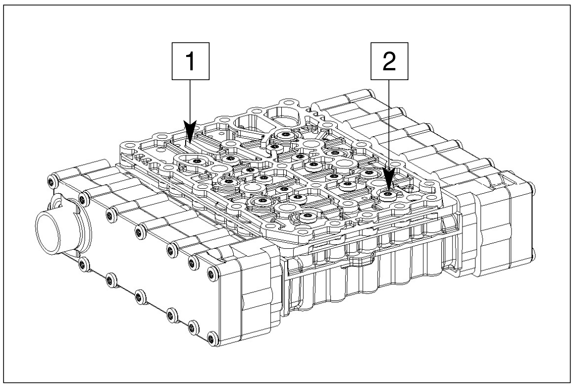


180DTM237

⑰ Place duct plate (1) and fix it equally by means of Torx screws (2).

Tightening torque (M6/10.9 $\times$ 23) .... M_A = 10.5 Nm

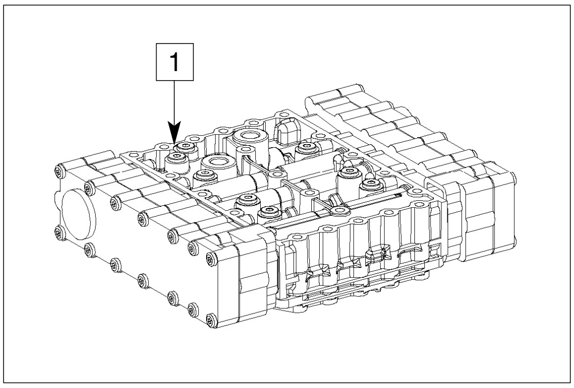
(S) Socket wrench TX-27   5873 042 002



180DTM238

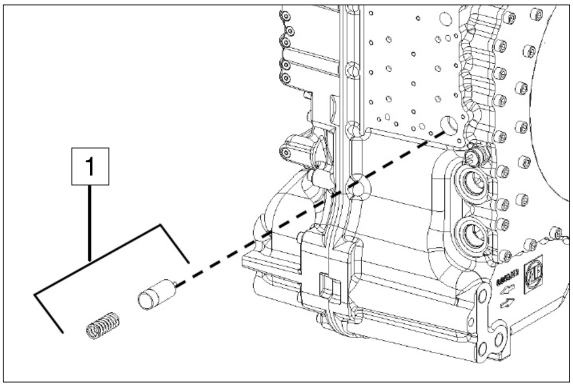
⑱ Provide the screw plugs M10x1 with O-rings 8 $\times$ 1.5 (1) and install them.

Tightening torque .... M_A = 6 Nm



180DTM239

⑲ Insert converter outlet pressure valve (1) into housing hole.

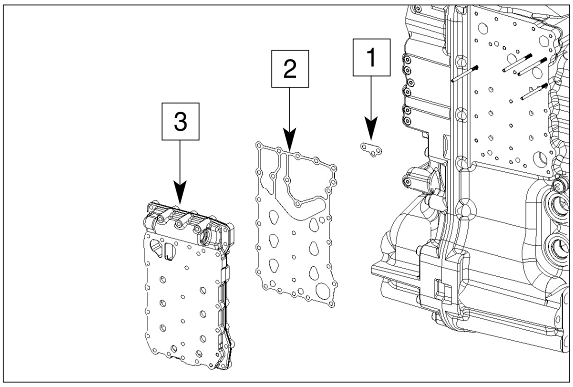


180DTM240

⑳ Fit 4 adjusting screws.

Mount sealing (1 and 2) and duct plate (3).

(S) Adjusting screws 5870 204 063

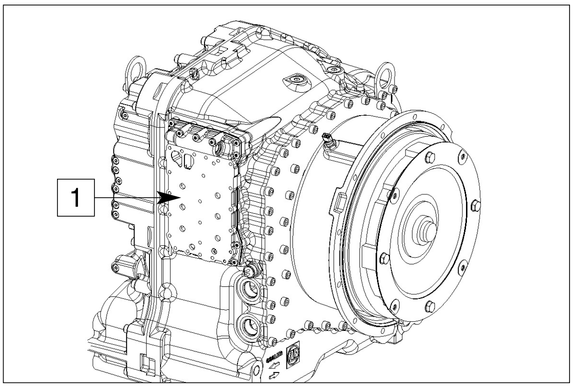


180DTM241

㉑ Fix duct plate with torx screws (1).

Tightening torque (M6/10.9×25) .... M_A = 9.5 Nm

Tightening torque (M6/10.9×60) .... M_A = 9.5 Nm



180DTM242

㉒ Mount filter differential pressure valve (1).

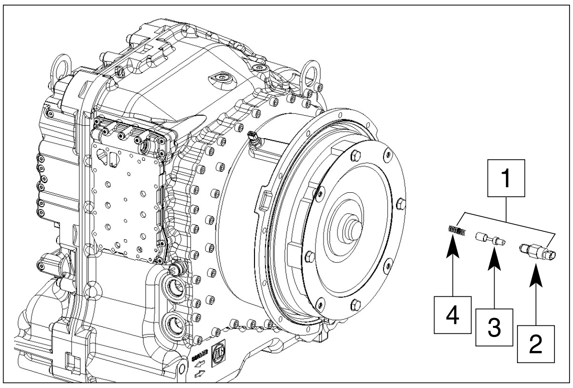
Filter differential pressure valve consists of :

2 = Switch with O-ring 13×2

3 = Piston

4 = Compression spring

Tightening torque .... M_A = 30 Nm



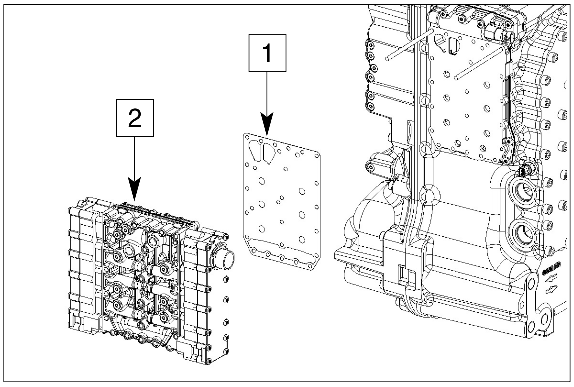
180DTM243

㉓ Fit two adjusting screws.

(S) Adjusting screws 5870 204 063

Mount sealing plate (1) and electro-hydraulic control unit (2).

※ It is not permitted to re-assemble the seal plate after opening the threaded joint shift unit/gearbox housing.
In case of repair it is always necessary to mount a new seal plate.

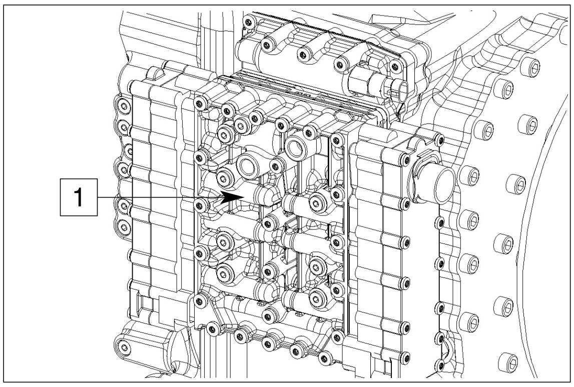


180DTM244

㉔ Evenly fix electro-hydraulic control unit (1) by means of torx screws.

Tightening torque (M6/10.9×80) .... M_A = 9.5 Nm
Tightening torque (M6/10.9×100) .... M_A = 9.5 Nm

(S) Torque wrench 5870 203 031
(S) Reducing adapter 5870 656 056
(S) Socket wrench TX-27 5873 042 002



180DTM245

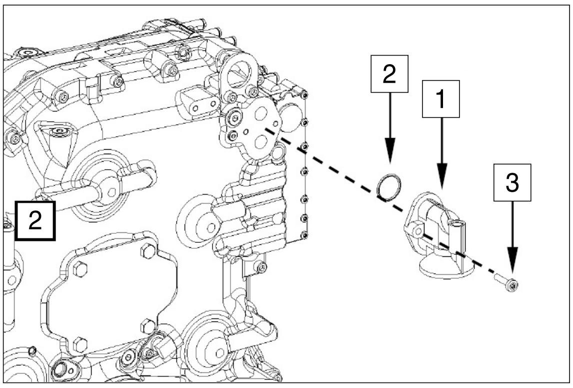
13) REASSEMBLY FINE FILTER (PRESSURE FILTER), OIL FILLER TUBE AND OIL DRAIN PLUG

(1) Installation of fine filter (pressure filter)

① Fix filter head (1) with O-rings 34.2x3 (2) by means of torx screws (3) on housing rear part.

Tightening torque (M8/10.9×35) .... M_A = 23 Nm

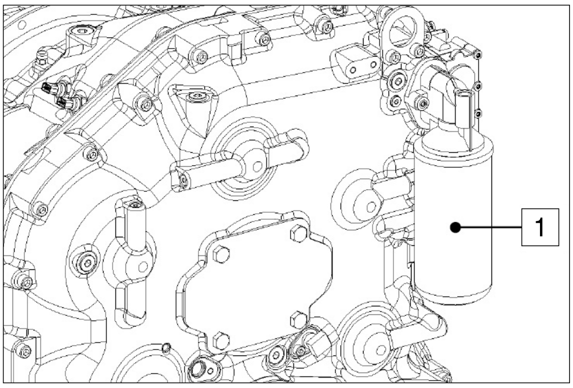
(S) Torque wrench 5870 203 034
(S) Socket wrench TX-40 5870 042 004



180DTM246

※ Stick to the following instructions for the installation of the filter (1) :

- Slightly oil sealing
- Turn in the filter until contact with the sealing surface is obtained, and then tighten it by hand with approx. 1/3 to 1/2 rotation.



180DTM247

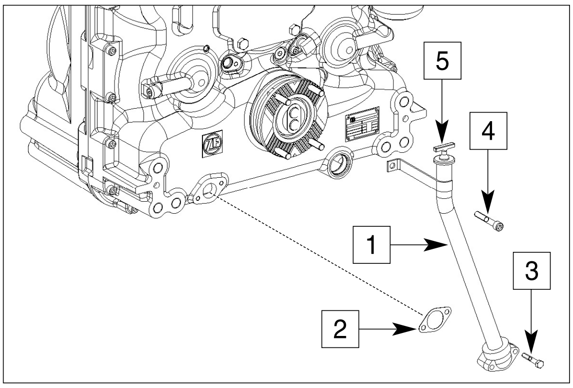
② Bring oil level tube (1) with seal (2) into contact position with the housing rear part and fix it by means of hexagon screws (3).

Tightening torque (M8/10.9×50) .... M_A = 34 Nm

Fix tab of oil level tube with hexagon screw (4) on housing rear part.

Tightening torque (M10/8.8×65) .... M_A = 46 Nm

Turn oil dipstick (5) into oil level tube.



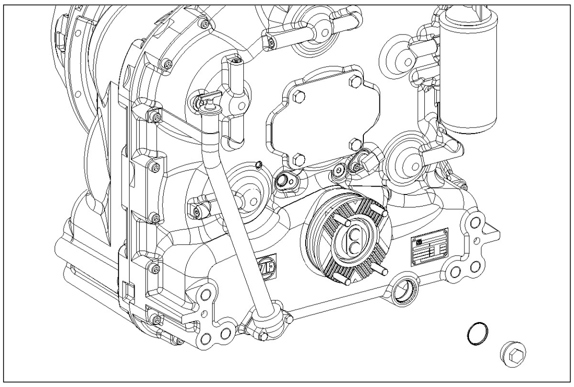
180DTM248

③ Install oil drain plug (1) with O-ring (2) 35 $\times$2

Tightening torque (M38$\times$1.5) .... M_A = 80 Nm

Fix identification plate (3) to the housing front part.

※ Use Loctite (type no. 5069).

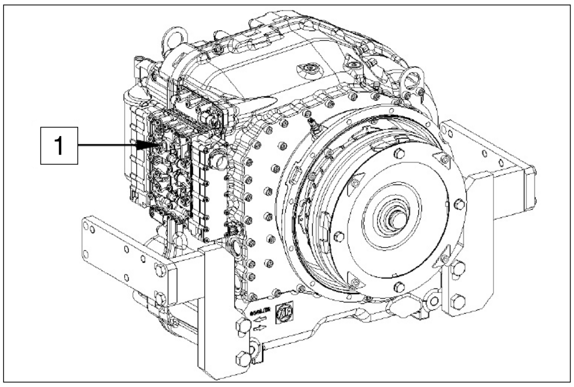


180DTM249

④ Fit screw plug M16$\times$1.5 (1) with O-ring 13$\times$2.

Tightening torque .... M_A = 23 Nm

※ Before putting the transmission into operation, fill it with oil according to the operator's manual.



180DTM250

3. DRIVE AXLE DISASSEMBLY

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 3-120 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

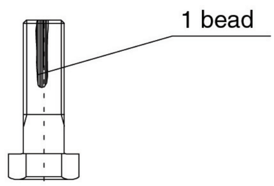
(3) Pre-assembly and control tightening has to be made in a short time(5 to 10min).

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

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

(6) Loctite quantity :

- At screws :



100D7XL80

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

4) UTILIZATION OF LOCTITE AND OPERATING SUPPLIES

(1) Hub assembly

Safety blocked parts	Joint	Loctite	Operating supplies
Spacer ring	Contact surface	572	-
Axle spindle	Screws	262	-
Axle spindle	Contact surface	270	-
Grommet	In planetary housing	270	-
Disk	In axle spindle	270	-
Adjusting screw with nut	In planetary housing	270	-
Support	Screw	262	-
Ring gear retainer	Screws	270	-
Pol wheel	Contact surface	638	-
Steering lever Track rod lever	Screws	262	- -
Steering lever Track rod lever	Contact surface	270	- -
Wheel hub cover	Thread	572	-
Radial seal rings Rubber casing	Contact surface	572	- -
Radial seal rings Steel casing	Contact surface	270	- -
Wheel safety nut → See page 3-167 → 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

Thread	Screw 8.8	Nut 8	Screw 10.9	Nut 10	Screw 12.9	Nut 12
Metric standard thread						
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	

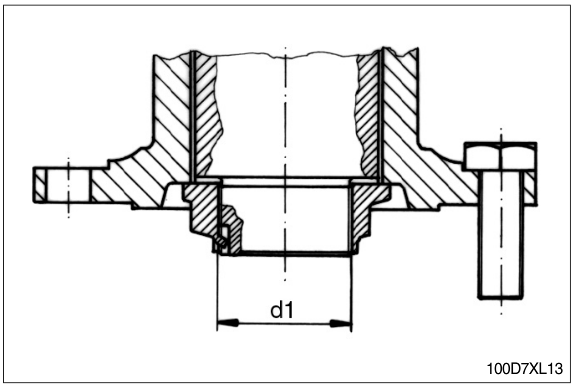
Unit : N·m

Thread	Screw 8.8	Nut 8	Screw 10.9	Nut 10	Screw 12.9	Nut 12
Metric fine thread						
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					

Wheel clamp nut(M18×2.0) : 350 Nm

(1) Tightening torque of the adjusting nut respective slotted nut at flanges respective gear

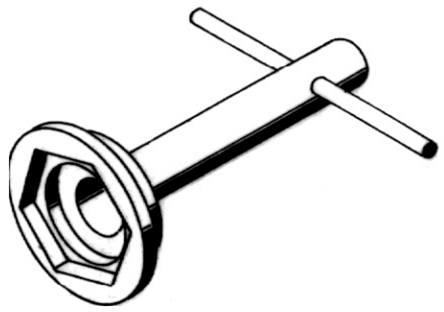
Thread d1(mm)	Torque (Nm)
M45×1.5	850



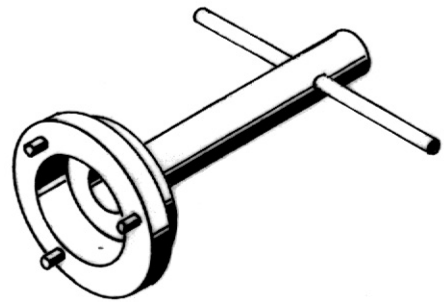
6) SERVICE TOOLS

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

(1) Spanner for wheel safety nut

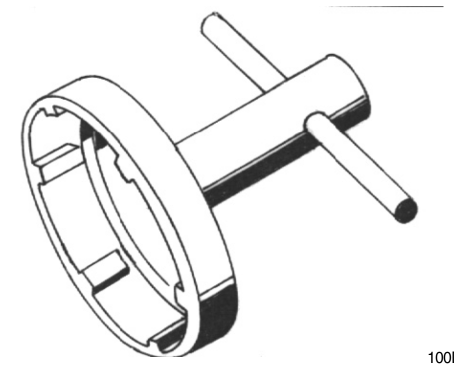


100D7XL14



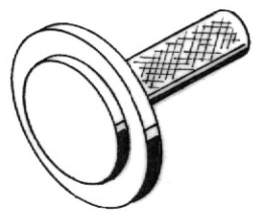
100D7XL15

(2) Spanner for splined nut(hub assembly)

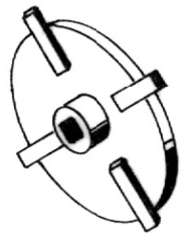


100D7XL16

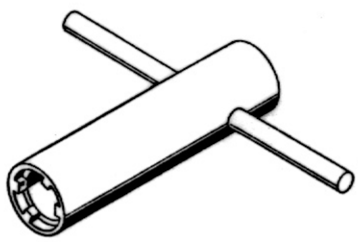
(3) Seal ring sleeve driver.


100D7XL17

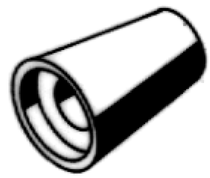
(4) Spanner for thread rings.
(Differential bearing)


100D7XL18

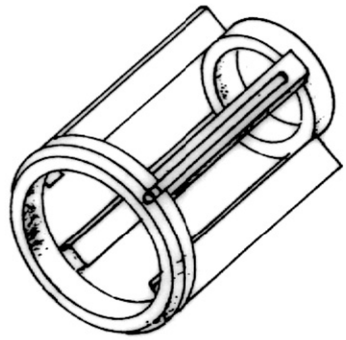
(5) Spanner for counter nut.
(Planetary gear drive)


100D7XL19

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

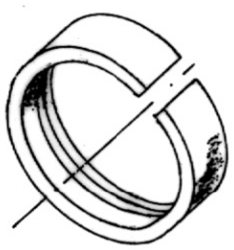

100D7XL82

(7) Centering tool for discs.



100D7XL20

(8) Installation tool for face seal.



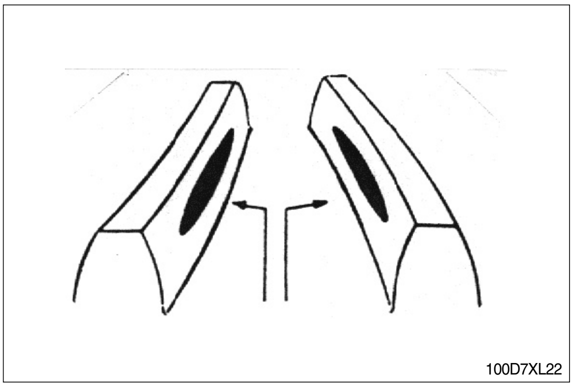
100D7XL21

7) ASSEMBLY DRIVE ASSEMBLY

(1) Adjustment of gear meshing of gleason gears

① Perfect marking

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

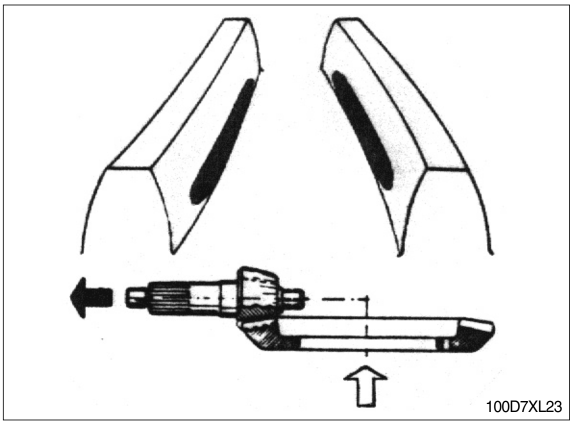


※ Improper gear meshing marks

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.

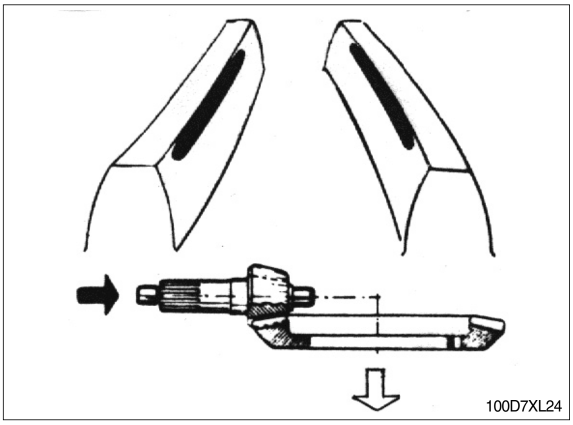
② Gear meshing to deep

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



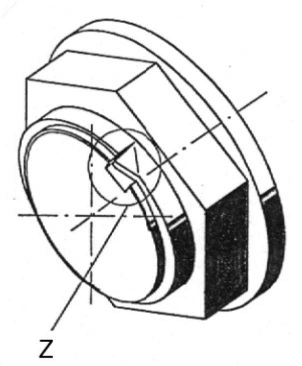
③ Gear meshing to high

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

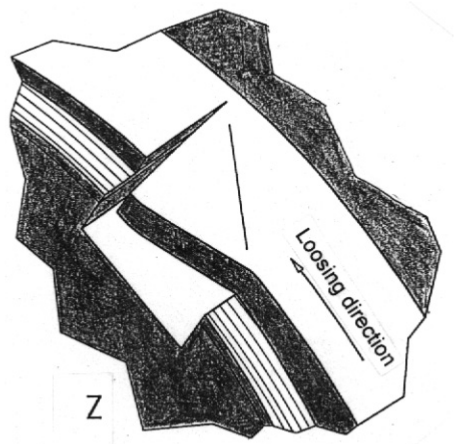


(2) Securing of the striking nut

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.

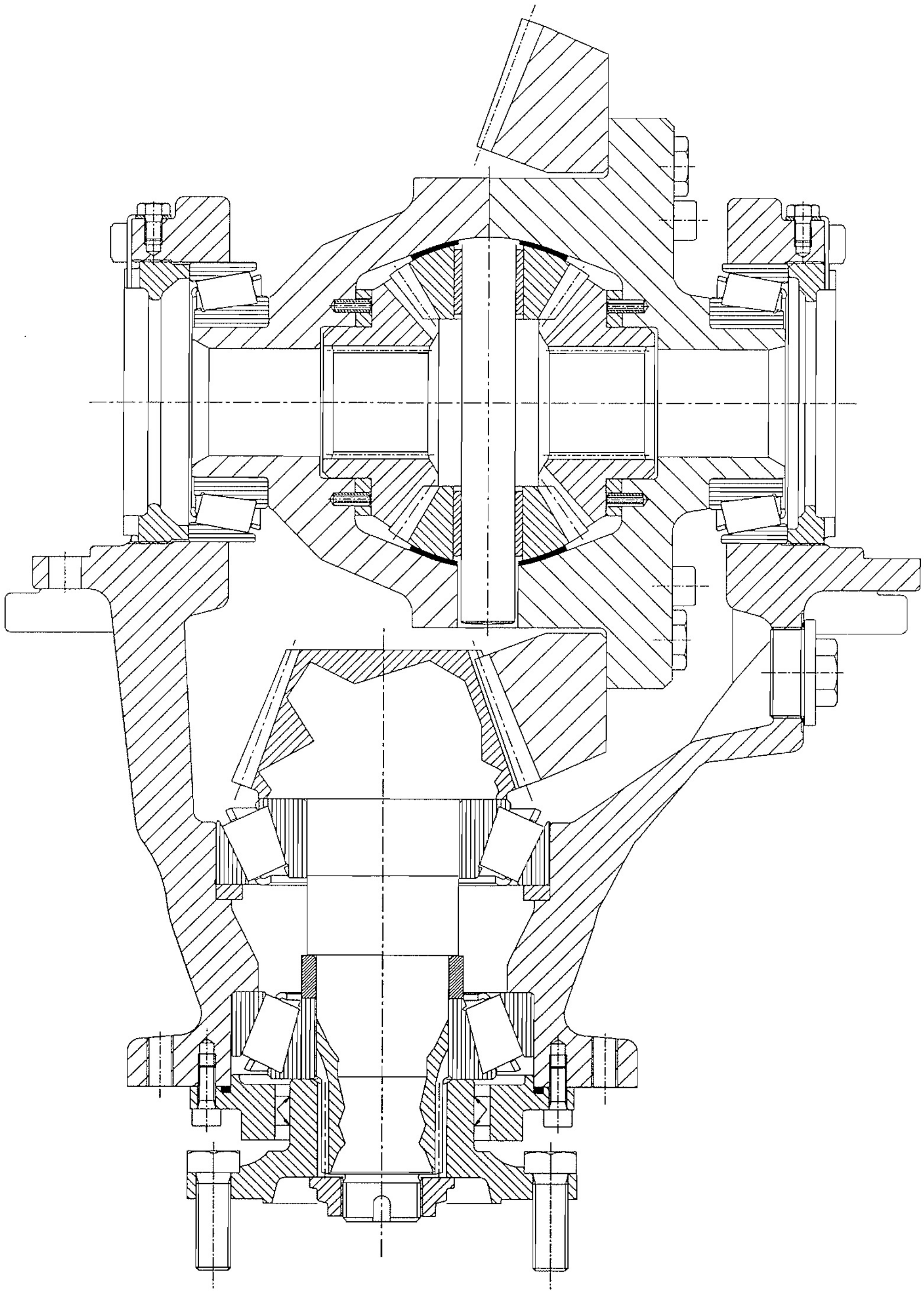
Striking nut at gear wheels, bearings etc.

- In thread : Assembly paste with MoS_2.

② **Removing of the striking nut**

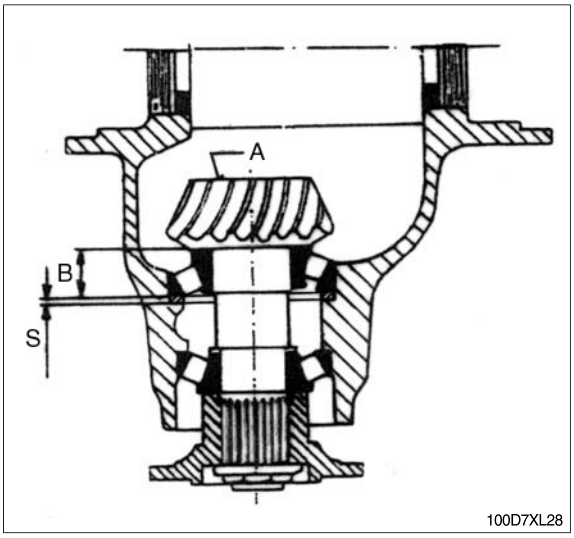
Bend away the nose and screw off the nut.

③ Drive assembly D 71



250DEXL27

(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 3-160 "Adjustment of gear meshing of gleason gears")

(S theorem = 3.2mm)

- 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.(B theorem = 40mm)

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

A = + 0.10 ; B = 39.95

S = 3.20mm(theorem)

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

= 3.25mm

- 0.10mm → Drive pinion value A

= **3.15mm** → Necessary thickness of the adjustment disk

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

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

※ If measure B is positive(e.g. 40.05) the adjustment disk has to be 0.05mm thinner than theorem S.
If measure B is negative(e.g. 39.95) the adjustment disk has to be 0.05mm 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.

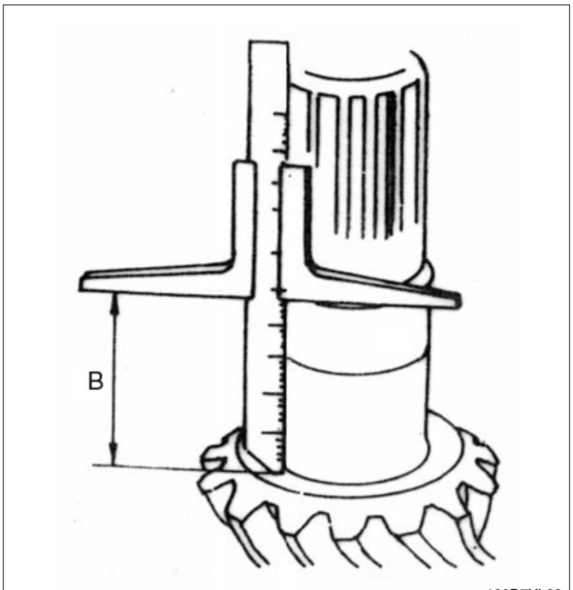
② Calculate the thickness C of the spacer ring.

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℃ and install it on the drive pinion shaft.(Drive on completely after it cools)

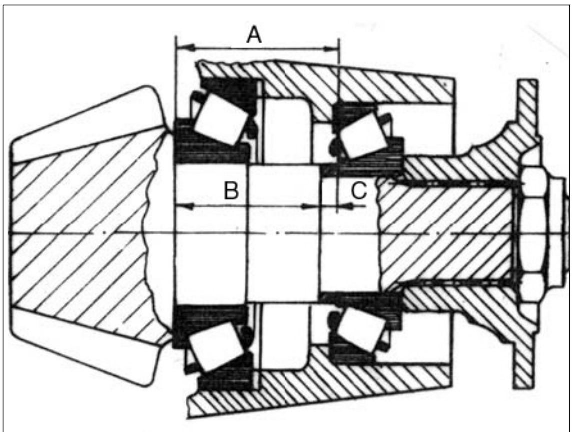


100D7XL28

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℃ 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 3-156. For tightening fix the differential carrier and block the drive flange.



100D7XL29

⑦ Measure the resistance of the bearings by using a torque wrench. If the measured value is not the prescribed 0.8 to 1.2Nm, 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.

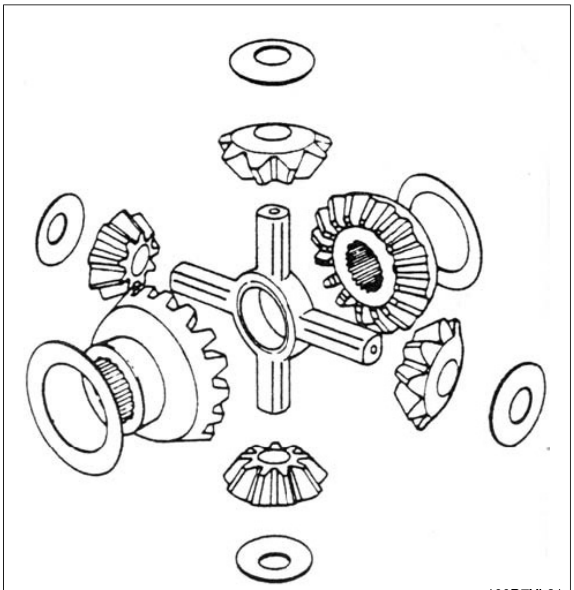
⑧ Install the radial seal ring with Loctite 572 applied. Fill the radial seal ring with bearing grease.
Fit the carrier of the parking brake(if present) on the differential carrier and tighten the screws.
Slip on the drive flange, screw on the safety nut with sealing compound between the contact surfaces. Tighten the safety nut according page 3-156. Lock the nut by striking the nut brim into the slot of the pinon.

8) ASSEMBLY OF THE DIFFERENTIAL

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

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

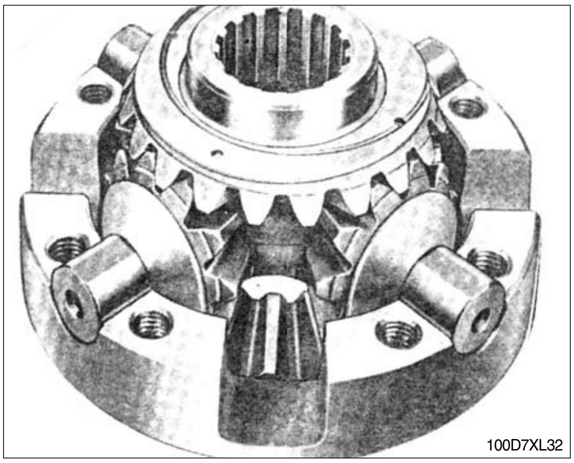
(2) Install the spider with differential gears and differential pinion thrust washers in the differential case.



100D7XL31

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

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

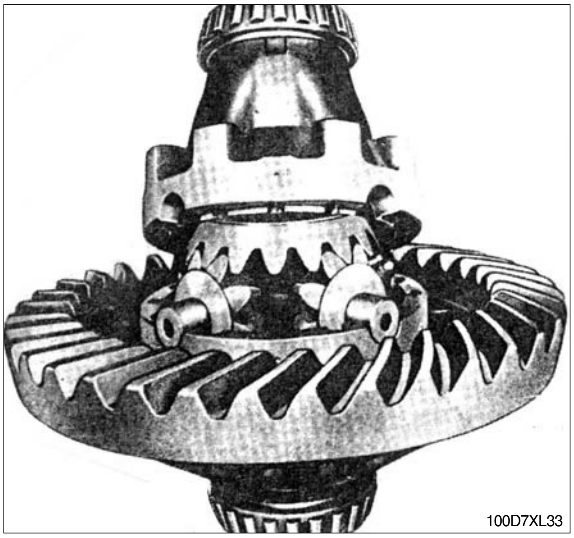


100D7XL32

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

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

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



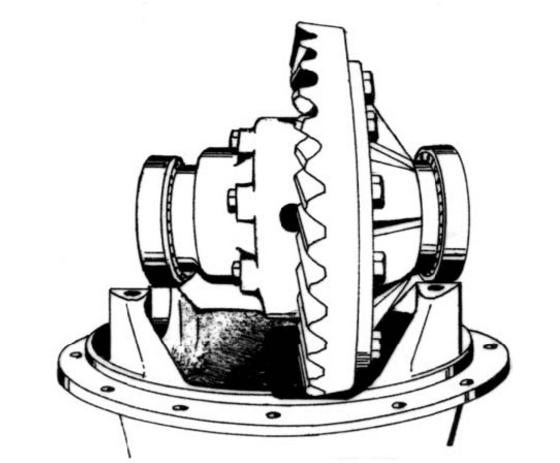
100D7XL33

9) ASSEMBLY OF DRIVE ASSEMBLY

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

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

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

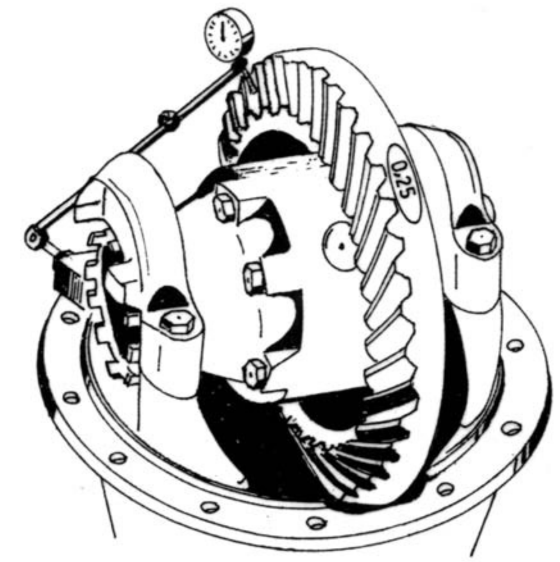


100D7XL34

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

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

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



100D7XL35

(7) Adjust gear meshing according to page 3-160 "Adjustment of gear meshing of gleason gears".

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

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

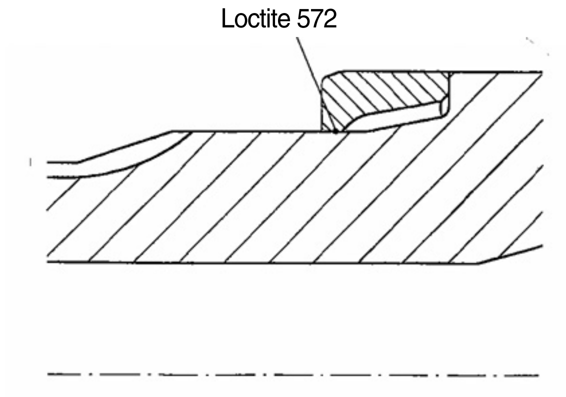
(10) Screw the lock plates for the thread rings and secure with Loctite 270, if need bend the lock plates.

100D7XL36

10) ASSEMBLY OF HUB ASSEMBLY

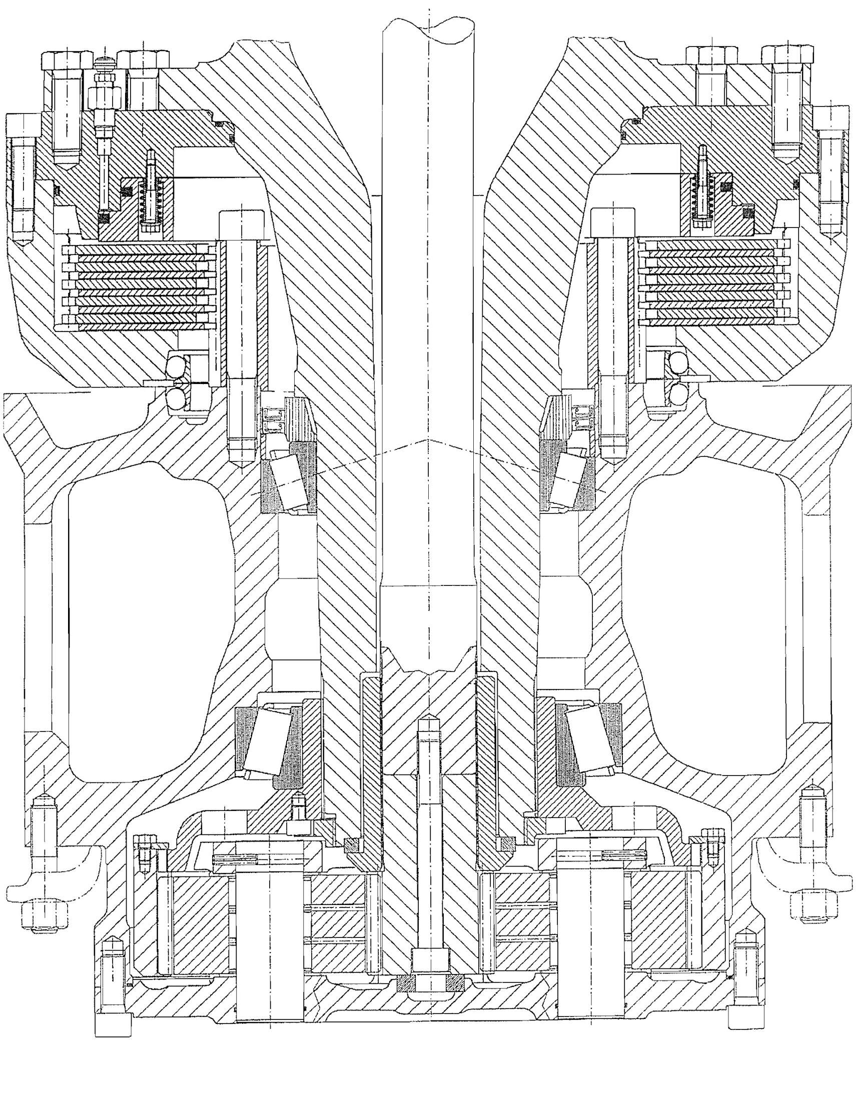
(1) Assembly of the spacer ring

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



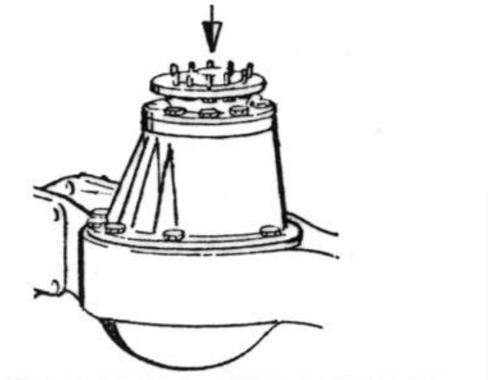
100D7XL37

(2) Hub assembly drive axle

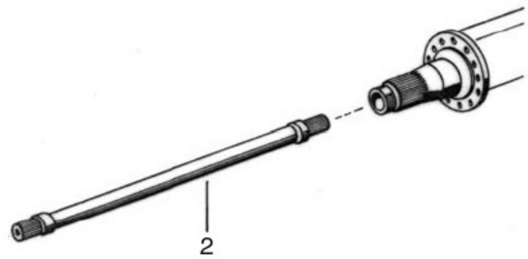


250DEXL38

11) ASSEMBLY OF THE DRIVE ASSEMBLY ONTO THE AXLE HOUSING



100D7XL39



100D7XL40

(1) Coat the contact surface of the axle housing with Epple 33 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.

(5) Assembly hub assembly

① Assembly of the spacer ring(if present) see page 3-167.
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 3-169.
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 3-175.

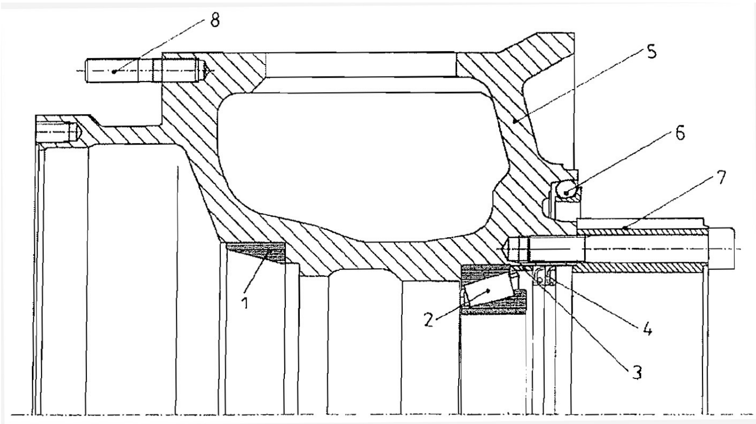
(6) Prepare wheel hub

① Press in outer rings of taper roller bearings(1+2), do not hammer them. Install inner ring of taper roller bearing(2).
② Install the ring(3) into the wheel hub(5).
③ Press the radial seal rings(4) with Loctite 572(rubber cage) respective Loctite 270(steel cage) applied into the wheel hub(5). Fill the radial seal rings with bearing grease.
④ Install the face seal(6) into the wheel hub(5).
⑤ Push the disc carrier(7) onto the wheel hub and bolt it, secure the screws with Loctite 262.
⑥ Screw the wheel studs (8) until they contact to the thread ground into the wheel hub.

(7) Mount wheel hub

① Push the pre-assembled wheel hub(5) parallel onto the axle spindle respective steering knuckle.

※ Be carefully not to damage the radial seal rings(4).



250DE7XL41

(8) Adjustment of wheel bearings

① **Tightening torque of the wheel safety nut.**

Series	Nm
91	500

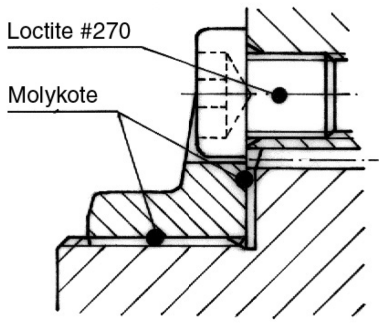
② **Adjustment of wheel bearings**

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

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

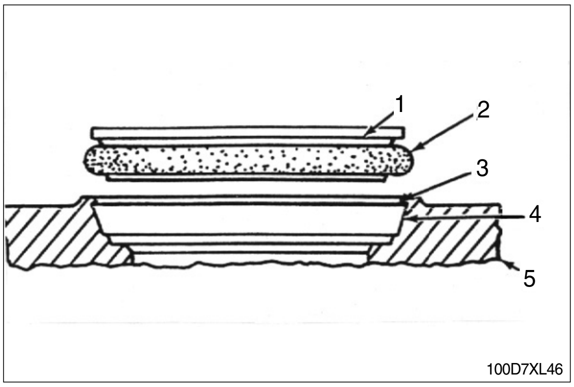
Screw on the wheel safety nut and tighten it with a 1.5 to 2 times higher tightening torque than the finish tightening torque. During the tightening, turn the wheel hub a few times and knock it with a plastic hammer. Untighten the wheel safety nut(about 180° back rotation), then tighten the wheel safety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

③ **Wheel safety nut**

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

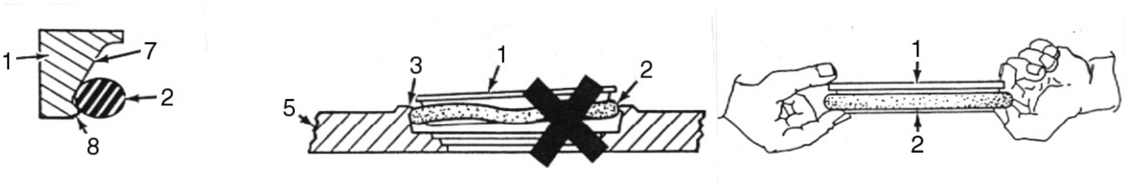
(9) Assembly of the face seal

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



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

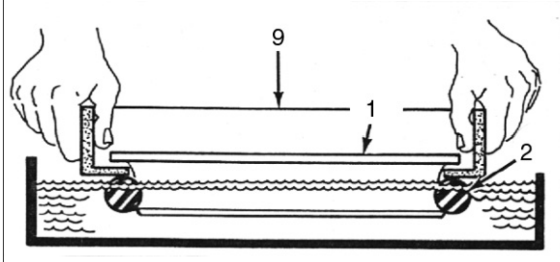
② After all components have been wiped clean, the torics should be installed on the metal seal rings so that they rest in the radius on the tail of the metal ring. Insure that the torics are not twisted by inspecting the mold flash line on the outside diameter of the toric for true circumferential tracking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



100D7XL47~49

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.



100D7XL50

⑧ Toric sliding on retainer ramp.

100D7XL51

⑨ Toric caught on housing retainer lip.

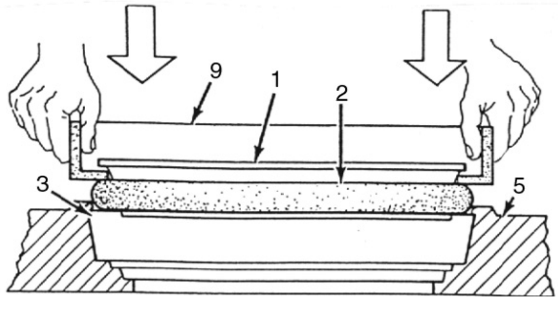
100D7XL52

⑩ Toric sliding on seal ramp.

100D7XL53

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

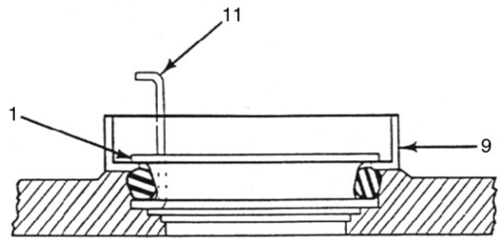
⑫ With all surfaces of the toric ring(2) wet with Isopropanol, use the installation tool(9) to position the seal ring(1) and the toric ring(2) squarely against the housing(5) as shown. Use sudden and even pressure to pop(push) the toric ring(2) under the retaining lip(3) of the housing(5).



100D7XL54

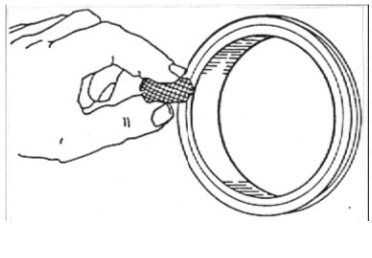
⑬ The seal can be adjusted by gently pushing the toric into position by hand or by using a fabricated adjustment hook.

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

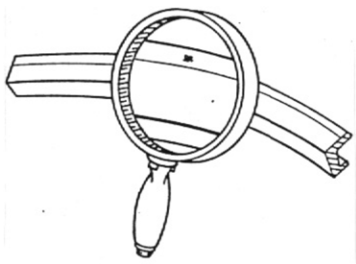


100D7XL55

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


100D7XL56

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



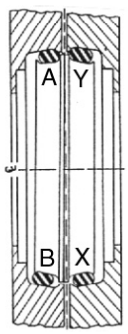
100D7XL57

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

※ **Results of incorrect assembly :**

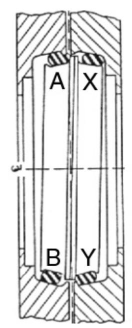
Point "A" and point "B" remain stationary.
Points "X" and "Y" rotate 180°.
This causes high pressure at "A" and "Y" and possible galling.
When rotated, points "B" and "X" have low pressure and possible leakage.

Original assembled position



100D7XL58

Rotated 180°



100D7XL59

⑱ After the unit to be sealed is assembled, a post-assembly leakage test can be performed to insure the seal is properly installed. A vacuum check is recommended rather than a pressure check as vacuum checks are more sensitive. Many users find this an easy check to combine with a vacuum fill technique for the lubricant. It is recommended the compartment be filled to the correct level with lubricant and then rotated slowly several revolutions to seat the seals.

A vacuum test will catch big seal damage such as broken seal rings or cut torics that may be caused in the last phases of assembly. The Duo-Cone seal is not designed to seal air, so some leakage can be expect using such a procedure.

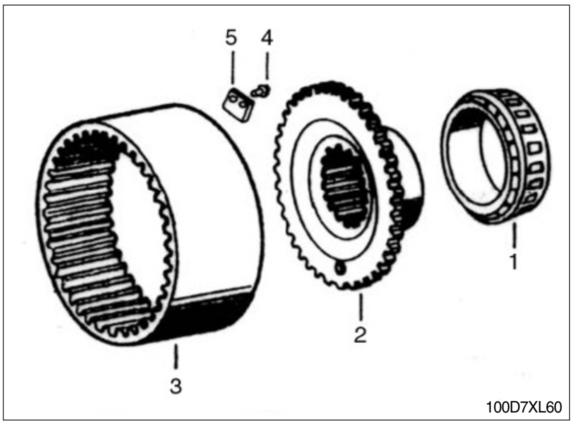
⑲ Following these guidelines and recommendations should insure optimum performance from the Duo-Cone-Seals.

10) ASSEMBLY OF PLANETARY GEAR DRIVE

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

Heat the taper roller bearing inner ring with cage(1) to about 100℃ and install it onto the ring gear carrier(2). Place the ring gear(3) onto the ring gear carrier.

Bolt the retainer(5) with the screws(4), secure the screws with Loctite 270.



100D7XL60

(2) Assembly of the ring gear carrier

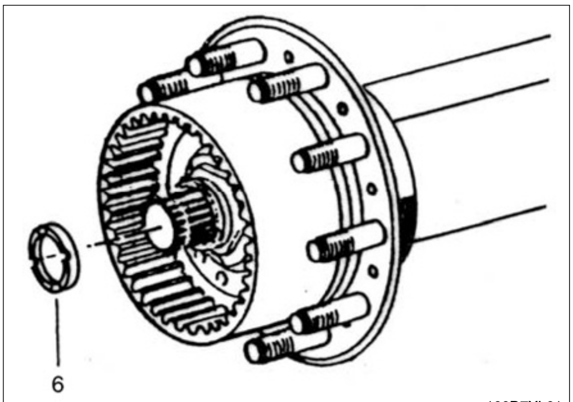
Install the ring gear carrier(2) with ring gear(3) into the wheel hub respective onto the steering knuckle respective axle spindle.

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

Subsequent adjust wheel bearings(see page 3-169).

(3) Assembly of the thrust ring

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

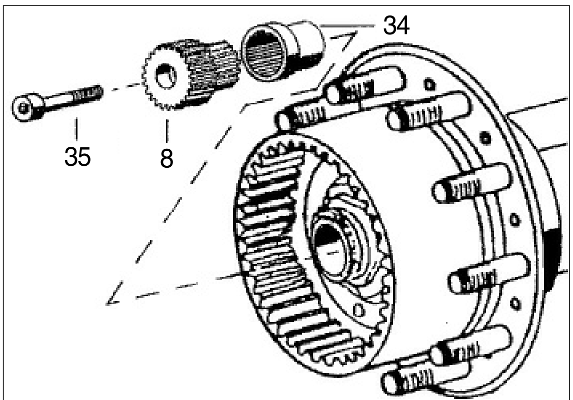


100D7XL61

(4) Assembly of the sun gear

Push the sleeve (34) onto the universal joint respective axle shaft. Introduce the sun gear (8) into the sleeve and bolt it with the screw (35) onto the universal joint respective axle shaft, secure the screw with Locitite 262.

Push the universal joint respective axle shaft towards the inside until the sun gear contacts to the sleeve and the sleeve contacts to the thrust ring.



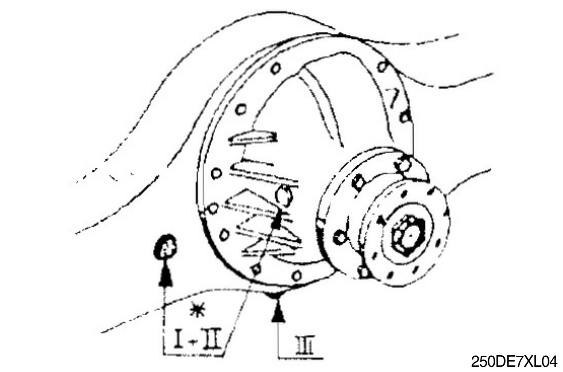
250DE7XL62

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

Single drive assembly

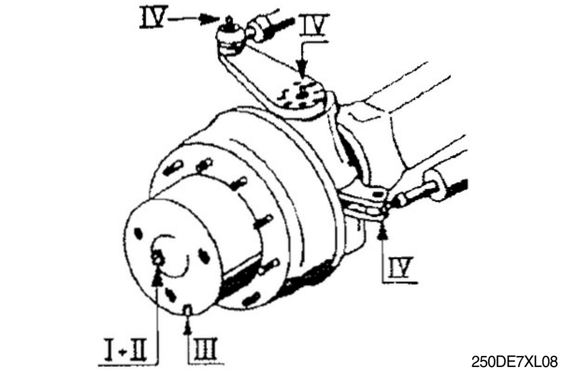
* The position is dependent from the respective axle version.

I=Oil fill plug
II=Oil level control plug
III=Oil drain plug



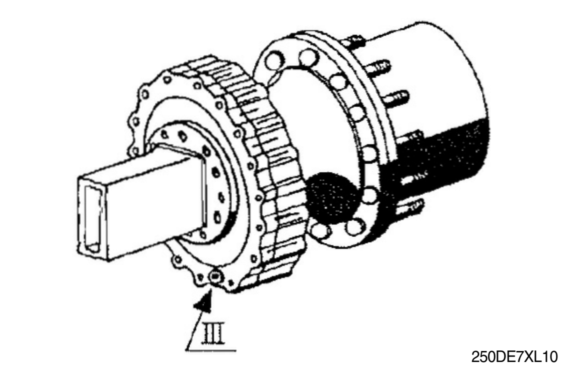
250DE7XL04

Hub assembly with planetary gear drive



250DE7XL08

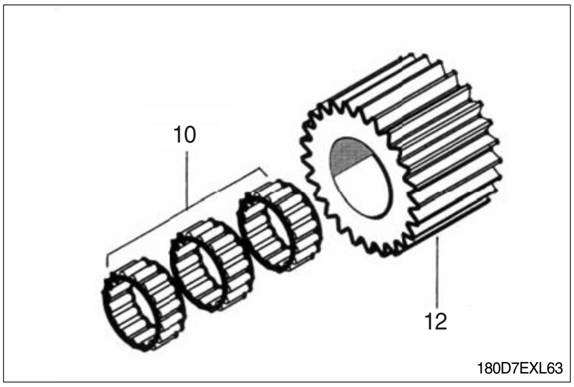
Hub assembly with wet disc brake



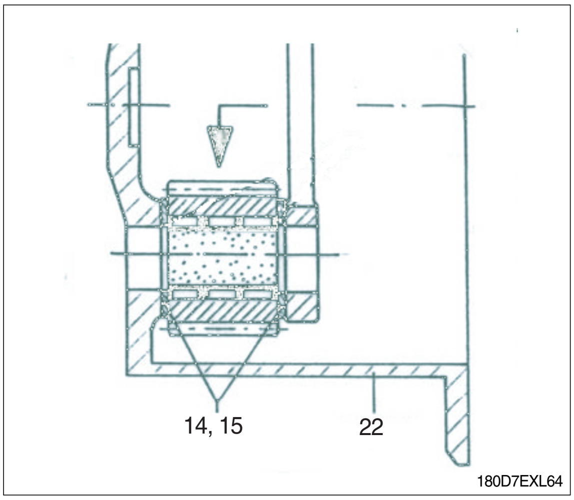
250DE7XL10

(5) Assembly of planetary gear

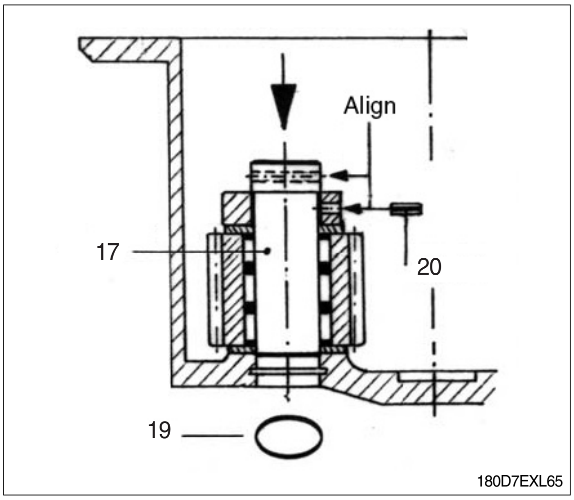
① **Prepare planetary gear :**
Install the needle bearing(10) into the planetary gear(12).



② Insert the preassembled planetary gears (12) with needle bearings (10) and thrust disks (14 , 15) into the planetary housing (22) (planetary housing in horizontal position).

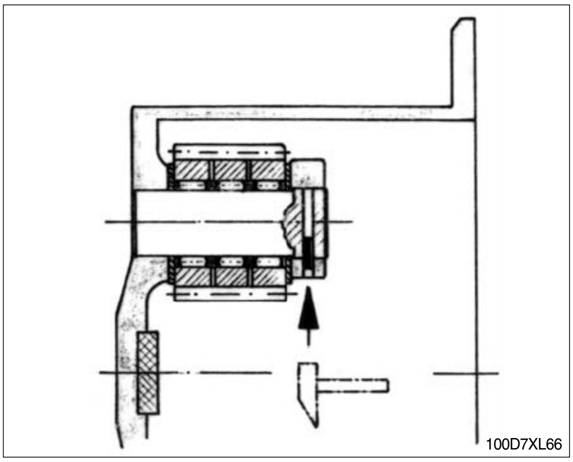


③ Place O-ring(19) into the slot of the planetary housing(22). Because of the difference of diameter of 0.1mm press the planetary pin(17) in direction of arrow. Be sure, that the bore hole of the locking pin in the planetary pin and planetary housing are aligned. After inserting, secure the planetary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



(6) Disassembly of planetary gear

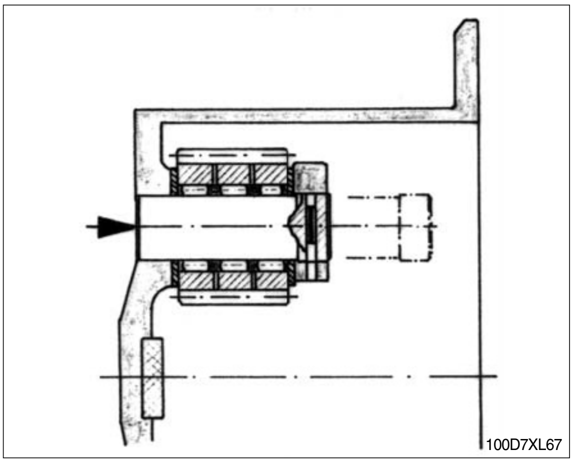
① Knock the locking pin(20, 21) completely to the inner side of the planetary pin.



100D7XL66

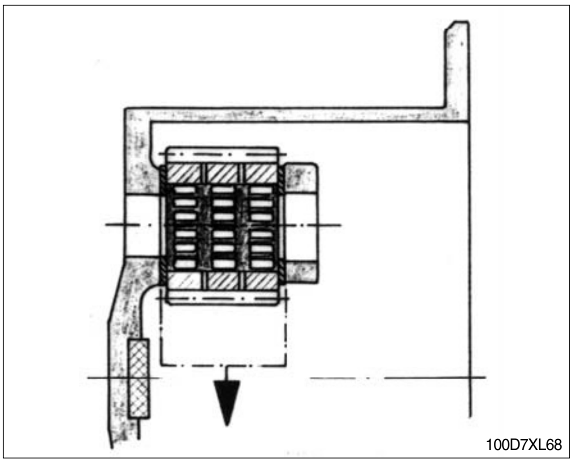
② Press the planetary pin in direction of arrow out of the planetary housing.

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



100D7XL67

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



100D7XL68

11) **Adjustment of the axial clearance**

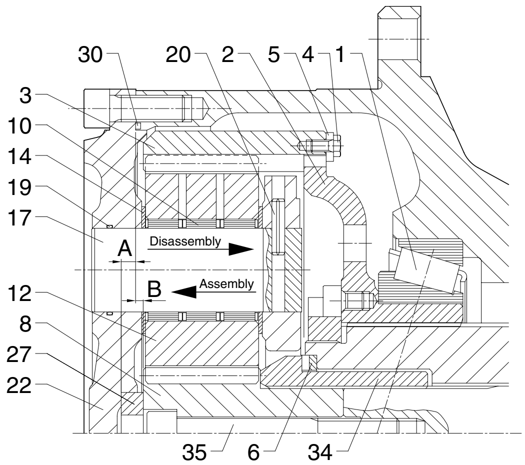
The axial clearance between sun gear and thrust disc (27) in the planetary housing must be 0.3-0.7 mm.

Measure distances :
Dimension A =
Dimension B =

Calculate required thickness, take the axial clearance (0.3 to 0.7 mm) into consideration.
Mount the correctly dimensioned thrust disc (if necessary, make final correction on a lathe) into the planetary housing. Secure with Loctite 270.

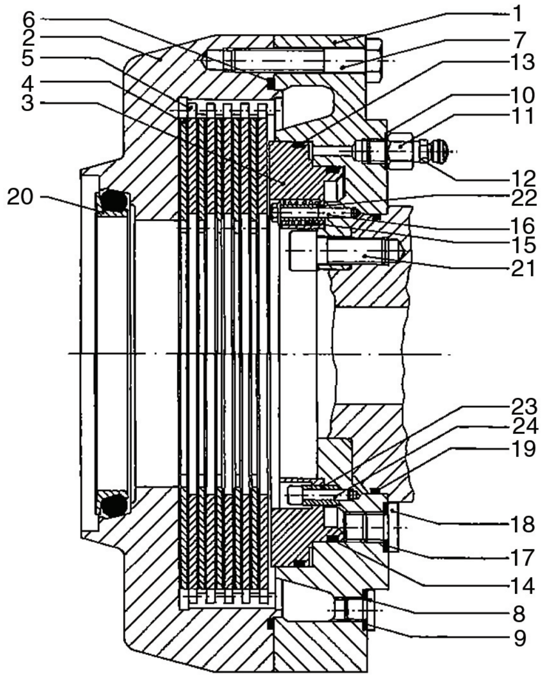
12) **Assembly of the planetary housing**

Place o-ring (30) into the slot of the planetary housing. Install the preassembled planetary housing and bolt it, secure with Loctite 262.



250DEXL71

13) Assembly of service brake



100D7XL83

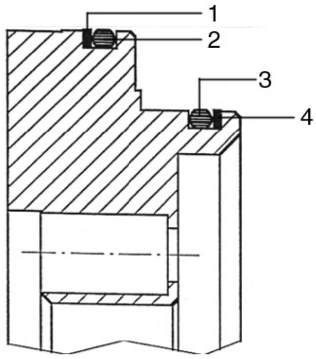
1	Brake carrier	9	Seal ring	17	Seal ring
2	Brake housing	10	Seal ring	18	Screw plug
3	Piston	11	Connection piece	19	O-ring
4	Inner disk	12	Breather	20	Face seal
5	Outer disk	13	Sealing ring	21	Screw
6	O-ring	14	Sealing ring	22	Tube
7	Screw	15	Spring	23	Bushing
8	Screw plug	16	Screw	24	Screw

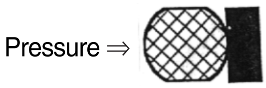
(2) **Assembly of the piston seals**

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.



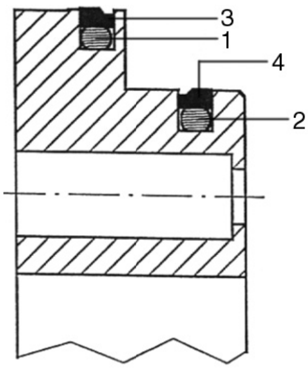


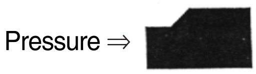
100D7XL73/84

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.

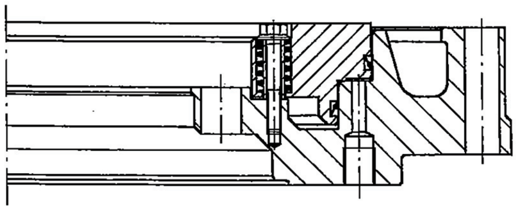




100D7XL74/85

1 Large O-ring
2 Small O-ring
3 Large supporting ring
4 Small supporting ring

(5) Assembly of the piston

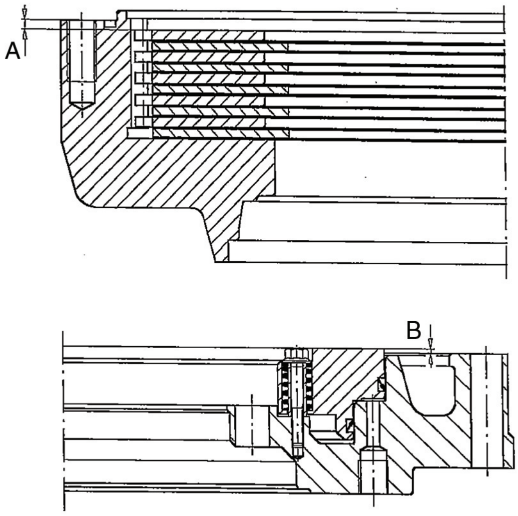


100D7XL86

Lubricate cylinder bore, apply the thread holes at wet disk brakes with Loctite 243. Place the piston onto the brake carrier(do not cant it).

Press the piston equal by hand into the brake carrier.

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 0.5mm 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)
4460	2.5[+0.7 / -0.1]	1.6

(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 3-170.

② Alignment of the discs

The alignment of the discs has to be made at mounting of the wheel hub by itself.

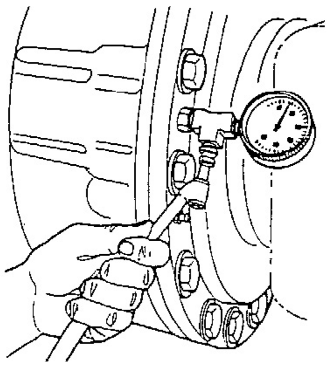
(7) Tightness checking instruction for brake hydraulic system and cooling oil room

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 117.5bar).
Test medium : Motor oil SAE 10W corresponding to MIL-L2104.

② Check cooling oil room for leaks

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.



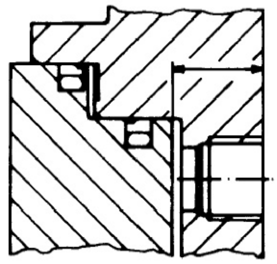
100D7XL75

(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.

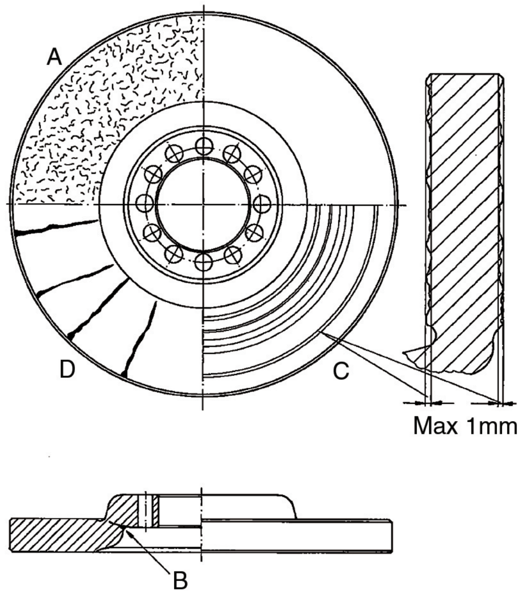
② Cooling fluid
· Hydraulic oil with an additive(LZ 9990A)

③ Check measure
It is measured through the check hole, while actuating the brake. The check measure, new, is marked in the housing below the hole. Is the measured dimension bigger than the marked dimension and max. wear dimension, unconditional consult Hyundai dealer.


100D7XL76

After working at the brake, bleed the brake hydraulic system and check for tightness.

(9) Brake disk



100D7XL78

A	Network - like formation of cracks	admissible
B	Radially shaped crack	not admissible
C	Uneven brake surface characteristics below 1.0mm	admissible
D	Continuous cracks	not admissible

(10) Spring - loaded sliding caliper brakes

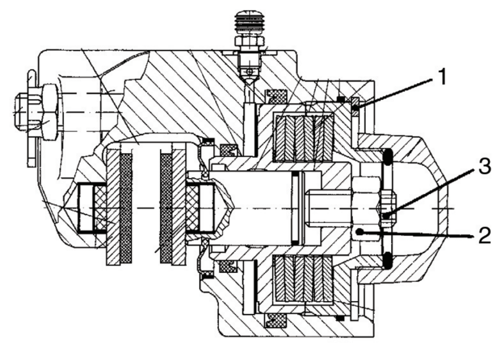
Safety notes :

· **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).

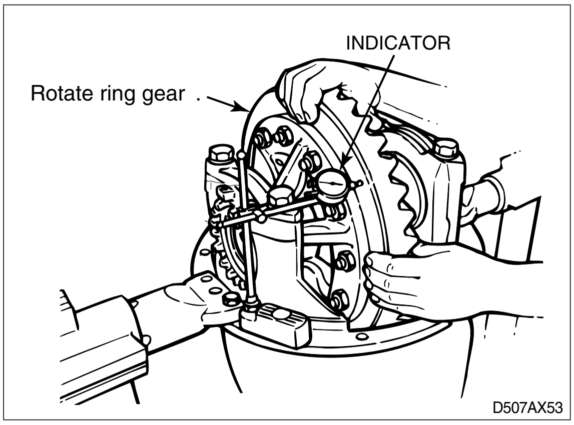


100D7XL79

GROUP 4 ADJUSTMENT

1. CHECKING THE RING GEAR BACKFACE RUNOUT

Runout specification : 0.20mm(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 0.20mm(0.008inch).

   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.

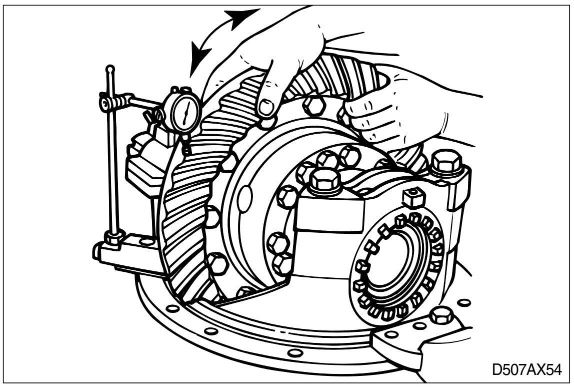
2. ADJUSTING THE GEARSET BACKLASH

Backlash specification : 0.13~0.18㎜
(0.005-0.007inch)

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.



D507AX54

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).

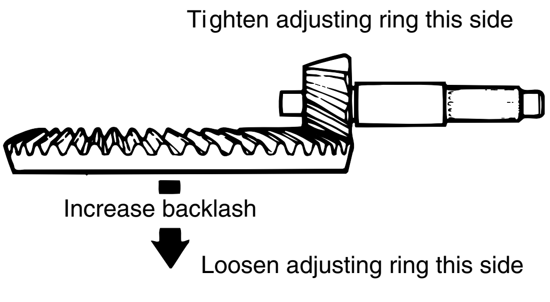
3) Hold the drive pinion in position.

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.

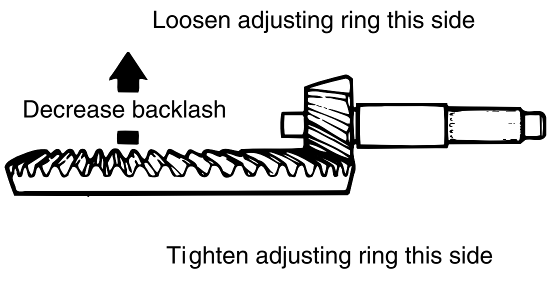
5) If the backlash reading is within specification, continue checking tooth contact patterns.
Otherwise, adjust backlash. Refer to step 6), and check, following steps 1)-4).

※ 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.



D507AX55

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

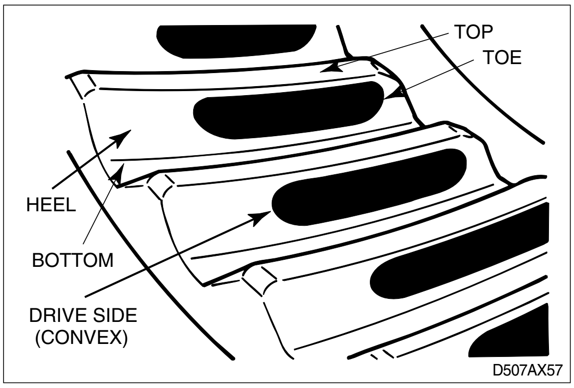


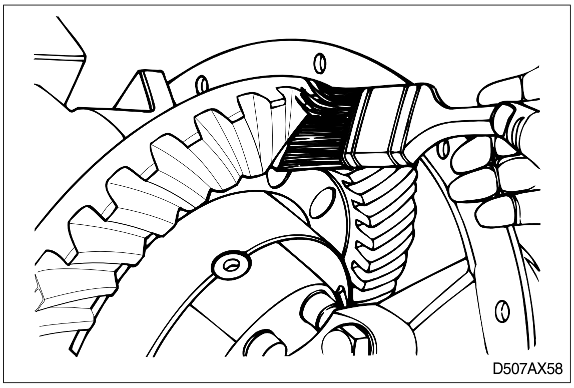
D507AX56

3. ADJUSTING TOOTH CONTACT PATTERN OF THE GEARSET

Always check tooth contact pattern on the drive side of the gear teeth.

1) Apply marking compound to approximately 12 teeth of the ring gear.





2) Rotate ring gear forward and backward so that the 12 marked teeth go past the drive pinion six times to get a good contact pattern.

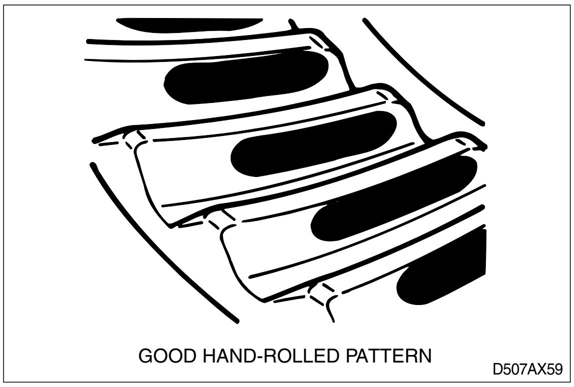
3) Compare the contact patterns.

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

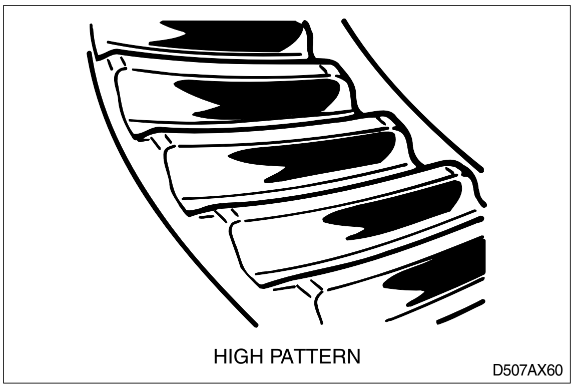
In used gearsets, a good contact pattern fills approximately the full length of the tooth. The top of the pattern is near the top of the tooth. The location should match the wear pattern on the tooth.

If the contact patterns require adjustment along the width of tooth(top/bottom), follow steps 4)-5).

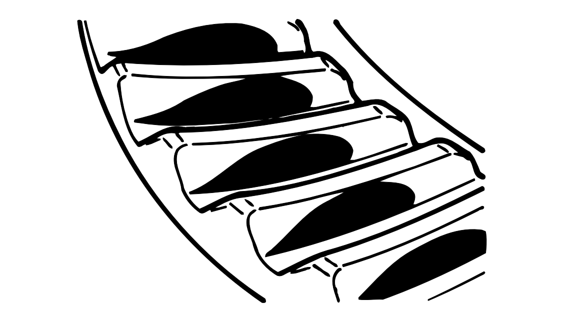
If the contact patterns requires adjustment along the length of tooth(toe/heel), follow step 6)-7).

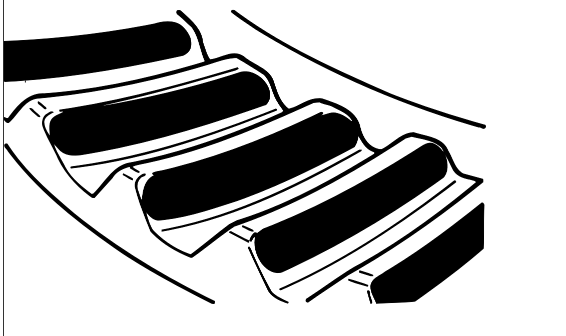


GOOD HAND-ROLLED PATTERN



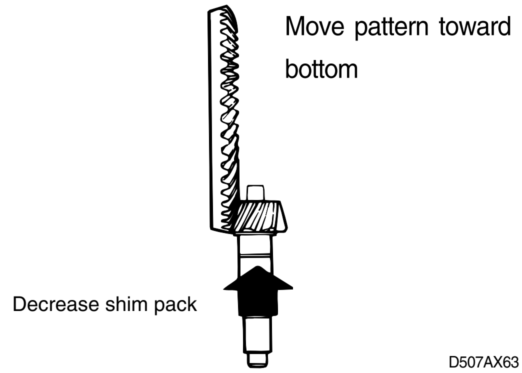
HIGH PATTERN


LOW PATTERN D507AX61


GOOD PATTERN IN OPERATION (USED GEARS) D507AX62

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

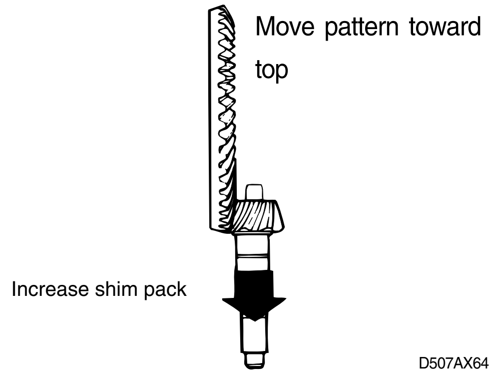
To correct, move the pinion toward the ring gear by decreasing the shim pack between pinion spigot and inner bearing cone. Refer to "Assembling the pinion bearing cage".



D507AX63

5) **Low pattern :** A low contact pattern indicates that the pinion was installed too deep into the carrier.

To correct, move the pinion away from the ring gear by increasing the shim pack between pinion spigot and inner bearing cone. Refer to "Assembling the pinion bearing cage".



D507AX64

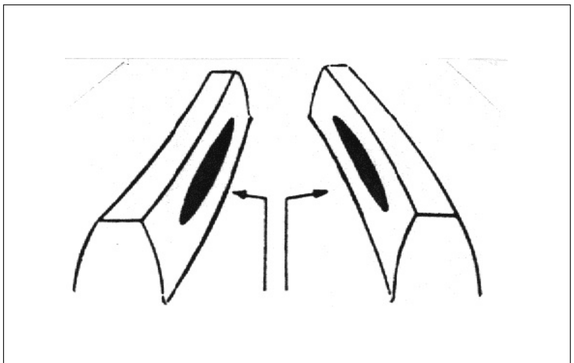
4. ADJUSTMENT OF GEAR MESHING OF GLEASON GEARS

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

Perfect marking

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

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

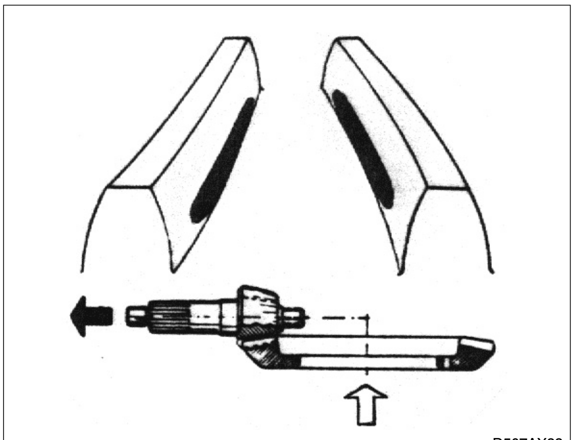


D507AX22

Gear meshing to deep

Increase the drive pinion distance by correction of the adjustment disk thickness.

Regulate the backlash by inwards moving of the ring gear.

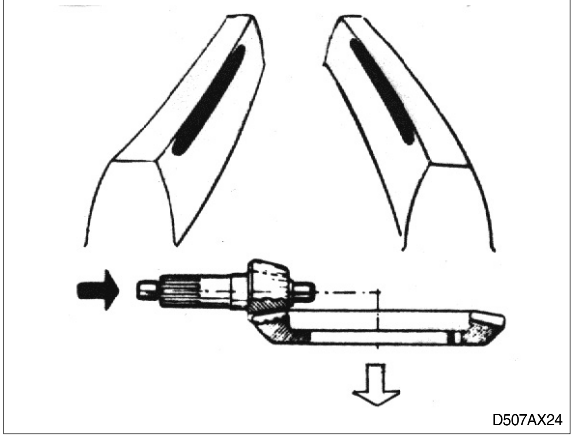


D507AX23

Gear meshing to high

Decrease the drive pinion distance by correction of the adjustment disk thickness.

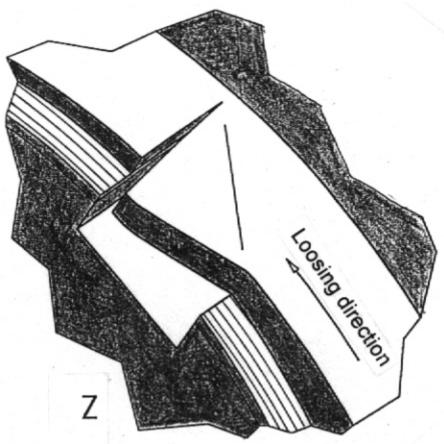
Regulate the backlash by outwards moving of the ring gear.



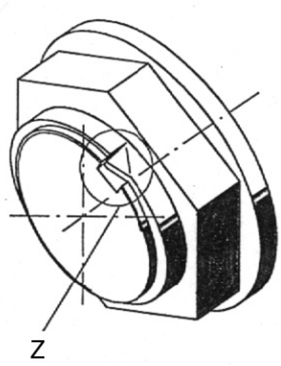
D507AX24

5. 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.



100D7XL25



100D7XL26

Using of Loctite and other operating supplies

1) 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).

2) Striking nut at through drive pinion

- In thread : Loctite 262.

3) Striking nut at gear wheels, bearings etc.

- In thread : assembly paste with MoS_2.

Removing of the striking nut

Bend away the nose and screw off the nut.

SECTION 4 BRAKE SYSTEM

GROUP 1 STRUCTURE AND FUNCTION

1. OUTLINE

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

BRAKE SYSTEM

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

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

Brake pump flow also goes to the parking brake solenoid valve in cut off valve.

The brake system contains the following components:

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

FULL POWER HYDRAULIC BRAKE SYSTEM

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

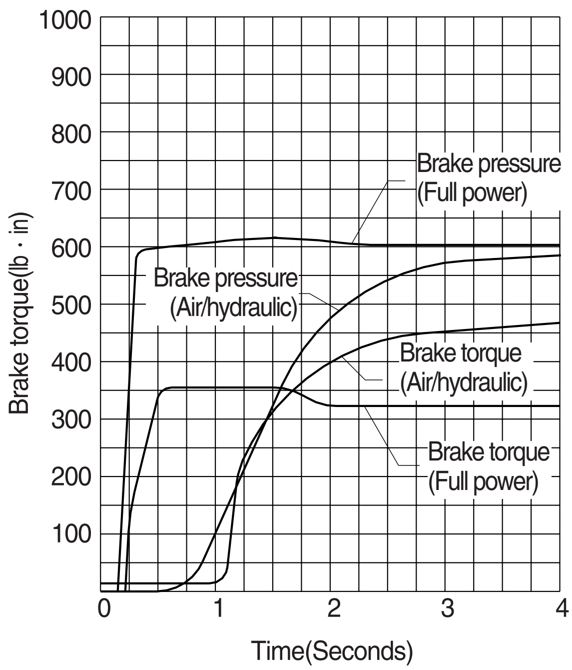
Full power systems can supply significantly higher brake pressures with relatively low reactive pedal forces. The reactive pedal force felt by the operator will be proportional to the brake line pressure being generated. This is referred to as brake pressure modulation.

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

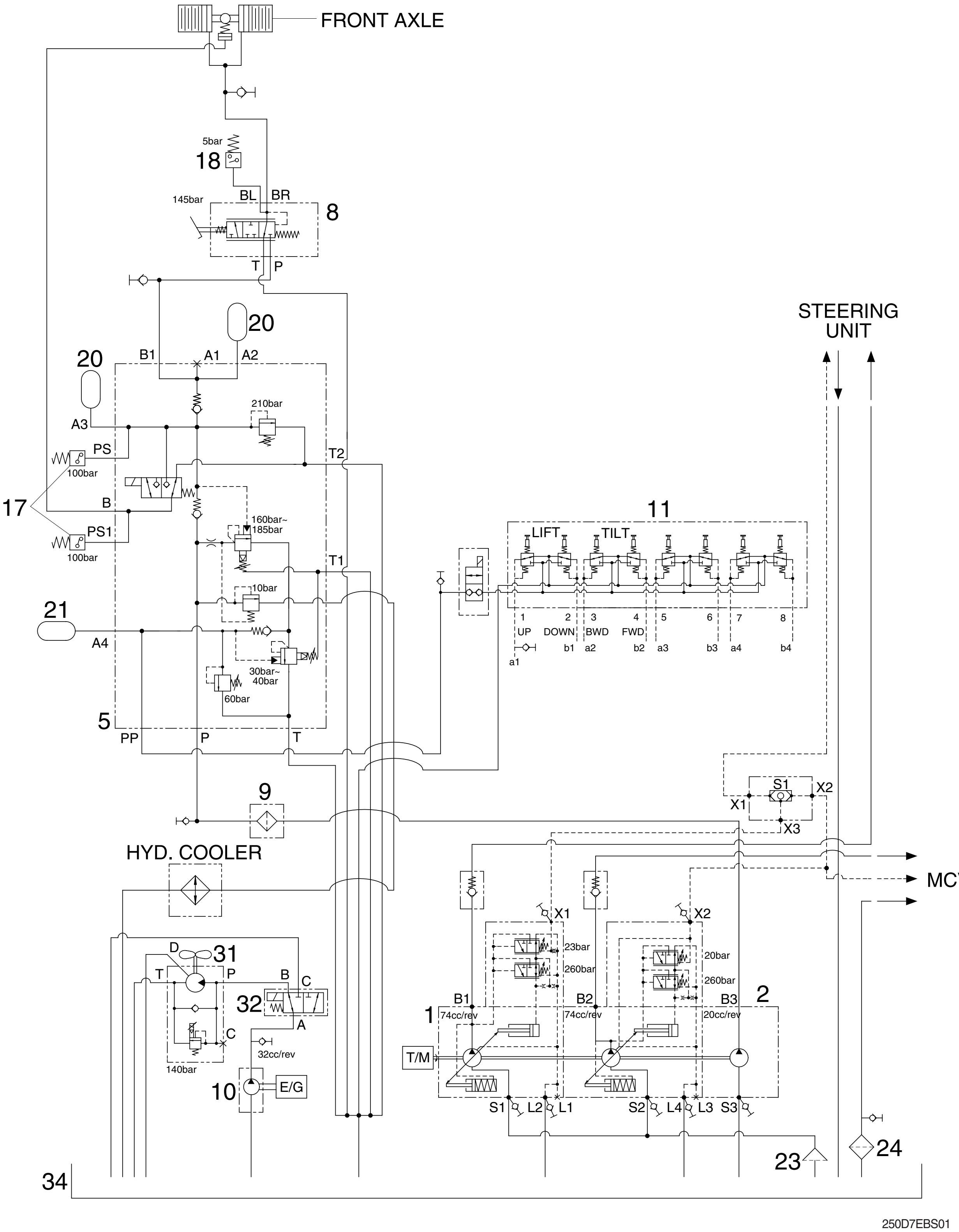
Because these systems are closed center, by using a properly sized accumulator, emergency power-off braking that is identical to power-on braking can be achieved. These systems can be either dedicated, where the brake system pump supplies only the demands of the brake system or non-dedicated, where the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

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

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

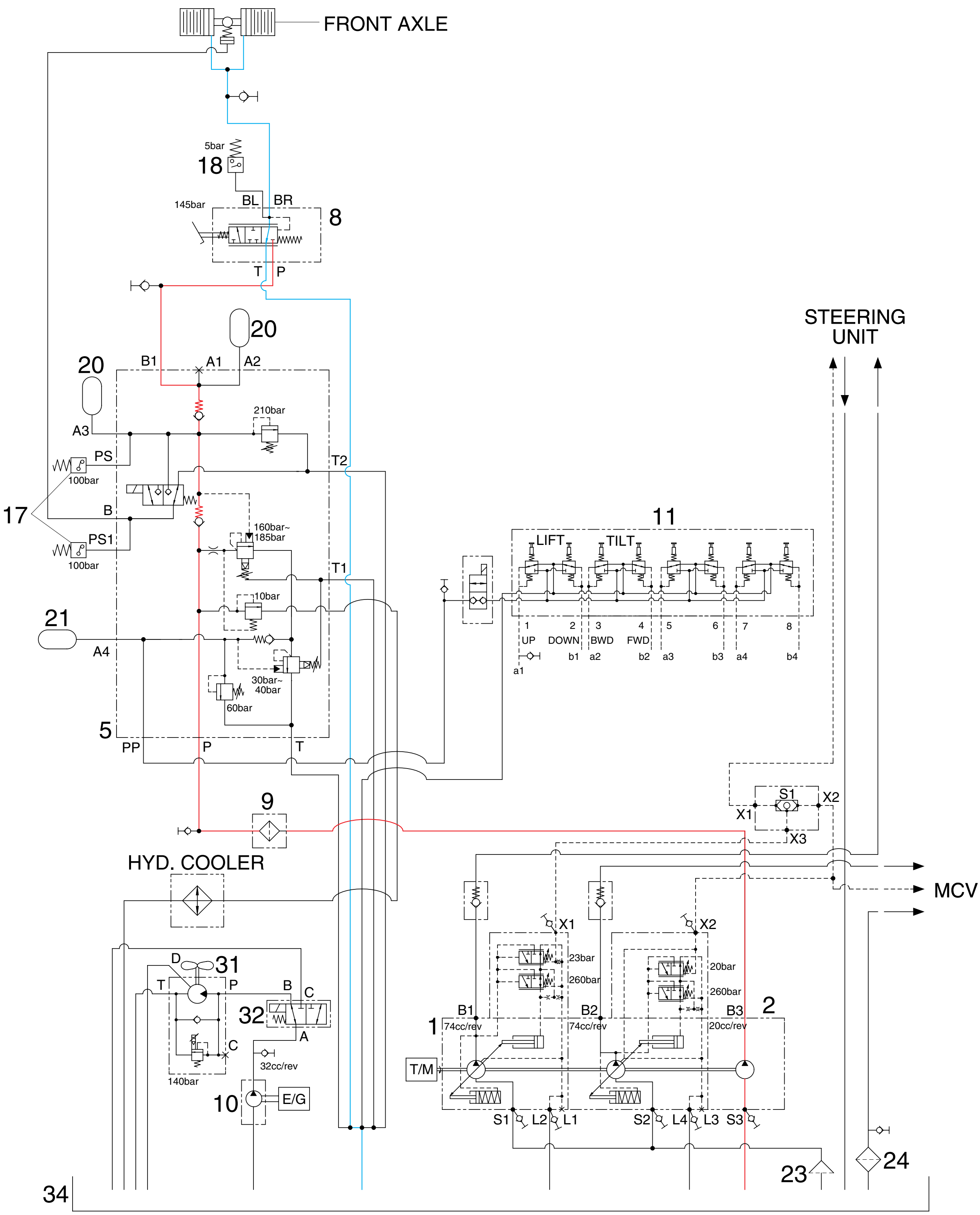


2. HYDRAULIC CIRCUIT



1	Main pump	11	RCV	23	Strainer
2	Auxiliary pump	17	Pressure switch	24	Return filter
5	Cut off valve	18	Pressure switch	31	Fan drive motor
8	Brake valve	20	Accumulator	32	Solenoid valve
9	Pressure filter	21	Accumulator	34	Hydraulic oil tank
10	Fan drive pump				

1) SERVICE BRAKE RELEASED



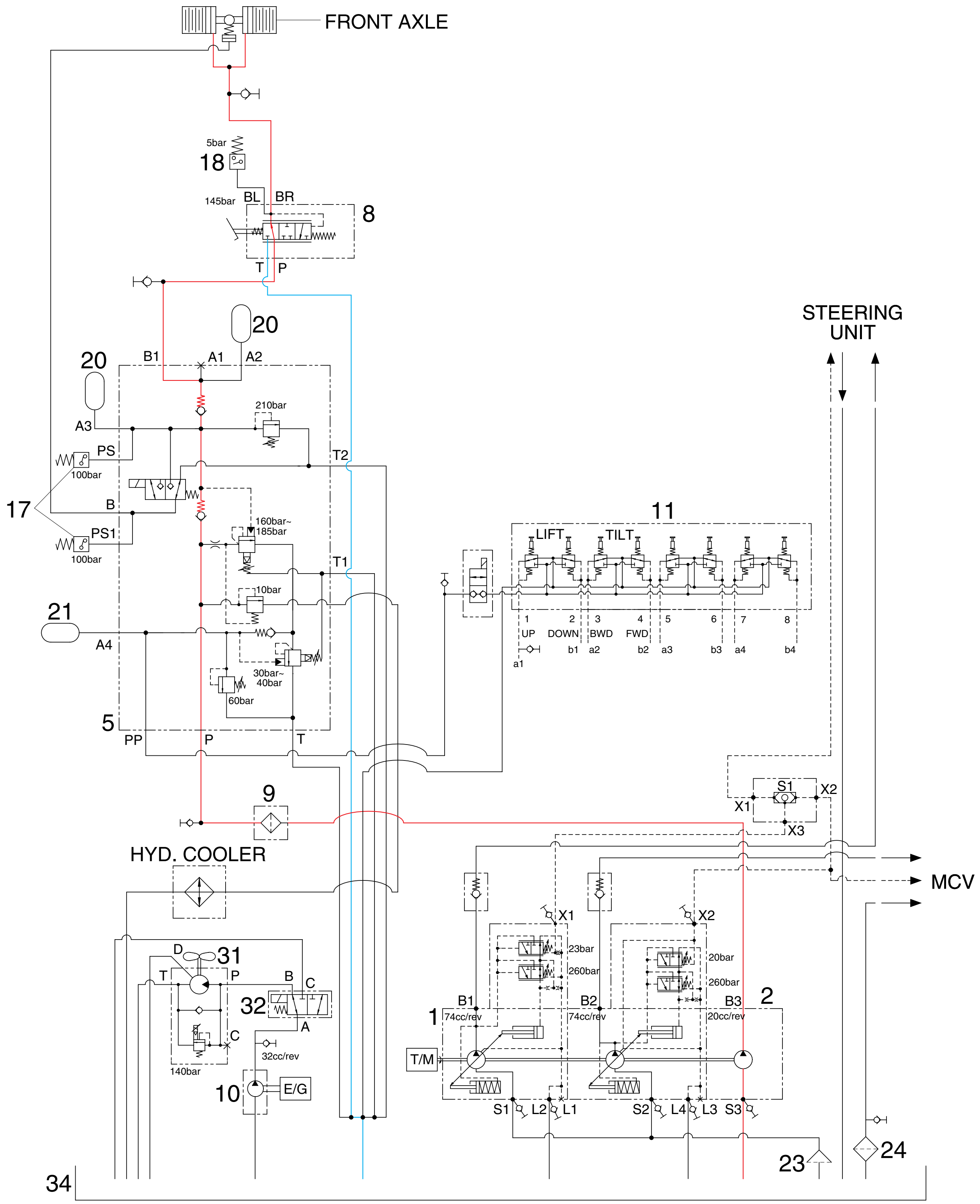
250D7EBS02

When the pedal of brake valve(8) 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.

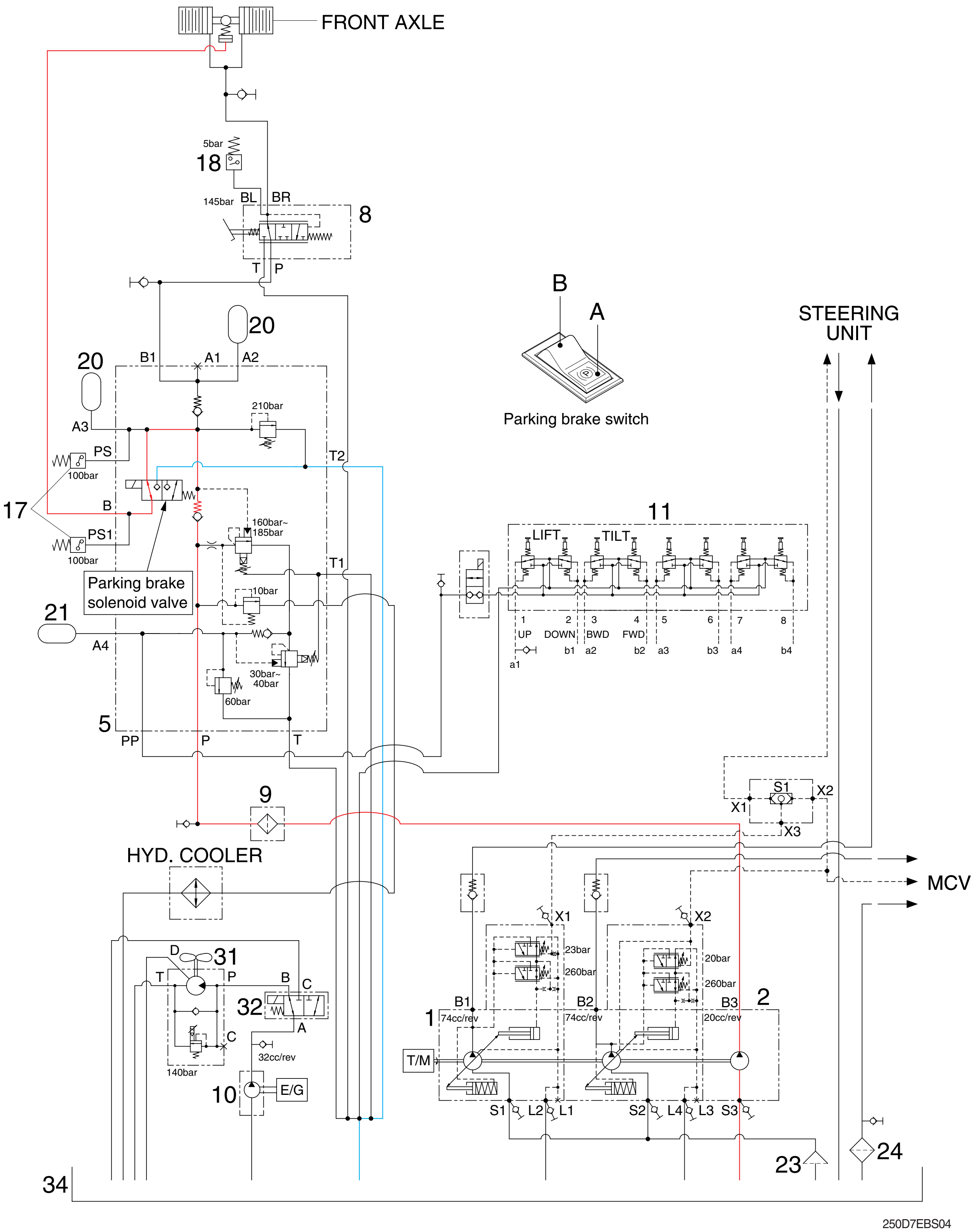
2) SERVICE BRAKE OPERATED



250D7EBS03

When the pedal of brake valve(8) 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(5) enters the piston in the front and rear axles. Therefore, the service brake is applied.

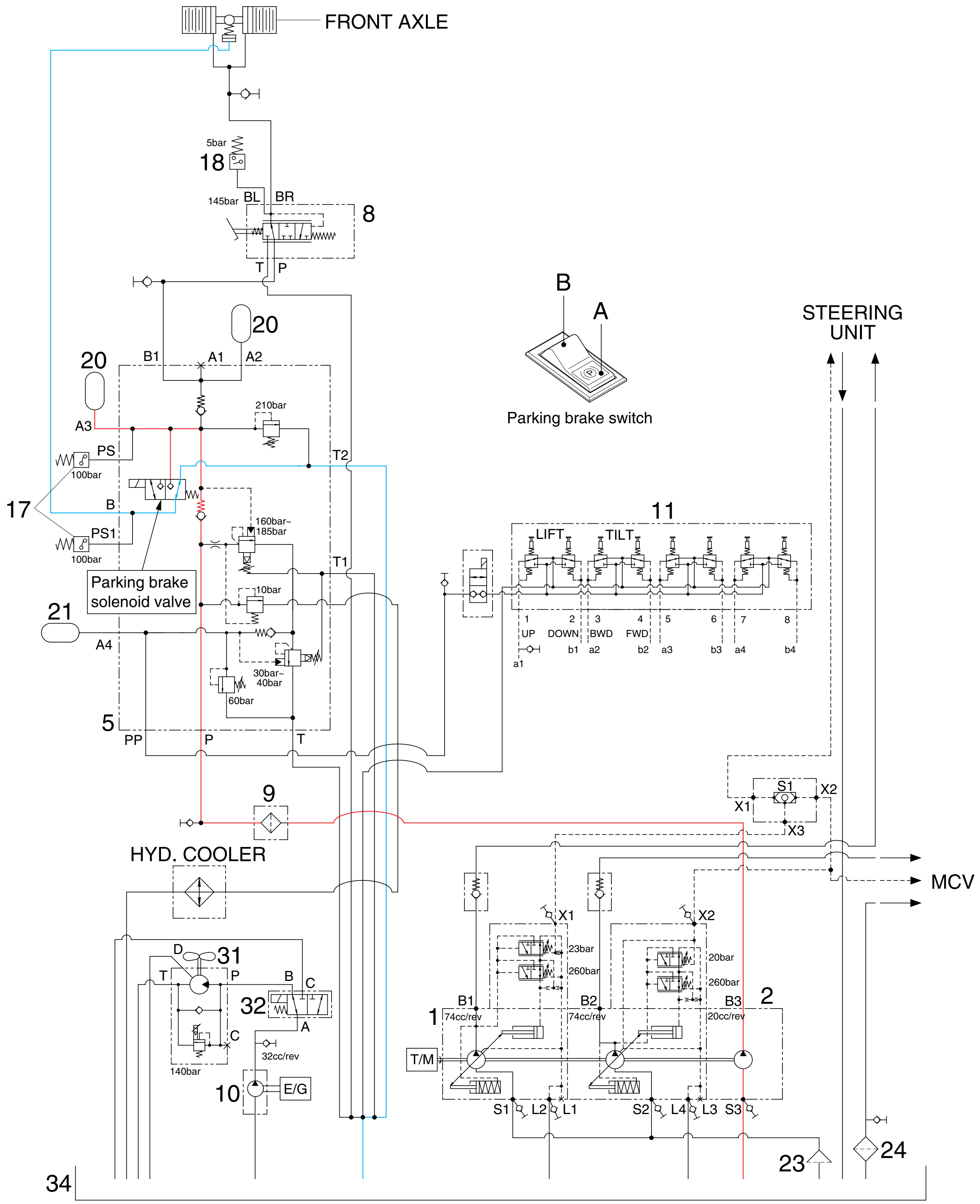
3) PARKING BRAKE RELEASED



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

Therefore, the hydraulic oil pressure is applied to the parking brake piston through the solenoid valve and the parking brake is kept released.

4) PARKING BRAKE OPERATED



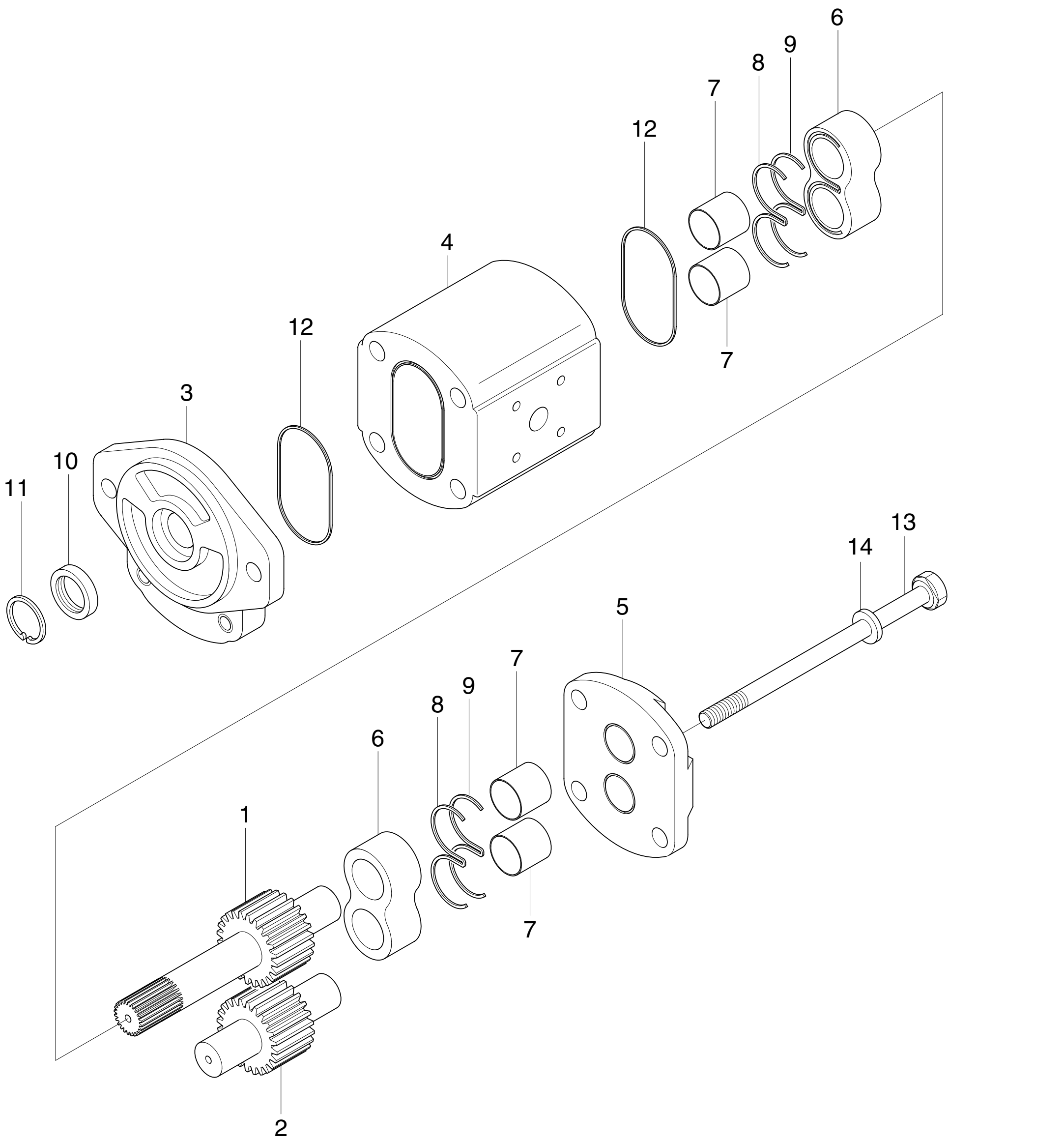
When the parking brake switch is pressed A position, the solenoid valve is deenergized and the valve open the drain port.

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

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

3. AUXILIARY PUMP (BRAKE)

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

This gear pump have a maximum delivery pressure of 170 kgf/cm^2.

The pressure loaded type gear pump is designed so that the clearance between the gear and the bushing can be automatically adjusted according to the delivery pressure. Therefore, the oil leakage from the bushing is less than that in the case of the fixed bushing type under a high discharge pressure.

Consequently, no significant reduction of the pump delivery occurs, even when the pump is operated under pressure.

2) PRINCIPLE OF OPERATION

(1) Mechanism for delivering oil

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

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

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

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

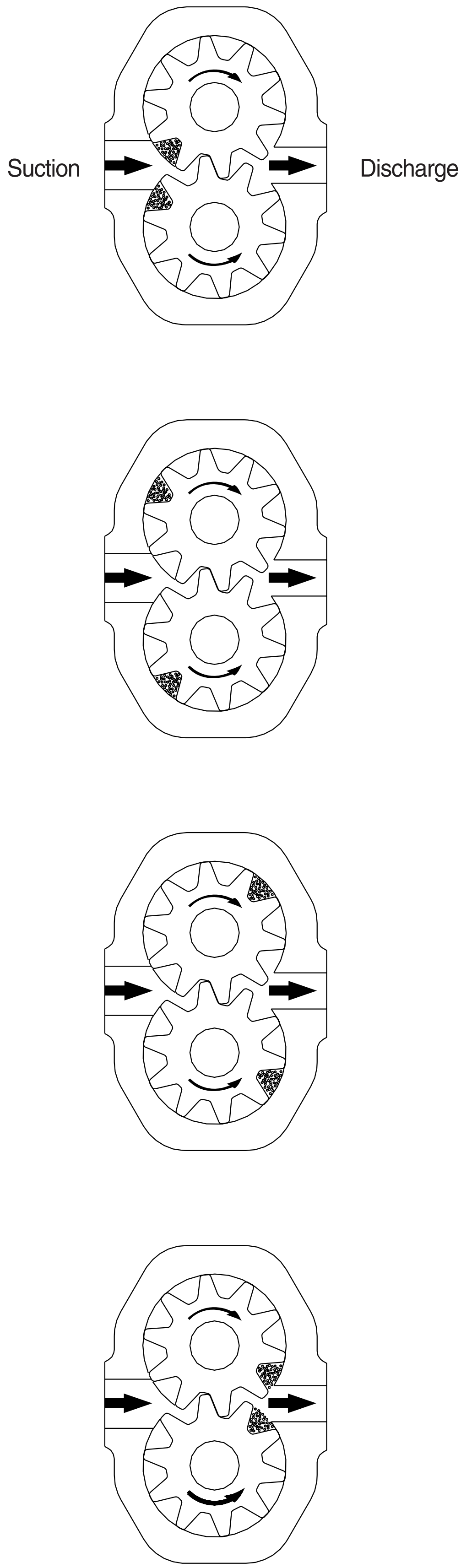
The amount of discharge increases with the speed of rotation of the gear.

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

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

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

In other words, the pressure depends on a counterpart.



(770-3ATM) 4-9

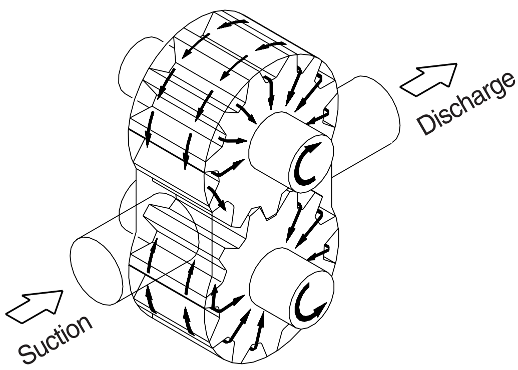
(2) Internal oil leakage

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

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

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

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



(770-3ATM) 4-10

(3) **Forces acting on the gear**

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

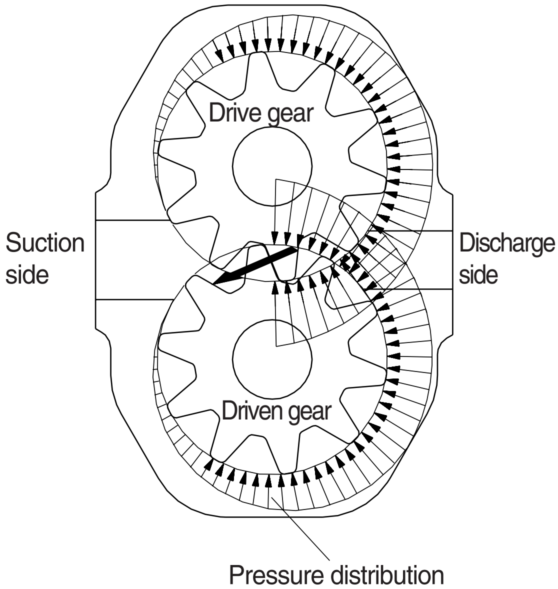
Due to the action of the delivery pressure, the oil pressure in higher on the delivery side of the pump, and due to suction pressure, is lower on the suction side. In the intermediate section, the pressure will gradually lower as the position moves from the delivery side to the suction side.

This phenomenon is shown in the drawing at right.

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

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

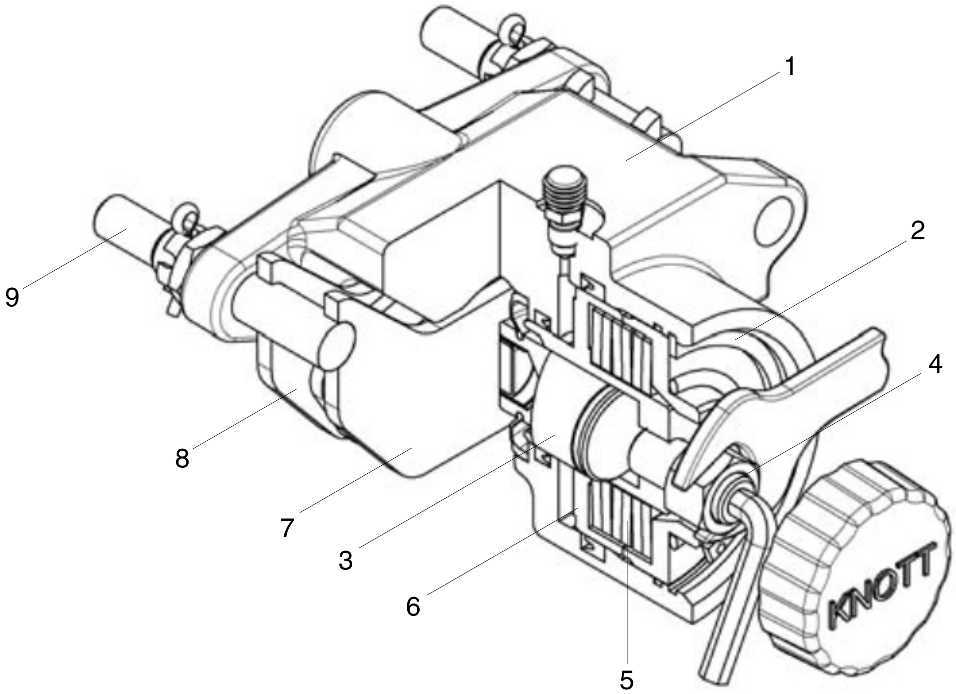
For this reason, an excessive increase in the delivery pressure must be avoided, since it will produce a large force which will act on the gears, placing an overload on the bearings, and resulting in a shortened service life of the bearing or interference of the gear with the case.



(770-3ATM) 4-11

4. PARKING BRAKE SYSTEM

1) STRUCTURE



100D7BS111

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

2) OPERATION

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

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

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

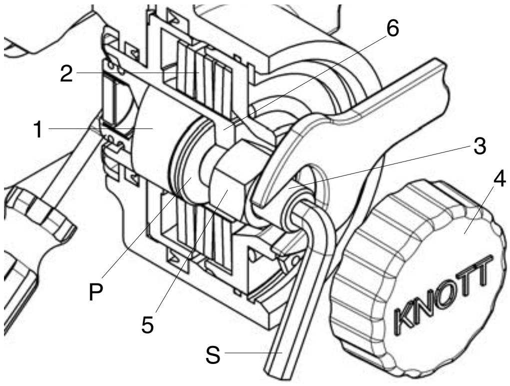
When the brake pad comes into contact with the brake disk, the reaction force shifts the housing onto the guide bolts until the brake pad is also pressed against the brake disk.

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

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

3) MOUNTING AND BASIC SETTING REGULATIONS

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



100D7BS112

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

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

(1) Mounting the brake

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

② Release the screw cap.

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

④ Mount the pressure connection again.
Apply the necessary release pressure to the brake until the bank of cup springs is completely pre-tensioned. Following carry out the following page basic setting regulation.

(2) BASIC SETTING REGULATION

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

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

Model	Adjusting screw	Clearance(mm)		Turns
250D-7E	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.

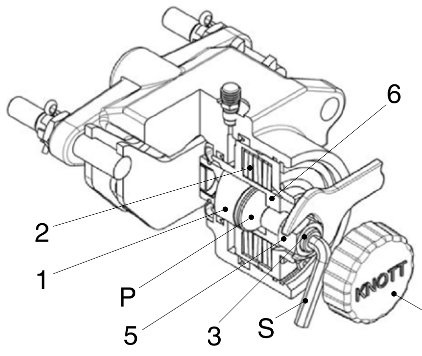
⑥ Hold the adjusting screw in position with the hexagonal socket wrench and lock with the lock nut.

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".

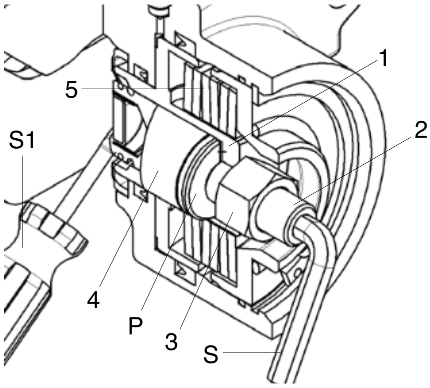
5) MAINTENANCE AND REPAIR WORK

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

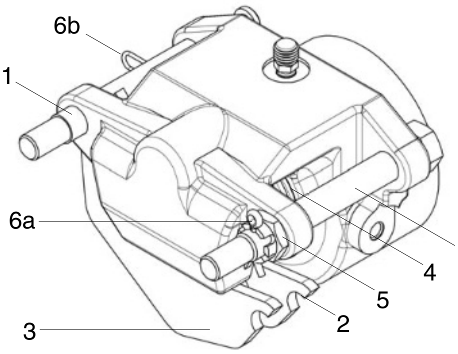


180D7EBS113

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.



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

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

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

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

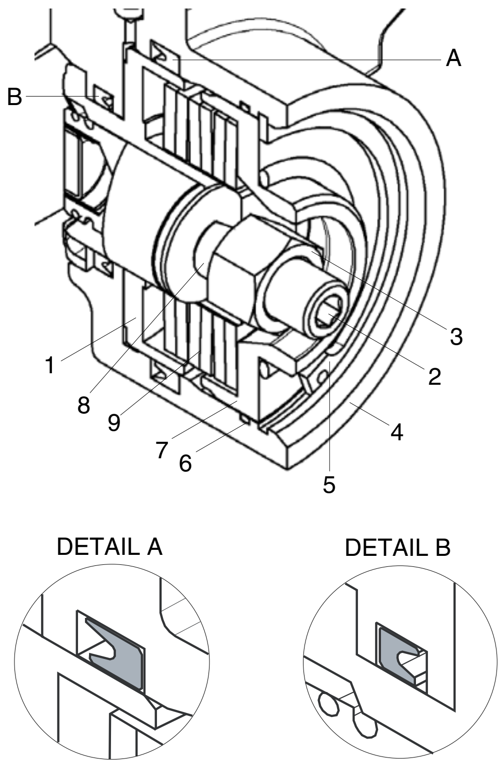
⑦ Exchange the brake pads and insert the guide bolts into the brake anchor plate. If you have removed the complete brake you have to amount the brake on both guide bolt again, now.

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

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

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

(2) Changing the seal



100D7BS115

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

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

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

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

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

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

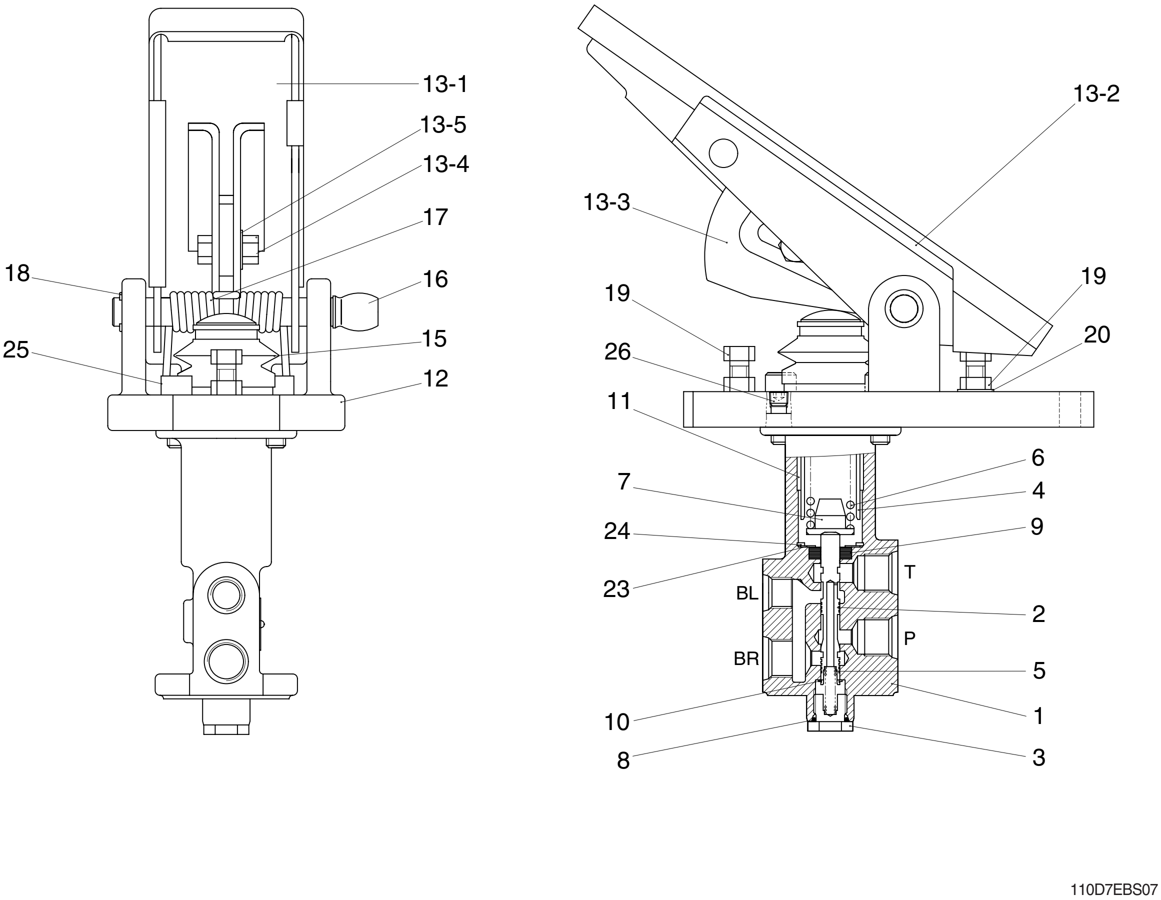
(2) General

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

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

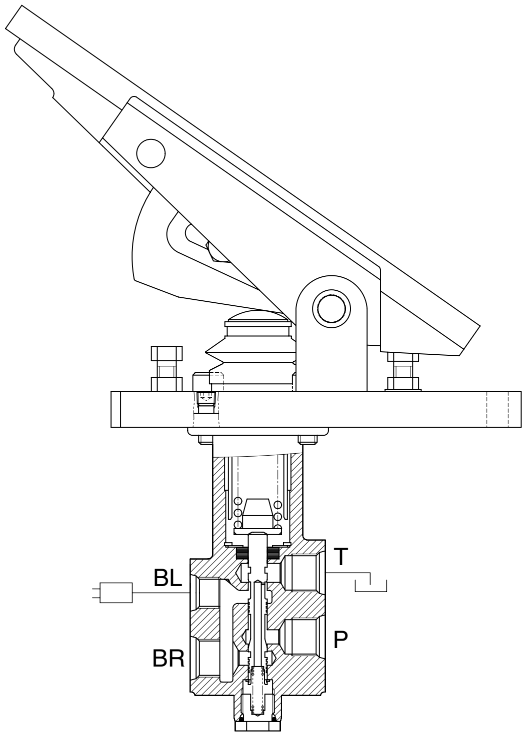
5. BRAKE VALVE

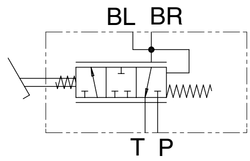
1) STRUCTURE



1	Body	11	Du bushing	17	Torsion spring
2	Spool	12	Pedal plate	18	Snap ring
3	Plug	13	Pedal assembly	19	Hexagon bolt
4	Holder(piston)	13-1	Pedal	20	Hexagon nut
5	Lower spring	13-2	Rubber	23	Plain washer
6	Main spring	13-3	Lock plate	24	Snap ring
7	Spring retainer	13-4	Hexagon bolt	25	Bolt
8	O-ring	13-5	Plate washer	26	Taper plug
9	Oil seal	15	Bellows		
10	Snap ring	16	Lock pin 1		

2) OPERATION





Hydraulic circuit

Port	Port name	Port size
P	Main pressure port	PF3/8
T	Drain port	PF3/8
BR	Brake cylinder port	PF3/8
BL	Pressure switch port	PF1/4

110D7EBS08

(1) Purpose

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

(2) Ready position

A connection is established between ports(BR) and ports(T) so that the wheel brakes ports(BR) are pressureless via the returns ports(T).

(3) Partial braking

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

The main spring(6) beneath pedal plate(12) is designed in such a way that the braking pressure changes depending on the angle. In the lower braking pressure range, the machine can be slowed sensitively.

When the braking process is commenced, the spool(2) is mechanically actuated via main spring (6). As spool(2) move downward, they will first close returns(T) via the control edges, thus establishing a connection between accumulator ports(P) and ports(BR) for the wheel brake cylinders. The foot force applied now determines the output braking pressure. The control spool(2) is held in the control position by the force applied(Spring assembly above the spool).
After output of the braking pressure, spool(2) is in a partial braking position, causing ports(P) and ports(T) to close and holding the pressure in ports(BR).

(4) Full braking position

When pedal is fully actuated, end position of the brakes is reached and a connection established between accumulator ports(P) and brake cylinder ports(BR). Returns(T) are closed at this point.

When the braking process is ended, a connection is once again established between brake cylinder ports(BR) and return ports(T), closing accumulator ports(P).

(5) Limiting the braking pressure

Pedal restriction bolt(19) on base plate below pedal is used to limit the braking pressure.

(6) Installation requirements

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

(7) Maintenance of the brake valve

No special maintenance beyond the legal requirements is necessary.

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

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

(8) Repair work

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

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

(9) Replacing the pedal cover

Pedal cover(13-2) is simply pulled of by hand. The new pedal cover is pushed over pedal(13-1) and tightened manually. Fasten the bellows with the strap retainers.

(10) Replacing the complete actuating mechanism

Carefully clamp the unit vertically in a fixture. The actuating mechanism can be removed by taking out the four bolts. Make sure that main spring (6) does not fall out. When installing the new actuating mechanism, make sure that main spring (6) is fitted in the right order.

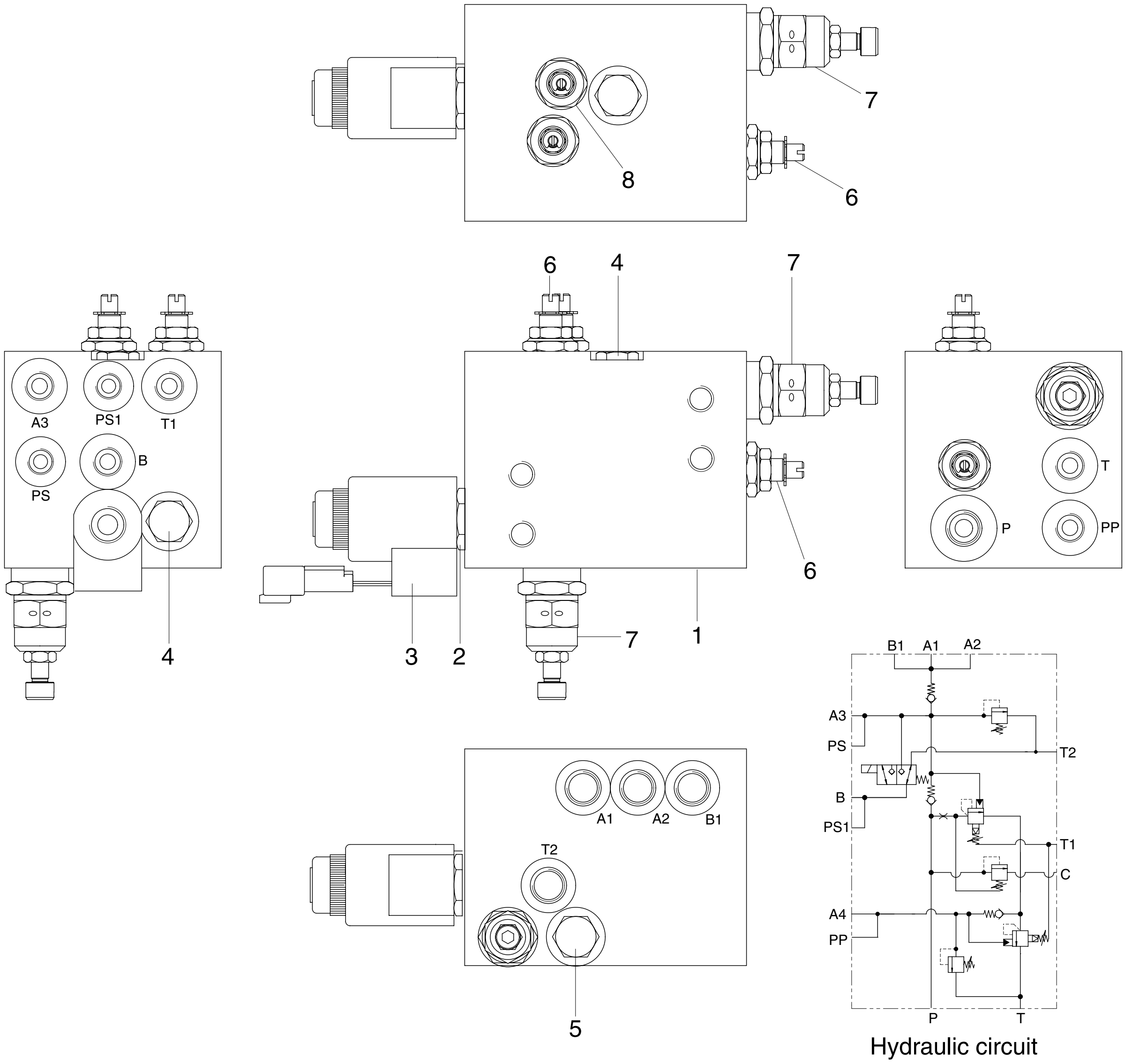
(11) Replacing the bellows

To change bellows(15) it is advisable to remove pedal(13). For this purpose, loosen retaining ring (18) and knock out pin 1(16) using a mandrill. When knocking out the bolt, make sure that the mandrill is applied to the side of the bolt without a knurl. Remove pedal(13) and bellows(15).

Now fit the new bellows and proceed in reverse order as described above. The upper portion of bellows is fastened to piston(4), its lower portion to pedal plate(12) secure the bellows using clamps.

6. CUT- OFF VALVE

1) STRUCTURE



Hydraulic circuit

180D7EBS35

1	Manifold	5	Check valve
2	Solenoid valve	6	Cut-off valve
3	Coil	7	Relief valve
4	Check valve	8	Logic valve

2) OPERATION

When the pump works, the oil under the pressure flows into P port.

The oil in P port is stored in the accumulator on A3 port.

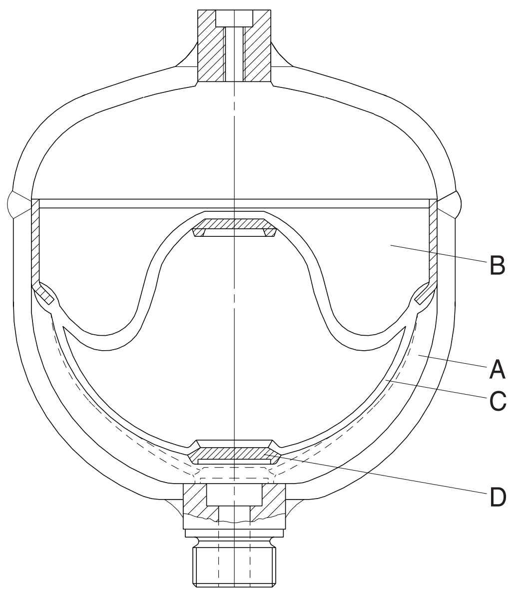
As the pressure on P line rises to 185bar, the cut off valve(1) starts cut-offing and the oil in the P port is unloaded. The pressure on P line goes down 160bar by the minute leakage from valve and other factors.

At this pressure, the cut-off valve starts cuting.

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

7. BRAKE ACCUMULATOR

1) STRUCTURE



(770-3ATM) 4-22

Item	81L1-0004	31E3-3187
Diameter	110mm	90mm
Mounting height	164mm	140mm
Nominal volume	0.7 l	0.35 l
Priming pressure	50kgf/cm^2	15kgf/cm^2
Operating medium	Oil	Oil
Operating pressure	Max 150kgf/cm^2	Max 170kgf/cm^2
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

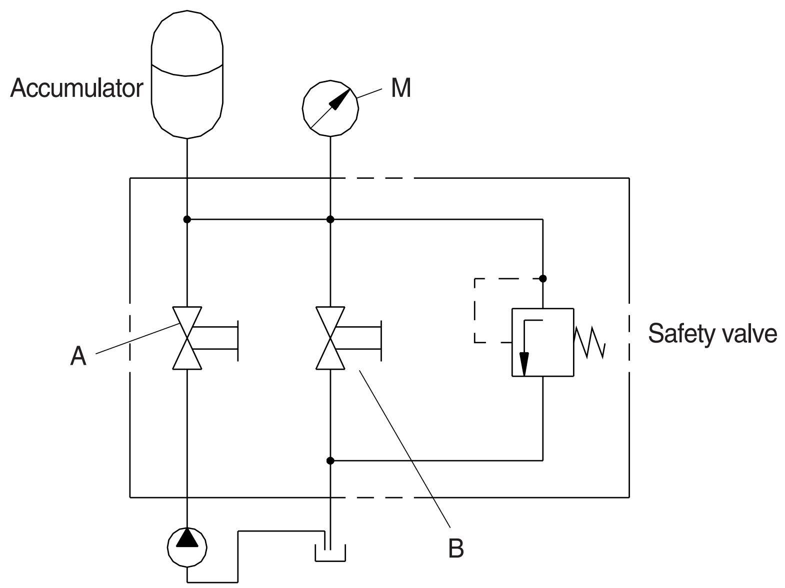
Before the accumulator is scrapped, its gas filling pressure must be reduced. For this purpose, drill a hole through gas chamber(B) using a drill approx. 3mm in diameter. The gas chamber is located on the side opposite the threaded port above the welding seam around the center of the accumulator.

※ 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.**



(770-3ATM) 4-23

(7) Repair work

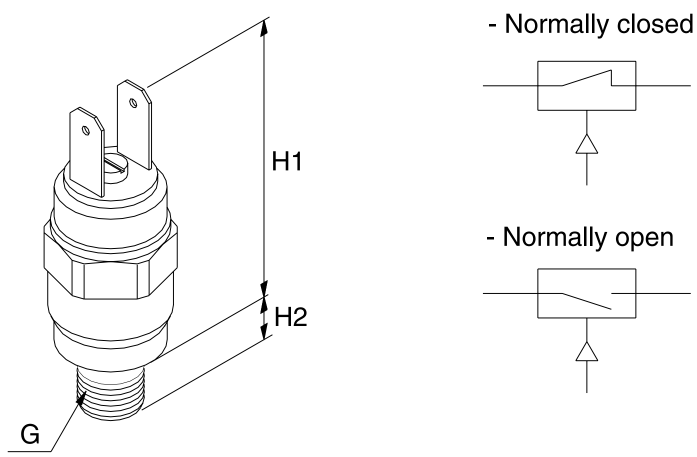
△ **When working on the braking system, always make sure that there is absolutely no pressure in the system. Even when the engine in switched off there will be some residual pressure in the system.**

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

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

8. PRESSURE SWITCHES

1) STRUCTURE



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· **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	$M12 \times 1.5$	46	9	50 ~ 150	95 ± 5	Max 42
Charging	NC	Oil	$M12 \times 1.5$	46	9	50 ~ 150	95 ± 5	Max 42
Brake stop	NO	Oil	$M12 \times 1.5$	46	9	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.**

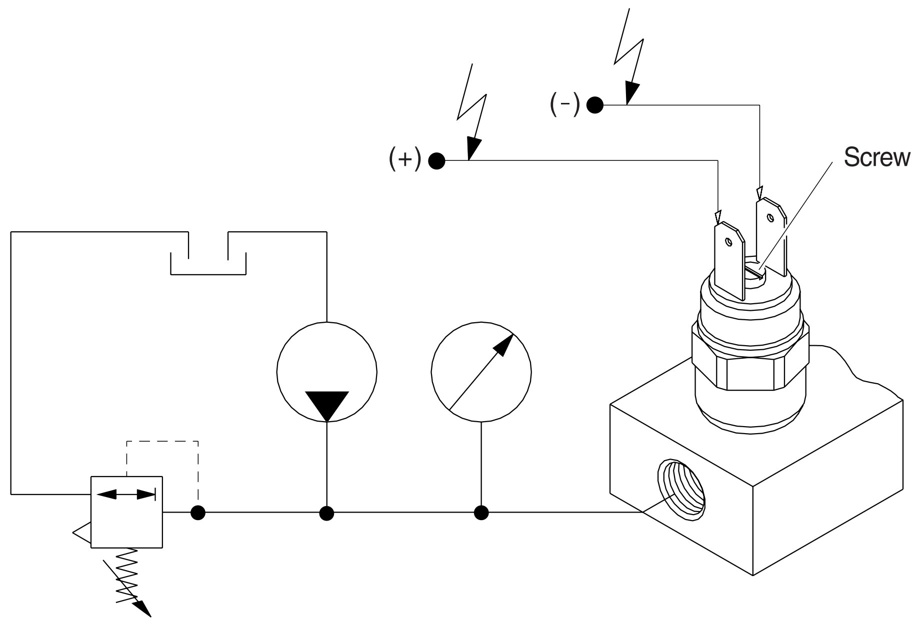
※ When doing repair work, make sure your environment is very clean.
Immediately close all open ports on the components and on pipes using plugs.

※ 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.



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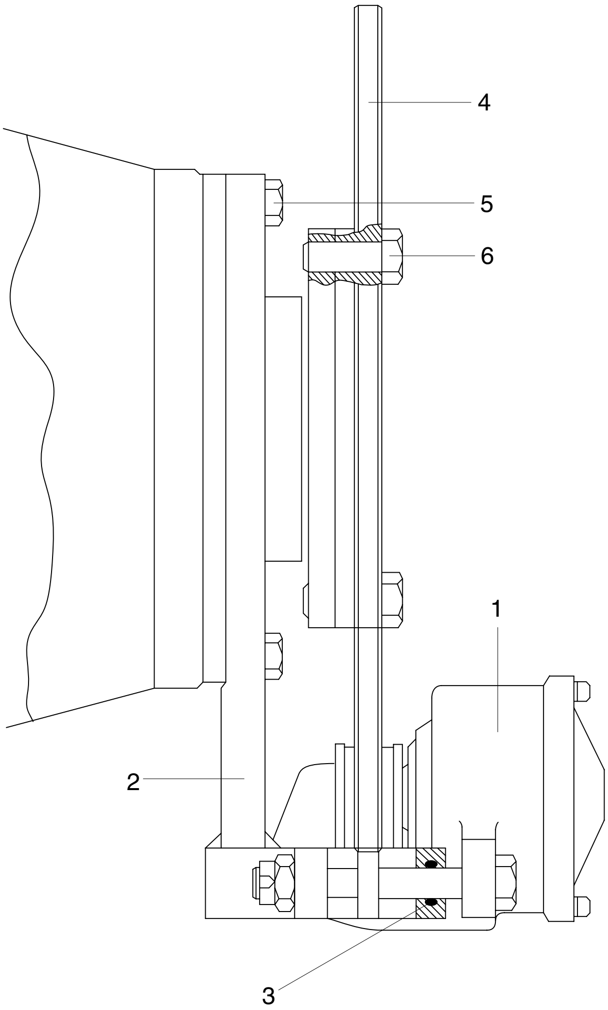
9. PARKING BRAKE



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1	Brake	4	Brake disk
2	Brake carrier	5	Hexagon screw
3	O-ring	6	Hexagon screw

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

1. OPERATIONAL CHECKS

This procedure is designed so the mechanic can make a quick check of the system using a minimum amount of diagnostic equipment. If you need additional information, read **structure and function**, Group 1.
A location will be required which is level and has adequate space to complete the checks.

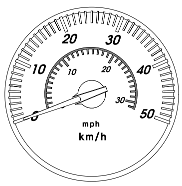
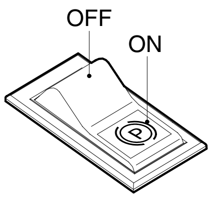
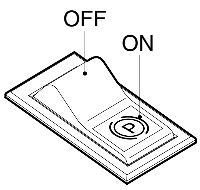
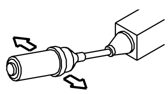
The engine and all other major components must be at operating temperature for some checks.

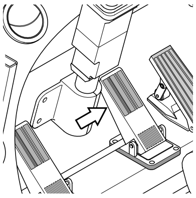
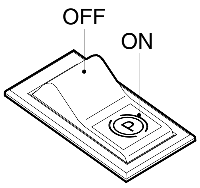
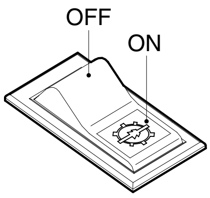
Locate system check in the left column and read completely, following the sequence from left to right. Read each check completely before performing.

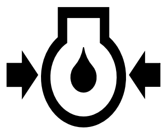
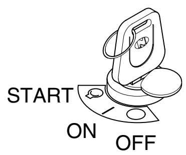
At the end of each check, if no problem is found(OK), that check is complete or an additional check is needed. If problem is indicated(NOT OK), you will be given repair required and group location.
If verification is needed, you will be given next best source of information:

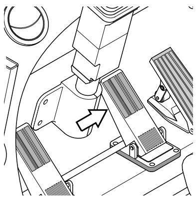
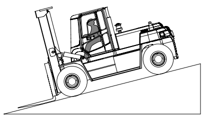
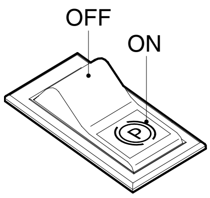
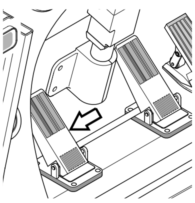
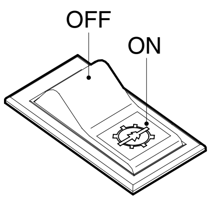
Chapter 2 : Troubleshooting
Group 3 : Tests and adjustments

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

Item	Description		Service action
Parking brake capacity check Seat belt must be worn while doing this check to prevent possible injury when machine stops suddenly.	 	Start engine. Fasten seat belt. Release parking brake and put transmission in 2nd gear forward. Drive machine at 8 km/hr and switch parking brake ON. **LOOK/FEEL** : Machine must come to a stop within 2 meters(6 feet) when parking brake is engaged at 8 km/hr. Transmission must shift to neutral.	**OK** Check completed. **NOT OK** Inspect parking brake. Go to group 3.
Parking brake transmission lockout check Engine running.	 	Turn parking brake to ON. Place transmission in 1st forward. Slowly increase engine speed to high idle. **LOOK** : Machine must not move.	**OK** Check completed. **NOT OK** Go to transmission control circuit in section 3.

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

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

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

2. TROUBLESHOOTING

1) SERVICE BRAKE

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

Step 1. Operational check out procedure(See section 1)
Step 2. Operational checks(In this group)
Step 3. Troubleshooting
Step 4. Tests and adjustments(See group 3)

Problem	Cause	Remedy
Poor or no brakes	Brake accumulator charge low	Do brake accumulator check.
	Brake pump standby pressure low	Do brake pump standby pressure test.
	Brake pressure low	Do brake valve pressure test.
	Air in system	Bleed brakes.
	Worn brake surface material	Inspect brake surface material.
	Leakage in brake valve	Do brake valve leakage test.
	Leakage in brake piston seal	Check for an over filled differential. Apply brakes and check for leakage from check plug. ※ **It is normal for the oil level to be slightly above the check plug.**
Aggressive brakes	Internal restriction in circuit	Remove lines and components.
	Clutch cut-off switch out of adjustment	Adjust switch.
	Brake valve malfunction	Disassemble and inspect.
	Low oil level	Check oil level.
Brakes drag	Brake pedal not returning properly	Inspect floor mat and pedal.
	Debris holding valve partially open in brake valve	Do brake valve pressure test.
	Warped brake disk	Inspect brake disk.
	Stuck brake piston	Repair.
Brakes lock up	Brake valve malfunction	Clean or replace brake valve.

Problem	Cause	Remedy
Brakes chatter	Air in brake system	Do brake bleed procedure.
	Worn brake surface material	Inspect brake surface material.
	Wrong oil in differential	Drain. Refill.
Hissing noise when brake pedal is held with engine stopped	Leakage in brake valve, or brake piston	Do brake system leakage test.
Brake pressure warning light will not go out or stays on excessively long after start-up	Malfunction in brake low pressure warning switch	Replace switch.
	Brake accumulator pressure too low	Recharge accumulator.
	Low brake pump standby pressure setting.	Do brake pump standby pressure test.
	Leakage in pressure reducing manifold block	Do pressure reducing valve manifold leakage test.
	Leakage in brake system	Do brake system components leakage tests.
	Worn brake pump	Do brake pump flow test.
	Leakage in parking brake solenoid	Do parking brake pressure test.

2) PARKING BRAKE MALFUNCTIONS

Problem	Cause	Remedy
Brake will not hold	Pads not adjusted correctly	Adjust parking brake.
	Malfunctioning parking brake solenoid	Inspect and replace.
	Worn brake disk and / or brake pads	Disassemble, inspect, repair.
	Brake piston hangs up in bore	Remove and inspect. Repair.
Brake disk overheats	Pads out of adjustment	Adjust parking brake.
	Brake not released	Release parking brake. Disassemble, inspect brake. Repair if necessary. Inspect for loosen or broken lines between brake pressure switch and indicator on dash.
Parking brake indicator in monitor does not come on when brake applied	Faulty wiring or switch	Inspect for loose or broken lines between brake pressure switch and indicator on dash. Inspect for a faulty indicator on dash. Replace if necessary.
Brake will not apply	Pads out of adjustment	Adjust parking brake.
	Malfunctioning wiring, switch, or solenoid	Check electric circuit.
	Restriction between brake valve and brake	Remove hose and inspect. Replace.

1. PARKING BRAKE PERFORMANCE

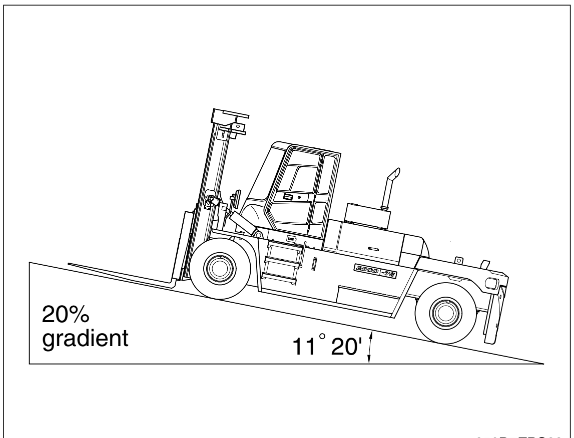
1) MEASUREMENT CONDITION

(1) Tire inflation pressure : Specified pressure

(2) Road surface : Flat, dry, paved surface with 1/5(11°20') gradient.

(3) Machine : In operating condition

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



250D7EBS33

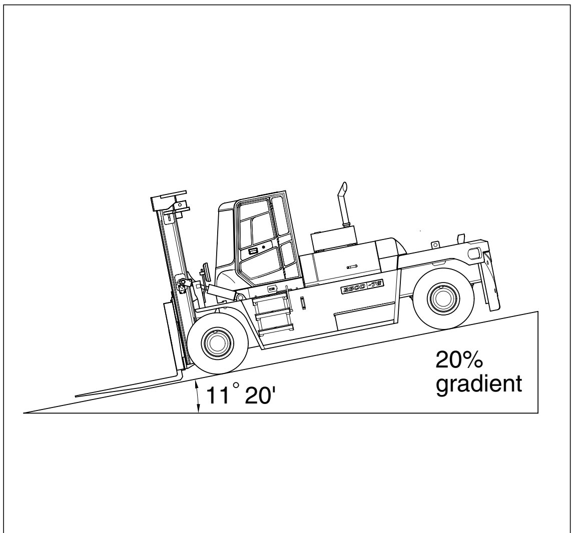
2) MEASURING PROCEDURE

(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.



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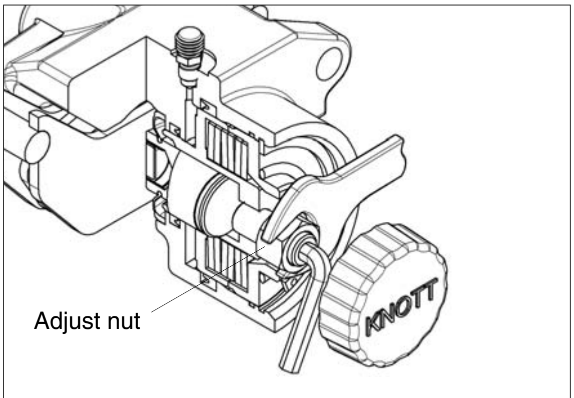
2. ADJUSTMENT OF BRAKE

1) External brake inspection

· Inspect for wear of brake pad.



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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
250D-7E	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.

2) ADJUSTING REGULATIONS

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

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

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

(3) Release the screw cap and unscrew.

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

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

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

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

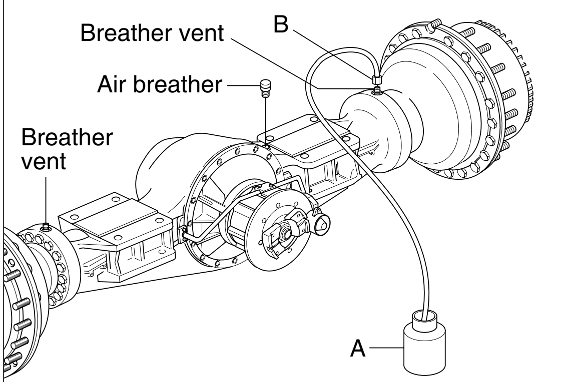
※ Actuate the brake valve several times and check the braking efficiency of the parking brake on a slope.

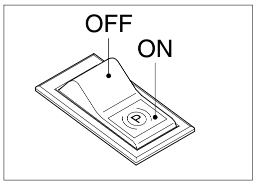
3. HYDRAULIC BRAKE BLEEDING PROCEDURE

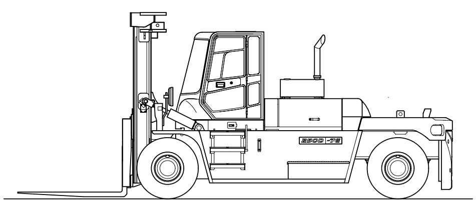
⚠ Escaping fluid under pressure can penetrate the skin causing serious injury. Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Search for leaks with a piece of cardboard. Protect hands and body from high pressure fluids.

※ If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result.
Doctors unfamiliar with this type of injury should reference a knowledgeable medical source.
Two people are required to bleed brake system oil, one to operate brake valve and other to open and close bleed screws.

1) Engage parking brake and block the tire.
2) Put a clear plastic tube on bleed screw(B) to route low to hydraulic reservoir filler tube or container(A).
3) Start engine and run at low idle.
4) Push and hold brake pedal down until brake bleeding procedure is complete.
   ※ If bubbles continue for more than 2 minutes, stop bleeding procedure.
   Check for and correct problem, then continue.
5) Open on bleed screw on differential and axle assembly until hydraulic oil starts to flow. Close bleed screw when oil is free of air. Release brake pedal.
6) Repeat steps 1-5 for each bleed screw.
7) Push either brake pedal and hold down.
8) Check hydraulic oil level.





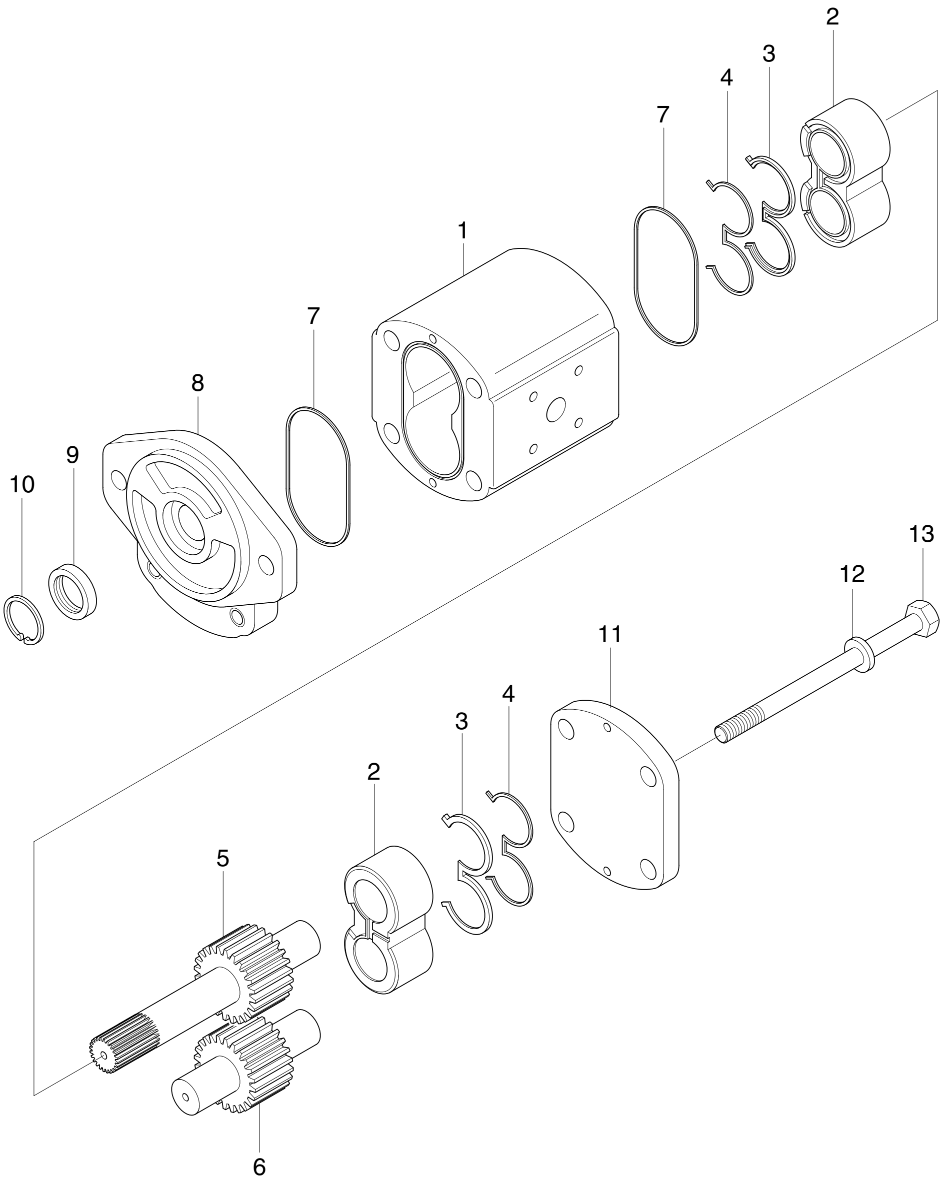


250D7EBS40

GROUP 4 DISASSEMBLY AND ASSEMBLY

1. AUXILIARY PUMP (BRAKE)

1) STRUCTURE



180D7EBP00

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

2) GENERAL INSTRUCTION

(1) Always work in a clean environment.

(2) Wash all components in solvent and blow dry with compressed air before refitting.

(3) Take care not to damage rubber seals.

(4) Avoid damaging precision machined surfaces.

(5) Components should fit into their housings without excessive force. If force is necessary, this normally means that the component does not have the correct dimensional tolerances of is aligned incorrectly.

(6) When hand pressure is insufficient, only use presses or rubber hammer to fit components.

(7) Never strike components with steel hammers.

(8) Steel bush must be fitted only with a suitable press.

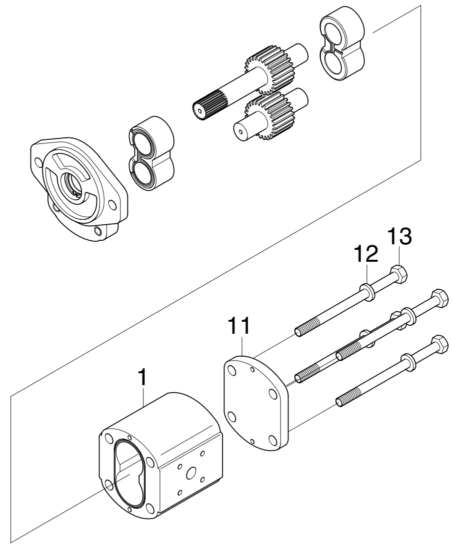
(9) Do not use hammers to fit bearings.

(10) Always respect the direction of rotation when assembling components.

3) DISASSEMBLY

(1) Loosen and remove the bolts (13) with washers (12) from the rear cover (11).

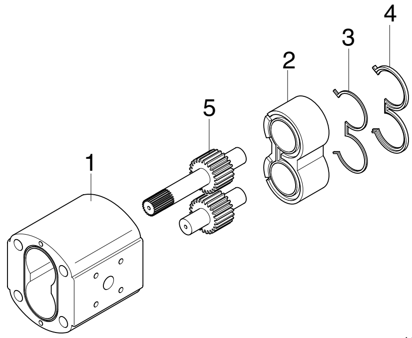
(2) Remove the rear cover (11) from the housing (1).



180D7EBP06

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

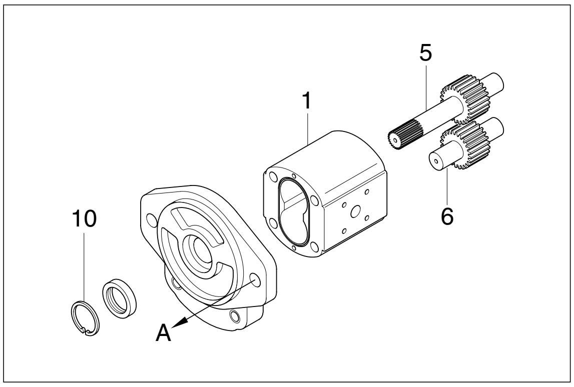
※ After removing the bush block (2) from the housing (1), clean the contacting surface of the bush block (2) with the journal of the shaft gear (5) and the drive gear (1), inspect for excessive wear, scoring or crack.



180D7EBP21

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

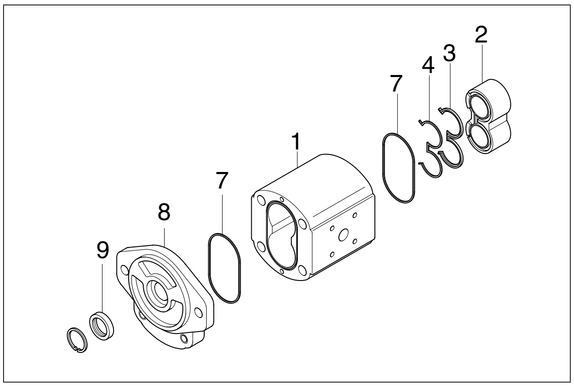
※ For the gear face of the shaft gear (5) and the driven gear (6), inspect for excessive wear, scoring or crack.



180D7EBP51

(5) Remove bush block (2), back up seal (3), channel seal (4) and O-ring (7) from the housing (1).

※ After removing the bush block (2) from the housing (1), inspect whether it is happened scratch or damage for inner surface of the housing (1).



180D7EBP52

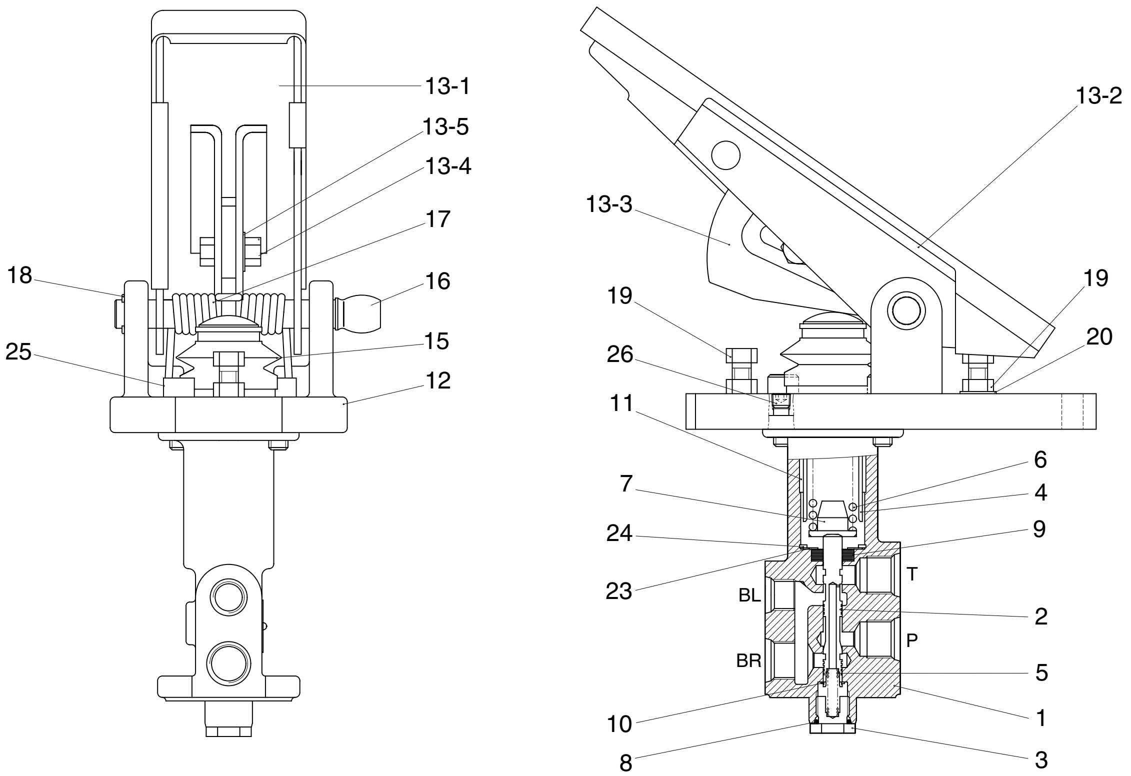
(6) Remove the retainer seal (9) from the front cover (8).

4) ASSEMBLY

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

2. BRAKE VALVE

1) STRUCTURE

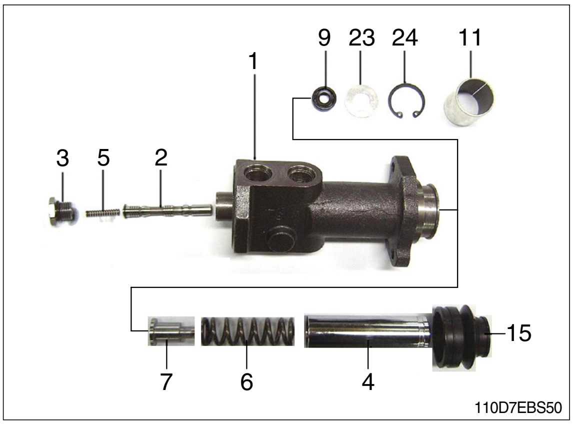


1	Body	11	Du bushing	17	Torsion spring
2	Spool	12	Pedal plate	18	Snap ring
3	Plug	13	Pedal assembly	19	Hexagon bolt
4	Holder(piston)	13-1	Pedal	20	Hexagon nut
5	Lower spring	13-2	Rubber	23	Plain washer
6	Main spring	13-3	Lock plate	24	Snap ring
7	Spring retainer	13-4	Hexagon bolt	25	Bolt
8	O-ring	13-5	Plate washer	26	Taper plug
9	Oil seal	15	Bellows		
10	Snap ring	16	Lock pin 1		

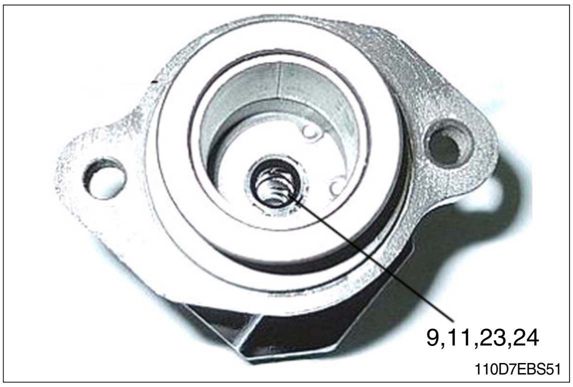
2) REASSEMBLY

(1) Body assembly

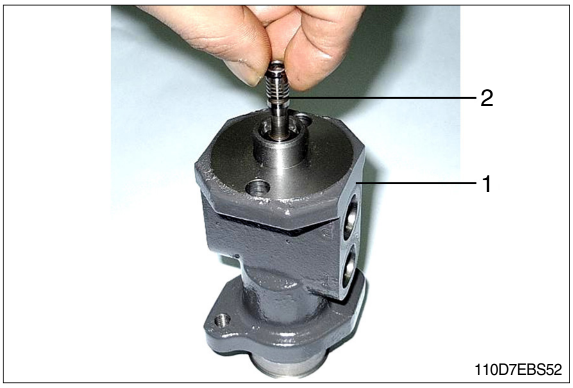
1 Body
2 Spool
3 Plug
4 Holder
5 Spring
6 Main spring
7 Spring retainer
9 Oil seal
11 DU bushing
15 Rubber cover
23 Plain washer
24 Stop ring



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



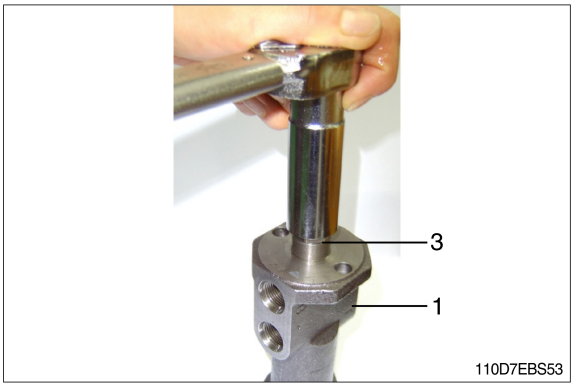
② Install spool(2) into body(1).



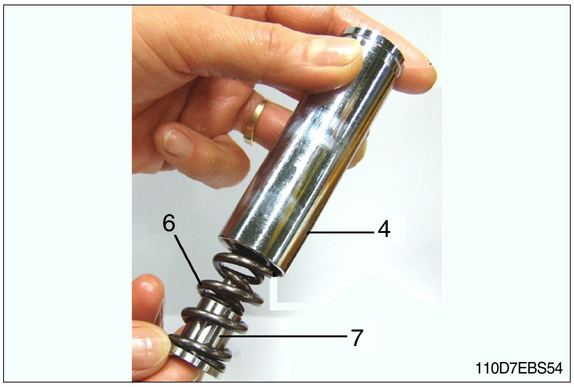
③ Tighten plug(3)
- Tool : 19mm spanner
- Tightening torque : 14.0~16.5kgf · m

⚠ **Press-in the DU bushing(11) with a exclusive jig.**

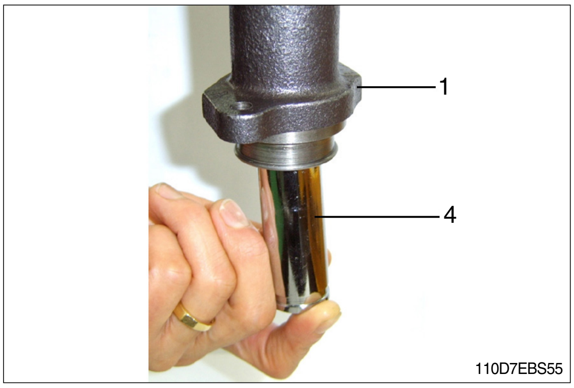
⚠ **Be careful of dust and scrap after washing the parts.**



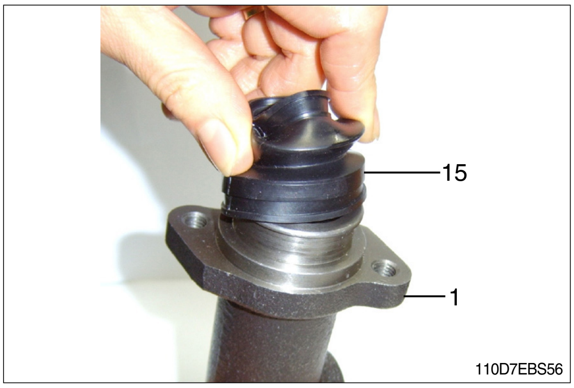
④ Spring retainer(7), main spring(6) and holder(4).



⑤ Holder(4)→Body(1)

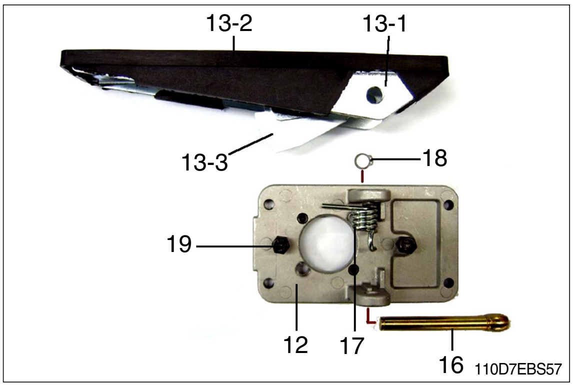


⑥ Rubber cover(15)



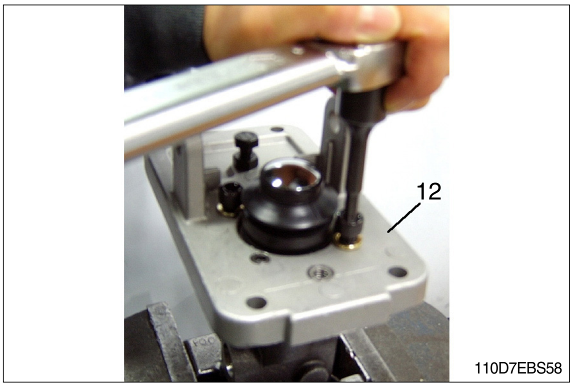
(2) Pedal plate assembly

12	Pedal plate
13-1	Pedal
13-2	Pedal cover
13-3	Lock plate
16	Lock pin(pedal)
17	Torsion spring
18	Stop ring
19	Hexagon bolt



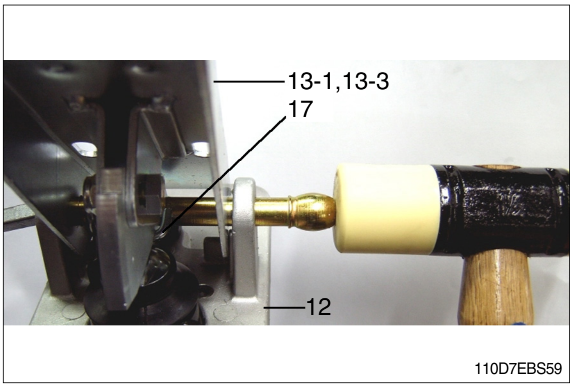
110D7EBS57

① Pedal plate(12) assembly
- Tool : 6mm torque wrench
- Tightening torque : 2.5~3.0kgf · m



110D7EBS58

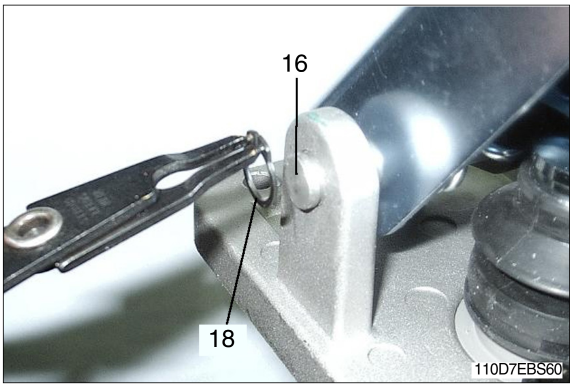
② Pre-assemble pedal assembly(13-1, 13-3) and torsion spring(17) on the pedal plate(12) with a bar of ø12 and then push the bar with a plastic hammer.
- Tool : ø12 bar, plastic hammer.



110D7EBS59

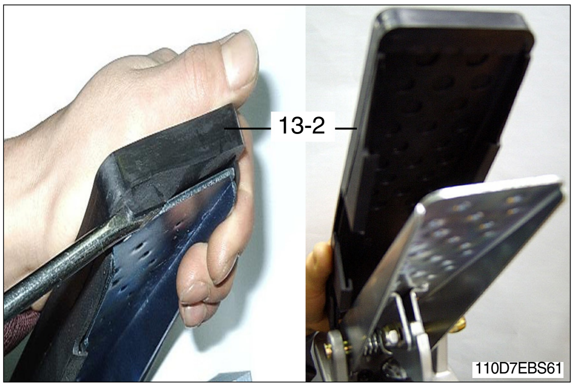
③ Lock pin(pedal)(16), stop ring(18).
- Tool : Snap ring plier for axis.

⚠ **To prevent pedal plate from being damaged stop ring(18) must be removed before removing lock pin(16).**

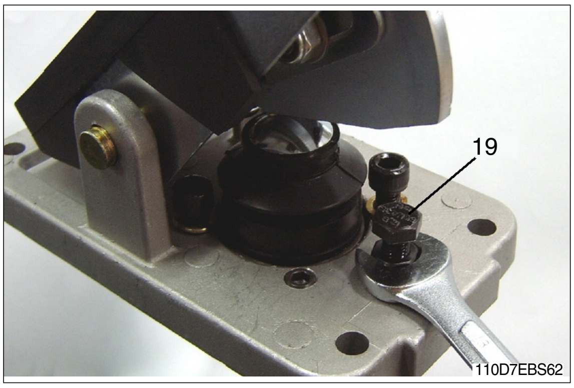


110D7EBS60

④ Rubber cover(13-2)



⑤ Hexagon bolt(19)
- Tool : 13mm spanner
- Tightening torque : 2.0kgf · m



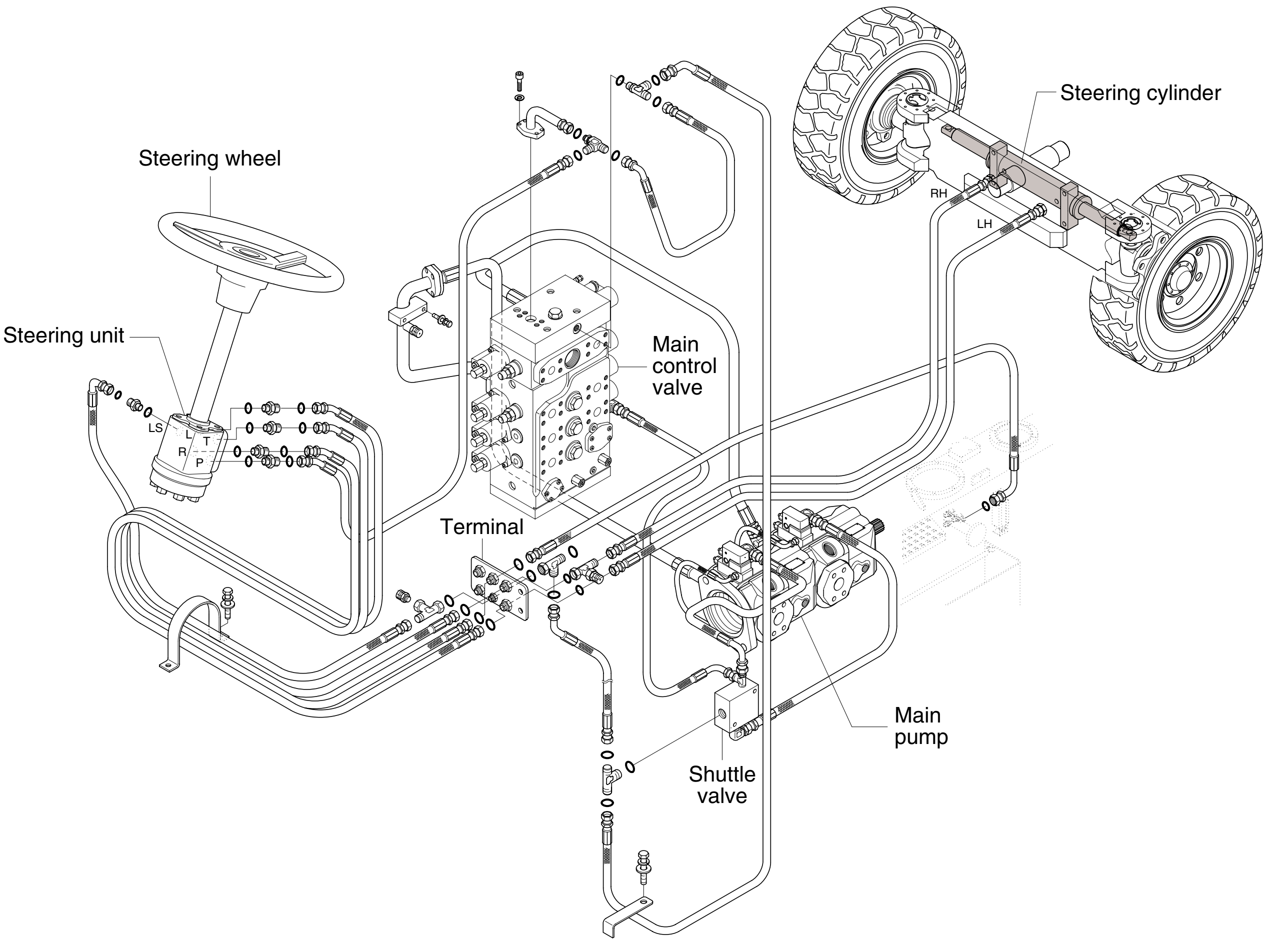
⚠ Never remove the hexagon bolt.
(Pressure setting valve deviation occurs)

SECTION 5 STEERING SYSTEM

SECTION 5 STEERING SYSTEM

GROUP 1 STRUCTURE AND FUNCTION

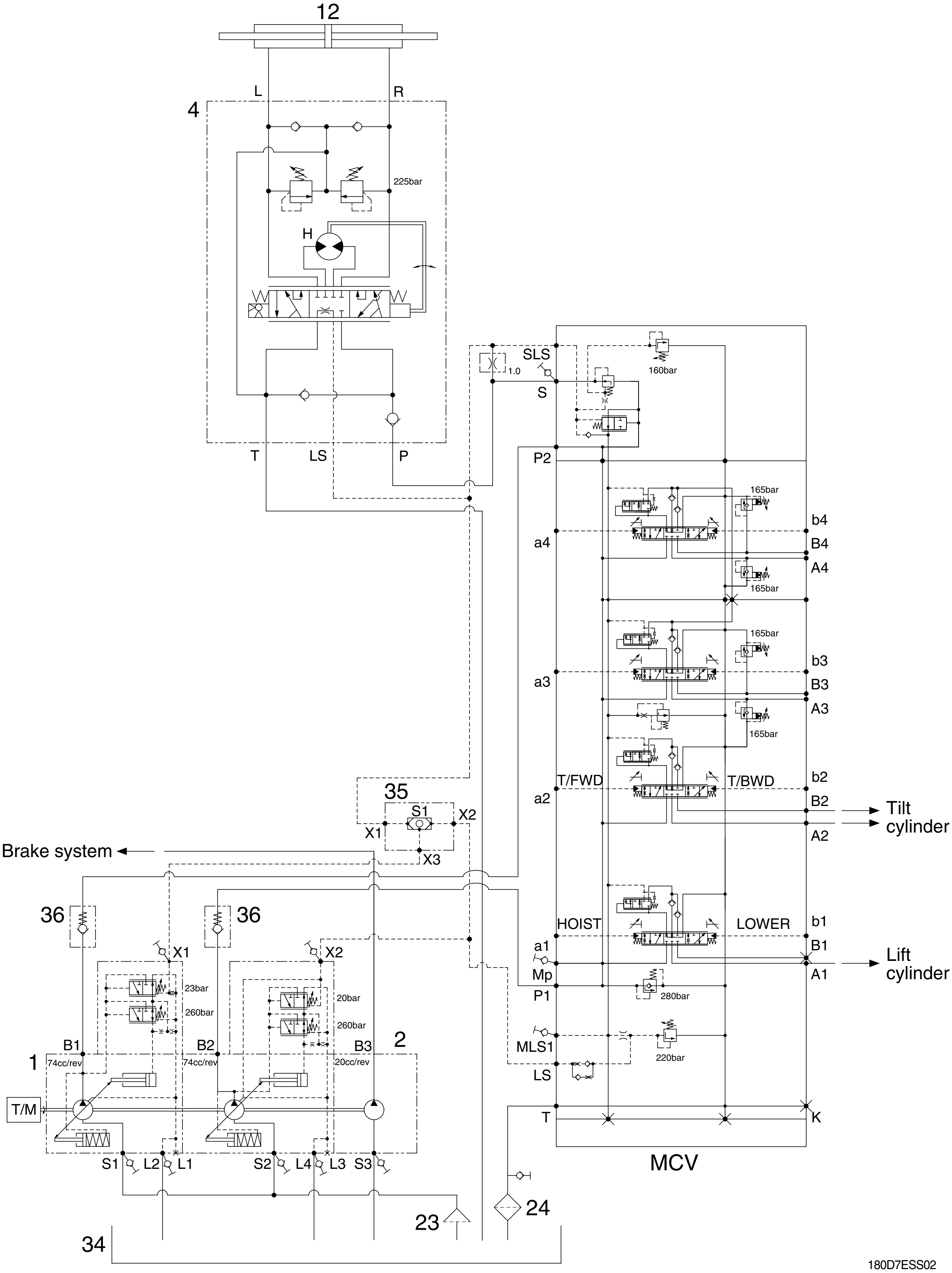
1. OUTLINE



180D7ESS01

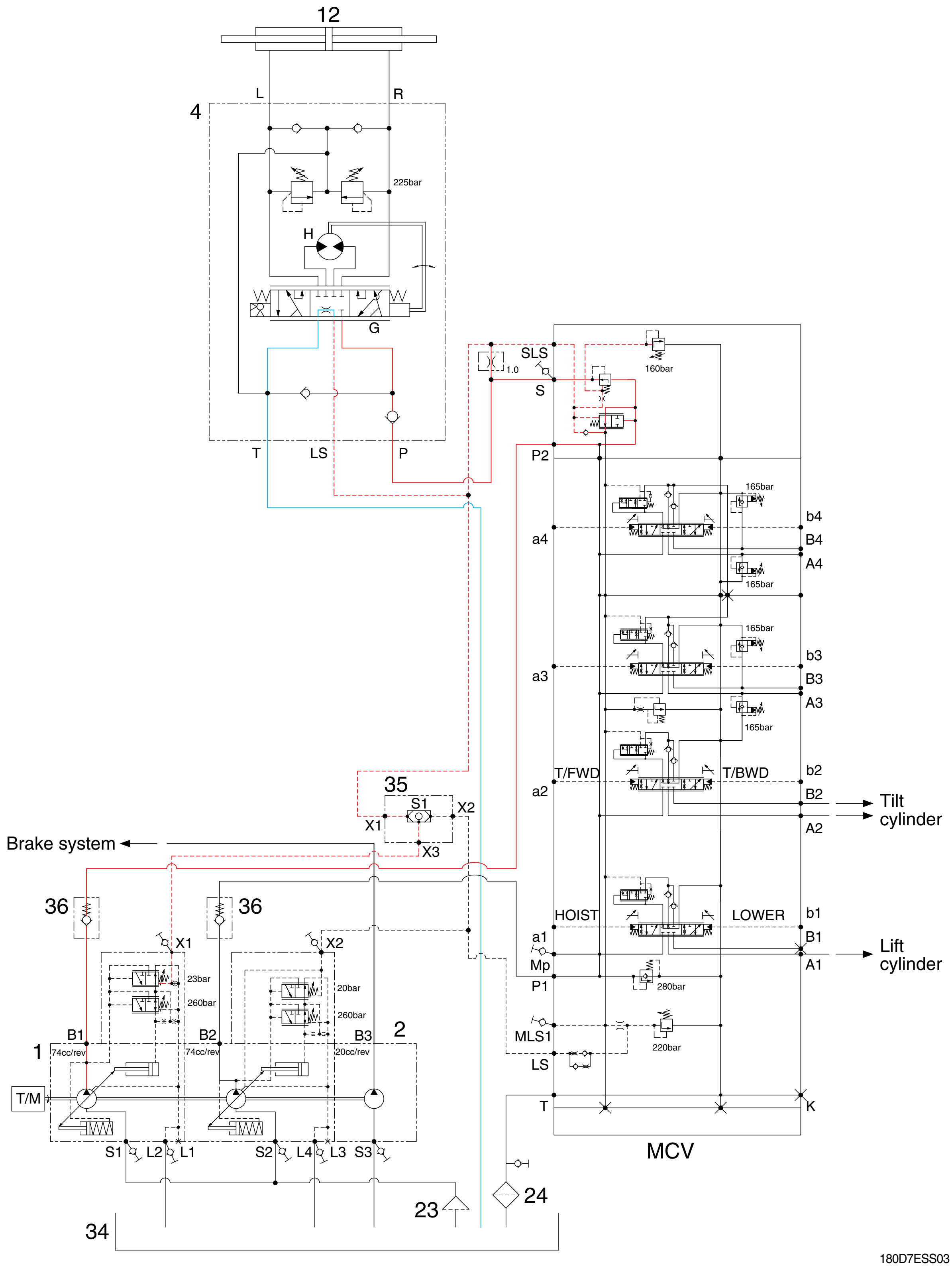
The steering system for this machine is composed of steering wheel assembly, steering unit, steering cylinder, steering axle and piping. The steering force given to the steering wheel enters the steering unit through the steering column. The required oil flow is sensed by the function of the control section of the unit, and pressurized oil delivered from the hydraulic pump is fed to the steering cylinder. The force produced by the steering cylinder moves the knuckle of steering tires through the intermediate link.
The axle body is unit structure having steering knuckles installed to its both ends by means of king pins. Hub and wheel are mounted through bearing to spindle of knuckle.

2. HYDRAULIC CIRCUIT



1	Main pump	24	Return filter
2	Auxiliary pump	34	Hydraulic tank
4	Steering unit	35	Shuttle valve
12	Steering cylinder	36	Check valve
23	Suction strainer		

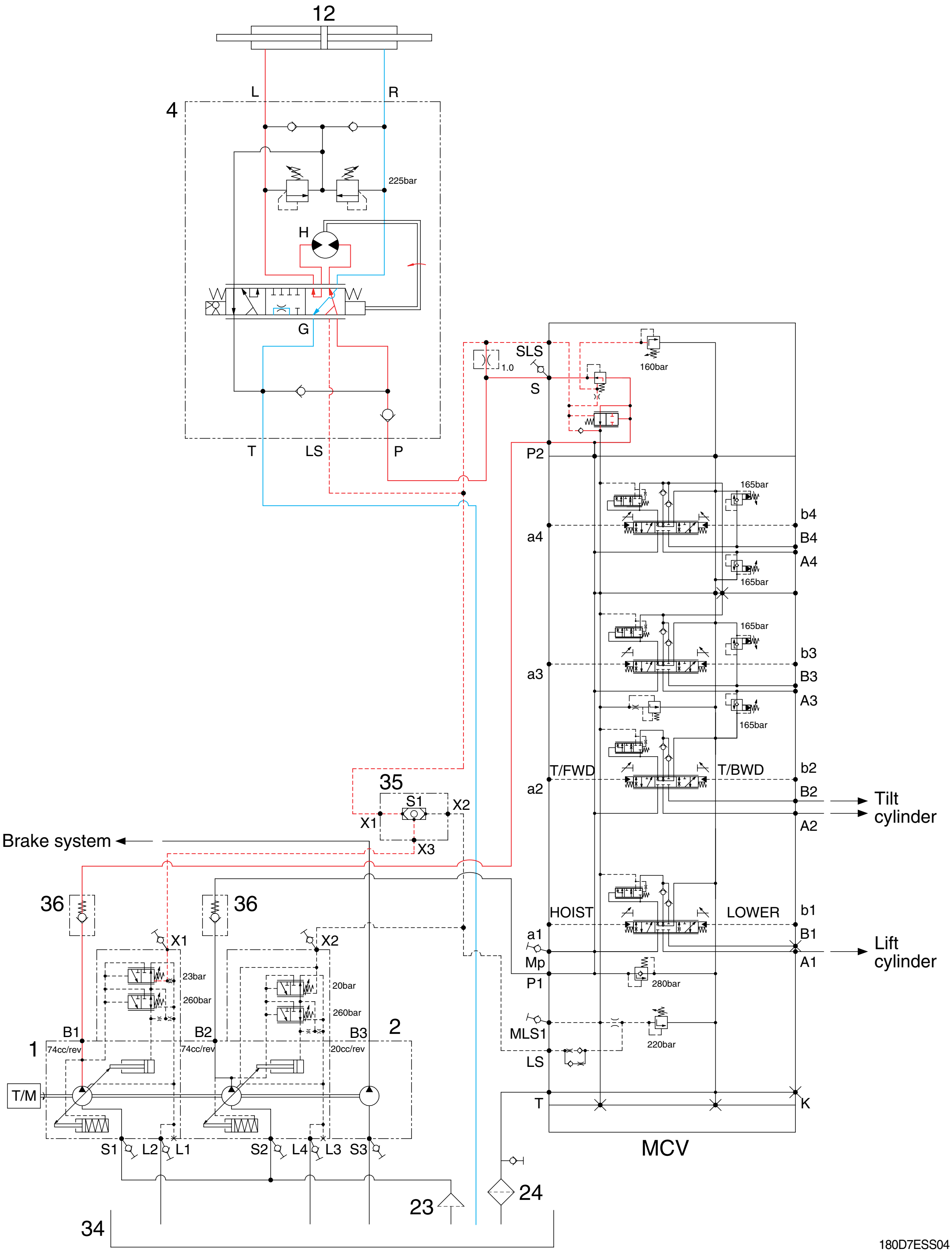
1) NEUTRAL



· 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(4) and almost all of pump flow goes to the main control valve.

2) LEFT TURN



· When the steering wheel is turned to the left, the spool(G) within the steering unit(4) connected with steering column turns in left hand direction.

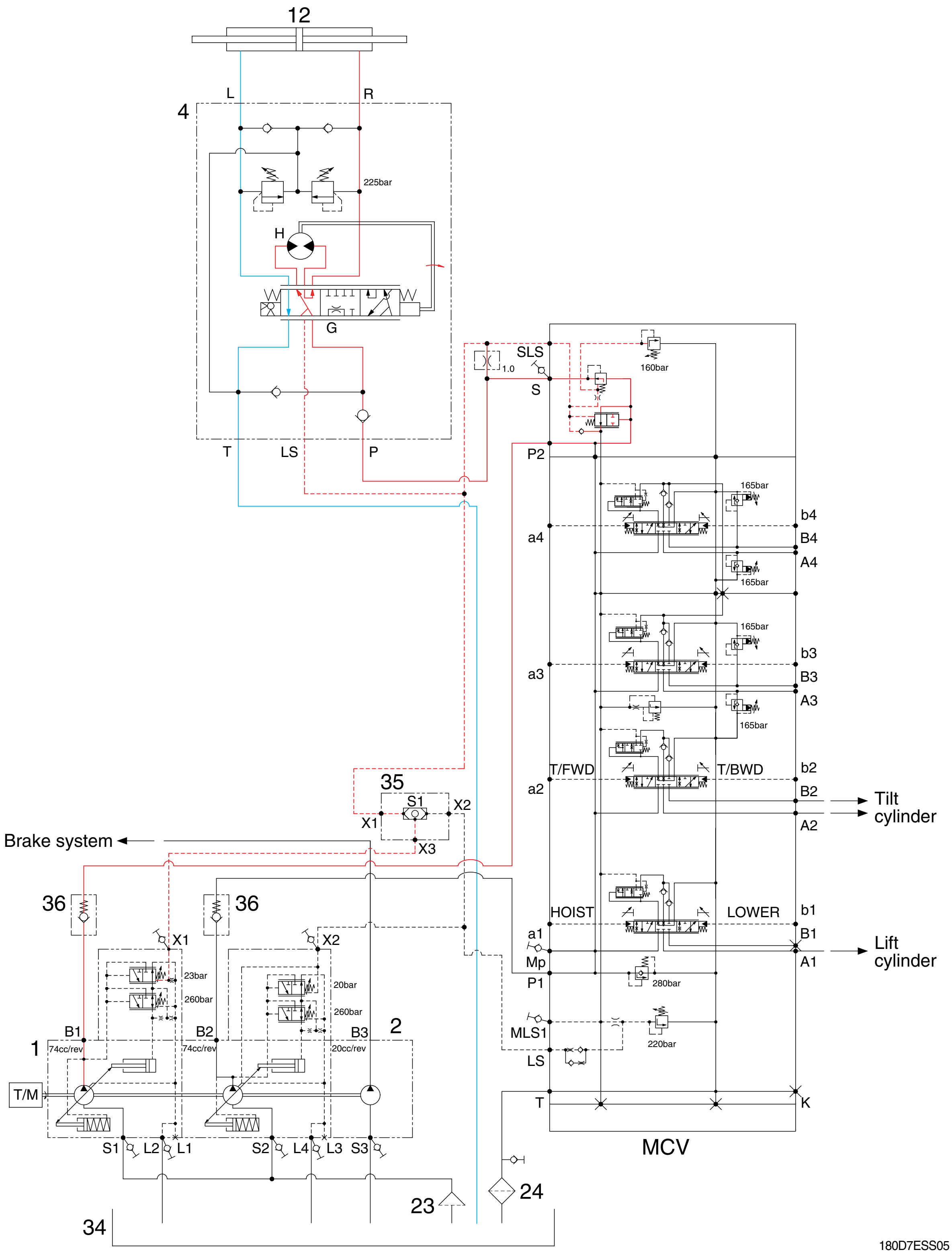
· At this time, the oil discharged from the main pump(1) flows into the spool(G) in the steering unit and flows the gerotor(H).

· 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.

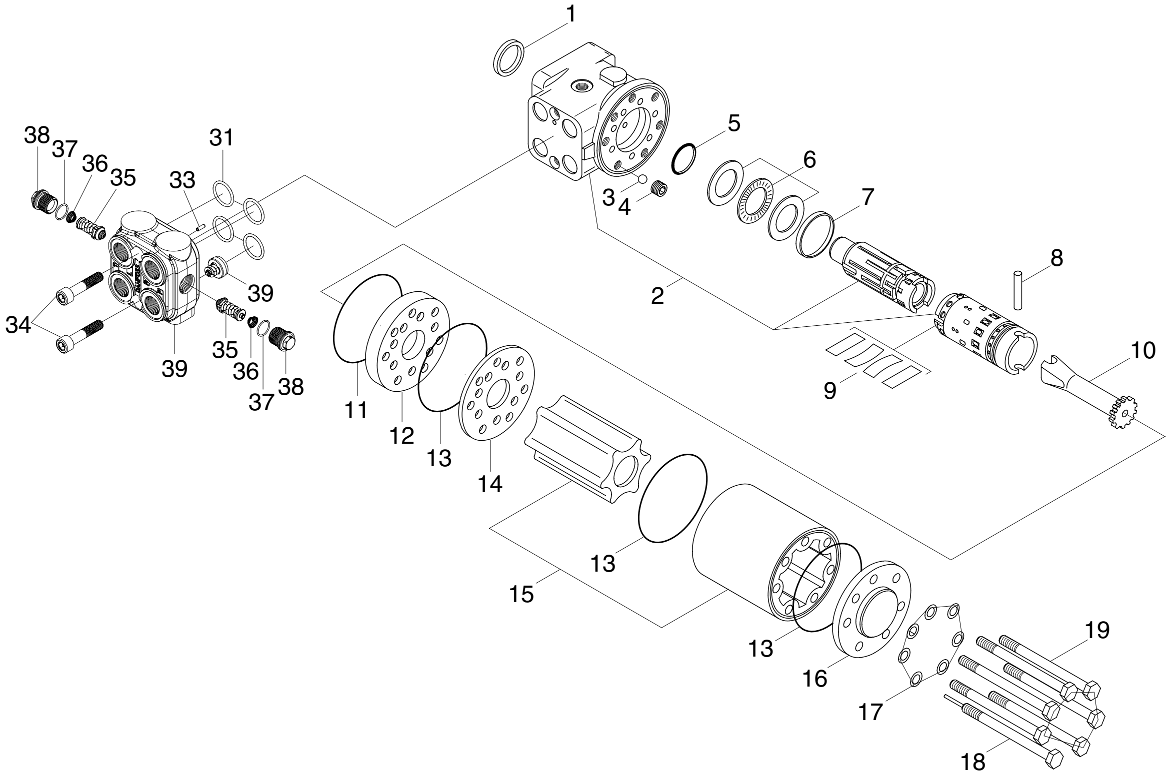
3) RIGHT TURN



· When the steering wheel is turned to the right, the spool(G) within the steering unit(4) 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 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

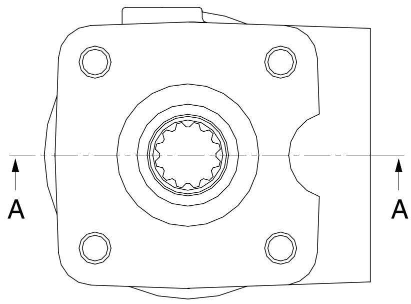
1) STRUCTURE

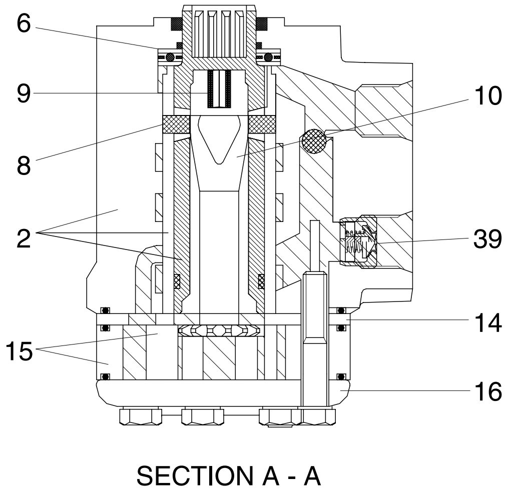


74095SE05

1	Dust seal ring	10	Cardan shaft	19	Screw
2	Housing, spool, sleeve	11	O-ring	31	Set of O-rings
3	Ball	12	Intermediate plate	33	Rolled pin
4	Thread bushing	13	O-ring	34	Screw
5	Roto glyd ring	14	Distributor plate	35	Shock valve
6	Bearing assembly	15	Gearwheel set	36	Spring
7	Ring	16	End cover	37	O-ring
8	Cross pin	17	Washer	38	Plug
9	Set of spring	18	Screw with pin	39	Housing, check valve

2) OPERATION





The steering unit consists of a rotary valve and a rotary meter.

Via a steering column the steering unit is connected to the steering wheel of the machine.

When the steering wheel is turned, oil is directed from the steering system pump via the rotary valve (spool and sleeve) and rotary meter (gear wheel set) to the cylinder ports L or R, depending on the direction of turn. The rotary meter meters the oil flow to the steering cylinder in proportion to the angular rotation of the steering wheel.

Spool is connected directly to the drive shaft (10) of steering wheel. It is connected to sleeve by cross pin (8) (not in contact with the spool when the steering wheel is at neutral) and neutral position spring (9).

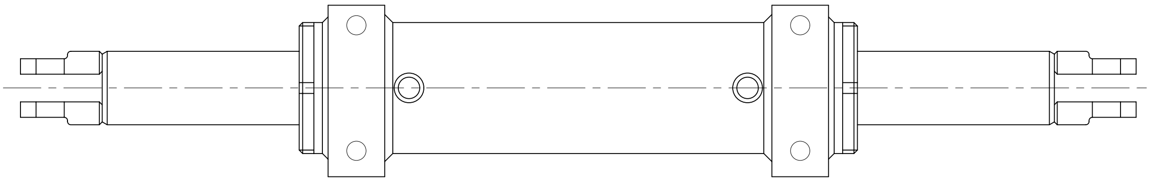
Cardan shaft (10) is meshed at the top with cross pin (8) and forms one unit with sleeve.

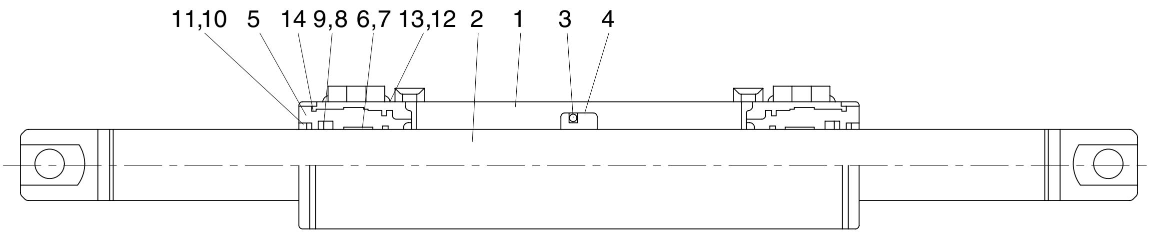
At the same time, it is meshed with gear rim of the gerotor set by spline.

There are four ports in valve body. They are connected to the pump circuit, tank circuit, and the head, and left and right steering cylinder. In addition, the pump port and tank port are connected inside the body by the check valve. Therefore, if there is any failure in the pump of engine, oil can be sucked in directly from the tank through the check valve.

4. STEERING CYLINDER

1) STRUCTURE





250D7ESS06

1	Tube assembly	6	Rod bush	11	Retaining ring
2	Rod assembly	7	Retaining ring	12	O-ring
3	Piston seal	8	U-packing	13	Back up ring
4	Wear ring	9	Back up-ring	14	O-ring
5	Rod cover	10	Dust wiper		

2) OPERATION

This machine use to cross connected cylinder for steering operation.
The steering cylinder use a rod cover(5) to remove piston and sealed seals. Dust wiper(10) located on the in side 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(8).

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.

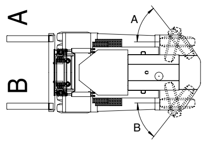
The engine and all other major components must be at operating temperature for some checks.

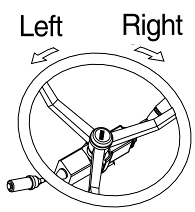
Locate system check in the left column and read completely, following this sequence from left to right. Read each check completely before performing.

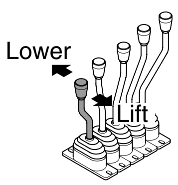
At the end of each check, if no problem is found(OK), that check is complete or an additional check is needed. If problem is indicated(NOT OK), you will be give repair required and group location. If verification is needed, you will be give next best source of information :

· Chapter 2 : Troubleshooting
· Group 3 : Tests and adjustments

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

<table>
<tr><th>Item</th><th>Description</th><th>Service action</th></tr>
<tr><td>Steering unit check</td><td>

Run engine at low idle.
Turn steering wheel until frames are at maximum right(A) and then left(B) positions.
LOOK : Frames must move smoothly in both directions.
When steering wheel is stopped, tires must stop.
FEEL : Excessive effort must not be required to turn steering wheel.
NOTE : It is normal for steering to drift from stops when steering wheel is released.</td><td>OK
Check completed.
NOT OK
Go to next check.</td></tr>
<tr><td>Steering system leakage check
Heat hydraulic oil to operating temperature.
Run engine at high idle.</td><td>

Turn steering wheel rapidly until frames are against stop.
Hold approximately 2kg on steering wheel.
Count steering wheel revolutions for 1 minute.
Repeat test in opposite direction.
LOOK : Steering wheel should rotate less than 3rpm.
NOTE : Use good judgment;
Excessive steering wheel rpm does not mean steering will be affected.</td><td>OK
Check completed.
NOT OK
Do steering system leakage test in group 3 to isolate the leakage.</td></tr>
<tr><td>Priority valve(In main pump) low pressure check</td><td>Park machine on a hard surface.
Hold brake pedal down.
Run engine at high idle.
Steer machine to the right and left as far as possible.
LOOK : Machine must turn at least half way to the right and left stops.</td><td>OK
Check completed.
NOT OK
Do priority valve pressure test.</td></tr>
<tr><td>Priority valve(In main pump) high pressure check
Run engine at high idle.</td><td>

Steer to steering stop and release steering wheel.
Lift, tilt hold over relief and observe engine rpm.
Turn steering wheel to steering stop and hold, observe engine rpm.
LOOK : Steering stall engine rpm must be higher than hydraulic stall rpm.</td><td>OK
Check completed.
NOT OK
Priority pressure is set too high. Do priority valve pressure test.</td></tr>
</table>

2. TROUBLESHOOTING

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

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

Step 2. Operational checks(In this group)

Step 3. Troubleshooting

Step 4. Tests and adjustments(See group 3)

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

Problem	Cause	Remedy
Slow or hard steering	Too much friction in the mechanical parts of the machine	Lubricate bearings and joints of steering column or repair if necessary. Check steering column installation.
	Cold oil	Warm the hydraulic oil.
	Low priority valve pressure setting	Do priority valve pressure test. Clean or replace cartridge in steering valve.
	Worn hydraulic pump	Do hydraulic pump performance check.
	Sticking priority valve spool	Remove and inspect.
	Broken priority valve spring	Remove and inspect.
Constant steering to maintain straight travel	Air in system	Check for foamy oil.
	Leakage in steering system	Do steering system leakage check.
	Worn steering unit	Do steering system leakage check. Do steering unit neutral leakage test in group 3.
	Leaf spring without spring force or broken	Replace leaf springs.
	Spring in double shock valve broken	Replace shock valve.
	Gear wheel set worn	Replace gear wheel set.
	Cylinder seized or piston seals worn	Replace defects parts.
Slow steering wheel movement will not cause any frame movement	Leakage in steering unit gerotor	Do steering system leakage check.
	Worn steering unit gerotor	Do steering leakage check.
Steering wheel can be turned with frames against steering stop	Leakage in steering system	Do steering system leakage check.
Steering wheel turns with no resistance and causes no frame movement	Broken steering column or splined coupling	Remove and inspect.
	Lack of oil in steering unit	Start engine and check steering operation.
	Leakage in steering system	Do steering system leakage test in group 3.

Problem	Cause	Remedy
Erratic steering	Air in oil Low oil level Sticking priority valve spool Loose cylinder piston Damaged steering unit	Check for foamy oil. Add recommended oil. Remove and inspect spool. Remove rod to inspect piston. Remove and inspect.
Spongy or soft steering	Air in oil Low oil level	Check for foamy oil. Add recommended oil.
Free play at steering wheel	Loose steering wheel nut Worn or damaged splines on steering column or unit	Tighten. Inspect.
Steering unit binding or steering wheel does not immediately return to neutral when released	Binding in steering column or misalignment of column High return pressure Contamination in steering unit Large particles of contamination in steering unit	Inspect. Check for a pinched or damaged return line. Inspect hydraulic filter for contamination. Repair cause of contamination. Flush hydraulic system. Inspect hydraulic filter for contamination. Repair cause of contamination. Flush hydraulic system.
Steering unit locks up	Worn or damaged steering unit	Repair or replace steering unit.
Abrupt steering wheel oscillation	Improperly timed gerotor gear in steering unit	Time gerotor gear.
Steering wheel turns by itself	Lines connected to wrong port	Reconnect lines.
Vibration in steering system or hoses jump	High priority valve setting	Do priority valve pressure test.
Neutral position of steering wheel cannot be obtained, i.e. there is a tendency towards "motoring"	Steering column and steering unit out of line Too little or no play between steering column and steering unit input shaft Pinching between inner and outer spools	Align the steering column with steering unit. Adjust the play and, if necessary, shorten the splines journal. Contact the nearest service shop.

Problem	Cause	Remedy
"Motoring" effect. The steering wheel can turn on its own.	Leaf springs are stuck or broken and have therefore reduced spring force	Replace leaf springs.
	Inner and outer spools pinch, possibly due to dirt	Clean steering unit or contact the nearest service shop.
	Return pressure in connection with the reaction between differential cylinder and steering unit too high	Reduce return pressure.
	Oil is needed in the tank	Fill with clean oil and bleed the system.
	Steering cylinder worn	Replace or repair cylinder.
	Gear wheel set worn	Replace gear wheel set.
	Spacer across cardan shaft forgotten	Install spacer.

Problem	Cause	Remedy
Backlash	Cardan shaft fork worn or broken Leaf springs without spring force or broken Worn splines on the steering column	Replace cardan shaft. Replace leaf springs. Replace steering column.
"Shimmy" effect. The steered wheels vibrate. (Rough tread on tires gives vibrations)	Air in the steering cylinder Mechanical connections or wheel bearings worn High priority valve setting pressure	Bleed cylinder. Find and remove the reason for air collection. Replace worn parts. Set pressure as regular value.
Steering wheel can be turned slowly in one or both directions without the steered wheels turning.	One or both shock valves are leaky or are missing in steering valve	Clean or replace defective of missing valves.
Steering is too slow and heavy when trying to turn quickly.	Insufficient oil supply to steering unit, pump defective or number of revolutions too low Relief valve setting too low Relief valve sticking owing to dirt Spool in priority valve sticking owing to dirt. Too weak spring in priority valve	Replace pump or increase number of revolutions. Adjust valve to correct setting. Clean the valve. Clean the valve, check that spool moves easily without spring. Replace spring by a stronger.
"Kick back" in steering wheel from system. Kicks from wheels.	Fault in the system	Contact authorized man or shop.

Problem	Cause	Remedy
Heavy kick-back in steering wheel in both directions.	Wrong setting of cardan shaft and gear-wheel set	Correct setting as shown in service manual.
Turning the steering wheel activates the steered wheels opposite.	Hydraulic hoses for the steering cylinders have been switched around	Connect lines to correct ports.
Hard point when starting to turn the steering wheel	Spring force in priority valve too weak Clogged orifices in LS side in priority valve Oil is too thick(Cold)	Replace spring by a stronger. Clean orifices in spool and in connecting plugs for LS. Let motor run until oil is warm.
Too little steering force (Possibly to one side only).	Pump pressure too low Too little steering cylinder Piston rod area of the differential cylinder too large compared with piston diameter	Correct pump pressure. Fit a larger cylinder. Fit cylinder with thinner piston rod or 2 differential cylinders.
Leakage at either input shaft, end cover, gear-wheel set, housing or top part.	Shaft defective Screws loose Washers or O-rings defective	Replace shaft seal. Tighten screws. Replace.

GROUP 3 TESTS AND ADJUSTMENTS

1. HYDRAULIC OIL CLEAN UP PROCEDURE USING PORTABLE FILTER CADDY

※ Service equipment and tool.

- Portable filter caddy
- Two 3658mm(12ft) × 1" I.D. 100R1 hoses with 3/4 M NPT ends
- Quick disconnect fittings
- Discharge wand
- Various size fittings and hoses

※ Brake system uses oil from hydraulic oil tank.
Flush all lines in the steering system.
Disassemble and clean major components for steering system.
Steering components may fail if steering system is not cleaned after hydraulic oil tank contamination.

1) If hydraulic system is contaminated due to a major component failure, remove and disassemble steering cylinders to clean debris from cylinders.

2) Install a new return filter element. Clean filter housing before installing new element.

※ For a failure that creates a lot of debris, remove access cover from hydraulic oil tank. Drain and clean hydraulic oil tank of fill the specified oil to hydraulic oil tank through upper cover.

3) To minimize oil loss, pull a vacuum in hydraulic oil tank using a vacuum pump. Connect filter caddy suction line to drain port at bottom of hydraulic oil tank using connector. Check to be sure debris has not closed drain port.

4) Put filter caddy discharge line into hydraulic oil tank filter hole so end is as far away from drain port as possible to obtain a through cleaning of oil.

5) Start the filter caddy. Check to be sure oil is flowing through the filters.
Operate filter caddy approximately 10 minutes so oil in hydraulic oil tank is circulated through filter a minimum of four times.

※ Hydraulic oil tank capacity 268 ℓ (71U.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.

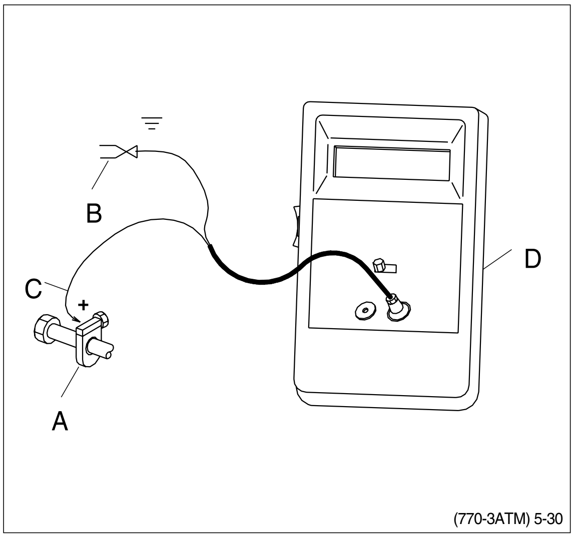
9) Install a new return filter element.

10) Check oil level in hydraulic oil tank ; Add oil if necessary.

2. TEST TOOLS

1) CLAMP-ON ELECTRONIC TACHOMETER INSTALLATION

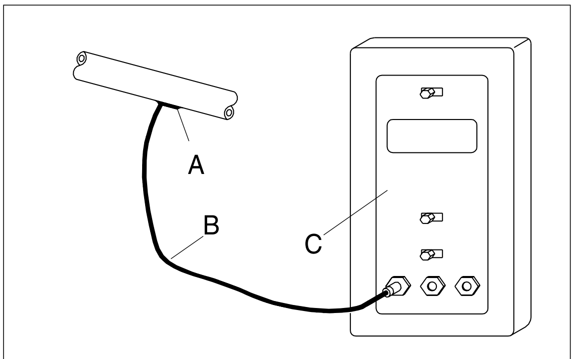
· Service equipment and tools
  Tachometer
  A : Clamp on tachometer.
  Remove paint using emery cloth and connect to a straight section of injection line within 100mm(4in) of pump. Finger tighten only-do not over tighten.
  B : Black clip(-). Connect to main frame.
  C : Red clip(+). Connect to transducer.
  D : Tachometer readout. Install cable.



(770-3ATM) 5-30

2) DIGITAL THERMOMETER INSTALLATION

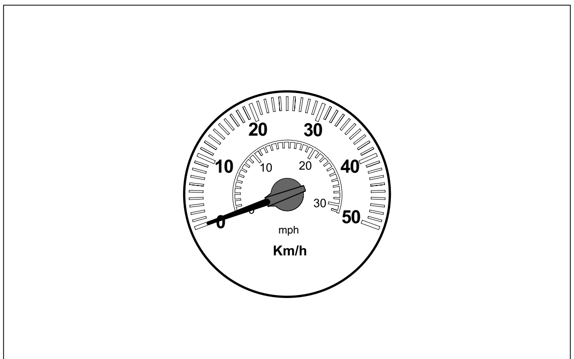
· Service equipment and tools
  Digital thermometer
  A : Temperature probe.
  Fasten to a bare metal line using a tie band. Wrap with shop towel.
  B : Cable.
  C : Digital thermometer.



(770-3ATM) 5-30

3) DISPLAY MONITOR TACHOMETER

The display monitor tachometer is accurate enough for test work.



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3. STEERING UNIT LEAKAGE TEST

· **SPECIFICATION**

Oil temperature　45±5°C(113±9°F)

Engine speed　High idle

Maximum leakage　7.5 ℓ/min(2gpm)

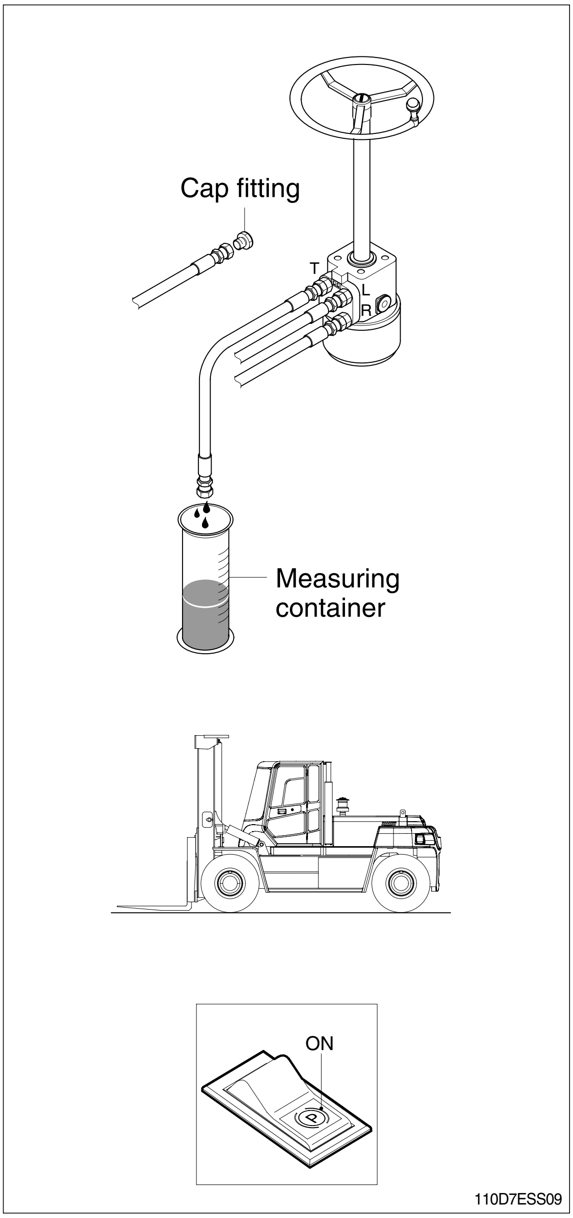
· **GAUGE AND TOOL**

Temperature reader

Measuring container(Approx. 20 ℓ)

Stop watch

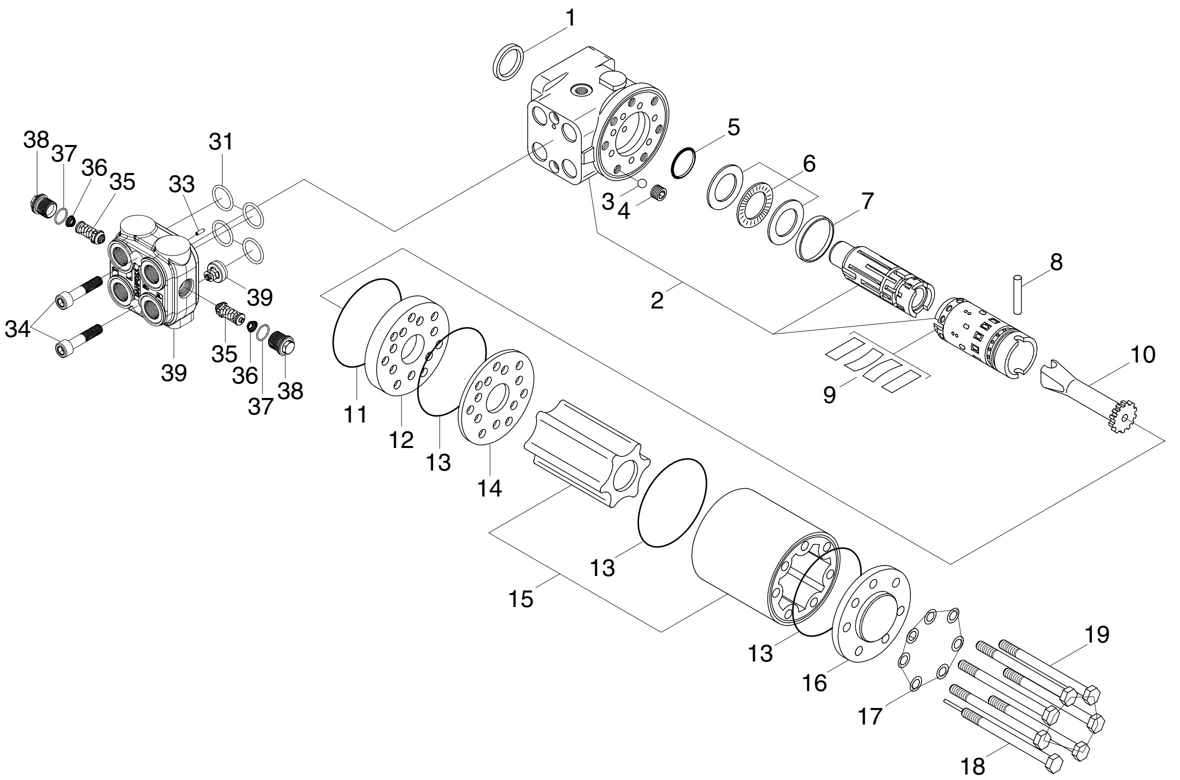
1) Install temperature reader.
(See temperature reader installation procedure in this group).
2) Heat hydraulic oil to specifications.
3) Disconnect return hose from fitting.
Install cap fitting.
4) Run engine at specifications. Rotate steering wheel completely to the right (or left) approximately 1.2kgf · 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

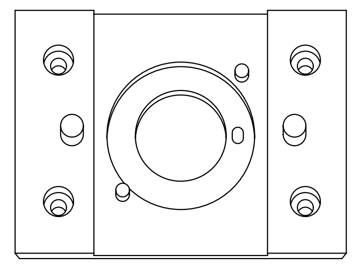
1) STRUCTURE



1	Dust seal ring	10	Cardan shaft	19	Screw
2	Housing, spool, sleeve	11	O-ring	31	Set of O-rings
3	Ball	12	Intermediate plate	33	Rolled pin
4	Thread bushing	13	O-ring	34	Screw
5	Roto glyd ring	14	Distributor plate	35	Shock valve
6	Bearing assembly	15	Gearwheel set	36	Spring
7	Ring	16	End cover	37	O-ring
8	Cross pin	17	Washer	38	Plug
9	Set of spring	18	Screw with pin	39	Housing, check valve

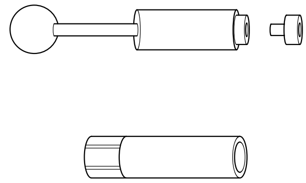
2) TOOLS

(1) Holding tool.



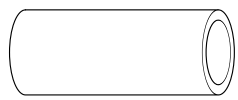
7405S STVLV38(1)

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



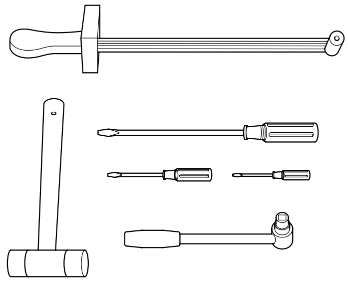
7405S STVLV38(2)

(3) Assembly tool for dust seal.



7405S STVLV38(3)

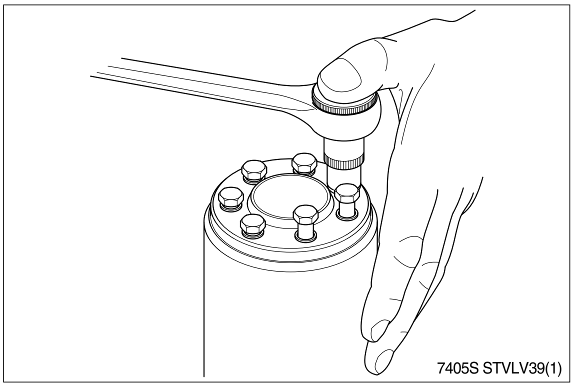
(4) Torque wrench 0-7.1kgf · m (0-51.6lb · ft).
13mm socket spanner
12mm screwdriver
6mm screwdriver
2mm screwdriver
Plastic hammer
Ratchet spanner



7405S STVLV38(4)

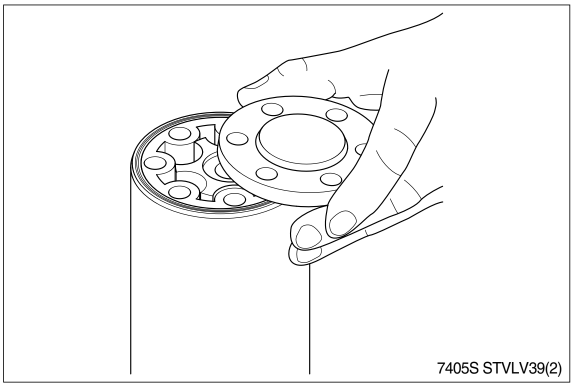
3) DISASSEMBLY

(1) Disassemble steering column from steering unit and place the steering unit in the holding tool. Screw out the screws in the end cover (7-off-one rolled pin).



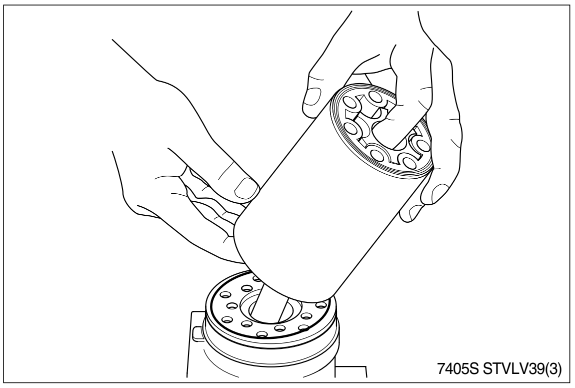
7405S STVLV39(1)

(2) Remove the end cover, sideways.



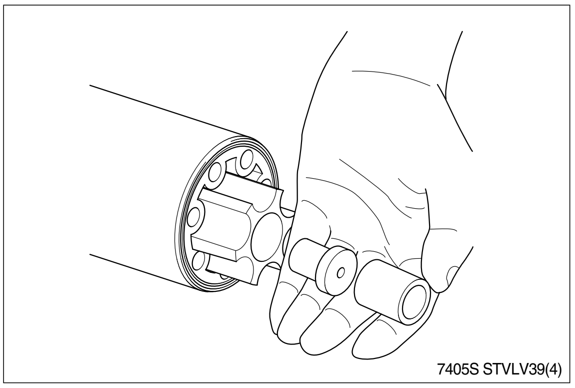
7405S STVLV39(2)

(3) Lift the gearwheel set with spacer bushing (and spacer if fitted) off the unit. Take out the two O-rings.



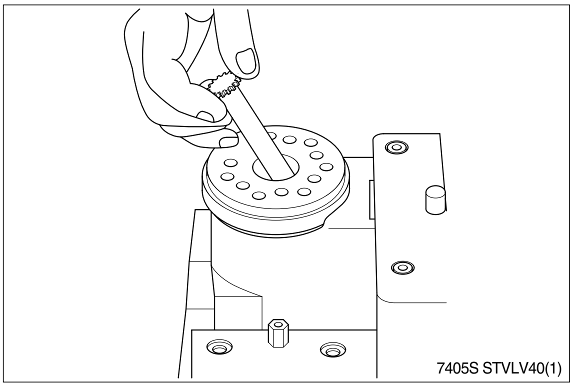
7405S STVLV39(3)

(4) Remove spacer bushing and spacer(if fitted) from the gearwheel.



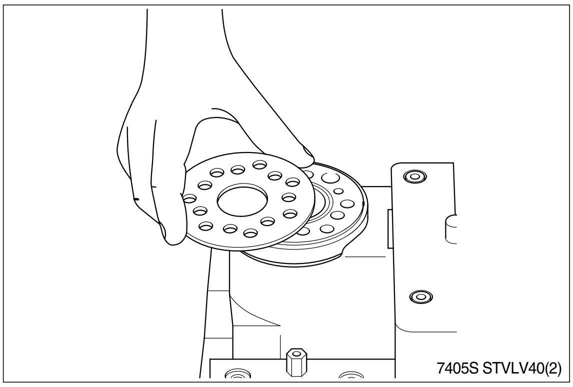
7405S STVLV39(4)

(5) Remove cardan shaft.



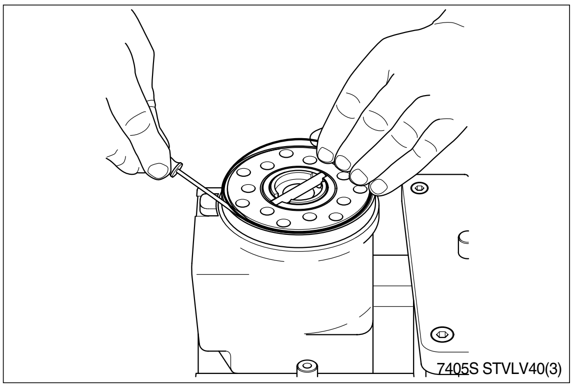
7405S STVLV40(1)

(6) Remove distributor plate.



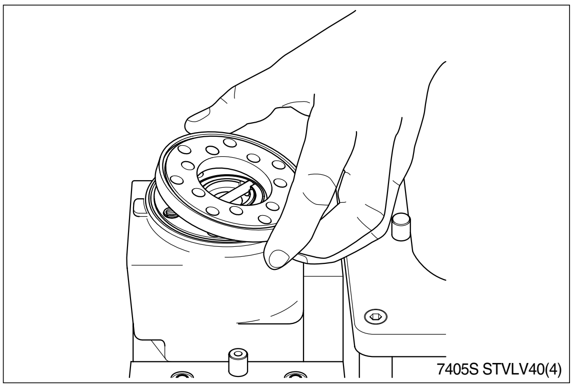
7405S STVLV40(2)

(7) Remove O-ring.



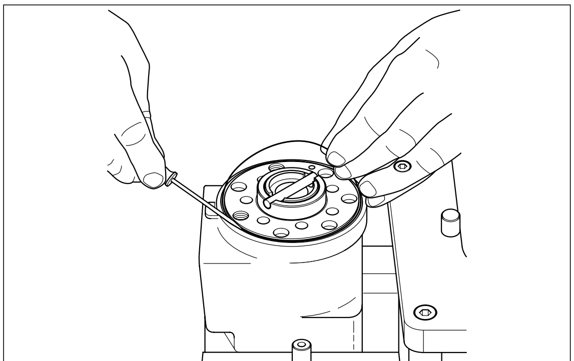
7405S STVLV40(3)

(8) Lift off intermediate plate.



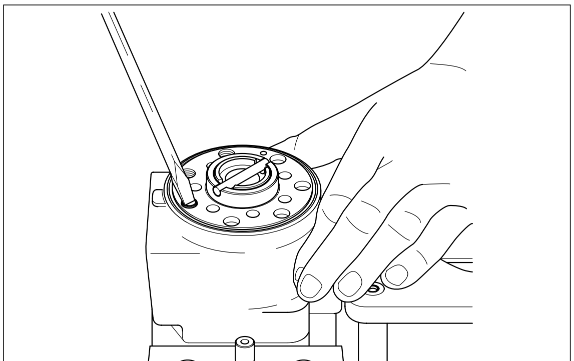
7405S STVLV40(4)

(9) Remove O-ring.



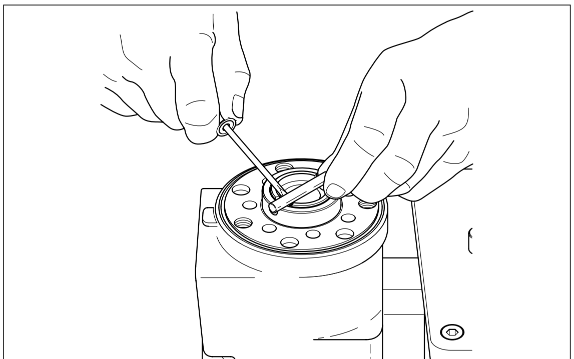
7405S STVLV41(1)

(10) Screw out the threaded bushing.



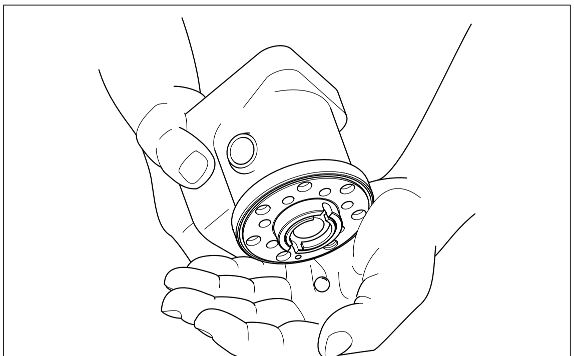
7405S STVLV41(2)

(11) Remove cross pin.



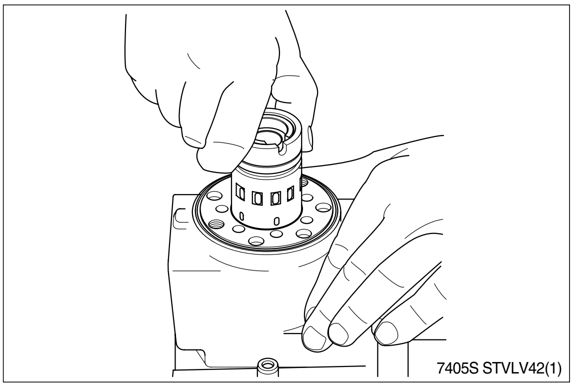
7405S STVLV41(3)

(12) Shake out the ball (ø 8.5 mm).



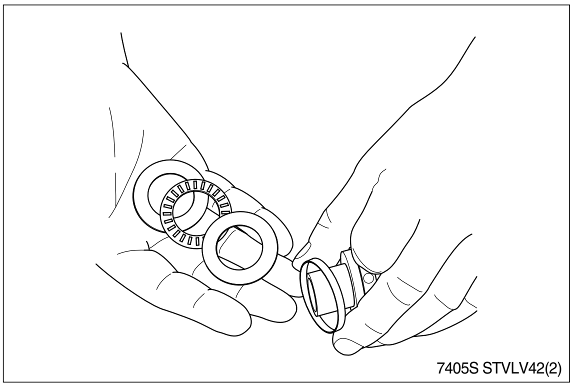
7405S STVLV41(4)

(13) Pull sleeve and spool out of the housing.



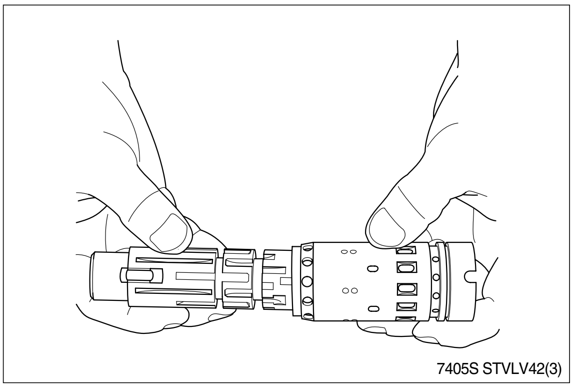
7405S STVLV42(1)

(14) Take ring, bearing races and needle bearing from sleeve and spool. The outer (thin) bearing race can sometimes "stick" in the housing, therefore check that it has come out.



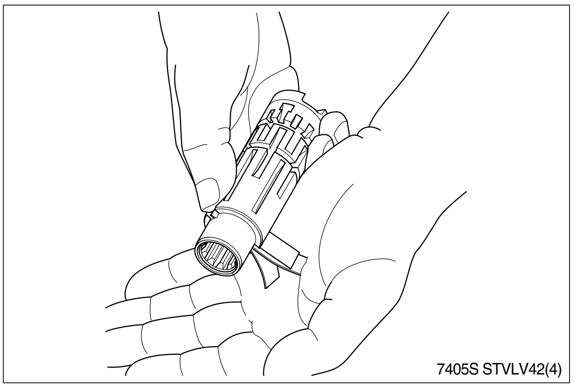
7405S STVLV42(2)

(15) Carefully pull the spool out of the sleeve.



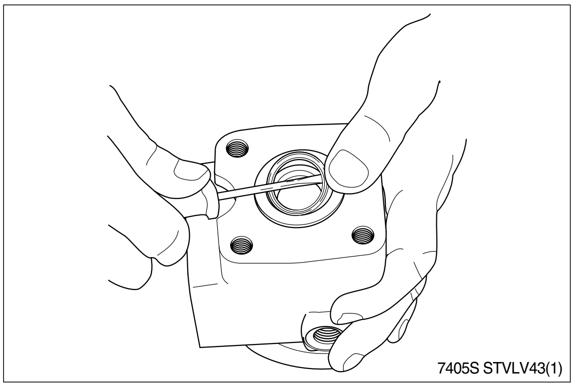
7405S STVLV42(3)

(16) Press the neutral position springs out of their slots in the spool.

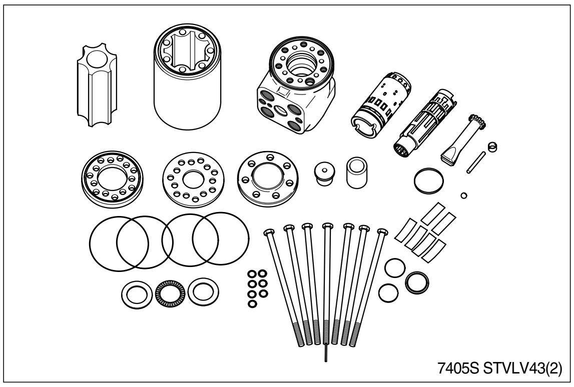


7405S STVLV42(4)

(17) Remove dust seal and O-ring.


7405S STVLV43(1)

(18) The steering unit is now completely disassembled.


7405S STVLV43(2)

Cleaning

Clamp all parts carefully in Shellsol K or the like.

Inspection an replacement

Replace all seals and washer. Check all parts carefully and make any replacements necessary.

Lubrication

Before assembly, lubricate all parts with hydraulic oil.

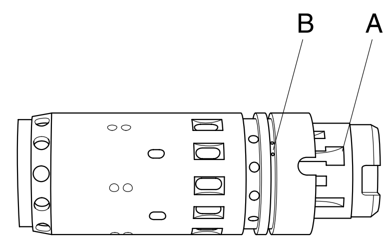
4) DISASSEMBLY

(1) Assemble spool and sleeve.

※ The sleeve and spool are correctly assembled when

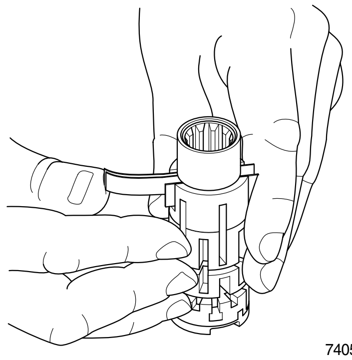
① The slots-in sleeve and spool-for the neutral position springs are opposite each other and

② One of the 3 T-shaped grooves (A) in the spool is opposite one of the sets (B) of small holes in the sleeve.

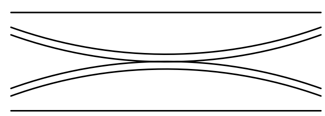


7405S STVLV44(1)

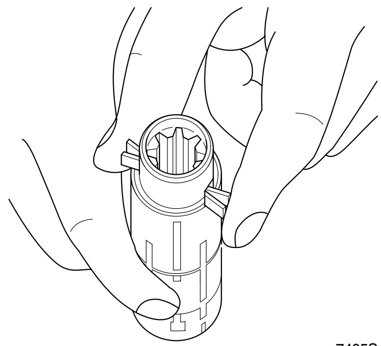
(2) Place the two flat neutral position springs in the slot.


7405S STVLV44(2)

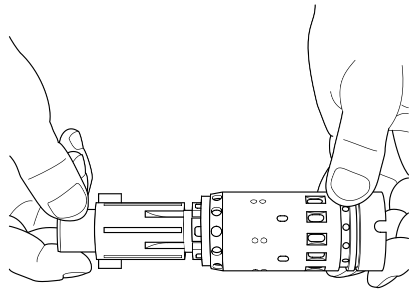
(3) Place the curved springs between the flat ones and press them into place.


7405S STVLV44(3)

(4) Line up the spring set.

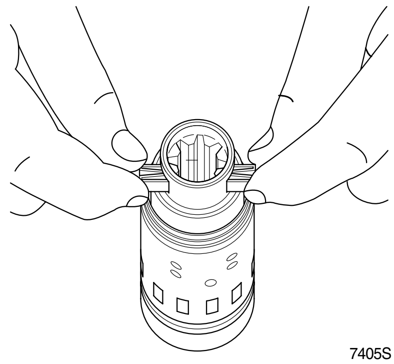

7405S STVLV44(4)

(5) Guide the spool into the sleeve.



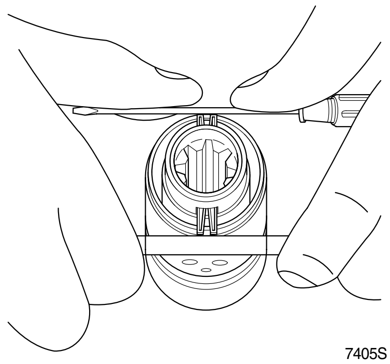
7405S STVLV45(1)

(6) Press the springs together and push the neutral position springs into place in the sleeve.



7405S STVLV45(2)

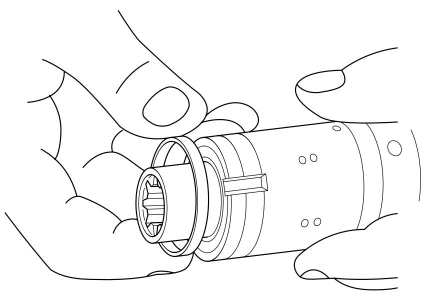
(7) Line up the springs and center them.



7405S STVLV45(3)

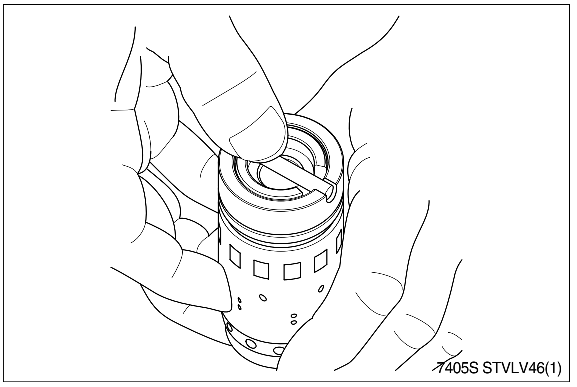
(8) Guide the ring down over the sleeve.

※ The ring should be able to rotate-free of the springs.



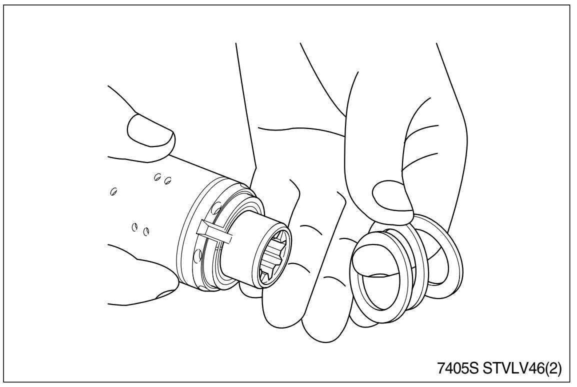
7405S STVLV45(4)

(9) Fit the cross pin into the spool/sleeve.



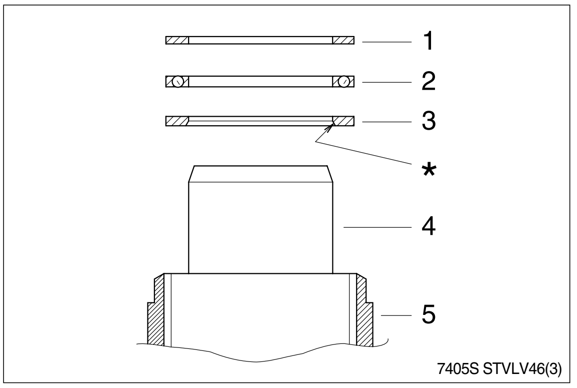
7405S STVLV46(1)

(10) Fit bearing races and needle bearing as shown on below drawing.



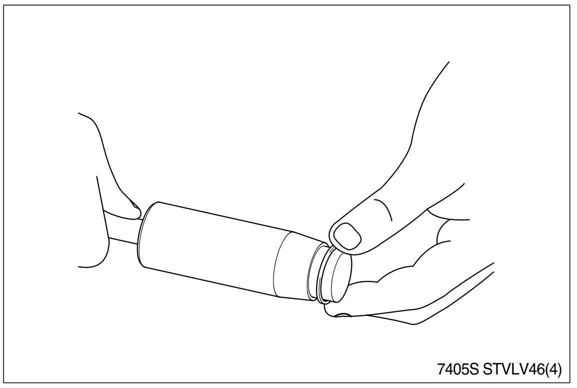
7405S STVLV46(2)

1 Outer bearing race
2 Needle bearing
3 Inner bearing race
4 Spool
5 Sleeve
* Inside chamfer on inner bearing race must face inner spool.

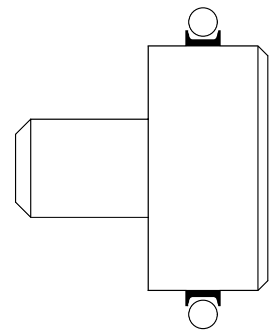


7405S STVLV46(3)

(11) Grease O-ring and kin-ring with hydraulic oil and place them on the tool. See next page.

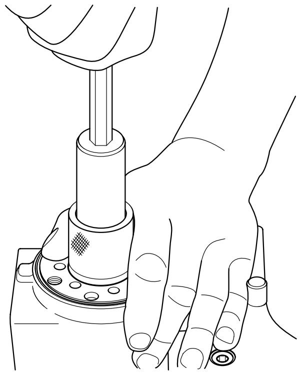


7405S STVLV46(4)



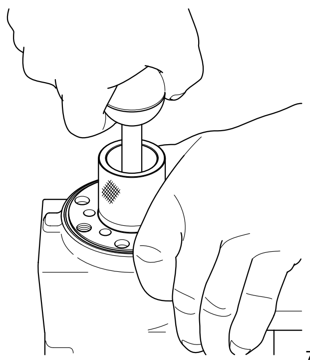
7405S STVLV47(1)

(12) Put the steering unit in the holding tool keeping the bore vertical. Guide the outer part of the assembly tool into the bore. Guide the inner part of the tool right to the bottom.



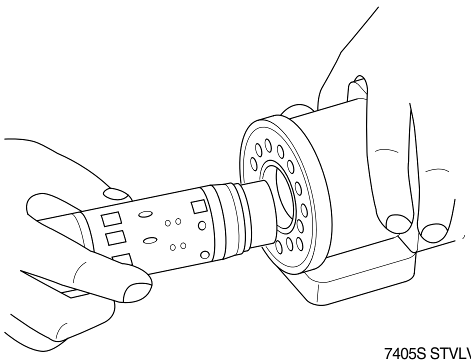
7405S STVLV47(2)

(13) Press and turn the O-ring into position in the housing. Draw the inner and outer parts of the assembly tool out of the steering unit bore, leaving the guide in the bore.



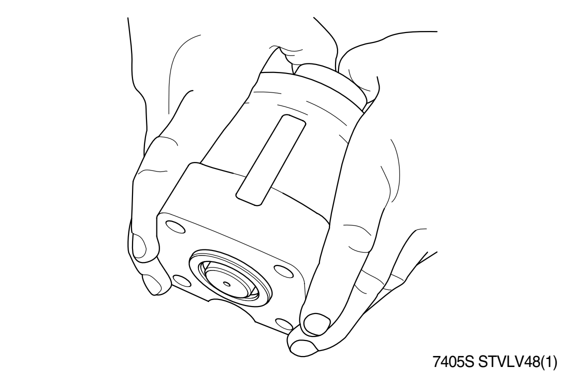
7405S STVLV47(3)

(14) Take the steering unit out of the holding tool and place it horizontally. With a light turning movement, guide the spool and sleeve into the bore.



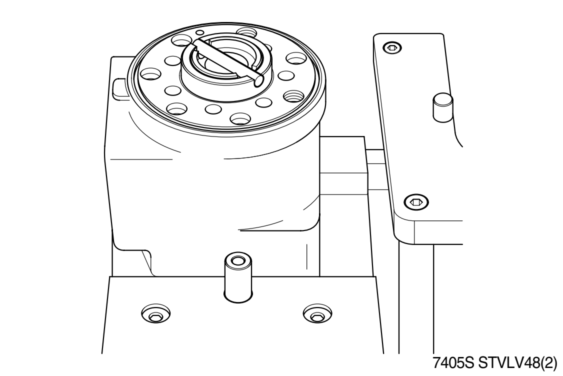
7405S STVLV47(4)

(15) The spool set will push out the assembly tool guide. The O-ring is now in position.



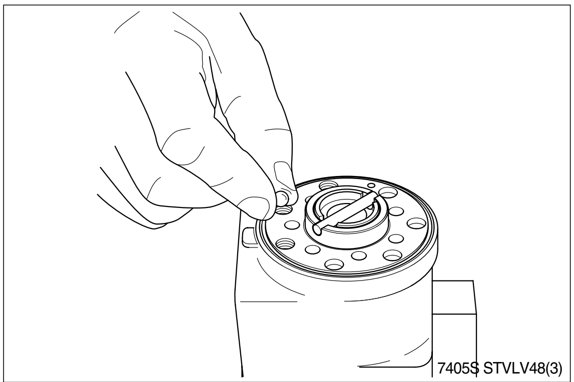
7405S STVLV48(1)

(16) Put the steering unit back into the holding tool keeping the bore vertical. place the cross pin in the spool/sleeve so that it is parallel to the port flange.



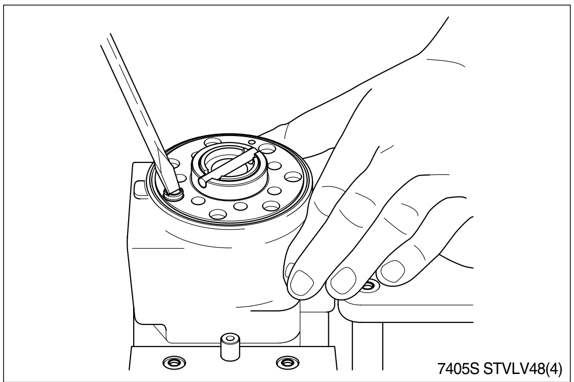
7405S STVLV48(2)

(17) Put the ball into the hole indicated by the arrow.



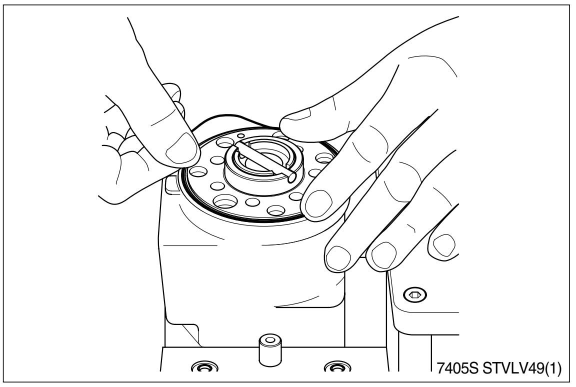
7405S STVLV48(3)

(18) Screw the threaded bushing lightly into the bore. The top of the bushing must lie just below the surface of the housing.



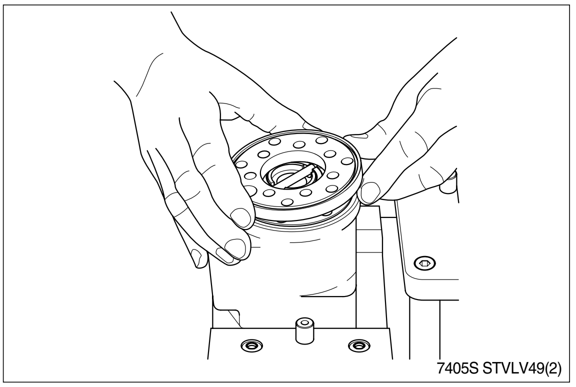
7405S STVLV48(4)

(19) The spool set will push out the assembly tool guide. The O-ring is now in position.



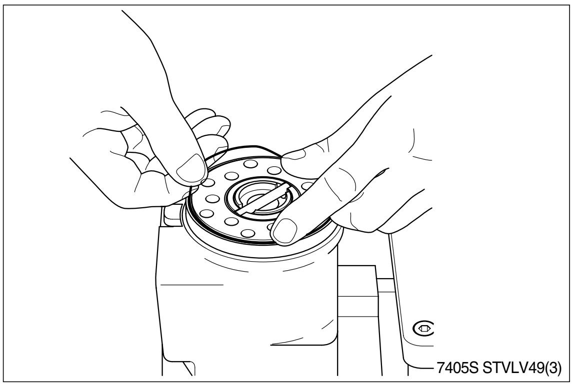
7405S STVLV49(1)

(20) Put the steering unit back into the holding tool keeping the bore vertical. place the cross pin in the spool/sleeve so that it is parallel to the port flange.



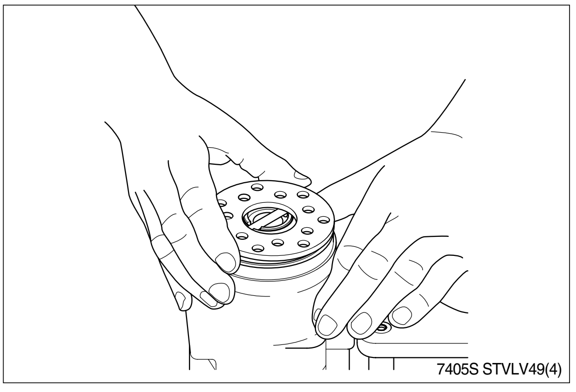
7405S STVLV49(2)

(21) Put the ball into the hole indicated by the arrow.



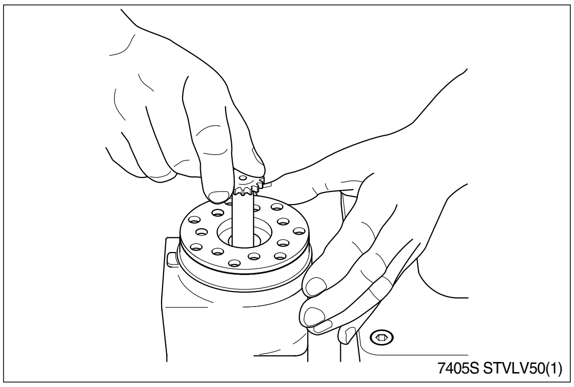
7405S STVLV49(3)

(22) Screw the threaded bushing lightly into the bore. The top of the bushing must lie just below the surface of the housing.



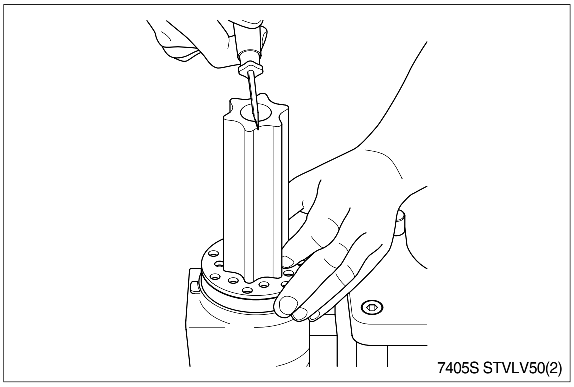
7405S STVLV49(4)

(23) Guide the cardan shaft down into the bore so that the slot is parallel with the connection flange.



7405S STVLV50(1)

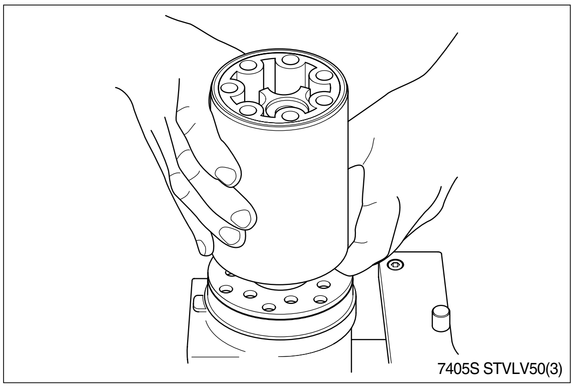
(24) Place the gear wheel (rotor) so that the cross pin from item 33 is positioned in relation to two tooth bases - as the screw driver indicates.



7405S STVLV50(2)

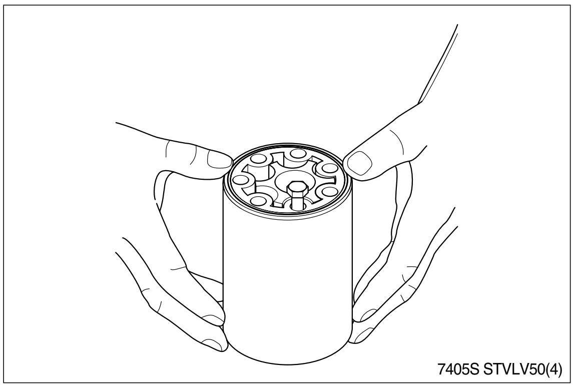
(25) Grease the two O-rings with mineral oil approximate viscosity 500 cSt at 20˚C and place them in the two grooves in the gear rim. Fit the gear rim so that the seven through holes match the holes in the distributor plate.

※ Turn the gear rim so that the smaller diameter of the holes face the distributor plate.



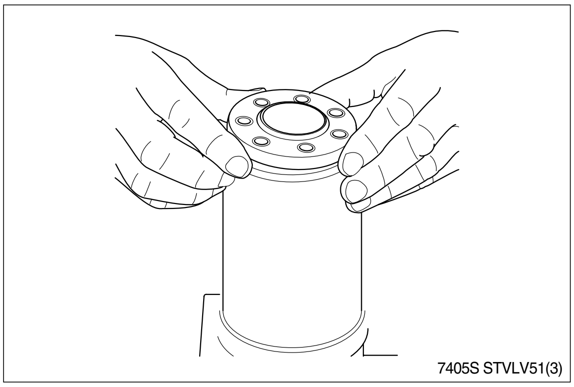
7405S STVLV50(3)

(26) Orientate the holes with a single screw.



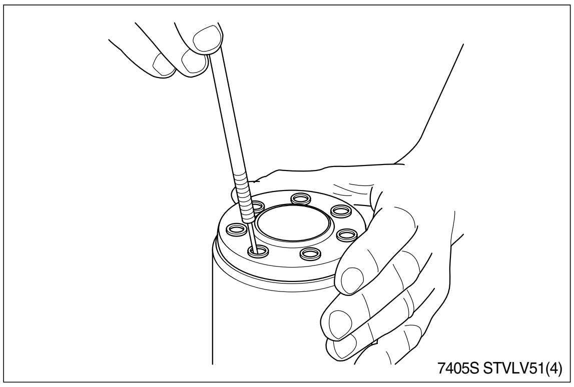
7405S STVLV50(4)

(27) Place the end cover in position.



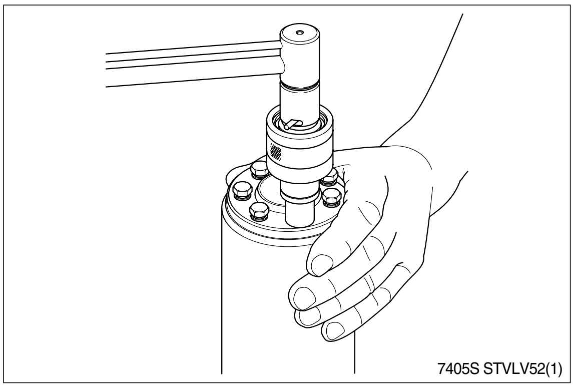
7405S STVLV51(3)

(28) Place the washers over the holes and the rolled pin in the hole shown.



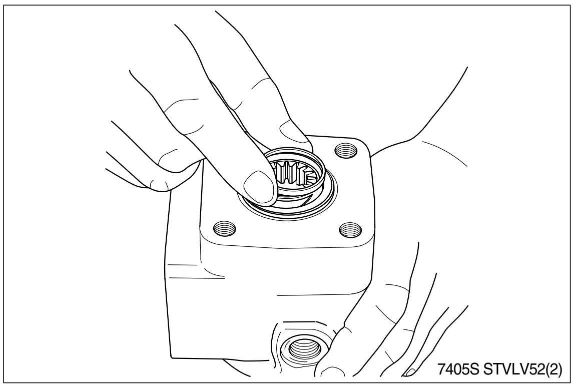
7405S STVLV51(4)

(29) Fit the other six screws. Cross - tighten all the screws and the rolled pin with a torque of $3^{\pm 0.6}$ kgf · m ($22^{\pm 4.4}$ lb · ft). Steering unit can now be function tested.



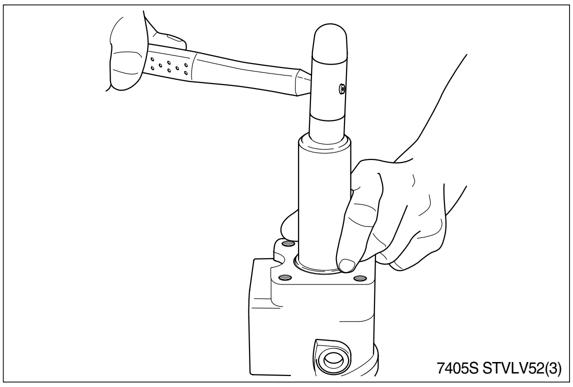
7405S STVLV52(1)

(30) Turn the steering unit 180° and place the dust seal ring in the housing.



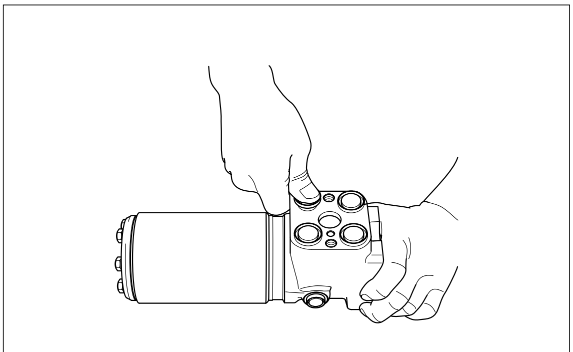
7405S STVLV52(2)

(31) Fit the dust seal ring in the housing using special tool and a plastic hammer.



7405S STVLV52(3)

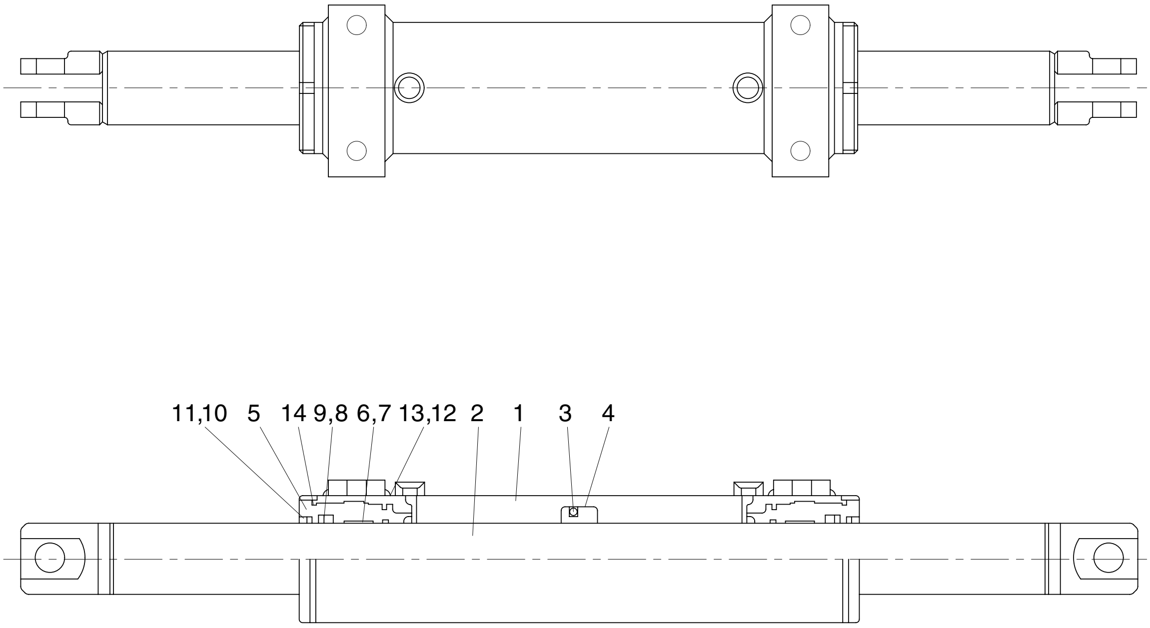
(32) Press the plastic plugs into the connection ports. Do not use a hammer.



7405S STVLV52(4)

2. STEERING CYLINDER

1) STRUCTURE



250D7ESS06

1	Tube assembly	6	Rod bush	11	Retaining ring
2	Rod assembly	7	Retaining ring	12	O-ring
3	Piston seal	8	U-packing	13	Back up ring
4	Wear ring	9	Back up-ring	14	O-ring
5	Rod cover	10	Dust wiper		

2) DISASSEMBLY

※ Before disassembling steering cylinder, release oil in the cylinder first.

(1) Put wooden blocks against the cylinder tube, then hold in & vice.

(2) Remove the cover by hook a wrench in the notch of cylinder head and turn counter-clockwise.

(3) Remove the cylinder rod and piston from the tube.

(4) Check wear condition of the sealing parts(O-ring, oil seal, dust seal, U-packing, bush). If there are some damage, replace with new parts.

3) CHECK AND INSPECTION

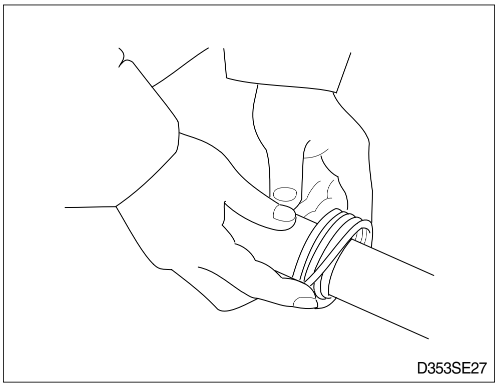
mm(in)

Check item	Criteria		Remarks
	Standard size	Repair limit	
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

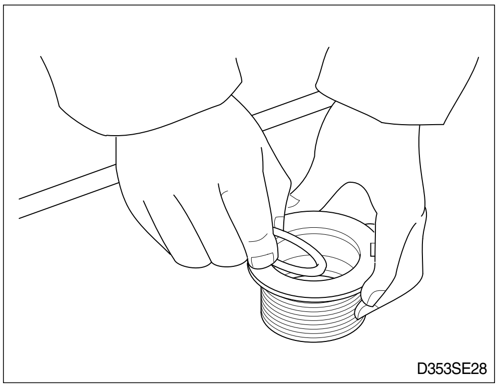
4) ASSEMBLY

(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.

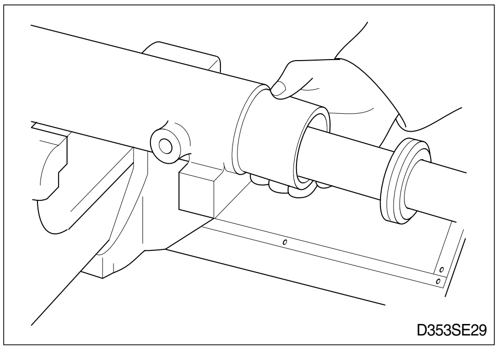


(2) Install the rod seal to the position in the gland applying a slight coat with grease prior to install.

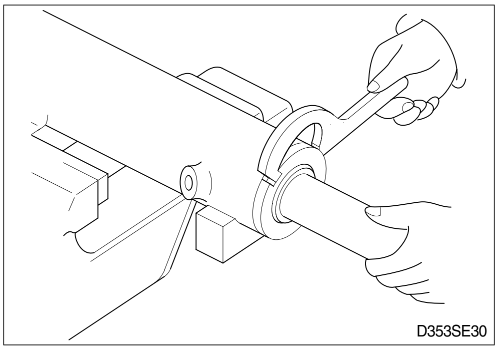


(3) Install the dust wiper to the gland using a special installing tool. Coat the dust wiper with grease slightly before installing.

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

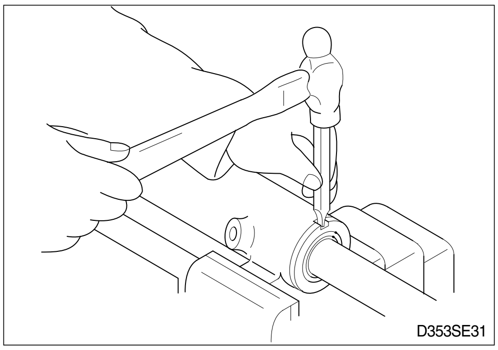


(5) Using a hook spanner, install the gland assembly, and tighten it with torque 60±6kgf · m (434±43lbf · ft).



(6) After the gland assembly was installed to the cylinder tube, calk at the tube end into the groove on the gland to prevent screw loosen-ing.

※ 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.

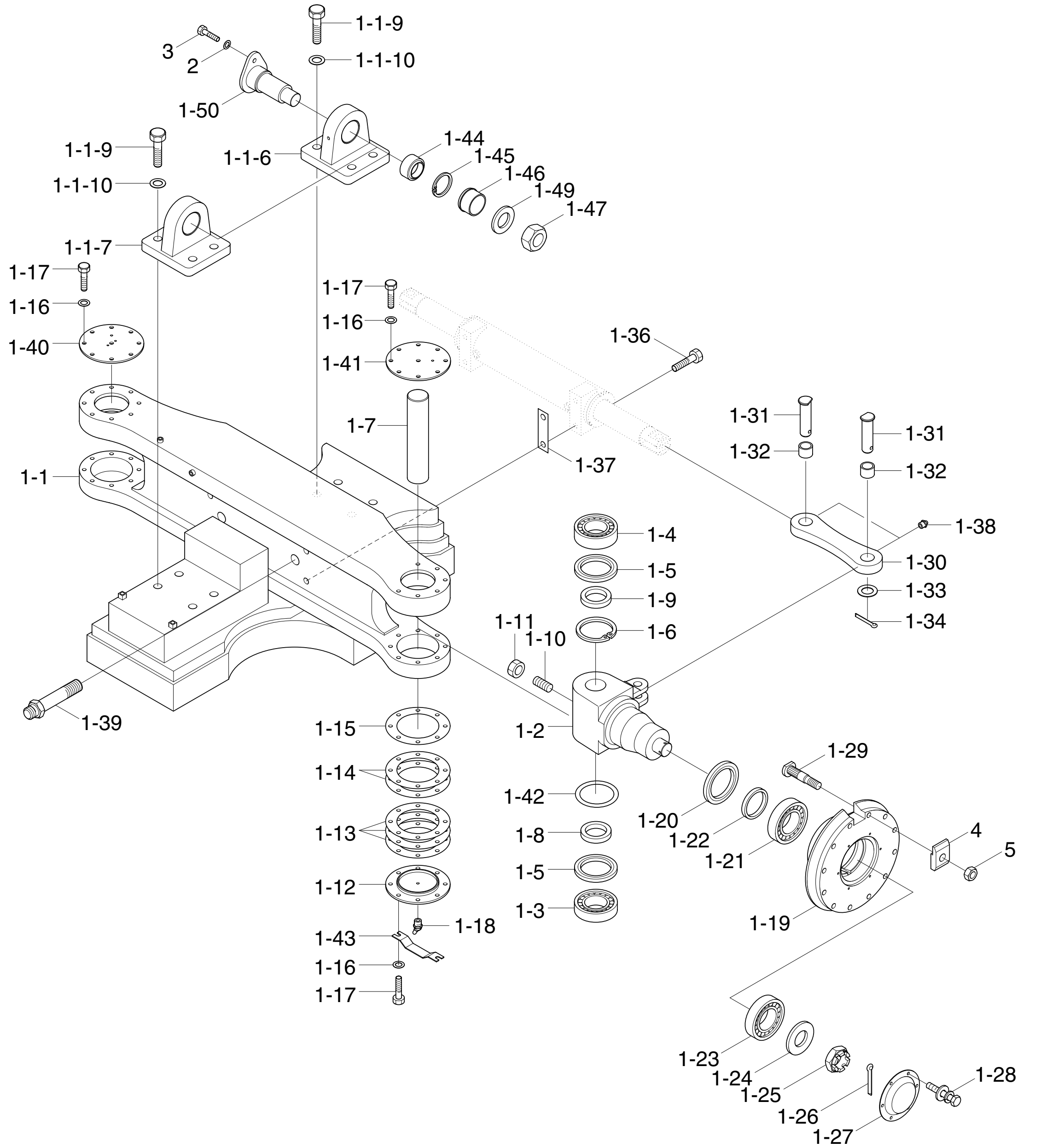
※ Then, repeat the above operation at gradually increasing engine rpm. This releases air from the system and completes preparation for operation.

(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

※ Do not remove the stopper bolt unless necessary.



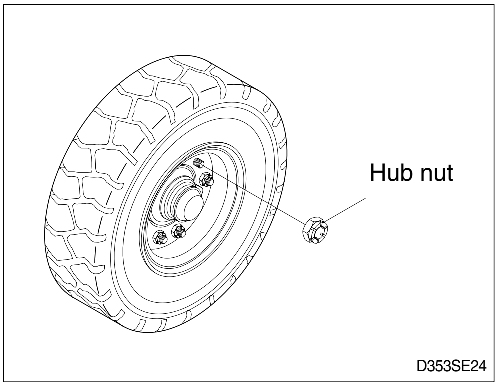
250D7ESS21

1	Steering axle assembly	1-11	Hexagon nut	1-25	Lock nut	1-40	Cover-RH
1-1	Steering axle	1-12	Cover	1-26	Split pin	1-41	Cover-LH
1-1-6	Plate	1-13	Shim (0.1t)	1-27	Cap	1-42	Spacer
1-1-7	Plate	1-14	Shim (0.2 t)	1-28	Bolt with washer	1-43	Plate
1-1-9	Hexagon bolt	1-15	Shim (0.5 t)	1-29	Hub bolt	1-44	Spherical plain bearing
1-1-10	Hardened washer	1-16	Hardened washer	1-30	Link	1-45	Retaining ring
1-2	Knuckle	1-17	Hexagon bolt	1-31	Link pin	1-46	Bushing
1-3	Taper roller bearing	1-18	Grease nipple	1-32	Bushing	1-47	Hexagon nut
1-5	Oil seal	1-19	Hub	1-33	Plain washer	1-49	Plain washer
1-6	Retaining ring	1-20	Oil seal	1-34	Split pin	1-50	Pin
1-7	King pin	1-21	Taper roller bearing	1-36	Hexagon bolt	2	Plain washer
1-8	Spacer	1-22	Spacer	1-37	Shim (0.2 t)	3	Hexagon bolt
1-9	Spacer	1-23	Taper roller bearing	1-38	Grease nipple	4	Ring clamp
1-10	Hexagon socket setscrew	1-24	Special washer	1-39	Connector	5	Hub nut

2) DISASSEMBLY

※ Servicing work on the knuckle part can be carried out without removing the axle assy from chassis. The work can be done by jacking up the balance weight part of the truck.

(1) Loosen the hub nut and take off the steering wheel tire.



(2) Remove Hub cap.

(3) Pull out split pin and remove lock nut, washer.

(4) Using the puller, take off the hub together with the roller bearing.

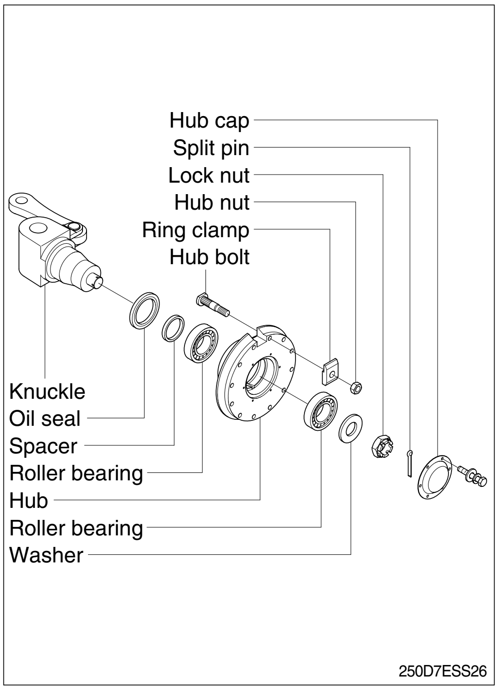
※ Be very careful because just before the hub comes off, tapered roller bearing will fall out.

(5) After hub is removed take off the inner race of roller bearing.

(6) Pull out oil seal.

※ 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(1-10) and nut(1-11).

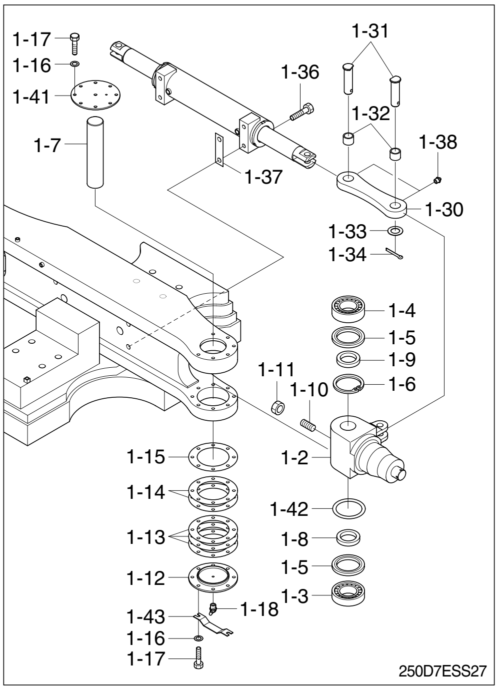
(9) Loosen with washer bolt(1-17) and remove cover (1-12, 1-41), shim(1-13, 1-14, 1-15). Remove grease nipple(1-18).

(10) Push out the king pin(1-7) without damaging the knuckle arm(1-2).

(11) At the same time the king pin is removed, pull out the oil seal(1-5).

(12) If defect is observed in taper roller bearing(1-3), pull it out by using extractor.

(13) Remove spilt pin(1-34), plain washer(1-33) and link pin(1-31).



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(1-10) of king pin(1-7).

(2) There is a notch in the middle of the king pin (1-7), 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.

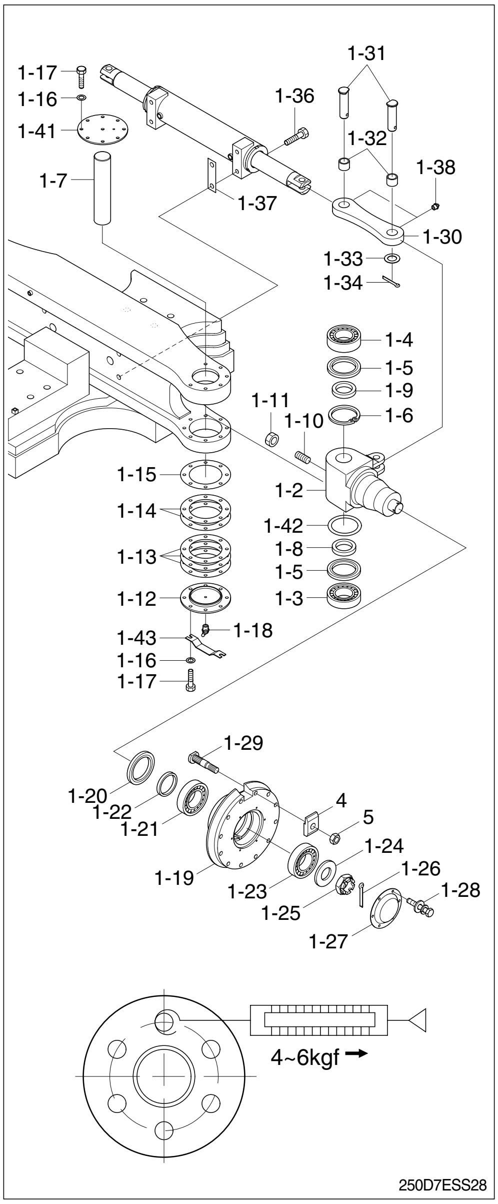
(4) Hub

① Mount oil seal(1-20) and inner race of tapered roller bearing(1-21) on the knuckle.
The bearing should be well greased before assembling.

② Install the outer race of the bearing(1-3) in the wheel center and assemble to the knuckle.

③ Put washer(1-24) in place, tighten with nut(1-25) and locked with split pin(1-26). 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(1-27).
Bearing should be well greased before assembling.



SECTION 6 HYDRAULIC SYSTEM

GROUP 1 STRUCTURE AND FUNCTION

1. HYDRAULIC SYSTEM OUTLINE

The hydraulic system is a pilot operated, ciosed center system which is supplied with flow from the fixed displacement main hydraulic pump.
The pilot control system is a low pressure, system which is supplied with flow from the auxiliary pump.

The hydraulic system components are :
- Main pump
- Auxiliary pump
- Main control valve
- Lift cylinder
- Tilt cylinders
- Remote control valve(Pilot control valve)
- OPSS solenoid valve
- Cut-off valve

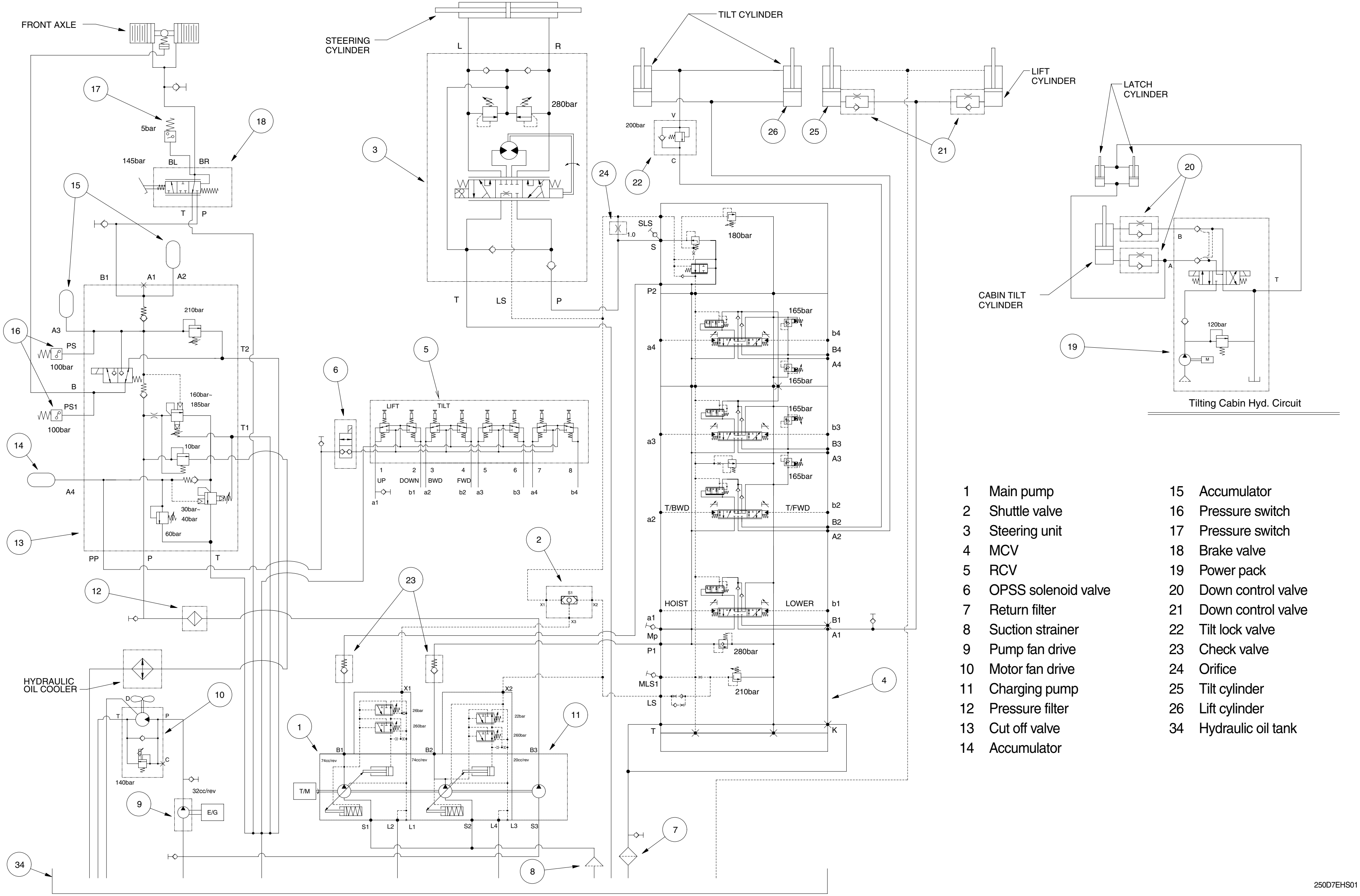
The oil from the B2 main pump via the priority spool built in the main control valve is combined with oil from the B1 main pump by parallel passage and flows the main control valve.

The main control valve is a parallel circuit type, closed center valve which routes flow to the lift, tilt and or auxiliary cylinders when the respective spools are shifted.

Flow from the brake pump is routed to the cut-off valve that charges the pressure in accumulators. After charging the pressure in accumulators for braking, the flow gose to accumulators for RCV. The cut-off valve flow either to the brake valve or to the remote control valve.
The remote control valve routed flow to either end of each spool valve section in the main control valve to control spool stroke.
A accumulator mounted on pilot supply unit supplies a secondary pressure source to operate remote control valve so the boom can be lowered if the engine is off.

The return circuit for the main hydraulic system have return filter inside the hydraulic tank. The return filter uses a filter element and a bypass valve. The bypass valve is located in the upside of filter.

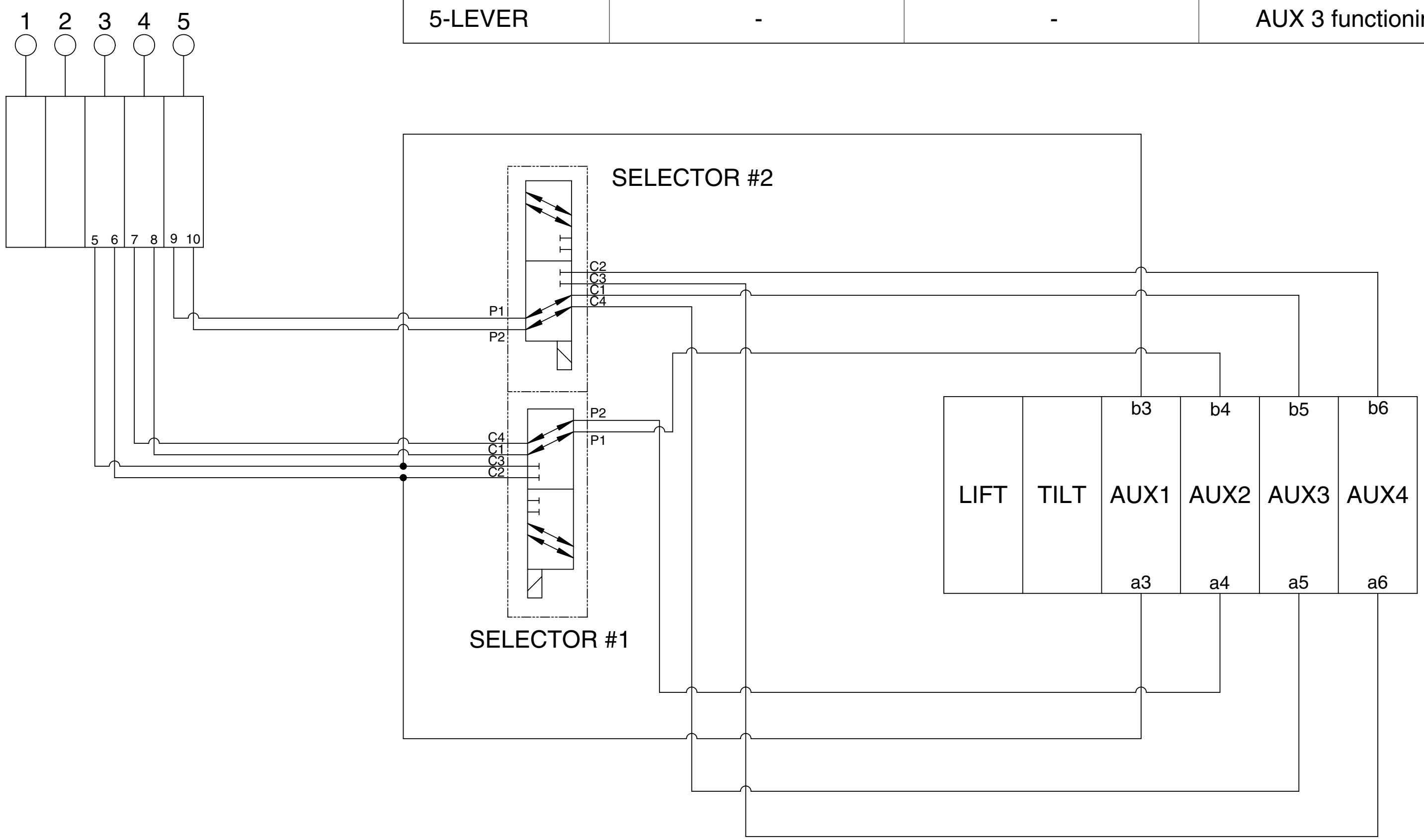
2. HYDRAULIC CIRCUIT



1. Main pump
2. Shuttle valve
3. Steering unit
4. MCV
5. RCV
6. OPSS solenoid valve
7. Return filter
8. Suction strainer
9. Pump fan drive
10. Motor fan drive
11. Charging pump
12. Pressure filter
13. Cut off valve
14. Accumulator
15. Accumulator
16. Pressure switch
17. Pressure switch
18. Brake valve
19. Power pack
20. Down control valve
21. Down control valve
22. Tilt lock valve
23. Check valve
24. Orifice
25. Tilt cylinder
26. Lift cylinder
34. Hydraulic oil tank

PILOT CIRCUIT(7 function for 5-lever)

	3-LEVER S/W OFF (SELECTOR #1 INACTIVATION)	3-LEVER S/W ON (SELECTOR #1 ACTIVATION)	5-LEVER S/W OFF (SELECTOR #2 INACTIVATION)	5-LEVER S/W ON (SELECTOR #2 ACTIVATION)
3-LEVER	AUX 1 functioning	AUX 1, 2 functioning	-	-
4-LEVER	AUX 2 functioning	Non-functioning	-	-
5-LEVER	-	-	AUX 3 functioning	AUX 4 functionig



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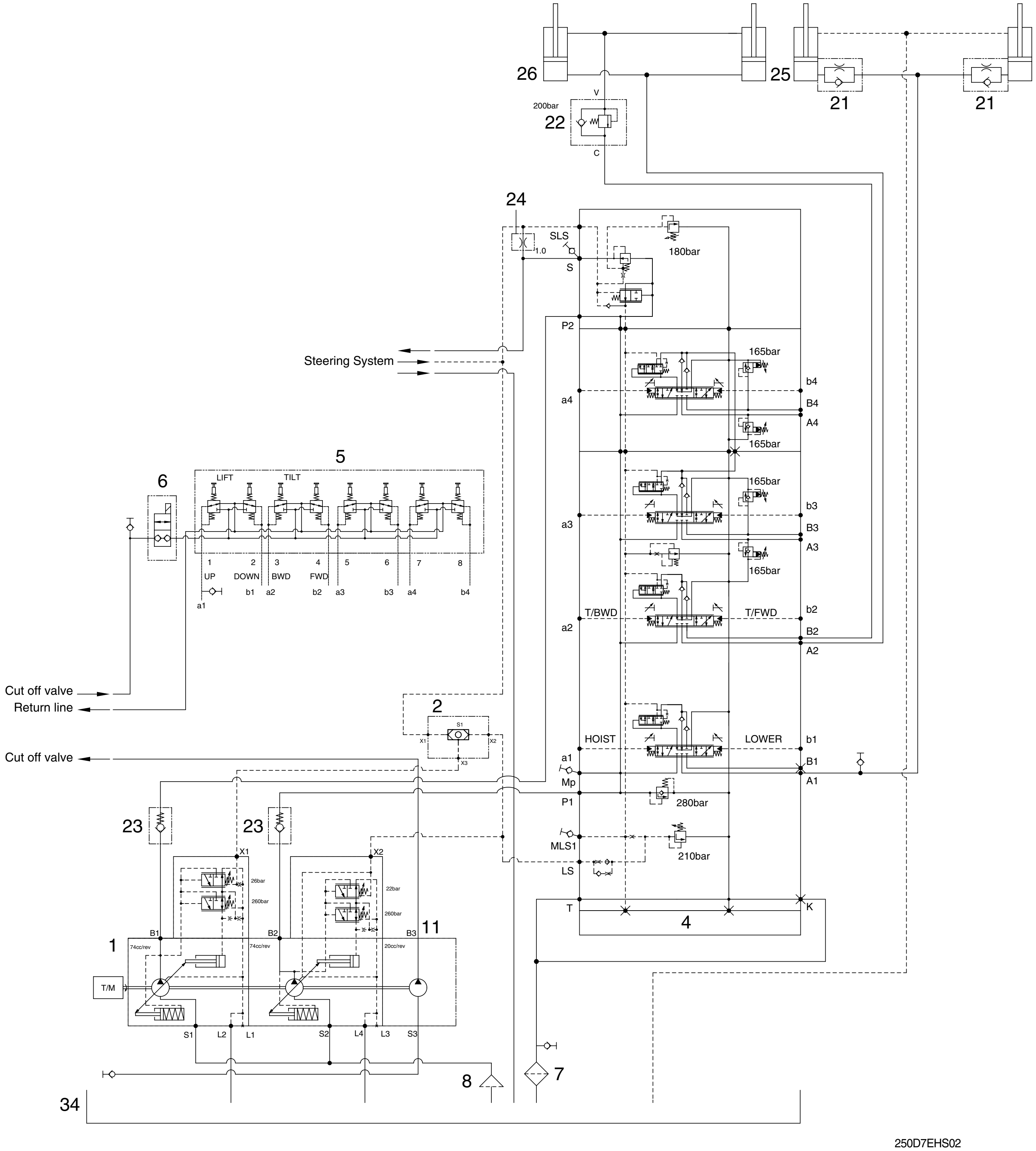
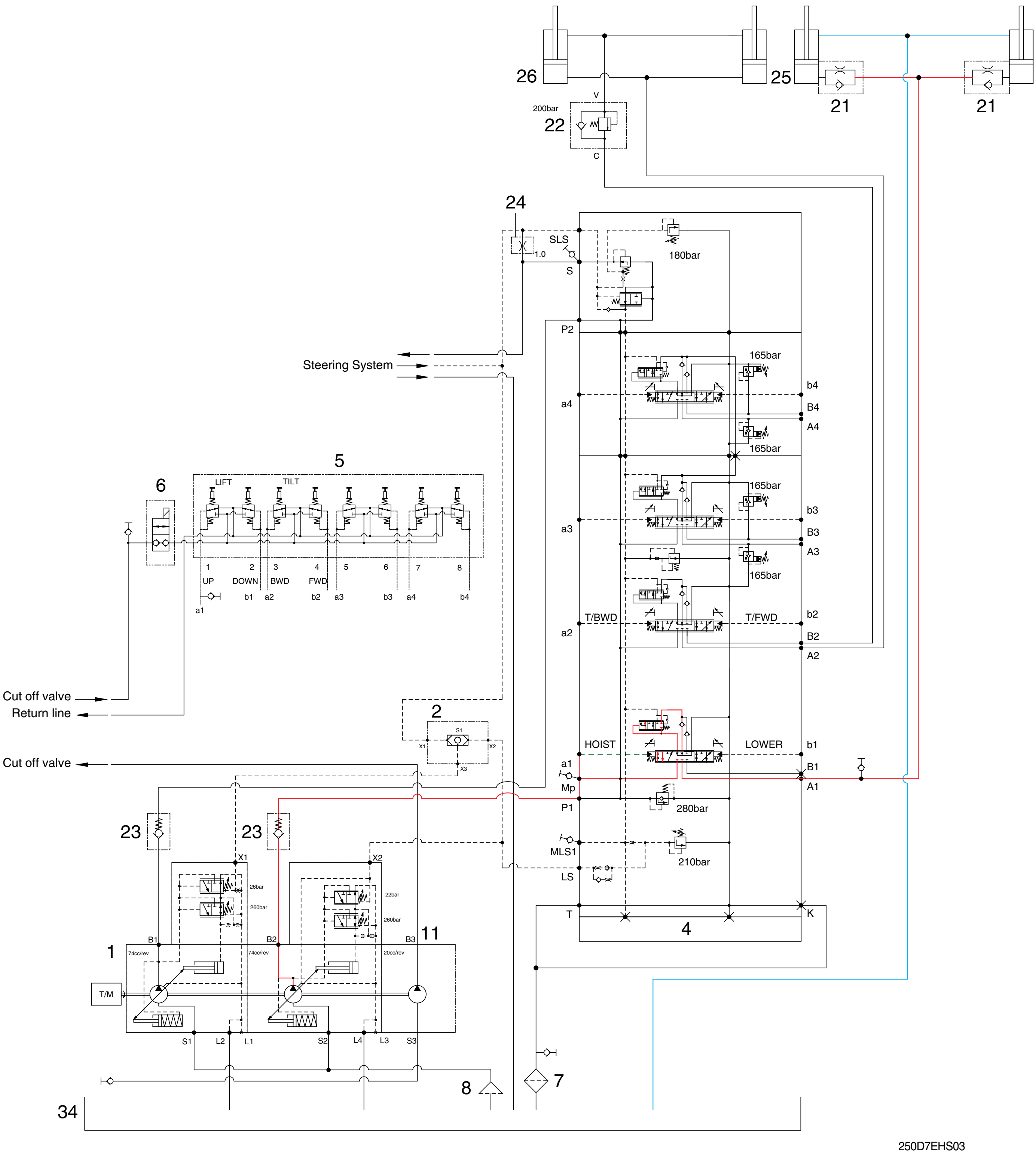
3. WORK EQUIPMENT HYDRAULIC CIRCUIT



1	Main pump	7	Return filter	23	Check valve
2	Shuttle valve	8	Strainer	24	Orifice
4	Main control valve	11	Charging pump	25	Lift cylinder
5	Remote control valve	21	Down control valve	26	Tilt cylinder
6	OPSS solenoid valve	22	Tilt lock valve	34	Hydraulic oil tank

1) WHEN THE LIFT CONTROL LEVER IS IN THE LIFT POSITION



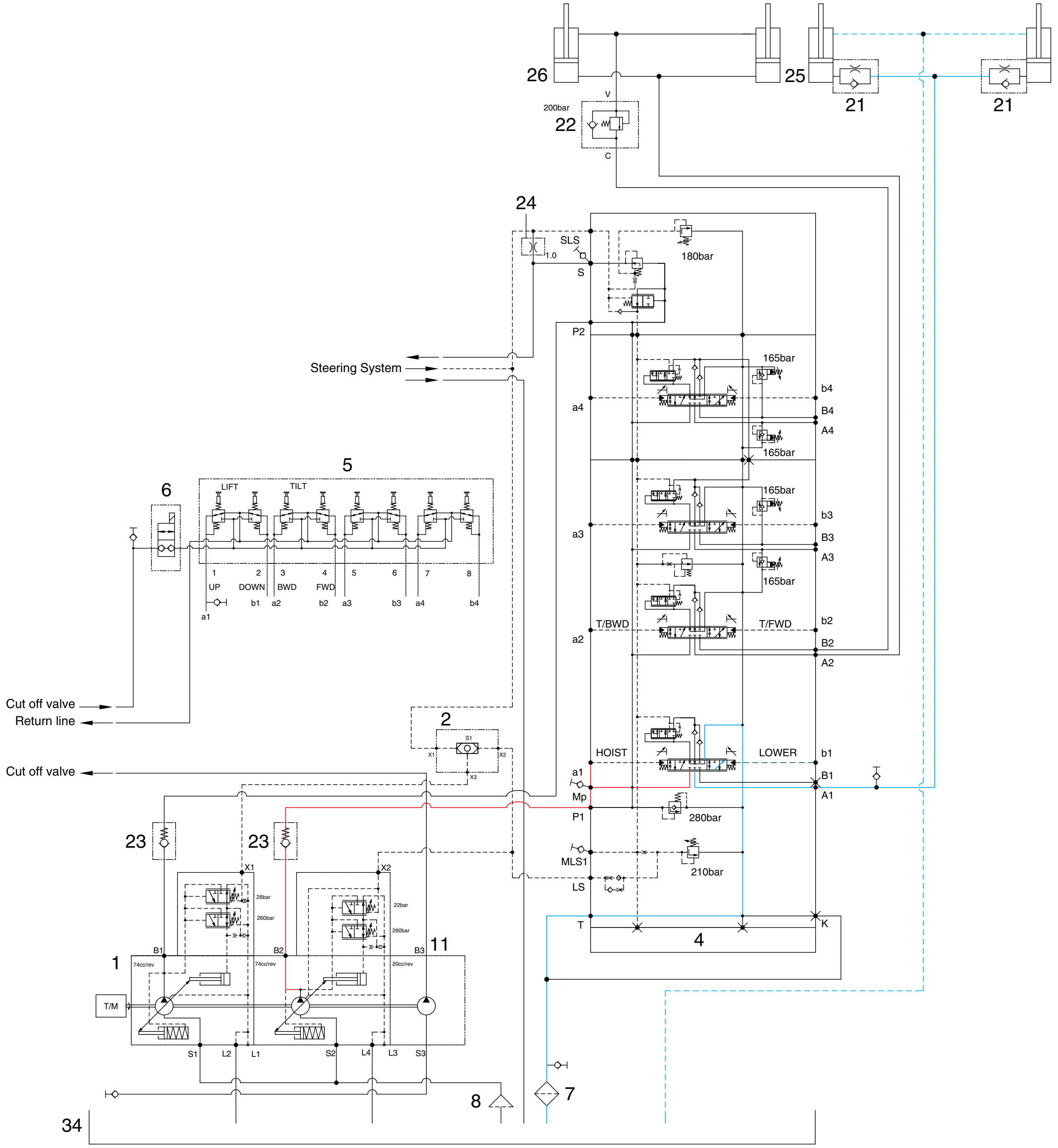
When the lift control lever is pulled back, the spool is moves to lift position by the pilot oil pressure from the remote control valve(5).

The oil from hydraulic main pump(1) flows into main control valve(4) and then goes to the large chamber of lift cylinder(25) by pushing the load check valve of the spool.

The oil from the small chamber of lift cylinder(25) returns to hydraulic oil tank(34) at the same time.

When this happens, the forks go up.

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

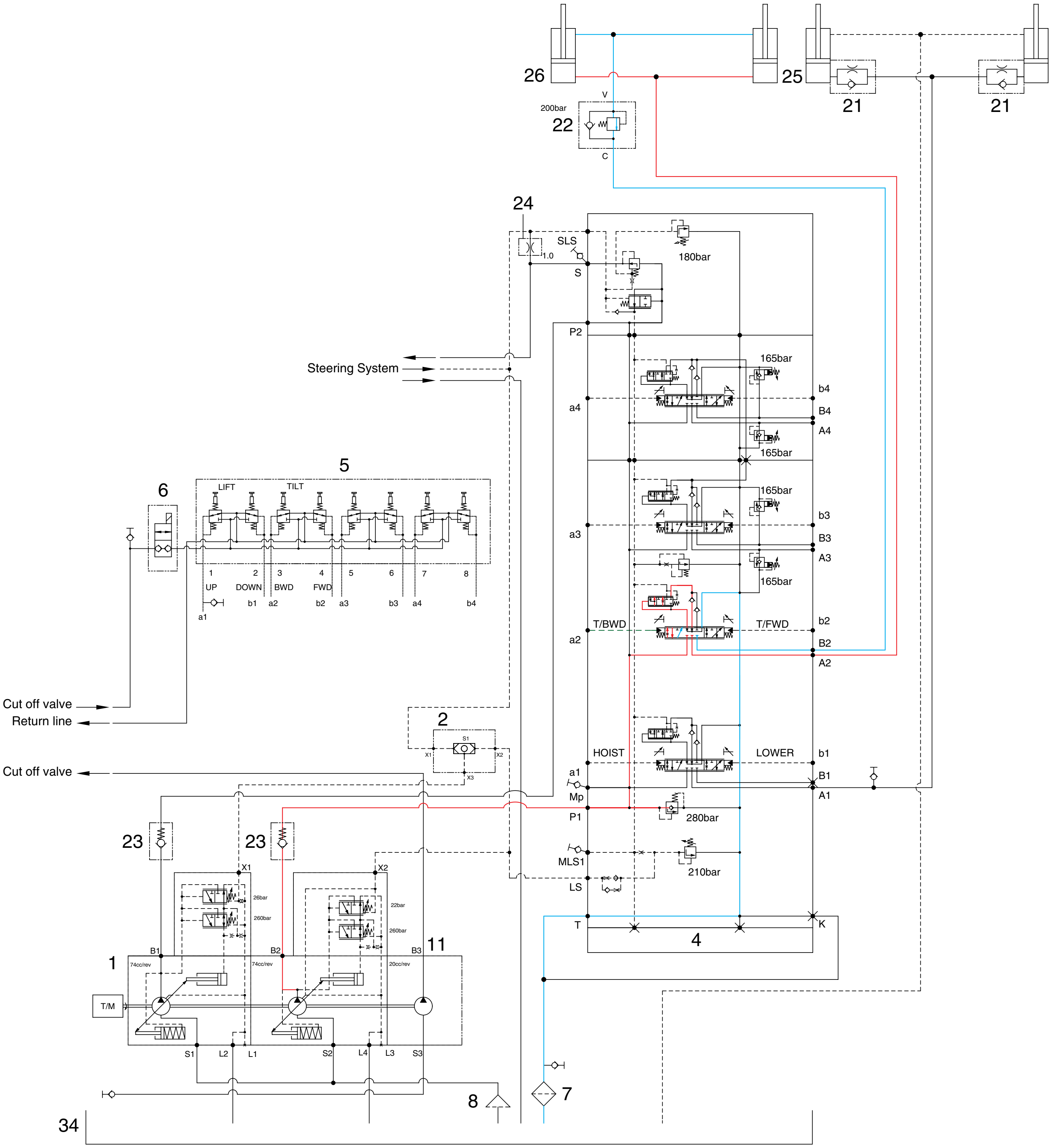


250D7EHS04

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(A1, A3) 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



250D7EHS05

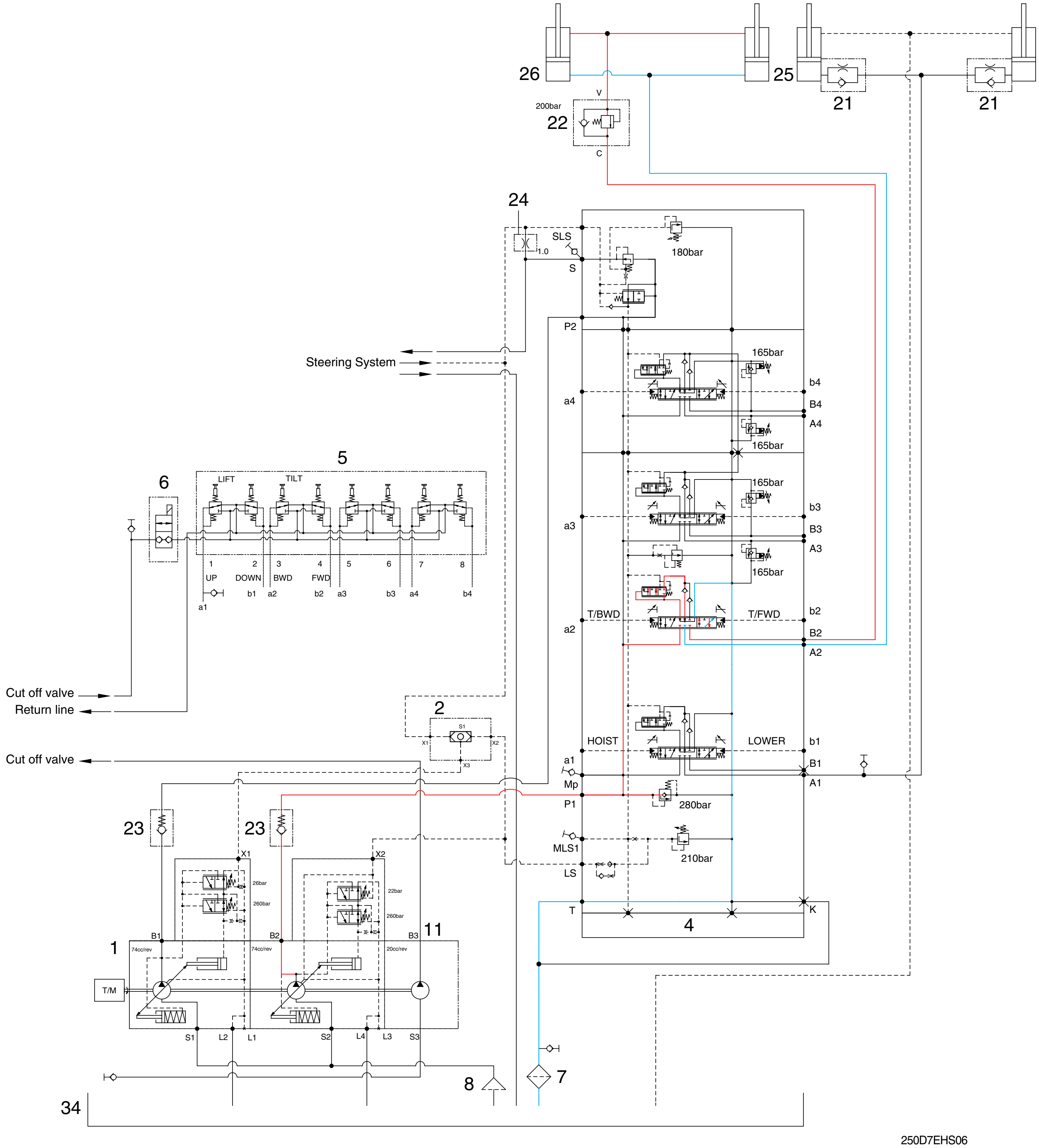
When the tilt control lever is pushed forward, the spool is moved to tilt forward position by the pilot oil pressure from the remote control valve(5).

The oil from hydraulic main pump(1) flows into main control valve(4) and then goes to the large chamber of tilt cylinder(26) by pushing the load check valve of the spool.

The oil at the small chamber of tilt cylinder(26) 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



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(26) by pushing the load check valve of spool.

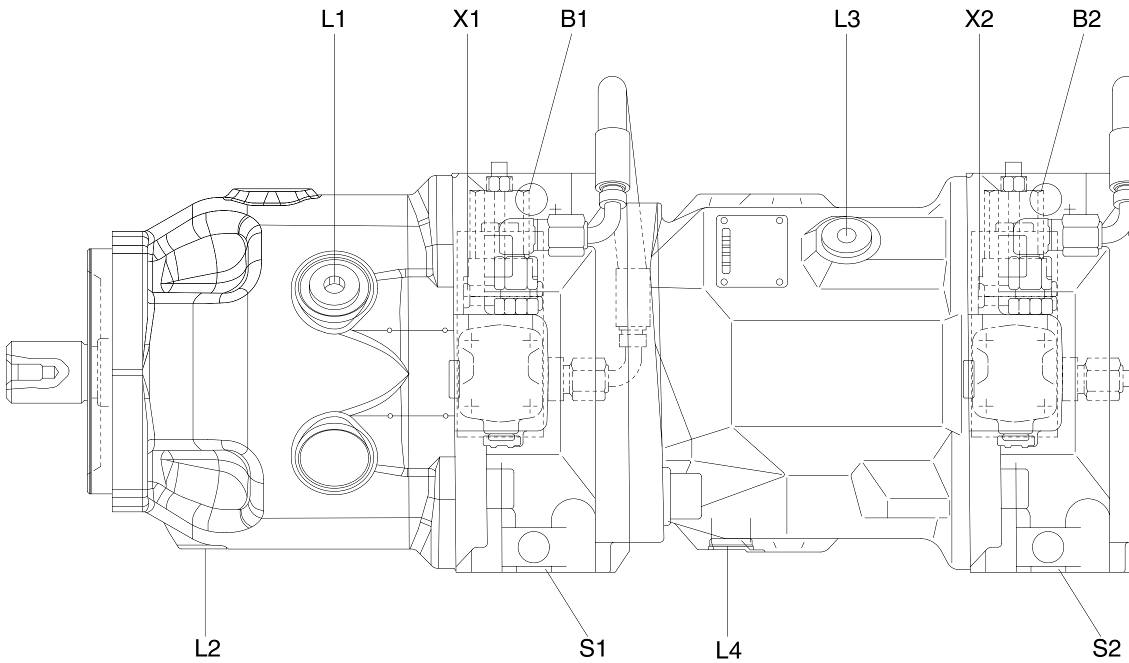
The oil at the large chamber of tilt cylinder(26) returns to hydraulic tank(34) at the same time.

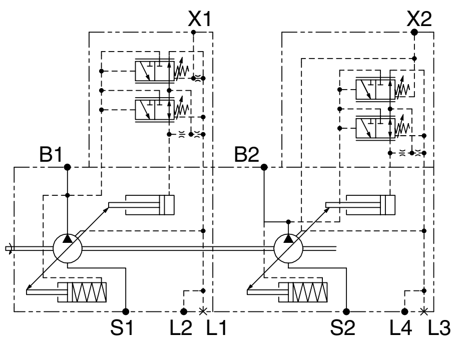
When this happens, the mast tilt backward.

4. MAIN PUMP

1) STRUCTURE (1/2)

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



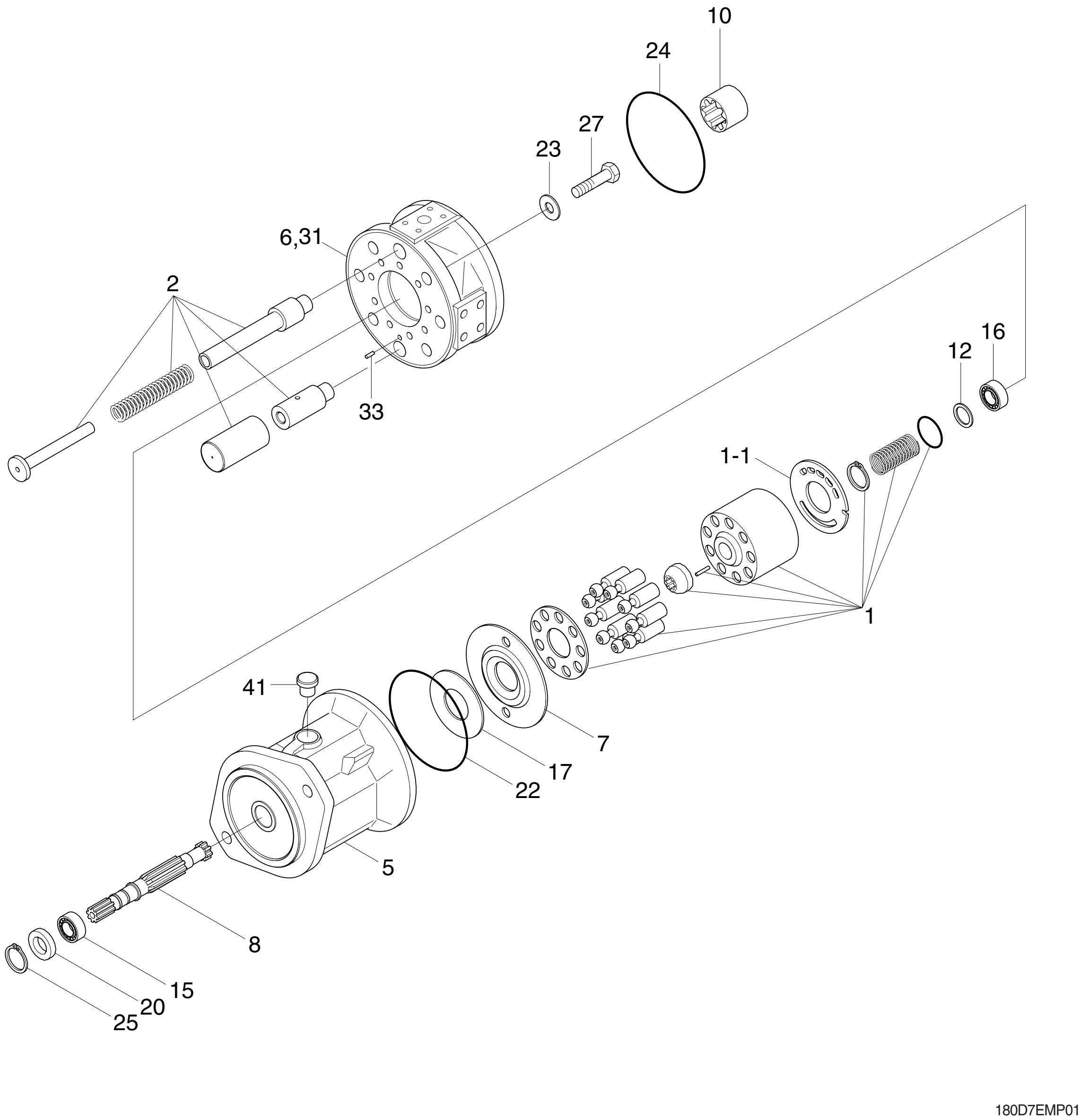


HYDRAULIC CIRCUIT

180D7EMP04

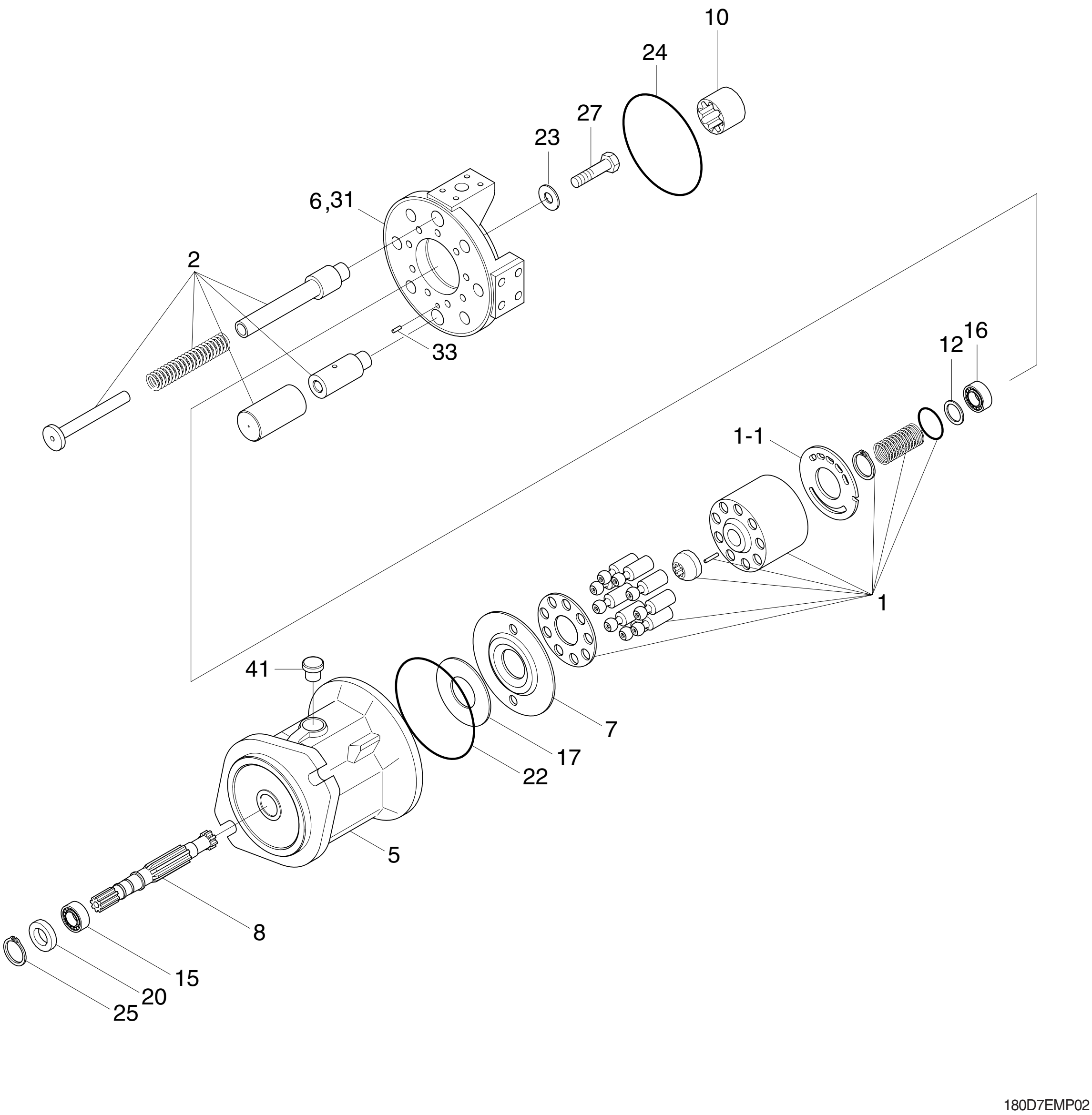
Port	Port name	Size
B1	Pressure port	SAE 1"
B2	Pressure port	SAE 1"
S1	Suction port	SAE 2"
S2	Suction port	SAE 2"
L1, L2	Case drain port	7/8-14UNF-28
L3, L4	Case drain port	7/8-14UNF-28
X1, X2	Pilot pressure port	7/16-20UNF-28

· **FRONT PUMP**



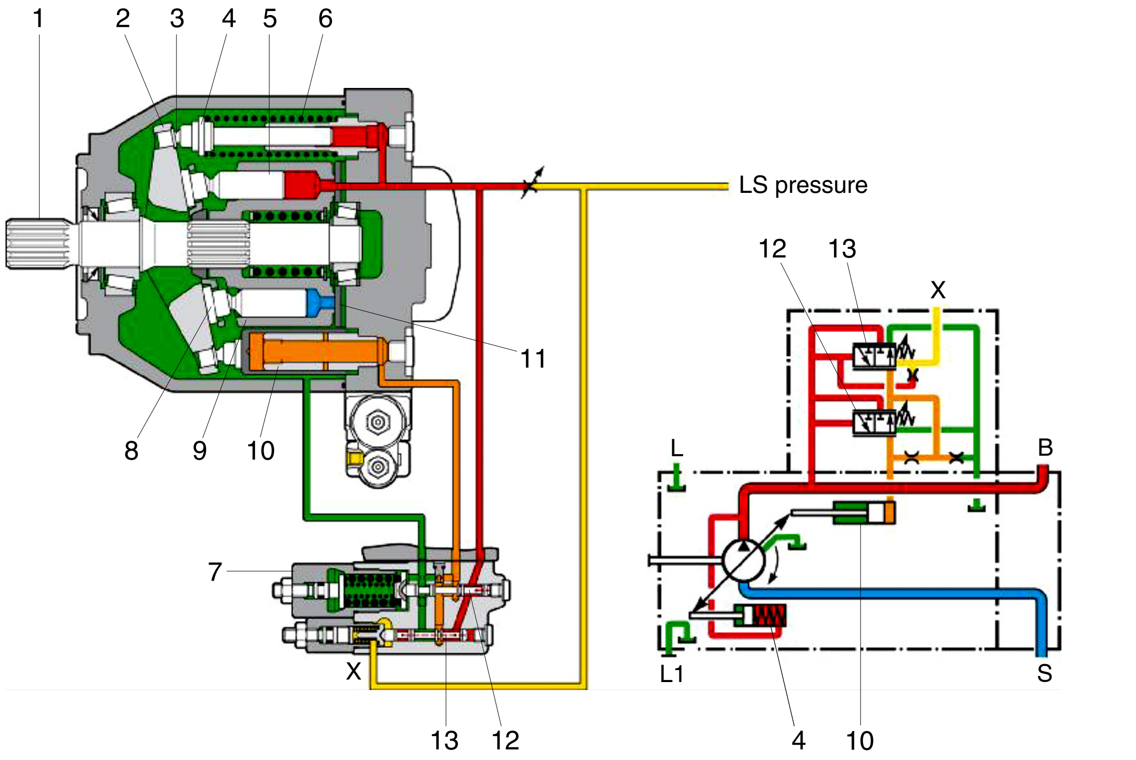
1-1	High speed rotary	15	Taper roller bearing	28	Locking screw
1-2	Control plate	16	Taper roller bearing	30	Locking screw
2	Adjusting piece	17	Bearing liner	33	Cylinder pin
5	Pump housing	20	Shaft seal ring	36	O-ring
6	Port plate	22	O-ring	51	Control valve
7	Swash plate	23	O-ring	52	Flange cover
8	Drive shaft	24	O-ring	54	Seal screw
10	Splined hub	25	Retaining ring	55	Seal screw
12	Shim	27	Socket screw		

· REAR PUMP



55-1	High speed rotary	62	Shim	71	Locking screw
55-2	Control plate	63	Taper roller bearing	72	Locking screw
56	Adjusting piece	64	Taper roller bearing	73	Cylinder pin
57	Pump housing	65	Bearing liner	89	Control valve
58	Port plate	66	Shaft seal ring	90	Flange cover
59	Swash plate	68	O-ring	93	Set screw
60	Drive shaft	69	Retaining ring		
61	Shim	70	Socket screw		

2) FUNCTION



1	Drive shaft	6	Counter spring	11	Control plate
2	Swash plate	7	Pressure & flow compensator valve	12	Pressure compensator spool
3	Shoe plate	8	Piston shoe	13	Flow compensator spool
4	Counter piston	9	Cylinder		
5	Piston	10	Control piston		

The steering pump and loader pump are variable displacement piston pump. The steering pump and loader pump are flow controlled by LS signal. When the steering and loader are not being used, the pumps are at low pressure standby.

The load sensing pressure that is sensed from steering and loader 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 loader hydraulic components from excessive pressure.

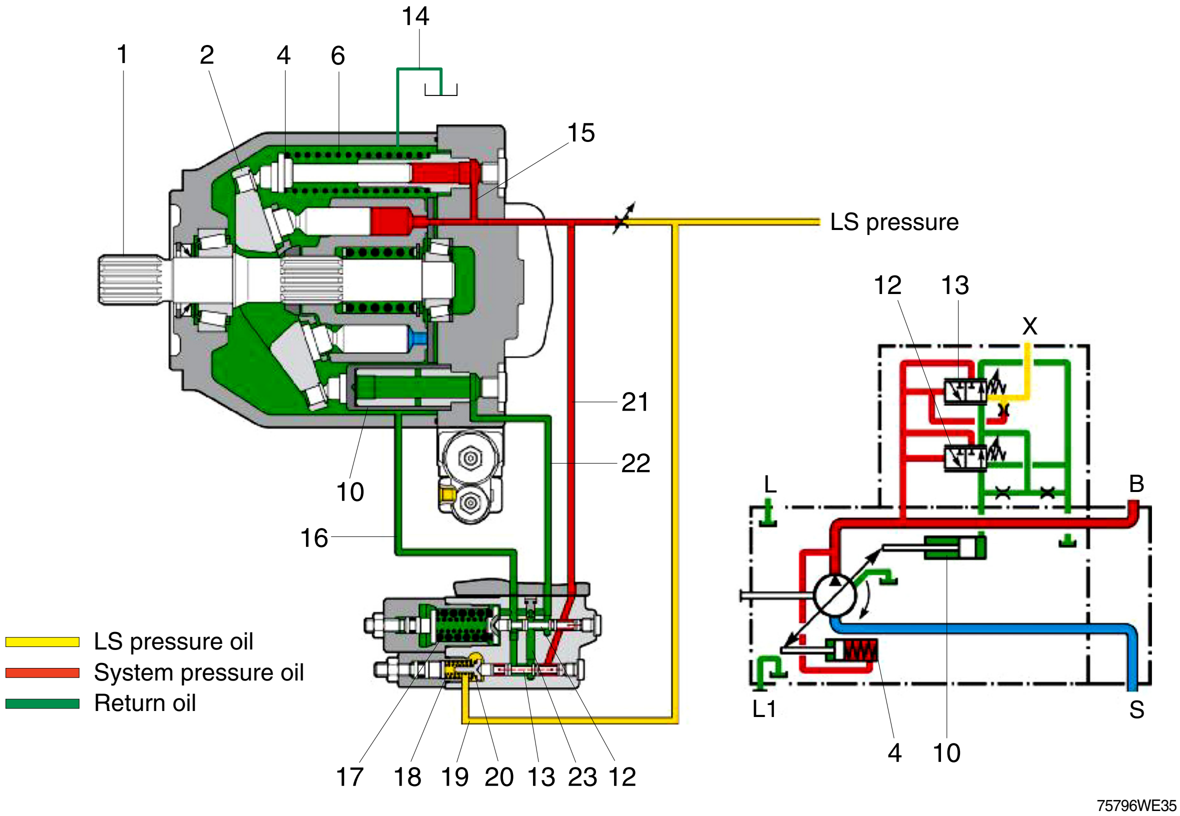
The swivel angle of the pumps is controlled by counter piston (4) and control piston (10). Counter spring (6) cause swash plate (2) to move at maximum displacement or causes swash plate (2) to upstroke.

Control piston (10) has a larger area (diameter) than counter piston (4). Control piston (10) causes swash plate (2) to destroke the pump.
Flow compensator spool (13) and/or pressure compensator spool (12) changes pump output by regulating the pump discharge pressure that is acting on control piston (10).

Control piston (10) diameter is larger than counter piston (4) diameter, the oil pressure that is acting against control piston (10) overcomes the force of counter spring (6). The oil pressure than causes the pump to destoke.

Pressure and flow compensator valve (7) also controls the maximum output of pump pressure.
When steering and loader pressure rises above pressure compensator setting, pressure compensator spool (12) overrides flow compensator spool (13). This causes the pump to destroke.

(1) Upstroking



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		

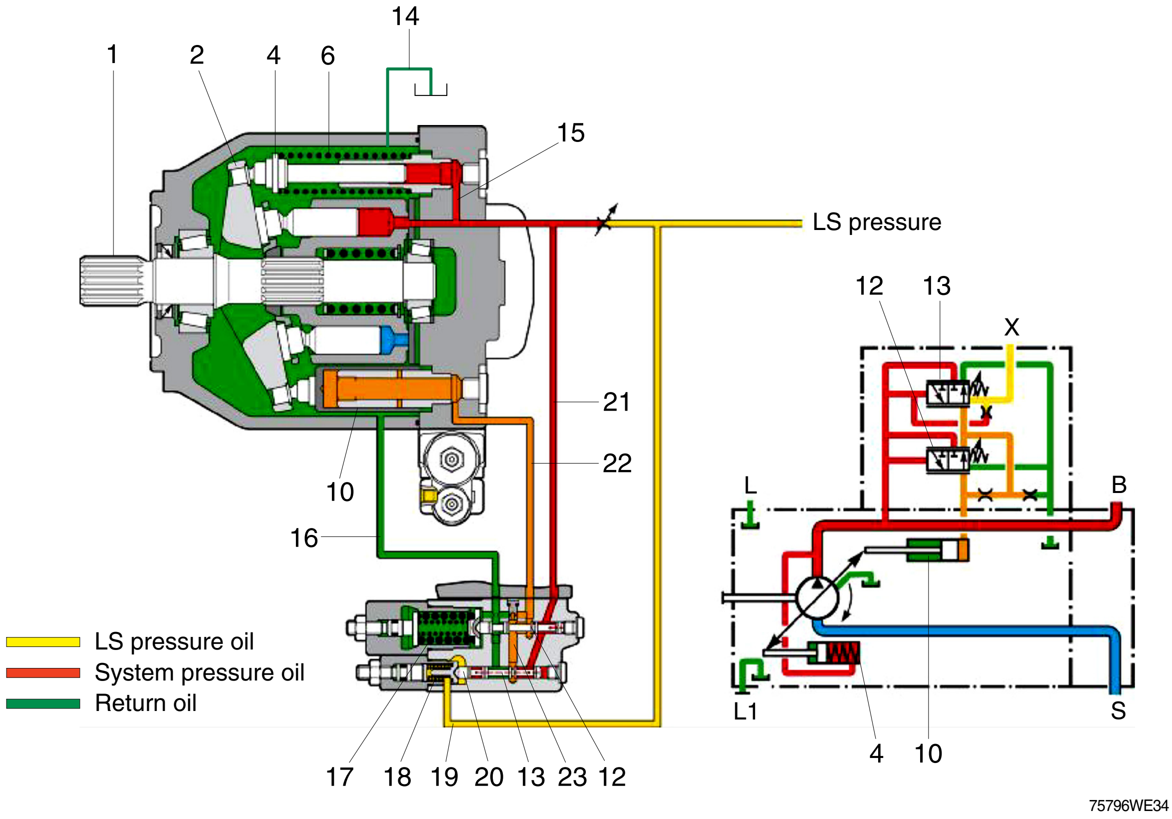
Upstroking of the pump occurs as flow demand from loader and steering system.
The increased flow demand causes a LS pressure in LS line (19). The LS pressure in LS line (19) combines with the force of spring (18) in cavity (20).
The force of spring (18) causes pump pressure to be higher than the LS pressure (19).
If the combination of LS pressure and of spring force is greater than the pump discharge pressure, this difference pressure causes spool (13) to move right. As spool (13) moves right, the spool (13) blocks the flow of supply oil to control piston (10). Pump swash plate (2) is controlled by pressure and flow as much as hydraulic system requests.

When the oil flow to control piston (10) is blocked, the pilot oil in passage (22) drains to passage (23). The oil then flows past pressure compensator spool (12) and through passage (16) into the housing and via the drain line (14) to tank.

Supply oil flows through passage (15) to counter piston (4). The oil acts against counter piston (4). The oil combines with the force of counter spring (6). This causes swash plate (2) to upstroke.

This also causes the pump flow to increase. As flow requirements are satisfied, the pump output pressure increase. The pressure increases until the pressure in passage (15) moves flow compensator spool (13) up to be satisfied with system requirement for pressure and flow.
¡¤Pump discharge pressure = force of spring (18) + LS pressure (19)

(2) Destroking



1	Drive shaft	13	Flow compensator spool	19	LS line from the metering pump
2	Swash plate	14	Case drain	20	Cavity
4	Counter piston	15	Passage	21	Passage
6	Counter spring	16	Passage	22	Passage
10	Control piston	17	Spring	23	Cavity
12	Pressure compensator spool	18	Spring		

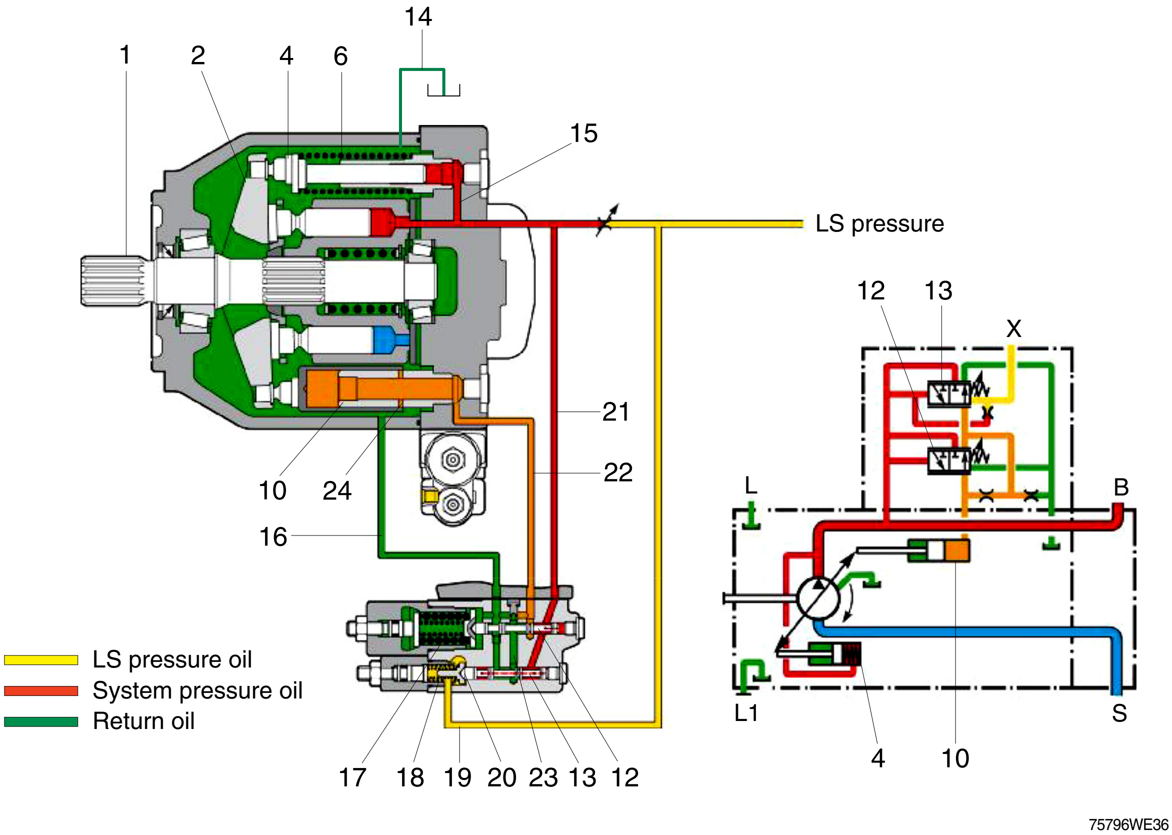
The decreased flow demand causes a LS pressure in line (19). The LS pressure in line (19) combines with the force of spring (18) in cavity (20).
This combination of LS pressure and of spring force is less than the pump pressure in passage (21). This causes flow compensator spool (13) to move left.
Pump oil now flows through passage (15). The oil then flows past flow compensator spool (13), through passage (22), and then to control piston (10).

The pump pressure behind control piston (10) is now greater than the combined force of counter piston(4) and of counter spring (6). The angle of swash plate (2) decreases.
This decreases the pump output and the system pressure.

When the lower flow requirements are met, flow compensator spool (13) moves right up to the balanced position. Swash plate (2) maintains an angle that is sufficient to provide the lower required pressure. If the operator does not turn the steering wheel and does not move RCV, then the pump will return to low pressure standby.

※ Control piston ¡æ Changes pump displacement ; influenced by controller.
Counter piston ¡æ Helps to change pump displacement but no possible to control this piston.

(3) Low pressure standby



1	Drive shaft	13	Flow compensator spool	19	LS line from the metering pump
2	Swash plate	14	Case drain	20	Cavity
4	Counter piston	15	Passage	21	Passage
6	Counter spring	16	Passage	22	Passage
10	Control piston	17	Spring	23	Cavity
12	Pressure compensator spool	18	Spring	24	Cross-drilled hole

Low pressure standby constitutes the following condition: a running engine and inactive steering and loader. There are no flow demands on the pump or pressure demands on the pump.
Therefore, there is no LS pressure in line (19).
Before you start the engine, counter spring (6) holds swash plate (2) at the maximum angle. As the pump begins to turn, oil begins to flow and pressure increases in the system.
Because of close centered steering control valve and close centered loader hydraulic system.

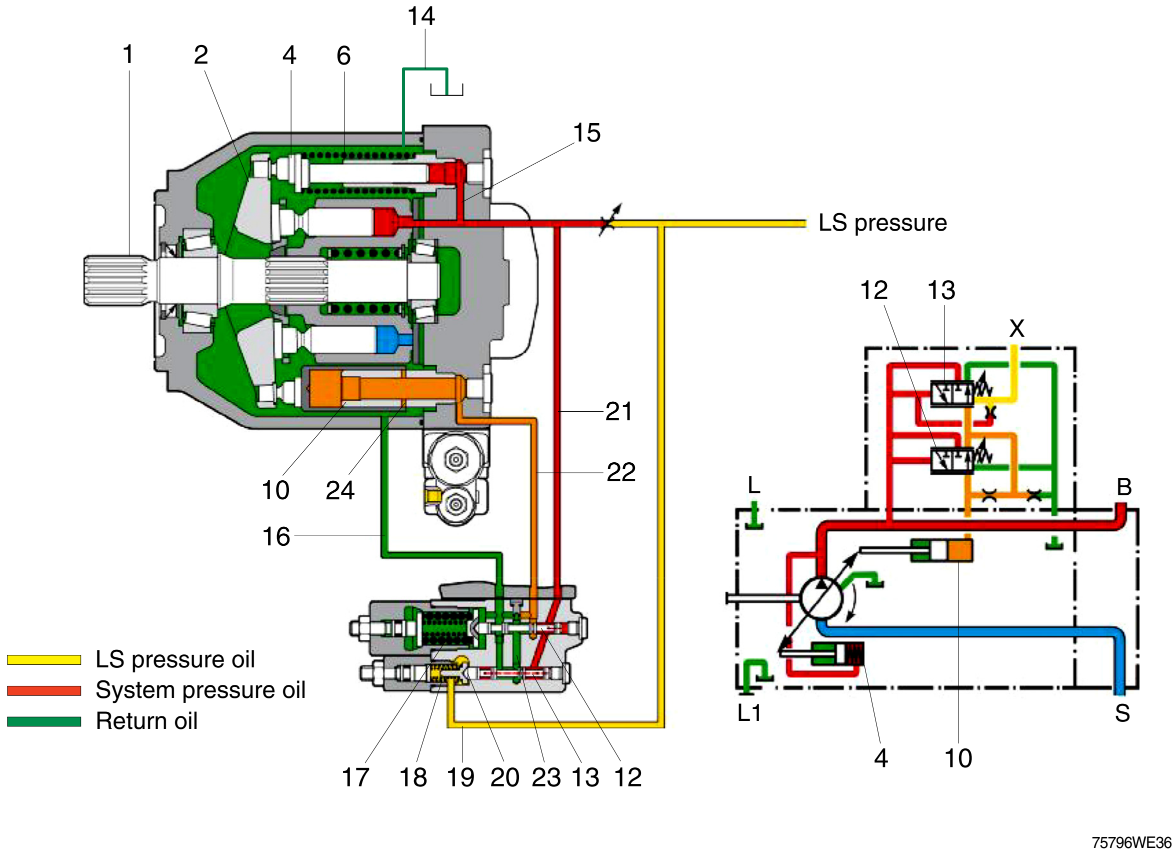
As this pressure increase, the pressure pushes flow compensator spool (13) against spring (18). This causes flow compensator spool (13) to move left. This opens passage (23) in order to allow pressure oil to flow to control piston (10).

The oil acts against control piston (10) in order to overcome the force of counter spring (6). The oil causes control piston (10) to move to the left.
When control piston (10) moves to the left, the piston moves swash plate (2) toward the minimum angle. Control piston (10) continues to move to the left until cross-drilled hole (24) allows the oil to drain to the case.

Cross-drilled hole (24) limits the maximum travel of control piston (10) to the left. The pump supplies a sufficient amount of flow that compensates for system leakage. The pump also supplies a sufficient of flow that compensates for leakage to the pump case. The leakage to the pump case is a result of the cross-drilled hole. The pump maintains low pressure standby. Low pressure standby pressure should not exceed 40 bar (580 psi).

※ Low pressure standby will vary in the same pump as the system leakage or the pump leakage increases. The pump will upstroke slightly in order to compensate for the increasing leakage. Control piston (10) will cover more of the cross-drilled hole.

(4) High pressure stall



1	Drive shaft	13	Flow compensator spool	19	LS line from the metering pump
2	Swash plate	14	Case drain	20	Cavity
4	Counter piston	15	Passage	21	Passage
6	Counter spring	16	Passage	22	Passage
10	Control piston	17	Spring	23	Cavity
12	Pressure compensator spool	18	Spring		

When the hydraulic system stalls under load or when the cylinders reach the end of the stroke, the main system pressure increases. But LS pressure (19) is regulated by LS relief valve on steering system and loader system. The pressure difference between discharged pump and LS pressure equal to spring (18). It means no flow is necessary. Therefore, discharged pressure push flow compensator spool (13) left . Supply oil now flows past flow compensator spool (13) and through passage (23). The oil flows past flow compensator spool (13) and into passage (22). The oil then flows to control piston (10).

Pump swash plate (2) will be minimum displacement if the operator does not turn the steering wheel and RCV, then the pump will return to low pressure standby.

(5) Adjustment of flow control

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

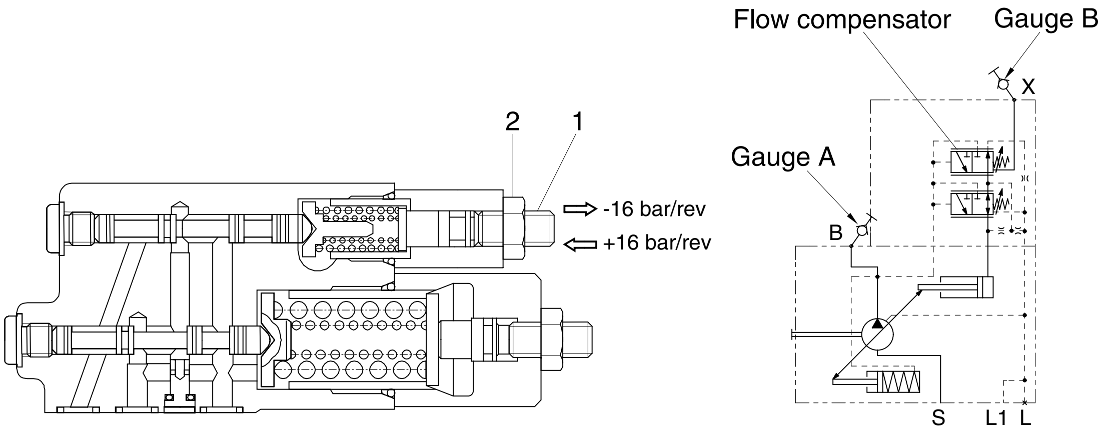
① **Conditions**

- Engine is running (at high or low idle).
- RCV is operated slowly (example : Boom up).
- Pressure gauges are installed.

※ Discharge pump flow should be less than max pump flow.

② **Procedures**

- Loosening the hexagon nut (2).
- Adjusting screw (1) of flow controller by tightening or loosing the screw (1).
  - · Flow setting : △P = Gauge A - Gauge B
  - · Specification : Steering pump (29 bar) / Loader pump (22 bar)



75796WE37

(6) Adjustment of pressure control

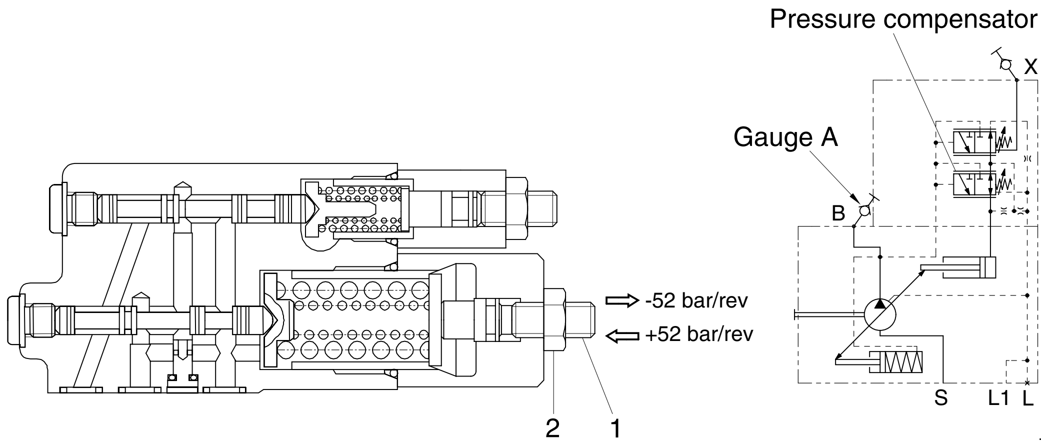
Pressure compensator setting must be carried out following procedures and conditions.

① **Conditions**

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

② **Procedures**

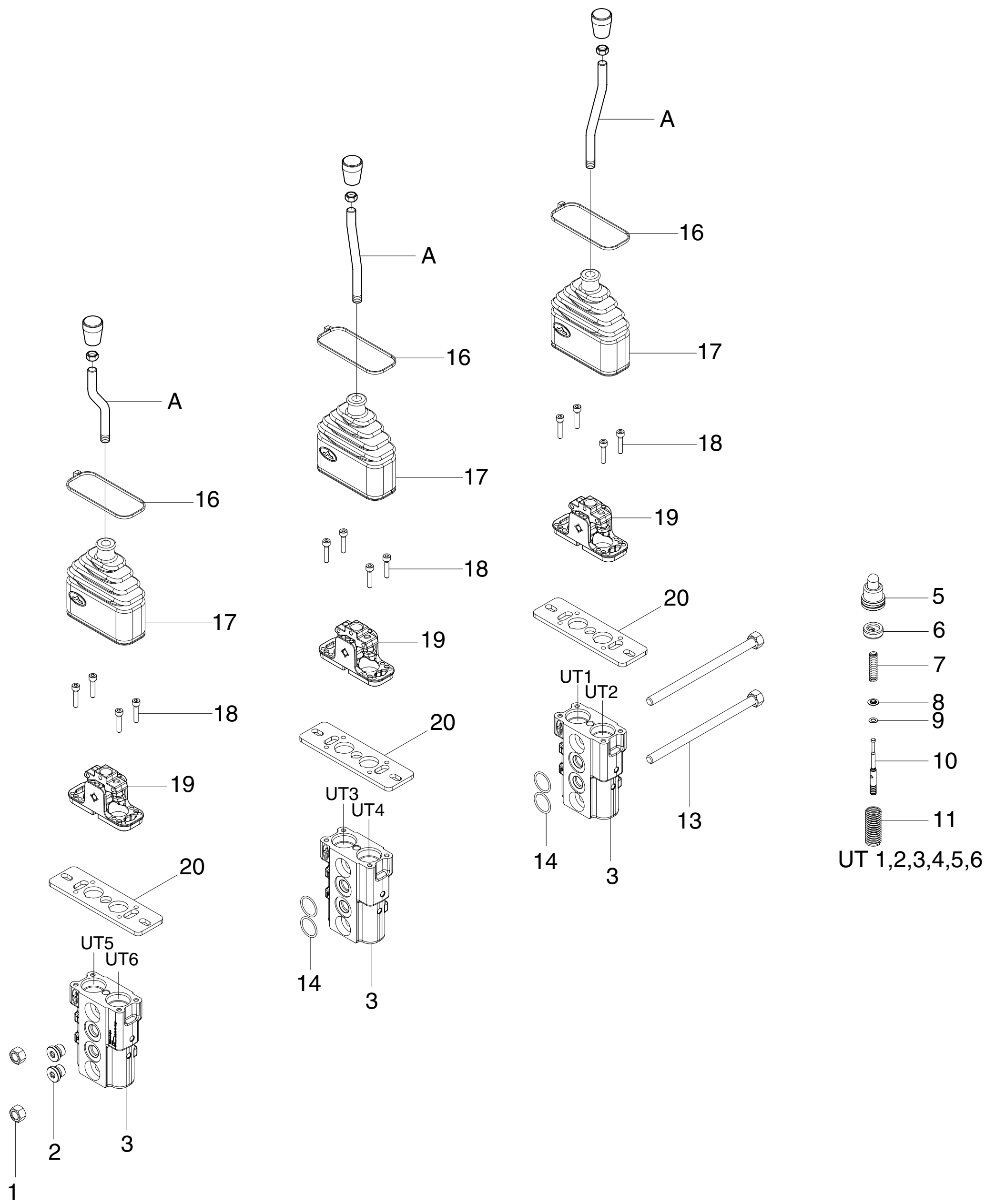
- Loosening the hexagon nut (2).
- Adjusting screw (1) of pressure controller by tightening or loosing the screw (1).
  - · Maximum pressure setting = Gauge A
  - · Specification : Steering pump (250 bar) / Loader pump (300 bar)



75796WE38

5. REMOTE CONTROL VALVE

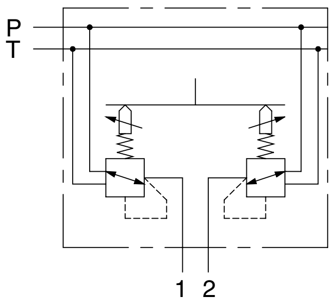
1) STRUCTURE



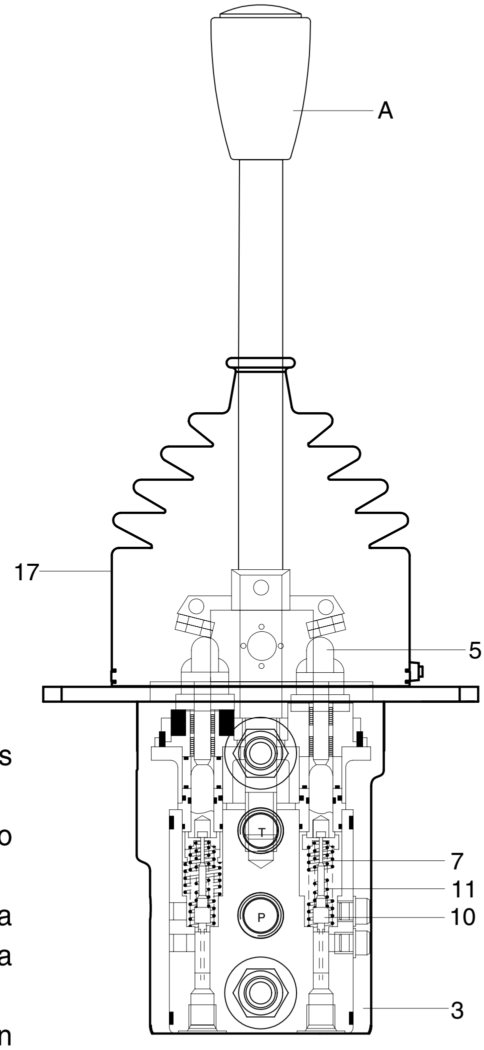
100D7RCV00

A	Lever	7	Metering spring	14	O-ring
1	Nut	8	Seeger ring	15	Kit 3
2	Plug	9	Seeger ring	16	Clamp
3	Body	10	Docking rod	17	Rubber bellows
4	Kit 1	11	Spring	18	Screw
5	Plunger kit	12	Kit 2	19	Support kit
6	Spring guide	13	Tie rod with nut	20	Flange

2) OPERATION



HYDRAULIC CIRCUIT



100D7RCV01

(1) Hydraulic functional principle

Pilot devices with end position locks operate as direct operated pressure reducing valves.

They basically comprise of control lever(A), two pressure reducing valves, body(3) and locks.

Each pressure reducing valve comprises of a plunger kit(5), a metering spring(7) and a spring(11).

At rest, control lever(A) is held in its neutral position by return springs(11). Ports(1, 2) are connected to tank port T.

When control lever(A) is deflected, plunger kit(5) is pressed against return spring(11) and metering spring(7).

Metering spring(7) initially moves docking rod(10) downwards and closes the connection between the relevant port and tank port T. At the same time the relevant port is connected to port P. The control phase starts as soon as docking rod(10) finds its balance between the force from metering spring(7) and the force, which results from the hydraulic pressure in the relevant port(ports 1, 2).

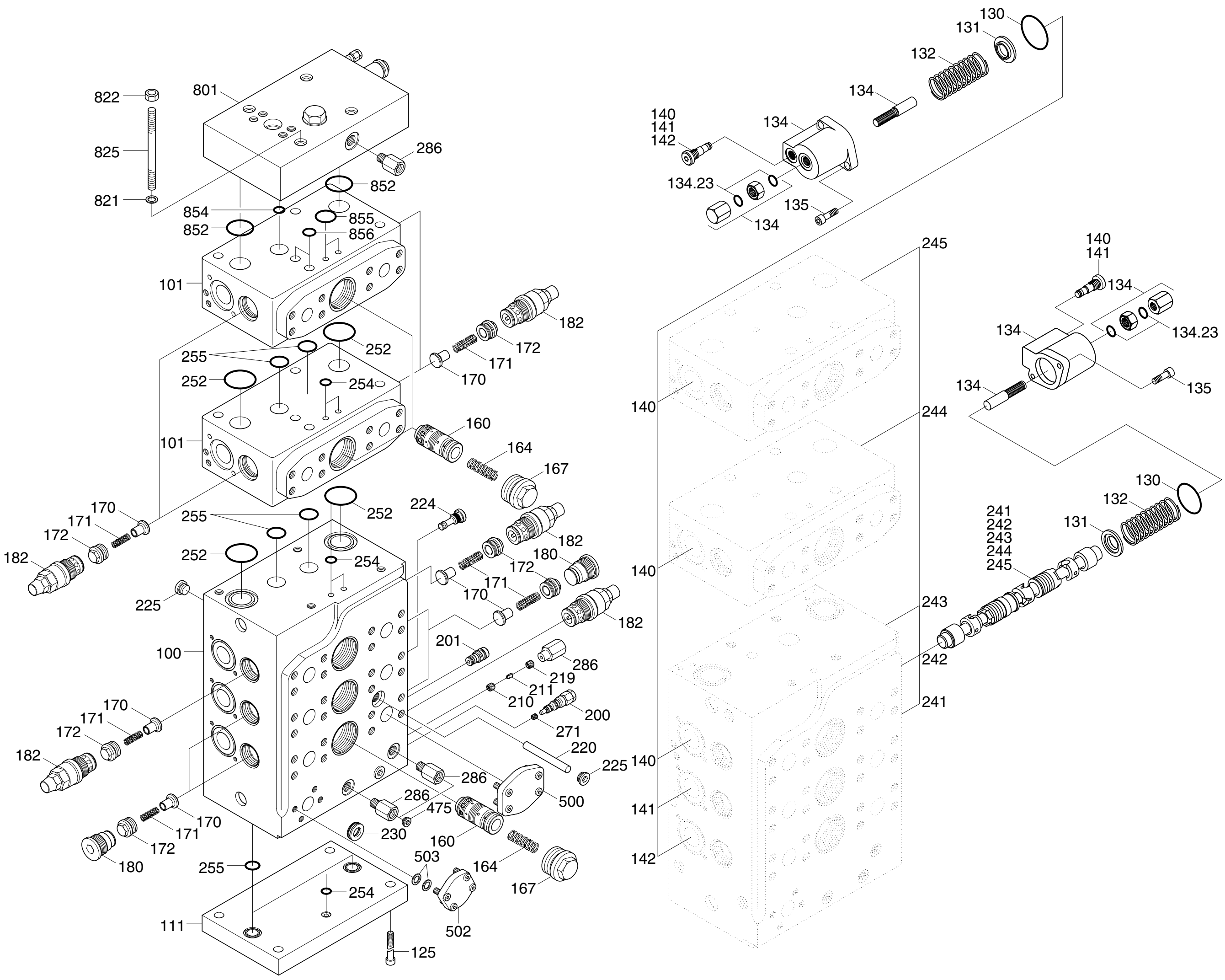
Due to the interaction between docking rod(10) and metering spring(7) the pressure in the relevant port is proportional to the stroke of plunger(5) and hence to the position of control lever(A).

This pressure control which is dependent on the position of the control lever and the characteristics of the control spring permits the proportional hydraulic control of the main directional valves and high response valves for hydraulic pumps.

A rubber bellows(17) protects the mechanical components in the housing from contamination.

6. MAIN CONTROL VALVE

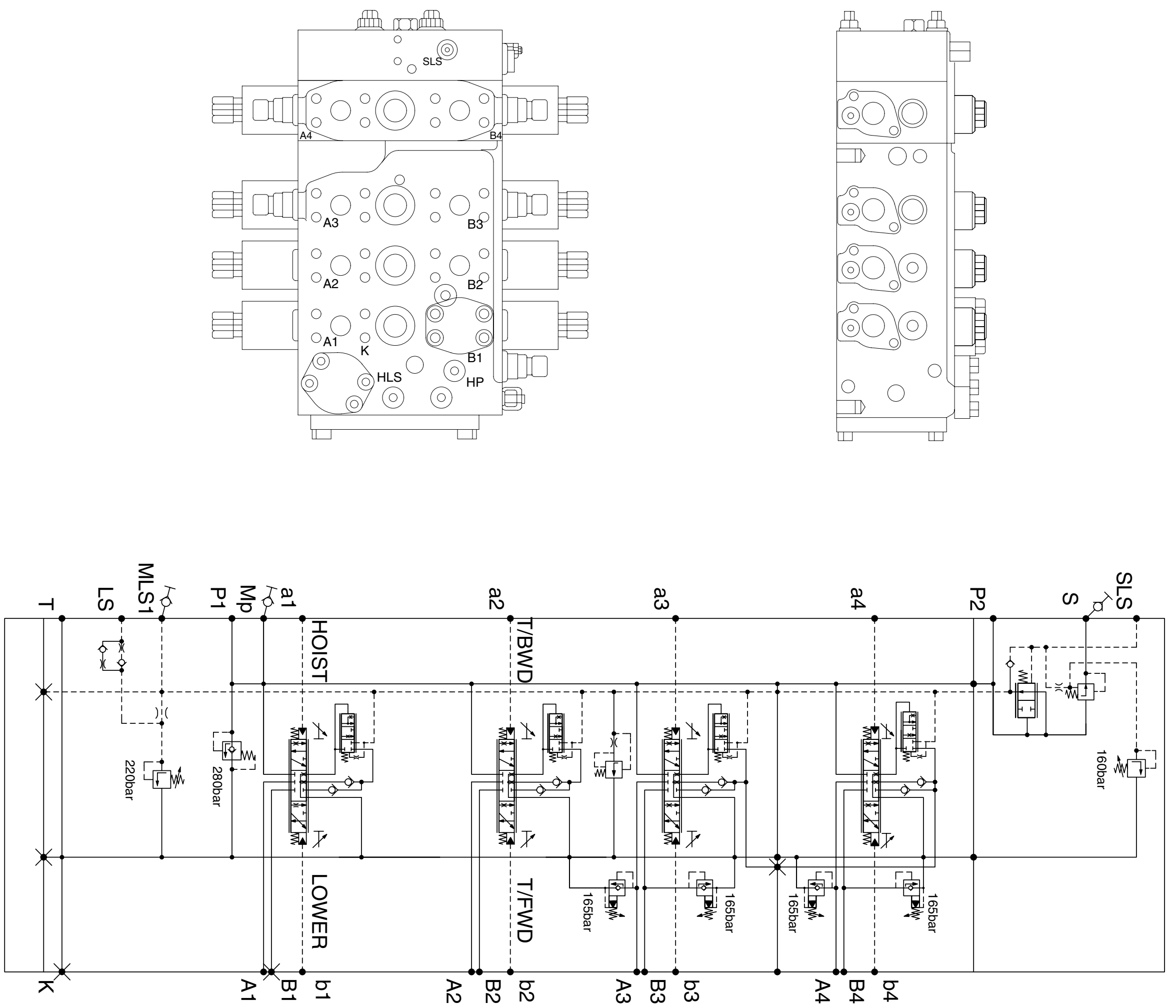
1) STRUCTURE



180D7EMCV01

100	Housing	160	Spool	220	Spool	286	Reducing piece
101	Housing	164	Compression spring	224	Locking screw	475	Locking screw
111	Plate	167	Locking screw	225	Locking screw	500	Blank flange
125	Cylinder	170	Cone	230	Connection piece	502	Blank flange
130	O-ring	171	Compression spring	241	Spool	503	Washer
131	Retainer spring	172	Locking screw	242	Spool	801	End block
132	Compression spring	180	Plug	243	Spool	821	Washer
134	Cover	182	Relief valve	244	Spool	822	Hexagonal nut
134.23	O-ring	200	Shuttle valve	245	Spool	825	Stud
135	Bolt	201	Drain orifice	252	O-ring	852	O-ring
140	Locking screw	210	Valve seat	254	O-ring	854	O-ring
141	Throttle check valve	211	Throttle bolt	255	Seal	855	O-ring
142	Throttle check valve	219	Valve seat	271	Orifice	856	Seal

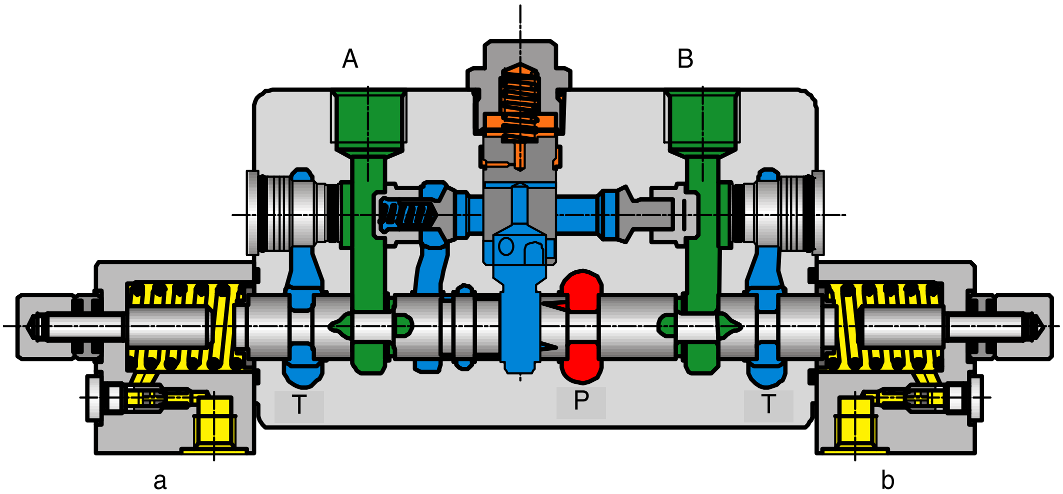
STRUCTURE



180D7EMCV02

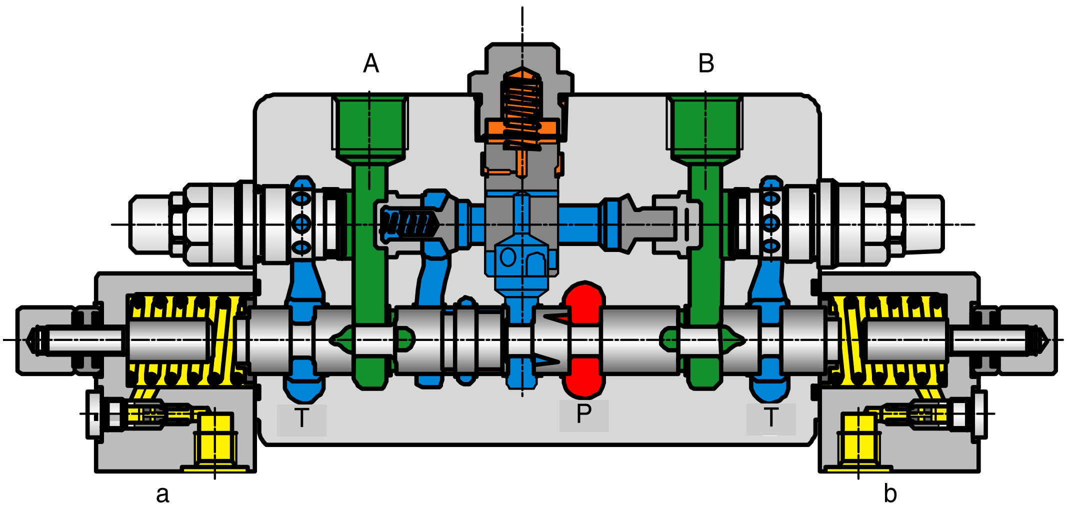
Port	Port name	Size	Port	Port name	Size
P1	From main pump	SAE 6000 psi 1 1/14"	a1, b1	From RCV lift port	9/16" - 18UNF
T	To hydraulic tank	SAE 6000 psi 1 1/14"	a2, b2	From RCV tilt port	9/16" - 18UNF
A1, B1	To lift cylinder port	SAE 6000 psi 1"	a3, b3	From RCV aux port	9/16" - 18UNF
A2, B2	To tilt cylinder port	SAE 6000 psi 1"	a4, b4	From RCV aux port	9/16" - 18UNF
A3, B3	To aux cylinder port	SAE 6000 psi 1"	LS	To shuttle valve	9/16" - 18UNF
A4, B4	To aux cylinder port	SAE 6000 psi 1"			
P2	From main pump	SAE 6000 psi 3/4"			
S	To steering unit	SAE 6000 psi 3/4"			

2) LIFT & TILT SECTION



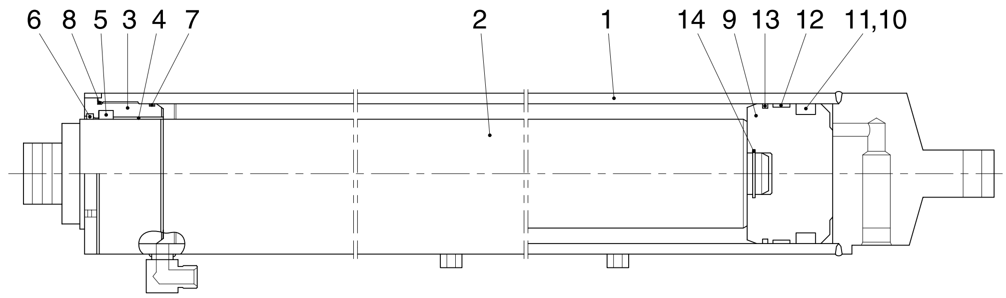
180D7EMCV12

3) AUXILIARY SECTION



180D7EMCV13

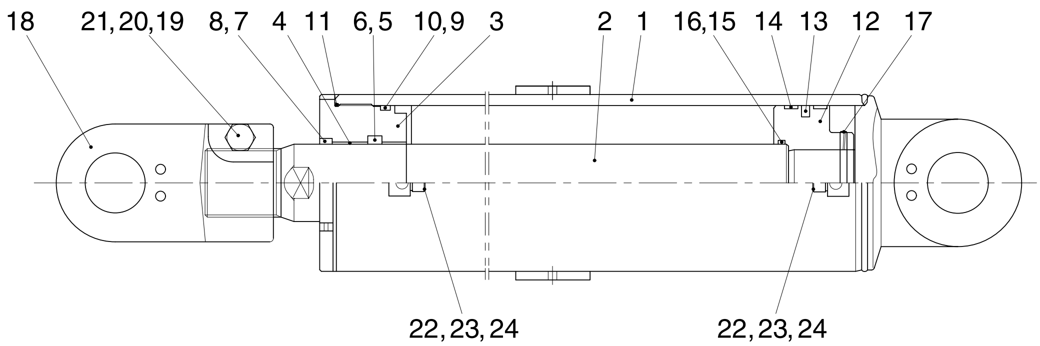
7. LIFT CYLINDER



250D7ECY01

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

8. TILT CYLINDER



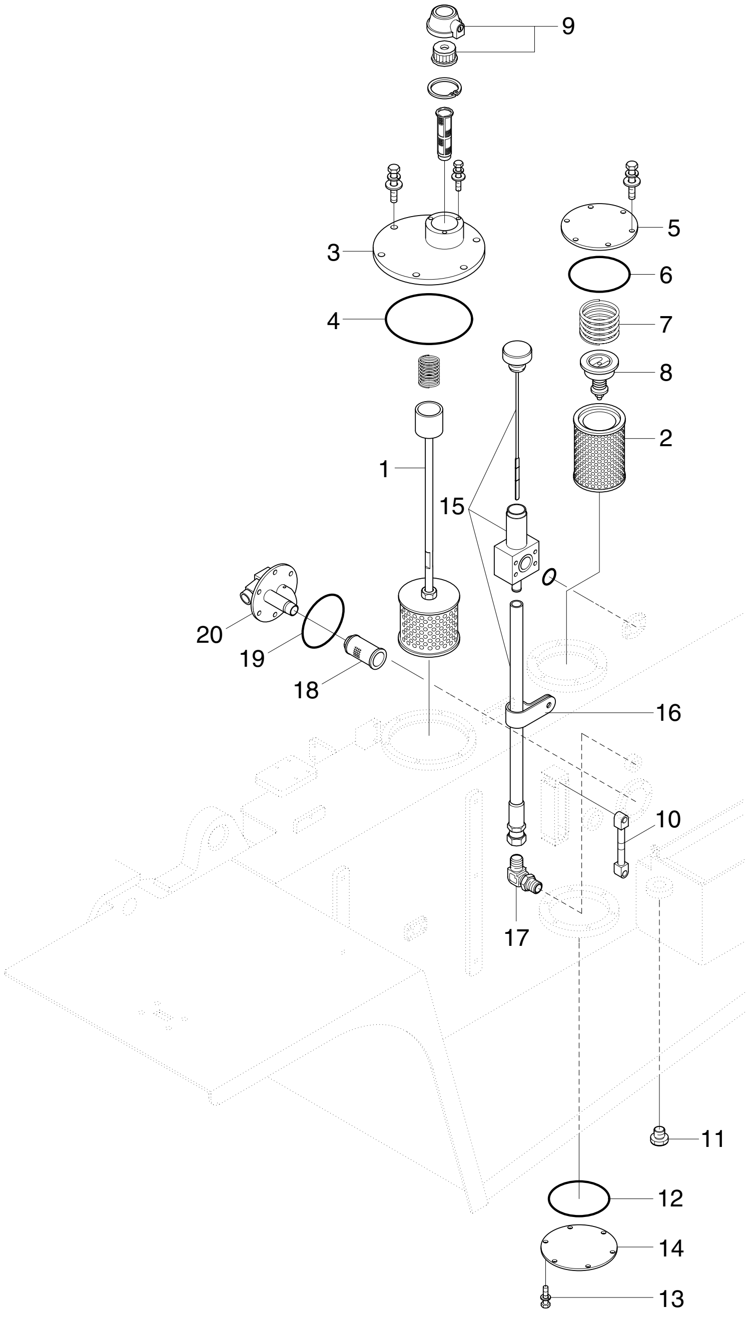
250D7ECY11

1	Tube assembly	9	O-ring	17	Set screw
2	Rod	10	Back up ring	18	Eye
3	Rod cover	11	O-ring	19	Hexagon bolt
4	DU-bushing	12	Piston	20	Spring washer
5	U-packing	13	Piston seal	21	Hexagon nut
6	Back up ring	14	Wear ring	22	O-ring
7	Dust wiper	15	O-ring	23	O-ring
8	Retaining ring	16	Back up ring	24	Dust cap

9. HYDRAULIC OIL TANK

1) STRUCTURE

- The oil from the hydraulic tank is sent from the pump through main control valve to the cylinders. In the return circuit, the oil from various parts merges.
- A part of oil is cooled in the oil cooler, passes through the hydraulic filter and returns to the hydraulic tank.



250D7EHS13

1	Strainer	8	Bypass valve	15	Dipstick gauge
2	Element	9	Air breather cap	16	Clamp
3	Cover	10	Level gauge	17	Elbow
4	O-ring	11	Magnetic plug	18	Element
5	Cover	12	O-ring	19	O-ring
6	O-ring	13	Bolt with washer	20	Cover
7	Spring	14	Suction flange		

2) AIR BREATHER

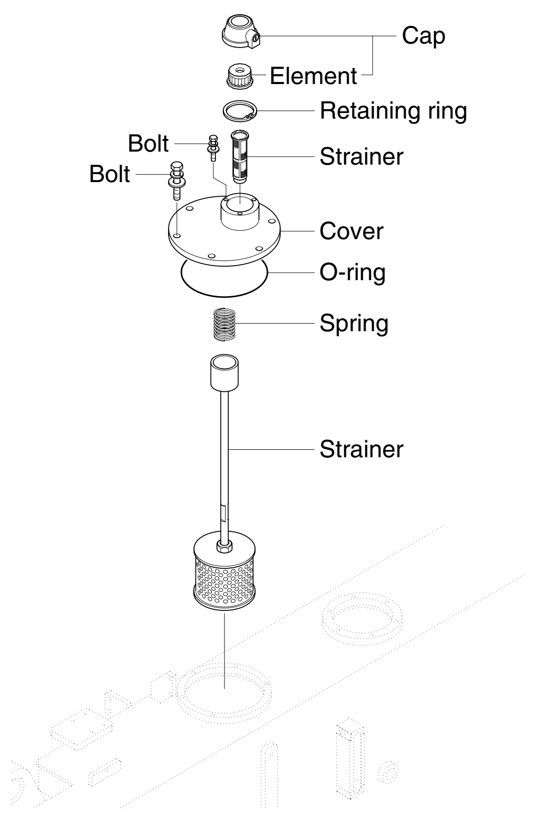
The air breather is equipped with the capacity to perform two functions simultaneously-as an air filter and as a breathing valve.

(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.

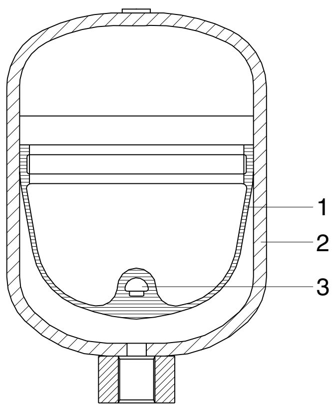


250D7EHT02

10. ACCUMULATOR

The accumulator is installed at the cut off valve. When the mast is left the raised position, and the control levers are operated with the engine stopped the pressure of the compressed nitrogen gas inside the accumulator sends pilot pressure to the control valve to actuate it and allow the boom and bucket to come down under their own weight.

Type of gas	Nitrogen gas(N_2)
Volume of gas	0.35 ℓ (0.1 U.S.gal)
Charging pressure of gas	15kg/cm² (213psi)
Max actuating pressure	170kg/cm² (2420psi)



1 Diaphragm
2 Steel pressure vessel
3 Closure button

7803AWE56

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

1. OPERATIONAL CHECKS

1) CHECK ITEM

(1) Check visually for deformation, cracks or damage of rod.

(2) Set mast vertical and raise 1m 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.

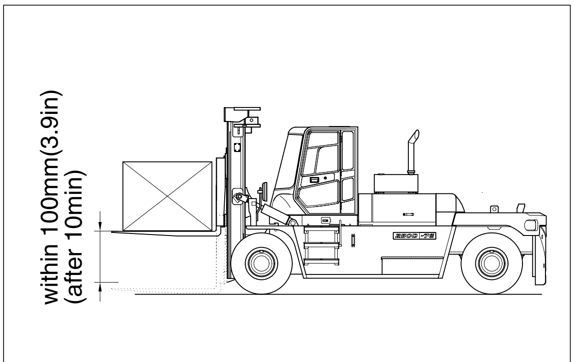
· **Hydraulic drift**

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

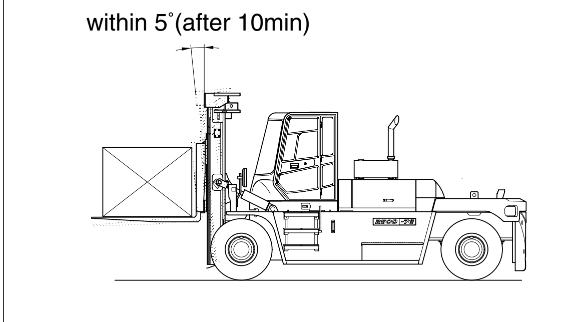
(3) If the hydraulic drift is more than the specified value, replace the control valve or cylinder packing.
Check that clearance between tilt cylinder bushing and mounting pin is within standard range.

mm (in)

Standard	Under 0.6 (0.02)



250D7EHS14

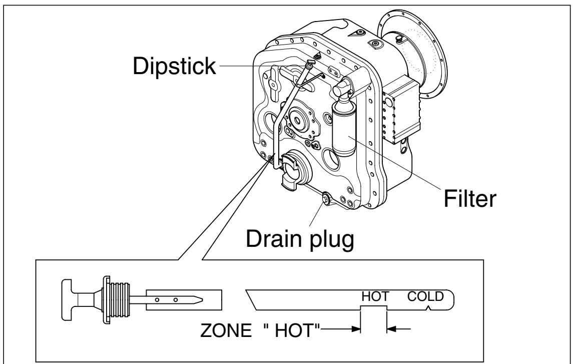


250D7EHS15

2) HYDRAULIC OIL

(1) Using dipstick, measure oil level, and oil if necessary.

(2) When changing hydraulic oil, clean suction strainer(screwed into outlet port pipe) and line filter(screwed into inlet pipe). Line filter uses paper element, so replace periodically(every 6 months or 1200 hours)



250D7EHS16

3) CONTROL VALVE

(1) Raise forks to maximum height and measure oil pressure.
Check that oil pressure is 210kgf/cm^2.
(2990psi)

2. TROUBLESHOOTING

1) SYSTEM

Problem	Cause	Remedy
Large fork lowering speed.	· Seal inside control valve defective. · Oil leaks from joint or hose. · Seal inside cylinder defective.	· Replace spool or valve body. · Replace. · Replace packing.
Large spontaneous tilt of mast.	· Tilting backward : Check valve defective. · Tilting forward : tilt lock valve defective. · Oil leaks from joint or hose. · Seal inside cylinder defective.	· Clean or replace. · Clean or replace. · Replace. · Replace seal.
Slow fork lifting or slow mast tilting.	· Lack of hydraulic oil. · Hydraulic oil mixed with air. · Oil leaks from joint or hose. · Excessive restriction of oil flow on pump suction side. · Relief valve fails to keep specified pressure. · Poor sealing inside cylinder. · High hydraulic oil viscosity. · Mast fails to move smoothly. · Oil leaks from lift control valve spool. · Oil leaks from tilt control valve spool.	· Add oil. · Bleed air. · Replace. · Clean filter. · Adjust relief valve. · Replace packing. · Change to SAE10W, class CF engine oil. · Adjust roll to rail clearance. · Replace spool or valve body. · Replace spool or valve body.
Hydraulic system makes abnormal sounds.	· Excessive restriction of oil flow pump suction side. · Gear or bearing in hydraulic pump defective.	· Clean filter. · Replace gear or bearing.
Control valve lever is locked	· Foreign matter jammed between spool and valve body. · Valve body defective.	· Clean. · Tighten body mounting bolts uniformly.
High oil temperature.	· Lack of hydraulic oil. · High oil viscosity. · Oil filter clogged.	· Add oil. · Change to SAE10W, class CF engine oil. · Clean filter.

Problem	Cause	Remedy
Actuator(cylinder or motor) works slowly or does not operate.	· Shortage of oil in oil tank. · Decrease of relief valve pressure. · Spool got stuck. · Shortage of oil flow to the valve.	· Check the oil level in the oil tank. · Install pressure gauge on the circuit, and check the pressure with it by handling the lever. · Check that manual lever moves smoothly. · Check that lever stroke is enough. · Check that oil flow of the pump is within specified rate.
Cylinder lowers considerably under normal circumstance.	· Internal leakage of cylinder happens frequently. · Excessive leakage from spool of the valve. · Spool got stuck. · Leakage in a part of the circuit.	· Fit the stop valve on the pipe between valve and cylinder, observe the internal leakage of cylinder. · Check the oil viscosity is not too low. · Check that manual lever moves smoothly. · Check the circuit. · Observe leakage from pipes.
Pressure does not increase sufficiently.	· Defect of relief valve. · Leakage in a part of the circuit.	· Check the relief valve. · Check the circuit. · Observe leakage from pipes.
Temperature rising of the hydraulic oil.	· Working with higher pressure than rated pressure. · Low viscosity of oil. · Leakage from a part of the circuit. · Oil leakage in the pump. · Insufficient suction of the pump.	· Check the flow pressure. · Check the sort of oil and viscosity. · Check if the circuit is relieved at all times. · Check if the temperature of pump surface higher 30°C than oil temperature. · Check the oil tank volume. · Check if the suction strainer is blocked.
Steering force is heavy.	· Defect of steering relief valve.	· Check the steering relief valve.

2) HYDRAULIC GEAR PUMP

Problem	Cause	Remedy
Pump does not develop full pressure.	· System relief valve set too low or leaking. · Oil viscosity too low. · Pump is worn out.	· Check system relief valve for proper setting. · Change to proper viscosity oil. · Repair or replace pump.
Pump will not pump oil.	· Reservoir low or empty. · Suction strainer clogged.	· Fill reservoir to proper level. · Clean suction strainer.
Noisy pump caused by cavitation.	· Oil too thick. · Oil filter plugged. · Suction line plugged or too small.	· Change to proper viscosity. · Clean filters. · Clean line and check for proper size.
Oil heating.	· Oil supply low. · Contaminated oil. · Setting of relief valve too high or too low. · Oil viscosity too low.	· Fill reservoir to proper level. · Drain reservoir and refill with clean oil. · Set to correct pressure. · Drain reservoir and fill with proper viscosity.
Foaming oil.	· Low oil level. · Air leaking into suction line. · Wrong kind of oil.	· Fill reservoir to proper level. · Tighten fittings, check condition of line. · Drain reservoir, fill with non-foaming oil.
Shaft seal leakage.	· Worn shaft seal. · Worn shaft in seal area.	· Replace shaft seal. · Replace drive shaft and seal.

3) MAIN RELIEF VALVE

Problem	Cause	Remedy
Can't get pressure	· Poppet stuck open or contamination under seat.	· Check for foreign matter between puppets and their mating parts. Parts must slide freely.
Erratic pressure	· Pilot poppet seat damaged.	· Replace the relief valve. · Clean and remove surface marks for free movement.
Pressure setting not correct	· Normal wear. Lock nut & adjust screw loose.	· See *How to set pressure on work main relief.
Leaks	· Damaged seats. · Worn O-rings. · Parts sticking due to contamination.	· Replace the relief valve. · Install seal and spring kit. · Disassemble and clean.

★ A good pressure gauge must be installed in the line which is in communication with the main relief. A load must be applied in a manner to reach the set pressure of the main relief unit.
Then, follow these steps:

· Loosen lock nut.
· Set adjusting nut to desired pressure setting.
· If desired pressure setting cannot be achieved, add or remove shims as required.
· Tighten lock nut.
· Retest in similar manner as above.

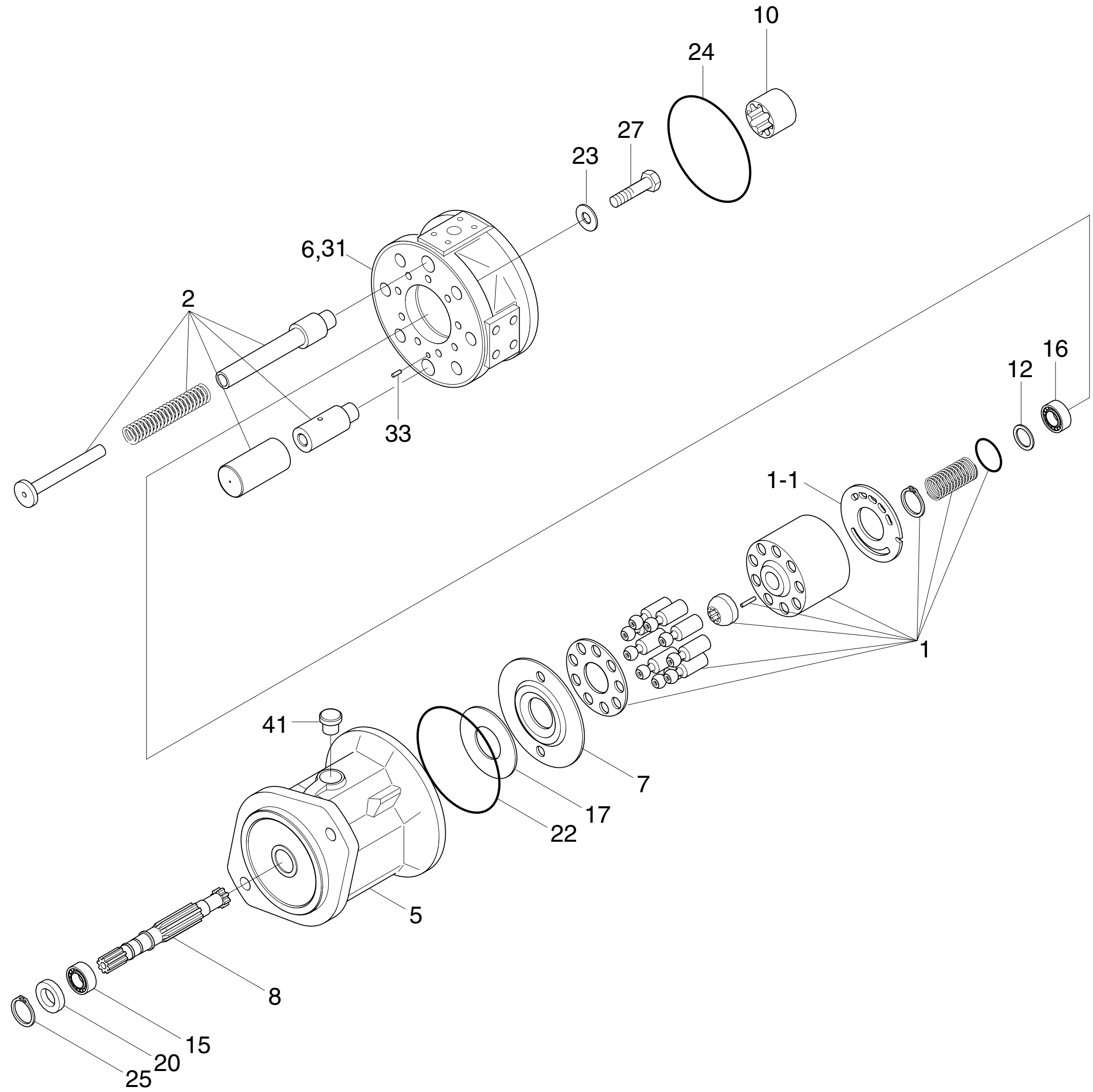
4) CYLINDER

Problem	Cause	Remedy
Oil leaks out from gland through rod.	· Foreign matters on packing. · Unallowable score on rod. · Unusual distortion of dust seal. · Chrome plating is striped.	· Replace packing. · Smooth rod surface with an oil stone. · Replace dust seal. · Replace rod.
Oil leaks out from cylinder gland thread.	· O-ring damaged.	· Replace O-ring.
Rod spontaneously retract.	· Scores on inner surface of tube. · Unallowable score on the inner surface of tube. · Foreign matters in piston seal.	· Smooth rod surface with an oil stone. · Replace cylinder tube. · Replace piston seal.
Wear(clearance between cylinder tube and wear ring)	· Excessive clearance between cylinder tube and wear ring.	· Replace wear ring.
Abnormal noise is produced during tilting operation.	· Insufficient lubrication of anchor pin or worn bushing and pin. · Bent tilt cylinder rod.	· Lubricate or replace. · Replace.

GROUP 3 DISASSEMBLY AND ASSEMBLY

1. MAIN PUMP

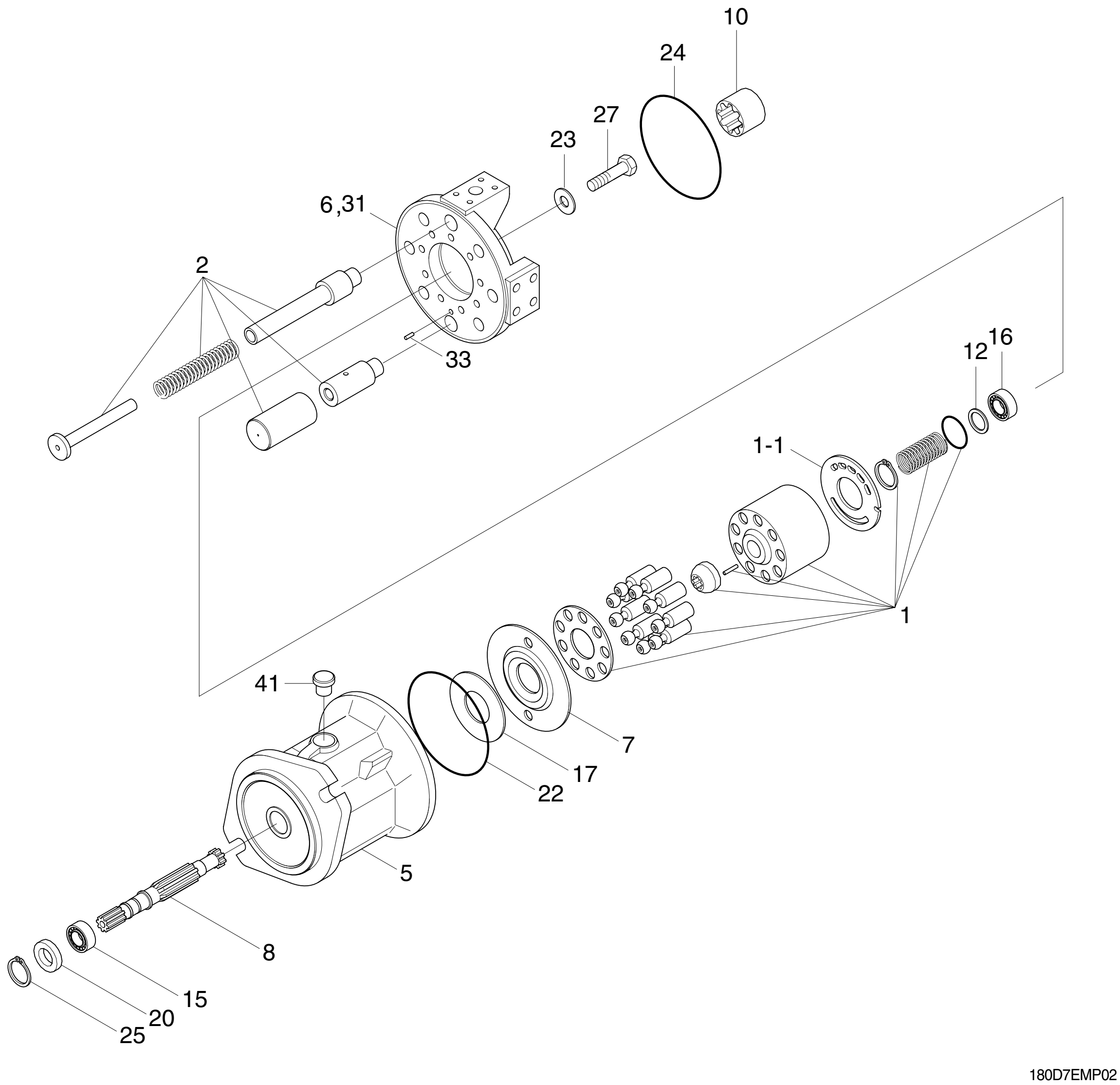
1) STRUCTURE (front)



180D7EMP01

1	Rotary group	10	Splined hub	23	O-ring
1-1	Control plate	12	Adjustment shim	24	O-ring
2	Adjusting piece	15	Tapered R/bearing	25	Retaining ring
5	Pump housing	16	Tapered R/bearing	27	Socket head screw
6	Port plate	17	Bearing liner	31	Double break-off pin
7	Swash plate	20	Shaft seal ring	33	Cylinder pin
8	Drive shaft	22	O-ring	41	Plug

STRUCTURE (rear)



1	Rotary group	12	Adjustment shim	24	O-ring
1-1	Control plate	15	Tapered R/bearing	25	Retaining ring
2	Adjusting piece	16	Tapered R/bearing	27	Socket head screw
5	Pump housing	17	Bearing liner	31	Double break-off pin
6	Port plate	20	Shaft seal ring	33	Cylinder pin
7	Swash plate	22	O-ring	41	Plug
8	Drive shaft	23	O-ring		
10	Splined hub				

2) GENERAL REPAIR GUIDE LINES

※ Observe the following guidelines when carrying out repairs on hydraulic pumps.

(1) Close off all openings of the hydraulic unit.

(2) Replace all of the seals.
Use only original spare parts.

(3) Check all sealing and sliding surfaces for wear.

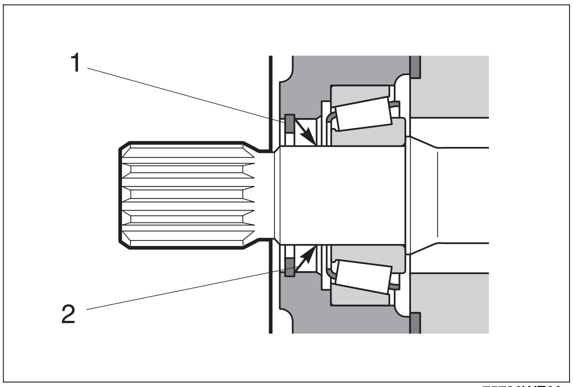
※ Re-work of the sliding surfaces by using, for example abrasive paper, can damage the surface.

(4) Fill the hydraulic pump with hydraulic oil before commissioning.

3) SEALING THE DRIVE SHAFT

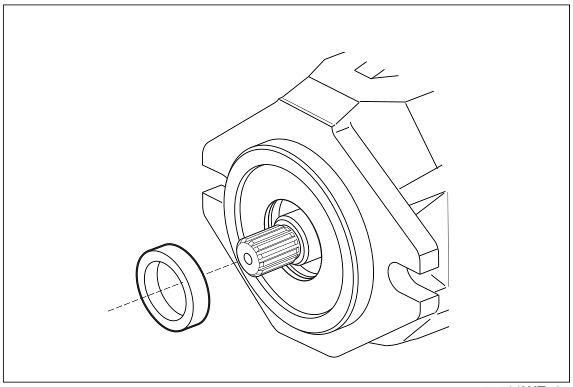
(1) Protect the drive shaft.
Remove the circlip.
Remove the shaft seal.

1 Circlip 2 Shaft seal



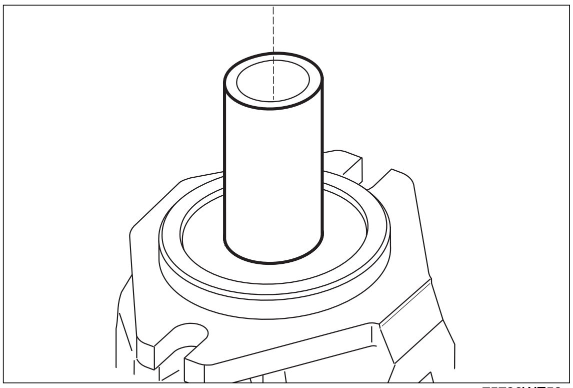
75796WE60

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



75796WE58

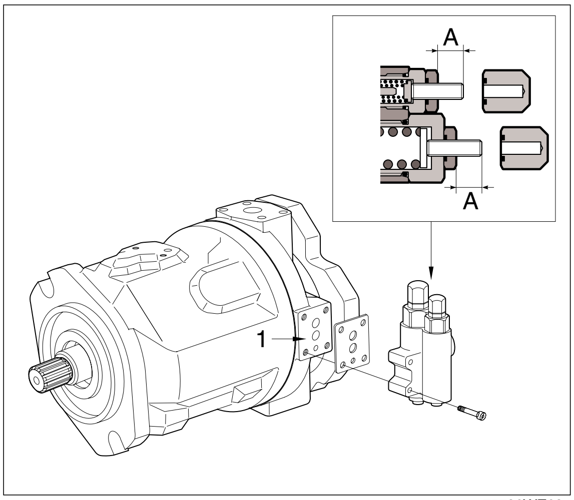
(3) Assemble the sealing ring, fitting tool holds the correct position of the sealing ring in the pump housing.
Assemble the circlip in the correct position.



75796WE59

4) SEALING / CLEANING THE CONTROL VALVE

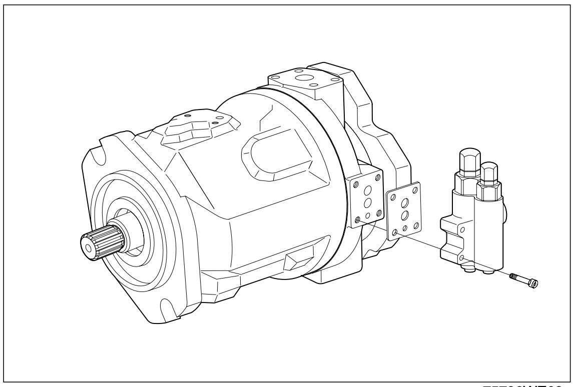
(1) Disassemble the control valve.
※ Measure dimension A and note down. Check sealing surface (1).



75796WE62

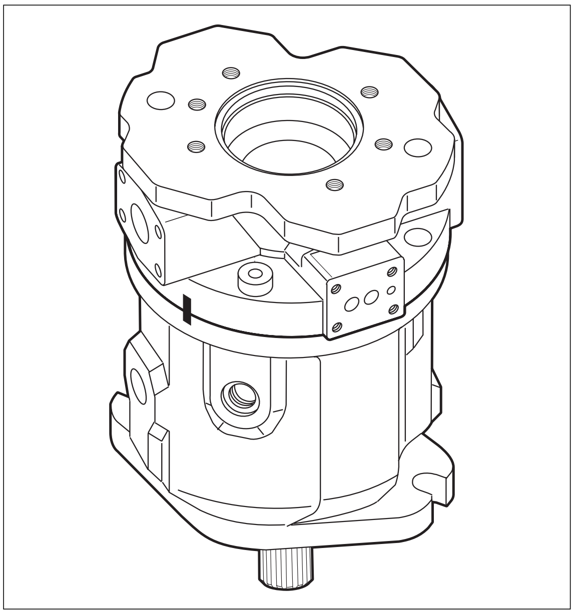
5) DISASSEMBLE THE PUMP

(1) Remove the control valve.



75796WE63

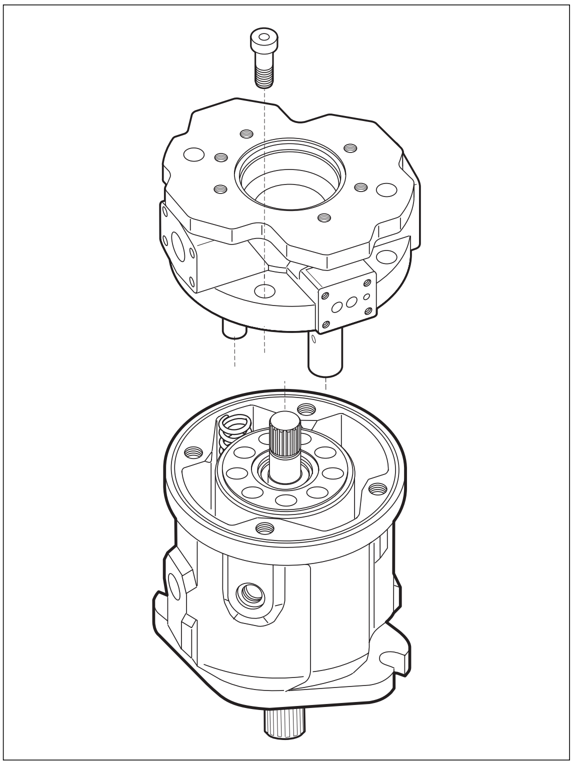
(2) Mark the location of the connection plate on the housing.



75796WE64

(3) Remove the connection plate fixing bolts and the connection plate.

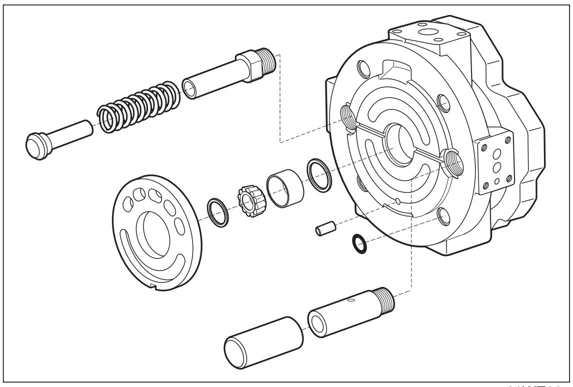
※ Distributor plate and adjustment piston can drop down.



75796WE65

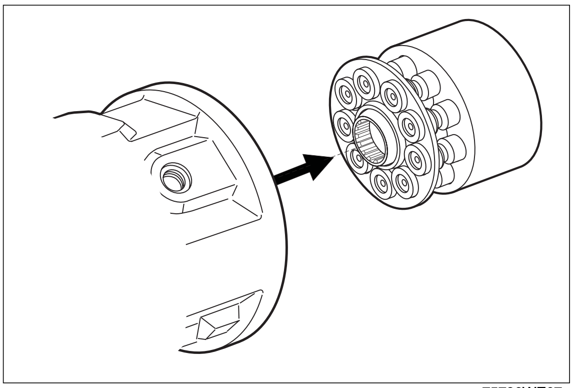
(4) Remove distributor plate.
Take note of the orientation.

※ Remove bearing with withdrawal tool.
Do not damage the sealing surface.



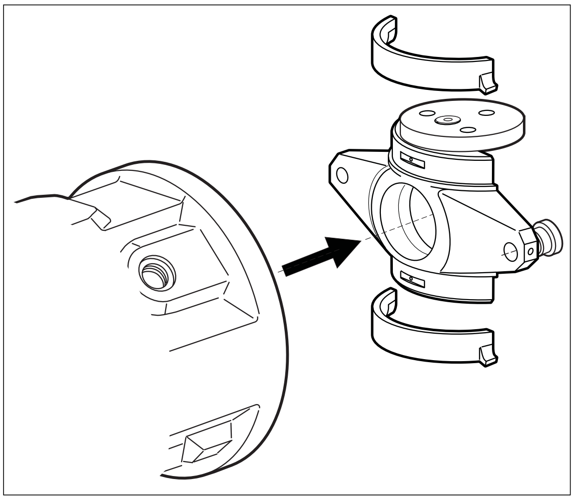
75796WE66

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



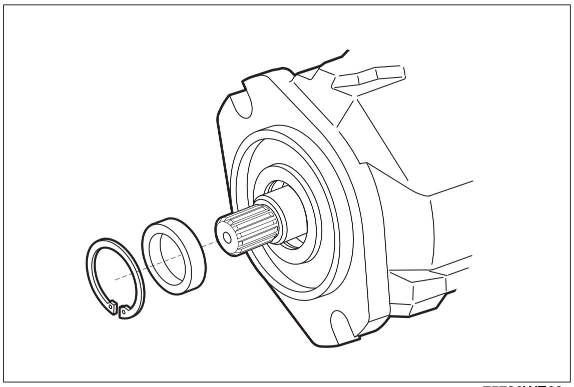
75796WE67

(6) Remove swash plate and bearing shells.



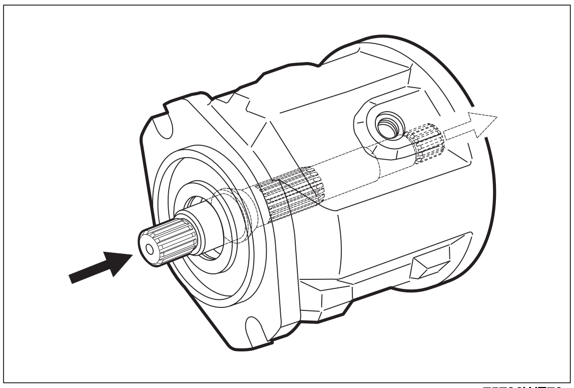
75796WE68

(7) Remove the circlip and the shaft seal.



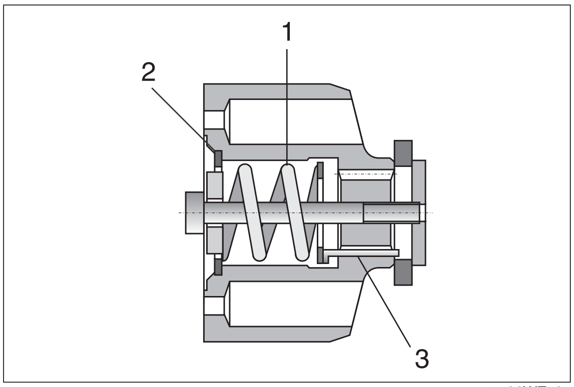
75796WE69

(8) Remove the drive shaft through rear side.



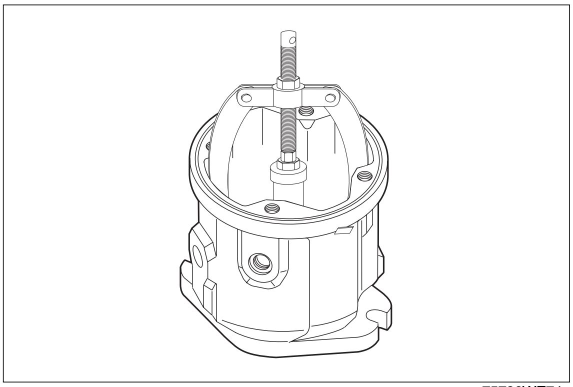
75796WE70

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



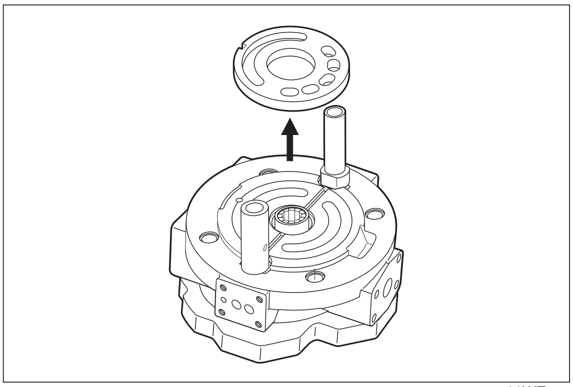
75796WE72

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



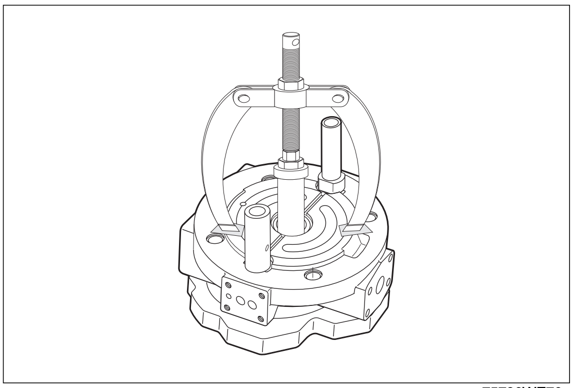
75796WE74

(11) Remove the control plate.



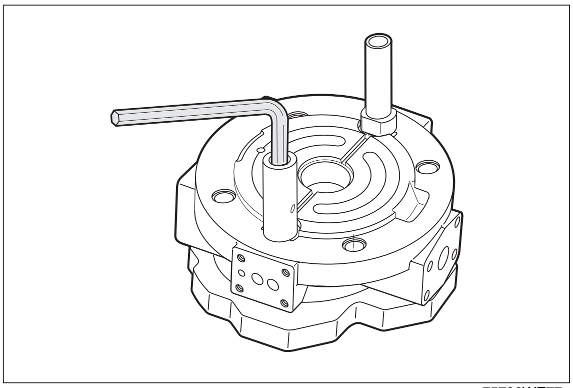
75796WE75

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



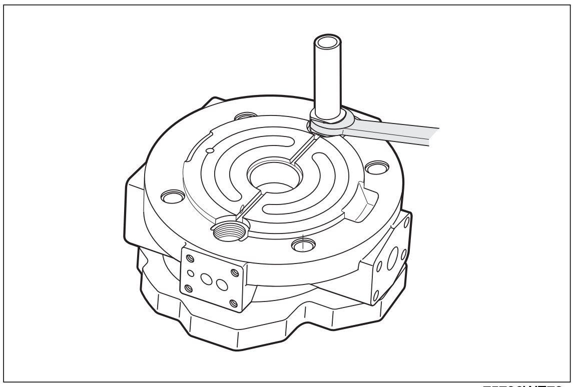
75796WE76

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



75796WE77

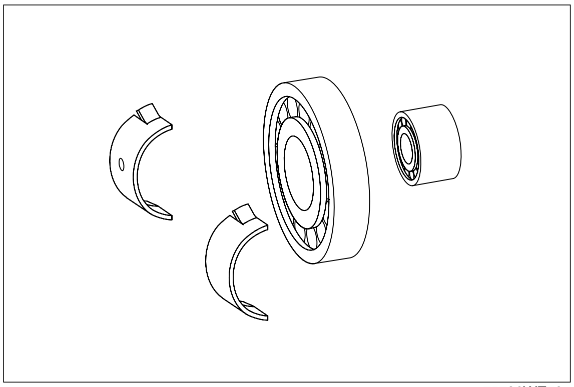
(14) Disassemble the guide of the opposite piston.



75796WE78

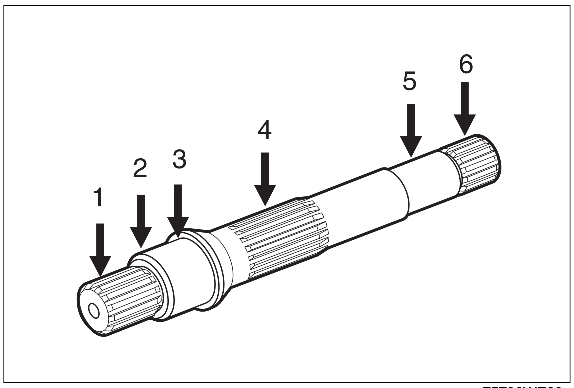
6) INSPECT HINTS

(1) Renew all bearings.



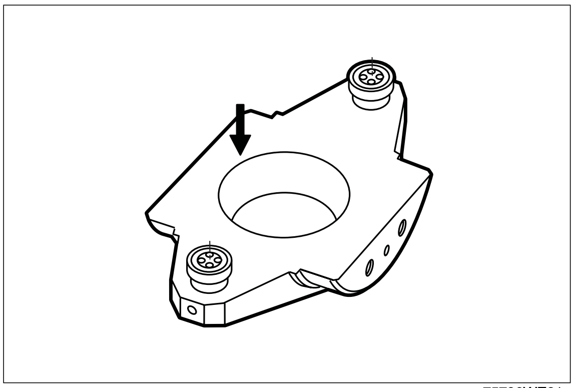
75796WE79

(2) Check :
1 Wear on splines, rust
2 Drive shaft seal wear grooves
3 Bearing seat
4 Splines for cylinder drive
5 Bearing seat



75796WE80

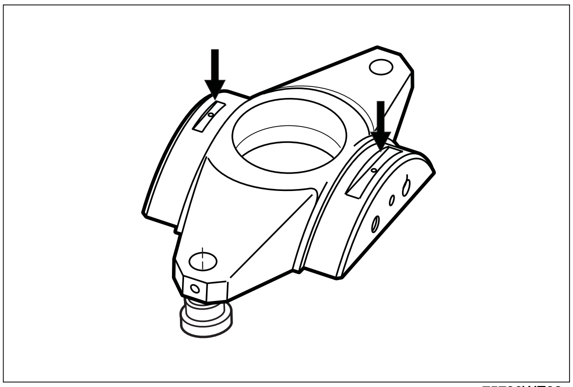
(3) Check :
Sliding surface free of grooves.



75796WE81

(4) Check :

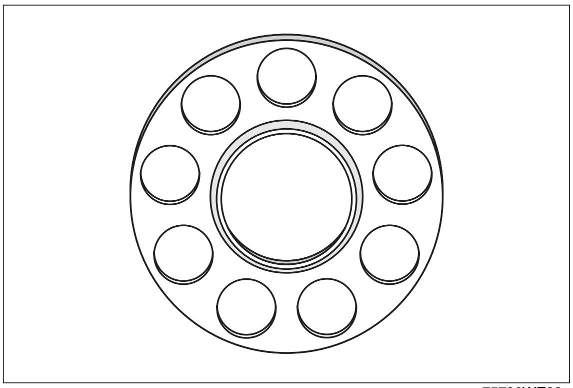
Bearing surfaces.



75796WE82

(5) Check :

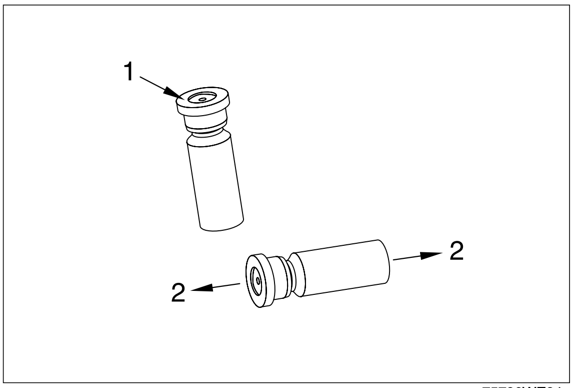
That the retaining plate is free of grooves and that there is no wear in the slipper pad area.



75796WE83

(6) Check :

Check to see that there are no scratches or metal deposits on the sliding surface (1) and that there is no axial play (2) (Pistons must only be replaced as a set).

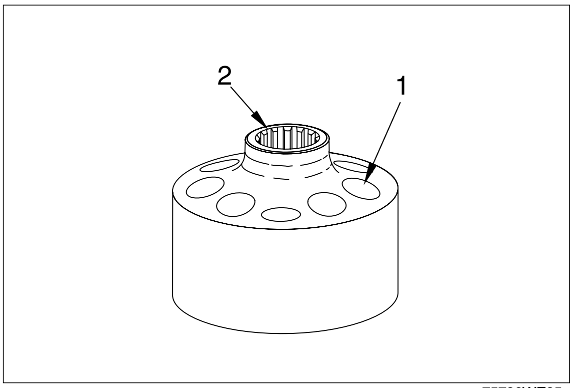


75796WE84

(7) Check :

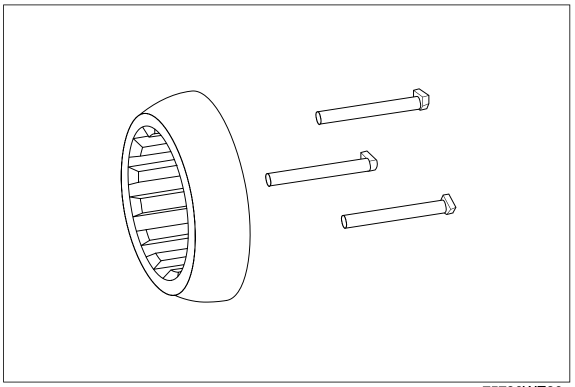
1 Cylinder bores

2 Splines



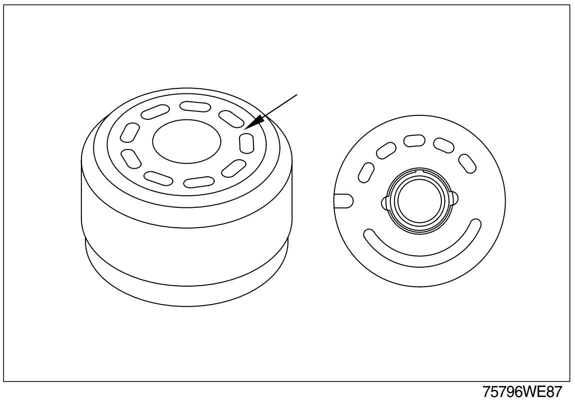
75796WE85

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



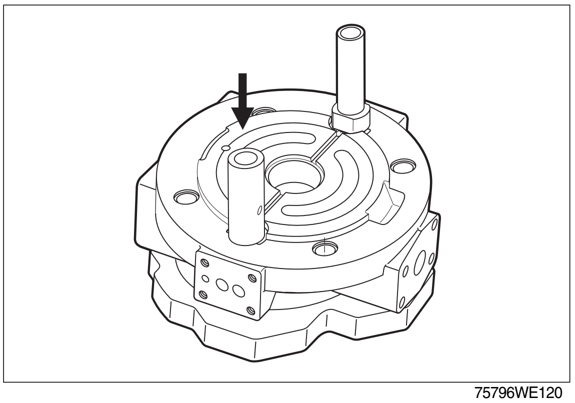
75796WE86

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



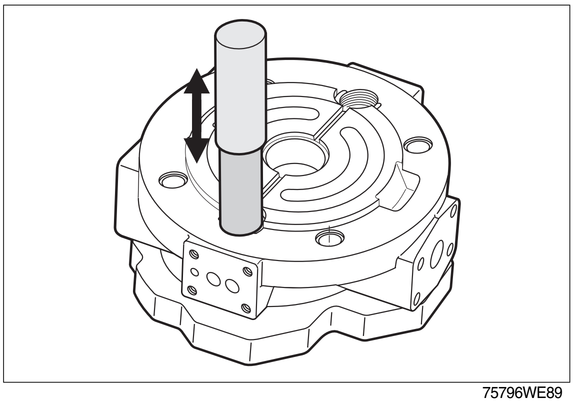
75796WE87

(10) Check :
Mounting surface - control plate undamaged.



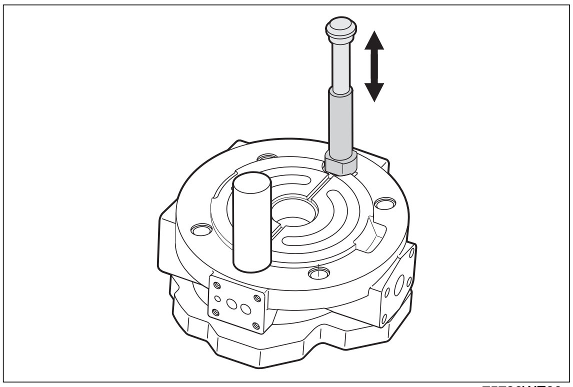
75796WE120

(11) Check :
Check running conditions of the control piston.



75796WE89

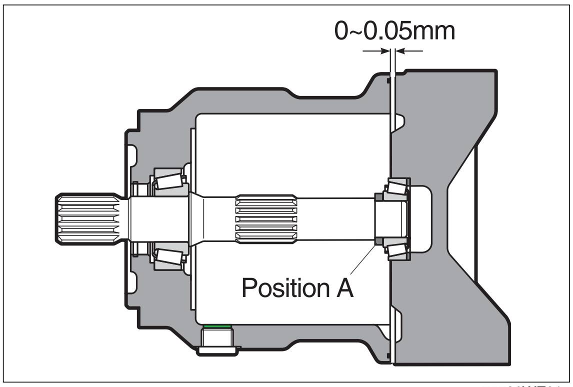
(12) Check :
Check running conditions of the opposite piston.



75796WE90

7) ADJUSTMENT OF TAPER ROLLER BEARING SET

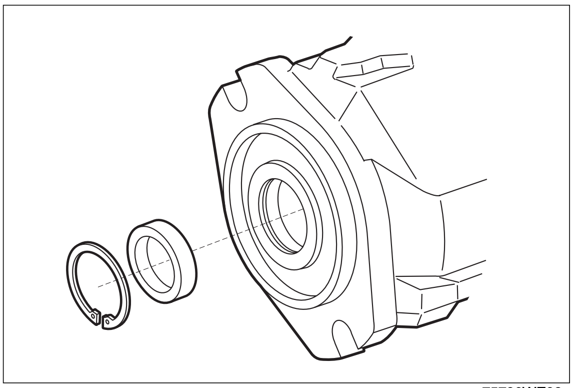
(1) Cast iron housing must have initial tension of the bearings : 0~0,05 mm, grind position A if necessary.



75796WE91

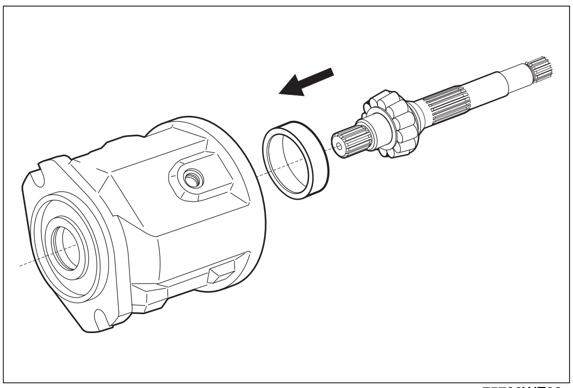
8) PUMP ASSEMBLY

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



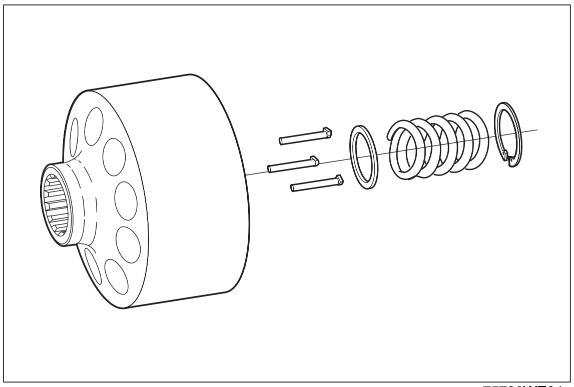
75796WE92

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



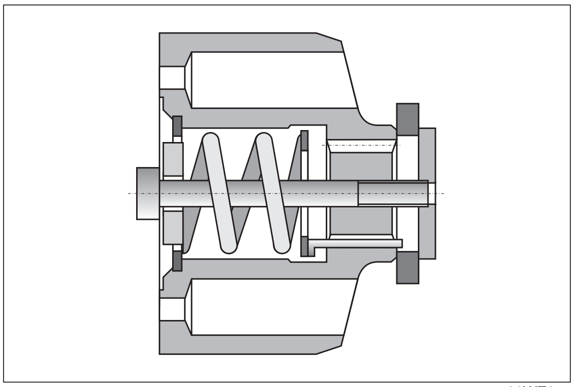
75796WE93

(3) Fit pressure pins using an assembly aid.



75796WE94

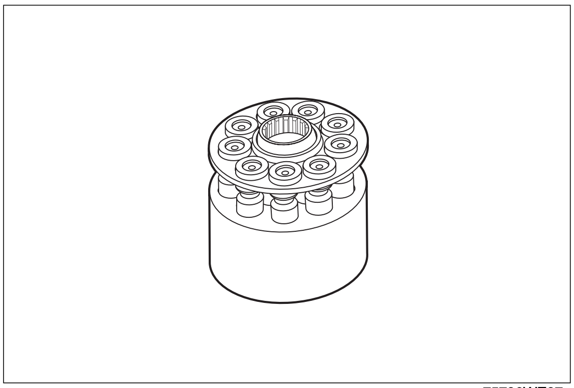
(4) Pre-tension the spring using a suitable device.



75796WE95

(5) Assemble piston with retaining plate.

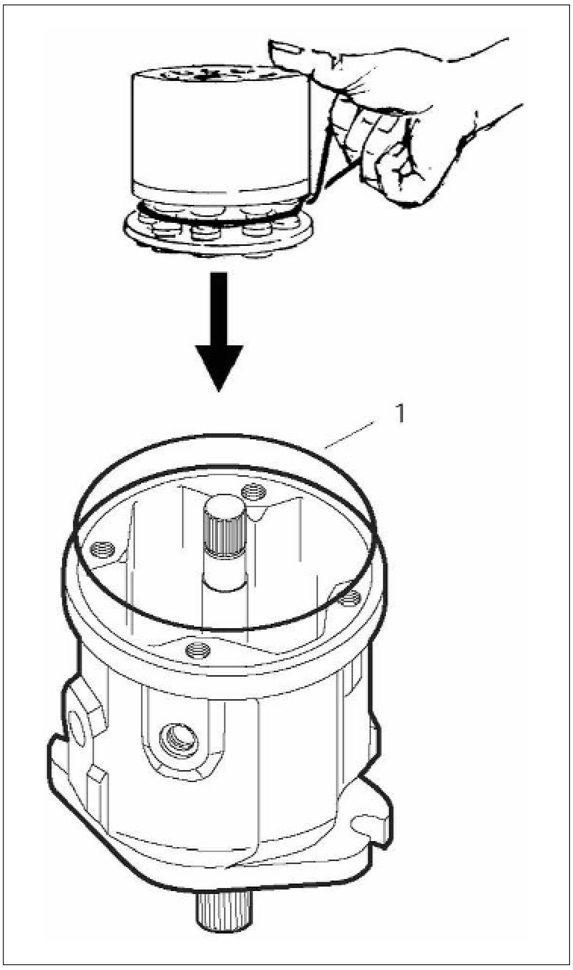
※ Oil piston and slipper pad.



75796WE97

(6) Fit rotary group.

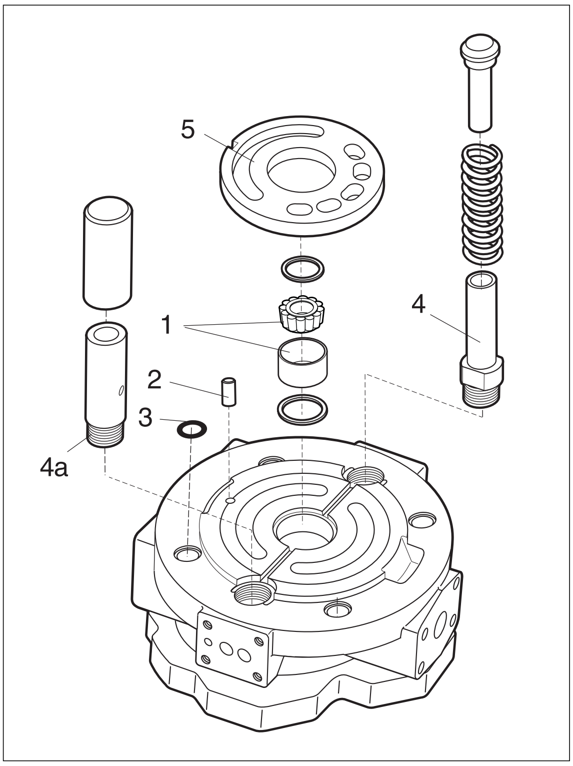
※ Hold the piston by using an O-ring.
Fit O-ring (1).



75796WE98

(7) Fit bearing (1) in connection plate.
Fit cyilindrical pin (2).
Fit O-rings (3) 4 pieces.
Fit adjustment spool (4) and guide piston (4a).
Fit distributor plate (5) (direction of rotation dependent)

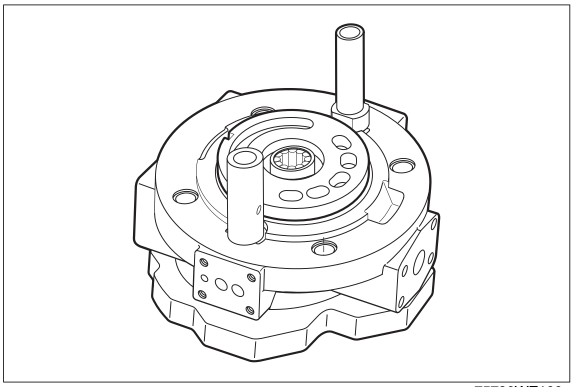
※ Assembly.
Hold the components in place with grease.



75796WE99

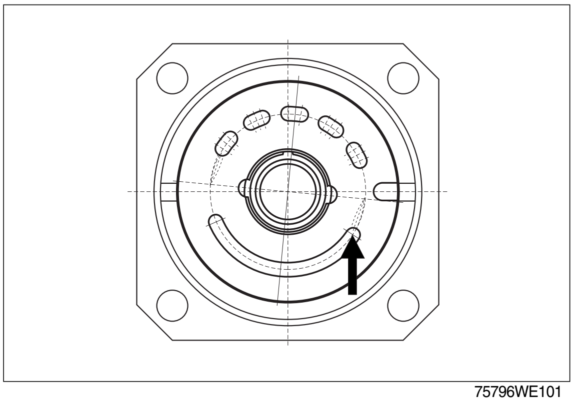
(8) Fit distributor plate.

※ Assembly aid : Grease



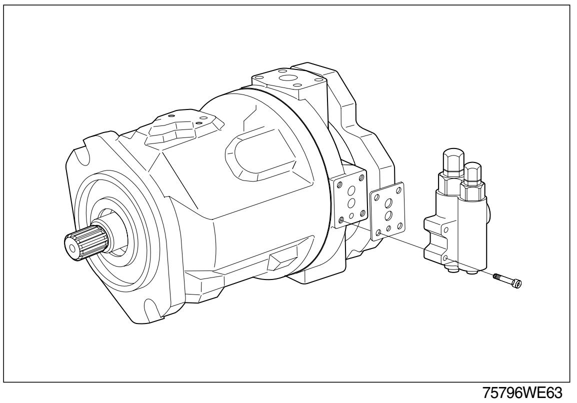
75796WE100

(9) For clockwise rotation pumps the distributor plate is off-set by 4 to the right from the centre position.
(Clockwise and anti-clockwise rotation distributor plates are not identical).



75796WE101

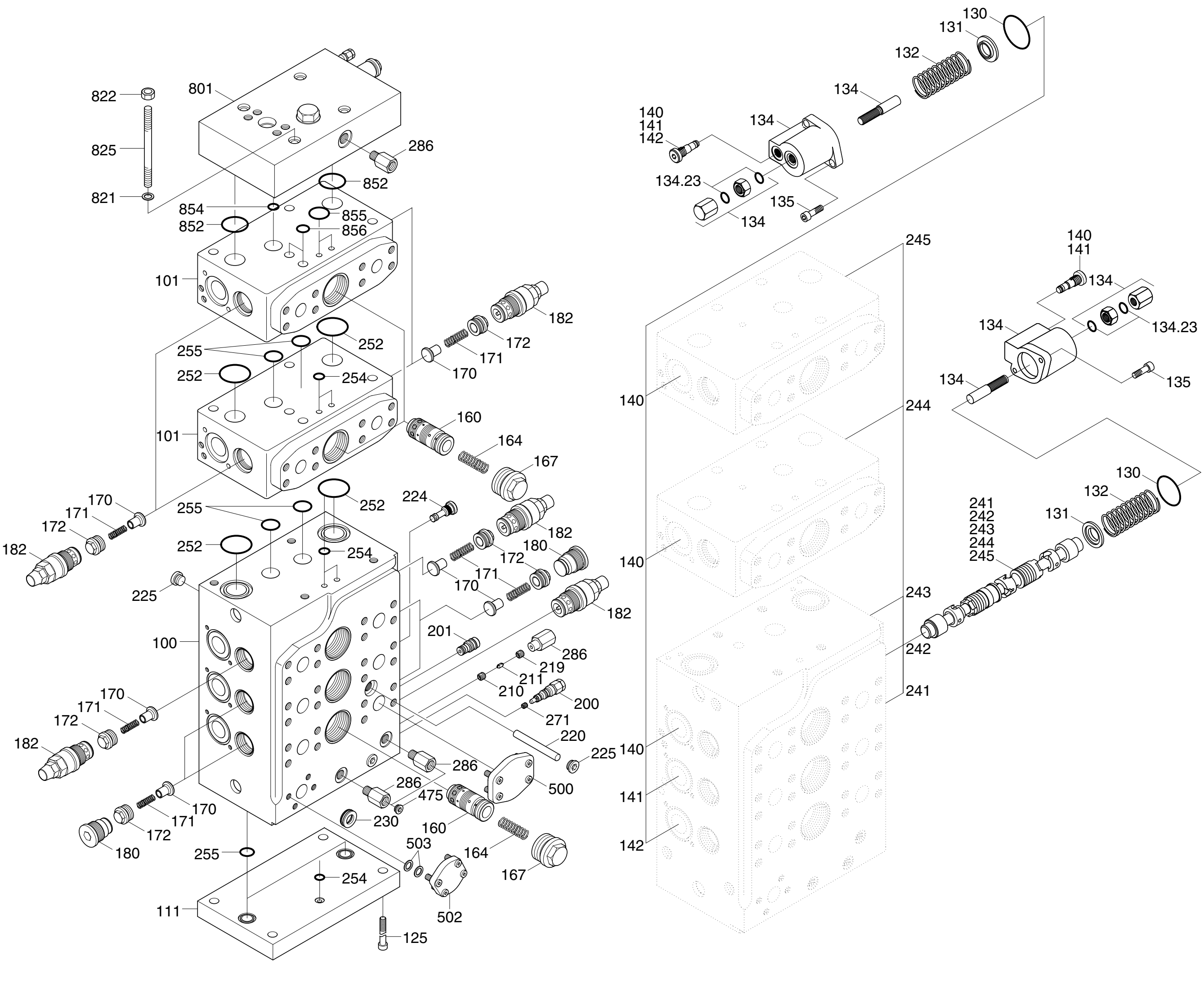
(10) Fit connection plate and control valve.



75796WE63

6. MAIN CONTROL VALVE

1) STRUCTURE



180D7EMCV01

100	Housing	160	Spool	220	Spool	286	Reducing piece
101	Housing	164	Compression spring	224	Locking screw	475	Locking screw
111	Plate	167	Locking screw	225	Locking screw	500	Blank flange
125	Cylinder	170	Cone	230	Connection piece	502	Blank flange
130	O-ring	171	Compression spring	241	Spool	503	Washer
131	Retainer spring	172	Locking screw	242	Spool	801	End block
132	Compression spring	180	Plug	243	Spool	821	Washer
134	Cover	182	Relief valve	244	Spool	822	Hexagonal nut
134.23	O-ring	200	Shuttle valve	245	Spool	825	Stud
135	Bolt	201	Drain orifice	252	O-ring	852	O-ring
140	Locking screw	210	Valve seat	254	O-ring	854	O-ring
141	Throttle check valve	211	Throttle bolt	255	Seal	855	O-ring
142	Throttle check valve	219	Valve seat	271	Orifice	856	Seal

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 SAE12 (1" 1/16-12UNF) & SAE16 (1" 5/16-12UNF) is 4.3kgf · m(31lbf · ft) and SAE6 (9/16-18UNF) is 2.5kgf · m(18lbf · 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 315 bar(4630psi).
(2) Back pressure of tank port should be less than 25 bar(367psi).
(3) The oil temperature should be between -20 ~ 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, 8, 5, 12 mm wrench.
(2) 17, 30, 36 mm spanner.
(3) Torque wrench adjustable from 0.9 ~ 4.3kgf · m(7 ~ 31lbf · ft).

6) INSTRUCTION FOR DISASSEMBLY AND REASSEMBLY

Before disassembly, visually inspect for leakage of oil and for part that have damage and clean the valve up. Preparation for assembly put the tag on each part to prevent wrong assembly and clean the parts completely. Inspect the parts if there is any scratch or dent, and check the movement. In assembly process, follow the tightening torque specification.

(1) Operation

Warm-up is very important before operation.

Be careful operating control valve when oil and valve temperature is low, to avoid stick by spool heat shock.

Not doing continual operates of main relief valve and port relief valve, warm valve uniformly by circulating oil to each cylinder.

Not doing neither inching operating nor multiple operation in low temperature to avoid heating locus of control.

(2) Relief valve

Exchanging complete relief valve is recommended. Therefore do not disassemble if there is any defect in the relief valve.

(3) Mounting

Be careful not to affect extreme force to control valve by hydraulic hose.

Tighten up all mounting blots in same torque.

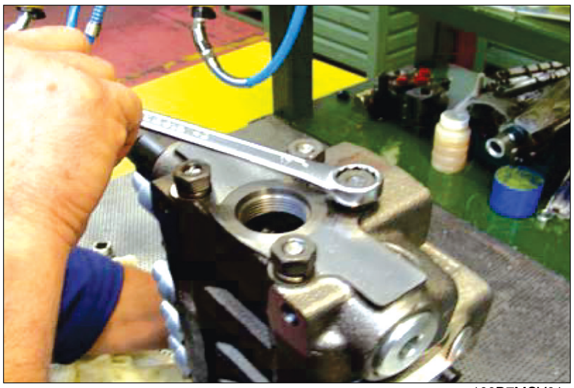
It is possible that seals are damaged by heat weld slag in which case of welding near the control valve.

To prevent contamination entering control valve, do not take off the shipping plug until install hydraulic hose.

6) DISASSEMBLY & ASSEMBLY

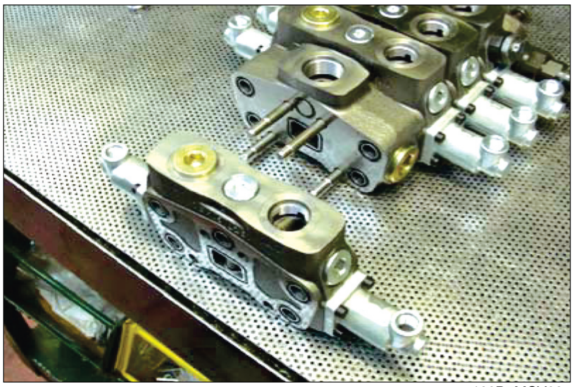
(1) Replacing complete working section

Loosen tightening two bolts with 17mm spanner.



100D7MCV01

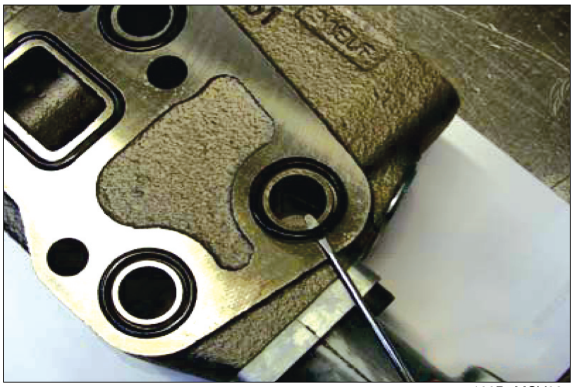
Taking out working section one by one.



100D7MCV02

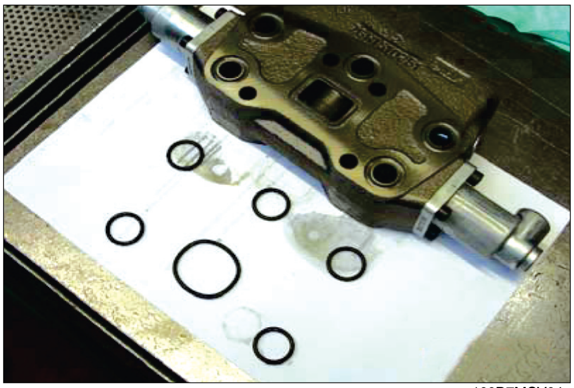
Remove O-rings on the surface of working section properly.

Pay special attention not to give any scratch on the surface.



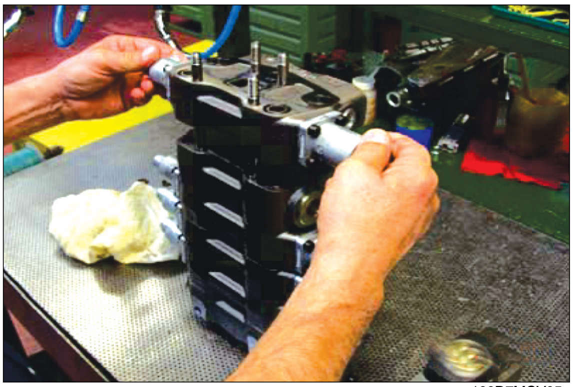
100D7MCV03

Prepare two sizes of O-rings.
And fix the O-rings on the right positions with some grease in order to avoid separation from the surface while moving.



100D7MCV04

Locate new or repaired working section in right position according to the order of functions.



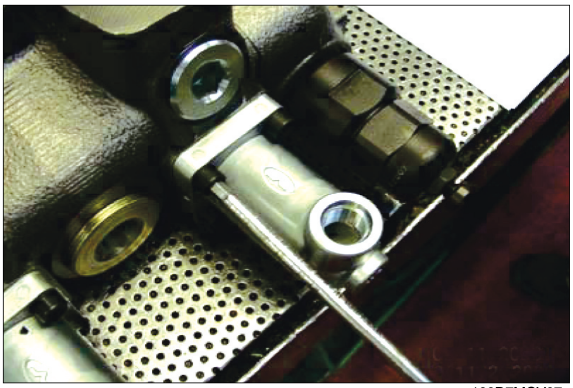
100D7MCV05

Tighten four nuts (M17) in a crisscross pattern with proper assembling torque of 4.3kgf · m(31lbf · ft).

100D7MCV06

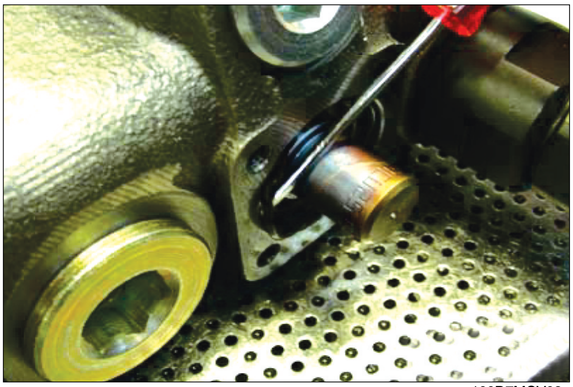
(2) **Replacing spool & control kit**

Loosen 4 screws holding aluminum kits to the body with 5mm wrench.



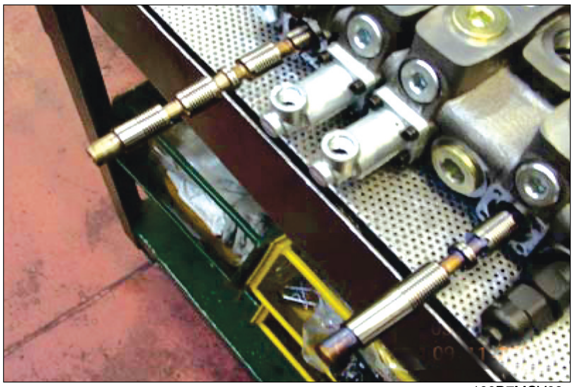
100D7MCV07

Take off all components and O-ring, valve inside, with attention not to give any damage to it.
Don't use anything with sharp edge.



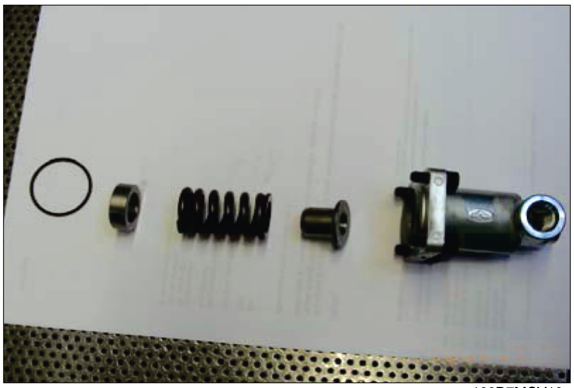
100D7MCV08

Take out the spool, as straight as possible. Even very little force on the spool while disassembling & assembling could make deformation on the spool.



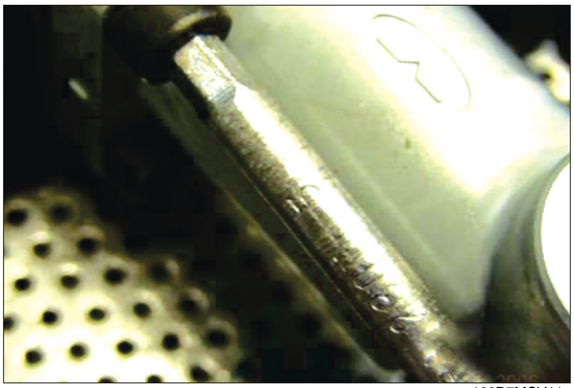
100D7MCV09

Prepare all components before starting reassembling spool control kit.



100D7MCV10

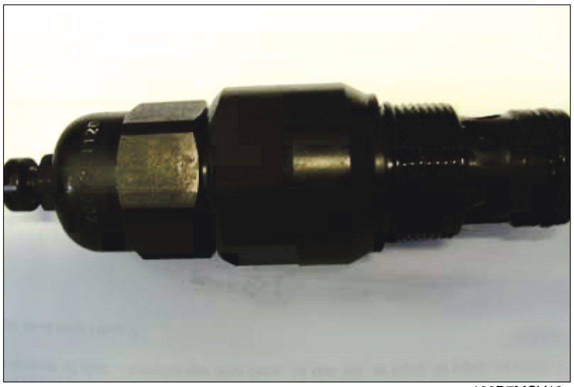
Fit aluminum kit to the body with 5mm wrench by 1.0kgf · m(7.2lbf · ft).



100D7MCV11

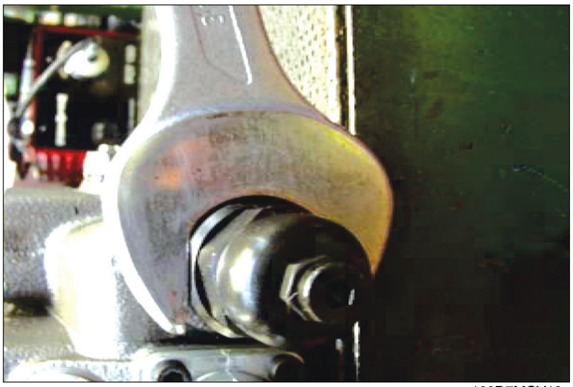
(3) **Replacing relief valve**

Prepare a new relief valve.



100D7MCV12

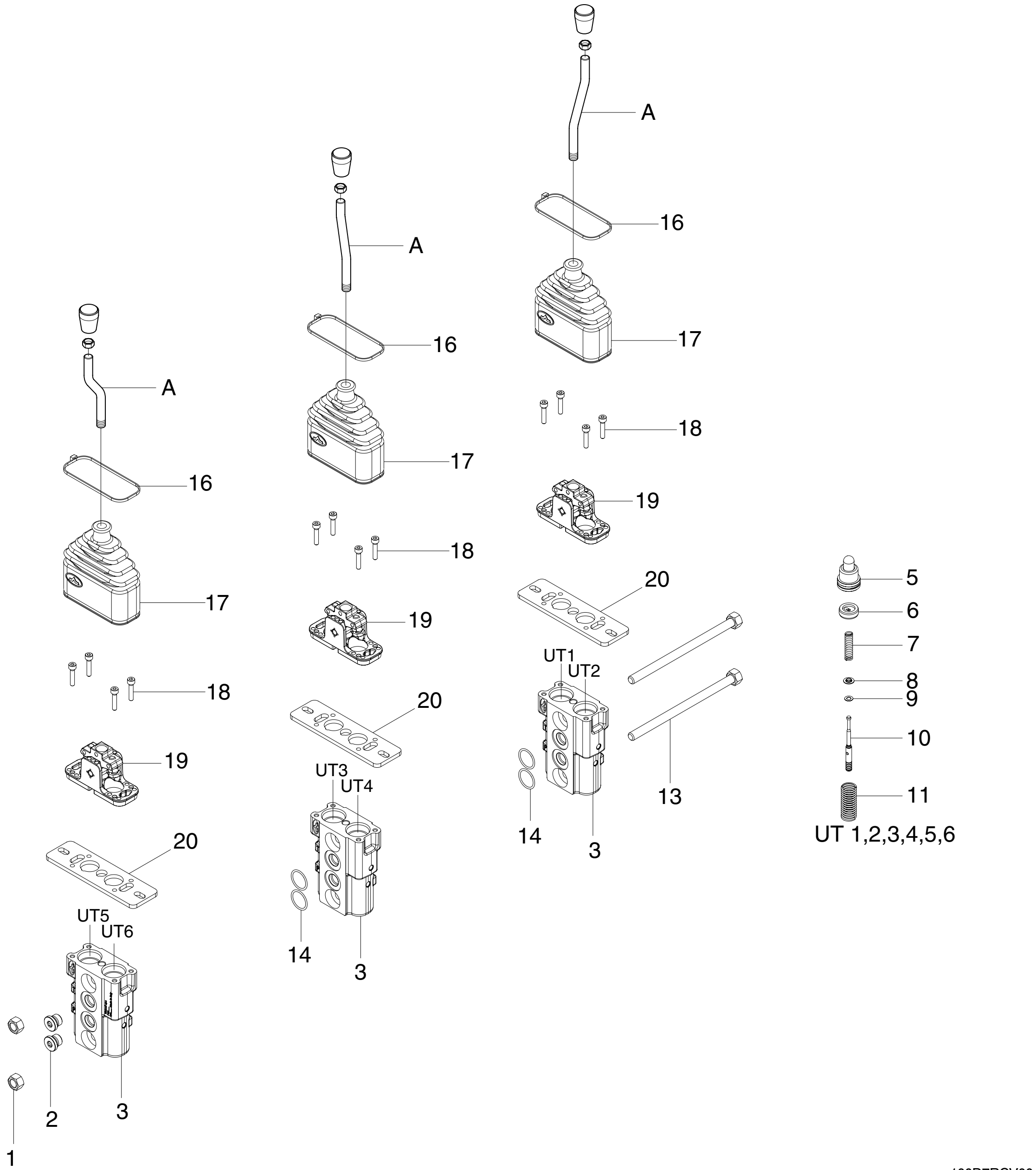
Replace old relief valve with new one. Relief valve should be fitted with proper tool, 36mm spanner, with 4.3kgf · m(31lbf · ft) torque.



100D7MCV13

3. REMOTE CONTROL VALVE

1) STRUCTURE



A	Lever	7	Metering spring	14	O-ring
1	Nut	8	Seeger ring	15	Kit 3
2	Plug	9	Seeger ring	16	Clamp
3	Body	10	Docking rod	17	Rubber bellow
4	Kit 1	11	Spring	18	Screw
5	Plunger kit	12	Kit 2	19	Support kit
6	Spring guide	13	Tie rod with nut	20	Flange

2) GENERAL PRECAUTIONS

(1) In the system, all of the pipes must be carefully cleaned before installation in order to remove dirt, rust, and deposits.
(2) The following cleaning procedures are recommended: Sanding, brushing, pickling, and flushing with a solvent to remove contaminating particles.
(3) The use of Teflon tape, hemp, or other "fillers" for joints is PROHIBITED
(4) Verify that the pipes, fittings and connections are not subjected to mechanical stress.
(5) Make sure that the pipes are not wound and that there are no abrasions on the surface.

3) PRECAUTION FOR DISASSEMBLY AND ASSEMBLY

(1) Valve piping joint should be tightened with the specified torque value. When piping, care should be taken not to apply excess pressure to the valve. If valve is installed with incorrect torque values, it might cause defect of spool operation, noise or vibration.
Recommended tightening torque of SAE 4 (7/16-20UNF) is 1.0kgf · m(7.2lbf · 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 ~ 1450psi).
(2) Back pressure of tank port should be less than 3 bar(43.5psi).
(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) 3mm wrench.
(2) 13mm socket spanner.
(3) Torque wrench adjustable from 1.02 ~ 3.06kgf · m(7.4 ~ 22.1lbf · ft).

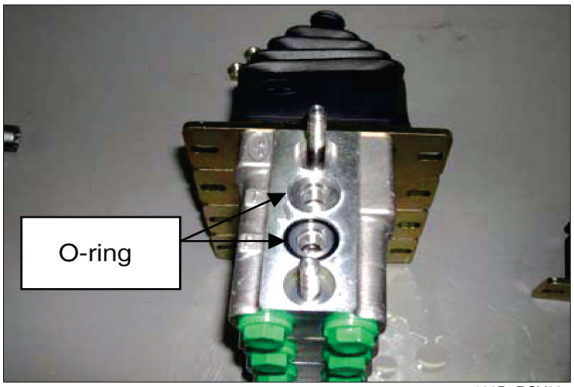
6) DISASSEMBLY & ASSEMBLY

(1) Replacing complete working section

Loosen two tightening bolts with 13mm 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.



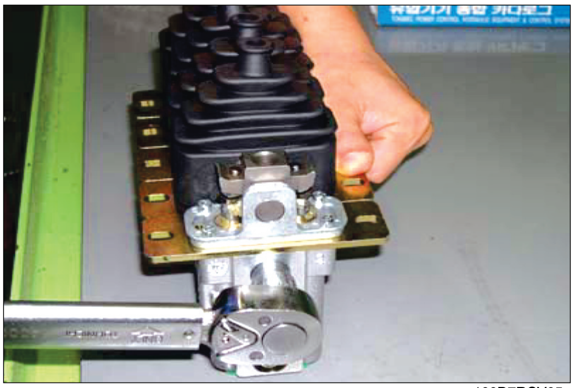
100D7RCV03

Tight M13 nut with proper torque 3.06kgf · m(22.1lbf · ft).

100D7RCV04

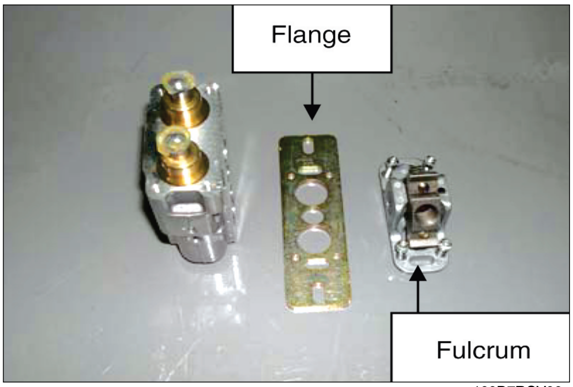
(2) Replacing pilot pressure spool

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



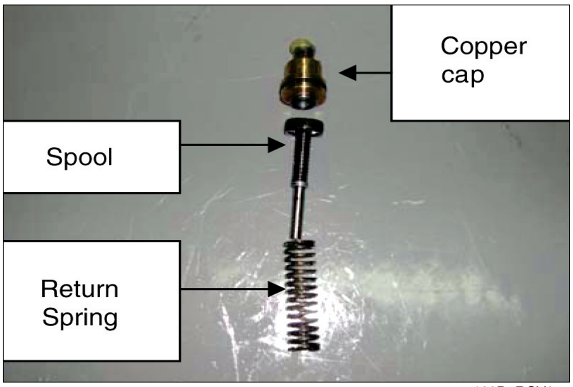
100D7RCV05

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



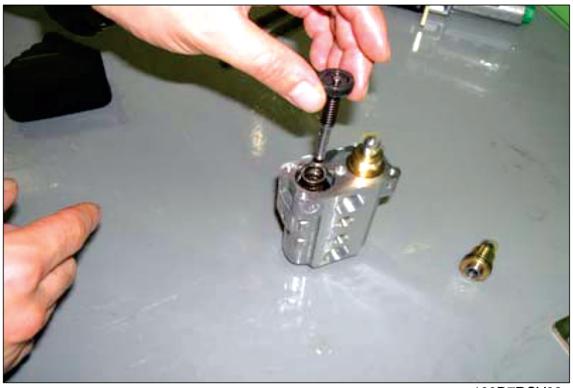
100D7RCV06

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



100D7RCV07

Reassemble the spool in opposite order mentioned above.
Insert spool as straight as possible not to give any damaged on it while inserting it into body.



100D7RCV08

Prepare copper cap in clean.
Apply some clean grease around the O-ring on the copper cap, in order to avoid any damage of O-ring while fitting it into body.

100D7RCV09

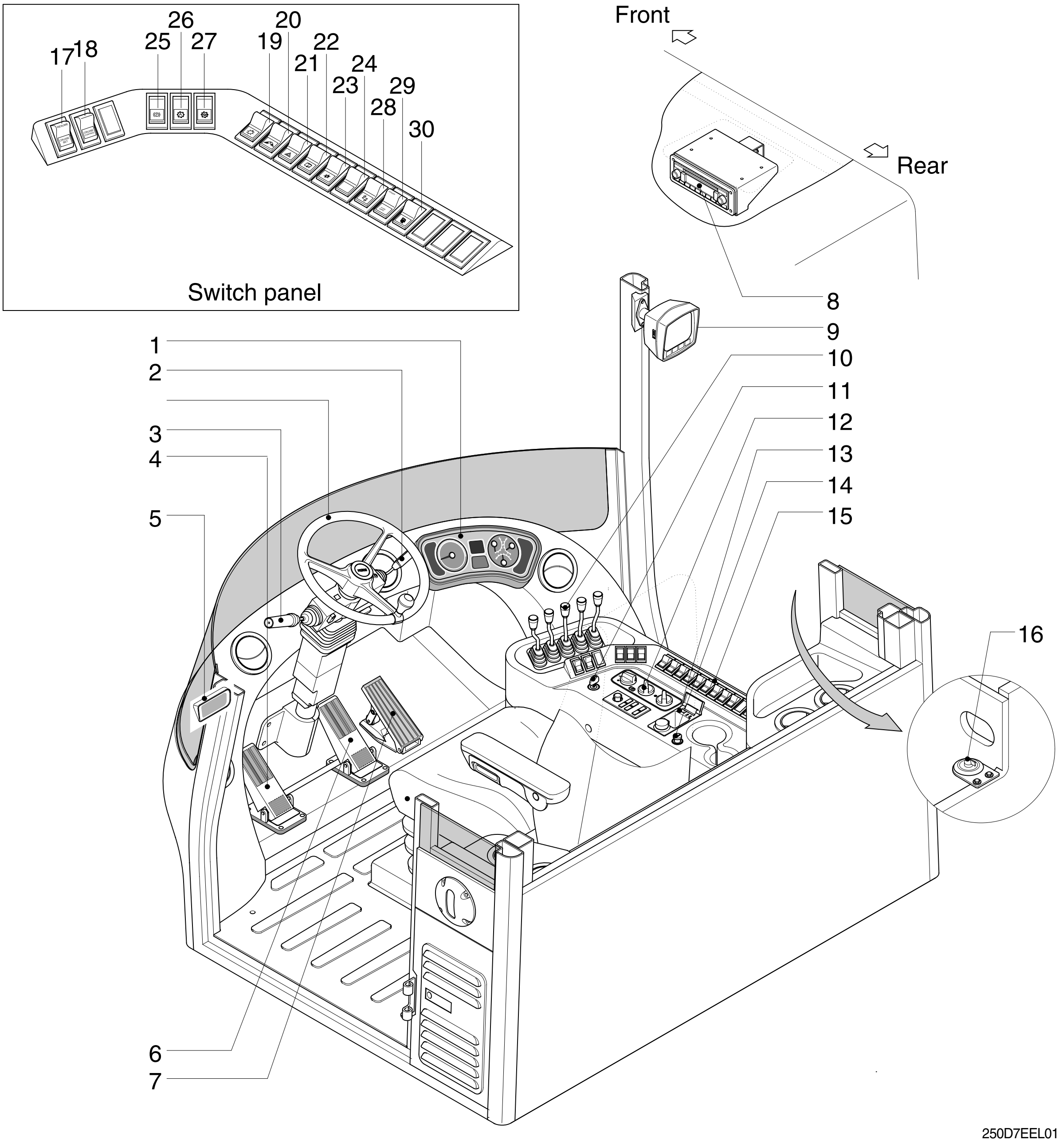
Hold tightly mounting flange and lay fulcrum on the flange and screw in clamp bolts in a crisscross pattern.
Clamp torque is 0.67kgf · m(4.9lbf · ft).

100D7RCV10

SECTION 7 ELECTRICAL SYSTEM

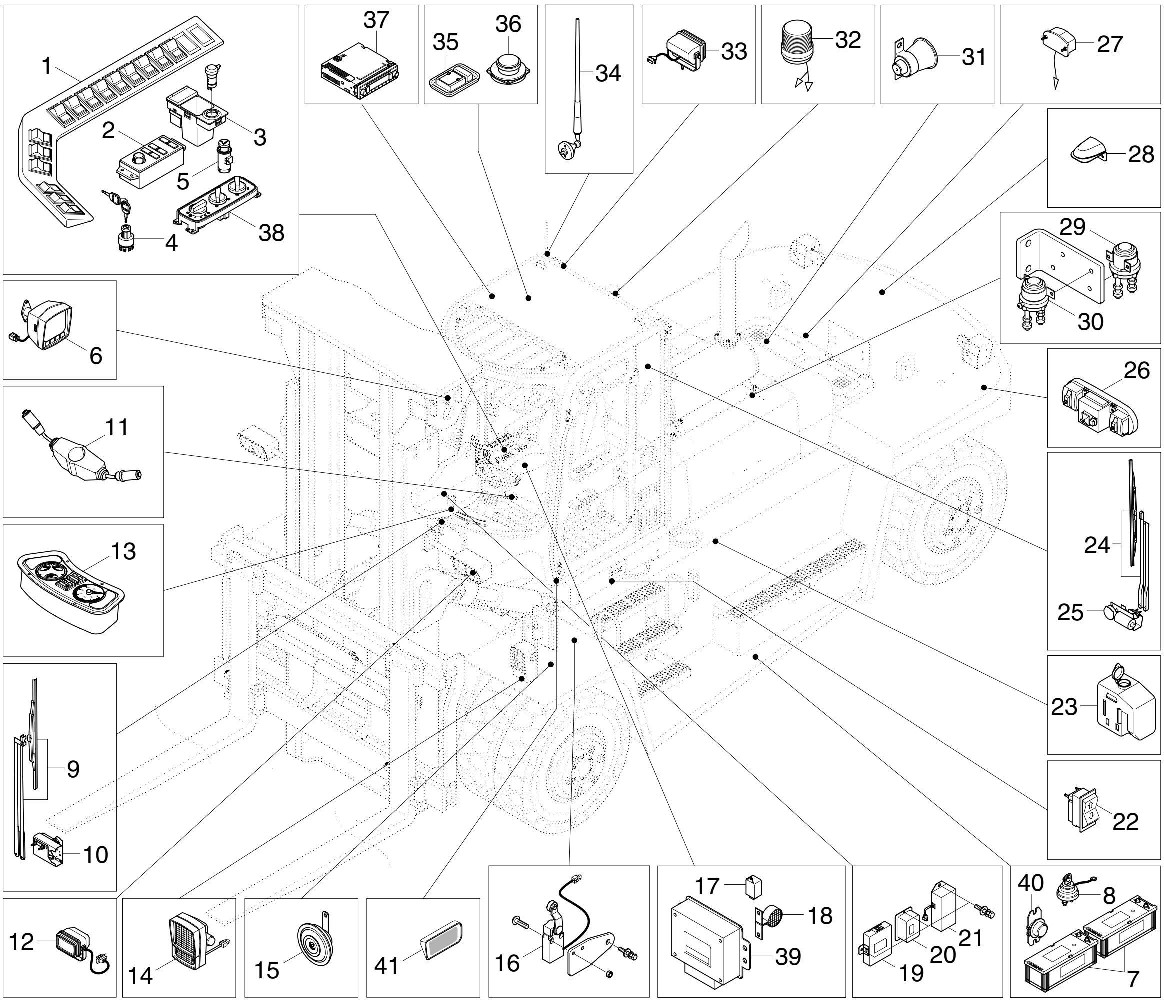
GROUP 1 COMPONENT LOCATION

1. LOCATION 1



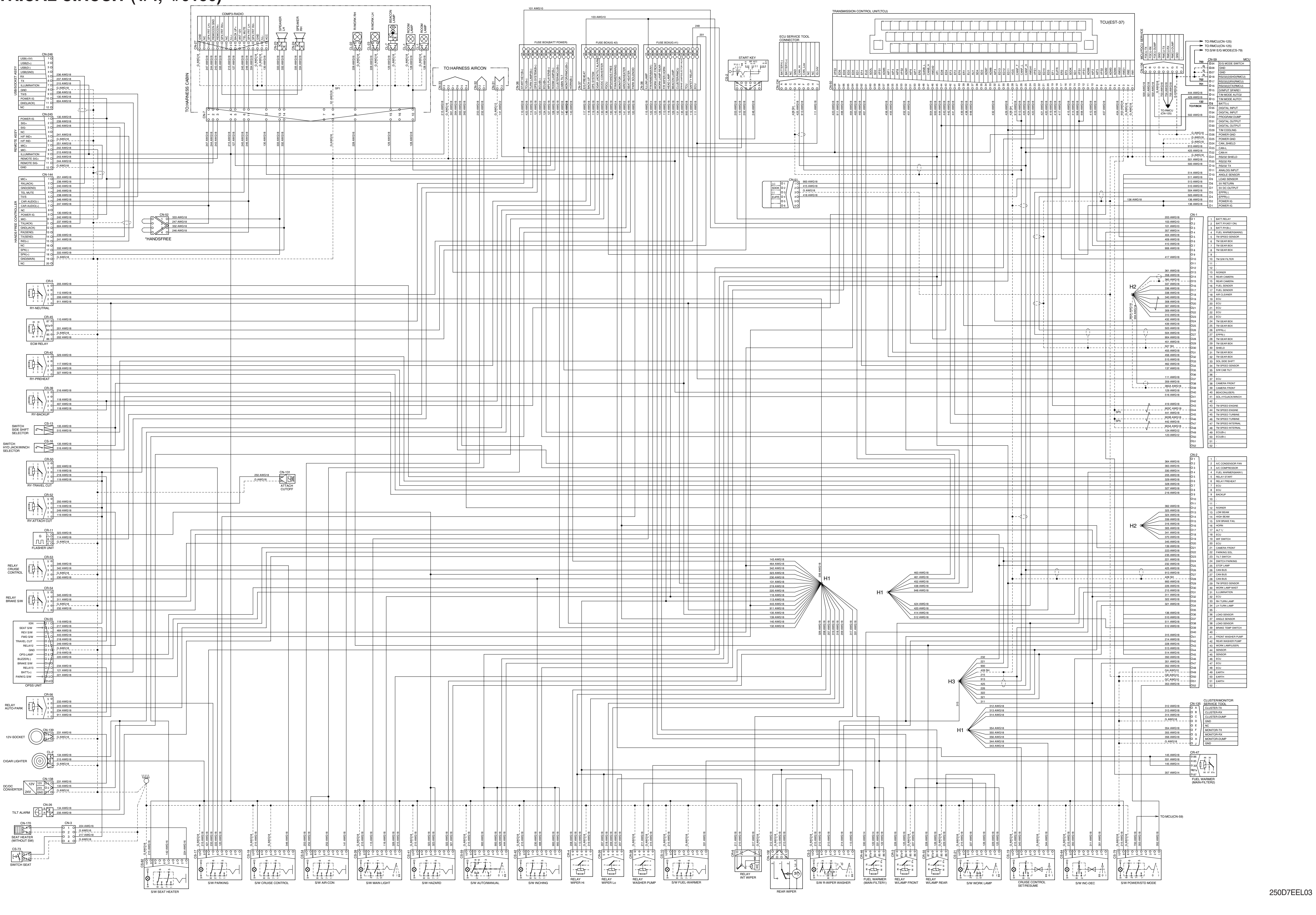
1	Cluster	11	Starting switch	21	Hazard switch
2	Multi function switch	12	Aircon & heater switch	22	Rear wiper/washer switch
3	Gear selector lever	13	Handsfree(opt)	23	Aircon switch
4	Inching pedal	14	Cigar lighter	24	Seat heat switch
5	Transmission error display	15	Switch board	25	Parking brake switch
6	Brake pedal	16	Master switch	26	Auto/Manual select switch
7	Accelerator pedal	17	Cruise set-resume switch	27	Inching switch
8	Radio and CD/MP3 player	18	Cruise switch	28	Inc/Dec switch
9	Monitor(opt)	19	Main light switch	29	Engine mode switch
10	Remote control lever	20	Work lamp swich	30	Fuel heater switch

2. LOCATION 2



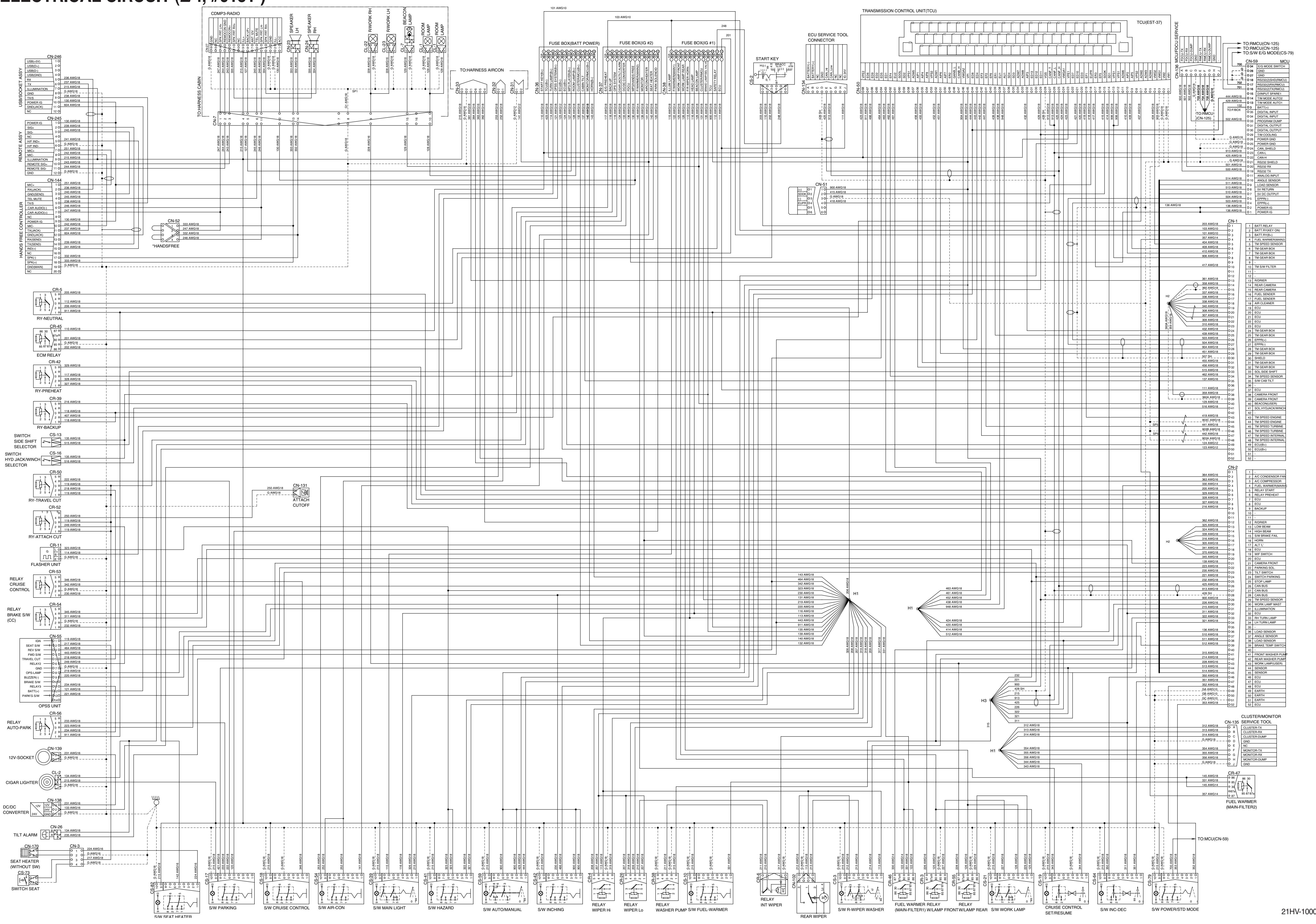
1	Switch panel	15	Horn	29	Start key
2	Remote controller	16	Tilt switch	30	Heater relay
3	USB & socket assembly	17	Int wiper relay	31	Travel alarm buzzer
4	Start switch	18	Alarm	32	Beacon lamp
5	Cigar lighter	19	Handsfree control relay	33	Work lamp assembly
6	Monitor assembly	20	OPSS unit	34	Antenna
7	Battery	21	Converter	35	Room lamp
8	Master switch	22	Cabin tilt switch	36	Speaker assembly
9	Wiper assembly	23	Washer reservoir tank	37	Radio and CD/MP3 player
10	Wiper motor	24	Rear wiper assembly	38	Aircon/Heater controller panel
11	Multifunction switch	25	Rear wiper motor	39	Fan drive control unit
12	Front turn lamp	26	Rear combination lamp	40	Battery relay
13	Cluster	27	License lamp	41	T/M display
14	Head lamp	28	Rear camera kit		

· ELECTRICAL CIRCUIT (1/4, -#0150)



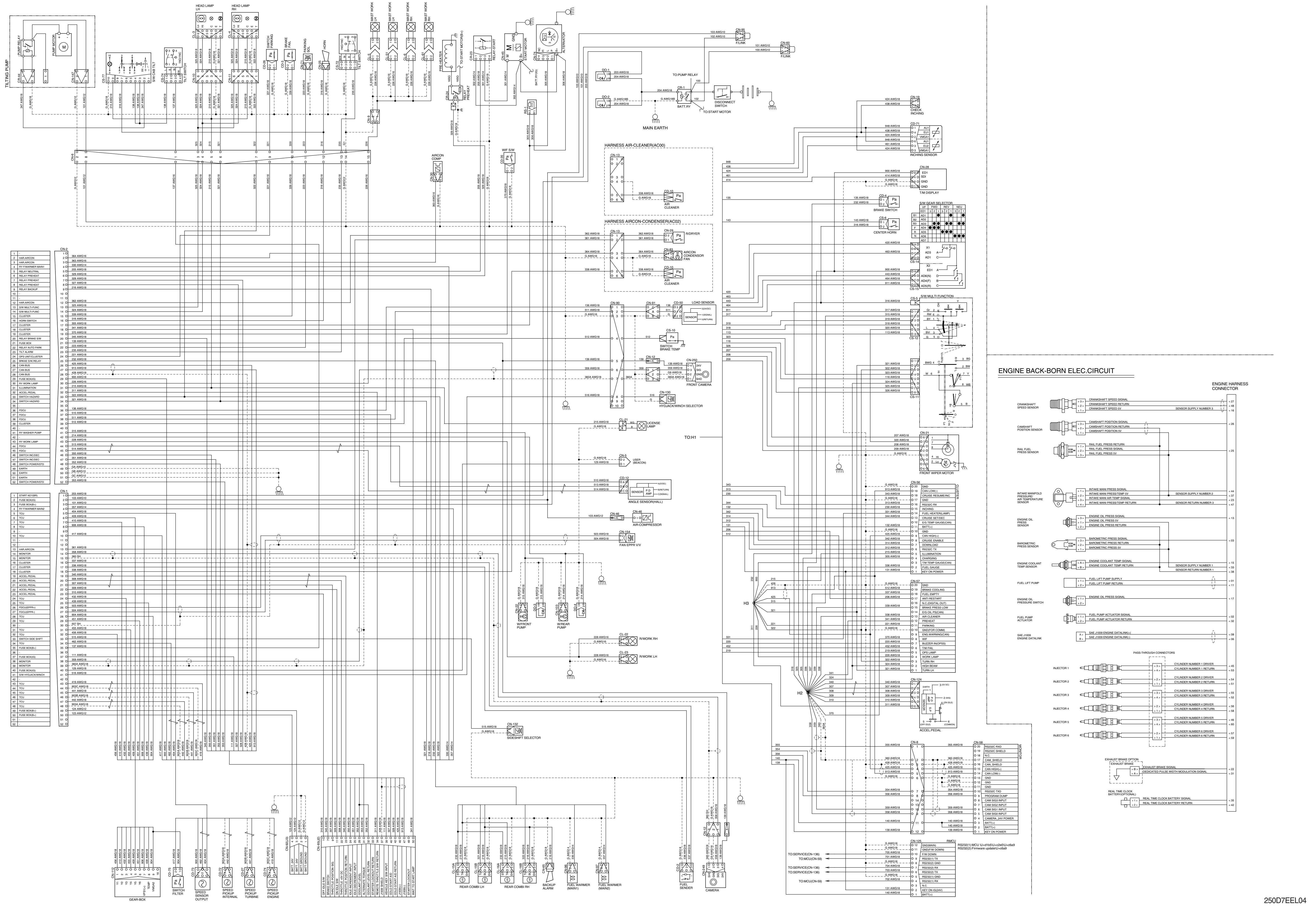
250D7EEL03

· ELECTRICAL CIRCUIT (2/4, #0151-)

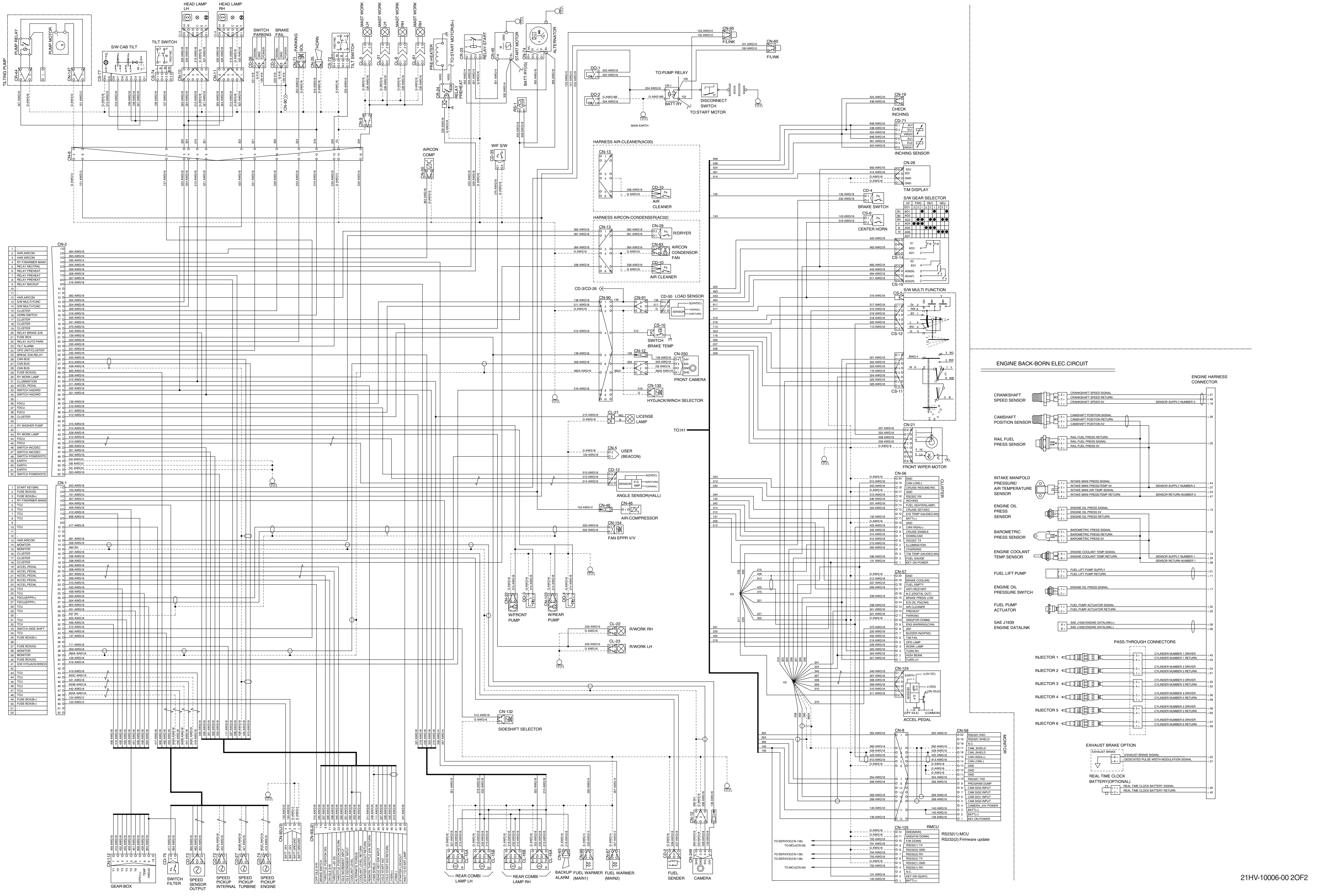


21HV-10006-00 1OF2

· ELECTRICAL CIRCUIT (3/4, -#0150)



· ELECTRICAL CIRCUIT (4/4, #0151-)



GROUP 3 CLUSTER

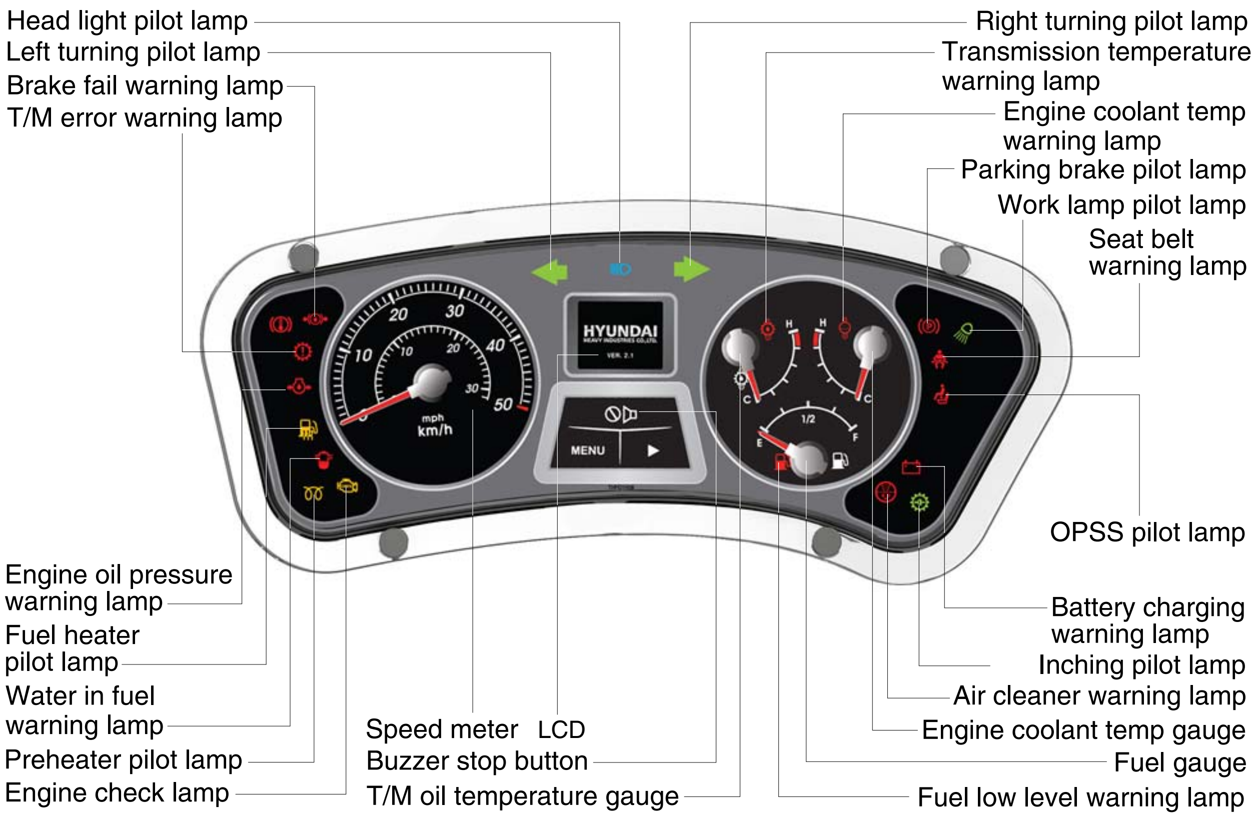
1) STRUCTURE

The gauges panel consists of gauges and monitors 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 lamp : Indicate abnormality of the truck.
- · Pilot lamp : Indicate operating status of the truck.

※ **The monitor installed on this truck does not entirely guarantee the condition of the truck. Daily inspection should be performed according to chapter 7. PLANNED MAINTENANCE AND LUBRICATION.**

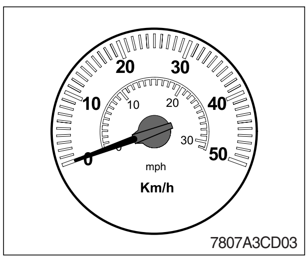
※ **When the monitor provides a warning immediately check the problem, and perform the required action.**



160D7ECD02

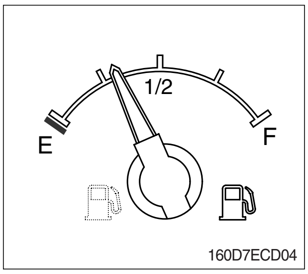
2) GAUGE

(1) Speed meter



① The speedmeter displays the speed of truck in mph and km/h.

(2) Fuel gauge

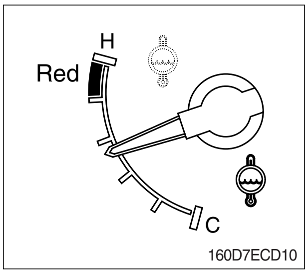


① This gauge indicates the amount of fuel in the fuel tank.

② Fill the fuel when the indicator moves **E** point, refuel as soon as possible to avoid running out of fuel.

※ **If the gauge indicates below E point even though the 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

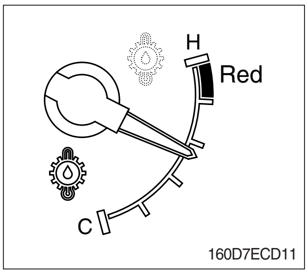


① This indicates the temperature of coolant.
 · Red range : Above 104° C (219° F)

② Keep idling engine at low speed until the indicator is in the operating range.

③ If the indicator is in the red range, turn OFF the engine, check the radiator and engine.

(4) Transmission oil temperature gauge



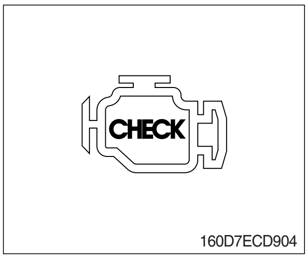
① This range indicates the temperature of transmission oil.
 · Red range : Above 107° C (225° F)

② Keep idling engine at low speed until the indicator is in the operating range.

③ If the indicator is in the red range, it means the transmission is overheated. Be careful that the indicator does not move into the red range.

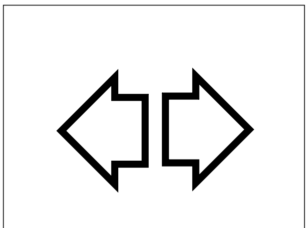
3) WARNING AND PILOT LAMP

(1) Engine check lamp



① This lamp light ON during a nonfatal engine system error. The engine can still be run, but the fault should be corrected as soon as possible.

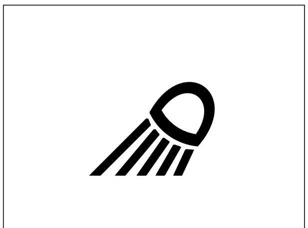
(2) Direction pilot lamp



77073CD10

① This lamp flashes when the signal indicator lever is moved.

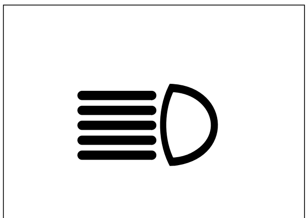
(3) Work lamp pilot lamp (front / rear)



77073CD11

① This lamp lights ON when cabin work lamp switch is pressed.

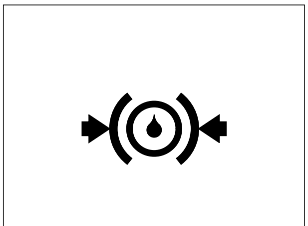
(4) Head light pilot lamp



160D7CD07

① This lamp comes ON when the main light switch is operated to 2nd step.

(5) Brake fail warning lamp



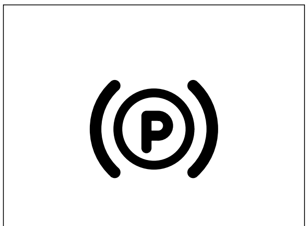
77073CD16

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.**

(6) Parking brake pilot lamp

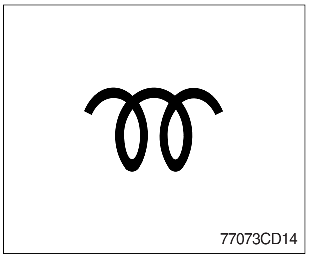


77073CD13

① When the parking brake is actuated, the lamp lights ON.

※ **Check the lamp is OFF before driving.**

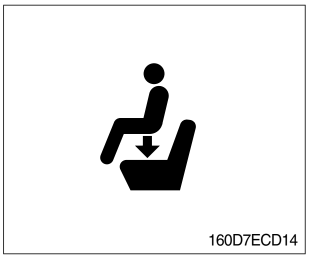
(7) Preheater pilot lamp



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 temperature, indicating that preheating is completed.

② When the lamp goes out the operator should start cranking the engine.

(8) OPSS pilot lamp (option)

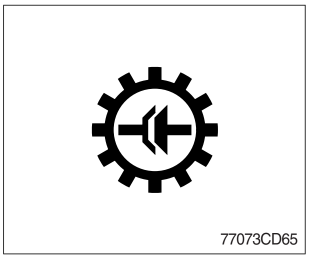


① This signal lamp lights ON when the operator leaves the seat.

② Powered travel movement of the truck shall be possible only if the operator is in the normal operating position. Transmission will automacally shift to neutral upon the exiting of the operator.

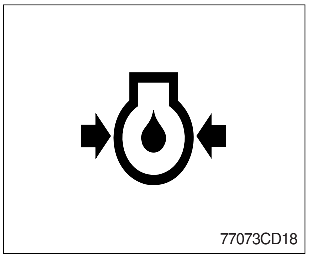
③ The forward/Reverse lever must be cycled through neutral with the operator in the normal operating position to ragain powered direction control.

(9) Inching pilot lamp



① When the inching switch is pressed, the lamp lights ON.

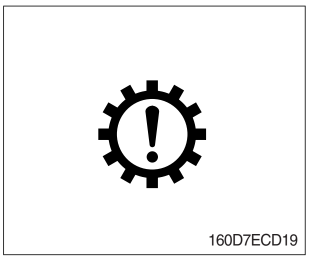
(10) Engine oil pressure warning lamp



① This lamp is 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.

(11) Transmission error warning lamp

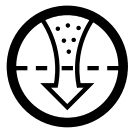


① This lamp lights ON and the T/M message display shows the error codes when an error occurs in the transmission.

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) Air cleaner warning lamp

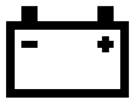


77073CD20

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.

(13) Battery charging warning lamp

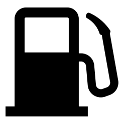


77073CD22

① This lamp is ON after key switch is turned ON.

② Check the battery charging circuit when this lamp comes ON during engine operation.

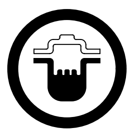
(14) Fuel low level warning lamp



77073CD23

① Fill the fuel immediately when the lamp is turned ON.

(15) Water in fuel warning lamp



160D7CD15

① This lamp lights up when the water separatoris full of water or malfunctioning.

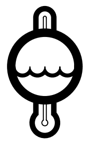
※ **When this lamp lights up, stop the truck and spill water out of the separator.**

(16) Seat belt warning lamp

77073CD24

① This lamp lights ON for the first five seconds after starting the truck.

(17) Engine coolant temperature warning lamp

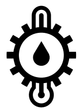


77073CD17

① This lamp is turned ON when the temperature of cooling water is over the normal temperature(104˚C, 219˚F).

② Check the cooling system when the lamp is ON.

(18) Transmission oil temperature warning lamp



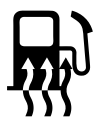
160D7ECD15

① This lamp informs the operator that transmission oil is above the specified temperature.

- Transmission oil temperature warning lamp ON : Abnormal
- Transmission oil temperature warning lamp OFF : Normal

※ **When this lamp lights up during operation, stop the engine and check the machine.**

(19) Fuel heater pilot lamp



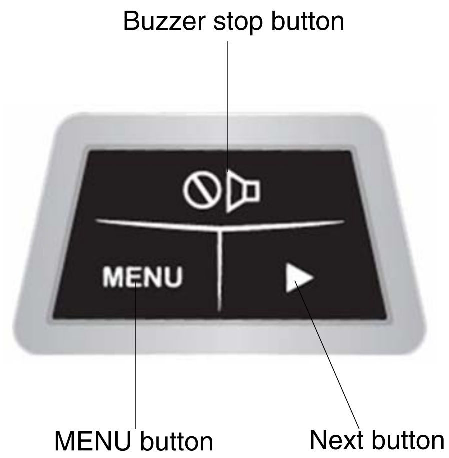
21093CD43

① This lamp is turned ON when the coolant temperature is below 10˚C (50˚F) or the hydraulic oil temperature 20˚C (68˚F).

② The automatic fuel warming is cancelled when the engine coolant temperature is above 60˚C, or the hydraulic oil temperature is above 45˚C since the start switch was ON position.

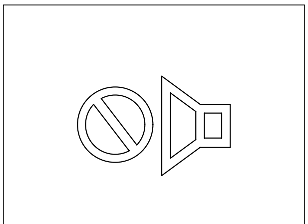
4) CLUSTER BUTTON

Each button has the following function.



160D7ECD121E

(1) Buzzer stop button

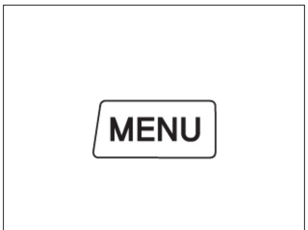


160D7ECD22

① This swich is used to stop the buzzer sound.

② Stop the buzzer when the switch is pressed.

(2) Menu and next button



160D7ECD23

160D7ECD24

① This swiches are used to choose the model or display the engine error on the LCD.

② Model select mode

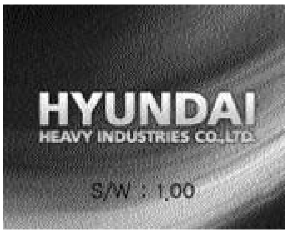
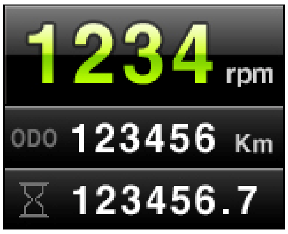
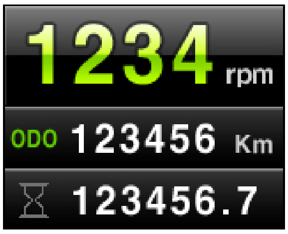
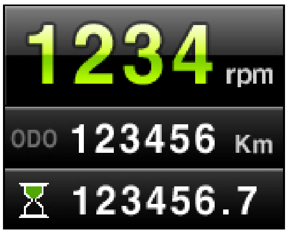
- The model is displayed on the LCD when the menu button and next button are pressed simultaneously for some longer seconds.
- Please don't change your truck model identity because it is already pre-set on the truck before delivery.

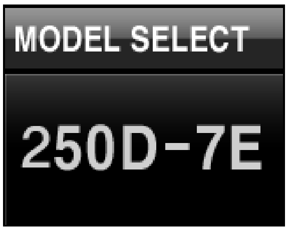
③ Engine error display

- The engine error is displayed on the LCD when the menu button is pressed.
- On pressing the next button , next page is displayed in case the error was occured 5 or more.
- On pressing the next botton once more, the LCD gets back to normal display status.

5) LCD

LCD has the functions to display start mode, standby mode, cruise function, model select and engine error.

NO	Display	Name	Description
1		Start mode	- Display initialization state with HYUNDAI logo and program version.
2		Standby mode	- Displays on the idle state. - Displays rpm, odometer and hourmeter
3			- Odometer is on, ODO is activated.
4			- Hourmeter is on, ⌛ is activated.
5		CRUISE function	- When cruise switch is on, displays CRUISE READY message. ※ Refer to the page 3-21.
6			- When cruise function is active, displays CRUISE ACTIVE message. ※ Refer to the page 3-22.

NO	Display	Name	Description
7		Model select	- On model select mode, displays like this image. ※ Refer to the page 7-20.
		Engine error display	- In case of below 4 engine errors displays like this image. ※ Refer to the page 7-20.
			- In case of over 4 engine errors displays like this image.
			- To display next page in case of over 4 errors, press ▶.

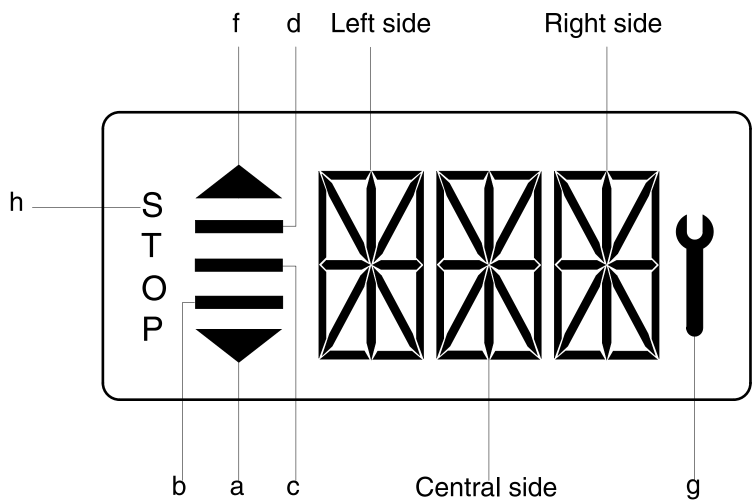
GROUP 4 TRANSMISSION MESSAGE INDICATOR

1) TRANSMISSION ERROR DISPLAY

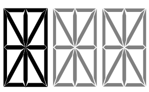
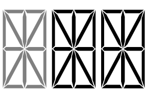
(1) Function

The display can be used with the gear selector. It indicates speed and driving direction as well as the activated inching.

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.



D507CD33

1	Bars	a, f	Automatic range(up and down shiftion)
		b, c, d,	Preselected gear
2	Left side		For the moment still without function
3	Central and Right side		On the two alphanumerica 16-segment display, the electric control unit issues the actual state of gear and driving direction. Besides, a two digit error code will be indicated via these two segment
4	Spanner	g	Electronic control unit recognized an error, is flashing
5	Letters STOP	h	Immediate stop is required(at the moment not activated)

(2) Abbreviations

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

2) DO AEB WORK

(1) Start engine after parking the machine on flat floor and blocking wheels.
(2) Release parking brake.
(3) With stepping on the service brake, operate T/M STALL(3 stage).
(To avoid defect of clutch pack, repeat 10 sec of operation and 10 sec of placing neutral)
(4) When the T/M oil temperature reaches 75~80°C, lock the parking brake and then shift gear to neutral position to keep the machine at LOW RPM.
(5) Connect the AEB STARTER to T/M controller.
(6) Push AEB STARTER over 3 seconds.
(7) Confirm the status of AEB from the DISPLAY.
- Normal operation shows "ST, KR, KV, K1, K2, K3" orderly for 3~5minutes.
- After the succesful completion, it displays "OK".
- With a new controller, it may display "F6" error code before AEB, it will disappear.

(8) In case of abnormal running, it may display "STOP" with the appropriate error code.
(9) After truobleshooting, start the machine again to repeat above.
※ As the STALL operation has to be done, the SERVICE BRAKE must be locked perfectly to avoid the fatal accident.
※ AEB mode : It controls the disc internal of the transmission, automatically.

3) DISPLAY DURING AEB-MODE

Symbol	Meaning	Remarks
PL	AEB-starter is plugged at the diagnostic plug	
ST	AEB-Starter-button is pressed	
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)j 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	Outputspeed_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	Parkbrake_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)

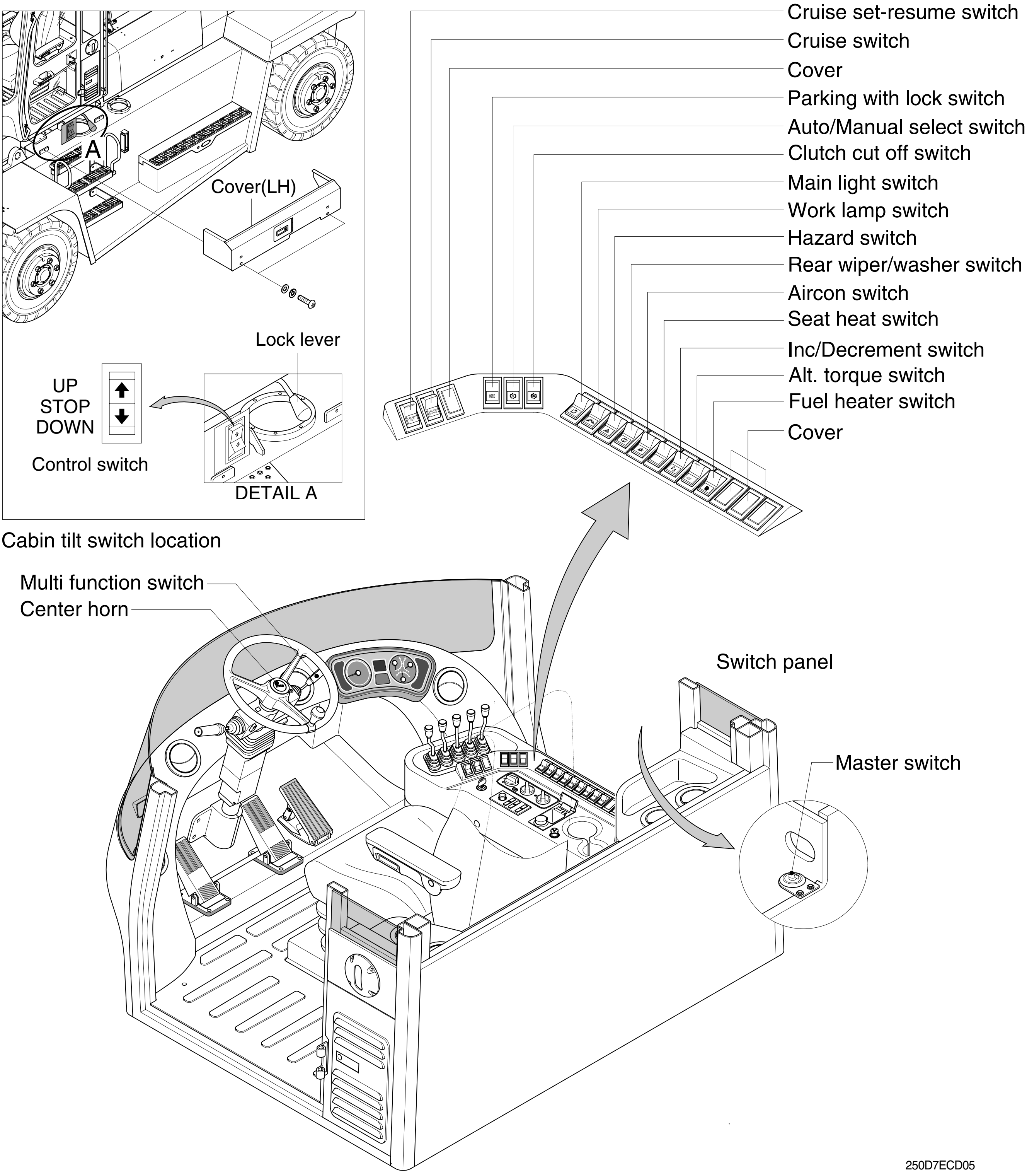
4) INITIALIZING THE INCHING SENSOR

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

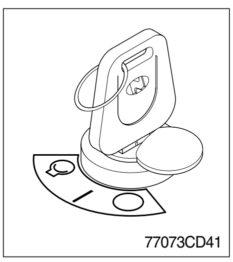
5) DISPLAY DURING INCHPEDAL CALIBRATION

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	Output speed is 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 pressed 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 big	Calibrations is aborted
FI and Stop	Sensor signal 1 and 2 don't match together	Calibrations is aborted

GROUP 5 SWITCHES



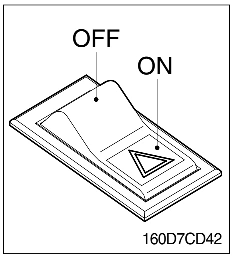
1) START SWITCH



(1) There are three positions, OFF, ON and START.

- ◯ (OFF) : None of electrical circuits activate.
- | (ON) : All the systems of truck operate.
- (START) : Use when starting the engine.
  Release key immediately after starting.

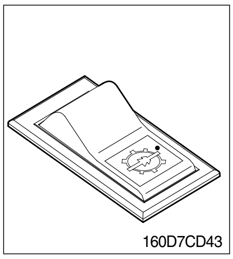
2) HAZARD SWITCH



(1) Use for parking, or loading truck.

※ **If the switch is left ON for a long time, the battery may be discharged.**

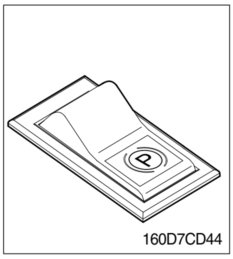
3) INCHING SWITCH



(1) If this switch is pressed, inching operation is applied to inching pedal.

(2) Also, inching lamp on the cluster is illuminated.

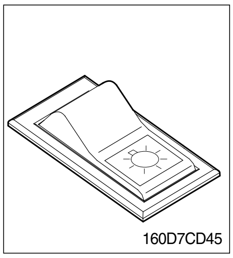
4) PARKING BRAKE SWITCH



(1) If this switch is pressed, the parking brake is applied and the gauge panel warning lamp will comes ON.

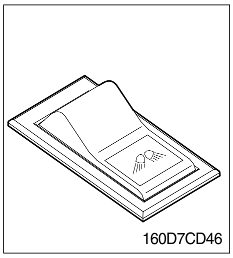
※ **When operating the gear selector lever, be sure to release the parking brake. If the truck is operated with the parking brake engaged, the brake will overheat and may cause the brake system to go out of order.**

5) MAIN LIGHT SWITCH



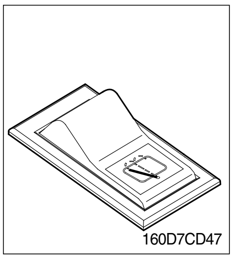
(1) This switch is used to operate the clearance lamp and head light by two steps.
- First step : Clearance lamp and cluster illumination lamp comes ON. Also, all of the indicator lamps of switches come ON.
- Second step : Head light comes ON.

6) WORK LAMP SWITCH



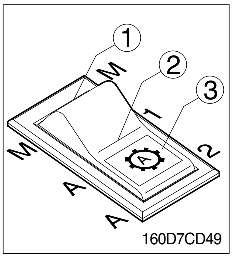
(1) This switch is used to operate the front and rear work lamps by two steps.
- First step : Front work lamp comes ON.
- Second step : Rear work lamp comes ON.

7) REAR WIPER AND WASHER SWITCH



(1) This switch is used to operate the rear wiper and washer by two steps.
- · First step : The rear wiper operates.
- · Second step : The washer liquid is sprayed and the rear wiper is operated only while pressing. If release the switch, return to the first step position.

8) AUTO/MANUAL CHANGEOVER SWITCH

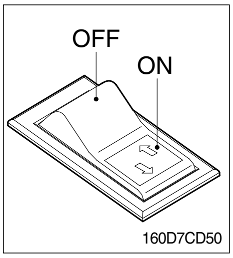


(1) Manual mode(①)
Press the top of the switch for the manual mode of the autoshift function. The operator selects the desired speed and the desired direction in the manual mode with the gear selector lever.

(2) Automatic 1st mode(②)
Place the switch in the middle position for the autoshift function changing from **1st** to **3rd** gear shift mode.

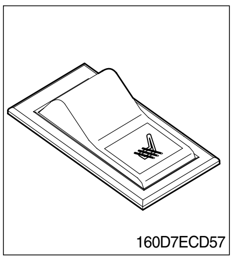
(3) Automatic 2nd mode(③)
Press the bottom of the switch fully for the autoshift function changing from **2nd** to **3rd** gear shift mode.

9) INC/DEC SWITCH



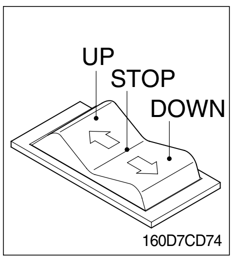
(1) When engine running, the low rpm of engine increase or decrease by 25rpm by operating this switch.
Engine low rpm returns to normal value when engine restarted.

10) HEATED SEAT SWITCH



(1) This switch is used to heat the seat.

11) CABIN TILT SWITCH



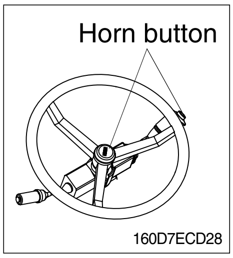
(1) Tilting UP cabin
Press the top of the switch fully to tilt the cabin upward.

(2) STOP the tilting operation(Default)
Release the switch to stop the tilting operation.

(3) Titilting DOWN cabin
Press the bottom of the switch fully to tilt the cabin downward.

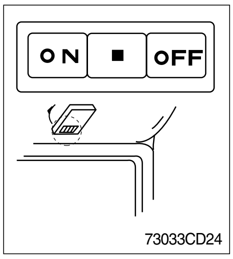
※ Refer to the operator's manual for cabin tilting procedure.

12) HORN BUTTON



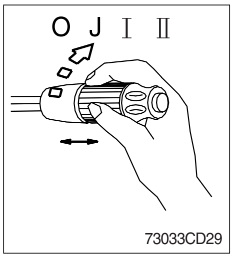
(1) If you press the button on the top of the multifunction switch and the center of the steering wheel, the horn will sound.

13) CAB LAMP SWITCH



(1) This switch turns ON the cab room lamp.

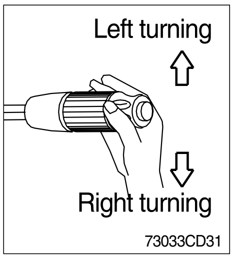
14) MULTI FUNCTION SWITCH



(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.

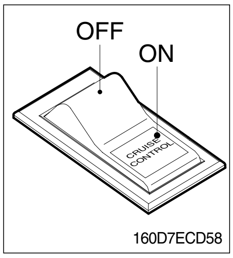
※ **Check the quantity of washer liquid in the tank. If the level of the washer liquid is LOW, add the washer liquid (In cold, winter days) or water. The capacity of the tank is 1 liter.**



(2) Turning switch

① This switch is used to warn or signal the turning direction of the truck to other vehicles or equipment.
② Push the lever up for turning left, pull the lever down for turning right.

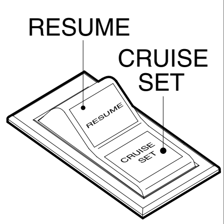
15) CRUISE SWITCH



(1) When this switch is turned ON, the CRUISE READY mode is selected and CRUISE ACTIVE is ready for activation.
(2) When this switch is turned off, the CRUISE function is cancelled.

※ Please refer to "CRUISE SET/RESUME SWITCH" for the detail functions.

16) CRUISE SET/RESUME SWITCH



160D7ECD59

(1) Auto cruise function is used to travel at constant engine speed with a desired engine rpm.

(2) This function is activated only when the CRUISE SWITCH is turned ON. If you want to travel the truck at constant speed, you raise the engine rpm and then press the CRUISE SET switch.

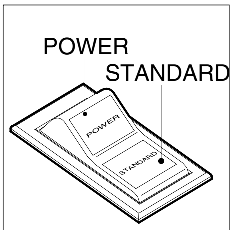
(3) By pressing the brake pedal, the truck is shifted to the CRUISE READY mode.
By pressing the RESUME, the engine rpm gets back to the previous rpm.

※ The cruise function does not work when the INCHING switch is turned ON.

※ This switch can adjust the engine rpm when the truck is placed in the CRUISE ACTIVE mode.
- RESUME : up by 25 rpm
- SET : down by 25 rpm

※ The "CRUISE READY" or "CRUISE ACTIVE" is displayed on the LCD when the CRUISE function is activated.
Please refer to the page 7-20 for the detail displays.

17) ENGINE MODE SWITCH

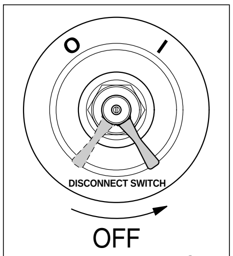


160D7ECD60

(1) This switch offers two selectable operating mode.
The operator can adjust the machine's performance with this selection switch.

(2) Function
① STANDARD MODE : This mode provides maximum fuel efficiency for general loading.
② POWER MODE : This mode provides maximum power output for heavy loading or hill climb.

18) MASTER SWITCH



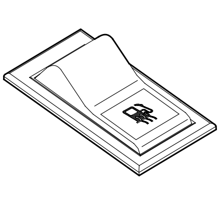
13033CD81

(1) This switch is used to shut off the entire electrical system.

(2) I : The battery remains connected to the electrical system.
O : The battery is disconnected to the electrical system.

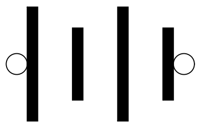
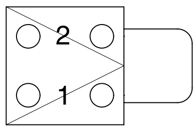
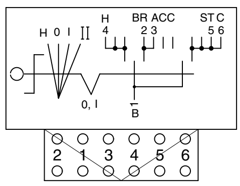
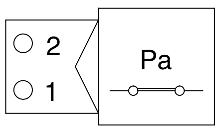
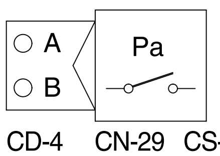
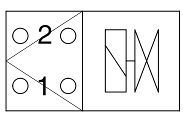
※ **Never turn the master switch to O(OFF) with the engine running. Engine and electrical system damage could result.**

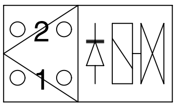
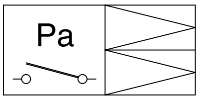
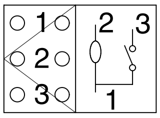
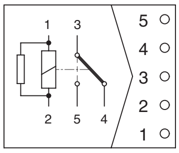
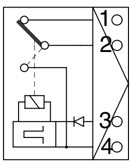
19) FUEL HEATER SWITCH

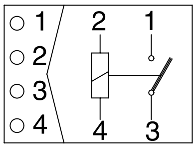
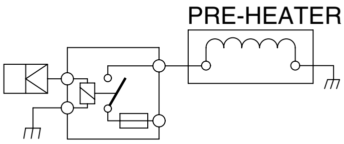
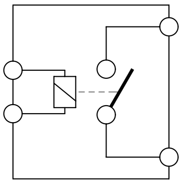
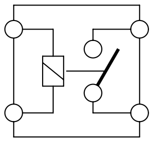
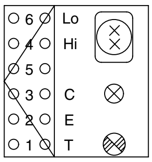
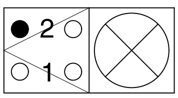

180D7ECD101

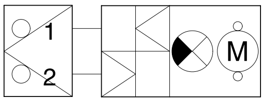
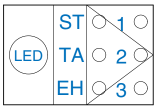
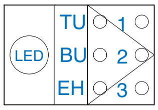
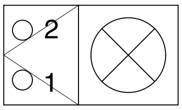
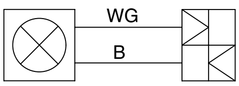
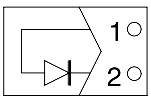
(1) This switch is used for the fuel heater of the pre-heater assy.

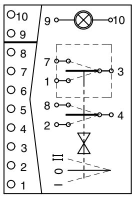
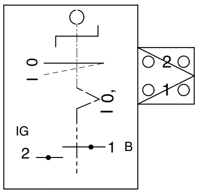
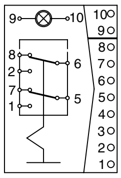
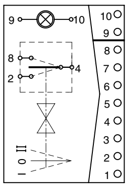
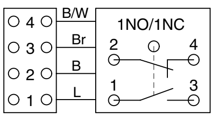
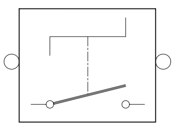
GROUP 6 ELECTRICAL COMPONENT SPECIFICATION

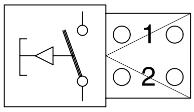
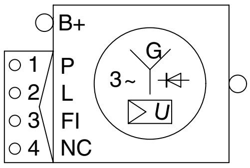
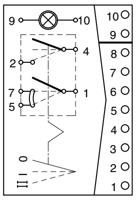
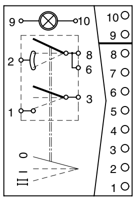
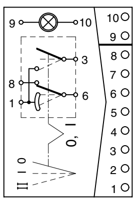
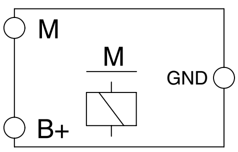
Part name	Symbol	Specifications	Check
Battery		12V × 112Ah (2EA)	※ When checking the battery charging indicator, Green : Normal condition Black : Discharge condition Transparency : change
Fusible link	 CN-60 CN-95	CN-60 : 24V 45A CN-95 : 24V 45A	※ Check disconnection Normal : 0 Ω (Connect ring terminal and check resistance between terminal 1 and 2)
Start key	 CS-2	-	※ Check contact OFF : ∞ Ω (For each terminal) ON : 0 Ω (For terminal 1-2, 1-3) ∞ Ω (For terminal 1-5) START : 0 Ω (For terminal 1-2, 1-3 and 1-5)
Pressure switch	 CD-3 CD-26	N.C type	※ Check contact Normal : 0 Ω (CLOSE)
Pressure switch	 CD-4 CN-29 CS-6 CD-75 CD-35	N.O type	※ Check contact Normal : ∞ Ω (OPEN)
Solenoid valve (fan EPPR valve)	 CN-71 CN-154 CN-156	24V 300A	※ Check resistance About 24 Ω

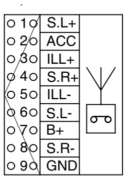
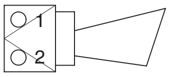
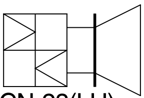
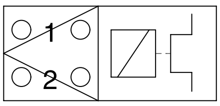
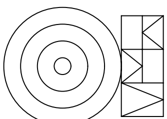
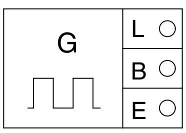
Part name	Symbol	Specifications	Check
Solenoid valve (cabin up solenoid, cabin down solenoid, parking solenoid	 CN-133 CN-135	24V max 1.5A	※ Check resistance About 24 Ω
Air cleaner pressure switch	 CD-10	Pressure : 635mmH_2O (N.O type)	※ Check contact Normal : ∞ Ω
Fuel sender	 CD-2	Reed switch : Magnetic type	※ Check resistance Full : About 50 Ω Low level : About 700 Ω
Relay (5pin)	 CR-4 CR-5 CR-39 CR-42 CR-45 CR-50 CR-52 CR-53 CR-54 CR-56 CR-12 CR-26 CR-38 CR-46 CR-3 CR-55 CR-47	24V 3-4 : 15A (85°C) 3-5 : 10A (85°C)	※ Check resistance Normal : 0 Ω (For terminal 3-4) : ∞ Ω (For terminal 3-5)
Int wiper relay	 CR-6	24V 5A Operating time : 2.5±1 sec	※ Check resistance Normal : 0 Ω (For terminal 1-2) : ∞ Ω (For terminal 2-4)

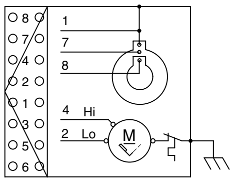
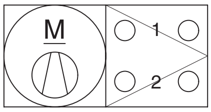
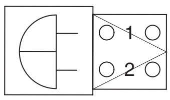
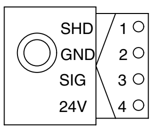
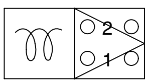
Part name	Symbol	Specifications	Check
Start relay	 CR-23	24V 300A Exciting current : 2.3A	※ Check resistance Normal : 10 Ω (For terminal 2-4) : ∞ Ω (For terminal 1-3)
Preheat relay	 CR-24	24V 200A Exciting current : 2.3A	※ Check resistance Normal : 10 Ω (For terminal coil) : ∞ Ω (Between ring term)
Pump relay	 CR-44	-	-
Battery relay	 CR-1	24V 100A/1000A Rated ampare : 100A (continue) 1000A (30 second) Exciting current : 0.5A	※ Check resistance Normal : 10 Ω (Between coil) : ∞ Ω (Terminal ring term)
Head lamp	 CL-3 CL-4	24V, H4 75/70W	※ Check resistance Abnormal : ∞ Ω (6-2, 4-2, 3-2, 1-2)
Work lamp	 CL-22 CL-23	24V 65W H3 bulb	※ Check disconnection Normal : A few Ω

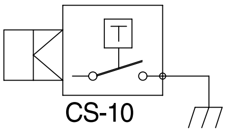
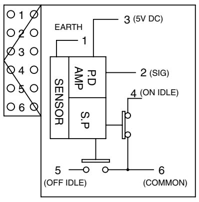
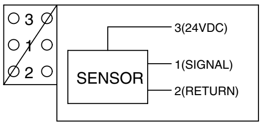
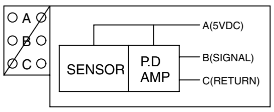
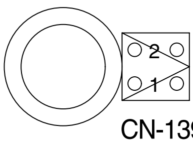
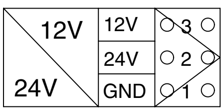
Part name	Symbol	Specifications	Check
Beacon lamp	 CL-7	24V 15W (Strobe type)	※ Check disconnection Normal : A few Ω Abnormal : ∞ Ω
Combination lamp	 CL-15A CL-16A  CL-15B CL-16B	24V 1W(tail) 24V 21W(turn)	※ Check disconnection Normal : A few Ω Abnormal : ∞ Ω
Room lamp	 CL-1	24V 10W	※ Check resistance Normal : A few Ω Abnormal : ∞ Ω
License lamp	 CL-21	24V 10W (1EA)	※ Check resistance Normal : A few Ω Abnormal : ∞ Ω
Diode	 DO-1 DO-2 DO-3 DO-4	Diode spec : 1N5406	-

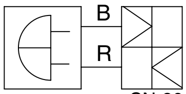
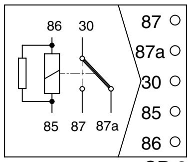
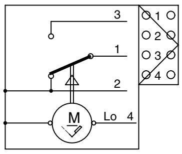
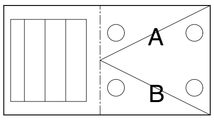
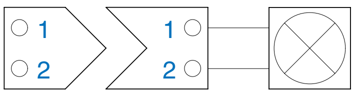
Part name	Symbol	Specifications	Check
Switch (Cabin tilt)	 CS-77	24V 8A	※ Check contact Ⅰ : 0 Ω (2-4, 1-3) ∞ Ω (8-4, 7-3) Ⅱ : 0 Ω (8-4, 7-3) ∞ Ω (2-4, 1-3) 0 :∞ Ω (7-3, 1-3, 8-4, 2-4)
Switch (Cabin tilt)	 CS-78	24V 20A	※ Check contact 0 :∞ Ω (1-2) Ⅰ : 0 Ω (1-2)
Switch (Locking type)	 CS-10 CS-17 CS-18 CS-34 CS-41 CS-42 CS-54 CS-79 CS-82	24V 8A	※ Check contact OFF : ∞ Ω (For terminal 1-5, 2-6) : 0 Ω (For terminal 5-7, 6-8) ON : ∞ Ω (6-8, 5-7) 0 Ω (2-6, 1-5)
Switch (Non-locking type)	 CS-19 CS-64	24V 8A	※ Check contact 0 :∞ Ω (For terminal 2-4, 1-7) Ⅰ : 0 Ω (2-4) Ⅱ : 0 Ω (4-8)
Tilt switch	 CS-72	24V 8A	※ Check contact S/W open : ∞ Ω (For terminal NO-COM) : 0 Ω (For terminal NC-COM) S/W closed : 0 Ω (For terminal NO-COM) : ∞ Ω (For terminal NC-COM)
Master switch		6~36V Continuous Capacity : 180Amp Push in capacity : 1000Amp	※ Check contact OFF : ∞ Ω

Part name	Symbol	Specifications	Check
Seat switch	 CS-73	24V 8A	※ Check contact OFF : ∞ Ω
Alternator	 CS-74	Delco Remy 24SI 24V 70A	※ Check voltage Normal : 24~28V
Switch	 CS-21 CS-39	24V 8A	※ Check contact 0 :∞ Ω (2-4, 1-7, 1-5) Ⅰ : ∞ Ω (2-4) 0 Ω (1-7, 1-5) Ⅱ : 0 Ω (2-4, 1-7, 1-5)
Switch	 CS-59	24V 8A	※ Check contact 0 :∞ Ω (2-8, 2-6, 1-3) Ⅰ : 0 Ω (2-8, 2-6) ∞ Ω (1-3) Ⅱ : 0 Ω (2-8, 2-6, 1-3)
Switch	 CS-3	24V 8A	※ Check contact 0 :∞ Ω (3-8, 3-1) 0 Ω (8-6) Ⅰ : ∞ Ω (3-8, 3-1) 0 Ω (6-1) Ⅱ : 0 Ω (3-1, 6-1)
Start motor	 CN-45	DENSO 24V 3.7kW	※ Operating or not

Part name	Symbol	Specifications	Check
Radio/USB player	 CN-27	DC28V 40Ohm × 2	※ Check resistance Power ON : 4 Ω + 4 Ω (For terminal 1-6, 4-8)
Horn	 CN-25 CN-25 CN-65	20~28V 100~115dB (A) (at 25V 2m) Max. 1.5A (at 24V)	※ Check operation Supply power(24V) to each terminal and connect ground.
Speaker	 CN-23(LH) CN-24(RH)	4 Ω 20W	※ Check resistance Normal : 50 Ω
Air conditioner compressor	 CN-30	24V 79W	※ Check contact Normal : 13.4 Ω
Cigar lighter	 CL-2	24V 5A	-
Flasher	 CR-11	24V 85~190 C/M 50dB	-

Part name	Symbol	Specifications	Check
Wiper motor	 CN-21	24V 1A 2-speed Auto parking	-
Washer pump	 CN-103 CN-22 CN-103 CN-83	24V 2.5A	※ Check contact Normal : 26.4 Ω (For terminal 1-2)
Warning buzzer	 CN-26 CN-26	18~32V 115±3dB(A) at 1m	-
Camera	 CN-249 CN-250	24V 2.5W Signaling : NTSC Angle of view : 145˚C	-
Fuel warmer	 CN-96 CN-97	24V 15A	※ Check resistance Abnormal : ∞ Ω

Part name	Symbol	Specifications	Check
Brake temp switch	 CS-10	N.O type	※ Check resistance Normal : ∞ Ω
Accel pedal	 CN-124	5V, hall sensor	※ Check voltage 0.5~3.9V (2-1)
Load sensor	 CD-50	24V, hall sensor	※ Check voltage 0.5~4.5 VDC (1-2)
Angle sensor	 CD-12	5V, hall sensor	※ Check voltage 0.4~4.5 VDC (B-C)
12V-socket	 CN-139	12V 120W Rated ampere : 10A	※ Check resistance Normal : A few Ω (1-2)
DC/DC converter	 CN-138	24V 10A Output voltage : 13±1VDC	※ Check resistance Normal : A few Ω (1-2, 1-3)

Part name	Symbol	Specifications	Check
Tilt alarm	 CN-26	24V 0.2A 90dB±5dB	※ Check resistance Normal : A few Ω
Relay	 CR-3 CR-46 CR-55	24V 30-87 : 20A 30-87a : 15A	※ Check resistance Normal : A few Ω (86-85) 0 Ω (30-87a) ∞ Ω (30-87)
Rear wiper	 CN-102	24V 1A 1-Speed Auto parking	-
Seat heaterr	 CN-170	24V	-
Mast work	 CL-5 CL-51 CL-6 CL-61	24V 65W H3	-

GROUP 7 CONNECTORS

1. CONNECTOR DESTINATION

Connector number	Type	No. of pin	Destination	Connector part No.	
				Female	Male
CN-1	KET	52	I/conn(Engine harness-Main harness)	MG643241	-
CN-2	KET	52	I/conn(Main harness-Engine harness)	-	MG613245
CN-3	DEUTSCH	4	Seat switch	-	DT04-4P
CN-5	DEUTSCH	2	Beacon	DT06-2S	DT04-2P
CN-6	AMP	16	I/conn(Frame harness-Engine harness)	368047-1	368050-1
CN-7	AMP	16	I/conn(Cabin harness-Main harness)	368047-1	368050-1
CN-8	KET	14	I/conn(Main harness-Monitor harness)	-	MG640352
CN-9	DEUTSCH	2	I/conn(Frame harness-Master W/Lamp harness)	DT06-2S	DT04-2P
CN-10	DEUTSCH	6	I/conn(Frame harness-Fender harness)	-	DT04-6P
CN-11	DEUTSCH	6	I/conn(Frame harness-Fender harness)	DT04-6P	-
CN-12	AMP	3	To rear camera harness	174357-2	174359-2
CN-13	KET	6	To condenser fan harness-Engine harness	MG610335	MG640337
CN-14	KET	6	Cabin harness	MG610049	MG620048
CN-15	KET	6	Aircon harness	MG610049	
CN-16	DEUTSCH	2	Mast work lamp harness	DT06-2S	DT04-2P
CN-19	KET	2	Inching potentiometer	MG610320	-
CN-20	KET	2	Engine harness	MG610331	MG640333
CN-21	DEUTSCH	8	Front wiper	D106-8S	-
CN-22	KET	2	Front washer	MG610320	-
CN-23	KET	2	Speaker LH	MG610070	
CN-24	KET	2	Speaker RH	MG610070	
CN-25	Molex	2	Horn	35825-0211	
CN-26	KET	1	Tilt alarm	ST730018-3	ST750036-3
CN-27	KUM	16	CD & MP3	PK145-16017	-
CN-28	AMP	8	T/M display	929504-3	-
CN-29	KET	2	Receiver dryer	MG640795	-
CN-30	KET	2	Compressor	MG610043	-
CN-31	AMP	2	Aircon harness	17146-2	-
CN-32	AMP	2	Aircon harness	-	174354-2
CN-33	AMP	6	Aircon harness	-	174264-2
CN-36	OPI	-	Fuse box	21HF-10500	-
CN-37	OPI	-	Fuse box	21HF-10500	-
CN-38	OPI	-	Fuse box	21HF-10500	-
CN-45	Ring term	1	Start motor	S820-31200	S820-20500
CN-46	KET	1	Engine harness-Air compressor	MG640944-5	MG650943-5
CN-50	AMP	68	Transmission control unit	963598-1	-

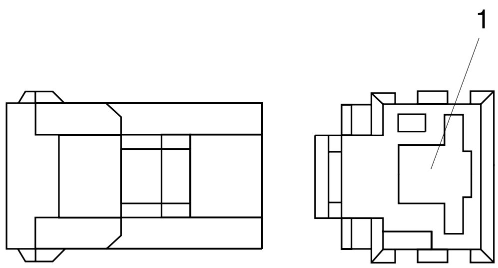
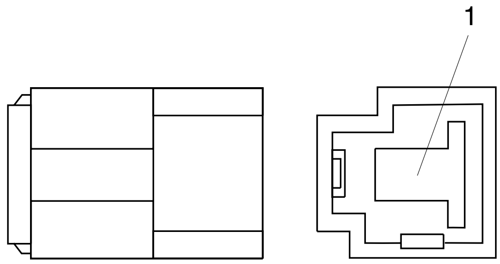
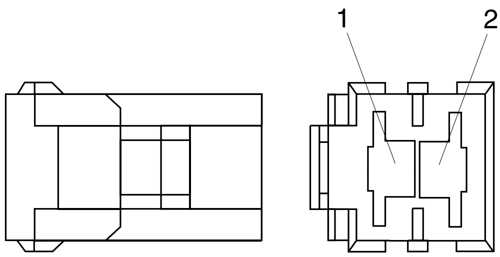
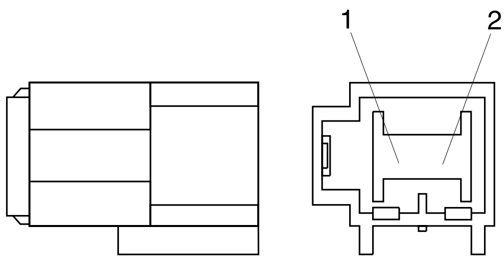
Connector number	Type	No. of pin	Destination	Connector part No.	
				Female	Male
CN-51	AMP	6	T/M diagnostic	-	926682-3
CN-52	KET	4	Handsfree controller	MG610331	-
CN-55	KET	14	Opss unit	MG610350	-
CN-56	AMP	20	Cluster	174047-2	-
CN-57	AMP	20	Cluster	175967-2	-
CN-59	AMP	36	Fan drive control unit	344111	-
CN-60	KET	2	Fusible link	-	MG620558
CN-65	DEUTSCH	2	Back-up buzzer	DT06-2S	-
CN-71	DEUTSCH	2	Parking solenoid	DT06-2S	-
CN-74	PACKARD	4	Alternator	12186568	-
CN-75	KET	1	Battery terminal(-)	MG640944-5	-
CN-83	KUM	2	Condenser fan	PB625-02027	-
CN-90	AMP	8	Frame harness	174982-2	17984-2
CN-91	DEUTSCH	3	Fender-RH	-	DT04-3P
CN-92	DEUTSCH	4	ECU connector(J3)	DT06-4S-EP06	-
CN-93	DEUTSCH	50	ECU connector(J2)	DRC26-50S01	-
CN-95	OPL/KET	2	Fusible link	21N4-01310	MG600558
CN-96	AMP	4	Fuel warmer	2-967325-3	-
CN-97	PACKARD	2	Fuel warmer(main filter)	15300027	-
CN-98	DEUTSCH	3	I/conn	DT063S-EP06	-
CN-102	AMP	4	Rear wiper motor	180900	-
CN-103	KET	2	Rear washer	MG610320	-
CN-112	ZF	16	Gear box	21L7-60290	-
CN-124	AMP	6	Accel pedal	174162-2	-
CN-131	DEUTSCH	2	Attach cut off	DT06-2S	
CN-133	AMP	2	Cabin down solenoid	-	174354-2
CN-134	AMP	2	Cabin up solenoid	174352-2	-
CN-135	DEUTSCH	9	Cluster/Monitor service tool	-	HD10-9-96P
CN-136	DEUTSCH	3	Fan drive control unit service tool	-	HD10-9-960
CN-138	KET	3	DC/DC converter	MG610045	-
CN-139	KET	2	12V socket	MG610043	-
CN-144	KET	20	Handsfree controller	MG610240	-
CN-154	DEUTSCH	2	Fan motor EPPR valve	DT06-2S	-
CN-169	KET	4	Program dump	DT06-4S-EP06	DT04-4P-E005
CN-245	AMP	12	Remote assy	368542	-
CN-246	AMP	12	USB & Socket assy	174045-2	-

Connector number	Type	No. of pin	Destination	Connector part No.	
				Female	Male
Switch					
CS-2	KET	6	Start key	MG610335	-
CS-3	DAEDONG	10	Rear wiper washer switch	250-10PRG	-
CS-6	KET	2	Center horn	-	MG640322
CS-10	DAEDONG	10	Fuel warmer switch	250-10PRG	-
CS-11	KET	8	Combination switch	MG610339	-
CS-12	KET	6	Combination switch	MG610335	-
CS-14	PACKARD	4	Gear selector	-	12010974
CS-15	PACKARD	4	Gear selector	12015797	-
CS-17	DAEDONG	10	Parking switch	250-10PRG	-
CS-18	DAEDONG	10	Cruise switch	250-10PRG	-
CS-19	DAEDONG	10	Cruise set/resume switch	250-10PRG	
CS-21	DAEDONG	10	Work lamp switch	250-10PRG	
CS-34	DAEDONG	10	Diagnostic switch	250-10PRG	
CS-39	DAEDONG	10	Main switch	250-10PRG	
CS-41	DAEDONG	10	Hazard switch	250-10PRG	
CS-42	DAEDONG	10	Inching switch	250-10PRG	
CS-54	DAEDONG	10	Aircon switch	250-10PRG	-
CS-59	DAEDONG	10	Auto/manual switch	250-10PRG	-
CS-64	DAEDONG	10	Inc/dec switch	250-10PRG	-
CS-72	DEUTSCH	4	Tilt switch	-	DT04-4P
CS-77	DAEDONG	10	Tilt operation	250-10PRG	-
CS-78	KET	2	Cabin tilt	MG610320	-
CS-79	DAEDONG	10	Power/STD switch	250-10PRG	174354-2
CS-82	DAEDONG	10	Seal heat switch	250-10PRG	-
Lamp					
CL-1	KET	2	Room lamp	-	MG610392
CL-2	KET	1	Cigar lighter	ST175036-3	ST730018-3
CL-3	DEUTSCH	6	Work lamp fender	DT06-6S	-
CL-5	DEUTSCH	2	Mast lamp-LH	DT06-2S	-
CL-6	DEUTSCH	2	Mast lamp-RH	DT06-2S	-
CL-7	-	6	Beacon lamp	S822-014000	S822-114000
CL-15	KLM	6	Rear combi LH	PB625-06027	-
CL-16	KLM	6	Rear combi RH	PB625-06027	-
CL-21	KET	1	License lamp	ST730018-3	ST750036-3
CL-22	DEUTSCH	2	R/work RH	-	DT04-2P
CL-23	DEUTSCH	2	R/work LH	DT06-2S	-
CL-24	-	1	Flasher lamp LH	S822-014000	S822-114000
CL-30	KET	2	Room lamp	MG610392	-
CL-51	DEUTSCH	2	Mast lamp-LH	DT06-2S	-
CL-61	DEUTSCH	2	Mast lamp-RH	DT06-2S	-

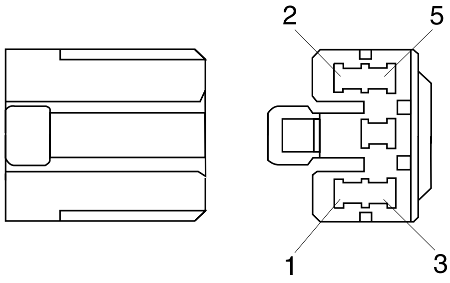
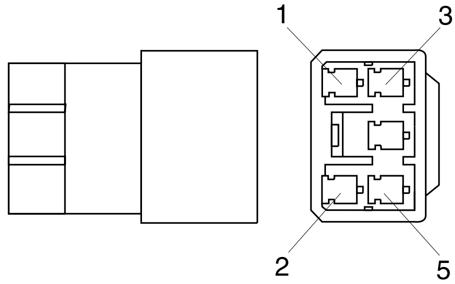
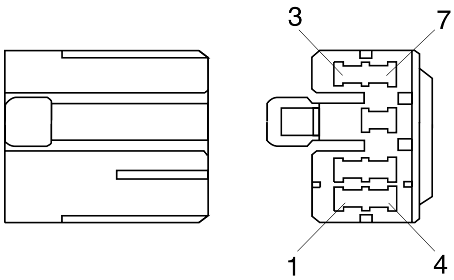
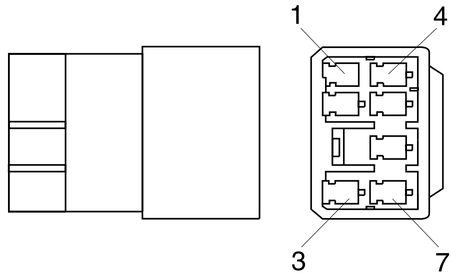
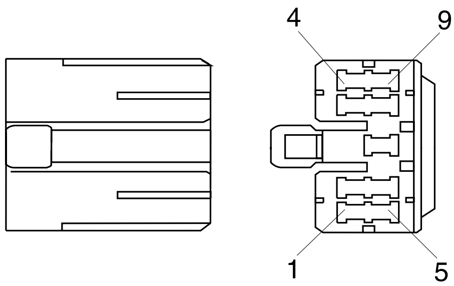
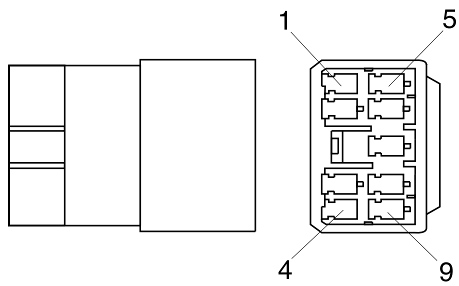
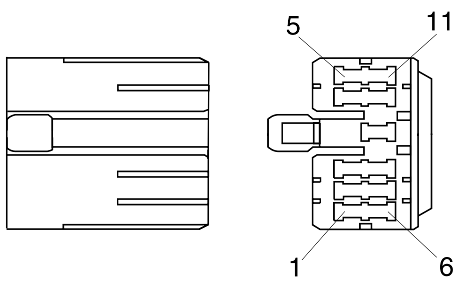
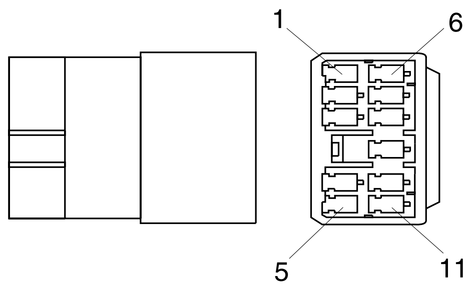
Connector number	Type	No. of pin	Destination	Connector part No.	
				Female	Male
Relay					
CR-3	HELLA	5	Front w/lamp relay	8TA003526-001	-
CR-4	AMP	5	Wiper HI relay	VCFM-1002	-
CR-5	AMP	5	Netural relay	VCFM-1002	-
CR-6	KET	4	Internal wiper relay	MG610047	-
CR-11	HELLA	5	Flasher unit	8JA003526-001	-
CR-12	AMP	5	Fan motor relay	VCFM-1002	-
CR-23	KET	4	Starter relay	MG610047	-
CR-26	AMP	5	Wiper low speed relay	VCFM-1002	-
CR-38	AMP	5	Washer pump relay	VCFM-1002	-
CR-39	AMP	5	Backup relay	VCFM-1002	-
CR-42	AMP	5	Preheat relay	VCFM-1002	-
CR-45	HELLA	5	ECM relay	8JA003526-001	-
CR-46	HELLA	5	Fuel warmer relay	8JA003526-001	-
CR-47	HELLA	5	Fuel warmer relay	8JA003526-001	-
CR-50	AMP	5	Travel cut relay	VCFM-1002	-
CR-52	AMP	5	Attach cut relay	VCFM-1002	-
CR-53	AMP	5	Cruise control relay	VCFM-1002	-
CR-54	AMP	5	Brake switch relay	VCFM-1002	-
CR-55	HELLA	5	Rear w/lamp relay	8JA003526-001	-
CR-56	AMP	5	Auto park relay	VCFM-1002	-
Sensor and pressure switch					
CD-2	KET	3	Fuel sender	MG610045	-
CD-3	DEUTSCH	2	Switch accumulator fail	-	DT04-2P
CD-4	AMP	1	Brake switch	171809-2	-
CD-8	AMP	2	Temp sender	827551-3	-
CD-10	Ring term	1	Air cleaner switch	ST730057-2	-
CD-12	DEUTSCH	1	Angle sensor	DT06-3S	DT04-3P
CD-18	AMP	1	Engine oil pressure switch	S819-010122	-
CD-26	DEUTSCH	2	Parking pressure switch	-	DT04-2P
CD-27	AMP	2	Speed pick-up turbine	963040-2	-
CD-29	ZF	2	Temp sender	21FF-10170	-
CD-35	DEUTSCH	2	Water in fuel switch	DT06-2S	-
CD-50	DEUTSCH	3	Load sensor	DTM06-3S	
CD-55	KET	2	RCV pressure switch	MG640795	-
CD-71	AMP	6	Inching sensor	1-967616-1	-
CD-72	AMP	2	Speed pick-up internal	963040-3	-
CD-73	AMP	3	Speed sensor output	282087	-
CD-74	AMP	2	Speed pick-up engine	963040-3	-
CD-75	AMP	2	Switch filter	282080-1	-

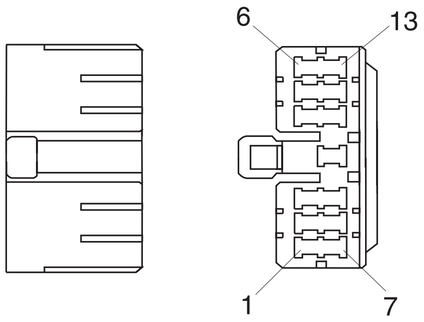
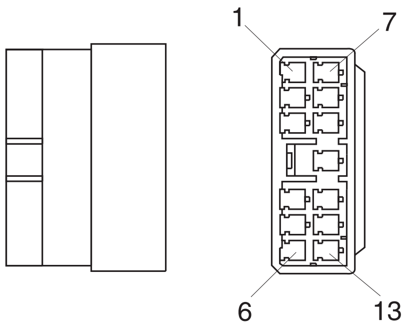
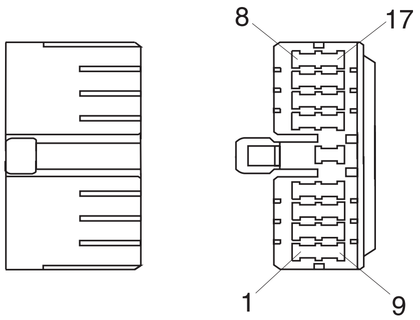
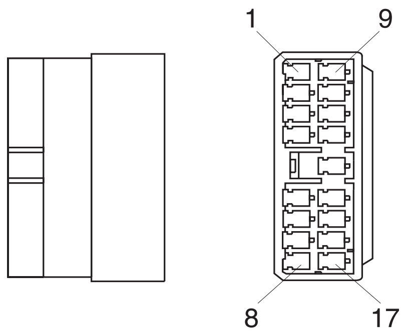
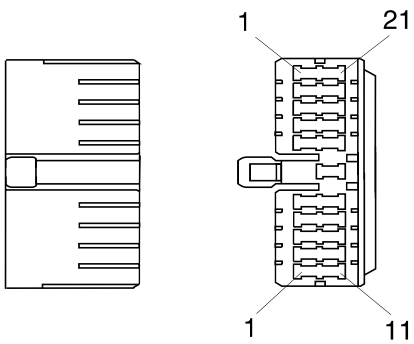
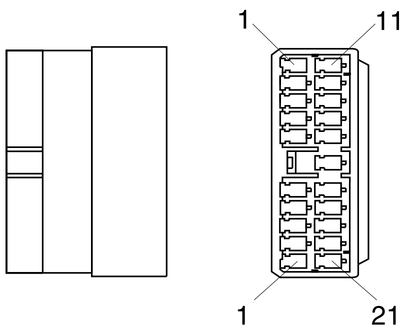
2. CONNECTION TABLE FOR CONNECTORS

1) 58-L TYPE CONNECTOR

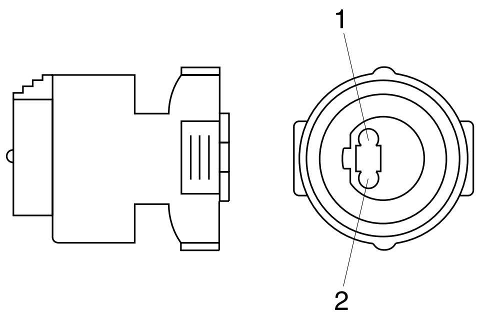
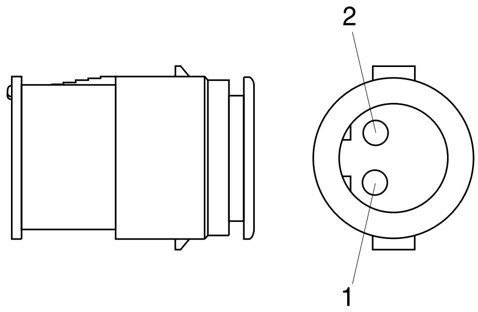
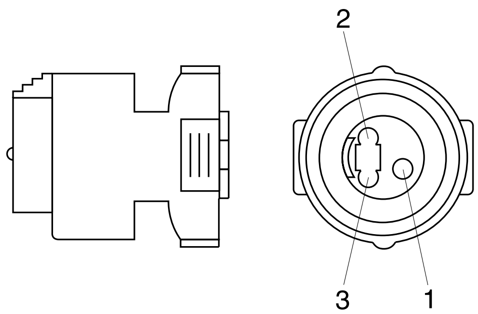
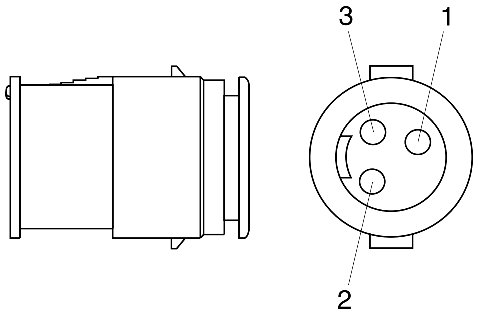
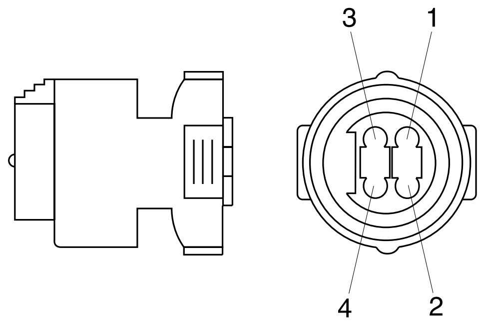
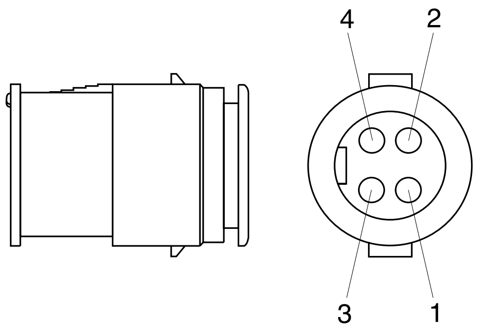
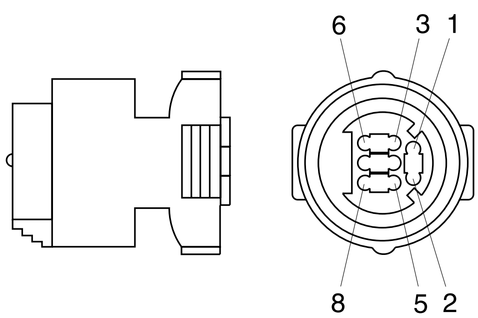
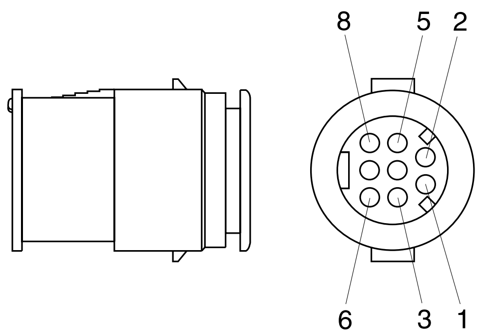
No. of pin	Receptacle connector(Female)	Plug connector(Male)
1	 S813-030100	 S813-130100
2	 S813-030200	 S813-130200

2) PA TYPE CONNECTOR

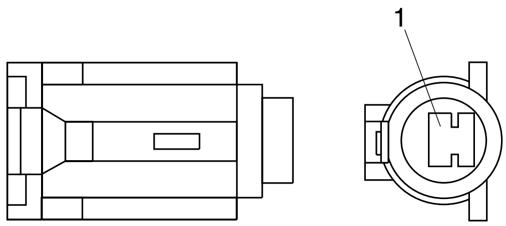
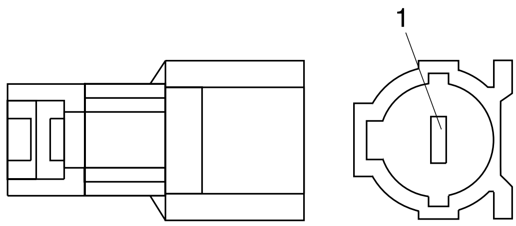
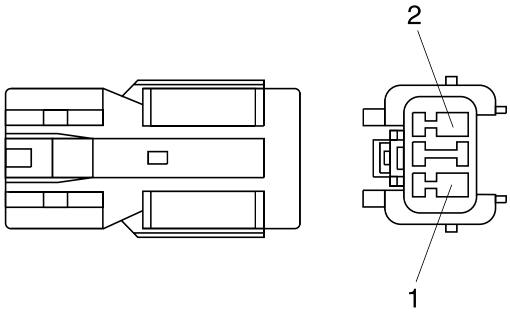
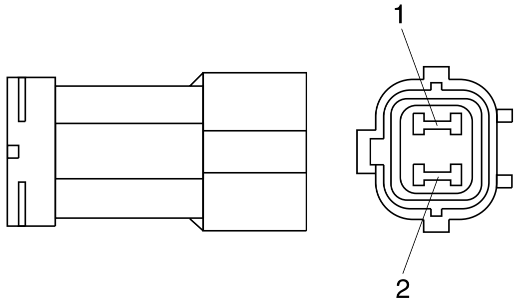
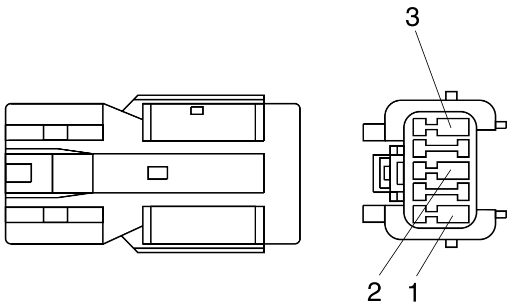
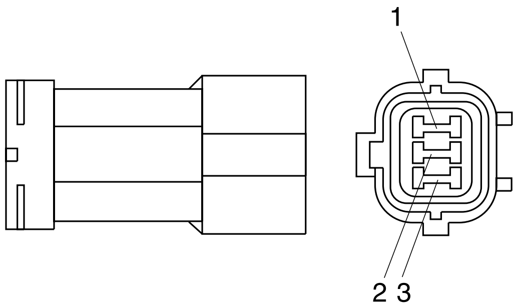
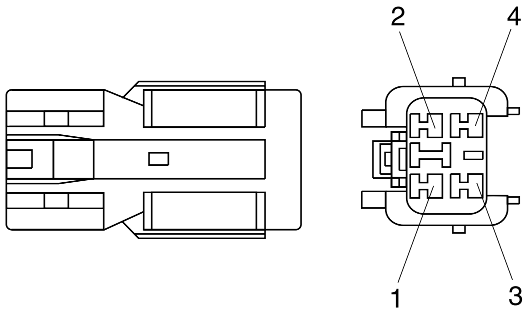
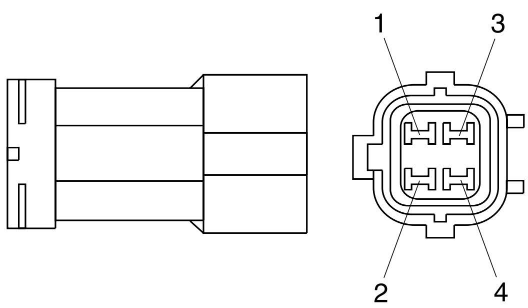
No. of pin	Receptacle connector(Female)	Plug connector(Male)
5	 S811-005002	 S811-105002
7	 S811-007002	 S811-107002
9	 S811-009002	 S811-109002
11	 S811-011002	 S811-111002

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

3) J TYPE CONNECTOR

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

4) SWP TYPE CONNECTOR

<table>
<tr><th>No. of pin</th><th>Receptacle connector(Female)</th><th>Plug connector(Male)</th></tr>
<tr><td>1</td><td>S814-001000</td><td>S814-101000</td></tr>
<tr><td>2</td><td>S814-002000</td><td>S814-102000</td></tr>
<tr><td>3</td><td>S814-003000</td><td>S814-103000</td></tr>
<tr><td>4</td><td>S814-004000</td><td>S814-104000</td></tr>
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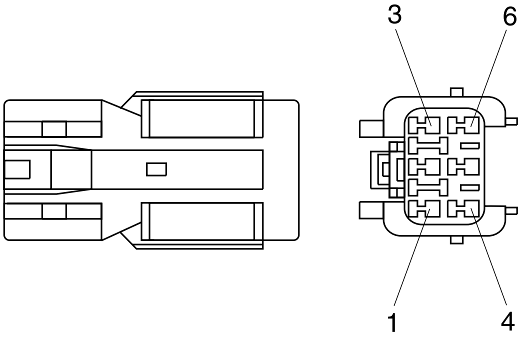
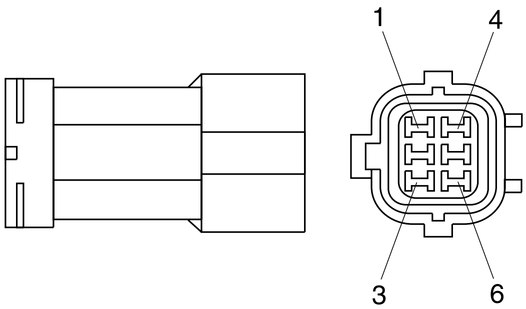
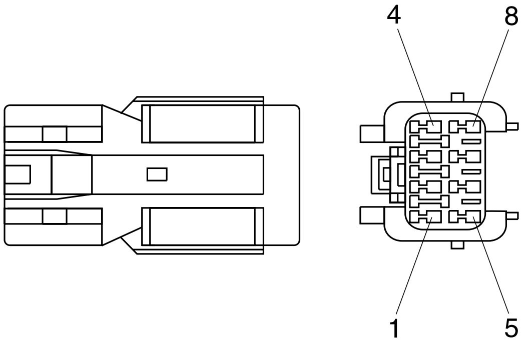
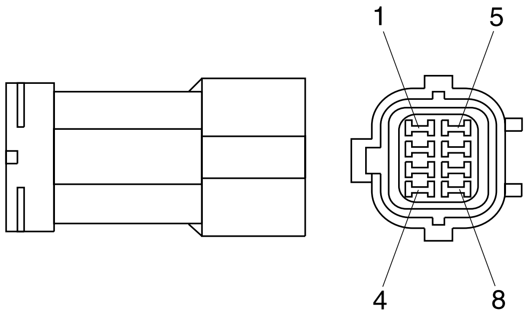
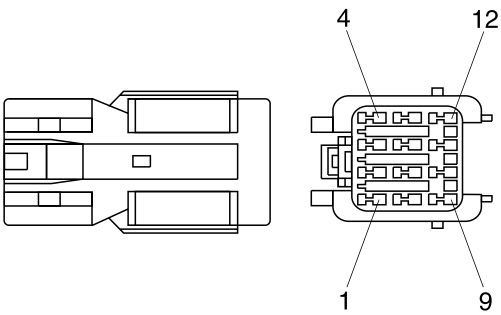
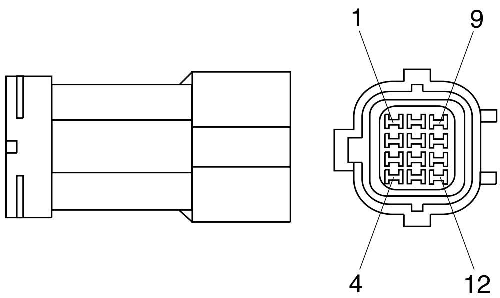
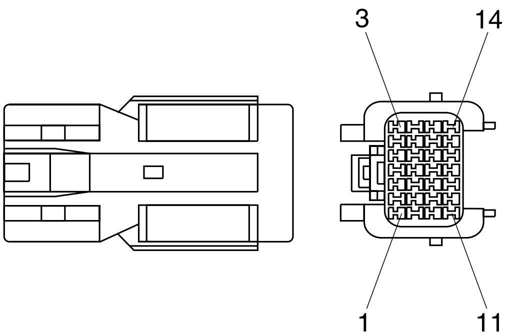
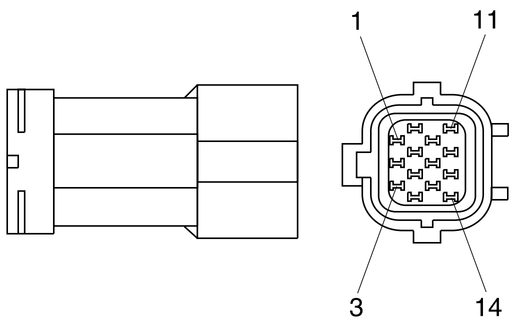
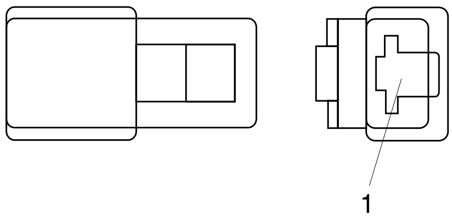
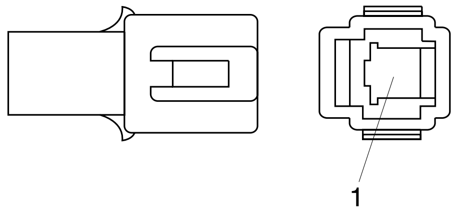
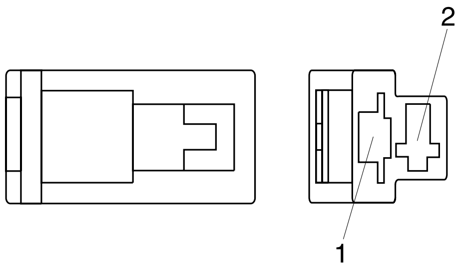
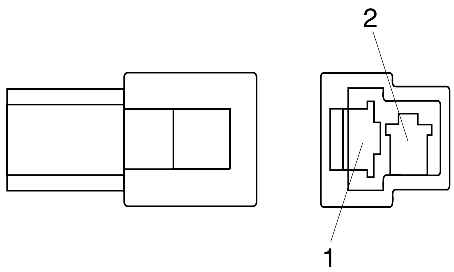
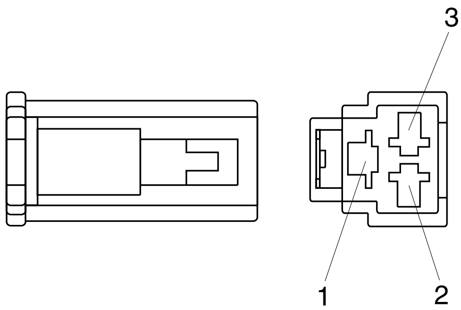
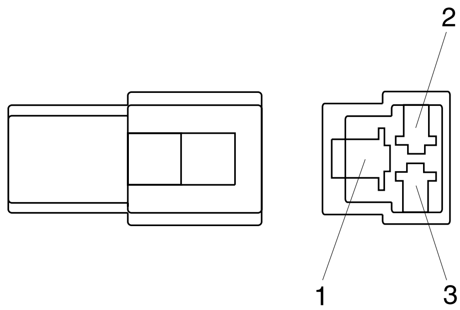
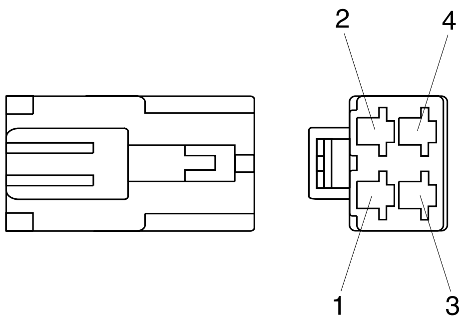
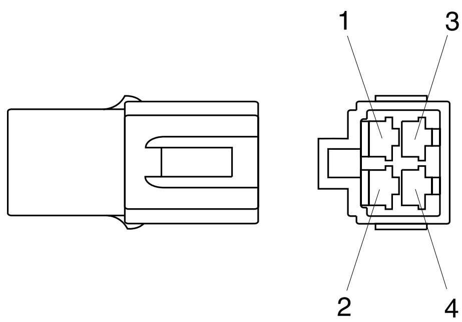
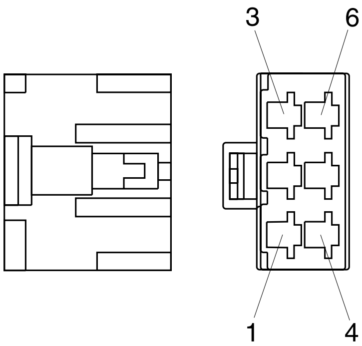
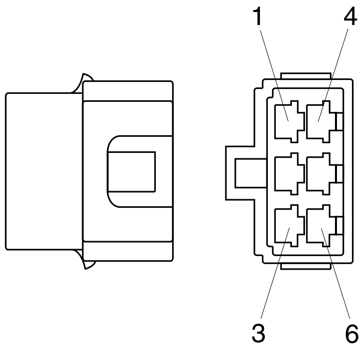
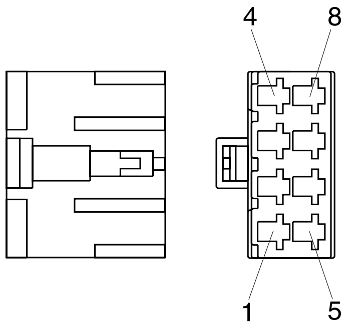
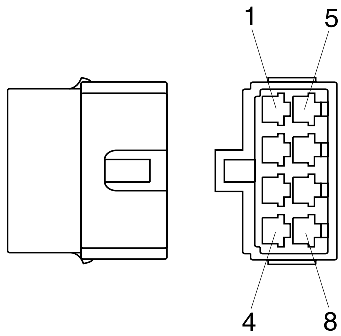
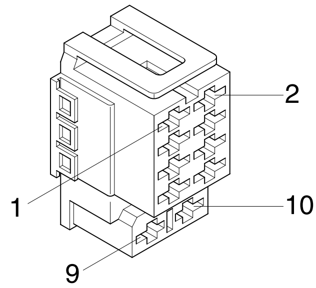
6	 S814-006000	 S814-106000
8	 S814-008000	 S814-108000
12	 S814-012000	 S814-112000
14	 S814-014000	 S814-114000

5) CN TYPE CONNECTOR

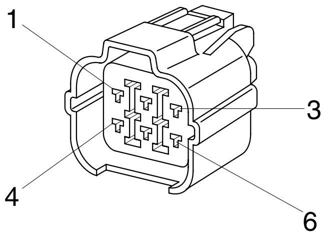
No. of pin	Receptacle connector(Female)	Plug connector(Male)
1	 S810-001202	 S810-101202
2	 S810-002202	 S810-102202
3	 S810-003202	 S810-103202
4	 S810-004202	 S810-104202

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

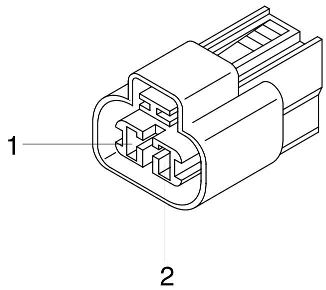
6) ITT SWF CONNECTOR

No. of pin	Receptacle connector(Female)	Plug connector(Male)
10	 SWF593757	

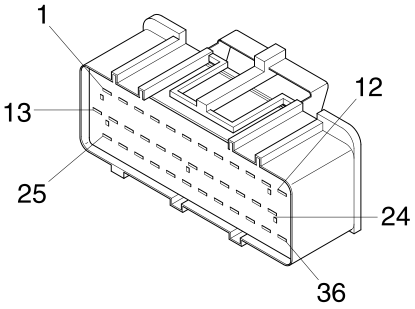
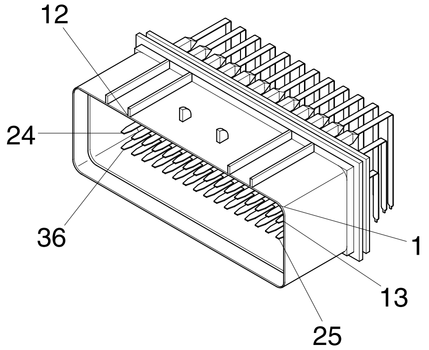
7) HW090 SEALED CONNECTOR

No. of pin	Receptacle connector(Female)	Plug connector(Male)
6	 6189-0133	

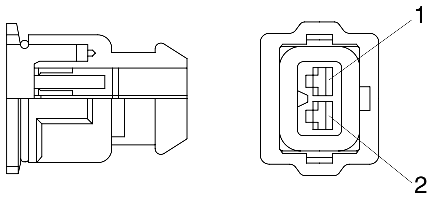
8) MWP02F-B CONNECTOR

No. of pin	Receptacle connector(Female)	Plug connector(Male)
2	 PH805-02028	

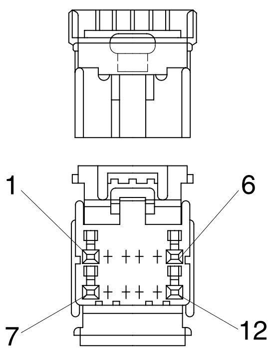
9) AMP ECONOSEAL CONNECTOR

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

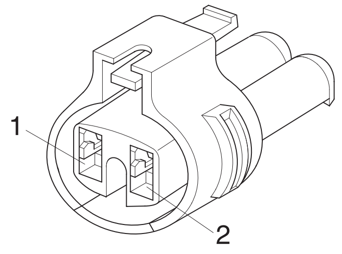
10) AMP TIMER CONNECTOR

No. of pin	Receptacle connector(Female)	Plug connector(Male)
2	 85202-1	

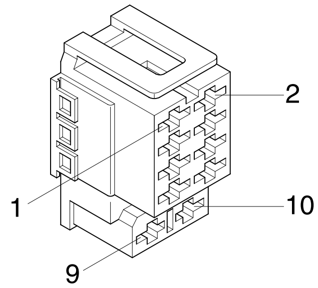
11) AMP 040 MULTILOCK CONNECTOR

No. of pin	Receptacle connector(Female)	Plug connector(Male)
12	 174045-2	

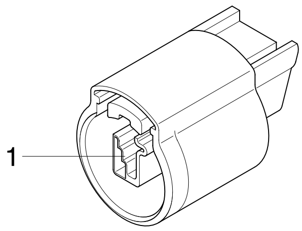
12) KET 090 WP CONNECTORS

No. of pin	Receptacle connector(Female)	Plug connector(Male)
2	 MG640795	

13) ITT SWF CONNECTOR

No. of pin	Receptacle connector(Female)	Plug connector(Male)
10	 SWF593757	

14) MWP NMWP CONNECTOR

No. of pin	Receptacle connector(Female)	Plug connector(Male)
1	 NMWP01F-B	

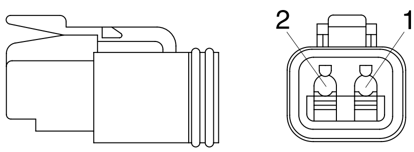
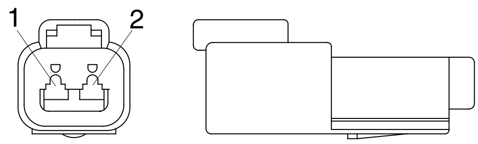
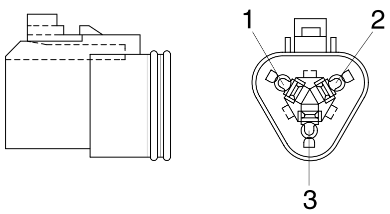
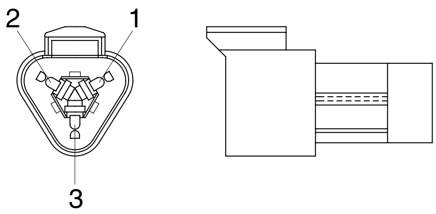
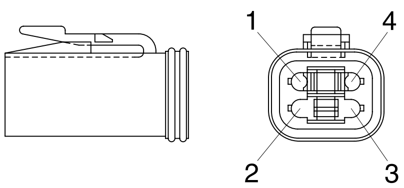
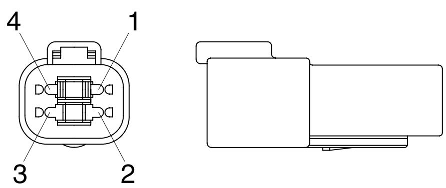
15) DEUTSCH DT CONNECTORS

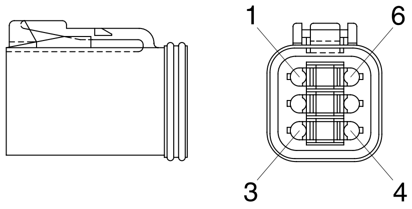
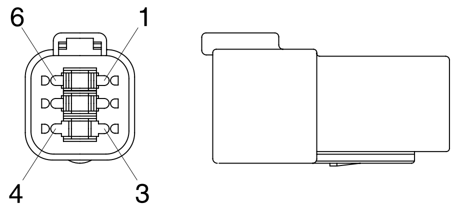
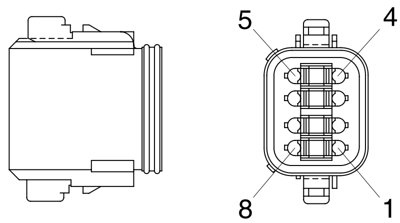
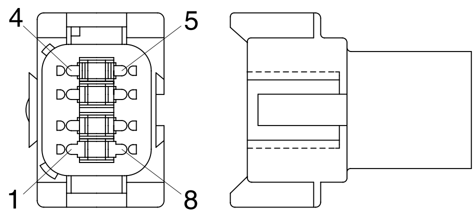
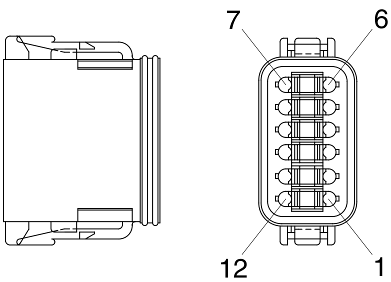
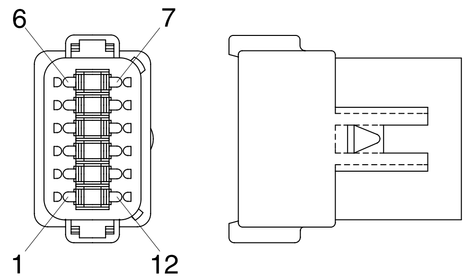
DT 06 - 3S - ★★★★

- ★★★★ — Modifications(See below)
- 3S — Number of contacts(P : Pin, S : Socket)
- 06 — 06 : Receptacle, 04 : Plug
- DT — Deutsch connectors

※ Modification

E003 : Standard end cap - gray
E004 : Color of connector to be black
E005 : Combination - E004 & E003
EP04 : End cap
EP06 : Combination P012 & EP04
P012 : Front seal enhancement - connectors color to black for 2, 3, 4 & 6pin

No. of pin	Receptacle connector(Female)	Plug connector(Male)
2	 DT06-2S	 DT04-2P
3	 DT06-3S	 DT04-3P
4	 DT06-4S	 DT04-4P

No. of pin	Receptacle connector(Female)	Plug connector(Male)
6	 DT06-6S	 DT04-6P
8	 DT06-8S	 DT04-8P
12	 DT06-12S	 DT04-12P

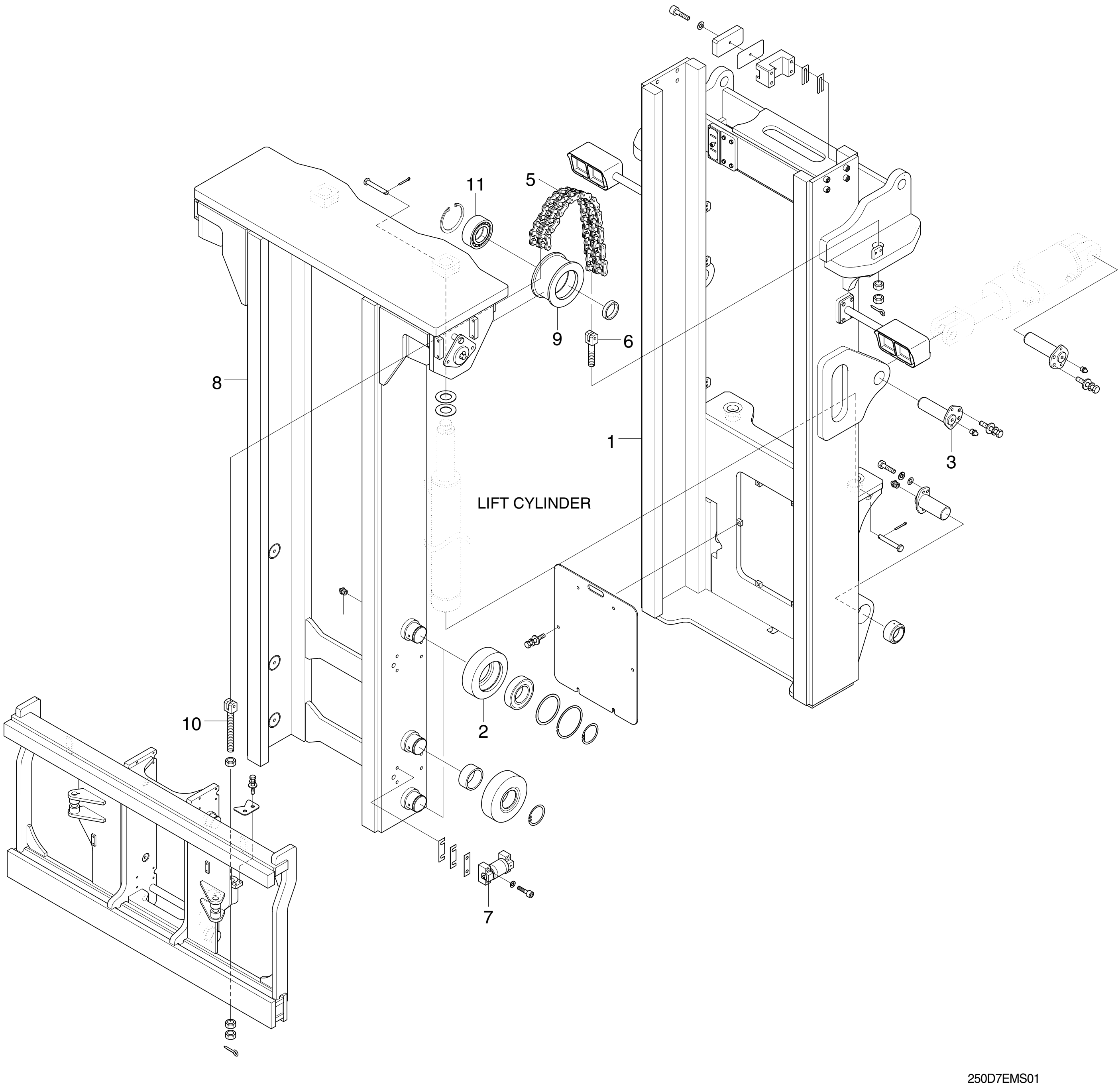
GROUP 8 TROUBLESHOOTING

Trouble symptom	Probable cause	Remedy
Lamps dimming even at maximum engine speed.	· Faulty wiring.	· Check for loose terminal and disconnected wire.
Lamps flicker during engine operation.	· Improper belt tension.	· Adjust belt tension.
Charge lamp does not light during normal engine oper.	· Charge lamp defective. · Faulty wiring.	· Replace. · Check and repair.
Alternator makes abnormal sounds.	· Alternator defective.	· Replace
Starting motor fails to run.	· Faulty wiring. · Insufficient battery voltage.	· Check and repair. · Recharge battery.
Starting motor pinion repeats going in and out.	· Insufficient battery voltage.	· Recharge battery.
Excessively low starting motor speed.	· Insufficient battery voltage. · Starting motor defective.	· Recharge battery. · Replace
Starting motor comes to a stop before engine starts up.	· Faulty wiring. · Insufficient battery voltage.	· Check and repair. · Recharge battery.
Heater signal does not become red.	· Faulty wiring. · Glow plug damaged.	· Check and repair. · Replace
Engine oil pressure caution lamp does not light when engine is stopped (with starting switch left in"ON" position).	· Caution lamp defective. · Caution lamp switch defective.	· Replace · Replace

SECTION 8 MAST

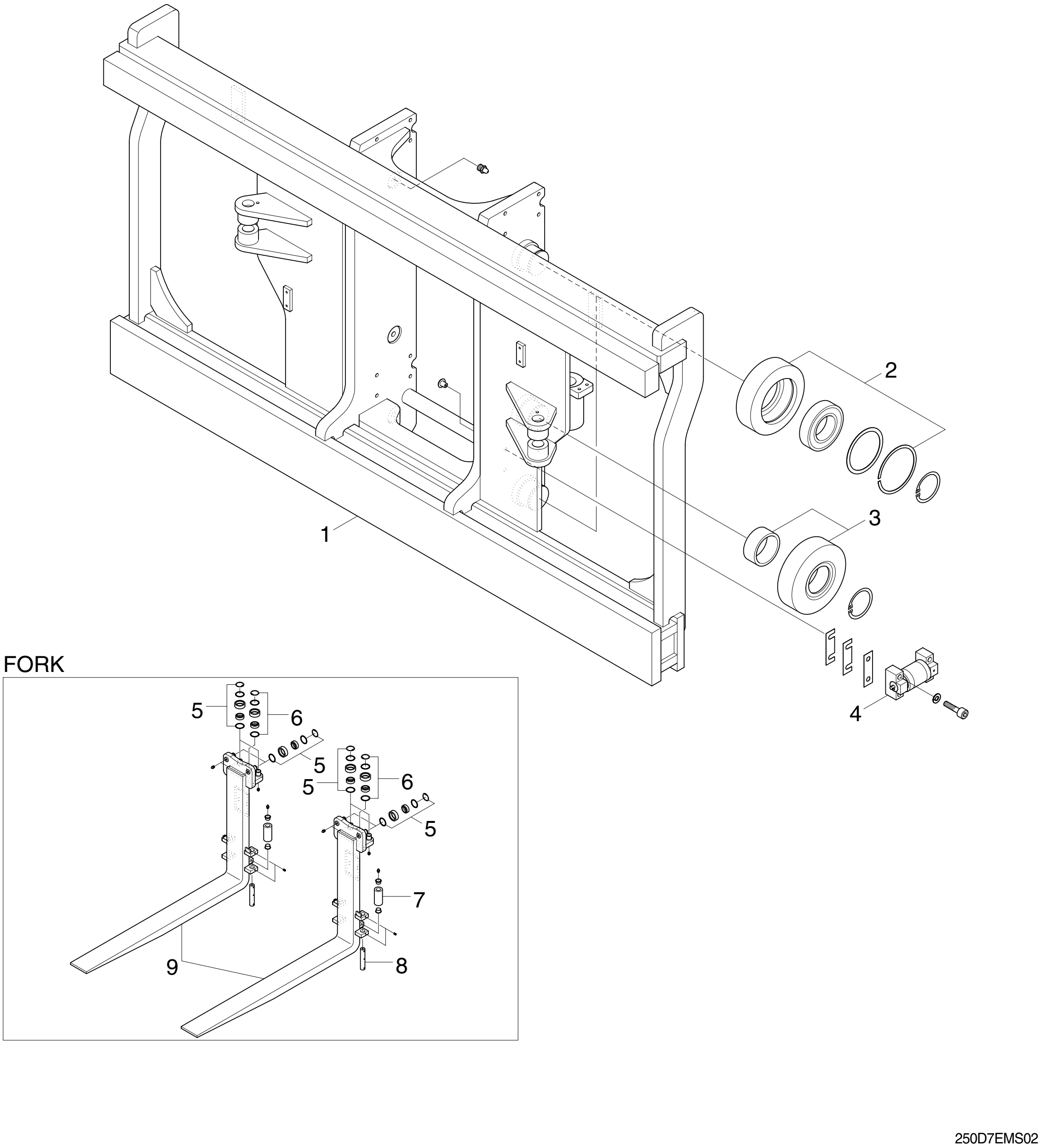
GROUP 1 STRUCTURE

1. 2 STAGE MAST(V MAST)



1	Outer mast	5	Lift chain	9	Chain sheave bearing
2	Roller bearing	6	Anchor bolt	10	Anchor bolt
3	Tilt cylinder pin	7	Side roller bearing	11	Roller bearing
4	Mast mounting pin	8	Inner mast		

2. CARRIAGE AND FORK



1	Carriage	6	Roller
2	Load roller bearing	7	Roller
3	Load roller bearing	8	Pin
4	Side roller	9	Fork
5	Roller		

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

1. OPERATIONAL CHECKS

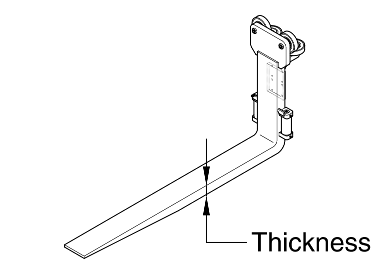
1) FORKS

(1) Measure thickness of root of forks and check that it is more than specified value.

EX : l =2450mm(96in)

mm(in)

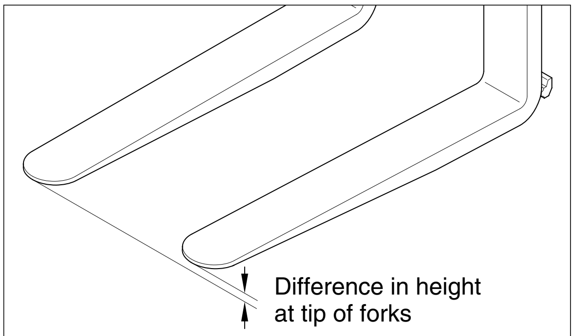
61HV-71201	110(4.3)	90(3.5)



180D7EFK01

2) Set forks in middle and measure out of parallel and difference in height at the top of forks.

Fork length (mm)	Height difference (mm)
below 1500	3
equal or above 1500	6



D255FK02

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 2.0mm(0.08in)
   - · Left-to-right clearance : Within 2.5mm (0.10in)
3) Check that there is an oil groove in bushing at mast support.
4) Set mast vertical, raise forks about 10cm from ground, and push center of lift chain with finger to check for difference in tension.
   If there is any difference in tension, adjust chain stopper bolt.
5) Check visually for abnormalities at thread of chain anchor bolt, and at contact surface between chain wheel and chain.
   Rotate chain wheel by hand and check for any play of bearing.

2. TROUBLESHOOTING

1) MAST

Problem	cause	Remedy
Forks fail to lower.	· Deformed mast or carriage.	· Disassemble, repair or replace.
Fork fails to elevate.	· Faulty hydraulic equipment. · Deformed mast assembly.	· See troubleshooting hydraulic pump and cylinders in section 6, hydraulic system. · Disassemble mast and replace damaged parts or replace complete mast assembly.
Slow lifting speed and insufficient handling capacity.	· Faulty hydraulic equipment. · Deformed mast assembly.	· See troubleshooting hydraulic pump and Cylinders in section 6, hydraulic system. · Disassemble mast and replace damaged parts or replace complete mast assembly.
Mast fails to lift smoothly.	· Deformed masts or carriage. · Faulty hydraulic equipment. · Damaged load and side rollers. · Unequal chain tension between LH & RH sides. · LH & RH mast inclination angles are unequal. (Mast assembly is twisted when tilted)	· Disassembly, repair or replace. · See Troubleshooting Hydraulic Cylinders pump and control valve in section 6, hydraulic system. · Replace. · Adjust chains. · Adjust tilt cylinder rods.
Abnormal noise is produced when mast is lifted and lower-ed.	· Broken load roller bearings. · Broken side roller bearings. · Deformed masts. · Bent lift cylinder rod. · Deformed carriage. · Broken sheave bearing.	· Replace. · Replace. · Disassemble, repair or replace. · Replace. · Replace. · Replace.
Abnormal noise is produced during tilting operation.	· Insufficient lubrication of anchor pin, or worn bushing and pin. · Bent tilt cylinder rod.	· Lubricate or replace. · Replace.

2) FORKS

Problem	cause	Remedy
Abrasion	Long-time operations causes the fork to wear and reduces the thickness of the fork. Inspection for thickness is needed. · Wear limit : Must be 90% of fork thickness	If the measured value is below the wear limit, replace fork.
Distortion	Forks are bent out of shape by a number of reasons such as overloading, glancing blows against walls and objects, and picking up load unevenly. · Difference in fork tip height : 15mm · Difference in fork tip width : 35mm	If the measured value exceeds the allowance, replace fork.
Fatigue	Fatigue failure may result from the fatigue crack even though the stress to fork is below the static strength of the fork. Therefore, a daily inspection should be done. · Crack on the fork heel. · Crack on the fork weldments.	Repair fork by expert. In case of excessive distortion, replace fork.

GROUP 3 ADJUSTMENT

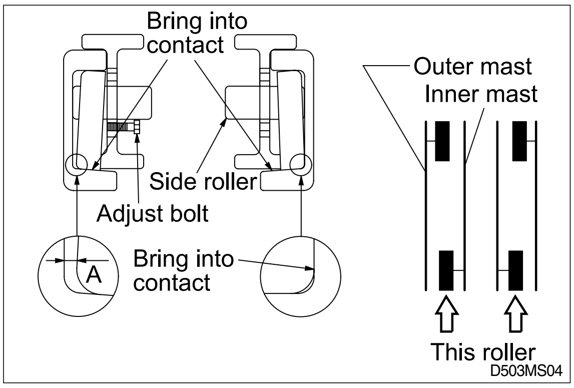
1. MAST LOAD ROLLER

1) INNER/OUTER MAST ROLLER CLEARANCE ADJUSTMENT

(1) Measure the clearance with the mast overlap at near 480mm(19in).

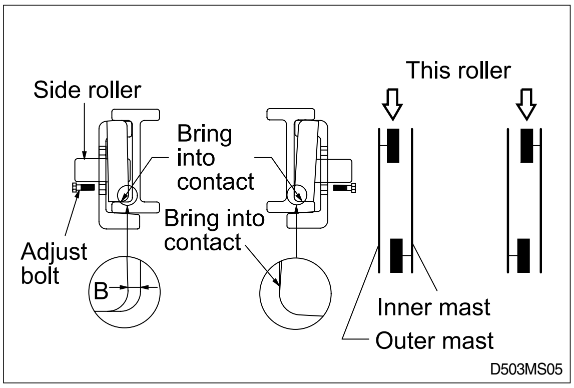
(2) Shift the inner mast to one side to bring the roller into contact with the outer mast, and adjust the clearance between the roller side face and mast at the closest position on the opposite side to the following value by adjust bolt.

· Standard clearance A, B = 0~0.6mm



(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.



※ When assembling the load roller bearings, it must be sure to observe the followings.

1) The outer race of the load roller bearings should be assembled to inward for 2.5mm radius round part and outward for 7mm radius round part.

2) When assembling and disassembling the load roller bearings, the jig fixture should be used so that it can be pressed to inner race of the roller bearings.
If it is not, the inner race of the load roller bearing could be seperated.

3) Remove the foreign materials in the grease oil passage of the roller brackets before assembling.

2) CARRIAGE LOAD ROLLER

(1) Measure the clearance when the center of the carriage upper roller is 100mm from the top of the inner mast.

(2) Measure the clearance at upper, middle and lower rollers after loosen the adjust screws from the side rollers. Shift the carriage to one side to bring the roller into contact with the inner mast, and measure the clearance between the roller side face and mast at the closest position on the opposite side to the following value by adjust screw.
  · Standard clearance C = 0~0.6mm

(3) Distribute the roller clearance equally to the left and right roller.

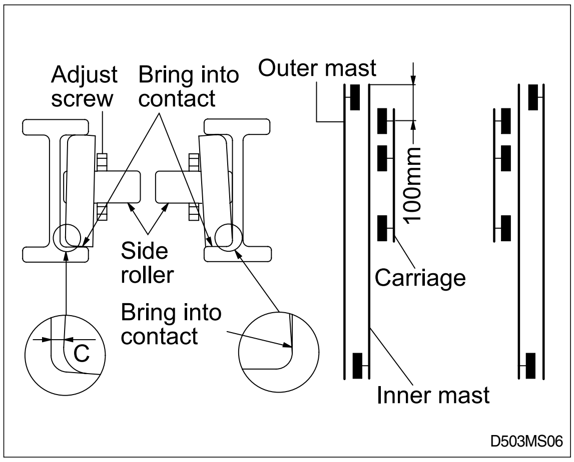
(4) After the adjustment, the carriage should move smoothly along the overall mast length.

※ When assembling the load roller bearings, it must be sure to observe the followings.

1) The outer race of the load roller bearings should be assembled to inward for 2.5mm radius round part and outward for 7mm radius round part.

2) When assembling and disassembling the load roller bearings, the jig fixture should be used so that it can be pressed to inner race of the roller bearings.
If it is not, the inner race of the load roller bearing could be seperated.

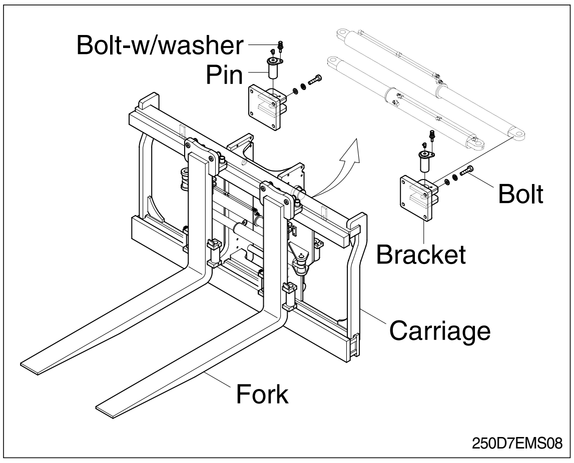
3) Remove the foreign materials in the grease oil passage of the roller brackets before assembling.



GROUP 4 REMOVAL AND INSTALLATION

1. FORKS

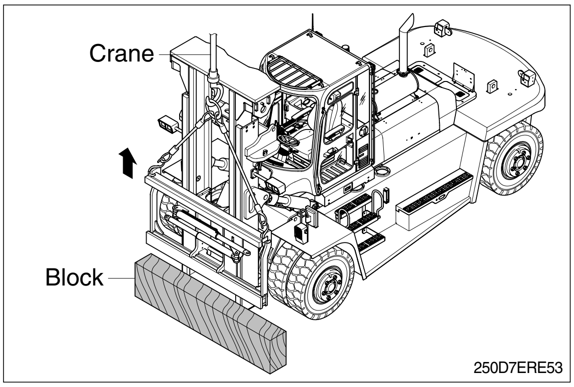
(1) Lower the fork carriage until the forks are approximately 25mm(1in) from the floor.
(2) Loosen and remove the bolt and washer from the bracket.
(3) Remove only one fork at a time.
※ On larger forks it may be necessary to use a block of wood.
(4) Reverse the above procedure to install load forks.



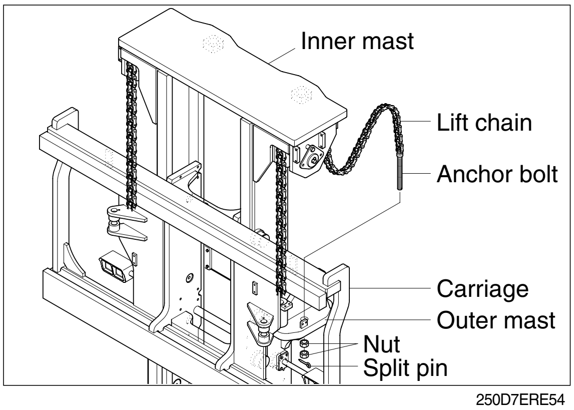
2. CARRIAGE ASSEMBLY

1) CARRIAGE

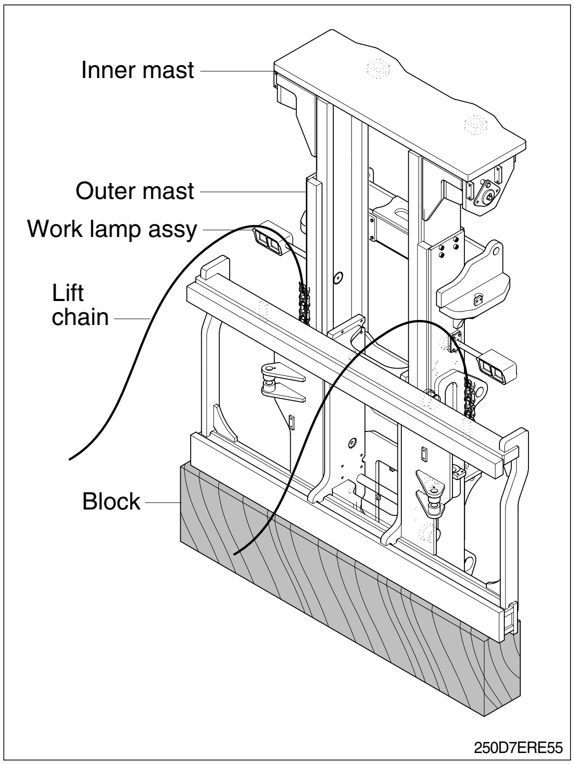
(1) With the mast vertical, raise the carriage high enough to place blocks under the load forks. This is done to create slack in the load chains when the carriage is lowered. Lower the carriage all the way down to the floor. Make sure the carriage is level, this will prevent any binding when the mast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

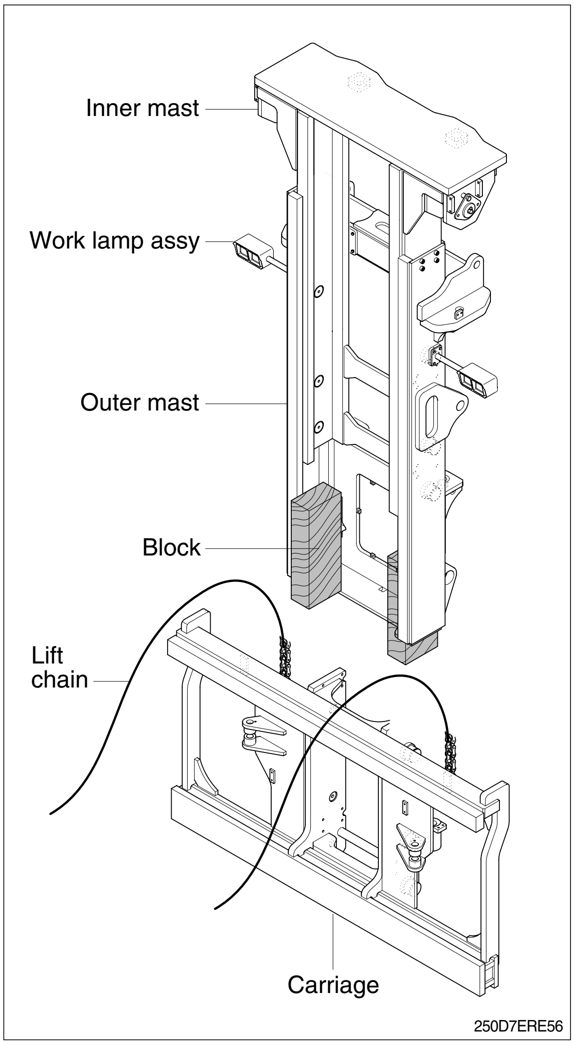


(5) Slowly raise inner mast upright until mast clears top of fork carriage. Move carriage to work area and lower mast.

⚠ **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.

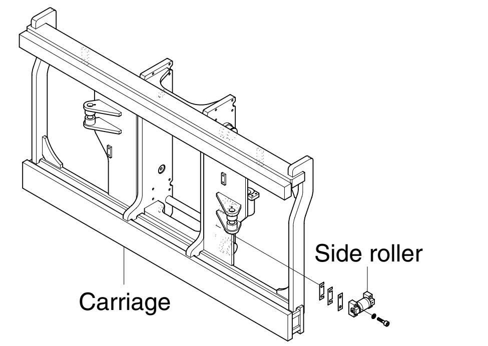


2) SIDE ROLLER

(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.



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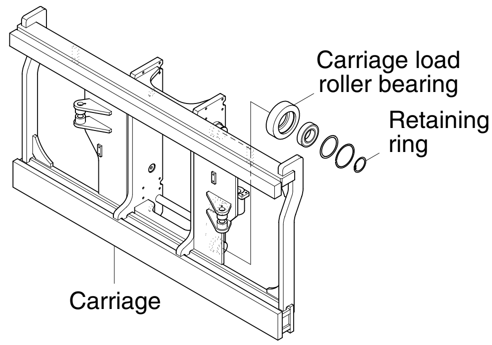
3) CARRIAGE LOAD ROLLER BEARING

(1) Remove carriage as outlined in the carriage removal paragraph.
(2) Using the plier, remove retaining rings from load roller bearing bracket.
(3) Using a plier, remove load roller bearings from load roller bearing bracket.
(4) Reverse the above procedure to assemble. Refer to MAST ROLLER ADJUSTMENT paragraph.



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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.

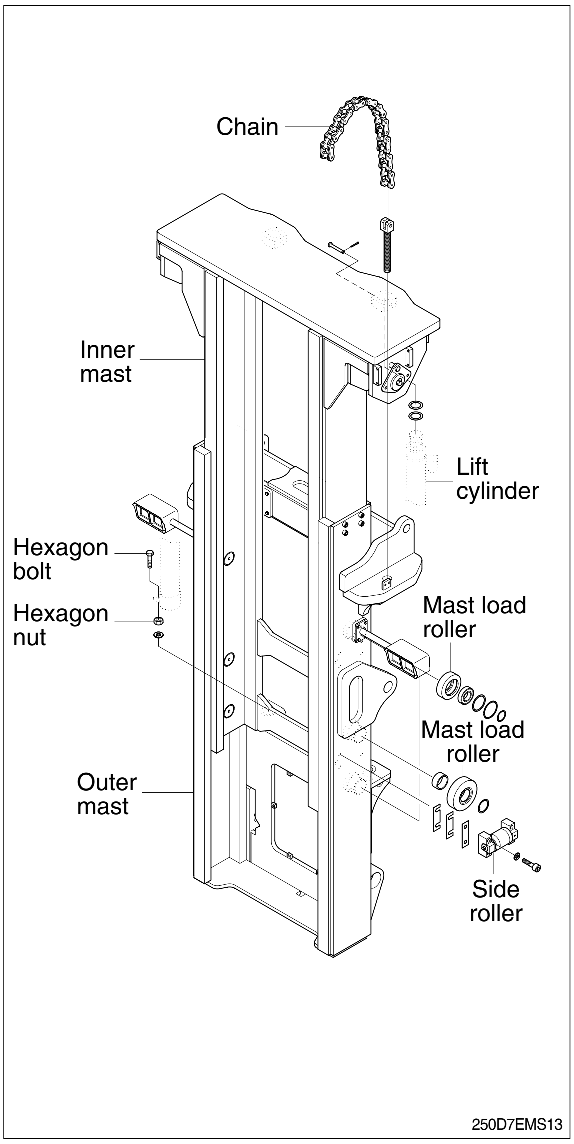
(8) Thoroughly clean, inspect and replace all worn or damaged parts.

(9) Reverse the above procedure to assemble. Refer to MAST ROLLER ADJUSTMENT paragraph.

(10) 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.
Lift inner mast upright straight up and out of outer mast section.

(11) Replace and reverse above procedure to install.

(12) Make all necessary measurements and adjustments.



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.

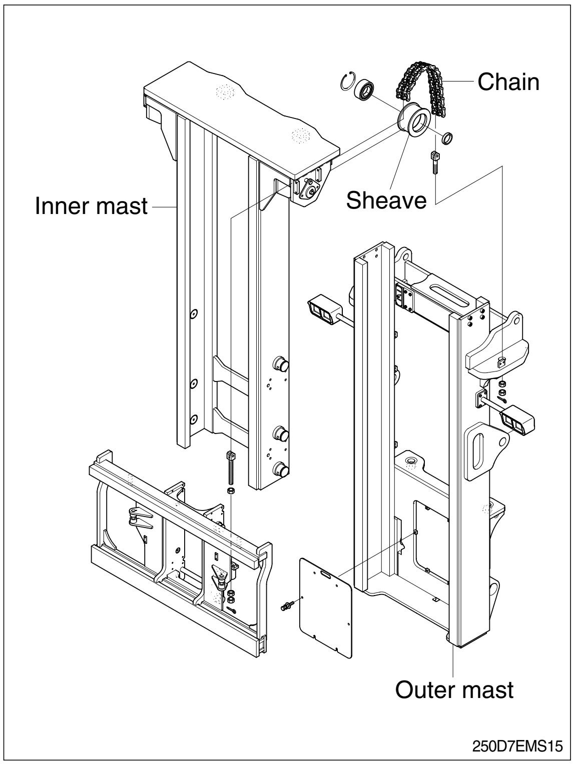
(2) Remove the split pin securing the chain anchor pins and discard. While supporting the chains, remove the chain anchor pins and drape the chain over the carriage.

(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) CARRIAGE CHAIN

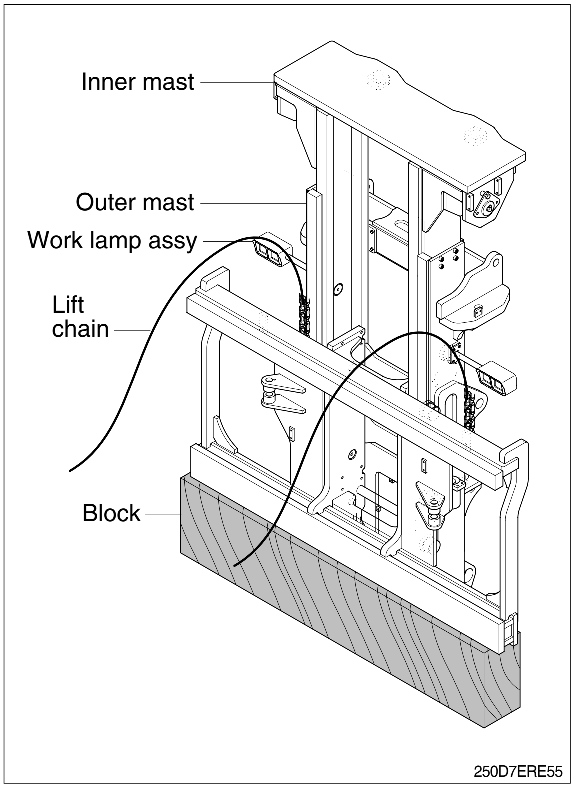
(1) Place a sling around carriage front plate and attach to an overhead hoist. Lift and secure carriage high enough so that split and chain anchor pins on carriage can be easily be removed. Remove chain anchor pins from carriage and drape chains out over carriage.

(2) Place a wooden block under the carriage and lower the carriage on the block.

(3) While supporting the chains, remove split pins and chain anchor pins from chain anchors.

(4) Remove chains and wash them with solvent. Refer to this section for Load chain inspection and maintenance.

(5) Reverse the above procedure to assemble and install. Use new split pins in chain anchor pins.
Refer to this section for Load chain lubrication and adjustment.



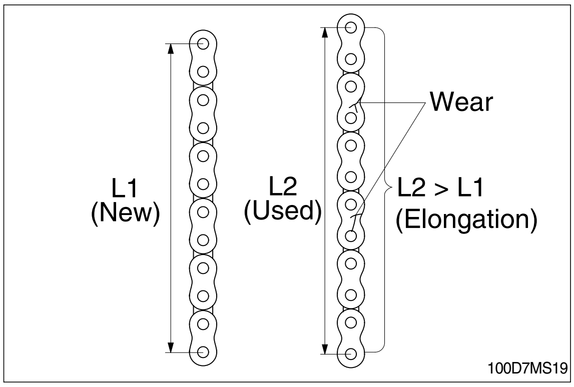
3) LOAD CHAIN INSPECTION AND MAINTENANCE

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 "as-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(12.7mm), 3/4(19.05mm), 1(25.4mm), 1-1/2(38.1mm), 2(50.8mm), use side A of scale.
· If pitch is 5/8(15.875mm), 1-1/4(31.75mm) or 2(50.8mm), 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.

4) LOAD CHAIN LUBRICATION AND ADJUSTMENT

(1) Lubrication

The most important consideration in field maintenance of lift chains is lubrication. Hard working, heavily loaded chains cannot be expected to give satisfactory wear life without scheduled periodic re-lubrication. Like all bearing surfaces, the precision manufactured, hardened steel, joint-wearing surfaces require a film of oil between mating parts to prevent rapid wear. Oil must penetrate the chain joint to prevent wear. Applying oil to external surfaces will prevent rust, but oil must flow into the live bearing surfaces for maximum wear life. Frequency of re-lube will vary with operating conditions and environment, the best estimate of lube period is 200 hours. Trucks parked outdoors or trucks in extremely severe service, may require more frequent re-lube to maintain an oil film on all chain surface.

· Wipe off the old oil with a clean cloth and blow out the remaining dirt with compressed air.

⚠ **Wear eye protection.**

· With a clean brush, apply EP-140 extreme pressure lubricant or heavy motor oil(40W).

(2) Replacement

Replace chains as a pair. It will be virtually impossible to maintain uniform loading between the strands if a new chain is put into service opposite an old chain. The jonts in the old chain will be greater than that on the new chain, greatly complicating the problem of maintaining equal chain tension. The new chain will wear more slowly causing it to bear the major portion of the load resulting in premature wear and fatigue failure. Don’t steam clean or decrease new chains.

The manufacturer’s grease is effective in reducing wear and corrosion. If the original factory lube is dried out or wiped off, soak the new chain in heavy engine oil for at 1/2 hour prior to installing on truck. After the old chains have been stripped from the mast, very carefully inspect chain anchors and sheaves. Broken, cracked or worn anchor must be replaced using the new anchor pin and split pin. Do not paint newly replaced chain after it has been installed.

(3) Adjustment

Chain adjustments are important for the following reasons :

- · Equal loading of chain.
- · Proper sequencing of mast.
- · Prevent over-stretching of chains.
- · Prevent chains from jumping off sheaves if they are too loose.

(4) Adjustment procedure

- · With mast in its fully collapsed and vertical position, lower the fork to the floor.
- · Adjust the chain length by loosening or tightening nut on the chain anchor.
- · After making adjustment on the mast, be sure to tighten the nut.