CONTENTS

1. STRUCTURE

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

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

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

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

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

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

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

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

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

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

2. HOW TO READ THE SERVICE MANUAL

Distribution and updating

Any additions, amendments or other changes will be sent to HYUNDAI distributors.

Get the most up-to-date information before you start any work.

Filing method

1. See the page number on the bottom of the page.
   File the pages in correct order.
2. Following examples shows how to read the page number.
   Example 1

   2 - 3

   - 2 : Item number(2. Structure and Function)
   - 3 : 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.

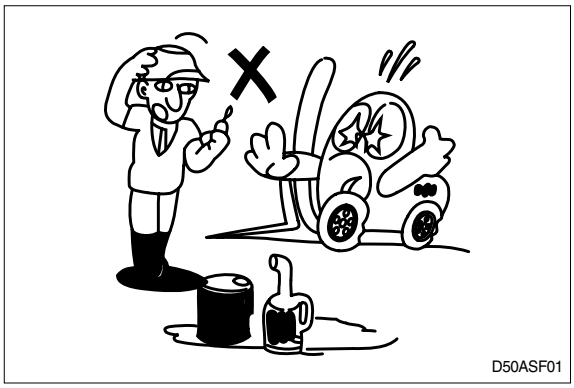
°C		°F	°C		°F	°C		°F	°C		°F
-40.4	-40	-40.0	-11.7	11	51.8	7.8	46	114.8	27.2	81	117.8
-37.2	-35	-31.0	-11.1	12	53.6	8.3	47	116.6	27.8	82	179.6
-34.4	-30	-22.0	-10.6	13	55.4	8.9	48	118.4	28.3	83	181.4
-31.7	-25	-13.0	-10.0	14	57.2	9.4	49	120.2	28.9	84	183.2
-28.9	-20	-4.0	-9.4	15	59.0	10.0	50	122.0	29.4	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

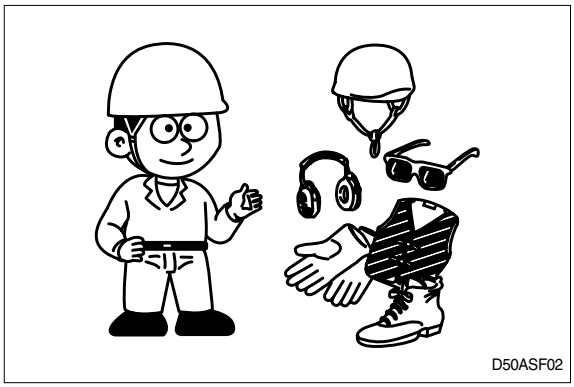
GROUP 1 SAFETY HINTS

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

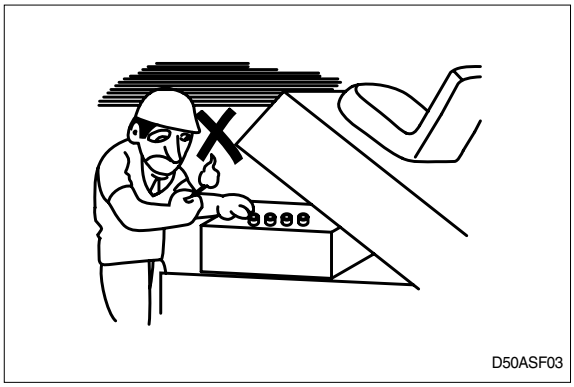
- Oil is a dangerous substance. Never handle oil, grease or oily clothes in places where there is any fire of flame.
  As preparation in case of fire, always know the location and directions for use of fire extinguishers and other fire fighting equipment.


D50ASF01

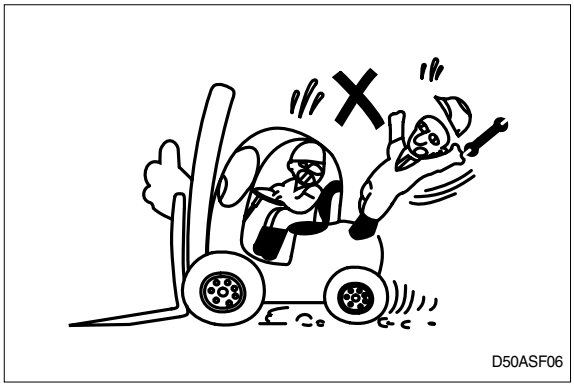
- Wear well-fitting helmet, safety shoes and working clothes. When drilling, grinding or hammering, always wear protective goggles.
  Always do up safety clothes properly so that they do not catch on protruding parts of machines. Do not wear oily clothes.
  When checking, always release battery plug.


D50ASF02

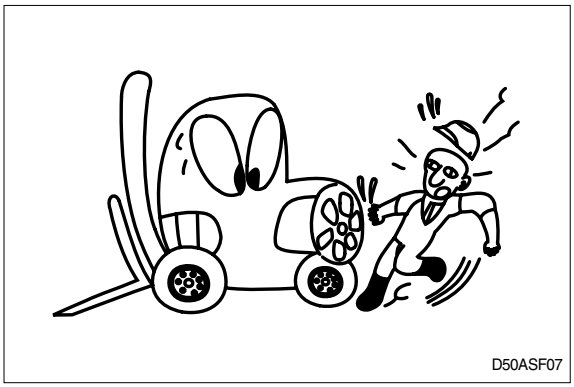
- Flames should never be used instead of lamps. Never use a naked flame to check leaks or the level of oil or electrolyte.


D50ASF03

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

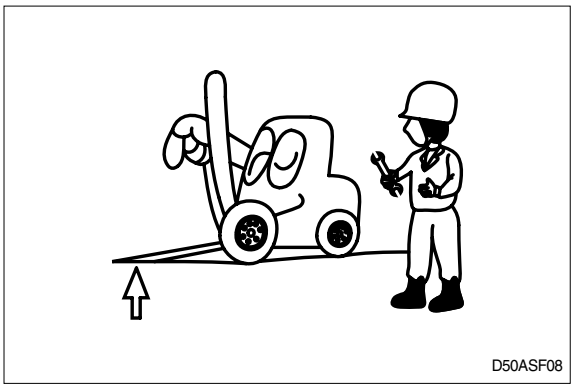

D50ASF06

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

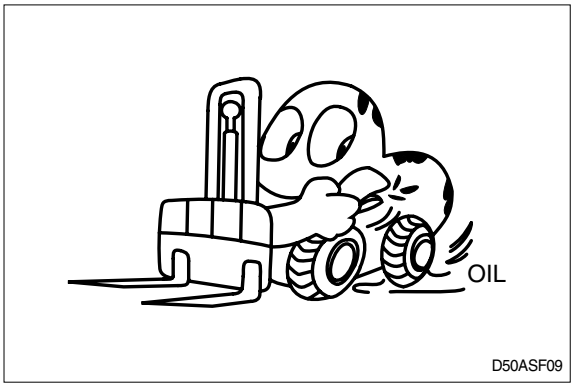

D50ASF07

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

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

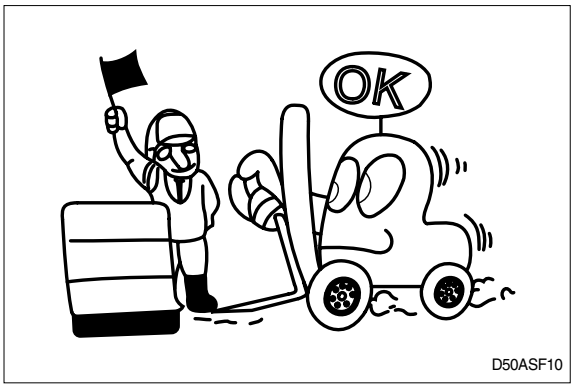

D50ASF08

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



D50ASF09

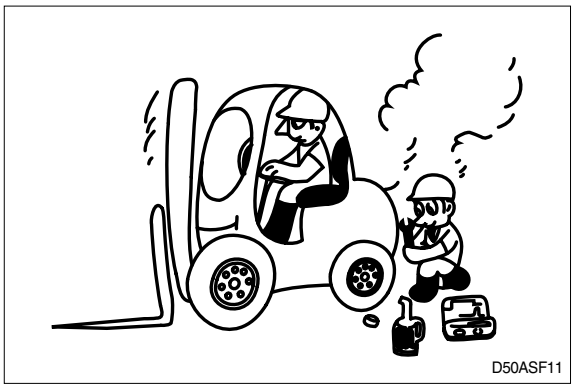
- When working with others, choose a group leader and work according to his instructions. Do not perform any maintenance beyond the agreed work.



D50ASF10

- Unless you have special instructions to the contrary, maintenance should always be carried out with the machine stopped. If maintenance is carried out with the machine 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.

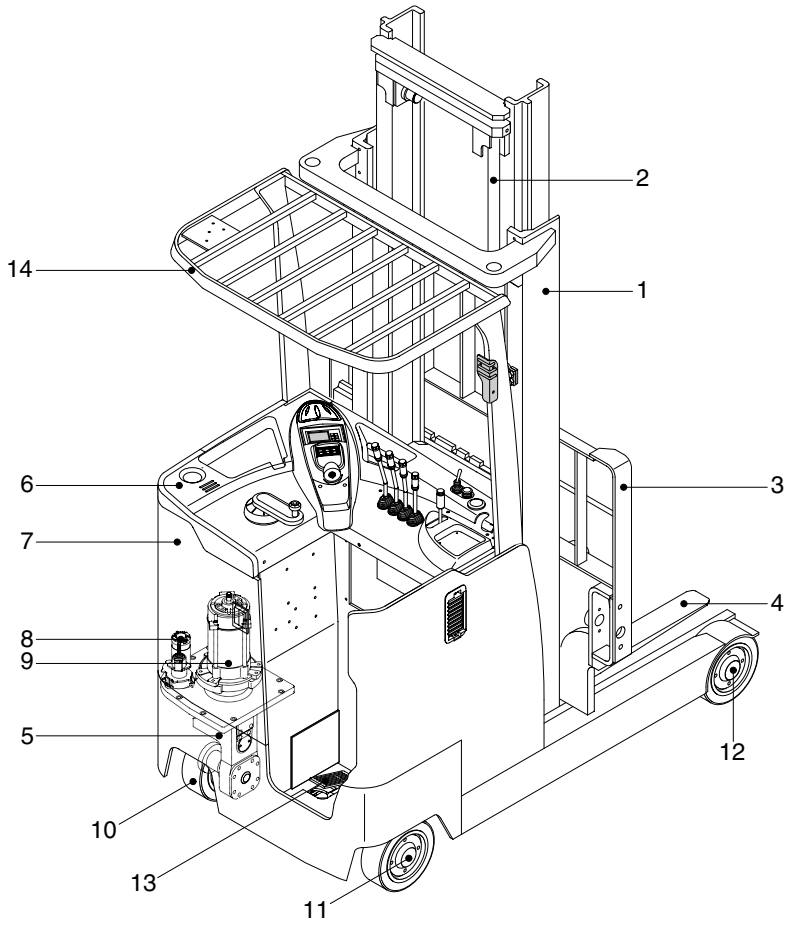


- Thoroughly clean the machine. In particular, be careful to clean the filler caps, grease fittings and the area around the dipsticks. Be careful not to let any dirt or dust into the system.
- Always use HYUNDAI Forklift genuine parts for replacement.
- Always use the grades of grease and oil recommended 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

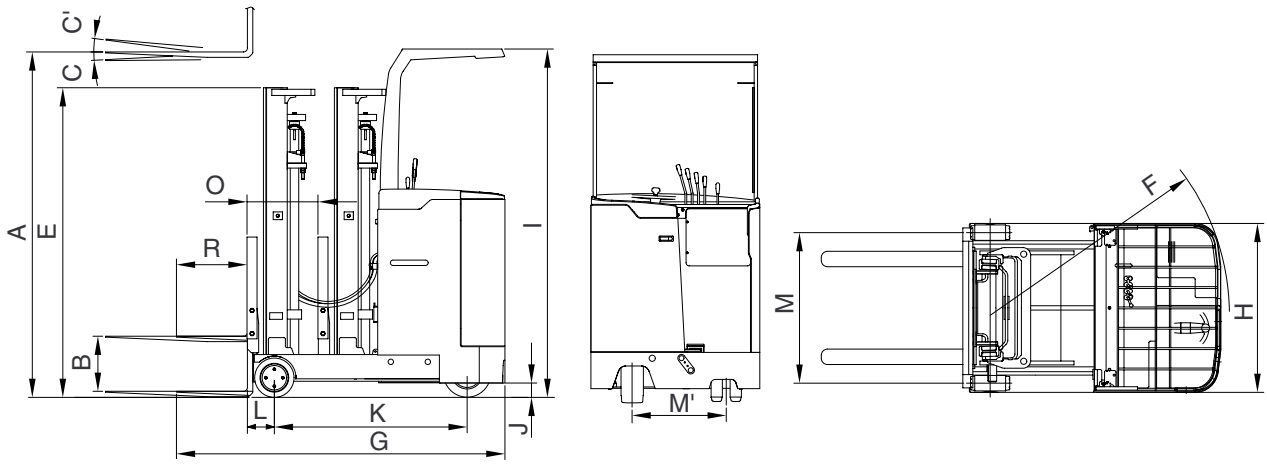


16BR7OM113

1	Mast	6	Dash board	11	Caster wheel
2	Lift cylinder	7	Frame	12	Load wheel
3	Carriage and backrest	8	EPS motor	13	Brake pedal
4	Forks	9	Drive motor	14	Overhead guard
5	Drive unit	10	Drive wheel		

2. SPECIFICATIONS

1) 10/13BR-7

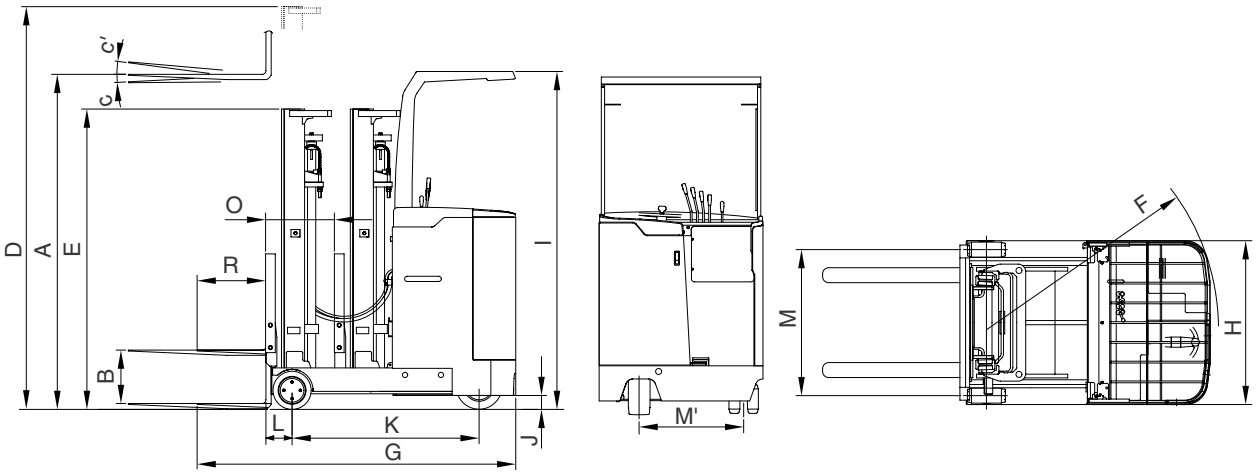


BR147SP01

Model			Unit	10BR-7	13BR-7
Capacity			kg	1000	1250
Load center		R	mm	500	←
Weight(Unloaded, with battery)			kg	2169	2214
Fork	Lifting height	A	mm	3000	←
	Free lift	B	mm	357	←
	Lifting speed(Unload/Load)		mm/sec	480/300	480/290
	Lowering speed(Unload/Load)		mm/sec	450/500	←
	L × W × T	L,W,T	mm	900 × 100 × 35	←
Mast	Tilt angle (forward/backward)	C/C'	degree	3/5	←
	Max height	D	mm	4025	←
	Min height	E	mm	1991	←
Body	Travel speed(Unload)		km/h	11.5	11.5
	Gradeability(Unload/Load)		%	18/21	19/18
	Min turning radius(Outside)	F	mm	1425	1460
ETC	Max hydraulic pressure		kgf/cm²	135	←
	Hydraulic oil tank		ℓ	18	←
Overall length(With fork)		G	mm	2110	←
Overall width(Load wheel)		H	mm	1070	←
Overhead guard height		I	mm	2260	←
Ground clearance		J	mm	85	←
Wheel base		K	mm	1115	1150
Wheel tread(Front/rear)		M/M'	mm	970 *1070/650	←
Reach stroke		O	mm	330	365

* Wide frame

2) 14/15/18BR-7

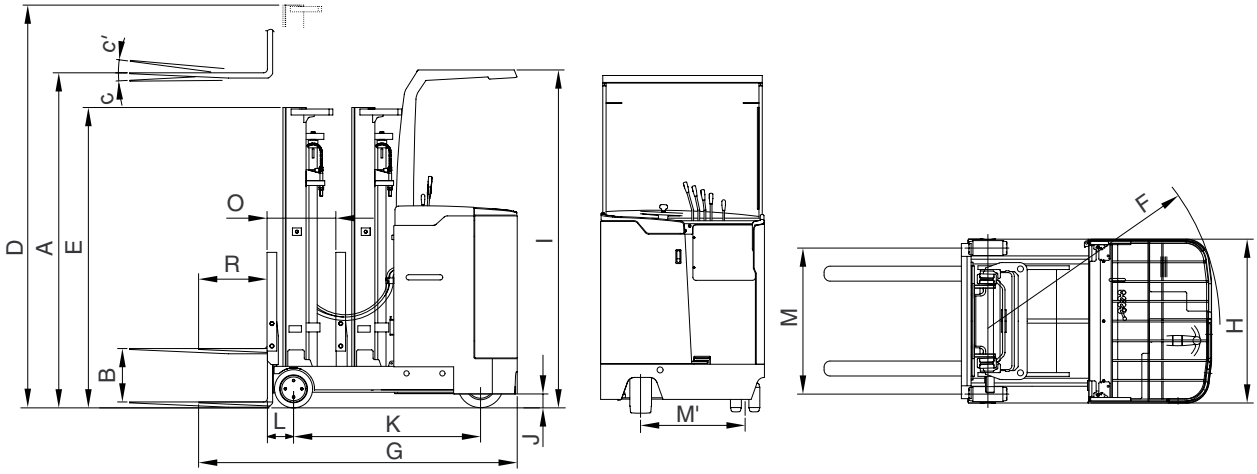


BR7SP01

Model			Unit	14BR-7	15BR-7	18BR-7
Capacity			kg	1350	1500	1800
Load center		R	mm	500	←	←
Weight(Unloaded, with battery)			kg	2240	2385	2427
Fork	Lifting height	A	mm	3000	←	←
	Free lift	B	mm	357	←	←
	Lifting speed(Unload/Load)		mm/sec	480/300	480/290	480/280
	Lowering speed(Unload/Load)		mm/sec	450/500	←	←
	L × W × T	L,W,T	mm	900 × 100 × 35	←	←
Mast	Tilt angle (forward/backward)	C/C'	degree	3/5	←	←
	Max height	D	mm	4025	←	←
	Min height	E	mm	1991	←	←
Body	Travel speed(Unload)		km/h	11	←	←
	Gradeability(Unload/Load)		%	16/30	16/29	15/26
	Min turning radius(Outside)	F	mm	1545	1605	1775
ETC	Max hydraulic pressure		kgf/cm²	190	←	←
	Hydraulic oil tank		ℓ	18	←	←
Overall length(With fork)		G	mm	2120	2155	←
Overall width(Load wheel)		H	mm	1070	←	←
Overhead guard height		I	mm	2260	←	←
Ground clearance		J	mm	70	←	←
Wheel base		K	mm	1250	1315	1500
Wheel tread(Front/rear)		M/M'	mm	970 *1070/650	←	←
Reach stroke		O	mm	450	480	665

* Wide frame

3) 20/25BR-7



BR7SP01

Model			Unit	20BR-7	25BR-7
Capacity			kg	2000	2500
Load center		R	mm	500	←
Weight(Unloaded, with battery)			kg	2738	2926
Fork	Lifting height	A	mm	3000	←
	Free lift	B	mm	415	←
	Lifting speed(Unload/Load)		mm/sec	470/300	470/280
	Lowering speed(Unload/Load)		mm/sec	450/500	←
	L×W×T	L,W,T	mm	1050×100×45	←
Mast	Tilt angle(Forward/backward)	C/C'	degree	3/5	←
	Max height	D	mm	4030	←
	Min height	E	mm	2025	←
Body	Travel speed(Unload)		km/h	12	←
	Gradeability(Unload/Load)		%	16/18	15/16
	Min turning radius(Outside)	F	mm	1790	1985
ETC	Max hydraulic pressure		kgf/cm²	190	←
	Hydraulic oil tank		ℓ	24	←
Overall length(With fork)		G	mm	2373	←
Overall width(Load wheel)		H	mm	1200	←
Overhead guard height		I	mm	2296	←
Ground clearance		J	mm	77	←
Wheel base		K	mm	1500	1700
Wheel tread(Front/rear)		M/M'	mm	1060 *1180/730	←
Reach stroke		O	mm	607	807

* Wide frame

3. SPECIFICATION FOR MAJOR COMPONENTS

1) 10/13BR-7

(1) MOTOR

Item	Unit	Drive motor	Hydraulic pump motor
Model	-	TSA200-100-063	TSA170-210-009
Type	-	AC	
Rated voltage	Vac	32V 3ø	30V 3ø
Output	kW	4.4	15.8
Insulation	-	Class F	

(2) BATTERY

Item	Unit	10BR-7	13BR-7
Model	-	VCI 225	
Rated voltage	V	48	
Capacity	AH/hr	225/5	
Electrolyte	-	WET	
Dimension(W×D×H)	mm	994×270×581.7	
Connector(CE spec)	-	SB350(SBE320)	
Weight	kg	380	

(3) CHARGER

Item	Unit	10/13BR-7
Type	-	Constant current, constant voltage
Battery capacity for charge	V-AH	48-200~230
AC input	V	Triple phase 410
		Single phase 220
		Triple phase 220/380
		Triple phase 440
DC output	V	62±1
Charge time	hr	8±2
Connector(CE spec)	-	SB 350(SBE320)

(4) GEAR PUMP

Item	Unit	Specification
Type	-	Fixed displacement gear pump
Capacity	cc/rev	16.5
Maximum operating pressure	bar	210
Rated speed(max/min)	rpm	3000/500

(5) MAIN CONTROL VALVE

Item	Unit	Specification
Type	-	3 spool, 4 spool
Operating method	-	Mechanical
Main relief valve pressure	bar	135

(6) DRIVE UNIT

Item	Unit	Specification
Gear ratio	-	20.125
Oil quantity	l	1.6

(7) WHEELS

Item	Specification
Type(Load / Drive /Caster)	Urethane / Rubber / Rubber
Quantity(Load / Drive /Caster)	2 / 1 / 2
Load wheel	254 × 100
Drive wheel	305 × 145
Caster wheel	178 × 73

(8) BRAKES

Item	Specification
Brakes(Service & Parking)	Disc brake

2) 14/15/18BR-7

(1) MOTOR

Item	Unit	Drive motor	Hydraulic pump motor
Model	-	TSA200-160-104	TSA170-210-009
Type	-	AC	
Rated voltage	Vac	30V 3 ø	
Output	kW	6.8	15.8
Insulation	-	Class F	

(2) BATTERY

Item	Unit	14BR-7	15BR-7	18BR-7
Model	-	VCI 230	VCF 280	VCI 300
Rated voltage	V	48		
Capacity	AH/hr	230/5	280/5	300/5
Electrolyte	-	WET		
Dimension(W × D × H)	mm	994 × 378 × 581.7		
Connector(CE spec)	-	SB350(SBE320)		
Weight	kg	400	480	500

(3) CHARGER

Item	Unit	14BR-7	15/18BR-7
Type	-	Constant current, constant voltage	
Battery capacity for charge	V-AH	48-200~230	48-280~365
AC input	V	Triple phase 410	
		Single phase 220	
		Triple phase 220/380	
		Triple phase 440	
DC output	V	62 ± 1	
Charge time	hr	8 ± 2	
Connector(CE spec)	-	SB 350(SBE320)	

(4) GEAR PUMP

Item	Unit	Specification
Type	-	Fixed displacement gear pump
Capacity	cc/rev	19.6
Maximum operating pressure	bar	210
Rated speed(max/min)	rpm	3000/500

(5) MAIN CONTROL VALVE

Item	Unit	Specification
Type	-	3 spool, 4 spool
Operating method	-	Mechanical
Main relief valve pressure	bar	190

(6) DRIVE UNIT

Item	Unit	Specification
Gear ratio	-	20.125
Oil quantity	l	1.6

(7) WHEELS

Item	Specification
Type(Load / Drive /Caster)	Urethane / Rubber / Rubber
Quantity(Load / Drive /Caster)	2 / 1 / 2
Load wheel	254 × 100
Drive wheel	305 × 145
Caster wheel	178 × 73

(8) BRAKES

Item	Specification
Brakes(Service & Parking)	Disc brake

3) 20/25BR-7

(1) MOTOR

Item	Unit	Drive motor	Hydraulic pump motor
Model	-	TSA200-160-104	TSA170-210-009
Type	-	AC	
Rated voltage	Vac	30V 3 ø	
Output	kW	6.8	15.8
Insulation	-	Class F	

(2) BATTERY

Item	Unit	20/25BR-7
Model(Type)	-	VCI 335
Rated voltage	V	48
Capacity	AH/hr	335/5
Electrolyte	-	WET
Dimension(W×D×H)	mm	994×378×581.7
Connector(CE spec)	-	SB350(SBE320)
Weight	kg	560

(3) CHARGER

Item	Unit	20/25BR-7
Type	-	Constant current, constant voltage
Battery capacity for charge	V-AH	48-280~365
AC input	V	Triple phase 410
		Single phase 220
		Triple phase 220/380
		Triple phase 440
DC output	V	62±1
Charge time	hr	8±2
Connector(CE spec)	-	SB 350(SBE320)

(4) GEAR PUMP

Item	Unit	Specification
Type	-	Fixed displacement gear pump
Capacity	cc/rev	19.6
Maximum operating pressure	bar	210
Rated speed(max/min)	rpm	3000/500

(5) MAIN CONTROL VALVE

Item	Unit	Specification
Type	-	3 spool, 4 spool
Operating method	-	Mechanical
Main relief valve pressure	bar	190

(6) DRIVE UNIT

Item	Unit	Specification
Max input torque	kgf · m	2200
Max input rpm	rpm	3500
Gear ratio	-	20.9
Oil quantity	l	4.4

(7) WHEELS

Item	Specification
Load / Drive / Caster	Urethane / Rubber / Rubber
Quantity(Load / Drive / Caster)	2 /1 /2
Load wheel	267 × 114
Drive wheel	382 × 142
Caster wheel	204 × 76

(8) BRAKES

Item	Specification
Brakes(Service & Parking)	Disc brake

4. TIGHTENING TORQUE FOR MAJOR COMPONENTS

1) 10/13BR-7

NO	Items		Size	kgf · m	lbf · ft
1	Electric system	Hyd pump motor mounting bolt	M10×1.5	6.9±1.4	50±10
2		Drive motor mounting bolt	M 8×1.25	2.0±0.2	14.4±1.4
3		Steering motor mounting bolt	M10×1.5	6.9±1.4	50±10
4	Hydraulic system	Hydraulic pump mounting bolt	M10×1.5	5±1.0	36.2±7.2
5		MCV mounting bolt, nut	M 8×1.25	2.5±0.5	18.1±3.6
6	Power train system	Drive wheel mounting bolt	M16×1.5	20.5±1.5	148.3±10.8
7		Load wheel mounting nut	M40×1.5	5±0.5	36.2±3.6
8		Caster wheel mounting bolt	M12×1.75	12.0±1.0	89.8±7.2
9		Drive unit bracket mounting bolt	M12×1.75	14.3±1.0	103.4±7.2
10	Other	Head guard mounting bolt	M12×1.75	19±3.0	137.4±21.7

2) 14/15/18BR-7

NO	Items		Size	kgf · m	lbf · ft
1	Electric system	Hyd pump motor mounting bolt	M10×1.5	6.9±1.4	50±10
2		Drive motor mounting bolt	M 8×1.25	2.0±0.2	14.4±1.4
3		Steering motor mounting bolt	M10×1.5	6.9±1.4	50±10
4	Hydraulic system	Hydraulic pump mounting bolt	M10×1.5	5±1.0	36.2±7.2
5		MCV mounting bolt, nut	M 8×1.25	2.5±0.5	18.1±3.6
6	Power train system	Drive wheel mounting bolt	M16×1.5	20.5±1.5	148.3±10.8
7		Load wheel mounting nut	M40×1.5	5±0.5	36.2±3.6
8		Caster wheel mounting bolt	M12×1.75	12.0±1.0	89.8±7.2
9		Drive unit bracket mounting bolt	M12×1.75	14.3±1.0	103.4±7.2
10	Other	Head guard mounting bolt	M12×1.75	19±3.0	137.4±21.7

3) 20/25BR-7

NO	Items		Size	kgf · m	lbf · ft
1	Electric system	Hyd pump motor mounting bolt	M10×1.5	6.9±1.4	50±10
2		Drive motor mounting bolt	M 8×1.25	2.0±0.2	14.4±1.4
3		Steering motor mounting bolt	M10×1.5	6.9±1.4	50±10
4	Hydraulic system	Hydraulic pump mounting bolt	M10×1.5	5±1.0	36.2±7.2
5		MCV mounting bolt, nut	M 8×1.25	2.5±0.5	18.1±3.6
6	Power train system	Drive unit mounting bolt, nut	M12×1.75	14.3±1.0	103.4±7.2
7		Drive wheel mounting nut	M14×1.5	14±1.5	101.2±10.8
8		Load wheel mounting nut	M50×1.5	5±0.5	36.2±3.6
9		Caster wheel mounting bolt	M12×1.75	10±2.0	72.3±14.4
10		Drive unit bracket mounting bolt	M12×1.75	14.3±1.0	103.4±7.2
11	Others	Head guard mounting bolt	M12×1.75	19±3.0	137.4±21.7

5. TORQUE CHART

Use following table for unspecified torque.

1) BOLT AND NUT - Coarse thread

Bolt size	8T		10T	
	kgf · m	lbf · ft	kgf · m	lbf · ft
M 6 × 1.0	0.85 ~ 1.25	6.15 ~ 9.04	1.14 ~ 1.74	8.2 ~ 12.6
M 8 × 1.25	2.0 ~ 3.0	14.5 ~ 21.7	2.7 ~ 4.1	19.5 ~ 29.7
M10 × 1.5	4.0 ~ 6.0	28.9 ~ 43.4	5.5 ~ 8.3	39.8 ~ 60.0
M12 × 1.75	7.4 ~ 11.2	53.5 ~ 81.0	9.8 ~ 15.8	70.9 ~ 114
M14 × 2.0	12.2 ~ 16.6	88.2 ~ 120	16.7 ~ 22.5	121 ~ 163
M16 × 2.0	18.6 ~ 25.2	135 ~ 182	25.2 ~ 34.2	182 ~ 247
M18 × 2.0	25.8 ~ 35.0	187 ~ 253	35.1 ~ 47.5	254 ~ 344
M20 × 2.5	36.2 ~ 49.0	262 ~ 354	49.2 ~ 66.6	356 ~ 482
M22 × 2.5	48.3 ~ 63.3	349 ~ 458	65.8 ~ 98.0	476 ~ 709
M24 × 3.0	62.5 ~ 84.5	452 ~ 611	85.0 ~ 115	615 ~ 832
M30 × 3.0	124 ~ 168	898 ~ 1214	169 ~ 229	1223 ~ 1656
M36 × 4.0	174 ~ 236	1261 ~ 1704	250 ~ 310	1808 ~ 2242

(1) Fine thread

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

2) PIPE AND HOSE(FLARE TYPE)

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

3) PIPE AND HOSE(ORFS TYPE)

Thread size(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 ℃(°F)
		10/13BR-7 14/15/18BR-7	20/25BR-7	-35 (-31) / -20 (-4) / -10 (14) / 0 (32) / 10 (50) / 20 (68) / 30 (86) / 40 (104)
Drive unit	Gear oil	1.6 (0.42)	4.4 (1.16)	SAE 80W/90
Hydraulic oil tank	Hydraulic oil	18.1 (4.0)	24 (5.3)	ISO VG 22 ISO VG 46 ISO VG 68
Fitting (Grease nipple)	Grease	0.1 (0.03)	0.1 (0.03)	NLGI No.1 NLGI No.2

GROUP 3 PERIODIC REPLACEMENT

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

These parts may deteriorate in time and are susceptible to wear. It is difficult to estimate the degree of wear at time of periodic maintenance; therefore, even if no apparent wear is found, always replace with new parts within the prescribed period of replacement(Or earlier if trouble is found).
Note that periodic replacement has nothing to do with guarantee service.

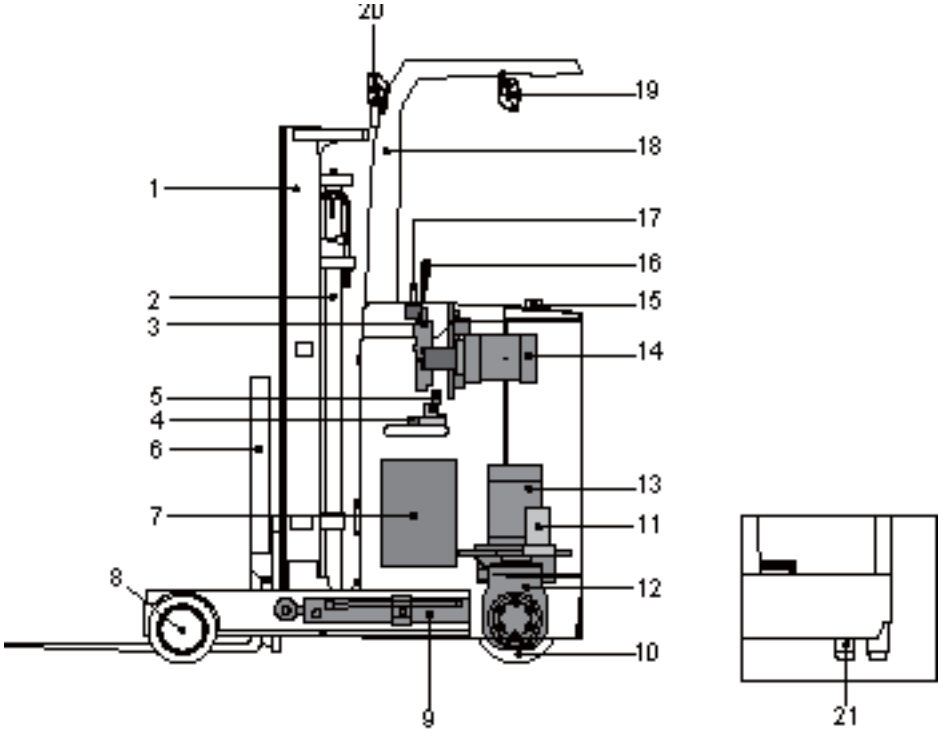
※ **Replacement of consumable service parts is not covered under warranty.**

No.	Description	Period of replacement
1	Hydraulic oil	Every 1 year
2	Brake fluid	Every 1 year
3	Differential oil	Every 1 year
4	Gear oil	Every 1 year
5	Wheel bearing grease	Every 1 year
6	Power steering hose	Every 1 year
7	Rubber parts of the power steering inside	Every 2 year
8	Cups and dust seals etc. of cylinder	Every 2 year
9	Reservoir tank tube	Every 1 year
10	Lift chain	Every 2 year
11	Hydraulic equipment hose	Every 2 year
12	Brake switch(hydraulic)	Every 2 year

SECTION 2 REMOVAL & INSTALLATION OF UNIT

SECTION 2 REMOVAL & INSTALLATION OF UNIT

GROUP 1 STRUCTURE



BR7RE01

1	Mast	8	Load wheel	15	Steering wheel
2	Lift cylinder	9	Reach cylinder	16	Control levers
3	Main control valve	10	Drive wheel	17	Accelerator
4	EPS filter	11	EPS actuator	18	Over head guard
5	EPS controller	12	Drive unit	19	Rear work lamp(opt)
6	Carriage & backrest	13	Drive motor	20	Front work lamp
7	Battery	14	Pump motor	21	Caster wheel

GROUP 2 REMOVAL AND INSTALLATION OF UNIT

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

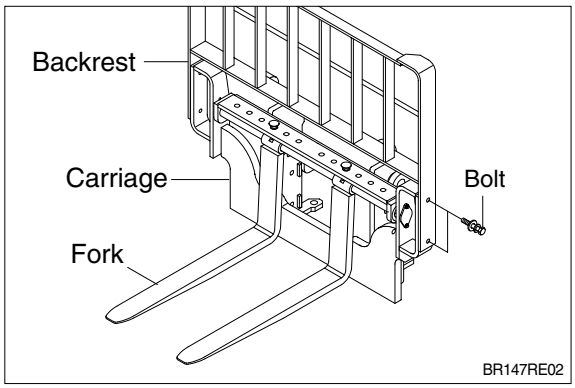
1. MAST

1) REMOVAL

Backrest & fork — Carriage — Piping — Mast

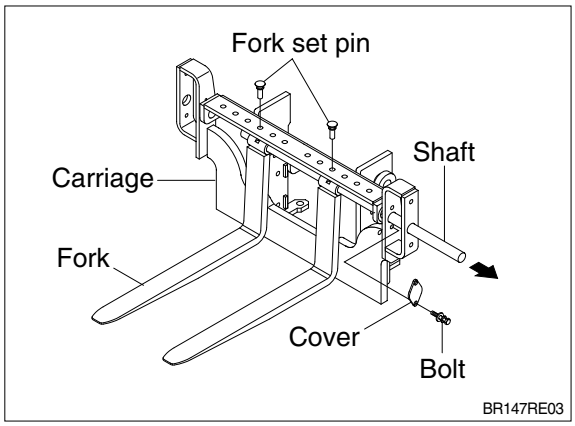
(1) Backrest

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



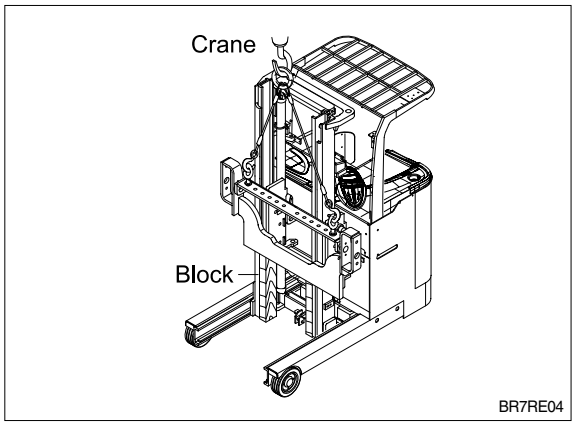
(2) Forks

① Remove shaft cover and bolt.
② Remove fork set pin and then draw out the shaft.
③ Carefully remove forks one by one.

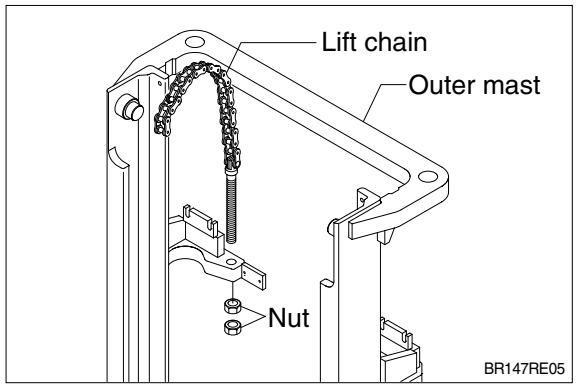


(3) Carriage

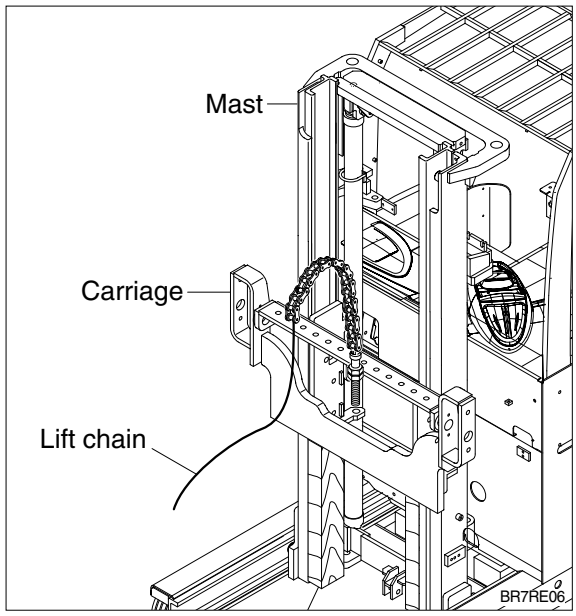
① With the mast vertical, raise the carriage high enough to place blocks under the load forks. This is done to create slack in the load chains when the carriage is lowered. Lower the carriage all the way down to the floor. Make sure the carriage is level, this will prevent any binding when the mast is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



② While supporting lift chains, remove the split pins and slide out chain anchor pins from the chain anchors of stationary upright.



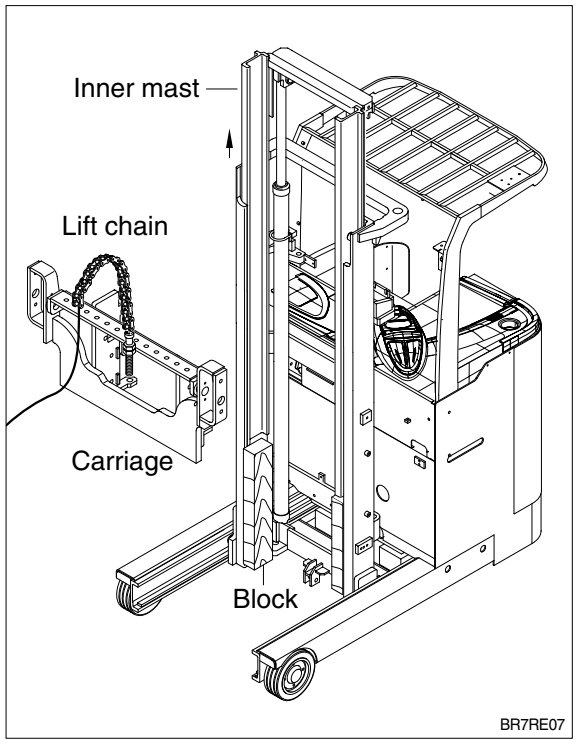
③ Pull the chains out of the sheaves and drape them over the front of the carriage.



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

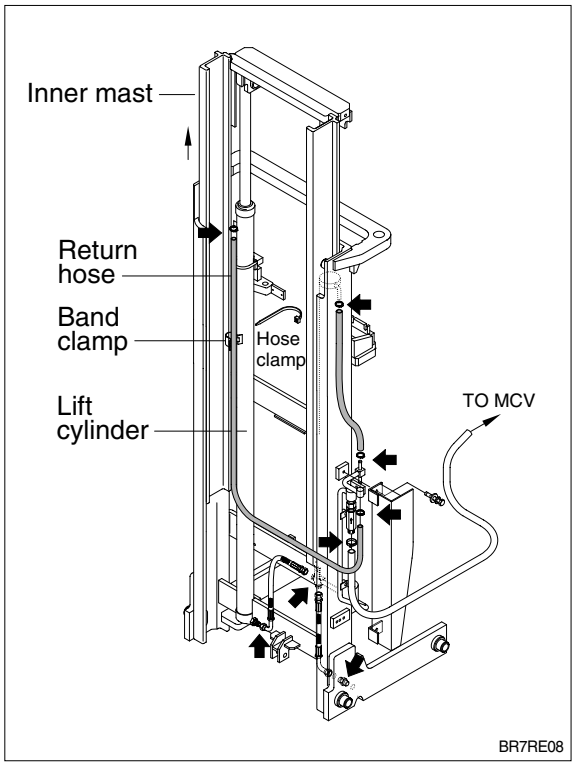
⚠ Make sure that carriage remains on floor and does not bind while mast is being raised.

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



(4) PIPING

① Remove the return hoses and clamps attached to the cylinder.
② Remove the return hoses from the connector.
③ Remove hose assembly, connector, down safety valve from the lift cylinder.
④ Disconnect hose assembly from the flow regulator.

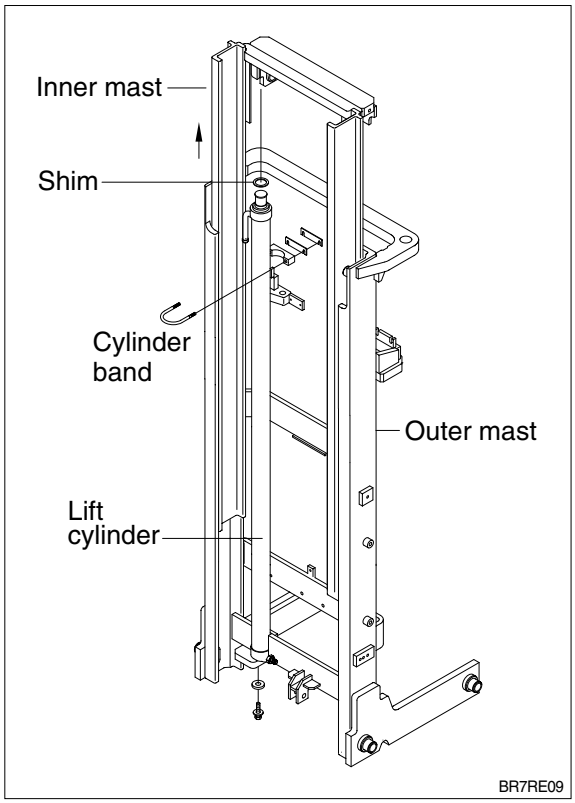


(5) LIFT CYLINDER

① Loosen hexagonal bolts and remove washers securing the lift cylinders to inner mast.
② Bind the lift cylinder with overhead hoist rope and pull up so that the rope has no slack or binding.

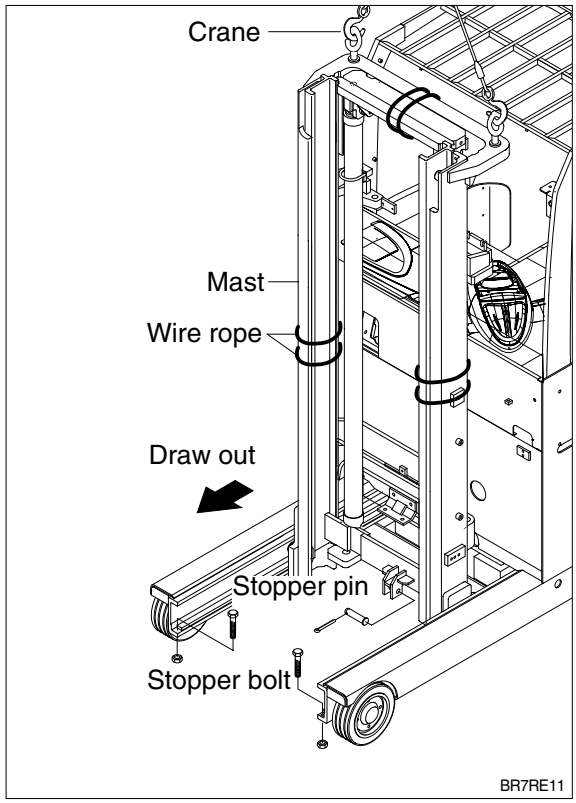
⚠ Make sure that the lift cylinder be tightened firmly for safety.

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



(6) MAST REMOVAL

① Pass wire rope around the inner and outer masts to allow lifting them out with a hoist.
② Remove the stopper pin at the end of reach cylinder and then remove the stopper bolt at the end of guide rail.
③ Draw out the mast from the guide rail with lifting up.
④ Lower the mast and place it on stand.

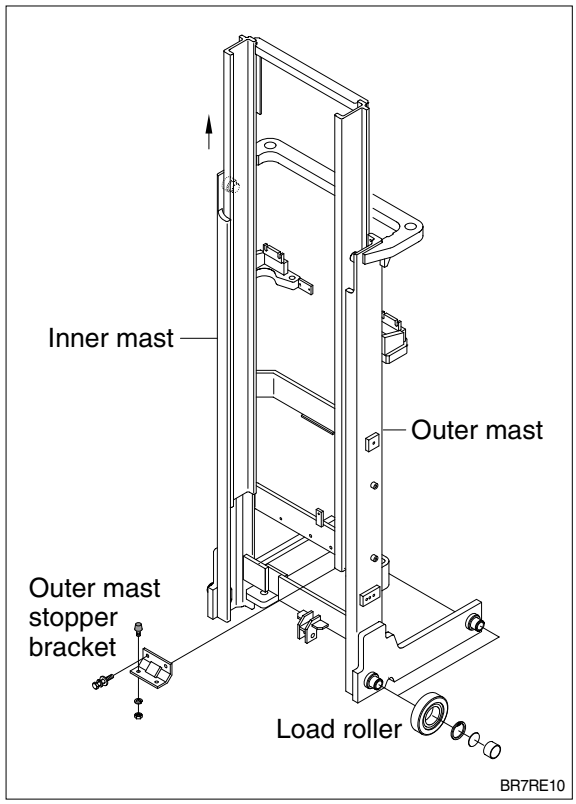


(7) INNER MAST

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

⚠ **Be careful the mast not to swing or fall.**

② Using an universal puller, remove the load rollers.



2) INSTALLATION

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

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

(1) LIFT CYLINDER INSTALLATION AND ADJUSTMENT

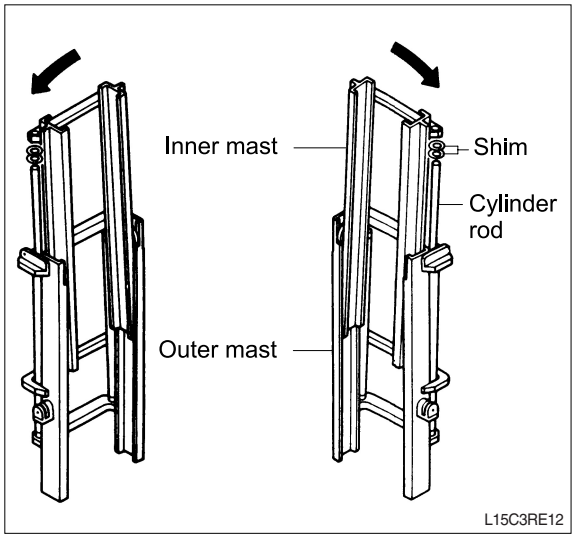
① Assemble the lift cylinder inside the outer mast, then tighten the stopper bolt. If the cylinder assembly has been replaced, adjust as follows so that the left and right cylinders are synchronized at the maximum lifting height.

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

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

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

· Shim thickness : 1.0mm(0.04in)



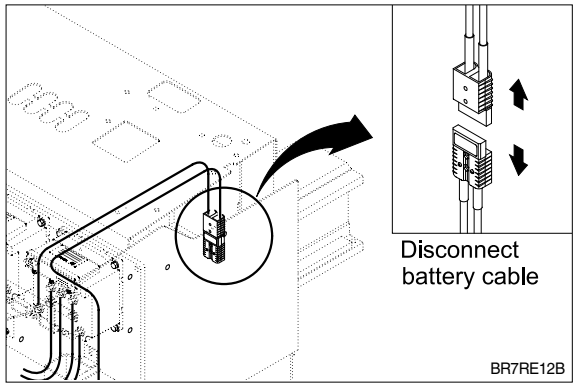
2. POWER TRAIN ASSEMBLY

1) REMOVAL

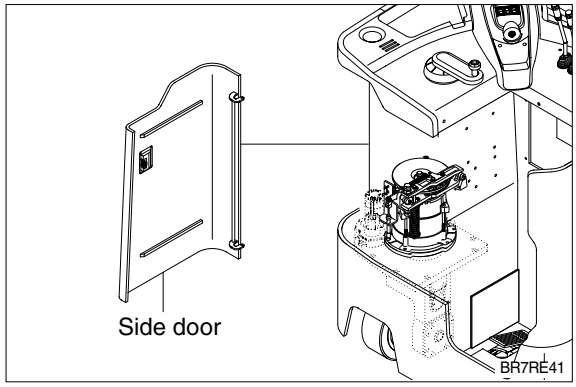
Battery connector → Side door → Steering parts → LH cover assy & center cover → Drive unit assembly

BR7RE001

(1) Disconnect the battery cable.

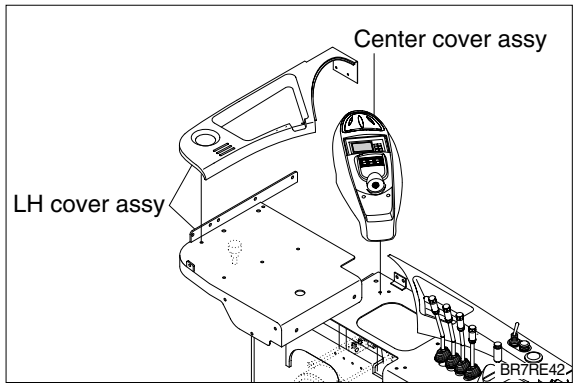


(2) Remove side door.

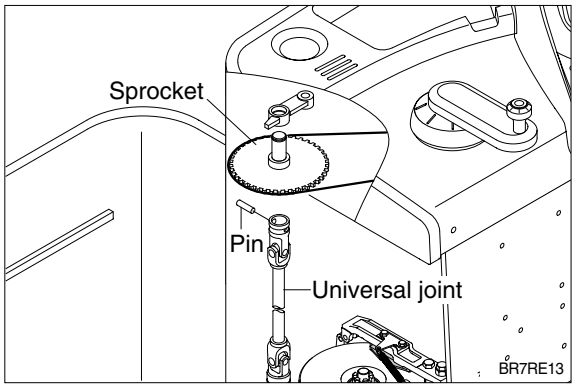


(3) Remove center cover assembly.

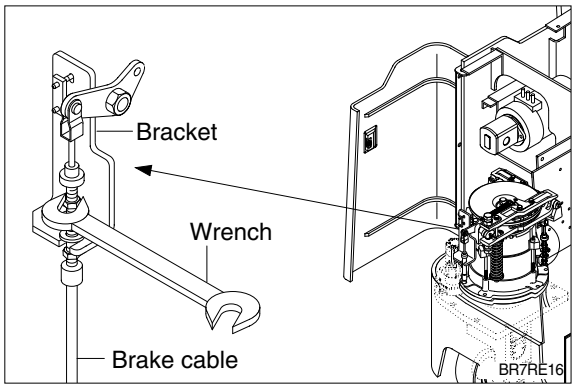
(4) Remove LH cover assembly.



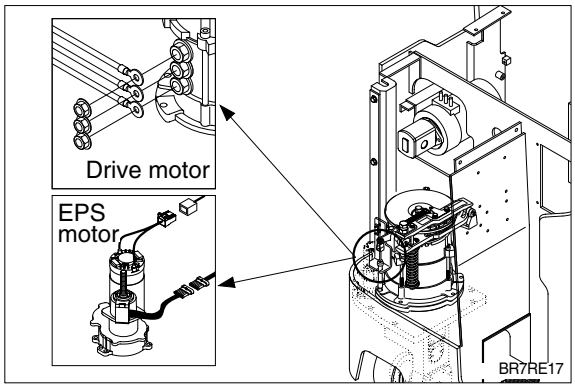
(5) Remove steering joint parts.



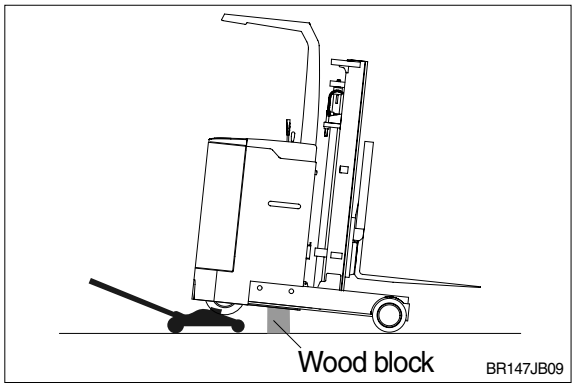
(6) Remove brake cable.



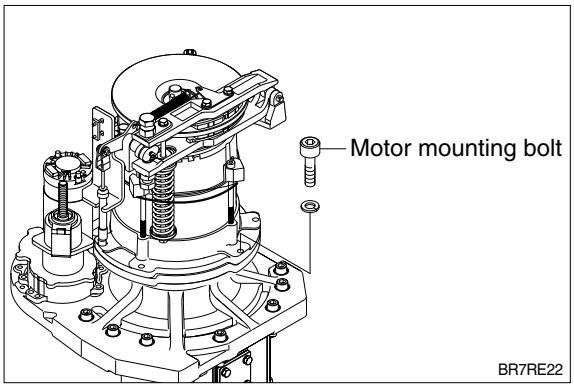
(7) Disconnect the wiring.
① Drive motor wiring
② EPS motor wiring.



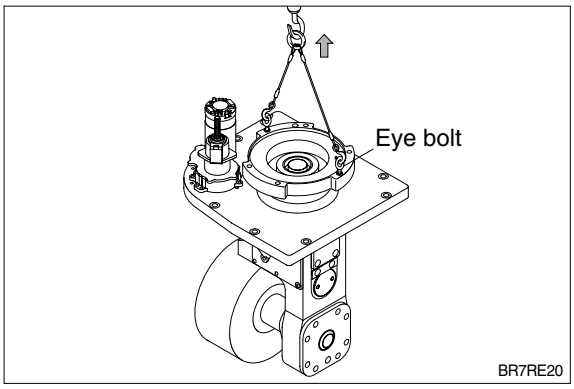
(8) Jack up the frame and support both side of frame on wood block.



(9) Remove motor mounting bolts and motor by lifting.



(10) Remove drive unit mounting bolts and pull out the drive unit by lifting with eye-bolts on motor mounting tap. (M8 × 1.25)

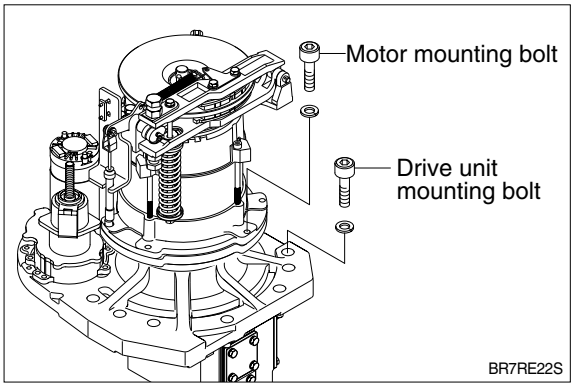


2) INSTALLATION

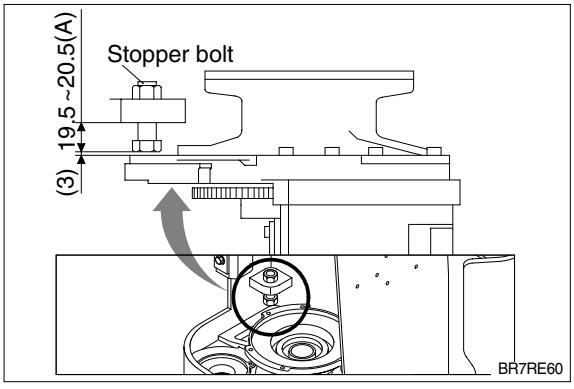
Installation is in the reverse order to removal, but be careful of following points.

(1) Drive unit mounting bolts (M12 × 1.75)
- Tightening torque : 13.2~16.2kgf · m (95.5~117.2lbf · ft)

(2) Drive motor mounting bolts (M8 × 1.25)
- Tightening torque : 3.7~4.1kgf · m (28.2~29.7lbf · ft)



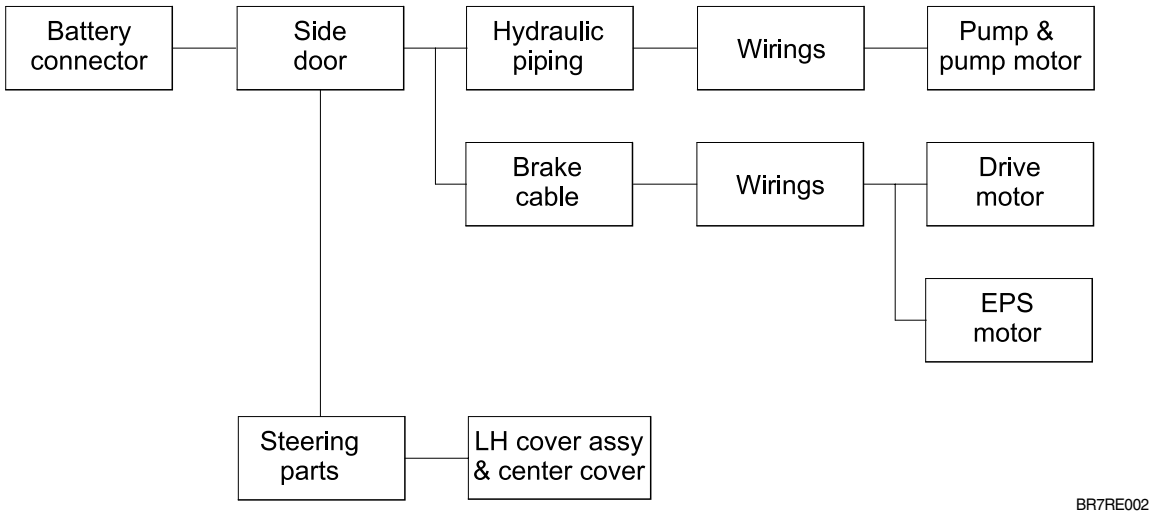
(3) Adjust stopper bolt(A) to 19.5~20.5.



3. ELECTRICAL COMPONENTS

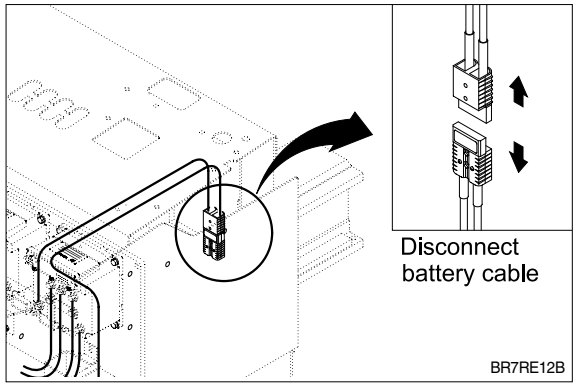
Before removing each component, disconnect cables and earth lines attached to the component.

1) REMOVAL

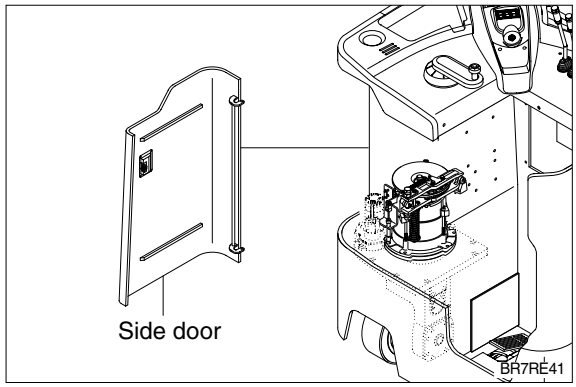


(1) PUMP MOTOR

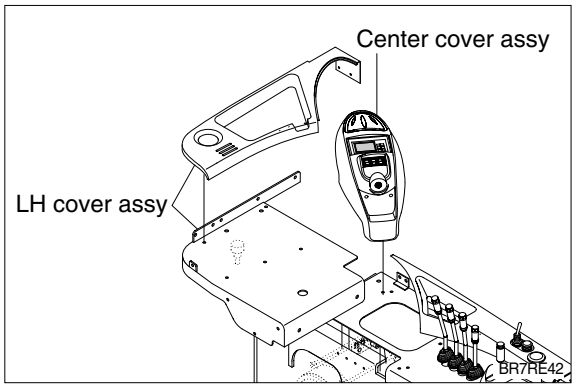
① Disconnect the battery cable.



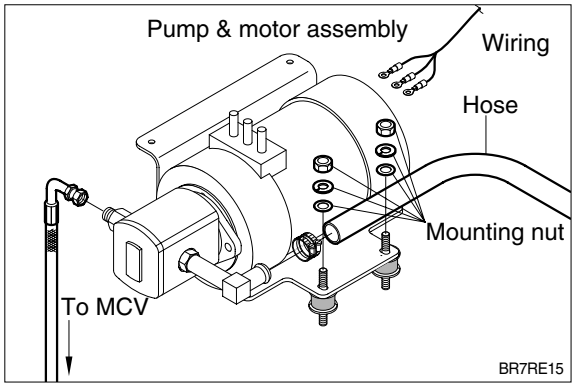
② Remove side door.



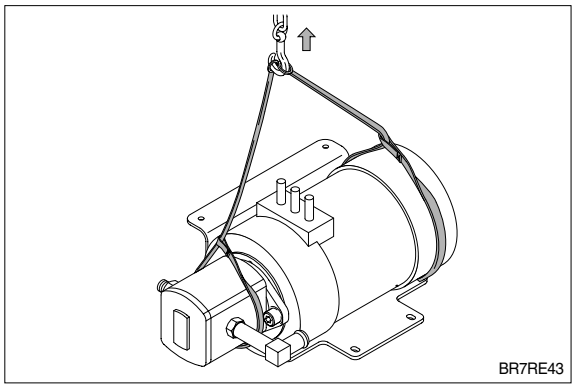
③ Remove LH cover assembly and center cover assembly.



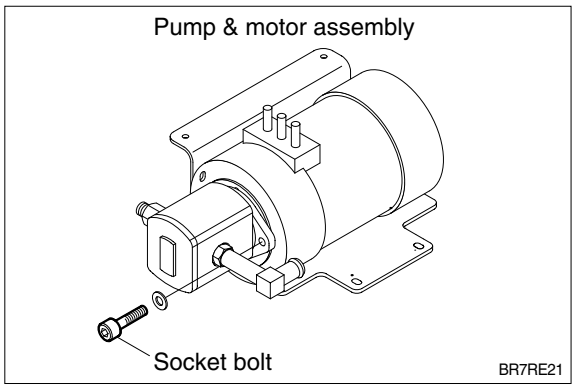
④ Disconnect the hose, pipe and wiring from pump & motor assembly.
Loosen mounting nuts from the bracket and then take out the assembly.



⑤ Tire wire rope around the hydraulic pump & pump motor assembly and lift up slowly.

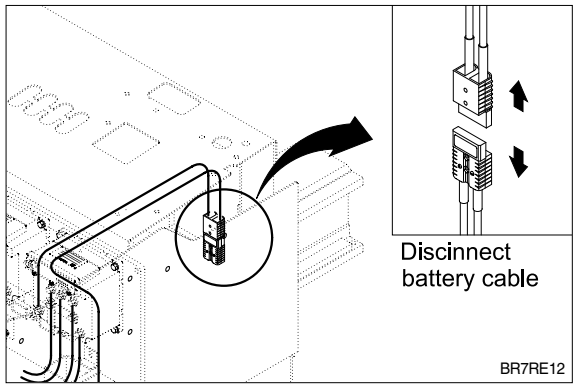


⑥ Remove 2 socket bolts fastening the pump & motor and then disengage the pump from motor.

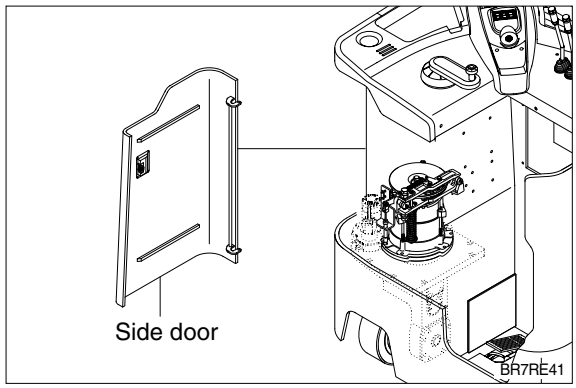


(2) DRIVE MOTOR

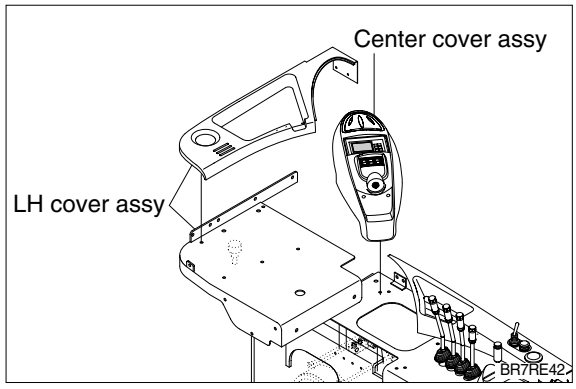
① Disconnect the battery cable.



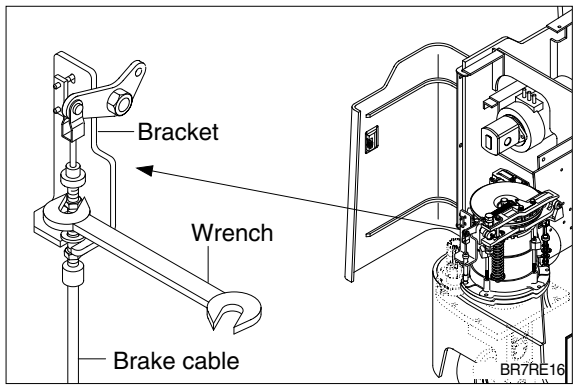
② Remove side door.



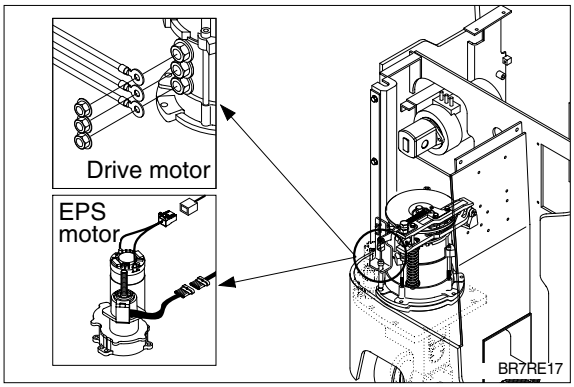
③ Remove center cover assembly.
④ Remove LH cover assembly.



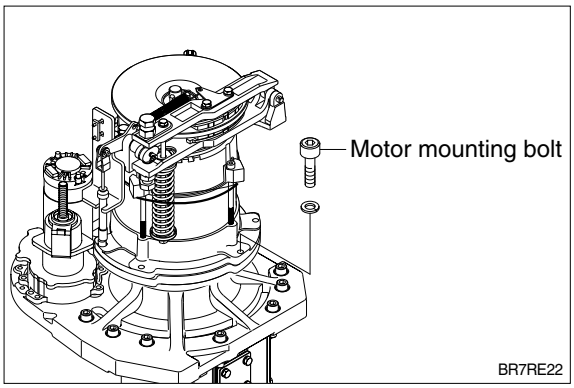
⑤ Remove brake cable.



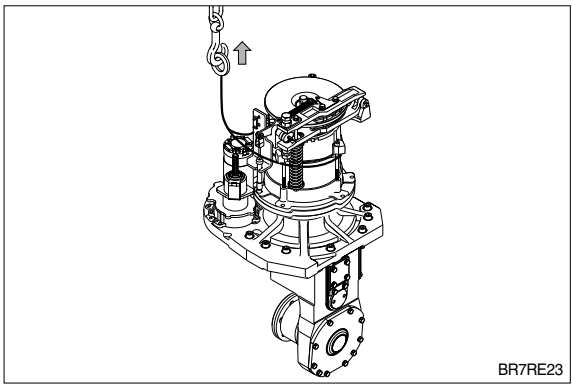
⑥ Disconnect wirings.
a. Drive motor wiring
b. EPS motor wiring



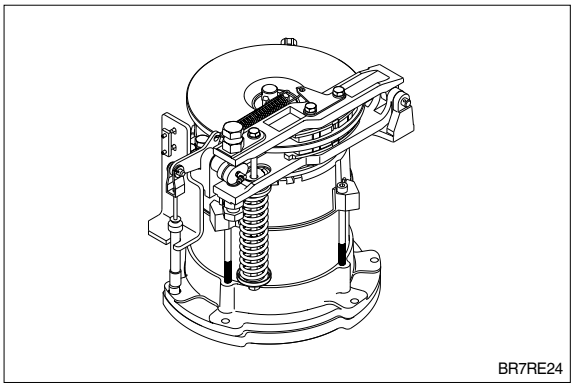
⑦ Remove bolts connecting the motor and drive unit.



⑧ Tie wire rope around the drive motor and lift up slowly.

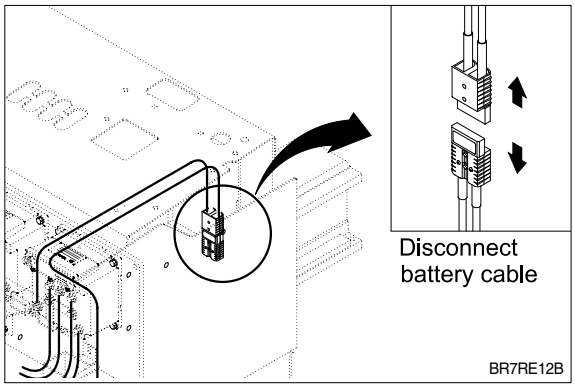


⑨ Put the motor on the clean work bench.

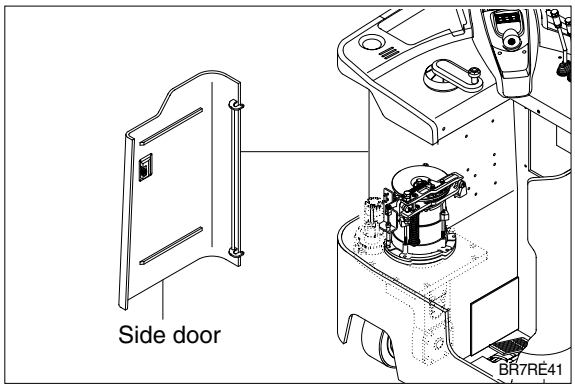


(3) EPS MOTOR

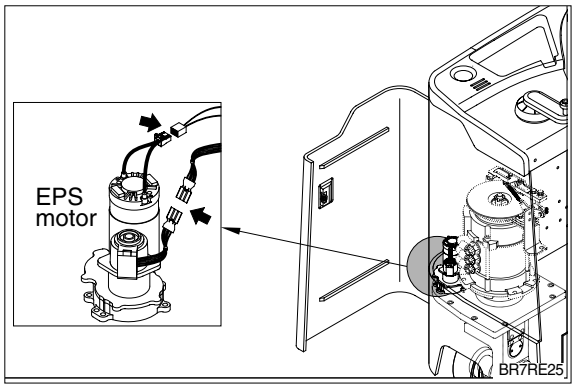
① Disconnect the battery cable.



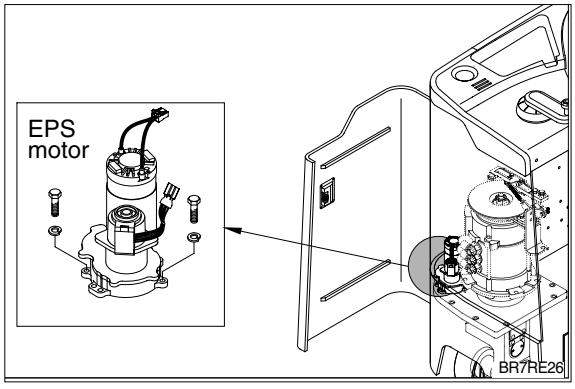
② Remove side door.



③ Disconnect wirings.



④ Loosen bolts and remove EPS motor assembly.



(4) BATTERY

① Turn on the key.

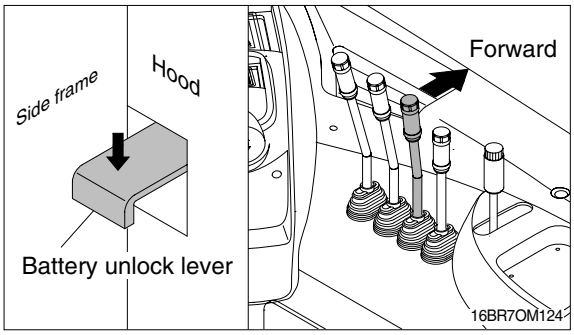
② Foot on the battery unlock lever to unlock the battery assembly.

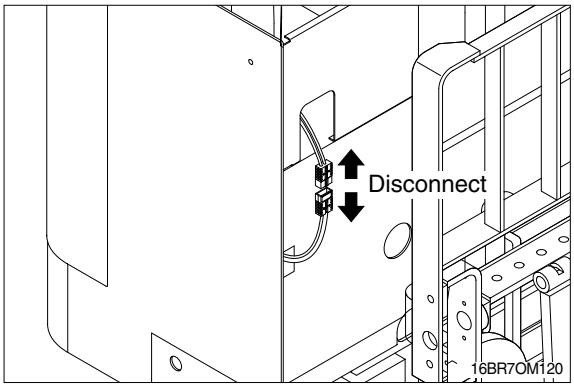
③ Push the reach lever until battery get out of frame inside.

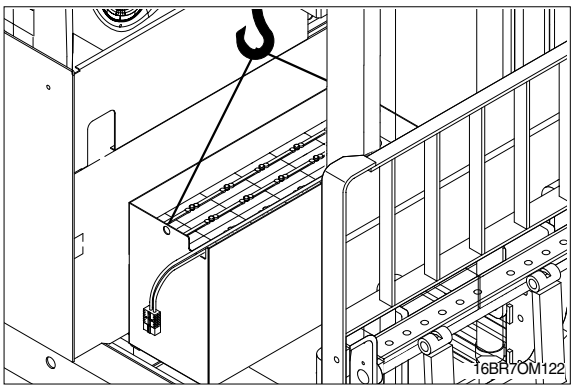
④ Turn off the key.

⑤ Disconnect the battery connector.

⑥ Using a battery hanger or carrier, carefully raise the battery assembly.







2) INSTALLATION

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

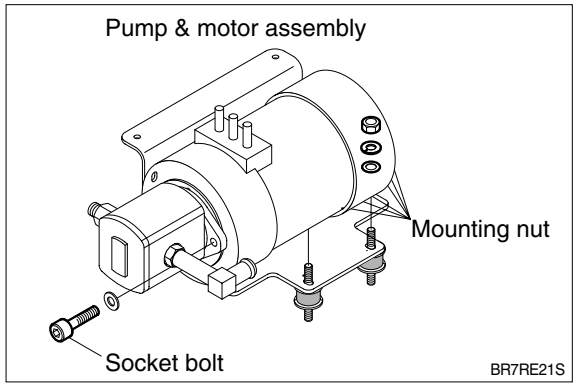
(1) PUMP MOTOR

① Pump motor mounting nut.

· Tightening torque : 5.5~9.3kgf · m
(40~60lbf · ft)

② Hydraulic pump mounting socket bolt

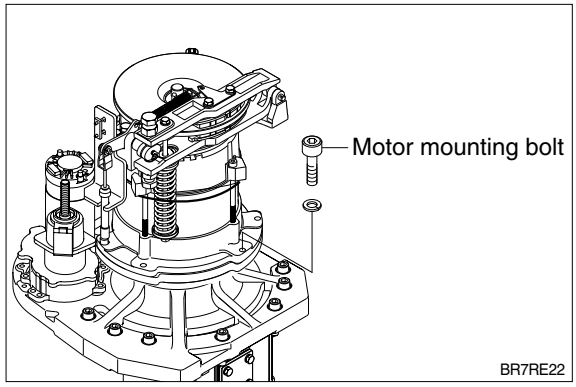
· Tightening torque : 4.0~6.0kgf · m
(28.9~43.4lbf · ft)



(2) DRIVE MOTOR

① Connection bolts between drive motor and drive unit.

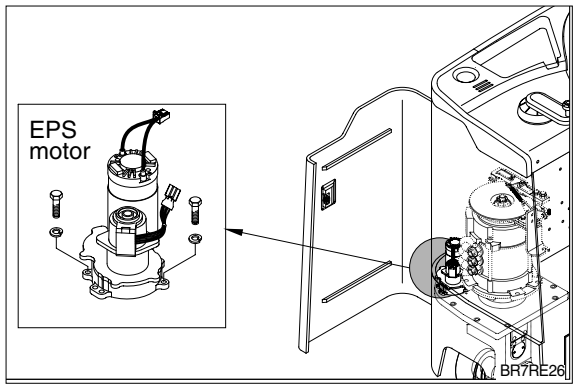
· Tightening torque : 1.8~2.2kgf · m
(13~16lbf · ft)



(3) EPS MOTOR

① EPS motor mounting bolts.

· Tightening torque : 1.8~2.2kgf · m
(13~16lbf · ft)



(4) BATTERY

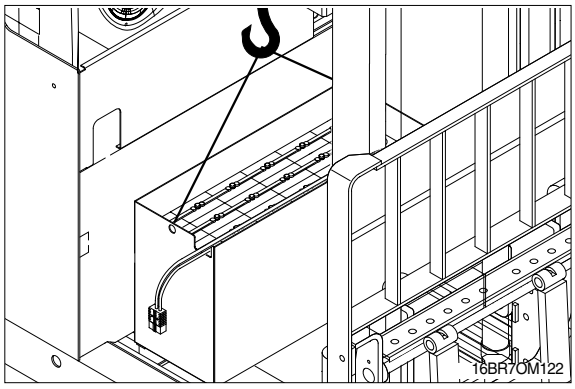
① Using a battery hanger or carrier, carefully put the battery assembly on the guard rail between mast and frame.

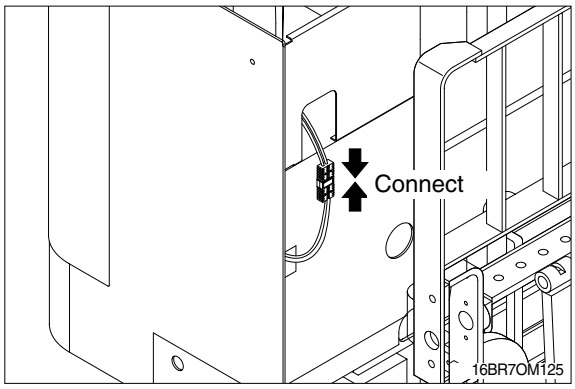
② Connect the battery connector.

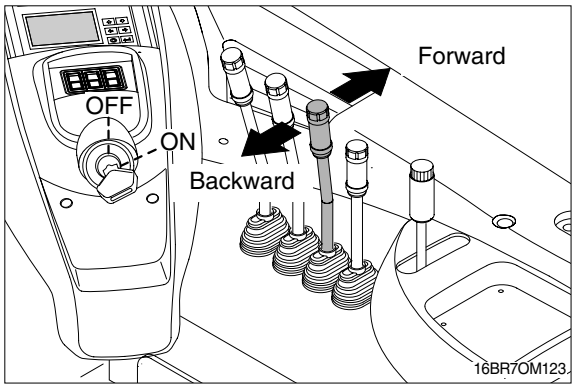
③ Turn on the key.

④ Pull the reach lever until it sounds locked. (Auto lock)

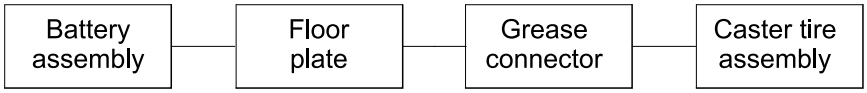
⑤ Complete installation.







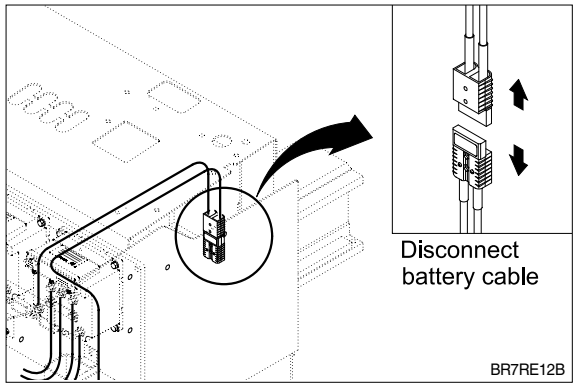
4. CASTER LINK ASSEMBLY



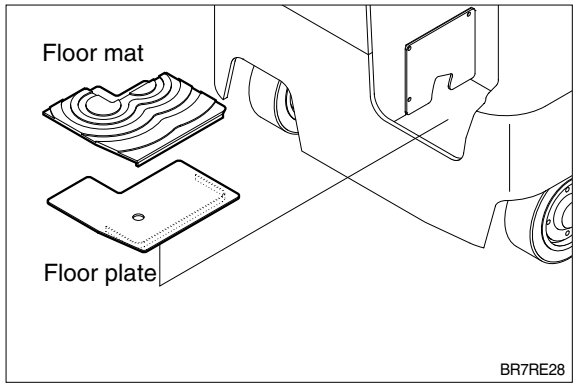
BR7RE003

1) REMOVAL

(1) Disconnect the battery cable.

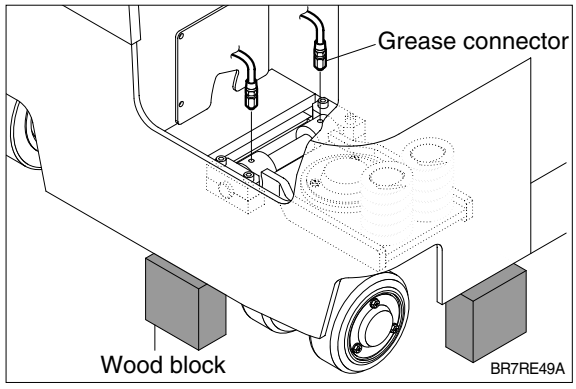


(2) Remove floor mat and floor plate.

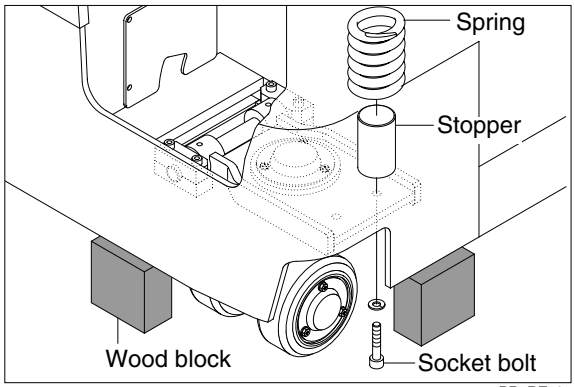


(3) Remove grease connector.

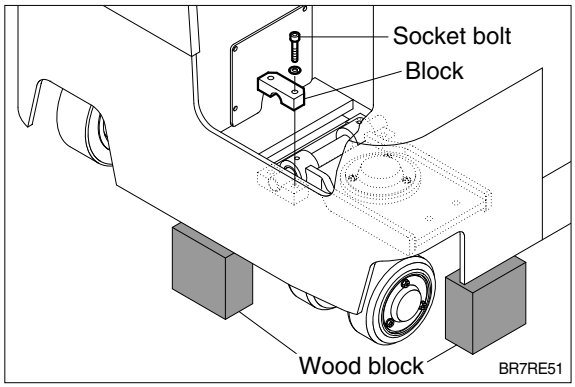
(4) Jack up the frame and support both side of frame on wood block.



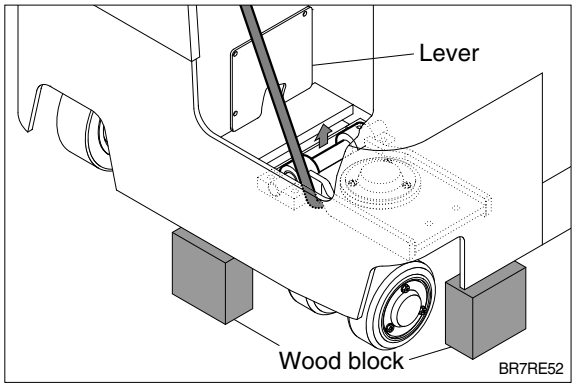
(5) Remove bolts, stopper and springs.



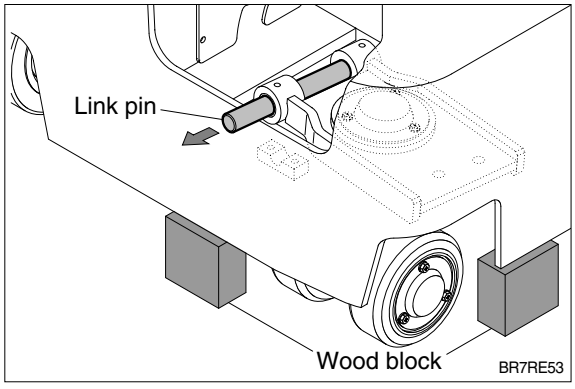
(6) Remove socket bolts and block.



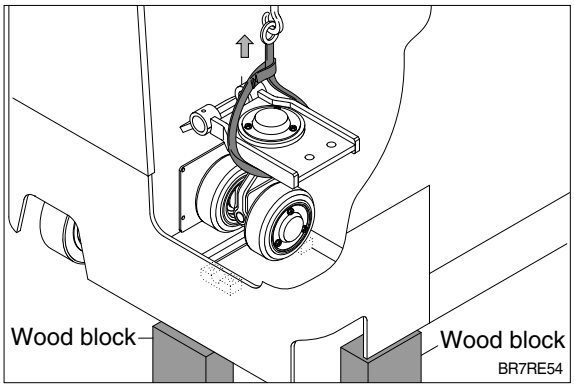
(7) Lift the caster suspension link assy with lever.



(8) Pull out the link pin from the caster suspension link.



(9) Tire wire rope around the suspension link and lift up slowly.

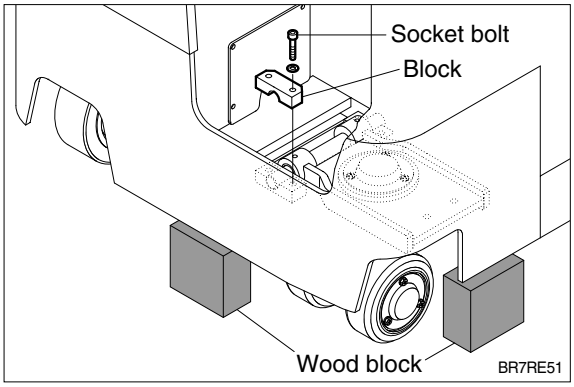


2) INSTALLATION

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

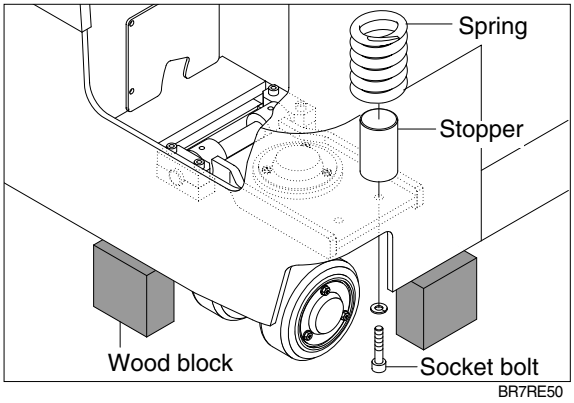
(1) Link pin mounting bolt.

· Tightening torque : 13.2~16.2kgf · m
(95.5~117.2lbf · ft)

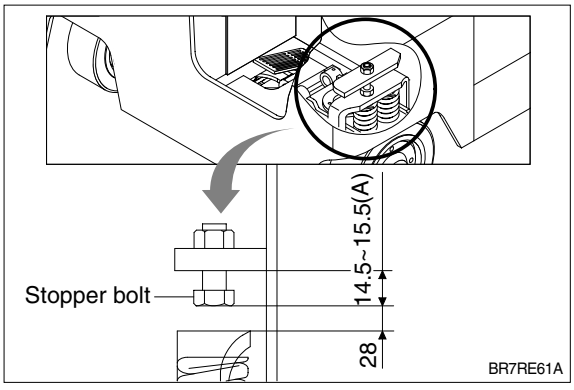


(2) Stopper fixing bolt.

· Tightening torque : 13.2~16.2kgf · m
(95.5~117.2lbf · ft)



(3) Adjust stopper bolt (A) to 14.5~15.5mm.



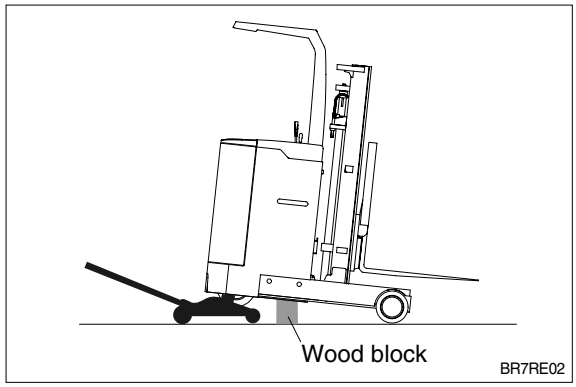
5. TIRE & WHEEL ASSEMBLY

1) REMOVAL

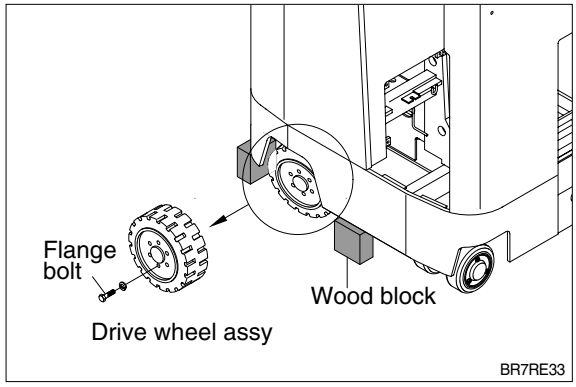
(1) DRIVE TIRE & WHEEL ASSEMBLY

① Jack up the frame and support both side of frame on wood block.

※ **Jack up until the tire clear off the ground.**

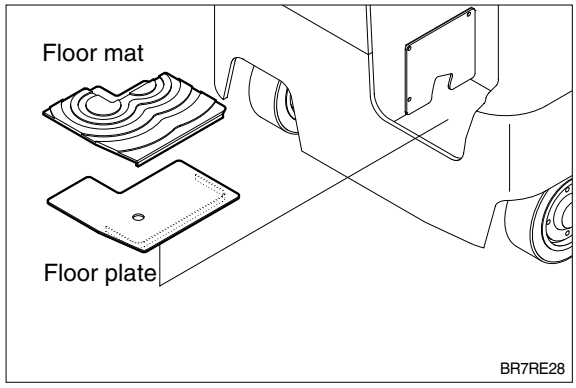


② Remove 6 flange bolts attaching the drive wheel and take off the drive wheel assembly.



(2) CASTER WHEEL ASSEMBLY

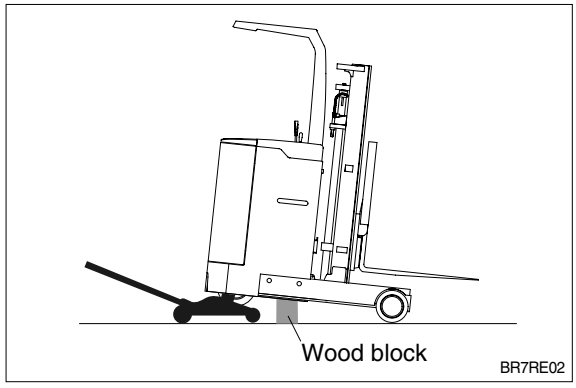
① Remove floor mat and floor plate.



② Jack up the frame.

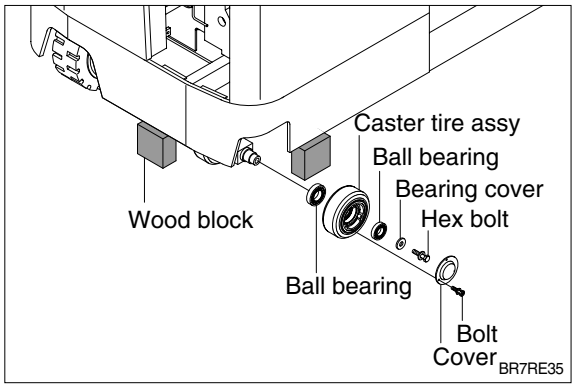
③ Blocking place under the frame with wood block

※ **Jack up until the tire clear off the ground.**



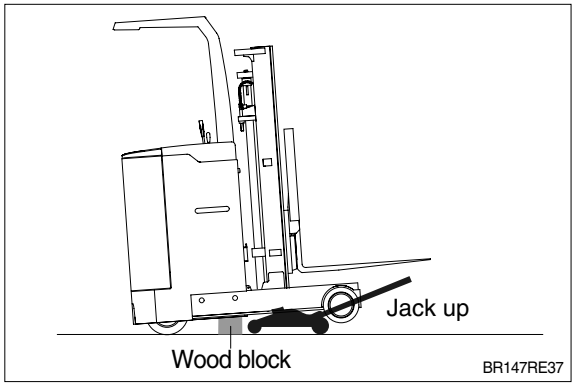
④ Take off the cover, and remove hex bolts, and bearing cover in succession.

⑤ Remove the caster tire assy and ball bearing.



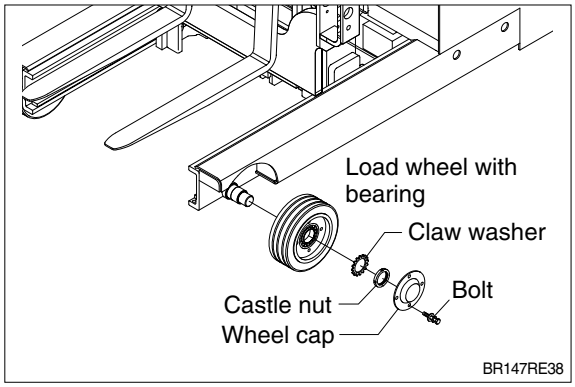
(3) LOAD WHEEL ASSEMBLY

① Jack up the reach legs and fix the machine with wood blocks.



② Take off the load wheel cap, and remove castle nut, and claw washer in succession.

Remove the load wheel together with bearing.



2) INSTALLATION

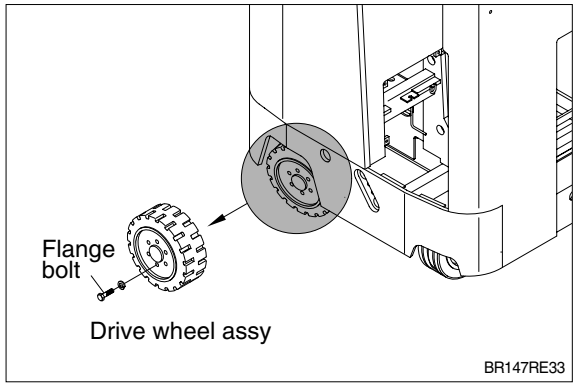
Installation is in the reverse order to removal, but be careful of the following points.

(1) Drive wheel flange bolts

· Tightening torque :

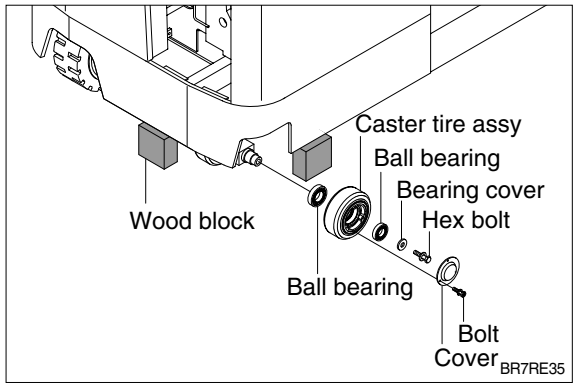
10/13/14/15/18BR-7 : 19~22kgf · m (137~159lbf · ft)

20/25BR-7 : 13.5~15.5kgf · m (98~112lbf · ft)



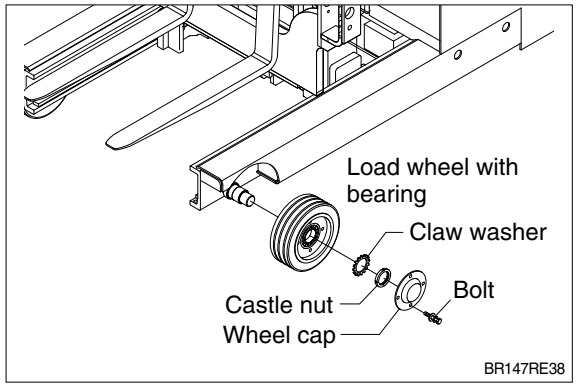
(2) Caster wheel bolts.

· Tightening torque : 8~12kgf · m (58~87lbf · ft)



(3) Load wheel bolts.

· Tightening torque : 4.5~5.5kgf · m (33~40lbf · ft)



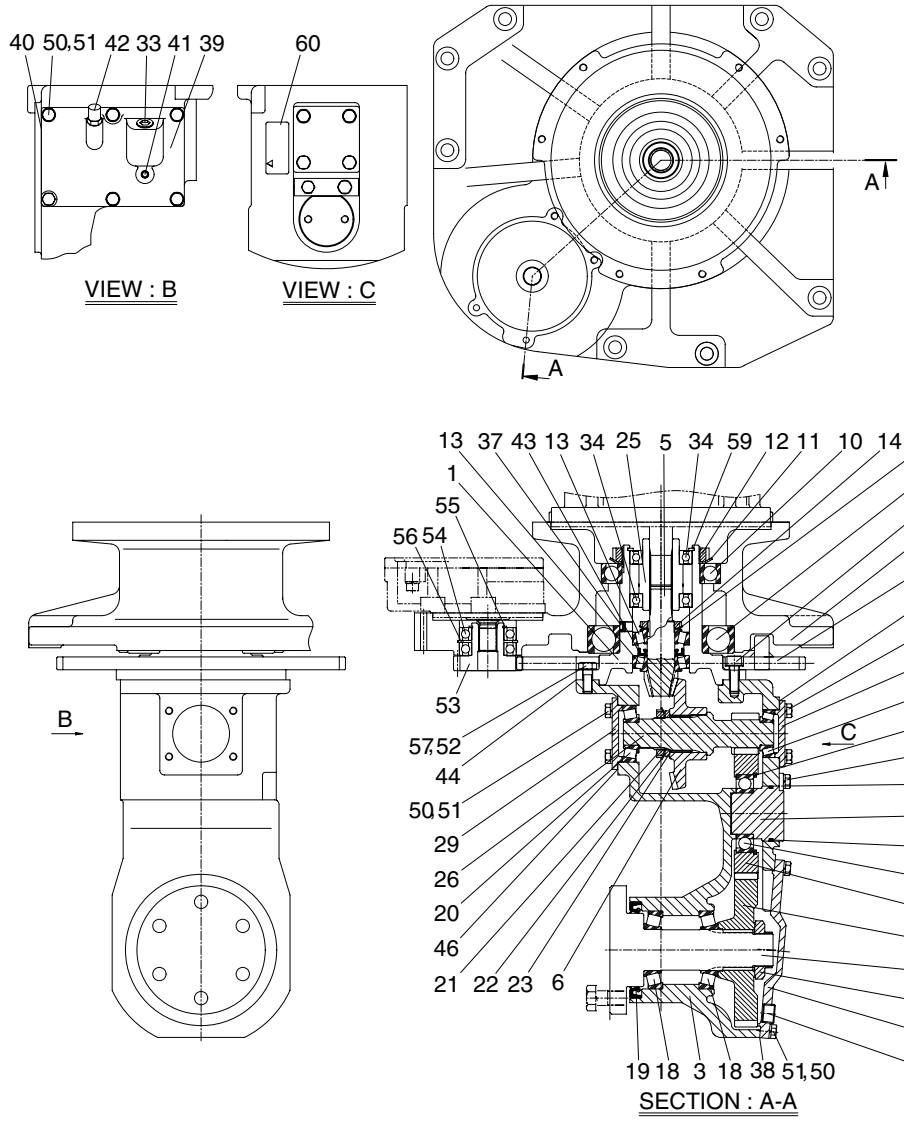
SECTION 3 POWER TRAIN SYSTEM

GROUP 1 STRUCTURE AND OPERATION

1. DRIVE AXLE UNIT

1) STRUCTURE

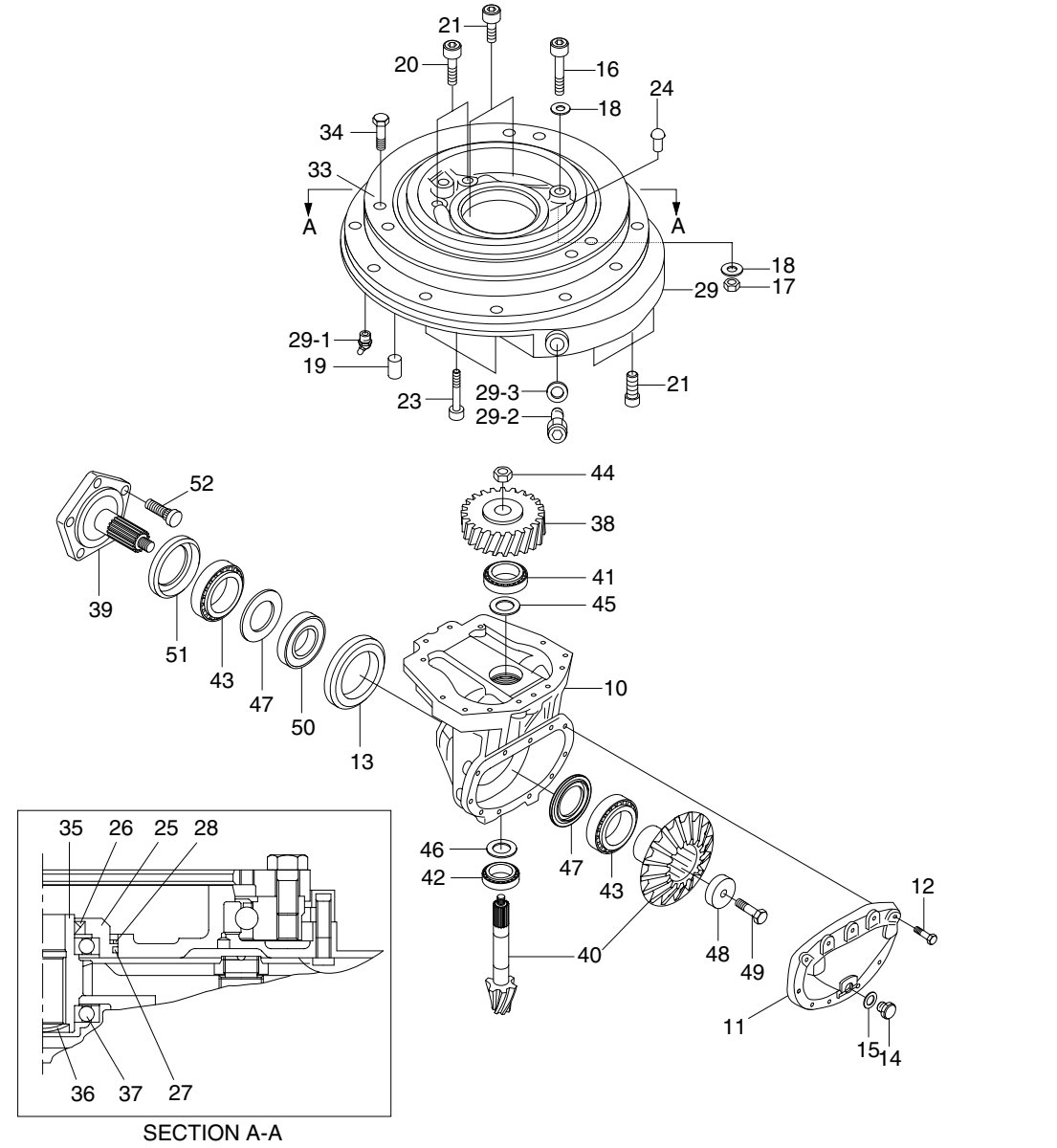
(1) 10/13/14/15/18BR-7



BR7DU100

1	Gear case cover	16	Bearing	31	Lock plate	46	Shim
2	Drive bracket	17	Bearing	32	Drive shaft nut	47	Socket bolt
3	Gear box case	18	Bearing	33	Taper plug	48	Washer
4	Cover	19	Seal	34	Bearing	49	Hexagon bolt
5	Spiral pinion	20	Taper roller bearing	35	O-ring	50	Spring washer
6	Spiral bevel gear	21	Bearing lock nut	36	Drive wheel shaft	51	Hexagon bolt
7	Steering gear	22	Bearing lock washer	37	Taper plug	52	Hexagon bolt
8	Idle gear	23	Gear spacer	38	Gasket	53	Pinion
9	Gear	24	Bearing	39	Cover	54	Pinion gear
10	Bearing	25	Sleeve	40	Gasket	55	Snap ring
11	Washer	26	Pinion shaft	41	Plug	56	Snap ring
12	Bearing lock nut	27	Idler gear shaft	42	Breather	57	Spring washer
13	Taper roller bearing	28	Snap ring	43	Oil seal	59	Snap ring
14	Bearing lock nut	29	Cover	44	Shim	60	Name plate
15	Bearing lock washer	30	Cover	45	Shim		

(2) 20/25BR-7



BR147DU103

10	Housing	25	Cover	39	Wheel shaft
11	Cover	26	Seal ring	40	Bevel gear set
12	Hexagon screw	27	O-ring	41	Taper roller bearing
13	Ring gamma	28	Circlip	42	Taper roller bearing
14	Magnet plug	29	Upper part	43	Taper roller bearing
15	Seal ring	29-1	Lub nipple	44	Hexagon nut
16	Socket head screw	29-2	Plug	45	Shim
17	Hexagon nut	29-3	Seal ring	46	Shim
18	Washer	33	Centering ring	47	Shim
19	Parallel pin	34	Hexagon screw	48	Washer
20	Socket head screw	35	Pinion	49	Hexagon screw
21	Socket head screw	36	Plug	50	Seal ring
23	Socket head screw	37	Ball bearing	51	Seal ring
24	Breather valve	38	Super gear	52	Wheel bolt

2. SPECIFICATION

1) 10/13/14/15/18BR-7

Item	Unit	Specification
Gear ratio	-	20.125
Oil quantity	ℓ	1.6

2) 20/25BR-7

Item	Unit	Specification
Gear ratio	-	20.9
Oil quantity	ℓ	4.4

GROUP 2 TROUBLESHOOTING

Problem	Probable cause	Remedy
Continuous metallic groan		
1) During acceleration	· Worn out gears.	- Adjust back-lash or replace gears.
	· Pinion and bevel gear meshed too deeply.	
2) During travelling at uniform speed	· Lack of gear oil.	- Refill
	· Worn out gears.	- Replace
	· Loose or worn out bearing.	- Adjust preload or replace.
	· Loose bevel gear wheel	- Replace bolts and washers. Tighten new bolts and washer.
3) When turning corners.	· Worn out differential gear or thrust washer.	- Replace
Continuous knocking sound		
1) During travelling at uniform speed	· Chipped gear teeth.	- Replace
	· Foreign matter in axle case.	- Clean
	· Worn out spline of drive shaft.	- Replace
Oil leakage		
1) Differential housing housing leaks.	· Oil level too high	- Lower oil level
	· Broken oil seal	- Replace
2) Axle case leaks	· Mounting bolts for housing loose.	- Retighten
	· Damaged packing case cracked.	- Replace
	· Worn out hub grease seal.	- Replace
3) Hub leaks	· Worn out oil seal.	- Replace
	· Worn out bearing or eccentric rotation due to damage.	- Replace
Power is not transmitted		
1) Drive shaft, gear	· Broken or slipped out drive shaft.	- Repair or replace
	· Gear teeth stripped or worn out.	- Replace
	· broken differential case parts.	- Replace
Oil leakage on wheel shaft	· Radial shaft seal wrongly installed or damaged.	· Remove wheel shaft and install a new radial shaft seal.
	· Race on wheel shaft damaged.	· Remove wheel shaft. Check wheel shaft race for reusability; if possible, rework.
Oil leakage on housing cover	· Housing cover not sealed.	· Seal housing cover with LOCTITE No. 574.
	· Housing cover or housing plane face uneven.	· Touch up plane faces with oil rubber.
	· Bolts not tightened according to the specified tightening torque.	Tighten bolts with the specified tightening torque.

Fault	Probable cause	Remedy
Oil leakage on oil filler or oil drain plug	· Dirt between sealing ring and housing. · Old sealing ring was used. · Bolts not tightened according to the specified tightening torque.	· Cleaning required. · Use new sealing ring · Tighten bolts with the specified tightening torque.
Oil leakage between housing and top section	· Seal faces not sealed or uneven. · Burrs on cylinder pin. · Bolts not tightened according to the specified tightening torque.	· Apply LOCTITE 574 onto seal faces. · Touch up seal faces with oil rubber. · Use a new cylinder pin. · Tighten bolts with the specified tightening torque.
Oil leakage on top section within helical gear stage / input	· Too much oil in transmission. · O-ring on cover defective. · Breather valve defective.	· Check oil level. · Install new O-ring. · Replace breather valve.
Beating noise at helical gear stage	· Teeth on input pinion and/or helical gear damaged by false installation.	· Check tooth flanks for damage and touch up damaged spots with oil rubber.
Ringing noise	· Helical gear stage running without oil.	· Check oil level. Refill oil.
Grinding noise	· Bearing preload or backlash not correctly adjusted.	· Checking and new adjustment.
Bearing damage on input pinion	· No axial play.	· Install new bearing and adjust axial play.
Pivoting bearing is difficult to rotate or backlash recognizable	· Cover disc loosened and dirt entered into the bearing. · Cage segments are damaged. · Plastic deformation of balls or ball race. · Bearing not relubricated. · Grease not distributed.	· Replace pivoting bearing. · Replace pivoting bearing. · Replace pivoting bearing. · Relubricate pivoting bearing. · Rotate pivoting bearing several times by hand.

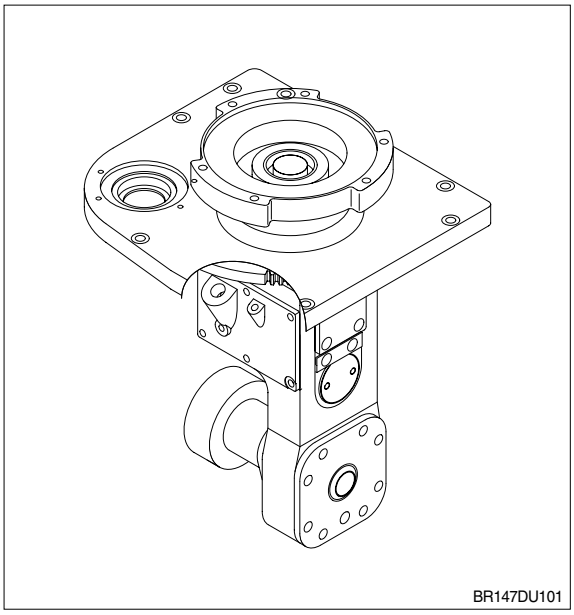
GROUP 3 DISASSEMBLY AND ASSEMBLY

1. 10/13/14/15/18BR-7

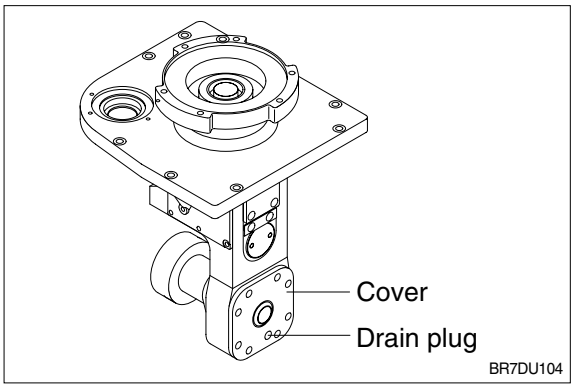
1) DISASSEMBLY

※ Before starting disassembly check the backlash and tooth contact for use as reference during assembly.

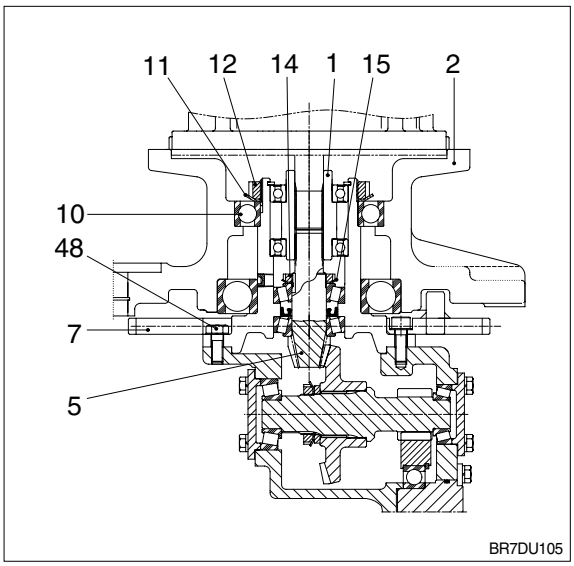
(1) Stabilize the drive unit assembly by using wooden block.



(2) Remove the plug and drain out the oil. Remove the gear case cover and drain out the oil.



(3) Loosen the lock nut and remove the lock nut(12) and washer(11).
(4) Remove drive unit bracket(2). Remove the outer race of bearing(10) and oil seal from bracket.
(5) Remove bolts(48) and remove the steering gear(7).
(6) Remove bolts(11EA).
(7) Remove the cover(1) of gear case with spiral bevel pinion(5).
(8) Remove bearing nut(14) by straightening the locking part of the bearing washer(15), and remove the spiral bevel pinion(5) from the cover of gear case(1).



(9) Remove the end cover(29, 30).

(10) Remove the bearing(16, 20) installed on the side of spiral bevel gear(6) for pinion shaft(26).

Loose the nut for spiral bevel gear(6) by straightening the locking of the washer and remove the nut(21) and the washer(22).

When loosening the nut, lock the pinion shaft by puting capper for between the idle gear(8) and the pinion shaft(26).

※ After removing the idle gear(8) remove the pinion shaft(26) and spiral bevel gear(6).

(11) Support drive shaft(36) at drive wheel side not to rotate.

Remove the lock nut(32) of drive gear and pull out the drive shaft(36) to drive wheel side.

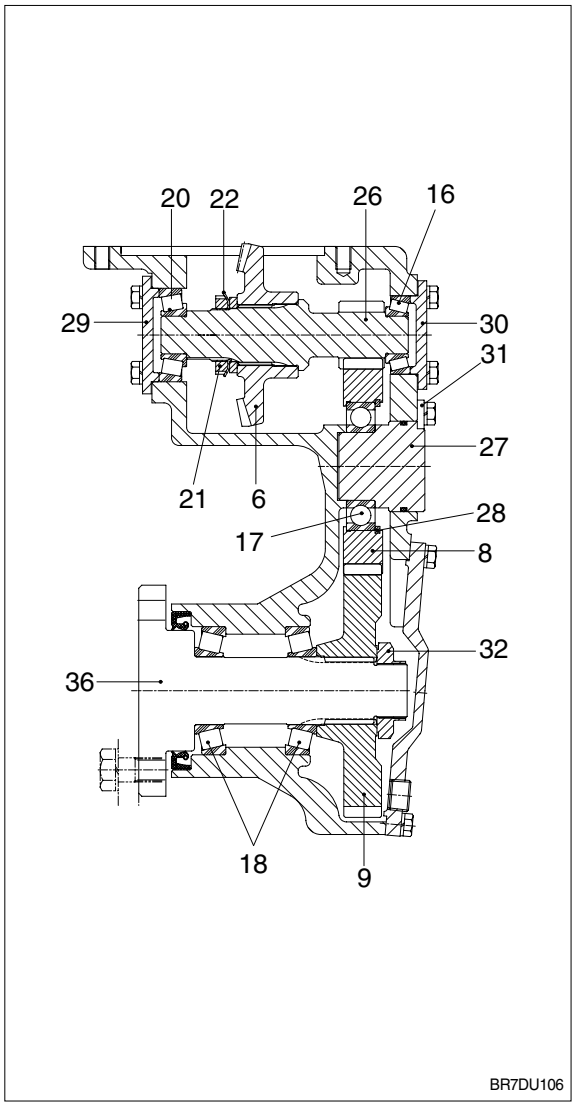
Remove the bearing(18) from drive shaft.

(12) Remove the locking plate(31) for idle gear shaft and remove idle gear shaft(27).

Pull out the idle gear from the side of drive gear(9).

(13) After removing the snap ring(28), remove the bearing(17) for idle gear.

(14) Pull out the pinion shaft(26) and the spiral bevel gear(6).



2) INSPECTION

(1) Inspect the gear case for cracks, bearing insertion parts for injuries, oil seals for damage and for other defects. Replace if found defective.
Inspect for gear case cracks visually and by use of flaw penetrants.

(2) Inspect the drive unit bracket for cracks, bearing insertion parts for injuries, bushings for damage, and other defects. Replace if found defective.

(3) Inspect the gear case cover for cracks, bearing insertion parts for injuries and for other defects. Replace if found defective.

(4) Inspect the spring adjuster and spring bracket for damage and spring for deterioration.
Replace parts found defective.

(5) Inspect the tooth part and spline part of steering pinion for damage and the bearing for damage, and replace the parts found defective.

(6) Inspect the bearing and oil seal of steering part for damage, and replace the parts found defective.

(7) Inspect the steering gear for damage, and replace parts found defective.

(8) Inspect the spiral pinion shaft, counter gear shaft and idle gear shaft for tooth damage and shaft bend, and the bearings for damage. Replace the parts if found defective.

(9) Inspect the spiral bevel pinion shaft for tooth damage and shaft bend, and the bearing holder and bearing for damage. Also inspect spiral bevel gear for damage.
Replace the parts if found defective.

(10) Inspect the drive wheel shaft for cracks, splines for wear and damage, and the bearings for damage. Replace the parts found defective.

3) ASSEMBLY

(1) Assemble the oil seal to the cover of gear case, assemble the bearing to spiral bevel pinion shaft. Assemble the spiral bevel pinion shaft bearing, washer and nut to the cover of gear case, and screw on the locking nut.
Tighten the locking nut while measuring starting torque required to start the bevel pinion turning.
Bevel pinion starting torque. 2.7~3.0kgf · cm(0.2~0.22lbf · ft)

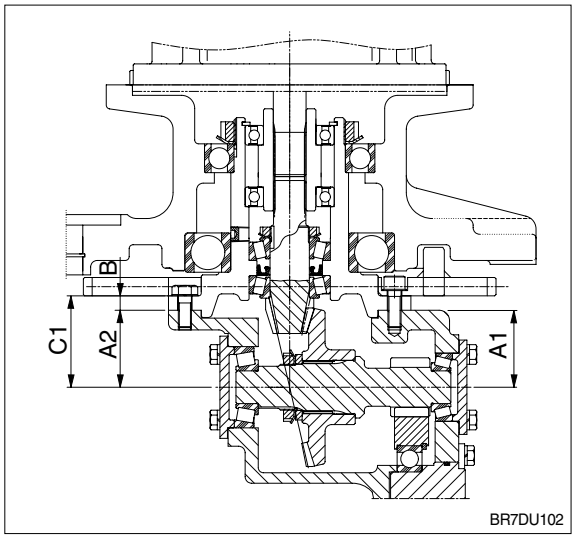
※ Apply loctite #271 white fastening lock nut (Item 12,14,21,32, Refer page 4-1).

(2) Assemble the drive wheel shaft to the gear case, assemble the spur gear from opposite side and screw on the locking nut. Tighten the locking nut while measuring starting torque required to start the spur gear turning. Spur gear starting torque. 23.6~26.3kgf · cm(1.7~1.9lbf · ft)

(3) Measure A1, A2 of the gear case and B of the gear case cover, and adjust C to be 69.00~69.10 by shim.

Shim thickness

3329022000 ····· 0.10mm
3329022100 ····· 0.20mm
3329022200 ····· 0.30mm
3329022300 ····· 0.50mm



(4) On the adjusting the tooth contact of spiral bevel gear, if changing the shim, idle of decrease the shim inserting between the cover of shaft both side and the gear case shim thickness.

Idle gear side		Drive tire side	
No.	Shim thickness	No.	Shim thickness
3329024400	0.10mm	3329024000	0.10mm
3329024500	0.20mm	3329024100	0.20mm
3329024600	0.30mm	3329024200	0.30mm
3329024700	0.50mm	3329024300	0.50mm

(5) Adjust the backlash between spiral bevel pinion and bevel gear.
Mount the dial gauge on gear case and read the backlash while rotating the drive wheel shaft.
Backlash 0.15~0.20mm
If the backlash is not within the specified range, readjust the bevel gear shims. Increase the shim thickness if the backlash is too large, and decrease if too small.

(6) Check the contact between the drive pinion and bevel gear tooth.
Clean the gear tooth and apply red lead of the surfaces of 8 or 9 bevel gear tooth.
Turn the bevel gear in both forward and reverse directions and determine by the patterns made on the tooth face whether the tooth is contacting properly.

4) INSTALLATION

Perform the removal in reverse order.

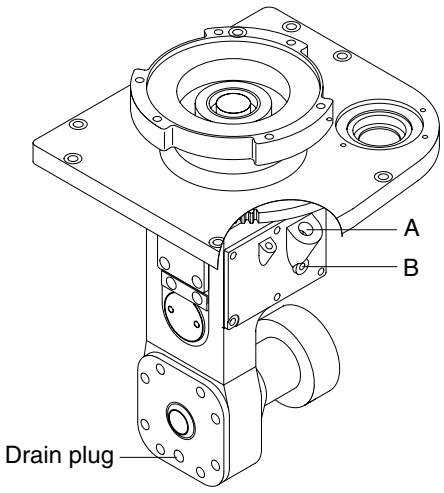
5) LUBRICATION PROCEDURES

Lubrication of drive unit gear case is performed as follows :

※ **Cover the brakes and drive motor with waste to prevent the gear oil from splashing on these parts.**

(1) Fill in oil through the filler hole A.

(2) After operating the vehicle for several hours, remove plug B and check the oil level. Replenish it now.

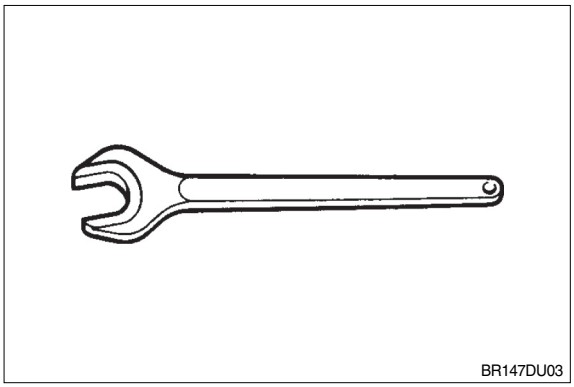


BR7DU107

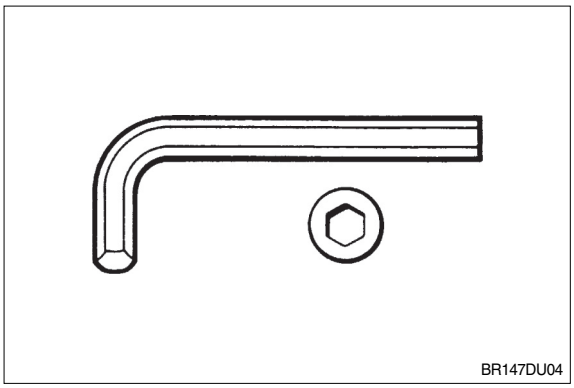
2. 20/25BR-7

1) STANDARD TOOLS

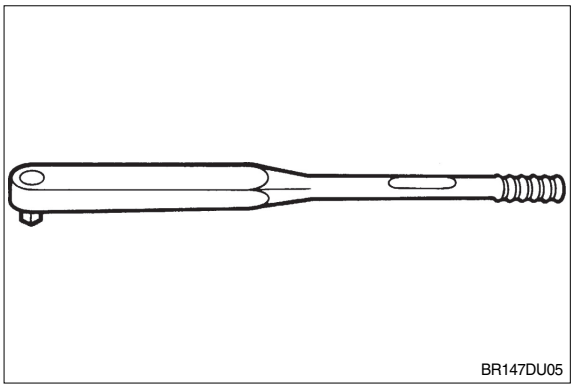
(1) Open jaw spanner 10, 13, 30㎜.



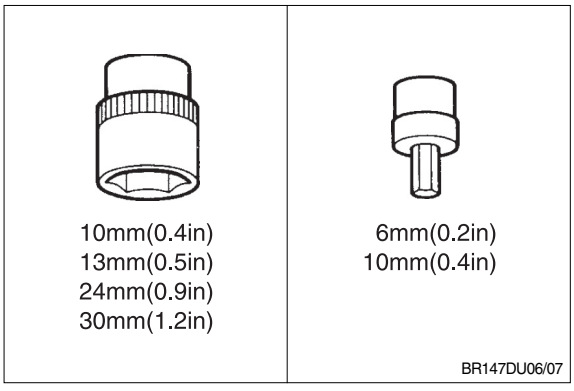
(2) Allen wrench 6, 10㎜.



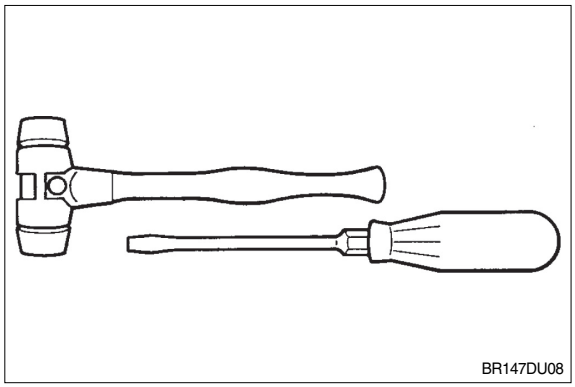
(3) Torque spanner
Adjustable from 9.5 to 300Nm.



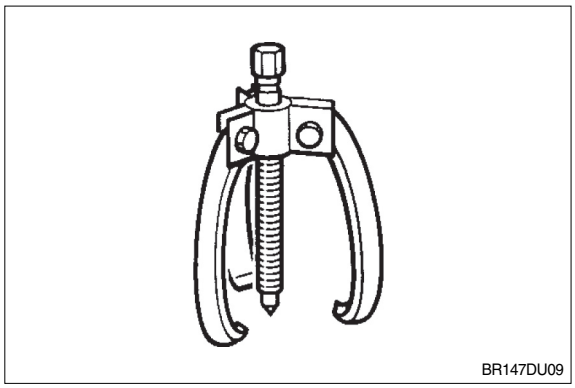
Hexagonal socket spanner.



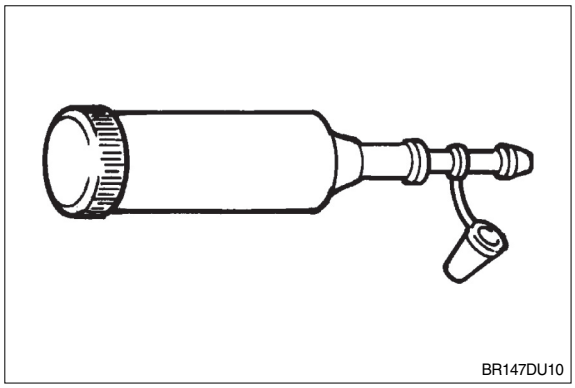
(4) Plastic hammer(1000g).
Steel hammer(250g).
Stable screwdrivers or levers.


BR147DU08

(5) Two-armed or three-armed puller.

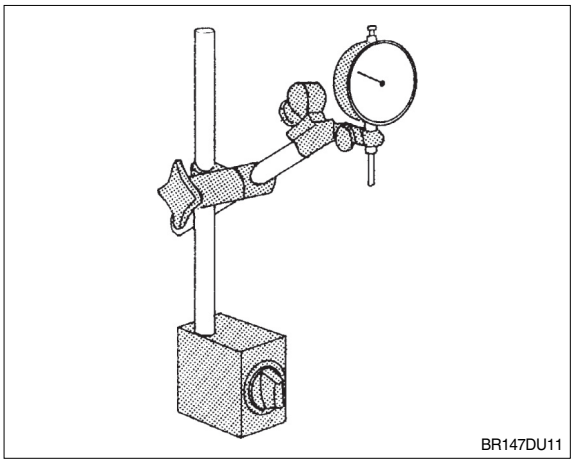

BR147DU09

(6) Grease gun
With adapter for hydraulic-type lubricating nipple acc. to DIN 71412-M8 × 1.

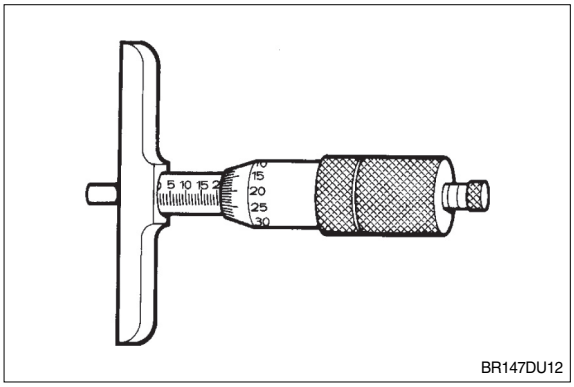

BR147DU10

2) MEASURING TOOLS

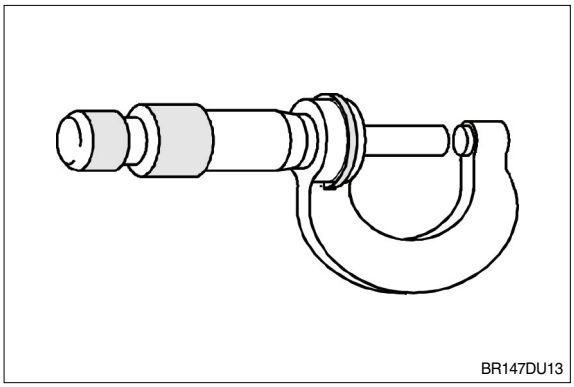
(1) Dial gauge with magnetic stand.



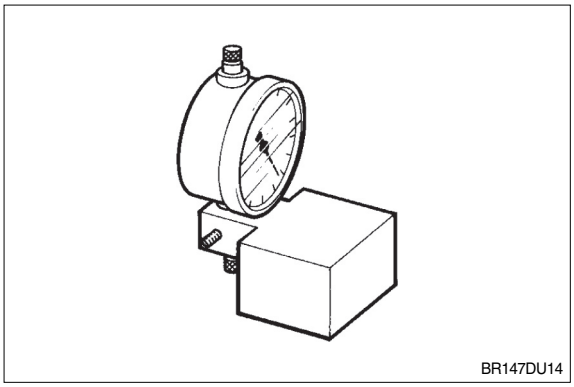
(2) Micrometer depth gauge
Measuring depth up to 70㎜.



(3) Micrometer
Measuring range up to 25㎜.



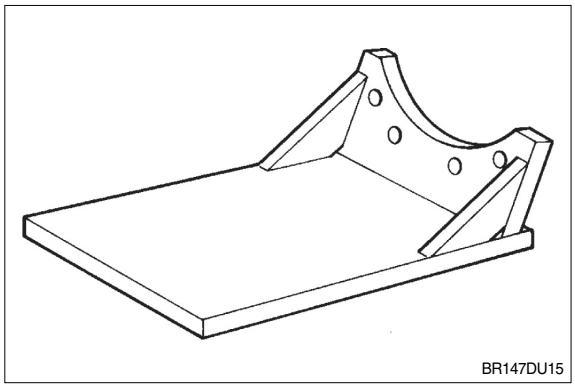
(4) Measuring device
For determination of installation dimension for bevel pinion shaft.



3) SPECIAL TOOLS

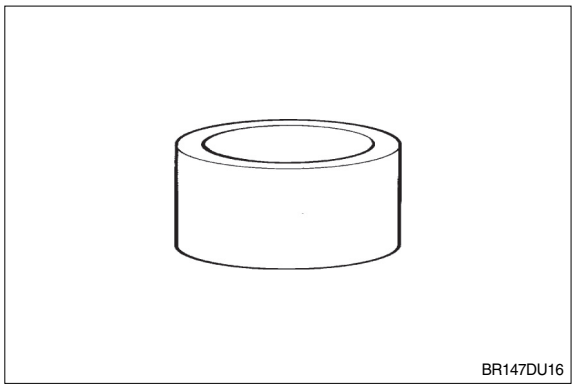
(1) Assembly plate(A)

If no assembly fixture is available.



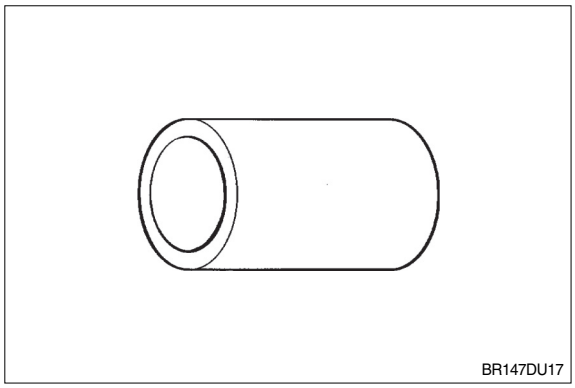
(2) Bush(B)

To press off bearing inner ring from bevel pinion shaft.



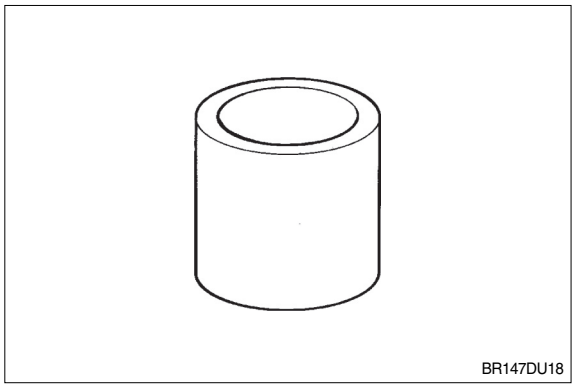
(3) Bush(C)

To press bearing inner ring onto bevel pinion shaft.



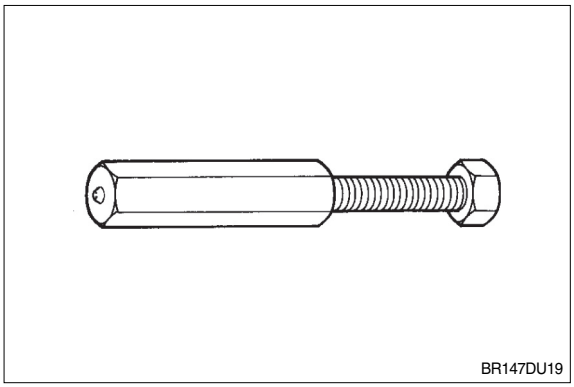
(4) Measuring bush(D)

For determination of installation dimension for bevel pinion shaft.



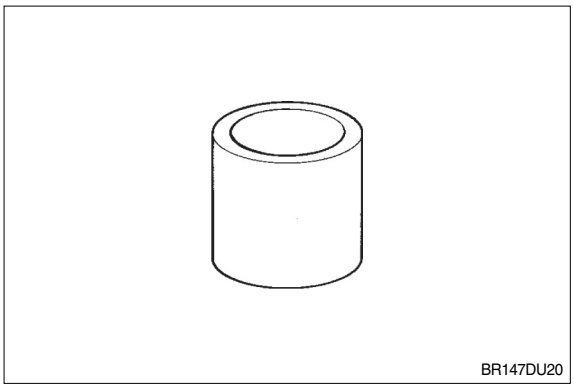
(5) Clamping fixture(F)

To clamp bevel pinion shaft into the housing.



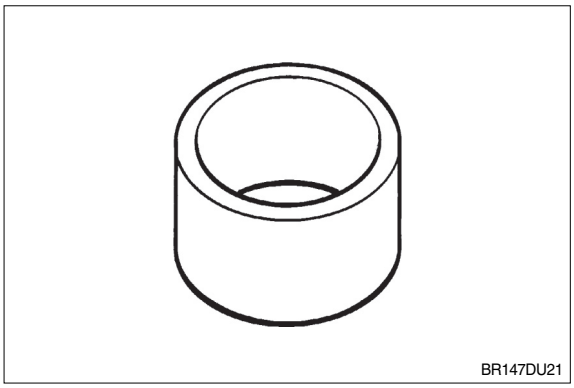
(6) Bush(G)

To press bearing inner ring onto bevel pinion shaft.



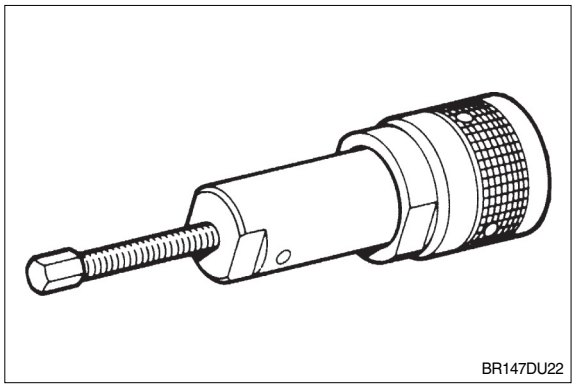
(7) Sleeve(H)

To press bearing inner ring onto wheel shaft and onto crown gear.



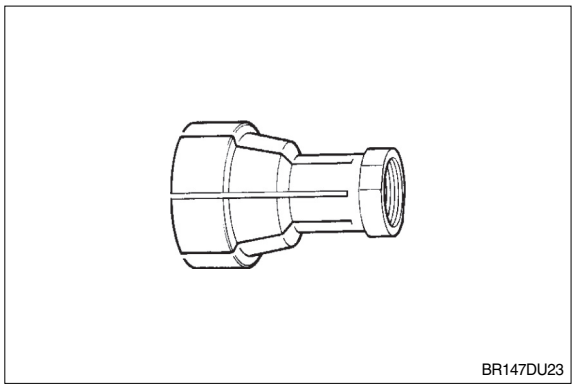
(8) Puller(M)

To pull off bearing inner rings from the wheel shaft and the crown gear.



BR147DU22

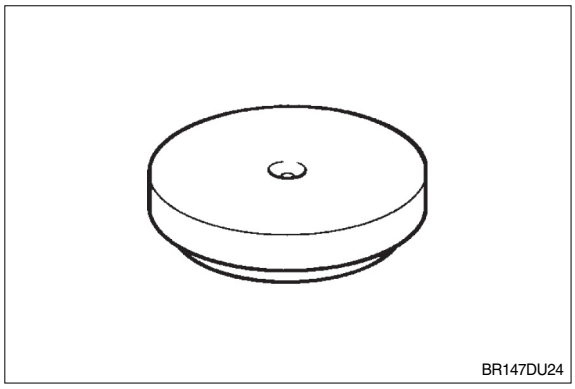
Clamping pliers



BR147DU23

(9) Pressure piece(N)

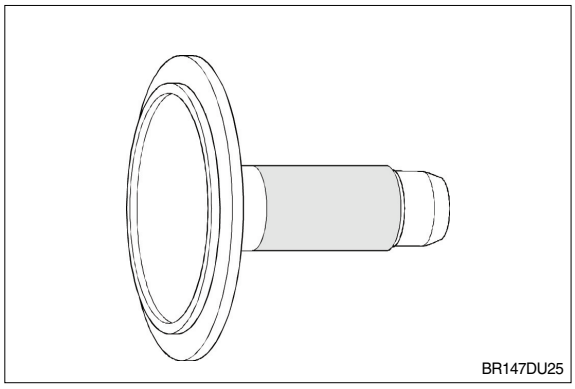
To pull off bearing inner ring from the crown gear.



BR147DU24

(10) Assembly drift(S)

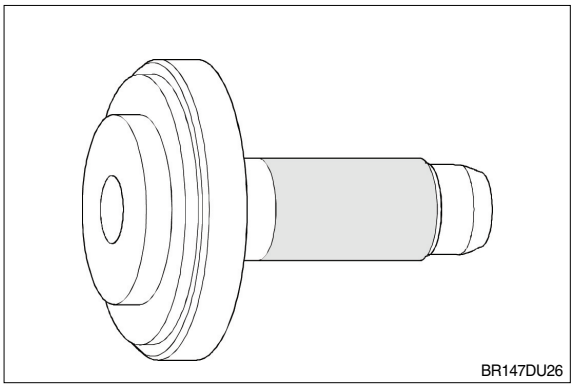
Install protective shield.



BR147DU25

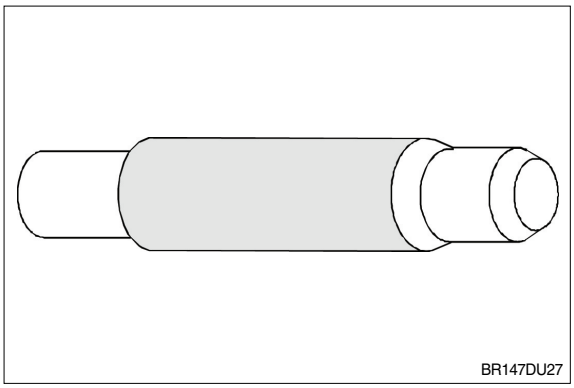
(11) Assembly drift(T)

Install radial shaft seal.



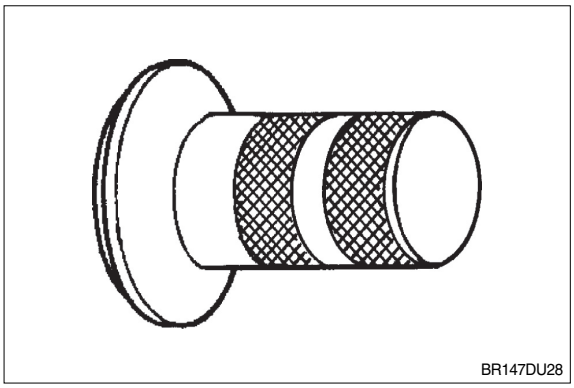
(12) Assembly drift(U)

To install breather filter.



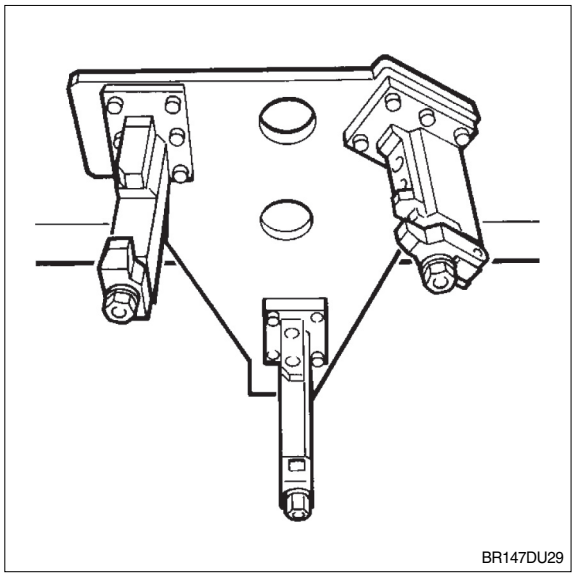
(13) Assembly drift(V)

To install grooved ball bearings into the housing seat.



4) DISASSEMBLY

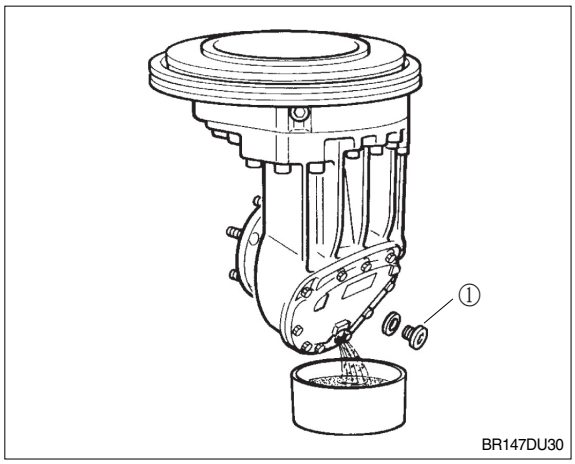
※ Prior to disassembly clean drive unit carefully. A great help is a bright, spacious working place, free of dirt and chips.
The necessary working steps are described and illustrated in the correct sequence.
Parts only available as assembly groups will not be stripped any further.
Please observe strictly the instructions of the vehicle manufacturer for removing the drive unit from the vehicle.
For dis-and reassembly we recommend to use a fixture as shown in below figure.


BR147DU29

(1) DRAIN OFF DRIVE UNIT

① Place a suitable receptacle under the oil drain plug(①) and unscrew it with a 6mm allen wrench.
Drain oil completely into the receptacle.

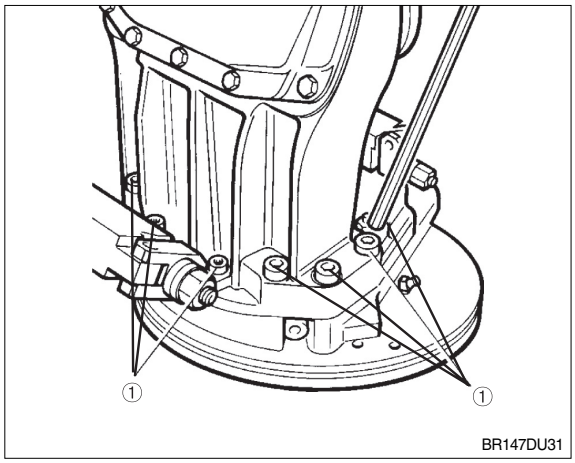
※ Do not drain oil into the sewerage system or into the soil.
Observe oil drain time.



BR147DU30

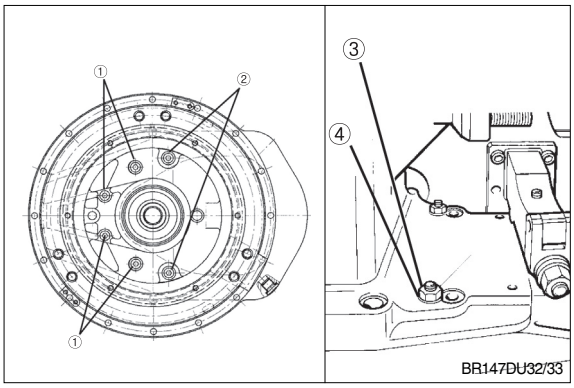
(2) REMOVE HOUSING TOP SECTION

① Loosen and remove the socket head bolts(①) on the bottom side of the drive unit housing as well as inside the housing top section.



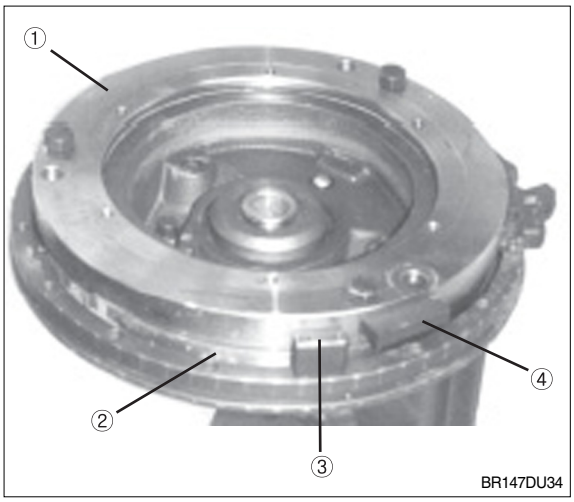
BR147DU31

② This drive unit has the housing top section additionally fastened to the housing by means of 2 socket head bolts(②), hexagon nuts(③) and washers (④).



③ For motor fixing the centering ring(②) is bolted onto the pivoting bearing(①).
Two final stops(③) on the chain tread and the lock plate(④) connected with the centering ring are required for the steering lock.

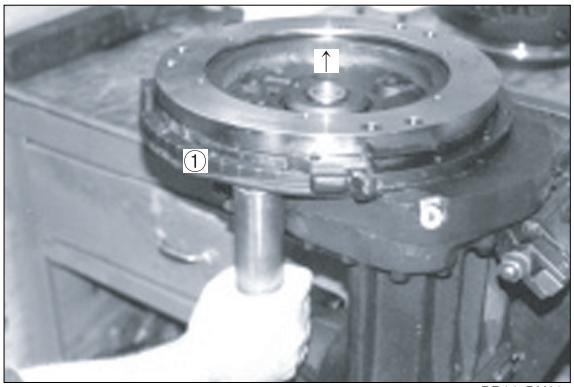
※ Only in case of damage the lock plate and the 2 final stops have to be removed and replaced.



④ Slightly beat with a plastic hammer or a copper mandrel from the bottom against the top section(①), so that it loosens from the transmission housing.
Cautiously lift off and remove the housing top section.

※ Housing top section can only be replaced completely. Centering ring can be reused.

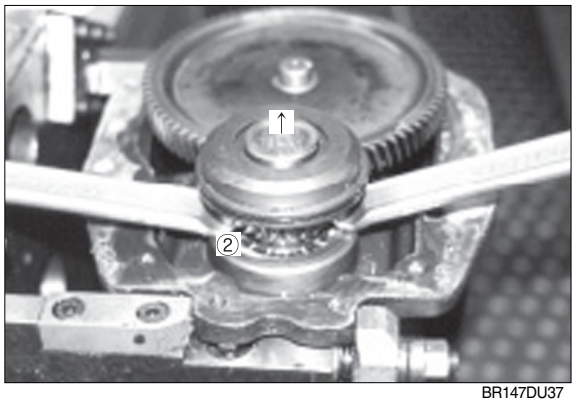
※ Remove cylinder pins, breather valve and grease nipples only in case of damage. Check housing top section acc. to chapter "Reassembly", refer to page 3-40 and keep it properly.



Remove input from the housing top section and dismantle it

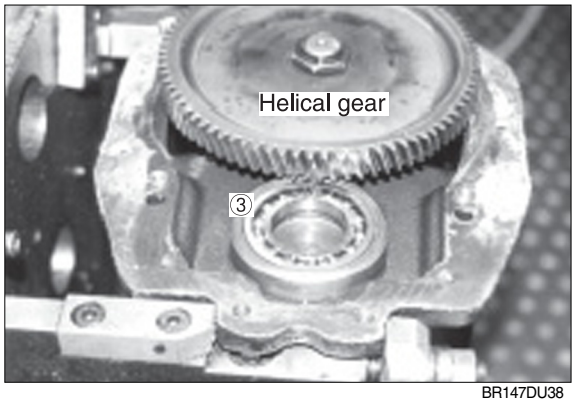
⑤ By means of two assembly levers press cover assy(②) cautiously against the bearing outer ring(With radial shaft seal, grooved ball bearing, O-ring and input pinion) out of the bearing bore.

※ Do not damage the input pinion toothing. Damages might cause loud-er running noises.



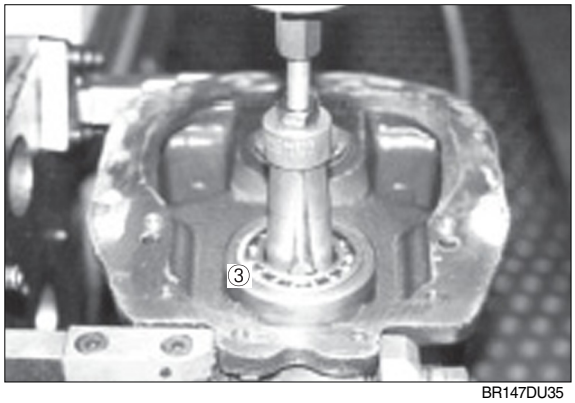
BR147DU37

※ Prior to remove the grooved ball bearing(③) the helical gear has to be taken off first, page 3-24, (7).



BR147DU38

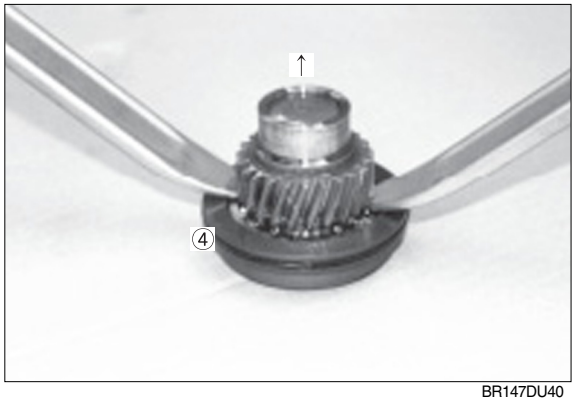
⑥ Pull grooved ball bearing(③) with a bearing extractor out of the bore hole in the housing top section and remove it.



BR147DU35

⑦ By means of two assembly levers press input pinion(④) cautiously out of the cover and remove it.

※ Do not damage the input pinion toothing. Damages might cause louder running noises.

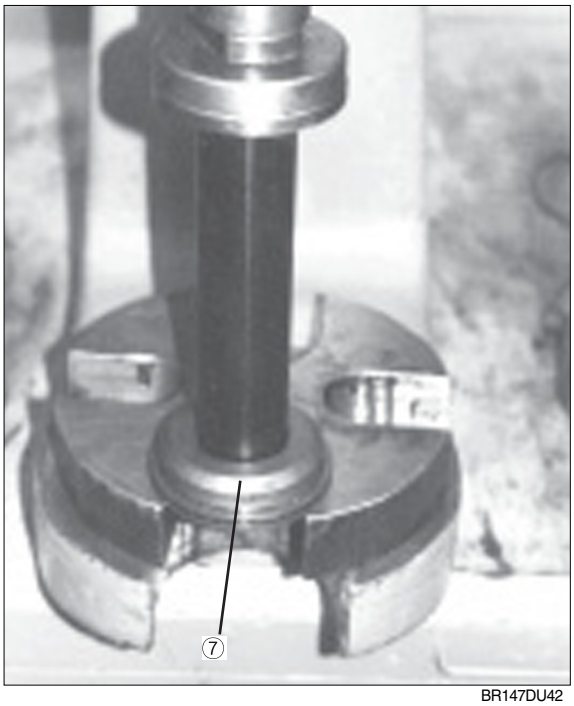


BR147DU40

⑧ Remove radial shaft seal(⑤) from the cover, only if unavoidable.

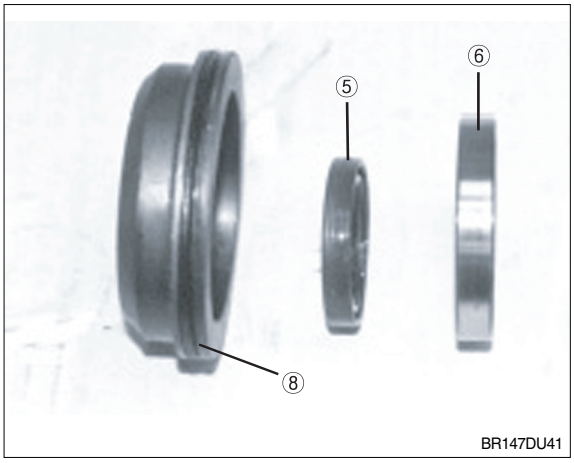
※ Radial shaft seal will be destroyed at removal. Use new radial shaft seal for reassembly.

⑨ By means of bush press radial shaft seal and grooved ball bearing(⑥) out of the cover(⑦) and remove them.
Remove O-ring(⑧) from the slot in the cover.



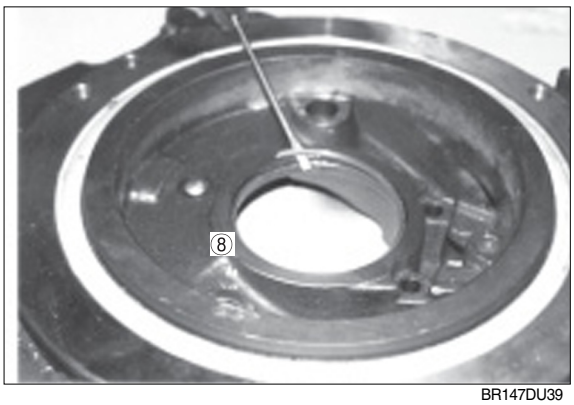
BR147DU42

※ Use O-ring only once.
For reassembly a new O-ring is to be used.



BR147DU41

⑩ Unsnap and remove circlip(⑧) with the aid of a screw driver from the housing top section.

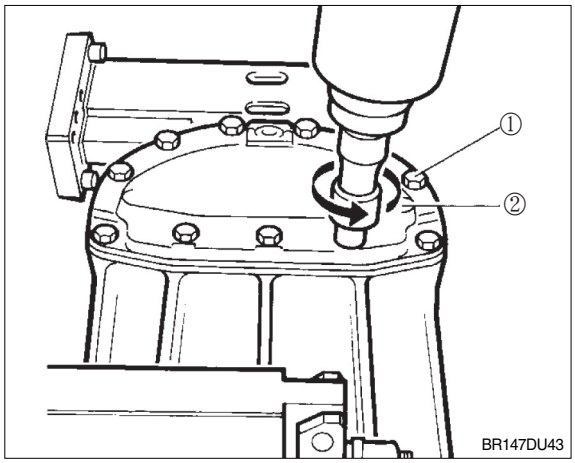


BR147DU39

(3) REMOVE HOUSING COVER

① Remove hexagon bolts(①) in the housing cover.

Loosen and remove housing cover(②) from the housing by slightly beating with a plastic hammer against the outer edge.

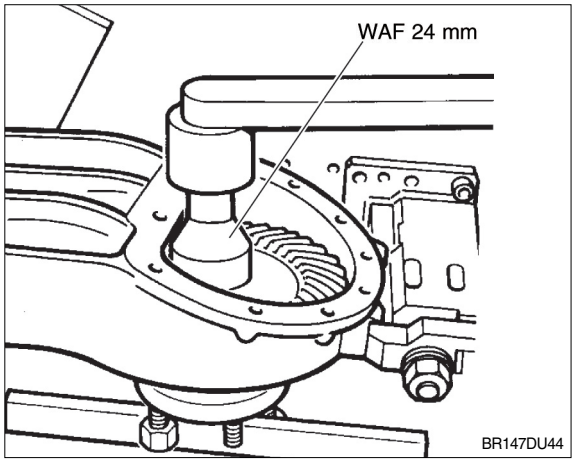


(4) REMOVE WHEEL SHAFT AND CROWN GEAR

① Place drive unit into the fixture and fasten it with screws.

Screw 2 wheel nuts onto the wheel bolts and hold the wheel shaft with a lever.

Screw off the hexagon bolt with a hexagonal spanner WAF= 24mm and remove it with the washer from the wheel shaft.

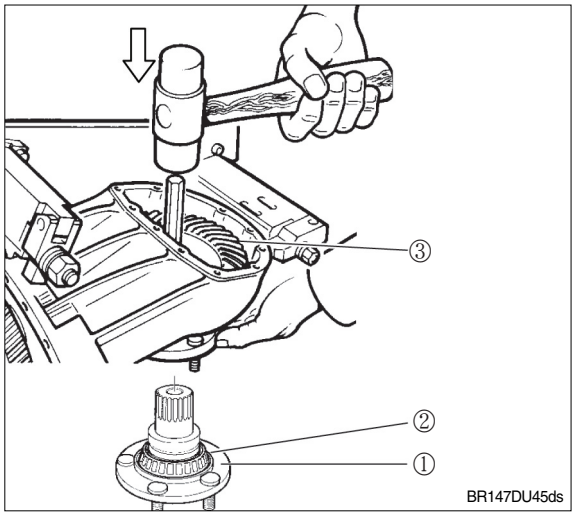


② Drive wheel shaft(①) with the aid of a copper mandrel and a hammer out of the housing and remove it.

※ Take care that the wheel shaft is not damaged during removal.

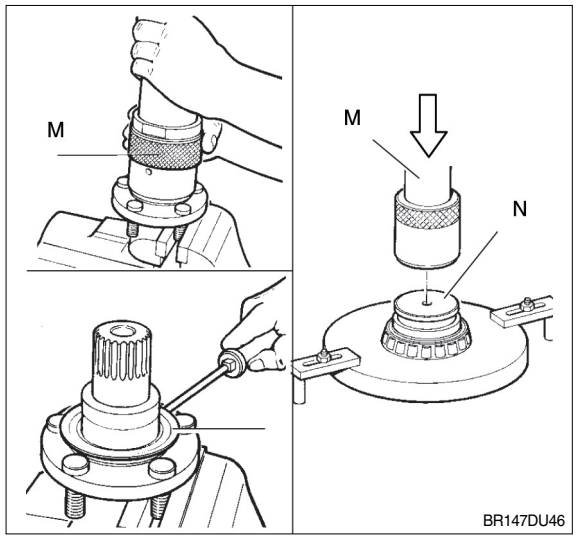
※ During disassembly of the wheel shaft the sealing ring(②) on the wheel shaft and the radial shaft seal in the housing can be damaged and should always be replaced.

③ Then carefully remove the crown gear(③) from the housing.



(5) REMOVE BEARING INNER RINGS FROM WHEEL SHAFT AND CROWN GEAR

① If the taper roller bearings are to be reused, we recommend to use puller **M**.
(See page 3-16 special tools)



Remove bearing inner ring from wheel shaft

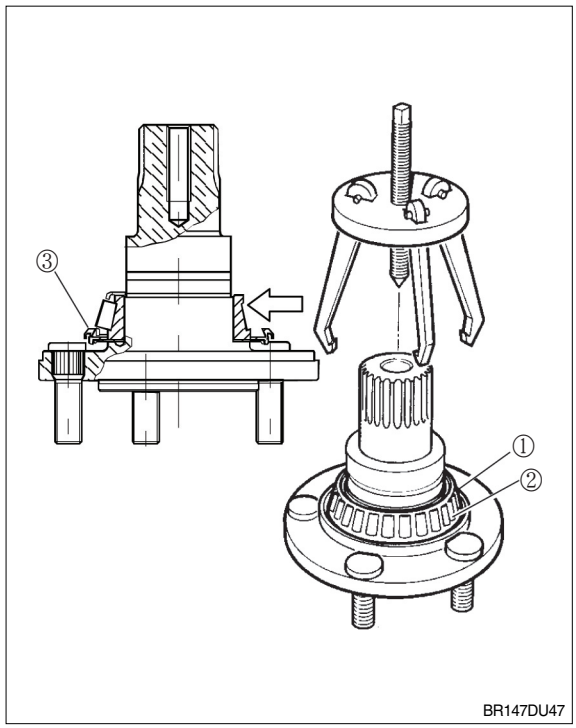
② Place clamping pliers of the puller onto the rollers of the bearing inner ring.
By means of union nut tightly connect clamping pliers with the rollers.
Bolt spindle to the wheel shaft face and remove the bearing inner ring cautiously and evenly at all sides.
Take off the sealing ring(①) from the wheel shaft.

※ Avoid damage at the wheel bolt threads at counter-supporting.
Protect wheel bolt thread against damage with suitable fixtures.

Remove bearing inner ring from crown gear

③ Proceed as described under(5), ② for removal of the bearing inner ring from the crown gear.
Crown gear should be clamped on the work bench and pressure piece **N** be inserted into the crown gear bore hole to support the spindle.
For replacement of the taper roller bearings, the following steps are required

- Open bearing cage(①) by cutting and remove the rollers(②).
- Cautiously remove the bearing inner ring with a puller(e.g. three-armed puller) over the bearing collar( ).
- Remove sealing ring(③) from wheel shaft.

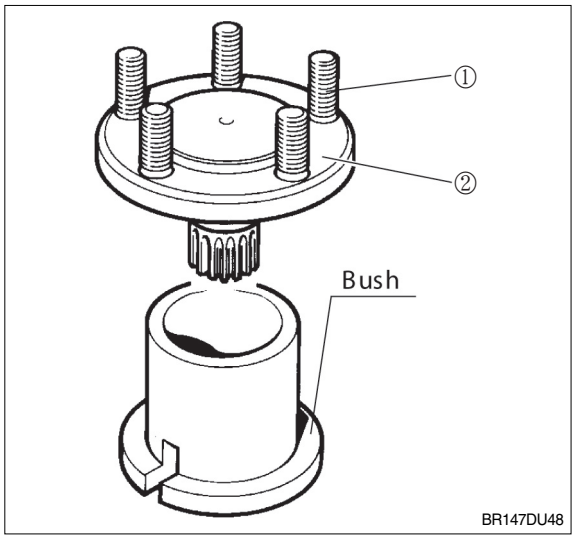


(6) PRESS WHEEL BOLTS OUT OF THE WHEEL SHAFT

① Wheel bolts(①) can only be pressed out at removed wheel shaft.

※ Make these 2 steps only in case of emergency. Do not damage wheel bolt threads at pressing-out.

- Place wheel shaft(②) into a suitable bush and press out wheel bolts with a press.
- By means of a copper mandrel and a hammer drive wheel bolts out of the wheel shaft. Be especially careful at this step, since at replacement or installation of the new wheel bolt with the old wheel shaft, the position of both parts to each other must exactly be obtained again.



BR147DU48

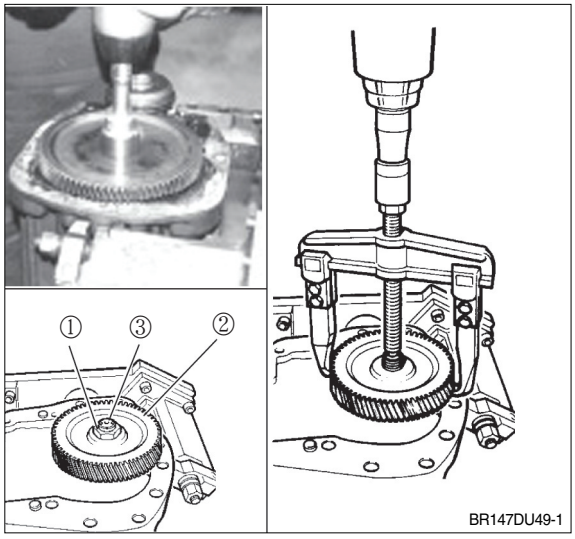
(7) REMOVE BEVEL PINION SHAFT

Remove helical gear

① Bevel pinion shaft can only be removed, when crown gear was taken off before. Unscrew hexagon nut(①).

※ Use hexagon nut only once.

② Pull off and remove helical gear(②) from bevel pinion shaft(③) with the aid of a puller (three-armed puller).

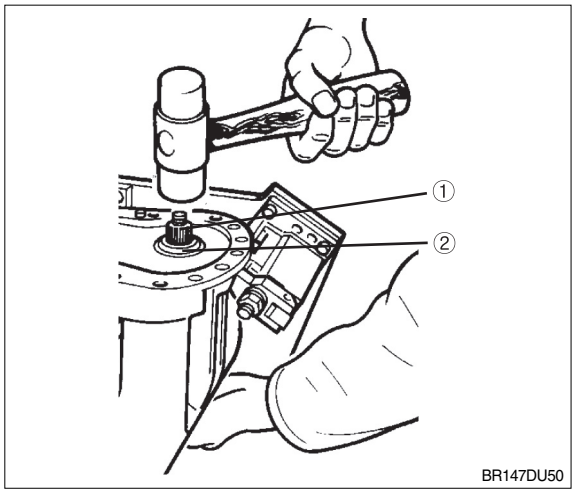


BR147DU49-1

Drive out bevel pinion shaft

③ Drive out bevel pinion shaft(①) with the aid of a plastic hammer from the bearing seat.
Take off and remove the taper roller bearing inner ring(②) from the bearing bore hole.

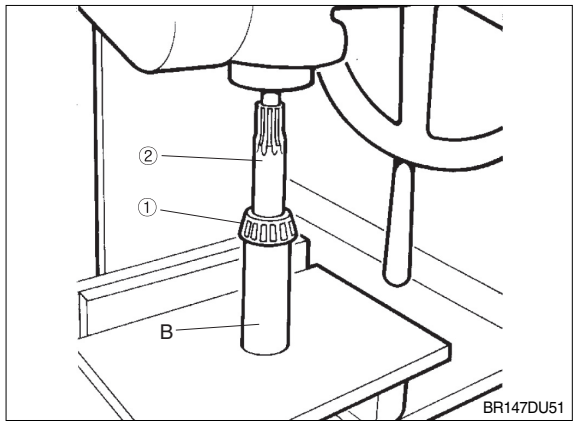
※ Take care that the bevel pinion shaft is not damaged during removal.



BR147DU50

Press off taper roller bearing inner ring from the bevel pinion shaft

④ By means of bush **B** press off the bearing inner ring(①) from the bevel pinion shaft(②).



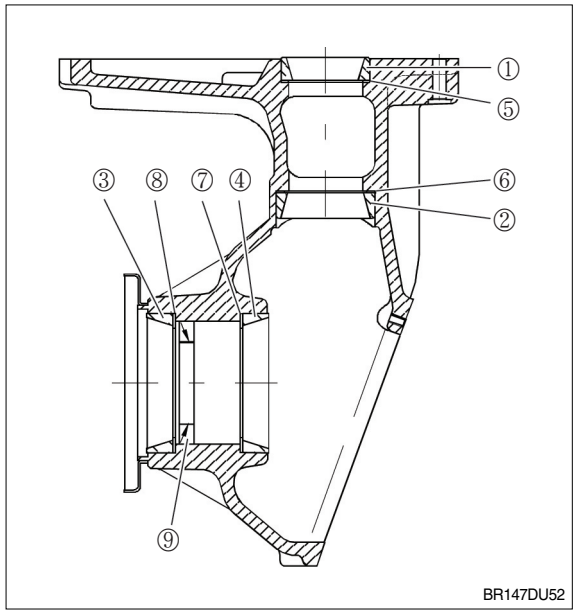
(8) REMOVE TAPER ROLLER BEARING OUTER RINGS AND RADIAL SHAFT SEAL

① Cautiously drive the bearing outer rings(①,②,③ and ④) for supporting of the wheel and bevel pinion shaft with the aid of a copper mandrel and a hammer out of the housing.
Take care that shim rings(⑤,⑥,⑦ and ⑧) are not damaged during removal of the bearing outer rings.

※ Put bearing outer ring to the respective bearing inner ring.
Do not reuse deformed or damaged shim rings.

② By means of a copper mandrel or robust screw driver and a hammer drive out and remove radial shaft seal(⑨) from the housing.

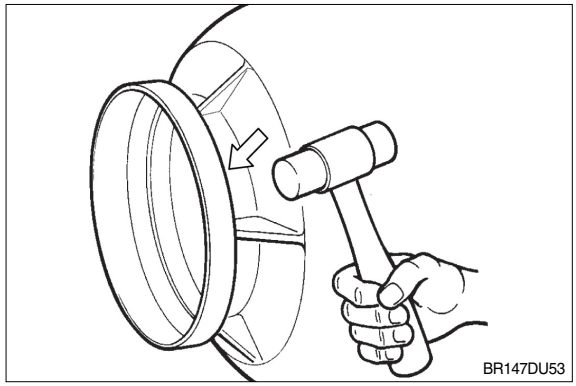
※ During disassembly of the wheel shaft the radial shaft seal can be damaged and must always be replaced.



(9) REMOVE THREAD PROTECTIVE SHIELD (GAMMA RING)

① By means of robust screw driver and a plastic hammer cautiously drive out and remove the thread protective shield from the adhesive point on the housing neck

※ Use the thread protective shield only once. For reassembly a new thread protective shield must be used.



5) REASSEMBLY

※ Clean all parts with a suitable cleaning agent and remove residues of LOCTITE.

⚠ **Keep away cleaning agent from your skin, do not drink it or inhale its vapours. Wear safety gloves and goggles. In case of skin contact rinse immediately with a lot of water. If by mistake the cleaning agent was swallowed, call medical aid immediately.**
Observe regulations for prevention of accidents.

※ Check all parts for wear, damages and cracks, if required replace them.
In case of damaged running teeth, the gear set parts have to be replaced per set.
Always replace damaged taper roller bearings(inner and outer ring).
Do not reuse deformed shim rings and worn thrust washers.
Touch up seal faces or smoothen them with a fine file.

※ For reassembly the following new parts should be used :

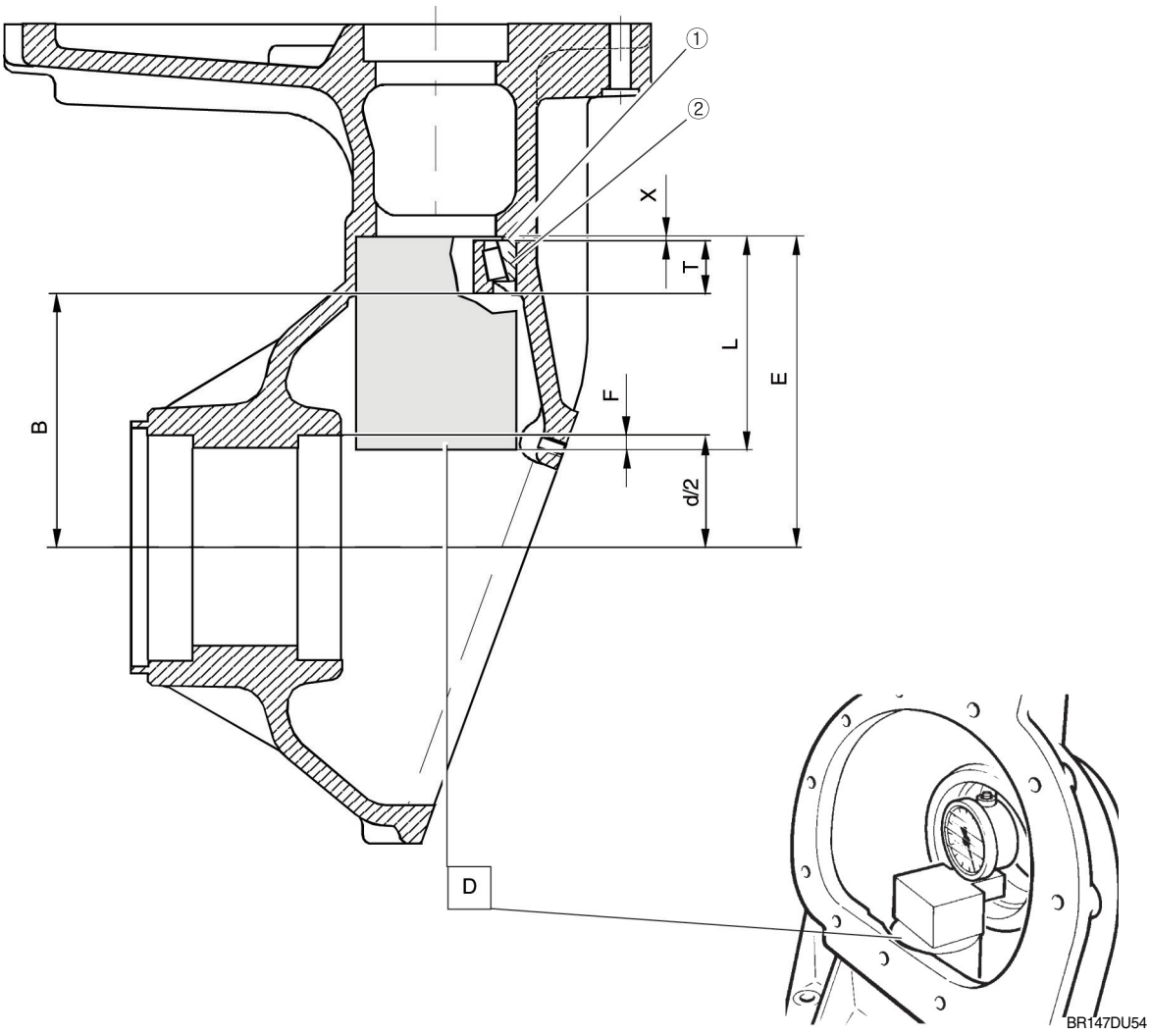
- Hexagon nut for bevel pinion shaft and helical gear fastening
- Hexagon bolt and washer for crown gear fastening
- Radial shaft seal on the wheel shaft
- Spring washers and lock washers
- Deformed or damaged shim rings
- Sealing rings on oil drain and oil filler plug

(1) DETERMINATION OF INSTALLATION DIMENSION FOR BEVEL PINION SHAFT

※ The bevel gear set, consisting of bevel gear shaft and bevel gear, is provided with certain installation dimensions. The installation dimension of the bevel pinion shaft is 100.00㎜.
The correct adjustment of the bevel pinion shaft is required for an exact setting of the contact pattern and the torsional backlash of the gearing.
Shim ring thickness and the correct adjustment of the bevel pinion shaft respectively can be determined acc. to the following method :

- Place measuring bush **D** into the housing-bearing bore and measure dimension F.
- Determine housing dimension **E** by the following equation. **E = L - F + d/2** which means :

L = Length of the measuring bush **D**(dimension marked on it 77.50mm)
F = Difference dimension from bearing seat diameter to front face measuring bush **D**
d/2 = Measure housing borehole
By means of the equation : **X = E - B - T** it is possible to calculate the thickness of the shim rings(①).
Which means :
B = Installation dimension of bevel pinion shaft is 100.00mm
(Factory setting of the installation dimension with a tolerance of ±0 is marked on the bevel pinion shaft)
T = Bearing width of the bearing(②)

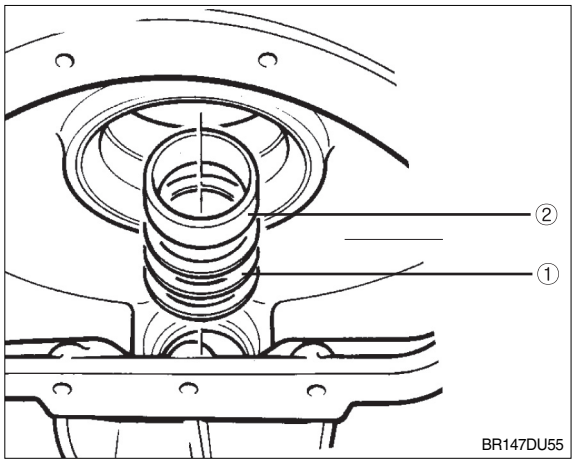


(2) PREASSEMBLE HOUSING

Bearing for bevel pinion shaft

① Shim ring thickness determined in page 3-27 has to be obtained by combining shim rings of variable thicknesses.
Place shim rings(①) into the bearing seat. Install bearing outer ring(②) into bearing seat in the housing.

※ A tolerance of ±0.05 from the determined dimension is permissible.

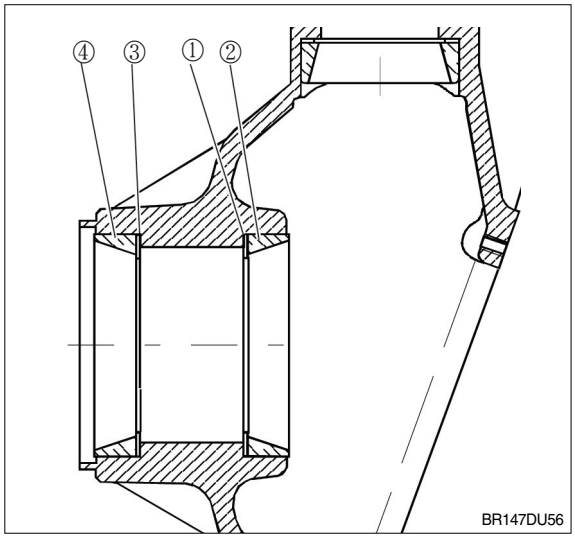


Bearing for wheel shaft

① Place shim ring pack(①and③, remove at disassembly) for presetting into both bearing seats. By means of a copper mandrel and a hammer install the bearing outer rings(②and④) of the wheel shaft bearing into the bearing bore until contact on both sides of the housing.

※ Do not reuse distorted shim rings.

※ Radial shaft seal between taper roller bearings and the thread protective shield are only allowed to be pressed in when the bearing is adjusted.



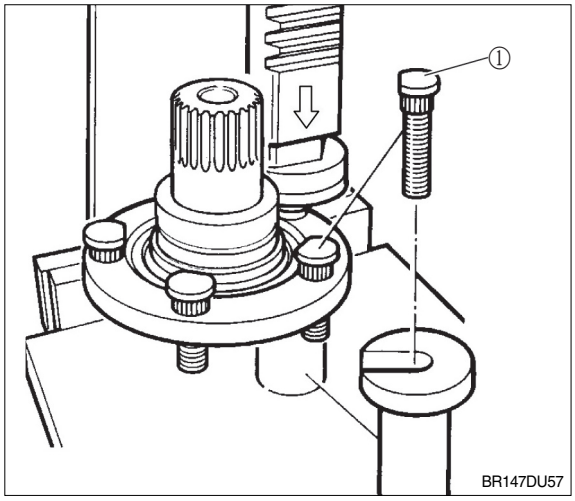
(3) PREASSEMBLE WHEEL SHAFT

Press in wheel bolts

① Wheel bolts(①) can only be pressed in when the wheel shaft is removed.

※ Make these steps only in case of emergency. For pressing-in take care that the flattened side on the bolt collar shows to the center of the wheel shaft.

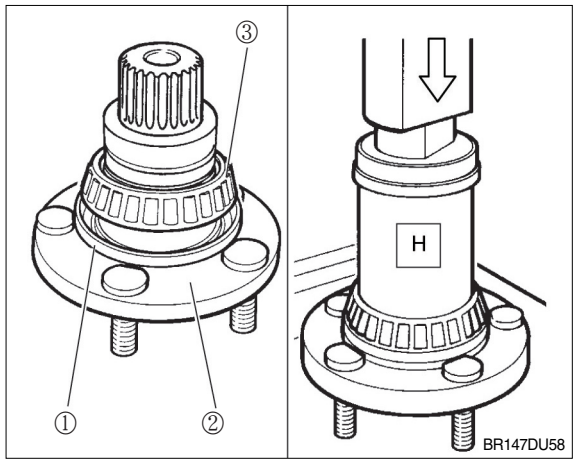
· Place wheel shaft(②) into a suitable bush and press in wheel bolts with a press. Be especially careful at this step, since at pressing in of the new wheel bolt with the old wheel shaft, the position of both parts to each other must exactly be obtained again.



Install sealing ring and bearing inner ring onto the wheel shaft

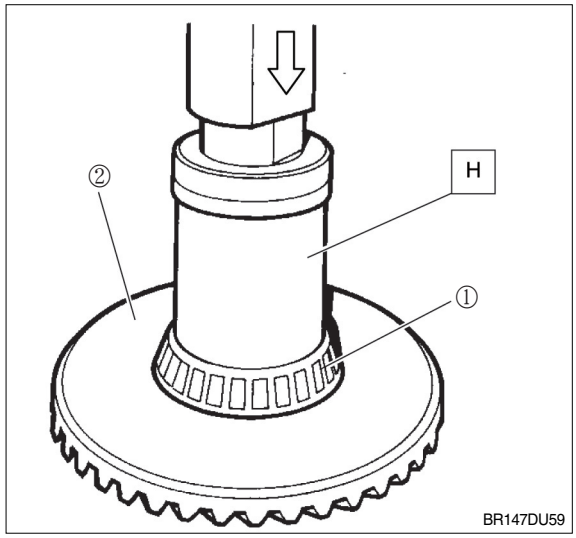
① Push sealing ring(①) on the wheel shaft(②). By means of sleeve **H** press bearing inner ring(③) onto the wheel shaft until contact.

※ **Only when the bearing is adjusted, the sealing and the taper roller bearing can be filled with grease SHELL Alvania R3.**



(4) PRESS BEARING INNER RING ONTO THE CROWN GEAR

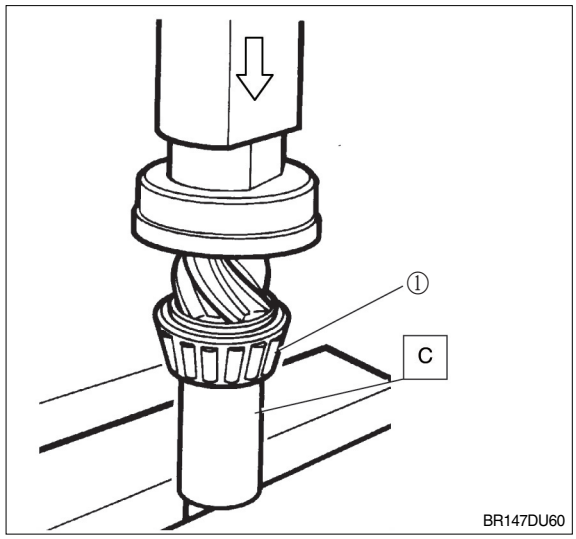
① By means of sleeve **H** press bearing inner ring(①) onto the crown gear(②) until contact.



(5) PREASSEMBLE BEVEL PINION SHAFT

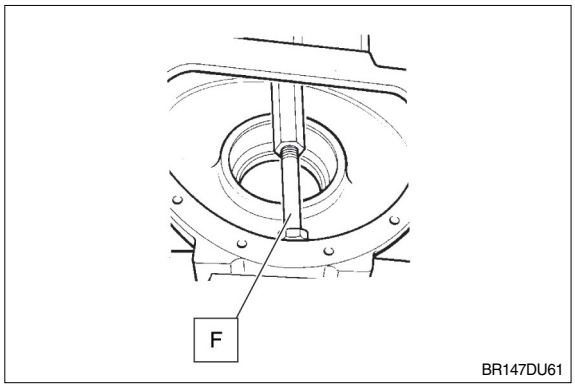
① By means of bush **C** cautiously install bearing inner ring(①) until contact.
If no press is available, the bearing can be installed in accordance with the following note.

※ Heat bearing inner ring up to max. 90℃ and install it until contact.
Install subsequently until contact after cooling down.



(6) INSTALL BEVEL PINION SHAFT INTO THE HOUSING

① Wet cage and space between rollers of the bearing inner ring with transmission oil. Insert preassembled bevel pinion shaft from the bottom into the housing and by means of clamping fixture **F** apply a slight preload to the bearing outer ring in the housing.



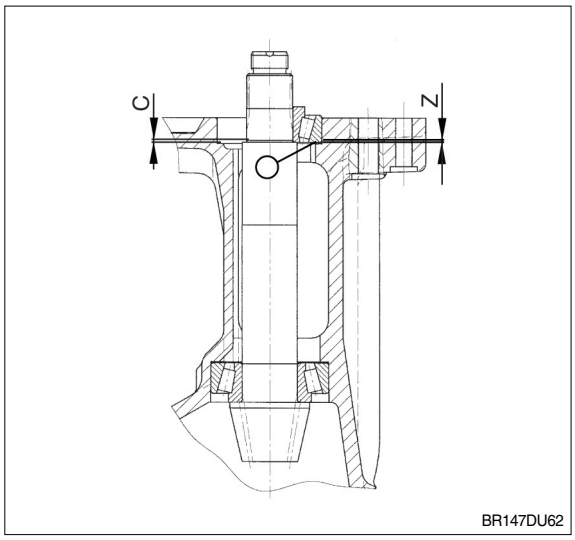
(7) MEASURE BEARING PLAY OF BEVEL PINION SHAFT AND ADJUST BEARING PRELOAD

Measure bearing play

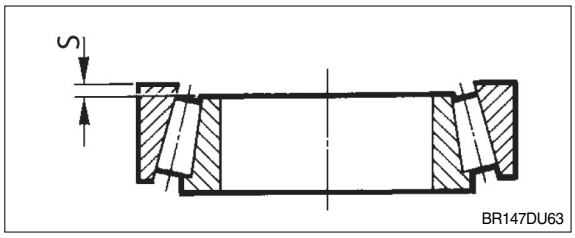
① With the following method the thickness of the shim ring(s)(①) to be added is determined.

Dim. C = Distance from collar of bevel pinion shaft to contact bearing outer ring.

Dim. S = Distance from plane face of bearing outer ring to plane face of bearing inner ring.



② Calculate shim ring thickness(①) by means of equation **Z = C + S**



③ Add shim ring corresponding with thickness Z.

Example :

C = 0.7 measured on housing and shaft

S = 0.08 measured on bearing

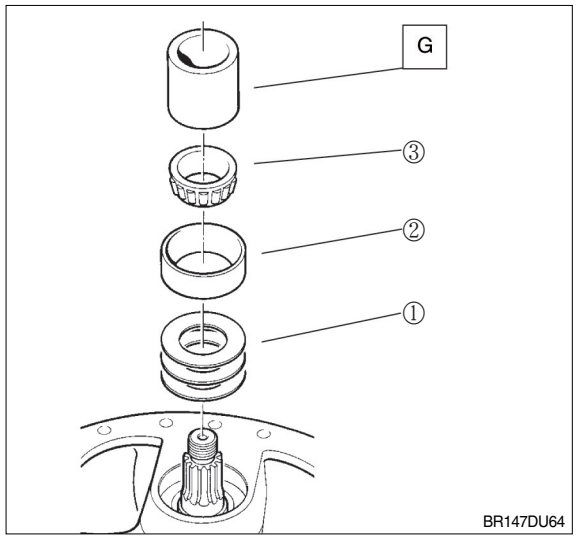
Z = 0.7 + 0.08 = 0.78mm

④ As per experience +0.02mm will be added to dimension **Z**, so that a bearing preload from 0.02 to 0.07mm is set.

Z = 0.78 + 0.02 = 0.8mm

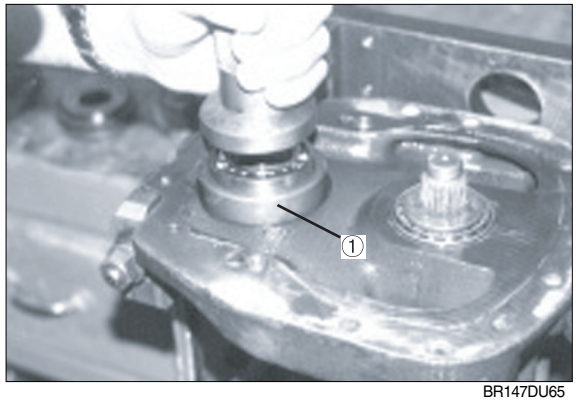
※ A bearing preload of 0.07mm shall be achieved.

⑤ Shim ring thickness(thickness Z) determined ①~③ has to be obtained by combining shim rings of variable thicknesses. Place shim ring(s) (①) into the bearing seat. Install bearing outer ring(②) by means of a copper mandrel and a hammer into bearing seat of the housing until contact with the shim ring. Then install by means of bush **G** the bearing inner ring(③) for the bevel pinion shaft bearing onto the bevel pinion shaft until contact.



※ Prior to helical gear installation, the grooved ball bearing must be installed into the housing seat first.

⑥ Drive grooved ball bearing(①) with assembly drift **V** into the bearing bore of the housing until contact.

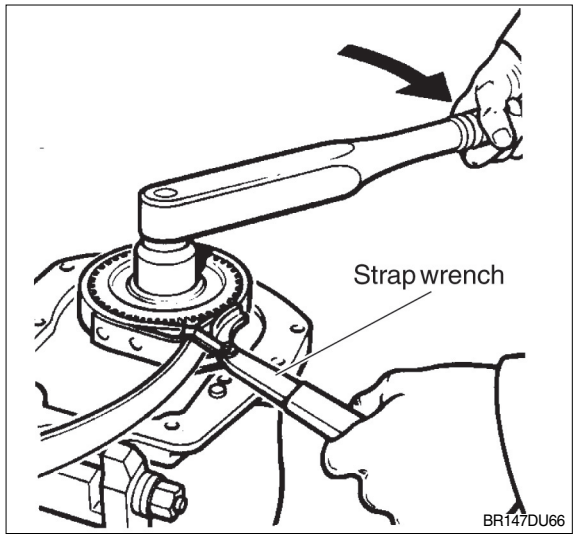


⑦ Carefully push the helical gear(①) onto the spline profile of the bevel pinion shaft and mount it until contact.

⑧ Hold helical gear with a suitable strap wrench, unscrew and tighten the hexagon nut. Do not damage helical gearing at counter-supporting.

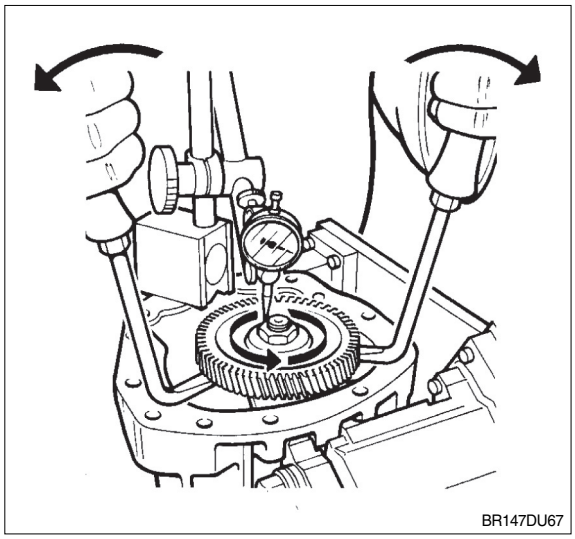
⑨ Tightening torque of the hexagon nut : 150Nm(111ft¡¤lb)

※ Use a new hexagon nut.
Peen hexagon nut after contact pattern check.



⑩ Press bevel pinion shaft down by hand and rotate it several times, so that the taper rollers in the bearing rings are aligned. Position dial gauge as shown in right figure and put the dial gauge indicator to **Zero**.
Mark position of the dial gauge on the helical gear with a colour pencil.
With both hands press bevel pinion shaft upwards and read the bearing play on the dial gauge. (as shown in right figure)
For checking no bearing play is allowed to be **measurable**.

※ This step has to be made with utmost caution and several times, in order to check the adjusted bearing preload.
A direct checking of the now adjusted bearing preload is not possible. However, the bevel pinion shaft must be rotatable by hand.

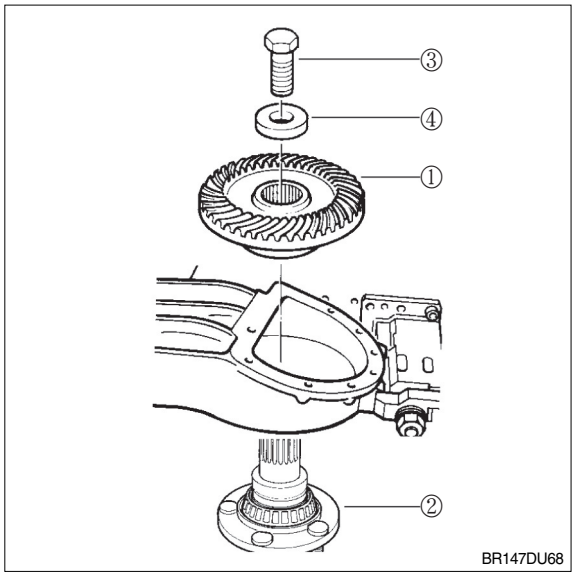

BR147DU67

Adjust bearing preload

Bearing preload : 0.02 to 0.07mm

⑪ Remove helical gear and bevel pinion shaft. Add necessary shim rings to obtain the required bearing preload and install the bevel pinion shaft as indicated in page 3-24. Apply a thin layer of **LOCTITE No.270** onto inner toothing of the helical gear(hub spline).
Install helical gear as in chapter page 3-24.

※ Remove excess LOCTITE with a cloth.



BR147DU68

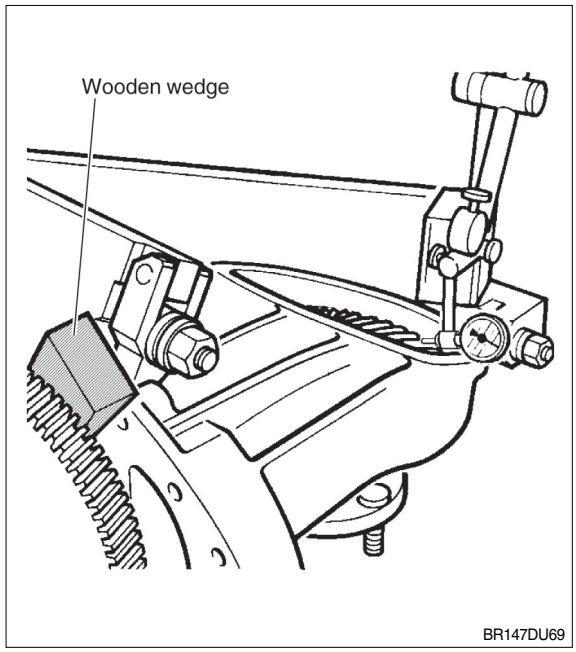
(8) MOUNT WHEEL SHAFT AND CROWN GEAR INTO THE HOUSING

※ **Radial shaft seal between the taper roller bearings has to be installed into the housing, only when bearing preload of the wheel shaft was determined.**

① Insert crown gear(①) into the housing. Cautiously install the wheel shaft(②) into the crown gear toothing. Bolt together the crown gear and the wheel shaft with hexagon bolt(③) and washer(④).

- Tightening torque of hexagon bolt : 245Nm

※ Use hexagon bolt and washer only once.



BR147DU69

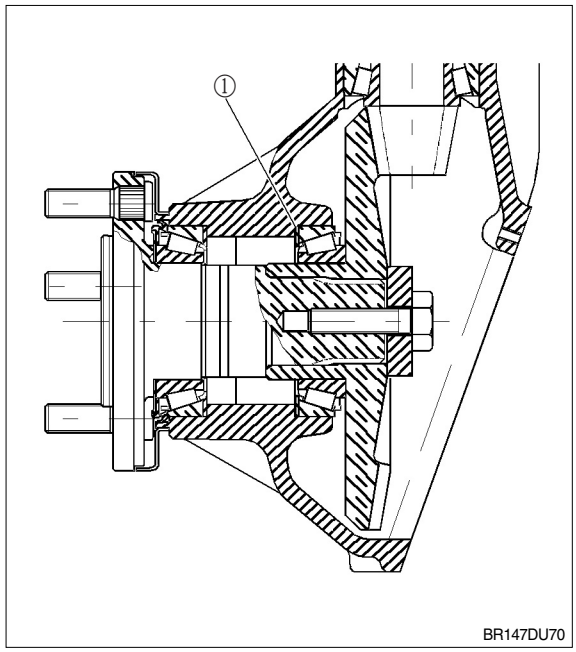
(9) MEASURE AND ADJUST TORSIONAL BACKLASH ON THE CROWN GEAR

① For measurement of the torsional backlash on the crown gear, the bevel pinion shaft has to be blocked against torsion, e.g. with a wooden wedge.
Position dial gauge with magnetic stand right-angled to a tooth flank and measure the torsional backlash rotating the wheel shaft.

- Torsional backlash 0.03~0.11㎜

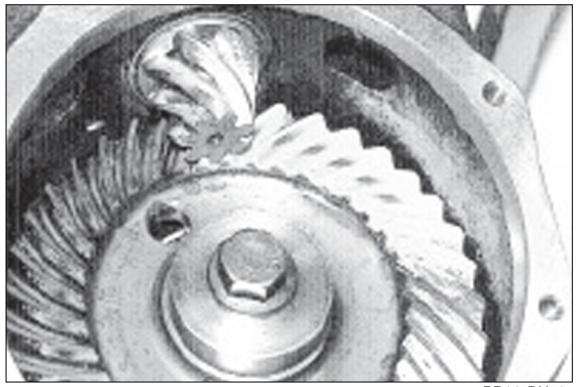
※ A mean value is to be achieved.

② Torsional backlash is corrected by adding or removing of the shim ring(s).



BR147DU70

③ Apply marking ink onto 3~4 tooth flanks of the crown gear and have it to get in mesh with the bevel pinion shaft several times.
Check contact pattern as described under next page.


BR147DU71

(10) CONTACT PATTERN CHECK

For a contact pattern check it is necessary to apply marking ink onto 3~4 tooth flanks of the crown gear. Have the ink-marked tooth flanks get into mesh with the bevel pinion several times. A better recognition of the contact pattern is possible, when the bevel pinion is braked slightly.

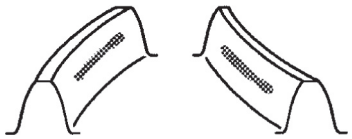
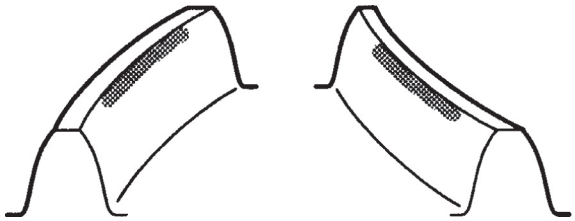
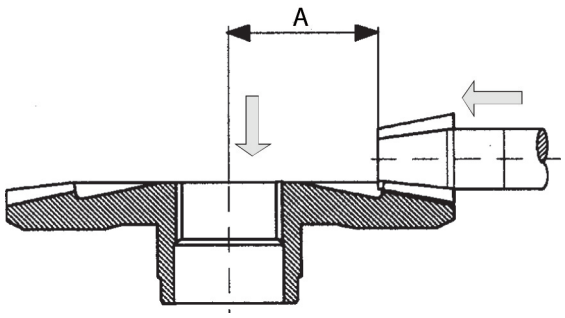
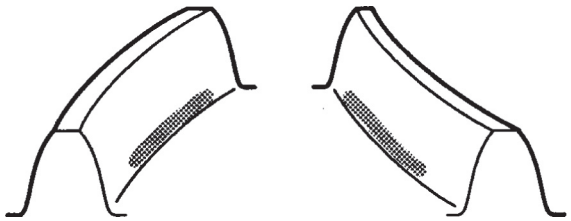
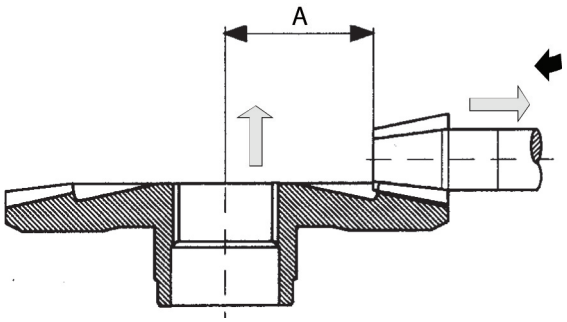
The contact patterns obtained have to be compared with the specified contact pattern as regards size and position. The specified contact patterns are indicated in below diagram.

Insignificant deviations of the ideal shape are possible and permissible. These deviations are firstly due to the varying contact pressures during contact pattern checking.

If there are considerable deviations it has to be checked if the installation dimensions were correctly kept. As a rule wrong installation dimensions are the cause for wrong contact patterns.

Only when at a repeated checking of the installation dimensions no correct contact patterns are obtainable, the position of the contact pattern should be corrected according to the diagram as shown below.

Installation specifications

<table>
<tr><td colspan="2">Correct contact battery Concave flank  Concave flank</td></tr>
<tr><td>Tooth contact on crown gear false contact patterns</td><td>Correct contact pattern adjustment by changing of the installation dimension in direction of the arrow</td></tr>
<tr><td>① Contact on tip
  </td><td>  </td></tr>
<tr><td>② Contact on root
  </td><td>  </td></tr>
</table>

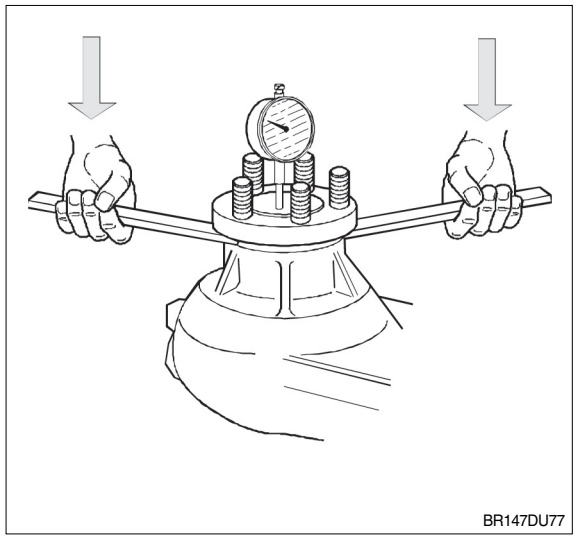
Setting specifications :

On principle all gear sets have to be mounted in accordance with the installation dimension(A).

Only in case of incorrect contact patterns the installation dimension(A) has to be changed.

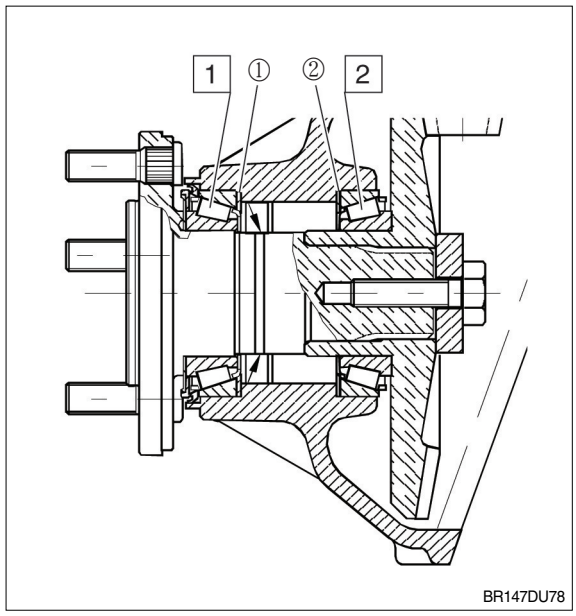
The extent of a change depends on the position of the contact patterns.

(11) MEASURE BEARING PLAY ON WHEEL SHAFT AND ADJUST BEARING PRELOAD


BR147DU77

① Press wheel shaft down by hand and rotate it several times, so that the taper rollers in the bearing rings are aligned.
Position dial gauge as shown in right figure and put the dial gauge indicator to **Zero**. Mark position of the dial gauge on the wheel shaft with a colour pencil.
With two levers(robust assembly levers) press wheel shaft upwards and read the bearing play on the dial gauge.

※ By using shim rings a minimum bearing play of approx. 0.02mm shall be achieved. Only then the final preload is to be adjusted.



BR147DU78

② Remove wheel shaft, by means of a copper mandrel and a hammer drive taper bearing outer ring out of the housing. (also see page 3-25)
Determine shim ring thickness(①) and install with shim ring into bearing seat of housing until contact.

Required bearing preload : 0.05 to 0.10mm

※ It is not possible to check the bearing preload adjusted now. At a check no bearing play is allowed to be measurable. However the wheel shaft must be rotatable by hand.

※ After setting of the bearing preload check the torsional backlash once more.
If the bearing friction torque(see page 3-38) or the torsional backlash are beyond the requested values a new adjustment is required. The final value has to be obtained by adding or removing of shim rings.

※ If for correction of the torsional backlash shim rings(②) are removed or added at bearing point , those have to be added or removed from the shim ring pack(①) at bearing point .

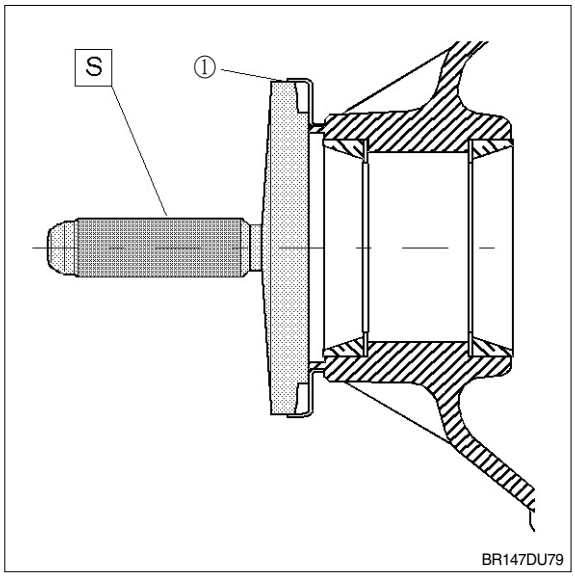
③ After correct adjustment of the bearing preload and the torsional backlash the wheel shaft has to be removed once again in order to install the thread protective shield and the radial shaft seal. Please observe sections (12) and (13).

(12) INSTALL THREAD PROTECTIVE SHIELD(GAMMA RING)

① Spray seat for thread protective shield with LOCTITE fast cleaner. Have fast cleaner work and thoroughly remove the dissolved dirt with a clean cloth.
Spray surface again and have it dried.

⚠ Hazardous when breathed or swallowed. Avoid contact with eyes or skin. Do not spray near open flame and glowing parts.

② Apply LOCTITE No.270 onto seat for the thread protective shield on the housing and press on the thread protective shield(①) by means of assembly drift **S** until contact.



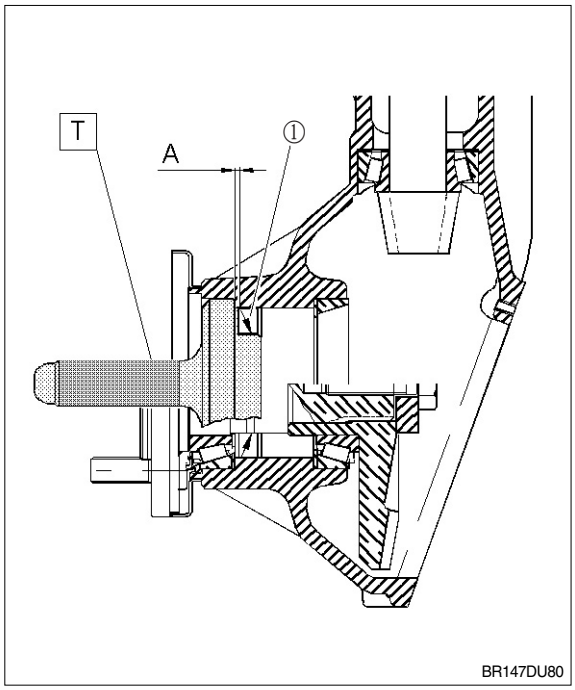
(13) INSTALL RADIAL SHAFT SEAL INTO THE HOUSING

① Remove wheel shaft and crown gear(also see page 3-24). Drive out taper roller bearing outer ring from the housing. Provide outer diameter of radial shaft seal(①) with a thin layer of LOCTITE No. 574 and install it by means of assembly drift **T** into the housing.

¤Ł Observe installation dimension A : GK25 LD $3.0^{+0.5}$mm

③ Apply a thin layer of LOCTITE No. 270 onto surface of inner toothing(hub spline)of the crown gear(①).

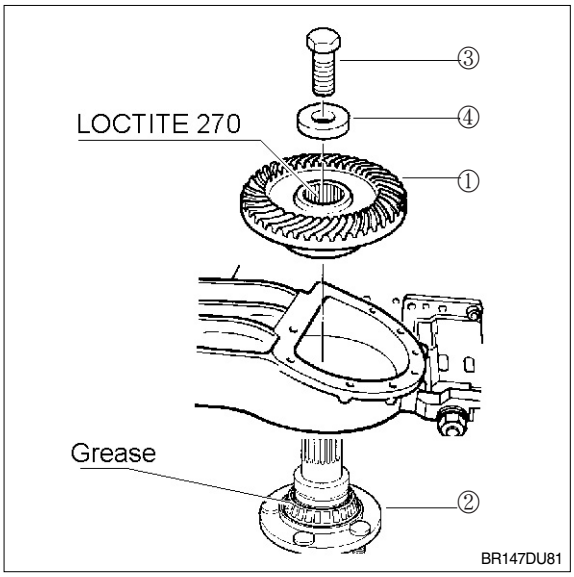
※ Apply LOCTITE only to the inner toothing of the crown gear.



④ Fill sealing ring and taper roller bearings on the wheel shaft(②) with SHELL Alvania R3 grease. Cautiously install wheel shaft(②) into the crown gear toothing.

※ Remove excess LOCTITE with a clean cloth.

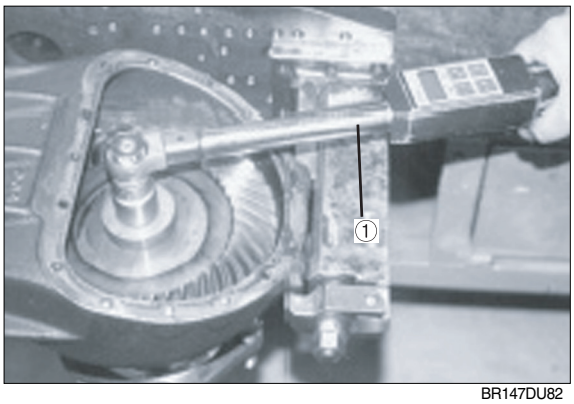
⑤ Bolt together the crown gear and the wheel shaft with hexagon bolt(③) and washer(④).
Bolt 2 wheel nuts onto the wheel bolts and lock wheel shaft with a lever.
・Tightening torque : 245Nm



Check bearing friction torque

⑥ Rotate wheel shaft several times in order to have aligned the taper rollers in the bearing rings. No bearing play must be measurable during the check.
However, the wheel shaft must be rotatable by hand. The bearing preload described in section(11) is correctly adjusted when a bearing friction torque of 9~12Nm is reached.
Use an electronic torque spanner(①) to check the bearing friction torque.

※ If the bearing friction torque is beyond the requested values, a new adjust-ment is required. [see section(11)]

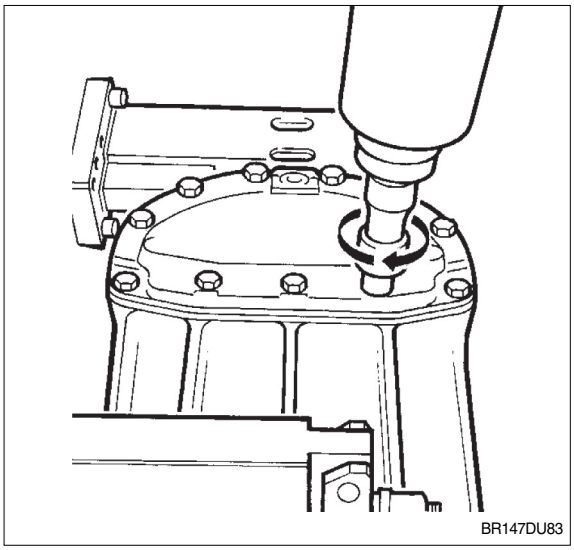


(14) INSTALL HOUSING COVER

① Apply a thin layer of LOCTITE sealing compound No.574 onto plane face of the housing. Apply one drop each of LOCTITE 243 onto threads of the hexagon bolts(②).

※ If tapped holes are drilled through the housing, the hexagon bolts must be sealed completely with LOCTITE.

② Fasten housing cover(①) with hexagon bolts(②) onto the housing.
・Tightening torque : 9.5Nm



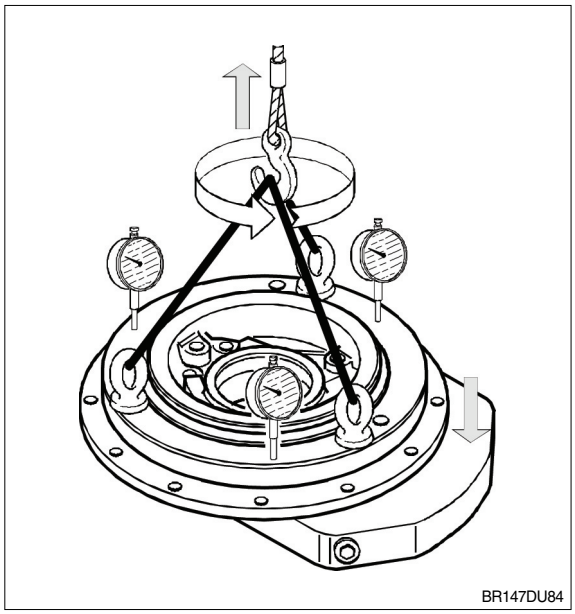
(15) CHECK PIVOTING BEARING(HOUSING TOP SECTION)

① The housing top section has to be replaced, if :

- The peened cover disc on the pivoting bearing has loosened.
- The pivoting bearing is difficult to rotate or sticking.
- The cage segments or balls are damaged.
- The maximum bearing play is exceeded.

※ The housing top section can only replaced completely.

※ Checking of housing top section :
Clamp the housing top section onto the assembly table. Screw 3 eye bolts into the outer ring of the pivoting bearing. Have the pivoting bearing rotated several times.



② Position three dial gauges onto the pivoting bearing and put the dial gauge indicator to **Zero**.
Mark position of the dial gauge on the pivoting bearing with a colour pencil.
Pull with approx. 50kg at the pivoting bearing by means of a medium pillar swivel crane and a spring balance.
Have the pivoting bearing rotated several times and put it back to the marking.

- Max. bearing play of pivoting bearing : 0.03㎜

Install breather valve

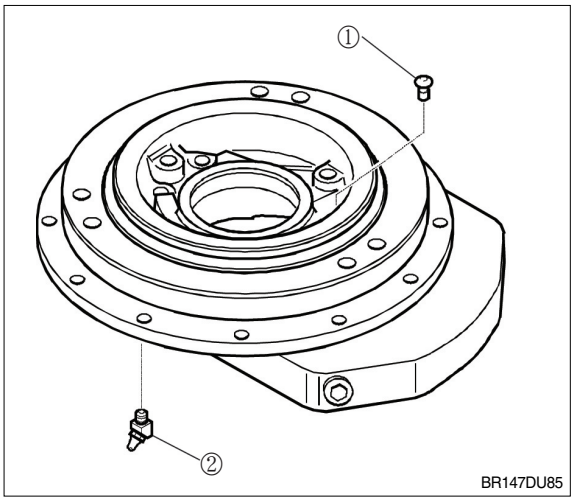
③ Drive breather valve(①) by means of press-in mandrel **U** carefully into the housing top section.

※ Take care for mounting that the cap of the breather valve can still move freely.

Install hydraulic-type lubricating nipple

④ Screw in hydraulic-type lubricating nipple(②) with an open-jaw spanner into the housing top section until contact.

· Tightening torque : 10Nm



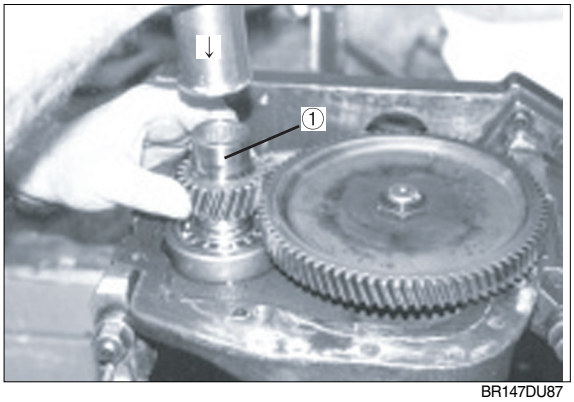
BR147DU85

(16) INSTALL INPUT INTO THE HOUSING TOP SECTION

① Cautiously install the input pinion(①) through the helical gearing.

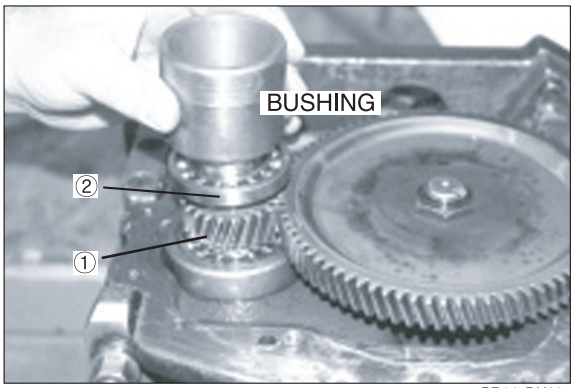
※ **Do not damage toothing of input pinion and helical gear. Damage might cause louder running noises.**

② By means of a copper mandrel cautiously install the input pinion(①) into the bearing bore or onto the bearing seat until contact.



BR147DU87

③ Install the grooved ball bearing(②) with a suitable bush onto the bearing seat of the input pinion until contact.

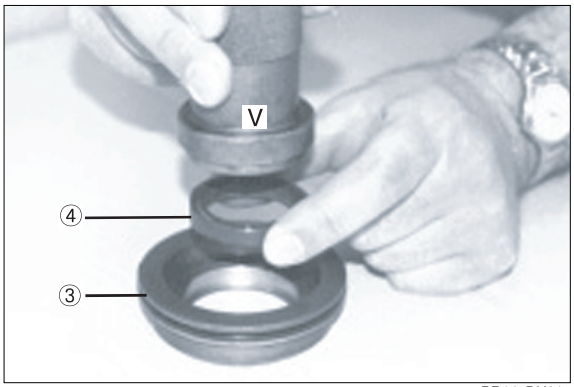


BR147DU86

④ Preassemble cover(③) as follows :

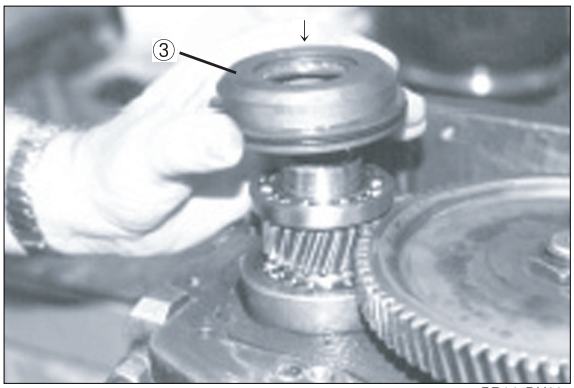
- Install radial shaft seal(④) by means of an assembly drift **V** with the correct side until contact.

※ Do not damage sealing lip of the shaft seal. Apply a thin layer of grease onto the sealing lip.



BR147DU91

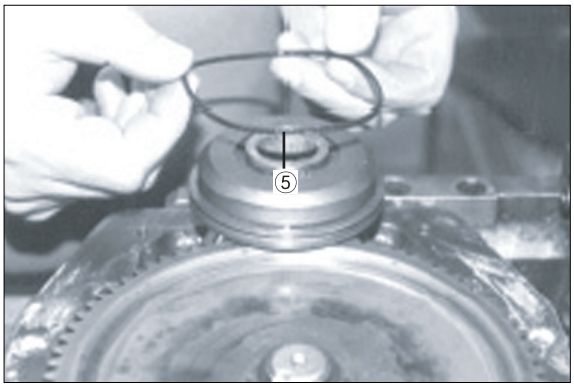
⑤ Cautiously put cover(③, with radial shaft seal preassembled) onto the pinion shaft and install it. By means of a plastic hammer mount cover until contact.



BR147DU90

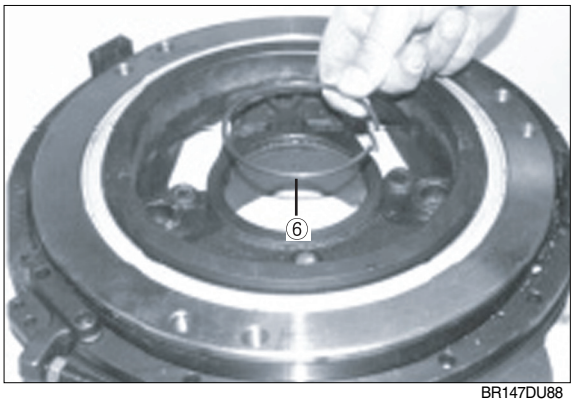
⑥ Insert O-ring(⑤) into slot of the cover.

※ Use new O-ring for installation.
Slightly wet O-ring with gear oil.



BR147DU89

⑦ Insert and snap in circlip(⑥) into bore hole of the housing top section.



BR147DU88

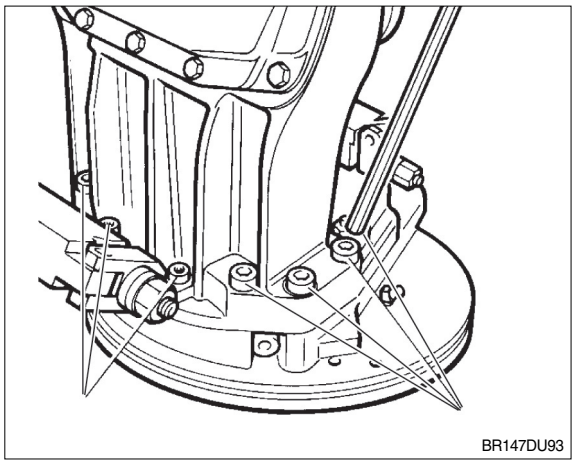
Install housing top section

⑧ Provide sealing surface of the housing with a thin layer of LOCTITE 574.

※ Plane faces of the housing and the housing top section have to be cleaned carefully before with LOCTITE fast cleaner and must be free of grease.

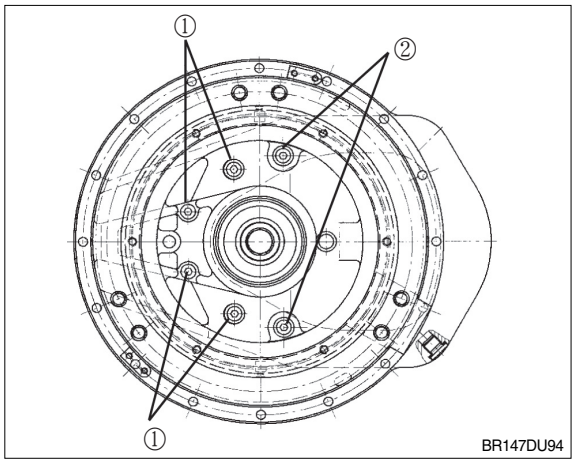
BR147DU92

⑨ Place housing top section onto the housing, so that the cylinderical pins in the transmission housing are positioned in the fitting bores of the top section.

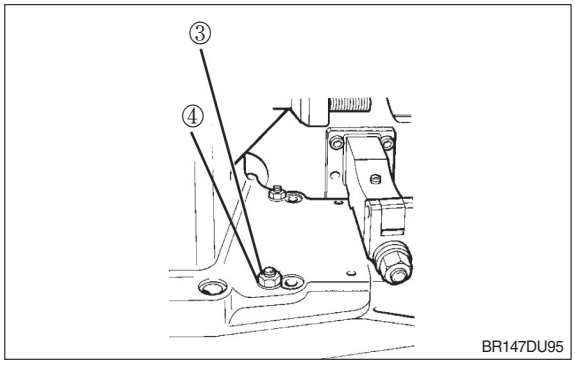


BR147DU93

⑩ Screw in the socket head bolts(①) at the bottom side of the housing as well as inside the housing top section and tighten them uniformly.
In addition also the 2 socket head bolts(②), hexagon nuts(③) and washers (④).



BR147DU94

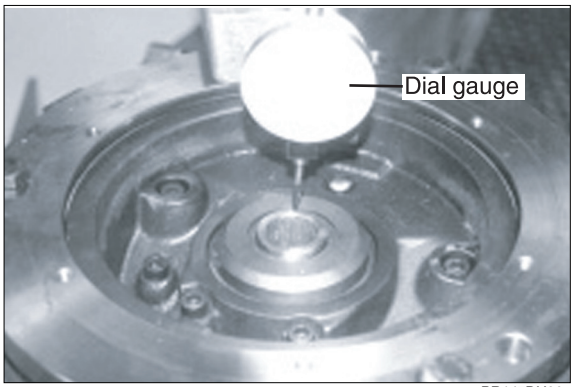


BR147DU95

Check axial play of the input in housing top section

⑪ Have wheel shaft rotated several times.
For measurement of the axial play of the input, a dial gauge with a magnetic stand is to be positioned right-angled onto the plane face of the input pinion and the dial indicator must be put to **Zero**.
Mark position of the dial gauge on the plane face with a colour pencil.
With both hands press input pinion upwards and downwards. Read the axial bearing play on the dial gauge.

※ Axial play of grooved ball bearing 0.1~0.4㎜. When checking a bearing play has to be measurable.



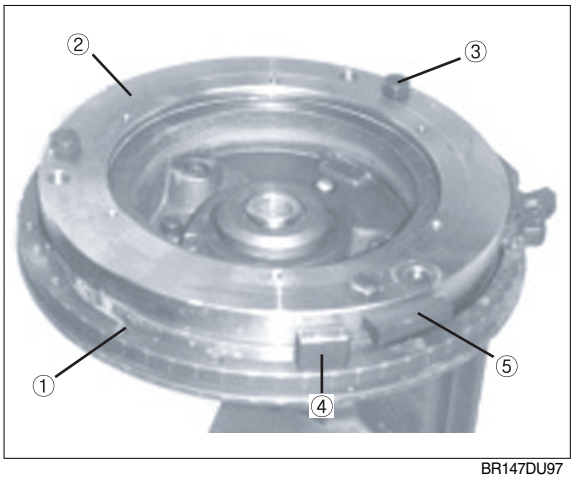
BR147DU96

⑫ Place centering ring(②) for motor fixing onto the pivoting bearing(①) and bolt it with the pivoting bearing. (Also observe instructions in the manual "Operating instructions for helical bevel gear GK 25LD".)

※ **Observe min. screw-in depth of the 6 fixing bolts(③).**

⑬ Steering lock is installed as follows :
- Screw two final stops(④) onto the chain tread.
- Place lock plate(⑤) into the groove in the centering ring and connect it with the pivoting bearing by means of screws.

※ For assembly please observe the specified mounting position of the steering lock in the relating installation drawing.



BR147DU97

(17) RELUBRICATION OF PIVOTING BEARING

① Under normal operating conditions the pivoting bearing has to be relubricated once a year. After cleaning with a steam jet device or similar, the pivoting bearing has to be relubricated.

② For the operation in a heavily dust-loaded or humid environment(e.g. cold store application) the pivoting bearing has to be relubricated 2x per month at least.

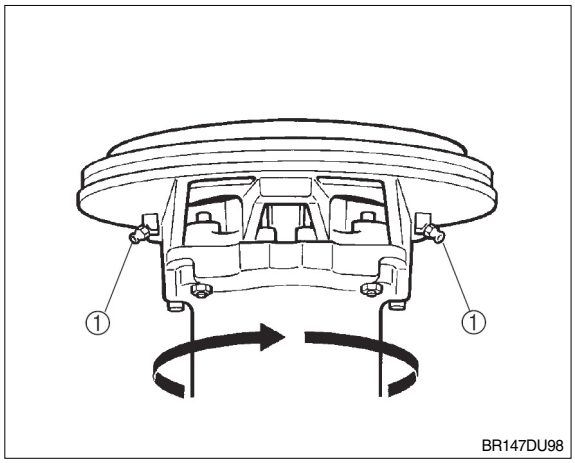
③ We recommend a grease of the quality SHELL Alvania R3 or grease of an equal composition and an equal specification.

Procedure :

- The pivoting bearing has two grease nipples(①).
- Over the two grease nipples press in the grease with a grease gun into the pivoting bearing.
  Drive unit has to be turned slowly.

※ Required grease volume for dry pivoting bearing approx. 55g.

- Rotate drive unit several times, so that the grease distributes completely.
- Remove the grease pressed out of the pivoting bearing with a cloth.

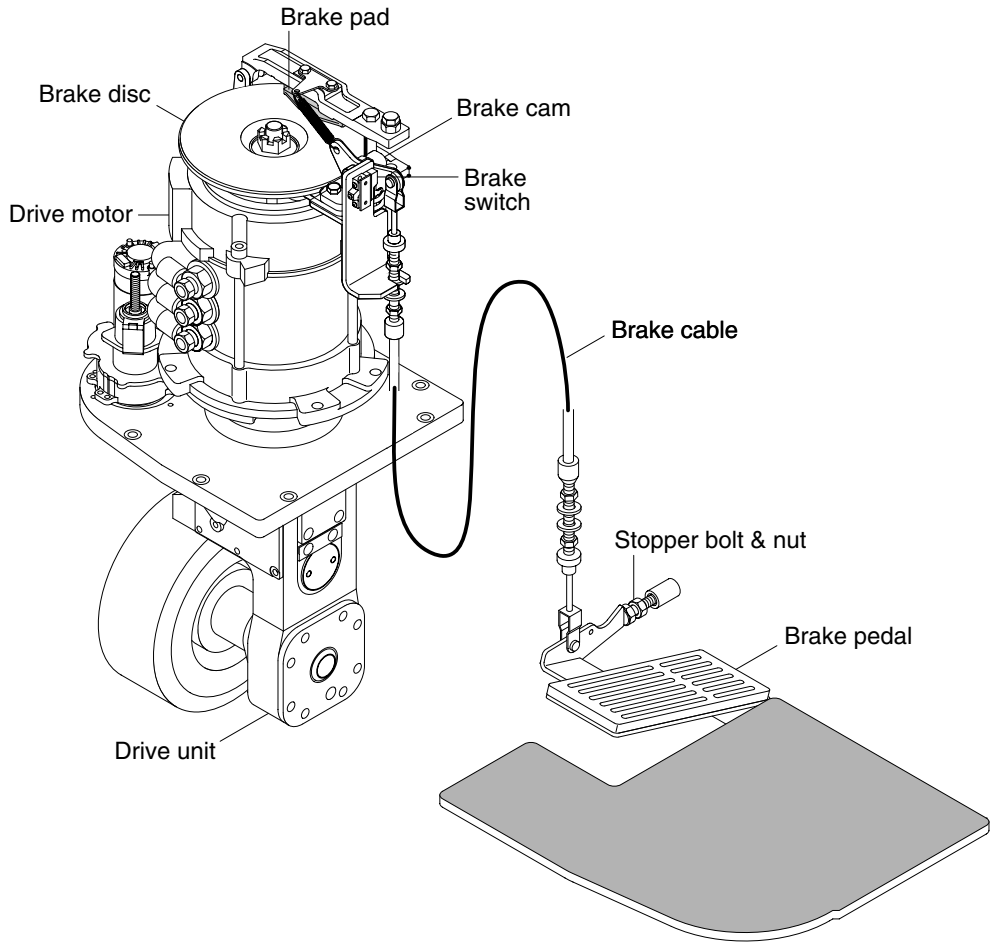


SECTION 4 BRAKE SYSTEM

SECTION 4 BRAKE SYSTEM

GROUP 1 STRUCTURE AND FUNCTION

1. OUTLINE



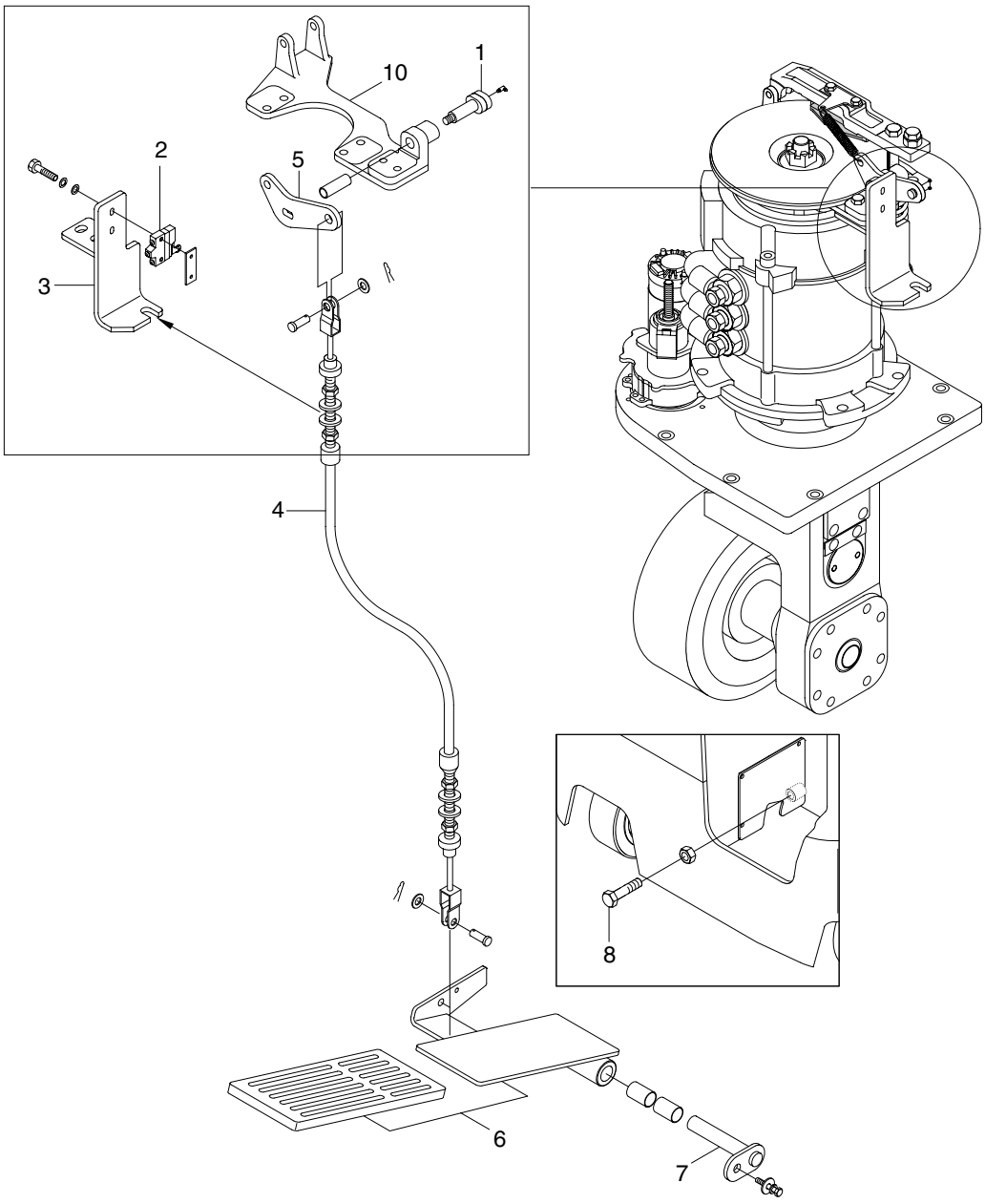
BR7BS01

2. SPECIFICATION

Item		10/13BR-7	14/15/18BR-7	20/25BR-7
Type		Deadman-type disc brake		
Brake pad	Material	Non-asbestos		
	Thickness (㎜)	9	←	←
	Min. Thickness (㎜)	4.5	←	←
Disc (Out dia. × thickness)		ø 225 × 10	←	←
Pedal height (㎜)		47	←	65
Spring length (㎜)		123	118	104
Brake distance	Unladen	Max 5.0m		
	laden	Max 2.5m		

3. BRAKE PEDAL AND PIPING

1) STRUCTURE



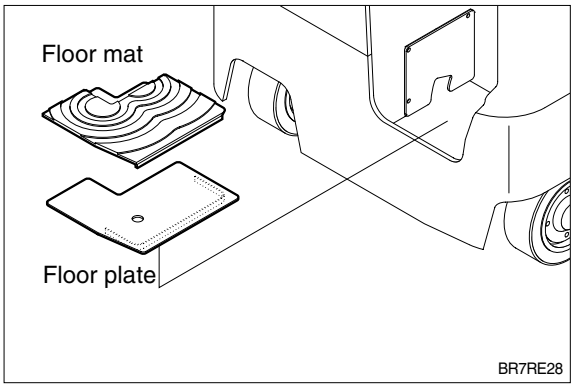
BR7BS02

1	Brake cam	6	Brake pedal
2	Brake switch	7	Pin
3	Bracket	8	Stopper bolt
4	Brake cable	10	Brake support
5	Brake cam lever		

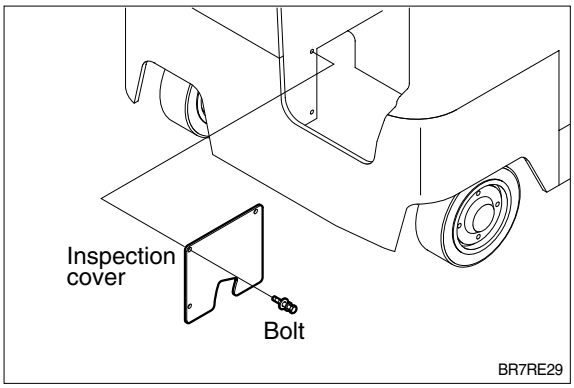
2) DISASSEMBLY AND ASSEMBLY

(1) Disassembly

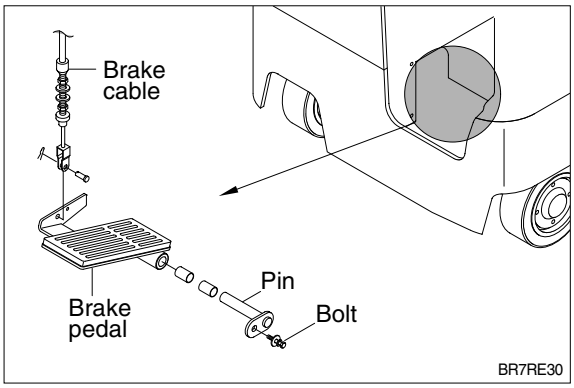
① Remove floor mat and floor plate.



② Remove inspection cover



③ Remove bolt, pin, spring and brake cable to remove brake pedal assembly.

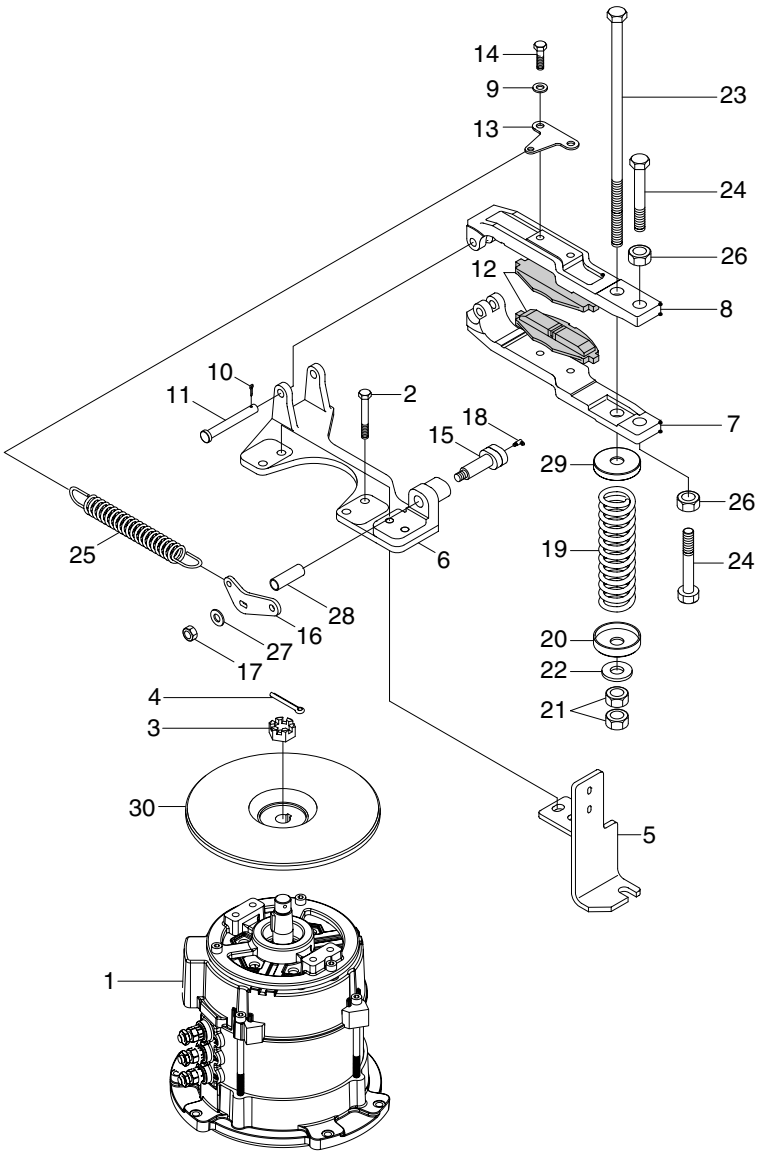


(2) Assembly

Perform disassembly in reverse order.

4. BRAKE SYSTEM

1) STRUCTURE



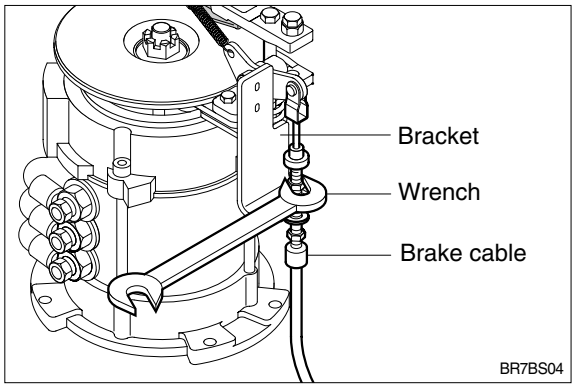
BR7BS03

1	Traction motor	11	Pin	21	Lock nut
2	W/Washer bolt	12	Pad assy	22	Washer
3	Hexagon head nut-slotted	13	Bracket	23	Rod bolt
4	Split pin	14	Bolt	24	Adjusting bolt
5	Cable bracket	15	Cam	25	Spring
6	Brake support	16	Cam lever	26	Nut
7	Under lever	17	Cam nut	27	Spring washer
8	Upper lever	18	Nipple	28	Du-bushing
9	Spring washer	19	Spring	29	Special cover
10	Split pin	20	Cover	30	Disc

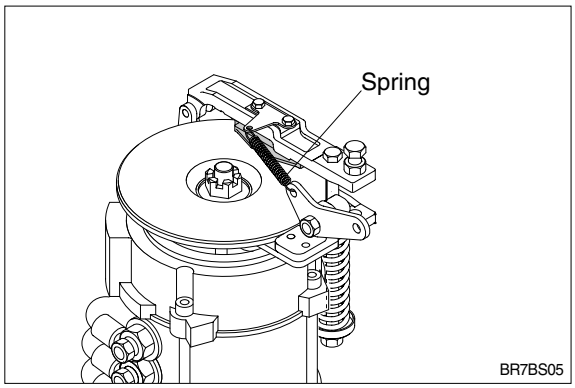
2) DISASSEMBLY AND ASSEMBLY

(1) Disassembly

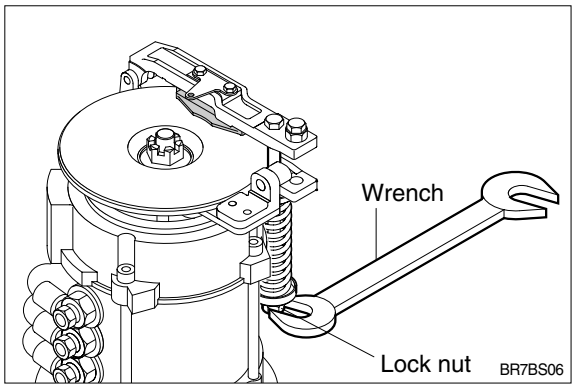
① Remove the brake cable from bracket.



② Remove spring from cam lever.

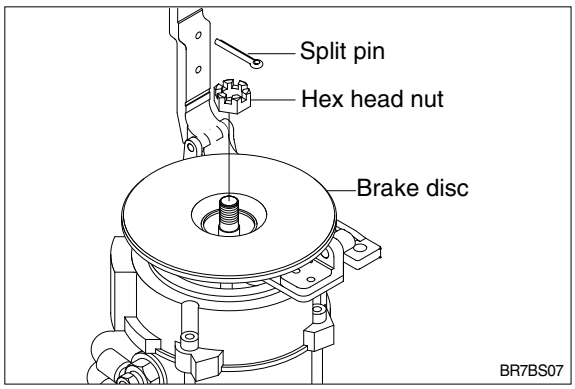


③ Remove rod bolt & spring after removing lock nut of brake spring.

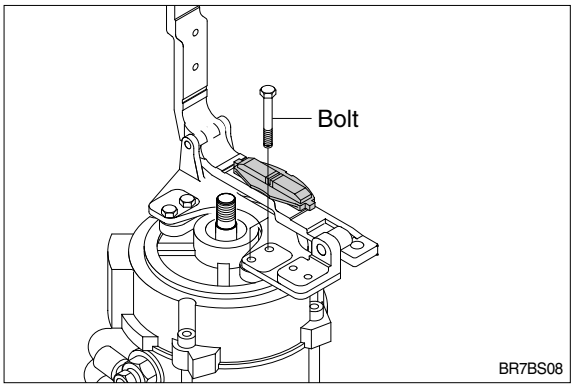


④ Remove the split pin from motor shaft and remove the hexagon head nut.

⑤ Remove brake disc from motor shaft.



⑥ Remove the bolts from brake support.

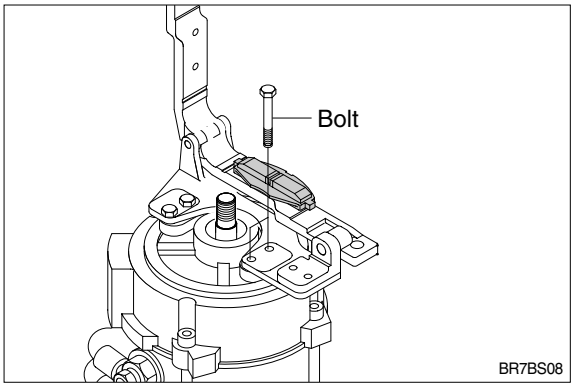


(2) Assembly

Assembly is in the reverse order to disassembly but be careful of following points.

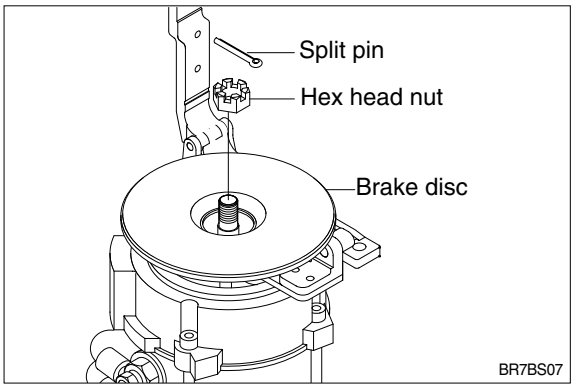
① Brake support mounting bolts.

· Tightening torque : 7.5~8.5kgf · m
(54~61lbf · ft)
M10 × 1.5



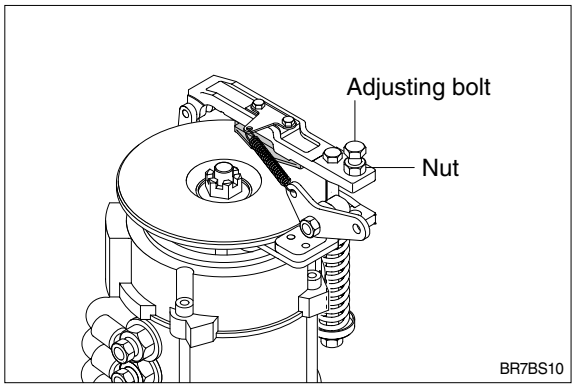
② Brake disc mounting hex head nut.

· Tightening torque : 14~16kgf · m
(101~116lbf · ft)
M20 × 1.5



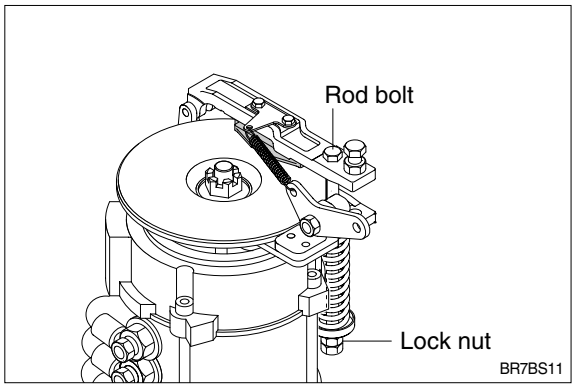
③ Adjusting bolt lock nuts.

· Tightening torque : 11.4~12.6kgf · m
(82~91lbf · ft)
M16 × 1.5



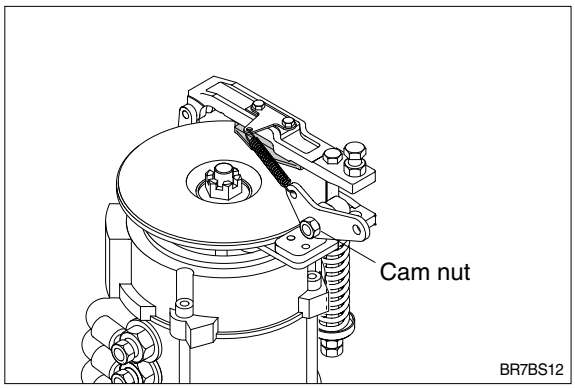
④ Rod bolts lock nuts.

· Tightening torque : 1.8~2.7kgf · m
(13~20lbf · ft)
M8 × 1.25



⑤ Cam nuts.

· Tightening torque : 0.8~1.1kgf · m
(6~8lbf · ft)
M6 × 1.0



5. INSPECTION

1) Brake pad inspection

(1) Contact normally?
(2) Any injuries?
(3) Any one sided contact?
(4) Service limit : 4.5mm(0.16")

2) Brake disc inspection

(1) Any damage or wear?
If so, plane the disc for revising.

3) Spring inspection

(1) Are the springs weakened or damaged?

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

1. OPERATIONAL CHECKS

1) BRAKE PEDAL OPERATION

(1) Once the pedal released, the machine must remain stopped.
(2) Check the pedal height is 46~66㎜(1.81~2.60 in).

2) BRAKE SYSTEM OPERATION

(1) Check the operation of brake cam.
(2) Measure lining at point with most wear, and check that lining thickness is at least 4.0㎜ (0.16in).

3) BRAKE FORCE

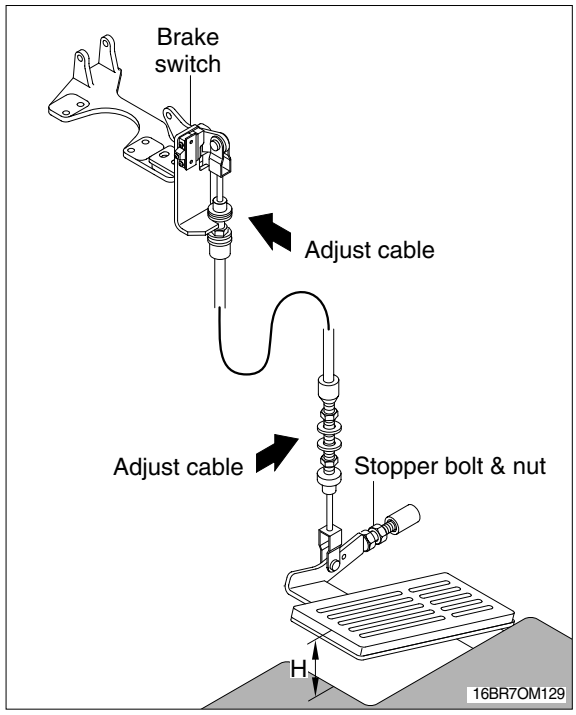
(1) Select a dry, flat, paved surface and drive truck at maximum speed when signal is given, stop truck immediately and measure distance from point where signal was given to point where truck stopped. (Unloaded)
 · Stopping distance : Within 5m (16' 5")
(2) Check that there is no pulling of steering wheel, pulling by brakes to one side or abnormal noise when making emergency stops.

4) CHECK AND ADJUSTMENT OF THE SERVICE BRAKE SYSTEM

(1) Check the pedal height(H) and adjust the stopper bolt & nut.

Model	Height(㎜)
10/13BR-7	47±1.0
14/15/18BR-7	47±1.0
20/25BR-7	65±1.0

(2) Check the brake switch to be operating condition while the pedal is depressed.



(3) Check the gap(B) between brake cam and adjusting bolt.

· B : 0.8~1.2mm

If the gap is too long and short adjust the adjusting bolt.

· Adjust nut tightening torque

11.4~12.6kgf · m(82.5~91.1lbf · ft)

Check the operation of the cam and bolt and then lubricate grease to them.

(4) Check the brake pad wear or any damage.

If brake pad is contacted any one side or pad thickness is 4.5mm, pad should be replaced together.

· Brake pad bolt tightening torque

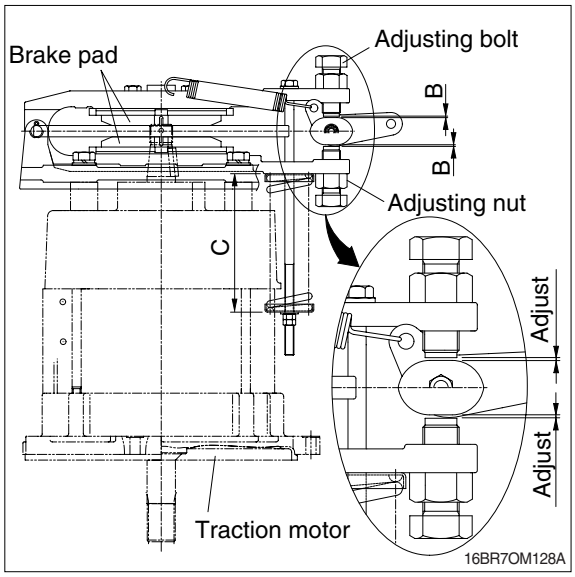
1.8~2.7kgf · m(13.0~19.5lbf · ft)

(5) Check the height(C) of brake spring and adjust the spring.

Model	Height(mm)
10/13BR-7	123±1.0
14/15/18BR-7	118±1.0
20/25BR-7	104±1.0

· Spring nut tightening torque

1.8~2.7kgf · m(13.0~19.5lbf · ft)



2. TROUBLESHOOTING

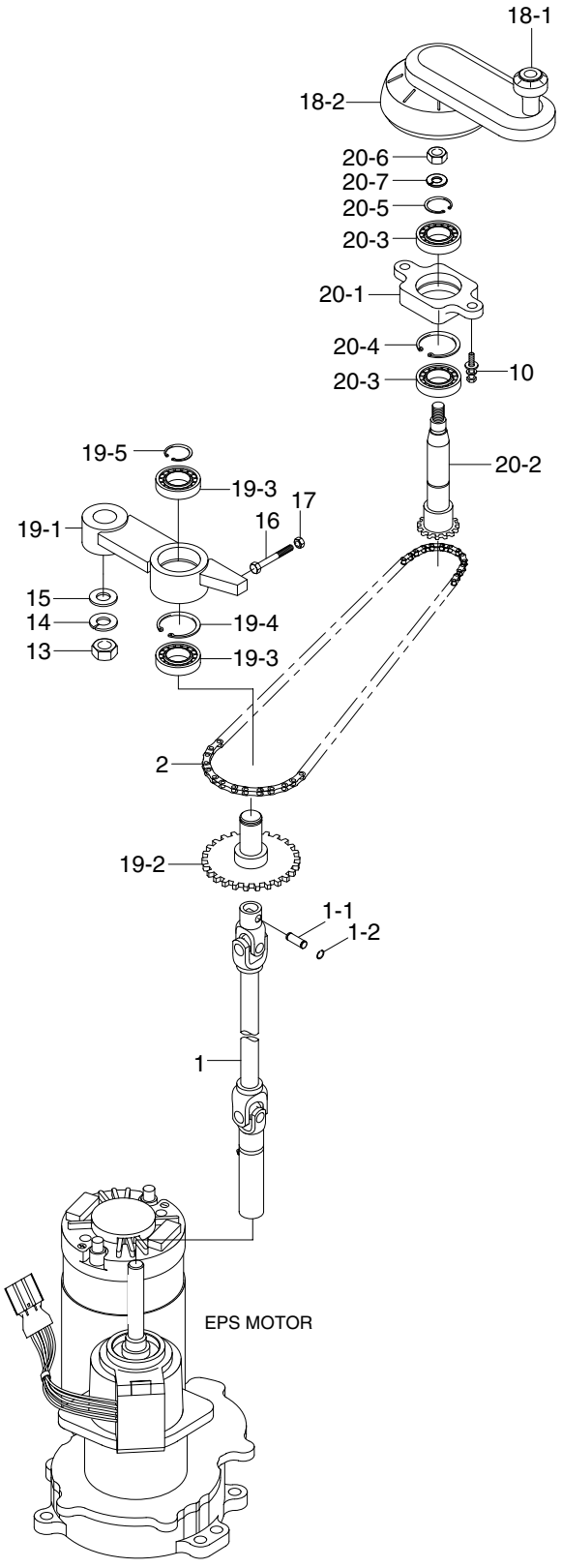
Problem	Cause	Remedy
Brake pad not releasing	· Pedal stroke is not enough	· Check and adjust
	· Clearance between cam & adjust bolt is not enough	· Check and adjust
Heavy brake pedal	· Brake spring is over fastened	· Check and adjust
	· Cable out of adjustment	· Check and adjust
Poor braking effect	· Brake spring broken or deteriorated	· Repair or replace
	· Pedal stroke is not enough	· Check and adjust
	· Brake pad worn	· Check and replace if defective
	· Faulty return due to rusting of parts	· Repair or replace
	· Clearance between cam & adjust bolt is not enough	· Check and adjust
Brake squeaks	· Brake pad glazed or dirty, worn, brake dust accumulation	· Check and replace if defective
	· Brake disc warped, cracked, dust accumulation	· Check and replace if defective
Unable driving	· Micro switch broken, unsuitable position	· Repair or replace
Brake is not working	· Brake spring height, out of adjustment	· Check and adjust
	· Brake spring broken	· Replace
	· Clearance between cam & adjust bolt, out of adjustment	· Check and adjust
	· Disc removed or worn	· Repair or replace
	· Micro switch is not working	· Check and replace if defective
	· Pedal stroke is not enough	· Check and adjust
	· Cable out of adjustment	· Check and adjust
	· Motor is broken	· Repair or replace
	· Motor shaft is broken	· Repair or replace

SECTION 5 STEERING SYSTEM

SECTION 5 STEERING SYSTEM

GROUP 1 STRUCTURE AND FUNCTION

1. OUTLINE



1	U-joint assy
1-1	Straight pin
1-2	Snap ring
2	Roller chain
10	Hexagon bolt
13	Hexagon nut
14	Spring washer
15	Plain washer
16	Bolt
17	Hexagon nut
18-1	Steering wheel
18-2	Steering wheel knob
19-1	Steering bracket
19-2	Sprocket assy
19-3	Ball bearing
19-4	Retaining ring
19-5	Retaining ring
20-1	Steering wheel bracket
20-2	Steering wheel shaft
20-3	Ball bearing
20-4	Retaining ring
20-5	Retaining ring
20-6	Hexagon nut
20-7	Spring washer

BR7SE03

2. SPECIFICATIONS AND SERVICE STANDARD

Type		1st stage	Chain
		2st stage	Gear
Steering wheel diameter (mm)		ø 300	
Steering wheel free play (mm)		25~50	
Steering chain slack (mm)		3~5	
Steering angle	Right turn	79°	
	Left turn	101°	
Minimum turning radius (mm)	10BR-7	1425	
	13BR-7	1460	
	14BR-7	1545	
	15BR-7	1605	
	18BR-7	1775	
	20BR-7	1790	
	25BR-7	1985	

3. TROUBLE SHOOTING

Problem		Cause	Remedy
Heavy steering	At traveling	· Damage of bearing at steering pinion	· Replace bearing
		· Damage of bearing of steering shaft of drive unit	· Replace bearing
		· Lack of grease of bearing	· Lubricate grease
	At releasing joint at spline	· Damage of bearing in steering racket	· Replace bearing
		· Over tension of roller chain	· Adjust the tension
Steering play is large (STD : 25~50mm)		· Looseness of roller chain	· Adjust the tension
		· Extension of roller chain	· Adjust the tension or replace the chain
		· Looseness of rubber coupling is large	· Replace coupling
		· Looseness of spline and joint is large	· Replace
		· Backlash of steering pinion and gear is large	· Replace
Steering wheel is robbed in one way during traveling		· Eccentric wear of tire	· Replace
		· Transformation of drive unit-rear axle	· Repair or replace
		· Transformation of frame	· Repair or replace

GROUP 2 DISASSEMBLY AND ASSEMBLY

1. TOOL

1) Standard tool

2) Universal puller

3) Vernier caliper

2. DISASSEMBLY

1) Remove the cap of steering wheel(18-2) and remove the hexagon nut(20-6) by means of box spanner.

2) Remove the steering wheel(18-2).

3) Loosen the nut(13) fixing the steering bracket(19-1).
   · Tightening torque(13) : 16±2kgf · m
   (116±4.5lbf · ft)

4) Loosen the bolt(16) that extends chain.

5) Remove the bolt(10) fixing the steering wheel bracket(20-1).
   · Tightening torque(10) : 7±0.7kgf · m
   (50.6±5.1lbf · ft)

6) Lift up the cover straighting up and remove the cover.

7) Remove the steering wheel bracket(20-1).

8) Take off the steering wheel shaft(20-2) after removing the snap ring(20-5).

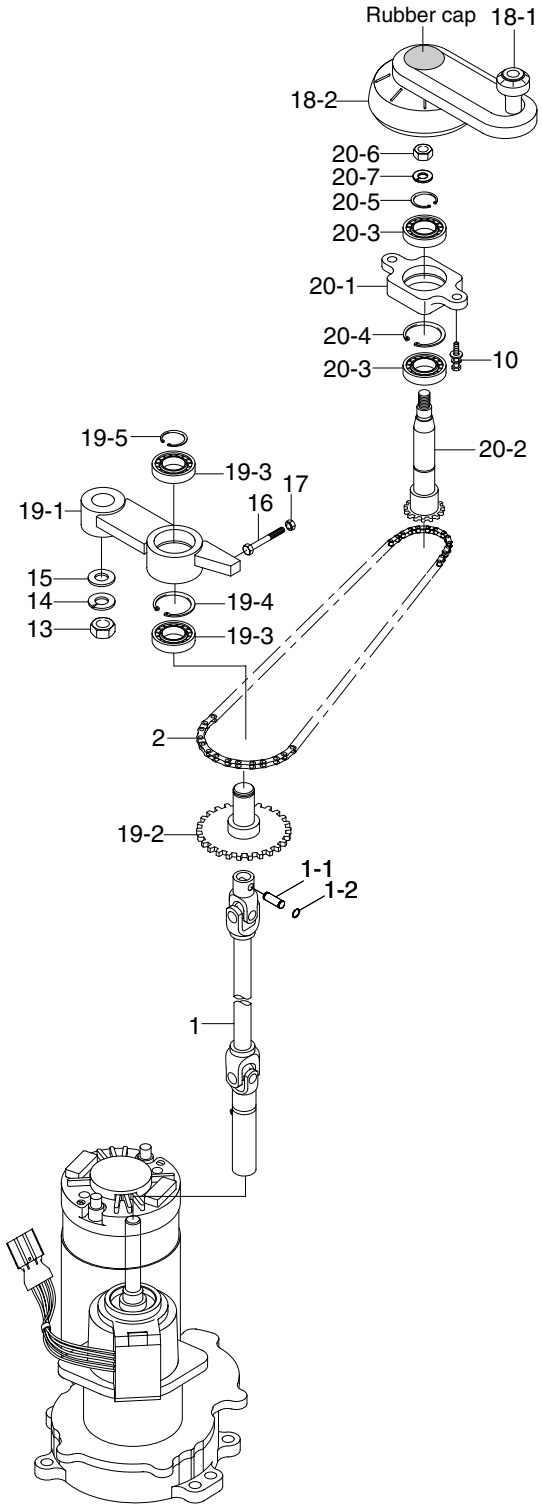
9) Remove the steering bracket(19-1).

10) Take off the sprocket assy(19-2) after removing the snap ring(19-5, 1-2) and straight pin(1-1).

11) Remove the U-joint assy(1).

3. ASSEMBLY

Perform the disassembly in reverse order.



4. INSPECTION

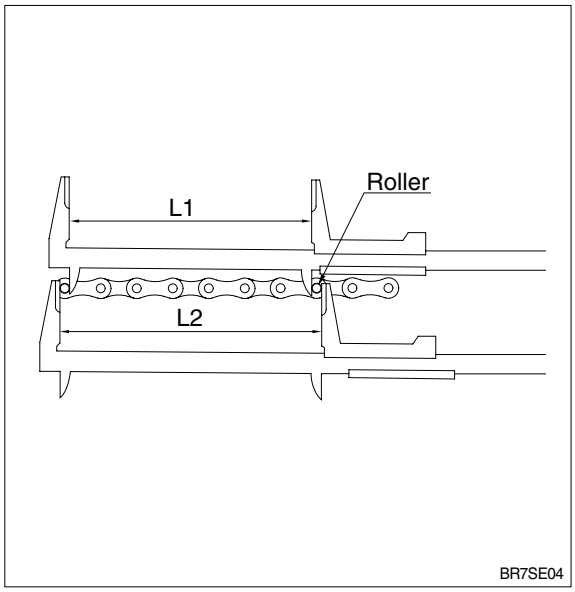
1) Inspect the steering chain for extension, cracks and damage and replace if defective.

$$L = \frac{L1 + L2}{2}$$

Standard : L = 76.20mm(3.00in) (6Link)
Limit : L = 77.34mm(3.04in)

2) Inspect the sprockets assy and steering wheel shaft for cracks and damage, and replace if defective.

3) Inspect the rubber coupling for cracks and the universal joint for faulty operation, and replace if defective.



5. ADJUSTMENT

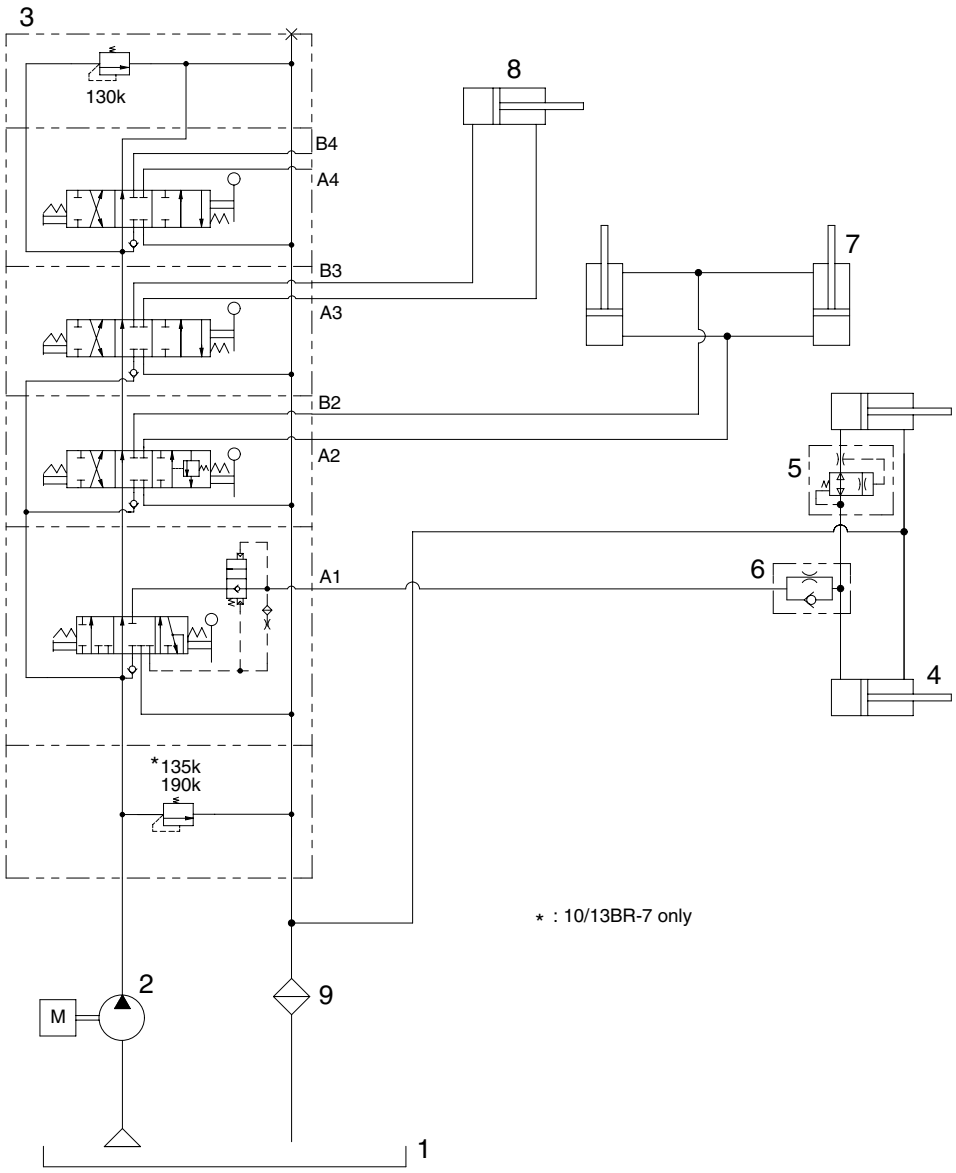
- Adjust the steering chain tension through the adjusting link so that the chain deflection will be 3-5mm(0.12~0.20in).
- Adjust the steering play to 25-80mm(1.0~3.0in).
- Adjust the steering wheel to close to operator's stand through fixing of spline in traveling.

SECTION 6 HYDRAULIC SYSTEM

SECTION 6 HYDRAULIC SYSTEM

GROUP 1 STRUCTURE AND FUNCTION

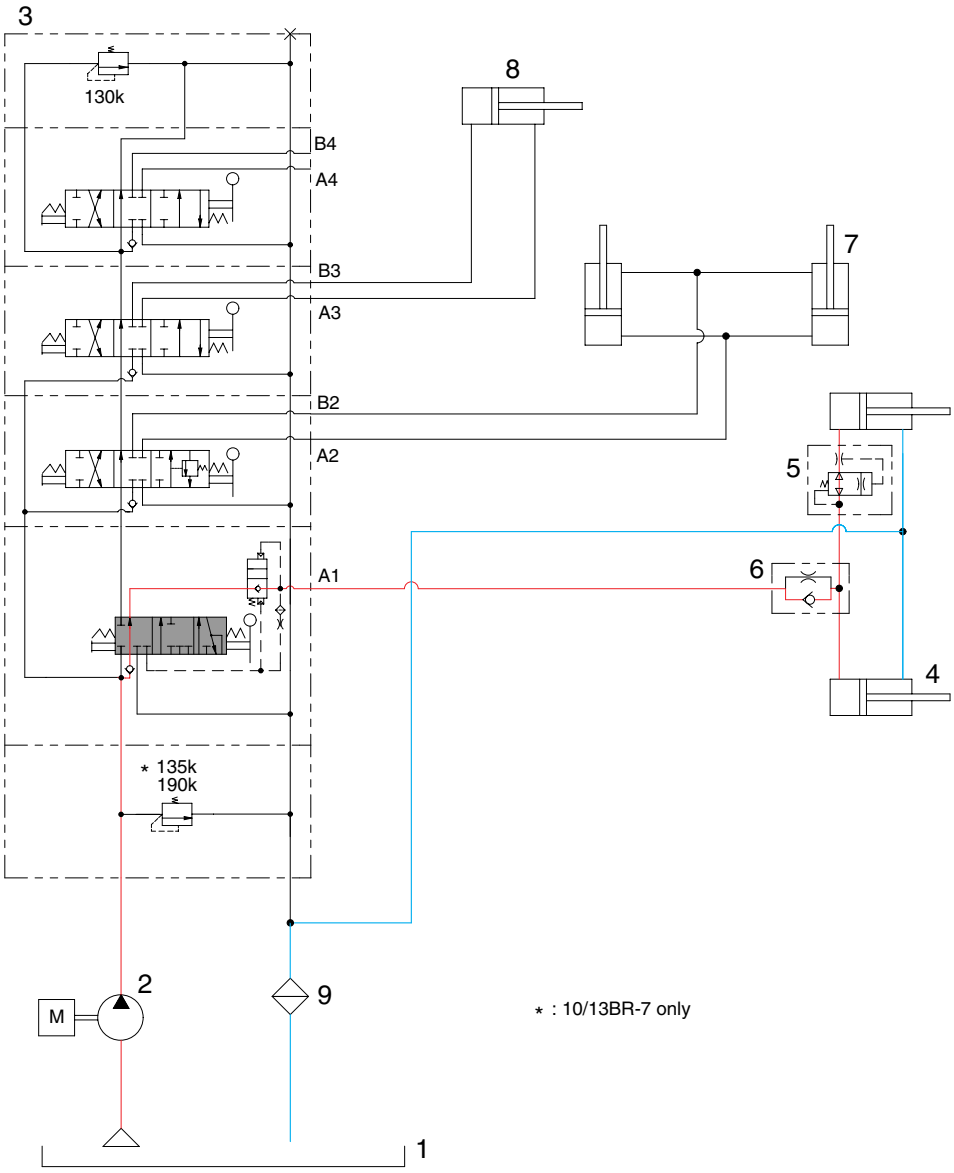
1. HYDRAULIC CIRCUIT



BR7HS01

1 Hydraulic tank
2 Hydraulic pump
3 Main control valve
4 Lift cylinder
5 Down safety valve
6 Down control valve
7 Tilt cylinder
8 Reach cylinder
9 Return filter

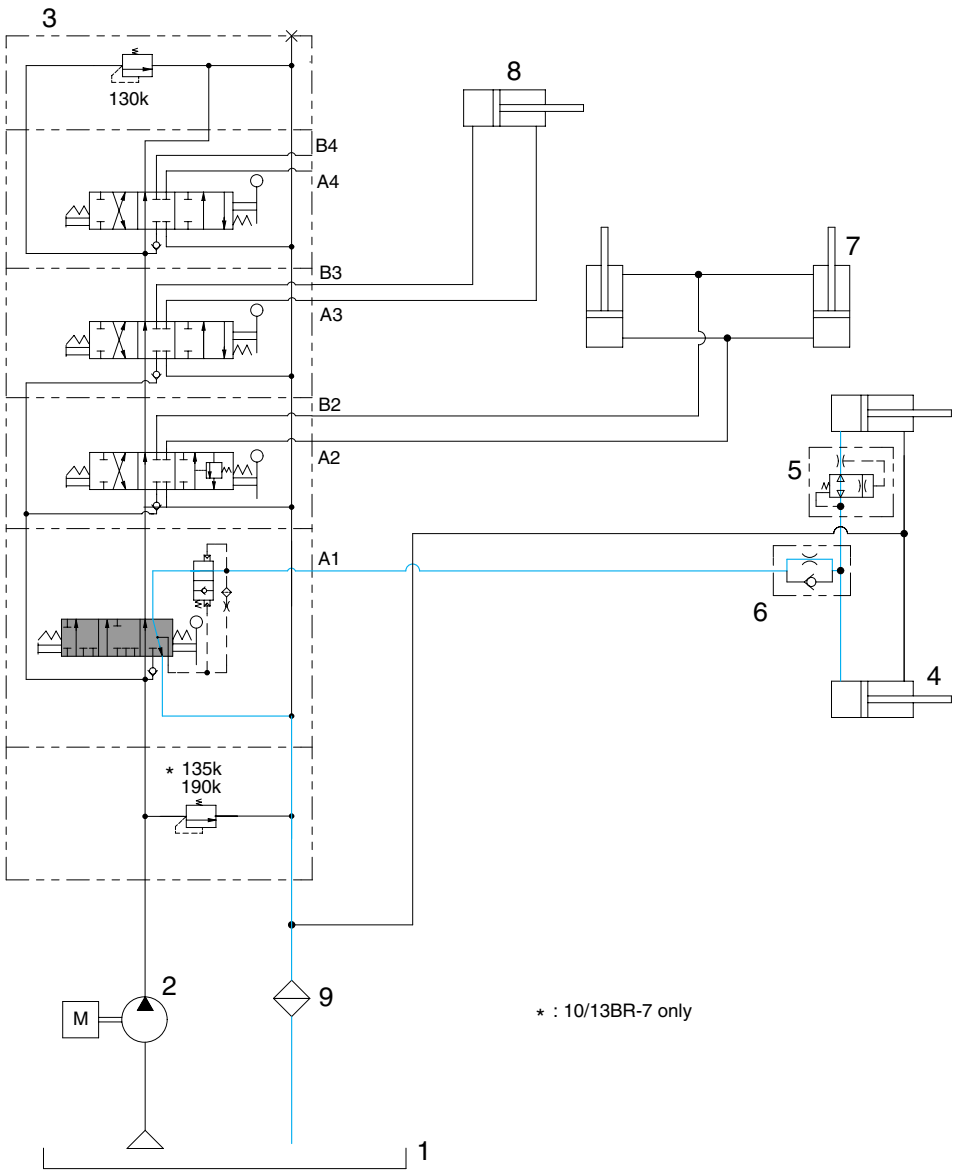
1) WHEN THE LIFT CONTROL LEVER IS IN THE LIFT POSITION



BR7HS02

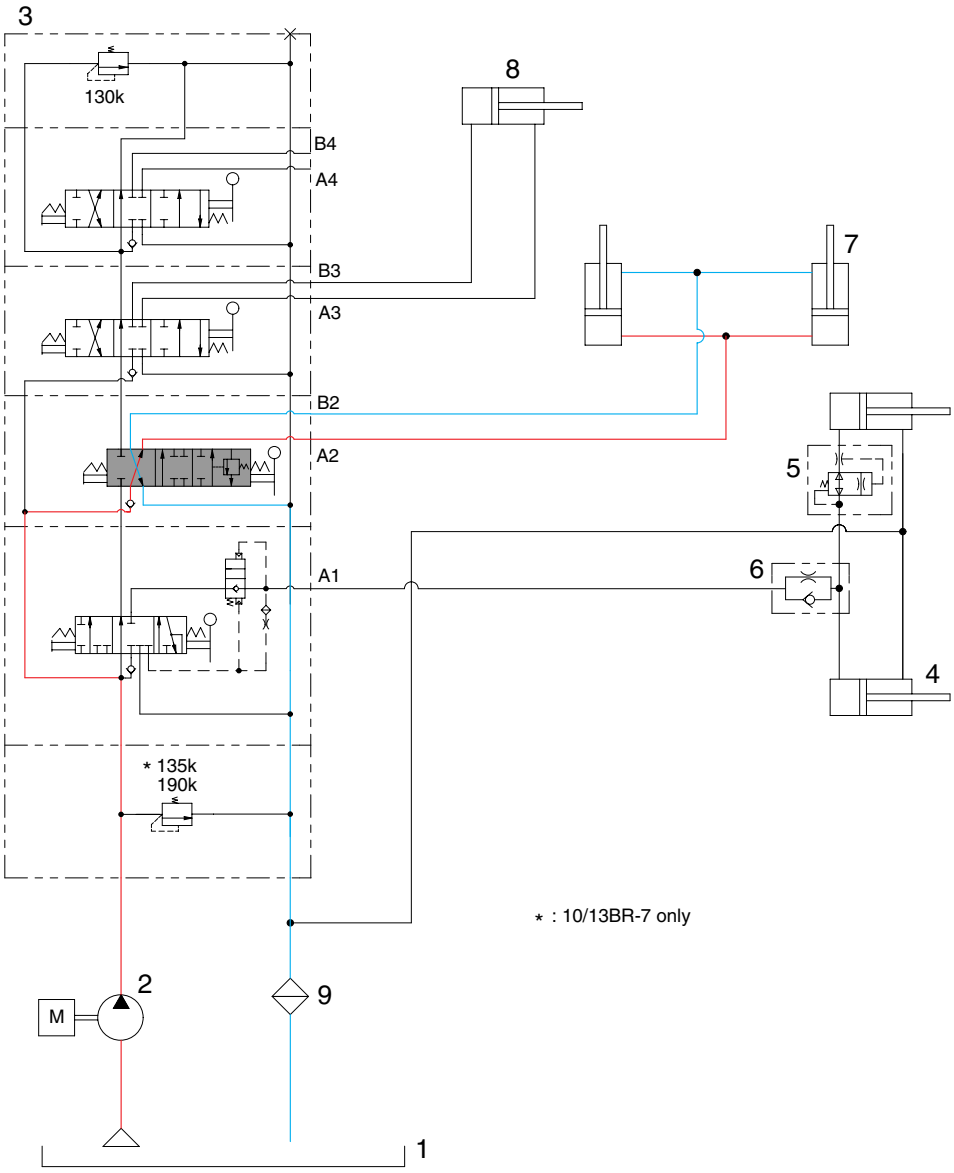
When the lift control lever is pulled back, the spool on the first block is moves to lift position.
The oil from hydraulic gear pump(2) flows into main control valve(3) and then goes to the large chamber of lift cylinder(4) by pushing the load check valve of the spool.
The oil from the small chamber of lift cylinder(4) returns to hydraulic oil tank(1) 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 is pushed forward, the spool on the first block is moved to lower position.
The work port(1B) and the small chamber and the large chamber are connected to the return passage, so the lift will be lowered due to its own weight.

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



BR7HS04

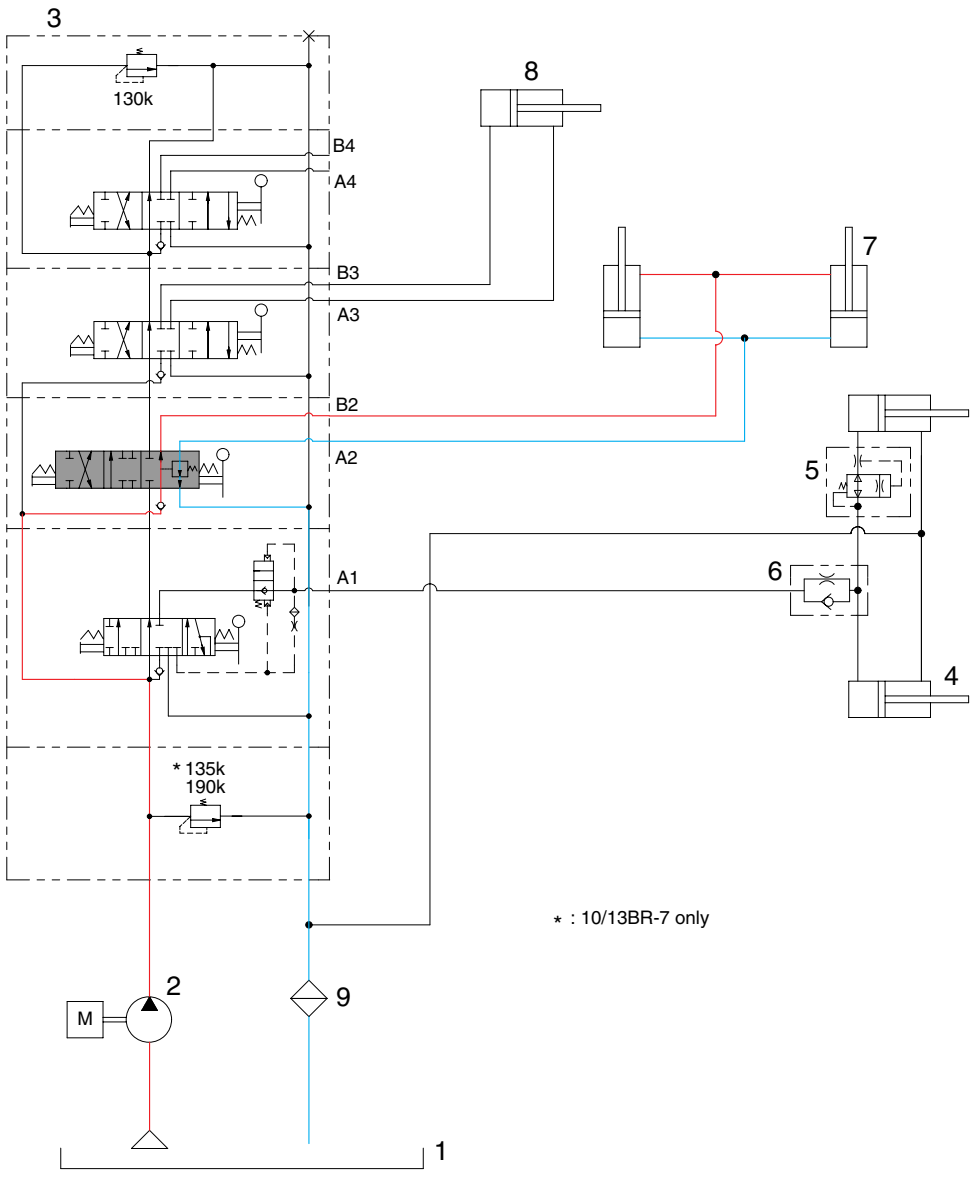
When the tilt control lever is pulled back, the spool on the second block is moved to tilt backward position.

The oil from hydraulic gear pump(2) flows into main control valve(3) and then goes to the large chamber of tilt cylinder(7) by pushing the load check valve of the spool.

The oil at the small chamber of tilt cylinder(7) returns to hydraulic tank(1) at the same time.

When this happens, the mast tilt backward.

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



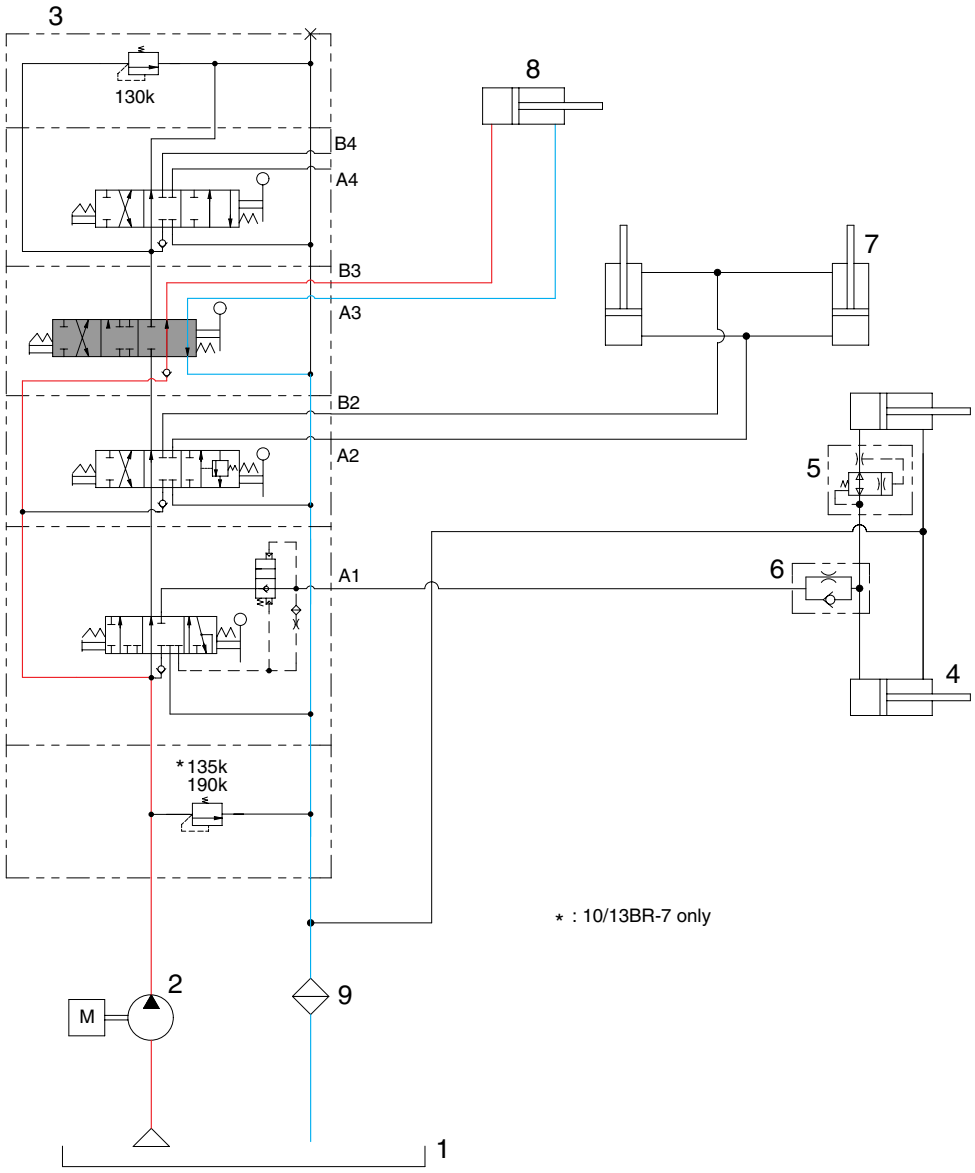
When the tilt control lever is pushed forward, the spool on the second block is moved to tilt forward position.

The oil from hydraulic gear pump(2) flows into main control valve(3) and then goes to the small chamber of tilt cylinder(7) by pushing the load check valve of spool.

The oil at the large chamber of tilt cylinder(7) returns to hydraulic tank(1) at the same time.

When this happens, the mast tilt forward.

5) WHEN THE REACH CONTROL LEVER IS IN THE FORWARD POSITION



BR7HS06

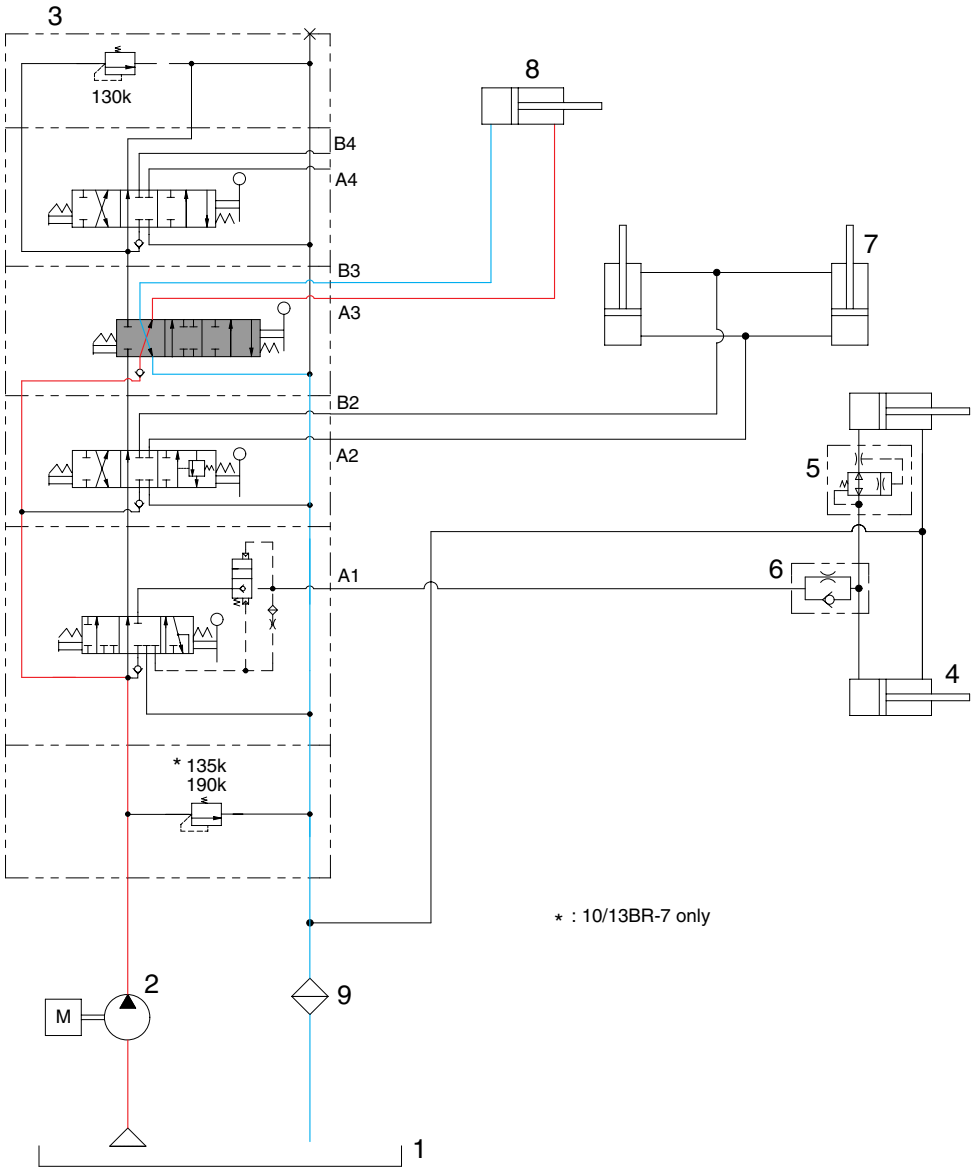
When the reach control lever is pushed forward, the spool on the third block is moved to reach forward position.

The oil from hydraulic gear pump(2) flows into main control valve(3) and then goes to the large chamber of reach cylinder(8) by pushing the load check valve of spool.

The oil at the small chamber of reach cylinder(8) returns to hydraulic tank(1) at the same time.

When this happens, the mast reaches forward.

6) WHEN THE REACH CONTROL LEVER IS IN THE BACKWARD POSITION



BR7HS07

When the reach control lever is pulled backward, the spool on the third block is moved to reach backward position.

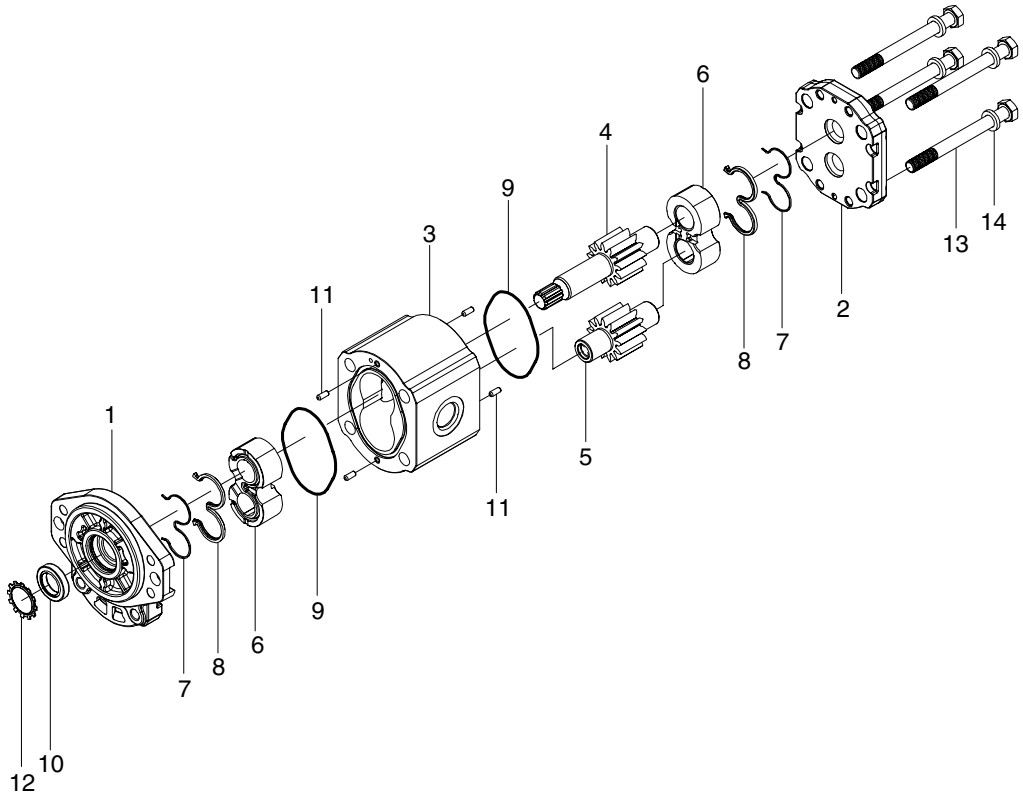
The oil from hydraulic gear pump(2) flows into main control valve(3) and then goes to the small chamber of reach cylinder(8) by pushing the load check valve of spool.

The oil at the large chamber of reach cylinder(8) returns to hydraulic tank(1) at the same time.

When this happens, the mast reaches backward.

2. HYDRAULIC GEAR PUMP

1) STRUCTURE



BRJ7HS19

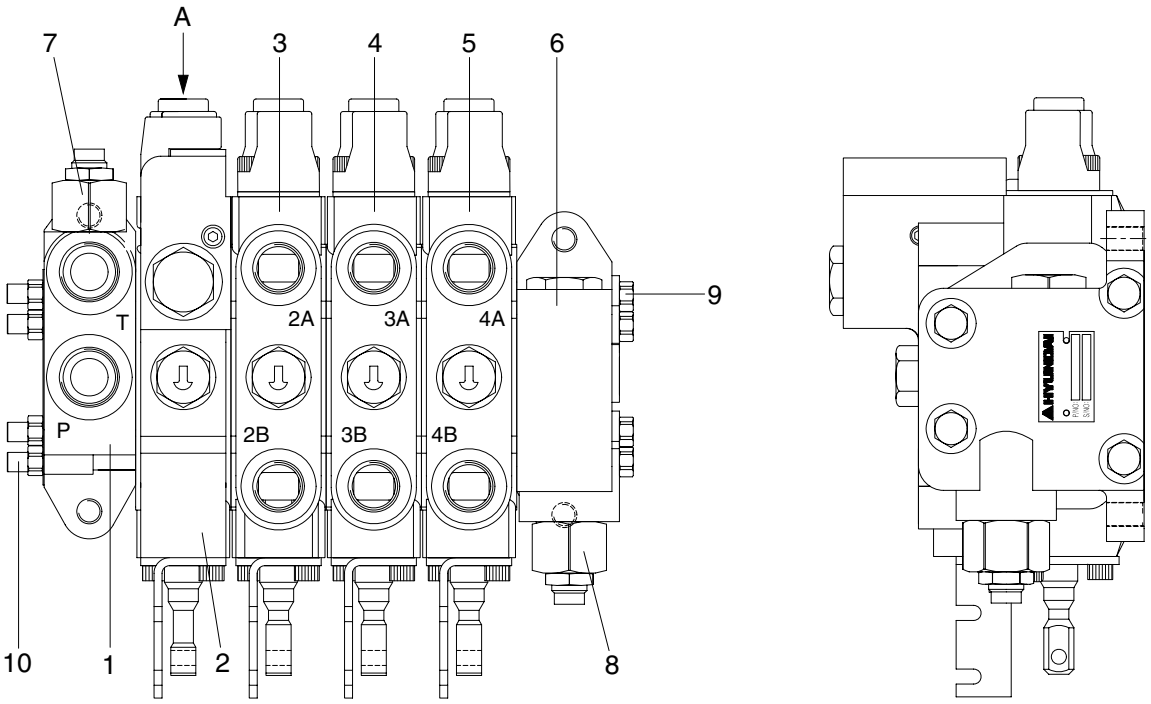
1	Mounting flange	6	Bearing block	11	Dowel pin
2	End cover	7	Backup ring	12	Start ring
3	Gear housing	8	Seal	13	Socket head bolt
4	Drive gear	9	O-ring	14	Spring washer
5	Idler shaft	10	Shaft seal		

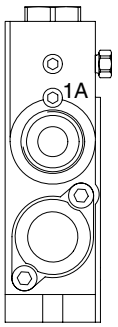
2) OPERATION

This pump comprises of an rear cover, a body, bushings and a housing bolted together with bolts. The gear journals are supported in side plate within pressure balanced bushings to give high volumetric and mechanical efficiencies.

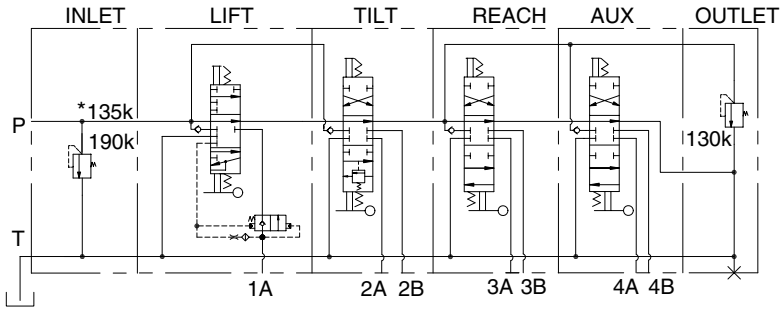
3. MAIN CONTROL VALVE

1) STRUCTURE (4 Spool, Normal)





VIEW A



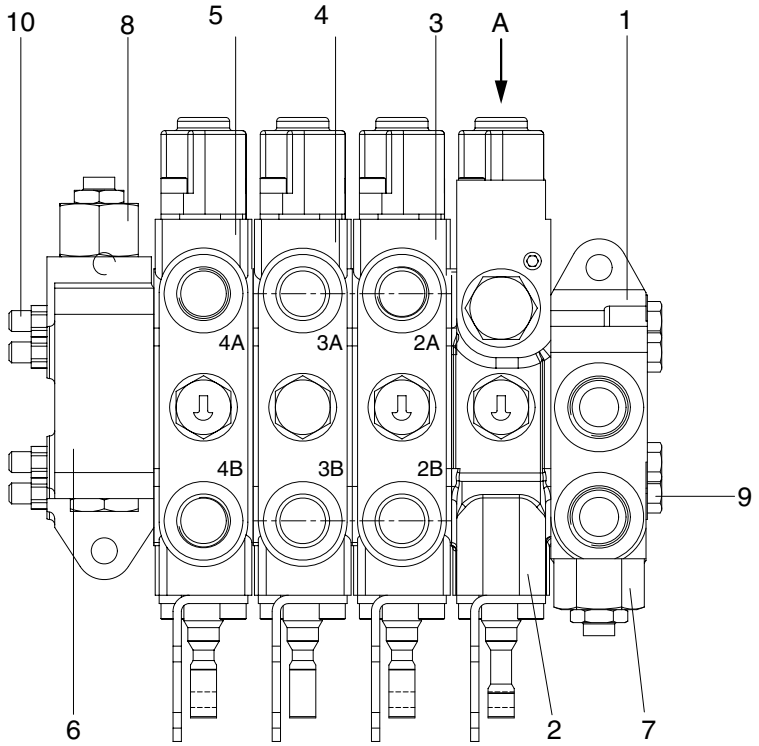
* : 10/13BR-7 only

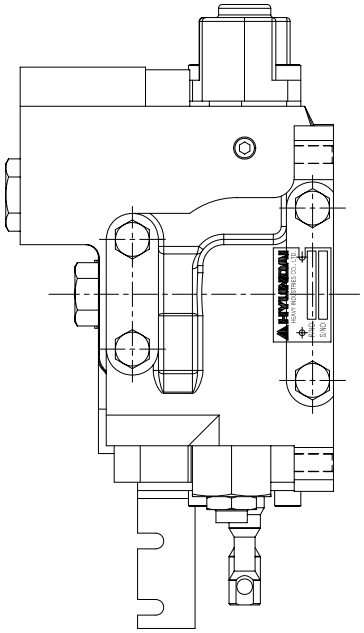
Port name	Size	Port
Inlet port	7/8-14UNF	P
Outlet port	7/8-14UNF	T
Work port	7/8-14UNF	1A
Work port	3/4-16UNF	2A, 2B, 3A, 3B, 4A, 4B

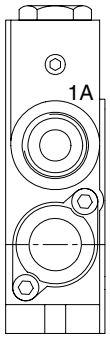
BR7HS08

1 Inlet block assy
2 Lift block assy
3 Tilt block assy
4 Reach block assy
5 Aux block assy
6 Outlet block assy
7 Main relief valve assy
8 Auxiliary relief valve assy
9 Long bolt
10 Nut

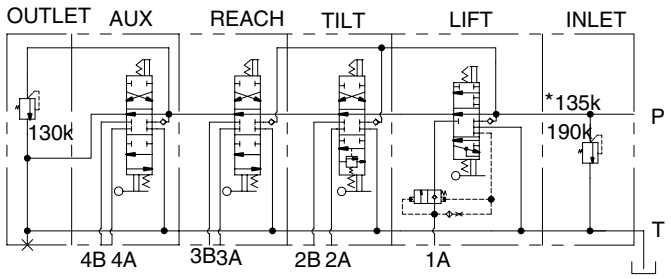
2) STRUCTURE(4 Spool, Reverse)







VIEW A



* : 10/13BR-7 only

Port name	Size	Port
Inlet port	7/8-14UNF	P
Outlet port	7/8-14UNF	T
Work port	7/8-14UNF	1A
Work port	3/4-16UNF	2A, 2B, 3A, 3B, 4A, 4B

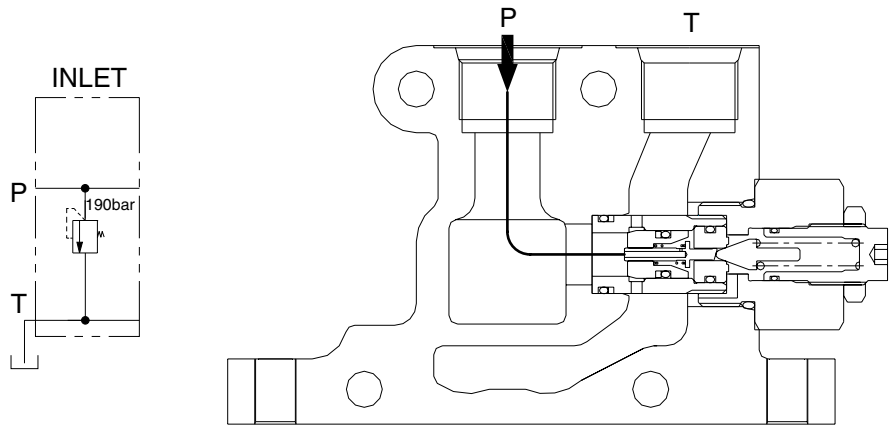
BR7HS08R

1 Inlet block assy
2 Lift block assy
3 Tilt block assy
4 Reach block assy
5 Aux block assy
6 Outlet block assy
7 Main relief valve assy
8 Auxiliary relief valve assy
9 Long bolt
10 Nut

3) INLET SECTION

(1) Operation

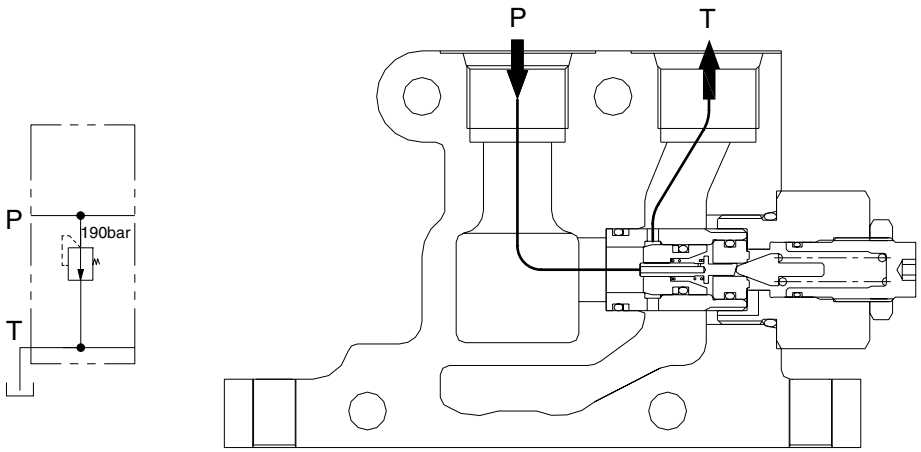
The inlet section contains the pump inlet connection and main relief valve.



22B7HS09

(2) Operation of relief valve at setting pressure

When the pressure at inlet reaches to setting pressure, the pilot poppet which is in the main relief valve is opened by pressure. At this condition the flow divert from the pump directly to the outlet tank.



22B7HS10

4) LIFT SECTION

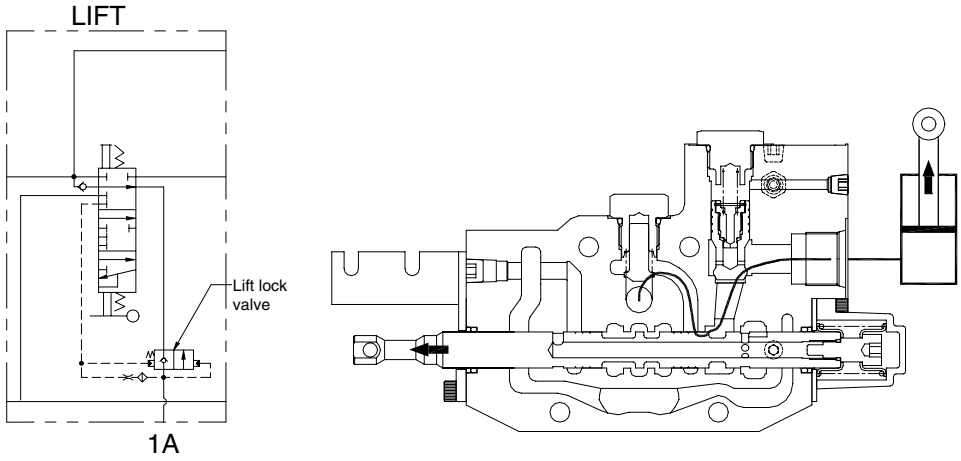
(1) Operation

The lift section has a single work port to direct flow to the lift cylinder. Only one work port is used, because the lift cylinder is single-acting(gravity returns the mast to the lowered position).

The lift section also contains part of the components which comprise the safety features. There is a lift lock check valve. At the neutral position, pressures in the lock valve are equalized across the lift lock poppet. In this manner, the spring bias keeps the lift lock valve closed and prevents lowering of the mast.

① Lifting

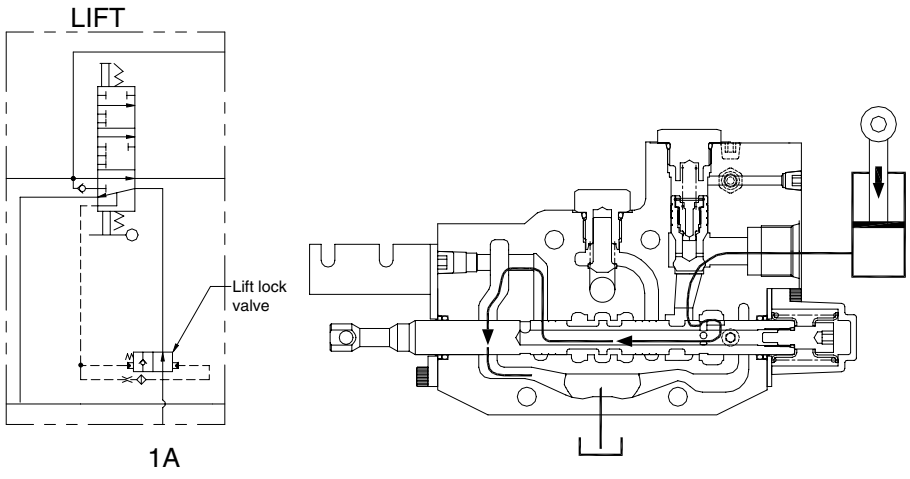
When the operator shifts the lever backwards, the spool is extended out of the valve, and this opens the internal fluid passages that lift the mast. Oil flows through the high pressure parallel cavity, past the load check valve, through the spool metering notches, past the lift lock check valve, and to the head side of the lift cylinder.



BR7HS11S

② Lowering

When the seated operator shifts the lever forwards, the spool retracts into the valve, and the oil is directed from the cylinder, past the lift lock check valve, past the spool metering notches, and to the common tank cavity.



BR7HS12S

Pressure is limited by the main relief valve.

5) TILT SECTION

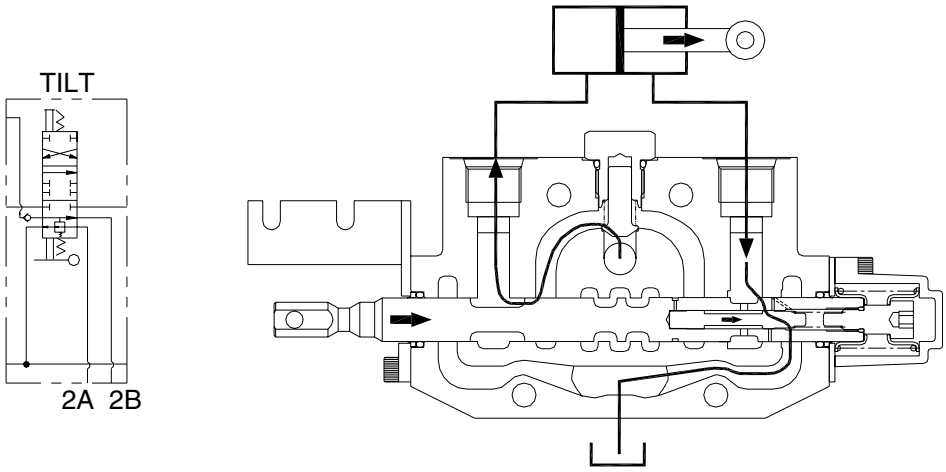
(1) Operation

The tilt spool contains an internal plunger which acts to stop tilt forward actuation when the battery power is off.

① Tilt forward

When the seated operator shifts the lever forward, pressure is applied to the head of the tilt cylinder, and the forks tilt forward. Oil is directed from the high pressure parallel passage past the load check valve, past the spool metering notches, and towards the cylinder head.

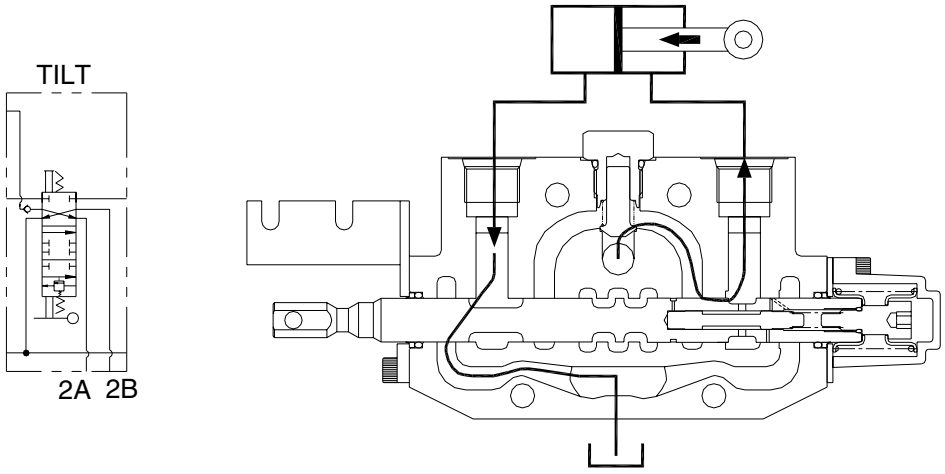
Simultaneously, the high pressure acts upon the end of the tilt lock plunger to move it towards the spring end of the spool. This plunger movement opens additional spool metering notches which control oil flow from the rod end of the cylinder to the tank return line.



22B7HS13

② Tilt back

When the seated operator shifts the lever back, the high pressure oil from the parallel passage is directed past the load check valve, past the spool metering notches, and to the rod side of the cylinder. Exhaust oil from the head side of the cylinder is directed past the spool metering notches to tank.



22B7HS14

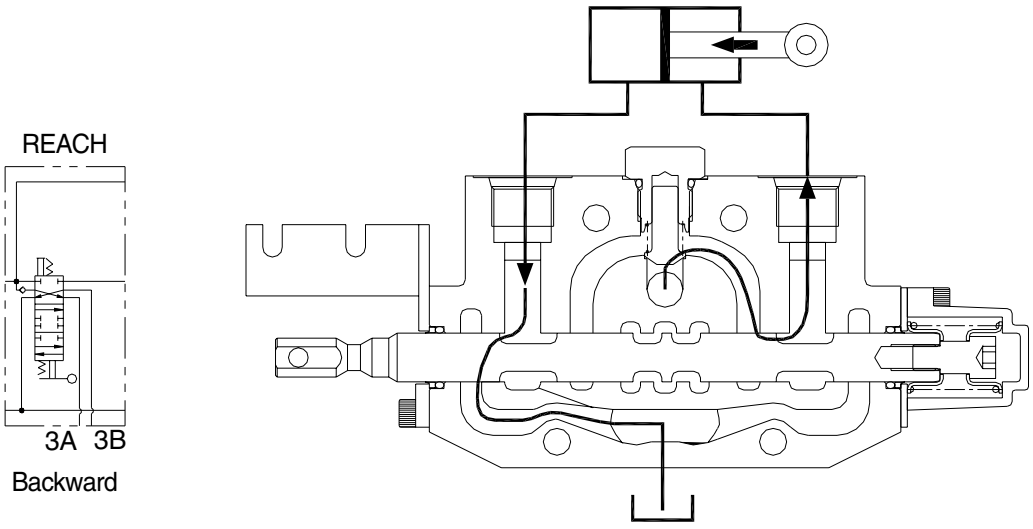
Pressure is limited by the main relief valve.

6) REACH SECTIONS

(1) Operation

① Reach back

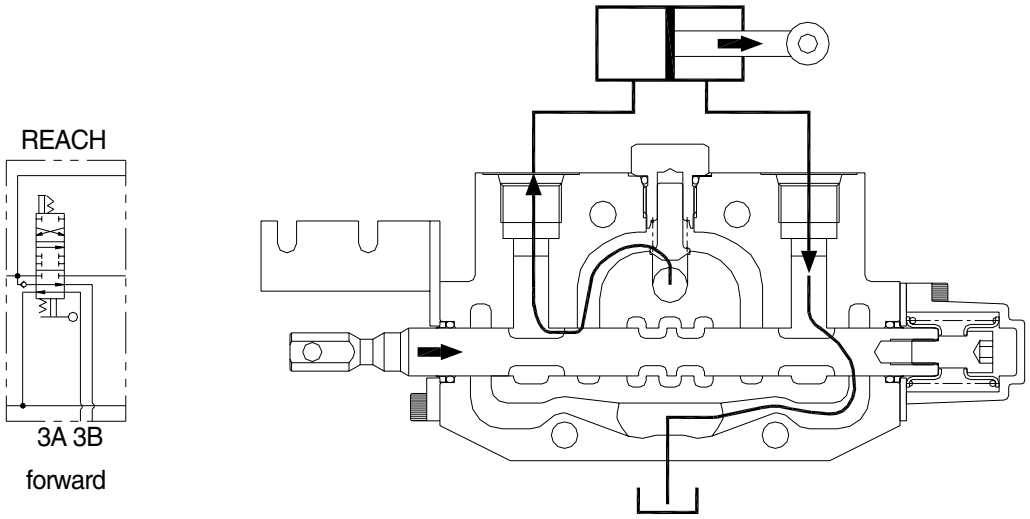
When the seated operator shifts the lever back, the high pressure oil from the parallel passage is directed past the load check valve, past the spool metering notches, and to the rod side of the cylinder. Exhaust oil from the head side of the cylinder is directed past the spool metering notches to tank.



BR7HS15R

② Reach forward

When the seated operator shifts the lever forward, pressure is applied to the head of the reach cylinder, and the forks tilt forward. Oil is directed from the high pressure parallel passage past the load check valve, past the spool metering notches, and towards the cylinder head.



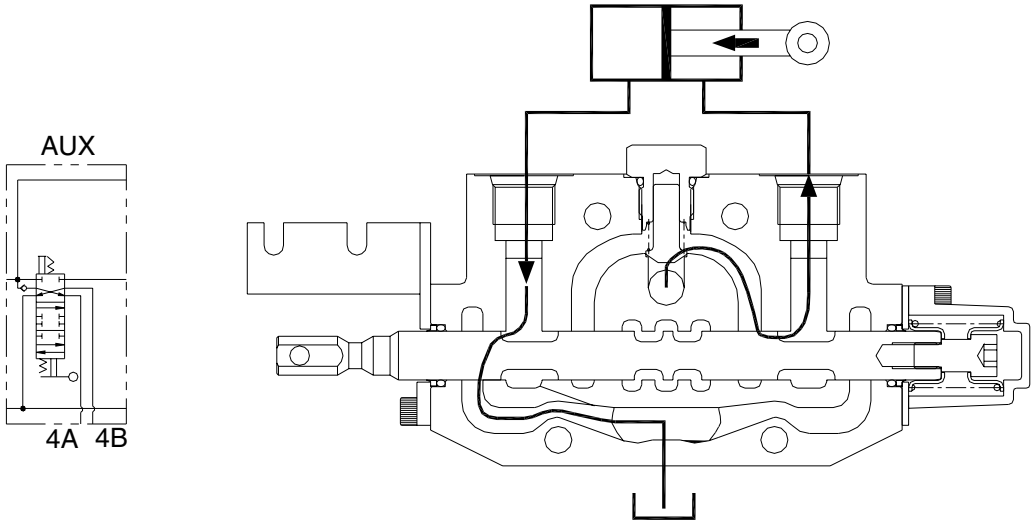
BR7HS16R

Pressure is limited by the main relief valve.

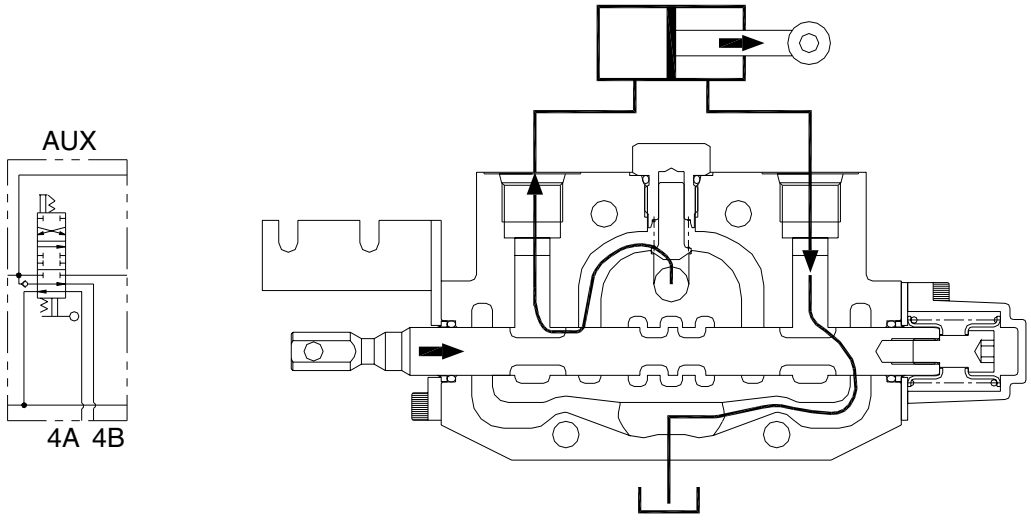
7) AUXILIARY SECTION

(1) Operation

Many different functions can be controlled by the auxiliary spool sections. In general, one work port is pressurized by high pressure oil from the parallel passage, past the load check valve, past the metering notches, and to the cylinder. Simultaneously, oil from the other work port is directed across the spool metering notches to tank.



BR7HS15



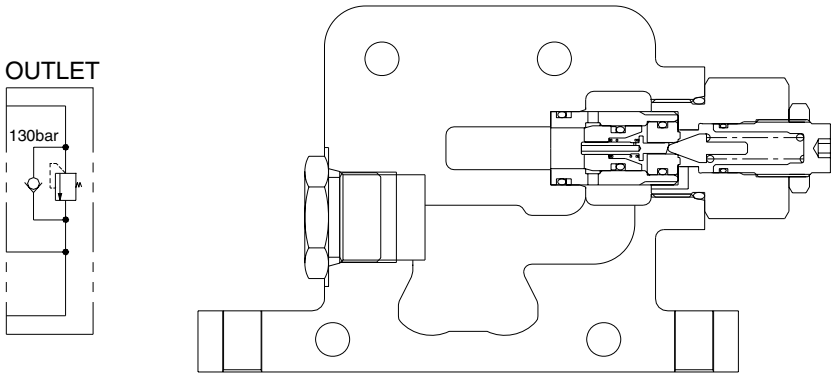
BR7HS16

Pressure is limited by the secondary main relief valve.

8) OUTLET SECTION

(1) Operation

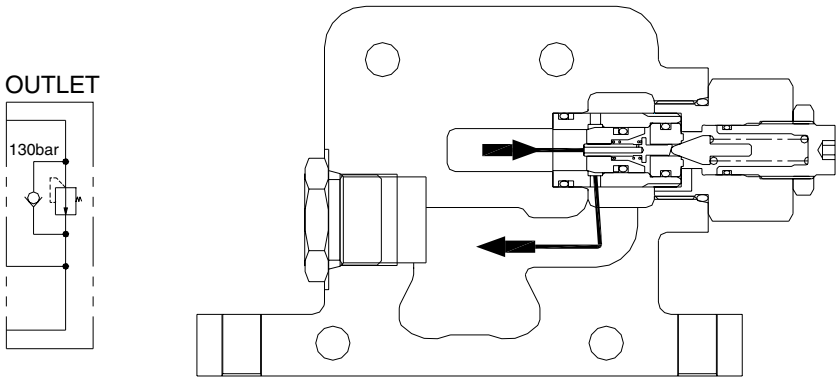
The outlet section contains the tank port and the secondary relief valve(with built-in anti-cavitation feature).



22B7HS17

(2) Operation of relief valve at setting pressure

When the pressure at outlet reaches to setting pressure, the pilot poppet which is in the main relief valve is opened by pressure. At this condition the flow divert from the pump directly to the tank line.

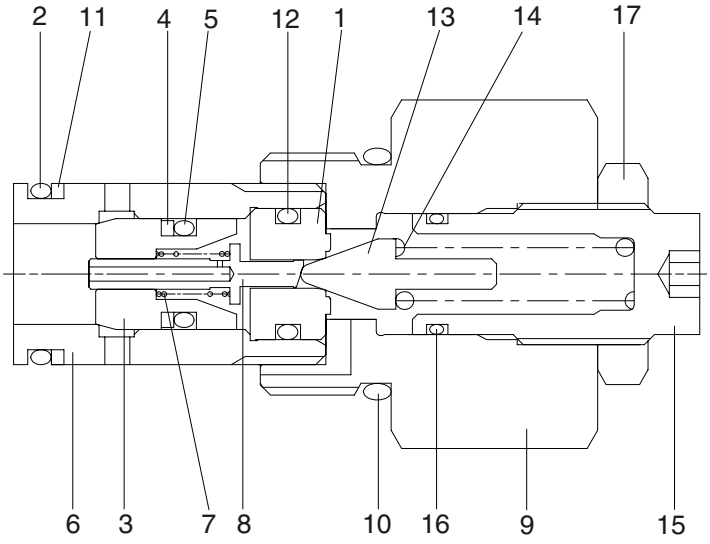


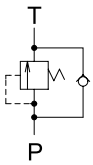
22B7HS18

9) MAIN RELIEF VALVE

This valve is a type of pilot piston to prevent hydraulic components and pipes from being broken by high pressure so, it keeps under pressure limited.

Relief valve pressure varies by 130kgf/cm² in accordance with 1 revolution of adjust bolt.





- Main relief valve : 190 kgf/cm² (10/13BR-7 : 135 kgf/cm²)
- Secondary main relief valve : 130 kgf/cm²
  (For 4 spool only)

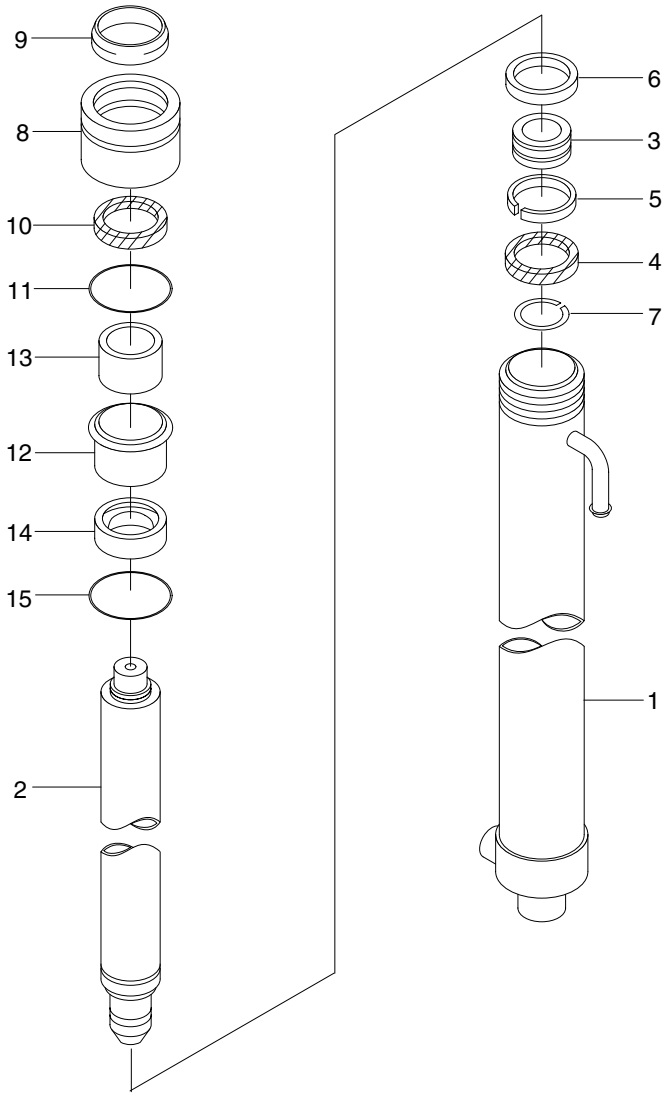
- Note : 1) Max. pressure of relief valve : 250 kgf/cm²
  2) Used pressure of hyd control valve : 190 kgf/cm² (10/13BR-7 : 135 kgf/cm²)

22B7HS20A

1	Pilot seat	7	Main spring	13	Pilot poppet
2	O-ring	8	Piston	14	Pilot spring
3	Main poppet	9	Body	15	Adjust screw
4	Back up ring	10	O-ring	16	O-ring
5	O-ring	11	Back up ring	17	Lock nut
6	Socket	12	O-ring		

4. LIFT CYLINDER

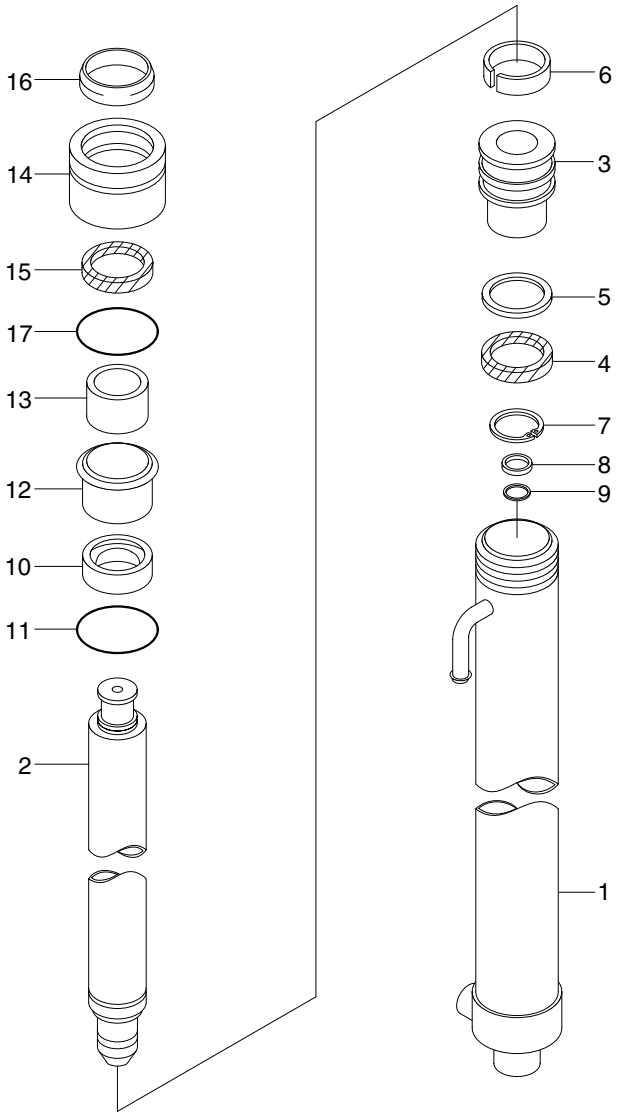
1) 10/13/14/15/18BR-7 (V-MAST)



BR7HS33

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

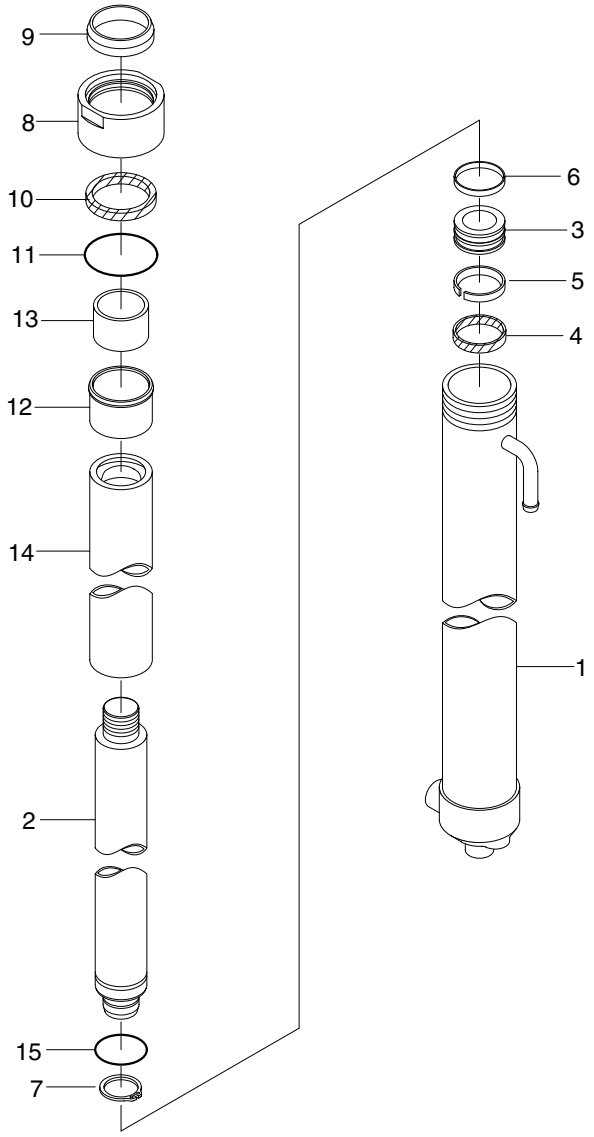
2) 10/13/14/15/18BR-7 (TF-MAST)



BR7HS34

1	Tube assy	7	Stop ring	13	Rod bushing
2	Rod	8	Cushion seal	14	Rod cover
3	Piston	9	Retaining ring	15	U-packing
4	U-packing	10	Spacer	16	Dust wiper
5	Back up ring	11	O-ring	17	O-ring
6	Wear ring	12	Stopper		

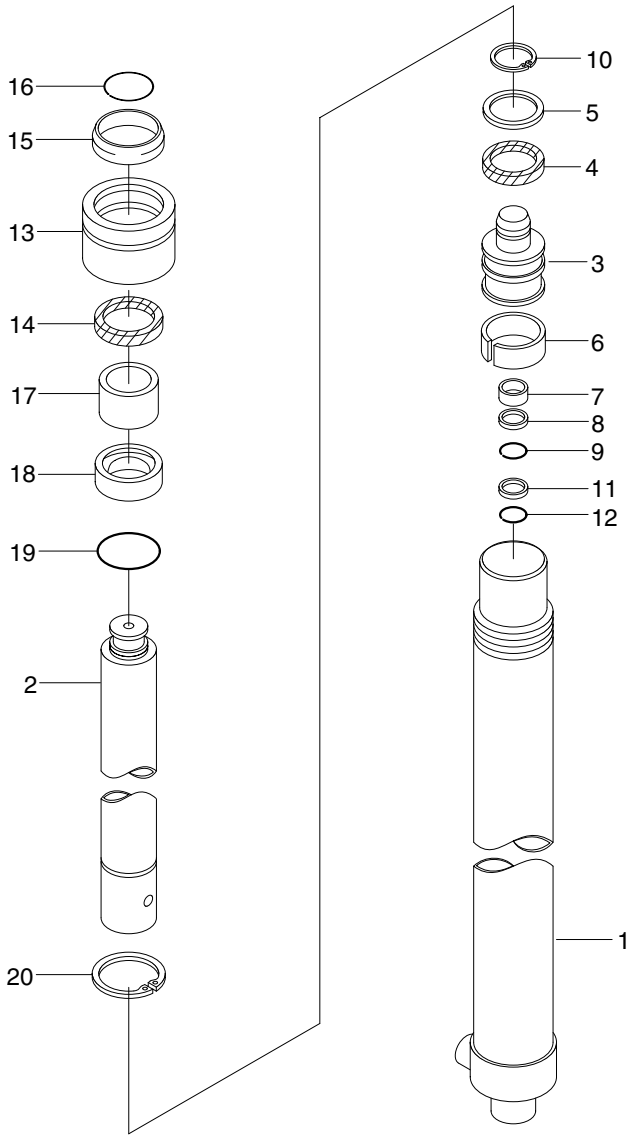
3) 20/25BR-7 (V-MAST)



BR7HS41

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

4) 20/25BR-7 (TF-MAST)

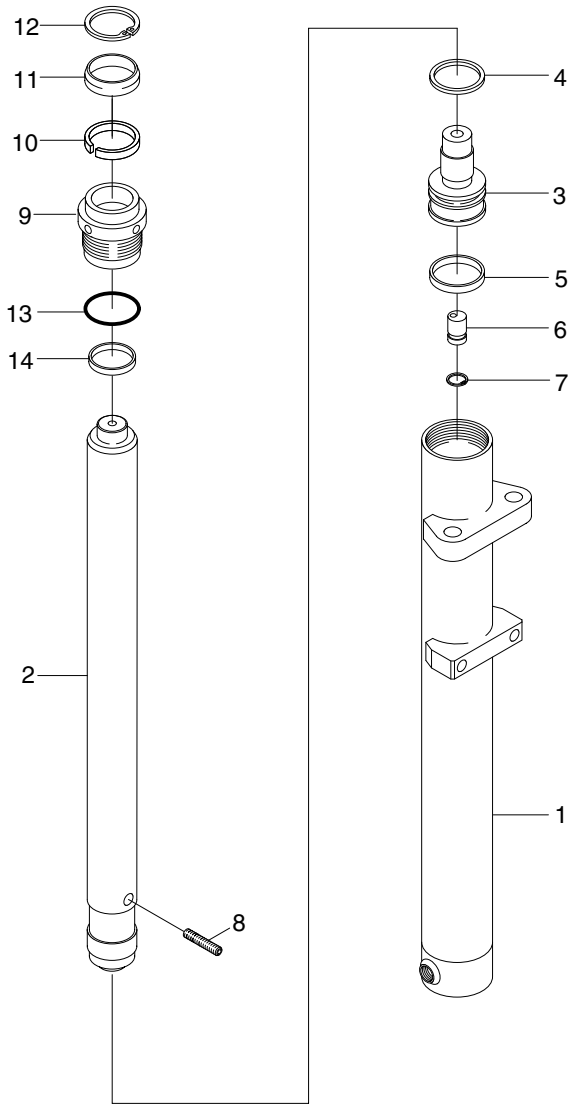


BR7HS42

1	Tube assy	8	Spacer	15	Dust wiper
2	Rod	9	Retaining ring	16	Retaining ring
3	Piston	10	Stop ring	17	Wear ring
4	U-packing	11	Cushion seal	18	Dust ring
5	Back up ring	12	Retaining ring	19	O-ring
6	Wear ring	13	Rod cover	20	Stop ring
7	Check valve	14	U-packing		

5. FREE LIFT CYLINDER

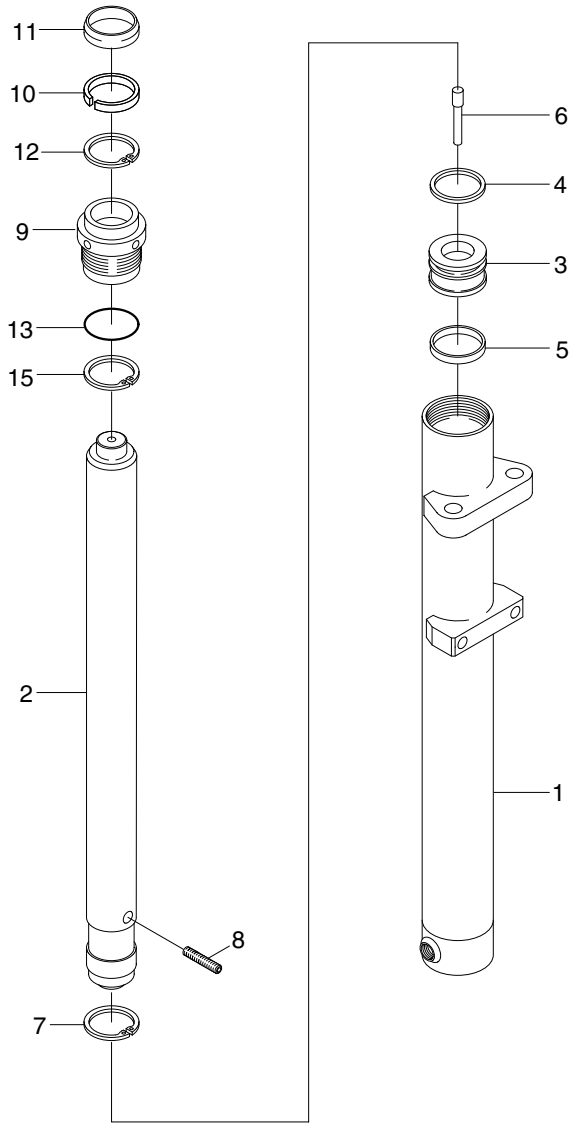
1) 10/13/14/15/18BR-7 (TF-MAST)



BR7HS35

1	Tube assy	6	Check valve	11	Dust wiper
2	Rod	7	Retaining ring	12	Snap ring
3	Piston	8	Set screw	13	O-ring
4	Piston seal	9	Gland	14	Back up ring
5	Wear ring	10	Rod seal		

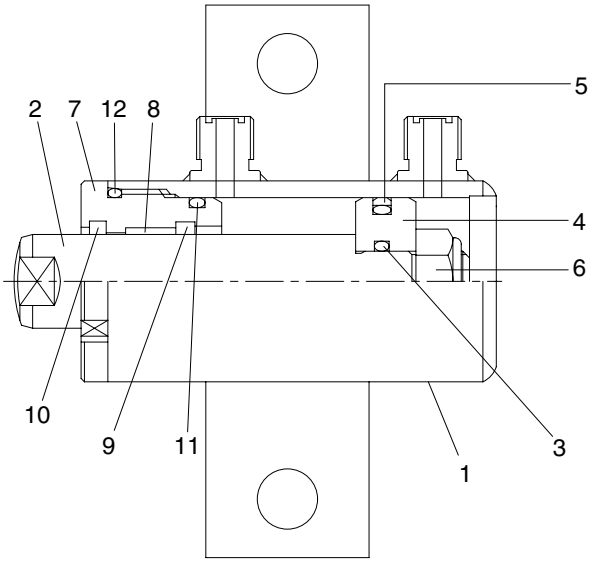
2) 20/25BR-7 (TF-MAST)



BR7HS43

1	Tube assy	6	Check valve	11	Dust wiper
2	Rod	7	Retaining ring	12	Snap ring
3	Piston	8	Set screw	13	O-ring
4	Piston seal	9	Gland	15	Back up ring
5	Wear ring	10	Rod seal		

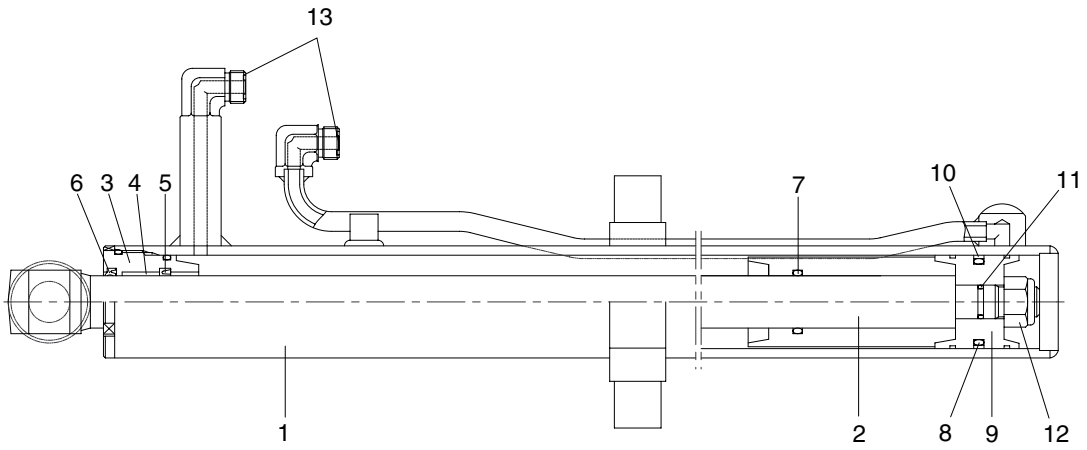
6. TILT CYLINDER



D255HS19

1	Tube assembly	5	Piston seal	9	Rod seal
2	Rod assembly	6	Nylon nut	10	Dust wiper
3	O-ring	7	Gland	11	O-ring
4	Piston	8	DU bushing	12	O-ring

7. REACH CYLINDER

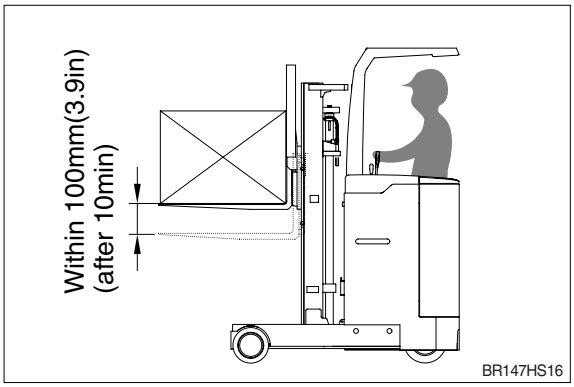


BR147HS14

1	Tube assembly	6	Dust wiper	11	O-ring
2	Rod assembly	7	O-ring	12	Nylon nut
3	Gland	8	O-ring	13	O-ring
4	DU bushing	9	Piston	14	Spacer
5	Rod seal	10	Piston seal		

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

1. OPERATIONAL CHECKS



1) CHECK ITEM

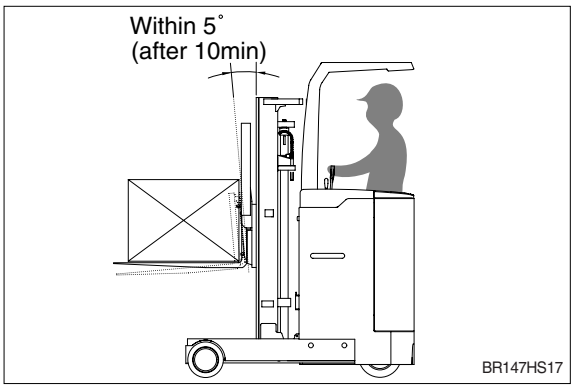
(1) Check visually for deformation, cracks or damage of rod.

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

· **Hydraulic drift**

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

If the hydraulic drift is more than the specified value, replace the control valve or cylinder packing.

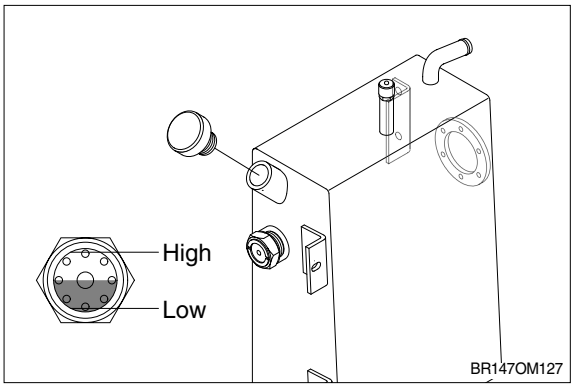


(3) Check that clearance between tilt cylinder bushing and mounting pin is within standard range.

mm (in)

Standard	Under 0.6 (0.02)

2) CHECK AND SUPPLY HYDRAULIC OIL



Check the hydraulic sump tank fluid level. Correct fluid level is important for proper system operation. Low fluid level can cause pump damage.

Hydraulic fluid expands as its temperature rises. Therefore, it is preferable to check the fluid level at operating temperature(after approximately 30 minutes of truck operation).

To check the fluid level, first park the truck on a level surface and apply the parking brake.

Put the mast upright in a vertical position and lower the fork carriage fully down. Check the hydraulic oil level. Keep the oil level above the LOW mark by adding recommended hydraulic fluid only, as required . **Do not overfill**.

Check the condition of the hydraulic fluid (age, color or clarity, contamination). Change (replace) the oil as necessary.

3) CONTROL VALVE

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

· 10/13BR-7 : 135kgf/cm^2 (1920psi)

· 14/15/18/20/25BR-7 : 190kgf/cm^2 (2700psi)

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 proper viscosity 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 proper viscosity 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 oil. · Clean filters. · Clean line and check for proper size.
Oil heating	· Oil supply low. · Contaminated oil. · Setting of relief valve too high or too low. · Oil viscosity too low.	· Fill reservoir to proper level. · Drain reservoir and refill with clean oil. · Set to correct pressure. · Drain reservoir and fill with proper viscosity.
Foaming oil	· Low oil level. · Air leaking into suction line. · Wrong kind of oil.	· Fill reservoir to proper level. · Tighten fittings, check condition of line. · Drain reservoir, fill with non-foaming oil.
Shaft seal leakage	· Worn shaft seal. · Worn shaft in seal area.	· Replace shaft seal. · Replace drive shaft and seal.

3) MAIN RELIEF VALVE

Problem	Cause	Remedy
Can't get pressure	· Poppet stuck open or contamination under seat.	· Check for foreign matter between poppets and their mating parts. Parts must slide freely.
Erratic pressure	· Pilot poppet seat damaged. · Poppet sticking.	· Replace the relief valve. · Clean and remove surface marks for free movement.
Pressure setting not correct	· Normal wear. Lock nut & adjust screw loose.	· See *Test of main control valve.
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 rod cover 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 rod cover thread	· O-ring damaged.	· Replace O-ring.
Rod spontaneously retract	· Scores on inner surface of tube. · Unallowable score on the inner surface of tube. · Foreign matters in piston seal.	· Smooth rod surface with an oil stone. · Replace cylinder tube. · Replace piston seal.
Wear(clearance between cylinder tube and wear ring)	· Excessive clearance between cylinder tube and wear ring.	· Replace wear ring.
Abnormal noise is produced during tilting operation	· Insufficient lubrication of anchor pin or worn bushing and pin. · Bent tilt cylinder rod.	· Lubricate or replace. · Replace.

GROUP 3 DISASSEMBLY AND ASSEMBLY

1. HYDRAULIC GEAR PUMP

※ **Tools required**

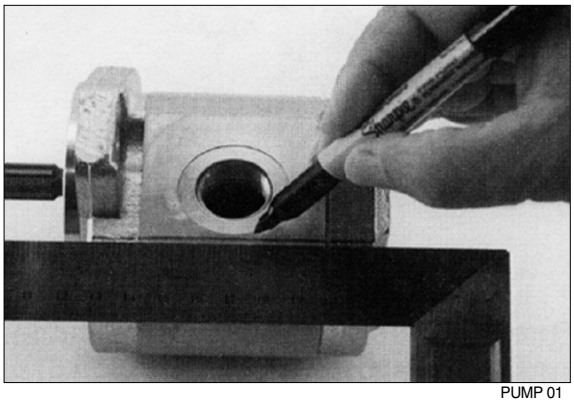
- Metric socket set
- Internal snap ring pliers
- Shaft seal sleeve
- Torque wrench

(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.

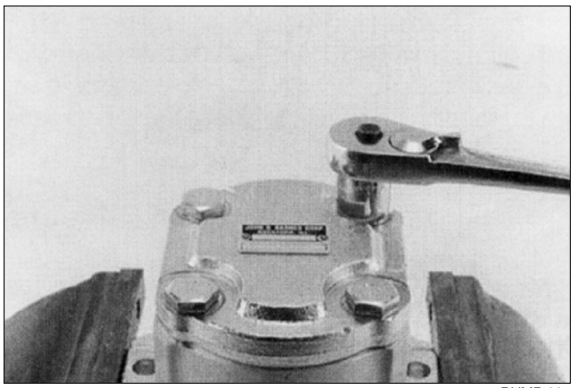


PUMP 01

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

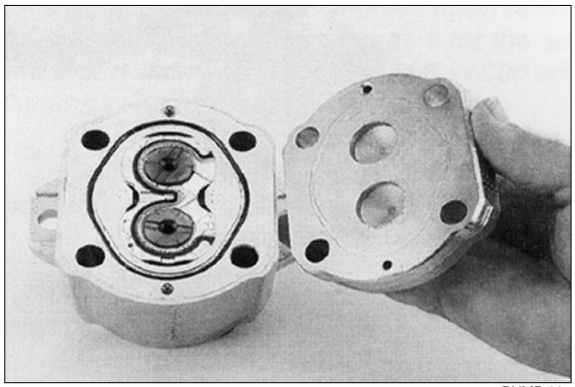
(6) Loosen the four metric hexagon head bolts.

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



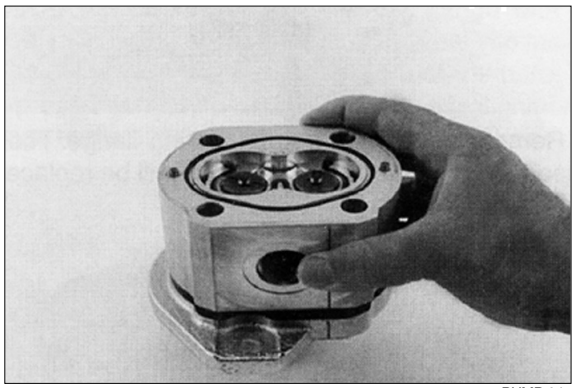
PUMP 02

(8) Lift and remove end cover.



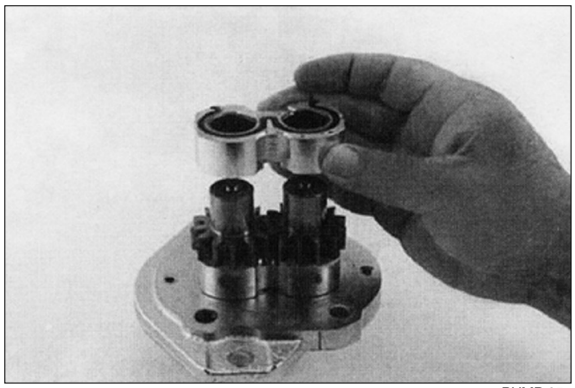
PUMP 03

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



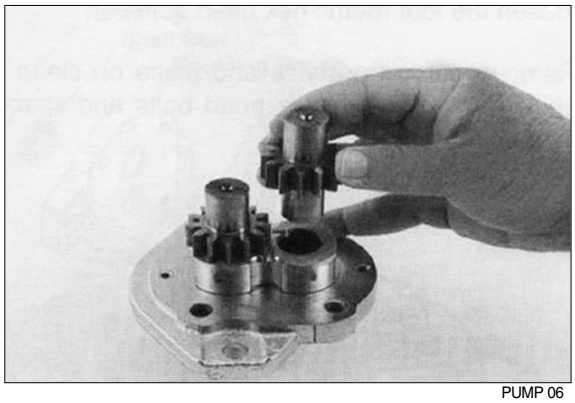
PUMP 04

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



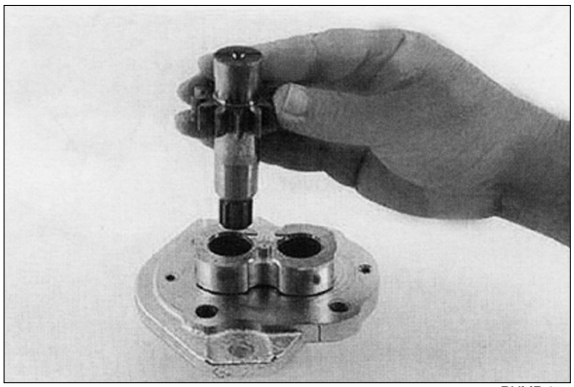
PUMP 05

(11) Remove idler shaft from bearing block.



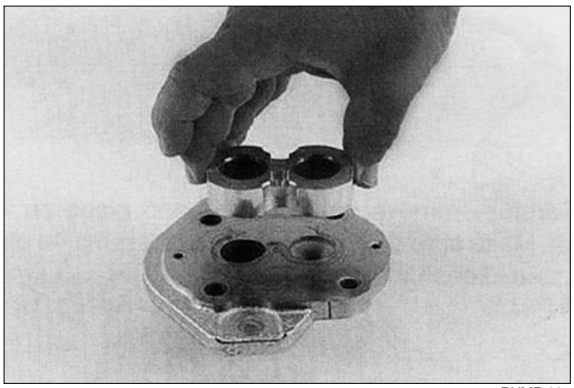
PUMP 06

(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.



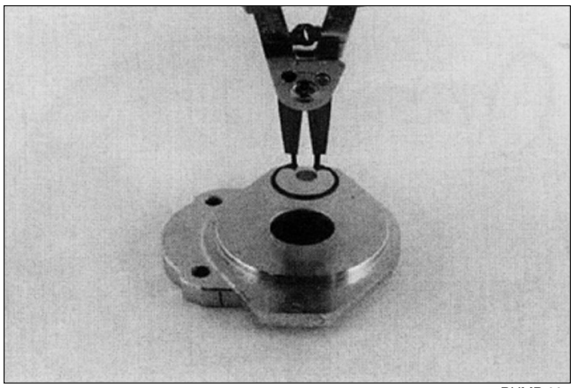
PUMP 07

(13) Remove the front bearing block.



PUMP 08

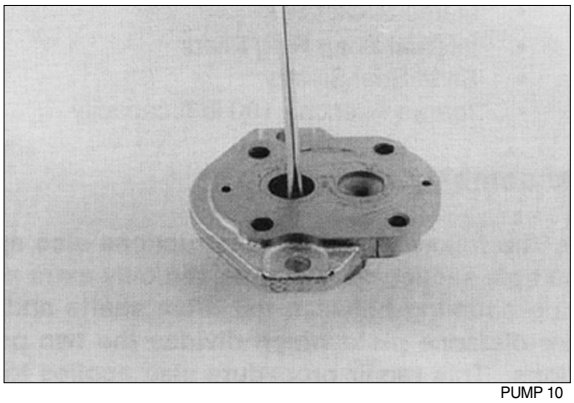
(14) Turn mounting flange over, with shaft seal up, and remove the retaining ring with proper snap ring pliers.



PUMP 09

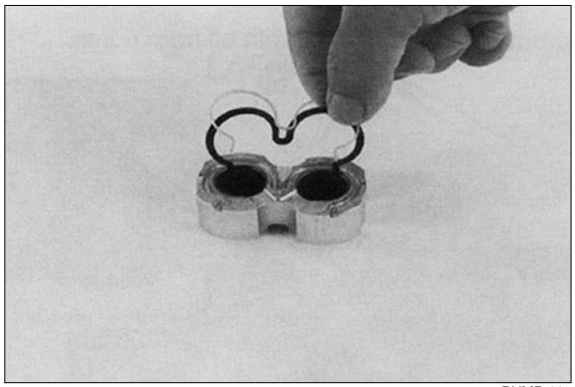
(15) Remove the oil seal from mounting flange, be careful not to mar or scratch the seal bore.

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



PUMP 10

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



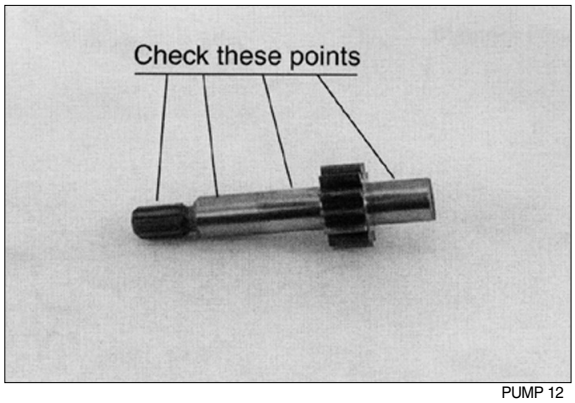
PUMP 11

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.

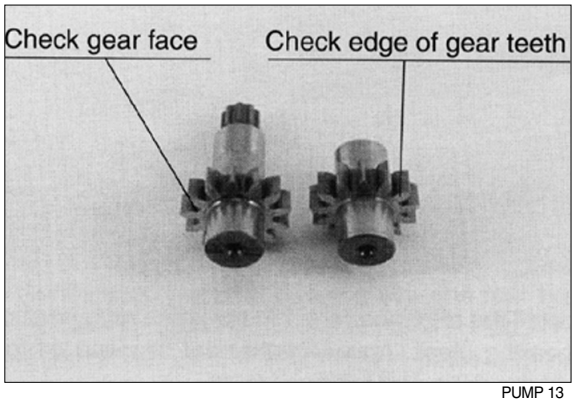
(2) Check drive shaft spline for twisted or broken teeth, check keyed drive shaft for broken or chipped keyway. No marks or grooves on shaft in seal area, some discoloration of shaft is allowable.

(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

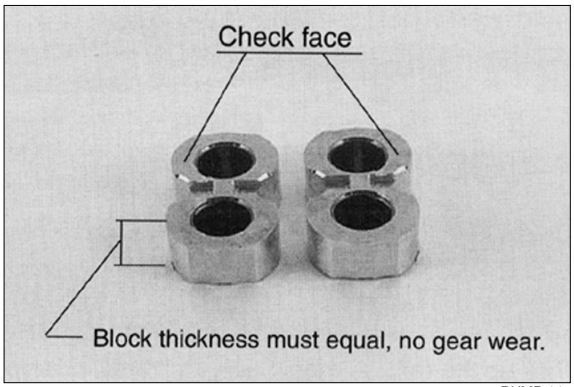
(5) Inspect bearing blocks for excessive wear or scoring on the surfaces which are in contact with the gears. Also inspect the bearings for excessive wear or scoring.

(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.

※ **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.**

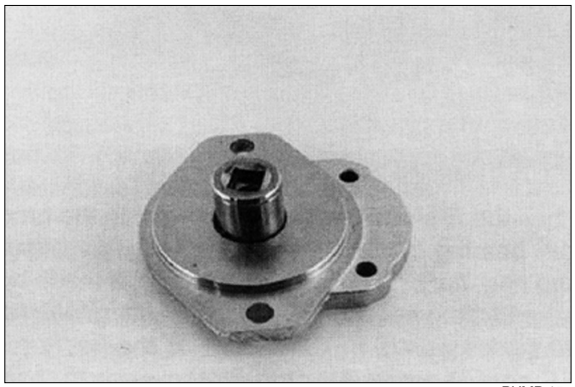


PUMP 14

3) ASSEMBLY

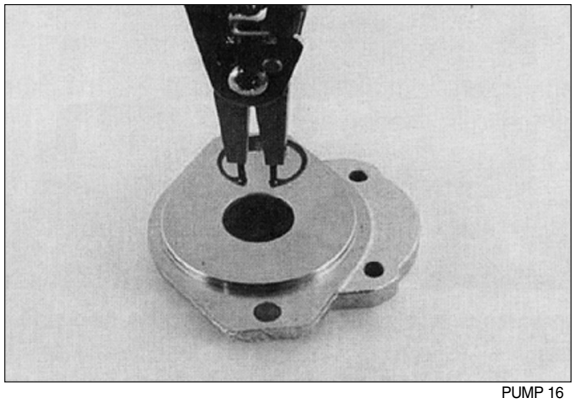
※ **New seals should be installed upon reassembly of pump.**

(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.



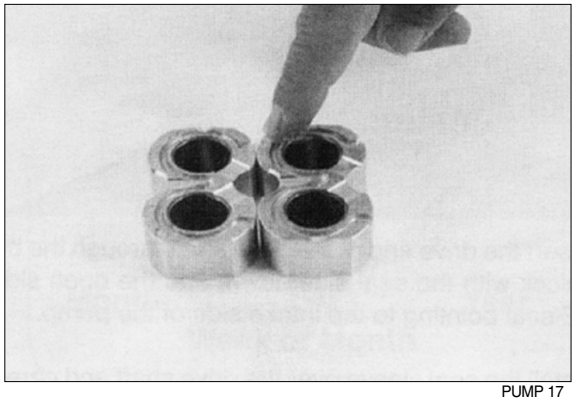
PUMP 15

(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.

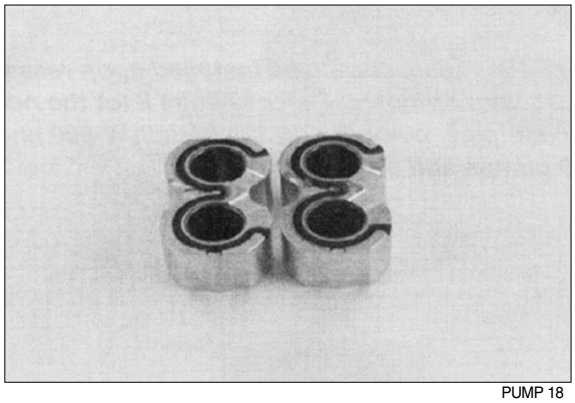


PUMP 17

(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.

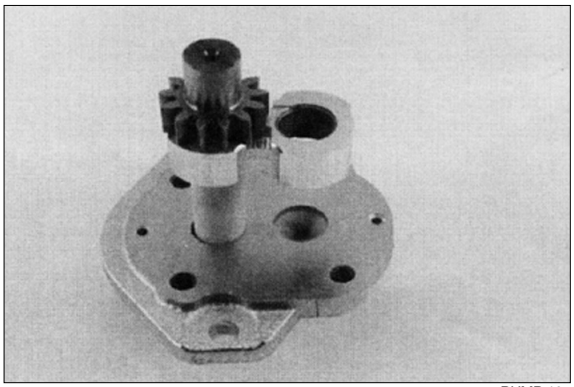
(6) Apply a light coating of petroleum jelly to the exposed face of the front bearing block.



PUMP 18

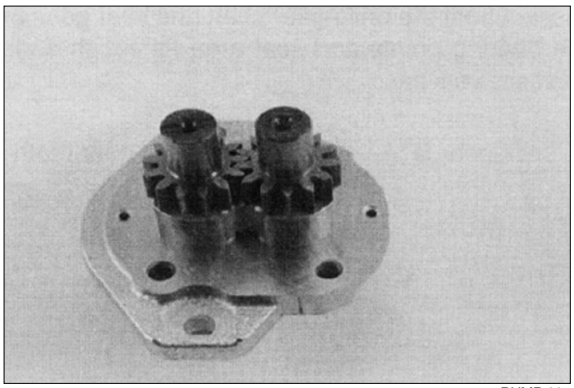
(7) Insert the drive end of the drive shaft through the bearing block with the seal side down, and the open side of the E-seal pointing to the intake side of the pump.

(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

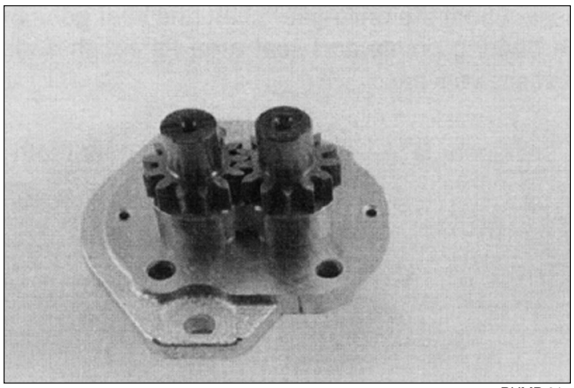
(9) Install the idler gear shaft in the remaining position in the bearing block. Apply a light coat of clean oil to the face of the drive and idler gears.



PUMP 20

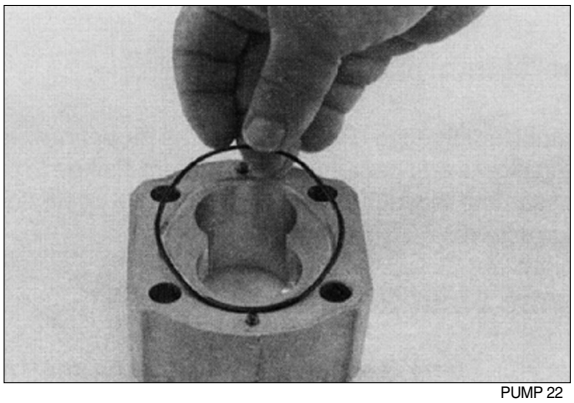
(10) Pick up the rear bearing block, with seal side up and with open end of the E-seal facing the intake side of the pump, place over the drive and idler gear shafts.

(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.



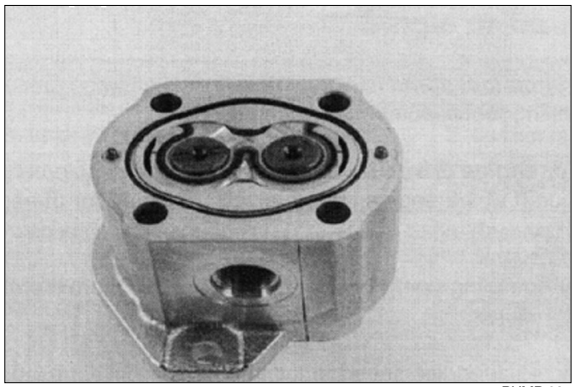
PUMP 21

(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.



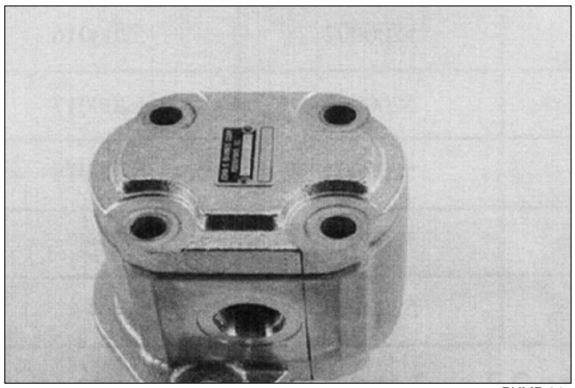
PUMP 22

(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.

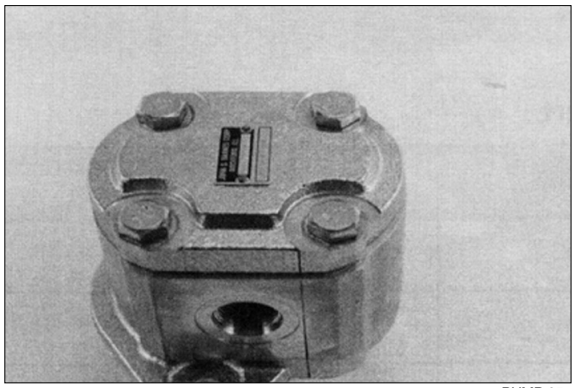

PUMP 23

(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.

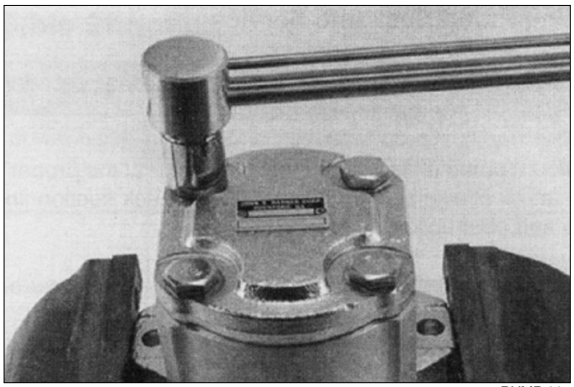

PUMP 25

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

· Tighten torque : 6~7kgf · m
(43.4~50.6lbf · 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

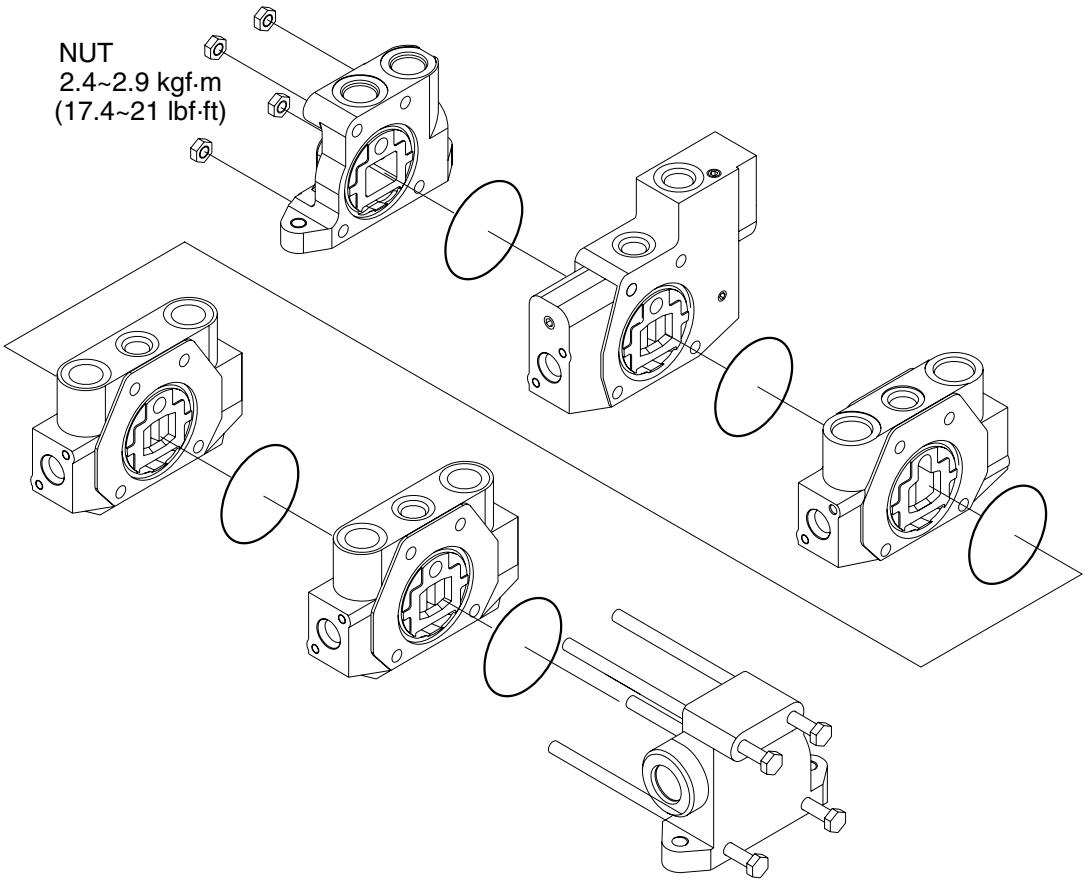
2. MAIN CONTROL VALVE

1) ASSEMBLY

(1) General

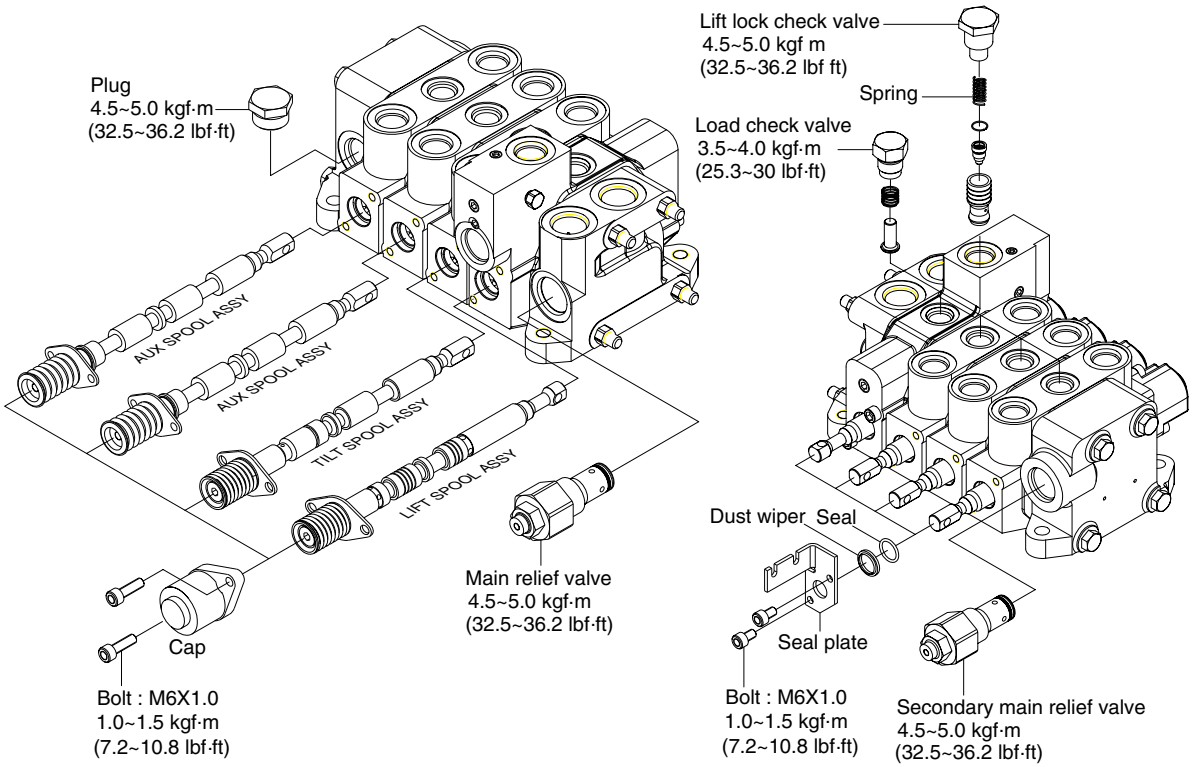
① Ensure that the assembly area will be clean and free of contamination.
② Use a flat(within 0.2㎜) work surface when bolting the valve sections together.
③ Use calibrated torque wrenches and instrumentation.
④ The formal Bills of Material, descriptions, and views are found in the attached documentation.
⑤ Additional auxiliary valve sections may be added to the main control valve in a similar manner as indicated below, as approved by the O.E.M.

(2) Block subassembly



22B7HS21

① Attach all the O-rings to the appropriate grooves between the spool sections.
② Stack the valve sections such that all the work ports are facing up, the spool ends are all in the same direction, and they are resting on a flat(within 0.2㎜), uniform surface.
③ Insert all the tie rods through the drilled holes in each of the housings.
④ Press the sections together, being carefully not to damage sealing surfaces or seals.
⑤ Install nuts to both ends of all tie rods and progressively torque in a circular pattern until reaching a torque of 2.4~2.9㎏f · ㎝(17.4~21㏈f · ft) on all tie rods. Periodically, make sure that the valve remains flat while applying torque.



BR7HS25

(3) Inlet section

① Install the main relief valve assembly into the lower side cavity of the inlet section, as illustrated. Torque to 4.5~5.0kgf · m(32.5~36.2lbf · ft).

② Install the plug assembly in the tank port of the inlet section. Torque to 4.5~5.0kgf · m (32.5~36.2lbf · ft)

(4) Lift section

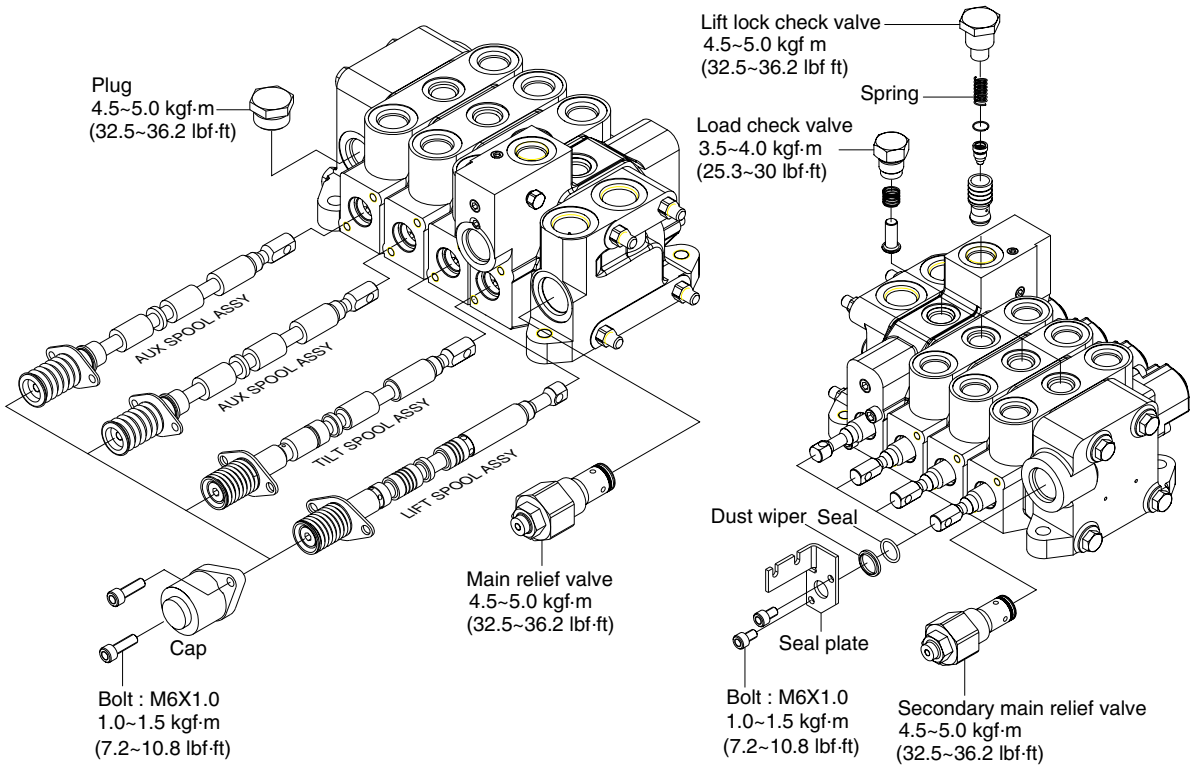
① The spool assembly should already consist of the lift spool, the return spring, one spring seat on either end of the spring, the seal plate, a spool seal, and a dust wiper. All of these are assembled on the end of the spool opposite the clevis.

② Insert the clevis end of the spool into the right-hand side of the spool bore(the tallest end of the housing). Place the spool cap over the spool and spring assembly and connect the cap to the housing using two bolts. Torque both bolts alternatively until a torque of 1.0~1.5kgf · m (7.2~10.8lbf · ft) is reached on both bolts.

③ Install the second spool seal and dust wiper over the clevis end of the spool and retain with a seal plate and two bolts. Torque both bolts alternatively until a torque of 1.0~1.5kgf · m(7.2~10.8lbf · ft) is reached on both bolts.

④ The load check assembly is inserted into the top center cavity. Torque to 3.5~4.0kgf · m (25.3~30lbf · ft)

⑤ Install the lift lock check valve assembly in the remaining open cavity in the top of the housing. Torque to 4.5~5.0kgf · m(32.5~36.2lbf · ft)



BR7HS25

(5) Tilt section

① The spool assembly should already consist of the tilt spool(with tilt plunger and spring inserted into the bore on the spring end), the return spring, one spring seat on either end of the spring, the seal plate, a spool seal, and a dust wiper. All of these are assembled on the end of the spool opposite the clevis.

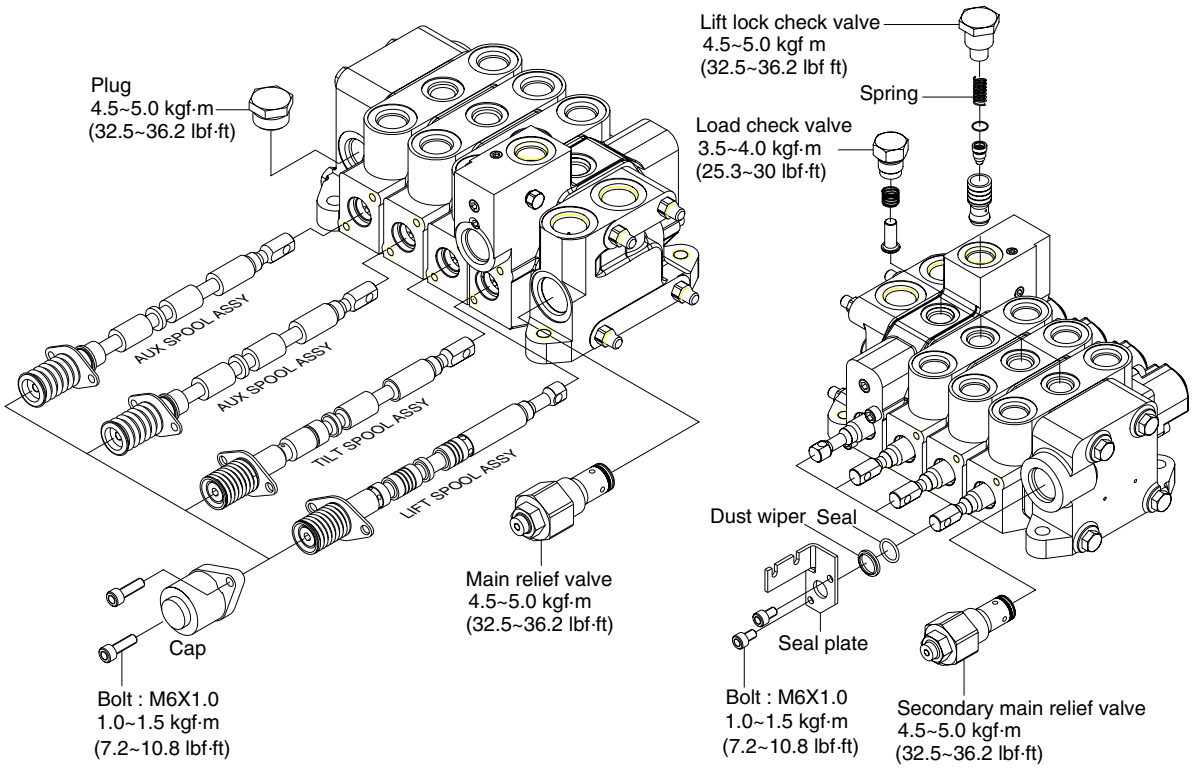
② Insert the clevis end of the spool into the right-hand side of the spool bore(the tallest end of the housing). Place the spool cap over the spool and spring assembly and connect the cap to the housing using two bolts. Torque both bolts alternatively until a torque of 1.0~1.5kgf · m (7.2~10.8lbf · ft) is reached on both bolts.

③ Install the second spool seal and dust wiper over the clevis end of the spool and retain with a seal plate and two bolts. Torque both bolts alternatively until a torque of 1.0~1.5kgf · m(7.2~10.8lbf · ft) is reached on both bolts.

④ The load check assembly is inserted into the top center cavity. Torque to 3.5~4.0kgf · m (25.3~30lbf · ft).

⑤ Install the anti-cavitation check valve in the housing cavity on the clevis end directly above the spool assembly. Torque to 4.5~5.0kgf · m(32.5~36.2lbf · ft).

⑥ Install the plug in the housing cavity above the spool assembly. Torque to 3.5~4.0kgf · m (25.3~30lbf · ft).



BR7HS25

(6) Reach section

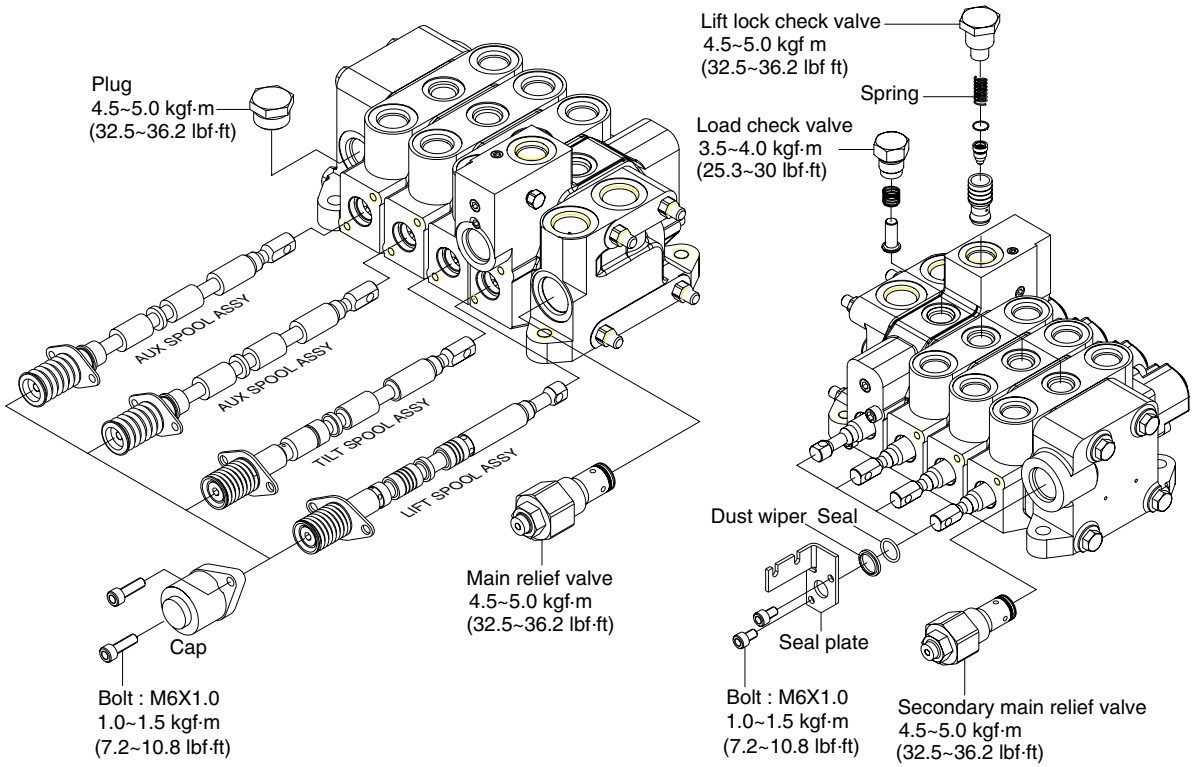
※ Same procedure for all aux sections, but spool assembly components may vary.

① The spool assembly should already consist of the proper reach spool, the return spring, one spring seat on either end of the spring, the seal plate, a spool seal, and a dust wiper. All of these are assembled on the end of the spool opposite the clevis.

② Insert the clevis end of the spool into the right-hand side of the spool bore(the tallest end of the housing). Place the spool cap over the spool and spring assembly and connect the cap to the housing using two bolts. Torque both bolts alternatively until a torque of 1.0~1.5kgf · m (7.2~10.8lbf · ft) is reached on both bolts.

③ Install the second spool seal and dust wiper over the clevis end of the spool and retain with a seal plate and two bolts. Torque both bolts alternatively until a torque of 1.0~1.5kgf · m(7.2~10.8lbf · ft) is reached on both bolts.

④ The load check assembly is inserted into the top center cavity. Torque to 3.5~4.0kgf · m (25.3~30lbf · ft).



BR7HS25

(7) Auxiliary section

※ Same procedure for all aux sections, but spool assembly components may vary.

① The spool assembly should already consist of the proper aux spool, the return spring, one spring seat on either end of the spring, the seal plate, a spool seal, and a dust wiper. All of these are assembled on the end of the spool opposite the clevis.

② Insert the clevis end of the spool into the right-hand side of the spool bore(the tallest end of the housing). Place the spool cap over the spool and spring assembly and connect the cap to the housing using two bolts. Torque both bolts alternatively until a torque of 1.0~1.5kgf · m (7.2~10.8lbf · ft) is reached on both bolts.

③ Install the second spool seal and dust wiper over the clevis end of the spool and retain with a seal plate and two bolts. Torque both bolts alternatively until a torque of 1.0~1.5kgf · m(7.2~10.8lbf · ft) is reached on both bolts.

④ The load check assembly is inserted into the top center cavity. Torque to 3.5~4.0kgf · m (25.3~30lbf · ft).

(8) Outlet section

① Install the secondary main relief valve into the cavity on the clevis end of the housing. Torque to 4.5~5.0kgf · m(32.5~36.2lbf · ft)

2) DISASSEMBLY

(1) General

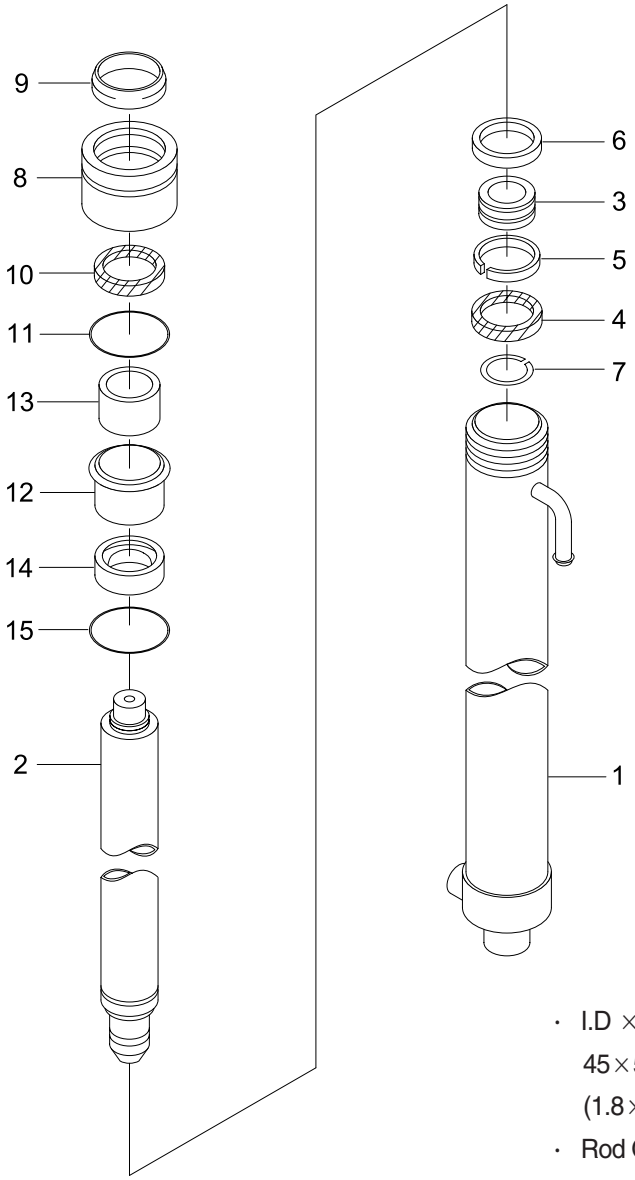
① Subassemblies (such as relief valves, check valves, and spools) may be removed without having to loosen the tie rods and disassembling the entire valve.
② Disassemble the valve sections on a flat working surface.
③ Ensure that the disassembly area will be clean and free of contamination.
④ Keep the disassembly area neat to avoid loss or damage of parts.

(2) Disassembly

① Loosen the tie rod nuts and remove the tie rods from the valve sections.
② Remove O-rings between valve sections and set aside to avoid damage.
③ Spools, relief valves, load check valves, lift lock poppet, solenoid valves, and plugs can all be removed from the valve sections. Refer to the associated assembly procedures, above, for specific torque and handling details. Inspect and repair or replace the assemblies as complete units, as may be necessary.
④ Valve components are precision items, and care must be taken when handing them to avoid damage or the introduction of contamination that could adversely affect performance.

3. LIFT CYLINDER

1) STRUCTURE



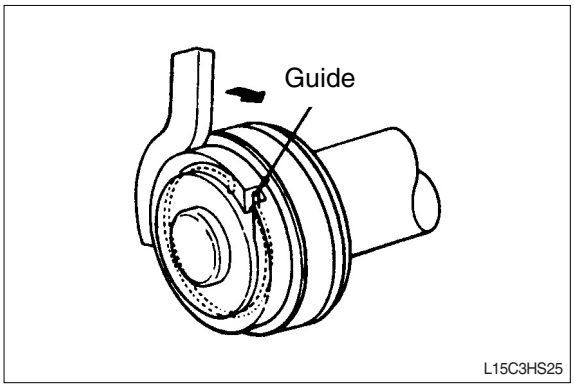
- I.D × O.D × Stroke (standard)
  45 × 55 × 1645mm
  (1.8 × 2.2 × 65 in)
- Rod O.D : 35mm (1.4 in)

B153HS14

1	Tube assy	6	Wear ring	11	O-ring
2	Rod	7	Stop	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.



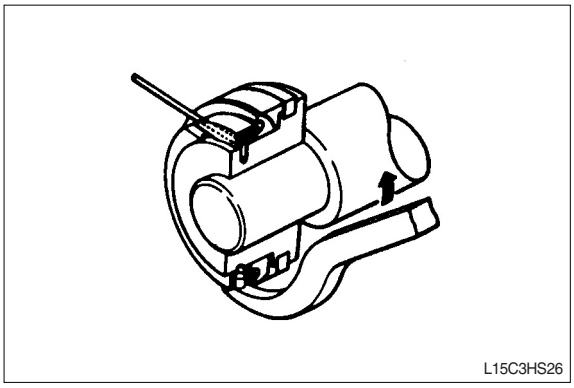
3) CHECK AND INSPECTION

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

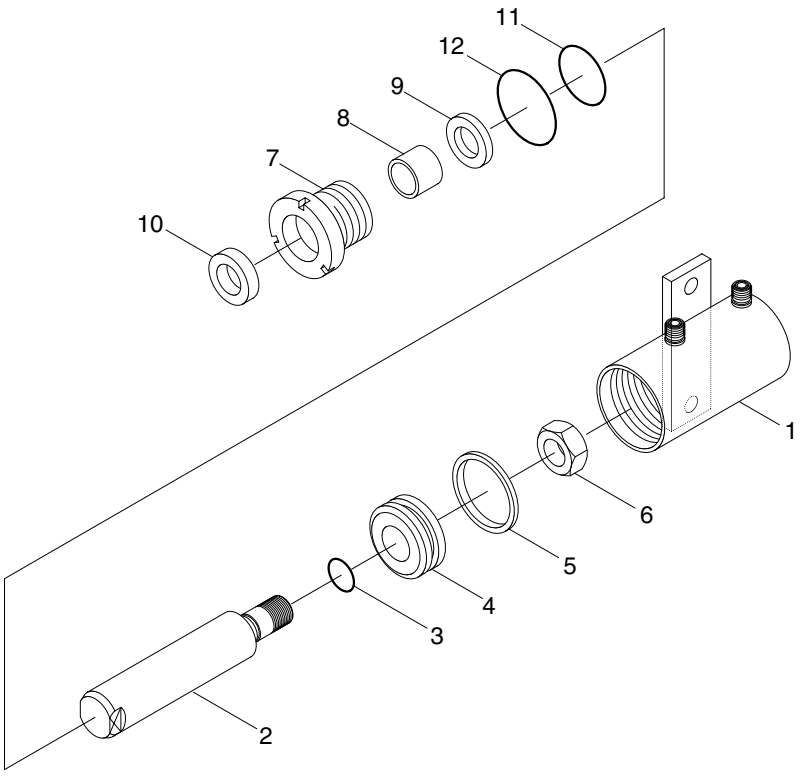
4) ASSEMBLY

(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

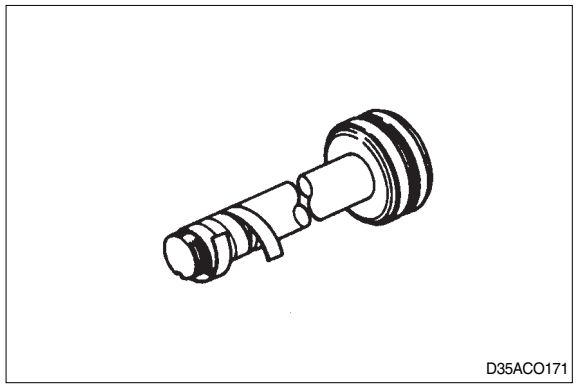


BR147HS15

1	Tube assy	5	Piston seal	9	Rod seal
2	Rod	6	Nut	10	Dust wiper
3	O-ring	7	Gland	11	O-ring
4	Piston	8	DU bushing	12	O-ring

2) DISASSEMBLY

(1) Hold the parallel parts of the cylinder tube bottom in a vice and mark the rod head end to show how much it is screwed in, then remove the rod head. Next, hook a wrench into the notch at the cylinder head and remove the cylinder head from cylinder tube.
When doing this, wind tape round the threaded part of the rod and be careful not to damage the dust seal and rod seal inside cylinder head.



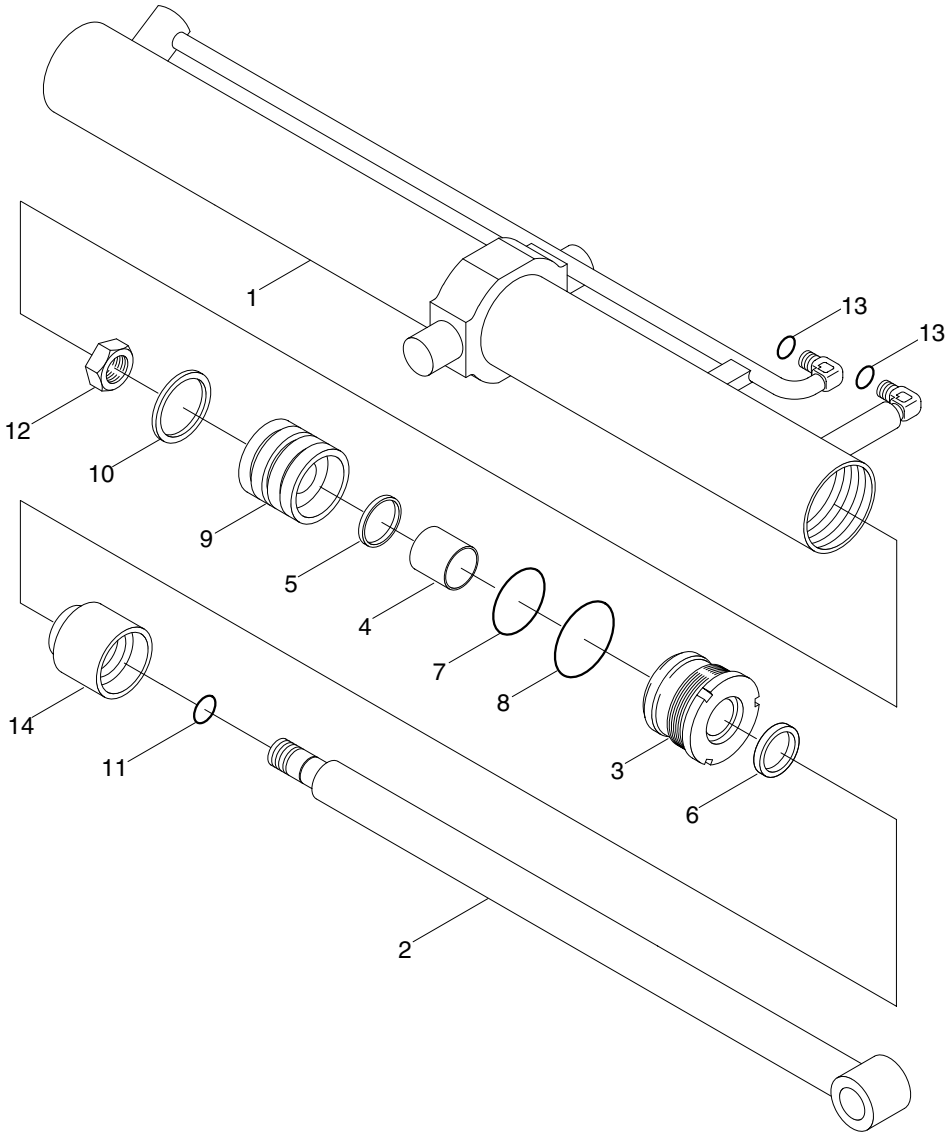
3) CHECK AND INSPECTION

mm(in)

Check item	Standard size	Repair limit	Remedy
Clearance between cylinder rod & bushing	0.072~0.288 (0.003~0.011)	0.5 (0.020)	Replace bushing
Clearance between rod head bushing & pin	0.10~0.35 (0.004~0.014)	0.6 (0.024)	Replace bushing

5. REACH CYLINDER

1) STRUCTURE

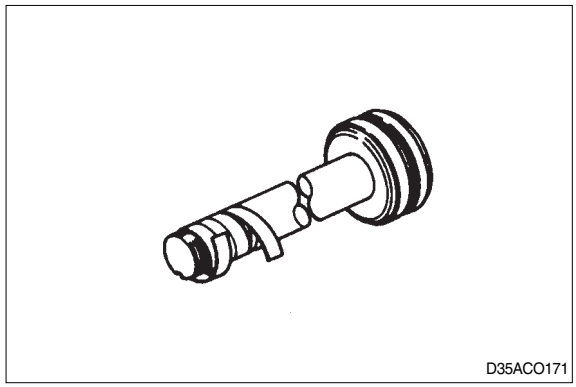


BR147HS21

1	Tube assy	6	Dust wiper	11	O-ring
2	Rod assy	7	O-ring	12	Nylon nut
3	Gland	8	O-ring	13	O-ring
4	DU bushing	9	Piston	14	Spacer
5	Rod seal	10	Piston seal		

2) DISASSEMBLY

(1) Hold the parallel parts of the cylinder tube bottom in a vice and mark the rod head end to show how much it is screwed in, then remove the rod head. Next, hook a wrench into the notch at the cylinder head and remove the cylinder head from cylinder tube.
When doing this, wind tape round the threaded part of the rod and be careful not to damage the dust seal and rod seal inside cylinder head.



3) CHECK AND INSPECTION

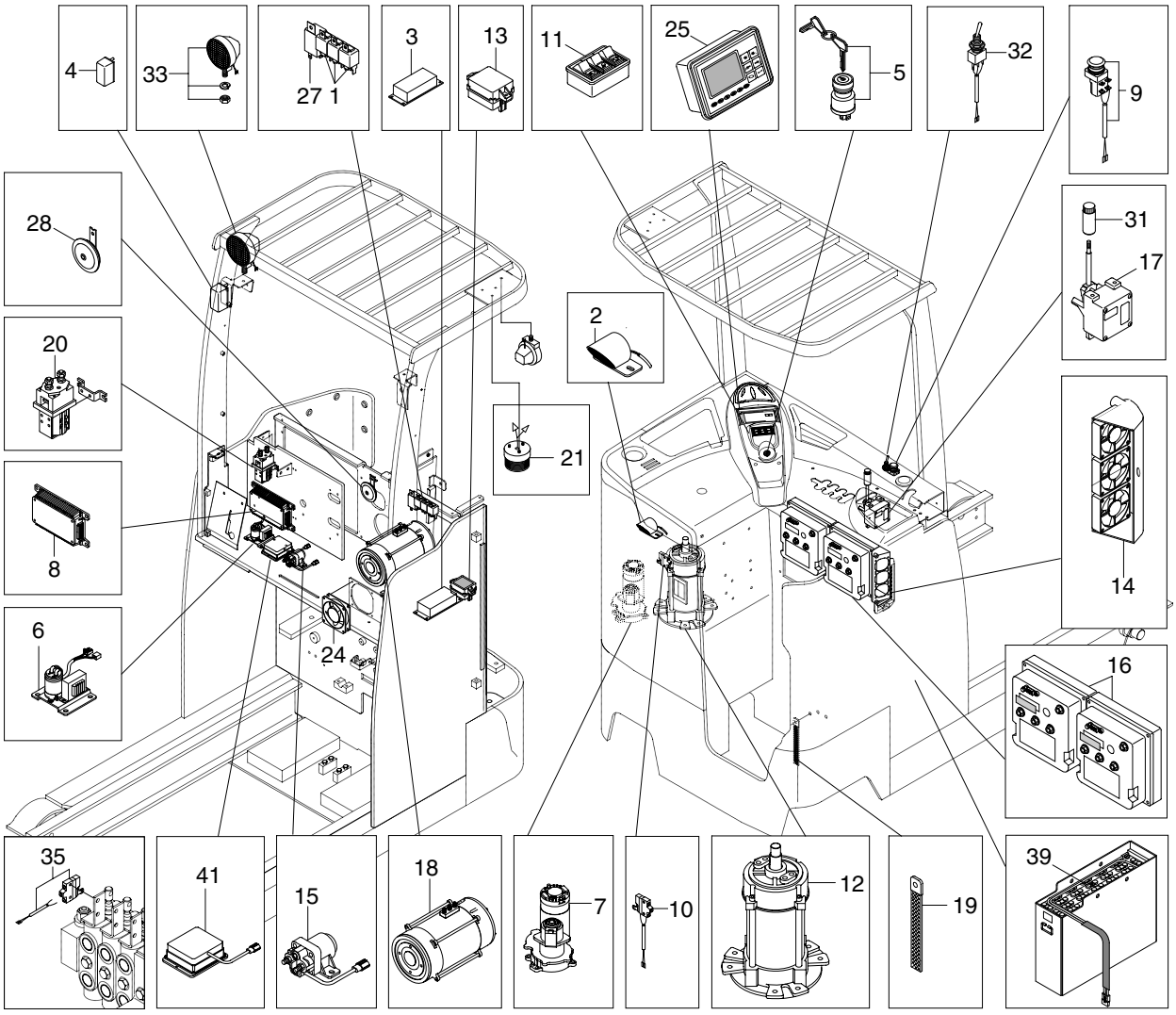
mm(in)

Check item	Standard size	Repair limit	Remedy
Clearance between cylinder rod & bushing	0.072~0.288 (0.003~0.011)	0.5 (0.020)	Replace bushing
Clearance between rod head bushing & pin	0.10~0.35 (0.004~0.014)	0.6 (0.024)	Replace bushing

SECTION 7 ELECTRICAL SYSTEM

SECTION 7 ELECTRICAL SYSTEM

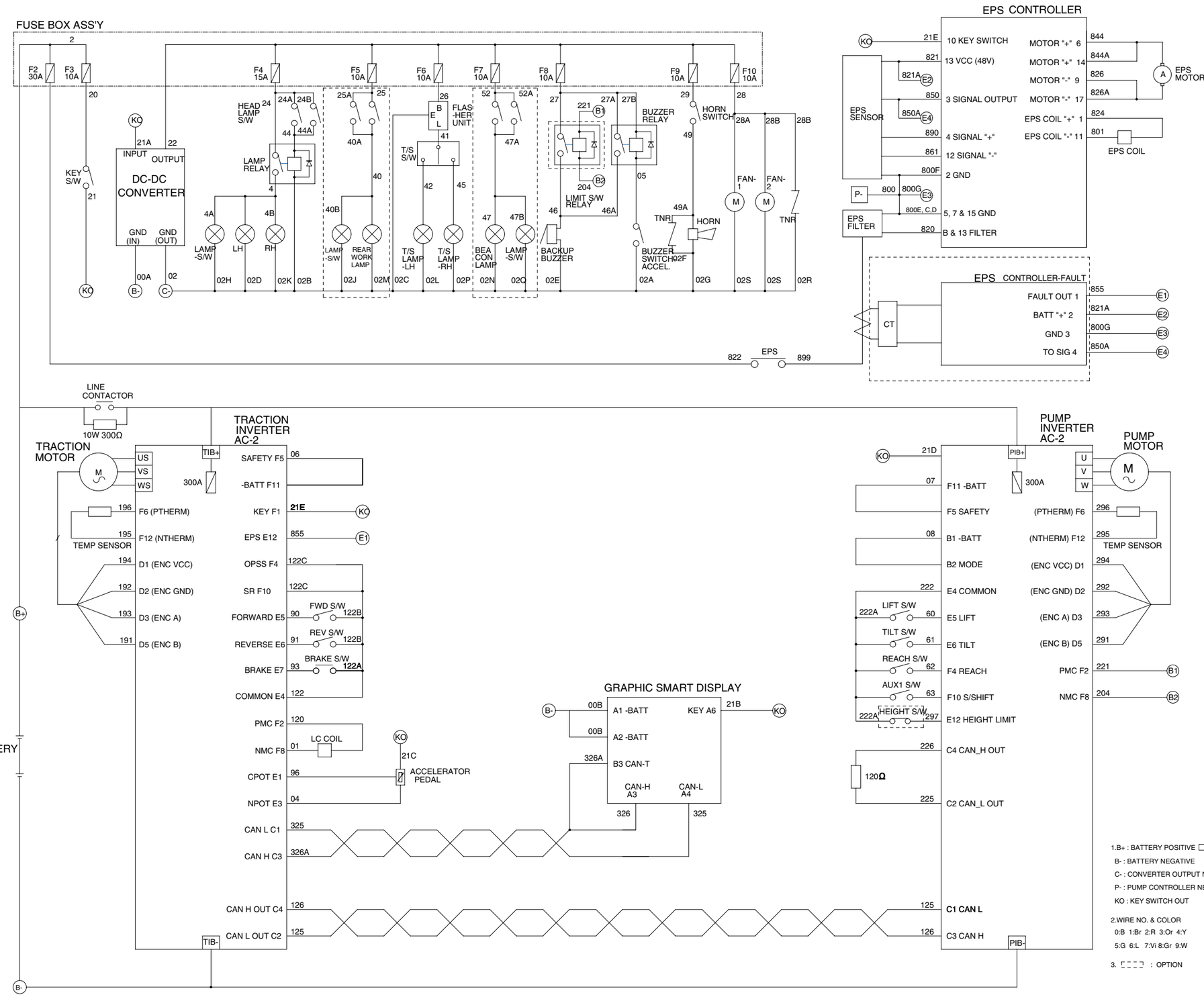
GROUP 1 COMPONENT LOCATION



BR7EL01

1 Relay
2 Back buzzer
3 DC-DC converter
4 Turn signal lamp
5 Key switch assy
6 EPS filter assy
7 EPS actuator
8 EPS controller
9 Horn switch
10 Micro switch
11 Switch assy
12 Traction motor
13 Fuse box assy
14 Fan assy
15 EPS contactor
16 AC2-Inverter
17 Accelerator assy
18 Pump motor
19 Static strap
20 Contactor
21 Beacon lamp
24 Fan
25 Display
27 Flasher unit assy
28 High horn
31 Knob
32 Toggle switch
33 Work-lamp sub assy
35 Switch assy
39 Battery
41 EPS controller-fault

GROUP 2 ELECTRICAL CIRCUIT



GROUP 3 ELECTRIC COMPONENTS

1. FUNCTIONS OF BATTERY FORKLIFT TRUCK AND ELECTRIC COMPONENTS.

The major functions of forklift truck can be divided into DRIVING FUNCTION and LOADING & UNLOADING FUNCTION.

All the components that work DRIVING and LOADING & UNLOADING functions are driven by AC MOTORS. And as the BATTERY works as power source of these motors, a charging device is needed.

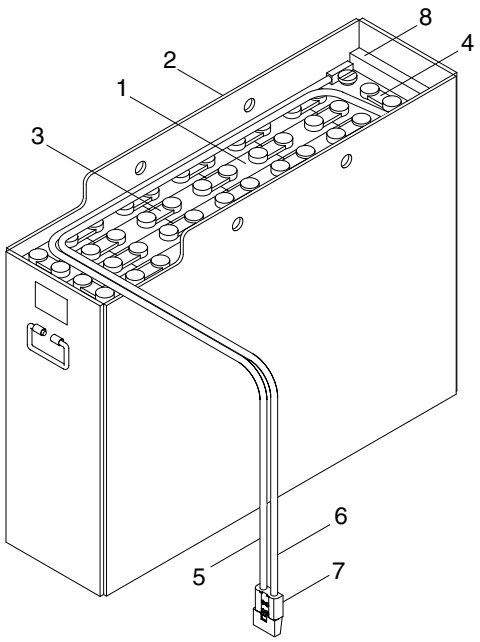
To drive the fork lift truck, a DRIVING CONTROL SYSTEM and some electric components such as direction change lever(forward/reverse section switch) and accelerator are required to select the driving direction and to control the speed of driving motor.

The CONTROL SYSTEM includes some protective circuits that protect the equipment and components from malfunctioning.

A MONITORING SYSTEM is installed in the monitor panel, which monitors the equipment and working condition, and let the operator take proper action. For the monitoring system, there are many sensors such as current sensors, hydraulic pressure sensors, and temperature sensors. The HYUNDAI Battery forklift trucks are equipped with the most advanced DRIVING CONTROL SYSTEM currently available world-widely. The operator friendliness features enable him to set the truck conditions properly according to each working circumstance easily on his seat, and the SELF-DIAGNOSTIC function displays current status of truck in working.

2. BATTERY

1) STRUCTURE

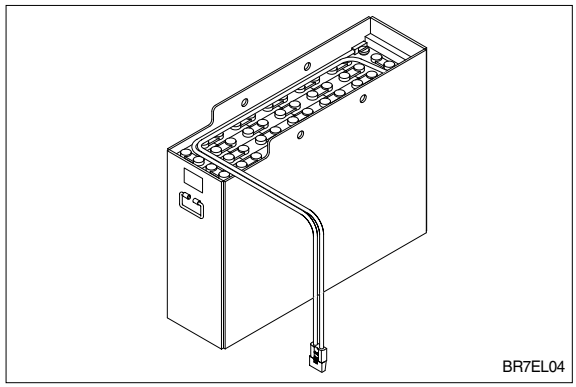


BR7EL03

1	Cells	5	Positive leading cable
2	Steel box	6	Negative leading cable
3	Cell connector	7	Plug
4	Row connector	8	Spacer

2) GENERAL

As in the battery forklift, the battery is an energy source, the handling of the battery is very important. The life and performance of the battery greatly depend on the ordinary handling and maintenance.
Therefore, be sure to check and maintain the battery so that it may be kept best.



3) SPECIFICATION AND SERVICE DATA

Item	Unit	10/13BR-7	14BR-7	15BR-7	18BR-7	20/25BR-7
Type	-	VCI 225	VCI 230	VCF 280	VCI 300	VCI 335
Rated voltage	V	48				
Capacity	AH/hr	225/5	230/5	280/5	300/5	335/5
Electrolyte	-	WET				
Dimension(W × D × H)	mm	994 × 270 × 581.7	994 × 378 × 581.7			
Connector(CE spec)	-	SB350(SBE320)				
Weight	kg	380	400	480	500	560

Fully charged specific gravity	1.280(25° C)
End of discharge specific gravity	1.130(25° C)
Discharge end voltage	48V
Electrolyte	Refined dilute sulfuric
Replenishment fluid	Refined water(pure water)
Insulation resistance	More than 1MΩ

4) SAFETY PRECAUTIONS

(1) When a sulfuric acid contact with skin

For acid contact with skin, eye or clothing, flush with water immediately. If swallowed, drink a large amount of water or milk. Seek medical attention immediately. When handling acid, always wear eye goggles or a face shield and rubber gloves.

(2) Strict prohibition of fire and ventilation

Since batteries generate explosive hydrogen gas, no fire should be drawn near. Before the battery charging, keep the battery cover open and check the ventilation status. Charging in an enclosed space can cause a explosion.

(3) Never place metallic articles on the batteries

If done so, it may cause “short circuit” accidents(dangerous especially while charging).
Sparks will be generated which is equally dangerous as open fires.

(4) Handling of charger

When connecting or disconnecting a battery from a charger or attempting maintenance, make sure switches are all off. Ensure that the charger and the battery are matched. If a 300Ah battery is used with a charger designed to charge a 500Ah battery, it will severely overcharge the battery.

5) OPERATION PRECAUTIONS

(1) Avoid over-discharge

If over-discharged, it will be difficult to restore the batteries to the original state by recharge. In order to maintain the batteries in use for long period of time, it is recommended to use the batteries with discharge amount not exceeding 80% of the rated capacity. Further care should be taken for preventing the unit cell voltage from falling below 1.5V.

(2) Avoid over-charge

If overcharged, the rise in battery temperature will become excessive, resulting in deterioration of plates and other parts and markedly shortening of battery life.

(3) Avoid excessive elevation of temperature

Be sure to open the cover of battery housing tray before charging. If there is a possibility of temperature to exceed 55°C, discontinue the charge operation temporarily, or reduce the charge current.

6) INSTRUCTION

(1) Unpacking

Electric traction storage batteries(herein after refer to as “batteries”) are delivered to customers in dry-charged condition. At unpacking, check whether the batteries and accessories have been damaged. If there are observed defects, you should notify the condition to our branch office or agent. Never remove the sealing plug until the battery is put into service.

(2) Performance and maintenance of batteries

① Initial charge

Wet-charged battery gradually decrease its capacity during storage. In order to provide sufficient discharge capacity in the first discharge, the good initial charge is required. The conditions of initial charging are seen as below at room temperature.

a. By modified constant voltage charger

Connect the battery to the charger and turn on the equalizing charge "ON". The battery will be fully charged and terminated automatically.

b. By constant voltage constant current charger

Connect the battery to the charger and turn on the equalizing charge "ON". The battery will be fully charged and terminated automatically.

c. By constant current charger

Connect the charger to the battery and charge the battery by 0.1C×5 hour rate nominal capacity current for 24 hours or more. The charge shall be terminated when one of the following condition is identified.

- When a constant value is indicated for more than 1 hour after the battery voltage has reached the maximum value.
- When more than 1 hour of charge is continued after the electrolyte specific gravity has risen fully and becomes constant.

② Discharge and capacity

The capacity of batteries is indicated at 5 hour rate capacity which means the battery can be discharged for 5 hours with the discharge current calculated by dividing the capacity value by 5 until the unit cell mean voltage reaches down to 1.7V at the electrolyte temperature of 30° C.

That is, the capacity is indicated by AH(ampere hour) being calculated as the product of ampere(A) and time(H). However, even in the same type of batteries, the capacity varies with the discharge conditions(discharge current, battery temperature and specific gravity of electrolyte) Even if the batteries discharged its full capacity, if immediately charged to full, there will be no harmful effects remained. Ideal charging amount(AH) is 110-125% of the amount of previous discharge.

③ Specific gravity of electrolyte

Specific gravity of electrolyte drops at discharge and rises at charge. When the batteries are fully charged, it becomes almost constant and shows no further rise. The specific gravity value varies with the change in temperature. Therefore specific gravity measurement should be made with temperature of electrolyte at the same so the measured specific gravity value could be corrected to that at the standard temperature of 25℃ by the following formula.

$$S_{25} = S_t + 0.0007(t-25)$$

Where, S_{25} : Specific gravity at 25℃
S_t : Actually measured specific gravity at t ℃
t : Electrolyte temperature (℃)

The standard specific gravity for this type of battery is 1.280±0.01(25℃) at full charge condition.
If the electrolyte is decreased naturally while using, distilled water shall be replenished up to the specified level. (Never refill sulfuric acid)
Only when large quantity of electrolyte is lost due to spillage, etc., dilute sulfuric acid specified in gravity shall be added.

④ **Normal charge**

Charge the discharged batteries as quickly as possible. The temperature of electrolyte before starting the charging operation shall preferably be below 45℃, and the temperature during the charge should be maintained at no higher than 55℃. (Under any unavoidable situations, it should never be above 55℃). Methods of charging varies in precise meaning with the types of chargers used. A standard charging method is described hereunder. (If a special method is mentioned to be adopted, follow that instruction).

a. Charging by modified constant voltage automatic charger

There is almost automatic charger today which complete the charging just only connecting the plug between battery and charger without outer operating timer but if your charger has it, after setting the timer for 3-4 hours and turn on the charger and the charger is left as it is, then the charge will be made automatically. In principle, regardless of the amount of previous discharge, it is not required to alter the setting of timer time. The recommendable current value of this type of charger is "5 hour rate current ×1.0~1.5" at the start of charging, and at the final stage it is "5 hour rate current ×0.15~0.25". Normally the charge is terminated within 8~12 hours automatically.

b. Charging by constant current constant voltage automatic charger

After a lapse of specified charging time after the switch is turned on, the charge will be completed by turning off the switch. The charging time can be calculated by the following formula.

$$\text{Charging time} = \frac{\text{Amount of previous discharge(AH)}}{\text{Capacity of charger(A)}} + 2\sim3\text{(H)}$$

When the amount of previous discharge is not known, use the 5 hour rate rated capacity of the batteries. At immediately after charging, the charge current is allowed up to 3 times 5 hour rate current. For charger provided with a timer, the charge will terminate automatically if the timer is set at the specified time according to the operation manual.

⑤ **Equalizing charge**

When large number of cells are used in a set of battery, the voltage and specific gravity of respective cells tend to become unequal, resulting in necessity of charging all the cells at an appropriate time in order to equalize them. This is called equalizing charge. Normally the equalizing charge should be carried out once every month. The methods are in normal type charger, extend the charge for 5 more hours after full charge at the final stage current, and in automatic charger which are in most cases provided with timer, extend the time setting for 3-6 more hours.

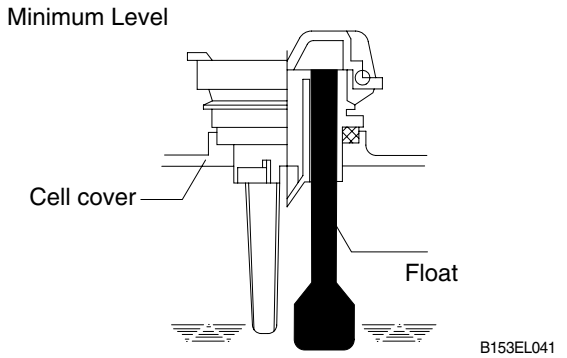
⑥ **Water replenishment**

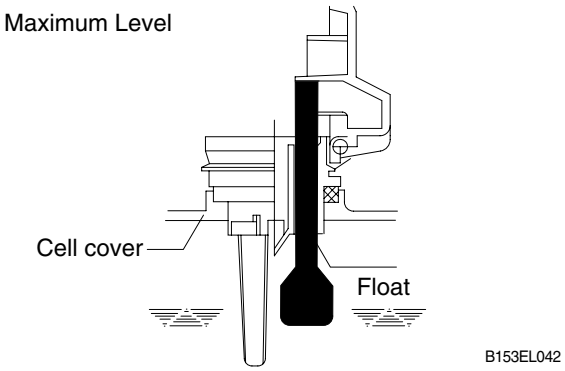
Only the water content of electrolyte is decreased due to electrolysis of water during charge and natural evaporation. If a battery used with the electrolyte decreased excessively, plates will deteriorate resulting in markedly shortening of battery life. Be sure to check the electrolyte level once every week. If the electrolyte level is lowered, replenish distilled water up to the specified level. In this case, never attempt to replenish sulfuric acid or tap water. Use only distilled water for battery replenishment. If the amount of water required for weekly addition to a unit cell for 100AH of battery capacity is in excess of 45cc, it is assumed that the cell is receiving overcharge. Accordingly, be sure to reduce slightly the daily charge amount. Under the normal conditions, the addition of water per week is 45cc or less. Incidentally, water replenishment should be made before charging to the contend of minimum level.

(for the purpose of uniform stirring of electrolyte by charging). If the electrolyte level is improper after completion of charging, you may topping up the electrolyte level to the maximum level .

a. Determination of replenishment time and methods(cell with ONE TOUCH CAP)

Confirm the electrolyte level by looking at the float in the ONE TOUCH CAP. If too low as shown in figure, replenish water. Replenishment shall be performed after opening the cover of the plug using syringe and jug. When refilling is completed, close each cover completely until “click” sound is heard.





⑦ Cleaning

If electrolyte spills or the cells are polluted with dust or stains, it will cause generation of leak current. Wipe off dust and stains with moist cloth and clean in such a manner that the cells are kept in dry condition. In the case of plastic containers or covers, never use such organic solvents as paint thinner and gasoline. If used, the plastic containers or covers may suffer cracking. If you are forced to use them, be sure to use white kerosene.

⑧ Notice on charging

The charging area must be well ventilated to facilitate exhaust of gas generated from the battery during charging. Charge the battery in an area free from iron working, welding, etc. Further the battery generates hydrogen, oxygen, acid mist and on rare occasions, hydrogen sulfide during charging depending on the case. Special care may be required in the case of equipment and objects near the battery that may contaminated or damaged. Do not pull out the charging plug during charging, as it will cause sparks. Since hydrogen gas generated during charging may remain in the area surrounding the battery after charging, never bring fire or flame close to this area. In case of counter-balance type vehicles, open the battery cover before charging.

⑨ Repair of failure cell

a. To remove a cell from the circuit or battery from steel tray, it is first necessary that the intercell connector be removed.
b. Before performing any repairs, you must open one-touch caps for gas purging of all cells. After you have finished that, must remove connector covers and on-touch caps from failure cell including surrounding cells. All vent holes of cells removed of one-touch caps must cover by four layers of water dampened cloth and then proceed with repairs. Using an acid syringe withdraw sufficient electrolyte from failure cell to reduce the liquid levels until minimum level indicating of one touch caps.
c. The safe and most efficient method of removing a connector is with hand or electric drill(ø 25㎜) from failure cell as well as all surrounding cells.

⚠ You must make sure to clear of explosive hydrogen gas in the cells before repairs. Be careful not to drill to far into the cell and damage the unit. During drilling operation make sure lead curls produced do not contact opposite cell poles and cause a spark.

d. Upon completion of drilling the intercell connectors, can be lifted off.
e. Lifted off the failure cell from circuit after removing of intercell connector.
f. Installing new cell and connector.
g. With surfaces properly cleaned and neutralized, position the connectors.
h. Place damp rags around each lead head. Hold tip of the welder in center of post move welder completely around top of post and out to the area where the post meets the connector. Move welder back to center of post and add molten lead until area is filled to top of connector. Again, move welder completely around area, with tip on molten lead. If you have jig for welding connector, have easier and better welding work.
i. When replacing electrolyte in a repaired cell, use sulphuric acid of the same specific gravity that is found in the balance of the battery.
j. Finally, rejoin connector covers and one-touch caps to the cells.

⑩ **Summary of daily maintenance**

a. Avoid overcharge. After discharge, charge the batteries immediately. The standard frequency of equalizing charge is more than once every month.
b. Check the electrolyte level once a week. If found decreased, replenish distilled water up to the specified level.
c. The top surface of battery cells should be kept clean and dry.
d. Be sure to keep open the cover of battery housing tray during charge.
e. Never draw near open fires such as lighted cigarettes or burning matches during charge.

(3) Others

① **Storage of batteries**

When batteries are stored, keep them distant from room heaters or other heat generating sources. Clean, cool and dry place where no direct sunlight is directed is suited for battery storage. Before putting into storage, it is important to charge the batteries and keep the electrolyte level at the specified level. When the temperature in storage location is higher than 20°C, check the specific gravity once a month, and when lower than 20°C, check it once every two months. If the measurements show values lower than 1.230(20°C), it is required to charge the battery in accordance with the method described in NORMAL CHARGE.

② **Maintenance record**

It is recommended to keep maintenance record in order to know the operational conditions of batteries. Daily charge and discharge, equalizing charge requirements, and water replenishment requirements can be clarified at a glance. Measurements of specific gravity and temperatures once every two to four months after equalizing charge and maintenance thereof will serve for battery health diagnosis.

③ **Electrolyte temperature**

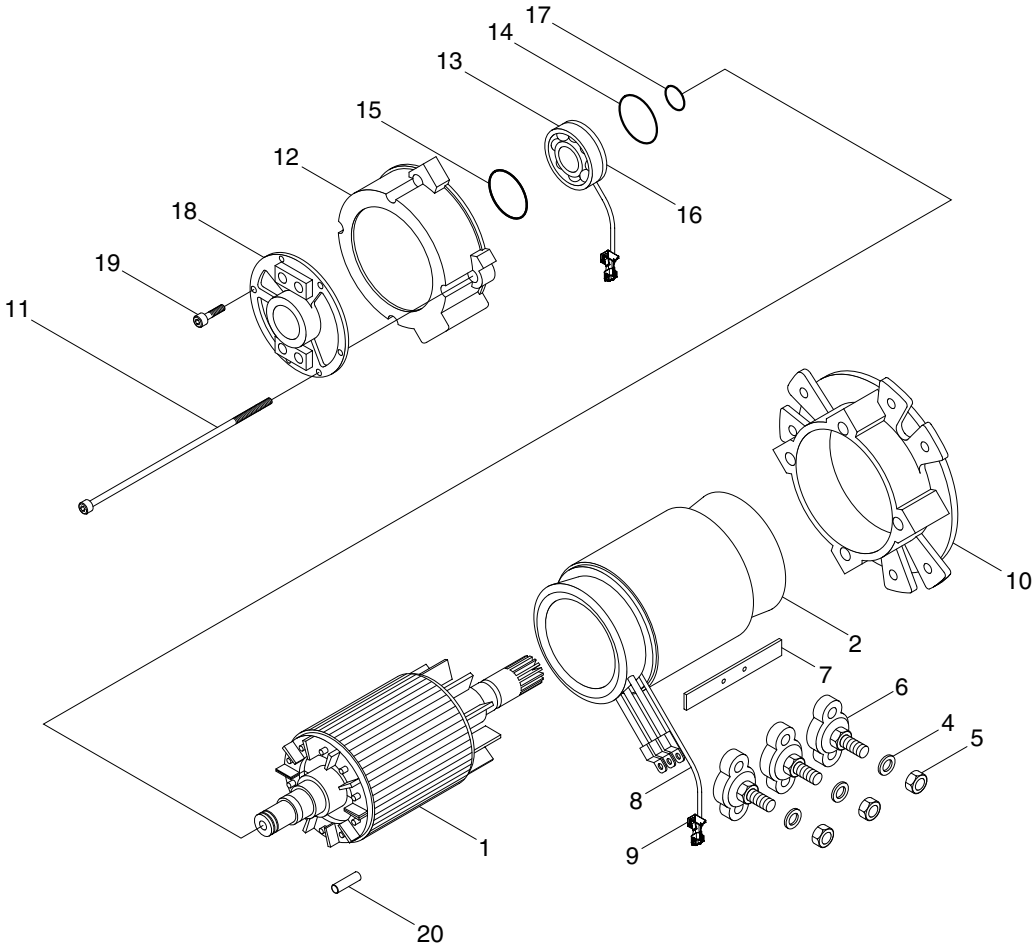
The operating temperature range of batteries is -10~45°C(temperature of electrolyte). If the batteries are exposed to cold atmosphere in discharged condition, the electrolyte may freeze, and in extreme cases, the capacity will be decreased, but, if not frozen, no adverse effects will be exerted over the life. Contrarily if the temperature is high, especially if used at above 55°C, the battery life will be considerably shortened. Care must be taken so that the temperature during charge will be maintained at 55°C or lower. Even under unavoidable circumstances it should not exceed 55°C.

7) TROUBLESHOOTING

Nature of trouble	Symptoms	Causes	Repair
Deformation	· Deformation of container, lid or one touch cap	· Excessive temperature rising or external impact	· Replace
Breakage	· Electrolyte leakage according to breakage of container, lid or one touch cap	· External impact, improper handling, excessive vibration	· Replace or install a new one
	· Termination of connector or pole post etc.	· Excessive temperature rising or vibration/external impact	· Replace
Sulfate	· Specific gravity drops and capacity is decreased.	· When left in state of discharge or left long without equalizing charge.	· Need equalizing charge
	· Charge voltage rises rapidly with immature gassing in earlier stage but specific gravity does not rise and charge can't be carried out.	· Insufficient charge.	· Need equalizing charge
		· When electrolyte is so decreased that plate is deposed.	· Need equalizing charge
		· When concentration of electrolyte rises.	· Adjust specific gravity
		· When impurities are mixed in electrolyte.	· Replace electrolyte
Decrease and falling of specific gravity	· May be easily detected by measurement of the specific gravity.	· Rise of temperature due to such trouble.	· Replace
		· When left long period without refilling of water.	· Refill water in regular period
		· Short circuit.	· Replace
Rise of specific gravity	· May be easily detected by measurement of the specific gravity.	· Diluted sulfuric acid is used in refilling.	· Adjust specific gravity after full charge.
		· When the electrolyte level excessively drops.	· Refill distilled water.
Mixing of impurities	· Decrease of capacity.	· Metals such as iron, copper, nickel and manganese.	· Under a fully discharged condition, pour out the electrolyte. Then pour in an acid of the specific gravity higher by 0.03~0.05 than that of the drained acid. Charge fully and adjust the specific gravity to the specified value.
	· Drop of charge and discharge voltage.	· Impurities such as sea water, caloric acid, nitric acid etc.	
	· Odor of generated gas and coloring of the electrolyte.	· Filling of impure water.	

3. DRIVE MOTOR

1) STRUCTURE



BR7EL06A

1	Rotor	9	Tab housing	16	Distance ring
2	Stator	10	Bearing ring	17	Locking ring
4	Disk	11	Screw	18	Flange
5	Hexagon nut	12	End shield	19	Screw
6	Terminal board	13	Sensor bearing	20	Woodruff key
7	Terminal board bottom	14	Locking ring		
8	Thermal sensor	15	O-ring		

2) SPECIFICATION

Item	Unit	10/13BR-7	14/15/18/20/25BR-7
Type	-	TSA200-100-063	TSA200-160-104
Rated voltage	Vac	32	30
Rated output	kW	4.4	6.8
Insulation	-	Class F	Class F

3) MAINTENANCE INSTRUCTION

※ Before starting the maintenance please disconnect the power supply.

(1) Ball bearing

Both ball bearing are maintenance free. Should it be necessary to remove the bearings in case of repair, they should be replaced. In any case the sealing parts (shaft sealing ring etc.) have to be replaced.

If a bearing which is to be replaced has only one sealing lip, this should be greased with quality bearing grease.

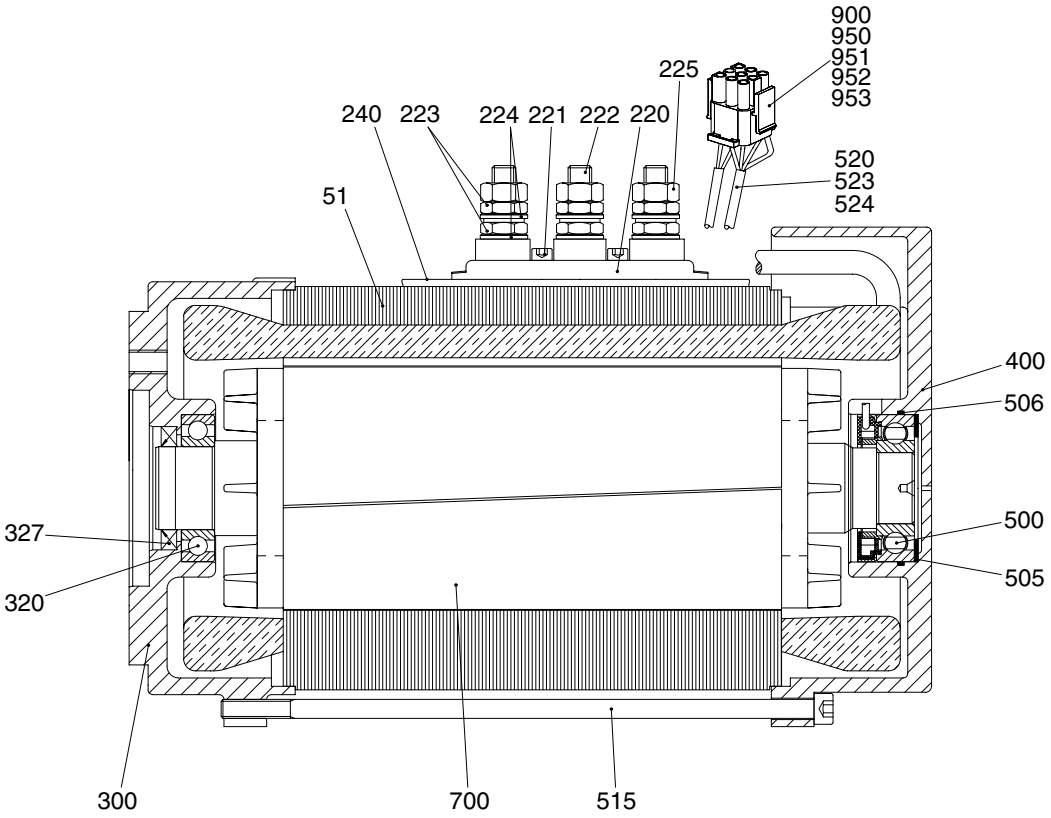
After approximately 10,000 operating hours the bearings have to be replaced.

(2) Disassembly and assembly

The motor is assembled and disassembled according to the relevant sectional drawing and part list. (See page 7-12)

4. PUMP MOTOR

1) STRUCTURE



20B7EL16

51	Stator	320	Ball bearing	524	Amp pin
220	Terminal	327	Shaft seal	700	Rotor
221	Cylinder screw	400	Commutator end plate	900	Plug
222	Hexagon screw	500	Sensor bearing	950	Amp pin
223	Hexagon nut	505	Wavy washer	951	Keying plug
224	Disk	506	O-ring	952	Wire seal
225	Hexagon nut	515	Cylinder bolt	953	Interface seal
240	Terminal base	520	Temp sensor		
300	Drive end cover	523	Tube		

2) SPECIFICATION

Item	Unit	Specification
Type	-	TSA170-210-009
Rated voltage	Vac	30
Rated output	kW	15.8
Insulation	-	Class F

3) INTERNAL INVOLUTE SPLINE DATA

Item	Unit	Specification
Flat root side fit	-	Class 7
No of teeth	EA	9
Spline pitch	mm	16/32
Pressure angle	Degree	30
Major diameter	mm	16.535
Form diameter	mm	15.977
Minor diameter	mm	12.9286
Pin diameter	mm	2.743
Measurement over 2 pins	mm	10.251/-0.1

4) MAINTENANCE INSTRUCTION

※ Before starting the maintenance please disconnect the power supply.

(1) Ball bearing

Both ball bearing are maintenance free. Should it be necessary to remove the bearings in case of repair, they should be replaced. In any case the sealing parts (shaft sealing ring etc.) have to be replaced.

If a bearing which is to be replaced has only one sealing lip, this should be greased with quality bearing grease.

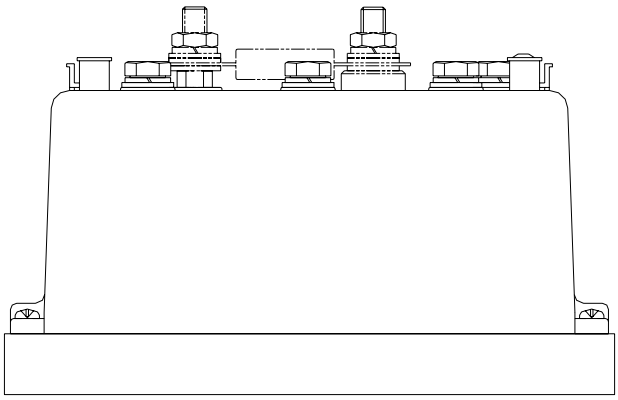
After approximately 10,000 operating hours the bearings have to be replaced.

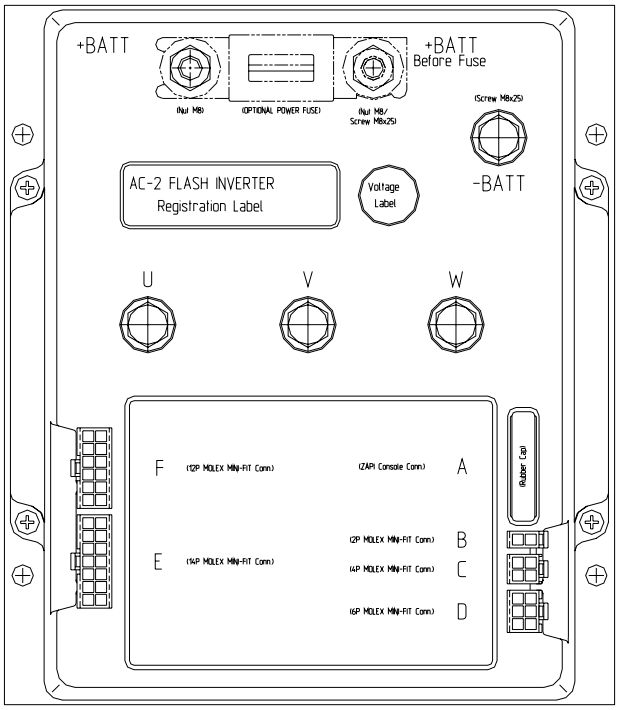
(2) Disassembly and assembly

The motor is assembled and disassembled according to the relevant sectional drawing and part list. (See page 7-14)

5. CONTROLLER SYSTEM

1) STRUCTURE





BRJ7EL11

(1) Specifications

Model	Model	Application	Type	Power	Current limit
10/13/14/15/18/20/25BR-7	AC2	Traction	AC	36-48V, 450A	450A/3min
	AC2	Pump	AC	36-48V, 450A	450A/3min

2) OPERATIONAL FEATURES

(1) Features

① Speed control.
② Optimum behavior an a slope due to the speed feedback:
- The motors speed follows the accelerator, starting a regenerative braking if the speed overtakes the speed set-point.
- The system can perform an electrical stop on a ramp (the machine is electrically hold on a slope) for a programmable time.

③ Electronic differential feature with torque balance between external and internal wheel.
④ Regenerative release braking based upon deceleration ramps.
⑤ Regenerative braking when the accelerator pedal is partially released (deceleration).
⑥ Direction inversion with regenerative braking based upon deceleration ramp.
⑦ Regenerative braking and direction inversion without contactors: only the main contactor is present.
⑧ Optimum sensitivity at low speeds.
⑨ Voltage boost at the start and with overload to obtain more torque (with current control).
⑩ Hydraulic steering function:
- The traction inverter sends a "hydraulic steering function" request to the pump inverter on the can-bus line.

⑪ Backing forward and reverse options are available, with the tune and the speed of the function programmable with a console or buttons on a display.
⑫ High efficiency of motor and battery due to high frequency commutations.
⑬ Modification of parameters through the programming console or buttons on a display.
⑭ Internal hour-meter with values that can be displayed on the console.
⑮ Memory of the last five alarms with relative hour-meter and temperature displayed on the console.
⑯ Diagnostic function with a console for checking main parameters.
⑰ Built in BDI feature.
⑱ Flash memory, software downloadable via serial link and via CANBUS.

(2) Diagnosis

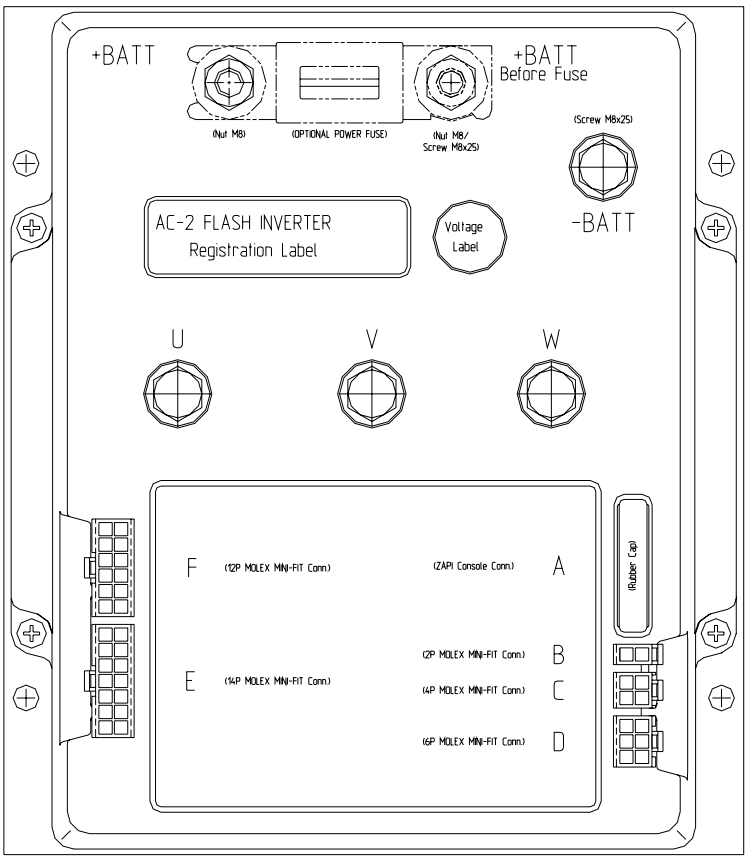
The microcontrollers continually monitor the inverter and carry out a diagnostic procedure on the main functions. The diagnosis is made in 4 points.

① Diagnosis on key switch closing that checks: watchdog circuit, current sensor, capacitor charging, phase's voltages, contactor drivers, can-bus interface, if the switch sequence for operation is correct and if the output of accelerator unit is correct, correct synchronization of the two μCS, integrity of safety related inputs hardware.
② Standby diagnosis in standby that checks: Watchdog circuit, phase's voltages, contactor driver, current sensor, can-bus interface.
③ Diagnosis during operation that checks: Watchdog circuits, contactor driver, current sensors, can-bus interface.
④ Continuous diagnosis that checks: Temperature of the inverter, motor temperature.

Diagnosis is provided in two ways. The digital console can be used, which gives a detailed information about the failure; the failure code is also sent on the Can-Bus.

3) DESCRIPTION OF THE CONNECTORS

(1) Traction controller



BRJ7EL12

No. of Pin	Function	Description
A1	PCLRXD	Positive serial reception.
A2	NCLRXD	Negative serial reception.
A3	PCLTXD	Positive serial transmission.
A4	NCLTXD	Negative serial transmission.
A5	GND	Negative console power supply.
A6	+12	Positive console power supply.
A7	FLASH	It must be connected to A8 for the flash memory programming.
A8	FLASH	It must be connected to A7 for the flash memory programming.
C1	CAN_L	Low level CAN-BUS voltage I/O.
C2	CAN_L_OUT	Low level CAN-BUS voltage I/O.
C3	CAN_H	High level CAN-BUS voltage I/O.
C4	CAN_H_OUT	High level CAN-BUS voltage I/O.
D1÷D6		Incremental ENCODER connector.
E1	CPOT	Accelerator potentiometer wiper.
E3	NPOT	Negative of accelerator unit, tested for wire disconnection diagnosis.
E4	COMMON	Common of pedal/FWD/REV/ENABLE/PB microswitches.
E5	FORW	Forward direction request input. It must be connected to the forward direction microswitch, active high.

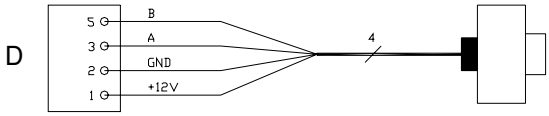
No. of Pin	Function	Description
E6	REVERSE	Reverse direction request input. It must be connected to the reverse direction microswitch, active high.
E7	PB	Brake request input. It must be connected to the brake pedal switch, active high.
E12	EPS FAULT	If eps system has problems, EPS fault signal is on. It is active low.
F1	KEY	Connected to the power supply through a microswitch (CH) with a 10A fuse in series.
F2	PMC	Positive of main contactor coil.
F4	PEDAL S/W	PEDAL S/W ; It must be connected to the PEDAL microswitch ; It is active high.
F5	SAFETY	If not connected to -Batt the MC coil power output will be disabled. It can also be used as a general purpose input.
F6	PTHERM	Input for motor temperature sensor.
F8	NMC	Negative of main contactor coil.
F10	SR/HB	Speed reduction (hand brake) input. Active low (switch opened). See also option chapter.
F11	GND	-Batt.
F12	NTHERM	-Batt.

Encoder installation

① Traction controller card is fit for different types of encoder. To control AC motor with a inverter, it is necessary to install an incremental encoder with 2 phases shifted of 90°. The encoder power supply can be +12V. It can have different electronic output.

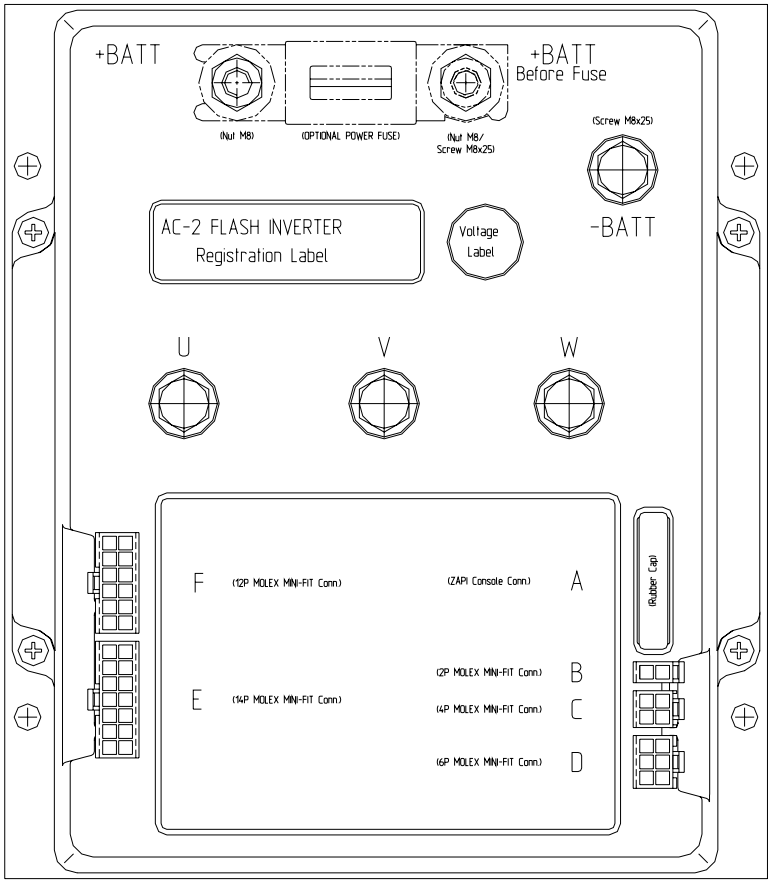
D1 : +12V - Positive of encoder power supply.
D2 : GND - Negative of encoder power supply.
D3 : A - Phase A of encoder.
D5 : B - Phase B of encoder.

② Connection of encoder with open collector output ; +12V power supply.



BRJ7EL26

(2) Pump controller



BRJ7EL12

No. of Pin	Function	Description
A1	PCLRXD	Positive serial reception.
A2	NCLRXD	Negative serial reception.
A3	PCLTXD	Positive serial transmission.
A4	NCLTXD	Negative serial transmission.
A5	GND	Negative console power supply.
A6	+12	Positive console power supply.
A7	FLASH	It must be connected to A8 for the flash memory programming.
A8	FLASH	It must be connected to A7 for the flash memory programming.
B1	-BATT	-Batt.
B2	MODE	This input allows the customer to select the software for traction or lifting application. Configuration : Mode : Open (not connected) : Traction inverter Mode : Close (connected with B1) : Pump inverter
C1	CAN_L	Low level CAN-BUS voltage I/O.
C2	CAN_L_OUT	Low level CAN-BUS voltage I/O.
C3	CAN_H	High level CAN-BUS voltage I/O.
C4	CAN_H_OUT	High level CAN-BUS voltage I/O.

No. of Pin	Function	Description
D1 ÷ D6		Incremental ENCODER connector.
E4	CM	Positive of the switches.
E5	LIFT	Lift switch input. Active high.
E6	TILT	Tilt switch input. Active high.
E12	HEIGHT LIMIT	Speed reduction input. Active low (switch opened).
F1	KEY	Connected to the power supply through a microswitch (CH) with a 10A fuse in series.
F2	PMC	Positive of limit switch relay.
F4	REACH	Reach switch input. Active high.
F5	SAFETY	If not connected to -Batt. the MC coil power output will be disabled. It can also be used as a general purpose input.
F6	PTHERM	Input for motor temperature sensor.
F8	NMC	Negative of limit switch relay.
F10	SIDE SHIFT	Side shift switch input. Active high.
F11	BATT.	-Batt.
F12	NTHERM	-Batt.

4) FUNCTION CONFIGURATION

■ TRACTION CONTROLLER

Using the CONFIG MENU of the programming console, the user can configure the following functions (see "OPERATIONAL FEATURE" chapter for an explanation of "hydraulic steering function") :

(1) Submenu "SET OPTIONS"

① **Hour counter**
- RUNNING : The counter registers travel time only.
- KEY ON : The counter registers when the "key" switch is closed.

② **Battery check**
- ON : The battery discharge level check is carried out; when the battery level reaches 10%, an alarm is signalled and the maximum current is reduced to the half of the programmed value.
- OFF : The battery discharge level check is carried out but no alarm is signalled.

③ **Cutback mode**
- PRESENT : Input F10 is managed as a cutback speed input.
- ABSENT : Input F10 is managed as a handbrake input.

④ **Traction cutout**

When the alarm "BATTERY LOW" appears, if this option is programmed to ON the traction maximum speed is reduced to 60Hz.

⑤ **Lift cutout**

When the alarm "BATTERY LOW" appears, if this option is programmed to ON the lift function is disabled.

⑥ **Stop on ramp**
- ON : The stop on ramp feature (truck electrically hold on a ramp) is managed for a fixed time (6 sec.).
- OFF: The stop on ramp feature is not performed.

⑦ **Pedal brake**
- ANALOG : The mechanical brake pedal has a switch and a potentiometer installed. When the accelerator is released and the pedal brake is pushed the inverter performs an electrical braking whose intensity is proportional to the brake pedal potentiometer. The minimum intensity is established by the "Release braking" parameter, when the brake pedal is slightly pressed (brake switch close but brake potentiometer at the minimum). The maximum intensity is established by the "Pedal braking" parameter when the brake pedal is fully pressed (brake potentiometer at the maximum). In the middle positions, the electrical braking intensity is a linear function between minimum and maximum intensity.
- DIGITAL : The truck does not have a potentiometer installed on the mechanical brake pedal, but only a microswitch; when the accelerator pedal is released and the brake pedal is pushed (brake switch closed), the inverter performs an electrical braking following "Pedal braking" parameter.

⑧ **Set temperature**
- DIGITAL : A digital (ON/OFF) motor thermal sensor is connected to C25 (C35) input.
- ANALOG : An analog motor thermal sensor is connected to C25 (C35) (the curve can be customized on a customer request).
- NONE : No motor thermal sensor switch is connected.

⑨ **EPS**

- ON : If this option is set to ON, electric power steering function is used.
- OFF : If this option is set to OFF, electric power steering function isn't used.

⑩ **Display**

If this option is set to on the communication with the graphic display is enabled.

⑪ **S.R.O.**

If this option is set to on the static return to off is requested for starting the truck.
The required sequence is :

- Seat-direction lever-accelerator pedal or :
- Seat-accelerator pedal-direction lever within the weq. delay time

If this option is set to off the required sequence to start the truck is :

- Direction lever-accelerator pedal or :
- Accelerator pedal-direct lever within the seq. delay time

⑫ **Pedal type**

- OPTION #1 : The pedal position is sent to the display for graphic indication.
- OPTION #2 : The speed set-point is sent to the display for graphic indication.

⑬ **Pedal brake stop**

If set to on the truck is stopped when the pedal brake is pressed.
If set to off the traction current is reduced to the half of the maximum current.

⑭ **Model selection**

There are 3 options, 13/18/20.
In case of BR truck, it has to be selected 13/18 or 20 (10/13BR-7→13, 14/15/18BR-7→18, 20/25BR-7→20).

⑮ **Lift limit**

If the mast is lifted preset height, traction speed reduction is working depends on the setting status of this function.

- ON : If set to on this function, traction speed control is performed.
- OFF : If set to off this function, traction speed control isn't performed.

(2) Submenu "ADJUSTMENTS"

① **Set pot brake min**

It records the minimum value of braking pedal potentiometer when the braking pedal switch is closed; the procedure is similar to the "Program Vacc" function (see page 7-54). This procedure must be carried out only if the "Pedal braking" option is programmed as "Analog".

② **Set pot brake max**

It records the maximum value of braking pedal potentiometer when the braking pedal is fully pressed; the procedure is similar to the "Program Vacc" function (see page 7-54). This procedure must be carried out only if the "Pedal braking" option is programmed as "Analog".

③ **Set battery type**

It selects the nominal battery voltage.

④ **Adjust battery**

Fine adjustment of the battery voltage measured by the controller.

⑤ **Throttle 0 zone**

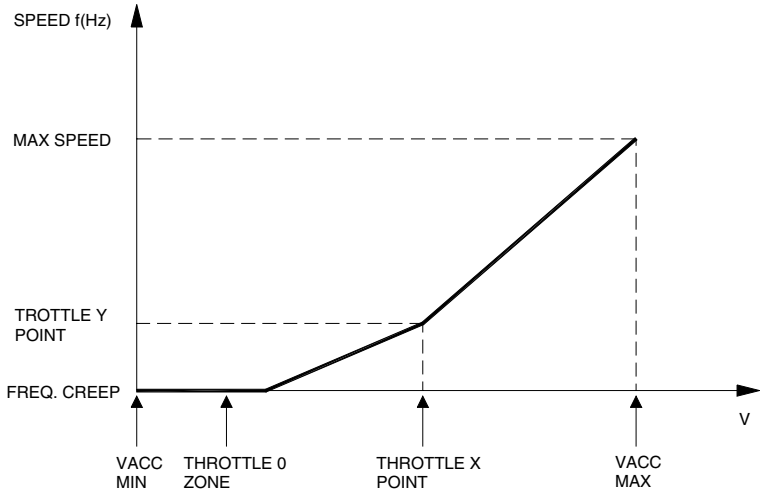
It establishes a deadband in the accelerator input curve (see also curve below).

⑥ **Throttle X point**

This parameter changes the characteristic of the accelerator input curve.

⑦ **Throttle Y point**

This parameter changes the characteristic of the accelerator input curve.



20B7EL17

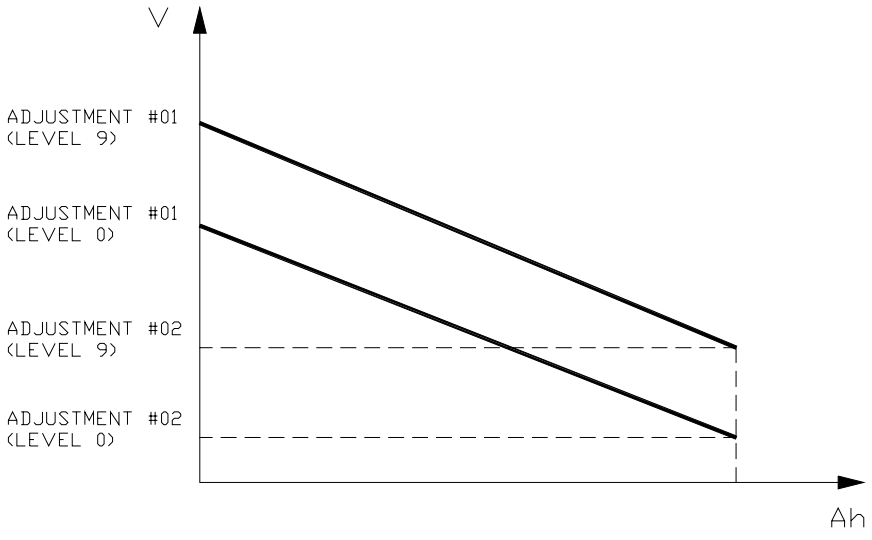
VACC MIN and VACC MAX are values programmable by the "Program Vacc" function.

⑧ **Adjustment #2 bdi**

It adjusts the lower level of the battery discharge table.

⑨ **Adjustment #1 bdi**

It adjusts the upper level of the battery discharge table.



BRJ7EL13

⑩ **Adjustment #03 :**

Set an increment of battery charge above actual value. If battery voltage exceed this total value the software recognize charging, and battery charge percentage increase to correct value also if battery isn't fully charged.

⑪ **PWM on main contactor**

- OFF : The inverter applies the battery voltage to the coil on F8 output.
- ON : The PWM reduces the voltage to the set value.

⑫ **PWM on aux output**

- OFF : The inverter applies the battery voltage to the coil on F9 output.
- ON : The PWM reduces the voltage to the set value.

⑬ **MC/AUX PWM** : It sets the PWM level in % on the outputs F8 and F9. Here is used to drive a main contactor.

⑭ **Adjustment #04** : This parameter determines the motor temperature level at which the "MOTOR TEMPERATURE" alarm is signalled. This parameter must be adjusted only if the "SET TEMPERATURE"(menu "SET OPTION") parameter is programmed "ANALOG"

⑮ **Speed factor**

It adjust the speed coefficient to have the correct speed indication on the display. This coefficient has to be regulated depending on truck mechanic characteristics. It results from the following formula :

Speed factor = 88*rr*p/ ø

Where : rr = total gearbox ratio

ø = traction wheel diameter(㎝)

P = number of pair poles of the motor

(3) Submenu "PARAMETER CHANGE"

① **Acceleration delay** : It determines the acceleration ramp.

② **Acceleration cutback** : It controls the acceleration ramps when lift limit is on.

③ **Release braking** : It controls the deceleration ramp when the travel request is released.

④ **Inverse braking** : It controls the deceleration ramp when the direction switch is inverted during travel.

⑤ **Pedal braking** : It determines the deceleration ramp when the travel request is released and the brake pedal switch is closed.

⑥ **Brake cutback** : It determines the deceleration ramp when the speed reduction input becomes active and the motor slow down.

⑦ **Max speed forward** : It determines the maximum speed in forward direction.

⑧ **Max speed backward** : It determines the maximum speed in backward direction.

⑨ **Turtle speed** : It determines the maximum speed at turtle mode.

⑩ **Frequency creep** : Minimum speed when the forward or reverse switch is closed, but the accelerator is on a minimum position.

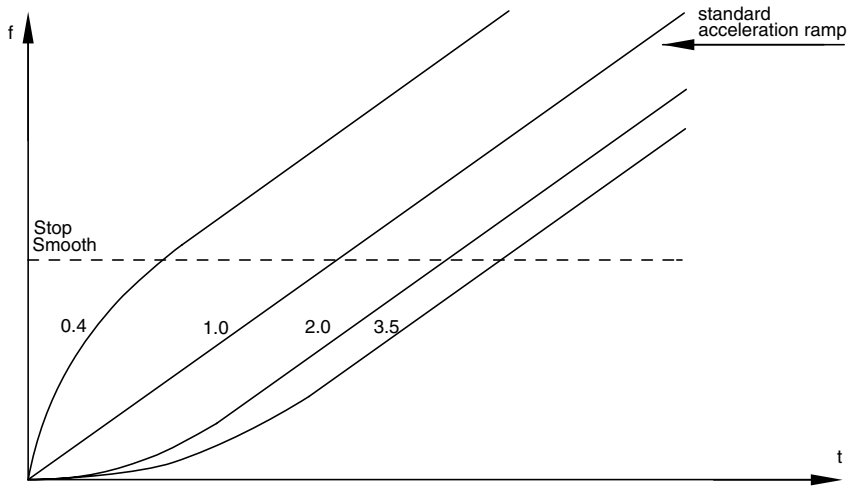
⑪ **Cutback speed 1** : Typically from 10% to 100%. It determines the percentage of the max speed applied when the cutback switch is active.
When set to 100% the speed reduction is ineffective.

⑫ **Maximum current** : This parameter changes the maximum current of the inverter.

⑬ **Acc. smooth** : It gives a different from to the acceleration curve in the frequency range 0 Hz to "Stop smooth" value (see the figure below).

⑭ **INV. smooth** : It gives a different from to the acceleration curve after a direction inversion in the frequency range 0 Hz to "Stop smooth" value (see the figure below).

⑮ **Stop smooth** : It sets the level of frequency where the smooth effect on the acceleration ramp ends.



BRJ7EL14A

■ PUMP CONTROLLER

Using the config menu of the programming console, the user can configure the following functions.

(1) Submenu "SET OPTIONS"

① **Hour counter**

- RUNNING : The counter registers travel time only.
- KEY ON : The counter registers when the "key" switch is closed.

② **Set temperature**

- DIGITAL : A digital (ON/OFF) motor thermal sensor is connected to A25 input.
- ANALOG : An analog motor thermal sensor is connected A25 (the curve can be customized on a customer request).
- NONE : No motor thermal sensor switch is connected.

③ **Electrical distribution**

In case of BRJ truck that has electro solenoid valves, It is set to On.
In case of BR truck that has manual valves, It is set to Off.

④ **Model selection**

There are 3 options , 13/18/20.
In case of BRJ truck, It has to be selected 13,18 or 20 (10/13BR-7→13, 14/15/18BR-7→18, 20/25BR-7→20).

⑤ **Digital lift**

- OFF : The lift sensor includes a lift switch and an analogue lift sensor. Lift speed can be controlled proportionally with lever position.
- ON : The lift sensor includes a lift switch only. Lift speed cannot be controlled proportionally.

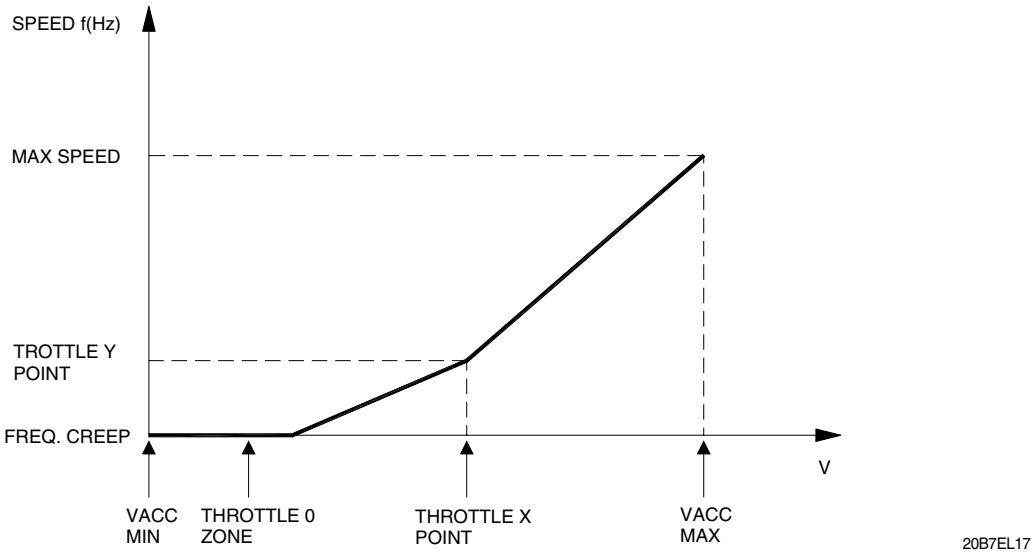
⑥ **Lifting Cutback**

If the mast is lifted preset height, Lift speed reduction is working
depends on the setting status of this function.

- ON : If set to on this function, Lift speed control is performed.
- OFF : If set to off this function, Lift speed control isn't performed.

(2) Submenu "ADJUSTMENTS"

① **Set battery type** : Selects the nominal battery voltage.
② **Adjust battery** : Fine adjustment of the battery voltage measured by the controller.
③ **Throttle 0 zone** : Establishes a deadband in the accelerator input curve (see also curve below).
④ **Throttle X zone** : This parameter changes the characteristic of the accelerator input curve.
⑤ **Throttle Y zone** : This parameter changes the characteristic of the accelerator input curve.



VACC MIN and VACC MAX are values programmable by the "PROGRAM VACC" function.

⑥ **Adjustment #04** : This parameter determines the motor temperature level at which the "MOTOR TEMPERATURE" alarm is signalled. This parameter must be adjusted only if the "SET TEMPERATURE" (menu "SET OPTION") parameter is programmed "ANALOG"

⑦ **PWM on main contactor**
-OFF: The inverter applies the battery voltage to the coil on F9 output.
-ON: The PWM reduces the voltage to the set value.

⑧ **PWM on aux output**
-OFF: The inverter applies the battery voltage to the coil on F8 output.
-ON: The PWM reduces the voltage to the set value.

⑨ **MC/AUX PWM**: It sets the PWM level in % on the outputs F8 and F9.

(3) Submenu "PARAMETER CHANGE"

① **Acceleration delay :** It determines the acceleration ramp.
② **Deceleration delay :** It determines the acceleration ramp.
③ **Max speed up :** It determines the maximum lifting speed with a potentiometer control.
④ **Min speed up :** It determines the minimum lifting speed with a potentiometer control when the lifting enable switch is closed.
⑤ **Cutback speed :** Speed reduction when the cutback switch is active.
⑥ **Reach speed :** It determines the reach speed.
⑦ **Shift speed :** It determines the side shift speed.
⑧ **Tilt speed :** It determines the tilt speed.
⑨ **Aux speed :** It determines the aux speed.
⑩ **Maximum current :** This parameter changes the maximum current of the inverter.
⑪ **Lifting speed 2 :** It determines the lift speed.
⑫ **ADJ curr buzzer :** It is the setting value to ring the back buzzer.

5) PROGRAMMING & ADJUSTMENTS

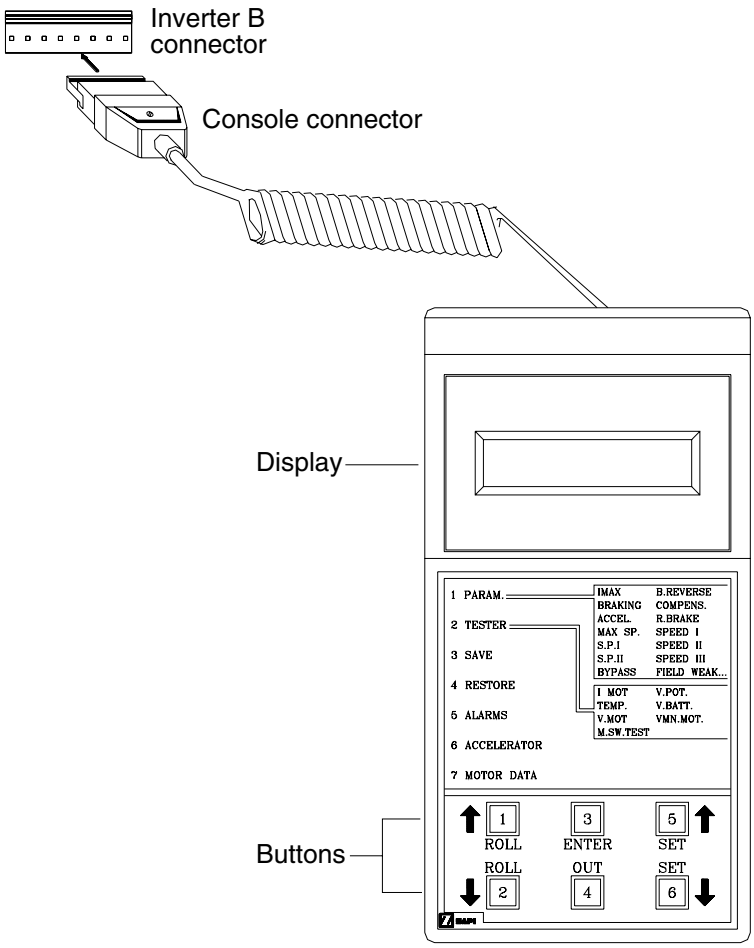
There are two ways to adjust parameter via a console or buttons on a display.

※ Adjustments via buttons on a display, please refer to the display section. (page 7-44)

ADJUSTMENTS VIA CONSOLE (Option)

Adjustment of parameters and changes to the inverter's configuration are made using the digital console. The console is connected to the "B" connector of the inverter.

(1) Descriptions of console

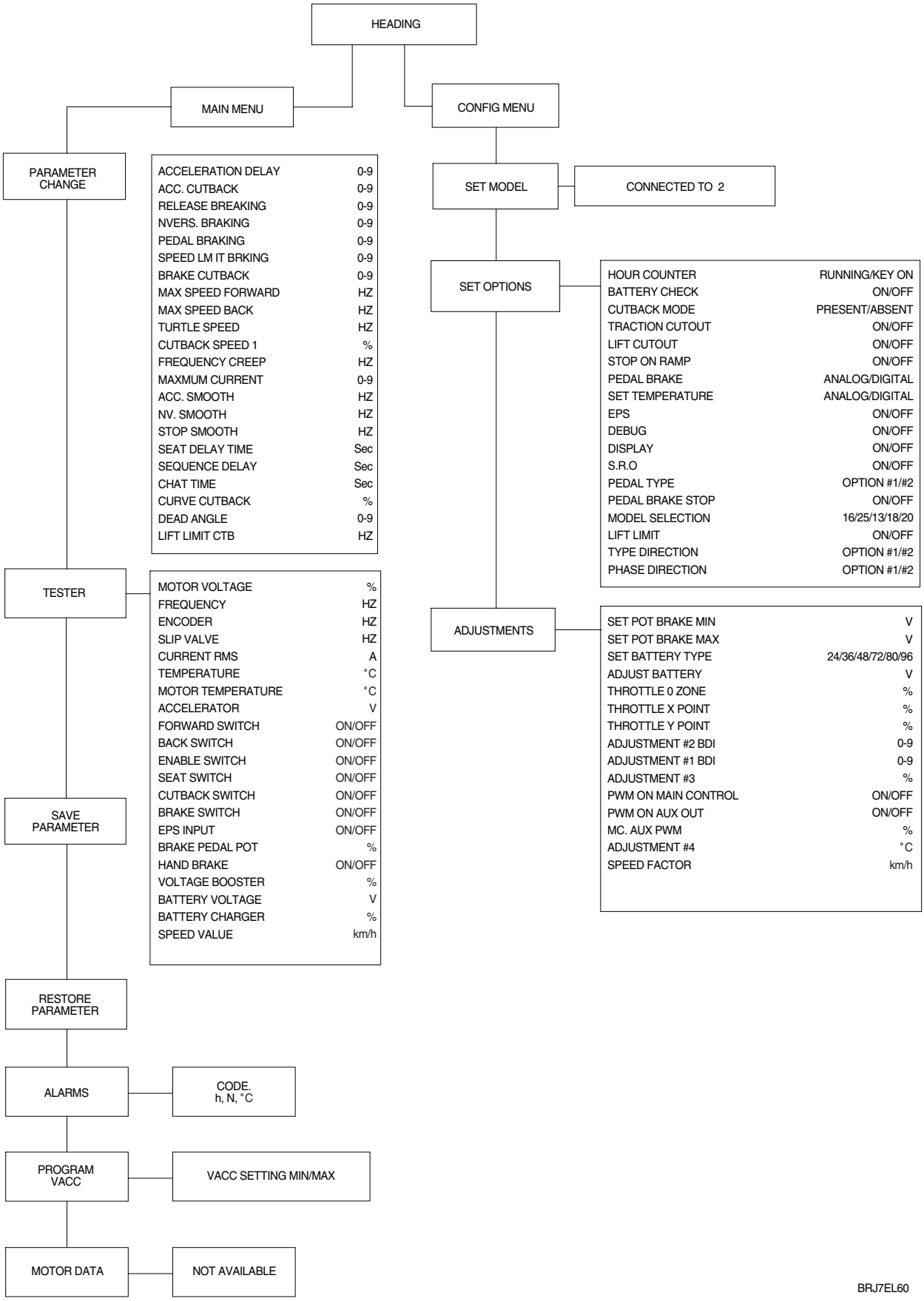


20B7EL15

※ Digital consoles used to communicate with AC inverter controllers must be fitted with EPROM CK ULTRA, minimum "Release number 3.02".

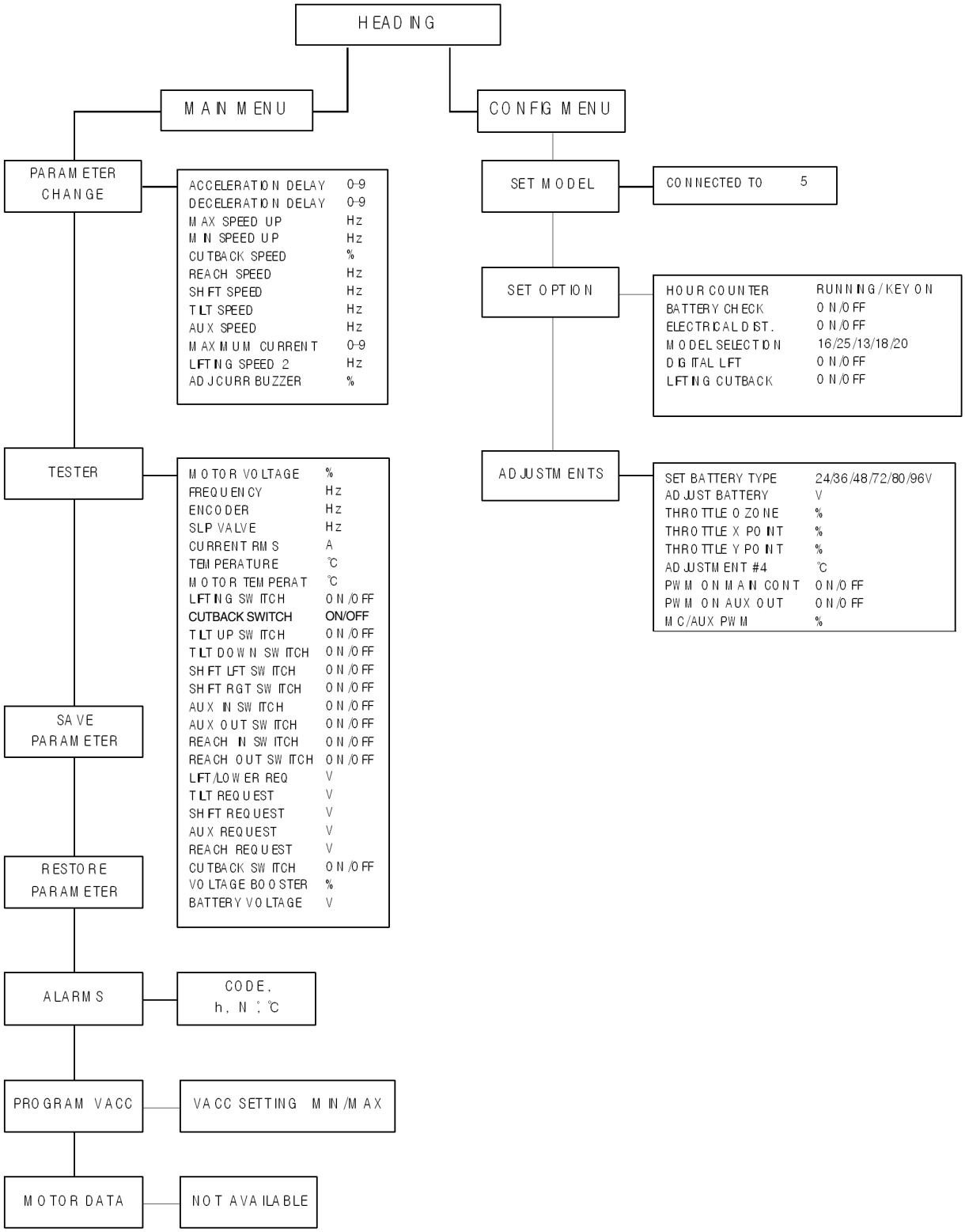
(2) Description of standard console menu

① Traction controller



BRJ7EL60

② Pump controller



BRJ7EL16

(3) Description of ALARMS menu

The microprocessor in the controller records the last five alarms that have occurred. Items remembered relative to each alarm are: the code of the alarm, the number of times the particular Alarm occurred, the hour meter count, and the inverter temperature.
This function permits a deeper diagnosis of problems as the recent history can now be accessed.
Flow chart showing how to use the ALARMS function via the digital console.

① Opening Zapi display.

② Press ENTER to go into the general menu.

③ The display will show:

④ Press ROLL UP or ROLL DOWN button until PARAMETER CHANGE. appear on the display.

⑤ The display shows:

⑥ Press ENTER to go into the ALARMS function.

⑦ The display will show the most recent alarm.

⑧ Each press of the ROLL UP button brings up following alarms. Pressing ROLL DOWN returns to the most recent.

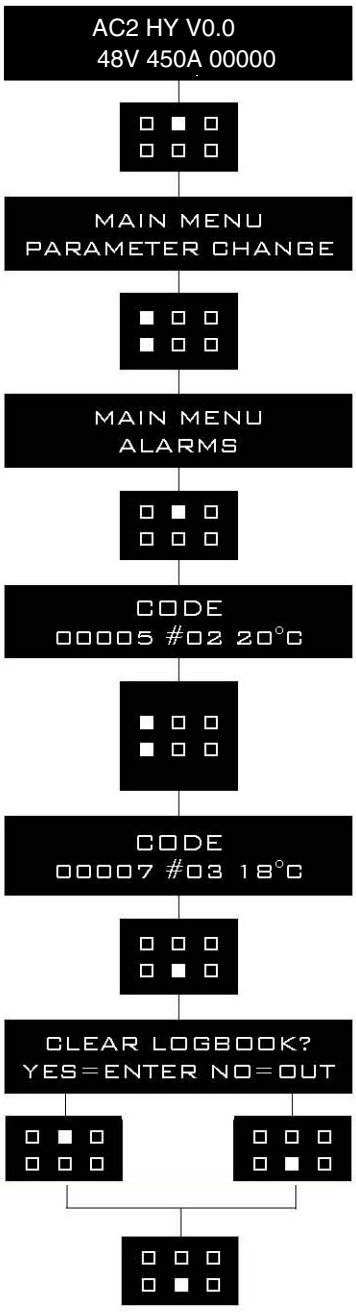
⑨ If an alarm has not occurred, the display will show: ALARM NULL.

⑩ When you have finished looking at the alarms, press OUT to exit the ALARMS menu.

⑪ The display will ask "CLEAR LOGBOOK?".

⑫ Press ENTER for yes, or OUT for NO.

⑬ Press OUT to return to the opening Zapi display.



BRJ7EL23

6) TESTER MENU

(1) Traction controller

The most important input or output signals can be measured in real time using the TESTER function of the console. The Console acts as a multimeter able to read voltage, current and temperature. In the following chapter a list of relative measurements for different configurations.

① Motor voltage

This is the voltage supplied to the motor by the inverter; it is expressed as a percentage of the full voltage (which depends of the battery voltage).

② Frequency

This is the frequency of the voltage and current supplied to the motor.

③ Encoder

This is the speed of the motor, expressed in the same unit of the frequency; this information comes from the speed sensor.

④ Slip value

This is the difference of speed between the rotating field and the shaft of the motor, expressed in the same unit of the frequency.

⑤ Current rms

Root Mean Square value of the motor current.

⑥ Temperature

The temperature measured on the aluminum heat sink holding the MOSFET devices.

⑦ Motor temperature

This is the temperature of the motor; if the option is programmed "None" it shows 0°.

⑧ Accelerator

The voltage of the accelerator potentiometer's wiper (CPOT). The voltage level is shown on the left hand side of the console display and the value in percentage is shown on the right hand side.

⑨ Forward switch

The level of the forward direction digital entry FW.

- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch.

⑩ Backward switch

The level of the reverse direction digital entry BW.

- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch

⑪ Seat switch

The level of the seat microswitch digital entry.

- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch.

⑫ Cutback switch

The level of the speed reduction microswitch.

- ON / GND = Input active, switch opened
- OFF / +VB = Input non active, switch closed.

⑬ Brake switch

The level of the pedal brake microswitch.

- ON / +VB = Input active, switch closed.
- OFF / GND = Input non active, switch open.

⑭ **Brake pedal pot.**

Voltage of the brake potentiometer's wiper (CPOTB). The parameter is active only if the PEDAL BRAKING parameter is set ANALOG.

⑮ **Hand brake**

The level of the handbrake microswitch.

- ON / GND = Input active, switch opened.
- OFF / +VB = Input non active, switch closed.

⑯ **Voltage booster**

This is the booster of the voltage supplied to the motor in load condition; it is expressed in a percentage of the full voltage.

⑰ **Battery voltage**

Level of battery voltage measured at the input of the key switch.

⑱ **Battery charge**

The percentage charge level of the battery.

⑲ **Speed value**

This is the speed value of drive.

(2) Pump controller

The most important input or output signals can be measured in real time using the TESTER function of the console. The Console acts as a multimeter able to read voltage, current and temperature. In the following chapter a list of relative measurements for different configurations.

① **Motor voltage**

This is the voltage supplied to the motor by the inverter; it is expressed as a percentage of the full voltage (which depends of the battery voltage).

② **Frequency**

This is the frequency of the voltage and current supplied to the motor.

③ **Encoder**

This is the speed of the motor, expressed in the same unit of the frequency; this information comes from the speed sensor.

④ **Slip value**

This is the difference of speed between the rotating field and the shaft of the motor, expressed in the same unit of the frequency.

⑤ **Current RMS**

Root mean square value of the motor current.

⑥ **Temperature**

The temperature measured on the aluminum heat sink holding the MOSFETdevices.

⑦ **Motor temperature**

This is the temperature of the motor; if the option is programmed "None" it shows 0°.

⑧ **Lifting switch**

Status of the lifting switch.

- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch.

⑨ **Descent switch**

Status of the lowering speed switch of the pump.

- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch.

⑩ **Tilt up switch**

Status of the tilt up switch of the pump.

- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch.

⑪ **Tilt down switch**

Status of the tilt down switch of the pump.

- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch.

⑫ **Shift left switch**

Status of the shift left speed switch of the pump.

- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch.

⑬ **Shift right switch**

Status of the shift right speed switch of the pump.

- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch.

⑭ **Aux in switch**

Status of the aux in switch of the pump.

- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch.

⑮ **Aux out switch**

Status of the aux out switch of the pump.

- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch.

⑯ **Reach in switch**

Status of the reach in switch of the pump.

- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch.

⑰ **Reach out switch**

Status of the reach out switch of the pump.

- ON / +VB = Active entry of closed switch.
- OFF / GND = Non active entry of open switch.

⑱ **Lift/lower request**

Level of the lift and lower analogue signal. The voltage is shown on the left hand side of the display and the value in percentage on the right hand side.

⑲ **Tilt request**

Level of the tilt analogue signal. The voltage is shown on the left hand side of the display and the value in percentage on the right hand side.

⑳ **Shift request**

Level of the shift analogue signal. The voltage is shown on the left hand side of the display and the value in percentage on the right hand side.

㉑ **Aux request**

Level of the auxiliary analogue signal. The voltage is shown on the left hand side of the display and the value in percentage on the right hand side.

㉒ **Reach request**

Level of the reach analogue signal. The voltage is shown on the left hand side of the display and the value in percentage on the right hand side.

㉓ **Cutback switch**

The level of the speed reduction microswitch.

- ON / GND = Input active, switch opened.
- OFF / +VB = Input non active, switch closed.

㉔ **Voltage booster**

This is the booster of the voltage supplied to the motor in load condition; it is expressed in a percentage of the full voltage.

㉕ **Battery voltage**

Level of battery voltage measured at the input of the key switch.

7) GENERAL SUGGESTION FOR SAFETY

For a proper installation take care of the following recommendations:

⚠ After operation, even with the key switch open, the internal capacitors may remain charged for some time. For safe operation, we recommend that the battery is disconnected, and a short circuit is made between battery positive and battery negative power terminals of the inverter using a resister between 10 ohm and 100 ohm.

⚠ Do not connect the inverter to a battery with a nominal value different from the value indicated on the controller plate. If the battery value is greater, the MOS may fail; if it is lower, the control unit does not "power up"

⚠ During battery charge, disconnect the controller from the battery.

⚠ Do not connect the controller to a battery with a nominal voltage different than the value indicated on the controller label. A higher battery voltage may cause power section failure. A lower voltage may prevent the logic operating.

⚠ Before doing any operation, ensure that the battery is disconnected and when all the installation is completed start the machine with the drive wheels raised from the floor to ensure that any installation error do not compromise safety.

⚠ Take care all the inductive devices in the truck (horn, solenoid valves, coils, contactors) have a proper transient suppression device.

8) EPS TROUBLESHOOTING

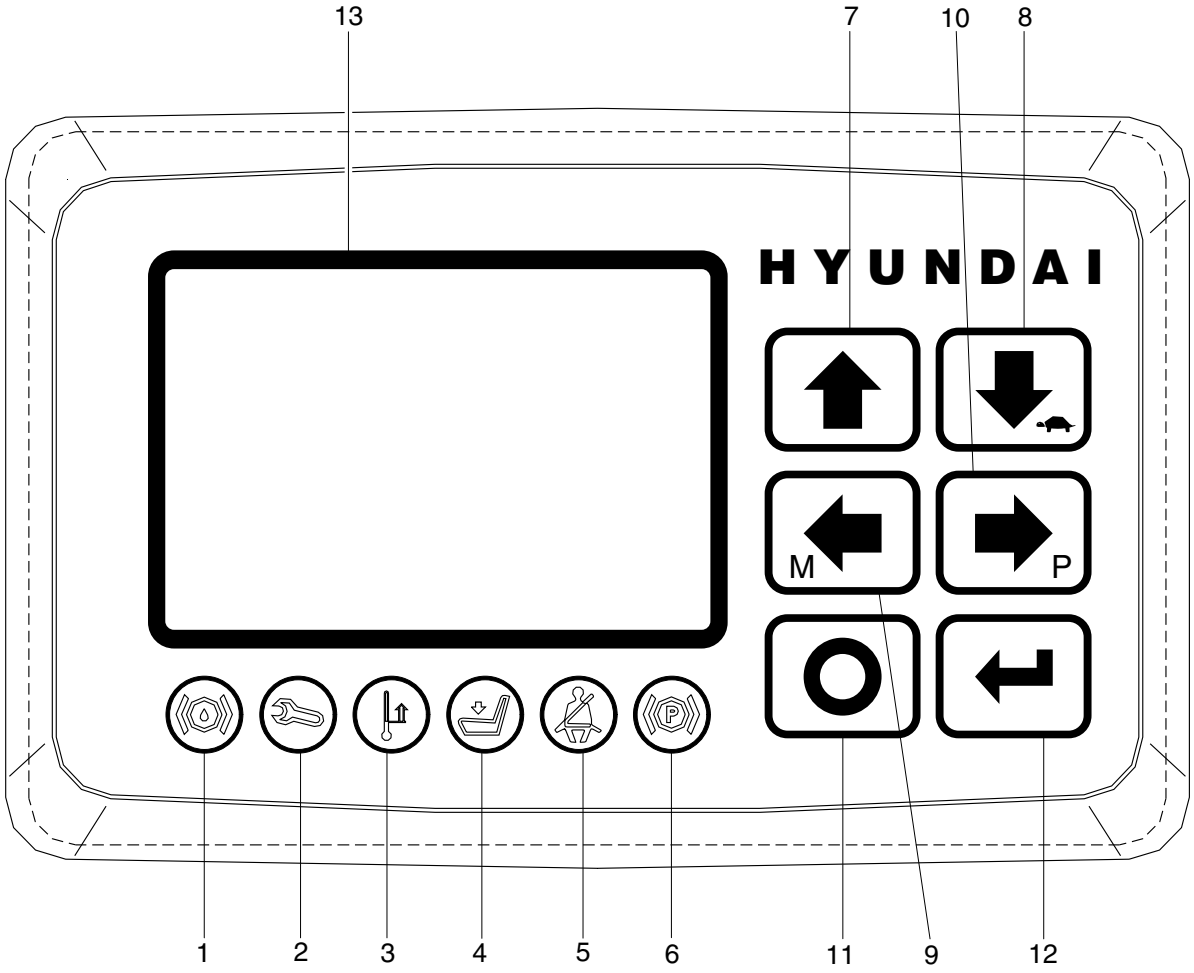
Problem	Preparable cause	Remedy
No working	- Although the key is turned, It doesn't operate. ・ Check the input power. ・ Can you measure 20~60V in No.2 & No.10 controller?	- No power ・ EPS failure, power charging condition or ・ main contactor isn't operated. The other system error.
	- It's not power problem. ・ Connector contact of torque sensor is unstable. ・ Check the contact condition. ・ Although connector is equipped again, Is it impossible to operate it? (At that time, check the operation with repeating key ON/OFF.)	- It operate occasionally. ・ Replace or repair connector pin.
	- It is disrelated. ・ Is output power of torque sensor normal? ・ Check the voltage between No. 5 controller and No. 3 controller whether it is 3V~9V.	- It is not 3V~9V. ・ Check the electric wiring. ・ Electric wiring of torque sensor failure ・ Torque sensor failure ¡ Replacement
	- It is under specification. ・ Check the operation of contactor. ・ Is the voltage between No. 1 controller and No.11 controller similar with input power.	- It's close to 0V. ・ Connector failure Replacement ・ Check whether connector terminal is combined abnormally,
	- It is similar with input power. ・ Check connector whether it is contacted. ・ Can you measure the input power between No.15 controller and No. 16 controller? (Key on)	・ Check the filter wiring and terminal.
	- Input power is measured. ・ Check the motor electric wiring and burning. ・ Check the commutator after removing motor cover.(Key on)	- It is getting black and dug.
	- It's clean. ・ Controller failure →Replace it.	
Weighty feeling of steering wheel	- Steering wheel is getting weighty during driving. Is getting light when wheel is rotated other side.	- Yes ・ It is normal. In case of long time steering to one way, controller reduce current automatically.
	- It's still weighty. ・ If key switch is turned on after being turned off, Is steering wheel getting light?	- It is getting light. ・ It which operate normally now is caused by input power malfunction.
	- It's still weighty. ・ Is it similar with input power when the voltage of No 5. controller and No. 13 controller is measured.	- It's close to 0V. - Replace or repair it.
	- It's similar with input power. ・ Can you measure 3V~9V between No. 5 terminal and No. 3 terminal when motor connector is removed and steering wheel is rotated.	- Yes ・ Check the motor whether it was burnt out.
	- Voltage is less than specification. ・ Torque sensor is failed. Replace it.	
	- Does this problem happen occasionally?	- Yes It return to normal caused by main power. Check the contact of torque sensor harness. Check the motor whether it was burnt out.

Problem	Preparable cause	Remedy
Weighty feeling of steering wheel	- Is one way of steering wheel light and is the other way weighty? -	- Yes · Torque sensor replacement (low wheel speed condition) · Controller replacement (Between low wheel speed and high wheel speed symptom is same.
Wheel locking	- Suddenly, wheel is locked during driving. (EPS stop) Is it normal when main power is turned off and turned on. - Yes, and repeat again. · Check the motor whether it was burnt out. · Check the commutator after removing cover. - It is clean. · Connector contact of torque sensor is unstable. · Check the contact. Is it impossible to operate it when connector is moved or installed again. (At that time, check whether it can be operated. - It's same. · Check the output value of torque sensor. · Check whether between No. 5 controller and No.3 controller is under 3~9V.	- No operation. · Refer to trouble table. - It's getting black and burnt out. · Replace motor. - It operate occasionally according to contact of wiring. · Replace or repair connector pin.
Wheel locking momentarily	- It is getting normal when you stop to rotate steering wheel momentarily and rotate it again. - Yes, and repeat again. · Check the motor whether it was burnt out. · Check the commutator after removing cover. - It was and burnt out.	- No operation. · Refer to trouble table. - Replace motor.
Wheel shaking	- Steering wheel shake during driving. Steering wheel shake in the special range. - It is still shaked. · Controller amplifier rate is too high. (Carry out amplifier rate test with shifting down step by step.)	- Yes · Is it uneven place? · Chain tension or chain gear ablation is strong. · Is spline shaft of torque sensor bent or eccentric by the external force.
Wheel rotation	- Steering wheel rotate to one way automatically.	· Replace torque sensor as manufacture failure. · Replace torque sensor as life limit.
A few wheel rotation	- Steering wheel rotate as 0¡Ø90¡Ø when main power is supplied or stopped.	· In case of uneven, problem happen. · In case chain tension is too strong, problem happen. · Check disconnection. (It should be disconnected with torque sensor input power.) (Check whether it connected with the other line.)

6. DISPLAY

1) STRUCTURE

The instrument panel has six built-in red LED, which provide the operator with an easy information about the status of some truck devices.



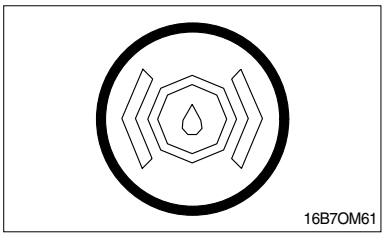
15B7OM65

1 Oil level warning lamp (option)
2 Wrench warning lamp
3 Thermometer warning lamp
4 Seat warning lamp
5 Seat belt warning lamp (option)
6 Handbrake warning lamp
7 Key 1 button
8 Key 2 button
9 Key 3 button
10 Key 4 button
11 Key 5 button
12 Key 6 button
13 LCD function

2) WARNING LAMP

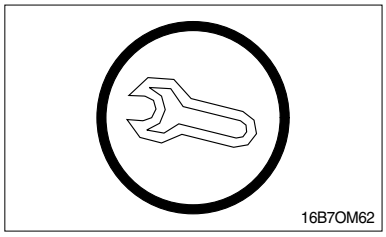
When the key switch is OFF, the display makes a general test lighting and switching OFF all the LED in sequence.

(1) Oil level warning lamp (Option)



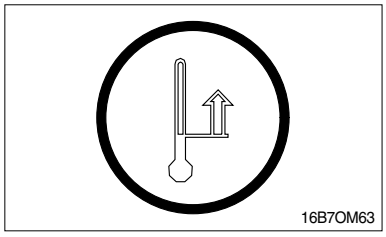
This LED lights when the measured oil level of the hydraulic circuit is under the minimum acceptable mark.
To connect the oil sensor output to the Analogue Input #1.

(2) Wrench warning lamp



This LED blinks when truck is in alarm condition.

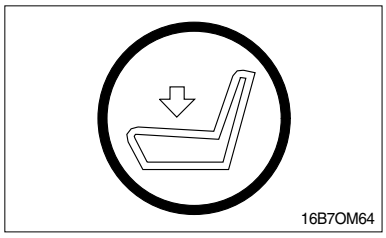
(3) Thermometer warning lamp



This LED blinks when one truck's controller is in alarm due IMS high temperature.

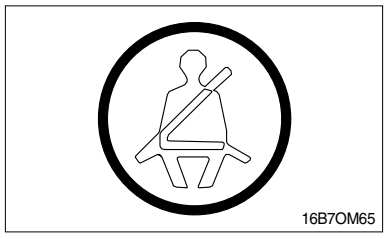
※ IMS : Input motor switch

(4) Seat warning lamp



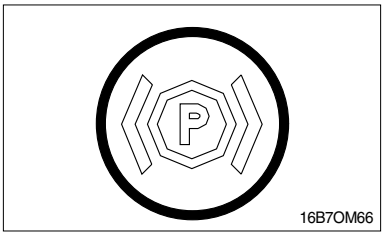
This LED lights when the operator is not on the seat.

(5) Seat belt warning lamp (Option)



(1) This LED lights to signal that the seat belt is not correctly fastened. To connect the Seat belt sensor to the Analogue Input #2.

(6) Handbrake warning lamp

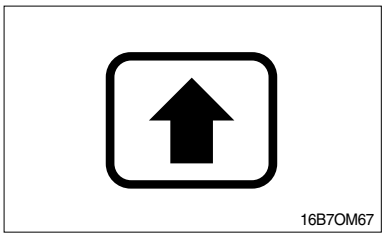


(1) This LED lights when the handbrake is activated.

3) TESTER MENU

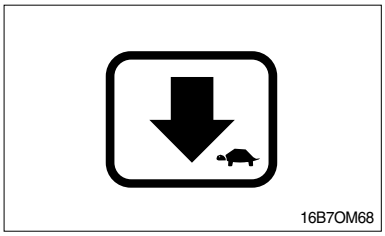
Status of keyboard buttons can be monitored in real time in the TESTER menu.

(1) Key 1 button



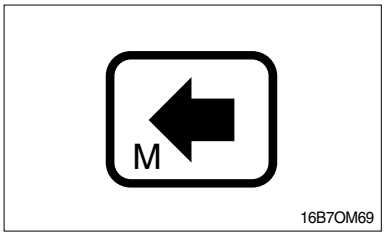
Status of ↑ keyboard button:
ON = Input active, button pushed
OFF = Input not active, button released

(2) Key 2 button



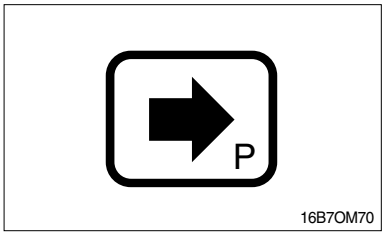
Status of ↓ TURTLE keyboard button:
ON = Input active, button pushed
OFF = Input not active, button released

(3) Key 3 button



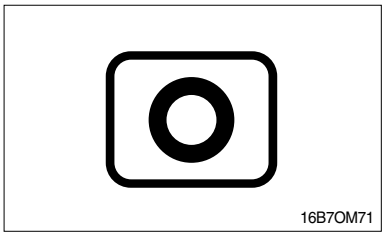
Status of ← M (Menu) keyboard button:
ON = Input active, button pushed
OFF = Input not active, button released

(4) Key 4 button



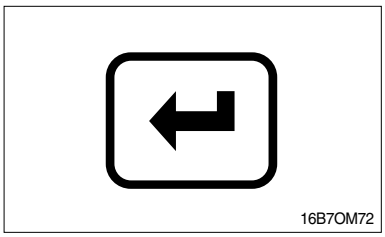
Status of → P (Performance) keyboard button:
ON = Input active, button pushed
OFF = Input not active, button released

(5) Key 5 button



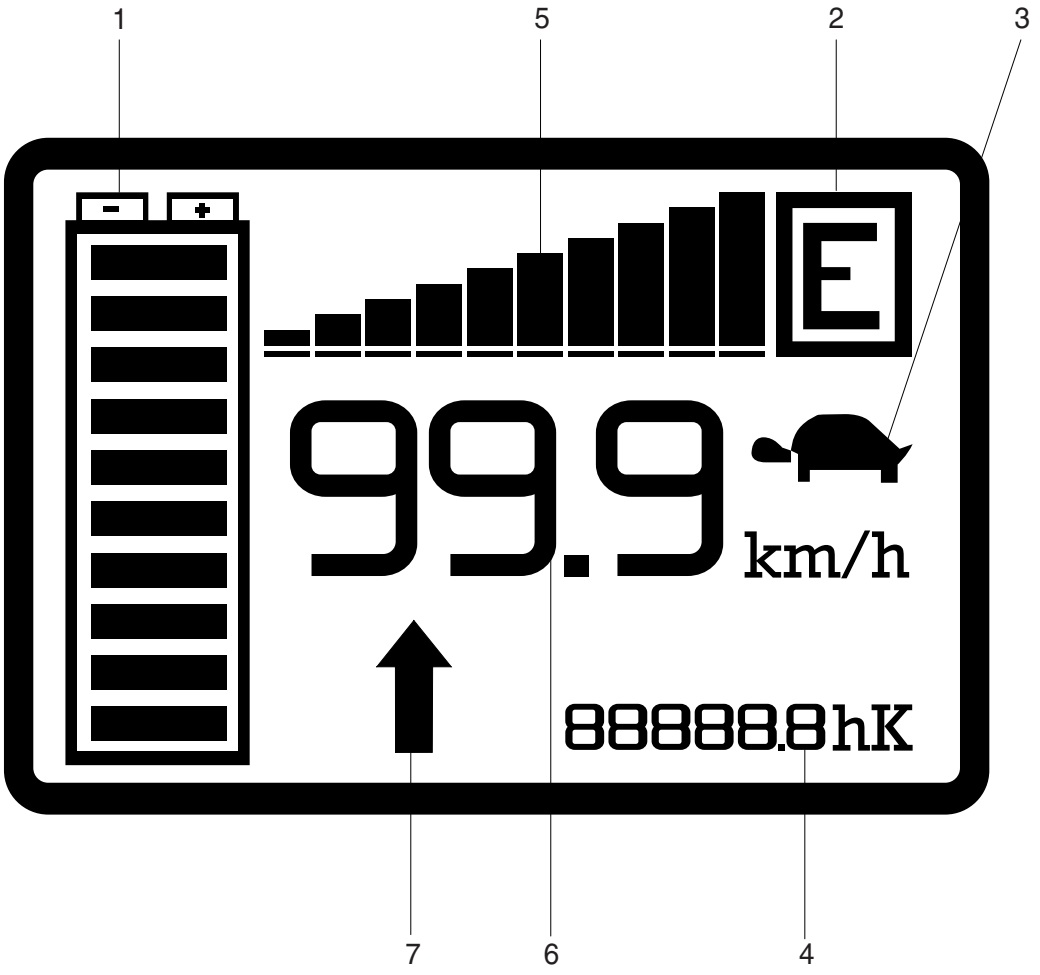
Status of ○ (Esc) keyboard button:
ON = Input active, button pushed
OFF = Input not active, button released

(6) Key 6 button



Status of ↵ (Enter) keyboard button:
ON = Input active, button pushed
OFF = Input not active, button release

4) LCD FUNCTION



(1) Battery's state of charge

The battery's state of charge indication is displayed on the left side of the unit (1); it is shown by ten notches. Each notch represents the 10% of the battery charge. As the battery becomes discharged, the notches turn off progressively, one after the other, in proportion to the value of the residual battery charge. When the residual battery charge is $\leq$ 20 % the notches displayed start to blink.

(2) Performance

The letter which appears in the rectangle displayed in the top right side of the unit (2) shows the performance mode which is being used in the controller.

Performances can be scrolled pressing button . When one performance is selected, the related information will be sent via can-bus to traction and pump controllers that will manage this data. The standard functioning reduces truck performance passing from the high to economic performance.

The real meaning, in terms of parameters level of these performances, depends on software present on pump and traction controllers:

- "H" corresponds to highest performance;
- "N" corresponds to normal performance;
- "E" corresponds to economic performance;

(3) Turtle

The turtle symbol (3) is normally off; when it appears (fixed) it shows activation of the "soft" mode of the truck, in which maximum speed and acceleration are reduced. The "soft" mode can be activated pressing button [↓].

(4) Hour meter

The number displayed on the bottom right side of the unit (4) shows the Hours Worked.
The letter present near the hour meter shows which hour meter is displayed:

- K : the key hour meter is displayed;
- T : the traction hour meter is displayed;
- P : the pump hour meter is displayed; it increases if pump control is working.

(5) Accelerator

The accelerator level indication is displayed on the central top side of the unit (5); it is shown by ten notches. When the accelerator level is minimum only a notch is displayed, when the accelerator level is maximum all the ten notches are displayed. Each notch represents 1/10 of the difference between maximum and minimum accelerator level.

(6) Speed

The number displayed under the accelerator notches on the center of the unit (6) shows the truck speed. The unit can be km/h or mph depending on the SPEED UNIT parameter setting.

(7) Wheel position

The notch displayed on the left of the hour meter (7) represents the wheel (only one of the nine notches is displayed) and shows the steering angle (it corresponds to the relative truck direction if the truck is running).

(8) Running direction

The arrow (8) shows the set truck rulling direction. The arrow point is up to when the truck is forward running; the arrow point is down when the truck is reverse running. If the truck doesn't run a dot is displayed instead of the arrow.

5) DESCRIPTION OF PROGRAMMABLE FUNCTIONS

(1) Menu set model

① Connect to

Using CANBUS link, every module connected to can net can act as the "access node" to the canbus net for the external world.

For example the ZAPI hand console (or the PC-Win console) can be physically connected to one module and, by the canbus, virtually connected to any other module of the net.

This parameter is used to select the module to which the user wishes to be connected.

Following the numbers associated to each module in Zapi canbus system are showed.

Number associated in canbus net	Module
02	TRACTION
05	PUMP
16	GRAPHIC SMART DISPLAY

(2) Menu set options

① Power selector

It sets the truck performances.

OPTION #1 : H (High performance)

OPTION #2 : N (Normal performance)

OPTION #3 : E (Economic performance)

② Hour counter

It sets the hour counter displayed.

OPTION #1 : The key hour meter is displayed

OPTION #2 : The traction hour meter is displayed

OPTION #3 : The pump hour meter is displayed

③ Auxiliary output #1

The options are :

PRESENT : An external load is connected between PAUX and NAUX.
The related diagnosis are enabled.

ABSENT : No external load is connected between PAUX and NAUX.
The related diagnosis are disabled.

④ Auxiliary voltage #1

It specifies the percentage of battery voltage supplied to AUX coil to close the AUXILIARY electro valve. This parameter can be changed in the range 0% to 100%.

⑤ Speed unit

It sets the speed unit.

OPTION #1 : The speed unit is km/h

OPTION #2 : The speed unit is mph

⑥ User password

The options are :

ON : After key-on a user password is asked to utilize the Graphic Smart Display

OFF : No user password needed

⑦ **Maintenance**

The options are :

PRESENT : A maintenance hour-counter is incremented with key ON.

When the hours elapsed reach the programmed value with the display the warning "SERVICE REQUIRED" is shown.

ABSENT : No "SERVICE REQUIRED" warning

⑧ **Maintenance done**

It can be ON/OFF. This parameter is normally off. Setting the "MAINT. DONE" on at next key-on the maintenance hours are updated with the display' s hour meter contents. This operation erases the "MAINTENANCE NEEDED" warning if it is present.

⑨ **Seat belt status**

It sets the "Seat belt" diagnostic LED indication in the following way:

OPTION #1 : No "Seat belt" indication. The diagnostic LED is not used.

OPTION #2 : If the seat belt are not fastened at Key-ON the diagnostic LED blinks for three times than it turns off.

OPTION #3 : The diagnostic LED blinks until the seat belt is fastened than it turns off.

(3) Submenu "ADJUSTMENTS"

① **Delay display OFF**

This parameter sets the display ON "Service time". If the CNB#4 is connected to +batt after key-off the display is still supplied for a programmable time, follow the table below to choose your temporization :

Delay display off level	0	1	2	3	4	5	6	7	8	9
Service time [sec]	1	3	5	7	9	11	13	15	17	20

6) DESCRIPTION OF CONSOLE USING

(1) Access to SET MODEL menu.

The only parameter present in SET MODEL function is CONNECTED TO.

By setting this parameter, operator can connect ZAPI console to every ZAPI product connected to CAN-BUS line. This functionality allows completely control of every ZAPI product without changing the position of the console connector.

① Opening Zapi menu.

② Press ROLL UP & SET UP buttons to enter CONFIG MENU.

③ The display will show: SET MODEL. If another menu is displayed, press ROLL UP or ROLL DOWN until SET MODEL appears.

④ Press ENTER to go into the SET MODEL.

⑤ The display will shows the first option, only CONNECTED TO option is present in this menu.

⑥ Press SET UP or SET DOWN buttons in order to select the desired value for selected option.

⑦ New desired value appears.

⑧ Press OUT to exit the menu.

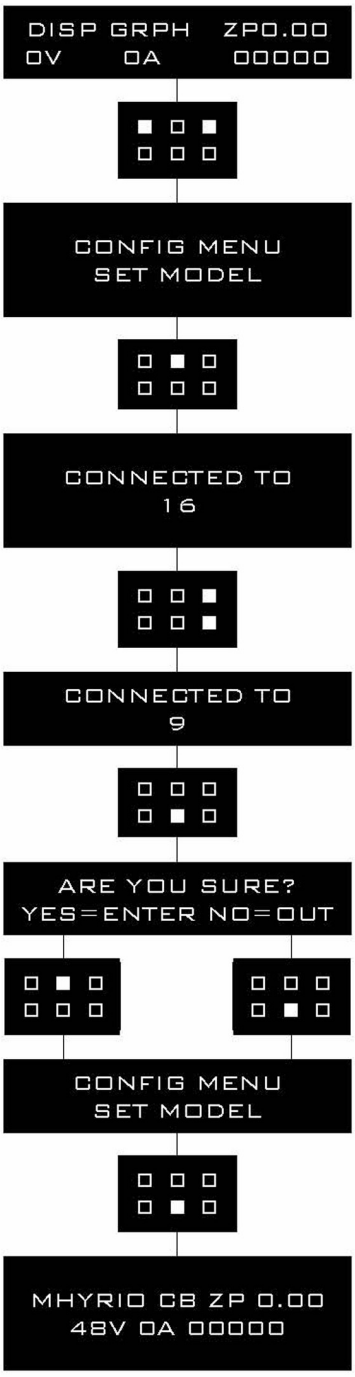
⑨ The display will ask "ARE YOU SURE?"

⑩ Press ENTER for YES, or OUT if you do not accept the changes.

⑪ SET MODEL menu appears.

⑫ Press OUT again. Console now disconnects and reconnects.

⑬ Display now shows the opening Zapi Menu of the ZAPI product corresponding to option selected at point 7.



20B7EL28

(2) Flow chart showing how to make changes to option menu:

① Opening Zapi menu.

② Press ROLL UP & SET UP Buttons to enter CONFIG MENU.

③ The display will show: SET MODEL.

④ Press ROLL UP or ROLL DOWN until SET OPTIONS appears.

⑤ SET OPTIONS menu appears.

⑥ Press ENTER to go into the SET OPTIONS menu.

⑦ The display will show the first option.

⑧ Press ROLL UP or ROLL DOWN buttons until desired option appears.

⑨ Desired option appears.

⑩ Press SET UP or SET DOWN buttons in order to modify the value for selected option.

⑪ New value for selected option appears.

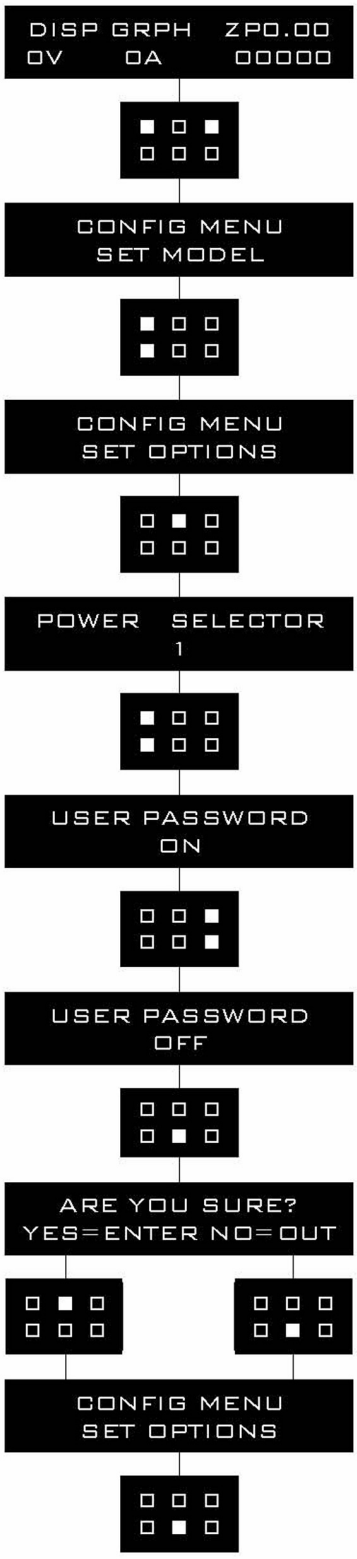
⑫ Press OUT to exit the menu.

⑬ Confirmation request appears.

⑭ Press ENTER to accept the changes, or press OUT if you do not accept the changes.

⑮ SET OPTIONS menu appears.

⑯ Press OUT again. Display now shows the opening Zapi menu.



20B7EL29

(3) Flow chart showing how to use the TESTER function of the digital console:

① Opening Zapi menu.

② Press ENTER to go into the MAIN MENU.

③ The display will show: PARAMETER CHANGE.

④ Press ROLL UP or ROLL DOWN until TESTER menu appears on the display.

⑤ The display will show: TESTER.

⑥ Press ENTER to go into the TESTER function.

⑦ The first variable to be tested is shown on the display.

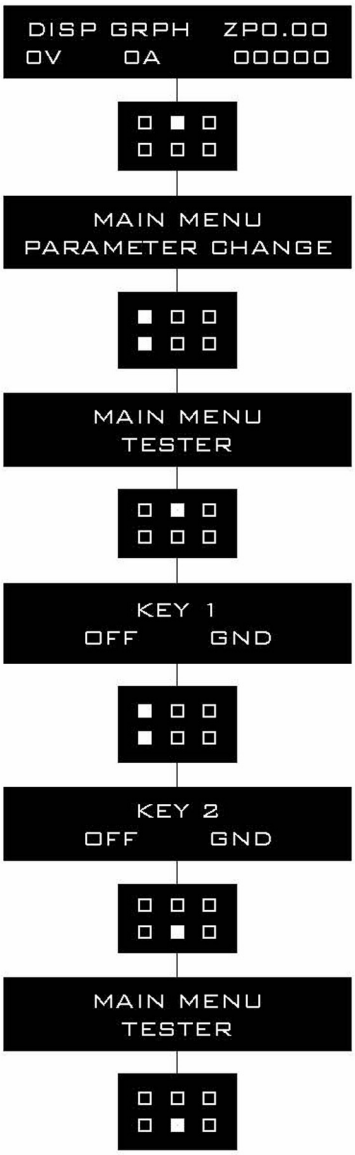
⑧ Press either ROLL UP or ROLL DOWN buttons.

⑨ Next variable for measurement appears.

⑩ When you have finished press OUT.

⑪ The Display will show: TESTER.

⑫ Press OUT again and return to opening Zapi menu.



20B7EL30

Remember it is not possible to make any changes using TESTER.
All you can do is measure as if you were using a pre-connected multimeter.

7) DESCRIPTION OF ALARM MENU

The microprocessor in the controller records the last five alarms that have occurred. Items remembered relative to each alarm are: the code of the alarm, the number of times the particular alarm occurred and the hour meter count. This function permits deeper diagnosis of problems as the recent history can now be accessed.

Flow chart showing how to use the ALARMS function via the digital console:

① Opening Zapi menu.

② Press ENTER to go into the MAIN MENU.

③ The display will show:

④ Press ROLL UP or ROLL DOWN until ALARMS menu appears on the display.

⑤ The display will show:

⑥ Press ENTER to go into the ALARMS menu.

⑦ The display will show the most recent alarm.

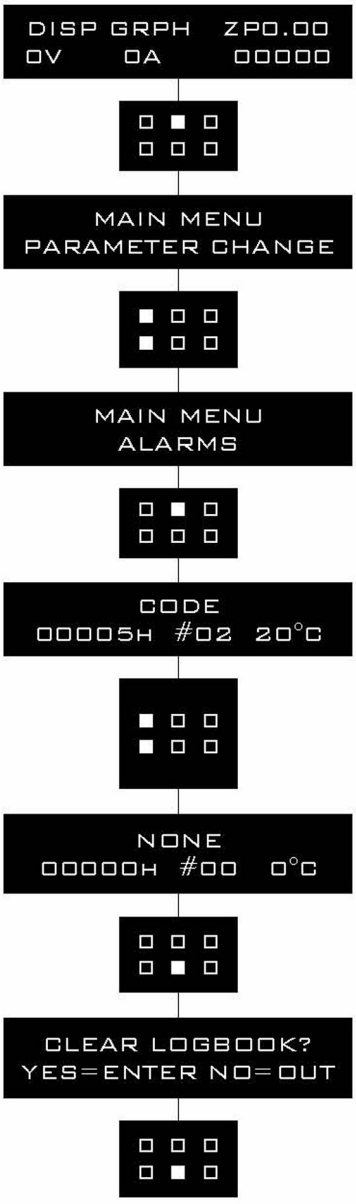
⑧ Each press of ROLL UP button brings up following alarms. Pressing ROLL DOWN returns to the most recent.

⑨ If an alarm has not occurred, the display will show: NONE.

⑩ When you have finished looking at the alarms, press OUT to exit the ALARMS menu.

⑪ The display will ask: "CLEAR LOGBOOK?" Press ENTER for Yes, or OUT for No.

⑫ Press OUT again and return to opening Zapi menu.



20B7EL31

8) STRUCTURE OF DISPLAY MENU

Graphic Smart Display present a software structure made by menus and submenus. It is possible to have access to Graphic Smart Display menu structure by the six operator buttons integrated in a membrane keyboard.

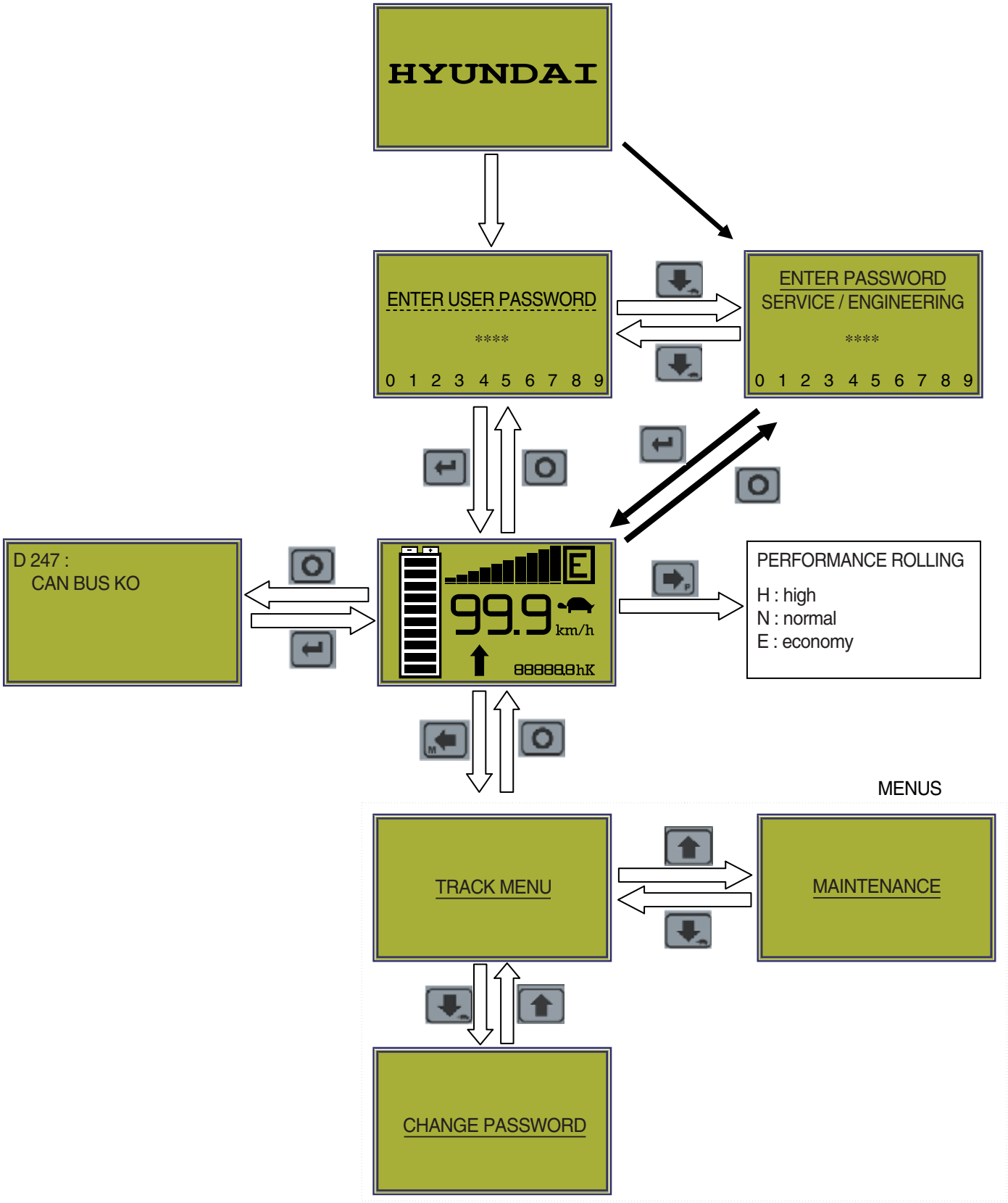
At turn on the display shows the HYUNDAI logo for some seconds, then asks the starting password to have access to the main page (if "USER PASSWORD" option is ON), otherwise it shows directly the main page (if "USER PASSWORD" option is OFF).

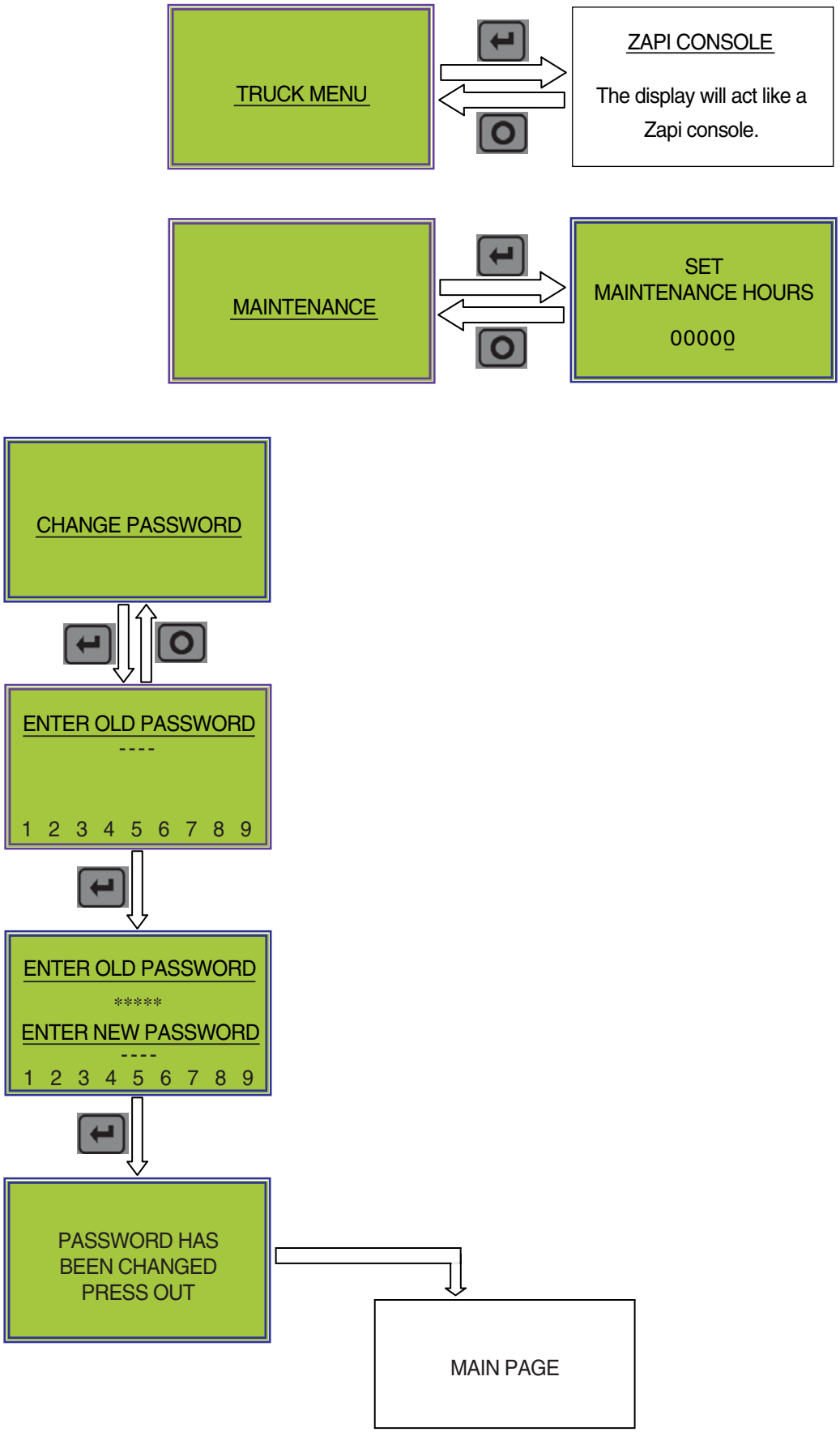
The main page, if there aren't alarms, shows battery charge, truck speed (in km/h or mph, it depends on "SPEED UNIT" parameter) and key/traction/pump hour meter (see "HOUR COUNTER" option); if alarms are present, it will show alarm code, node initials in which alarm has occurred and alarm description.

From the main page it is possible to have access to the ALARM page (if alarms occur) and to MENUS page. The CHANGE PASSWORD MENU is always accessible and visible, while the others ones are accessible and showed, by entering service password. To enter this password is necessary to push the out button (button #5) of membrane keyboard; this will show a entering password page.

By using service password it's possible to enter in all menus (TRUCK, CHANGE PASSWORD, MAINTENANCE).

It follows flow chart diagram of menu structure.


HYUNDAI
ENTER USER PASSWORD
****
0 1 2 3 4 5 6 7 8 9
ENTER PASSWORD
SERVICE / ENGINEERING
****
0 1 2 3 4 5 6 7 8 9
D 247 :
CAN BUS KO
99.9
km/h
PERFORMANCE ROLLING
H : high
N : normal
E : economy
MENUS
TRACK MENU
MAINTENANCE
CHANGE PASSWORD
BR7SM23


TRUCK MENU
ZAPI CONSOLE
The display will act like a Zapi console.
MAINTENANCE
SET MAINTENANCE HOURS
00000
CHANGE PASSWORD
ENTER OLD PASSWORD
----
1 2 3 4 5 6 7 8 9
ENTER OLD PASSWORD
*****
ENTER NEW PASSWORD
----
1 2 3 4 5 6 7 8 9
PASSWORD HAS BEEN CHANGED PRESS OUT
MAIN PAGE

20B7EL41

(1) Performance rolling

From MAIN PAGE using membrane keyboard numbers, it is possible to select the performance mode which must be used in traction and pump controllers.
Performance can be chosen with button 4, and it is displayed in the top right side of the unit.
When one performance is selected, the related information will be sent via canbus to traction and pump controllers that will manage this data. The standard functioning reduces truck performance passing from high performance mode (H) to economy performance mode (E).
The real meaning, in terms of parameters level of these performances, depends on software present on pump and traction controllers.

Button 4 Selects in sequence the truck performance (H → N → E).

(2) Using dashboard like console

By entering the service or engineering password, from MAIN PAGE it's possible to have access to TRUCK MENU, which allows user to use dashboard as a real Zapi digital console connected to one module of canbus net.
Here with roll buttons (button 1 and 2 of membrane keyboard) and enter button (button 6), it is possible to choose which module of canbus net has to be connected to the display.
When the display has been connected, it works exactly like a Zapi digital console.
Buttons of membrane keyboard do the same functions of Zapi console keys.

Button 1 Performs function of the ROLL UP console key
Button 2 Performs function of the ROLL DOWN console key
Button 3 Performs function of the SET DOWN console key
Button 4 Performs function of the SET UP console key
Button 5 Performs function of the OUT console key
Button 6 Performs function of the ENTER console key

(3) Using of password menu (option)

From MAIN PAGE it's always possible to have access to CHANGE PASSWORD MENU. Here with ENTER button (button 6 of membrane keyboard) the operator can change user Graphic Smart Display password.
To edit password use these buttons:

SET UP / SET DOWN	Shifts cursor through 10 digits on the bottom side of unit
ENTER	Inputs digit selected or saves all changing
OUT	Cancels one digit or exits (if there is no digit input yet)

(4) Set maintenance hours (option)

By entering the service or engineering password from MAIN PAGE it's possible to access to MAINTENANCE MENU. Here the service can change the programmed work hours between two maintenances.
Buttons of membrane keyboard have the same functions in the RESET HOURMETERS MENU:

Button 1 Increases digit marked by cursor
Button 2 Decreases digit marked by cursor
Button 3 Shifts cursor on previous digit
Button 4 Shifts cursor on following digit
Button 5 Cancels all changing and out from hour meter submenu
Button 6 Saves all changing

9) ANALYSIS OF GRAPHIC SMART DISPLAY RELATED ALARMS

(1) Graphic Smart Display alarms

① WATCHDOG

Cause:

At start-up the watch dog signal is already active before the software has generated it. At standby or running condition the watch dog signal is not active (in alarm status).

Troubleshooting:

The WD hardware circuit or microcontroller output port are damaged. In both cases no external component are involved. Replace the logic board.

② COIL SHORTED

Cause:

This alarm occurs when there is a short circuit of the AUXILIARY coil connected to CNB#1 output. After the overload condition has been removed, the alarm exits automatically by releasing and then enabling a travel demand.

Troubleshooting:

A) The typical root cause for this error code to be displayed is in the harness or in the load coil. So the very first check to carry out concerns connections between dashboard outputs and loads.

B) In case no failures/problems have been found externally, the problem is in the logic card, which has to be replaced.

③ DRIVER SHORTED

Cause:

The driver of the auxiliary electro valve coil is shorted.

Troubleshooting:

A) Check if there is a short or a low impedance pull-down between NAUX (CNB#1) and -BATT.

B) The driver circuit is damaged in the logic board, which has to be replaced.

④ AUX DRIVER OPEN

Cause:

The AUX coil driver is not able to drive the load. The device itself or its driving circuit is damaged.

Troubleshooting:

This type of fault is not related to external components; replace the logic board.

⑤ HARDWARE FAULT

Cause:

At key-on the dashboard checks if the AUX driver is turned off by a not active (alarm status) watch-dog signal. If it is not turned off then the alarm is generated.

Troubleshooting:

The problem is inside the logic, no external component are involved, replace the logic board.

⑥ **CAN BUS KO**

Cause:

Graphic Smart Display doesn't receive messages from canbus line or the hour meter synchronization at key-on fails.

Troubleshooting:

A) If this fault code is displayed together with other alarm messages, the fault is probably to be looked for in the Graphic Smart Display can interface, since the display seems to be unable to receive any can message. So it is suggested to check Graphic Smart Display canbus wiring and connection.

B) Otherwise, the fault is in the can interface of other modules present on canbus network.

(2) Graphic Smart Display warnings

① **EEPROM KO**

Cause:

It's due to an HW or SW defect of the non-volatile embedded memory supporting the dashboard parameters. This alarm does not inhibit the machine operations, but the truck will work with the Graphic Display parameters default values.

Troubleshooting:

Try to execute a CLEAR EEPROM operation (refer to console manual).

Switch the key off and on to check the result. If the alarm occurs permanently, it is necessary to replace the logic. If the alarm disappears, the previously stored parameters will have been replaced by the default parameters.

② **MAINTENANCE NEEDED**

Cause:

This is just a warning to call for the time programmed maintenance.

Troubleshooting:

It is just enough to turn the MAINTENANCE DONE option to level ON after the maintenance is executed.

(3) Alarms visualization

When an alarm condition occurs, Graphic Smart Display gives the information showing the initial of module in which the alarm occurred, the alarm code and description.

For example, the information:

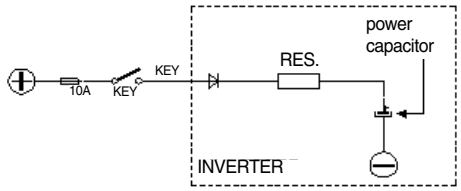
```
M 245:
    WRONG SET BAT
```

means that the alarm 245 - "WRONG SET BATTERY" occurred in the master traction controller (M).

Here the table with the alarm codes and the respective meaning is shown.

10) DIAGNOSTIC FAULT CODES

Code	Alarm	Traction (T)	Pump (P)	Description
8	WATCHDOG	○	○	The test is made in both running and standby. It is a self-diagnosing test within the logic. If an alarm should occur, replace the logic.
13	EEPROM KO	○	○	Fault in the area of memory in which the adjustment parameters are stored; this alarm inhibits machine operation. If the defect persists when the key is switched OFF and ON again, replace the logic. If the alarm disappears, remember that the parameters stored previously have been cancelled and replaced by the default values.
17	LOGIC FAILURE #3	○		Fault in the hardware section of the logic board which manages the hardware current protection. Replace the logic board.
19	LOGIC FAILURE #1	○	○	This alarm signals that an undervoltage / overvoltage protection operation has occurred. Two possible reasons: A) A real undervoltage / overvoltage situation happened. B) Fault in the hardware section of the logic board which manages the overvoltage protection. Replace the logic card.
30	VMN LOW	○	○	The test is carried out during initial diagnosis and in standby. Possible causes: A) Problem with the motor connections or the motor power circuit; check if the 3 phases are correctly connected; check if there's a dispersion of the motor towards ground; B) Inverter failure, replace it
31	VMN HIGH	○	○	The test is carried out during initial diagnosis and in standby. Possible causes: A) Problem with the motor connections or the motor power circuit; check if the 3 phases are correctly connected; check if there's a dispersion of the motor towards ground; B) Inverter failure, replace it
38	CONTACTOR OPEN	○	○	The main contactor coil has been driven by the logic board, but the contactor does not close. Two possible reasons: A) The wires to the coil are interrupted or not well connected. B) The contact of the contactor is not properly working.
49	I=0 EVER	○	○	Traction or Pump Controller current too low.

Code	Alarm	Traction (T)	Pump (P)	Description
53	STBY I HIGH	○	○	Test carried out in standby. Check if the current is 0. If not verified, an alarm is signalled which inhibits machine operations. Possible causes: A) Current sensor failure; B) Logic failure: first replace the logic; if the defect persists, replace the power unit.
60	CAPACITOR CHARGE	○	○	Follows the charging capacitor system:  When the key is switched ON, the inverter tries to charge the capacitor through a power resistance, and check if the capacitor are charged within a timeout. If this is not true: an alarm is signalled; the main contactor is not closed. Possible reasons: A) The charging resistance is opened; if it is opened. B) The charging circuit has a failure. C) There is a problem on the power modules.
61	HIGH TEMPERATURE	○	○	Inverter temperature is greater than 75° C. The maximum current is reduced proportionally to the temperature increase. The inverter stops at 100° C. If the alarm is signalled when the inverter is cold: A) Check the wiring of the thermal sensor; B) Thermal sensor failure; C) Logic failure.
65	MOTOR TEMPERATURE	○	○	This warning is signalled if the motor temperature switch opens (digital sensor) or if the analog signal overtakes the cut off level. If it happens when the motor is cold, check the wiring. If all is ok, replace the logic board.
66	BATTERY LOW	○	○	If the "battery check" option is ON, a battery discharge algorithm is carried out. When the charge level is 10%, this alarm is signalled and the current is reduced to the half of the programmed level.
74	DRIVER SHORTED	○	○	When the key is switched ON, the μP checks that the MC coil driver is not shorted; if it is, this alarm is signalled; replace the logic board.
75	CONTACTOR DRIVER		○	When the initial diagnosis is finished, the traction logic closes the MC and checks the voltage on the drain of the driver. If this is not low, an alarm is signalled. Replace the logic.
76	COIL SHORTED	○	○	When the key is switched ON the μP checks the MC driver FF SR. If it does not react in a correct way to the μP stimulus, the alarm is signalled. Replace the logic board. The FF SR makes an hardware control of the current in the MC coil. If this is too high, it opens the MC and the alarm is signalled.Check if there are external shortcircuit and if the ohmic value of the MC is correct; otherwise replace the logic.

Code	Alarm	Traction (T)	Pump (P)	Description
77	COIL INTERRUPTED	○	○	Main contactor line is interrupted.
78	VACC NOT OK	○	○	The test is made in standby. This alarm indicates that the accelerator voltage is 1 V greater than the minimum value programmed by the PROGRAM VACC function. Possible causes: A) The potentiometer is not correctly calibrated; B) The potentiometer is defective.
79	INCORRECT START	○	○	This alarm signals an incorrect starting sequence. Possible causes: A) Running microswitch failure; B) Error in sequence made by the operator; C) Incorrect wiring; D) If the default persists, replace the logic.
80	FORW + BACK	○	○	The test is carried out continuously. An alarm is signalled when a double running request is made simultaneously. Possible causes: A) Defective wiring; B) Running microswitch failure; C) Incorrect operation; D) If the defect persists, replace the logic.
82	ENCODER ERROR	○	○	Two consecutive readings of the encoder speed are too much different in between: because of the inertia of the system it is not possible the encoder changes its speed a lot in a short period. Probably an encoder failure has occurred (e.g. one or two channels of the encoder are corrupted or disconnected). Check both the electric and the mechanical encoder functionality. Also the electromagnetic noise on the sensor bearing can be a cause for the alarm.
86	PEDAL WIRE KO	○	○	This alarm is signalled if a fault is detected in the accelerator unit wiring (NPOT or PPOT cable is interrupted).
228	MODEL MISMATCH		○	Model truck selected for the pump is not the same of traction one.
237	SAFETY	○		This alarm is signalled when the "SAFETY" input is open. The "SAFETY" circuit gets active and opens the drivers of LC and EB and stops the machine. Verify the "SAFETY" input connection.
238	SAFETY KO	○		This alarm is present in combi systems (traction + pump). If a stopping alarm is detected on the pump, the traction also stops. The failure must be looked for in the pump inverter.
239	SLIP PROFILE	○		Slip profile is wrong (es.slip freq0 >slip freq1).
240	MOTOR STALL	○		Encoder locked.
242	MOTOR STALL		○	Encoder locked.
243	SEQUENCE FAULT	○		Wrong Sequence to begin traction(es. First pedal activated and then forward switch activated).

Code	Alarm	Traction (T)	Pump (P)	Description
245	WRONG SET BATT.	○	○	When the key is turned ON, the controller check the battery voltage and verifies it is within a window around the nominal value. Replace the battery with a correct battery.
246	SAFETY		○	This alarm is signalled when the "SAFETY" input is open. The "SAFETY" circuit gets active and opens the drivers of LC and EB and stops the machine. Verify the "SAFETY" input connection.
247	CAN BUS KO	○	○	The diagnosis of the CAN-BUS line is present only if the inverter uses this link (depends on the software version). It is signalled if the inverter does not receive any message from the CAN-BUS line. First of all, check the wiring. If it is ok, the problem is on the logic board, which must be replaced.
248	DISPLAY ENABLE	○		Communication with display ok but waiting for display message.
249	THERMIC SENSOR	○	○	The range of inverter temperature sensor is always checked and a warning is signalled if it is out of range. When this alarm is signalled, check the connection of the sensors.
250	HANDBRAKE	○		The truck does not start because the handbrake switch is opened. Possible causes: A) Defective wiring; B) Failure of the microswitch; C) Incorrect operation of the operator; D) If the defect persist, replace the logic.
251	WAITING FOR NODE	○		The controller receives from a remote module via CAN BUS the information that it isn't possible to close the LC (the module isn't ready locked in an alarm state). Verify the other modules to determinate in which of them there is the problem.
	WAITING FOR TRAC		○	
252	CHAT MODE	○	○	No command(traction or pump) for CHAT TIME minutes.
253	AUX OUTPUT KO	○	○	The μP checks the driver of the electromechanical brake. If the status of the driver output does not correspond to the signal coming from the μP, the alarm is signalled. Replace the logic.
254	CAN BUS DISP KO	○		No Can Communication with display.

7. BATTERY CHARGER

This explains basic information related to charger to help you easily understand and use it. This includes the contents from the way to install a charger to tips for emergency situations. This is focused on practices aiming to be usefully utilized in the field.

1) BASIC INFORMATION

(1) What is charger

Charger is a device which makes a battery accept D.C electricity under optimal condition as it transforms A.C provided from external source of electricity.

The charger is a constant-current and constant-voltage way, SCR type charger that it has advantages as follows

① Even though A.C input voltage fluctuates within 10% of rated voltage (220/380/410/440V), the current and voltage provided to the battery are stable.

② As minimizing the increase of temperature while charging a battery, it minimizes the stress on the battery.

③ The noisy of charger is minimal but the charging efficiency is very high.

④ It prevents from under charging and overcharging.

Therefore, it helps the battery to maintain its performance for longer time and to prolong the life of the battery.

(2) Notice on caring chargers

① If any abnormal status is found while using a charger, immediately stop using and check the charger. If it is impossible to take an appropriate measure for yourself, please apply for A/S.

② While charging, hydrogen and oxygen gas is produced. Use or approach of fire should be strictly prohibited.

③ Keep clean to prevent from sneak current and attack on the interface and surroundings of the battery.

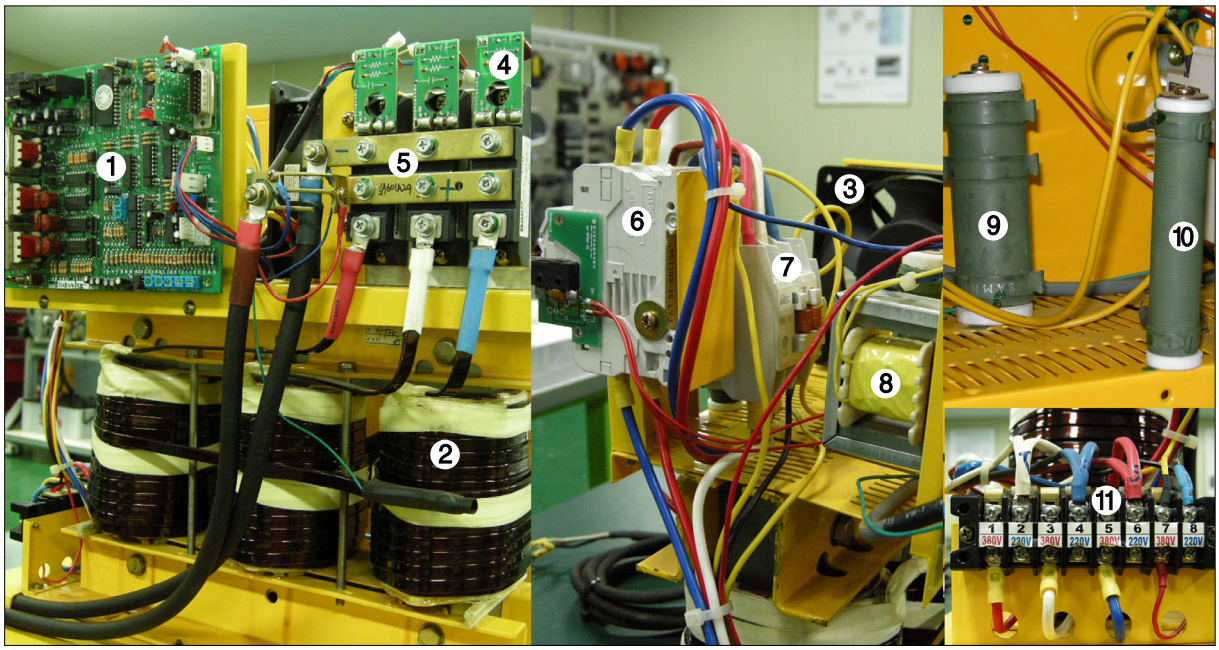
④ Check the electrolyte of the battery every week and provide distilled water immediately if it is required. (Electrolyte has to be provided between 10~12㎜ level on the positive plate inside storage battery)

⑤ If battery liquid temperature becomes over 55° C, charging should be stopped.
If it is continued,
- the appearance is transformed
- and metal area can be attacked as electrolyte overflows

⑥ Electric forklift truck using battery should be charged as soon as the charging lamp is on while driving. As batteries are internally discharged naturally if they are deposed for a long time, charge them once or twice a month to prevent from reducing the lives of batteries.

⑦ When a green sign is on among charging status indication lamps, please notify that it is not converted as equalized charge for stabilization of charging status.

(3) Names of each part (independent items)



BR7BAT30

1	Main PCB board	5	Shunt	9	Resistance (RD)
2	Main trans (Class H)	6	NFB	10	Resistance (DR)
3	Cooling fan	7	MG S/W	11	TAP changer
4	SCR module	8	Assistant trans		

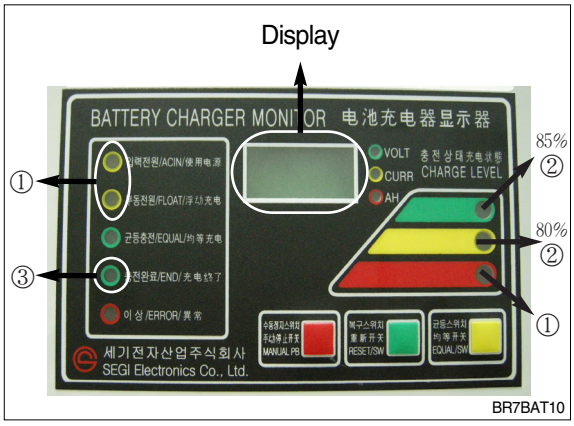
2) CHARGER INSTALLATION METHOD

(1) Location for charger installation

① Dry and well ventilated place.
② No inflammable and B7 fire are near by.
③ Safe place where no collision possibility with people or equipment is.

(2) Check points before installing charger

① Enough capacity of AC input power source to operate charger.
② Standard electric wire for power source by capacity.



3) HOW TO USE A CHARGER

(1) General charging method (Floating charging)

① Charging by this method supplies electric power to the charger as operating external AC power switch of the charger.
② Connect battery connecter and charger connecter.

· According to charging condition

① If there is no abnormality found when the charger checks itself for 3-4 seconds after inputting AC input power source, the charger slowly increases the electric flow for charging and the charging condition lamp in the lower part of the front panel for floating charging of "input" is on.
② When charging is processed about 80%, yellow lamp in the middle of the front panel, which shows that the charging condition is in the middle, is on and then green lamp is on when charging is processed over 85% until charging is completed.
③ When charging is completed, "charging is completed" lamp is on in the monitor and other lamps of all monitors become off.

(2) Equalized charging

① **Equalized charging is**

Equalized charging is to correct the battery when it does not normally perform its functions as the voltage differences are too big between cells of a battery.

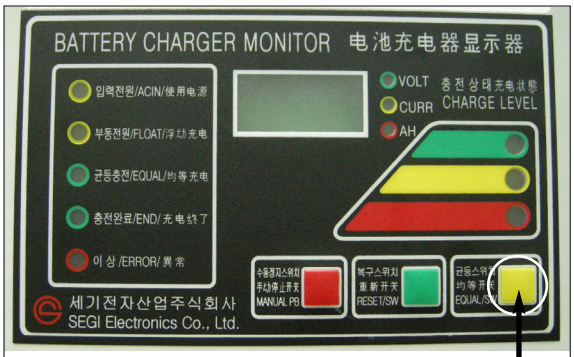
When equalized charging is required?

- When re-operates the battery after having left the battery for a long time.
- When a battery is over-discharged.
- When there is large deviation of voltage and specific gravity between battery cells.
- When change or supply electrolyte of battery.

② **Tips for equalized charging**

If once push the equalized charging button on the monitor in the beginning of charging, the equalized charging lamp becomes on and starts charging.

※ **When the green charging condition lamp is on (over 85% charged), the equalized charging switch is locked that it does not operate even pushing the button.**



Equalized charging switch

BR7BAT10

4) HOW TO CHECK THE CHARGER'S NORMAL OPERATION

After changing SCR module or PCB (SE-5000SN), the charger's normal operation should be checked.

· Checking order

(1) Separate the charger and battery connector.

(2) Separate lower cover in the front of the charger.

(3) Check the AV input voltage used from the input switch terminal in the lower left side of the inside of the charger.

Checking method between terminals.
Input voltage setting value → 220V 380V
- Between terminals No. 2 - No. 4 220V 380V
- Between terminals No. 2 - No. 6 220V 380V
- Between terminals No. 4 - No. 6 220V 380V

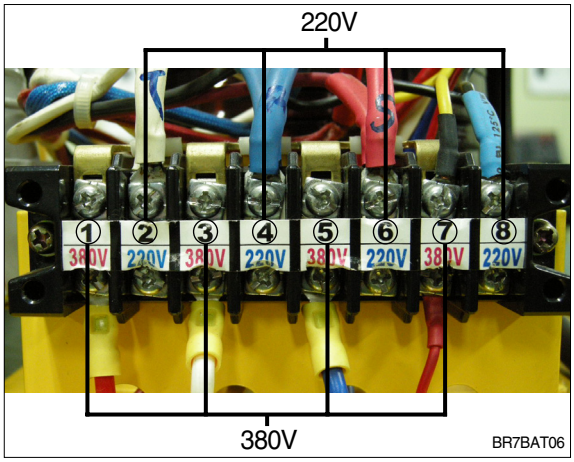
※ **Above cases are under normal operations.**

※ **When installing charger for the first time or moving its location, check and make it sure if the voltage is appropriately connected.**

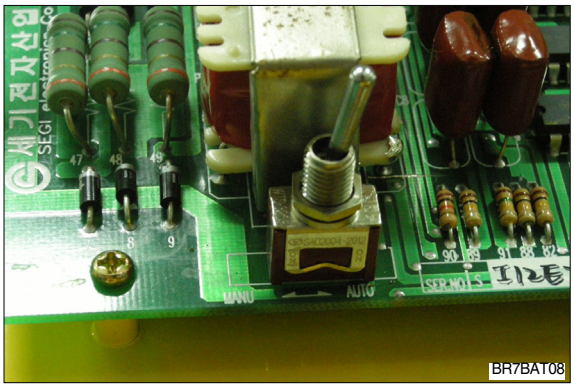
Refer to No. 2 of the charger installation method for the terminal connection method.

- In case of 220V : (2), (4), (6), (8)
- In case of 380V : (1), (3), (5), (7)

It should be connected to the terminal.



(4) Convert the automatic / manual switch to manual.
The automatic/manual switch is located in the lower left part of the PCB
Be sure to check if battery connector is separated in advance.



BR7BAT08

(5) MG/SW operation
(This switch is operated automatically.)

(6) Check the charging voltage soft start function (refer to the monitor)

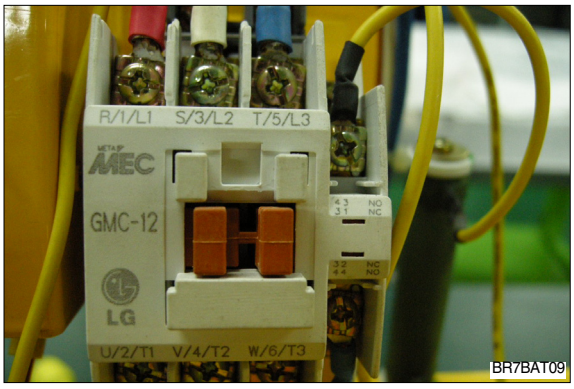
① After 5 seconds next to turn the manual switch on.
Input, floating charge and red charging condition lamp is on.

② After 15 seconds next to turn the manual switch on.
Yellow charging condition lamp is on while charging.

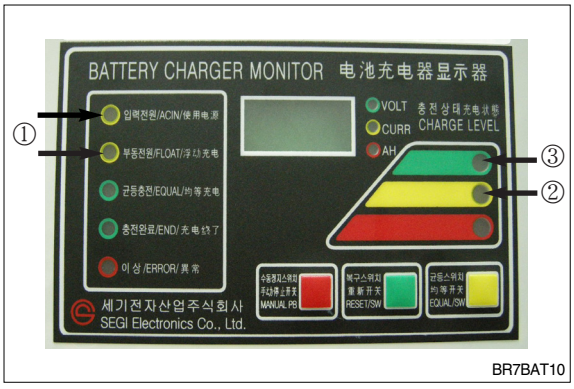
③ After green lamp becomes on, measure the output voltage of the battery connector by multi measure. If measured voltage is between 62.5V ~ 63.5V, it is normal. (Rated voltage : 63V)

④ After 30 seconds next to turn on the manual switch, if buzzer rings for 10 seconds and END lamp is on, it is under normal condition.

※ **When yellow lamp under charging condition is on after 1~2 times repetition, convey the automatic/ manual switch to the automatic and check if the charger trips automatically.**



BR7BAT09

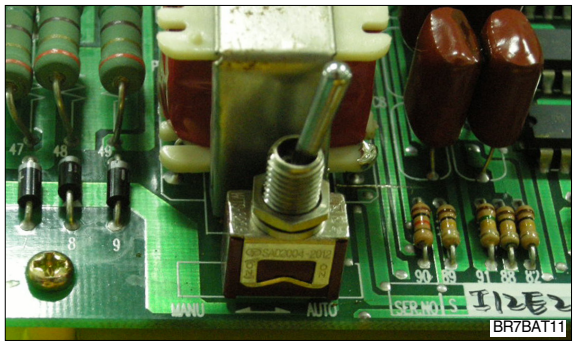


BR7BAT10

(7) If charger's out voltage is under 60V, it is abnormal.
Please refer to the error sheet.

(8) When the charging voltage is indicated as normal condition (63V), convert automatic / manual switch to automatic and start charging.

※ **Display error code on the front cover as following table.**



No	Code	Description of error
1	E.F	EPROM fail
2	O.V	Over voltage - Refer to page 7-73
3	O.C	Over current - Refer to page 7-72, 74.
4	F.B	Battery error (After starting charging, the voltage doesn't go over 52V for 2 hours.) Check the battery.
5	O.T	Transformer over heat (Stop charging when it is over 160˚C). - If input voltage is high, output current is over normal value and there is heat in the trans because of SCR control part fault. - Check the output current and PCB control board
6	O.H	Heatsink over heat (Stop charging when it is over 100˚C). - Check the cooling fan, SCR connection cable contact point and control part.
7	A.O	Power supply error (input power 220/380V wrong wiring). - Refer to page 7-71.
8	A.F	Power supply error (absent phase) - Check if input cable is open.
9	A.C	AC fail (black out) - Check if input voltage is right.
10	L.C	Low current (If this sign is on for setting value (60 sec), charging is over).
11	F	Manual stop.

5) CHECK POINTS BEFORE APPLYING A/S

(1) AC input power source switch is input.

(2) Check if the battery connector of the forklift truck and charger's connector are connected.

(3) Check points when "Error" lamp is on in the front monitor of the charger.

(4) Check the front cover indicator.

① A.F : Input three phase power source continuity check = Check if input three phase power source is normal with AC voltage meter.

② A.O : Error on selection of input power source of 220V or 380V - Check it appropriately with full three phases.

③ A.C : Check if the input power source (220V or 380V) is normal.

④ O.C : Check the electric current, as charging current of the battery is over-standards condition.

⑤ O.V : Check the voltage, as charging voltage of the battery is over-voltage condition (66V).
Normally it is 63V±1V.

(5) Check other abnormalities as well. Then apply for A/S when on-site measurements are not applicable.

BR7BAT10

6) ERROR DETECTION

(1) Error list

① Only floating charge lamp is on in the monitor but it is not charged.

② ON and OFF is repeated with a few minutes intervals even after starting charging.

③ Charger TRIP is occurred after abnormality lamp is on.
In case error code is "O.V"

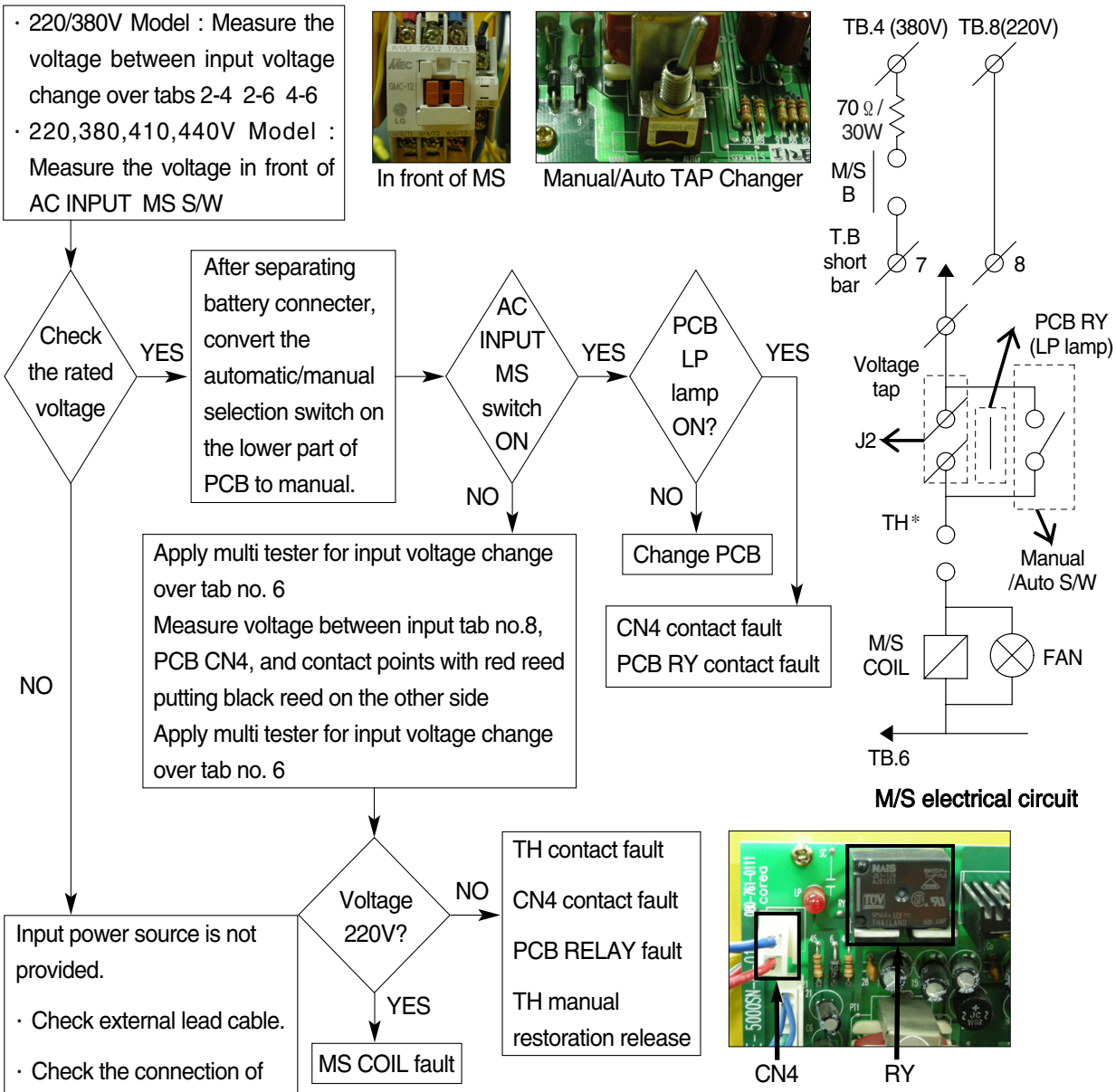
④ Charger TRIP is occurred after abnormality lamp is on.
In case error code is "O.C"

⑤ Charger TRIP is occurred after it started charging and charging completion lamp is on.

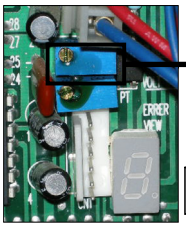
⑥ Charger has no response even the battery connector is connected.

(2) Troubleshooting

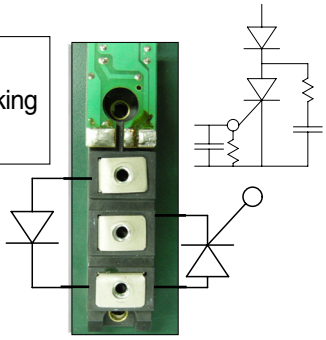
① Only floating charge lamp is on after indicating "A.O", It's not charged.



② ON and OFF is repeated with a few minutes intervals after starting charging.
Indicate "O.C" on the monitor.
- TH is operated (AC input over-current TRIP).

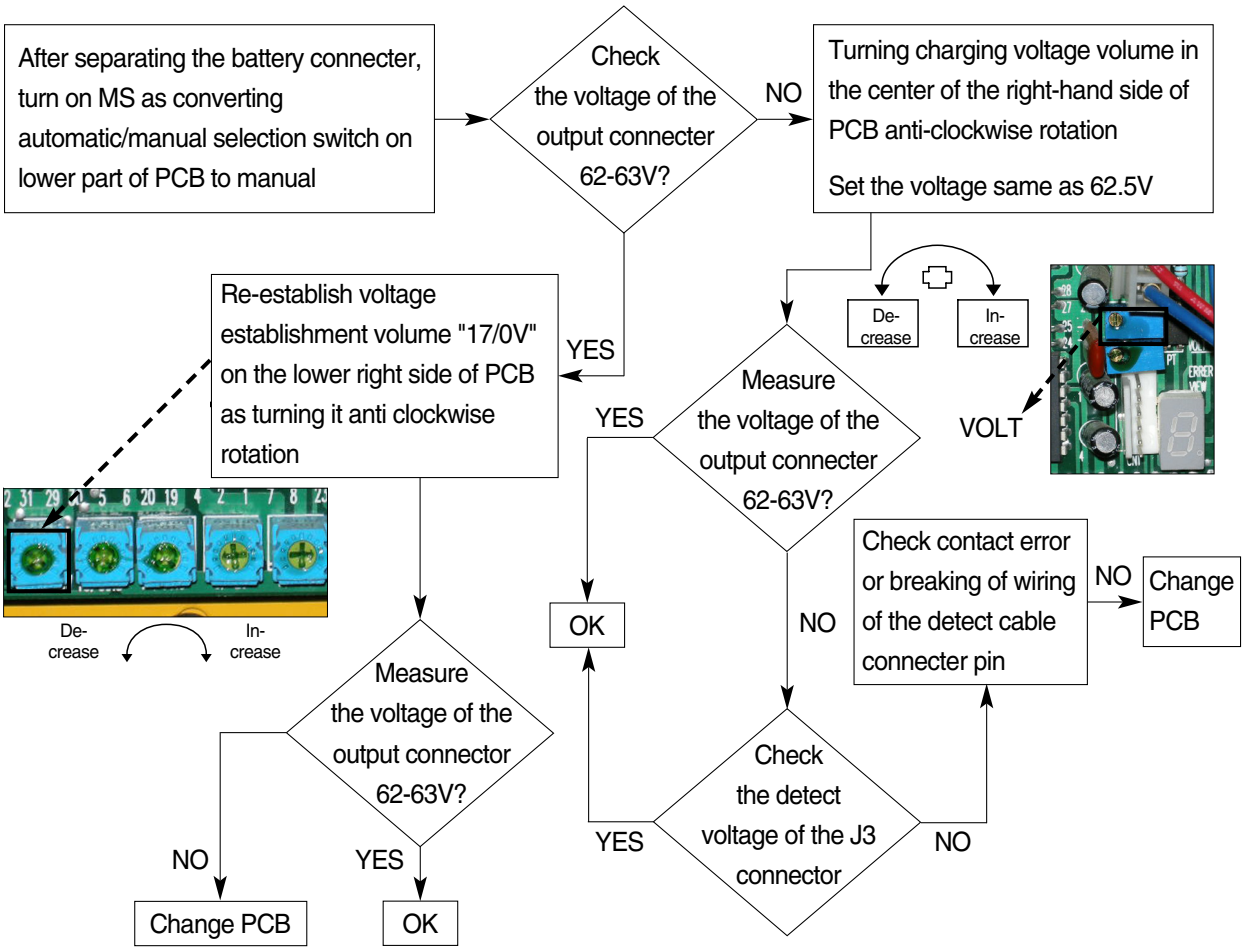


Serious trans noisy under the condition. Is MS on?
NO
Measure output current using DC current measure
Current value : 15~20A /100AH
NO
Exceed Standard current
Adjust output current within PCB Re-adjust to VR
YES
· TH Setting fault
· Re-adjust TH setting value
TH. TRIP
YES
Change TH
NO
Complete
Rated Current SETTING
YES
NO
Complete
Change PCB
YES
* Refer to SCR Module checking method

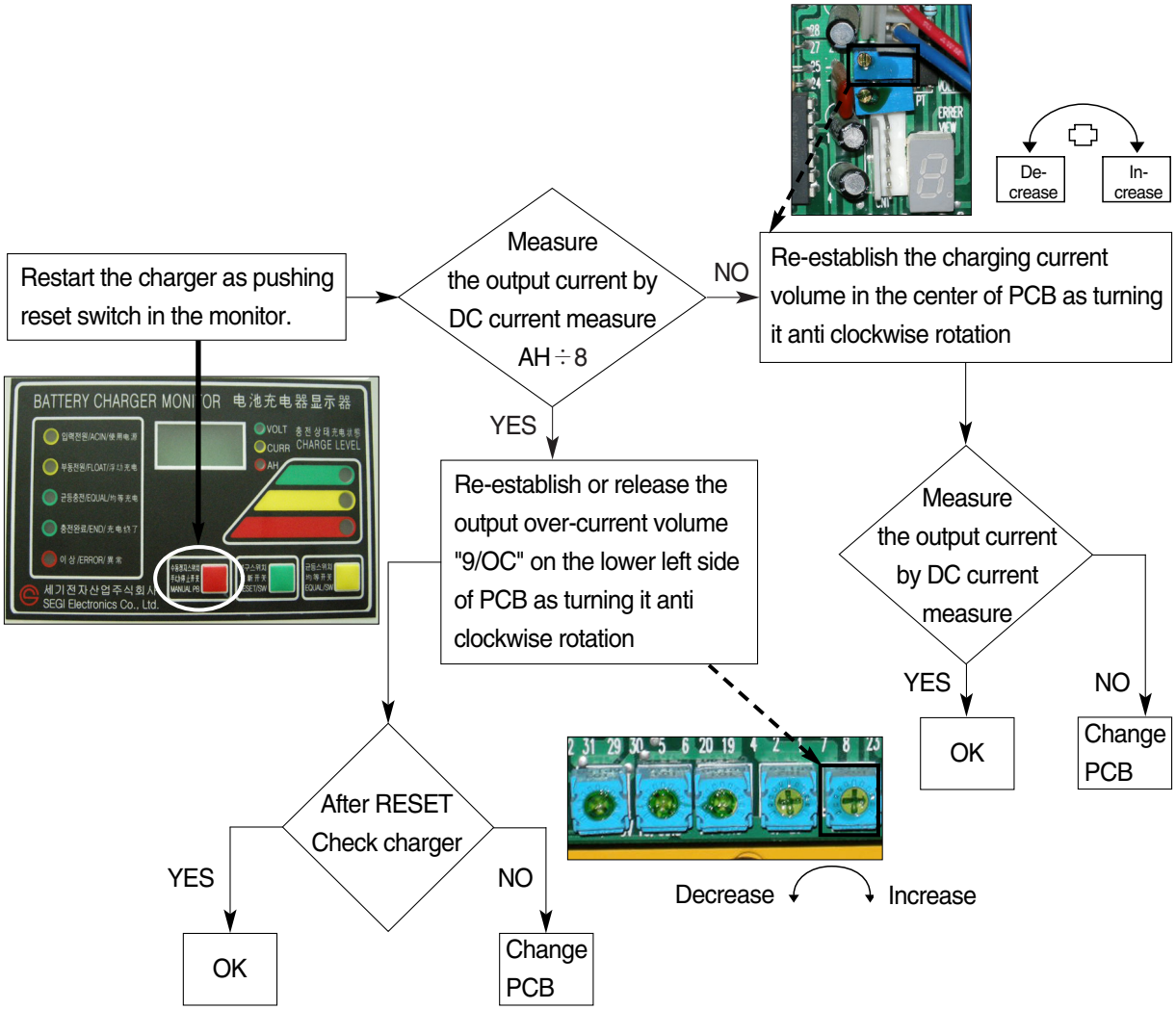


NO
Change SCR MODULE
Separate the battery connector and tune the charger off
Check SCR Module
YES
Check MAIN TRANS VOLT
NO
Change PCB
Check the normal operating condition of the charger
YES

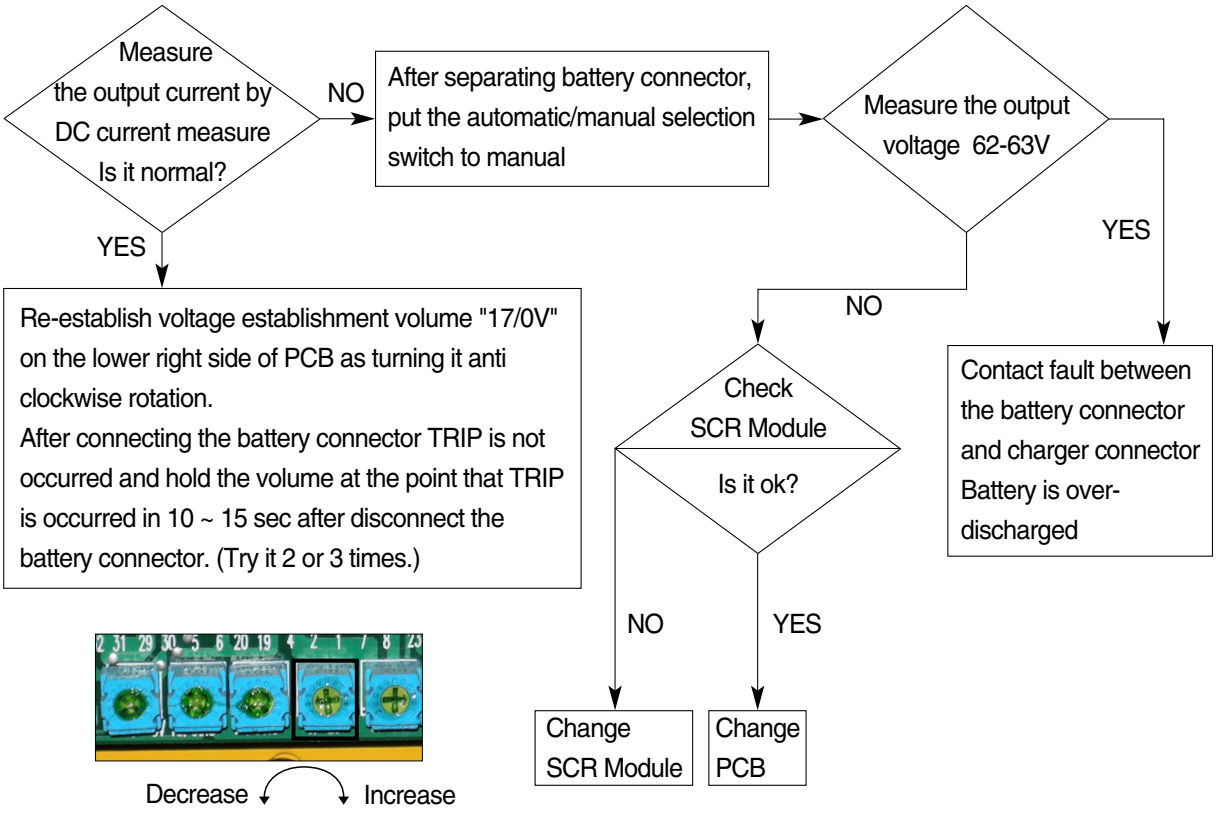
③ **Charger TRIP is occurred after abnormality lamp is on.**
In case error code is "O.V" → Over-voltage output / Set at 66Vdc (In case of BATT 48V)



④ **Charger TRIP is occurred after abnormality lamp is on.**
In case error code is "O.C" → Output over current, established as 120% of the rated current.

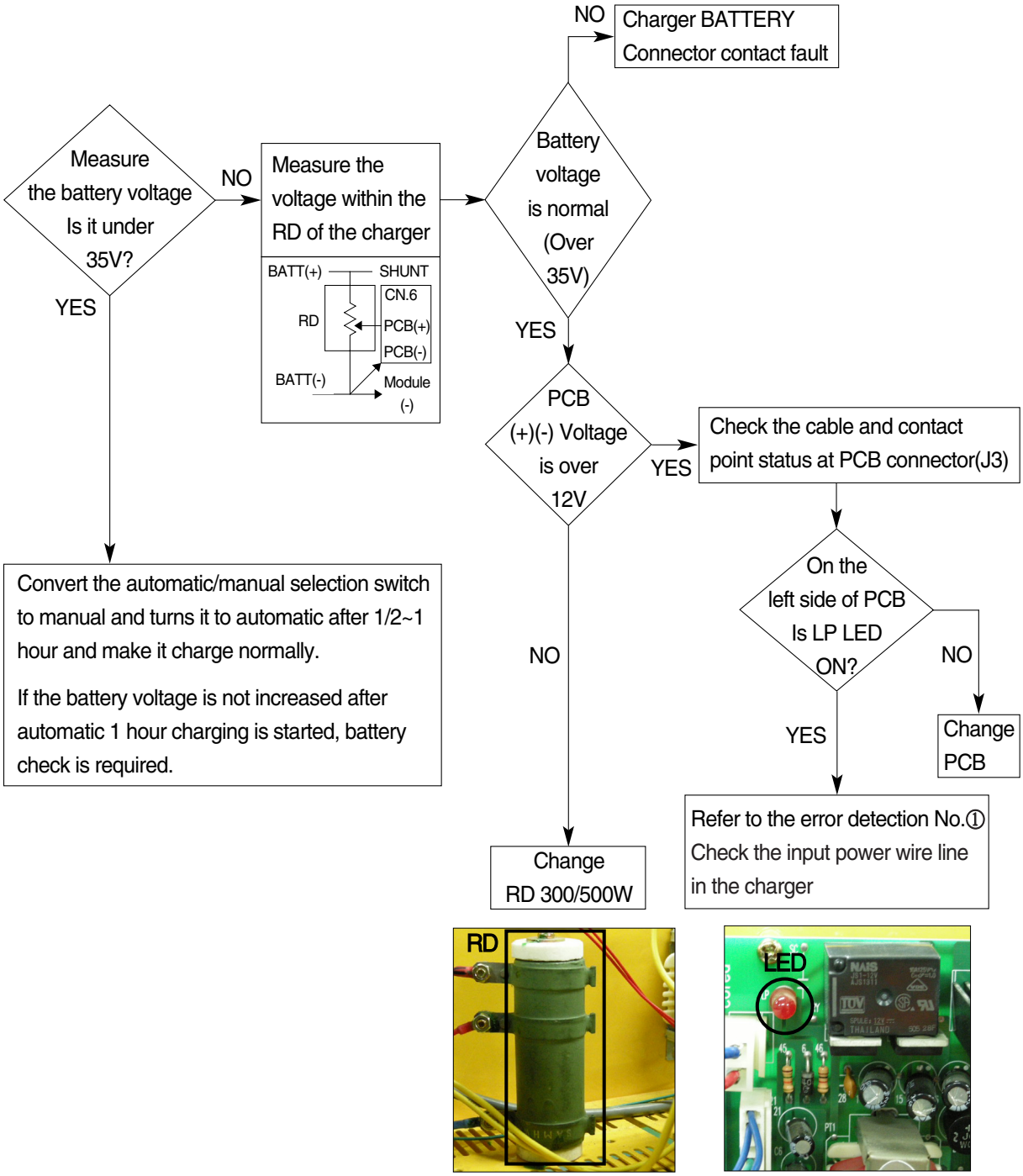


⑤ Charger TRIP is occurred after it started charging and charging completion lamp is on.
(In case input voltage is normal - Refer to the error detection No. 1)
Restore the charger as pushing reset switch.



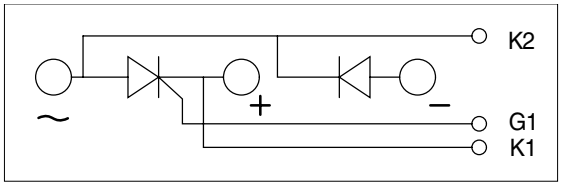
⑥ Charger has no response even if the battery connector is connected.

- In case only floating LED is on, charger input power is cut off or doesn't connect. (In case the input voltage is normal - Refer to the error detection No. ①)

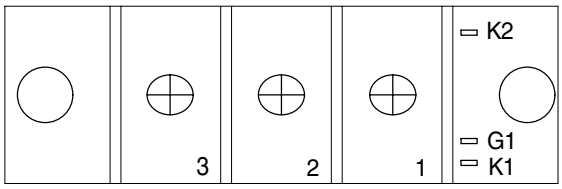


7) HOW TO CHECK THE SCR MODULE

Circuit

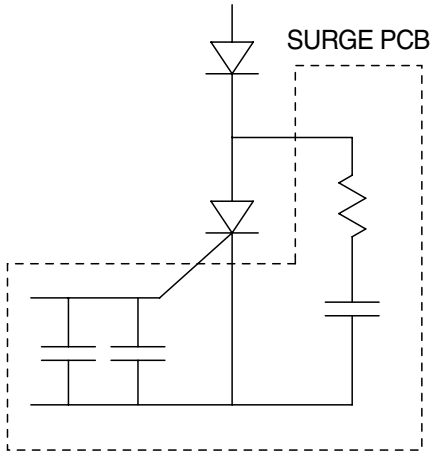


Real diagram

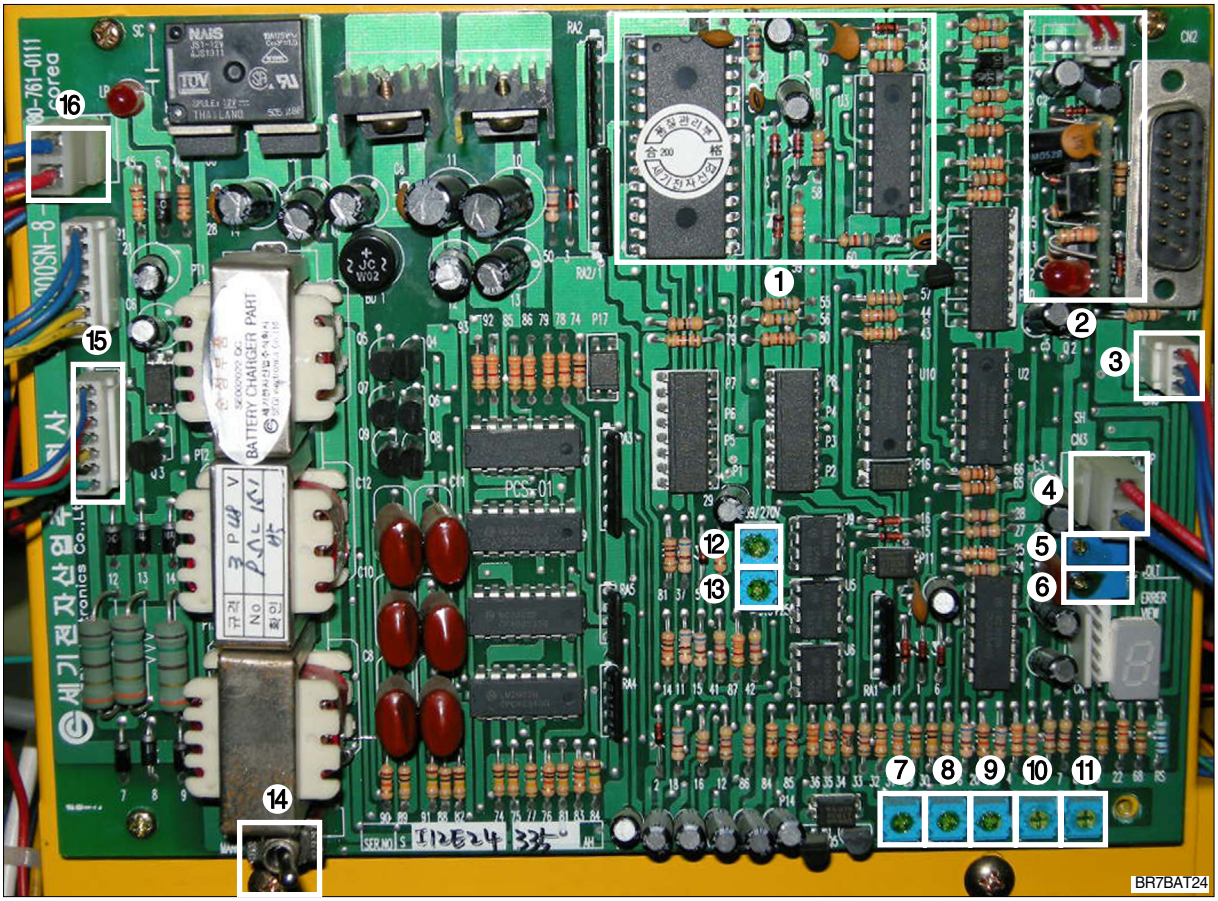


* Before checking SCR MODULE, be sure to disconnect bus bar and wire on the terminal.

No.	Measuring point (Real diagram)	Measure value
1	No.1 ~ No.3	Forward : Under 100 kΩ Reverse : Infinity (∞)
2	No.2 ~ No.3	Forward : Infinity (∞) Reverse : Infinity (∞)
3	G1 ~K1	Forward : Under 100 Ω Reverse : Under 100 Ω But It depends on the module. If it is not 0 Ω , It is Ok.
4	G1 ~ K2	Forward : Infinity (∞) Reverse : Infinity (∞)



8) PCB MAJOR PARTS NAME AND LOCATION



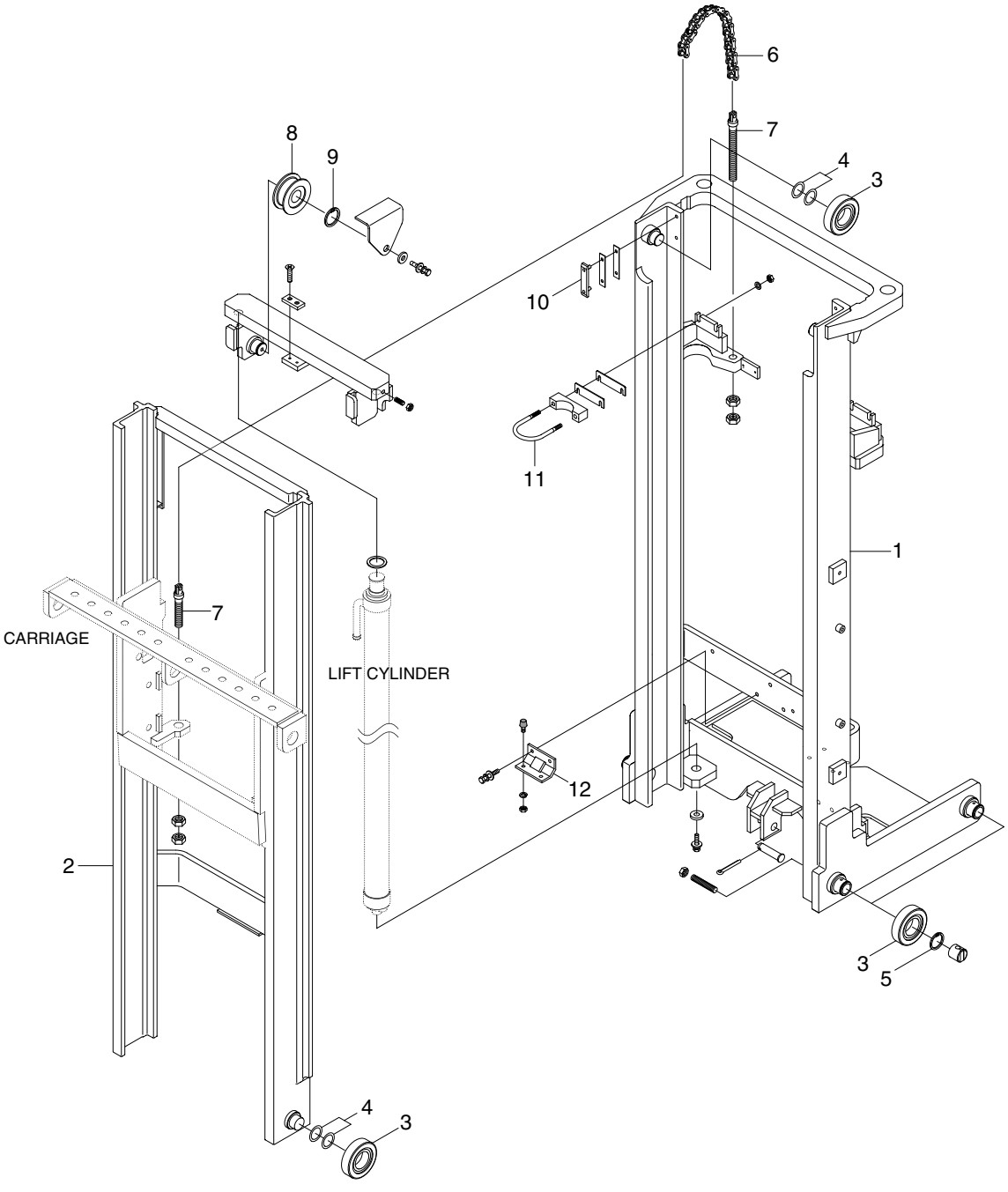
1	Micro control unit #1	7	Over voltage	13	Set input over current
2	Micro control unit #2	8	Monitor level yellow	14	Auto/manual switch
3	CN6 voltage detect	9	Monitor level green	15	SCR control connector
4	SH current detect	10	Under current	16	CN4 RY contact point
5	Adjust charging current	11	Over current		
6	Adjust charging voltage	12	Set input over voltage		

SECTION 8 MAST

GROUP 1 STRUCTURE

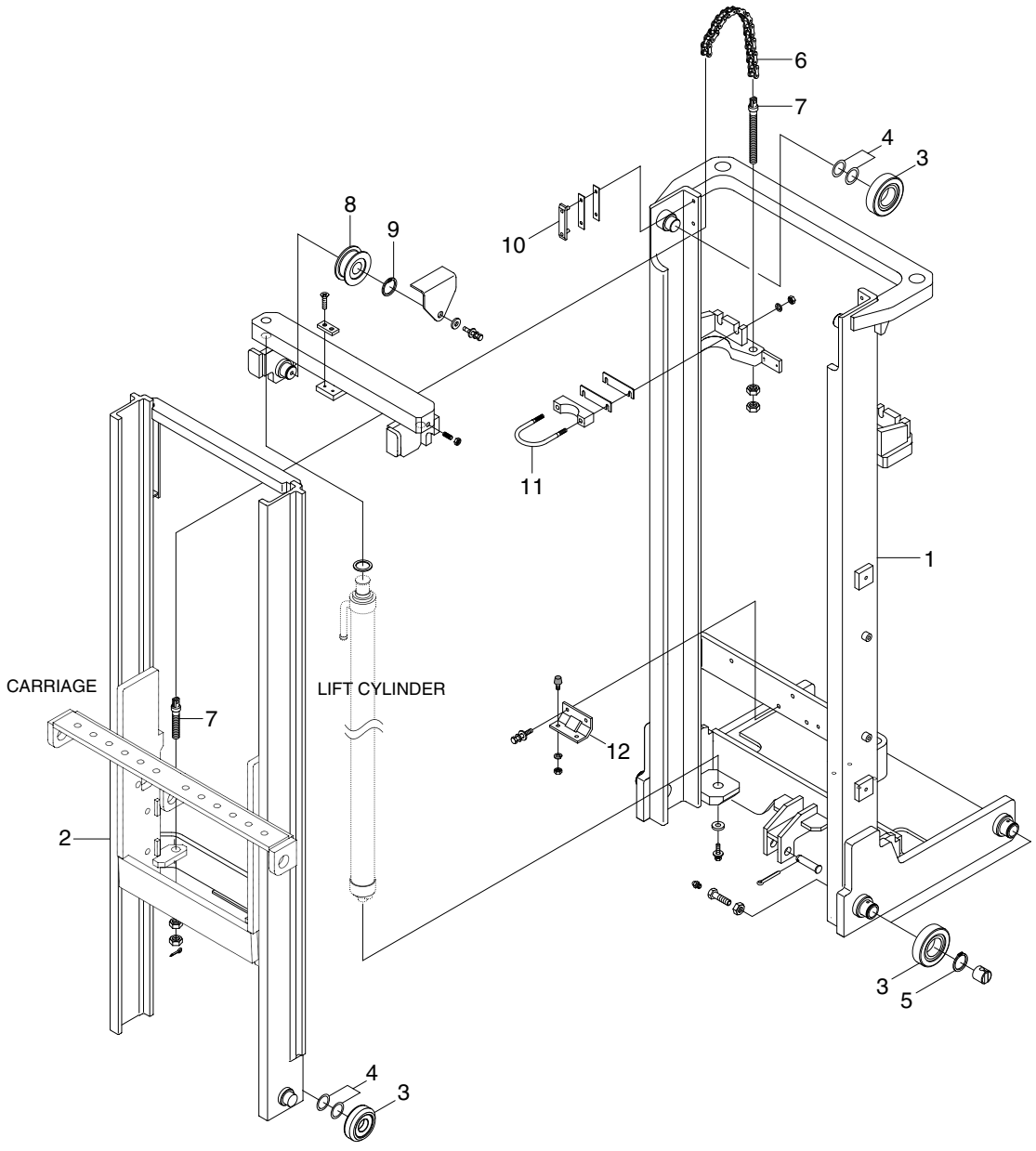
1. 2 STAGE MAST(V MAST)

1) 10/13/14/15/18BR-7



1	Outer mast	5	Retaining ring	9	Retaining ring
2	Inner mast	6	Lift chain	10	Back up liner
3	Roller	7	Anchor bolt	11	U-bolt
4	Shim(0.5, 1.0t)	8	Chain sheave	12	Inner support

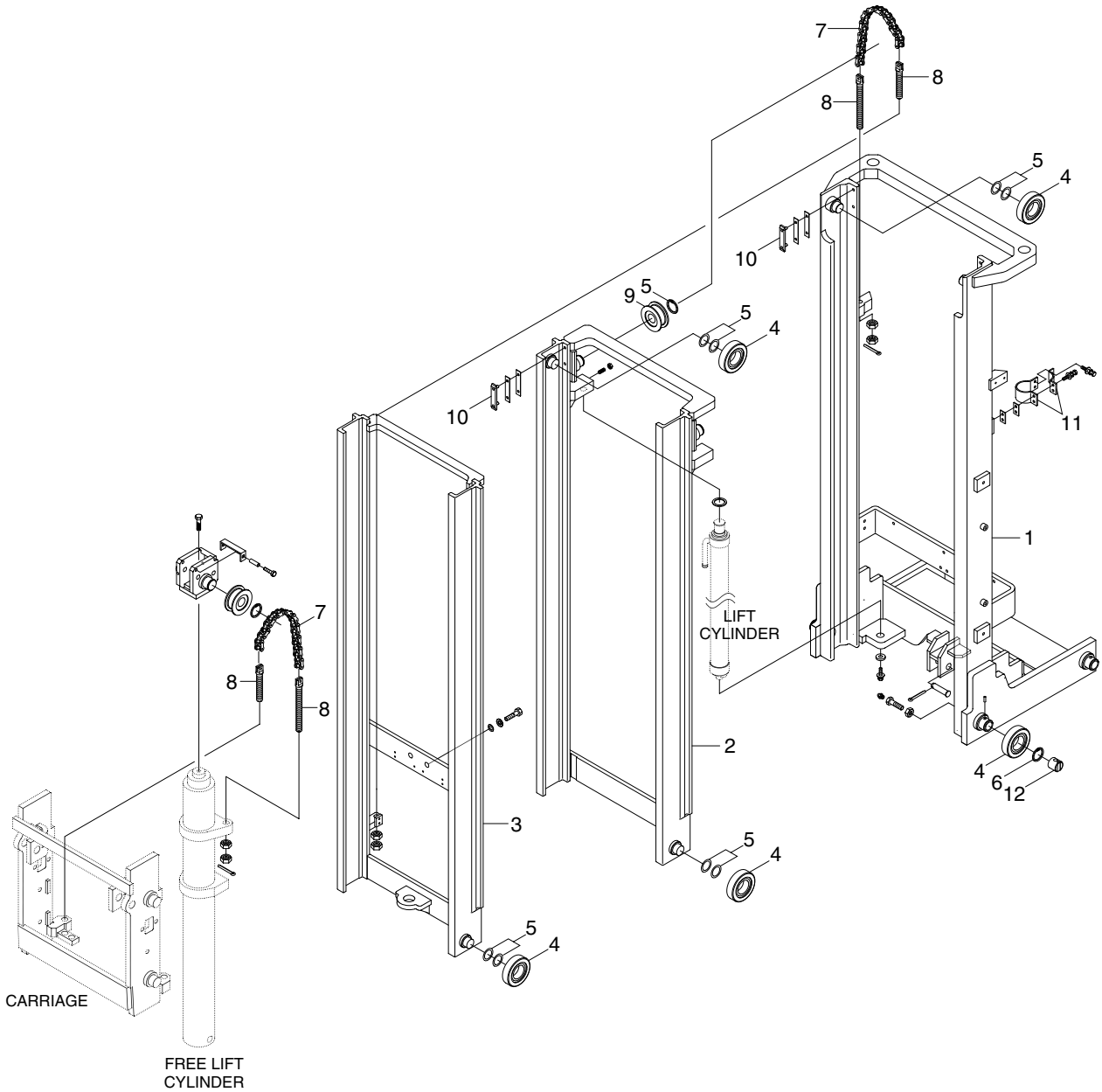
2) 20/25BR-7



BR7MS02

1	Outer mast	5	Retaining ring	9	Retaining ring
2	Inner mast	6	Lift chain	10	Back up liner
3	Roller	7	Anchor bolt	11	U-bolt
4	Shim(0.5, 1.0t)	8	Chain sheave	12	Inner support

2. 3 STAGE MAST(TF MAST)

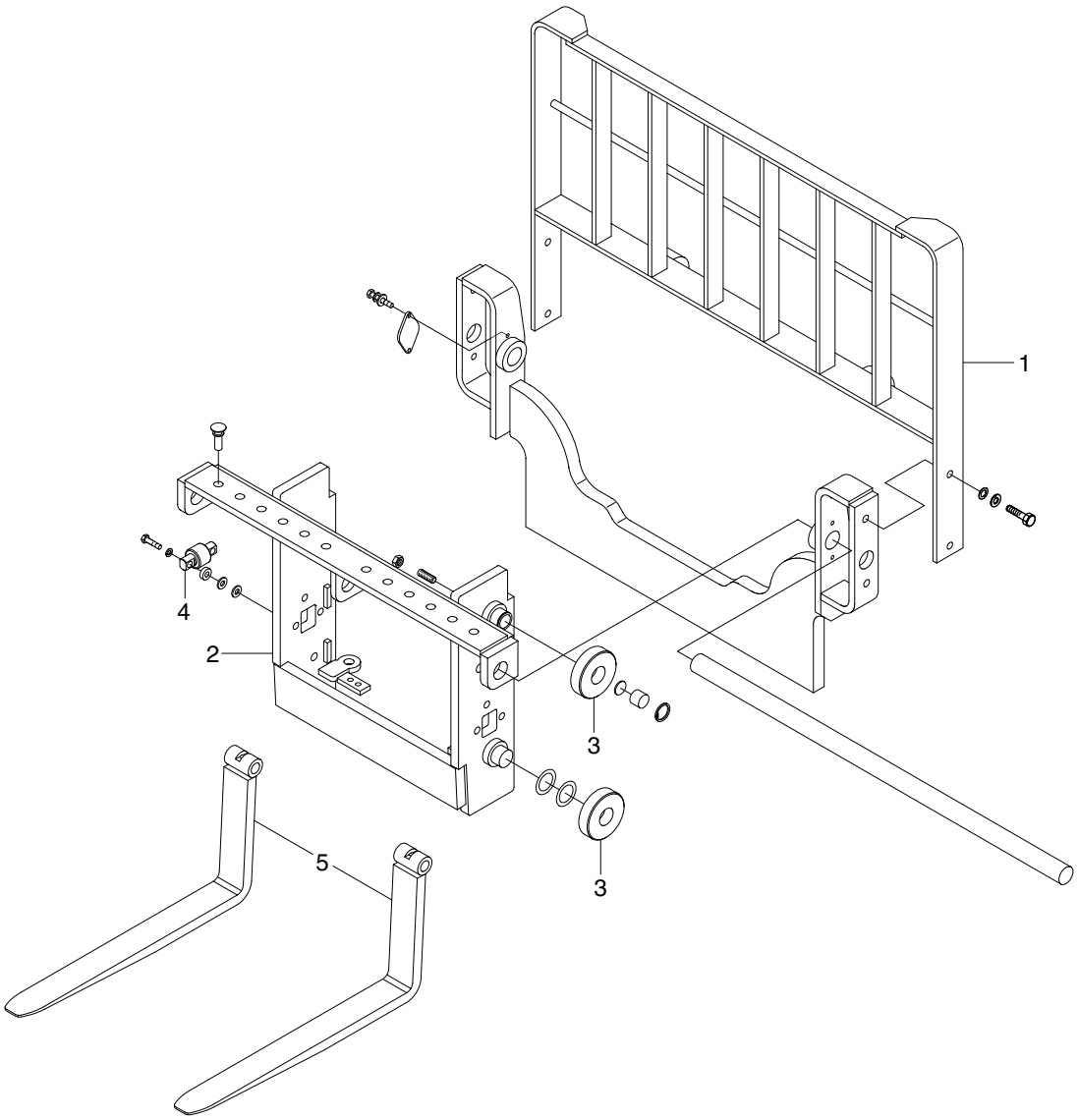


BR7MS03

1	Outer mast	5	Shim(0.5, 1.0t)	9	Chain sheave
2	Middle mast	6	Retaining ring	10	Back up liner
3	Inner mast	7	Lift chain	11	Cylinder clamp
4	Roller	8	Anchor bolt	12	Side roller bearing

3. CARRIAGE, BACKREST AND FORK

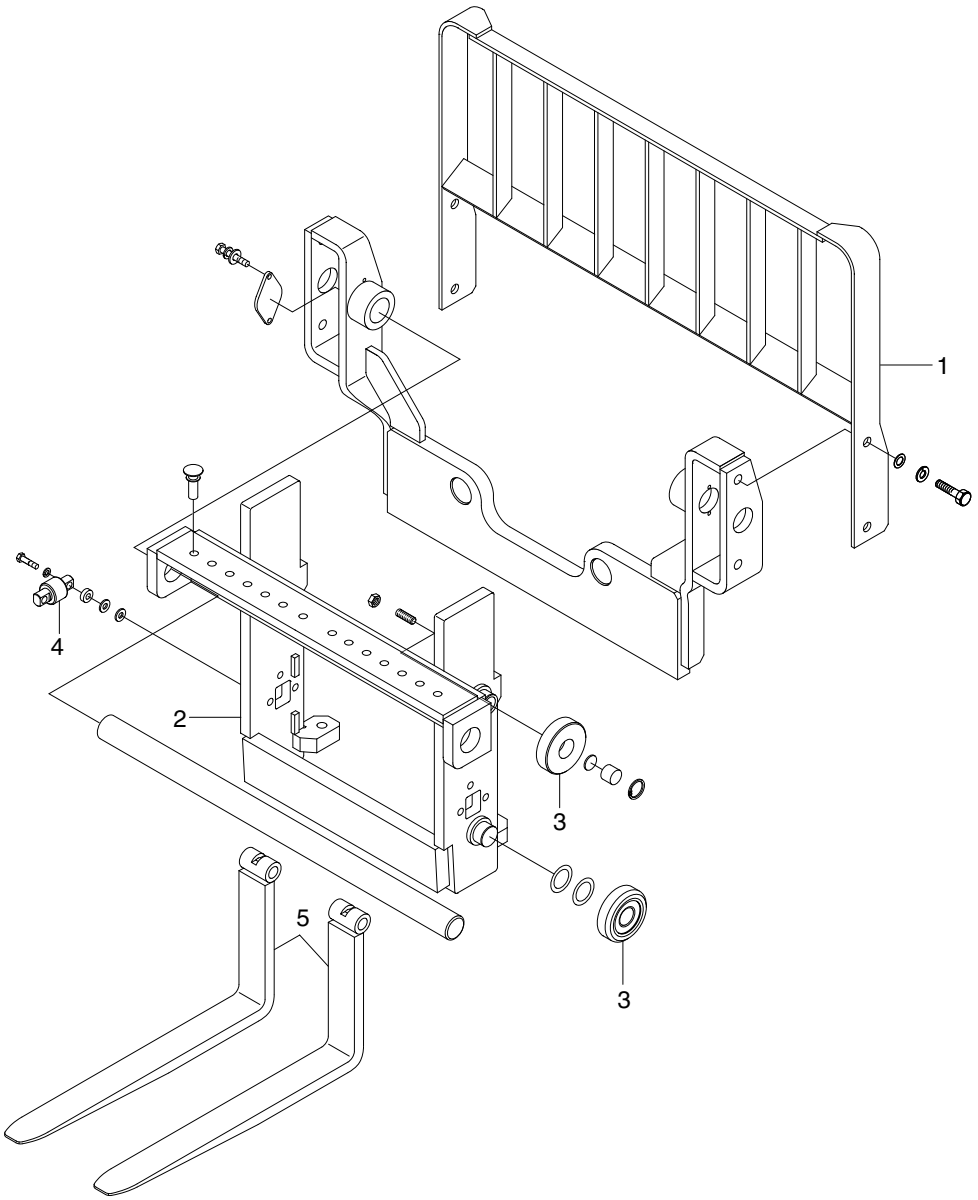
1) 10/13/14/15/18BR-7(SHAFT TYPE)



BR7MS04

1	Backrest	4	Side roller
2	Carriage	5	Fork assy
3	Load roller		

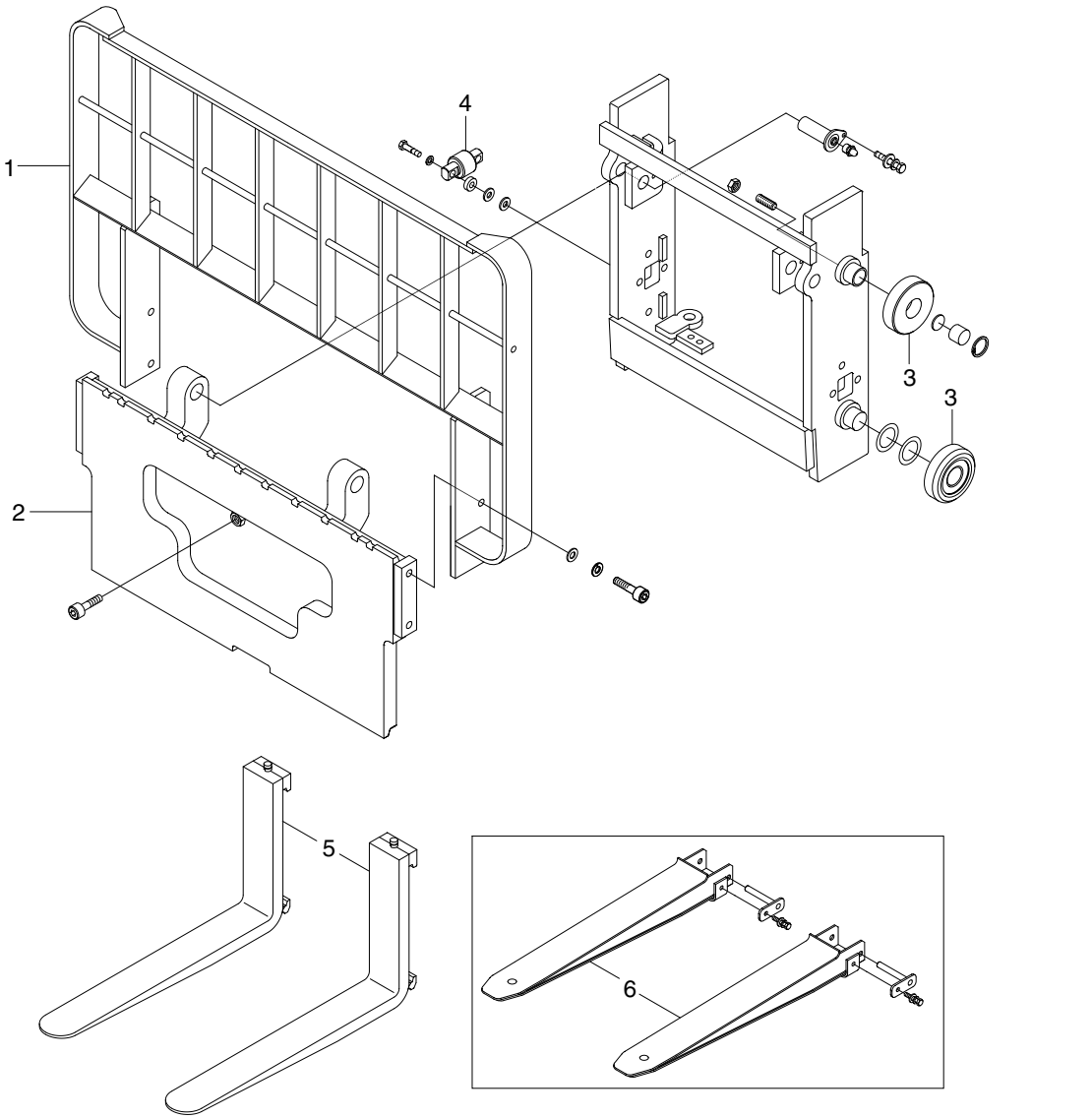
2) 20/25BR-7(SHAFT TYPE)



BR7MS04S

1	Backrest	4	Side roller
2	Carriage	5	Fork assy
3	Load roller		

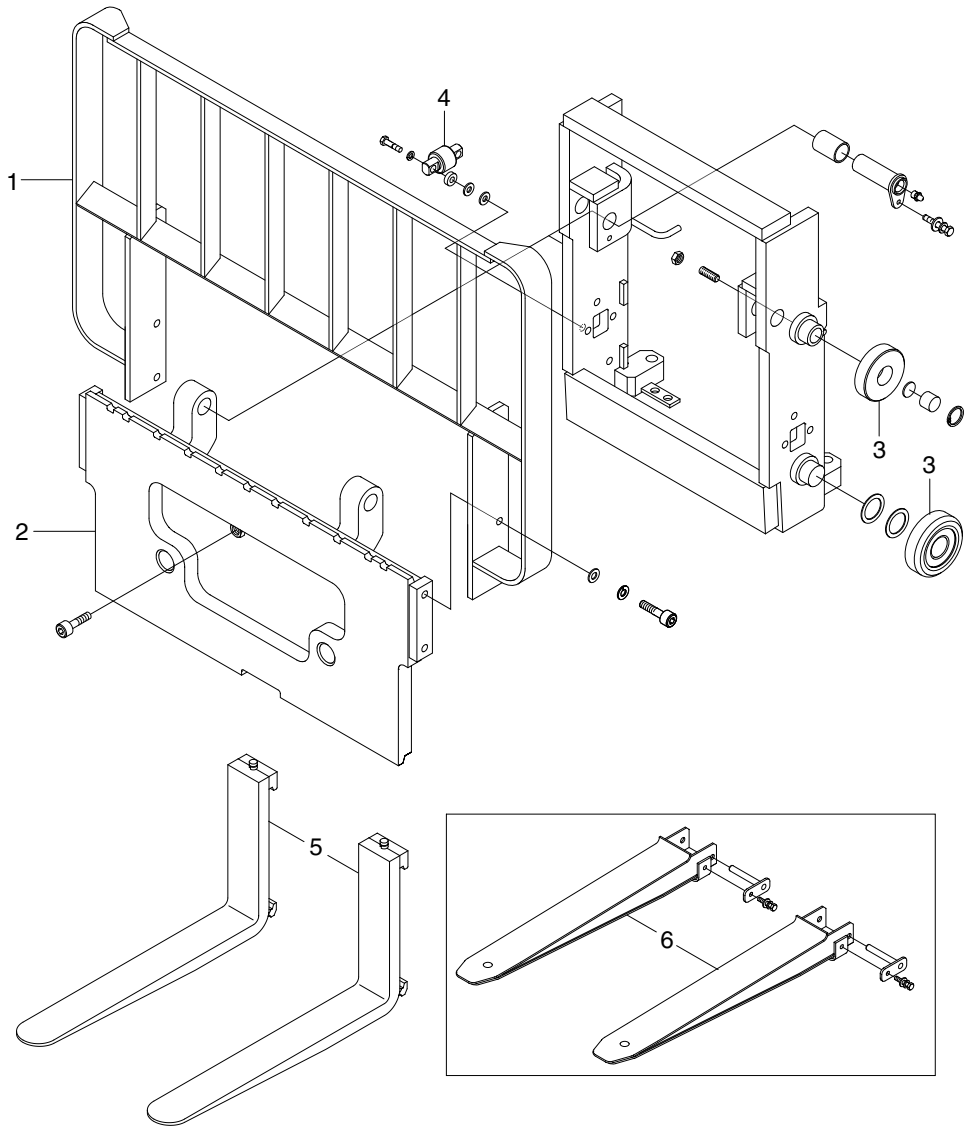
3) 10/13/14/15/18BR-7(HOOK TYPE)



BR7MS05

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

4) 20/25BR-7(HOOK TYPE)



BR7MS05S

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

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

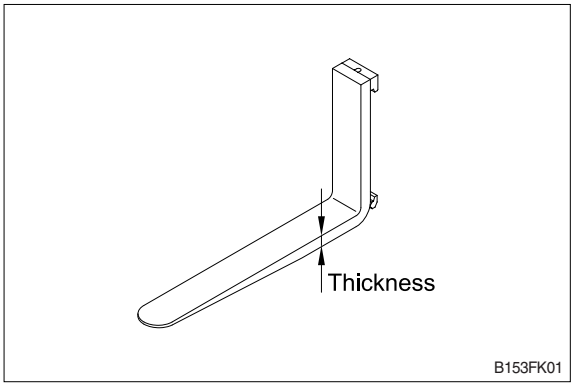
1. OPERATIONAL CHECKS

1) FORKS

(1) Measure thickness of root of forks and check that it is more than specified value.

mm(in)

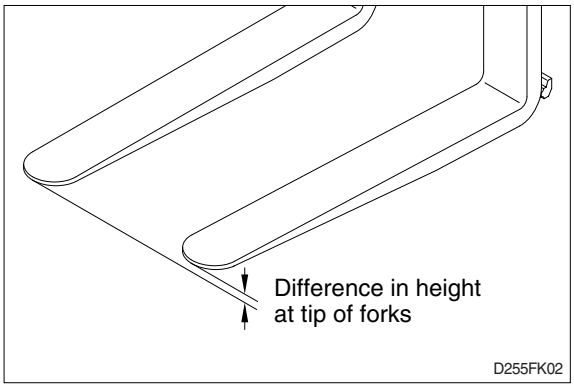
STD Fork assy	Applicable model	STD	Limit
64FY-12030	10/13/14/15/18BR-7	35(1.4)	32(1.3)
64HN-21010	20/25BR-7	45(1.8)	40(1.6)



(2) Set forks in middle and measure difference in height at tip of forks.

mm

Model	Fork length	Height difference
10/13/14/15/18/ 20/25BR-7	equal or below 1200	3
	above 1200	6



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

2. MAST

1) Check for cracks at mast stay, tilt cylinder bracket, guide bar, fork carriage and roller shaft weld. Check visually or use crack detection method. Repair any abnormality.
2) Set mast vertical, raise forks about 10cm from ground and check front-to-rear clearance and left-to-right clearance between inner mast and fork carriage, and between outer mast and inner mast. Use these figures to judge if there is any play at roller or rail.
   - Front-to-rear clearance : Within 2.0mm(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

<table>
<tr><th>Problem</th><th>Cause</th><th>Remedy</th></tr>
<tr><td>Abrasion</td><td>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</td><td>If the measured value is below the wear limit, replace fork.</td></tr>
<tr><td>Distortion</td><td>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
<table>
<tr><th>Fork length (mm)</th><th>Height difference(mm)</th></tr>
<tr><td>equal or below 1200</td><td>3</td></tr>
<tr><td>above 1200</td><td>6</td></tr>
</table></td><td>If the measured value exceeds the allowance, replace fork.</td></tr>
<tr><td>Fatigue</td><td>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.</td><td>Repair fork by expert.
In case of excessive distortion, replace fork.</td></tr>
</table>

GROUP 3 ADJUSTMENT

1. MAST LOAD ROLLER(V MAST)

1) INNER/OUTER MAST ROLLER CLEARANCE ADJUSTMENT

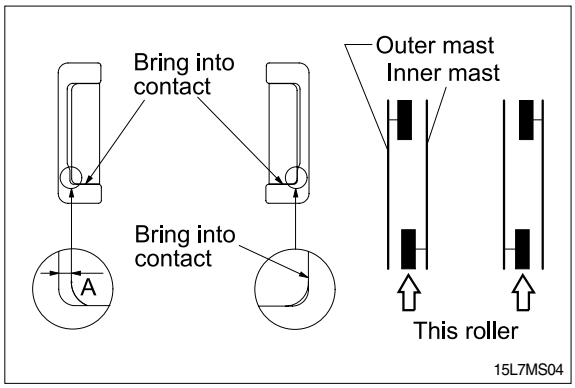
(1) Measure the clearance with the mast overlap at near 480mm.

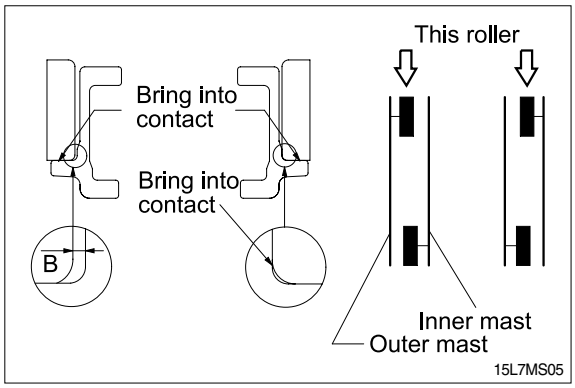
(2) Shift the inner mast to one side to bring the roller into contact with the outer mast, and adjust the clearance between the roller side face and mast at the closest position on the opposite side to the following value by inserting the inner/outer mast roller shim.

- Standard clearance A, B = 0.3 ~ 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.

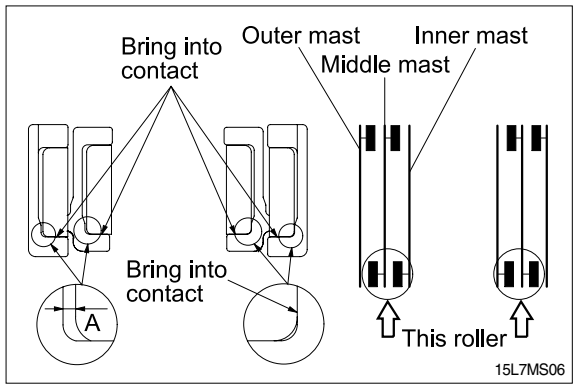
(4) After the adjustment, check that the inner mast moves smoothly in the outer mast.





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.

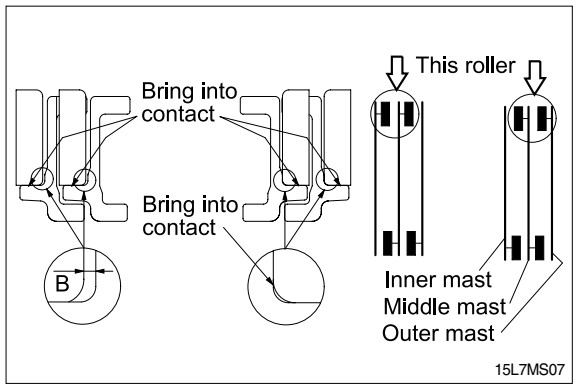
(2) Shift the inner mast to one side to bring the roller into contact with the outer mast and the middle mast, and adjust the clearance between the roller side face and mast at the closest position on the opposite side to the following value by inserting the inner and middle mast roller shim, respectively.

- Standard clearance A = 0.3~0.6mm
- 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.

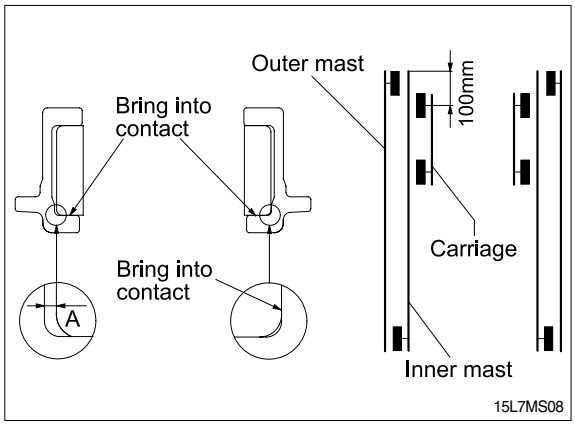
(2) Shift the inner mast to one side to bring the roller into contact with the middle mast and the inner mast, and adjust the clearance between the roller side face and mast at the closest position on the opposite side to the following value by inserting the outer and middle mast roller shim, respectively.

- Standard clearance B = 0.3~0.6mm
- 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 100㎜ from the top of the inner mast.

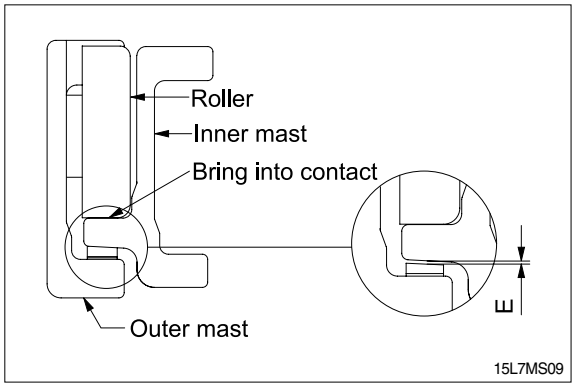
(2) Measure the clearance at upper, lower rollers after loosen the adjust screws from the side rollers. Shift the carriage to one side to bring the roller into contact with the inner mast, and measure the clearance between the roller side face and mast at the closest position on the opposite side to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

- Standard clearance C = 0.3~0.6㎜
- Shim thickness 0.5, 1.0㎜

(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 inner mast at the bottom position.

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

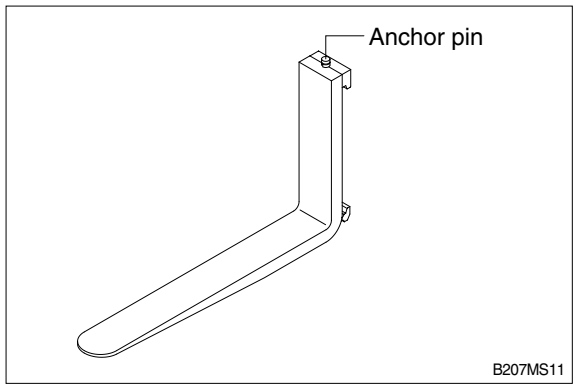
- Standard clearance E = 0.5 ~ 1.0㎜
- Shim thickness 0.5, 1.0㎜

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

GROUP 4 REMOVAL AND INSTALLATION

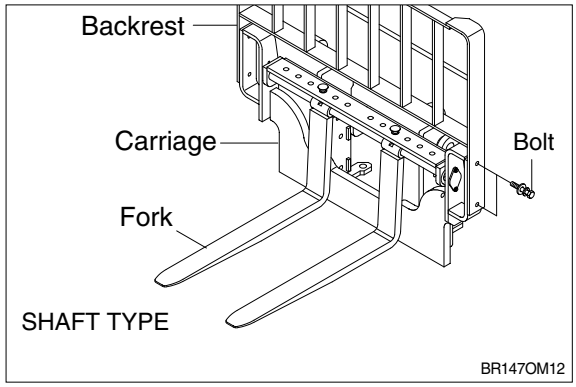
1. FORKS

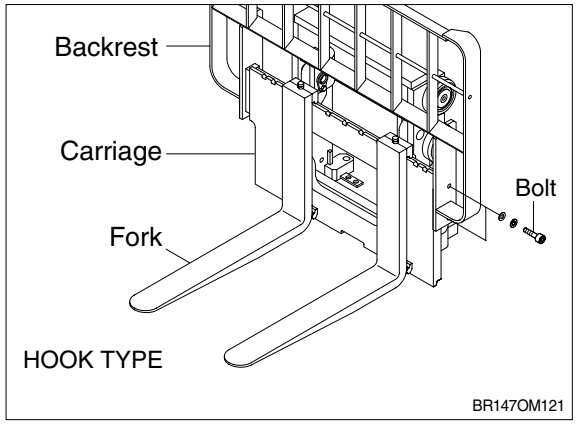
1) Lower the fork carriage until the forks are approximately 25mm(1inch) from the floor.
2) Release fork anchor pins and slide forks, one by one, toward the center of the carriage where a notch has been cut in the bottom plate for easy fork removal.
3) Remove the fork one by one. On larger forks it may 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.

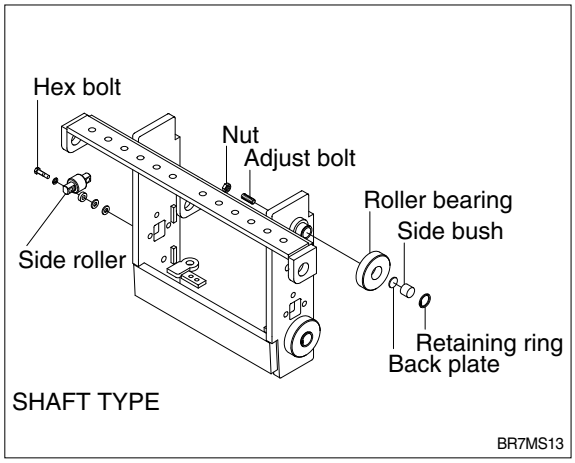
(2) Loosen and remove hex bolts and side rollers from carriage side pate.

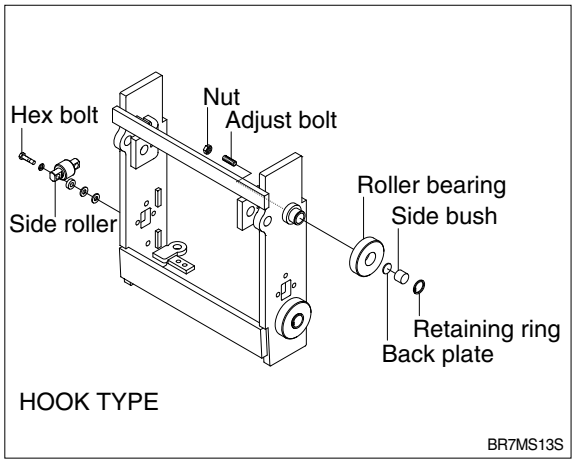
(3) Thoroughly clean, inspect and replace all worn or damaged parts.

(4) Reverse the above procedure to assembly.

※ **Adjustment**

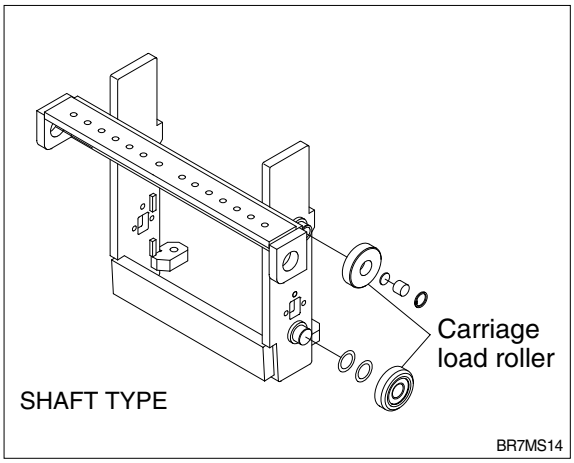
- Once carriage is properly installed, loosen hex bolts, (if not already done) allowing carriage to be centered in the inner mast.
- Adjust side roller by tightening hex bolts until side roller just makes contact with mast.
- Adjust side bush by tightening adjust bolts until side bush just makes contact with mast.
- 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.

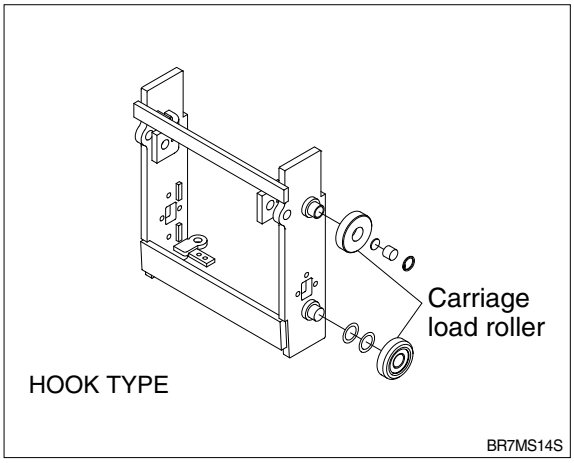




3) CARRIAGE LOAD ROLLER

(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.

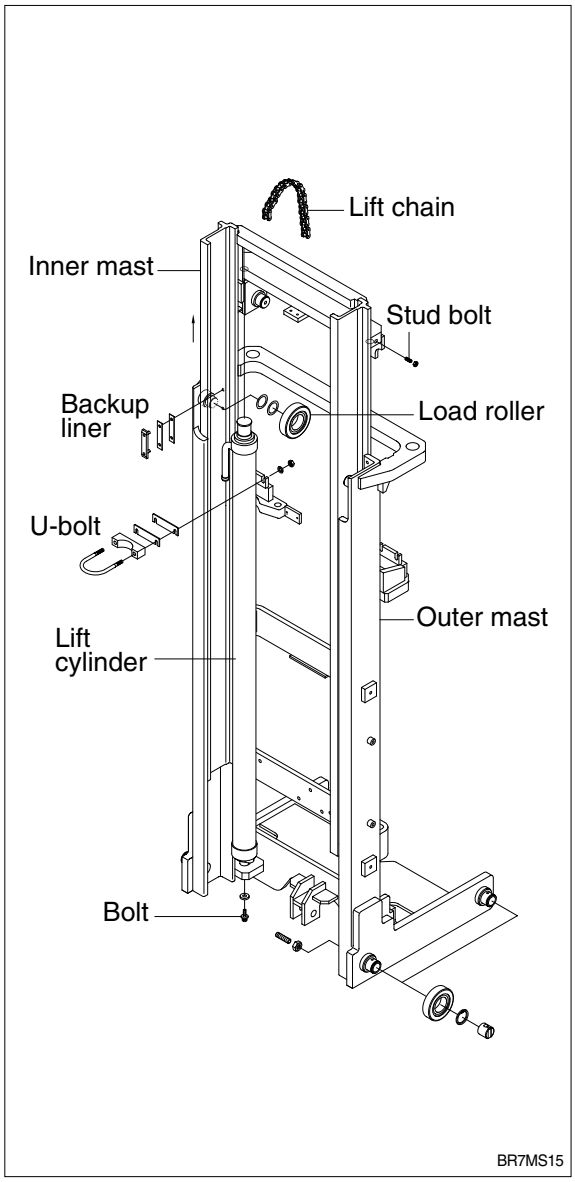




4) MAST LOAD ROLLER AND BACK UP LINER

(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 to one side.

② Loosen and remove hexagon bolt securing bottom cylinder from outer mast.

③ Loosen and remove bolts and special washers securing lift cylinders to middle mast.

④ Attach chains or sling to the inner and middle mast section at top crossmember. Using an overhead hoist, slowly raise the uprights high enough to clear lift cylinder.

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

⑥ Using the overhead hoist raise inner and middle masts. Place 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.

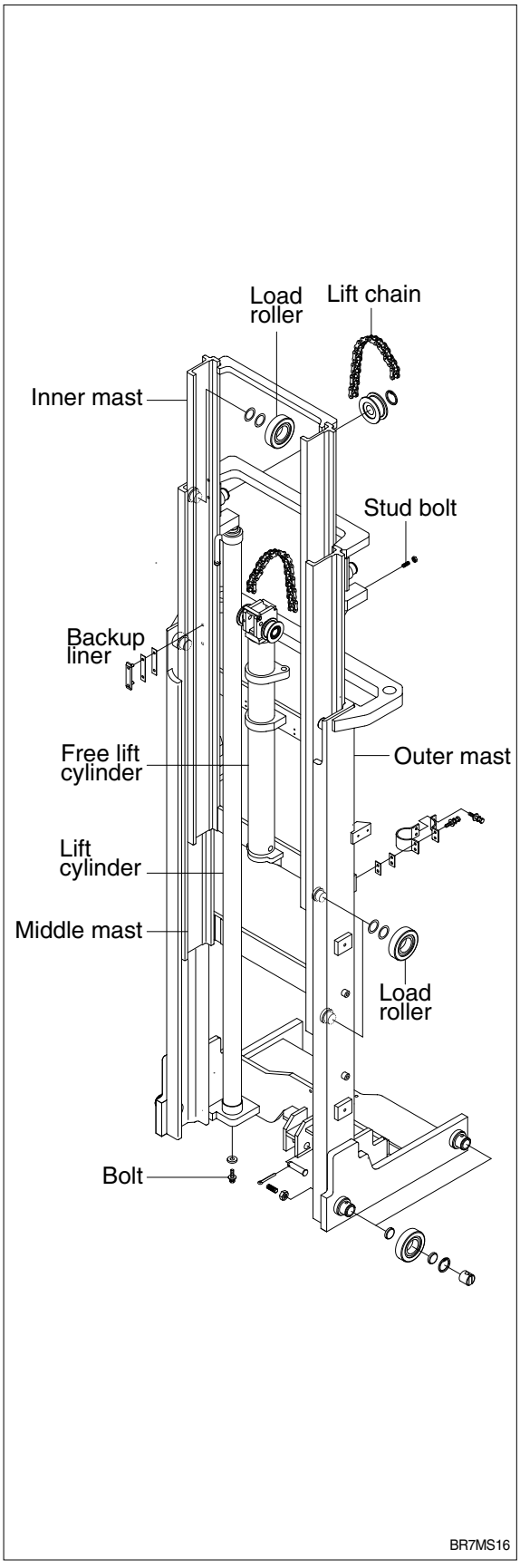
⑧ Using a pryer, remove load rollers from load bracket. Remove back up liners and shims.

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 player, 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.

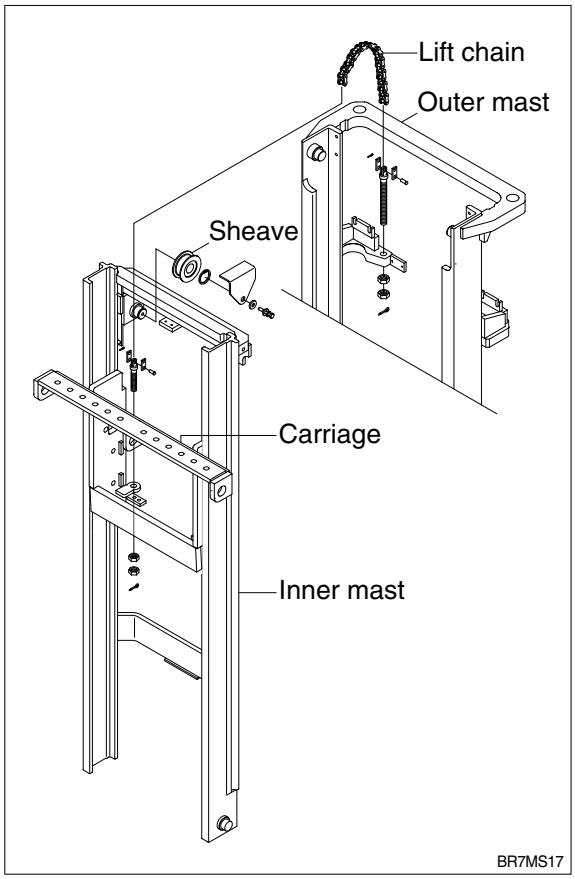
② Remove the split pin securing the chain anchor pins and discard. While supporting the chains, remove the chain anchor pins and drape the chains over the carriage.

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

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

⑤ Thoroughly clean, inspect and replace all worn or damaged parts.

⑥ Reverse the above to assemble and install. Use new split pins in chain anchor pins.



(2) Rear chain sheave(TF mast)

① Raise and securely block carriage and inner mast section.

② Remove the split pin securing the chain anchor pins and discard. While supporting the chains, remove the chain anchor pins from outer mast section.

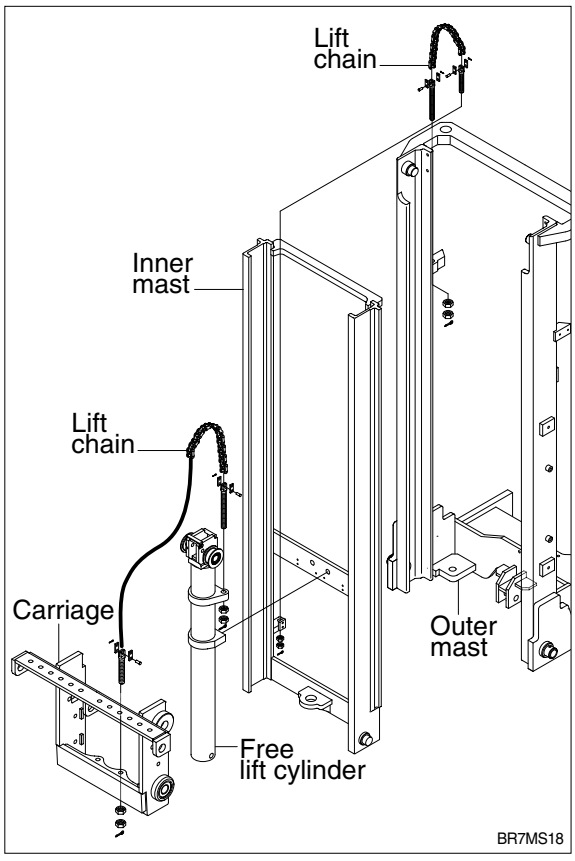
③ Remove chains.

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 wheel bearing support(TF mast)

① Remove the carriage assembly and move to one side.
② After removing bolt to securing chain wheel bearing support assembly to free lift cylinder.
After a sling to the chain wheel bearing 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 wheel bearing to chain wheel bearing support.
④ Remove bearing retaining ring from chain wheel bearing and press bearings from chain wheel bearings.
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 phenomenon that affects most metals and many plastics. After many repeated heavy loads, the plates may crack and the chains will eventually break. Fatigue cracks are almost always found through the pitch holes perpendicular to the pitch line. Contrast this failure mode to the random failures caused by stress-corrosion cracking. If cracks are present, replace all the chain on the truck. Noise in the chain indicates that the plate is on the verge of cracking and will be failed before long.

④ Tight joints

All joints in lift chain should flex freely. Tight joints resist flexure, increase internal friction, thus increasing chain tension required to lift a given load. Increased tension accelerates wear and fatigue problems.

Tight joints in lift chains can be caused by :

- Bent pins or plates.
- Rusty joints.
- Peened plate edges.

Oil rusty chains and replace chains with bent or peened components.

⑤ Protruding or turned pins

Heavily loaded chains operating with lube generate tremendous friction between pins and plates. In extreme cases, the frictional torque in the joint can actually turn pins in the press-fit outside plates. If chain is allowed to operate in this condition, the pins slowly work out of the chain causing chain failure. Turned pins can be quickly spotted because the flats on the V heads are no longer in line. Chains with turned or protruding pins should be replaced immediately. Do not attempt to repair the chain by driving pins back into the chain.

⑥ Chain side wear

A wear pattern on pin heads and outside plates indicates misalignment. This condition damages chain and sheaves as well as increasing internal friction in the chain system.

⑦ Chain anchors and 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 joints in the old chain will be greater than that on the new chain, greatly complicating the problem of maintaining equal chain tension. The new chain will wear more slowly causing it to bear the major portion of the load resulting in premature wear and fatigue failure. Don't steam clean or decrease new chains.

The manufacturer's grease is effective in reducing wear and corrosion. If the original factory lube is dried out or wiped off, soak the new chain in heavy engine oil for at 1/2 hour prior to installing on truck. After the old chains have been stripped from the mast, very carefully inspect chain anchors and chain wheel bearing. 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.