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 AND 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.

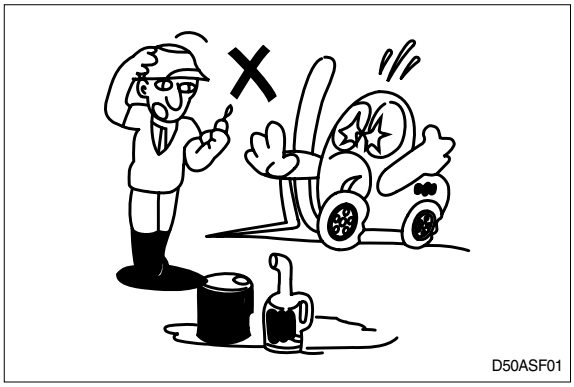
°C		°F	°C		°F	°C		°F	°C		°F
-40.4	-40	-40.0	-11.7	11	51.8	7.8	46	114.8	27.2	81	117.8
-37.2	-35	-31.0	-11.1	12	53.6	8.3	47	116.6	27.8	82	179.6
-34.4	-30	-22.0	-10.6	13	55.4	8.9	48	118.4	28.3	83	181.4
-31.7	-25	-13.0	-10.0	14	57.2	9.4	49	120.2	28.9	84	183.2
-28.9	-20	-4.0	-9.4	15	59.0	10.0	50	122.0	29.4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

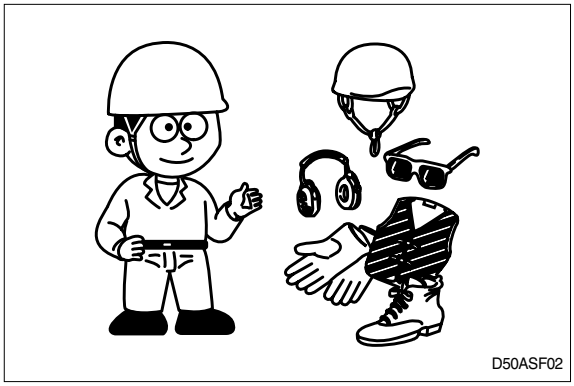
GROUP 1 SAFETY HINTS

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

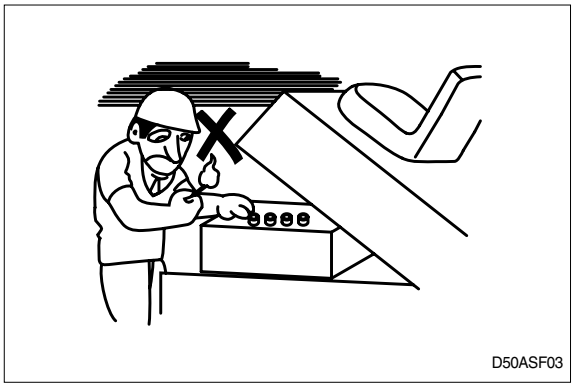
- Oil is a dangerous substance. Never handle oil, grease or oily clothes in places where there is any fire of flame.
  As preparation in case of fire, always know the location and directions for use of fire extinguishers and other fire fighting equipment.


D50ASF01

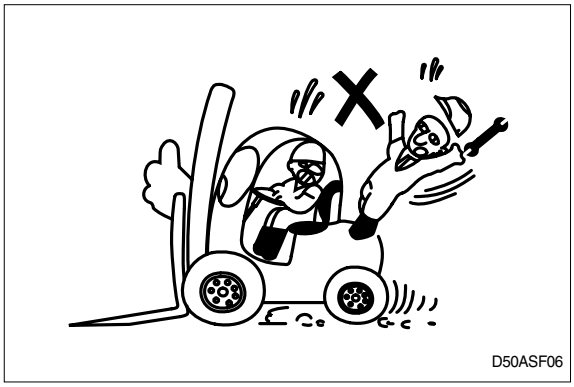
- Wear well-fitting helmet, safety shoes and working clothes. When drilling, grinding or hammering, always wear protective goggles.
  Always do up safety clothes properly so that they do not catch on protruding parts of machines. Do not wear oily clothes.
  When checking, always release battery plug.


D50ASF02

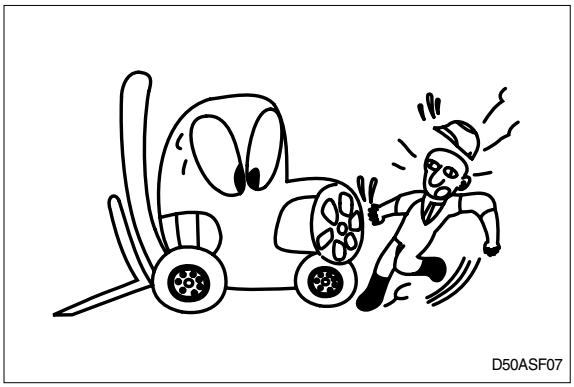
- Flames should never be used instead of lamps. Never use a naked flame to check leaks or the level of oil or electrolyte.


D50ASF03

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

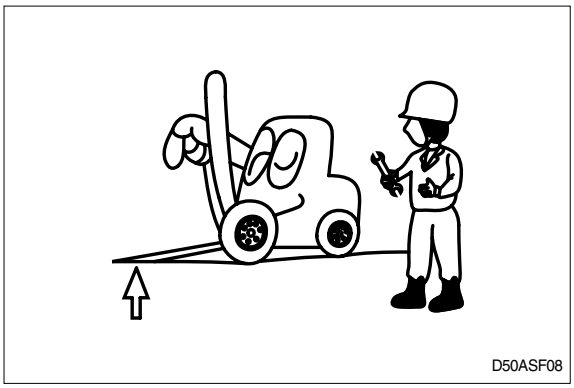

D50ASF06

· 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.

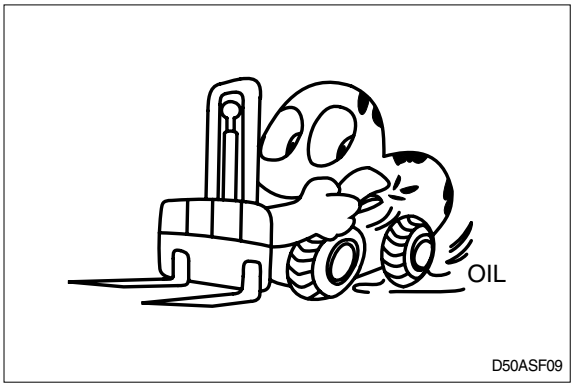

D50ASF07

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.

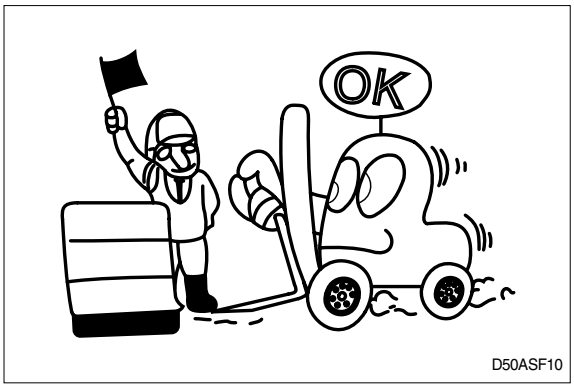

D50ASF08

· 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.



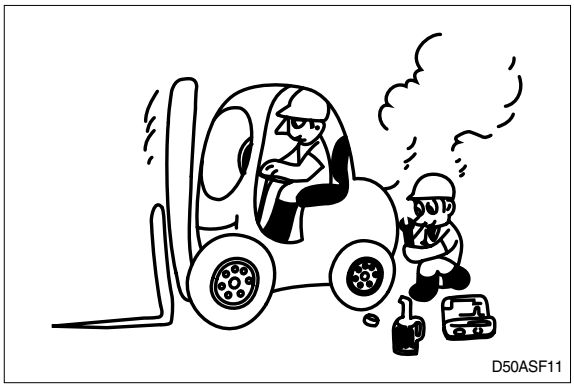
D50ASF09

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



D50ASF10

· 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.

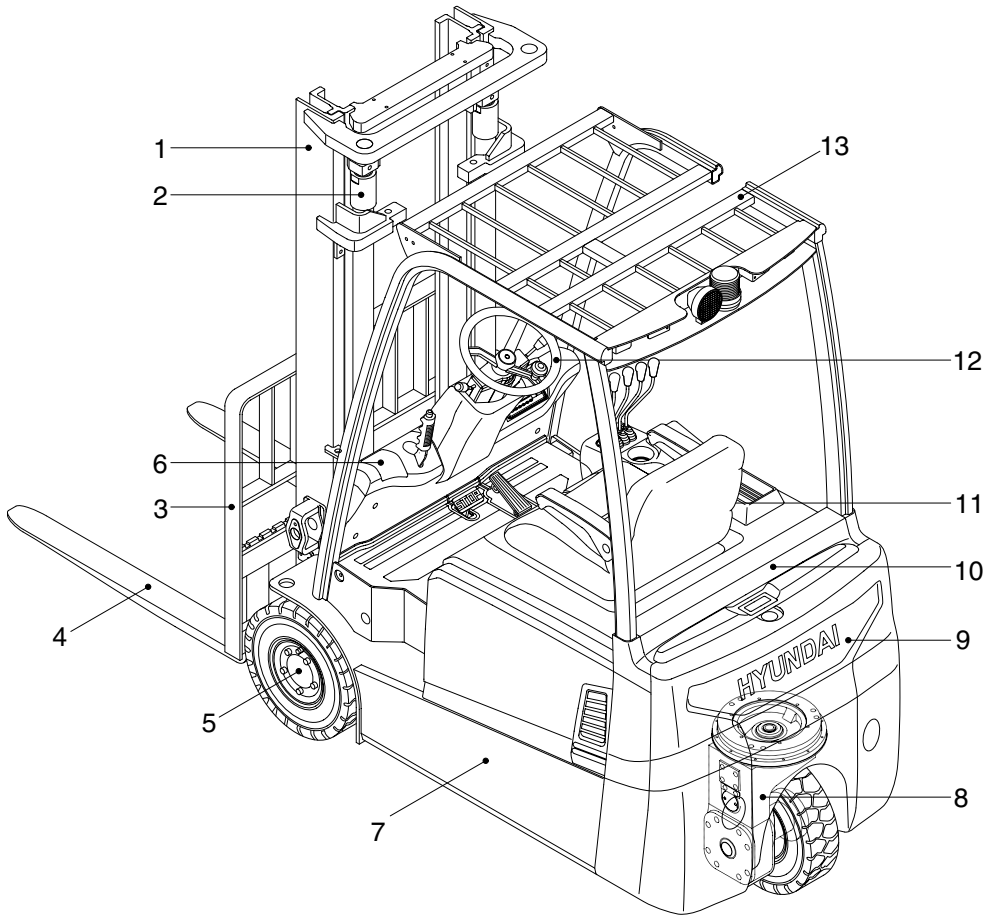

D50ASF11

· 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.
· 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

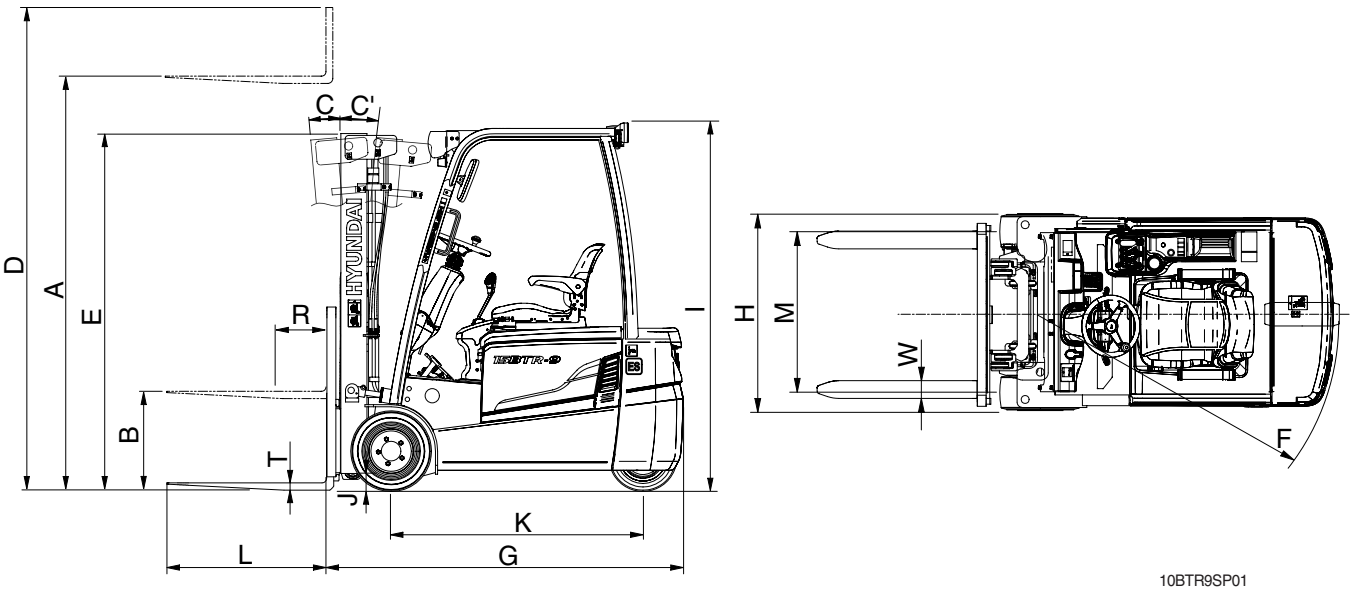
1. GENERAL LOCATIONS



10BTR9OM113

1	Mast	6	Dash board	11	Seat
2	Lift cylinder	7	Frame	12	Steering wheel
3	Carriage and backrest	8	Steering axle	13	Overhead guard
4	Forks	9	Counterweight		
5	Drive unit	10	Battery cover		

2. SPECIFICATIONS



Model			Unit	10BTR-9	13BTR-9	15BTR-9
Capacity			kg (lb)	1000 (2000)	1300 (2500)	1500 (3000)
Load center		R	mm (ft-in)	500 (24")	←	←
Weight			kg (lb)	2390 (5270)	2610 (5750)	2850 (6280)
Fork	Lifting height	A	mm (ft-in)	3025 (9' 11")	←	←
	Free lift	B	mm (in)	35 (1' 4")	←	←
	Lifting speed[Unload/Load]		mm/sec	530/310	530/300	530/290
	Lowering speed[Unload/Load]		mm/sec	450/500	←	←
	L × W × T	L,W,T	mm (in)	800 × 80 × 35 (31.5 × 3.1 × 1.4)	←	←
Mast	Tilt angle forward/backward	C/C'	degree	5/6	←	←
	Max height	D	mm (ft-in)	3535 (11' 7")	←	←
	Min height	E	mm (ft-in)	1970 (6' 6")	←	←
Body	Travel speed [Unload]		km/h	13.0	←	←
	Gradeability [Load]		%	18	15	13
	Min turning radius [Outside]	F	mm(ft-in)	1335 (4' 5")	1425 (4' 8")	1480 (4' 10")
ETC	Max hydraulic pressure		kgf/cm²	190	←	←
	Hydraulic oil tank		ℓ (usgal)	18	←	←
Overall length		G	mm (ft-in)	1655 (5' 5")	1750 (5' 9")	1810 (5' 11")
Overall width		H	mm (ft-in)	990 (3' 3")	←	←
Overhead guard height		I	mm (ft-in)	1985 (6' 6")	←	←
Ground clearance (Mast)		J	mm (in)	85 (3.4")	←	←
Wheel base		K	mm (ft-in)	1065 (3' 6")	1165 (3' 10")	1220 (4' 0")
Wheel tread front/Rear		M	mm (ft-in)	835 (2' 9")	←	←

3. SPECIFICATION FOR MAJOR COMPONENTS

1) CONTROLLER

Item	Unit	Traction motor controller	Pump motor controller
Model	-	ACE2	←
Type	-	MOSFET	←
Dimension	mm	200×185×95	←
Current limit	A	500	←
Communication	-	CAN	←

2) MOTOR

Item	Unit	Traction	Pump
Model	-	AMDH6001	AMDA4001
Type	-	AC	AC
Rated voltage	Vac	16	16
Output	kW	4.3	9.0
Insulation	-	Class F	Class F

3) BATTERY

Item	Unit	10BTR-9	13BTR-9	15BTR-9
Rated voltage	V	24	←	←
Dimension(W×L×H)	mm	827×324×627	827×432×627	827×486×627
Min. Battery weight	kg	432	570	657
Max. Battery weight	kg	478	630	727
Connector	-	SRE 320A BLACK		

4) CHARGER

Item	Unit	10/13/15BTR-9
Type	-	Constant current, constant voltage
Battery capacity for charge	V-AH	24V/625~750
AC input	V	Triple phase 410
		Single phase 220
		Triple phase 220/380
		Triple phase 440
DC output	V	32±1
Charge time	hr	6±2
Connector	-	SRE 320A BLACK

5) 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

6) MAIN CONTROL VALVE

Item	Unit	Specification
Type	-	3 spool, 4 spool
Operating method	-	Mechanical
Main relief valve pressure	bar	150
2nd relief valve pressure	bar	130

7) DRIVE UNIT

Item	Unit	Specification
Max. axle load	kg/lb	2000/4410
Maximum brake-torque	N · m	1400
Maximum wheel torque	N · m	470
Gear ratio	-	20.5
Weight without fluid	kg/lb	55.3/122
Oil quantity	ℓ /U.S · qt	6.0/6.3

8) WHEELS

Item	10/13/15BTR-9
Type (STD/OPT)	SOLID/Non-marking
Quantity (front/rear)	2/1
Front-drive	18×7-8
Rear-steering	18×7-8

9) BRAKES & STEERING

Item		Specification
Brakes	Travel	Front wheel, wet disc brake
	Parking	Ratchet type
Steering	Type	Full hydraulic, power steering
	Steering angle	90° to both right and left angle, respectively

4. TIGHTENING TORQUE FOR MAJOR COMPONENTS

NO	Items		Size	kgf · m	lbf · ft
1	Electric system	Hyd pump motor mounting bolt	M 8 × 1.25	3.4 ± 0.7	24.6 ± 5.1
2		Traction motor mounting bolt	M 8 × 1.25	2.5 ± 0.5	18.1 ± 3.6
3	Hydraulic system	Hydraulic pump mounting bolt	M10 × 1.5	6.9 ± 1.4	49.9 ± 10.1
4		MCV mounting bolt, nut	M10 × 1.5	6.9 ± 1.4	49.9 ± 10.1
5		Steering unit mounting bolt	M10 × 1.5	6.9 ± 1.4	49.9 ± 10.1
6		Brake cylinder mounting bolt	M10 × 1.5	6.9 ± 1.4	49.9 ± 10.1
7		Hydraulic oil tank mounting bolt	M 8 × 1.25	3.4 ± 0.7	24.6 ± 5.1
8	Power train system	Drive axle mounting bolt, nut	M12 × 1.75	14.3 ± 1.0	103 ± 7.2
9		Steering axle mounting bolt, nut	M14 × 2.0	13.8 ± 1.3	99.8 ± 9.4
10		Front wheel mounting nut	M14 × 1.5	15.7 ± 2.3	114 ± 16.6
11		Rear wheel mounting nut	M14 × 1.5	15.7 ± 2.3	114 ± 16.6
12	ETC	Counterweight mounting bolt	M30 × 3.5	100 ± 15	723 ± 108
13		Seat mounting bolt	M 8 ×1.25	2.5 ± 0.5	18.1 ± 3.6
14		Head guard mounting bolt	M12 ×1.75	12.8 ± 3.0	93 ± 22

5. TORQUE CHART

Use following table for unspecified torque.

1) BOLT AND NUT

(1) Coarse thread

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	2.73 ~ 4.12	19.7 ~ 29.8
M10 × 1.5	4.0 ~ 6.0	28.9 ~ 43.4	5.5 ~ 8.3	39.8 ~ 60
M12 × 1.75	7.4 ~ 11.2	53.5 ~ 79.5	9.8 ~ 15.8	71 ~ 114
M14 × 2.0	12.2 ~ 16.6	88.2 ~ 120	16.7 ~ 22.5	121 ~ 167
M16 × 2.0	18.6 ~ 25.2	135 ~ 182	25.2 ~ 34.2	182 ~ 247
M18 × 2.5	25.8 ~ 35.0	187 ~ 253	35.1 ~ 47.5	254 ~ 343
M20 × 2.5	36.2 ~ 49.0	262 ~ 354	49.2 ~ 66.6	356 ~ 482
M22 × 2.5	48.3 ~ 63.3	350 ~ 457	65.8 ~ 98.0	476 ~ 709
M24 × 3.0	62.5 ~ 84.5	452 ~ 611	85.0 ~ 115	615 ~ 832
M30 × 3.5	124 ~ 168	898 ~ 1214	169 ~ 229	1223 ~ 1655
M36 × 4.0	174 ~ 236	1261 ~ 1703	250 ~ 310	1808 ~ 2242

(2) Fine thread

Bolt size	8T		10T	
	kgf · m	lbf · ft	kgf · m	lbf · ft
M 8 × 1.0	2.17 ~ 3.37	15.7 ~ 24.3	3.04 ~ 4.44	22.0 ~ 32.0
M10 × 1.25	4.46 ~ 6.66	32.3 ~ 48.2	5.93 ~ 8.93	42.9 ~ 64.6
M12 × 1.25	7.78 ~ 11.58	76.3 ~ 83.7	10.6 ~ 16.0	76.6 ~ 115
M14 × 1.5	13.3 ~ 18.1	96.2 ~ 130	17.9 ~ 24.1	130 ~ 174
M16 × 1.5	19.9 ~ 26.9	144 ~ 194	26.6 ~ 36.0	193 ~ 260
M18 × 1.5	28.6 ~ 43.6	207 ~ 315	38.4 ~ 52.0	278 ~ 376
M20 × 1.5	40.0 ~ 54.0	289 ~ 390	53.4 ~ 72.2	386 ~ 522
M22 × 1.5	52.7 ~ 71.3	381 ~ 515	70.7 ~ 95.7	512 ~ 692
M24 × 2.0	67.9 ~ 91.9	491 ~ 664	90.9 ~ 123	658 ~ 890
M30 × 2.0	137 ~ 185	990 ~ 1338	182 ~ 248	1314 ~ 1795
M36 × 3.0	192 ~ 260	1389 ~ 1879	262 ~ 354	1893 ~ 2561

2) PIPE AND HOSE(FLARE TYPE)

Thread size	Width across flat(mm)	kgf · m	lbf · ft
1/4"	19	4	28.9
3/8"	22	5	36.2
1/2"	27	9.5	68.7
3/4"	36	18	130
1"	41	21	152
1-1/4"	50	35	253

3) PIPE AND HOSE(ORFS TYPE)

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

4) FITTING

Thread size	Width across flat(mm)	kgf · m	lbf · ft
1/4"	19	4	28.9
3/8"	22	5	36.2
1/2"	27	9.5	68.7
3/4"	36	18	130
1"	41	21	152
1-1/4"	50	35	253

6. RECOMMENDED LUBRICANTS

Use only oils listed below or equivalent.
Do not mix different brand oil.

Service point	Kind of fluid	Capacity ℓ (U.S. gal)	Ambient temperature °C(°F)
			-50 (-58) -30 (-22) -20 (-4) -10 (14) 0 (32) 10 (50) 20 (68) 30 (86) 40 (104)
Drive unit	Gear oil	6.0 (1.6)	SAE 80W-90
Front axle	Gear oil	0.5 (0.13)	MOBIL FLUID 424
Hydraulic oil tank	Hydraulic oil	18.1 (4.78)	★ISO VG 15 ISO VG 46 ISO VG 68
Brake system	Brake oil	0.5 (0.13)	★HYDRAULIC OIL ISO VG10 (AZOLLA ZS10) HYDRAULIC OIL ISO VG32 (AZOLLA ZS32)
Fitting (Grease nipple)	Grease	0.1 (0.03)	★NLGI No.1 NLGI No.2

- API : American Petroleum Institute
- SAE : Society of Automotive Engineers
- ISO : International Organization for Standardization
- NLGI : National Lubricating Grease Institute

★ : Cold region
Russia, CIS, Mongolia

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.

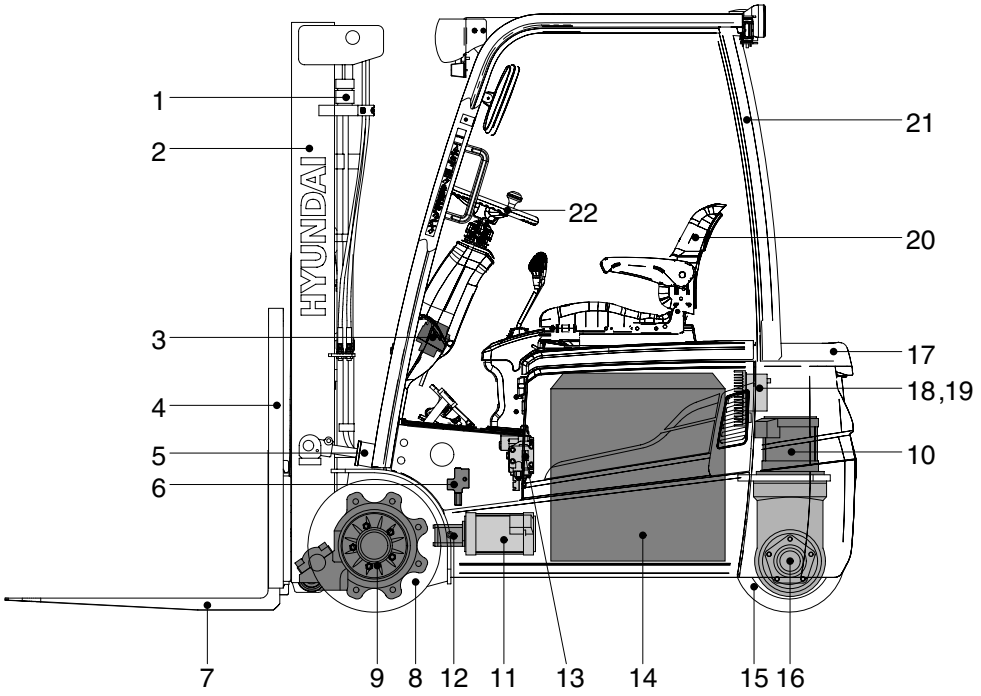
※ **Replacement of consumable service parts is not covered under warranty.**

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 AND INSTALLATION OF UNIT

SECTION 2 REMOVAL & INSTALLATION OF UNIT

GROUP 1 MAJOR COMPONENTS



10BTR9RE01

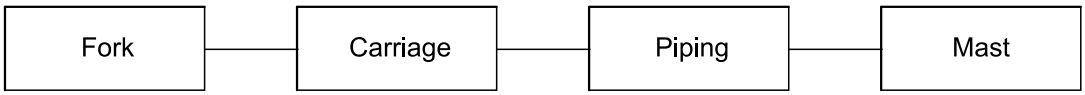
1	Lift cylinder	9	Front axle	17	Counterweight
2	Mast	10	Drive motor	18	Traction controller
3	Steering unit	11	Pump motor	19	Pump controller
4	Backrest	12	Hydraulic pump	20	Seat
5	Tilt cylinder	13	Main control valve	21	Overhead guard
6	Priority valve	14	Battery	22	Steering wheel
7	Forks	15	Rear wheel		
8	Front wheel	16	Drive unit		

GROUP 2 REMOVAL AND INSTALLATION OF UNIT

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

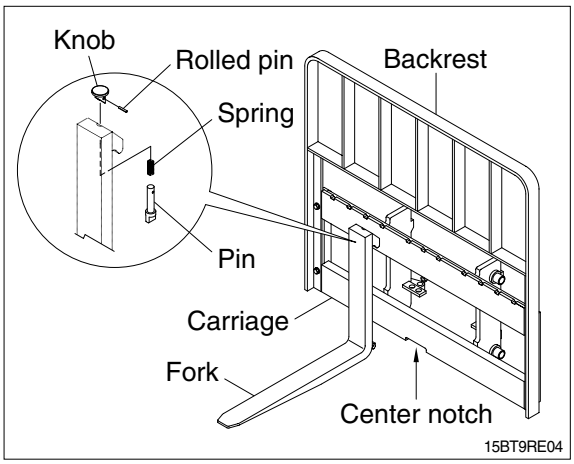
1. MAST

1) REMOVAL



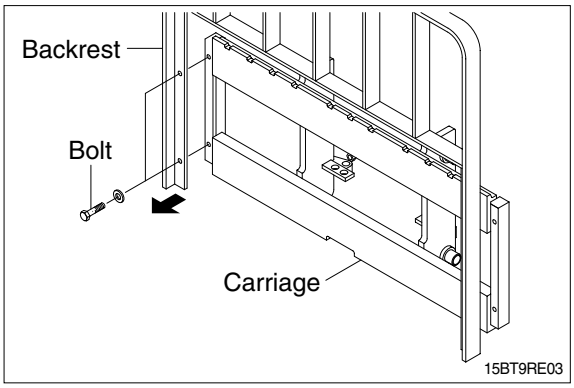
(1) Forks

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



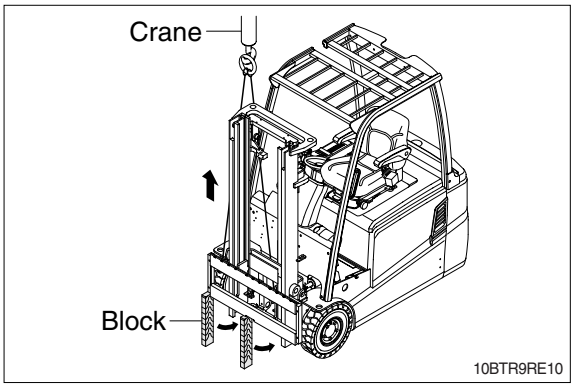
(2) Backrest(If necessary)

① Remove bolts securing backrest to fork carriage. Disassemble the backrest from the carriage.

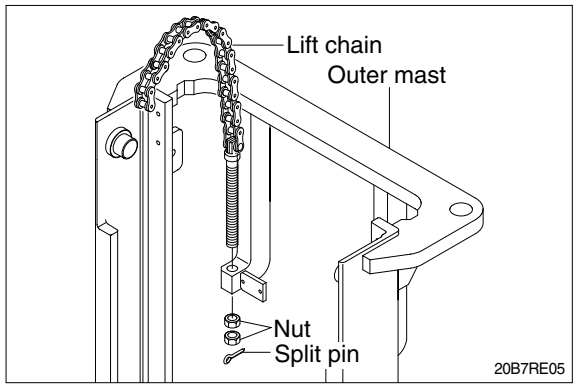


(3) Carriage

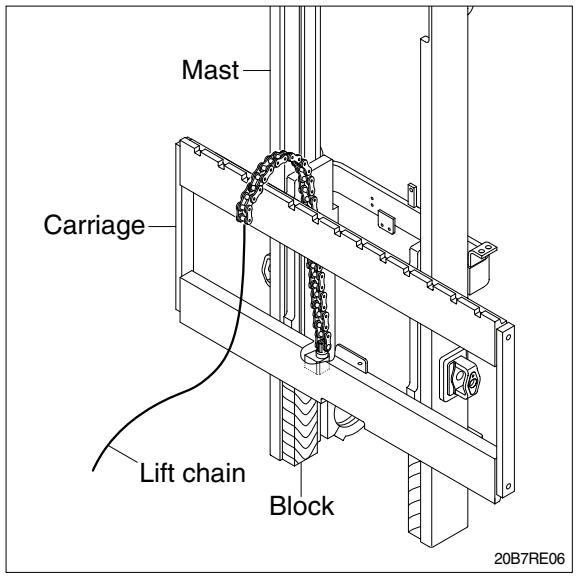
① With the mast vertical, raise the carriage high enough to place blocks under the load forks. This is done to create slack in the load chains when the carriage is lowered. Lower the carriage all the way down to the floor. Make sure the carriage is level, this will prevent any binding when the mast is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



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



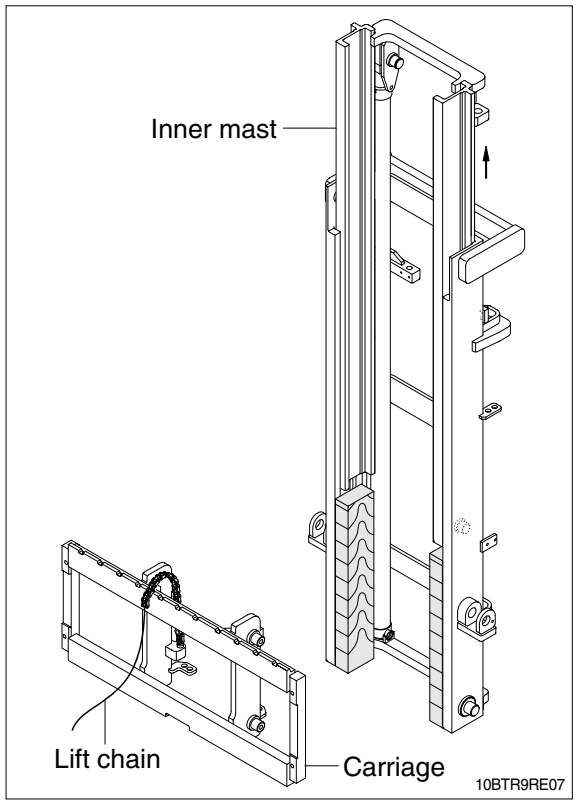
③ Pull the chains out of the sheaves and drape them over the front of the carriage.



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

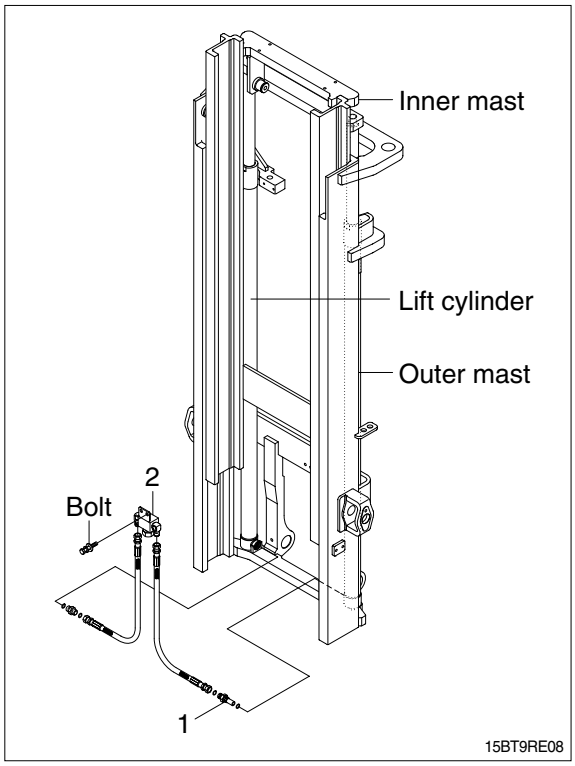
⚠ **Make sure that carriage remains on floor and does not bind while mast is being raised.**

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



(4) Piping

① Loosen the bolts (2EA) of the weld-connector (2) from low crossmember of the outer mast.
② Disconnect the connectors from the lift cylinders.
③ Disassemble the velocity fuse valve (1), hoses, and weld-connector (2).

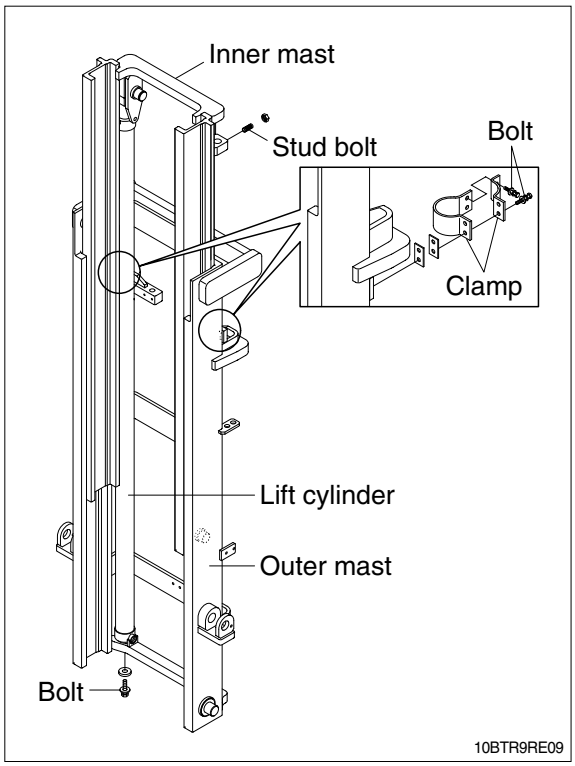


(5) Lift cylinder

① Loosen hexagonal bolts and remove washers securing the lift cylinders to outer 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.

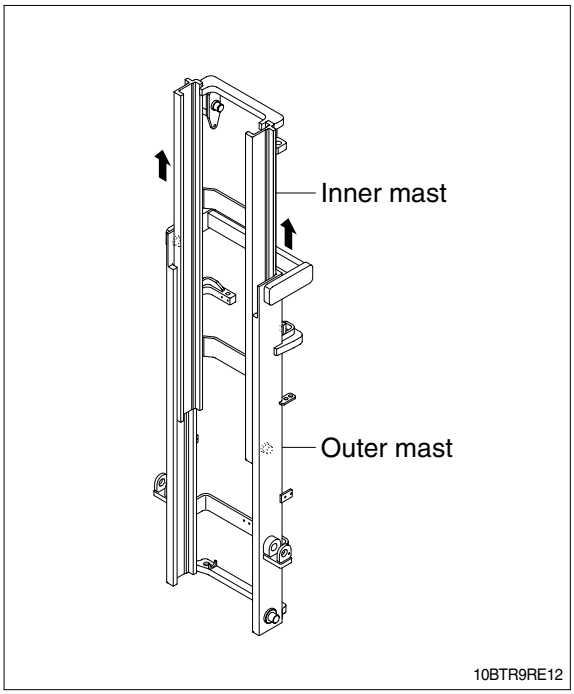
③ Loosen and remove hexagon bolts and clamp securing the lift cylinder to outer mast.
④ Using an overhead hoist, slowly raise the inner mast high enough to clear lift cylinder.
⑤ Using an overhead hoist, draw out lift cylinder carefully and put down on the work floor.



(6) 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.**

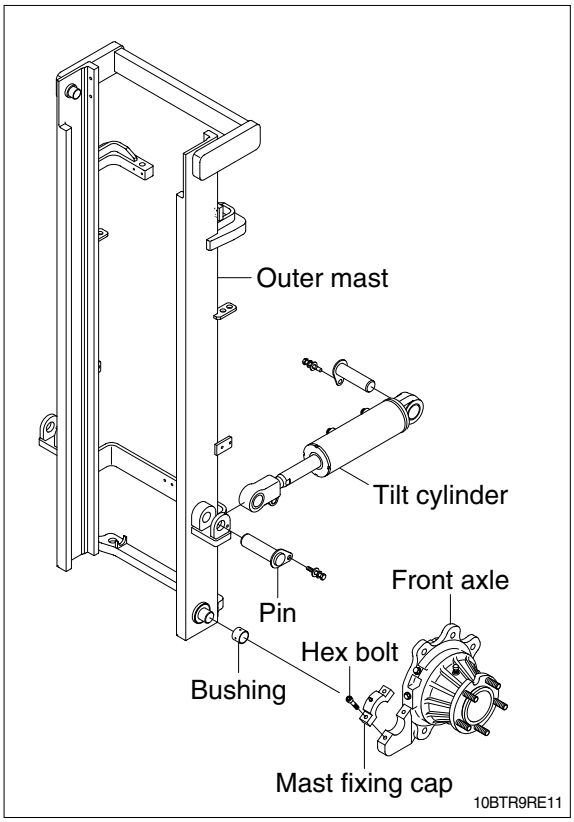


(7) Tilt cylinder pin

① Attach a crane to the stay at the top of the outer mast, and raise enough to sustain jacked up machine.

※ This operation is carried out from under the machine, so use a pit, or if there is no pit, jack up the machine and loosen with on impact wrench.

② Remove the hex bolts from the pins of the tilt cylinders and the hex bolts of the mast fixing caps to the front axles, and take out the pins, the mast fixing caps, and then slowly raise up the outer mast.



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) Bronze bushings

① Check the inside of the bronze bushings for wear which are the contact area with the mast mounting pins.

② Jack up the machine so that the front is raised and then using an overhead hoist, assemble the outer mast to the front axles.

(2) Tilt cylinder pin

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

(3) Lift cylinder installation and adjustment

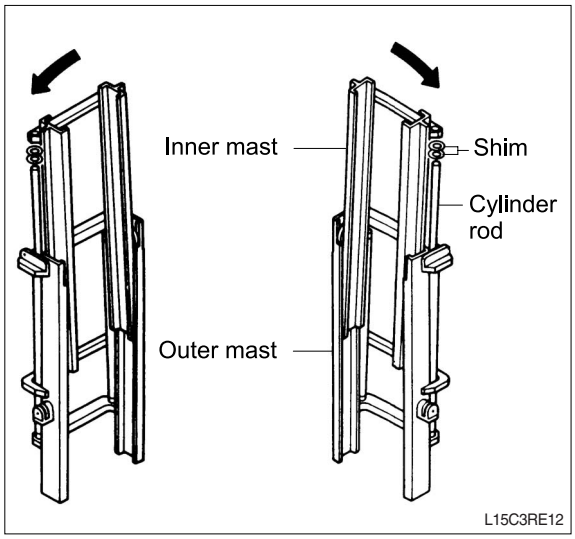
① Assemble the lift cylinder inside the outer mast, then tighten the stopper bolt. If the cylinder assembly has been replaced, adjust as follows so that the left and right cylinders are synchronized at the maximum lifting height.

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

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

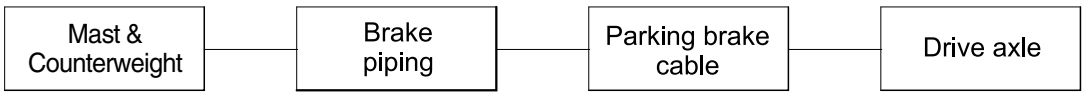
※ If play is to RIGHT, install adjustment shim to RIGHT cylinder.

· Shim thickness : 1.0mm(0.04in)



2. POWER TRAIN ASSEMBLY

1) REMOVAL

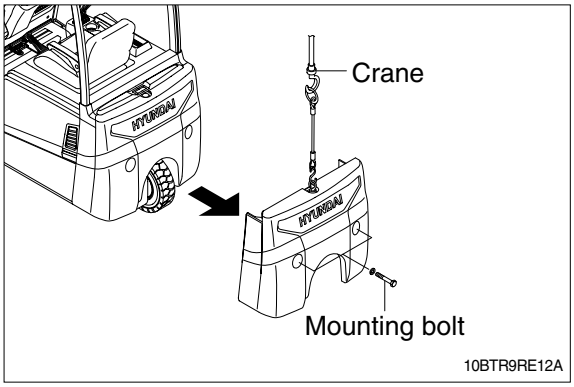


B153RE00

(1) Mast and counterweight

Refer to section on mast(Page 2-5)

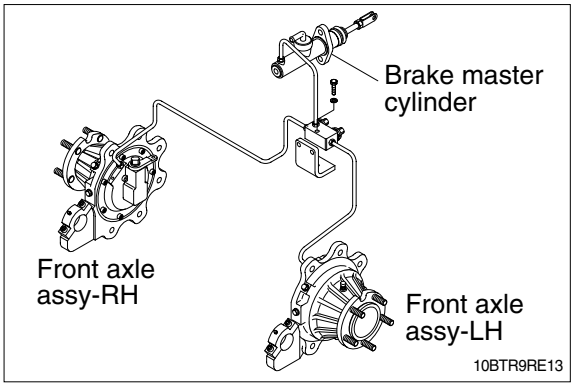
※ After removing mast, remove the counterweight to prevent the truck from turning over.



10BTR9RE12A

(2) Brake piping

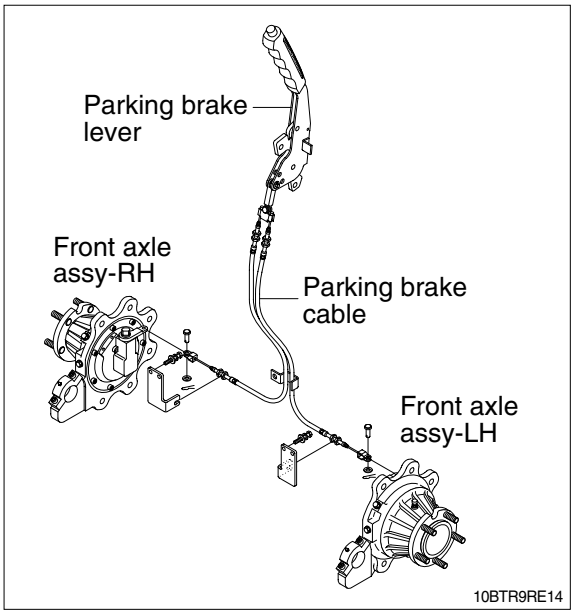
Disconnect the brake piping from the front axles.



10BTR9RE13

(3) Parking brake cable

Disconnect parking brake cable from the front axle assys.

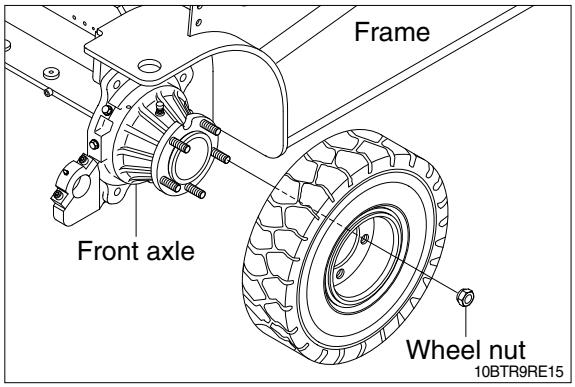


10BTR9RE14

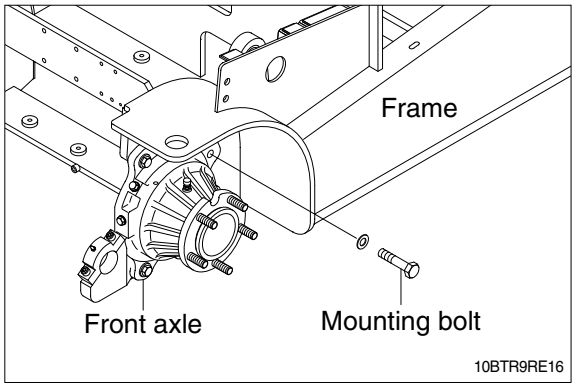
(4) Front axle assy

※ Drain the oil before disassembling the front axles.

① Unscrew five wheel nuts and remove the wheel.



② Loosen seven mounting bolts on the truck frame and carefully take out the front axles.

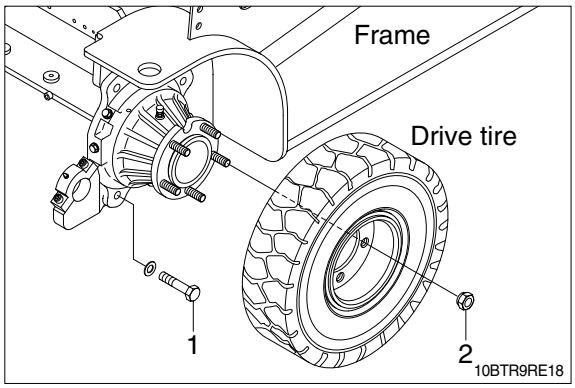


2) INSTALLATION

Installation is the reverse order of removal, but be careful of the following tightening torque.

· Tightening torque

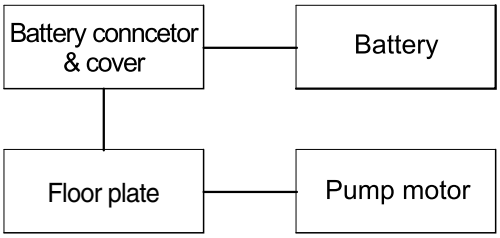
Item	kgf · m	lbf · ft
Front axle (1)	12.5 ~ 15	90.4 ~ 109
Wheel nut (2)	12.5 ~ 15.5	90.4 ~ 112



3. ELECTRICAL COMPONENTS

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

1) REMOVAL

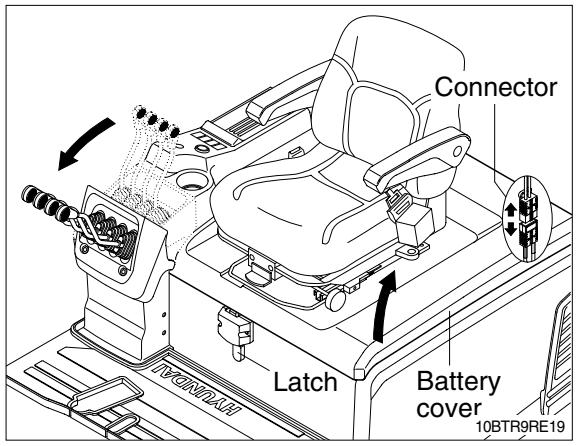


B15T5RE001

(1) Battery

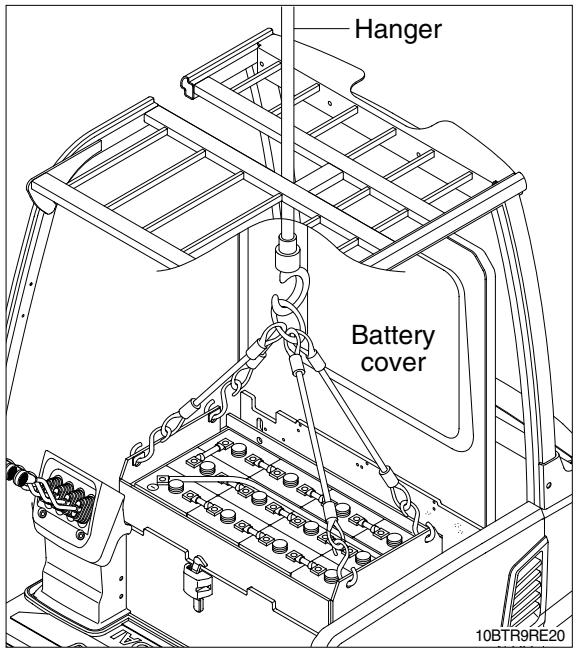
⚠ **Before pulling out the battery plug, tilt the mast forward a little, and lower the fork to the lowest position.**
The batteries weigh from around 450kg to 690kg so the extreme care must be taken when handling them.

① Disconnect the battery connector.
Release the battery cover latch and open the battery cover.



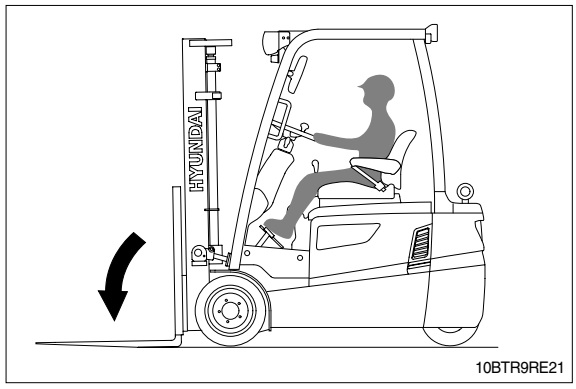
② Using a battery hanger, carefully raise the battery assembly.

※ Be careful not to damage overhead guard or control system.

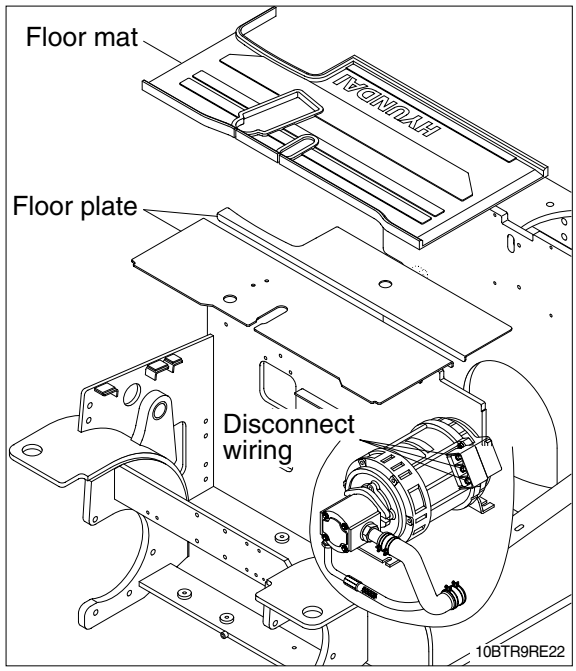


(2) Pump motor

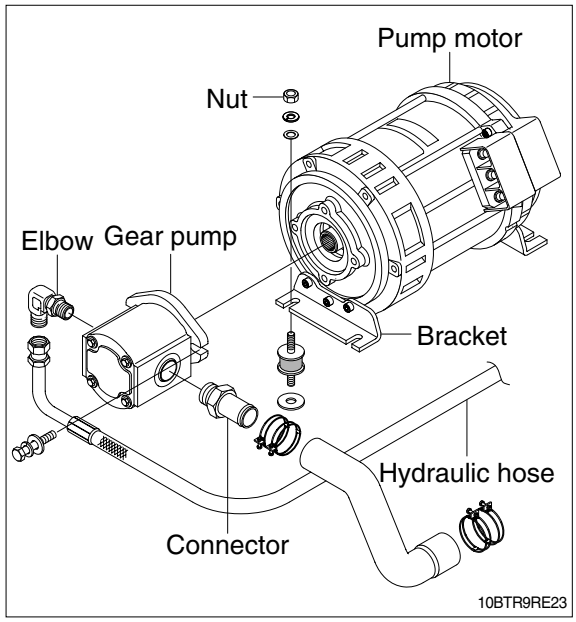
① Lower the fork to floor.



② Remove floor mat and front floor plate.
Disconnect the wiring of pump motor.



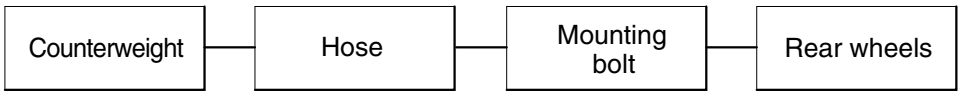
③ Remove elbow and connector and then disconnect the hydraulic hose from the gear pump.
Remove the gear pump from pump motor.
Remove the tightening nuts of the motor mounting bracket.
Remove the pump motor from mounting bracket.



4. STEERING AXLE

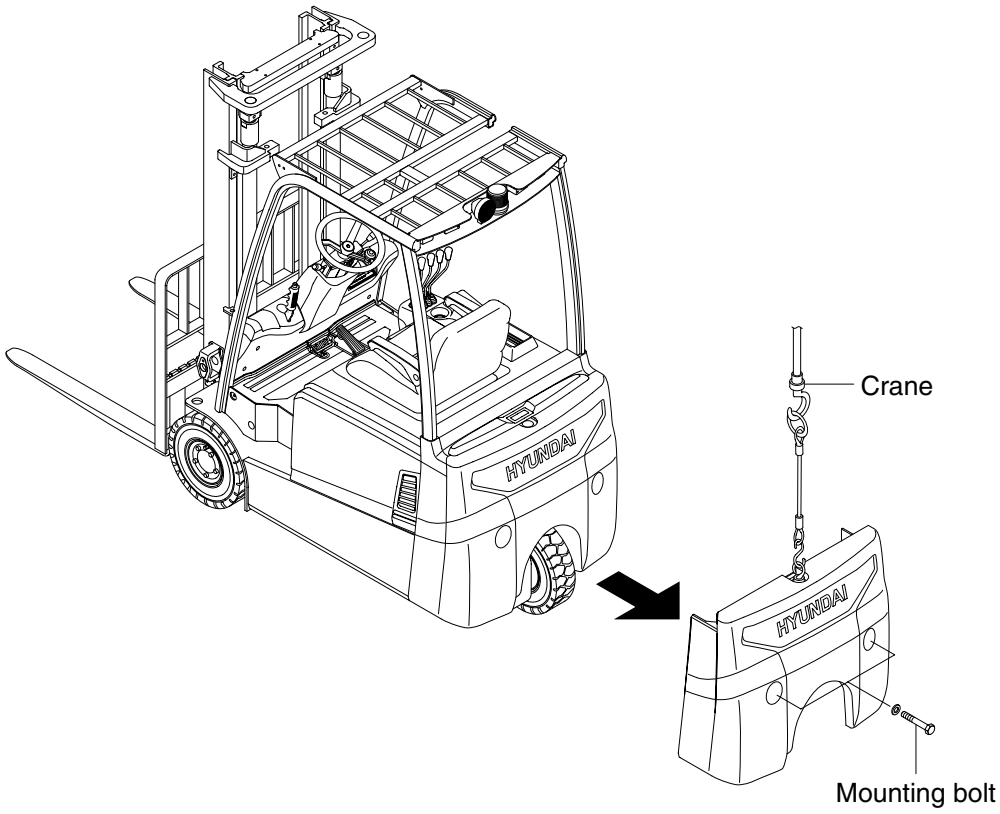
1) 10/13/15BTR-9

(1) Removal



B15T5RE91

※ Before removing counterweight apply the parking brake.



10BTR9RE24

① **Counterweight**

Install a lifting tool in the counterweight, and raise with a crane.

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

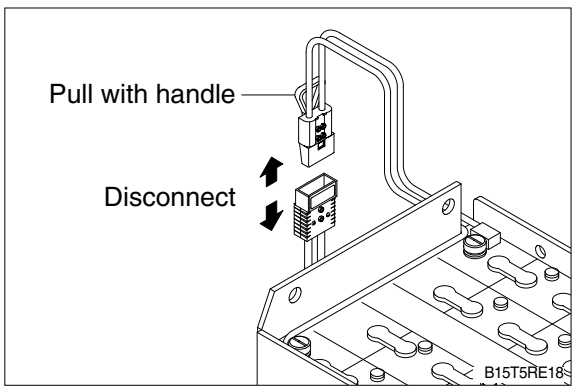
· Weight of counterweight(standard)

10BTR-9	525kg (1160lb)
13BTR-9	590kg (1300lb)
15BTR-9	695kg (1530lb)

· Tightening torque : 184~214 kgf · m (1330~1550lbf · ft)

② **Battery connector**

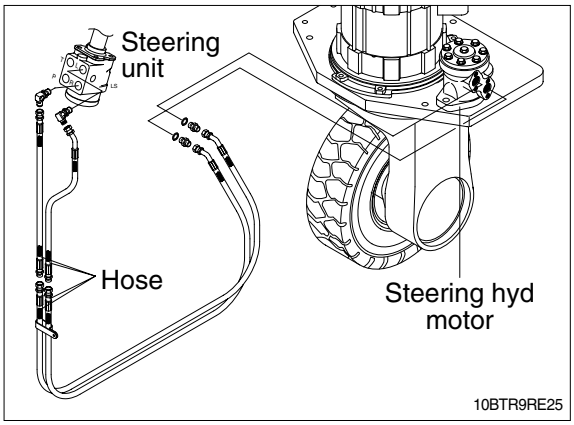
Disconnect the battery connector.



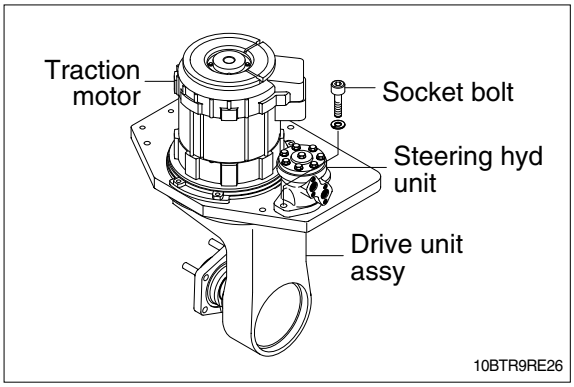
B15T5RE18

③ **Hose**

Disconnect the hoses from steering hydraulic motor.

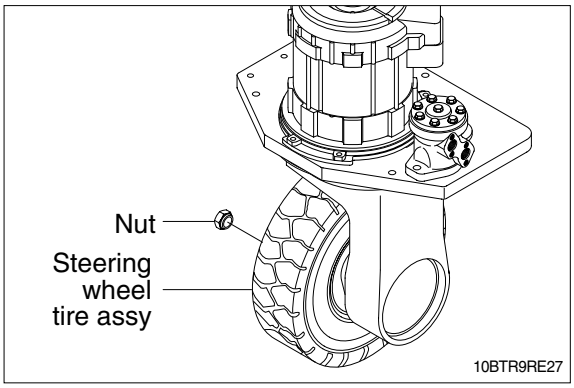


④ Loosen socket bolts and remove steering hydraulic motor assy from drive unit assy.



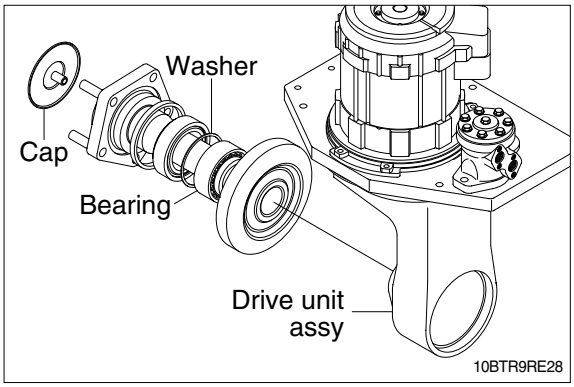
⑤ Jacking up the chassis of truck.

Loosen the hub nut and take off the steering wheel tire assembly.

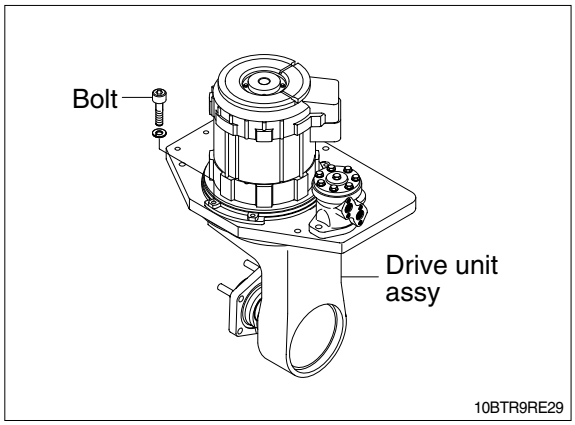


⑥ Remove the hub cap.

Pull out the bearings and washers.



⑦ Loosen bolts and remove drive unit assy from chassis.



SECTION 3 POWER TRAIN SYSTEM

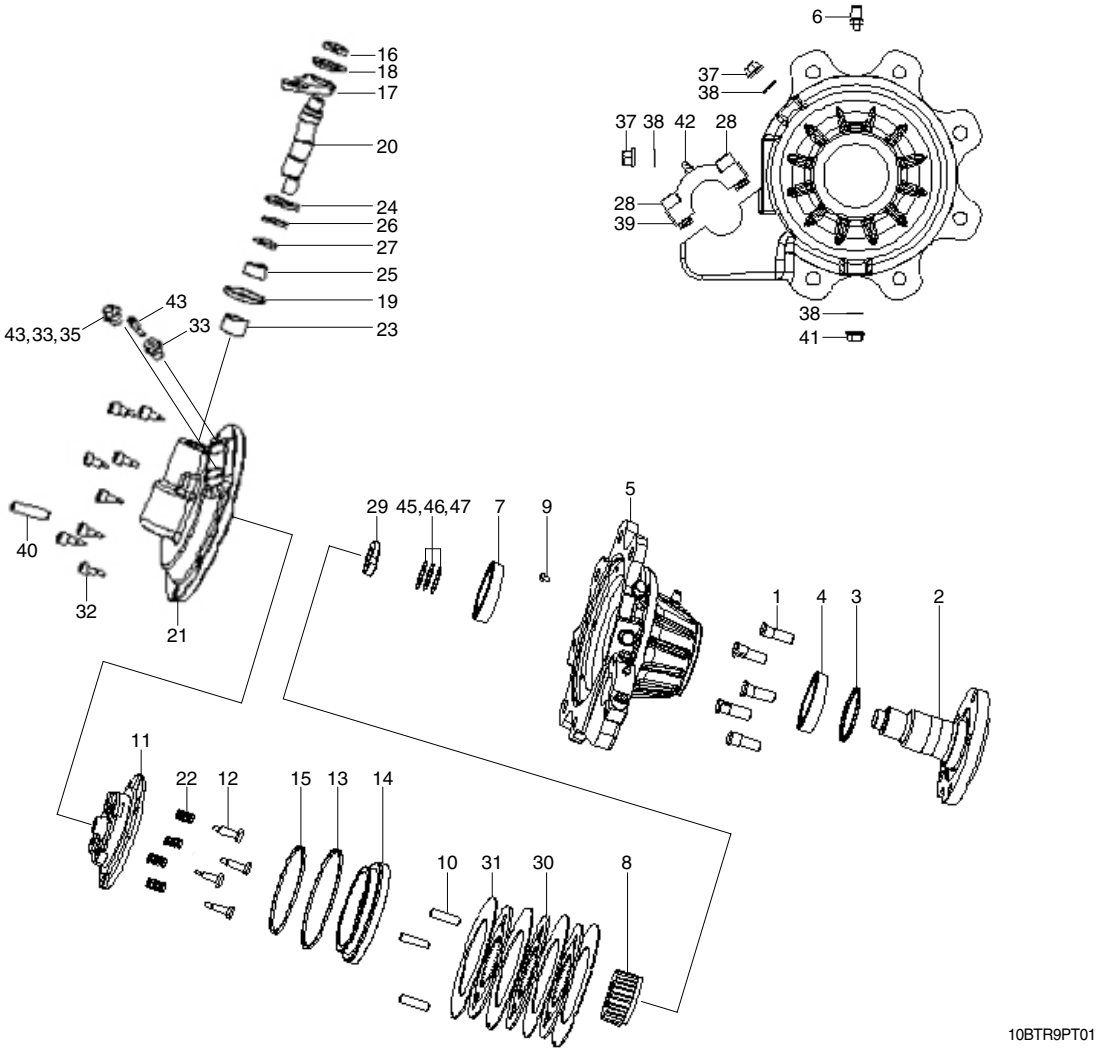
SECTION 3 POWER TRAIN SYSTEM

GROUP 1 STRUCTURE AND OPERATION

1. FRONT AXLE ASSY

1) STRUCTURE

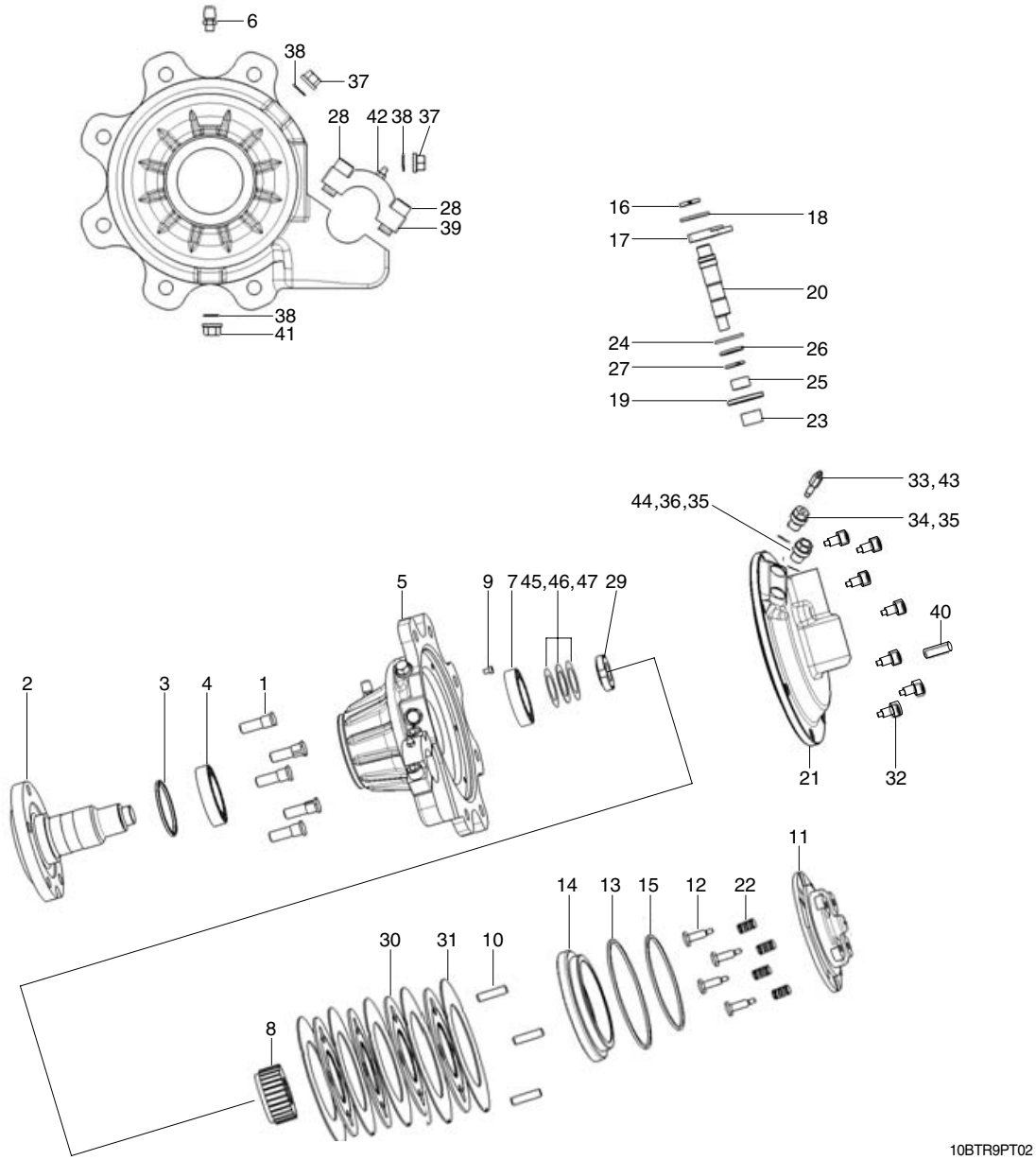
(1) Front axle, LH



10BTR9PT01

1	Wheel bolt	17	Parking lever (LH)	33	Fitting
2	Dirve shaft	18	Plain washer	34	Bleeder screw
3	Oil seal	19	Bushing	35	O-ring
4	Taper roller bearing	20	Cam shaft	36	Fitting brake line
5	Housing (LH)	21	Cover (LH)	37	Plug
6	Air breather	22	Spring	38	O-ring
7	Taper roller bearing	23	Needle roller bearing	39	Cap
8	Collor, Spline	24	Plain washer	40	Dowel pin
9	Socket bolt	25	Roller	41	Plug
10	Pin	26	Plain washer	42	Nipple
11	Actuator	27	Snap ring	43	Fitting cap
12	Bolt	28	Bolt	44	Fitting cap
13	Square ring	29	Lock nut	45	Shim
14	Piston	30	Disc	46	Shim
15	Square ring	31	Plate	47	Shim
16	Snap ring	32	Socket bolt		

(2) Front axle, RH



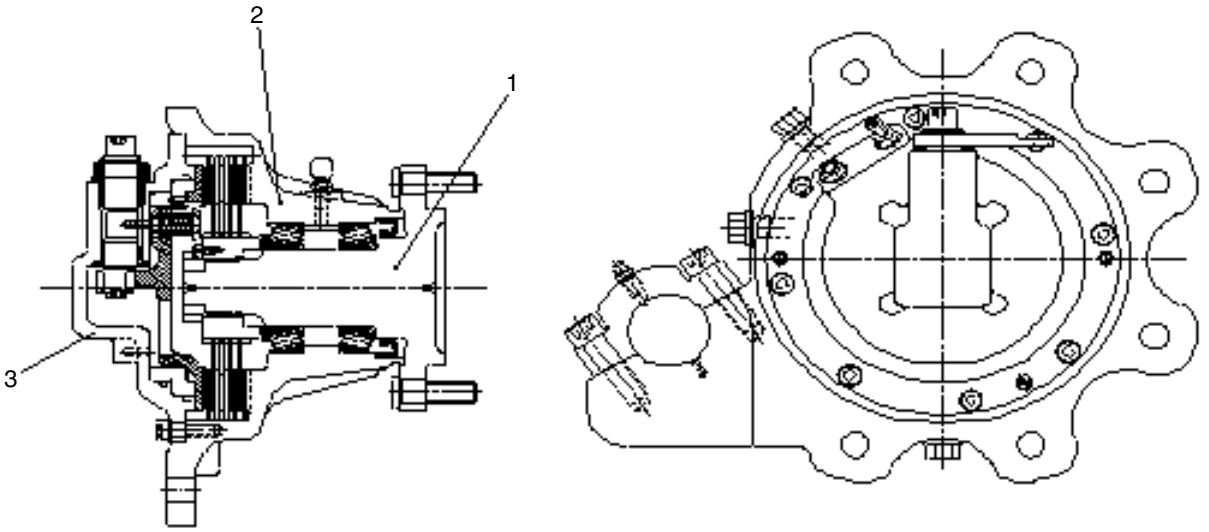
1	Wheel bolt	17	Parking lever (RH)	33	Fitting
2	Dirve shaft	18	Plain washer	34	Bleeder screw
3	Oil seal	19	Bushing	35	O-ring
4	Taper roller bearing	20	Cam shaft	36	Fitting brake line
5	Housing (RH)	21	Cover (RH)	37	Plug
6	Air breather	22	Spring	38	O-ring
7	Taper roller bearing	23	Needle roller bearing	39	Cap
8	Collor, Spline	24	Plain washer	40	Dowel pin
9	Socket bolt	25	Roller	41	Plug
10	Pin	26	Plain washer	42	Nipple
11	Actuator	27	Snap ring	43	Fitting cap
12	Bolt	28	Bolt	44	Fitting cap
13	Square ring	29	Lock nut	45	Shim
14	Piston	30	Disc	46	Shim
15	Square ring	31	Plate	47	Shim
16	Snap ring	32	Socket bolt		

2) SPECIFICATION

Item		Unit	Specification
Max axle load (1 axle)		kg/lb	2100/4630
Max input speed		rpm	5000
Gear ratio		-	20.0
Brake type		-	Wet disc brake
Max brake torque		kgf · m	250 (at 60 bar)
Oil type	Front axle	-	Mobilfluid 424
	Brake	-	Hydraulic oil SAE 10W(AZOLLA ZS32)
Oil volume	Front axle	liter	0.6×2EA
	Brake	cc	3.5×2EA

3) SYSTEM OPERATION

(1) General specification



10BTR9PT05

1 Drive shaft assy
2 Housing assy
3 Brake cover assy

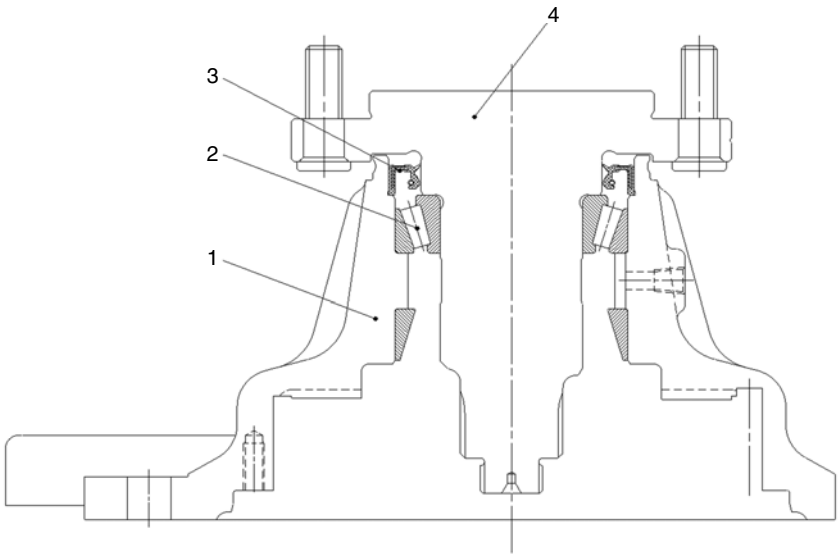
① Outline of the power transmission system

The front axle assy is composed of the drive shaft assy (1), housing assy (2), and brake cover assy (3).

The traction power is transmitted from the drive unit assy and the drive shaft of the front assy is transmitted only traction torque and braking torque.

(2) Basic components

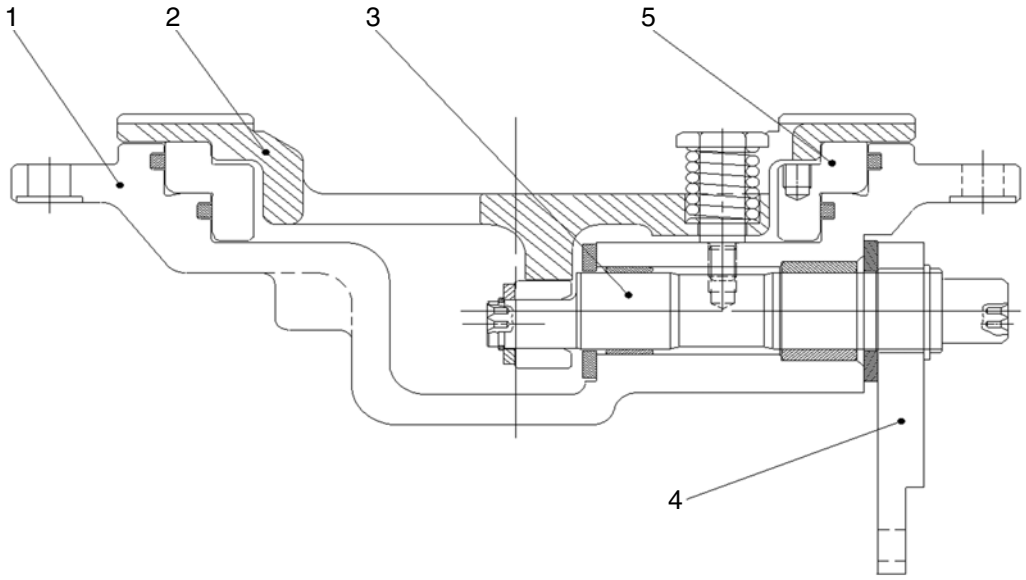
① Housing assy



10BTR9PT06

1	Housing	3	Oil seal
2	Taper roller bearing	4	Drive shaft

② Brake cover assy

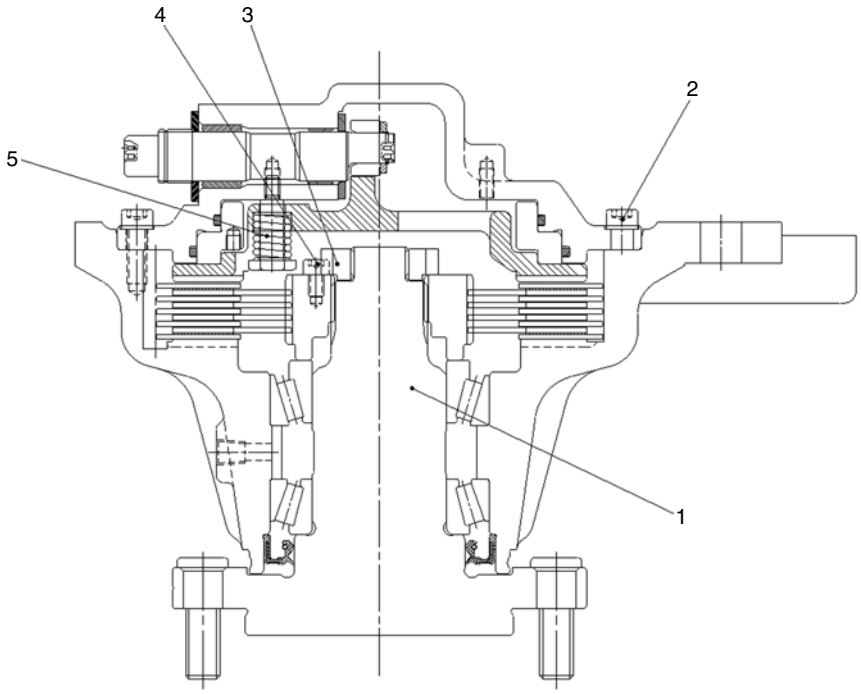


10BTR9PT07

1 Brake cover
2 Actuator
3 Cam shaft
4 Parking lever
5 Piston

(3) Tightening torque

① Housing assy



10BTR9PT08

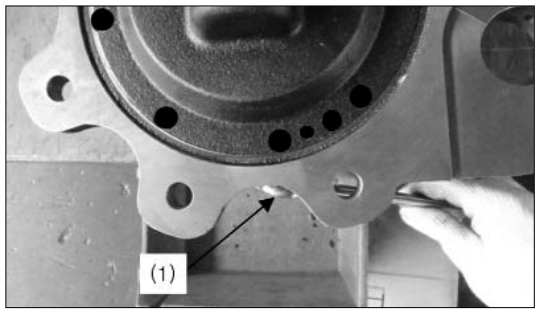
1	Drive shaft	0.25±0.05kgf · m
2	Housing bolt	3.6±0.1kgf · m
3	Lock nut	21±1.0kgf · m
4	Bolt	0.95±0.15kgf · m
5	Brake bolt	1.5±0.10kgf · m

GROUP 2 DISASSEMBLY AND ASSEMBLY

1. DISASSEMBLY OF THE FRONT AXLE ASSY

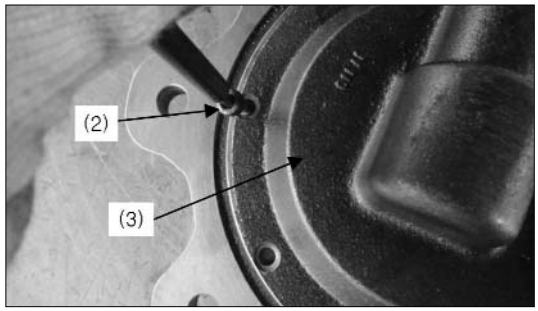
1) DISASSEMBLY OF THE HOUSING

(1) Remove the drain plug of the housing using the wrench (1) and O-ring, and then, drain out the oil.



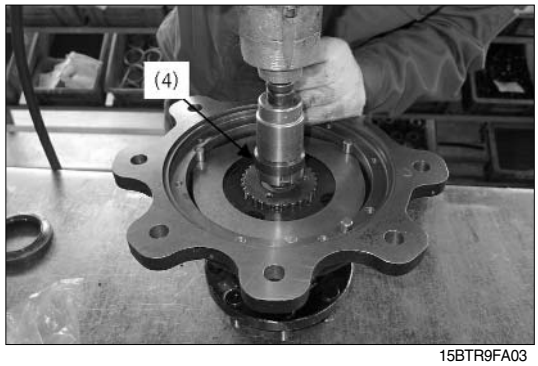
15BTR9FA01

(2) Loosen the socket bolts (2, 8EA), and remove the brake cover assy (3).



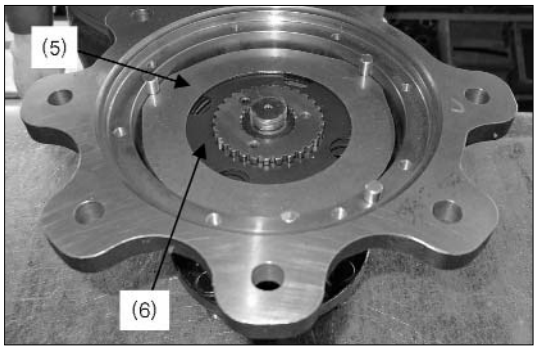
15BTR9FA02

(3) Remove the lock nut (4).

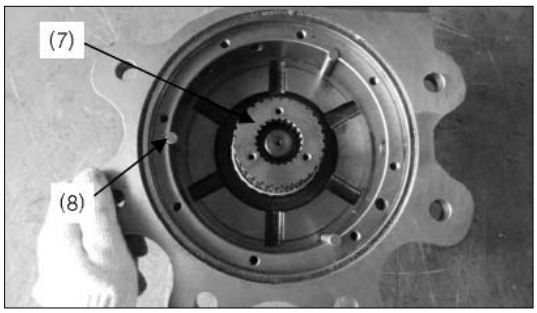


15BTR9FA03

(4) Remove plate (5, 5pcs), discs (6, 4EA), collar spline (7, 1pcs) and pin (8, 3EA).

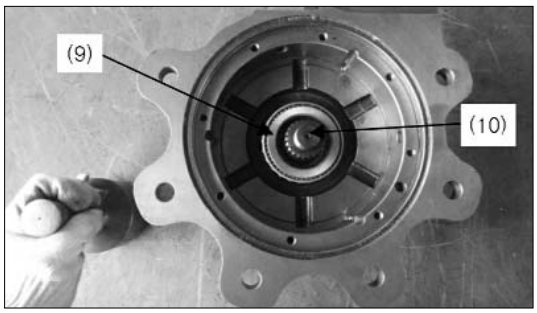


15BTR9FA04



15BTR9FA05

(5) Disassemble the drive shaft (10) and the bearing (9) using the special tool and the plastic mallet.

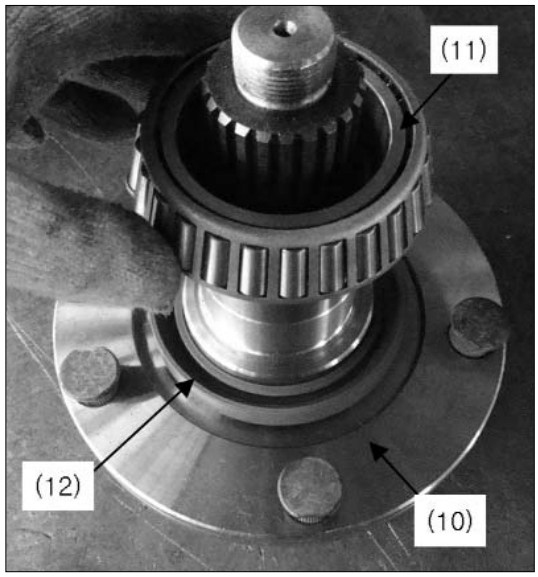


15BTR9FA06

※ It should be removed the bearing cup which is assembled on the opposite side of the housing prior to dissassemble the drive shaft (10) and the bearing (9).

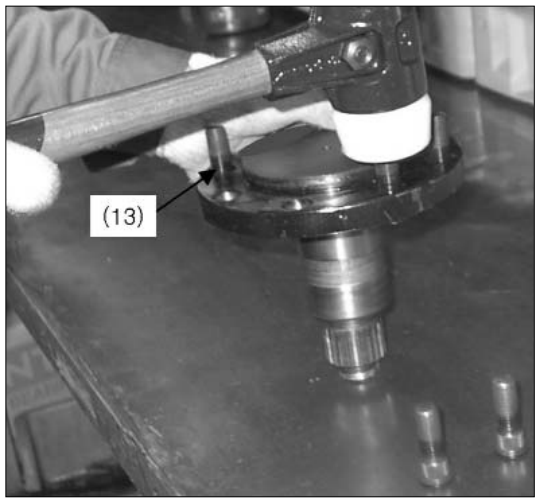

15BTR9FA07

(6) Take out the bearing (11) and the oil seal (12) from the drive shaft (10).



15BTR9FA08

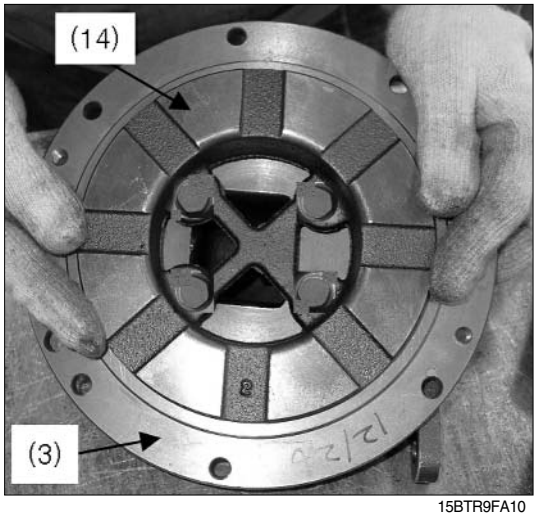
(7) Remove the wheel bolts (13, 5EA).



15BTR9FA09

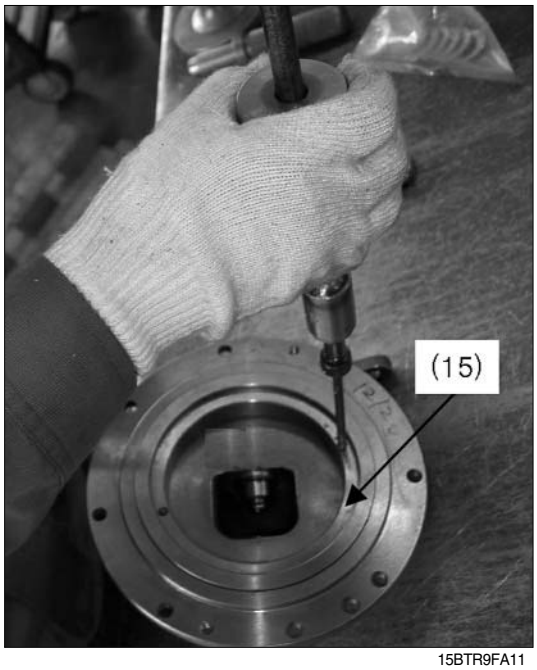
2) DISASSEMBLY THE BRAKE COVER ASSY

(1) Disassemble the actuator (14, 1EA) from the brake cover (3).

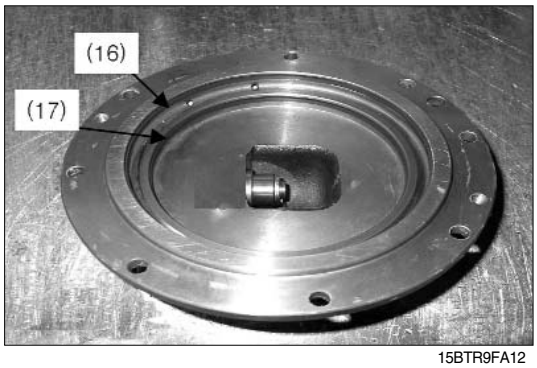


15BTR9FA10

(2) Remove the square ring 1 (16) and the square ring 2 (17) after disassembling the piston (15) using the special tool.

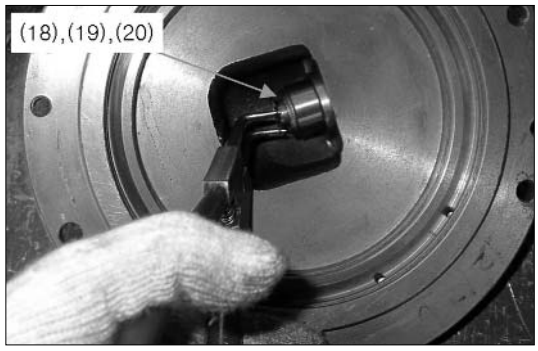


15BTR9FA11



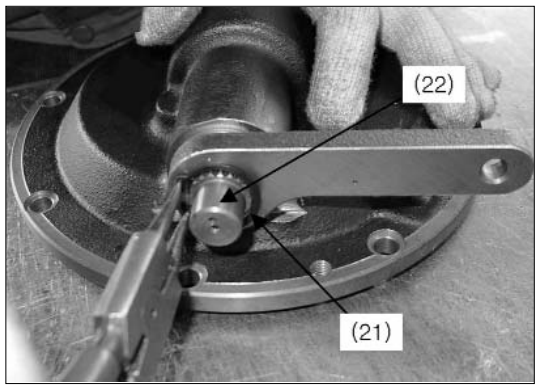
15BTR9FA12

(3) Remove the snap ring (18), washer (19) and the roller (20).



15BTR9FA13

(4) Disassemble the cam shaft (22) after removing the snap ring (21).

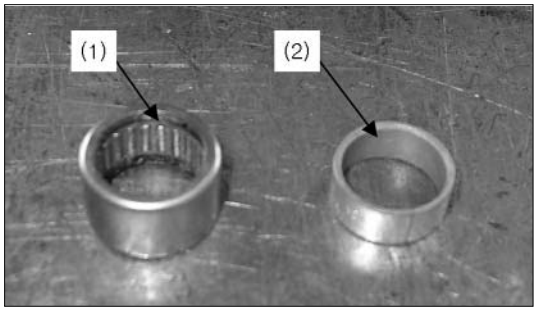


15BTR9FA14

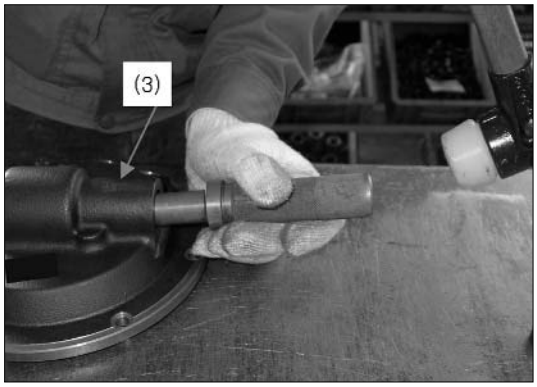
2. ASSEMBLY THE FRONT AXLE ASSY

1) ASSEMBLY THE HOUSING ASSY

(1) Apply the bond (#1102) on the outside of the needle bearing (1) and the Loctite (#609) on the outside of the bush (2), and then assemble to the brake cover (3).

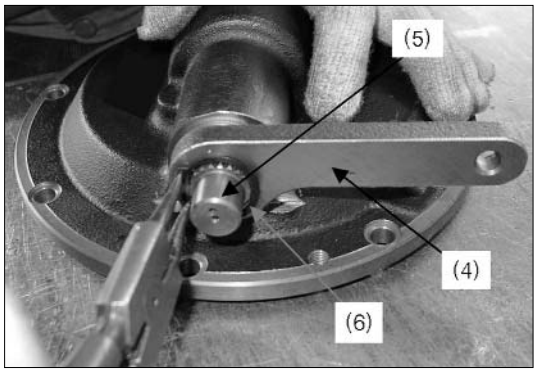


15BTR9FA15



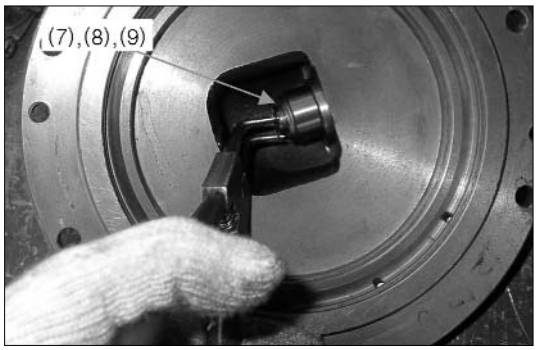
15BTR9FA16

(2) Fit the snap ring (6) after assembling the parking lever (4) to the camshaft (5).



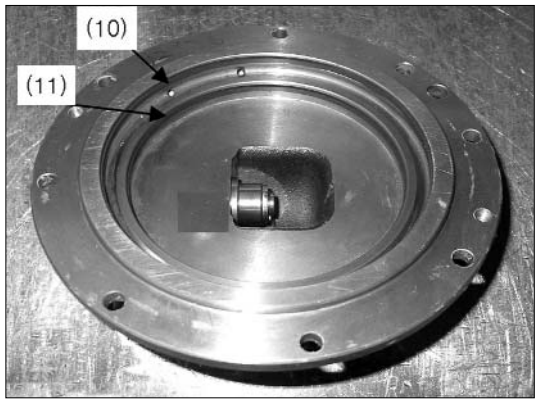
15BTR9FA17

(3) Assemble the snap ring (7), washer (8), and roller (9).



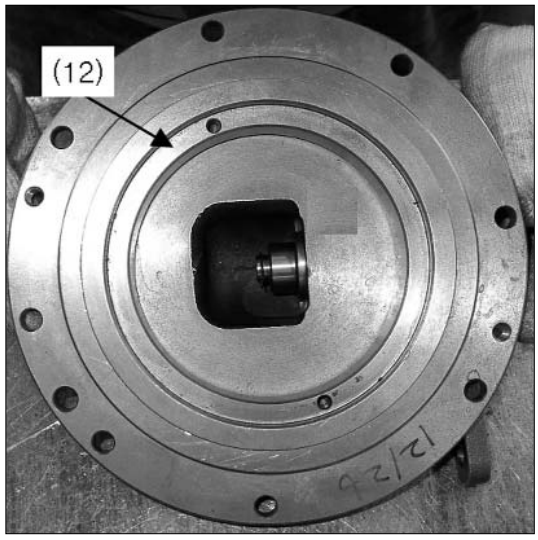
15BTR9FA18

(4) Assemble the square ring 1 (10) and square ring 2 (11) on the piston (12).



15BTR9FA19

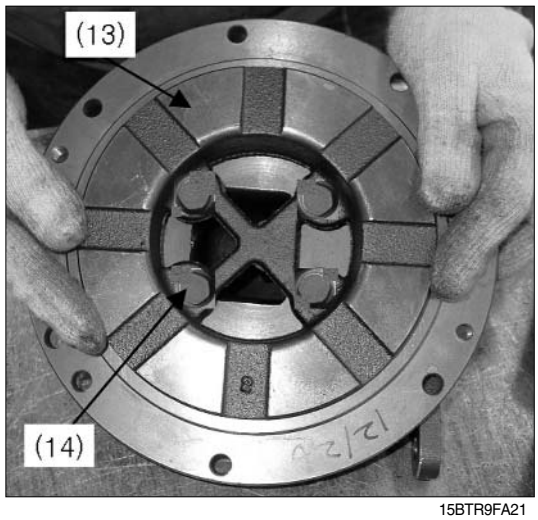
※ It should be used the special tool for the piston and apply the Mobil #424 on the moving surface of the piston, and assemble it.



15BTR9FA20

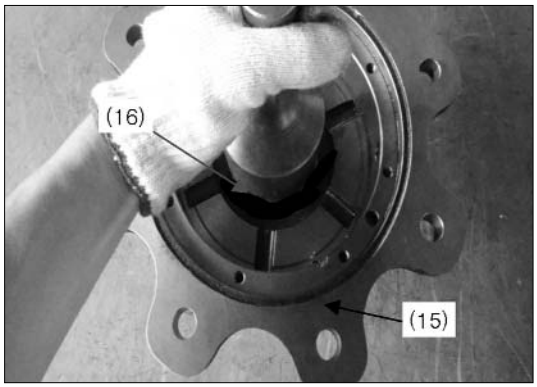
(5) Apply the Loctite #271 on the brake bolt (14) and assemble the brake bolt (14) with spring on the actuator (13).
· Tightening torque : 1.4~1.6 kg · m

※ It should be confirmed that the piston is returned by blowing air to the brake oil port after assembling the brake bolt (14).



15BTR9FA21

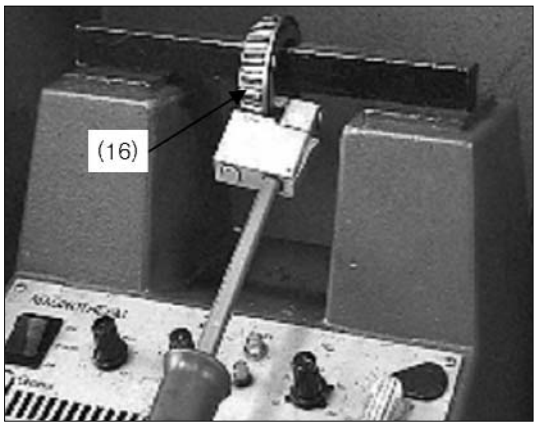
(6) Assemble the bearing cup (16, 2EA) to the housing (15) using the special tool and the plastic mallet.



15BTR9FA22

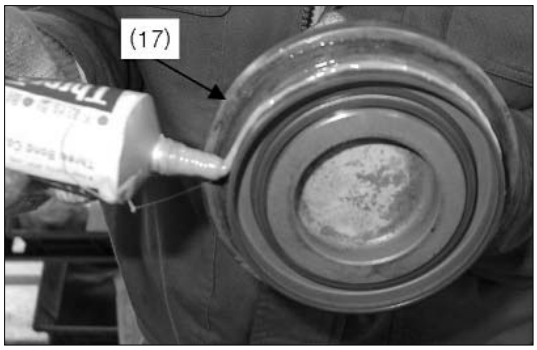
(7) After heating to 100℃ for the bearing cones (16, 2EA), and assemble the bearing cones to the housing (15) using the special tool and the plastic mallet with applying Mobil #424.

※ It should be assembled the bearing cone with heating state.



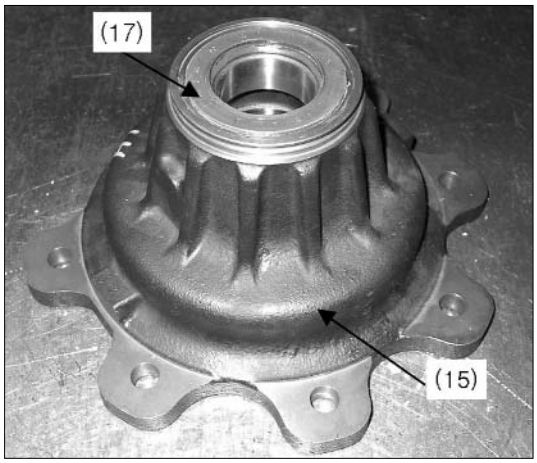
15BTR9FA23

(8) After applying the bond (#1102) on the outside of the oil seal (17) and the Mobil #424 on the rib surface of the oil seal, assemble the oil seal (17) to the housing (15).



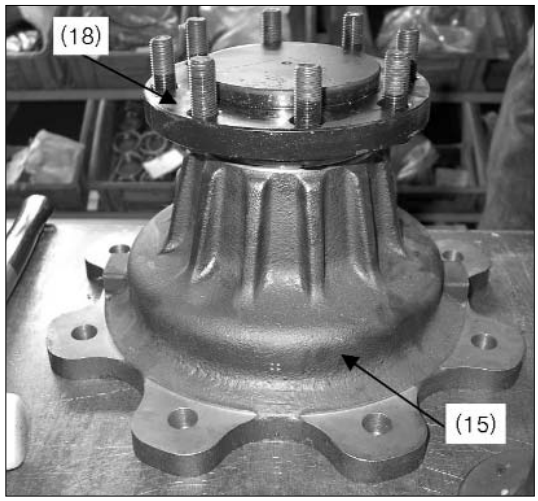
15BTR9FA24

※ It should be used the special tool when assembling the oil seal.



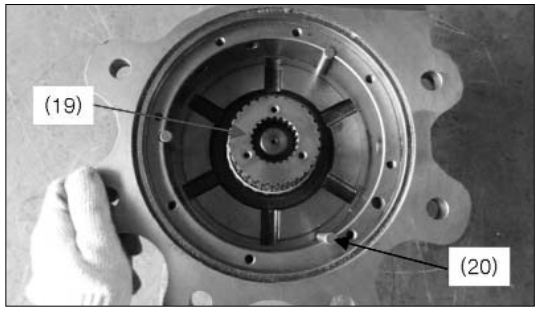
15BTR9FA25

(9) Assemble the drive shaft assy (18) to the housing (15).



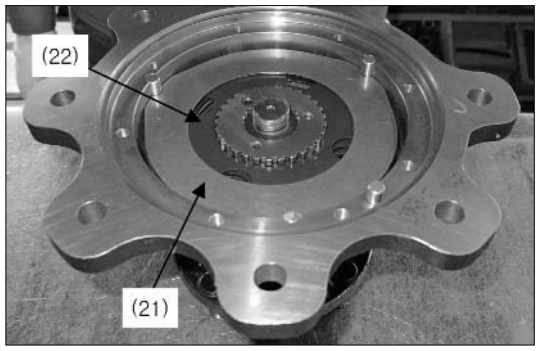
15BTR9FA26

(10) Assemble the collor spline (19, 1EA) and pin (20, 3EA) to the housing.



15BTR9FA27

(11) Assemble the plate (21, 5pcs) and the disc (22, 4pcs) to the housing.



15BTR9FA28

※ After applying the Loctite #242 on the bolts (3EA), assemble the bolts to the collor spline (19) with tightening torque (0.8~1.1kg · m).
Apply the Loctite #277 to the lock nut and tighten it with tightening torque (20.0~22.0kgf · m).
Before tighten the lock nut, adjust the starting torque 0.25~0.35 kgf · m with suitable shim.

(12) Apply the Loctite to the socket bolt (23) and tighten it with tightening torque (5.0~7.0kgf · m).

15BTR9FA29

SECTION 4 BRAKE SYSTEM

SECTION 4 BRAKE SYSTEM

GROUP 1 STRUCTURE AND FUNCTION

1. OUTLINE

There are two brake systems, the service brake system and the parking brake system.

In the service brake system, oil pressure is generated in the master cylinder by treading on the brake pedal. This pressure causes the brake lever to press the pressure pin which gives braking pressure to the disk carrier.

In the parking brake system, the brake lever is operated by cable. Therefore the pressure pin makes braking pressure onto the disk carrier.

2. SPECIFICATION

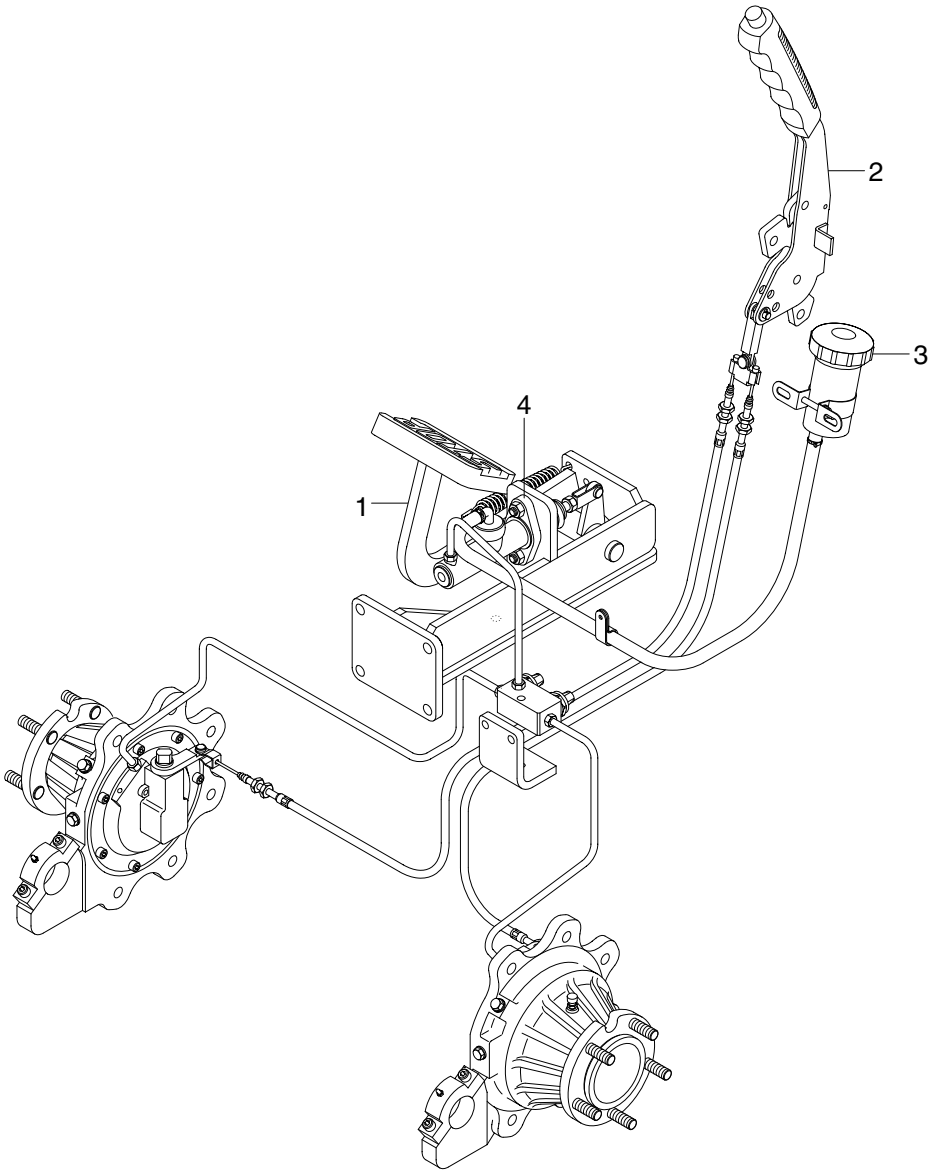
1) BRAKE

Item		Unit	Specification
Brake type		-	Wet disc brake
Operating brake pressure		kgf/cm^2	60~80
Brake fluid	Type	-	AZOLA ZS10
	Volume	cc	3.5 (1 axle)

2) PARKING BRAKE

Item	Specification
Type	Ratchet, internal expanding mechanical type
Parking lever stroke (°)	18.6
Parking cable stroke	60mm

3. BRAKE PEDAL AND PIPING

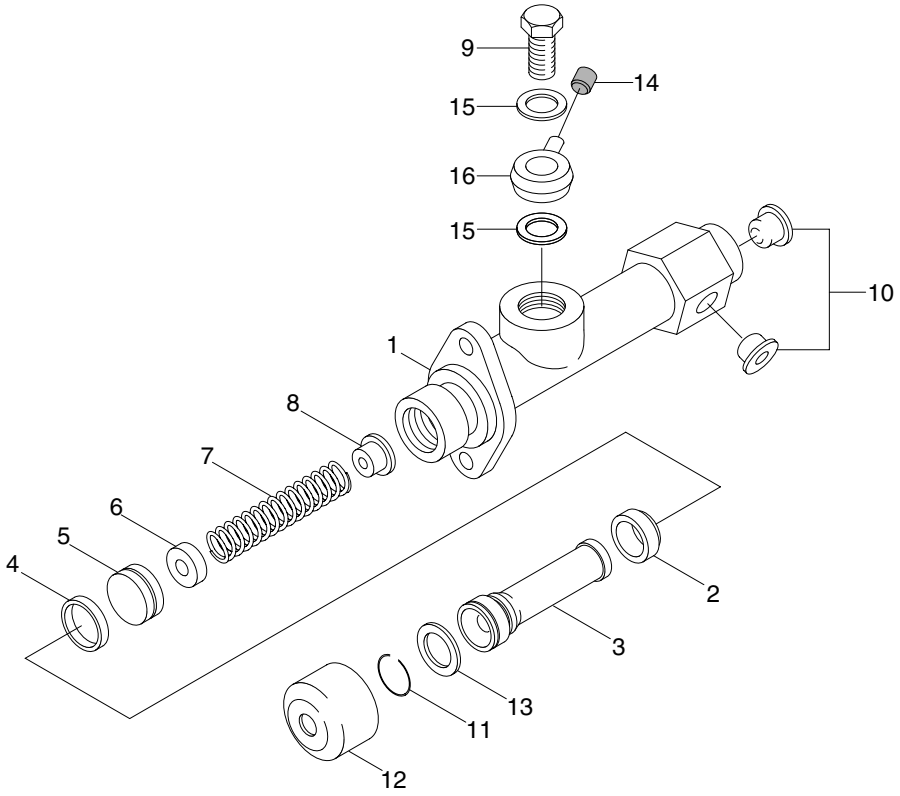


10BTR9BS01

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

4. BRAKE MASTER CYLINDER

1) STRUCTURE



20B7BS03

1	Body	7	Spring	13	Plate
2	Secondary cup	8	Check valve assembly	14	Cap
3	Piston	9	Union bolt	15	Gasket
4	Spacer	10	Cap	16	Union
5	Primary cup	11	Retaining ring		
6	Spring seat	12	Boot		

2) DISASSEMBLY AND ASSEMBLY

(1) Remove the boot(12).
(2) Take out the retaining ring(11) and plate(13).
(3) Take out the piston(3), secondary cup(2), spacer(4), primary cup(5), spring seat(6), spring(7) and check valve assembly(8) from cylinder.
(4) Perform assembly in reverse order of disassembly and add special working.
- Body and metallic parts should be washed and cleaned with petroleum solvents then dry the parts by air. Rubber parts should be washed with brake oil.
- Coat the rubber grease inner surface of cylinder.

2) INSPECTION

(1) Cylinder

Check the corrosion and pitching of inner surface of cylinder.
If any defects are noted, replace the parts.

(2) Piston

Check for wear of piston, replace the piston if necessary.

Item	Standard gap	Allowable limit
Gap of cylinder and piston	0.020~0.080㎜	0.2㎜

(3) Rubber parts

Check for wear of secondary cup and primary cup and replace them with new ones if necessary.

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

1. OPERATIONAL CHECKS

1) BRAKE PIPING

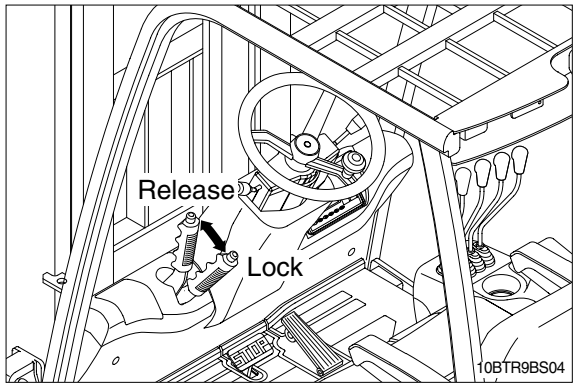
(1) Check pipes, hoses and joints for damage, oil leakage or interference.
(2) Operate brake pedal and check operating force when pedal in depressed. Check also change in operating force, and change in position of pedal when pedal is kept depressed.

2) BRAKING FORCE

(1) Select a dry, flat, paved surface and, drive truck at maximum speed. When signal is given, stop truck immediately and measure distance from point where signal was given to point where truck stopped(unloaded)
 · Stopping distance : Within 5m(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.

3) PARKING BRAKE

(1) Operating force of parking lever is 20 - 30 kgf · m(144 - 217lbf · ft).
(2) Check that parking brake can hold machine in position when loaded on 15% slope. If there is no slope available, travel at low speed and check braking effect of parking brake.



2. TROUBLESHOOTING

Problem	Cause	Remedy
Brakes do not work	· Oil leakage in the system or oil to low low in tank.	· Repair oil leakage. After bleeding fill fill oil tank of master cylinder to specified level with brake oil.
	· Air trapped in the system.	· Bleed air completely from the brake lever.
	· Worn out of deteriorated piston cup in master cylinder resulting in oil leakage	· Inspect cylinder and piston for degree of wear. On satisfactory, replace cup.
Brake pedal travel too large	· Air trapped in the system.	· Bleed air completely out. · Inspect oil tube joints & connections and replace leaking parts.
Wheel feel heavy	· Return port in master cylinder closed by piston cup.	· Inspect master cylinder. · Repair or replace pedal return spring.

GROUP 3 ADJUSTMENTS

1. ADJUSTMENT OF PEDAL

1) BRAKE PEDAL

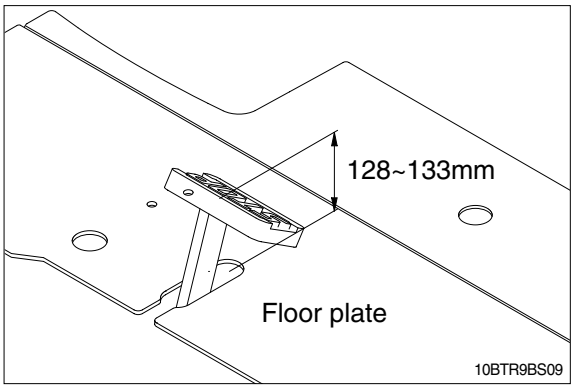
(1) Pedal height from floor plate adjust with stopper bolt.

· Pedal height : 128~133mm (5.1~5.2in)

(2) Play

Adjust with rod of mast cylinder.

· Pedal play : 4~6mm (0.16~0.23in)

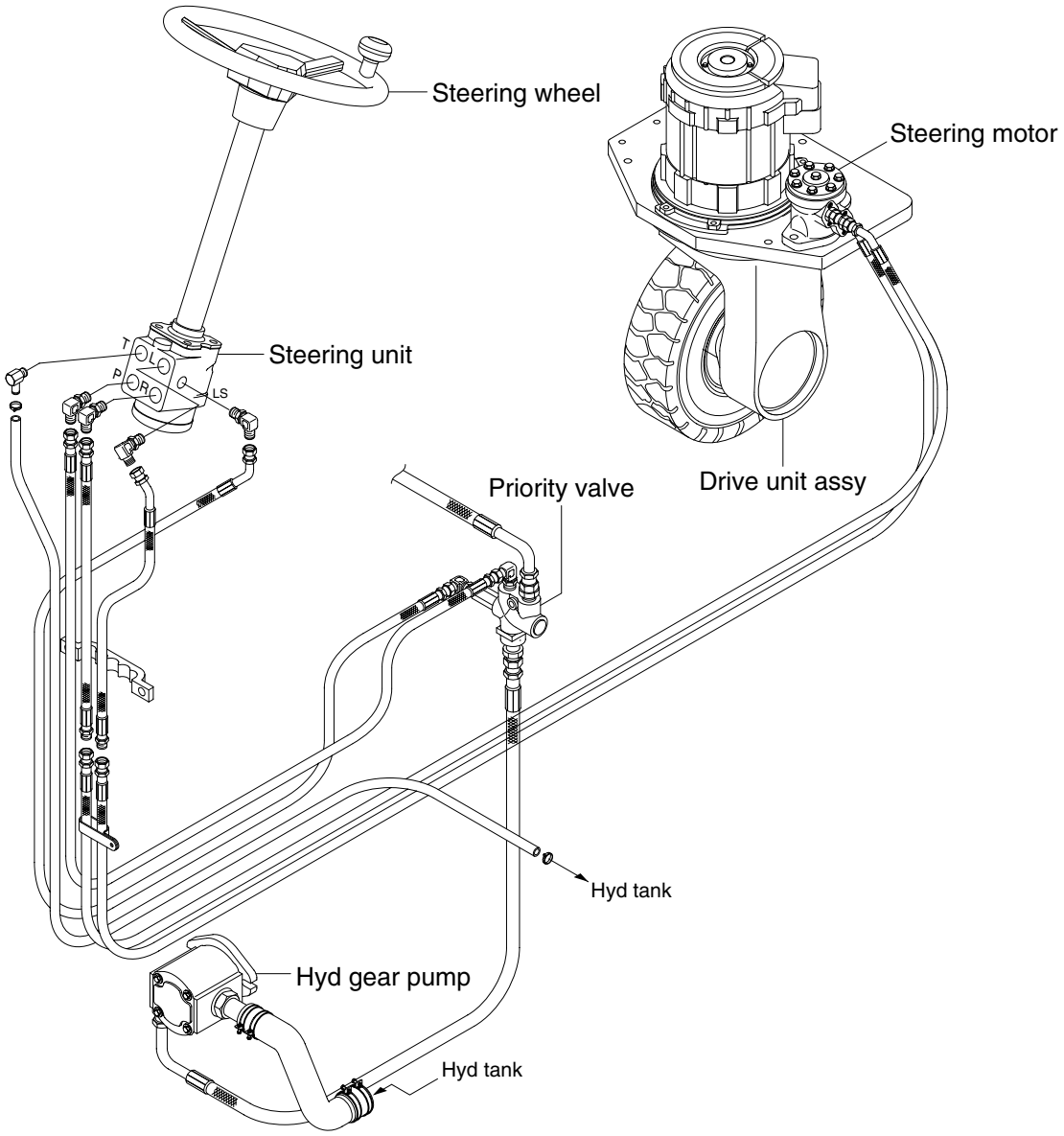


SECTION 5 STEERING SYSTEM

SECTION 5 STEERING SYSTEM

GROUP 1 STRUCTURE AND FUNCTION

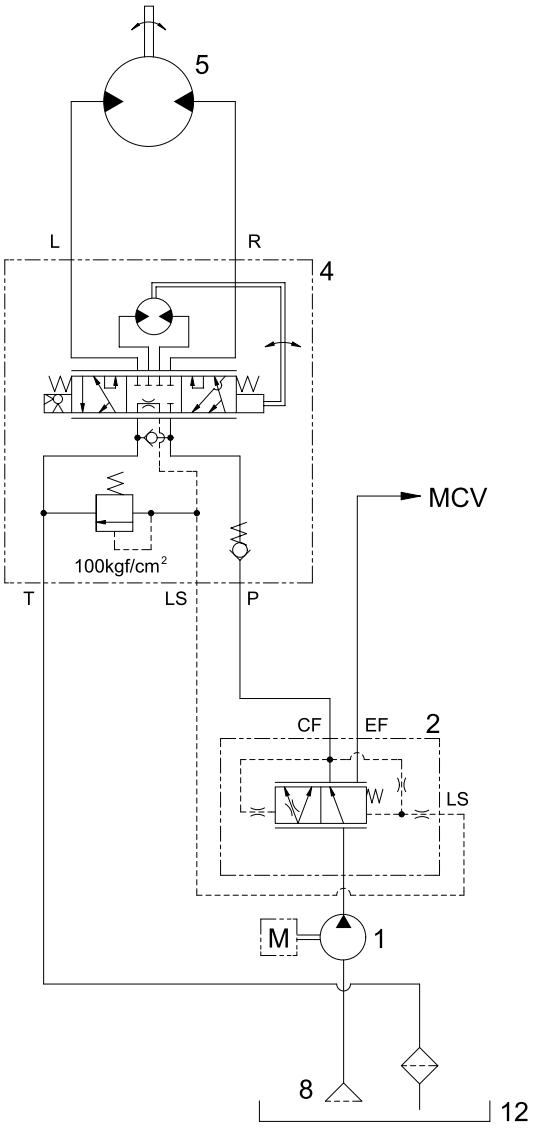
1. OUTLINE



10BTR9SS01

The steering system for this truck is composed of steering wheel assembly, steering unit, steering motor, drive unit assy and pipings. The steering force given to the steering wheel enters the steering unit through the steering column. The required oil flow is sensed by the function of the control section of the unit, and pressurized oil delivered from the hydraulic pump is fed to the steering motor.

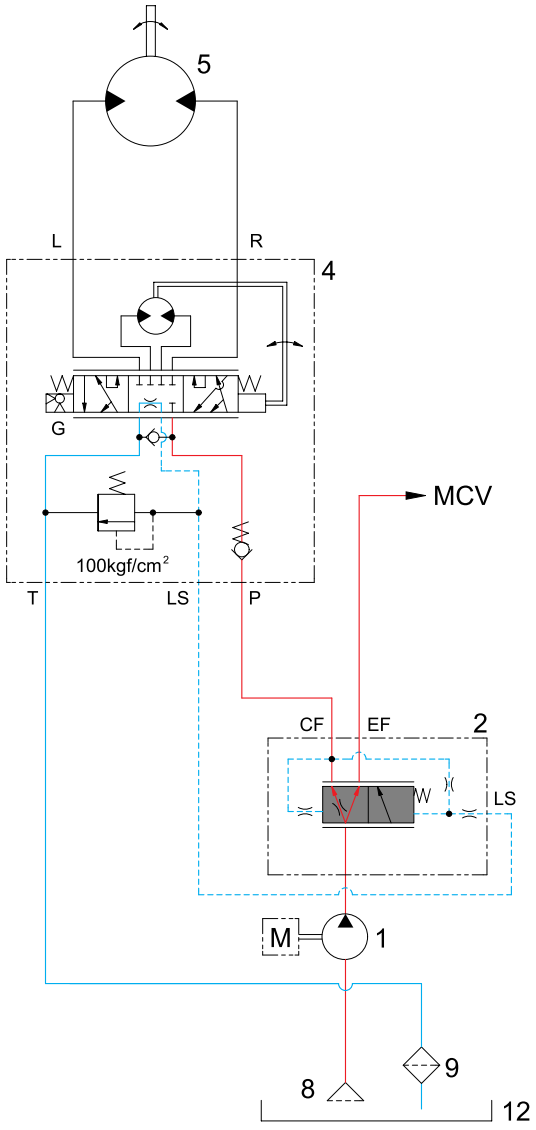
2. HYDRAULIC CIRCUIT



10BTR9SS26

1	Hydraulic gear pump	8	Suction strainer
2	Priority valve	9	Return filter
4	Steering unit	12	Hydraulic tank
5	Hydraulic motor		

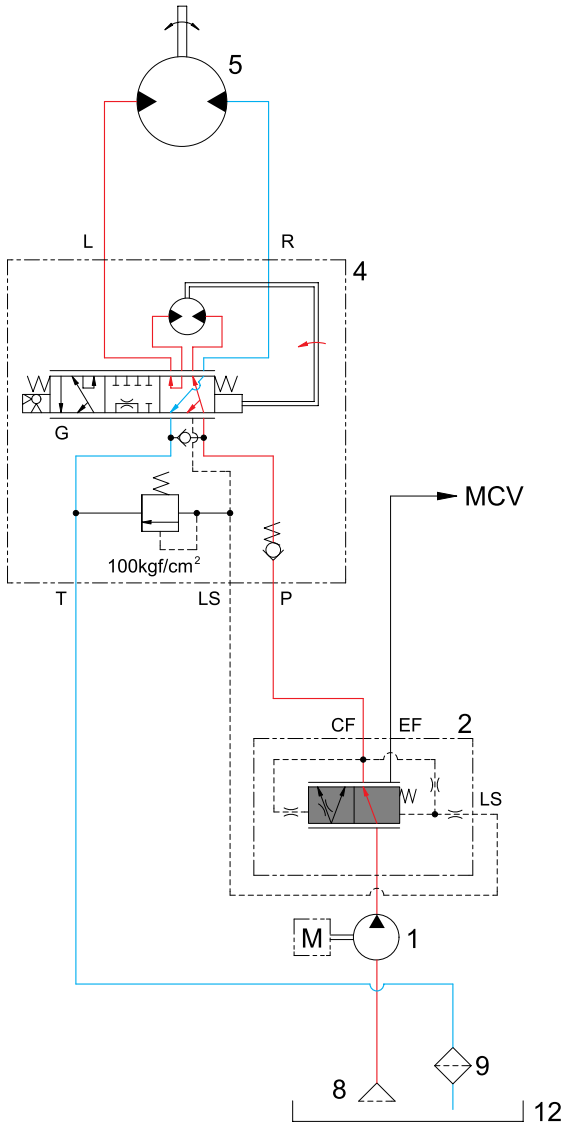
1) NEUTRAL



10BTR9SS04

The steering wheel is not being operated so control spool(G) does not move.
The oil from hydraulic tank(12) enters hydraulic gear pump(1) and pressurized so that the oil flows into the inlet port(P) of steering unit(4).
Oil flows out of T port to the hydraulic tank(12).

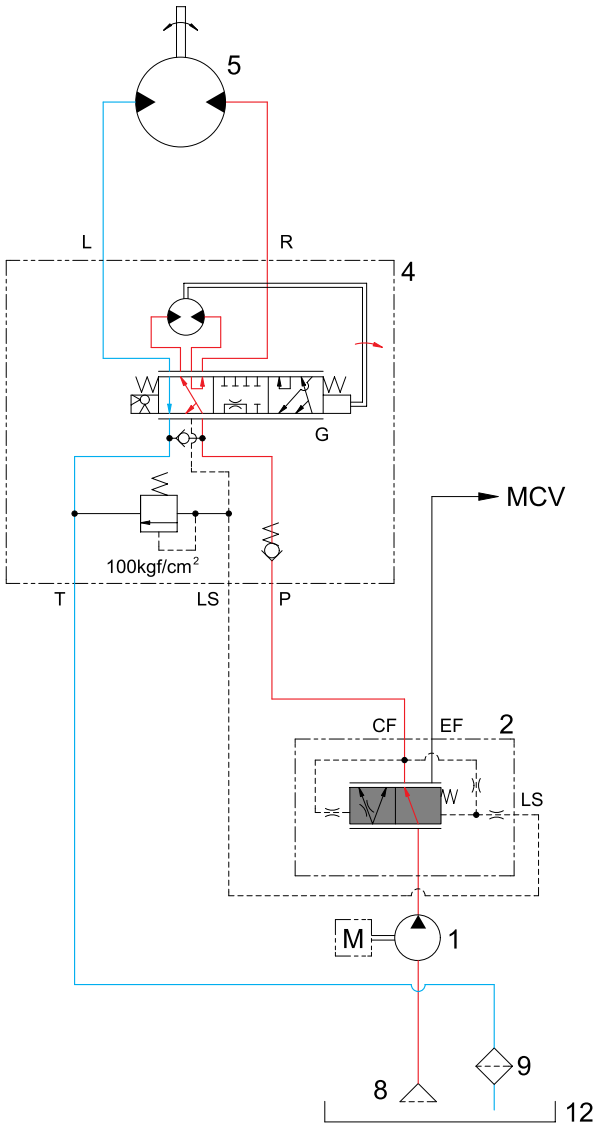
2) LEFT TURN



10BTR9SS06

When the steering wheel is turned to the left, the spool(G) within the steering unit(4) connected with steering column turns in left hand direction.
At this time, the oil discharged from hydraulic gear pump(1) flows into the spool(G) of the steering unit(4) through the inlet port(P) and flows to gerotor(H).
Oil flow from the gerotor flows back into the spool(G) where it is directed out to the left work port(L).
Oil returned from hydraulic motor(5) returns to hydraulic tank(12).
When the above operation is completed, the machine turns to the left.

3) RIGHT TURN

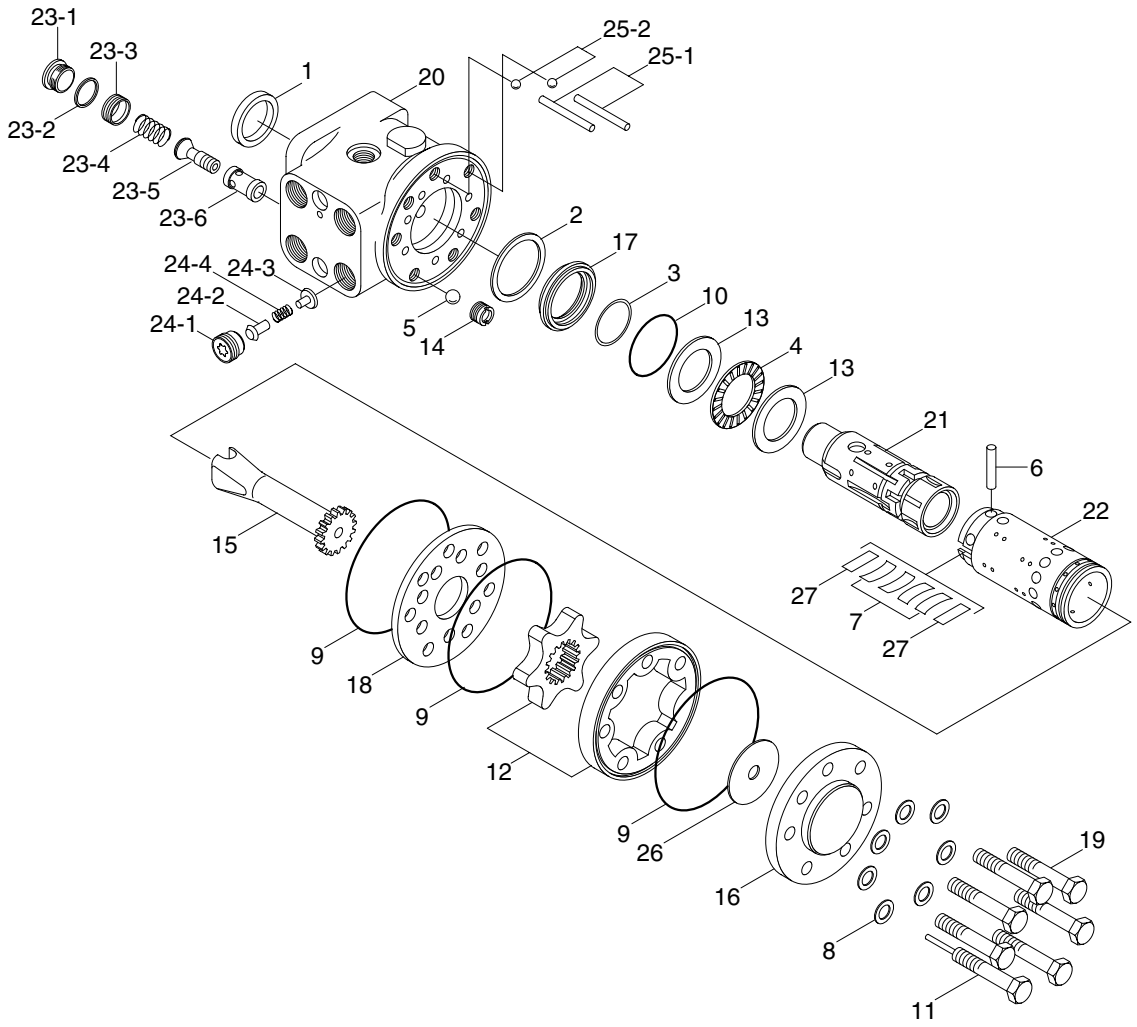


10BTR9SS08

When the steering wheel is turned to the right, the spool(G) within the steering unit(4) connected with steering column turn in right hand direction.
At this time, the oil discharged from hydraulic gear pump(1) flows into the spool(G) of the steering unit(4) through the inlet port(P) and flows to gerotor(H).
Oil flow from the gerotor flows back into the spool(G) where it is directed out to the right work port(R).
Oil returned from hydraulic motor(5) returns to hydraulic tank(12).
When the above operation is completed, the machine turns to the right.

3. STEERING UNIT

1) STRUCTURE



20B7SS09

1	Dust seal	14	Bore screw	23-4	Spring
2	Retaining ring	15	Drive shaft	23-5	Spool
3	Cap seal	16	End cap	23-6	Bushing
4	Thrust bearing	17	Bushing	24	P-port check valve
5	Ball	18	Plate	24-1	Plug
6	Pin	19	Cap screw	24-2	Poppet
7	Center spring	20	Housing	24-3	Spring seat
8	Washer	21	Spool	24-4	Spring
9	O-ring	22	Sleeve	25	Suction valve
10	O-ring	23	Relief valve	25-1	Roll pin
11	Rolled screw	23-1	Plug	25-2	Ball
12	Gerotor set	23-2	O-ring	26	Spacer
13	Bearing race	23-3	Spring seat	27	Plate spring

2) OPERATION

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

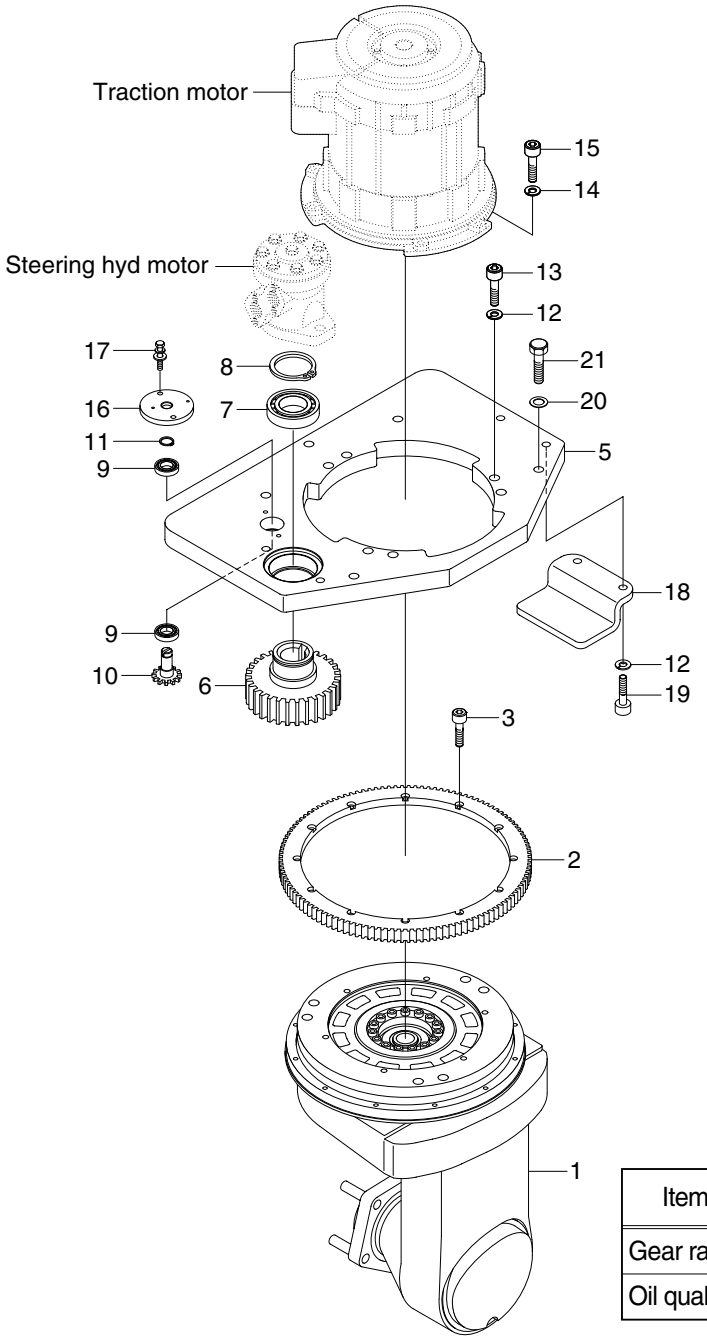
When the steering wheel is turned, the spool turns, the oil path is switched and the oil is fed into the metering device. As a result, the rotor is caused to run by oil pressure, and the sleeve is caused to run through the drive shaft and cross pin. Therefore, when the spool is turned, the spool turns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

⚠ **If the hoses of the steering system are incorrectly connected, the steering wheel can turn very rapidly when the key switch is ON. Keep clear of the steering wheel when the key switch is ON.**

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

4. DRIVE UNIT

1) STRUCTURE

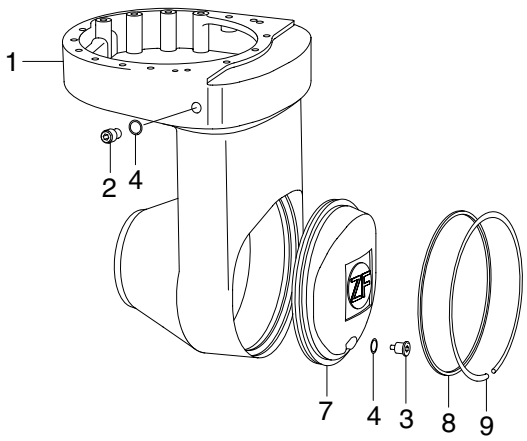


Item	Unit	Spcification
Gear ratio	-	20.5
Oil quality	ℓ	6.0

10BTR9SS10

1	Drive unit assy	9	Ball bearing	16	Bracket
2	Steering gear	10	Pinion	17	Bolt w/washer-hex
3	Socket bolt	11	Retaining ring (C)	18	Bracket
5	Drive unit bracket	12	Spring washer	19	Socket bolt
6	Steering pinion	13	Socket bolt	20	Plain washer
7	Roller bearing	14	Spring washer	21	Hex bolt
8	Retaining ring (C)	15	Socket bolt		

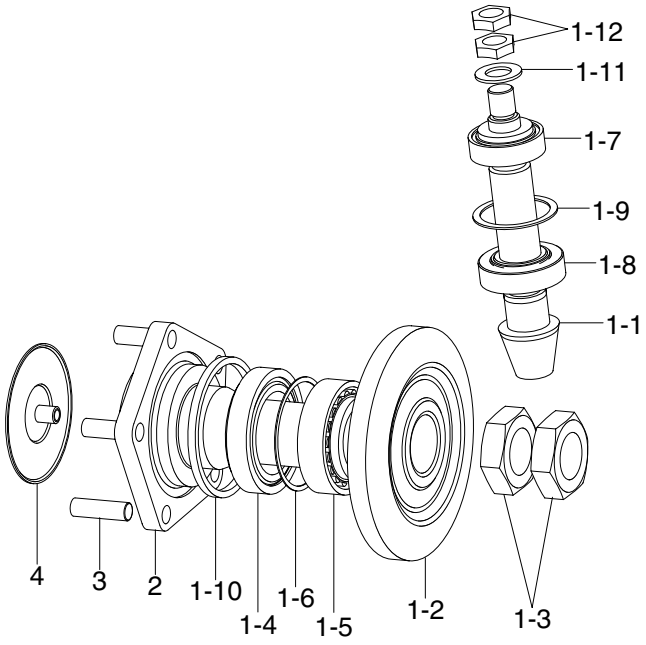
(1) Drive unit (1/4)



10BTR9DU01

1	Housing	4	Ring-seal	9	Circlip
2	Plug	7	Cover		
3	Plug-w/magnet	8	O-ring		

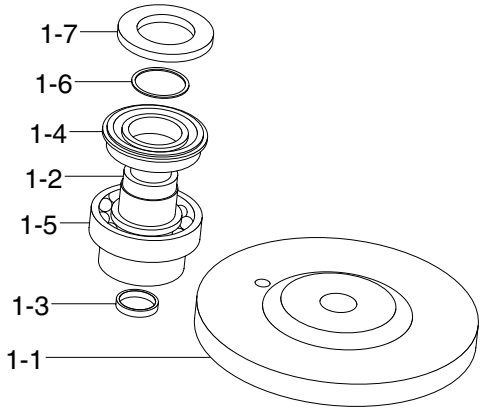
(2) Drive unit (2/4)



10BTR9DU02

1-1	Pinion shaft	1-6	Shim ring	1-11	Shim
1-2	Bevel gear	1-7	Taper roller bearing	1-12	Hexagon nut
1-3	Hexagon nut	1-8	Taper roller bearing	2	Wheel shaft
1-4	Taper roller bearing	1-9	Shim	3	Bolt-wheel
1-5	Taper roller bearing	1-10	Shaft sealing ring	4	Protection cap

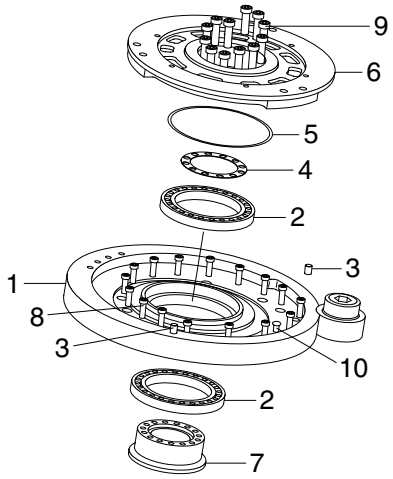
(3) Drive unit (3/4)



10BTR9DU03

1-1	Spur gear	1-4	Ball bearing	1-7	Sealing ring-shaft
1-2	Input pinion	1-5	Ball bearing		
1-3	Plug	1-6	Retaining ring		

(4) Drive unit (4/4)

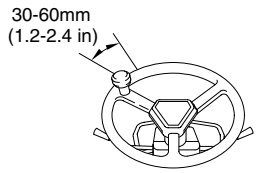


10BTR9DU04

1	Housing upper part	5	O-ring	9	Torx screw
2	Taper roller bearing	6	Connecting plate	10	Valve-breather
3	Cylindrical pin	7	Bush		
4	Shim set	8	Cylindrical screw		

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

1. OPERATIONAL CHECKS

Check item	Checking procedure
Steering wheel 	· Set rear wheels facing straight forward, then turn steering wheel to left and right. Measure range of steering wheel movement before rear wheel starts to move. Range should be 30~60mm at rim of steering wheel. If play is too large, adjust at gear box. Test steering wheel play with forklift stopped.
Knuckle	· Check knuckle visually or use crack detection method. If the knuckle is bent, the tire wear is uneven, so check tire wear.
Steering axle	· Ask assistant to drive machine at minimum turning radius. · Fit bar and a piece of chalk at outside edge of counterweight to mark line of turning radius. · Min turning radius(Outside) : Refer to page 1-5 (Specifications)
Hydraulic pressure of power steering	Remove cap from check port of priority valve and install oil pressure gauge. Turn steering wheel fully and check oil pressure. ※ Oil pressure : 100 kgf/cm^2 (1425 psi)

2. TROUBLESHOOTING

1) STEERING SYSTEM

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

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

2) POWER STEERING UNIT

Problem	Cause	Remedy
Oil leakage	· Fittings loose, worn, or damaged.	· Check and replace the damaged parts.
	· Deteriorated seals by excessive heat.	· Replace the seals.
	· Loose screw or its deteriorated sealing.	· Replace the sealing and tighten screw appropriately.
	· Internal seals worn or damaged.	· Replace it.
	· Damaged seal grooves.	· Replace the unit or related parts.
	· Housing crack.	· Replace the unit.
Noise or vibration	· Air inclusion in the system.	· Bleed the air.
	· Valve timing error when the unit is assembled.	· Correct the timing.
	· Hydraulic pipe noise interference.	· Consult the component manufacturer.
	· Control valve damage or clogging.	· Replace the valve.
Heavy steering operation	· Lack of sufficient oil supply.	· Check the pump and the line.
	· Excessive heat.	· Locate the heat source and correct it.
	· Broken pump.	· Replace it.
	· Leakage in the line or connections.	· Replace it.
	· Clogged orifice.	· Disassemble, clean, and reassemble it.
	· High back pressure.	· Adjust the pressure.
Irregular or no response	· Broken pump.	· Replace it.
	· Excessive heat.	· Locate the heat source and remove it.
	· Broken centering spring.	· Replace it.
	· Misalignment with column.	· Disassemble and adjust it.
	· Incorrect piping to the four port.	· Correct it.
	· Parts missing.	· Install the parts correctly.
	· High back pressure.	· Adjust the pressure.
	· Corrosion on the moving parts.	· Replace it.

3) DRIVE UNIT

(1) Noises

Problem	Cause	Remedy
High-pitch, striking noise	· Gearing of spur gear stage damaged.	· Replacement of the gearing parts.
	· Contamination or dirt on gearing parts.	· Change oil or replace relevant gearing part if necessary.
High-pitch, continuous noise	· Motor/transmission connection defective.	· Check motor fitting or replace input pinion/motor.
	· Mechanical motor connection not OK.	· Check motor dimensions and motor connection.
Dull, grinding noise	· Tapered roller bearing of the wheel bearing defective.	· Replace the tapered roller bearing.
	· Bevel gear stage gearing damaged.	· Replacement of the gearing parts.

(2) Leaks

Problem	Cause	Remedy
Breathers	· Oil level too high.	· Correct oil level.
Housing cover	· O-ring damaged or worn.	· Replace o-ring.
Gear shaft	· Radial rotary shaft sealing ring damaged or worn.	· Replace radial rotary shaft sealing ring.
Oil seal plugs	· Plugs not tightened to specified tightening torque.	· Check tightening torque, tighten if required.
	· Sealing ring damaged or worn.	· Replace sealing ring.
Transmission motor shaft connection	· Radial rotary sealing ring in the transmission damaged or worn.	· Replace radial rotary shaft sealing ring.

(3) Drive with limited or no function

Problem	Cause	Remedy
Motors	· Connecting loose or defective cable.	· Change/tighten connecting cable.
Drive unit	· Motor/transmission blocked.	· Change motor/transmission.
	· Brake blocked.	· Change brake.

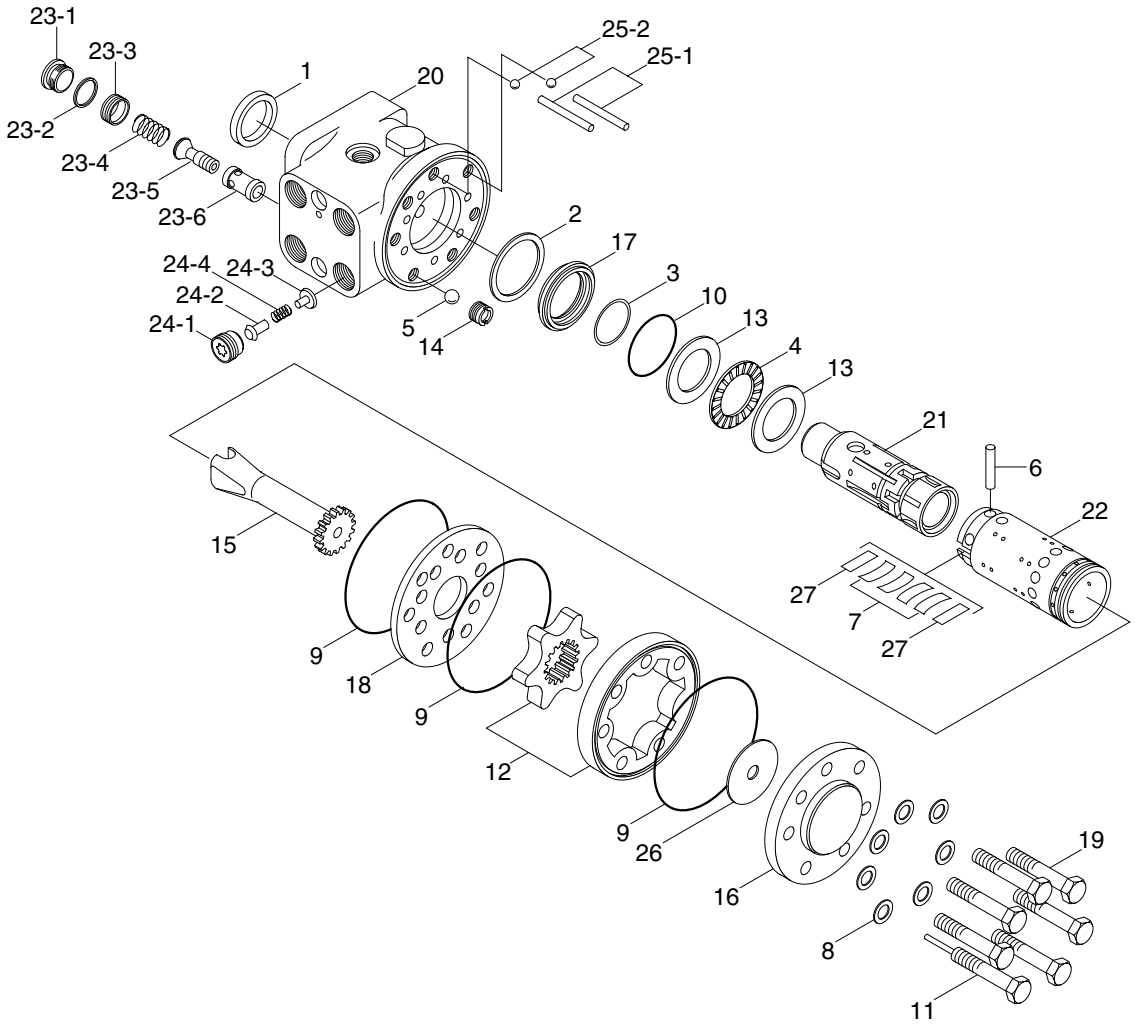
(4) Braking response faulty

Problem	Cause	Remedy
Brake Drive unit (if fitted)	· Friction lining worn.	· Replace brake.
	· Friction lining soiled by oil, grease, or dust.	· Clean friction lining; replace brake if necessary.
	· Incorrect adjustment of brake air gap.	· Readjust brake air gap.

GROUP 3 DISASSEMBLY AND ASSEMBLY

1. STEERING UNIT

1) STRUCTURE

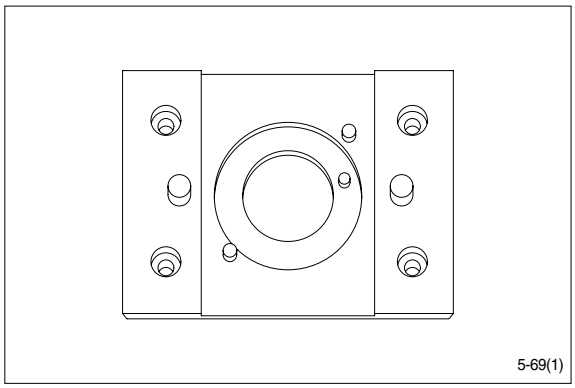


20B7SS09

1	Dust seal	14	Bore screw	23-4	Spring
2	Retaining ring	15	Drive shaft	23-5	Spool
3	Cap seal	16	End cap	23-6	Bushing
4	Thrust bearing	17	Bushing	24	P-port check valve
5	Ball	18	Plate	24-1	Plug
6	Pin	19	Cap screw	24-2	Poppet
7	Center spring	20	Housing	24-3	Spring seat
8	Washer	21	Spool	24-4	Spring
9	O-ring	22	Sleeve	25	Suction valve
10	O-ring	23	Relief valve	25-1	Roll pin
11	Rolled screw	23-1	Plug	25-2	Ball
12	Gerotor set	23-2	O-ring	26	Spacer
13	Bearing race	23-3	Spring seat	27	Plate spring

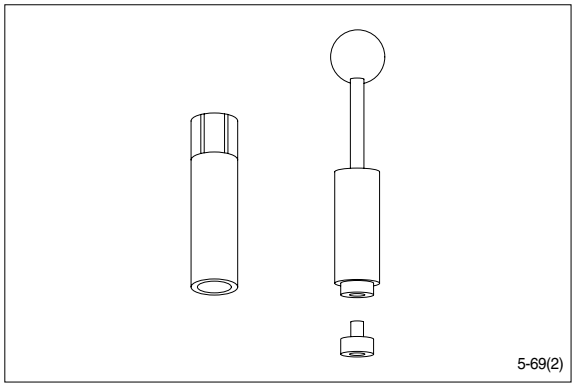
2) TOOLS

(1) Holding tool.



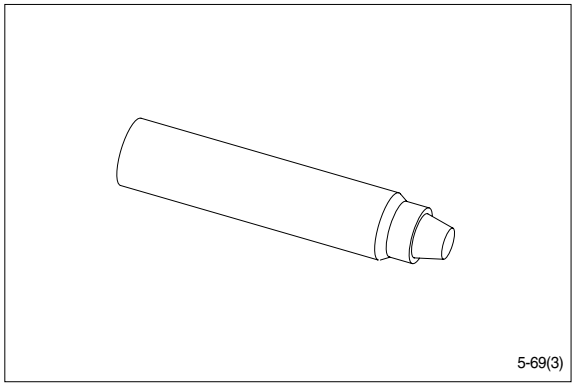
5-69(1)

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



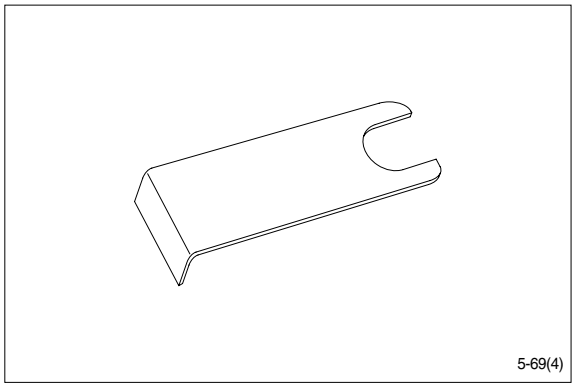
5-69(2)

(3) Assembly tool for lip seal.



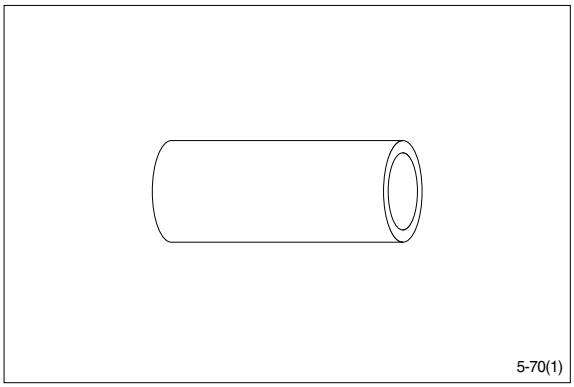
5-69(3)

(4) Assembly tool for cardan shaft.

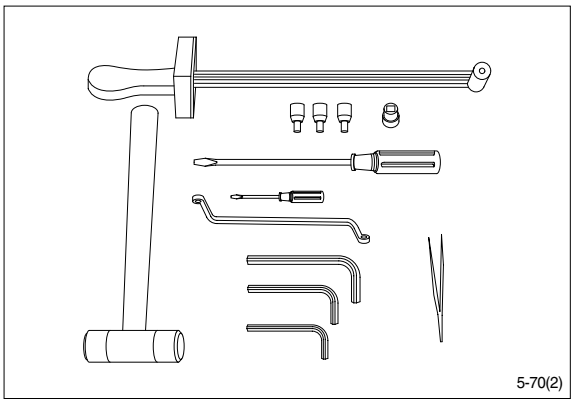


5-69(4)

(5) Assembly tool for dust seal.

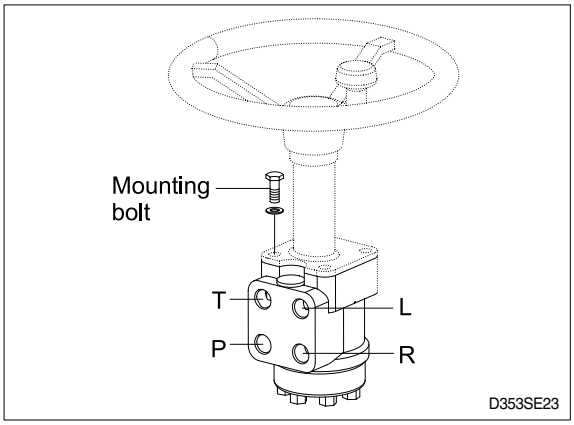


(6) Torque wrench 0~7.1kgf · m
(0~54.4lbf · ft)
13mm socket spanner
6, 8mm and 12mm hexagon sockets
12mm screwdriver
2mm screwdriver
13mm ring spanner
6, 8 and 12mm hexagon socket spanners
Plastic hammer
Tweezers



3) TIGHTENING TORQUE

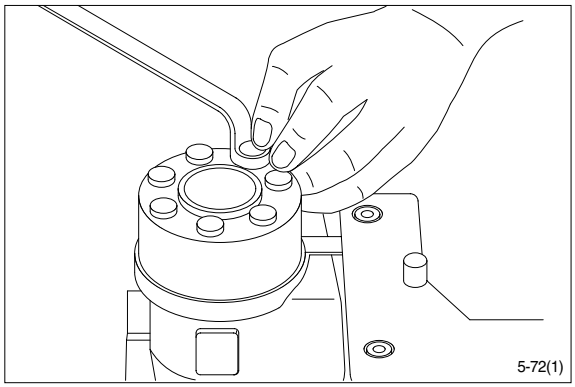
L : Left port
R : Right port
T : Tank
P : Pump



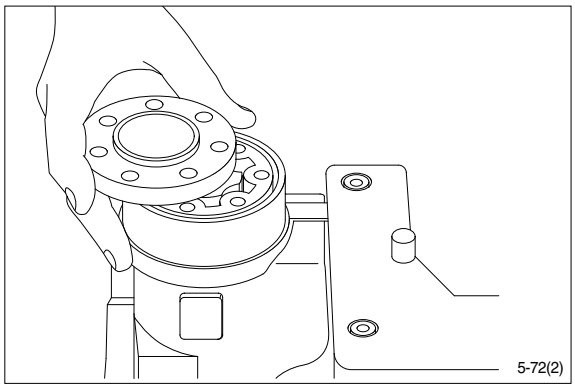
Port	Size	Torque [kgf · m(lbf · ft)]
L	3/4 UNF - 16	6.1 ±0.6 (44.1±4.3)
R	3/4 UNF - 16	6.1 ±0.6 (44.1±4.3)
T	3/4 UNF - 16	6.1 ±0.6 (44.1±4.3)
P	3/4 UNF - 16	6.1 ±0.6 (44.1±4.3)
Mounting bolt	M10×1.5	5 ±1 (36±7.2)

4) DISASSEMBLY

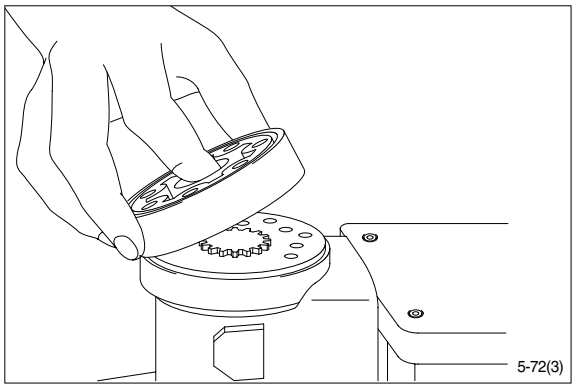
(1) Disassemble steering column from steering unit and place the steering unit in the holding tool.
Screw out the screws in the end cover(6-off plus one special screw).


5-72(1)

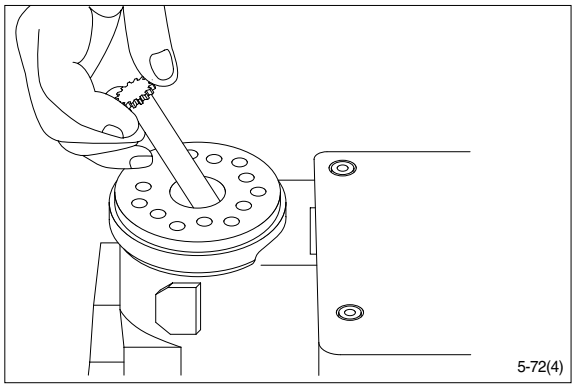
(2) Remove the end cover, sideways.


5-72(2)

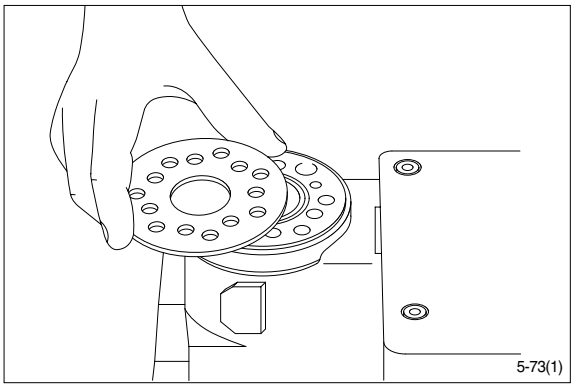
(3) Lift the gearwheel set(With spacer if fitted) off the unit.
Take out the two O-rings.


5-72(3)

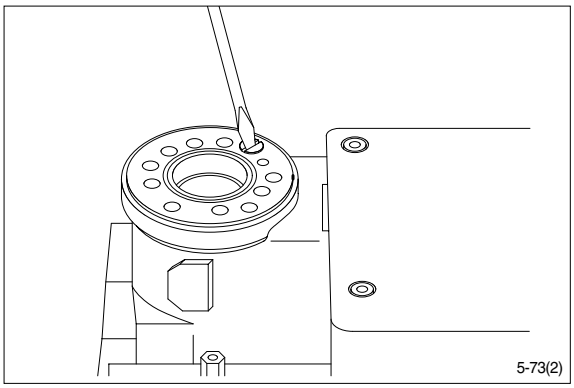
(4) Remove cardan shaft.


5-72(4)

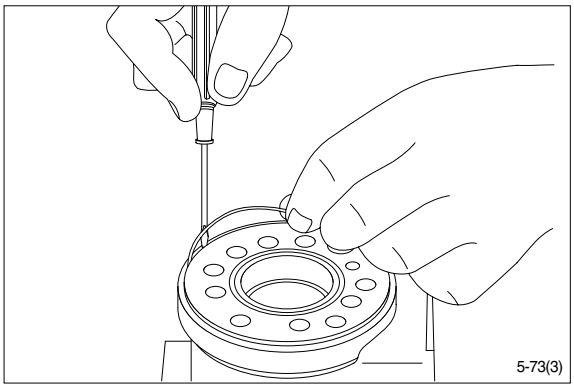
(5) Remove distributor plate.



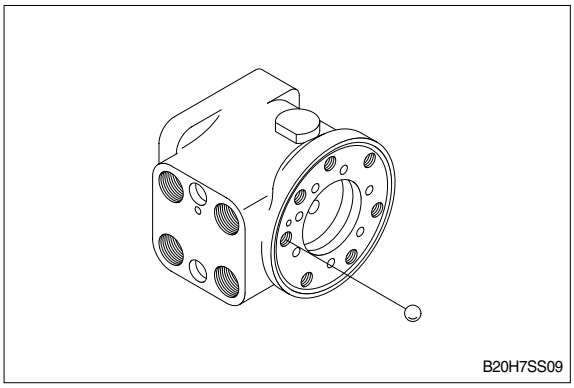
(6) Screw out the threaded bush over the check valve.



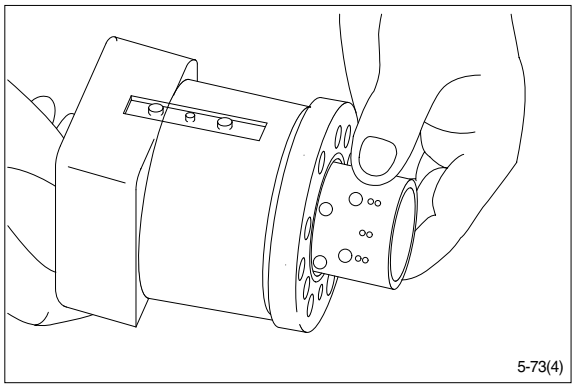
(7) Remove O-ring.



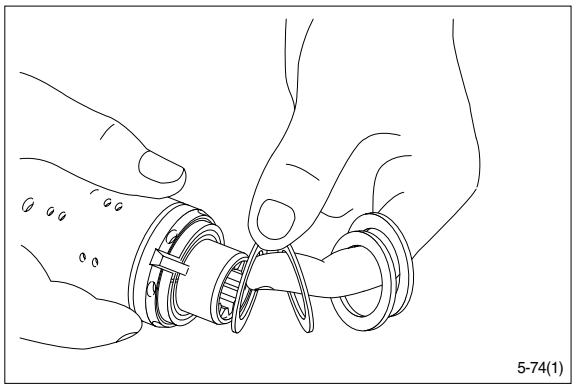
(8) Shake out the check valve ball.



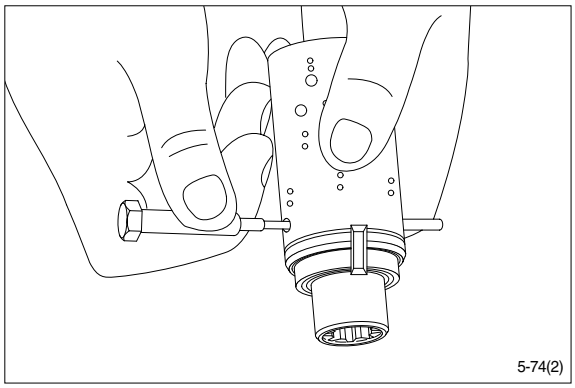
(9) Take care to keep the cross pin in the sleeve and spool horizontal. The pin can be seen through the open end of the spool. Press the spool inwards and the sleeve, ring, bearing races and thrust bearing will be pushed out of the housing together.


5-73(4)

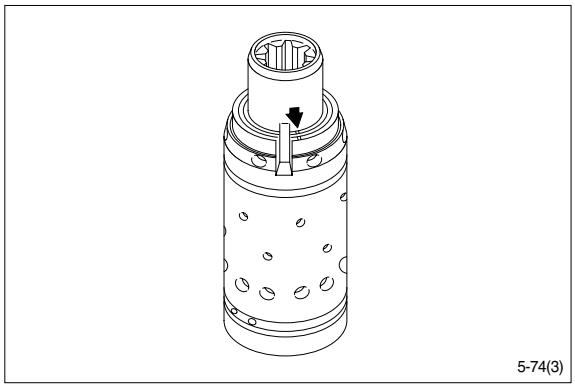
(10) Take ring, bearing races and thrust bearing from sleeve and spool. The outer (Thin) bearing race can sometimes "stick" in the housing, therefore check that it has come out.


5-74(1)

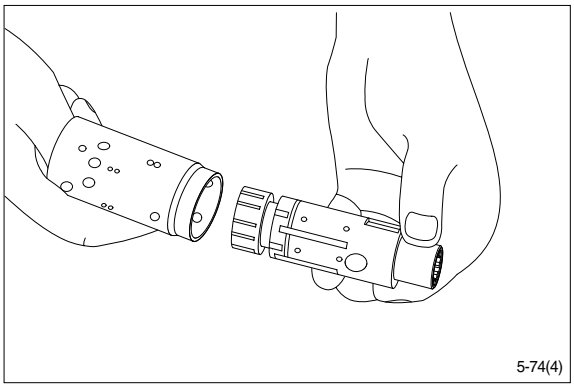
(11) Press out the cross pin. Use the special screw from the end cover.


5-74(2)

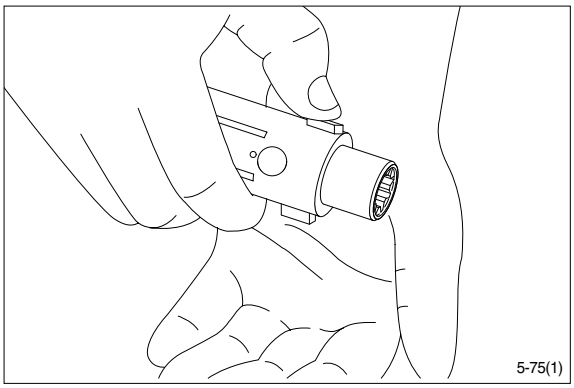
※ A small mark has been made with a pumice stone on both spool and sleeve close to one of the slots for the neutral position springs(See drawing).
If the mark is not visible, remember to leave a mark of your own on sleeve and spool before the neutral position springs are disassembled.


5-74(3)

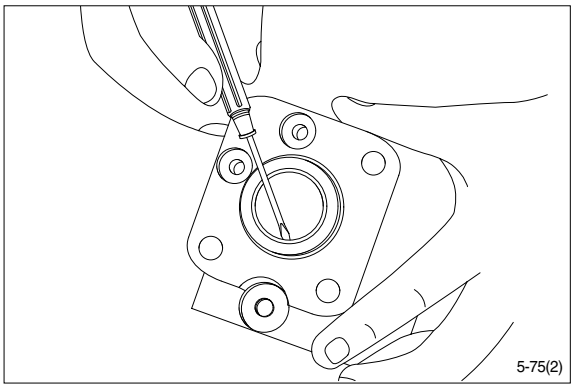
(12) Carefully press the spool out of the sleeve.



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

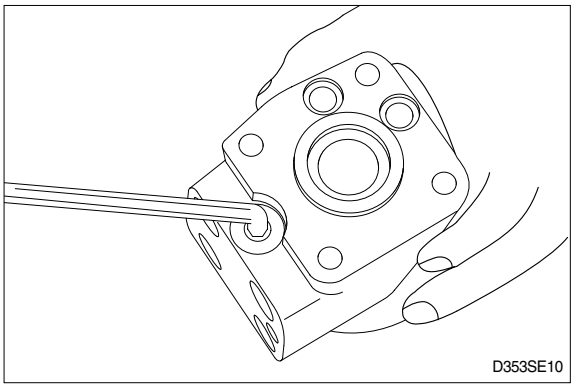


(14) Remove dust seal and O-ring.

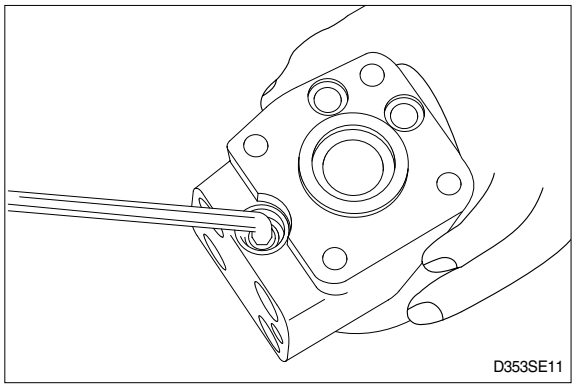


Disassembling the pressure relief valve

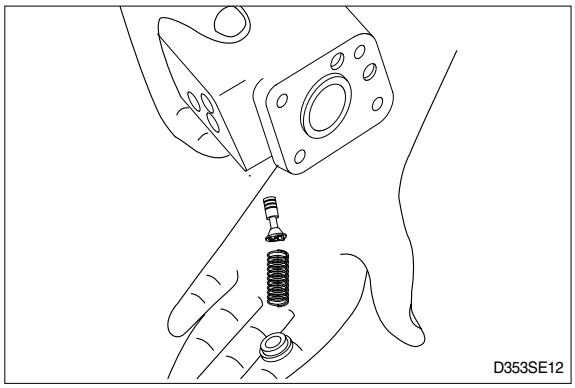
(15) Screw out the plug using an 8mm hexagon socket spanner.
Remove seal washers.



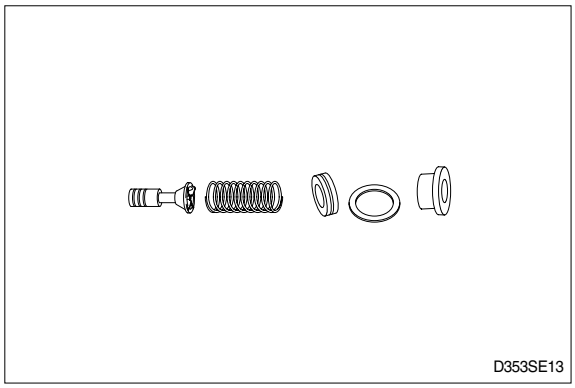
(16) Unscrew the setting screw using an 8㎜ hexagon socket spanner.



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



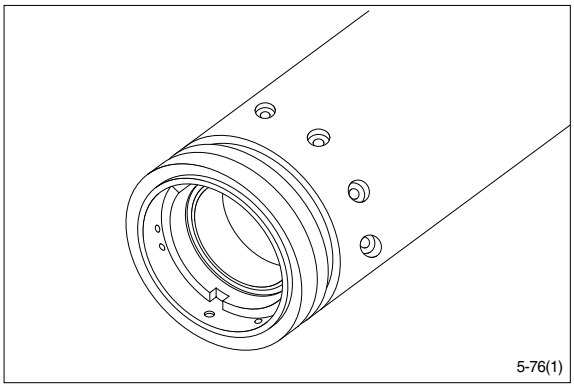
(18) The pressure relief valve is now disassembled.



5) ASSEMBLY

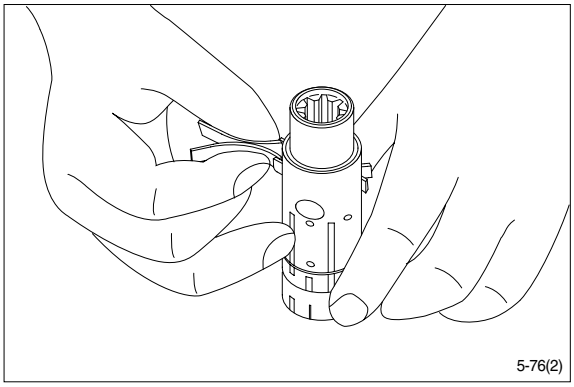
(1) Assemble spool and sleeve.

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



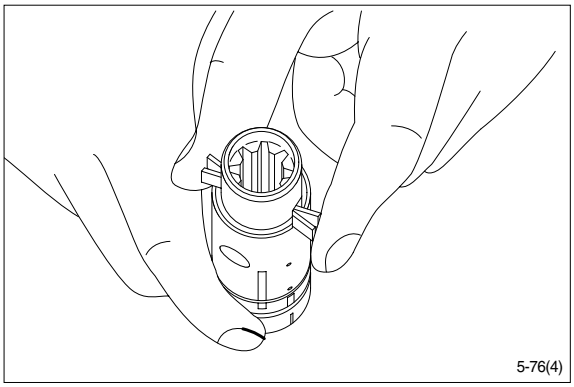
5-76(1)

(2) Place the two flat neutral position springs in the slot.
Place the curved springs between the flat ones and press them into place (see assembly pattern).



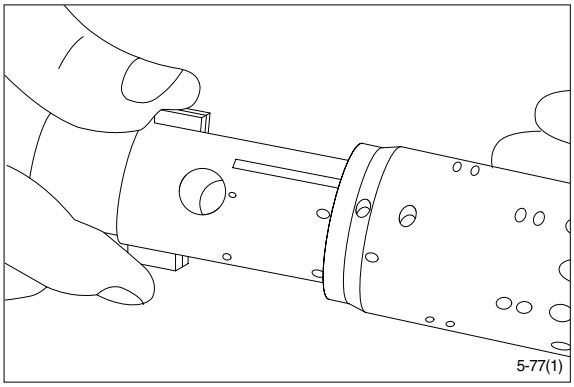
5-76(2)

(3) Line up the spring set.



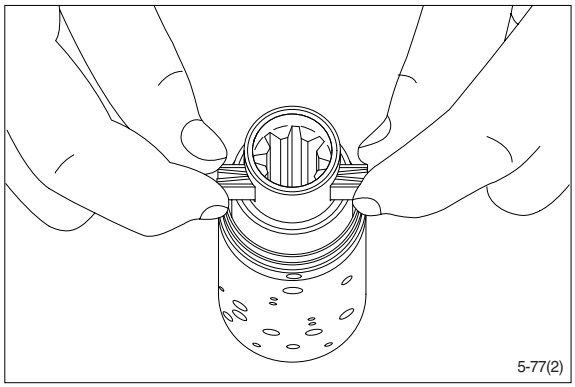
5-76(4)

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

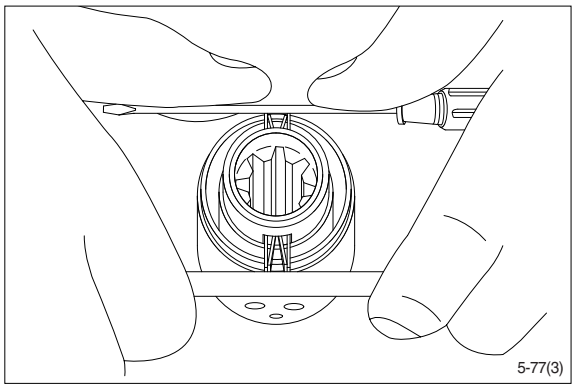


5-77(1)

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

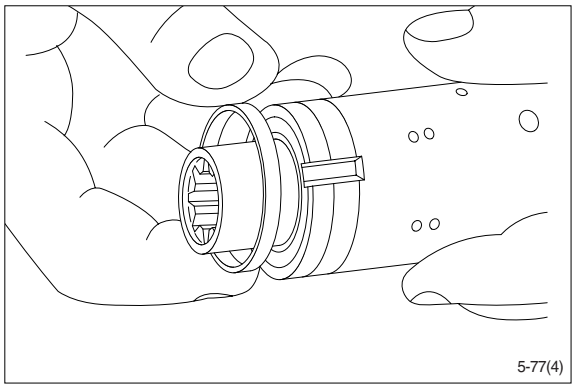

5-77(2)

(6) Line up the springs and center them.

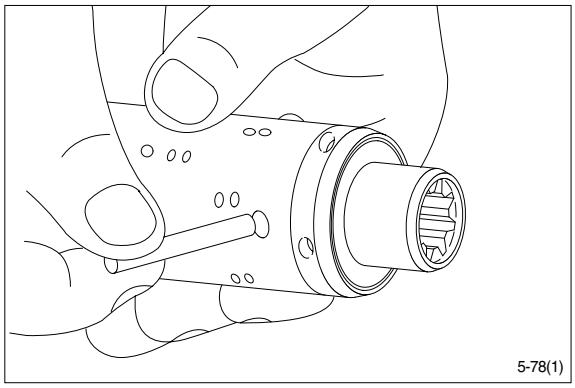

5-77(3)

(7) Guide the ring down over the sleeve.

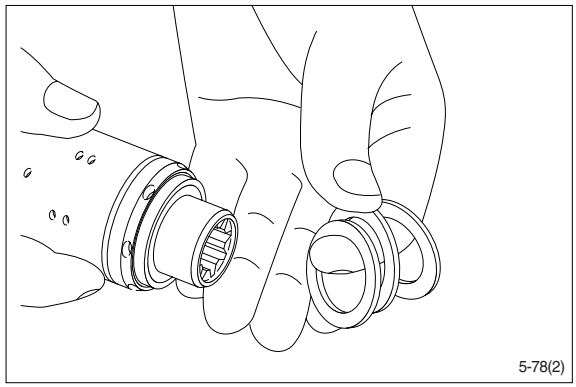
※ The ring should be able to rotate free of the springs.


5-77(4)

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

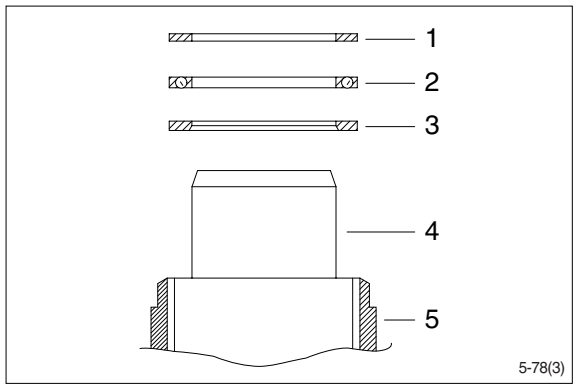

5-78(1)

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



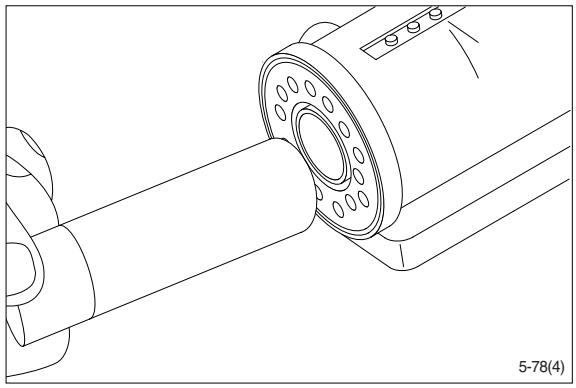
※ **Assembly pattern for standard bearings**

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

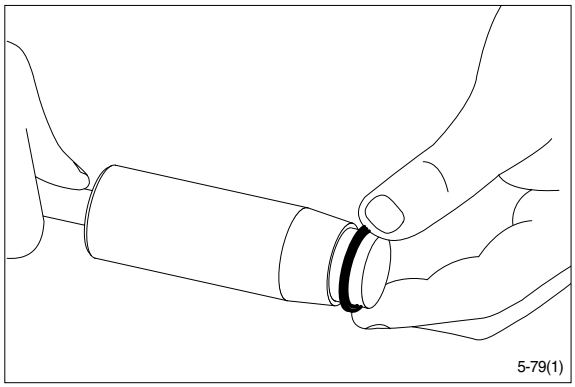


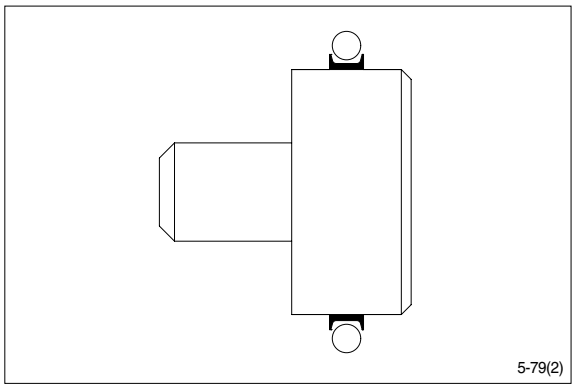
Installation instruction for O-ring

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

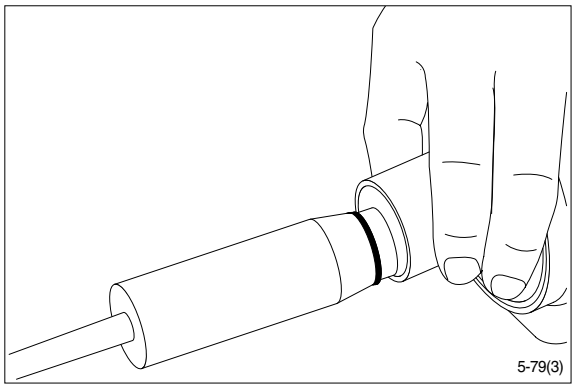


(11) Grease O-ring with hydraulic oil and place them on the tool.

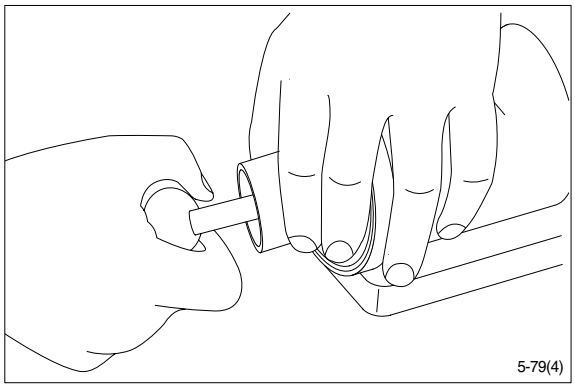

5-79(1)


5-79(2)

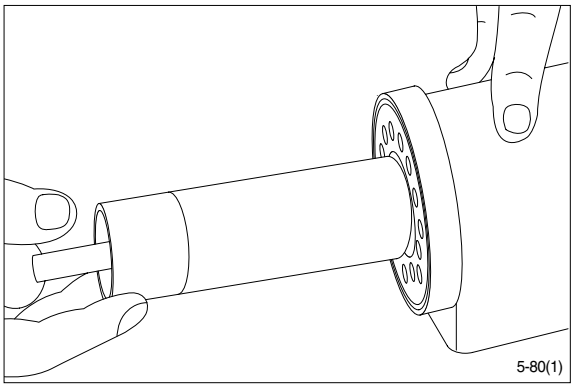
(12) Hold the outer part of the assembly tool in the bottom of the steering unit housing and guide the inner part of the tool right to the bottom.


5-79(3)

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

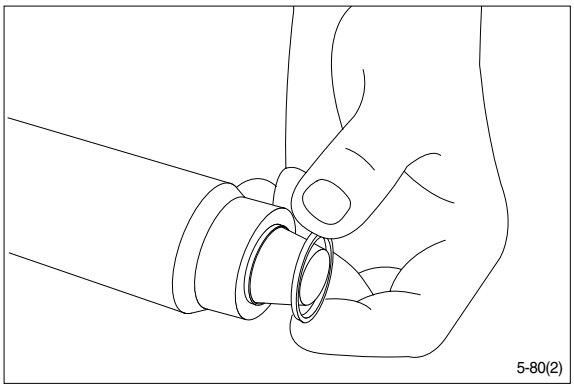

5-79(4)

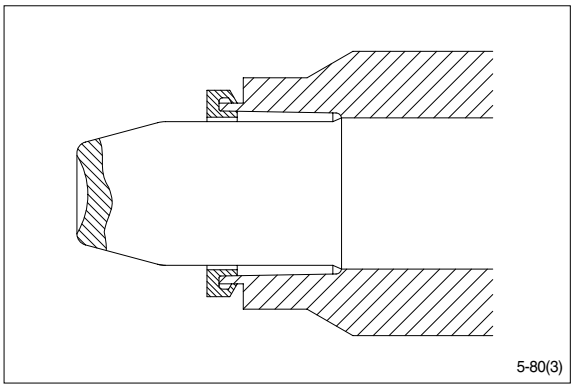
(14) Draw the inner and outer parts of the assembly tool out of the steering unit bore, leaving the guide from the inner part in the bore.



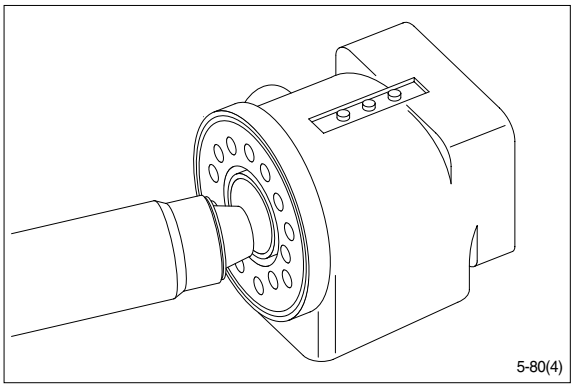
Installation instructions for lip seal

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

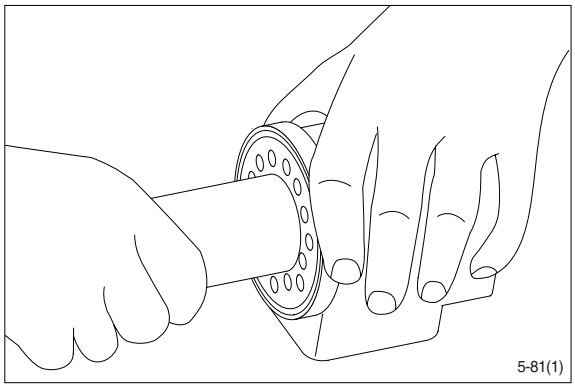




(16) Guide the assembly tool right to the bottom.

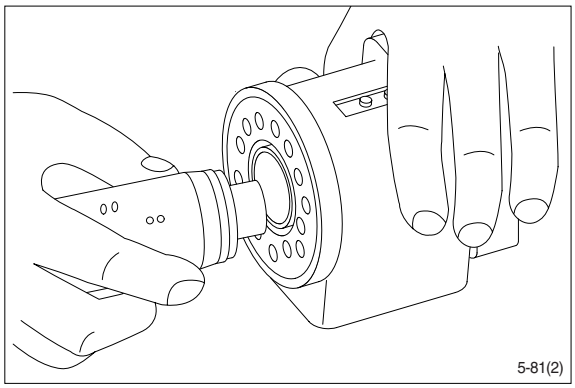


(17) Press and turn the lip seal into place in the housing.

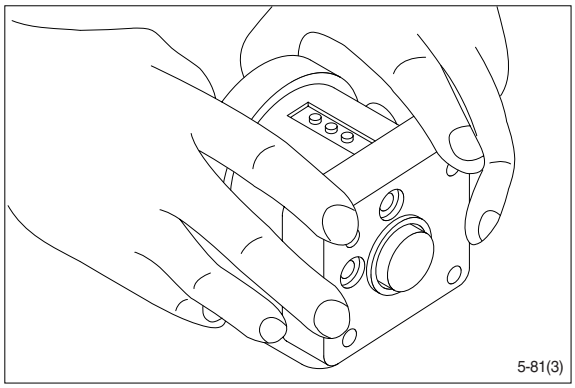


(18) With a light turning movement, guide the spool and sleeve into the bore.

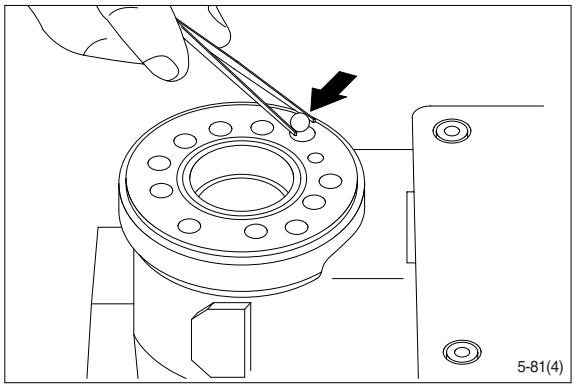
※ Fit the spool set holding the cross pin horizontal.



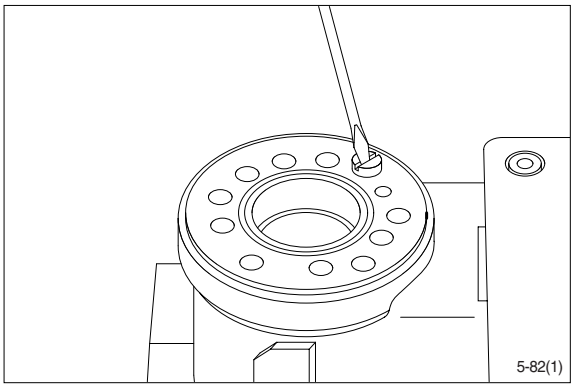
(19) The spool set will push out the assembly tool guide.
The O-ring are now in position.



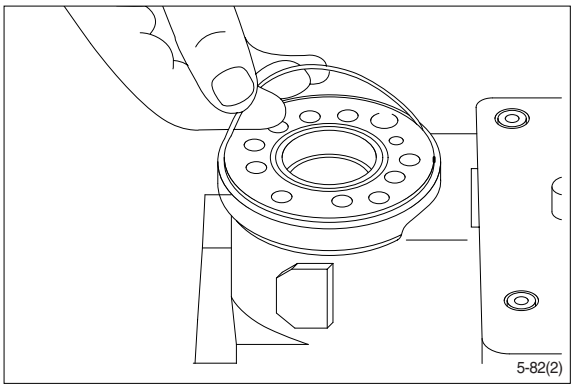
(20) Turn the steering unit until the bore is vertical again. Put the check valve ball into the hole indicated by the arrow.



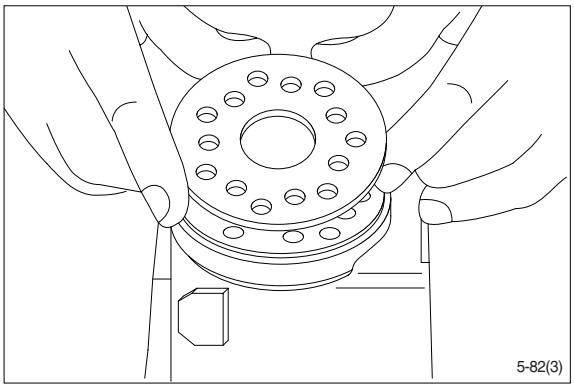
(21) Screw the threaded bush lightly into the check valve bore. The top of the bush must lie just below the surface of the housing.



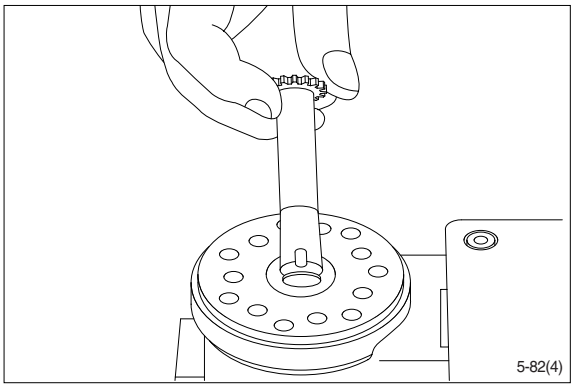
(22) Grease the O-ring with mineral oil approx. viscosity 500 cSt at 20°C.



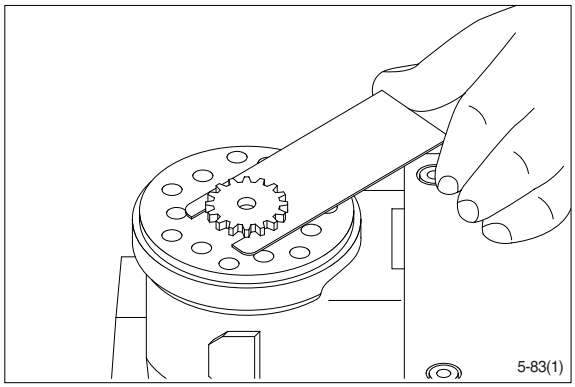
(23) Place the distributor plate so that the channel holes match the holes in the housing.



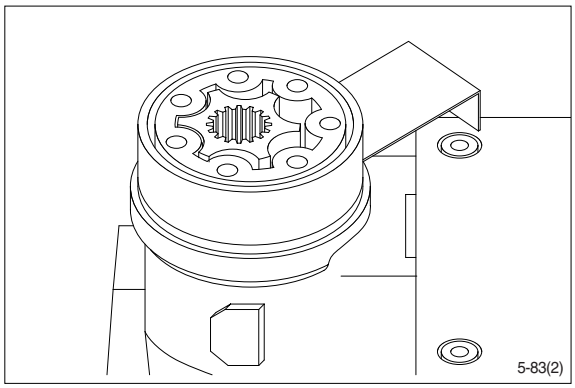
(24) Guide the cardan shaft down into the bore so that the slot is parallel with the connection flange.



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



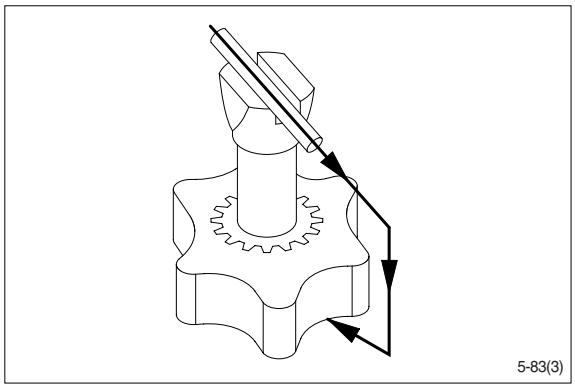
(26) Grease the two O-rings with mineral oil approx. viscosity 500 cSt at 20°C and place them in the two grooves in the gear rim. Fit the gearwheel and rim on the cardan shaft.



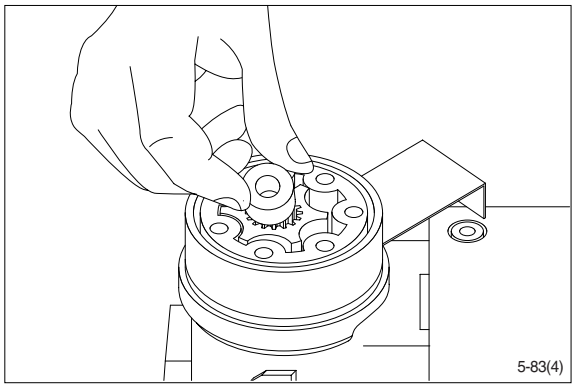
(27) Important

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

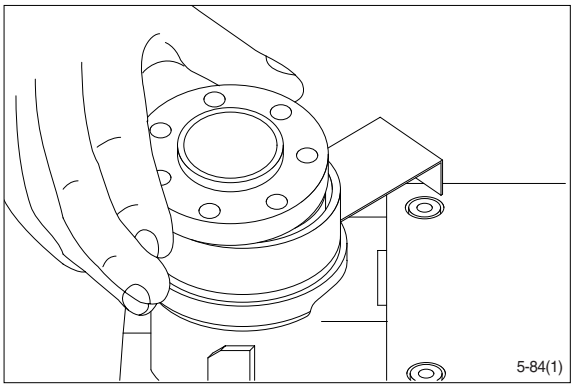
Turn the gear rim so that the seven through holes match the holes in the housing.



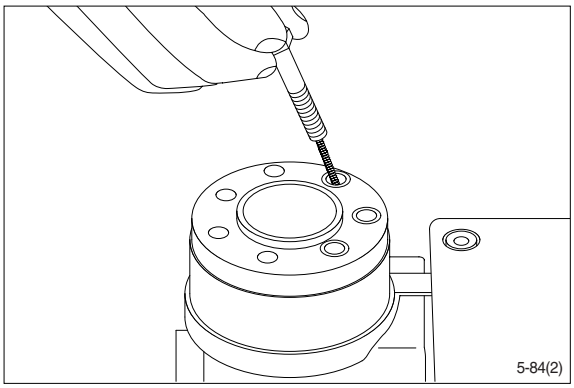
(28) Fit the spacer, if any.



(29) Place the end cover in position.

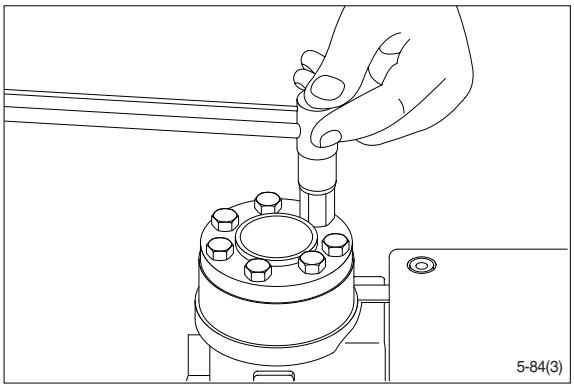


(30) Fit the special screw with washer and place it in the hole shown.

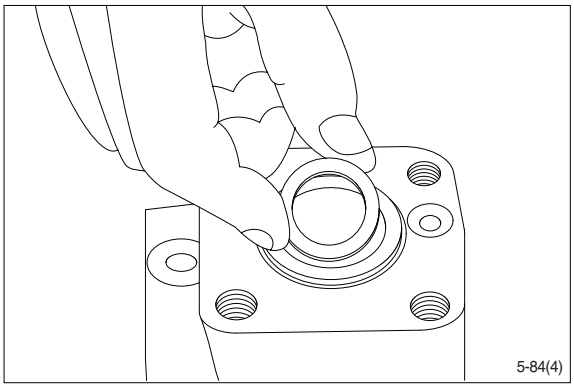


(31) Fit the six screws with washers and insert them. Cross-tighten all the screws and the rolled pin.

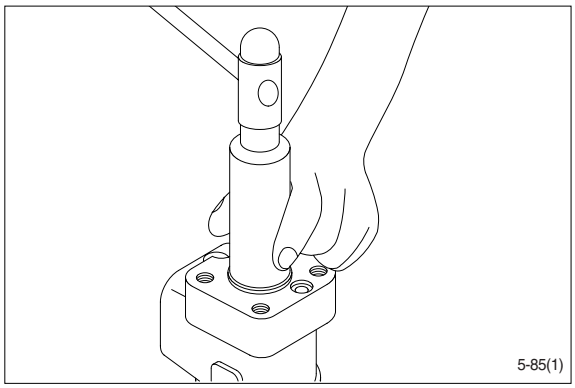
· Tightening torque : 4.0±0.5kgf · m
(28.9±3.6lbf · ft)



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

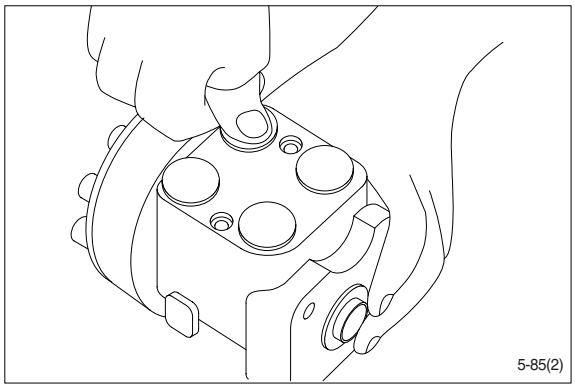


(33) Fit the dust seal ring in the housing.


5-85(1)

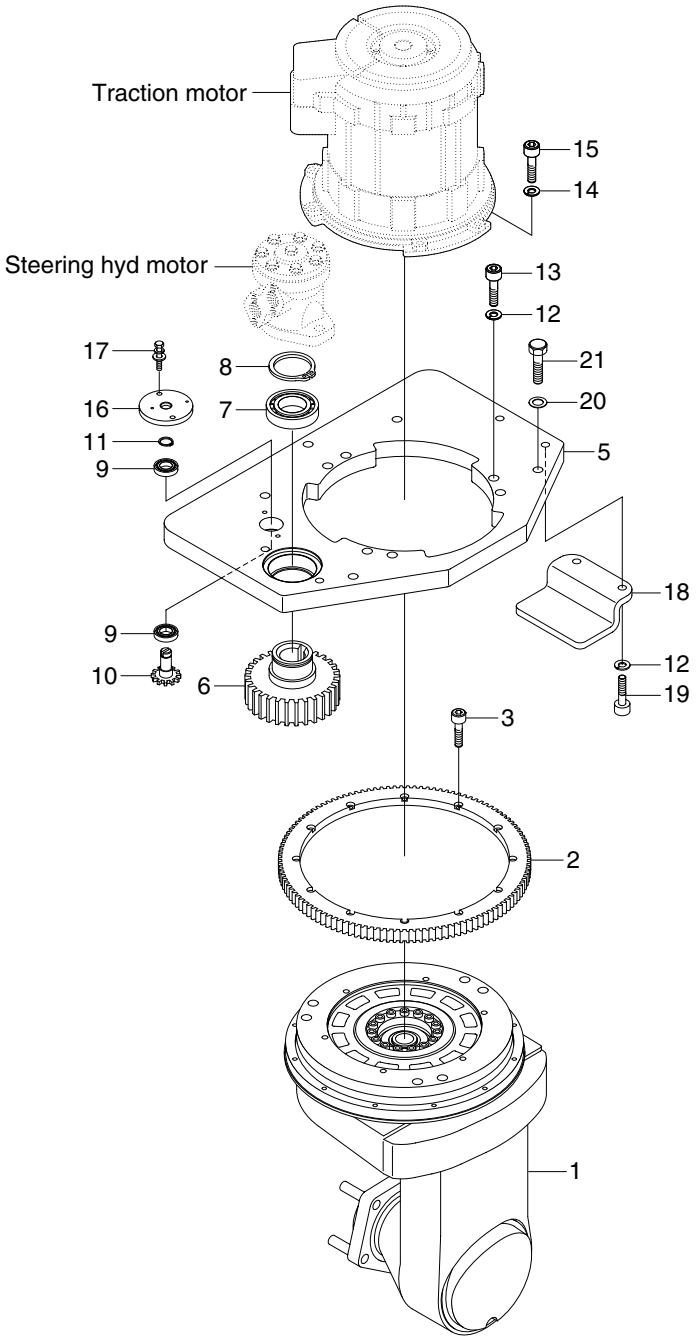
(34) Press the plastic plugs into the connection ports.

※ Do not use a hammer.


5-85(2)

2. DRIVE UNIT

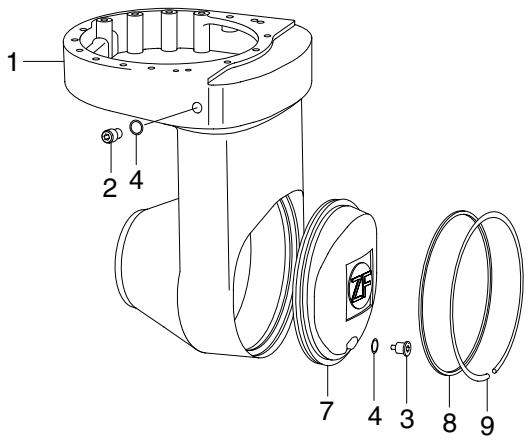
1) STRUCTURE



10BTR9SS10

1	Drive unit assy	9	Ball bearing	16	Bracket
2	Steering gear	10	Pinion	17	Bolt w/washer-hex
3	Socket bolt	11	Retaining ring (C)	18	Bracket
5	Drive unit bracket	12	Spring washer	19	Socket bolt
6	Steering pinion	13	Socket bolt	20	Plain washer
7	Roller bearing	14	Spring washer	21	Hex bolt
8	Retaining ring (C)	15	Socket bolt		

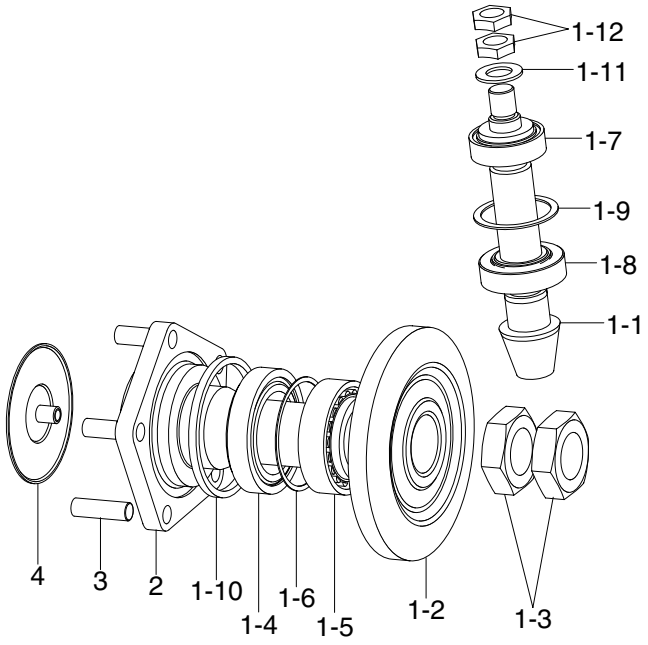
(1) Drive unit (1/4)



10BTR9DU01

1	Housing	4	Ring-seal	9	Circlip
2	Plug	7	Cover		
3	Plug-w/magnet	8	O-ring		

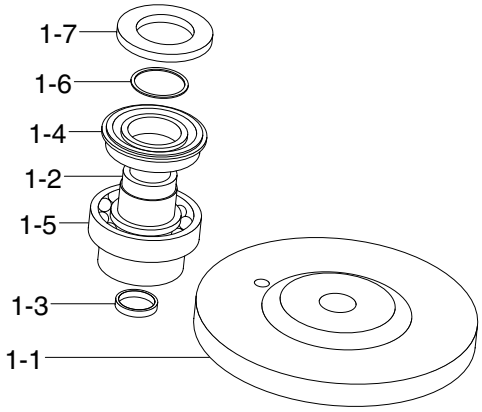
(2) Drive unit (2/4)



10BTR9DU02

1-1	Pinion shaft	1-6	Shim ring	1-11	Shim
1-2	Bevel gear	1-7	Taper roller bearing	1-12	Hexagon nut
1-3	Hexagon nut	1-8	Taper roller bearing	2	Wheel shaft
1-4	Taper roller bearing	1-9	Shim	3	Bolt-wheel
1-5	Taper roller bearing	1-10	Shaft sealing ring	4	Protection cap

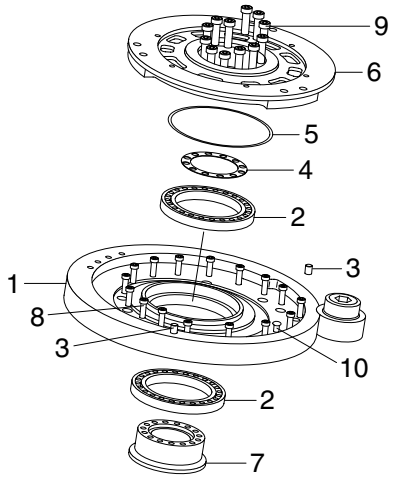
(3) Drive unit (3/4)



10BTR9DU03

1-1	Spur gear	1-4	Ball bearing	1-7	Sealing ring-shaft
1-2	Input pinion	1-5	Ball bearing		
1-3	Plug	1-6	Retaining ring		

(4) Drive unit (4/4)



10BTR9DU04

1	Housing upper part	5	O-ring	9	Torx screw
2	Taper roller bearing	6	Connecting plate	10	Valve-breather
3	Cylindrical pin	7	Bush		
4	Shim set	8	Cylindrical screw		

2) CHECK AND INSPECTION

When repairing the drive unit, ensure utmost cleanliness and excellent workmanship.
Dismantle the drive unit only if any damaged parts must be replaced. After removing screws or nuts, loosen covers and housing parts which were installed with seals by slight blows with a plastic hammer. Use suitable pulling devices for removing parts being tightly installed on the shafts, such as bearings, bearing rings and similar.

Carry out disassembly and reassembly work on a clean working place. Use special tools which have been developed for this purpose. Prior to reinstallation of the parts, clean contact faces of housings and covers from residues of seals. Remove any burrs or similar irregularities with an oil stone. Clean housings and end covers, in particular corners and angles, with a suitable detergent. Damaged or heavily worn parts must be replaced, with an expert assessing whether parts subject to normal wear during operation, such as bearings, thrust washers etc. will be reinstalled.

Parts such as seal rings, lock plates, split pins etc. must generally be replaced. Radial seal rings with worn or broken sealing lip must also be replaced. In particular, ensure that no chips or other foreign bodies remain in the housing. Check the lube oil holes and grooves regarding unhindered passage.
Oil according to the relating List of Lubricants shall be applied to all bearings prior to their installation:

※ Only a heating furnace or an electric drier is permitted for heating parts such as bearings, housings, etc.
Parts fitted in heated state must be readjusted after cooling-down to ensure a perfect contact.

※ When assembling the unit, exactly observe the tightening torques and setting data indicated in the manual.
Tighten screws and nuts according to the enclosed standard table, unless otherwise specified.

When fitting snap rings and retaining rings, pay attention to an exact contact in the grooves.

Never wash disks having organic friction linings (e.g. paper disks) since this would have an adverse effect on lining adhesion.
Only dry-cleaning is permitted (leather cloth).

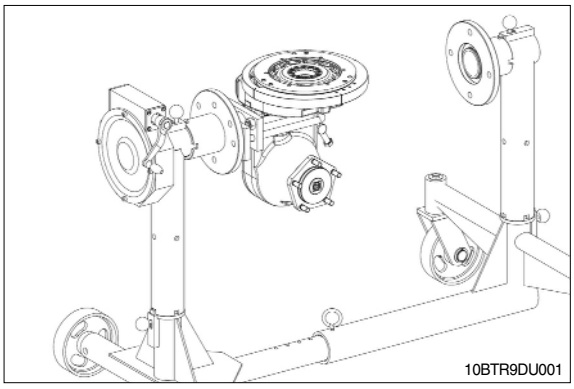
⚠ When using detergents, observe the manufacturer's instructions regarding their handling.

3) DISASSEMBLY

Clamp the unit.

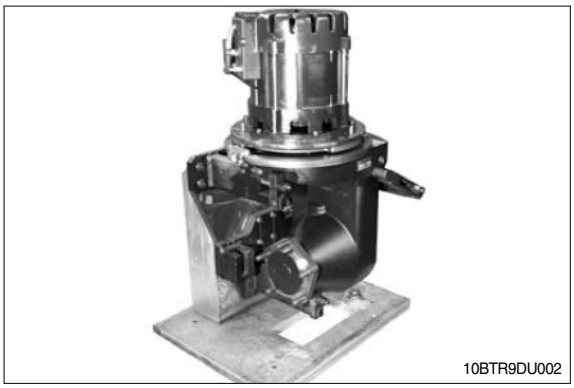
(S) Assembly truck 5870 350 000
(S) Clamping device AA00 852 804

※ The following figures show a different clamping device. Hyundai offers only the device shown in fig. 001.


10BTR9DU001

Loosen all screw plugs and drain the oil.

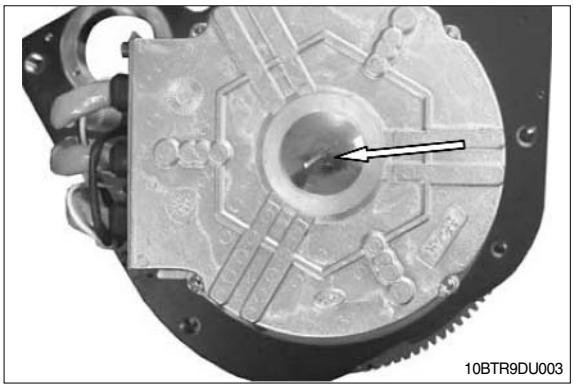
⚠ **Waste oil to be disposed of ecologically and according to the legal provisions.**


10BTR9DU002

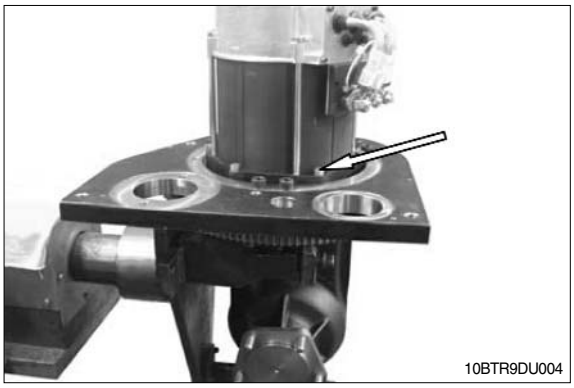
(1) Components and upper housing part

Geared steering version

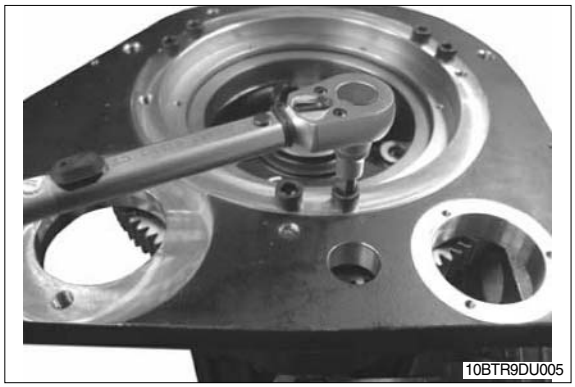
① Loosen the screw plug on top of the motor (arrow). Turn the eyebolt into the motor shaft behind and fix the lifting device.


10BTR9DU003

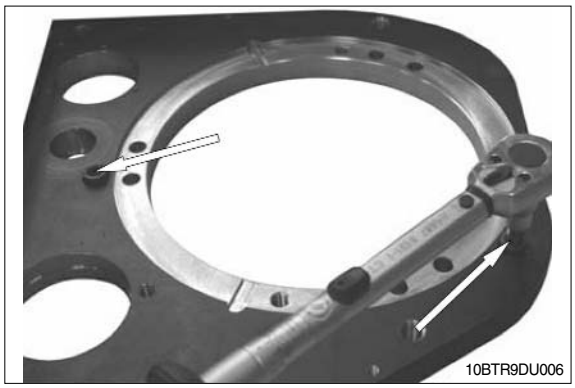
② Loosen the cylindrical screws on the motor (see arrow) and remove the motor by means of the lifting device.


10BTR9DU004

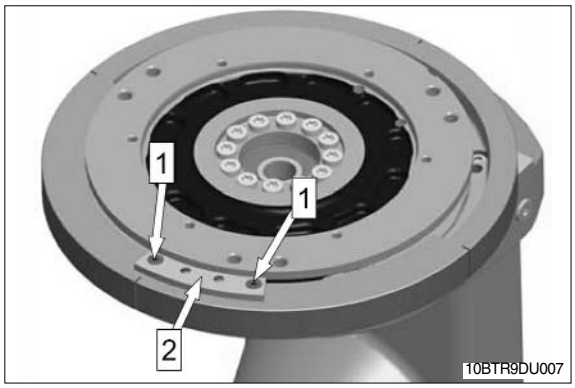
③ Loosen the cylindrical screws. Loosen the frame plate by means of slight hits with a plastic hammer and remove it.



④ If necessary, remove the cylindrical screws (steering stop).



⑤ Loosen countersunk screws (arrows 1) and lift off the steering stop (arrow 2).

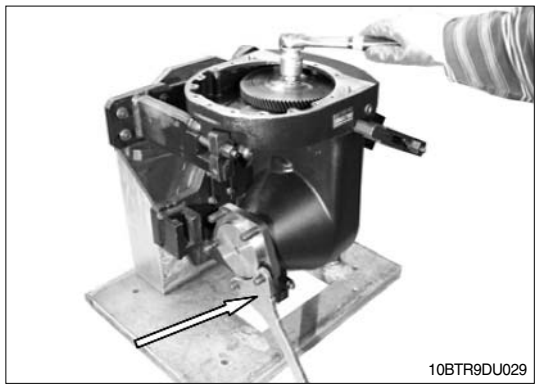


(2) Input and output

① Use lever to remove protective cap from the gear shaft.

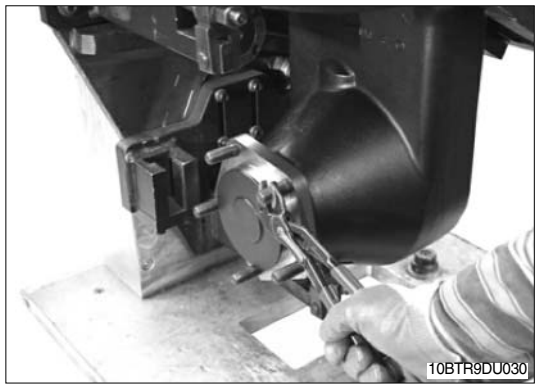
② Install locking device (S) on the gear shaft (see arrow) thus blocking the gear shaft against rotation. Loosen both hexagon nuts on the bevel gear shaft one after the other.
Remove disk.

(S) Locking device 5870 240 002



③ If necessary, block gear shaft against rotation by means of the locking device (S) (see previous figure) and dismantle the wheel bolt with suitable pliers.

※ It is possible to unscrew the wheel bolts with dismounted and mounted gear shaft.



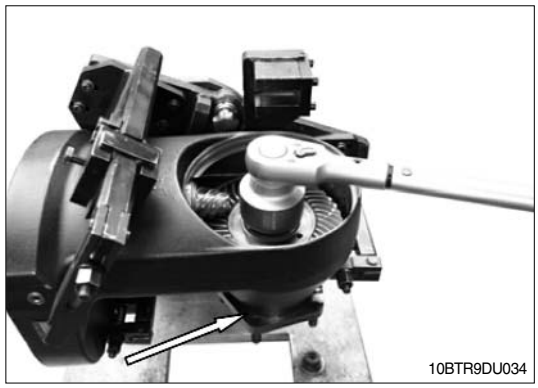
④ Disengage snap ring from the annular groove on the housing.

⑤ Lift off the cover on the cast brackets.

⑥ Remove O-ring (see arrow).

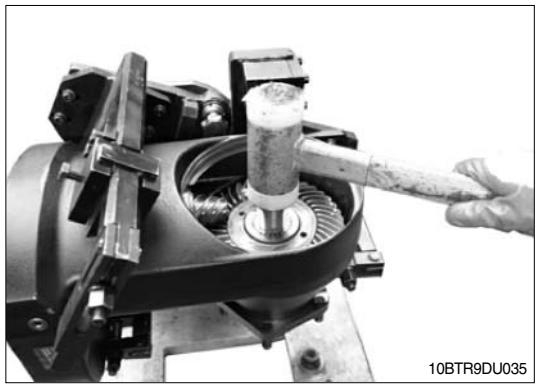
⑦ Install locking device (S) on the gear shaft (see arrow) thus blocking the gear shaft against rotation. Loosen both hexagon nuts on the gear shaft one after the other.
Remove disk.

(S) Locking device 5870 240 002



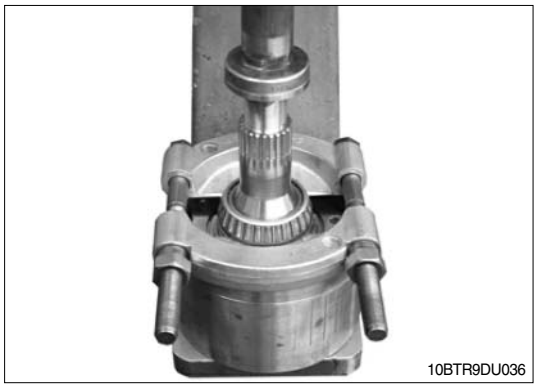
⑧ Carefully remove the gear shaft from the crown wheel using a plastic hammer.

※ Pay attention : gear shaft releases downwards.

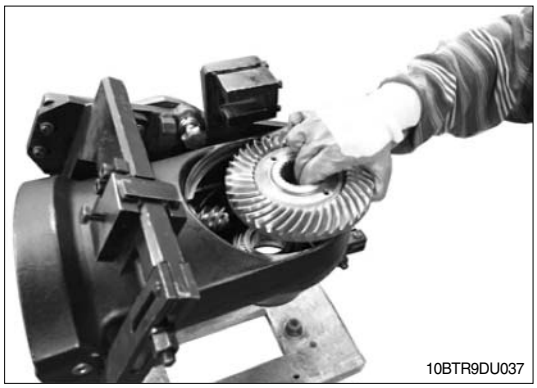


⑨ Press off the bearing inner ring from the gear shaft.

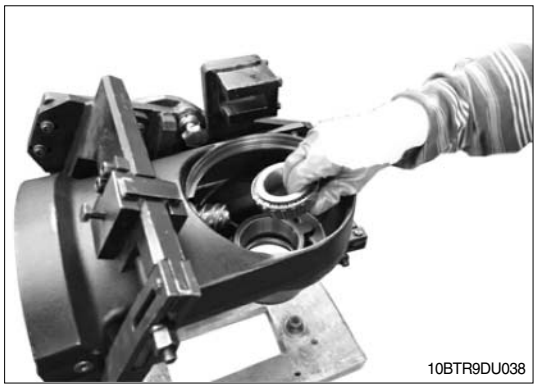
(S) Cut-off device 5870 300 028



⑩ Remove the crown wheel from the housing.

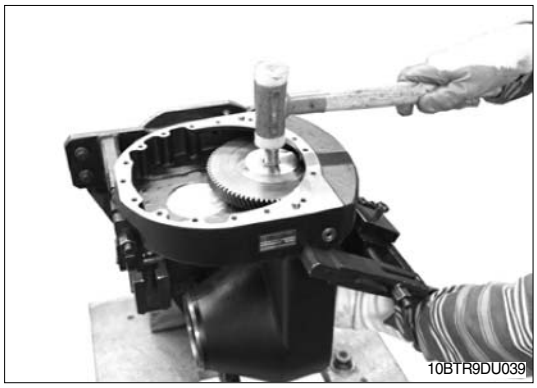


⑪ Remove the bearing inner ring out of the housing.

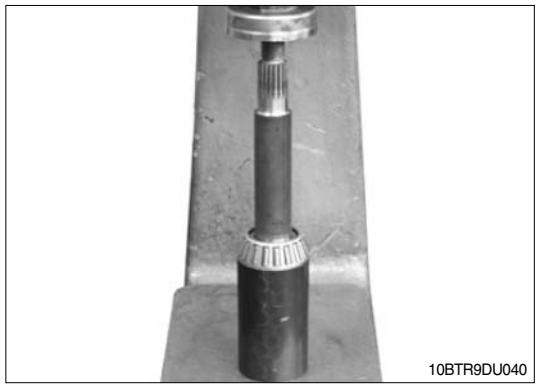


⑫ Carefully remove the bevel gear shaft out of the spur gear using a plastic hammer (bearing inner ring below) and take out from the bottom.

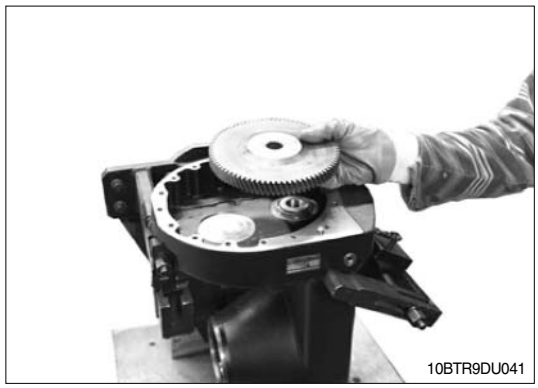
※ Pay attention : Bevel gear releases downwards.



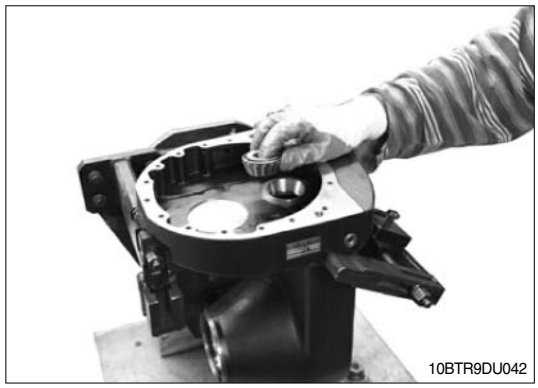
⑬ Support the bearing inner ring with a suitable sleeve and press it off the bevel gear shaft.



⑭ Remove spur gear from the housing.

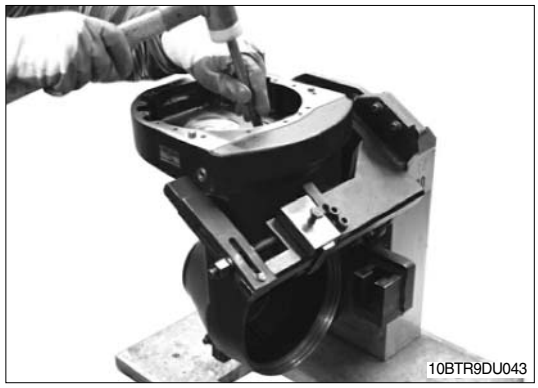


⑮ Remove bearing inner ring from the housing.

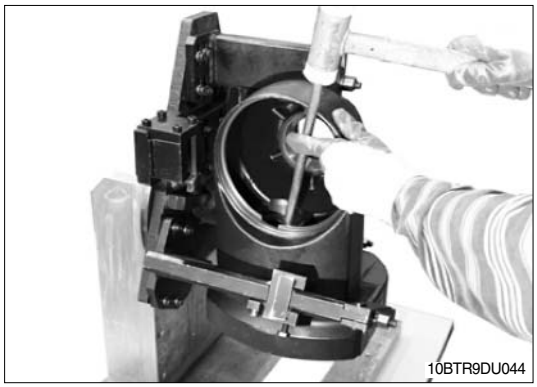


⑯ Force bearing outer ring out of the housing and remove the adjusting washer behind.

※ Pay attention so that the releasing adjusting washer does not drop. Mark installation position. Assembly aid.

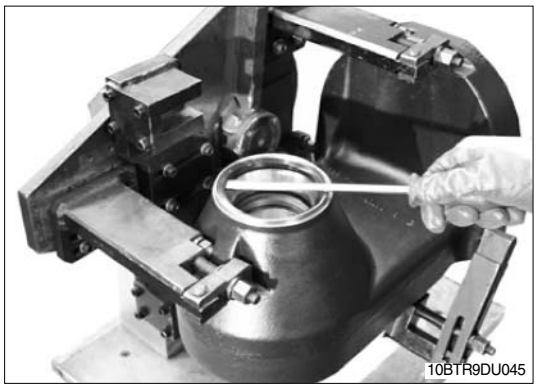


⑰ Force out the opposite bearing outer ring.



⑱ Lift-off shaft seal.

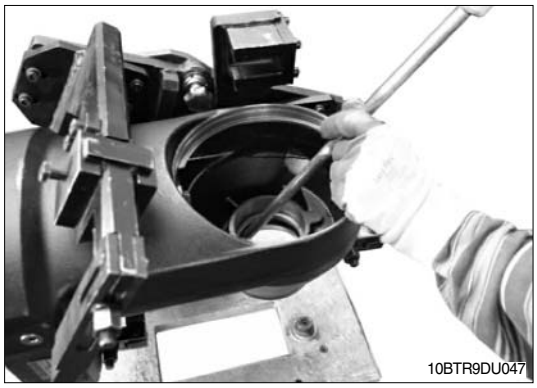
※ If the shaft seal is stuck, you can force it out from the opposite side.



⑲ Force bearing outer ring out of the housing and remove the adjusting washer behind.

※ Pay attention so that the releasing adjusting washer does not drop. Mark installation position. Assembly aid.

⑳ Force out the opposite bearing outer ring.



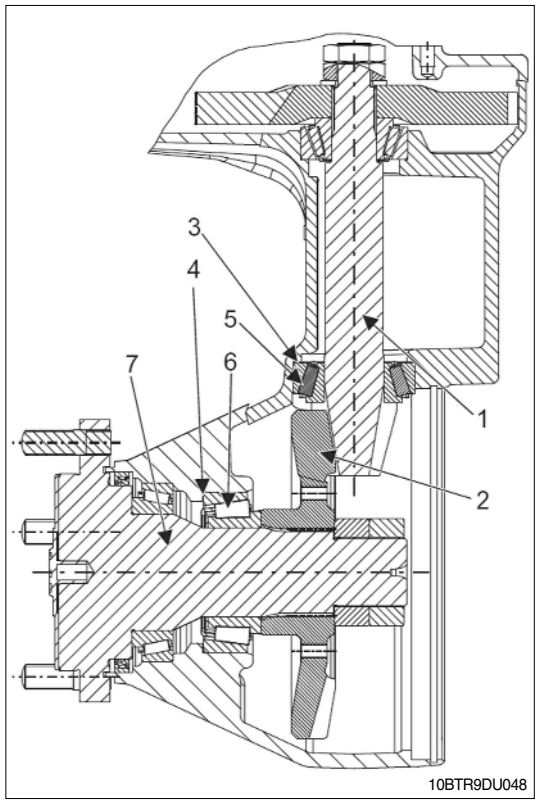
4) REASSEMBLY

(1) Input and output

※ If either crown wheel or bevel gear shaft is damaged, both parts must be jointly replaced.

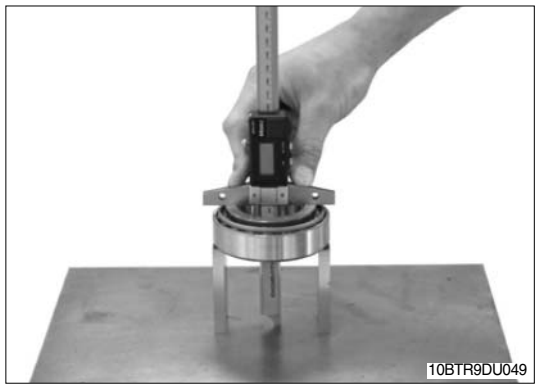
Legend :
1 = Bevel gear shaft
2 = Crown wheel
3 = Adjusting washer of contact pattern
4 = Adjusting washer of backlash
(circumferent. backlash)
5 = Taper roller bearing
6 = Taper roller bearing
7 = Gear shaft

※ If a new taper roller bearing (fig. 048 item 5) is used, determine the bearing width and compare it with the previous bearing to match the adjusting washer (item 3).



① Determine thickness of the adjusting washer removed during disassembly. Determine bearing width of the new and the old taper roller bearing and calculate thickness of adjusting washer.

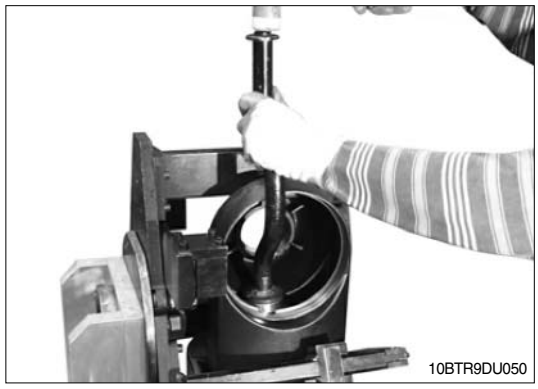
Calculation example A :
Bearing width (old bearing) e.g. . . 22.35 mm
Adjusting washer (old) e.g. . . . . + 0.30 mm
Bearing width (new bearing) e.g. - 22.25 mm
Adjusting washer (new) e.g. 0.40 mm



② Insert the adjusting washer into the bearing hole on the housing. Fit the bearing outer ring until contact is obtained.

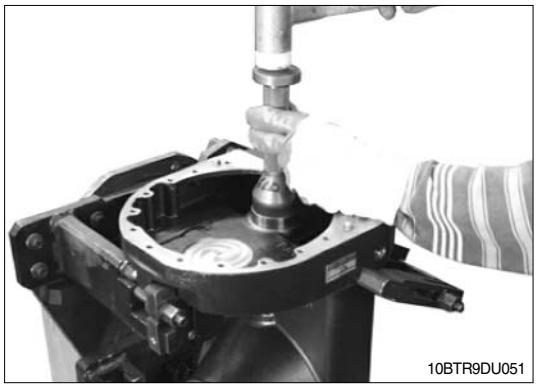
(S) Driver tool AA00 607 184

※ When installing the old taper roller bearing (fig. 048 item 5), use the adjusting washer removed during disassembly.

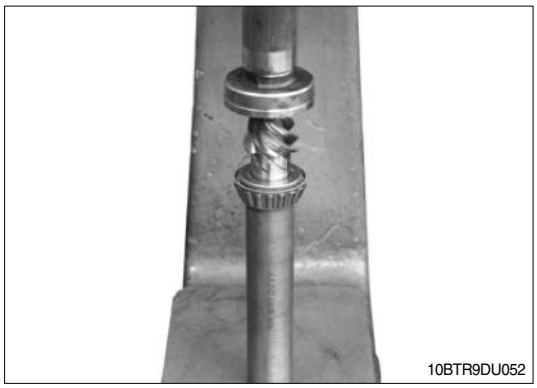


③ Fit bearing outer ring into the bearing hole on the housing until contact is obtained.

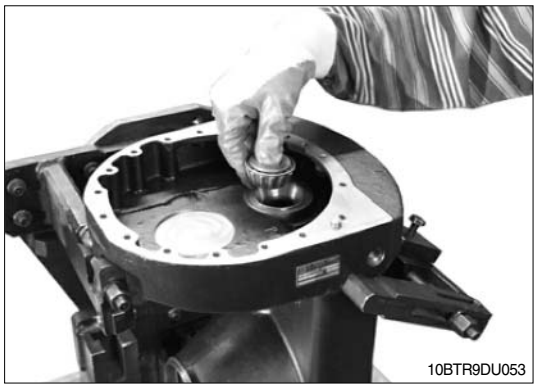
(S) Driver tool AA00 658 635



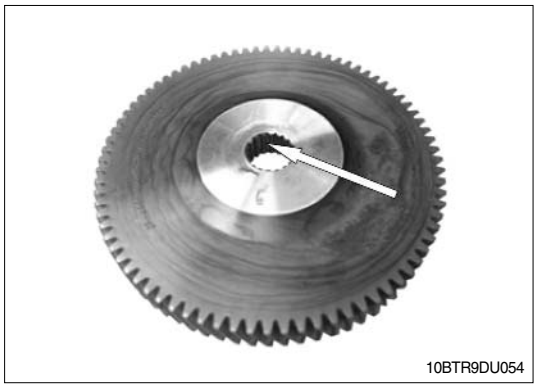
④ Press-on the bearing inner ring until contact with the bevel gear shaft is obtained.



⑤ Insert bearing inner ring into the bearing outer ring.



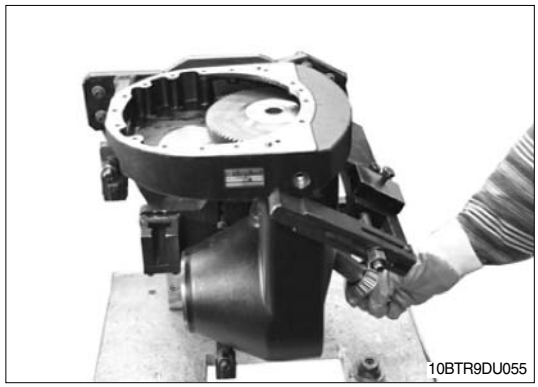
⑥ Wet inner gearing at the spur gear evenly with Loctite 270.



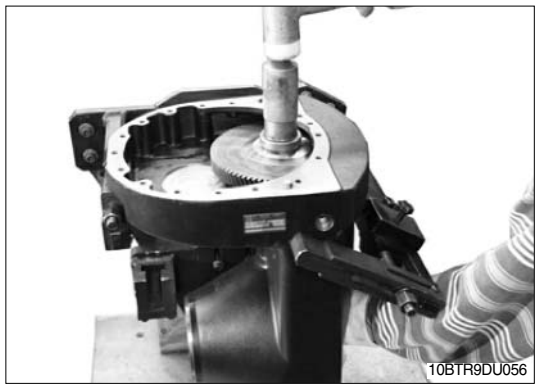
⑦ Place the spur gear on top of the housing.

※ Observe the installation position. Convex side of spur gear to face upwards.

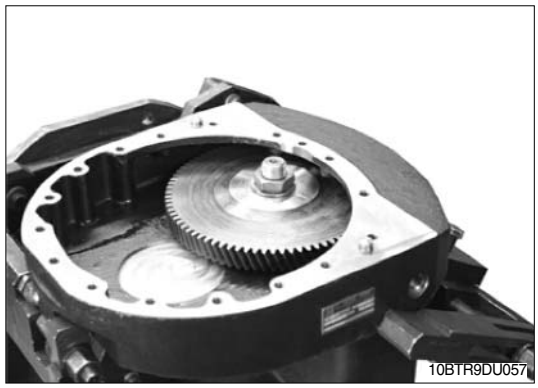
Mount the preassembled bevel gear shaft to the spur gear from below.



⑧ Press against the bevel gear shaft from below. Use a suitable sleeve and a plastic hammer to bring the spur gear carefully to contact position.



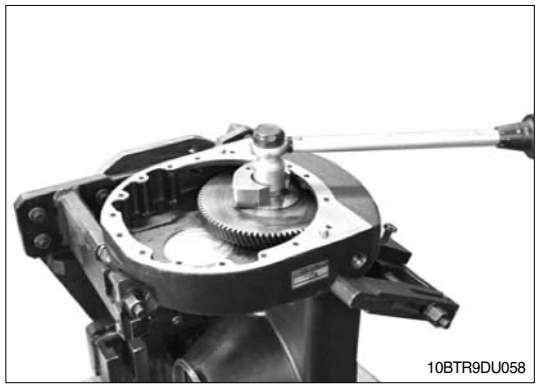
⑨ Install the disk on the bevel gear shaft. Hand-tighten a hex. nut without using a wrench until contact is obtained.



⑩ Position the counter support (S). Tighten the second hexagon nut.

· Tightening torque : M_A = 200 Nm

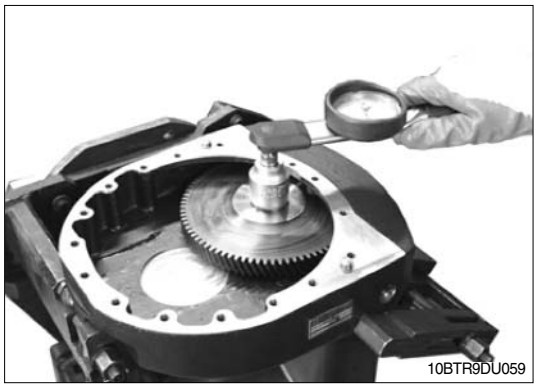
(S) Stop AA00 321 773



⑪ Check rolling torque of the bevel gear shaft bearing 0.7~1.3 Nm.

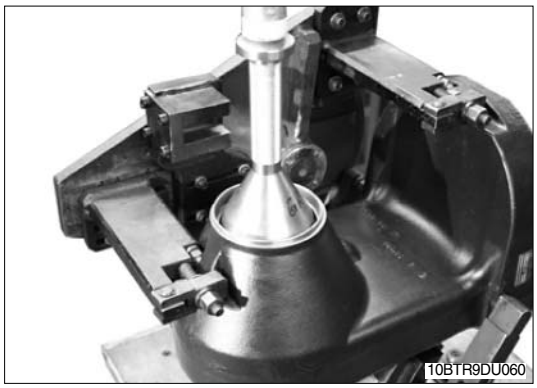
※ Try to achieve the lower value.

※ If rolling torque is incorrect, loosen both hexagon nuts and repeat the work steps shown in fig. 057~059. Use the lower hexagon nut for correction.



⑫ Drive in the bearing outer ring until contact is obtained.

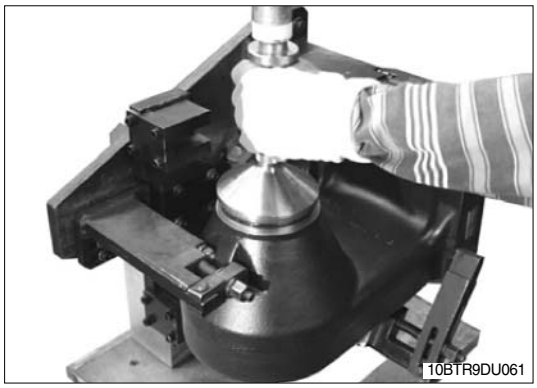
(S) Driver tool AA00 603 011



⑬ Install shaft seal by means of driver tool (S).

(S) Driver tool AA00 603 138

※ Apply grease (Shell Alvania RL3) to the shaft seal inner side.



※ When installing a new taper roller bearing (fig. 048 item 6), determine the bearing width and compare it with the previous bearing to match the adjusting washer (item 4).

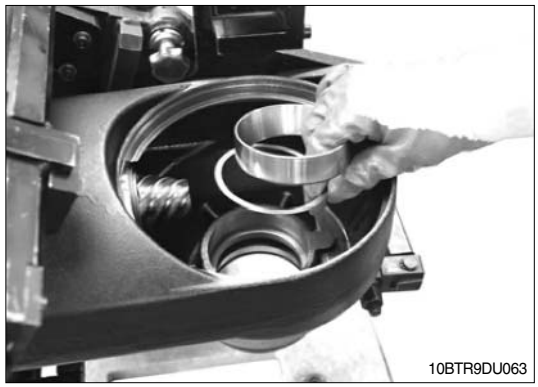
⑭ Determine bearing width of new and old taper roller bearing as well as thickness of adjusting washer.

Calculation example B :
Bearing width (old bearing) e.g. . . 32.10 mm
Adjusting washer (old) e.g. . . . . + 0.30 mm
Bearing width (new bearing) e.g. - 32.20 mm
Adjusting washer (new) e.g. 0.20 mm

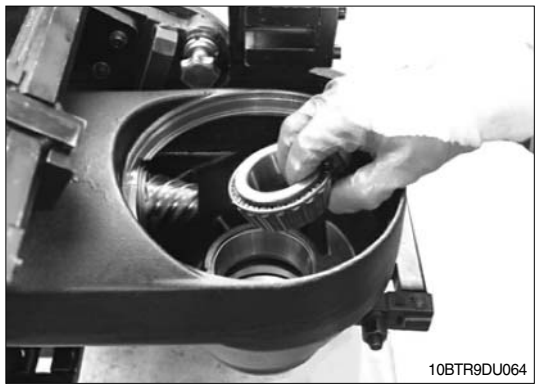
⑮ Insert adjusting washer into the bearing hole and force in bearing outer ring until contact is obtained.

(S) Driver tool AA00 658 776

※ When installing the old taper roller bearing (fig. 048 item 6), use the adjusting washer removed during disassembly.

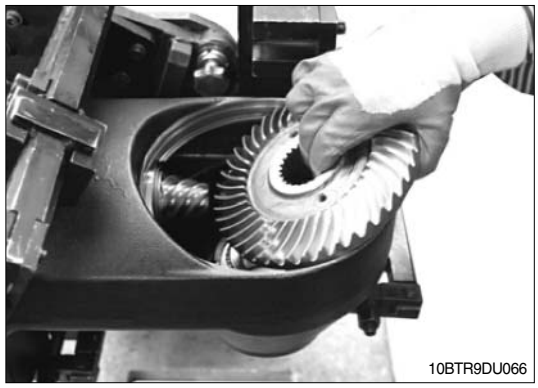


⑯ Insert the bearing inner ring into the bearing outer ring.

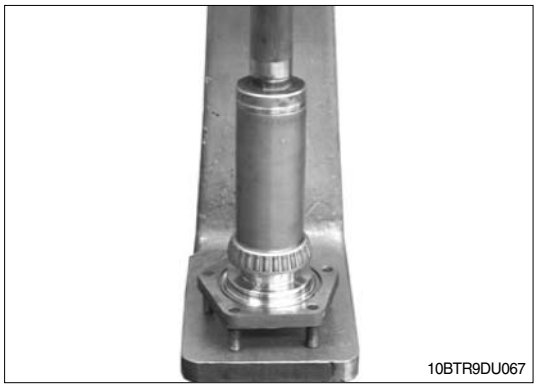


⑰ Wet inner gearing at the crown wheel evenly with Loctite 270.

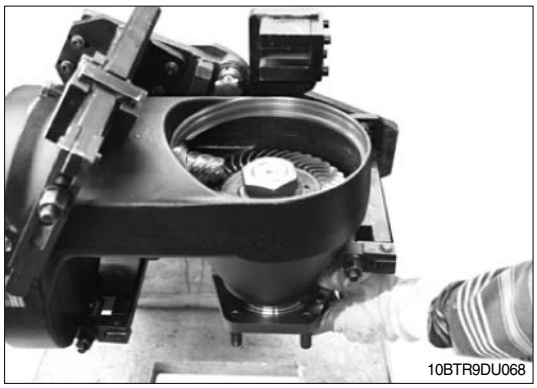
⑱ Position the crown wheel at the bearing inner ring, as illustrated.



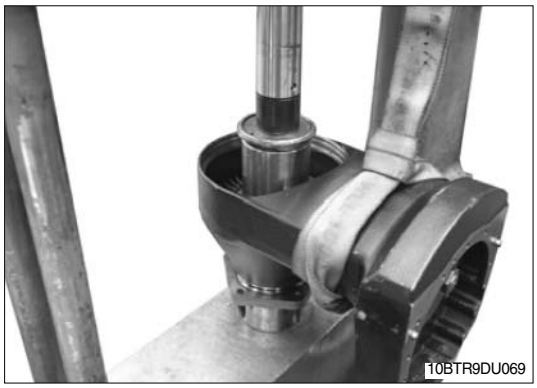
⑲ Press on the bearing inner ring until contact with the gear shaft is obtained.



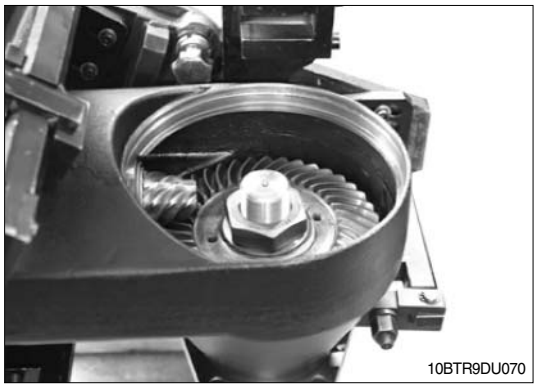
⑳ Install the gear shaft on the crown wheel from below.
Secure with hexagon nut.



㉑ Support unit on the gear shaft. Use a press to bring crown wheel and suitable sleeve to contact position.



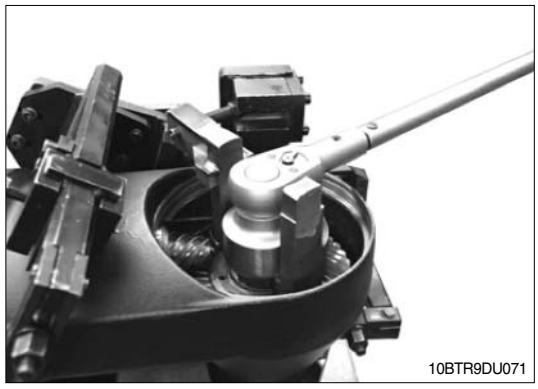
㉒ Hand-tighten a hexagon nut without using a wrench until contact is obtained.



㉓ Fix and support the locking device (S) on the gear shaft.
Position the counter support (S) and adjust contact position. Tighten the second hexagon nut.

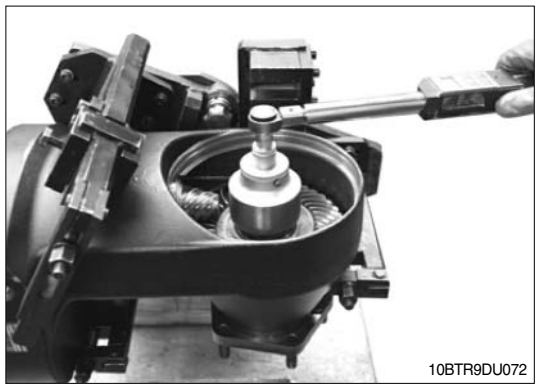
· Tightening torque : M_A = 550 Nm

(S) Locking device 5870 240 002
(S) Counter support AA00 857 163


10BTR9DU071

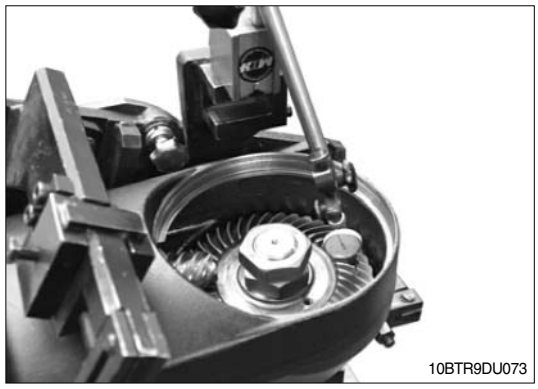
㉔ Check rolling torque of the gear shaft bearing 13~22 Nm.

※ Try to achieve the lower value.
※ If the rolling torque is incorrect, loosen both hexagon nuts and repeat work steps shown in fig. 070~072. Use the lower hexagon nut for correction.


10BTR9DU072

㉕ Place dial indicator at right angles to the tooth flank of the crown wheel and check backlash (0.10~0.18 mm).

※ In case of any deviation from the required backlash correct the adjusting washer (fig. 063/fig. 048 item 4) according to the following specification :
Insufficient backlash-install thinner adjusting washer
Excessive backlash-install thicker adjusting washer


10BTR9DU073

㉖ Then cover some drive and coast flanks on the crown wheel with marking ink and rotate crown wheel in both directions several times. Compare the obtained contact pattern with the examples on page 5-59.

(S) Locking device 5870 240 002

※ If the contact pattern differs, use a suitable shim for correction (figure 050/fig. 048 item 3).

㉗ Grease the O-ring and install it into the annular groove on the cover (see arrow).

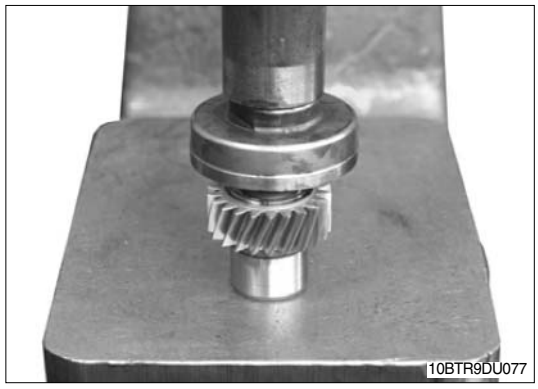
㉘ Mount the preassembled cover into the housing until contact is obtained.

※ Observe installation position. Bring recess for taper roller bearing into the correct position. See arrow.

㉙ Insert snap ring into the annular groove on the housing and fix the cover.

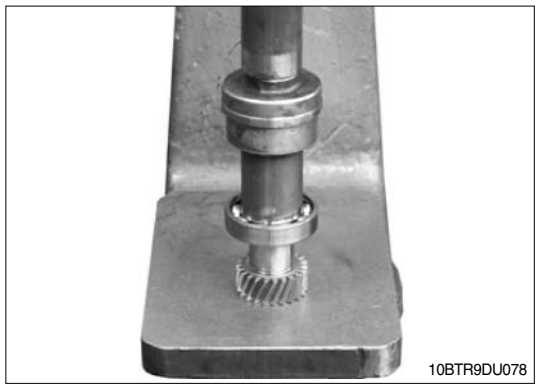
(2) Upper housing part and components

① If removed, or in case of a new part, flush-mount the protection cap with the open side facing inwards.



② Press ball bearing onto the input pinion until contact is obtained.

※ Apply assembly force only on the bearing inner ring.

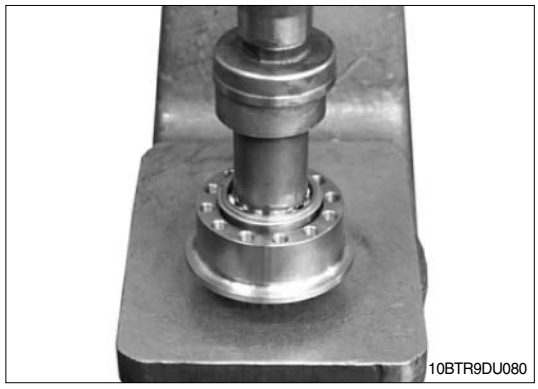


③ Install preassembled input pinion into the bushing as illustrated.

④ Press ball bearing onto the input pinion until contact is obtained.

※ Observe installation position. Snap ring to show upwards/outwards.

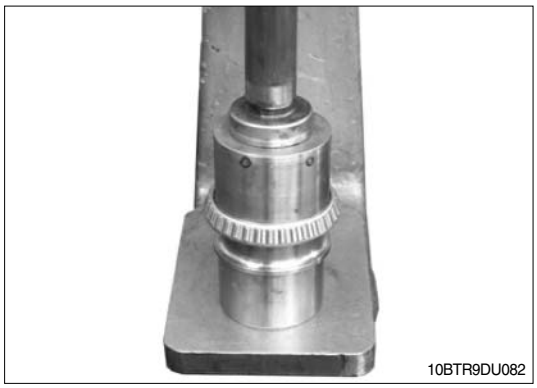
※ Apply assembly force only on the bearing inner ring.



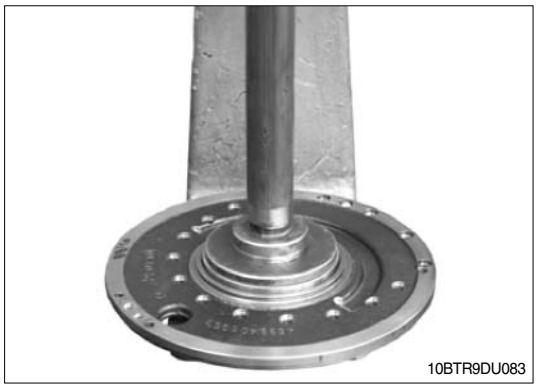
⑤ Fix ball bearing on the input pinion by means of a retaining ring.


10BTR9DU081

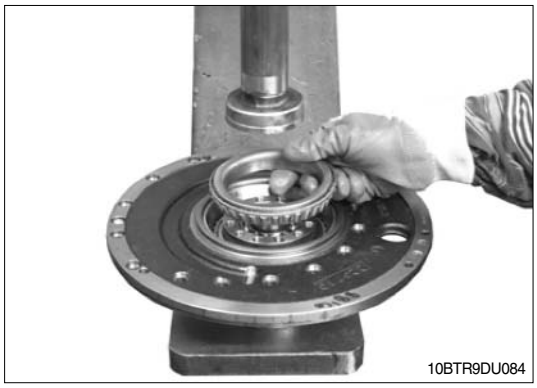
⑥ Press bearing inner ring onto the bushing as illustrated.


10BTR9DU082

⑦ Insert both bearing outer rings onto the upper housing part until contact is obtained.


10BTR9DU083

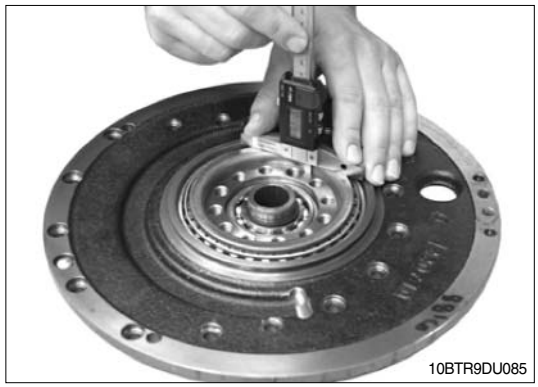
⑧ Place upper housing part on the preassembled bushing, as illustrated. Place bearing inner ring as illustrated and carefully bring into contact position by means of a hand operated press.


10BTR9DU084

⑨ Adjust rolling torque of the connection plate bearing (fig. 085~097).

Support the preassembled upper housing part on the bushing. Determine dimension I from front side of bearing inner ring to front side of bushing.

Dimension I e.g. . . . . 9.90 mm

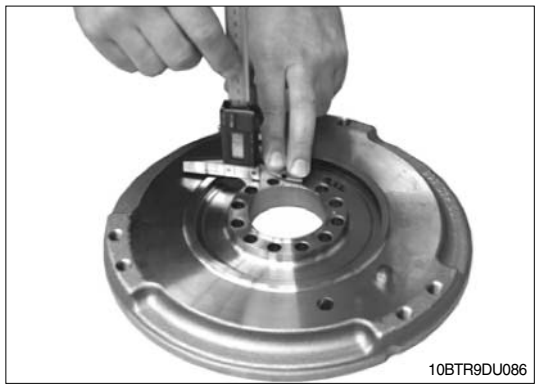


⑩ Determine dimension II on connection plate.

Dimension II e.g. . . . . 9.65 mm

※ Also see the following figure.

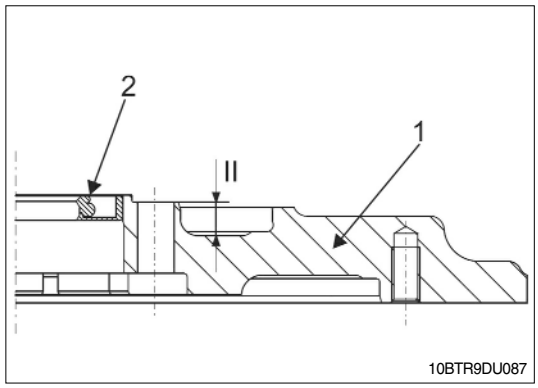
Calculate the adjusting washer thickness for rolling torque adjustment of connection plate.



Calculation example C :

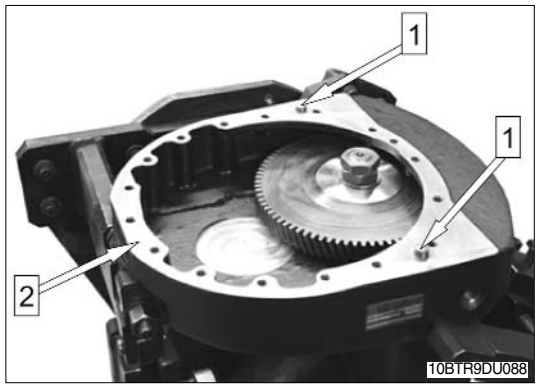
Dimension I e.g. . . . . 9.90 mm
Dimension II e.g. . . . . - 9.65 mm
Bearing pre-load . . . . . - 0.10 mm
Adjusting washer **0.15 mm**

Legend :
1 = Connection plate
2 = Shaft seal
II = Dimension II (fig. 086)

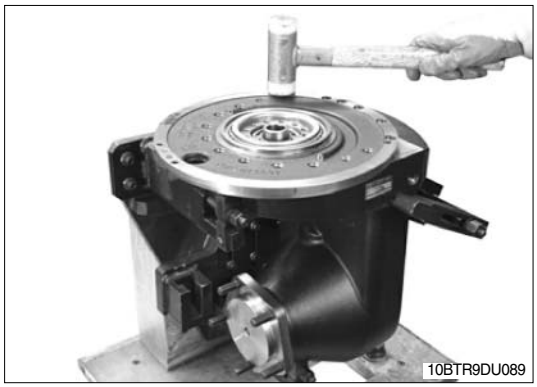


⑪ If removed, or in case of a new part, install cylindrical pins (see arrows 1).

Wet mounting face (arrow 2) with Loctite 574.

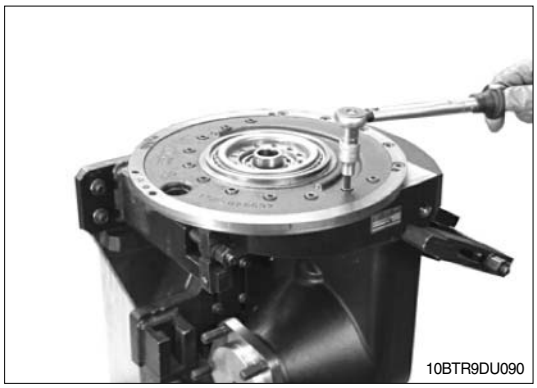


⑫ Use a plastic hammer to bring the upper housing part carefully into contact position with the housing.



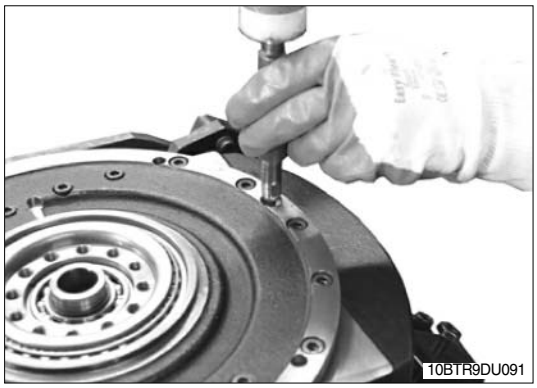
⑬ Fix the upper housing part by means of cylindrical screws.

· Tightening torque (M8/10.9) : M_A = 30 Nm



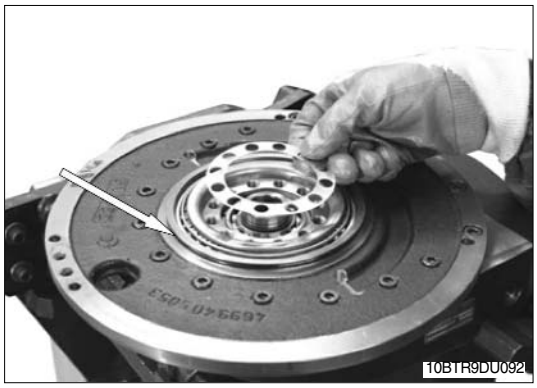
⑭ If removed, or in case of a new part, install breather (S) on upper housing part by means of a driver tool.

(S) Press-fit mandrel AA00 852 929



⑮ Place the adjusting washer determined in fig. 086 onto the bushing (e.g. s = 0.15 mm).

Grease the O-ring and place it into the annular groove on the upper housing part (see arrow).

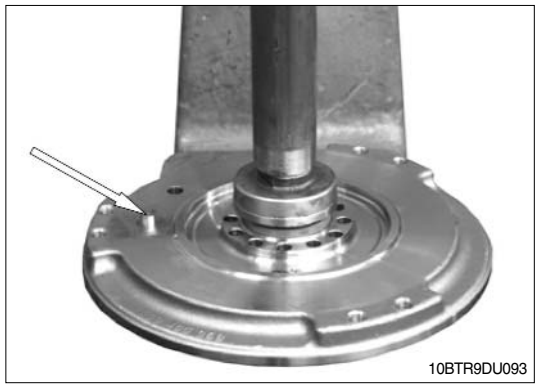


⑯ Flush-mount the shaft-seal into the connection plate.

※ Apply grease (Shell Alvania RL3) to the inner side of the shaft seal.

※ Observe installation position. Also refer to fig. 087.

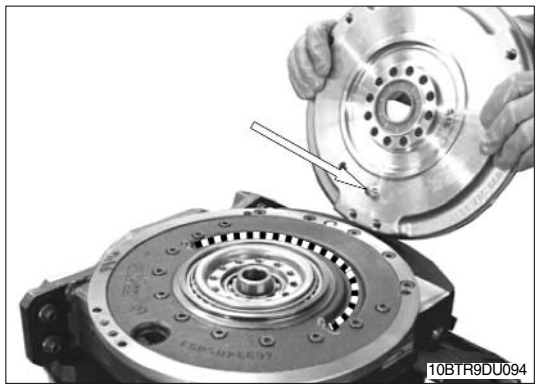
If removed, or in case of a new part, insert the cylindrical pin (see arrow) into the hole near the M12-threads, until contact is obtained.



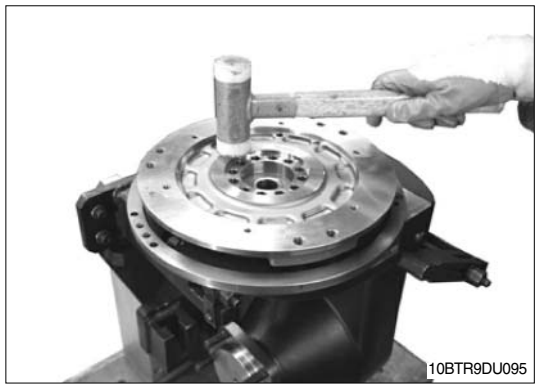
⑰ Mount the connection plate on the input pinion/on the bushing.

※ Ensure that the sealing lip on the shaft seal is not turned up.

※ Observe installation position. Cylindrical pin (see arrow) to face the casting recess on the upper housing part (dashed line).



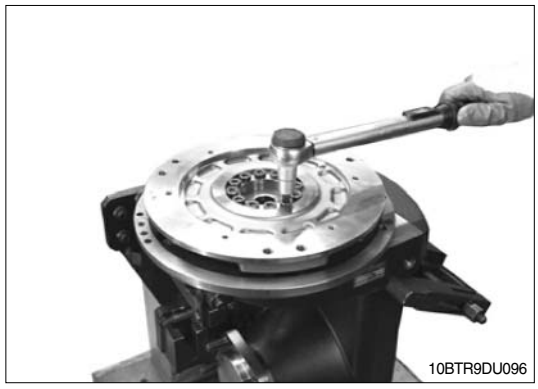
⑱ Use a plastic hammer to bring the connection plate carefully into contact position.



⑲ Fix the connection plate by means of Torx screws.

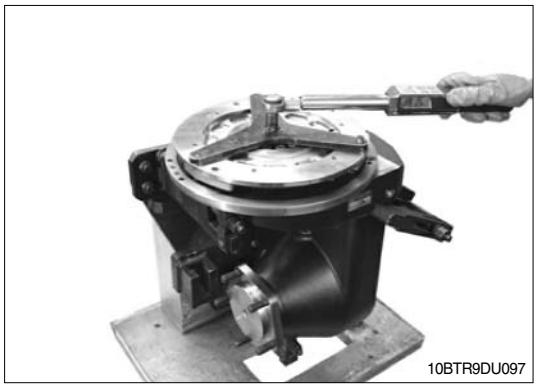
· Tightening torque : M_A = 79 Nm

※ Tighten screws crosswise.



⑳ Check rolling torque of connection plate bearing 18~25Nm.

(S) Assembly fixture AA00 630 183

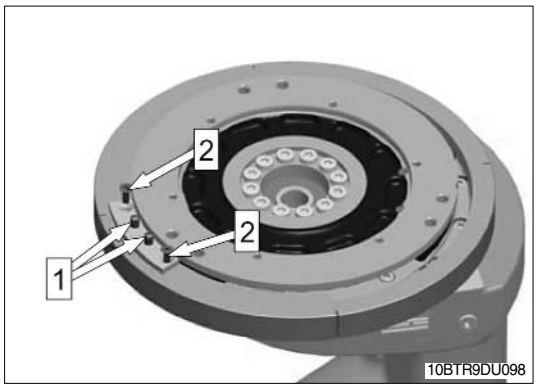


Geared steering version

① Mount steering stop as illustrated. Force in grooved pins in alignment with the steering stop. Fix steering stop by means of countersunk screws.

· Tightening torque (M6/10.9) : M_A = 14Nm

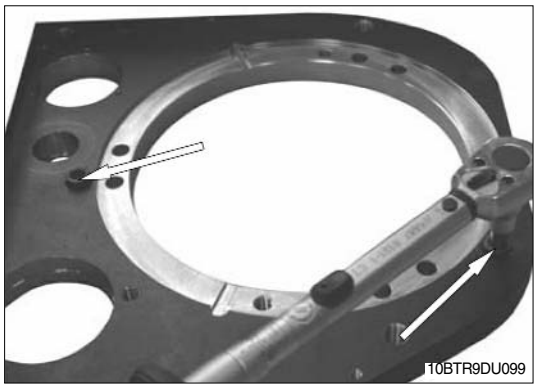
※ Secure countersunk screws with Loctite 243.



② If removed, or in case of a new part, install cylindrical screws.

· Tightening torque (M12/8.8) : M_A = 79Nm

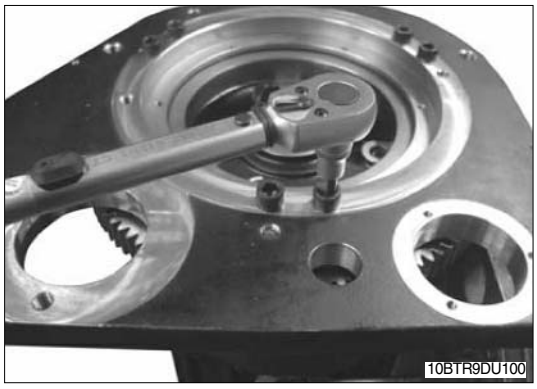
※ Mount cylindrical screws with Loctite 243.



③ Place frame plate onto the connection plate and fix it by means of cylindrical screws.

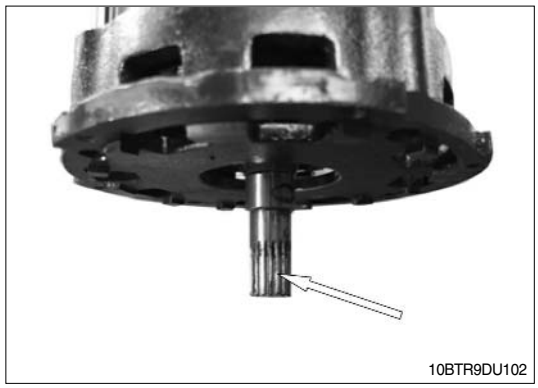
· Tightening torque (M12/10.9) : M_A = 79Nm

※ Secure cylindrical screws with Loctite 243.



④ Wet inner gearing at the input pinion evenly with grease.

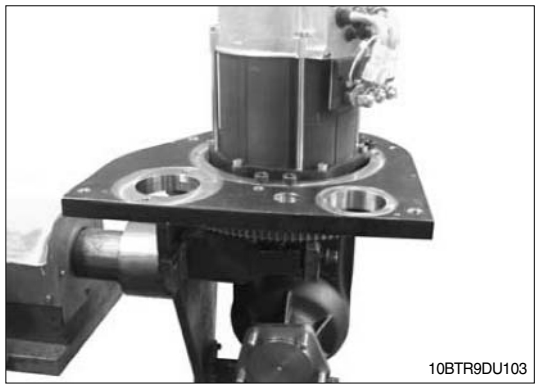
⑤ Apply grease evenly on the shaft at the electric motor.



⑥ Place electric motor onto the connection plate and fix it by means of cylindrical screws.

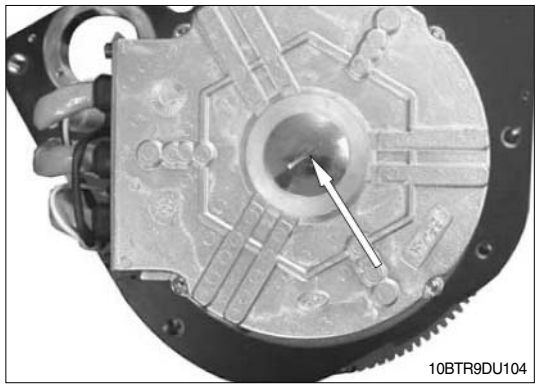
· Tightening torque (M8/8.8) : M_A = 23Nm

※ Observe installation position.
See disassembly.



⑦ Turn screw plug into the electric motor.

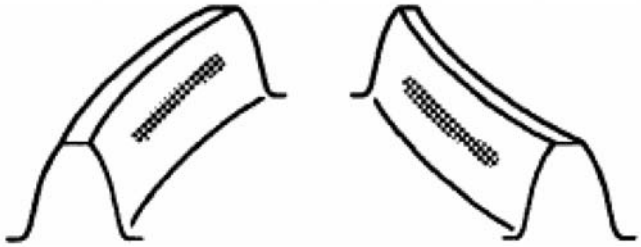
※ For tightening torque see motor manufacturer.



CONTACT PATTERN EXAMPLES OF GLEASON TOOTH SYSTEM

Ideal contact pattern:

Concave flank



convex flank

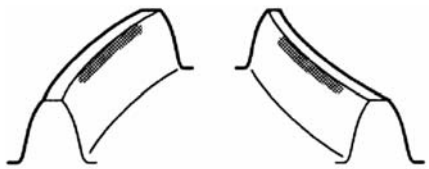
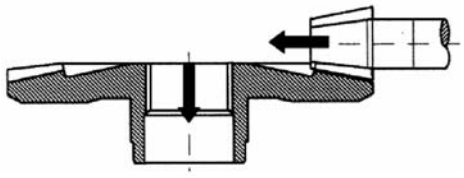
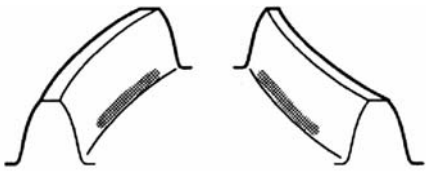
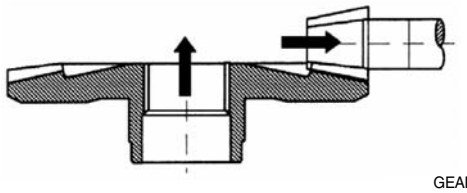
GEAR1

Contact pattern setting:

The contact patterns are viewed on the crown wheel flanks.
The contact pattern must be tangent to the center of tooth flank (middle of tooth), otherwise it is too far on the tooth top or on the tooth root.

Flank glossary:

Convex flank = Drive side
Concave flank = Coast side

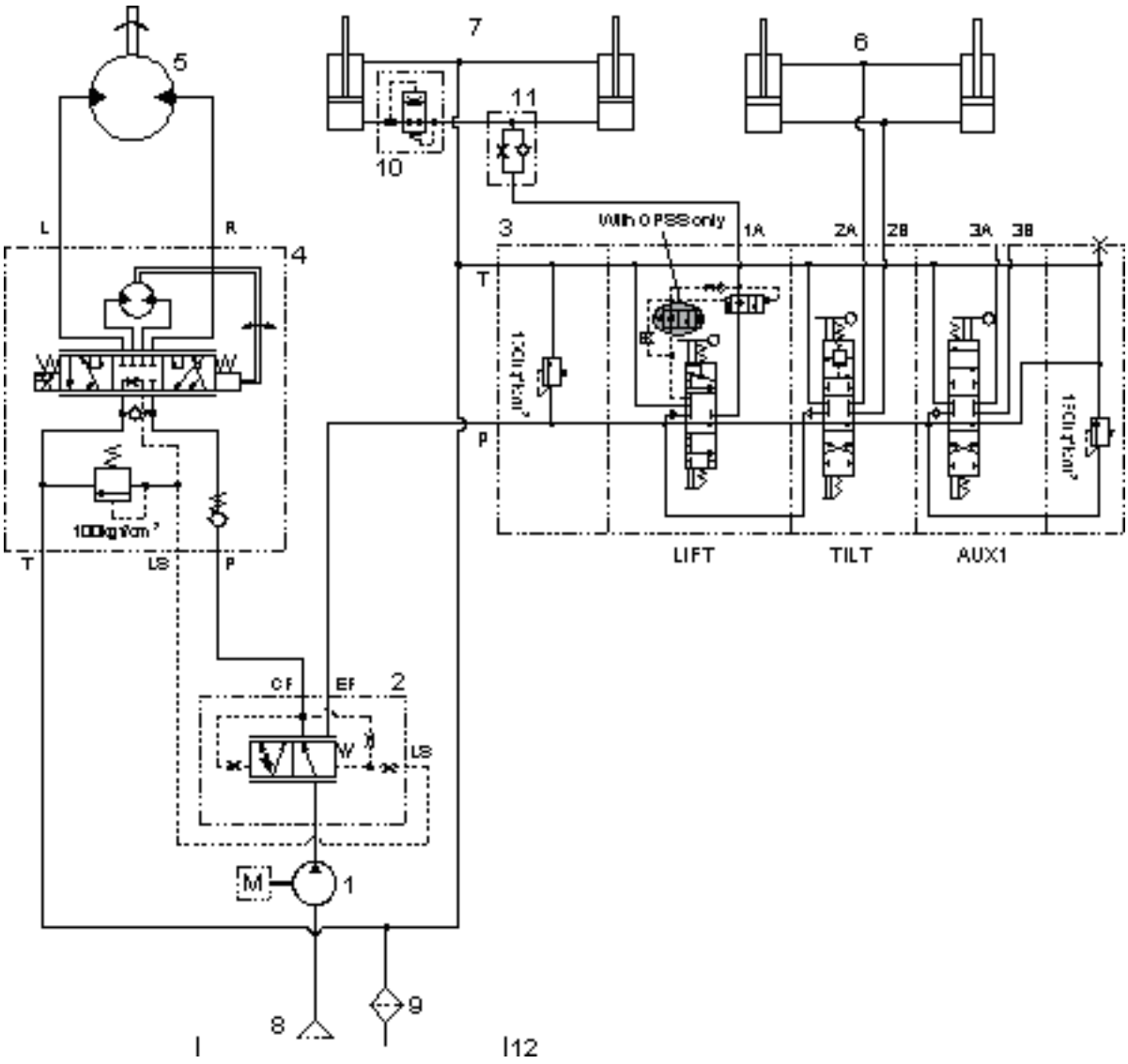
Incorrect contact patterns:		**Correct contact pattern setting by varying the installation position towards the arrow direction**
Addendum tooth position:		
Addendum tooth position:		

GEAR2

⚠ **If the contact pattern is incorrect, change the adjusting washer depending on the direction of arrow. Dismantle the unit for this purpose.**

SECTION 6 HYDRAULIC SYSTEM

1. HYDRAULIC CIRCUIT

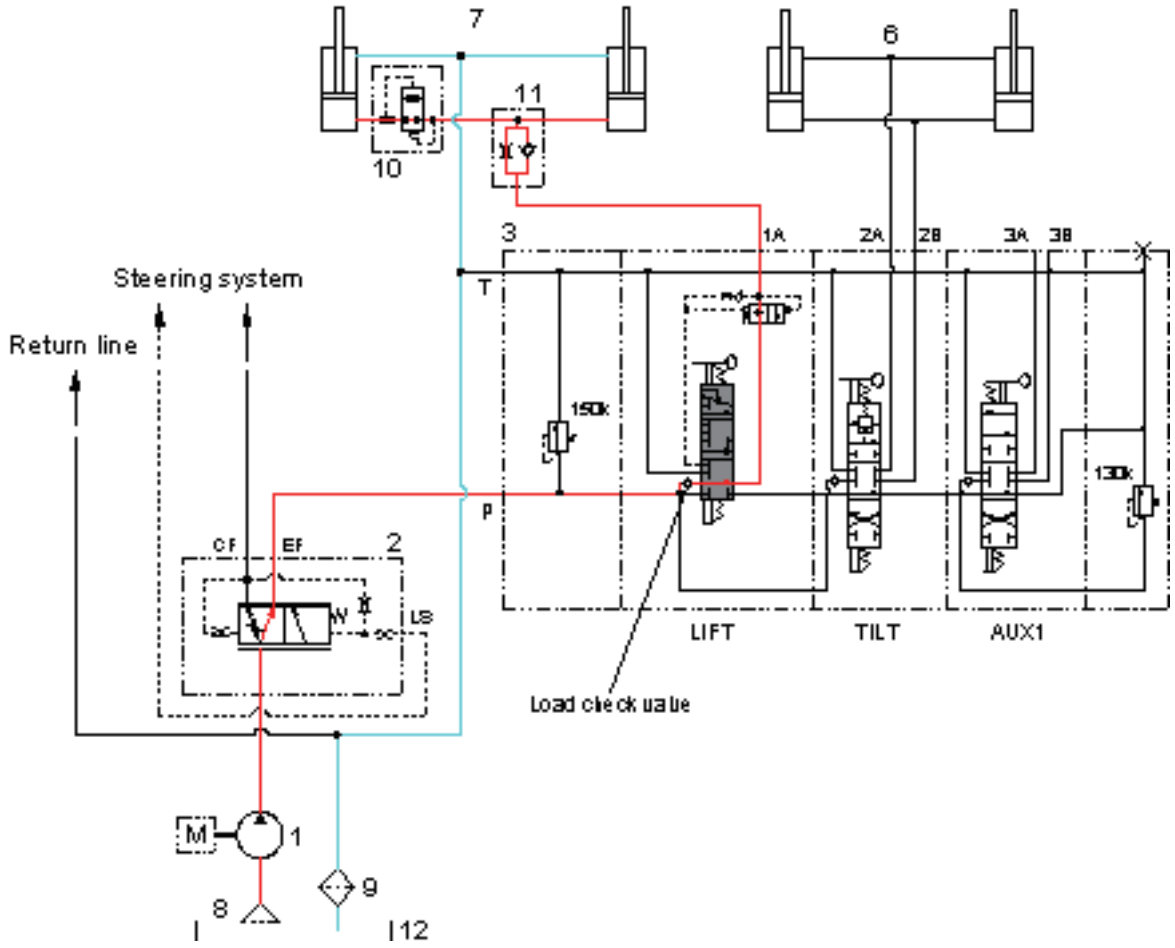


10BTR9HS01

1	Hydraulic gear pump	7	Lift cylinder
2	Priority valve	8	Suction strainer
3	Main control valve	9	Return filter
4	Steering unit	10	Down safety valve
5	Hydraulic motor	11	Down control valve
6	Tilt cylinder	12	Hydraulic oil tank

※ The circuit diagram may differ from the equipment, so please check before a repair.

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

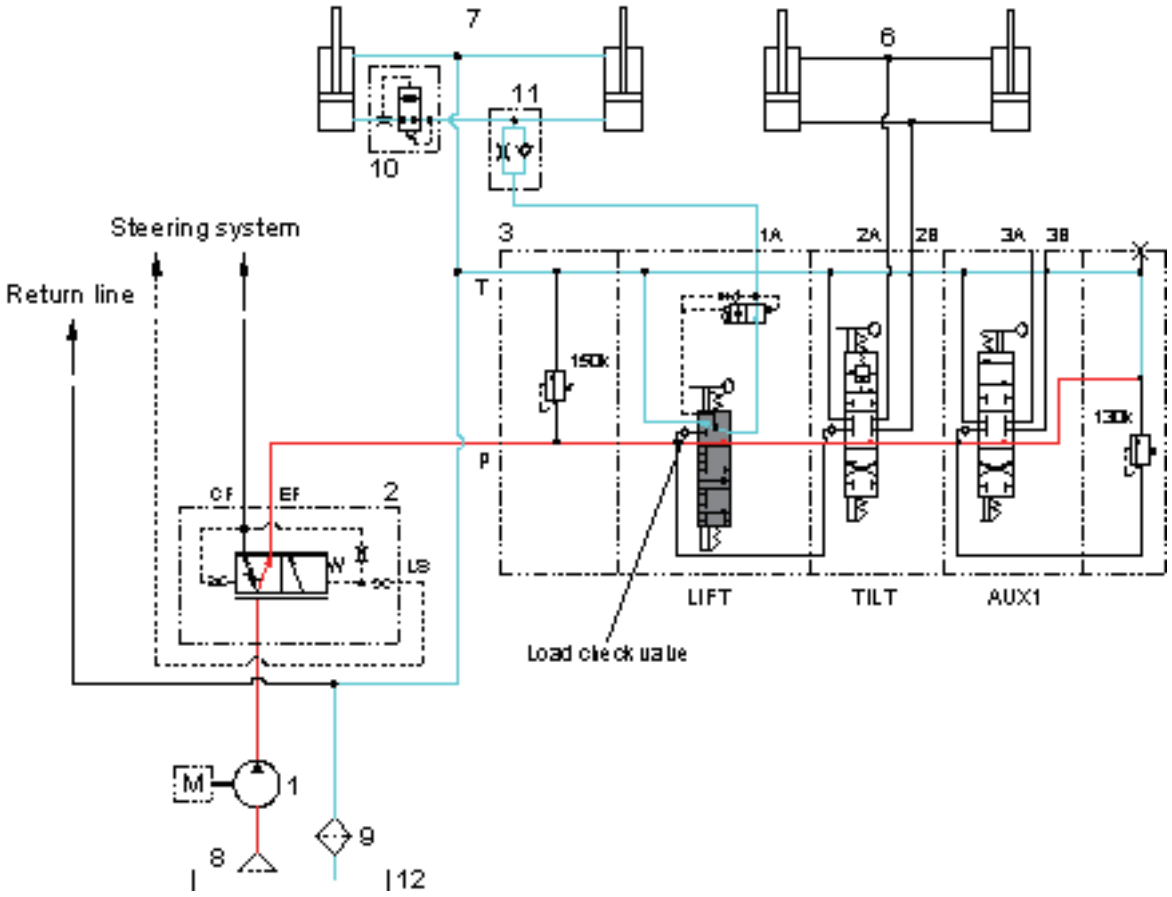


10BTR9HS02

When the lift control lever is pulled back, the spool on the first block is moves to lift position.
The oil from hydraulic gear pump(1) flows into main control valve(3) and then goes to the large chamber of lift cylinder(7) by pushing the load check valve of the spool.
The oil from the small chamber of lift cylinder(7) returns to hydraulic oil tank(12) at the same time.
When this happens, the forks go up.

※ The circuit diagram may differ from the equipment, so please check before a repair.

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

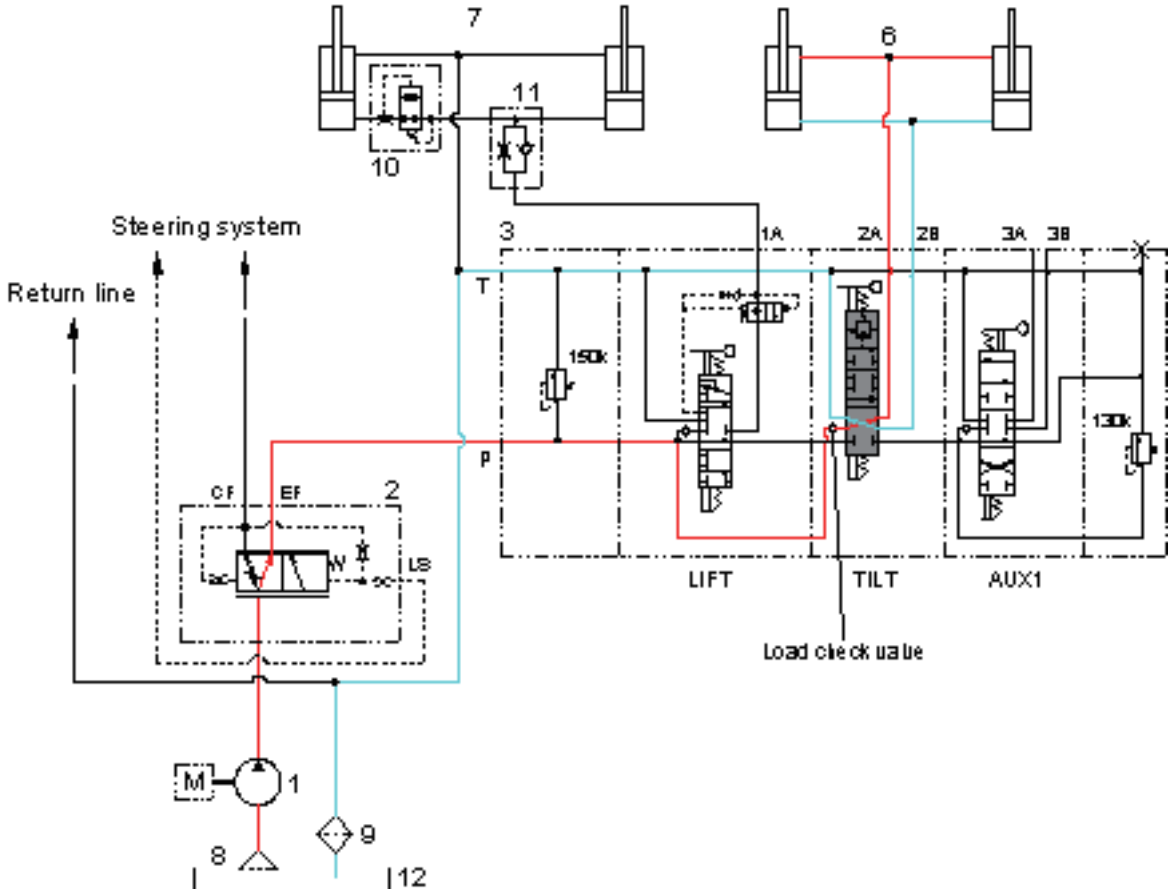


10BTR9HS03

When the lift control lever is pushed forward, the spool on the first block is moved to lower position. The work port(1A) and the small chamber and the large chamber are connected to the return passage, so the forks will be lowered due to its own weight.

※ The circuit diagram may differ from the equipment, so please check before a repair.

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



10BTR9HS04

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

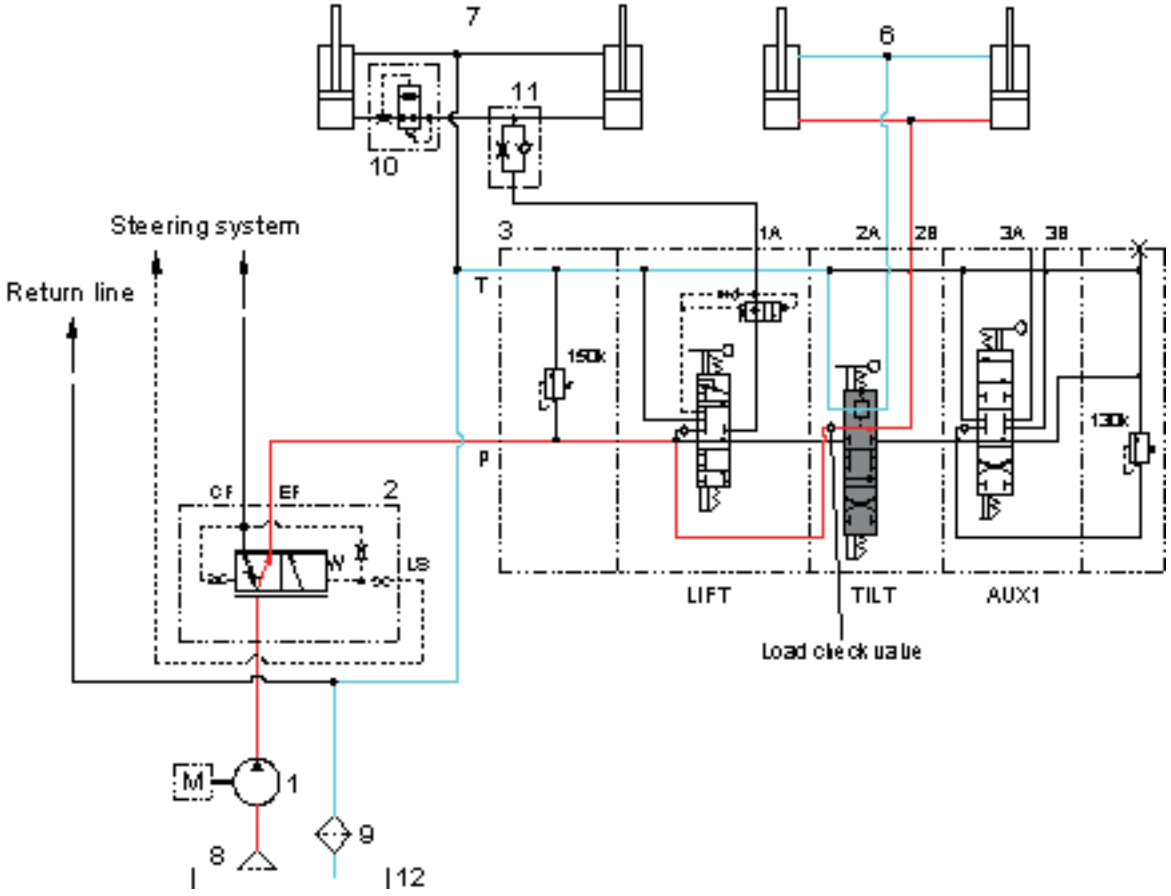
The oil from hydraulic gear pump(1) flows into main control valve (3) and then goes to the large chamber of tilt cylinder(6) by pushing the load check valve of the spool.

The oil at the small chamber of tilt cylinder(6) returns to hydraulic tank(12) at the same time.

When this happens, the mast tilt forward.

※ The circuit diagram may differ from the equipment, so please check before a repair.

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



10BTR9HS05

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

The oil from hydraulic gear pump(1) flows into main control valve(3) and then goes to the small chamber of tilt cylinder(6) by pushing the load check valve of spool.

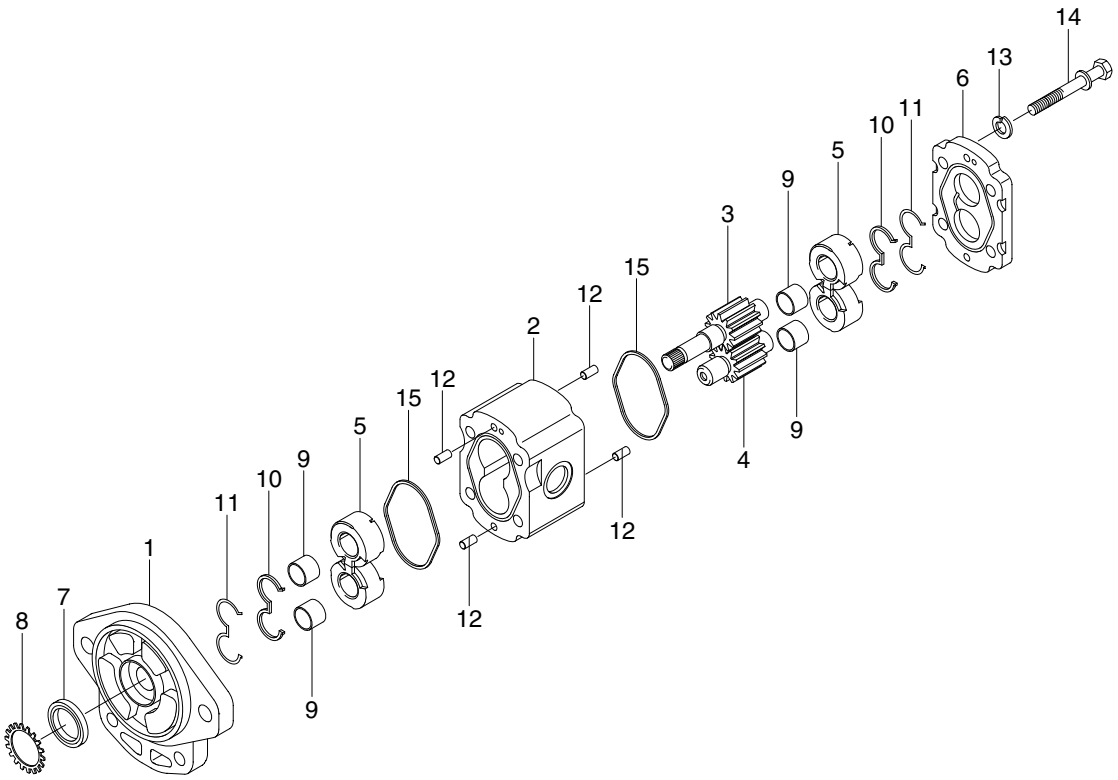
The oil at the large chamber of tilt cylinder(6) returns to hydraulic tank(12) at the same time.

When this happens, the mast tilt backward.

※ The circuit diagram may differ from the equipment, so please check before a repair.

2. HYDRAULIC GEAR PUMP

1) STRUCTURE



10BTR9HS19

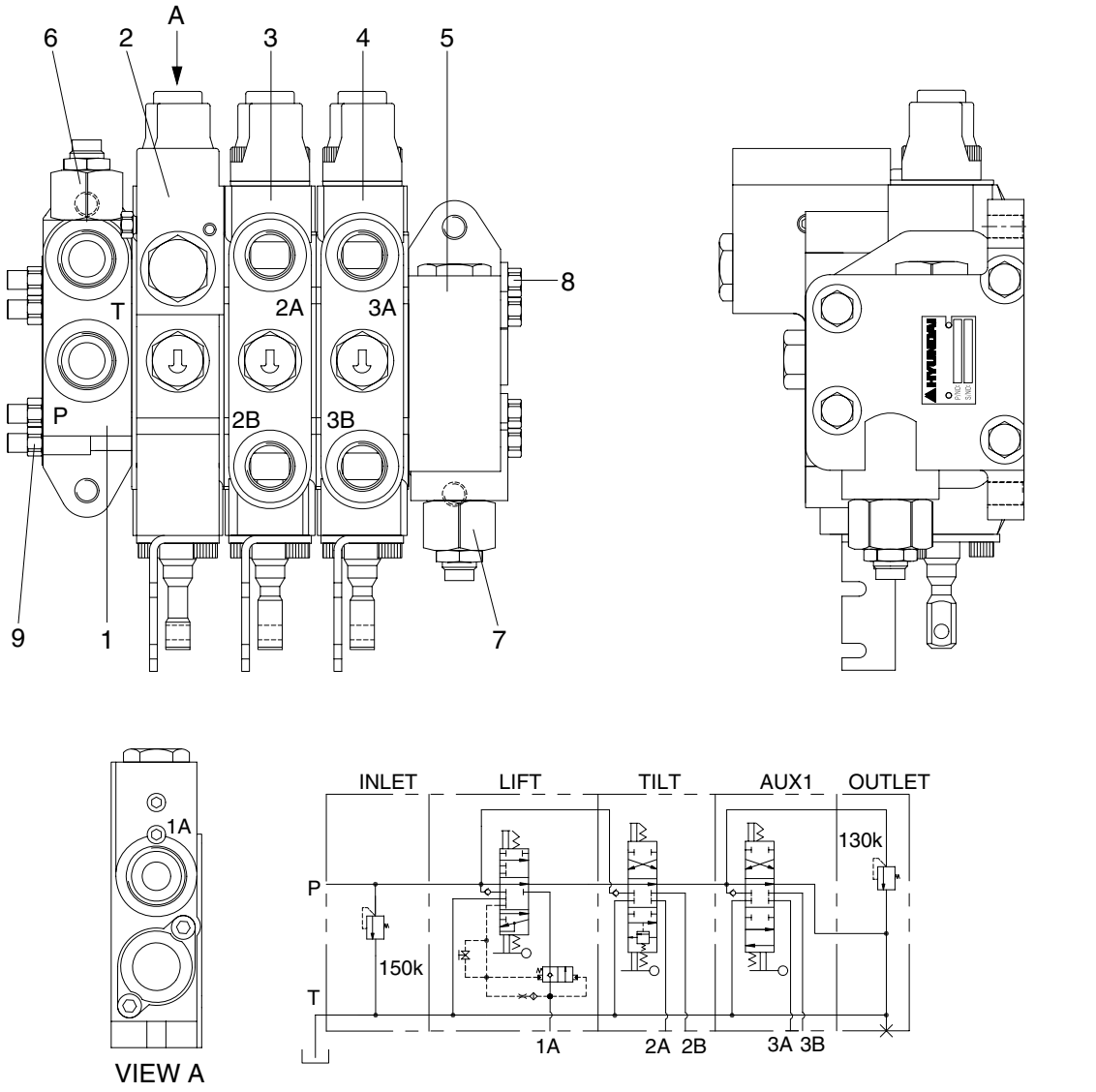
1	Housing assy	6	Rear cover	11	E-back up ring
2	Body	7	Oil seal	12	Pin-S
3	Drive gear	8	Snap ring	13	Wahser
4	Idler gear	9	Bushing	14	Bolt
5	Side plate assy	10	E-seal	15	Square seal

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 (without OPSS)

1) STRUCTURE (3 Spool)

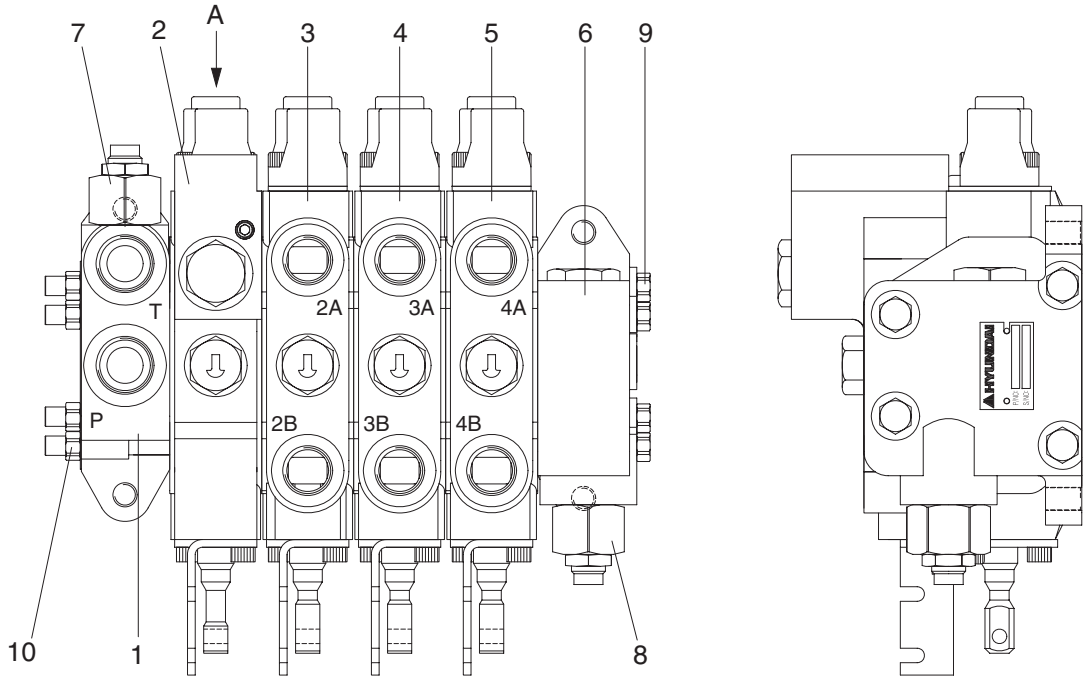


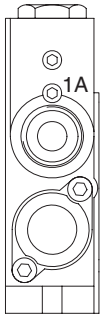
10BTR9HS07A

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

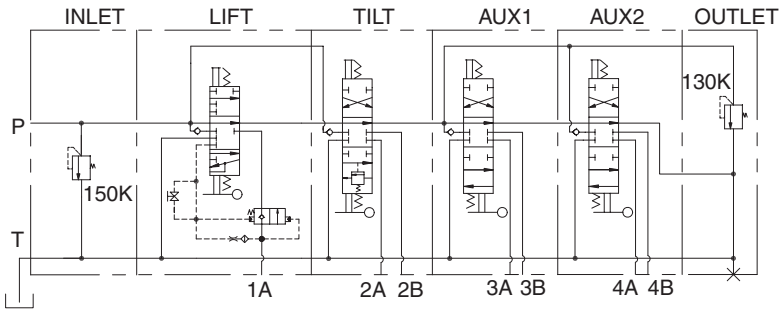
1 Inlet block assy
2 Lift block assy
3 Tilt block assy
4 Aux 1 block assy
5 Outlet block assy
6 Main relief valve assy
7 Auxiliary relief valve assy
8 Long bolt
9 Nut

2) STRUCTURE (4 Spool)





VIEW A



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

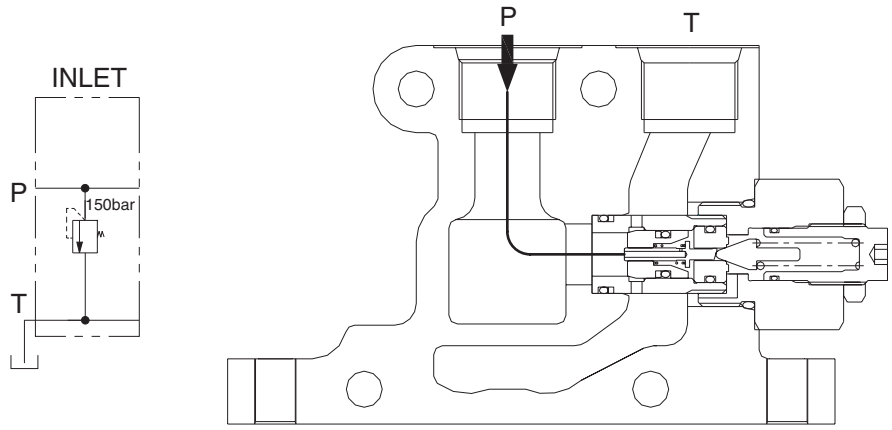
10BTR9HS07B

1 Inlet block assy
2 Lift block assy
3 Tilt block assy
4 Aux 1 block assy
5 Aux 2 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

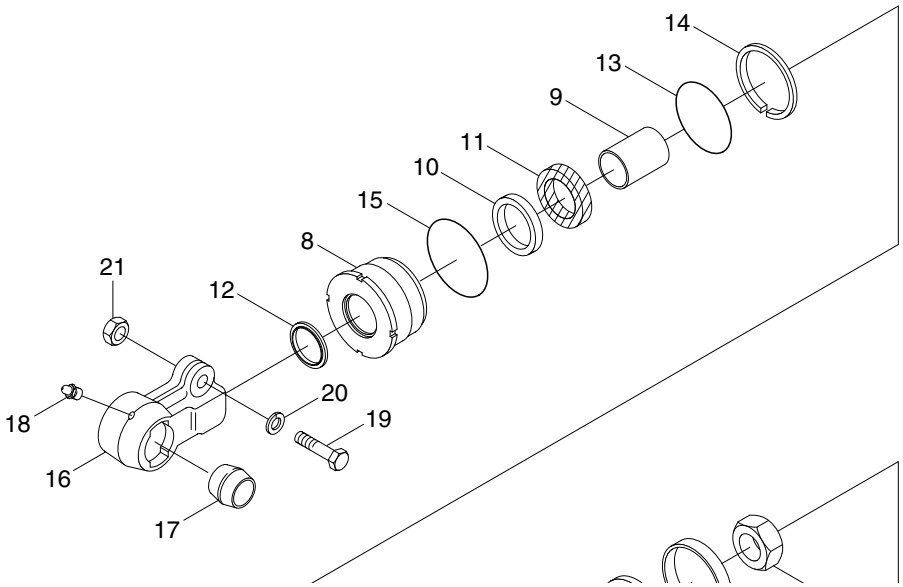
The inlet section contains the pump inlet connection and main relief valve.



10BTR9HS09

(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.



10BTR9HS10

4) LIFT SECTION

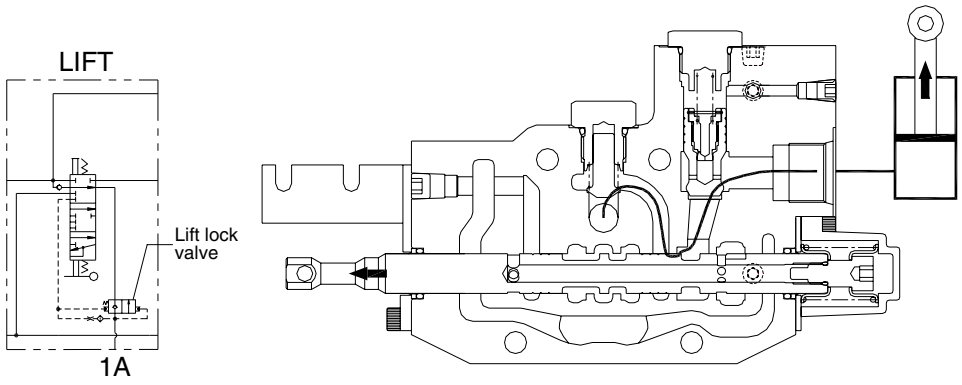
(1) Operation

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

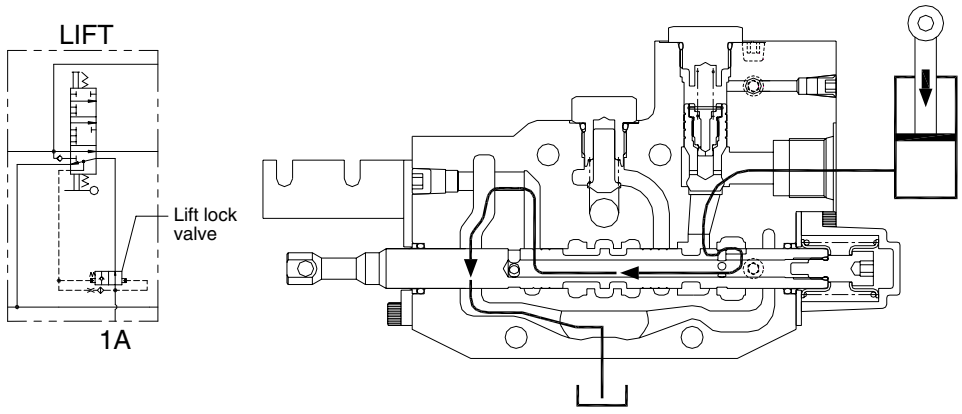
When the operator shifts the lever backwards, the spool is extended out of the valve, and this opens the internal fluid passages that lift the mast. Oil flows through the high pressure parallel cavity, past the load check valve, through the spool metering notches, past the lift lock check valve, and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



22B7HS11

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.



22B7HS12

Pressure is limited by the main relief valve.

5) TILT SECTION

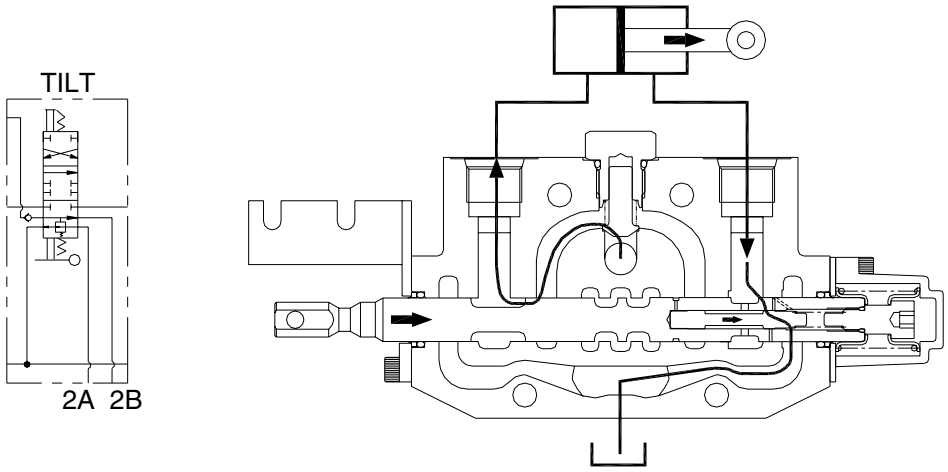
(1) Operation

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.

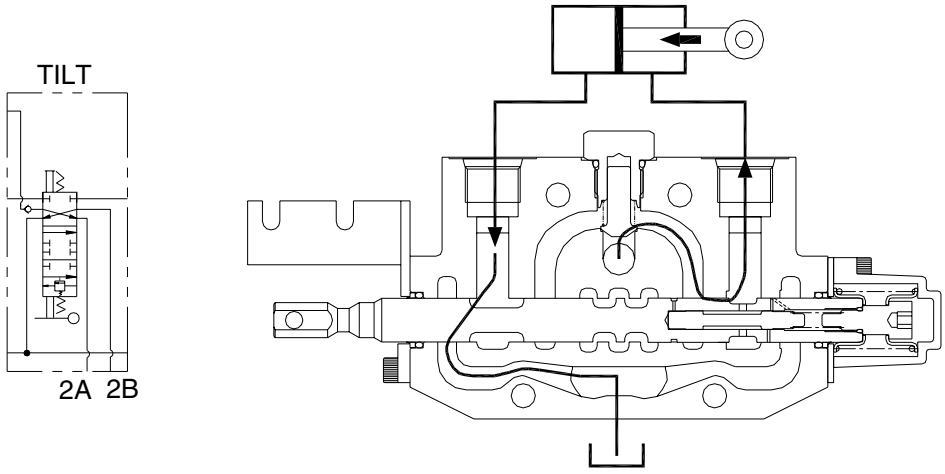
Simultaneously, the high pressure acts upon the end of the tilt lock plunger to move it towards the spring end of the spool. This plunger movement opens additional spool metering notches which control oil flow from the rod end of the cylinder to the tank return line.



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.



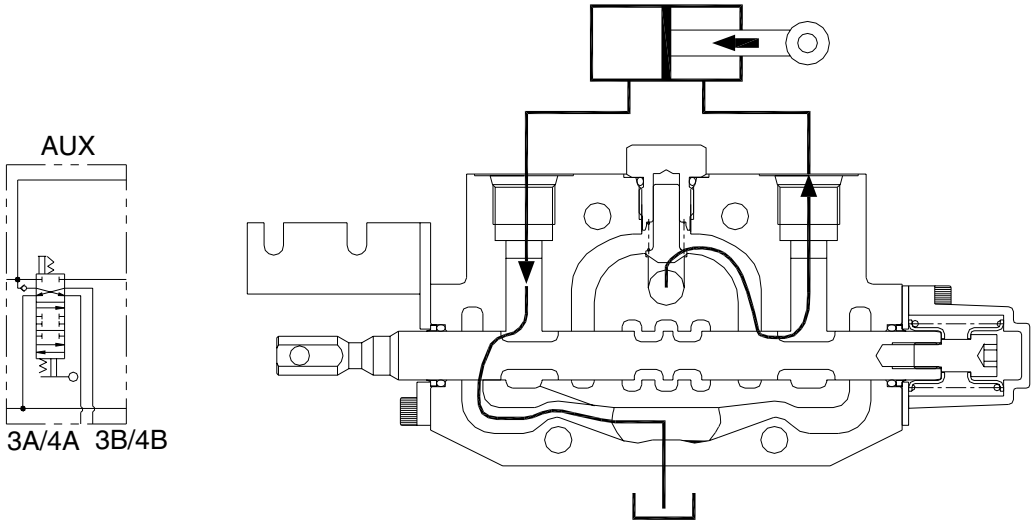
22B7HS14

Pressure is limited by the main relief valve.

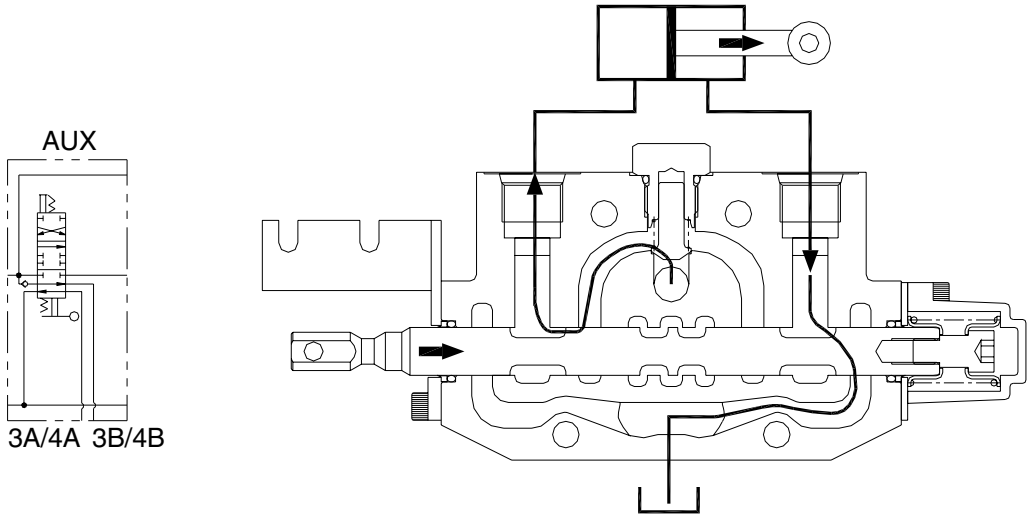
6) AUXILIARY SECTIONS

(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.



22B7HS15



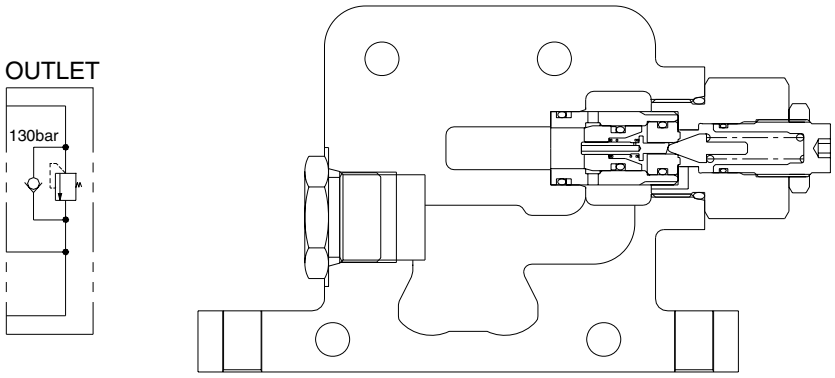
22B7HS16

Pressure is limited by the secondary main relief valve.

7) OUTLET SECTION

(1) Operation

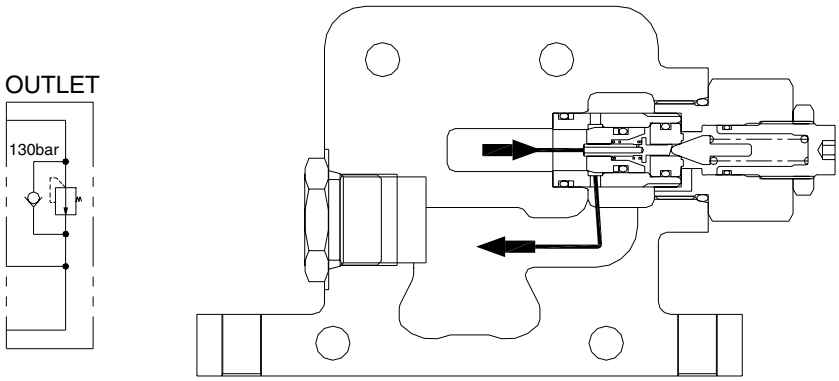
The outlet section contains the tank port and the secondary relief valve(with built-in anti-cavitation feature).



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.

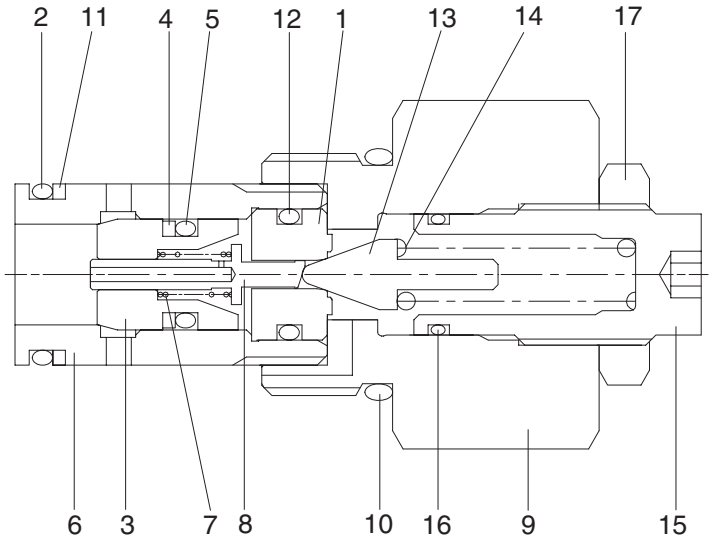


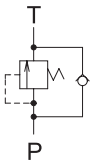
22B7HS18

8) 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 : 150 kgf/cm^2

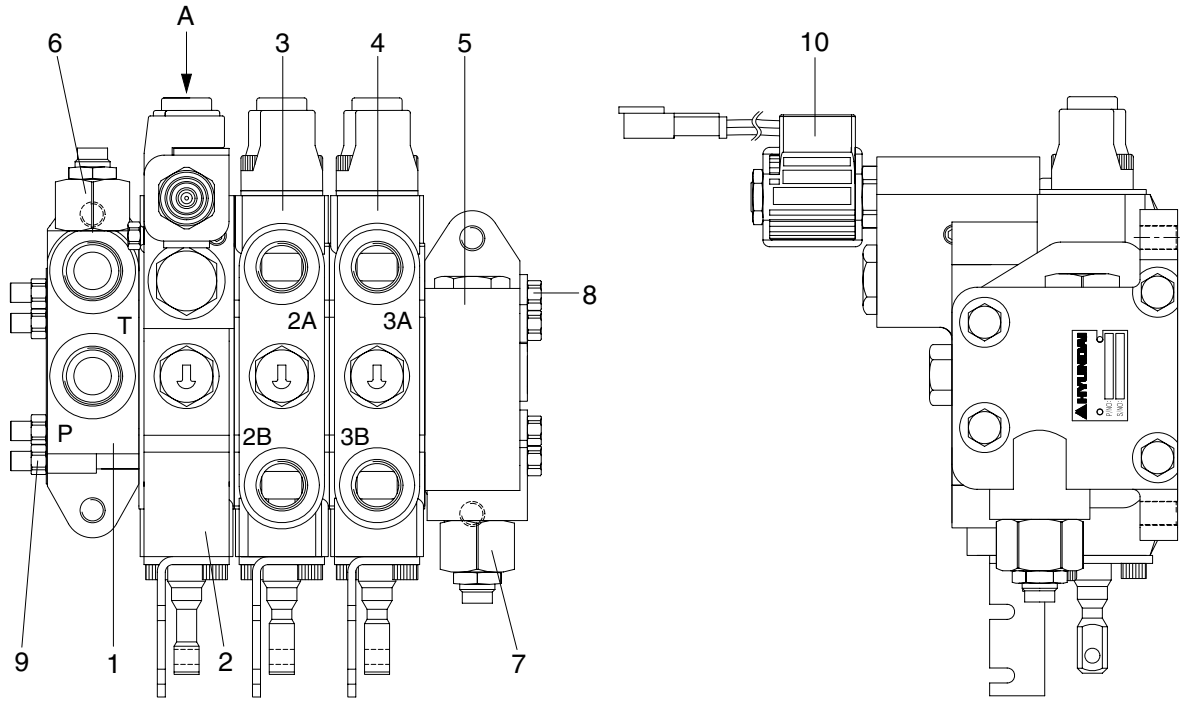
· Auxiliary relief valve : 130 kgf/cm^2
(For 3,4 spool only)

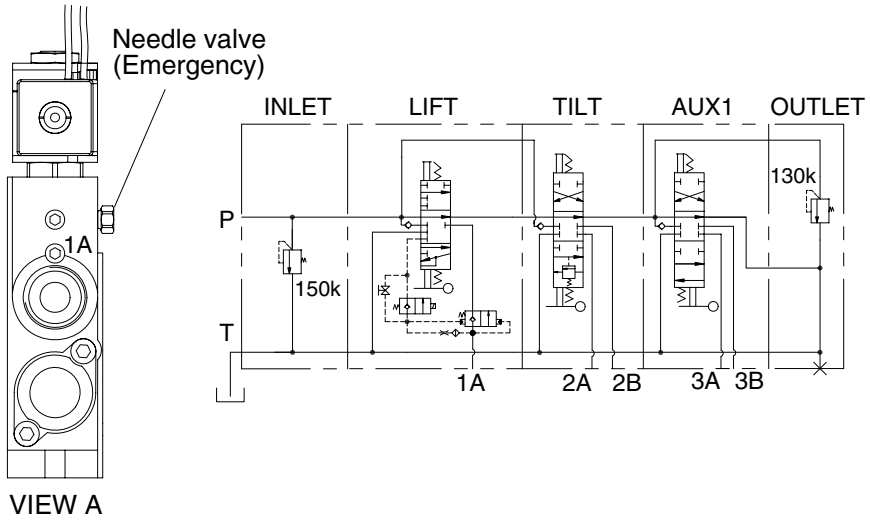
10BTR9HS20

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		

MAIN CONTROL VALVE (with OPSS)

1) **STRUCTURE** (3 Spool)



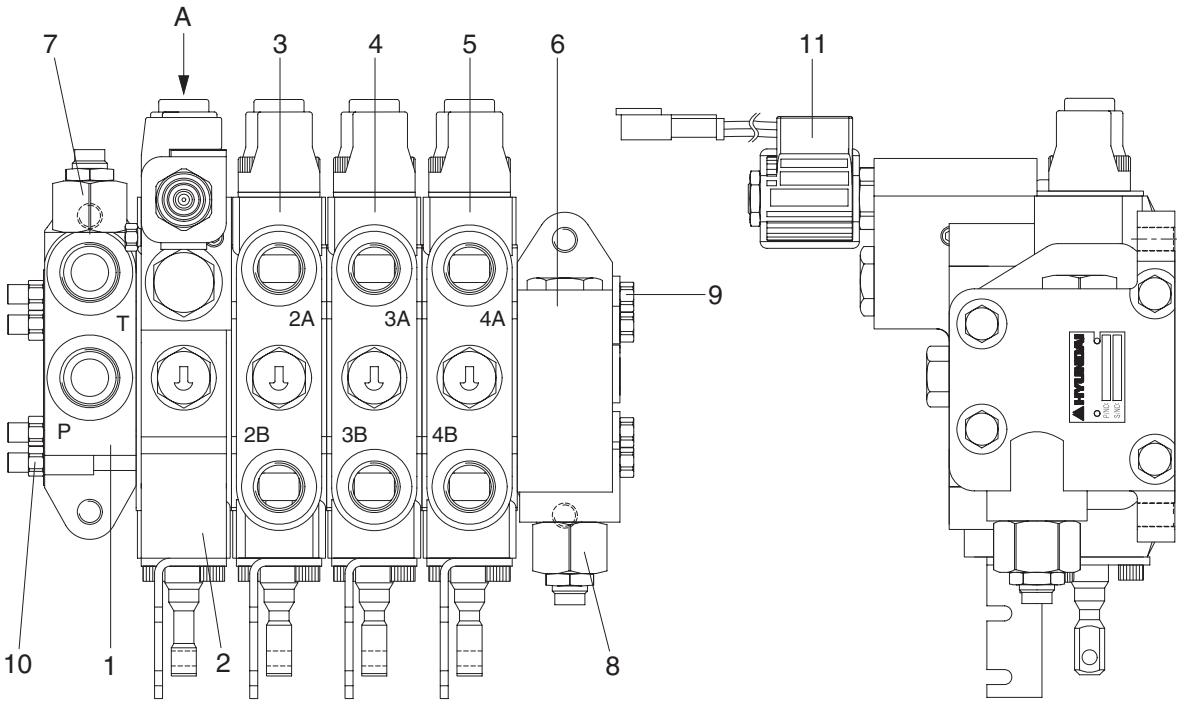


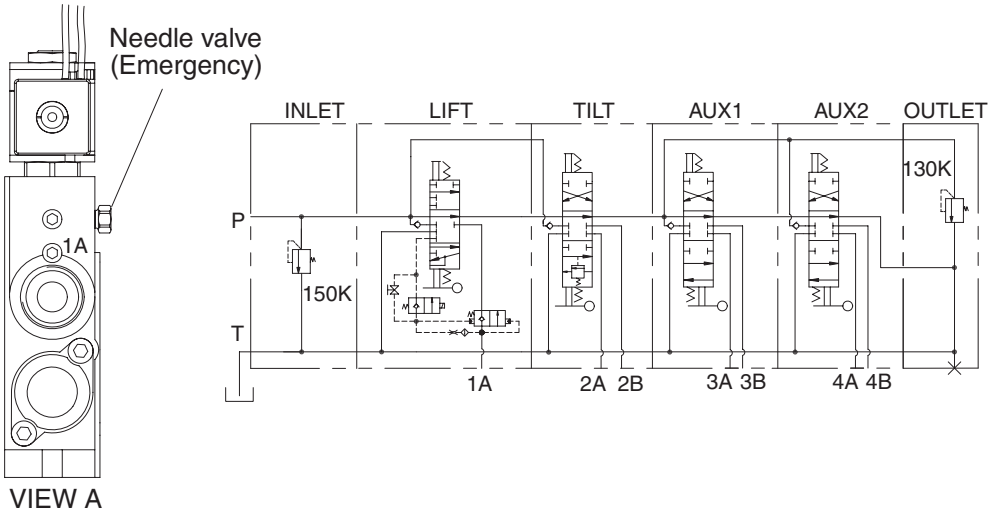
Port name	Size	Port
Inlet port	7/8-14UNF	P
Outlet port	7/8-14UNF	T
Work port	7/8-14UNF	1A
Work port	3/4-16UNF	2A, 2B, 3A, 3B

15BT9HS08

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

2) STRUCTURE (4 Spool)





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

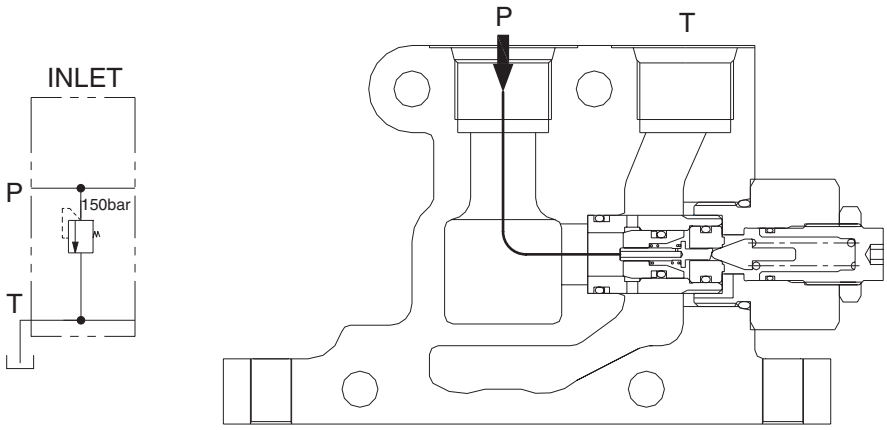
10BTR9HS08A

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

3) INLET SECTION

(1) Operation

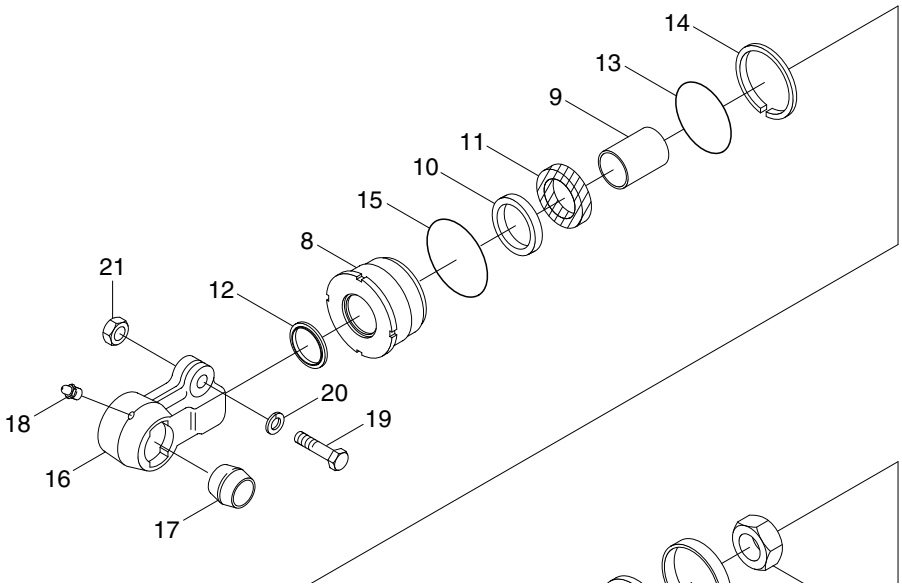
The inlet section contains the pump inlet connection and main relief valve.



10BTR9HS09

(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.



10BTR9HS10

4) LIFT SECTION

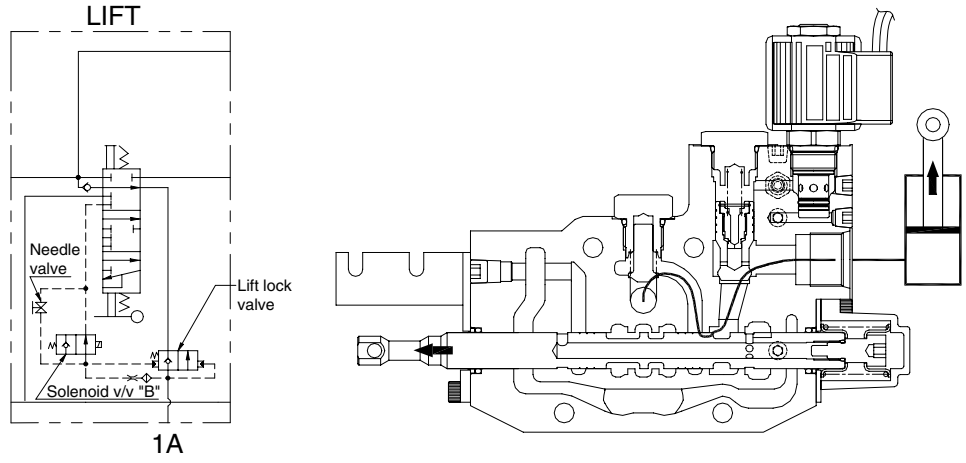
(1) Operation

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

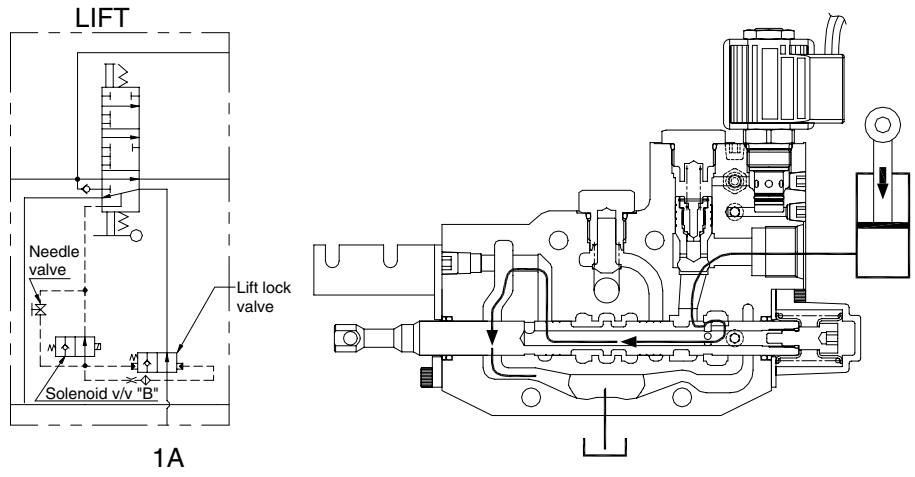
When the operator shifts the lever backwards, the spool is extended out of the valve, and this opens the internal fluid passages that lift the mast. Oil flows through the high pressure parallel cavity, past the load check valve, through the spool metering notches, past the lift lock check valve, and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



22B7HS11S

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.



22B7HS12S

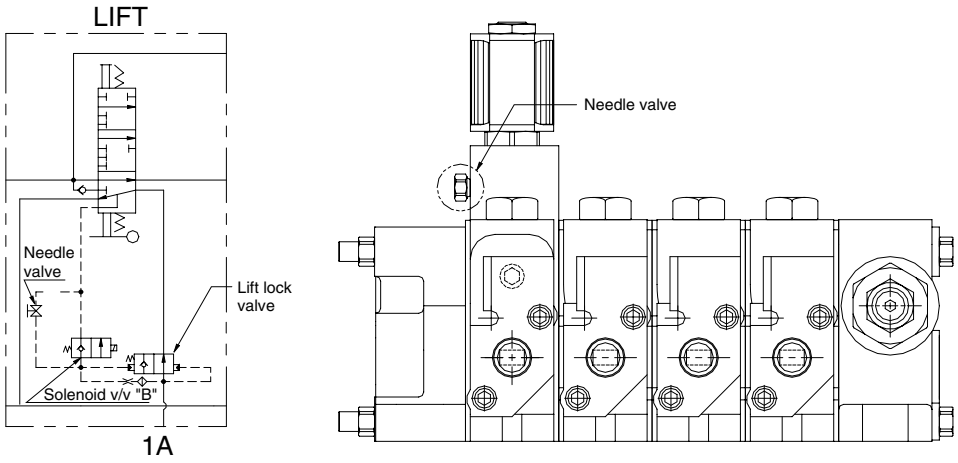
Pressure is limited by the main relief valve.

③ **Secondary lowering method** : A secondary lowering method is available in the event of the loss of battery power that is needed to energize the normally closed solenoid valve.

Important note : Before opening the secondary needle valve, make sure personnel and equipment are safely positioned to avoid accidents. Be careful to operate this secondary valve slowly, as heavy loads may be suspended.

A manual valve(needle valve) is located on the lift section, and it can be operated by opening the vehicle cowling and rotating the manual valve(needle valve) counterclockwise with a wrench.

Open the manual valve (needle valve) approximately 2 turn (do not rotate more than 3 turns). Then shift the lift spool slowly for controlled lowering. This should be just enough for slow, controlled movement of the mast.



22B7HS12AS

Pressure is limited by the main relief valve.

5) TILT SECTION

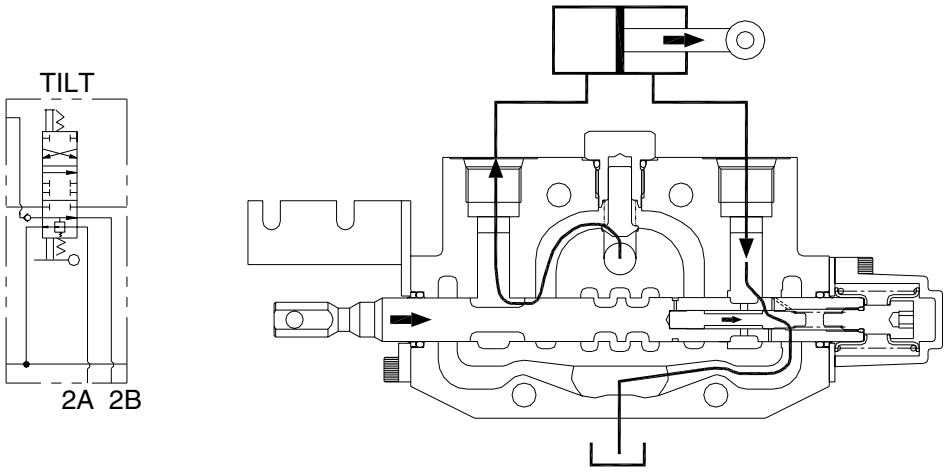
(1) Operation

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.

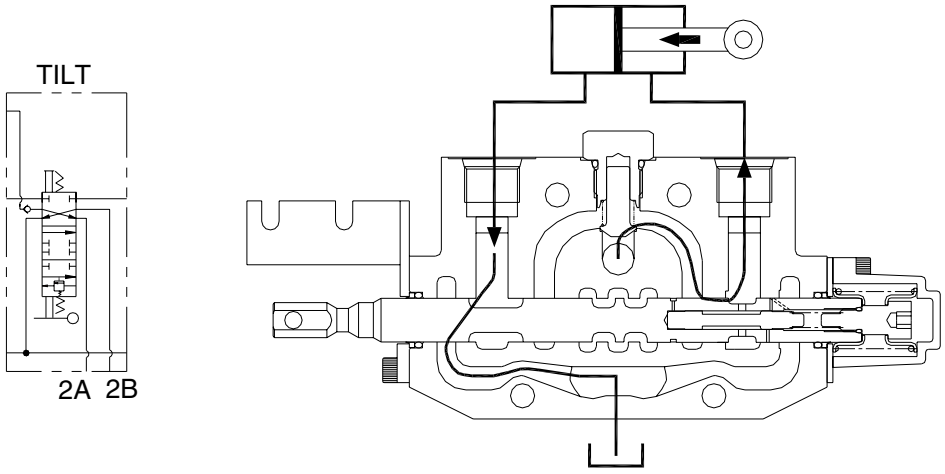
Simultaneously, the high pressure acts upon the end of the tilt lock plunger to move it towards the spring end of the spool. This plunger movement opens additional spool metering notches which control oil flow from the rod end of the cylinder to the tank return line.



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.



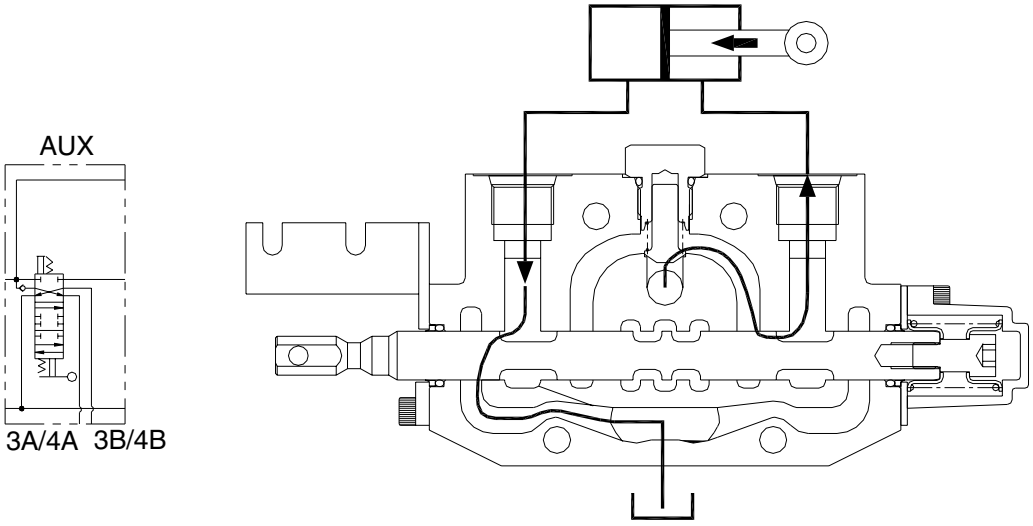
22B7HS14

Pressure is limited by the main relief valve.

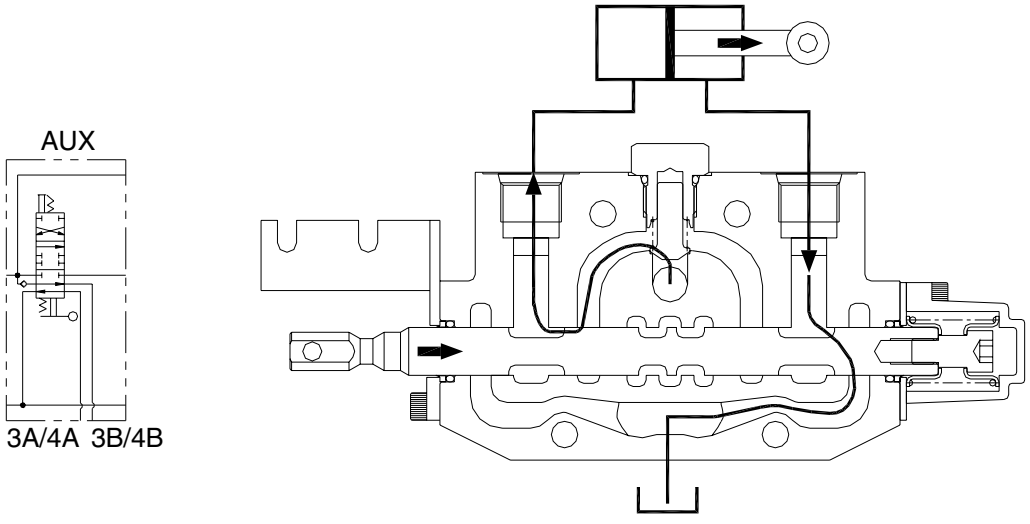
6) AUXILIARY SECTIONS

(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.



22B7HS15



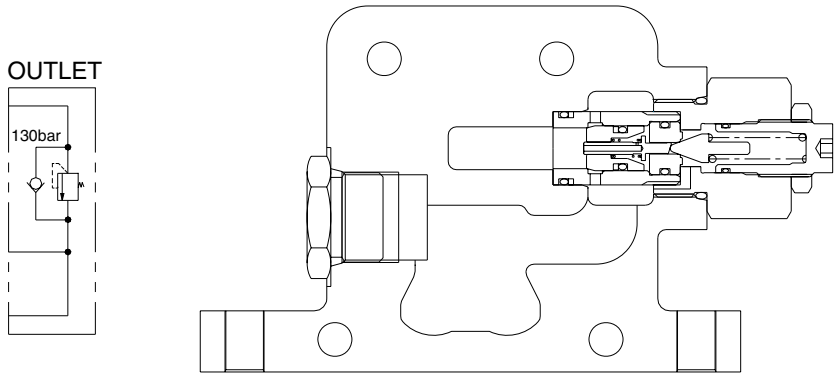
22B7HS16

Pressure is limited by the secondary main relief valve.

7) OUTLET SECTION

(1) Operation

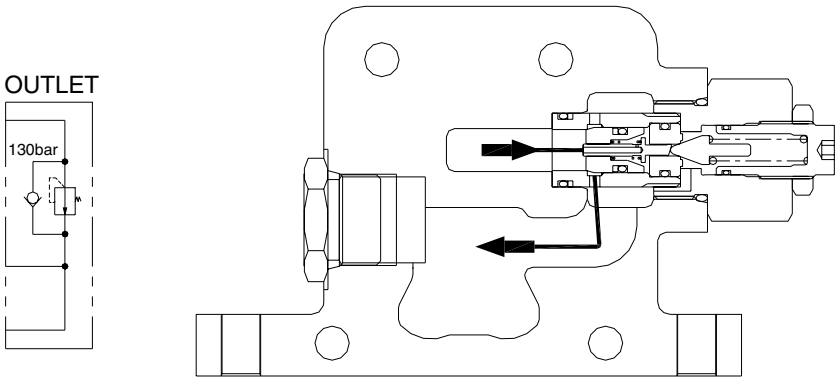
The outlet section contains the tank port and the secondary relief valve(with built-in anti-cavitation feature).



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.

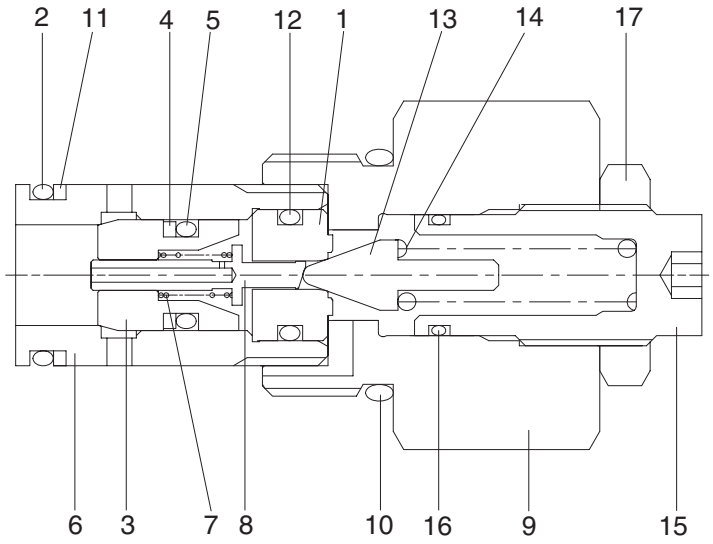


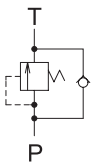
22B7HS18

8) 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.





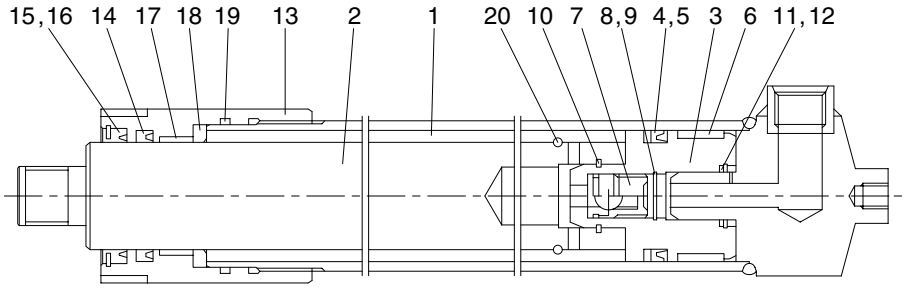
· Main relief valve : 150 kgf/cm²

· Auxiliary relief valve : 130 kgf/cm²
(For 3,4 spool only)

10BTR9HS20

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		

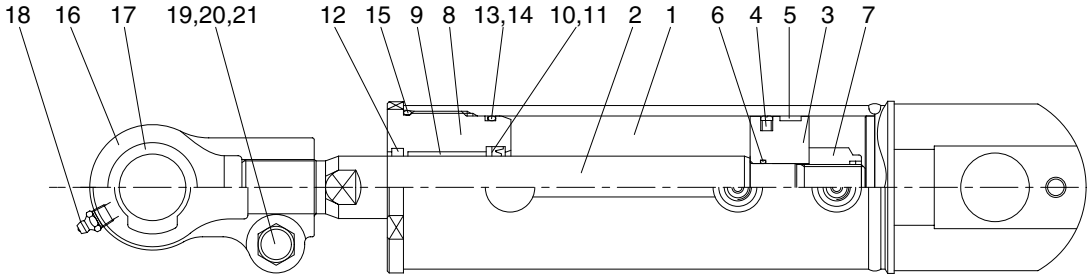
4. LIFT CYLINDER



10BTR9HS18

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

5. TILT CYLINDER



10BTR9HS07

1	Tube assembly	8	Rod cover	15	O-ring
2	Rod	9	Rod bush	16	Eye
3	Piston	10	U-packing	17	Spherical bearing
4	Piston seal	11	Back up ring	18	Grease nipple
5	Wear ring	12	Dust wiper	19	Hex bolt
6	O-ring	13	O-ring	20	Spring washer
7	Hex nylon nut	14	Back up ring	21	Lock nut

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

1. OPERATIONAL CHECKS

1) CHECK ITEM

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

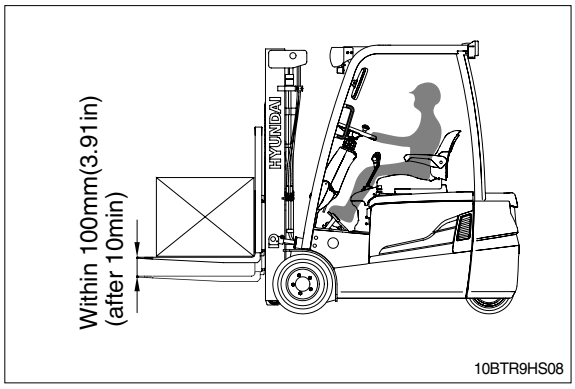
(2) Set mast vertical and raise 1m from ground. Wait for 10 minutes and measure hydraulic drift(amount forks move down and amount mast tilts forward).

· **Check condition**

- Hydraulic oil : Normal operating temp (50°C)
- Mast substantially vertical.
- Rated capacity load.

· **Hydraulic drift**

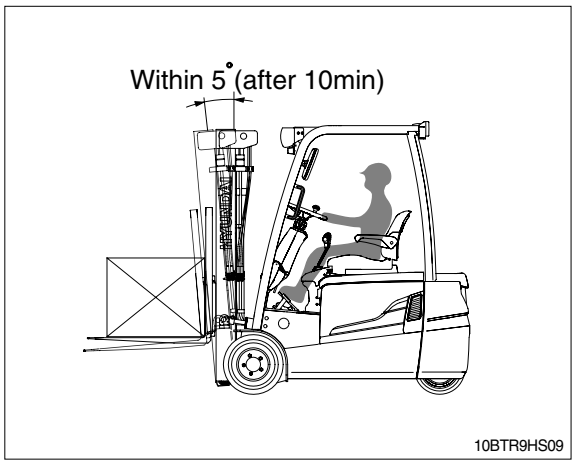
- Down(Downward movement of forks)
: Within 100mm (3.9in)
- Forward(Extension of tilt cylinder)
: Within 5°



(3) If the hydraulic drift is more than the specified value, replace the control valve or cylinder packing.
Check that clearance between tilt cylinder bushing and mounting pin is within standard range.

mm (in)

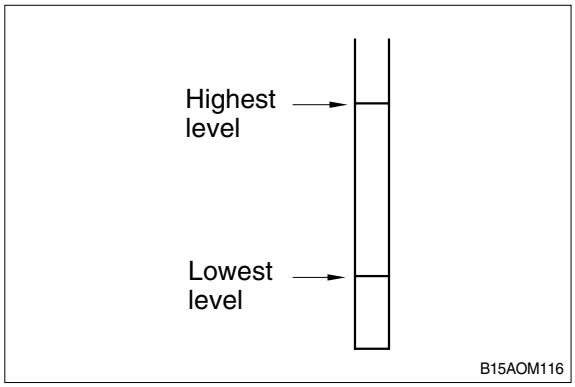
Standard	Under 0.6 (0.02)



2) HYDRAULIC OIL

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

(2) When changing hydraulic oil, clean suction strainer(screwed into outlet port pipe) and line filter(screwed into inlet pipe). Line filter uses paper element, so replace periodically(every 6 months or 1000 hours)



3) CONTROL VALVE

(1) Raise forks to maximum height and measure oil pressure.
Check that oil pressure is 150kgf/cm^2.
(2130psi)

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 ISO VG46. · 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 ISO VG46. · Clean filter.

2) HYDRAULIC GEAR PUMP

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

3) MAIN RELIEF VALVE

Problem	Cause	Remedy
Can't get pressure	· Poppet D, E or K stuck open or contamination under seat.	· Check for foreign matter between poppets D, E or K and their mating parts. Parts must slide freely.
Erratic pressure	· Pilot poppet seat damaged. · Poppet C sticking in D.	· Replace the relief valve. · Clean and remove surface marks for free movement.
Pressure setting not correct	· Normal wear. Lock nut & adjust screw loose.	· See *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

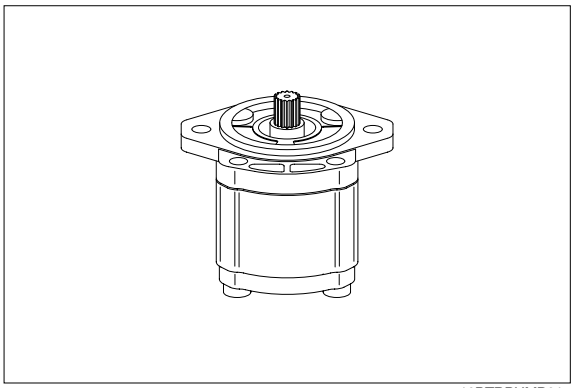
Problem	Cause	Remedy
Oil leaks out from rod cover through rod	· Foreign matters on packing. · Unallowable score on rod. · Unusual distortion of dust seal. · Chrome plating is striped.	· Replace packing. · Smooth rod surface with an oil stone. · Replace dust seal. · Replace rod.
Oil leaks out from cylinder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

GROUP 3 DISASSEMBLY AND ASSEMBLY

1. HYDRAULIC GEAR PUMP

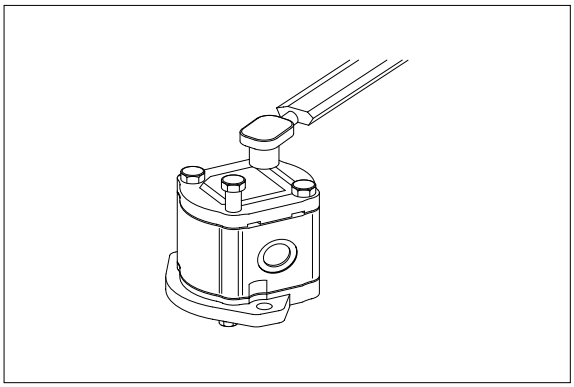
1) DISASSEMBLY

(1) Throughly clean the outside of the pump so that it can not remain the foreign material on the pump.



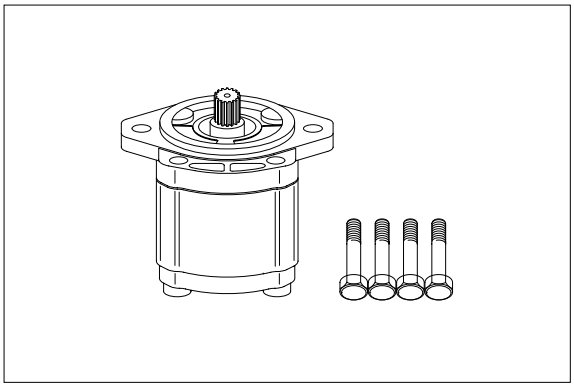
10BTRPUMP01

(2) Loosen and remove the bolts (4EA) from the pump cover.



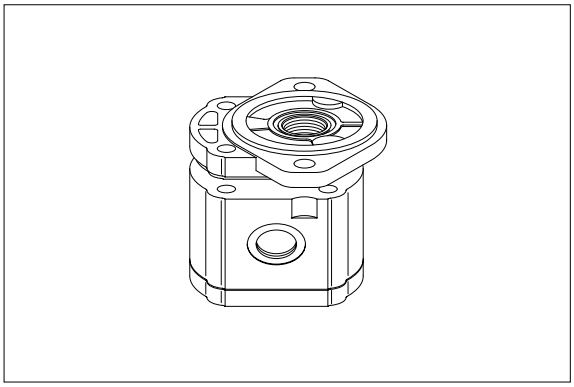
10BTRPUMP02

(3) Remove the sharp edge of the drive shaft and smear a clean grease on the shaft end to prevent any damage from the lip of the oil seal when removing the housing. (It should be carried out above work when it is necessary for replacing the oil seal)



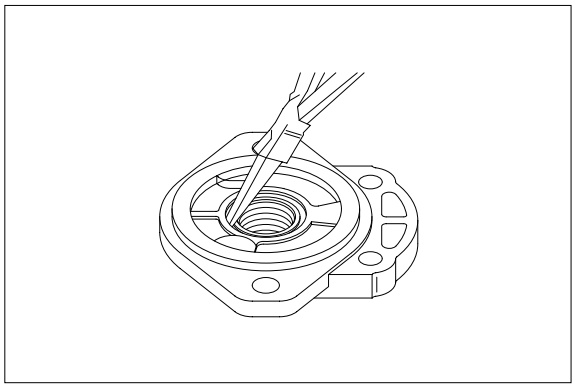
10BTRPUMP03

(4) Disassemble the housing to take care of keeping the shaft as straight as possible during removal.
If the housing is stuck to the drive shaft, tap around the edge with the rubber hammer in order to break away from the body.
At this time, it should be kept to remain assembly position for the shaft and other components while removing the mounting flange.



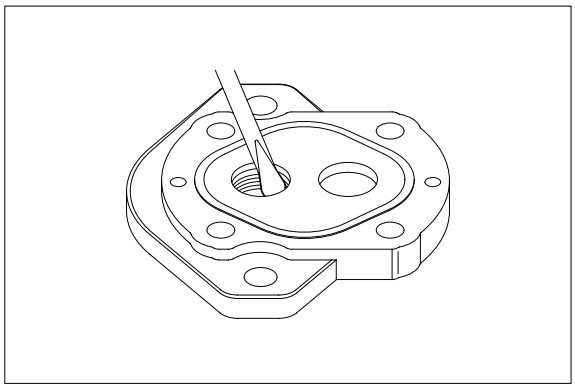
10BTRPUMP04

(5) Take off the snap ring using the proper tool. (If should be carried out above work when it is necessary for replacing the oil seal)



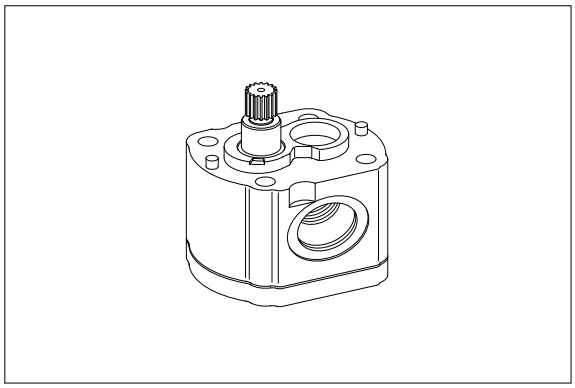
10BTRPUMP05

(6) Remove the oil seal from the cover to pay keen attention to do not damaging the surface of the shaft hole. (It should be carried out above work when it is necessary for replacing the oil seal)



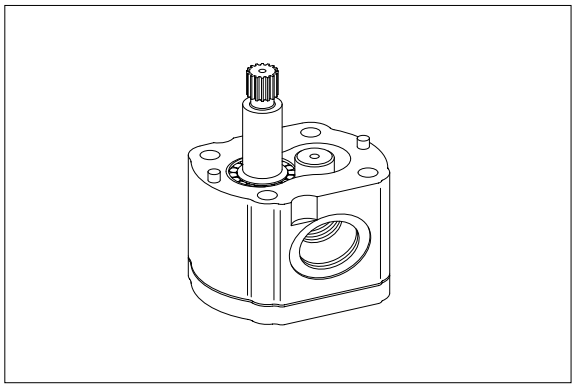
10BTRPUMP06

(7) Remove the side plate after lifting up the drive gear so that it can remove easily the side plate to the upward.



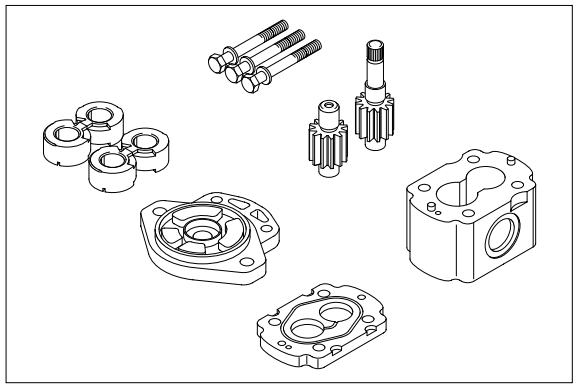
10BTRPUMP07

(8) Disassemble the drive gear and the idle gear. At this time, pay keen attention to keep as straight as possible for the gear shaft to the hole of the housing.



10BTRPUMP08

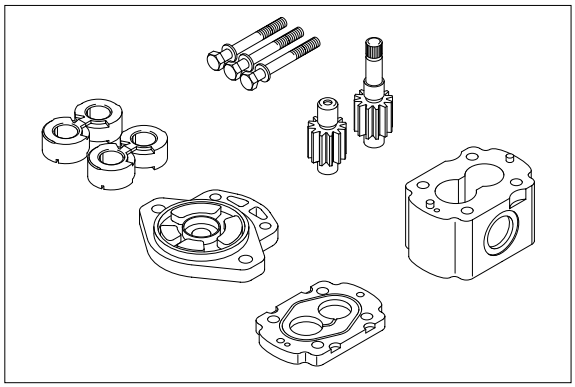
(9) Disassemble the rear cover and side plate of the lower side from the pump housing.



10BTRPUMP09

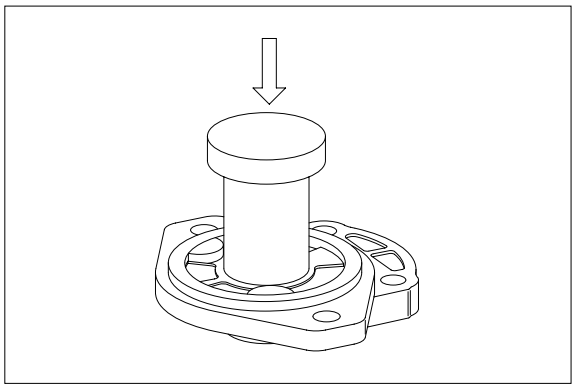
2) ASSEMBLY

(1) Throughly clean the components of the pump so that it can not remain the foreign material on the components.



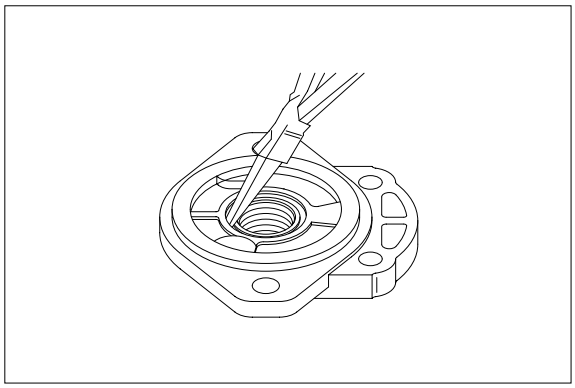
10BTRPUMP09

(2) Insert the oil seal carefully and fix it inside of the mounting flange using the proper tool.



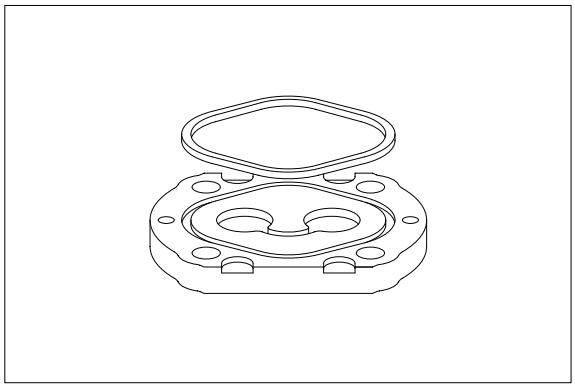
10BTRPUMP10

(3) Fit the snap ring in pre-arranged position using the proper tool.



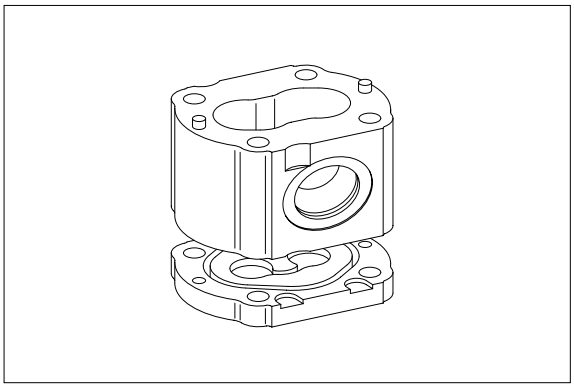
10BTRPUMP05

(4) Insert the square seal in the right position of the rear cover.
Smear clean grease on the square seal to prevent it from taking off the rear cover when it is assembled.



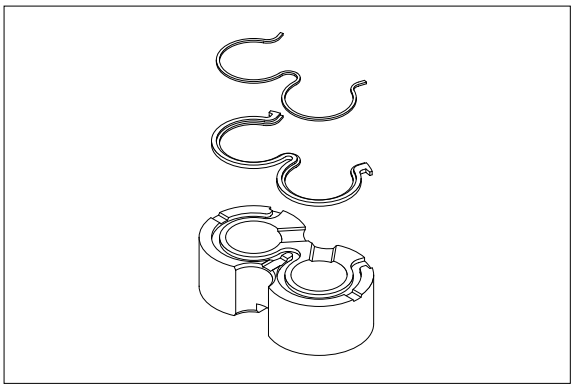
10BTRPUMP11

(5) Insert the pin in pre-arranged position of the rear cover after fitting the pin in the bottom side of the body.



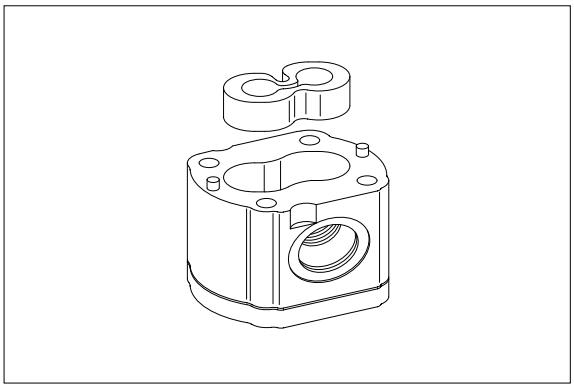
10BTRPUMP12

(6) Insert the E-seal in the right position of the side plate.
After that, fit the back up ring in the groove of the E-seal.
Apply clean grease on the E-seal. (It is same as the side plate and back up ring.)



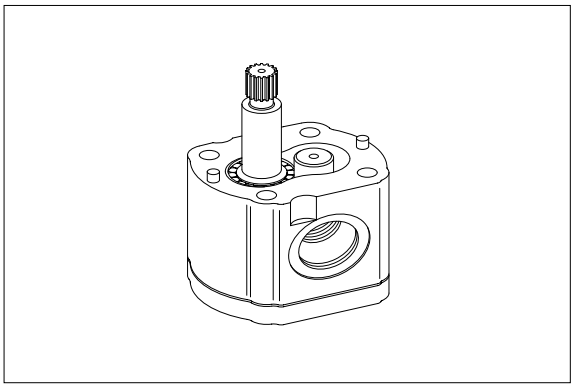
10BTRPUMP13

(7) Insert side plate assembly in the body to keep as straight as possible.
When assembling the side plate assembly, it should be assembled the seal side to the rear cover that is the opposite side to the gear.
Take care to the direction of the seal.



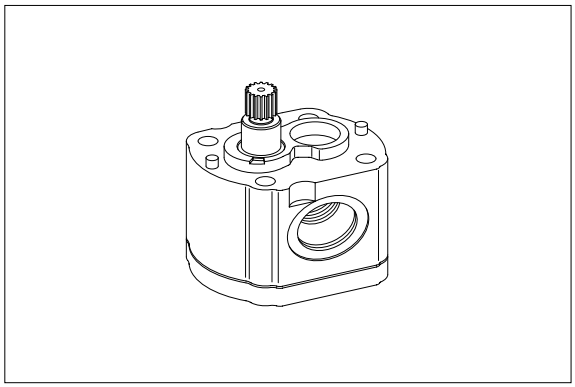
10BTRPUMP14

(8) Insert the drive gear and the idle gear in the pump housing.



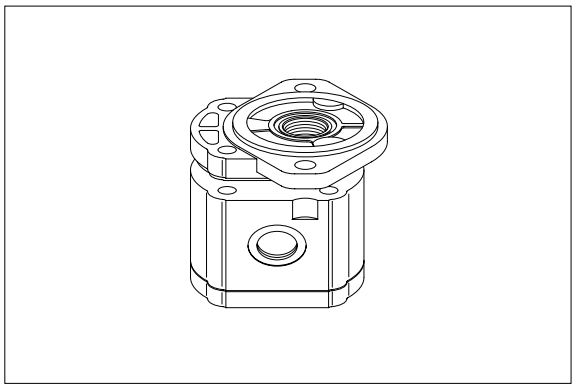
10BTRPUMP08

(9) Insert the side plate in the body to take care of direction of the side plate.



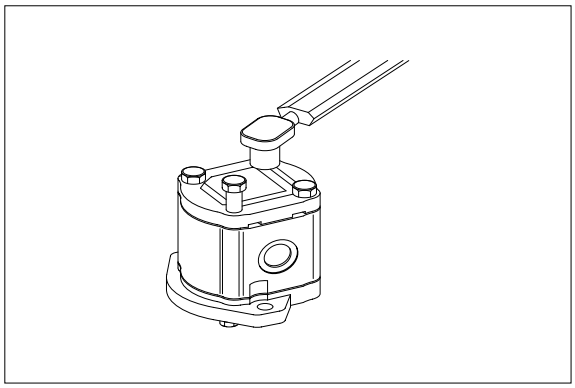
10BTRPUMP07

(10) Assemble the cover on the pump housing.



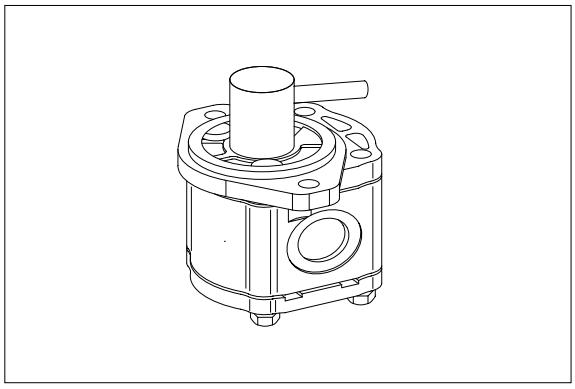
10BTRPUMP04

(11) Tighten alternately the bolts one after another in a diagonal direction order with 45~48Nm torque value after inserting the washer.



10BTRPUMP02

(12) When turning the drive shaft by hand, make sure that it can be rotated freely.
If it is not, it could be pinched E-seal between the shaft of drive gear and side plate by taking the E-seal from the groove of the side plate.



10BTRPUMP15

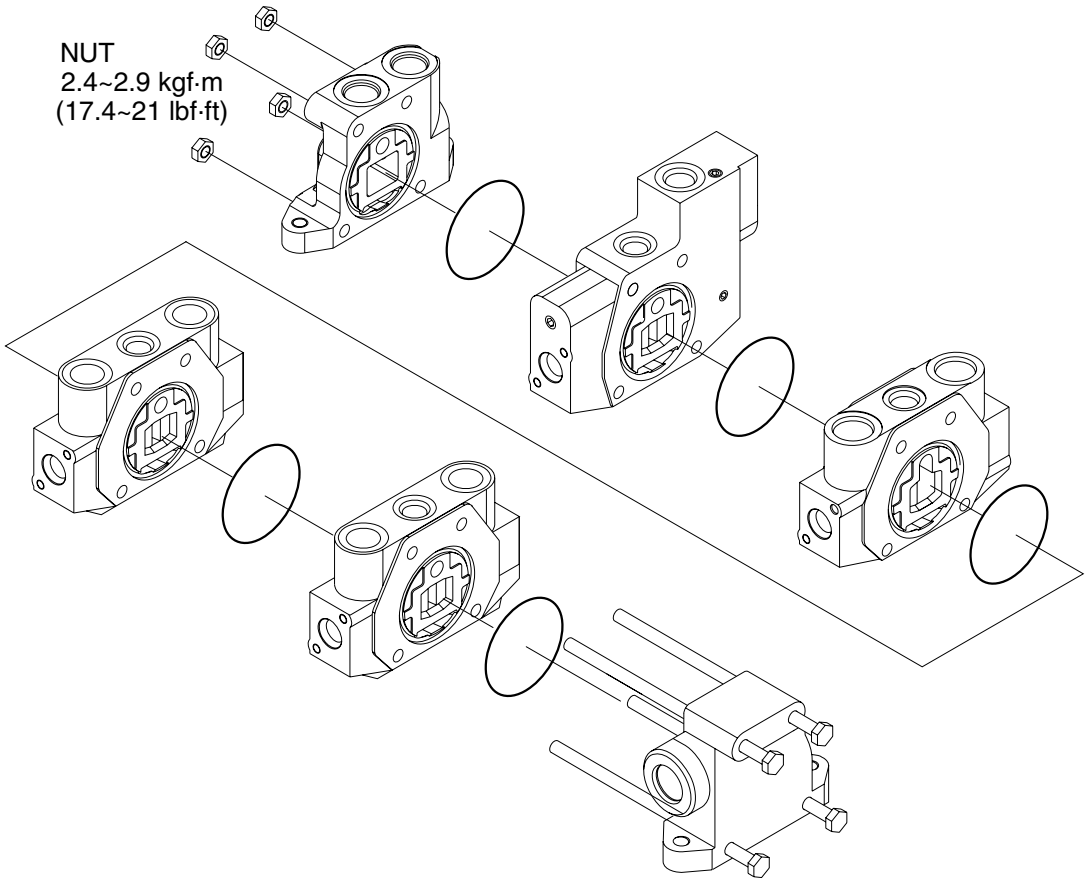
2. MAIN CONTROL VALVE (with OPSS)

1) ASSEMBLY

(1) General

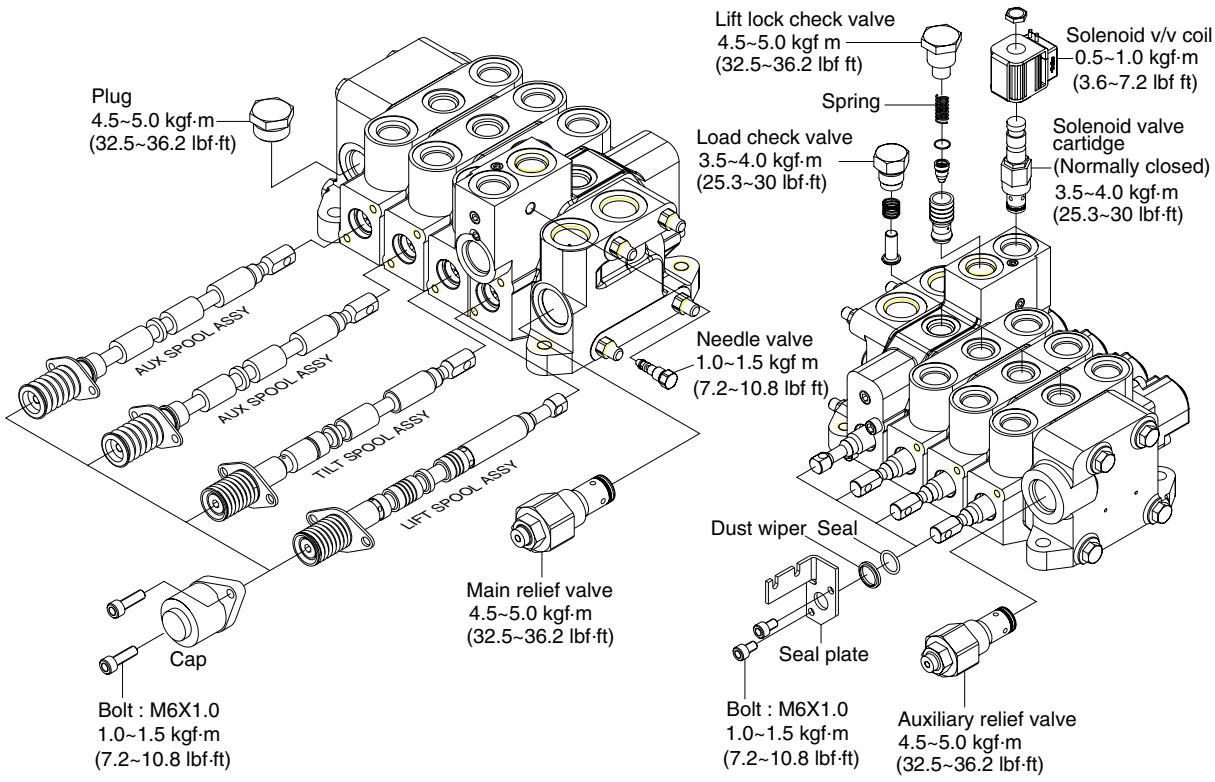
① Ensure that the assembly area will be clean and free of contamination.
② Use a flat(within 0.2㎜) work surface when bolting the valve sections together.
③ Use calibrated torque wrenches and instrumentation.
④ Additional auxiliary valve sections may be added to the main control valve in a similar manner as indicated below.

(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.



15BT9HS25S

(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.

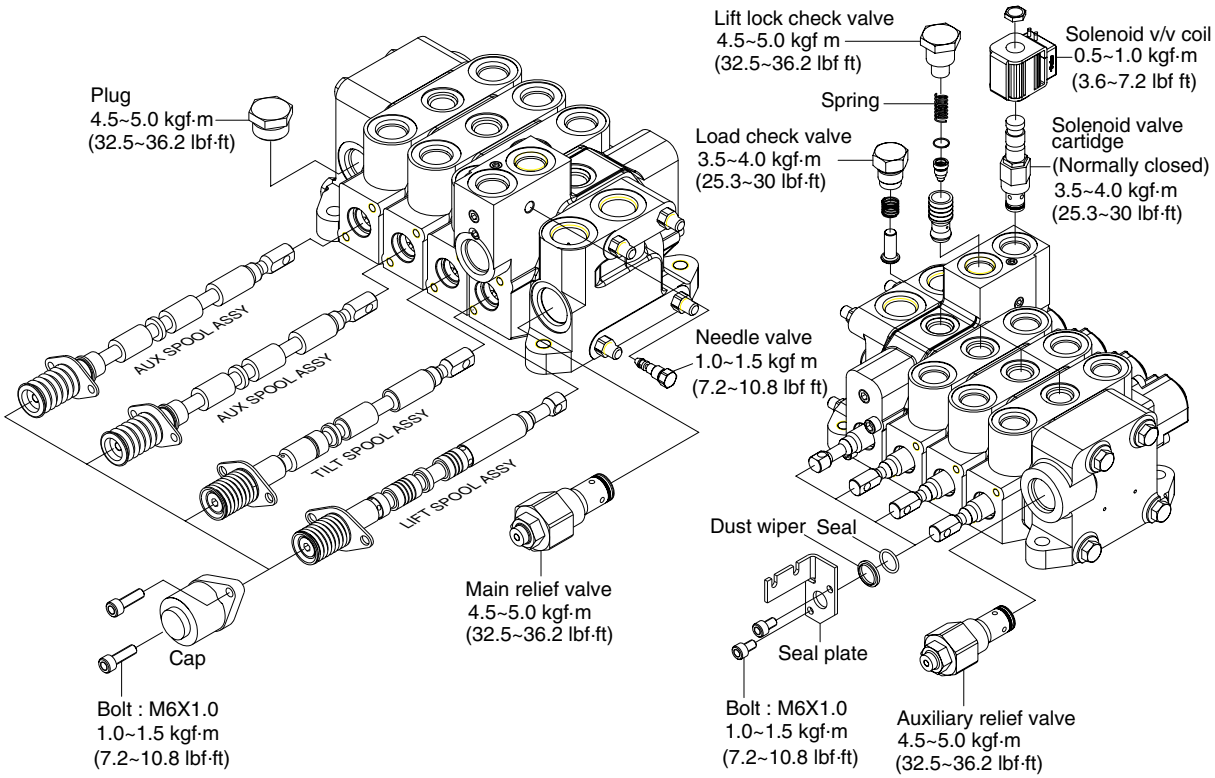
③ Install the second spool seal and dust wiper over the clevis end of the spool and retain with a seal plate and two bolts. Torque both bolts alternatively until a torque of 1.0~1.5kgf · m(7.2~10.8lbf · ft) is reached on both bolts.

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

⑤ The normally closed solenoid is installed in the rightmost cavity on the top of the section. Torque to 3.5~4.0kgf · m (25.3~30lbf · ft)

⑥ 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)

⑦ Install the needle valve subassembly in the cavity on the inlet-facing surface of the housing. Torque to 1.0~1.5kgf · m (7.2~10.8lbf · ft)



15BT9HS25S

(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.

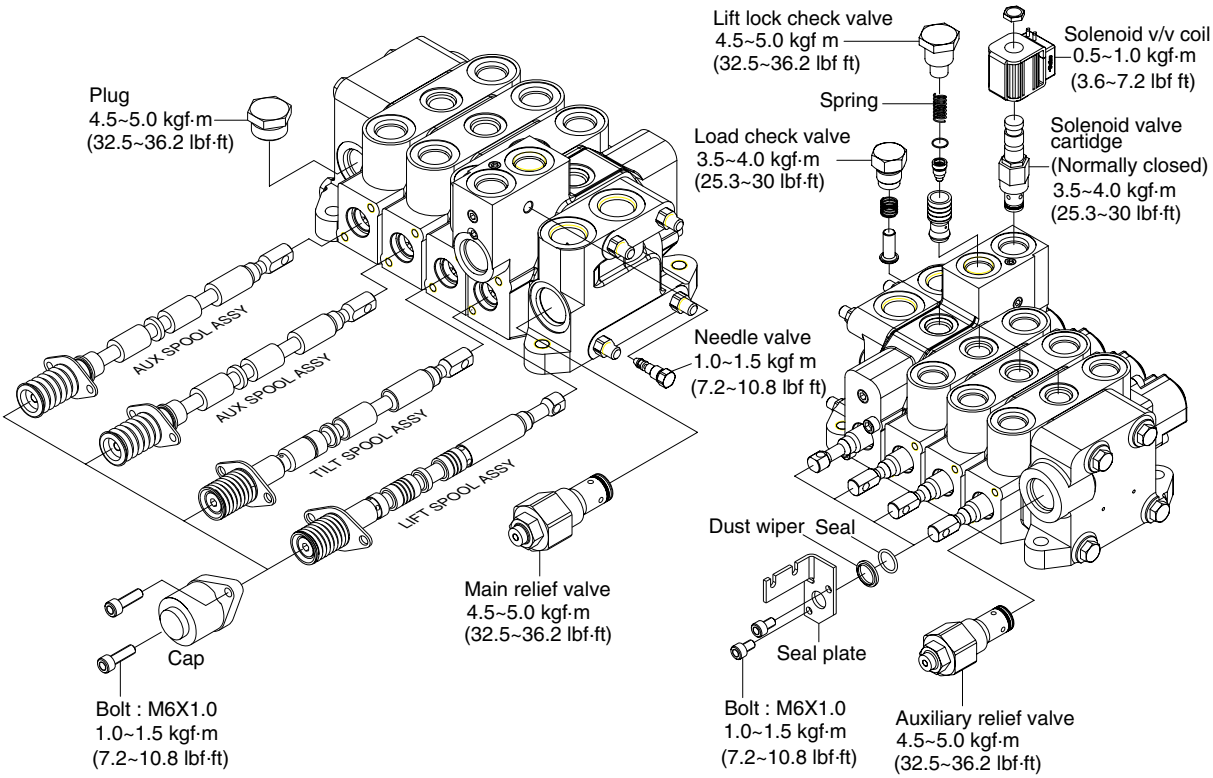
② Insert the clevis end of the spool into the right-hand side of the spool bore(the tallest end of the housing). Place the spool cap over the spool and spring assembly and connect the cap to the housing using two bolts. Torque both bolts alternatively until a torque of 1.0~1.5kgf · m (7.2~10.8lbf · ft)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



15BT9HS25S

(6) 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).

(7) 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

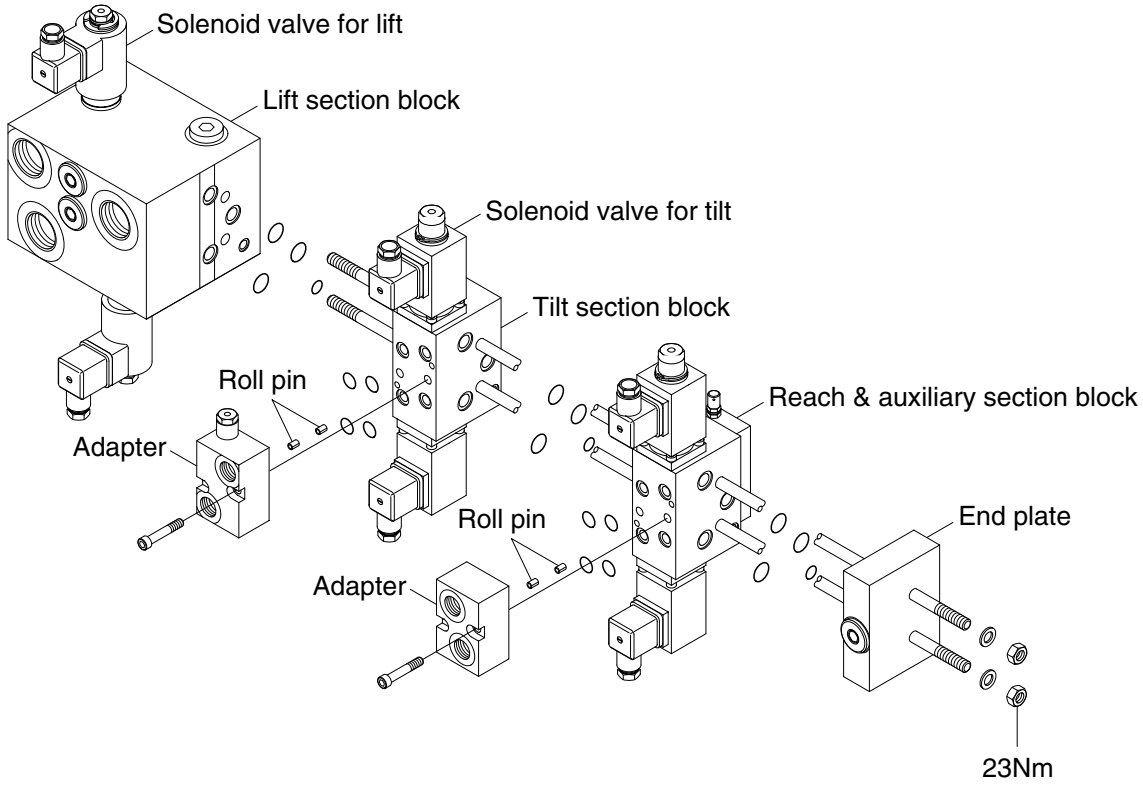
① Loosen the tie rod nuts and remove the tie rods from the valve sections.

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. MAIN CONTROL VALVE



15BT9HS34

1) ASSEMBLY INSTRUCTION

(1) General

① Ensure that the assembly area will be clean and free of contamination.
② Use a flat(within 0.5㎜) work surface when bolting the valve sections together.
③ Use calibrated torque wrenches and instrumentation.

(2) Block subassembly

① Attach all the O-rings to the appropriate grooves between the spool sections.
② Stack the valve sections as below picture on a flat surface.
③ Insert all the tie rods through the drilled holes in each of the housings.
④ Press the sections together being careful not to damage sealing surfaces or seals.
⑤ Install nuts to tie rods and progressively torque in a circular pattern until reaching a torque of 2.3 kgf · cm^2(23Nm) on all tie rods.

(3) Lift block solenoid assembly

① The solenoide is installed upper side and below side cavities in lift block. Torque to 4.1kgf · cm^2
② (40Nm)
③ Install the O-ring, coil, O-ring and washer to the assemblied cartridge.
Insert the lock washer to the groove of the cartridge.

(4) Tilt & Auxiliary section assembly

① The solenoid is installed upper side and below side in tilt & auxiliary block with bolts.
Torque to 1kgf · m (10Nm)
② Install the coil, O-ring and washer to the assemblied cartridge.
③ Insert the snap ring to the groove of the cartridge.
④ Insert the roll pin to the pin hole on the front side of each block.
⑤ Place the O-rings in the O-ring grooves.
⑥ Insert the ancillary blocks to the each body with bolts.

2) DISASSEMBLY INSTRUCTION

(1) General

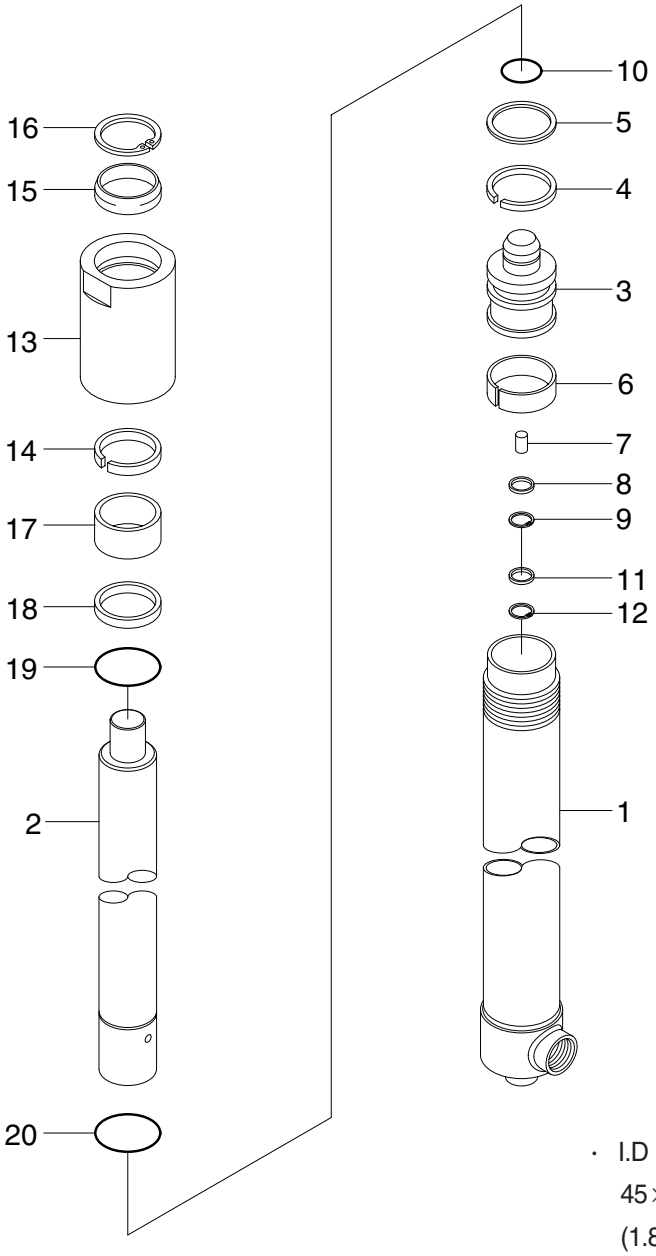
① Disassemble the valve sections on a flat working surface.
② Ensure that the disassembly area will be clean and free of contamination.
③ Keep the disassembly area neat to avoid loss or damage of parts.

(2) Perform the assembly in reverse order

① Remove the solenoid valves and ancillary blocks from the main blocks.
② Loosen the tie-rods from the valve section.
③ Remove the seals between valve section.
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.

4. LIFT CYLINDER

1) STRUCTURE



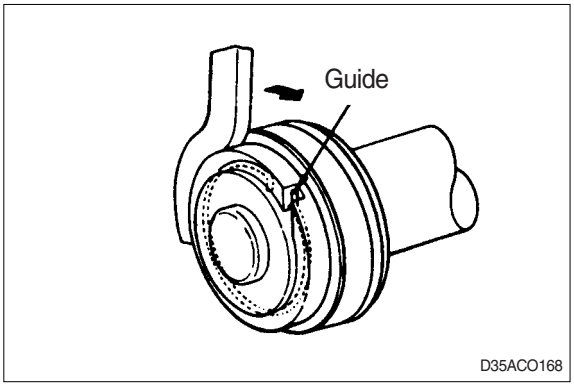
- I.D × O.D × Stroke (standard)
  45 × 55 × 1495mm
  (1.8 × 2.2 × 58.9 in)
- Rod O.D : 35mm (1.4 in)

15BT9HS14

1	Tube assy	8	Spacer	15	Dust wiper
2	Rod	9	Retaining ring	16	Retaining ring
3	Piston	10	Stop ring	17	Rod bush
4	U-packing	11	Cushion seal	18	Spacer
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		

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.



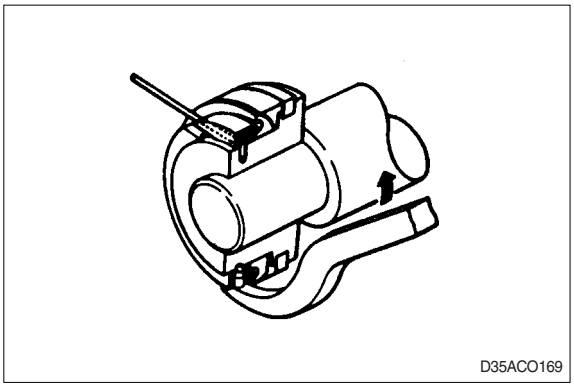
3) CHECK AND INSPECTION

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

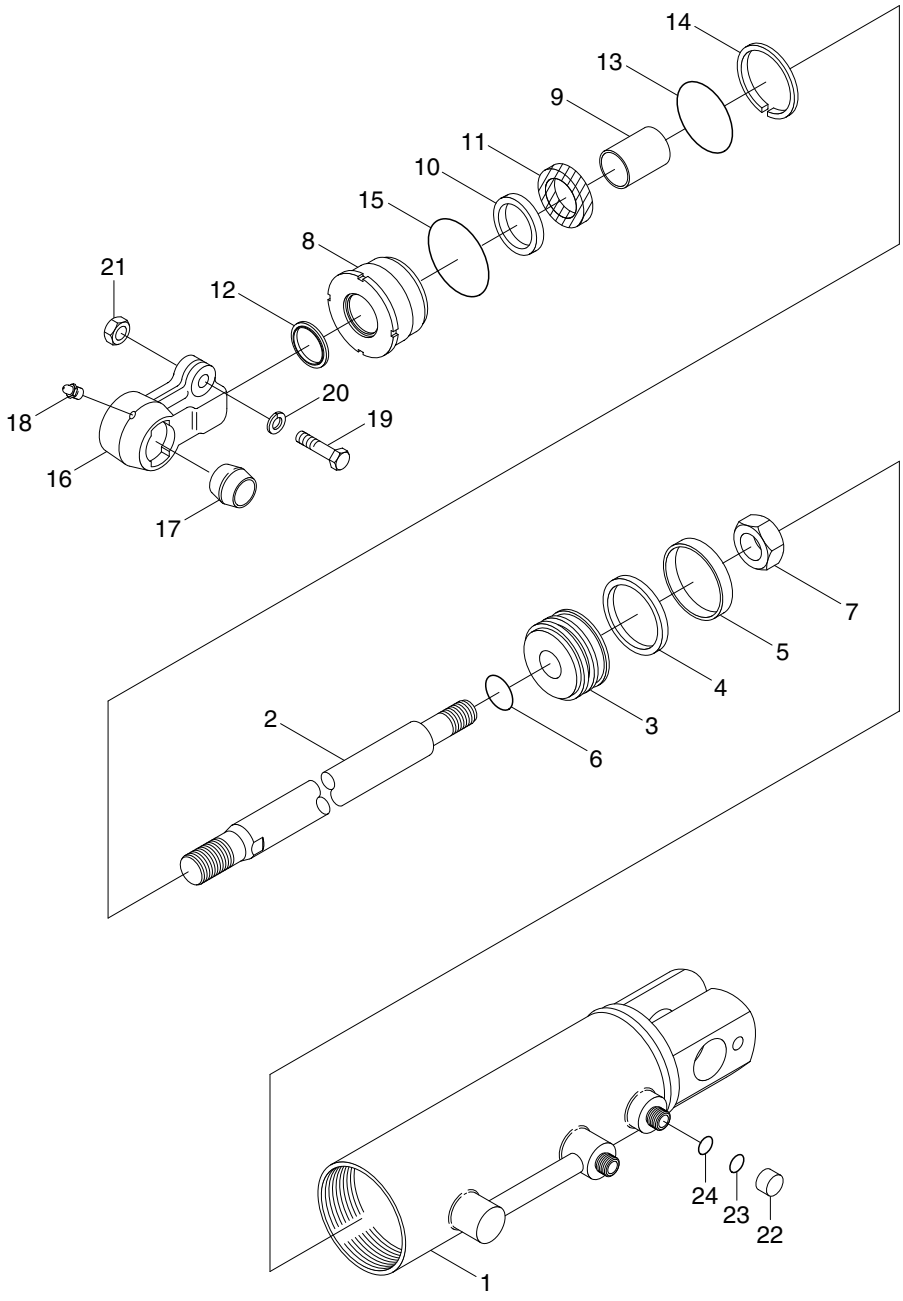
4) ASSEMBLY

(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.



5. TILT CYLINDER

1) STRUCTURE

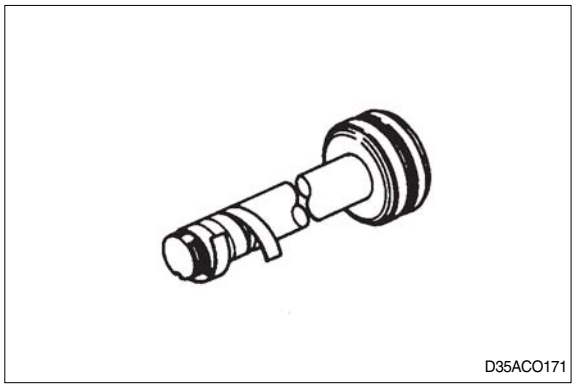


10BTR9HS10

1	Tube assy	9	Bushing	17	Spherical bearing
2	Rod	10	Rod seal	18	Grease nipple
3	Piston	11	Back up ring	19	Hexagon bolt
4	Piston seal	12	Dust wiper	20	Spring washer
5	Wear ring	13	O-ring	21	Hexagon nut
6	O-ring	14	Back up ring	22	Dust cap
7	Nylon nut	15	O-ring	23	O-ring
8	Gland	16	Rod eye	24	O-ring

2) DISASSEMBLY

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



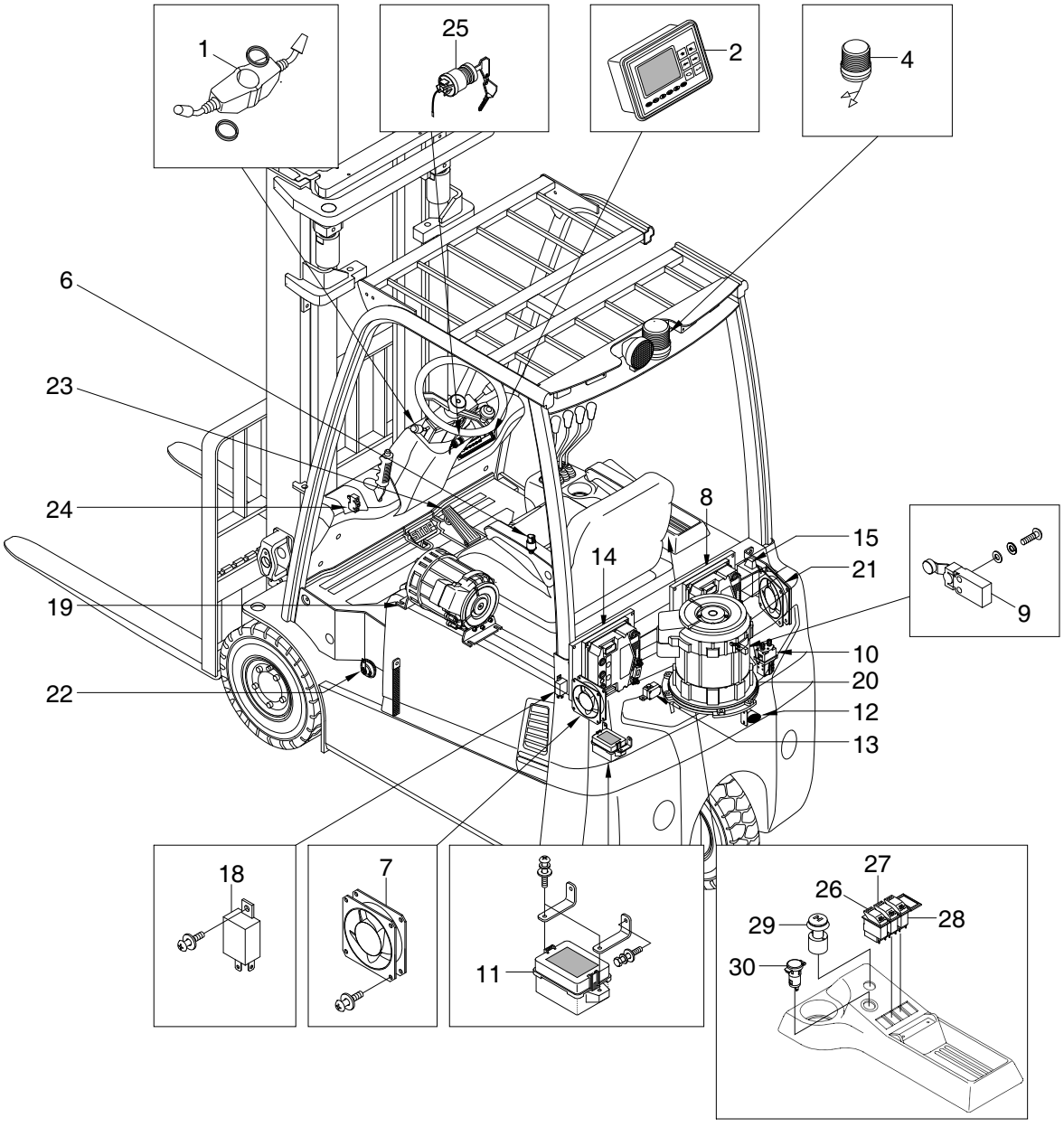
3) CHECK AND INSPECTION

mm(in)

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

SECTION 7 ELECTRICAL SYSTEM

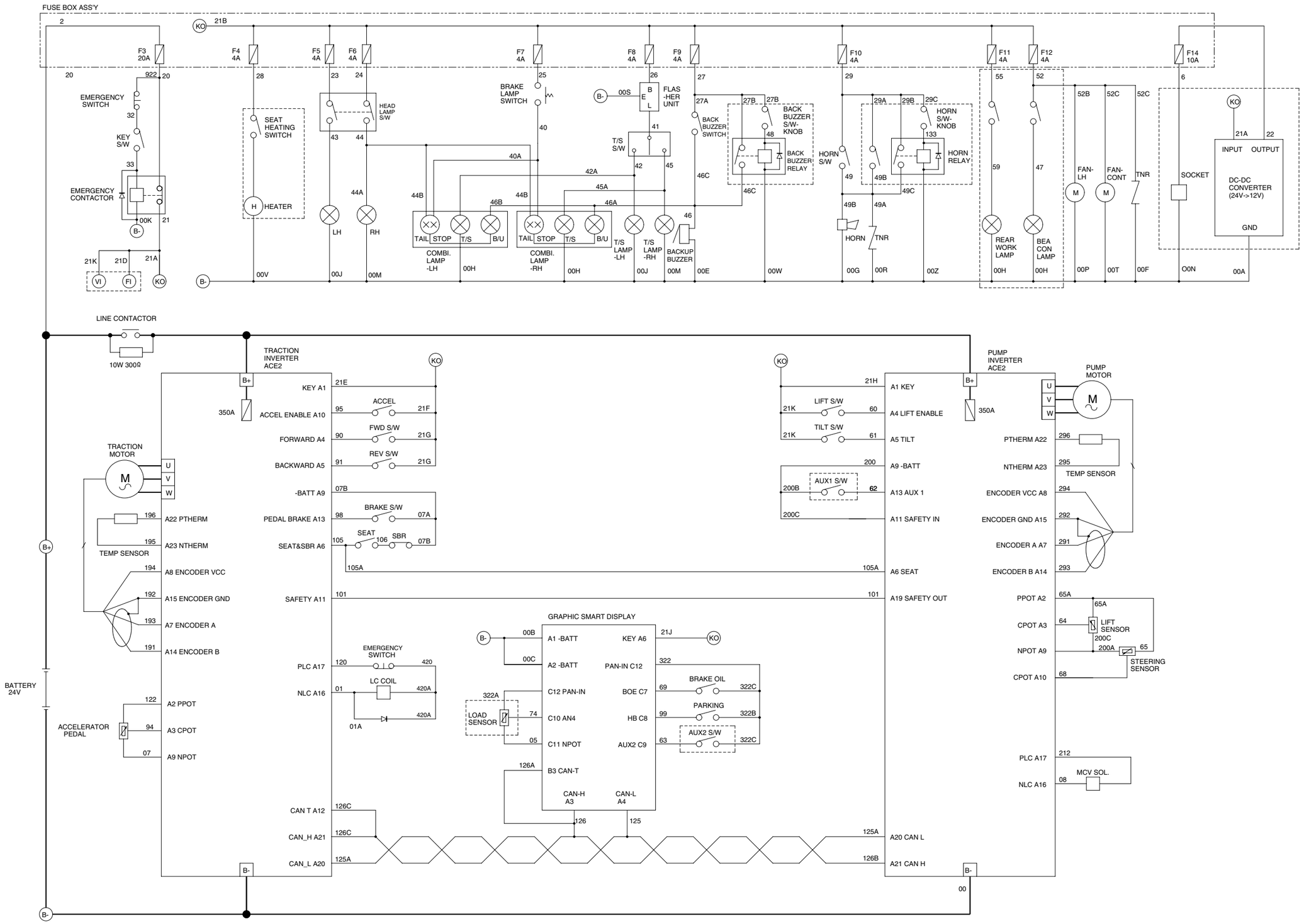
GROUP 1 COMPONENT LOCATION



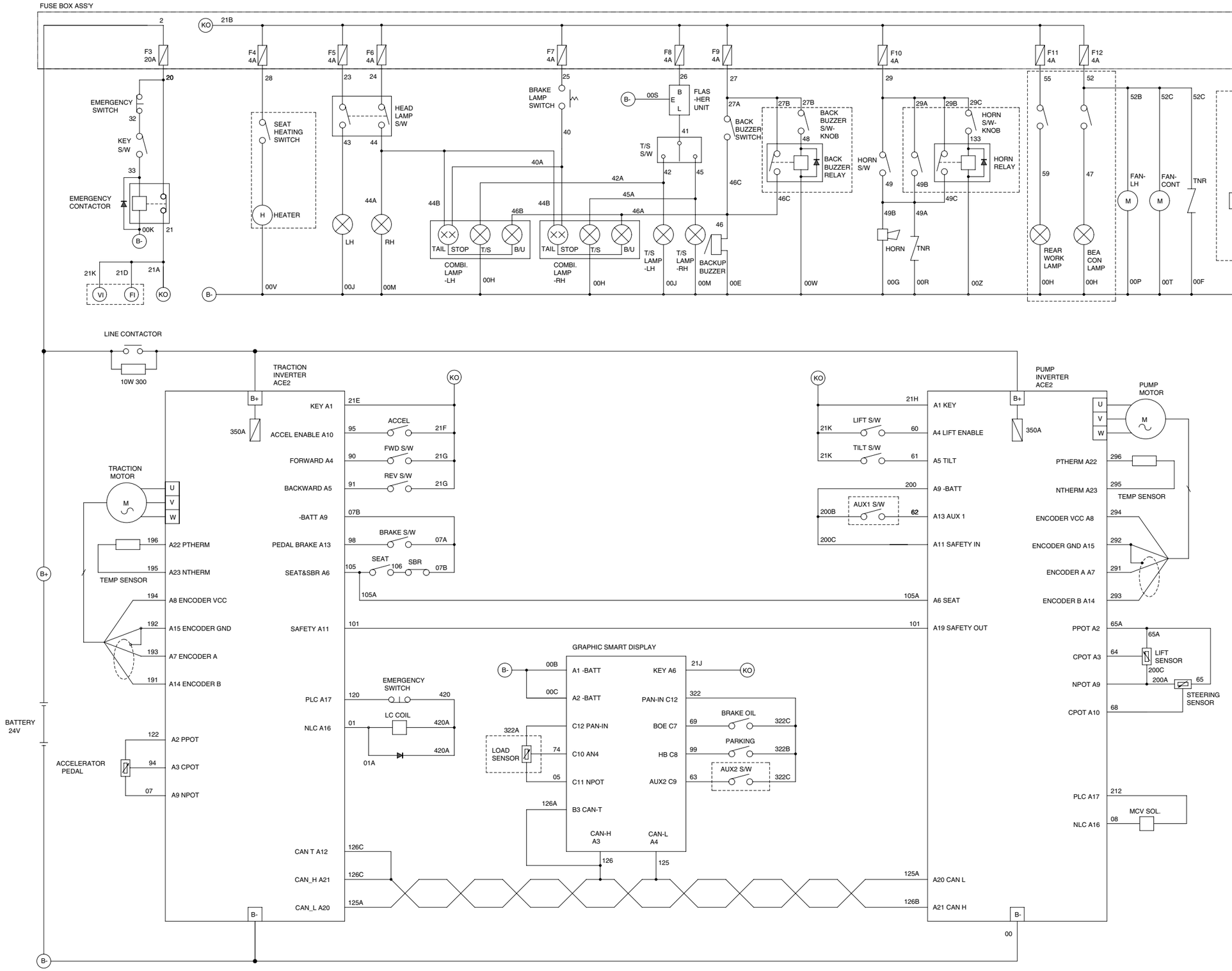
10BTR9EL02

1	Combination switch	11	Fuse box	22	Horn high
2	Display	12	Back buzzer	23	Accelerator assy
3	Converter	13	Angle sensor	24	Parking switch assy
4	Beacon lamp	14	Pump controller	25	Key switch assy
6	Pressure sensor	15	Fuse & relay cover assy	26	Head lamp switch
7	Fan	18	Flasher unit assy	27	Work lamp switch
8	Traction controller	19	Pump motor	28	Beacon switch
9	SBR switch assy	20	Traction motor	29	Emergency switch
10	Contactor	21	Fan	30	Socket assy

· ELECTRICAL CIRCUIT (1/12, NON-UL, 10BTR-9 : -#0039, 13BTR-9 : -#0062, 15BTR-9 : -#0205)

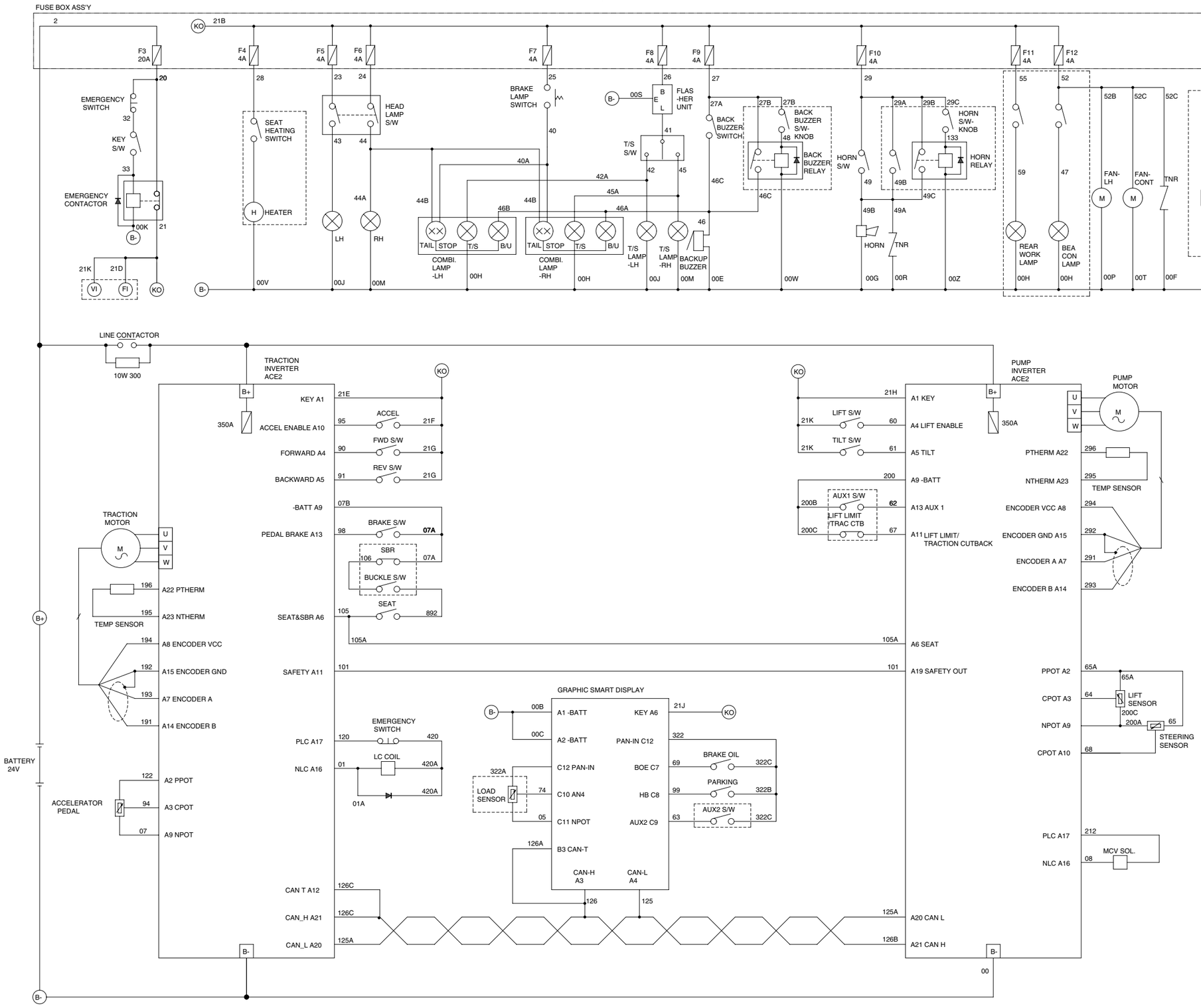


· ELECTRICAL CIRCUIT (2/12, NON-UL, 10BTR-9 : #0040-0047, 13BTR-9 : #0063-0066, 15BTR-9 : #0206-0255)



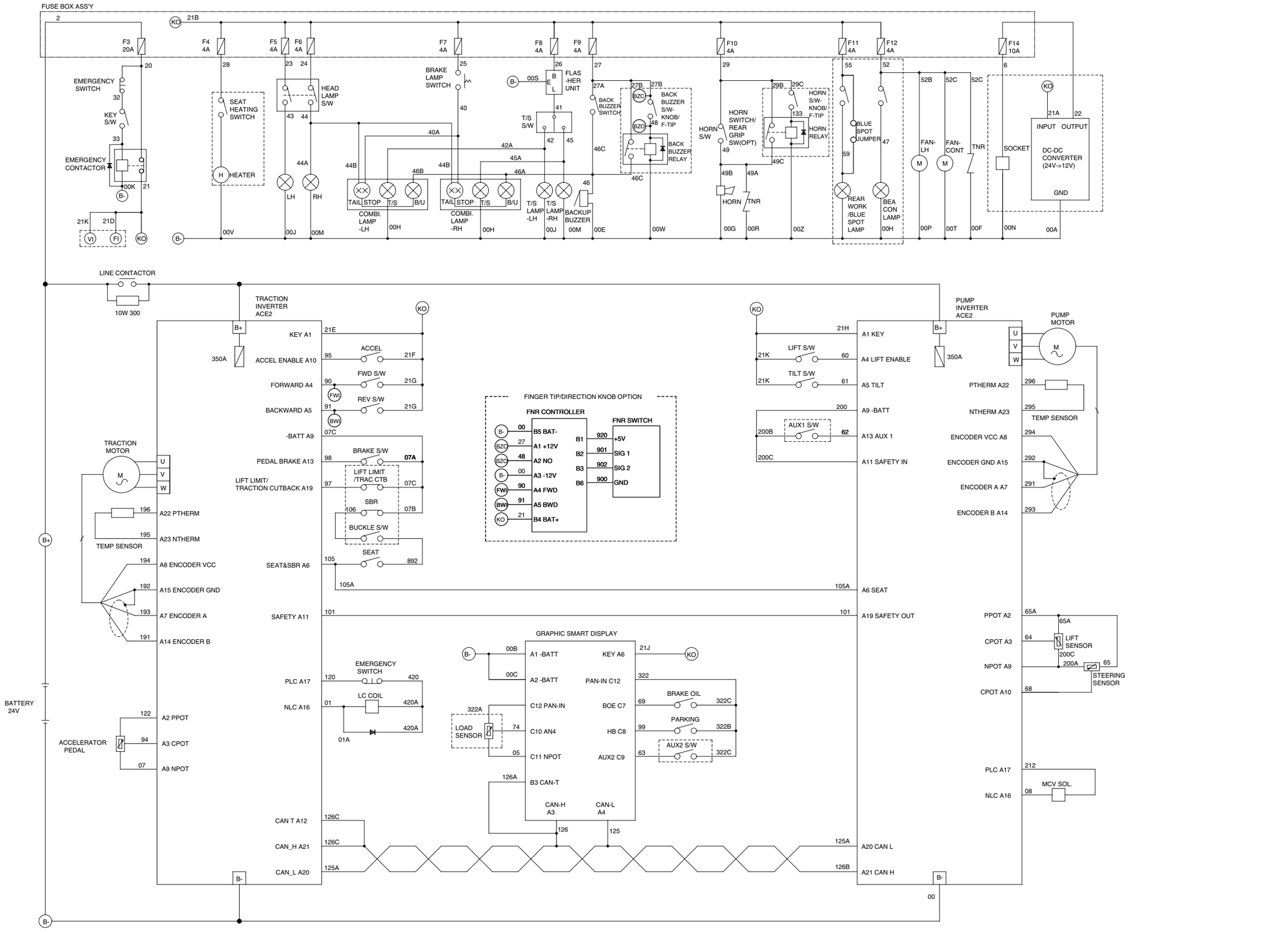
21HT-90016-01

· ELECTRICAL CIRCUIT (3/12, NON-UL, 10BTR-9 : #0048-0053, 13BTR-9 : #0067-0079, 15BTR-9 : #0256-0374)



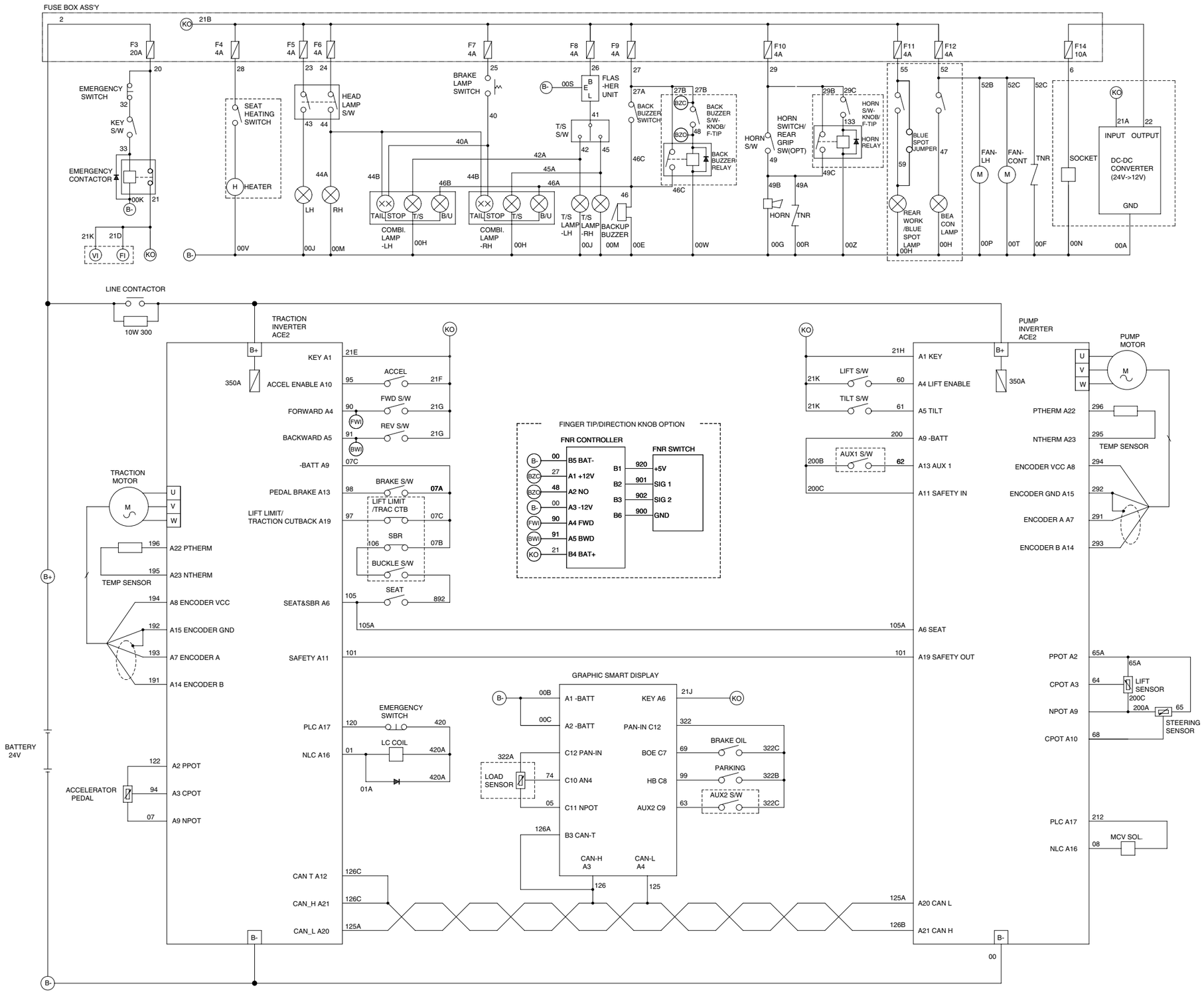
21HT-90017-00

· ELECTRICAL CIRCUIT (4/12, NON-UL, AUSTRALIA OPTION, 10BTR-9 : #0048-0053, 13BTR-9 : #0067-0079, 15BTR-9 : #0256-0374)



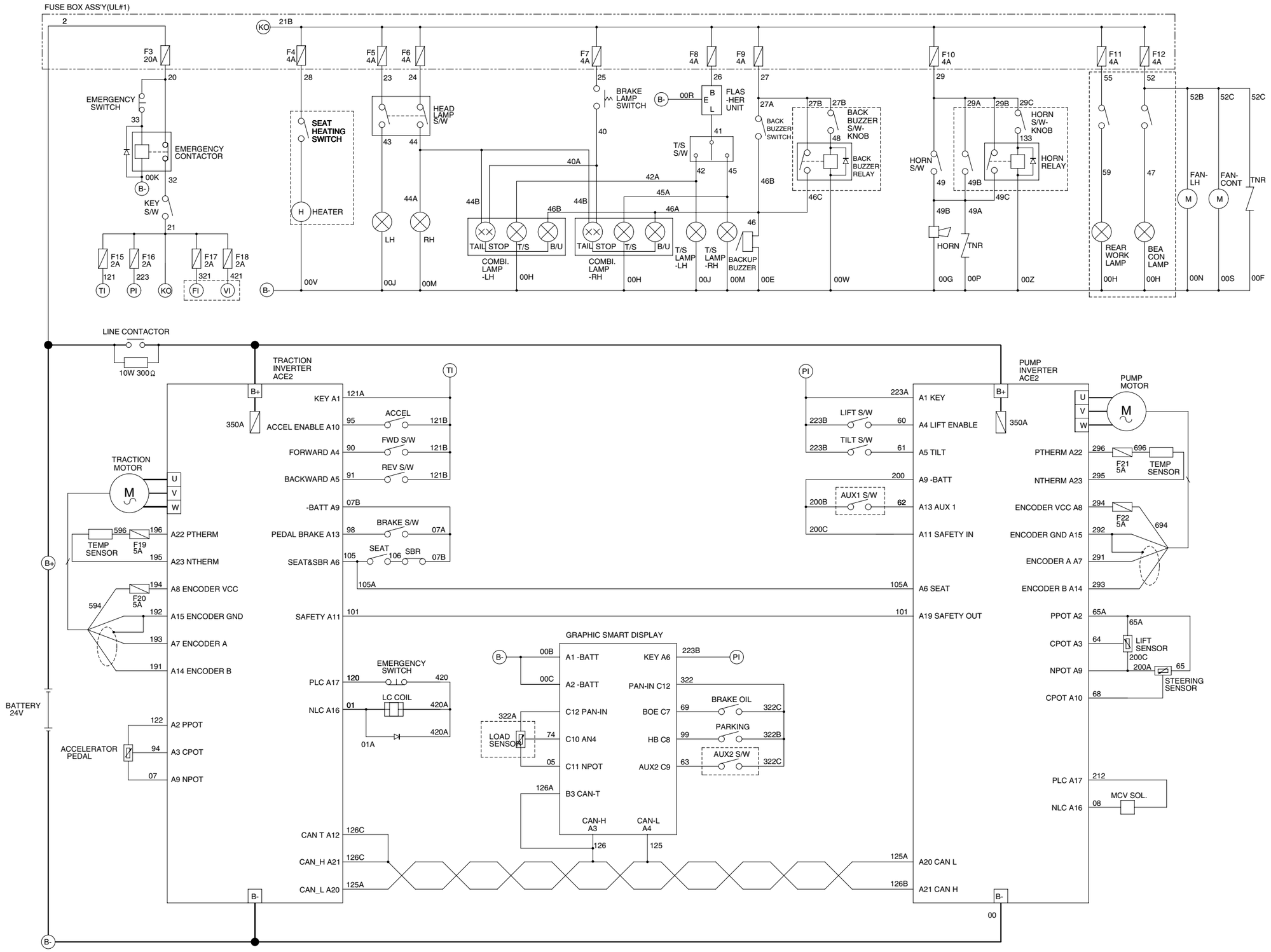
21HT-90018-01

· ELECTRICAL CIRCUIT (5/12, NON-UL, 10BTR-9 : #0054-, 13BTR-9 : #0080-, 15BTR-9 : #0375-)

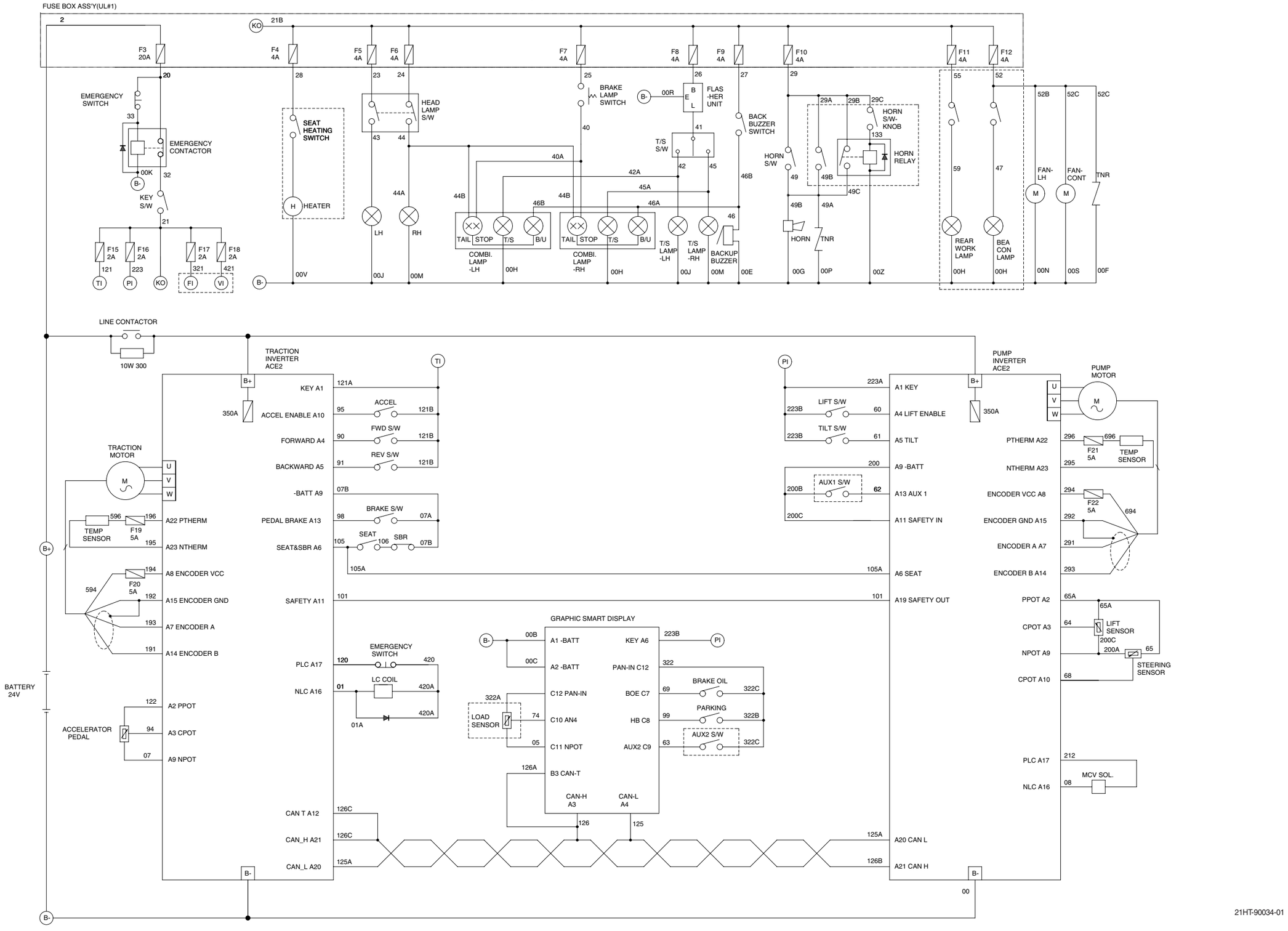


21HT-90019-00

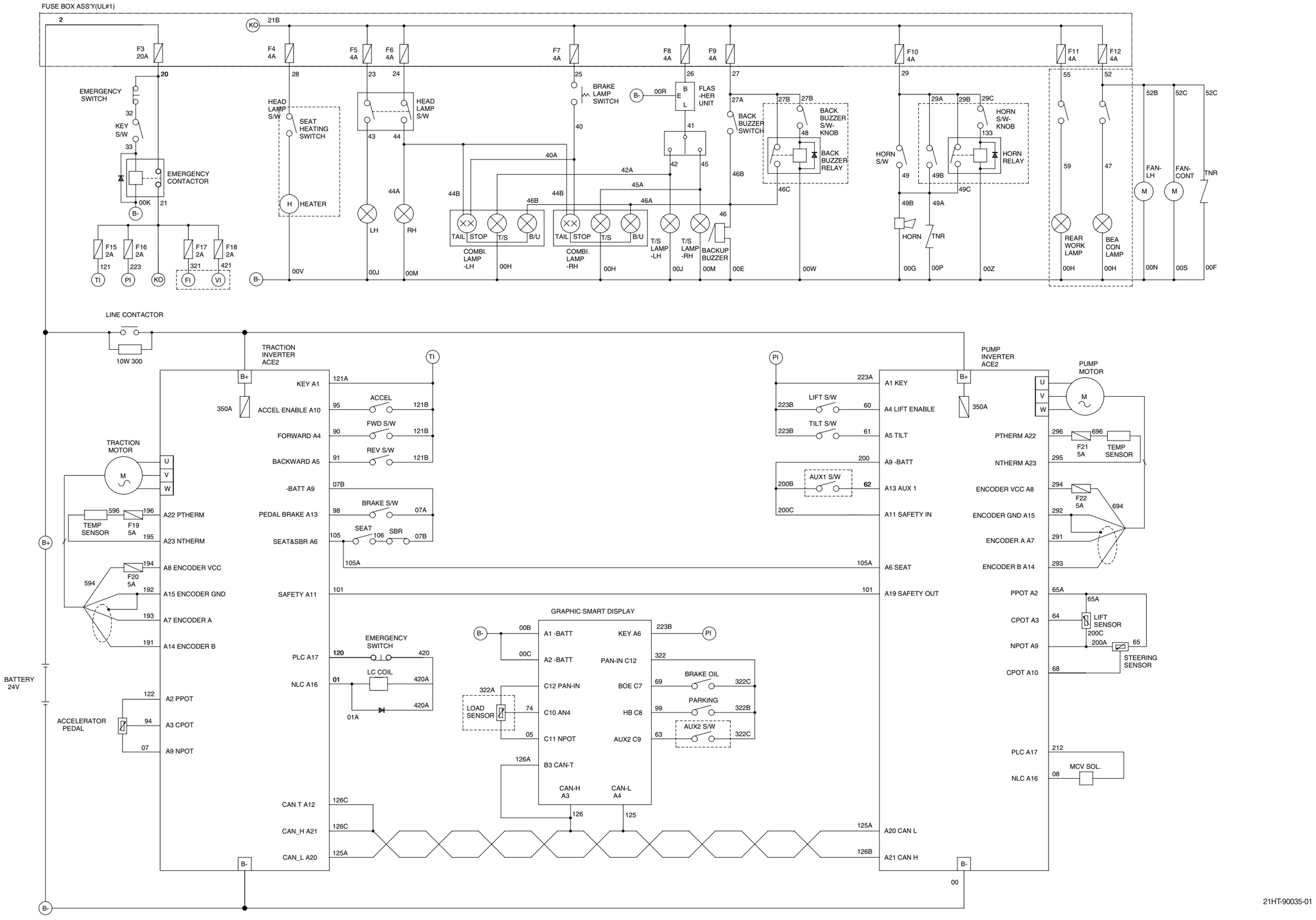
· ELECTRICAL CIRCUIT (6/12, UL, 10BTR-9: -#0001, 13BTR-9: -#0001, 15BTR-9: -#0006)



· ELECTRICAL CIRCUIT (7/12, UL, 10BTR-9: #0002-0039, 13BTR-9: #0002-0062, 15BTR-9: #0007-0205)

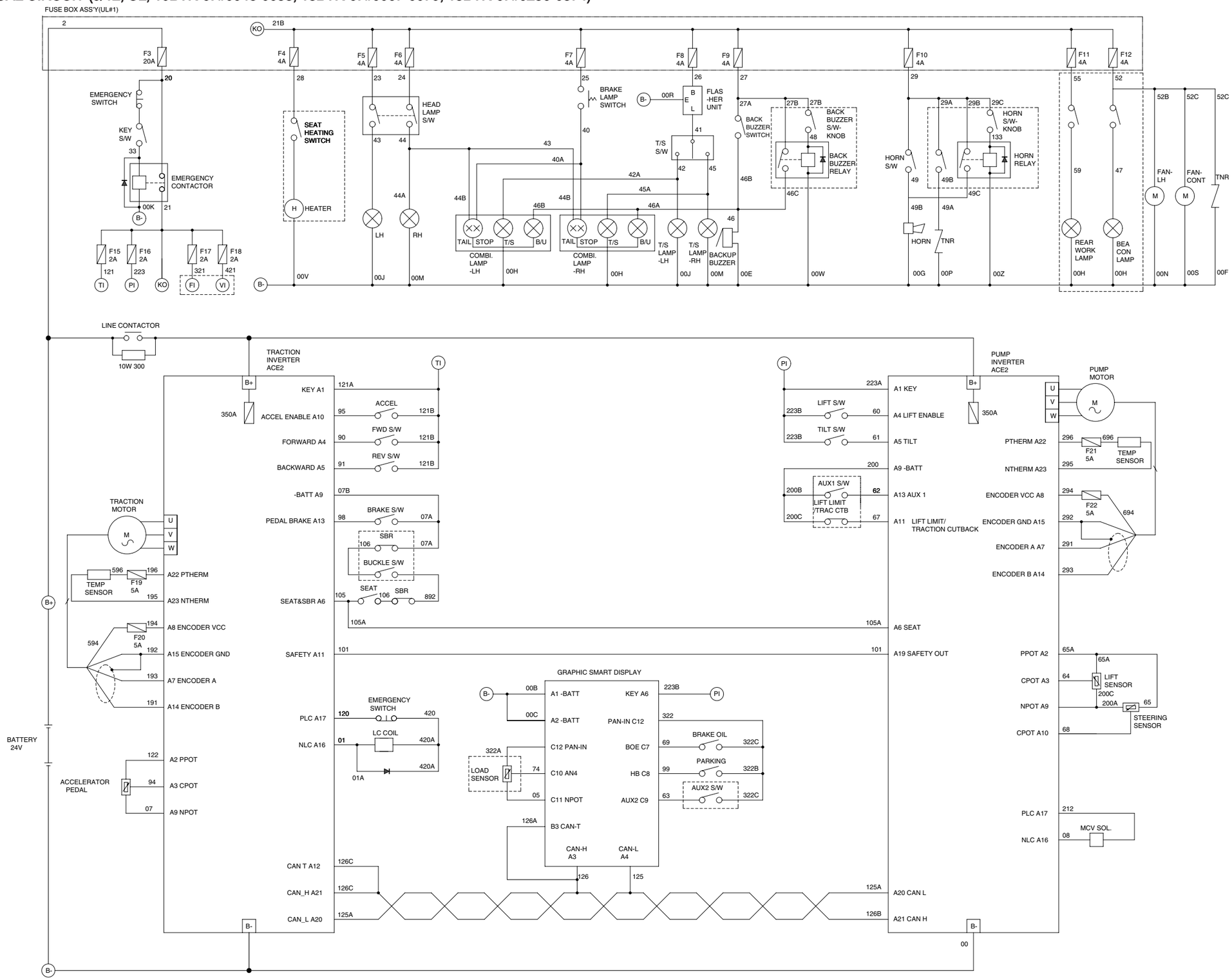


· ELECTRICAL CIRCUIT (8/12, UL, 10BTR-9: #0040-0048, 13BTR-9: #0063-0067, 15BTR-9: #0206-0255)

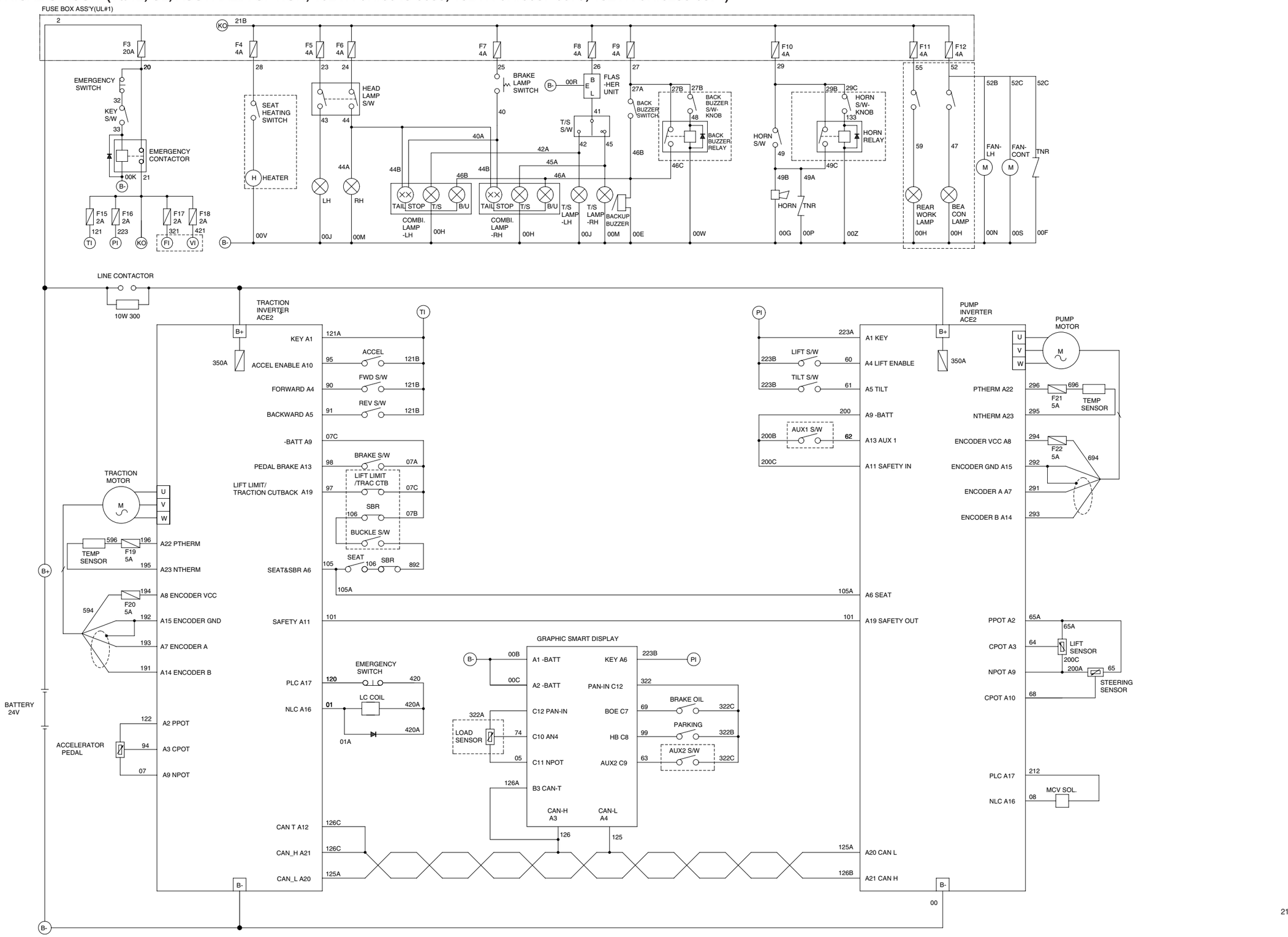


21HT-90035-01

· ELECTRICAL CIRCUIT (9/12, UL, 10BTR-9: #0048-0053, 13BTR-9: #0067-0079, 15BTR-9: #0256-0374)

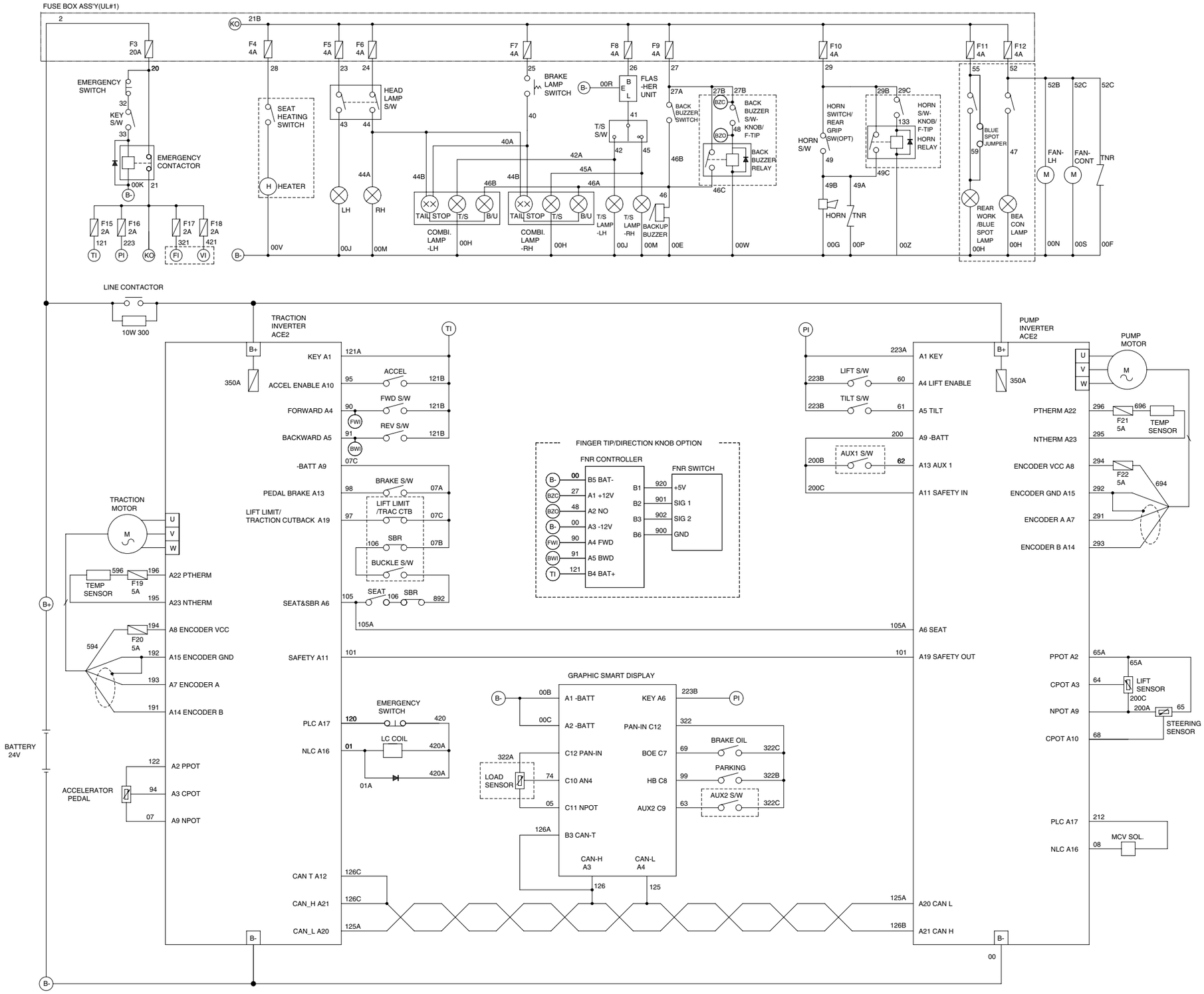


· ELECTRICAL CIRCUIT (10/12, UL, AUSTRALIA OPTION, 10BTR-9: #0048-0053, 13BTR-9: #0067-0079, 15BTR-9: #0256-0374)



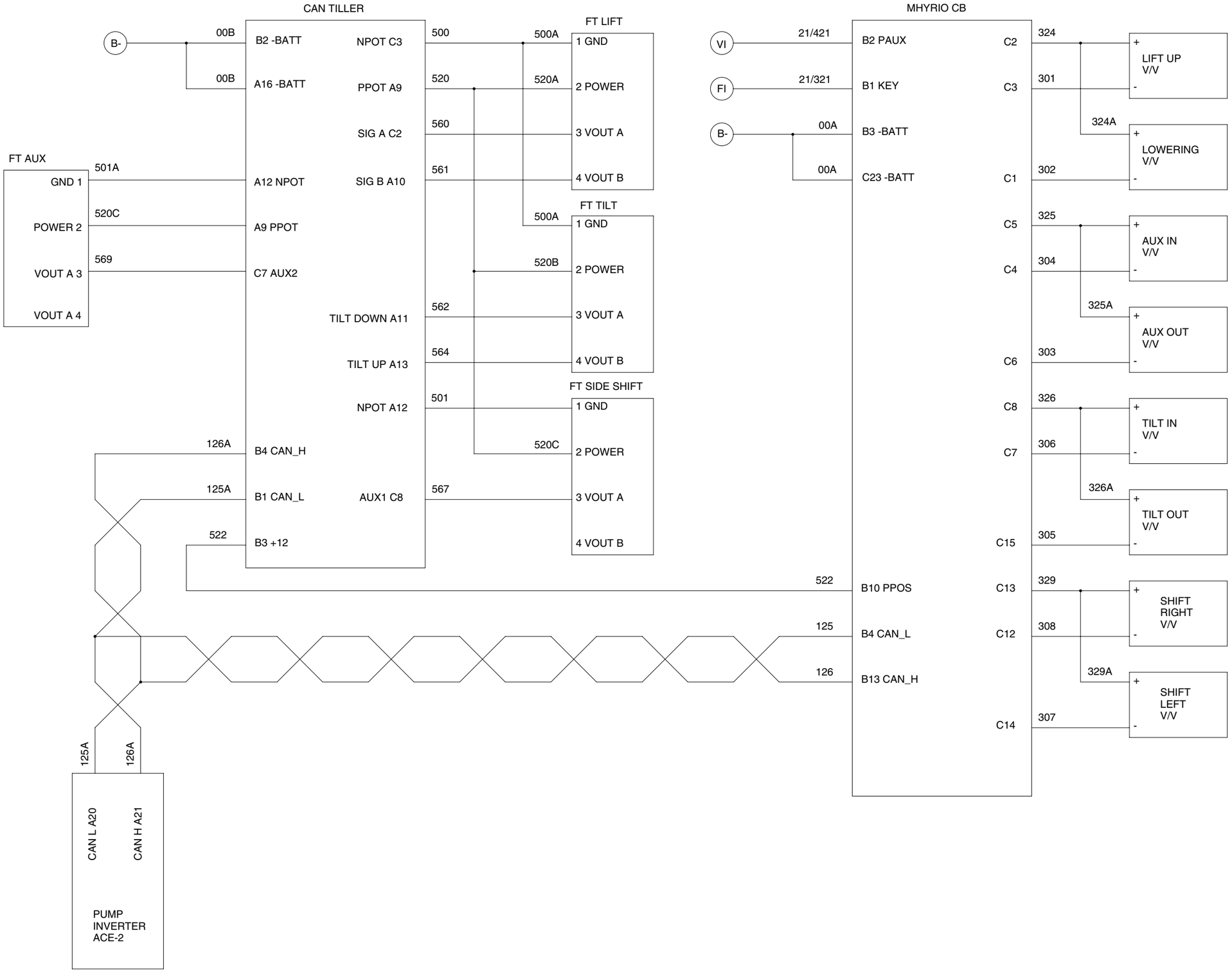
21HT-90037-01

· ELECTRICAL CIRCUIT (11/12, UL, 10BTR-9 : #0054-, 13BTR-9 : #0080-, 15BTR-9 : #0375-)



21HT-90038-00

· ELECTRICAL CIRCUIT (12/12, FINGERTIP)



21HT-90021-00

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.

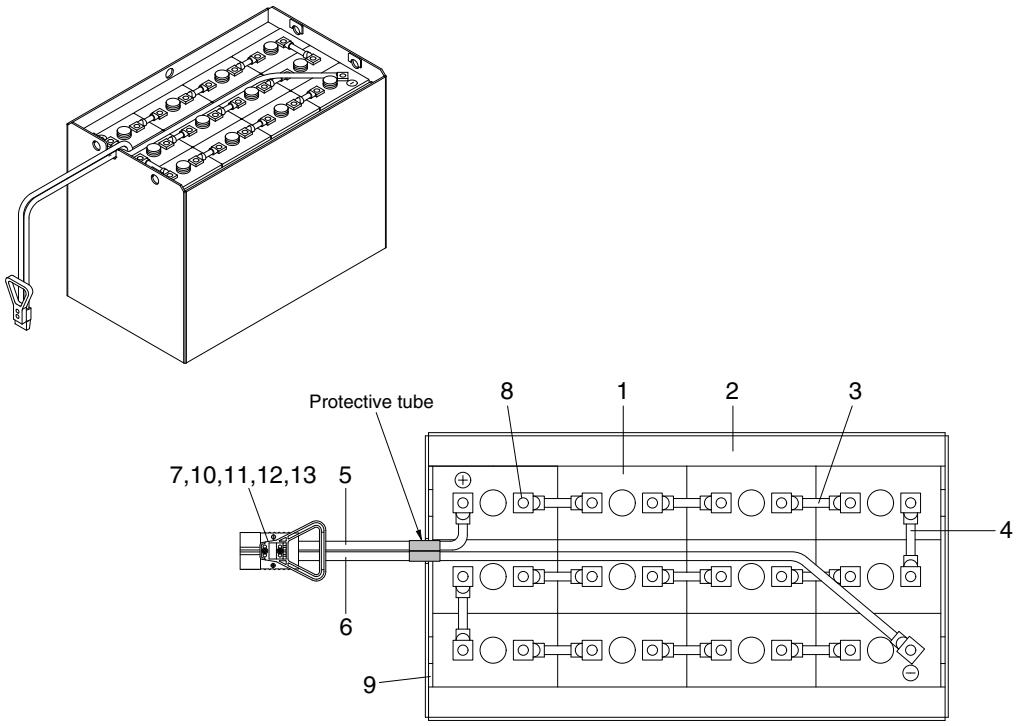
To drive the fork lift truck, a DRIVING CONTROL SYSTEM and some electric components such as direction change lever(forward/reverse section switch) and accelerator are required to select the driving direction and to control the speed of driving motor.

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

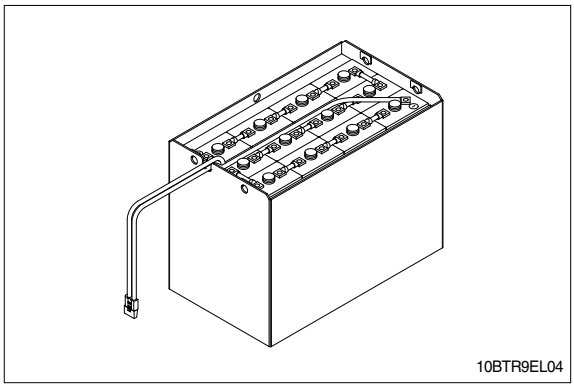


10BTR9EL03

1	Cells	8	Wrench bolt
2	Steel box	9	Spacer
3	Cell connector	10	Handle
4	Row connector	11	Screw
5	Positive leading cable	12	Nut
6	Negative leading cable	13	Spring washer
7	Plug		

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	10BTR-9	13BTR-9	15BTR-9
Type	-	5PzS625	6PzS750	
Rated voltage	V	24		
Capacity	AH/hr	625	750	
Electrolyte	-	WET		
Dimension(W × D × H)	mm	827 × 324 × 627	827 × 432 × 627	827 × 486 × 627
Connector	-	SB350		
Weight(Max/Min)	kg	478/432	630/570	727/657

Fully charged specific gravity	1.280(25° C)
End of discharge specific gravity	1.130(25° C)
Discharge end voltage	48V(option 36V)
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℃, 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°C by the following formula.

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

Where, S_{25} : Specific gravity at 25°C

S_t : Actually measured specific gravity at t °C

t : Electrolyte temperature (°C)

The standard specific gravity for this type of battery is 1.280±0.01(25°C) 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.

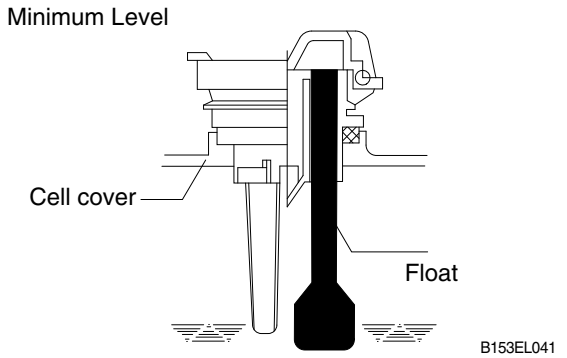
⑥ **Water replenishment**

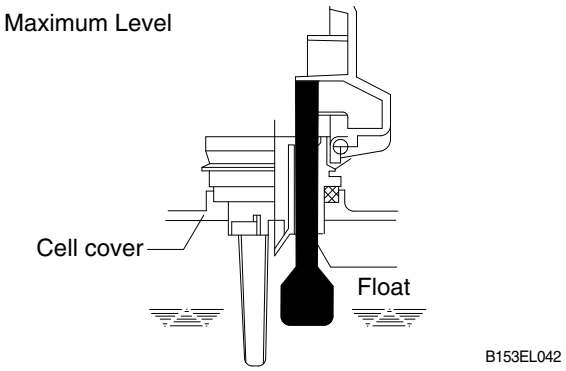
Only the water content of electrolyte is decreased due to electrolysis of water during charge and natural evaporation. If a battery used with the electrolyte decreased excessively, plates will deteriorate resulting in markedly shortening of battery life. Be sure to check the electrolyte level once every 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℃, check the specific gravity once a month, and when lower than 20℃, check it once every two months. If the measurements show values lower than 1.230(20℃), 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**

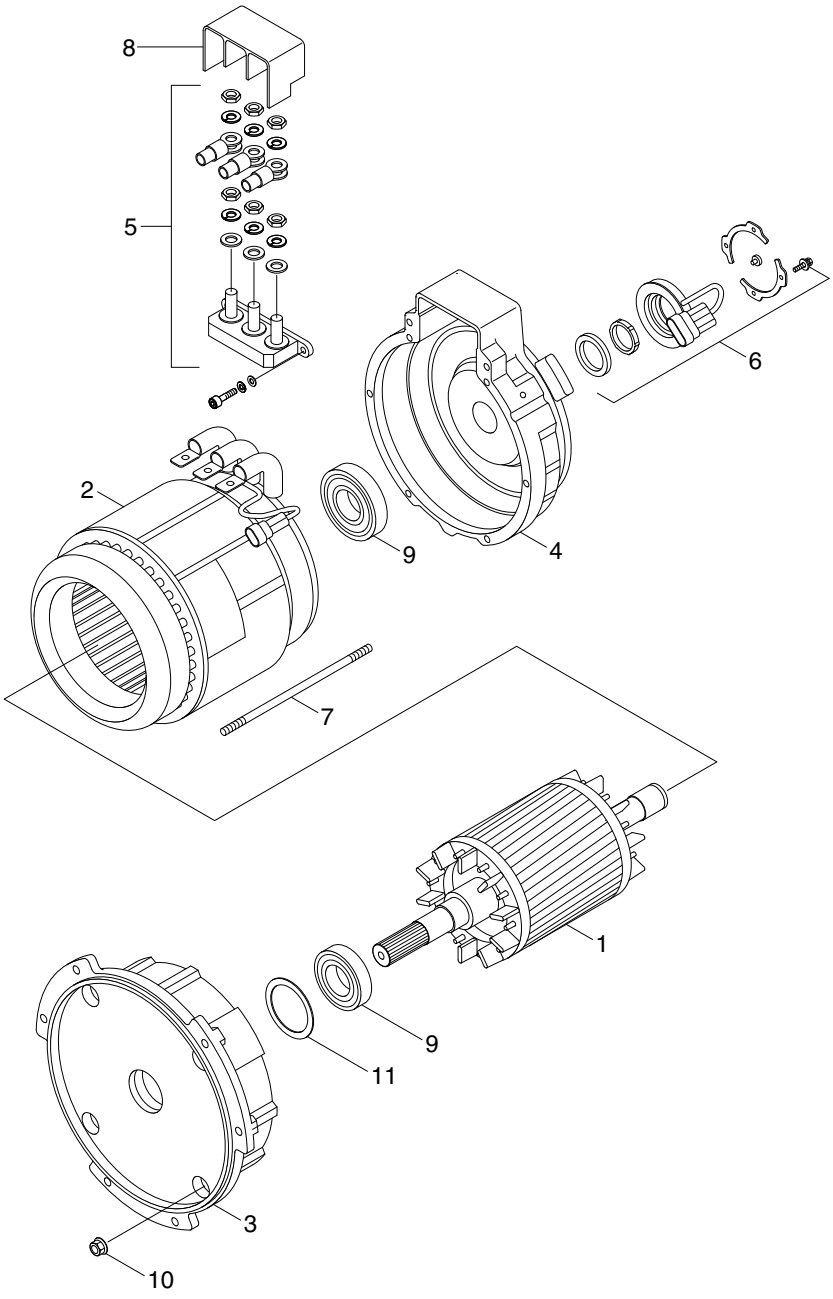
The operating temperature range of batteries is -10~45℃(temperature of electrolyte). If the batteries are exposed to cold atmosphere in discharged condition, the electrolyte may freeze, and in extreme cases, the capacity will be decreased, but, if not frozen, no adverse effects will be exerted over the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

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, chloric acid, nitric acid etc.	
	· Odor of generated gas and coloring of the electrolyte.	· Filling of impure water.	

3. DRIVE MOTOR

1) STRUCTURE



10BTR9EL07

1	Rotor assy	5	Terminal block(A)	9	Bearing
2	Startor assy	6	Speed sensor kit	10	Flange nut
3	Endbell De	7	Stud bolt	11	Wave washer
4	Endbell	8	Terminal protector		

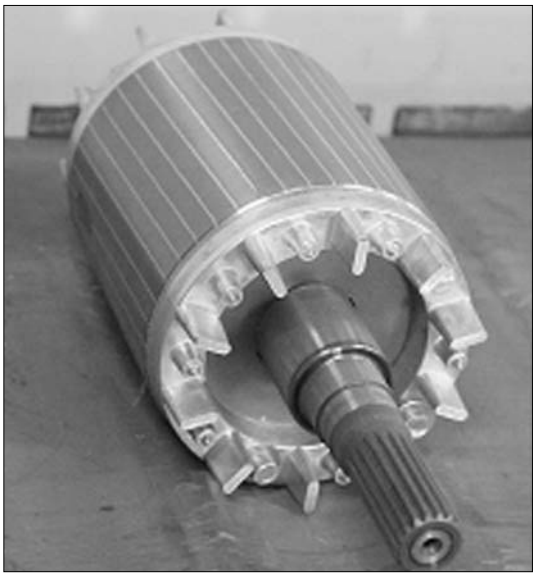
2) SPECIFICATION

Item	Unit	Specification
Type	-	AMDH6001
Rated voltage	V	16
Rated output	kW	4.3
Insulation	-	Class F

3) INSPECTION

(1) Rotor assembly inspection

- Rotor should always be cleaned with compressed air. If the dirt will not come off lightly wipe off with piece of cotton or soft cloth wetted with gasoline.
- Rotor out diameter : ø 123.1 ± 0.05
- Tool : Vernier calipers and standard tool

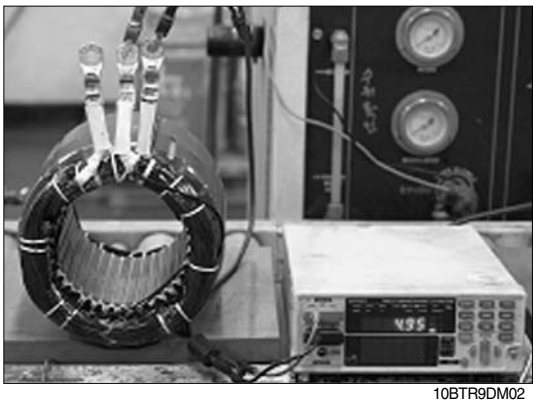


10BTR9DM01

(2) Stator assembly inspection

① Stator should always be cleaned with compressed air. If the dirt will not come off lightly wipe off with piece of cotton or soft cloth wetted with gasoline, using care not to damage the coil insulation.

② Use mmΩ tester and check for two power line of stator repeatedly (U-V, V-W, W-U).
At that time resistance is around 3.08 mmΩ.



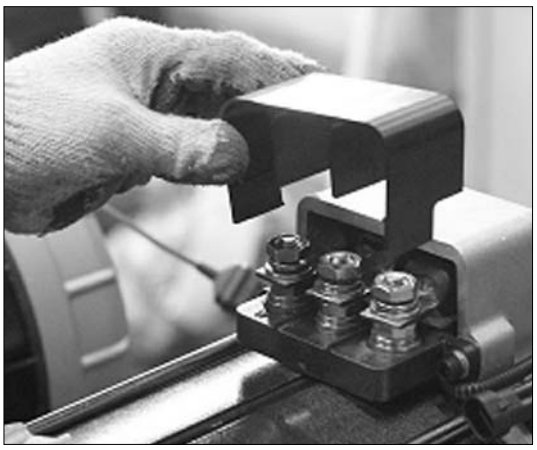
10BTR9DM02

③ Insulation test
Use Insulation tester (1000Vac, Min. 10MΩ) and measure as a picture. If the insulation is defective, replace with new parts.

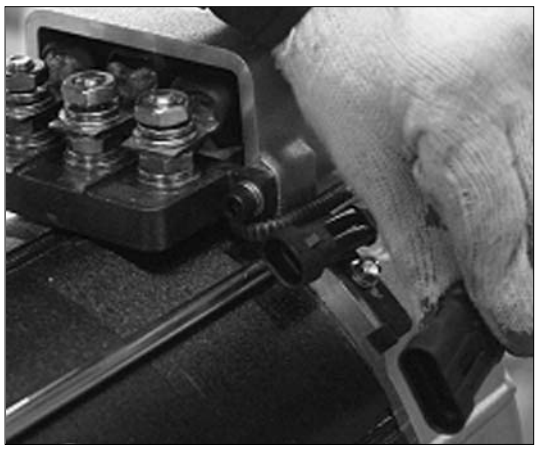
10BTR9DM03

4) DISASSEMBLY FOR AC MOTOR

(1) Before disassembling motor, remove terminal protector from the motor and separate thermistor and speed sensor connectors from hanger.



10BTR9DM04

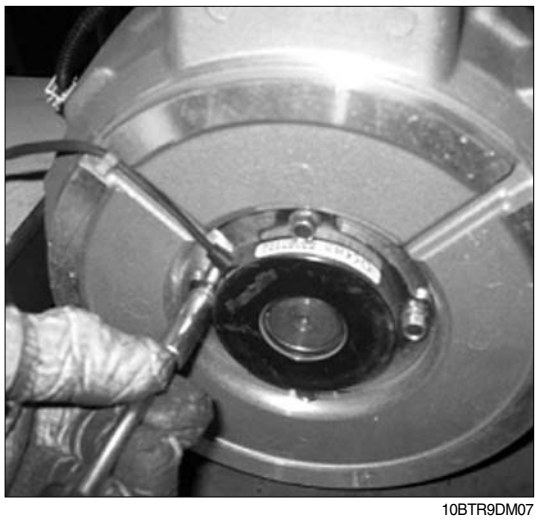


10BTR9DM05

(2) Remove 3-nuts from terminal block of the motor to disassemble terminal block from the motor.

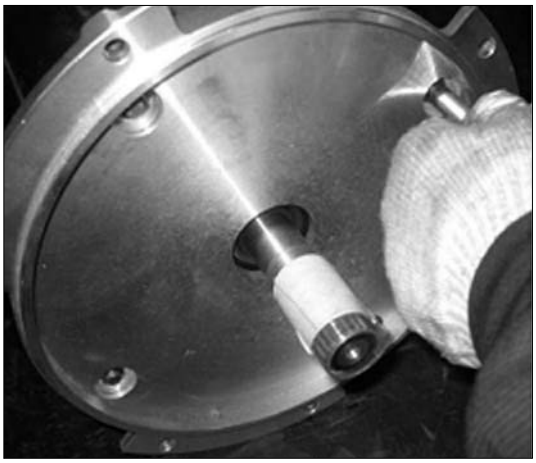
10BTR9DM06

(3) Remove 4 screw fixing speed sensor on the enbell side and then disassemble speed sensor, fixed nut and toothed wheel of the motor.



10BTR9DM07

(4) Remove 4 flange nuts with available general tool on the endbell drive side.



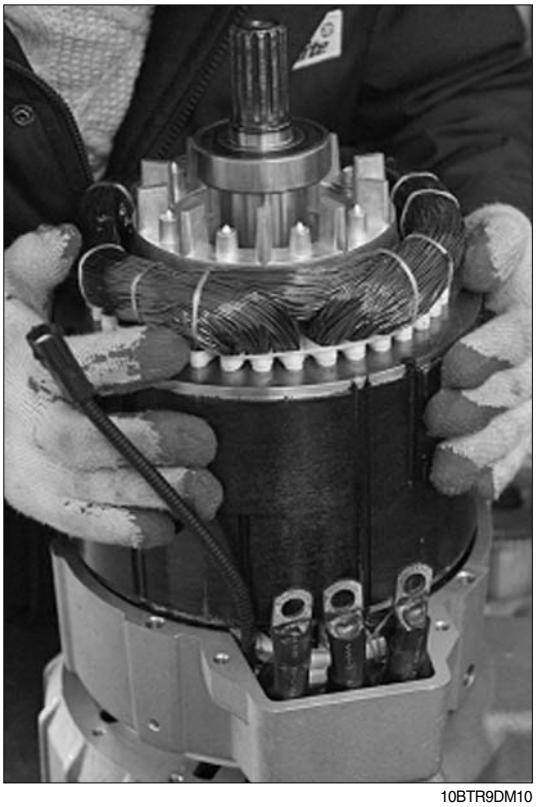
10BTR9DM08

(5) Remove endbell de and wave washer.

10BTR9DM09

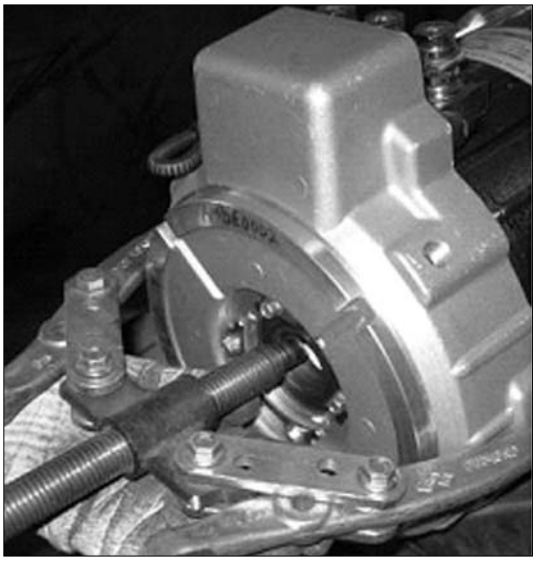
(6) Remove stator assembly by hand or suitable tool.

Removing stator



10BTR9DM10

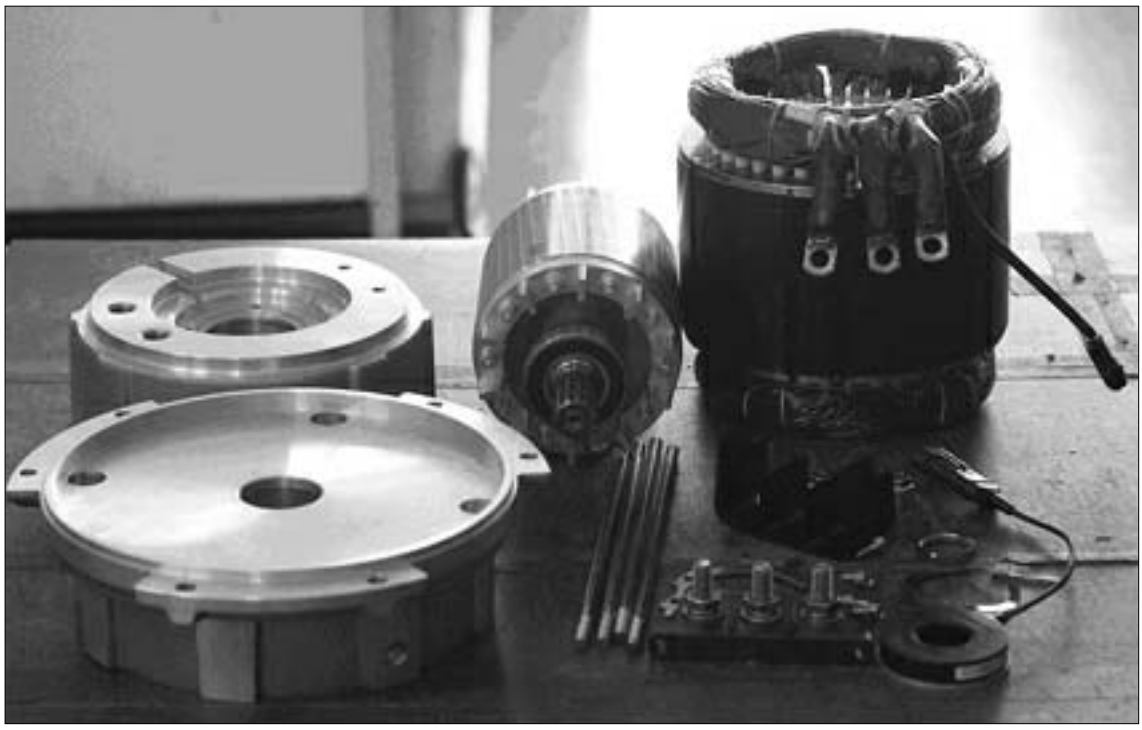
Removing endbell



10BTR9DM11

(7) Remove endbell from rotor assembly by hand-puller as a above picture.

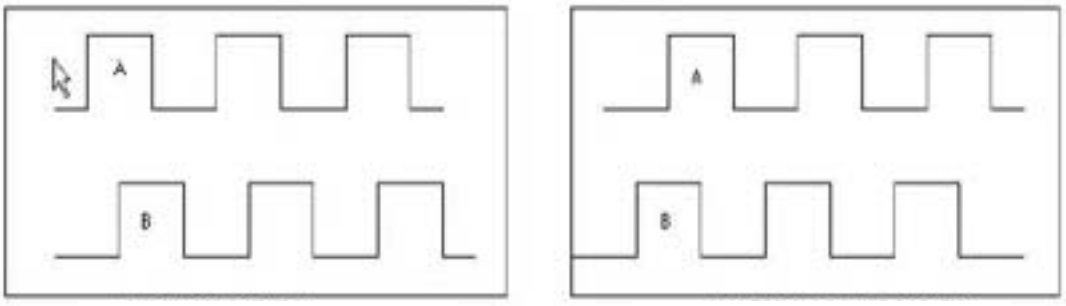
(8) The motor are composed of 5-parts
(Rotor assembly, stator assembly, enbell de, endbell, ETC)



10BTR9DM12

5) ASSEMBLY AND INSTALLATION

(1) Perform assembly in the reverse order of disassembling
(2) After assembling, check for speed sensor. Normal signal is as below.

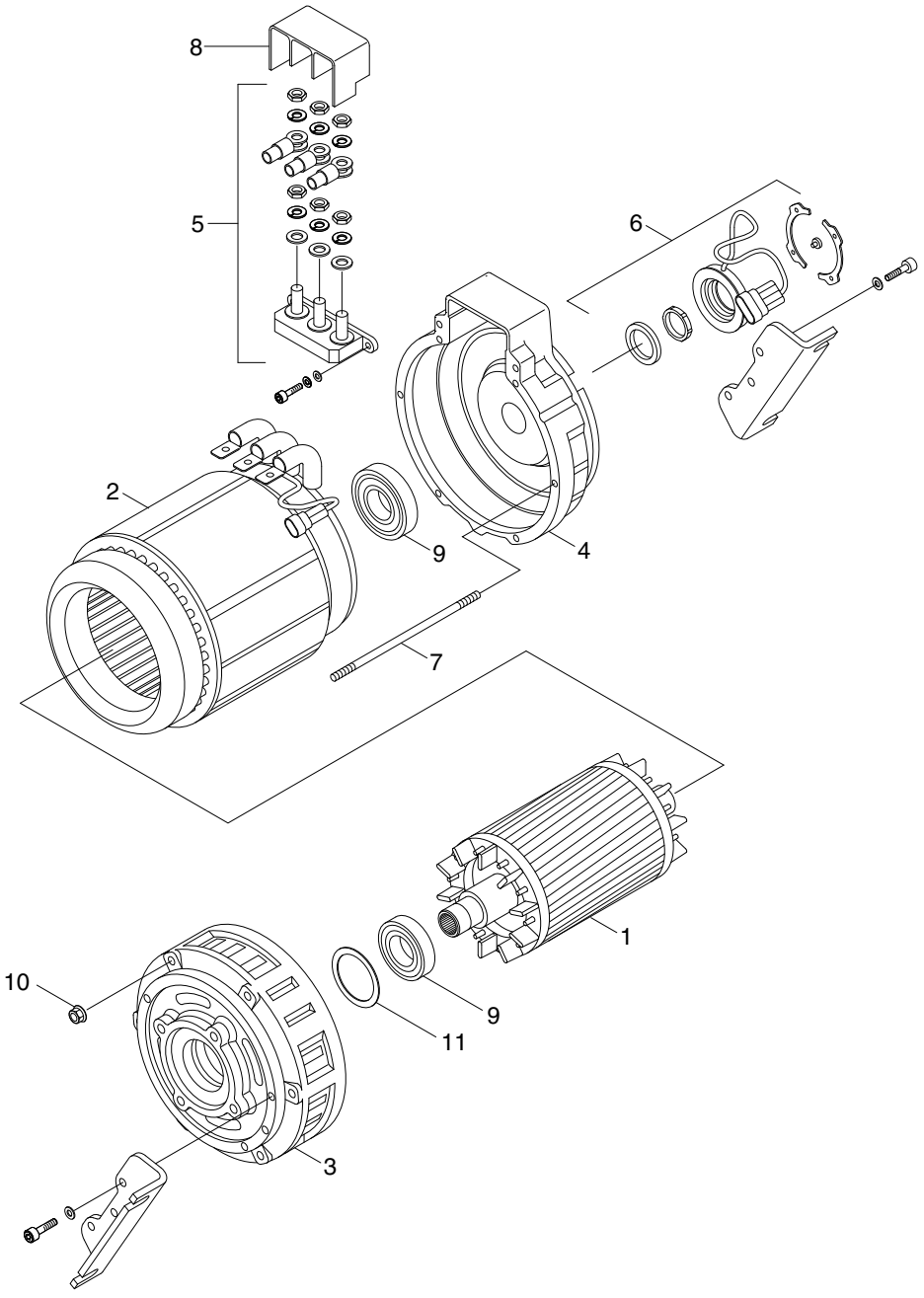


Clockwise rotation　　Counter clockwise rotation

10BTR9DM13

4. PUMP MOTOR

1) STRUCTURE



10BTR9EL16

1	Rotor assy	5	Terminal block(A)	9	Bearing
2	Startor assy	6	Speed sensor kit	10	Flange nut
3	Front endbell	7	Stud bolt	11	Wave washer
4	Rear endbell	8	Terminal, protector		

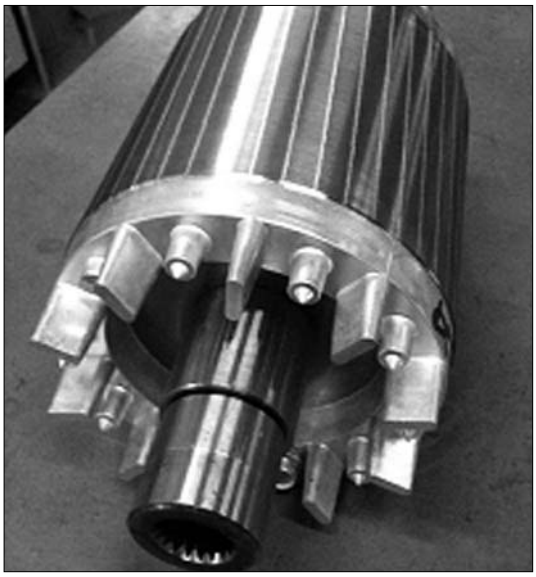
2) SPECIFICATION

Item	Unit	Specification
Type	-	AMDA4001
Rated voltage	V	16
Rated output	kW	9.0
Insulation	-	Class F

3) INSPECTION

(1) Rotor assembly inspection

- Rotor should always be cleaned with compressed air. If the dirt will not come off lightly wipe off with piece of cotton or soft cloth wetted with gasoline.
- Rotor out diameter : ø 123.1 ± 0.05
- Tool : Vernier calipers and standard tool

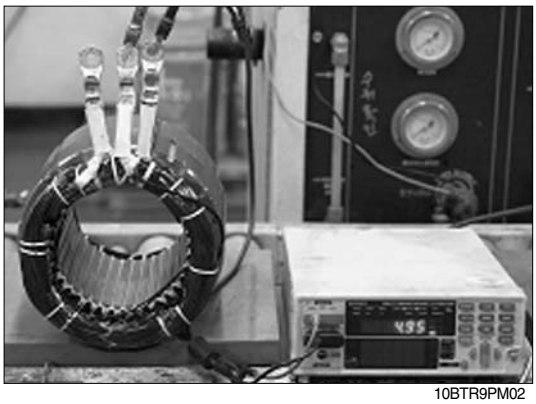


10BTR9PM01

(2) Stator assembly inspection

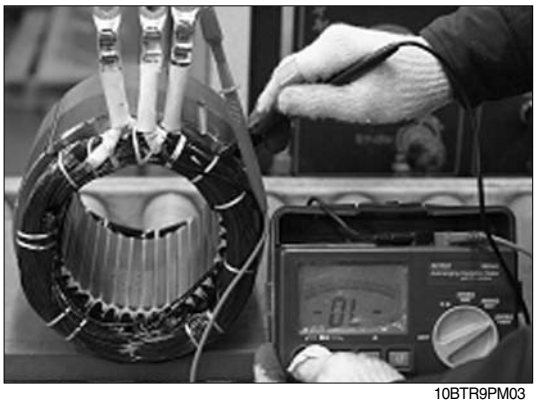
① Stator should always be cleaned with compressed air. If the dirt will not come off lightly wipe off with piece of cotton or soft cloth wetted with gasoline, using care not to damage the coil insulation.

② Use mmΩ tester and check for two power line of stator repeatedly (U-V, V-W, W-U).
At that time resistance is around 1.78 mmΩ.



10BTR9PM02

③ Insulation test
Use Insulation tester (1000Vac, Min. 10MΩ) and measure as a picture. If the insulation is defective, replace with new parts.

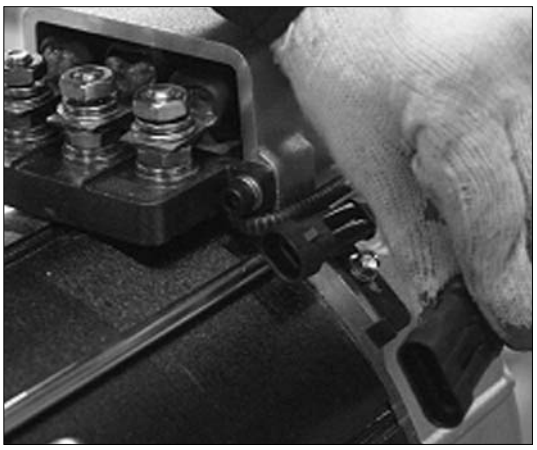


10BTR9PM03

4) DISASSEMBLY FOR AC MOTOR

(1) Before disassembling motor, remove terminal protector from the motor and separate thermistor and speed sensor connectors from hanger.

10BTR9PM04



10BTR9PM05

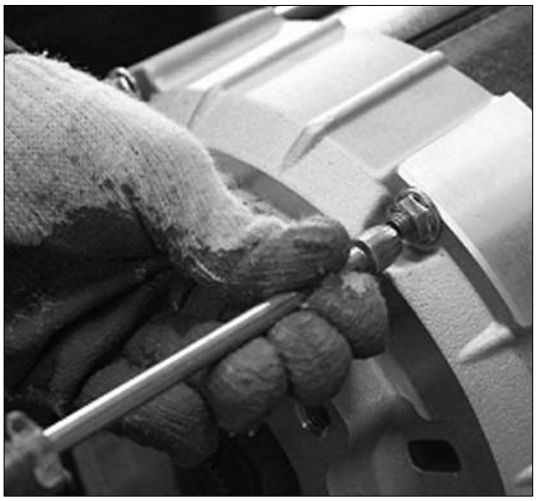
(2) Remove 3-nuts from terminal block of the motor to disassemble terminal block from the motor.

10BTR9PM06

(3) Remove 4 screws fixing speed sensor on the enbell side and then disassemble speed sensor, fixed nut and toothed wheel of the motor.

10BTR9PM07

(4) Remove 6 flange nuts with available general tool on the endbell drive side.



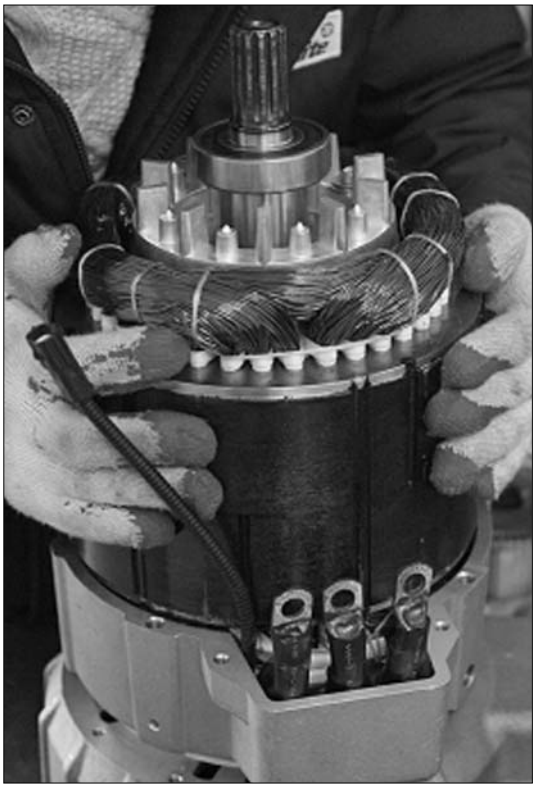
10BTR9PM08

(5) Remove endbell de and wave washer.

10BTR9PM09

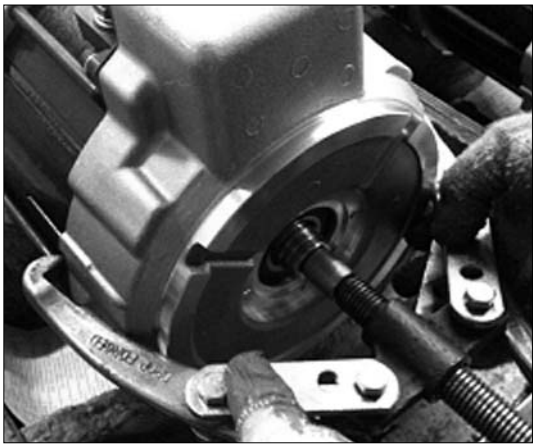
(6) Remove stator assembly by hand or suitable tool.

Removing stator



10BTR9PM10

Removing endbell



10BTR9PM11

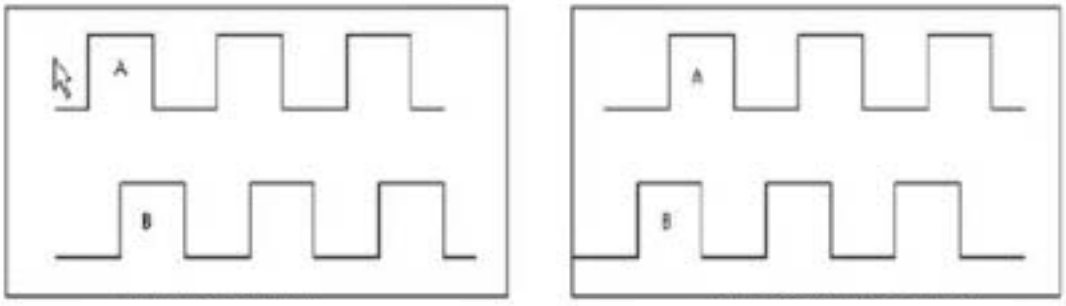
(7) Remove endbell from rotor assembly by hand-puller as a above picture.

(8) The motor are composed of 5-parts
(Rotor assembly, stator assembly, enbell de, endbell, ETC)

10BTR9PM12

5) ASSEMBLY AND INSTALLATION

(1) Perform Assembly in the reverse order of disassembling.
(2) After Assembling, check for speed sensor. Normal signal is as below.

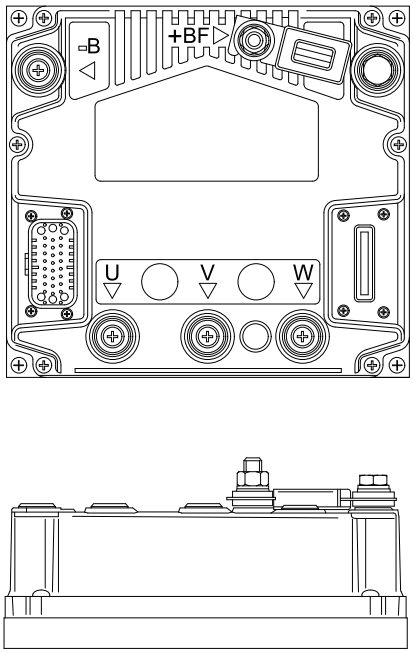


Clockwise rotation　　Counter clockwise rotation

10BTR9PM13

5. CONTROLLER SYSTEM

1) STRUCTURE (Traction controller/Pump controller)



Traction controller
Pump controller

10BTR9EL10

(1) Specifications

Model	Model	Normal battery voltage	Continuous output current	Current limit
10/13/15BTR-9	ACE2 24V 500Arms	24V	250Arms	500Arms / 3min

2) PIN MAP DESCRIPTION

(1) TRACTION INVERTER (ACE2)

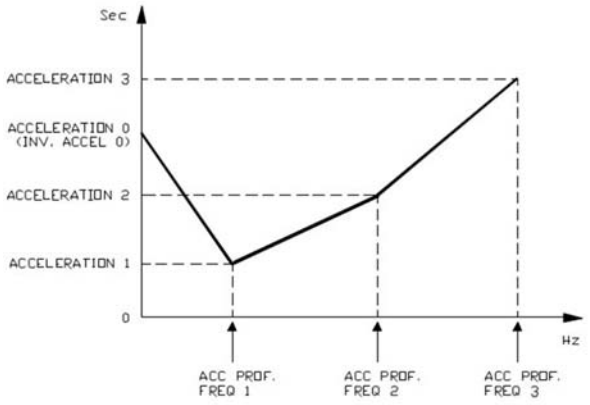
No. of Pin	Function	Description
A1	KEY	Input of the key switch signal.
A2	PPOT	Potentiometer positive.
A3	CPOT	Accelerator potentiometer wiper signal.
A4	FORW	Forward direction request input.
A5	REV	Backward direction request input.
A6	SEAT&SBR	SEAT and SBR(Side Battery Removal) input.
A7	ENC A	Traction motor encoder phase A.
A8	ENC VCC	Encoder positive power supply.
A9	- BATT	Negative power supply. It is used as NPOT, without PEDAL WIRE KO diagnosis, for acceleration potentiometer.
A10	ENABLE	Traction request input.
A11	SAFETY	It is connected to SAFETY OUT (CNA#19) of pump controller.
A12	CANT	If it is connected with A21. it introduces the120 Ohm termination resistance between CAN-L and CAN-H.
A13	PB	Pedal brake request input.
A14	ENC B	Traction motor encoder phase B.
A15	ENC GND	Encoder negative power supply.
A16	NLC	Main contactor coil output. The coil is driven to negative reference.
A17	PLC	Positive of the main contactor.
A18	NA	-
A19	NA	-
A20	CAN L	Low level CAN-BUS voltage I/O.
A21	CAN H	High level CAN-BUS voltage I/O.
A22	PTHERM	Input for traction motor temperature sensor.
A23	NTHERM	Negative of traction motor temperature sensor.

(2) PUMP INVERTER (ACE2)

No. of Pin	Function	Description
A1	KEY	Input of the key switch signal.
A2	PPOT	Positive of steering Potentiometer & lift potentiometer.
A3	CPOT	Lift potentiometer wiper signal.
A4	LIFT ENABLE	Input for lifting enable input.
A5	TILT	Input for tilt up and tilt down digital input.
A6	SEAT&SBR	SEAT and SBR(Side Battery Removal) input.
A7	ENC A	Pump motor encoder phase A.
A8	ENC VCC	Encoder positive power supply.
A9	- BATT	Negative power supply.
A10	CPOT	Steering potentiometer wiper.
A11	SAFETY IN	Connect to -BATT.
A12	NA	-
A13	AUX1	Input for shift right and shift left digital input.
A14	ENC B	Pump motor encoder phase B.
A15	ENC GND	Encoder negative power supply.
A16	NLC	MCV solenoid coil output.The coil is driven to negative reference.
A17	PLC	Positive of MCV solenoid coil.
A18	NA	-
A19	SAFETY OUT	it is connected to SAFETY IN (CNA#11) of traction controller.
A20	CAN L	Low level CAN-BUS voltage I/O.
A21	CAN H	High level CAN-BUS voltage I/O.
A22	PTHERM	Input for pump motor temperature sensor.
A23	NTHERM	Negative of pump motor temperature sensor.

3) MENU DESCRIPTION

(1) TRACTION INVERTER

PARAMETER CHANGE	
ACCELERATION 0	It specifies the motor acceleration at 0 Hz. At level 0 the acceleration is maximum. Increasing the parameter's level the acceleration decreases.
INV. ACCEL 0	It specifies the motor acceleration at 0 Hz after an inversion of direction. At level 0 the acceleration is maximum. Increasing the parameter's level the acceleration decreases.
ACCELERATION 1	It specifies the motor acceleration at ACC PROF. FREQ 1 [Hz]. At level 0 the acceleration is maximum. Increasing the parameter's level the acceleration decreases.
ACCELERATION 2	It specifies the motor acceleration at ACC PROF. FREQ 2 [Hz]. At level 0 the acceleration is maximum. Increasing the parameter's level the acceleration decreases.
ACCELERATION 3	It specifies the motor acceleration at ACC PROF. FREQ 3 [Hz]. At level 0 the acceleration is maximum. Increasing the parameter's level the acceleration decreases.
ACC PROF. FREQ 1	In correspondence to this frequency in [Hz] the acceleration is defined by the ACCELERATION 1 parameter.
ACC PROF. FREQ 2	In correspondence to this frequency in [Hz] the acceleration is defined by the ACCELERATION 2 parameter.
ACC PROF. FREQ 3	In correspondence to this frequency in [Hz] the acceleration is defined by the ACCELERATION 3 parameter.
 CONTROL 1	
RELEASE BRAKING	Seconds. It controls the deceleration ramp when the travel request is released. The parameter sets the time needed to decelerate the traction motor from 100Hz to 0Hz.
INVERS. BRAKING	Seconds. It controls the deceleration ramp when the direction switch is inverted during travel. The parameter sets the time needed to decelerate the traction motor from100Hz to 0Hz.
DECEL. BRAKING	Seconds. It controls the deceleration ramp when the accelerator has turned down but not completely released. The parameter sets the time needed to decelerate the traction motor from 100Hz to 0Hz.
PEDAL BRAKING	Seconds. This parameter determines the deceleration ramp when the travel request is released and the brake pedal switch is closed. It sets the time needed to decelerate the traction motor from 100Hz to 0Hz.

PARAMETER CHANGE	
SPEED LIMIT BRK	Seconds. It controls the deceleration ramp when a speed reduction has been activated. The parameter sets the time needed to decelerate the traction motor from 100Hz to 0Hz.
CURVE BRAKING	Seconds. It controls the deceleration ramp when a curve speed reduction has been activated. The parameter sets the time needed to decelerate the traction motor from 100Hz to 0Hz.
MAX SPEED FORW	Hz. It determines the maximum speed in forward direction. when truck steer angle is in 10 degrees.
MAX SPEED BACK	Hz. It determines the maximum speed in backward direction. when truck steer angle is in 10 degrees.
TURTLE SPEED	Hz. It determines the maximum speed when turtle mode is activated.
CURVE CUTBACK	Speed reduction when the truck is doing a curve. The parameter sets the speed setpoint when the truck driving wheels are running in opposite direction (3 wheels truck, steering angle greater than roughly 67°); or when the maximum steering angle is reached (4 wheels truck, the internal wheel is stopped). In intermediate steering angles, the speed setpoint will be within a range between the straight wheel speed and the CURVE CUTBACK SPEED.
STEER DEAD ANGLE	It is the angle value at the speed start to reduction
FREQUENCY CREEP	Hz value. This is the minimum speed applied when the forward or reverse switch is closed, but the accelerator is at its minimum.
MAXIMUM CURRENT	Maximum level of the current (percentage of the maximum current of the controller).
BRK SMOOTH	It gives a parabolic form to the deceleration ramp.
STOP BRK SMOOTH	Hz. It sets the level of frequency where the smooth effect of the deceleration parabolic form ends.
AUXILIARY TIME	Time units value (seconds). For the encoder version, it determines the time duration the truck is hold on the ramp if the STOP ON RAMP option is ON.
SEQUENCE DE. TIME	It sets the maximum delay time between the accelerator is pressed and the direction lever is moved out of the neutral position. If this time is expired the truck stops with warning : "SEQUENCE FAULT"

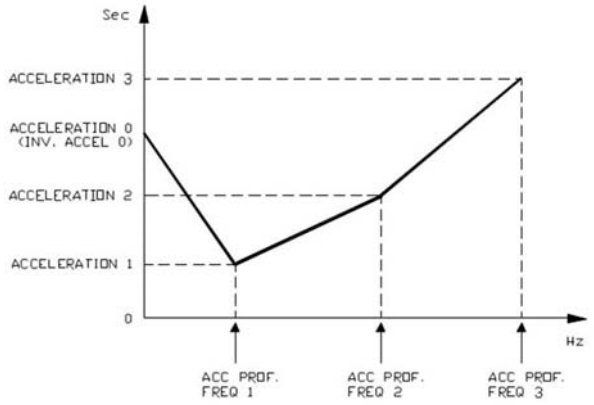
SET OPTION	
HOUR COUNTER	This option specifies the hour counter mode. It can be set one of two: - RUNNING: The counter registers travel time only. - KEY ON: The counter registers when the "key" switch is closed.
BATTERY CHECK	This option specifies the handling of the low battery charge detection. There are tree levels: - Level 0:Nothing happens, the battery charge level is calculated but is ignored, it means no action is taken when the battery is discharged. - Level 1:BATTERY LOW alarm is raised when the battery level is calculated being less than or equal to 10% of the full charge. The BATTERY LOW alarm reduces the maximum current down to 50% of the full truck current and the maximum truck speed down to 24% of the full truck speed and it inhibits the Lifting function. - Level 2:BATTERY LOW alarm is raised when the battery level is calculated being less than or equal to 10% of the full charge. But is ignored, it means no action is taken when the battery is discharged. - Level 3:BATTERY LOW alarm is raised when the battery level is calculated being less than or equal to 10% of the full charge. The BATTERY LOW alarm reduces the maximum truck speed down to 24% of the full truck speed and it inhibits the Lifting function.
STOP ON RAMP	Only when the encoder is present, it is possible to electrically hold the truck on a slope when the accelerator is released but the tiller is not released. - ON: The stop on ramp feature (truck electrically hold on a ramp) is managed for a time established by AUXILIARY TIME parameter. - OFF: The stop on ramp feature is not performed. That means the truck comes down slowly during the AUXILIARY TIME.
SET MOT.TEMPERAT	It can be set: - ANALOG: An analogue sensor for the control of the motor temperature is connected to CNA#22. Typically the temperature sensor is a PTC (positive thermal coefficient resistance), providing the sensor characteristic to Zapi the correct table can be loaded in the controller software. 1. DIGITAL: A digital (on/off) sensor for the motor temperature monitoring is connected to CNA#22 input. 2. NONE:No temperature sensor is connected.
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 seq. delay timeIf this option is set to off the required sequence to start the truck is : ・Direction lever-accelerator pedal or : ・Accelerator pedal-direction lever within the seq. delay time.
DISPLAY	OFF: when display is not connected to the CAN bus. ON: when display is connected to the CAN bus.

SET OPTION	
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.
PEDAL BRK.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.

ADJUSTMENTS	
MAX STEER RIGHT	This is the function to record in the controller EEPROM the steering poti output voltage when the wheels are fully turned right (maximum of the steering poti range).
MAX STEER LEFT	This is the function to record in the controller EEPROM the steering poti output voltage when the wheels are fully turned left (minimum of the steering poti range).
MAX STEER 0 POS.	This is the function to record in the controller EEPROM the steering poti output voltage when the wheels are straight.
SET STEER LEFT	This parameter sets the max steering angle in left direction.
SET STEER RIGHT	This parameter sets the max steering angle in right direction.
ADJUST BATTERY	Fine adjustment of the battery voltage measured by the controller.
THROTTLE 0 ZONE	Establishes a deadband in the accelerator input curve.
THROTTLE X POINT	This parameter, together with the THROTTLE Y POINT, changes the characteristic of the accelerator input curve : when the accelerator is de-pressed to X point per cent, the corresponding truck speed is Y point per cent of the Maximum truck speed. Therelationship between the accelerator position and the truck speed is linear between the THROTTLE 0 ZONE and the X point and also between the X point and the maximum accelerator position but with two different slopes.
THROTTLE Y POINT	This parameter, together with the THROTTLE X POINT, changes the characteristic of the accelerator input curve : when the accelerator is de-pressed to X point per cent, the corresponding truck speed is Y point per cent of the Maximum truck speed. The relationship between the accelerator position and the truck speed is linear between the THROTTLE 0 ZONE and the X point and also between the X point and the maximum accelerator position but with two different slope.
BAT. MIN ADJ.	Adjust the lower level of the battery charge table (Level 0 to 9).
BAT. MAX ADJ.	Adjust the upper level of the battery charge table (Level 0 to 9).
BDI ADJ. STARTUP	Adjust the upper level of the battery charge at the key on.
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.
CHECK UP DONE	Turn it On when the required Maintenance service has been executed to cancel the CHECK UP NEEDED warning.
CHECK UP TYPE	It specifies the handling of the CHECK UP NEEDED warning: - NONE: No CHECK UP NEENED warning. - OPTION#1: CHECK UP NEENED warning shown on the hand set and Graphic Smart Display after the setting value of "CHECK UP TIME" parameter. - OPTION#2: Equal to OPTION#1 but Speed reduction after the setting value of "CHECK UP TIME" plus 40 hours. - OPTION#3: Equal to OPTION#2 but the truck definitively stops after the setting value of "CHECK UP TIME" plus 80 hours.

ADJUSTMENTS	
CHECK UP TIME	Hours. It specifies the time of the CHECK UP NEEDED warning.
MAIN CONT VOLT	It specifies the percentage of battery voltage supplied to MC coil to close the contactor.
AUX OUTPUT VOLT	It specifies the percentage of battery voltage supplied to AUX coil to close the AUXILIARY electro valve.
MAIN CONT. V RID	It specifies the percentage of MAIN CONT VOLT parameter, supplied to MC coil to keep the contactor closed.
DISP SPD FACTOR	It adjusts 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 (cm). P = number of pair poles of the motor.
SEAT DELAY	It determines the delay time between the opening of the seat switch on CNA#6 digital input and the start of the truck electrical braking.
CHAT TIME DELAY	After no travel or pump request is active for the chat time the line contactor is automatically opened. To restart, the the operator needs to press the accelerator pedal or activate the hydraulic levers.

(2) PUMP INVERTER

PARAMETER CHANGE	
ACCELERATION 0	It specifies the motor acceleration at 0 Hz. At level 0 the acceleration is maximum. Increasing the parameter's level the acceleration decreases.
ACCELERATION 1	It specifies the motor acceleration at ACC PROF. FREQ 1 [Hz]. At level 0 the acceleration is maximum. Increasing the parameter's level the acceleration decreases.
ACCELERATION 2	It specifies the motor acceleration at ACC PROF. FREQ 2 [Hz]. At level 0 the acceleration is maximum. Increasing the parameter's level the acceleration decreases.
ACCELERATION 3	It specifies the motor acceleration at ACC PROF. FREQ 3 [Hz]. At level 0 the acceleration is maximum. Increasing the parameter's level the acceleration decreases.
ACC PROF. FREQ 1	In correspondence to this frequency in [Hz] the acceleration is defined by the ACCELERATION 1 parameter.
ACC PROF. FREQ 2	In correspondence to this frequency in [Hz] the acceleration is defined by the ACCELERATION 2 parameter.
ACC PROF. FREQ 3	In correspondence to this frequency in [Hz] the acceleration is defined by the ACCELERATION 3 parameter.
 CONTROL 1	
RELEASE BRAKING	Seconds. It controls the deceleration ramp when the pump request is released. The parameter sets the time needed to decelerate the pump motor from 100Hz to 0Hz.
MAX SPEED LIFT	It determines the pump maximum speed when LIFT ENABLE switch is closed .
1ST SPEED COARSE	It determines the pump maximum speed when SPEED1 switch is closed .
2nd SPEED COARSE	It determines the pump maximum speed when SPEED2 switch is closed .
3rd SPEED COARSE	It determines the pump maximum speed when SPEED3 switch is closed .
HYD SPPED FINE	It determines the pump maximum speed when an hydraulic steering function request is received via CAN BUS.
HYDRO TIME	It is the remaining time after that the Hydro request goes down.
FREQUENCY CREEP	Minimum speed when the LIFT ENABLE switch is closed, but the accelerator is on a minimum position.
MAXIMUM CURRENT	This parameter changes the maximum current of the inverter.
AUXILARY TIME	Time units value (seconds). It is the time delay before close the EM brake when motor speed reach 0rpm.

SET OPTION	
HOUR COUNTER	This option specifies the hour counter mode. It can be set one of two: - RUNNING: The counter registers travel time only. - KEY ON: The counter registers when the "key" switch is closed.
BATTERY CHECK	This option specifies the handling of the low battery charge detection. There are tree levels: - Level 0:Nothing happens, the battery charge level is calculated but is ignored, it means no action is taken when the battery is discharged. - Level 1:BATTERY LOW alarm is raised when the battery level is calculated being less than or equal to 10% of the full charge. The BATTERY LOW alarm reduces the maximum current down to 50% of the full truck current and the maximum truck speed down to 23% of the full truck speed and it inhibits the Lifting function. - Level 2:BATTERY LOW alarm is raised when the battery level is calculated being less than or equal to 10% of the full charge. But is ignored, it means no action is taken when the battery is discharged. - Level 3:BATTERY LOW alarm is raised when the battery level is calculated being less than or equal to 10% of the full charge. The BATTERY LOW alarm reduces the maximum truck speed down to 23% of the full truck speed and it inhibits the Lifting function.
SET MOT.TEMPERAT	It can be set: - ANALOG: An analogue sensor for the control of the motor temperature is connected to CNA#22. Typically the temperature sensor is a PTC (positive thermal coefficient resistance), providing the sensor characteristic to Zapi the correct table can be loaded in the controller software. 1. DIGITAL: A digital (on/off) sensor for the motor temperature monitoring is connected to CNA#22 input. 2. NONE:No temperature sensor is connected.
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.
JOY STICK	OFF : Use lever command valves; ON : Use fingertip command valves.
DISPLAY	OFF: Display Not present; ON: Display present.
SHIFT FUNCTION (option)	This menu appears when JOYSTICK (in the SET OPTION) is ON. OFF : The truck doesn't have the side shift function (default) ON : The truck has the side shift function
AUX FUNCTION (option)	This menu appears when JOYSTICK (in the SET OPTION) is ON. OFF : The truck doesn't have the aux function (default) ON : The truck has the aux function (option)
LEVER FULL (option)	This menu appears when JOYSTICK (in the SET OPTION) is ON. OFF : The restricted combinations of the fingertip lever are available. For example, lift plus tilt forward movement is disabled for safety. ON : All combinations of the fingertip lever are available.

ADJUSTMENTS	
LOAD SENSOR	ON : Load Sensing Function is activated OFF : Load Sensing Function is disactivated.
OVERLOAD TYPE	This option specifies how overload alarm works in overloaded situation. NONE : There would'n be any kind of alarms or limitations . OPTION #1 : If the weight of load filed on forks exceeds the overload weight set in overload parameter, OVER LOAD alarm will be displayed and followed by traction & pump limitation except lift down function. OPTION #2 : If the weight of load filed on forks exceeds the overload weight set in overload parameter, OVER LOAD alarm will be displayed.
ADJ MIN LOAD	This parameter is used to show and configurate the minimum voltage of load weight sensor output in case of empty weight loaded.
ADJ REF LOAD	This parameter is used to show and configurate the reference voltage of load weight sensor output in case of reference weight loaded.
REF. LOAD WEIGHT	This parameter is used to show and configurate the reference load weight.
MAX LOAD WEIGHT	This parameter is used to show and configurate the trigger condition for LOAD SENSOR alarm. If the loaded weight exceeds the weight indicated in this paramter, The TIP OVER accident can occur, which is fatal for driver' safety, so LOAD SENSOR alarm will be displayed and followed by traction & pump limitation except lift down function. * The figures in this parameter should be higher than OVERLOAD WEIGHT paratmer
OVERLOAD WEIGHT	This parameter is used to show and configurate the trigger condition for OVER LOAD alarm. If the loaded weight exceeds the weight indicated in this paramter, overload alarm and function limitation will occur accroding to OVERLOAD TYPE paramter. * The figures in this parameter should be higher than RATED LOAD W parameter and lower than MAX LOAD WEIGHT paratmer.
LOAD SPEED UPD	For accuracy, Load Sensor only works when the pump motor speed is lower than as set in this paramter.
ADJUST BATTERY	Fine adjustment of the battery voltage measured by the controller.
THROTTLE 0 ZONE	It establishes a dead band in the lift potentiometer input curve.
THROTTLE X POINT	This parameter, together with the THROTTLE Y POINT, changes the characteristic of the lift potentiometer input curve : when the potentiometer is depressed to X point per cent, the corresponding pump speed is Y point percent of the Maximum pump speed. The relationship between the lift potentiometer position and the pump speed is linear between the THROTTLE 0 ZONE and the X point and also between the X point and the maximum potentiometer position but with two different slopes.

ADJUSTMENTS	
THROTTLE Y POINT	This parameter, together with the THROTTLE X POINT, changes the characteristic of the lift potentiometer input curve : when the potentiometer is de-pressed to X point per cent, the corresponding pump speed is Y point per cent of the Maximum pump speed. The relationship between the potentiometer position and the pump speed is linear between the THROTTLE 0 ZONE and the X point and also between the X point and the maximum accelerator position but with two different slope.
MAIN CONT. VOLT	It specifies the percentage of battery voltage supplied to OPSS VALVE coil to close the contactor.
AUX OUTPUT VOLT	It specifies the percentage of battery voltage supplied to AUX coil to close the AUXILIARY electro valve.
MAIN CONT. V RID	It specifies the percentage of MAIN CONT VOLT parameter, supplied to MC coil to keep the contactor closed.
MAX. POT LOWER (OPTION)	This menu appears when JOYSTICK (in the SET OPTION) is ON. Volts. It sets the maximum value for the lowering sensor.
MIN. POT LOWER (OPTION)	This menu appears when JOYSTICK (in the SET OPTION) is ON. Volts. It sets the minimum value for the lowering sensor.
MAX. POT LIFT (OPTION)	This menu appears when JOYSTICK (in the SET OPTION) is ON. Volts. It sets the maximum value for the lift sensor.
MIN. POT LIFT (OPTION)	This menu appears when JOYSTICK (in the SET OPTION) is ON. Volts. It sets the minimum value for the lift sensor.
MAX. TILT DOWN (OPTION)	This menu appears when JOYSTICK (in the SET OPTION) is ON. Volts. It sets the maximum value for the tilt down sensor.
MIN. TILT DOWN (OPTION)	This menu appears when JOYSTICK (in the SET OPTION) is ON. Volts. It sets the minimum value for the tilt down sensor.
MAX. TILT UP (OPTION)	This menu appears when JOYSTICK (in the SET OPTION) is ON. Volts. It sets the maximum value for the tilt up sensor.
MIN. TILT UP (OPTION)	This menu appears when JOYSTICK (in the SET OPTION) is ON. Volts. It sets the minimum value for the tilt up sensor.
MAX. SHIFT LEFT (OPTION)	This menu appears when JOYSTICK (in the SET OPTION) is ON. Volts. It sets the maximum value for the side shift left sensor.
MIN. SHIFT LEFT (OPTION)	This menu appears when JOYSTICK (in the SET OPTION) is ON. Volts. It sets the minimum value for the side shift left sensor.
MAX. SHIFT RIGHT (OPTION)	This menu appears when JOYSTICK (in the SET OPTION) is ON. Volts. It sets the maximum value for the side shift right sensor.
MIN. SHIFT RIGHT (OPTION)	This menu appears when JOYSTICK (in the SET OPTION) is ON. Volts. It sets the minimum value for the side shift right sensor.
MAX. AUX OUT (OPTION)	This menu appears when JOYSTICK (in the SET OPTION) is ON. Volts. It sets the maximum value for the aux out sensor.
MIN. AUX OUT (OPTION)	This menu appears when JOYSTICK (in the SET OPTION) is ON. Volts. It sets the minimum value for the aux out sensor.
MAX. AUX IN (OPTION)	This menu appears when JOYSTICK (in the SET OPTION) is ON. Volts. It sets the maximum value for the aux in sensor.
MIN. AUX IN (OPTION)	This menu appears when JOYSTICK (in the SET OPTION) is ON. Volts. It sets the minimum value for the aux in sensor.

4) TESTER MENU

TRACTION INVERTER	
HOUR METER TRUCK	This parameter displays the working hour of traction controller.
BATTERY VOLTAGE	Voltage value with 1 decimal digit. Battery voltage value measured at the key on.
MOTOR VOLTAGE	Percentage value. It is the voltage generated by the inverter expressed in percent of the actual battery voltage. 100% means the sine wave width is close to the actual battery voltage; 0% means the sine wave width is null.
VOLTAGE BOOSTER	Percentage value. It is the booster contribute to the voltage really supplied to the motor expressed in per cent of the actual battery voltage.
FREQUENCY	Hz value. This is the frequency of the sine waves the inverter is supplying.
ENCODER	Hz value. This is the speed of the motor measured with the encoder and expressed in the same unit of the FREQUENCY reading.
SLIP VALUE	Hz value. This is the slip between the frequency and the speed of the motor(SLIP VALUE = FREQUENCY-ENCODER).
CURRENT RMS	Ampere value. Root Mean Square value of the line current in the motor.
MOTOR POWER	It is the motor power.
BATTERY CHARGE	Percentage value. It supplies the residual charge of the battery as a percentage of the full charge level.
TEMPERATURE	°C value. This is the temperature of the inverter base plate. This temperature is used for the HIGH TEMPERATURE alarm detection.
MOTOR TEMPERAT.	°C value. This is the temperature of the motor windings picked up with an analog sensor inside the motor. Normally this sensor is a PTC Philips KTY84-130. This temperature is used only to raise a warning. when the motor temperature overtakes the MOTOR OVERTEMP setting.
ACCELERATOR	From 0.0V to 5.0V. ACCELERATOR reading is in the range 0.0 to 5.0Vdc.
SEAT SWITCH	ON/OFF. This is the status of seat switch.
FORWARD SWITCH	ON/OFF. This is the status of forward signal.
BACKWARD SWITCH	ON/OFF. This is the status of backward signal.
ENABLE SWITCH	ON/OFF. This is the status of enable switch.
BRAKE SWITCH	ON/OFF. This is the status of pedal brake switch.
HANDBRAKE	ON/OFF. This is the status of pedal handbrake switch from display.
STEER ANGLE	° value. This is the angle of steering wheel.

PUMP INVERTER	
HOUR METER TRUCK	This parameter displays the working hour of pump controller.
BATTERY VOLTAGE	Voltage value with 1 decimal digit. Battery voltage value measured at the key on.
MOTOR VOLTAGE	Percentage value. It is the voltage generated by the inverter expressed in percent of the actual battery voltage. 100% means the sine wave width is close to the actual battery voltage; 0% means the sine wave width is null.
VOLTAGE BOOSTER	Percentage value. It is the booster contribute to the voltage really supplied to the motor expressed in per cent of the actual battery voltage.
FREQUENCY	Hz value. This is the frequency of the sine waves the inverter is supplying.
ENCODER	Hz value. This is the speed of the motor measured with the encoder and expressed in the same unit of the FREQUENCY reading.
SLIP VALUE	Hz value. This is the slip between the frequency and the speed of the motor(SLIP VALUE = FREQUENCY-ENCODER).
CURRENT RMS	Ampere value. Root Mean Square value of the line current in the motor.
MOTOR POWER	It is the motor power.
TEMPERATURE	℃ value. This is the temperature of the inverter base plate. This temperature is used for the HIGH TEMPERATURE alarm detection.
MOTOR TEMPERAT.	℃ value. This is the temperature of the motor windings picked up with an analog sensor inside the motor. Normally this sensor is a PTC Philips KTY84-130. This temperature is used only to raise a warning. when the motor temperature overtakes the MOTOR OVERTEMP setting.
SEAT SWITCH	ON/OFF. This is the status of seat switch.
LIFTING CONTROL	From 0.0V to 5.0V. LIFTING reading is in the range 0.0 to 5.0Vdc.
LIFTING SWITCH	ON/OFF. This is the status of the lift switch.
1ST SPEED SWITCH	ON/OFF. This is the status of the tilt switch.
2ND SPEED SWITCH	ON/OFF. This is the status of the sideshift switch.
3RD SPEED SWITCH	ON/OFF. This is the status of the HYD AUX switch, from display.
HYDRO SPEED REQ.	ON/OFF. This is the status of hydro speed request.
STEER POT.	From 0.0V to 5.0V. STEERING reading is in the range 0.0 to 5.0Vdc.
LOAD WEIGHT	From 0Kg to 2500Kg. It is the load sensor output
LOAD POT.	From 0.0V to 5.0V. LOAD SENSING reading is in the range 0.0 to 5.0Vdc.
LIFT/LOW REQUEST	Shadow when you are not in JOYMODE. From 0.0V to 5.0V and from 0% and 100%. LIFT/LOWER fingertip.
TILT REQUEST	Shadow when you are not in JOYMODE. From 0.0V to 5.0V and from 0% and 100%. TILT fingertip.
SHIFT REQUEST	Shadow when you are not in JOYMODE. From 0.0V to 5.0V and from 0% and 100%. SHIFT fingertip.
AUX REQUEST	Shadow when you are not in JOYMODE. From 0.0V to 5.0V and from 0% and 100%. AUX fingertip.

6. FINGERTIP CONTROLLER

1) INTRODUCTION OF FINGER TIP

The general forklift performs lifting and tilting using the mechanical lever mounted on MCV (Main Control Valve) by an operator.

A new system is designed in order to improve operator's convenience and match up with marketing trend. That is what is called a finger tip or mini- lever system. The system is to apply electric levers and proportional valve instead of mechanical levers and MCV. The attachments are operated as controlling the solenoid of a proportional valve according to the voltage of an electric lever.

2) GENERAL CHARACTERISTIC

(1) Functional characteristics

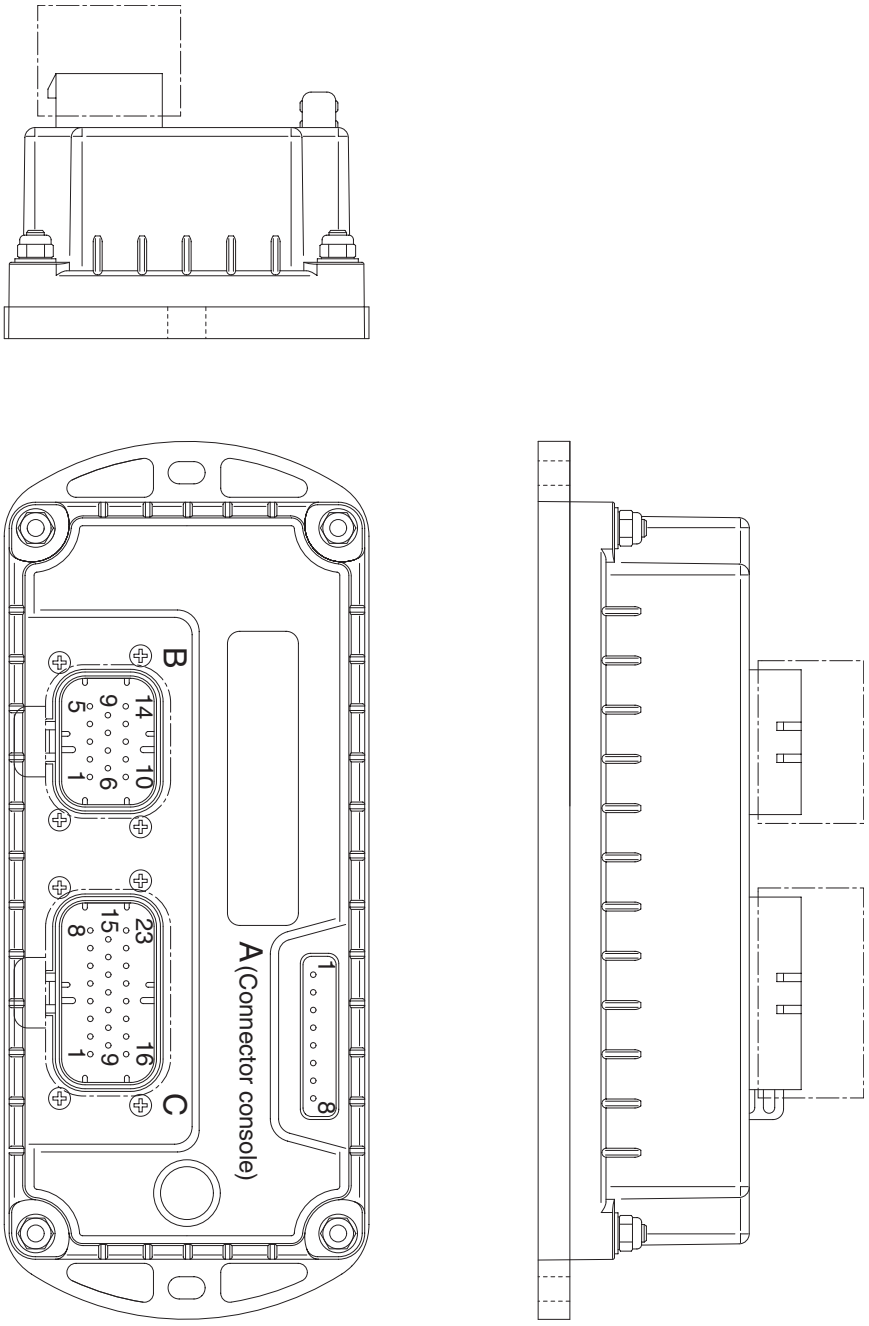
Voltage [V] ····· 24/36/48/80V
Output for ON-OFF valves [n°] ····· 3
Output for proportional valves [n°] ····· 9
Digital inputs [n°] ····· 3
Analog inputs [n°] ····· 1
RS-232 [n°] ····· 1
CAN [n°] ····· 1
Protection ····· IP65

(2) Input

Analog inputs : Mhyrio provides 1 analog input. The analog device can be supplied at +12. It is necessary to specify in the order the voltage selected. The supply output is able to deliver max 100 mA.

Proportional valves are driven in current mode with programmable frequency. The valves voltage supply is the same used for ON-OFF valves and the current range have to be defined. Via console or display it is adjustable in a big range, but the shunts can be adapted to every types of valves (minimum current 200 mA, maximum current up to 2 A).

3) STRUCTURE



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4) Description of connectors

No. of Pin	Function	Description
A1	PCLRXD	Serial communication interface
A2	NCLRXD	Serial communication interface
A3	PCLTXD	Serial communication interface
A4	NCLTXD	Serial communication interface
A5	GND	Negative supply.
A6	+12	+12V supply.
A7	-	
A8	-	
B1	+KEY	Mhyrio CB positive power supply
B2	PAUX	Input of valves positive power supply
B3	-BATT	Mhyrio CB negative supply
B4	CAN_L	CAN low signal in
B9	CAN_T	CAN termination : connect to CANH_OUT to insert a 120 ohm termination resistance
B10	PPO_S	Positive supply of analog devices (+12 V)
B13	CAN_H	Can high signal in
B14	CANH_OUT	Can high signal out
C1	NEVP1	Negative of the proportional electro valve lift up.
C2	PEVP1/2	Positive of the proportional electro valves lift up & lowering.
C3	NEVP2	Negative of the proportional electro valve lowering.
C4	NEVP3	Negative of the proportional electro valve reach in.
C5	PEVP3/4	Positive of the proportional electro valves reach in & reach out.
C6	NEVP4	Negative of the proportional electro valve reach out.
C7	NEVP5	Negative of the proportional electro valve tilt up.
C8	PEVP5/6	Positive of the proportional electro valves tilt up & tilt down.
C12	NEVP7	Negative of the proportional electro valve side shift right.
C13	PEVP7/8	Positive of the proportional electro valves side shift right & left.
C14	NEVP8	Negative of the proportional electro valve side shift left.
C15	NEVP6	Negative of the proportional electro valve tilt down.
C19	NEVP	Negative of buzzer relay
C20	PEVP	Positive of buzzer relay
C23	-BATT	Mhyrio CB negative supply

Type	Function	Description
SET BATTERY TYPE	12/24/36 /48/72/80	This parameter sets the battery nominal voltage, that is the key input voltage (MHYRIO supply)
V valves coil	12/24/36 /48/72/80	This parameter sets the ON/OFF valves coil nominal voltage.
Valves supply	12/24/36 /48/72/80	This parameter sets the voltage of the valve's coil positive supply.
EVP type	DIGITAL	It sets EVP single to ON-OFF valve type
	ANALOG	It sets EVP single to proportional valve type
EVP1 type	DIGITAL	It ses EVP1 to ON-OFF valve type
	ANALOG	It sets EVP1 to PROPORTIONAL valve type
EVP2 type	DIGITAL	It sets EVP2 to ON-OFF valve type
	ANALOG	It sets EVP2 to PROPORTIONAL valve type
EVP3 type	DIGITAL	It sets EVP3 to ON-OFF valve type
	ANALOG	It sets EVP3 to PROPORTIONAL valve type
EVP4 type	DIGITAL	It sets EVP4 to ON-OFF valve type
	ANALOG	It sets EVP4 to PROPORTIONAL valve type
EVP5 type	DIGITAL	It sets EVP5 to ON-OFF valve type
	ANALOG	It sets EVP5 to PROPORTIONAL valve type
EVP6 type	DIGITAL	It sets EVP6 to ON-OFF valve type
	ANALOG	It sets EVP6 to PROPORTIONAL valve type
EVP7 type	DIGITAL	It sets EVP7 to ON-OFF valve type
	ANALOG	It sets EVP7 to PROPORTIONAL valve type
EVP8 type	DIGITAL	It sets EVP8 to ON-OFF valve type
	ANALOG	It sets EVP8 to PROPORTIONAL valve type
MODEL TRUCK	OPTION #1	It sets every parameter to counter balanced type truck
	OPTION #2	It sets every parameter to BRJ type truck

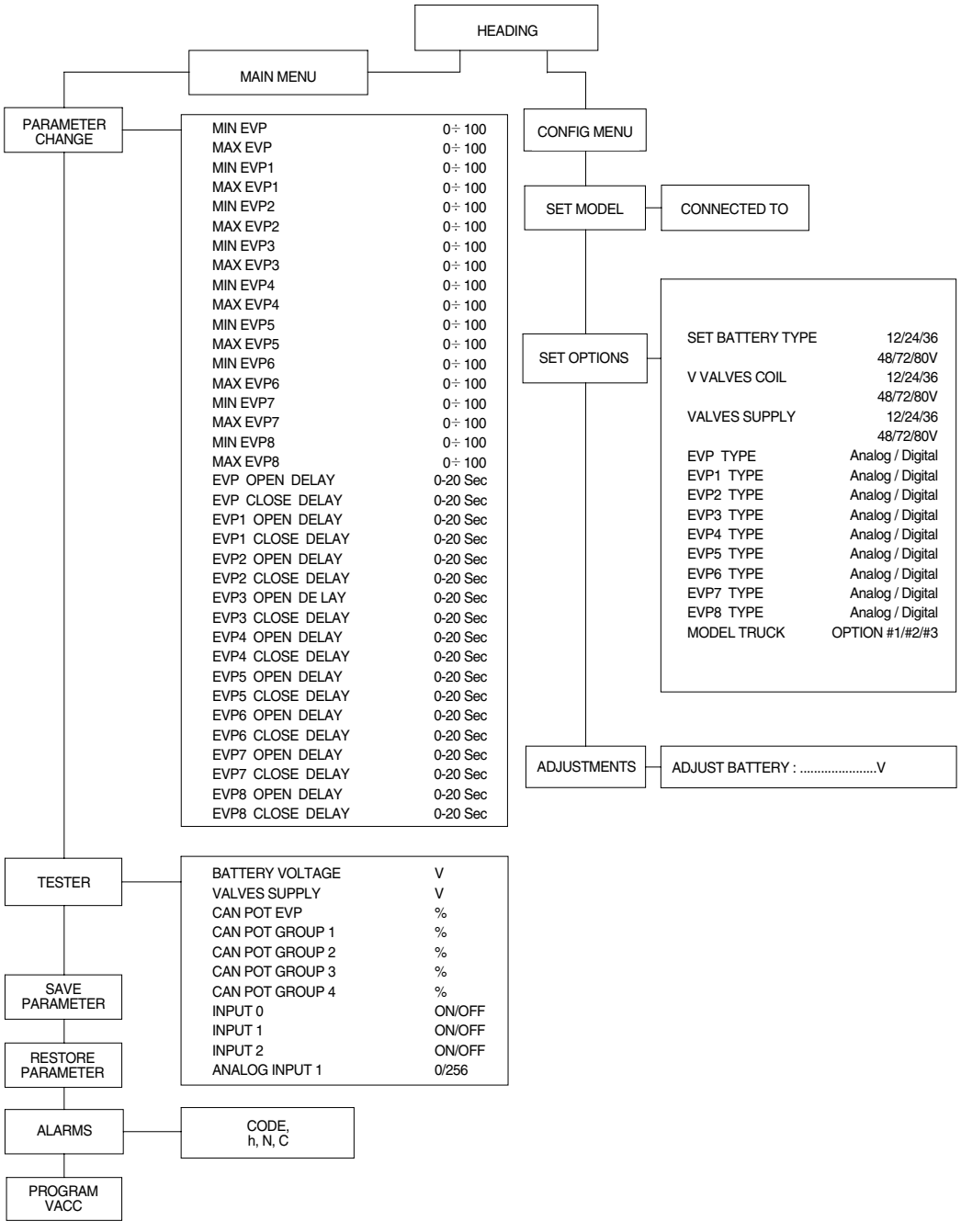
5) ADJUSTMENTS & FUNCTION

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

(1) Adjustments via console or buttons on a display

Adjustment of Parameters and changes to the controller's configuration are made using the Digital Console or buttons on a display. The console can be connected directly to Mhyrio CB (connector A), or it can be physically connected to another controller in the CANBUS net, then virtually connected to Mhyrio CB (which is node 9 of the net). If you don't have the console, you can do adjustments using the buttons on a display easily.

(2) Description of standard console menu



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(3) Description of parameters that may be programmed (parameter change)

In addition to the configuration, parameter settings can be factory set (default parameters), or the customer can make changes according to the application, using a digital console or a display. During the setting up procedure on the machine, the console can remain connected to the controller during travel. The parameters can be modified in real time, during operation. Pay attention to the polarity of the console connector. Refer to chapter 7.1 and 7.2 of this manual for connection details.

CONNECTION OF THE CONSOLE TO THE CONTROLLER MUST BE MADE WITH THE KEY SWITCH TURNED OFF.

The following parameters can be modified:

① **Min EVP**

This parameter adjusts the minimum current of the SINGLE valve, if it is set as proportional (see "set option menu").

② **Max EVP**

This parameter adjusts the MAXIMUM current of the SINGLE valve, if it is set as proportional (see "set option menu").

③ **Min EVP1**

This parameter adjusts the minimum current of valve 1, if it is set as proportional (see "set option menu").

④ **Max EVP1**

This parameter adjusts the maximum current of valve 1, if it is set as proportional (see "set option menu").

⑤ **Min EVP2**

This parameter adjusts the minimum current of valve 2, if it is set as proportional (see "set option menu").

⑥ **Max EVP2**

This parameter adjusts the maximum current of valve 2, if it is set as proportional (see "set option menu").

⑦ **Min EVP3**

This parameter adjusts the minimum current of valve 3, if it is set as proportional (see "set option menu").

⑧ **Max EVP3**

This parameter adjusts the maximum current of valve 3, if it is set as proportional (see "set option menu").

⑨ **Min EVP4**

This parameter adjusts the minimum current of valve 4, if it is set as proportional (see "set option menu").

⑩ **Max EVP4**

This parameter adjusts the maximum current of valve 4, if it is set as proportional (see "set option menu").

⑪ **Min EVP5**

This parameter adjusts the minimum current of valve 5, if it is set as proportional (see "set option menu").

⑫ **Max EVP5**

This parameter adjusts the maximum current of valve 5, if it is set as proportional (see "set option menu").

⑬ **Min EVP6**

This parameter adjusts the minimum current of valve 6, if it is set as proportional (see "set option menu").

⑭ **Max EVP6**

This parameter adjusts the maximum current of valve 6, if it is set as proportional (see "set option menu").

⑮ **Min EVP7**

This parameter adjusts the minimum current of valve 7, if it is set as proportional (see "set option menu").

⑯ **Max EVP7**

This parameter adjusts the maximum current of valve 7, if it is set as proportional (see "set option menu").

⑰ **Min EVP8**

This parameter adjusts the minimum current of valve 8, if it is set as proportional (see "set option menu").

⑱ **Max EVP8**

This parameter adjusts the maximum current of valve 8, if it is set as proportional (see "set option menu").

⑲ **EVP Open delay**

Single proportional valve current ramping up time: this parameter sets the single valve current ramp, to change from 0 A to operating current.

⑳ **EVP Close delay**

Single proportional valve current ramping down time: this parameter sets the single valve closing ramp, to change from operating current to 0 A.

㉑ **EVP1 Open delay**

EVP1 proportional valve current ramping up time: this parameter sets the EVP1 valve current ramp, to change from 0 A to operating current.

㉒ **EVP1 Close delay**

EVP1 proportional valve current ramping down time: this parameter sets the EVP1 valve closing ramp, to change the coil current from operating current to 0 A.

㉓ **EVP2 Open delay**

EVP2 proportional valve current ramping up time: this parameter sets the EVP2 valve current ramp, to change from 0 A to operating current.

㉔ **EVP2 Close delay**

EVP2 proportional valve current ramping down time: this parameter sets the EVP2 valve closing ramp, to change the coil current from operating current to 0 A.

㉕ **EVP3 Open delay**

EVP3 proportional valve current ramping up time: this parameter sets the EVP3 valve current ramp, to change from 0 A to operating current.

㉖ **EVP3 Close delay**

EVP3 proportional valve current ramping down time: this parameter sets the EVP3 valve closing ramp, to change the coil current from operating current to 0 A.

㉗ **EVP4 Open delay**

EVP4 proportional valve current ramping up time: this parameter sets the EVP4 valve current ramp, to change from 0 A to operating current.

㉘ **EVP4 Close delay**

EVP4 proportional valve current ramping down time: this parameter sets the EVP4 valve closing ramp, to change the coil current from operating current to 0 A.

㉙ **EVP5 Open delay**

EVP5 proportional valve current ramping up time: this parameter sets the EVP5 valve current ramp, to change from 0 A to operating current.

㉚ **EVP5 Close delay**

EVP5 proportional valve current ramping down time: this parameter sets the EVP5 valve closing ramp, to change the coil current from operating current to 0 A.

㉛ **EVP6 Open delay**

EVP6 proportional valve current ramping up time: this parameter sets the EVP6 valve current ramp, to change from 0 A to operating current.

㉜ **EVP6 Close delay**

EVP6 proportional valve current ramping down time: this parameter sets the EVP6 valve closing ramp, to change the coil current from operating current to 0 A.

㉝ **EVP7 Open delay**

EVP7 proportional valve current ramping up time: this parameter sets the EVP7 valve current ramp, to change from 0 A to operating current.

㉞ **EVP7 Close delay**

EVP7 proportional valve current ramping down time: this parameter sets the EVP7 valve closing ramp, to change the coil current from operating current to 0 A.

㉟ **EVP8 Open delay**

EVP8 proportional valve current ramping up time: this parameter sets the EVP8 valve current ramp, to change from 0 A to operating current.

㊱ **EVP8 Close delay**

EVP8 proportional valve current ramping down time: this parameter sets the EVP8 valve closing ramp, to change the coil current from operating current to 0 A.

(3-1) Description to change parameters by a console

The flow chart shows how to change parameters by a console.

① Opening finger tip controller menu (MHY CB)

② Press ENTER to go into the GENERAL MENU.

③ The display will show: PARAMETER CHANGE.

④ Press ENTER to go into the PARAMETER CHANGE menu.

⑤ The display will show the first parameter.

⑥ Press ROLL UP and ROLL DOWN buttons until desired parameter appears.

⑦ The names of the parameters appear on the display.

⑧ When the desired parameter appears, the display will show a level number that will be between 0 and 9. Press either SET UP or SET DOWN buttons to change the Level value.

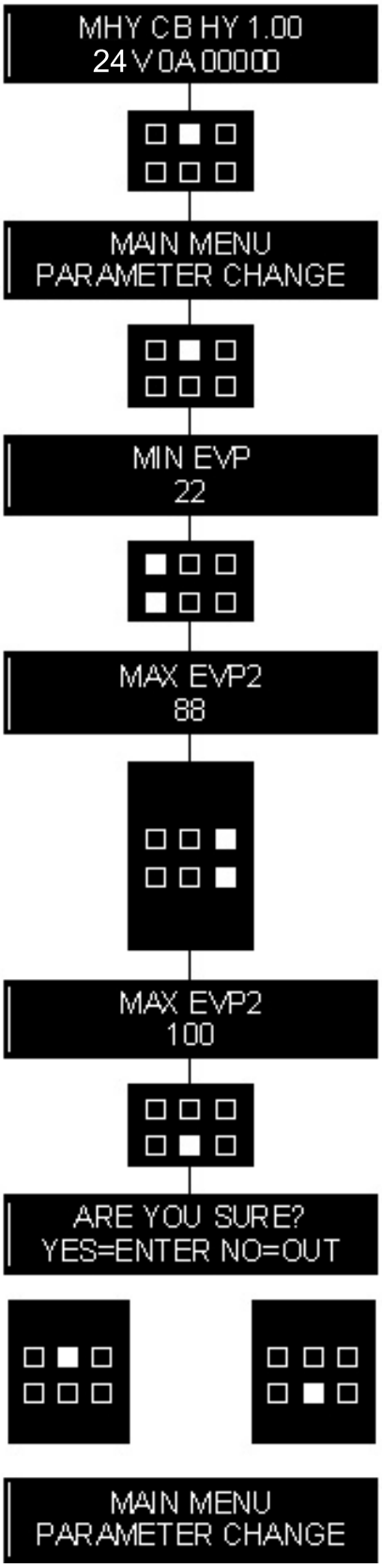
⑨ The display will show the new level.

⑩ When you are satisfied with the results of the changes you have made, press OUT.

⑪ The display asks: "ARE YOU SURE?".

⑫ Press ENTER to accept the changes, or press OUT if you do not wish to accept the changes and wish to make further modifications to the parameters.

⑬ The display will show: PARAMETER CHANGE.



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(3-2) Description to change parameters by a display

The flow chart shows how to change parameters by buttons on a display.

① Press [O] to enter password for 2~3 seconds.
The display will show: ENTER PASSWORD.

② Enter the password using [←] [→] and [↵].
After finishing entering it, press [←] for 2~3 sec

③ The display will show: TRUCK MENU.

④ Press [↵].

⑤ The display will show : CONNECTED TO :

⑥ If the display doesn't show : MHY CB HY 1.00,
Press [↑] or [↓] until MHY CB HY 1.00 appears on the display. After that, press [↵]

⑦ The display will show : CONNECTED TO:
With more information.

⑧ Press [↵] to go into the GENERAL MENU.

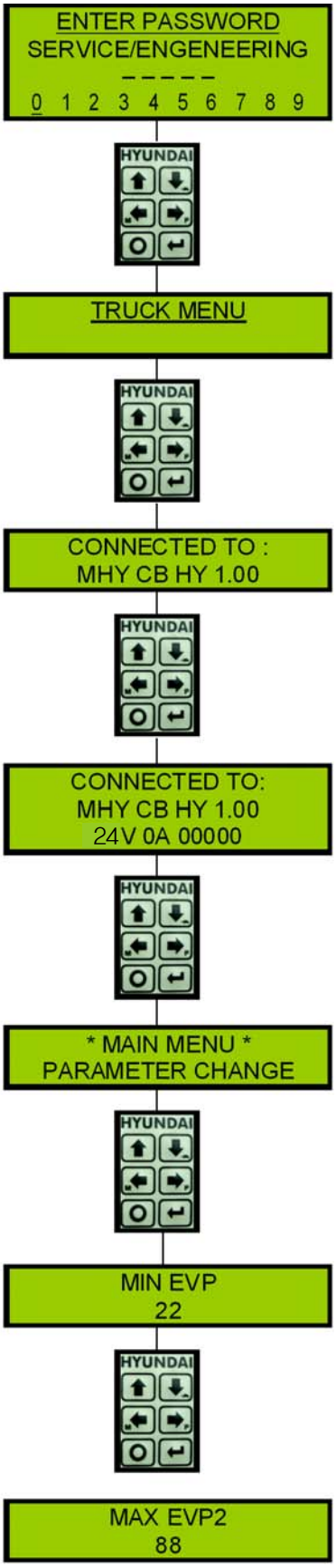
⑨ The display will show :.PARAMETER CHANGE

⑩ Press [↵] to go into the PARAMETER CHANGE menu.

⑪ The display will show : MIN EVP

⑫ Press [↑] and [↓] until desired parameter appears.

⑬ The names of parameters appear on the display.



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① When the desired parameter appears, the display will show a level number that will be between 0 and 9. Press either [M] or [P] to change the level value

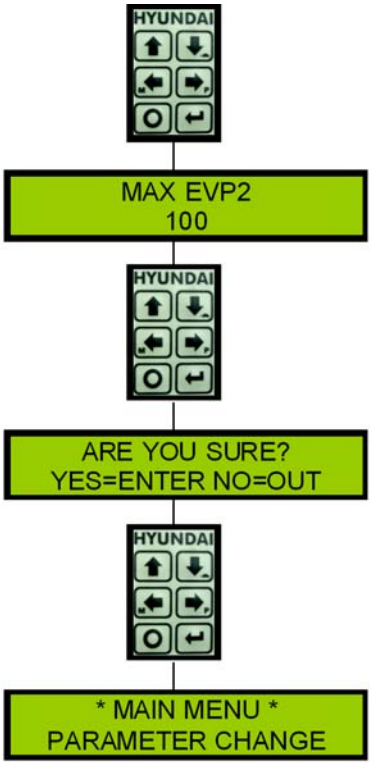
② The display will show the new level.

③ When you are satisfied with the results of the changes you have made, press [O].

④ The display asks : "ARE YOU SURE?"

⑤ Press [↵] to accept the changes,or press [O] if you do not wish to accept the changes and wish to make further modifications to the parameters.

⑥ The display will show: PARAMETER CHANGE



BRJ7EL65

(4) TESTER MENU

Following parameters can be measured in real time in the TESTER menu:

① Battery voltage
Level of battery voltage measured at the input of the key switch.

② Valves supply
Level of voltage at the positive valve supply input (B2).

③ CAN POT EVP
Single proportional valve current set point, received by canbus.

④ CAN POT group 1
Group 1 proportional valves current set point, received by canbus.

⑤ CAN POT group 2
Group 2 proportional valves current set point, received by canbus.

⑥ CAN POT group 3
Group 3 proportional valves current set point, received by canbus.

⑦ CAN POT group 4
Group 4 proportional valves current set point, received by canbus.

⑧ Input 0
Level of digital input 0:
- ON / +VB : input active, switch closed
- OFF / COND : input not active, switch open.

⑨ Input1
Level of digital input 1:
- ON / +VB : input active, switch closed
- OFF / COND : input not active, switch open.

⑩ Input 2

Level of digital input 2 :

- ON / +VB : input active, switch closed
- OFF / COND : input not active, switch open.

⑪ Analog input 1

Voltage of the analog input.

(4-1) Description to check data by a console

The flow chart shows how to use the TESTER function of the digital console**.**

① Opening finger tip controller menu (MHY CB)

② Press ENTER to go into the GENERAL MENU.

③ The display will show: PARAMETER CHANGE.

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

⑤ The display shows: TESTER.

⑥ Press ENTER to go into the TESTER function.

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

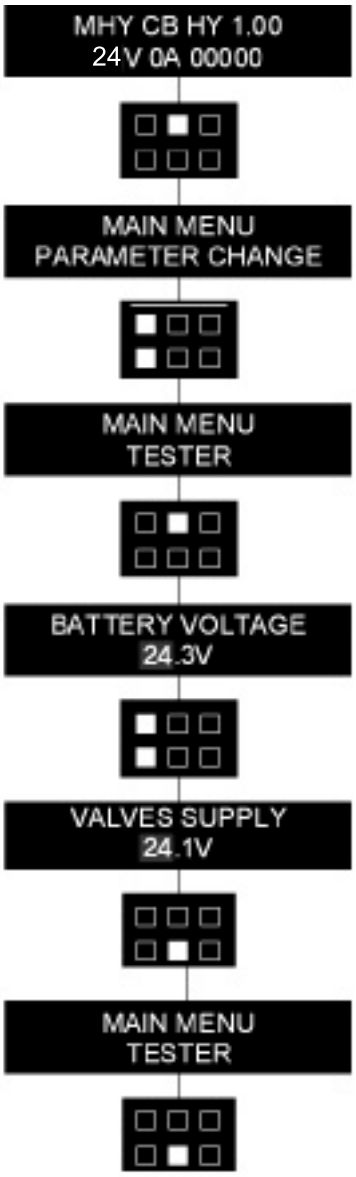
⑧ Press either ROLL UP or ROLL DOWN buttons.

⑨ Next variable for measurement appears.

⑩ When you have finished, press OUT.

⑪ The display shows: TESTER.

⑫ Press OUT again and return to opening HY menu.



BTR9EL66

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.

(4-2) Description to check data by a display

The flow chart shows how to use the TESTER function of buttons on a display.

① Press [O] to enter password for 2~3 seconds.
The Display will show: ENTER PASSWORD.

② Enter the password using [◀M] [▶P] and [↵].
After finishing entering it, press [◀M] for 2~3 sec

③ The display will show: TRUCK MENU.

④ Press [↵]

⑤ The display will show : CONNECTED TO :

⑥ If the display doesn't show : MHY CB HY 1.00,
Press [↑] or [↓] until MHY CB HY 1.00 appears on the display. After that, press [↵]

⑦ The display will show : CONNECTED TO:
With more information.

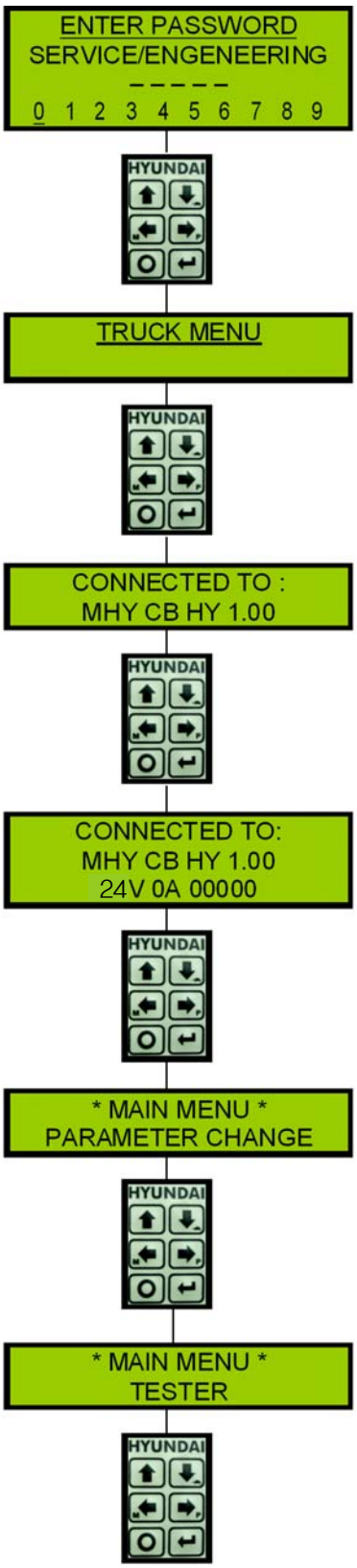
⑧ Press [↵] to go into the GENERAL MENU.

⑨ The display will show : PARAMETER CHANGE

⑩ Press [↑] or [↓] until TESTER menu appears on the display.

⑪ The display shows : TESTER

⑫ Press [↵] to go into the TESTER function.



BTR9EL67

① The first variable to be tested is shown on the display

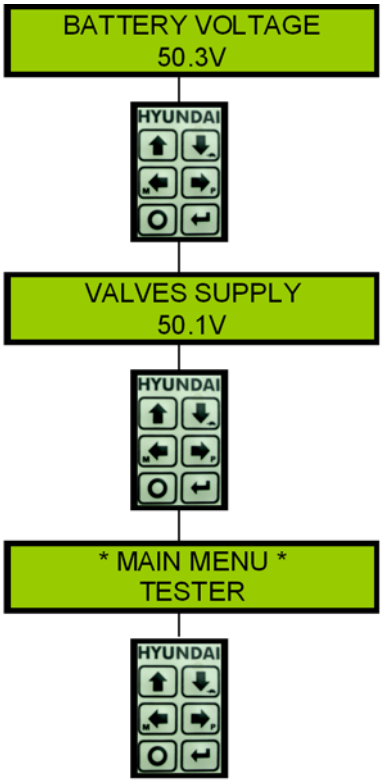
② Press either ⬆ or ⬇.

③ Next variable for measurement appears.

④ When you have finished, press O.

⑤ The display shows : TESTER

⑥ Press O again and return to MHY CB HY.



BRJ7EL68

6) ANALYSIS OF ALARMS

① **EEPROM KO**

Fault in the area of memory where the adjustment parameters are stored. This Alarm does not inhibit machine operation but operation goes on with default values; if fault is still present when the Key Switch is re-cycled, replace the logic. If the fault disappears, the previously stored Parameters will have been replaced by the default parameters.

② **CAN BUS KO**

There is a problem related to the CAN-BUS line. The error is signalled if the MHYRIO controller 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.

③ **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.

④ **WRONG SET BATTERY**

This fault is signalled if the battery voltage is non consistent with the set battery programmed in the 'set option' menu.

⑤ **Undervoltage**

This fault is signalled if an undervoltage condition is detected in the MHYRIO power supply.

⑥ **FF valves**

Flip-flop circuit, that manages on/off valve drivers short-circuit protection, does not reset in the correct way. The problem is probably in the hardware circuit.

⑦ **Coil shorted**

ON/OFF valves drivers are protected against coil short circuit; if a short is present across the coil, the flip-flop circuit is set and the alarm is signalled.

⑧ **EV driver short**

One of the on/off valves driver is shorted; check the external connection, if it is ok the driver is probably damaged.

⑨ **EVP driver short**

The single proportional valve driver is shorted; check the external connection, if it is ok the driver is probably damaged.

⑩ **EVPG1 driver short**

One of the Group 1 valves drivers is shorted; check the external connection, if it is ok the driver is probably damaged.

⑪ **EVPG2 driver short**

One of the Group 2 valves drivers is shorted; check the external connection, if it is ok the driver is probably damaged.

⑫ **EVPG3 driver short**

One of the Group 3 valves drivers is shorted; check the external connection, if it is ok the driver is probably damaged.

⑬ **EVPG4 driver short**

One of the Group 4 valves drivers is shorted; check the external connection, if it is ok the driver is probably damaged.

⑭ **EV driver KO**

One of the On/Off valves drivers is open (it does not close when it is commanded by the microcontroller).

⑮ **EVP driver KO**

The single proportional valve driver is open (it does not close when it is commanded by the microcontroller).

⑯ **EVPG1 driver KO**

One of the Group 1 valves drivers is open (it does not close when it is commanded by the microcontroller).

⑰ **EVPG2 driver KO**

One of the Group 2 valves drivers is open (it does not close when it is commanded by the microcontroller).

⑱ **EVPG3 driver KO**

One of the Group 3 valves drivers is open (it does not close when it is commanded by the microcontroller).

⑲ **EVPG4 driver KO**

One of the Group 4 valves drivers is open (it does not close when it is commanded by the microcontroller).

⑳ **HI side driver KO**

The high side driver which supply the valves coils positive is shorted or open.

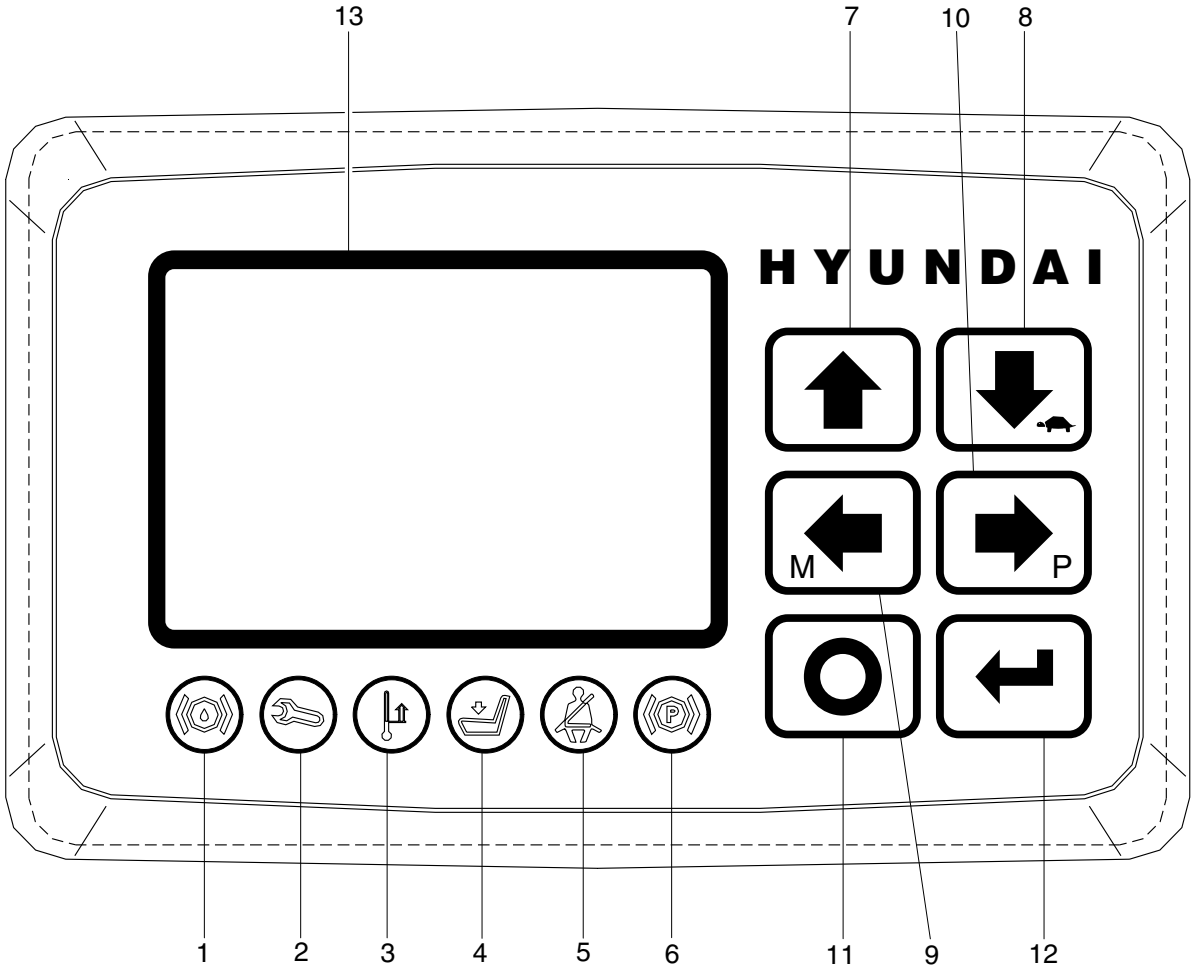
㉑ **Waiting for PEV**

There isn't the valves positive power supply. Check B2 input then verify the VALVES SUPPLY parameter is correctly set.

7. 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.



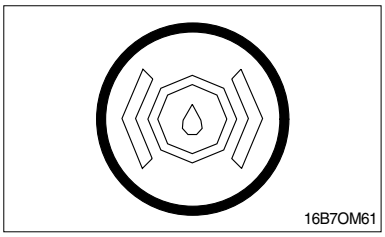
15B7OM65

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

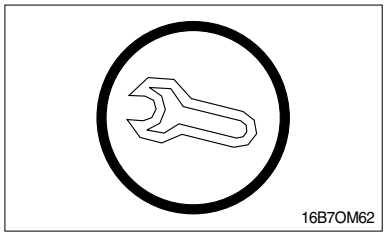
When the key switch is OFF, the display makes a general test lighting and switching OFF all the LED in sequence.

(1) Oil level warning lamp (Option)



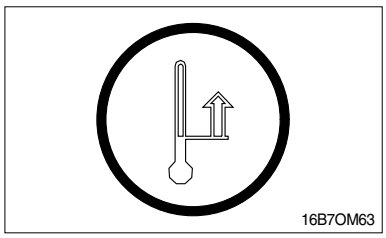
This LED lights when the measured oil level of the hydraulic circuit is under the minimum acceptable mark.
To connect the oil sensor output to the Analogue Input #1.

(2) Wrench warning lamp



This LED blinks when truck is in alarm condition.

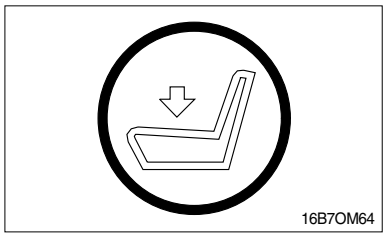
(3) Thermometer warning lamp



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

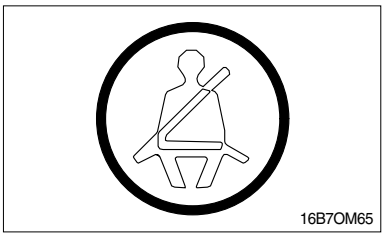
※ IMS : Input motor switch

(4) Seat warning lamp



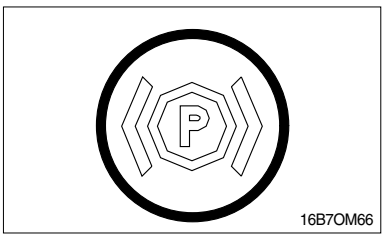
This LED lights when the operator is not on the seat.

(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

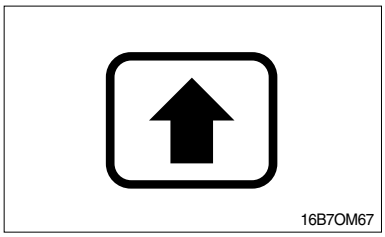


(1) This LED lights when the handbrake is activated.

3) TESTER MENU

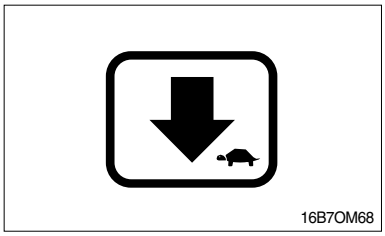
Status of keyboard buttons can be monitored in real time in the TESTER menu.

(1) Key 1 button



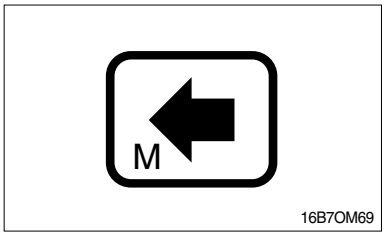
Status of ↑ keyboard button:
ON = Input active, button pushed
OFF = Input not active, button released

(2) Key 2 button



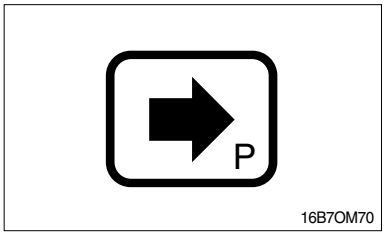
Status of ↓ TURTLE keyboard button:
ON = Input active, button pushed
OFF = Input not active, button released

(3) Key 3 button



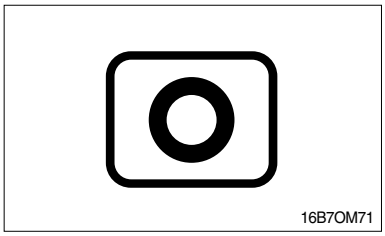
Status of ← M (Menu) keyboard button:
ON = Input active, button pushed
OFF = Input not active, button released

(4) Key 4 button



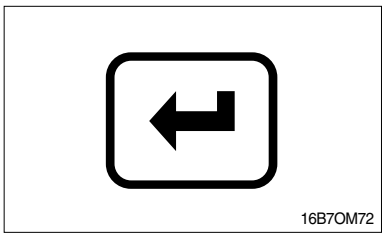
Status of → P (Performance) keyboard button:
ON = Input active, button pushed
OFF = Input not active, button released

(5) Key 5 button



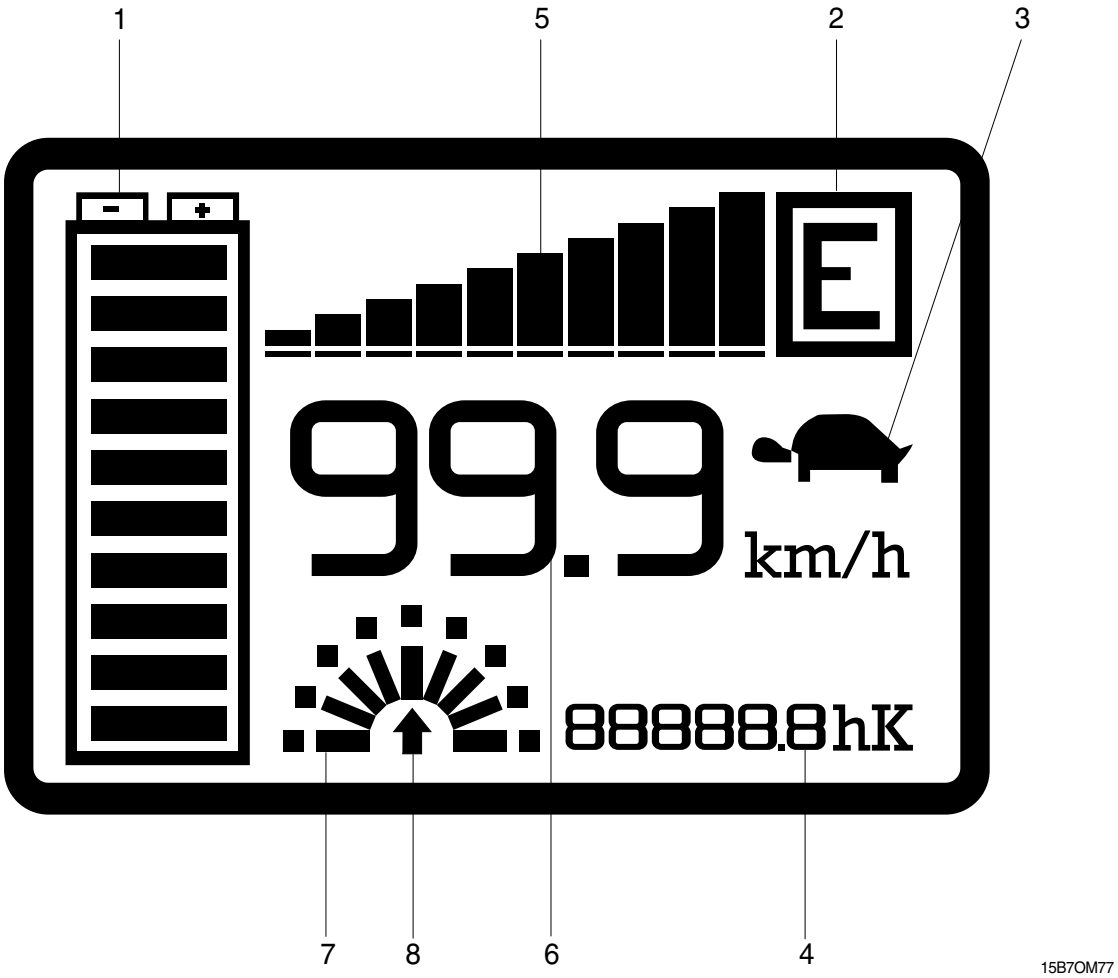
Status of O (Esc) keyboard button:
ON = Input active, button pushed
OFF = Input not active, button released

(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 [P] . 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 running direction. The arrow point is up 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
09	MHYRIO (Option)
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" warnig 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.

⑩ **Steer angle**

The options are :

ON : It shows the direction of steering on display.

OFF : It don't shows the direction of steering on display. It just shows the direction of forward and backward.

⑪ **Model**

The options are :

Option #1 : Conunterbalanced type truck

Option #2 : Reach type truck

(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.

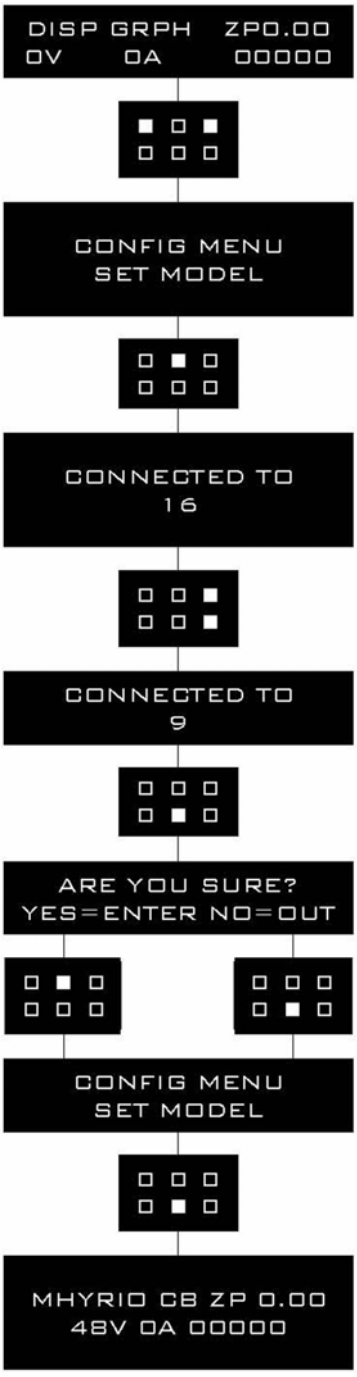
⑨ The display will ask "ARE YOU SURE?"

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.

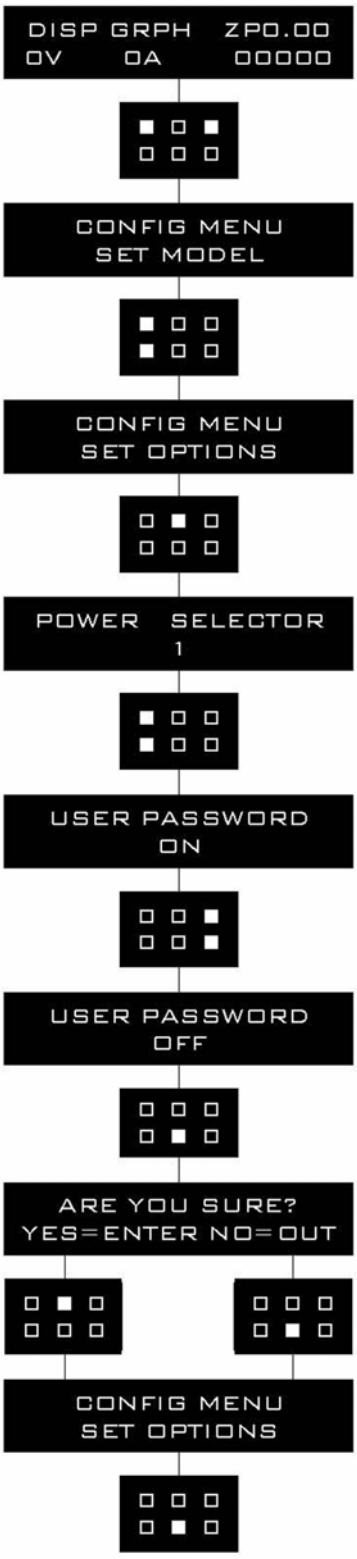
⑫ Press OUT to exit the menu.

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.

□ 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.

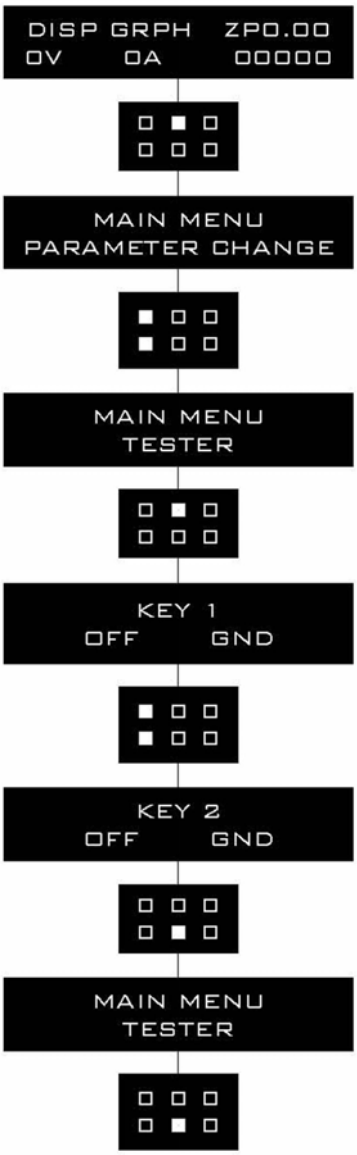
⑧ Press either ROLL UP or ROLL DOWN buttons.

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.

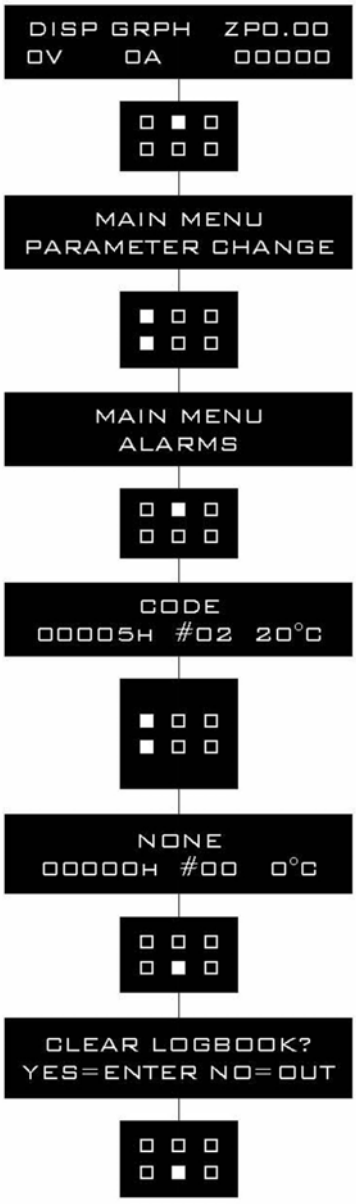
⑧ Each press of ROLL UP button brings up following alarms. Pressing ROLL DOWN returns to the most recent.

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.

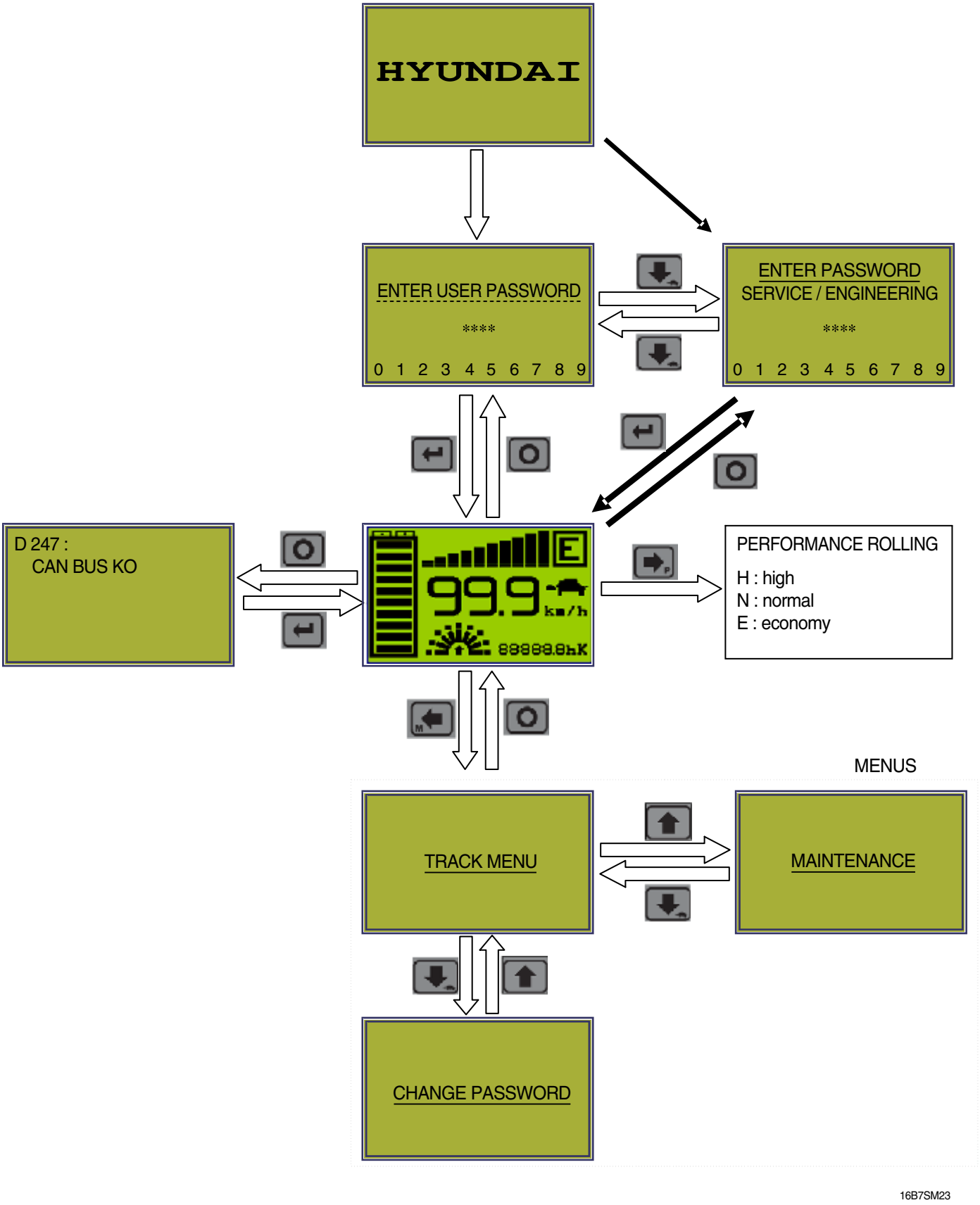
At turn on the display shows the HYUNDAI logo for some seconds, then asks the starting password to have access to the main page (if "USER PASSWORD" option is ON), otherwise it shows directly the main page (if "USER PASSWORD" option is OFF).

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.

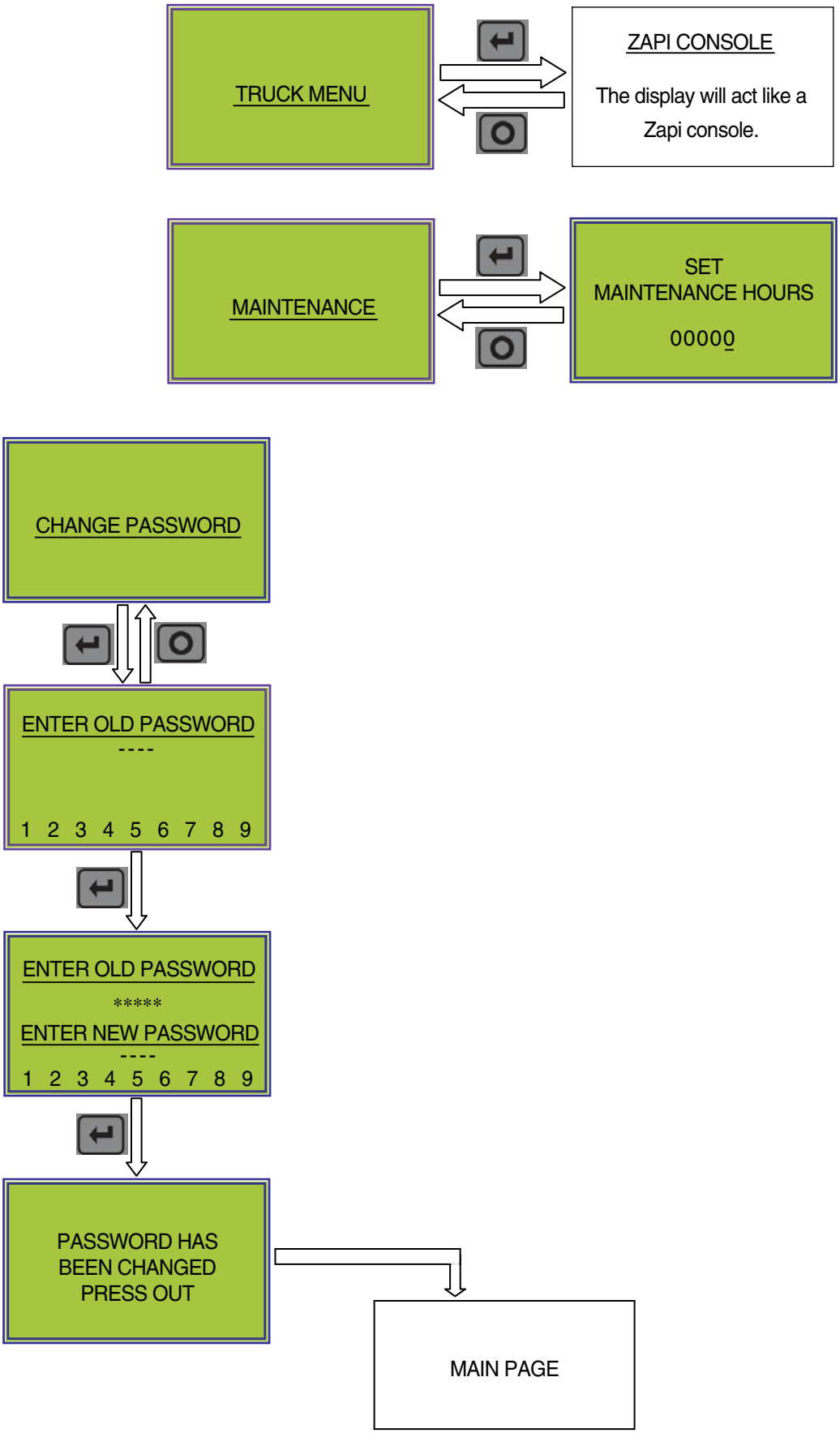
From the main page it is possible to have access to the ALARM page (if alarms occur) and to MENUS page. The CHANGE PASSWORD MENU is always accessible and visible, while the others ones are accesible and showed, by entering service password. To enter this password is necessary to push the out button (button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

16B7SM23


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

(1) Traction controller

Code	Alarm name	Description	Condition that has to occur to come out from alarm status
13	EEPROM KO	Warning: Eeprom fault, controller will use default parameters	- To remove Warning cause
17	LOGIC FAILURE #3	Alarm: failure in over-load protection hw circuit	- To remove alarm condition + activation of traction request - Check the controller
18	LOGIC FAILURE #2	Alarm: failure in U, V, W voltage feedback circuit	- To remove alarm condition + activation of traction request
19	LOGIC FAILURE #1	Alarm: an overvoltage or undervolt. condition has been detected	- To recycle the key switch - Sometimes if battery voltage is too low, it can be happens - Check the controller
30	VMN LOW	Alarm: wrong voltage on motor power outputs; failure in the power section or in the mosfet driver circuit or in the motor	- If the alarm is present in Init status, remove the alarm condition - If the alarm has occurred in stby or running mode, it is necessary to remove alarm condition and to activate a traction request - Check the U, V, W cable and motor and if there is any shorted circuit with frame or any other parts of truck - Check the controller
31	VMN HIGH	Alarm: wrong voltage on motor power outputs; failure in the power section or in the mosfet driver circuit or in the motor	- If the alarm is present in Init status, remove the alarm condition - If the alarm has occurred in stby or running mode, it is necessary to remove alarm condition and to activate a traction request - Check the U, V, W cable and motor and if there is any shorted circuit with frame or any other parts of truck - Check the controller
37	CONTACTOR CLOSED	Alarm: line contactor power contact is stuck	- To remove alarm cause within a timeout; if the timeout is elapsed, it is necessary to re-cycle the key - Check the contactor & cables attached to the contactor
38	CONTACTOR OPEN	Alarm: line contactor power contact does not pull-in	- To remove alarm cause within a timeout; if the timeout is elapsed, it is necessary to re-cycle the key - Check the contactor & cables attached to the contactor
53	STBY I HIGH	Alarm: wrong voltage in the current sensor feedback circuit	- If the alarm is present in Init status, remove the alarm condition - If the alarm has occurred in stby or running mode, it is necessary to remove alarm condition and to activate a traction request

Code	Alarm name	Description	Condition that has to occur to come out from alarm status
60	CAPACITOR CHARGE	Alarm: power capacitor voltage does not increase when the key is turned ON; failure in the power section, or in the Logic PCB, or in the driver PCB, or in the motor	- To remove alarm condition - Check the contactor resistance (300 Ω, 10W) - Check the controller
62	TH. PROTECTION	Warning: Traction temperature higher than 75˚C	- To remove Warning cause
65	MOTOR TEMPERAT.	Warning: Traction motor temperature high	- To remove Warning cause - Check the motor temp-sensor
66	BATTERY LOW	Warning: battery charge level below 10%	- To remove Warning cause
74	DRIVER SHORTED	Alarm: line contactor coil driver is shorted	- If the alarm is present in Init status, remove the alarm cause - If the alarm has occurred in stby or running mode, it is necessary to remove alarm cause and to activate traction request
75	CONTACTOR DRIVER	Alarm: line contactor coil driver is open (not able to drive the coil to the correct voltage)	- To remove alarm cause and to activate traction request
78	VACC NOT OK	Warning: acc. signal (CPOT) voltage higher than VACC MIN +1V while the traction enable switch is open	- To remove Warning cause - Re-configurate VASS ACCEL
79	INCORRECT START	Warning: wrong traction request sequence	- To remove Warning cause
80	FORW + BACK	Warning: forward and reverse inputs are both active	- To remove Warning cause
82	ENCODER ERROR	Alarm: motor speed sensor (encoder) does not work properly	- To recycle the key - Check the motor encoder
84	STEER SENSOR KO	Alarm: steering sensor signal out of range	- To remove alarm cause
217	SENS MOT TEMP KO	Warning: The output of the motor thermal sensor is out of range	- To remove warning cause
221	SEAT MISMATCH	Alarm: seat input mismatch between PUMP and TRAC controller	- Check the wire connection. Need to recycle the key
223	WATCHDOG#1	Alarm: The watchdog signal #1 is not in the correct status	- To remove alarm cause

Code	Alarm name	Description	Condition that has to occur to come out from alarm status
224	AUX COIL SHORT	Alarm: shortcircuit on EB/AUX coil	- To remove alarm cause
226	VACC OUT RANGE	Waring: The accelerator input is out of the range Vacc_min ÷ Vacc_max, which has been acquired with “PROGRAMM VACC” function	- Try to perform a program VACC
227	WATCHDOG#2	Alarm: The watchdog signal #2 is not in the correct status	- To remove alarm cause
228	CHAT TIME	Warning: the chat time has expired	- To activate traction or pump request
229	SAFETY INPUT	Alarm: The safety input is open (it is not connected to -Batt)	- To remove alarm cause
230	MC COIL SHORT	Alarm: shortcircuit on MC coil	- To remove alarm cause
231	COIL SHORT HW KO	Alarm: The harware to check a MC or EB/AUX coil shorted is damaged	- Check the controller
232	KEY OFF SHORT	Alarm: At Start-up the Keyoff logic signal is low	- Check the connection. Check the key input signal.
233	POWER MOS SHORT	Alarm: Short circuit on the power Mosfets	- Check the controller
234	DISPLAY ENABLE	Warning: the display enable signal has not been received to operate the truck	- To remove warning cause
235	HANDBRAKE	Warning: handbrake microswitch is open and a travel request is active	- To remove Warning cause
236	CURRENT GAIN	Warning: The Maximum current gain parameters are the default values, which means the maximum current adjustment procedure has not been carried out yet	- Check the controller
237	ANALOG INPUT	Alarm: the analog channel ready is not updated	- Check the controller
238	WRONG 0 VOLTAGE	Alarm: The motor phases voltage feedback are out of permitted range	- To remove alarm cause
239	SAFETY OUTPUT	Alarm: The Safety-out driver is damaged (shorted or open)	- To remove alarm cause
240	HARDWARE FAULT	Alarm: The mosfets driver are not switched off with watch-dog signal in alarm status	- Check the controller
241	FLASH CHECKSUM	Alarm: The program verify is not OK	- Try to program the controller again. Check the controller logic board

Code	Alarm name	Description	Condition that has to occur to come out from alarm status
242	MOTOR STALL	Warning: the encoder signal is constantly zero when the maximum torque is applied to the motor	- To recycle the key - Check the motor and encoder
243	SEQUENCE FAULT	Warning: an incorrect start sequence has been detected on the seat, pedal and levers commands	- To remove Warning cause
245	WRONG RAM MEMORY	Alarm: The program checks the contents of main RAM registers and find a “dirty value”	- Check the controller
246	AUX DRIV.OPEN	Alarm: Driver of EB/AUX coil is damaged (not able to apply the brake)	- Check the controller
248	NO CAN MSG.	Alarm: Traction has lost Can communication with #X	- To remove alarm cause - Check if any other alarm happens (Some alarms such as CHAT TIME or PEDAL WIRE KO, alarms related to CONTACTOR, DISPLAY ENABLE, alarms related to CANBUS can make this alarm sometimes.) - Check the communication with all controllers
249	CHECK UP NEEDED	Warning: truck reached the hour time for maintenance	- Reset the checkup hour time
250	THERMIC SENS. KO	Warning: Traction temp. sensor is out of range	- To remove Warning cause
251	WRONG SET BAT.	Alarm: the battery voltage does not correspond to SET BATTERY programming	- To remove alarm cause
253	SLIP_PROFILE	Warning: Error on the parameters of the slip profile setting	- Check in the hardware settings menu the value of those parameters
254	AUX DRIV.SHRT.	Alarm: the EB/AUX driver is shorted so it is not able to open the contactor	- Check the controller

(2) Pump controller

Code	Alarm name	Description	Condition that has to occur to come out from alarm status
13	EEPROM KO	Warning: Eeprom fault, controller will use default parameters	- To remove Warning cause
17	LOGIC FAILURE #3	Alarm: failure in over-load protection hw circuit	- To remove alarm condition + activation of pump request - Check the controller
18	LOGIC FAILURE #2	Alarm: failure in U, V, W voltage feedback circuit	- To remove alarm condition + activation of pump request
19	LOGIC FAILURE #1	Alarm: an overvoltage or undervolt. condition has been detected	- To recycle the key switch - Sometimes if battery voltage is too low, it can be happens - Check the controller
30	VMN LOW	Alarm: wrong voltage on motor power outputs; failure in the power section or in the mosfet driver circuit or in the motor	- If the alarm is present in Init status, remove the alarm condition - If the alarm has occurred in stby or running mode, it is necessary to remove alarm condition and to activate a pump request - Check the U, V, W cable and motor and if there is any shorted circuit with frame or any other parts of truck - Check the controller
31	VMN HIGH	Alarm: wrong voltage on motor power outputs; failure in the power section or in the mosfet driver circuit or in the motor	- If the alarm is present in Init status, remove the alarm condition - If the alarm has occurred in stby or running mode, it is necessary to remove alarm condition and to activate a pump request - Check the U, V, W cable and motor and if there is any shorted circuit with frame or any other parts of truck - Check the controller
37	CONTACTOR CLOSED	Alarm: line contactor power contact is stuck	- To remove alarm cause within a timeout; if the timeout is elapsed, it is necessary to re-cycle the key - Check the contactor & cables attached to the contactor
38	CONTACTOR OPEN	Alarm: line contactor power contact does not pull-in	- To remove alarm cause within a timeout; if the timeout is elapsed, it is necessary to re-cycle the key - Check the contactor & cables attached to the contactor
53	STBY I HIGH	Alarm: wrong voltage in the current sensor feedback circuit	- If the alarm is present in Init status, remove the alarm condition - If the alarm has occurred in stby or running mode, it is necessary to remove alarm condition and to activate a pump request

Code	Alarm name	Description	Condition that has to occur to come out from alarm status
60	CAPACITOR CHARGE	Alarm: power capacitor voltage does not increase when the key is turned ON; failure in the power section, or in the Logic PCB, or in the driver PCB, or in the motor	- To remove alarm condition - Check the contactor resistance (300 Ω, 10W) - Check the controller"
62	TH. PROTECTION	Warning: Pump temperature higher than 75˚C	- To remove Warning cause
65	MOTOR TEMPERAT.	Warning: Pump motor temperature high	- To remove Warning cause - Check the motor temp-sensor
74	DRIVER SHORTED	Alarm: line contactor coil driver is shorted	- If the alarm is present in Init status, remove the alarm cause - If the alarm has occurred in stby or running mode, it is necessary to remove alarm cause and to activate pump request
75	CONTACTOR DRIVER	Alarm: line contactor coil driver is open (not able to drive the coil to the correct voltage)	- To remove alarm cause and to activate pump request
78	VACC NOT OK	Warning: lift signal (CPOT) voltage higher than VACC MIN +1V while the lift enable switch is open	- To remove Warning cause - Re-configurate VASS ACCEL
79	INCORRECT START	Warning: wrong pump request sequence	- To remove Warning cause
80	FORW + BACK	Warning: forward and reverse inputs are both active	- To remove Warning cause
82	ENCODER ERROR	Alarm: motor speed sensor (encoder) does not work properly	- Tto recycle the key - Check the motor encoder
206	POT MISMATCH FT1	Alarm: FT1 dual signal mismatch	- Check the wire connections
207	POT MISMATCH FT2	Alarm: FT2 dual signal mismatch	- Check the wire connections
208	SHIFT OUT OF RNG	Warning: Shift signal is out of range	- Check the wire connections
209	AUX OUT OF RANGE	Warning: Aux signal is out of range	- Check the wire connections
210	TILT OUT OF RNG.	Warning: Tilt signal is out of range	- Check the wire connections
211	LIFT OUT OF RNG.	Warning: Lift signal is out of range	- Check the wire connections
212	ACQUIRE FT4	Warning: FT4 acquisition is wrong (aux)	- Make a new acquisition

Code	Alarm name	Description	Condition that has to occur to come out from alarm status
213	ACQUIRE FT3	Warning: FT3 acquisition is wrong (shift)	- Make a new acquisition
214	ACQUIRE FT2	Warning: FT2 acquisition is wrong (tilt)	- Make a new acquisition
215	ACQUIRE FT1	Warning: FT1 acquisition is wrong (lift/lower)	- Make a new acquisition
216	MHYRIO IN ALARM	Warning: Mhyrio is in alarm	- To remove Warning cause
217	SENS MOT TEMP KO	Warning: The output of the motor thermal sensor is out of range.	- To remove warning cause
218	LOADSENS.OUT RNG	Warning: load sensor out of range	- To remove warning cause
219	FORKS OVERLOADED	Warning: overload weight is reached	- To remove warning cause
221	SEAT MISMATCH	Alarm: seat input mismatch between PUMP and TRAC controller	- Check the wire connection. Need to recycle the key
223	WATCHDOG#1	Alarm: The watchdog signal #1 is not in the correct status	- To remove alarm cause
224	AUX COIL SHORT	Alarm: shortcircuit on EB/AUX coil	- To remove alarm cause
226	VACC OUT RANGE	Waring:The lift input is out of the range Vacc_min ÷ Vacc_ max, which has been acquired with “PROGRAMM VACC” function	- Try to perform a program VACC
227	WATCHDOG#2	Alarm: The watchdog signal #2 is not in the correct status	- To remove alarm cause
228	CHAT TIME	Warning: the chat time has expired	- To activate traction or pump request
229	SAFETY INPUT	Alarm: The safety input is open (it is not connected to -Batt)	- To remove alarm cause
230	MC COIL SHORT	Alarm: shortcircuit on MC coil	- To remove alarm cause
231	COIL SHORT HW KO	Alarm: The harware to check a MC or EB/AUX coil shorted is damaged	- Check the controller
232	KEY OFF SHORT	Alarm: At Start-up the Keyoff logic signal is low	- Check the connection. Check the key input signal.
233	POWER MOS SHORT	Alarm: Short circuit on the power Mosfets	- Check the controller
234	DISPLAY ENABLE	Warning: the display enable signal has not been received to operate the truck	- To remove warning cause

Code	Alarm name	Description	Condition that has to occur to come out from alarm status
235	HANDBRAKE	Warning: handbrake microswitch is open and a travel request is active	- To remove Warning cause
236	CURRENT GAIN	Warning: The Maximum current gain parameters are the default values, which means the maximum current adjustment procedure has not been carried out yet	- Check the controller
237	ANALOG INPUT	Alarm: the analog channel ready is not updated	- Check the controller
238	WRONG 0 VOLTAGE	Alarm: The motor phases voltage feedback are out of permitted range	- To remove alarm cause
239	SAFETY OUTPUT	Alarm: The Safety-out driver is damaged (shorted or open)	- To remove alarm cause
240	HARDWARE FAULT	Alarm: The mosfets driver are not switched off with watch-dog signal in alarm status	- Check the controller
241	FLASH CHECKSUM	Alarm: The program verify is not OK	- Try to program the controller again. Check the controller logic board
242	MOTOR STALL	Warning: the encoder signal is constantly zero when the maximum torque is applied to the motor	- To recycle the key - Check the motor and encoder
248	NO CAN MSG.	Alarm: Pump has lost Can communication with #X	- To remove alarm cause - Check if any other alarm happens (Some alarms such as CHAT TIME or PEDAL WIRE KO, alarms related to CONTACTOR, DISPLAY ENABLE, alarms related to CANBUS can make this alarm sometimes.) - Check the communication with all controllers
249	CHECK UP NEEDED	Warning: truck reached the hour time for maintenance.	- Reset the checkup hour time
250	THERMIC SENS. KO	Warning: Pump temp. sensor is out of range	- To remove Warning cause
251	WRONG SET BAT.	Alarm: the battery voltage does not correspond to SET BATTERY programming	- To remove alarm cause
253	SLIP_PROFILE	Warning: Error on the parameters of the slip profile setting.	- Check in the hardware settings menu the value of those parameters
254	AUX DRIV.SHRT.	Alarm: the EB/AUX driver is shorted so it is not able to open the contactor	- Check the controller

8. 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.

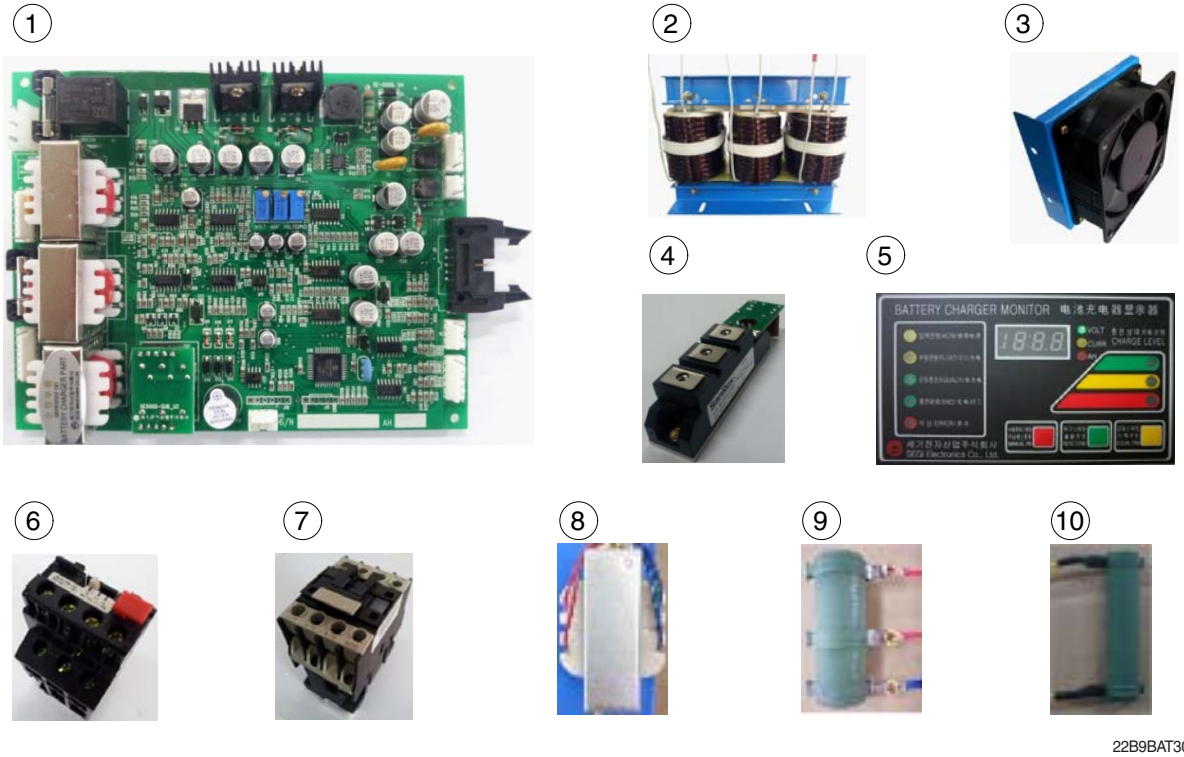
④ Check the electrolyte of the battery every week and provide distilled water immediately if it is required. (Electrolyte has to be provided between 10~12 ㎜ level on the positive plate inside storage battery)

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)



22B9BAT30

1	Main PCB board	5	Monitor PCB	9	Resistance (RD)
2	Main trans (Class H)	6	Overload	10	Resistance (DR)
3	Cooling fan	7	MG S/W		
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) Table for capacity of charger input cable

48 V battery	Capacity of cable	Input voltage	Remarks
200-365 AH	4P - 2.5 mm^2	Based on 3 ø 380 V 3 ø 440 V	For 3 ø 220V, one step higher capacity cable should be used. (2.5 mm^2 → 4mm^2)
400-580 AH	4P - 4 mm^2		
600-800 AH	4P - 6 mm^2		
850-1000 AH	4P - 10 mm^2		
24 V battery	-		
200-600 AH	4P - 2.5 mm^2		
700-1000 AH	4P - 4 mm^2		
80V battery	-		
500-600 AH	4P - 6 mm^2		
700-800 AH	4P - 10 mm^2		

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.

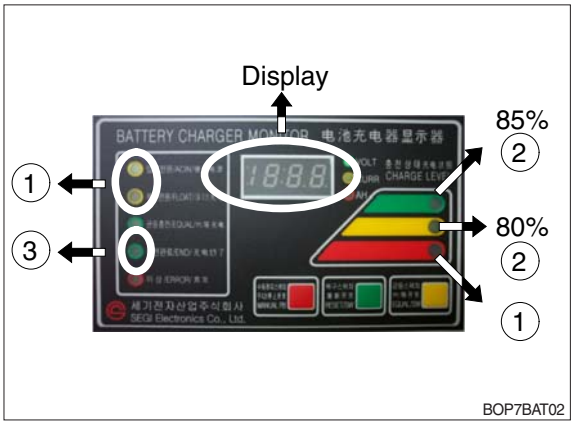
· **According to charging condition**

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 A charging voltage, current, amount and time are displayed in order on a monitor display window.

③ 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.

④ 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.

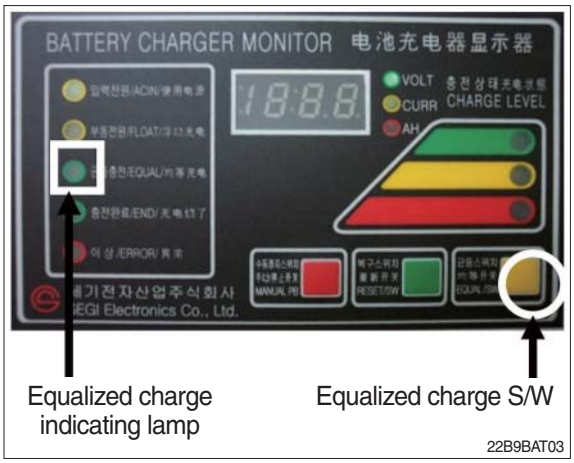
When equalized charging is required?

- 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.**



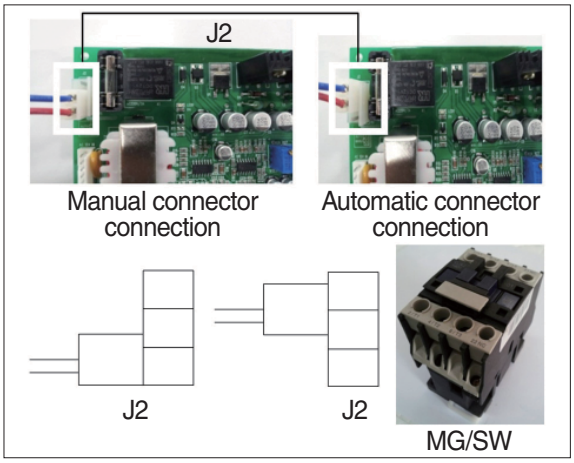
22B9BAT03

(3) Automatic/Manual switching method

Automatic connector. Manual switching connector (J2) is located on a left top corner of PCB.

※ **In case of manual switching for charger checking, make sure that the battery connector is separated beforehand.**

⊙ MG/SW operation
(Refer to the charger trouble SHEET components manual)



22B9BAT04

(4) Checking charging voltage soft start function (Refer to the monitor)

① Plug it into a manual connector and input after 5 sec., a floating charge, charging status red LED lights up.
② After 15 sec., charging status yellow LED lights up.
③ After a green LED lights up, if measured voltage comes out as lula64V by measuring output voltage of battery connector side with multi-meter, then it is normal.
④ After 30 sec. of switching to a manual connector, if a buzzer sound rings continuously for 10 sec. and completion LED lights up, then it is normal.
⑤ If you confirm that the charger operates in normal after checking manual switching of the charger, make sure that the charger is switched to automatic.

BOP7BAT10

⑥ If charger's out voltage is under 60 V, it is abnormal.
Please refer to the error sheet.

⑦ When the charging voltage is indicated as normal condition (64 V), convert automatic / manual switch to automatic and start charging.

※ **Display error code on the front cover as following table.**

22B9BAT11

No	Code	Description of error
1	E.F	EPROM fail
2	O.V	Over voltage - Refer to page 7-90
3	O.C	Over current - Refer to page 7-89, 7-91.
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 7-88.
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.

4) CHECK POINTS BEFORE APPLYING A/S

(1) AC input power source switch is input.

(2) Check if the battery connector of the order picker 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.

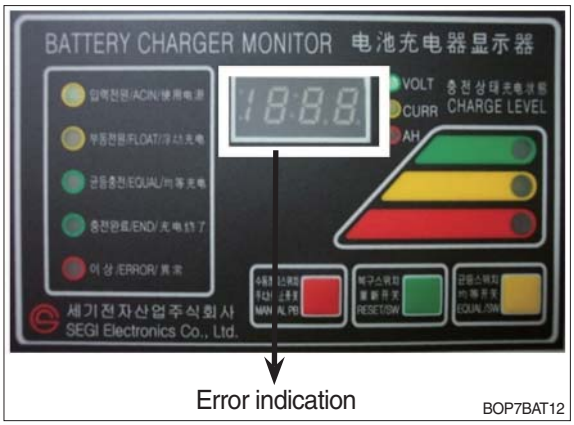
② A.O : Error on selection of input power source of 220V or 380V - Check it appropriately with full three phases.

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 64V±1.0V.

(5) Check other abnormalities as well. Then apply for A/S when on-site measurements are not applicable.



5) 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"

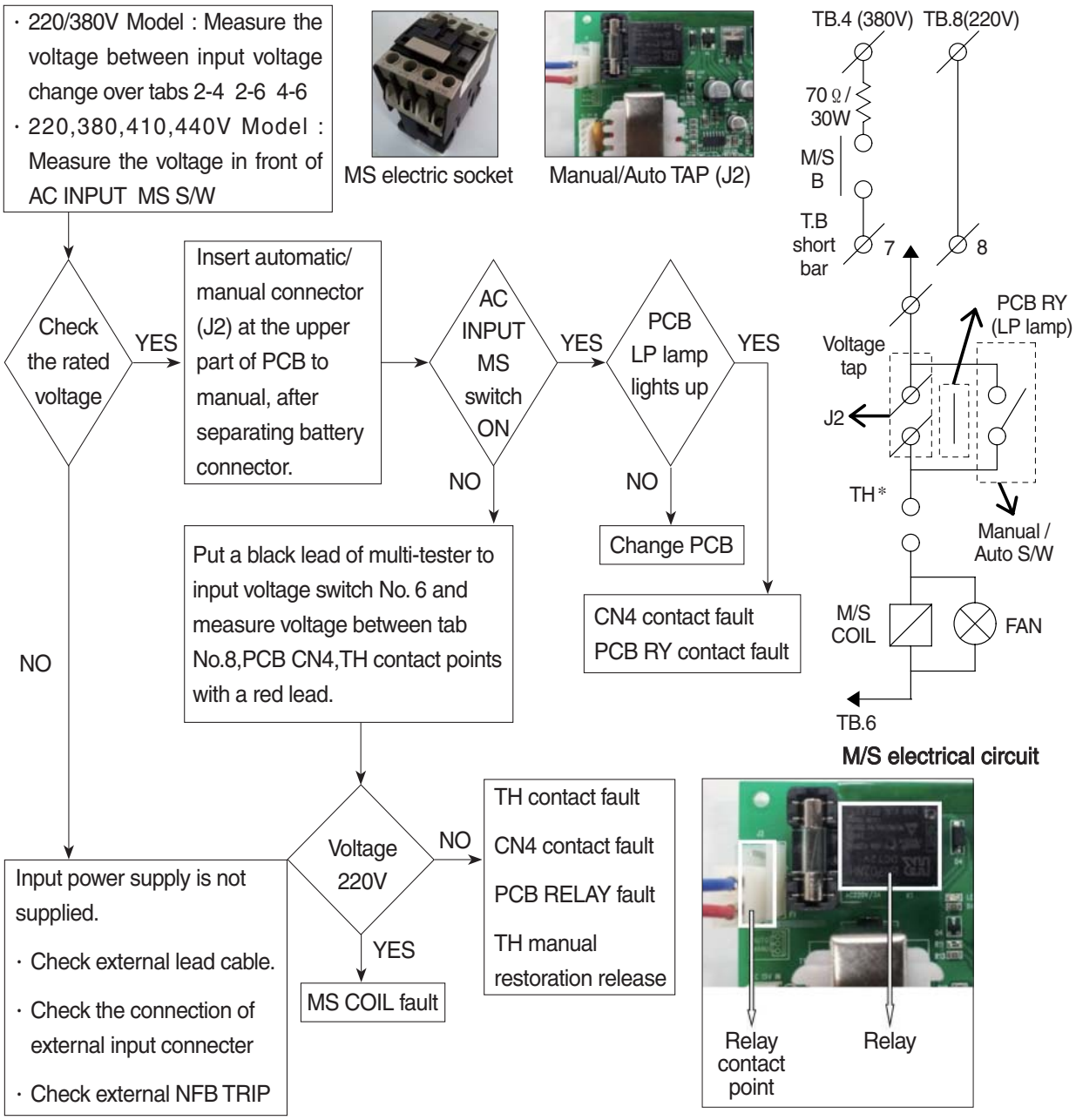
⑤ Charger TRIP is occurred after it started charging and charging completion lamp is on.

⑥ Charger has no response even the battery connector is connected.

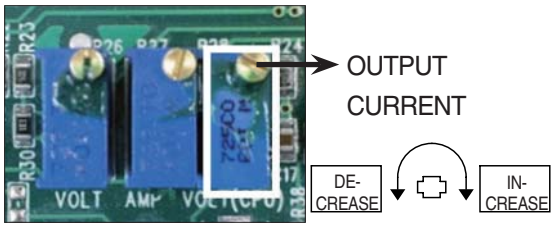
⑦ SCR module checking method

(2) Troubleshooting

① Only floating charge lamp is on after indicating "A.O", It's not charged.

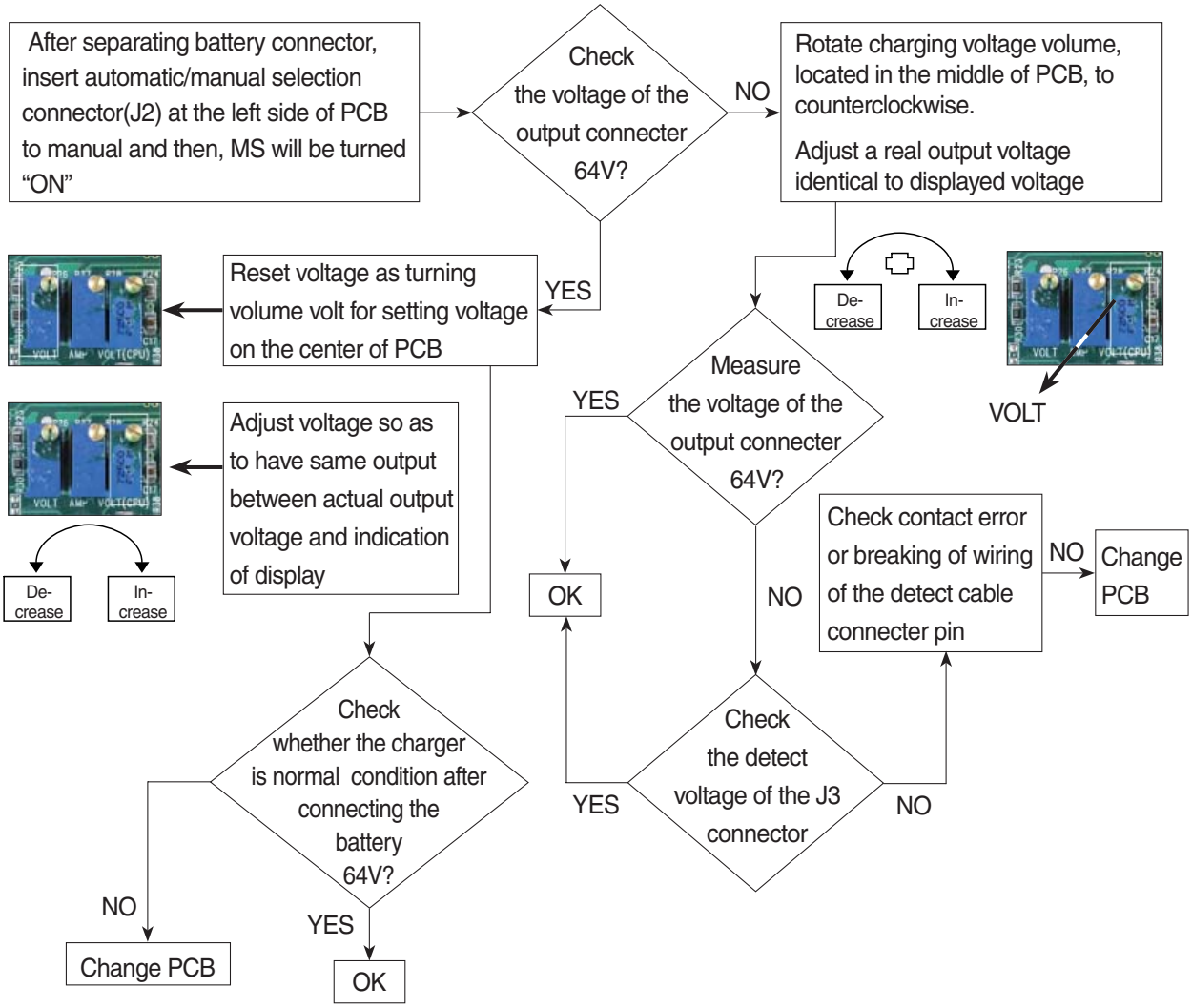


② ON and OFF is repeated with a few minutes intervals after starting charging.
Indicate "O.C" on the monitor.
- TH is operated (AC input over-current TRIP).

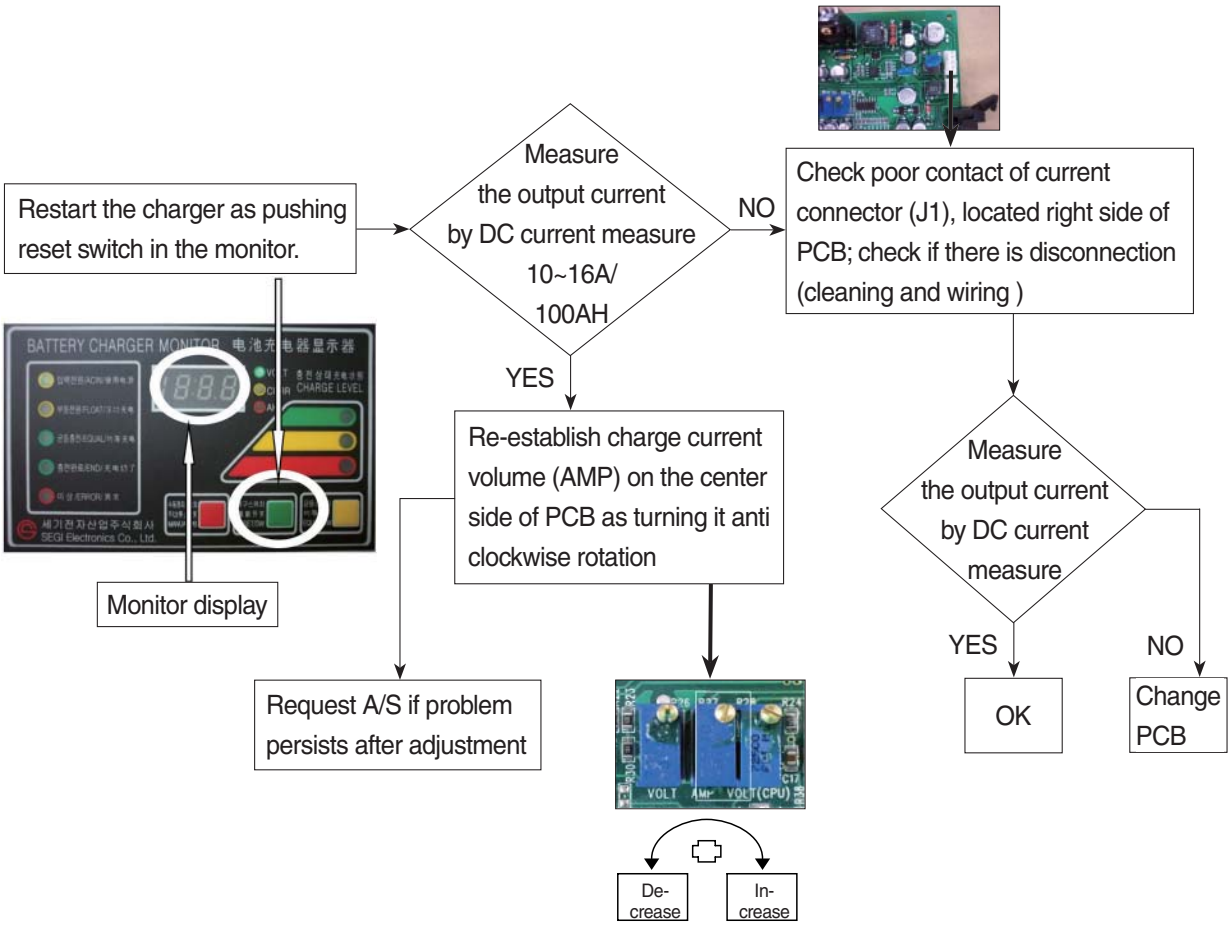


Trans noise is severe at MS ON status
NO
Measure output current using DC current measure
Current value : 10~16A /100AH
NO
Exceed Standard current
Adjust output current AMP, VR within PCB Re-adjust to VR
YES
· TH Setting fault
· Re-adjust TH setting value
TH. TRIP
YES
Change TH
NO
Complete
YES
* Refer to SCR Module checking method
Rated Current SETTING
YES
NO
Complete
Change PCB
Separate the battery connector and tune the charger off
Check SCR Module
NO
Change SCR MODULE
YES
Check MAIN TRANS VOLT
NO
Change PCB
Check the normal operating condition of the charger
YES

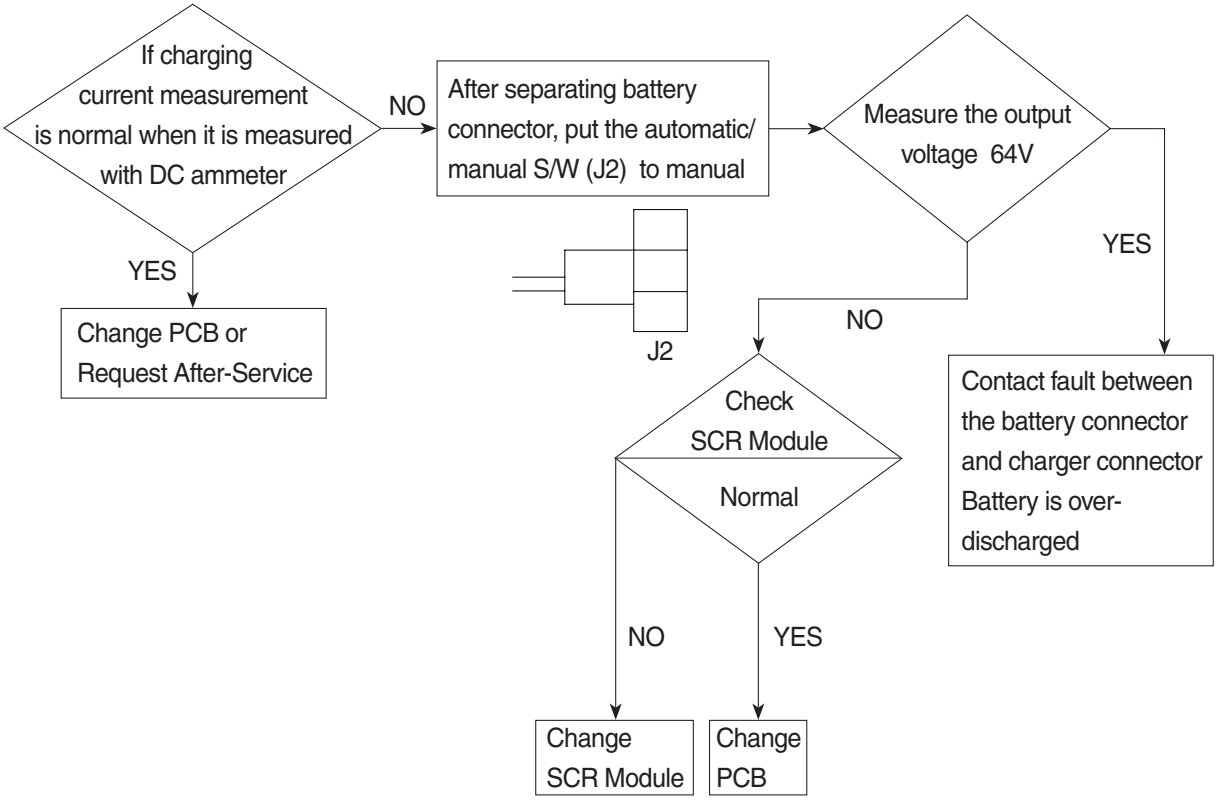
③ Charger TRIP is occurred after abnormality lamp is on.
In case error code is "O.V" → Over-voltage output / Set at 66V (In case of BATT 48V)
34V (In case of BATT 24V)
108V (In case of BATT 80V)



④ **Charger TRIP is occurred after abnormality lamp is on.**
After opening the cover which is located on the front bottom side of the charger.
In case error code is "O.C" → Output over current, established as 110~120% of the rated current.

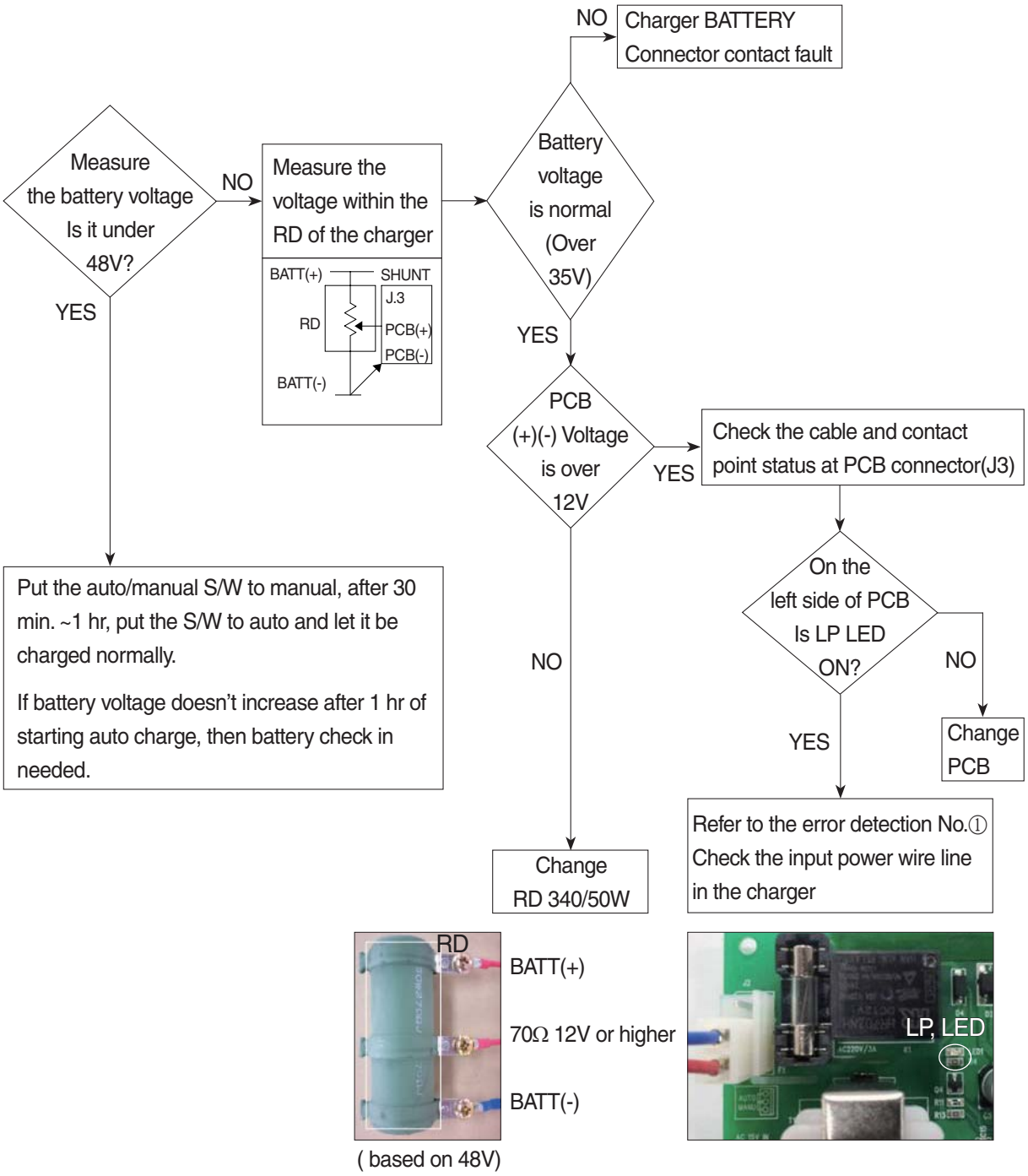


⑤ **Charger TRIP is occurred after it started charging and charging completion lamp is on.**
(In case input voltage is normal - Refer to the error detection No. 1)
Restore the charger as pushing reset switch.



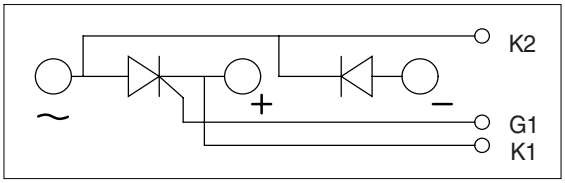
⑥ **Charger has no response even if the battery connector is connected.**

- 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)

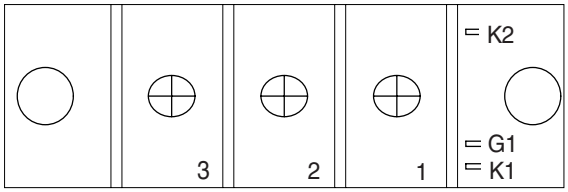


7) HOW TO CHECK THE SCR MODULE

Circuit

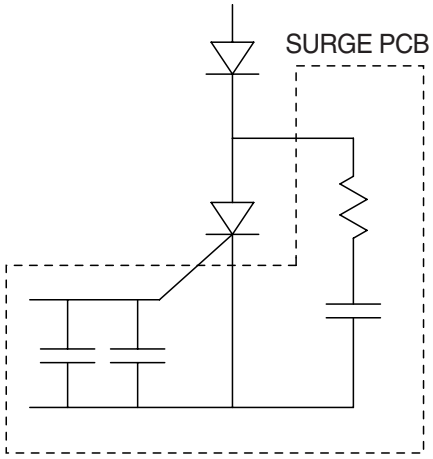


Real diagram

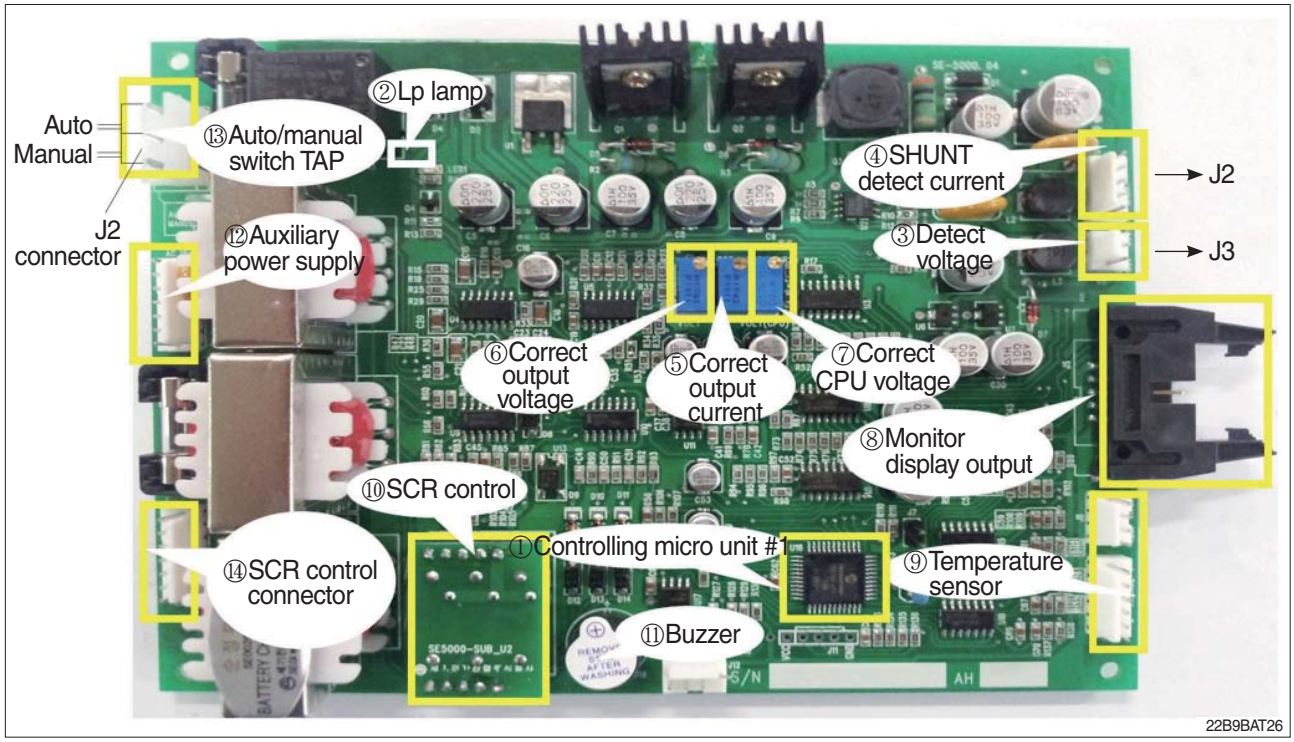


* Before checking SCR MODULE, be sure to disconnect bus bar and wire on the terminal.

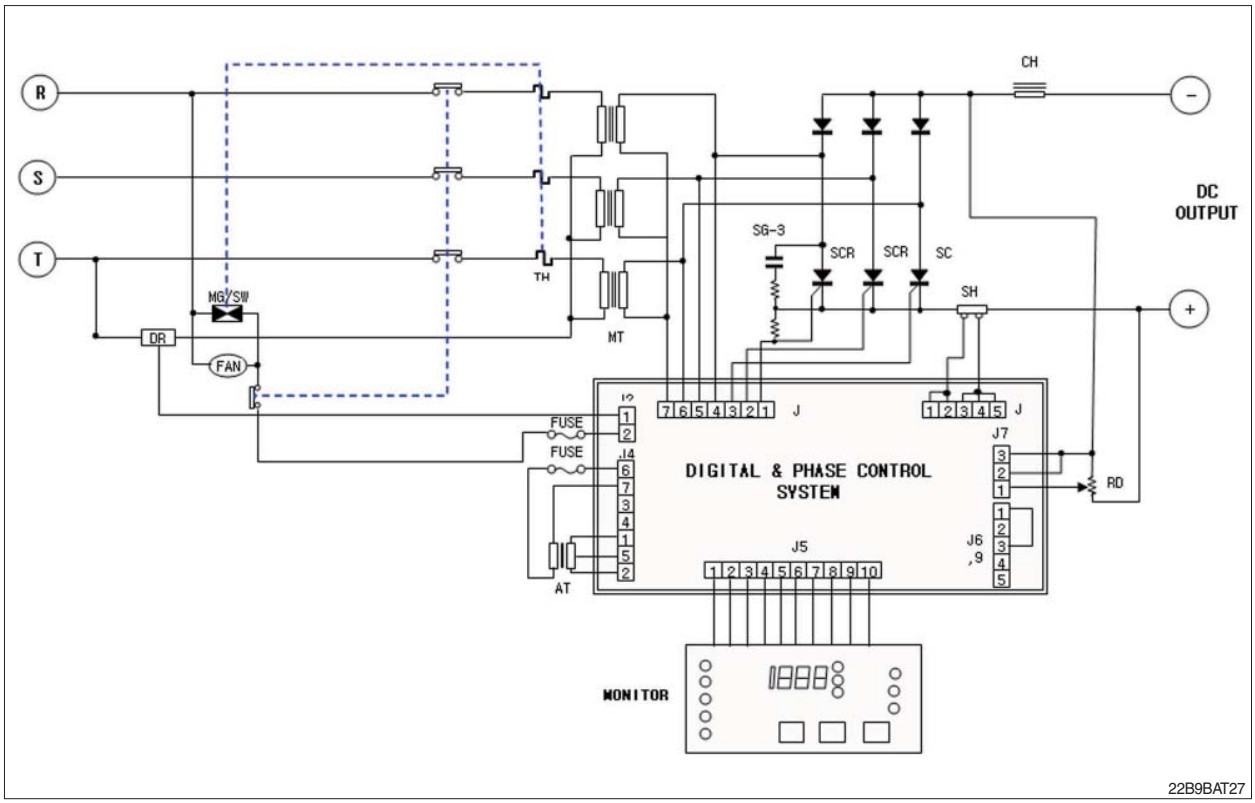
No.	Measuring point (Real diagram)	Measure value (Measurement of digital tester)
1	No.1 ~ No.3	Forward : Under 100 k ohm Reverse : Infinity (∞)
2	No.2 ~ No.3	Forward : Infinity (∞) Reverse : Infinity (∞)
3	G1 ~ K1	Forward : Under 100 ohm Reverse : Under 100 ohm But It depends on the module. If it is not 0 ohm, It is Ok.
4	G1 ~ K2	Forward : Infinity (∞) Reverse : Infinity (∞)



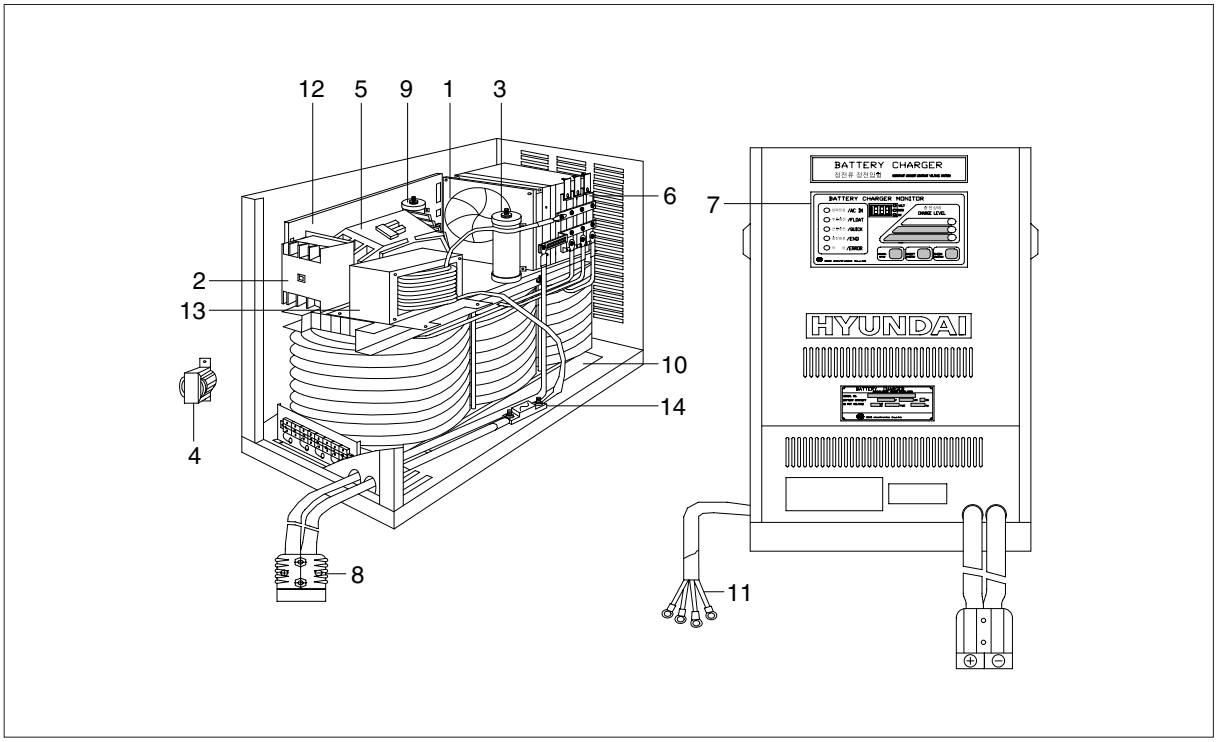
8) PCB MAJOR PARTS (NAME AND LOCATION)



1	Controlling MICOM #1	6	Correct output voltage	11	Buzzer
2	Lp lamp	7	Correct CPU voltage	12	Auxiliary power supply
3	Detect voltage	8	Monitor display output	13	Auto/manual switch TAP
4	SHUNT detect current	9	Temperature sensor	14	SCR control connector
5	Correct output current	10	SCR control		


R
S
T
MG/SW
DR
FAN
TH
MT
CH
SG-3
SCR
SCR
SC
SH
DC
OUTPUT
FUSE
FUSE
AT
DIGITAL & PHASE CONTROL
SYSTEM
J5
J7
RD
MONITOR
22B9BAT27

CHARGER INTERIOR PARTS



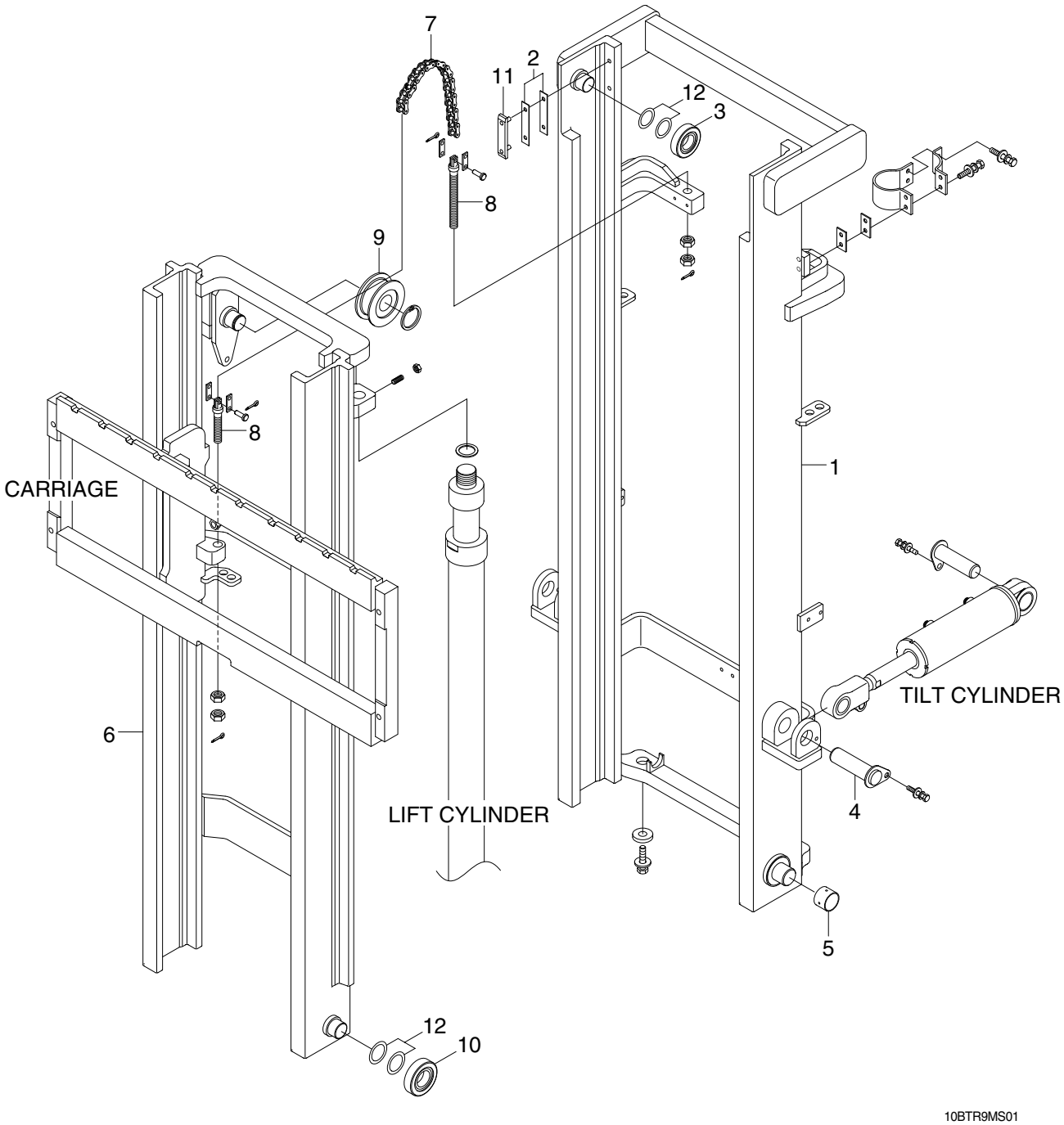
22B9BAT28

No	Part name	Remarks
1	AC fan	
2	Over load	
3	Resister RD	
4	Trans-aux	
5	Magnet switch	
6	SCR module	
7	Monitor	
8	DC out cable	
9	Resister DR	
10	Main transformer	
11	AC input cable	
12	Main control board	
13	Filter	
14	Fuse	

SECTION 8 MAST

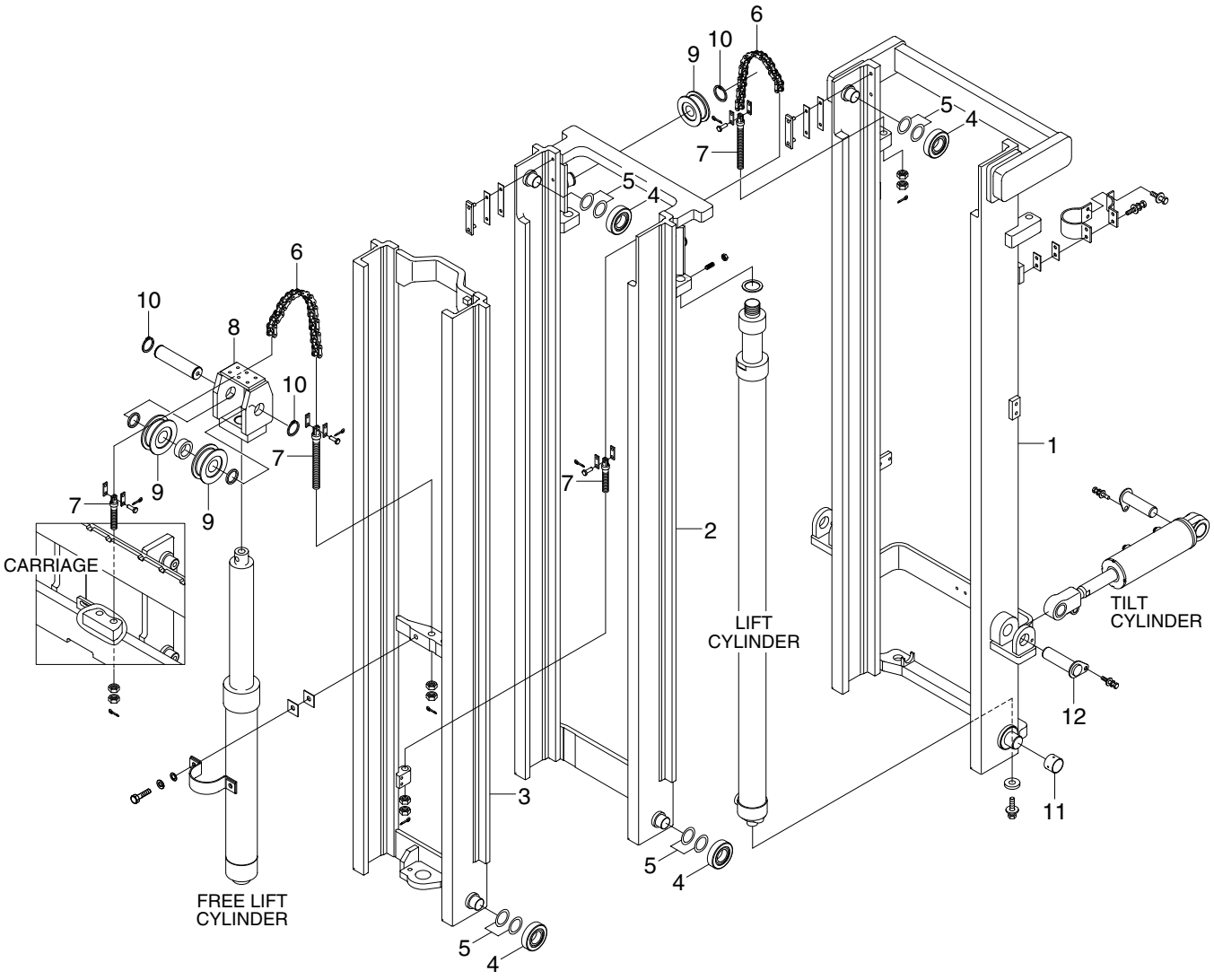
GROUP 1 STRUCTURE

1. 2 STAGE MAST(V MAST)



1	Outer mast	5	Bronze bushing	9	Chain wheel bearing
2	Shim (0.5, 1.0t)	6	Inner mast	10	Roller
3	Roller	7	Lift chain	11	Back up liner
4	Tilt cylinder pin	8	Anchor bolt	12	Shim(0.5, 1.0t)

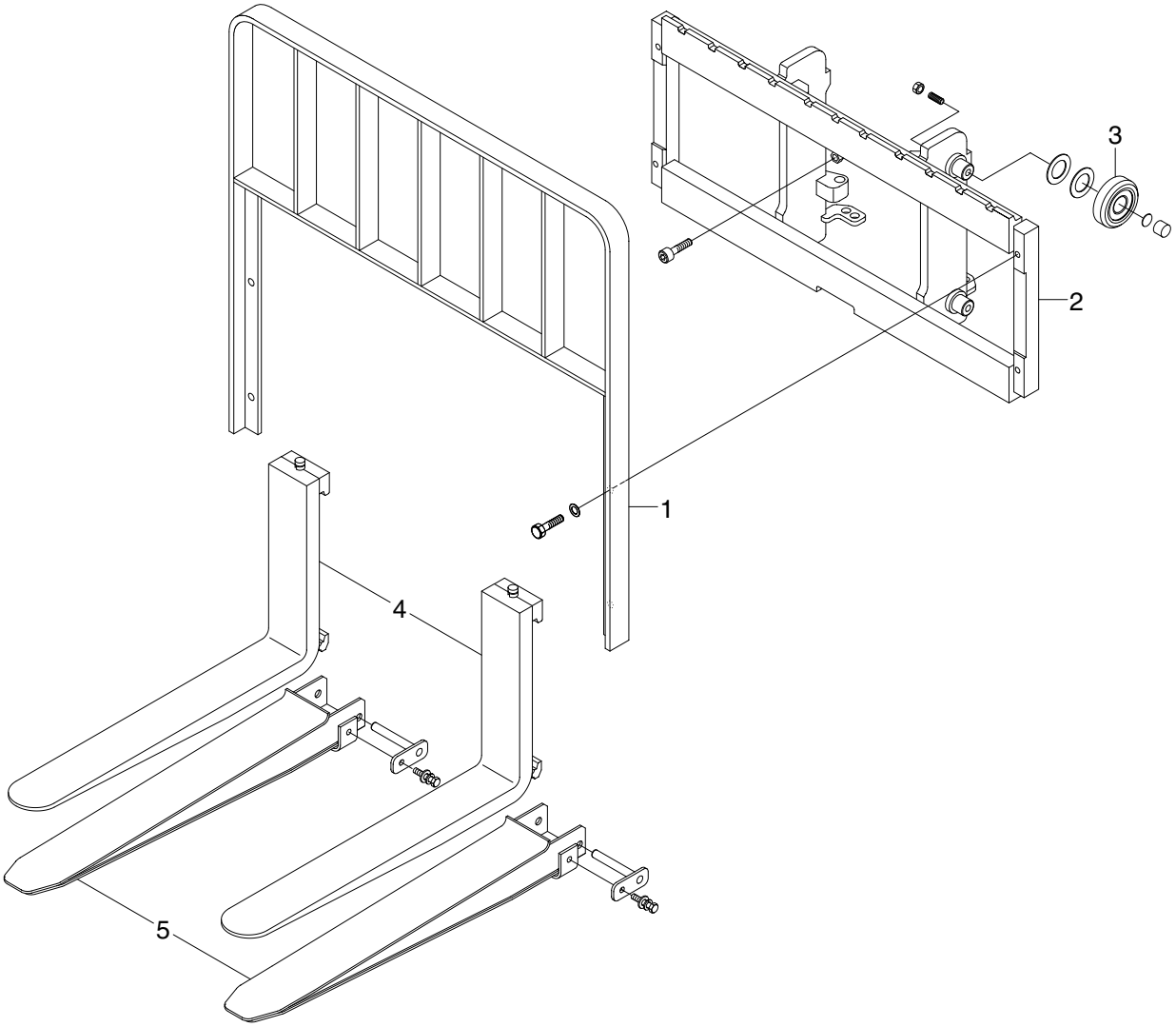
2. 3 STAGE MAST(TF MAST)



10BTR9MS02

1	Outer mast	5	Shim(0.5, 1.0t)	9	Sheave
2	Middle mast	6	Lift chain	10	Retaining ring
3	Inner mast	7	Anchor bolt	11	Bushing
4	Roller	8	Sheave bracket	12	Tilt cylinder pin

3. CARRIAGE, BACKREST AND FORK



10BTR9MS03

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

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

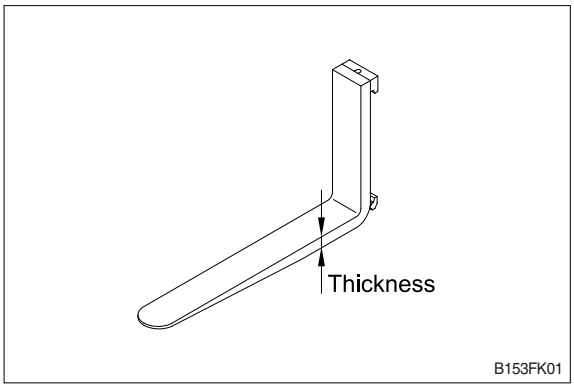
1. OPERATIONAL CHECKS

1) FORKS

(1) Measure thickness of root of forks and check that it is more than specified value.
EX : l =900mm(35.4in)

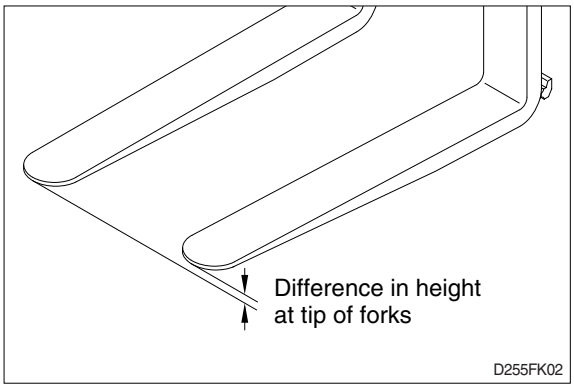
mm(in)

STD Fork assy	Applicable model	Standard	Limit
64HT-12030	10/13/15BTR-9	35(1.4)	32(1.3)



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

Model	Fork length (mm)	Height difference(mm)
10/13/15BTR-9	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 CLEAR-ANCE ADJUSTMENT

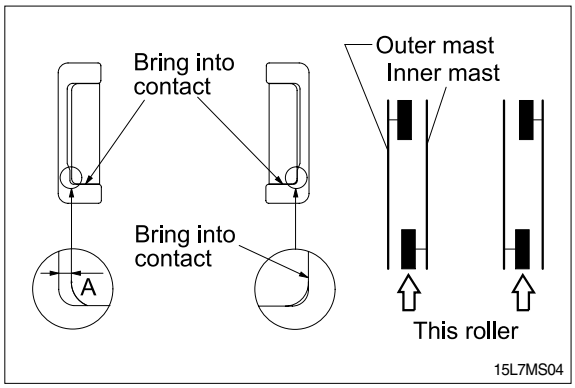
(1) Measure the clearance with the mast overlap at near 480mm.

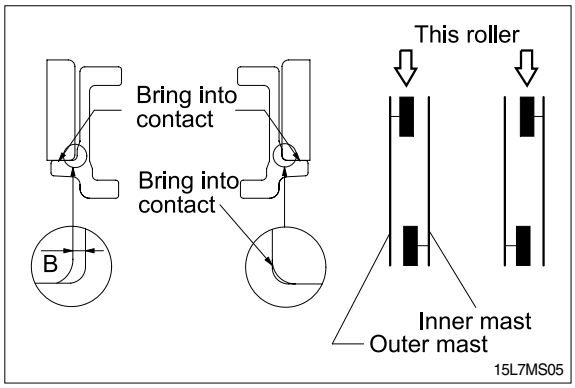
(2) Shift the inner mast to one side to bring the roller into contact with the outer mast, and adjust the clearance between the roller side face and mast at the closest position on the opposite side to the following value by inserting the inner/outer mast roller shim.

- 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.

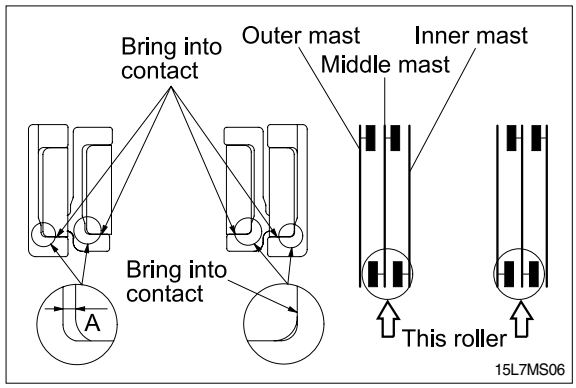
(4) After the adjustment, check that the inner mast moves smoothly in the outer mast.





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.

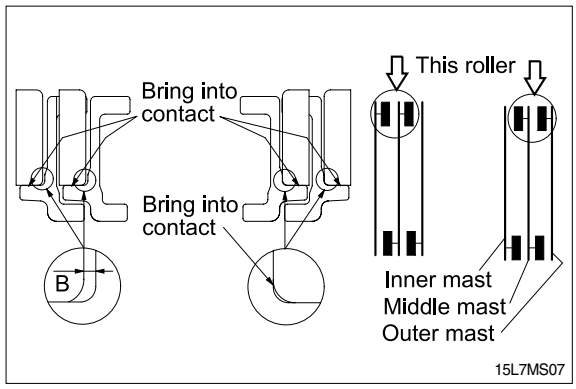
(2) Shift the inner mast to one side to bring the roller into contact with the outer mast and the middle mast, and adjust the clearance between the roller side face and mast at the closest position on the opposite side to the following value by inserting the inner and middle mast roller shim, respectively.

- 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 outer mast and the middle mast, and adjust the clearance between the roller side face and mast at the closest position on the opposite side to the following value by inserting the outer and middle mast roller shim, respectively.

- Standard clearance B = 0.3~0.6mm
- 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

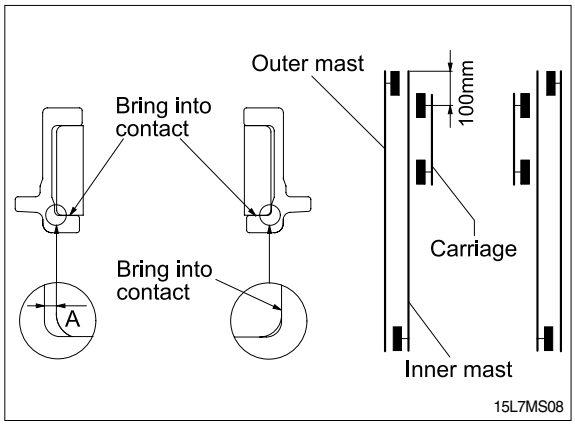
(1) Measure the clearance when the center of the carriage upper roller is 100㎜ from the top of the inner mast.

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

- Standard clearance C = 0.3~0.6㎜
- 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.



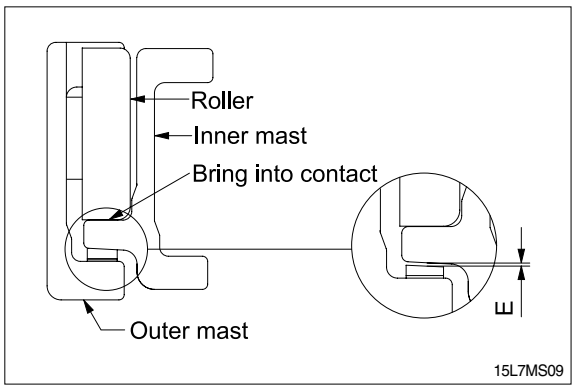
4) MAST BACK UP LINER

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

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

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

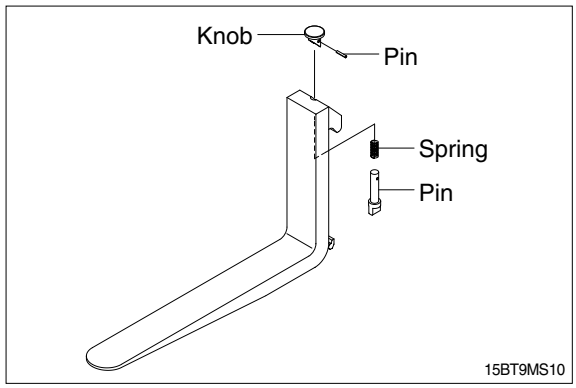
(3) After the adjustment, the mast should move smoothly.



GROUP 4 REMOVAL AND INSTALLATION

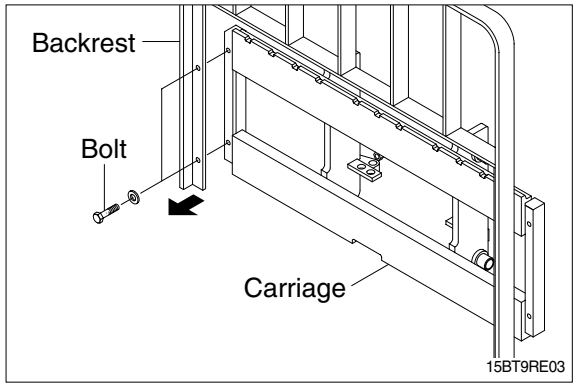
1. FORKS

1) Lower the fork carriage until the forks are approximately 25mm(1inch) from the floor.
2) Turn the knob up 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. Disassemble the backrest from the 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.

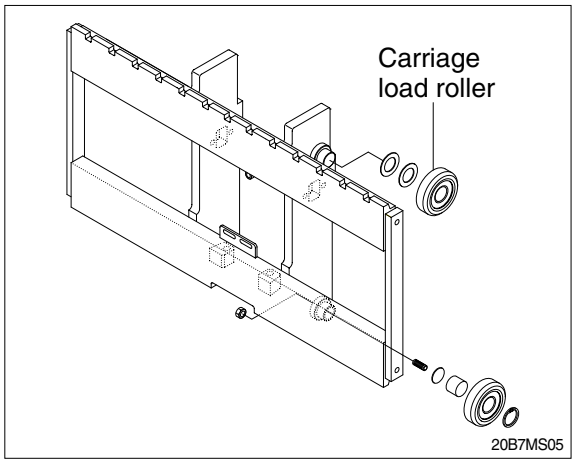
⚠ Make sure carriage remains on floor and does not bind while mast is being raised.

(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) CARRIAGE LOAD ROLLER

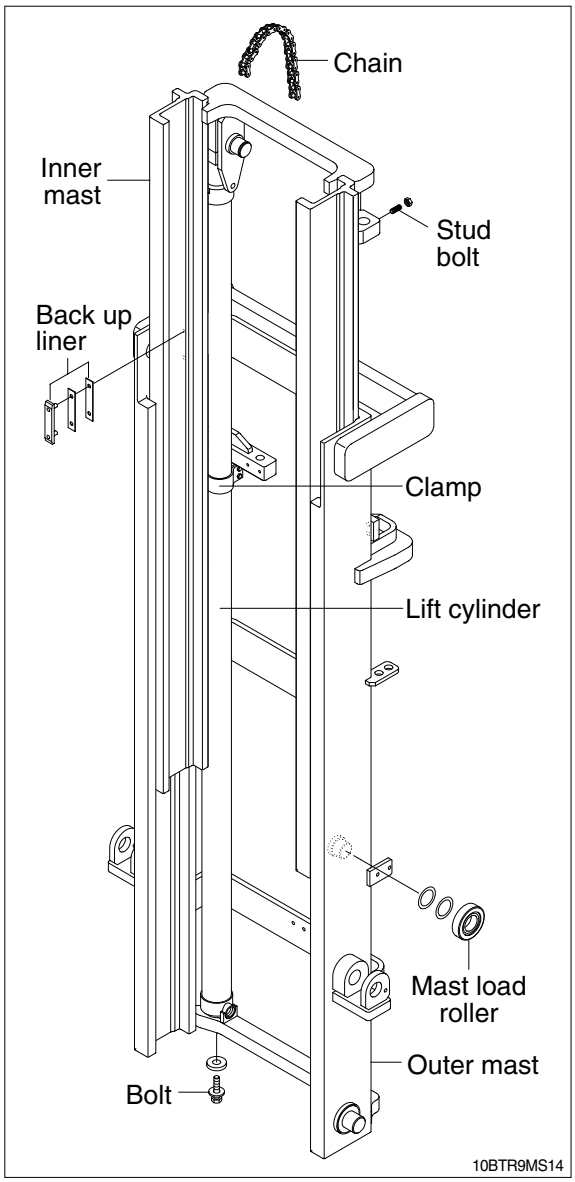
(1) Remove carriage as outlined in the carriage assembly removal paragraph.
(2) Loosen and remove flat head bolts and plain washers from top load roller bracket.
(3) Using a pryer, remove load rollers from load roller bracket.
(4) Reverse the above procedure to assemble. Refer to MAST ROLLER ADJUSTMENT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



3) MAST LOAD ROLLER AND BACK UP LINER

(1) 2 stage mast(V mast)

① Remove the carriage assembly and move them to one side.
② Loosen and remove hexagon bolts and washers securing lift cylinders to inner mast.
③ Loosen and remove hexagon bolts and nuts securing lift cylinders to inner mast.
④ Attach chains or sling to the inner mast section at top crossmember. Using an overhead hoist, slowly raise the inner mast high enough to clear lift cylinder.
⑤ After lowering the lift cylinder rods, and disconnecting lift cylinder hose, tilt the lift cylinders LH and RH and them with ropes to the outer mast.
⑥ Using the overhead hoist, lower inner mast until top and bottom rollers and back up liners are exposed.
⑦ Using a pryer, remove load rollers from load roller bracket. Remove back up liners and shims.
⑧ Thoroughly clean, inspect and replace all worn or damaged parts.
⑨ Reverse the above procedure to assemble. Refer to MAST LOAD ROLLER ADJUSTMENT paragraph.



(2) 3 stage mast(TF mast)

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

② Loosen and remove hexagon bolt securing bottom cylinder from outer mast.

③ Loosen and remove band and special washers securing lift cylinders to middle mast. Remove the spring pin.

④ Attach chains or sling to the inner and middle mast section at top crossmember. Using an overhead hoist, slowly raise the uprights high enough to clear lift cylinder.

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

⑥ Using the overhead hoist raise inner and middle masts. Place 4 inch block of wood under the free lift cylinder bracket of the inner mast then lower mast sections (this will create slack in the chains).

⑦ Remove retaining rings securing chain sheaves to sheave support brackets. While support chains, remove chain sheaves and let chains hang free. The upper outer and lower middle mast rollers and back up liners are now exposed.

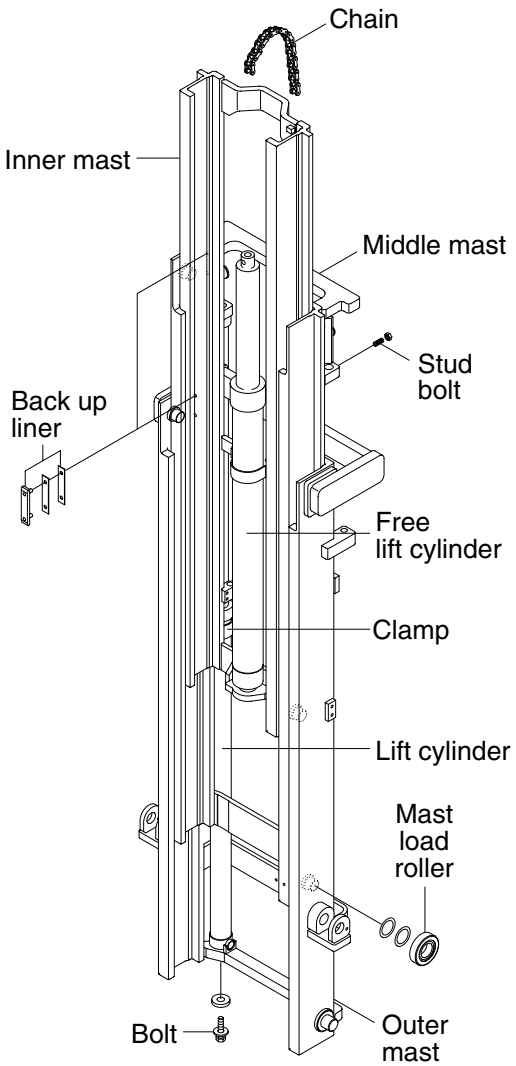
⑧ Using a player, remove load rollers from load bracket. Remove back up liners and shims.

⑨ Attach chains or sling to the middle mast section at top crossmember. Using an overhead hoist, slowly raise the middle mast until top and bottom rollers are exposed.

⑩ Using a pryer, remove load rollers from load roller bracket.

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

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



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4) 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.

5) 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.

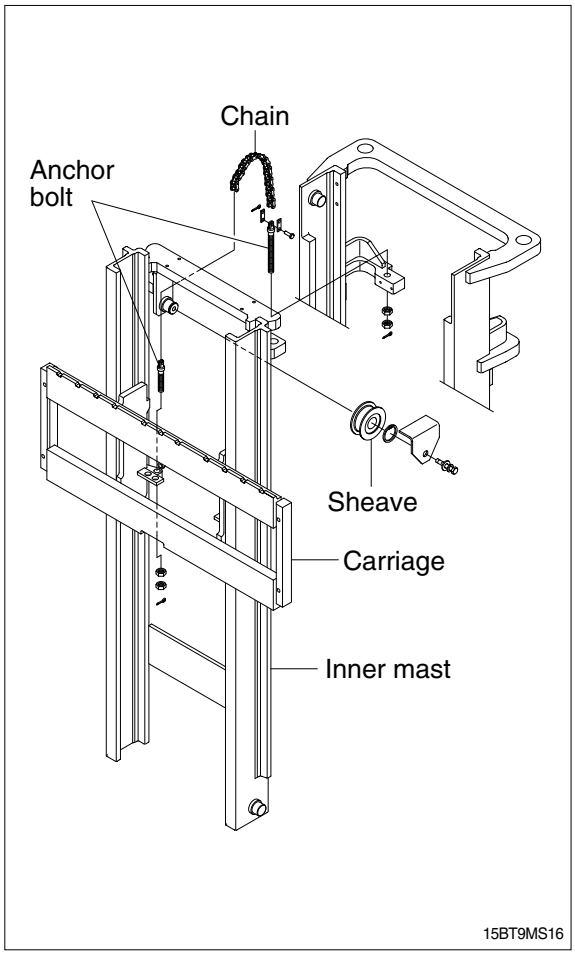
② Remove the split pin securing the chain anchor pins and discard.
While supporting the chains, remove the chain anchor pins and drape the chains over the carriage.

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.

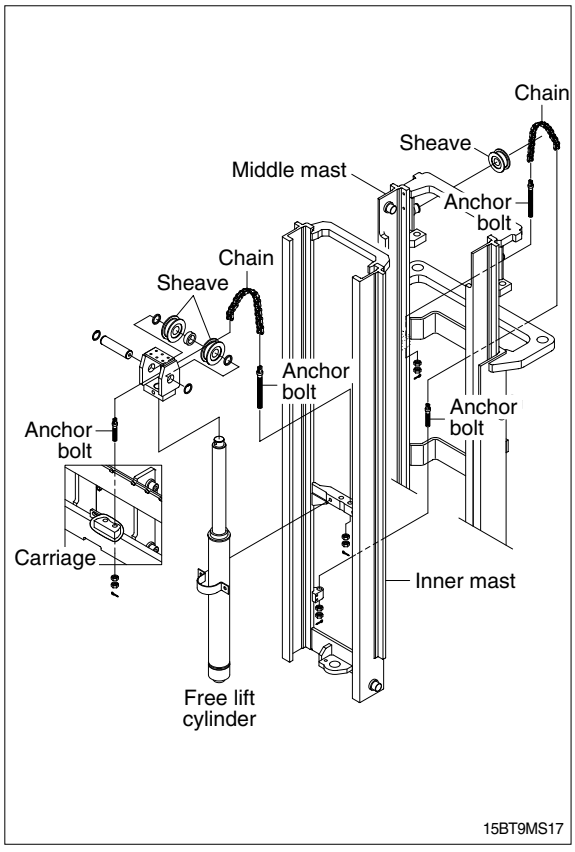
③ Remove chains.

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 develops in service is due to material being worn off pin outer diameter and pitch hole inner diameter on the inside plate.

Chain wear can be measured using a wear scale or steel tape. When chains have elongated 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.