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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.

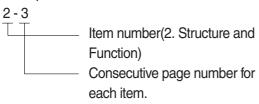
#### Filing method

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



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

#### Revised edition mark(1)23...)

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					
A	Safety	Special safety precautions are necessary when performing the work.					
	carry	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.

1	Millimete	rs to inche	es				Ф			1mm =	0.03937 in
		0	1	2	3	4	5	6	7	8	9
Ī	0		0.039	0.079	0.118	0.157	0.197	0.236	0.276	0.315	0.354
	10	0.394	0.433	0.472	0.512	0.551	0.591	0.630	0.669	0.709	0.748
	20	0.787	0.827	0.866	0.906	0.945	0.984	1.024	1.063	1.102	1.142
	30	1.181	1.220	1.260	1.299	1.339	1.378	1.417	1.457	1.496	1.536
	40	1.575	1.614	1.654	1.693	1.732	1.772	1.811	1.850	1.890	1.929
							©				
a) .	50	1.969	2.008	2.047	2.087	2.126	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 1 kg = 2.2046 lb

	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	l
40	88.18	90.39	92.59	94.80	97.00	99.21	101.41	103.62	105.82	108.03	
											l
50	110.23	112.44	114.64	116.85	119.05	121.25	123.46	125.66	127.87	130.07	l
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	l
80	176.37	178.57	180.78	182.98	185.19	187.39	189.60	191.80	194.01	196.21	l
90	198.42	200.62	202.83	205.03	207.24	209.44	211.64	213.85	216.05	218.26	l

Liter to U.S. Gallon 1  $\iota$  = 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  $\iota$  = 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

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

kgf/cm² to lbf/in²

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         <			1						3	1	
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         <		0	1	2	3	4	5	6	7	8	9
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 <td></td> <td></td> <td>14.2</td> <td>28.4</td> <td>42.7</td> <td>56.9</td> <td>71.1</td> <td>85.3</td> <td>99.6</td> <td>113.8</td> <td>128.0</td>			14.2	28.4	42.7	56.9	71.1	85.3	99.6	113.8	128.0
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	10	142.2	156.5	170.7	184.9	199.1	213.4	227.6	241.8	256.0	270.2
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         166	20	284.5	298.7	312.9	327.1	341.4	355.6	369.8	384.0	398.3	412.5
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	30	426.7	440.9	455.1	469.4	483.6	497.8	512.0	526.3	540.5	554.7
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 <td< td=""><td>40</td><td>568.9</td><td>583.2</td><td>597.4</td><td>611.6</td><td>625.8</td><td>640.1</td><td>654.3</td><td>668.5</td><td>682.7</td><td>696.9</td></td<>	40	568.9	583.2	597.4	611.6	625.8	640.1	654.3	668.5	682.7	696.9
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 <td< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></td<>											
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 <td>50</td> <td>711.2</td> <td>725.4</td> <td>739.6</td> <td>753.8</td> <td>768.1</td> <td>782.3</td> <td>796.5</td> <td>810.7</td> <td>825.0</td> <td>839.2</td>	50	711.2	725.4	739.6	753.8	768.1	782.3	796.5	810.7	825.0	839.2
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 <td>60</td> <td>853.4</td> <td>867.6</td> <td>881.8</td> <td>896.1</td> <td>910.3</td> <td>924.5</td> <td>938.7</td> <td>953.0</td> <td>967.2</td> <td>981.4</td>	60	853.4	867.6	881.8	896.1	910.3	924.5	938.7	953.0	967.2	981.4
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 <td>70</td> <td>995.6</td> <td>1010</td> <td>1024</td> <td>1038</td> <td>1053</td> <td>1067</td> <td>1081</td> <td>1095</td> <td>1109</td> <td>1124</td>	70	995.6	1010	1024	1038	1053	1067	1081	1095	1109	1124
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	80	1138	1152	1166	1181	1195	1209	1223	1237	1252	1266
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	90	1280	1294	1309	1323	1337	1351	1365	1380	1394	1408
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											
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	100	1422	1437	1451	1465	1479	1493	1508	1522	1536	1550
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	110	1565	1579	1593	1607	1621	1636	1650	1664	1678	1693
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	120	1707	1721	1735	1749	1764	1778	1792	1806	1821	1835
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	130	1849	2863	1877	1892	1906	1920	1934	1949	1963	1977
160     2276     2290     2304     2318     2333     2347     2361     2375     2389     2404       170     2418     2432     2446     2460     2475     2489     2503     2518     2532     2546	140	1991	2005	2020	2034	2048	2062	2077	2091	2105	2119
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170         2418         2432         2446         2460         2475         2489         2503         2518         2532         2546	150	2134	2148		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	180	2560	2574	2589	5603	2617	2631	2646	2660	2674	2688
											2973
											3115
											3257
230   3271   3286   3300   3314   3328   3343   3357   3371   3385   3399	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 -27.8 -27.2 -26.7 -26.1	-19 -18 -17 -16 -15	-2.2 -0.4 1.4 3.2 5.0	-8.9 -8.3 -7.8 -6.7 -6.7	16 17 18 20 20	60.8 62.6 64.4 68.0 68.0	10.6 11.1 11.7 12.8 12.8	51 52 53 55 55	123.8 125.6 127.4 131.0 131.0	30.0 30.6 31.1 32.2 32.2	86 87 88 90	186.8 188.6 190.4 194.0 194.0
-25.6	-14	6.8	-6.1	21	69.8	13.3	56	132.8	32.8	91	195.8
-25.0	-13	8.6	-5.6	22	71.6	13.9	57	134.6	33.3	92	197.6
-24.4	-12	10.4	-5.0	23	73.4	14.4	58	136.4	33.9	93	199.4
-23.9	-11	12.2	-4.4	24	75.2	15.0	59	138.2	34.4	94	201.2
-23.3	-10	14.0	-3.9	25	77.0	15.6	60	140.0	35.0	95	203.0
-22.8	-9	15.8	-3.3	26	78.8	16.1	61	141.8	35.6	96	204.8
-22.2	-8	17.6	-2.8	27	80.6	16.7	62	143.6	36.1	97	206.6
-21.7	-7	19.4	-2.2	28	82.4	17.2	63	145.4	36.7	98	208.4
-21.1	-6	21.2	-1.7	29	84.2	17.8	64	147.2	37.2	99	210.2
-20.6	-5	23.0	-1.1	35	95.0	21.1	70	158.0	51.7	125	257.0
-20.0	-4	24.8	-0.6	31	87.8	18.9	66	150.8	40.6	105	221.0
-19.4	-3	26.6	0	32	89.6	19.4	67	152.6	43.3	110	230.0
-18.9	-2	28.4	0.6	33	91.4	20.0	68	154.4	46.1	115	239.0
-18.3	-1	30.2	1.1	34	93.2	20.6	69	156.2	48.9	120	248.0
-17.8	0	32.0	1.7	35	95.0	21.1	70	158.0	51.7	125	257.0
-17.2	1	33.8	2.2	36	96.8	21.7	71	159.8	54.4	130	266.0
-16.7	2	35.6	2.8	37	98.6	22.2	72	161.6	57.2	135	275.0
-16.1	3	37.4	3.3	38	100.4	22.8	73	163.4	60.0	140	284.0
-15.6	4	39.2	3.9	39	102.2	23.3	74	165.2	62.7	145	293.0
-15.0	5	41.0	4.4	40	104.0	23.9	75	167.0	65.6	150	302.0
-14.4	6	42.8	5.0	41	105.8	24.4	76	168.8	68.3	155	311.0
-13.9	7	44.6	5.6	42	107.6	25.0	77	170.6	71.1	160	320.0
-13.3	8	46.4	6.1	43	109.4	25.6	78	172.4	73.9	165	329.0
-12.8	9	48.2	6.7	44	111.2	26.1	79	174.2	76.7	170	338.0
-12.2	10	50.0	7.2	45	113.0	26.7	80	176.0	79.4	172	347.0

# SECTION 1 GENERAL

Group	1	Safety hints ·····	1-1
Group	2	Specifications	1-5
Group	3	Periodic replacement ·····	1-13

#### **GROUP 1 SAFETY HINTS**

Careless performing of the easy work may cause injuries.

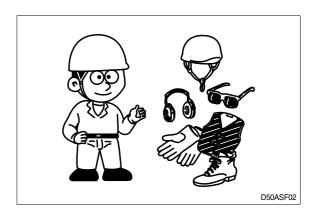
Take care to always perform work safely, at least observing the following.

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

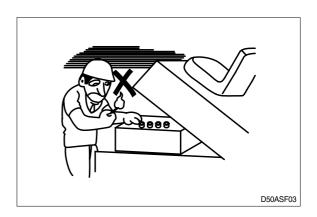
As preparation in case of fire, always know the location and directions for use of fire extinguishers and other fire fighting equipment.

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

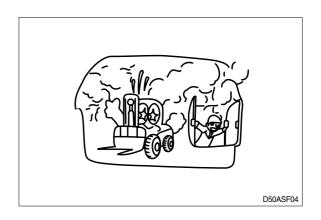




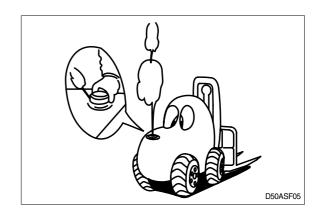
 Flames should never be used instead of lamps. Never use a naked flame to check leaks or the level of oil or electrolyte.



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



- ♠ Be particularly careful when removing the radiator cap and the hydraulic oil tank filler cap, if this is done immediately after using the machine, there is a danger that boiled oil may spurt out.
- The procedure for releasing the hydraulic pressure is as follows: lower the fork to the ground, and stop the engine(Motor), move the control levers to each position two or three times.
- · When working on top of the machine, be careful not to lose your balance and fall.

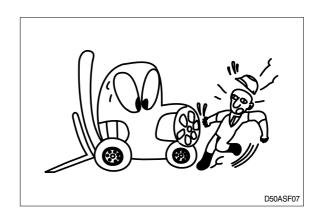




 Hand a caution sign in the operator's compartment (For example Do not start or Maintenance in progress).

This will prevent anyone from starting or moving the machine by mistake.

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

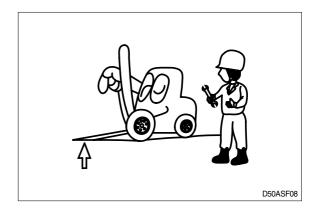


When inspecting the engine is running parts, or near such parts, always stop the engine first.

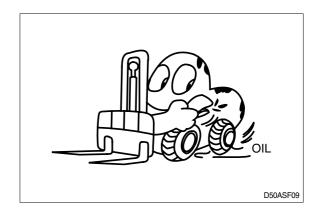
Before checking or servicing accumulator or piping, depress brake pedal repeatedLy to release pressure.

Park the machine on firm, flat ground.
 Lower the fork to the ground and stop the engine.

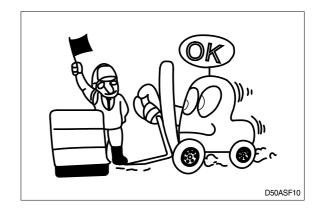
Return each lever to **NEUTRAL** and apply the brake lock.



 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.



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



 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.



 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.

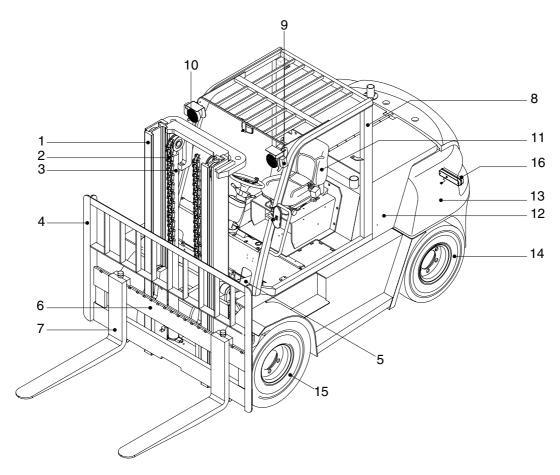


- Thoroughly clean the machine. In particular, be careful to clean the filler caps, grease fittings and the area around the dipsticks. Be careful not to let any dirt or dust into the system.
- · Always use HYUNDAI Forklift genuine parts for replacement.
- Always use the grades of grease and oil recommended 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.
- $\cdot\,$  After injecting grease, always wipe off the oil grease that was forced out.
- · Do not handle electrical equipment while wearing wet places, as this can cause electric shock.
- · During maintenance do not allow any unauthorized person to stand near the machine.
- Be sure you fully understand the contents of the operation. It is important to prepare necessary tools and parts and to keep the operating area clean.
- When checking an open gear case there is a risk of dropping things in. Before removing the covers to inspect such cases, empty everything from your pockets. Be particularly careful to remove wrenches and nuts.
- Way to use dipstick
   Push the dipstick fully into the guide, and then pull out.

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

## **GROUP 2 SPECIFICATIONS**

### 1. MAJOR COMPONENTS



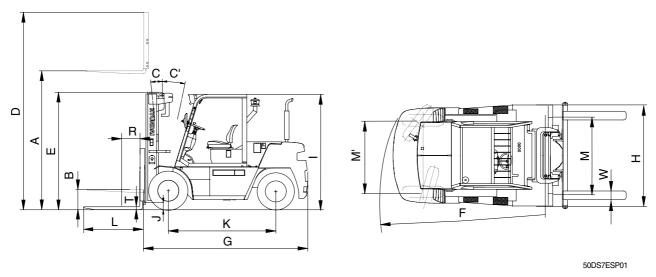
50DS7EOM54

- 1 Mast
- 2 Lift chain
- 3 Lift cylinder
- 4 Backrest
- 5 Tilt cylinder
- 6 Carrige

- 7 Forks
- 8 Overhead guard
- 9 Turn signal lamp
- 10 Head lamp
- 11 Operator's seat
- 12 Bonnet

- 13 Counterweight
- 14 Rear wheel
- 15 Front wheel
- 16 Rear combination lamp

## 2. SPECIFICATIONS



	Model			50DS-7E	60DS-7E	70DS-7E
Capacit			Unit kg	5000	6000	7000
-	Load center R		mm	600	←	←
	Unloaded)	n		8602	9245	9871
vveigini	Lifting height	Α	kg	3000	<i>32</i> +3 ←	<i>507</i> 1 ←
			mm			
	Free lift	В	mm	140	<b>←</b>	←
Fork	Lifting speed(Unload/Load)		mm/sec	480/450	480/440	480/430
	Lowering speed(Unload/Load)		mm/sec	450/500	←	←
	$L \times W \times T$	L,W,T	mm	1200×150×60	1200×150×60	←
	Tilt angle (forward/backward)	C/C'	degree	15/10	←	←
Mast	Max height	D	mm	4320	←	←
	Min height	Е	mm	2515	←	←
	Travel speed		km/h	35.5	35.4	35.2
Body	Gradeability		degree(%)	24.8(46.2)	22.1(40.7)	20.0(36.5)
	Min turning radius(Outside)	F	mm	3270	3315	3360
	Max hydraulic pressure		kgf/cm²	185	←	←
ETC	Hydraulic oil tank		l	105	←	<b>←</b>
	Fuel tank		l	150	←	←
Overall	length	G	mm	3500	3565	3620
Overall width		Н	mm	2087	←	←
Overhea	ad guard height	I	mm	2500	←	←
Ground clearance		J	mm	195	←	←
Wheel b	pase	K	mm	2300	←	←
Wheel t	read front/rear	M, M'	mm	1580/1604	←	<b>←</b>

### 3. SPECIFICATION FOR MAJOR COMPONENTS

## 1) ENGINE

Item	Unit	Specification
Model	-	MITSUBISHI S6S-T
Туре	-	4-cycle, in-line, Vertical OHV
Cooling Method	-	Water cooling
Number of cylinders and arrangement	-	6 cylinders, in line
Firing order	-	1-5-3-6-2-4
Combustion chamber type	-	Indirect injection
Cylinder bore X stroke	mm(in)	94×120(3.7×4.7)
Piston displacement	cc(cu in)	4996(305)
Compression ratio	-	22
Rated gross horse power	ps/rpm	92/2300
Maximum gross torque at rpm	kgf ⋅ m/rpm	29.9/1700
Engine oil quantity	l (U.S.gal)	16.5(4.3)
Dry weight	kg(lb)	360(792)
High idling speed	rpm	2570
Low idling speed	rpm	820
Rated fuel consumption	g/ps.hr	180
Starting motor	V-kW	24-5.0
Alternator	V-A	24-50
Battery	V-AH	12-96×2
Fan belt deflection	mm(in)	10~12(0.4~0.5)

## 2) MAIN PUMP

Item	Unit	Specification
Туре	-	Fixed displacement gear pump
Capacity	cc/rev	34+34+9
Maximum operating pressure	bar	250
Rated speed (Max/Min)	rpm	3000/600

## 3) MAIN CONTROL VALVE

Item	Unit	Specification
Туре	-	Sectional
Operating method	-	Mechanical
Main relief valve pressure	bar	185/150
Flow capacity	lpm	163

## 4) POWER TRAIN DEVICES

	Item		Specification		
	Model		W280, 2.526/248 (TL, ZF SACH)		
Torque converter	Туре		3 Element, 1 stage, 2 phase		
	Stall ratio		2.526		
	Туре		Full auto, Power shift		
	Gear shift(FR/RR	1)	3/3		
Transmission	Control		Electrical single lever type		
	Overhaul ratio	FR	1:4.446 2:2.341 3:0.974		
		RR	1:4.443 2:2.340 3:0.973		
Anda	Туре		Front-wheel drive type, fixed location		
Axle	Gear ratio		10.545		
	Q'ty(FR/RR)		Double: 4/2		
Wheels	Front(drive)		8.25-15-14 PR		
	Rear(steer)		8.25-15-14 PR		
Dueline	Travel		Front wheel, Duo-servo/dry, wet disc brake/wet		
Brakes	Parking		Toggle, internal expanding mechanical type		
Ota a sina a	Туре		Full hydraulic, power steering		
Steering	Steering angle		75.87° to both right and left angle, respectively		

## 4. TIGHTENING TORQUE FOR MAJOR COMPONENTS

NO		ITEMS		kgf ⋅ m	lbf ⋅ ft
1	Engine mounting bolt, nut		M16×2.0	7.5	54
2	Engine	Radiator mounting bolt, nut	M10×1.5	6.9±1.4	50±10
3		Torque converter mounting bolt	M10×1.5	6.9±1.4	50±10
4	Hydraulic MCV mounting bolt, nut		M12×1.75	12.8±3.0	93±22
5	system	Steering unit mounting bolt	M10×1.5	6.9±1.4	50±10
6	Transmission mounting bolt, nut		M16×2.0	7.5	54
7		Drive axle mounting bolt, nut	M24×3.0	100±15	723±108
8	Power train	Steering axle mounting bolt, nut	M18×2.5	41.3±6.2	300±45
9	system	Front wheel mounting nut	M22×1.5	61.2±9.2	448±67
10		Rear wheel mounting nut	M22×1.5	61.2±9.2	448±67
11	Counterweight mounting bolt		M30×3.5	120±15	1555±239
12	Others	Operator's seat mounting nut	M 8×1.25	2.5±0.5	18.1±3.6
13		Head guard mounting bolt	M12×1.75	12.8±3.0	93±22

## 5. TORQUE CHART

Use following table for unspecified torque.

## 1) BOLT AND NUT

## (1) Coarse thread

Dolt size	8	Т	10T		
Bolt size	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	

## (2) Fine thread

Daltaine	8	Т	10	OT .	
Bolt size	kgf ⋅ m	kgf · m lbf · ft		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"	3/4" 36 18		130
1"	41	21	152
1-1/4"	50	35	253

## 3) PIPE AND HOSE(ORFS TYPE)

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

## 4) FITTING

Thread size(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
1"	41	21	152
1-1/4"	50	35	253

#### 6. RECOMMENDED LUBRICANTS

Use only oils listed below or equivalent.

Do not mix different brand oil.

			Ambient temperature °C (°F)							
Service point	Kind of fluid	Capacity (U.S.gal)	-20 (-4)	-10 (14)	0 (32)	10 (50)	20 (68)	30 (86)	40 (104)	
							SAE 30			
							SAE 30			
Engine oil	Engine oil	16.5(4.3)		SAE 10\	W					
pan		10.0(1.0)			SAE 1	0W-30				
					S	AE 15W-	40			
Torque										
converter	T/M oil	12 (3.2)			AFT DEX	KRON III				
11 01 151 1155 1011		, ,								
Axle	Gear oil	10.5			Mobilflu	uid 424				
	Geal oil	(2.8)			MODIIIC	11U 424				
	I basker die				201/000					
Hydraulia				I	SO VG32					
Hydraulic tank	Hydraulic oil	66 (17.4)			ISC	) VG46				
						ISO '	VG68			
Fuel tank	Diesel fuel 100		ASTM	D975 N	0.1					
1 dortani	Dicoci idei	(26.4)				ASTM D	975 No.2			
Fitting	Grease	_		NLC	3l No.1					
(Grease nipple)	Grodoo					NLG	l No.2			
Brake reservoir	Hyd oil	_			1000 (11		0.1/2.55			
tank	i iya oli	- IIO L		Azolla Z	S32 (Hydra	aulic oil IS	SO VG32)			
Radiator	Antifreeze:Water 50:50	21.5 (5.7)		Eth	nylene glyco	ol base pe	ermanent	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 frequency of oil change must be doubled.

## **GROUP 3 PERIODIC REPLACEMENT**

For operation safety, never fail to perform periodic maintenance or make periodic replacement of the consumable parts listed in the following.

These parts may deteriorate in time and are susceptible to wear. It is difficult to estimate the degree of wear at time of periodic maintenance; therefore, even if no apparent wear is found, always replace with new parts within the prescribed period of replacement(Or earlier if trouble is found).

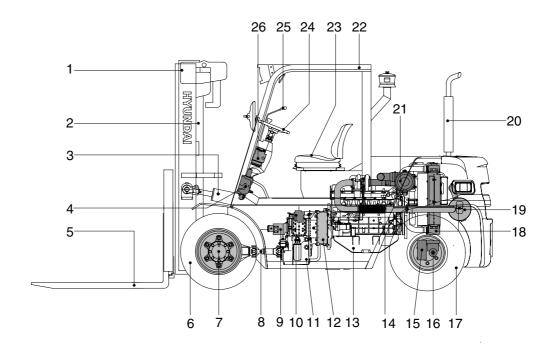
Note that periodic replacement has nothing to do with guarantee service.

No.	Description	Period of replacement		
1	Master cylinder and wheel cylinder caps, dust seals	Every 1 year		
2	Brake hose or tube	Every 1 or 2 years		
3	Brake reservoir tank and tube	Every 2 to 4 years		
4	Power steering hose	Every 2 years		
5	Stop lamp switch(Oil pressure type)	Every 2 years		
6	Fuel hose	Every 2 to 4 years		
7	Rubber parts of power steering	Every 2 to 4 years		
8	Lift chain	Every 2 to 4 years		
9	Hose of load handling	Every 1 or 2 years		

# SECTION 2 REMOVAL & INSTALLATION OF UNIT

Group	1	Structure ····	2-1
Group	2	Removal and installation of unit	2-2

## GROUP 1 STRUCTURE



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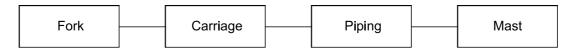
1	Mast	10	Priority valve	19	Muffler
2	Lift cylinder	11	Transmission	20	Silencer
3	Tilt cylinder	12	Torque converter	21	Air cleaner
4	Control valve	13	Engine	22	Overhead guard
5	Fork	14	Exhaust pipe	23	Seat
6	Front wheel	15	Steering axle	24	Steering wheel
7	Drive axle	16	Steering cylinder	25	Control lever
8	Propeller shaft	17	Rear wheel	26	Steering unit
9	Hydraulic pump	18	Radiator		

#### **GROUP 2 REMOVAL AND INSTALLATION OF UNIT**

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

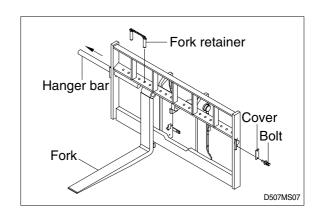
#### 1. MAST

#### 1) REMOVAL



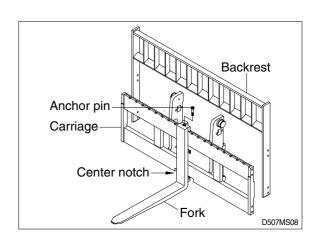
#### (1) SHAFT TYPE FORKS

- ① Lower the fork carriage until the forks are approximately 25mm(1in) from the floor.
- ② Release fork retainer and remove cover.
- ③ Slide one hanger bar at a time out of carriage assembly.
- ④ Remove only one fork at a time.
- \* On larger forks it may be necessry to use a block of wood.



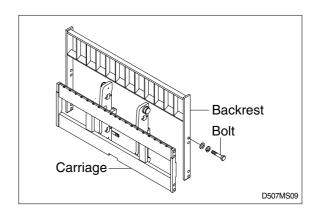
#### (2) HOOK ON TYPE FORKS(OPTION)

- ① Lower the fork carriage until the forks are approximately 25mm(1in) from the floor.
- ② Release fork anchor pins and slide one fork at a time toward the center of the carriage where a notch has been cut in the bottom plate for easy fork removal.
- ③ Remove only one fork at a time.
- \* On larger forks it may be necessry to use a block of wood.



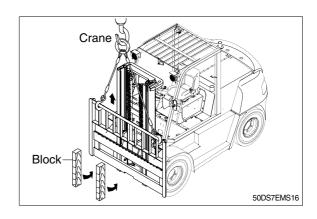
#### (3) BACKREST(HOOK ON TYPE)

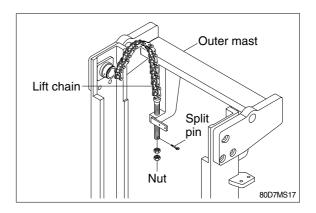
① Remove bolts securing backrest to fork carriage lift backrest straight up and remove it from carriage.



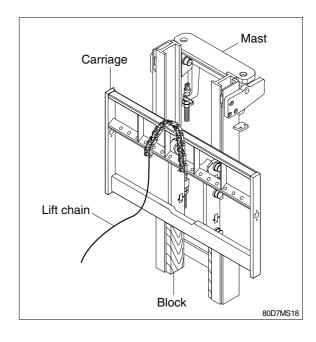
#### (4) CARRIAGE

- 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 nuts from the chain anchor bolts of stationary upright.

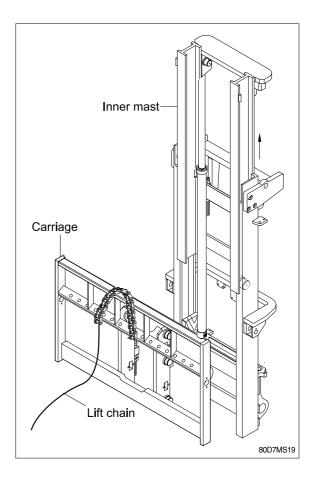




③ Pull the chains out of the sheaves and drape them over the front of the carriage.



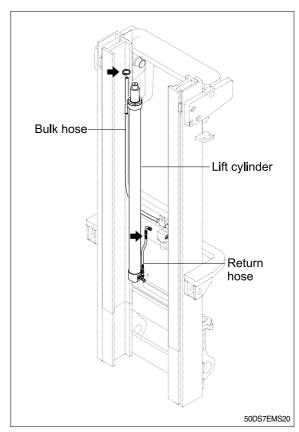
- ④ Slowly raise inner mast upright until mast clears top of fork carriage. Move carriage to work area and lower the mast.
- ▲ Make sure that carriage remains on floor and does not bind while mast is being raised.
- \* Inspect all parts for wear or damage. Replace all worn or damaged parts.



#### (5) PIPING

- ① Remove the bulk hoses and clamps attached to the cylinder.
- ② Remove the return hose from the down control valve.
- 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.

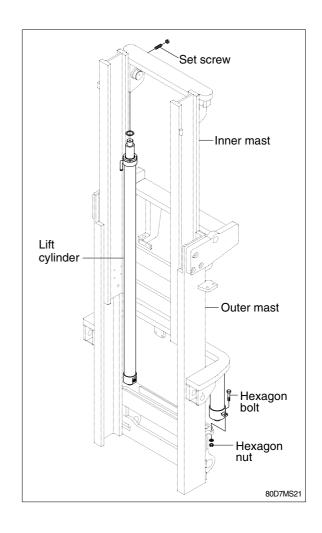


#### (6) LIFT CYLINDER

- 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.

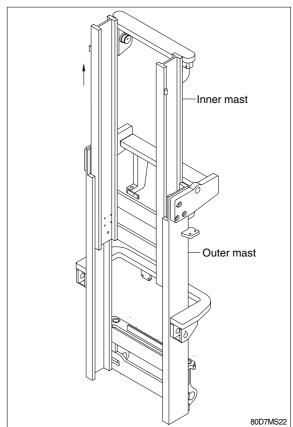
- ③ Loosen and remove hexagon bolts and nuts securing lift cylinders to outer mast.
- Using an overhead hoist, slowly raise the inner mast high enough to clear lift cylinder.
- ⑤ Using an overhead hoist, draw out lift cylinder carefully and put down on the work floor.



#### (7) 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.



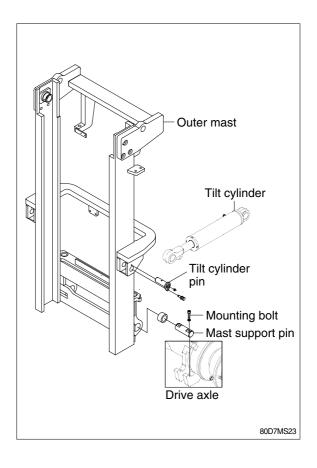
#### (8) TILT CYLINDER PIN

#### (9) 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 tatally 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

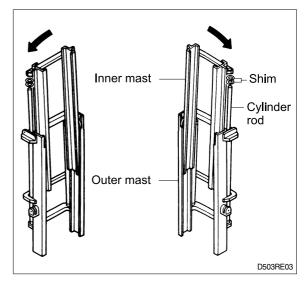
- ① Check the mast support pins for wear, then install pins into the mast support bracket and drive axle
- ② Jack up the machine so that the front is raised and then using an overhead hoist assemble outer mast to drive axle unit.
- ③ Tighten mounting socket bolts to drive axle unit.
  - $\cdot$  Tightening torque : 49.2~66.6kgf  $\cdot$  m(355~481lbf  $\cdot$  ft)

#### (2) TILT CYLINDER PIN

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

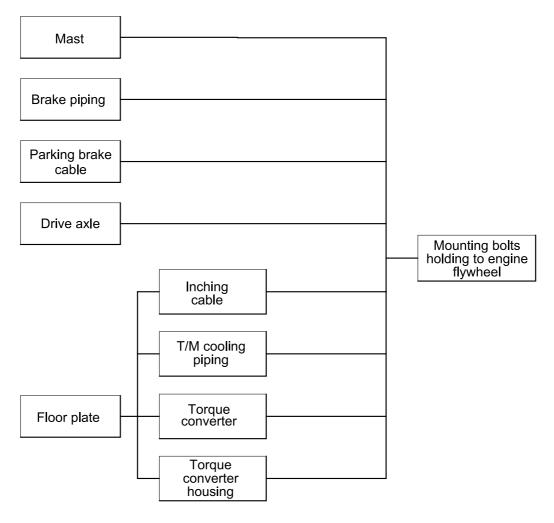
#### (3) LIFT CYLINDER INSTALLATION AND ADJUSTMENT

- 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



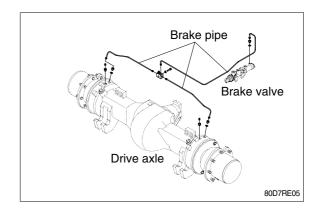
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#### (1) Mast

Refer to section on mast(Page 2-2)

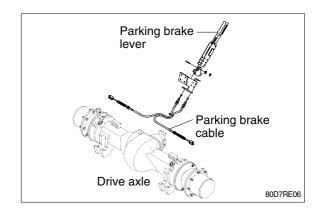
#### (2) Brake piping

Disconnect the brake piping from the wheel cylinder end.



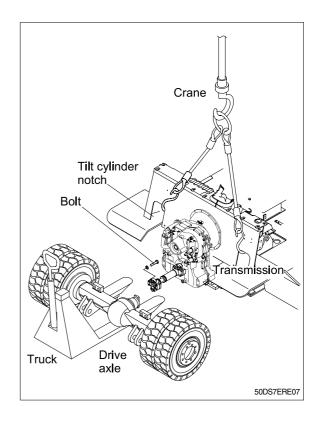
#### (3) Parking brake cable

Disconnect parking brake cable from the wheel brake assembly.

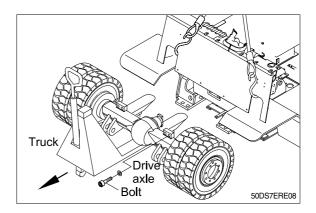


#### (4) Drive axle

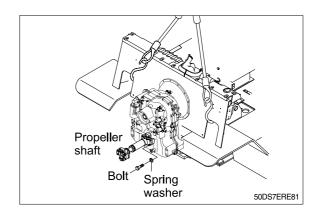
- \* Before removing the drive axle unit, drain all of the oil from the axle.
- ① Attach a crane to the tilt cylinder notches on the dashboard and raise the machine.
- ② Loosen hexagonal bolts connecting drive axle to propeller shaft.
- ③ Put the block under the front axle and support under the drive axle with a truck.



④ Remove drive axle mounting bolts from the frame and then slowly pull out the truck with drive axle to the front.

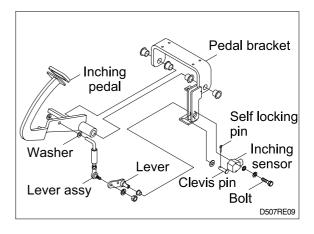


⑤ Remove propeller shaft from the transmission by loosening the mounting bolts.



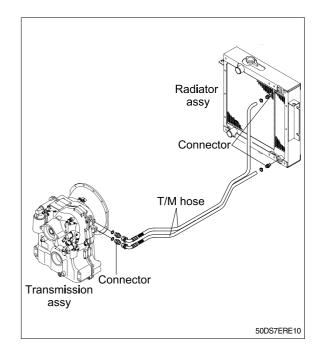
## (5) Inching linkage

Remove the nut, clevis pins and self locking pin.



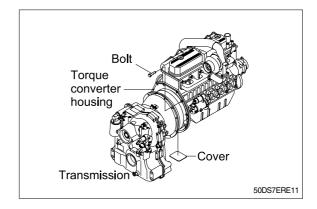
#### (6) Transmission cooling piping

- ① Disconnect cooling hose and connector from the transmission.
- \* Make sure that the coolant be drained from the hose.



#### (7) Torque converter

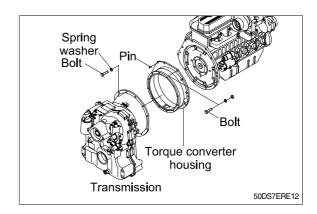
① Remove the cover on bottom face of the torque converter housing then remove the 4 mounting bolts installed on the engine flywheel. To rotate the flywheel, remove 1 mounting bolt, then insert a turning tool in the mounting hole. One man must turn the engine fan by hand while the other turns the flywheel.



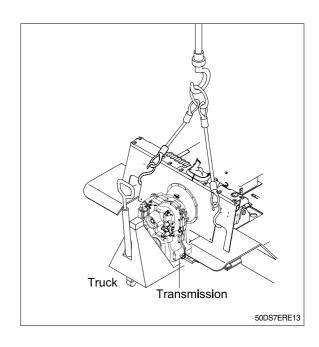
# (8) Mounting bolts holding to flywheel housing

① Remove the transmission assembly from the torque converter housing by loosening the mounting bolts.

Remove torque converter housing from the engine flywheel by loosening the mounting bolts and pins.



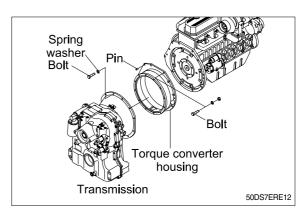
② Using a moving truck slowly pull out transmission assembly to the front.



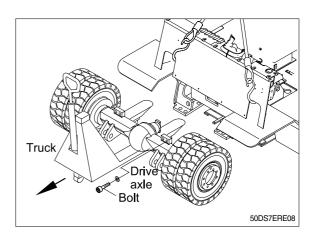
#### 2) INSTALLATION

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

- (1) Tightening torque of mounting bolt for torque converter housing.
  - $\cdot$  6.0~8.9kgf  $\cdot$  m(43~64lbf  $\cdot$  ft)

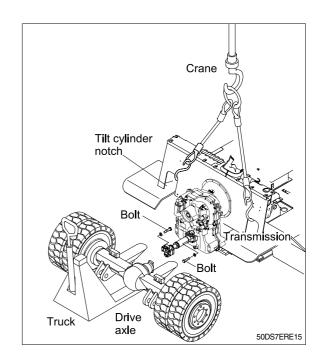


- (2) Tightening torque of mounting bolt for drive axle.
  - $\cdot$  100  $\pm$  15kgf  $\cdot$  m(723  $\pm$  108.5lbf  $\cdot$  ft)



(3) Tightening torque of mounting bolt for transmission and propeller shaft.

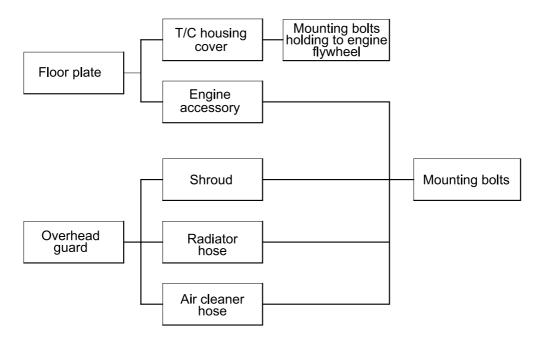
 $\cdot$  7  $\pm$  0.7kgf  $\cdot$  m(50.6  $\pm$  5lbf  $\cdot$  ft)



#### 3. ENGINE

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

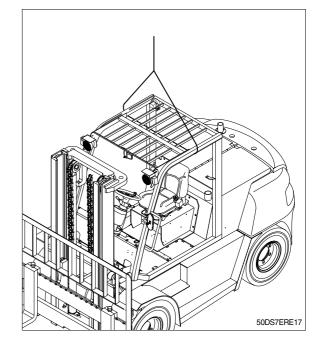
#### 1) REMOVAL



D503RE25

#### (1) Overhead guard

Remove the wiring for rear combination lamp, working lamp, head lamp and flasher lamp on the stay of the overhead guard and then raise it together with the bonnet.



(2) Remove the torque converter housing cover, mounting bolts installed to flywheel housing.

For details, 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.

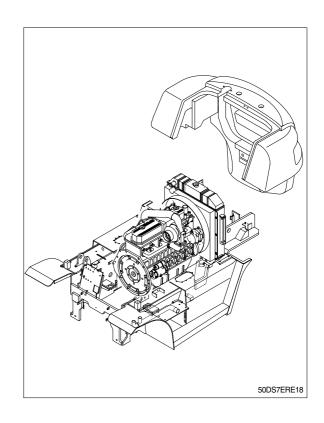
#### (4) Radiator hose

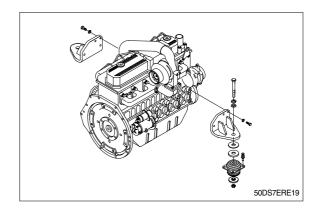
Open the drain valve of the radiator and drain the cooling water, then remove the radiator hose.

#### (5) Mounting bolt

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 engine and radiator.

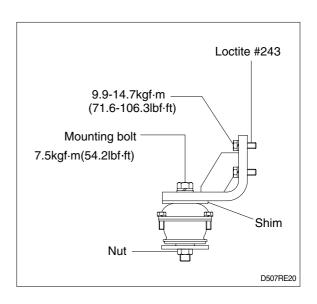




#### 2) INSTALLATION

Installation is the reverse order of 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(#243) when installing.
- \*\* Before installing the bolts, loctite in the holes should be removed by a tap.



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

 $\cdot$  6.0~8.9kgf  $\cdot$  m(43~64lbf  $\cdot$  ft)

#### (4) Radiator hoses

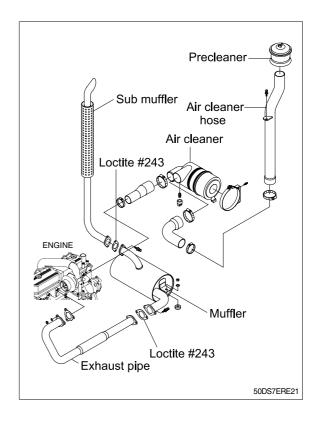
· Distance to insert hose : 42mm(1.65in)

#### (5) Air cleaner hose

Insert the air cleaner hose securely and fit a clamp.

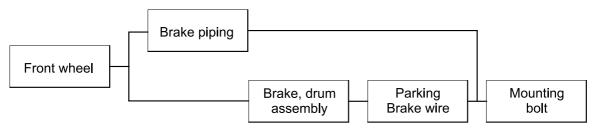
#### Distance to insert hose

Air cleaner hose: 89mm(3.5in)Engine end(MHI): 60mm(2.36in)



#### 4. WHEEL BRAKE

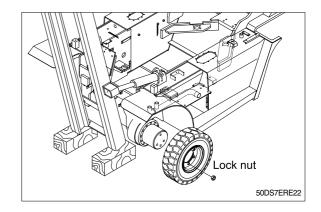
#### 1) REMOVAL



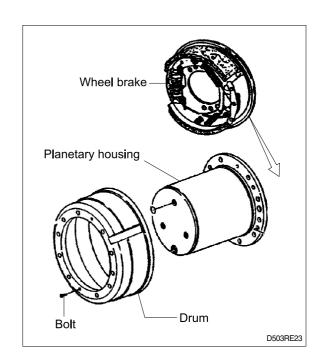
D503RE34

#### (1) Front wheel

Put a block under the mast and tilt forward, or jack up the bottom of the frame to raise the front wheels off the ground, then remove the front wheels.



(2) Brake, drum assembly.



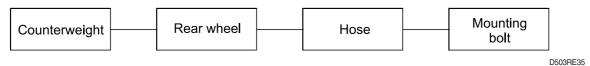
#### 2) INSTALLATION

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

- (1) Tightening torque of hub nut for front wheel.
  - $\cdot$  61.2kgf  $\cdot$  m(443lbf  $\cdot$  ft)

#### 5. STEERING AXLE

#### 1) REMOVAL



Mounting bolt

50DS7ERE30

#### (1) Counterweight

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

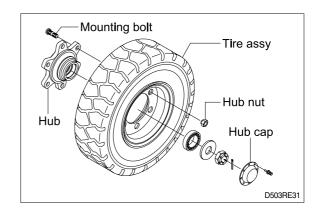
Remove the mounting bolts, raise slightly and move it slowly to rear side.

· Weight of counterweight(standard)

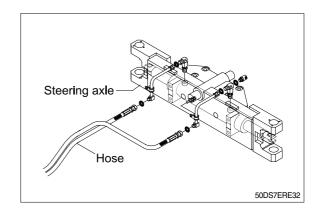
50DS-7E: 2,120kg(4,674lb) 60DS-7E: 2,680kg(5,908lb) 70DS-7E: 3,250kg(7,165lb)

#### (2) Rear wheel

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



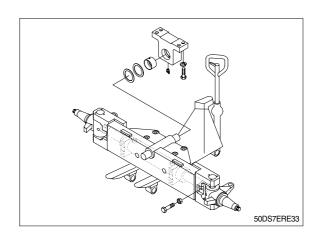
#### (3) Hose



#### (4) Mounting bolt

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

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



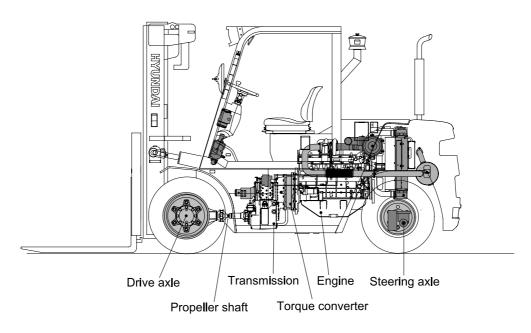
# SECTION 3 POWER TRAIN SYSTEM

Group	1	Structure and operation	3-1
Group	2	Operation and maintenance	3-31
Group	3	Disassembly and assembly	3-58
Group	4	Adjustment ·····	3-154

# **SECTION 3 POWER TRAIN SYSTEM**

# **GROUP 1 STRUCTURE AND OPERATION**

#### 1. POWER TRAIN COMPONENT OVERVIEW



50DS7EPT01

The power train consists of the following components:

- · Torque converter
- · Transmission
- · Propeller shaft
- · Drive axle

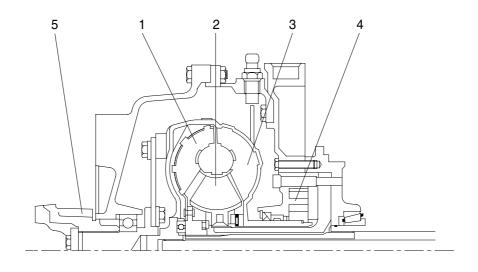
Engine power is transmitted to the transmission through the torque converter.

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.

#### 2. TORQUE CONVERTER



D503TM01

1 Turbine

3 Pump

5 Input shaft

2 Stator

4 Transmission pump

The converter is working according to the Trilok-system, i.e. it assumes at high turbine speed the characteristics, and with it the favorable efficiency of a fluid clutch.

The converter will be defined according to the engine power so that the most favorable operating conditions for each installation case are given.

#### The Torque converter is composed of 3 main components:

#### Pump wheel - turbine wheel - stator(Reaction member)

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

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

The oil, escaping out of the pump wheel, enters the turbine wheel and is there inversed in the direction of flow.

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

Due to the inversion, the stator receives a reaction moment.

The relation turbine moment/pump moment is called torque conversion. This is the higher the greater the speed difference of pump wheel and turbine wheel will be.

Therefore, the maximum conversion is created at standing turbine wheel.

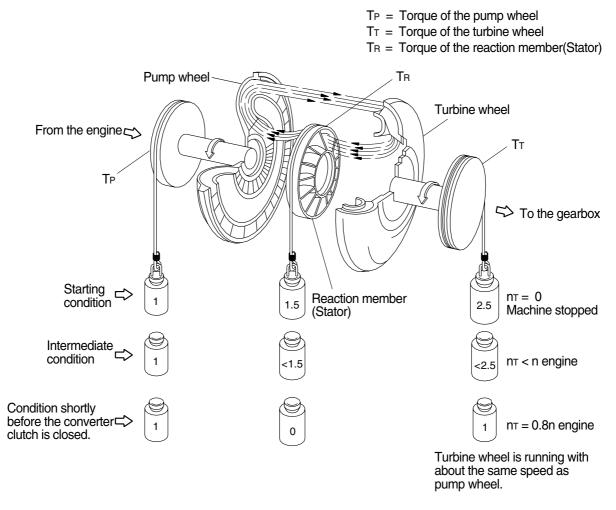
With increasing output speed, the torque conversion is decreasing. The adoption of the output speed to a certain required output moment is infinitely variable and automatically achieved by the torque converter.

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

From this point on, the converter is working similar to a fluid clutch.

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

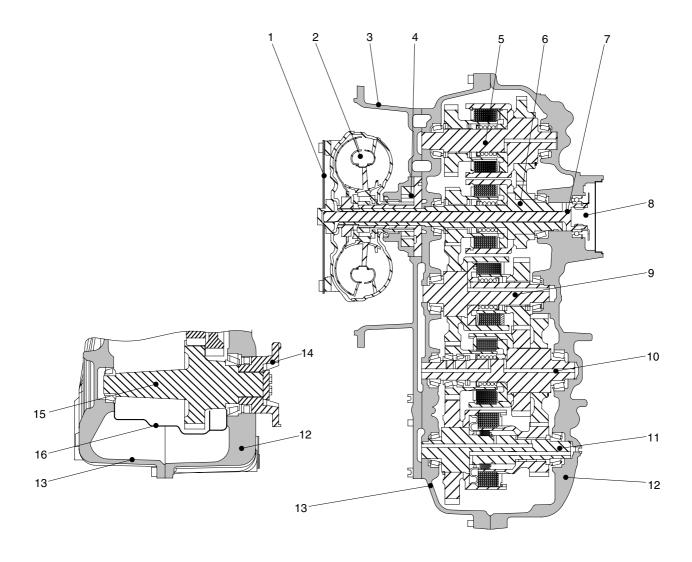
#### Function of a hydrodynamic torque converter(Schematic view)



D503TM02

#### 3. TRANSMISSION

## 1) LAYOUT

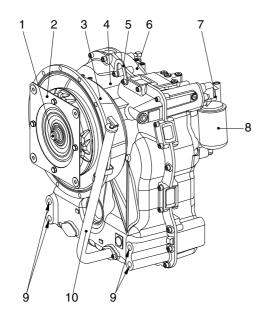


50DS7ETM03

- 1 Flex plate for direct mount
- 2 Converter
- 3 Converter bell housing
- 4 Transmission pump
- 5 Clutch shaft(KV)
- 6 Input shaft/clutch shaft(KR)
- 7 Central shaft/input shaft PTO
- 8 Connection, PTO; coaxial, engine-dependent
- 9 Clutch shaft(KD)
- 10 Clutch shaft(KE)
- 11 Clutch shaft(KC)

- 12 Transmission housing rear part
- 13 Transmission housing front part
- 14 Output flange
- 15 Output shaft
- 16 Screen sheet

#### 2) INSTALLATION VIEW



8 14 13 9 12 11 9

FRONT VIEW

**REAR VIEW** 

- 1 Converter
- 2 Direct mount via flex plate
- 3 Converter bell housing
- 4 Transmission housing-front part
- 5 Transport bracket
- 6 Transmission housing-rear part
- 7 Filter head

- 8 Filter
- 9 Transmission mounting holes M16×1.5
- 10 Oil filter tube with oil dipstick
- 11 Oil drain plug 7/8"14 UNF 2B
- 12 Output flange MECH 6C
- 13 Identification plate
- 14 Connection PTO;coaxial, engine-dependent

#### 3) OPERATION OF TRANSMISSION

#### (1) Gearbox diagram

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

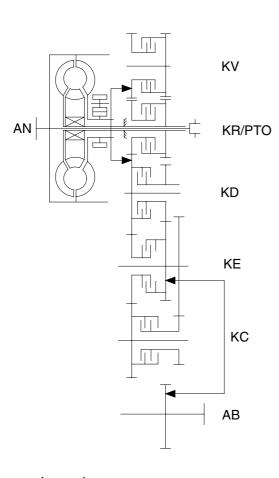
All gears are constantly meshing and carried on antifriction bearings.

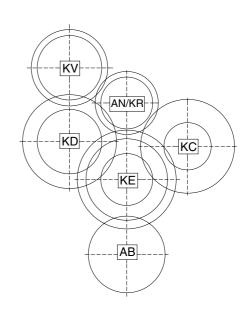
The gear wheels, bearings and clutches are cooled and lubricated with oil.

The 3-speed reversing transmission is equipped with 5 multi-disk clutches.

At the shifting, the actual plate pack is compressed by a piston, movable in axial direction, which is pressurized by pressure oil.

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





#### Legend:

AN = Input

KV = Clutch forward

KR = Clutch reverse

KC = Clutch 1st speed

KD = Clutch 2nd speed

KE = Clutch 3rd speed

PTO = Power take-off

AB = Output

#### Diagram Clutches

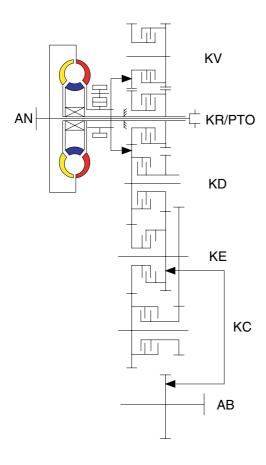
·		
Driving direction	Speed	Clutch
	1	KV/KC
Forward	2	KV/KD
	3	KV/KE
	1	KR/KC
Reverse	2	KR/KD
	3	KR/KE

#### (2) Forward

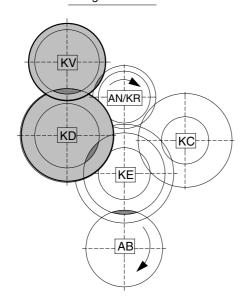
In forward, forward clutch and 1st, 2nd, 3rd clutch are engaged.

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

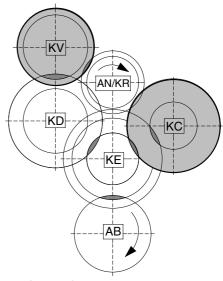
Transmission diagram



2nd gear forward



1st gear forward



#### Legend:

AN = Input

KV = Clutch forward

KR = Clutch reverse

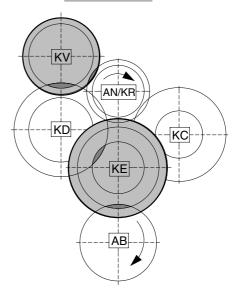
KC = Clutch 1st speed

KD = Clutch 2nd speed

KE = Clutch 3rd speed PTO = Power take-off

AB = Output

3rd gear forward

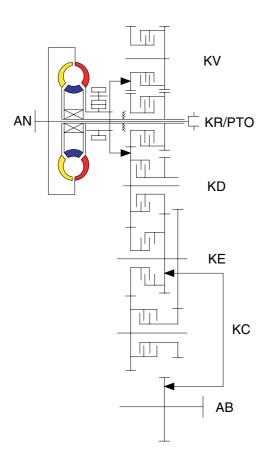


#### (3) Reverse

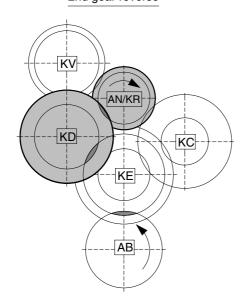
In reserve, reserve clutch and 1st, 2nd, 3rd clutch are engaged.

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

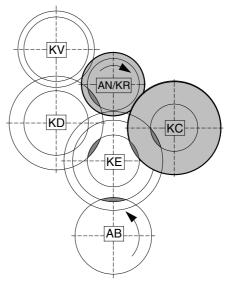
Transmission diagram



2nd gear reverse



1st gear reverse



#### Legend:

AN = Input

KV = Clutch forward

KR = Clutch reverse

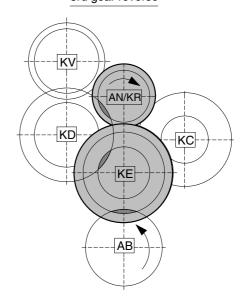
KC = Clutch 1st speed

KD = Clutch 2nd speedKE = Clutch 3rd speed

PTO = Power take-off

AB = Output

3rd gear reverse



#### 4) TRANSMISSION CONTROL

Transmission control see measuring points and oil circuit diagram see page 3-10.

The transmission pump which is necessary for the oil supply of the converter and for the transmission control is located within the transmission on the engine-dependent input shaft.

The pump feed rate is Q=45 l/min, at n<sub>engine</sub>=1500min<sup>-1</sup>

This pump is sucking the oil out of the oil sump via the coarse filter, and deliverse it to the main pressure valve via the fine filter.

The 5 clutches of the transmission are controlled via the 5 proportional valves Y1 to Y5.

The direct proportional control with separate pressure modulation for each clutch controls the pressures towards the clutches which are involved in the gear change.

This allows a hydraulic overlapping of the clutches to be engaged and disengaged.

The pressure modulation to the respective clutch is controlled by cup springs and proportional valves in the package.

This creates spontaneous shifting without tractive effort interruption.

The following criteria are considered during the shifting operation:

- RPM of engine, turbine, gear chain and output
- Transmission temperature
- Shifting mode(upshifting, downshifting, reverse shifting and gear engagement out of neutral)
- Load condition(full and partial load, drive, coast, including consideration of load reversals during shifting)
- Electronic inching

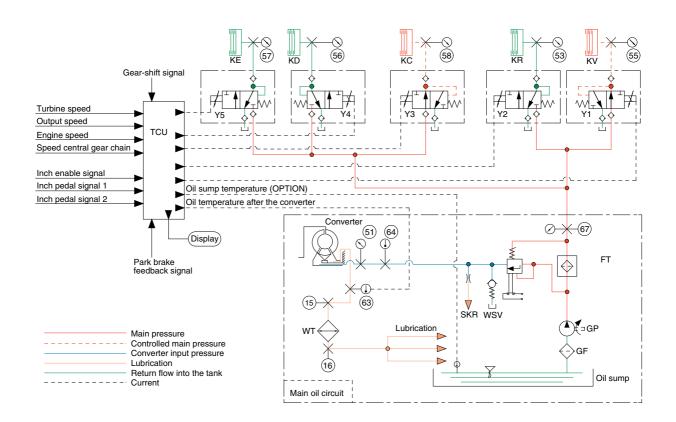
The main pressure valve limits the max, control pressure to 16+3 bar and release the main stream towads the converter-and lubrication circuit.

The converter inlet incorporates a converter safety valve which protects the converter from high internal pressure(opening pressure 11+2 bar).

Within the converter, the oil serves for transmitting the power according to the well-known hydrodynamic principle(see Chapter torque converter page 3-2)

To avoid cavitation, the converter must always be completely filled with oil.

#### · Hydraulic circuit



50DS7EPT31

Driving	Coor		Propo	ortional val	ve under c	urrent		Engaged	alutahas
direction	Gear	Y1	Y2	Y3	Y4	Y5	N	Lilgageu	Ciulciies
	1	•		•				KV	KC
Forward	2	•			•			KV	KD
	3	•				•		KV	KE
	1		•	•				KR	KC
Reverse	2		•		•			KR	KD
	3		•			•		KR	KE
Engaged clutch		KV	KR	KC	KD	KE			
Curr. No. of meas. points		55	53	58	56	57			

GF Coarse filter

GP Transmission pump

FT Filter

HVD Main pressure valve, 16+3 bar

WSV Converter safety valve, 11+2 bar

SKR Lubrication of KR clutch

WT Heat exchanger

Y1 Proportional valve, clutch KV

Y2 Proportional valve, clutch KR

Y3 Proportional valve, clutch KC

Y4 Proportional valve, clutch KD

Y5 Proportional valve, clutch KE

KV KV clutch, forward

KR KR clutch, reverse

KC KC clutch, 1st gear

KD KD clutch, 2nd gear

KE KE clutch, 3rd gear

TCU Transmission control unit

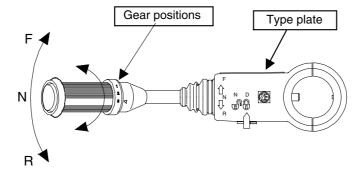
#### 5) GEAR SELECTOR(DW-3)

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 :

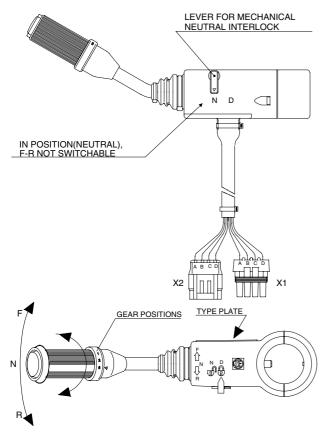
Position "N" - Controller lever blocked in this position

Position <sub>"D"</sub> - Driving



D507PT12

#### Gear selector(DW-3)



F = Forward

N = Neutral

R = Reverse

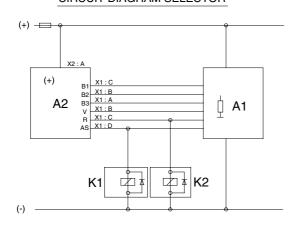
D = Mechanical neutral interlock

1 = 1st speed

2 = 2nd speed

3 = 3rd speed

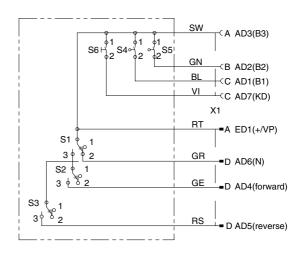
### CIRCUIT DIAGRAM SELECTOR



#### CODING GEAR SELECTOR

OUTPUT								KD			
SPEED		FOI	FORWARD REVERSE NEUTRAL								
SPE	יבט	1	2	3	1	2	3	1	2	3	
AD1	B1	•			•			•			
AD2	B2			•			•			•	
AD3	ВЗ	•	•	•	•	•	•	•	•	•	
AD4	٧	•	•	•							
AD5	R				•	•	•				
AD6	AS							•	•	•	
AD7											•

#### CIRCUIT DIAGRAM SELECTOR



K1 = Relay starter interlock

K2 = Relay reverse lights

A1 = TCU(Transmission Control Unit)

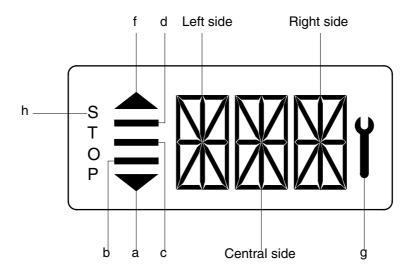
A2 = Gear selector

#### 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.



D507CD33

1	Bars	a, f	Automatic range(up and down shifting)
'	Dais	b, c, d,	Preselected gear
2	Left side		For the moment still without function
	Central and		On the two alphanumeric 16-segment display, the electric control
3	Right side		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	Actual gear and direction Central side shows actual gear	
1, 2, 3	Right side shows actual direction	
NN (Central and right side)	Not neutral, waiting for neutral after power up or a severse fault	To engage a gear, first move shift selector to neutral position and again to F to R position
1 bar	Manual mode 1st 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 torgue 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) Display during AEB-Mode

Symbol	Meaning	Remarks
PL	AEB-Starter is plugged at the diagnostic plug	
ST	AEB-Starter-button is pressed	
KAKE KV, KR	Calibraiting clutch KCKE, KV or KR resp.	KC, KD for 2 gear transmission KC, KD, KE for 3 gear transmission
_and Kx	Wait for start, initialization of clutch Kx, x : C, D, E, V, R	
≡and Kx	Fast fill time determination of clutch Kx	
=and Kx	Compensating pressure determination of clutch Kx	
OK	Calibration for all clutches finished	Transmission stays in neutral, you have to restart the TCU(ignition off/on) after removing AEB-Starter
STOP	AEB canceled(activation stopped)	Transmission stays in neutral, you have to restart the TCU(ignition off/on)
STOP and Kx	AEB stopped, clutch Kx can't be calibrated	Transmission stays in neutral, you have to restart the TCU(ignition off/on)
Spanner and Kx	Kx couldn't be calibrated, AEB finished	Transmission stays in neutral, you have to restart the TCU(ignition off/on)
ΔE	Engine speed too low  → raise engine speed	
▽ E	Engine speed too high  → lower engine speed	
ΔΤ	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)

## (5) Definition of the error codes

#### ① Introduction

The error codes consists of two hexadecimal numbers.

The first number shows the type of signal, the second number shows signal and the type of the error.

# ② Description of error codes

First No.	Meaning of number
1 hex	Digital input signals
2 hex	Analog input signals
3 hex	Speed signals
4 hex	Speed signals
7 hex	Analog current output signals
8 hex	Analog current output signals
9 hex	Digital output signals
A hex	Digital output signals
B hex	Clutch errors
D hex	Power supply
E hex	High speed signals
F hex	General errors

#### ③ List of error codes

Number	Meaning of error code
11 hex	Logical error at gear range signal
12 hex	Logical error at direction select signal
21 hex	Short circuit to battery voltage at clutch cutoff input
22 hex	Short circuit to ground or open circuit at clutch cutoff input
25 hex	Short circuit to battery voltage or open circuit at temperature sensor input
26 hex	Short circuit to ground at temperature sensor input
31 hex	Short circuit to battery voltage at engine speed input
32 hex	Short circuit to ground or open circuit at engine speed input
33 hex	Logical error at engine speed input
34 hex	Short circuit to battery voltage at turbine speed input
35 hex	Short circuit to ground or open circuit at turbine speed input
36 hex	Logical error at turbine speed input
37 hex	Short circuit to battery voltage at internal speed input
38 hex	Short circuit to ground or open circuit at internal speed input
39 hex	Logical error at internal speed input

Number	Meaning of error code
3A hex	Short circuit to battery voltage or open circuit at output speed input
3B hex	Short circuit to ground or open circuit at output speed input
3C hex	Logical error at output speed input
71 hex	Short circuit to battery voltage at clutch KC
72 hex	Short circuit to ground at clutch KC
73 hex	Open circuit at clutch KC
74 hex	Short circuit to battery voltage at clutch KD
75 hex	Short circuit to ground at clutch KD
76 hex	Open circuit at clutch KD
77 hex	Short circuit to battery voltage at clutch KE
78 hex	Short circuit to ground at clutch KE
79 hex	Open circuit at clutch KE
84 hex	Short circuit to battery voltage at clutch KV
85 hex	Short circuit to ground at clutch KV
86 hex	Open circuit at clutch KV
87 hex	Short circuit to battery voltage at clutch KR
88 hex	Short circuit to ground at clutch KR
89 hex	Open circuit at clutch KR
91 hex	Short circuit to ground at relay reverse warning alarm
92 hex	Short circuit to battery voltage at relay reverse warning alarm
93 hex	Open circuit at relay reverse warning alarm
94 hex	Short circuit to ground at relay starter interlock
95 hex	Short circuit to battery voltage at relay starter interlock
96 hex	Open circuit at relay starter interlock
97 hex	Short circuit to ground at park brake solenoid
98 hex	Short circuit to battery voltage at park brake solenoid
99 hex	Open circuit at park brake solenoid

Number	Meaning of error code
B1 hex	Slippage at clutch KC
B2 hex	Slippage at clutch KD
B3 hex	Slippage at clutch KE
B5 hex	Slippage at clutch KV
B6 hex	Slippage at clutch KR
D1 hex	Short circuit to battery voltage at power supply for sensors
D2 hex	Short circuit to ground at power supply for sensors
D3 hex	Low voltage at battery
D4 hex	High voltage at battery
D5 hex	Error at valve power supply 1
D6 hex	Error at valve power supply 2
E5 hex	Communication failure on devicenet
F1 hex	General EEPROM fault
F2 hex	Configuration lost
F3 hex	Application error

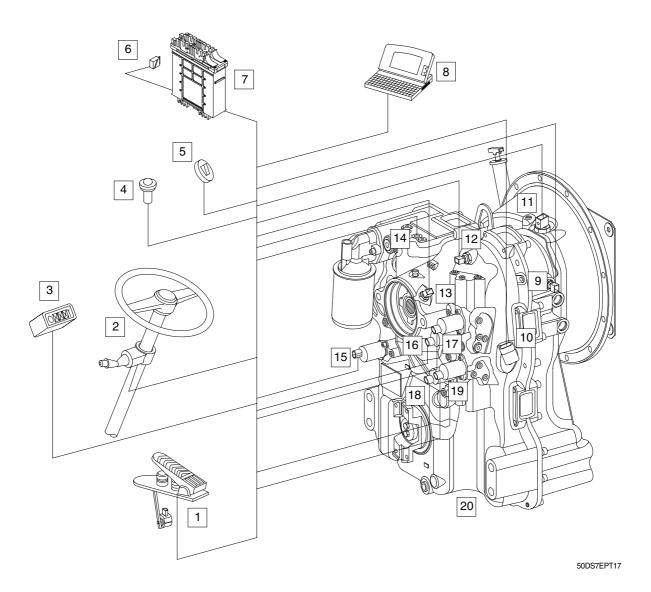
#### 6) ELECTRONIC CONTROL FOR POWER TRANSMISSION

#### (1) Description of the basic functions

The powershift transmission 3 WG-94 EC of series WG-90 is equiped with the electronic transmission control EST-65 specially developed for this purpose.

The system process the driver command according to the follwing criteria:

- $\cdot$  Gear determination depending on driving speed and load condition.
- · If required, protection against operationg errors is possible via electronic protection (programming)
- · Protection against overspeeding(on the basis of engine and turbine speed)
- · Pressure cut-off possible(vehicle-specific, only after coordination with ZF)
- · Switch-over possibility for automatic / manual operation
- · Downshifting functions possible
- · Electronic inching



- 1 Inching pedal
- 2 Gear selector
- 3 Display
- 4 Optical warning
- 5 Switch for driving program Manual/Automatic
- 6 CAN connection
- 7 TCU
- 8 Diagnostic Laptop with ZF diagnostic system Testman/Pro
- 9 Inductive sensor speed of central gear chain
- 10 Speed sensor output

- 11 Temperature measuring point after the converter (No. 63)
- 12 Inductive sensor turbine speed
- 13 Inductive sensor engine speed
- 14 Temperature measuring point for the converter (No. 64)
- 15 Proportional valve Y3 KC clutch
- 16 Proportional valve Y2 KR clutch
- 17 Proportional valve Y1 KV clutch
- 18 Proportional valve Y5 KE clutch
- 19 Proportional valve Y4 KD clutch
- 20 Ergopower transmission 3 WG-94 EC

#### (2) Inching device

This function is especially suitable for lift trucks. Without modifying the engine speed, it allows a continuously variable reduction of the driving speed to such a level that operation at a very low speed is possible. In this way, the driver can move the vehicle to a certain position with high accuracy.

At the same time, a large part of the enging power is available for driving the hydraulic lifting system, due to the high engine speed.

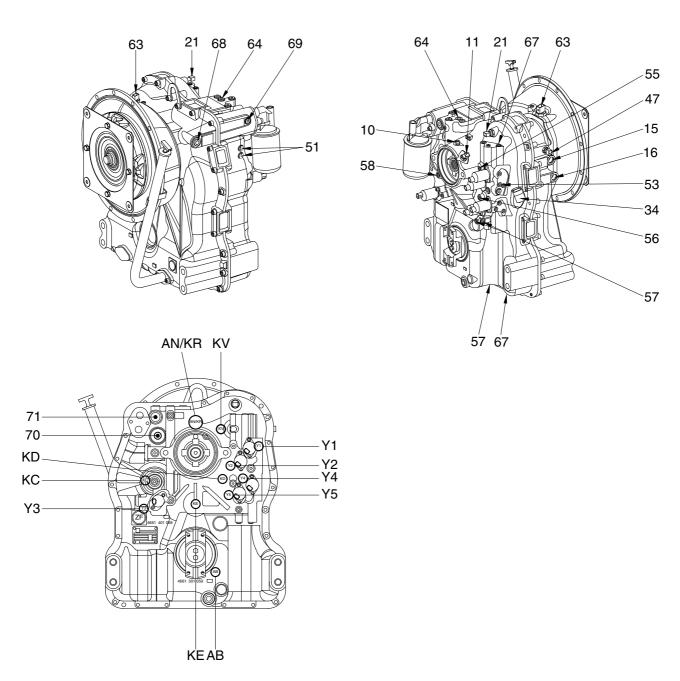
The electrical inching is operated via a separate inching pedal fitted with an angle-of-rotation sensor.

By means of the proportional valve technology, the TCU controls the pressure in the driving direction clutch in such a way that the driving speed is adjusted in accordance with the position of the inching angle-of-rotation sensor. Clutch overloading is prevented by the electronic protection.

- \* After each readjustment of the inching linkage, the IPK(Inch Pedal Calibration-Inch Sensor Calibration) must be carried out.
  - During the inching calibration mode, the position of the inching pedal in neutral position and at full actuation is determined by the calibration process and stored in the TCU.
- \* The inching function does not become active until successful completion of AEB and IPK start.

#### 4. TRANSMISSION MEASURING POINTS AND CONNECTIONS

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



50DS7ETM04

# 1) Measuring points for pressure oil and temperature

Port		Size		
51	Before the converter -	opening pressure	11 + 2 bar	M10x1
53	Reverse clutch	KR	16 + 3 bar	M10x1
55	Forward clutch	KV	16 + 3 bar	M10x1
56	Clutch	KD	16 + 3 bar	M10x1
57	Clutch	KE	16 + 3 bar	M10x1
58	Clutch	KC	16 + 3 bar	M10x1
63	Temperature after the	M14x1.5		
64	Temperature sensor			M12x1.5
67	System pressure		16 + 3 bar	M10x1

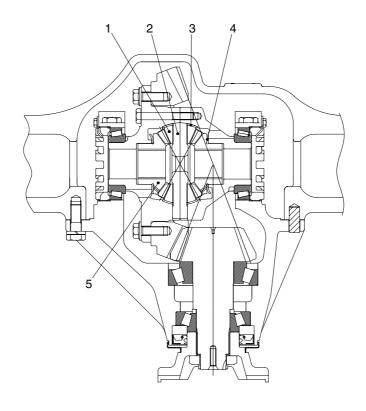
# 2) Valves and connections

Port	Description	Size
10	Breather	M10x1
15	Connection towards heat exchange	7/8" 14 UNF
16	Connection from heat exchanger	7/8" 14 UNF
68	Connection after fine filter	9/6-18 UNF-2B
69	Connection before fine filter	7/8" 14 UN 2A
70	Converter safety valve(WSV)	
71	Main pressure valve(HDV)	

# 3) Inductive transmitters and speed sensor

Port		Size	
11	Inductive transmitter	n Engine	M18x1.5
21	Inductive transmitter	n Turbine	M18x1.5
34	Speed sensor	n Output	-
47	Inductive transmitter	n Central gear train	M18x1.5

# 5. DIFFERENTIAL CARRIER ASSEMBLY 1) STRUCTURE



80D7AX02

No	Item	Unit	Specification
1	Differential pinion gear inner diameter	mm(in)	20.000 - 20.021(0.787~0.788)
2	Spider outer diameter	mm(in)	19.959 - 19.980(0.786~0.787)
3	Pinion gear washer	mm(in)	1.92 - 2.08(0.076~0.082)
4	Side gear washer	mm(in)	1.95 - 2.05(0.077~0.081)
5	Side gear	-	-

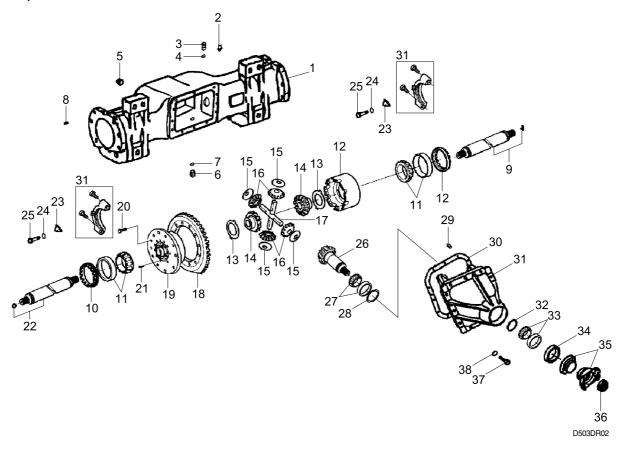
## 2) OPERATION

Differential transmits the power from the transmission to drive wheel.

Differential is composed of 4 pinions(1), 2 side gears(5) and 1 spider(2).

The spider is meshed vertically between 4 pinions(1) and 2 side gear(5), so the engagement become a right angle.

# 6. DRIVE AXLE A. DRY TYPE 1) STRUCTURE



1	Axle housing	14	Side gear	27	Taper roller bearing
2	Air breather	15	thrust washer	28	Shin set(0.15, 0.20, 0.25t)
3	plug	16	Pinion gear	29	Dowel pin
4	Gasket	17	Spider	30	Gasket
5	Plug	18	Ring gear	31	Carrier housing assembly
6	Plug	19	Differential case-LH	32	Spacer set(5.37, 5.40, 5.43t)
7	O-ring	20	Wheel bolt	33	Taper roller bearing
8	Pin	21	Bolt	34	Oil seal
9	Drive shaft assembly-RH	22	Drive shaft assembly-LH	35	Input flange assembly
10	Adjust nut	23	Plate	36	Nut
11	Taper roller bearing	24	Spring washer	37	Bolt
12	differential case-RH	25	Bolt	38	Spring washer
13	Thrust washer	26	Pinion shaft		

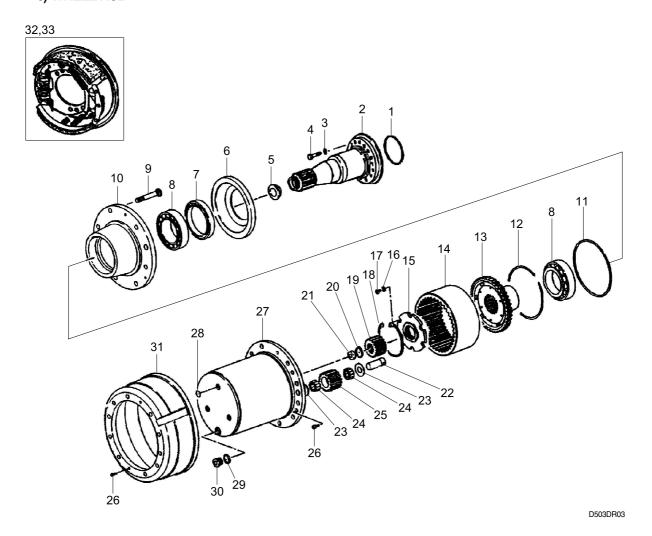
#### 2) OPERATION

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

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

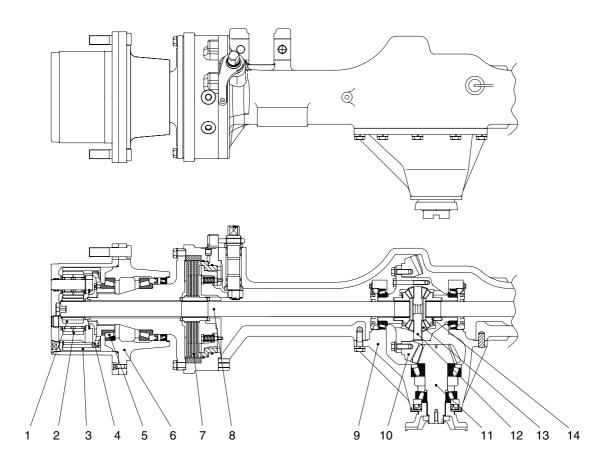
The power from the transmission in transferred through the hypoid pinion, hypoid gear, differential case, the pinion of the differential device and the side gear to the drive axle shaft by the side gear spline and to the hub and wheel mounted on the shaft by high tension bolts.

# 3) WHEEL HUB



1	O-ring	12	C-ring	S 23	Thrust washer
2	Brake tube	13	Carrier	24	Needle bearing
3	Washer	14	Ring gear	25	Planetary gear
4	Bolt	15	Nut	26	Bolt
5	Bushing	16	Washer	27	Planetary housing
6	Hub cover	17	bolt	28	O-ring
7	Oil seal	18	Snap ring	29	O-ring
8	Taper roller bearing	19	Sun gear	30	Plug
9	Wheel bolt	20	Snap ring	31	Brake drum
10	Wheel hub	21	Stopper	32	Wheel brake assembly-LH
11	O-ring	22	Shaft	33	Wheel brake assembly-RH

# B. WET TYPE1) STRUCTURE



80D7AX03

1	Sun gear	6	Hub assy	11	Pinion shaft
2	Planetary gear	7	Disk brake	12	Spider
3	Inner gear	8	Drive shaft	13	Differential pinion gear
4	Inner gear carrier	9	Differential carrier assy	14	Differential side gear
5	Tapered bearing	10	Ring gear		

#### 2) OPERATION

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

Pinion shaft(11) is connected to transmission output shaft with spline.

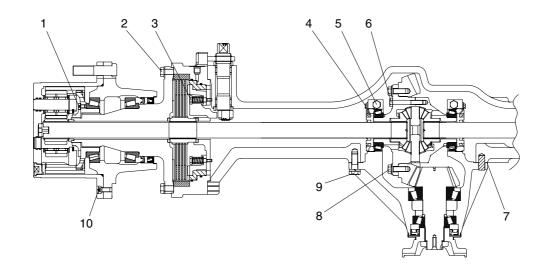
The power of transmission is transmitted to differential which consists of pinion shaft(11) and ring gear(10) and the differential rotates the drive shaft(8).

The differential transmits the drive force from transmission to wheels.

The differential consists of 4 pinions(13), 2 side gears(14) and spider and the engagement between 4 pinions(13) and 2 side gears(14) makes a right angle.

Side gear(14) and drive shaft(8) are connected with spline and the drive shaft(8) transmits the drive force to planetary gear(2), inner gear(3), wheel hub(6) and drive wheels.

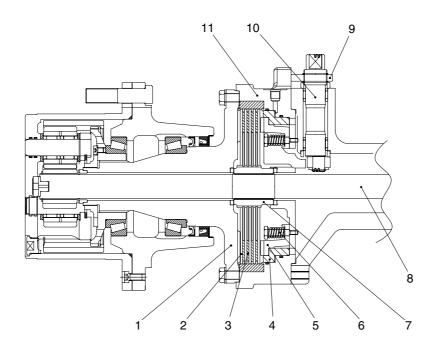
# 3) DRIVE AXLE TIGHTENING TORQUE



80D7AX04

No	Item	Specification
1	Inner carrier	$2.2\pm0.3$ kgf $\cdot$ m (15.9 $\pm2.2$ lbf $\cdot$ ft)
2	Spindle	12 $\pm$ 0.5kgf $\cdot$ m (86.8 $\pm$ 3.6lbf $\cdot$ ft)
3	Parking piston	$1.5\pm0.1$ kgf $\cdot$ m ( $10.8\pm0.7$ lbf $\cdot$ ft)
4	Adjuster nut	$1.0\pm0.2$ kgf · m ( $7.2\pm1.4$ lbf · ft)
5	Differential cap	$16\pm0.5$ kgf $\cdot$ m ( $116\pm3.6$ lbf $\cdot$ ft)
6	Differential case	$6\pm0.5$ kgf $\cdot$ m (43.4 $\pm$ 3.6lbf $\cdot$ ft)
7	Connection between differential carrier and drive axle	Gasket
8	Ring gear	13.5 $\pm$ 0.5kgf $\cdot$ m (97.6 $\pm$ 3.6lbf $\cdot$ ft)
9	Differential carrier assembly	18.0 $\pm$ 0.5kgf $\cdot$ m (130 $\pm$ 3.6lbf $\cdot$ ft)
10	Wheel hub	$3.0\pm0.3$ kgf $\cdot$ m (21.7 $\pm2.2$ lbf $\cdot$ ft)

## 4) DISK BRAKE



80D7AX05

1	Spindle	5	Parking piston	9	Parking lever
2	Steel plate	6	Parking piston mounting bolt	10	Parking lever shaft
3	Disk plate	7	Spline collar	11	Brake housing
4	Service piston	8	Drive shaft		

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

Because it is possible to use the brake semi-permanently, there is no need to replace or change the lining as drum type brake do.

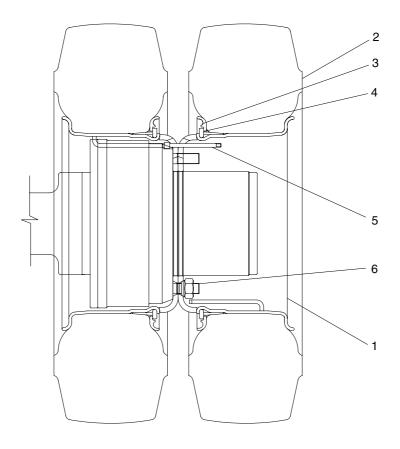
Parking brake's lever system is the serration type, so it is possible to adjust the play.

Because it is easy to maintain the gap of both brakes, high brake efficiency and minimum disproportional braking deviation is acquired.

Major components are 4 disk plates(3), 5 steel plates(2), service piston(4), parking piston(5), parking lever(9) and brake housing(11).

Braking force is applied by restricting the driving force from drive shaft(8) and spline collar(7).

## 7. TIRE AND WHEEL



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

- 1) The tire acts to absorb the shock from the ground surface to the machine, and at the same time they must rotate in contact with the ground to gain the power which drives the machine.
- 2) Various types of tires are available to suit the purpose. Therefore it is very important to select the correct tires for the type of work.

## **GROUP 2 OPERATION AND MAINTENANCE**

#### 1. OPERATION

## 1) DRIVING PREPARATION AND MAINTENANCE

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

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

- \*\* Because the converter and the oil cooler, installed in the vehicle, as well as the pipes can empty at standstill into the transmission, the oil level check must be carried out at engine idling speed and operation temperature of the transmission.
- At the oil level check, the vehicle has to be secured against rolling by blocks, articulated vehicles additionally against unintended turning-in.

#### 2) DRIVING AND SHIFTING

#### (1) Neutral position

Neutral position will be selected via the gear selector.

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

A gear can be engaged.

#### (2) Starting

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

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

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

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

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

#### - Upshifiting under load.

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

#### Downshifting under load.

Downshfting 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<sup>-1</sup>).

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 programm 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<sup>-1</sup> 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-3-22)

#### 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 counterclock rotation, remove and clean it
- Insert oil dipstick slowly into the oil level tube until contact is obtained, and pull it out again.
- On the oil dipstick, the oil level must be lying in the zone "HOT"
- Insert the oil dipstick again, and tighten it by clockwise rotation

If the oil level has dropped in operating temperature condition below the "HOT" zone, it is absolutely necessary to replenish oil.

An oil level above the "HOT" marking, is leading to a too high oil temperature.

#### (2) Oil change and filter replacement intervals

\* First oil change after 100 operating hours in service.

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

#### ① Oil change and oil filling capacity

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

- Clean oil drain plug with magnetic insert and surface on the housing and install again along with O-ring.
- Fill in oil(about 24 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.

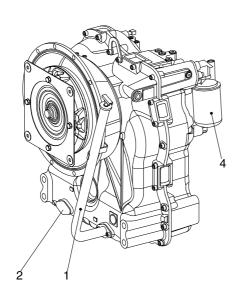
At the mounting of the filter, any exertion of force has to be avoided.

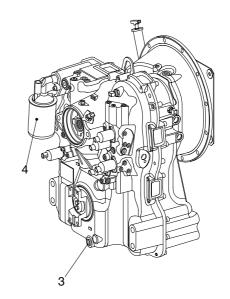
\* Treat the filter carefully at the installation, the transport and the storage.

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.



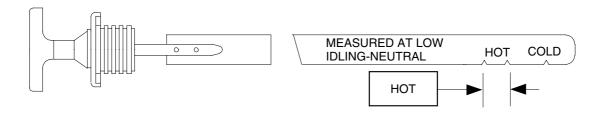


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# Legend:

- 1 = Oil filler tube with oil dipstick
- 2 = Mounting provision for oil filler tube with oil dipstick(option)
- 3 = Oil drag plug 7/8" 14 UNF 2B
- 4 = Fine filter

## Oil dipstick



D507PT20

#### 2) DRIVE AXLE

#### (1) General information

Drive axles generate small metal wear particles at a fairly steady rate, especially during the breakin period. If these fine, but hard particles are allowed to circulate in the lubricant, along with external moisture and dirt, internal components will wear at a much faster rate than normal.

## (2) Magnets and magnetic drain plugs

Planetary axles are equipped with magnetic drain plus that have a minimum pick-up capacity of 0.57kg(20 ounces) of low carbon steel. The drain plug must be checked for metal particles at every oil change interval.

\* Hyundai recommends replacing the magnetic drain plug each time the oil is changed.

Use the correct part. Pipe plugs will leak if used as a drain plug.

The magnetic drain plug can be reused if, after cleaning, the plug has a minimum pick-up capacity of 0.57kg(20 ounces) of low carbon steel.

#### (3) Breather

▲ Cover the breather when steam cleaning the housing. If the breather is not covered, water can enter the housing and contaminate the oil.

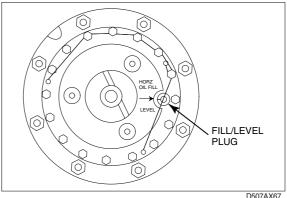
Breathers release pressure and vacuum condensation to minimize premature oil and component failure.

#### (4) Oil level

### ▲ Check and adjust oil

For complete fill procedures for wet disc brakes.

- ▲ To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.
- \* Fill and drain plugs are located in both brake housing and the main housing.
- ① Make sure the vehicle is on a level surface.
- \* For axles with a common oil level that have drain and fill plugs only in the axle assembly, proceed to step ③.
- ② Rotate the wheels so that the "Oil level lines" on the wheel ends are parallel to the ground.
- ③ Clean the area around the fill/level plug. Remove the fill/level plug from the wheel ends and the axle housing bowl. The oil level must be even with the bottom of the hole of the fill/level plug.



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- ④ If oil flows from the hole when you loosen the plug: The oil level is high. Let the oil drain to the correct level.
- \* Do not fill only through the axle housing bowl.
- ⑤ If the oil level is below the bottom of the hole of the fill/level plug: Fill the axle at each wheel end and the axle housing bowl to the bottom of the fill plug hole with the specified oil. Wait and allow the oil to flow through the axle.
  - Check the oil level again and fill to the specified level if necessary.
- (6) Install the fill/level plugs. Apply thread compound and tighten. Refer to the "Torque table".

#### (5) Oil change

- ♠ Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury can result.
- Make sure the vehicle is on a level surface.
   Put large containers under the axle and wheel ends.
- ② Raise the vehicle so that the wheels are off the ground. Support the vehicle with safety stands.
- ③ Rotate the wheels so that the "fill/level" plugs in the wheel ends are toward the ground.
- Remove the drain plugs from both brake housing and the main housing. Drain and discard the oil properly. Clean the plug.
- ⑤ Install the drain plugs in both brake housings and the main housing. Apply thread compound and tighten. Refer to the "torque table".
- ⑥ Rotate the wheels so that the "oil level lines" on the wheel ends are parallel to the ground. Lower the vehicle.
- ⑦ Clean the area around the fill/level plug.
  Remove the fill/level plug from the wheel ends and the axle housing bowl.
- \* Do not fill only through the axle housing bowl.
- Solution Shill the axle at each each wheel end and the axle housing bowl to the bottom of the fill plugs hole with the specified oil. Wait and allow the oil to flow through the axle. Check the oil level again and fill to the specified level of necessary.
- Install the fill/level plugs. Apply thread compound and tighten. Refer to the "torque table".

#### (6) Oil change intervals and specifications

	Off-highway ope	Oil specification	Remarks		
Recommended initial oil change	Check oil level	Petroleum oil change	Synthetic oil change	Transmission oil	Initial use or refill
100 operating hours	250 operating hours*	1,000 operating hours or twice a year(whichever comes first)	-	Transmission oil	OK to use only for refill

\* The checking interval depends on individual operating conditions, speeds and loads, severe operating conditions may require more frequent checks.

## 3. TROUBLESHOOTING

# 1) DRIVE AXLE

# (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.	<ol> <li>Worn or damaged piston seal.</li> <li>Melted or extruded piston seals.</li> <li>Corrosion, pitting, wear or other damage, marks, scratches to piston and/or brake housing bore in area of seal/sealing lips.</li> </ol>	<ol> <li>Replace piston seals.</li> <li>Correct cause of overheating and replace seals.</li> <li>Clean, smooth, rework or replace affected parts.</li> </ol>
External leak  1. Loose bleeder screw. 2. Loose inlet fitting or plugs. 3. Damaged inlet fitting or plugs or damaged seats.		<ol> <li>Tighten bleeder screw to 2.0~2.7kgf · m(15-20lb-ft)</li> <li>Tighten inlet fitting to 3.4~4.8kgf · m(25-35 lb-ft)</li> <li>Replace inlet fitting or plug and O-ring if used.</li> </ol>

# (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 approved materials.
Gration, Vibration.	material deed.	Drain and flush fluid from axle. Replace with approved fluid.
		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.	Install brake cooling system if not already installed on vehicle.
		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.	Check for proper fill level.
	2. Leaking face seal.	2. Replace or reinstall face seal assembly.
	3. Loose or damaged plugs.	Tighten drain, fill or forced cooling plug.     Replace if damaged.
	Deteriorated or inadequate sealant used at joint.	Dissemble, clean, re-seal and re-assemble brake housing joint.
Brake drags.	More than 1.4bar(20psi) pressure applies when brakes released.     Damaged piston return spring	Repair hydraulic system so pressure is less than 1.4bar(20psi) when brakes released and while machine is operating in any mode.     Repair or replace piston return spring
	assembly.	assembly.
	3. Piston not returning.	3. Check piston seals and seal separator.
	Wrong cooling and/or actuation fluid used.	Check piston seals and seal separator for swelling or damaged. Replace as necessary.  Purge system and use correct fluid.
	5. Tight or damaged splines(eg. friction disc-to-hub driver).	5. Repair or replace parts.

# (4) BRAKE DOES NOT APPLY

Condition	Possible cause	Correction
Low or no pressure to brake	1. Empty fluid reservoir.	Fill reservoir to correct level with specified fluid.
	2. Damaged hydraulic system.	2. Repair hydraulic system.
	3. Leaked of brake actuation fluid.	Refer to "Brake leaks actuation fluid" in this section.
	Parking brake not adjusted properly.	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	More than 1.4bar(20psi) pressure applied when brakes released.	Repair hydraulic system so pressure is less than 1.4bar(20psi) when brakes released and while machine is operating in any mode.
	Damaged piston return spring assembly.	Repair or replace piston return spring assembly.
	3. Piston not returning.	Check piston seals for swelling or damage.  Replace as necessary.
	Wrong cooling and/or actuation fluid used.	Check piston seals for swelling or damage.  Purge system and use specified fluid.
	5. Parking brake not adjusted properly.	Adjust parking brake lever as described in assembly of this manual.

# (6) BRAKING PERFORMANCE

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

# (7) DIFFERENTIAL

No	Problem	Cause
1	Regular noise	1. Lubricating oil shortage.
		2. Incorrect oil specification.
		3. Wheel bearing adjustment failure or defect.
		4. Drive gear and pinion adjustment failure.
		5. Drive gear or pinion gear damage or wear.
		6. Large or small gear backlash.
		7. Pinion bearing wear or loosening.
		8. Side bearing wear or loosening.
2	Irregular noise	1. Irregular rotation of ring gear.
		1) Loosened drive gear fixing bolt.
		2) Drive gear defect.
		2. Differential bearing damage.
3	Noise only at the rotation	1. Differential drive gear and pinion shaft or spider are tightly meshed.
		2. Side gear and differential case are tightly meshed.
		3. Differential pinion and side gear defect.
		4. Thrust washer wear or damage.
		5. Too large backlash (between side gear and pinion)
4	Lubricating oil leakage	1. Oil leakage at the axle hub carrier side.
		1) Too high oil level.
		2) Incorrect oil specification.
		3) Clogged axle housing breather.
		2. Pinion axle leakage.
		1) Too high oil level.
		2) Incorrect oil specification.
		3) Clogged breather.
		4) Wear or incorrect assembly of oil seal.
5	Drive wheel stopping	1. Axle shaft damaged.
		1) Wheel bearing loosening.
		2) Short length of shaft.
		3) Stud and nut loosening.
		2. Drive gear teeth damaged.
		3. Pinion gear of differential side gear is damaged.
		4. Spider of differential pinion is damaged.

# 2) TRANSMISSION

# (1) GENERAL INSPECTION WHILE DRIVING

No	Problem	Cause
1	Failure at the specific gear	Low oil pressure or no pressure.
	stage	1) No oil, low level or high oil viscosity.
		2) Loose inching control valve connection, incorrect adjustment or
		damage.
		3) Inching valve spool sticked or open.
		4) Oil pump damage or defect.
		5) T/C pump gear side bolt breakage or gear not meshing with
		pump.
		6) Main regulator valve sticked or open.
		7) Oil circuit clogged or strainer contaminated.
		8) T/M inside leakage.
		Control valve gasket damage.
		- Clutch shaft metal sealing wear or damage.
		- Clutch piston seal damage or wear.
		9) Control valve gasket wear cause oil leakage.
		2. Abnormal connection of outer line of cooler.
		3. Mechanical defect inside the T/M
2	Gear shift failure	1. Low oil pressure.
		2. Main regulator valve does not move.
		Malfunctioning of solenoid or relative electric components.
3	T/M overheating	1. Clogged cooling line.
		2. Oil level is too high or too low.
		3. Low pump pressure, pump wear or defect.
		4. Partial clutch wear or slip
		5. Air mixed with oil, air leakage at the pump input port.
		6. Insufficient oil flow through the T/C.
		7. Overload on the machine.
		8. Too excessive inching operation.
		9. Too excessive stall operation of T/C.
		10. Cooler bypass valve stick or open. Oil flow insufficient through oil
		cooler.

No	Problem	Cause
4	Slow clutch meshing or failure	1. Low oil pressure.
		2. Low converter oil pressure.
		3. Air mixed with oil
		Air mixed through the pump input port.
		2) Low oil level
		Abnormal adjustment of inching valve linkage.
5	Reverse gear shift failure	Excessive wear of disk and plate at reverse clutch.
		2. Oil leakage from seal.
		3. Reverse clutch components defect.
		Metal sealing wear or defect.
		2) Clutch piston seal wear or defect.
		3) Another components damaged.
		4. Malfunction of solenoid or related electric parts.
6	Forward gear shift failure	Excessive wear of disk and plate at forward clutch.
		2. Oil leakage from seal.
		3. Forward clutch components defect.
		Metal sealing wear or defect.
		2) Clutch piston seal wear or defect.
		3) Another components damaged.
		4. Malfunction of solenoid or related electric parts.
7	Low stall speed	Incorrect engine performance.
		2. Torque converter stator failure.
8	High stall speed at all of gear	1. Low oil level.
	stage	2. Air mixed with oil.
		3. Clutch slip.
		4. T/C malfunctioning.
9	High stall speed at partial	1. Clutch line leakage.
	direction or speed	2. Clutch defect.
10	Slow clutch meshing and rough	Incorrect adjustment of inching valve.
	gear shift	2. Inching valve not closed or clogged orifice.
		3. Low main pressure.
		4. Low pressure of direction clutch.
		5. Oil leakage.
		6. Valve spool spring weakened or damaged.
11 Abnormal movement to the 1. Clutch defect, clutch		Clutch defect, clutch disk and plate damaged.
	specified direction at neutral	2. Valve spool defect or spool sticked.

# (2) ABNORMAL NOISE CHECK LIST

No	Problem	Cause
1	Noise only at neutral	Gear or bearing wear inside the pump.
		2.Torque converter stator wear.
		3. Low oil level.
		4. Gear parts of engine and T/M pump's misalignment with that of
		converter housing and pump.
2	Pump noise	1. Loud noise irregularly repeats if there's contaminents in the T/M
		hydraulic components.
		2. Regular noise means pump defect.
3	T/M noise	1. Converter housing and pump gear misalignment with engine or T/M
		2. T/M components wear or damage.
		1) Gear damage.
		2) Clutch plate and disk slip noise.
		3) Thrust washer defect.
		4) Another components wear or damage.
4	Control valve noise	1. Air mixed into hydraulic system.
		1) Air leakage from the pump input port.
		2. Clogged oil passage.
		3. Abnormal spool movement.

# (3) PRESSURE TEST CHECK LIST

No	Problem	Cause
1	FR/RR clutch low pressure	Incorrect adjustment of inching valve linkage
		Inching spool sticked and open.
		Clutch and piston oil leakage.
		Regulator spring defect.
		Low oil pressure.
		Incorrect connection of cooler external line.
2	High clutch and main pressure	Pressure regulation valve does not move smoothly.
		Clogged hydraulic line.
3	Low clutch pressure	Oil leakage due to incorrect assembly of clutch piston seal.
		Damage or wear of clutch piston seal and shaft seal.
		Valve contact surface not flat or gasket damage.
4	Low main pressure	Low oil quantity
		Pressure regulation valve does not move smoothly.
		Pump wear
		Internal leakage
		Low oil pressure
5	High converter pressure	Main regulation valve sticked and open, oil overflow to converter.
		Clogged internal passage of converter assembly.
		Clogged oil line.
6	Low converter pressure	Clogged main regulator valve.
7	Low converter output pressure,	Low oil pressure
	cooler input pressure.	Cooler bypass valve sticked and open.
8	High converter output pressure, cooler input pressure	Clogged or restricted cooler line.

# (4) Transmission fault 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
25	S.C. to battery voltage or O.C. at transmission sump temperature sensor input The measured voltage is too high:		<ul> <li>Check the cable from TCU to the sensor</li> <li>Check the connectors</li> <li>Check the temperature sensor</li> </ul>
26	S.C. to ground at transmission sump temperature sensor input The measured voltage is too low:     Cable is defective and is contacted to vehicle ground     Temperature sensor has an internal defect     Connector pin is contacted to vehicle ground	No reaction, TCU uses default temperature OP mode : Normal	<ul> <li>Check the cable from TCU to the sensor</li> <li>Check the connectors</li> <li>Check the temperature sensor</li> </ul>
27	S.C. to battery voltage or O.C. at retarder/torque converter 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		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/torque converter temperature sensor input The measured voltage is too low:	No reaction, TCU uses default temperature OP mode : Normal	<ul> <li>Check the cable from TCU to the sensor</li> <li>Check the connectors</li> <li>Check the temperature sensor</li> </ul>
2B	Inchsensor-signal mismatch the measured voltage from CCO and CCO2 signal don't match:  · Cable is defective  · Sensor has an internal defect	During inching mode: TCU shifts to neutral While not inching: no change OP-Mode: normal	<ul> <li>Check the cable from TCU to the sensor</li> <li>Check the connectors</li> <li>Check the sensor</li> </ul>
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	<ul> <li>Check the cable from TCU to the sensor</li> <li>Check the connectors</li> <li>Check the speed sensor</li> </ul>
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	<ul> <li>Check the cable from TCU to the sensor</li> <li>Check the connectors</li> <li>Check the speed sensor</li> </ul>
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

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
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	<ul> <li>Check the cable from TCU to the sensor</li> <li>Check the connectors</li> <li>Check the speed sensor</li> <li>This fault is reset after power up of TCU</li> </ul>
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	<ul> <li>Check the cable from TCU to the sensor</li> <li>Check the connectors</li> <li>Check the speed sensor</li> <li>Check the sensor gap</li> </ul>
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	<ul> <li>Check the cable from TCU to the sensor</li> <li>Check the connectors</li> <li>Check the speed sensor</li> </ul>
38	S.C. to ground at internal speed input TCU measures a voltage less than 0.45V at speed input pin Cable/connector is defective and is contacted to vehicle ground Speed sensor has an internal defect	OP mode : Substitute clutch control	Check the cable from TCU to the sensor     Check the connectors     Check the speed sensor
39	Logical error at internal speed input TCU measures a internal speed over a threshold and at the next moment the measured speed is zero  · Cable/connector is defective and has bad contact  · Speed sensor has an internal defect  · Sensor gap has the wrong size	OP mode : Substitute clutch control	<ul> <li>Check the cable from TCU to the sensor</li> <li>Check the connectors</li> <li>Check the speed sensor</li> <li>Check the sensor gap</li> <li>This fault is reset after power up of TCU</li> </ul>
ЗА	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	selection	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
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	<ul> <li>Check the cable from TCU to the sensor</li> <li>Check the connectors</li> <li>Check the speed sensor</li> </ul>
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	<ul> <li>Check the cable from TCU to the sensor</li> <li>Check the connectors</li> <li>Check the speed sensor</li> <li>Check the sensor gap</li> <li>This fault is reset after power up of TCU</li> </ul>
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	<ul> <li>Check the sensor signal of output speed sensor</li> <li>Check the sensor gap of output speed sensor</li> <li>Check the cable from TCU to the sensor</li> <li>This fault is reset after power up of TCU</li> </ul>
54	Vehicle1 timeout Time of CAN-message Vehicle1 from display computer Interference on CAN-Bus CAN wire/connector is broken CAN wire/connector is defective and has contact to vehicle ground or battery voltage	TCU shifts to neutral NN(because of shifting lever)	Check vehicle controller     Check wire of CAN-Bus     Check cable to vehicle controller
57	EEC1 timeout Timeout of CAN-message EEC1 from EEC controller Interference on CAN-Bus CAN wire/connector is broken CAN wire/connector is defective and has contact to vehicle ground or battery voltage	OP-Mode : substitute clutch control	<ul> <li>Check EEC controller</li> <li>Check wire of CAN-Bus</li> <li>Check cable to EEC controller</li> </ul>
71	S.C. to battery voltage at clutch KC The measured resistance value of the valve is out of limit, the voltage at KC valve is too high  Cable/connector is defective and has contact to battery voltage  Regulator has an internal defect	TCU shifts to neutral OP mode: Limp home If failure at another clutch is pending TCU shifts to neutral OP mode: TCU shutdown	<ul> <li>Check the cable from TCU to the gearbox</li> <li>Check the connectors from TCU to the gearbox</li> <li>Check the regulator resistance*</li> <li>Check internal wire harness of the gearbox</li> <li>* See page 3-57</li> </ul>

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
72	S.C. to ground at clutch KC  The measured resistance value of the valve is out of limit, the voltage at KC valve is too low  Cable/connector is defective and has contact to vehicle ground  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 3-57
73	O.C. at clutch KC The measured resistance value of the valve is out of limit  · Cable/connector is defective and has no contact to TCU  · Regulator has an internal defect	TCU shifts to neutral OP mode: Limp home If failure at another clutch is pending TCU shifts to neutral OP mode: TCU shutdown	<ul> <li>Check the cable from TCU to the gearbox</li> <li>Check the connectors from gearbox to TCU</li> <li>Check the regulator resistance*</li> <li>Check internal wire harness of the gearbox</li> <li>* See page 3-57</li> </ul>
74	S.C. to battery voltage at clutch KD The measured resistance value of the valve is out of limit, the voltage at KD valve is too high  Cable/connector is defective and has contact to battery voltage  Regulator has an internal defect	TCU shifts to neutral OP mode: Limp home If failure at another clutch is pending TCU shifts to neutral OP mode: TCU shutdown	<ul> <li>Check the cable from TCU to the gearbox</li> <li>Check the connectors from gearbox to TCU</li> <li>Check the regulator resistance*</li> <li>Check internal wire harness of the gearbox</li> <li>* See page 3-57</li> </ul>
75	S.C. to ground at clutch KD  The measured resistance value of the valve is out of limit, the voltage at KD valve is too low  Cable/connector is defective and has contact to vehicle ground  Cable/connector is defective and has contact to another regulator output of the TCU  Regulator has an internal defect	is pending	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 3-57
76	O.C. at clutch KD  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	If failure at another clutch	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 3-57
77	S.C. to battery voltage at clutch KE The measured resistance value of the valve is out of limit, the voltage at KE valve is too high  Cable/connector is defective and has contact to battery voltage  Regulator has an internal defect	If failure at another clutch is pending	<ul> <li>Check the cable from TCU to the gearbox</li> <li>Check the connectors from gearbox to TCU</li> <li>Check the regulator resistance*</li> <li>Check internal wire harness of the gearbox</li> <li>* See page 3-57</li> </ul>

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
78	S.C. to ground at clutch KE  The measured resistance value of the valve is out of limit, the voltage at KE valve is too low  · Cable/connector is defective and has contact to vehicle ground  · 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 3-57
79	O.C. at clutch KE 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	If failure at another clutch	<ul> <li>Check the cable from TCU to the gearbox</li> <li>Check the connectors from gearbox to TCU</li> <li>Check the regulator resistance*</li> <li>Check internal wire harness of the gearbox</li> <li>* See page 3-57</li> </ul>
84	S.C. to battery voltage at clutch KV The measured resistance value of the valve is out of limit, the voltage at KV valve is too high  Cable/connector is defective and has contact to battery voltage  Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	<ul> <li>Check the cable from TCU to the gearbox</li> <li>Check the connectors from gearbox to TCU</li> <li>Check the regulator resistance*</li> <li>Check internal wire harness of the gearbox</li> <li>* See page 3-57</li> </ul>
85	S.C. to ground at clutch KV  The measured resistance value of the valve is out of limit, the voltage at KV valve is too low  · Cable/connector is defective and has contact to vehicle ground  · Cable/connector is defective and has contact to another regulator output of the TCU  · Regulator has an internal defect		<ul> <li>Check the cable from TCU to the gearbox</li> <li>Check the connectors from gearbox to TCU</li> <li>Check the regulator resistance*</li> <li>Check internal wire harness of the gearbox</li> <li>* See page 3-57</li> </ul>
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	If failure at another clutch	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 3-57
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  Regulator has an internal defect	If failure at another clutch is pending	<ul> <li>Check the cable from TCU to the gearbox</li> <li>Check the connectors from gearbox to TCU</li> <li>Check the regulator resistance*</li> <li>Check internal wire harness of the gearbox</li> <li>* See page 3-57</li> </ul>

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  Cable/connector is defective and has contact to another regulator output of the TCU  Regulator has an internal defect	If failure at another clutch is pending	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 3-57
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	If failure at another clutch	<ul> <li>Check the cable from TCU to the gearbox</li> <li>Check the connectors from gearbox to TCU</li> <li>Check the regulator resistance*</li> <li>Check internal wire harness of the gearbox</li> <li>* See page 3-57</li> </ul>
B1	Slippage at clutch KC TCU calculates a differential speed at closed clutch KC. If this calculated value is out of range, TCU interprets this as slipping clutch  Low pressure at clutch KC  Low main pressure  Wrong signal at internal speed sensor  Wrong signal at output speed sensor  Urong size of the sensor gap  Clutch is defective	If failure at another clutch	Check pressure at clutch KC 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 Check signal at output speed sensor Replace clutch
B2	Slippage at clutch KD TCU calculates a differential speed at closed clutch KD. If this calculated value is out of range, TCU interprets this as slipping clutch Low pressure at clutch KD Low main pressure Wrong signal at internal speed sensor Wrong signal at output speed sensor Urong size of the sensor gap Clutch is defective	If failure at another clutch	Check pressure at clutch KD 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 Check signal at output speed sensor Replace clutch

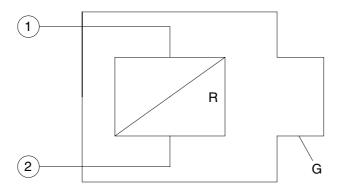
Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
B3	Slippage at clutch KE TCU calculates a differential speed at closed clutch KE. If this calculated value is out of range, TCU interprets this as slipping clutch  Low pressure at clutch KE  Low main pressure  Wrong signal at internal speed sensor  Wrong signal at output speed sensor  Urong size of the sensor gap  Clutch is defective	If failure at another clutch	Check pressure at clutch KE     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     Check signal at output speed sensor     Replace clutch
B5	Slippage at clutch KV TCU calculates a differential speed at closed clutch KV. If this calculated value is out of range, TCU interprets this as slipping clutch  Low pressure at clutch KV  Low main pressure  Wrong signal at internal speed sensor  Wrong signal at turbine speed sensor  Wrong size of the sensor gap  Clutch is defective	TCU shifts to neutral OP mode: Limp home If failure at another clutch is pending TCU shifts to neutral OP mode: TCU shutdown	Check pressure at clutch KV     Check main pressure in the system     Check sensor gap at internal speed sensor     Check sensor gap at turbine speed sensor     Check signal at internal speed sensor     Check signal at turbine speed sensor     Replace clutch
B6	Slippage at clutch KR TCU calculates a differential speed at closed clutch KR. If this calculated value is out of range, TCU interprets this as slipping clutch  Low pressure at clutch KR  Low main pressure  Wrong signal at internal speed sensor  Wrong signal at turbine speed sensor  Wrong size of the sensor gap  Clutch is defective	TCU shifts to neutral OP mode: Limp home If failure at another clutch is pending TCU shifts to neutral OP mode: TCU shutdown	<ul> <li>Check pressure at clutch KR</li> <li>Check main pressure in the system</li> <li>Check sensor gap at internal speed sensor</li> <li>Check sensor gap at turbine speed sensor</li> <li>Check signal at internal speed sensor</li> <li>Check signal at turbine speed sensor</li> <li>Replace clutch</li> </ul>
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 converter TCU measured a temperature in the retarder oil that is over the allowed threshold	No reaction OP mode : Normal	Cool down machine     Check oil level     Check temperature sensor
B9	Overspend engine	Retarder applies OP mode : Normal	-
ВС	Overtemp converter TCU measured a transmission output speed aabove the define threshold	No reaction OP mode : Normal	
C0	Engine torque or engine power overload TCU calculates an engine torque or engine power above the defined thresholds	OP mode : Normal	

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
C1	Transmission output torque overload TCU calculates an transmission output torque above the defined threshold	OP mode : Normal	
C2	Transmission input torque overload TCU calculates an transmission output torque above the defined threshold	programmable : No reaction or shift to neutral OP mode : Normal	
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
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	Meaning of the fault code	Reaction of the TCU	Possible steps to repair
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	<ul> <li>Check the cable from TCU to the display</li> <li>Check the connectors at the display</li> <li>Change display</li> </ul>
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 or Inchpedal calibration data lost TCU was not able to read correct clutch adjustment parameters Interference during saving data on non volatile memory TCU is brand new	Default values : 0 for AEB	· Execute AEB

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

## ① Actuator



76043PT19

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

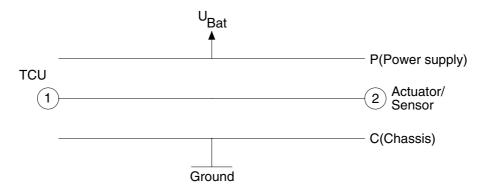
Short cut to ground  $R_{12} = R$ ;  $R_{1G} = 0$ ,  $R_{2G} = R$  or  $R_{1G} = R$ ,  $R_{2G} = 0$ 

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

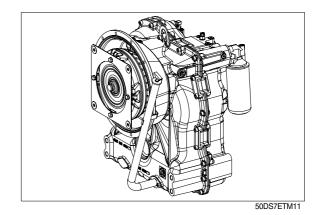
Short cut to ground  $R_{12}=0$ ;  $R_{1C}=R_{2C}=0$ ,  $R_{1P}=R_{2P}=\infty$ 

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

# **GROUP 3 DISASSEMBLY AND ASSEMBLY**

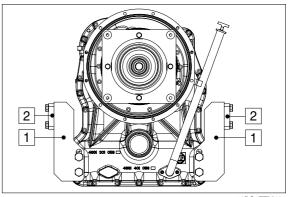
# 1. TRANSMISSION DISASSEMBLY 1) DISASSEMBLY

Transmission 3 WG-94 EC



① Attach transmission to the assembly truck by means of clamping angles(1) and holding fixtures(2).

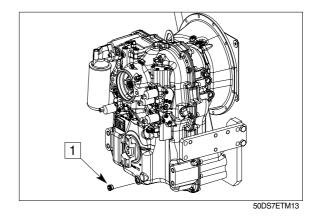
(S) Assembly truck	5870 350 000
(S) Holding fixtures	5870 350 063
(S) Clamping angles	5870 350 124



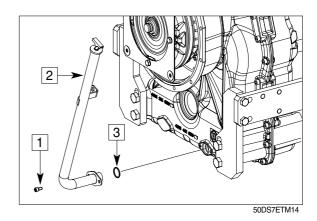
#### 50DS7ETM12

## (1) Removal of the filter

- \* Drain oil prior to starting disassembly.
- ① Remove screw plug(1).
- ▲ Disposal of oil according to legal requirements.



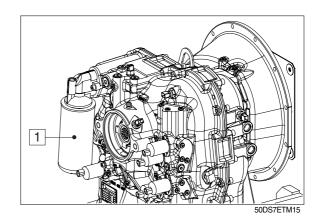
- ② Loosen the cylindrical screws(1) and remove the oil filler tube with the oil dipstick(2).
- \* Remove the O-ring(3) from the oil filler tube.



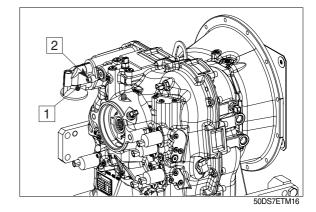
3-58

- ③ Separate the fine filter(1) from the filter head by means of belt wrench.
  - (S) Belt wrench

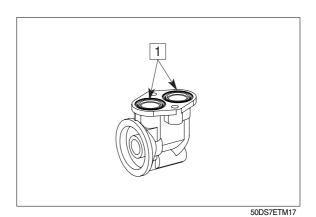
5870 105 005



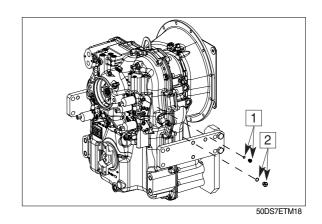
④ Loosen the cylindrical screws(2) and separate the filter head(1) from the transmission housing.



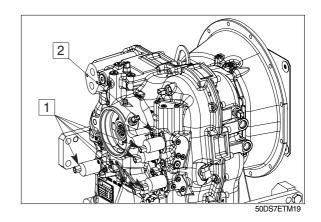
⑤ Remove both O-rings(1) out of the annular groove of the filter head.



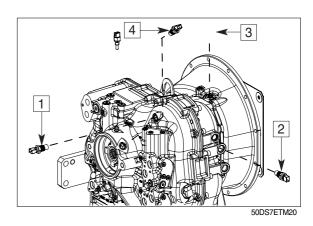
- 2) DISASSEMBLY PRESSURE CONTROLLER (PROPORTIONAL VALVES), INDUCTIVE SENSOR, SPEED SENSOR(HALL SENSOR), TEMPERATURE SENSOR, BREATHER AND SCREW PLUGS
  - ① Remove all screw plugs with O-ring(1 and 2).



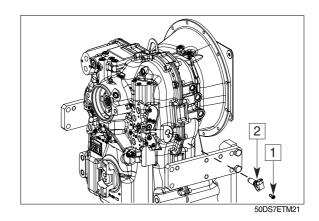
② Loosen cylindrical screws(1) and remove pressure controller(proportional valves, 2).



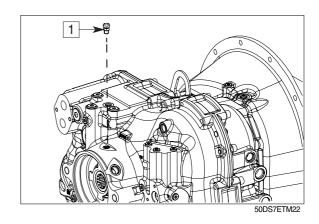
- ③ Remove positioned parts.
  - 1 = Inductive sensor-n turbine
  - 2 = Inductive sensor-n central gear chain
  - 3 = Temperature sensor, measuring point "63" after converter
  - 4 = Inductive sensor
- \* Remove O-rings.



- ④ Loosen cylindrical screw(1) and remove speed sensor(2).
  - 2 = Speed sensor-n output(Hall sensor)
- \* Remove O-rings.

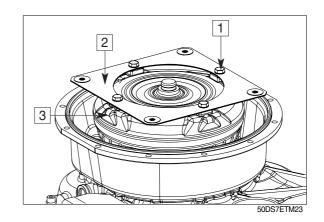


⑤ Remove breather (1).

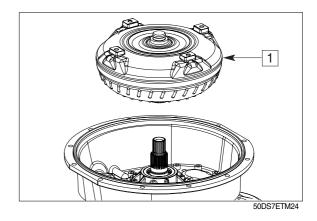


# 3) DISASSEMBLY CONVERTER AND CENTRAL SHAFT(PTO SHAFT)

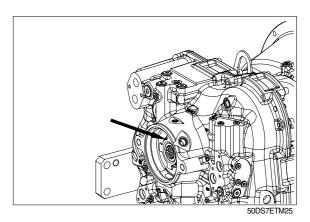
① Loosen cylindrical screws(1) and separate the flexplate(2) from the converter(3).



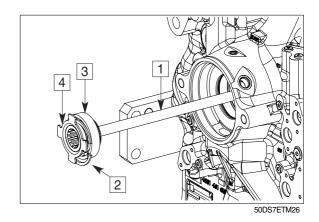
② Pull off converter(1) by hand.



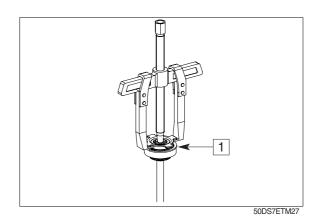
③ Disengage the retaining ring(see arrow).



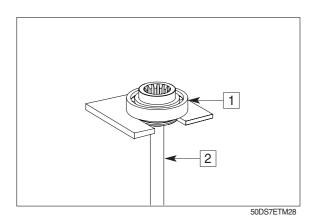
- ④ Pull the central shaft assy out of the housing hole.
  - 1 = Central shaft
  - 2 = Retaining ring
  - 3 = Ball bearing
  - 4 = Toothed disk



⑤ Pull the toothed disk(1) from the central shaft.

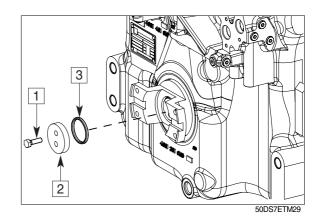


⑤ Press the ball bearing(1) from the central shaft(2).

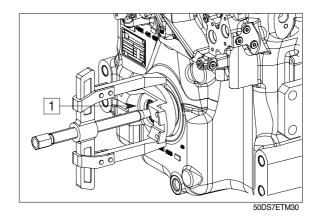


# 4) DISASSEMBLY OF OUTPUT FLANGE

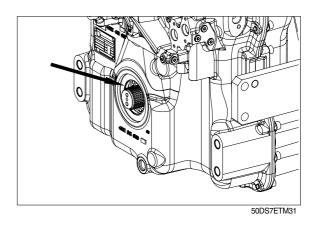
① Loosen the hexagon screws(1) and remove disk and O-ring(2 and 3).



② Pull output flange(1) off the output shaft by means of two-armed puller.



③ Remove shaft seal(see arrow) from the housing hole by means of assembly lever.



# 5) DISASSEMBLY OF MAIN PRESSURE VALVE AND CONVERTER SAFETY VALVE

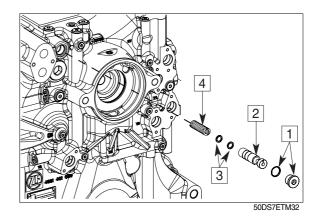
① Loosen screw plug(1) and remove main pressure valve(control pressure valve):

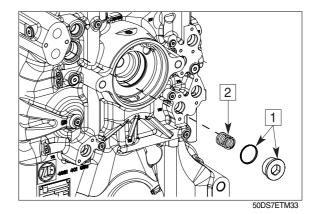
Main pressure valve consists of:

- 1 = Screw plug with O-ring
- 2 = Piston
- 3 = Spacer rings
- 4 = Compression spring
- ② Loosen screw plug(1) and remove converter safety valve.

Converter safety valve consists of :

- 1 = Screw plug with O-ring
- 2 = Pressure valves
- = Valve assy is installed in the housingnot visible-(functional check of valve see below ③).

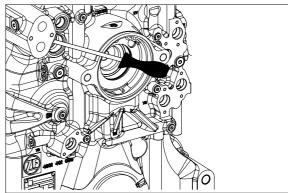




#### ③ Functional check of valve.

\* Use a screwdriver to check the movability of the ball in the valve.

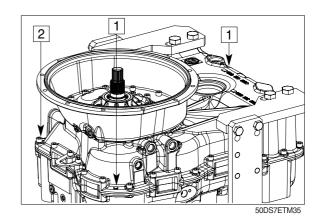
If the valve is o.k., it does not need to be removed.



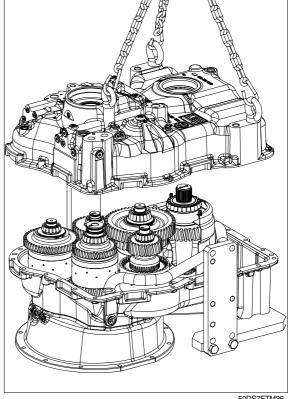
50DS7ETM34

#### 6) REMOVAL OF CLUTCHES AND DISASSEMBLY OF OIL PRESSURE PUMP

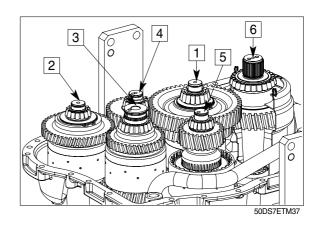
- ① Force out cylindrical pins(1).
- ② Loosen bolted connection(2) of housing front and rear part.
- ▲ Make sure to leave 2 cylindrical screws crosswise in the bolted connection(2). Transmission rear part is not fixed to the clamping angle and could get loose when turning.



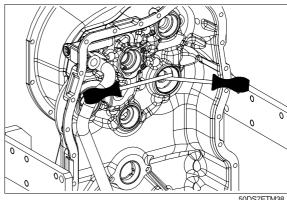
- 3 Rotate transmission housing 180°, loosen the last 2 cylindrical screws from the bolted connection housing front and rear part and separate housing rear part by means of lifting device.
- \* Support by means of assembly lever.
  - (S) Assembly lever 5870 345 036



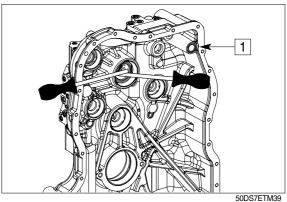
- ① Lift the clutches out of the housing in the following sequence:
  - 1 = Clutch KE (Clutch-3rd gear)
  - 2 = Clutch KV (Clutch-forward)
  - 3 = Clutch KR (Clutch-reverse and input)
  - 4 = Clutch KD (Clutch-2nd gear)
  - 5 = Clutch KC (Clutch-1st gear)
  - 6 = Output with screen sheet

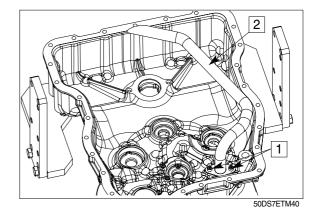


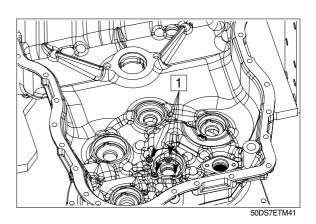
- ⑤ Use assembly lever to remove all bearing outer rings from the housing front part.
- \* If, contrary to the ZF recommendation, the tapered roller bearings of clutches and output are not replaced, it is imperative to ensure the previous pairing(bearing outer ring/bearing inner ring).
- \* Bearing outer ring and bearing inner ring must be marked.
- 6 Use assembly lever to remove all bearing outer rings from the housing rear part.
- \* If, contrary to the ZF recommendation, the tapered roller bearings of clutches and output 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.
- ? Remove O-ring(1).
- suction tube(2).



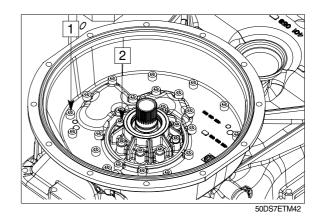




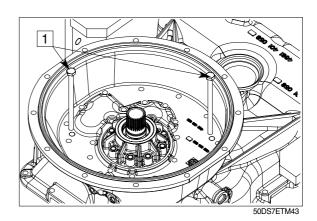




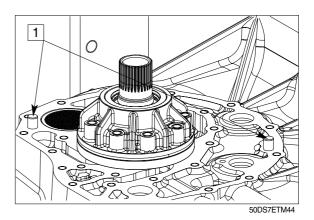
① Loosen bolted connection between converter bellhousing/transmission housing(1) and pressure oil pump/ transmission housing(2).



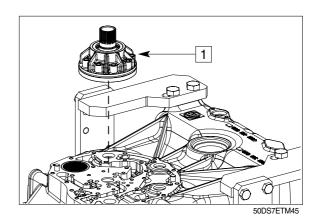
- ① Press converter bellhousing off the housing equally by means of hexagon screws M10(1).
- \*\* Difficult disassembly due to fixing by cylindrical pins.



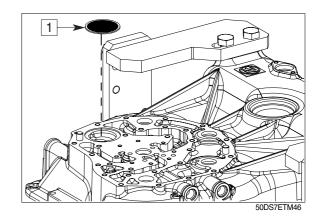
② If required, remove both cylindrical pins (1).



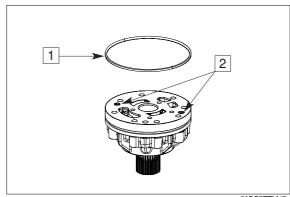
③ Remove oil pressure pump(1).



Remove filter(1).



- (5) Remove O-ring(1).
- (6) Loosen cylindrical screws(2).

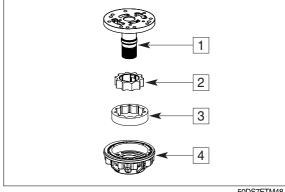


50DS7ETM47

\* Check oil pressure pump:

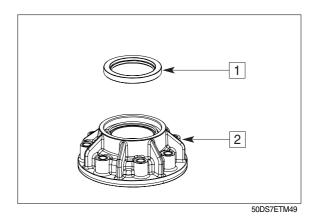
In case of wear marks in the pump housing, stator hollow shaft or on the inner and outer rotor, the complete oil pressure pump is to be replaced.

- 1 = Stator hollow shaft
- 2 = Inner rotor
- 3 = Outer rotor
- 4 = Pump housing



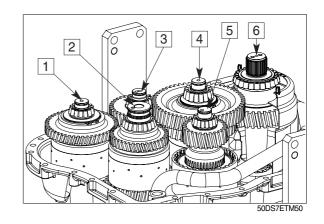
50DS7ETM48

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



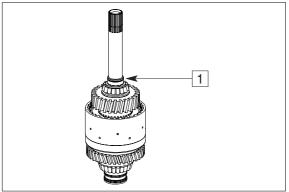
#### 7) DISASSEMBLY CLUTCHES:

- 1 = Clutch KV(Clutch-forward)
- 2 = Clutch KR(Clutch-reverse and input)
- 3 = Clutch KD(Clutch-2nd gear)
- 4 = Clutch KE(Clutch-3rd gear)
- 5 = Clutch KC(Clutch-1st gear)
- 6 = Output



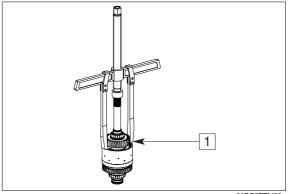
#### (1) Clutch KR/input

① Disengage rectangular ring(1).



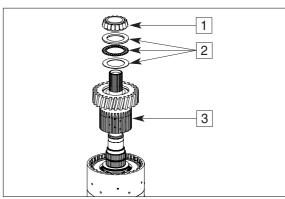
50DS7ETM51

② Pull off bearing inner ring with inner disk carrier(1).

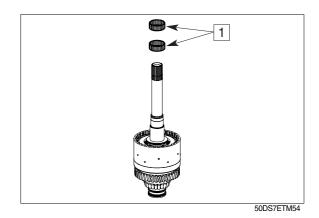


50DS7ETM52

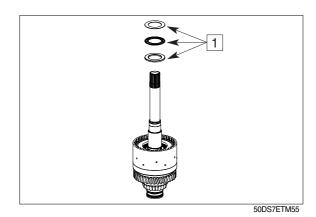
3 Remove bearing inner ring(1), axial bearing assy(2) and inner disk carrier (3).



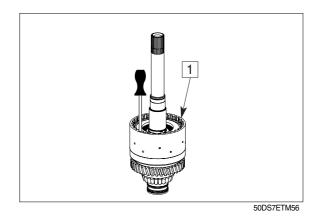
④ Remove needle cage(1).



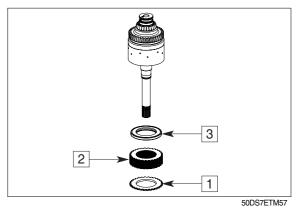
⑤ Remove axial bearing assy(1).



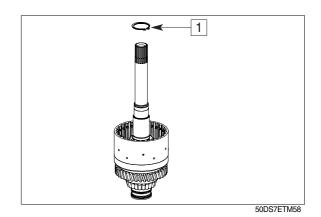
⑥ Disengage snap ring(1).



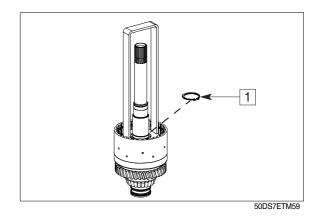
⑦ Remove end plate(1), disk package(2) and plate with cup springs(3) from the disk carrier.



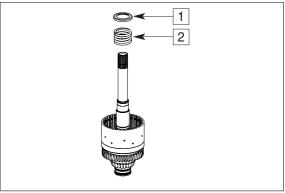
® Remove retaining ring-contact position of axial bearing(1).



- Preload compression spring and disengage retaining ring(1).
  - (S) Assembly aid 5870 345 114

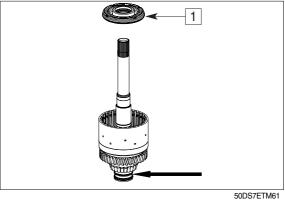


① Remove cup spring(1) and compression spring(2).

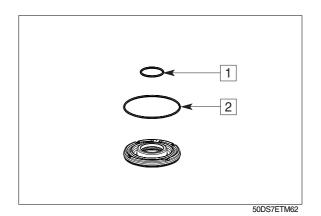


50DS7ETM60

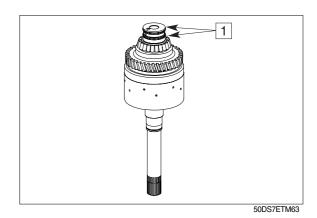
① By means of compressed air(see arrow), press piston(1) off the shaft/disk carrier (see arrow) and remove it.



2 Remove both O-rings(1 and 2).

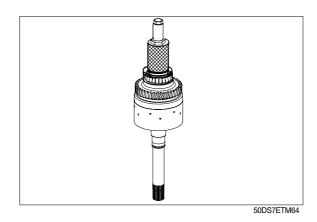


③ Disengage rectangular rings(1).



Pull tapered roller bearing(inner ring) off the shaft.

(S) Grab sleeve 5873 001 026 (S) Basic tool 5873 001 000



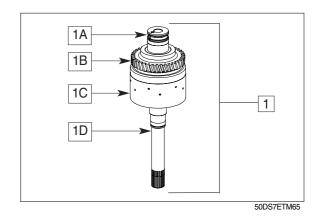
\* The clutch(1) cannot be disassembled. It is supplied by the spare parts service only as a complete assy which consists of:

1A = Ball

1B = Helical gear

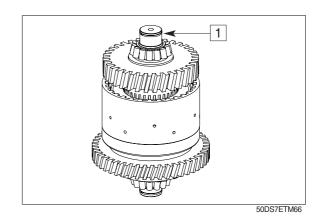
1C = Disk carrier

1D = Input shaft

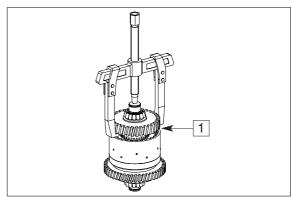


# (2) Clutch KV

① Snap out rectangular ring(1).

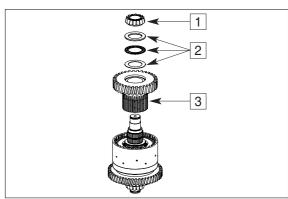


② Pull off bearing inner ring with inner disk carrier(1).



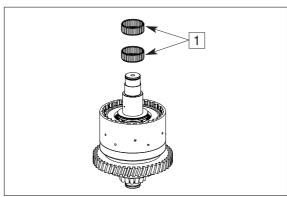
50DS7ETM67

③ Remove bearing inner ring(1), axial bearing assy(2) and inner disk carrier(3).

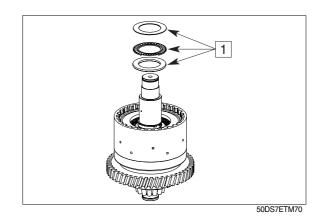


50DS7ETM68

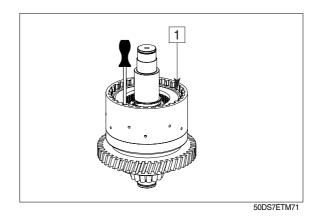
④ Remove needle cage(1).



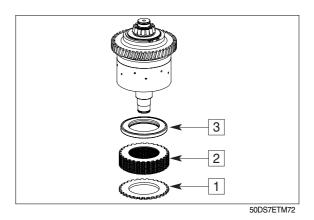
⑤ Remove axial bearing assy(1).



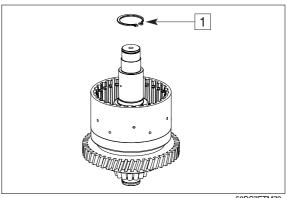
6 Remove snap ring(1).



⑦ Remove end plate(1), disk package(2) and plate(3) from the disk carrier.



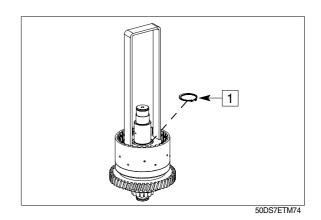
® Remove retaining ring-contact position of axial bearing(1).



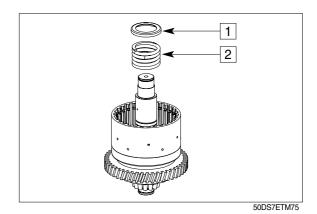
Preload compression spring and remove retaining ring(1).

(S) Assembly aid

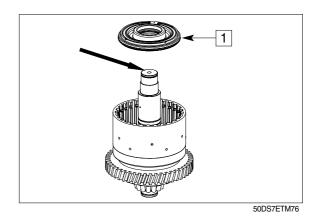
5870 345 114



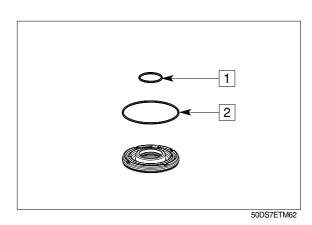
Remove cup spring(1) and compression spring(2).



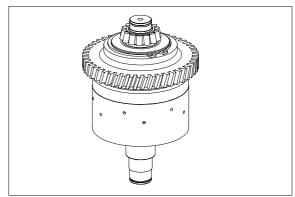
① By means of compressed air(see arrow), press piston(1) off the shaft/disk carrier and remove it.



2 Remove both O-rings(1 and 2).



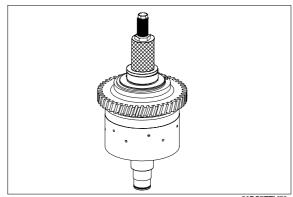
(3) Snap out rectangular ring(1).



50DS7ETM78

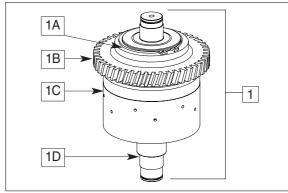
 Pull tapered roller bearing(inner ring) off the shaft.

(S) Grab sleeve 5873 000 029 (S) Basic tool 5873 000 000



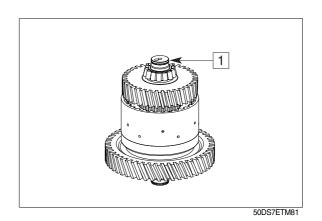
50DS7ETM79

- \* The clutch(1) cannot be disassembled. It is supplied by the spare parts service only as a complete assy which consists of:
  - 1A = Retaining ring
  - 1B = Helical gear
  - 1C = Disk carrier
  - 1D = Shaft



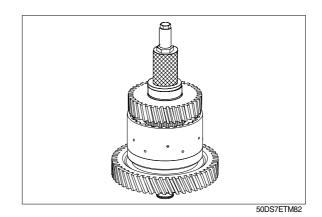
# (3) Clutch KD

① Snap out rectangular ring(1).

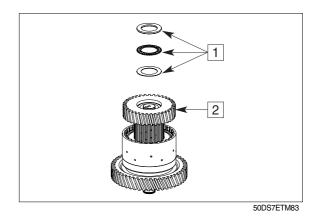


② Pull tapered roller bearing(inner ring) off the shaft.

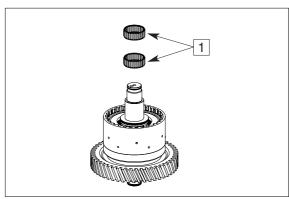
(S) Grab sleeve 5873 000 029 (S) Basic tool 5873 000 000



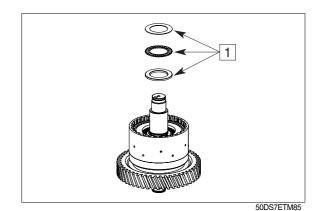
③ Remove axial bearing assy(1) and inner disk carrier.



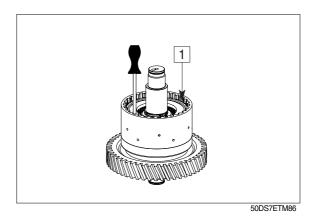
④ Remove needle cage(1).



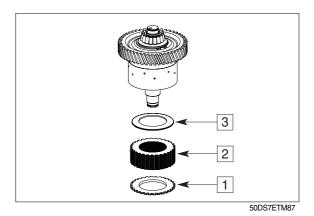
⑤ Remove axial bearing assy(1).



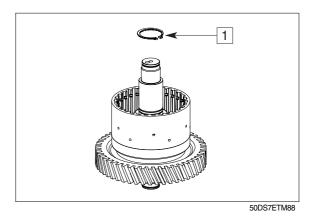
⑥ Remove snap ring(1).



⑦ Remove end plate(1), disk package(2) and cup spring(3) from the disk carrier.



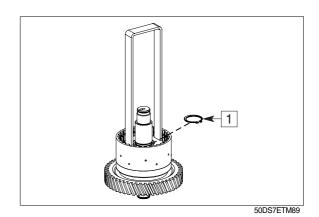
Remove retaining ring-contact position of axial bearing(1).



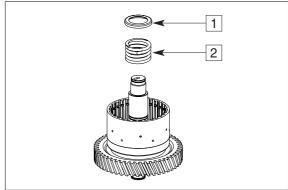
Preload compression spring and remove snap ring(1).

(S) Assembly aid

5870 345 114

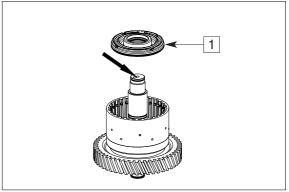


Remove spring cup(1) and compression spring(2).



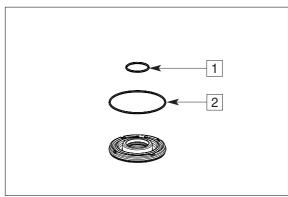
50DS7ETM90

① By means of compressed air(see arrow), press piston(1) off the shaft/disk carrier and remove it.

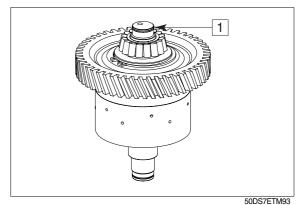


50DS7ETM91

2 Remove both O-rings(1 and 2).

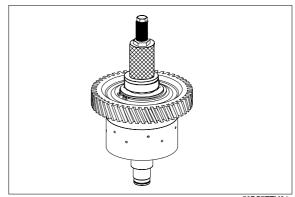


(3) Snap out rectangular ring(1).

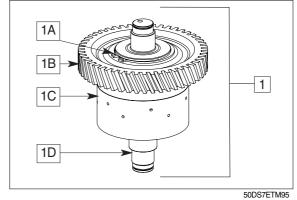


(4) Pull tapered roller bearing(inner ring) off the shaft.

(S) Rapid grip 5873 011 011 (S) Extractor set 5870 026 100

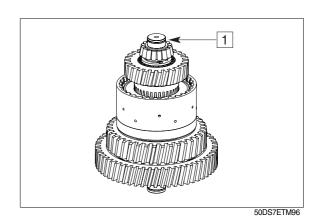


- \* The clutch(1) cannot be disassembled. It is supplied by the spare parts service only as a complete assy which consists of:
  - 1A = Retaining ring
  - 1B = Helical gear
  - 1C = Disk carrier
  - 1D = Shaft



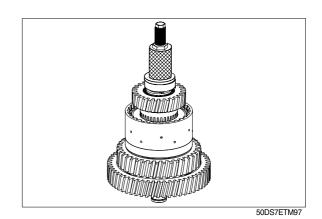
# (4) Clutch KE

① Snap out rectangular ring(1).

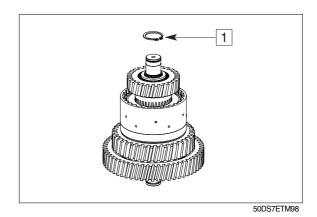


② Pull tapered roller bearing(inner ring) off the shaft.

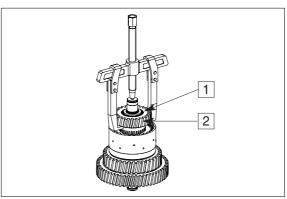
(S) Grab sleeve 5873 000 029 (S) Basic tool 5873 001 000



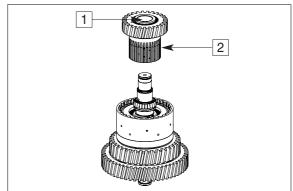
 $\ensuremath{\Im}$  Remove retaining ring(1).



④ Remove bearing inner ring(1) and inner disk carrier(2).

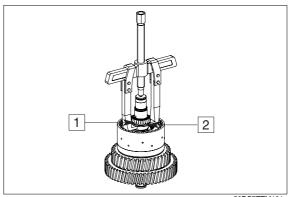


 $\ensuremath{\mbox{\fontfamily{0.05ex}\mbox{\$ inner disk carrier(2).



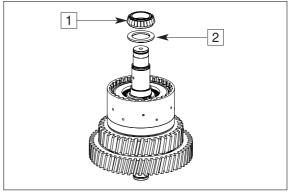
50DS7ETM100

⑥ Pull off bearing inner ring(1) and running disk(2).



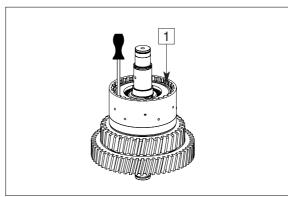
50DS7ETM101

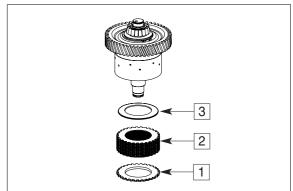
⑦ Remove bearing inner ring(1) and running disk(2).



50DS7ETM102

® Disengage snap ring(1).

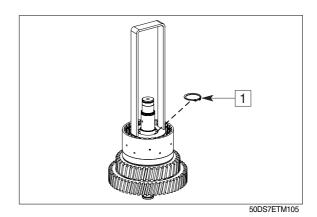




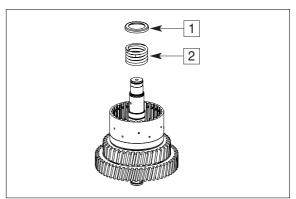
50DS7ETM104

- Preload compression spring and remove snap ring(1).
  - (S) Assembly aid

5870 345 114

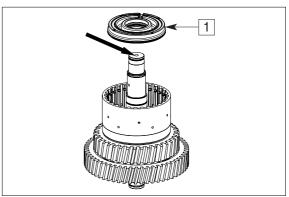


① Remove spring cup(1) and compression spring(2).

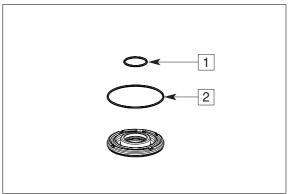


50DS7ETM106

② By means of compressed air(see arrow), press piston(1) off the shaft/disk carrier and remove it.

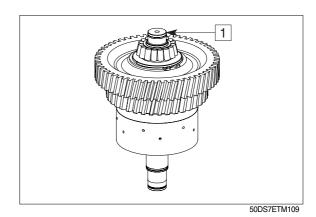


Remove both O-rings(1 and 2).



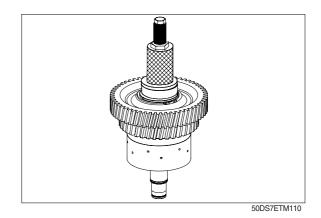
50DS7ETM62

(1) Snap out rectangular ring(1).

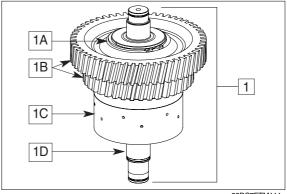


15 Pull tapered roller bearing(inner ring) off the shaft.

(S) Rapid grip 5873 011 011 (S) Basic tool 5873 001 000

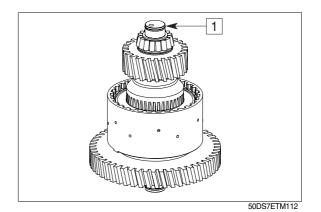


- \* The clutch(1) cannot be disassembled. It is supplied by the spare parts service only as a complete assy which consists of:
  - 1A = Retaining ring
  - 1B = Helical gears
  - 1C = Disk carrier
  - 1D = Shaft

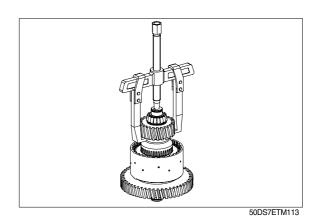


# (5) Clutch KC

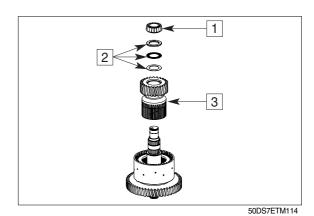
① Snap out rectangular ring(1).



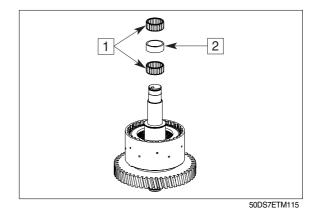
② Pull off bearing inner ring with inner disk carrier(1).



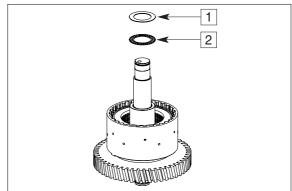
③ Remove bearing inner ring(1), axial bearing assy(2) and inner disk carrier (3).



④ Remove needle cage(1) and bush(2).

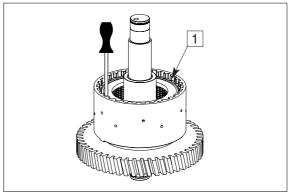


⑤ Remove axial disk(1) and axial needle cage(2).



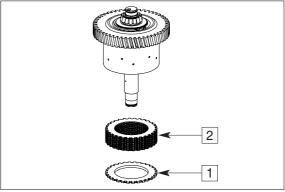
50DS7ETM116

⑥ Disengage snap ring(1).



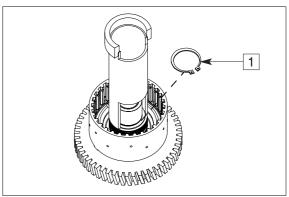
50DS7ETM117

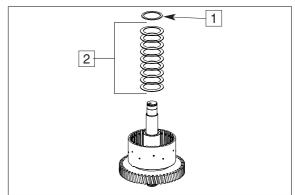
Remove end plate(1) and disk package(2) from the disk carrier.



50DS7ETM118

- Preload compression springs and remove snap ring(1).
  - (S) Assembly aid 5870 506 128

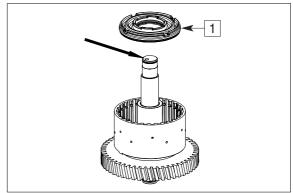




50DS7ETM120

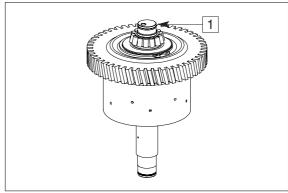
① By means of compressed air(see arrow), press piston(1) off the shaft/disk carrier and remove it.

Remove both O-rings.



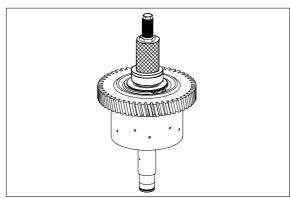
50DS7ETM121

① Snap out rectangular ring(1).

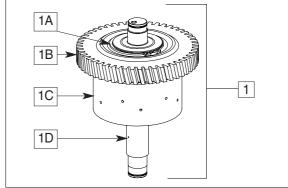


50DS7ETM122

- ② Pull tapered roller bearing(inner ring) off the shaft.
  - (S) Grab sleeve 5873 002 029
  - (S) Basic tool 5873 000 001



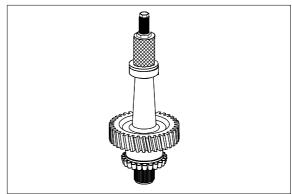
- \*\* The clutch(1) cannot be disassembled. It is supplied by the spare parts service only as a complete assy which consists of:
  - 1A = Retaining ring
  - 1B = Helical gear
  - 1C = Disk carrier
  - 1D = Shaft



# (6) Output shaft

① Pull the bearing inner ring off the output shaft.

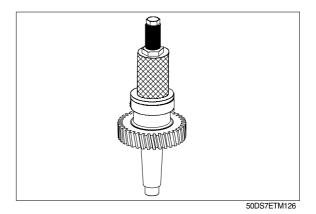
(S) Grab sleeve	5873 000 029
(S) Basic tool	5873 000 001



50DS7ETM125

 $\ensuremath{\text{@}}$  Rotate output shaft 180° and pull off bearing inner ring.

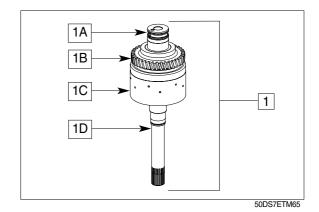
(S) Grab sleeve	5873 002 035
or	
(S) Rapid grip	5873 012 011
(S) Basic tool	5873 002 000



# 2. TRANSMISSION ASSEMBLY 1) REASSEMBLY OF CLUTCHES:

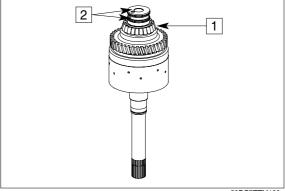
#### (1) Clutch KR/input

- \*\* The clutch(1) is supplied by the spare parts service only as a complete assy which consists of:
  - 1A = Ball
  - 1B = Helical gear
  - 1C = Disk carrier
  - 1D = Input shaft
- ① Heat up bearing inner ring(approx. 120°C).

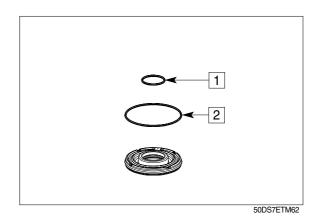


50DS7ETM128

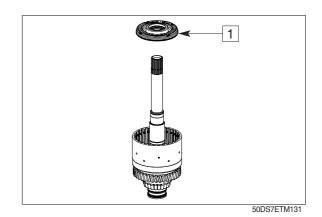
- ② Mount bearing inner ring(1) until contact is obtained.
  - Fit rectangular rings  $50 \times 2.5(2)$ .
- ▲ Wear protective gloves.
- \* Adjust bearing inner ring after cooling-down.



- ③ Insert both O-rings(1 and 2) into the piston grooves and oil them.
  - $1 = 40 \times 3$
  - $2 = 104.5 \times 3$

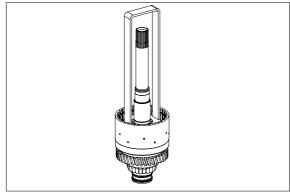


- ④ Insert piston(1) into the disk carrier.
- \* Pay attention to the installation position, see Figure.



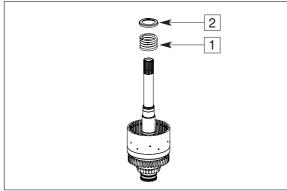
- ⑤ Use a hand-operated press to place piston into the disk carrier by means of the assembly aid.
  - (S) Assembly aid

5870 345 114



50DS7ETM132

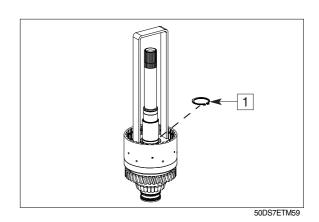
⑥ Mount compression spring(1) and cup spring(2).



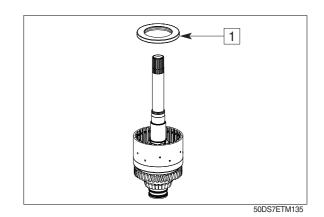
50DS7ETM60

- ② By means of the assembly aid, preload compression spring under a handoperated press until the retaining ring 40 ×1.75(1) can be snapped in.
  - (S) Assembly aid

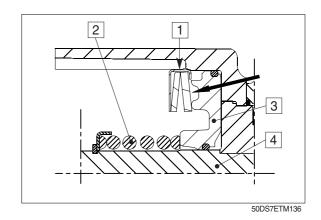
5870 345 114



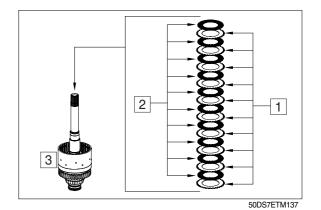
- Mount plate assy with cup springs(1),
   with the open side showing towards the
   piston(see arrow).
- \* Installation position plate-see below figure.



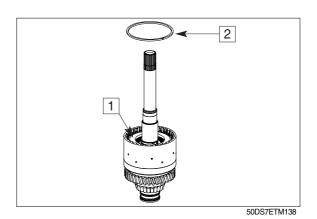
- Fit plate(1) according to sketch(see arrow).
  - 1 = Plate with cup springs
  - 2 = Compression spring with spring cup and retaining ring
  - 3 = Piston with O-rings
  - 4 = Clutch assy



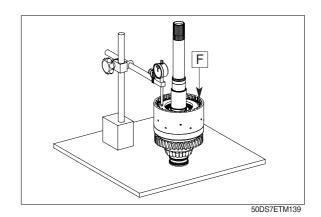
- ① Install outer and inner disks alternately into the disk carrier(3) as shown in figure.
  - Starting with an outer disk and ending with an inner disk.
  - 1 = Outer disks(10 pcs)
  - 2 = Inner disks(10 pcs)
  - 3 = Clutch assy



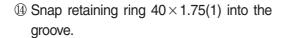
- ① Mount end plate(1) with the flat side showing towards the disk package and fix it by means of snap ring(2)(e.g. thickness=2.5mm/recommended value).
- \* Pay attention to the installation position of the end plate.



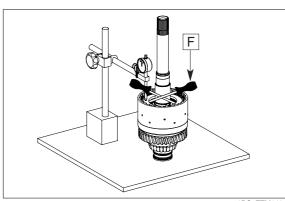
② Equally press on end plate with F (approx. 100N = 10kg) and set dial indicator to "zero".



- (3) Then press end plate against the snap ring(upwards) and read the disk clearance.
- \* Disk clearance: 2.2 to 2.6mm
- \*\* In case of deviations, the disk clearance must be corrected with an appropriate snap ring(optional thickness = 2.0 ...... 3.5mm/available in steps of 0.25mm).



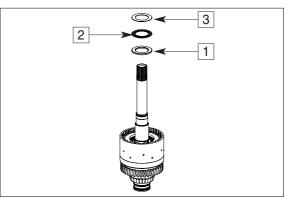
\* Contact for axial bearing - see below figure.





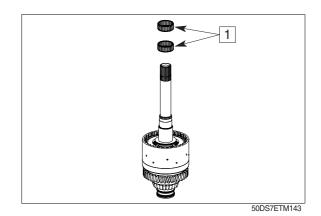
50DS7ETM141

- 5 Mount running disk  $40 \times 60 \times 3.5(1)$ , axial needle cage  $40 \times 60 \times 3(2)$  and axial washer  $40 \times 60 \times 1(3)$  and oil them.
- \*\* Fit running disk(1), with the chamfer showing towards the retaining ring.



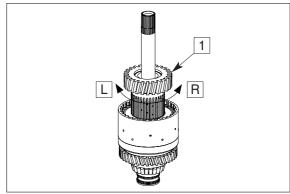
50DS7ETM142

1 Mount needle cage  $40 \times 45 \times 17(1)$  and oil it.



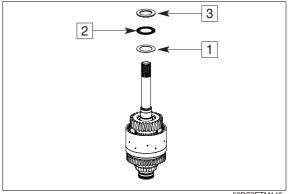
17 Mount inner disk carrier until contact is obtained.

Install inner disks by short ccw/cw rotations of the inner disk carrier(1).



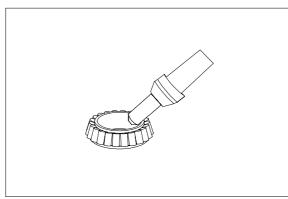
50DS7ETM144

- 8 Mount axial washer  $40 \times 60 \times 1(1)$ , axial needle cage  $40 \times 60 \times 3(2)$  and running disk(3)  $40 \times 60 \times 3.5$  and oil them.
- \* Fit running disk(3), with the chamfer showing towards the tapered roller bearing.



50DS7ETM145

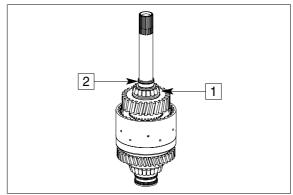
(19) Heat up bearing inner ring(approx. 120°C).



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

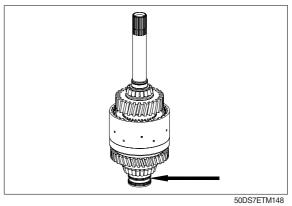
Fit rectangular ring  $30 \times 2(2)$ .

- ▲ Wear protective gloves.
- \* Adjust bearing inner ring after cooling-down.



50DS7ETM147

- \* 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.



30D07E1W1140

#### (2) Clutch KV

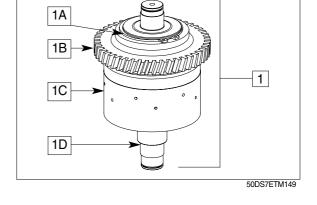
The clutch(1) is supplied by the spare parts service only as a complete assy which consists of :

1A = Retaining ring

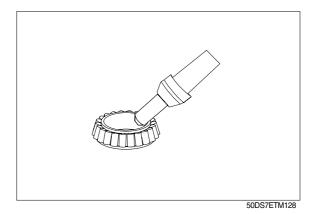
1B = Helical gear

1C = Disk carrier

1D = Shaft



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

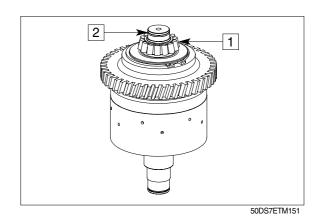


② Mount bearing inner ring(1) until contact is obtained.

Fit rectangular rings  $30 \times 2(2)$ .

▲ Wear protective gloves.

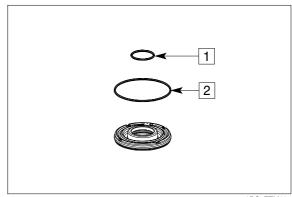
\* Adjust bearing inner ring after cooling-down.



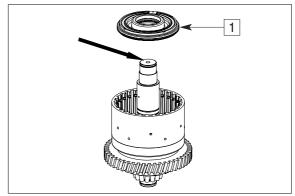
③ Insert both O-rings(1 and 2) into the piston grooves and oil them.

 $1 = 40 \times 3$ 

 $2 = 104.5 \times 3$ 

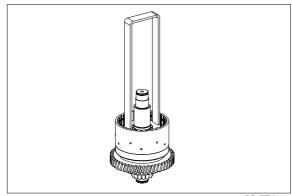


- ④ Insert piston(1) into the disk carrier.
- \* Pay attention to the installation position, see figure.



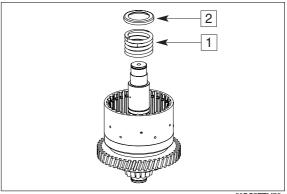
50DS7ETM76

- ⑤ Use a hand-operated press to place piston into the disk carrier by means of the assembly aid.
  - (S) Assembly aid 5870 345 114

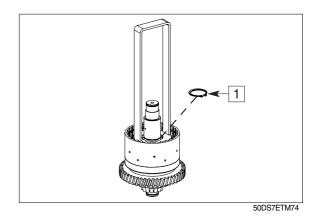


50DS7ETM154

⑥ Mount compression spring(1) and spring cup(2).

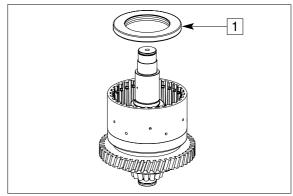


- ② By means of the assembly aid, preload compression spring under a handoperated press until the retaining ring 40 ×1.75(1) can be snapped in.
  - (S) Assembly aid 5870 345 114



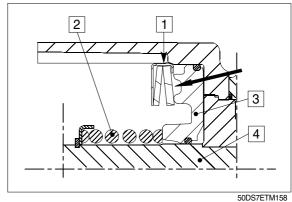
3-98

- Mount plate assy with cup springs(1),
   with the open side showing towards the
   piston(see arrow).
- \* Installation position plate-see below figure.



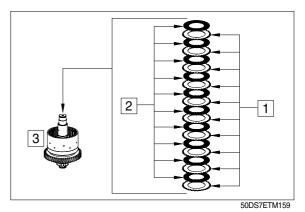
50DS7ETM157

- Fit plate (1) according to sketch(see arrow).
  - 1 = Plate with cup springs
  - 2 = Compression spring with cup spring and retaining ring
  - 3 = Piston with O-rings
  - 4 = Clutch assy

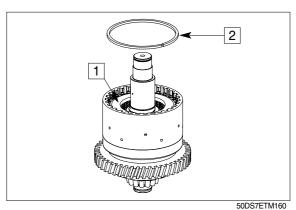


SUDS/ETWIS

- (I) Install outer and inner disks alternately into the disk carrier(3) as shown in figure.
  Starting with an outer disk and ending with an inner disk.
  - 1 = Outer disks(10 pcs)
  - 2 = Inner disks(10 pcs)
  - 3 = Clutch assy

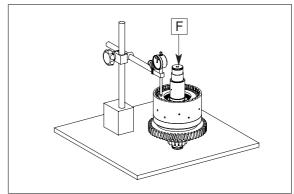


- ① Mount end plate(1) with the flat side showing towards the disk package and fix it by means of snap ring(2)(e.g. thickness=2.5mm/recommended value).
- \* Pay attention to the installation position of the end plate.



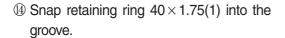
30DO/LTWT0

② Equally press on end plate with F (approx. 100N = 10kg) and set dial indicator to "zero".

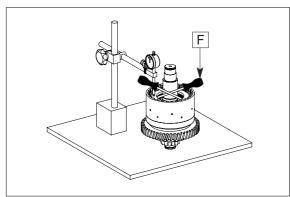


50DS7ETM161

- (3) Then press end plate against the snap ring(upwards) and read the disk clearance.
- \* Disk clearance: 2.2 to 2.6mm
- \*\* In case of deviations, the disk clearance must be corrected with an appropriate snap ring(optional thickness = 2.0~3.5mm/available in steps of 0.25mm).



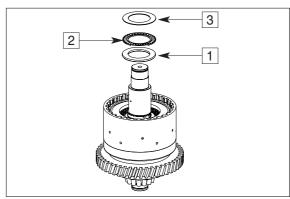
\* Contact for axial bearing-see below figure.



50DS7ETM162

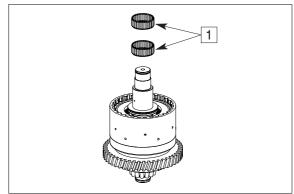
50DS7ETM163

- 5 Mount running disk  $40 \times 60 \times 3.5(1)$ , axial needle cage  $40 \times 60 \times 3(2)$  and axial washer  $40 \times 60 \times 1(3)$  and oil them.
- \*\* Fit running disk(1), with the chamfer showing towards the retaining ring.



50DS7ETM164

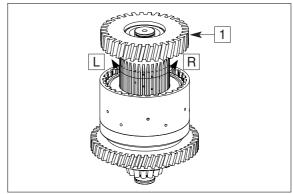
6 Mount needle cage  $40\times45\times17(1)$  and oil it.



50DS7ETM69

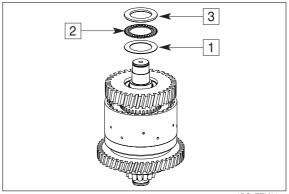
Mount inner disk carrier until contact is obtained.

Install inner disks by short ccw/cw rotations of the inner disk carrier(1).



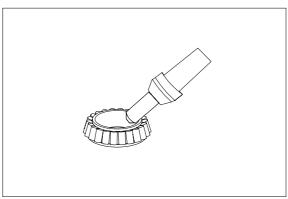
50DS7ETM166

- 8 Mount axial washer  $40 \times 60 \times 1(1)$ , axial needle cage  $40 \times 60 \times 3(2)$  and running disk(3)  $40 \times 60 \times 3.5$  and oil them.
- \*\* Fit running disk(3), with the chamfer showing towards the tapered roller bearing.



50DS7ETM167

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

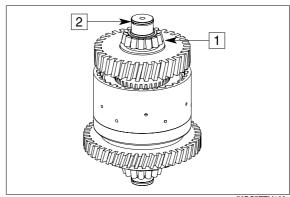


50DS7ETM128

② Mount bearing inner ring(1) until contact is obtained.

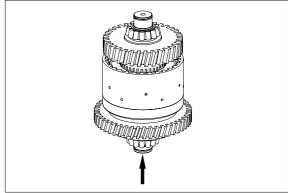
Fit rectangular ring  $30 \times 2(2)$ .

- ▲ Wear protective gloves.
- \* Adjust bearing inner ring after cooling-down.



50DS7ETM169

- \* 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.



#### (3) Clutch KD

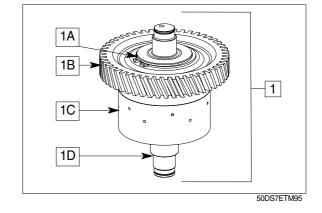
\*\* The clutch(1) is supplied by the spare parts service only as a complete assy which consists of:

1A = Retaining ring

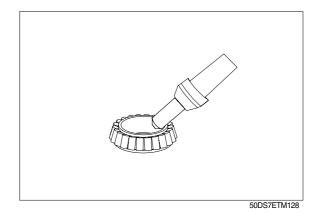
1B = Helical gear

1C = Disk carrier

1D = Shaft



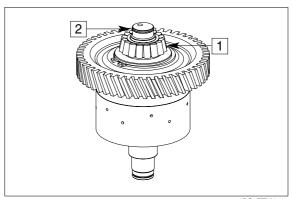
① Heat up bearing inner ring(approx. 120°C).



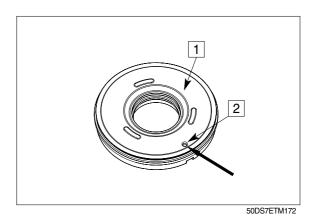
② Mount bearing inner ring(1) until contact is obtained.

Fit rectangular rings  $30 \times 2(2)$ .

- ▲ Wear protective gloves.
- \* Adjust bearing inner ring after cooling-down.

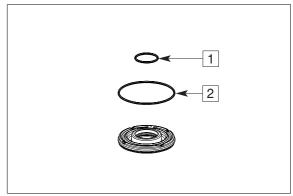


- ③ Piston(1) with drain valve.
- \* Check function of the drain valve (2). There must be no jamming of the ball(see arrow).
- \* The piston(1) is supplied by the spare parts service only as a complete assy.



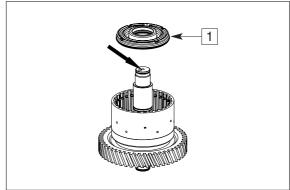
4 Insert both O-rings(1 and 2) into the piston grooves and oil them.

$$1 = 40 \times 3$$
  
 $2 = 104.5 \times 3$ 



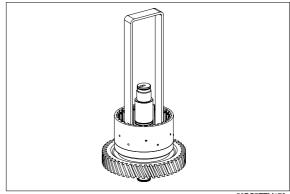
50DS7ETM62

- ⑤ Insert piston(1) into the disk carrier.
- \* Pay attention to the installation position, see figure.



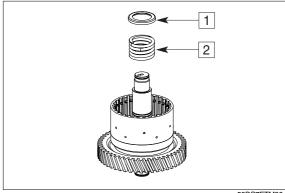
50DS7ETM91

- ⑥ Use a hand-operated press to place piston into the disk carrier by means of the assembly aid.
  - (S) Assembly aid 5870 345 114

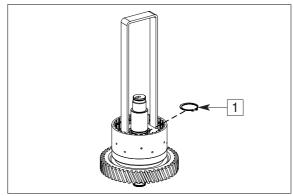


50DS7ETM173

Mount compression spring(1) and spring cup(2).

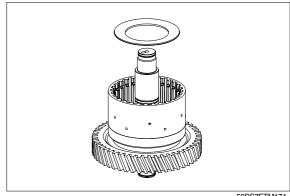


- ® By means of the assembly aid, preload compression spring under a handoperated press until the retaining ring 40  $\times$  1.75(1) can be snapped in.
  - 5870 345 114 (S) Assembly aid



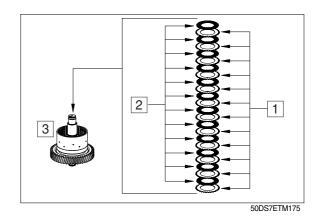
50DS7ETM89

- \* Pay attention to the installation position, see next page TM177.

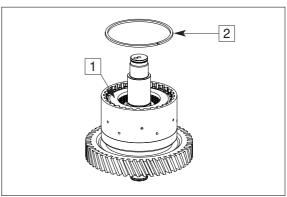


50DS7ETM174

- 10 Install outer and inner disks alternately into the disk carrier(3) as shown in figure. Starting with an outer disk and ending with an inner disk.
  - 1 = Outer disks(12 pcs)
  - 2 = Inner disks(12 pcs)
  - 3 = Clutch assy

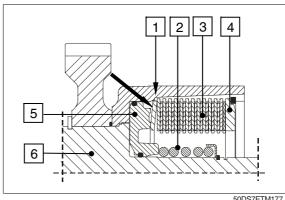


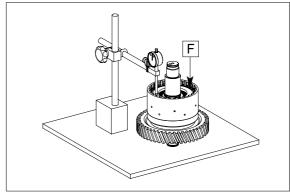
- ① Mount end plate(1) with the flat side showing towards the disk package and fix it by means of snap ring(2) (e.g. thickness = 2.5mm/recommended value).
- \* Pay attention to the installation position of the end plate, see next page TM177.



50DS7ETM176

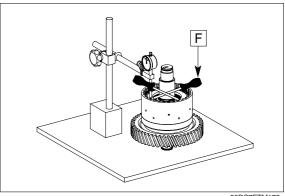
- ② Cap spring(1) according to sketch(see arrow).
  - 1 = Cup spring
  - 2 = Compression spring with spring cup and retaining ring
  - 3 = Inner clutch- and outer clutch disc
  - 4 = End shim
  - 5 = Piston with O-rings
  - 6 = Clutch assy.
- 3 Equally press on end plate with F (approx. 100N = 10kg) and set dial indicator to "zero".



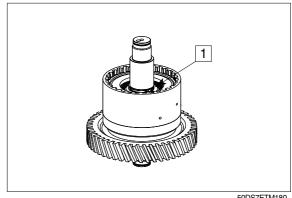


50DS7ETM178

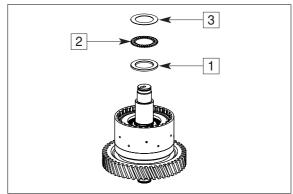
- (4) Then press end plate against the snap ring(upwards) and read the disk clearance.
- \* Disk clearance: 2.6 to 3.1mm.
- \* In case of deviations, the disk clearance must be corrected with an appropriate snap ring(optional thickness = 2.0~3.5mm/available in steps of 0.25mm).
- 5 Snap retaining ring  $40 \times 1.75(1)$  into the groove.
- \* Contact for axial bearing see next page TM181.



50DS7ETM179

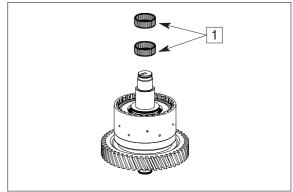


- 6 Mount running disk  $40 \times 60 \times 3.5(1)$ , axial needle cage  $40 \times 60 \times 3(2)$  and axial washer  $40 \times 60 \times 1(3)$  and oil them.
- \* Fit running disk(1), with the chamfer showing towards the retaining ring.



50DS7ETM181

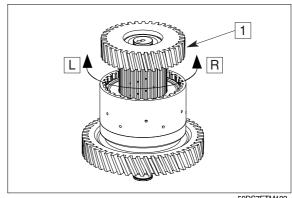
n Mount needle cage  $40 \times 45 \times 17(1)$  and oil it.



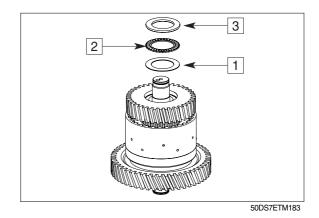
50DS7ETM84

Mount inner disk carrier until contact is obtained.

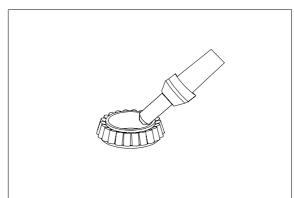
Install inner disks by short ccw/cw rotations of the inner disk carrier(1).



- 9 Mount axial washer  $40 \times 60 \times 1(1)$ , axial needle cage  $40 \times 60 \times 3(2)$  and running disk(3)  $40 \times 60 \times 3.5$  and oil them.
- \* Fit running disk(3), with the chamfer showing towards the tapered roller bearing.



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

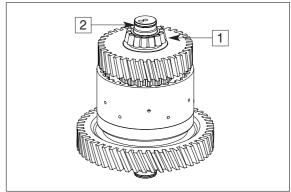


50DS7ETM128

② Mount bearing inner ring(1) until contact is obtained.

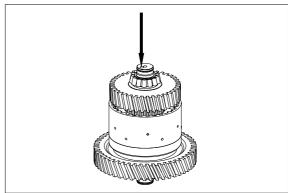
Fit rectangular ring  $30 \times 2(2)$ .

- ▲ Wear protective gloves.
- \* Adjust bearing inner ring after cooling-down.



50DS7ETM184

- \* 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.



#### (4) Clutch KE

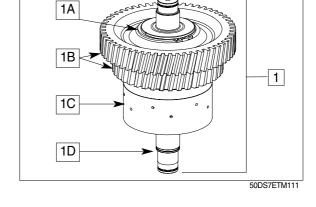
\* The clutch(1) is supplied by the spare parts service only as a complete assy which consists of:

1A = Retaining ring

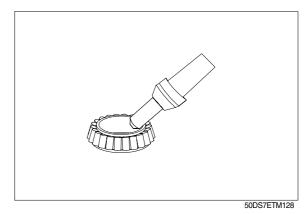
1B = Helical gear

1C = Disk carrier

1D = Shaft



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

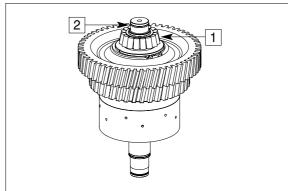


② Mount bearing inner ring(1) until contact is obtained.

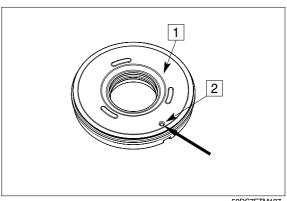
Fit rectangular ring  $30 \times 2(2)$ .

#### ▲ Wear protective gloves.

\* Adjust bearing inner ring after cooling-down.

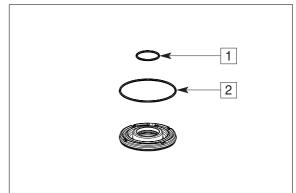


- ③ Piston(1) with drain valve.
- \* Check function of the drain valve(2). There must be no jamming of the ball(see arrow).
- \* The piston(1) is supplied by the spare parts service only as a complete assy.

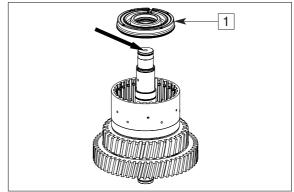


4 Insert both O-rings(1 and 2) into the piston grooves and oil them.

 $1 = 40 \times 3$  $2 = 104.5 \times 3$ 

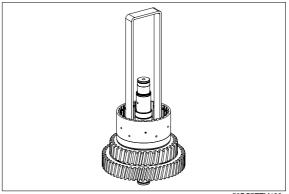


50DS7ETM62



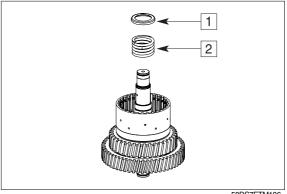
50DS7ETM107

- ⑤ Use a hand-operated press to place piston into the disk carrier by means of the assembly aid.
  - (S) Assembly aid 5870 345 114

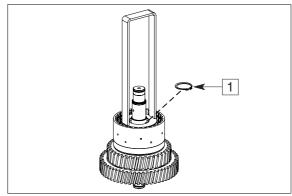


50DS7ETM188

⑥ Mount compression spring(1) and spring cup(2).

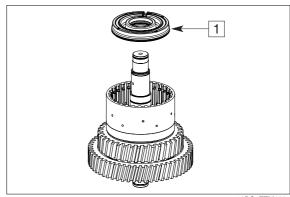


- ② By means of the assembly aid, preload compression spring under a handoperated press until the retaining ring 40 ×1.75(1) can be snapped in.
  - (S) Assembly aid 5870 345 114



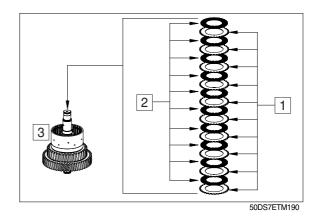
50DS7ETM105

- \* Pay attention to the installation position, see next page TM192.

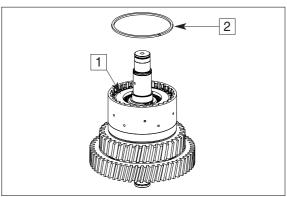


50DS7ETM189

- Install outer and inner disks alternately into the disk carrier(3) as shown in figure.
  - Starting with an outer disk and ending with an inner disk.
  - 1 = Outer disks(10 pcs)
  - 2 = Inner disks(10 pcs)
  - 3 = Clutch assy

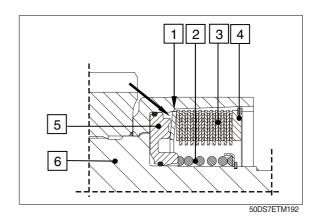


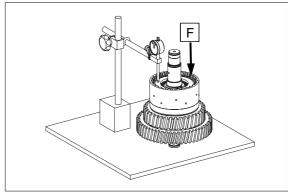
- Mount end plate(1) with the flat side showing towards the disk package and fix it by means of snap ring(2) (e.g. thickness=2.5mm/recommended value).
- \*\* Pay attention to the installation position of the end plate, see next page TM192.



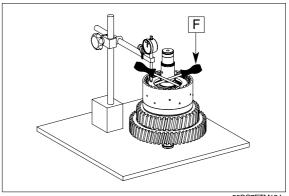
50DS7ETM191

- ① Cap spring(1) according to sketch(see arrow).
  - 1 = Cup spring
  - 2 = Compression spring with spring cup and retaining ring
  - 3 = Inner clutch-and outer clutch disc
  - 4 = End shim
  - 5 = Piston with O-rings
  - 6 = Clutch assy
- 12 Equally press on end plate with F (approx. 100 N = 10kg) and set dial indicator to "zero".

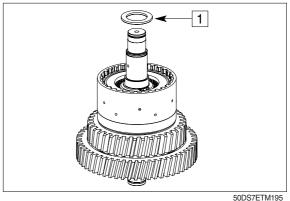




- (3) Then press end plate against the snap ring(upwards) and read the disk clearance.
- \* Disk clearance: 2.2 to 2.6mm.
- \* In case of deviations, the disk clearance must be corrected with an appropriate snap ring(optional thickness=2.0~3.5mm/available in steps of 0.25mm).
- 4 Mount running disk  $35 \times 52 \times 3.5(1)$ .
- \* Fit running disk(1), with the chamfer showing towards the retaining ring.

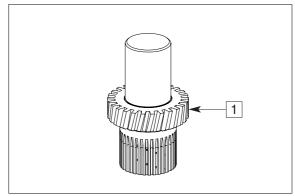


50DS7ETM194



(5) Press in both bearing outer rings into the inner disk carrier(1) until contact is obtained.

Then mount the bearing inner rings.

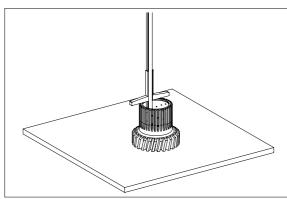


50DS7ETM196

- \*\* Setting of axial play of the inner disk carrier bearing  $\pm$  0.05mm(see TM197 to TM202) :
- ⑤ Determine dimension "X2" of the inner disk carrier → see below figure.

Calculation (	example	:
---------------	---------	---

Dimension A	97.00mm
Dimension B	- 57.00mm
Dimension X2	= 40.00mm



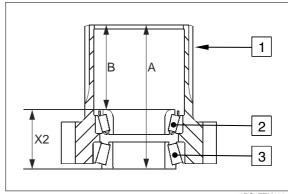
50DS7ETM197

#### ① Legend:

1 = Inner disk carrier

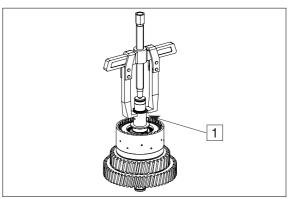
 $2 = \text{Tapered roller bearing } 59 \times 35 \times 16$ 

 $3 = \text{Tapered roller bearing } 62 \times 35 \times 18$ 



50DS7ETM198

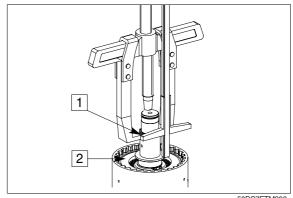
Mount the retaining ring e.g. 35×2.0(1) and bring it into contact position by means of a two-armed puller.



### Determine dimension "X1" from retaining ring(1) to running disk(2).

→ see below figure.

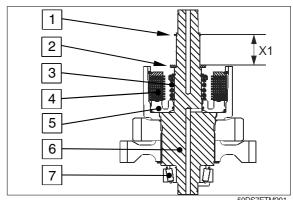
Dimension X1 = 42.1mm



#### 50DS7ETM200

#### 20 Legend:

- $1 = \text{Retaining ring } 35 \times 2.0$
- $2 = Running disk 35 \times 52 \times 3.5$
- 3 = Compression spring with cup spring and retaining ring
- 4 = Disk package with end plate and snap ring
- 5 = Piston with O-rings
- 6 = Clutch assy
- 7 = Tapered roller bearing



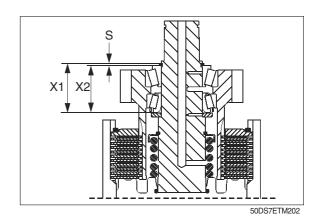
50DS7ETM201

#### ② Axial play of inner disk carrier bearing $\pm 0.05$

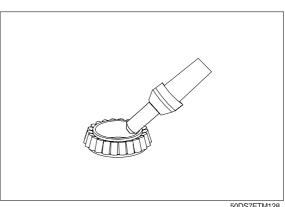
Calculation example:

Dimension X1 -----42.10mm Dimension X2 ------ 40.00mm Dimension S(retaining ring) ---= 2.10 mm

- \* Determined retaining ring S = 2.10mm
- \* Axial play must be set with the retaining ring(optional thickness = 1.8~2.7mm/ available in steps of 0.10mm).

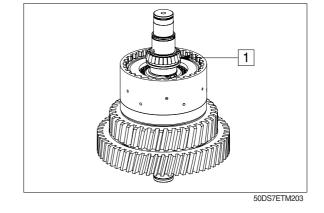


22 Heat up bearing inner ring(approx. 120°C).

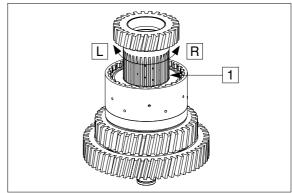


50DS7ETM128

- 23 Mount bearing inner ring(1) until contact is obtained.
- » Different bearing sizes → see page 3-124 TM198.
- ▲ Wear protective gloves.
- \* Adjust bearing inner ring after cooling-down.

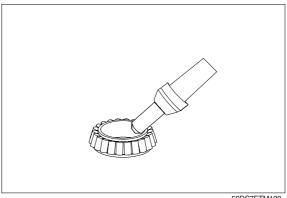


- 2 Mount inner disk carrier until contact is obtained.
  - Install inner disks by short ccw/cw rotations of the inner disk carrier(1).



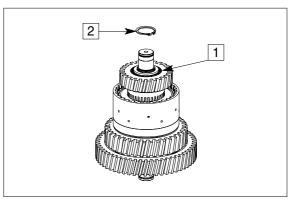
50DS7ETM204

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



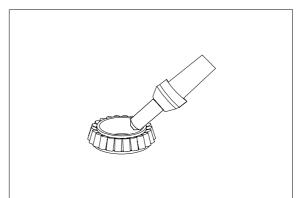
50DS7ETM128

- 3 Mount bearing inner ring(1) until contact is obtained.
- ▲ Wear protective gloves.
- \* Adjust bearing inner ring after cooling-down.
  - Snap in retaining ring  $35 \times 2.1(2)$ .
- \* Pay attention to an exact contact of the retaining ring in the groove.



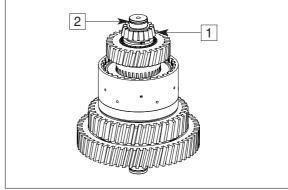
50DS7ETM205

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



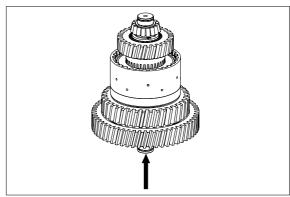
50DS7ETM128

- Mount bearing inner ring(1) until contact is obtained.
  Fit rectangular ring 30 × 2(2).
- ▲ Wear protective gloves.
- \* Adjust bearing inner ring after cooling-down.



50DS7ETM206

- \* 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.



#### (5) Clutch KC

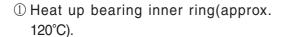
\*\* The clutch(1) cannot be disassembled.
It is supplied by the spare parts service only as a complete assy which consists of:

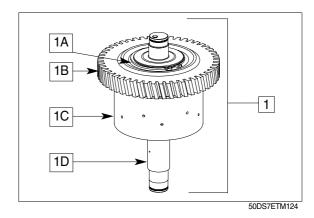
1A = Retaining ring

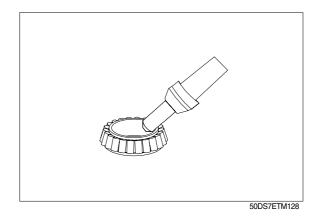
1B = Helical gear

1C = Disk carrier

1D = Shaft





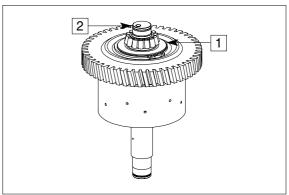


② Mount bearing inner ring(1) until contact is obtained.

Fit rectangular rings  $30 \times 2(2)$ .

▲ Wear protective gloves.

\* Adjust bearing inner ring after cooling-down.



50DS7ETM208

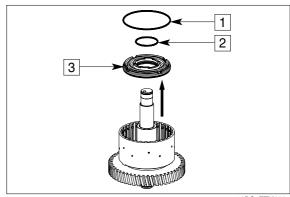
③ Insert both O-rings(1 and 2) into the piston(3) grooves and oil them.

 $1 = 115 \times 3$ 

 $2 = 52 \times 3$ 

Insert piston(3) into the disk carrier.

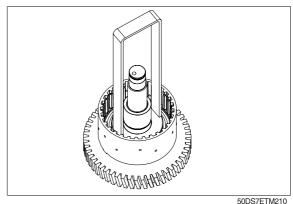
- \* Pay attention to the installation position, see next page TM211.
- \*\* Check function of the drain valve (see arrow) - There must be no jamming of the ball.



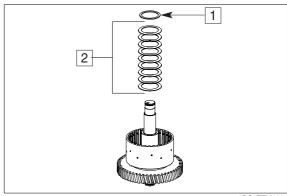
50DS7ETM209

- 4 Use a hand-operated press to place piston into the disk carrier by means of the assembly aid.
  - (S) Assembly aid

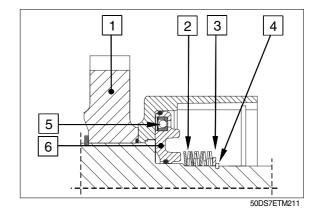
5870 345 114



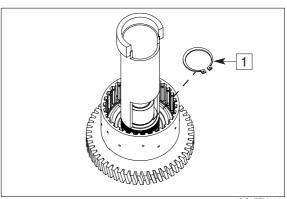
- ⑤ Mount cup spring package(1) and disk
- \* Installation position of the cup springs, see below figure.



- 6 Install cup springs according to the sketch.
  - 1 = Clutch
  - 2 = Cup springs(9 pcs)
  - 3 = Disk
  - $4 = \text{Retaining ring}(50 \times 2)$
  - 5 = Drain valve(piston)
  - 6 = Piston with O-Rings



- By means of the assembly aid, preload cup springs under a handoperated press until the retaining ring  $50 \times 2(1)$  can be snapped in.
  - (S) Assembly aid 5870 506 128

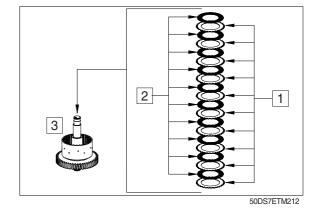


50DS7ETM119

® Install outer and inner disks alternately into the disk carrier(3) as shown in figure.

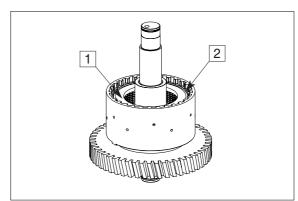
Starting with an outer disk and ending with an inner disk.

- 1 = Outer disks(10 pcs)
- 2 = Inner disks(10 pcs)
- 3 = Clutch assy



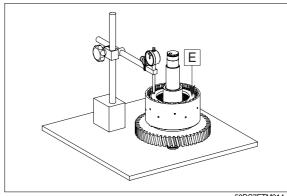
9 Mount end plate(1) with the flat side showing towards the disk package and fix it by means of snap ring(2)(e.g. thickness=2.5mm/recommended value).

\* Pay attention to the installation position of the end plate.

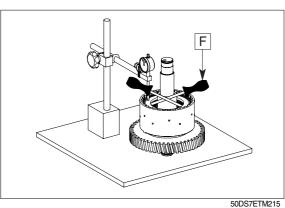


50DS7ETM213

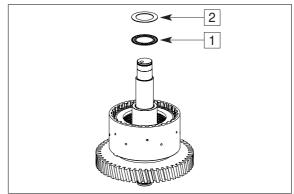
10 Equally press on end plate with F (approx. 18 N to 20 N = 1.8 to 2.0kg) and set dial indicator to "zero".



- ① Then press end plate against the snap ring(upwards) and read the disk clearance.
- \* Disk clearance: 2.0 to 3.0mm.
- \* In case of deviations, the disk clearance must be corrected with an appropriate snap ring(optional thickness  $s=2.0\sim4.0$ mm/available in steps 0.25mm).

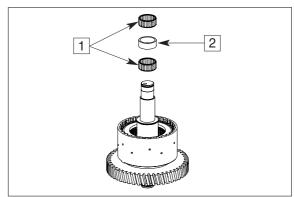


1 Mount axial needle cage  $35 \times 52 \times 2$  (1) and axial disk  $35 \times 52 \times 1(1)$  and oil them.



50DS7ETM116

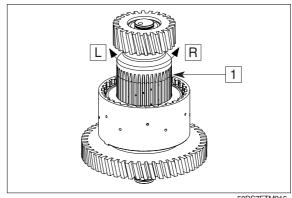
bush(2) and oil it.



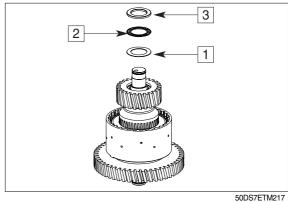
50DS7ETM115

(4) Mount inner disk carrier until contact is obtained.

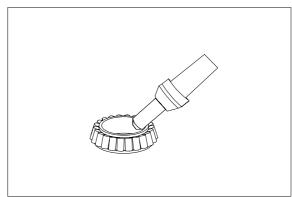
Install inner disks by short ccw/cw rotations of the inner disk carrier(1).



- 5 Mount axial washer  $35 \times 60 \times 1(1)$ , axial needle cage  $40 \times 60 \times 3(2)$  and running disk(3)  $40 \times 60 \times 3.5$  and oil them.
- \* Fit running disk(3), with the chamfer showing towards the tapered roller bearing.



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

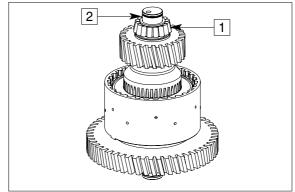


50DS7ETM128

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

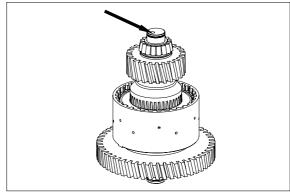
Fit rectangular ring  $30 \times 2(2)$ .

- ▲ Wear protective gloves.
- \* Adjust bearing inner ring after cooling-down.



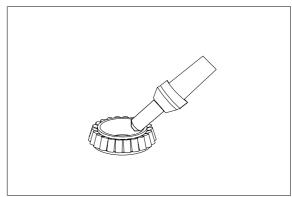
50DS7ETM218

- \* 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.



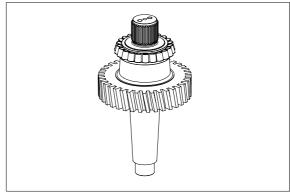
#### (6) Output

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



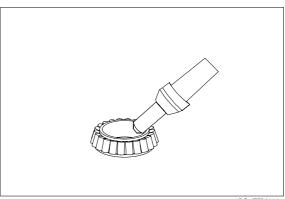
50DS7ETM128

- ② Mount bearing inner ring(1) until contact is obtained.
- ▲ Wear protective gloves.
- \* Adjust bearing inner ring after cooling-down.



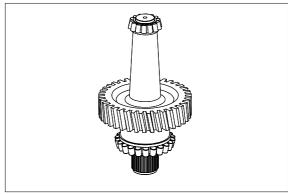
50DS7ETM220

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



50DS7ETM128

- ④ Mount bearing inner ring(1) until contact is obtained.
- ▲ Wear protective gloves.
- \* Adjust bearing inner ring after cooling-down.

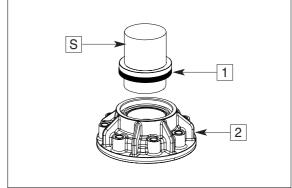


### 2) RESSEMBLY OF OIL PRESSURE PUMP AND REINSTALLATION OF CLUTCHES

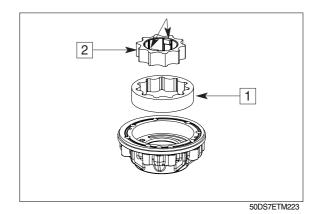
#### (1) Reassembly of oil pressure pump

- \*\* In case of wear marks in the pump housing, stator hollow shaft, inner rotor, outer rotor and on the sliding bearing, the pump assy must be replaced.
  - 1 = Stator hollow shaft
  - 2 = Inner rotor
  - 3 = Outer rotor
  - 4 = Pump housing with sliding bearing
- 2 3 4 50DS7ETM48
- ① With the sealing lip showing downwards, carefully insert the shaft seal 55×75×8 (1) into the pump housing(2) until contact is obtained.
- \* Apply sealing agent(Loctite no. 574) to the outer diameter.
  - (S) Driver tool

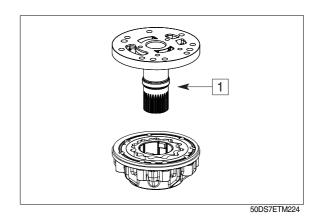
5870 048 219



- ② Mount outer rotor(1) and inner rotor(2).
- \*\* The driver pins of the inner rotor (see arrows) are to be fitted in upward direction.

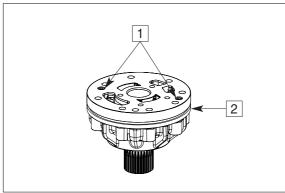


③ Fit stator hollow shaft(1).



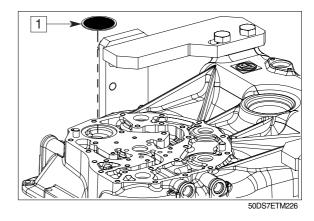
- 4 Fix stator hollow shaft radially with two cylindrical screws(1).
- \* Do not tighten the cylindrical screws just turn them in until contact is obtained and then turn them back by approx. ½ rotation.

Place O-ring(2)  $135 \times 3$  into the annular groove and grease it.

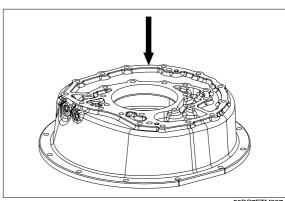


50DS7ETM225

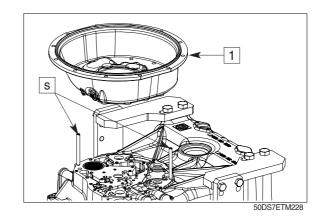
⑤ Insert filter(1).



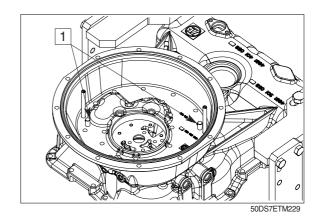
6 Wet mounting face bell housing with Loctite(type no. 574).



- Tit two adjusting screws(S) and position converter bellhousing(1) equally until contact is obtained.
- \* Pay attention to the hole pattern.
  - (S) Adjusting screws(M10) 5870 204 007

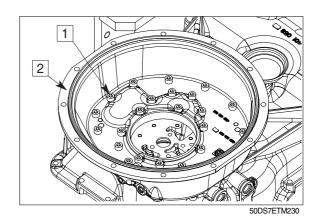


Solution Force the cylindrical pins 12×24(1) into the holes(blind holes) until contact is obtained.

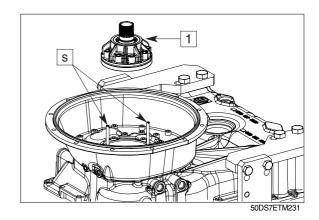


 $\$ 9 Fix converter bell housing(1) with cylindrical screws M10 $\times$ 30(2).

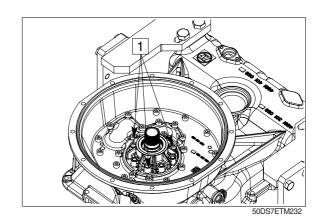
Tightening torque(M10/8.8  $\times$  30) ......  $M_A$  = 46Nm



- ① Fit two adjusting screws(S) and mount preassembled pump(1).
- \* Pay attention to the hole pattern.
  - (S) Adjusting screws(M8) 5870 204 011

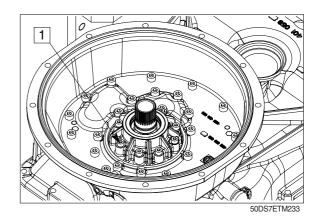


- ① Position transmission pump with 3 cylindrical screws(1) M8×60(3×120° offset position) equally until contact is obtained.
- \* Do not damage(shear off) the O-ring.



2 Fix transmission pump with cylindrical screws M8  $\times$  60(1).

Tightening torque (M8/8.8  $\times$  60) ·····  $M_A = 23Nm$ 



(3) Fix pump with cylindrical screws(1 and 2).

 $1 = M8 \times 16$ 

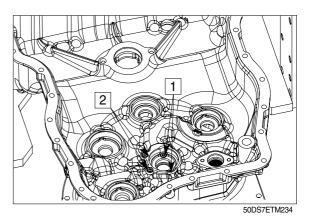
 $2 = M8 \times 35$ 

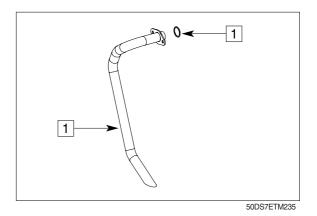
Tightening torque M8/8.8  $\times$  16 -----  $M_A$  = 23Nm Tightening torque M8/8.8  $\times$  35 -----  $M_A$  = 23Nm

- \* New cylindrical screws are to be fitted on a general basis.
- \*\* These cylindrical screws are already provided with adhesive (microcapsule).

The microcapsule bursts when the screw is turned in, wets screw and nut thread and hardens.

Mount O-ring  $30 \times 3(1)$  onto the suction tube(2) and grease it.

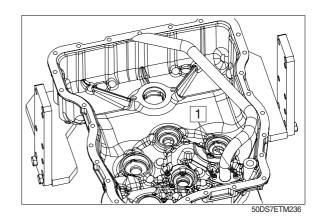




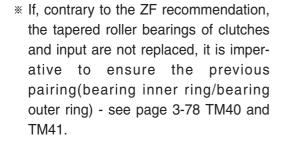
4 Fix suction tube(1) with cylindrical screws  $M8 \times 16(2)$ .

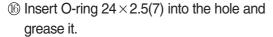
Tightening torque M8/8.8  $\times$  16 -----  $M_A = 23Nm$ 

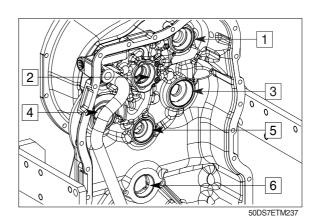
- When reusing the cylindrical screws, they must be secured with Loctite no. 243.
- \*\* New cylindrical screws are already provided with adhesive (microcapsule). The microcapsule bursts when the screw is turned in, wets screw and nut thread and hardens.



- (5) Insert all bearing outer rings into the bearing holes of both housing parts(see figure TM236 and TM237).
  - 1 = KV clutch forward
  - 2 = KR clutch reverse and input
  - 3 = KD clutch 2nd gear
  - 4 = KC clutch 1st gear
  - 5 = KE clutch 3rd gear
  - 6 = Output
- \* Place bearing outer rings into the bearing holes using assembly grease.



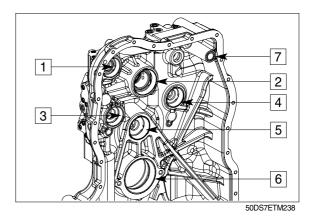


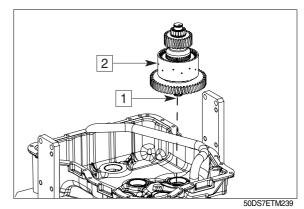


#### (2) Reinstallation of clutches

① Align and grease rectangular ring  $30 \times 2$  (1).

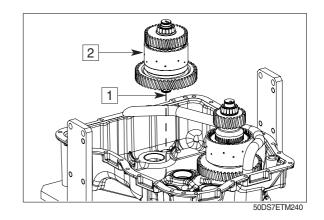
Position clutch KC(2).





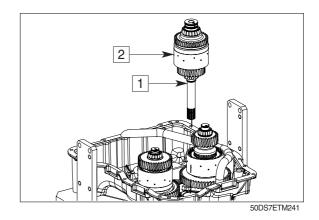
② Align and grease rectangular ring  $30 \times 2$  (1).

Position clutch KD(2).



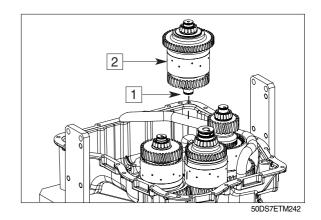
 $\ \, \mbox{3}$  Align and grease rectangular rings 50  $\times$  2.5(1).

Position clutch KR- input(2).

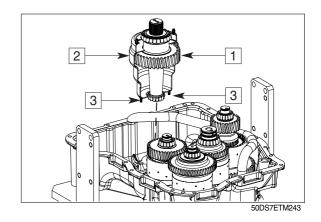


4 Align and grease rectangular ring  $30 \times 2$  (1).

Position clutch KV(2).

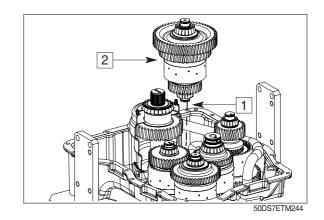


- ⑤ Position output shaft(1) together with screen sheet(2).
- \*\* Bolts(3) of screen sheet must be fixed into the pilot holes.

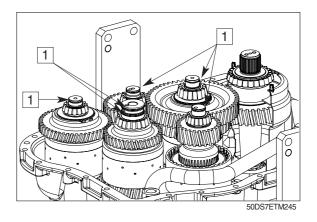


 $\ensuremath{\textcircled{6}}$  Align and grease rectangular ring 30  $\times$  2 (1).

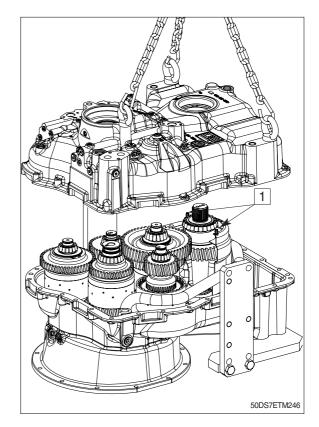
Position clutch KE(2).



⑦ Align and grease rectangular rings(1).



- ® Use the lifting device to carefully bring the transmission housing rear part into contact position.
- \*\* Bolts(1) of screen sheet must be fixed into the pilot holes.
- Wet mounting face with Loctite (type no. 574).



Hand-tighten the transmission housings crosswise with 2 cylindrical screws(1).

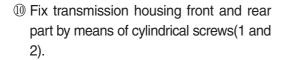
Fit cylindrical pins  $12 \times 24(2)$  centrically to the mounting face.

Tighten the transmission housing front and rear part crosswise with 4 cylindrical screws M10(1).

Tightening torque -----  $M_A = 46Nm$ 

▲ Transmission rear part is not fixed to the holding fixture and could get loose after turning.

Secure the connection with cylindrical screws.

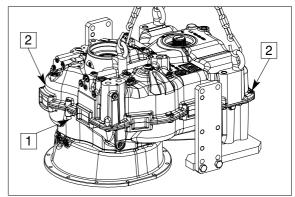


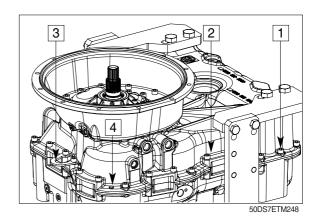
Fit bracket(3).

Cylindrical screws(1)  $M10 \times 30(11EA)$ Cylindrical screws(1)  $M10 \times 50(17EA)$ 

Tightening torque(M10/8.8  $\times$  30)  $\cdots$   $M_A = 46$ Nm Tightening torque(M10/8.8  $\times$  50)  $\cdots$   $M_A = 46$ Nm

 $4 = \text{cylindrical pin } 12 \times 24$ 





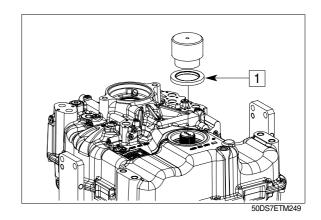
#### 3) REASSEMBLY OF OUTPUT FLANGE

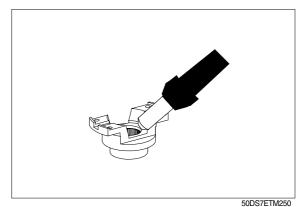
- ① Use driver tool to fit the shaft seal  $70 \times 100 \times 10(1)$  until contact position, with the sealing lip showing towards the oil sump.
  - (S) Driver tool

5870 048 057

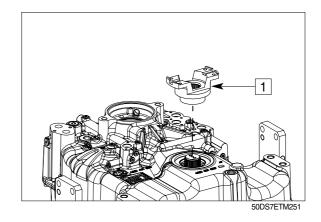
- \* Fill space between sealing lip and dust lip with grease.
- \* Wet outer diameter with spirit.



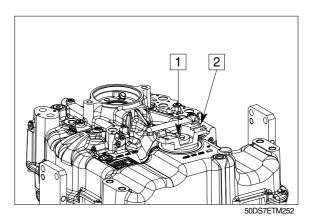




- ③ Mount output flange(1) until contact is obtained.
- ▲ Wear protective gloves.
- \* Adjust output flange after cooling down.



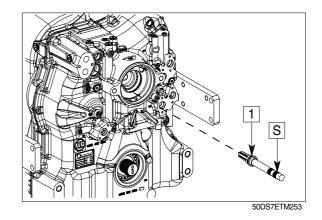
- ④ Insert O-ring 38 × 4 into the space between output flange and shaft.
  - Fix output flange by means of washer(1) and hexagon screws  $10 \times 25(2)$ .
  - Tightening torque(M8/10.9  $\times$  25) ·····  $M_A = 34Nm$



# 4) REASSEMBLY OF CONVERTER SAFETY VALVE AND MAIN PRESSURE VALVE

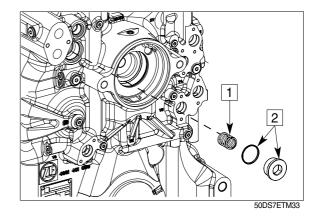
#### (1) Reassembly of converter safety valve

- ① Insert valve(1) with drift(S) into the housing until contact is obtained.
  - (S) Drift 5870 705 012



② Place compression spring(1) into the transmission hole and fit screw plug M38  $\times$  1.5(2) with O-ring 35 $\times$ 2(3).

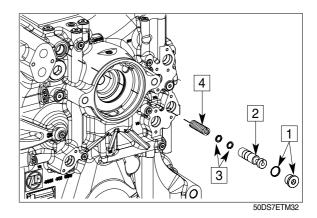
Tightening torque  $\cdots M_A = 46Nm$ 



## (2) Reassembly of main pressure valve (control pressure valve)

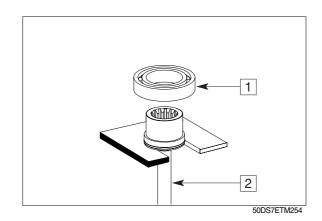
- ① Main pressure valve consists of :
  - 1 = Screw plug M22  $\times$  1.5 with O-ring  $19 \times 2$
  - 2 = Piston
  - 3 = Spacer ring(2 pcs)
    Recommended value 5mm
  - 4 = Compression spring
- The main pressure 16+3 bar is determined by means of the spacer rings.
   Gradation of available spacer rings see parts manual.

Tightening torque  $\cdots M_A = 60 \text{Nm}$ 

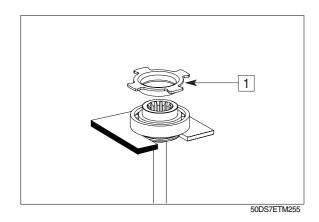


## 5) REASSEMBLY OF CENTRAL SHAFT (PTO) AND CONVERTER

① Press tapered bearing(1) onto the central shaft(2) until contact is obtained.



② Press the toothed disk(1) onto the pump shaft until contact is obtained.

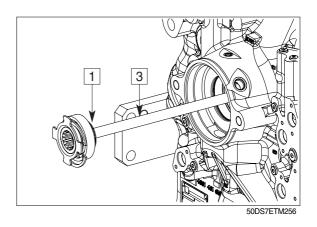


③ Mount rectangular ring  $50 \times 2.5(1)$ .

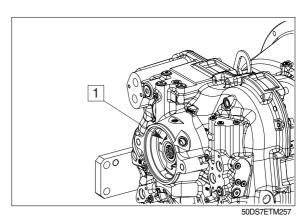
Grease and centrically align rectangular ring.

Mount retaining ring  $75 \times 2.5(2)$ .

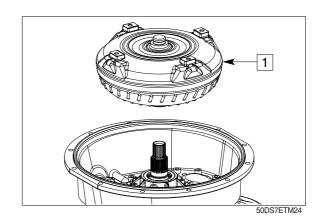
Mount central shaft(3) until contact is obtained.



4 Fix central shaft with retaining ring 75  $\times$  2.5(1).



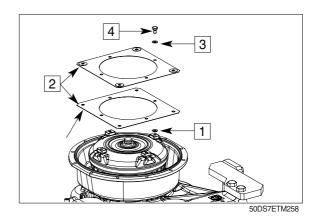
⑤ Mount converter(1) until contact is obtained.

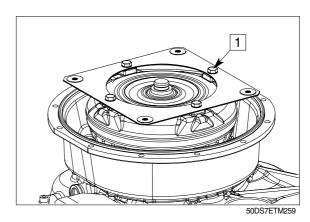


⑥ Position 1 washer/each/thickness= 1.0mm (4EA) (1) onto the flexplate mounting webs(4EA).

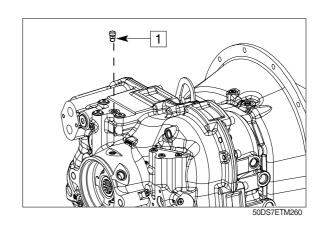
Place flexplates(2).

- \*\* Pay attention to the installation position. Spot-welded reinforcing disks of the flexplate to be arranged towards the outside-see arrows.
  - Mount washer(3) to the hexagon screw  $M10 \times 16(4)$  and fix the flexplates.
- ⑦ Tighten hexagon screws M10 × 16(1). Tightening torque(M10/8.8 × 16) · · · · ·  $M_A$  = 46Nm
- \* When reusing the hexagon screws they must be secured with Loctite 243.
- \*\* New hexagon screws are already provided with adhesive (microcapsule). The microcapsule bursts when the screw is turned in, wets screw and nut thread and hardens.
- ▲ Fix converter axially. Risk of injury.





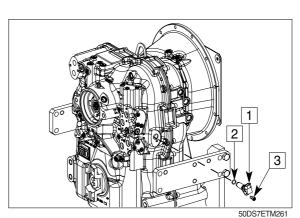
- 6) REASSEMBLY OF PRESSURE CONTROLLER (PROPORTIONAL VALVES), INDUCTIVE SENSOR, SPEED SENSOR(HALL SENSOR), TEMPERATURE SENSOR, BREATHER AND SCREW PLUGS
  - ① Mount breather (1).



② Mount output Hall sensor-(1) onto the speed sensor, install Oring  $15.5 \times 2.6(2)$  and fix it with cylindrical screws  $M8 \times 16$  (3).

Tightening torque(M8/8.8x16)  $\cdots$   $M_A = 23Nm$ 

- \* When reusing the cylindrical screw, it must be secured with Loctite no. 243.
- \*\* New cylindrical screw is already provided with adhesive(microcapsule). The microcapsule bursts when the screw is turned in, wets screw and nut thread and hardens.



#### ③ Fit positioned parts.

1 = Inductive sensor with O-ring  $15 \times 2$ - n turbine

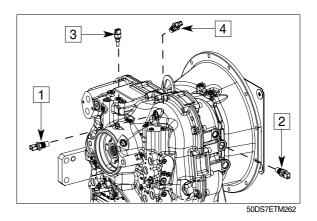
2 = Inductive sensor with O-ring  $15 \times 2$ - n central gear chain

3 = Inductive sensor with O-ring  $15 \times 2$ - n engine

Tightening torque  $\cdots M_A = 30 \text{ Nm}$ 

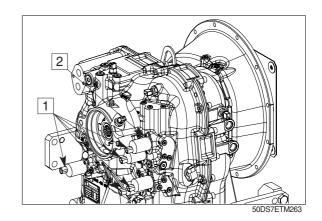
4 = Temperature sensor with O-ring  $11 \times 2$ Measuring point "63" after the converter

Tightening torque  $\cdots M_A = 25Nm$ 

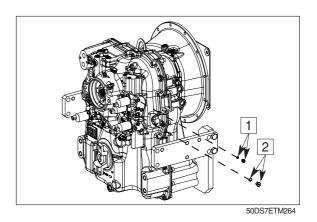


④ Fix pressure controller-proportional valves-(1) with the cylindrical screws M6x12(2).

Tightening torque(M6/8.8  $\times$  12) ·····  $M_A = 9.5 Nm$ 

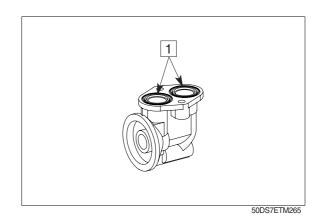


- ⑤ Mount all screw plugs(1 and 2) with O-rings.
  - $1 = Screw plug \ M10x1 \ with \ O\text{-ring}$   $8 \times 1.5 (24EA)$   $Tightening \ torque(M10 \times 1) \cdot \cdots \cdot M_A = 6Nm$
  - 2 = Screw plug 9/16-18 UNF with O-ring  $11.9\times 2(7\text{EA})$  Tightening torque(9/16-18 UNF)  $\cdots$  M<sub>A</sub> = 15Nm



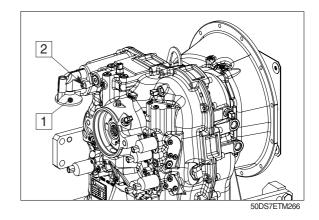
#### 7) REASSEMBLY OF FILTER, CLOSING COMPONENTS, OIL FILLER TUBE WITH OIL DIPSTICK AND OIL DRAIN PLUG

① Place O-rings  $34.2 \times 3(1)$  into the holes and grease them.

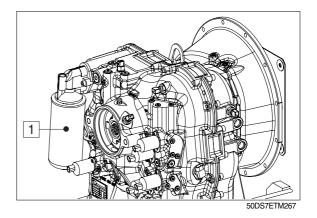


② Attach filter head(1) with cylindrical screws M8x30 (2).

Tightening torque(M8/8.8  $\times$  30) ······  $M_A = 23Nm$ 



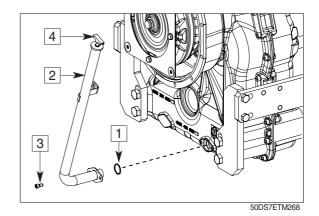
- \* The fine filter(1) has to be fitted as follows:
  - · Slightly oil the seal
  - Turn in the filter until contact with the sealing surface is obtained, and then tighten it by hand with approx. 1/3 to 1/2 rotation.



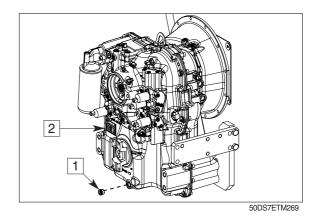
③ Install O-ring 30×3(1) onto the oil suction tube(2), grease it and fix it with cylindrical screws  $M8 \times 16(3)$  to the transmission housing.

Mount oil dipstick(4).

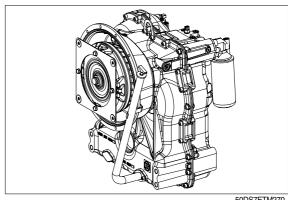
Tightening torque (M8/8.8  $\times$  16) ······  $M_A = 23 \text{ Nm}$ 



④ Fit oil drain plug 7/8-14 UN 2A(1). Tightening torque(7/8-14 UN 2A) ····  $M_A = 30 \text{ Nm}$ Fix identification plate(2) by means of grooved pins  $3 \times 5$ .



\* Before putting the transmission into operation, fill it with oil according to Operator's Manual.



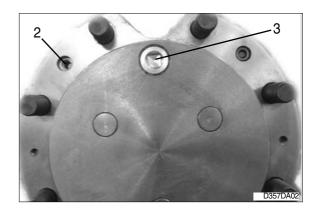
#### 3. DISASSEMBLY OF DRIVE AXLE

### 1) REMOVAL AND DISASSEMBLY OF WHEEL HUB

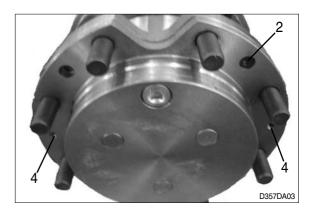
(1) Loosen drain plug with a torque wrench(1) and drain oil.



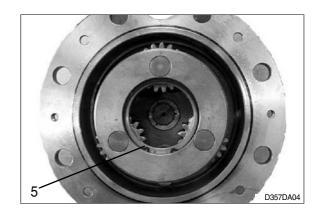
(2) Loosen 4 socket head bolts(2) and a plug(3) from the housing of planetary.



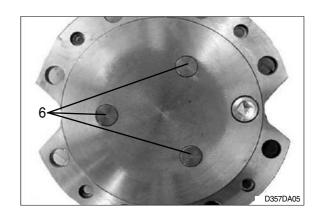
(3) Fit socket head bolt(2) into the 2 tap holes(4) and remove housing of planetary.



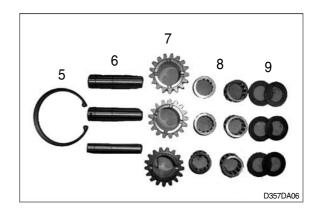
(4) Remove snap ring(5) from the housing of planetary.



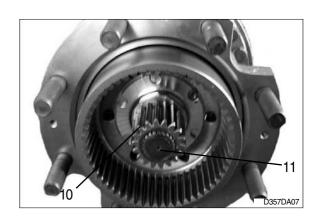
(5) Remove 3 pins(6) with a plastic hammer.



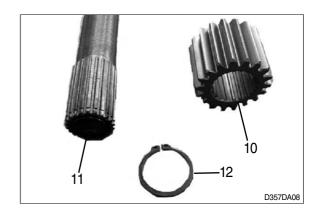
(6) Remove needle bearing(8), planet gear(7) and thrust washer(9).



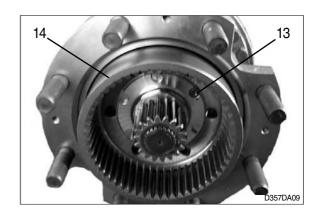
(7) Remove sun gear(10) and drive shaft(11).



(8) Remove snap ring(12) and then remove sun gear(10) from the shaft(11).



(9) After removing bolt(13), remove ring gear(14) and torque plate assembly from the axle tube.



(10) Remove snap ring from the ring gear(14) and disassemble internal gear carrier.

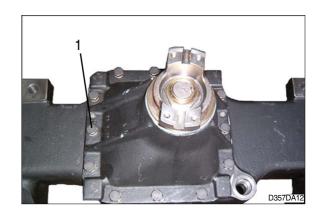


(11)Remove bearing cup from the wheel hub by using jig and hammer. Shaft seal will be damaged.

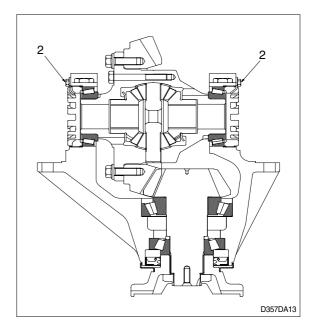


# 2) REMOVAL AND DISASSEMBLY OF AXLE HOUSING

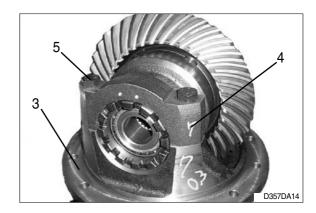
(1) Loosen 12 bolts(1) and then remove carrier from the housing by using a lifting machine.



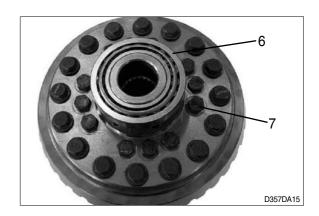
(2) For the reassembly, check rolling resistance and record it. Remove backing plate(2).



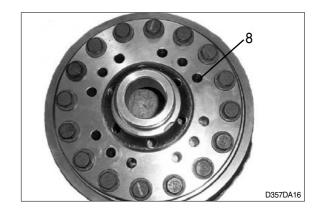
- (3) Before removing differential assembly from carrier(3), check the location of cap(4) and mark it for reassembly.
- (4) Remove 4 hexagon bolts(5) and cap(4).



(5) Disassemble bearing(6) from the differential housing and remove 12 bolts (7).



- (6) Remove differential assembly from the carrier.
- (7) After removing 12 mounting bolts(8) from the housing and then disassemble ring gear.

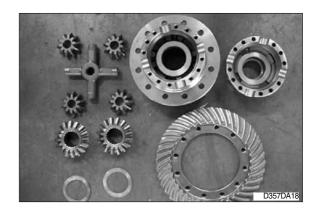


(8) Check the mark on the housing and separate the housing from the differential. If there is no mark, be sure to mark on the housing.

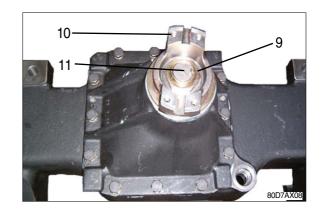
When reassembling, it must be placed at the same position as before.



(9) Remove thrust washer, side gear, pinion gear and spider and then place them on the clean bench.

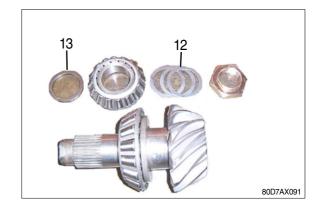


- (10)After loosening lock nut(9), remove yoke(11).
- (11)Remove drive bevel pinion shaft (10) by using a plastic hammer.
- \* Be careful not to damage bevel pinion shaft.

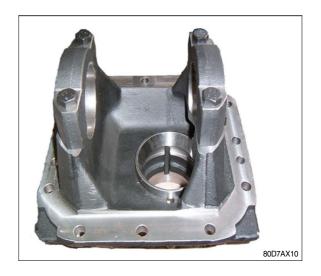


(12)Remove shim(12) and spacer(13) from pinion shaft.

Using a bearing puller, disassemble inner race of taper roller bearing from the pinion shaft.



- (13) Remove outer race of taper roller bearing and shim from the housing by using a jig and hammer.
- \* Do not reuse damaged shims.



(14) Remove outer race of taper roller bearing from the opposite side.



#### 4. REASSEMBLY OF DRIVE AXLE

Clean all of the parts with cleaner and then remove remained loctite.

\* Be careful not to spill cleaner on your body.

Avoid drinking cleaner or breathing its fumes.

Wear protective clothing, glasses and gloves.

If spilled on the skin, flush your skin with water immediately.

If swallowed, get medical attention immediately.

Please observe safety regulations.

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

#### 1) ADJUSTMENT OF BEVEL PINION SHAFT

Adjusting shim of bevel pinion shaft.

- (1) Adjust shim thickness and bevel pinion shaft with following method.
- ① Measure "E" at the housing.
- ② By the equation "  $X = E B T \pm C$  ", define the the shim thickness(1).
  - B: Mounting dimension of bevel pinion shaft, 133.20mm (5.2 in)
  - T: Height of bearing.
  - C: Dimension of carved seal on the pinion. If there's no carved seal C=0.

EX): From the housing

"E" = 162.95mm (6.4in)

B is factory dimension

"B" = 133.20mm (5.2in)

From the bearing

T'' = 29.25 mm (1.2 in)

Carved seal on the pinion

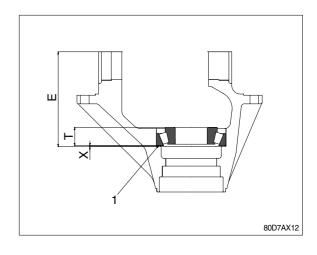
"C"= 0.05mm (0.002in)

Shim thickness:

 $\mathbf{X}$  = 162.95 -133.20 - 29.25 + 0.05

= 0.55mm (0.022in)

If teeth are damaged, replace bevel gear and shaft



(2) Using different kinds of shims, adjust shim thickness as measured by previous equation. Place shims at the bearing place.

Using a jig, assemble drive bearing so that the outer race contact with the bearing place.



- (3) Heat inner race of bearing to max 100°C and then assemble it to the pinion shaft. Also inner race should contact with bearing place.
- Measuring play of bevel pinion shaft end Measure shim thickness by following method.

Dimension "Q": Distance from bearing outer race surface to spacer surface.

Dimension "S": Distance from bearing outer race surface to inner race surface.

From the below equation, define required shim thickness **Z**.

$$"Z=S+Q"$$

EX): From the bearing

S = 2.25mm (0.09in)

From the housing

Q = 3.15mm (0.12in)

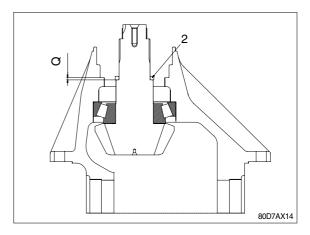
Required shim thickness Z:

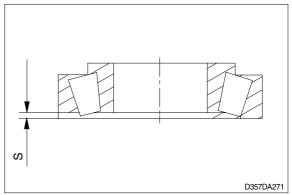
$$Z = 2.25 + 3.15 = 5.40$$
mm (0.21in)

Unit: mm(in)

Р	Q	Z
2.25(0.089)	3.15(0.124)	5.40(0.213)
2.30(0.091)	3.15(0.124)	5.45(0.215)
2.35(0.093)	3.15(0.124)	5.50(0.217)
2.40(0.094)	3.15(0.124)	5.55(0.219)
2.45(0.096)	3.15(0.124)	5.60(0.220)







#### 2) ADJUSTMENT OF PINION SHAFT

(1) Assemble bearing cup.

Assemble spacer to the pinion shaft and then install measured shims onto the spacer.





(2) Insert pinion shaft into the carrier.
Assemble bearing cone, yoke and lock nut.

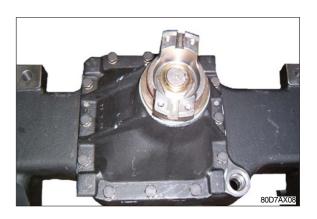
Apply loctite #271 or #277 on the thread of pinion and then tighten lock nut.

• Tightening torque :  $45\sim51 \text{kgf} \cdot \text{m}$  (325 $\sim369 \text{lbf} \cdot \text{ft}$ ).

Measure rolling resistance of pinion shaft. Adjust shim thickness.

• Rolling resistance :  $0.20 \sim 0.41 \text{kgf} \cdot \text{m}$  ( $1.4 \sim 2.9 \text{lbf} \cdot \text{ft}$ ).

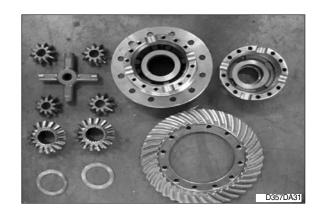
Coke lock nut into the pinion shaft slot.



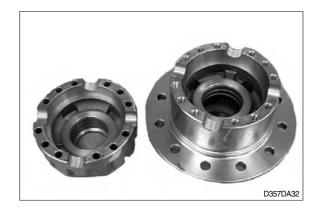
#### 3) ASSEMBLY OF DIFFERENTIAL ASSEMBLY

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

Apply grease on the bevel gear and thrust washer.



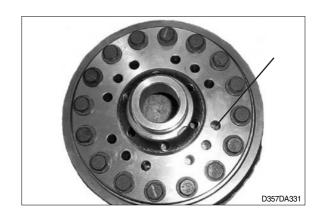
- (2) Assemble differential housing.
- Check marks on the housing.Match two marks at the same position.



(3) Tighten 12 bolts(7) to the differential housing.

Apply loctite #271 or #277 on the thread of bolt.

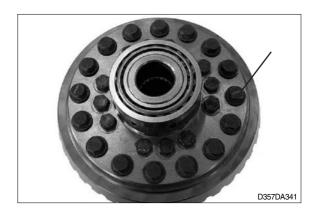
• Tightening torque : 5.0~7.5kgf • m (36~54lbf • ft)



(4) Assemble ring gear by tightening 12 bolts(6).

Apply loctite #271 or #277 on the thread of bolt.

• Tightening torque :  $12.5 \sim 14.5 \text{kgf} \cdot \text{m}$  ( $90 \sim 105 \text{lbf} \cdot \text{ft}$ )



(5) Install differential assembly onto the carrier. Place the bearing cup and screw into the housing. At this moment, using a screw adjust rotation backlash.

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

 Rotation backlash: 0.18~0.23mm (0.007~0.009in)



Unit:  $kgf \cdot m$  ( $lbf \cdot ft$ )

- (6) Assemble bearing cap.
- \* Fix bearing cap with hexagon bolt.
  - · Tightening torque : 15.0~17.0kgf · m (108~123lbf · ft)

Measure rolling resistance of tapered roller bearing.

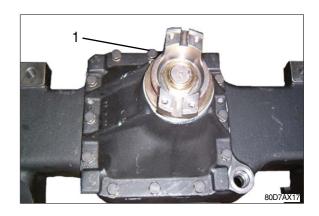
The right table shows the relation between preload(P) of bevel pinion shaft and rolling resistance(Z) calculated at 1).

Р	Z
0.20(1.45)	0.35~0.41(2.53~2.95)
0.25(1.81)	0.40~0.46(2.89~3.33)
0.30(2.17)	0.45~0.49(3.25~3.54)
0.35(2.53)	0.50~0.56(3.62~4.05)
0.408(2.95)	0.56~0.62(4.05~4.48)
0.50(3.62)	0.62~0.70(4.48~5.06)

- (7) Confirm that the screw contacts with bearing.
- (8) After complete assembly of bearing, measure rotation backlash once more and readjust with a screw if needed.
- (9) Apply loctite #271 to the thread of bearing cap bolt.
  - · Tightening torque: 15.0~17.0kgf · m(108~123lbf · ft).
- (10)Assemble plate with hexagon bolts. Apply loctite #271 or #277 to the thread of bolt and then assemble at the tightening torque of  $0.80 \sim 1.20 \text{ kgf} \cdot \text{m} (5.8 \sim 8.7 \text{lbf} \cdot \text{ft})$ .
- \* Assemble opposite side with the same methods.
- (11) Apply marking liquid to 3~4 teeth of crown gear and then bring bevel pinion gear contact with the crown gear several times. Check out the contacted shape.

#### 4) ASSEMBLY OF CARRIER

- (1) Assemble carrier assembly into the axle housing.
- (2) Apply loctite #271 or #277 to thread of bolt and then assemble at the tightening torque of  $11\sim13$ kgf · m(79.6 $\sim94.0$ lbf · ft).



#### 5) ASSEMBLY OF WHEEL HUB

- Insert bearing into wheel hub.
   Confirm that the bearing and wheel hub contact completely.
- \*\* Apply grease or oil to shaft seal and then assemble it from the direction of outer side of wheel hub.
- (2) Install wheel hub assembly to the tube flange of axle completely.
  Install bearing cone.

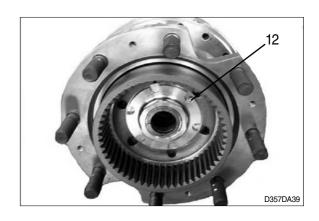




(3) Insert shim, fix the torque plate and ring gear with snap ring and assemble them to the axle tube.

Apply loctite #271 or #277 on the tapped side of bolt(12) and tighten at the tightening torque of  $1.5\sim1.7$ kgf· m ( $108\sim123$ lbf·ft).

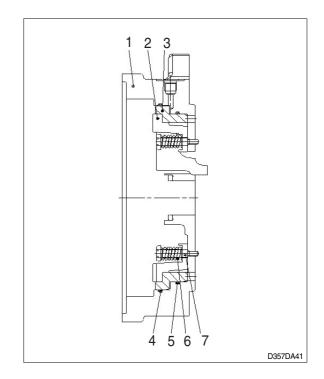
Apply grease on the bushing.



(4) Assemble square ring(4, 5) with oil(MOBIL #424) to the brake housing. Assemble piston(3) after applying oil sufficiently and apply loctite #271 to spring(6) and 4 bolts(4).

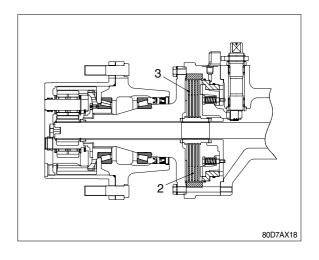
· Tightening torque : 1.4~1.6kgf · m (10.1~11.6lbf · ft)

\* Check the status of square ring and replace if damaged.



#### Assembling plate and inspection

- ① Assemble 4 plates(8) and 3 disks(9) into the brake housing(1).
- ② Before assembling, clean all of the parts completely and remove burrs.
- ③ Disk must be assembled after 12 hours of infiltrate.( MOBILFLUID #424 )
- After assembling plate and disk, confirm that the tolerance with brake housing surface is 2.1~2.6mm(0.08~0.10in).
   (Spindle protrusion is 1.4mm(0.06in) and operation stroke of plate(8) and disk(9) assembly is 1.0~1.5mm(0.04~0.06in))
- ⑤ After tightening the bolt(10), confirm that parking lever(11) stroke is 17~32mm (0.67~1.26in) when pulling lever at the operation force of 25kgf.m(181lbf · ft).
  - In case that the parking lever(11) distance is wrong, disassemble lever shaft(12) to rotate spline by 1 pitch and then reassemble it.
- ⑥ Apply loctite #5127 to spindle side of brake housing(1)



Unit: mm(in)

Spline	Parking lever operation distance		
1 pitch	17(0.67)		

(5) Assemble sun gear to axle shaft and fix it with snap ring.

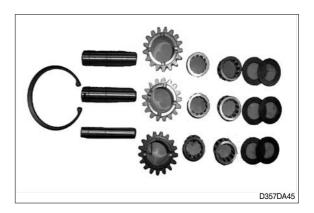
Assemble axle shaft to the axle assembly. Apply grease on the shaft where bushing contacts.

Apply grease to teeth parts of planetary gear.

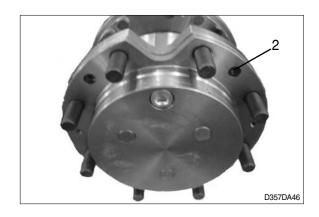


(6) Assemble internal components of planetary carrier in the reverse order to disassembly.



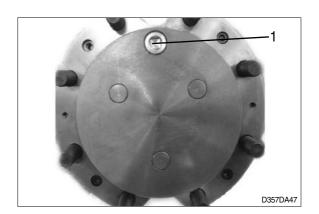


- (7) Install planetary carrier assembly to wheel hub and tighten bolt(2).
  - Tightening torque : 2.5~4.0kgf  $\cdot$  m (18.1~28.9lbf  $\cdot$  ft)



## (8) Assemble wheel hub and tighten plug(1).

 $\cdot$  Tightening torque : 3.5~6.0kgf  $\cdot$  m  $(25.3{\sim}43.4 \text{lbf} \cdot \text{ft})$ 

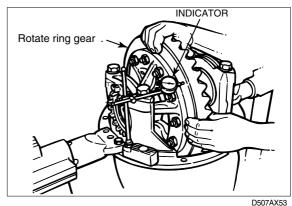


#### **GROUP 4 ADJUSTMENT**

#### 1.CHECKING **GEAR** THE RING **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 "Disassembling the differential carrier assembly".
- 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.



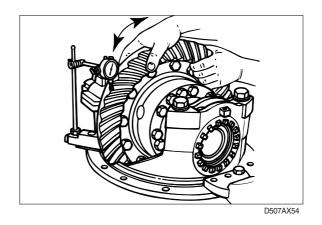
#### 2. ADJUSTING THE GEARSET BACKLASH

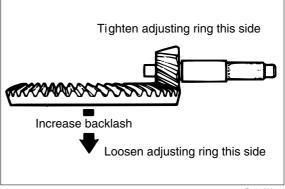
Backlash specification: 0.13~0.18mm (0.005-0.007inch)

If the old gearset is installed, adjust the backlash to the setting that was measured before the carrier was disassembled.

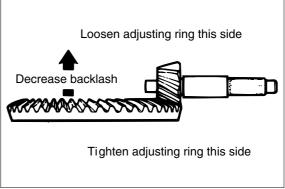
If a new gearset is installed, adjust the backlash to the correct specification for new gearsets.

- 1) Attach a dial indicator on the mounting flange of the carrier.
- 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.
- Loosen one bearing adjusting ring one notch, then tighten the opposite ring the same amount.





D507AX55

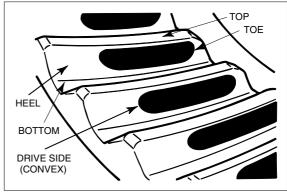


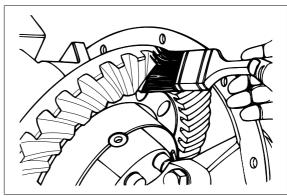
D507AX56

#### 3.ADJUSTING TOOTH CONTACT PATTERN OF THE GEARSET

Always check tooth contact pattern on the drive side of the gear teeth.

1) Apply marking compound to approximately 12 teeth of the ring gear.





D507AX58

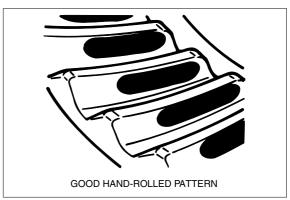
- 2) Rotate ring gear forward and backward so that the 12 marked teeth go past the drive pinion six times to get a good contact pattern.
- 3) Compare the contact patterns.

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

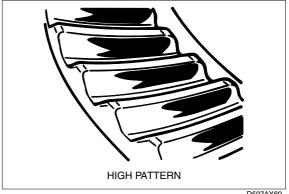
In used gearsets, a good contact pattern fills approximately the full length of the tooth. The top of the pattern is near the top of the tooth. The location should match the wear pattern on the tooth.

If the contact patterns require adjustment along the width of tooth(top/bottom), follow steps 4)-5).

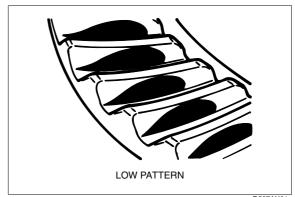
If the contact patterns requires adjustment along the length of tooth(toe/heel), follow step 6)-7).



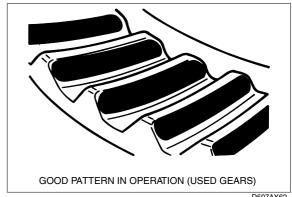
D507AX59



D507AX60



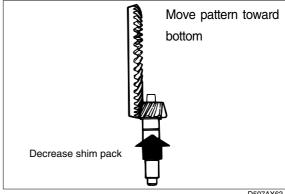
D507AX61



D507AX62

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

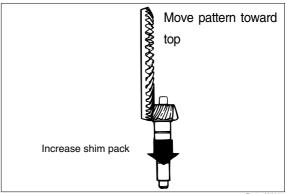
To correct, move the pinion toward the ring gear by decreasing the shim pack between pinion spigot and inner bearing cone. Refer to "Assembling the pinion bearing cage".



D507AX63

5) Low pattern: A low contact pattern indicates that the pinion was installed too deep into the carrier.

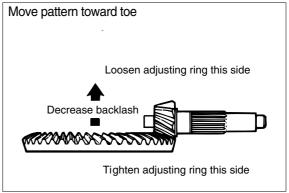
To correct, move the pinion away from the ring gear by increasing the shim pack between pinion spigot and inner bearing cone. Refer to "Assembling the pinion bearing cage".



D507AX64

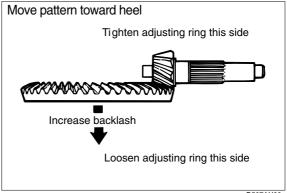
6) Heel pattern: Decrease the gearset backlash(within specified range) to move contact pattern toward toe and away from heel.

Refer to "Adjusting the gearset backlash".



D507AX65

7) Toe pattern: Increase the gearset backlash(within specified range) to move contact pattern toward heel and away from toe. Refer to "Adjusting the gearset backlash".



D507AX66

## SECTION 4 BRAKE SYSTEM

Group	1	Structure and function 4-1
Group	2	Operational checks and troubleshooting 4-17
Group	3	Tests and adjustments4-22

## SECTION 4 BRAKE SYSTEM

#### **GROUP 1 STRUCTURE AND FUNCTION**

#### 1. OUTLINE

There are two brake systems, the foot brake system and the hand brake system.

In the foot (wheel) brake system, oil pressure is generated in the master cylinder by treading on the brake pedal. This pressure causes the wheel cylinder pistons to extend, expanding the brake shoes and pressing them against the brake drums to attain braking force.

In the hand (parking) brake system, the brake shoes are expanded by operating the brake lever. Force from the lever is transmitted to the brake shoes through the hand brake cables and a lever arm in each wheel brake assembly.

The wheel brake is the duo-servo type. With force applied to both the primary and secondary shoes, this type provides a large amount of brake force.

In addition, the brake equipped with automatic adjusters which constantly adjust the clearance between the shoe and the drum, compensation for wear due to the shoe friction and thus keeping the clearance constant.

#### 2. SPECIFICATION

#### 1) WHEEL BRAKE(DRY TYPE)

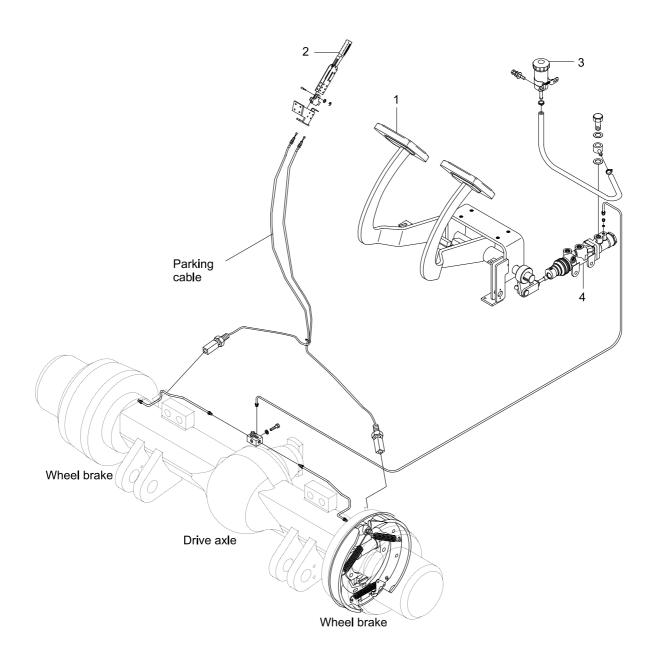
Item		Specification	
Туре		Front wheel, duo-servo & auto adjustment type	
Service brake shoe size		ø 314×80mm(12.4×3.15in)	
Wheel cylinder bore diameter		ø 34.93mm(1.37in)	
Master cylinder bore diameter		ø 40mm(1.57in)	
De del edicatorent	Free height	122~128mm(4.8~5.0in)	
Pedal adjustment	Idle strock	4~6.5mm(0.16~0.25in)	
Brake drum diameter Normal		315mm(12.4in)	
Wheel cylinder installation torque		2.04~2.55kgf · m(14.8~18.4lbf · ft)	
Backing plate installation torque		15~17kgf · m(108~123lbf · ft)	
Brake oil		Only use for brake fluid DOT3	

#### 2) PARKING BRAKE

Itam	Specification		
Item	Dry type	Wet type	
Туре	Toggle, internal expanding mechanical type		
Parking lever stroke	281mm	322mm	
Parking cable stroke	20mm	48mm	

## 3. BRAKE PEDAL AND PIPING

## 1) DRY TYPE

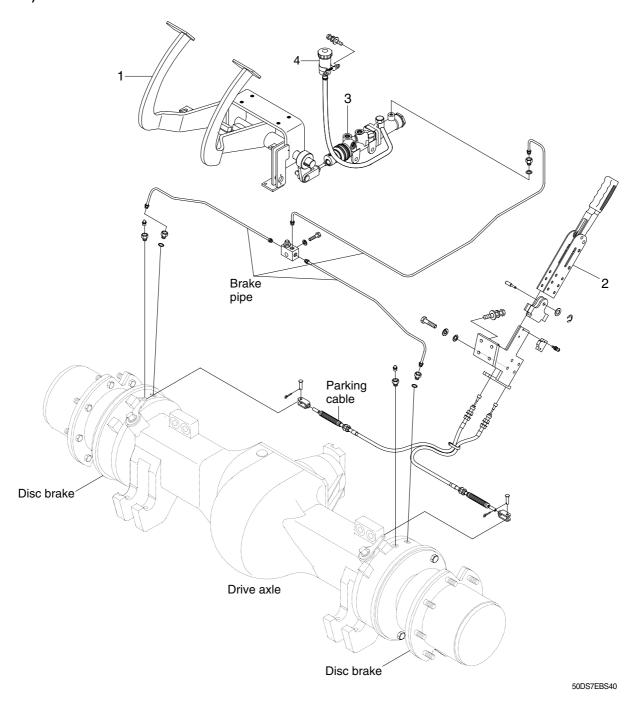


50DS7EBS03

- 1 Brake pedal & bracket assembly
- 2 Parking lever assembly

- 3 Reservoir tank assembly
- 4 Brake master cylinder

## 2) WET TYPE



- 1 Brake pedal & bracket assembly
- 2 Parking lever assembly

- 3 Reservoir tank assembly
- 4 Brake master cylinder

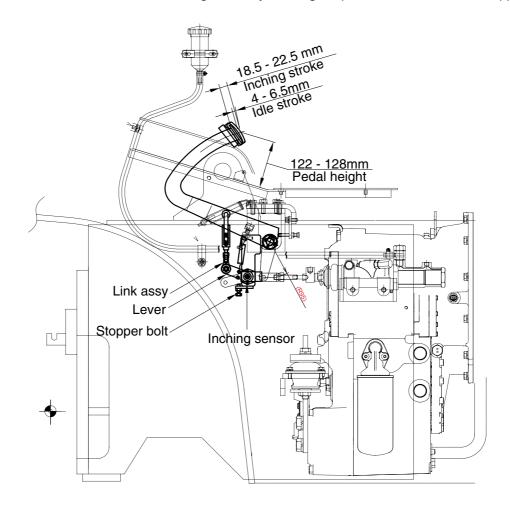
#### 3) DO AEB WORK

- (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, KC, KD, KE" orderly for 3~5minutes.
  - · After the successful completion, it displays " OK".
  - · With a new controller, it may display "F6" error code before AEB, but after AEB, it will disappear.
- (8) In case of abnormal running, it may display "STOP" with the appropriate error code.
- (9) After troubleshooting, 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.

#### 4. INCHING PEDAL AND LINKAGE

The brake pedal serves to actuate the hydraulic brakes on the front axle. At the beginning of the pedal stroke, the inching spool of the transmission control valve is actuated to shift the hydraulic clutch to neutral and turn off the driving force. By treading the pedal further, the brake is applied.



D507BS01

#### 1) INITIALIZING THE INCHING SENSOR

- (1) Start engine after parking the machine on flat floor and blocking wheels.
- (2) Release parking brake and keep neutral gear shift.
- (3) Adjust the inching sensor linkage so that the regular voltage is supplied to inching sensor when operating the pedal.

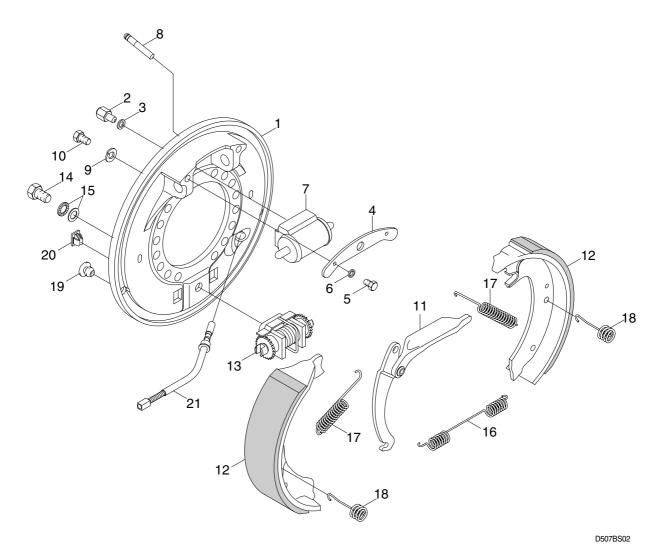
(Regular voltage; Before pedal operation( $1 \pm 0.1V$ ),

After pedal operation( $3.5\pm0.1V$ ))

- (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. WHEEL BRAKE

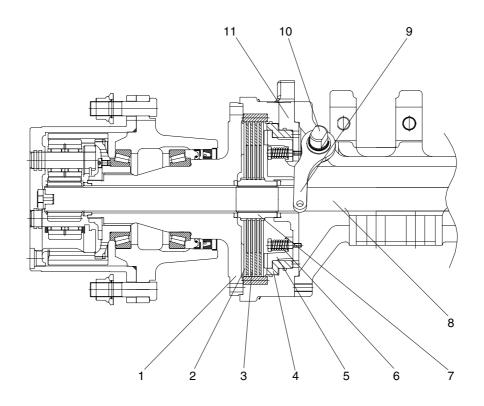
## 1) DRY TYPE



1	Back plate(LH, RH)	8	Air breather	15	Lock washer
2	Adapter	9	Spring washer	16	Return spring
3	Washer	10	Cylinder bolt	17	Return spring
4	Holder	11	Lever shoe assembly	18	Pressure spring
5	Spring washer	12	Brake shoe assembly	19	Plug
6	Holder bolt	13	Adjuster assembly	20	Plug
7	Cylinder assembly	14	Adjuster bolt	21	Parking cable(LH, RH)

#### 6. WET DISK BRAKE

#### 1) STRUCTURE



D507TM238

1	Spindle	5	Service piston	9	Parking lever
2	Steel plate	6	Parking piston fixing bolt	10	Parking lever shaft
3	Disk plate	7	Spline collar	11	Brake housing
4	Parking piston	8	Drive shaft		

#### 2) OPERATION

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

Because it is possible to use the brake semi-permanently, there is no need to replace or change the lining as drum type brake do.

Parking brake's lever system is the serration type, so it is possible to adjust the play.

Because it is easy to maintain the gap of both brakes, high brake efficiency and minimum disproportional braking deviation is acquired.

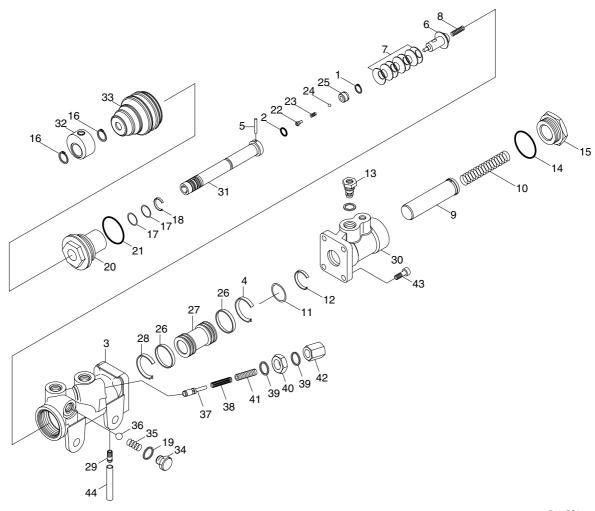
Major components are 4 disk plates(3), 5 steel plates(2), service piston(4), parking piston(5), parking lever(9) and brake housing(11).

Braking force is applied by restricting the driving force from drive shaft(8) and spline collar(7).

### 7. BRAKE VALVE

## A. DRY TYPE

## 1) STRUCTURE



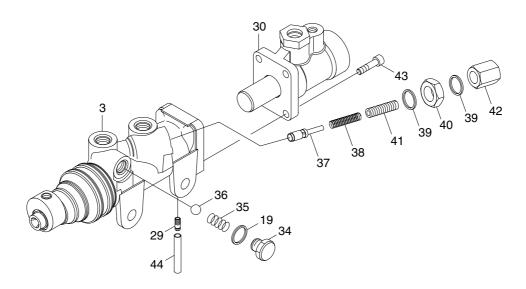
D507BS0
D301 D00

1	Stop ring	16	Stop ring	31	Push rod
2	Seal	17	Seal	32	Connector
3	Booster housing	18	Seal	33	Dust cover
4	Seal	19	Seal	34	Plug
5	Cylindrical thorn	20	Guide plug	35	Spring
6	Flow valve	21	Seal	36	Ball
7	Spring	22	Spring guide	37	Relief valve body
8	Push rod spring	23	Spring	38	Spring
9	Main piston	24	Ball	39	Washer
10	Spring	25	Check valve housing	40	Nut
11	Seal	26	Sliding guide	41	Adjusting screw
12	Seal	27	Seal	42	Plug
13	Valve plug	28	Seal	43	Fixing screw
14	Seal	29	Vent hole fitting	44	Rubber pipe
15	Closing plug	30	Master cylinder housing		

### 2) DISASSEMBLY

- All operations must be carried out with the greatest care, following the instructions carefully. The disassembly instructions are being provided in chronological.
- (1) Unscrew the 4 screws(43), in order to be able to separate the front housing(3) from the rear housing(30).

Then disassemble the check valve and the limiting pressure valve composed of parts(19, 34~42).



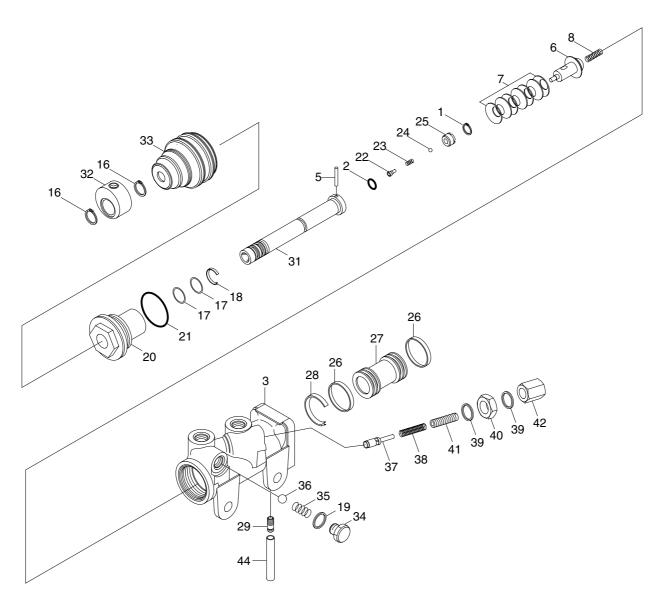
D507BS08

- (2) By means of retaining ring pinces remove retaining ring(16), accurnulator fitting(32) and then the second retaining ring(16).

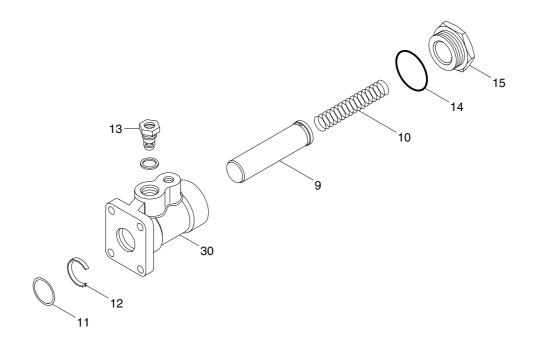
  Remove rubber cap(33).
- (3) Unscrew guide cap(20) and then extract rod(31) and spring(8).

  After the extraction of the rod(31) remove pin(5) and disassemble parts(1, 2, 6, 7, 22~25).

  Remove piston(27), extracting it from the side opposite to the threaded hole.



D507BS09

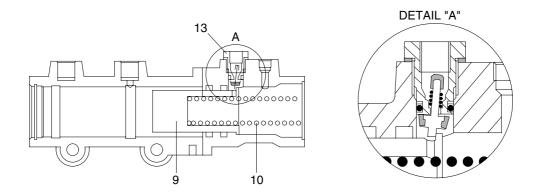


D507BS10

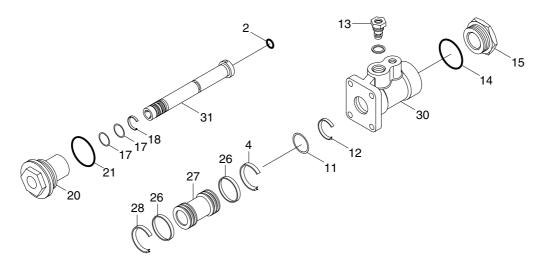
- (4) Unscrew rear cap completely(15) by making sure that it's not being disconnected abruptly; remove then O-ring, spring(10) and the joints(9). In order to remove the piston(9), knock the cylinder body on a piece of wood. Only at last unscrew valve(13).
- (5) Remove the O-ring and the lip seal still inside the pump body with the aid of an "L" iron. Remove all of the other gaskets from the disassembled components, namely the drive rod(31), the piston(27).
- (6) Clean all the components thoroughly and check that there is no ribbing inside the piston slide cylinder(27) of the pump body; smooth if necessary. Lubricate the components either with mineral or with hydraulic oil, according to their use destination.

#### 3) ASSEMBLY

- \* The assembly must be carried out by following the so far described sequence but in reverse order, taking great care not to assemble the new gaskets back to front or upside down.
- \* Take the utmost care in assembling the components shown at stage 4, by assembling first of all valve(13), then piston(9), spring(10) and only afterwards the other components.



D507BS11



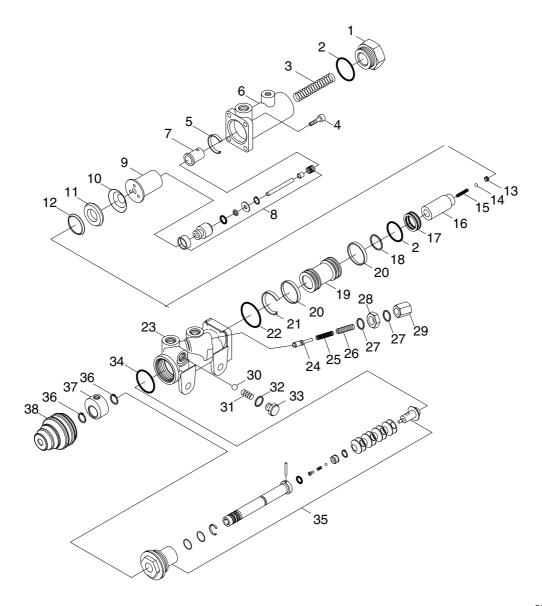
D507BS12

· SEAL KIT: ZTAX-00077

▲ Use only brake fluid(DOT3) in the compensation reservoirs.

## B. WET TYPE

## 1) STRUCTURE

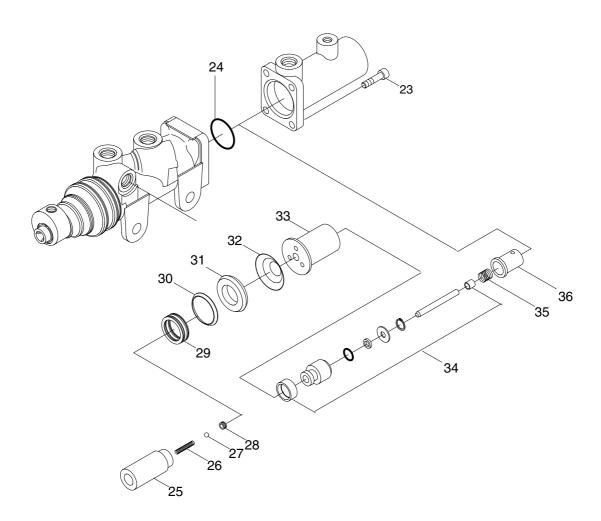


D507BS42

1	Plug	11	Seal	21	Seal	31	Spring
'	J						
2	Seal	12	Ring	22	Seal	32	Seal
3	Spring	13	Seal	23	Booster housing	33	Plug
4	Screw	14	Ball	24	Relief valve body	34	Seal
5	Seal	15	Spring	25	Spring	35	Push rod
6	B/Cyl Housing	16	Auxiliary piston	26	Adjustment screw	36	Stop ring
7	Spring guide	17	Ring	27	Washer	37	Connector
8	Valve	18	Seal	28	Nut	38	Dust cover
9	Piston	19	Booster piston	29	Plug		
10	Spring	20	Sliding guide	30	Ball		

#### 2) DISASSEMBLY

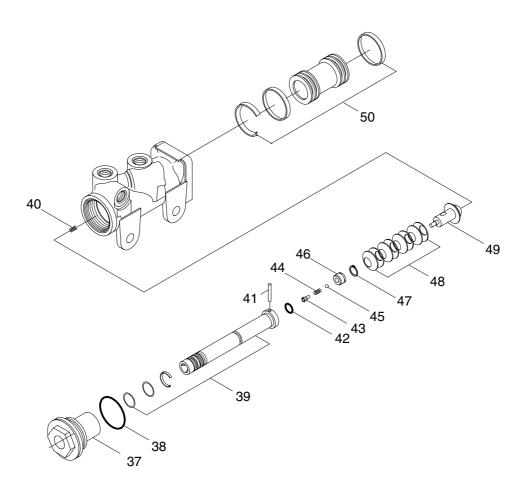
- ▲ All operations must be carried out with the greatest care, following the instructions carefully. The disassembly instructions are being provided in chronological.
- (1) Unscrew the 4 screws(23), in order to separate the booster from the brake cylinder housing. Separate the two parts and remove the components that are inside from(25) to(36), in order to remove spring(26) and ball(27), you should remove seal(28) from piston containing the seal(25).



D507BS43

- (2) Unscrew guide cap(37) and then remove O-ring(38), rod(39), spring(40) and the piston(50). Once rod(39) has been removed, take out pin(41) and all the components that are inside the rod from(42) to(49).
- (3) Remove the lip seal inside the brake cylinder housing by means of on L-Iron.

  Remove all other seals from the disassembled components, namely drive(39), piston(50), O-ring housing(29) and valve(34).
- (4) Clean all the components thoroughly and check that there is no ribbing inside the pisiton slide cylinder(50) of the brake cylinder housing; Smooth if necessary. Lubricate the components, particularly the seals by means of proper oil, or better with grease suitable for ATE(Automatic test equipment) braking systems. Take great care not to contaminate components operating on brake fluid with mineral oil and vice-versa.



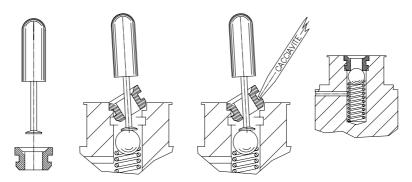
D507BS44

#### 3) ASSEMBLY

- \* The assembly procedure must be carried out by following the sequence described before in reverse order, taking great care not to fit the new seals back to front or upside down.
- (1) In order to fit the valve inside the piston containing the seal(25) following these instructions.

Fit the seal into the appropriate tool and press ball and spring into the seat;

Fit one end of the seal (as shown in the picture) and then fit the rest of the seal with a screwdriver. Make sure that the seal is fitted proplely by inserting the screwdriver into the hole and by checking that seal is not misshappen in any way.



D507BS52

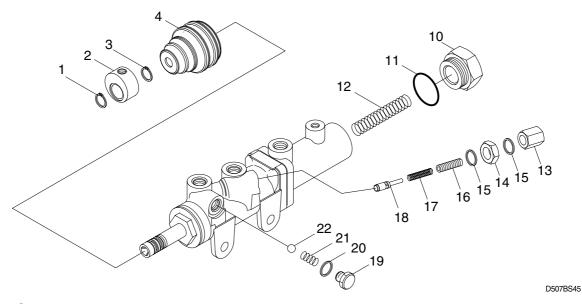
#### 4) SEALS REPLACEMENT IN BRAKE CYLINDERS WITH HYDRAULIC BOOSTER

All operations must be carried out with the greatest care, following the instructions given carefully. The disassembly instructions are being provided in chronological order.

(1) After disassembling retaining ring(1), accumulator fitting(2) and then the second retaining ring(3), remove rubber cap(4).

Then disassemble the check valve composed of parts(19~22) and the relief valve composed of parts(13~18) only in case of failure.

Unscrew rear cap completely(10) by making sure that it's not being disconnected abrupty; remove then O-ring (11), spring (12).



· SEAL KIT: ZTAX-00040

▲ Use only brake fluid(SAE10W) in the compensation reservoirs.

#### **GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING**

#### 1. OPERATIONAL CHECKS

#### A. DRY TYPE

#### 1) BRAKE PIPING

- (1) Check pipes, hoses and joints for damage, oil leakage or interference.
- (2) Operate brake pedal and check operating force when pedal in depressed. Check also change in operating force, and change in position of pedal when pedal is kept depressed.

#### 2) WHEEL BRAKE

#### Compact wheel base chassis

- (1) Measure lining at point with most wear, and check that lining thickness is at least 2.0mm(0.08in).
- (2) Hold lining surface with screwdriver to prevent piston from coming out, depress brake pedal and check movement of shoe.
- (3) Remove brake shoe from anchor pin, and check for rust or wear. When assembling, coat sliding parts with special brake grease.

#### 3) BRAKE DRUM

- (1) Measure inside diameter of drum, and check that it is within 315mm(12.4in).
- (2) Tighten mounting bolt of drum  $2.5 \sim 4.0 \text{kgf} \cdot \text{m} (18 \sim 29 \text{lbf} \cdot \text{ft})$ .

#### 4) BACKING PLATE

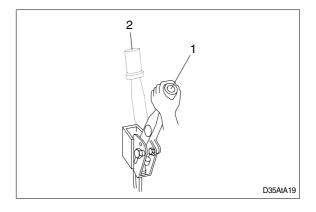
- Check visually for deformation or cracks.
   Check particularly for deformation at outside circumference of plate and at mounting bolt.
- (2) Coat mounting bolt with loctite and tighten :  $15 \sim 17 \text{kgf} \cdot \text{m} (108 \sim 123 \text{lbf} \cdot \text{ft})$ .

#### 5) BRAKING FORCE

- (1) Select a dry, flat, paved surface and drive truck at maximum speed. When signal is given, stop truck immediately and measure distance from point where signal was given to point where truck stopped. (unloaded)
  - · Stopping distance: Within 5m(197in)
- (2) Check that there is no pulling of steering wheel, pulling by brakes to one side or abnormal noise when making emergency stops.

#### 6) PARKING BRAKE

- (1) Operating force of parking lever is 35 40 kgf  $\cdot$  m(253 290lbf  $\cdot$  ft).
- (2) Check that parking brake can hold machine in position when loaded on 20% slope. If there is no slope available, travel at low speed and check braking effect of parking brake.



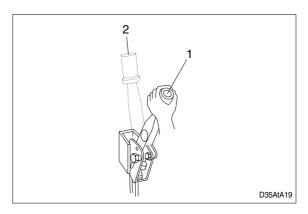
#### **B. WET TYPE**

#### 1) BRAKE PIPING

- (1) Check pipes, hoses and joints for damage, oil leakage or interference.
- (2) Operate brake pedal and check operating force when pedal in depressed. Check also change in operating force, and change in position of pedal when pedal is kept depressed.

#### 2) PARKING BRAKE

- (1) Operating force of parking lever is 35 40 kgf  $\cdot$  m(253 290lbf  $\cdot$  ft).
- (2) Check that parking brake can hold machine in position when loaded on 20% slope. If there is no slope available, travel at low speed and check braking effect of parking brake.



# 2. TROUBLESHOOTING A. DRY TYPE

Problem	cause	Remedy
Insufficient braking force	Hydraulic system leaks oil.	· Repair and add oil.
	· Hydraulic system leaks air.	· Bleed air.
	· Lining surface soiled with water or oil.	· Clean or replace.
	Lining surface roughened or in poor contact with drum.	· Repair by polishing or replace.
	· Lining worn.	· Replace.
	Brake valve or wheel cylinder mal- functioning.	· Repair or replace.
	Hydraulic system clogged.	· Clean.
Brake acting unevenly.	· Tires unequally inflated.	· Adjust tire pressure.
(Machine is turned to one	· Brake out of adjustment.	· Adjust.
side during braking.)	· Lining surface soiled with water or oil.	· Clean or replace.
σ σ,	· Earth intruding into brake drum.	· Clean.
	· Lining surface roughened.	· Repair by polishing or replace.
	Lining in poor contact with drum.	· Repair by polishing.
	· Lining worn.	· Replace.
	Brake drum worn or damaged	· Repair or replace.
	(distortion or rusting).	
	Wheel cylinder malfunctioning.	· Repair or replace.
	Brake shoe poorly sliding.	· Adjust.
	Back plate mounting bolt loose.	· Retighten or replace.
	Back plate deformed.	· Replace.
	Wheel bearing out of adjustment.	· Adjust or replace.
	· Hydraulic system clogged.	· Clean.
Brake trailing.	· Pedal has no play.	· Adjust.
	· Brake shoe poorly sliding.	· Adjust.
	· Wheel cylinder mal-functioning.	· Repair or replace.
	· Piston cup faulty.	· Replace.
	· Return spring fatigued or bent.	· Replace.
	Parking brake fails to return or out of adjustment.	· Repair or adjust.
	Brake valve return port clogged.	· Clean.
	Hydraulic system clogged.	· Clean.
	· Wheel bearing out of adjustment.	· Adjust or replace.
Brake chirps	S · Brake trailing.	See above. Brake trailing.
'	Piston fails to return.	· Replace.
	· Lining worn.	· Replace.
	· Lining surface roughened.	Repair by polishing or replace.

Problem	cause	Remedy
Brake squeaks	· Lining surface roughened.	· Repair by polishing or replace.
	· Lining worn.	· Replace.
	· Poor shoe to lining contact.	· Replace.
	· Excessively large friction between	· Clean and apply brake grease.
	shoe and back plate.	
	· Foreign matter on drum sliding surfa-	· Clean
	ce.	
	Drum sliding surface damaged or distorted.	· Replace.
	Brake shoe deformed or poorly installed.	· Replace or repair.
	· Back plate mounting bolt loosening.	· Retighten.
	· Worn anchor or other contact portion.	· Replace.
	· Lining poor contact with drum.	Repair or replace.
	· Anti-rattle spring poorly installed.	· Repair or replace.
Brake rapping	· Drum sliding surface roughened.	· Repair by polishing or replace.
	Drum eccentric or excessively distorted.	· Replace.
	· Lining surface roughened.	· Repair by polishing or replace.
Large pedal stroke	· Brake out of adjustment.	· Adjust.
	· Hydraulic line sucking air.	· Bleed air.
	Oil leaks from hydraulic line, or lack of oil.	· Check and repair or add oil.
	· Lining worn.	· Replace.
	Shoe tilting or does not return completely.	· Repair.
	Lining in poor contact with brake drum.	· Repair.
Pedal dragging.	· Twisted push rod caused by improp-	· Adjust.
	erly fitted brake valve.	
	· Brake valve seal faulty.	· Replace.
	· Flow control valve orifice clogged.	· Clean or replace.

#### B. WET TYPE

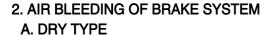
Problem	cause	Remedy
Insufficient braking force	· Hydraulic system leaks oil.	· Repair and add oil.
	· Hydraulic system leaks air.	· Bleed air.
	· Disk worn.	· Replace.
	· Brake valve malfunctioning.	· Repair or replace.
	Hydraulic system clogged.	· Clean.
Brake acting unevenly.	· Tires unequally inflated.	· Adjust tire pressure.
(Machine is turned to one	· Brake out of adjustment.	· Adjust.
side during braking.)	· Disk surface roughened.	· Repair by polishing or replace.
	· Wheel bearing out of adjustment.	· Adjust or replace.
	· Hydraulic system clogged.	· Clean.
Brake trailing.	· Pedal has no play.	· Adjust.
	· Piston cup faulty.	· Replace.
	· Brake valve return port clogged.	· Clean.
	· Hydraulic system clogged.	· Clean.
	· Wheel bearing out of adjustment.	· Adjust or replace.
Brake chirps	· Brake trailing.	· See above. Brake trailing.
	· Piston fails to return.	· Replace.
	· Disk worn.	· Replace.
	· Disk surface roughened.	· Repair by polishing or replace.
Brake squeaks	· Disk surface roughened.	· Repair by polishing or replace.
	· Disk worn.	· Replace.
	· Excessively large friction between	· Clean and apply brake grease.
	disk plate.	
Large pedal stroke	· Brake out of adjustment.	· Adjust.
	· Hydraulic line sucking air.	· Bleed air.
	· Oil leaks from hydraulic line, or lack	· Check and repair or add oil.
	of oil.	
	· Disk worn.	· Replace.
Pedal dragging.	· Twisted push rod caused by improp-	· Adjust.
	erly fitted brake valve.	
	Brake valve seal faulty.	· Replace.

#### **GROUP 3 TESTS AND ADJUSTMENTS**

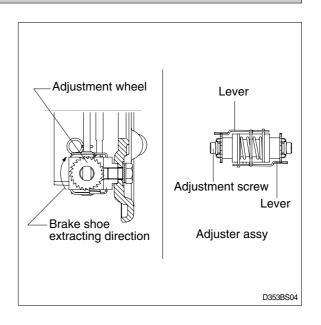
## 1. ADJUSTMENT OF WHEEL BRAKE (DRY TYPE)

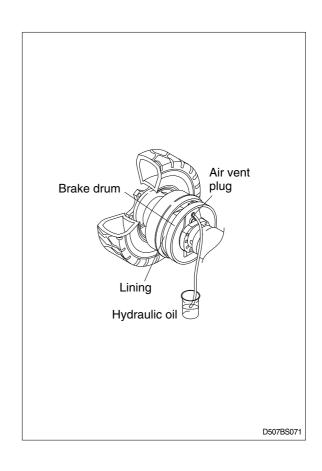
#### Adjust with engine stopped.

- 1) Jack up truck. Extend adjustment screw by clicking adjustment wheel teeth with a screwdriver until wheel (mounted on brake drum being adjusted) offers a light resistance when turned by hand. Back adjustment wheel by 25~30 teeth to shorten length of adjustment screw.
- When backing adjustment wheel, be sure to adequately raise adjustment lever to keep it free from interference with adjustment wheel. If lever is bent by mistake, it loses proper function.
- After adjusting brake, drive machine for about 500m, then check heat of brake drum at 4 points to confirm that brakes are not dragging.
- 3) After adjusting, confirm that brake stopping distance is within standard range.



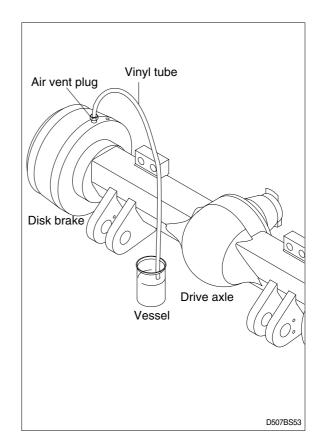
- 1) Air bleeding should be performed by two persons:
  - One rides on truck for depressing and releasing brake pedal: the other person is on the ground and removes cap from air vent plug on wheel cylinder.
- 2) Block the front wheel securely and apply parking brake.
- 3) Start the engine.
- 4) Attach a vinyl tube to air vent plug and immerse other end of tube into a vessel filled with hydraulic oil.
- 5) Loosen air vent plug by turning it 3/4 with a wrench. Depress brake pedal to drain oil mixed with air bubbles from plug hole.
- 6) Depress brake pedal until no air bubbles come out of air vent plug hole.
- 7) After completion of air bleeding, securely tighten air vent plug. Install cap on plug.





#### **B. WET TYPE**

- 1) Air bleeding should be performed by two persons:
  - One rides on truck for depressing and releasing brake pedal: the other person is on the ground and removes cap from air vent plug on wheel cylinder.
- 2) Block the front wheel securely and apply parking brake.
- 3) Start the engine.
- Attach a vinyl tube to air vent plug and immerse other end of tube into a vessel filled with hydraulic oil.
- Loosen air vent plug by turning it 3/4 with a wrench. Depress brake pedal to drain oil mixed with air bubbles from plug hole.
- 6) Depress brake pedal until no air bubbles come out of air vent plug hole.
- 7) After completion of air bleeding, securely tighten air vent plug. Install cap on plug.
- 8) Same way for the opposite side.



#### 3. ADJUSTMENT OF PEDAL

#### 1) BRAKE PEDAL

#### (1) Pedal height from floor plate

Adjust with stopper bolt.

· Pedal height: 122~128mm(4.8~5.0in)

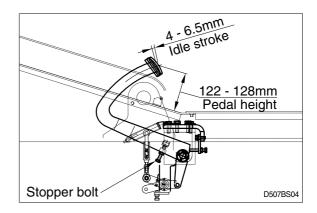
#### (2) Idle stroke

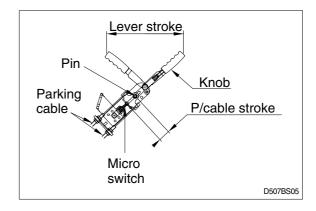
Adjust with rod of master cylinder

· Play: 4~6.5mm(0.16 ~ 0.25in)

#### (3) Micro switch for parking brake (if equipped)

- After assembling parking brake and parking cable, put the parking brake lever released.
- ② Loosen the nut for parking brake plate to play up and down.
- ③ Move up the plate so that the stopper can be contacted with the pin and then reassemble nut.
  - Micro switch stroke when parking brake is applied: 2~3mm(0.08 ~ 0.1in)





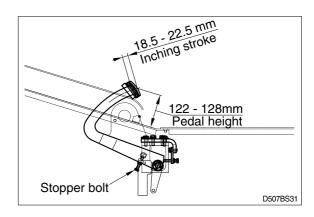
#### 2) INCHING PEDAL

#### (1) Pedal height from floor plate

Adjust with stopper bolt.

Pedal height: 122~128mm(4.8~5.0in)

(2) Adjust bolt so that brake pedal interconnects with inching pedal at inching pedal stroke 18.5~22.5mm(0.72~0.88in).



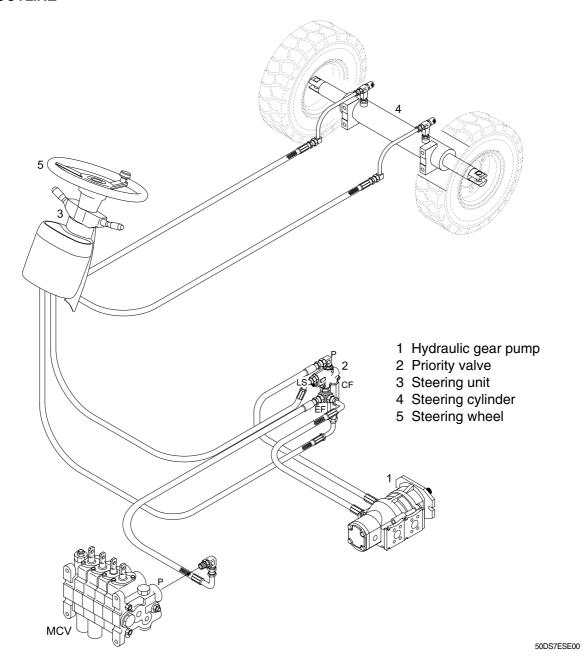
## **SECTION 5 STEERING SYSTEM**

Group	1 Structure and function	5-1
Group	2 Operational checks and troubleshooting	5-11
Group	3 Disassembly and assembly	5-13

## **SECTION 5 STEERING SYSTEM**

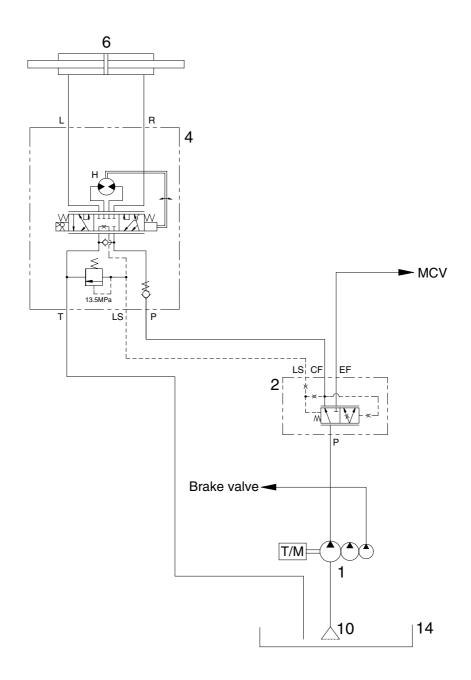
## **GROUP 1 STRUCTURE AND FUNCTION**

#### 1. OUTLINE



The steering system for this machine is composed of steering wheel assembly, steering unit, steering cylinder, trail 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 kingpins. Hub and wheel are mounted through bearing to spindle of knuckle.

## 2. HYDRAULIC CIRCUIT

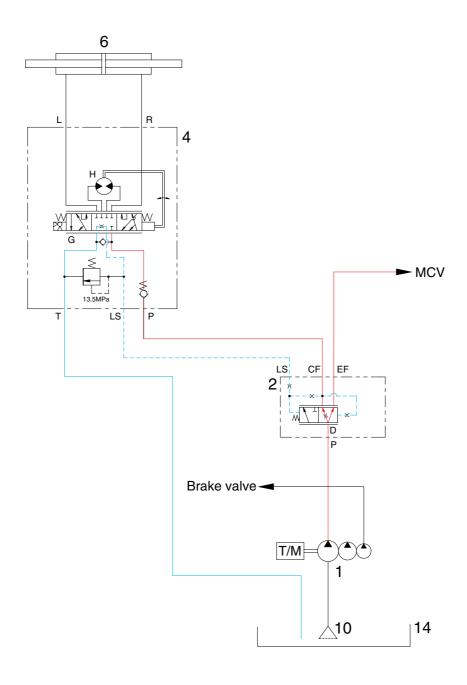


50DS7ESE01

- 1 Hydraulic gear pump
- 2 Priority valve
- 4 Steering unit

- 6 Steering cylinder
- 10 Suction filter
- 14 Hydraulic tank

## 1) NEUTRAL



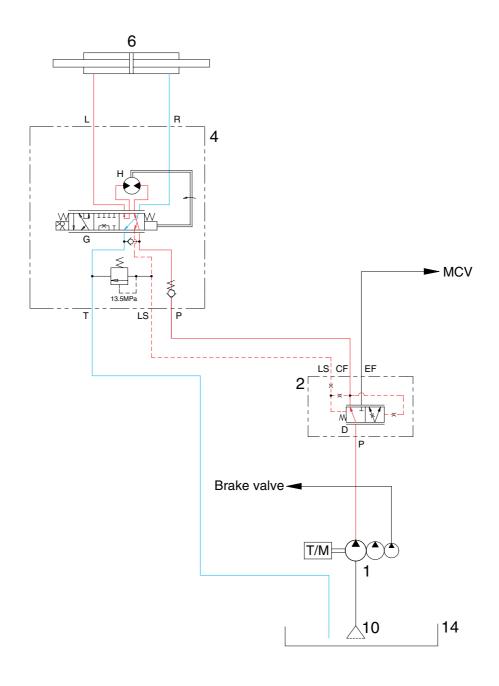
50DS7ESE02

The steering wheel is not being operated, so control spool(G) does not move.

The oil from hydraulic gear pump(1) enters the port P of priority valve(3) and the inlet pressure oil moves the spool(D) to the left.

Oil flow into LS port to the hydraulic tank(14), so the pump flow is routed to the main control valve through the EF port.

#### 2) LEFT TURN



50DS7ESE03

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.

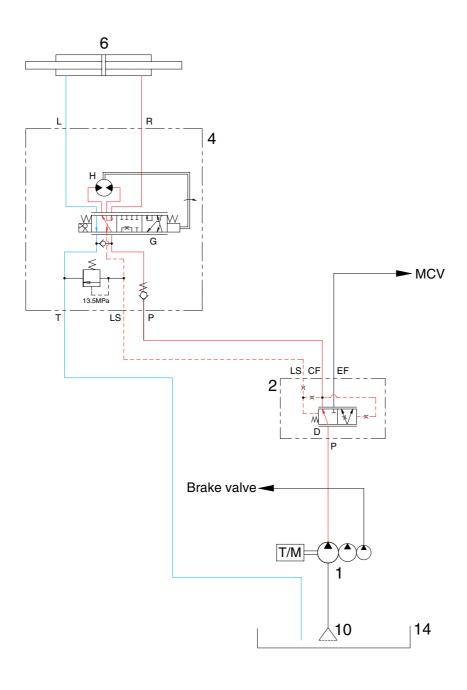
At this time, the oil discharged from the pump flows into the spool(G) the steering unit through the spool(D) of priority valve and flows the gerotor(H).

Oil flow from the gerotor flows back into the spool(G) where it is directed out the left work port(L).

Oil returned from cylinder returns to hydraulic tank(14).

When the above operation is completed, the machine turns to the left.

#### 3) RIGHT TURN



50DS7ESE04

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 pump flows into the spool(G) the steering unit through the spool(D) of priority valve and flows the gerotor(H).

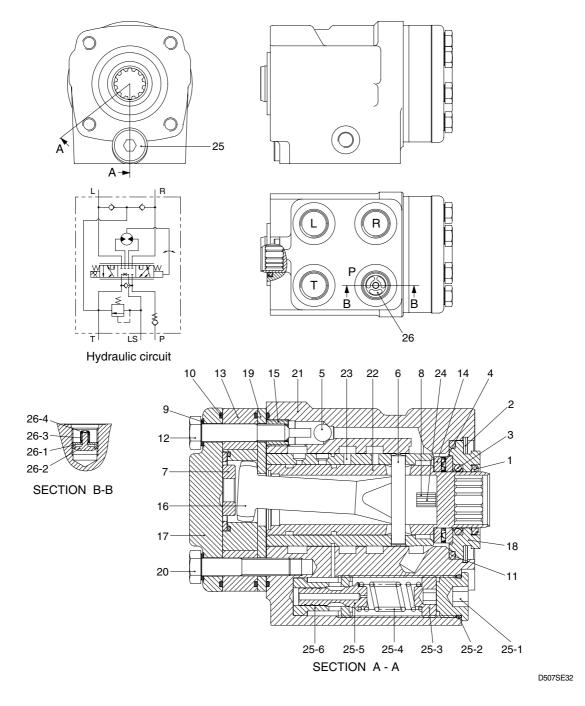
Oil flow from the gerotor flows back into the spool(G) where it is directed out the right work port(R).

Oil returned from cylinder returns to hydraulic tank(14).

When the above operation is completed, the machine turns to the right.

## 3. STEERING UNIT

## 1) STRUCTURE



1	Dust seal	10	O-ring	19	Plate	25-3	Spring seat
2	Retaining ring	11	O-ring	20	Cap screw	25-4	Spring
3	Cap seal	12	Rolled screw	21	Housing	25-5	Spool
4	Thrust bearing	13	Gerotor set	22	Spool	25-6	Bushing
5	Ball	14	Bearing race	23	Sleeve	26	Check valve
6	Pin	15	Bore screw	24	Plate spring	26-1	Guide
7	Spacer	16	Drive shaft	25	Relief valve	26-2	Shim
8	Center spring	17	End cap	25-1	Plug	26-3	Spring
9	Washer	18	Bushing	25-2	O-ring	26-4	Washer

#### 2) OPERATION

The steering unit is composed of the control valve(rotary valve) and the metering device. The control valve controls the flow of oil from the pump in the interior of the unit depending on the condition of the steering wheel. The metering device is a kind of hydraulic motor composed of a stator and a rotor. It meters the required oil volume, feeds the metered oil to the power cylinder and detects cylinder's motion value, that is, cylinder's motion rate.

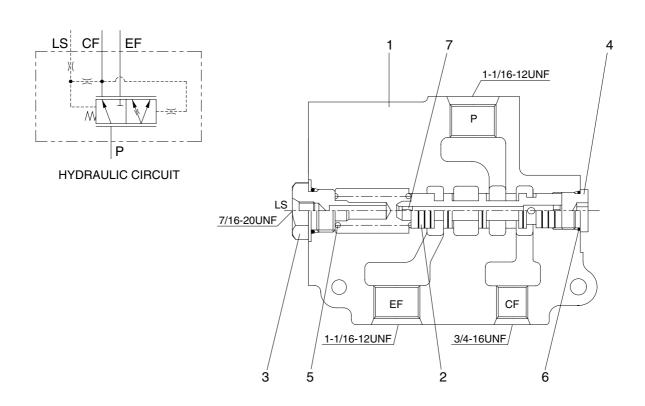
When the steering wheel is turned, the spool turns, the oil path is switched and the oil is fed into the metering device. As a result, the rotor is caused to run by oil pressure, and the sleeve is caused to run through the drive shaft and cross pin. Therefore, when the spool is turned, the spool turns by the same value in such a manner that it follows the motion of the spool. Steering motion can be accomplished when this operation is performed in a continuous state.

⚠ If the hoses of the steering system are incorrectly connected, the steering wheel can turn very rapidly when the engine is started. Keep clear of the steering wheel when starting the engine.

The centering spring for the spool and sleeve is provided to cause the valve to return to the neutral position. It is therefore possible to obtain a constant steering feeling, which is transmitted to the hands of the driver. Return to the center position occurs when the steering wheel is released.

#### 4. PRIORITY VALVE

## 1) STRUCTURE



50DS7ESE06

1	Body	4 End plug
---	------	------------

2 Spool

Spring pulg 6 O-ring

7 Orifice

#### 2) OPERATION

The oil from the hydraulic gear pump flows to the priority valve.

The priority valve supplies a flow of oil to the steering system and lift, tilt system.

Spring

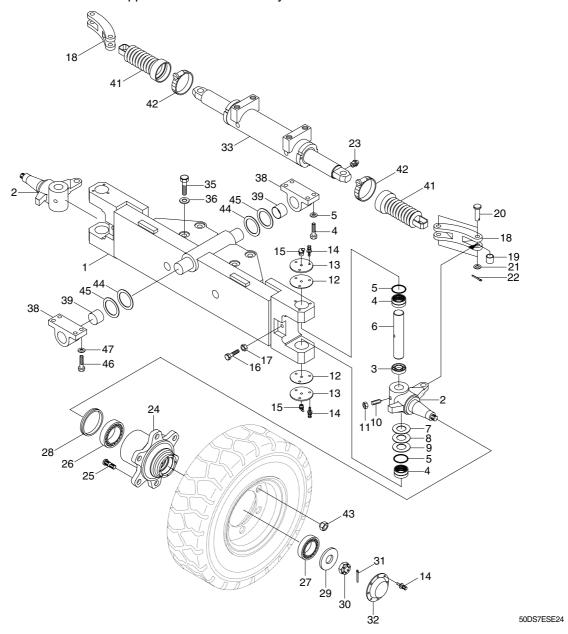
The steering flow is controlled by the steering unit to operate the steering cylinder.

The remainder of the oil flow from the pump flows to the main control valve.

## 5. STEERING AXLE

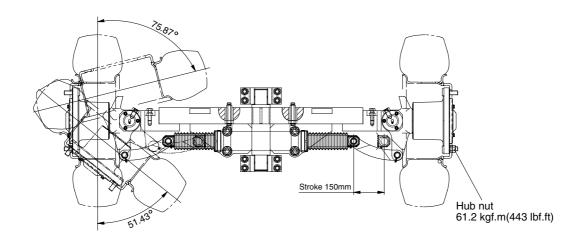
## 1) STRUCTURE

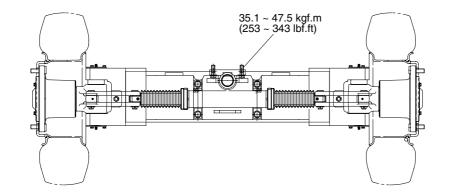
\* Do not remove the stopper bolt unless necessary.



1	Steering axle	12	Gasket	23	Grease nipple	35	Cover
2	Knuckle	13	Cover	24	Hub	36	Hexagon bolt
3	Thrust bearing	14	Bolt w/washer	25	Hub bolt	38	Support
4	Needle bearing	15	Grease nipple	26	Taper roller bearing	39	Bushing
5	Oil seal	16	Hexagon bolt	27	Taper roller bearing	41	Steer cylinder boot
6	King pin	17	Hexagon nut	28	Oil seal	42	Clamp
7	Thrust washer	18	Link	29	Special washer	43	Hub nut
8	Shim washer	19	Inner race bushing	30	Lock nut	44	Shim(1.0t)
9	Shim washer	20	Link pin	31	Split pin	45	Shim(0.5t)
10	Set screw	21	Special washer	32	Hub cap	46	Hexagon bolt
11	Hexagon nut	22	Split pin	33	Steering cylinder	47	Hardened washer

## 2) TIGHTENING TORQUE AND SPECIFICATION





50DS7ESE07

Туре	Unit	Center pin support single shaft
Structure of knuckle	-	Elliott type
Toe-in	degree	0
Camber	degree	0
Caster	degree	0
King pin angle	degree	0
Max steering angle of wheels(Inside/Outside)	degree	75.87/ 51.43
Tread	mm(in)	1604(63.1)

## GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

## 1. OPERATIONAL CHECKS

Check item	Checking procedure		
Steering wheel 30-60mm (1.2-2.4 in)	<ul> <li>Set rear wheels facing straight forward, then turn steering wheel to left and right.         Measure range of steering wheel movement before rear wheel starts to move.         Range should be 30~60mm at rin of steering wheel. If play is too large, adjust at gear box.         Test steering wheel play with engine at idling.</li> </ul>		
Knuckle	Check knuckle visually or use crack detection method. If the knuckle is bent, the tire wear is uneven, so check tire wear.		
Steering axle	<ul> <li>Put camber gauge in contact with hub and measure camber.         If camber is not within 0±0.5°; rear axle is bent.     </li> <li>Ask assistant to drive machine at minimum turning radius.</li> <li>Fit bar and a piece of chalk at outside edge of counterweight to mark line of turning radius.</li> <li>If minimum turning radius is not within±100mm (±4in)of specified value, adjust turning angle stopper bolt.         Min turning radius(Outside)     </li> <li>50DS-7E 3270mm(128in)</li> <li>60DS-7E 3315mm(130in)</li> <li>70DS-7E 3360mm(132in)</li> </ul>		
Hydraulic pressure of power steering	Remove plug from outlet port of flow divider and install oil pressure gauge.  Turn steering wheel fully and check oil pressure.  ** Oil pressure: 135 ~ 140 kgf/cm² (132 ~ 137bar)		

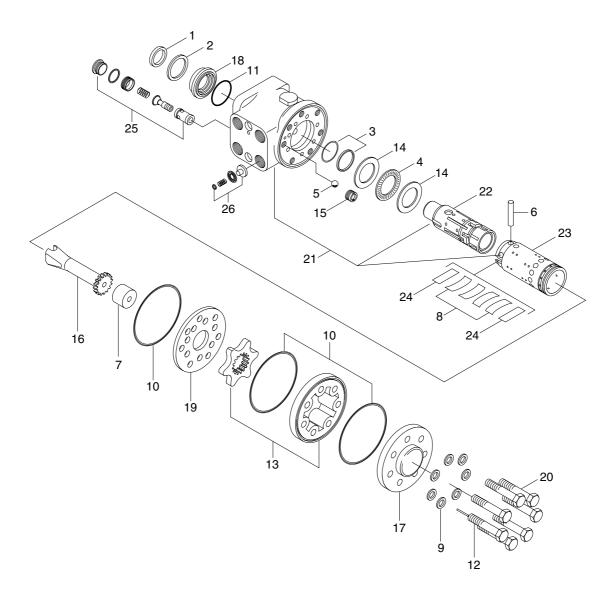
## 2. TROUBLESHOOTING

Problem	cause	Remedy
Steering wheel drags.	· Low oil pressure.	· Check lockout. Repair.
	· Bearing faulty.	· Clean or replace.
	· Spring spool faulty.	· Clean or replace.
	· Reaction plunger faulty.	· Replace.
	· Ball-and-screw assembly faulty.	· Clean or replace.
	· Sector shaft adjusting screw excessi-	· Adjust.
	vely tight.	
	· Gears poorly meshing.	· Check and correct meshing.
	· Flow divider coil spring fatigued.	· Replace.
Steering wheel fails to return	· Bearing faulty.	· Clean or replace.
smoothly.	· Reaction plunger faulty.	· Replace.
	· Ball-and-screw assy faulty	· Clean or replace.
	· Gears poorly meshing.	· Check and correct meshing.

cockout loosening. letal spring deteriorated. ear backlash out of adjustment. lockout loosening. ir in oil circuit. //e aulty. (Valve fails to open.) ing ipe(from pump to power steering	<ul> <li>Retighten.</li> <li>Replace.</li> <li>Adjust.</li> <li>Retighten.</li> <li>Bleed air.</li> </ul> Adjust valve set pressure and check for specified oil pressure.
ear backlash out of adjustment.  ockout loosening. ir in oil circuit.  re aulty. (Valve fails to open.)  ng ipe(from pump to power steering	<ul> <li>Adjust.</li> <li>Retighten.</li> <li>Bleed air.</li> </ul> Adjust valve set pressure and check for specified oil pressure.
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ve aulty. (Valve fails to open.) ng ipe(from pump to power steering	Adjust valve set pressure and check for specified oil pressure.
aulty. (Valve fails to open.)  ng ipe(from pump to power steering	for specified oil pressure.
ng ipe(from pump to power steering	for specified oil pressure.
ipe(from pump to power steering	·
ipe(from pump to power steering	
	. Renair or renlace
/linder) dented or cloaged	· Repair or replace.
, , , , , , , , , , , , , , , , , , , ,	
•	· Add oil.
	Repair.     Bleed air completely.
	· bleed all completely.
-	· Repair or replace.
	ricpail of replace.
	· Adjust valve set pressure and check
,	specified oil pressure.
_	·
	· Repair or replace.
	· Bleed air completely.
low control valve orifice clogged.	· Clean
ng	
ipe(from tank to pipe) dented or	· Repair or replace.
ogged.	
acking foreign materal.	· Replace
iston rod damage.	· Grind surface with oil stone.
od seal damage and distortion.	· Replace
hrome gilding damage.	· Grind
-ring damage.	· Replace
ylinder tube damage.	· Tube replace.
ube inside damage.	· Grind surface with oil store.
•	· Replace
	· Replace
•	
	plectrom pump to power steering ylinder) dented or clogged.  pump ack of oil.  ill inlet pipe sucks air.  sufficient air bleeding.  pump  ill inlet pipe sucks air.  //e  aulty. (Unbalance oil pressure)  ing  ipe(from pump to power steering)  ented or clogged.  aufficient air bleeding.  low control valve orifice clogged.  ing  ipe(from tank to pipe) dented or logged.  acking foreign materal.  iston rod damage.  od seal damage and distortion.  hrome gilding damage.  -ring damage.  ylinder tube damage.  ube inside damage and distortion  ushing wear.

## GROUP 3 DISASSEMBLY AND ASSEMBLY

# 1. STEERING UNIT 1) STRUCTURE

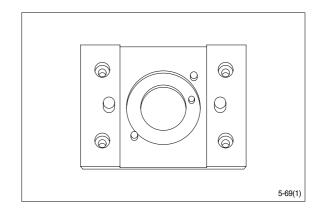


50DS7ESE05

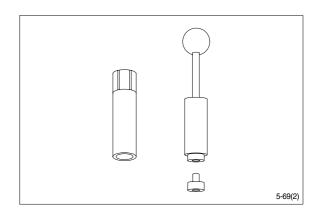
1	Dust seal	10	O-ring	19	Plate
2	Retaining ring	11	O-ring	20	Cap screw
3	Cap seal	12	Rolled screw	21	Housing
4	Thrust bearing	13	Gerotor set	22	Spool
5	Ball	14	Bearing race	23	Sleeve
6	Pin	15	Bore screw	24	Plate spring
7	Spacer	16	Drive shaft	25	Relief valve
8	Center spring	17	End cap	26	Check valve
9	Washer	18	Bushing		

## 2) TOOLS

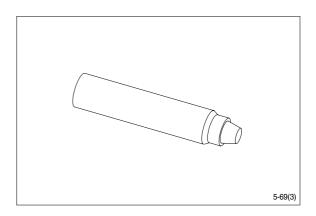
(1) Holding tool.



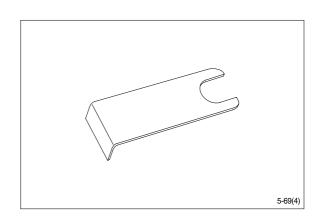
(2) Assembly tool for O-ring and kin-ring.



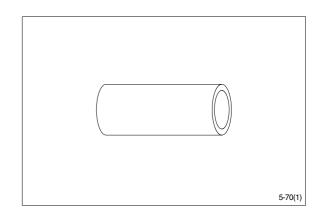
(3) Assembly tool for lip seal.



(4) Assembly tool for cardan shaft.



#### (5) Assembly tool for dust seal.



## (6) Torque wrench $0 \sim 7.1 \text{kgf} \cdot \text{m}$ $(0 \sim 54.4 \text{lbf} \cdot \text{ft})$

13mm socket spanner

6,8mm and 12mm hexagon sockets

12mm screwdriver

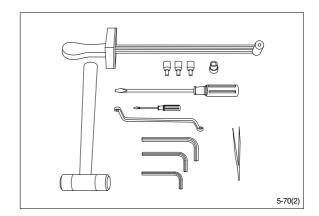
2mm screwdriver

13mm ring spanner

6, 8 and 12mm hexagon socket spanners

Plastic hammer

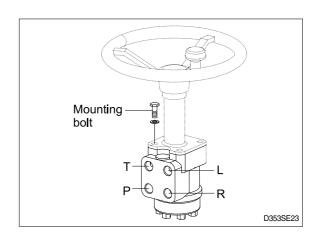
**Tweezers** 



#### 3) TIGHTENING TORQUE

L : Left port R : Right port T : Tank

P : Pump

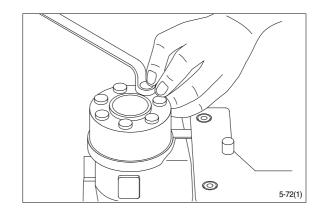


Port	Size	Torque [kgf ⋅ m(lbf ⋅ ft)]		
L	3/4 - 16UNF	6.1±0.6 (44±4.3)		
R	3/4 - 16UNF	6.1 ± 0.6 (44 ± 4.3)		
Т	3/4 - 16UNF	6.1±0.6 (44±4.3)		
Р	3/4 - 16UNF	6.1±0.6 (44±4.3)		
Mounting bolt	M10×1.5	4.0 ±0.5 (29±3.6)		

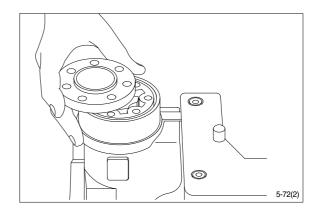
## 4) DISASSEMBLY

(1) Disassemble steering column from steering unit and place the steering unit in the holding tool.

Screw out the screws in the end cover(6-off plus one special screw).

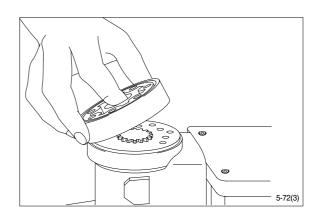


(2) Remove the end cover, sideways.

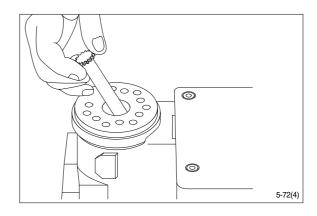


(3) Lift the gearwheel set(With spacer if fitted) off the unit.

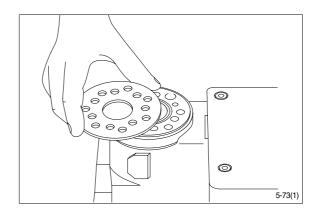
Take out the two O-rings.



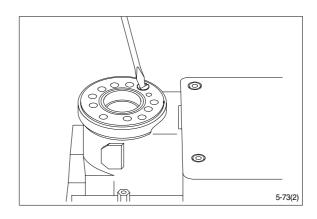
(4) Remove cardan shaft.



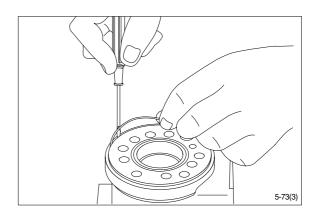
(5) Remove distributor plate.



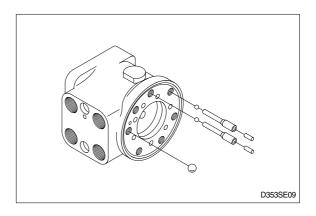
(6) Screw out the threaded bush over the check valve.



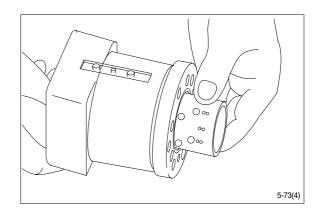
(7) Remove O-ring.



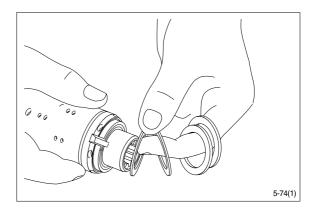
(8) Shake out the check valve ball and suction valve pins and balls.



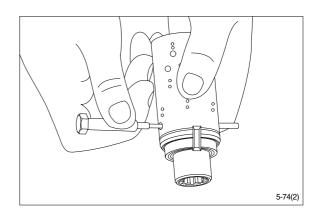
(9) Take care to keep the cross pin in the sleeve and spool horizontal. The pin can be seen through the open end of the spool. Press the spool inwards and the sleeve, ring, bearing races and thrust bearing will be pushed out of the housing together.



(10) Take ring, bearing races and thrust bearing from sleeve and spool. The outer (Thin) bearing race can sometimes "stick" in the housing, therefore check that it has come out.

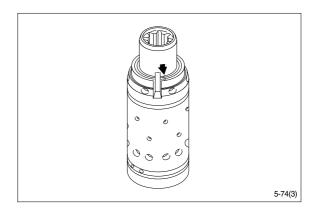


(11) Press out the cross pin. Use the special screw from the end cover.

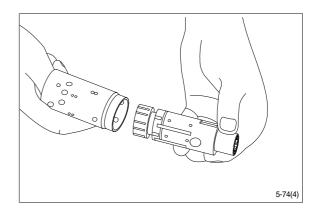


\*\* A small mark has been made with a pumice stone on both spool and sleeve close to one of the slots for the neutral position springs(See drawing).

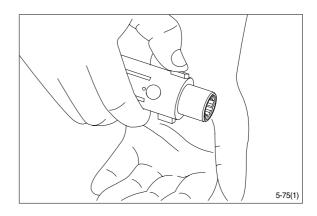
If the mark is not visible, remember to leave a mark of your own on sleeve and spool before the neutral position springs are disassembled.



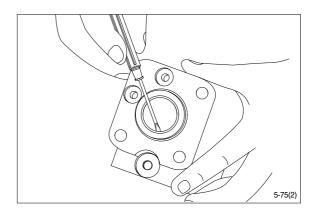
(12) Carefully press the spool out of the sleeve.



(13) Press the neutral position springs out of their slots in the spool.



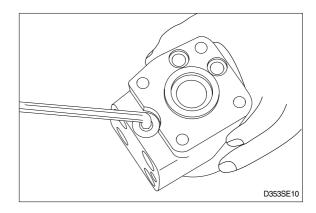
(14) Remove dust seal and O-ring.



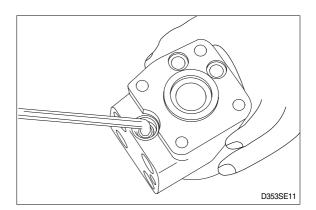
## Disassembling the pressure relief valve

(15) Screw out the plug using an 8mm hexagon socket spanner.

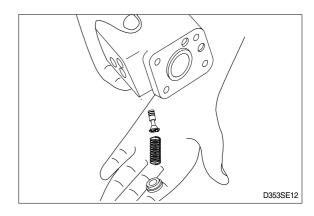
Remove seal washers.



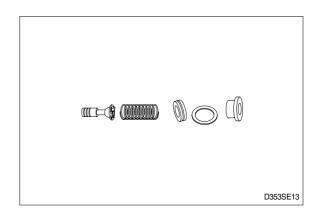
(16) Unscrew the setting screw using an 8mm hexagon socket spanner.



(17) Shake out spring and piston. The valve seat is bonded into the housing and cannot be removed.

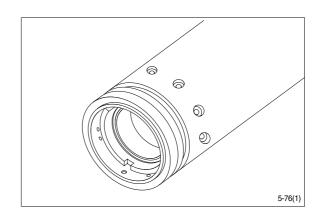


(18) The pressure relief valve is now disassembled.



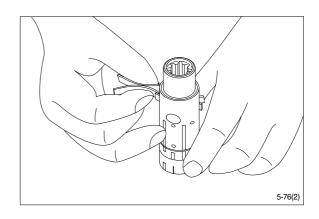
#### 5) ASSEMBLY

- (1) Assemble spool and sleeve.
- When assembling spool and sleeve only one of two possible ways of positioning the spring slots is correct. There are three slots in the spool and three holes in the sleeve in the end of the spool / sleeve opposite to the end with spring slots. Place the slots and holes opposite each other so that parts of the holes in the sleeve are visible through the slots in the spool.

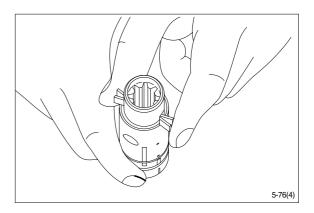


(2) Place the two flat neutral position springs in the slot.

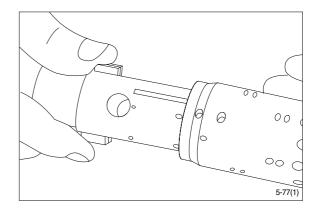
Place the curved springs between the flat ones and press them into place (see assembly pattern).



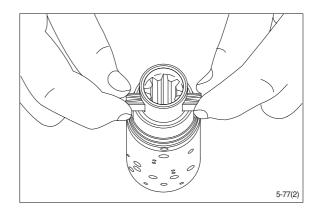
(3) Line up the spring set.



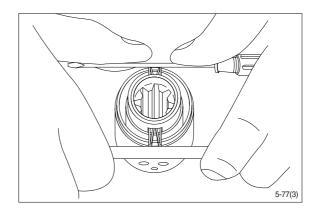
(4) Guide the spool into the sleeve. Make sure that spool and sleeve are placed correctly in relation to each other.



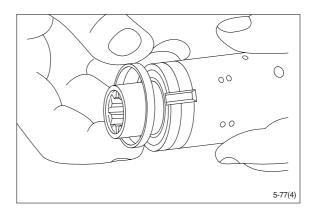
(5) Press the springs together and push the neutral position springs into place in the sleeve.



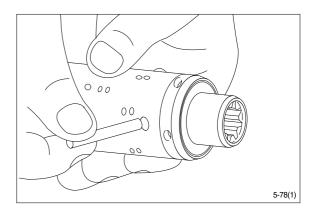
(6) Line up the springs and center them.



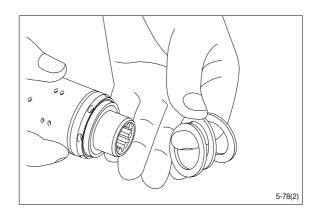
- (7) Guide the ring down over the sleeve.
- \* The ring should be able to rotate free of the springs.



(8) Fit the cross pin into the spool / sleeve.

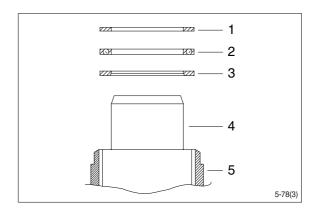


(9) Fit bearing races and needle bearing as shown on below drawing.



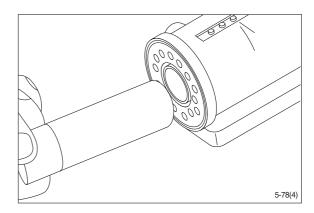
#### \* Assembly pattern for standard bearings

- 1 Outer bearing race
- 2 Thrust bearing
- 3 Inner bearing race
- 4 Spool
- 5 Sleeve

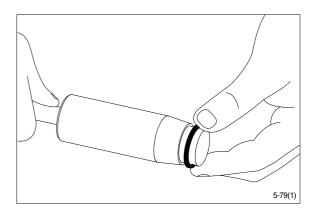


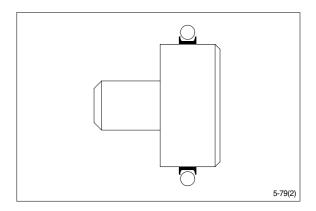
## Installation instruction for O-ring

(10) Turn the steering unit until the bore is horizontal. Guide the outer part of the assembly tool into the bore for the spool / sleeve.

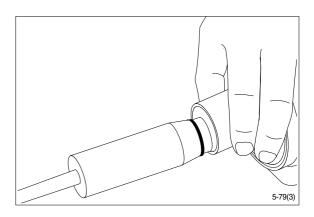


(11) Grease O-ring with hydraulic oil and place them on the tool.

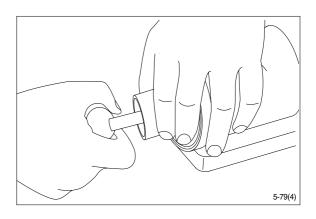




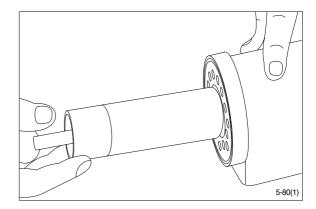
(12) Hold the outer part of the assembly tool in the bottom of the steering unit housing and guide the inner part of the tool right to the bottom.



(13) Press and turn the O-ring into position in the housing.

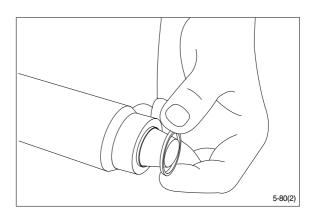


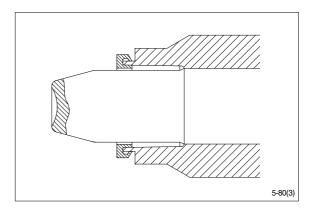
(14) Draw the inner and outer parts of the assembly tool out of the steering unit bore, leaving the guide from the inner part in the bore.



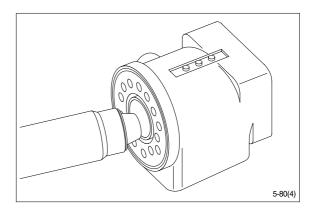
#### Installation instructions for lip seal

(15) Lubricate the lip seal with hydraulic oil and place it on the assembly tool.

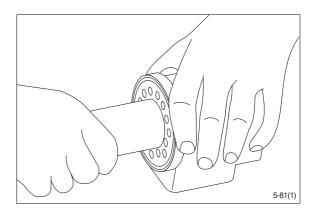




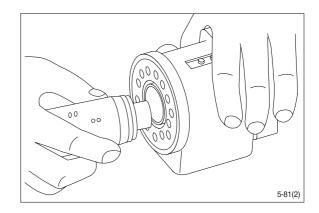
(16) Guide the assembly tool right to the bottom.



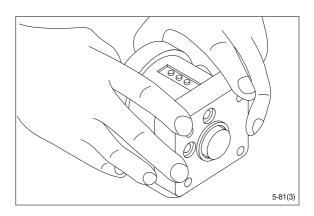
(17) Press and turn the lip seal into place in the housing.



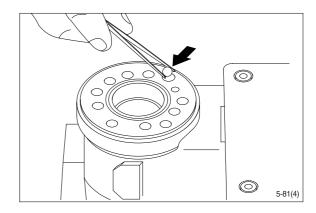
- (18) With a light turning movement, guide the spool and sleeve into the bore.
- \* Fit the spool set holding the cross pin horizontal.



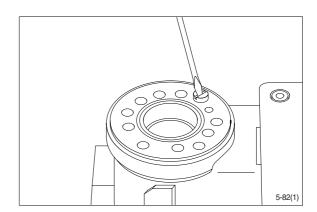
(19) The spool set will push out the assembly tool guide. The O-ring are now in position.



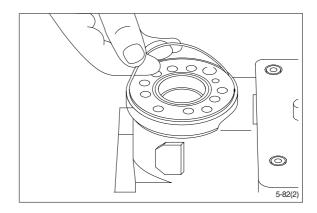
(20) Turn the steering unit until the bore is vertical again. Put the check valve ball into the hole indicated by the arrow.



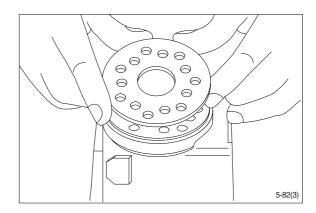
(21) Screw the threaded bush lightly into the check valve bore. The top of the bush must lie just below the surface of the housing.



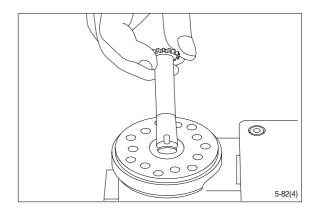
(22) Grease the O-ring with mineral oil approx. viscosity 500 cSt at 20℃.



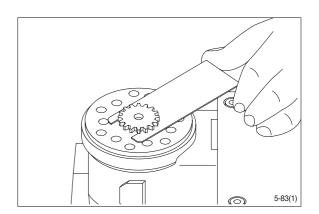
(23) Place the distributor plate so that the channel holes match the holes in the housing.



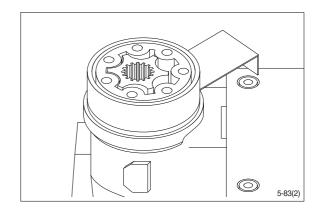
(24) Guide the cardan shaft down into the bore so that the slot is parallel with the connection flange.



(25) Place the cardan shaft as shown - so that it is held in position by the mounting fork.



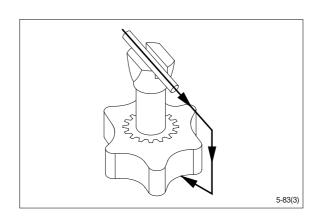
(26) Grease the two O-rings with mineral oil approx. viscosity 500 cSt at 20°C and place them in the two grooves in the gear rim. Fit the gearwheel and rim on the cardan shaft.



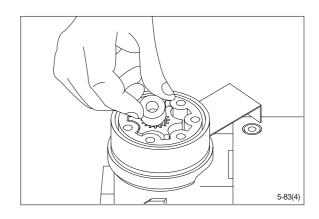
#### (27) Important

Fit the gearwheel(Rotor) and cardan shaft so that a tooth base in the rotor is positioned in relation to the shaft slot as shown.

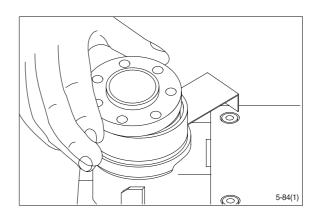
Turn the gear rim so that the seven through holes match the holes in the housing.



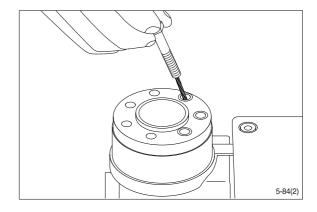
(28) Fit the spacer, if any.



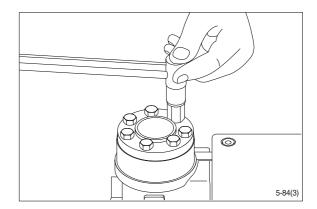
(29) Place the end cover in position.



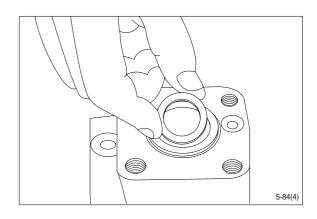
(30) Fit the special screw with washer and place it in the hole shown.



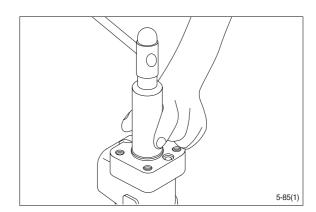
- (31) Fit the six screws with washers and insert them. Cross-tighten all the screws and the rolled pin.
  - $\cdot$  Tightening torque : 4.0  $\pm~$  0.5kgf  $\cdot$  m (28.9  $\pm~$  3.6lbf  $\cdot$  ft)



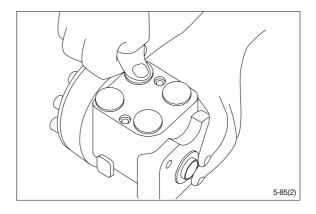
(32) Place the dust seal ring in the housing.



(33) Fit the dust seal ring in the housing.

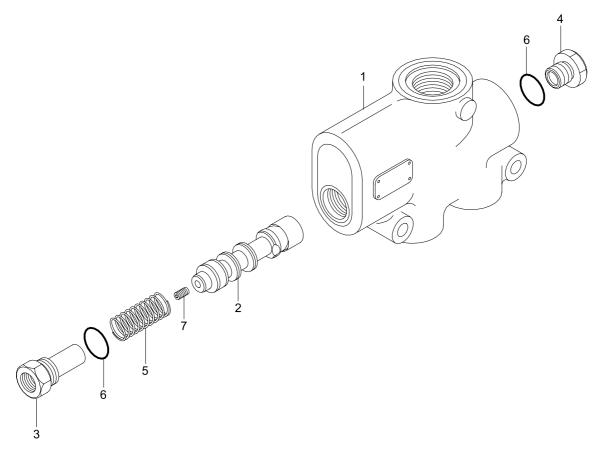


- (34) Press the plastic plugs into the connection ports.
- \* Do not use a hammer!



# 2. PRIORITY VALVE

# 1) STRUCTURE



50DS7ESE08

- 1 Body
- 2 Spool
- 3 Spring plug
- 4 End plug
- 5 Spring
- 6 O-ring

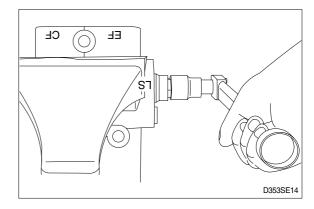
7 Orifice

#### 2) DISASSEMBLY

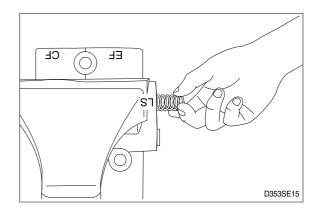
\*\* Cleanliness is the primary means of assuring satisfactory the priority valve life. Select clean place.

Before removing the piping, clean the surrounding area of valve ports.

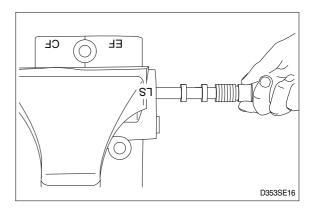
- (1) Fix the body(1) in a vise with copper or lead sheets.
  - Do not over tighten jaws.
- (2) Loosen plug(3) for LS port.



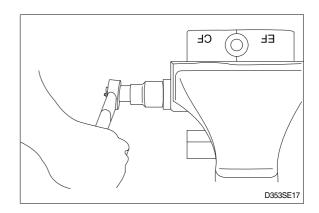
(3) Remove spring(5).



- (4) Remove spool assy(2).
- « Can't remove the orifice(7) from spool(2), because the orifices were locked at the spool.

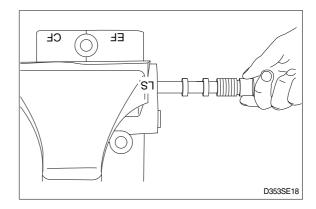


(5) Remove plug(4) and separate O-ring(6) and plug(3, 4) individually.

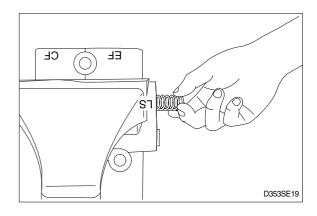


#### 3) ASSEMBLY

- \*\* Clean all metal parts in clean solvent and blow dry with air and correct any damage, burrs and rust.
- \* Do not wipe dry with cloth or paper towel.
- \* Replace seals such as O-ring with new ones as a rule and coat with grease.
- (1) Fix the body(1) in a vise.
- (2) Insert the spool(2).
- Secure the spool(2) remain in their correct direction.
- Secure the spool(2) to move smoothly by finger.

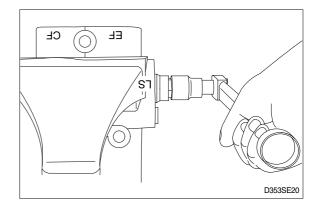


(3) Insert the spring(5) into the body(1).



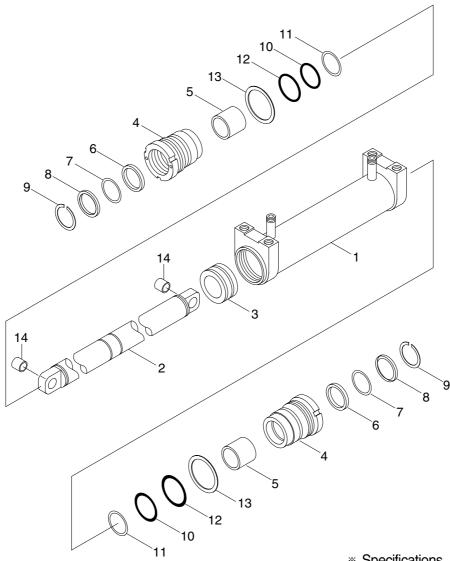
(4) Install the O-ring(6) onto plug(3, 4) and install the plug(3, 4) into the body(1).

· Tighten torque : 4.5kgf · m(32.5lbf · ft)



#### 3. STEERING CYLINDER

# 1) STRUCTURE



\* Specifications

· Cylinder bore : 80mm · Outer diameter : 94mm

· Stroke(half) : 150mm

· Rod diameter : 55mm

D507SE21

ı	rube assy
2	Rod

3 Piston seal

4 Gland

5 Bushing 6 Rod seal

Back up ring 7

8 **Dust wiper** 

9 Snap ring

10 O-ring

Back up ring 11

12 O-ring

13 Lock washer

Pin bushing

#### 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.

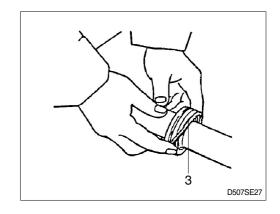
#### 3) CHECK AND INSPECTION

mm(in)

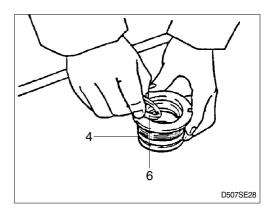
Object Nove	Crit	eria	Remaks	
Check item	Standard size Repair limit		nemaks	
Clearance between piston & cylinder tube	0.05~0.25		Replace piston seal	
Clearance between cylinder rod & bushing	0.05~0.18 (0.002~0.007)	0.3 (0.01)	Replace bushing	
Seals, O-ring	Damage		Replace	
Cylinder rod	De	nts	Replace	
Cylinder tube	Bit	ing	Replace	

#### 4) ASSEMBLY

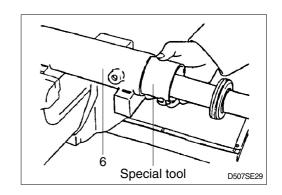
- (1) Install a new piston seal(3) around the groove on the piston.
- \* Be careful not to scratch the seal too much during installation or it could not be seated properly.



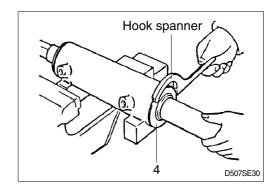
(2) Install the rod seal(6) to the position in the gland(4) applying a slight coat with grease prior to install.



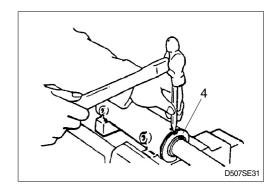
- (3) Install the dust wiper(8) to the gland(4) using a special installing tool. Coat the dust wiper with grease slightly before installing.
- (4) Using a special tool, install gland assembly into the cylinder tube(1).



(5) Using a hook spanner, install the gland(4) assembly, and tighten it with torque  $60\pm6$ kgf  $\cdot$  m (434 $\pm4$ 3lbf  $\cdot$  ft).



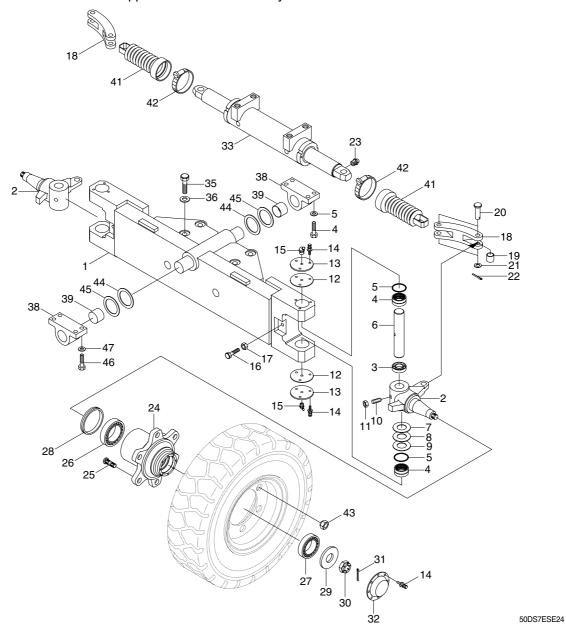
- (6) After the gland(4) assembly was installed to the cylinder tube(1), calk at the tube end into the groove on the gland to prevent screw loos-ening.
- \* If it is needed to calk again, never calk on the same place.



- (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.

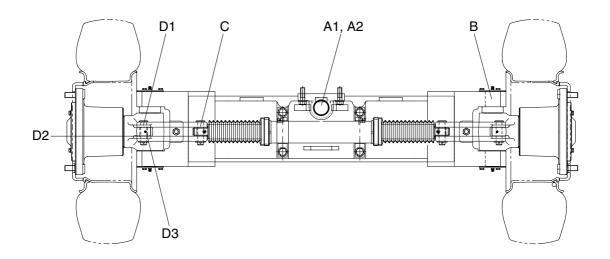
# 4. STEERING AXLE

# 1) STRUCTURE



1	Steering axle	12	Gasket	23	Grease nipple	35	Cover
2	Knuckle	13	Cover	24	Hub	36	Hexagon bolt
3	Thrust bearing	14	Bolt w/washer	25	Hub bolt	38	Support
4	Needle bearing	15	Grease nipple	26	Taper roller bearing	39	Bushing
5	Oil seal	16	Hexagon bolt	27	Taper roller bearing	41	Steer cylinder boot
6	King pin	17	Hexagon nut	28	Oil seal	42	Clamp
7	Thrust washer	18	Link	29	Special washer	43	Hub nut
8	Shim washer	19	Inner race bushing	30	Lock nut	44	Shim(1.0t)
9	Shim washer	20	Link pin	31	Split pin	45	Shim(0.5t)
10	Set screw	21	Special washer	32	Hub cap	46	Hexagon bolt
11	Hexagon nut	22	Split pin	33	Steering cylinder	47	Hardened washer

# 2) CHECK AND INSPECTION



50DS7ESE25

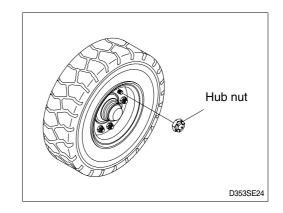
unit: mm(in)

Na		مام ماد	:1	Crit	Remarks	
No.	C	heck	ilem	Standard size	Repair limit	nemarks
	Shaft	A1	OD of shaft	60(2.4)	59.5(2.3)	
Α	Shait	A2	ID of bushing	60(2.4)	59.5(2.3)	
В	OD of king pin		50(2.0)	49.8(2.0)	Replace	
С	OD of steering cylinder pin		22(0.9)	21.9(0.9)		
		D1	OD of pin	22(0.9)	21.9(0.9)	
D	Knuckle	D2	Vertical play	-	0.2(0.008)	Adjust shim
		D3	ID of bushing	22(0.9)	22.5(0.9)	Replace

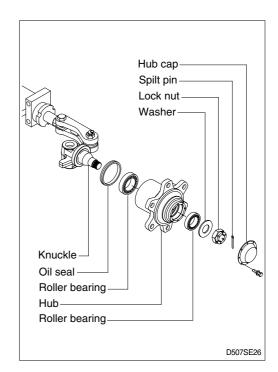
· OD : Outer diameter · ID : Inner diameter

#### 3) DISASSEMBLY

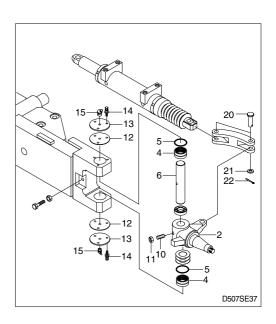
- \*\* Servicing work on the knuckle part can be carried out without removing the axle assy from chassis. The work can be done by jacking up the balance weight part of the truck.
- (1) Loosen the hub nut and take off the steering wheel tire.



- (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(10) and nut(11).
- (9) Loosen with washer bolt(14) and remove cover (13), gasket(12). Remove grease nipple(15).
- (10) Push out the king pin(6) without damaging the knuckle arm(2).
- (11) At the same time the king pin is removed, pull out the oil seal(5).
- (12) If defect is observed in needle bearing(4), pull it out by using extractor.
- (13) Remove spilt pin(22), special washer(21) and link pin(20).



#### 4) ASSEMBLY

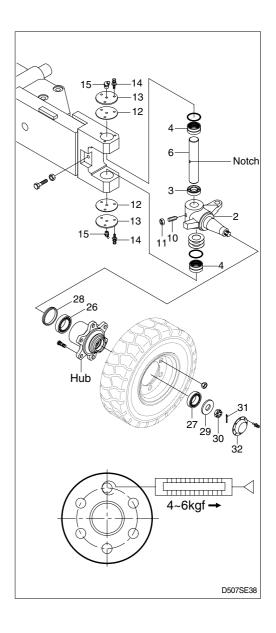
\*\* In reassembling, have all parts washed, grease applied to lubricating parts, and all expendable items such as oil seal and spring washers replaced by new ones.

Perform the disassembly in reverse order.

- (1) Tighten the set screw(10) of king pin(6).
- (2) There is a notch in the middle of the king pin(6), make sure that this notch is on the set screw side.
- (3) Do not hammer to drive in needle bearing(4) because it will break.
  Always use drive-in tool. In assembling the thrust bearing(3), be sure that the fixed ring of the bearing is placed in position facing the knuckle(2).

#### (4) Hub

- ① Mount oil seal(28) and inner race of tapered roller bearing(26) on the knuckle. The bearing should be well greased before assembling.
- ② Install the outer race of the bearing(27) in the wheel center and assemble to the knuckle.
- ③ Put washer(29) in place, tighten with nut(31) and locked with split pin(30). 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(32). Bearing should be well greased before assembling.



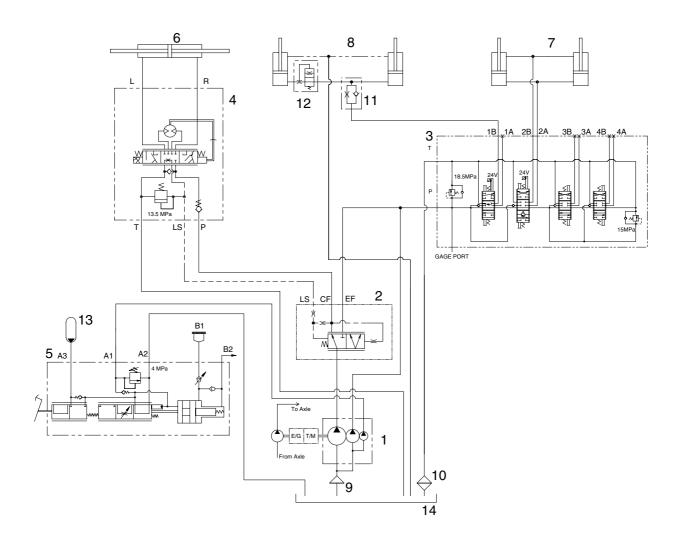
# SECTION 6 HYDRAULIC SYSTEM

Group	1 Structure and function	· 6-1
Group	2 Operational checks and troubleshooting	·· 6-15
Group	3 Disassembly and assembly	·· 6-19

# **SECTION 6 HYDRAULIC SYSTEM**

# **GROUP 1 STRUCTURE AND FUNCTION**

#### 1. HYDRAULIC CIRCUIT

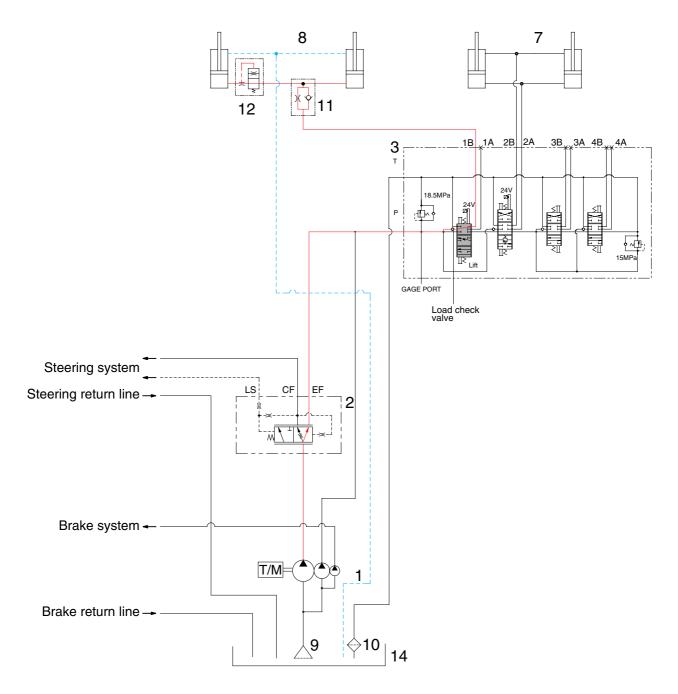


50DS7EHS01

- 1 Hydraulic gear pump
- 2 Priority valve
- 3 Main control valve
- 4 Steering unit
- 5 Brake valve
- 6 Steering cylinder
- 7 Tilt cylinder

- 8 Lift cylinder
- 9 Suction filter
- 10 Return filter
- 11 Down control valve
- 12 Down safety valve
- 13 Accumulator
- 14 Hydraulic tank

# 1) WHEN THE LIFT CONTROL LEVER IS IN THE LIFT POSITION



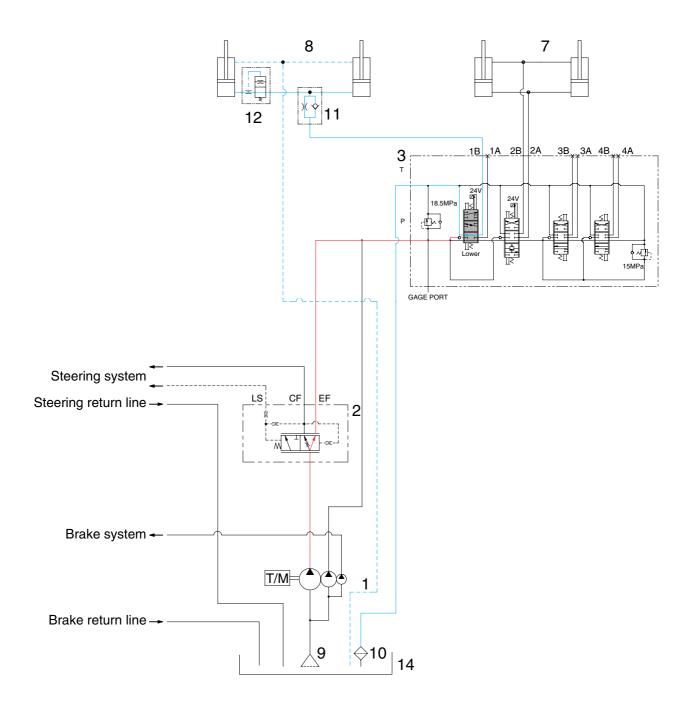
50DS7EHS02

When the lift control lever is pulled back, the spool on the first block is moves to lift position.

The oil from hydraulic gear pump(1) flows into main control valve(3) and then goes to the large chamber of lift cylinder(8) by pushing the load check valve of the spool.

The oil from the small chamber of lift cylinder(8) returns to hydraulic oil tank(14) at the same time. When this happens, the forks go up.

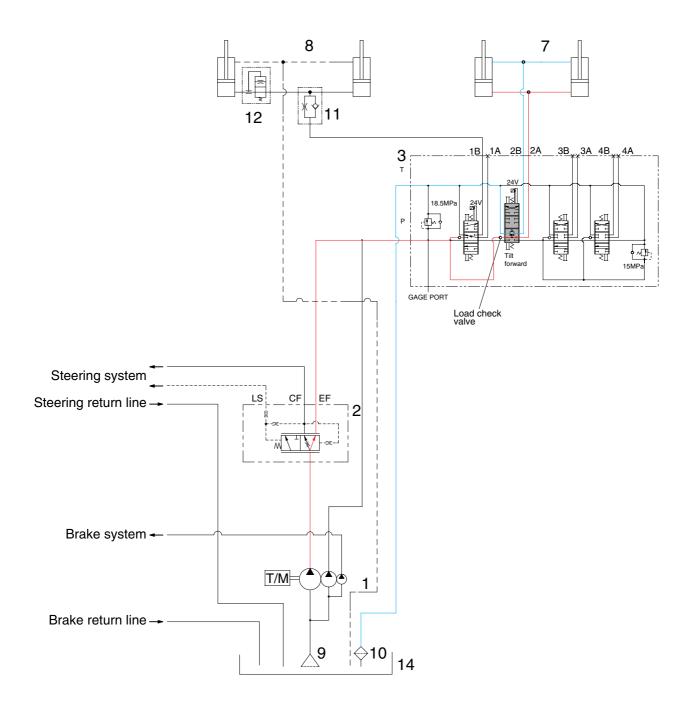
# 2) WHEN THE LIFT CONTROL LEVER IS IN THE LOWER POSITION



50DS7EHS03

When the lift control is pushed forward, the spool on the first block is moved to lower position. The work port(1B) 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



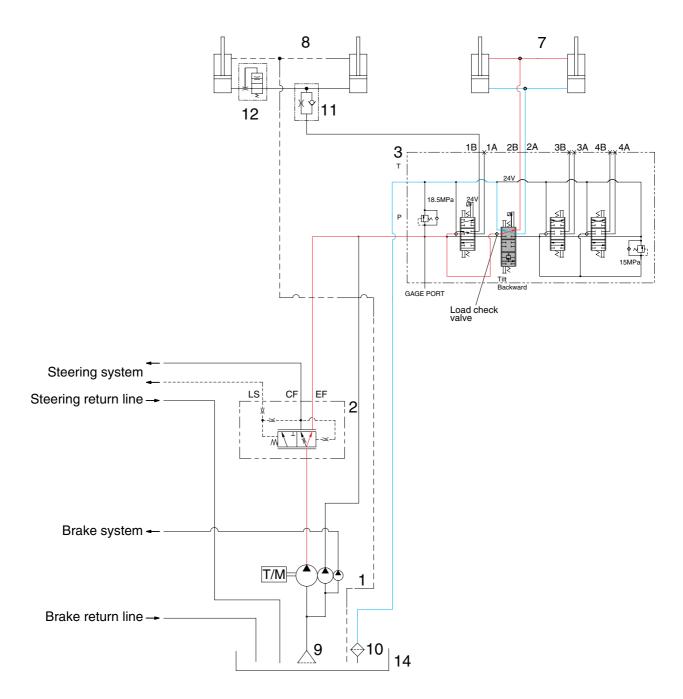
50DS7EHS04

When the tilt control lever is pushed forward, the spool on the second block is moved to tilt forward position.

The oil from hydraulic gear pump(1) flows into main control valve(3) and then goes to the large chamber of tilt cylinder(7) by pushing the load check valve of the spool.

The oil at the small chamber of tilt cylinder(7) returns to hydraulic tank(14) at the same time. When this happens, the mast tilt forward.

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



50DS7EHS05

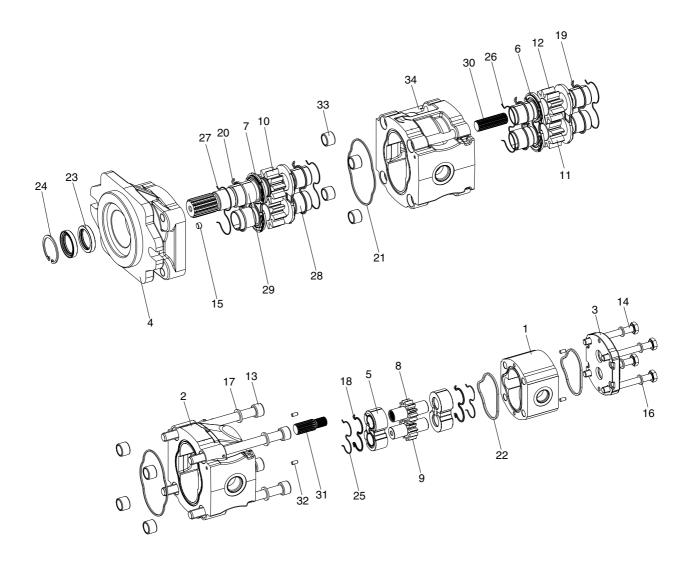
When the tilt control lever is pulled back, the spool on the second block is moved to tilt backward position.

The oil from hydraulic gear pump(1) flows into main control valve(3) and then goes to the small chamber of tilt cylinder(7) by pushing the load check valve of spool.

The oil at the large chamber of tilt cylinder(7) returns to hydraulic tank(14) at the same time. When this happens, the mast tilt backward.

# 2. HYDRAULIC GEAR PUMP

# 1) STRUCTURE

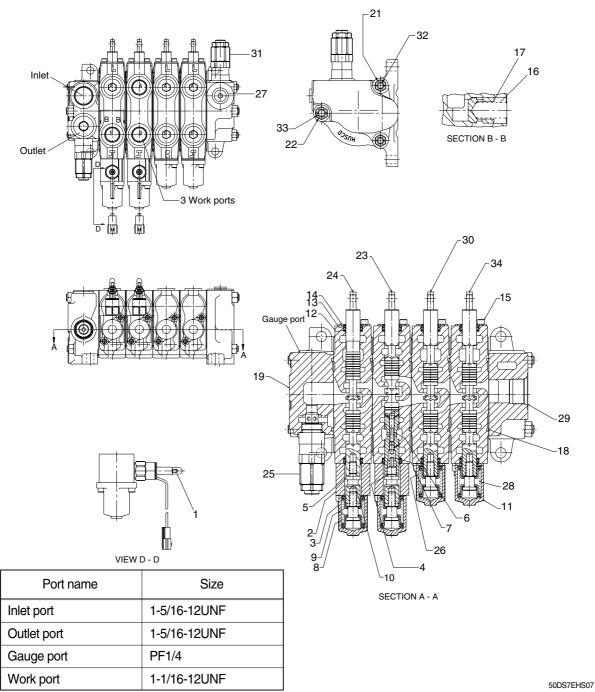


80D7HS06

1	Body	13	Screw	25	Antiextrusion
2	Body	14	Screw	26	Antiextrusion ring
3	Rear cover	15	Grub screw	27	Upper antiextrusion ring
4	Cover	16	Washer	28	Sleeve bearing
5	Thrust plate	17	Washer	29	Upper sleeve bearing
6	Thrust plate	18	Seal	30	Hub
7	Upper thrust plate	19	Seal	31	Hub
8	Drive gear	20	Upper seal	32	Dowel pin
9	Driven gear	21	Standard seal	33	Steel bushing
10	Drive shaft	22	Seal	34	G. housing
11	Driven gear	23	Shaft seal		
12	Drive shaft	24	Ring		

#### 3. MAIN CONTROL VALVE

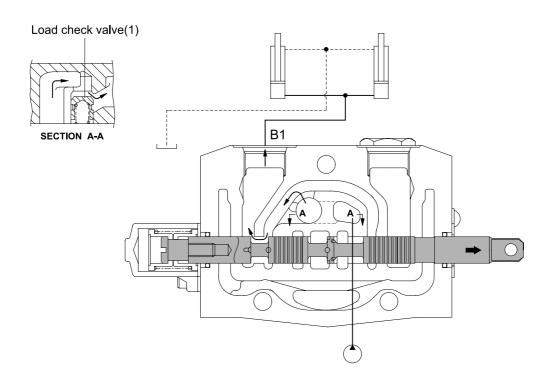
# 1) STRUCTURE(4 Spool)



1	Solenoid valve	13	Wiper	25	Main relief valve
'	_		•		
2	Cap	14	Plate	26	Cap
3	Cap	15	Screw	27	Plug
4	Spool end	16	Spring	28	Spring
5	Spool end	17	Poppet	29	Outlet section assy
6	Piston	18	O-ring	30	Spool section assy(Aux)
7	Spring	19	Inlet section assy	31	Relief valve assy
8	Seal plate	20	Plug	32	Tie rod
9	Spring seat	21	Nut	33	Tie rod
10	Spool end	22	Nut	34	Spool section assy(Aux)
11	Cap	23	Spool section assy(Tilt)		
12	Seal	24	Spool section assy(Lift)		

#### 2) LIFT SECTION OPERATION

# (1) Lift position



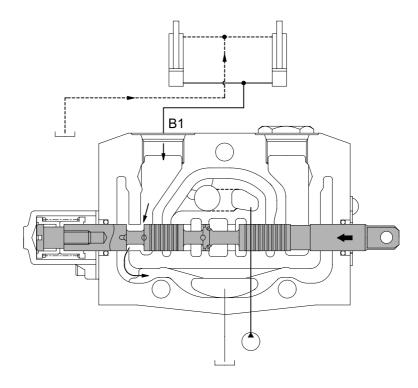
D353HS08

When the lift control lever is pulled back, the spool moves to the right and the neutral passage is closed.

The oil supplied from the pump pushes up the load check valve(1) and flow into lift cylinder port(B1). The pump pressure reaches proportionally the load of cylinder and fine control finished by shut off of the neutral passage.

The return oil from cylinder flows into the tank.

# (2) Lower position



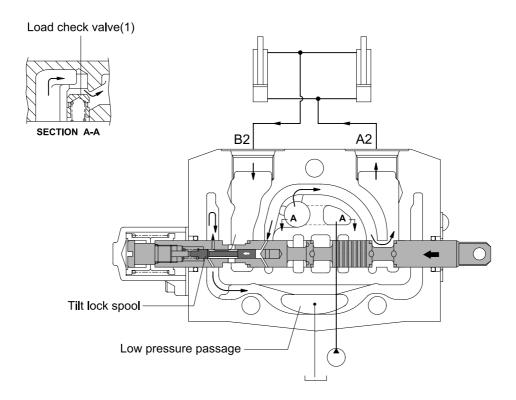
D353HS09

When the lift control lever is pushed forward, the spool moves to the left and the neutral passage is closed.

The spool moves to the lift lower position, opening up the neutral passage to tank and (B1) $\rightarrow$ T. In lift lower position the fork drops due to its own weight.

#### 3) TILT SECTION OPERATION

#### (1) Tilt forward position



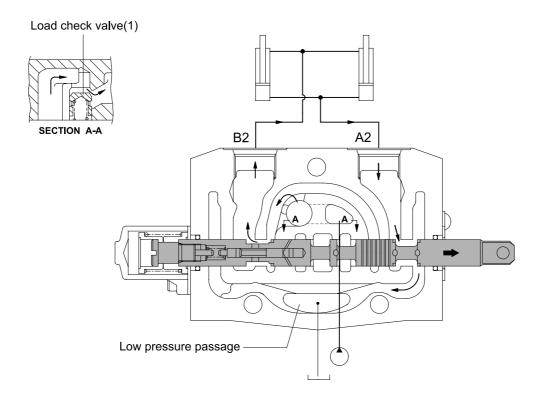
D353HS10

When the tilt control lever is pushed forward, the spool moves to the left and the neutral passage is closed.

The oil supplied from the pump pushes up the load check valve(1) and flow into tilt cylinder port(A2). The pump pressure reaches proportionally the load of cylinders and fine control finished by closing the neutral passage.

The return oil from cylinder port(B2) flows into the tank through the hole of the tilt lock spool.

#### (2) Tilt backward position



D353HS11

When the tilt control lever is pulled back, the spool moves to the right and the neutral passage is closed.

The oil supplied from the pump pushes up the load check valve(1) and flows into tilt cylinder port(B2). The pump pressure reaches proportionally the load of cylinder and fine control finished by shut off of the neutral passage.

The return oil from cylinder port(A2) flows into the tank via the low pressure passage.

#### 4) MAIN RELIEF VALVE

#### (1) Pressure setting

A good pressure gauge must be installed in the line which is in communication with the work port relief. A load must be applied in a manner to reach the set pressure of the relief unit.

#### **Procedure**

- ① Loosen lock nut.
- ② Set adjusting nut to desired pressure setting.
- ③ If desired pressure setting cannot be achieved, add or remove shims as required.
- 4 Tighten lock nut.
- ⑤ Retest in similar manner as above.

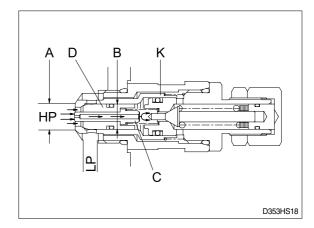
# Pilot section Relief valve Check valve poppet(K) poppet(D) Pilot poppet(E) Lock nut Shim يصبك (Simon Piston poppet(C) Housing Pilot spring Adjust nut Piston spring · Main relife valve: 181 bar · Secondary main relife valve : 147 bar (For 3, 4 spool only) D353HS99

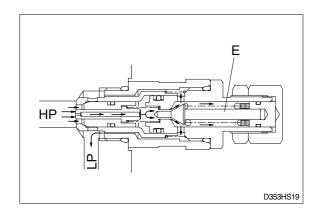
#### (2) Function

#### ① As work port relief

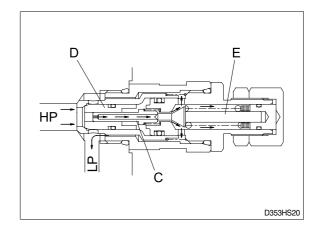
The relief valve is in communication between the high pressure port HP and low pressure LP. Oil is admitted through the hole in poppet C and because of the differential area between diameters A and B relief valve poppet D and check valve poppet K are tightly seated as shown.

The oil pressure in the high pressure port HP has reached the setting of the pilot poppet spring force and unseats the pilot poppet E and oil flows around the poppet through the cross drilled holes and to the low pressure area LP.

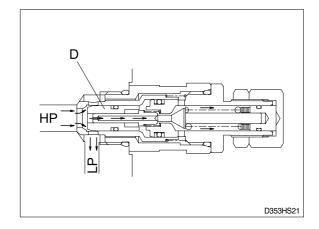




The loss of oil behind poppet C, effected by the opening of pilot poppet E, causes poppet C to move back and seat against pilot puppet E. This shuts off the oil flow to the area behind relief valve poppet D, and causes a low pressure area internally.

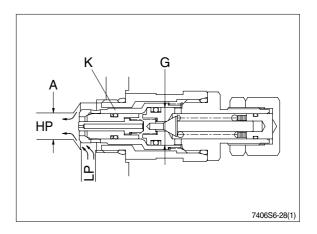


The imbalance of pressure on the inside as compared to that of the high pressure port HP, forces the relief valve poppet D to open and relieve the oil directly to the low pressure chamber LP in the valve.

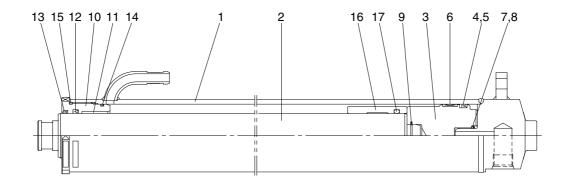


#### 2 As anti void

The anti-void unit supplies oil to the high pressure port HP when cavitation has occurred. A lower pressure exists in the port HP compared to the low pressure chamber LP. The difference between the effective area of diameter A and G causes imbalance of the check valve poppet K which unseats, thus allowing oil from the low pressure chamber LP to enter the port HP and fill the void.



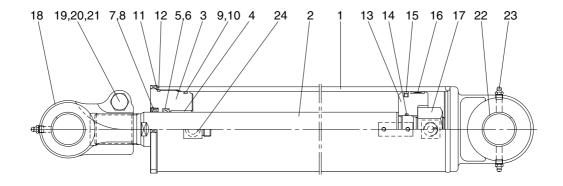
# 4. LIFT CYLINDER



D507HS12

1	Tube assy	7	Cushion seal	13	Dust wiper
2	Rod	8	Retaining ring	14	O-ring
3	Piston	9	Retaining ring	15	O-ring
4	Piston seal	10	Gland	16	Spacer
5	Back up ring	11	Du bushing	17	O-ring
6	Wear ring	12	Rod seal		

# **5. TILT CYLINDER**



D507HS13

1	Tube assy	9	O-ring	17	Nylon nut
2	Rod	10	Back up ring	18	Rod eye
3	Gland	11	Lock washer	19	Hexagon bolt
4	DU bushing	12	O-ring	20	Hexagon nut
5	Rod seal	13	Piston	21	Spring washer
6	Back up ring	14	O-ring	22	DU bushing
7	Dust wiper	15	Piston seal	23	Grease nipple
8	Snap ring	16	Wear ring	24	O-ring

#### **GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING**

#### 1. OPERATIONAL CHECKS

#### 1) CHECK ITEM

- (1) Check visually for deformation, cracks or damage of rod.
- (2) Load maximum load, 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).
  - · Hydraulic drift
  - Down(Downward movement of forks)
  - : Within 100mm(3.9in)
  - Forward(Extension of tilt cylinder)
  - : Within 5°

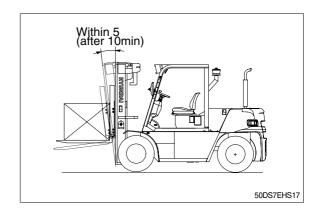
If the hydraulic drift is more than the specified value, replace the control valve or cylinder packing.

(3) Check that clearance between tilt cylinder bushing and mounting pin is within standard range.

mm (in)

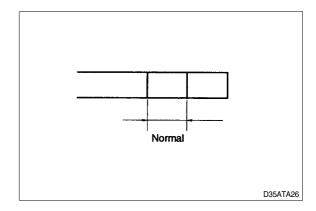
Standard Under 0.6 (0.02)

# Within 100mm(3.9in) (after 10min)



### 2) HYDRAULIC OIL

- 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).



#### 3) CONTROL VALVE

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

Check that oil pressure is 185kgf/cm<sup>2</sup>.

(2683psi)

# 2. TROUBLESHOOTING

# 1) SYSTEM

Problem	cause	Remedy
Large fork lowering speed.	· Seal inside control valve defective.	· Replace spool or valve body.
	· Oil leaks from joint or hose.	· Replace.
	· Seal inside cylinder defective.	· Replace packing.
Large spontaneous tilt of mast.	Tilting backward : Check valve defective.	· Clean or replace.
	Tilting forward : tilt lock valve defective.	· Clean or replace.
	· Oil leaks from joint or hose.	· Replace.
	Seal inside cylinder defective.	· Replace seal.
Slow fork lifting or slow mast	· Lack of hydraulic oil.	· Add oil.
tilting.	Hydraulic oil mixed with air.	· Bleed air.
	Oil leaks from joint or hose.	· Replace.
	Excessive restriction of oil flow on pump suction side.	· Clean filter.
	Relief valve fails to keep specified pressure.	· Adjust relief valve.
	Poor sealing inside cylinder.	· Replace packing.
	· High hydraulic oil viscosity.	Change to SAE10W, class CD engine oil.
	Mast fails to move smoothly.	Adjust roll to rail clearance.
	Oil leaks from lift control valve spool.	Replace spool or valve body.
	Oil leaks from tilt control valve spool.	Replace spool or valve body.
Hydraulic system makes abnormal sounds.	Excessive restriction of oil flow pump suction side.	· Clean filter.
	Gear or bearing in hydraulic pump defective.	· Replace gear or bearing.
Control valve lever is locked	Foreign matter jammed between spool and valve body.	· Clean.
	· Valve body defective.	Tighten body mounting bolts uniformly.
High oil temperature.	· Lack of hydraulic oil.	· Add oil.
	· High oil viscosity.	Change to SAE10W, class CD engine oil.
	· Oil filter clogged.	· Clean filter.
	+	

#### 2) HYDRAULIC GEAR PUMP

Problem	Cause	Remedy
Pump does not develop full	· System relief valve set too low or	Check system relief valve for proper
pressure.	leaking.	setting.
	· Oil viscosity too low.	· Change to proper viscosity oil.
	· Pump is worn out.	· Repair or replace pump.
Pump will not pump oil.	· Reservoir low or empty.	· Fill reservoir to proper level.
	Suction strainer clogged.	· Clean suction strainer.
Noisy pump caused by	· Oil too thick.	· Change to proper viscosity.
cavitation.	· Oil filter plugged.	· Clean filters.
	· Suction line plugged or too small.	· Clean line and check for proper size.
Oil heating.	· Oil supply low.	· Fill reservoir to proper level.
	· Contaminated oil.	· Drain reservoir and refill with clean oil.
	· Setting of relief valve too high or too	· Set to correct pressure.
	low.	
	· Oil viscosity too low.	· Drain reservoir and fill with proper
		viscosity.
Foaming oil.	· Low oil level.	· Fill reservoir to proper level.
	· Air leaking into suction line.	· Tighten fittings, check condition of
		line.
	· Wrong kind of oil.	· Drain reservoir, fill with non-foaming
		oil.
Shaft seal leakage.	· Worn shaft seal.	· Replace shaft seal.
	· Worn shaft in seal area.	· Replace drive shaft and seal.

#### 3) MAIN RELIEF VALVE

Problem	Cause	Remedy
Can't get pressure	Poppet D, E or K stuck open or contamination under seat.	Check for foreign matter between poppets D, E or K and their mating parts. Parts must slide freely.
Erratic pressure	Pilot poppet seat damaged.     Poppet C sticking in D.	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	<ul><li>Damaged seats.</li><li>Worn O-rings.</li><li>Parts sticking due to contamination.</li></ul>	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:

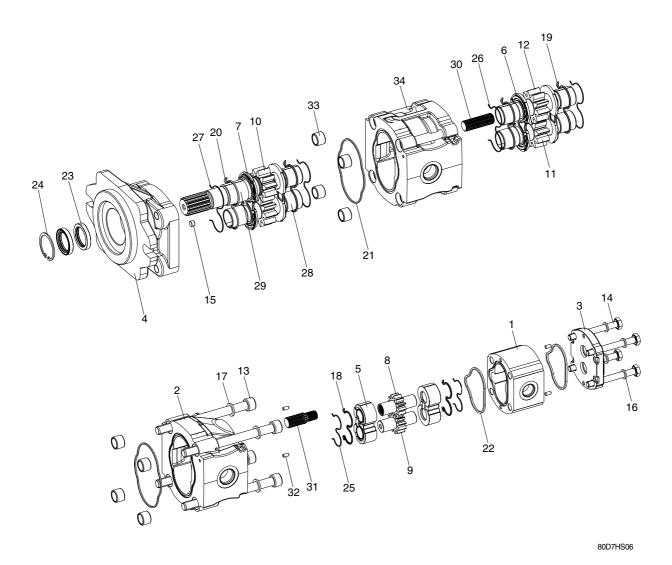
- · Loosen lock nut.
- · Set adjusting nut to desired pressure setting.
- · If desired pressure setting cannot be achieved, add or remove shims as required.
- · Tighten lock nut.
- · Retest in similar manner as above.

## 4) LIFT CYLINDER

Problem	Cause	Remedy
Oil leaks out from gland	· Foreign matters on packing.	· Replace packing.
through rod.	· Unallowable score on rod.	· Smooth rod surface with an oil stone.
	· Unusual distortion of dust seal.	· Replace dust seal.
	· Chrome plating is striped.	· Replace rod.
Oil leaks out from cylinder gland thread.	· O-ring damaged.	· Replace O-ring.
Rod spontaneously retract.	· Scores on inner surface of tube.	· Smooth rod surface with an oil stone.
	Unallowable score on the inner suface of tube.	· Replace cylinder tube.
	· Foreign matters in piston seal.	· Replace piston seal.
Wear(clearance between	· Excessive clearance between	· Replace wear ring.
cylinder tube and wear ring)	cylinder tube and wear ring.	
Abnormal noise is produced	· Insufficient lubrication of anchor pin or	· Lubricate or replace.
during tilting operation.	worn bushing and pin.	
	· Bent tilt cylinder rod.	· Replace.

# **GROUP 3 DISASSEMBLY AND ASSEMBLY**

# 1. MAIN PUMP 1) STRUCTURE



1	Body	13	Screw	25	Antiextrusion
2	Body	14	Screw	26	Antiextrusion ring
3	Rear cover	15	Grub screw	27	Upper antiextrusion ring
4	Cover	16	Washer	28	Sleeve bearing
5	Thrust plate	17	Washer	29	Upper sleeve bearing
6	Thrust plate	18	Seal	30	Hub
7	Upper thrust plate	19	Seal	31	Hub
8	Drive gear	20	Upper seal	32	Dowel pin
9	Driven gear	21	Standard seal	33	Steel bushing
10	Drive shaft	22	Seal	34	G. housing
11	Driven gear	23	Shaft seal		
12	Drive shaft	24	Ring		

#### 2) GENERAL INSTRUCTION

#### (1) Cleanliness

① Cleanliness is the primary means of assuring satisfactory hydraulic pump life.

Components such as flanges and covers are best cleaned in soap and hot water, then air dried.

Gears should be washed in solvent, air dried, and oiled immediately.

# ▲ Certain cleaning solvents are flammable. Do not allow sources of ignition in the area when using cleaning solvents.

- ② Protect all exposed surfaces and open cavities from damage and foreign material.
- \* Gear journals and gear faces are super finished. Take care not to touch these surfaces after oil and solvent.

#### (2) Lubrication of moving parts

During assembly, all running surfaces(Bearing and wear plate) must be lightly lubricated with a clean oil or aerosol lubricant.

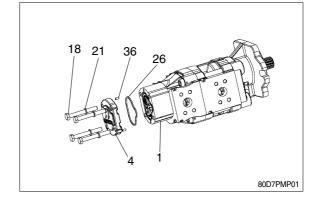
#### (3) Tools required for assembly

- ① Socket set(1/2" drive)
- ② Internal snap ring pliers
- ③ Shaft seal sleeve or clear tape
- ④ Torque wrench(200lbf ⋅ ft capacity)
- (5) Plastic hammer
- (6) Torque wrench box end adapters

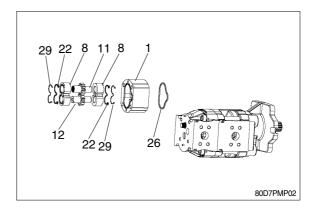
#### 3) DISASSEMBLY

#### (1) Rear section

- ① Loosen and remove the clamp bolts(18) from rear working section(1).
- \* Related parts Washer(21), rear cover(4), dowel pin(36) and square-ring(26).

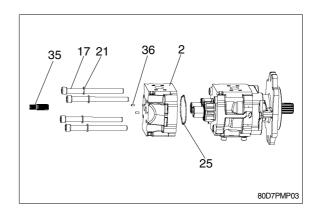


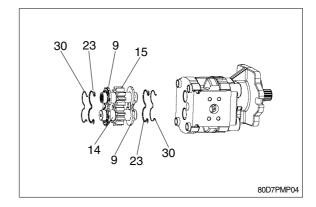
- ② Remove driving gear(11), driven gear(12) with thrust plate parts(8, 22, 29), keeping gear as straight as possible, and working section(1) also.
- Related parts
  Back-up ring(29), O-ring(22), thrust plate
  (8), working body(1) and square ring(26).



#### (2) Center section

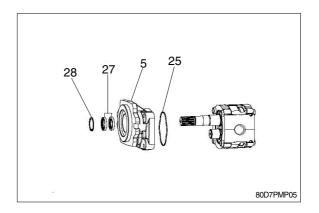
- ① Remove through shaft(35) from driving shaft(15).
- ② Loosen and remove the clamp bolt(17) with washer(21), and then remove the working section(2) with dowel pin(36).
- Related partsSquare ring(25).
- ③ Remove driving gear(15), driven gear(14) with thrust plate parts (9, 23, 30), keeping gear as straight as possible, from first working body.
- \* Related parts Back-up ring(30), O-ring(23) and thrust plate (9).



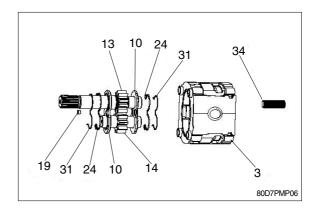


#### (3) Front section

① Remove the snap-ring(28) and shaft seal (27), and then remove mounting flange (5) and square ring(25) from working section(3).

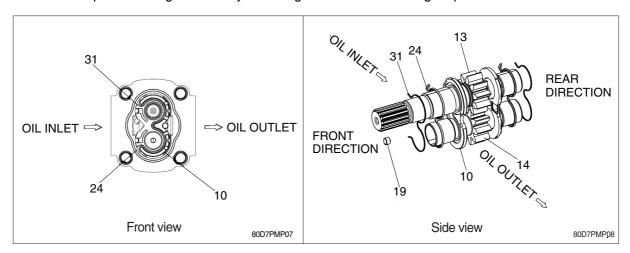


- ② Remove driving gear(13), driven gear(14) with through shaft(34) and thrust plate parts(10,24,31) from the working body (3), keeping gear as straight as possible.
- \* Related parts Plug(19), back-up ring(31), O-ring(24) and thrust plate(10).



#### 4) REASSEMBLY

\*\* Information for assembly way of thrust plates
It is important that all of thrust plate parts in this hydraulic pump should be assembled such as below picture during reassembly. Below figures show assembling sequence and direction.



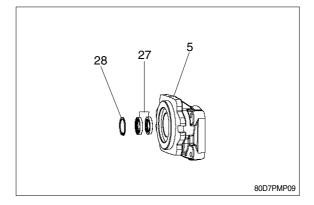
- 10 Thrust plate
- 14 Driven gear
- 19 Plug

- 24 O-ring
- 31 Back-up ring

#### (1) Front cover area

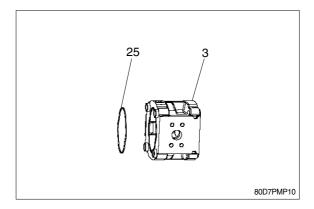
Driving gear

- ① Insert the shaft seal(27) carefully and fit it inside of mounting flange(5) with proper tool.
- ② Fit the snap-ring(28) in pre-arranged position with proper tool.

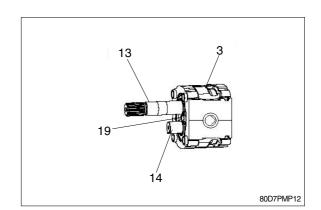


#### (2) Center section

- ① Fit the square ring(25) on the prearranged groove of the working section(3).
- \*\* Smear clean grease on the square ring (25) to avoid drifting away of square ring from the working section(3).



- ② Locate the o-ring(24) on the groove prearranged on the thrust plate(10).
- ③ Then, locate back-up ring(31) on the groove pre-arranged on the seals(10, 24) with plug(19).
- \*\* Smear clean grease on the seal(24,31). (The front and rear thrust plates and seals and back-up ring are same.)
- ④ Insert the driving gear(13) and driven gear(14) into working section(3) while keeping the gears straight.
- \* Locate thrust plate(10+24+31) with care for the direction.



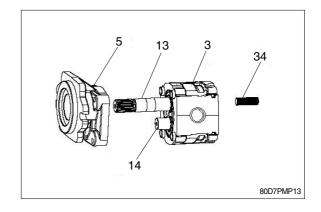
31 24 10

10

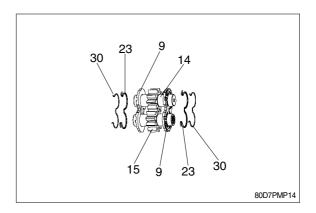
24 31

80D7PMP11

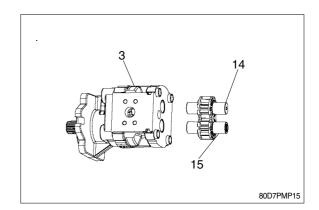
- ⑤ Locate the completed mounting flange (5+27+28) to working section(3) while tacking care not to give any damage on the shaft seal by edge of shaft(13).
- ⑥ Insert the through shaft(34) to rear side of the driving shaft(13).



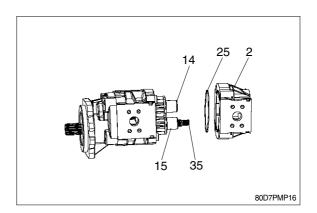
- ② Locate the O-ring(23) on the groove prearranged on the thrust plate(9).
- Then, locate back-up ring(30) on the groove pre-arranged on the seals(9, 23).
- \*\* Smear clean grease on the seal(9,23) (The front and rear thrust plates and seals and back-up ring are same.)



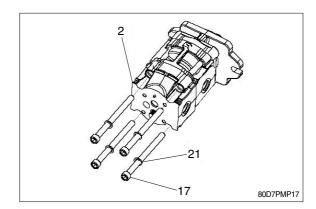
(9) Insert the driving shaft(15) and driven gear(14) including the completed thrust plate(9+23+30) into working section(3) while keeping the plate straight.



- (1) Insert the through shaft(35) into driving shaft(15), and then locate the working body(2) after inserting the squaring ring (25) to body(2).
- \*\* Smear clean grease on the square ring (25) to avoid drifting away of square ring from the working body(2).

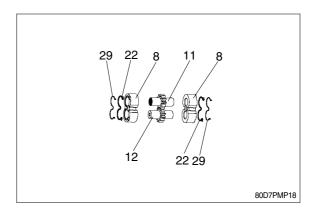


① Tighten the bolt(17) with washer(21) in a cross pattern to torque valve of 140Nm.

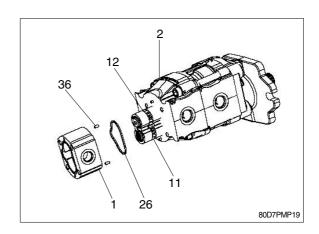


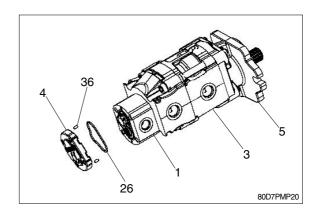
#### (3) Rear section

- ① Locate the O-ring(22) on the groove prearranged on the thrust plate(8).
- ② Then, locate back-up ring(29) on the groove pre-arranged on the seals(8, 22).
- \* Smear clean grease on the seal(8,22) (The front and rear thrust plates and seals and back-up ring are same.)

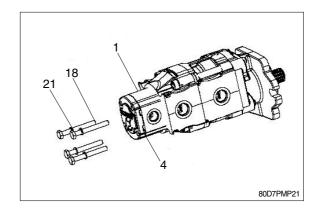


- ③ Locate the driving gear(11) and driven gear(12) with thrust plate parts(8+22+29) into working section(2).
- ④ Insert the dowel pin into the working section(2) and then, locate the rear working section(1) to working section(2) while keeping the gear straight.
- \* Smear clean grease on the square ring (26) to avoid drifting away of square ring from the rear working section(1).
- ⑤ Locate the rear cover(4) after inserting the square ring(26) and the dowel pin(36) into the rear working section(1).
- \*\* Smear clean grease on the square ring(26) to avoid drifting away of square ring(26) from the rear cover(4).

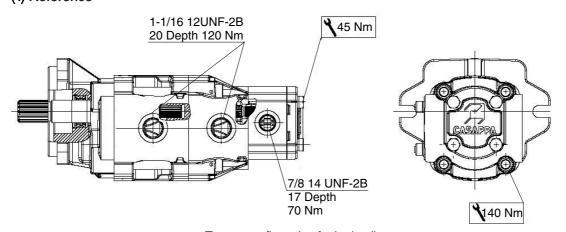




- ⑤ Tighten the bolt(18) with washer(21) in a cross pattern to torque valve of 45Nm.
- \* Check that the pump rotate freely when the driving shaft is turned by hand. If not a thrust plate seal may be pinched.



#### (4) Reference

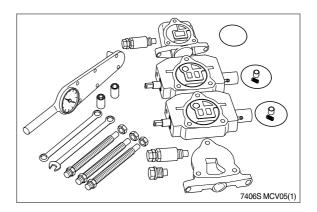


Torque configuration for hydraulic pump

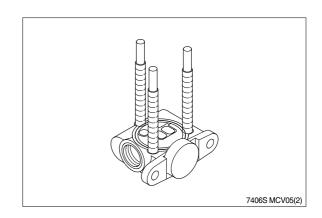
80D7PMP22

#### 2. MAIN CONTROL VALVE

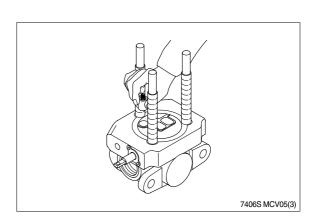
 Lay out valve components on a clean, flat working surface. The inlet assembly will include an O-ring, and the spool section(s) include an O-ring, a load check poppet and a load check spring. Tools required for basic valve assembly include 3/4 and 11/16 open or box end wrenches and a torque wrench with thin wall sockets.



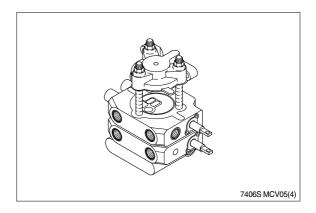
2) Assemble tie rod nuts to one end of each tie rod with one or two threads showing. Insert tie rods through tie rod holes of inlet (Large tie rod at top). Lay inlet on end with tie rods up, place O-ring into position.



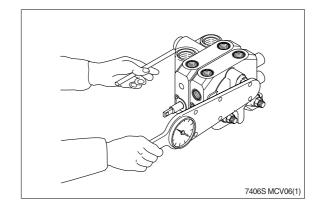
3) Place first spool section(O-ring side up) on inlet section, position O-ring and insert load check poppet(Nose down) and spring (Behind poppet) into load check cavity as shown. Repeat this procedure for each spool section; The load check springs are compressed by the following sections during assembly.



4) Position end section on last spool section as shown and hand tighten tie rod nuts. The end section on picture is a "turn around" section without ports. Universal outlet /power beyond section and power beyond and closed center sections are also used as end sections. These end sections do not have O-ring grooves.



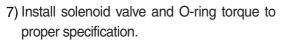
5) Position valve assembly with the mounting pads of the end sections on a flat surface. To obtain proper alignment of end sections relative to the spool sections apply downward pressure to the end sections; Snug tie rod nuts to about 10lbf · ft. Final torque the two 11/16 nuts to 48±5lbf · ft; Final torque the 3/4 nut to 74±8lbf · ft. Check for proper spool movement.



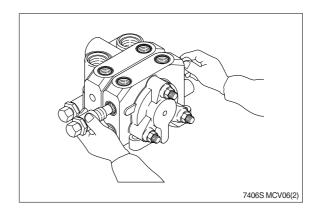
6) Install auxiliary valves and plugs and torque to proper specifications.

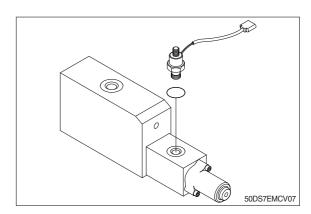
#### \* General assembly notes:

- A. Lever assemblies can be installed on section before or after complete valve assembly.
- B. The load check and spring may be omitter from assembly in certain circuit conditions (i.e., motor spools).



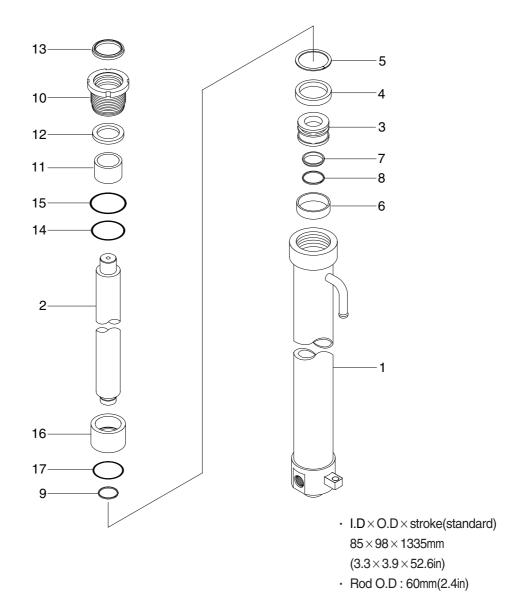
\* Solenoid valve torque :  $10 \pm 1$ lbf · ft





### 3. LIFT CYLINDER

### 1) STRUCTURE



D507HS19

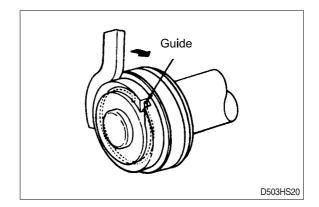
- Tube assy
   Rod
   Piston
- 4 Piston seal
- 5 Back up ring
- 6 Wear ring
- 7 Cushion seal
- 8 Retainning ring
- 9 Retainning ring

- 10 Gland
- 11 Du bushing
- 12 Rod seal
- 13 Dust wiper
- 14 O-ring
- 15 O-ring
- 16 Spacer
- 17 O-ring

#### 2) DISASSEMBLY

 Hold the cylinder tube in a vice, loosen the cylinder head and remove it.
 Remove the spacer from the cylinder tube

and knock out the bushing. Hook a wrench in the hole in the retainer at the piston end and turn. Lever up the edge of the guide, then turn the guide in again and the guide can be removed.



#### 2) CHECK AND INSPECTION

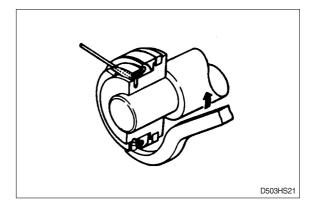
mm(in)

Check item		Standard size	Repair limit	Remedy
Clearance between cylin- bushing	der rod &	0.05~0.25 (0.002~0.01)	0.4 (0.0015)	Replace bushing
Clearance between pisto tube	on ring &	0.05~0.35 (0.002~0.013)	0.5 (0.02)	Replace piston ring

#### 3) ASSEMBLY

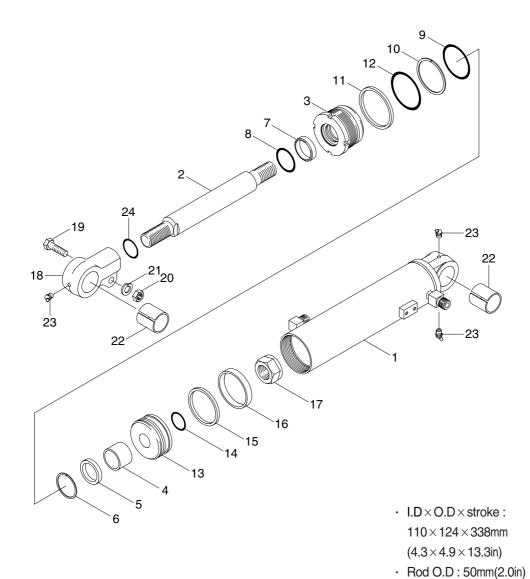
(1) Soak the piston ring in hydraulic oil at a temperature of 40 to 50°C, expand the inside diameter and assemble on the piston. Install a piston seal.

Bend the edge of the guide and rotate it to install the guide completely.



### 4. TILT CYLINDER

### 1) STRUCTURE



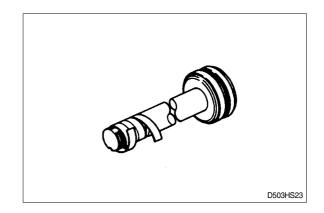
D507HS22

1	Tube assy	9	O-ring	17	Nylon nut
2	Rod	10	Back up ring	18	Rod eye
3	Gland	11	Lock washer	19	Hexagon bolt
4	DU bushing	12	O-ring	20	Hexagon nut
5	Rod seal	13	Piston	21	Spring washer
6	Back up ring	14	O-ring	22	DU bushing
7	Dust wiper	15	Piston seal	23	Grease nipple
8	Snap ring	16	Wear ring	24	O-ring

#### 2) DISASSEMBLY

(1) Hold the parallel parts of the cylinder tube bottom in a vice and mark the rod head end to show how much it is screwed in, then remove the rod head. Next, hook a wrench into the notch at the cylinder head and remove the cylinder head from cylinder tube.

When doing this, wind tape round the threaded part of the rod and be careful not to damage the dust seal and rod seal inside cylinder head.



#### 3) CHECK AND INSPECTION

mm(in)

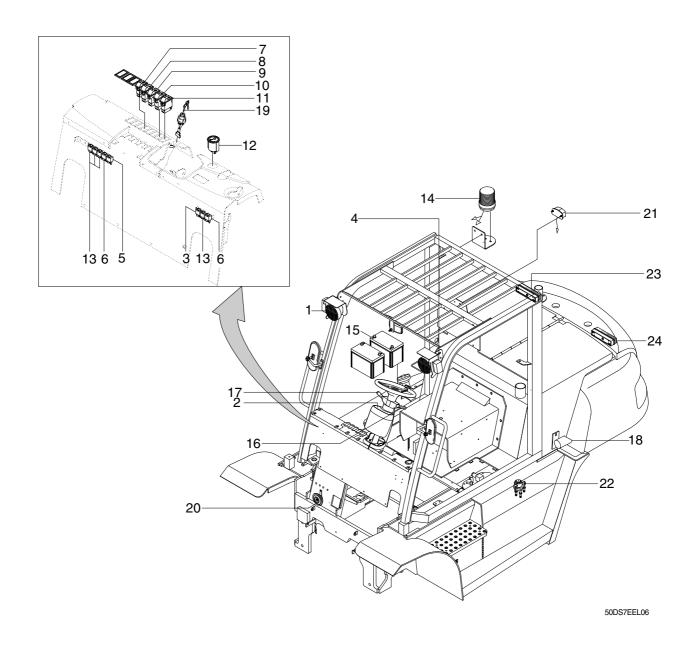
Check item	Standard size	Repair limit	Remedy
Clearance between cylinder rod & bushing	0.072~0.288 (0.003~0.011)	0.5 (0.020)	Replace bushing
Clearance between rod head bushing & pin	0.10~0.35 (0.004~0.014)	0.6 (0.024)	Replace bushing

# SECTION 7 ELECTRICAL SYSTEM

Group	1 Component location ·····	7-1
Group	2 Electrical circuit ·····	7-2
Group	3 Component specification	7-12
Group	4 Connector destination	7-13
Group	5 Troubleshooting	7-16

# SECTION 7 ELECTRICAL SYSTEM

## **GROUP 1 COMPONENT LOCATION**



1	vvork iamp	
2	Operating panel	
3	Glow timer	
4	Flasher lamp	
5	Flasher unit	
6	Relay 5P	
7	Beacon switch	

14/aul. laussia

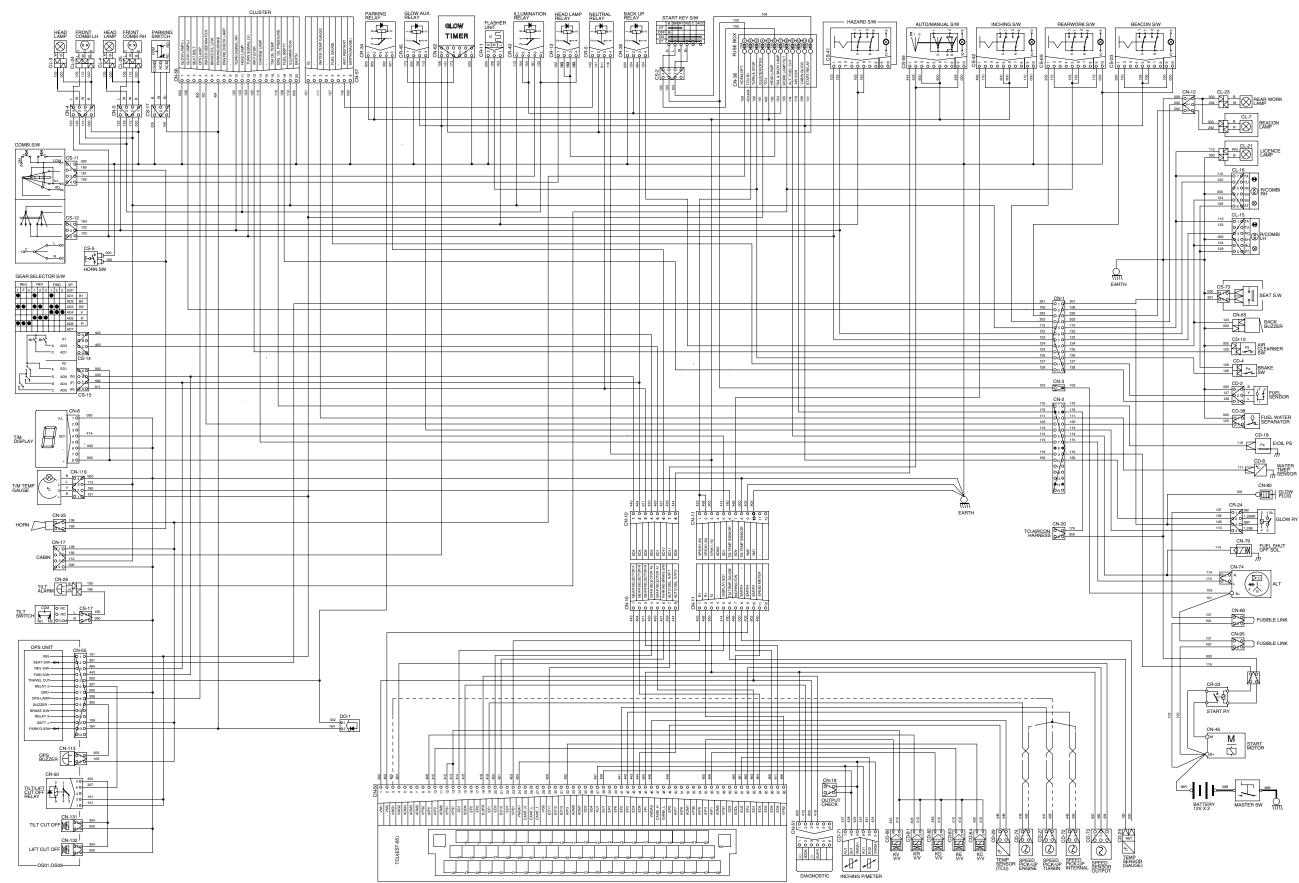
7 Beacon switch 8 Work lamp switch Auto/Manual switch
Hazard switch
T/M oil temp gauge
Relay 4P
Beacon lamp
Battery
Gear selector

Inching switch

9

17 Combination switch
18 Backup alarm
19 Start switch
20 High horn
21 License lamp
22 Start relay
23 RH combination lamp
24 LH combination lamp

#### **GROUP 2 ELECTRICAL CIRCUIT**

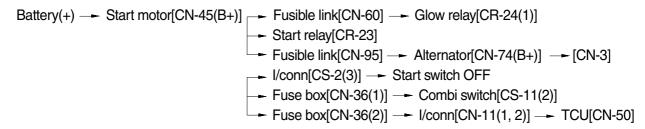




#### 1. POWER CIRCUIT

The negative terminal of the battery is grounded to the machine chassis. When the start switch is in the off position, the current flows from the positive battery terminal.

#### 1) OPERATING FLOW

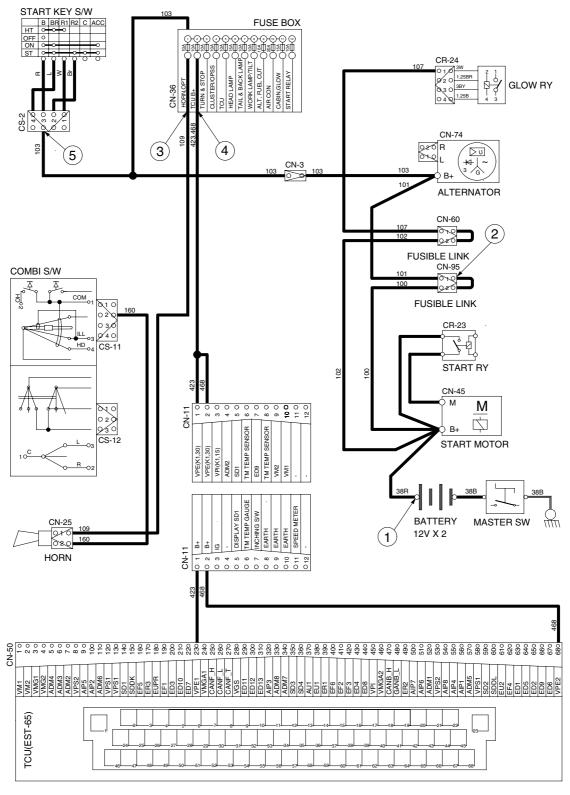


#### 2) CHECK POINT

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

**\*\* GND : Ground** 

#### **POWER CIRCUIT**



50DS7EEL02

#### 2. STARTING CIRCUIT

#### 1) OPERATING FLOW

\* The engine can be started only when the gearshift is in neutral position. The operator should be seated when starting.

(1) When start key switch is in ON position

Start switch ON [CS-2(4)]  $\longrightarrow$  Fuse box[No.6  $\rightarrow$ 5]  $\longrightarrow$  Gear selector switch[CS-15(A)]

(2) When start key switch is START position

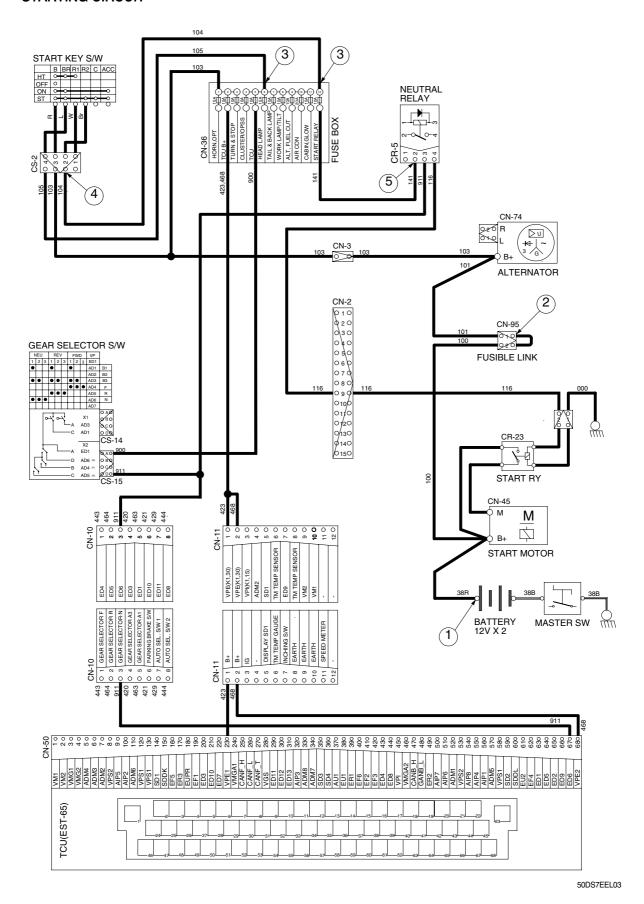
Start switch START[CS-2(2)] 
$$\longrightarrow$$
 Fuse box[No. 12]  $\longrightarrow$  Neutral relay[CR-5(2)  $\longrightarrow$  (4)]  $\longrightarrow$  I/conn[CN-2(9)]  $\longrightarrow$  Start relay[CR-23]

#### 2) CHECK POINT

Engine	Key switch	Check point	Voltage
Running	ON	① - GND (Battery B+) ② - GND (Fusible link) ③ - GND (Fuse box No.6, 12) ④ - GND (Start key) ⑤ - GND (Neutral relay)	24V

**\* GND: Ground** 

#### STARTING CIRCUIT



#### 3. CHARGING CIRCUIT

When the starter is activated and the engine is started, the operator release the start switch to the ON position. Charging current generated by operating alternator flows into the battery.

The current also flows from alternator to each electrical component through the fusible link(CN-60) and the fuse box.

#### 1) OPERATING FLOW

(1) Warning flow
Alternator[CN-74(L)] - I/conn[CN-2(7)] - Cluster charging lamp ON [CN-56(14)]

(2) Charging flow
Alternator[CN-74(B+)] — Fusible link[CN-95] — Starter[CN-45(B+)] — Battery(+) terminal charging

I/conn[CN-3] — Fuse box

#### 2) CHECK POINT

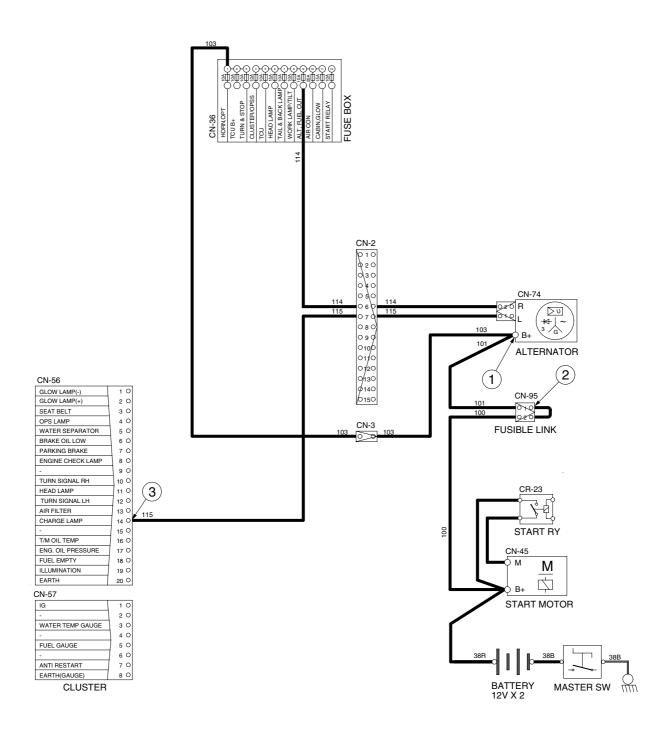
Engine	Key switch	Check point	Voltage
ON	ON	① - GND (Alternator B+) ② - GND (Start switch) ③ - GND (Cluster)	24V

#### \* GND: Ground

#### \* Cautions

- 1. When using an arc welder, always disconnect the ground lead from the battery to prevent alternator or battery damage.
- 2. Attach the welding ground clamp as close to the weld area as possible to prevent welding current from damaging the bearings of the alternator.
- 3. Do not disconnect the battery when the engine is running. The voltage surge can damage the diode and resistors in the electrical system.
- 4. Do not disconnect an electric wire before the engine is stopped and the switchs are OFF.

#### **CHARGING CIRCUIT**



50DS7EEL04

#### 4. PREHEATING CIRCUIT

Combustion chamber glow plugs are used in order to give satisfactory starting of low ambient temperatures.

#### 1) OPERATING FLOW

```
Battery(+) terminal Fusible link[CN-95] - I/conn[CS-2(3)] - Start switch(B)
Fusible link[CN-60] - Glow relay[CR-24]
```

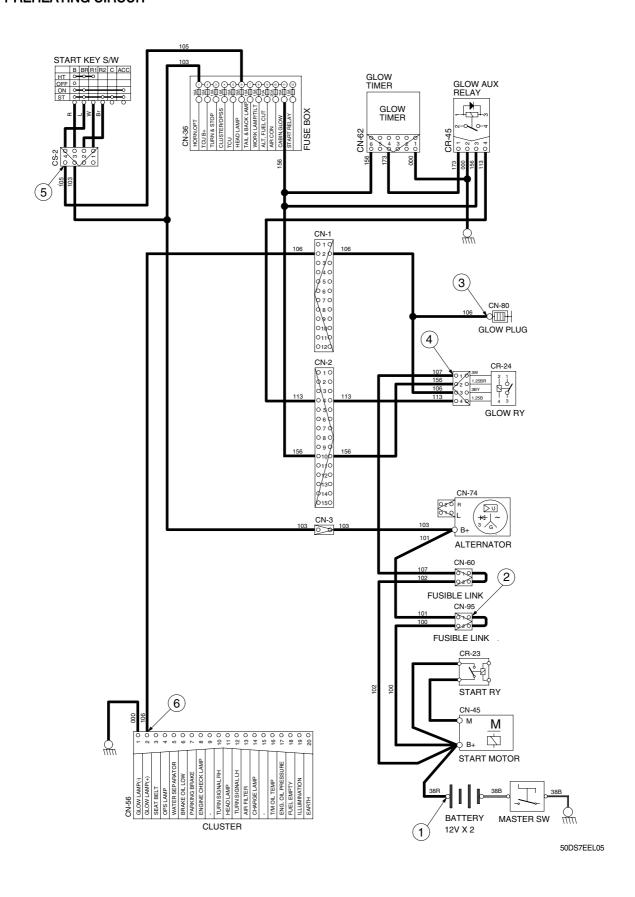
\* When you turn the start switch to the ON position, the glow relay makes the glow plugs operated and the glow lamp of the cluster turned ON.

```
Start switch ON [CS-2(4)] — Fuse box [NO.6\rightarrow11] — Glow timer[CN-62(6)\rightarrow(4)] — I/conn[CN-2(4)] — Glow relay ON [CR-24] — Glow plug operating[CN-80] — I/conn[CN-1(2)] — Cluster[CN-56(2)] — Glow pilot lamp ON
```

#### 2) CHECK POINT

Engine	Key switch	Check point	Voltage
Stop		① - GND (Battery B+)	
		② - GND (Fusible link)	0.417
	HEAT	③ - GND (Glow plug)	
		④ - GND (Glow relay)	24V
		⑤ - GND (Start switch)	
		⑥ - GND (Glow lamp)	

#### PREHEATING CIRCUIT



# **GROUP 3 COMPONENT SPECIFICATION**

No	Part name	Qty	Specification
1	Battery	2	12V×80AH RC : 130min CCA : 630A
2	Working lamp	1	24V, 70W
3	License lamp	1	24V, 3W x 2
4	Rear Combination lamp	2	24V, 25/10W (Stop/Tail) 24V, 25W (Turn) 24V, 25W (Back Up)
5	Head lamp	2	24V, 70W
6	Flasher lamp	2	24V, 25/10W
7	Glow relay	1	24V, 300A
8	Relay (4P)	4	24V, 20A
9	Relay (5P)	3	24V, 6A
10	Flasher Unit	1	85±10CM, (21W + 21W) x 2 + 3W x 2
11	Back buzzer	1	24V, 90±5dB, 60±10C/M
12	Horn	1	24V, 1.5A, 100 ~ 115 dB
13	Fuel level sender	1	Float indicate E 1/2 F  Resistance( $\Omega$ ) 105 32.5 5  Tolerance( $\Omega$ ) $\pm 2.5$ $\pm 0.5$ $\pm 0.5$
14	Master Switch	1	24V, 180A
15	Combination Switch	1	Direction 4.5A, Tail 5A Head 6A, Horn 4A
16	Brake Switch	1	24V, 50W
17	Working Lamp Switch	1	24V, 8A
18	Hazard Switch	1	24V, 8A
19	Beacon Inching	1	24V, 8A
20	Auto manual Switch	1	24V, 8A
21	Start switch	1	24V, 30A

# **GROUP 4 CONNECTOR DESTINATION**

Connector	Туре	No. of pin	Destination	Connector part No.		
number			Destination	Female	Male	
CN-1	AMP	12	I/conn(Dashboard harness-frame harness)	S816-012002	S816-112002	
CN-2	AMP	15	I/conn(Frame harness-dashboard harness)	2-85262-1	368301-1	
CN-3	KET	1	I/conn(Frame harness-dashboard harness)	MG640944-5	MG650943-5	
CN-4	KET	4	LH support harness	S810-004201	-	
CN-5	KET	4	Support harness	S810-004201	-	
CN-8	AMP	8	Transmission display	929504-3	-	
CN-10	AMP	8	I/conn(Dashboard harness-T/M harness)	S816-008002	S816-108002	
CN-11	AMP	12	I/conn(Dashboard harness-T/M harness)	S816-012002	S816-112002	
CN-12	KET	3	Rear support harness	S810-003201	-	
CN-17	AMP	4	Cabin	S816-004002	-	
CN-18	KET	2	Inching sensor	-	S814-102100	
CN-19	KET	2	Output check	S814-002100	MG610320	
CN-20	KET	4	Aircon harness	S810-002201	S810-102201	
CN-25	MOLEX	2	Horn	35825-0211	-	
CN-26	KET	2	Tilt alarm	S822-014000	S822-114000	
CN-36	-	2	Fuse box	21HF-10500	-	
CN-45	RING TERM	2	Start motor	S820-308000	-	
CN-48	KET	2	Hour meter	S822-014000	S822-114000	
CN-50	AMP	68	Transmission control unit	963598-1	-	
CN-51	AMP	6	Diagnostic	926682-3	-	
CN-55	KET	14	OPS unit	S814-014100	-	
CN-56	AMP	20	Cluster	368511-2	-	
CN-57	AMP	8	Cluster	368540-2	-	
CN-60	-	2	Fusible link	21N4-01320	S813-130201	
CN-62	-	6	Glow timer	S810-006202	-	
CN-65	KET	2	Back buzzer	S822-014000	S822-114000	
CN-74	KET	2	Alternator	MG640188-4	-	
CN-79	YAZAKI	1	Fuel cut off solenoid	7211-2215	-	
CN-80	RING TERM	1	Glow plug	S820-204000	-	
CN-95	KET	2	Fusible link	21N4-01311	S813-130201	
CN-119	KET	4	Transmission temperature gauge	S810-004201	-	
CN-131	AMP	2	Cut off sol 1(tilt)	S816-002002	-	
CN-132	AMP	2	Cut off sol 2(lift)	S816-002002	-	

Connector number	Туре	No. of pin	Destination	Connecto	Connector part No.	
				Female	Male	
Switch						
CS-2	KET	4	Start switch	S810-004201	-	
CS-11	KET	4	Combination switch	S810-004201	-	
CS-12	KET	3	Combination switch	S810-003201	-	
CS-14	PACKARD	4	Gear selector switch	12010974	-	
CS-15	PACKARD	4	Gear selector switch	12015797	-	
CS-17	KET	3	Parking switch	S810-003201	-	
CS-23	SWF	10	Beacon lamp switch	593757	-	
CS-41	SWF	10	Hazard switch	593757	-	
CS-42	SWF	10	Inching switch	593757	-	
CS-59	SWF	10	Auto manual switch	593757	-	
CS-69	SWF	10	Rear work switch	593757	-	
Lamp						
CL-15	KET	6	Combination lamp-LH	S814-006100	-	
CL-16	KET	6	Combination lamp-RH	S814-006100	-	
CL-21	KET	2	License lamp	S822-014000	S822-114000	
Relay	I			1		
CR-5	KET	4	Neutral relay	S810-004201	-	
CR-11	-	3	Flasher unit relay	S810-003702	-	
CR-13	KET	4	Head lamp relay	S810-004201	-	
CR-23	KET	2	Start relay	S814-002100	S814-102100	
CR-24	KET	4	Glow relay	S810-004201	-	
CR-34	-	6	Parking relay	S810-006202	-	
CR-35	KET	4	Back up relay	S810-004201	-	
CR-40	-	6	Illumination relay	S810-006202	-	
Sensor and	pressure swit	ch				
CD-2	KET	3	Fuel sendor	S810-003201	-	
CD-4	KET	2	Stop lamp switch	S822-014000	-	
CD-8	KET	1	Water temperature sensor	S822-014000	-	
CD-10	KET	1	Air cleaner switch	ST730057-2	-	
CD-18	AMP	1	Engine oil pressure switch	171809-2	-	
CD-27	AMP	2	Turbin speed input	963040-3	-	
CD-29	-	2	T/M temperature sensor	21FF-10170	-	
CD-38	-	2	Water separator	-	S816-102003	
CD-71	AMP	6	Inching sensor	1-967616-1	-	
CD-72	AMP	2	Gear train speed sensor	963040-3	-	
CD-73	AMP	3	Output speed sensor	282087	-	
CD-74	AMP	2	Engine speed sensor	963040-3	-	
CD-80	PACKARD	2	KV Solenoid	12162197	-	

Connector number	Туре	No. of pin	Destination	Connector part No.	
				Female	Male
CD-81	PACKARD	2	KR Solenoid	12162197	-
CD-82	PACKARD	2	KD Solenoid	12162197	-
CD-83	PACKARD	2	KE Solenoid	12162197	-
CD-84	PACKARD	2	KC Solenoid	12162197	-
CD-90	AMP	2	Temp sensor	827551-3	-

# **GROUP 5 TROUBLESHOOTING**

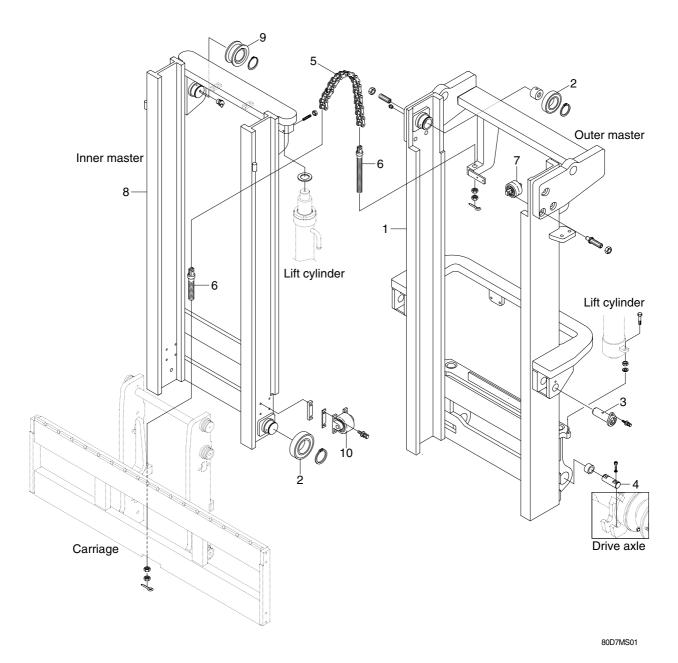
Trouble symptom	Probable cause	Remedy
Lamps dimming even at maxi-	· Faulty wiring.	· Check for loose terminal and discon-
mum engine speed.		nected wire.
Lamps flicker during engine	· Improper belt tension.	· Adjust belt tension.
operation.		
Charge lamp does not light d-	· Charge lamp defective.	· Replace.
uring normal engine operation.	· Faulty wiring.	· Check and repair.
Alternator makes abnormal	· Alternator defective.	· Replace
sounds.		
Starting motor fails to run.	· Faulty wiring.	· Check and repair.
	· Insufficient battery voltage.	· Recharge battery.
Starting motor pinion repeats	· Insufficient battery voltage.	· Recharge battery.
going in and out.		
Excessively low starting motor	· Insufficient battery voltage.	· Recharge battery.
speed.	· Starting motor defective.	· Replace
Starting motor comes to a stop	· Faulty wiring.	· Check and repair.
before engine starts up.	· Insufficient battery voltage.	· Recharge battery.
Heater signal does not beco-	· Faulty wiring.	· Check and repair.
me red.	· Glow plug damaged.	· Replace
Engine oil pressure caution	· Caution lamp defective.	· Replace
lamp does not light when enig-	· Caution lamp switch defective.	· Replace
ne is stopped		
(with starting switch left in "ON"		
position).		

# SECTION 8 MAST

Group	1	Structure ·····	8-1
Group	2	Operational checks and troubleshooting	8-5
Group	3	Adjustment	8-8
Group	4	Disassembly and assembly	8-10

# **GROUP 1 STRUCTURE**

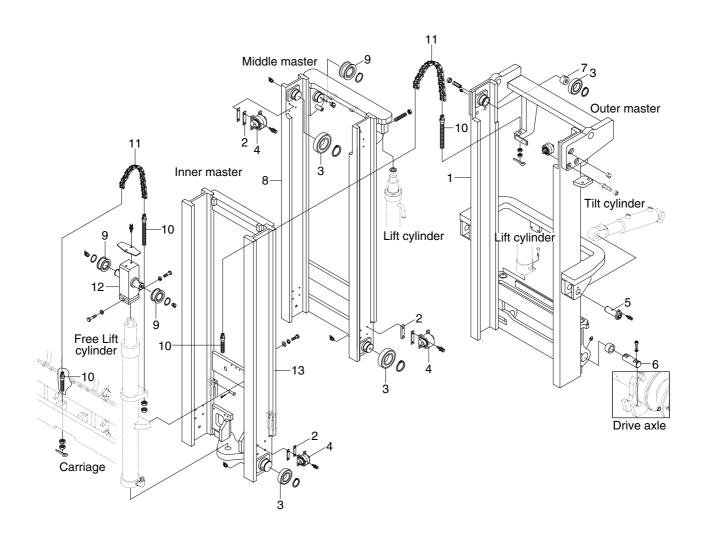
## 1. 2 STAGE MAST(V MAST)



- 1 Outer mast
- 2 Roller bearing
- 3 Tilt cylinder pin
- 4 Mast mounting pin
- 5 Lift chain
- 6 Anchor bolt
- 7 Side roller bearing
- 8 Inner mast

- 9 Chain sheave bearing
- 10 Side roller bearing

### 2. 3 STAGE MAST(TF MAST)



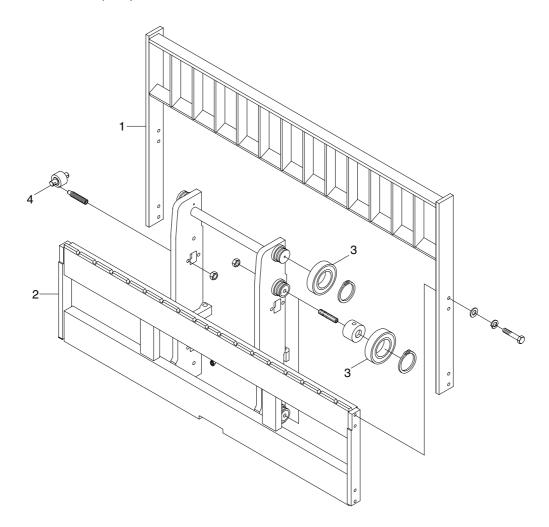
50DS7EMS011

- 1 Outer mast
- 2 Shim
- 3 Roller bearing
- 4 Side roller bearing
- 5 Tilt cylinder pin
- 6 Mast mounting pin
- 7 Wear plug
- 8 Middle mast
- 9 Sheave
- 10 Anchor bolt

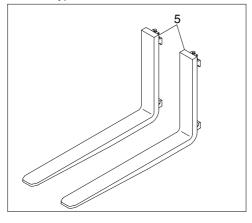
- 11 Chain
- 12 Sheave bracket
- 13 Inner mast

## 3. CARRIAGE, BACKREST AND FORK

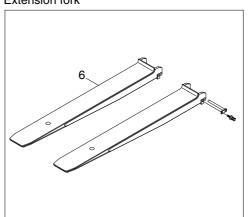
## 1) HOOK ON TYPE(STD)



Hook on type fork



Extension fork

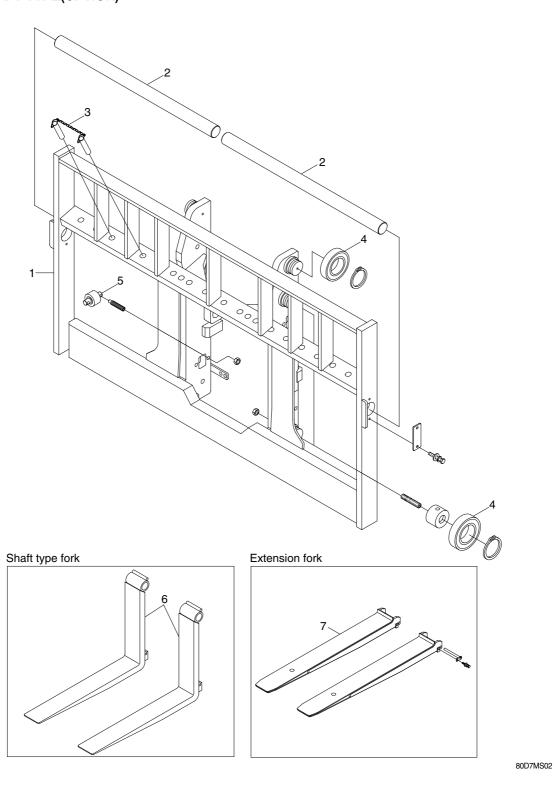


50DS7EMS03

- 1 Backrest
- 2 Carriage
- 3 Roller

- 4 Side roller
- 5 Fork
- 6 Extension fork

## 2) SHAFT TYPE(OPTION)



- 1 Carriage & backrest
- 2 Hanger bar
- 3 Fork retaining
- 4 Roller

- 5 Side roller
- 6 Fork
- 7 Extension fork

## **GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING**

#### 1. OPERATIONAL CHECKS

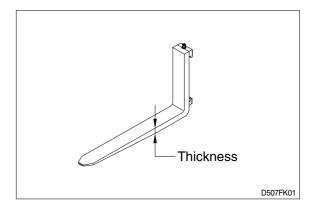
#### 1) FORKS

(1) Measure thickness of root of forks and check that it is more than specified value.

EX: l = 1200 mm(47 in)

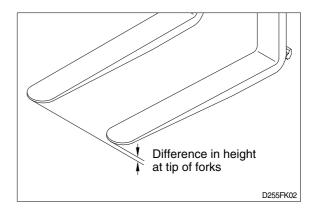
mm(in)

STD Fork assy	Applicable model	Standard	Limit
F14710011	50DS-7E	60(2.4)	54(2.1)
F14710111	60DS-7E	65(2.6)	59(2.3)
F14710111	70DS-7E	65(2.6)	59(2.3)



2) Set forks in middle and measure out of parallel and difference in height at the top of forks.

	mm(in)			
Model	lodel Fork length	lodal Faulclamenth	Model Faulclameth	Height
Model		difference		
50DS-7E	equal or	0		
60DS-7E	below 1500	3		
70DS-7E	above 1500	6		



 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-toright 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.	<ul> <li>See troubleshooting hydraulic pump and cylinders in section 6, hydraulic system.</li> <li>Disassemble mast and replace damag-ed parts or replace complete mast assembly.</li> </ul>
Slow lifting speed and insufficient handling capacity.	Faulty hydraulic equipment.      Deformed mast assembly.	<ul> <li>See troubleshooting hydraulic pump and Cylinders in section 6, hydraulic system.</li> <li>Disassemble mast and replace damag-ed parts or replace complete mast assembly.</li> </ul>
Mast fails to lift smoothly.	<ul> <li>Deformed masts or carriage.</li> <li>Faulty hydraulic equipment.</li> <li>Damaged load and side rollers.</li> <li>Unequal chain tension between LH &amp; RH sides.</li> <li>LH &amp; RH mast inclination angles are unequal. (Mast assembly is twisted when tilted)</li> </ul>	<ul> <li>Disassembly, repair or replace.</li> <li>See Troubleshooting Hydraulic Cylinders pump and control valve in section 6, hydraulic system.</li> <li>Replace.</li> <li>Adjust chains.</li> <li>Adjust tilt cylinder rods.</li> </ul>
Abnormal noise is produced when mast is lifted and lowered.	<ul> <li>Broken load roller bearings.</li> <li>Broken side roller bearings.</li> <li>Deformed masts.</li> <li>Bent lift cylinder rod.</li> <li>Deformed carriage.</li> <li>Broken sheave bearing.</li> </ul>	<ul> <li>Replace.</li> <li>Replace.</li> <li>Disassemble, repair or replace.</li> <li>Replace.</li> <li>Replace.</li> <li>Replace.</li> </ul>
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

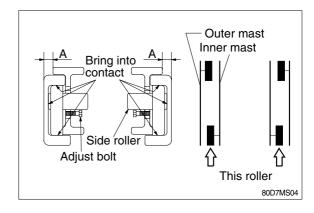
Problem	cause	Remedy
Abrasion	Long-time operations causes the fork to wear and reduces the thickness of the fork.  Inspection for thickness is needed.  · Wear limit: Must be 90% of fork thickness	If the measured value is below the wear limit, replace fork.
Distortion	Forks are bent out of shape by a number of reasons such as overloading, glancing blows against walls and objects, and picking up load unevenly.  • Difference in fork tip height  Fork length   Height   difference(mm)   equal or below 1500   3   above 1500   6	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**

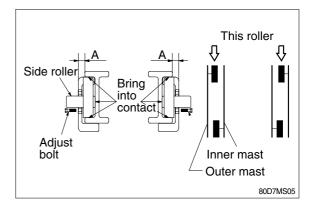
#### 1. MAST LOAD ROLLER

## 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 side roller into contact with the outer mast, and adjust the clearance between the end of inner beam and the outside of outer mast position on the opposite side to the following value by adjust bolt.
  - · Reference clearance A = 43.1mm

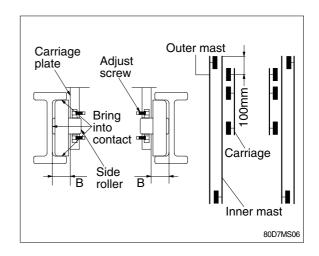


- (3) Distribute the clearance A equally to the left and right.
- (4) After the adjustment, check that the inner mast moves smoothly in the outer mast.



## 2) CARRIAGE LOAD ROLLER

- (1) Measure the clearance when the center of the carriage upper roller is 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 side roller into contact with the inner mast, and measure the clearance between inner face of the inner mast and carriage plate at the closest position on the opposite side to the following value by adjust screw.
  - · Reference clearance B = 56.9mm
- (3) Distribute the clearance B equally to the left and right.
- (4) After the adjustment, the carriage should move smoothly along the overall mast length.

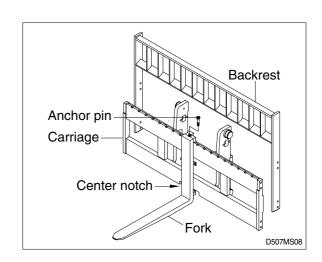


## **GROUP 4 REMOVAL AND INSTALLATION**

#### 1. FORKS

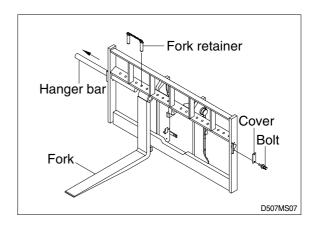
## 1) HOOK ON TYPE

- (1) Lower the fork carriage until the forks are approximately 25mm(1in) from the floor.
- (2) Release fork anchor pins and slide one fork at a time toward the center of the carriage where a notch has been cut in the bottom plate for easy fork removal.
- (3) Remove only one fork at a time.
- \* On larger forks it may be necessary to use a block of wood.
- (4) Reverse the above procedure to install load forks.



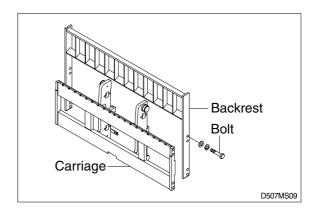
## 2) SHAFT TYPE(Option)

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



## BACKREST(Hook on type)

- Remove bolts securing backrest to fork carriage. Lift backrest straight up and remove from carriage.
- 2) Position backrest on carriage and lower in place. Install and tighten bolts.



#### 3. CARRIAGE ASSEMBLY

#### 1) CARRIAGE

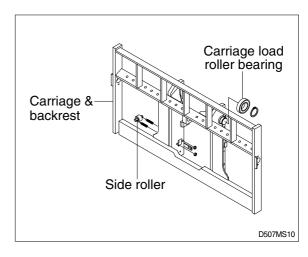
- (1) With the mast vertical, raise the carriage high enough to place blocks under the load forks. This is done to create slack in the load chains when the carriage is lowered. Lower the carriage all the way down to the floor. Make sure the carriage is level, this will prevent any binding when the mast 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) Slowly raise inner mast upright until mast clears top of fork carriage. Move carriage to work area and lower mast.
- \* Make sure carriage remains on floor and does not bind while mast is being raised.
- (5) Inspect all parts for wear or damage. Replace all worn or damaged parts.
- (6) Reverse the above steps to reinstall.
- \* Replace the split pin of chain anchor with new one.

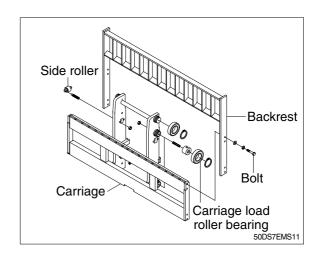
#### 2) SIDE ROLLER

- (1) Remove carriage as outlined in the carriage removal paragraph.
- (2) Loosen and remove nuts, adjust screws and side rollers from carriage side plate.
- (3) Thoroughly clean, inspect and replace all worn or damaged parts.
- (4) Reverse the above procedure to assembly.

#### \* Adjustment

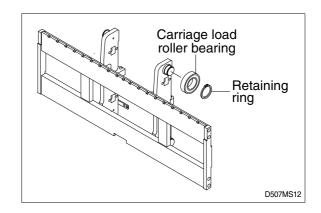
- Once carriage is properly installed, loosen nuts and adjust screws, (if not already done) allowing carriage to be centered in the inner mast.
- Adjust side roller by tightening screw until side roller just makes contact with mast.
   Back off approximately 1/10 turn on screw and tighten nut to lock screw in place.
- Run carriage up and down along the inner mast to be sure the carriage has free movement and does not stick. Also, make sure chains are properly adjusted. Refer to chain adjustment paragraph. Make adjustment when necessary and recheck operation of carriage.





## 3) CARRIAGE LOAD ROLLER BEARING

- (1) Remove carriage as outlined in the carriage removal paragraph.
- (2) Using the plier, remove retaining rings from load roller bearing bracket.
- (3) Using a plier, remove load roller bearings from load roller bearing bracket.
- (4) Reverse the above procedure to assemble. Refer to MAST ROLLER ADJUST-MENT paragraph.



#### 4. MAST LOAD ROLLER

### 1) 2 STAGE MAST(V MAST)

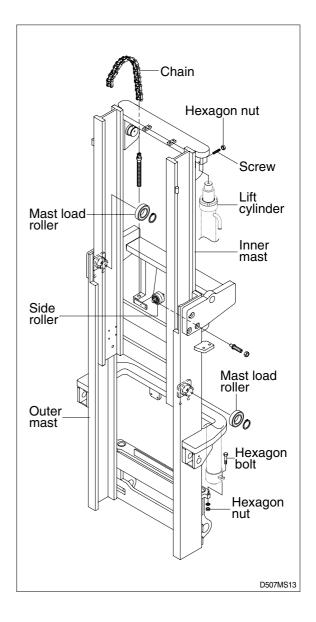
- (1) Remove the carriage assembly and move them to one side.
- (2) Loosen and remove hexagon nuts and screws securing lift cylinders to inner mast.
- (3) Loosen and remove hexagon bolts and nuts securing lift cylinders to outer mast.
- (4) Attach chains or sling to the inner mast section at top crossmember. Using an overhead hoist, slowly raise the inner mast high enough to clear lift cylinder.
- (5) After lowering the lift cylinder rods, and disconnecting lift cylinder hose, tilt the lift cylinders(LH and RH) with ropes to the outer mast.
- (6) Using the overhead hoist, lower inner mast until top and bottom rollers are exposed.
- (7) Using a plier, remove load rollers from load roller bracket. Remove side rollers.
- (8) Thoroughly clean, inspect and replace all worn or damaged parts.
- (9) Reverse the above procedure to assemble. Refer to MAST ROLLER ADJUSTMENT paragraph.
- After completing all necessary steps for (10) 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.

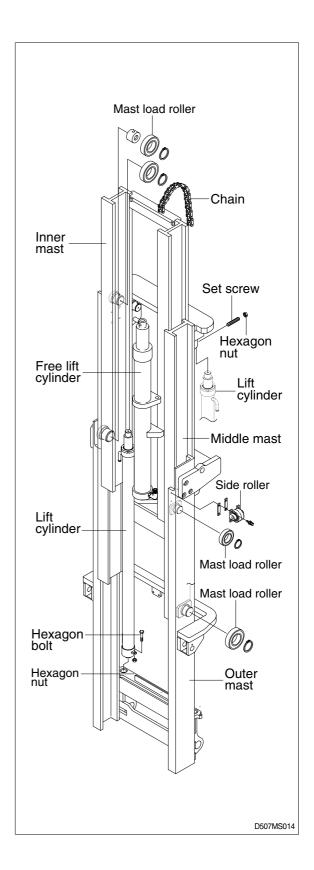
Replace and reverse above procedure to (11) install.

Make all necessary measurements and (12) adjustments.



## 2) 3 STAGE MAST(TF MAST)

- (1) Remove the carriage assembly and move it to one side.
- (2) Loosen and remove hexagon bolt securing bottom cylinder from outer mast.
- (3) Loosen and remove set screws and nuts securing lift cylinders to middle mast.
- (4) Attach chains or sling to the inner and middle mast section at top crossmember. Using an overhead hoist, slowly raise the uprights high enough to clear lift cylinder.
- (5) After lowering the lift cylinder rods, and disconnecting lift cylinder hose, tilt the lift cylinders LH and RH and tie them with ropes to the outer mast.
- (6) Using the overhead hoist raise inner and middle masts. Place 4inch block of wood under the free lift cylinder bracket of the inner mast then lower mast sections(this will create slack in the chains).
- (7) Remove retaining rings securing chain sheaves to sheave support brackets while supporting chains, remove chain sheaves and let chains hang free.
  - The upper outer and lower middle mast rollers and back up liners are now exposed.
- (8) Using a plier, remove load rollers from load bracket. Remove side rollers from mast.
- (9) Attach chains or sling to the middle mast section at top crossmember. Using an overhead hoist, slowly raise the middle mast until top and bottom rollers are exposed.
- (10) Using a plier, remove load rollers from roller bracket.
- (11) Thoroughly clean, inspect and replace all worn or damaged parts.
- (12) Reverse the above procedure to assemble. Refer to MAST LOAD ROLLER ADJ-USTMENT Paragraph.



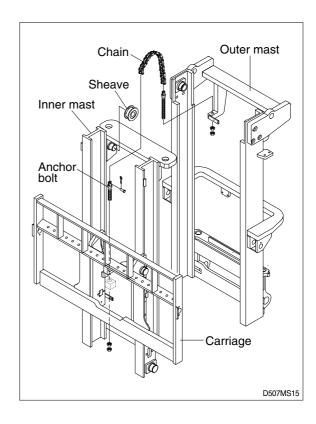
#### 5. CHAIN

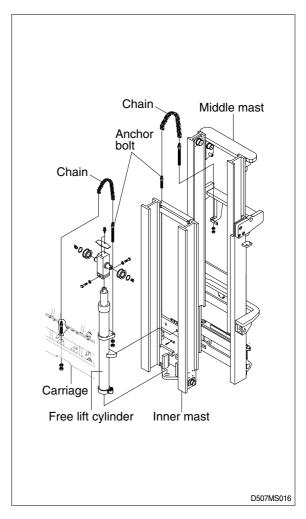
## 1) CHAIN SHEAVE

- (1) Place a sling around carriage and attach to an overhead hoist. Lift carriage high enough so that the tension on the chain over sheaves is relieved after the carriage is blocked. Position wooden blocks under the carriage and lower it.
- (2) Remove the split pin securing the chain anchor pins and discard. While supporting the chains, remove the chain anchor pins and drape the chain over the carriage.
- (3) Remove retaining ring securing sheaves to sheave support. Remove sheaves with bearings.
- (4) Remove bearing retaining ring from sheave and press bearings from sheaves.
- (5) Thoroughly clean, inspect and replace all worn or damaged parts.
- (6) Reverse the above to assemble and install. Use new split pins in chain anchor pins.

#### 2) Rear chain sheave(TF mast)

- (1) Raise and securely block carriage and inner mast section.
- (2) Remove the split pin securing the chain anchor pins and discard.
- (3) Remove chains.
- (4) Remove retaining ring securing chain sheaves to sheave support. Pry off sheaves with bearings.
- (5) Remove bearing retaining ring from sheave and press bearings from sheaves.
- (6) Thoroughly clean, inspect and replace all worn or damaged parts.
- (7) Reverse the above procedure to assemble and install. Use new split pins in chain anchor pins.





#### Sheave support(TF mast)

- (1) Remove the carriage assembly and move to one side.
- (2) After removing bolt to securing sheave support assembly to free lift cylinder. Attach a sling to the sheave support assembly. Using an overhead hoist, lift support assembly straight up and off of free lift cylinder. Move assembly to work area.
- (3) Remove retaining ring securing sheave to sheave support.
- (4) Remove bearing retaining ring from sheave and press bearings from sheaves.
- (5) Thoroughly clean, inspect and replace all worn or damaged parts.
- (6) Reverse the above procedure to install.

#### 4) Rear chain(TF mast)

- (1) Remove the carriage assembly and move to one side. Refer to carriage removal and installation.
- (2) Raise and securely block truck approximately 6 inches from the floor.
- (3) Using a sling or chain around inner mast section attached to an overhead hoist, slowly raise inner mast until there is enough slack in the chains to remove them. Block inner mast section.
- (4) Remove split pins and chain anchor pins securing chains to chain anchor(part of inner mast).
- (5) While supporting the chains, remove split and chain anchor pins securing chains to chain anchors attached to outer mast section.
- (6) Remove chains.
- (7) Reverse the above to assemble and install. Use new split pins in chain anchor pins. Refer to this section for Load chain lubrication and adjustment.

#### 5) Carriage chain

- (1) Place a sling around carriage front plate and attach to an overhead hoist. Lift and secure carriage high enough so that split and chain anchor pins on carriage can be easily be removed. Remove chain anchor pins from carriage and drape chains out over carriage.
- (2) Place a wooden block under the carriage and lower the carriage on the block.
- (3) While supporting the chains, remove split pins and chain anchor pins from chain anchors.
- (4) Remove chains and wash them with solvent. Refer to this section for Load chain inspection and maintenance.
- (5) Reverse the above procedure to assemble and install. Use new split pins in chain anchor pins. Refer to this section for Load chain lubrication and adjustment.

#### 6) Load chain inspection and maintenance

After every 200 hours of truck operation, lift chains should be inspected and lubricated inspect for the following chain conditions :

#### (1) Wear

As the chain flexes on and off the sheaves, the joints very gradually wear. The stretch a chain developes 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 2%, 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 penomenon 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(15.875 mm), 1-1/4(31.75 mm) or 2(50.8 mm), use side B.
- · Align point A or B to center of a pin and note position of the opposite A or B point.
- · If other point also lines up with a pin, the chain is worn and should be replaced.

If any of the above conditions exists(cracked plates, turned pins, stretching etc), the chains should be replaced in pairs as a complete assembly. Order chains by part number to insure the correct chain length, pitch and material specifications.

#### 7) Load chain lubrication and adjustment

#### (1) Lubrication

The most important consideration in field maintenance of lift chains is lubrication. Hard working, heavily loaded chains cannot be expected to give satisfactory wear life without scheduled periodic re-lubrication. Like all bearing surfaces, the precision manufactured, hardened steel, joint-wearing surfaces require a film of oil between mating parts to prevent rapid wear. Oil must penetrate the chain joint to prevent wear. Applying oil to external surfaces will prevent rust, but oil must flow into the live bearing surfaces for maximum wear life. Frequency of re-lube will vary with operating conditions and environment, the best estimate of lube period is 200 hours. Trucks parked outdoors or trucks in extremely severe service, may require more frequent re-lube to maintain an oil film on all chain surface.

· Wipe off the old oil with a clean cloth and blow out the remaining dirt with compressed air.

#### A 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.
- $\cdot$  Prevent chains from jumping off sheaves if they are too loose.

## (4) Adjustment procedure

- $\cdot$  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.