CONTENTS

SECTION 8 MAST

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.

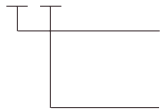
2. HOW TO READ THE SERVICE MANUAL

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



Item number(2. Structure and Function)
Consecutive page number for each item.

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

10 - 4
10 - 4 - 1
10 - 4 - 2] Added pages
10 - 5

Revised edition mark(①②③…)

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

Revisions

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

Symbols

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

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

3. CONVERSION TABLE

Method of using the Conversion Table

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

Example

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

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

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

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

2. Convert 550mm into inches.

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

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

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

Millimeters to inches

1mm = 0.03937 in

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

Millimeters to inches

1mm = 0.03937in

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

Kilogram to Pound

1kg = 2.2046lb

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

Liter to U.S. Gallon

1 ℓ = 0.2642 U.S.Gal

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

Liter to U.K. Gallon

1 ℓ = 0.21997 U.K.Gal

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

kgf · m to lbf · ft

1kgf · m = 7.233lbf · ft

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

kgf/cm² to lbf/in²

1kgf / cm² = 14.2233lbf / in²

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

TEMPERATURE

Fahrenheit-Centigrade Conversion.

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

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

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

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

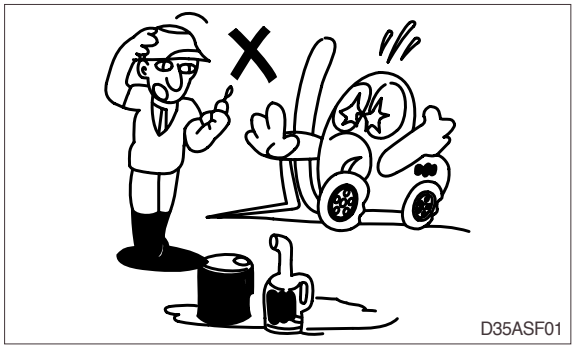
°C		°F	°C		°F	°C		°F	°C		°F
-40.4	-40	-40.0	-11.7	11	51.8	7.8	46	114.8	27.2	81	117.8
-37.2	-35	-31.0	-11.1	12	53.6	8.3	47	116.6	27.8	82	179.6
-34.4	-30	-22.0	-10.6	13	55.4	8.9	48	118.4	28.3	83	181.4
-31.7	-25	-13.0	-10.0	14	57.2	9.4	49	120.2	28.9	84	183.2
-28.9	-20	-4.0	-9.4	15	59.0	10.0	50	122.0	29.4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

SECTION 1 GENERAL

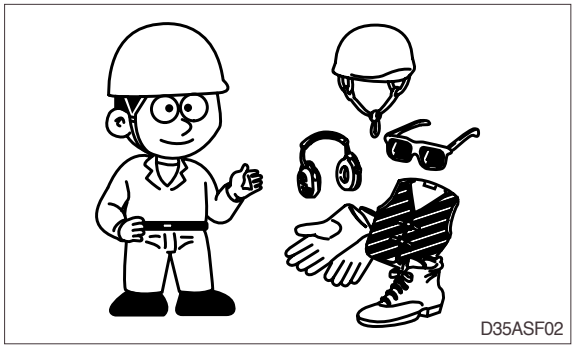
GROUP 1 SAFETY HINTS

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

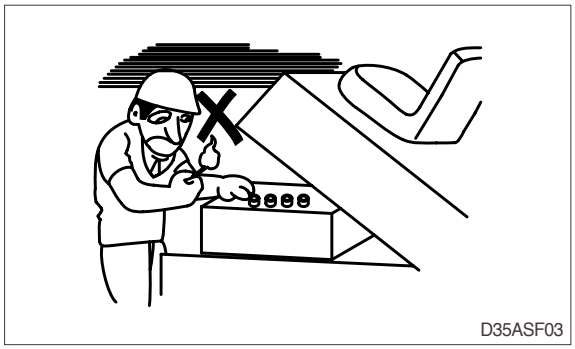
- Oil is a dangerous substance. Never handle oil, grease or oily clothes in places where there is any fire of flame.
  As preparation in case of fire, always know the location and directions for use of fire extinguishers and other fire fighting equipment.


D35ASF01

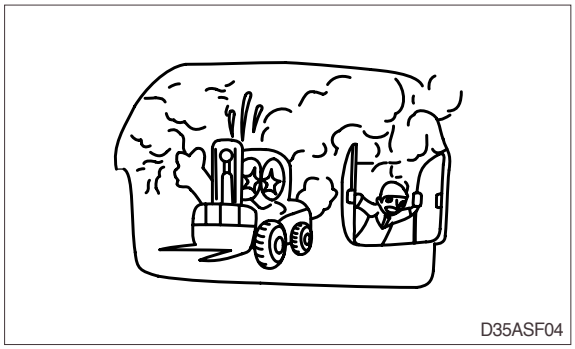
- Wear well-fitting helmet, safety shoes and working clothes. When drilling, grinding or hammering, always wear protective goggles.
  Always do up safety clothes properly so that they do not catch on protruding parts of machines. Do not wear oily clothes.
  When checking, always release battery plug.


D35ASF02

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

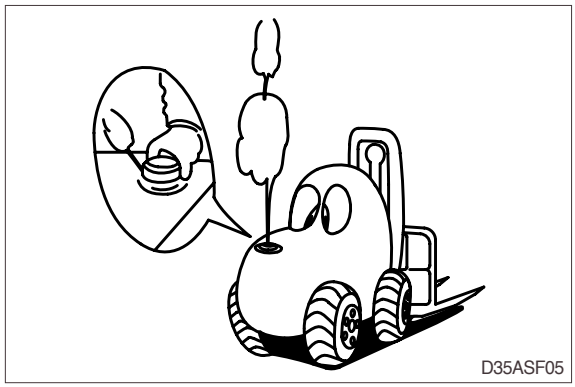

D35ASF03

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


D35ASF04

⚠ 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.

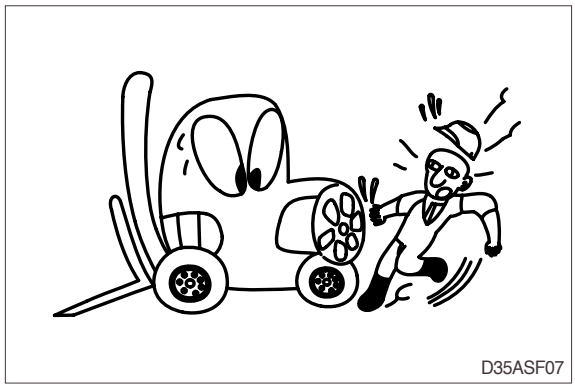

D35ASF05

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


D35ASF06

· 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.

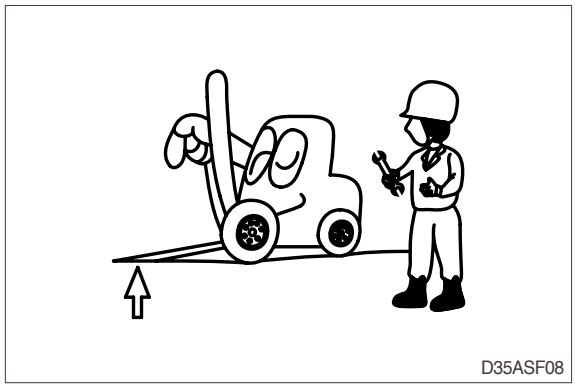
⚠ It is extremely dangerous to try to check the fan belt tension while the engine is running.


D35ASF07

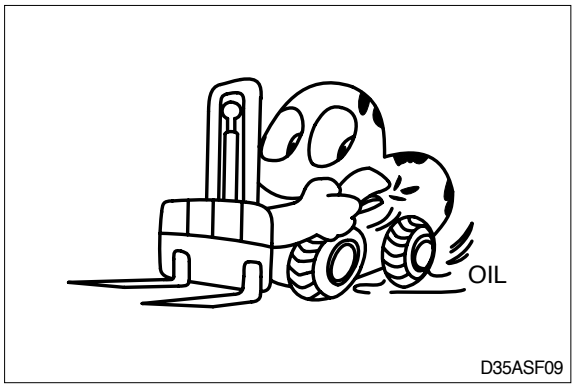
When inspecting the engine is running parts, or near such parts, always stop the engine first.

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

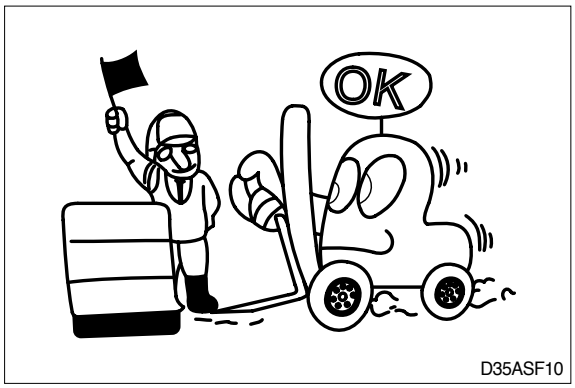
· Park the machine on firm, flat ground.
Lower the fork to the ground and stop the engine.
Return each lever to **NEUTRAL** and apply the brake lock.


D35ASF08

· 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.

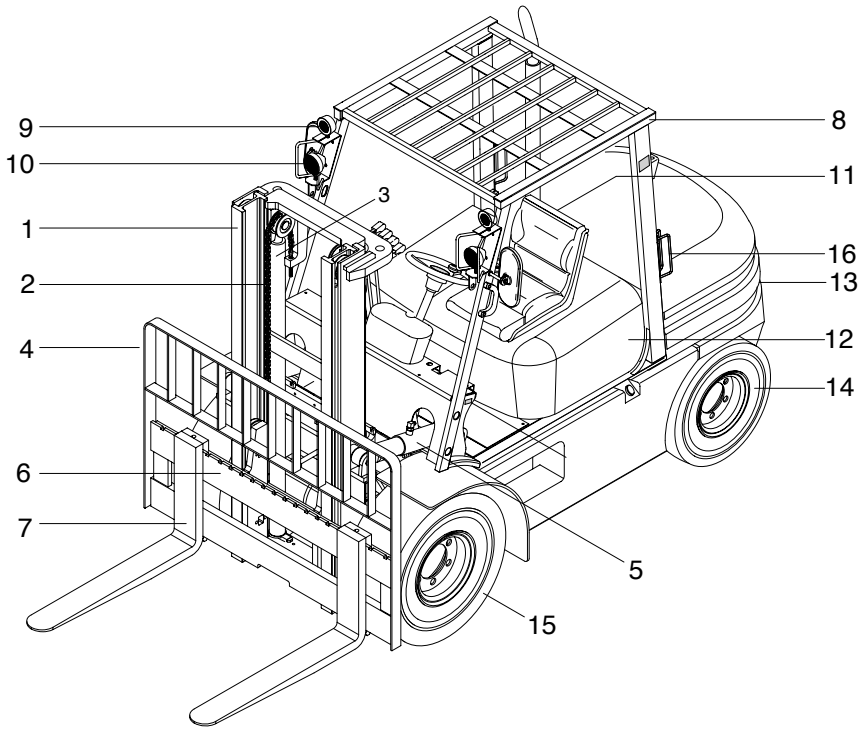
· Always remember that the hydraulic oil circuit is under pressure. When feeding or draining the oil or carrying out inspection and maintenance, release the pressure first.

- 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.
- After injecting grease, always wipe off the oil grease that was forced out.
- Do not handle electrical equipment while wearing wet places, as this can cause electric shock.
- During maintenance do not allow any unauthorized person to stand near the machine.
- Be sure you fully understand the contents of the operation. It is important to prepare necessary tools and parts and to keep the operating area clean.
- When checking an open gear case there is a risk of dropping things in. Before removing the covers to inspect such cases, empty everything from your pockets. Be particularly careful to remove wrenches and nuts.
- Way to use dipstick
  Push the dipstick fully into the guide, and then pull out.

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

GROUP 2 SPECIFICATIONS

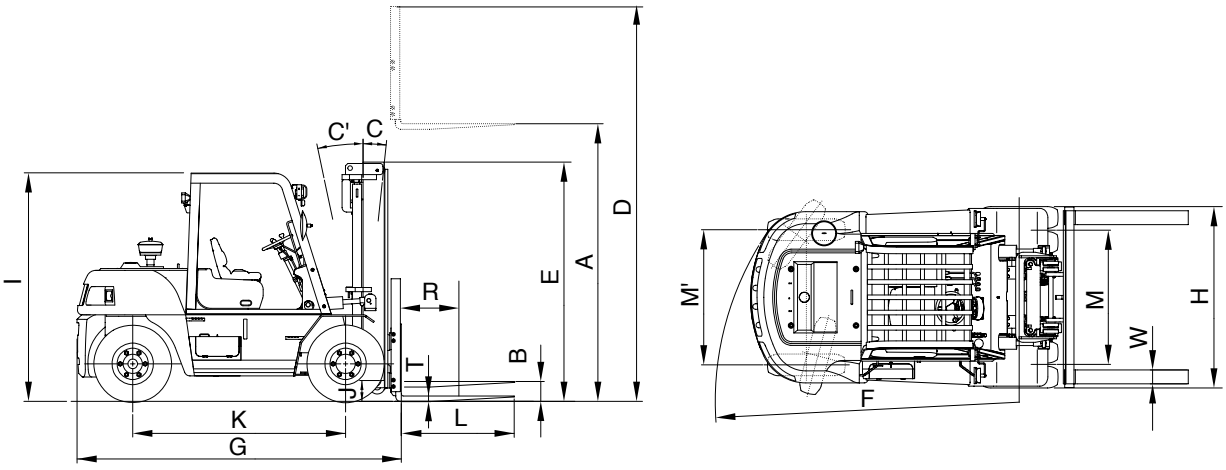
1. GENERAL LOCATIONS



D153OM01

1	Mast	7	Fork	13	Counterweight
2	Lift chain	8	Overhead guard	14	Rear wheel
3	Lift cylinder	9	Turn signal lamp	15	Front wheel
4	Backrest	10	Head lamp	16	Rear combination lamp
5	Tilt cylinder	11	Operator's seat		
6	Carriage	12	Bonnet		

2. SPECIFICATIONS



D153SP01

Model			Unit	HDF 15III	HDF 18III
Capacity			kg	1500	1750
Load center		R	mm	500	←
Weight(Unloaded)			kg	2800	2980
Fork	Lifting height	A	mm	3300	←
	Free lift	B	mm	155	←
	Lifting speed(Unload/Load)		mm/sec	520/480	←
	Lowering speed(Unload/Load)		mm/sec	340/500	←
	L×W×T	L,W,T	mm	920×100×35	←
Mast	Tilt angle forward/backward	C/C'	degree	6/10	←
	Max height	D	mm	4320	←
	Min height	E	mm	2135	←
Body	Travel speed		km/h	20.6	←
	Gradeability		degree	15.2	13.5
	Min turning radius(Outside)	F	mm	1765	←
ETC	Max hydraulic pressure		kgf/cm²	150	←
	Hydraulic oil tank		ℓ	36	←
	Fuel tank		ℓ	30	←
Overall length		G	mm	2190	2220
Overall width		H	mm	1090	←
Overhead guard height		I	mm	2135	←
Ground clearance		J	mm	105	←
Wheel base		K	mm	1350	←
Wheel tread front/rear		M, M'	mm	912/905	←

3. SPECIFICATION FOR MAJOR COMPONENTS

1) ENGINE

Item	Unit	Specification
Model	-	ISUZU 4LE1PW-06
Type	-	4 cycle turbocharged diesel type
Cooling Method	-	Water cooling
Number of cylinders and arrangement	-	4 cylinders, In-line
Firing order	-	1-3-4-2
Combustion chamber type	-	In-direct injection
Cylinder bore X stroke	mm(in)	85×96(3.35×3.78)
Piston displacement	cc(cu in)	2179(133)
Compression ratio	-	21.5: 1
Rated gross horse power	hp/rpm	44.5/2400
Maximum gross torque at rpm	kgf · m/rpm	13.9/1600
Engine oil quantity	ℓ (U.S.gal)	8.1~5.6(2.1~1.5)
Dry weight	kg(lb)	180(397)
High idling speed	rpm	2640
Low idling speed	rpm	850
Rated fuel consumption	g/ps.hr	198
Starting motor	V-kW	DENSO(12-2.0)
Alternator	V-A	DENSO(12-35)
Battery	V-AH	12-100
Fan belt deflection	mm(in)	10(0.39)

2) MAIN PUMP

Item	Unit	Specification
Type	-	Fixed displacement gear pump
Capacity	cc/rev	24.5
Maximum operating pressure	bar	207
Rated speed (Max/Min)	rpm	3000/500

3) MAIN CONTROL VALVE

Item	Unit	Specification
Type	-	Sectional
Operating method	-	Mechanical
Main relief valve pressure	bar	185/150
Flow capacity	lpm	80

4) POWER TRAIN DEVICES

Item			Specification
Torque converter	Model		OKAMURA MD14
	Type		3 Element, 1 stage, 2 phase
	Stall ratio		2.8 : 1
Transmission	Type		Full-automatic power shift
	Gear shift(FR/RR)		1/1
	Adjustment		Electrical single lever type, kick-down system
	Overhaul ratio	FR	13.720 : 1
		RR	14.090 : 1
Axle	Type		Front-wheel drive type, fixed location
	Gear		Hypoid gear type
Wheels	Qty(FR/RR)		2/2
	Front(Drive)		6.5-10-12PR
	Rear(steering)		5.0-8-8PR
Brakes	Travel		Front wheel, duo-servo & auto adjustment type
	Parking		Toggle, internal expanding mechanical type
Steering	Type		Full hydraulic, power steering
	Steering algle		80 ° to both right and left angle, respectively

4. TIGHTENING TORQUE OF MAJOR COMPONENTS

No	Items		Size	kgf · m	lbf · ft
1	Engine	Engine mounting bolt, nut	M16×2.0	7.5	54
2		Radiator mounting bolt, nut	M 8×1.25	2.5±0.5	18.1±3.6
3	Hydraulic system	MCV mounting bolt, nut	M10×1.25	7.45±1.5	54±10.8
4		Steering unit mounting bolt	M10×1.5	6.9±1.4	50±10
5		Torque converter mounting bolt	M 8×1.25	4.17	30
6	Power train system	Transmission mounting bolt, nut	M12×1.75	12.8±3.0	93±22
7		Drive axle mounting bolt, nut	M20×1.5	62.8±9.4	454±68
8		Steering axle mounting bolt, nut	M20×2.5	58±8.7	420±63
9		Front wheel mounting nut	M14×1.5	17±1.0	123±7.2
10		Rear wheel mounting bolt	M10×1.25	7.43±1.5	54±10.8
11	Others	Counterweight mounting bolt	M30×2.5	215±33	1555±239
12		Operator's seat mounting nut	M 8×1.25	2.5±0.5	18.1±3.6
13		Head guard mounting bolt	M10×1.5	6.9±1.4	50±10

5. TORQUE CHART

Use following table for unspecified torque.

1) BOLT AND NUT

(1) Coarse thread

Bolt size	8T		10T	
	kgf · m	lbf · ft	kgf · m	lbf · ft
M 6 × 1.0	0.85 ~ 1.25	6.15 ~ 9.04	1.14 ~ 1.74	8.2 ~ 12.6
M 8 × 1.25	2.0 ~ 3.0	14.5 ~ 21.7	2.7 ~ 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

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

2) PIPE AND HOSE(FLARE TYPE)

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

3) PIPE AND HOSE(ORFS TYPE)

Thread size(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	130.2
1-7/16-12	41	21	151.9
1-11/16-12	50	35	253.2

4) FITTING

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

6. RECOMMENDED LUBRICANTS

Use only oils listed below or equivalent.

Do not mix different brand oil.

Service point	Kind of fluid	Capacity ℓ (U.S.gal)	Ambient temperature °C (°F)
			-20 (-4) / -10 (14) / 0 (32) / 10 (50) / 20 (68) / 30 (86) / 40 (104)
Engine oil pan	Engine oil	8.1 (2.1)	SAE 30 SAE 10W SAE 10W-30 SAE 15W-40
Torque converter transmission	ATF	5.5 (1.5)	DEXRON III
Axle	Gear oil	2.6 (0.7)	SAE 80W-90/API GL-5
Hydraulic tank	Hydraulic oil	36 (9.5)	ISO VG32 ISO VG46 ISO VG68
Fuel tank	Diesel fuel	30 (7.9)	ASTM D975 No.1 ASTM D975 No.2
Fitting (Grease nipple)	Grease	-	NLGI No.1 NLGI No.2
Brake reservoir tank	Brake oil	0.5 (0.13)	SAE J1703e
Radiator	Antifreeze Water 50:50	17 (4.5)	Ethylene glycol base permanent type

NOTES :

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

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

③ **If any engine oil of API service class CC is used instead of class CD 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 degrees 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).

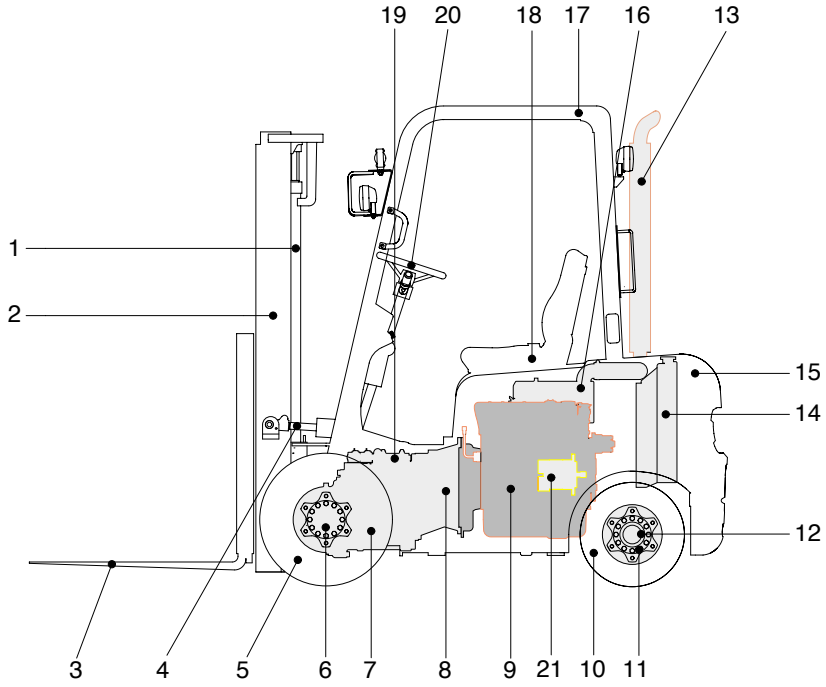
※ Replacement of consumable service parts in not covered under warranty.

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 AND INSTALL OF UNIT

SECTION 2 REMOVAL & INSTALL OF UNIT

GROUP 1 MAJOR COMPONENTS



D153RE01

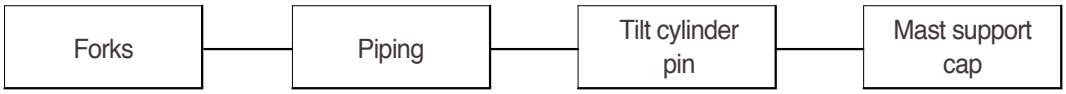
1	Lift cylinder	8	Torque converter	15	Counterweight
2	Mast	9	Engine	16	Air cleaner
3	Fork assy	10	Rear wheel	17	Overhead guard
4	Tilt cylinder	11	Steering axle(rear axle)	18	Operator's seat
5	Front wheel	12	Steering cylinder	19	Control valve
6	Drive axle	13	Muffler	20	Steering wheel
7	Transmission	14	Radiator	21	Hydraulic pump

GROUP 2 REMOVAL AND INSTALL OF UNIT

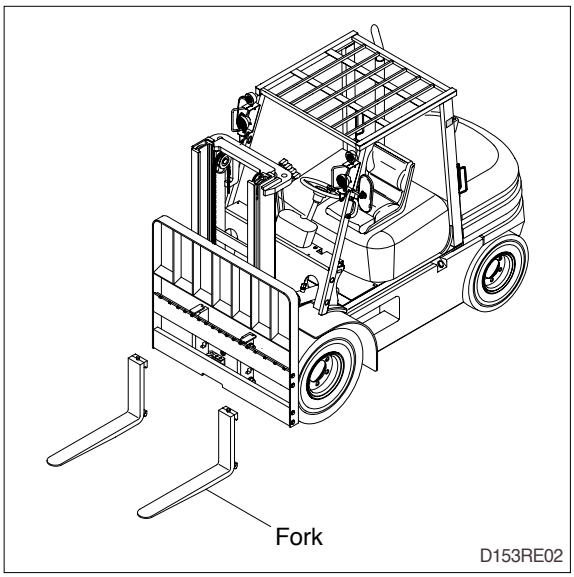
Remove and install the following units as explained in the flow chart.

1. MAST

1) REMOVAL



(1) Forks

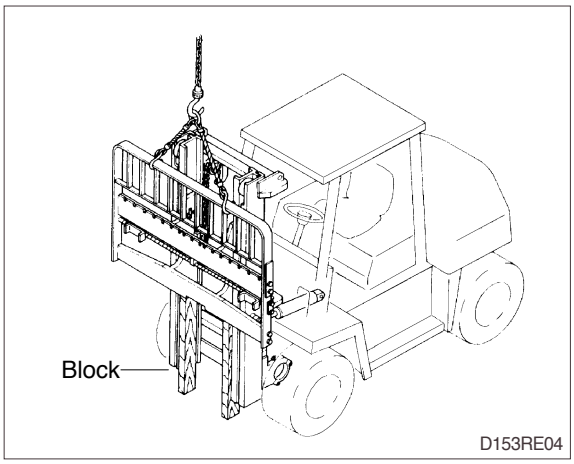


(2) Piping

Raise the fork carriage to make it easy to remove the piping. Remove the piping and the return hose from the control valve.

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

※ Insert blocks to prevent the carriage from coming down.

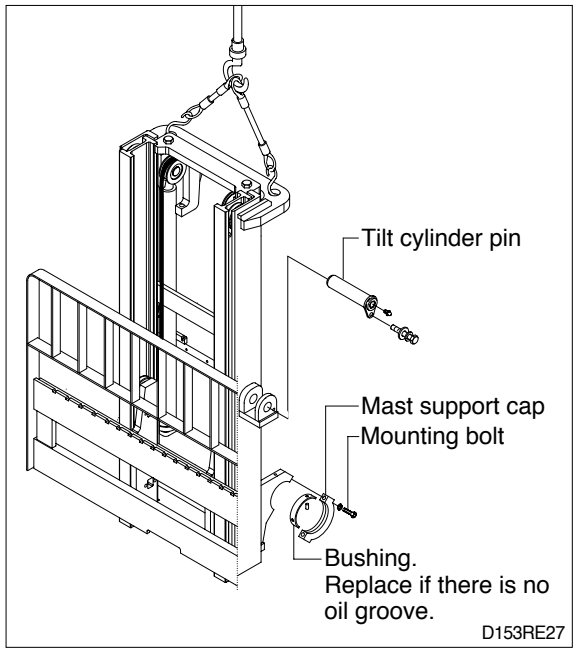


(3) Tilt cylinder pin

(4) Mast support cap

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

(1) Mast support cap

Check the mast support bushing for wear, then tighten the cap mounting bolts.

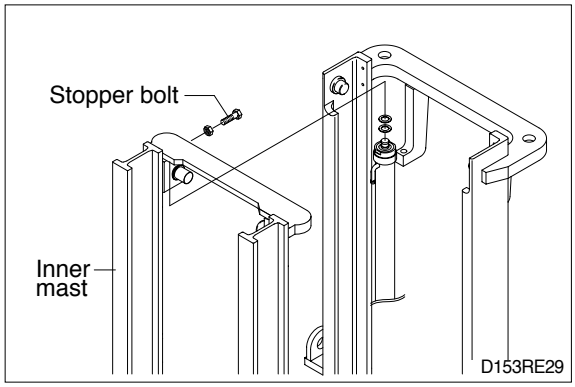
· Tighten torgue : 19.9 ~ 27.0 kgf · m (144 ~ 195 lbf · ft)

(2) Tilt cylinder pin

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

2. LIFT CYLINDER

Only one end of the lift cylinder is removed.



1) REMOVAL

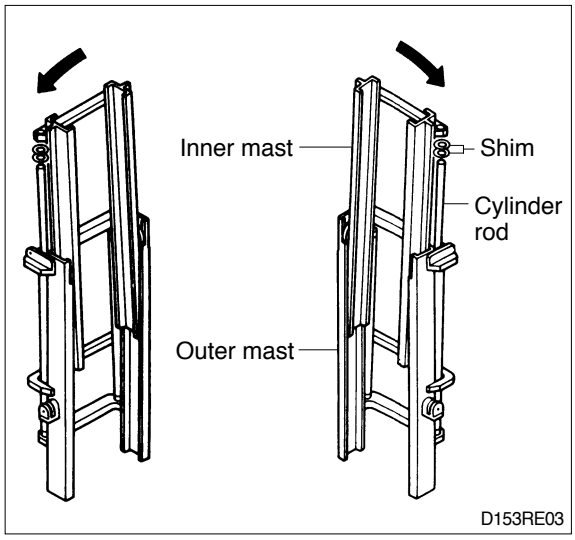
(1) Remove the stopper bolt connecting the lift cylinder rod with the inner mast, then raise the inner mast.

※ Insert a block to prevent the inner mast from coming down.

(2) Remove the cylinder clamp and the piping from the down control valve, then raise about 300㎜(12in) with a crane and pull out from the bottom.

※ Insert a blind plug immediately after removing the piping.

2) INSTALLATION AND ADJUSTMENT



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

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

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

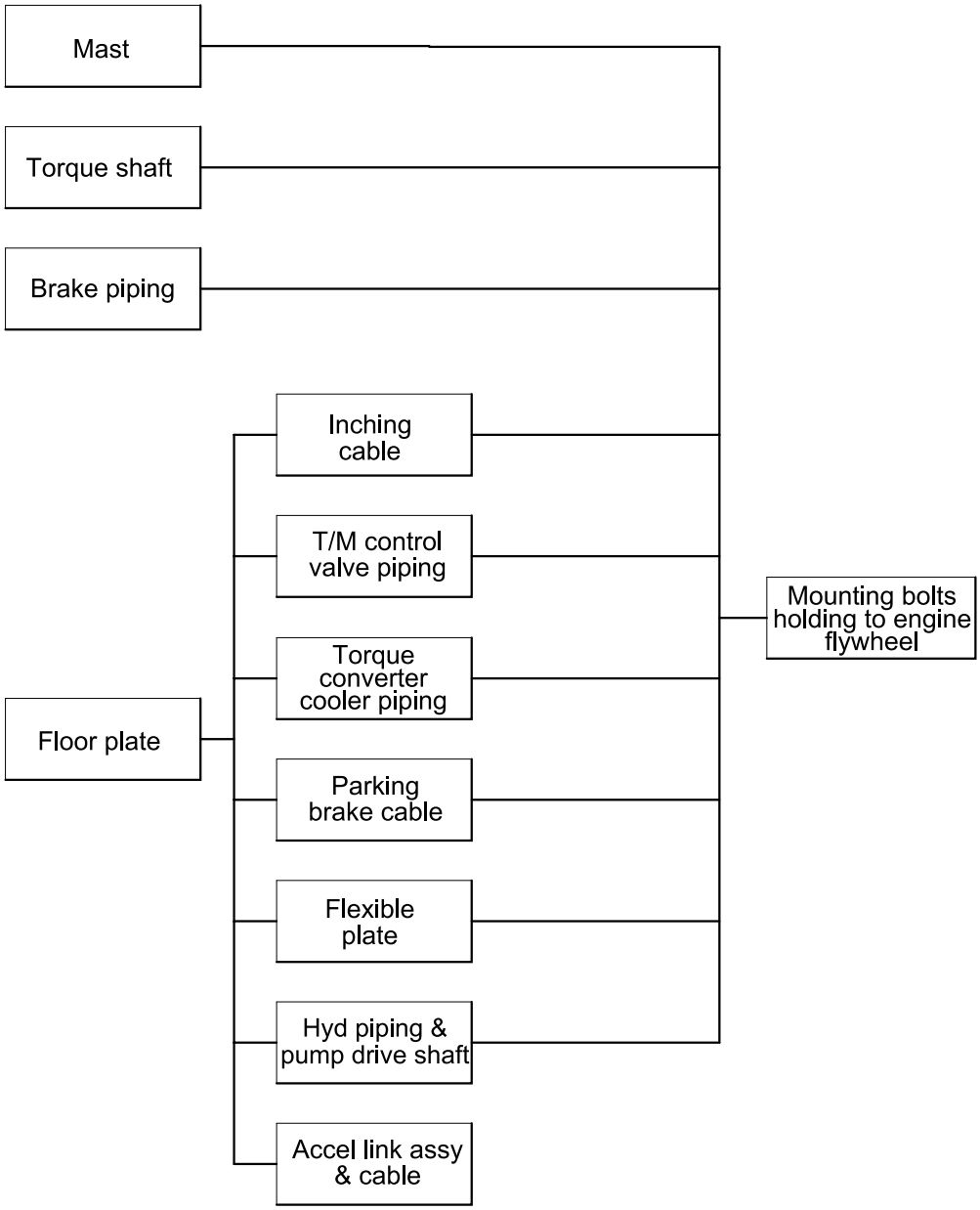
※ If play is to RIGHT, install adjustment shim to RIGHT cylinder.

· Shim thickness : 1.0㎜(0.04in)

3. TORQUE CONVERTER + TRANSMISSION + FRONT AXLE(POWER TRAIN ASSEMBLY)

Leave the engine inside the frame, move the power train assembly as a unit to the front and remove.

1) REMOVAL

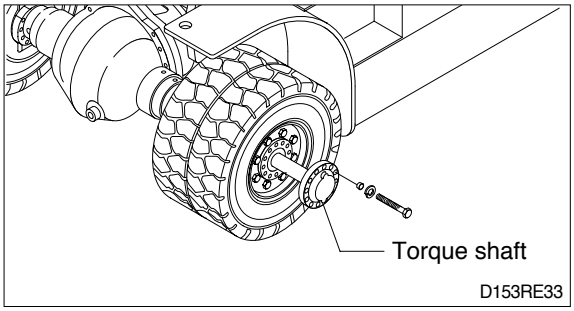


(1) Mast

See section on mast.(Page 2-2)

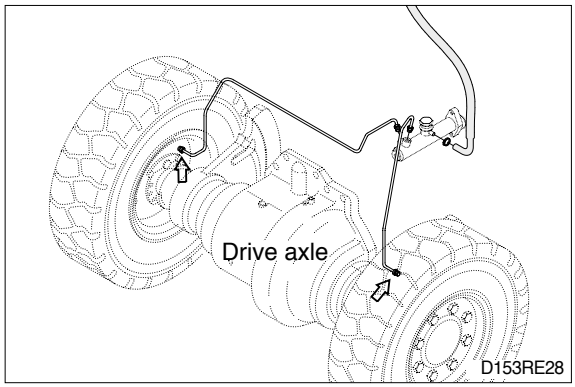
(2) Torque shaft

Pull out about 200mm(7.9in) to make the front wheel free.



(3) Brake piping

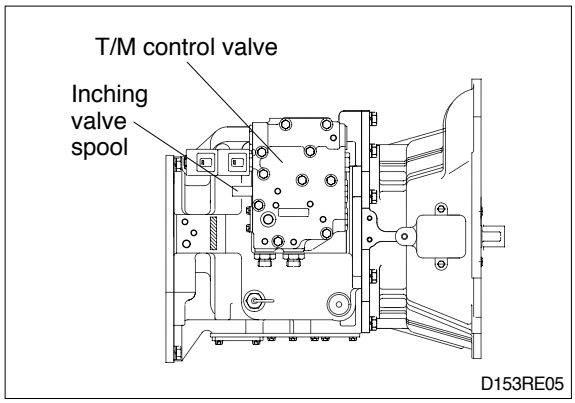
Disconnect the brake piping from the wheel cylinder end.



(4) Remove the bolts, clevis pin and self locking pin.

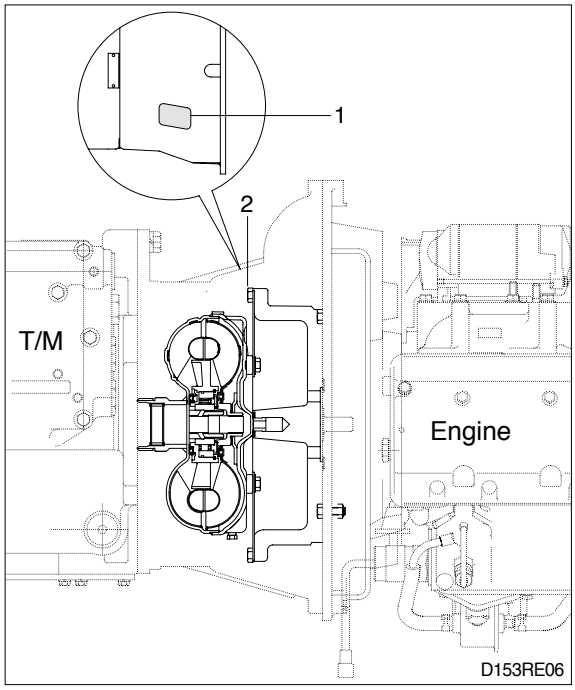
(5) Control valve piping

Remove the hose because it is in the way when pulling the power train assembly out to the front. Fit blind plugs to prevent dust or dirt from entering.



(6) Flexible plate

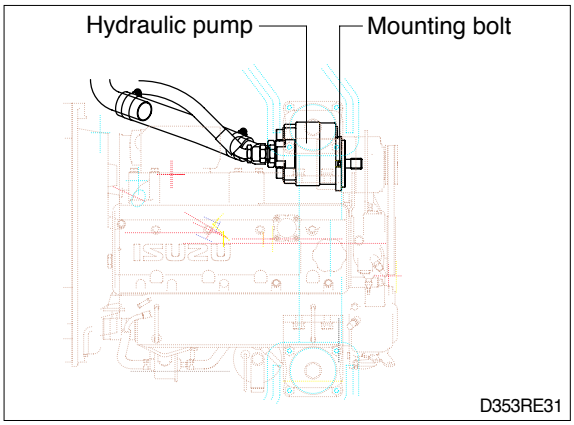
Remove the cover(1) on the top face of the torque converter housing then remove the 8 mounting bolts(2) installed to the engine flywheel. To rotate the flywheel, remove 1 mounting bolt, then insert a turning tool in the mounting hole. One man must turn the engine fan by hand while the other turns the flywheel.



(7) Hydraulic piping

Remove the pipe for the hydraulic pump installed on the engine side PTO.

If the hose hangs down, a large amount of hydraulic oil will come out, so install a blind plug.



(8) Pump drive shaft

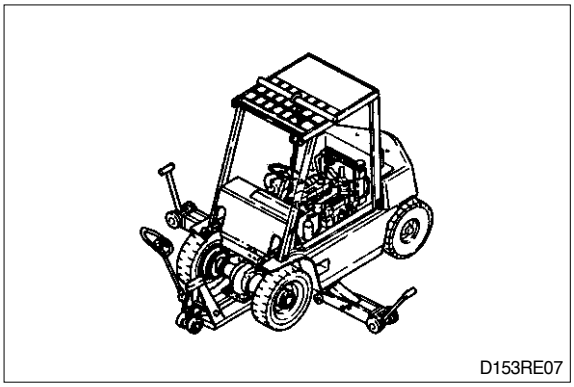
Remove 2 mounting bolts for pump drive shaft tightened to the transmission.

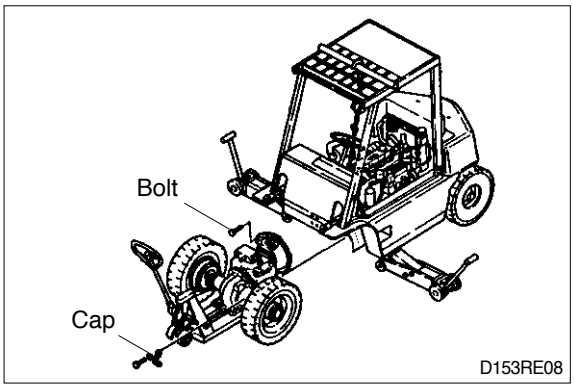
(9) Mounting bolts holding to flywheel housing

① Using a chain block, raise the engine to the overhead guard. Put jacks under the frame on both sides(or attach a crane to the tilt cylinder notches on the dashboard), and support the bottom of the transmission on a truck.

② Remove the front axle caps and the mounting bolts installed to the engine flywheel. Insert a screwdriver in the joint and disconnect.

Operating the jacks on the left and right, raise the front of the frame and pull out slowly. When doing this, be careful not to catch the wiring harnesses, hoses and pipes.

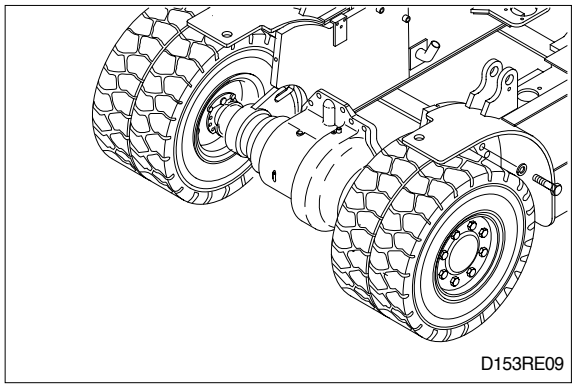




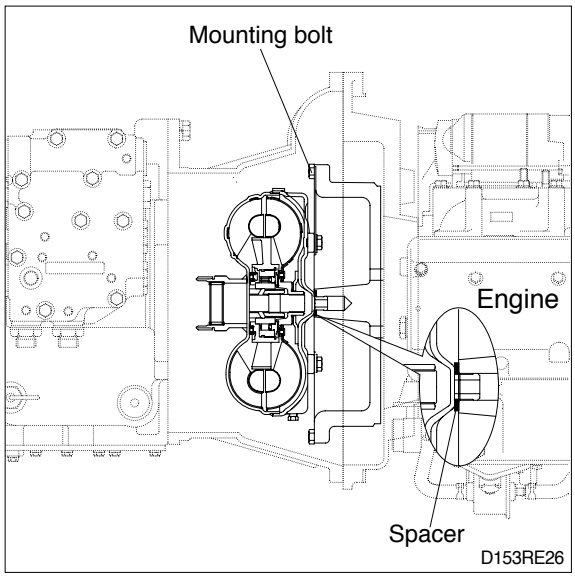
2) INSTALLATION

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

(1) Tightening torque of mounting bolt for drive axle plate.
· 26.8~32.0kgf · m(194~231lbf · ft)


D153RE09

(2) Tightening torque of mounting bolt for transmission and engine.
· 4.17kgf · m(30.2lbf · ft)

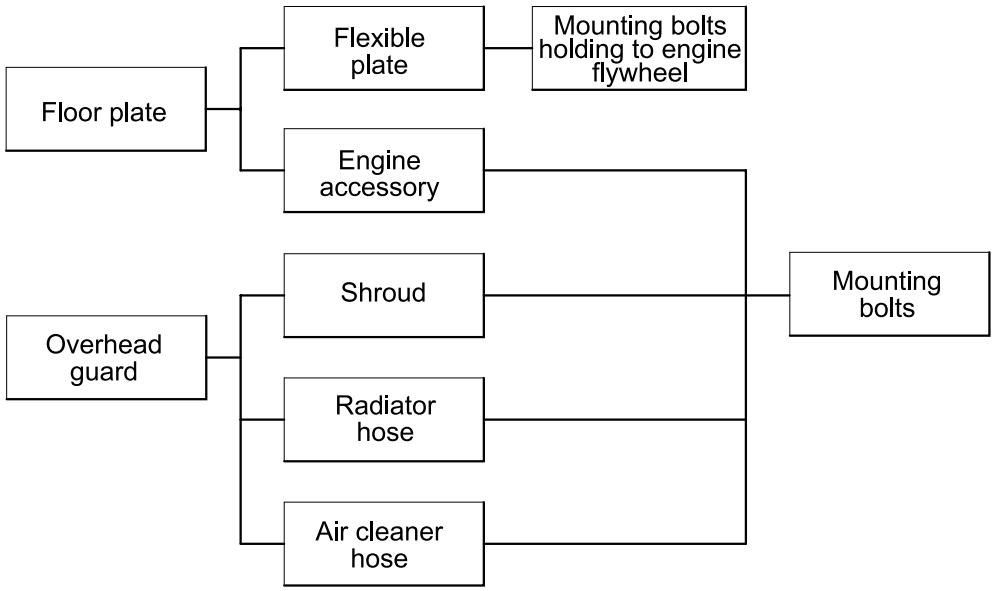


D153RE26

4. ENGINE

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

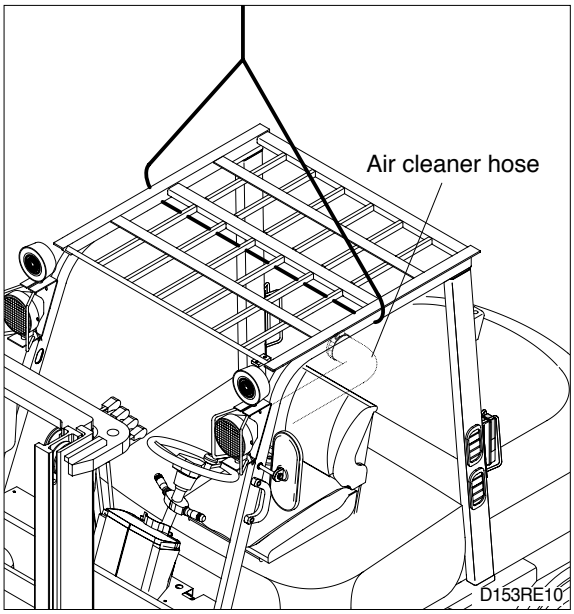
1) REMOVAL



D35ARE22

(1) Overhead guard

Remove the wiring for the rear combination lamp on the rear stay of the overhead guard and air cleaner hose, then raise together with the bonnet.



D153RE10

(2) Flexible plate, mounting bolts installed to flywheel housing.
For details, see page 2-6.

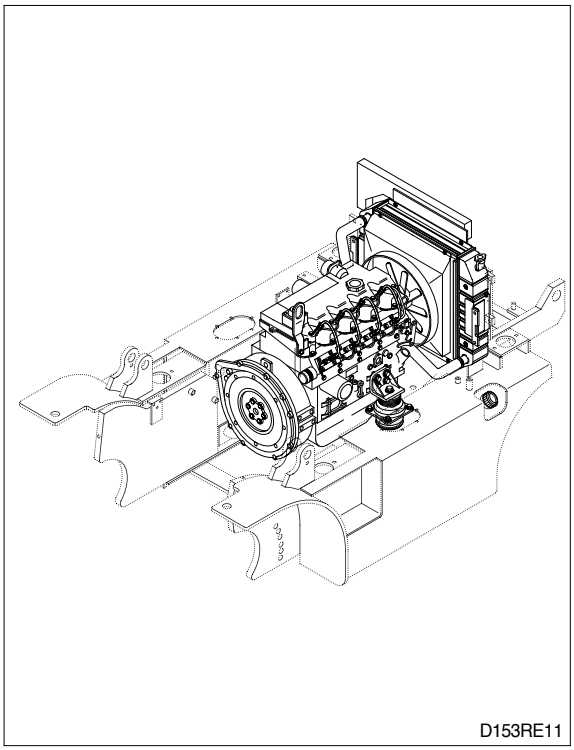
(3) Engine accessory

Remove all wiring harnesses, cables and hoses between the engine and the 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

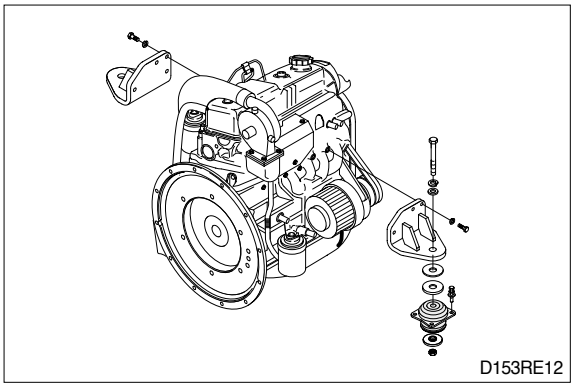
Open the drain valve of the radiator and drain the cooling water, then remove the radiator hose.


D153RE11

(5) Mounting bolt

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

※ When sliding the engine, if it hits the radiator it will damage the radiator, so it is better to remove the radiator if possible.


D153RE12

2) INSTALLATION

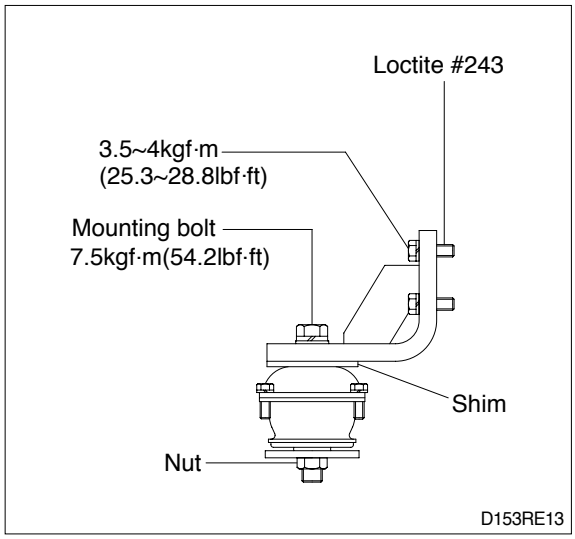
Installation is in the reverse order to removal, but be careful of the following points.

(1) Tighten the engine mounting bolts and nuts.

(2) Tighten the engine mounting bracket bolts.

※ Do not remove the bolts unless necessary. Loctite is coated on the thread of bolt. So if the bolts must be removed, coat the loctite(#243) when installing.

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



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

· 4.17kgf · m(30.2lbf · ft)

(4) Radiator hoses

· Distance to insert hose : 30mm(1.18in)

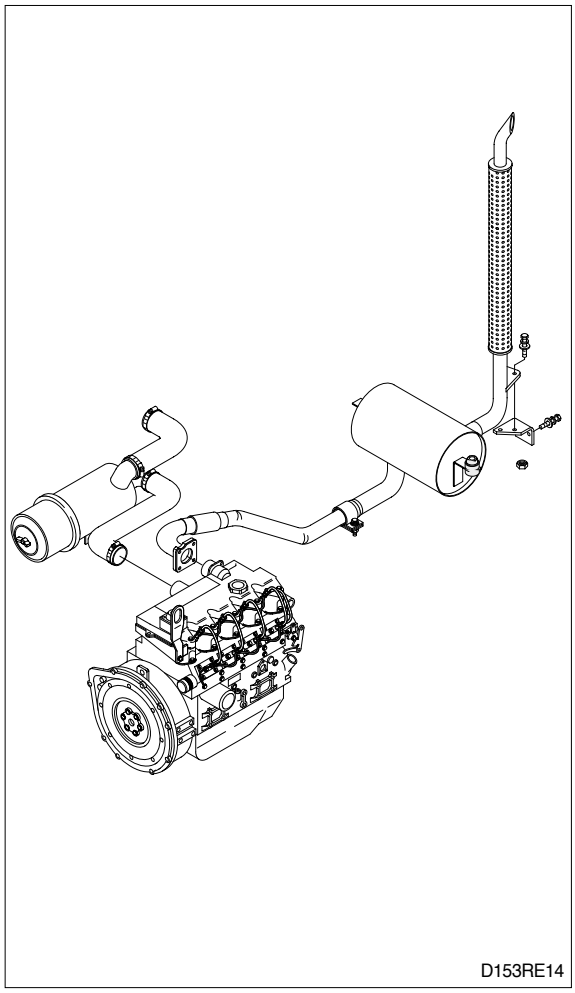
(5) Air cleaner hose

Insert the air cleaner hose securely and fit a clamp.

Distance to insert hose

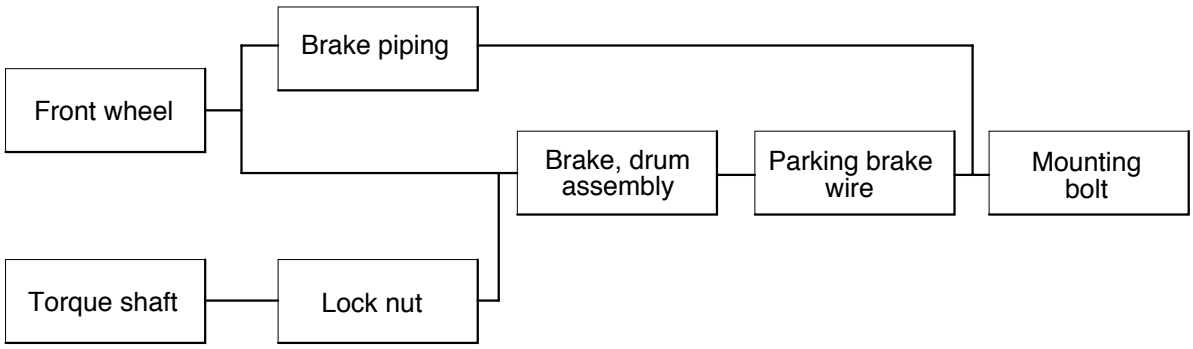
· Air cleaner hose : 57mm(2.24in)

· Engine end : 32mm(1.26in)



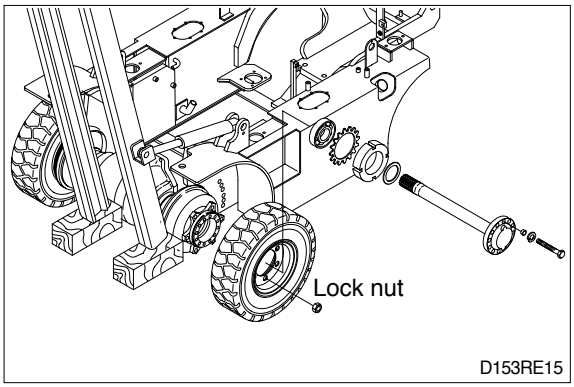
5. WHEEL BRAKE

1) REMOVAL



(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.



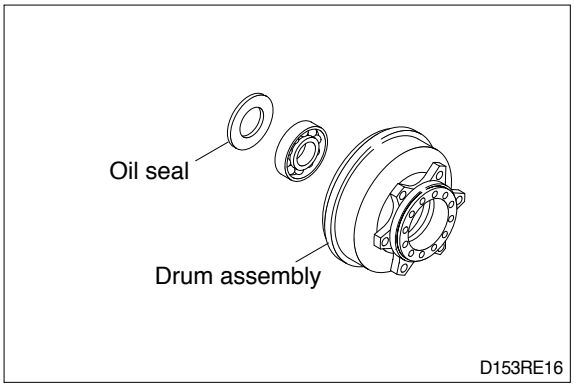
(2) Lock nut

Raise the lock plate, and remove the lock nut(width across flats: 95㎜) with a hub nut wrench.

(3) Brake, drum assembly

The oil seal inside the hub acts as a seal for the axle shaft end. Therefore when removing or installing the brake and drum assembly, remove or install in a straight line to prevent twisting the seal up and down or to the right and left.

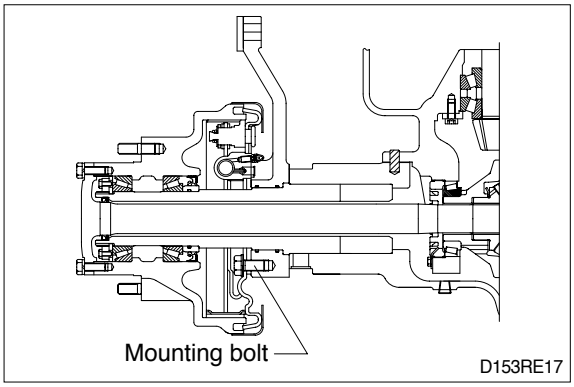
When the brake and drum assembly is removed, the oil seal is connected to the inside of the hub.



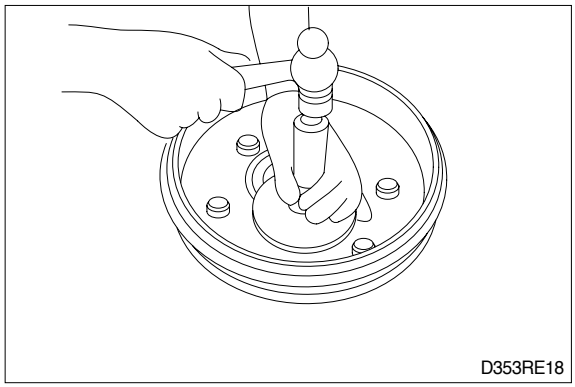
2) INSTALLATION

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

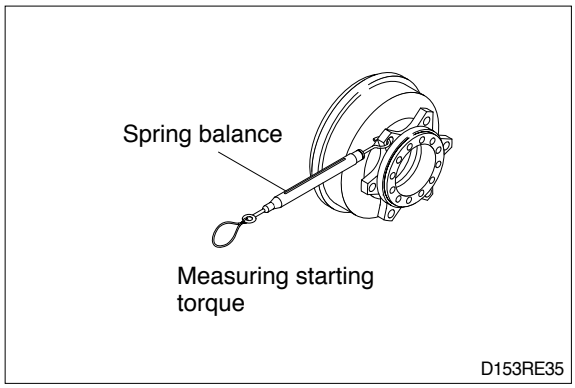
(1) Coat the mounting bolts with loctite and tighten to 15~21㎏f · m(108.5~152lbf · ft).



(2) When replacing the oil seal inside the hub, be careful to install the seal facing in the correct direction(Lip on outside) and knock into place.


D353RE18

(3) Wipe the inside of the brake drum clean, coat the lip of the seal with grease, and assemble the brake and drum assembly. Adjust the starting torque with the nut.
Attach a spring balance to the hub bolt and adjust the nut to give a starting force of 6 to 15kgf(13~33lbf).



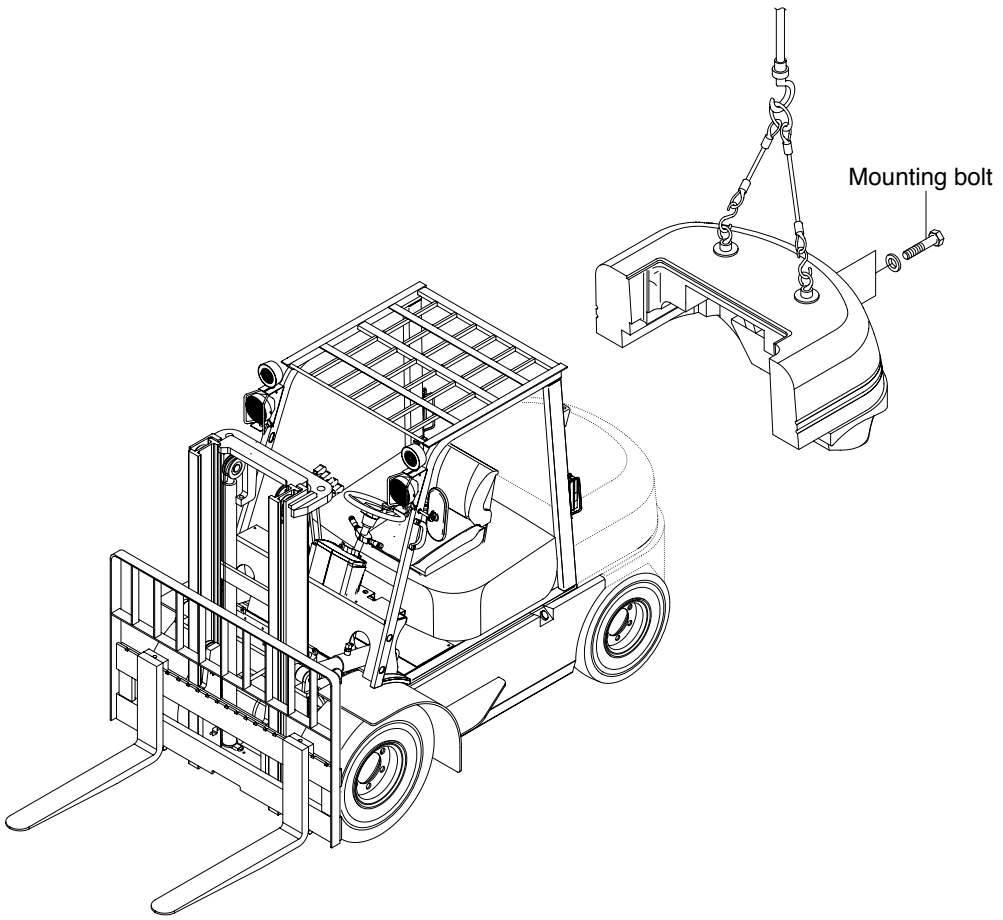
D153RE35

(4) Tightening torque of hub nut for front wheel.
· 11~13kgf · m(79.6~94lbf · ft)
Coat the hub bolt with molybdenum disulphide.

6. REAR AXLE

1) REMOVAL

Counter weight → Rear wheel (Left side) → Hose → Mounting bolt



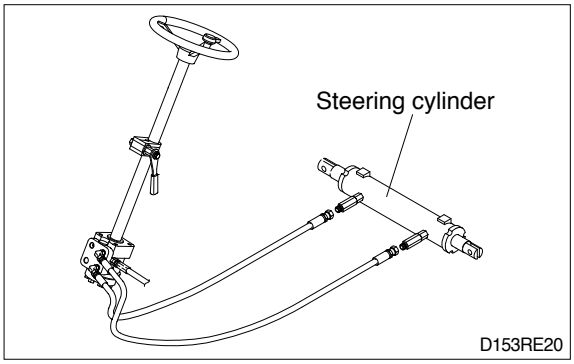
D153RE19

(1) Counterweight

Install a lifting tool in the hole in the counterweight, and raise with a crane.
Remove the mounting bolts, raise slightly and move to the rear.

· Weight of counterweight(standard)
HDF15III : 870kg(1,918lb)
HDF18III : 1,090kg(2,403lb)

(2) Hose

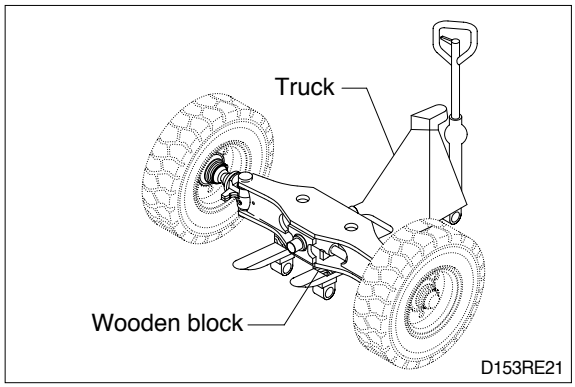


D153RE20

(3) Mounting bolt

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

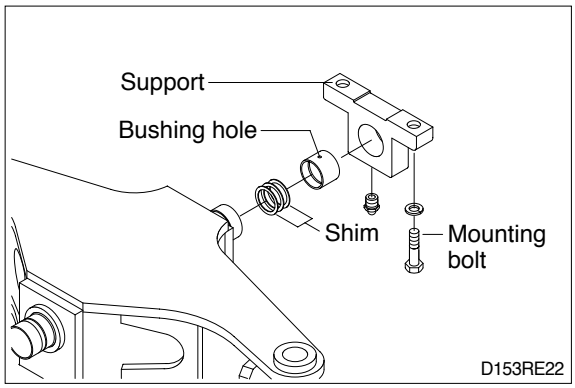
There are shims between the support and rear axle to prevent play.



2) INSTALLATION

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

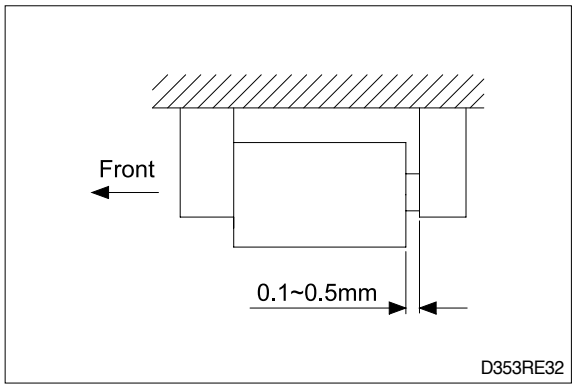
(1) When replacing the bushing at the support, install so that the hole in the bushing faces up.



(2) Install the support so that the clearance is under 0.5mm when the support is pushed fully to the rear.

Tightening torque of mounting bolt for support.

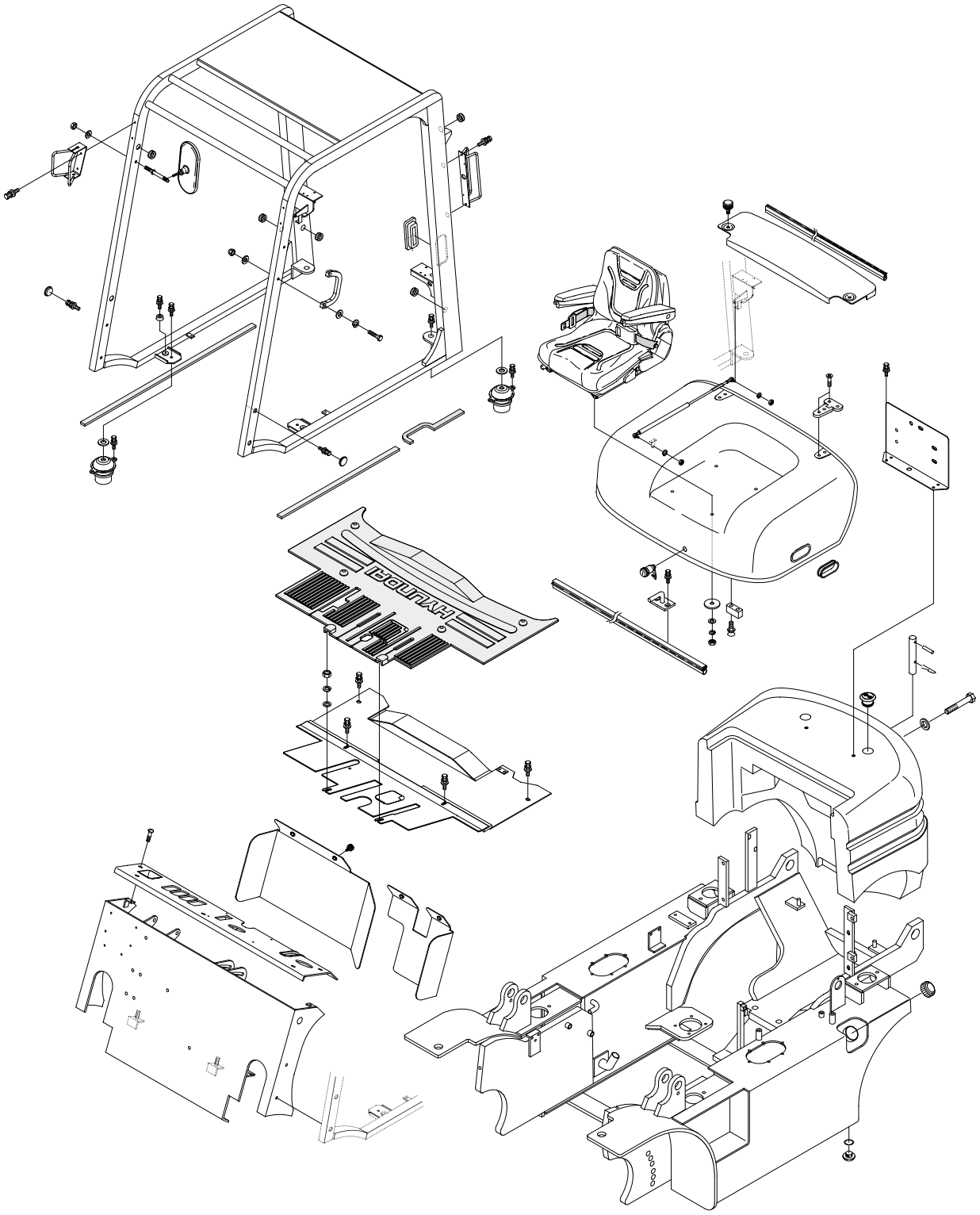
· 29~32kgf · m(210~231lbf · ft)



(3) When installing the rear wheel, coat the hub bolt with molybdenum disulphide, and tighten the nut to 35kgf · m(253lbf · ft).

(4) When installing the counterweight, align with the center of frame. Coat the mounting bolt with molybdenum disulphide and tighten 215±33 kgf · m(1555±239lbf · ft).

7. OUTER PANELS



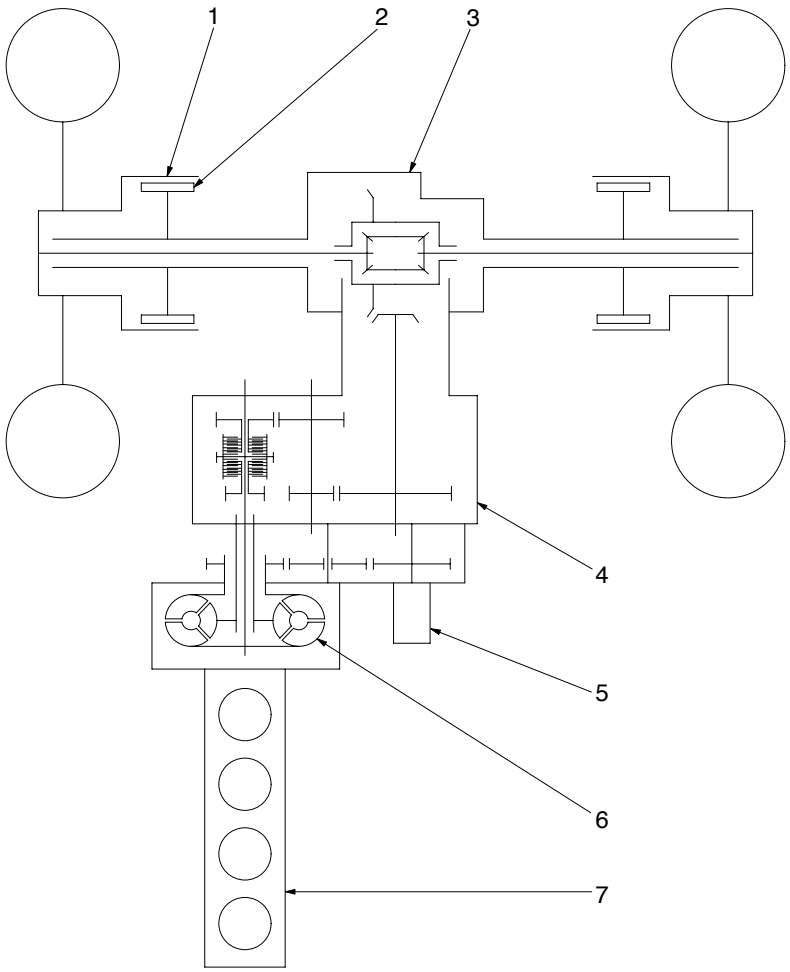
D153RE23

SECTION 3 POWER TRAIN SYSTEM

GROUP 1 STRUCTURE AND OPERATION

1. POWER TRAIN DIAGRAM

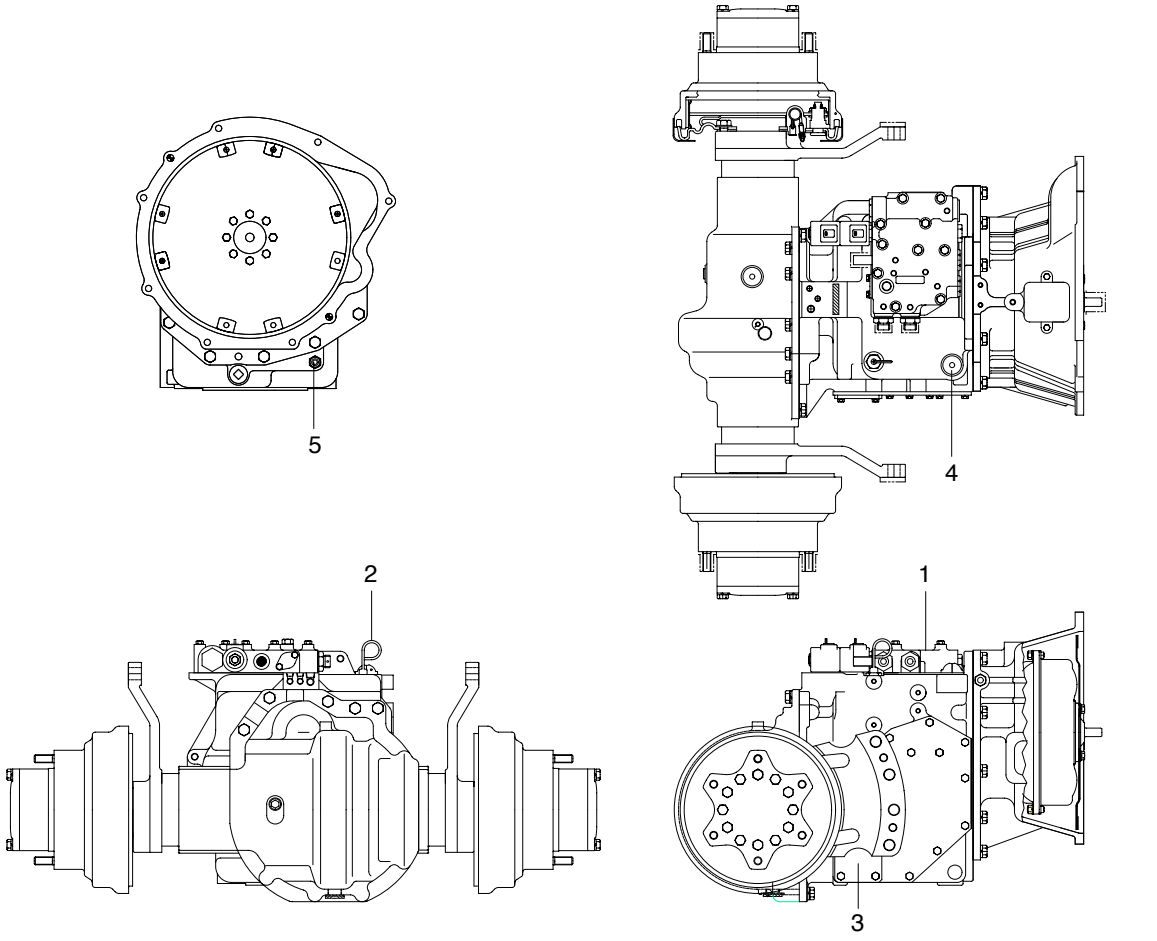
The TORQFLOW transmission uses one-speed forward and one-speed reverse transmission.
The torque converter, differential, and final drives are strengthened to match them with increased engine output and machine traveling performance.



D153PT26

1	Brake drum	4	Transmission	6	Torque converter
2	Brake	5	Hydraulic gear pump	7	Engine
3	Drive axle				

2. INSTALLATION VIEW



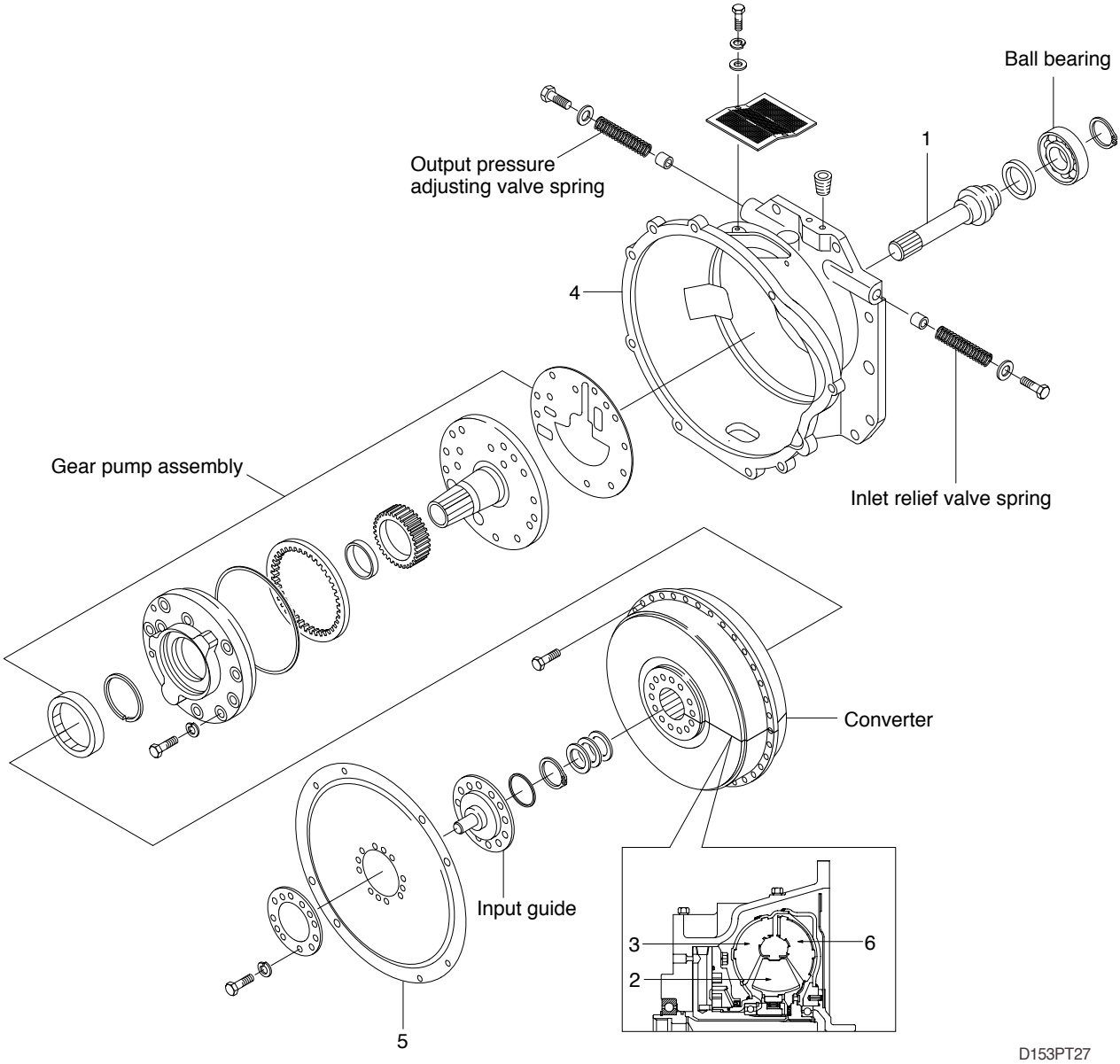
1	Control valve	3	Oil filter	5	Temperature sender
2	Dipstick	4	Air breather		

3. TRANSMISSION

1) TORQUE CONVERTER

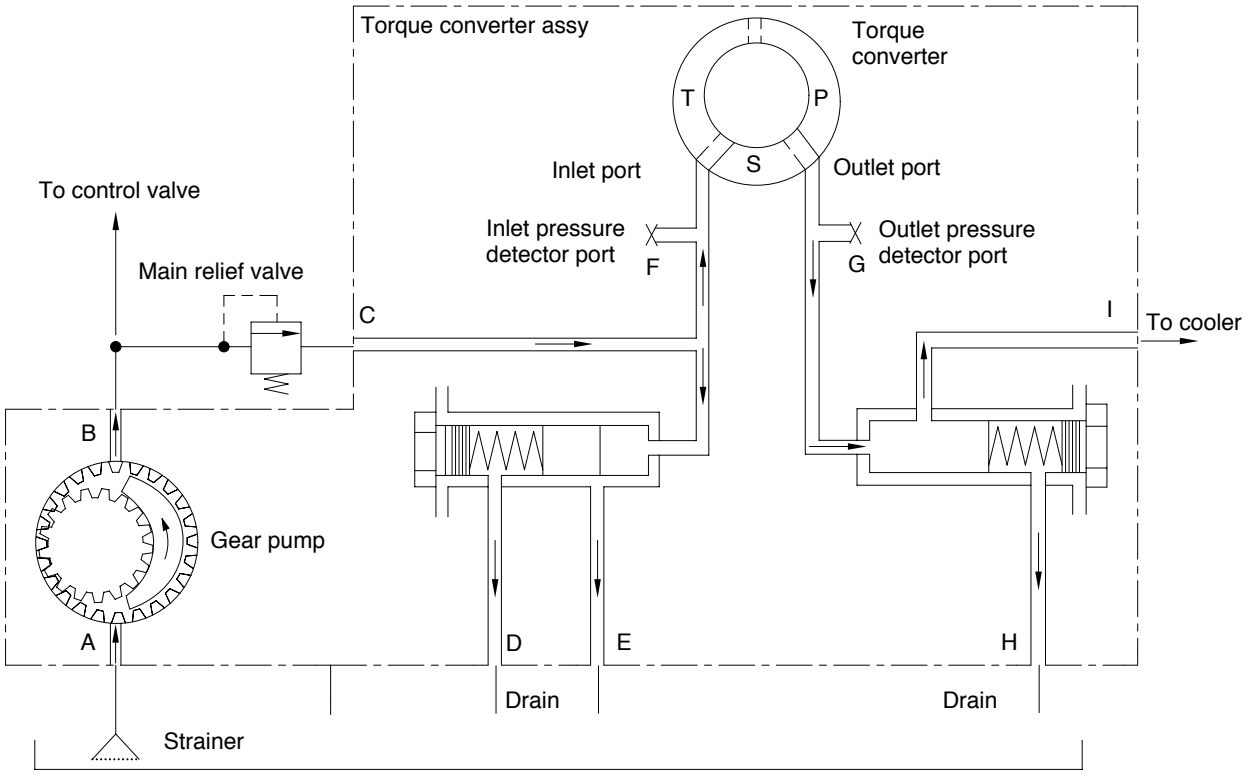
The torque converter is directly bolted to the engine flywheel housing.
Engine output is delivered from the flywheel to the flexible plate.

① Structure



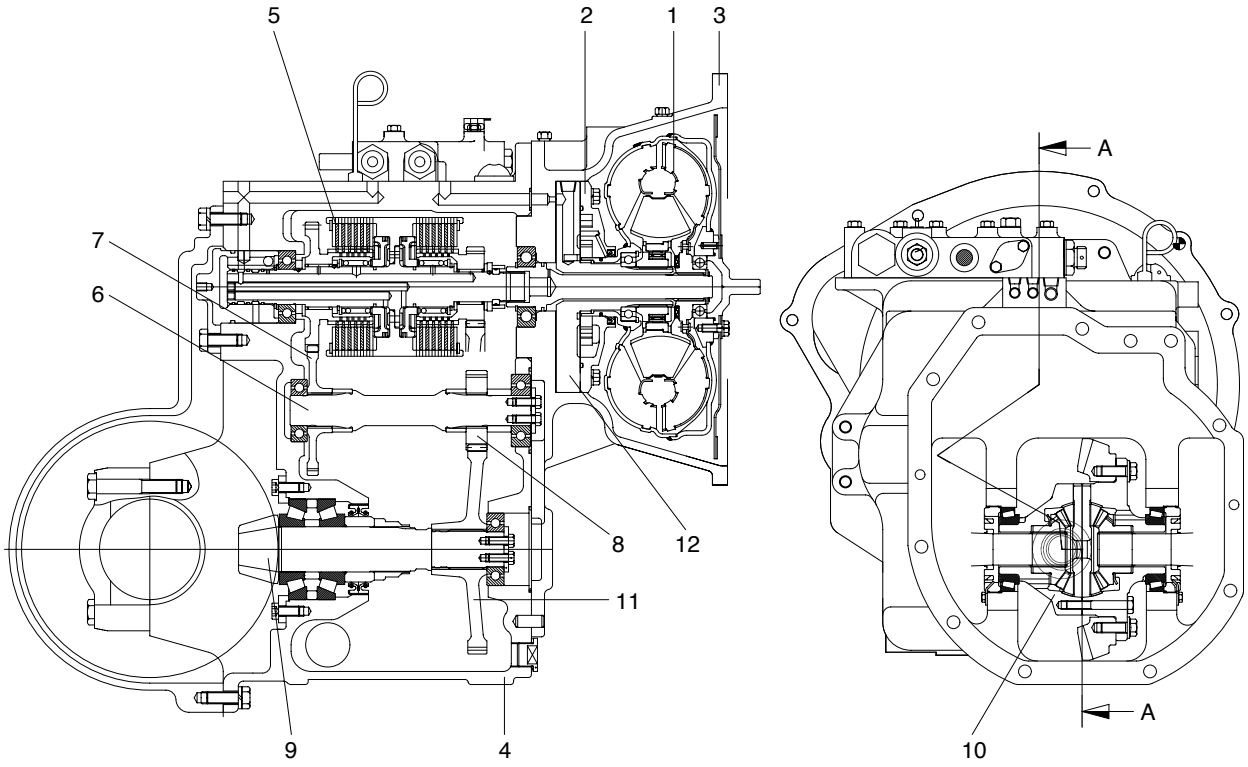
1	Turbine shaft	· 3-element, 1-stage, 2-phase
2	Stator	· Stall speed : 3500rpm
3	Impeller	· Maximum input pressure : 7kgf/cm^2
4	Housing	
5	Flexible plate	
6	Turbine	

(2) Hydraulic circuit

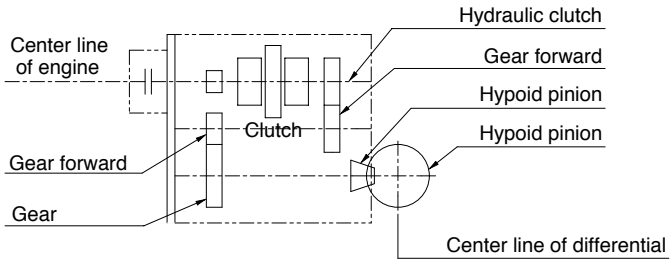


L15C3TC11

2) TORQFLOW TRANSMISSION



SECTION A - A



	F	R
Gear ratio	2.744	2.818

D153PT01

1	Torque converter	5	Hydraulic clutch	9	Hypoid gear set
2	Pump	6	Forward shaft	10	Differential
3	Torque converter housing	7	Forward gear	11	Drive gear
4	Transmission case	8	Forward gear	12	Stator shaft

3) OPERATION

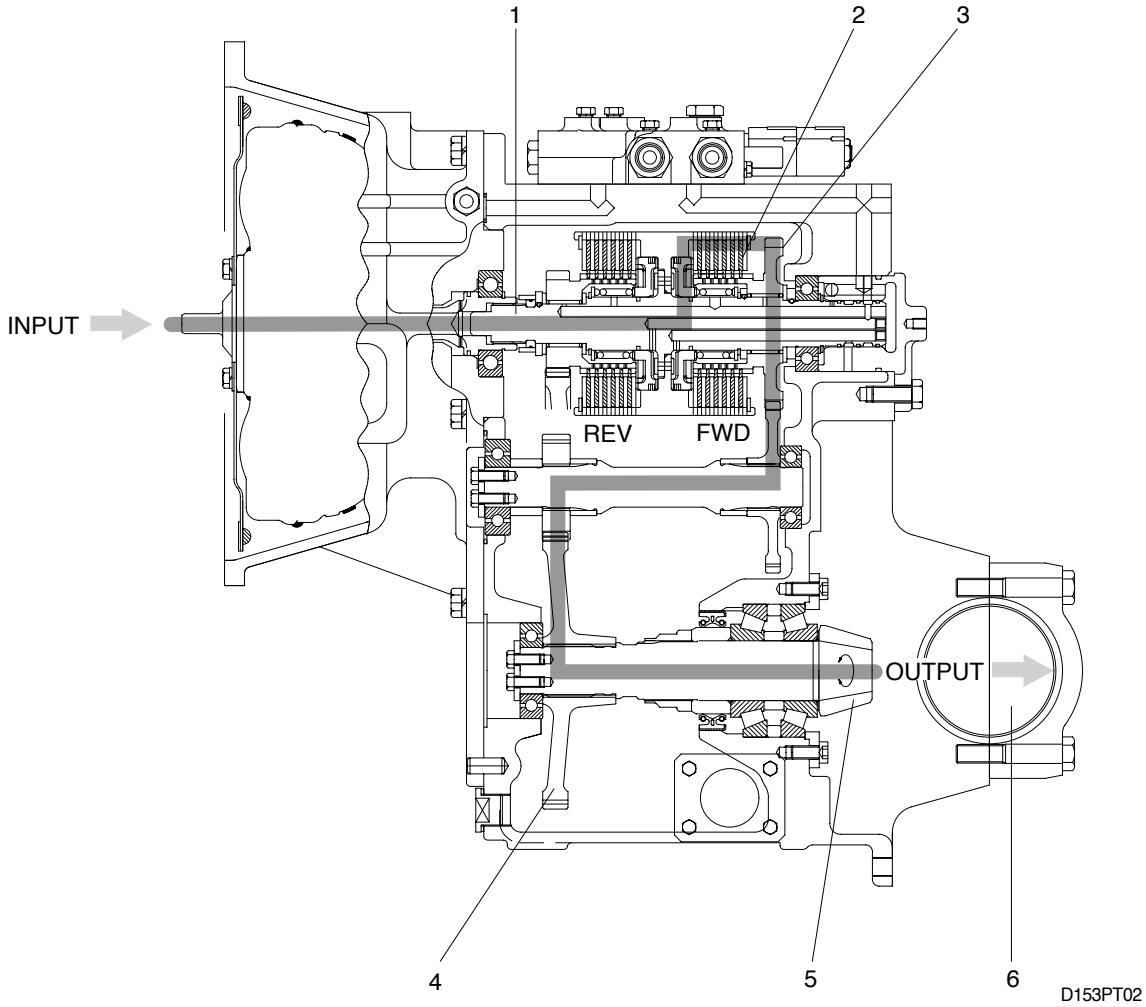
The torque converter consists of three elements; an impeller wheel connected to the input side and a turbine wheel and stator wheel connected to the output side. The torque converter is filled with oil. The engine rotates the impeller wheel and the impeller blade will give the fluid energy. Oil flows out along the path by centrifugal force, and this energy will give the turbine wheel torque. The fluid passing through the rotating turbine wheel generates counter torque of the stator while its flow is changed by the stator. Counter torque is added to the turbine, and as the result of this, the output torque is increased several times as engine torque.

The torque converter gives the maximum output torque when the truck starts running. When the truck runs at high speed, high torque is not required and output torque is gradually reduced. Since the engine and driven axle are connected through the fluid, return vibrations or shocks from the axle is absorbed and the longevity of the power transmission system is extended. Truck speed cannot cause the engine to stall. Torque is automatically converted according to the trucks speed. This makes the drive operation much easier and work can be done more efficiently.

The power of the engine is transferred from the turbine shaft to the clutch shaft through the torque converter, and the forward/reverse rotation is selected by the hydraulic clutch. The power is transferred from the forward drive gear to the driven gear of the hypoid pinion through the drive shaft and gear. For reverse, the power is transferred from the reverse drive gear of the clutch to the driven gear of the hypoid pinion through the reverse shaft and gear, drive shaft and gear to reversely rotate the pinion.

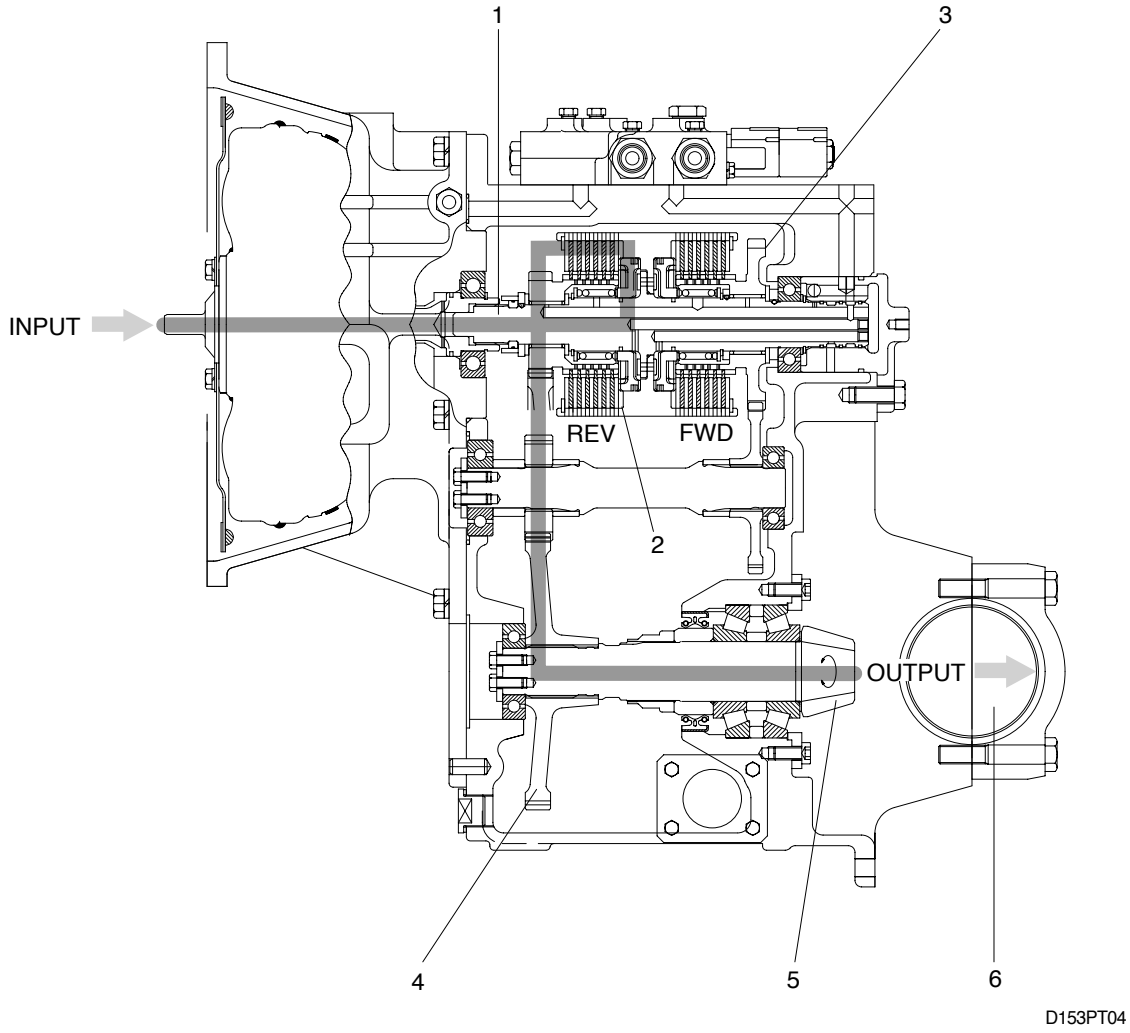
4) TRANSMISSION OPERATING MODES

(1) Forward



In forward the torque converter is turned by the engine. The torque converter turbine shaft turns the forward/reverse clutch pack shaft(1) and clutch packs at turbine speed. The piston in the forward clutch pack(2) is pressurized by transmission fluid from the control valve. The piston applies pressure to the discs in the clutch pack, causing the clutch to engage. As the clutch engages, it turns the low forward output gear(3). The low forward output gear engages the forward shaft gear and turns the forward shaft. The gear on the other end of the forward shaft engages the pinion shaft spur gear(4) which turns the pinion shaft and pinion gear(5). The pinion gear then turns the ring gear(6) in a forward direction, moving the machine forward.

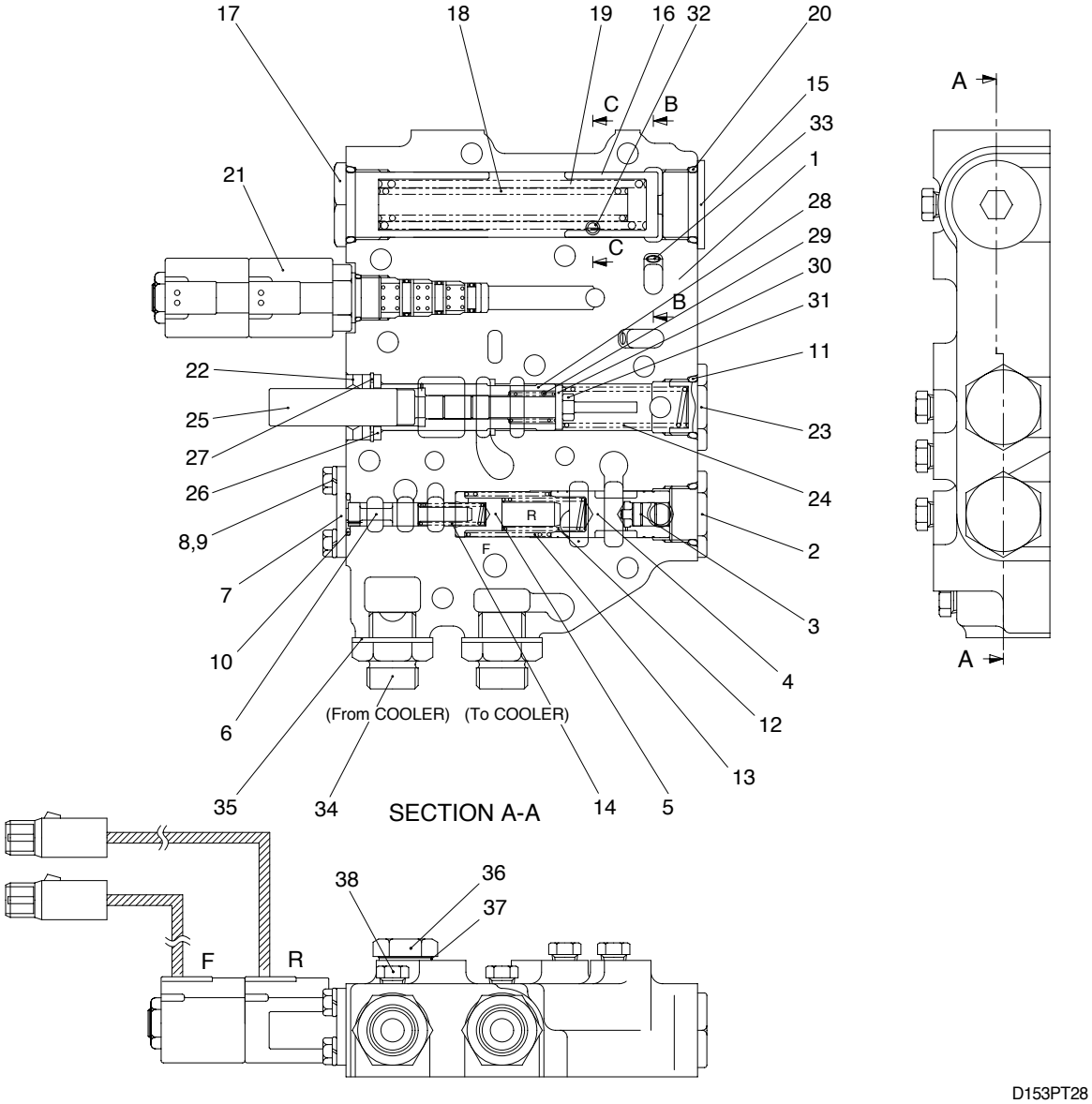
(2) Reverse



In reverse the torque converter is turned by the engine. The torque converter turbine shaft turns the forward/reverse clutch pack shaft(1) and clutch packs. The piston in the reverse clutch pack(2) is pressurized by transmission fluid from the control valve. The piston applies pressure to the discs in the reverse clutch pack, causing the clutch to engage. As the clutch engages, it turns the reverse output gear(3), the reverse output gear engages the pinion shaft spur gear(4), turning the spur gear, the pinion shaft, and the pinion gear(5). The pinion gear then turns the ring gear(6) in a rearward direction moving the truck in reverse.

4. CONTROL VALVE

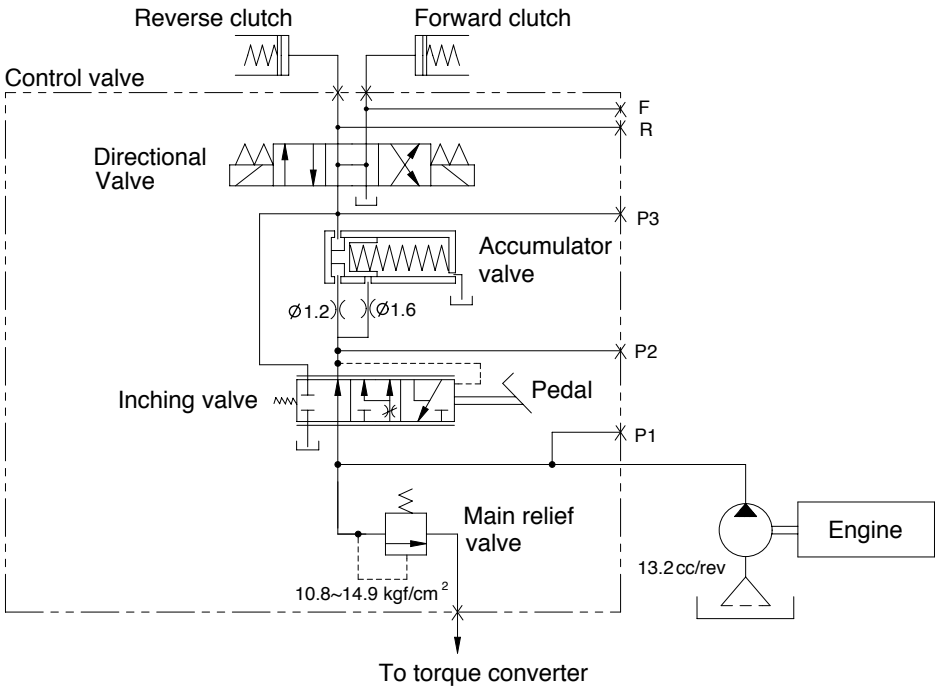
1) STRUCTURE



D153PT28

1	Body	14	Spring	27	Snap ring
2	Plug	15	Plug	28	Valve
3	Piston	16	Piston	29	Spring
4	Valve	17	Stopper	30	Stopper
5	Stopper	18	Spring	31	Nut
6	Valve	19	Spring	32	Screw
7	Plate	20	O-ring	33	Screw
8	Washer	21	Solenoid valve	34	Nipple
9	Bolt	22	Oil seal	35	Spring washer
10	O-ring	23	Plug	36	Plug
11	O-ring	24	Spring	37	Washer
12	Spring	25	Spool	38	Plug
13	Spring	26	Plate		

2) HYDRAULIC CIRCUIT



D153PT11

3) OPERATION

The control valve mainly consists of the main relief valve, inching valve, accumulator valve and directional valve.

The discharged oil from the gear pump enters main relief valve of the control valve and its pressure is adjusted 10.8~14.9kgf/cm^2 (153.6~211.9psi).

The oil sent from the main relief valve flows into the torque converter. The main relief valve is built into the torque converter to prevent excessively raising the oil pressure in the converter due to oil viscosity rising when cold.

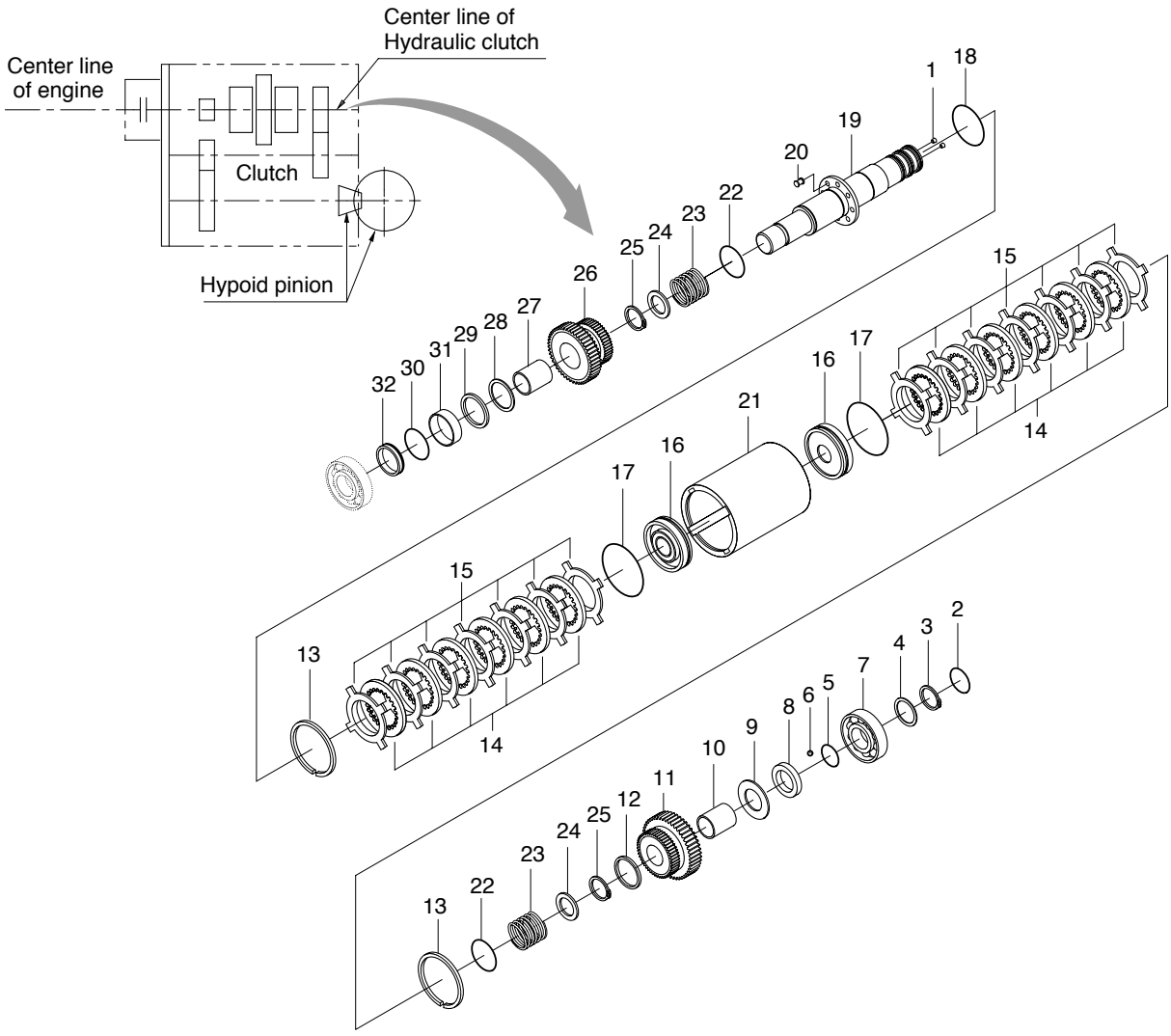
Pressure adjusted oil passes through pressure detecting valve, inching valve and directional valve, and operates the forward or reverse hydraulic clutch.

The pressure detecting valve and built in accumulator provide a soft plugging when changing gears. The pressure detecting valve allows the accumulator to absorb the small shocks of rapid pressure build-up and quick release during gear changes. When full pressure builds up, the pressure detecting valve shuts the accumulator off and allows it to empty so it is ready to function again during gear change.

The inching control is actuated through the inching pedal. This permits the clutch to partially disengage, so that engine rpm can be increased for lifting while travel speed remains low.

5. HYDRAULIC CLUTCH

1) STRUCTURE(Reverse and forward 1st)



D153PT12

1	T/Plug	12	Spacer	23	Spring
2	Seal ring	13	Ring	24	Washer
3	Snap ring	14	Disc	25	Snap ring
4	Spacer	15	Plate	26	Gear
5	Spring	16	Piston	27	Needle bearing
6	Steel ball	17	Seal ring	28	Washer
7	Ball bearing	18	O-ring	29	Spacer
8	Spacer	19	Shaft	30	Spring
9	Washer	20	Rivet	31	Spacer
10	Bearing	21	Drum	32	Spacer
11	Gear	22	Seal ring		

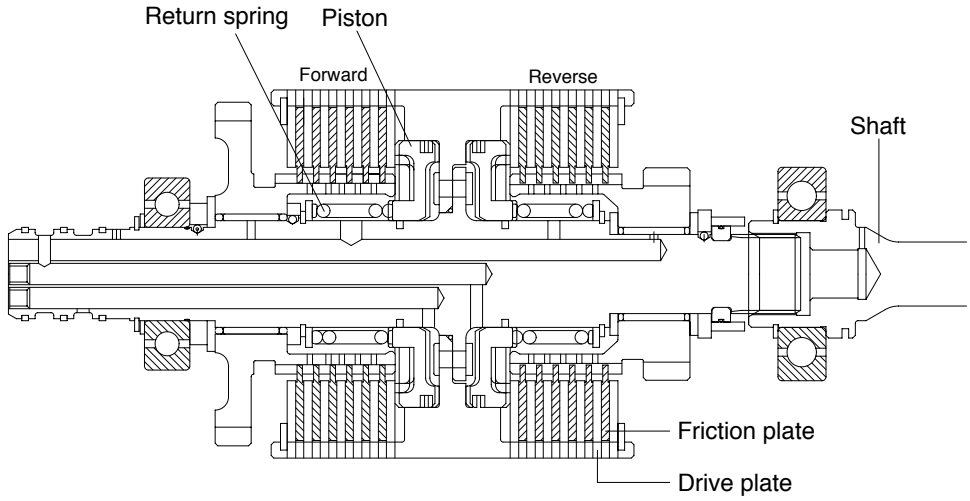
2) CLUTCH PACKS

The clutch packs have a driving side and a driven side for each gear selection, a total of two(1 forward, 1 reverse). One clutch pack assembly has two selections on the same shaft, forward and reverse, and the clutches are back to back with a spur gear in the middle.

The forward reverse clutch pack is driven by the turbine shaft of the torque converter. The assembly makes up the main part of the driving sides of the two clutch packs. This assembly is rotating at turbine speed whenever the torque converter turbine is rotating, no matter what gear is selected, including neutral.

Into each of these driven clutch pack bodies fits a hydraulic piston, and a set of alternating drive plates(steel) and friction plates(fiber faced). The steel plates have teeth on the outer edge which slide into the slots in the clutch pack body, and rotate with the clutch pack. Each of the fiber faced plates have teeth on the inner edge which engage a spline on a driven gear. A return spring on the shaft keeps the piston from engaging the clutch when there is no hydraulic pressure from the control valve.

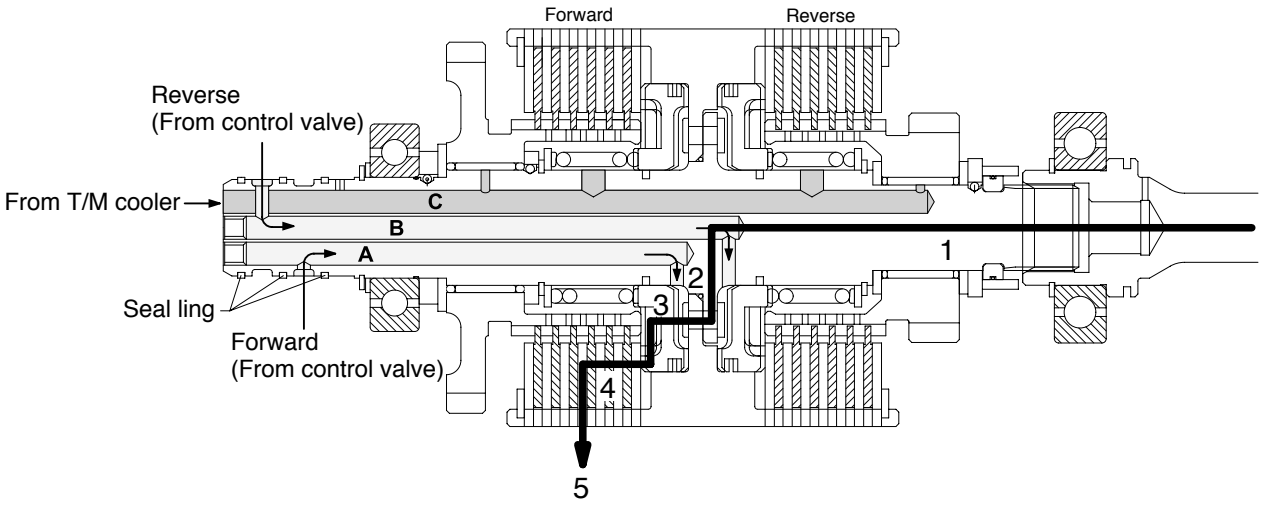
A driven gear(or output gear) slides over the clutch pack shaft and engages the teeth on the inside edge of the friction plates.



Forward/reverse clutch pack assembly

D153PT23

3) OPERATION



D153PT24

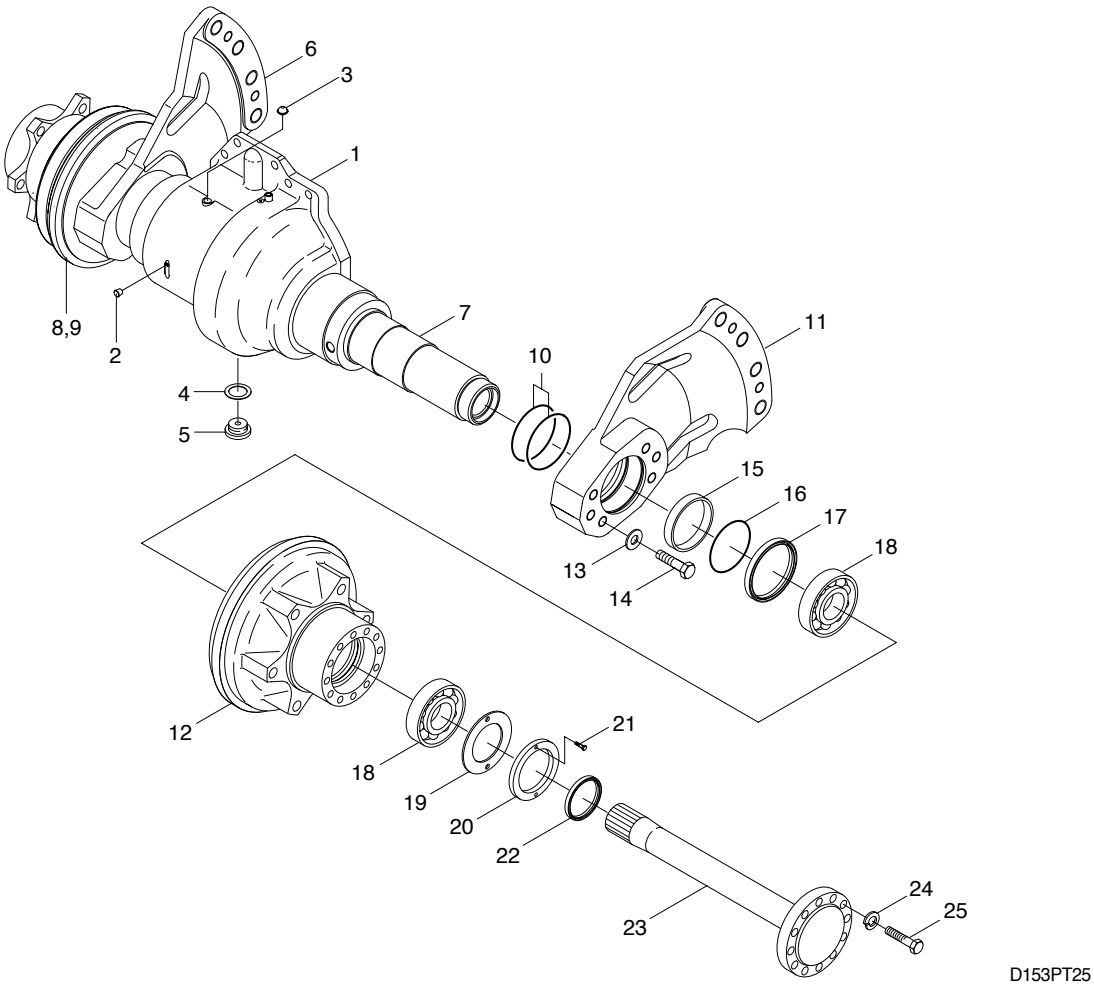
When a gear is selected by the operator, the following happens.

1 The clutch pack shaft is being driven by the torque converter.
2 The spur gear and clutch pack body is attached to shaft and rotates with it.
3 The clutch piston is pressurized by transmission fluid from the control valve.
4 The pressurized piston compresses the drive plates and the friction plates, causing them to rotate together.
5 The driven(or output) gear rotates with the clutch pack body and drives the forward shaft gear or pinion spur gear, depending on gear selection.

There are three oil ports that enter the clutch pack shafts through the manifold caps. Two(A, B) are for supplying transmission fluid to the clutch pistons. The third(C) is to supply lubrication to the gears and clutch discs. Seal rings separate oil flow from manifold cap.

6. DRIVE AXLE

1) STRUCTURE



1	Housing	10	O-ring	18	Taper roller bearing
2	Plug	11	Support drive (L)	19	Plate
3	Cap	12	Hub	20	Nut
4	Gasket	13	Washer	21	Bolt
5	Plug	14	Bolt	22	Oil seal
6	Support drive (R)	15	Retainer	23	Drive shaft
7	Axle tube	16	O-ring	24	Washer
8	Brake assembly (R)	17	Oil seal	25	Bolt
9	Brake assembly (L)				

2) OPERATION

Both sides of the housing are supported by the frame and the center is mounted on the transmission case with bolts.

The mast is installed on the front of the drive axle housing through the trunnion. The final deceleration and differential device built in the housing guarantee accurate rotation and smooth operation. The power from the transmission is transferred through the hypoid pinion, hypoid gear, differential case, the pinion of the differential device and the side gear to the drive axle shaft by the side gear spline and to the hub and wheel mounted on the shaft by high tension bolts.

GROUP 2 TROUBLESHOOTING

Problem	Probable cause	Remedy
1. Excessive oil temperature rise		
1) Torque converter	· Improper oil level.	· Check oil level. Add or drain oil as necessary.
	· Impeller interfering with surroundings.	· After draining oil from oil tank and transmission, check and replace interfering parts.
	· Stator and free wheel malfunctioning.	· Check engine (stalling) speed. If necessary, replace.
	· Air sucked in.	· Check the inlet side joint or pipe. If necessary, retighten joint or replace gasket.
	· Water intruding into transmission case	· Check drained oil. If necessary, change oil.
	· Bearing worn or seizing.	· Disassemble, inspect, repair or replace.
	· Gauge malfunctioning.	· Check and, if necessary, replace.
2) Transmission	· Clutch dragging.	· Check to see whether or not machine moves even when transmission is placed in neutral position. If so, replace clutch plate.
	· Bearing worn or seized.	· Disassemble, check and replace.
2. Noise operation		
1) Torque converter	· Cavitation produced.	· Change oil, replace parts leaking air.
	· Flexible plate damaged.	· Listen to rotating sound at lowspeed operation. If necessary, replace flexible plate.
	· Bearing damaged or worn.	· Disassemble, check and replace.
	· Gear damaged.	· Disassemble, check and replace.
	· Impeller interfering with surroundings.	· Check impeller or check drained oil for mixing of foreign matter. If necessary, change oil.
	· Bolt loosening.	· Disassemble and check. If necessary, retighten or replace.
	· Spline worn.	· Disassemble, check and replace.
	· Noise gear pump operation.	· Disassemble, check and replace.
2) Transmission	· Dragging caused by seizing clutch.	· Check to see whether or not machine moves even when transmission is in neutral position. If so, replace clutch plate.
	· Bearing worn or seizing.	· Disassemble, check and replace
	· Gear damaged.	· Disassemble, check and replace
	· Bolt loosening.	· Disassemble, check and retighten or replace
	· Spline worn.	· Disassemble, check and replace

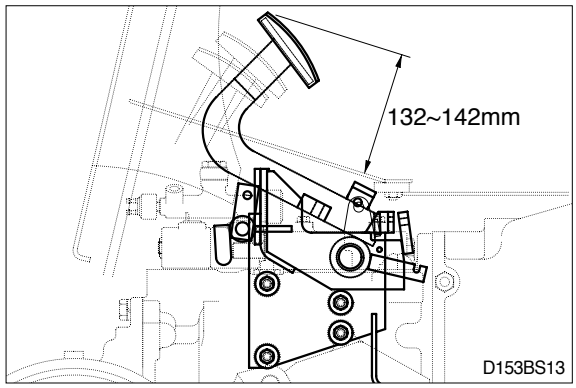
Problem	Probable cause	Remedy
3. Low output power		
1) Torque converter	· Insufficient hydraulic pressure :	
	- Low oil level.	- Check oil level and add oil
	- Air sucked in.	- Check joints and pipes. If necessary, retighten joint or replace packing.
	- Oil filter clogging.	- Check and replace
	- Oil pump worn. (Low delivery flow)	- Check oil pressure. If necessary replace pump.
	- Regulator valve coil spring fatigued.	- Check spring tension. If necessary, replace.
	- Control valve spool malfunctioning.	- Disassemble, check and repair or replace.
	- Piston or O-ring worn.	- Disassemble, check measure and replace.
	· Stator free wheel cam damaged.	- Check stalling speed. (Increased engine load will cause excessive drop of stalling speed.)
		- Check oil temperature rise. If any, replace free wheel.
2) Transmission	· Flexile plate deformed	· Replace flexible plate
	· Stator free wheel seizing.	- Check temperature plate. (No-load will cause temperature rise)
		- Replace free wheel if a drop of starting output is found.
	· Impeller damaged for interfering with the surroundings.	- Check drained oil for foreign matter. If any, change oil.
	· Use of poor quality of oil or arising of air bubbles.	- Check and change oil.
	- Air sucked in from inlet side.	- Check joints and pipes. If necessary, retighten joint or replace packing.
	- Low torque converter oil pressure accelerates generation of air bubbles.	- Check oil pressure.
	- Oil mixing with water.	- Check drained oil and change oil.
	- Inching rod out of adjustment.	- Check and adjust.
	· Clutch slipping	
	- Lowering of weight.	- Check oil pressure.
	- Piston ring or O-ring worn.	- Disassemble, check, measure and replace.
	- Clutch piston damaged.	- Disassemble, check and replace.
	- Clutch plate seizing or dragging.	- Check to see whether or not machine moves even when transmission is in neutral position. If so, replace.

Problem	Probable cause	Remedy
4. Unusual oil pressure		
1) Oil pressure is high	· Control valve malfunctioning.	(1)Check for spool operation. If necessary, replace valve. (2)Check for clogging of small hole in valve body. If necessary, clean or repair.
	· Cold weather. (high oil viscosity)	· When atmospheric temp is below freezing point(when normal oil pressure is recovered if heated to 60 ~ 80℃), change oil.
	· Use of improper oil.	· Check and change oil.
2) Oil pressure is low	· Gear pump malfunctioning(worn).	· Disassemble, check and replace.
	· Oil leaks excessively : (1)Control valve oil spring defective.	· Check spring tension (see spring specification). If necessary replace.
	(2)Control valve spool defective.	· Disassemble, check, and repair or replace valve.
	· Air sucked in.	· Check joints and pipes. If necessary, retighten joint or replace packing.
	· Low oil level.	· Check oil level and add oil.
	· Oil filter clogging.	· Check and replace.
3) Transmission	· Oil leaks excessively.	· Disassemble, check (piston ring and O-ring for wear and other defects), and replace.
5. Power is not transmitted		
1) Torque converter	· Clutch plate damaged.	· Check for damage by listening to abnormal sounds at a low converter speed and replace.
	· Low oil level.	· Check oil level and add oil
	· Oil pump driving system faulty.	· Disassemble and check for wear of pump gear, shaft and spline. Replace defective parts.
	· Shaft broken.	· Check and replace.
	· Lack of oil pressure.	· Check oil pump gear for wear and for oil suction force. If necessary, replace pump.

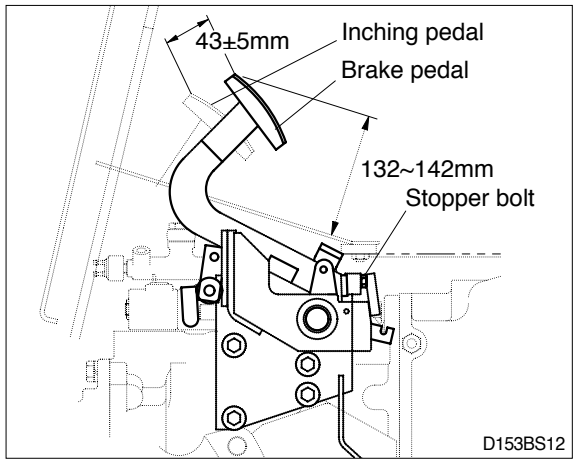
Problem	Probable cause	Remedy
5. Power is not transmitted 2) Transmission	· Low oil level.	· Check oil level and add oil.
	· Inching valve and link lever improperly positioned.	· Check measure and adjust.
	· Forward/reverse spool and link lever improperly positioned.	· Check and adjust.
	· Clutch fails to disengage : (1)Clutch case piston ring defective.	· Disassemble, check and replace
	(2)Main shaft plug slipping out.	· Disassemble, check and repair or replace
	· Clutch seizing.	· Check to see whether or not machine moves even then transmission is in neutral position. If so, replace.
	· Shaft broken off.	· Disassemble, check(main shaft, etc.), and replace.
	· Clutch drum damaged (spring groove).	· Disassemble, check and replace.
	· Clutch snap ring broken.	· Disassemble, check and repair or replace.
6. Oil leakage (Transmission and torque converter)	· Oil leaks from oil seal.	· Disassemble and check for wear of seal lips and mating sliding surfaces (pump boss, coupling etc.) Replace oil seal, pump boss, coupling, etc.
	· Oil leaks from case joining surfaces.	· Check and retighten or replace packing.
	· Oil leaks from joint or pipe.	· Check and repair or replace gasket.
	· Oil leaks from drain plug.	· Check and retighten or replace gasket.
	· Oil leaks from a crack.	· Check and replace cracked part.

1. INCHING PEDAL

1) Depress inching pedal fully, and move gear shift lever to FORWARD or REVERSE. Check that machine does not move even when engine speed is increased slightly.
2) Adjust stopper bolt so that pedal height is 132~142mm (5.2~5.6in).



3) Adjust bolt so that brake pedal interconnects with inching pedal at a stroke of 43±5mm.



2. HYDRAULIC PRESSURE

1) Block wheels of truck, and pull parking lever. Install oil pressure gauge at inlet of control valve.
2) Move direction control lever to FORWARD or REVERSE, depress accelerator pedal and run engine at 1500rpm. Measure clutch pressure and torque converter pressure and check that they are within specified range.

3. ENGINE STALL SPEED

Move direction control lever to FORWARD or REVERSES, and run engine at maximum speed. Check that maximum engine speed is within specified range.

※ **This check raises the temperature of the oil in the torque converter, so do not run this test for a long period.**

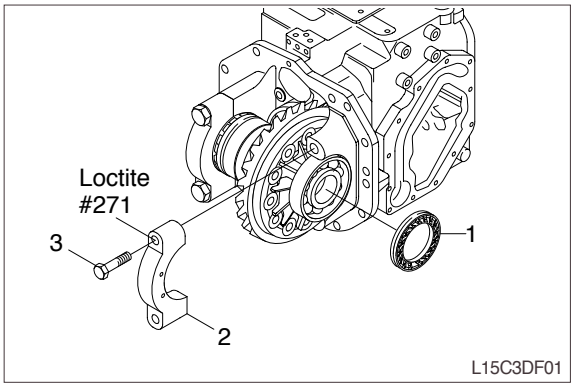
Model	Stall speed
ISUZU 1LE1PW-06	1600rpm

4. DIFFERENTIAL

1) Fitting differential assembly

(1) Install the differential assembly and fit adjust screw gear(1).

(2) Apply loctite in the hole of cap(2), and temporarily tighten with bolt(3).

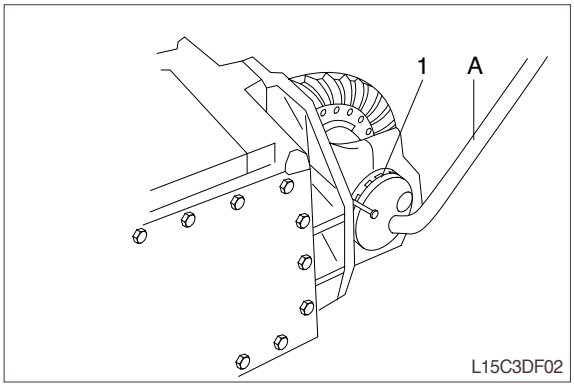


2) Adjustment of backlash

※ Tighten the adjust screw gear(1).

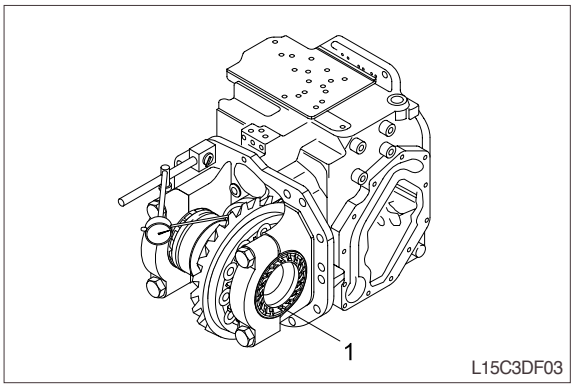
(1) To adjust the backlash, loosen one adjustment screw gear 1 notch and tighten the other screw gear 1 notch. Gradually move the differential case in this way, and watch the indicator of the dial gauge to adjust to the correct value.
- Backlash between ring gear and pinion gear : 0.18~0.23mm(0.007~0.009in).

(2) Turn the bevel gear to adjust screw gear(1) at 4 places.



3) ADJUSTMENT OF THE SIDE BEARING PRELOAD

Tighten adjust screw gear(1) uniformly at 20kgf · m(145lbf · ft)



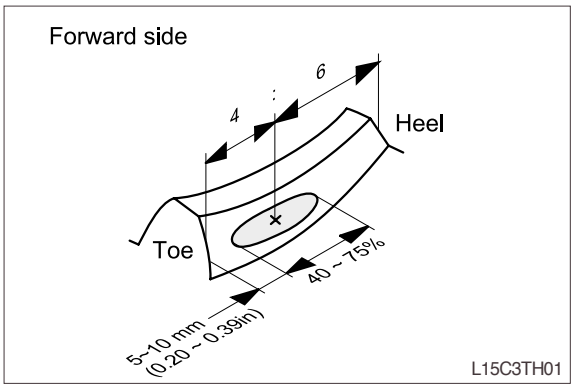
4) ADJUSTING TOOTH CONTACT

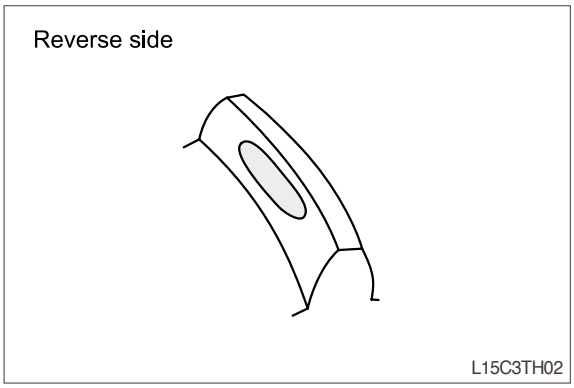
(1) Coat the tooth face of the bevel pinion lightly with red lead(minimum).

(2) Rotate the bevel gear forward and backward.

(3) Inspect the pattern left on the teeth.

· Tooth contact should be checked with no load on the bevel pinion. The tooth contact pattern should cover about 40~75% of the length of the tooth, with weak contact at both ends.





(4) If the result of the inspection shows that the correct tooth contact is not being obtained, adjust again as follows.
(See next page for details)
Adjust shims at pinion shaft.
Adjust backlash of bevel gear.

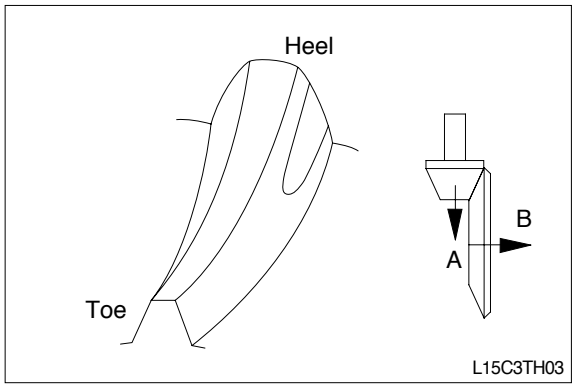
※ Adjust backlash of bevel gear side bearing.

※ Tooth contact should be checked with no load on the bevel pinion. The tooth contact pattern should cover about 40~75% of the length of the tooth, with weak contact at both ends.

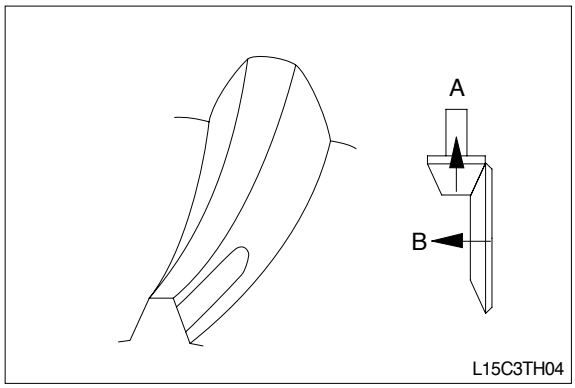
The tooth contact should be correct on both the FORWARD and REVERCE side of the teeth, however, if it is impossible to adjust both sides correctly, the FORWARD side must be correct.

5) INCORRECT TOOTH CONTACT

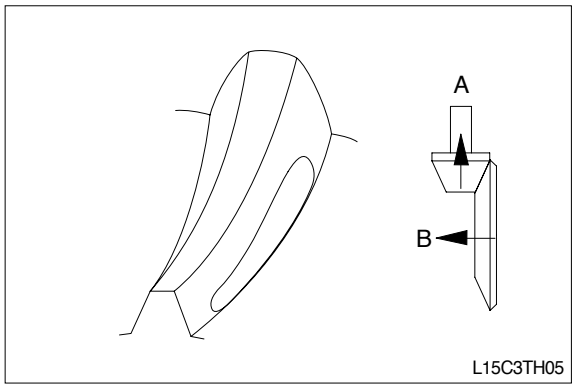
(1) Increase the shim thickness at the pinion shaft to move the pinion in direction A.
Then move the bevel gear away from the pinion gear in direction B.
Adjust the backlash again.



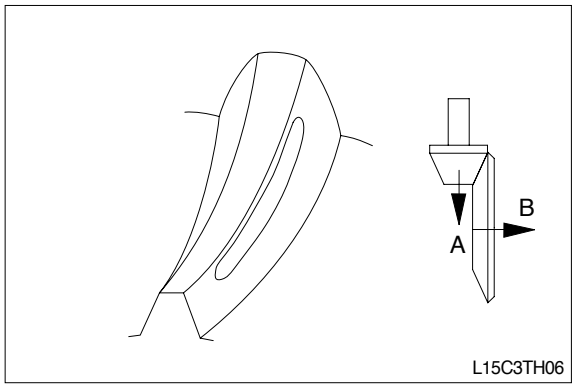
(2) Reduce the shim thickness at the pinion shaft to move the pinion in direction A.
Then move the bevel gear closer to the pinion gear in direction B.
Adjust the backlash again.



(3) Reduce the shim thickness at the pinion shaft to move the pinion in direction A.
Then move the bevel gear closer to the pinion gear in direction B.
Adjust the backlash again.



(4) Increase the shim thickness at the pinion shaft to move the pinion in direction A.
Then move the bevel gear away from the pinion gear in direction B.
Adjust the backlash again.



1. TRANSMISSION

1) DISASSEMBLY

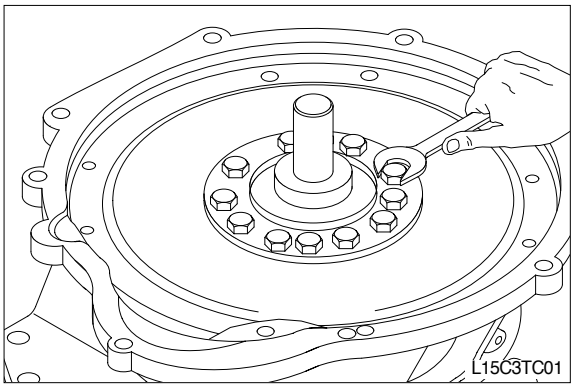
(1) Disassemble torque converter assembly

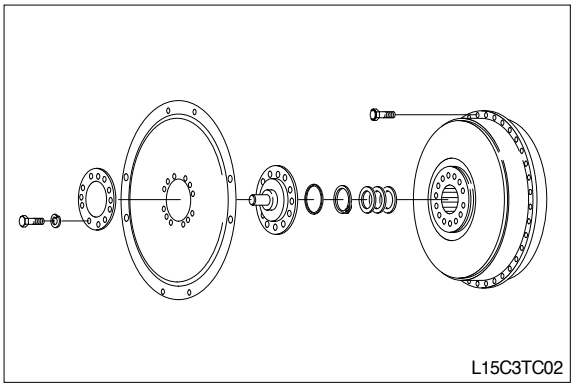
Drain the transmission fluid and disconnect the torque converter assembly from the engine and the transmission.

(2) Disassemble input side of torque converter

Remove the input plate bolts and the input plate, input guide, and O-rings.

Tool(s) required : 12㎜ Wrench.

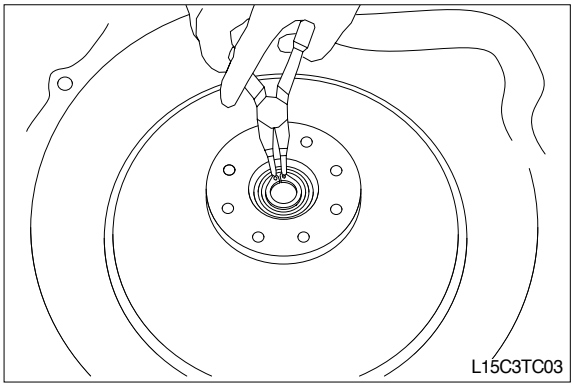




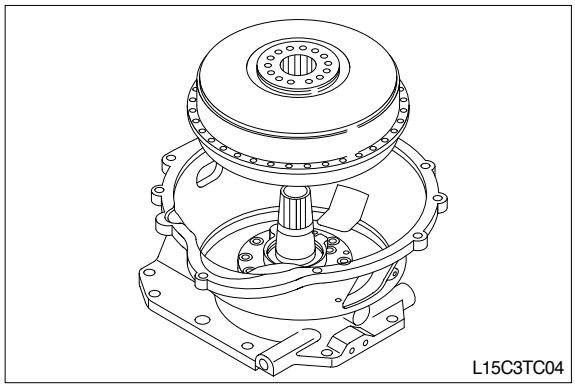
(3) Extract torque converter

① Remove the turbine shaft snap ring.

Tool(s) required : Snap ring pliers



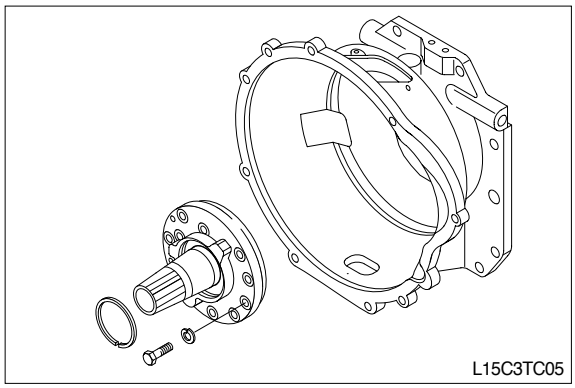
② Ease the torque converter out of the housing so as not to damage the pump oil seal.



(4) Extract pump

Remove the inner turbine shaft snap ring and all bolts holding the pump.

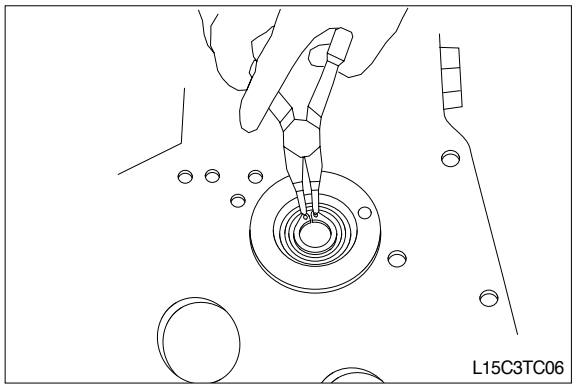
Tool(s) required : 12㎜ socket wrench



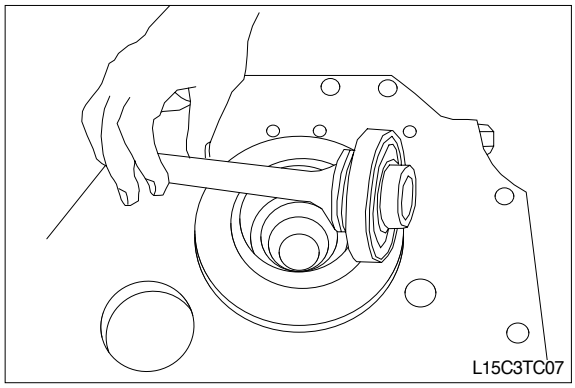
(5) Extract turbine shaft

① Remove the two snap rings.

Tool(s) required : 12㎜ socket wrench



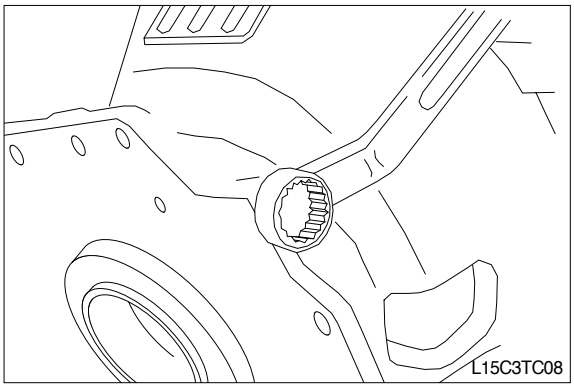
② Extract the turbine shaft.



(6) Extract valves

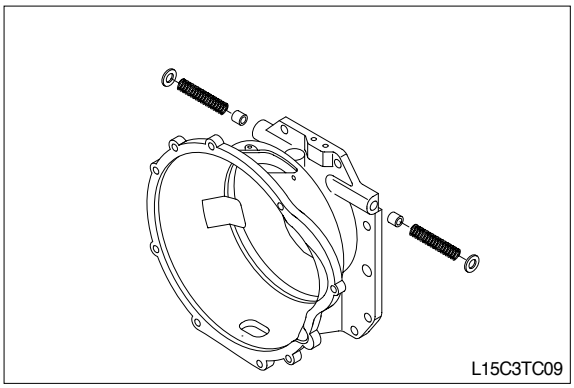
① Remove the two plugs.

Tool(s) required : 24㎜ wrench.



② Remove the springs and pistons.
Level the two sets-the springs especially-so that they do not get confused.

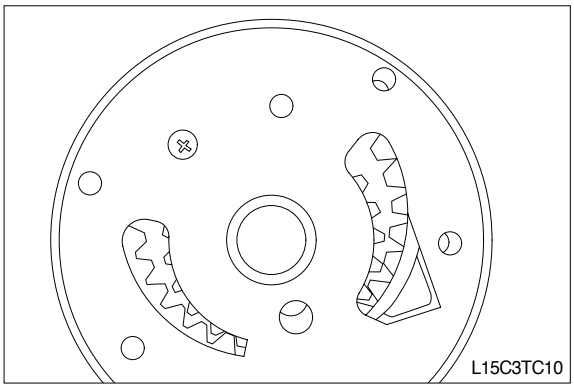
Tool(s) required : 24㎜ wrench.



(7) Disassemble oil pump

Remove the O-ring and philips screws and disassemble the pump.

Tool(s) required : Snap ring pliers.



2) ASSEMBLY

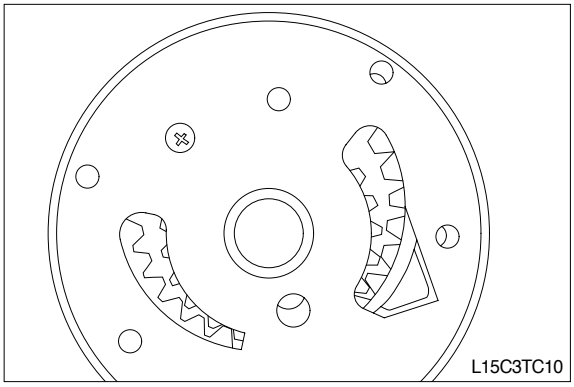
The assembly procedure is the reverse of the disassembly procedure above, but requires additional care as noted below.

(1) Assembly oil pump

Return the gears and stator support to their positions before disassembly.

Check the gear action. If the gears do not rotate smoothly, disassemble the pump and start over.

· Bolt tightening torque : 0.1kgf · m(0.72lbf · ft)



(2) Install valves

The valve assemblies are different, so make sure that they go back into the proper holes.

· Plug tightening torque : 5.0kgf · m(36.2lbf · ft)

(3) Install turbine shaft

Make sure that the sealing material is seal completely inside before inserting the shaft.

· Bolt tightening torque : 2.1kgf · m(5.2lbf · ft)

(4) Install pump

Lightly grease the pump casing with lithium grease (Shell albania Z or equivalent) to avoid breaking or twisting O-ring when you insert it.

(5) Install torque convert

Fill the oil seal lip cavity one-half full with lithium grease or coat the surface with clean hydraulic fluid to avoid damaging the oil seal and bushing when you insert the torque converter.

(6) Install input side of torque converter

Coat the O-ring with lithium grease before installing.

· Bolt tightening torque : 2.1kgf · m(15.2lbf · ft)

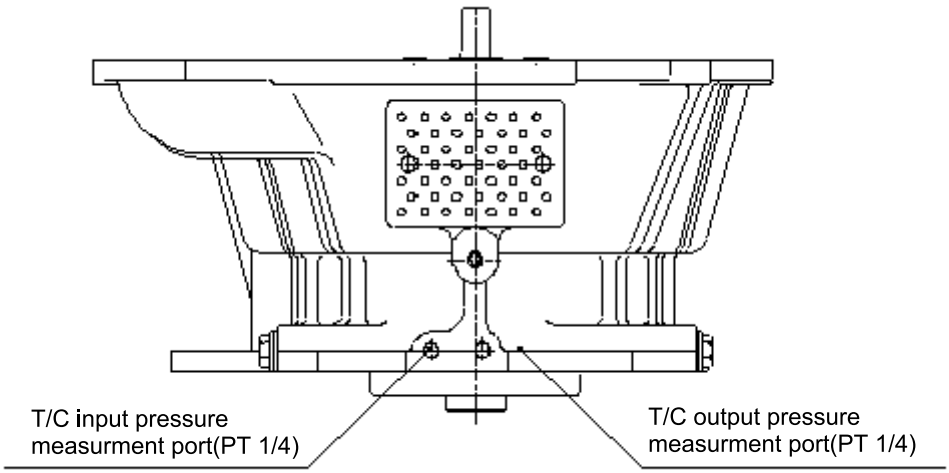
(7) Install torque converter assembly

Connect the torque converter assembly to the engine and the transmission.

※ After each step, check your work against the maintenance standards which appear after the procedure.

※ Apply semidrying liquid gasket to the circumference of oil seals, but do not allow it to get on the lips or the shaft's sliding surface.

3) TORQUE CONVERTER ASSEMBLY DRAWING



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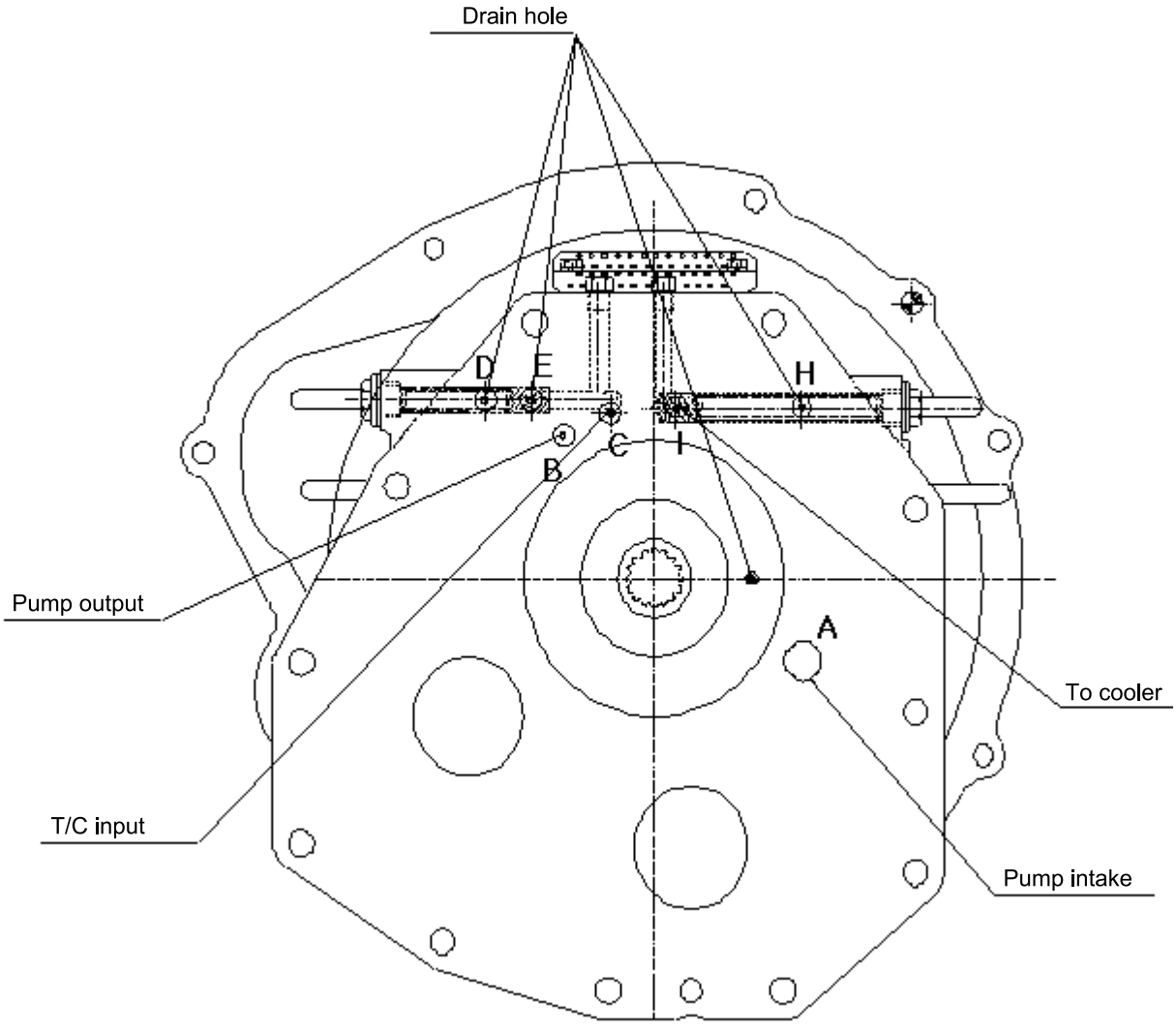

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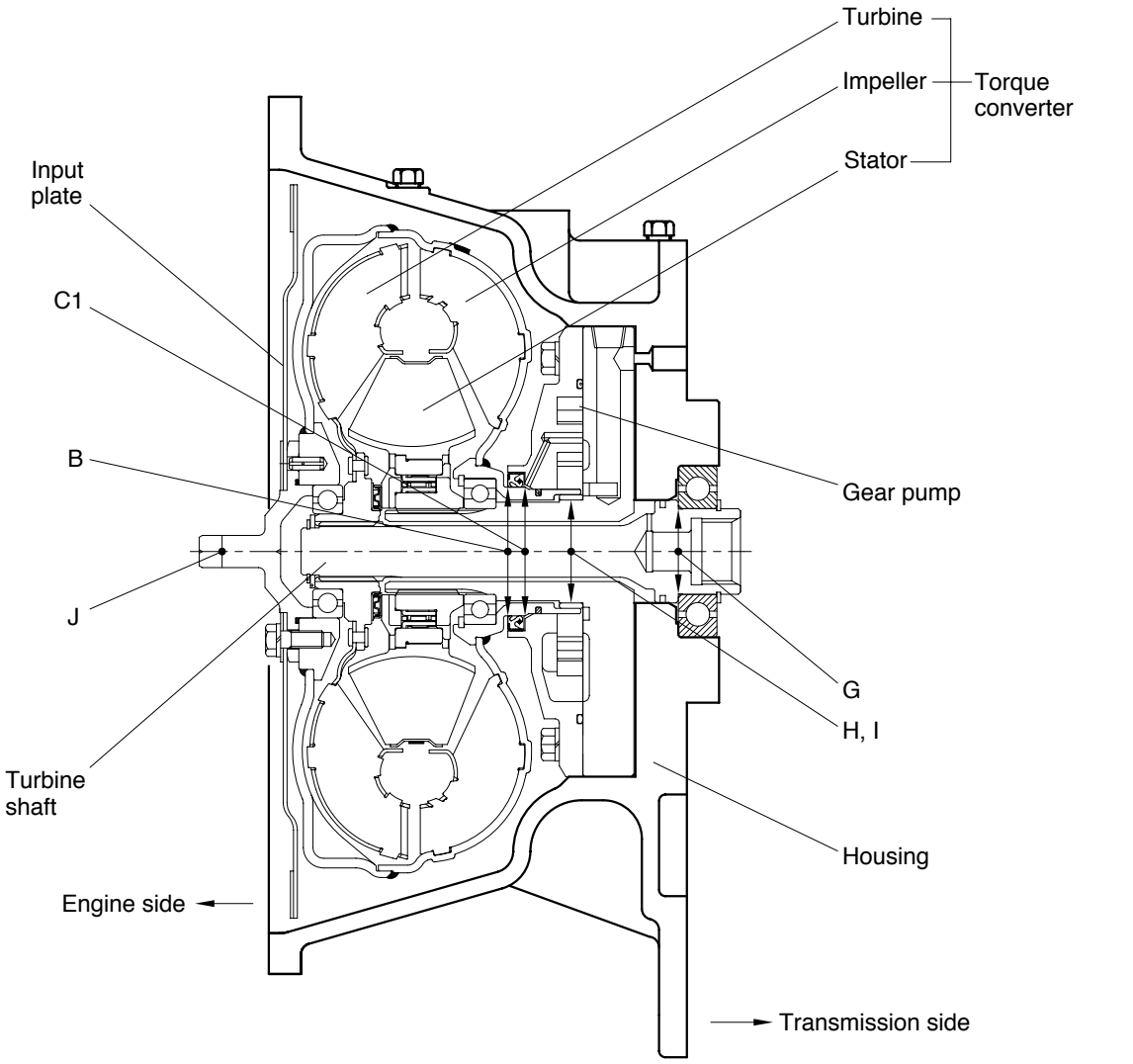
4) CHECK AND INSPECTION



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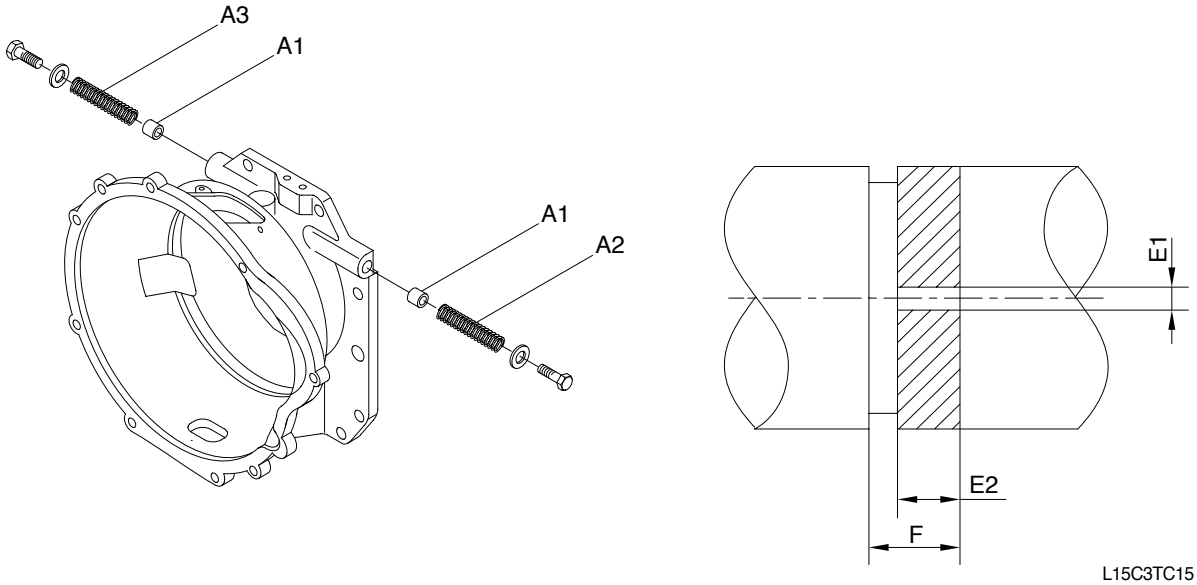


L15C3TC15

Unit : mm(in), kg(lb)

No.	Check item				Criteria		Remedy
					Standard size	Repair limit	
A	Torque converter input output valve	A_1	Clearance between piston and housing hole		0.015-0.025 (0.0006-0.001)	0.065 (0.0025)	Replace piston
		A_2	Torque converter inlet relief valve spring	Free length	89.9 (3.54)	87.3 (3.43)	Replace
				Installed length	63 (2.48)	63 (2.48)	
				Installed load	7.70 (16.98)	6.94 (15.3)	
		A_3	Torque converter output pressure adjusting valve spring	Free length	122 (4.80)	120.4 (4.74)	
				Installed length	103.5 (4.07)	103.5 (4.07)	
				Installed load	3.45 (7.61)	3.11 (2.36)	
B	Oil seal O.D				-	60 (2.36)	
C	Torque converter impeller valve	C_1	Oil seal mating face outer dia		59.952-60.000 (2.360-2.362)	59.852 (2.356)	
E	Seal spring	E_1	Clearance of abutment when housing is inserted		0.1-0.3 (0.004-0.012)	1.0 (0.04)	
		E_2	Ring with		48.0-48.025 (1.889-1.890)	2.7 (0.089)	
F	Turbine shaft(Seal ring groove width)				2.56-2.60 (0.100-0.102)	2.7 (0.106)	
G	Housing(Seal ring portion inner dia)				48.0-48.025 (1.889-1.890)	48.12 (1.894)	
H	Impeller hub O.D				47.951-47.970 (1.887-1.888)	Clearance between hub and bushing 0.1(0.0039)	
I	Pump bushing				47.975-48.000 (1.889-1.890)		
J	Pilot(Tip outer dia)		Isuzu engine		15 (0.59)	14.85 (0.38)	Corrected by hard chrome plating

5) MAINTENANCE STANDARDS

(1) Hydraulic pressure

No	Location	Pressure (kgf/cm^2)	Cracking pressure (kgf/cm^2)
1	Torque converter input	3 ~ 7	5
2	Torque converter output	2 ~ 5.5	2.3

※ Cracking pressure means the pressure at which the valve begins to open.

(2) Tightening torques

No	Location	Thread specifications		Tightening torque in kgf · m(lbf · ft)	
				Target	Maximum
1	Input plate	Small hexagonal bolt	M8×1.25×20	2.1(15.2)	2.7(19.5)
2	Pump	Small hexagonal bolt	M8×1.25×40	2.1(15.2)	2.7(19.5)
3	Valves	Plug	M16×1.25×10	5.0(36)	6.5(47)
4	Cover	Small hexagonal bolt	M8×1.25×12	0.98(7)	1.3(9)
5	Torque converter fluid outlets	Hexagonal plug with hole	PT 1/4	3.5(25.3)	4.4(31.8)
6	Pump assembly	Small flathead screw	M5×0.8×16	0.1(0.72)	0.3(2.2)
7	Blind plug	Hexagonal plug with hole	PT3/4	5.8(42)	7.2(52.1)

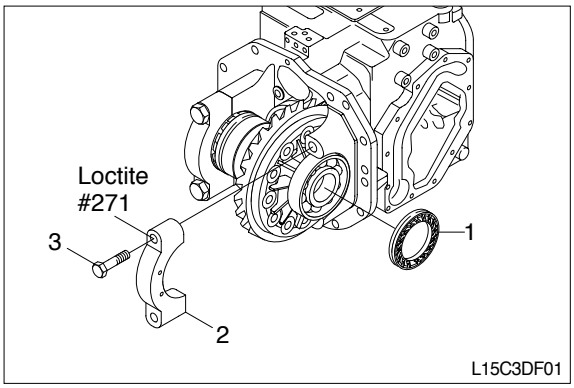
2. TRANSMISSION

※ Keep all parts in order as disassembly progresses. Take care to properly identify each part and its order of removal.
If necessary, keep notes and put markings on parts using a non-destructive marker such as a felt-tipped pen.

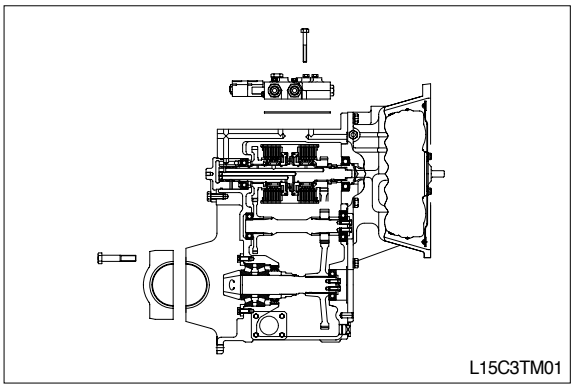
1) DISASSEMBLY

(1) Differential, torque converter, control valve

① Detach the differential from the torque converter.

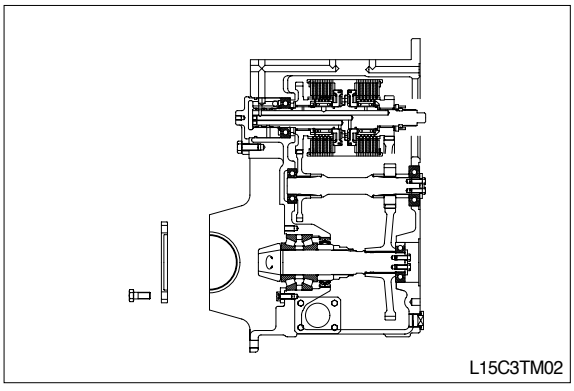


① Remove the control valve.



(2) Plate

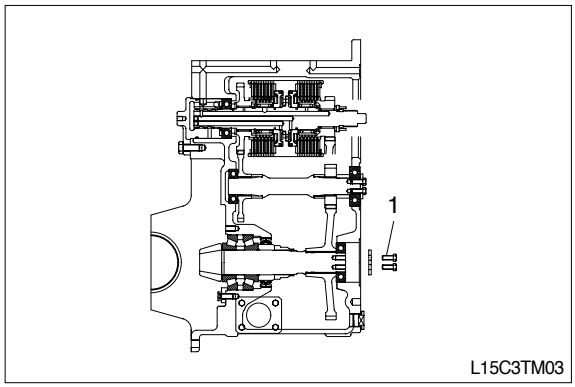
① Remove the plate



(3) Pinion shaft

① Remove pinion shaft bolt(1).

② Fit a dolly block(copper rod) and tap the pinion shaft with a hammer to remove.



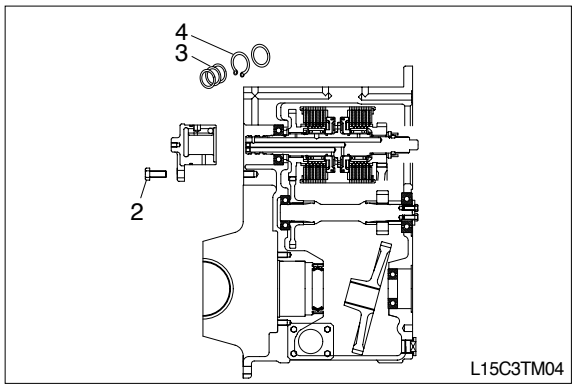
(4) Seal ring cap

① Remove bolt(2) and fit the bolt to the tapped hole.
Remove the seal ring cap.

※ Pull out the cap straight without twisting it.

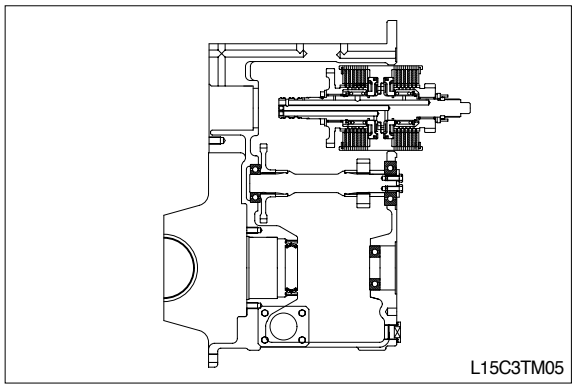
② Remove seal ring(3).

③ Remove snap ring(4).



(5) Clutch pack assembly

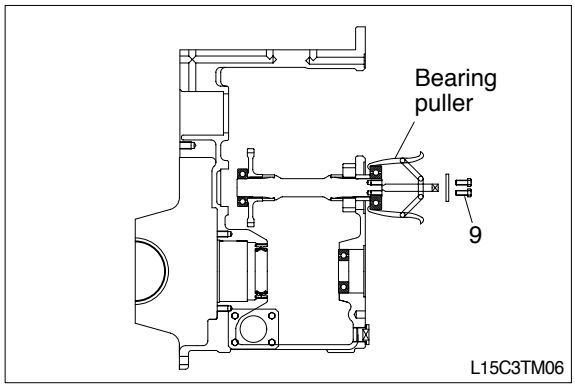
Remove front and rear clutch pack assembly.



(6) Idler shaft assembly

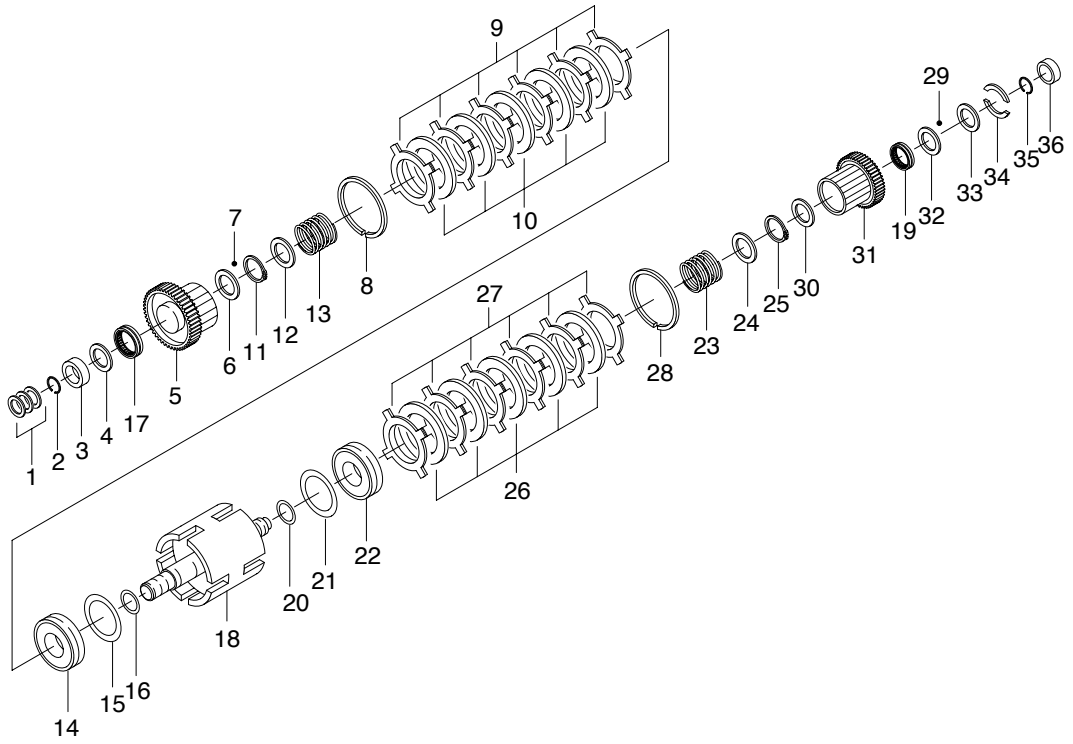
① Remove bolt(9) and slide the shaft assembly as shown in the drawing.

② Remove the bearing and the shaft assembly using a bearing puller.



(7) Disassembly of components of clutch pack assembly

※ The number shows the sequence of disassembly.



L15C3CL01

1	Sealing	13	Spring	25	Snap ring
2	Spring	14	Piston	26	Disc
3	Spacer	15	Sealing	27	Plate
4	Washer	16	Sealing	28	Ring
5	Gear	17	Needle bearing	29	Ball
6	Spacer	18	Shaft assembly	30	Washer
7	Ball	19	Needle bearing	31	Gear
8	Ring	20	Sealing	32	Washer
9	Plate	21	Sealing	33	Spacer
10	Disc	22	Piston	34	Spacer
11	Snap ring	23	Spring	35	Spring
12	Washer	24	Washer	36	Spacer

※ Spring under heavy compression. Carefully remove with press.

2) ASSEMBLY

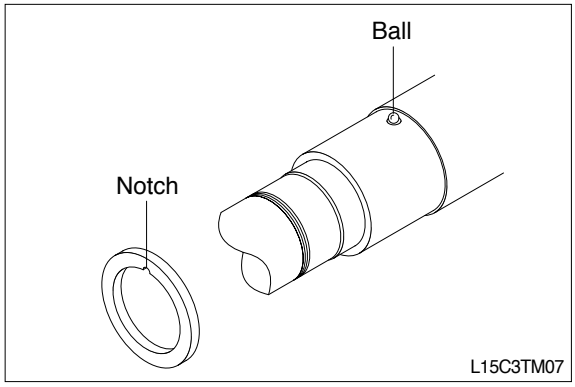
※ Cleanliness is of extreme importance in the repair and overhaul of this assembly. Perform all disassembly work in a clean area. Overhaul the transaxle only in a clean, dust-free location, using clean tools and equipment. Dirt or grit will damage the highly-machined sufaces and result in premature failure of components. Cleanliness of interior surfaces, orifices, etc. is extremely important to the proper operation of the hydraulic circuit. The exterior surface of the unit must be thoroughly cleaned of all dirt and foreign substances to prevent contamination of the parts during overhaul. Protect all components from dust and dirt while repairs are being made. Be sure the work area is kept clean.

(1) Assembly of components of the clutch pack assembly.

Assembly is in the reverse order to disassembly but pay attention to the following.

① **Piston ring**

Fit the piston ring.



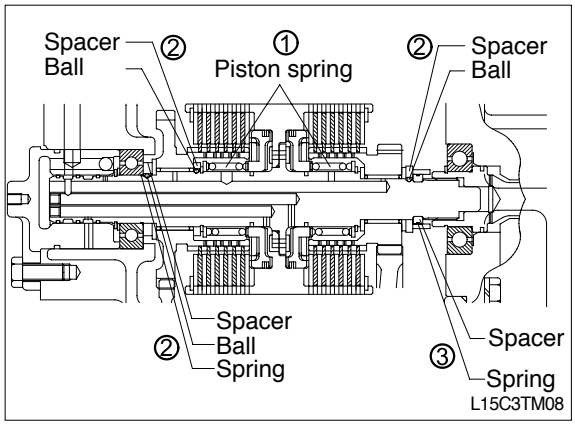
② **Ball, Spacer, Spring**

Coat the ball with oil and then fix it to the hole of the shaft match the notch of the spacer with the ball and insert.

③ **Spacer, Spring**

Spacer consists of two halves.

Fix the spacer with a spring.



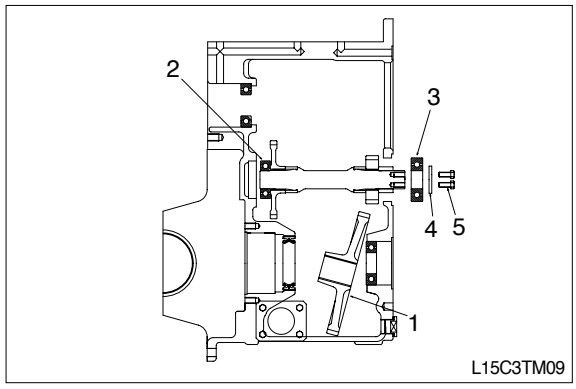
(2) Idler shaft assembly

① Prefit gear(1) in the case.

② Fit bearing(2) on the idler shaft and install in the case.

③ Fix bearing(3) fix it with plate(4) and bolt (5).

· Tightening torque : 2.8 ~ 3.5kgf · m
(20 ~25lbf · ft)



(3) Clutch pack assembly

① Fit bearing(1) in the case.

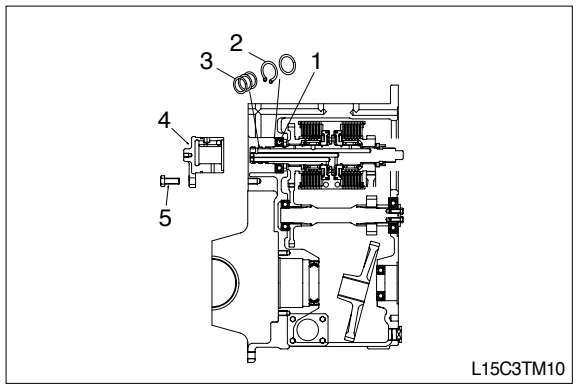
② Fit F-R clutch pack assembly.

③ Fit snap ring(2).

④ Fit seal ring(3).

⑤ Fit seal ring cap fix with bolt(5).

· Tightening torque : 10 ~ 12.5kgf · m
(72 ~90lbf · ft)

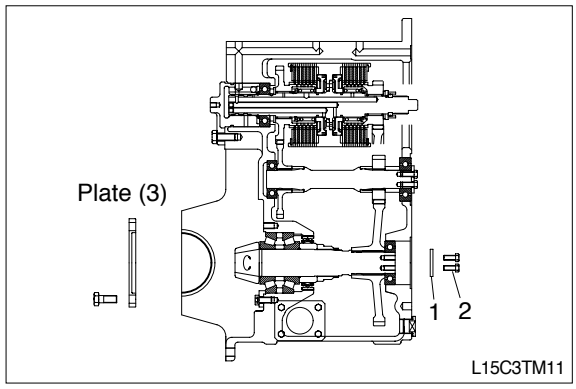


(4) Pinion shaft assembly

① Install pinion shaft assembly in the case.

② Fix with plate(1) and bolt(2).

③ Fix plate(3).

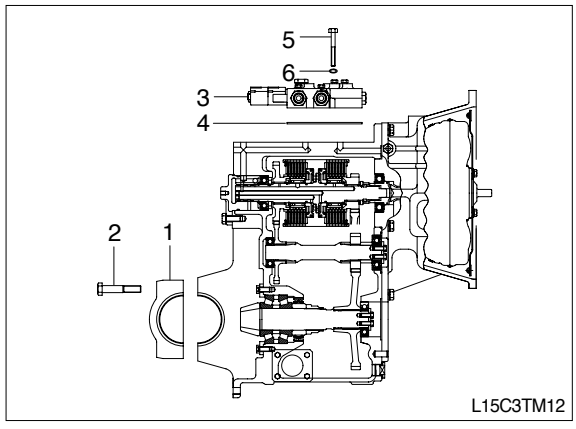


(5) Differential, control valve

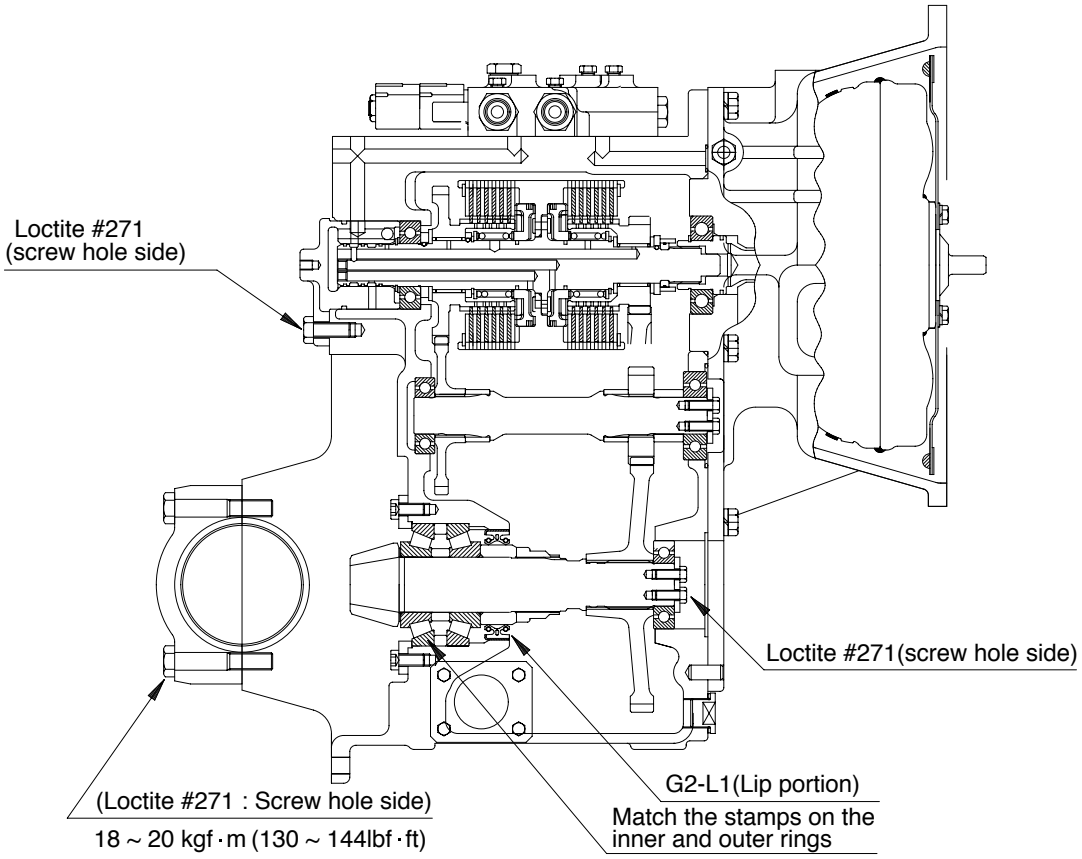
① Fit the differential to the case with cap(1) and bolt(2).

※ Refer to adjustment of backlash after attaching the differention.

② Fit control valve(3) and gasket(4) with bolt(5).

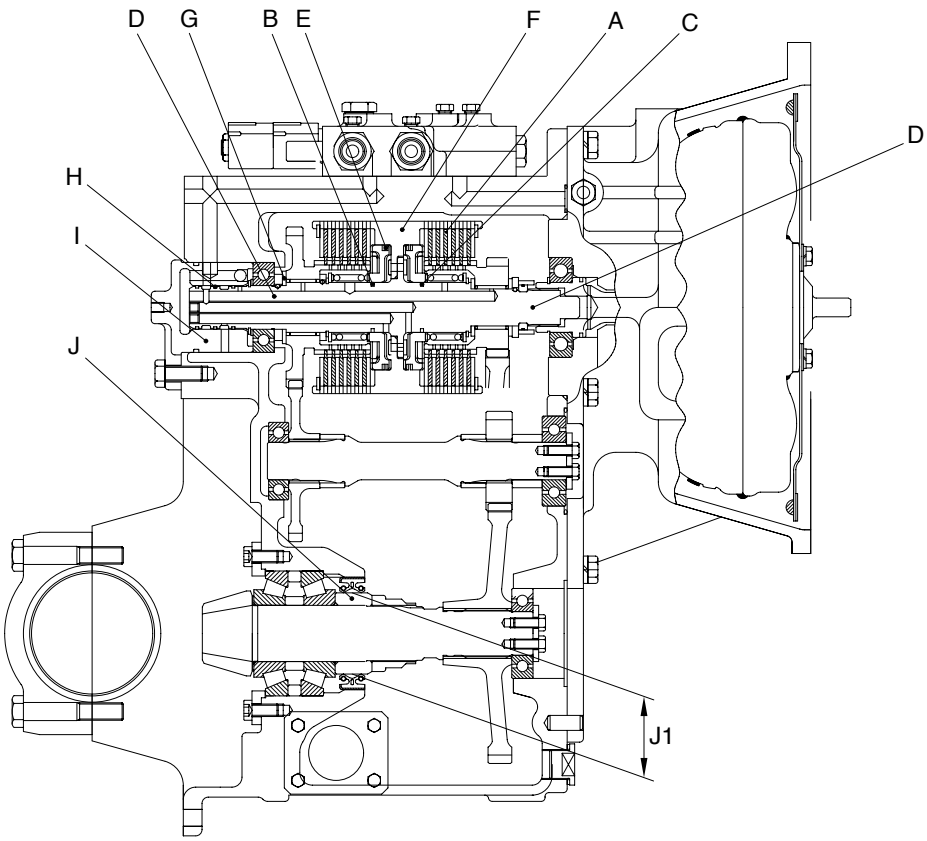


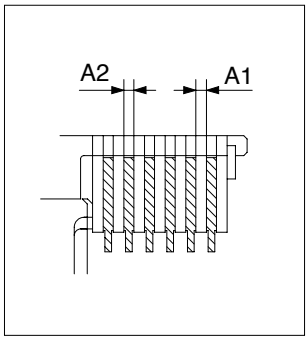
3) TORQUEFLOW TRANSMISSION ASSEMBLY DRAWING

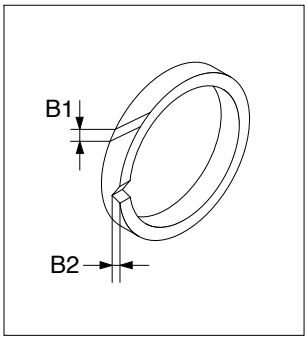


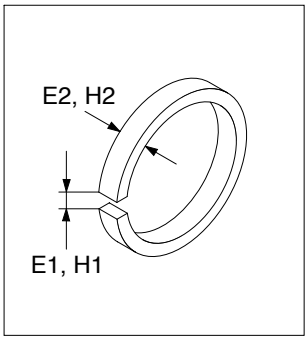
L15C3TM13

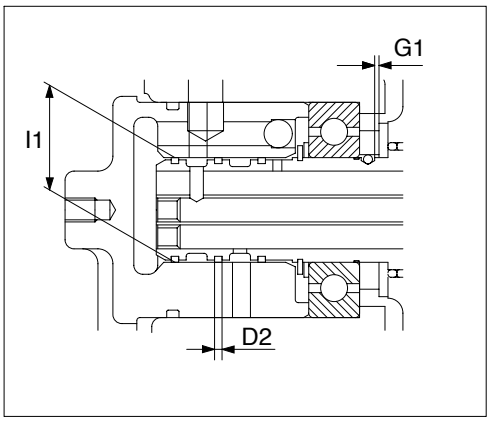
4) CHECK AND INSPECTION

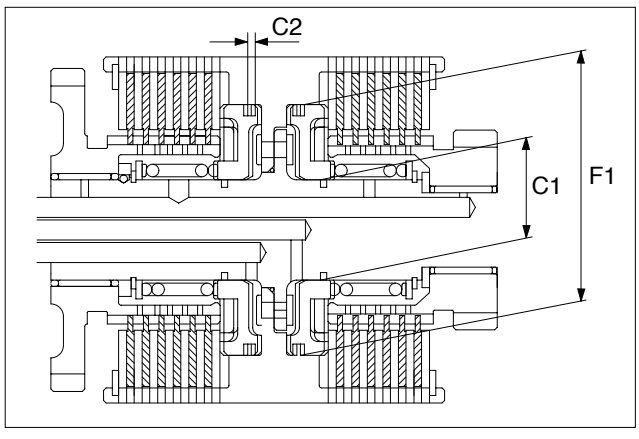












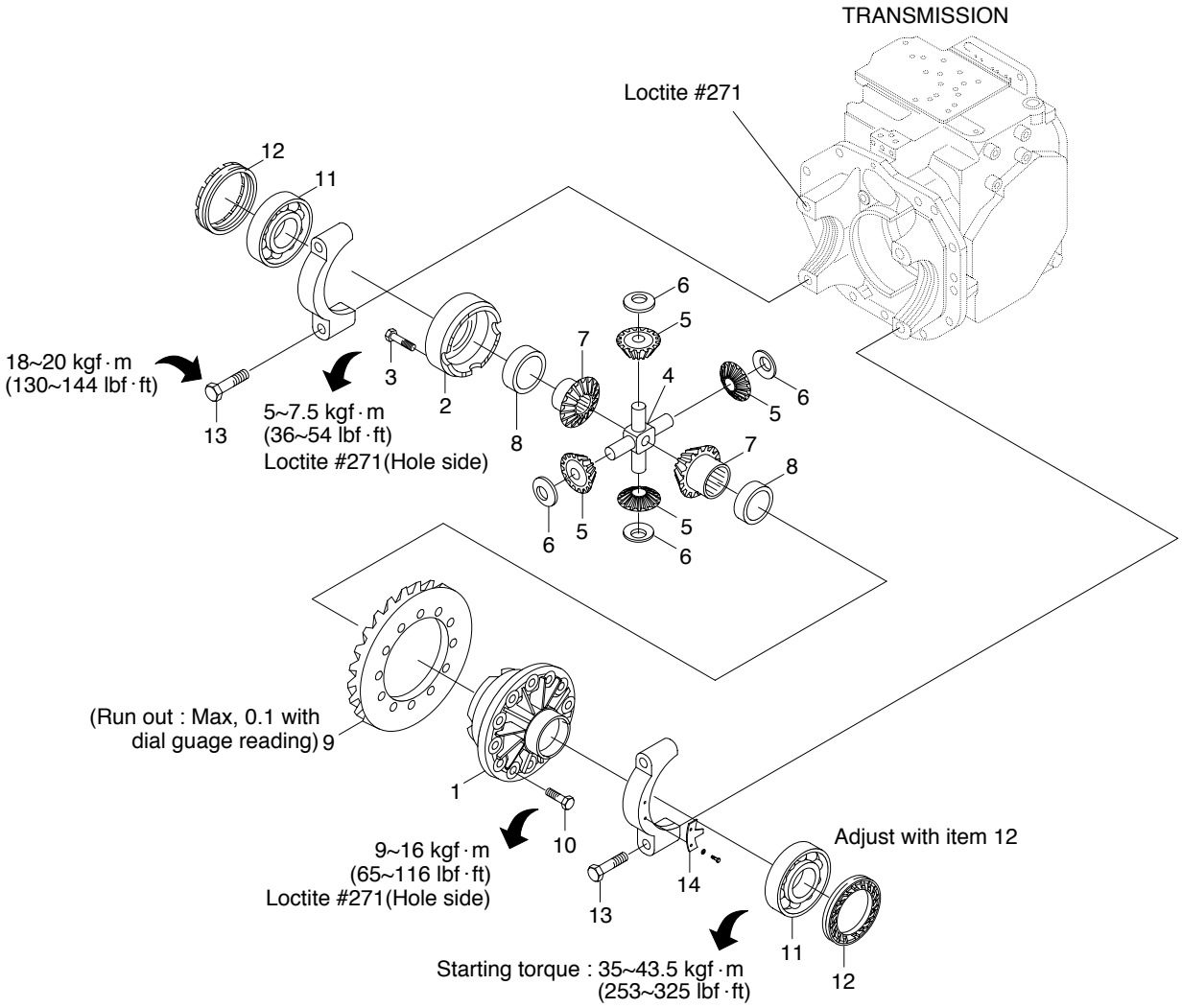
L15C3TM14

Unit : mm(in)

No	Check item			Criteria		Remedy
				Standard size	Repair limit	
A	Plate	A_1	Thickness of drive plate	3.13-3.27 (0.123-0.129)	2.9 (0.114)	Replace
		A_2	Thickness of driven plate	2.90-3.05 (0.114-0.120)	2.6(0.102) (Oil groove depth Min0.2)(0.008)	
B	Sealing	B_1	Clearance of abutment when piston is inserted	0.36-0.56 (0.014-0.002)	-	Replace at each disassembly
		B_2	Depth of the side face oil groove	0.15-0.35 (0.006-0.014)	To be grooved	
		(D_1)	Width of groove for insertion	2.60-2.65 (0.102-0.104)	2.8 (0.110)	
C	Piston	C_1	Sealing matching face I.D	40.025-40.050 (1.576-1.577)	40.2 (1.583)	Replace
		C_2	Width of groove when sealing is inserted.	3.1-3.2 (0.122-0.126)	3.4 (0.134)	
D	Drive shaft	D_1	Width of the groove for inserting sealing.	2.60-2.65 (0.102-0.104)	2.8 (0.110)	
		D_2	Width of the groove of inserting sealing.	2.60-2.65 (0.102-0.104)	2.8 (0.110)	
E	Sealing	E_1	Clearance of abutment when clutch case is inserted	2.97-2.99 (0.117-0.118)	1.0 (0.039)	
		E_2	Width	0.2-0.4 (0.008-0.157)	2.77 (0.109)	
		(C_2)	Width of groove for insertions	3.1-3.2 (0.122-0.126)	3.4 (0.134)	
F	Clutch case	F_1	Sealing matching face I.D	100-100.054 (3.937-3.939)	100.3 (3.949)	
G	Thrust	G_1	Thickness	2.9-3.1 (0.114-0.122)	2.5 (0.098)	
H	Sealing	H_1	Clearance of abutment when cap is inserted	0.05-0.25 (0.002-0.010)	0.65 (0.026)	
		H_2	Width	2.47-2.49 (0.097-0.098)	2.25 (0.089)	
		(D_1)	Width of groove for insertions	2.60-2.65 (0.102-0.104)	2.8 (0.110)	
I	Cap	I_1	Sealing matching face I.D	35.000-35.021 (1.378-1.379)	35.2 (2.552)	
J	Retainer	J_1	Oil seal maching face O.D	64.926-65.000 (2.556-2.559)	64.83 (1.386)	
-	Each gear	-	Backlash	0.08-0.28 (0.003-0.011)	-	
		-	Clearance of thrust	0.3-0.7 (0.012-0.028)	-	
-	Gasket, O-ring, seals			-	-	Replace with a new part when disassembly and assembly

3. DIFFERENTIAL

1) STRUCTURE

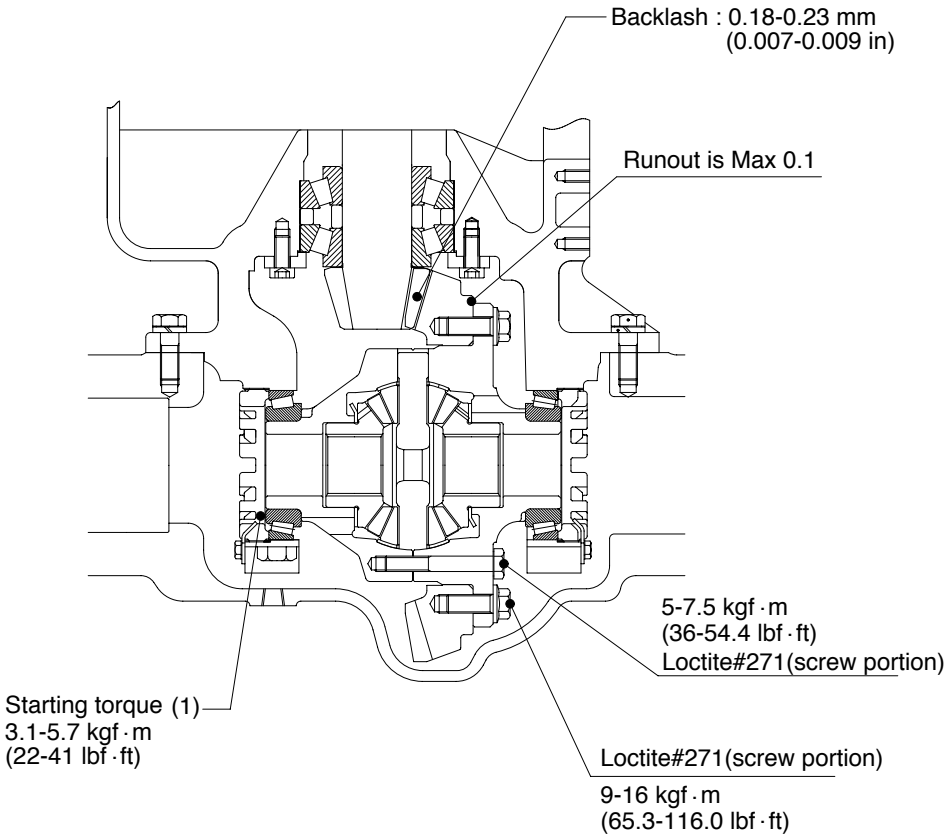


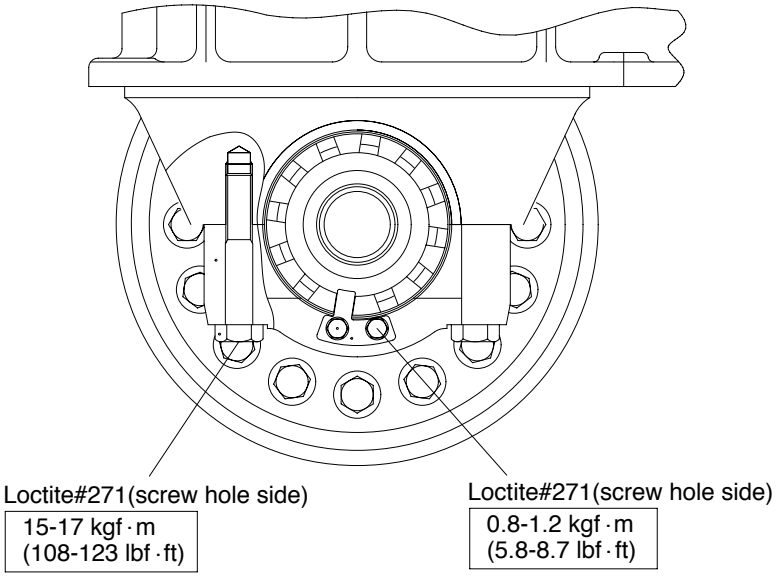
L15C3DF04

※ Ring gear and pinion must be replaced as one unit.
Do not replace one without the other.

1	Case	6	Washer	11	Taper bearing
2	Case	7	Differential pinion	12	Screw gear
3	Hexagon bolt	8	Bushing	13	Bolt
4	Spider	9	Bevel gear	14	Plate
5	Differential pinion	10	Bolt		

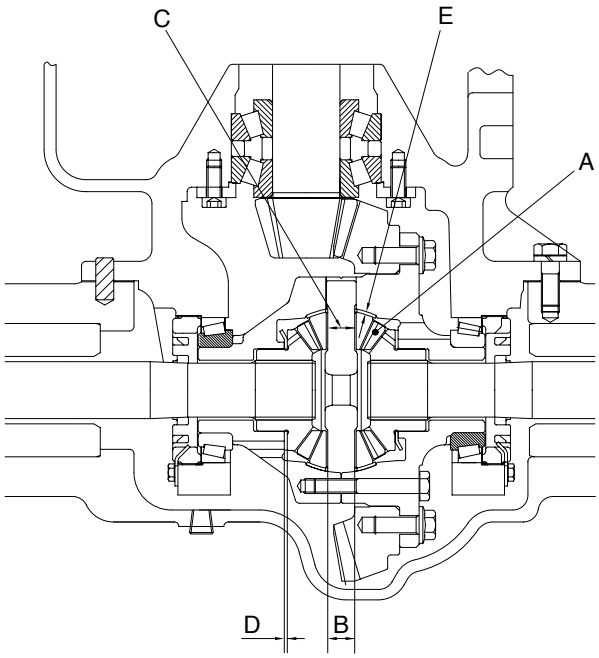
2) DIFFERENTIAL ASSEMBLY DRAWING





L15C3DF05

3) CHECK AND INSPECTION



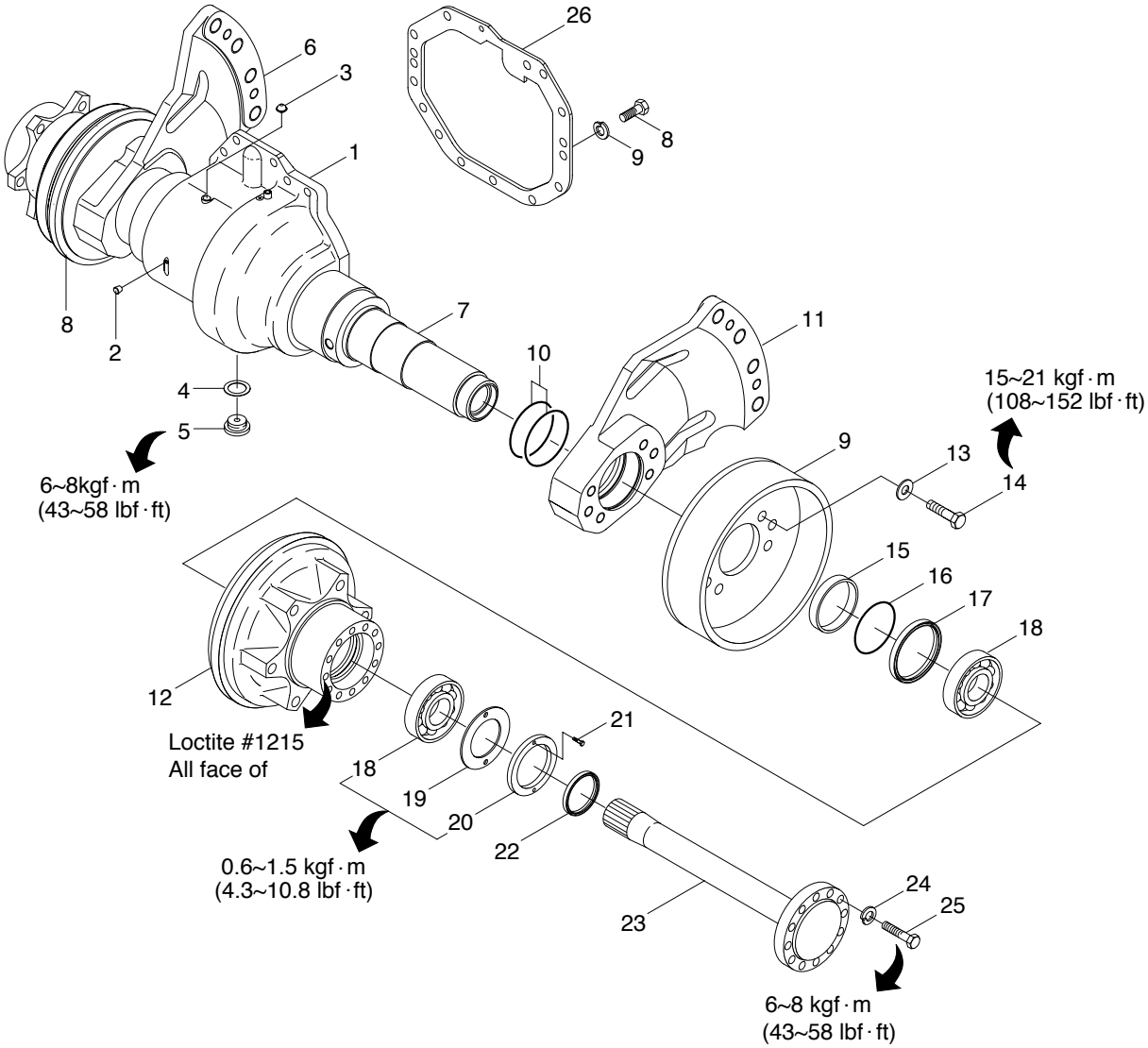
L15C3DF07

Unit : mm(in)

No	Check item	Criteria		Remedy
		Standard size	Repair limit	
A	Differential pinion gear and side gear	-	Scratches on the teeth	Replace (Replace bevel gear and pinion)
B	O.D of spider	19.959-19.980 (0.785-0.787)	19.75 (0.777)	Replace
C	I.D of differential pinion gear	20.0-20.021 (0.787-0.788)	20.1 (0.791)	
D	Width of bushing	1.94-2.06 (0.076-0.081)	1.7 (0.067)	
E	Width of bushing	1.52-1.68 (0.060-0.066)	1.3 (0.05)	
-	(I.D of brake drum)	254.0-254.2 (10.00-10.01)	256 (10.08)	
-	Gasket O-ring Seals	-	-	Replace with new parts when reassembling after disassembling.

4. DRIVE AXLE

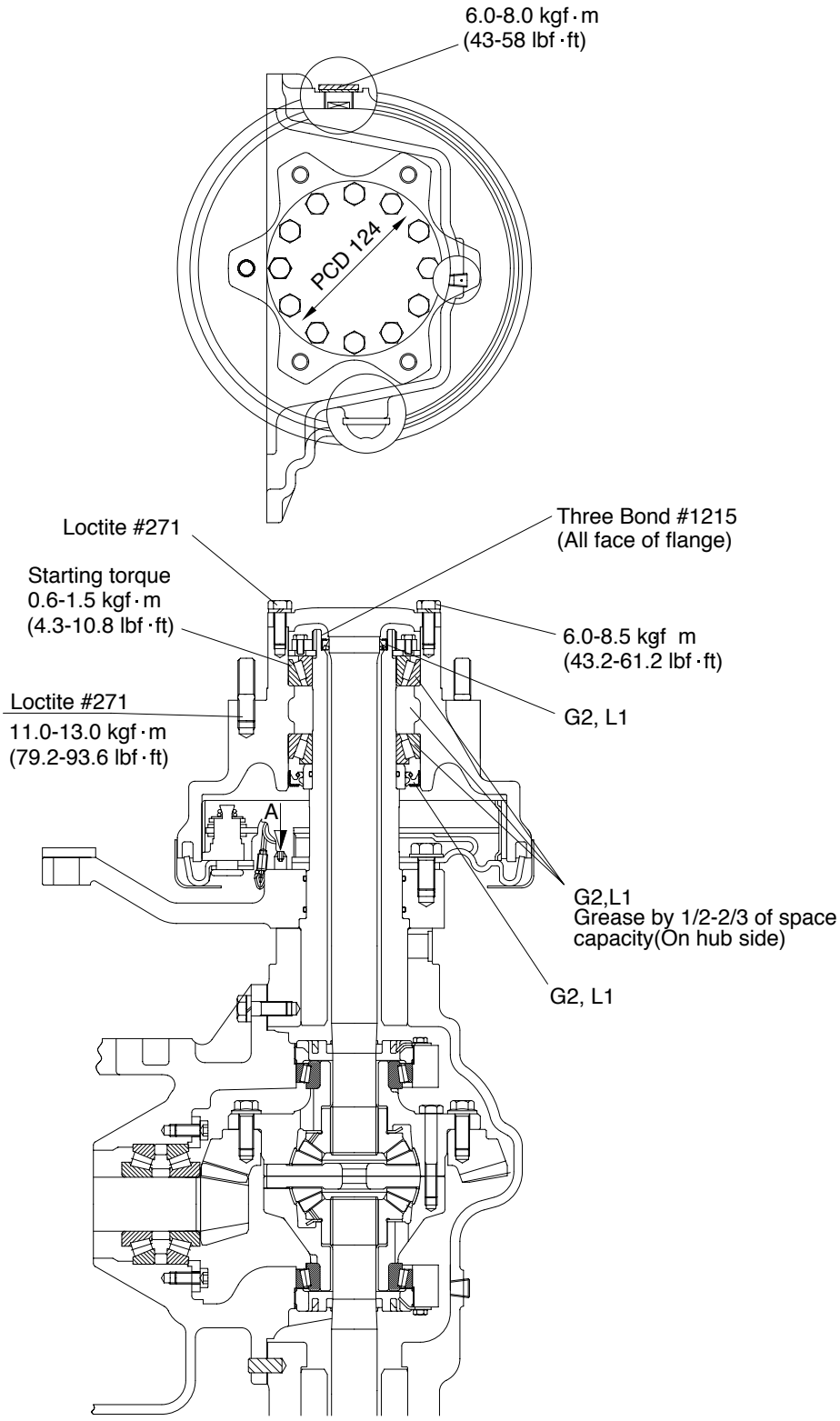
1) DISASSEMBLY AND ASSEMBLY



L15C3DA01

1	Housing	10	O-ring	19	Plate
2	Plug	11	Support drive(LH)	20	Nut
3	Cap	12	Hub	21	Bolt
4	Gasket	13	Washer	22	Oil seal
5	Plug	14	Bolt	23	Drive shaft
6	Support drive(RH)	15	Retainer	24	Washer
7	Axle tube	16	O-ring	25	Bolt
8	Brake assembly(RH)	17	Oil seal		
9	Brake assembly(LH)	18	Taper roller bearing		

2) ASSEMBLY OF DRIVE AXLE



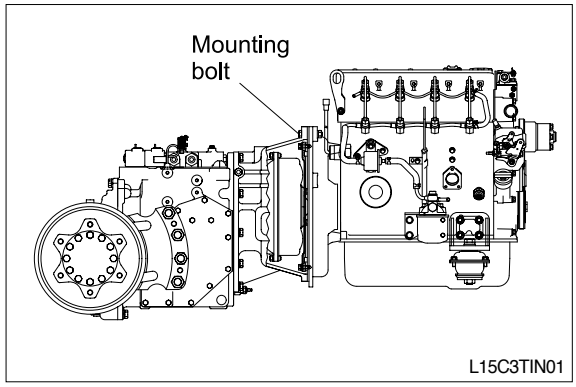
L15C3DA02

3) INSTALLATION

Perform installation in the reverse order to removal, paying attention to the following.

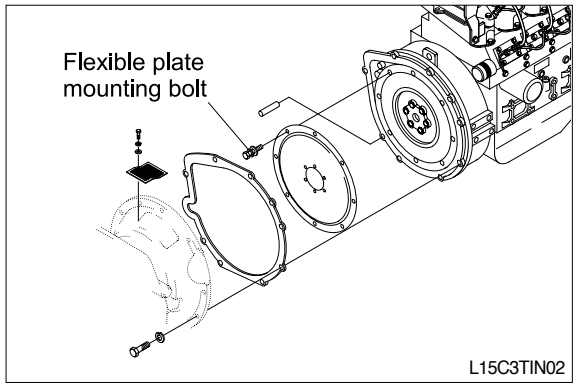
(1) Tightening torque converter case mounting bolt.

· Tightening torque : 6.0-7.5kgf · m
(43-54lbf · ft)



(2) Tightening flexible plate mounting bolt.

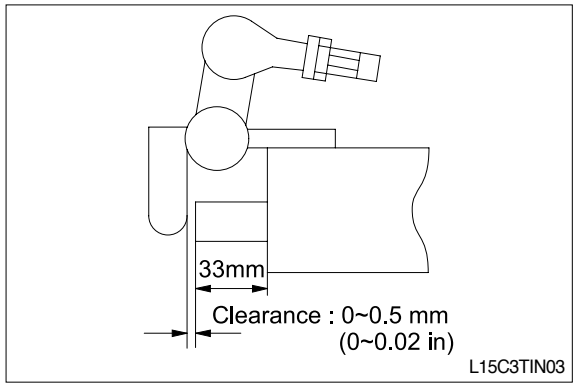
· Tightening torque : 2.8-3.5kgf · m
(20-25lbf · ft)



(3) Pedal assembly brake piping.

① **Inching drawing**
Refer to the drawing on the right.

② **Adjustment of pedal**
Refer to “Adjustment of pedal”



SECTION 4 BRAKE SYSTEM

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 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 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

Item		Specification
Type		Front wheel, duo-servo & auto adjustment type
Brake shoe size		254×48.5mm
Wheel cylinder bore diameter		22.22mm
Master cylinder diameter		15.87mm
Pedal adjustment	Free height	132~142mm
	Pedal play	10mm
Brake drum diameter	Normal	255mm
Wheel cylinder installation torque		0.8~1.2kgf · m
Backing plate installation torque		15~21kgf · m
Brake oil		Only use for brake fluid DOT3

2) PARKING BRAKE

Item	Specification
Type	Toggle, internal expanding mechanical type
Parking lever stroke	214mm
Parking cable stroke	18.1mm

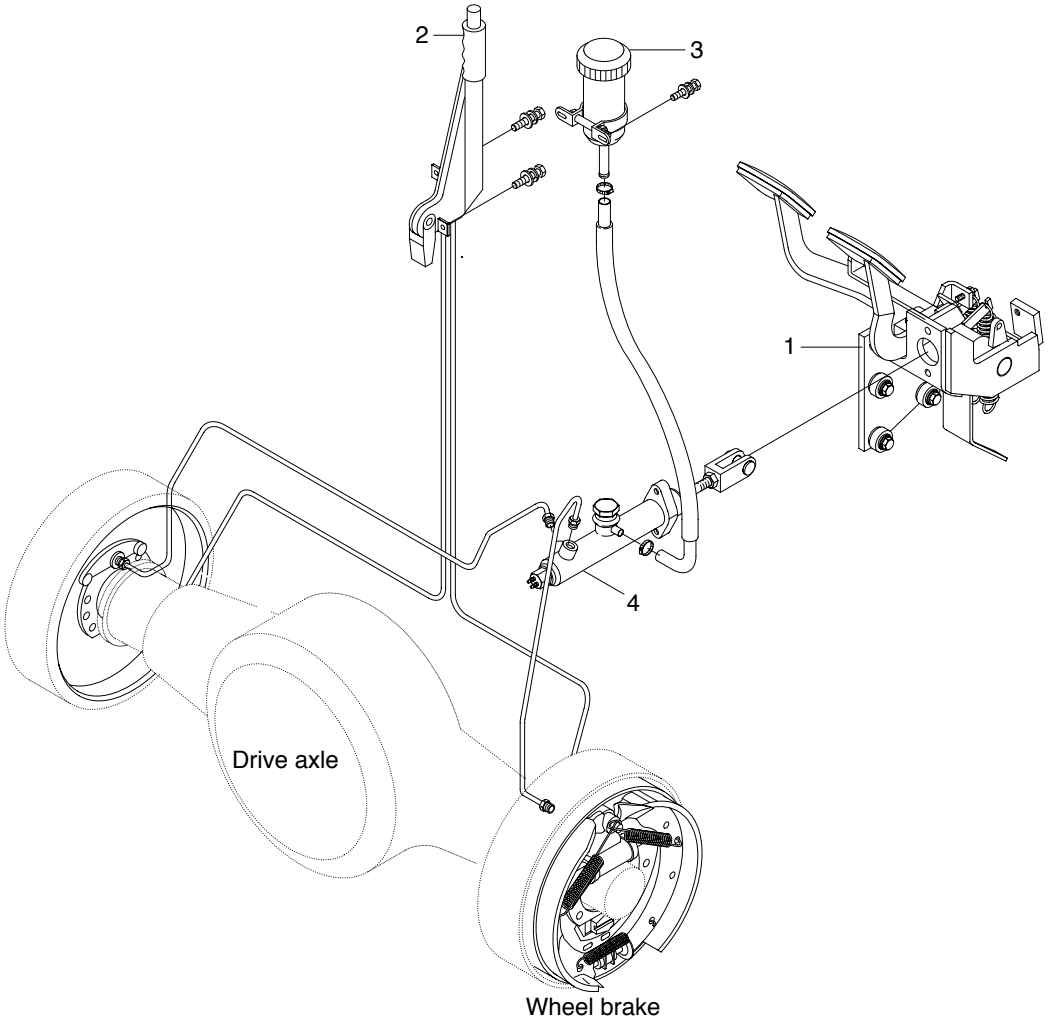
3. BRAKE PEDAL AND PIPING

The brake system provides two systems, a foot brake and a parking brake.

In the foot brake system, the oil pressure which is generated in the master cylinder when the brake pedal is depressed is transmitted to the wheel cylinders. The piston of the wheel cylinder presses the brake shoes and then moves outward causing contact with the drums and braking force is obtained. In the parking brake system, the force is transmitted to move the brake shoe through a brake cable to activate the brake when the brake lever is operated.

The wheel brake is a dual servo type in which the actuating force is applied to both the primary and secondary shoes. Even if the applied force is small, a large braking force will be obtained.

These brakes are equipped with self adjusters which continuously adjusts the brakes in small increments in direct proportion to the wear of the linings.



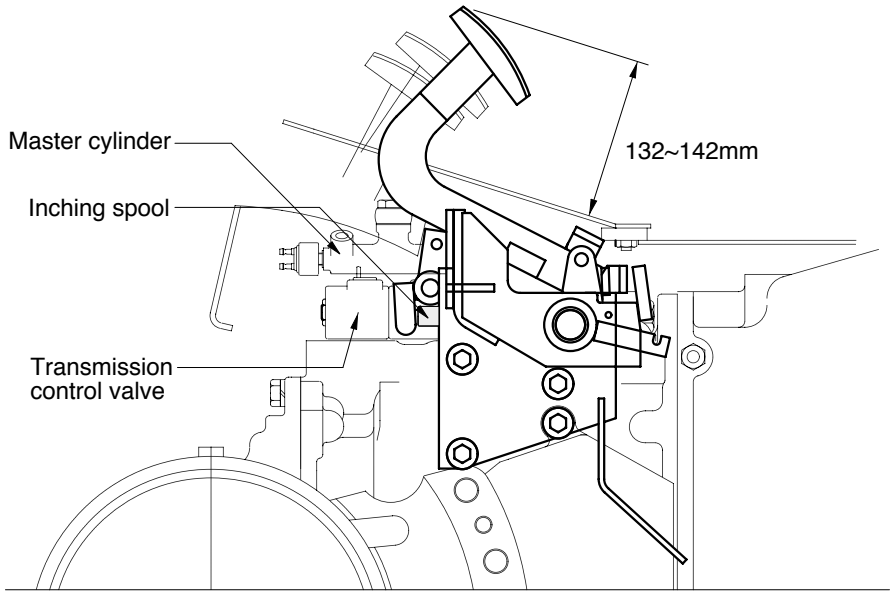
D153BS03

1 Brake pedal & bracket assy
2 Parking lever assy
3 Reservoir tank assy
4 Master cylinder

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 are applied.



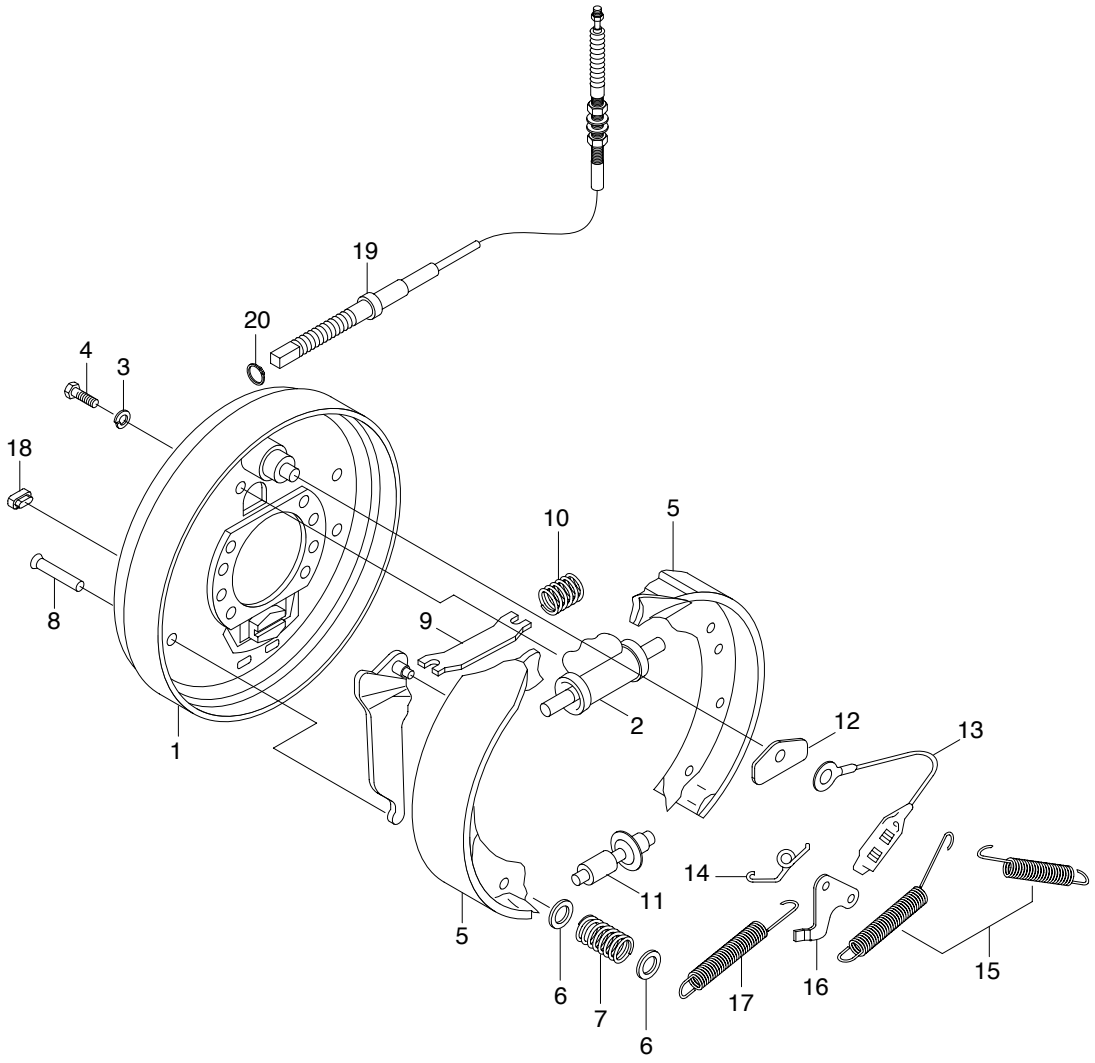
D153BS01

5. WHEEL BRAKE

1) STRUCTURE

The wheel brake assembly mounts to the flange on the drive axle housing casting and is basically contained within the hub assembly.

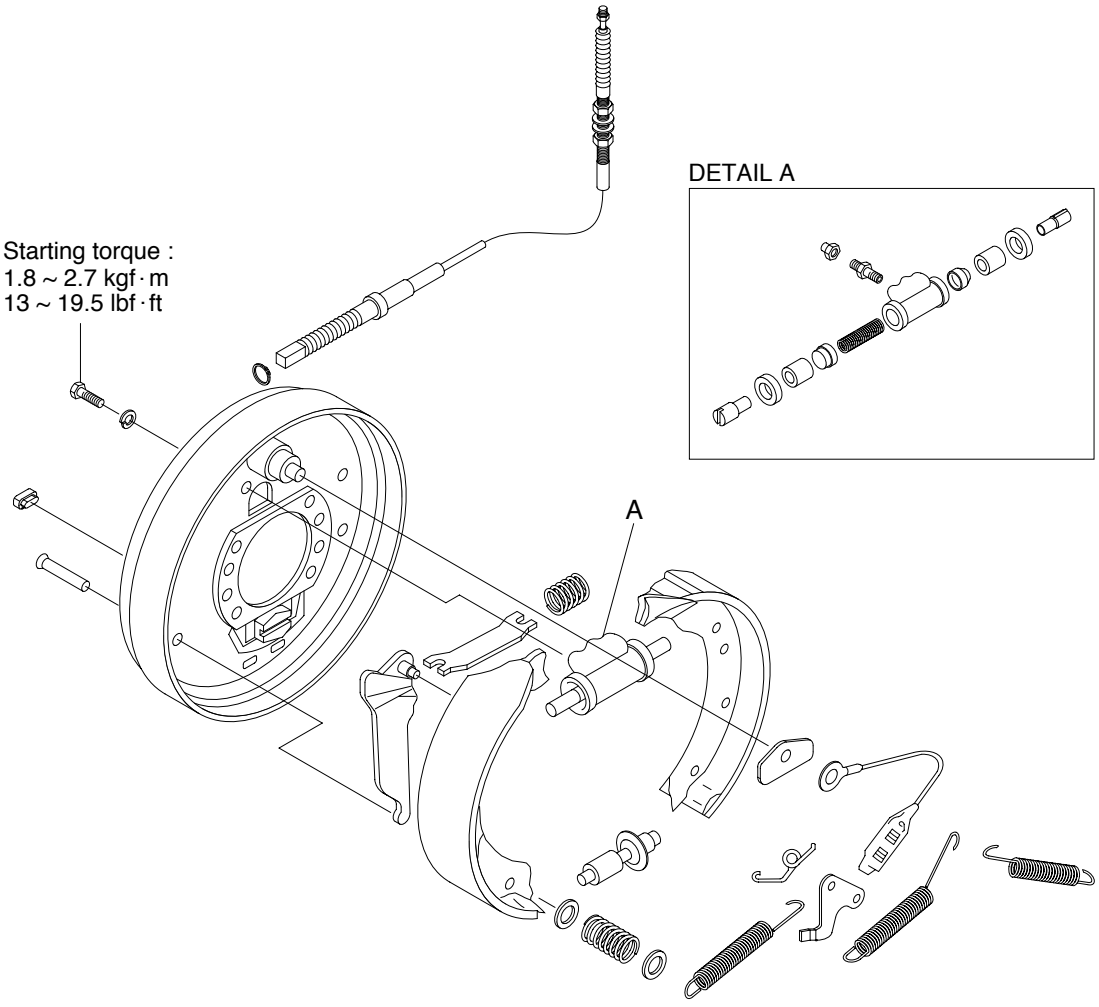
The inside of the hub is machined and acts as the brake drum.



D153BS10

1	Back plate-LH/RH	8	Shoe head pin	15	Shoe return spring
2	Wheel cylinder assembly	9	Strut	16	Adjuster lever
3	Spring washer	10	Strut spring	17	Adjuster spring-LH/RH
4	Hexagon bolt	11	Adjuster assembly-LH/RH	18	Rubber
5	Shoe lining assembly-LH/RH	12	Shoe guide	19	Parking cable-LH/RH
6	Shoe cup	13	Adjuster cable	20	E-ring
7	Shoe head spring	14	Guide		

2) DISASSEMBLY AND ASSEMBLY



(1) Check and inspection

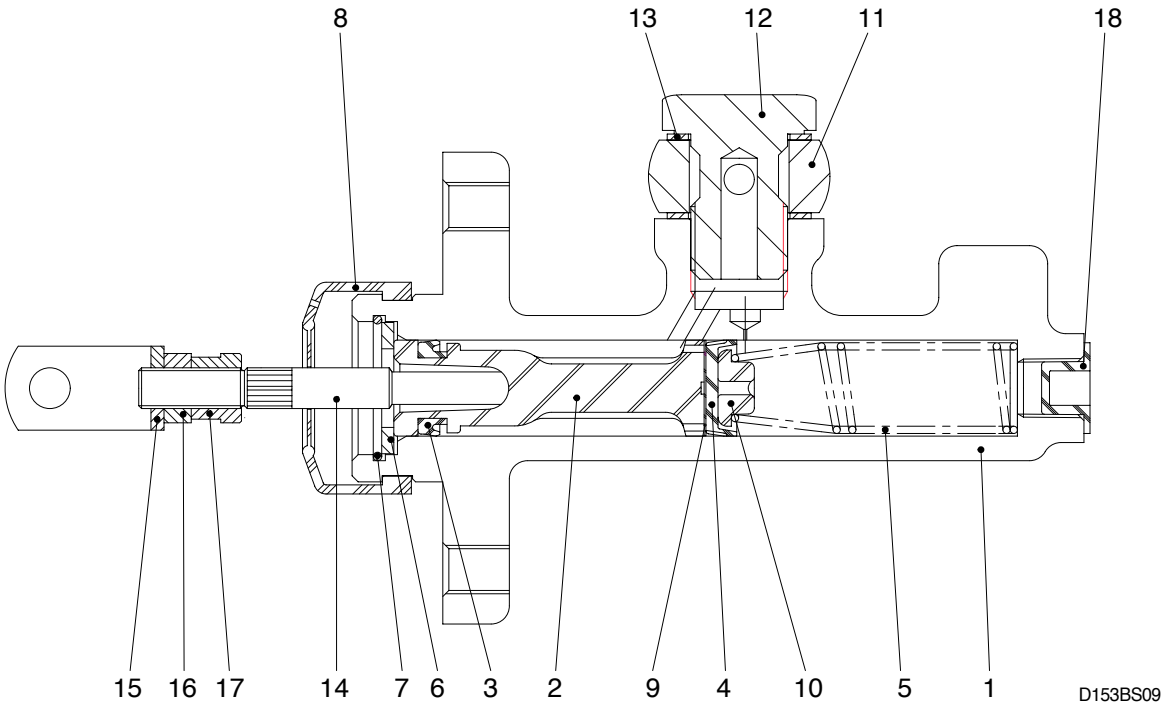
Unit : mm(in)

Check item	Criteria		Remedy
	Standard size	Repair limit	
Thickness of lining	4.5 (0.17)	2.0 (0.08)	Replace
Deterioration of return spring	Free length 124 (4.9)	136 (5.36)	
Thickness of hooked part of return spring	2.9 (0.11)	2.0 (0.08)	
Clearance between piston and cylinder	0-0.05 (0-0.002)	0.2 (0.008)	

※ Check that there are no scratches on the sliding face of the wheel cylinder.
Check also that there is no damage of loss of elasticity of the cup.

6. BRAKE MASTER CYLINDER

1) STRUCTURE



1	Body	7	Snap ring	13	Washer
2	Piston	8	Boot	14	Rod
3	Secondary cup	9	Spacer	15	Head
4	Primary cup	10	Spring seat	16	Head pin
5	Spring	11	Union	17	Nut
6	Plate	12	Union bolt	18	Cap

2) DISASSEMBLY

(1) Remove the master cylinder boot(8) and remove the rod(14).

(2) Remove the snap ring(7) and take out the plate(6), the piston(2), the piston primary cup(4), and piston spring(5).

(3) Specification of master cylinder.

· Cylinder bore diameter : 15.87㎜

· Piston stroke : 29.0㎜

3) INSPECTION

(1) Clean and check these components.

※ Use isopropyl alcohol or brake fluid for washing the components. Do not use gasoline, kerosene or any other mineral oils. When using alcohol, do not leave rubber parts in the liquid for more than 30 seconds.

(2) Inspect the inside wall of the master cylinder, and if any faults are found, replace the cylinder assembly.

(3) Replace the boot(8), the primary cup(4), piston(2), if deformation or any other defect is found.

4) ASSEMBLY

※ Prior to assembly make sure again of no contaminant of the components. Apply a thin coat of brake oil to the components.

· Assembly is in reverse order to disassembly.

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

1. OPERATIONAL CHECKS

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 255mm(10.03in).
(2) Tighten mounting bolt of drum 1.08 ~ 1.28kgf · m(7.8 ~ 9.3lbf · ft).

4) BACKING PLATE

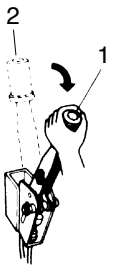
(1) Check visually for deformation or cracks.
Check particularly for deformation at outside circumference of plate and at mounting bolt.
(2) Coat mounting bolt with loctite and tighten : 2.6kgf · m(18.8lbf · ft).

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 20 - 30 kgf(44 - 66lbf).
(2) Check that parking brake can hold machine in position when loaded on 15% slope. If there is no slope available, travel at low speed and check braking effect of parking brake.



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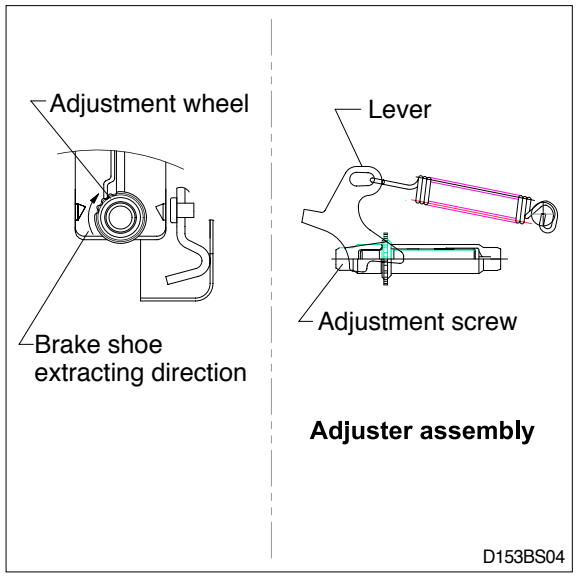
2. TROUBLESHOOTING

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

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

GROUP 3 TESTS AND ADJUSTMENTS

1. ADJUSTMENT OF WHEEL BRAKE



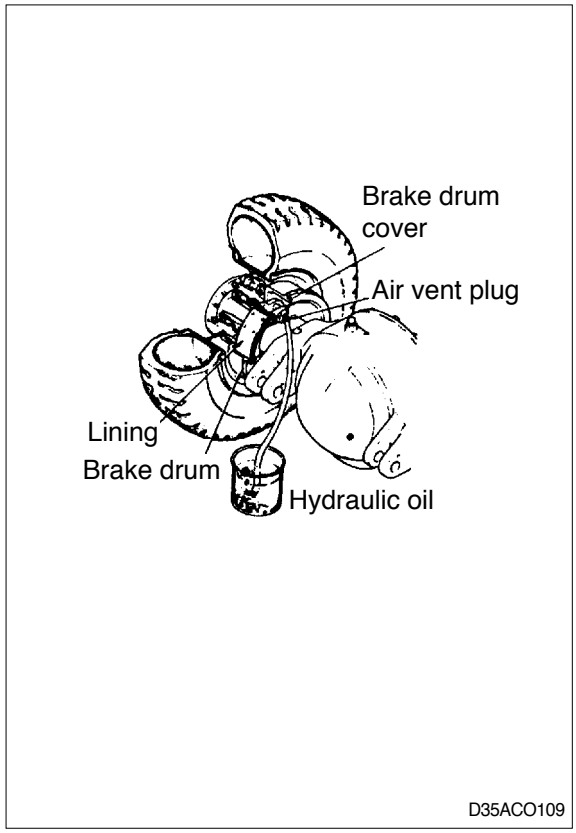
⚠ Adjust with engine stopped.

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.

2) 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.

2. AIR BLEEDING OF BRAKE SYSTEM



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.

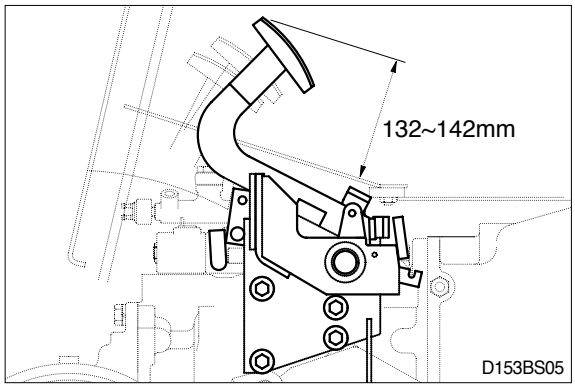
3. ADJUSTMENT OF PEDAL

1) BRAKE PEDAL

(1) Pedal height from floor plate

Adjust with stopper bolt.

· Pedal height : 132~142mm(5.2~5.6in)



(2) Play

Adjust with rod of master cylinder

· Play : 10mm(0.4in)

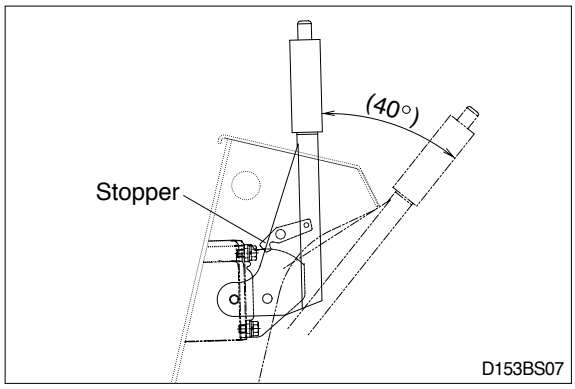
(3) Micro switch for parking brake (if equipped)

① 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



2) INCHING PEDAL

(1) Pedal height from floor plate

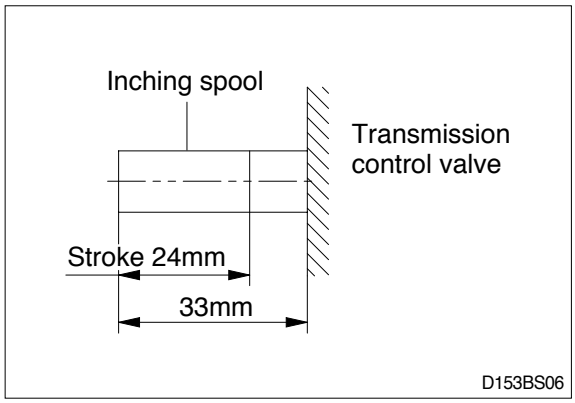
Adjust with stopper bolt.

· Pedal height : 132~142mm(5.2~5.6in)

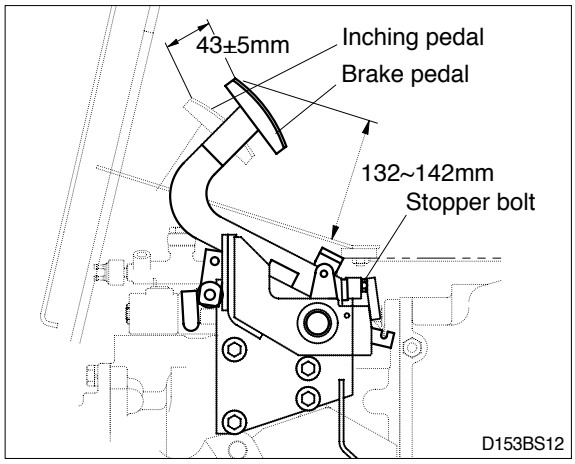
(2) Inching spool protrusion

Adjust with inching cable so that when the inching pedal is fully returned, the protrusion of spool from the end face of the control valve is the specified valve.

· Protrusion : 33mm(1.3in)



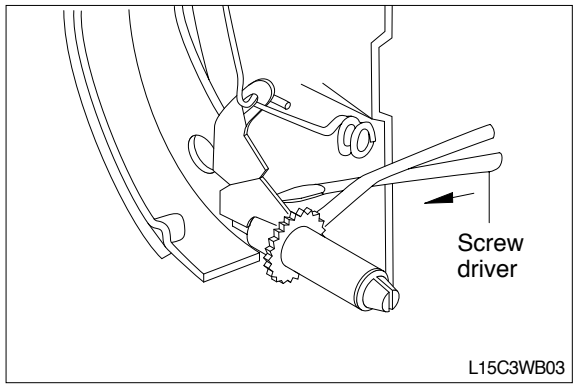
(3) Adjust bolt so that brake pedal interconnects with inching pedal at inching pedal stroke 43±5.0mm.

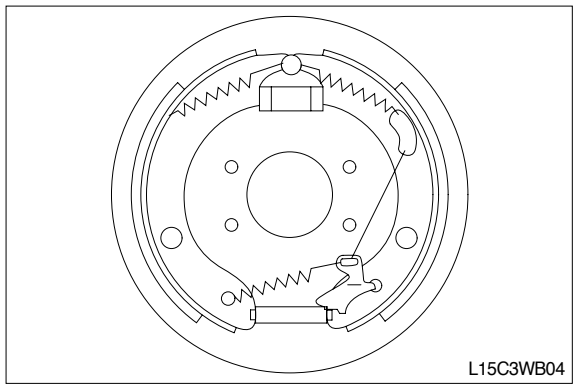


4. ADJUSTMENT OF WHEEL BRAKE

1) Jack up truck, extend adjustment acrew 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.

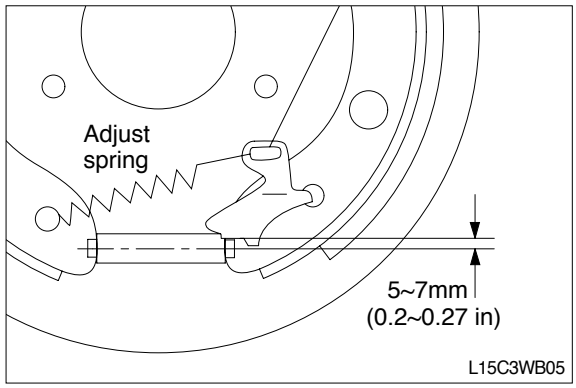
※ When backing adjustment wheel, be sure to adequately raise adjustment level to keep it free from interference with adustment weel. If level is bent by mistake, it loses proper function.





5. TEST AFTER ADJUSTMENT

1) Try pulling cable by hand in direction shown by arrow to confirm that adjustment lever disengages from a tooth of adjustment screw. Release the cable, and lever will come into engagement with next tooth and, after clicking adjustment wheel one tooth, return to original position.



2) If adjustment lever fails to perform above mentioned operation at all or operates intermittently, check adjustment lever for height at which lever comes into engagement with wheel teeth. The lever must come into engagement with a tool 5~7㎜ above a horizontal plane includig center line of adjustment screw. If lever comes into contact with wheel at any height above or below the standard range, lever will fail to engage with wheel teeth or, even when engaged, fail to click the wheel.

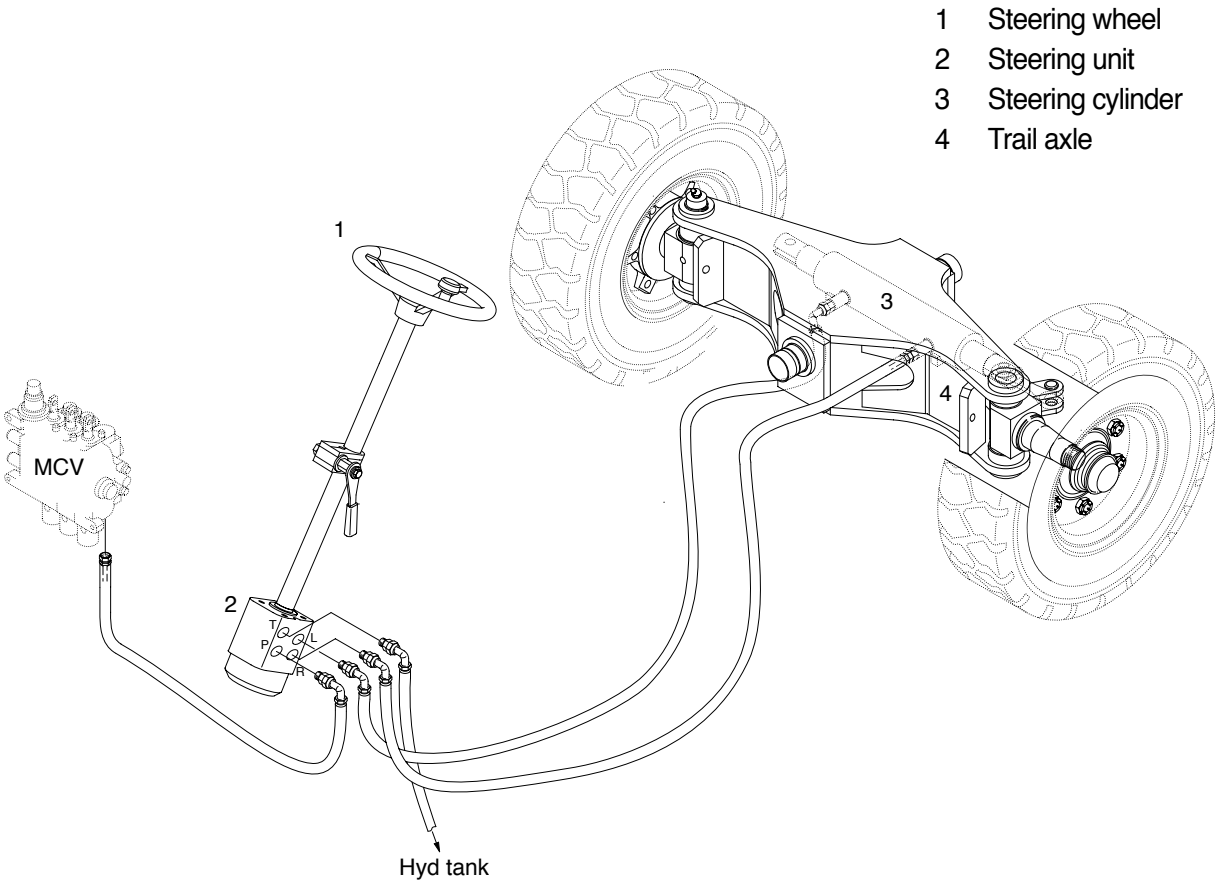
3) If necessary perform the following checking and remedies :
   (1) Check that cable guide is properly installed in secondary shoe.
   (2) Check that adjustment spring is hooked by proper method to proper hole in primary shoe.
   (3) Replace cable if necessary.
   (4) Replace adjustment lever if necessary.

SECTION 5 STEERING SYSTEM

SECTION 5 STEERING SYSTEM

GROUP 1 STRUCTURE AND FUNCTION

1. OUTLINE

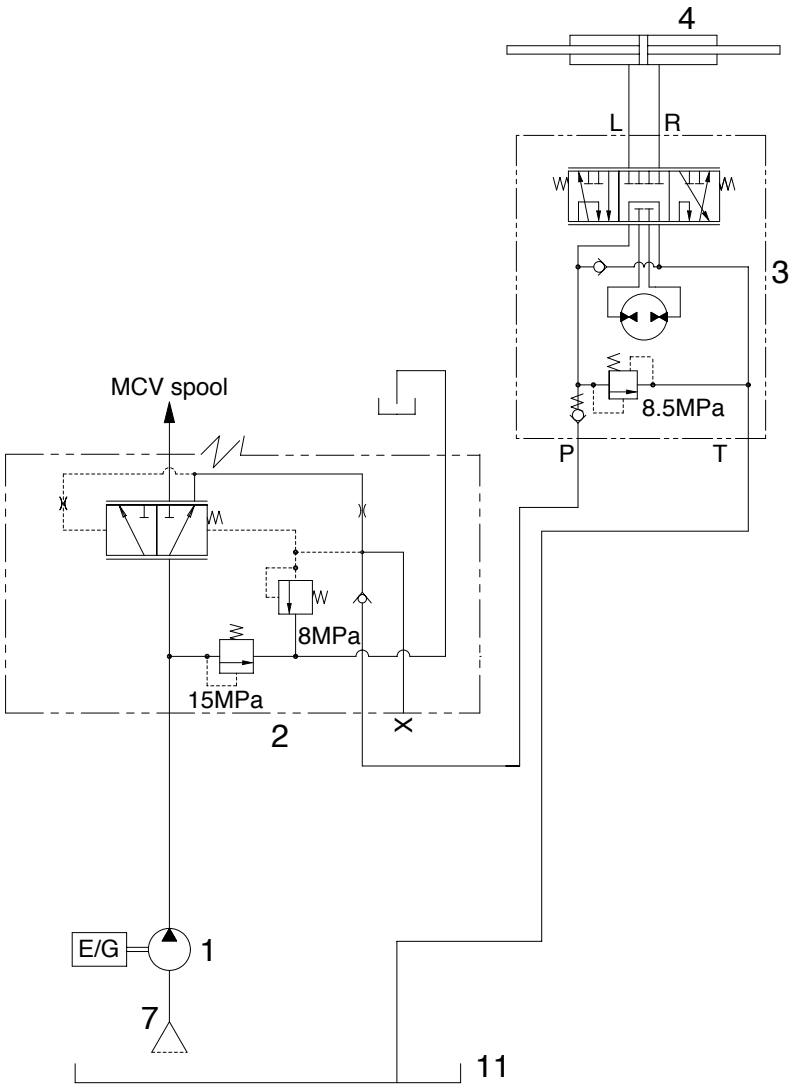


D153SE00

The steering system for this machine is composed of steering wheel assembly(1), steering unit(2), steering cylinder(3), trail axle(4) and pipings. 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.

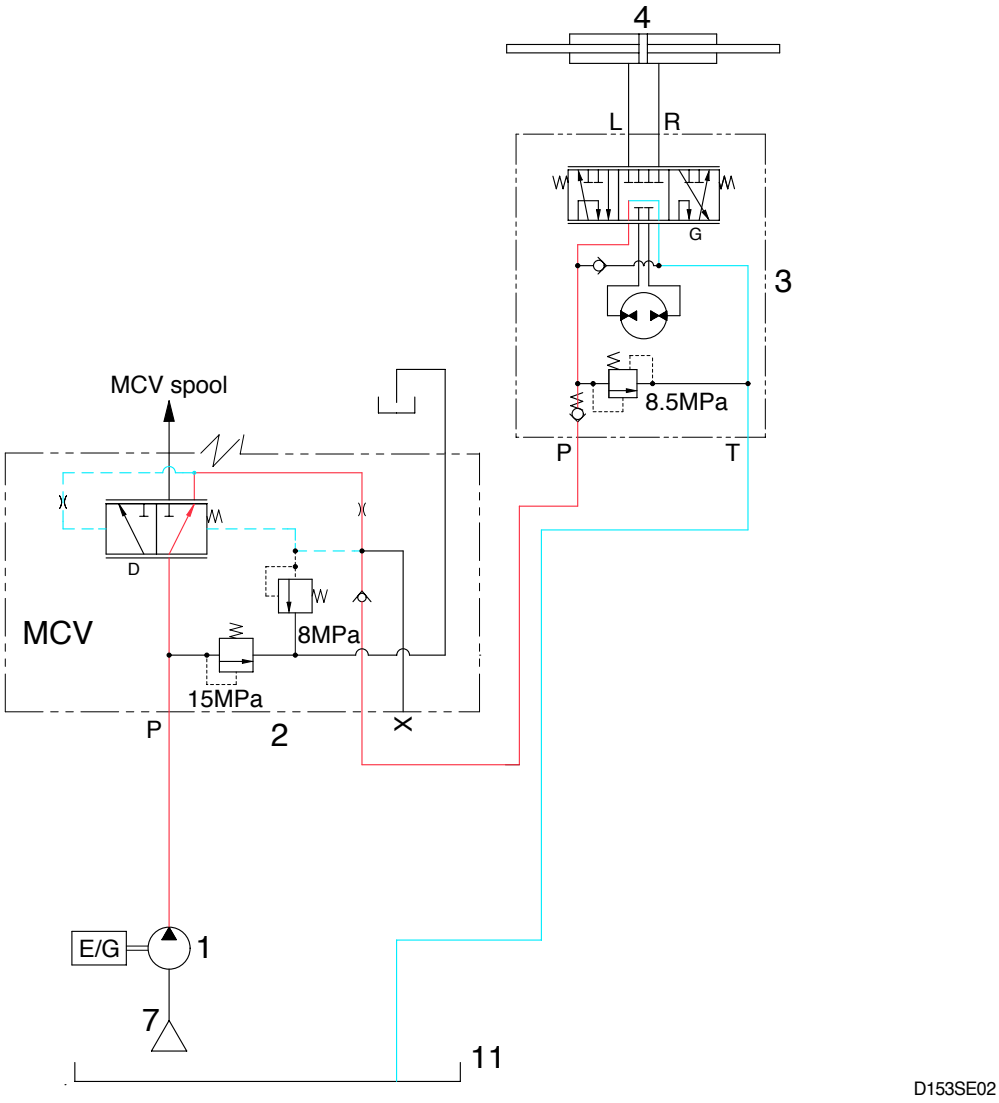
2. HYDRAULIC CIRCUIT



D153SE01

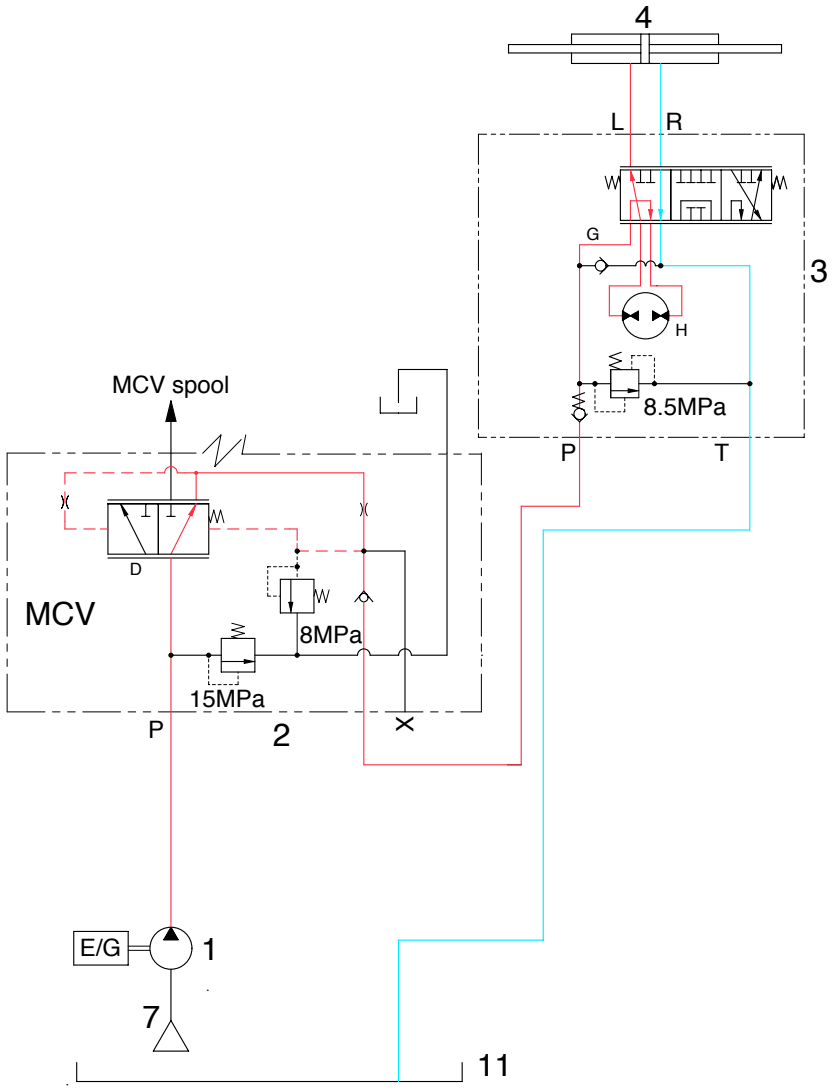
1	Hydraulic gear pump	4	Steering cylinder
2	MCV (Priority valve)	7	Suction filter
3	Steering unit	11	Hydraulic tank

1) NEUTRAL



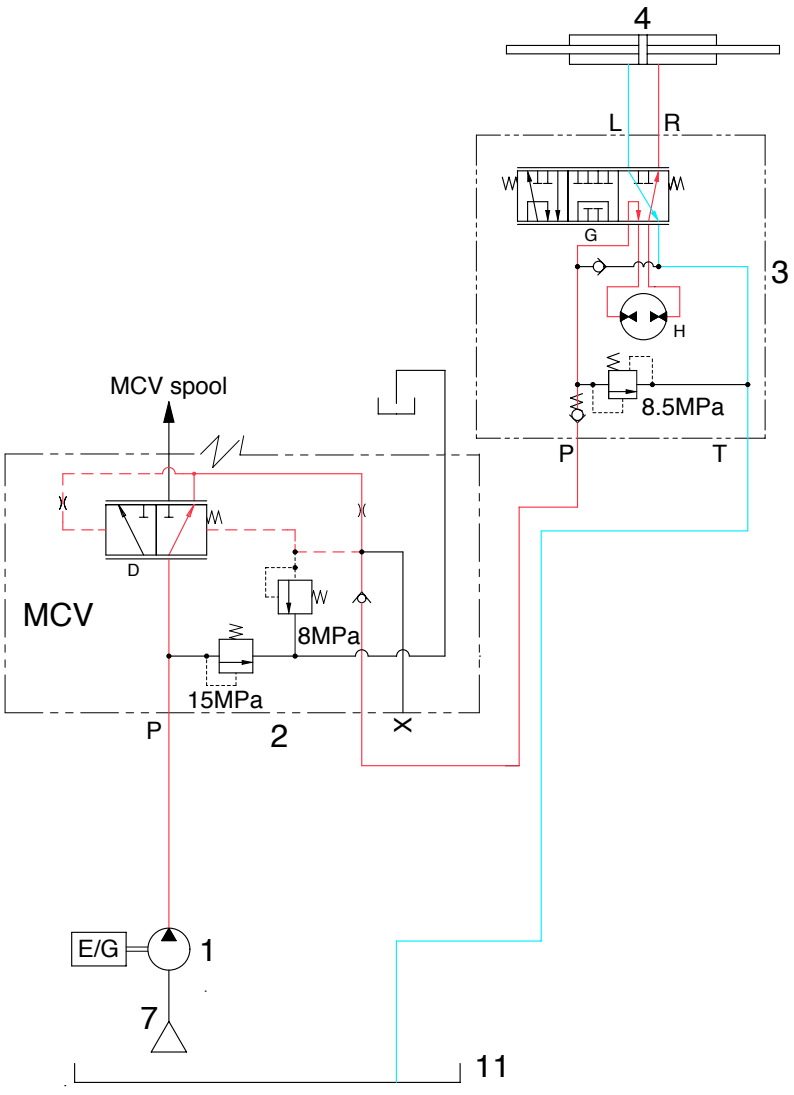
The steering wheel is not being operated so control spool(G) does not move.
The oil from hydraulic gear pump(1) enters port P of MCV(Priority valve) and the inlet pressure oil moves the spool(D) to the left.
Oil flow into LS port to the hydraulic tank(11).
So, the pump flow is routed to the main control valve.

2) LEFT TURN



When the steering wheel is turned to the left, the spool(G) within the steering unit(3) connected with steering column turns in left hand direction.
At this time, the oil discharged from the pump flows into the spool(G) within the steering unit through the spool(D) of priority valve and flows to the gerotor(H).
Oil flow from the gerotor(H) flows back into the spool(G) where it is directed out of the left work port(L).
Oil returned from cylinder returns to hydraulic tank(11).
When the above operation is completed, the machine turns to the left.

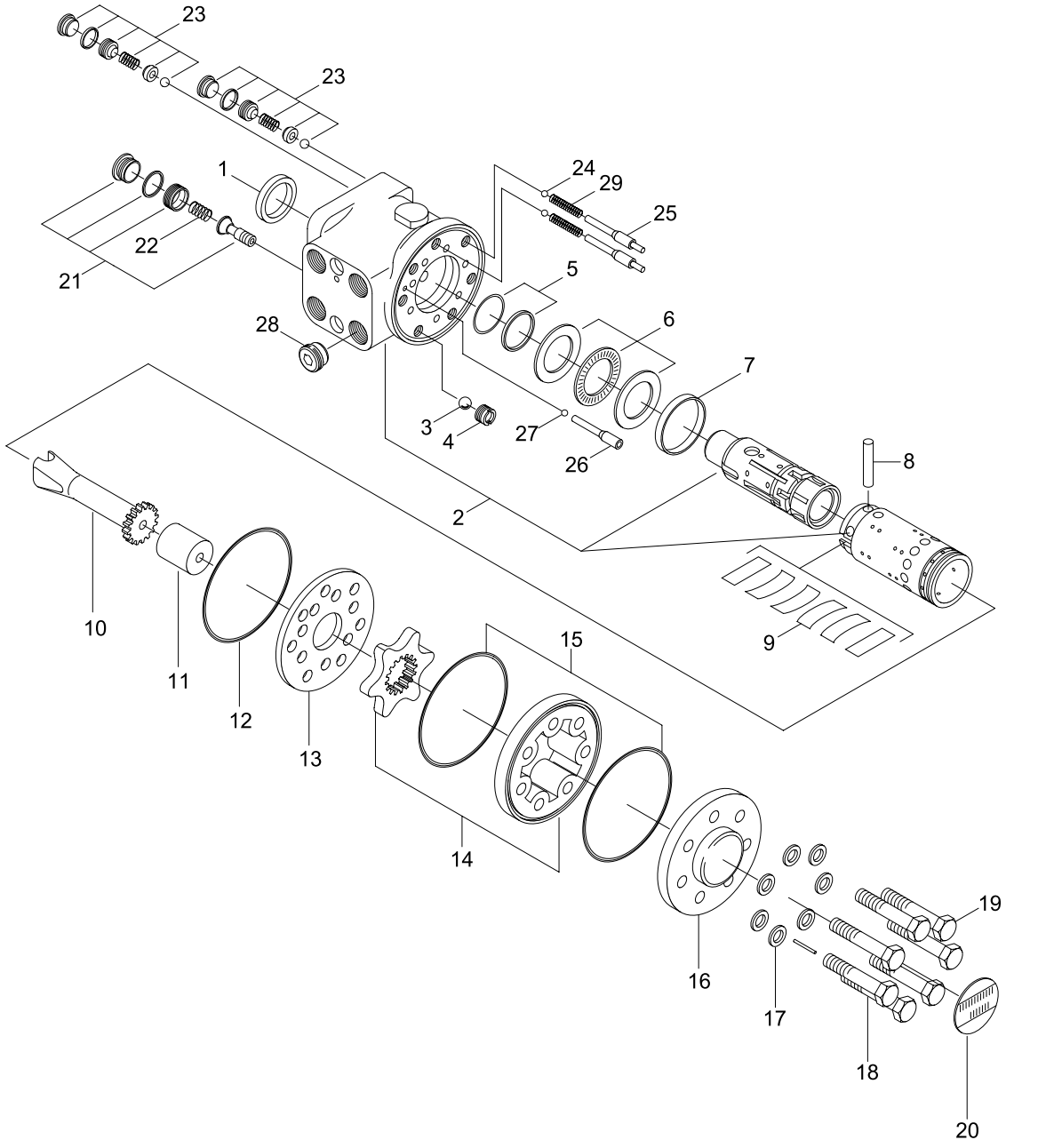
3) RIGHT TURN



When the steering wheel is turned to the right, the spool(G) within the steering unit(3) connected with steering column turns in right hand direction.
At this time, the oil discharged from the pump flows into the spool(G) within the steering unit through the spool(D) of priority valve and flows to the gerotor(H).
Oil flow from the gerotor(H) flows back into the spool(G) where it is directed out of the right work port(R).
Oil returned from cylinder returns to hydraulic tank(11).
When the above operation is completed, the machine turns to the right.

3. STEERING UNIT

1) STRUCTURE



D153SE05

1	Dust seal	11	Spacer	21	Relief valve assembly
2	Housing assembly	12	O-ring	22	Spring
3	Ball	13	Distributor plate	23	Shock valve, Complete
4	Thread bushing	14	Gear wheel set	24	Ball
5	O-ring	15	O-ring	25	Suction valve pin
6	Bearing assembly	16	End cover	26	Screw
7	Ring	17	Washer	27	Ball
8	Cross pin	18	Special screw	28	Check valve
9	Spring set	19	Screw	29	Suction valve spring
10	Cardan shaft	20	Name plate		

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.

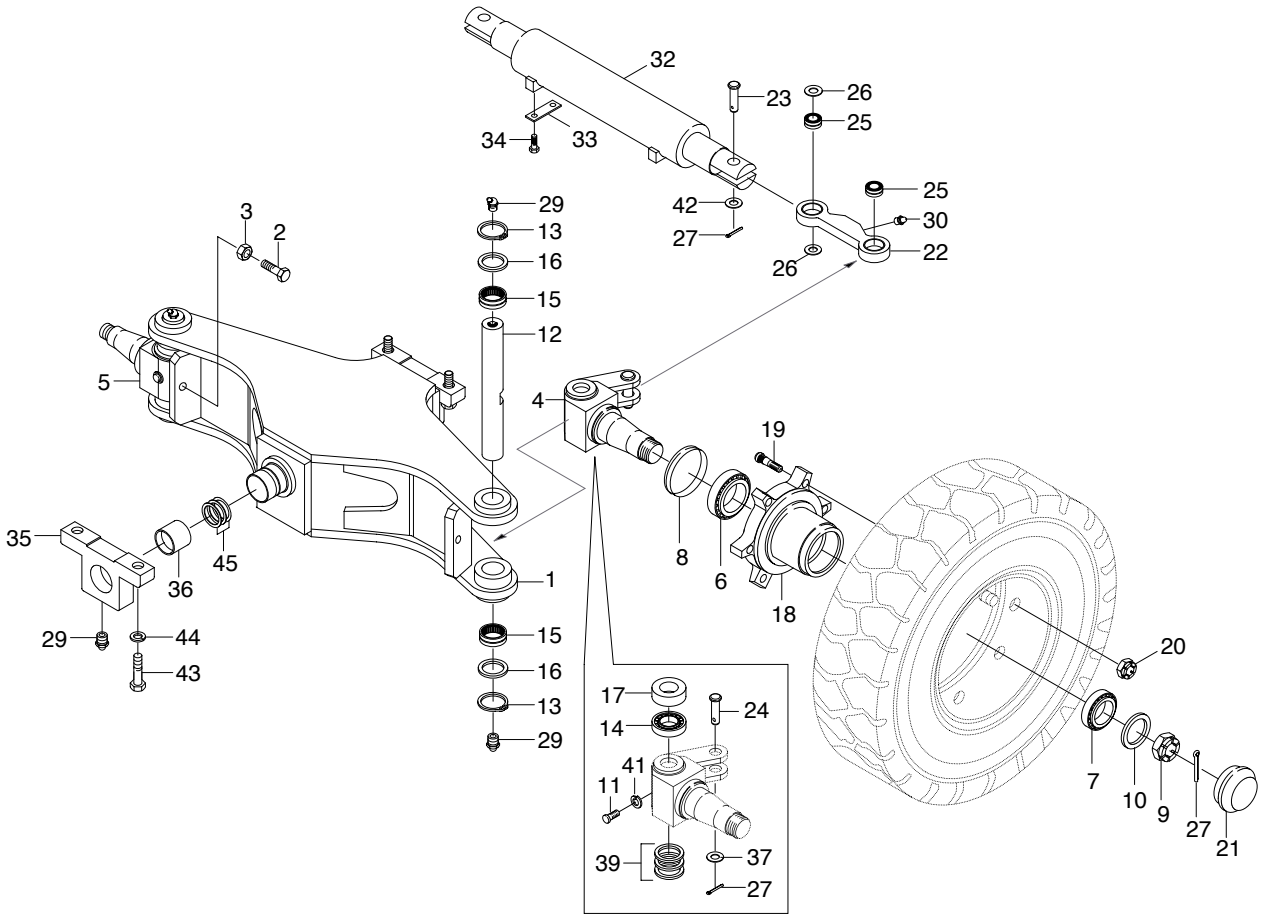
When the steering wheel is turned, the spool turns, the oil path is switched and the oil is fed into the metering device. As a result, the rotor is caused to run by oil pressure, and the sleeve is caused to run through the drive shaft and cross pin. Therefore, when the spool is turned, the spool turns 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. TRAIL AXLE

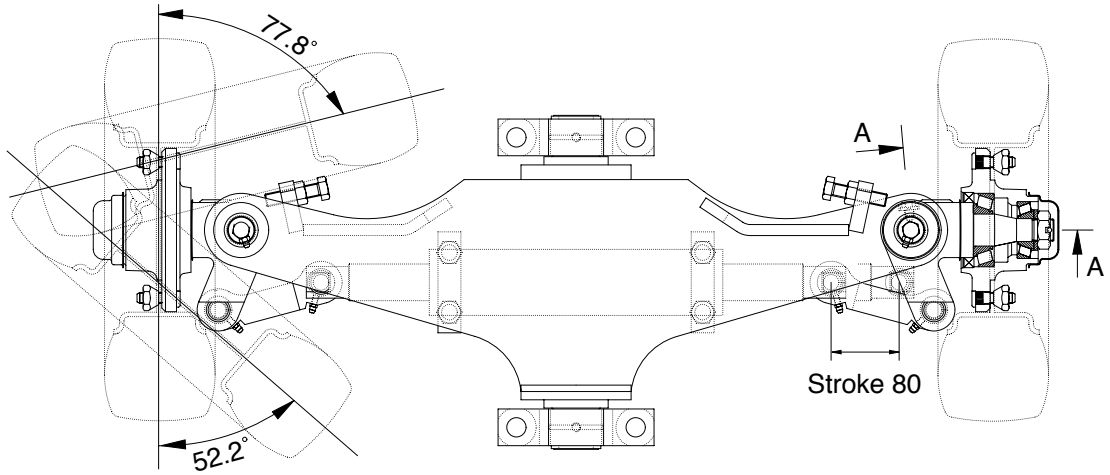
1) STRUCTURE

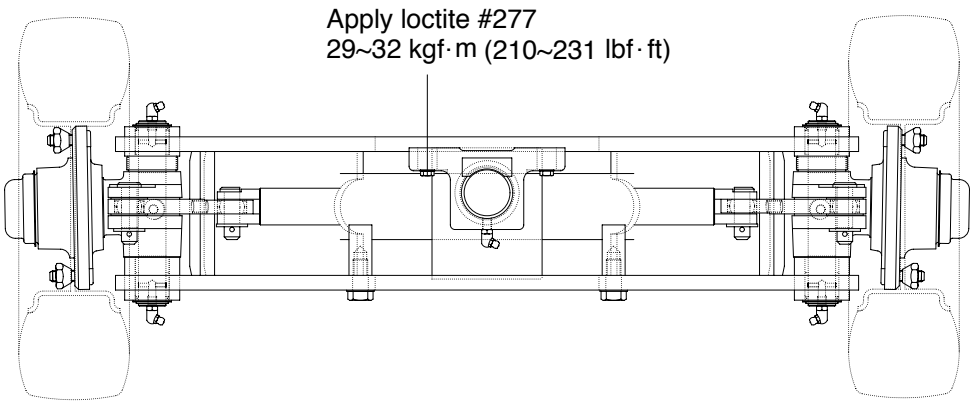


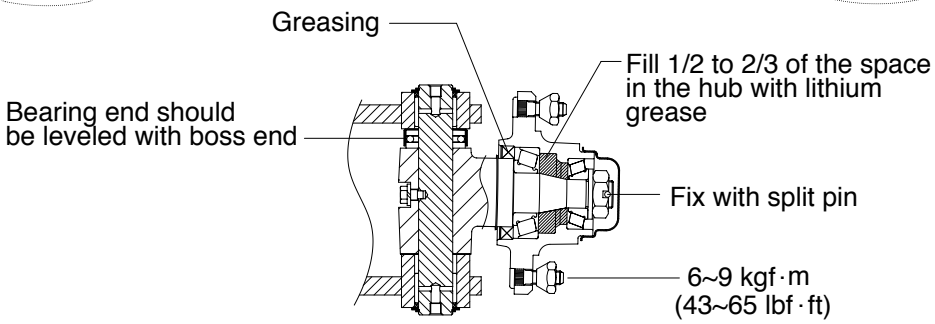
D153SE22

1	Steering axle	15	Needle bearing	29	Grease nipple
2	Bolt	16	Oil seal	30	Grease nipple
3	Nut	17	Thrust cap bearing	32	Steering cylinder
4	Knuckle-LH	18	Hub wheel	33	Lock plate
5	Knuckle-RH	19	Hub bolt	34	Bolt
6	Taper roller bearing	20	Hub nut	35	Trunnion block
7	Taper roller bearing	21	Wheel cap	36	Bushing
8	Oil seal	22	Link	39	Shim(0.13t)
9	Low castle nut	23	Clevice pin	41	Spring washer
10	Plain washer	24	Clevice pin	42	Plain washer
11	Special bolt	25	Bearing	43	Bolt
12	King pin	26	Thrust washer	44	Spring washer
13	Retaining ring	27	Split pin	45	Washer
14	Thrust bearing	28	King pin washer		

2) TIGHTENING TORQUE AND SPECIFICATION







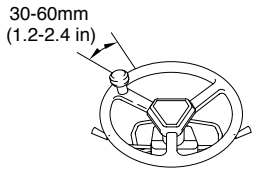
SECTION A-A

D153SE08

Type	Unit	Center pin support single shaft
Structure of knuckle	-	Elliott type
Toe-in	degree	0
Camber	degree	1
Caster	degree	0
King pin angle	degree	0
Max steering angle of wheels(Inside/Outside)	degree	77.8 / 52.2
Tread	mm(in)	905(35.6)

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

1. OPERATIONAL CHECKS

<table>
<tr><th>Check item</th><th>Checking procedure</th></tr>
<tr><td>Steering wheel
 
</td><td>· 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 30~60㎜ at rim of steering wheel. If play is too large, adjust at gear box.
Test steering wheel play with engine at idling.</td></tr>
<tr><td>Knuckle</td><td>· Check knuckle visually or use crack detection method. If the knuckle is bent, the tire wear is uneven, so check tire wear.</td></tr>
<tr><td>Steering axle</td><td>· Put camber gauge in contact with hub and measure camber. If camber is not within 1±0.5 °; rear axle is bent.
· Ask assistant to drive machine at minimum turning radius.
· Fit bar and a piece of chalk at outside edge of counterweight to mark line of turning radius.
· If minimum turning radius is not within±100㎜ (±4in)of specified value, adjust turning angle stopper bolt.
Min turning radius(Outside)
<table>
<tr><td>HDF 15III</td><td>1765mm</td></tr>
<tr><td>HDF 18III</td><td>1765mm</td></tr>
</table></td></tr>
<tr><td>Hydraulic pressure of power steering</td><td>Remove plug from outlet port of flow divider and install oil pressure gauge.
Turn steering wheel fully and check oil pressure.
※ Oil pressure : 82kgf/㎠ (80bar)</td></tr>
</table>

2. TROUBLESHOOTING

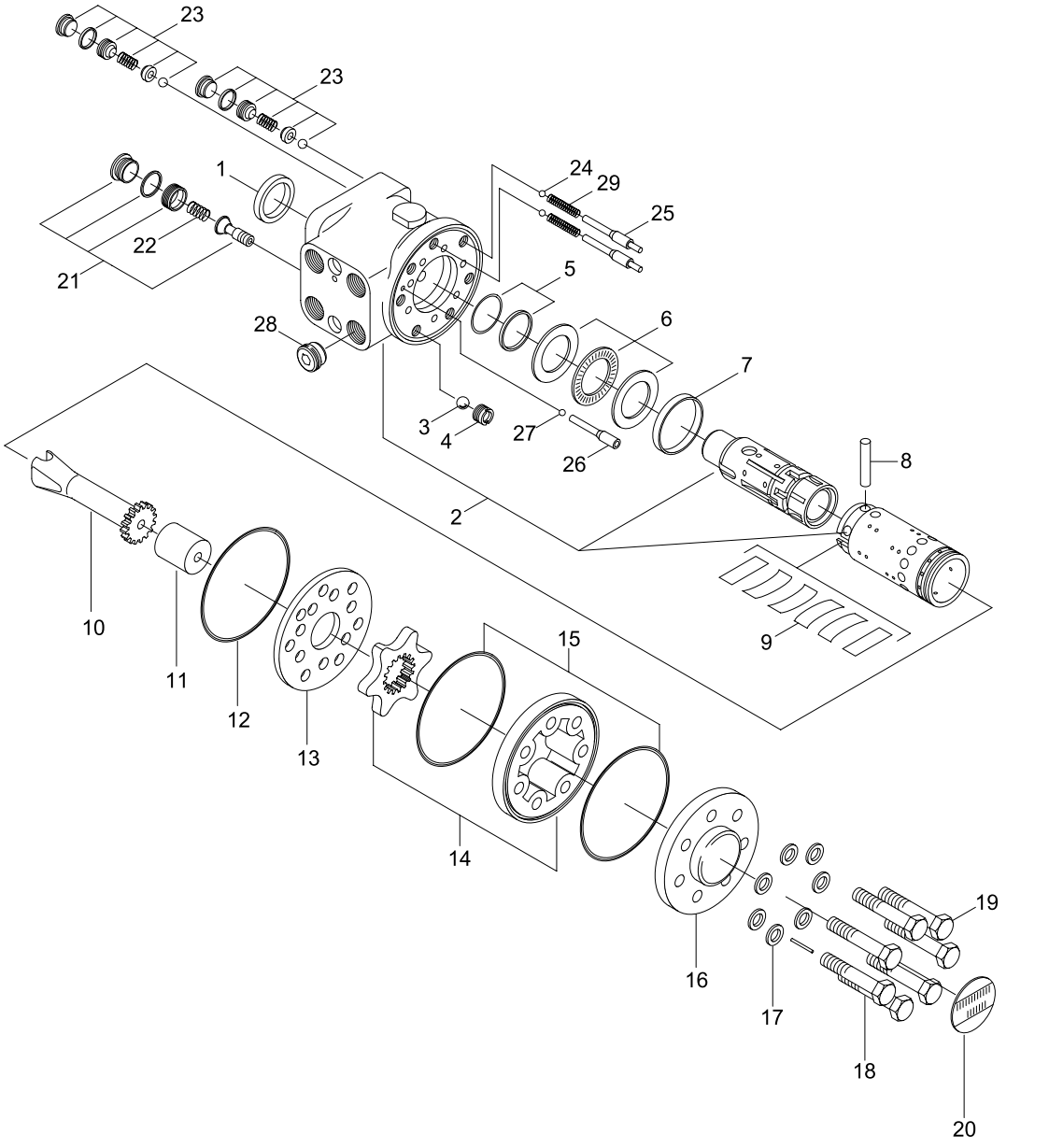
Problem	Cause	Remedy
Steering wheel drags.	· Low oil pressure. · Bearing faulty. · Spring spool faulty. · Reaction plunger faulty. · Ball-and-screw assembly faulty. · Sector shaft adjusting screw excessively tight. · Gears poorly meshing. · Flow divider coil spring fatigued.	· Check lockout. Repair.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

Problem	Cause	Remedy
Steering wheel turns unsteadily. Steering system makes abnormal sound or vibration.	· Lockout loosening. · Metal spring deteriorated. · Gear backlash out of adjustment. · Lockout loosening. · Air in oil circuit.	· Retighten. · Replace. · Adjust. · Retighten. · Bleed air.
Abnormal sound heard when steering wheel is turned fully	Valve · Faulty. (Valve fails to open.) Piping · Pipe(from pump to power steering cylinder) dented or clogged.	· Adjust valve set pressure and check for specified oil pressure. · Repair or replace.
Piping makes abnormal sounds.	Oil pump · Lack of oil. · Oil inlet pipe sucks air. · Insufficient air bleeding.	· Add oil. · Repair. · Bleed air completely.
Valve or valve unit makes abnormal sounds.	Oil pump · Oil inlet pipe sucks air. Valve · Faulty. (Unbalance oil pressure) Piping · Pipe(from pump to power steering) dented or clogged. · Insufficient air bleeding.	· Repair or replace. · Adjust valve set pressure and check specified oil pressure. · Repair or replace. · Bleed air completely.
Insufficient or variable oil flow.	· Flow control valve orifice clogged.	· Clean
Insufficient or variable discharge pressure.	Piping · Pipe(from tank to pipe) dented or clogged.	· Repair or replace.
Steering cylinder head leakage (Piston rod)	· Packing foreign materal. · Piston rod damage. · Rod seal damage and distortion. · Chrome gilding damage.	· Replace · Grind surface with oil stone. · Replace · Grind
Steering cylinder head thread (A little bit leak is no problem)	· O-ring damage.	· Replace
Welding leakage	· Cylinder tube damage.	· Tube replace.
Rod	· Tube inside damage. · Piston seal damage and distortion	· Grind surface with oil store. · Replace
Piston rod bushing inner diameter excessive gap	· Bushing wear.	· Replace

GROUP 3 DISASSEMBLY AND ASSEMBLY

1. STEERING UNIT

1) STRUCTURE

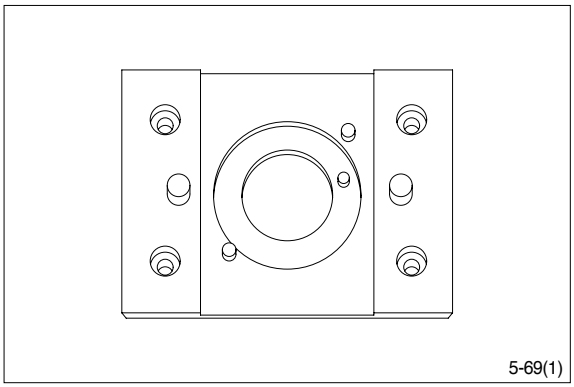


D153SE05

1	Dust seal	11	Spacer	21	Relief valve assembly
2	Housing assembly	12	O-ring	22	Spring
3	Ball	13	Distributor plate	23	Shock valve, Complete
4	Thread bushing	14	Gear wheel set	24	Ball
5	O-ring	15	O-ring	25	Suction valve pin
6	Bearing assembly	16	End cover	26	Screw
7	Ring	17	Washer	27	Ball
8	Cross pin	18	Special screw	28	Check valve
9	Spring set	19	Screw	29	Suction valve spring
10	Cardan shaft	20	Name plate		

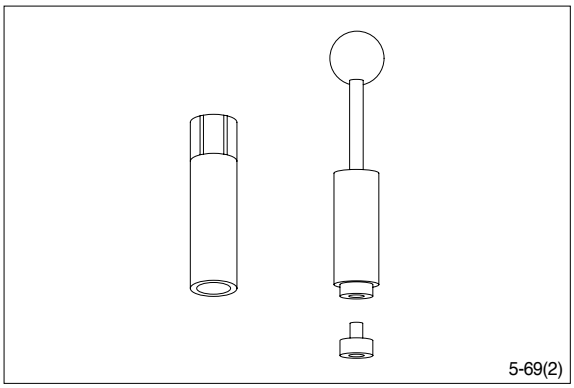
2) TOOLS

(1) Holding tool.



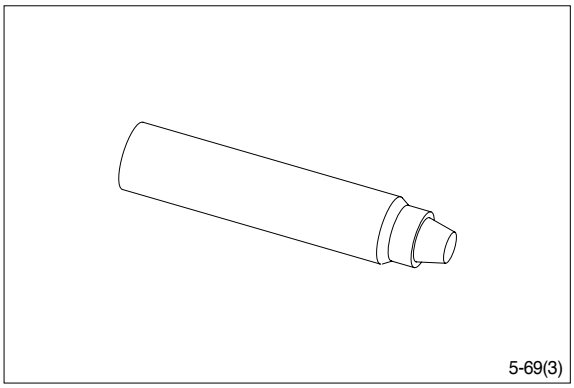
5-69(1)

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



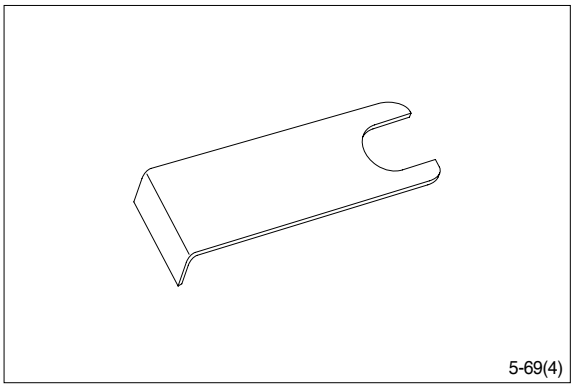
5-69(2)

(3) Assembly tool for lip seal.



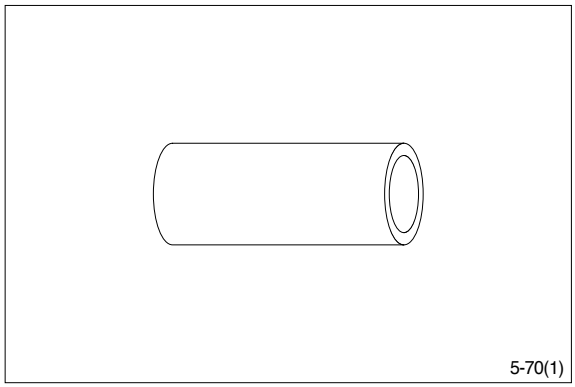
5-69(3)

(4) Assembly tool for cardan shaft.

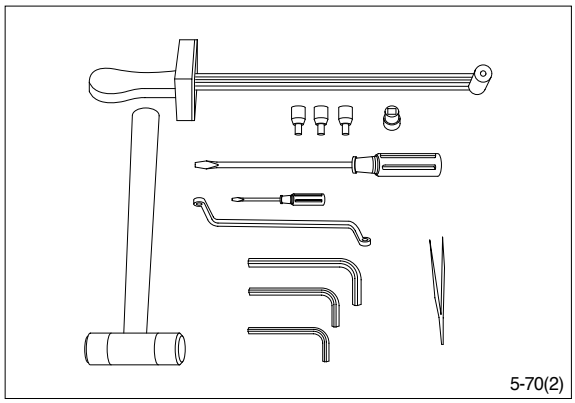


5-69(4)

(5) Assembly tool for dust seal.

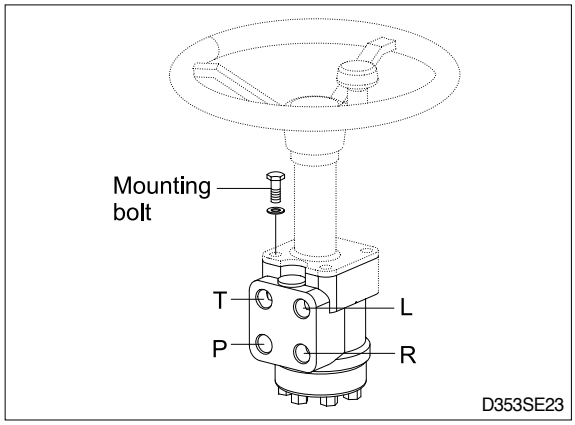


(6) Torque wrench 0~7.1kgf · m
(0~54.4lbf · ft)
13mm socket spanner
6, 8mm and 12mm hexagon sockets
12mm screwdriver
2mm screwdriver
13mm ring spanner
6, 8 and 12mm hexagon socket spanners
Plastic hammer
Tweezers



3) TIGHTENING TORQUE

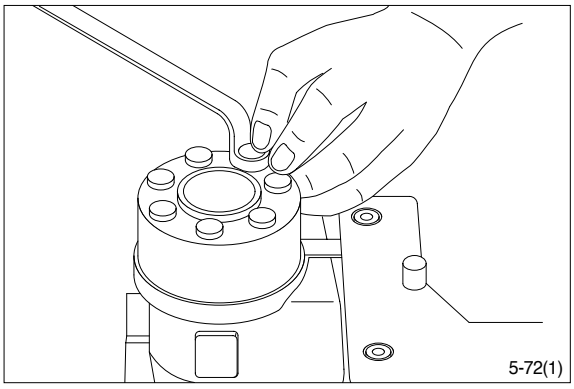
L : Left port
R : Right port
T : Tank
P : Pump



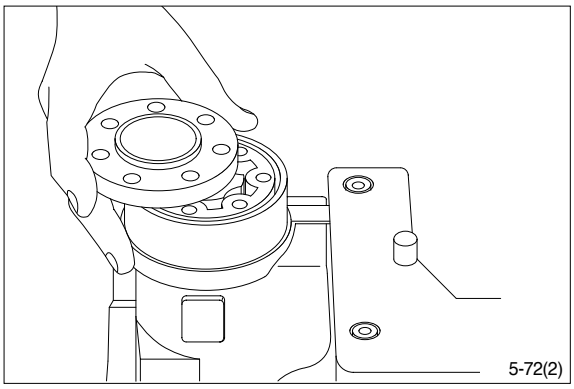
Port	Size	Torque [kgf · m(lbf · ft)]
L	3/4 UNF - 16	13 (94)
R	3/4 UNF - 16	13 (94)
T	3/4 UNF - 16	13 (94)
P	3/4 UNF - 16	13 (94)
Mounting bolt	M10×1.5	5.0 ±1.0 (36±7.2)

4) DISASSEMBLY

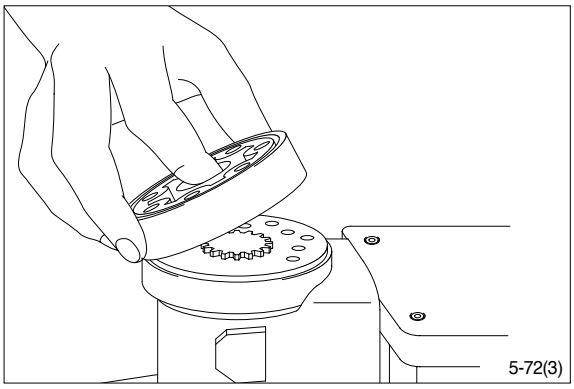
(1) Disassemble steering column from steering unit and place the steering unit in the holding tool.
Screw out the screws in the end cover(6-off plus one special screw).


5-72(1)

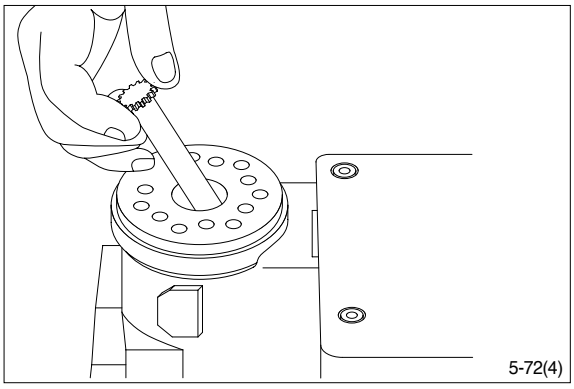
(2) Remove the end cover, sideways.


5-72(2)

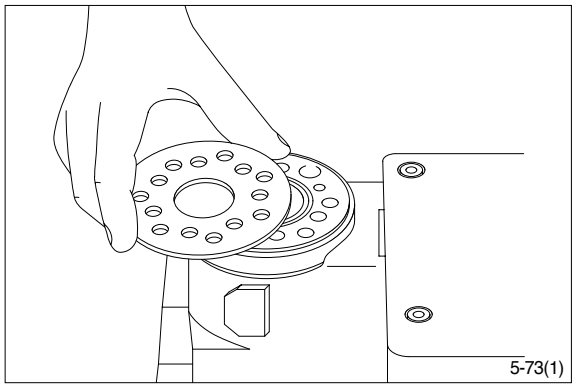
(3) Lift the gearwheel set(With spacer if fitted) off the unit.
Take out the two O-rings.


5-72(3)

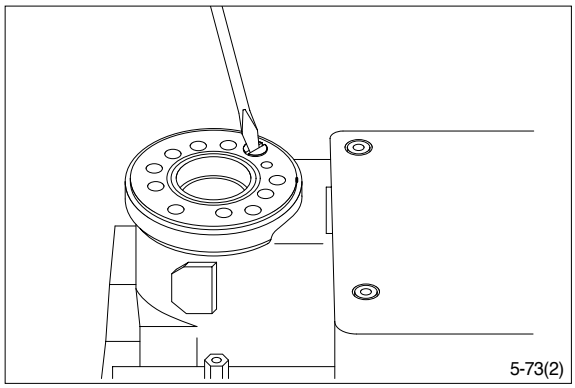
(4) Remove cardan shaft.


5-72(4)

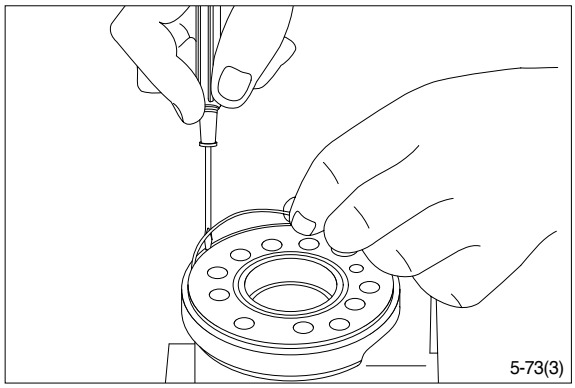
(5) Remove distributor plate.


5-73(1)

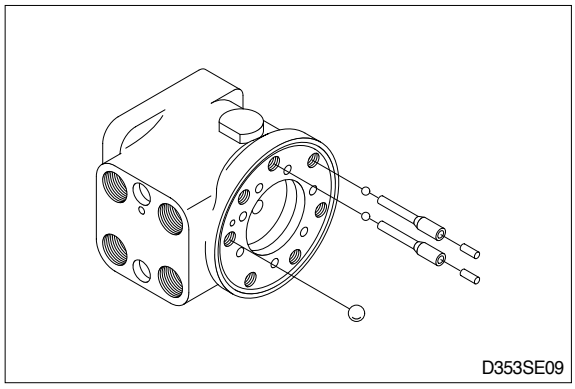
(6) Screw out the threaded bush over the check valve.


5-73(2)

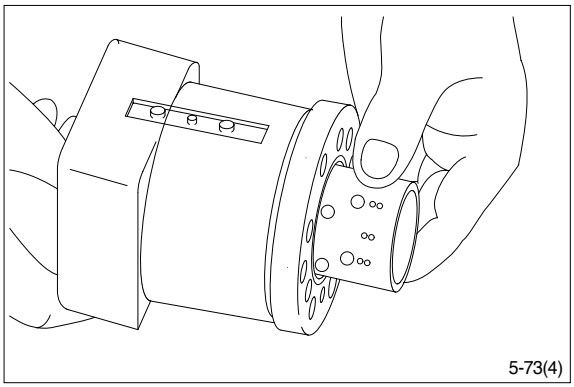
(7) Remove O-ring.


5-73(3)

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

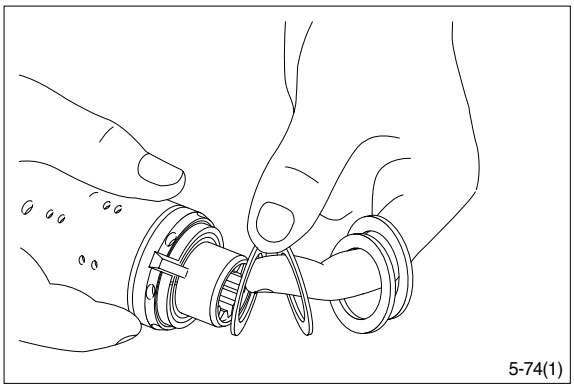

D353SE09

(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.



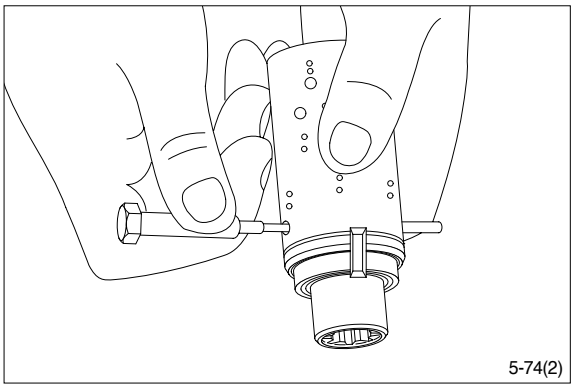
5-73(4)

(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.



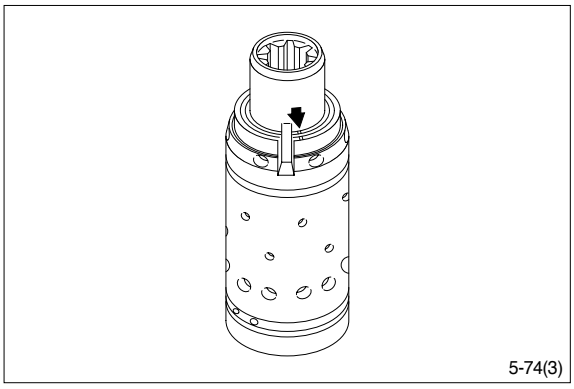
5-74(1)

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



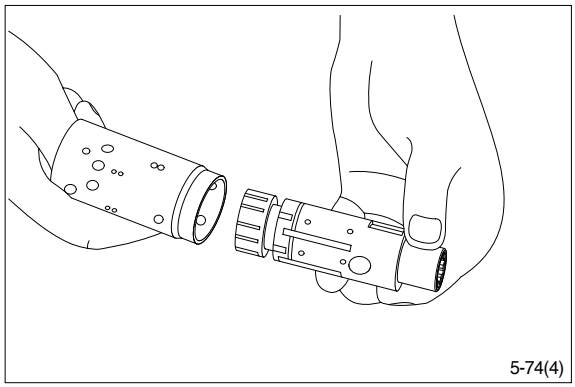
5-74(2)

※ A small mark has been made with a pumice stone on both spool and sleeve close to one of the slots for the neutral position springs(See drawing).
If the mark is not visible, remember to leave a mark of your own on sleeve and spool before the neutral position springs are disassembled.

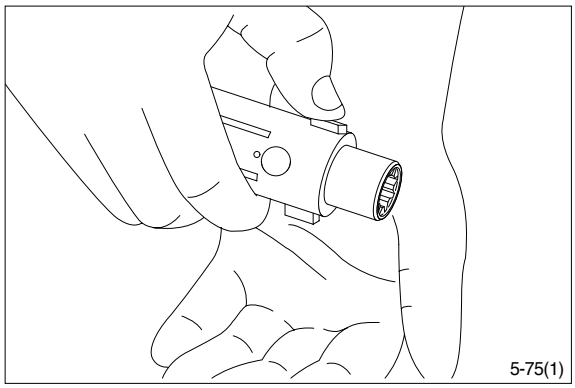


5-74(3)

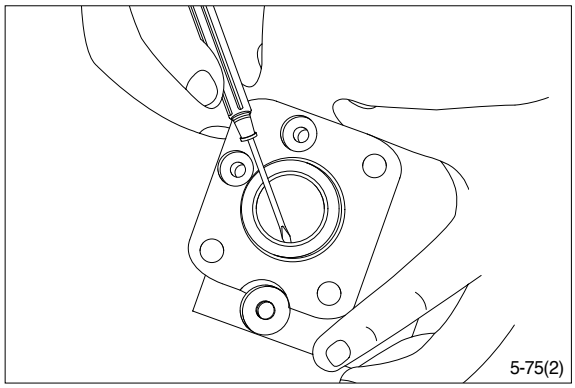
(12) Carefully press the spool out of the sleeve.



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

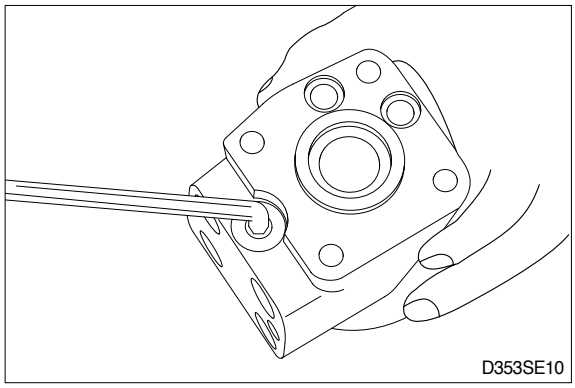


(14) Remove dust seal and O-ring.

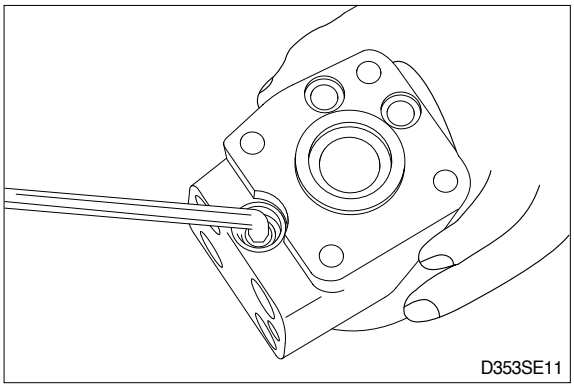


Disassembling the pressure relief valve

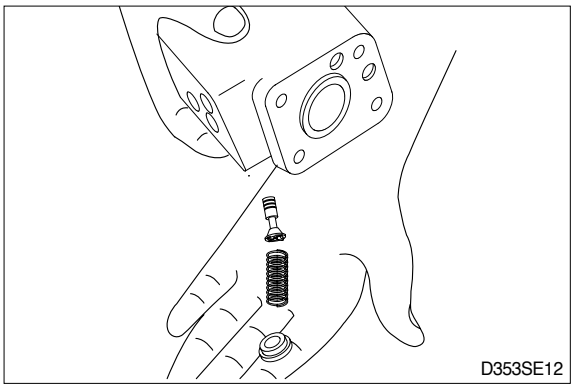
(15) Screw out the plug using an 8㎜ hexagon socket spanner.
Remove seal washers.



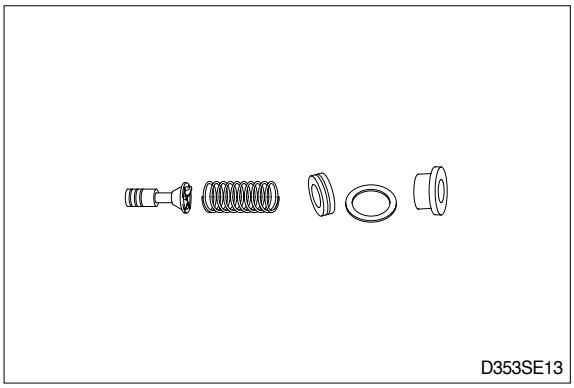
(16) Unscrew the setting screw using an 8mm hexagon socket spanner.



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



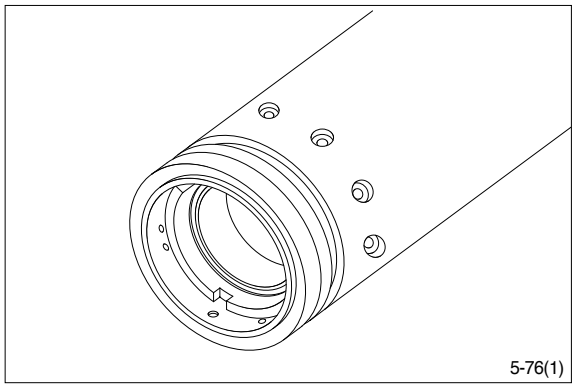
(18) The pressure relief valve is now disassembled.



5) ASSEMBLY

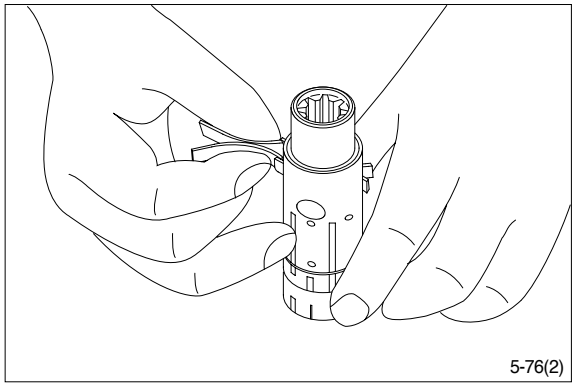
(1) Assemble spool and sleeve.

※ 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.



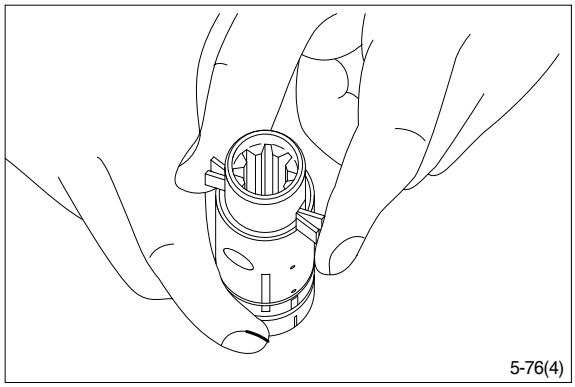
5-76(1)

(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).



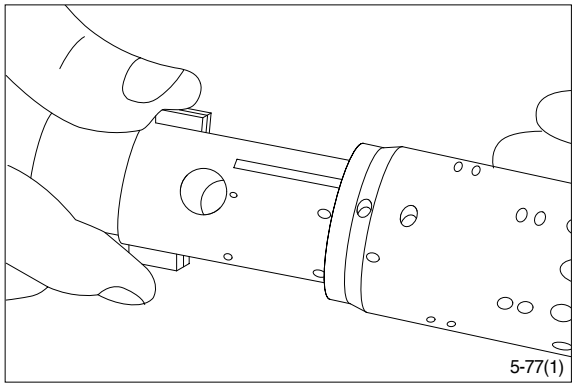
5-76(2)

(3) Line up the spring set.



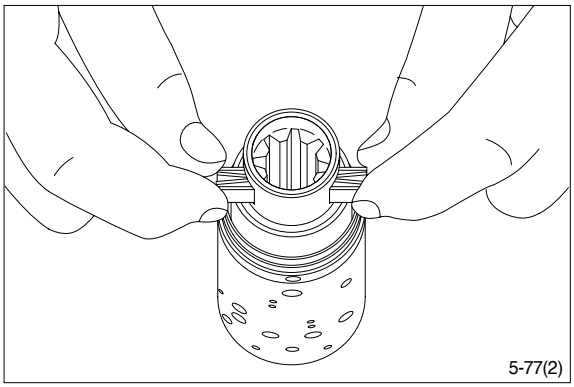
5-76(4)

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

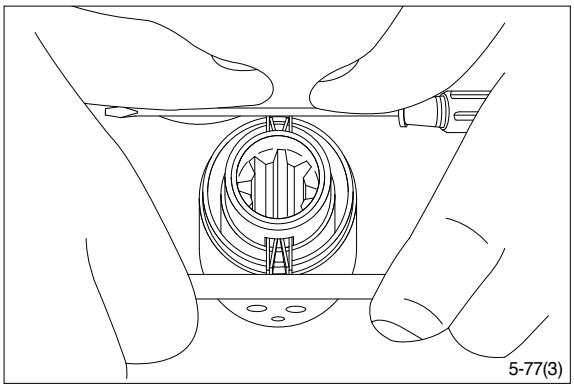


5-77(1)

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

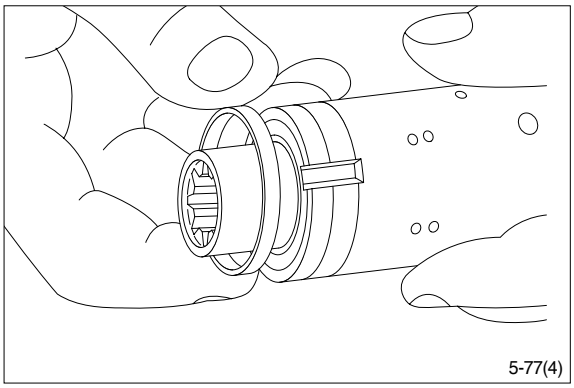

5-77(2)

(6) Line up the springs and center them.

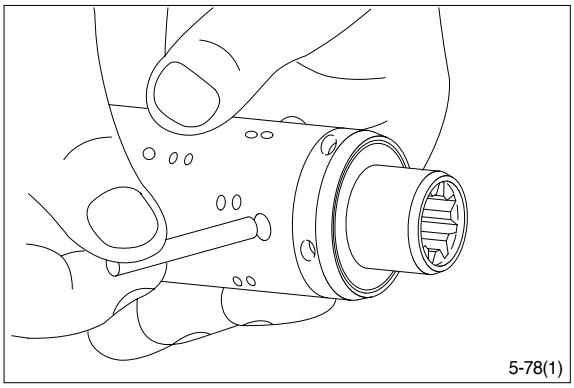

5-77(3)

(7) Guide the ring down over the sleeve.

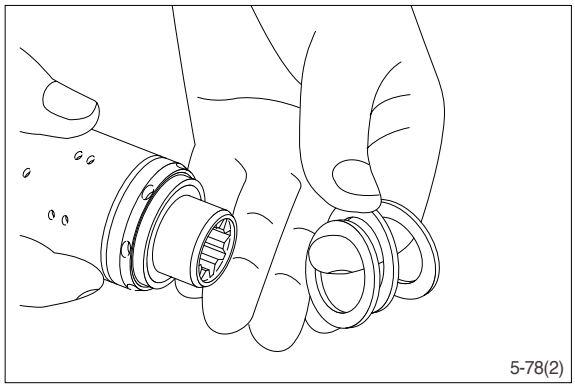
※ The ring should be able to rotate free of the springs.


5-77(4)

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

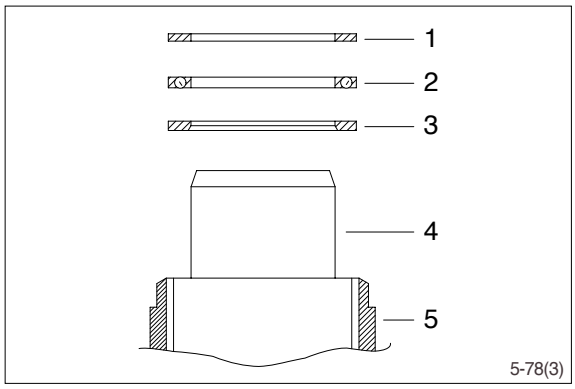

5-78(1)

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


5-78(2)

※ **Assembly pattern for standard bearings**

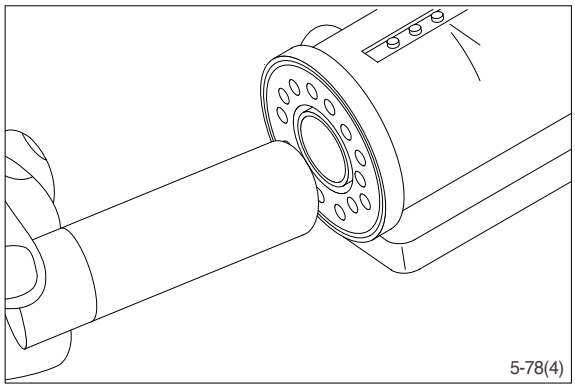
1 Outer bearing race
2 Thrust bearing
3 Inner bearing race
4 Spool
5 Sleeve



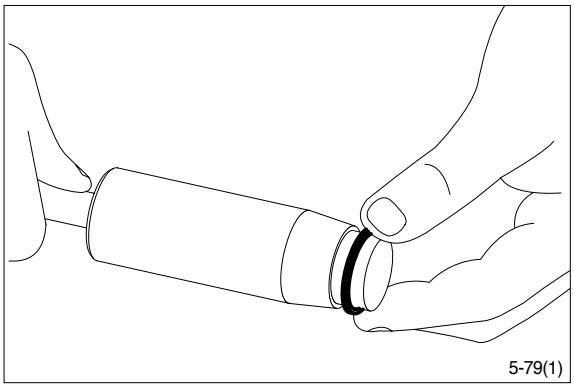
5-78(3)

Installation instruction for O-ring

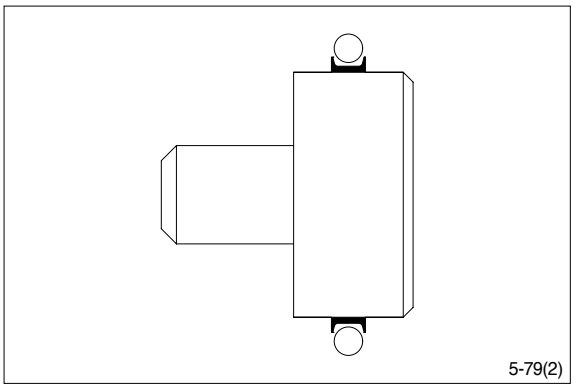
(10) Turn the steering unit until the bore is horizontal. Guide the outer part of the assembly tool into the bore for the spool / sleeve.


5-78(4)

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

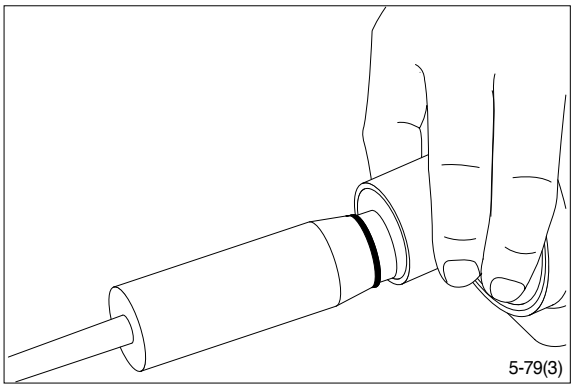


5-79(1)



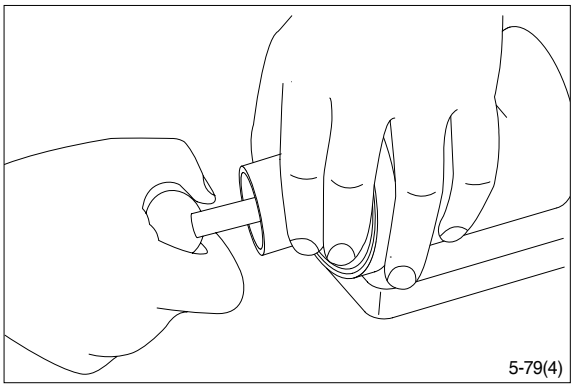
5-79(2)

(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.



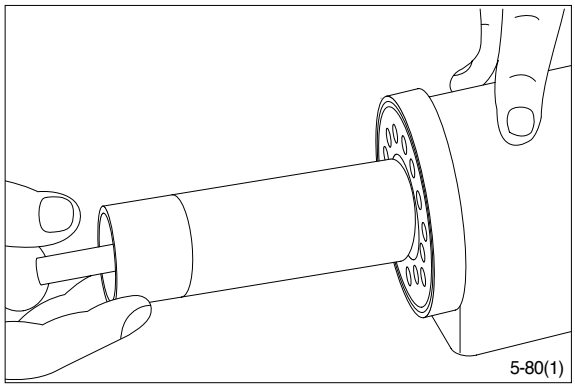
5-79(3)

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



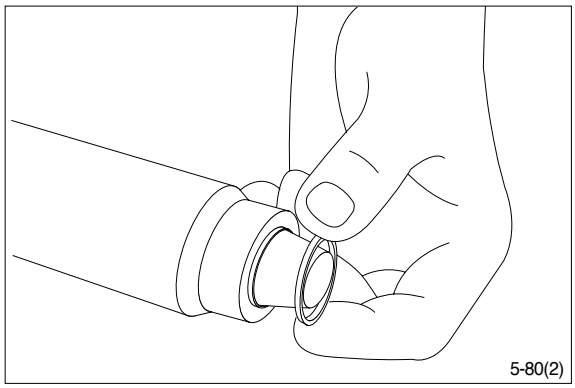
5-79(4)

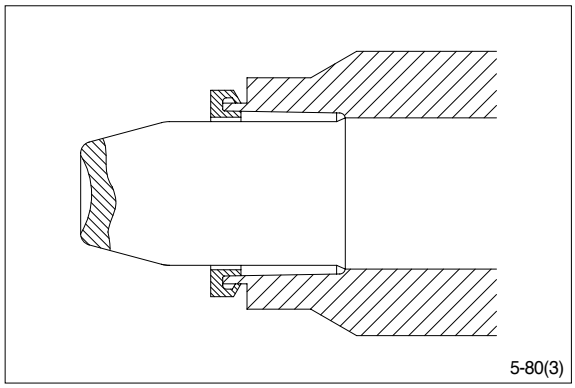
(14) Draw the inner and outer parts of the assembly tool out of the steering unit bore, leaving the guide from the inner part in the bore.


5-80(1)

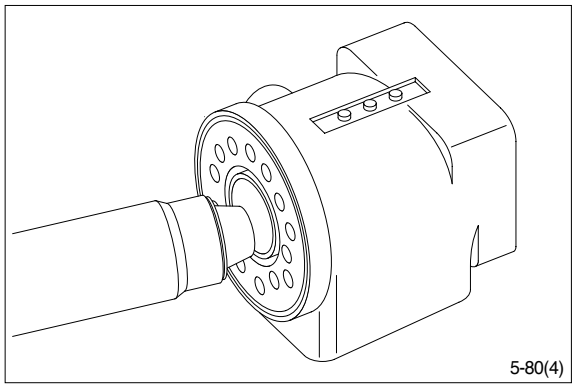
Installation instructions for lip seal

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

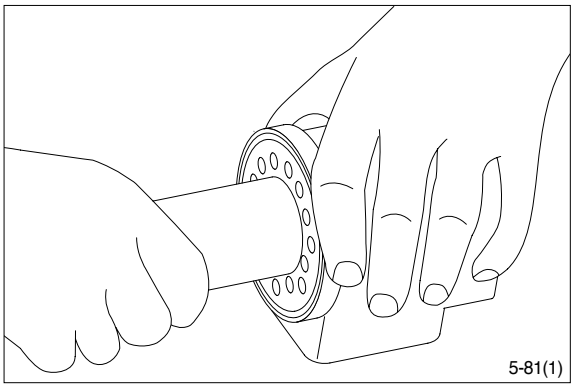

5-80(2)


5-80(3)

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

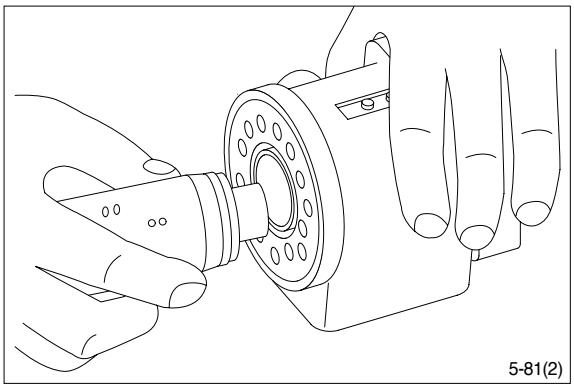

5-80(4)

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

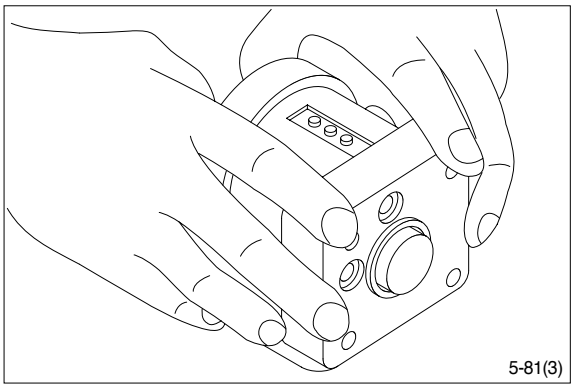

5-81(1)

(18) With a light turning movement, guide the spool and sleeve into the bore.

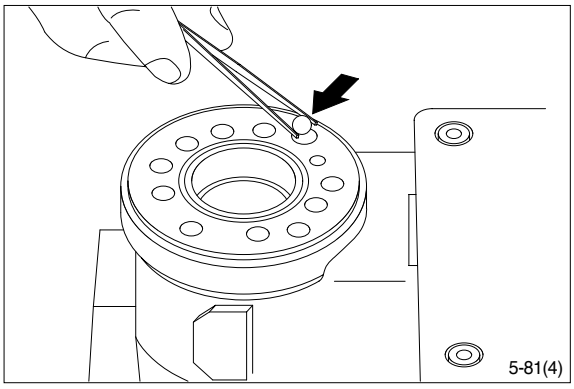
※ Fit the spool set holding the cross pin horizontal.


5-81(2)

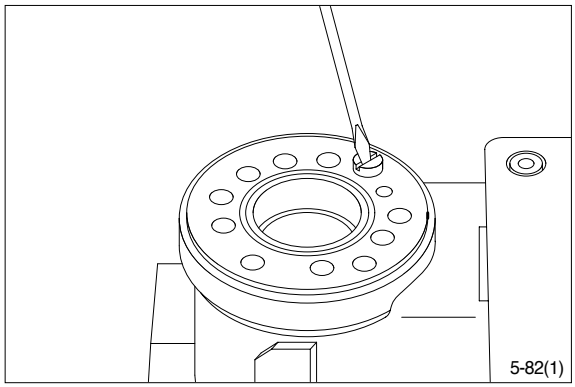
(19) The spool set will push out the assembly tool guide. The O-ring are now in position.


5-81(3)

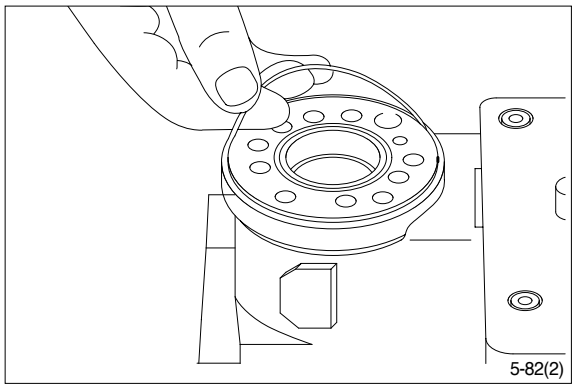
(20) Turn the steering unit until the bore is vertical again. Put the check valve ball into the hole indicated by the arrow.


5-81(4)

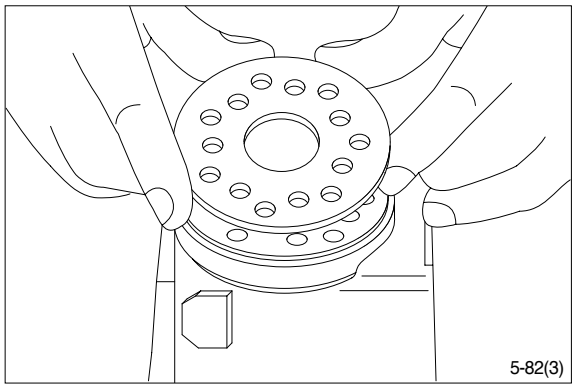
(21) Screw the threaded bush lightly into the check valve bore. The top of the bush must lie just below the surface of the housing.



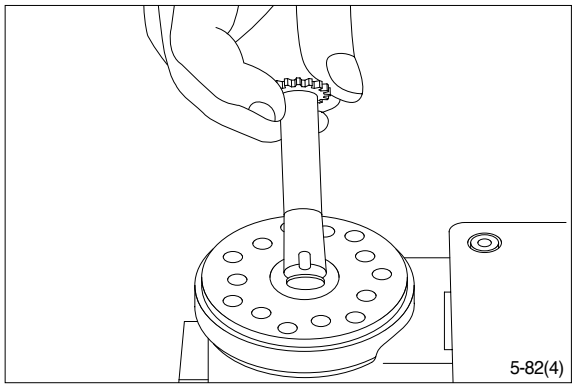
(22) Grease the O-ring with mineral oil approx. viscosity 500 cSt at 20℃.



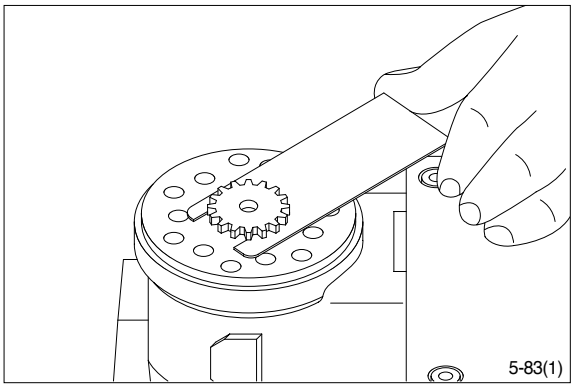
(23) Place the distributor plate so that the channel holes match the holes in the housing.



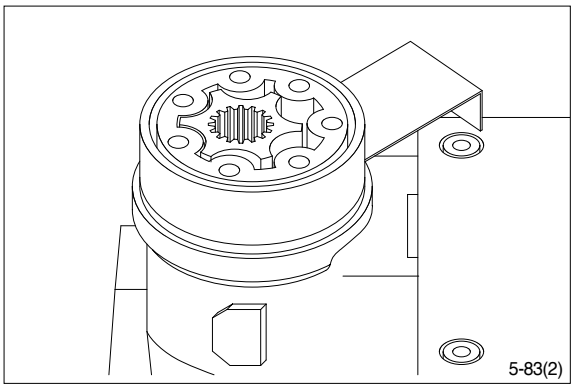
(24) Guide the cardan shaft down into the bore so that the slot is parallel with the connection flange.



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



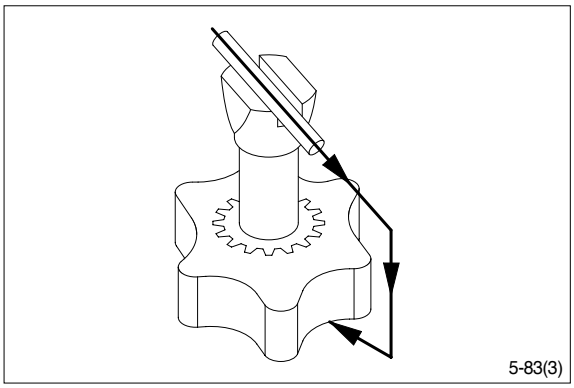
(26) Grease the two O-rings with mineral oil approx. viscosity 500 cSt at 20 ℃ and place them in the two grooves in the gear rim. Fit the gearwheel and rim on the cardan shaft.



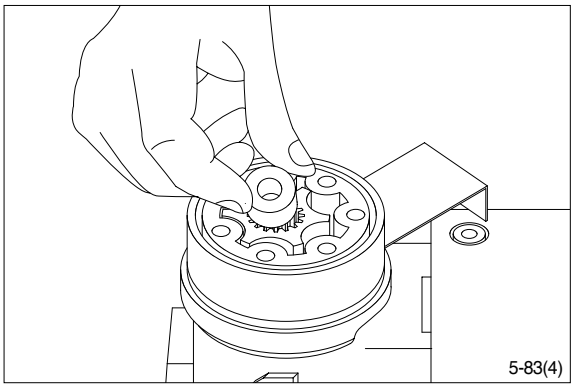
(27) Important

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.

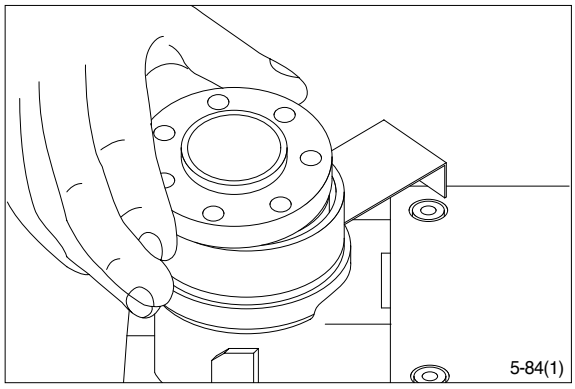
Turn the gear rim so that the seven through holes match the holes in the housing.



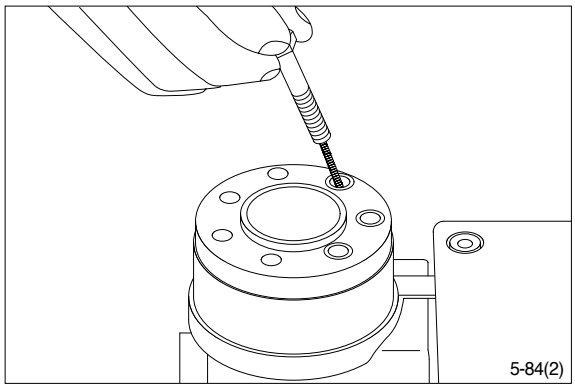
(28) Fit the spacer, if any.



(29) Place the end cover in position.

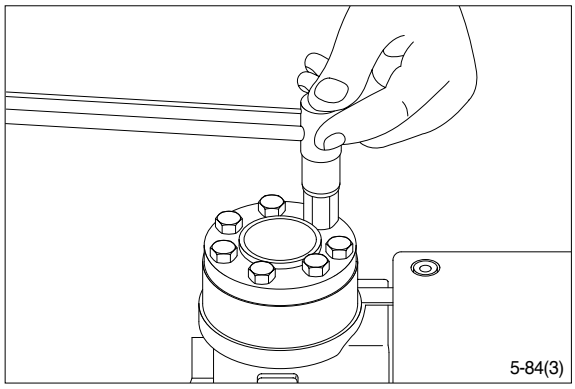

5-84(1)

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

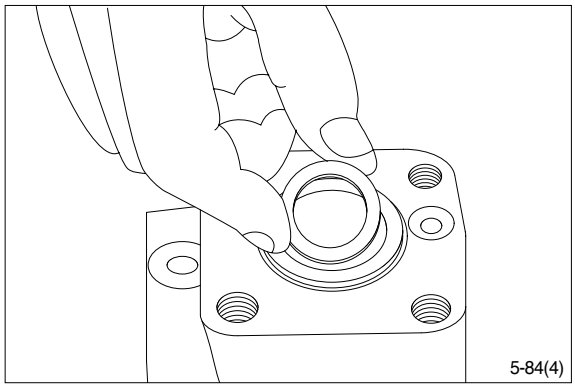

5-84(2)

(31) Fit the six screws with washers and insert them. Cross-tighten all the screws and the rolled pin.

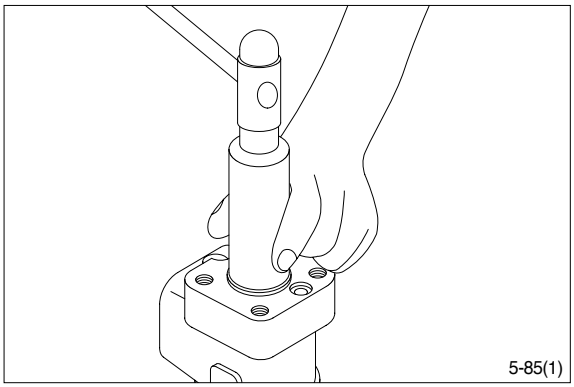
· Tightening torque : 4.0 ± 0.5kgf · m
(28.9 ± 3.6lbf · ft)


5-84(3)

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


5-84(4)

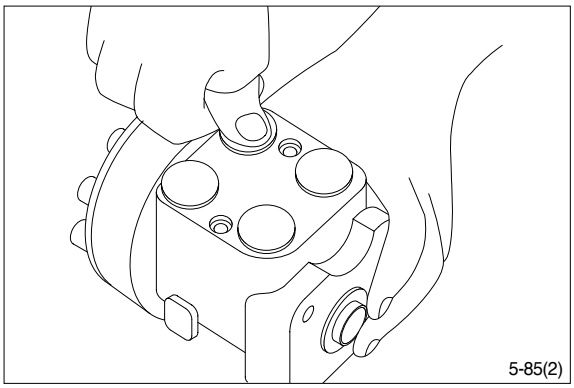
(33) Fit the dust seal ring in the housing.



5-85(1)

(34) Press the plastic plugs into the connection ports.

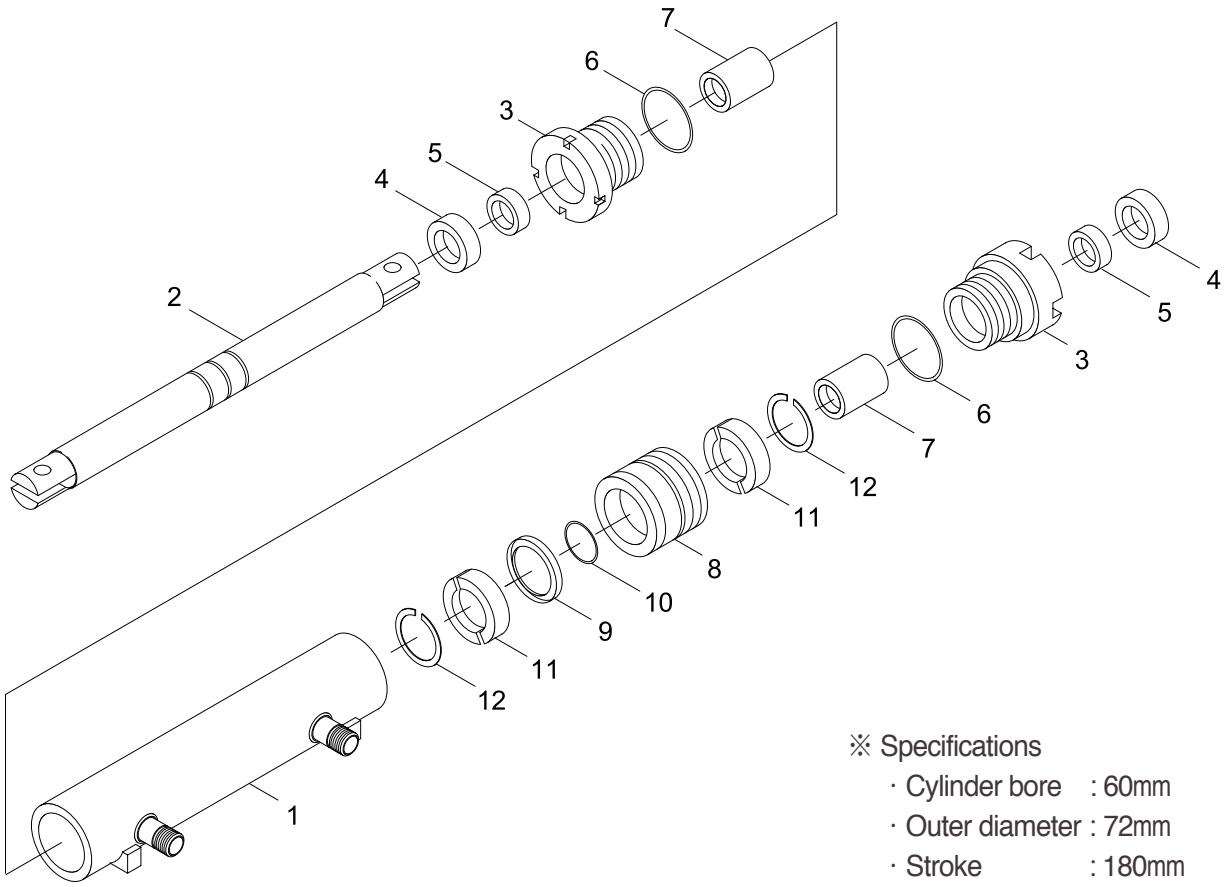
※ Do not use a hammer!



5-85(2)

2. STEERING CYLINDER

1) STRUCTURE



※ Specifications
- · Cylinder bore : 60mm
- · Outer diameter : 72mm
- · Stroke : 180mm
- · Rod diameter : 40mm

D503SE21

1	Tube assembly	5	U-packing	9	Slipper seal
2	Rod assembly	6	O-ring	10	O-ring
3	Rod cover	7	Du-bushing	11	Ring
4	Dust wiper	8	Piston	12	Retaining ring

2) DISASSEMBLY

※ Before disassembling steering cylinder, release oil in the cylinder first.

(1) Put wooden blocks against the cylinder tube, then hold in a vice.

(2) Remove the gland by hooking 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. If there are some damage, replace with new parts.

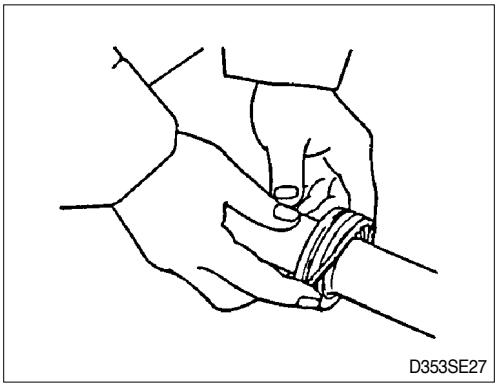
3) CHECK AND INSPECTION

mm(in)

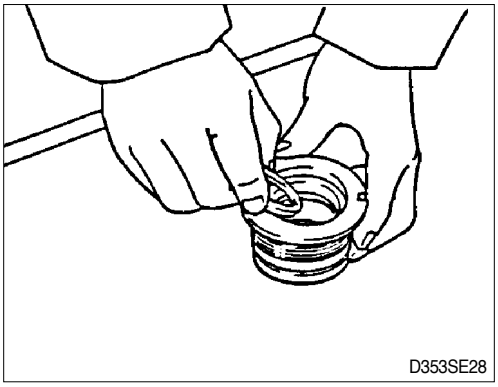
Check item	Criteria		Remedy
	Standard size	Repair limit	
Clearance between piston & cylinder tube	0.064~0.137 (0.0025~0.0054)	0.180 (0.0070)	Replace piston seal
Clearance between cylinder rod & bushing	0.024~0.112 (0.0009~0.0044)	0.120 (0.0049)	Replace bushing
Seals, O-ring	Damage		Replace
Cylinder rod	Dents		Replace
Cylinder tube	Biting		Replace

4) ASSEMBLY

(1) Install a new piston seal into the groove on the ※ piston. Be careful not to scratch the seal too much during installation or it will not seat properly.

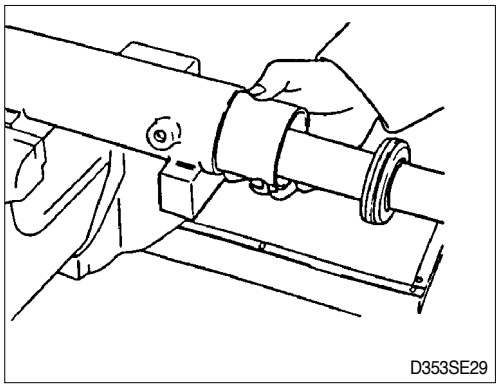

D353SE27

(2) Install the rod seal to the position in the gland applying a slight coat with grease prior to installation.

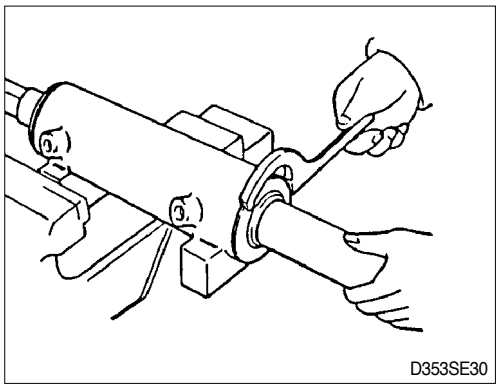

D353SE28

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

(4) Fix the cylinder with a special tool and then install gland assembly into the cylinder tube.

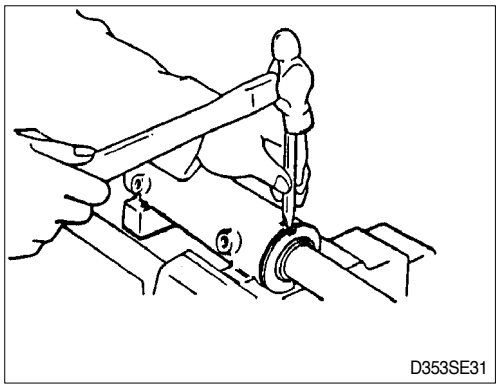

D353SE29

(5) Using a hook spanner, install the gland assembly, and tighten it with torque 40±4kgf · m (289±29lbf · ft).


D353SE30

(6) After the gland assembly was installed to the cylinder tube, calk at the tube end into the groove on the gland to prevent screw loosening.

※ If it need calking again, never using previous calking position.


D353SE31

(7) Move the piston rod back and forth several times for the full distance of its stroke. This helps to seat the ring and seals before applying full hydraulic pressure to the cylinder.

(8) Install cylinder into trail axle.

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

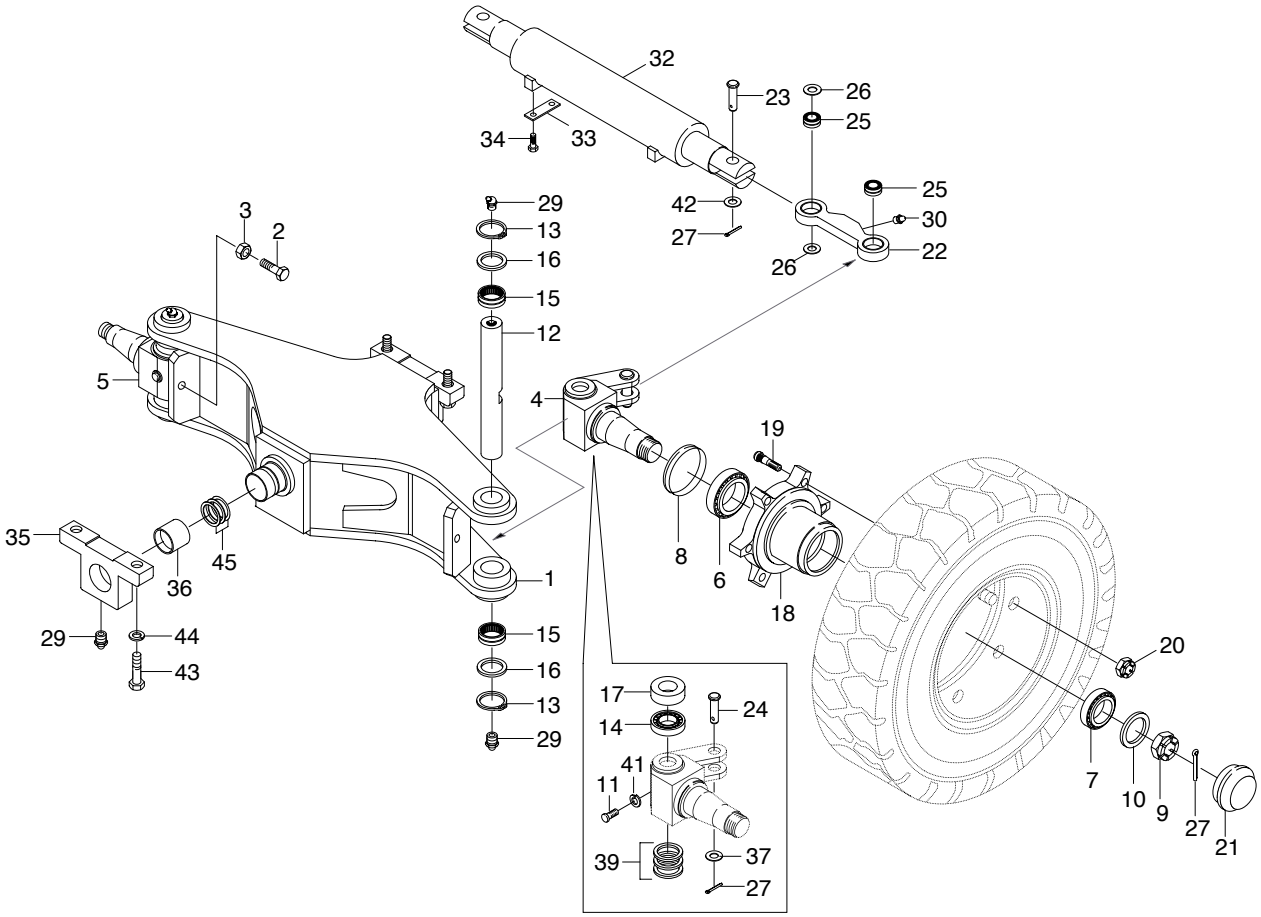
※ Then, repeat the above operation at gradually increasing engine rpm. This releases air from the system and completes preparation for operation.

(10) Stop the engine, lower the floating rear wheels, and check pump joints for oil leaks and looseness and retighten, them as required.

3. TRAIL AXLE

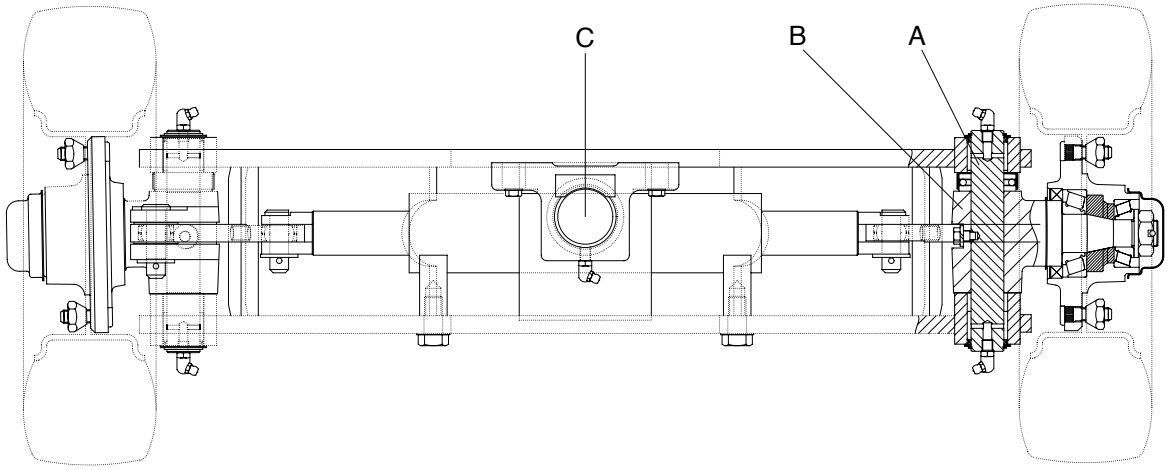
1) STRUCTURE

※ Do not remove the stopper bolt unless necessary.



1	Steering axle	15	Needle bearing	29	Grease nipple
2	Bolt	16	Oil seal	30	Grease nipple
3	Nut	17	Thrust cap bearing	32	Steering cylinder
4	Knuckle-LH	18	Hub wheel	33	Lock plate
5	Knuckle-RH	19	Hub bolt	34	Bolt
6	Taper roller bearing	20	Hub nut	35	Trunnion block
7	Taper roller bearing	21	Wheel cap	36	Bushing
8	Oil seal	22	Link	39	Shim(0.13t)
9	Low castle nut	23	Clevice pin	41	Spring washer
10	Plain washer	24	Clevice pin	42	Plain washer
11	Special bolt	25	Bearing	43	Bolt
12	King pin	26	Thrust washer	44	Spring washer
13	Retaining ring	27	Split pin	45	Washer
14	Thrust bearing	28	King pin washer		

2) CHECK AND INSPECTION



D153SE35

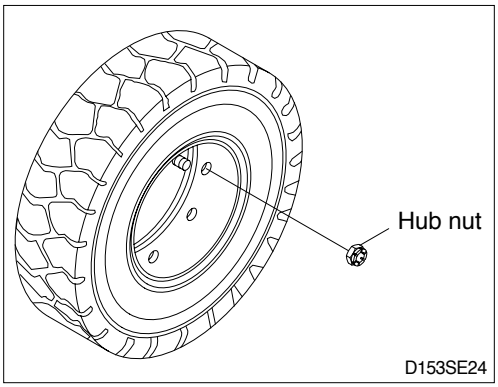
mm(in)

No.	Check item	Criteria		Remedy
		Standard size	Repair limit	
A	Diameter of king pin	30(1.18)	29.8(1.17)	Replace
B	Vertical play of knuckle	-	0.2(0.008)	Adjust with shims
C	Diameter of center pin	50(1.96)	49.5(1.94)	Replace
-	Rear axle, hub, knuckle, bearing	· Damage, wear · Seizure, abnormal noise, defective rotation		Replace

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 wheel cap.

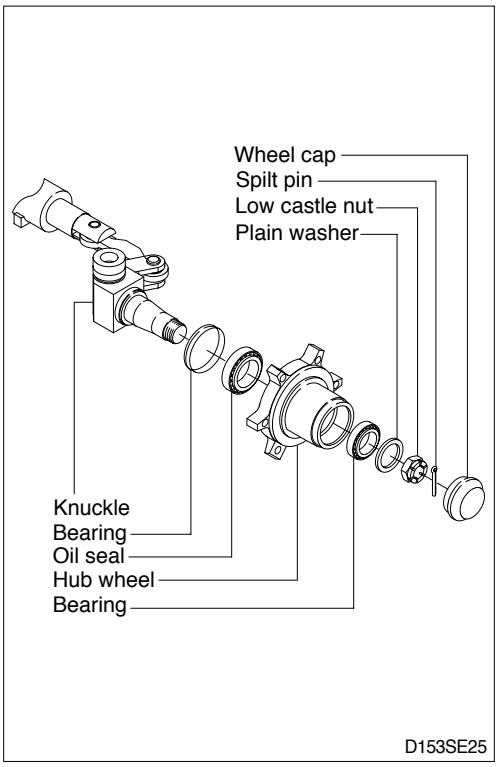
(3) Pull out split pin and remove low castle nut and plain washer.

(4) Using the puller, take off the wheel hub together with the bearing.
Be very careful because just before the hub comes off, tapered roller bearing will fall out.

(5) After wheel hub is removed take off the inner race of 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 slotted nut in the knuckle to protect the threaded portion.

(8) Loosen special bolt(11) and spring washer(41).

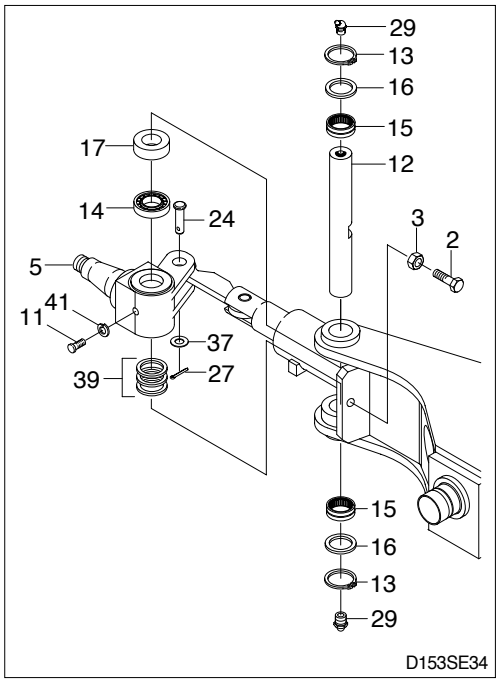
(9) Pry out the retaining ring(13) and remove oil seal(16).

(10) Push out the king pin(12) without damaging the knuckle(5).

(11) Pull out the needle bearing(15).
If defect is observed in needle bearing(15), pull it out by using extractor.

(12) Remove the spilt pin(27) and the clevis pin(24). Then, remove the knuckle(5).

※ Repeat the same procedure for the other side.



4) ASSEMBLY

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

(1) Tighten the special bolt(11) of king pin.

※ There is a notch in the middle of the king pin(12), make sure that this notch is on the special bolt side.

(2) Do not hammer to drive in needle bearing(15) because it will break.
Always use drive-in tool. Be sure that the fixed ring of the bearing is placed in position facing the knuckle.

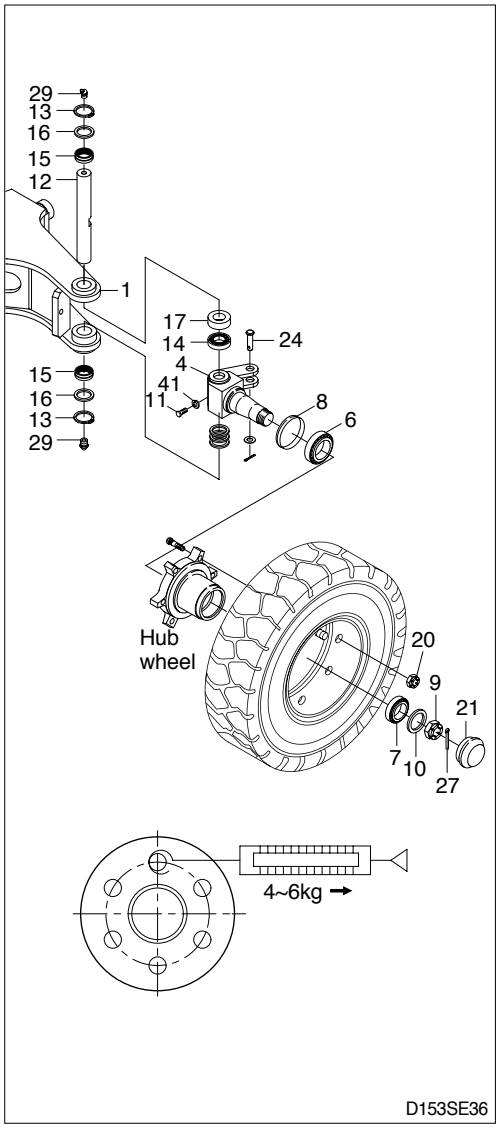
(3) Wheel hub

① Mount oil seal(8) and inner race of tapered roller bearing(6) on the knuckle(4). The bearing should be well greased before assembling.

② Install the outer race of the bearing(7) in the wheel center and assemble to the knuckle.

③ Tighten with nut(9) and locked with split pin(27). 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.

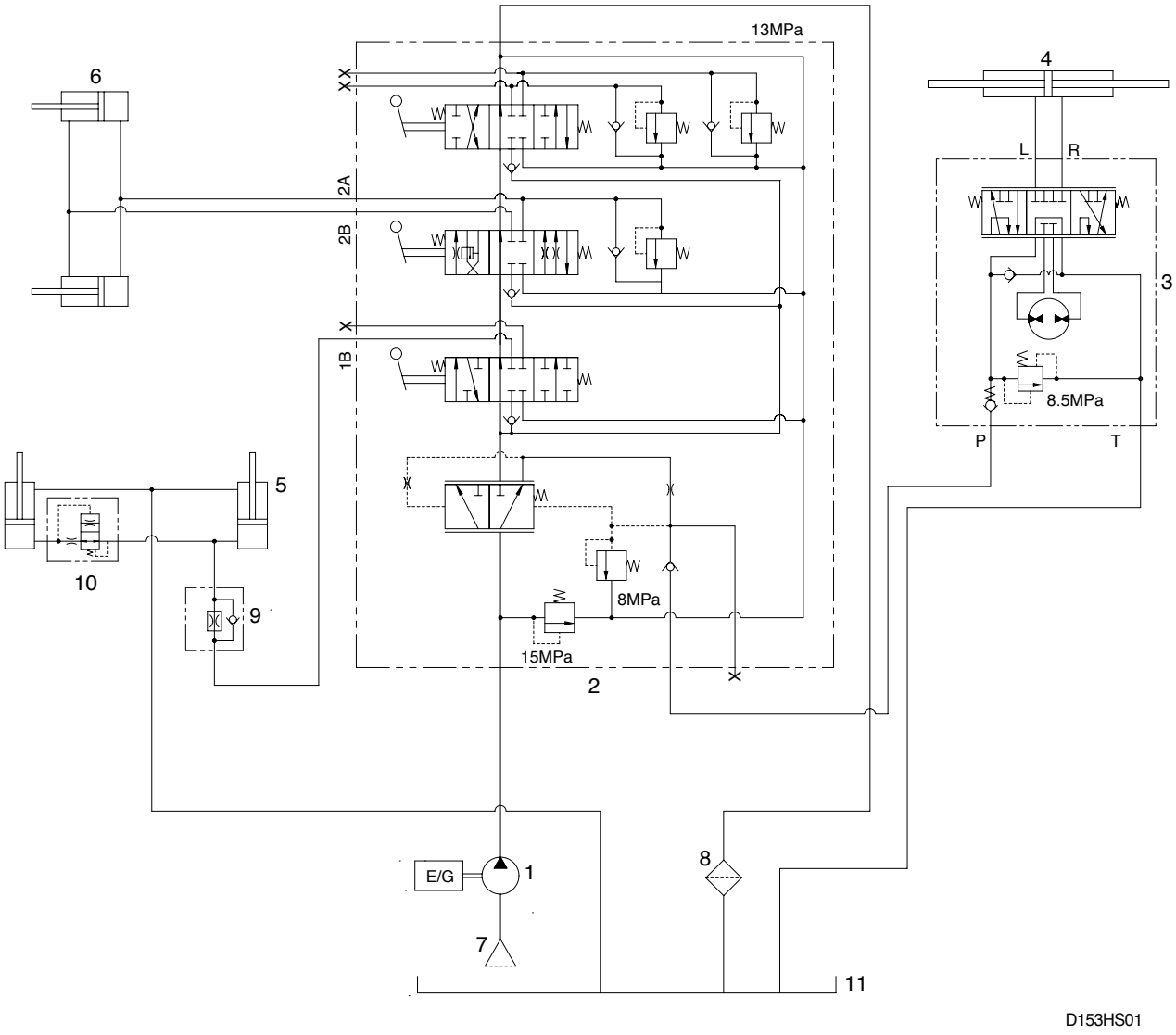
④ Mount the wheel cap(21). Bearing should be well greased before assembling.



SECTION 6 HYDRAULIC SYSTEM

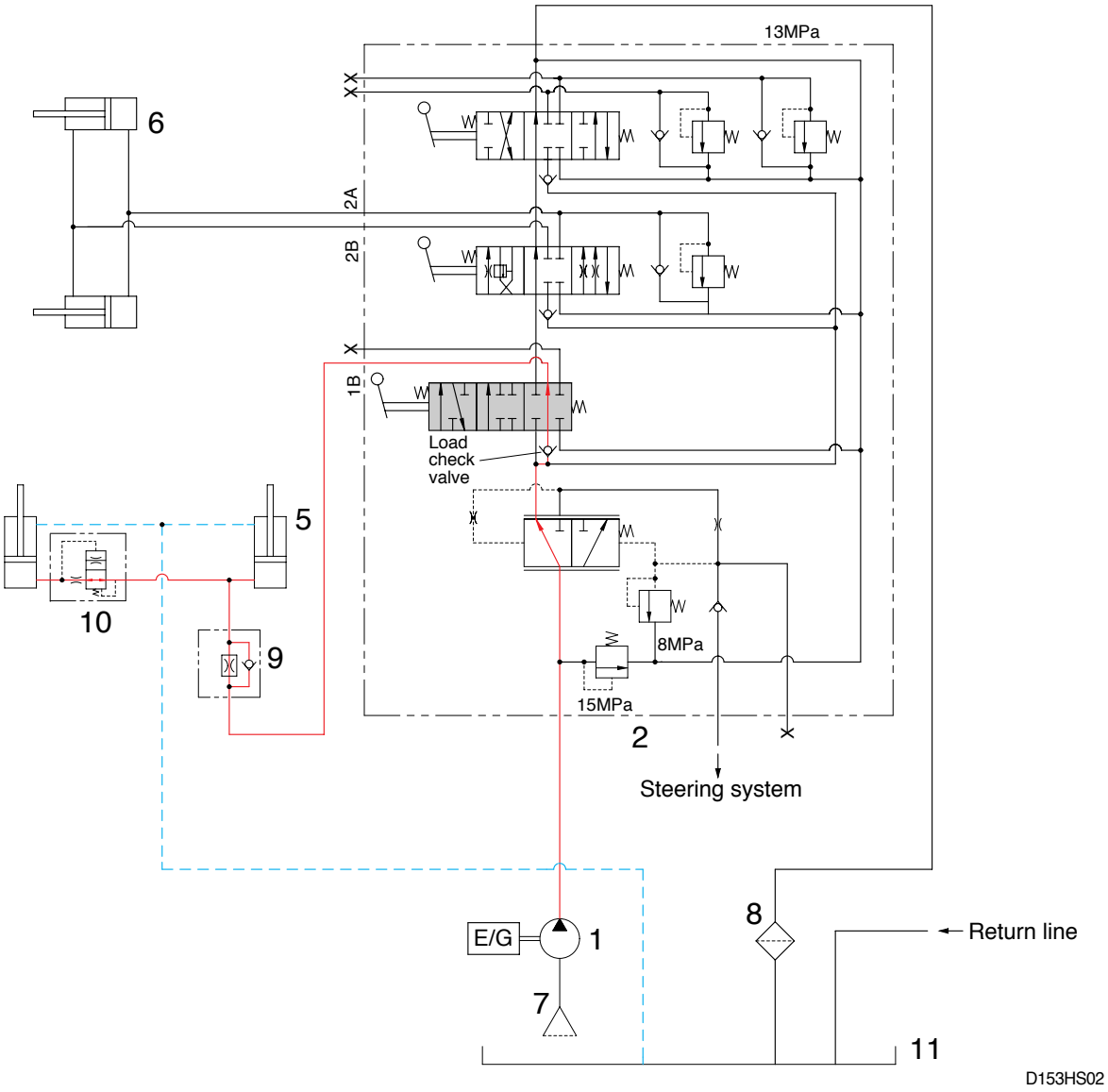
GROUP 1 STRUCTURE AND FUNCTION

1. HYDRAULIC CIRCUIT



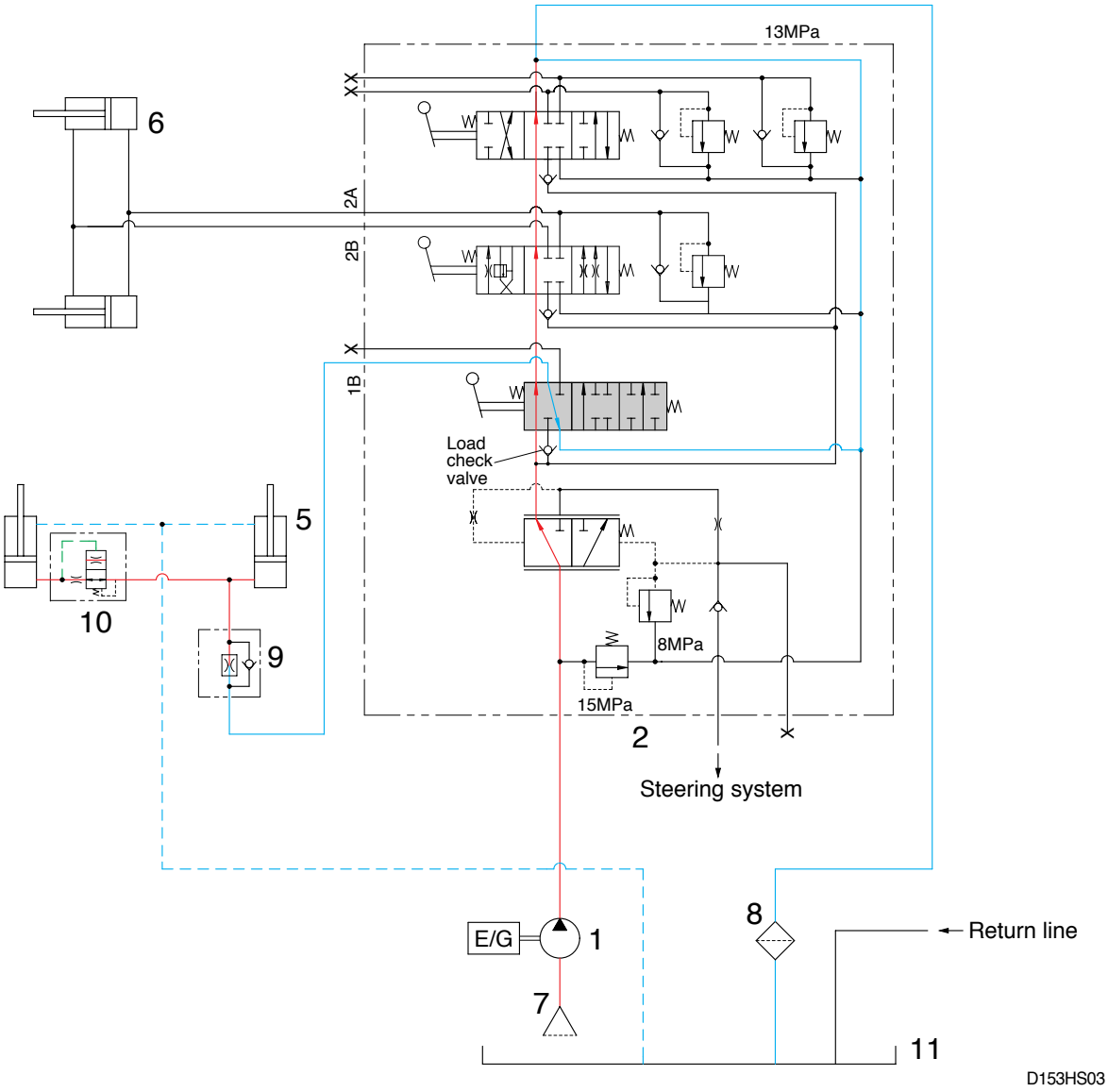
1	Hydraulic gear pump	7	Suction filter
2	Main control valve	8	Return filter
3	Steering unit	9	Down control valve
4	Steering cylinder	10	Down safety valve
5	Lift cylinder	11	Hydraulic tank
6	Tilt cylinder		

1) WHEN THE LIFT CONTROL LEVER IS IN THE LIFT POSITION



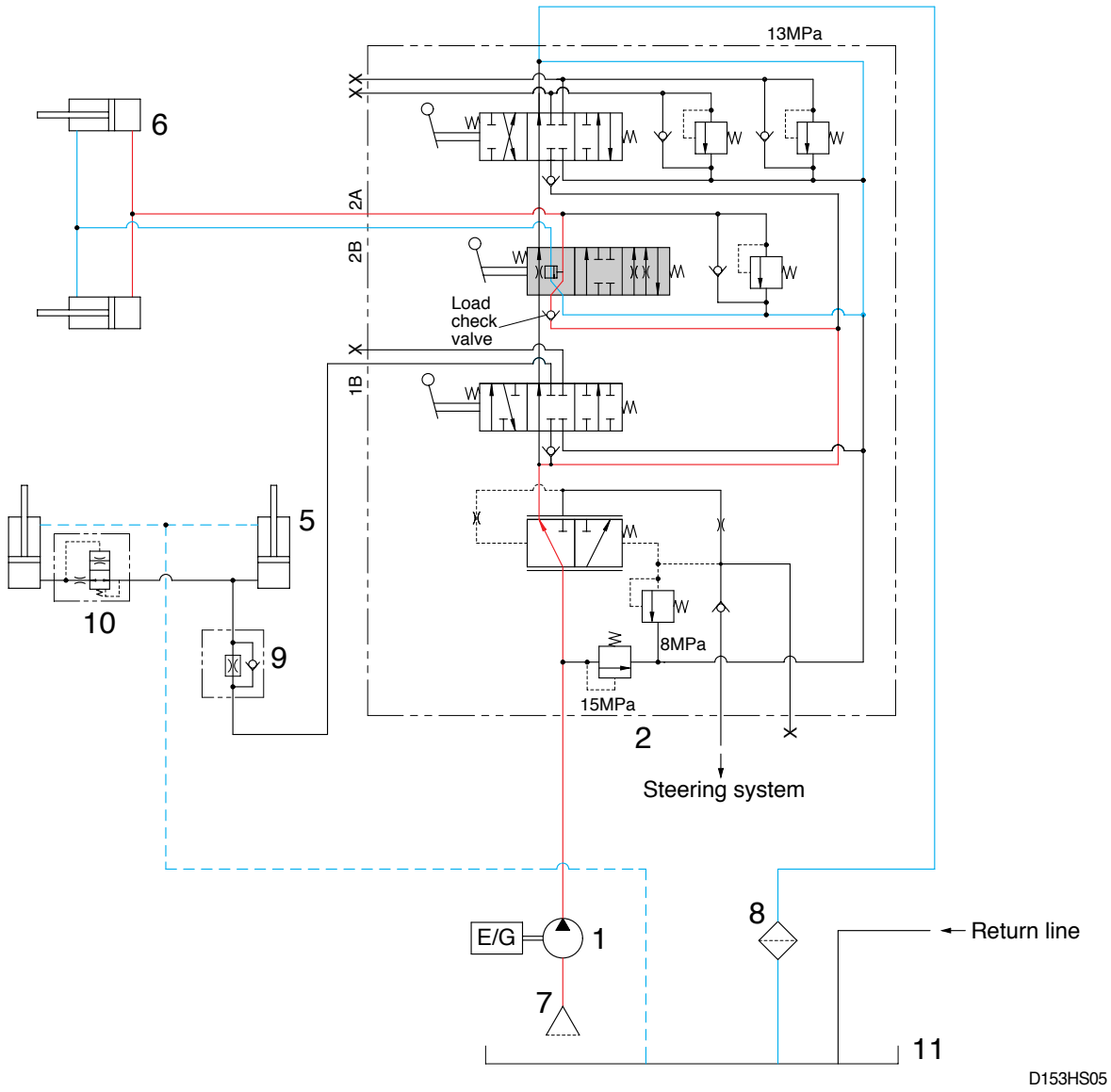
When the lift control lever is pulled back, the spool on the first block moves to lift position.
The oil from hydraulic gear pump(1) flows into main control valve(2) and then goes to the large chamber of lift cylinder(5) by pushing the load check valve of the spool.
The oil from the small chamber of lift cylinder(5) returns to hydraulic oil tank(11) at the same time.
When this happens, the forks go up.

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



When the lift control lever is pushed forward, the spool on the first block moves 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



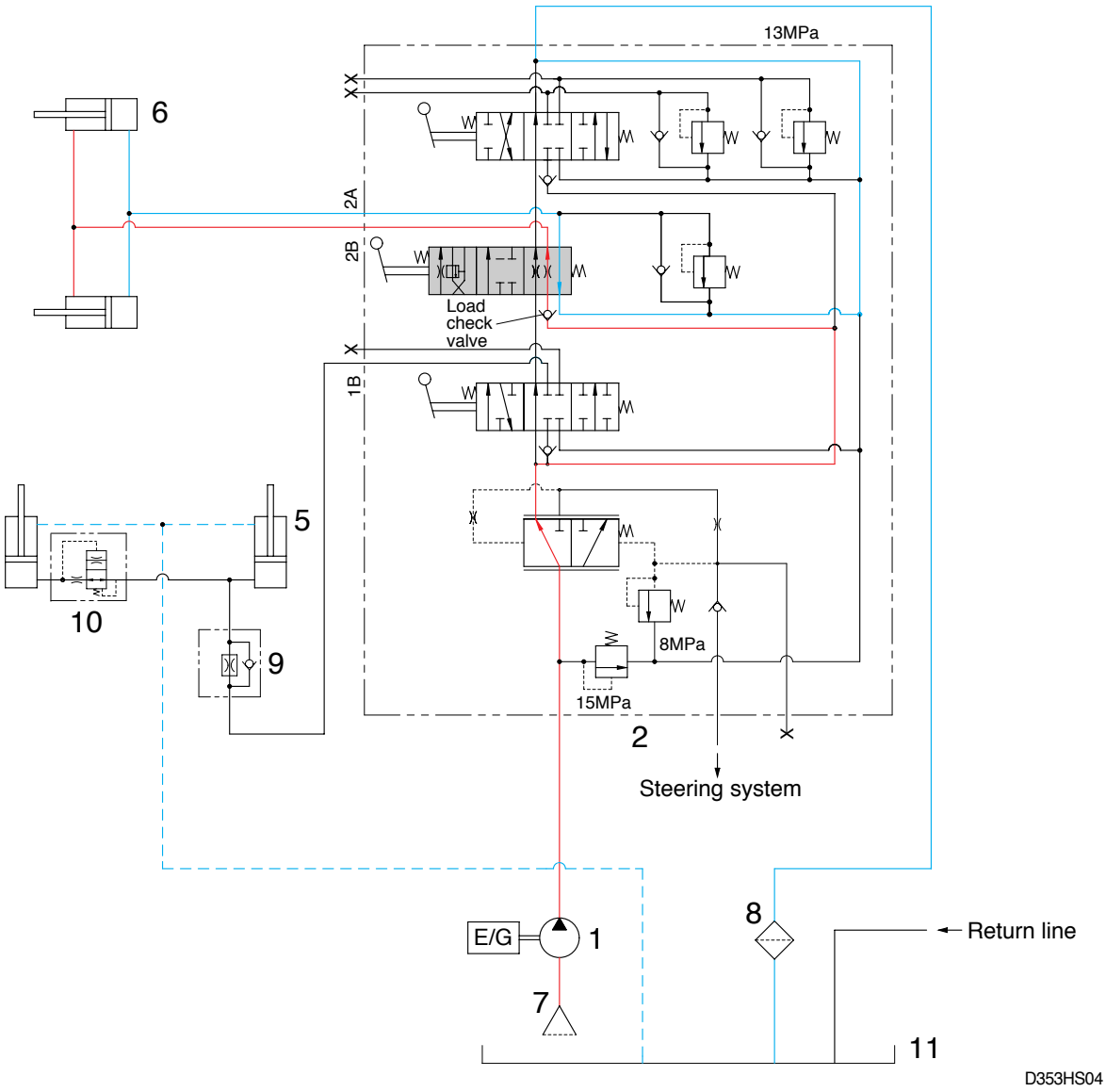
When the tilt control lever is pushed forward, the spool on the second block moves to tilt forward position.

The oil from hydraulic gear pump(1) flows into main control valve(2) and then goes to the large chamber of tilt cylinder(6) by pushing the load check valve of the spool.

The oil at the small chamber of tilt cylinder(6) returns to hydraulic tank(11) at the same time.

When this happens, the mast tilt forward.

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



When the tilt control lever is pulled back, the spool on the second block moves to tilt backward position.

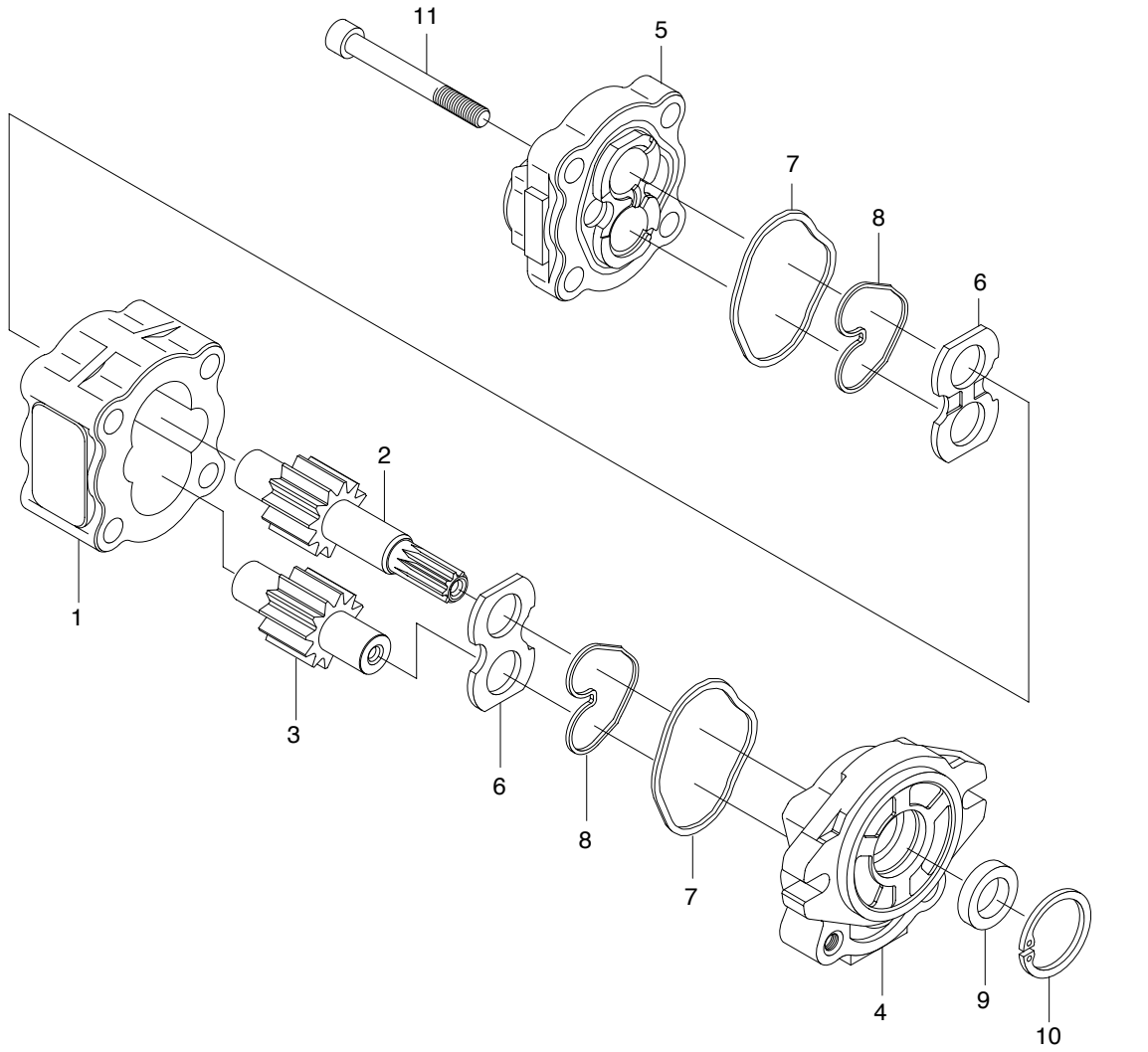
The oil from hydraulic gear pump(1) flows into main control valve(2) and then goes to the small chamber of tilt cylinder(6) by pushing the load check valve of the spool.

The oil at the large chamber of tilt cylinder(6) returns to hydraulic tank(11) at the same time.

When this happens, the mast tilts backward.

2. HYDRAULIC GEAR PUMP

1) STRUCTURE



D153HS06

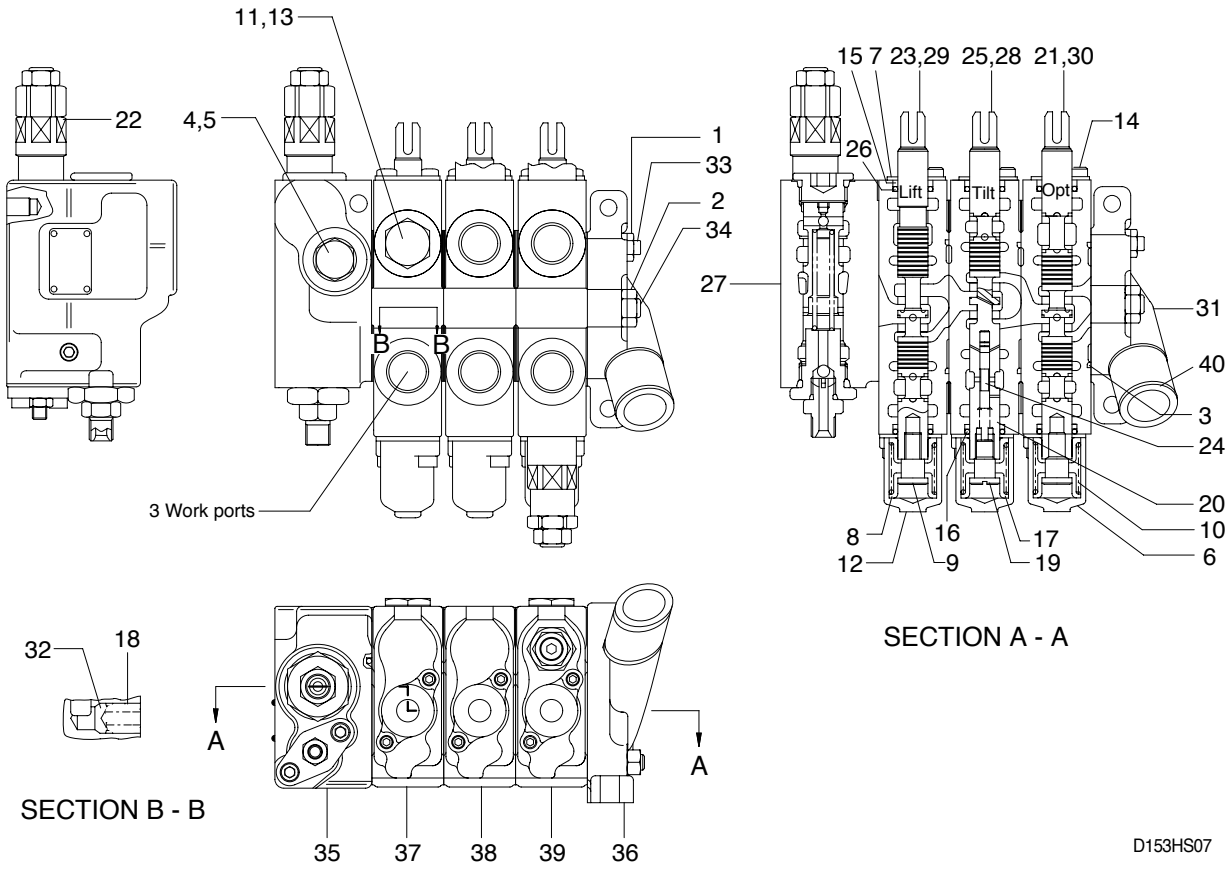
1	Gear plate	5	Cover	9	Oil seal
2	Drive gear	6	Pressure plate	10	Snap ring
3	Driven gear	7	Plate seal	11	Flange head screw
4	Mounting flange	8	Back up ring		

2) OPERATION

This pump comprised of an end cover, a body, bushings and a mounting flange bolted together with through bolts. The gear journals are supported in plane bearings within pressure balanced bushings to give high volumetric and mechanical efficiencies.

3. MAIN CONTROL VALVE

1) STRUCTURE (3 Spool)

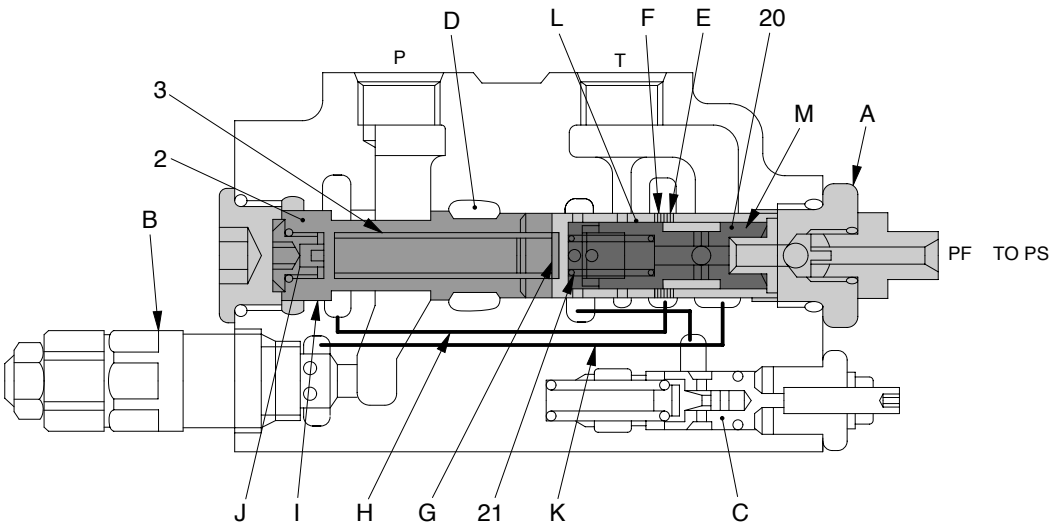


Port name	Size
Inlet port	1-5/16-12UN
Outlet port	1-5/16-12UN
Gauge port	PF1/4
Work port	1-1/16-12UN

1	Special nut	15	Wiper	28	Spool housing
2	Special nut	16	O-ring	29	Spool housing
3	O-ring	17	Spring seat	30	Spool housing
4	O-ring	18	Spring	31	Outlet housing
5	Plug	19	Spool end	32	Poppet
6	Spool cap	20	Spring	33	Tie rod
7	Seal plate	21	Spool	34	Tie rod
8	Spring seat	22	Main relief valve	35	Inlet section assy
9	Spool end	23	Spool	36	Outlet section assy
10	Spring	24	Piston	37	Spool section assy
11	O-ring	25	Spool	38	Spool section assy
12	Cap screw	26	O-ring	39	Spool section assy
13	Plug	27	Inlet housing	40	Plug
14	Screw				

2) LIFT SECTION OPERATION

(1) Structure and description

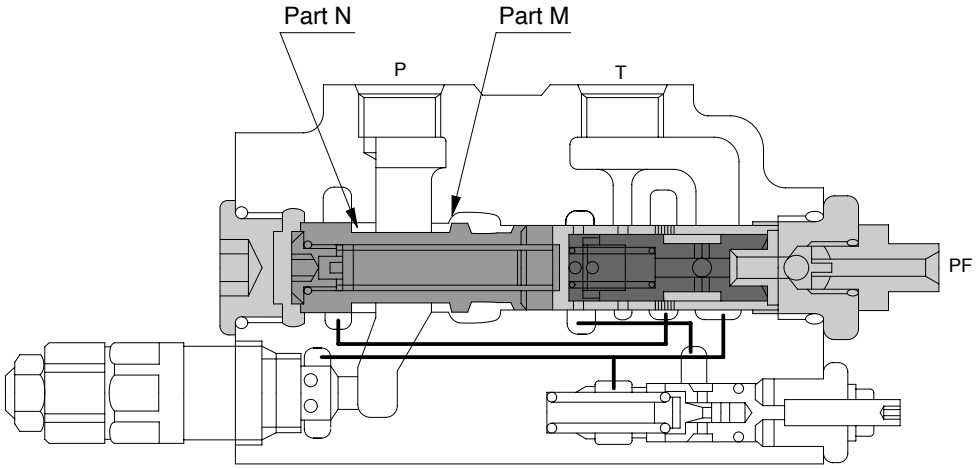


D153HS071

A	Connector assembly	H	Oil passage
B	Main relief valve	I	Pilot passage
C	PF port relief valve	J	Damper
D	EF passage(Main)	K	Tank passage
E	Orifice for control stand-by flow	L	Chamber
F	Orifice	M	Damper orifice for 20 position
G	Damper orifice for 2(spool)		

(2) Operation

① Incase of not running the PF side circuit

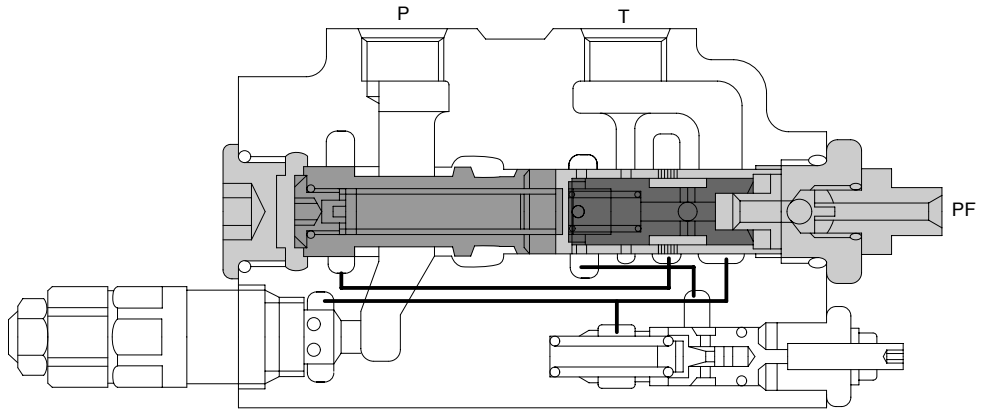


D153HS072

Position of spool and piston when PF port does not be operated when pump displacement is over the stand-by flow volume Q_A.

Oil flows from P(pump) port to PF side through passage H and orifice E. The pressure measured before orifice E is running through the passage I and acting on the head of spool 2, and the one measured after orifice E is running through the orifice G and acting on the tail of spool 2. Therefore the pressure difference makes a push on spring 3, and the spool moves along with the pushed spring. By the movement of spool, part M is opened, and the coil can be runned toward EF side.
Oil amount to EF can be determined on orifice E and stand-by amount, Q_A flows to PF side.

② When running PF side circuit



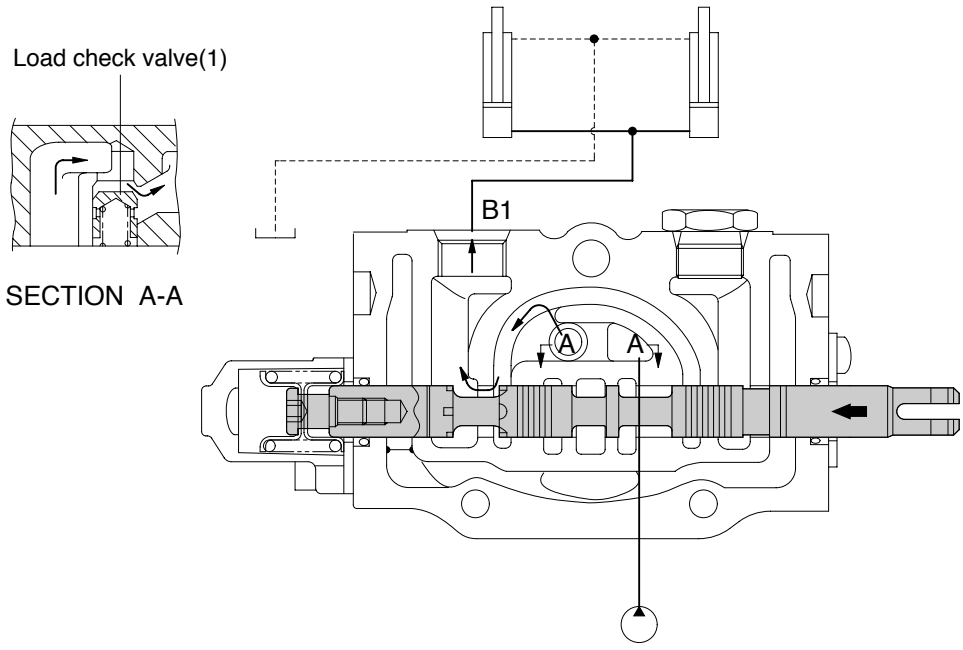
D153HS073

Position of spool and piston when PF port operates when pump displacement is over the controlled flow Q_B.

For the pressure difference running type, K room flows to tank(T side). By the same reason, the piston 20 moves toward the direction of opened orifice E when the pressure of PF side reasoned to switching pressured P_A. In this case, oil amount is determined on orifice E and F, and the fall amount Q_B flows.
When the pressure on PF side is reduced to the switching pressure P_B, orifice E is closed by the piston 20 which is moving by the force of spring 21, and the oil amount is reduced to stand-by amount, Q_A.

3) LIFT SECTION OPERATION

(1) Lift position



D153HS08

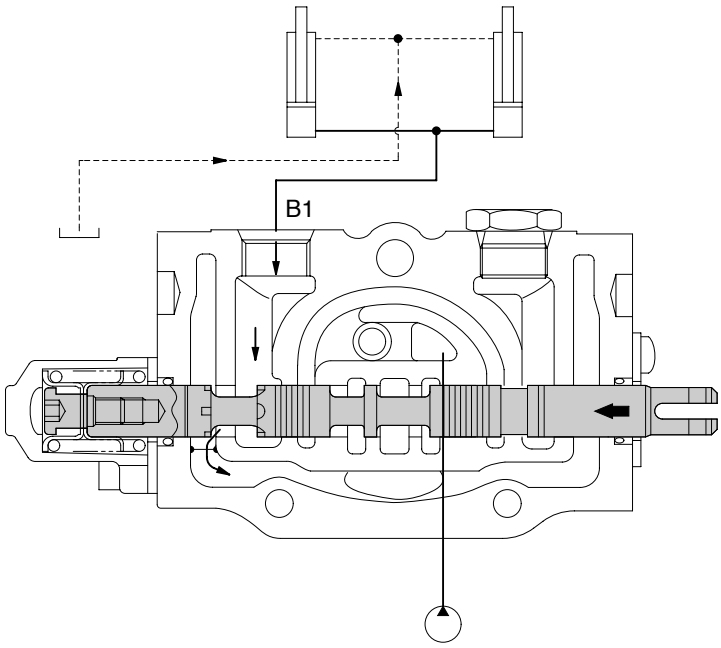
When the lift control lever is pulled back, the spool moves to the right and the neutral passage is closed.

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

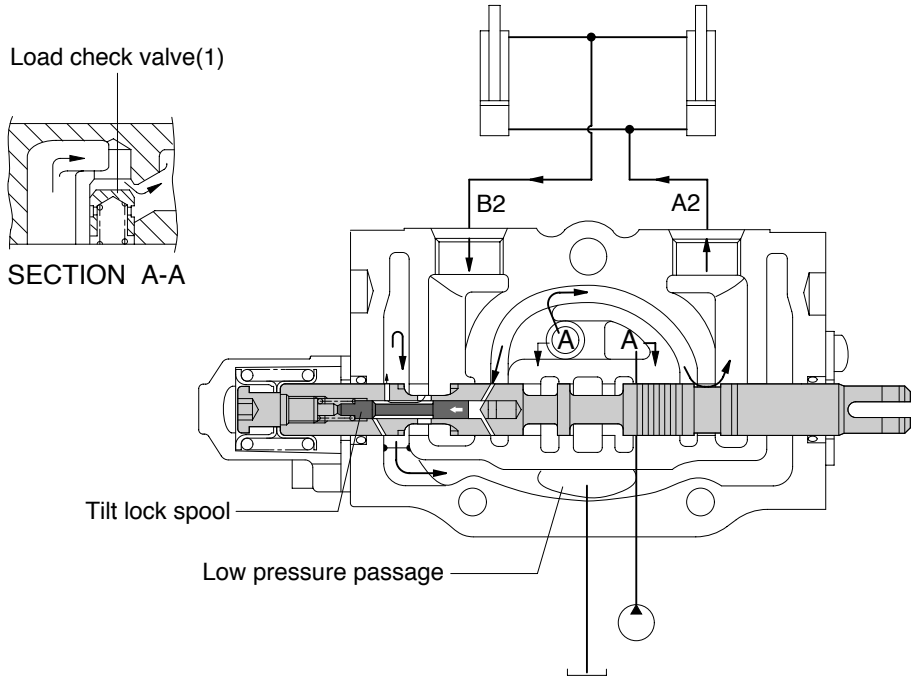


D153HS09

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)→T.
In lift lower position the fork drops due to its own weight.

4) TILT SECTION OPERATION

(1) Tilt forward position



D153HS10

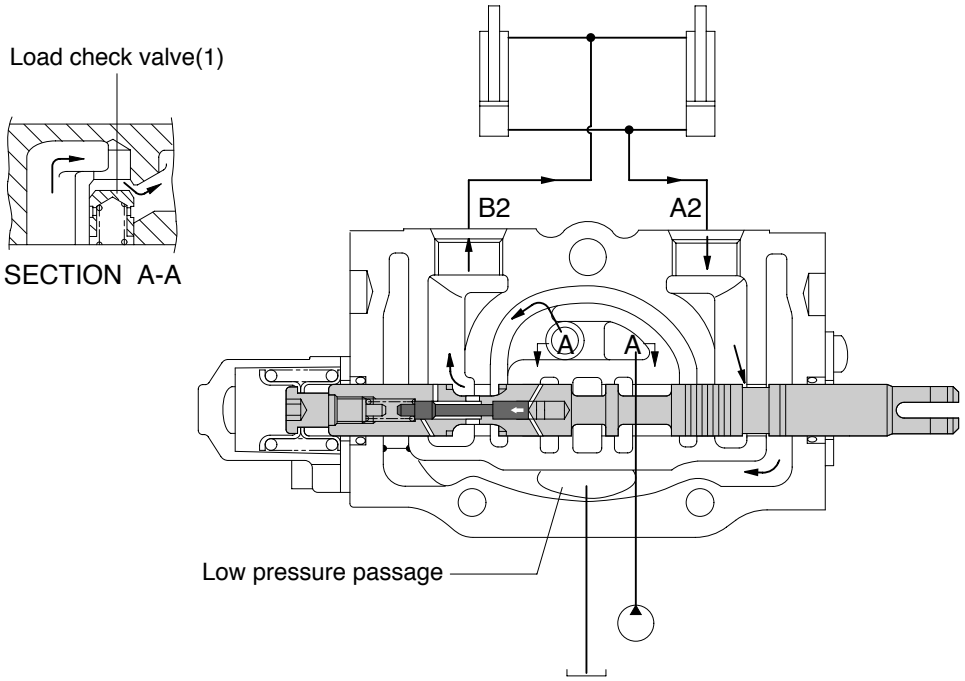
When the tilt control lever is pushed forward, the spool moves to the left and the neutral passage is closed.

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



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.

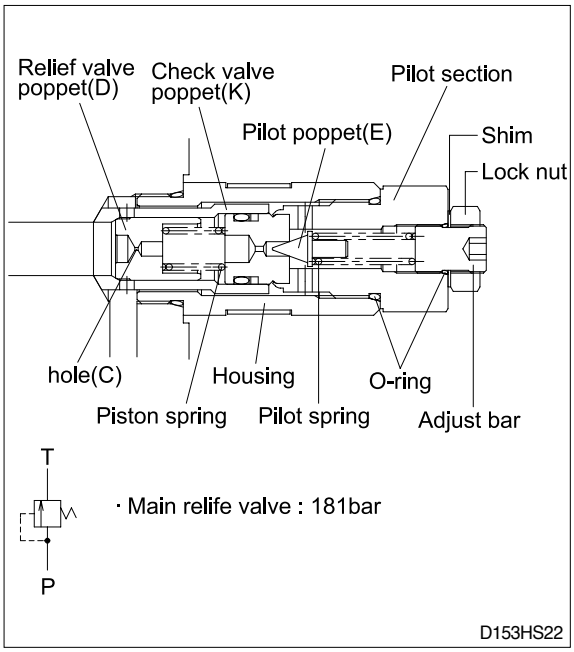
5) MAIN RELIEF VALVE

(1) Pressure setting

A good pressure gage 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

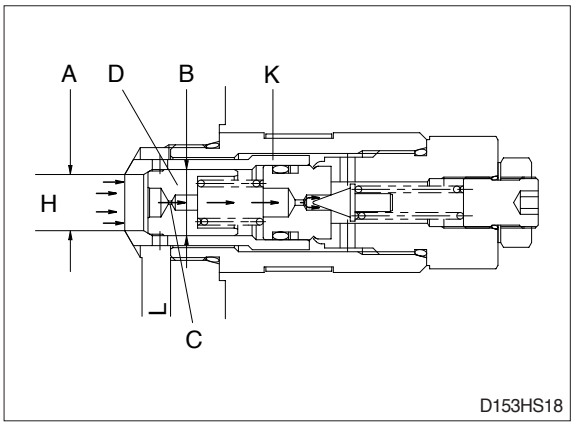
① Loosen lock nut.
② Set adjusting bar to desired pressure setting.
③ Tighten lock nut.
④ Retest in similar manner as above.



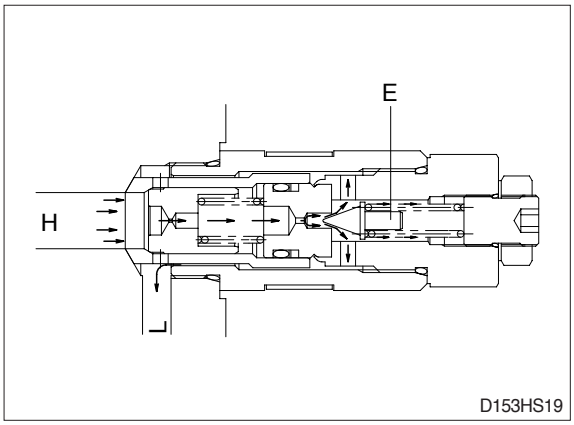
(2) Function

① **As work port relief**

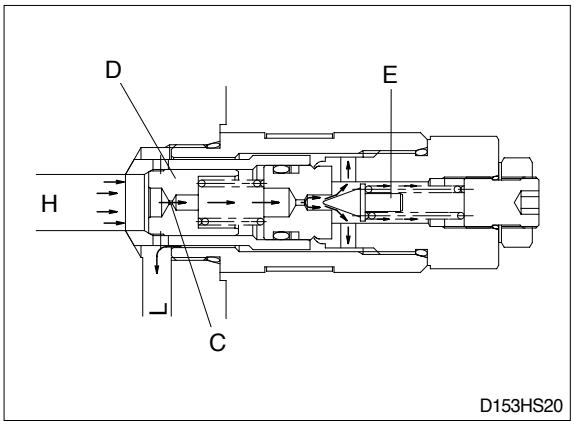
The relief valve is in communication between the high pressure port HP and low pressure LP. Oil is admitted through the hole C and because of the differential area between diameters A and B relief valve poppet D and check valve puppet K are tightly seated as shown.



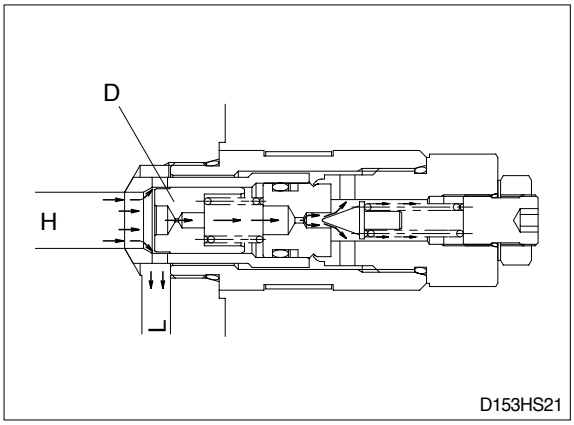
The oil pressure in the high pressure port HP has reached the setting of the pilot poppet spring force and unseats the pilot poppet E and oil flows around the poppet through the cross drilled holes and to the low pressure area LP.



The loss of oil behind poppet C, effected by the opening of pilot poppet E. This shuts off the oil flow to the area behind relief valve poppet D, and causes a low pressure area internally.

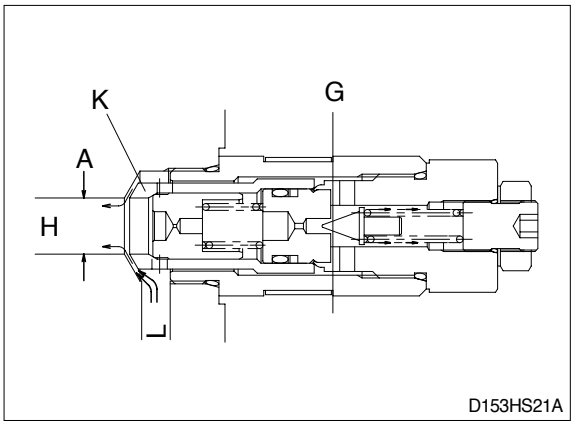


The imbalance of pressure on the inside as compared to that of the high pressure port HP, forces the relief valve poppet D to open and relieve the oil directly to the low pressure chamber LP in the valve.

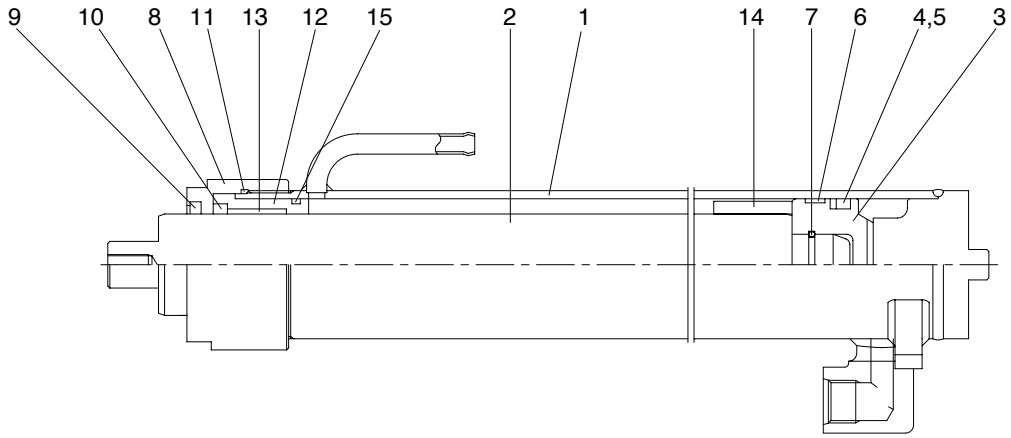


② **As anti void**

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.



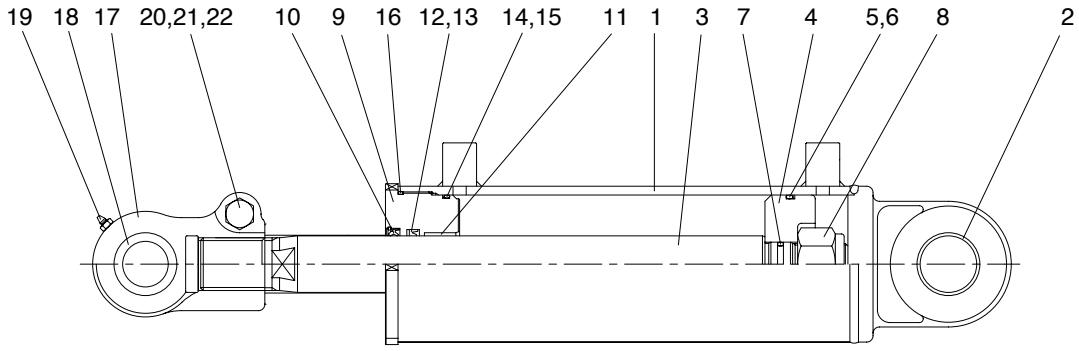
4. LIFT CYLINDER



D153HS12

1	Tube assy	6	Wear ring	11	O-ring
2	Rod	7	Retaining ring	12	Stopper
3	Piston	8	Rod cover	13	Du bushing
4	U-packing	9	Dust wiper	14	Spacer
5	Back up ring	10	U-packing	15	O-ring

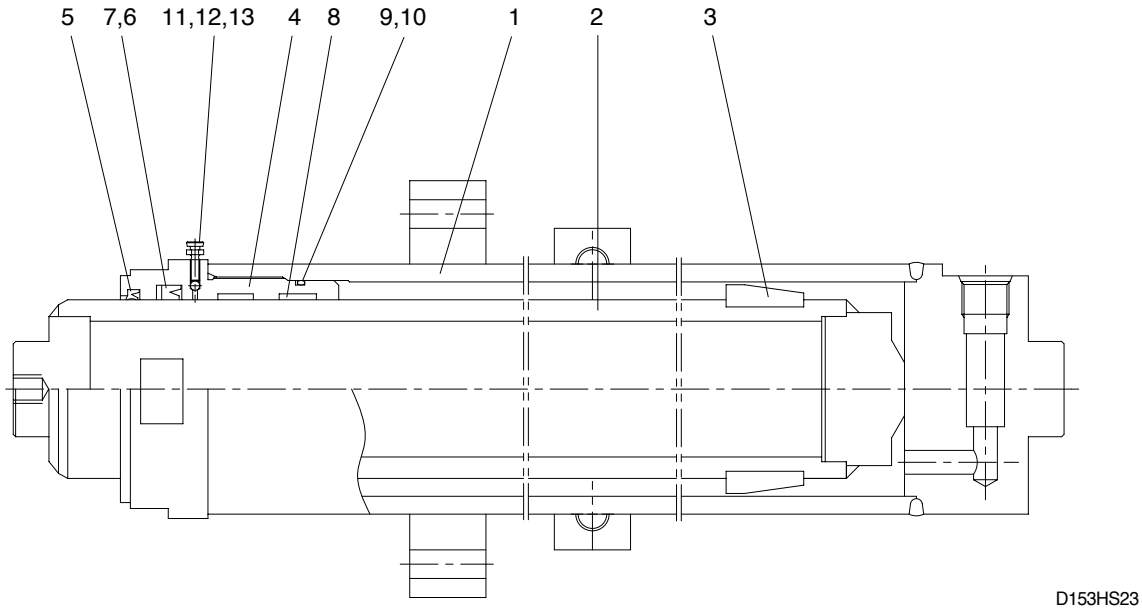
5. TILT CYLINDER



D153HS13

1	Tube assy	9	Rod cover	17	Rod eye
2	Du bushing	10	Dust wiper	18	Bushing
3	Rod	11	Du bushing	19	Grease nipple
4	Piston	12	U packing	20	Hexagon bolt
5	O-ring	13	Back up ring	21	Spring washer
6	Back up ring	14	O-ring	22	Hexagon nut
7	O-ring	15	Back up ring		
8	Hexagon nut	16	O-ring		

6. FREE LIFT CYLINDER



1	Tube assembly	6	U-packing	11	Steel ball
2	Rod assembly	7	Back up ring	12	Bleeder screw
3	Ring	8	Slyd ring	13	Set screw
4	Gland nut	9	O-ring		
5	Dust wiper	10	Back up ring		

1. OPERATIONAL CHECKS

1) CHECK ITEM

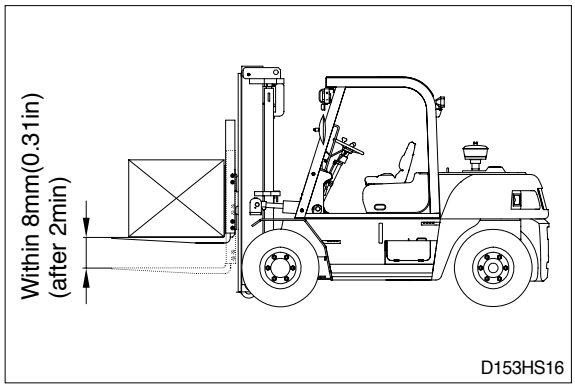
(1) Check visually for deformation, cracks or damage of rod.

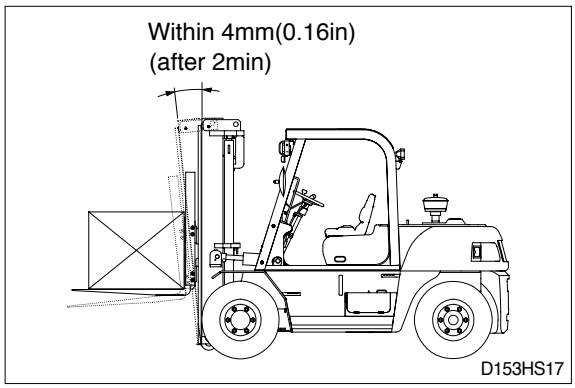
(2) Load maximum load, set mast vertical and raise 1m from ground. Wait for 2 minutes and measure hydraulic drift(amount forks move down and amount mast tilts forward).

· **Hydraulic drift**

- Down(Downward movement of forks)
  : Within 8mm(0.31in)
- Forward(Extension of tilt cylinder)
  : Within 4mm(0.16in)

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.

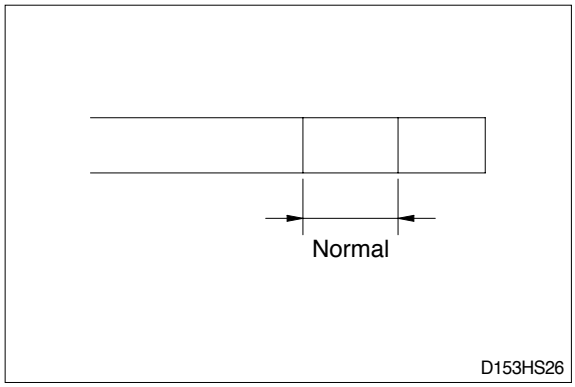
mm (in)

Standard	Under 0.6 (0.02)

2) HYDRAULIC OIL

(1) Using dipstick, measure oil level, and oil if necessary.

(2) When changing hydraulic oil, clean suction strainer(screwed into outlet port pipe) and line filter(screwed into inlet pipe). Line filter uses paper element, so replace periodically(every 6 months or 1200 hours)



3) CONTROL VALVE

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

Check that oil pressure is 82 - 152kgf/cm^2.

(1166 - 2162psi)

2. TROUBLESHOOTING

1) SYSTEM

Problem	Cause	Remedy
Large fork lowering speed.	· Seal inside control valve defective. · Oil leaks from joint or hose. · Seal inside cylinder defective.	· Replace spool or valve body. · Replace. · Replace packing.
Large spontaneous tilt of mast.	· Tilting backward : Check valve defective. · Tilting forward : tilt lock valve defective. · Oil leaks from joint or hose. · Seal inside cylinder defective.	· Clean or replace. · Clean or replace. · Replace. · Replace seal.
Slow fork lifting or slow mast tilting.	· Lack of hydraulic oil. · Hydraulic oil mixed with air. · Oil leaks from joint or hose. · Excessive restriction of oil flow on pump suction side. · Relief valve fails to keep specified pressure. · Poor sealing inside cylinder. · High hydraulic oil viscosity. · Mast fails to move smoothly. · Oil leaks from lift control valve spool. · Oil leaks from tilt control valve spool.	· Add oil. · Bleed air. · Replace. · Clean filter. · Adjust relief valve. · Replace packing. · Change to SAE10W, class CD engine oil. · Adjust roll to rail clearance. · Replace spool or valve body. · Replace spool or valve body.
Hydraulic system makes abnormal sounds.	· Excessive restriction of oil flow pump suction side. · Gear or bearing in hydraulic pump defective.	· Clean filter. · Replace gear or bearing.
Control valve lever is locked	· Foreign matter jammed between spool and valve body. · Valve body defective.	· Clean. · Tighten body mounting bolts uniformly.
High oil temperature.	· Lack of hydraulic oil. · High oil viscosity. · Oil filter clogged.	· Add oil. · Change to SAE10W, class CD engine oil. · Clean filter.

2) HYDRAULIC GEAR PUMP

Problem	Cause	Remedy
Pump does not develop full pressure.	· System relief valve set too low or leaking. · Oil viscosity too low. · Pump is worn out.	· Check system relief valve for proper setting. · Change to proper viscosity oil. · Repair or replace pump.
Pump will not pump oil.	· Reservoir low or empty. · Suction strainer clogged.	· Fill reservoir to proper level. · Clean suction strainer.
Noisy pump caused by cavitation.	· Oil too thick. · Oil filter plugged. · Suction line plugged or too small.	· Change to proper viscosity. · Clean filters. · Clean line and check for proper size.
Oil heating.	· Oil supply low. · Contaminated oil. · Setting of relief valve too high or too low. · Oil viscosity too low.	· Fill reservoir to proper level. · Drain reservoir and refill with clean oil. · Set to correct pressure. · Drain reservoir and fill with proper viscosity.
Foaming oil.	· Low oil level. · Air leaking into suction line. · Wrong kind of oil.	· Fill reservoir to proper level. · Tighten fittings, check condition of line. · Drain reservoir, fill with non-foaming oil.
Shaft seal leakage.	· Worn shaft seal. · Worn shaft in seal area.	· Replace shaft seal. · Replace drive shaft and seal.

3) MAIN RELIEF VALVE

Problem	Cause	Remedy
Can't get pressure	· Poppet 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.	· Replace the relief valve. · Clean and remove surface marks for free movement.
Pressure setting not correct	· Normal wear. Lock nut & adjust screw loose.	· See *How to set pressure on work main relief.
Leaks	· Damaged seats. · Worn O-rings. · Parts sticking due to contamination.	· Replace the relief valve. · Install seal and spring kit. · Disassemble and clean.

★ A good pressure gauge must be installed in the line which is in communication with the main relief. A load must be applied in a manner to reach the set pressure of the main relief unit.
Then, follow these steps:

- Loosen lock nut.
- Set adjusting nut to desired pressure setting.
- If desired pressure setting cannot be achieved, add or remove shims as required.
- Tighten lock nut.
- Retest in similar manner as above.

4) LIFT CYLINDER

Problem	Cause	Remedy
Oil leaks out from gland through rod.	· Foreign matters on packing. · Unallowable score on rod. · Unusual distortion of dust seal. · Chrome plating is striped.	· Replace packing. · Smooth rod surface with an oil stone. · Replace dust seal. · Replace rod.
Oil leaks out from cylinder gland thread.	· O-ring damaged.	· Replace O-ring.
Rod spontaneously retract.	· Scores on inner surface of tube. · Unallowable score on the inner suface of tube. · Foreign matters in piston seal.	· Smooth rod surface with an oil stone. · Replace cylinder tube. · Replace piston seal.
Wear(clearance between cylinder tube and wear ring)	· Excessive clearance between cylinder tube and wear ring.	· Replace wear ring.
Abnormal noise is produced during tilting operation.	· Insufficient lubrication of anchor pin or worn bushing and pin. · Bent tilt cylinder rod.	· Lubricate or replace. · Replace.

GROUP 3 DISASSEMBLY AND ASSEMBLY

1. HYDRAULIC GEAR PUMP

※ Tools required

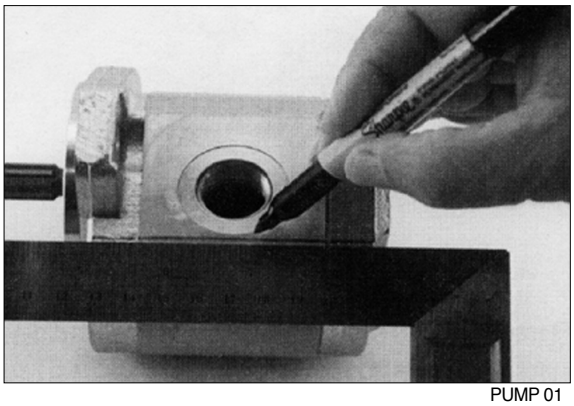
- Metric socket set
- Internal snap ring pliers
- Shaft seal sleeve
- Torque wrench : 13.8 kgf · m (100lbf · ft)

(1) It is very important to work in a clean work area when repairing hydraulic products. Plug ports and wash exterior of pump with a proper cleaning solvent before continuing.

(2) Remove port plugs and drain oil from pump.

(3) Use a permanent marker pen to mark a line across the mounting flange, gear housing and end cover. This will assure proper reassembly and rotation of pump.

(4) Remove key from drive shaft if applicable.

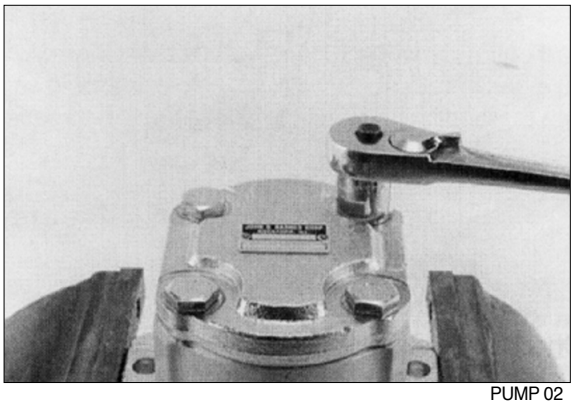


PUMP 01

(5) Clamp mounting flange in a protected jaw vise with pump shaft facing down.

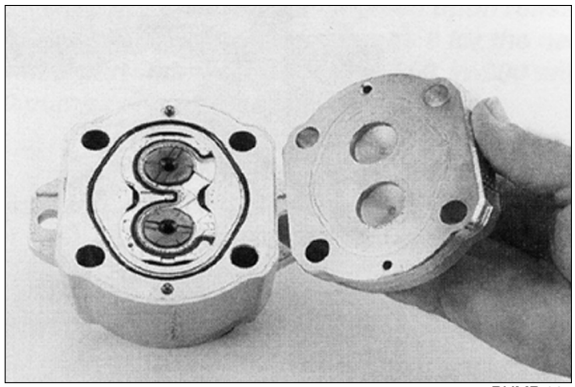
(6) Loosen the four metric hexagon head bolts.

(7) Remove pump from vise and place on clean work bench, remove the four hexagon head bolts and spacers applicable.



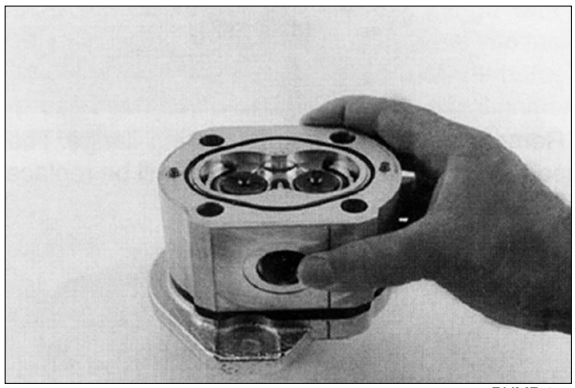
PUMP 02

(8) Lift and remove end cover.



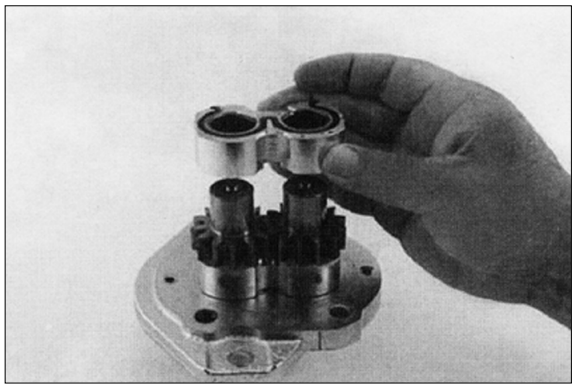
PUMP 03

(9) Carefully remove gear housing and place on work bench. Make sure the rear bearing block remains on the drive and idler shafts.



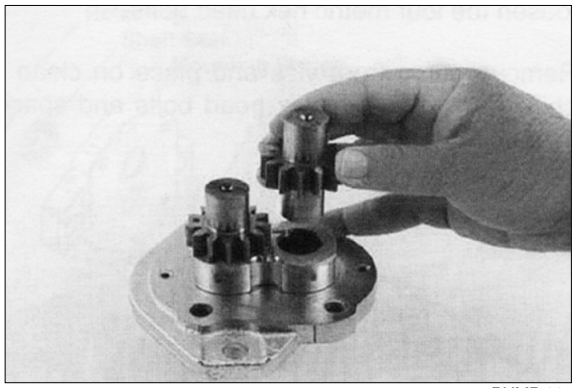
PUMP 04

(10) Remove rear bearing block from drive and idler shafts.



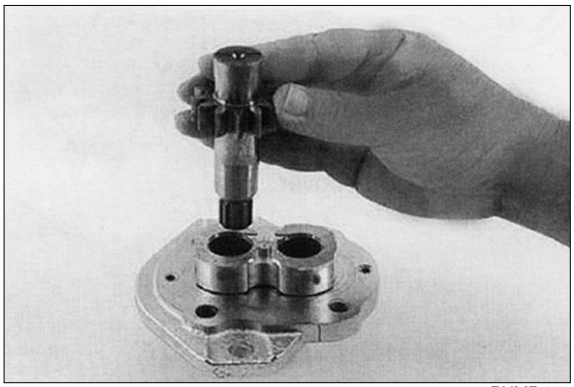
PUMP 05

(11) Remove idler shaft from bearing block.



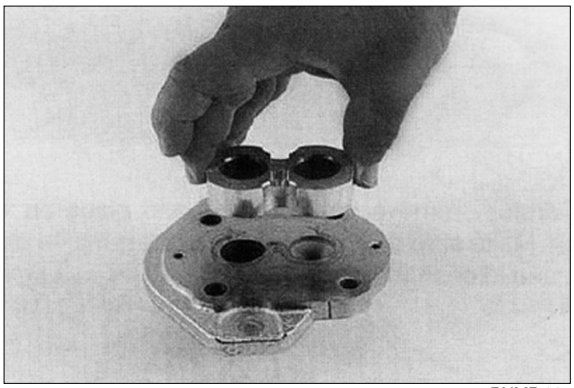
PUMP 06

(12) Remove drive shaft from mounting flange. There is no need to protect the shaft seal as it will be replaced as a new item.



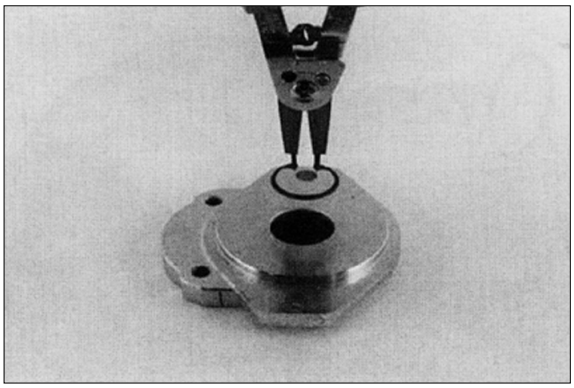
PUMP 07

(13) Remove the front bearing block.



PUMP 08

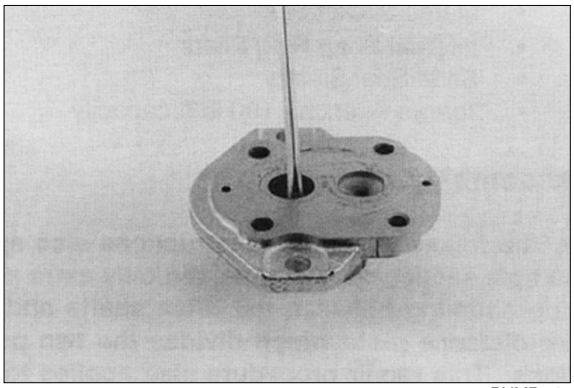
(14) Turn mounting flange over, with shaft seal up, and remove the retaining ring with proper snap ring pliers.



PUMP 09

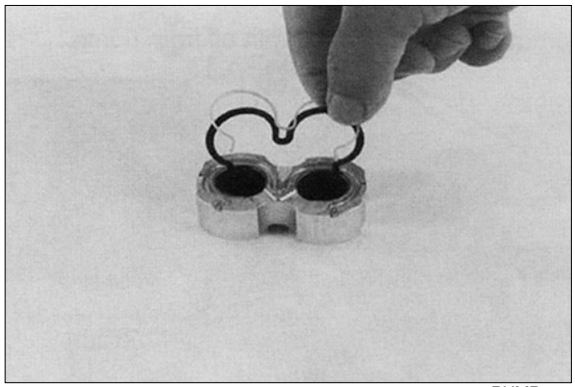
(15) Remove the oil seal from mounting flange, be careful not to mar or scratch the seal bore.

(16) Remove the dowel pins from the gear housing. Do not lose pins.



PUMP 10

(17) Remove seals from both bearing blocks and discard.



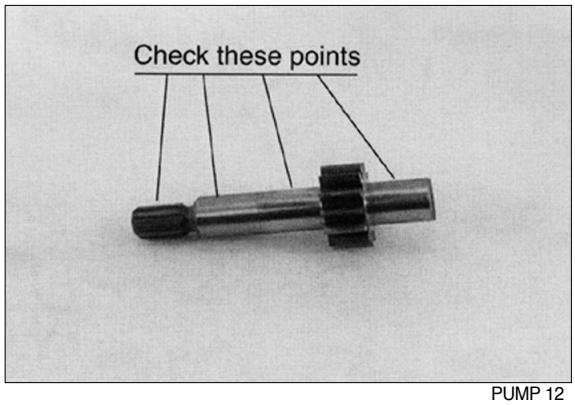
PUMP 11

2) INSPECT PARTS FOR WEAR

(1) Clean and dry all parts thoroughly prior to inspection. It is not necessary to inspect the seals as they will be replaced as new items.

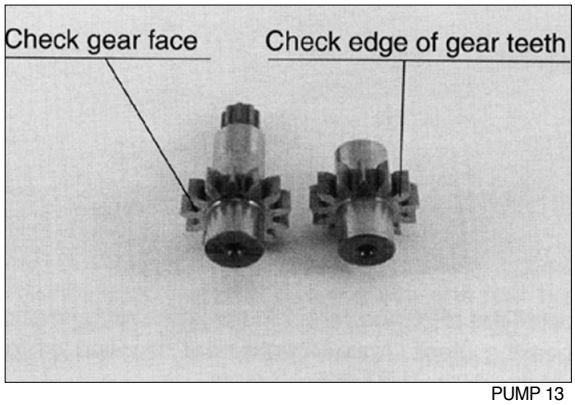
(2) Check drive shaft spline for twisted or broken teeth, check keyed drive shaft for broken or chipped keyway. No marks or grooves on shaft in seal area, some discoloration of shaft is allowable.

(3) Inspect both the drive gear shaft and idler gear shafts at the bearing points and seal area for rough surfaces and excessive wear.



PUMP 12

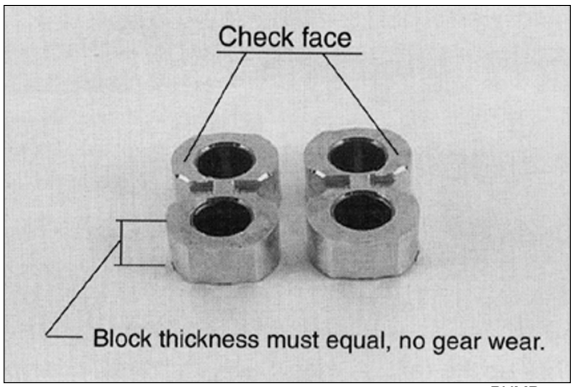
(4) Inspect gear face for scoring or excessive wear. If the face edge of gear teeth are sharp, they will mill into the bearing blocks. If wear has occurred, the parts are unusable.



PUMP 13

(5) Inspect bearing blocks for excessive wear or scoring on the surfaces which are in contact with the gears. Also inspect the bearings for excessive wear or scoring.

(6) Inspect the area inside the gear housing. It is normal for the surface inside the gear housing to show a clean "wipe" on the inside surface on the intake side. There should not be excessive wear or deep scratches and gouges.



PUMP 14

※ **General information**

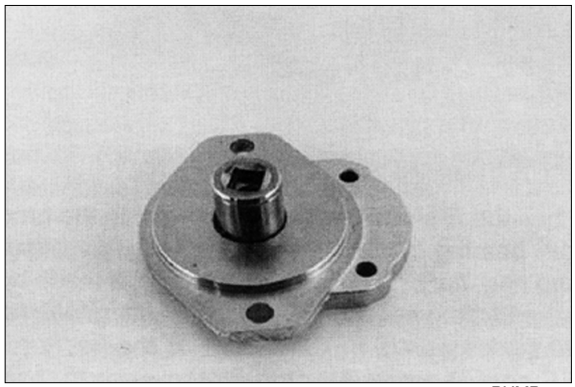
It is important that the relationship of the mounting flange, bearing blocks and gear housing is correct. Failure to properly assemble this pump will result with little or no flow at rated pressure.

※ **This pump is not bi-rotational.**

3) ASSEMBLY

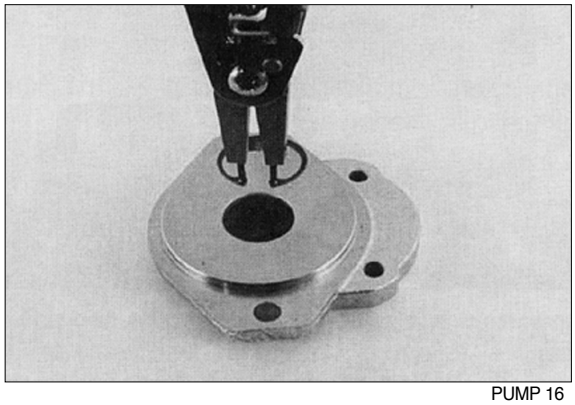
※ New seals should be installed upon reassembly of pump.

(1) Install new shaft seal in mounting flange with part number side facing outboard. Press the seal into the seal bore until the seal reaches the bottom of the bore. Uniform pressure must be used to prevent misalignment or damage to the seal.



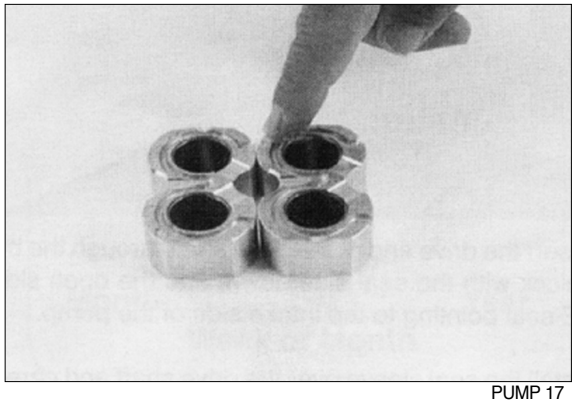
PUMP 15

(2) Install retaining ring in groove in seal bore of mounting flange.



PUMP 16

(3) Place front and back bearing blocks on a clean surface with the E-seal grooves facing up. Apply a light coating of petroleum jelly in the grooves. Also coat the E-seal and backup with the petroleum jelly, this will help keep the seals in place during assembly.

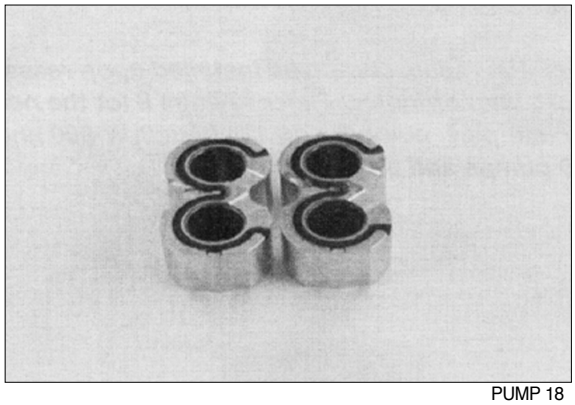


PUMP 17

(4) Place the E-seals, flat side outward, into the grooves in both bearing blocks. Follow by carefully placing the backup ring, flat side outward, in the groove made by the E-seal and the groove in the bearing block.

(5) Place mounting flange, with shaft seal side down, on a clean flat surface.

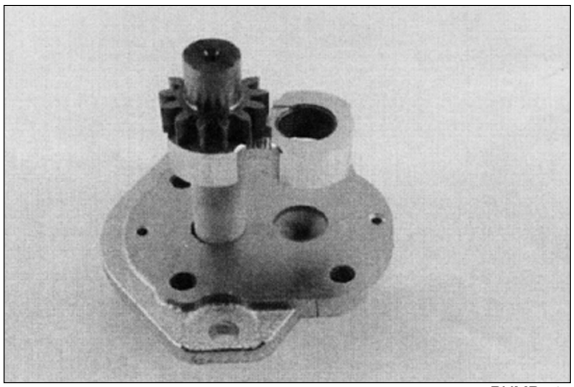
(6) Apply a light coating of petroleum jelly to the exposed face of the front bearing block.



PUMP 18

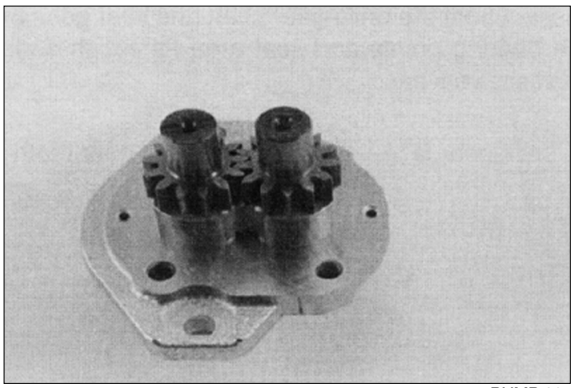
(7) Insert the drive end of the drive shaft through the bearing block with the seal side down, and the open side of the E-seal pointing to the intake side of the pump.

(8) Install the seal sleeve over the drive shaft and carefully slide the drive shaft through the shaft seal. Remove the seal sleeve from shaft.



PUMP 19

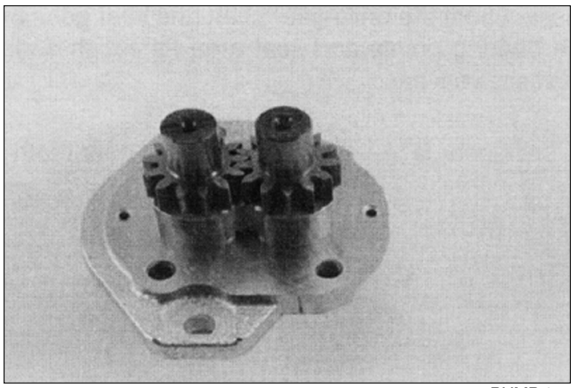
(9) Install the idler gear shaft in the remaining position in the bearing block. Apply a light coat of clean oil to the face of the drive and idler gears.



PUMP 20

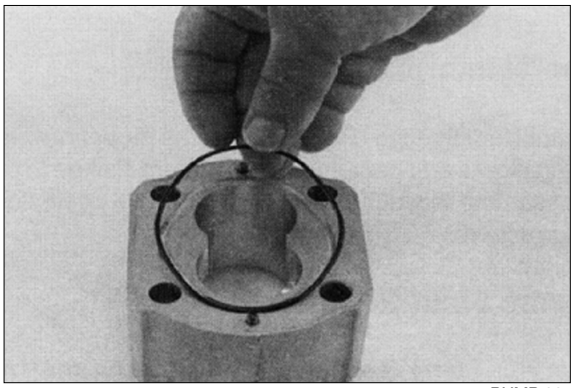
(10) Pick up the rear bearing block, with seal side up and with open end of the E-seal facing the intake side of the pump, place over the drive and idler gear shafts.

(11) Install two dowel pins in the holes in the mounting flange or two long dowel pins through gear housing if pump is a multiple section pump.



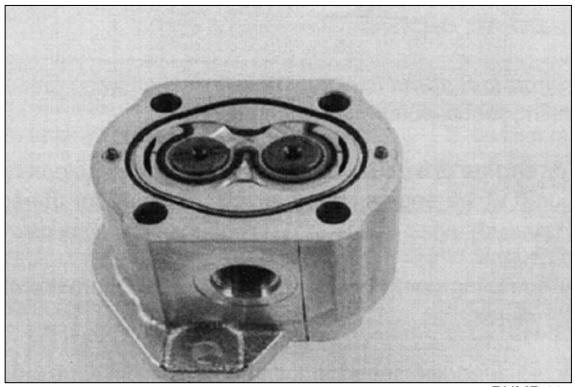
PUMP 21

(12) To install the O-rings in the gear housing, apply a light coating of petroleum jelly in the grooves on both sides of the gear housing.
Also coat the new O-ring and install them in the grooves.



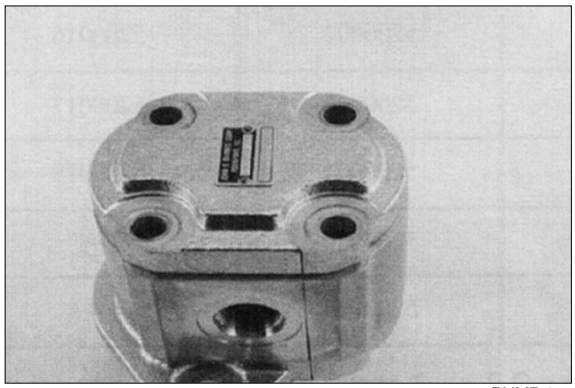
PUMP 22

(13) Gently slide the gear housing over the rear bearing block assembly, slide housing down until the housing engages the dowel pins. Press firmly in place with hands, do not force or use any tool.
Check to make sure the intake port in the housing in on the same side as the open end of the E-seal and that the marked lines on the mounting flange and gear housing are in alignment.

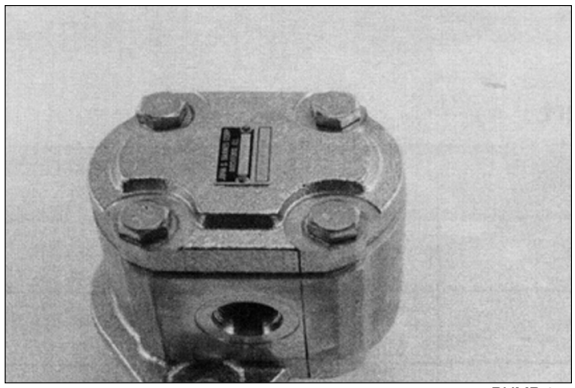

PUMP 23

(14) The surface of the rear bearing block should be slightly below the face of the gear housing. If the bearing block sits higher then the rear face of the gear housing then the E-seal or O-ring have shifted out of the groove. If this is the case, remove the gear housing and check for proper seal installation.

(15) Install the two remaining dowel pins in the rear of the gear housing and place the end cover over the back of the pump.


PUMP 24

(16) Install the four spacers and hexagon head bolts through the bolt holes in the end cover, hand tighten.

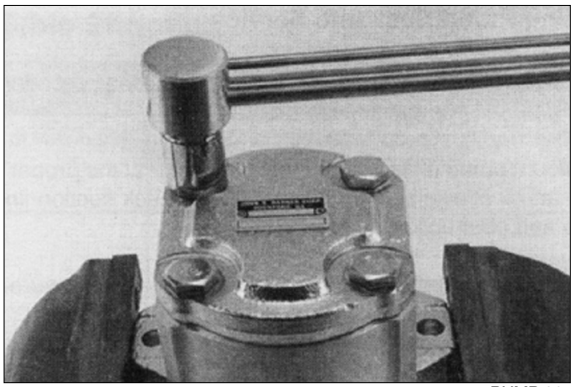

PUMP 25

(17) Place mounting flange of the pump back in the protected jawed vise and alternately torque the bolts.

· Tighten torque : 11.1~11.8kgf · m
(80~85lbf · ft)

(18) Remove pump from vise.

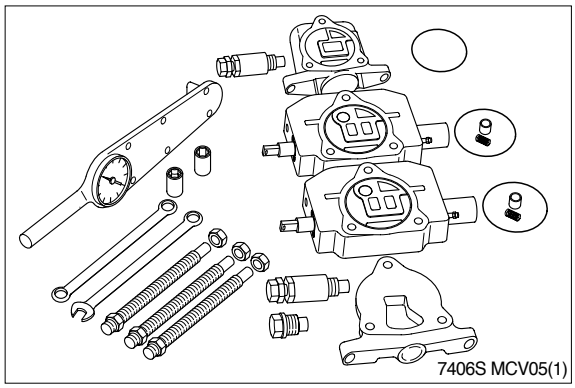
(19) Place a small amount of clean oil in the inlet of the pump and rotate the drive shaft away from the inlet one revolution. If the drive shaft binds, disassemble the pump and check for assembly problems, then reassemble the pump.



PUMP 26

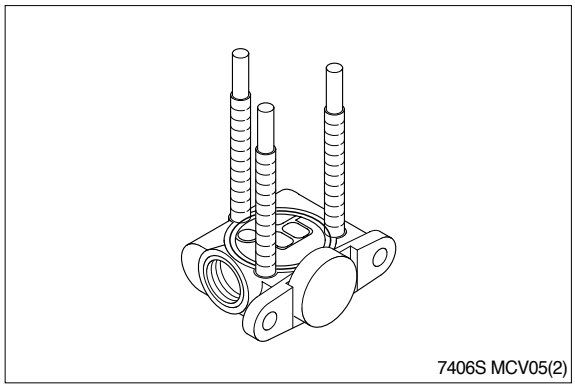
2. MAIN CONTROL VALVE

1) 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 puppet 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.



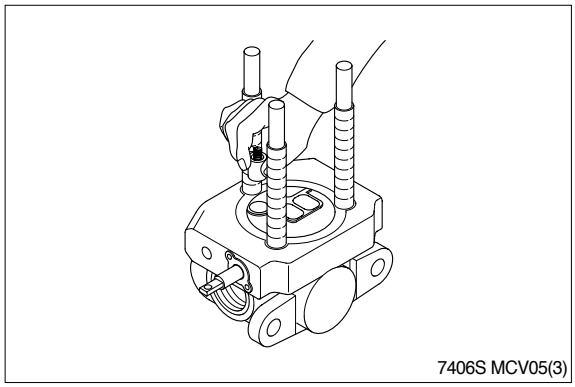
7406S MCV05(1)

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.



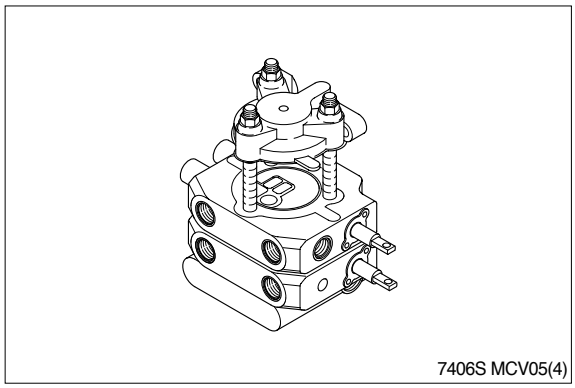
7406S MCV05(2)

3) Place first spool section(O-ring side up) on inlet section, position O-ring and insert load check puppet(nose down) and spring (behind puppet) 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.



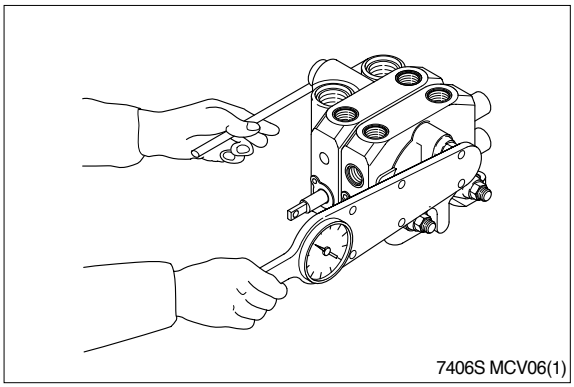
7406S MCV05(3)

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.



7406S MCV05(4)

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±lbf · ft
Final torque one 3/4 nut to 74±8lbf · ft.
Check for proper spool movement.

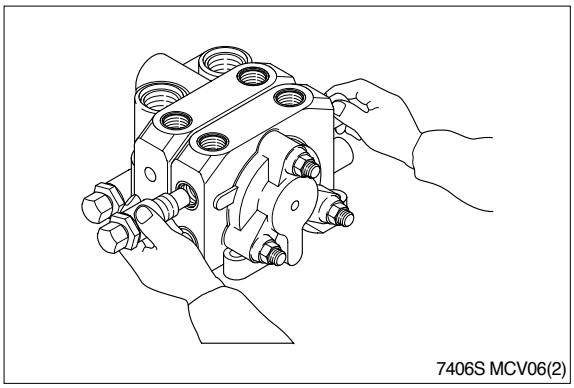

7406S MCV06(1)

6) Install auxiliary valves and plugs and torque to proper specifications.

※ **General assembly notes**:

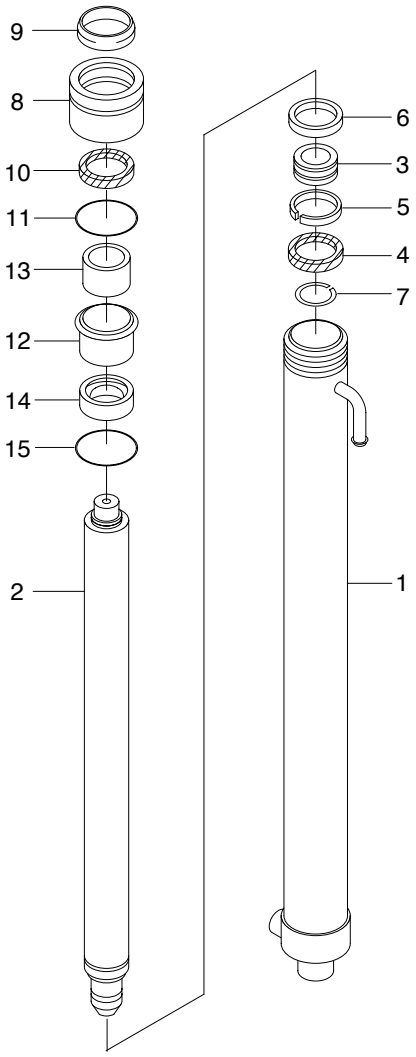
A. Lever assemblies can be installed on section before or after complete valve assembly.

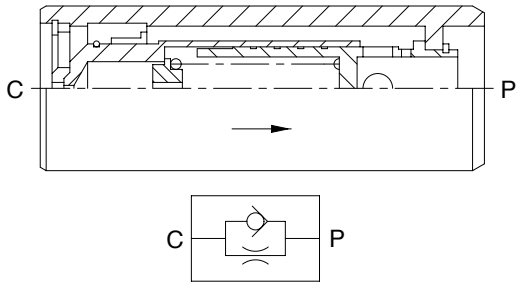
B. The load check and spring may be omitter from assembly in certain circuit conditions(i.e., motor spools).


7406S MCV06(2)

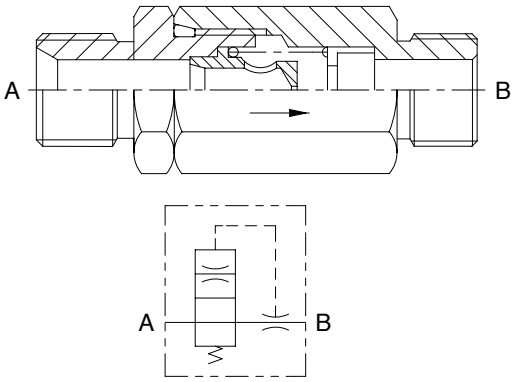
3. LIFT CYLINDER

1) STRUCTURE





Down control valve



Down safety valve

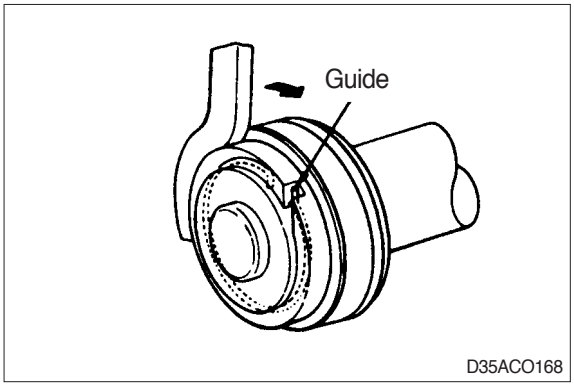
- I.D×O.D×Stroke : 50×58×1185mm
  (2.0×2.3×46.6 in)
- Rod O.D : 40mm (1.6 in)

D153HS14

1	Tube assy	6	Wear ring	11	O-ring
2	Rod assy	7	Retaining ring	12	Stopper
3	Piston	8	Rod cover	13	Du bushing
4	U-packing	9	Dust wiper	14	Spacer
5	Back up ring	10	U-packing	15	O-ring

2) DISASSEMBLY

(1) 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.



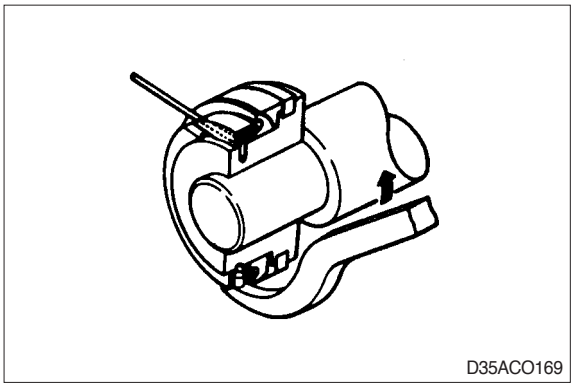
3) CHECK AND INSPECTION

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 piston ring & tube	0.05~0.030 (0.002~0.012)	0.5 (0.020)	Replace piston ring

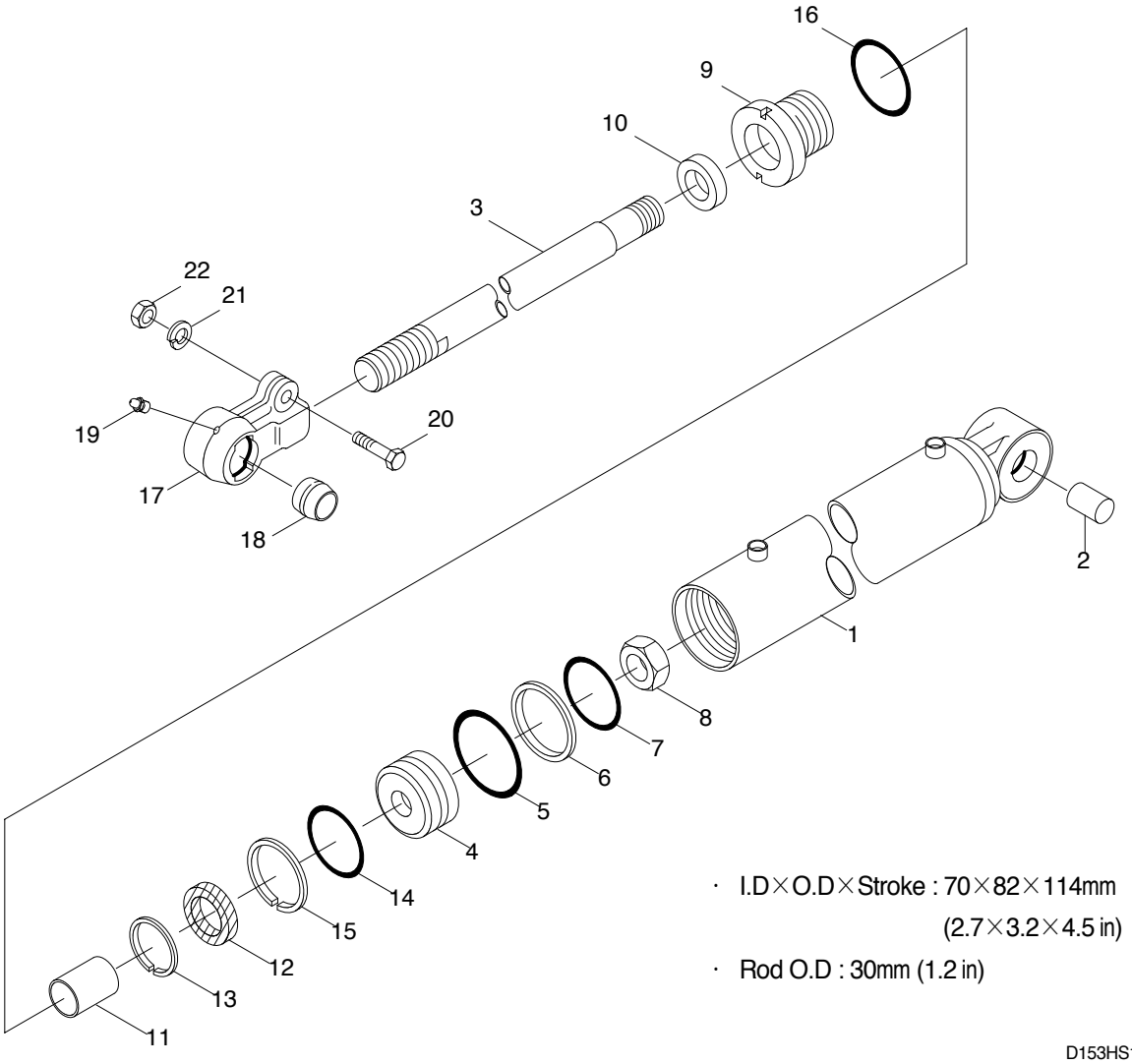
4) ASSEMBLY

(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



· I.D×O.D×Stroke : 70×82×114mm
(2.7×3.2×4.5 in)

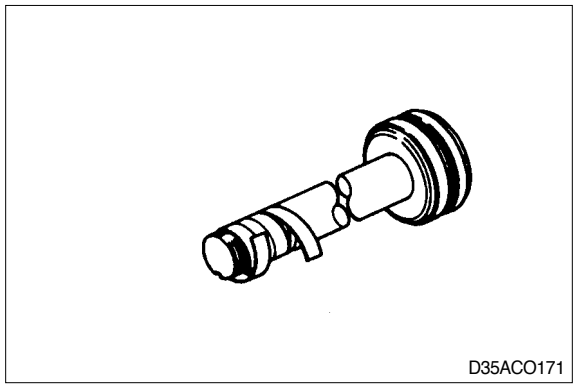
· Rod O.D : 30mm (1.2 in)

D153HS15

1	Tube assy	9	Rod cover	16	O-ring
2	Du bushing	10	Dust wiper	17	Eye
3	Rod assy	11	Du bushing	18	Bushing
4	Piston	12	U-packing	19	Grease nipple
5	O-ring	13	Back up ring	20	Hexagon bolt
6	Back up ring	14	O-ring	21	Spring washer
7	O-ring	15	Back up ring	22	Hexagon nut
8	Lock nut				

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.


D35ACO171

3) CHECK AND INSPECTION

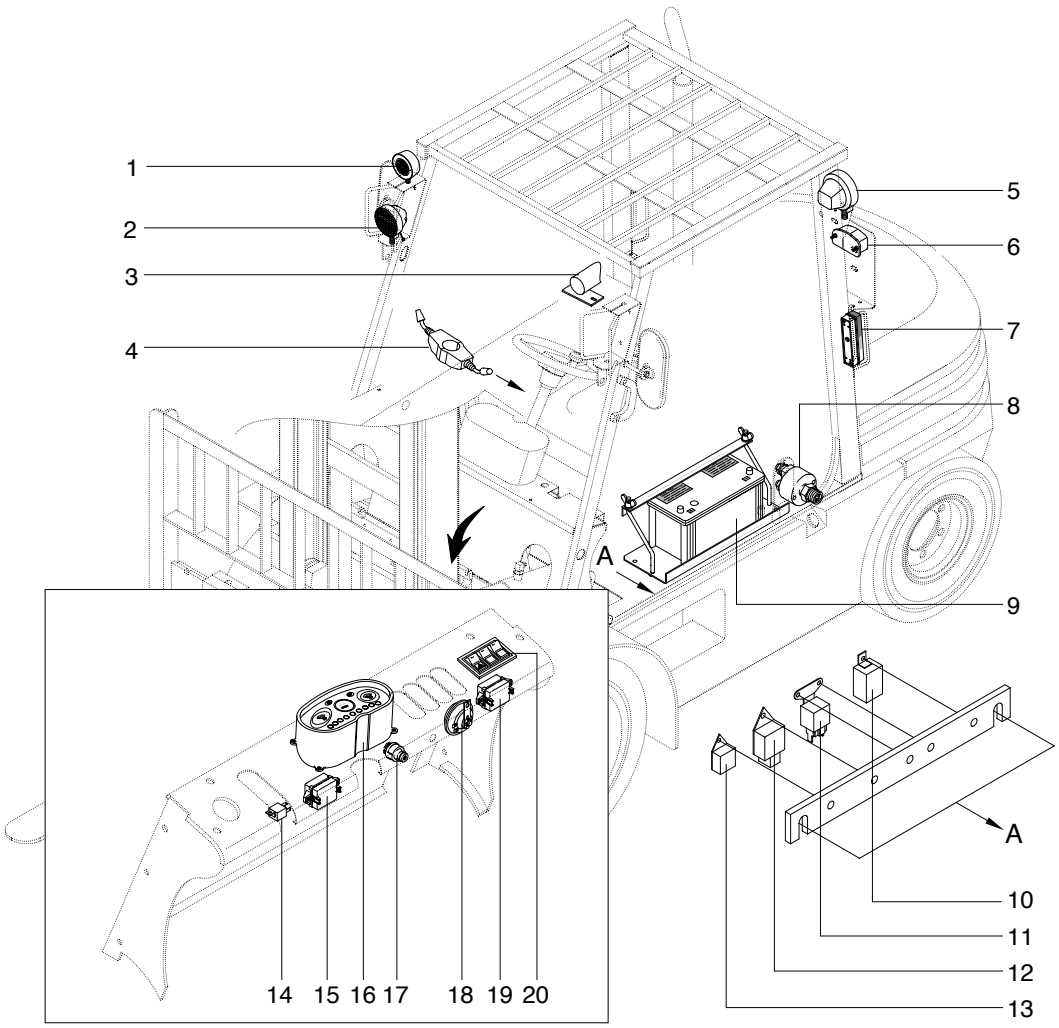
mm(in)

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

SECTION 7 ELECTRICAL SYSTEM

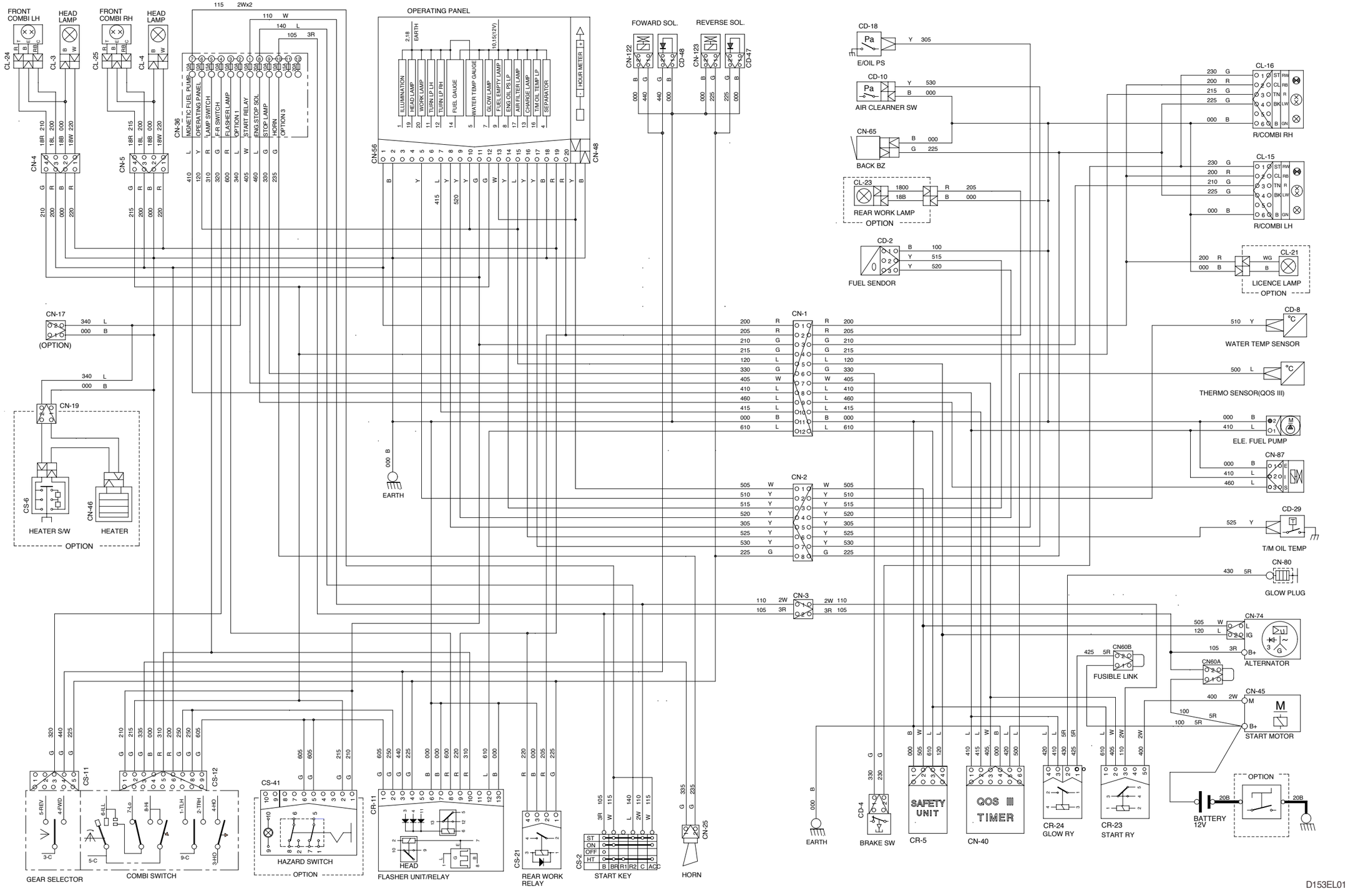
GROUP 1 COMPONENT LOCATION



D153EL00

1	Flasher lamp	8	Master switch	15	Flasher relay
2	Head lamp	9	Battery	16	Operating panel
3	Back horn	10	Start relay	17	Starter switch
4	Combination switch	11	Glow relay	18	Horn assembly
5	Rear work lamp	12	Glow timer	19	Fuse box assembly
6	License lamp	13	Safety unit	20	Hazard switch
7	Combination lamp	14	Relay		

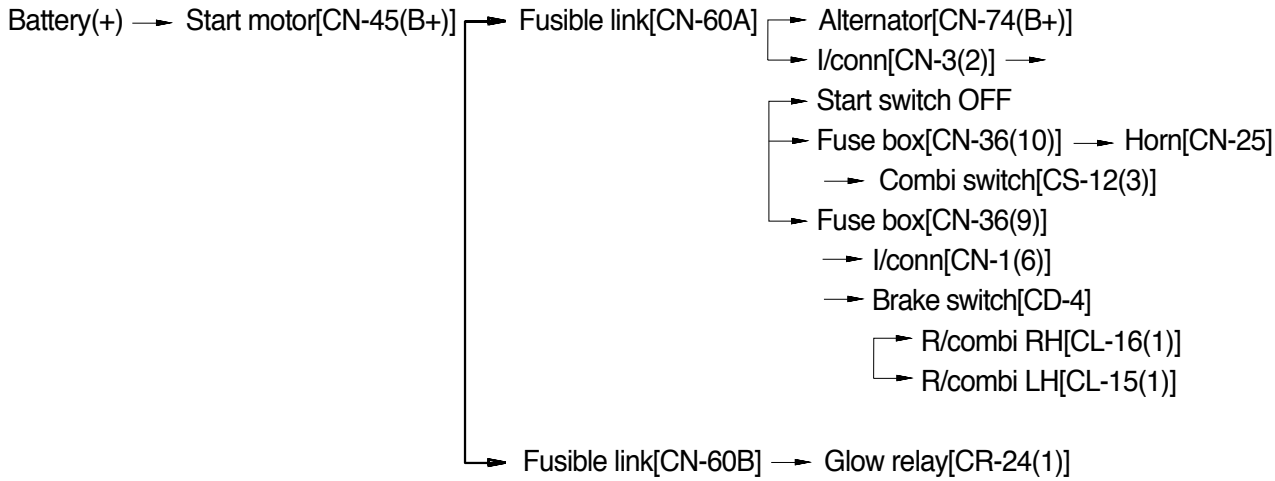
GROUP 2 ELECTRICAL CIRCUIT



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

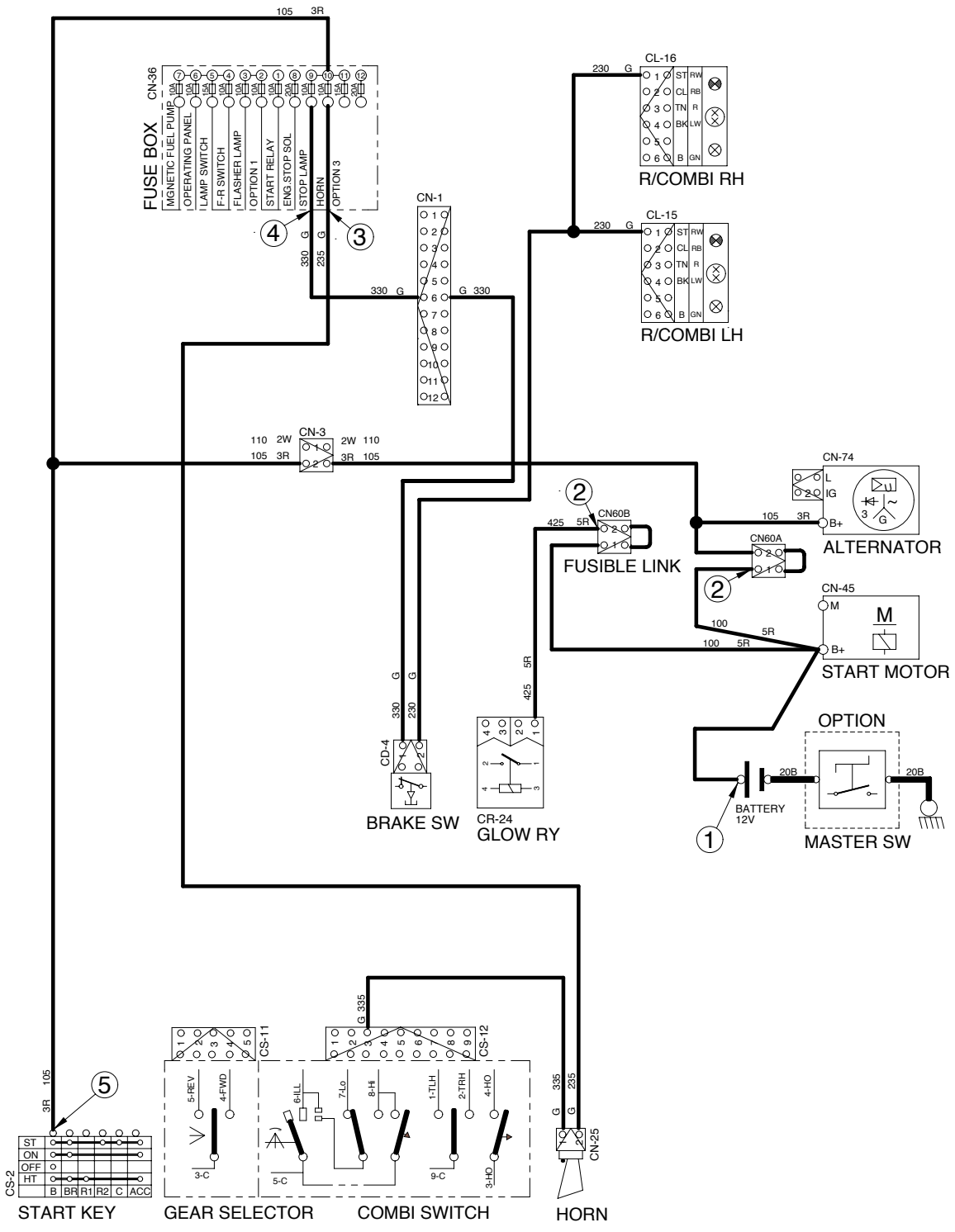


2) CHECK POINT

Engine	Key switch	Check point	Voltage
OFF	OFF	① - GND (Battery(+)) ② - GND (Fusible link) ③ - GND (Fuse No.10) ④ - GND (Fuse No.9) ⑤ - GND (Start key)	12V

※ I/conn : Intermediate connector
GND : Ground

POWER CIRCUIT



D153EL02

2. STARTING CIRCUIT

1) OPERATING FLOW

Battery(+) → Start motor[CN-45(B+)] → Fusible link[CN-60A] → Altermator[CN-74(B+)]
Fusible link[CN-60A] → I/conn[CN-3(2)] →
- Start switch[CS-2(B)]
- Fuse box[CN-36(10)] → Horn[CN-25]
- Fuse box[CN-36(10)] → Combi switch[CS-12(3)]

※ The engine can be started only when the gearshift is in neutral position.

(1) When start key switch is in ON position

Start switch ON [CS-2(Acc)] → Fuse box[CN-36(7)] → I/conn[CN-1(8)] →
- Electric fuel pump [CN-87(2)]
- QOS III timer[CN-40(1)]
- Glow relay[CR-24(3)]

(2) When start key switch is START position

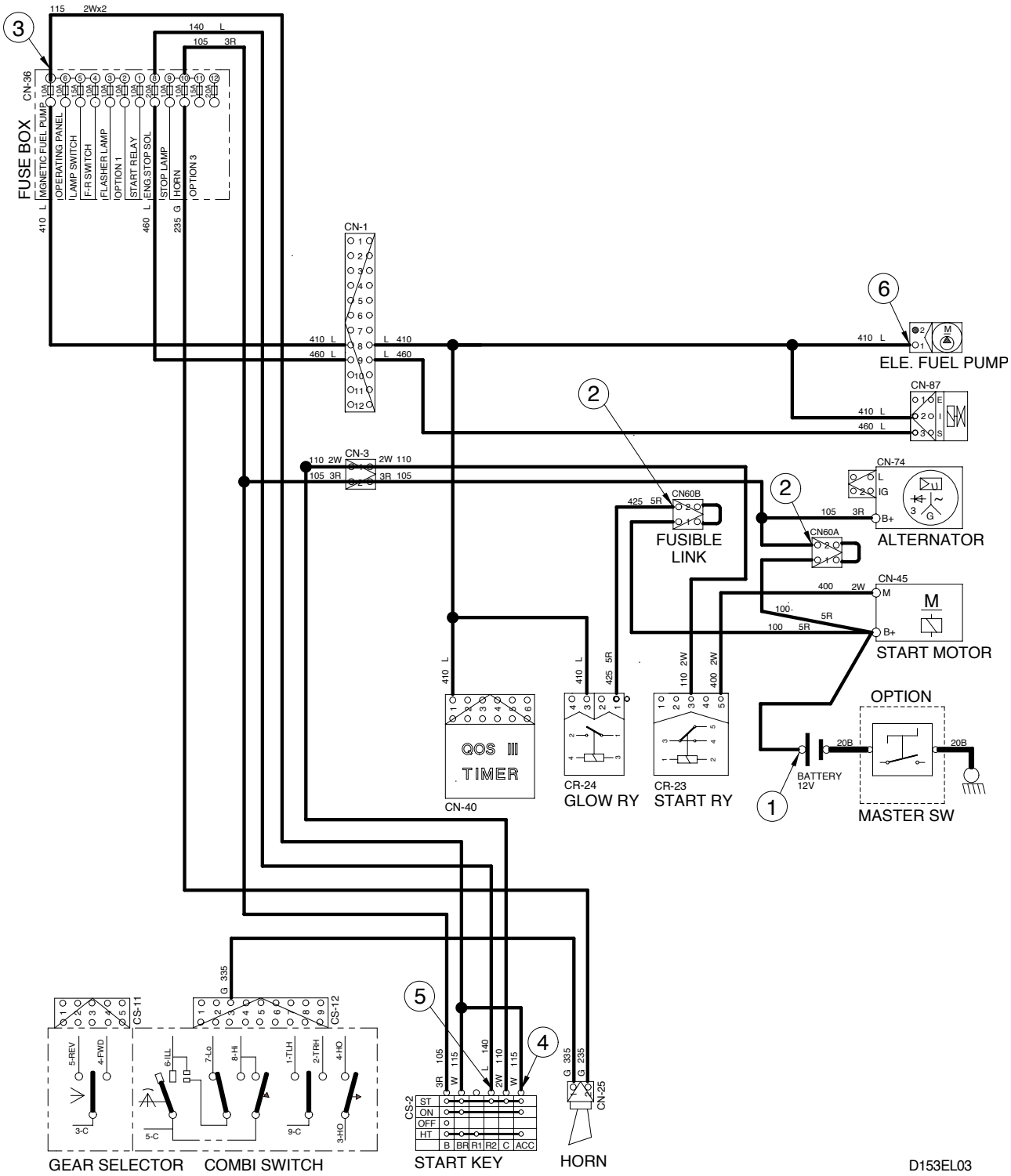
Start switch START →
- [CS-2(R2)] → Fuse box[CN-36(8)] → I/conn[CN-1(9)] → [CN-87(3)]
- [CS-2(C)] → I/conn[CN-3(1)] → Start relay[CR-23(3)→(5)] → Start motor[CN-45(M)]

2) CHECK POINT

Engine	Key switch	Check point	Voltage
Running	ON	① - GND (Battery B+) ② - GND (Fusible link) ③ - GND (Fuse box No.7) ④ - GND (Start key) ⑤ - GND (Start key) ⑥ - GND (Ele fuel pump)	12V

※ I/conn : Intermediate connector
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)] → Safety unit[CR-5(2)]
→ I/conn[CN-2(1)] → Operating panel[CN-56(13)]
→ Cluster charging warning lamp ON

(2) Charging flow

Alternator[CN-74(B+)] → Starter motor[CN-45(B+)] → Battery(+) → Charging

2) CHECK POINT

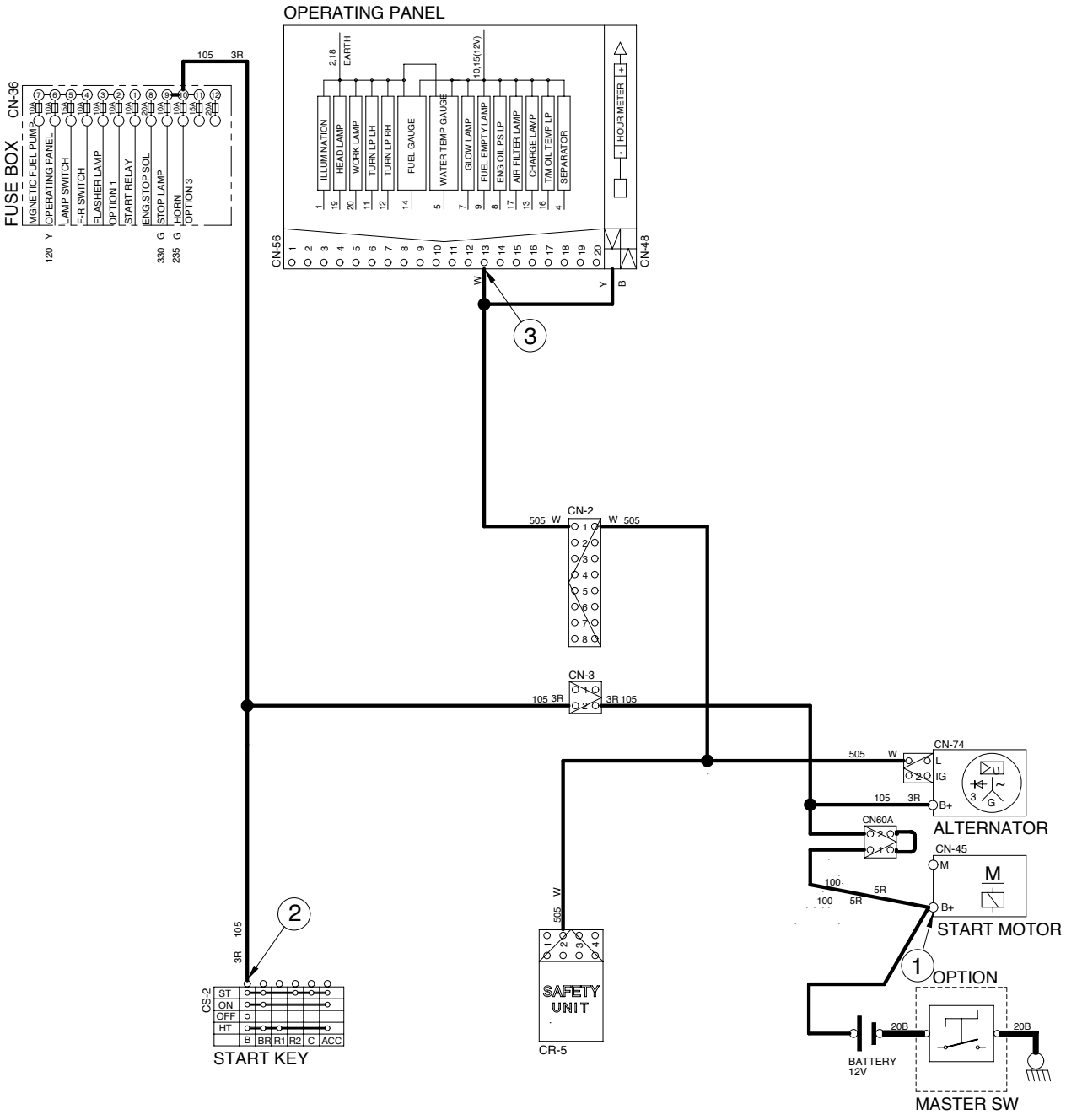
Engine	Key switch	Check point	Voltage
ON	ON	① - GND (Alternator B+) ② - GND (Start switch) ③ - GND (Cluster)	12V

※ 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



D153EL04

4. PREHEATING CIRCUIT

Combustion chamber glow plugs are used in order to give satisfactory starting of low ambient temperatures.

OPERATING FLOW

1) Battery(+) → Start motor[CN-45(B+)] → Fusible link[CN-60A] → Alternator[CN-74(B+)]
Fusible link[CN-60A] → [CN-3(2)] → Start switch[CS-2(B)]
[CN-3(2)] → Fuse box[CN-36(10)]
Fusible link[CN-60B] → 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.

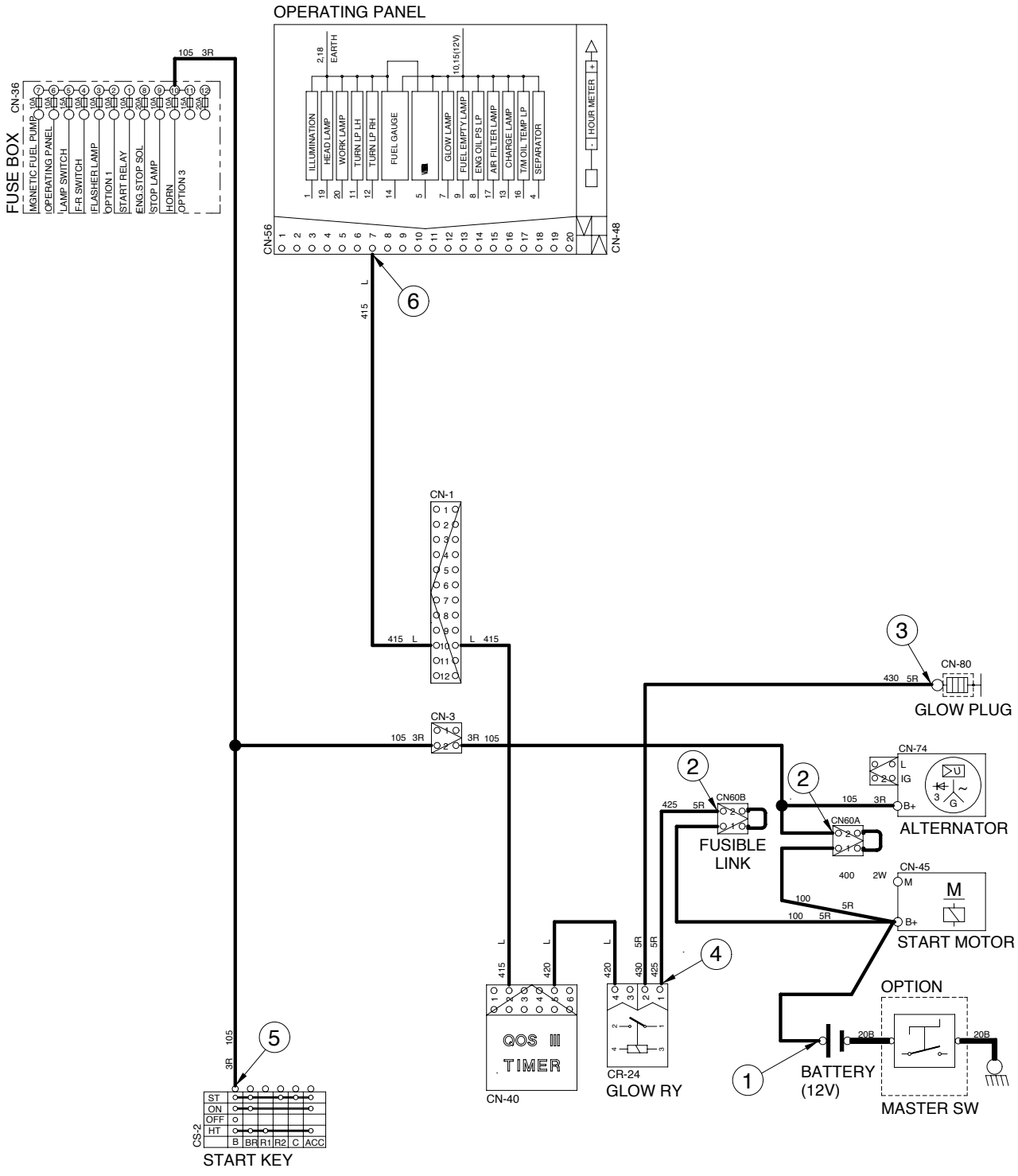
Thermo sensor → QOS III timer[CN-40(6→2)] → I/conn[CN-1(10)] → Operating panel[CN-56(7)]
QOS III timer[CN-40(6→2)] → Glow lamp ON
Thermo sensor → QOS III timer[CN-40(6→5)] → Glow relay[CR-24(4→3, 1→2)] → Glow plug[CN-80]

2) CHECK POINT

Engine	Key switch	Check point	Voltage
Stop	HEAT	① - GND (Battery B+) ② - GND (Fusible link) ③ - GND (Glow plug) ④ - GND (Glow relay) ⑤ - GND (Start switch) ⑥ - GND (Glow lamp)	12V

※ GND : Ground

PREHEATING CIRCUIT



D153EL05

GROUP 3 COMPONENT SPECIFICATION

<table>
<tr><th>No</th><th>Part name</th><th>Qty</th><th>Specification</th><th>Remark</th></tr>
<tr><td>1</td><td>Battery</td><td>1</td><td>12V×75AH
Reserve capacity : 130min
-18。C Cold cranking ampere : 630A
Charge acceptance : 10A
Life cycle : 5200Cycle
5HR Capacity : 58AH</td><td></td></tr>
<tr><td>2</td><td>Working lamp</td><td>1</td><td>12V, 55W</td><td></td></tr>
<tr><td>3</td><td>License lamp</td><td>1</td><td>12V, 3.4W×12</td><td></td></tr>
<tr><td>4</td><td>Combination lamp</td><td>2</td><td>12V, 21W(T/S) 12V, 10W(Back)
12V, 5W (Tail)
12V, 21W(Stop)</td><td></td></tr>
<tr><td>5</td><td>Head lamp</td><td>2</td><td>12V, 55W</td><td></td></tr>
<tr><td>6</td><td>Flasher lamp</td><td>2</td><td>12V, 23/8W</td><td></td></tr>
<tr><td>7</td><td>Starter relay</td><td>1</td><td>Engine Accessory</td><td></td></tr>
<tr><td>8</td><td>Flasher & Relay</td><td>1</td><td>12V, 20A (Relay)
12V, (21W+21W)×2+3W (Flasher)
130W (Harzard)</td><td></td></tr>
<tr><td>9</td><td>Back horn</td><td>1</td><td>12V, 90±5dB, 60±10C/M</td><td></td></tr>
<tr><td>10</td><td>Horn</td><td>1</td><td>12V, 1.5A, 105 ~ 115 dB</td><td></td></tr>
<tr><td>11</td><td>Fuel level sender</td><td>1</td><td>Reed switch - Magnet type
<table>
<tr><td>Float indicate</td><td>E</td><td>1/2</td><td>F</td></tr>
<tr><td>Resistance[Ω]</td><td>95</td><td>32.5</td><td>7</td></tr>
<tr><td>Allowance[Ω]</td><td>±2.5</td><td>±5</td><td>±2.5</td></tr>
</table></td><td></td></tr>
<tr><td>12</td><td>Master switch</td><td>1</td><td>12V, 10A</td><td></td></tr>
<tr><td>13</td><td>Combination switch</td><td>1</td><td>12V, 10A</td><td></td></tr>
<tr><td>14</td><td>Hazard switch</td><td>1</td><td>12V, 16A</td><td></td></tr>
<tr><td>15</td><td>Start switch</td><td>1</td><td>Engine Accessory</td><td></td></tr>
<tr><td>16</td><td>Glow plug</td><td>1</td><td>12V, Engine Accessory</td><td></td></tr>
<tr><td>17</td><td>Safety unit</td><td>1</td><td>12V, Engine Accessory</td><td></td></tr>
</table>

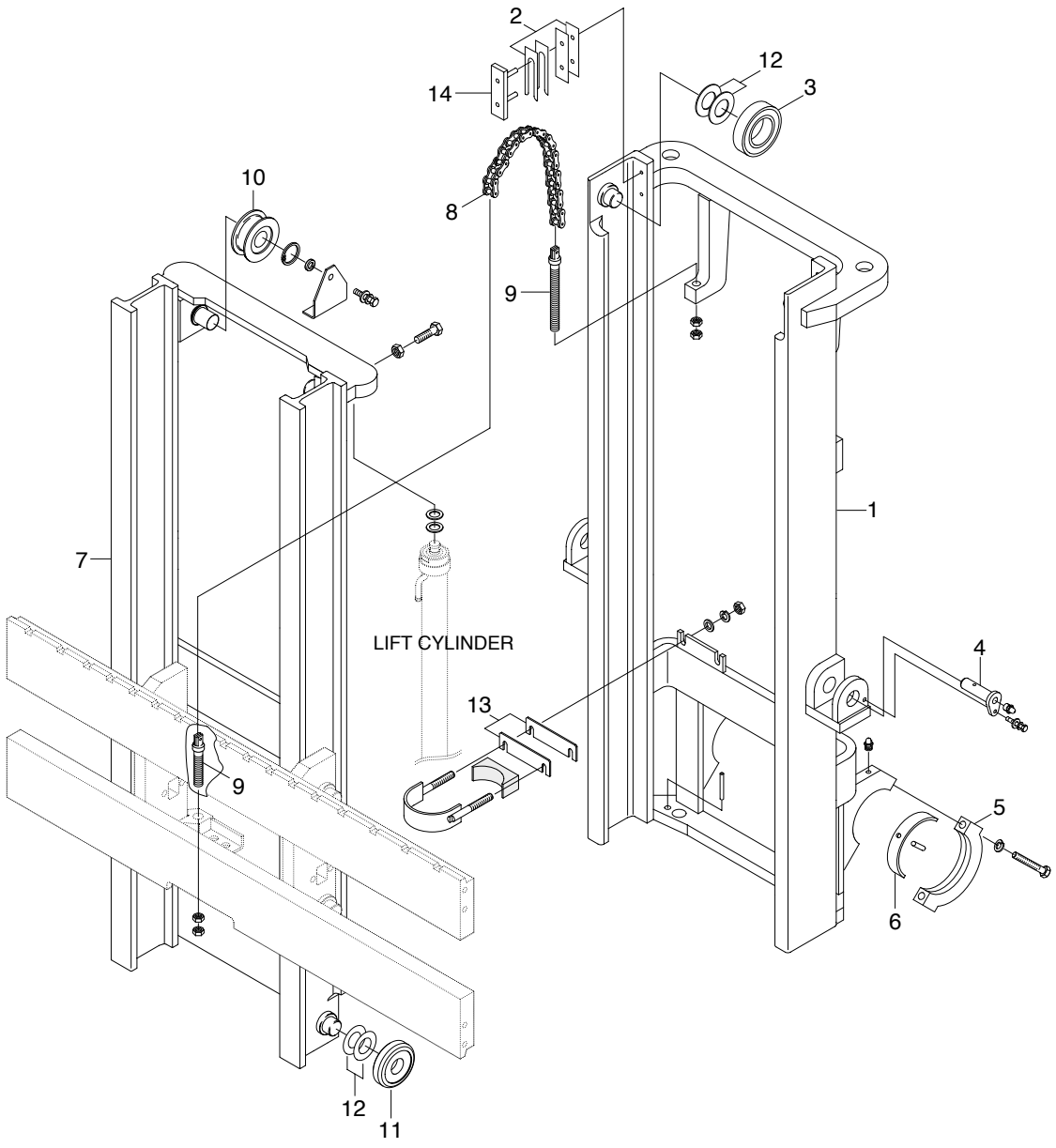
Connector number	Type	No. of pin	Destination	Connector part No.	
				Female	Male
CN-1	KET	12	I/conn(Dashboard harness-frame harness)	MG640348	MG610346
CN-2	KET	8	I/conn(Dashboard harness-frame harness)	MG640341	MG610339
CN-3	DAEDONG	2	I/conn(Dashboard harness-frame harness)	312-2P-F	312-2P-M
CN-4	KET	4	Support harness	S810-004201	-
CN-5	KET	4	Support harness	S810-004201	-
CN-17	KET	2	Option	-	MG610043
CN-19	KET	2	Option	-	MG610043
CN-25	MOLEX	2	Horn	35215-0200	-
CN-40	KET	6	Qos III timer	263020006	-
CN-45	KET	2	Start motor	-	MG610041
CN-48	KET	2	Hour meter	ST730018-3	ST750036-3
CN-56	MOLEX	20	Operating panel	35109-2010	-
CN-60A	-	2	Fusible link	S813-030200	-
CN-60B	-	2	Fusible link	S813-030200	-
CN-61	AMP	2	Magnatic fuel pump	263050002	-
CN-65	KET	2	Back horn	ST730018-3	ST750036-3
CN-74	YAZAKI	3	Alternator	7323-2735-60	-
CN-80	-	1	Glow plug	GP140105	-
CN-87	KET	3	Engine stop solenoid	263020003	-
CN-122	AMP	2	Forward solenoid	263050002	-
CN-123	AMP	2	Reverse solenoid	263050002	-
Switch					
CS-2	RING TERM	5	Start switch	GP140105	-
CS-11	AMP	5	Steering combinaton switch	-	172494-1
CS-12	AMP	9	Steering combinaton switch	-	172496-1
CS-41	SWF	10	Harzard switch	593757	-
Lamp					
CL-15	DAEDONG	6	Combination lamp-LH	110-6P-F	-
CL-16	DAEDONG	6	Combination lamp-RH	100-6P-F	-
CL-21	KET	2	License lamp	ST730018-3	ST750036-3
CL-23	KET	2	Working lamp	ST730018-3	ST750036-3
Relay					
CR-3	KET	4	Work lamp relay	S810-004201	-
CR-5	KET	4	Safety unit	263020004	-
CR-11	KET	13	Flasher unit relay	-	MG610216
CR-23	YAZAKI	5	Start relay	7323-2857-30	-
CR-24A	DAEDONG	2	Glow relay	312-1P-F	-
CR-24B	-	2	Glow relay	263020002	-

Connector number	Type	No. of pin	Destination	Connector part No.	
				Female	Male
Sensor and pressure switch					
CD-2	-	3	Fuel level sensor	263020003	
CD-4	KET	2	Stop lamp switch	ST730018-3	
CD-8	KET	1	Water temp sender	ST730018-3	
CD-10	KET	2	Air cleaner sensor	ST730057-2	
CD-18	KET	1	Engine oil pressure switch	GP140080	
CD-29	AMP	1	T/M Oil temp switch	S819-010112	
CD-30	KET	1	Thermo sensor	ST730057-2	
CD-47	AMP	2	Diode	S816-002002	
CD-48	AMP	2	Diode	S816-002002	

SECTION 8 MAST

GROUP 1 STRUCTURE

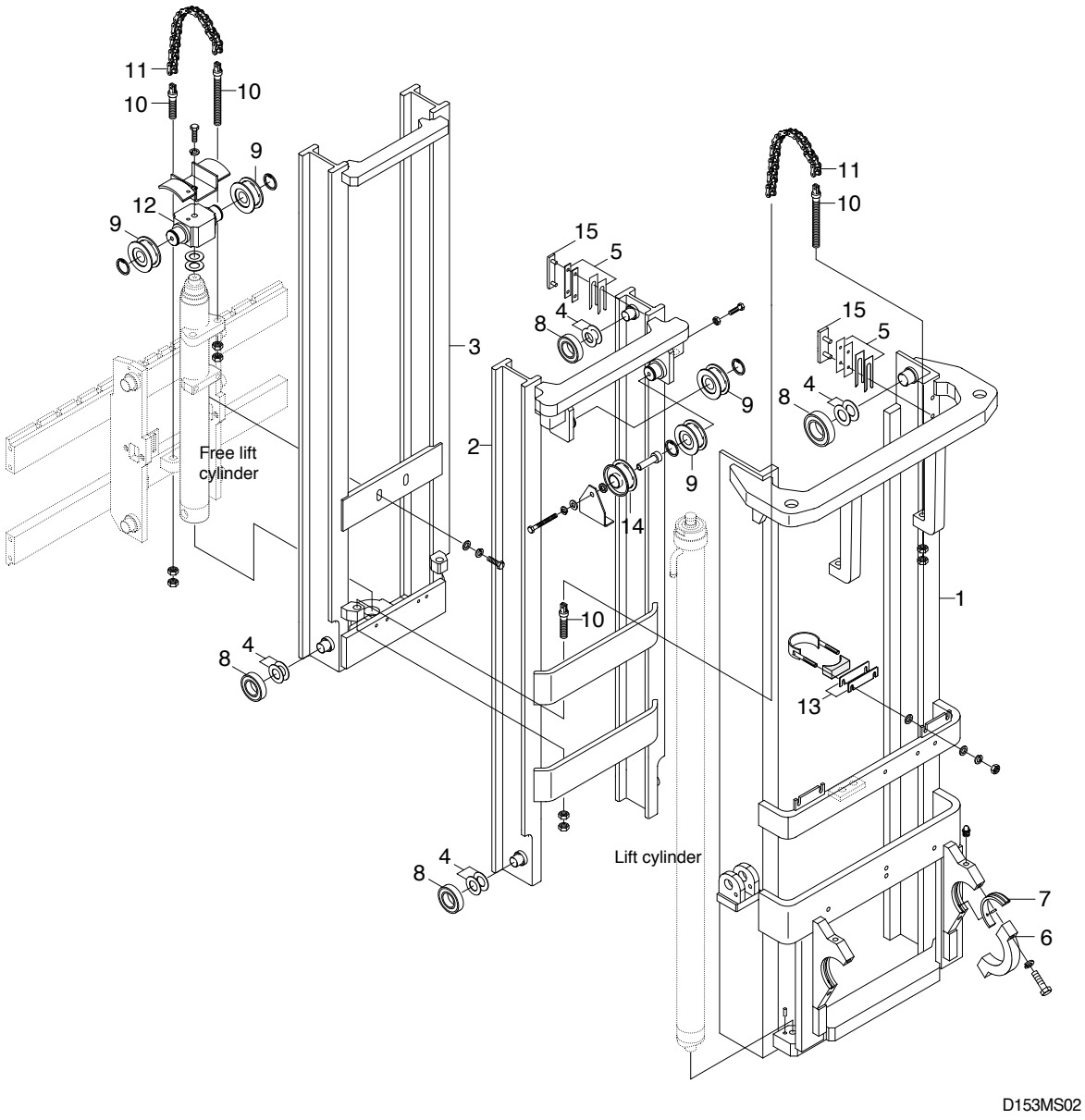
1. 2 STAGE MAST(V MAST)



D153MS01

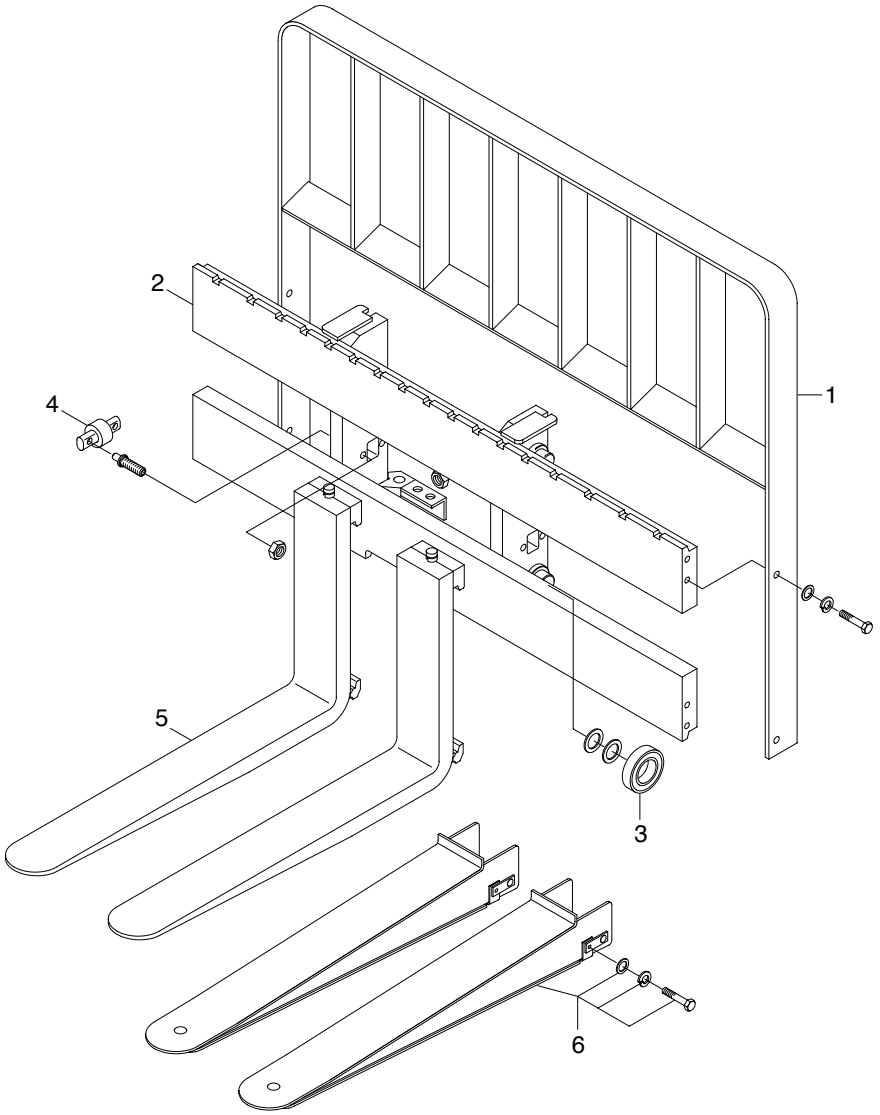
1	Outer mast	6	Bushing	11	Roller
2	Shim(0.5, 1.0t)	7	Inner mast	12	Shim(0.5, 1.0t)
3	Roller	8	Lift chain	13	Shim(0.5, 1.0t)
4	Tilt cylinder pin	9	Anchor bolt	14	Back up liner
5	Cap	10	Chain sheave		

2. 3 STAGE MAST(TF MAST)



1	Outer mast	6	Cap	11	Chain
2	Middle mast	7	Bushing	12	Cylinder head
3	Inner mast	8	Roller	13	Shim(0.5, 1.0t)
4	Shim(0.5, 1.0t)	9	Chain sheave	14	Back up liner
5	Shim(0.5, 1.0t)	10	Anchor bolt		

3. CARRIAGE, BACKREST AND FORK



D153MS03

1	Backrest	3	Load roller	5	Fork assembly
2	Carriage	4	Side roller	6	Extension fork

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

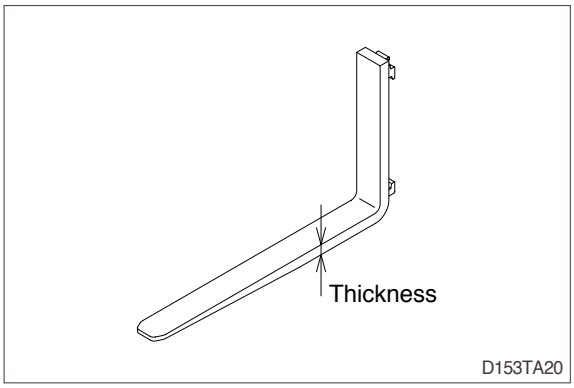
1. OPERATIONAL CHECKS

1) FORKS

(1) Measure thickness of root of forks and check that it is more than specified value.
EX : ℓ =1070mm(42.1in)

mm(in)

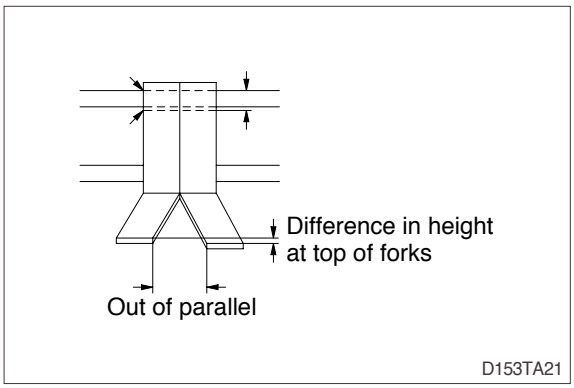
STD Fork assy	Applicable model	Standard	Limit
F5B129820	HDF15/18 III	40(1.6)	37(1.5)



2) Set forks in middle and measure out of parallel and difference in height at top of forks.

mm(in)

Difference in height	Max 15(0.6)
Out-of-parallel	Max 35(1.4)



3) Most force is concentrated at root of fork and at hook, so use crack detection method to check cracks.

2. MAST

1) Check for cracks at mast stay, tilt cylinder bracket, guide bar, fork carriage and roller shaft weld. Check visually or use crack detection method. Repair any abnormality.
2) Set mast vertical, raise forks about 10cm from ground and check front-to-rear clearance and left-to-right clearance between inner mast and fork carriage, and between outer mast and inner mast. Use these figures to judge if there is any play at roller or rail.
   · Front-to-rear clearance : Within 2.0mm(0.08in)
   · Left-to-right clearance : Within 2.5mm (0.10in)
3) Check that there is an oil groove in bushing at mast support.
4) Set mast vertical, raise forks about 10cm from ground, and push center of lift chain with finger to check for difference in tension.
   If there is any difference in tension, adjust chain stopper bolt.
5) Check visually for abnormalities at thread of chain anchor bolt, and at contact surface between chain wheel and chain.
   Rotate chain wheel by hand and check for any play of bearing.

2. TROUBLESHOOTING

1) MAST

Problem	Cause	Remedy
Forks fail to lower.	· Deformed mast or carriage.	· Disassemble, repair or replace.
Fork fails to elevate	· Faulty hydraulic equipment.	· See troubleshooting hydraulic pump and cylinders in section 6, hydraulic system.
	· Deformed mast assembly.	· Disassemble mast and replace damaged parts or replace complete mast assembly.
Slow lifting speed and insufficient handling capacity.	· Faulty hydraulic equipment.	· See troubleshooting hydraulic pump and cylinders in section 6, hydraulic system.
	· Deformed mast assembly.	· Disassemble mast and replace damaged parts or replace complete mast assembly.
Mast fails to lift smoothly.	· Deformed masts or carriage.	· Disassembly, repair or replace.
	· Faulty hydraulic equipment.	· See Troubleshooting Hydraulic Cylinders, pump and control valve in section 6, hydraulic system.
	· Damaged load and side rollers.	· Replace.
	· Unequal chain tension between LH & RH sides.	· Adjust chains.
	· LH & RH mast inclination angles are unequal. (Mast assembly is twisted when tilted)	· Adjust tilt cylinder rods.
Abnormal noise is produced when mast is lifted and lowered.	· Broken load roller bearings.	· Replace.
	· Broken side roller bearings.	· Replace.
	· Deformed masts.	· Disassemble, repair or replace.
	· Bent lift cylinder rod.	· Replace.
	· Deformed carriage.	· Replace.
	· Broken sheave bearing.	· Replace.
Abnormal noise is produced during tilting operation.	· Insufficient lubrication of anchor pin, or worn bushing and pin.	· Lubricate or replace.
	· Bent tilt cylinder rod.	· Replace.

2) FORKS

Problem	Cause	Remedy
Abrasion	Long-time operations causes the fork to wear and reduces the thickness of the fork. Inspection for thickness is needed. · Wear limit : Must be 90% of fork thickness	If the measured value is below the wear limit, replace fork.
Distortion	Forks are bent out of shape by a number of reasons such as overloading, glancing blows against walls and objects, and picking up load unevenly. · Difference in fork tip height : 15㎜ · Difference in fork tip width : 35㎜	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(V MAST)

1) INNER/OUTER MAST ROLLER CLEARANCE ADJUSTMENT

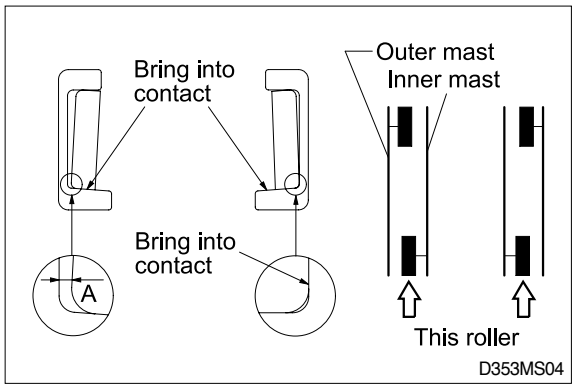
(1) Measure the clearance with the mast overlap at near 480㎜.

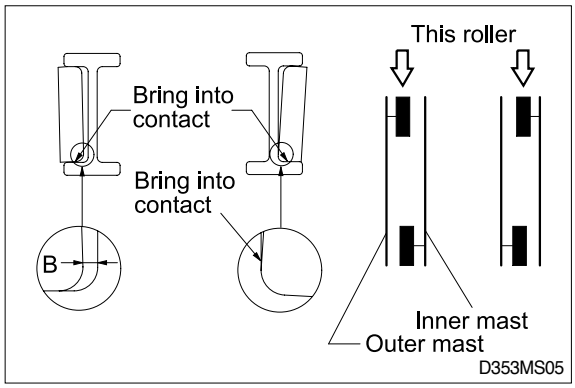
(2) Shift the inner mast to one side to bring the roller into contact with the outer mast, and adjust the clearance between the roller side face and mast at the closest position on the opposite side to the following value by inserting the inner/outer mast roller shim.

- Standard clearance A, B = 0~0.6㎜
- Shim thickness 0.5, 1.0㎜

(3) Distribute the shim thickness equally to the left and right roller. Refer to Mast load roller and back up liner, removal and Installation.

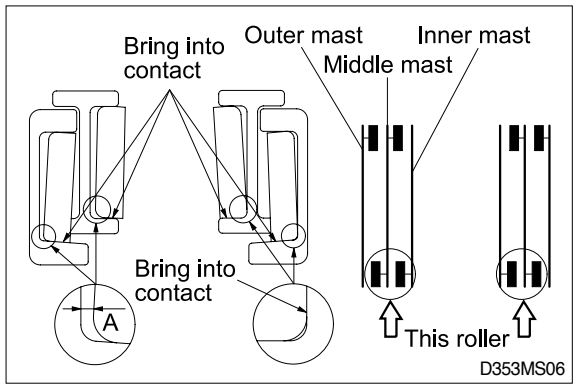
(4) After the adjustment, check that the inner mast moves smoothly in the outer mast.





2. MAST LOAD ROLLER(TF MAST)

1) INNER AND MIDDLE MAST ROLLER CLEARANCE ADJUSTMENT



(1) Measure the clearance with the mast overlap at near 480mm.

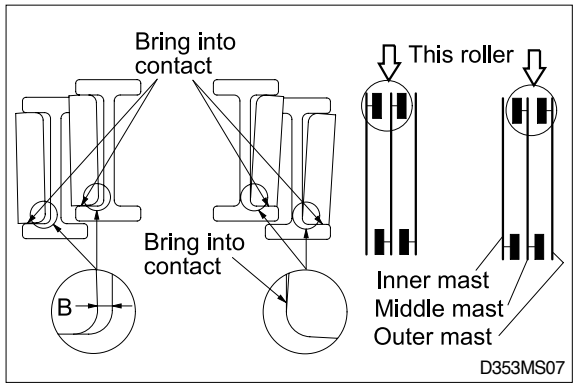
(2) Shift the inner mast to one side to bring the roller into contact with the outer mast and the middle mast, and adjust the clearance between the roller side face and mast at the closest position on the opposite side to the following value by inserting the inner and middle mast roller shim, respectively.

- Standard clearance A = 0~0.6mm
- Shim thickness 0.5, 1.0mm

(3) Distribute the shim thickness equally to the left and right roller. Refer to Mast load roller and back up liner, removal and Installation.

(4) After the adjustment, check that the inner mast moves smoothly in the middle mast, and the middle mast moves smoothly in the outer mast.

2) OUTER AND MIDDLE MAST UPPER ROLLER CLEARANCE ADJUSTMENT.



(1) Measure the clearance with the mast overlap at near 480mm.

(2) Shift the inner mast to one side to bring the roller into contact with the outer mast and the middle mast, and adjust the clearance between the roller side face and mast at the closest position on the opposite side to the following value by inserting the outer and middle mast roller shim, respectively.

- Standard clearance B = 0~0.6mm
- Shim thickness 0.5, 1.0mm

(3) Distribute the shim thickness equally to the left and right roller. Refer to Mast load roller and back up liner, removal and Installation.

(4) After the adjustment, check that the inner mast moves smoothly in the middle mast, and the middle mast moves smoothly in the outer mast.

3) CARRIAGE LOAD ROLLER

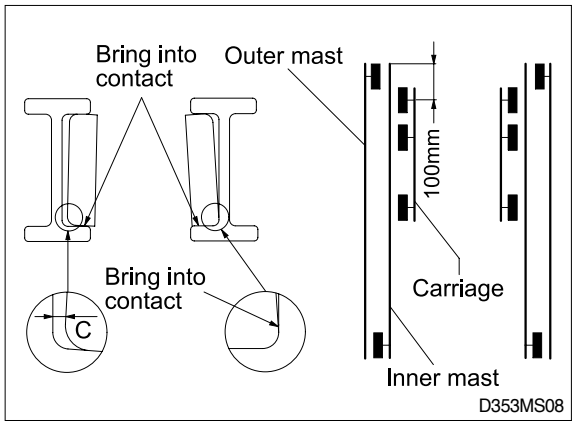
(1) Measure the clearance when the center of the carriage upper roller is 100mm from the top of the inner mast.

(2) Measure the clearance at upper, middle and lower rollers after loosen the adjust screws from the side rollers. Shift the carriage to one side to bring the roller into contact with the inner mast, and measure the clearance between the roller side face and mast at the closest position on the opposite side to the following value by inserting the carriage roller shim.

- Standard clearance C = 0~0.6mm
- Shim thickness 0.5, 1.0mm

(3) Distribute the shim thickness equally to the left and right roller. Refer to Carriage assembly.

(4) After the adjustment, the carriage should move smoothly along the overall mast length.



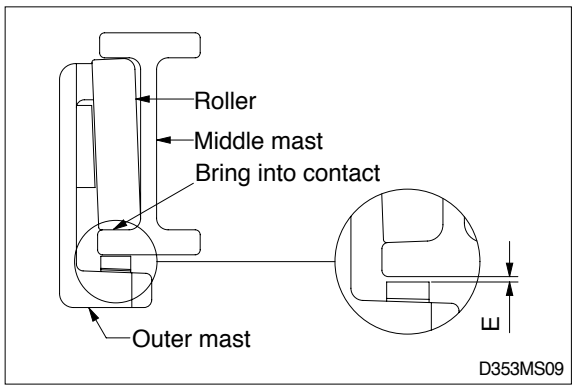
4) MAST BACK UP LINER

(1) Measure the clearance with the middle mast at the bottom position.

(2) With the middle mast in contact with the outer mast roller, adjust the clearance between the mast back up liner and middle mast to the following value by inserting the back up liner shim.

- Standard clearance E = 0.2 ~ 0.6mm
- Shim thickness 0.5, 1.0mm

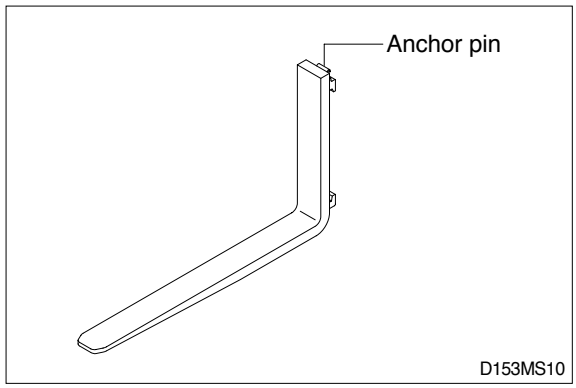
(3) After the adjustment, the mast should move smoothly.



GROUP 4 REMOVAL AND INSTALLATION

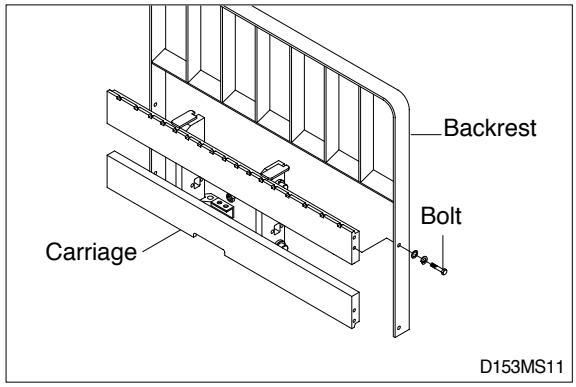
1. FORKS

1) Lower the fork carriage until the forks are approximately 25mm(1inch) from the floor.
2) Release fork anchor pins and slide forks, one by one, toward the center of the carriage where a notch has been cut in the bottom plate for easy fork removal.
3) Remove the fork one by one. On larger forks it may be necessary to use a block of wood.
4) Reverse the above procedure to install load forks.



2. BACKREST

1) 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 elevating upright until mast clears top of fork carriage. Move carriage to work area and lower mast.

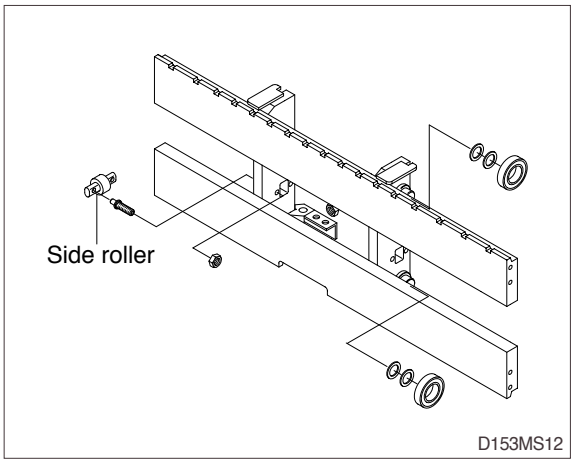
⚠ Make sure carriage remains on floor and does not bind while mast is being raised.

(5) Inspect all parts for wear or damage. Replace all worn or damaged pars.
(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 assembly and removal paragraph.
(2) Loosen and remove nuts, adjust screws and side rollers from carriage side pate.
(3) Thoroughly clean, inspect and replace all worn or damaged parts.
(4) Reverse the above procedure to assembly.

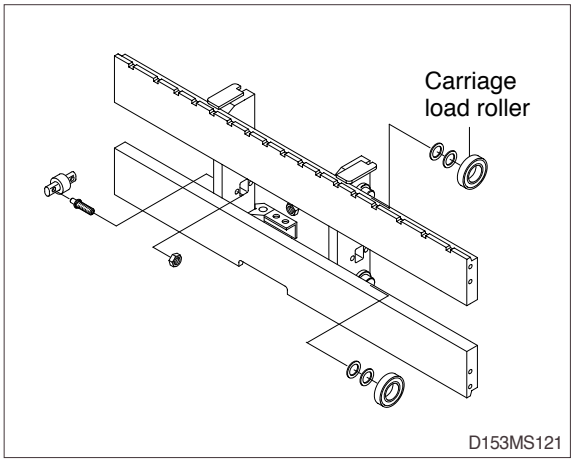


※ **Adjustment**

- 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 for 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

(1) Remove carriage as outlined in the carriage assembly removal paragraph.
(2) Loosen and remove flat head bolts and plain washers from top load roller bracket.
(3) Using a pryer, remove load rollers from load roller bracket.
(4) Reverse the above procedure to assemble. Refer to MAST ROLLER ADJUSTMENT paragraph.



4) MAST LOAD ROLLER AND BACK UP LINER

(1) 2 stage mast(V mast)

① Remove the carriage assembly and move them to one side.

② Loosen and remove hexagon bolts and washers securing lift cylinders to inner mast.

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

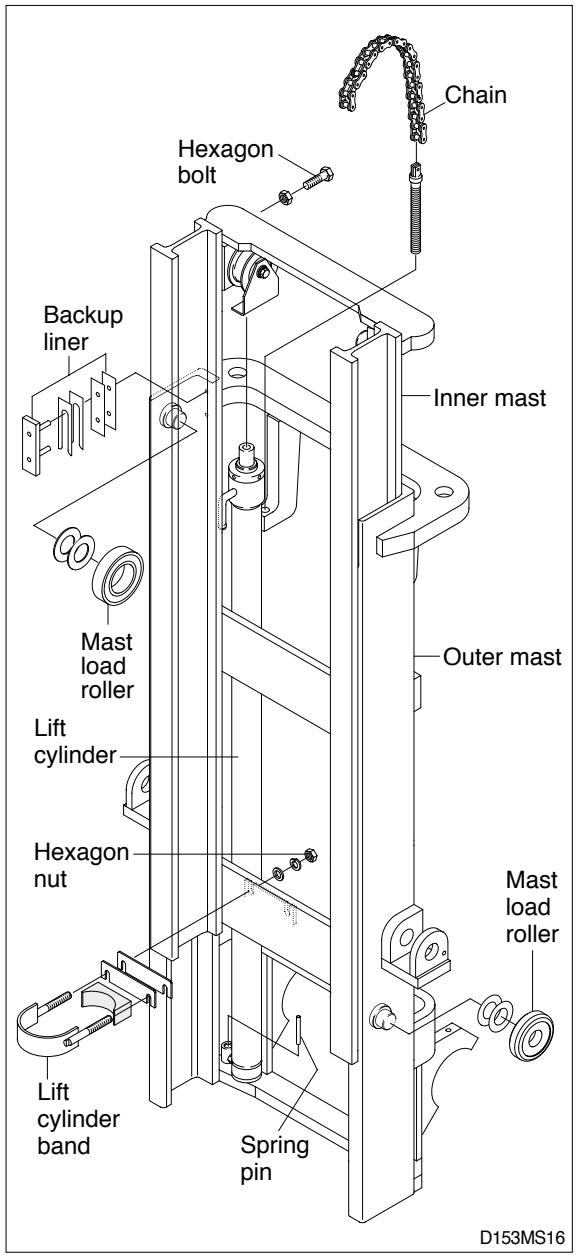
⑤ After lowering the lift cylinder rods, and disconnecting lift cylinder hose, tilt the lift cylinders LH and RH and them with ropes to the outer mast.

⑥ Using the overhead hoist, lower inner mast until top and bottom rollers and back up liners are exposed.

⑦ Using a pryer, remove load rollers from load roller bracket. Remove back up liners and shims.

⑧ Thoroughly clean, inspect and replace all worn or damaged parts.

⑨ Reverse the above procedure to assemble. Refer to MAST LOAD ROLLER ADJUSTMENT paragraph.



(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 band and special washers securing lift cylinders to middle mast. Remove the spring pin.

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 4 inch 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 support chains, remove chain sheaves and let chains hang free. The upper outer and lower middle mast rollers and back up liners are now exposed.

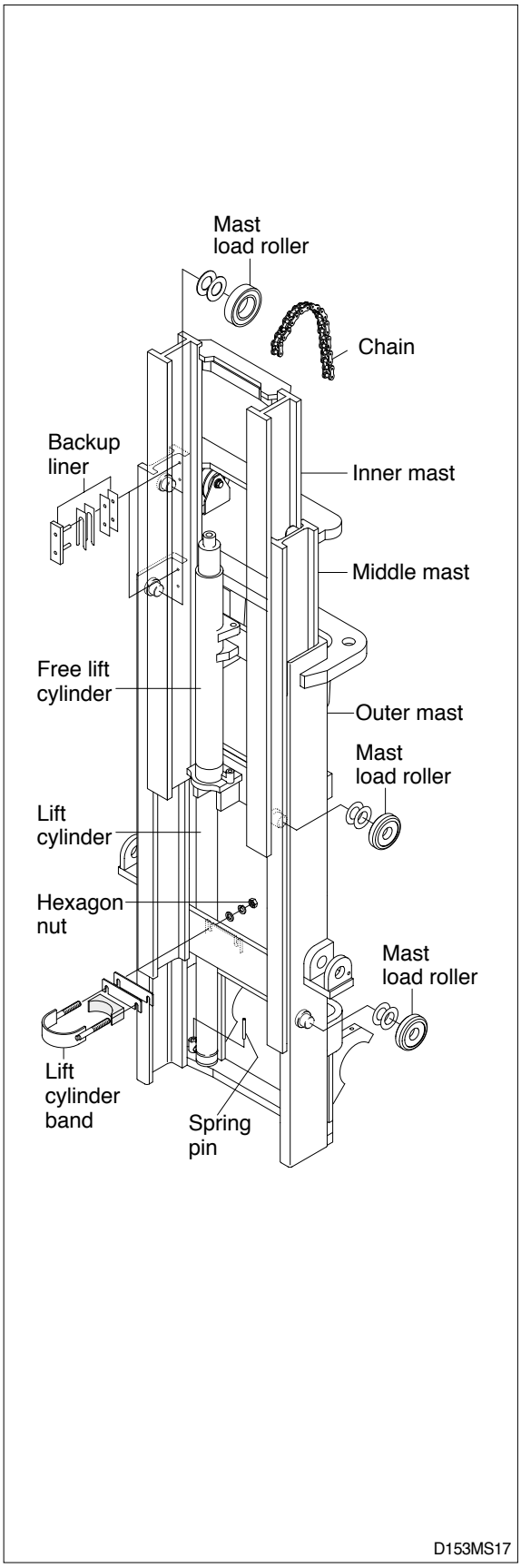
⑧ Using a player, remove load rollers from load bracket. Remove back up liners and shims.

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 pryer, remove load rollers from load roller bracket.

⑪ Thoroughly clean, inspect and replace all worn or damaged parts.

⑫ Reverse the above procedure to assemble. Refer to MAST LOAD ROLLER ADJUSTMENT paragraph.



5) ELEVATING MAST

(1) Inner mast (V mast)

① After completing all necessary steps for load rollers and back up liner removal use an overhead hoist and sling or chain around upper crossmember of the inner mast section.
② Lift inner mast upright straight up and out of outer mast section.
③ Replace and reverse above procedure to install. Make all necessary measurements and adjustments.

(2) Inner and middle mast(TF mast)

① After completing all necessary steps for load rollers and back up liner removal. Remove rear chains and sheave support if not already done.
② Disconnect free lift cylinder hose. Drain hose into a suitable pan or container and cap hose.
③ While supporting free lift cylinder assembly, remove bolts and washers securing cylinder to mast crossmember.
④ Place a sling around free lift cylinder and attach to an overhead hoist. Slowly raise and move cylinder to one side.
⑤ Attach chains or sling to the inner mast section at top crossmember. Using an overhead hoist slowly raise the upright straight up and out of middle mast section.
⑥ Attach chains or sling to the middle mast section at top crossmember. Using an overhead hoist slowly raise the upright straight up and out of outer mast section.
⑦ Replace upright and reverse above procedure to install. Make all necessary measurements and adjustments.

6) CHAIN

(1) Chain sheave(V mast)

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.

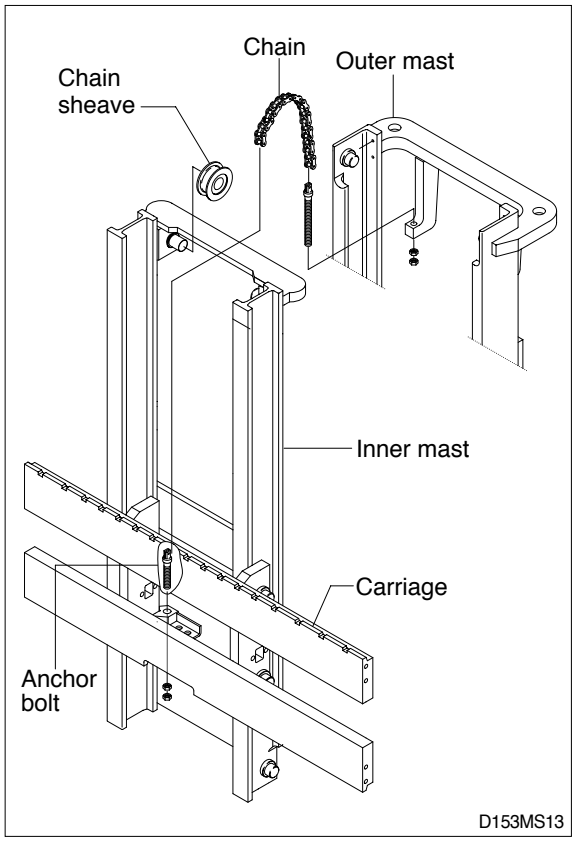
② Remove the split pin securing the chain anchor pins and discard. While supporting the chains, remove the chain anchor pins and drape the chains over the carriage.

③ Remove retaining ring securing sheaves to sheave support. Remove sheaves with bearings.

④ Remove bearining 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. While supporting the chains, remove the chain anchor pins from outer mast section.

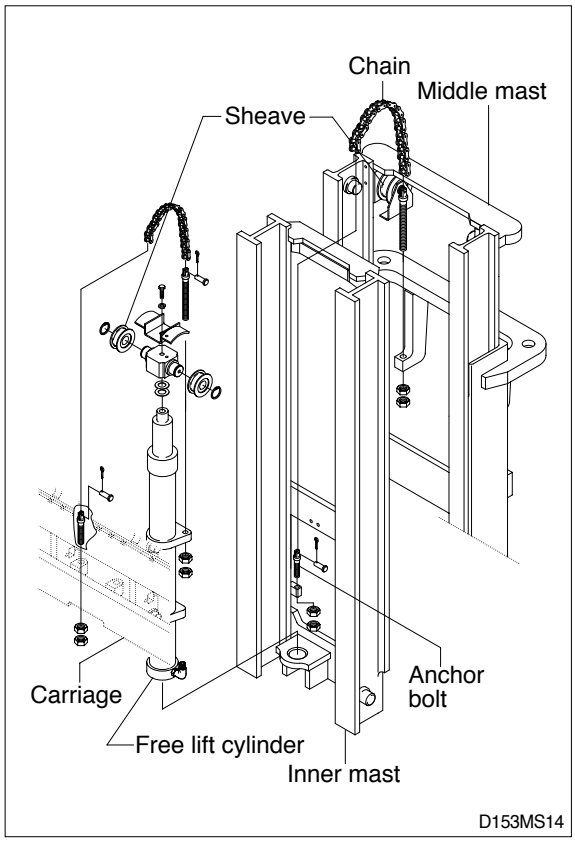
③ Remove chains.

④ Remove retaining ring securing chain sheaves to sheave support. Pry off sheaves with bearings.

⑤ Remove bearing retaining ring from sheave and press bearings from sheaves.

⑥ Thoroughly clean, inspect and replace all worn or damaged parts.

⑦ Reverse the above procedure to assemble and install. Use new split pins in chain anchor pins.



(3) Chain sheave support(TF mast)

① Remove the carriage assembly and move to one side.

② After removing bolt to securing chain sheave support assembly to free lift cylinder.
After a sling to the chain 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 chain sheave to chain wheel bearing support.

④ Remove bearing retaining ring from chain sheave and press bearings from chain sheave.

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 chain wheel bearings, 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 our 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 chain wheel bearings**

An inspection of the chain system includes a close examination of chain anchors and chain wheel bearings. 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. Chain wheel bearings with badly worn flanges and outside diameter should be replaced. Heavy flange wear indicates chain misalignment.

⑧ Chain wear scale

The chain can be checked for wear or stretching with the use of a chain wear scale. Stretching of a chain is due to the elongation of the pitch holes and wearing of the pin O.D. The greatest amount of stretching occurs at the areas of the chain that flex over the sheaves most frequently. Check the chain at this point with a scale. The wear scale has instructions printed on the sides for use in determining chain stretch and are as follows :

· Determine pitch length of chain using 6 inch scale on one side of wear scale.
· If pitch is 1/2(12.7㎜), 3/4(19.05㎜), 1(25.4㎜), 1-1/2(38.1㎜), 2(50.8㎜), use side A of scale.
· If pitch is 5/8(15.875㎜), 1-1/4(31.75㎜) or 2(50.8㎜), use side B.
· Align point A or B to center of a pin and note position of the opposite A or B point.
· If other point also lines up with a pin, the chain is worn and should be replaced.

If any of the above conditions exists(cracked plates, turned pins, stretching etc), the chains should be replaced in pairs as a complete assembly. Order chains by part number to insure the correct chain length, pitch and material specifications.

(7) Load chain lubrication and adjustment

① Lubrication

The most important consideration in field maintenance of lift chains is lubrication. Hard working, heavily loaded chains cannot be expected to give satisfactory wear life without scheduled periodic re-lubrication. Like all bearing surfaces, the precision manufactured, hardened steel, joint-wearing surfaces require a film of oil between mating parts to prevent rapid wear. Oil must penetrate the chain joint to prevent wear. Applying oil to external surfaces will prevent rust, but oil must flow into the live bearing surfaces for maximum wear life. Frequency of re-lube will vary with operating conditions and environment, the best estimate of lube period is 200 hours. Trucks parked outdoors or trucks in extremely severe service, may require more frequent re-lube to maintain an oil film on all chain surface.

· Wipe off the old oil with a clean cloth and blow out the remaining dirt with compressed air.

⚠ Wear eye protection.

· With a clean brush, apply EP-140 extreme pressure lubricant or heavy motor oil(40W).

② Replacement

Replace chains as a pair. It will be virtually impossible to maintain uniform loading between the strands if a new chain is put into service opposite an old chain. The jonts in the old chain will be greater than that on the new chain, greatly complicating the problem of maintaining equal chain tension. The new chain will wear more slowly causing it to bear the major portion of the load resulting in premature wear and fatigue failure. Don't steam clean or decrease new chains.

The manufacturer's grease is effective in reducing wear and corrosion. If the original factory lube is dried out or wiped off, soak the new chain in heavy engine oil for at 1/2 hour prior to installing on truck. After the old chains have been stripped from the mast, very carefully inspect chain anchors and chain sheave. Broken, cracked or worn anchor must be replaced using the new anchor pin and split pin. Do not paint newly replaced chain after it has been installed.

③ **Adjustment**

Chain adjustments are important for the following reasons :

- Equal loading of chain.
- Proper sequencing of mast.
- Prevent over-stretching of chains.
- Prevent chains from jumping off sheaves if they are too loose.

④ **Adjustment procedure**

- With mast in its fully collapsed and vertical position, lower the fork to the floor.
- Adjust the chain length by loosening or tightening nut on the chain anchor.
  After making adjustment on the mast, be sure to tighten the nut.