CONTENTS

FOREWORD

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 truck and explains the safety hints for maintenance.

SECTION 2 REMOVAL & INSTALLATION OF UNIT

This section explains the procedures and techniques of removal and installation of each component.

SECTION 3 POWER TRAIN SYSTEM

This section explains the structure, disassembly and assembly of the drive axle unit.

SECTION 4 BRAKE SYSTEM

This section explains the brake mechanism, each component and operation.

SECTION 5 STEERING SYSTEM

This section explains the structure of the steering system.

SECTION 6 HYDRAULIC SYSTEM

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

SECTION 7 ELECTRICAL SYSTEM

This section explains the electrical circuit and each component.

It serves not only to give an understanding electrical system, but also serves as reference material for troubleshooting.

SECTION 8 MAST

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

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

2. HOW TO READ THE SERVICE MANUAL

Distribution and updating

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

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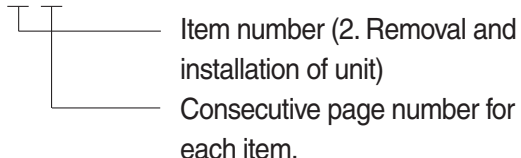
Filing method

1. See the page number on the bottom of the page.

   File the pages in correct order.

2. Following examples shows how to read the page number.

   Example 1

   2 - 3

   ⌐ Item number (2. Removal and installation of unit)

   └ 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.

   6 - 4

   6 - 4 - 1 ⌐
            ├ Added pages
   6 - 4 - 2 ┘

   6 - 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 55 mm into inches.

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

(2) Locate the number 5 in 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, 55 mm = 2.165 inches.

2. Convert 550 mm 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 55 mm.

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

(3) The original value (550 mm) 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 550 mm = 21.65 inches.

Millimeters to inches

1 mm = 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

	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

	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

1 kgf · m = 7.233 lbf · 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

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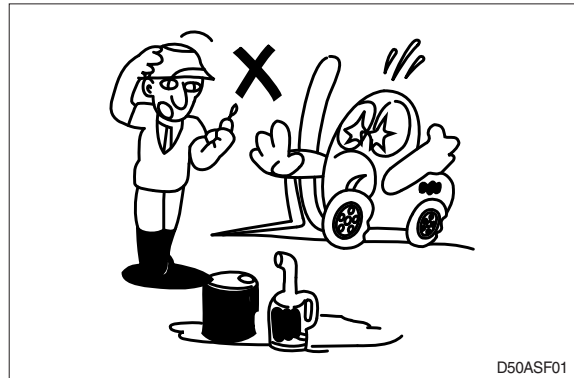
· Wear well-fitting helmet, safety shoes and working clothes.   When drilling, grinding or hammering, always wear protective goggles. Always do up safety clothes properly so that they do not catch on protruding parts of truck. Do not wear oily clothes.

When checking, always release battery plug.

D50ASF02
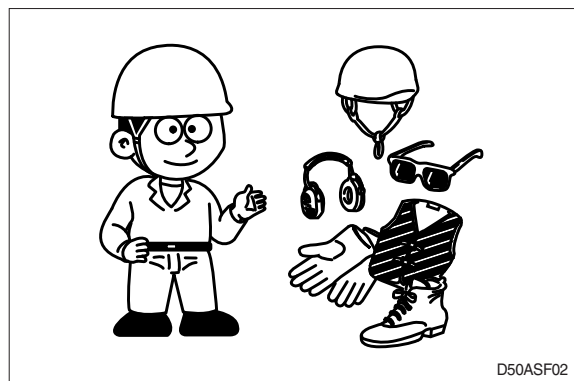
· Flames should never be used instead of lamps.   Never use a naked flame to check leaks or the level of oil or electrolyte.

D50ASF03
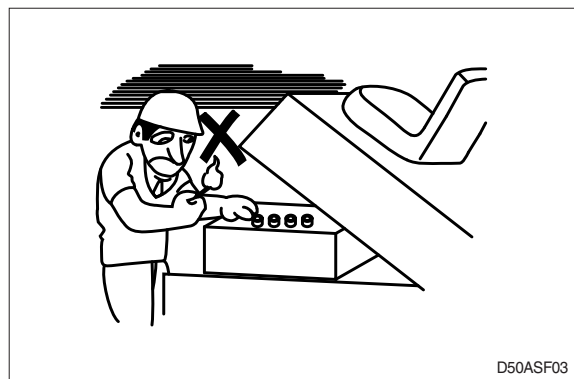
· When working on top of the machine, be careful not to lose your balance and fall.

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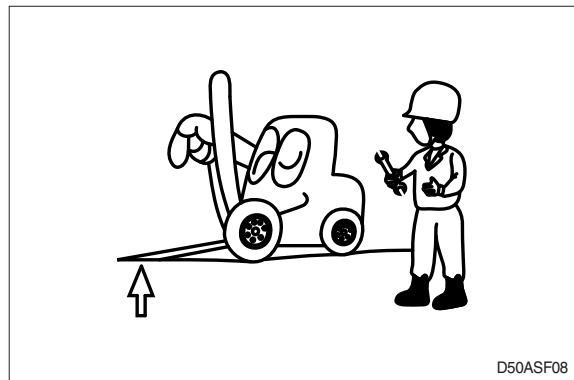
· Immediately remove any oil or grease on the floor of the operator's compartment, or on the handrail.   It is very dangerous if someone slips while on the truck.

OIL

D50ASF09
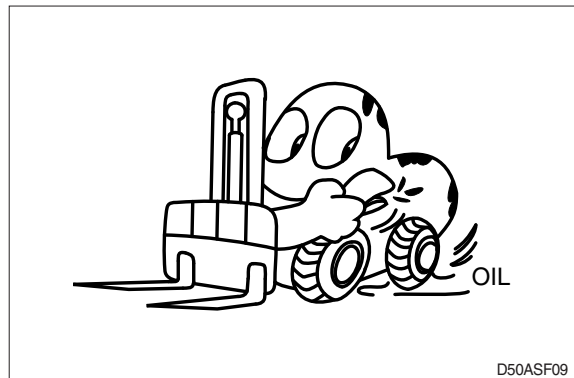
· When working with others, choose a group leader and work according to his instructions. Do not perform any maintenance beyond the agreed work.

D50ASF10
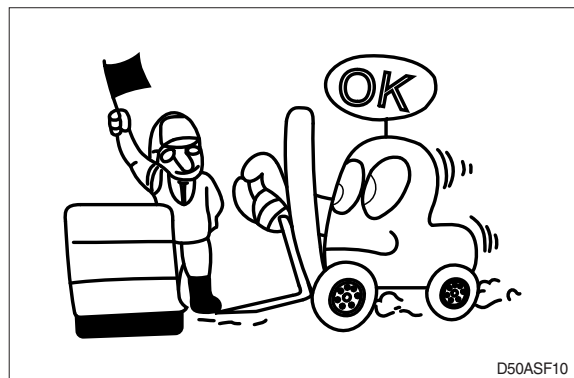
· Always remember that the hydraulic oil circuit is under pressure.   When feeding or draining the oil or carrying out inspection and maintenance, release the pressure first.

D50ASF11

· Thoroughly clean the truck. 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 truck.
· 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

VIEW : A
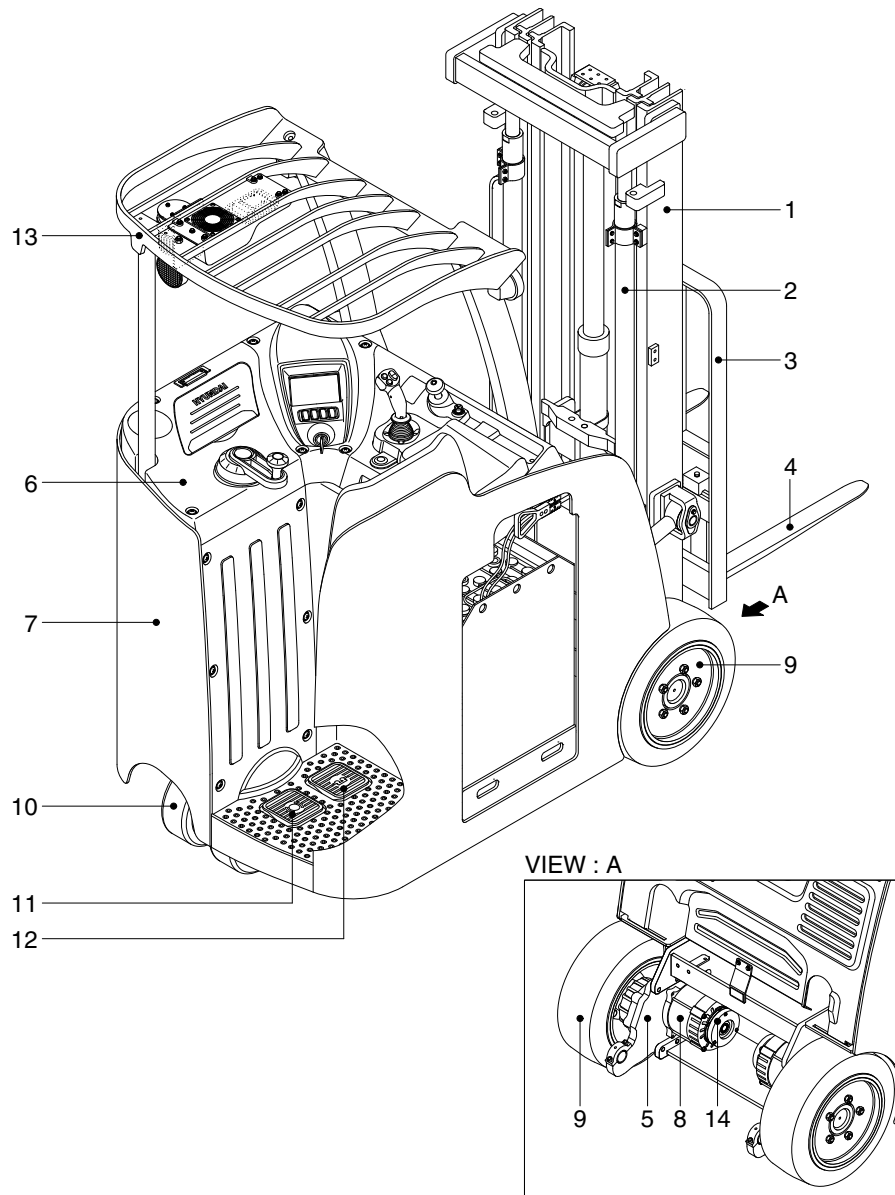
18BCS9OM113

1	Mast	6	Dashboard	11	Brake switch
2	Lift cylinder	7	Frame	12	Dead man switch
3	Carriage and backrest	8	Drive motor	13	Overhead guard
4	Forks	9	Drive wheel	14	Electric service brake
5	Drive unit	10	Steering wheel		

2. SPECIFICATIONS

18BCS9SP01
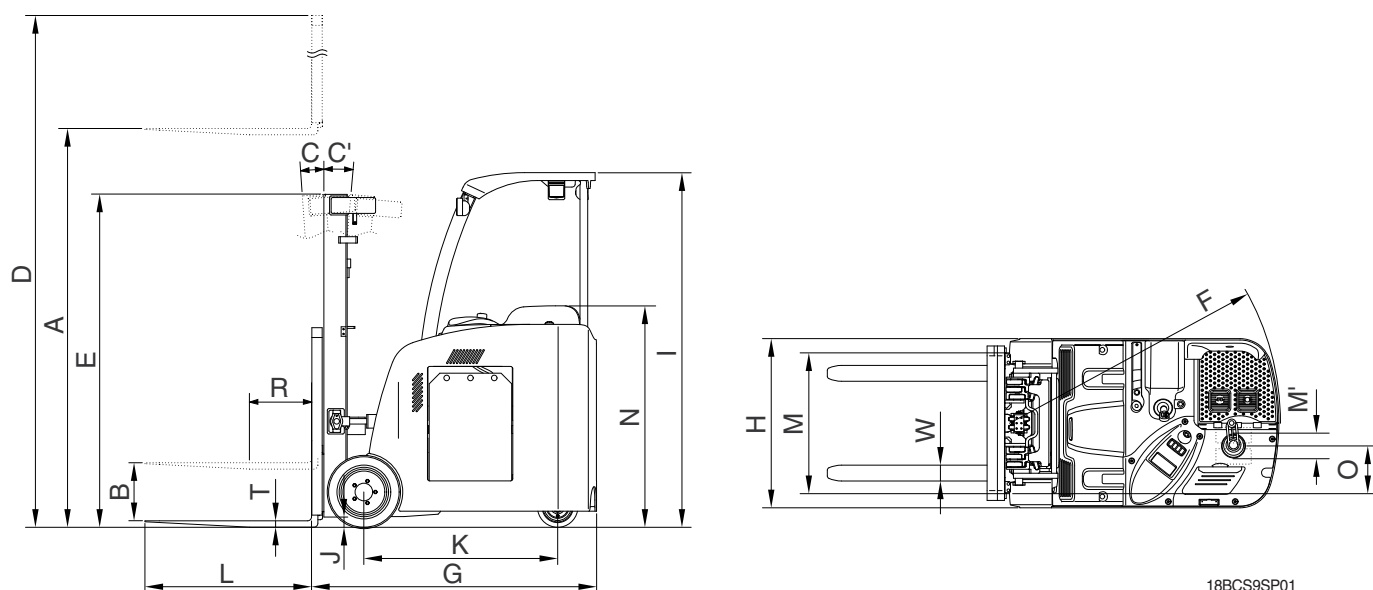
Model		Unit	15BCS-9	18BCS-9	20BCS-9
Capacity		kg (lb)	1361 (3000)	1588 (3500)	1814 (4000)
Load center distance	R	mm (in)	610 (24")	←	←
Weight (Unloaded, with battery)		kg (lb)	3862 (8514)	4074 (8981)	4211 (9283)
Fork	Lifting height	A	mm (ft-in)	4740 (15' 7")	←	4735 (5' 6")
	Free lift	B	mm (in)	1113 (3' 8")	←	←
	Lifting speed (Unload/Load)		mm/sec	560/360	560/340	560/330
	Lowering speed (Unload/Load)		mm/sec	430/480	←	←
	L×W×T	L,W,T	mm (in)	1050×100×40 (41.3×3.9×1.6)	←	←
Mast	Tilt angle (forward/backward)	C/C'	degree	5/5	←	←
	Max height	D	mm (ft-in)	5954 (19' 6")	←	←
	Min height	E	mm (ft-in)	2120 (6' 11")	←	←
Body	Travel speed (Unload/Load)		km/h	12.1/12.1	←	←
	Gradeability (Unload/Load)		%	15/15	←	←
	Min turning radius (Outside)	F	mm (ft-in)	1397 (4' 7")	←	1467 (4' 10")
	Body height	N	mm (ft-in)	1395 (4' 7")	←	←
ETC	Max hydraulic pressure		kgf/cm²	170	←	←
	Hydraulic oil tank		l (usgal)	20 (5.3)	←	←
Overall length (to face of forks)	G	mm (ft-in)	1727 (5' 8")	←	1797 (5' 11")
Overall width	H	mm (ft-in)	1067 (3' 6")	←	←
Overhead guard height	I	mm (ft-in)	2235 (7' 4")	←	←
Ground clearance (center of wheel base)	J	mm (in)	100 (3.9")	←	←
Wheel base	K	mm (ft-in)	1152 (3' 9")	←	1222 (4' 0")
Wheel tread (Front/rear)	M/M'	mm (ft-in)	889/181 (35"/7.1")	←	←
Distance (Front ↔ rear)	O	mm (ft-in)	265 (10.4")	←	←

3. SPECIFICATION FOR MAJOR COMPONENTS

1) MOTOR

Item	Unit	Drive motor	Hydraulic pump motor
Model	-	AMDD4004	ABDD4002
Type	-	AC	←
Rated voltage	Vac	30V 3 ∅	←
Output	kW	4.5	14
Insulation	-	Class F	←

2) BATTERY

Item	Unit	15/18BCS-9	20BCS-9
Model	-	VCJ7	VCJ8
Rated voltage	V	36	
Capacity	AH/hr	700/5	800/5
Electrolyte	-	WET	
Dimension (W×D×H)	mm	975×450×787	975×520×787
Connector (CE spec)	-	SB350	
Weight	kg	1080 ± 50	1230 ± 50

3) CHARGER

Item	Unit	15/18/20BCS-9
Type	-	Constant current, constant voltage
Battery capacity for charge	V-AH	36-128 ± 5 %
AC input	V	Triple phase 220 / 380
		Triple phase 410
		Triple phase 440
DC output	V	36±1
Charge time	hr	6±2
Connector (CE spec)	-	SB350

4) GEAR PUMP

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

5) MAIN CONTROL VALVE

Item	Unit	Specification
Type	-	3 spool, 4 spool
Operating method	-	Electric
Main relief valve pressure	bar	170

6) STEERING UNIT

Item	Unit	Specification
Type	-	Dynamic load sensing/Non load reaction
Displacement	cc/rev	40
Rated flow	gpm	6.0
Relief pressure	kgf/cm^2	120^{+5}_{0}

7) DRIVE UNIT

Item	Unit	Specification
Gear ratio	-	27.1
Oil quantity	l	0.45

8) STEERING AXLE

Item	Specification
Type	Full hydraulic power steering
Steering angle	90˚ to both right and left angle, respectively

9) WHEELS

Item	15/18/20BCS-9
Type (Front/rear)	Rubber / Urethane
Quantity (Front/rear)	2 / 2
Front wheel	ø 308 × 178
Rear wheel	ø 254 × 127

10) BRAKES

Item	Specification
Brakes (Service)	Regen brake
Brakes (Parking)	Electric brake (2EA)

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	2.5±0.5	18.1±3.6
2		Drive motor mounting bolt	M 8×1.25	1.5±0.2	10.8±1.4
3		Steering motor mounting bolt	M12×1.75	10.5±1.5	75.9±10.8
4	Hydraulic system	Hydraulic pump mounting bolt	M10×1.5	5±1.0	36.2±7.2
5		MCV mounting bolt, nut	M 8×1.25	2.5±0.5	18.1±3.6
6	Power train system	Drive wheel mounting bolt	M16×1.5	15.7±2.3	114±16.6
7		Steering wheel mounting nut	M40×1.5	5±0.5	36.2±3.6
8		Drive unit bracket mounting bolt	M14×2.0	16.0±2.0	116±14.5
9		Steering axle mounting bolt	M14×2.0	16.0±2.0	116±14.5
9	Other	Head guard mounting bolt (front)	M16×2.0	29.5±4.5	213±32.5
10		Head guard mounting bolt (rear)	M12×1.75	12.5±1.5	90.4±10.8

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) 15/18/20BCS-9	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	0.45 × 2EA (0.12 × 2EA)			SAE 80W-90						
Hydraulic oil tank	Hydraulic oil	20 (5.3)		★ISO VG 15							
						ISO VG 46					
							ISO VG 68				
Fitting (Grease nipple)	Grease	0.1 (0.03)		★NLGI No.1							
							NLGI No.2				

★ : 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	Every 2 year

SECTION 2 REMOVAL & INSTALLATION OF UNIT

GROUP 1 MAJOR COMPONENTS
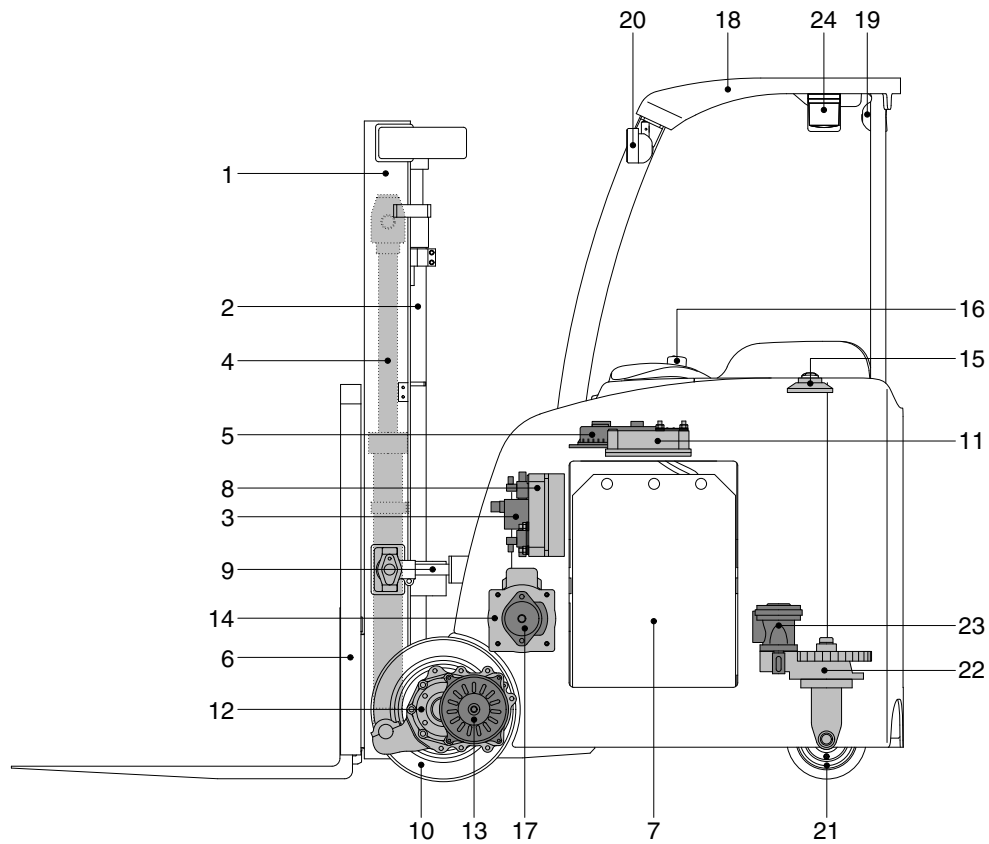
18BCS9RE01

1	Mast	9	Tilt cylinder	17	Hydraulic pump		
2	Lift cylinder	10	Drive wheel	18	Overhead guard		
3	Main control valve	11	Pump controller	19	Rear work lamp (opt)		
4	Free lift cylinder	12	Drive unit	20	Front work lamp		
5	Fingertip controller	13	Drive motor	21	Steering wheel		
6	Carriage & backrest	14	Pump motor	22	Steering axle		
7	Battery	15	Steering handle	23	Steering hydraulic motor		
8	Drive controller	16	Joystick	24	Beacon lamp (opt)		

GROUP 2 REMOVAL AND INSTALLATION OF UNIT

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

1. MAST

1) REMOVAL

| Fork | — | Carriage | — | Piping | — | Lift cylinder | — | Mast |

18BCS9RE000

(1) Forks

① Lower the fork carriage until the forks are approximately 25 mm (1 in) 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.

15BT9RE04
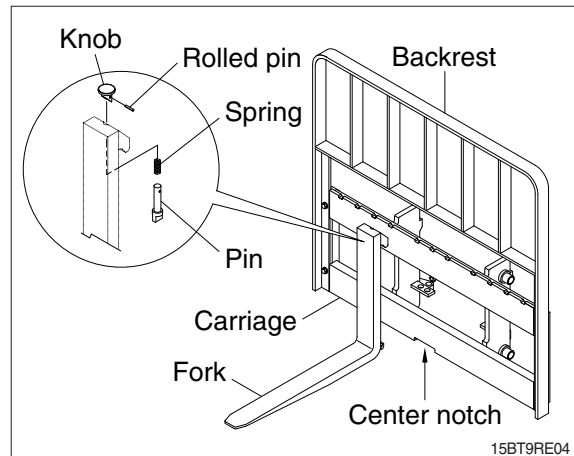
(2) Backrest (If necessary)

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

15BT9RE03
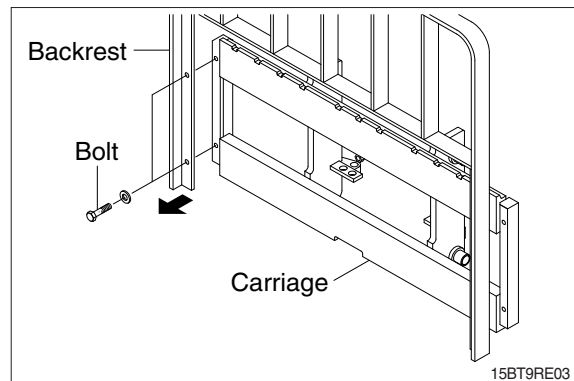
(3) Carriage

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.

18BCS9RE10
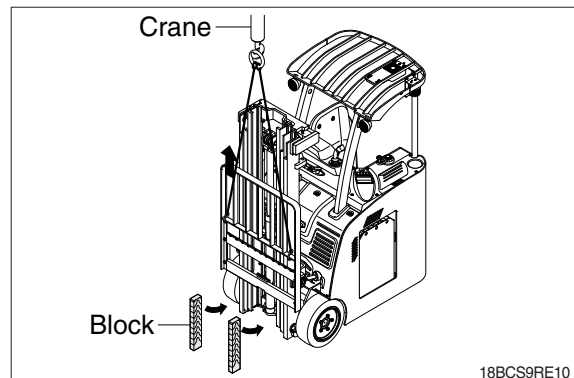
② While supporting lift chains, remove the split pins and nuts from the anchor bolts and slide out chain anchor bolts from the chain anchors of stationary upright.
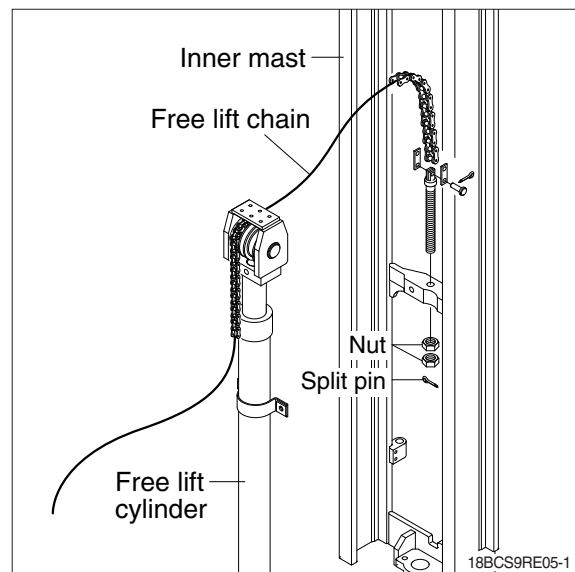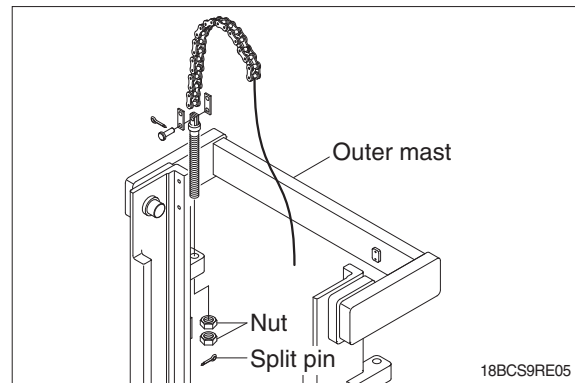
Outer mast

Nut

Split pin

18BCS9RE05

Inner mast

Free lift chain

Nut

Split pin

Free lift cylinder

18BCS9RE05-1

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

Inner mast

Middle mast

Free lift chain

Carriage

Lift chain

Outer mast

Block

18BCS9RE06
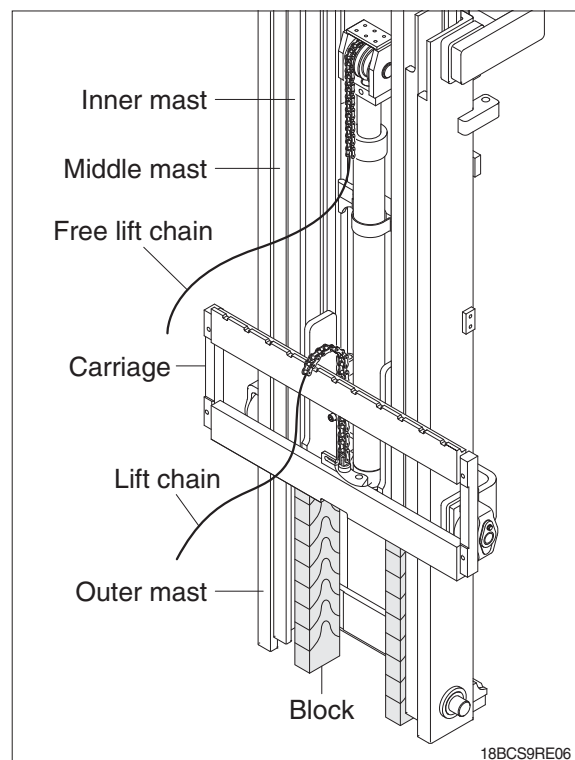
④ Slowly raise inner mast upright until mast clears top of fork carriage. Move carriage to work area and lower the mast.

⚠ **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.

Inner mast

Free lift chain

Middle mast

Outer mast

Carriage

Lift chain

Block

18BCS9RE07
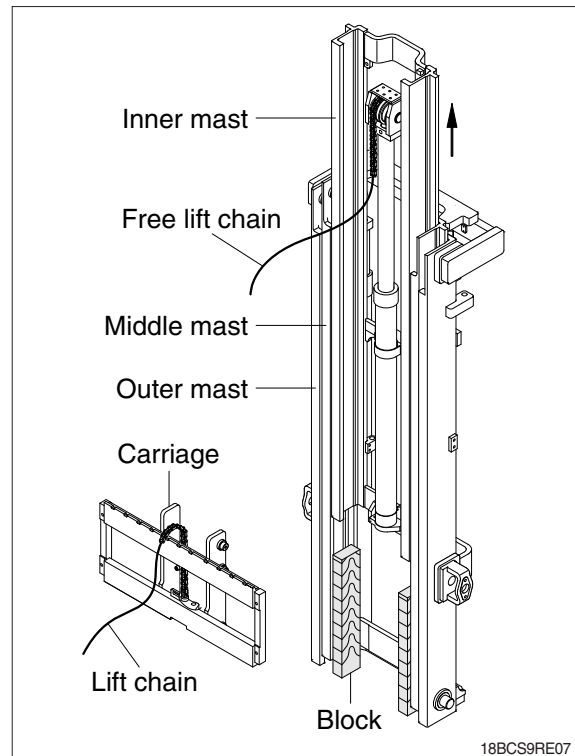
(4) Piping

① Disconnect the return hoses attached to the lift cylinder.

② Remove the return hoses from the pipe (2).

③ Remove the velocity fuse valve (1) from the lift cylinder.

④ Disconnect and remove the free lift hose.

⑤ Loosen the bolt and remove the pipe (2) from the outer mast.

⑥ Loosen the bolt and remove the pipe (4) from the middle mast.

18BCS9RE08
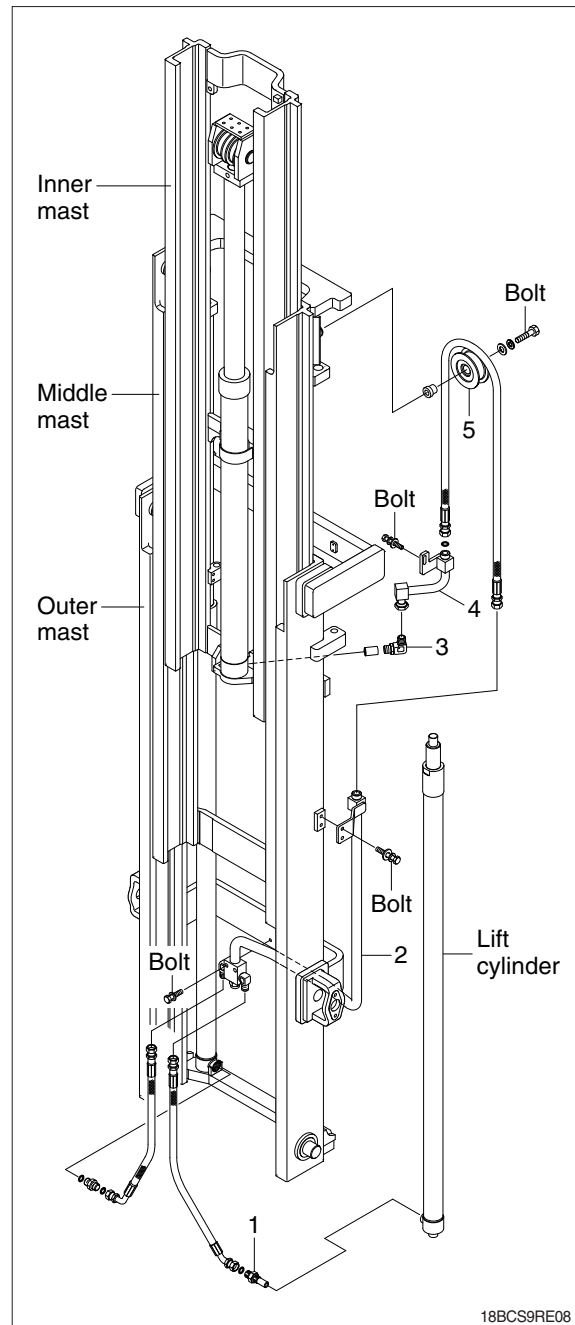
(5) Free lift cylinder

① Bind the free lift cylinder with overhead hoist rope and pull up so that the rope has no slack or binding.

② Loosen the bolts and remove clamp, shims securing the free lift cylinder to inner mast.

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

③ Using an overhead hoist draw out free lift cylinder carefully and put down on the work floor.

18BCS9RE08-1
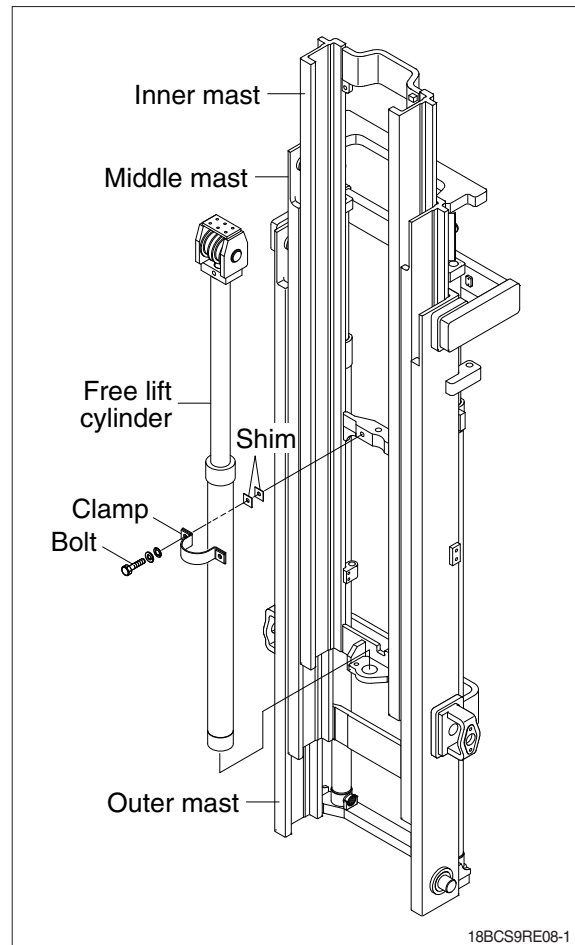
(6) Lift cylinder

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

② Loosen the nuts and socket set screws from the middle mast.

③ 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.

④ Loosen and remove hexagon bolts and clamp securing the lift cylinder to outer mast.

⑤ Using an overhead hoist, slowly raise the inner mast high enough to clear lift cylinder.

⑥ Using an overhead hoist, draw out lift cylinder carefully and put down on the work floor.

18BCS9RE09
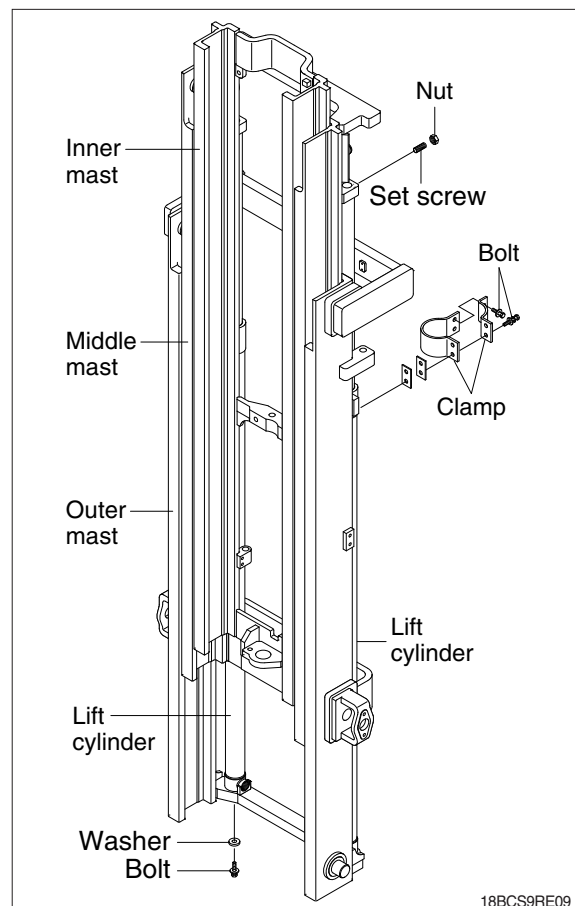
(7) Inner mast

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

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

18BCS9RE12
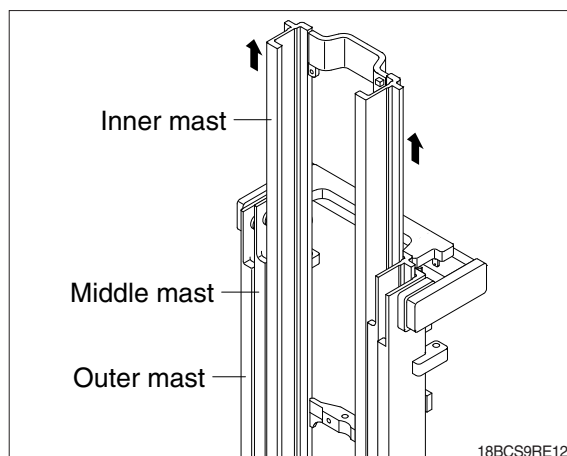
(8) Middle mast

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

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

18BCS9RE13
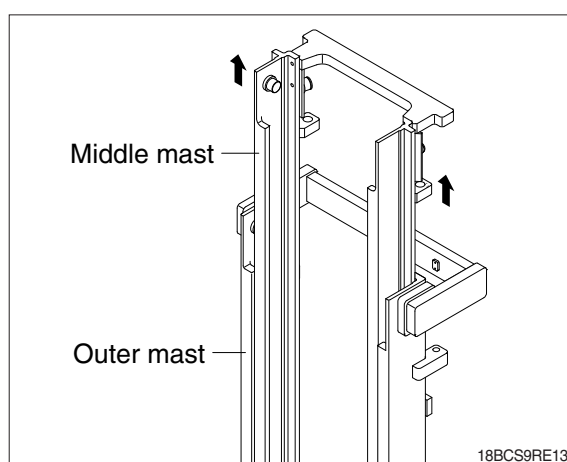
(9) Outer mast

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 truck, so use a pit, or if there is no pit, jack up the truck and loosen with on impact wrench.

② Loosen the bolts and remove the tilt cylinder mounting pins.

③ Loosen the screws and remove the flange cover from the drive units and then slowly raise up the outer mast

18BCS9RE11
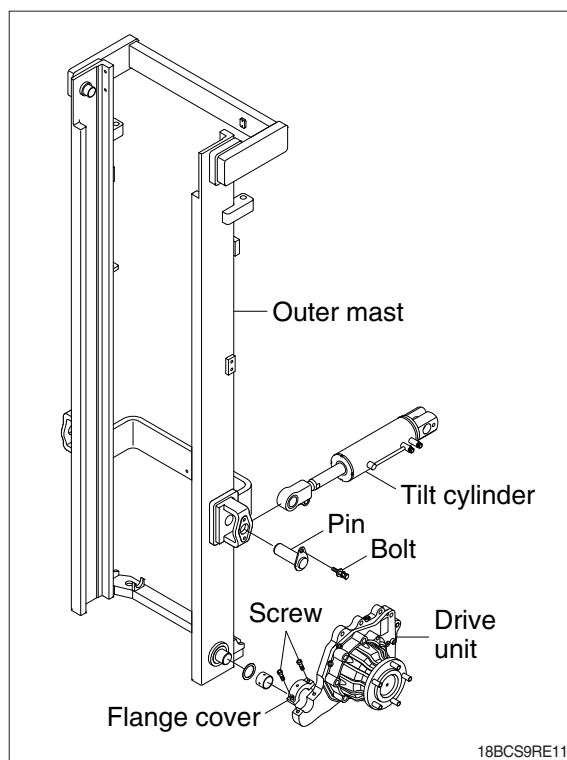
2) INSTALLATION

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) Brone 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 outer mast to drive axle unit.

(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 : 1.0 ㎜ (0.04 in)
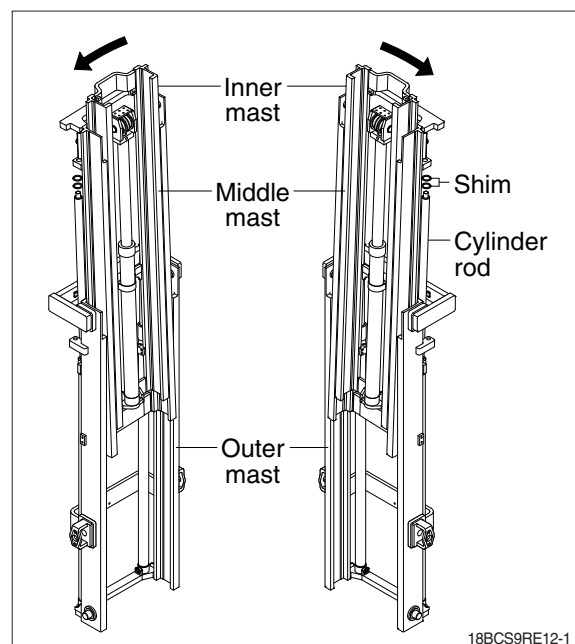
18BCS9RE12-1

2. POWER TRAIN ASSEMBLY

1) REMOVAL

Mast		Battery connector		Front cover		Cable and harness		Traction motor assembly		Drive unit assembly

18BCS9RE001

(1) Mast

Refer to section on mast (page 2-2).

(2) Disconnect the battery cable.

18BCS9OM120
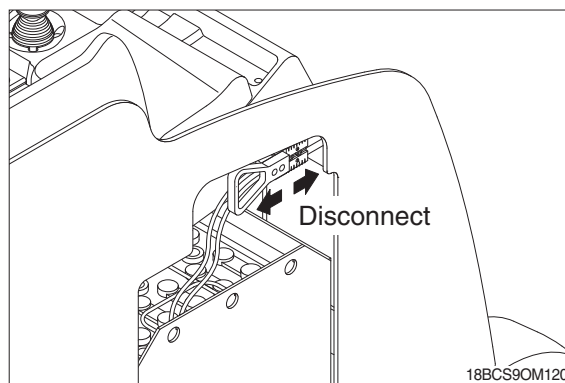
(3) Front cover.

① Loosen bolt and remove the lock bracket.
· Tightening torque : 0.85~1.25 kgf·m
(6.1~9.0 lbf·ft)
② Pull out the knob and remove the front cover.

18BCS9RE41
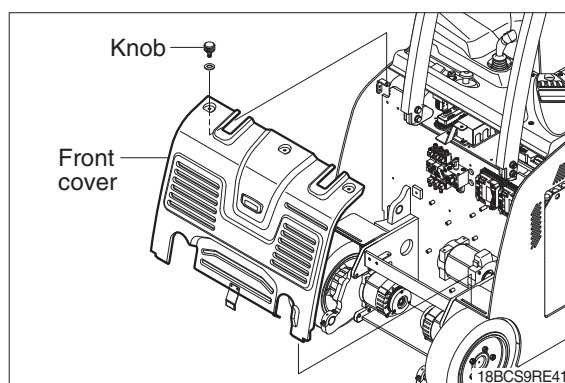
(4) Cables and harnesses.

① Disconnect the harness to the electric brake assembly.

18BCS9RE13A

② Disconnect the cables and harness to the drive motor assembly.

Wiring

18BCS9RE16
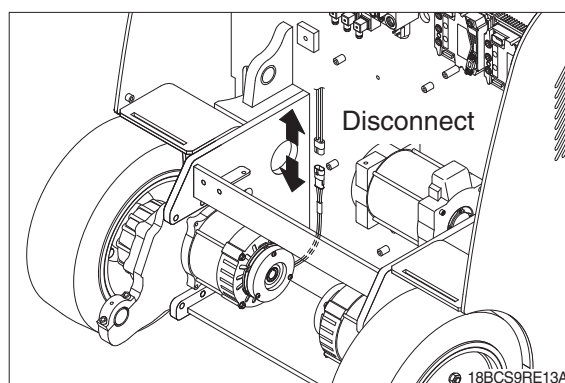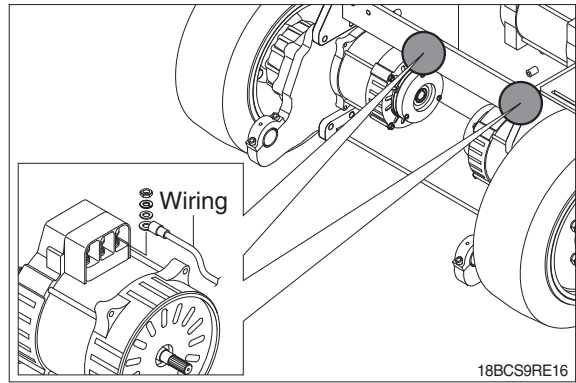
(5) Jack up the frame and support both side of frame on wood block.

18BCS9JB09A
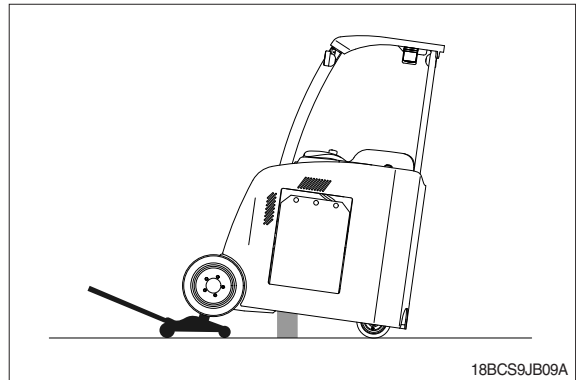
(6) Loosen hub bolt and remove the tire.

Hub bolt

18BCS9RE17
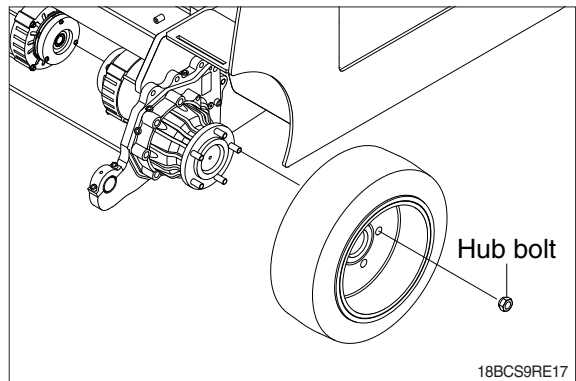
(7) **Drive motor assembly**
Loosen the mounting socket bolt and remove the drive motor with the electric brake from the drive unit carefully.

Socket bolt

18BCS9RE22
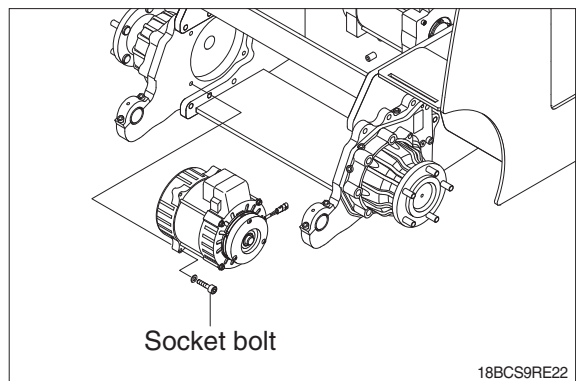
(8) Drive unit assembly

Loosen the mounting socket bolts and remove the drive unit carefully.
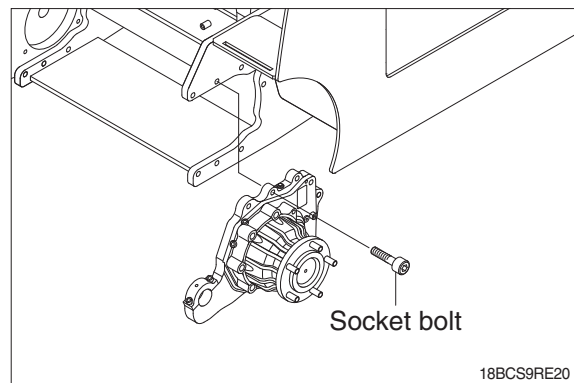
Socket bolt

18BCS9RE20

2) INSTALLATION

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

(1) Drive unit mounting bolts (M14 × 2.0)
   · Tightening torque : 14~18 kgf · m
                         (101~130 lbf · ft)

(2) Drive motor mounting bolts (M8 × 1.25)
   · Tightening torque : 1.3~1.7 kgf · m
                         (9.4~12.3 lbf · ft)

(3) Electric brake mounting bolts (M6 × 1.0)
   · Tightening torque : 0.9~1.1 kgf · m
                         (6.5~8.0 lbf · ft)

※ Apply loctite #277 all of the bolt before tightening.

(4) Tire hub bolt
   · Tightening torque : 13.4~18.0 kgf · m
                         (28.2~29.7 lbf · ft)
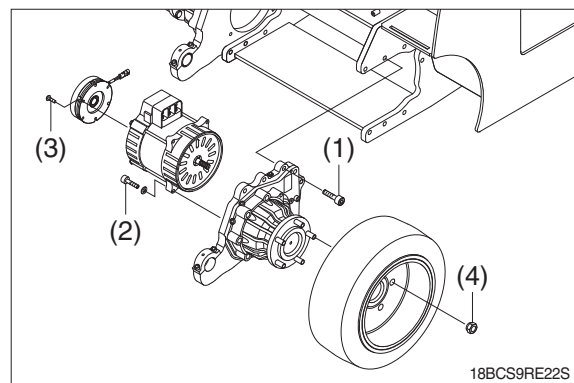
18BCS9RE22S

3. ELECTRICAL COMPONENTS

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

1) REMOVAL


```
┌──────────┐   ┌──────────┐   ┌──────────┐   ┌──────────┐   ┌──────────┐
│ Battery  │───│  Front   │─┬─│ Wirings  │───│Hydraulic │───│ Pump &   │
│connector │   │  cover   │ │ │          │   │ piping   │   │pump motor│
└──────────┘   └──────────┘ │ └──────────┘   └──────────┘   └──────────┘
                            │ ┌──────────┐   ┌──────────┐   ┌──────────┐
                            └─│ Wirings  │───│  Brake   │───│  Drive   │
                              │          │   │  cable   │   │  motor   │
                              └──────────┘   └──────────┘   └──────────┘
```
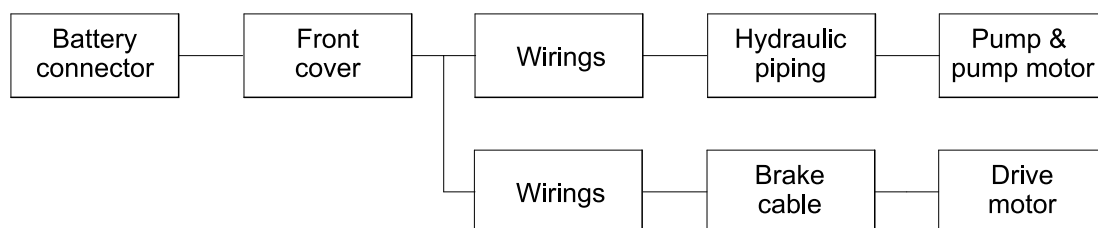
18BCS9RE002

(1) PUMP MOTOR

※ Drain the oil before disassembling the pump motor.
① Disconnect the battery cable.

18BCS9OM120
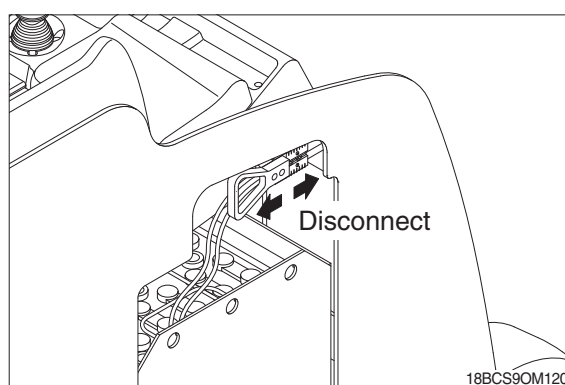
② Remove the front cover.
※ Refer to 2-7 page for details.

18BCS9RE41
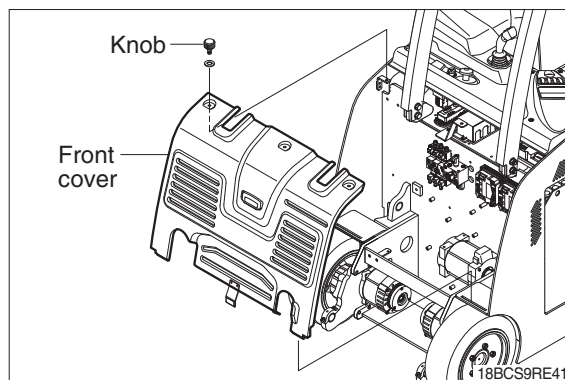
③ Disconnect the cables and wirings from pump & motor assembly.

④ Disconnect the suction hose and the hose assembly.

Pump & motor assembly

Priority valve

Wiring

Hyd tank

Hose

18BCS9RE15
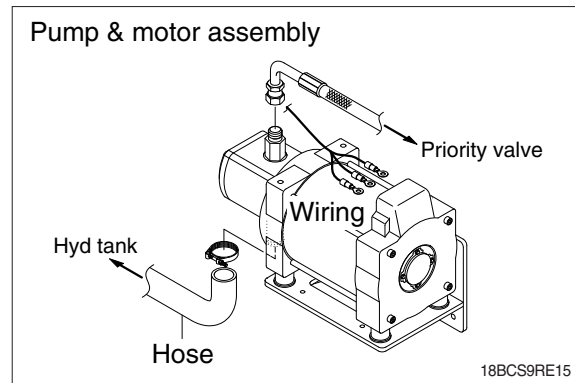
⑤ Loosen mounting nuts from the bracket.

Mounting nut

18BCS9RE15-1
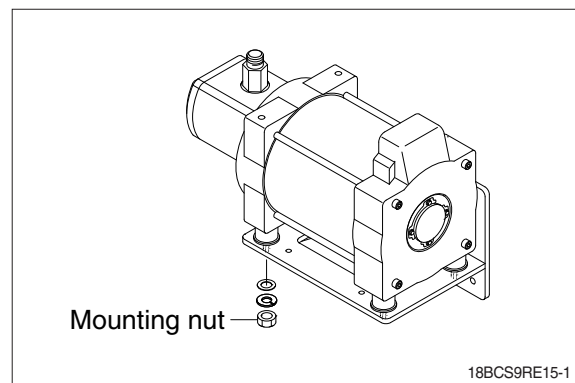
⑥ Tire wire rope around the hydraulic pump & pump motor assembly and lift up slowly.

18BCS9RE43
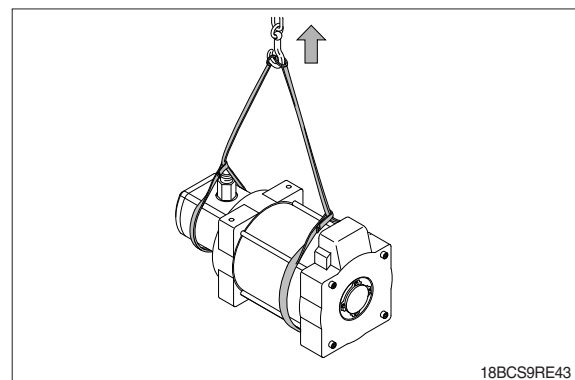
⑦ Remove 2 bolts fastening the pump & motor and then disengage the pump from motor.

Pump & motor assembly

Hex bolt

18BCS9RE21

2-13
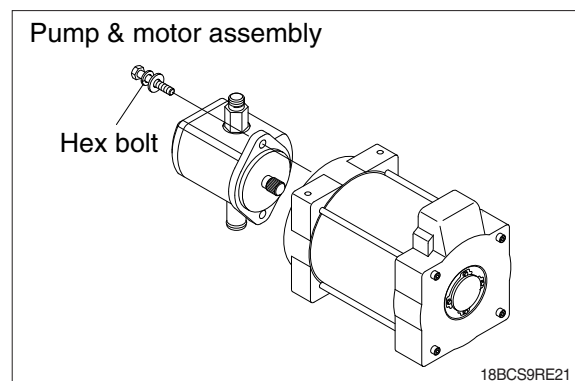
(2) DRIVE MOTOR

① Disconnect the battery cable.

18BCS9OM120

② Remove the front cover.

Knob
Front cover
18BCS9RE41

③ Disconnect the harness to the electric brake assembly.

Disconnect
18BCS9RE13A
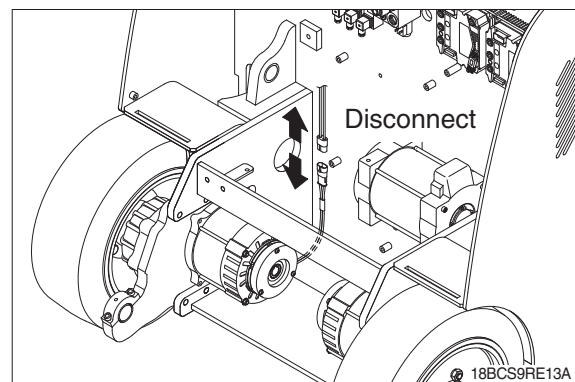
④ Disconnect the cables and harness to the drive motor assembly.

Wiring
18BCS9RE16

⑤ Tie wire rope around the drive motor not to drop.

18BCS9RE23
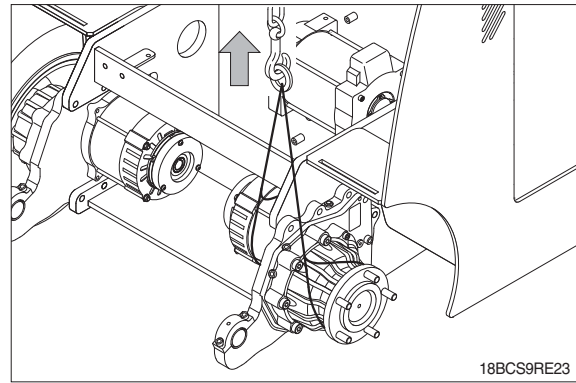
⑥ Remove socket bolts connecting the motor and drive unit and lift up slowly.

Socket bolt   18BCS9RE22A
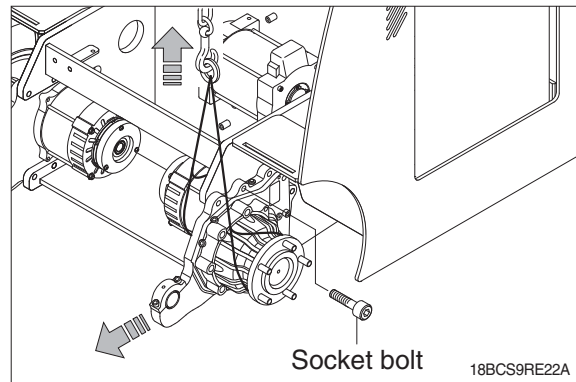
⑦ Put the motor on the clean work bench.

18BCS9RE24
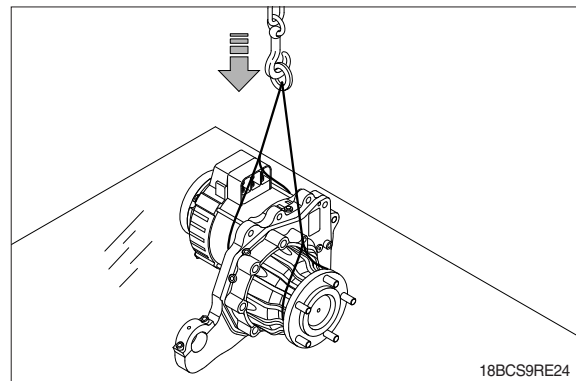
(3) BATTERY

① Disconnect the battery connector.

Disconnect

18BCS9OM120

② Pull the side plate out.

Side plate

18BCS9OM121A
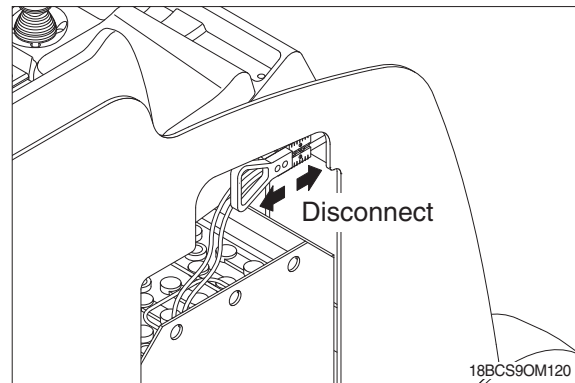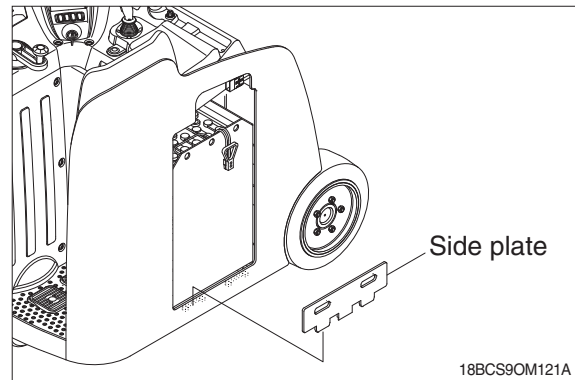
③ Adjust the height of the roller of the stand to that of the roller of the truck and pull the battery out carefully.
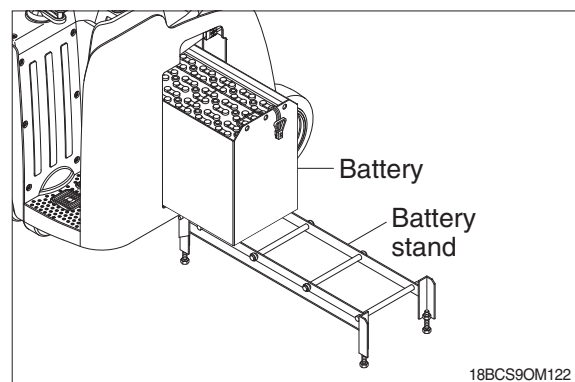
Battery

Battery stand

18BCS9OM122

2) INSTALLATION

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

(1) PUMP MOTOR

① Pump motor mounting nut. (M8×1.25)
 · Tightening torque : 2.0~3.0 kgf · m
  (14.5~21.7 lbf · ft)
② Hydraulic pump mounting bolt.
 (M10×1.5)
 · Tightening torque : 5.5~8.3 kgf · m
  (39.8~60.0 lbf · ft)

Pump & motor assembly

Hex bolt

Mounting nut

18BCS9RE21S
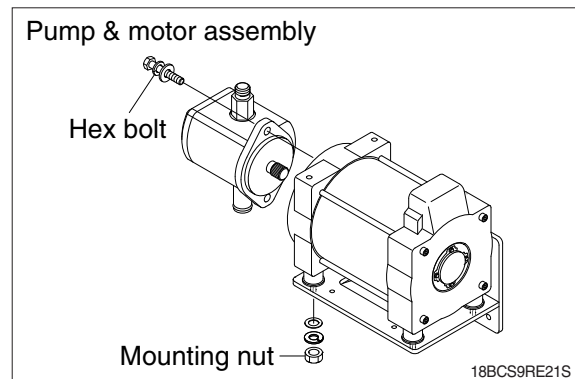
(2) DRIVE MOTOR

① Drive motor mounting bolt (M8×1.25) and drive unit.
 · Tightening torque : 1.3~1.7 kgf · m
  (9.4~12.3 lbf · ft)

※ Apply loctite #277 on the thread of the bolt before tightening.

Motor mounting bolt
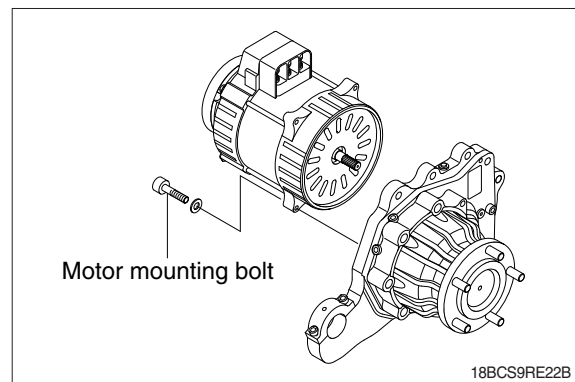
18BCS9RE22B

(3) BATTERY

① Using a battery stand carefully put the battery assembly on the battery compartment.

Battery

Battery stand

18BCS9OM122

② Place the side plate.

Side plate

18BCS9OM121A

③ Connect the battery connector.

Connect

18BCS9OM120A

4. STEERING AXLE ASSEMBLY

Battery connector	Inner cover	Harness and hydraulic hose	Steering hyd motor	Tire and rim assy	Steering axle assy
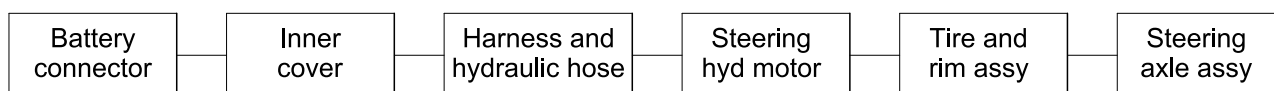
18BCS9RE003

1) REMOVAL

(1) Disconnect the battery cable.

Disconnect

18BCS9OM120
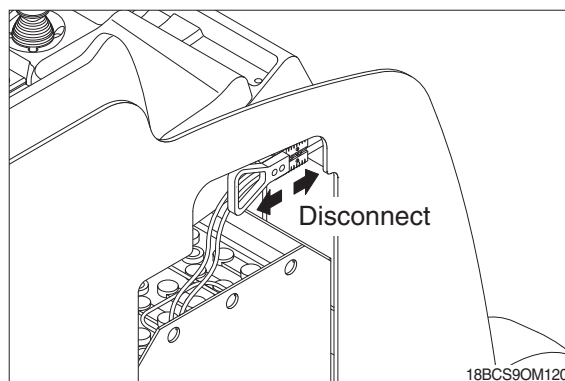
(2) Loosen the bolt and remove the inner cover.

Inner cover

Bolt

18BCS9RE28
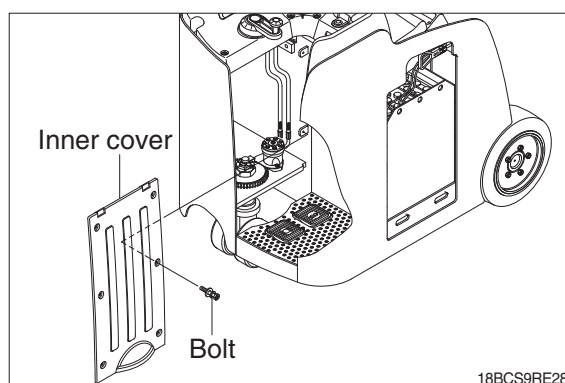
(3) Disconnect the harness from the steering sensor.

(4) Disconnect the hoses from the steering hydraulic motor.

※ Drain the oil before disassembling the steering hydraulic motor.

Disconnect

Hose

Steering motor

Steering sensor

18BCS9RE49A
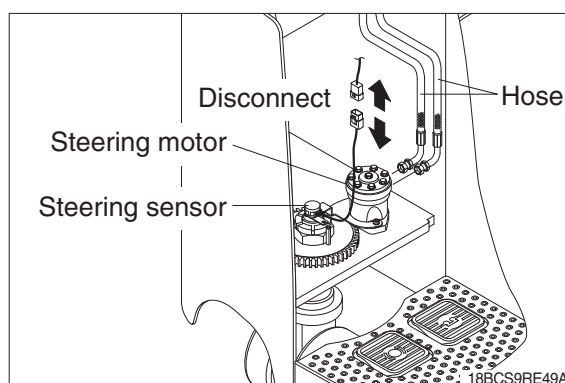
(5) Loosen the nut and remove the steering sensor and lever.

Steering sensor

Lever

18BCS9RE50
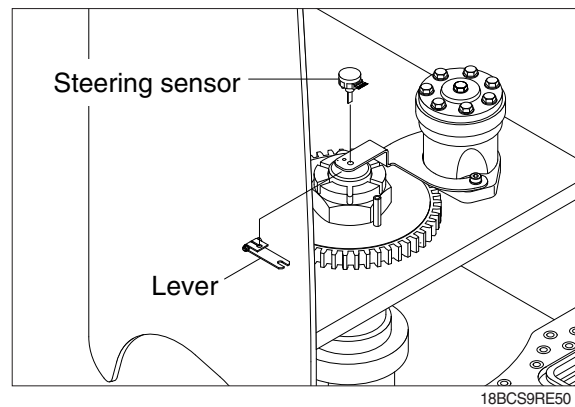
(6) Loosen the socket bolt and remove the bracket.

(7) Pull the spring pin out.

Socket bolt

Spring pin

Bracket

18BCS9RE51
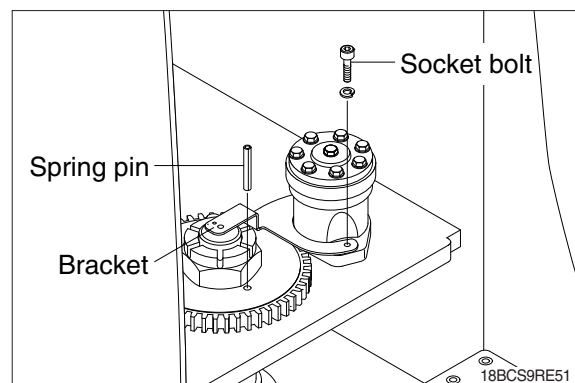
(8) Loosen the bolt and spring washer.

(9) Remove the steering hydraulic motor with steering pinion carefully.

Hydraulic motor

Steering pinion

Sepcial washer
Bolt

18BCS9RE52
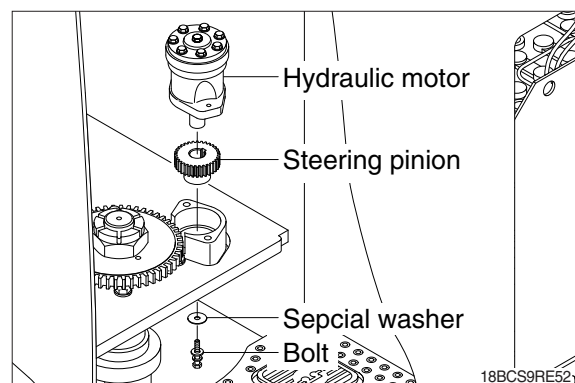
(10) Jack up the frame and support both side of frame on wood block.

Wood block

18BCS9RE53
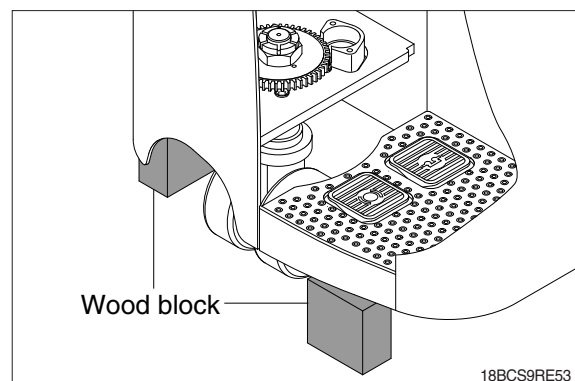
(11) Loosen the wheel nut and remove the tire and rim assembly.

Tire & rim assembly
Bearing
Bolt
Washer
Wheel nut
Cover

18BCS9RE54
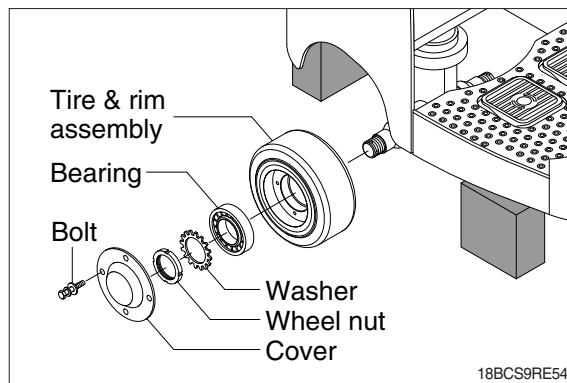
(12) Pull the spring pin out.

(13) Loosen the castle nut and remove the steering gear assembly.

Castle nut
Steering gear
Spring pin

18BCS9RE55
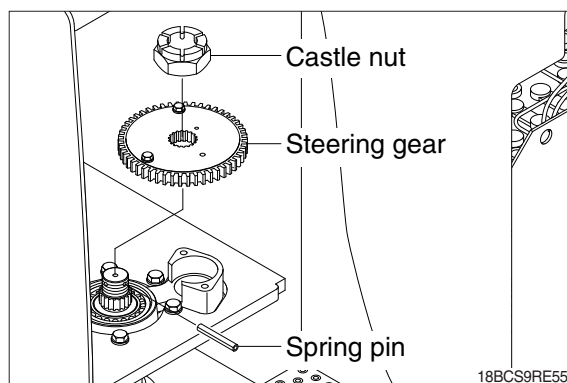
(14) Loosen the bolt and remove the steering axle assembly carefully.

※ Do not use the oil seal twice.

Bolt
Steering axle assembly

18BCS9RE56
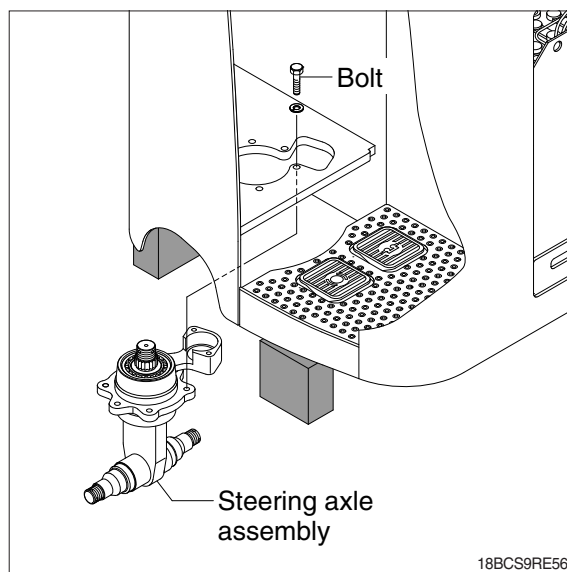
2) INSTALLATION

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

(1) Steering axle assembly mounting bolt (1).
  · Tightening torque : 14~18 kgf · m
  (101~130 lbf · ft)
※ Apply loctite #277 on the thread of the bolt before tightening.

(2) Hex bolt (2).
  · Tightening torque : 2~3 kgf · m
  (14.5~21.7 lbf · ft)

(3) Socket bolt (3).
  · Tightening torque : 9~12 kgf · m
  (65.1~86.8 lbf · ft)
※ Apply loctite #277 on the thread of the bolt before tightening.

Bolt (1) · Hydraulic motor · Sepcial washer · Bolt (2)

18BCS9RE57

Socket bolt (3)

18BCS9RE58
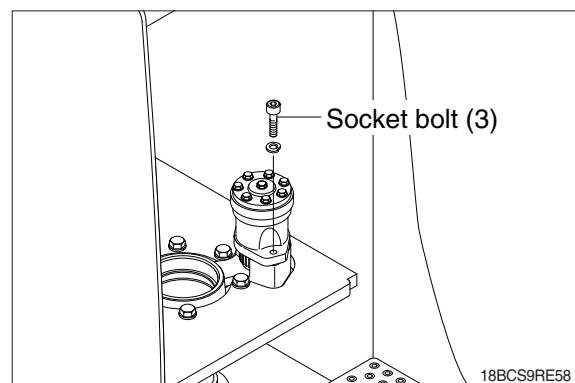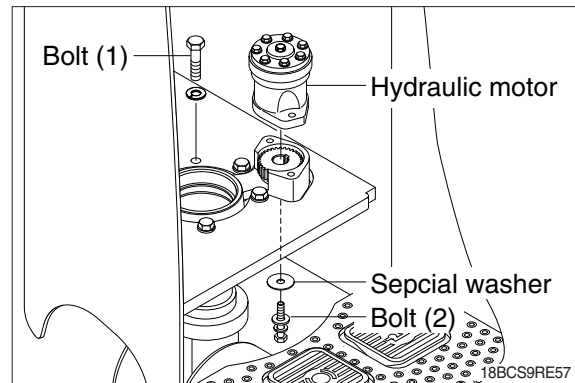
(4) Tightening castle nut

① Tightening the castle nut until the bracket is not rotated and then loosen it reverse direction until the preload becomes 30~35 kgf · cm.
② Fit the spring pin.

Castle nut · Spring pin

18BCS9RE59
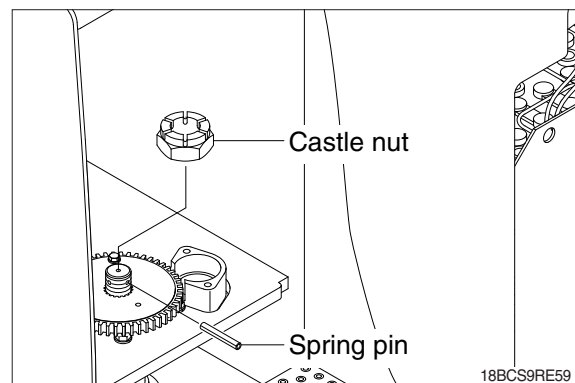
※ Fill the Shell retinax grease up to base line of the upper taper roller bearing (if disassembled).
※ Apply the grease on the surface of the seal lip.

Grease · Bearing · Seal lip

18BCS9RE60

2-22
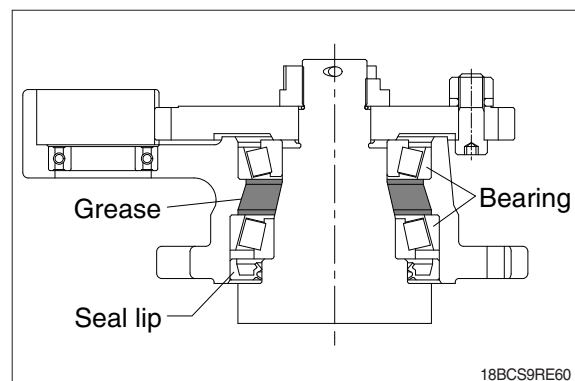
(5) Steering sensor assembling

① Fit the steering sensor into the bracket.

Steering sensor
Bracket

18BCS9RE61
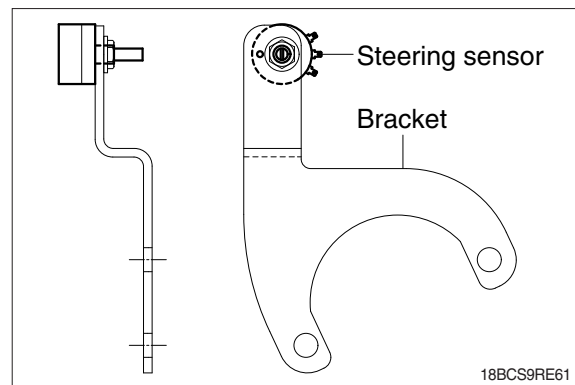
② Turn the shaft of the steering sensor clockwise to the maximum.

Maximum

18BCS9RE62
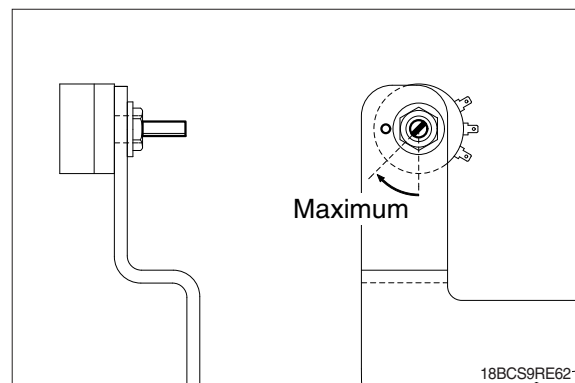
③ Align the groove of the steering sensor shaft with the lever in a straight line and fit them with the bolt and nut.

Lever

18BCS9RE63
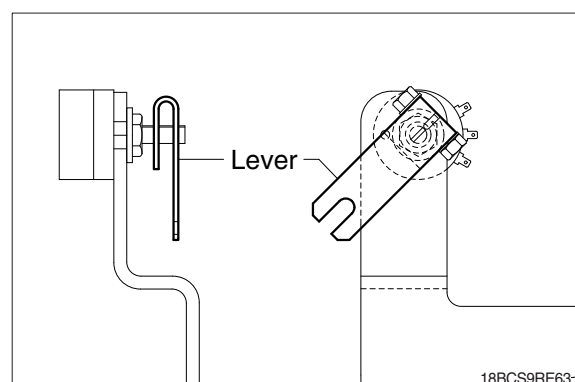
④ Install the sub assembly as prepared above to the steering axle bracket.
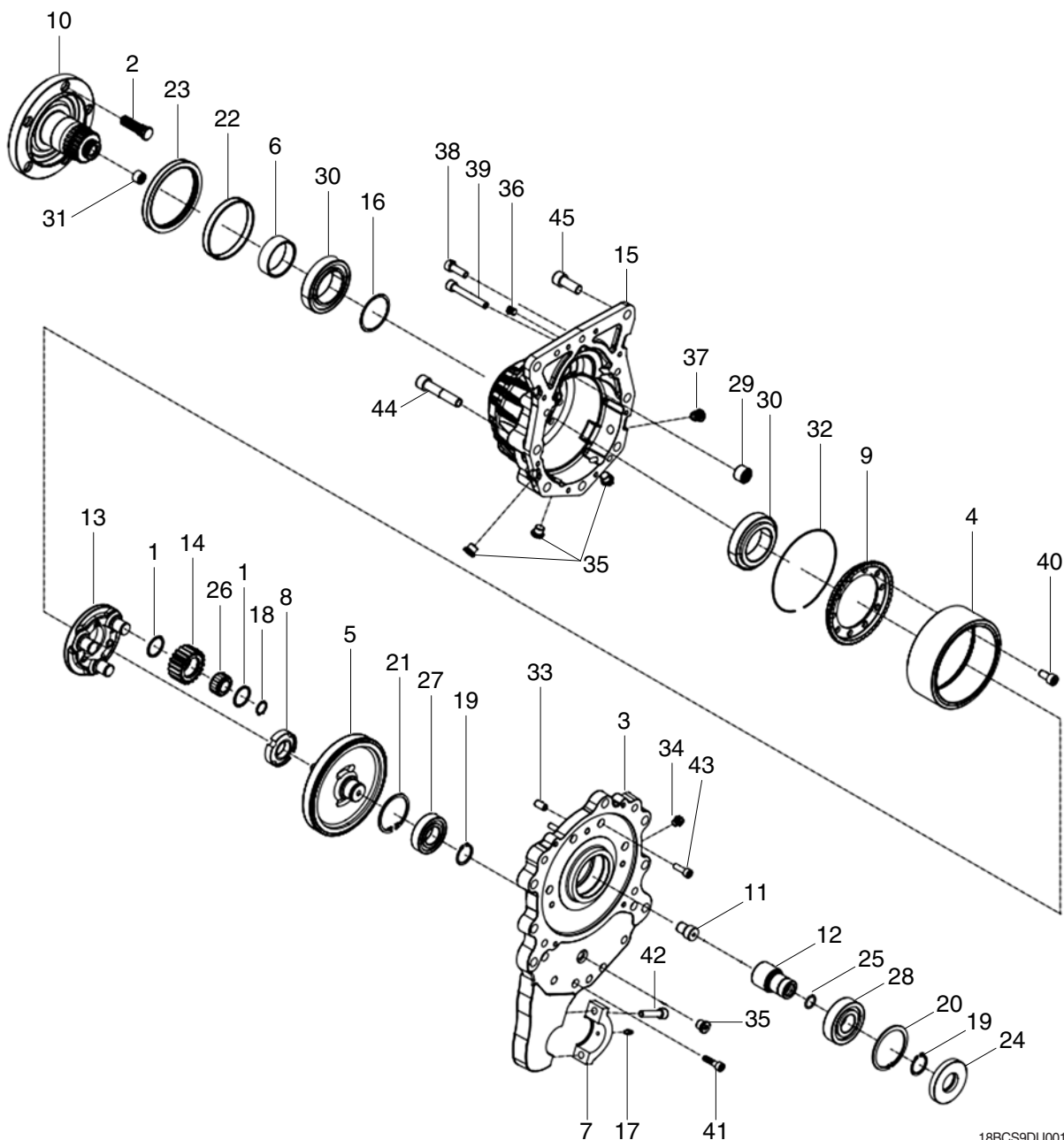

Spring pin
Castle nut
Front
Rear
Lever

18BCS9RE64
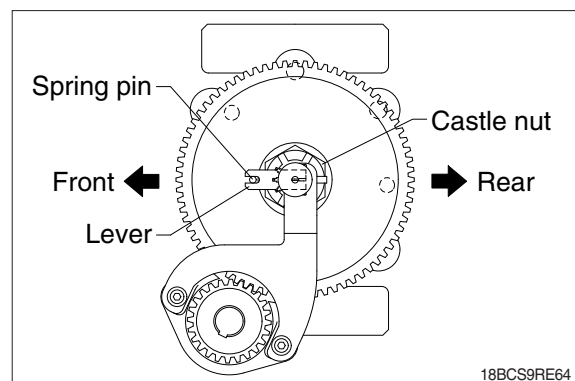
SECTION 3 POWER TRAIN SYSTEM

GROUP 1 STRUCTURE AND OPERATION

1. DRIVE UNIT

1) STRUCTURE - LH

18BCS9DU001

1	Elastic ring	13	Planetary carrier	25	O-ring	37	Magnetic plug
2	Wheel hub bolt	14	Planet gear	26	Roller bearing	38	Screw
3	Gearbox cover - LH	15	Gearbox housing	27	Ball bearing	39	Screw
4	Planetary ring gear	16	Spacer	28	Ball bearing	40	Screw
5	Spur gear	17	Grease nipple	29	Needle roller bearing	41	Screw
6	Spacer	18	Snap ring - shaft	30	Roller bearing	42	Screw
7	Cover flange - LH	19	Snap ring - shaft	31	Needle roller cage	43	Screw
8	Locking nut	20	Snap ring - hole	32	Elastic ring	44	Screw
9	Ring gear carrier disc	21	Snap ring - hole	33	Dowel pin	45	Screw
10	Wheel hub	22	Seal	34	Breather plug		
11	Pinion pin	23	Shaft seal	35	Plug		
12	Pinion	24	Seal	36	Plug		

STRUCTURE - RH
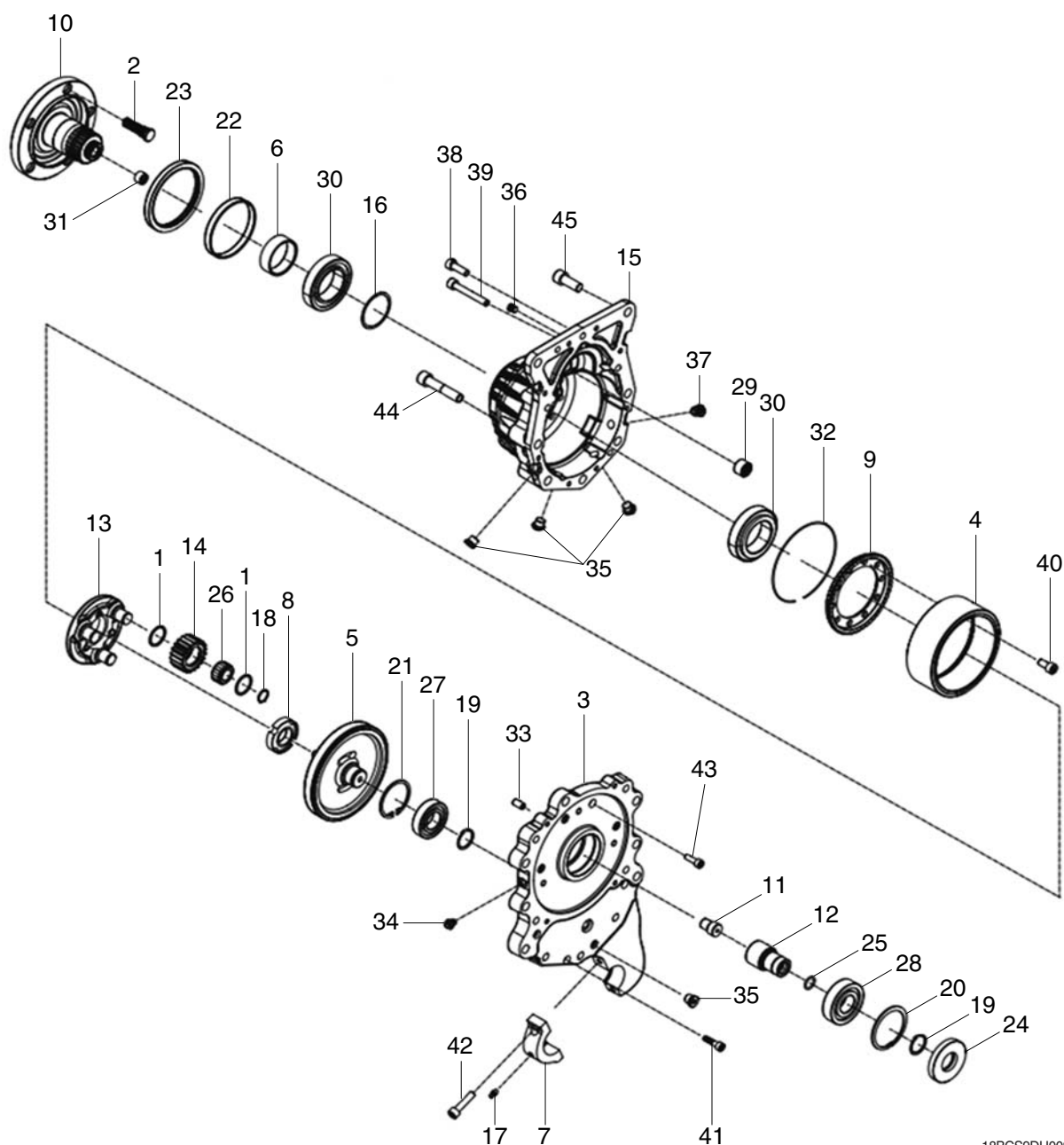
18BCS9DU002

1	Elastic ring	13	Planetary carrier	25	O-ring	37	Magnetic plug
2	Wheel hub bolt	14	Planet gear	26	Roller bearing	38	Screw
3	Gearbox cover - RH	15	Gearbox housing	27	Ball bearing	39	Screw
4	Planetary ring gear	16	Spacer	28	Ball bearing	40	Screw
5	Spur gear	17	Grease nipple	29	Needle roller bearing	41	Screw
6	Spacer	18	Snap ring - shaft	30	Roller bearing	42	Screw
7	Cover flange - RH	19	Snap ring - shaft	31	Needle roller cage	43	Screw
8	Locking nut	20	Snap ring - hole	32	Elastic ring	44	Screw
9	Ring gear carrier disc	21	Snap ring - hole	33	Dowel pin	45	Screw
10	Wheel hub	22	Seal	34	Breather plug		
11	Pinion pin	23	Shaft seal	35	Plug		
12	Pinion	24	Seal	36	Plug		

2. SPECIFICATION

Item	Unit	Specification
Gear ratio	-	27.1
Oil quantity	l	0.45 × 2EA

3. OPERATION

The drive units are composed of the drive unit (LH) and the drive unit (RH) which are connected with the motor as a power transmission system to assemble the drive wheel for the battery type fork lift.
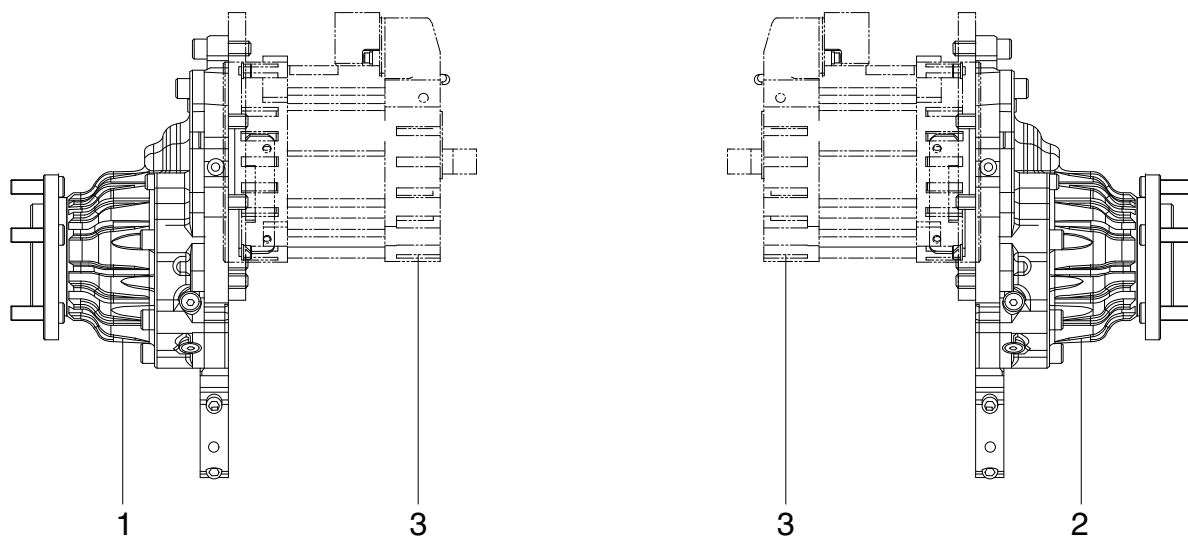
18BCS9DU003

| 1 | Drive unit (LH) | 2 | Drive unit (RH) | 3 | Drive motor |

The power of the drive motor which is received from signal of the controller transmits to the dirve gear and the power transfered from the drive gear transmits to the drive wheel via the planetary gear and wheel hub. As a result, it is able to drive to forward and reverse of the fork lift.

GROUP 2 TROUBLESHOOTING

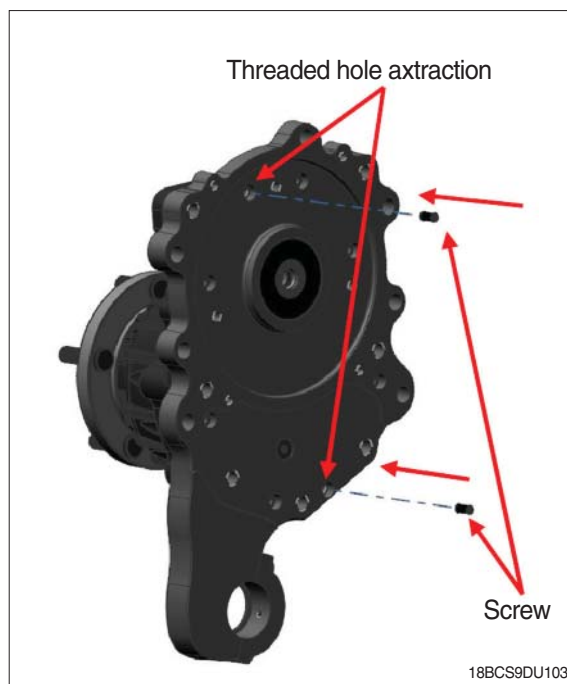| Problem	Cause	Remedy
1. Consecutive noise in the housing	· Lack of oil	· Refill the oil
	· Incorrect contact between planetary gear and driving gear	· Disassemble, check and readjusting
	· Damage, wear planetary gear and driving gear	· Replace damaged or wear gear
	· Loosened or worn wheel hub bearing	· Disassemble, check and readjusting or replace the components
2. Abnormal noise during rotation	· Excessive back lash the driving gear and planetary gear	· Replace the driving gear and the planetary gear
	· Damage, worn of the gear	· Replace the gear
	· Damage, worn of the bearing	· Disassemble, check and readjusting or replace the bearing
3. Oil leakage	· Overfill to the specified level	· Readjust oil level
	· Pluged air breather	· Clean or replace the air breather
	· Damage, worn, poor assembly for oil seal of wheel hub	· Replace oil seal
	· Poor assembly of the drain plug	· Disassemble, check and readjusting
	· Damage O-ring for motor connection	· Replace the O-ring
4. No rotation of the drive wheel	· Breakage, deformation the shaft	· Replace the shaft
	· Damage, breakgae the gear	· Replace the gear
	· Damage, breakgae the bearing	· Replace the bearing
5. Brake 　No operation the brake	· Damage, deformation the friction disc or plate	· Disassemble, check, replace
No smooth operation the brake pedal	· Damage, deformation the friction disc of the brake	· Disassemble, check, replace
No release the brake	· Defect the brake disc assembly	· Disassemble, check, replace
Frequent refilling the brake oil	· Leakage from the piston seal	· Disassemble the piston seal and replace it
Available braking when depressing the brake pedal with maximum	· Excessive clearance of the discs due to wear of the friction disc for operation	· Adjust the stroke of the brake pedal · Disassemble the brake pack, check and replace it · Readjust the stroke of the piston

GROUP 3 DISASSEMBLY AND ASSEMBLY

1. DISASSEMBLY

※ During assembly and disassembly activities use caution and proper safety equipment, in observance of the rules provided by safety laws.

1) GEARBOX DISASSEMBLY

(1) Remove the oil from gearbox.

※ Respect the environment.
Do not dispose into the environment.

(2) Using the appropriate wrench remove the screws.

Gearbox oil drain

18BCS9DU101

Screw

18BCS9DU102
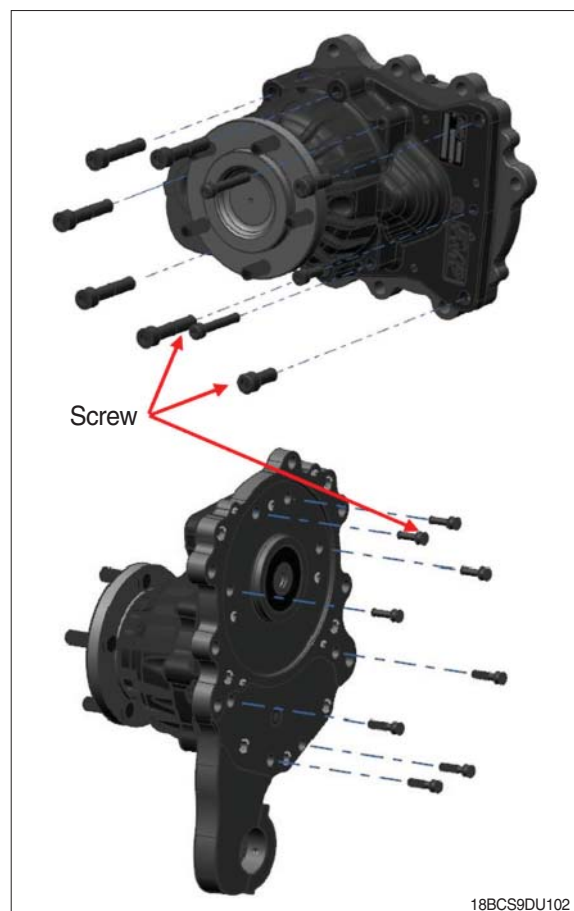
(3) Insert 2 grub screws in the threaded hole extraction of the cover.

Threaded hole axtraction

Screw

18BCS9DU103

(4) Insert 2 screws in the threaded hole extraction of the cover.

※ Pay attention not to damage components.
※ Compulsory requirement.

Screw

18BCS9DU104

(5) Tighten the screws and so remove the gearbox cover.

⚠ Watch your step, your back and your hands : the component is heavy, move it carefully.

Screw

18BCS9DU105
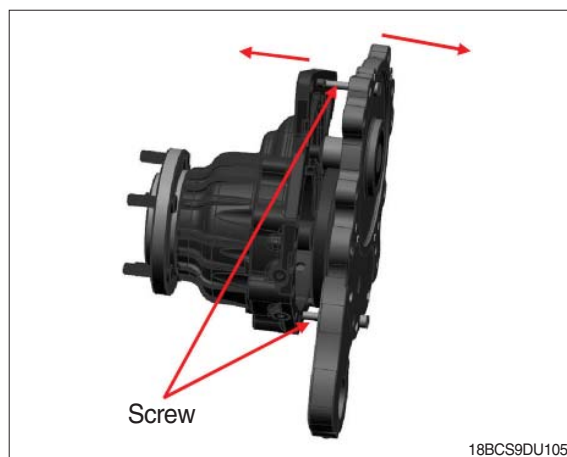
(6) Remove the grub screws from the housing.

※ Pay attention not to damage components.
※ Compulsory requirement.

Screw

18BCS9DU106
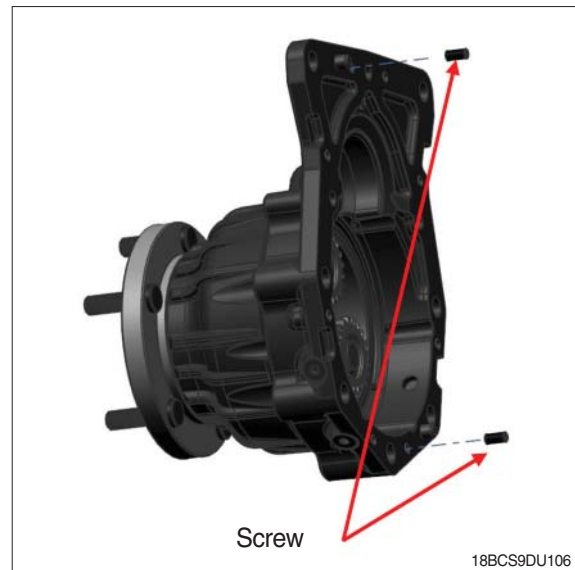
(7) Using the appropriate pliers remove the snap rings of the planetary carrier.

※ Pay attention not to damage components.

Snap ring

18BCS9DU107
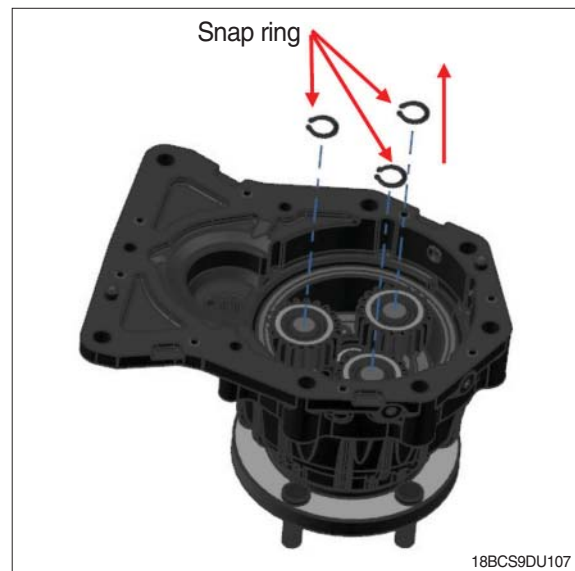
(8) Using the extractor remove the assembled planet gears.

Planet gear

18BCS9DU108
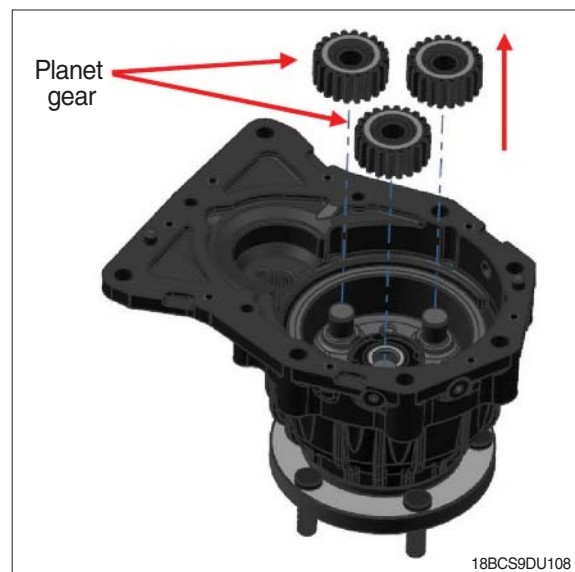
(9) Using the appropriate wrench remove the locknut.

※ The crushing must be cut out before to removing the locknut.
※ Pay attention not to damage components.
※ Compulsory requirement.

Locknut

Locknut crushing

18BCS9DU109
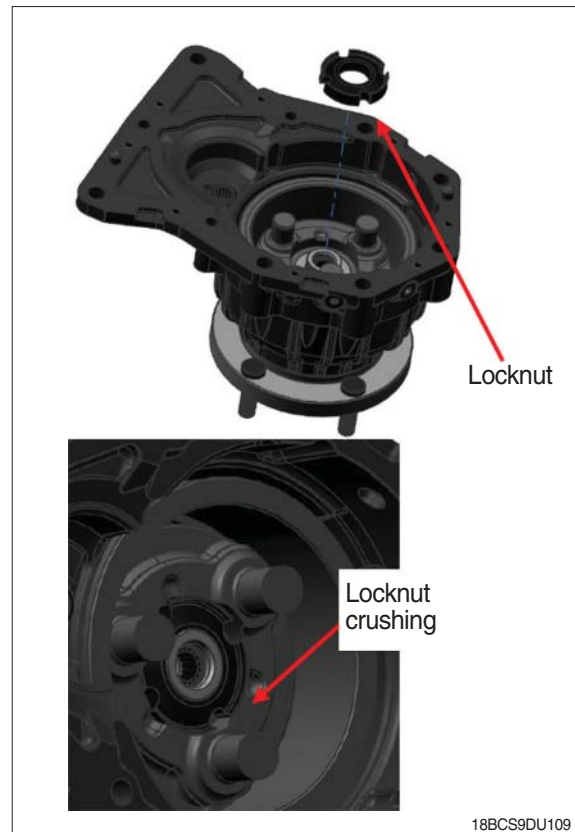
(10) Place the gearbox on 3 pins and using the press push the hub and so remove it.

※ Pay attention not to damage components.
※ Compulsory requirement.
⚠ Crush hazard : keep hands clear.

Press piston

Planetary carrier

Hub

Pin

18BCS9DU110
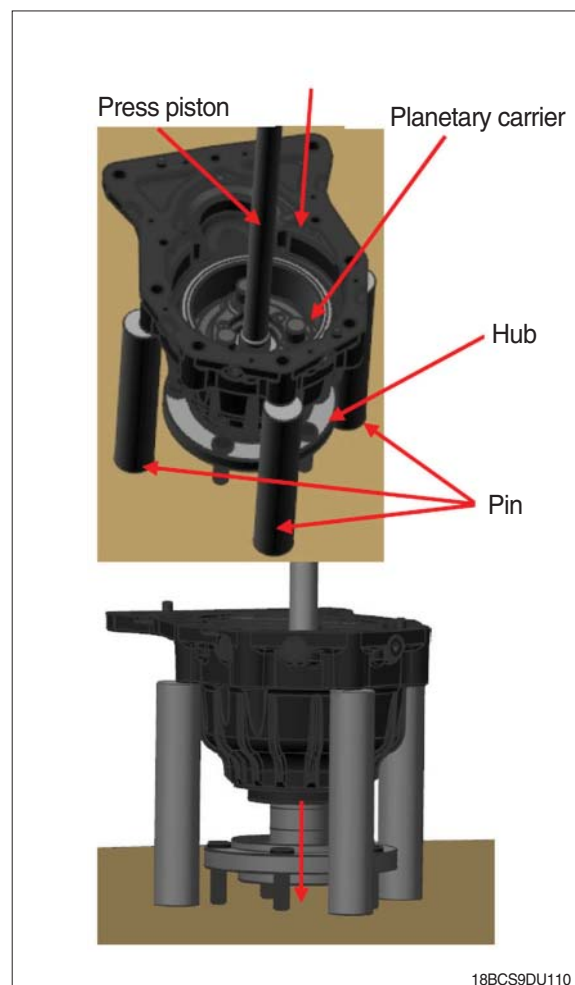
(11) Using the appropriate wrench remove the screws of the planetary ring gear.

Screw

18BCS9DU111
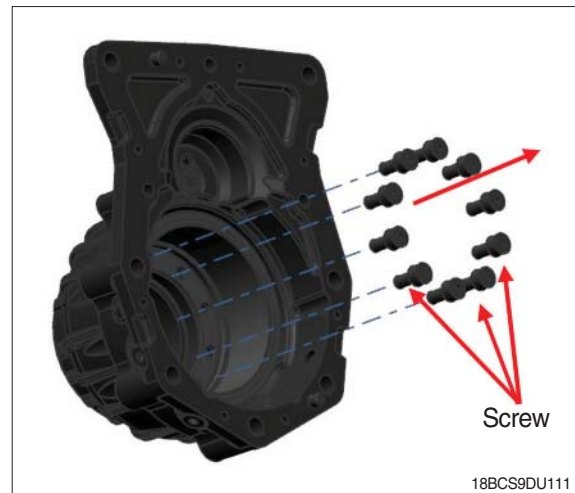
(12) Then remove the planetary ring gear.

Planetary ring gear

18BCS9DU112
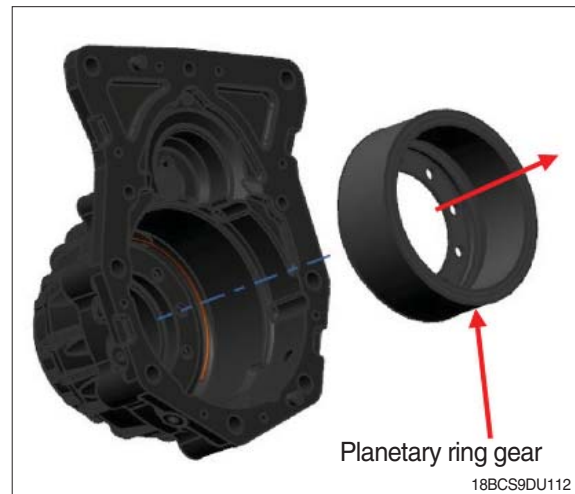
2) COVER DISASSEMBLY

(1) Remove the input shaft seal.

Seal

18BCS9DU113

(2) Using the appropriate pliers remove the snap ring.
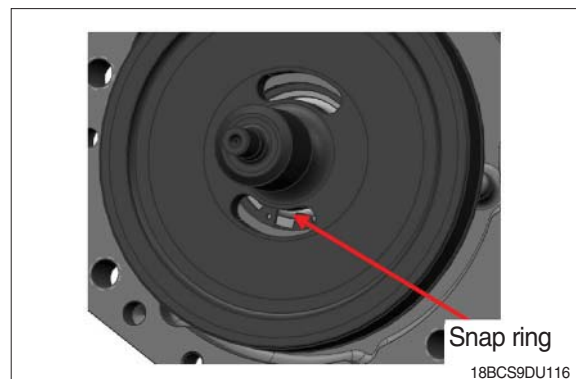

Snap ring

18BCS9DU114
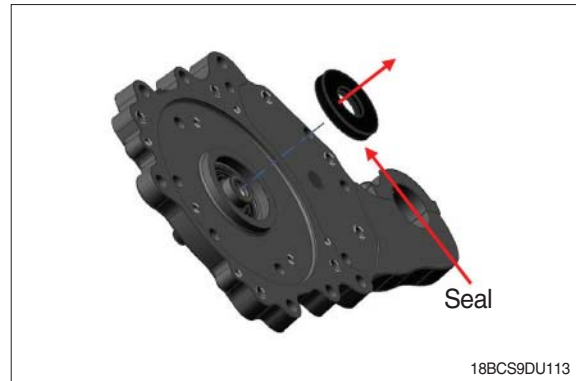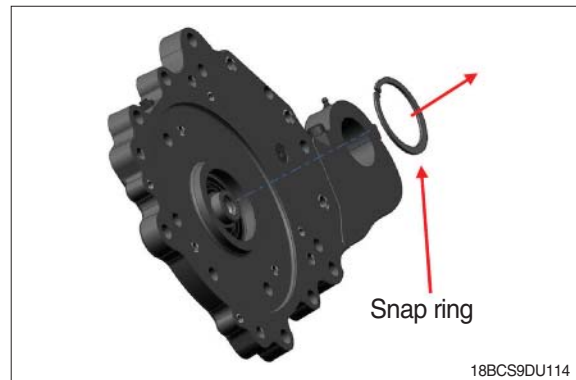
(3) Remove the input shaft assy. Use the press if necessary.
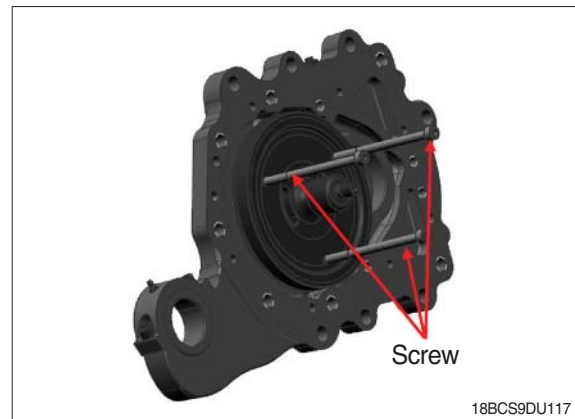
⚠ **Crush hazard : keep hands clear.**

18BCS9DU115
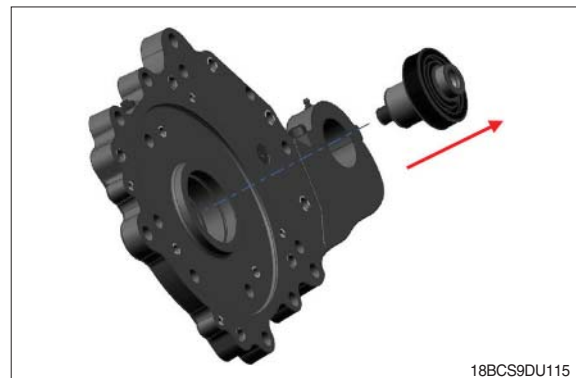
(4) Using the appropriate pliers, release the snap ring of the sun gear.
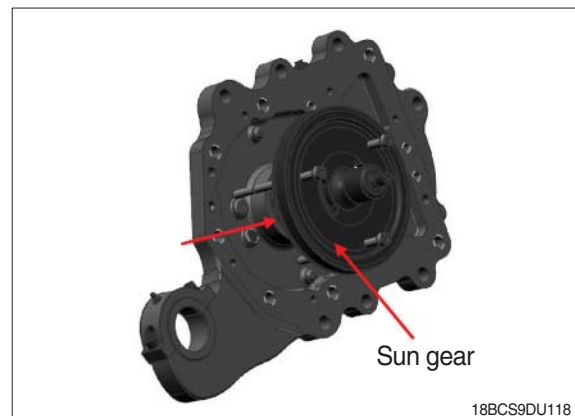
※ Pay attention not to damage components.

Snap ring

18BCS9DU116

(5) Insert 3 M8 screws in the threaded holes of the sun gear.

※ Pay attention not to damage components.
※ Compulsory requirement.

Screw

18BCS9DU117

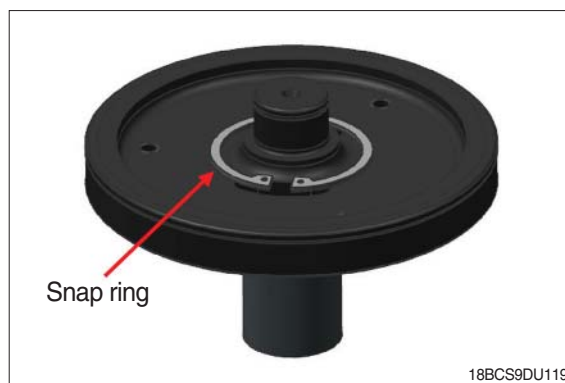(6) For remove the sun gear tighten the screws.
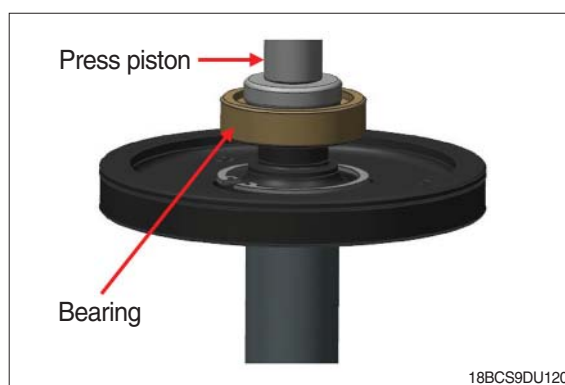
※ Pay attention not to damage components.

Sun gear

18BCS9DU118

2. DISASSEMBLY

1) COVER DISASSEMBLY

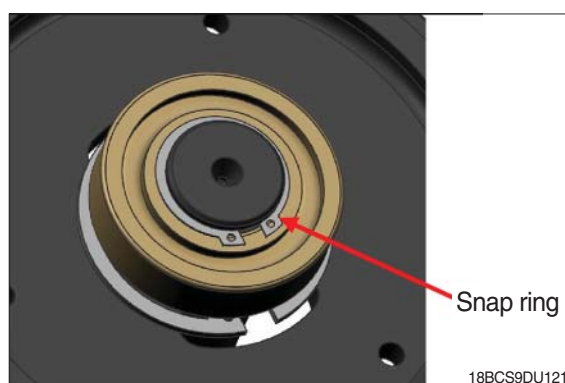(1) Place the spur gear on the tool and place on it the snap ring.

Snap ring

18BCS9DU119

(2) Place the bearing on the sun gear and using the press insert it.

⚠ **Crush hazard : keep hands clear.**
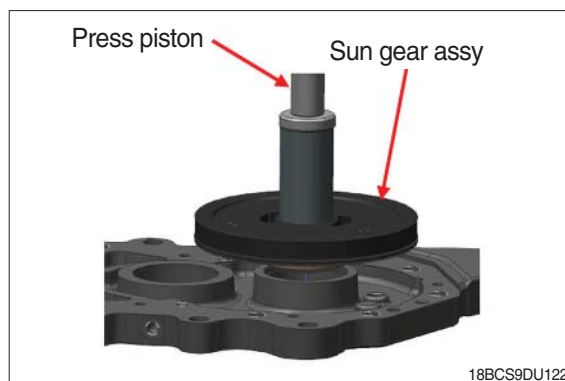
Press piston

Bearing

18BCS9DU120

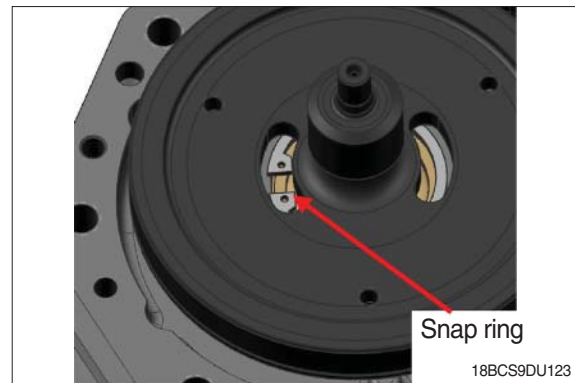(3) Using the appropriate pliers insert the snap ring and so to block the bearing.

Snap ring

18BCS9DU121

(4) Place the sun gear assy on the cover and insert it by press.

⚠ **Crush hazard : keep hands clear.**

Press piston   Sun gear assy

18BCS9DU122

(5) Using the appropriate pliers insert the snap ring and so block the sun gear.

Snap ring

18BCS9DU123

(6) Place the input shaft assy on the gearbox cover and insert it using the press.

※ Use the tool for this operation.

⚠ **Crush hazard : keep hands clear.**

Press piston

Tool   Input shaft assy

18BCS9DU124
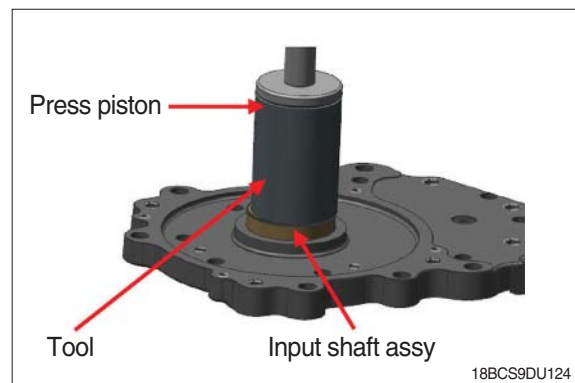
(7) Insert the snap ring using the appropriate pliers.

Snap ring

18BCS9DU125
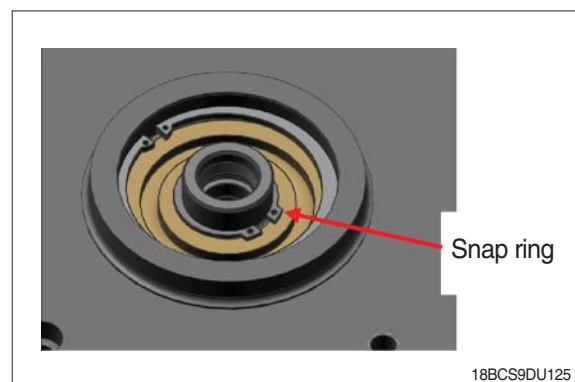
(8) Place the seal on seat cover and using the appropriate tool, insert it.

※ Use the rubber hammer for this operation.
※ Pay attention not to damage components.

Tool   Seal

18BCS9DU126

2) GEARBOX ASSEMBLY

(1) Insert the planetary ring gear in the gearbox housing.

※ Pay attention not to damage components.
※ Compulsory requirement.

Planetary ring gear

18BCS9DU127
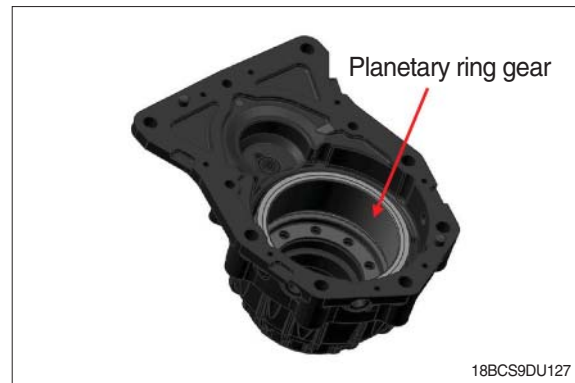
(2) Spread with medium threadlocker the screws and place them in the appropriate seat.
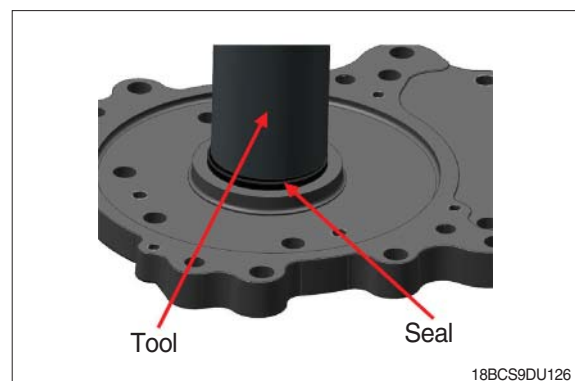
※ Pay attention not to damage components.
※ Sealing/locking fluid application.

Screw

Spread with threadlocking

18BCS9DU128

(3) Tighten the screws with a torque of 7.1 kgf · m (51.4 lbf · ft).

※ Tighten the screws in a criss-cross pattern.
※ Tightening with torque wrench.

18BCS9DU129

(4) Place the housing on the hub.

⚠ Watch your step, your back and your hands : the component is heavy, move it carefully.

18BCS9DU130

(5) Place the bearing in the hub and using the press insert it.

※ The bearing must be heated for this operation (about 80 ˚C).
※ Use an appropriate tool to push the bearing.
※ Pay attention not to damage components.
※ Compulsory requirement.
⚠ **Crush hazard : keep hands clear.**
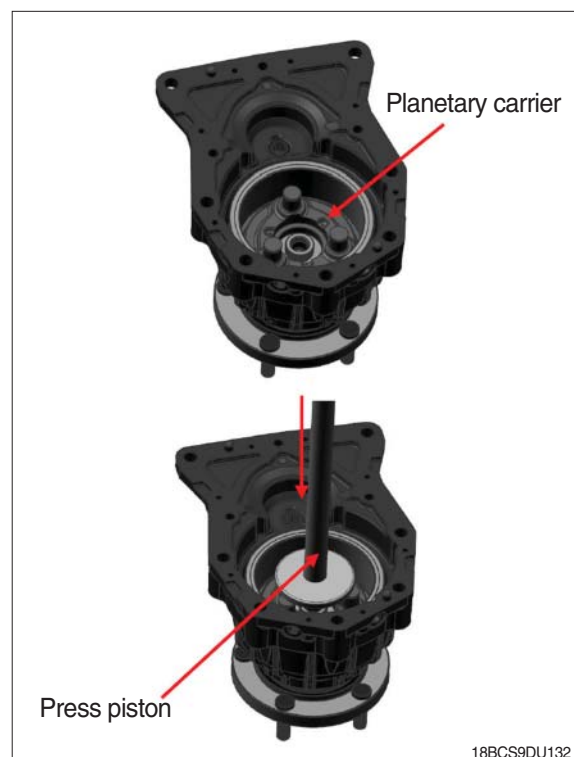

Bearing

Press piston

18BCS9DU131

(6) Place the planetary carrier on the hub.

※ The planetary carrier must be heated (about 70 ˚C) for this operation.
※ Use an appropriate tool to push the planetary carrier.
⚠ **Watch your step, your back and your hands : the component is heavy, move it carefully.**
⚠ **Crush hazard: keep hands clear.**

Planetary carrier

Press piston

18BCS9DU132

(7) Place a planet gear assy on a planetary gear pin and, using the press, insert it. Repeat the operation for all planet gears assy.

Planetary gear

Press piston

18BCS9DU133
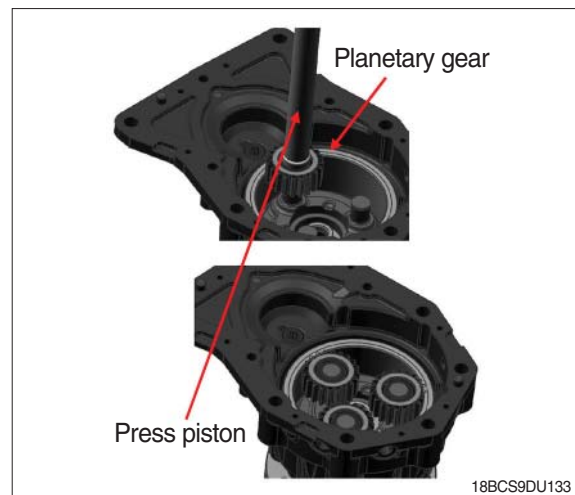
(8) Using the appropriate pliers insert the snap rings on the planet gears.

Snap ring

18BCS9DU134
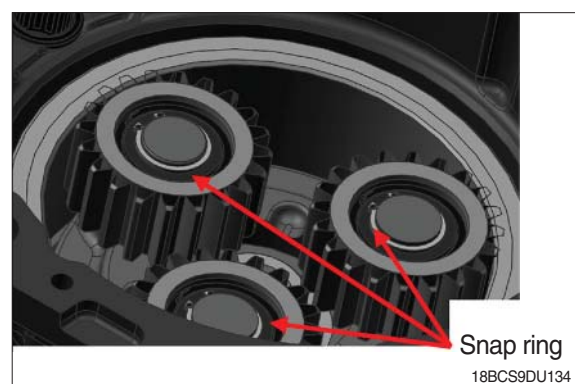
(9) Spread with liquid gasketing the housing.

※ Sealing/locking fluid application.

Liquid gasketing

18BCS9DU135
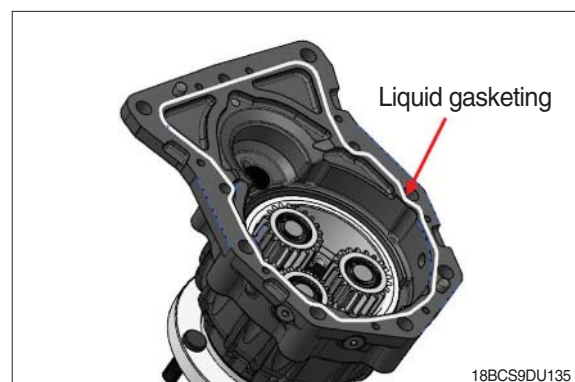
(10) Place the gearbox cover assy and insert it on the gearbox. Use the rubber hammer if necessary.

⚠ Watch your step, your back and your hands : the component is heavy, move it carefully.

※ Pay attention not to damage components.

Gearbox cover assy

18BCS9DU136
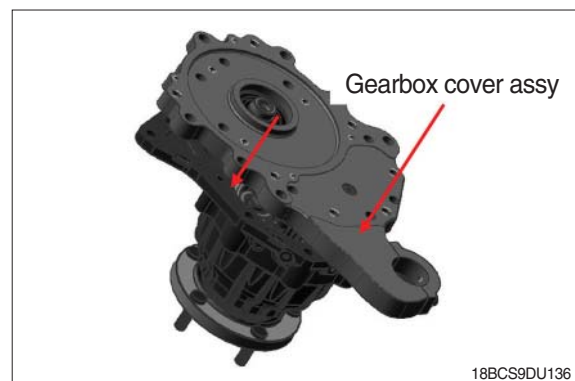
(11) Insert the screws and tighten them using the following torque :

M8   : 3.6 kgf · m (26.0 lbf · ft)
M10 : 7.1 kgf · m (51.4 lbf · ft)
M14 : 24.0 kgf · m (174 lbf · ft)

※ Spread with medium threadlocker the screws.
※ Tightening with torque wrench.
※ Sealing/locking fluid application.

Snap ring

18BCS9DU137
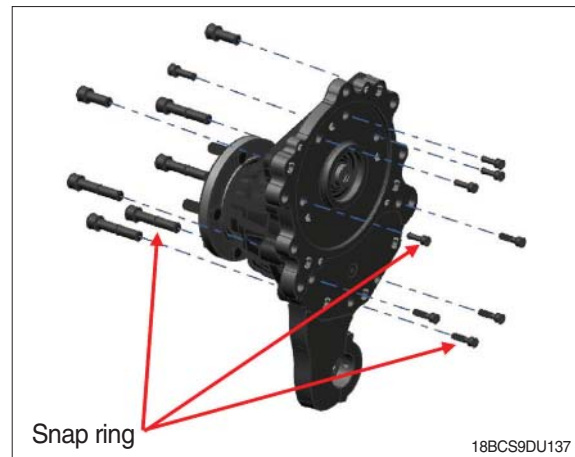
SECTION 4 BRAKE SYSTEM

GROUP 1 STRUCTURE AND FUNCTION

1. STRUCTURE
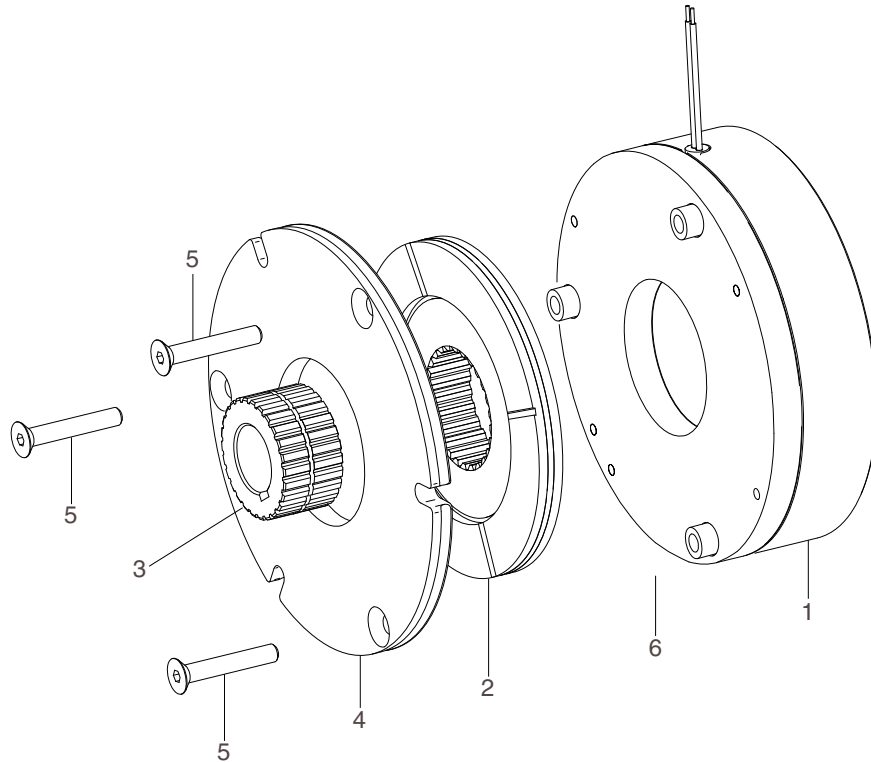
10BOP7EB01

1	Inductor	4	Flange
2	Friction disc	5	Screw
3	Hub	6	Adjusting spacer

2. SPECIFICATION

Item	Unit	Specification
Nominal torque (Standard version)	N.m	70
Nominal airgap (S+0.1/-0.5)	mm	0.35
Nominal torque	N.m	9.1 (M6 on ⌀ 132 mm)
		22 (M8 on ⌀ 145 mm)
		9.1 (M6 on ⌀ 168 mm)

3. PRE-INSTALLATION CHECKS

Check that in the process of unpacking and subsequent handling prior to assembly, the mounting features and parts of the brake are undamaged. Prior to fitting, remove and clean off any foreign matter which may have found its way into the assembly during transit, also ensure that the interfaces to which the brake is mounted are clean and free from burrs or swellings.

4. PRECAUTIONS AND RESTRICTIONS ON USE

1) RESTRICTIONS ON USE

(1) The equipment is designed for dry running. Friction faces must be kept completely clean of any oil, grease or abrasive dust.

(2) Exceeding the maximum rotation speeds stated in the specification invalidates the warranty.

(3) The equipment can be fitted either horizontally.

(4) This equipment is designed for an ambient temperature of 40 ˚F maximum (155 ˚C insulation class).

2) PRECAUTIONS AND SAFETY MEASURES

⚠ During maintenance, ensure that the mechanism to be braked by the equipment is at rest and that there is no risk of accident start-up. All interventions have to be made by qualified personnel owning this manual.

⚠ Any modification made to the brake without the express authorization of representative of Hyundai, in the same way than any use out of the contractual specifications accepted by Hyundai, will result in the warranty being invalidated and Hyundai will no longer be liable in any way with regard to conformity.

5. REASSEMBLY AND INSTALLATION

1) PK brakes are delivered completely assembled.

2) Put the key into the shaft then slide the hub (3) onto the shaft and secure it axially by suitable means.

3) Slide the brake onto the hub (3), taking care not to damage the splines of the disc (2). Make sure that the disk locates properly on the splines of the hub.

4) Secure the brake in position using suitable screws, (see fig. EB02 and Spec). Secure the fitting screws using a loctite 270 type thermoplastic liquid.

5) Switch the equipment on and confirm that the friction disc rotates freely.

⚠ **Do not grease the guiding splines (friction disc / hub). It will change the brake's performances.**

⚠ **Respect obligatory the direction of the hub when mounting (see the brake drawing).**

Fitting screws

BRP7EB02

6. DISC REPLACEMENT

⚠ **When the maximum airgap is reached, the brake will not release correctly. It is then necessary to replace the friction disc.**

1) To replace the friction disc (2), fit transport screws on the brake (fig. EB03), then remove the brake from the motor.

2) Undo the assembly screws (5) then take out the flange (4) and the friction disc (2), fig. EB04.

2 x M6 x 50mm
Transport screws

BRP7EB03
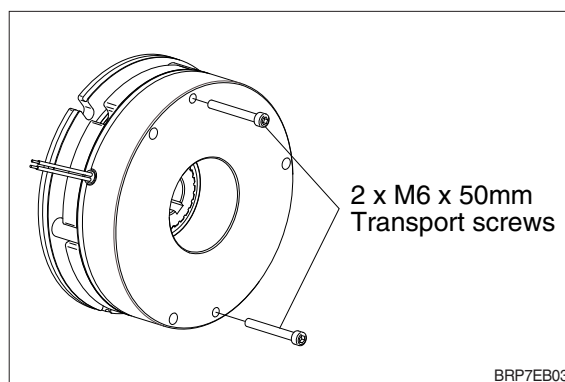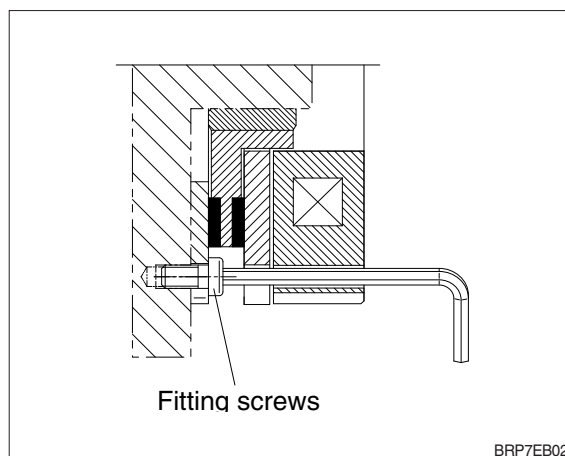
3) Put the new friction disc into position, fit the flange (4) and the assembly screw (5) secured with loctite 221 or similar.

Assembly screws

BRP7EB04
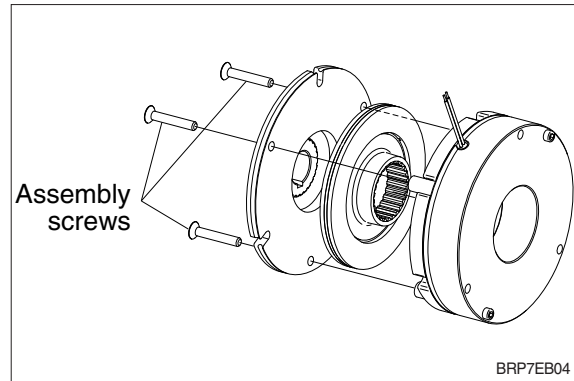
7. ELECTRICAL CONNECTION

1) IMPORTANT RECOMMENDATIONS

⚠ All works on the electrical connections have to be made with power off.

⚠ Ensure compliance with the nominal supply voltage (inadequate supply causes a reduction in the starting distance).

The connecting wires should be of sufficient diameter to prevent voltage drops between the source and equipment supplied.

I (A) / L (m)	0 ~ 10 m	10 ~ 20 m
0~3 (A)	1.5 mm²	1.5 mm²
3~6 (A)	1.5 mm²	2.5 mm²

Tolerance for the supply voltage to the brake terminals +5% / -10% (NF C 79-300).

8. MAINTENANCE

The brake is required to be kept in good working order and must be included in the planned maintenance program. This must include regular examination for wear and removal of friction dust caused by friction facing wear. The frequency of inspection depends on the duty demanded of the brake.

9. TROUBLESHOOTING AND FAULT ELIMINATION

Fault	Cause	Remedy
Brake does not release	· Power supply is too low. · Power supply is interrupted. · Airgap too large. · Worn disc. · Coil is damaged. · Voltage present at switch off position.	· Adjust power supply. · Reconnect power supply. · Replace the disc. · Replace the disc. · Replace the brake. · Check the customer's power supply.
Brake does not brake	· Grease on friction faces.	· Replace the disc.
Nuisance braking	· Power supply is too low.	· Adjust power supply.

SECTION 5 STEERING SYSTEM

GROUP 1 STRUCTURE AND FUNCTION

1. OUTLINE
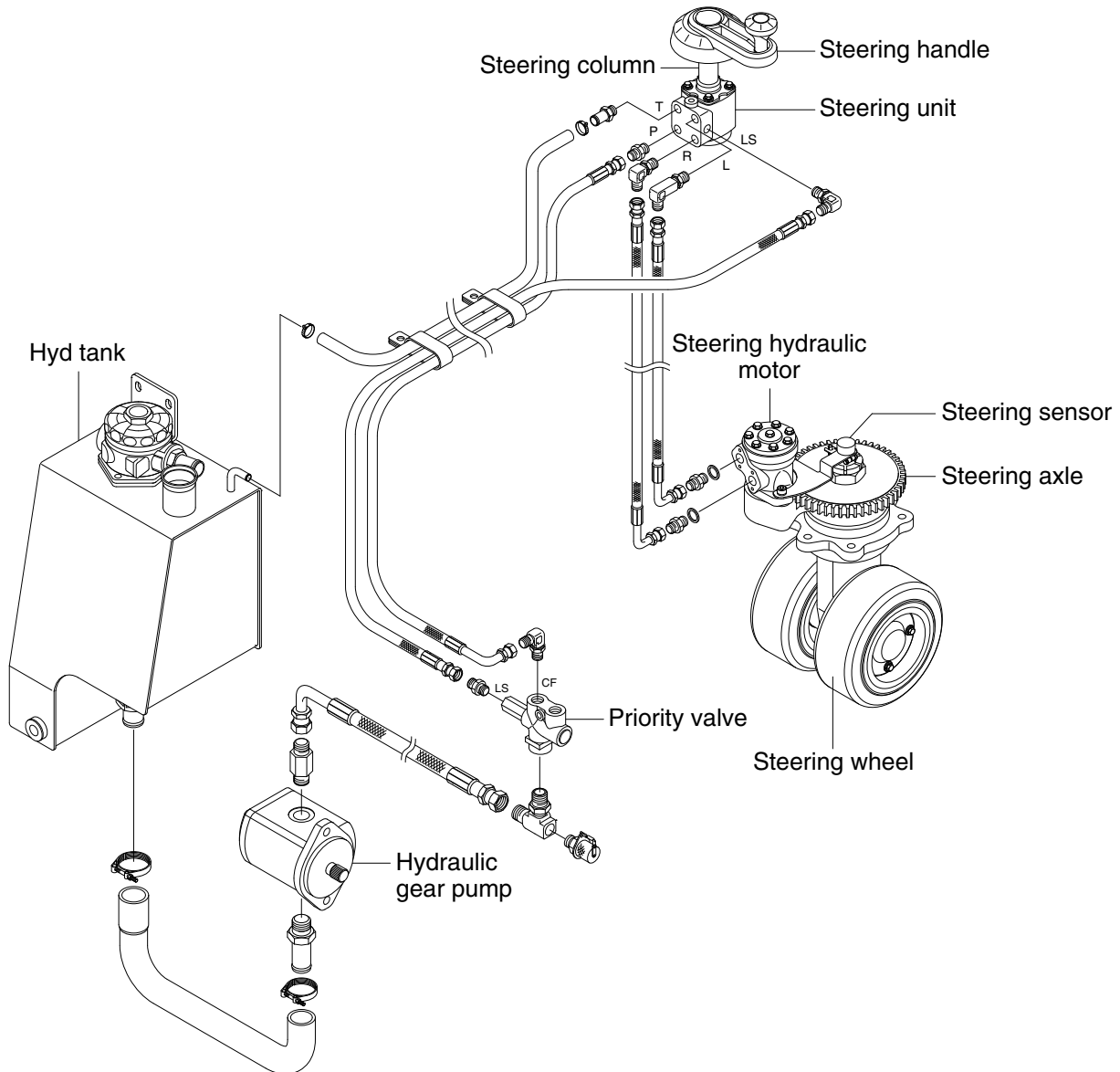
18BCS9SS01

The steering system for this truck is composed of steering wheel assembly, steering unit, steering hydraulic motor, steering axle 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 steering unit, and pressurized oil delivered from the hydraulic pump is fed to the steering hydraulic motor.

The force produced by the steering hydraulic motor rotates the steering axle through the steering pinion.

Steering axle is mounting to the main frame by the hexagon bolt.

Steering wheels are mounted to the steering axle with the ball bearing.

2. HYDRAULIC CIRCUIT

120kgf/cm²

MCV
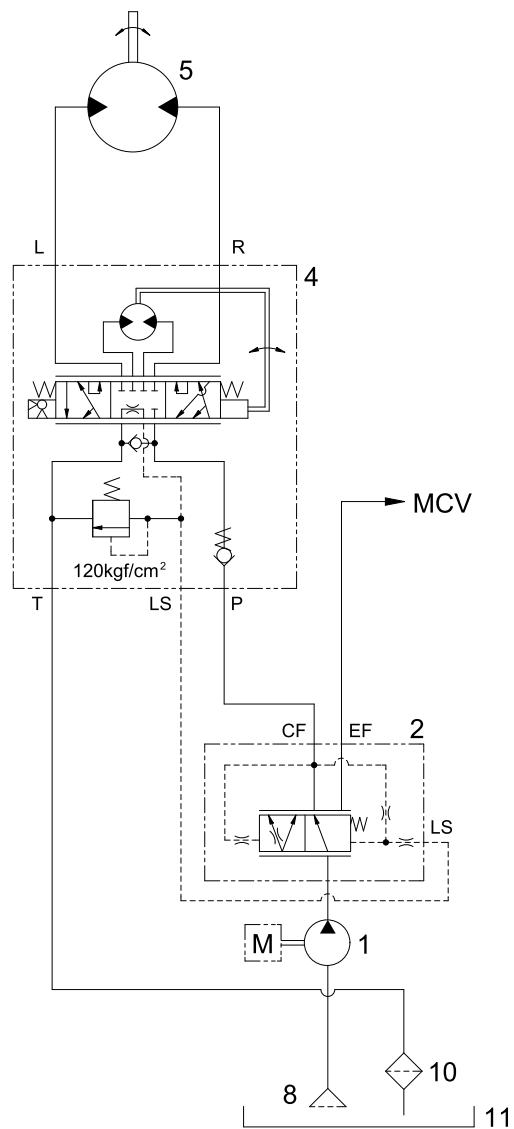
18BCS9SS26

1	Hydraulic gear pump	8	Suction strainer
2	Priority valve	10	Return filter
4	Steering unit	11	Hydraulic tank
5	Steering hydraulic motor		

(1) NEUTRAL
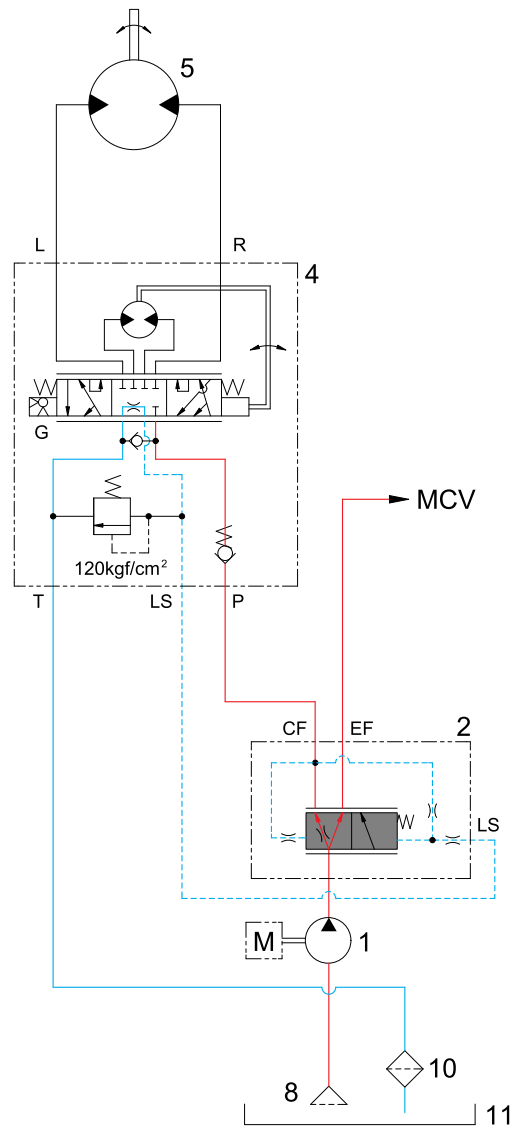
18BCS9SS04

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

The oil from the hydraulic gear pump (1) enters P port of the steering unit (4) through the priority valve (4) and standby for steering system.

Almost all of pump flow goes to the attachment system (main control valve) through the EF port and partly flows into the hydraulic tank (11) through the control spool (G).

(2) LEFT TURN
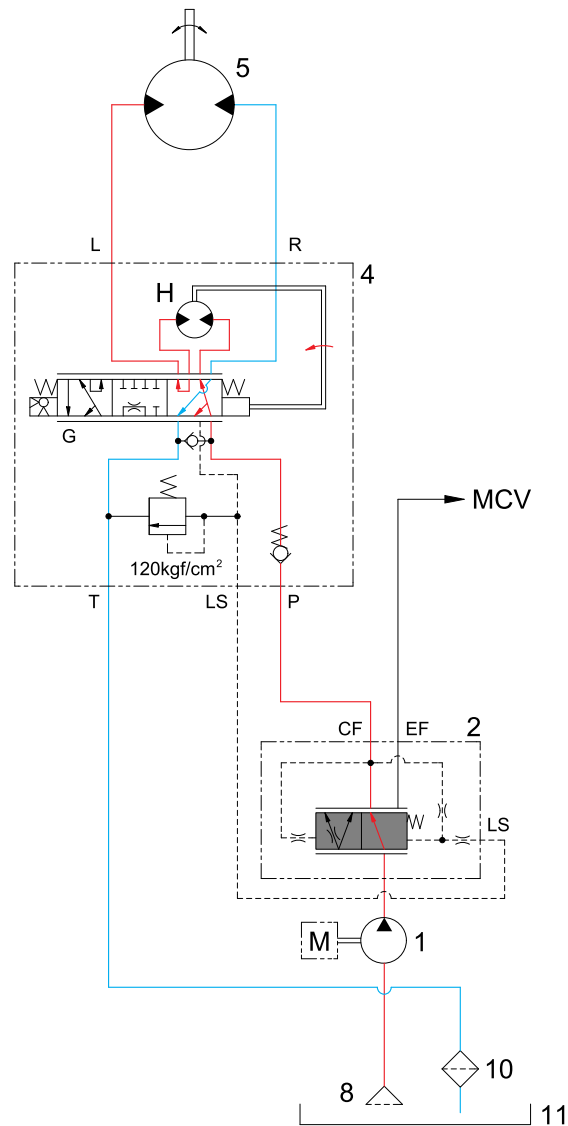
18BCS9SS06

When the steering handle 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 steering hydraulic motor (5) returns to hydraulic tank (11) through the spool (G).

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

(3) RIGHT TURN
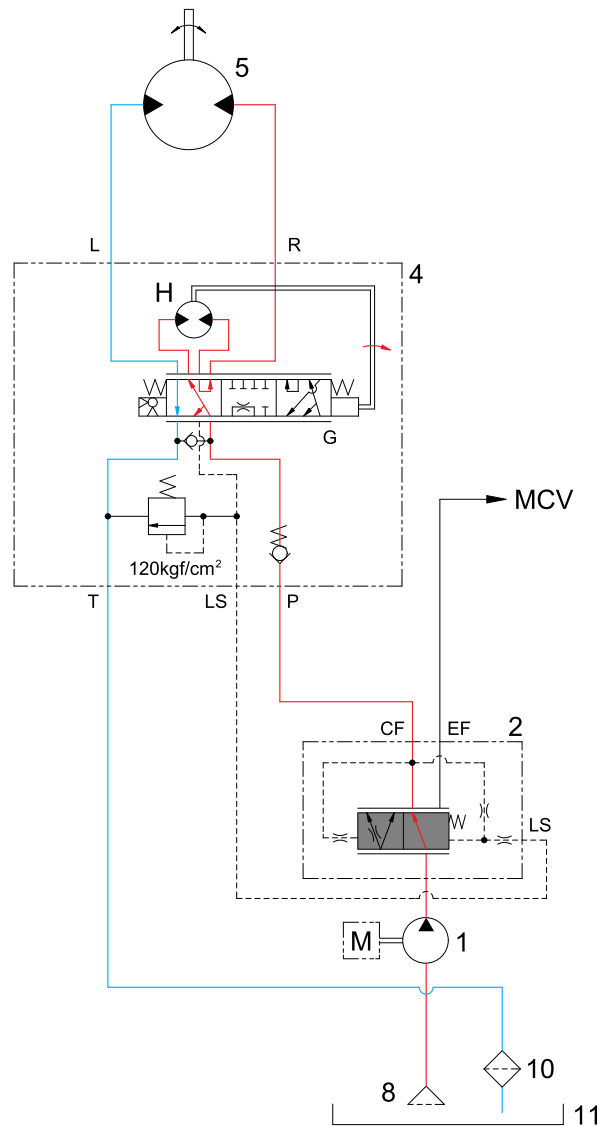
18BCS9SS08

When the steering handle 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 steering hydraulic motor (5) returns to hydraulic tank (11) through the spool (G).

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

3. STEERING UNIT

1) STRUCTURE
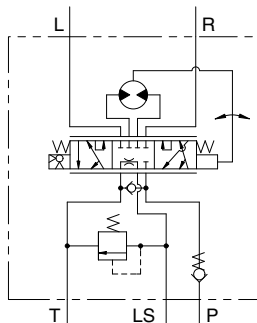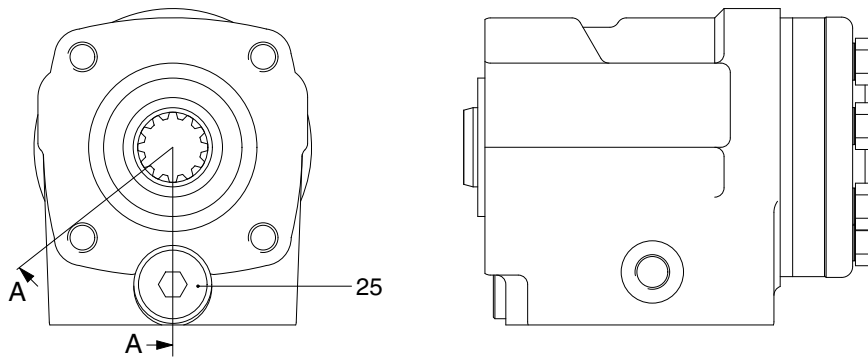
Hydraulic circuit
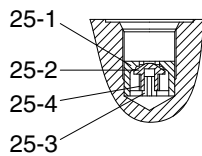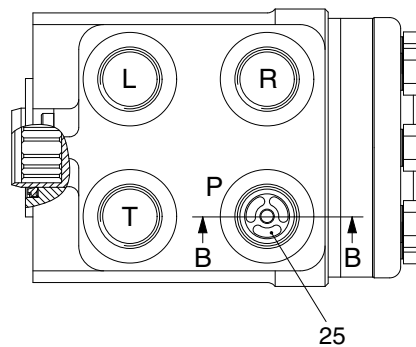
SECTION B-B
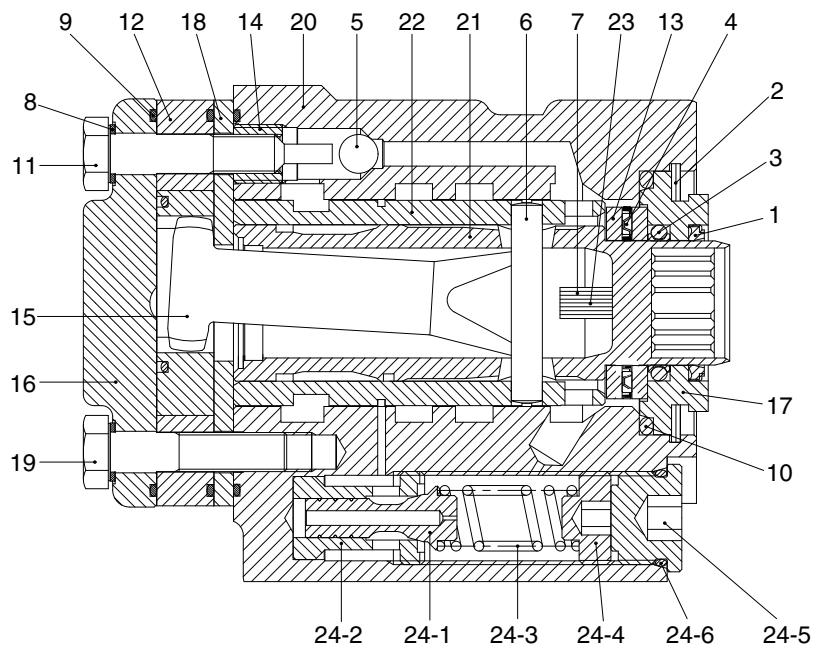
SECTION A - A

18BCS9SE32

1 Dust seal	10 O-ring	19 Cap screw	24-4 Spring seat
2 Retaining ring	11 Rolled screw	20 Housing	24-5 Plug
3 Cap seal	12 Gerotor set	21 Spool	24-6 O-ring
4 Thrust bearing	13 Bearing race	22 Sleeve	25 P-port check valve
5 Ball	14 Bore screw	23 Plate spring	25-1 Plug
6 Pin	15 Drive	24 Relief valve	25-2 Poppet
7 Center spring	16 End cap	24-1 Spool	25-3 Spring seat
8 Washer	17 Gland bushing	24-2 Bushing	25-4 Spring
9 O-ring	18 Plate	24-3 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 steering hydraulic motor and detects steering hydraulic motor's motion value, that is, steering hydraulic motor'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. STEERING HYDRAULIC MOTOR

1) STRUCTURE
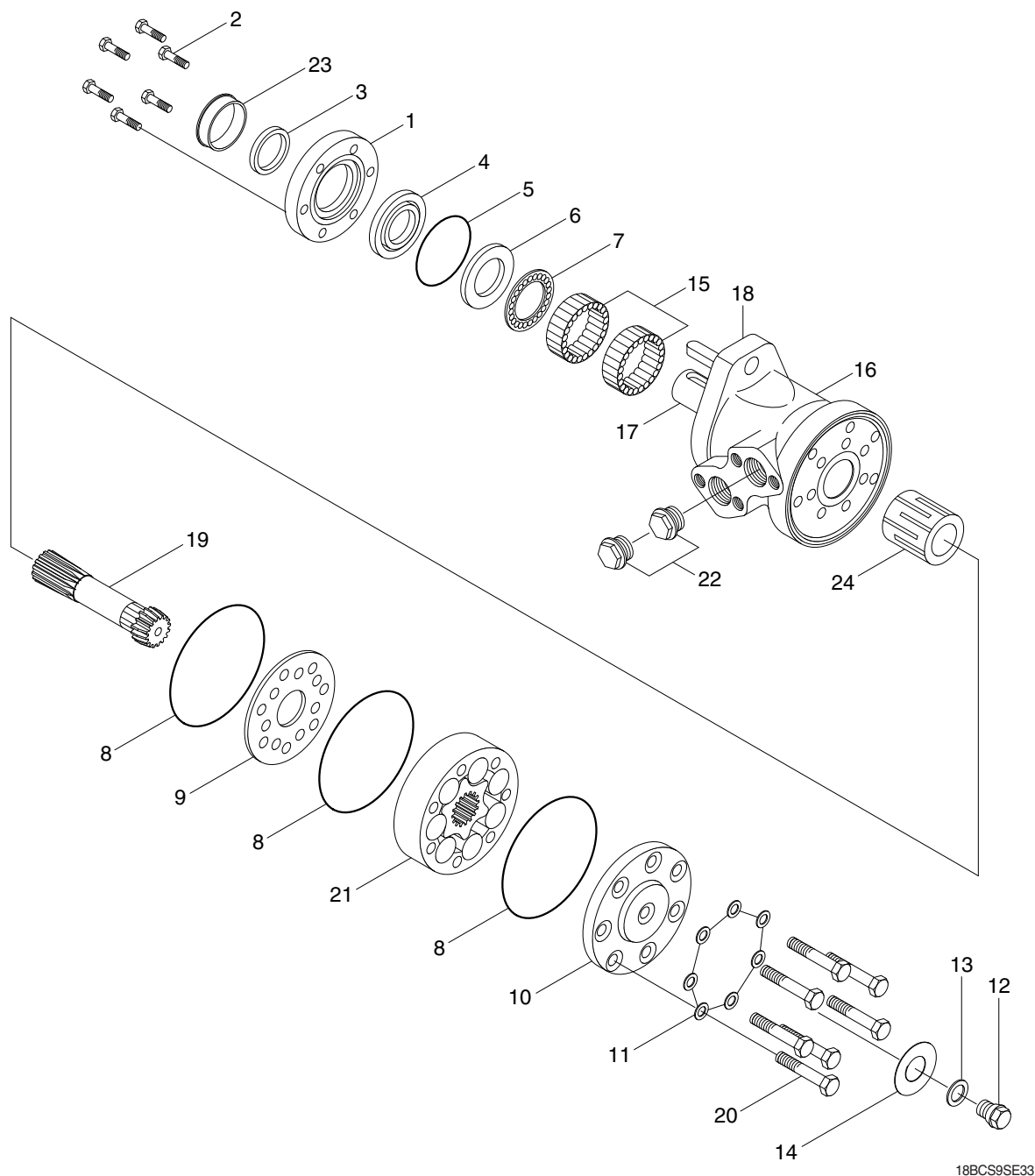
18BCS9SE33

1	Spigot flange	9	Distributor plate	17	Output shaft
2	Screw	10	End cover	18	Parallel key
3	Dust seal	11	Washer	19	Cardan shaft
4	Shaft seal	12	Drain plug	20	Screw
5	O-ring	13	Washer	21	Gear wheel set
6	Bearing race	14	Name plate	22	Plug
7	Needle bearing	15	Needle bearing	23	Ring
8	O-ring	16	Housing	24	Pin

5. PRIORITY VALVE

1) STRUCTURE

HYDRAULIC CIRCUIT
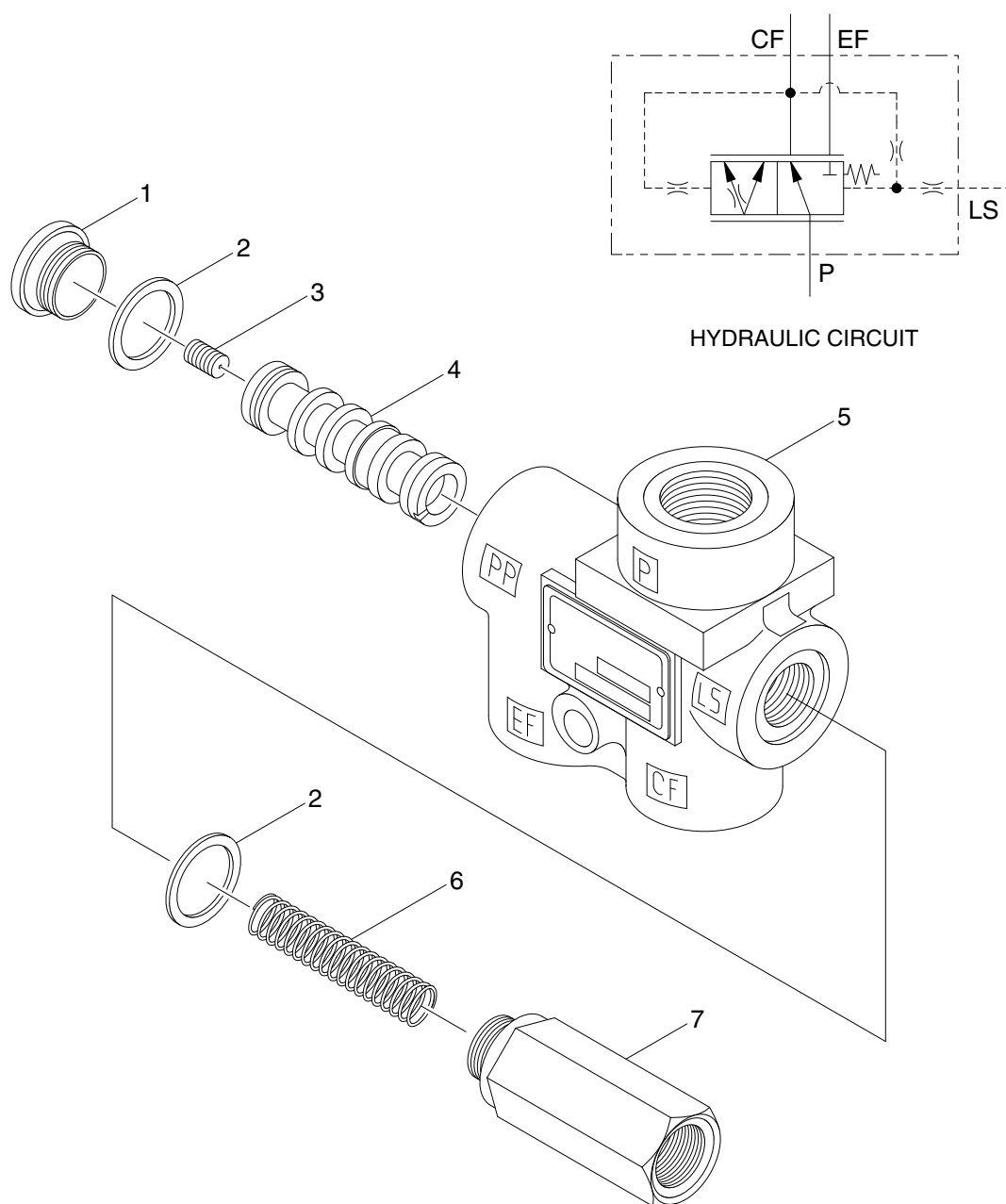
18BCS9SE06

1	Plug	4	Spool	7	Plug
2	Seal	5	Housing		
3	Orifice	6	Spring		

2) OPERATION

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

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

The steering flow is controlled by the steering unit to operate the steering hydraulic motor.

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

6. STEERING AXLE AND WHEEL

1) STRUCTURE

STEERING SENSOR

STEERING HYDRAULIC MOTOR

FRAME

18BCS9SE24-1

1	Steering axle assy	1-7	Bearing	8	Lever	15	Spring washer
1-1	Steering axle wa	2	Bolt	9	Hexagon bolt	16	Ball beating
1-2	Bracket	3	Spring washer	10	Spring washer	17	Rear tire
1-3	Taper roller bearing	4	Spring pin	11	Plain washer	18	Washer bearing
1-4	Taper roller bearing	5	Steering pinion	12	Hexagon nut	19	Rolling bearing nut
1-5	Oil seal	6	Special bolt	13	Bracket	20	End cover
1-6	Steering gear assy	7	Bolt with washer	14	Socket bolt	21	Washer with bolt

2) TIGHTENING TORQUE AND SPECIFICATION

Right turn (98°)

Left turn (82°)

Default (41.5°)

A

A

SECTION A-A

Axle mounting bolt ∗
14~18 kgf·m
(101~130 lbf·ft)

Socket bolt ∗
9-12 kgf·m
(65.1~86.8 lbf·ft)

Socket bolt
2-3 kgf·m
(14.5~21.7 lbf·ft)
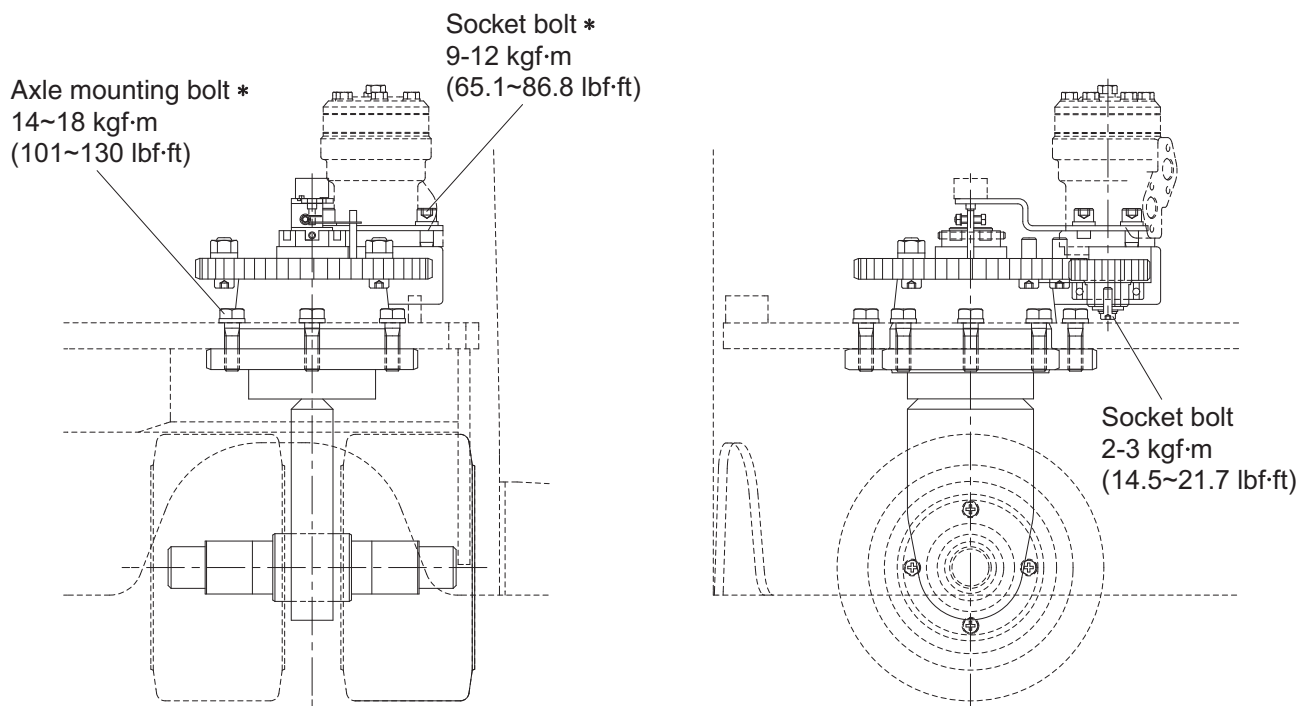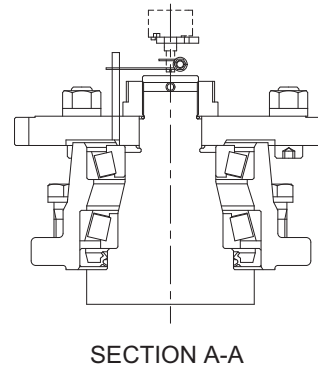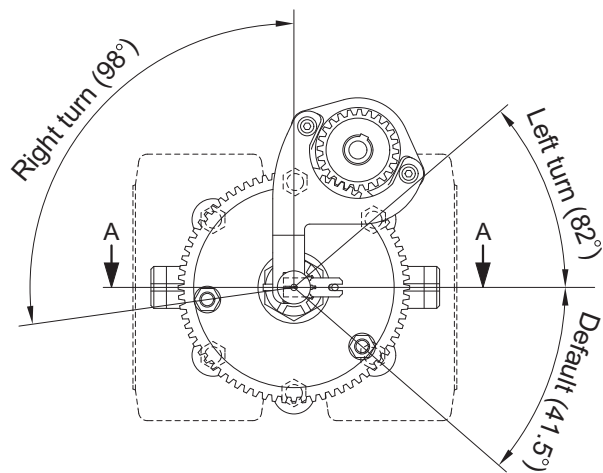
∗ Apply loctite #277 on the thread of the bolt before tightening.

18BCS9SE25

Item	Unit	Specification
Tread	mm (in)	265 (10.4)

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

1. OPERATIONAL CHECKS

Check item	Checking procedure
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) <table><tr><td>15BCS-9</td><td>1397 mm (4' 7"))</td></tr><tr><td>18BCS-9</td><td>1397 mm (4' 7"))</td></tr><tr><td>20BCS-9</td><td>1467 mm (4' 10")</td></tr></table>
Hydraulic pressure of power steering	Remove plug from outlet port of flow divider and install oil pressure gauge. Turn steering wheel fully and check oil pressure. ※ Oil pressure : 120 kgf/cm^2 (1710 bar)

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

1. STEERING UNIT

1) STRUCTURE
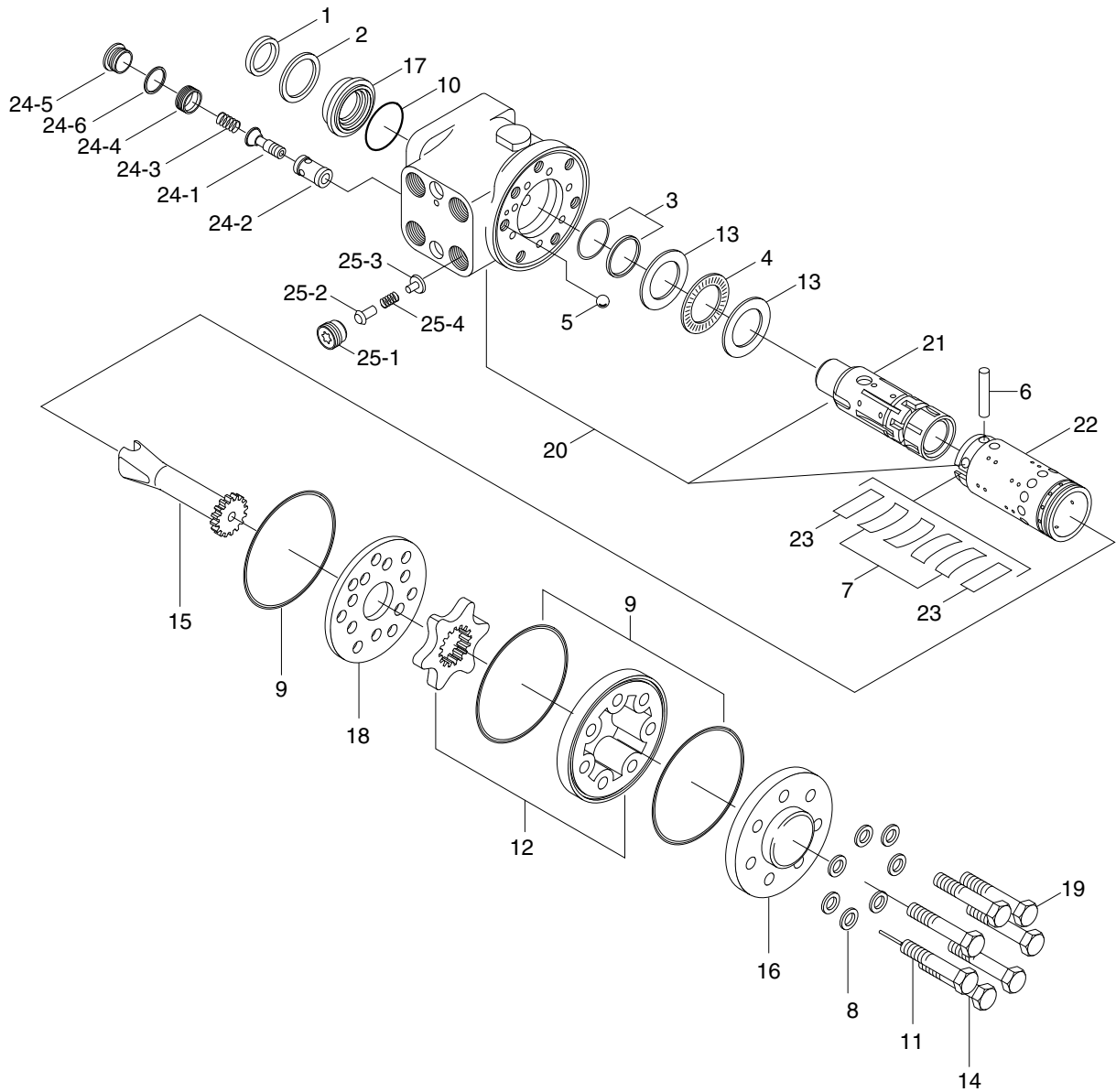
18BCS9SE05

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

2) TOOLS

(1) Holding tool.

5-69(1)
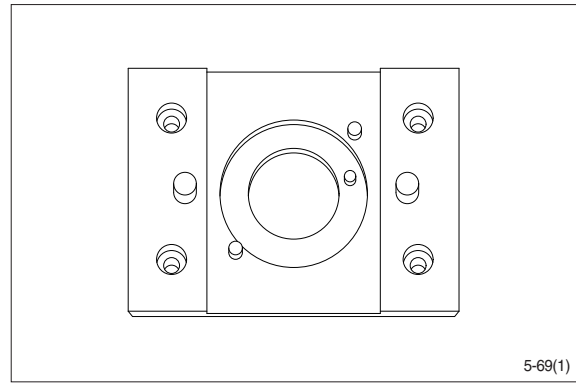
(2) Assembly tool for O-ring and kin-ring.

5-69(2)
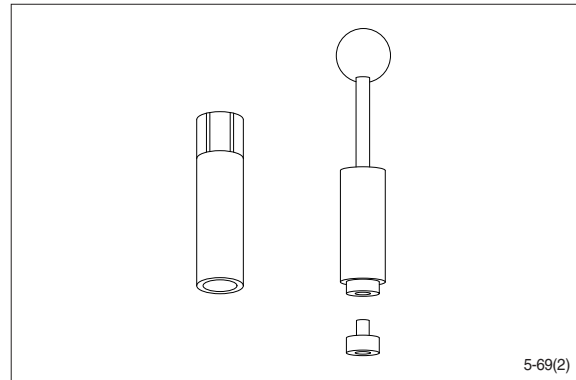
(3) Assembly tool for lip seal.

5-69(3)
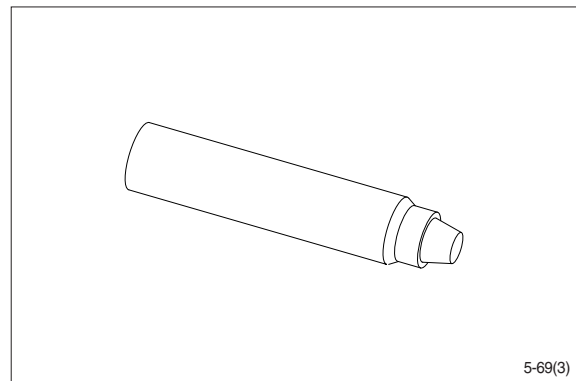
(4) Assembly tool for cardan shaft.

5-69(4)
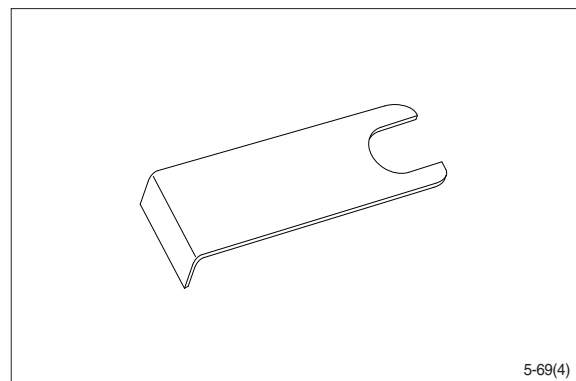
(5) Assembly tool for dust seal.

5-70(1)
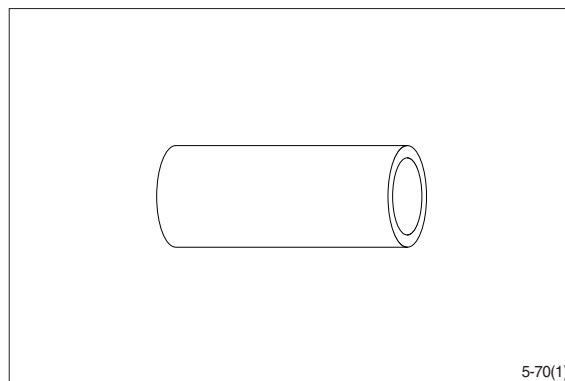
(6) Torque wrench 0~7.1 kgf · m
                  (0~54.4 lbf · ft)
    13 mm socket spanner
    6, 8 mm and 12 mm hexagon sockets
    12 mm screwdriver
    2 mm screwdriver
    13 mm ring spanner
    6, 8 and 12 mm hexagon socket spanners
    Plastic hammer
    Tweezers

5-70(2)
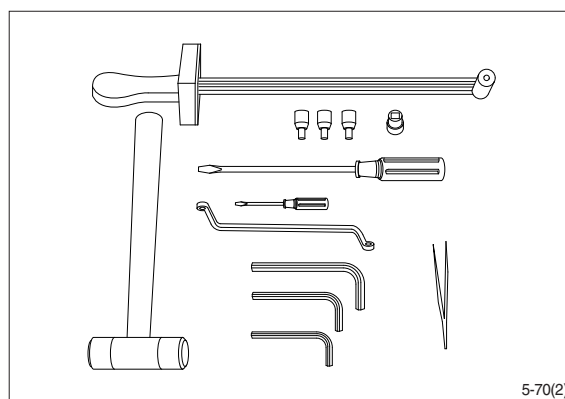
3) TIGHTENING TORQUE

    L   : Left port
    R   : Right port
    T   : Tank port
    P   : Pump port
    LS : Load sensing port

Mounting bolt

T
P
L R   LS

18BCS9SE23
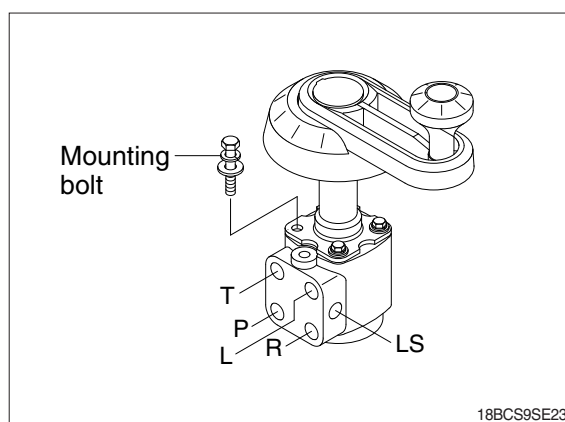
Port	Size	Torque [kgf · m (lbf · ft)]
L	3/4-16 UNF - 16	6.1±0.6 (44.1±4.3)
R	3/4-16 UNF - 16	6.1±0.6 (44.1±4.3)
T	3/4-16 UNF - 16	6.1±0.6 (44.1±4.3)
P	3/4-16 UNF - 16	6.1±0.6 (44.1±4.3)
LS	7/16 - 20UNF	4.0±0.5 (28.9±3.6)
Mounting bolt	M10×1.5	4.0±0.5 (28.9±3.6)

4) DISASSEMBLY

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

5-72(1)
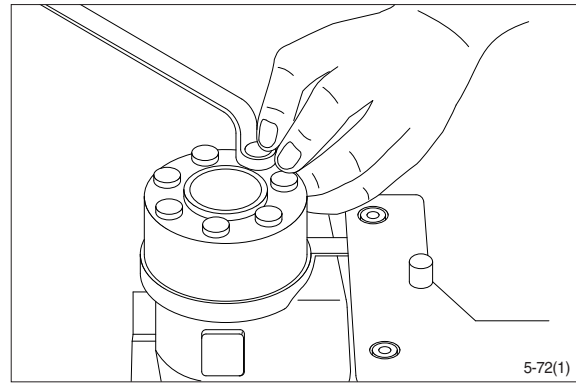
(2) Remove the end cover, sideways.

5-72(2)
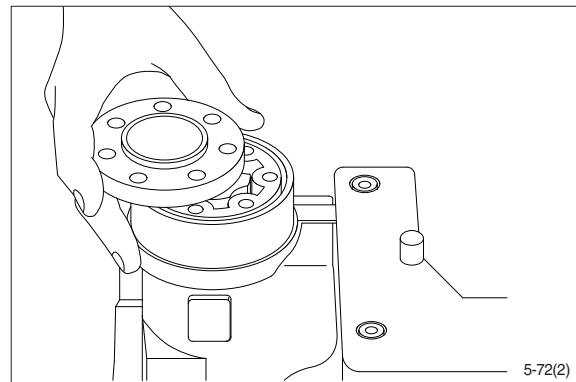
(3) Lift the gearwheel set off the unit.
Take out the two O-rings.

5-72(3)
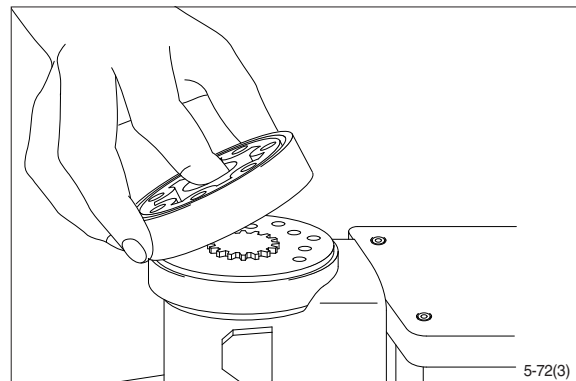
(4) Remove cardan shaft.

5-72(4)
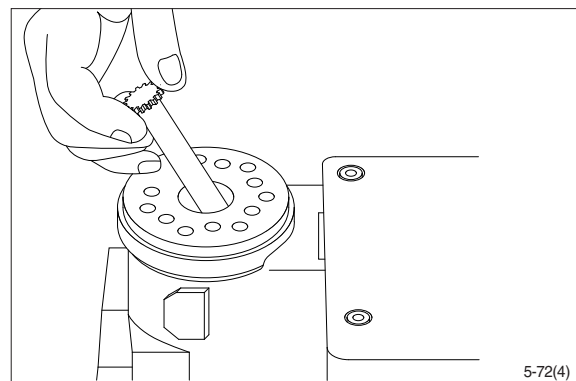
(5) Remove distributor plate.

5-73(1)
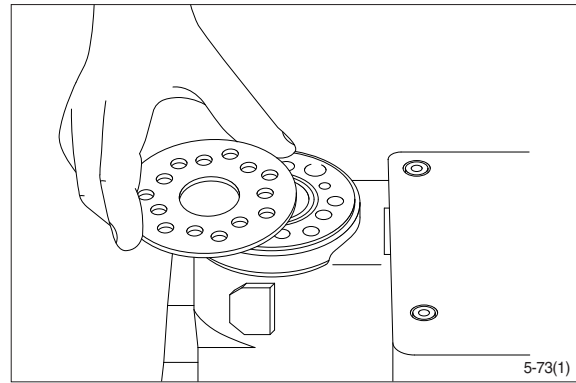
(6) Screw out the threaded bush over the check valve.

5-73(2)

(7) Remove O-ring.

5-73(3)
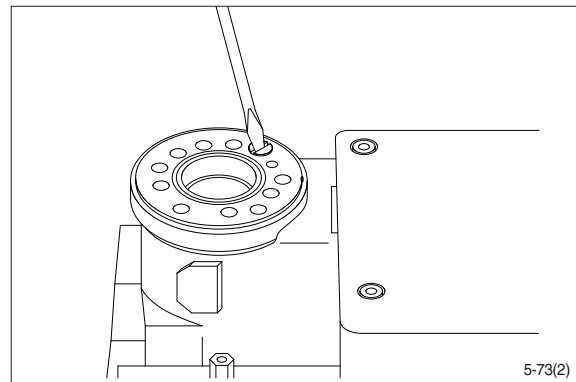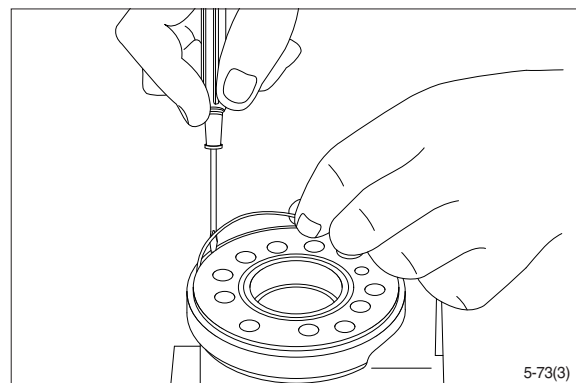
(8) Shake out the check valve ball and suction valve pins and balls.

D353SE09
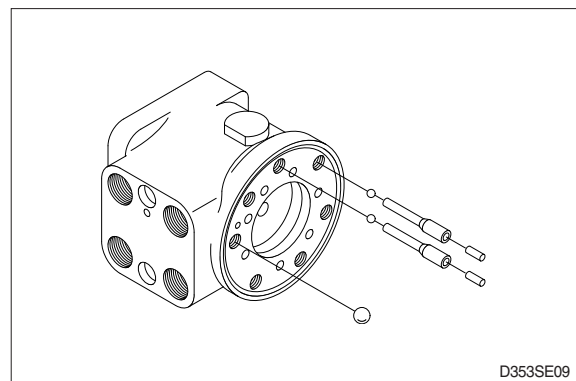
(9) Take care to keep the cross pin in the sleeve and spool horizontal. The pin can be seen through the open end of the spool. Press the spool inwards and the sleeve, ring, bearing races and thrust bearing will be pushed out of the housing together.

5-73(4)
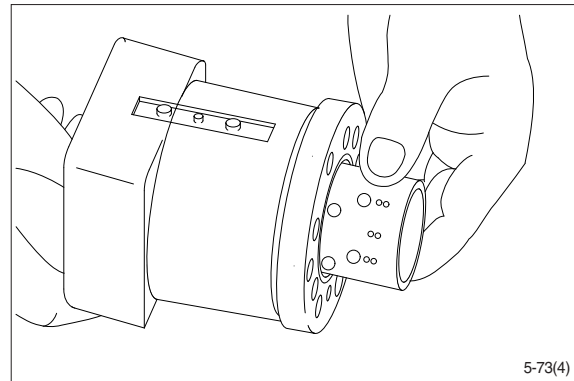
(10) Take ring, bearing races and thrust bearing from sleeve and spool. The outer (Thin) bearing race can sometimes "stick" in the housing, therefore check that it has come out.

5-74(1)
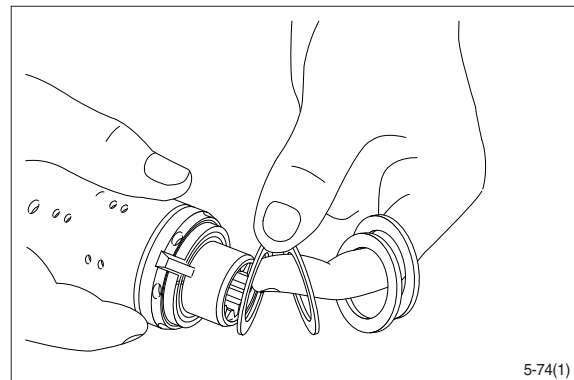
(11) Press out the cross pin. Use the special screw from the end cover.

5-74(2)
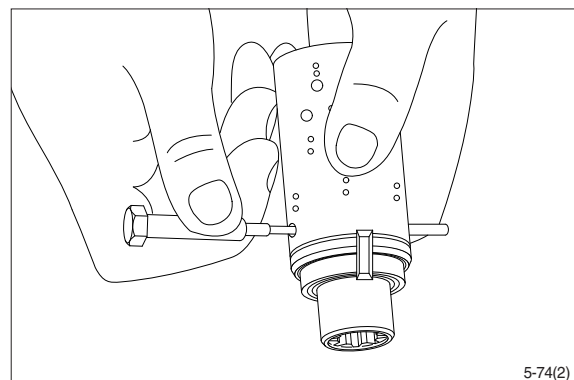
※ A small mark has been made with a pumice stone on both spool and sleeve close to one of the slots for the neutral position springs (See drawing).
If the mark is not visible, remember to leave a mark of your own on sleeve and spool before the neutral position springs are disassembled.

5-74(3)
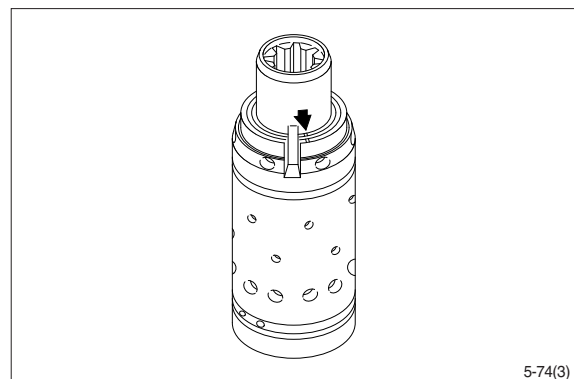
(12) Carefully press the spool out of the sleeve.

5-74(4)
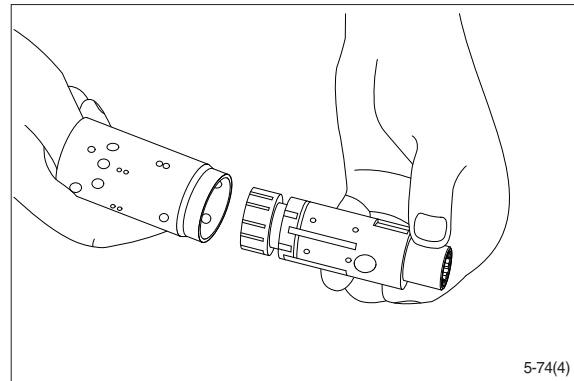
(13) Press the neutral position springs out of their slots in the spool.

5-75(1)
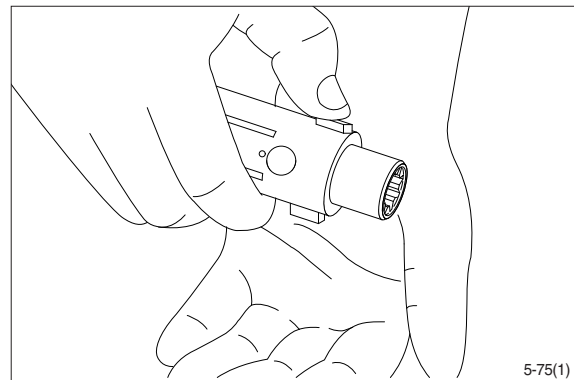
(14) Remove dust seal and O-ring.

5-75(2)
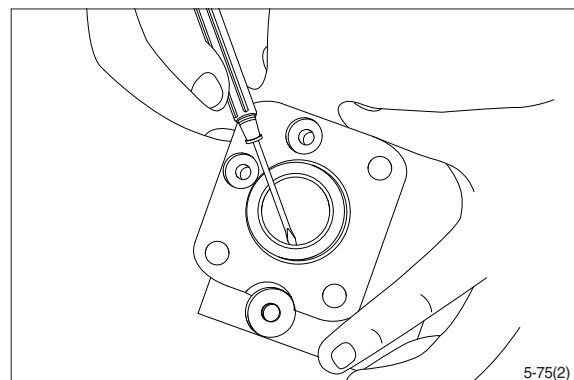
Disassembling the pressure relief valve

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

D353SE10
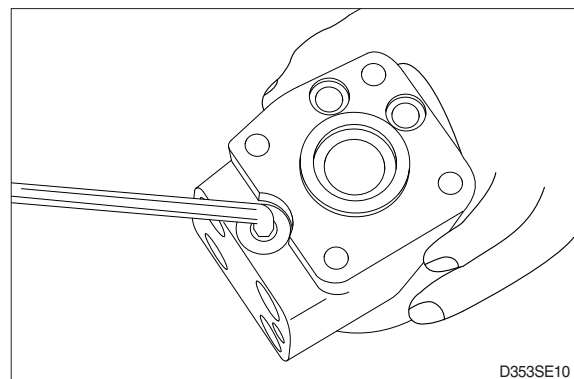
(16) Unscrew the setting screw using an 8mm hexagon socket spanner.

D353SE11
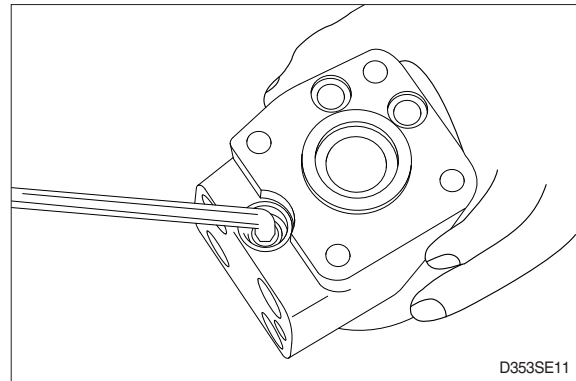
(17) Shake out spring and piston. The valve seat is bonded into the housing and cannot be removed.

D353SE12
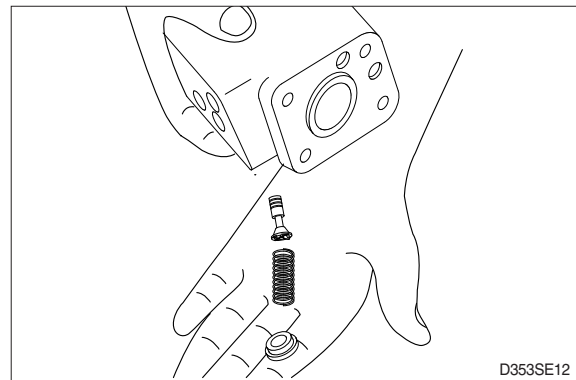
(18) The pressure relief valve is now disassembled.

D353SE13
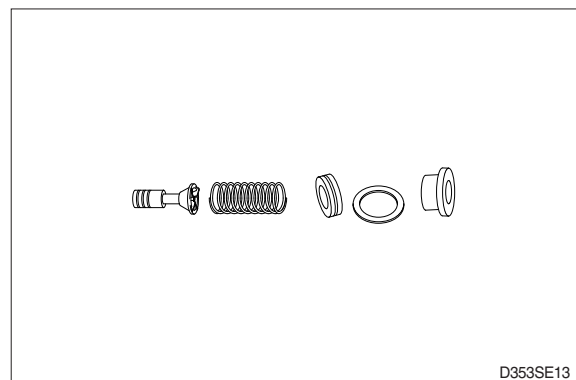
5) ASSEMBLY

(1) Assemble spool and sleeve.

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

5-76(1)
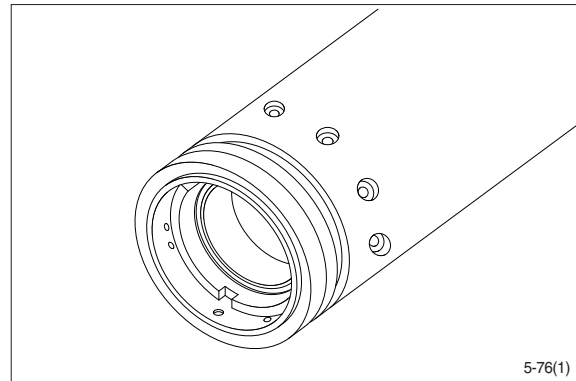
(2) Place the two flat neutral position springs in the slot.
Place the curved springs between the flat ones and press them into place (see assembly pattern).

5-76(2)
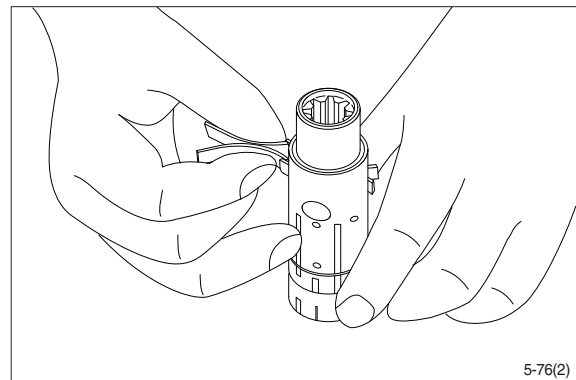
(3) Line up the spring set.

5-76(4)
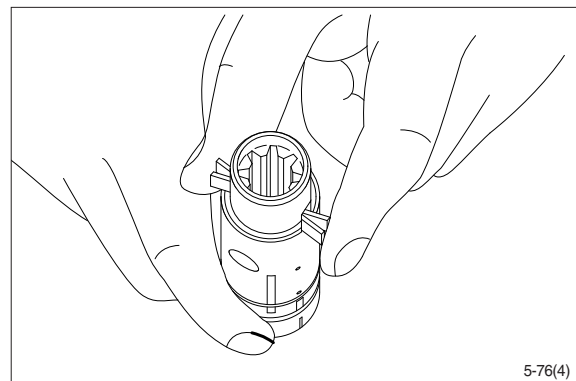
(4) Guide the spool into the sleeve. Make sure that spool and sleeve are placed correctly in relation to each other.

5-77(1)
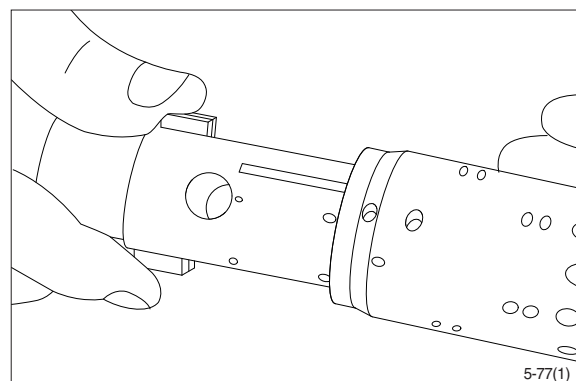
(5) Press the springs together and push the neutral position springs into place in the sleeve.

5-77(2)
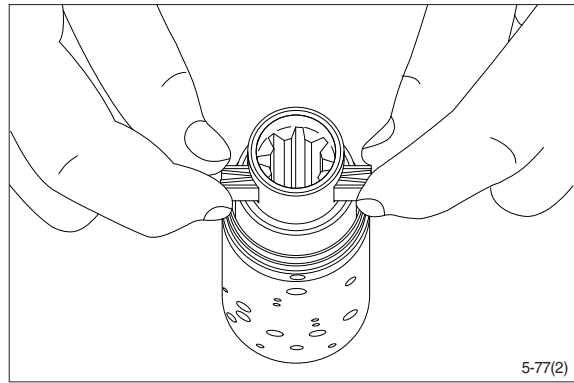
(6) Line up the springs and center them.

5-77(3)
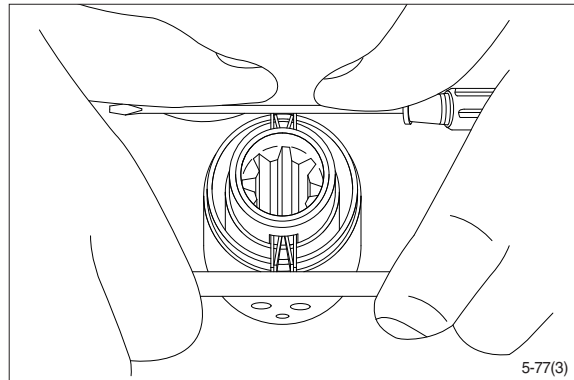
(7) Guide the ring down over the sleeve.
※ The ring should be able to rotate free of the springs.

5-77(4)
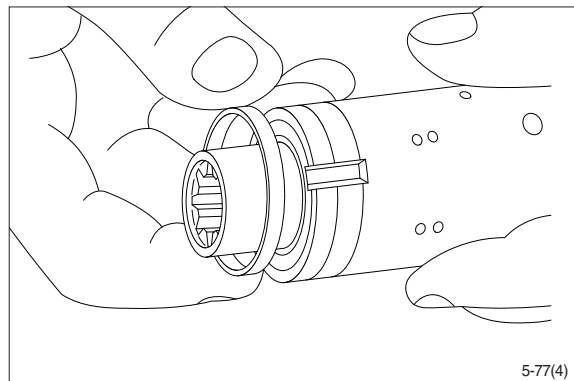
(8) Fit the cross pin into the spool / sleeve.

5-78(1)
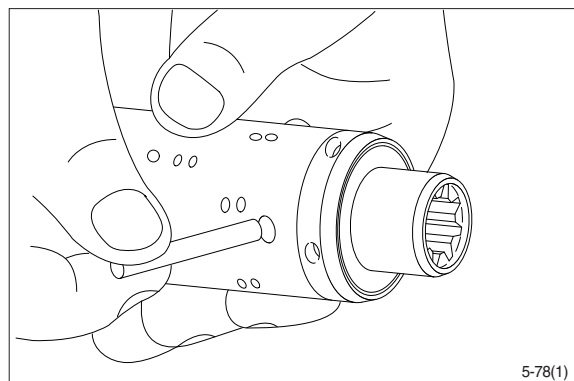
(9) Fit bearing races and needle bearing as shown on below drawing.

5-78(2)
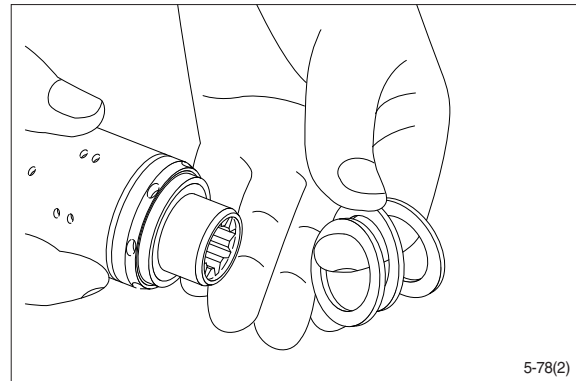
※ **Assembly pattern for standard bearings**

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

5-78(3)
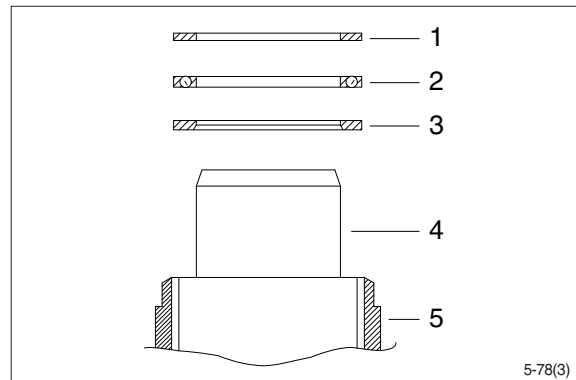
Installation instruction for O-ring

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

5-78(4)
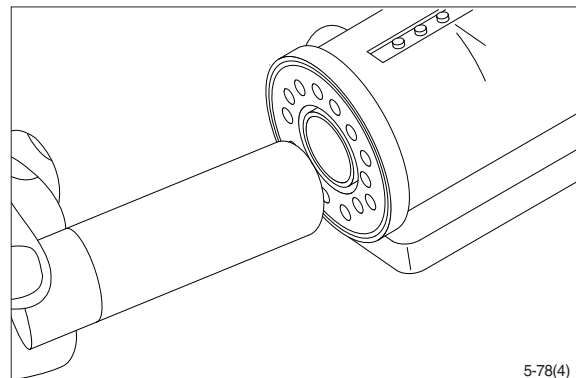
(11) Grease O-ring with hydraulic oil and place them on the tool.

5-79(1)

5-79(2)
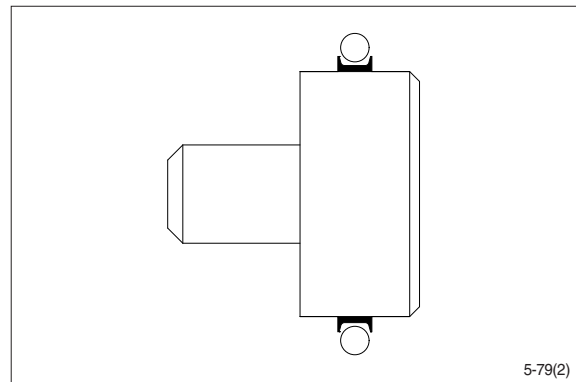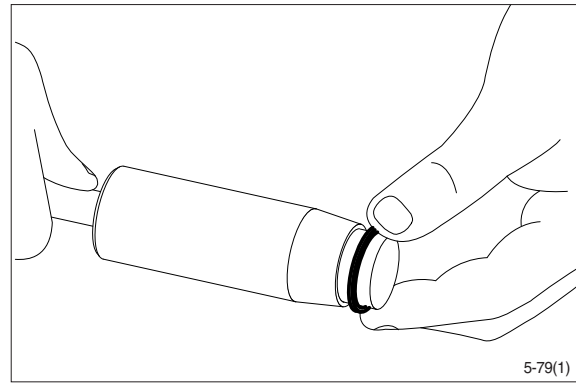
(12) Hold the outer part of the assembly tool in the bottom of the steering unit housing and guide the inner part of the tool right to the bottom.

5-79(3)
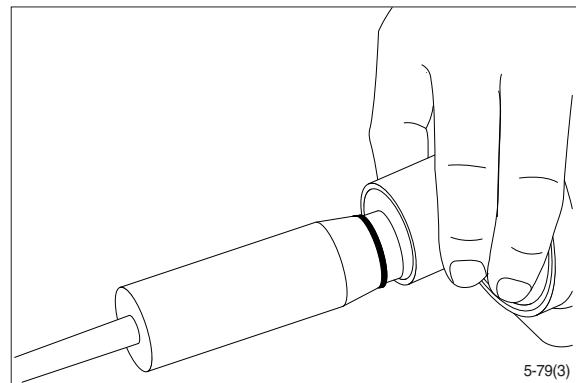
(13) Press and turn the O-ring into position in the housing.

5-79(4)
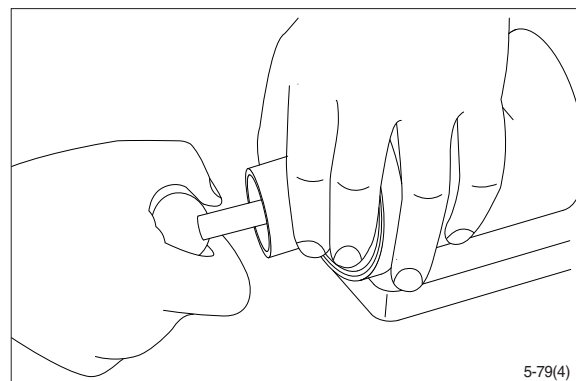
(14) Draw the inner and outer parts of the assembly tool out of the steering unit bore, leaving the guide from the inner part in the bore.

5-80(1)
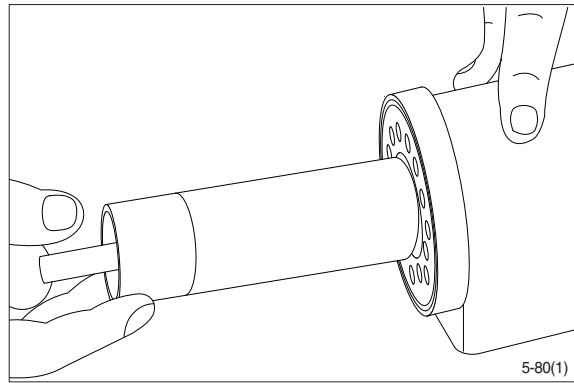
Installation instructions for lip seal

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

5-80(2)

5-80(3)
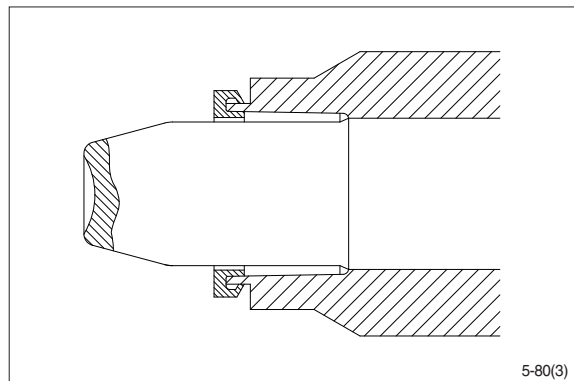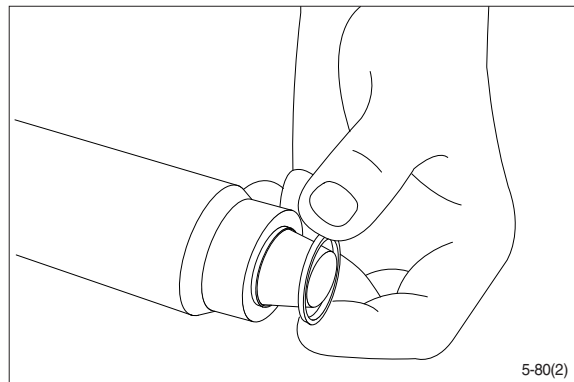
(16) Guide the assembly tool right to the bottom.

5-80(4)
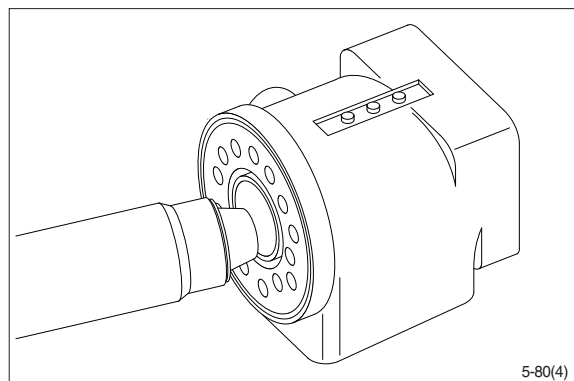
(17) Press and turn the lip seal into place in the housing.

5-81(1)
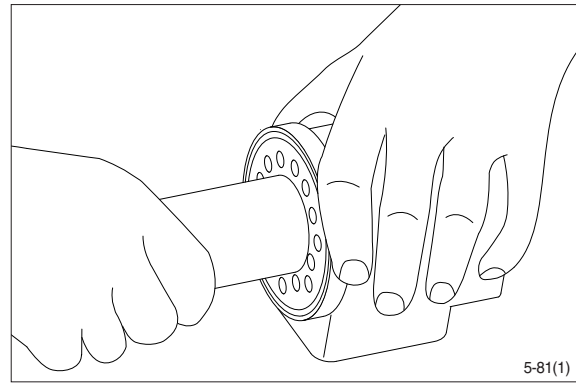
(18) With a light turning movement, guide the spool and sleeve into the bore.
Fit the spool set holding the cross pin horizontal.

5-81(2)
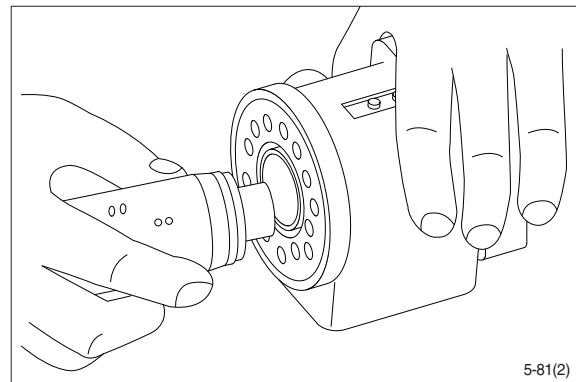
(19) The spool set will push out the assembly tool guide. The O-ring are now in position.

5-81(3)
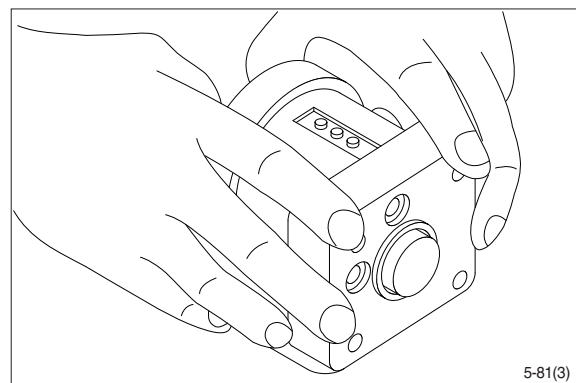
(20) Turn the steering unit until the bore is vertical again. Put the check valve ball into the hole indicated by the arrow.

5-81(4)
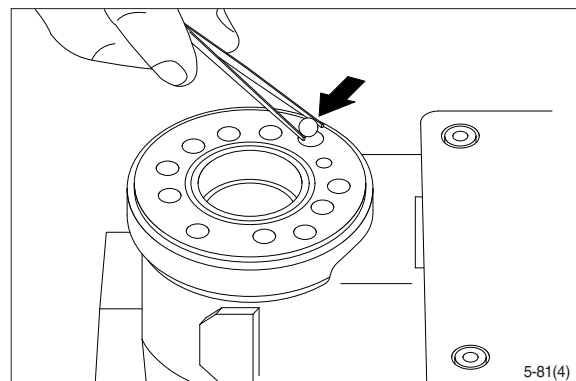
(21) Screw the threaded bush lightly into the check valve bore. The top of the bush must lie just below the surface of the housing.

5-82(1)
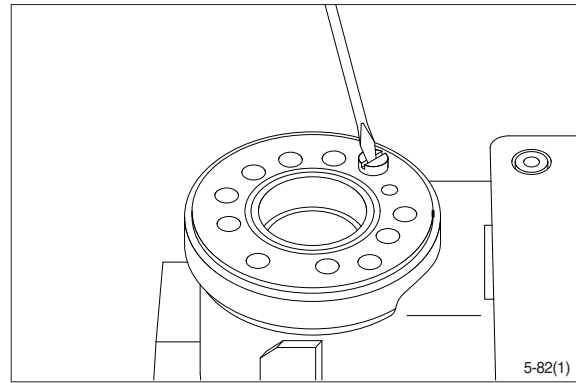
(22) Grease the O-ring with mineral oil approx. viscosity 500 cSt at 20 °C .

5-82(2)
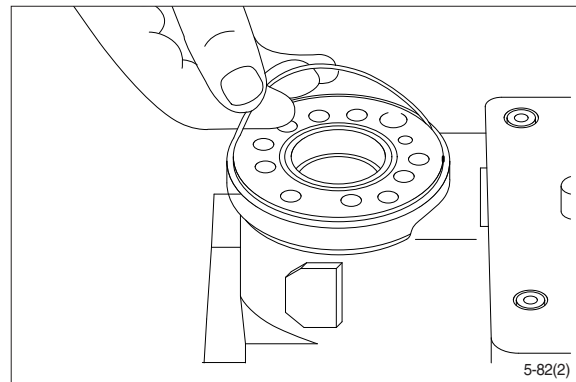
(23) Place the distributor plate so that the channel holes match the holes in the housing.

5-82(3)
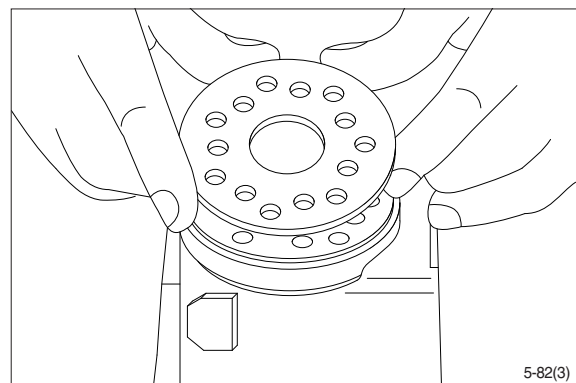
(24) Guide the cardan shaft down into the bore so that the slot is parallel with the connection flange.

5-82(4)
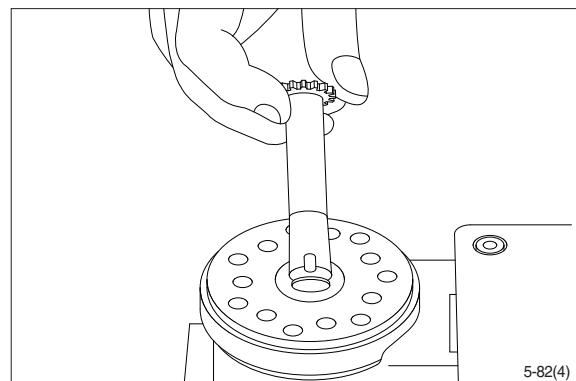
(25) Place the cardan shaft as shown - so that it is held in position by the mounting fork.

5-83(1)
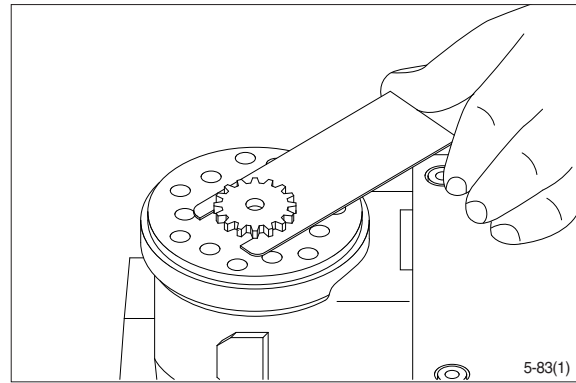
(26) Grease the two O-rings with mineral oil approx. viscosity 500 cSt at 20 °C and place them in the two grooves in the gear rim. Fit the gearwheel and rim on the cardan shaft.

5-83(2)
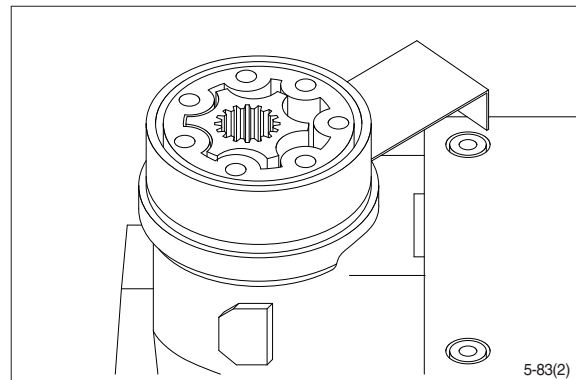
(27) **Important**

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.

5-83(3)
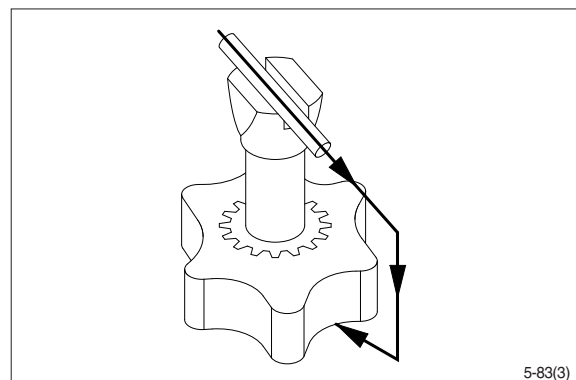
(28) Place the end cover in position.

5-84(1)
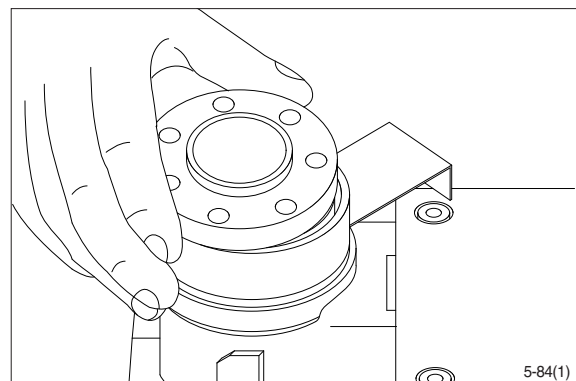
(29) Fit the special screw with washer and place it in the hole shown.

5-84(2)
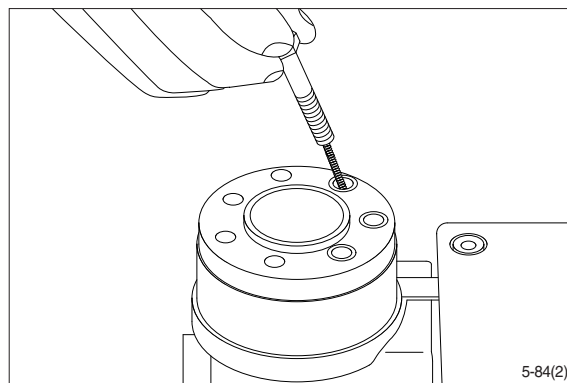
(30) Fit the six screws with washers and insert them. Cross-tighten all the screws and the rolled pin.
· Tightening torque : 4.0±0.5 kgf · m
(28.9±3.6 lbf · ft)

5-84(3)
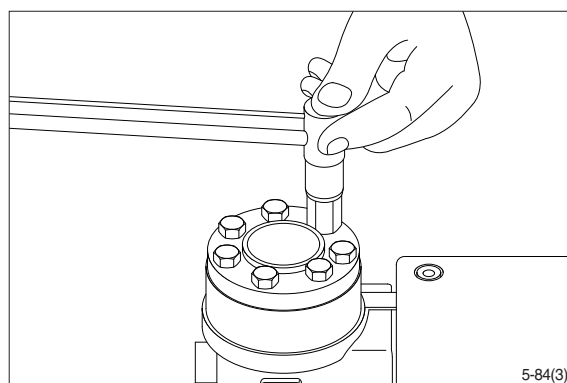
(31) Place the dust seal ring in the housing.

5-84(4)
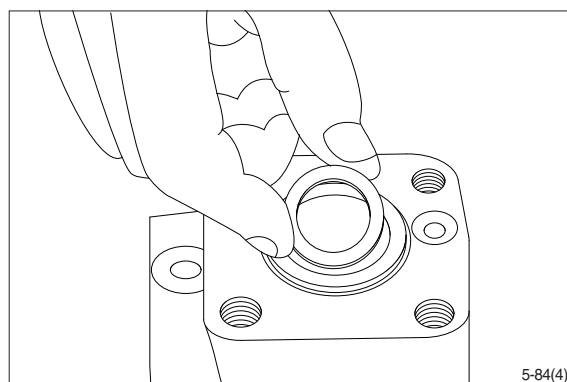
(32) Fit the dust seal ring in the housing.

5-85(1)
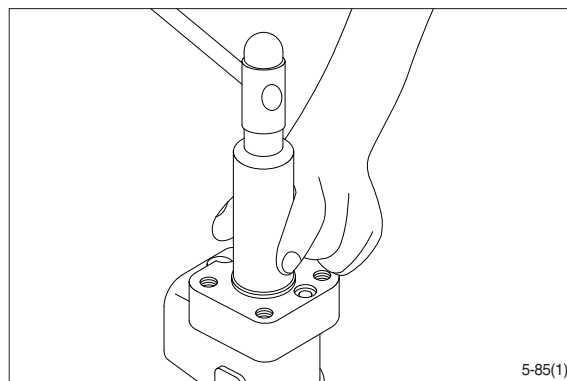
(33) Press the plastic plugs into the connection ports.

※ Do not use a hammer!

5-85(2)
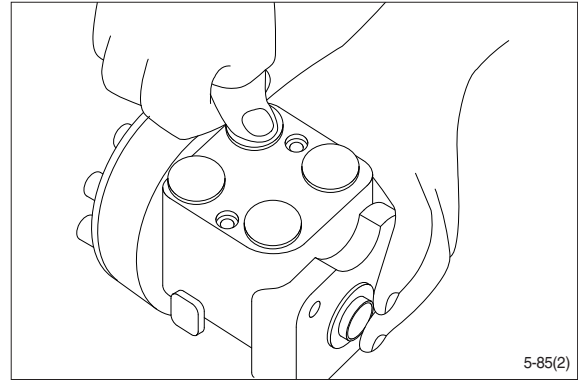
2. HYDRAULIC MOTOR

1) DISASSEMBLY

(1) Seal plugs

Put the motor in a holding tool, with the output shaft downward.
For end port version, use 10 mm (0.4 in) hexagon socket spanner.

B15T5SM01
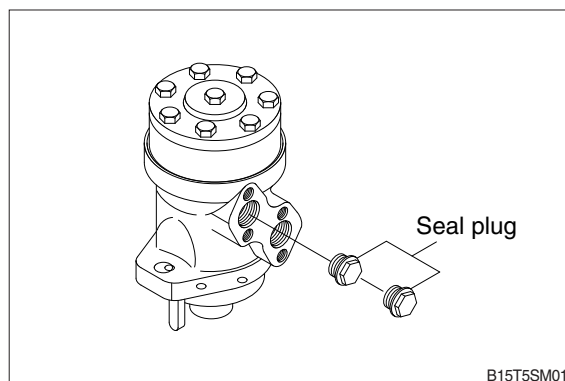
(2) Drain plug and washer

A/flat, other version : 19 mm (0.75 in)
Not SAE washer.

B15T5SM02
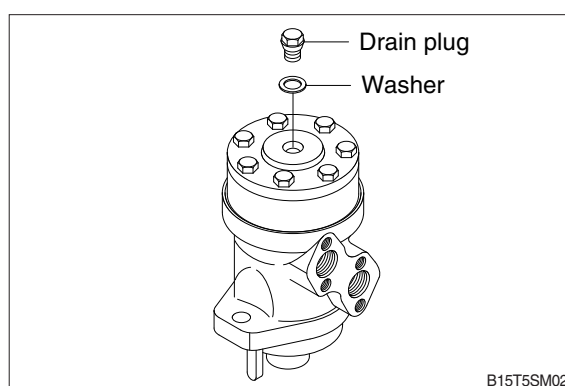
(3) Screws, washers (7 off)

Use a 13 mm (0.5 in) spanner socket.

B15T5SM03
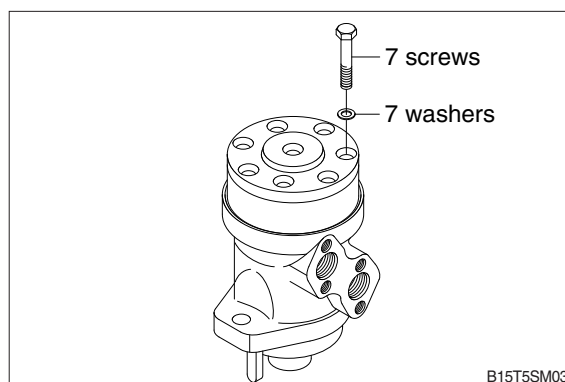
(4) End cover, gear wheel set, O-ring (2 off)

Remove end cover sideways.
Keep fingers under the gear wheel set to prevent the parts from falling out.

B15T5SM04
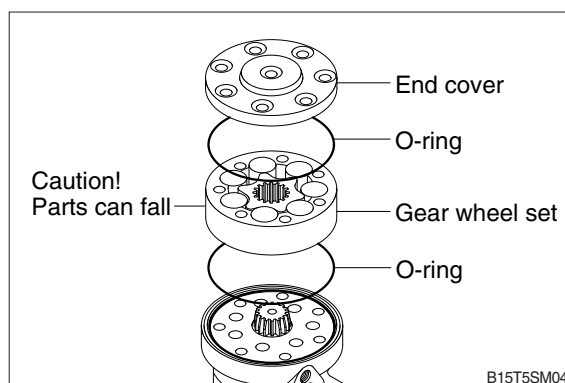
(5) Cardan shaft, plate, O-ring.
   Remove orderly.

Distributor plate

O-ring

Cardan shaft

B15T5SM05
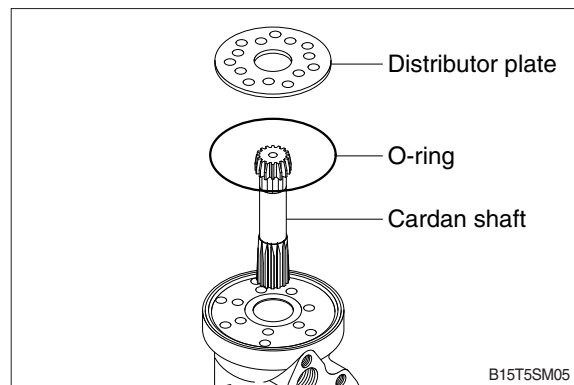
(6) **Output shaft**

Shaft and bearings should normally not be removed from housing. However, if necessary for inspecfion and cleaning, remove the shaft from the housing front end. The rear bearing can thus remain in the housing. After this, turn the motor.

Output shaft

Do not disassemle unless necessary !

B15T5SM06
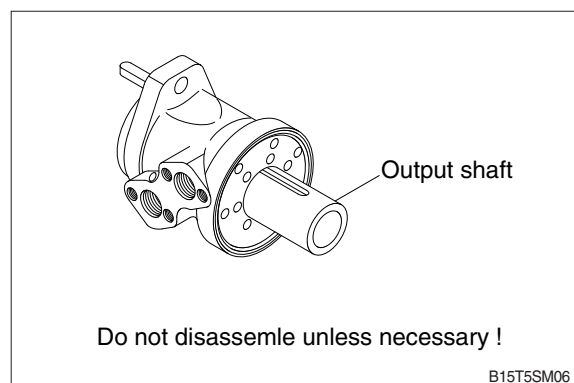
(7) **Screws, spigot flange**

Use torques-spanner type T30, 9 mm (0.35 in)screw driver or hexagon socket spanner 4 or 5 mm (0.16 or 0.20 in).

Housing

Spigot flange

Screw

B15T5SM07
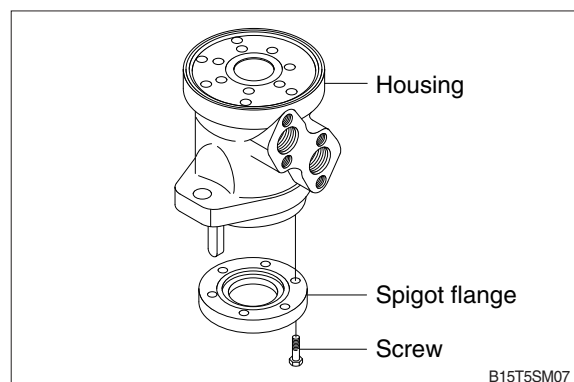
(8) **O-ring, bearing race, shaft seal**
   Use a 2 mm (0.08 in) screw driver.

Housing

Bearing race

O-ring

Shaft seal

B15T5SM08
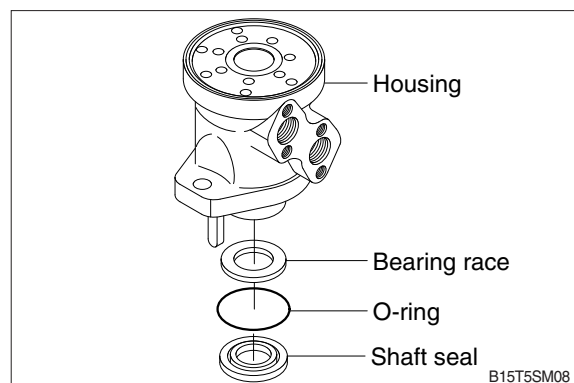
(9) Dust seal, needle bearing

Use a 4 mm (0.16 in) screw driver.

Housing

Needle bearing

Dust seal

B15T5SM09
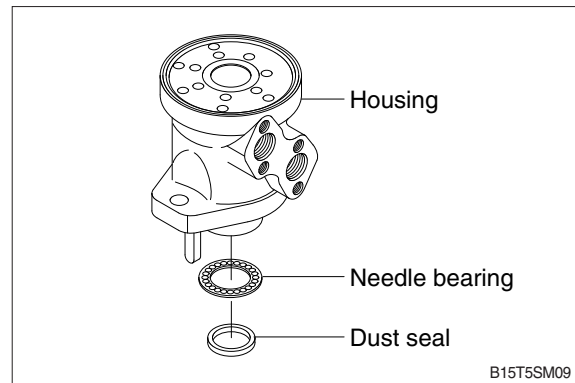
2) ASSEMBLY

· Clean all parts carefully with low aromatic kerosine
· Check all parts carefully and replace if necessary
· Before assembly, lubricate all parts with hydraulic oil and grease rubber parts with vaseline.

(1) Needle bearing

Place needle bearing onto the output shaft side.

Housing

Needle bearing

B15T5SM11
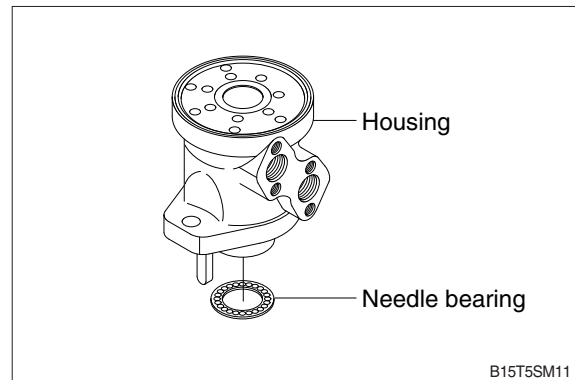
(2) Shaft seal

Knock the seal into position in the spigot flange. Check that the seal lies against the cover recess.

Housing

Shaft seal

B15T5SM12
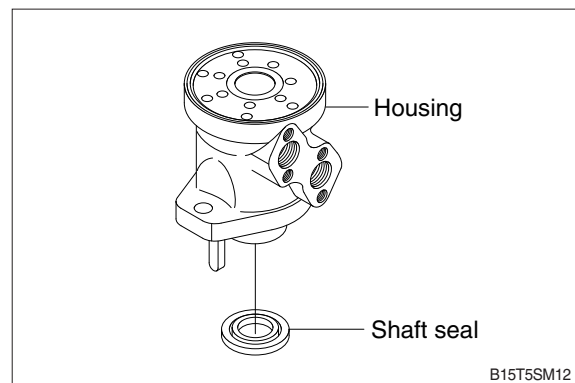
(3) Dust seal ring

Place the dust seal ring in the spigot flange and knock it into position with a plastic hammer and appropriate mandrel.

Housing

Dust seal

B15T5SM13
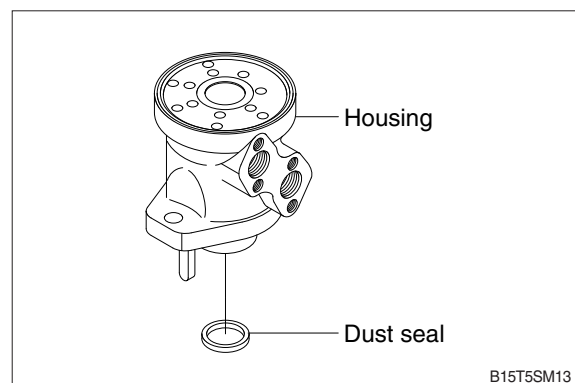
(4) Bearing race, O-ring

Grease the O-ring with vaseline and fit the bearing race and O-ring into the spigot flange.

Housing

Bearing race

O-ring

B15T5SM14
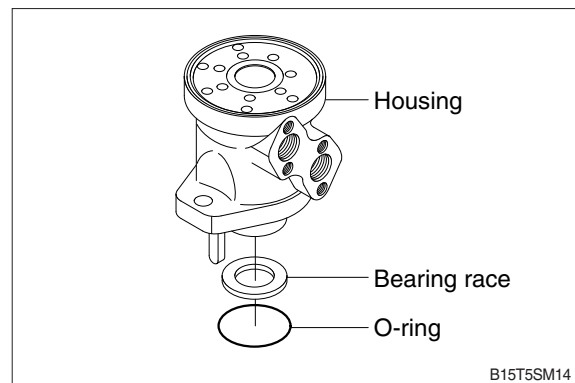
(5) Spigot flange

Turn so that the holes line up.

Housing

Spigot flange

B15T5SM15
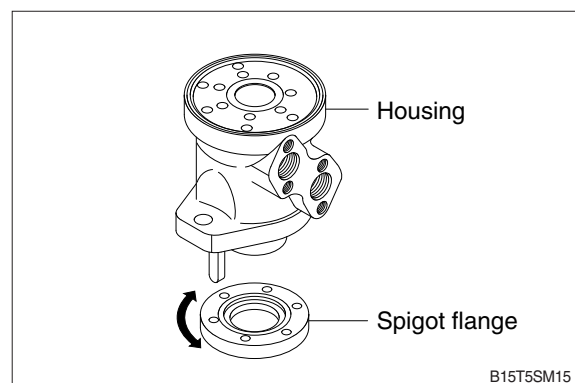
(6) Screws (6 off)

· Tightening torque

① Slotted screw M6
   0.5~0.8 kgf · m (3.6~5.8 lbf · ft)

② Hexagon socket screws M5
   0.5~1.0 kgf · m (3.6~7.2 lbf · ft)

③ Hexagon socket screws M6
   1.2~1.5 kgf · m (8.7~10.8 lbf · ft)

④ Torx screws M6
   0.5~0.8 kgf · m (3.6~5.8 lbf · ft)

※ Omit spring washer, if the screw head is protruding from spigot flange when screw has been tightened (old OMR metric version only). After this, turn the motor.

Housing

Screw

B15T5SM16
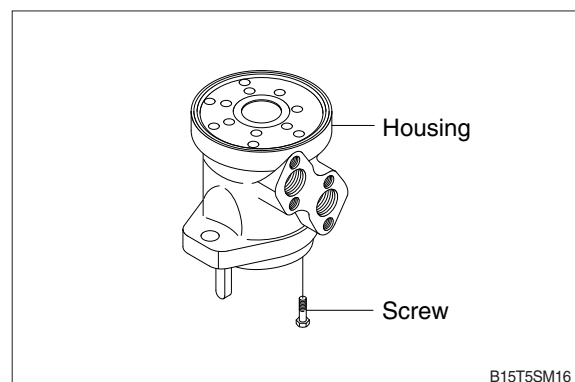
(7) Output shaft (1 1/4 inch splined shaft)

The rear shaft end of 1 1/4 inch splined shafts must be marked before fitted.

The mark must be positioned vertically above a communication slot leading up to the front annular channel.

Grease the journals with hydraulic oil.

Output shaft

B15T5SM17
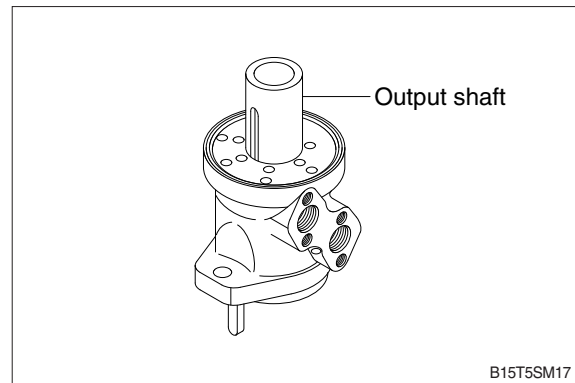
(8) O-ring, distributor plate

Grease the O-ring and put it in the O-ring groove of the housing.

Turn the distributor plate so that the holes line up.

Distributor plate

O-ring

B15T5SM18
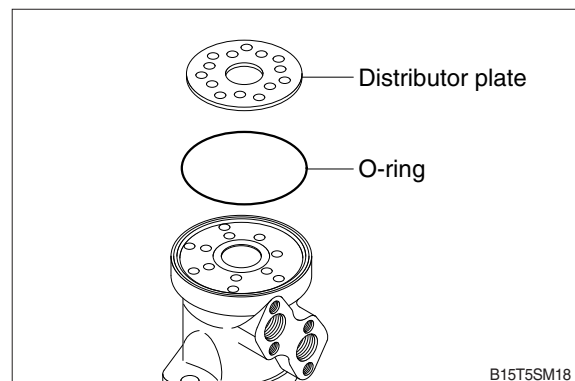
(9) Cardan shaft

Guide the cardan shaft down into the motor housing.

Cardan shaft

B15T5SM19
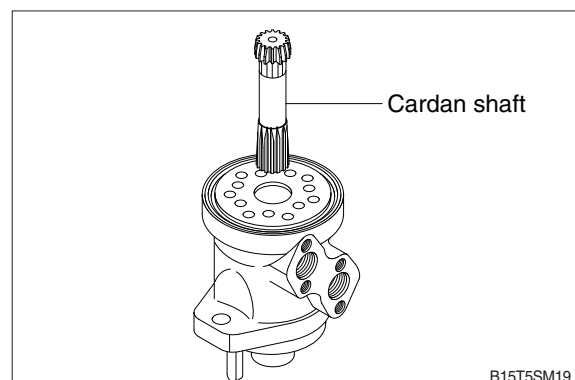
(10)Gear wheel set, O-rings

Place the O-rings (greased) in the O-ring grooves of the gearwheel.

In gearwheels with non through splines place the gearwheel with the recess in the spline hole facing down towards the housing.

O-ring

Caution!
Parts can fall

Gear wheel set

O-ring

B15T5SM20
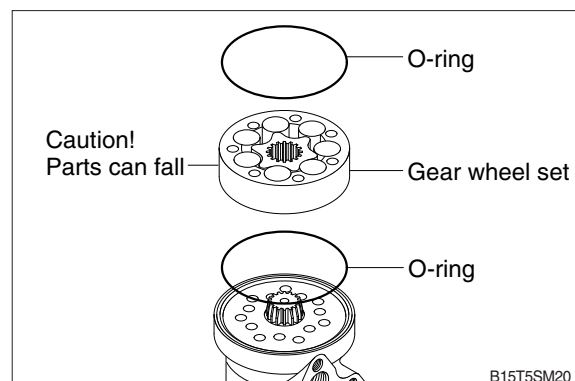
(11) Gear wheel set

Place the gearwheel set on the cardan shaft so that the top of a tooth in the external teeth of the gearwheel are vertically above the key slot in the output shaft (cylindrical or tapered) or the top of a tooth on a 1 inch splined shaft. In motors with 1 1/4 inch splined shaft the tooth top must be positioned vertically above the mark, see point 13.

Turn the gearwheel set counter clockwise until the cardan shaft and the gearwheel start to mesh (15°).

Turn the gearwheel rim so that the holes made for the screws line up.

Caution!
Parts can fall — — Gear wheel set

B15T5SM21
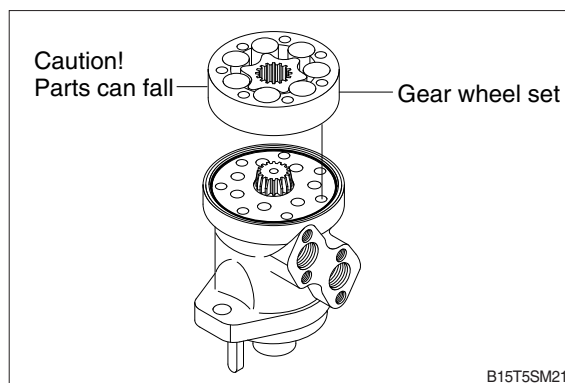
(12) End cover

Turn the end cover so that the holes line up.

— End cover

Housing —

B15T5SM22
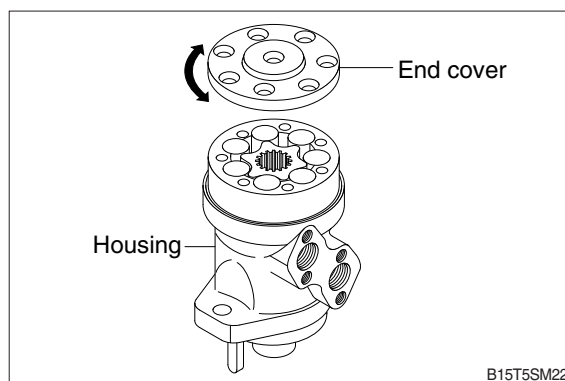
(13) Washer, screws (7 off)

Use a 13 mm spanner socket.
· Tightening torque :
3.0~3.5 kgf · m (21.7~25.3 lbf · ft)

7 screws

7 washers

B15T5SM23
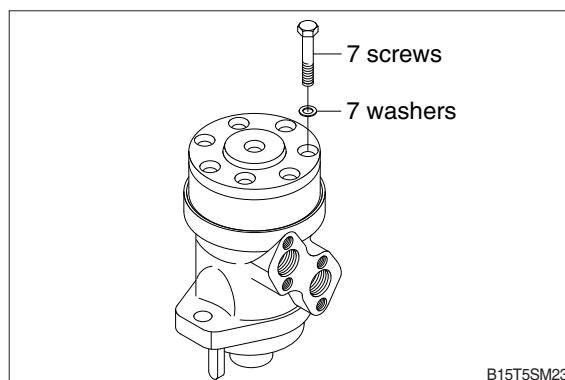
(14)Washer, drain plug

Use a 19 mm spanner socket.

· Tightening torque :
  3~6 kgf · m (21.7~43.4 lbf · ft)

Drain plug
Washer

B15T5SM24
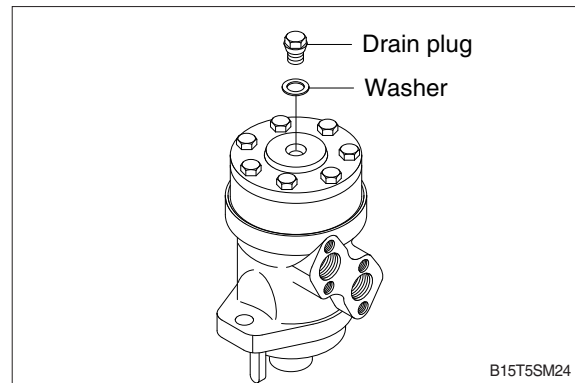
(15)Seal plugs (threaded plugs)

Side port version.
Screw plastic plugs.

Seal plug

B15T5SM25
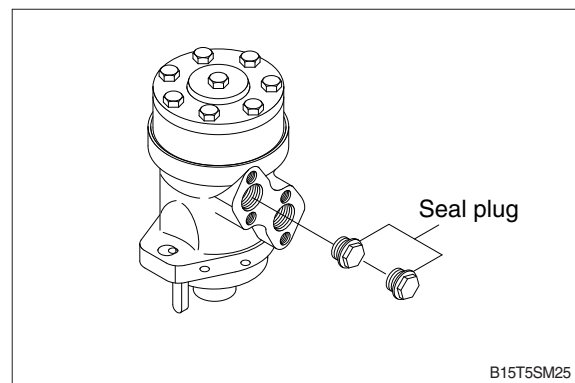
3. PRIORITY VALVE

1) STRUCTURE
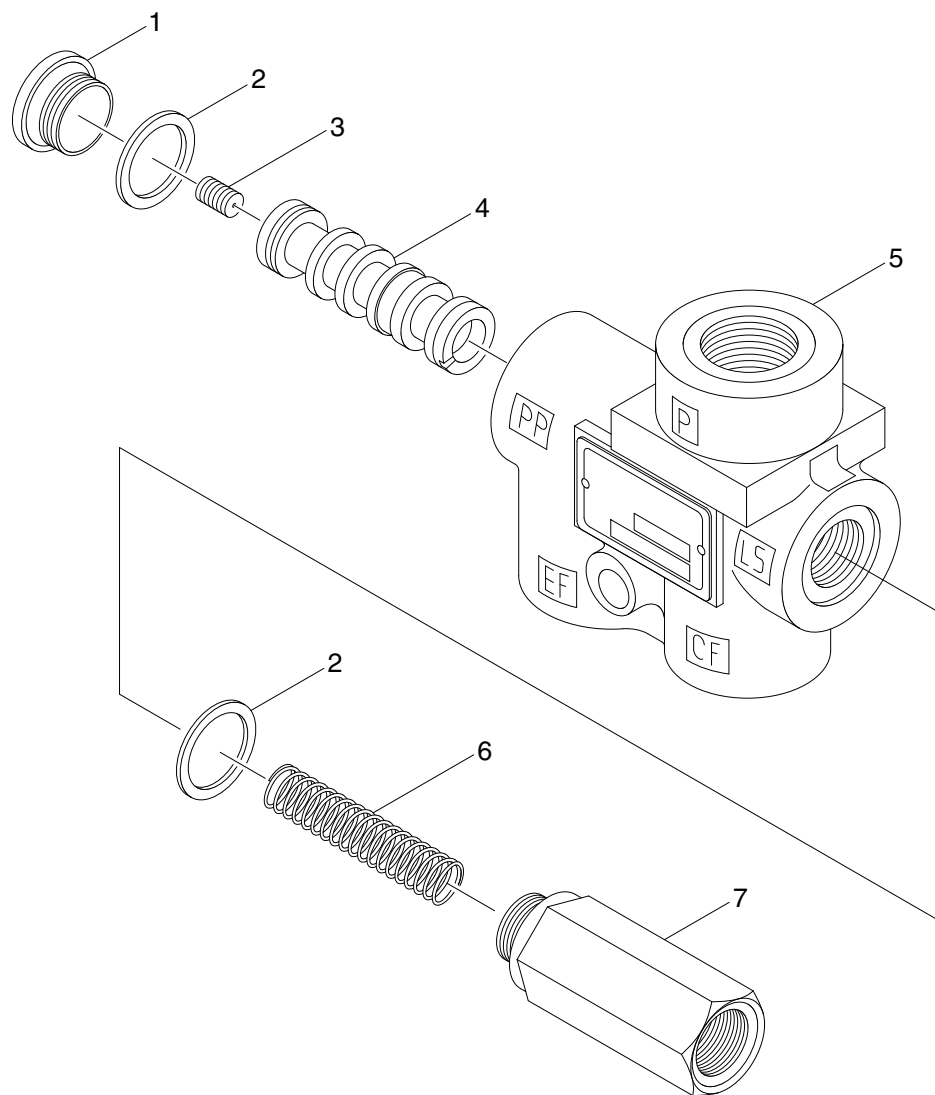
18BCS9SE08

1	Plug	4	Spool	7	Plug
2	Seal	5	Housing		
3	Orifice	6	Spring		

2) DISASSEMBLY

※ Cleanliness is the primary means of assuring satisfactory the priority valve life.
Select clean place.
Before removing the piping, clean the surrounding area of valve ports.

(1) Fix the housing (5) in a vise with copper or lead sheets.
Do not over tighten jaws.
(2) Loosen plug (7) for LS port.

18BCS9SE14

(3) Remove spring (6).

18BCS9SE15
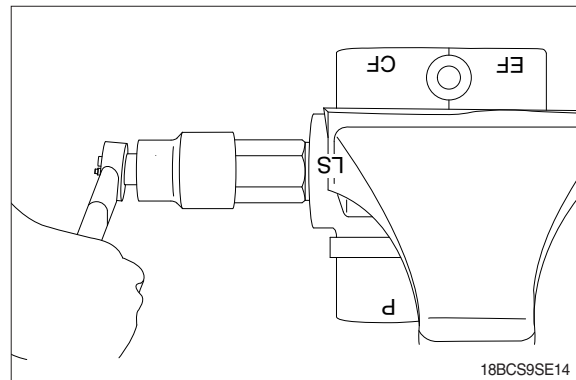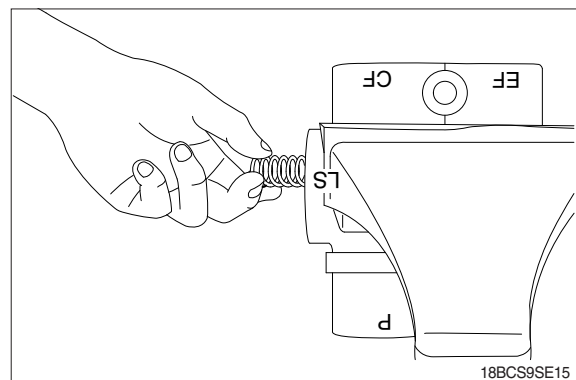
(4) Remove spool assy (4).
※ Can't remove the orifice (3) from spool (4), because the orifices were locked at the spool.

18BCS9SE16
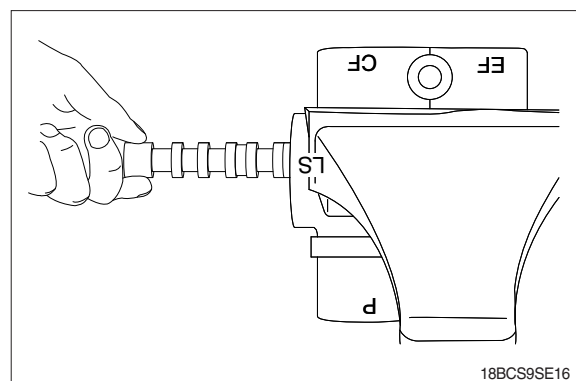
(5) Remove plug (1) and separate seal (2) and plug (1, 7) individually.

18BCS9SE17
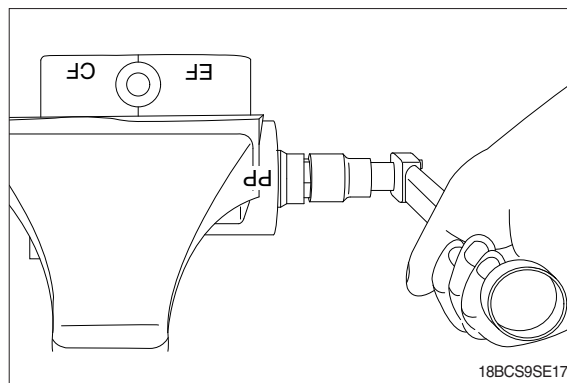
3) ASSEMBLY

※ Clean all metal parts in clean solvent and blow dry with air and correct any damage, burrs and rust.
※ Do not wipe dry with cloth or paper towel.
※ Replace seals with new ones as a rule and coat with grease.

(1) Fix the housing (5) in a vise.
(2) Insert the spool (4).

※ Secure the spool (4) remain in their correct direction.
※ Secure the spool (4) to move smoothly by finger.
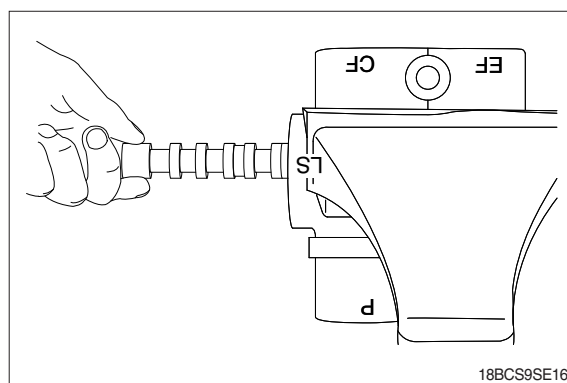
18BCS9SE16

(3) Insert the spring (6) into the housing (5).
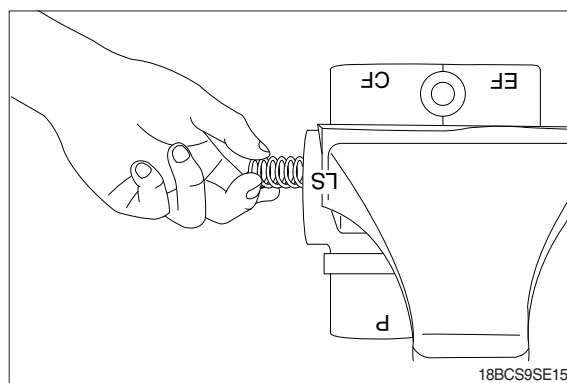
18BCS9SE15

(4) Install the seal (2) onto plug (1, 7) and install the plug (1, 7) into the housing (5).
· Tighten torque : 4.5 kgf · m (32.5 lbf · ft)

18BCS9SE14

4. STEERING AXLE AND WHEEL

1) STRUCTURE

STEERING SENSOR

STEERING HYDRAULIC MOTOR

FRAME

18BCS9SE24-1

1	Steering axle assy	1-7	Bearing	8	Lever	15	Spring washer
1-1	Steering axle wa	2	Bolt	9	Hexagon bolt	16	Ball beating
1-2	Bracket	3	Spring washer	10	Spring washer	17	Rear tire
1-3	Taper roller bearing	4	Spring pin	11	Plain washer	18	Washer bearing
1-4	Taper roller bearing	5	Steering pinion	12	Hexagon nut	19	Rolling bearing nut
1-5	Oil seal	6	Special bolt	13	Bracket	20	End cover
1-6	Steering gear assy	7	Bolt with washer	14	Socket bolt	21	Washer with bolt

5-45

2) CHECK AND INSPECTION

Fill the Shell retinax grease
up to base line of upper
taper roller bearing
(if disassembled)

Taper roller bearing

Apply grease on
the surface of seal lip

18BCS9SS15

(1) Check for any bend or twist. Slight bend or twist can be straightened by press, however, if not, replace the axle.

(2) Make visual check for cracks or other defects, also check the condition of fit of bearings.

(3) Check play of axle and sleeve bearing of bracket.
Replace the bracket if the play is excessive.

GROUP 1 STRUCTURE AND FUNCTION

1. HYDRAULIC CIRCUIT

18BCS9HS01

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

1) WHEN THE JOYSTICK IS IN THE LIFT POSITION
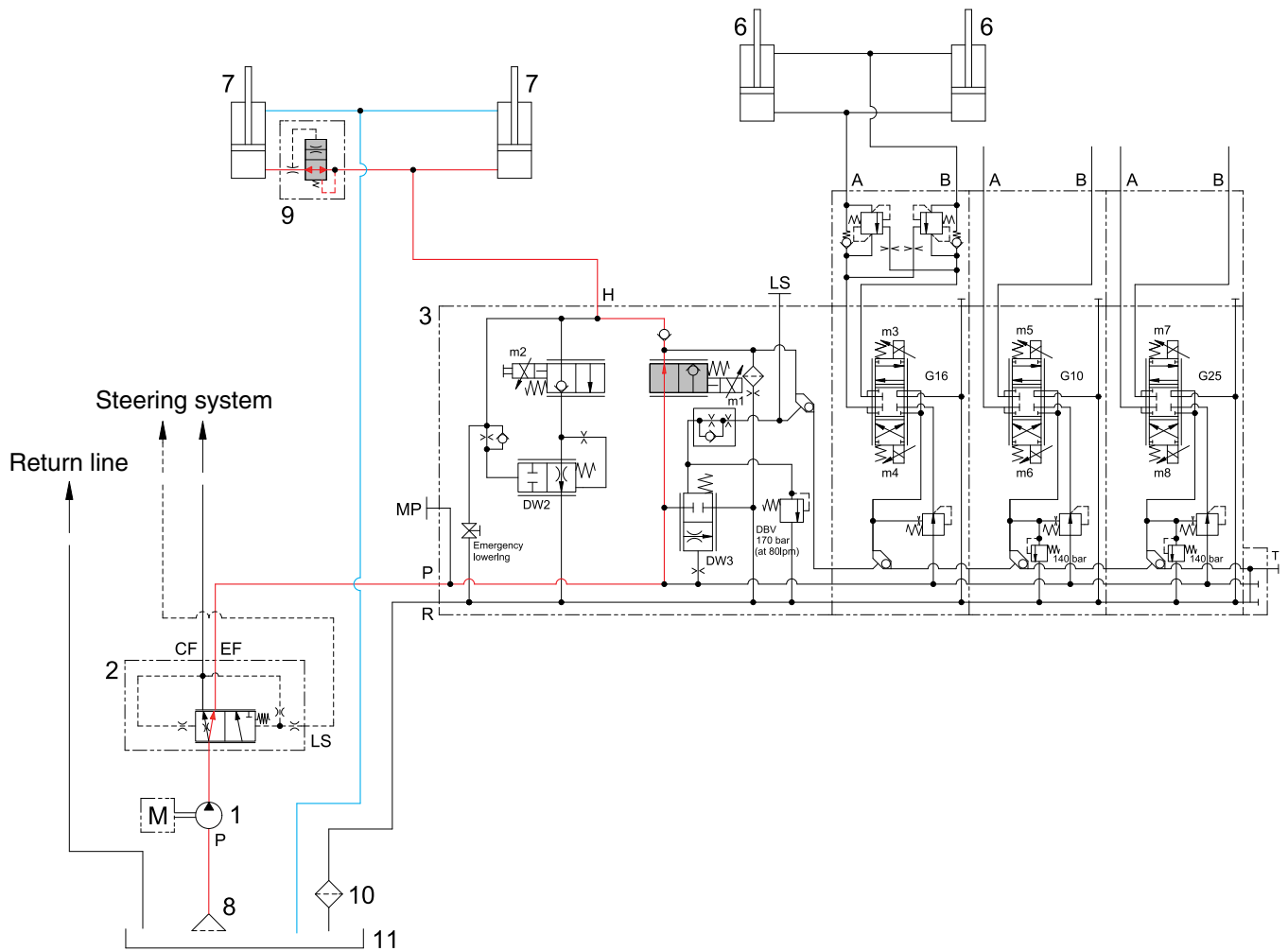
18BCS9HS02

When the joystick is pulled back, the solenoid valve (M1) on the main block is energized and then the spool moves to lift position.

The oil from hydraulic gear pump (1) flows into main control valve (3) through the priority valve (2) and then goes to the large chamber of lift cylinder (7) by pushing the load check valve on the main block.

The oil from the small chamber of lift cylinder (7) returns to hydraulic oil tank (11) at the same time. When this happens, the forks go up.

2) WHEN THE JOYSTICK IS IN THE LOWER POSITION
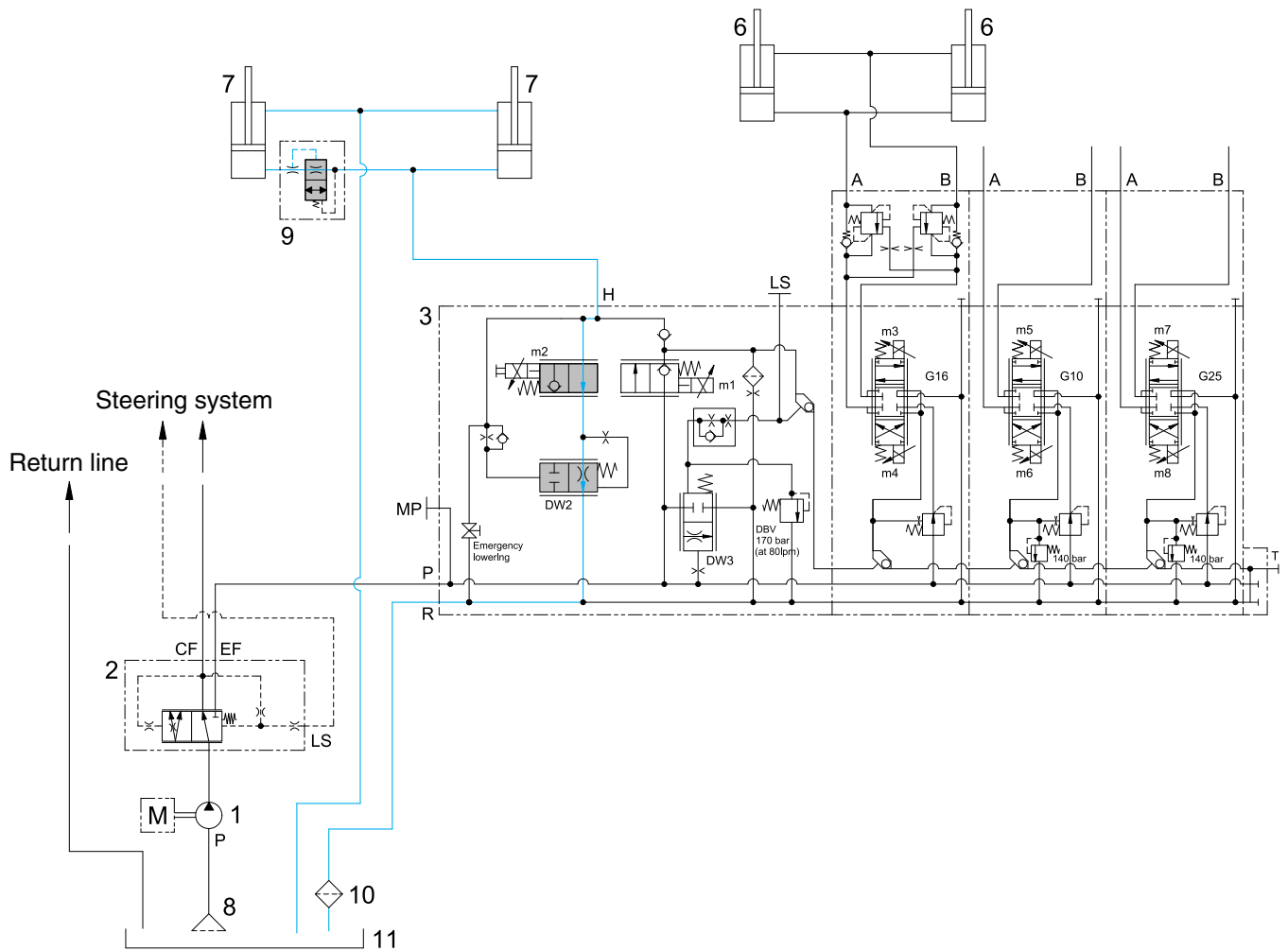
18BCS9HS03

When the joystick is pushed forward, the solenoid valve (M2) on the main block is energized and then the spool moves to lower position.

The oil of the small chamber and the large chamber flows to the hydraulic tank at the same time, so the forks will be lowered due to its own weight.

3) WHEN THE JOYSTICK IS IN THE FORWARD POSITION
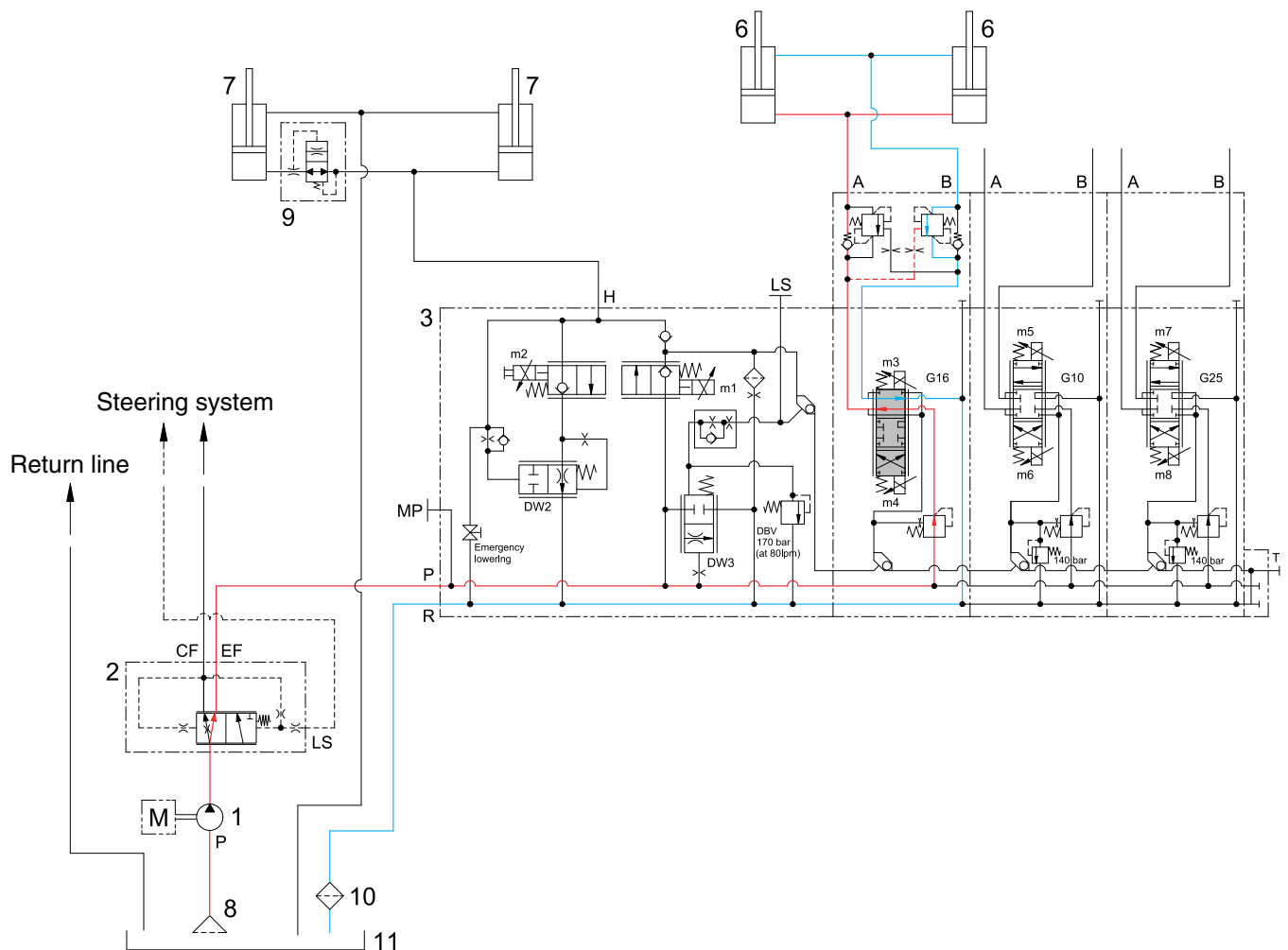
18BCS9HS04

When the tilt button of the joystick is pushed forward position, the solenoid valve (M3) on the tilt block is energized and then the spool moves to tilt forward position.

The oil from hydraulic gear pump (1) flows into main control valve (3) through the priority valve (2) and then goes to the large chamber of tilt cylinder (6) by pushing the load check valve on the tilt block.

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

When this happens, the mast tilt forward.

4) WHEN THE TILT CONTROL LEVER IS IN THE BACKWARD POSITION
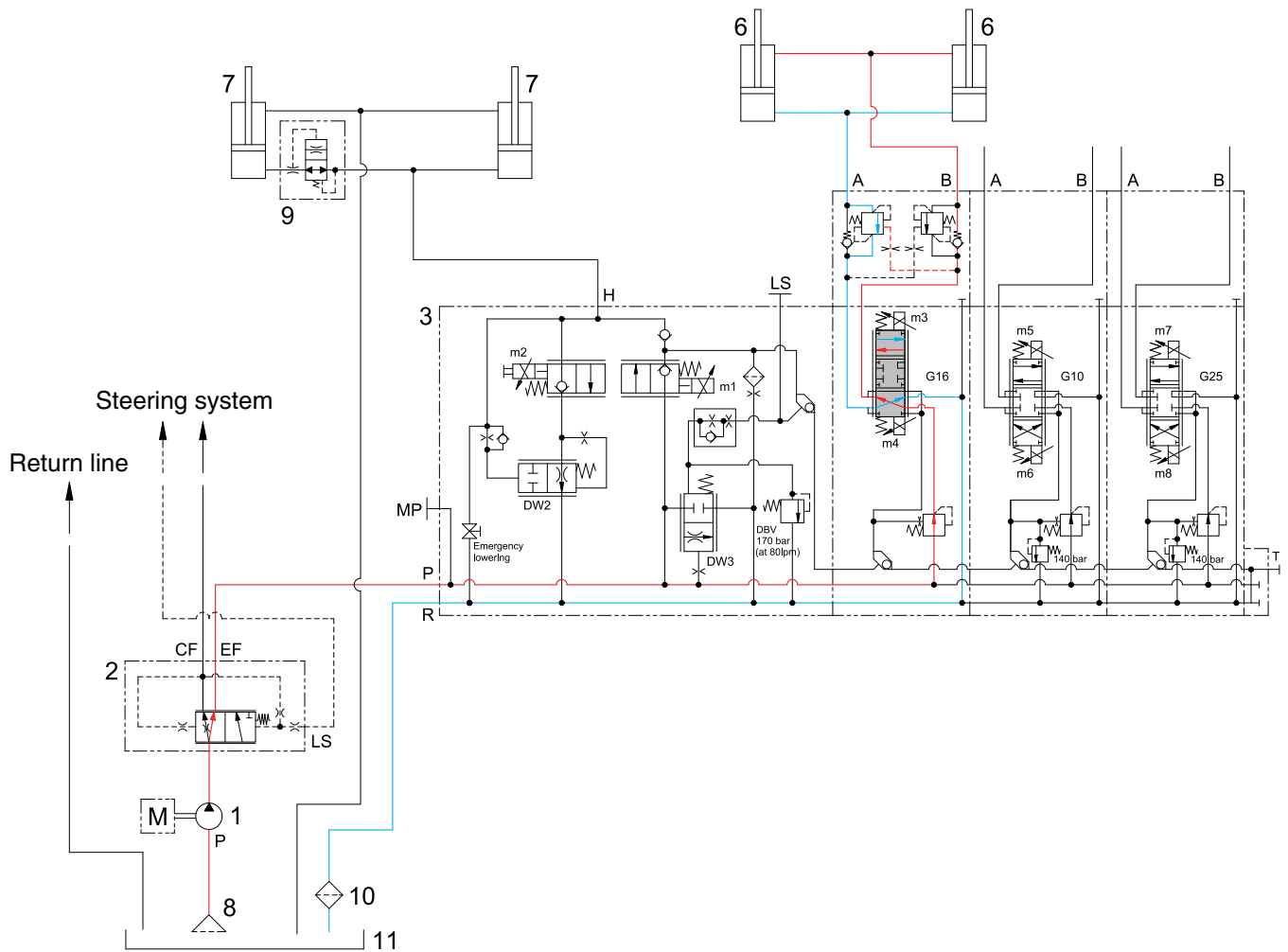
18BCS9HS05

When tilt button of the joystick is pushed the backward position, the solenoid valve (M4) on the tilt block is energized and then the spool moves to tilt backward position.

The oil from hydraulic gear pump (1) flows into main control valve (3) through the priority valve (2) and then goes to the small chamber of tilt cylinder (6) by pushing the load check valve on the tilt block.

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

When this happens, the mast tilt backward.

2. HYDRAULIC GEAR PUMP

1) STRUCTURE
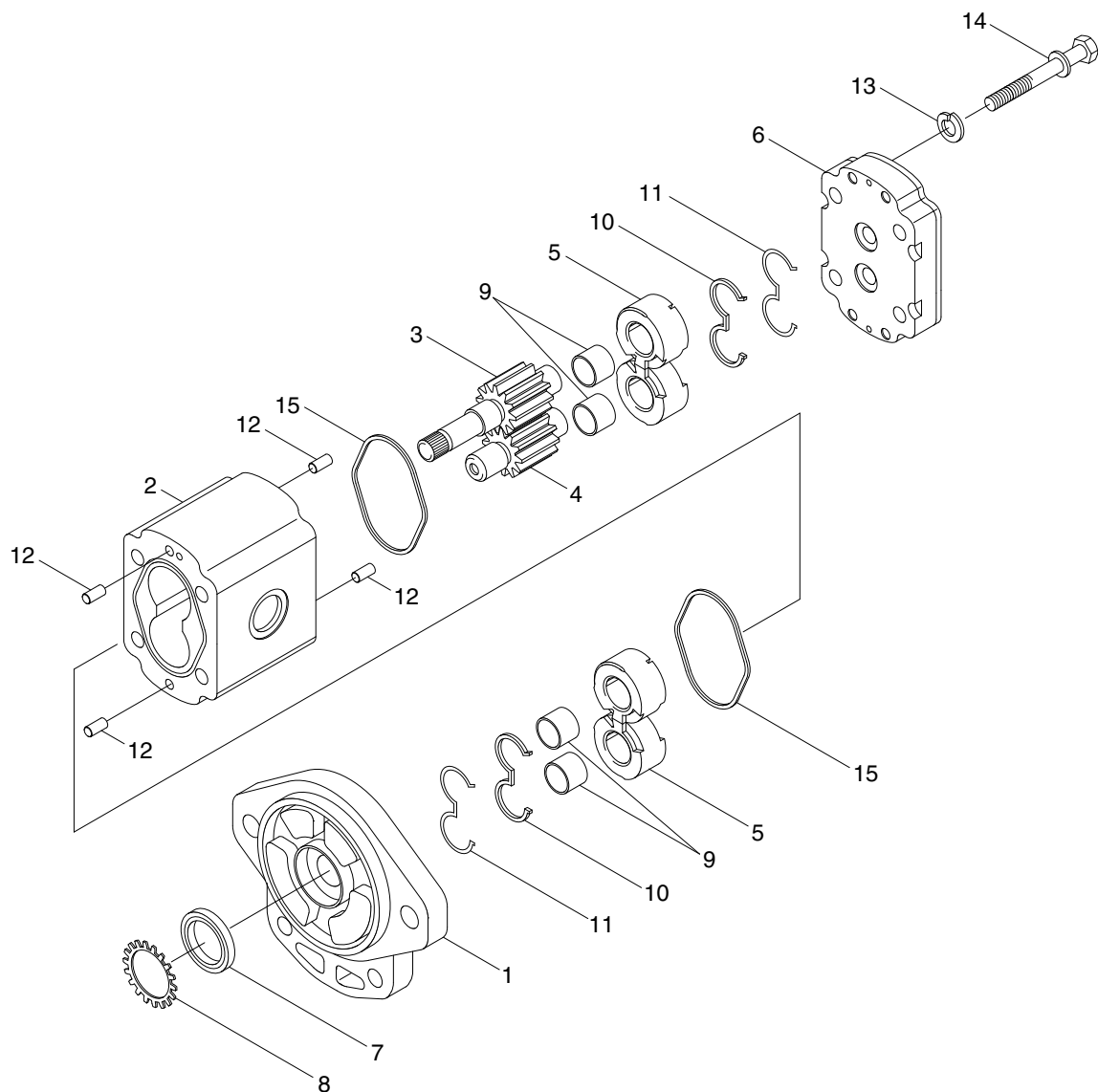
14BRJ9HS19

1	Housing	6	Rear cover	11	E-back up ring
2	Body	7	Oil seal	12	Pin
3	Drive gear	8	Snap ring	13	Washer
4	Idle gear	9	DU bushing	14	Hex bolt
5	Side plate	10	E-seal	15	O-ring

2) OPERATION

This pump comprises of an rear cover (6), a body (2), bushings (9) and a housing (1) bolted together with bolts (14). The gear journals are supported in side plate (5) within pressure balanced bushings to give high volumetric and mechanical efficiencies.

3. MAIN CONTROL VALVE

1) STRUCTURE (3 Spool)

18BCS9HS12A

Port name	Size	Port
Inlet port	1 1/16-12UN	P
Outlet port	1 1/16-12UN	R
Work port	1 1/16-12UN	H
Work port	9/16-18 UNF	A, B
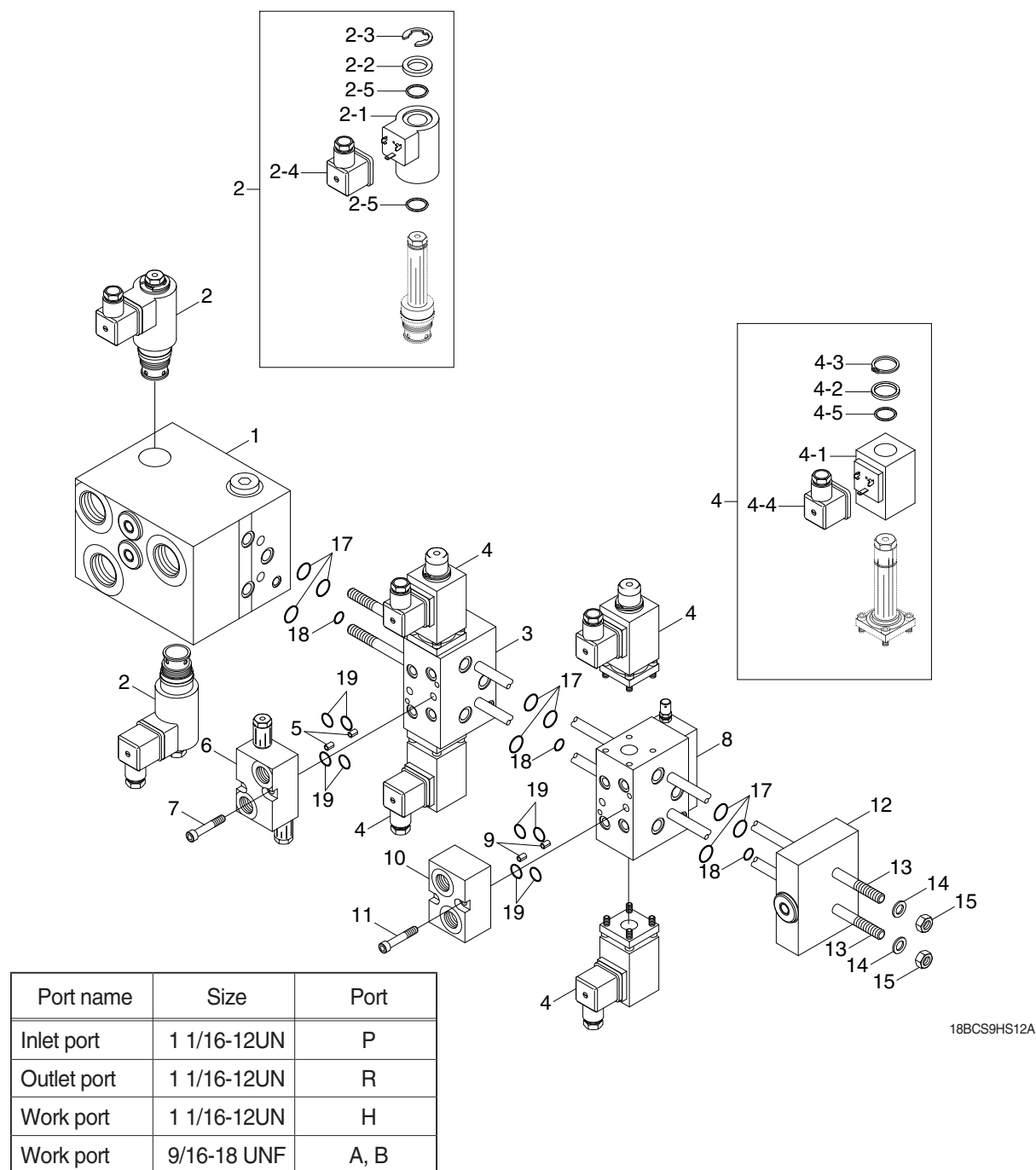
1	Main block	4-2	Disc	11	Hex socket screw
2	Solenoid valve (Lift)	4-3	Circlip	12	End block
2-1	EVI coil	4-4	Black plug	13	Tension rod
2-2	Washer	4-5	O-ring	14	Shape washer
2-3	Lock washer	5	Roll pin	15	Hexagon nut
2-4	Black plug	6	Adapter	17	O-ring
2-5	O-ring	7	Hex socket screw	18	O-ring
3	Tilt block	8	Auxiliary block	19	O-ring
4	Solenoid valve	9	Roll pin		
4-1	Coil	10	Adapter		

2) STRUCTURE (4 Spool, Option)

Port name	Size	Port
Inlet port	1 1/16-12UN	P
Outlet port	1 1/16-12UN	R
Work port	1 1/16-12UN	H
Work port	9/16-18 UNF	A, B
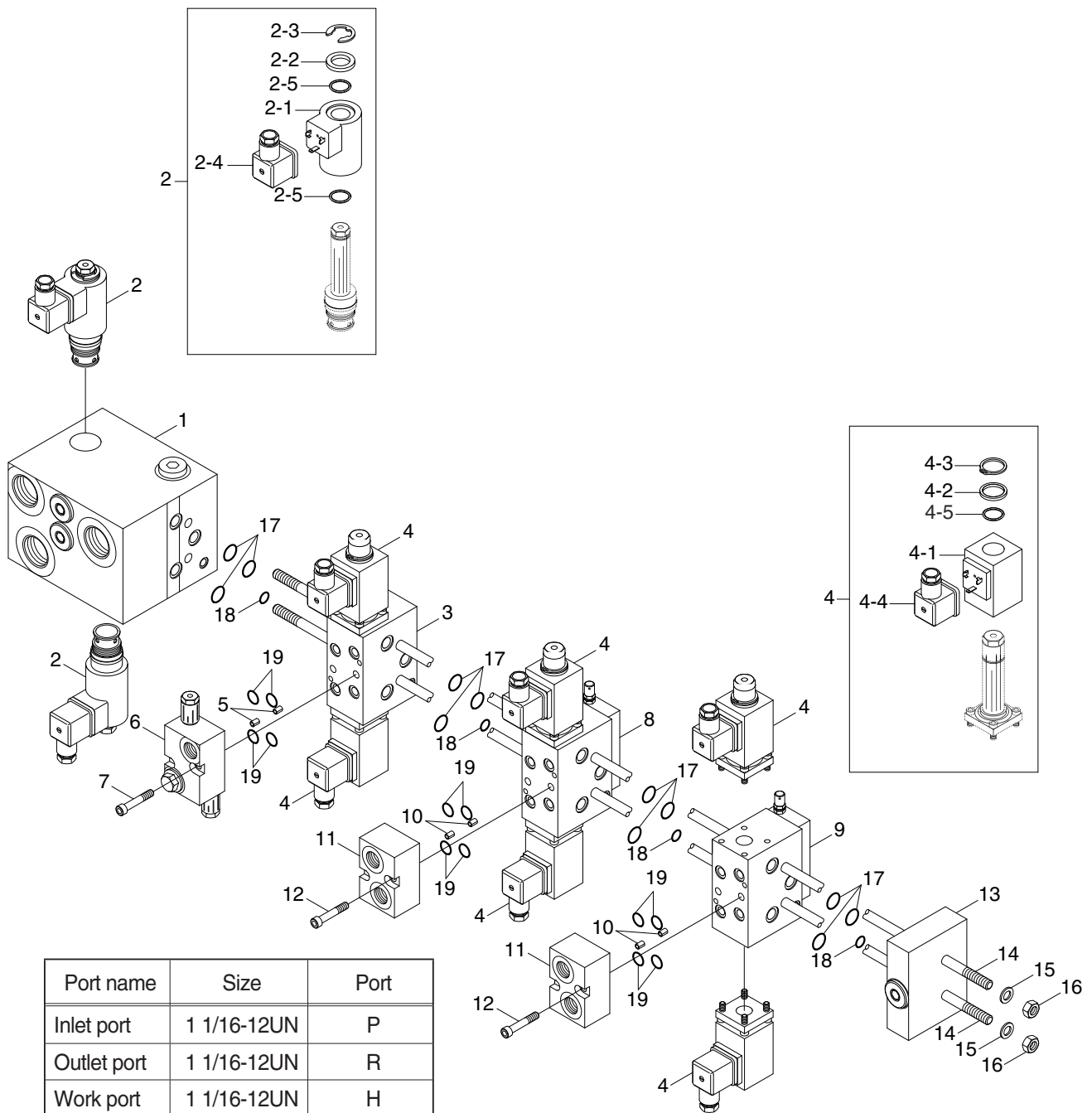
18BCS9HS12

1	Main block	4-2	Disc	11	Adapter
2	Solenoid valve (Lift)	4-3	Circlip	12	Hex socket screw
2-1	EVI coil	4-4	Black plug	13	End block
2-2	Washer	4-5	O-ring	14	Tension rod
2-3	Lock washer	5	Roll pin	15	Shape washer
2-4	Black plug	6	Adapter	16	Hexagon nut
2-5	O-ring	7	Hex socket screw	17	O-ring
3	Tilt block	8	Auxiliary block	18	O-ring
4	Solenoid valve	9	Auxiliary block	19	O-ring
4-1	Coil	10	Roll pin		

3) EMERGENCY LOWERING

In case of the mast cannot be lowered due to a problem in the controller, active the emergency lowering valve on the valve block with hexagonal wrench.

(1) Turn off the electric emergency switch.

(2) Open the lowering valve using the 5mm hexagonal wrench. Slowly lower the mast and the load carriage.

(3) After lowering, close the emergency lowering valve.

Emergency lowering valve

BRJ7HS30

4. LIFT CYLINDER (TF-MAST)

15, 16　14　17　18　19　13　2　1　　20　10　7　8, 9　4, 5　3　6　11, 12
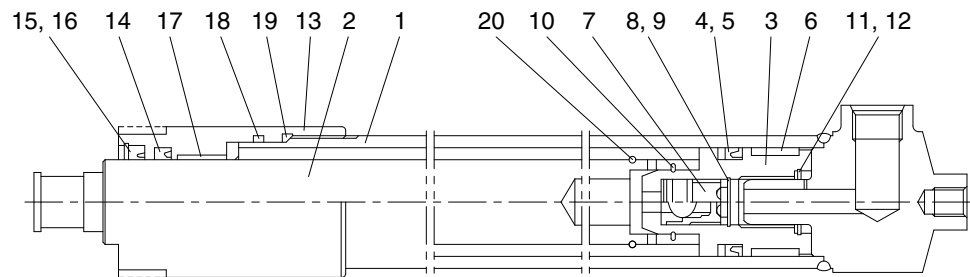
18BCS9HS33

1	Tube assy	8	Spacer	15	Dust wiper
2	Rod	9	Retaining ring	16	Retaining ring
3	Piston	10	Stop ring	17	Rod bushing
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		

5. FREE LIFT CYLINDER (TF-MAST)
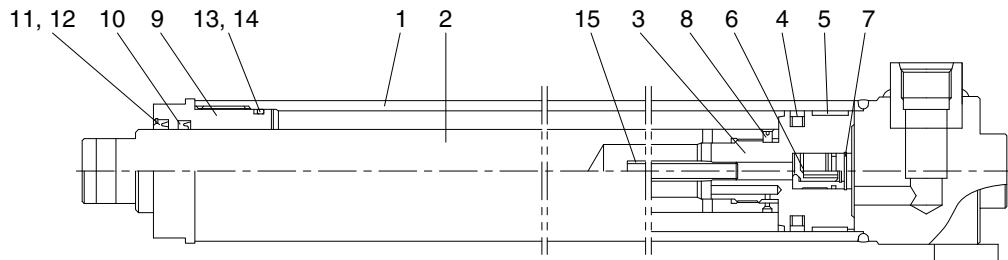
18BCS9HS35

1	Tube assy	6	Check valve	11	Dust wiper
2	Rod	7	Retaining ring	12	Retaining ring
3	Piston	8	Set screw	13	O-ring
4	Piston seal	9	Grand cover	14	Back up ring
5	Wear ring	10	U-packing	15	Pipe

6. TILT CYLINDER
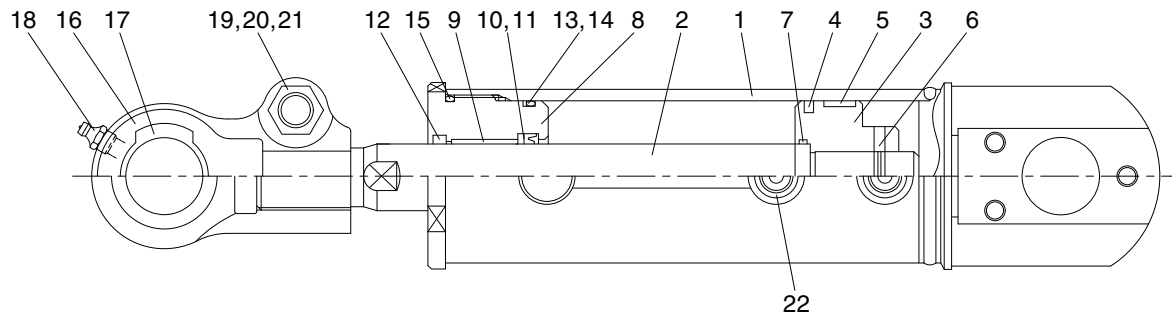
18BCS9HS19

1	Tube assembly	9	Rod bushing	17	Spherical bushing
2	Rod	10	U-packing	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	Set screw	14	Back up ring	22	O-ring
7	O-ring	15	O-ring		
8	Rod cover	16	Eye		

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

1. OPERATIONAL CHECKS

1) CHECK ITEM

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

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

· **Hydraulic drift**

- Down (Downward movement of forks)
 : Within 100 mm (3.9 in)

- Forward (Extension of tilt cylinder)
 : Within 5°

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

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

mm (in)

Standard	Under 0.6 (0.02)

Within 100mm(3.91in)
(after 10min)

18BCS9HS16

Within 5° (after 10min)

18BCS9HS17
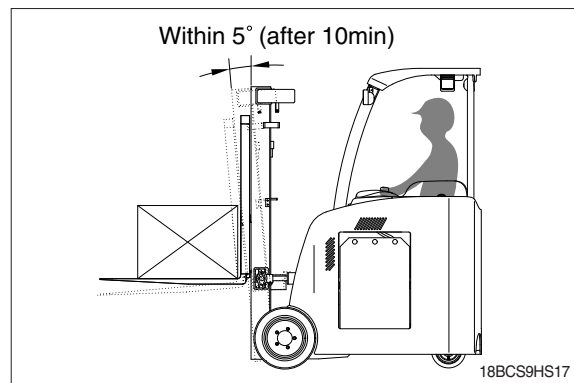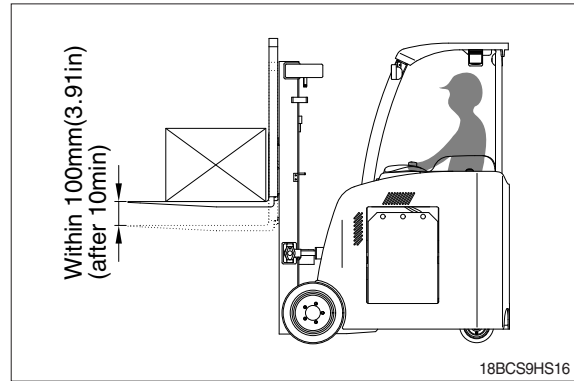
2) CHECK AND SUPPLY HYDRAULIC OIL

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

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

Oil level gauge

High
Low

18BCS9OM127

To check the oil level, first park the truck on a level surface.

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

Check the condition of the hydraulic oil (age, color or clarity, contamination). Change the oil as necessary.
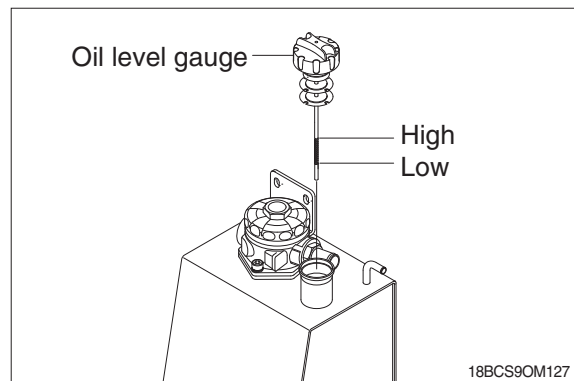
3) CONTROL VALVE

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

· 15/18/20BCS-9 : 170 kgf/cm² (2418 psi)

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 defec- tive. · Tilting forward : tilt lock valve defect- ive. · 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 SAE 10W, class CF engine oil. · Adjust roll to rail clearance. · Replace spool or valve body. · Replace spool or valve body.
Hydraulic system makes abnormal sounds	· Excessive restriction of oil flow pump suction side. · Gear or bearing in hydraulic pump defective.	· Clean filter. · Replace gear or bearing.
Control valve lever is locked	· Foreign matter jammed between sp- ool 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 SAE 10W, class CF engine oil. · Clean filter.

2) HYDRAULIC GEAR PUMP

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

3) MAIN RELIEF VALVE

Problem	Cause	Remedy
Can't get pressure	· Poppet stuck open or contamination under seat.	· Check for foreign matter between poppets and their mating parts. Parts must slide freely.
Erratic pressure	· Pilot poppet seat damaged.	· Replace the relief valve.
Pressure setting not correct	· Normal wear. Lock nut & adjust screw loose.	· See ★How to set pressure on work main relief.
Leaks	· Damaged seats. · Worn O-rings. · Parts sticking due to contamination.	· Replace the relief valve. · Install seal and spring kit. · Disassemble and clean.

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

  · Loosen lock nut.
  · Set adjusting nut to desired pressure setting.
  · If desired pressure setting cannot be achieved, tighten or loosen the adjusting screw 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

※ **Tools required**

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

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

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

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

(4) Remove key from drive shaft if applicable.
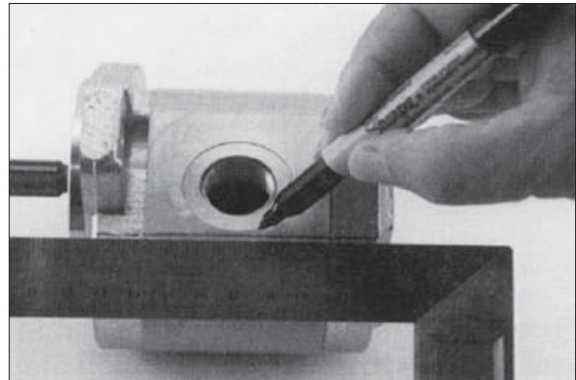
PUMP 01

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

(6) Loosen the four metric hexagon head bolts.

(7) Remove pump from vise and place on clean work bench, remove the four hexagon head bolts and spacers applicable.
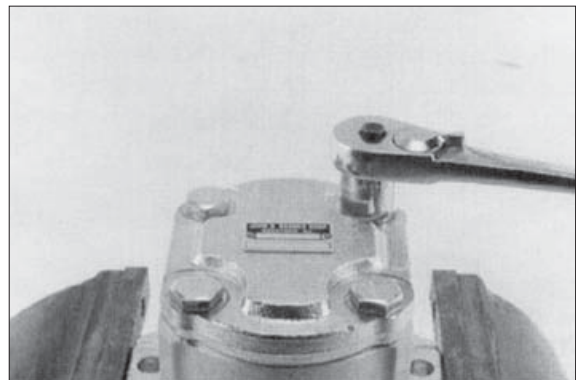
PUMP 02

(8) Lift and remove end cover.
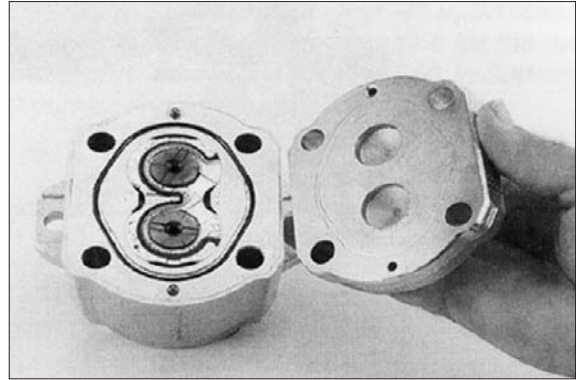
PUMP 03

(9) Carefully remove gear housing and place on work bench. Make sure the rear bearing block remains on the drive and idler shafts.
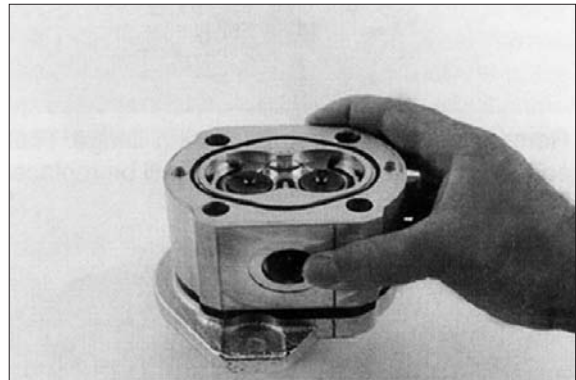
PUMP 04

(10) Remove rear bearing block from drive and idler shafts.
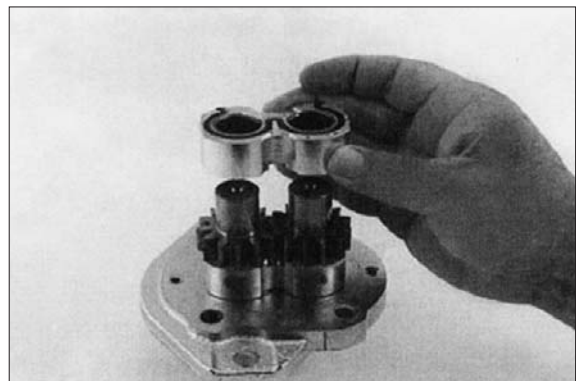
PUMP 05

(11) Remove idler shaft from bearing block.
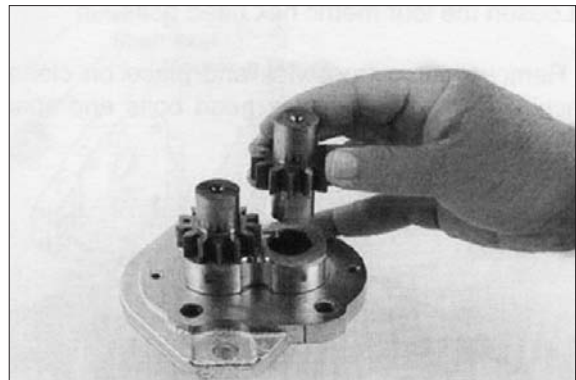
PUMP 06

(12) Remove drive shaft from mounting flange. There is no need to protect the shaft seal as it will be replaced as a new item.
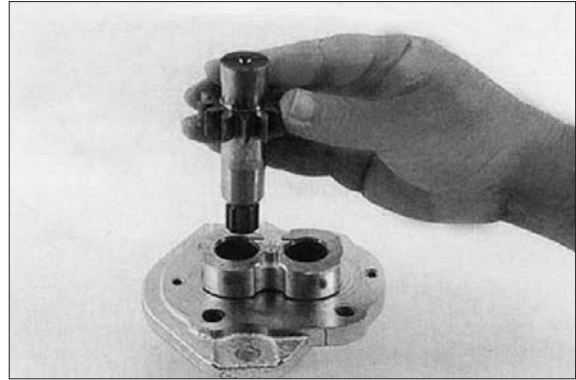
PUMP 07

(13) Remove the front bearing block.
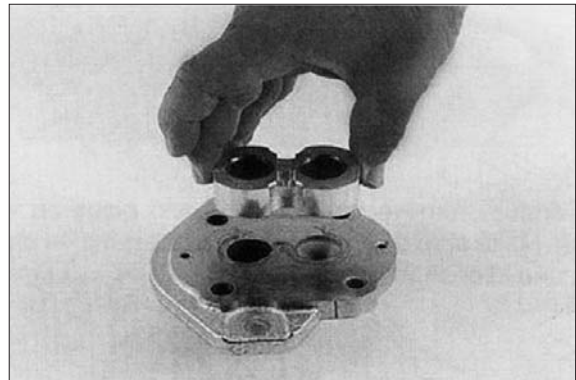
PUMP 08

(14) Turn mounting flange over, with shaft seal up, and remove the retaining ring with proper snap ring pliers.
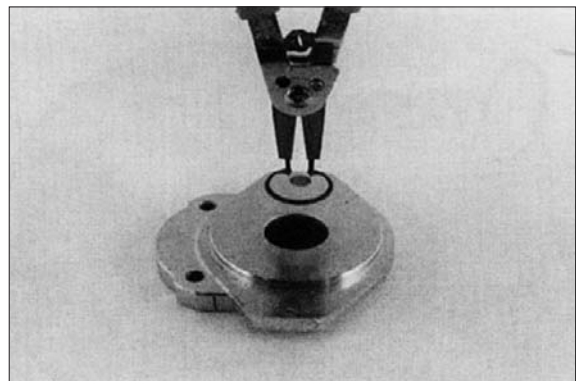
PUMP 09

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

(16) Remove the dowel pins from the gear housing. Do not lose pins.
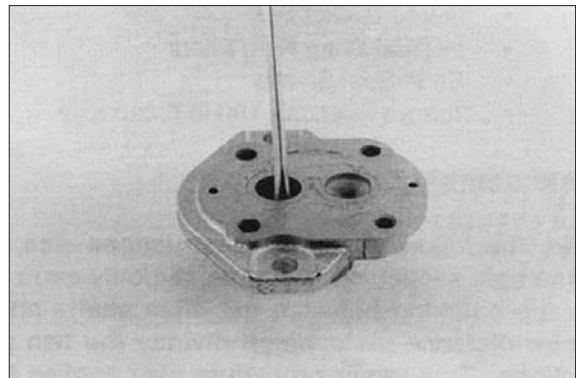
PUMP 10

(17) Remove seals from both bearing blocks and discard.
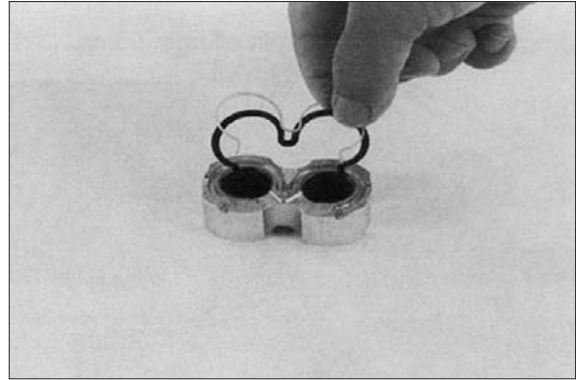
PUMP 11

2) INSPECT PARTS FOR WEAR

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

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

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

Check these points

PUMP 12

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

Check gear face   Check edge of gear teeth
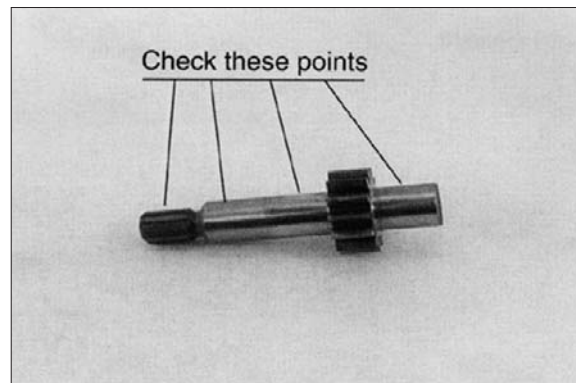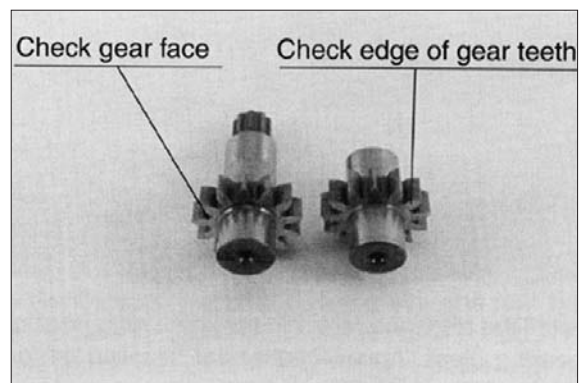
PUMP 13

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

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

※ **General information**

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

※ **This pump is not bi-rotational.**

Check face

Block thickness must equal, no gear wear.
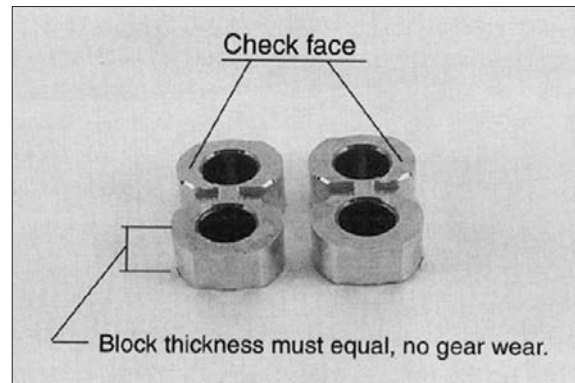
PUMP 14

3) ASSEMBLY

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

(1) Install new shaft seal in mounting flange with part number side facing outboard. Press the seal into the seal bore until the seal reaches the bottom of the bore. Uniform pressure must be used to prevent misalignment or damage to the seal.
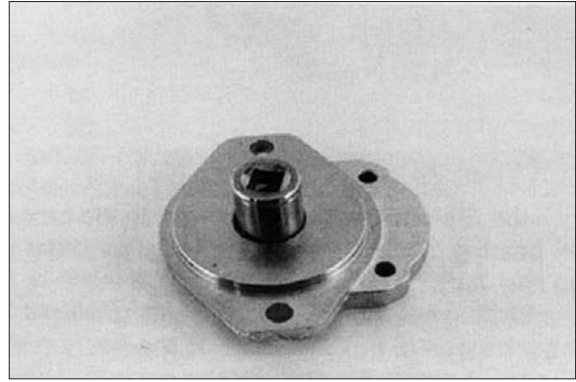
PUMP 15

(2) Install retaining ring in groove in seal bore of mounting flange.
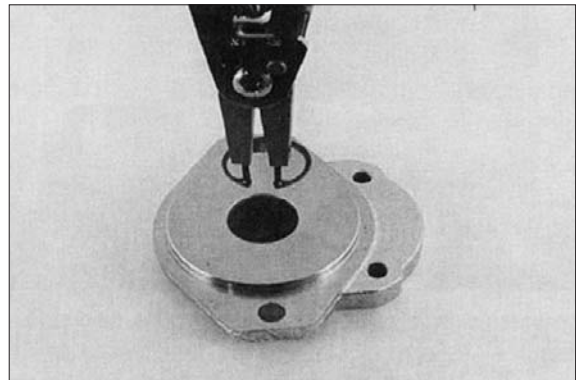
PUMP 16

(3) Place front and back bearing blocks on a clean surface with the E-seal grooves facing up. Apply a light coating of petroleum jelly in the grooves. Also coat the E-seal and backup with the petroleum jelly, this will help keep the seals in place during assembly.
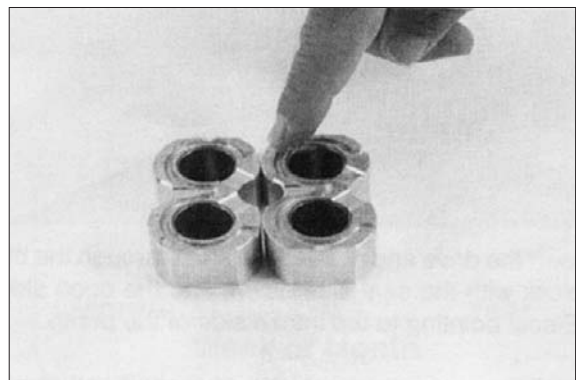
PUMP 17

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

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

(6) Apply a light coating of petroleum jelly to the exposed face of the front bearing block.
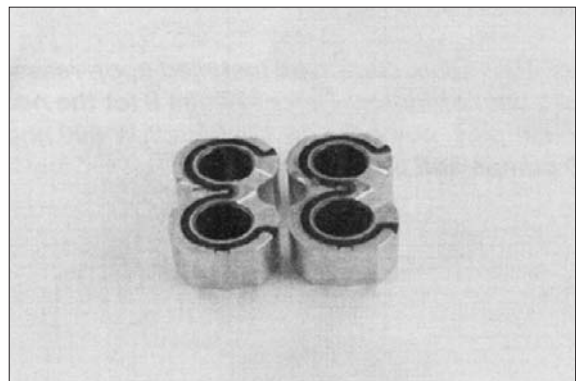
PUMP 18

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

(8) Install the seal sleeve over the drive shaft and carefully slide the drive shaft through the shaft seal. Remove the seal sleeve from shaft.
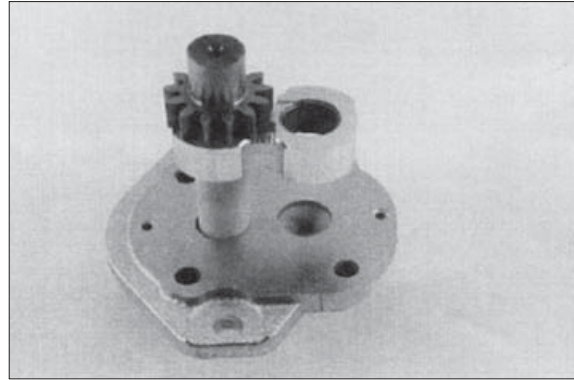
PUMP 19

(9) Install the idler gear shaft in the remaining position in the bearing block. Apply a light coat of clean oil to the face of the drive and idler gears.
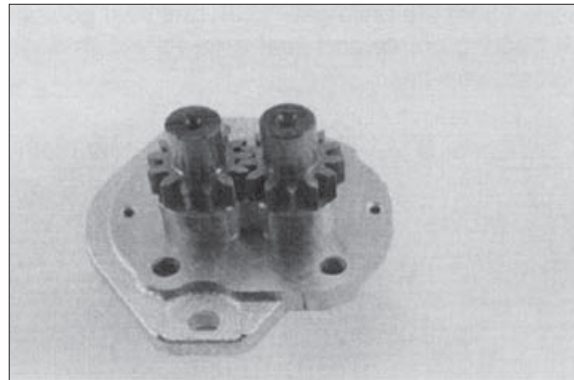
PUMP 20

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

(11) Install two dowel pins in the holes in the mounting flange or two long dowel pins through gear housing if pump is a multiple section pump.
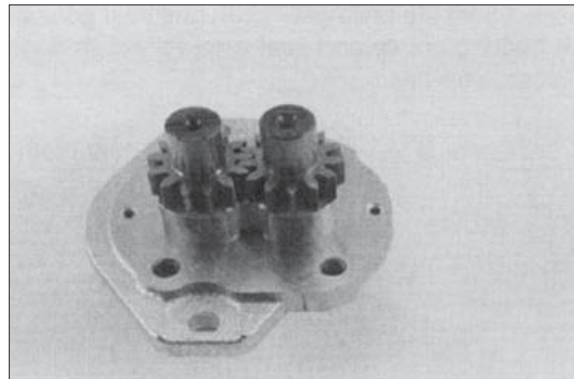
PUMP 21

(12) To install the O-rings in the gear housing, apply a light coating of petroleum jelly in the grooves on both sides of the gear housing.
Also coat the new O-ring and install them in the grooves.
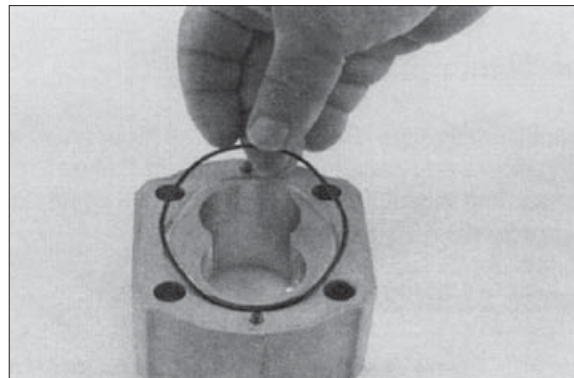
PUMP 22

(13) Gently slide the gear housing over the rear bearing block assembly, slide housing down until the housing engages the dowel pins. Press firmly in place with hands, do not force or use any tool.
Check to make sure the intake port in the housing in on the same side as the open end of the E-seal and that the marked lines on the mounting flange and gear housing are in alignment.
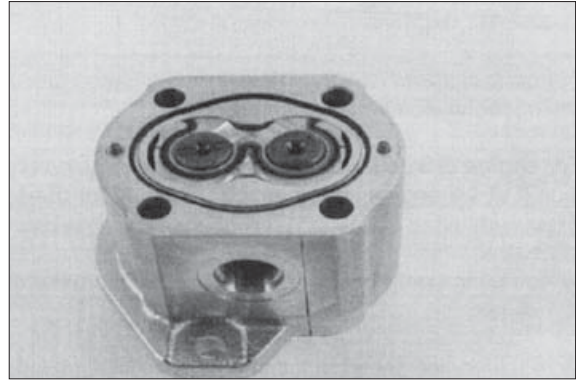
PUMP 23

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

(15) Install the two remaining dowel pins in the rear of the gear housing and place the end cover over the back of the pump.
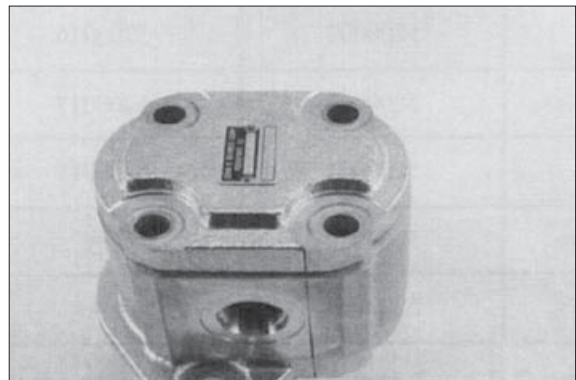
PUMP 24

(16) Install the four spacers and hexagon head bolts through the bolt holes in the end cover, hand tighten.
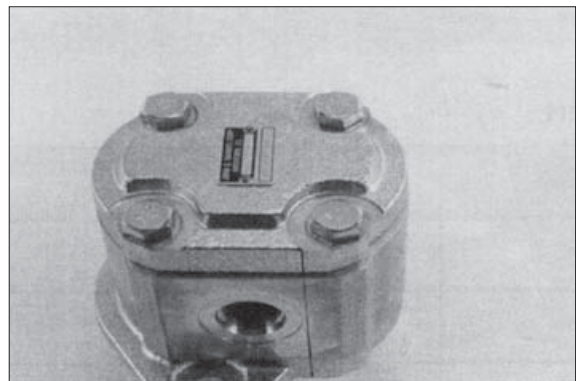
PUMP 25

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

    · Tighten torque : 6~7 kgf · m

                   (43.4~50.6 lbf · ft)

(18) Remove pump from vise.

(19) Place a small amount of clean oil in the inlet of the pump and rotate the drive shaft away from the inlet one revolution. If the drive shaft binds, disassemble the pump and check for assembly problems, then reassemble the pump.
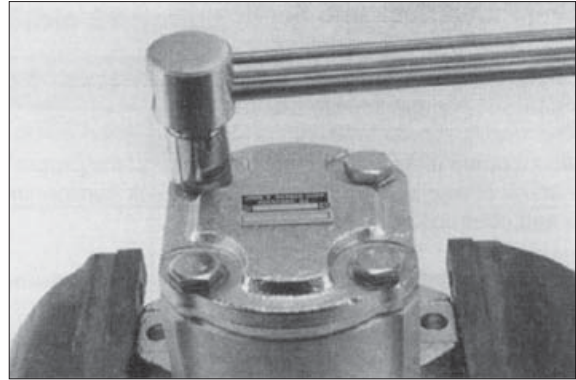
PUMP 26

2. MAIN CONTROL VALVE

Solenoid valve for lift
Lift section block
O-ring
Solenoid valve for tilt
Tilt section block
Auxiliary section block
Roll pin
Adapter
End plate
Roll pin
Adapter
Hex nut
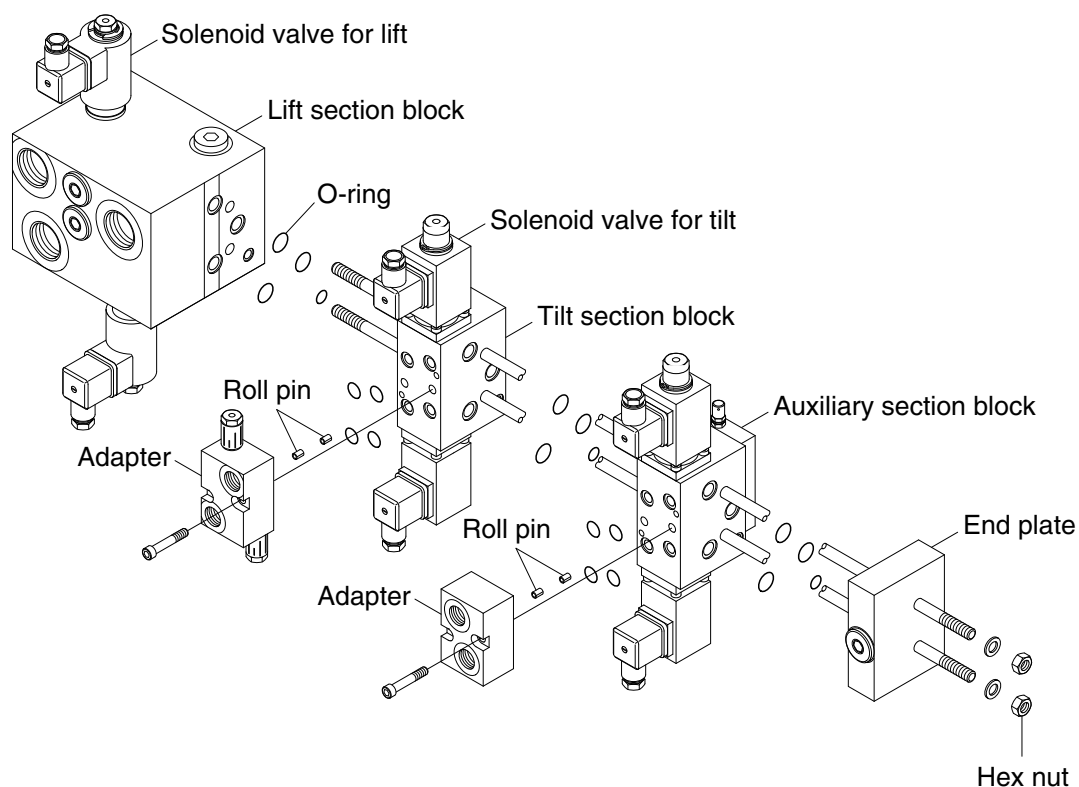
18BCS9HS34

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 mm) work surface when bolting the valve sections together.
③ Use calibrated torque wrenches and instrumentation.

(2) Block sub assembly
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 · m (16.6 lbf · ft) 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 4.1 kgf · m (29.7 lbf · ft)

② Install the O-ring, coil, O-ring and washer to the assemblied cartridge.

③ 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 1 kgf · m (7.2 lbf · ft)

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.

3. LIFT CYLINDER (TF-MAST)

1) STRUCTURE
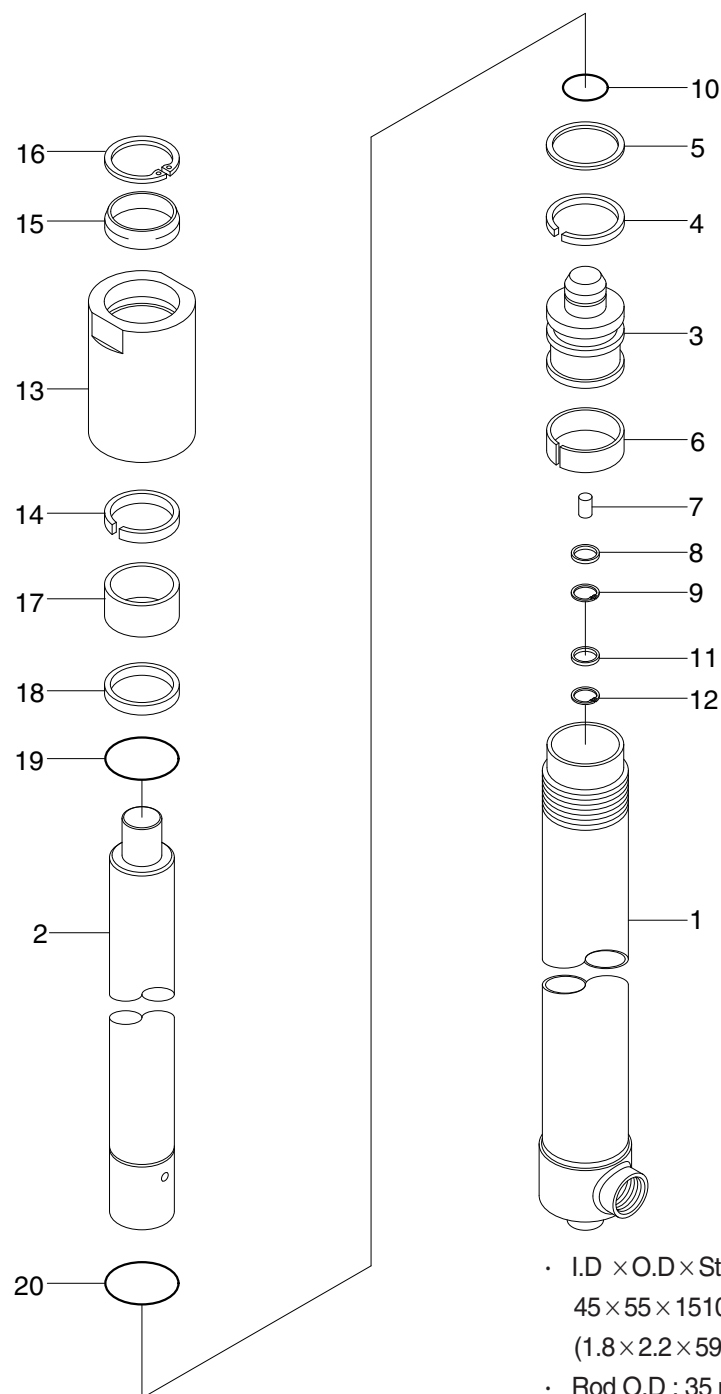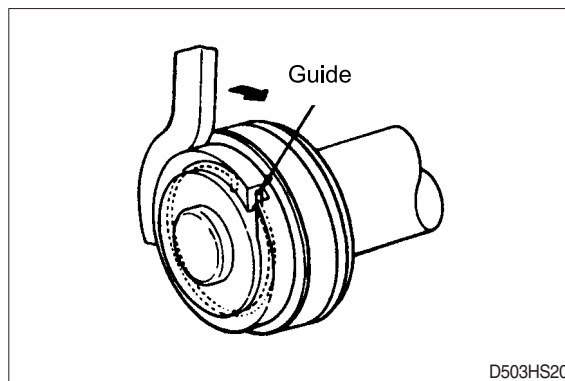
· I.D × O.D × Stroke (standard, TF470)
  45 × 55 × 1510 mm
  (1.8 × 2.2 × 59.4 in)
· Rod O.D : 35 mm (1.4 in)

18BR9HS33

|						
1	Tube assy	8	Spacer	15	Dust wiper
2	Rod	9	Retaining ring	16	Retaining ring
3	Piston	10	Stop ring	17	Rod bushing
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		

6-28

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.

D503HS20

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 ℃, 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.

D503HS21

5) TIGHTENING TORQUE

Part name	Item	Size	Torque	
			kgf · m	lbf · ft
Rod cover	13	M55×2	40±4.0	289±28.9

※ Apply loctite #242 on the thread of the bolt before tightening.

4. FREE LIFT CYLINDER (TF-MAST)

1) STRUCTURE
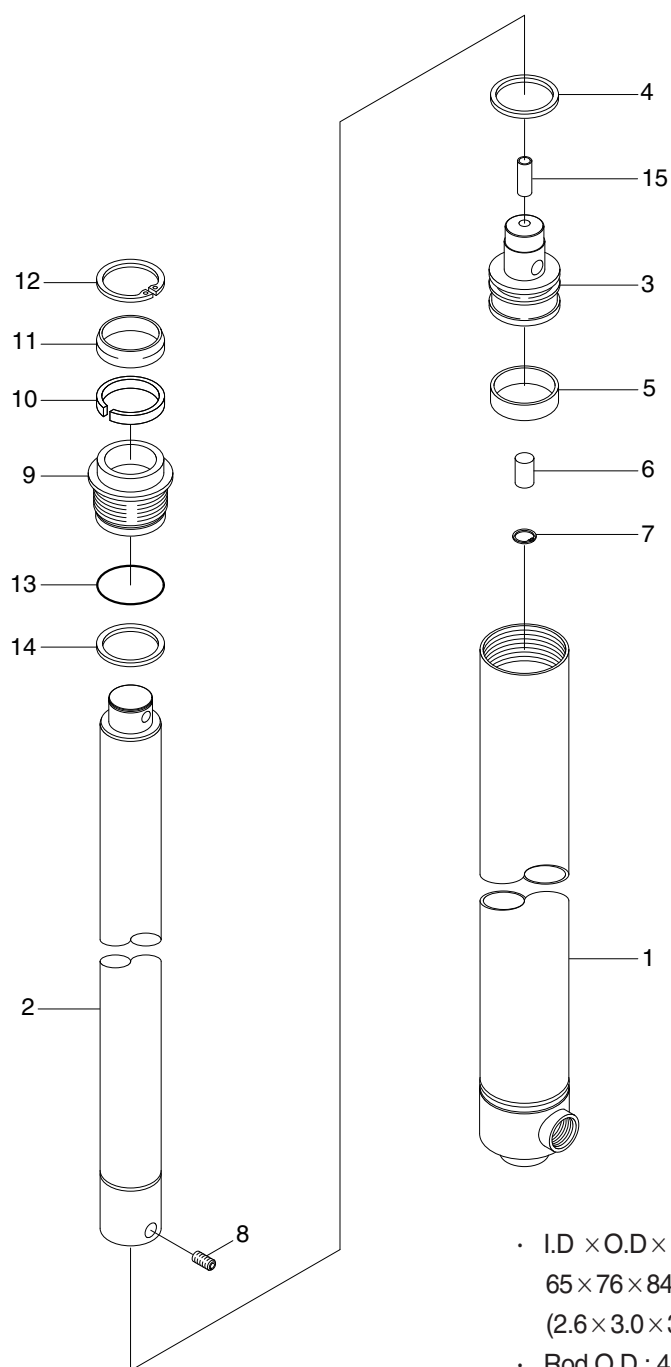
- I.D $\times$ O.D $\times$ Stroke (standard, TF470)
  $65 \times 76 \times 840$ mm
  $(2.6 \times 3.0 \times 33.1$ in)
- Rod O.D : 45 mm (1.8 in)

18BCS9HS33A

1	Tube assy	6	Check valve	11	Dust wiper
2	Rod	7	Retaining ring	12	Retaining ring
3	Piston	8	Set screw	13	O-ring
4	Piston seal	9	Grand cover	14	Back up ring
5	Wear ring	10	U-packing	15	Pipe

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.

D503HS20

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℃, 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.

D503HS21

5) TIGHTENING TORQUE

Part name	Item	Size	Torque	
			kgf · m	lbf · ft
Rod cover	9	M70×2	50±5.0	362±36.2
Pipe	15	M10×1	1.5±0.15	10.8±1.1
Set screw	8	M8×1.25	0.7±0.07	5.1±0.5

※ Apply loctite #242 on the thread of the bolt before tightening.

5. TILT CYLINDER

1) STRUCTURE
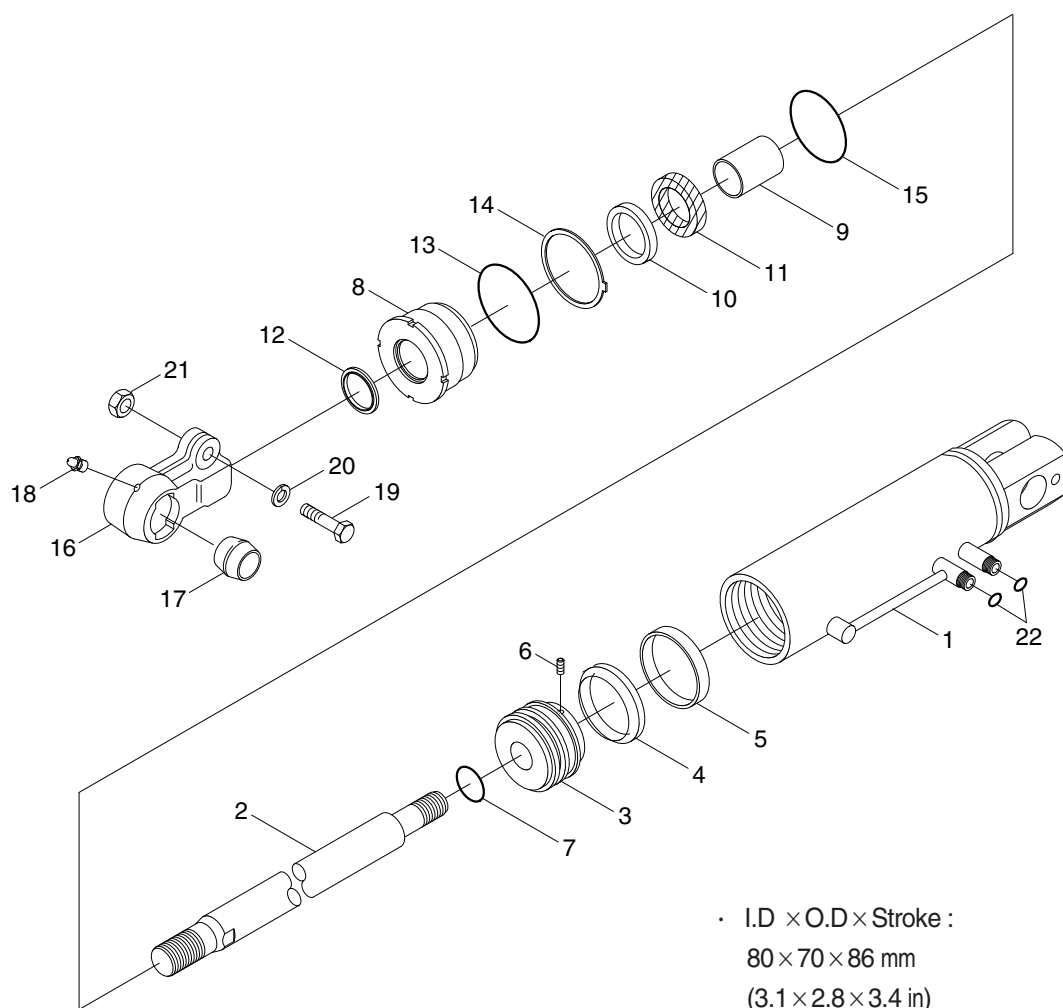
- I.D × O.D × Stroke :
  80 × 70 × 86 mm
  (3.1 × 2.8 × 3.4 in)
- Rod O.D : 30 mm (1.2 in)

18BCS9HS15

1	Tube assembly	9	Rod bushing	17	Spherical bushing
2	Rod	10	U-packing	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	Set screw	14	Back up ring	22	O-ring
7	O-ring	15	O-ring		
8	Rod cover	16	Eye		

2) DISASSEMBLY

(1) Hold the parallel parts of the cylinder tube bottom in a vice and mark the rod head end to show how much it is screwed in, then remove the rod head. Next, hook a wrench into the notch at the cylinder head and remove the cylinder head from cylinder tube.

When doing this, wind tape round the threaded part of the rod and be careful not to damage the dust seal and rod seal inside cylinder head.
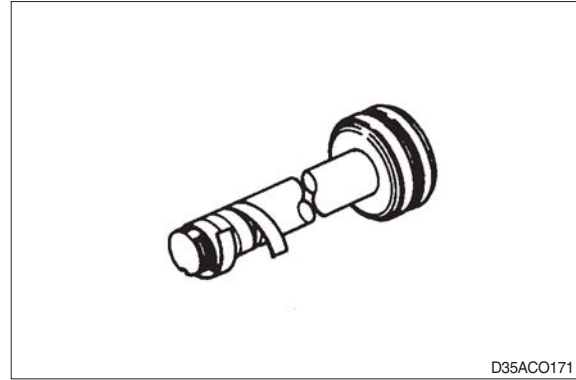
D35ACO171

3) CHECK AND INSPECTION

mm (in)

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

4) TIGHTENING TORQUE

Part name	Item	Size	Torque	
			kgf · m	lbf · ft
Rod cover	8	M75×2	40±4.0	289±28.9
Piston	3	M22×2	30±3.0	217±21.7
Set screw	6	M8×1.25	1.5±0.15	10.8±1.1

※ Apply loctite #242 on the thread of the bolt before tightening.

SECTION 7 ELECTRICAL SYSTEM

GROUP 1 COMPONENT LOCATION
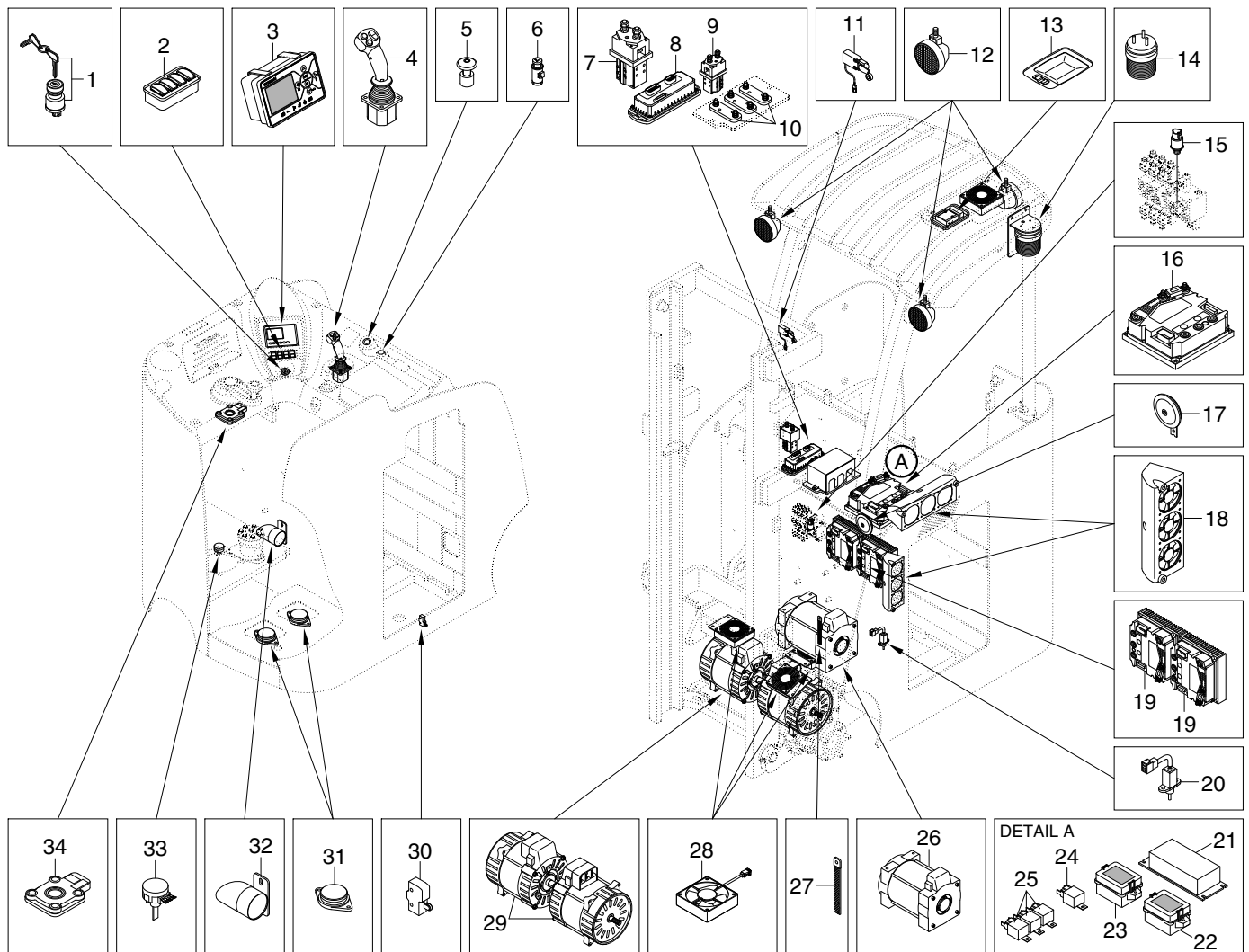
18BCS9EL01

1	Start switch	
2	Switch board	
3	Cluster	
4	Joystick	
5	Emergency switch	
6	Power socket	
7	Contactor	
8	Fingertip controller	
9	Contactor	
10	Fuse plate	
11	Speed limit switch	
12	Work lamp	
13	Room lamp	
14	Beacon lamp	
15	Pressure sensor	
16	Pump controller	
17	Horn	
18	Fan assy	
19	Traction controller	
20	Lift sensor	
21	DC-DC converter	
22	Fuse box (UL#1)	
23	Fuse box (UL#2)	
24	Relay	
25	Relay	
26	Pump motor	
27	Static strap	
28	Fan	
29	Traction motor	
30	Micro switch	
31	Seat switch	
32	Back buzzer	
33	Steering sensor	
34	Steering sensor	

FUSE BOX ASS'Y (UL #1)

F1 10A F2 5A F3 5A F4 5A F5 5A F6 5A F7 5A F8 5A F9 5A F10 5A F11 5A

EMERGENCY SWITCH
KEY S/W
EMERGENCY CONTACTOR

DC-DC CONVERTER
INPUT OUTPUT
GND (IN) GND (OUT)

HORN RELAY 133A
BACK BUZZER RELAY 133A
FWD RELAY 233

HEAD LAMP S/W
BLUE SPOT EXT
REAR WORK LAMP S/W
BEACON LAMP S/W

FAN-CONT1 80C
FAN-CONT2 80B
FAN-LH MOTOR 80D
FAN-RH MOTOR 80E
FAN-PUMP MOTOR 80H
TNR
SOCKET

ROOM LAMP S/W
FAN S/W

BACKUP BUZZER
LH LAMP-S/W RH
REAR WORK LAMP/ BLUE SPOT LAMP
LAMP-S/W
BEACON LAMP
LAMP-S/W

FAN RELAY

ROOM LAMP LH
FAN-LH
LAMP-S/W
TNR

LINE CONTACTOR
10W 300

TRACTION RIGHT ACE-2
F21 2A
A1 KEY
BRAKE S/W
A5 BRAKE
250A

RIGHT TRACTION MOTOR
U V W

TEMP SENSOR
F24 5A 396 696 A22 PTHERM
395 A23 NTHERM
F25 5A 394 694 A8 (ENCODER VCC)
392 A15 (ENCODER GND)
391 A7 (ENCODER A)
393 A14 (ENCODER B)

420 A17 PLC/PEB
ELECTRICAL BRAKE RH
09 A18 NEB
E/M SWITCH
120 01 A16 NLC
TRACTION LC COIL

97 A2 12V PPOT
STEERING SENSOR
96 A10 CPOT
06 A9 -BATT
06A A13 MODEL(MASTER)
FOOT S/W 92 A6 ENABLE (+)

TRACTION LEFT ACE-2
F22 2A
221 A1 KEY
SR S/W 95 A4 TRAVEL SR
SBR S/W 68 A5 SBR SW
250A

LEFT TRACTION MOTOR
U V W

TEMP SENSOR
F26 5A 196 496 A22 PTHERM
195 A23 NTHERM
F27 5A 194 494 A8 (ENCODER VCC)
192 A15 (ENCODER GND)
191 A7 (ENCODER A)
193 A14 (ENCODER B)
92A A6 ENABLE FOOT

SAFETY OUT A19 11 A11 SAFETY IN
SAFETY IN A11 111 A19 SAFETY OUT

CAN H A21 126 126A A21 CAN H
CAN L A20 125 126B 125A A20 CAN L
A12 CAN T

ELECTRICAL BRAKE LH 220 509 A17 PEB/FAN RELAY +
A18 NEB
A16 FAN RELAY -

PUMP INVERTER ACE-2
F23 2A
321 A1 KEY
350A

PUMP MOTOR
U V W

TEMP SENSOR
F28 5A 296 596 A22 PTHERM
295 A23 NTHERM
F29 5A 294 594 A8 (ENCODER VCC)
292 A15 (ENCODER GND)
291 A7 (ENCODER A) HORN RELAY+ A17 133
293 A14 (ENCODER B) HORN RELAY- A18 209
72A A2 12V PPOT BUZZER RELAY- A16 309
LOAD SENSING POTENTIOMETER 74 A3 CPOT SAFETY A11 04B
04 A9 -BATT LIFT CUTBACK A6 04B
TILT ANGLE POTENTIOMETER 70 A10 CPOT BATT - A9
72 A2 12V PPOT

126D A21 CAN H
126C 125C A20 CAN L

ELECTRIC FORKLIFT DISPLAY
A3 CAN-L A2 CAN-H
A4 CAN-T
A5 BATT+ 12V B7 31
A6 KEY -BATT A1 00D

JOYSTICK
3 CAN-H CAN-L 4
SHIELD 5
2 +12V - BATT 1
521

MHYRIO CB
F31 5A 421 B10
F30 2A 921 B2 PAUX
21E B1 KEY
00B B3 -BATT
00C C23 -BATT

C2 924 LIFT UP V/V
C3 901 924A LIFT DOWN V/V
C1 902
C5 925 AUX IN V/V
C4 903 925A AUX OUT V/V
C6 904
C8 926 TILT IN V/V
C7 905 926A TILT OUT V/V
C15 906
C13 929 SHIFT RIGHT V/V
C12 907 929A SHIFT LEFT V/V
C14 908

C16 24V PPOT 233
C9 24V NPOT 409
B13 CAN_H 126E
B4 CAN_L 125D

SASA SENSOR
1 CAN-H 2 CAN-L
3 KEY -BATT 4
F32 5A 331

BATT 36V

18BCS9EL02

7-2

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

15/18BCS-9
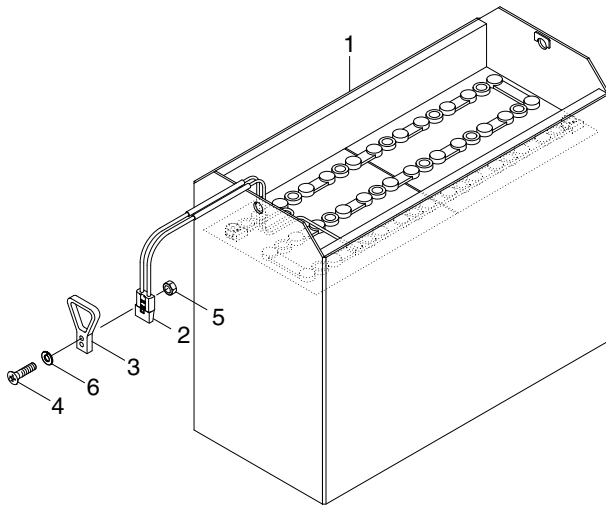
20BCS-9
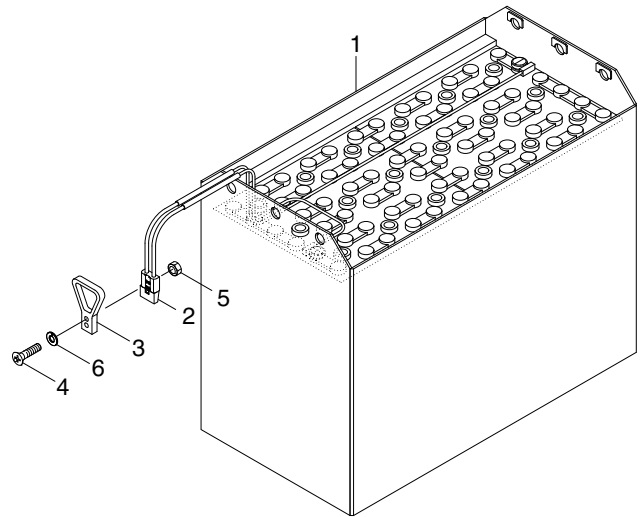
18BCS9EL03

1	Cells	4	Round head screw
2	Battery connector	5	Weld nut
3	Handle	6	Spring washer

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.

18BCS9EL04
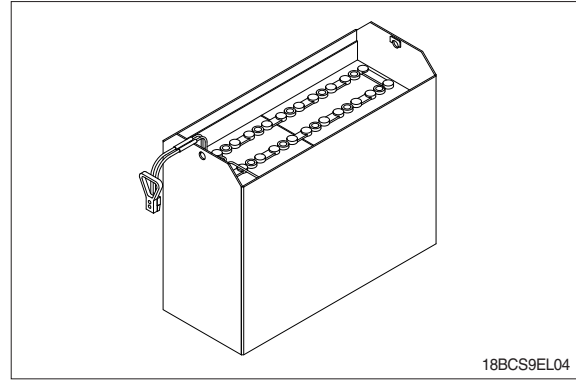
3) SPECIFICATION AND SERVICE DATA

Item	Unit	15/18BCS-9	20BCS-9
Type	–	VCJ7	VCJ8
Rated voltage	V	36	
Capacity	AH/hr	700/5	800/5
Electrolyte	–	WET	
Dimension (W×D×H)	mm	975×450×787	975×520×787
Connector	–	SB 350	
Weight	kg	1080±50	1230±50

Fully charged specific gravity	1.280 (25°C)
End of discharge specific gravity	1.130 (25°C)
Discharge end voltage	36 V
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 1.5 V.

(2) Avoid over-charge

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

(3) Avoid excessive elevation of temperature

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

6) INSTRUCTION

(1) Unpacking

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

(2) Performance and maintenance of batteries

① Initial charge

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

a. By modified constant voltage charger

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

b. By constant voltage constant current charger

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

c. By constant current charger

Connect the charger to the battery and charge the battery by $0.1C \times 5$ 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°C, and the temperature during the charge should be maintained at no higher than 55°C. (Under any unavoidable situations, it should never be above 55°C). Methods of charging vary 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 completes 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.

$$\text{Charging time} = \frac{\text{Amount of previous discharge(AH)}}{\text{Capacity of charger(A)}} + 2 \sim 3\text{(H)}$$

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 is 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.

Minimum Level

Cell cover

Float

B153EL041

Maximum Level

Cell cover

Float

B153EL042
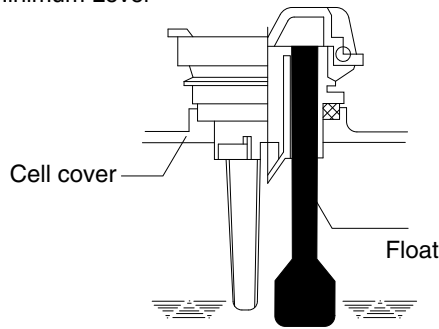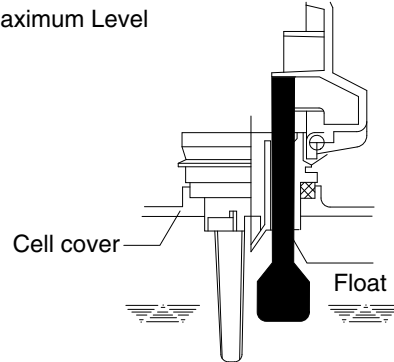
⑦ Cleaning

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 (⌀ 25 mm) from failure cell as well as all surrounding cells.

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

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

⑩ **Summary of daily maintenance**
   a. Avoid overcharge. After discharge, charge the batteries immediately. The standard frequency of equalizing charge is more than once every month.
   b. Check the electrolyte level once a week. If found decreased, replenish distilled water up to the specified level.
   c. The top surface of battery cells should be kept clean and dry.
   d. Be sure to keep open the cover of battery housing tray during charge.
   e. Never draw near open fires such as lighted cigarettes or burning matches during charge.

(3) Others

① **Storage of batteries**

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

② **Maintenance record**

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

③ **Electrolyte temperature**

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

7) TROUBLESHOOTING

Nature of trouble	Symptoms	Causes	Corrective Action
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 · Termination of connector or pole post etc.	· External impact, improper handling, excessive vibration · Excessive temperature rising or vibration/external impact	· Replace or install a new one · Replace
Sulfate	· Specific gravity drops and capacity is decreased. · Charge voltage rises rapidly with immature gassing in earlier stage but specific gravity does not rise and charge can't be carried out.	· When left in state of discharge or left long without equalizing charge. · Insufficient charge. · When electrolyte is so decreased that plate is deposed. · When concentration of electrolyte rises. · When impurities are mixed in electrolyte.	· Need equalizing charge · Need equalizing charge · Need equalizing charge · Adjust specific gravity · 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. · When left long period without refilling of water. · Short circuit.	· Replace · Refill water in regular period · Replace
Rise of specific gravity	· May be easily detected by measurement of the specific gravity.	· Diluted sulfuric acid is used in refilling. · When the electrolyte level excessively drops.	· Adjust specific gravity after full charge. · Refill distilled water.
Mixing of impurities	· Decrease of capacity. · Drop of charge and discharge voltage. · Odor of generated gas and coloring of the electrolyte.	· Metals such as iron, copper nickel and manganese. · Impurities such as sea water, chloric acid, nitric acid etc. · Filling of impure water.	· 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.

3. DRIVE MOTOR

1) STRUCTURE

UL-EE
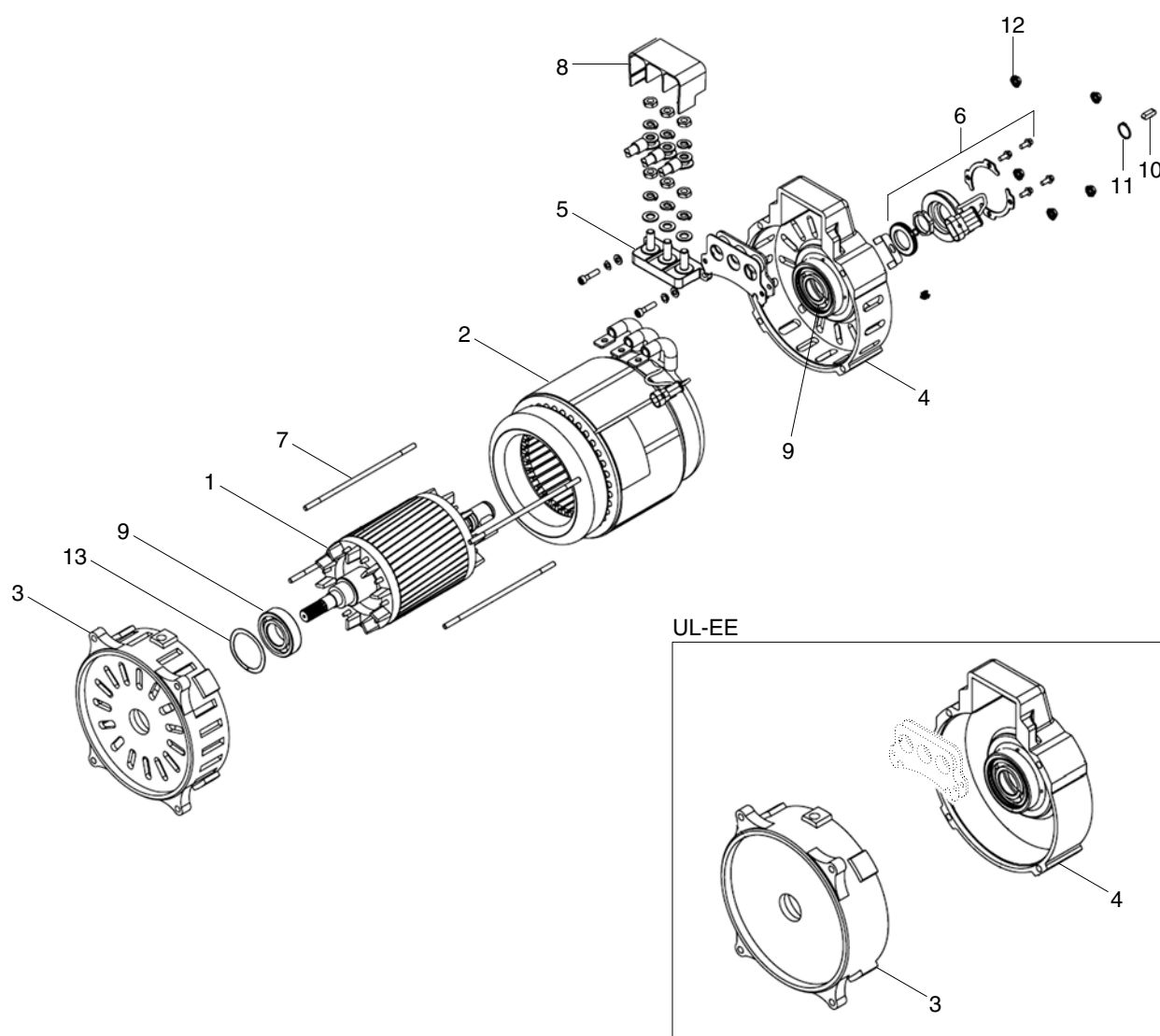
18BCS9EL06A

1	Rotor assembly	6	Speed sensor kit	11	Snap ring
2	Stator assembly	7	Stud bolt	12	Flange nut
3	Endbell de	8	Protector-terminal	13	Wave washer
4	Endbell	9	Bearing		
5	Block-terminal A	10	Sunk key		

2) SPECIFICATION

Item	Unit	15/18/20BCS-9
Type	-	AMDU6001
Rated voltage	Vac	24
Rated output	kW	4.3
Insulation	-	Class F
Speed	rpm	1750
Frequency	Hz	60

3) MAINTENANCE INSTRUCTION

(1) Inspection

① **Rotor assembly**

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 : ∅ 123.1 ± 0.05

Tool : Vernier calipers and standard tool

18BR9EL41

② **Stator assembly**

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.

Use m Ω tester and check for two power line of stator repeatedly (U-V, V-W, W-U).

At that time resistance is around 6.3 m Ω.

Insulation test

Use insulation tester (1000 Vac, Min. 10 M Ω) and measure as a picture.

If the insulation is defective, replace with new parts.
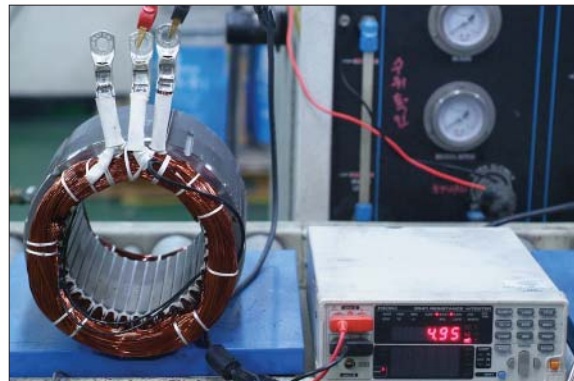
18BR9EL42
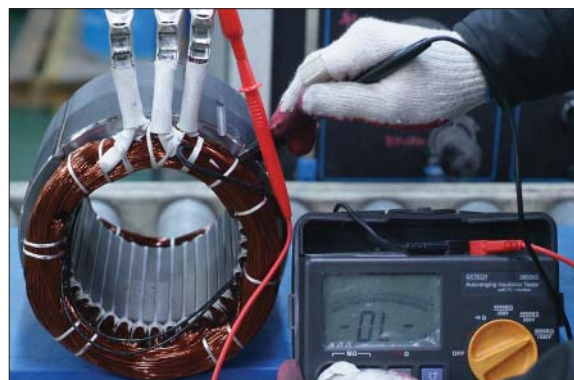
18BR9EL43

(2) Disassembly for AC motor

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

18BR9EL44

18BR9EL45

② Remove 3-nuts from terminal block of the motor to disassemble terminal block from the motor.
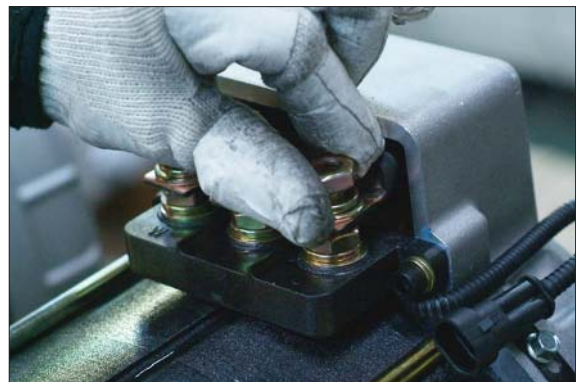
18BR9EL46

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

18BR9EL47

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

18BR9EL48

⑤ Remove endbell de and wave washer.

18BR9EL49

⑥ Remove stator assembly by hand or suitable tool.
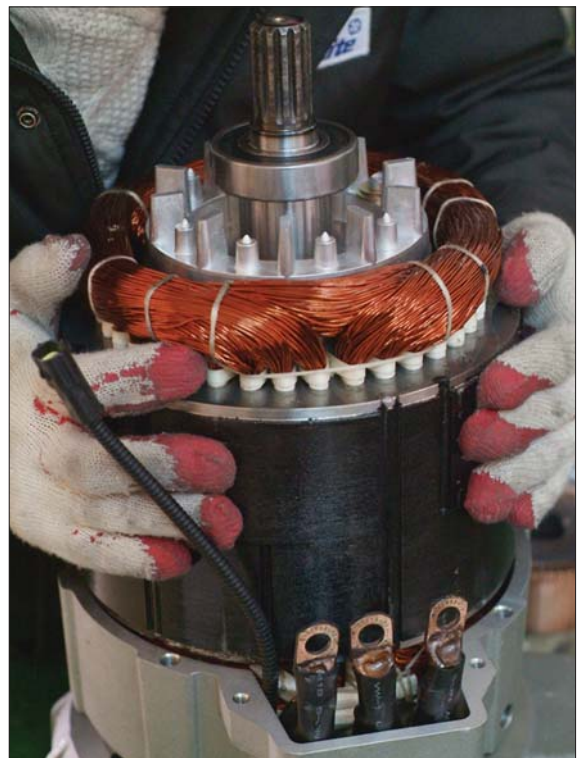
18BR9EL50

⑦ Remove endbell from rotor assembly by hand-puller as a right picture.

18BR9EL51

⑧ The motor are composed of 5-parts (rotor assembly, stator assembly, enbell de, endbell, etc).
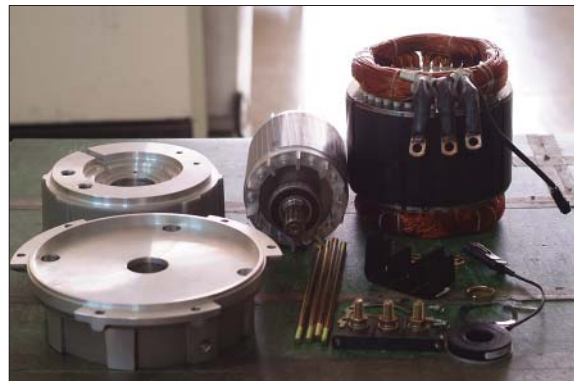
18BR9EL52

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

Clockwise rotation

Phase A

Phase B
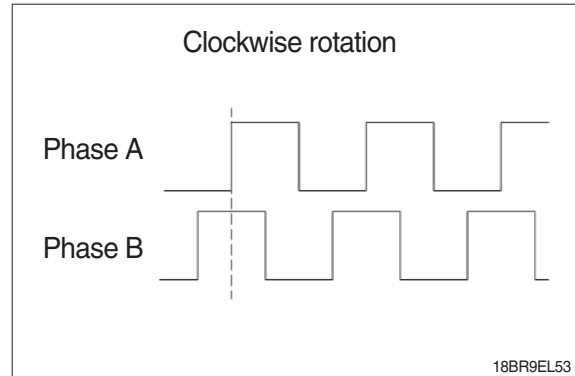
18BR9EL53

4. PUMP MOTOR

1) STRUCTURE
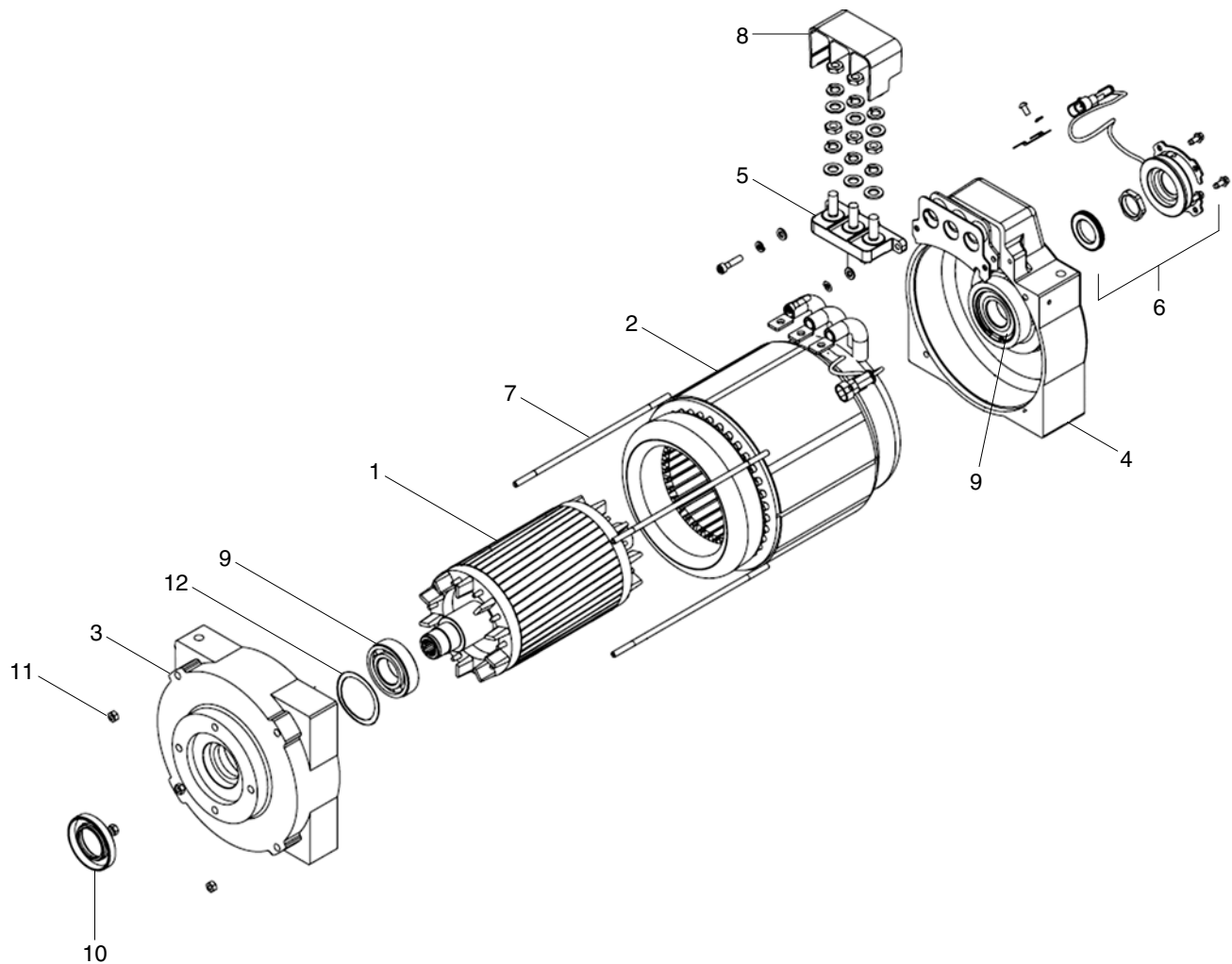
18BCS9EL16

1	Rotor assembly	5	Block-terminal A	9	Bearing
2	Stator assembly	6	Speed sensor kit	10	Oil seal
3	Endbell De	7	Stud bolt	11	Flange nut
4	Endbell	8	Protector-terminal	12	Wave washer

2) SPECIFICATION

Item	Unit	Specification
Type	-	AMBP4001
Rated voltage	Vac	24
Rated output	kW	14.0
Insulation	-	Class F
Speed	rpm	2180
Freq.	Hz	75
P.F.	-	-
Duty	%	S3-15
Voltage	V	24
Current	A	458

3) INSPECTION

(1) Rotor assembly

① 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 : ∅123.1± 0.05

Tool : Vernier calipers and standard tool

18BR9EL54

② **Stator assembly**

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.

Use m℧ tester and check for two power line of stator repeatedly (U-V, V-W, W-U).

At that time resistance is around 1.87 m℧.
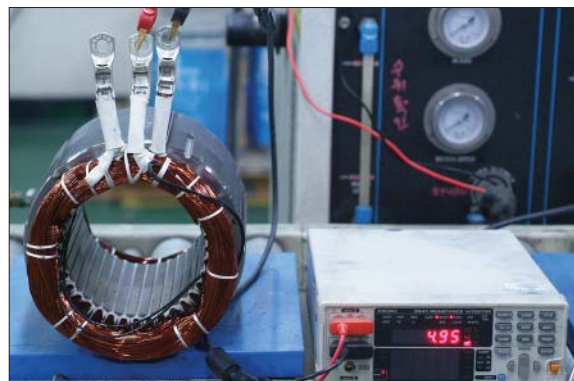
18BR9EL42

Insulation test
Use insulation tester (1000 Vac, Min. 10
MΩ) and measure as a picture.
If the insulation is defective, replace with
new parts.
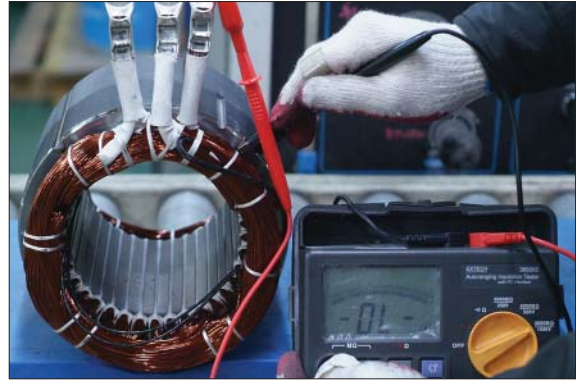
18BR9EL43

4) Disassembly for AC motor

① Before disassembling motor, remove
terminal protector from the motor and
separate thermistor and speed sensor
connectors from hanger.
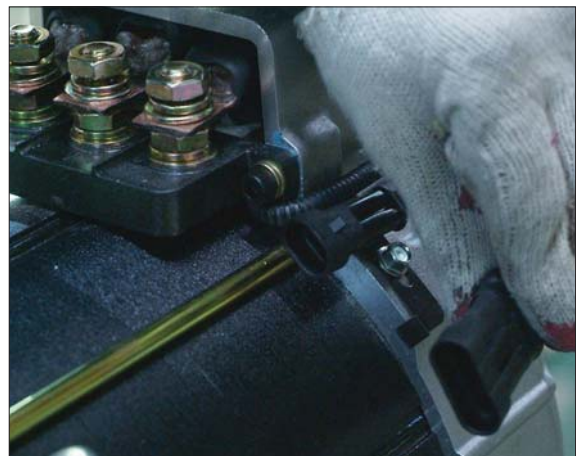
18BR9EL44

18BR9EL45

② Remove 3-nuts from terminal block of the
motor to disassemble terminal block from
the motor.
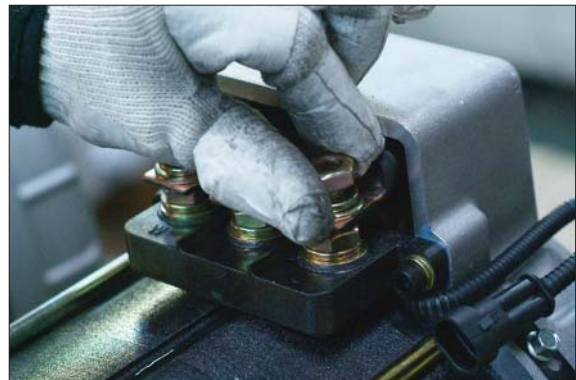
18BR9EL46

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

18BR9EL55

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

18BR9EL56

⑤ Remove endbell de and wave washer.

18BR9EL57

⑥ Remove stator assembly by hand or suitable tool.

18BR9EL58

⑦ Remove endbell from rotor assembly by hand-puller as a right picture.

18BR9EL51

⑧ The motor are composed of 5-parts (rotor assembly, stator assembly, enbell de, endbell, etc).

18BR9EL59

5) Assembly and installation
① Perform assembly in the reverse order of disassembling.
② After assembling, check for speed sensor.
Normal signal is as right.

Clockwise rotation

Phase A

Phase B
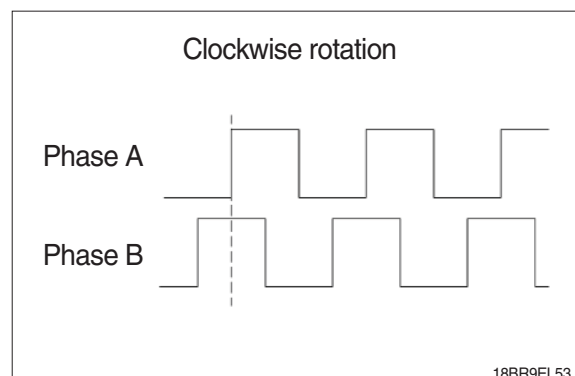
18BR9EL53

5. CONTROLLER SYSTEM

1) STRUCTURE
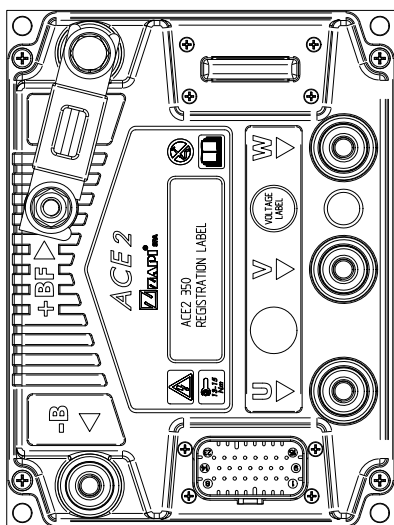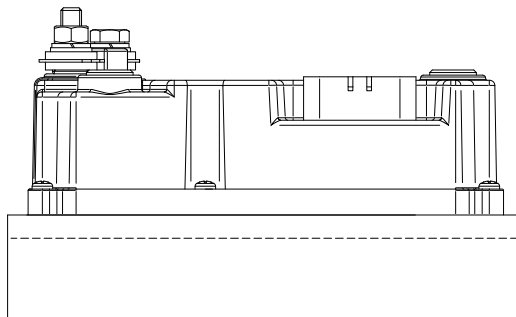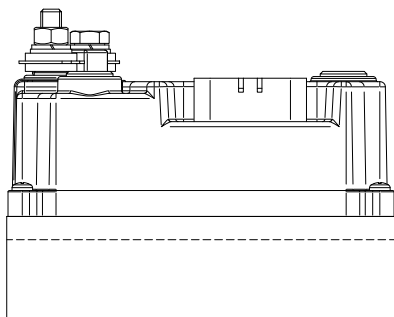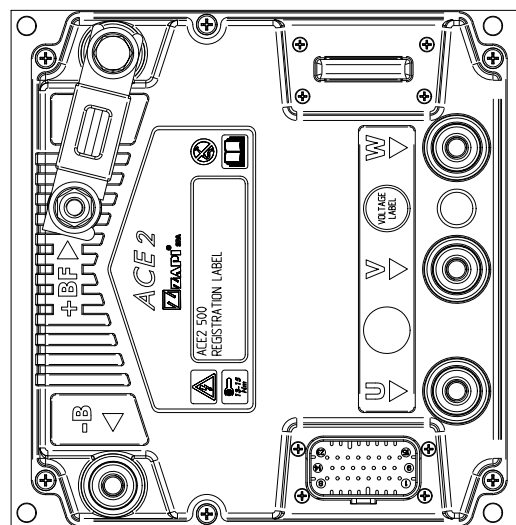
Traction controller	Pump controller

18BCS9EL11

(1) Specifications

Model	Model	Application	Type	Power	Current limit
15/18/20BCS-9	ACE2	Traction	AC	48V, 350A×2	350A/3min
	ACE2	Pump	AC	48V, 500A	500A/3min

2) OPERATIONAL FEATURES

(1) Features

① Speed control.

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

③ Electronic differential feature with torque balance between external and internal wheel.

④ Regenerative release braking based upon deceleration ramps.

⑤ Regenerative braking when the accelerator pedal is partially released (deceleration).

⑥ Direction inversion with regenerative braking based upon deceleration ramp.

⑦ Regenerative braking and direction inversion without contactors: only the main contactor is present.

⑧ Optimum sensitivity at low speeds.

⑨ Voltage boost at the start and with overload to obtain more torque (with current control).

⑩ Hydraulic steering function:
- The traction inverter sends a "hydraulic steering function" request to the pump inverter on the can-bus line.

⑪ Backing forward and reverse options are available, with the tune and the speed of the function programmable with Zapi console or buttons on a display.

⑫ High efficiency of motor and battery due to high frequency commutations.

⑬ Modification of parameters through the programming console or buttons on a display.

⑭ Internal hour-meter with values that can be displayed on the console.

⑮ Memory of the last five alarms with relative hour-meter and temperature displayed on the console.

⑯ Diagnostic function with Zapi console for checking main parameters.

⑰ Built in BDI feature.

⑱ Flash memory, software downloadable via serial link and via CANBUS.

(2) Diagnosis

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

① Diagnosis on key switch closing that checks: watchdog circuit, current sensor, capacitor charging, phase's voltages, contactor drivers, can-bus interface, if the switch sequence for operation is correct and if the output of accelerator unit is correct, correct synchronization of the two μ CS, integrity of safety related inputs hardware.

② Standby diagnosis in standby that checks: Watchdog circuit, phase's voltages, contactor driver, current sensor, can-bus interface.

③ Diagnosis during operation that checks: Watchdog circuits, contactor driver, current sensors, can-bus interface.

④ Continuous diagnosis that checks: Temperature of the inverter, motor temperature.

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

3) DESCRIPTION OF THE CONNECTORS

(1) Traction controller
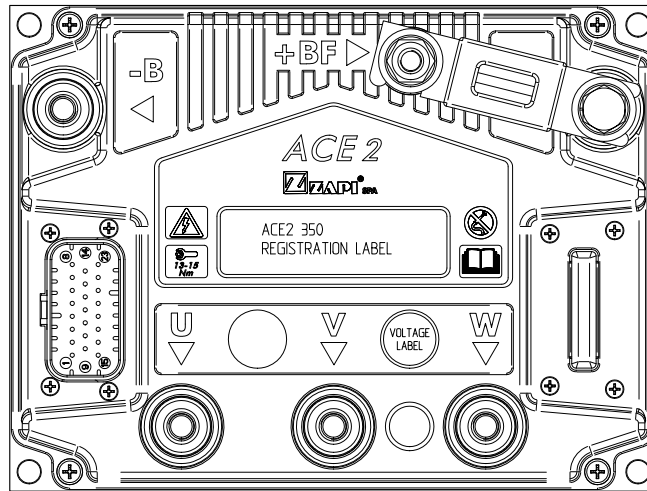
18BCS9EL11

① Master

No. of pin	Function	Description
A1	KEY	Input of the key switch signal.
A2	PPOT	Potentiometer positive for steering sensor.
A3	NA	-
A4	NA	-
A5	BRAKE	Input for brake digital input.
A6	ENABLE	Input for foot switch digital input.
A7	ENC A	Right motor encoder phase A.
A8	ENC VCC	Encoder positive power supply.
A9	- BATT	Negative power supply.
A10	CPOT	Steering sensor wiper signal.
A11	SAFETY IN	If not connected to slave A19 (safety output), the MC coil power output will be disabled.
A12	NA	-
A13	MODEL	MODE : Closed (connected with A9) - Traction master.
A14	ENC B	Right motor encoder phase B.
A15	ENC GND	Encoder negative power supply.
A16	NLC	Main contactor coil driver (drives to -Batt).

No. of pin	Function	Description
A17	PLC/PEB	Positive of main contactor coil / Electrical brake (RH).
A18	NEB	Electrical brake (RH) coil driver (drives to -Batt).
A19	SAFETY OUT	If not connected to slave A11 (safety in), the MC coil power output will be disabled.
A20	CAN L	Low level CAN-BUS voltage I/O.
A21	CAN H	High level CAN-BUS voltage I/O.
A22	PTHERM	Input for right motor temperature sensor.
A23	NTHERM	Negative of right motor temperature sensor.

Encoder installation

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

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

② Connection of encoder with open collector output ; +12V power supply.
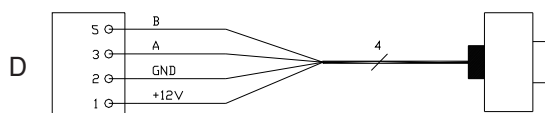
BRJ7EL26

② Slave

No. of pin	Function	Description
A1	KEY	Input of the key switch signal.
A2	NA	-
A3	NA	-
A4	TRAVEL SR	Input for travel speed reduction digital input.
A5	SBR	Input for SBR (Side Battery Removal) digital input.
A6	ENABLE FOOT	Input for foot switch digital input.
A7	ENC A	Left motor encoder phase A.
A8	ENC VCC	Encoder positive power supply.
A9	NA	-
A10	NA	-
A11	SAFETY IN	If not connected to master A19 (safety out), MC coil power output will be disabled.
A12	CAN_T	If it is connected with A21. it introduces the120 Ohm termination resistance between CAN-L and CAN-H.
A13	MODEL	MODE : open - Traction slave.
A14	ENC B	Left motor encoder phase B.
A15	ENC GND	Encoder negative power supply.
A16	NLC	Fan relay coil driver (drives to -Batt).
A17	PLC/PEB	Positive of electrical brake (LH) coil/Fan relay coil.
A18	NEB	Electrical brake (LH) coil driver (drives to -Batt).
A19	SAFETY OUT	If not connected to master A11 (safety in), MC coil power output will be disabled.
A20	CAN L	Low level CAN-BUS voltage I/O.
A21	CAN H	High level CAN-BUS voltage I/O.
A22	PTHERM	Input for left motor temperature sensor.
A23	NTHERM	Negative of left motor temperature sensor.

(2) Pump controller
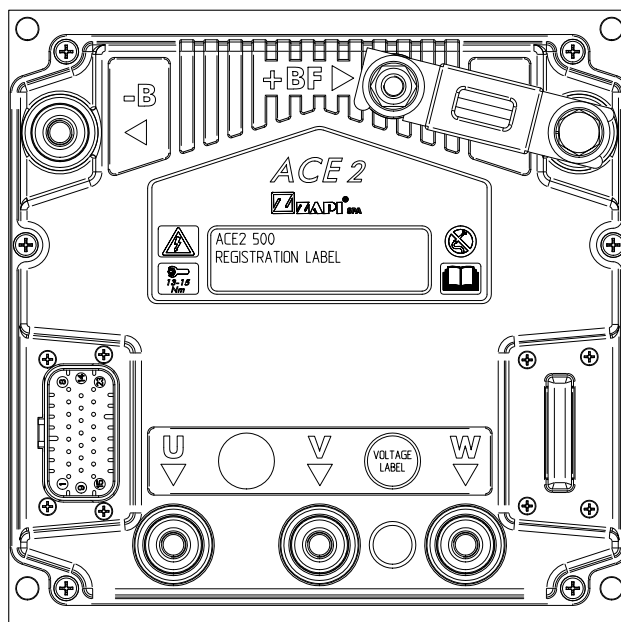
18BCS9EL11

No. of pin	Function	Description
A1	KEY	Input of the key switch signal.
A2	PPOT	Potentiometer positive for tilt angle sensor and load sensor.
A3	CPOT	Load sensor wiper signal.
A4	NA	-
A5	NA	-
A6	LIFT CUTBACK	Input for lift cutback digital input.
A7	ENC A	Pump motor encoder phase A.
A8	ENC VCC	Encoder positive power supply.
A9	- BATT	Negative power supply.
A10	CPOT	Tilt angle sensor wiper signal.
A11	SAFETY	If not connected to -Batt, the MC coil power output will be disabled.
A12	NA	-
A13	NA	-
A14	ENC B	Pump motor encoder phase B.
A15	ENC GND	Encoder negative power supply.
A16	NLC	Buzzer relay coil driver (drives to -Batt).
A17	PLC/PEB	Positive of buzzer relay coil / horn relay coil.
A18	NEB	Horn relay coil driver (drives to -Batt).

No. of pin	Function	Description
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 pump motor temperature sensor.
A23	NTHERM	Negative of pump motor temperature sensor.

4) FUNCTION CONFIGURATION

■ TRACTION CONTROLLER - MASTER

Using the CONFIG MENU of the programming console, the user can configure the following functions.

(1) Submenu "SET OPTIONS"

① **Display**
  - OFF: when display is not connected to the CAN bus.
  - ON : when display is connected to the CAN bus.

② **Seat switch**
  - HANDLE : CNA #6 is managed as tiller input (no delay when released).
  - SEAT : CNA #6 is managed as seat input (with a delay when released - debouncing function).

③ **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.

④ **Push pull**
  It determines the X & Y axle's function of Joystick.

⑤ **T. speed red**
  It decides an active or inactive of TRAVEL SPEEED REDUCTION function.

⑥ **Forward relay**
  It decides that a forward relay is present / absent.

⑦ **Battery check**
  This option specifies the handling of the low battery charge detection.
  There are four 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 ess 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.

⑧ **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.

⑨ **Aux output #1**
  BRAKE : Drives an electromagnetic brake coil.

⑩ **Steer table**

OPTION#1 is a steer table of 20BCS-9 Truck.

⑪ **Set mot. temperature**

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.

⑫ **Truck model sel**

This display model setting from traction inverter. There are 2 models. (20BCS-9 or 23BCS-9)

(2) Submenu "ADJUSTMENTS"

① **Set battery type**

It selectes the nominal battery voltage.

② **Adjust battery**

Fine adjustment of the battery voltage measured by the controller.

③ **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).

④ **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).

⑤ **Set steer 0-pos.**

This is the function to record in the controller EEPROM the steering poti output voltage when the wheels are straight.

⑥ **Set steer right**

This parameter sets the max steering angle in left direction.

⑦ **Set steer left**

This parameter sets the max steering angle in right direction.

⑧ **Throttle 0 zone**

Establishes a deadband in the accelerator input curve.

⑨ **Throttle X1 map**

This parameter changes the characteristic of the accelerator input curve.

  - Range = 0 - 100%, Resolution = 1%

⑩ **Throttle Y1 map**

This parameter changes the characteristic of the accelerator input curve.

  - Range = 0 - 100%, Resolution = 1%

⑪ **Throttle X2 map**

This parameter changes the characteristic of the accelerator input curve.

  - Range = 0 - 100%, Resolution = 1%

⑫ **Throttle Y2 map**

This parameter changes the characteristic of the accelerator input curve.

 - Range = 0 - 100%, Resolution = 1%

⑬ **Throttle X3 map**

This parameter changes the characteristic of the accelerator input curve.

 - Range = 0 - 100%, Resolution = 1%

⑭ **Throttle Y3 map**

This parameter changes the characteristic of the accelerator input curve.

 - Range = 0 - 100%, Resolution = 1%

⑮ **Bat. min adj.**

Adjust the lower level of the battery charge table (-12.8% ~ 12.7%).

⑯ **Bat. max adj.**

Adjust the upper level of the battery charge table (-12.8% ~ 12.7%).

⑰ **Bdi adj s.UP min**

Adjust the lower level of the battery charge table (-12.8% ~ 12.7%).

When the key on, this setting table is applied.

⑱ **Bdi adj s.up max**

Adjust the upper level of the battery charge table (-12.8% ~ 12.7%).

When the key on, this setting table is applied.
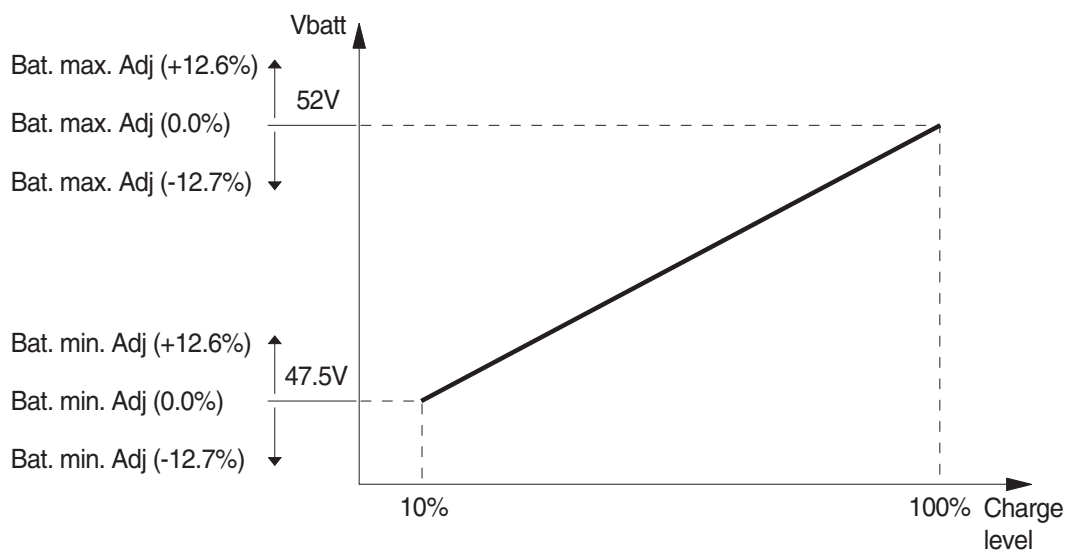
18BR9EL61

⑲ **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.

⑳ **Load HM from mdi**

Not used.

㉑ **Mainten. reset**

It determines to cancel the MAINTENANCE HOUR warning.

㉒ **Maintenance**

Setting for NONE / OPTION#1 / OPTION#2 / OPTION#3 of MAINTENANCE.

㉓ **M. pre warn time**

Time to set the maintenance pre waring time before the maintenance time.

㉔ **Maintenance time**

Time setting for the maintenance time.

㉕ **Main cont. volt**

It specifies the percentage of battery voltage supplied to MC coil to close the contactor.

㉖ **Aux output volt**

It specifies the percentage of battery voltage supplied to EB coil to apply the electro mechanic brake.

㉗ **Main cont. V rid**

It specifies the percentage of MAIN CONT VOLT parameter, supplied to MC coil to keep the contactor closed.

㉘ **Aux output V rid**

It specifies the percentage of AUX OUT VOLT parameter, supplied to EB coil to keep the electro mechanic brake applied.

㉙ **Mot high temp**

It determines the motor temperature level at which the "MOTOR HIGH TEMP" alarm is signaled.

㉚ **Motor shutdown**

It determines the motor temperature level at which the "MOTOR SHUTDOWN" alarm is signaled.

㉛ **HT mot current**

It determines the maximum current when the motor temperature is reached to the "MOTOR HIGH TEMP" setting.

㉜ **HM max speed**

It determines the maximum speed when the motor temperature is reached to the "MOTOR HIGH TEMP" setting.

㉝ **Batt. low speed**

The MAXIMUM SPEED when the battery level is calculated being less than or equal to 10% of the full charge.

㉞ **Mot. sta max curr**

It determines the maximum current when the motor is stalled.

㉟ **Batt. low current**

The MAXIMUM CURRENT when the battery level is calculated being less than or equal to 10% of the full charge.

㊱ **Speed 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

(3) Submenu "PARAMETER CHANGE"

① **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.

② **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.

③ **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.

④ **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.

⑤ **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.

⑥ **Acc prof. freq 1**

In correspondence to this frequency in [Hz] the acceleration is defined by the ACCELERATION 1 parameter.

⑦ **Acc prof. freq 2**

In correspondence to this frequency in [Hz] the acceleration is defined by the ACCELERATION 2 parameter.

⑧ **Acc prof. freq 3**

In correspondence to this frequency in [Hz] the acceleration is defined by the ACCELERATION 3 parameter.
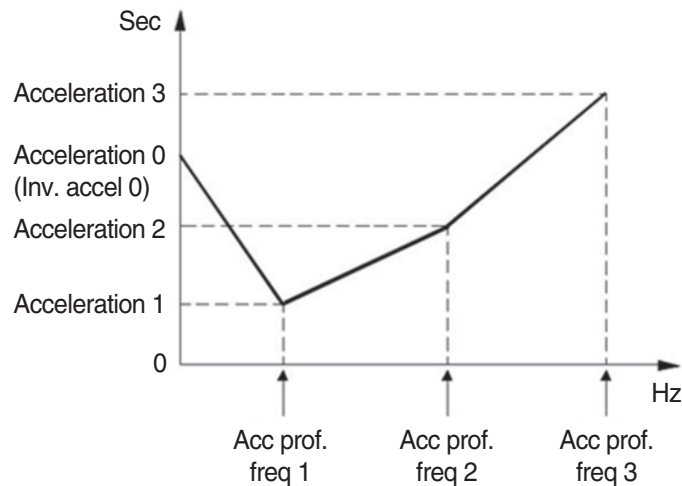
18BCS9EL14

⑨ **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 100 Hz to 0 Hz.

⑩ **Inverse 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 from 100 Hz to 0 Hz.

⑪ **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 100 Hz to 0 Hz.

⑫ **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 100 Hz to 0 Hz.

⑬ **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 100 Hz to 0 Hz.

⑭ **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 100 Hz to 0 Hz.

⑮ **Til. rel. braking**

Seconds. It controls the deceleration ramp when the tiller is released (not used).

⑯ **Enable del time**

It's a delay time for enable s/w.

⑰ **Max speed forw**

Hz. It determines the maximum speed in forward direction. When truck steer angle is in 10 degrees.

⑱ **Max speed back**

Hz. It determines the maximum speed in backward direction. When truck steer angle is in 10 degrees.

⑲ **Turtle speed**

Hz. It determines the maximum speed when turtle mode is activated.

⑳ **Travel speed red**

It determines the traction maximum speed when travel speed reduction switch is open.

㉑ **Cutback speed**

Speed reduction when the cutback switch is active.

㉒ **Steer dead angle**

It is the angle value at the speed start to reduction.

㉓ **Mid. curve. ctb**

Hz value. It determines the maximum speed when truck steer angle is over MIDDLE ANGLE.

㉔ **Middle angle**

% value. It determines the steer tire angle range be able to get MID. CURVE CTB speed. This setting value is always higher than STEER DEAD ANGLE.
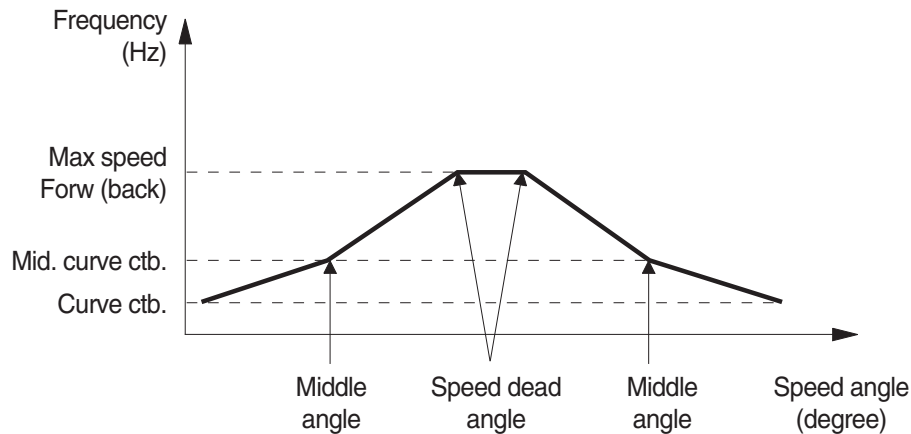
18BR9EL60

㉕ **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.

㉖ **Maximum current**

Maximum level of the current (percentage of the maximum current of the controller).

㉗ **Brk smooth**

It gives a parabolic form to the deceleration ramp.

㉘ **Stop brk smooth**

Hz. It sets the level of frequency where the smooth effect of the deceleration parabolic form ends.

㉙ **Chat time**

After no travel or pump request is active for the chat time the line contactor is utomatically opened. To restart, the operator need to press the accelerator pedal or activate the hydraulic levers.

㉚ **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.

㉛ **Rollback speed**

It determines the maximum speed for the rolling down on a slope.

㉜ **M.track speed red**

It determines the maximum speed when the MAINTENANCE is set to OPTOIN #2 or #3.

■ TRACTION CONTROLLER - SLAVE

Using the CONFIG MENU of the programming console, the user can configure the following functions.

(1) Submenu "SET OPTIONS"

① 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.

② Fan relay coil

It determines that the fan relay coil is present or abasent.

③ Cooling fan

Cooling fan installed on nearby motors and controllers will work as follows;
- OPTION #1 : Fans work always.
- OPTION #2 : Fans work in case a temperature of controller or motor exceeds a temperature set on FAN WORKING TEMP menu.
- OPTION #3 : Fans work when motors work.

④ 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.

⑤ Aux output #1

Not used

⑥ 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.
- DIGITAL : A digital (on/off) sensor for the motor temperature monitoring is connected to CNA #22 input.
- NONE : No temperature sensor is connected.

(2) Submenu "ADJUSTMENTS"

① **Set battery type**

It selectes the nominal battery voltage.

② **Adjustments battery**

Fine adjustment of the battery voltage measured by the controller.

③ **Load HM from mdi**

Not used

④ **Main cont. volt**

It specifies the percentage of battery voltage supplied to fan relay coil to apply the fan.

⑤ **Aux output volt**

It specifies the percentage of battery voltage supplied to EB coil to apply the electro mechanic brake.

⑥ **Main cont. v rid**

It specifies the percentage of MAIN CONT VOLT parameter, supplied to fan relay coil to keep the fan applied.

⑦ **Aux output v rid**

It specifies the percentage of AUX OUT VOLT parameter, supplied to EB coil to keep the electro mechanic brake applied.

(3) Submenu "PARAMETER CHANGE"

① **Maximum current**

Maximum level of the current (percentage of the maximum current of the controller).

② **Rollback speed**

It determines the maximum speed for the rolling down on a slope (decided from master controller).

③ **Fan working temp**

If COOLING FAN menu is set as option #2, this menu is used to set a temperature limitation which allows fans to work when a temperature of controller or motor exceeds the limitation.

▪ PUMP CONTROLLER

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

(1) Submenu "SET OPTIONS"

① **Seat switch**
- HANDLE : CNA #6 is managed as tiller input (no delay when released).
- SEAT : CNA #6 is managed as seat input (with a delay when released - debouncing function).

② **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.

③ **Stop on ramp**
OFF : After the truck is stopped electrobrake is closed
ON : Motor is kept in torque for AUXILIARY TIME parameter than the electrobrake is closed.

④ **Aux output #1**
BRAKE : A18 used to drive electobrake.
FREE : A18 not used.
OPTION #1 : A18 used as backward indication.

⑤ **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.
- DIGITAL : A digital (on/off) sensor for the motor temperature monitoring is connected to CNA #22 input.
- NONE : No temperature sensor is connected.

⑥ **Load sensor**
ON : Load sensing function is activated.
OFF : Load sensing function is disactivated.

⑦ **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.

⑧ **Backup function**
It decides that the back-up alarm is present or absent.

⑨ **Fork leveling**
- ON : Auto fork leveling function is not activated.
- OFF : Auto fork leveling function is activated.

⑩ **Sasa sensor**
It decides that the SASA sensor is present or absent.

⑪ **Tilt sp red func**
It decides that the tilt speed reduction function is present or absent.

(2) Submenu "ADJUSTMENTS"

① **Set battery type**

It selectes the nominal battery voltage.

② **Adjust battery**

Fine adjustment of the battery voltage measured by the controller.

③ **Throttle 0 zone**

It establishes a dead band in the lift potentiometer input curve.

④ **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.

⑤ **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.

⑥ **Main cont. volt**

It specifies the percentage of battery voltage supplied to buzzer relay coil to apply the buzzer.

⑦ **Aux output volt**

It specifies the percentage of battery voltage supplied to horn relay coil to apply the horn.

⑧ **Main cont. V rid**

It specifies the percentage of MAIN CONT VOLT parameter, supplied to buzzer relay coil to keep the buzzer applied.

⑨ **Aux output V rid**

It specifies the percentage of AUX OUT VOLT parameter, supplied to horn relay coil to keep the horn applied.

⑩ **Motor high temp**

It determines the motor temperature level at which the "MOTOR HIGH TEMP" alarm is signaled.

⑪ **Mot. shutdown temp**

It determines the motor temperature level at which the "MOTOR SHUTDOWN" alarm is signaled.

⑫ **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.

⑬ **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.

⑭ **Ref. load weight**

This parameter is used to show and configurate the reference load weight.

⑮ **Rated load w.**

This parameter is used to show and configurate the rated load weight.

⑯ **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 parameter, The TIP OVER accident can occur, which is fatal for driver' safety, so load sensor alarm will be displayed and followed by traction and pump limitation except lift down function.

* The figures in this parameter should be higher than OVERLOAD WEIGHT parameter.

⑰ **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 parameter, overload alarm and function limitation will occur accroding to OVERLOAD TYPE parameter.

* The figures in this parameter should be higher than RATED LOAD W parameter and lower than MAX LOAD WEIGHT parameter.

⑱ **Load speed upd**

For accuracy, Load Sensor only works when the pump motor speed is lower than as set in this parameter.

⑲ **Fork level min.**

This parameter is used to show and configurate the minimum voltage of fork leveling sensor output in case of tilt out fully.

⑳ **Fork level max.**

This parameter is used to show and configurate the reference voltage of fork leveling sensor output in case of tilt in fully.

⑳ **Fork lvl center**

This parameter is used to show and configurate the reference voltage of fork leveling sensor output when the fork is horizontal position.

㉑ **Fork center dead**

It sets the percentage of center dead zone from the center value, when fork leveling function is doing.

㉒ **Fork appr. range**

It sets the percentage of approach range from the center value, when fork leveling function is doing.

㉓ **Fork min speed**

It sets the motor speed reduction percentage of the set tilt speed, when fork leveling function is doing.

㉔ **Fork valve min**

It sets the percentage of tilt valve current, when fork leveling function is doing.

(3) Submenu "PARAMETER CHANGE"

① 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.

② 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.

③ 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.

④ 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.

⑤ Acc prof. freq 1

In correspondence to this frequency in [Hz] the acceleration is defined by the ACCELERATION 1 parameter.

⑥ Acc prof. freq 2

In correspondence to this frequency in [Hz] the acceleration is defined by the ACCELERATION 2 parameter.

⑦ Acc prof. freq 3

In correspondence to this frequency in [Hz] the acceleration is defined by the ACCELERATION 3 parameter.
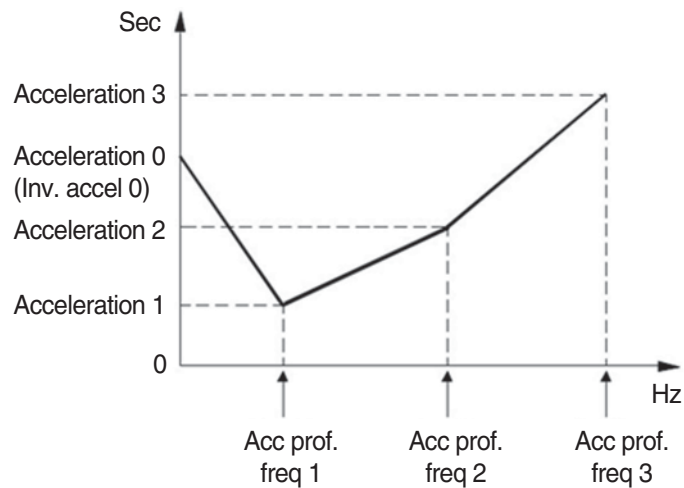
18BCS9EL14

⑧ Acc. torque del.

It determines the acceleration ramp when torque control is set to ON.

⑨ Dec. torque del.

It determines the deceleration ramp when torque control is set to ON.

⑩ 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 100 Hz to 0 Hz.

⑪ Max speed lift

It determines the pump maximum speed when lift enable switch is closed.

⑫ **Lift cutb. speed**

It determines the lifting maximum speed when the lift cutback switch is open

⑬ **1st speed coarse**

It determines the pump maximum speed when speed1 switch is closed.

⑭ **Auto fork speed**

It determines the pump speed when the automatic fork leveling function is performed.

⑮ **Tilt speed red**

It determines the tilt speed when the analog sensor output is lower than "TILT DOWN RED" or higher than "TILT UP RED" setting.

⑯ **Tilt up red**

Tilt up reduction value for tilt speed reduction.

⑰ **Tilt down red**

Tilt down reduction value for tilt speed reduction.

⑱ **2nd speed coarse**

It determines the pump maximum speed when speed2 switch is closed.

⑲ **3rd speed coarse**

It determines the pump maximum speed when speed3 switch is closed.

⑳ **Idle speed**

It determines the pump idle speed.

㉑ **Hyd speed fine**

It determines the pump maximum speed when an hydraulic steering function request is received via CAN BUS.

㉒ **Hydro speed del.**

It is the delay time after the HYD SPEED FINE request is OFF.

㉓ **Sasa sensor**

It determines the steering speed (IDLE SPEED or HYD SPEED FINE) depending on this setting.

㉔ **Batt. low speed**

The MAXIMUM SPEED when the battery level is calculated being less than or equal to 10% of the full charge.

㉕ **Batt. low current**

The MAXIMUM CURRENT when the battery level is calculated being less than or equal to 10% of the full charge.

㉖ **M. pump speed red**

It determines the maximum speed when the MAINTENANCE is set to OPTOIN#2 or #3.

㉗ **Mot. ht max speed**

It determines the maximum current when the motor temperature is reached to the "MOTOR HIGH TEMP" setting.

㉘ **Mot. ht max curre**

It determines the maximum speed when the motor temperature is reached to the "MOTOR HIGH TEMP" setting.

㉙ **Frequency creep**

Minimum speed when the lift enable switch is closed, but the accelerator is on a minimum position.

㉚ **Maximum current**

This parameter changes the maximum current of the inverter.

㉚ **Auxiliary time**

Time units value (seconds). It is the time delay before close the EM brake when motor speed reach 0 rpm.

㉛ **Rollback speed**

Not used.

㉜ **Mot. sta max curr**

It determines the maximum current when the motor is stalled.

5) PROGRAMMING & ADJUSTMENTS

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

※ Adjustments via buttons on a display, please refer to the display section. (page 7-64)

ADJUSTMENTS VIA CONSOLE (Option)

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

(1) Descriptions of console

Inverter B connector

Console connector

Display

```
1  PARAM.        IMAX       B.REVERSE
                 BRAKING    COMPENS.
                 ACCEL.     R.BRAKE
2  TESTER        MAX SP.    SPEED I
                 S.P.I      SPEED II
3  SAVE          S.P.II     SPEED III
                 BYPASS     FIELD WEAK...
4  RESTORE
                 I MOT      V.POT.
5  ALARMS        TEMP.      V.BATT.
                 V.MOT      VMN.MOT.
6  ACCELERATOR   M.SW.TEST

7  MOTOR DATA
```

Buttons

↑	1		3		5	↑
	ROLL		ENTER		SET	
	ROLL		OUT		SET	
↓	2		4		6	↓

20B7EL15

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

(2) Description of standard console menu

① Traction controller - master

```
                                        ┌──────────────┐
                                        │   HEADING    │
                                        └──────────────┘
                    ┌──────────────┐
                    │  MAIN MENU   │
                    └──────────────┘
```

PARAMETER CHANGE		
ACCELERATION 0	Sec	
INV. ACCEL 0	Sec	
ACCELERATION 1	Sec	
ACCELERATION 2	Sec	
ACCELERATION 3	Sec	
ACC PROG. FREQ 1	Hz	
ACC PROG. FREQ 2	Hz	
ACC PROG. FREQ 3	Hz	
RELEASE BRAKING	Sec	
INVERS. BRAKING	Sec	
DECEL. BRAKING	Sec	
PEDAL BRAKING	Sec	
SPEED LIMIT BRK	Sec	
CURVE BRAKING	Sec	
TIL. REL. BRAKING	Sec	
ENABLE DEL. TIME	Sec	
MAX SPEED FORW	Hz	
MAX SPEED BACK	Hz	
TURTLE SPEED	Hz	
TRAVEL SPEED RED	Sec	
CUTBACK SPEED	Sec	
SPEER DEAD ANGLE	%	
MID. CURVE CTB.	%	
MIDDLE ANGLE	%	
FREQUENCY CREEP	Hz	
MAXIMUM CURRENT	%	
BRK SMOOTH	Sec	
STOP BRK SMOOTH	Hz	
CHAT TIME	Sec	
AUXILIARY TIME	Sec	
ROLLBACK SPEED	Sec	
M. TRAC SPEED RED	Sec	

TESTER	
BATTERY VOLTAGE	V
MOTOR VOLTAGE	%
FREQUENCY	Hz
ENCODER	Hz
SLIP VALUE	Hz
CURRENT RMS	A
ID FILTERED RMS	A
IQ FILTERED RMS	A
MOTOR POWER	-
FLUX MILLIWB	Wb
MOTION TORQUE	Nm
BATTERY CHARGER	℃
TEMPERATURE	℃
MOTOR TEMPERAT.	V
ACCELERATOR	ON/OFF
HANDLE/SEAT	SW
FORWARD SWITCH	ON/OFF
BACKWARD SWITCH	ON/OFF
BRAKE SWITCH	ON/OFF
CUTBACK SWITCH	ON/OFF
CUTBACK SWITCH 2	ON/OFF
HAND BRAKE	ON/OFF
STEER ANGLE	°
INT WHEEL CUTB	-
2ND HOURMETERS	H
THROTTLE X AXIS	-
THROTTLE Y AXIS	-
I REDUCTION	%

SAVE PARAMETER

RESTORE PARAMETER

ALARMS	
	CODE.
	h, N, ° C

PROGRAM VACC	
	VACC SETTING MIN/MAX

SET MODEL	
	CONNECTED TO 2

SET OPTIONS	
DISPLAY	ON/OFF
SEAT SWITCH	HANDLE/SEAT
HOUR COUNTER	RUNNING/KEY ON
BATTERY CHECK	LEVEL 0/1/2/3
PUSH PULL	X/Y
T. SPEED RED ACT/INACT	ACT/INACT
FORWARD RELAY PRESENT	FRESENT/ABSENT
STOP ON RAMP	ON/OFF
AUX OUTPUT #1	BRAKE
STEER TABLE	OPTION #1
SET MOT. TEMPERAT	ANALOG/DIGITAL/NONE
TRUCK MODEL SEL	20/23BCS-9

ADJUSTMENTS	
SET BATTERY TYPE	V
ADJUST BATTERY	V
MAX STEER RIGHT	V
MAX STEER LEFT	V
SET STEER 0 POS.	V
SET STEER RIGHT	°
SET STEER LEFT	°
THROTTLE 0 ZONE	%
THROTTLE X1 MAP	%
THROTTLE Y1 MAP	%
THROTTLE X2 MAP	%
THROTTLE Y2 MAP	%
THROTTLE X3 MAP	%
THROTTLE Y3 MAP	%
BAT. MIN ADJ.	%
BAT. MAX ADJ.	%
BDI ADJ S. UP MIN	%
BDI ADJ S. UP MAN	%
ADJUSTMENT #03	%
LOAD HM FROM MDI	NOT USED
MAINTEN RESET	-
MAINTENANCE	NONE/OPTION #1/#2/#3
M. PRE WARN TIME	H
MAINTENANCE TIME	H
MAIN CONT. VOLT	%
AUX OUTPUT VOLT	%
MAIN CONT. V RID	%
AUX OUTPUT V RID	%
MOT HIGH TEMP	℃
MOTOR SHUTDOWN	℃
HT MOT CURRENT	A
HM MAX SPEED	-
BATT. LOW SPEED	-
MOT. STA MAX CURR	A
BATT. LOW CURRENT	A
SPEED FACTOR	-

② Traction controller - slave

```
                                    ┌──────────────────┐
                                    │     HEADING      │
                    ┌──────────────┐└──┬────────────┬──┘
                    │  MAIN MENU   ├───┘            │
                    └──────────────┘                │
                                                    │
┌──────────────┐  ┌─────────────────────────┐  ┌──────────────┐  ┌──────────────────────────────┐
│  PARAMETER   ├──│ MAXIMUM CURRENT      %  │  │  SET MODEL   ├──│       CONNECTED TO 2         │
│   CHANGE     │  │ ROLLBACK SPEED       -  │  └──────────────┘  └──────────────────────────────┘
└──────────────┘  │ FAN WORKING TEMP    ℃  │
                  └─────────────────────────┘  ┌──────────────┐  ┌──────────────────────────────────┐
                                               │  SET OPTIONS ├──│ HOUR COUNTER     RUNNING/KEY ON  │
┌──────────────┐  ┌─────────────────────────┐  └──────────────┘  │ FAN RELAY COIL   PRESENT / ABSENT│
│    TESTER    ├──│ BATTERY VOLTAGE      V  │                    │ COOLING FAN      OPTION #1 / #2 / #3│
└──────────────┘  │ MOTOR VOLTAGE        %  │                    │ STOP ON RAMP     ON/OFF          │
                  │ FREQUENCY            Hz │                    │ AUX OUTPUT #1    NOT USED        │
                  │ ENCODER              Hz │                    │ SET MOT.TEMPERAT NONE/DIGITAL/ANALOG│
                  │ SLIP VALUE           Hz │                    └──────────────────────────────────┘
                  │ CURRENT RMS          A  │
                  │ ID FILTERED RMS      A  │  ┌──────────────┐  ┌──────────────────────────────────┐
                  │ IQ FILTERED RMS      A  │  │ ADJUSTMENTS  ├──│ SET BATTERY TYPE    V           │
                  │ MOTOR POWER          -  │  └──────────────┘  │ ADJUST BATTERY      V           │
                  │ FLUX MILLIWB         Wb │                    │ LOAD HM FROM MDI    NOT USED    │
                  │ MOTION TORQUE        Nm │                    │ MAIN CONT. VOLT     %           │
                  │ TEMPERATURE          ℃ │                    │ AUX OUTPUT VOLT     %           │
                  │ MOTOR TEMPERAT.      V  │                    └──────────────────────────────────┘
                  │ HANDLE / SEAT SW     ON/OFF│
                  │ CUTBACK SWITCH       ON/OFF│
                  │ 2ND HOURMETERS       H  │
                  │ I REDUCTION          %  │
                  └─────────────────────────┘
┌──────────────┐
│     SAVE     │
│  PARAMETER   │
└──────────────┘
┌──────────────┐
│   RESTORE    │
│  PARAMETER   │
└──────────────┘
┌──────────────┐  ┌──────────────────────────┐
│    ALARMS    ├──│          CODE.           │
└──────────────┘  │        h, N, ℃          │
                  └──────────────────────────┘
┌──────────────┐  ┌──────────────────────────┐
│ PROGRAM VACC ├──│  VACC SETTING MIN/MAX    │
└──────────────┘  └──────────────────────────┘
```

③ Pump controller

```
                              ┌─────────────┐
                              │   HEADING   │
                              └─────────────┘
              ┌─────────────┐
              │  MAIN MENU  │
              └─────────────┘
```

PARAMETER CHANGE		
ACCELERATION 0	Sec	
ACCELERATION 1	Sec	
ACCELERATION 2	Sec	
ACCELERATION 3	Sec	
ACC PROF.FREQ 1	Hz	
ACC PROF.FREQ 2	Hz	
ACC PROF.FREQ 3	Hz	
ACC. TORQUE DEL.	%	
DEC. TORQUE DEL.	%	
RELEASE BRAKING	Sec	
MAX SPEED LIFT	Hz	
LIFT CUTB. SPEED	Hz	
1ST SPEED COARSE	Hz	
AUTO FORK SPEED	Hz	
TILT SPEED	Hz	
TILT UP RED	-	
TILT DOWN RED	-	
2ND SPEED COARSE	Hz	
3RD SPEED COARSE	Hz	
IDLE SPEED	Hz	
HYD SPEED FINE	Hz	
HYDRO SPEED DEL.	Sec	
SASA SENSOR	Hz	
BATT. LOW SPEED	Hz	
BATT.LOW CURRENT	A	
M.PUMP SPEED RED	Hz	
MOT.HT MAX SPEED	A	
MOT.HT MAX CURRE	-	
FREQUENCY CREEP	Hz	
MAXIMUM CURRENT	%	
AUXILIARY TIME	Sec	
ROLLBACK SPEED	Not used	
MOT.STA MAX CURR	A	

TESTER	
BATTERY VOLTAGE	V
MOTOR VOLTAGE	%
FREQUENCY	Hz
ENCODER	Hz
SLIP VALVE	Hz
CURRENT RMS	A
ID FILTERED RMS	A
IQ FILTERED RMS	A
MOTOR POWER	-
FLUX MILLIWB	Wb
MOTION TORQUE	Nm
TEMPERATURE	°C
MOTOR TEMPERAT.	°C
HANDLE/SEAT SW.	ON/OFF
LIFTING SWITCH	ON/OFF
CUTBACK SWITCH	ON/OFF
HYDRO SPEED REQ.	ON/OFF
FORK LEVEL BUT	ON/OFF
TILT POT	V / %
2ND HOURMETERS	h
LOAD WEIGHT	kg
LIFT/LOW REQUEST	%
TILT REQUEST	%
SHIFT REQUEST	%
AUX REQUEST	%
HORN BUTTON JOY.	ON/OFF
SHIFT BUTTON JOY	ON/OFF
AUX BUTTON JOY.	ON/OFF
LOWER SWITCH	ON/OFF
AUX IN SWITCH	ON/OFF
AUX OUT SWITCH	ON/OFF
TILT UP SWITCH	ON/OFF
TILT DW SWITCH	ON/OFF
SHIFT R SWITCH	ON/OFF
SHIFT L SWITCH	ON/OFF
G AXIS JOYSTICK	-
Y AXIS JOYSTICK	-
X AXIS JOYSTICK	-
MODE SELECT	-
TRUCK MODEL SEL.	20/23

SAVE PARAMETER

RESTORE PARAMETER

ALARMS	CODE. h, N, °C

PROGRAM VACC	VACC SETTING MIN/MAX

SET MODEL	CONNECTED TO 2

SET OPTIONS	
SEAT SWITCH	HANDLE / SEAT
HOUR COUNTER	RUNNING / KEYON
STOP ON RAMP	ON/OFF
AUX OUTPUT #1	BRAKE / FREE / OPT#1
SET MOT. TEMPERA	ANALOG / DIGITAL / NONE
LOAD SENSOR	ON/OFF
OVERLOAD TYPE	NONE / OPTION #1/#2
BACKUP FUNCTION	PRESENT / ABSENT
FORK LEVELING	ON / OFF
SASA SENSOR	PRESENT / ABSENT
TILT SP RED FUNC	PRESENT / ABSENT

ADJUSTMENTS	
SET BATTERY TYPE	V
ADJUST BATTERY	V
THROTTLE 0 ZONE	%
THROTTLE X POINT	%
THROTTLE Y POINT	%
MAIN CONT. VOLT	%
AUX OUTPUT VOLT	%
MAIN CONT. V RID	%
AUX OUTPUT V RID	%
MOTOR HIGH TEMP	°C
MOT.SHUTDOWN TEM	°C
ADJ MIN LOAD	V
ADJ REF LOAD	V
REF. LOAD WEIGHT	kg
RATED LOAD W.	kg
MAX LOAD WEIGHT	kg
OVERLOAD WEIGHT	kg
LOAD SPEED UPD	-
FORK LEVEL MIN.	V
FORK LEVEL MAX.	V
FORK LVL CENTER	V
FORK CENTER DEAD	%
FORK APPR. RANGE	%
FORK MIN SPEED	%
FORK VALVE MIN	%

(3) Description of ALARMS menu

The microprocessor in the controller records the last five alarms that have occurred. Items remembered relative to each alarm are: the code of the alarm, the number of times the particular Alarm occurred, the hour meter count, and the inverter temperature.

This function permits a deeper diagnosis of problems as the recent history can now be accessed. Flow chart showing how to use the ALARMS function via the digital console.

① Opening Zapi display.

② Press ENTER to go into the general menu.

③ The display will show:

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

⑤ The display shows:

⑥ Press ENTER to go into the ALARMS function.

⑦ The display will show the most recent alarm.

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

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

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

⑪ The display will ask "CLEAR LOGBOOK?".

⑫ Press ENTER for yes, or OUT for NO.

⑬ Press OUT to return to the opening Zapi display.

```
        AC2 HY V0.0
       48V 450A 00000

        MAIN MENU
     PARAMETER CHANGE

        MAIN MENU
         ALARMS

          CODE
      00005 #02 20°C

          CODE
      00007 #03 18°C

      CLEAR LOGBOOK?
     YES=ENTER NO=OUT
```

BRJ7EL23

7-48
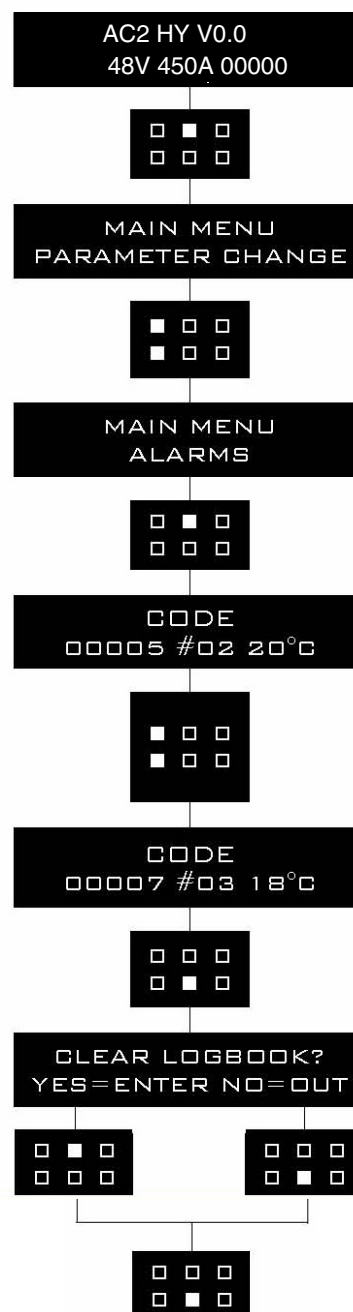
6) TESTER MENU (IN DISPLAY, MONITORING MENU)

(1) Traction controller - master

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

① **Battery voltage**

Voltage value with 1 decimal digit. Battery voltage value measured at the key on.

② **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.

③ **Frequency**

Hz value. This is the frequency of the sine waves the inverter is supplying.

④ **Encoder**

Hz value. This is the speed of the motor measured with the encoder and expressed in the same unit of the FREQUENCY reading.

⑤ **Slip value**

Hz value. This is the slip between the frequency and the speed of the motor (SLIP VALUE = FREQUENCY-ENCODER).

⑥ **Current RMS**

Ampere value. Root Mean Square value of the line current in the motor.

⑦ **ID filtered RMS**

Ampere value. Root Mean Square value of the current in d axle.

⑧ **IQ filtered RMS**

Ampere value. Root Mean Square value of the current in q axle.

⑨ **Motor power**

It is the power provided to the motor.

⑩ **Flux milliwb**

Wb value. Estimated flux into the motor.

⑪ **Motion torque**

Nm value. Estimated motion torque value.

⑫ **Battery charge**

Percentage value. It supplies the residual charge of the battery as a percentage of the full charge level.

⑬ **Temperature**

°C value. This is the temperature of the master inverter heatsink. This temperature is used for the HIGH TEMPERATURE alarm detection.

⑭ **Motor temperature**

°C value. This is the temperature of the right 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.

⑮ **Accelerator**

From 0.0V to 5.0V. ACCELERATOR reading is in the range 0.0 to 5.0Vdc.

⑯ **Handle / seat SW.**

ON/OFF. This is the status of handle/seat switch.

⑰ **Forward switch**

ON/OFF. This is the status of forward signal.

⑱ **Backward switch**

ON/OFF. This is the status of backward signal.

⑲ **Brake switch**

ON/OFF. This is the status of pedal brake switch.

⑳ **Cutback switch**

ON/OFF. This is the status of cutback switch.

㉑ **Cutback switch 2**

ON/OFF. This is the status of cutback switch 2.

㉒ **Handbrake**

ON/OFF. This is the status of pedal handbrake switch from display.

㉓ **Steer angle**

° value. This is the angle of the steering wheel.

㉔ **Int wheel cutb.**

This is the indication of the speed reduction applied to the internal wheel; in other words, it shows the ratio of the two speeds.

㉕ **2nd hourmeters**

This parameter displays the working hour of master controller.

㉖ **Throttle X axis**

Value of the X axis set point sent from the joystick to zapi controller.

㉗ **Throttle Y axis**

Value of the Y axis set point sent from the joystick to zapi controller.

㉘ **I reduction**

Percentage of the maximum current that can be applied to the motor.

(2) Traction controller - slave

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

① **Battery voltage**

Voltage value with 1 decimal digit. Battery voltage value measured at the key on.

② **Motor voltage**

Percentage value. It is the voltage generated by the inverter expressed in percent of the actual battery voltage.

③ **Frequency**

Hz value. This is the frequency of the sine waves the inverter is supplying.

④ **Encoder**

Hz value. This is the speed of the motor measured with the encoder and expressed in the same unit of the FREQUENCY reading.

⑤ **Slip value**

Hz value. This is the slip between the frequency and the speed of the motor.

⑥ **Current RMS**

Ampere value. Root Mean Square value of the line current in the motor.

⑦ **ID filtered RMS**

Ampere value. Root Mean Square value of the current in d axle.

⑧ **IQ filtered RMS**

Ampere value. Root Mean Square value of the current in q axle.

⑨ **Motor power**

It is the power provided to the motor.

⑩ **Flux milliwb**

Wb value. Estimated flux into the motor.

⑪ **Motion torque**

Nm value. Estimated motion torque value.

⑫ **Temperature**

°C value. This is the temperature of the master inverter heatsink. This temperature is used for the HIGH TEMPERATURE alarm detection.

⑬ **Motor temperature**

°C value. This is the temperature of the right 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.

⑭ **Handle / seat SW.**

ON/OFF. This is the status of handle/seat switch.

⑮ **Cutback switch**

ON/OFF. This is the status of cutback switch.

⑯ **2nd hourmeters**

This parameter displays the working hour of slave controller.

⑰ **I reduction**

Percentage of the maximum current that can be applied to the motor

(3) Pump controller

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

① **Battery voltage**

Voltage value with 1 decimal digit. Battery voltage value measured at the key on.

② **Motor voltage**

Percentage value. It is the voltage generated by the inverter expressed in percent of the actual battery voltage.

③ **Frequency**

Hz value. This is the frequency of the sine waves the inverter is supplying.

④ **Encoder**

Hz value. This is the speed of the motor measured with the encoder and expressed in the same unit of the FREQUENCY reading.

⑤ **Slip value**

Hz value. This is the slip between the frequency and the speed of the motor (SLIP VALUE = FREQUENCY-ENCODER).

⑥ **Current RMS**

Ampere value. Root Mean Square value of the line current in the motor.

⑦ **ID filtered RMS**

Ampere value. Root Mean Square value of the current in d axle.

⑧ **IQ filtered RMS**

Ampere value. Root Mean Square value of the current in q axle.

⑨ **Motor power**

It is the power provided to the motor.

⑩ **Flux milliwb**

Wb value. Estimated flux into the motor.

⑪ **Motion torque**

Nm value. Estimated motion torque value.

⑫ **Temperature**

°C value. This is the temperature of the master inverter heatsink. This temperature is used for the HIGH TEMPERATURE alarm detection.

⑬ **Motor temperature**

°C value. This is the temperature of the right 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.

⑭ **Handle / seat SW.**

ON/OFF. This is the status of handle/seat switch.

⑮ **Lifting switch**

ON/OFF. This is the status of the lifting switch.

⑯ **Cutback switch**

ON/OFF. This is the status of cutback switch.

⑰ **Hydro speed req.**

ON/OFF. This is the status of hydro speed request.

⑱ **Fork level but**

ON/OFF. This is the status of horn switch on joystick.

⑲ **Tilt pot**

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

⑳ **2nd hourmeters**

This parameter displays the working hour of pump controller.

㉑ **Load weight**

This shows the measured load weight.

㉒ **Lift/low request**

Shadow when you are not in JOYMODE. From 0.0V to 5.0V and from 0% and 100%. LIFT/LOWER fingertip.

㉓ **Tilt request**

Shadow when you are not in JOYMODE. From 0.0V to 5.0V and from 0% and 100%. TILT fingertip.

㉔ **Shift request**

Shadow when you are not in JOYMODE. From 0.0V to 5.0V and from 0% and 100%. SHIFT fingertip.

㉕ **Aux request**

Shadow when you are not in JOYMODE. From 0.0V to 5.0V and from 0% and 100%. AUX fingertip.

㉖ **Horn button joy.**

ON/OFF. This is the status of horn switch on joystick.

㉗ **Shift button joy.**

ON/OFF. This is the status of shift switch on joystick.

㉘ **Aux button joy.**

ON/OFF. This is the status of aux switch on joystick.

㉙ **Lower switch**

ON/OFF. This is the status of lowering switch on joystick.

㉚ **Aux in switch**

ON/OFF. This is the status of aux in switch on joystick.

㉛ **Aux out switch**

ON/OFF. This is the status of aux out switch on joystick.

㉜ **Tilt up switch**

ON/OFF. This is the status of tilt up switch on joystick.

㉝ **Tilt dw switch**

ON/OFF. This is the status of tilt down switch on joystick.

㉞ **Shift R switch**

ON/OFF. This is the status of shift right switch on joystick.

㉟ **Shift L switch**

ON/OFF. This is the status of shift left switch on joystick.

㊱ **G axis joystick**

This is the amount of joystick G axis operation.

㊲ **Y axis joystick**

This is the amount of joystick X axis operation.

㊳ **X axis joystick**

This is the amount of joystick Y axis operation.

㊴ **Mode select**

Perfomance sent from the display to Zapi controller.

㊵ **Truck model sel.**

Type of the truck selected: 20 or 23.

8. FINGERTIP JOYSTICK CONTROLLER

1) INTRODUCTION OF FINGER TIP (JOYSTICK)

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. The system is to apply electric joystick 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] ··· 24/36/48V
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

A (Connector console)

B

14 10
9   6
5   1

C

23   16
15   9
8   1
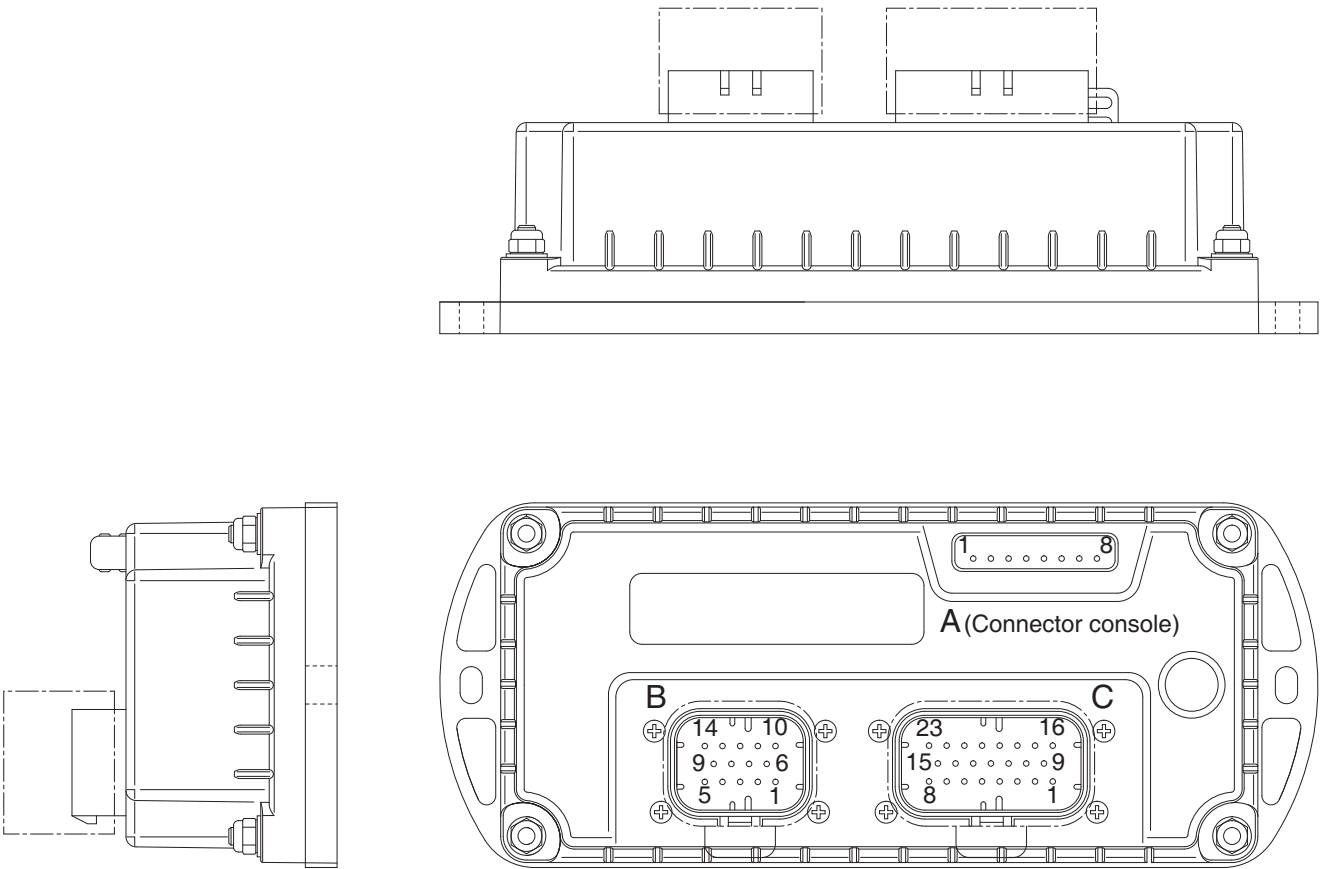
Fingertip controller

18BCS9EL61

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 (B14) to insert a 120 ohm termination resistance
B10	PPO_S	Positive supply of analog devices (+12 V) (Joystick, CAN encoder)
B13	CAN_H	Can high signal in
B14	CANH_OUT	Can high signal out (should be connected to B9)
C1	NEVP1	Negative of the proportional electro valve lift up.
C2	PEVP1/2	Positive of the proportional electro valves lowering.
C3	NEVP2	Negative of the proportional electro valve lift up.
C4	NEVP3	Negative of the proportional electro valve attach-B. (common proportional valve-B for reach out, tilt down, side shift left)
C5	PEVP3/4	Positive of the proportional electro valves attach-A, attach-B
C6	NEVP4	Negative of the proportional electro valve attach-A. (common propotional valve-A for reach in, tilt up, side shift right)
C9	NEV1	Negative of reach ON/OFF valve.
C10	NEV2	Negative of tilt ON/OFF valve.
C11	NEV3	Negative of side shift ON/OFF valve.
C12	NEVP7	Negative of the fan relay.
C13	PEVP7/8	Positive of the fan relay.
C16	PEV1	Positive of reach ON/OFF valve.
C17	PEV2	Positive of tilt ON/OFF valve.
C18	PEV3	Positive of side shift ON/OFF valve.
C23	-BATT	Mhyrio CB negative supply

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

MAIN MENU → PARAMETER CHANGE		
MIN EVP	0÷100	
MAX EVP	0÷100	
MIN EVP1	0÷100	
MAX EVP1	0÷100	
MIN EVP2	0÷100	
MAX EVP2	0÷100	
MIN EVP3	0÷100	
MAX EVP3	0÷100	
MIN EVP4	0÷100	
MAX EVP4	0÷100	
MIN EVP5	0÷100	
MAX EVP5	0÷100	
MIN EVP6	0÷100	
MAX EVP6	0÷100	
MIN EVP7	0÷100	
MAX EVP7	0÷100	
MIN EVP8	0÷100	
MAX EVP8	0÷100	
EVP OPEN DELAY	0-20 Sec	
EVP CLOSE DELAY	0-20 Sec	
EVP1 OPEN DELAY	0-20 Sec	
EVP1 CLOSE DELAY	0-20 Sec	
EVP2 OPEN DELAY	0-20 Sec	
EVP2 CLOSE DELAY	0-20 Sec	
EVP3 OPEN DELAY	0-20 Sec	
EVP3 CLOSE DELAY	0-20 Sec	
EVP4 OPEN DELAY	0-20 Sec	
EVP4 CLOSE DELAY	0-20 Sec	
EVP5 OPEN DELAY	0-20 Sec	
EVP5 CLOSE DELAY	0-20 Sec	
EVP6 OPEN DELAY	0-20 Sec	
EVP6 CLOSE DELAY	0-20 Sec	
EVP7 OPEN DELAY	0-20 Sec	
EVP7 CLOSE DELAY	0-20 Sec	
EVP8 OPEN DELAY	0-20 Sec	
EVP8 CLOSE DELAY	0-20 Sec	

HEADING

CONFIG MENU

SET MODEL → CONNECTED TO

SET OPTIONS

SET BATTERY TYPE	12/24/36 48/72/80V
V VALVES COIL	12/24/36 48/72/80V
VALVES SUPPLY	12/24/36 48/72/80V
EVP TYPE	Analog / Digital
EVP1 TYPE	Analog / Digital
EVP2 TYPE	Analog / Digital
EVP3 TYPE	Analog / Digital
EVP4 TYPE	Analog / Digital
EVP5 TYPE	Analog / Digital
EVP6 TYPE	Analog / Digital
EVP7 TYPE	Analog / Digital
EVP8 TYPE	Analog / Digital
MODEL TRUCK	OPTION #1/#2/#3

ADJUSTMENTS → ADJUST BATTERY : V

TESTER

BATTERY VOLTAGE	V
VALVES SUPPLY	V
CAN POT EVP	%
CAN POT GROUP 1	%
CAN POT GROUP 2	%
CAN POT GROUP 3	%
CAN POT GROUP 4	%
INPUT 0	ON/OFF
INPUT 1	ON/OFF
INPUT 2	ON/OFF
ANALOG INPUT 1	0/256

SAVE PARAMETER

RESTORE PARAMETER

ALARMS → CODE, h, N, C

PROGRAM VACC

BRJ7EL62A

6) 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) Submenu "PARAMETER CHANGE"

EVP 1	Proportional valve for lift down (C2-C1)
EVP 2	Proportional valve for lift up (C2-C3)
EVP 3	Common proportional valve for reach out, tilt down, side shift left (C5-C4) (Attach-B)
EVP4	Common proportional valve for reach in, tilt up, side shift rignt (C5-C4) (Attach-A)

① **Min EVP** (not being used)

This parameter adjusts the minimum current of the SINGLE valve.

② **Max EVP** (not being used)

This parameter adjusts the MAXIMUM current of the SINGLE valve.

③ **Min EVP1** (lift down)

This parameter adjusts the minimum current of valve 1 (lift down).

④ **Max EVP1** (lift down)

This parameter adjusts the maximum current of valve 1 (lift down).

⑤ **Min EVP2** (lift up)

This parameter adjusts the minimum current of valve 2 (lift up).

⑥ **Max EVP2** (lift up)

This parameter adjusts the maximum current of valve 2 (lift up).

⑦ **Min EVP3** (attach-B)

This parameter adjusts the minimum current of valve 3 (common proportional valve for reach out, tilt down, side shift left).

⑧ **Max EVP3** (attach-B)

This parameter adjusts the maximum current of valve 3 (common proportional valve for reach out, tilt down, side shift left).

⑨ **Min EVP4** (attach-A)

This parameter adjusts the minimum current of valve 4 (common proportional valve for reach in, tilt up, side shift right).

⑩ **Max EVP4** (attach-A)

This parameter adjusts the maximum current of valve 4 (common proportional valve for reach in, tilt up, side shift right).

⑪ **Min EVP5** (not being used)

This parameter adjusts the minimum current of valve 5.

⑫ **Max EVP5** (not being used)

This parameter adjusts the maximum current of valve 5.

⑬ **Min EVP6** (not being used)

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

⑭ **Max EVP6** (not being used)

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

⑮ **Min EVP7** (not being used)

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

⑯ **Max EVP7** (not being used)

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

⑰ **Min EVP8** (not being used)

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

⑱ **Max EVP8** (not being used)

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

⑲ **EVP Open delay** (not being used)

Single proportional valve current ramping up time: this parameter sets the single valve current ramp, to change coil current from minimum EVP to maximum EVP.

⑳ **EVP Close delay** (not being used)

Single proportional valve current ramping down time: this parameter sets the single valve closing ramp, to change coil current from maximum EVP to minimum EVP.

㉑ **EVP1 Open delay** (lift down)

EVP1 proportional valve current ramping up time: this parameter sets the EVP1 valve current ramp, to change the coil current from minimum EVP1 to maximum EVP1.

㉒ **EVP1 Close delay** (lift down)

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

㉓ **EVP2 Open delay** (lift up)

EVP2 proportional valve current ramping up time: this parameter sets the EVP2 valve current ramp, to change the coil current from minimum EVP2 to maximum EVP2.

㉔ **EVP2 Close delay** (lift up)

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

㉕ **EVP3 Open delay** (attach-B)

EVP3 proportional valve current ramping up time: this parameter sets the EVP3 valve current ramp, to change the coil current from minimum EVP3 to maximum EVP3.

㉖ **EVP3 Close delay** (attach-B)

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

㉗ **EVP4 Open delay** (attach-A)

EVP4 proportional valve current ramping up time: this parameter sets the EVP4 valve current ramp, to change the coil current from minimum EVP4 to maximum EVP4.

㉘ **EVP4 Close delay** (attach-A)

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

㉙ **EVP5 Open delay** (not being used)

EVP5 proportional valve current ramping up time: this parameter sets the EVP5 valve current ramp, to change the coil current from minimum EVP5 to maximum EVP5.

㉚ **EVP5 Close delay** (not being used)

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

㉛ **EVP6 Open delay** (not being used)

EVP6 proportional valve current ramping up time: this parameter sets the EVP6 valve current ramp, to change the coil current from minimum EVP6 to maximum EVP6.

㉜ **EVP6 Close delay** (not being used)

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

㉝ **EVP7 Open delay** (not being used)

EVP7 proportional valve current ramping up time: this parameter sets the EVP7 valve current ramp, to change the coil current from minimum EVP7 to maximum EVP7.

㉞ **EVP7 Close delay** (not being used)

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

㉟ **EVP8 Open delay** (not being used)

EVP8 proportional valve current ramping up time: this parameter sets the EVP8 valve current ramp, to change the coil current from minimum EVP8 to maximum EVP8.

㊱ **EVP8 Close delay** (not being used)

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

(2) Submenu "SET OPTIONS"

① **Set Battery Type**

This parameter sets the battery nominal voltage, that is the key input voltage (Mhyrio supply). (36V in for C/B trucks)

② **V Valves Coil**

This parameter sets the ON/OFF valves coil nominal voltage. (24V for C/B trucks)

③ **Valves Supply**

This parameter sets the voltage of the valve's coil positive supply. (36V for C/B trucks)

④ **Model Truck**

This parameter changes entire parameter's value to each model's default value as below after recycle of key.

This parameter supposed to be "OPTION #1" for C/B trucks.

- Option #1 : C/B trucks
- Option #2 : BRJ-7
- Option #3 : BRP-9
- Option #4 : BRJ-9

7) TESTER MENU (IN DISPLAY, MONITORING 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.

8) GENERAL SUGGESTION FOR SAFETY

For a proper installation take care of the following recommendations:

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

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

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

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

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

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

6. INSTRUMENT PANEL : DISPLAY

1) STRUCTURE

The DISPLAY has 6 red LEDs indicating the status information of the lift truck to the driver.

Spare #1		Spare #2
Brake oil level		Park brake
Wrench		Seat belt
Thermometer		Seat
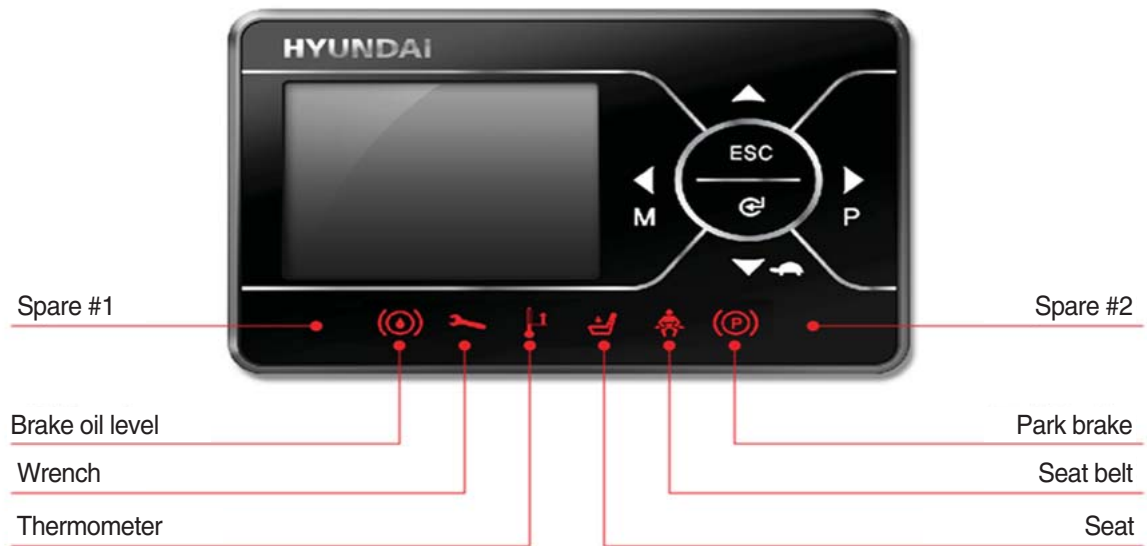
22BH9OM65

2) WARNING LAMP

(1) Brake oil level warning lamp

22BH9EFD01
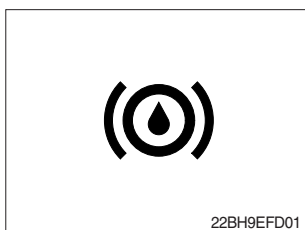
This LED lights when measured level of brake oil stored in reservoir tank is below the minimum acceptable mark.

※ **BCS-9 truck does not have any mechanical brake which requires brake oil, so that re-fill of brake oil is not required.**

(2) Wrench warning lamp

22BH9EFD02
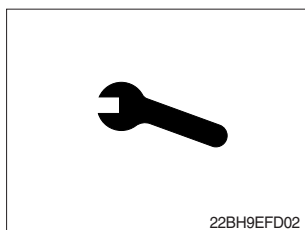
This LED lights when an electric device (controller, motor, cable, etc.) is in abnormal condition.

(3) Thermometer warning lamp

22BH9EFD03
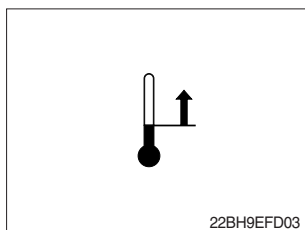
This LED lights when the controller or motor temperature is high.

(4) Seat warning lamp

22BH9EFD04

This LED lights when the operator is not on the dead man switch.

(5) Seat belt warning lamp

22BH9EFD05
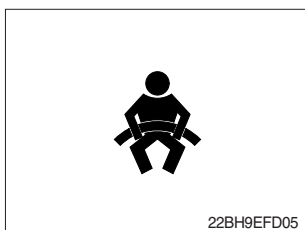
When operator starts the truck, LED blinks for 5 seconds, which means initial diagnosis is on going, and buttons on display will work properely just after the diagnosis is completed.

(6) Parking brake warning lamp

22BH9EFD06
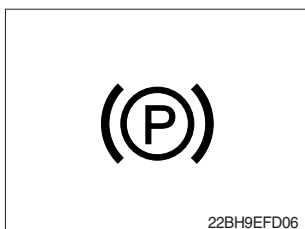
This LED lights when the parking brake is activated.

3) BUTTON

These buttons are used to select or change the menu and input value of the LCD function and display menu.

(1) Up button
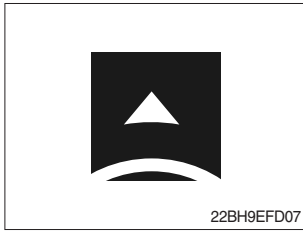
Press to select upward move.

(2) DOWN/TURTLE button

Press to select downward move.
TURTLE MODE ON/OFF

(3) LEFT/MENU button
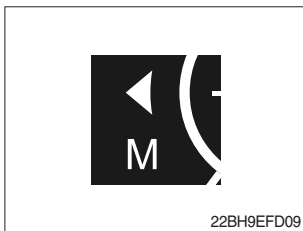
Press to select leftward move.
Go into the menu.

(4) RIGHT/PERFORMANCE button

Press to select rightward move.
POWER MODE H/N/E

(5) Cancel (ESC) button
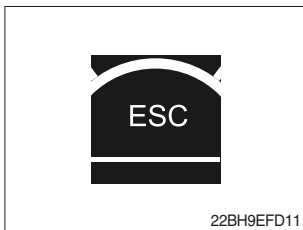
Press to select cancel.
Keep pressing this button shows PASSWORD entry field.

(6) ENTER button

Press to select Enter.

4) LCD FUNCTION (MAIN SCREEN)

MAIN SCREEN

22BH9EFD13

1	Current time	6	Hour meter
2	Turtle mode	7	Wheel position and running direction
3	Truck speed pointer	8	Power mode
4	Speed level	9	BDI (Battery Discharge Indicator)
5	Truck speed	10	Load weight (option)

(1) Current time

The number shows the current time according to the setting, which can be changed by DISPLAY Setting [6. 5), Page 7-69].

(2) Turtle mode

The turtle symbol is normally off. When this symbol appears, the Turtle Mode is activated regardless of the Power Mode of the truck to reduce the maximum speed to the setpoint. This mode can be activated by pressing the [button icon] button.

(3) Truck speed pointer

The speed of the truck is indicated with a pointer.

(4) Speed level

This indicator shows the truck speed same as the (3) Speed pointer.

(5) Truck speed

The truck speed is shown in number. According to the DISPLAY setting km/h or mph unit is available.

(6) Hour meter

The number shows the hours worked. The letter present near the hour meter shows which hour meter is displayed.
- hK: the Key Hour shows the truck Key ON time;
- hT: the Traction Hour shows the Gate ON (driven) time of the traction motor.
- hP: the Pump Hour shows the Gate ON (driven) time of the pump motor.

(7) Wheel position and running direction

The arrow point is up when the truck is forward running and points down when the truck is reverse running. The arrow point is moved to the leftward or the rightward according as the direction of the steering angle.

(8) Power mode

The letter; H, N, or E, shows the Power Mode which is being used in the controller. The mode can be scrolled by pressing the ▶P button sequentially. When a mode is selected, the related information will be sent via CAN-BUS to traction and pump controllers that will manage this data.

H (High)   - corresponds to the highest performance
N (Normal)   - corresponds to normal performance
E (Economic) - corresponds to economic performance

(9) BDI (Battery Discharge Indicator)

The battery state of charge is shown by ten bars. Each bar represents the 10% of the battery charge. As the battery becomes discharged, the bars turn off progressively, one after another, in proportion to the value of the residual battery charge. When the residual battery charge is 20% or under, the bars displayed become red.

※ How to adjust BDI

If necessary, service man can a adjust BDI with adjustment #1, #2 BDI menu.

① BAT. MAX ADJ.

It adjusts the upper level of the battery discharge table. Higher value means higher voltage.

② BAT. MIN ADJ.

It adjusts the lower level of the battery discharge table. Higher value means higher voltage. (for detail menu, please refer to page 7-31)

5) HOW TO USE DISPLAY MENU

22BH9EFD14
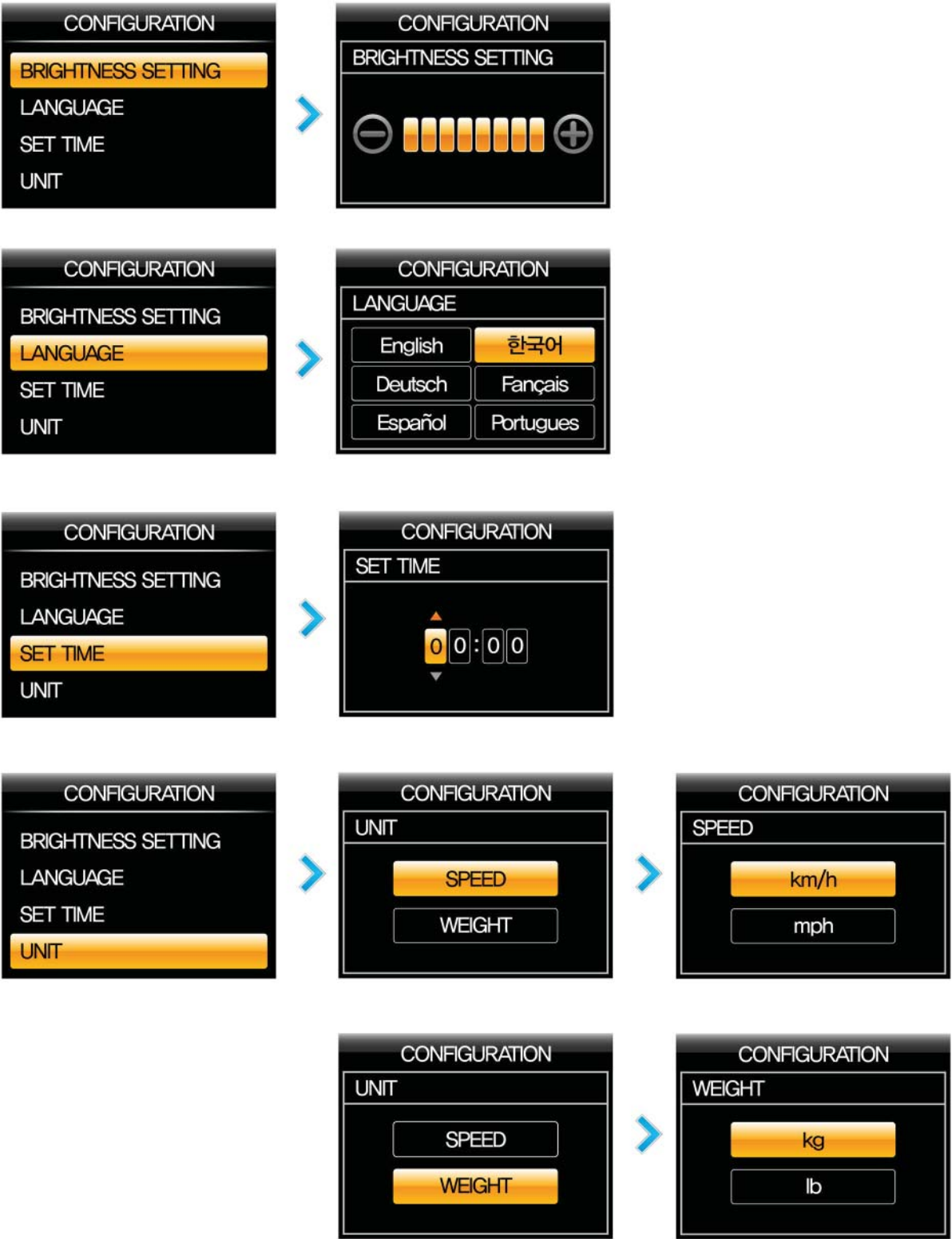
20BC9EFD15

6) DESCRIPTION OF THE TRUCK MENU

(1) Access to truck menu

[ESC] If this button is pressed long, the PASSWORD dialog appears.

Enter correct PASSWORD, then on MAIN SCREEN, Press [M] button to access the controller "TRUCK MENU"

(2) How to change detail menus

The detail items of menu can be changed as follows ;
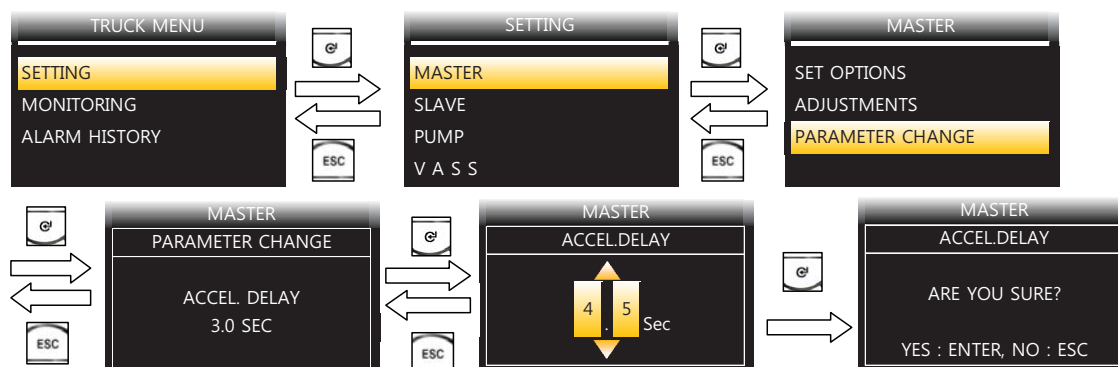
22B9EL24

Selection can be made in 4 methods as follows ;

- ON/OFF Selection
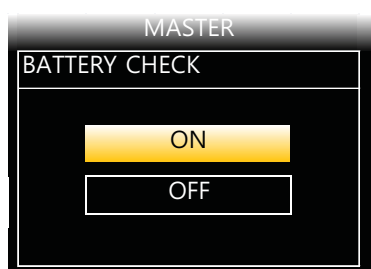
22B9EL25

Select a desired value with [▲] , [▼] button, then save with [↵] button or press [ESC] button to escape without saving.

- Type Selection
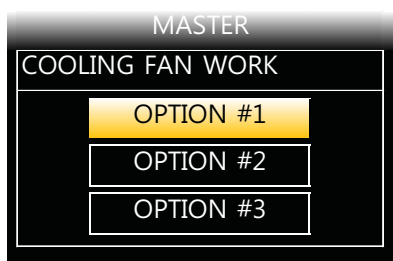
22B9EL30

Select a desired value with [▲] , [▼] button, then save with [↵] button or press [ESC] button to escape without saving.

- Level Selection
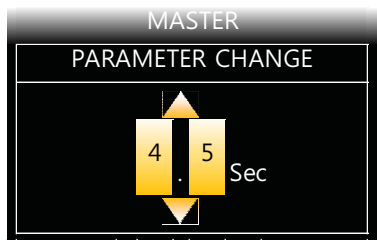
MASTER
PARAMETER CHANGE

4 . 5 Sec

22B9EL30

Select a desired value with [▲] , [▼] button, then save with [↵] button or press [ESC] button to escape without saving.

7) ALARM & ALARM HISTORY

(1) How to check alarms

Normally, ALARM SCREEN pops up if any kind of a alarm happens, but service man can switch between a MAIN SCREEN and ALARM SCREEN with ESC , ⏎ buttons as follows :

ESC ⇧ ⇩ ⏎ (Press more than 1 sec)

CODE	NAME
T26	Contactor Open
PDE	Waiting for Node

TRIP

18BR9EL35

(2) Detail description of ALARM SCREEN
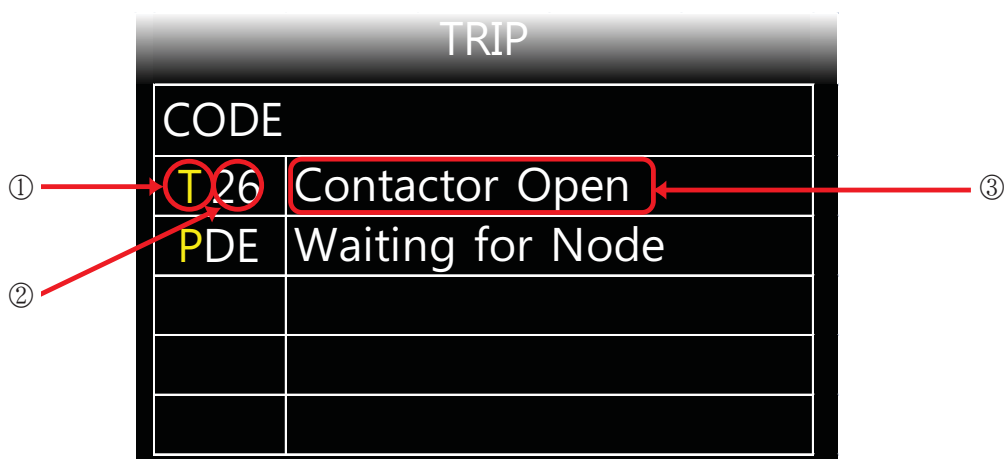
18BR9EL36

① First yellow capital letter shows in which controller the alarm happens as below;

   T : Traction

   P : Pump

② Following two letters or digits show alarm code. Please refer to 7. ALARM CODE (Page 7-81).

③ This shows a name of ALARM. Please refer to 7. ALARM CODE (page 7-81).

(3) Alatm history

    Alarm History can be looked up as follows ;
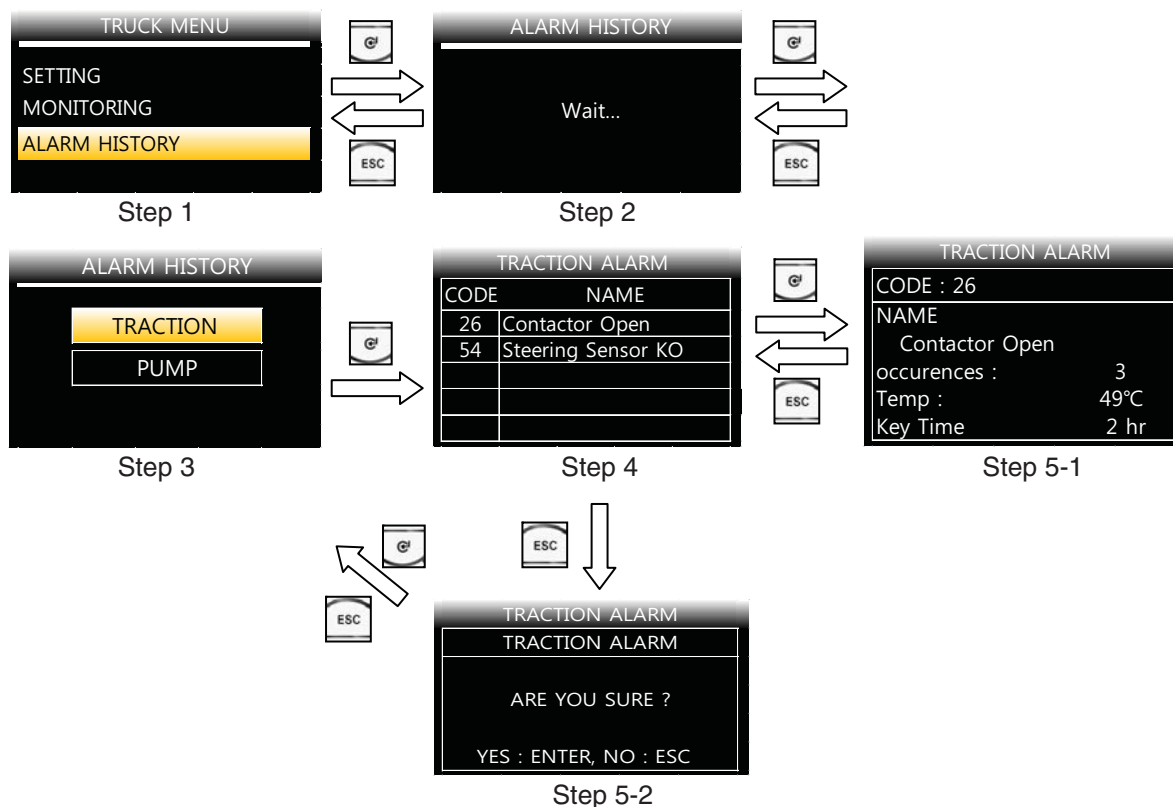
18BR9EL37

① Step 1 : Service man can check the alarm history on ALARM HISTORY menu
② Step 2 : When service man enter the ALARM HISTORY menu, display read entire alarm records of all controller. So it takes 9~15 seconds to read.
③ Step 3 : When display finish to read alarm records, service man can choose each controller to read the alarm history.
④ Step 4 : When service man enters each controller's alarm history, service man can check simply up to 5 alarms and choose a specific alarm to read detail alarm information.
⑤ Step 5-1 : When service man press [↵] button at Step 4, operator can see a detail alarm information of chosen alarm. Please refer to 6-7)-(4) DETAIL ALARM INFORMATION below.
⑥ Step 5-2 : When service man press [ESC] button at Step 4, service man can see a alarm clear menu. If service man press [↵] button, Recorded alarms of selected controller will be erased.
(to verify cleaned alarm records, service man should be back to Step 1 & 2 to refresh.)
If operator press [ESC] button, just escape to step 3 without clearing

(4) Detail alarm information
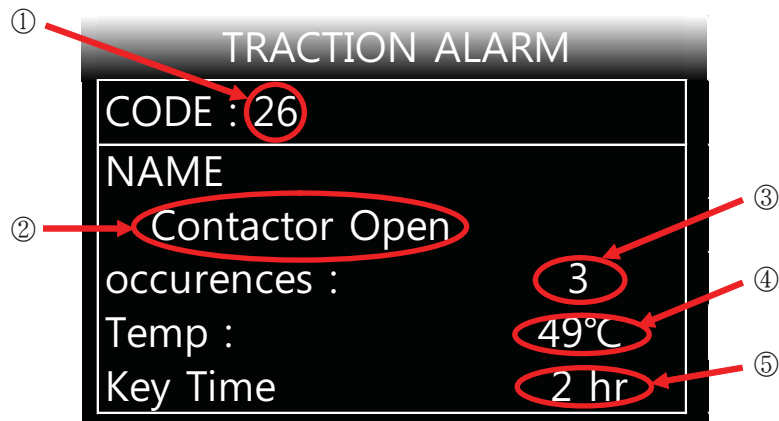
22B9EL38

① Code of alarm
② Name of alarm
③ Count of alarm
④ Temperature of controller as alarm occurs.
⑤ Hourmeter of controller as alarm occurs.

8) VASS SETUP USING DISPLAY MENU

This function searches and memorizes the minimum and maximum potentiometer wiper voltage of the accelerator pedal, lift lever, and steering sensor which use potentiometer sensors. The belows show how to use the VASS function of DISPLAY.

(All figures in belows are just example.)

※ While even a motor is running, VASS can not be configured properly, so please be sure that all motors are not running before entering configuration process & saving.

(1) ACCEL VASS setting method

V.A.S.S	
ACCEL	
MIN FORWARD	0.76V
MAX FORWARD	1.76V
MIN REVERSE	0.76V
MAX REVERSE	1.76V

Please make sure that all motors are not running & direction lever is in NEUTRAL position.

V.A.S.S	
ACCEL	READY
MIN FORWARD	0.76V
MAX FORWARD	1.76V
MIN REVERSE	0.76V
MAX REVERSE	1.76V

If "READY" appears beside ACCEL, you are in configuration process.
Set direction lever in FORWARD position.

V.A.S.S	
ACCEL	READY
MIN FORWARD	0.90V
MAX FORWARD	0.90V
MIN REVERSE	0.76V
MAX REVERSE	1.76V

Now, you can see that voltage value of MIN FORWARD and MAX FORWARD are changed.
Step on accel pedal fully, then Take foot off accel pedal.

V.A.S.S	
ACCEL	READY
MIN FORWARD	0.90V
MAX FORWARD	4.47V
MIN REVERSE	0.76V
MAX REVERSE	1.76V

Now, you can see that voltage value of MAX FORWARD are changed.
Set direction lever in REVERSE position. (Sometimes, depending on controller model, MIN FORWARD value looks like that it is fixed as 0.0V, which is normal.)

V.A.S.S	
ACCEL	READY
MIN FORWARD	0.90V
MAX FORWARD	4.47V
MIN REVERSE	0.90V
MAX REVERSE	0.90V

Now, you can see that voltage value of MIN REVERSE and MAX REVERSE are changed.
Step on accel pedal fully, then Take foot off accel pedal

22B9EL39-1

```
         V.A.S.S
ACCEL              READY
MIN FORWARD        0.90V
MAX FORWARD        4.47V
MIN REVERSE        0.90V
MAX REVERSE        4.47V
```

Now, you can see that voltage value of MAX REVERSE are changed.
Please make sure that all motors are not running & direction lever is in NEUTRAL position.

```
         V.A.S.S
ACCEL             FINISH


      ARE YOU SURE ?


  YES : ENTER, NO : ESC
```
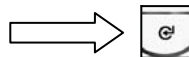
22B9EL39-2

(2) STEER ANGLE VASS setting method

```
           V.A.S.S
STEER ANGLE
STEER RIGHT        2.45V
STEER LEFT         4.24V
STEER 0-POS        3.64V
```

Please make sure that all motors are not running & direction lever is in NEUTRAL position.

```
           V.A.S.S
STEER ANGLE     READY
STEER RIGHT        2.94V
STEER LEFT         4.24V
STEER 0-POS        3.64V
```

If "READY" appears beside STEER ANGLE, you are in configuration process. Now, operator can see that voltage value of STEER RIGHT is changed.
Turn steer handle to right-end fully, the value will be changed.

```
           V.A.S.S
STEER ANGLE     READY
STEER RIGHT        1.20V
STEER LEFT         1.20V
STEER 0-POS        3.64V
```

Now, you can see that voltage value of STEER RIGHT is saved.
Turn steer handle to left-end fully, the voltage value will be changed.

```
           V.A.S.S
STEER ANGLE     READY
STEER RIGHT        1.20V
STEER LEFT         7.84V
STEER 0-POS        7.84V
```

Now, you can see that voltage value of STEER LEFT is saved.
Turn steer handle to center position, the voltage value will be changed.
Please make sure that all traction motors are not running

```
           V.A.S.S
STEER ANGLE     READY

      ARE YOU SURE ?


  YES : ENTER, NO : ESC
```

22B9EL41
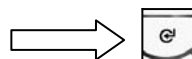
9) STRUCTURE OF TRUCK MENU

TRUCK MENU is in order to make configuration of truck easily, and consists of 3 major categorys : SETTING, MONITORING, ALARM HISTORY.

[To know how to get in to TRUCK MENU, refer to 6-6)-(1) "ACCESS TO TRUCK MENU" page 7-71]

(1) Settings

TRUCK MENU
SETTING
MONITORING
ALARM HISTORY

SETTING
MASTER
SLAVE
PUMP
V A S S

MASTER
SET OPTIONS
ADJUSTMENTS
PARAMETER CHANGE
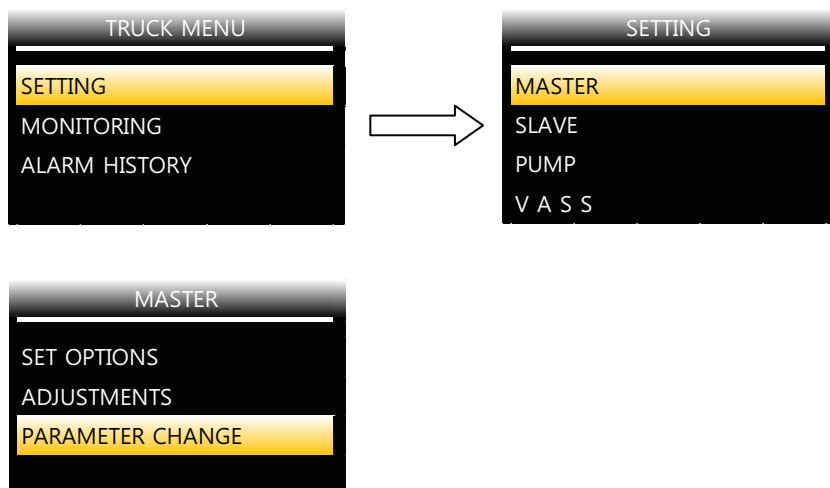
22B9EL42

In SETTINGS, service man can choose a specific controller's submenu or VASS menu.

① TRACTION->SET OPTIONS

Refer to 5-4)- ■ "TRACTION CONTROLLER"-(1) "SET OPTIONS" (page 7-29, 7-36)

② TRACTION->ADJUSTMENTS

Refer to 5-4)- ■ "TRACTION CONTROLLER"-(2) "ADJUSTMENTS" (page 7-30, 7-37)

③ TRACTION->PARAMETER CHANGE

Refer to 5-4)- ■ "TRACTION CONTROLLER"-(3) "PARAMETER CHANGE" (page 7-33, 7-37)

④ PUMP->SET OPTIONS

Refer to 5-4)- ■ "PUMP CONTROLLER"-(1) "SET OPTIONS" (page 7-38)

⑤ PUMP->ADJUSTMENTS

Refer to 5-4)- ■ "PUMP CONTROLLER"-(2) "ADJUSTMENTS" (page 7-39)

⑥ PUMP->PARAMETER CHANGE

Refer to 5-4)- ■ "PUMP CONTROLLER"-(3) "PARAMETER CHANGE" (page 7-41)

⑦ V.A.S.S

Refer to 6-8) "VASS SETUP USING DISPLAY MENU" (page 7-76)

(2) Monitoring

TRUCK MENU
SETTING
MONITORING
ALARM HISTORY

MONITORING
MASTER
SLAVE
PUMP

MONITORING	
MASTER	
Voltage booster	0%
Battery voltage	47.9V
Battery charge	50V
Device Name	HY
H/W VER	DA2M
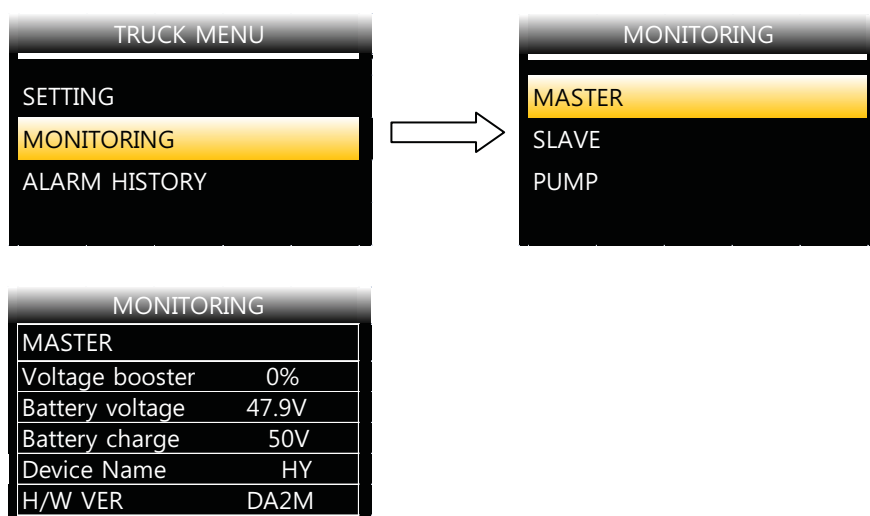
22B9EL43

In MONITORING MENU, service man can check various stats of trucks.

① TRACTION

　　Refer to 5-6)-(1) "Traction controller" (page 7-49, 7-51)

② PUMP

　　Refer to 5-6)-(3) "Pump controller" (page 7-52)

(3) Alarm history

　　Refer to 6-7) "ALARM & ALARM HISTORY" (page 7-62)

7. ALARM CODE

1) TRACTION CONTROLLER

No	Code	Alarm name	Master	Slave	Description	
					Cause	Troubleshooting
1	D	EEPROM KO	○	○	Warning : EEPROM fault, controller will use default parameters.	- To remove warning cause.
2	11	Logic Failure#3	○	○	Alarm : failure in over-load protection hw circuit.	- To remove alarm condition + activation of pump request. - Check the controller.
3	12	Logic Failure#2	○	○	Alarm : failure in U, V, W voltage feedback circuit.	- To remove alarm condition + activation of pump request.
4	13	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.
5	1E	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.
6	1F	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.
7	25	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 and cables attached to the contactor.
8	26	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 and cables attached to the contactor.
9	35	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.

No	Code	Alarm name	Master	Slave	Description	
					Cause	Troubleshooting
10	3C	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, 10 W). - Check the controller.
11	3E	TH. Protection	○	○	Warning : pump temperature higher than 75 °C.	- To remove warning cause.
12	41	Motor Temperat.	○	○	Warning : pump motor temperature high.	- To remove warning cause. - Check the motor temp-sensor.
13	42	Battery Low	○		Warning : battery charge level below 10%.	- To remove warning cause.
14	4A	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.
15	4B	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.
16	4E	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-configure VASS ACCEL.
17	4F	Incorrect Start	○	○	Warning : wrong pump request sequence.	- To remove warning cause.
18	50	Forw + Back	○	○	Warning : forward and reverse inputs are both active.	- To remove warning cause.
19	52	Encoder Error	○	○	Alarm : motor speed sensor (encoder) does not work properly.	- To recycle the key. - Check the motor encoder.
20	54	Steer Sensor KO	○	○	Alarm : steering sensor signal out of range	- To remove alarm cause.
21	CF	Model Mismatch	○	○	Alarm : parameter "TRUCK MODEL SEL." is being modified.	- Key off and on controller.
22	D0	Selection Error	○	○	Alarm : A-13 input state is been modified.	- Key off and on controller.
23	D1	CANBUS DISP. KO	○	○	Alarm : master has lost can communication with the display	- To remove alarm cause.
24	D2	Display Enable	○	○	Warning : the display enable signal has not been received to operate the truck.	- To remove warning cause.

No	Code	Alarm name	Master	Slave	Description	
					Cause	Troubleshooting
25	D3	Maint pre Warn	○	○	Warning : this alarm occurs when the controller works after "M. PRE WARN TIME" hours.	- Set to ON " MAINTEN. RESET " parameter.
26	D4	Maintenance Hour	○	○	Warning : this alarm occurs when the controller works after "M. PRE WARN TIME" hours.	- Set to ON " MAINTEN. RESET " parameter.
27	D5	Motor Shutdown	○	○	Alarm : motor temperature is greater than the parameter " MOTOR SHUTDOWN ".	- Leave the truck at rest to allow the temperature to decrease.
28	D6	Side Battery Rem	○	○	Warning : side battery removal sensor is open.	- To remove warning cause. - Check the SBR sensor.
29	D7	Enable S/W Open	○	○	Warning : accelerator is activated with A-6 opened.	- Press pedal A-6 and the activate accelerator.
30	D8	CAN BUS Joystick	○	○	Controller doesn't receive joystick can message.	- Check wiring between controller and joystick.
31	D9	Left ENC Locked	○		Encoder speed from theleft motor is zero.	- Check the connection between the left motor and the left controller.
32	DA	Torque Profile	○	○	Parameter regarding the torque are not corrected.	- Perform clear EEPROM command.
33	DB	IQ Mismatched	○	○	Torque current doesn't follow the set point.	- Change the controller.
34	DD	Seat Mismatch	○	○	A-6 state of the right controller is different from A-6 of the left controller.	- Check the wiring of A-6.
35	DE	Waiting For NODE	○	○	Warning : pump controller signals that other controllers are in alarm status.	- To recycle the key. - Check if any other alarm happens (Some alarms such as CHAT TIME or PEDAL WIRE KO, alarms related to CONTACTOR, DISPALY ENABLE, alarms reated to CANBUS can make this alarm sometimes). - Check the communication with all controllers (display TRUCK MENU → MONITORING → choose controller → H/W ver, S/W ver. If CAN communication is not available, H/W ver, S/W ver will be blank).
36	DF	Watchdog #1	○	○	Alarm : the watchdog signal #1 is not in the correct status.	- To remove alarm cause.
37	E0	AUX Coil Short	○	○	Alarm : shortcircuit on EB/ AUX coil.	- To remove alarm cause.

No	Code	Alarm name	Master	Slave	Description	
					Cause	Troubleshooting
38	E1	Safety Input KO	○	○	A-11 voltage is not correct.	- Check wiring between A-19 and A-11 of the left and right controller.
39	E2	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.
40	E3	Watchdog#2	○	○	Alarm : the watchdog signal #2 is not in the correct status.	- To remove alarm cause.
41	E4	Chat Time	○		Warning : the chat time has expired.	- To activate traction or pump request.
42	E5	Safety Input	○	○	Alarm : the safety input is open (it is not connected to –Batt).	- To remove alarm cause.
43	E6	MC Coil Short	○	○	Alarm : shortcircuit on MC coil.	- To remove alarm cause.
44	E7	Coil Short HW KO	○	○	Alarm : the harware to check a MC or EB/AUX coil shorted is damaged.	- Check the controller.
45	E8	Key Off Short	○	○	Alarm : at start-up the keyoff logic signal is low.	- Check the connection. - Check the key input signal.
46	E9	Power MOS Short	○	○	Alarm : short circuit on the power Mosfets.	- Check the controller.
47	EB	Handbrake	○	○	Warning : handbrake microswitch is open and a travel request is active.	- To remove warning cause.
48	EC	Curremt Gain	○	○	Warning : the maximum current gain parameters are the default values, which means the maximum current adjustment procedure has not been carried out yet.	- Ask the assistance of an engineer at the development department to do the correct adjustment procedure of the current gain parameters..
49	ED	Analog Input	○	○	Alarm : the analog channel ready is not updated.	- Check the controller.
50	EE	Wrong 0 Voltage	○	○	Alarm : the motor phases voltage feedback are out of permitted range.	- To remove alarm cause.
51	EF	Safety Output	○	○	Alarm : the safety-out driver is damaged (shorted or open).	- To remove alarm cause.
52	F0	Hardware Fault	○	○	Alarm : the mosfets driver are not switched off with watch-dog signal in alarm status.	- Check the controller.

No	Code	Alarm name	Master	Slave	Description	
					Cause	Troubleshooting
53	F1	Flash Checksum	○	○	Alarm : the program verify is not OK.	- Try to program the controller again. - Check the controller logic board.
54	F2	Right ENC Locked	○		Encoder speed from the right motor is zero.	- Check the connection between the right motor and the left controller.
55	F3	Sens Mot Temp KO	○	○	Warning : the output of the motor thermal sensor is out of range.	- To remove warning cause.
56	F4	Software Error	○	○	Alarm : CANBUS line of ACE2 is in CANBUS line OFF condition.	- Check CANBUS connection. If CANBUS connection is OK, replace the logic of ACE2.
57	F5	Wrong RAM memory	○	○	Alarm : the algorithm implemented to check the main RAM registers finds a wrong contents: the register is "dirty". This alarm inhibit the machine operations.	- Try to switch the key off and then on. If the alarm is still present, replace the ACE2 logic board.
58	F6	AUX Driv. Open	○	○	Alarm : the AUX coil driver is not able to drive the load. The device itself or its driving circuit is damaged.	- This type of fault is not related to external components; Replace the ACE2 logic board.
59	F7	Data Acquisition	○	○	Alarm : data communication is now processing.	- If this alarm occurs, when sensor setting procedure, recycle the key.
60	F8	NO CAN MSG.	○	○	Alarm : slave 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.
61	F9	Check Up Needed			Warning : truck reached the hour time for maintenance.	- Reset the checkup hour time.
62	FA	Thermic Sens. KO	○	○	Warning : pump temp. sensor is out of range.	- To remove warning cause.
63	FB	Wrong Set BAT.	○	○	Alarm : the battery voltage does not correspond to SET BATTERY programming.	- To remove alarm cause.
64	FC	Power Mismatch	○	○	The power calculated from the controller is not corrected.	- Change the controller.
65	FD	Foc Lost	○		Field current doesn't follow the set point.	- Change the controller.
66	FE	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

No	Code	Alarm name	Pump	Description	
				Cause	Troubleshooting
1	D	EEPROM KO	○	Warning : EEPROM fault, controller will use default parameters.	- To remove warning cause.
2	11	Logic Failure#3	○	Alarm : failure in over-load protection hw circuit.	- To remove alarm condition + activation of pump request. - Check the controller.
3	12	Logic Failure#2	○	Alarm : failure in U, V, W voltage feedback circuit.	- To remove alarm condition + activation of pump request.
4	13	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.
5	1E	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.
6	1F	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.
7	25	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 and cables attached to the contactor.
8	26	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 and cables attached to the contactor.
9	35	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.

No	Code	Alarm name	Pump	Description	
				Cause	Troubleshooting
10	3C	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, 10 W). - Check the controller.
11	3E	TH. Protection	○	Warning : pump temperature higher than 75 °C.	- To remove warning cause.
12	41	Motor Temperat.	○	Warning : pump motor temperature high.	- To remove warning cause. - Check the motor temp-sensor.
13	42	Battery Low	○	Warning : battery charge level below 10%.	- To remove warning cause.
14	4A	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.
15	4B	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.
16	4E	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-configure VASS ACCEL.
17	4F	Incorrect Start	○	Warning : wrong pump request sequence.	- To remove warning cause.
18	50	Forw + Back	○	Warning : forward and reverse inputs are both active.	- To remove warning cause.
19	52	Encoder Error	○	Alarm : motor speed sensor (encoder) does not work properly.	- To recycle the key. - Check the motor encoder.
20	B6	Fork Sens. Outrng	○	Warning : value of fork sensor (AUTO TILT LEVELING) is out of range.	- Check the fork sensor if AUTO TILT LEVELING option. - Re-configure firk sensor of AUTO TILT LEVELING option.
21	B7	Fork Sensor Lock	○	Warning : value of fork sensor (AUTO TILT LEVELING) is fixed even tilt request is activated.	- Check the fork sensor if AUTO TILT LEVELING option. - Re-configure firk sensor of AUTO TILT LEVELING option.
22	B8	Fork Wrong Dir.	○	Warning : direction of "AUTO TILT LEVELING" movement is not correct.	- Check if operator operates truck correctly. - Check the tilt sensor of fork leveling option. - Re-configure tilt sensor of fork leveling option.

No	Code	Alarm name	Pump	Description	
				Cause	Troubleshooting
23	BB	Aux2 Out Of Rng.	○	Warning : voltage value of AUX2 sensor is out of range.	- Re-configure the AUX2 lever. - Check the AUX2 lever.
24	BC	AUX1 Out Of Rng.	○	Warning : voltage value of AUX1 sensor is out of range.	- Re-configure the AUX1 lever. - Check the AUX1 lever.
25	BD	Tilt Out Of RNG.	○	Warning : voltage value of TILT sensor is out of range.	- Re-configure the TILT lever. - Check the TILT lever.
26	BE	Lift Out Of RNG.	○	Warning : voltage value of LIFT sensor is out of range.	- Re-configure the LIFT lever. - Check the LIFT lever.
27	BF	Acquire Aux2	○	Warning : controller is configuration "AUX2" lever function.	- Finish the configuration process.
28	C0	Acquire Aux1	○	Warning : controller is configuration "AUX1" lever function.	- Finish the configuration process.
29	C1	Acquire Tilt	○	Warning : controller is configuration "TILT" lever function.	- Finish the configuration process.
30	D2	Load Sens. Error	○	Alarm : load weight sensor detects that loaded weight exceeds the weight limitation or load weight sensor is not wirking properly.	- To remove alarm cause. - Check the load weight sensor.
31	D3	Overload	○	Warning : load weight sensor detects that loaded weight exceeds the weight limited in OVERLOAD WEIGHT programming.	- To remove warning cause.
32	D5	Motor Shutdown	○	Alarm : motor temperature is greater than the parameter " MOTOR SHUTDOWN ".	Leave the truck at rest to allow the temperature to decrease.
33	D8	Model Mismatch	○	Alarm : parameter "TRUCK MODEL SEL." is being modified.	- Key off and on controller.
34	D9	Joystick Error	○	Joystick is in alarm.	- Check joystick alarm.
35	DA	Torque Profile	○	Parameter regarding the torque are not corrected.	- Perform clear EEPROM command.
36	DB	IQ Mismatched	○	Torque current doesn't follow the set point.	- Change the controller.

No	Code	Alarm name	Pump	Description	
				Cause	Troubleshooting
37	DE	Waiting For NODE	○	Warning : pump controller signals that other controllers are in alarm status.	- To recycle the key. - Check if any other alarm happens (Some alarms such as CHAT TIME or PEDAL WIRE KO, alarms related to CONTACTOR, DISPALY ENABLE, alarms reated to CANBUS can make this alarm sometimes.) - Check the communication with all controllers (display TRUCK MENU → MONITORING → choose controller → H/W ver, S/W ver. If CAN communication is not available, H/W ver, S/W ver will be blank.)
38	DF	Watchdog #1	○	Alarm : the watchdog signal #1 is not in the correct status.	- To remove alarm cause.
39	E0	AUX Coil Short	○	Alarm : shortcircuit on EB/ AUX coil.	- To remove alarm cause.
40	E2	CAN BUS KO SASA		sasa sensor CAN BUS data are not receive	- Check can connection between pump controller and sasa sensor.
41	E3	Watchdog#2	○	Alarm : the watchdog signal #2 is not in the correct status.	- To remove alarm cause.
42	E5	Safety Input	○	Alarm : the safety input is open (it is not connected to –Batt).	- To remove alarm cause.
43	E6	MC Coil Short	○	Alarm : shortcircuit on MC coil.	- To remove alarm cause.
44	E7	Coil Short HW KO	○	Alarm : the harware to check a MC or EB/AUX coil shorted is damaged.	- Check the controller.
45	E8	Key Off Short	○	Alarm : at start-up the keyoff logic signal is low.	- Check the connection. - Check the key input signal.
46	E9	Power MOS Short	○	Alarm : short circuit on the power Mosfets.	- Check the controller.
47	EB	Handbrake	○	Warning : handbrake microswitch is open and a travel request is active.	- To remove warning cause.
48	EC	Curremt Gain	○	Warning : the maximum current gain parameters are the default values, which means the maximum current adjustment procedure has not been carried out yet.	- Ask the assistance of an engineer at the development department to do the correct adjustment procedure of the current gain parameters.
49	ED	Analog Input	○	Alarm : the analog channel ready is not updated.	- Check the controller.

No	Code	Alarm name	Pump	Description Cause	Description Troubleshooting
50	EE	Wrong 0 Voltage	◯	Alarm : the motor phases voltage feedback are out of permitted range.	- To remove alarm cause.
51	EF	Safety Output	◯	Alarm : the safety-out driver is damaged (shorted or open).	- To remove alarm cause.
52	F0	Hardware Fault	◯	Alarm : the mosfets driver are not switched off with watch-dog signal in alarm status.	- Check the controller.
53	F1	Flash Checksum	◯	Alarm : the program verify is not OK.	- Try to program the controller again. - Check the controller logic board.
54	F2	Encoder Locked	◯	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.
55	F3	Sens Mot Temp KO		Warning : the output of the motor thermal sensor is out of range.	- To remove warning cause.
56	F4	Software Error	◯	Alarm : CANBUS line of ACE2 is in CANBUS line OFF condition.	- Check CANBUS connection. If CANBUS connection is OK, replace the logic of ACE2.
57	F5	Wrong RAM memory	◯	Alarm : the algorithm implemented to check the main RAM registers finds a wrong contents: the register is "dirty". This alarm inhibit the machine operations.	- Try to switch the key off and then on. If the alarm is still present, replace the ACE2 logic board.
58	F6	AUX Driv. Open	◯	Alarm : the AUX coil driver is not able to drive the load. The device itself or its driving circuit is damaged.	- This type of fault is not related to external components; replace the ACE2 logic board.
59	F7	Data Acquisition	◯	Alarm : data communication is now processing.	- If this alarm occurs, when sensor setting procedure, recycle the key.
60	F8	NO CAN MSG.	◯	Alarm : 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.
61	F9	Check Up Needed	◯	Warning : truck reached the hour time for maintenance.	- Reset the checkup hour time.
62	FA	Thermic Sens. KO	◯	Warning : pump temp. sensor is out of range.	- To remove warning cause.

No	Code	Alarm name	Pump	Description	
				Cause	Troubleshooting
63	FB	Wrong Set BAT.	○	Alarm : the battery voltage does not correspond to SET BATTERY programming.	- To remove alarm cause.
65	FD	Foc Lost	○	Field current doesn't follow the set point.	- Change the controller.
66	FE	AUX Driv. Shrt.	○	Alarm : the EB/AUX driver is shorted so it is not able to open the contactor.	- Check the controller.

3) DIAGNOSTIC FAULT CODES OF MHYRIO

No	Code	Alarm name	Description
1	8	WATCHDOG	The test is made in both running and standby. It is a self-diagnosing test within the logic. If an alarm should occur, replace the logic.
2	13	EEPROM KO	Fault in the area of memory in which the adjustment parameters are stored; this alarm inhibits machine operation. If the defect persists when the key is switched OFF and ON again, replace the logic. If the alarm disappears, remember that the parameters stored previously have been cancelled and replaced by the default values.
3	227	SLAVE COM. ERROR	Main uC and Slave uC communicate via a local serial interface. This alarm occurs when the main uC does not receive the communication from the slave uC through this serial interface. It is necessary to replace the controller.
4	228	"EVPG1 DRIV SHORT"	One of the Group 1 valves drivers is shorted; check the external connection, if it is ok the driver is probably damaged.
5	229	"EVPG2 DRIV SHORT"	One of the Group 2 valves drivers is shorted; check the external connection, if it is ok the driver is probably damaged.
6	230	"EVPG3 DRIV SHORT"	One of the Group 3 valves drivers is shorted; check the external connection, if it is ok the driver is probably damaged.
7	231	"EVPG4 DRIV SHORT"	One of the Group 4 valves drivers is shorted; check the external connection, if it is ok the driver is probably damaged.
8	232	"EVP 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	233	"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.
10	239	"EVP5_ OPEN_DELAY"	EVP Coil line is interrupet
11	241	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.
12	242	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.
13	243	EV DRIVER KO	One of the On/Off valves drivers is open (it does not close when it is commanded by the microcontroller).
14	244	"EVPG1 DRIVER KO"	One of the Group 1 valves drivers is open (it does not close when it is commanded by the microcontroller).
15	245	"EVPG2 DRIVER KO"	One of the Group 2 valves drivers is open (it does not close when it is commanded by the microcontroller).
16	246	"EVPG3 DRIVER KO"	One of the Group 3 valves drivers is open (it does not close when it is commanded by the microcontroller).

No	Code	Alarm name	Description
17	247	"EVPG4 DRIVER KO"	One of the Group 4 valves drivers is open (it does not close when it is commanded by the microcontroller).
18	248	UNDER VOLTAGE	This fault is signalled if an undervoltage condition is detected in the MHYRIO power supply
19	249	"EVP DRIVER KO"	The single proportional valve driver is open (it does not close when it is commanded by the microcontroller).
20	250	"HI SIDE DRIVER KO"	The high side driver which supply the valves coils positive is shorted or open.
21	251	"WRONG SET BAT."	This fault is signalled if the battery voltage is non consistent with the set battery programmed in the 'set option' menu.
22	252	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.

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 mm 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)
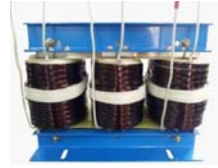
1	Main PCB board	5	Monitor PCB	9	Resistance (RD)
2	Main trans (Class H)	6	Overload	10	Resistance (DR)
3	Cooling fan	7	MG S/W		
4	SCR module	8	Assistant trans		

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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

36V battery	Capacity of cable	Input voltage	Remarks
200-365 AH	4P - 2.5 mm²		
400-80 AH	4P - 4 mm²		For 3 ø 220V, one step higher capacity cable should be used. (2.5 mm² → 4mm²)
600-800 AH	4P - 6 mm²		
850-1000 AH	4P - 10 mm²	Based on 3 ø 380 V 3 ø 440 V	
24 V battery	-		
200-600 AH	4P - 2.5 mm²		
700-1000 AH	4P - 4 mm²		
80V battery	-		
500-600 AH	4P - 6 mm²		
700-800 AH	4P - 10 mm²		

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.
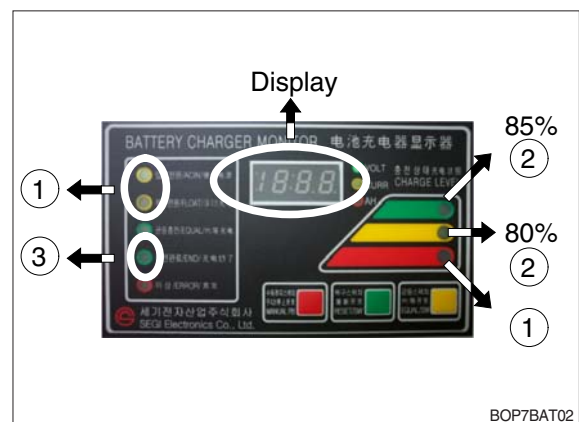
(2) Equalized charging

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.

22B9BAT01

BOP7BAT02

② **Tips for equalized charging**

If once push the equalized charging button on the monitor in the beginning of charging, the equalized charging lamp becomes on and starts charging.

※ **When the green charging condition lamp is on (over 85% charged), the equalized charging switch is locked that it does not operate even pushing the button.**

Equalized charge indicating lamp   Equalized charge S/W

22B9BAT03
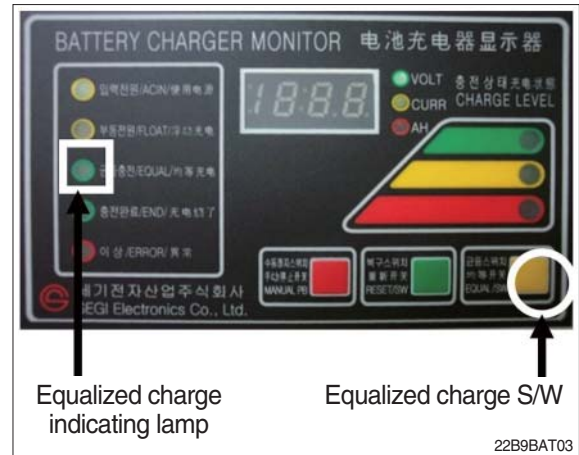
(3) Automatic/Manual switching method

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)

Manual connector connection   Automatic connector connection

J2   J2

MG/SW

22B9BAT04
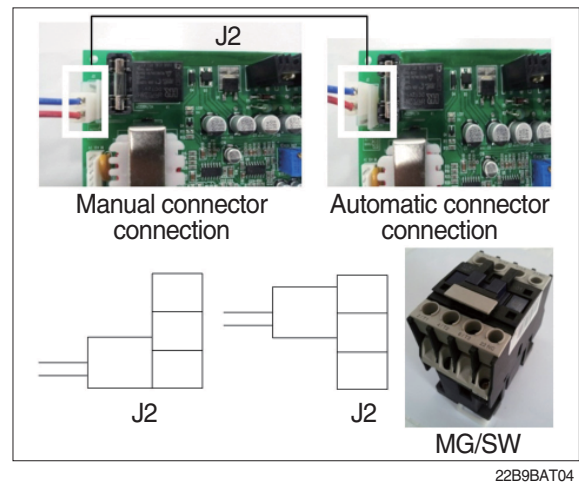
(4) Checking charging voltage soft start function (Refer to the monitor)

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 Iula64V 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 7-102
3	O.C	Over current - Refer to page 7-101, 7-103.
4	F.B	Battery error (After starting charging, the voltage doesn't go over 52 V 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 220/380 V wrong wiring). - Refer to page 7-100.
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.

Error indication

BOP7BAT12
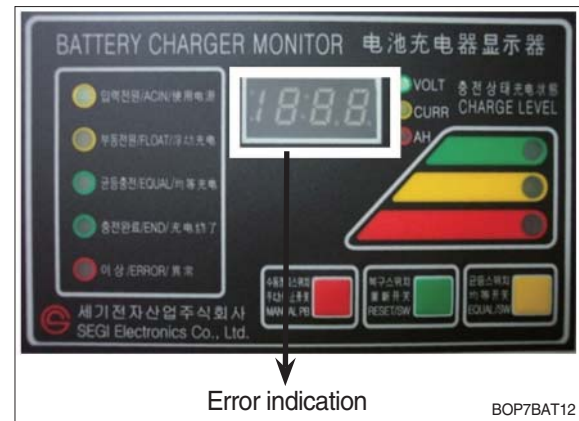
5) ERROR DETECTION

(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.

· 220/380V Model : Measure the voltage between input voltage change over tabs 2-4 2-6 4-6
· 220,380,410,440V Model : Measure the voltage in front of AC INPUT MS S/W

MS electric socket

Manual/Auto TAP (J2)

Check the rated voltage

YES →

Insert automatic/ manual connector (J2) at the upper part of PCB to manual, after separating battery connector.

→

AC INPUT MS switch ON

YES →

PCB LP lamp lights up

YES →

NO (from AC INPUT MS switch ON)

NO (from PCB LP lamp lights up)

Change PCB

CN4 contact fault
PCB RY contact fault

Put a black lead of multi-tester to input voltage switch No. 6 and measure voltage between tab No.8,PCB CN4,TH contact points with a red lead.

NO (from Check the rated voltage)

Voltage 220V

NO →

TH contact fault
CN4 contact fault
PCB RELAY fault
TH manual restoration release

YES →

MS COIL fault

Input power supply is not supplied.

· Check external lead cable.
· Check the connection of external input connecter
· Check external NFB TRIP

TB.4 (380V) TB.8(220V)

70 Ω / 30W

M/S B

T.B short bar   7   8

Voltage tap

J2

PCB RY (LP lamp)

TH *

Manual / Auto S/W

M/S COIL   ⊗ FAN

TB.6

M/S electrical circuit

Relay contact point   Relay

7-100

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).

OUTPUT
CURRENT

DE-CREASE → ↻ → IN-CREASE

```
                                                                    Adjust output current
Trans          NO    Measure output         Current         NO    Exceed            AMP, VR within PCB
noise is  ─────────  current using DC  ───  value : 10~16A  ────   Standard  ─────  Re-adjust to VR
severe at             current measure       /100AH                 current
MS ON
status                                        │YES

                                         · TH Setting fault                  YES
                                         · Re-adjust TH    ────  TH. TRIP  ──────  Change TH
                                           setting value
 YES
              * Refer to SCR                                  │NO                    Rated
                Module  checking                                                     Current
                method                                      Complete                 SETTING

                                                                              YES         NO

                                                                           Complete   Change PCB
```

```
                                   NO                      Change
                        ──────────────────────────────    SCR MODULE
Separate the battery          Check
connector and tune   ─────    SCR
the charger off               Module        Check
                              │YES          MAIN       NO    Change        Check the normal
                                        ──  TRANS   ──────  PCB    ─────    operating condition
                                            VOLT                            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)

After separating battery connector, insert automatic/manual selection connector(J2) at the left side of PCB to manual and then, MS will be turned "ON"

→

Check the voltage of the output connecter 64V?

NO →

Rotate charging voltage volume, located in the middle of PCB, to counterclockwise.

Adjust a real output voltage identical to displayed voltage

De-crease | In-crease

VOLT

YES ↓

Reset voltage as turning volume volt for setting voltage on the center of PCB

Measure the voltage of the output connecter 64V?

YES →

OK

NO ↓

Adjust voltage so as to have same output between actual output voltage and indication of display

De-crease | In-crease

Check contact error or breaking of wiring of the detect cable connecter pin

NO → Change PCB

Check whether the charger is normal condition after connecting the battery 64V?

Check the detect voltage of the J3 connector

YES → OK

NO →

NO ↓
Change PCB

YES ↓
OK

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.

Restart the charger as pushing reset switch in the monitor.

Monitor display

Measure the output current by DC current measure 10~16A/100AH

NO →

Check poor contact of current connector (J1), located right side of PCB; check if there is disconnection (cleaning and wiring)

YES

Re-establish charge current volume (AMP) on the center side of PCB as turning it anti clockwise rotation

Request A/S if problem persists after adjustment

De-crease   In-crease

Measure the output current by DC current measure

YES — OK

NO — Change PCB

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.

```
┌─────────────────────┐
│     If charging     │
│ current measurement │  NO   ┌──────────────────────┐      ┌──────────────────┐
│ is normal when it is├──────►│ After separating     ├─────►│ Measure the output│
│    measured with    │       │ battery connector,   │      │   voltage  64V   │
│     DC ammeter      │       │ put the automatic/   │      └──────────────────┘
└──────────┬──────────┘       │ manual S/W (J2) to   │         │            │
        YES│                  │ manual               │       NO│         YES│
           ▼                  └──────────────────────┘         ▼            ▼
┌──────────────────────┐                                ┌──────────┐  ┌──────────────────┐
│ Change PCB or        │              J2                │  Check   │  │ Contact fault    │
│ Request After-Service│                                │SCR Module│  │ between the      │
└──────────────────────┘                                │  Normal  │  │ battery connector│
                                                        └────┬──┬──┘  │ and charger      │
                                                          NO │  │ YES │ connector Battery │
                                                             ▼  ▼     │ is over-discharged│
                                                    ┌────────┐ ┌──────┐└──────────────────┘
                                                    │ Change │ │Change│
                                                    │SCR     │ │ PCB  │
                                                    │Module  │ │      │
                                                    └────────┘ └──────┘
```
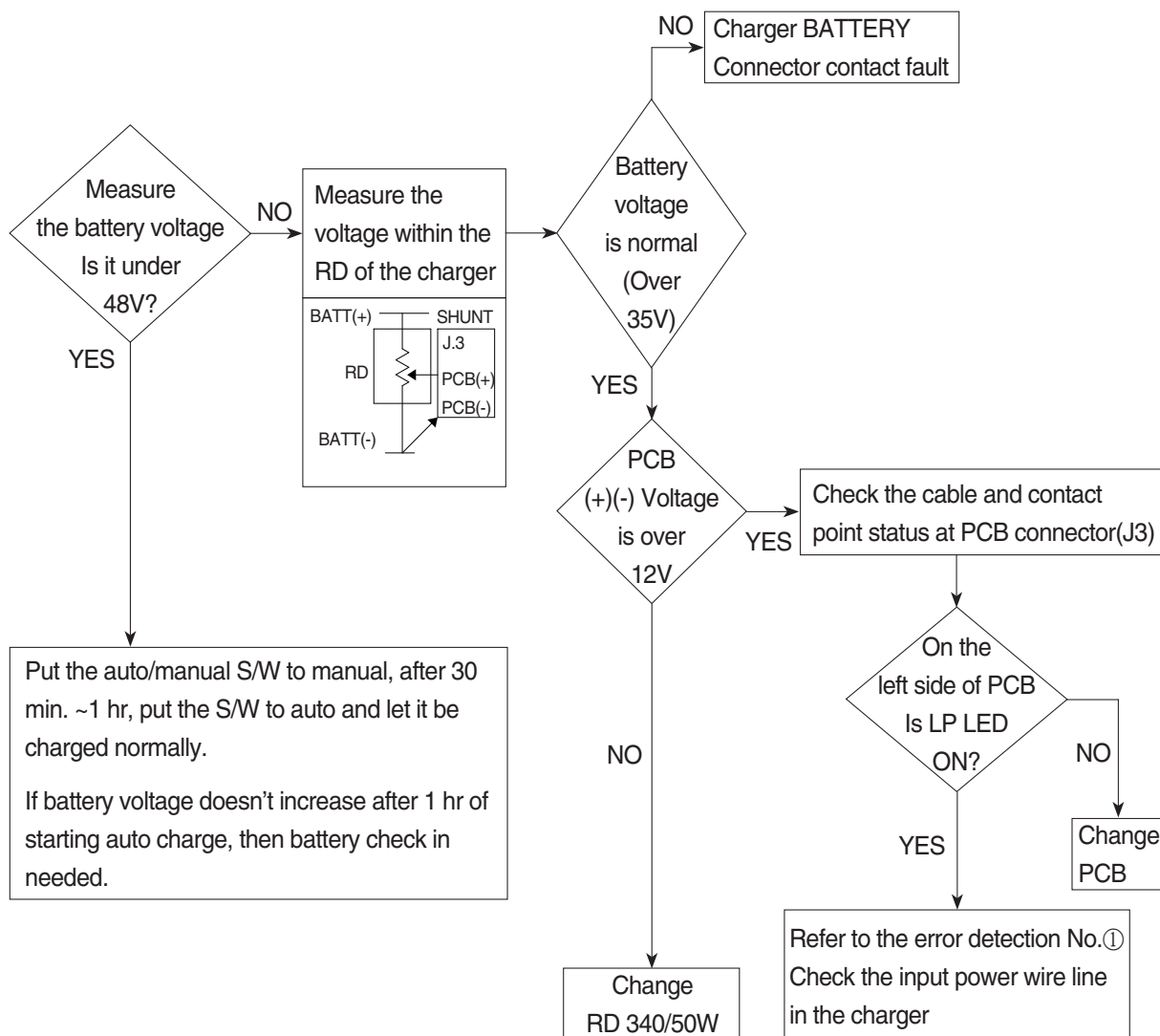
After separating battery connector, put the automatic/ manual S/W (J2) to manual

J2

Measure the output voltage 64V

Check SCR Module — Normal

Contact fault between the battery connector and charger connector Battery is over-discharged

Change SCR Module

Change PCB

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)
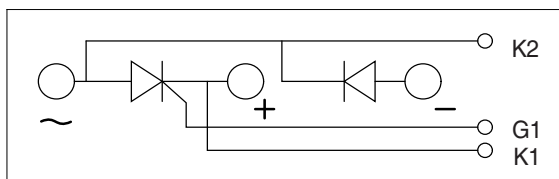
NO → Charger BATTERY Connector contact fault

Measure the battery voltage Is it under 48V? — NO → Measure the voltage within the RD of the charger

BATT(+) ——— SHUNT
                J.3
RD   PCB(+)
            PCB(-)
BATT(-)

Battery voltage is normal (Over 35V)

YES (from Measure the battery voltage)

Put the auto/manual S/W to manual, after 30 min. ~1 hr, put the S/W to auto and let it be charged normally.

If battery voltage doesn't increase after 1 hr of starting auto charge, then battery check in needed.

YES → PCB (+)(-) Voltage is over 12V — YES → Check the cable and contact point status at PCB connector(J3)

NO → Change RD 340/50W

On the left side of PCB Is LP LED ON? — NO → Change PCB

YES → Refer to the error detection No.① Check the input power wire line in the charger

RD
BATT(+)
70Ω 12V or higher
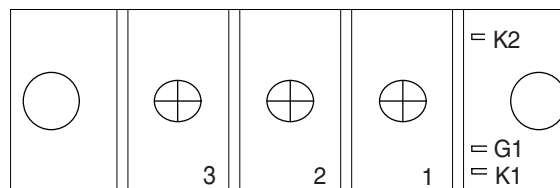BATT(-)
(based on 48V)

LP, LED

## 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 (∞)

SURGE PCB
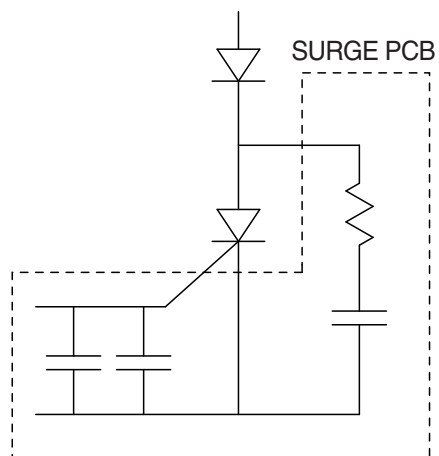
8) PCB MAJOR PARTS (NAME AND LOCATION)
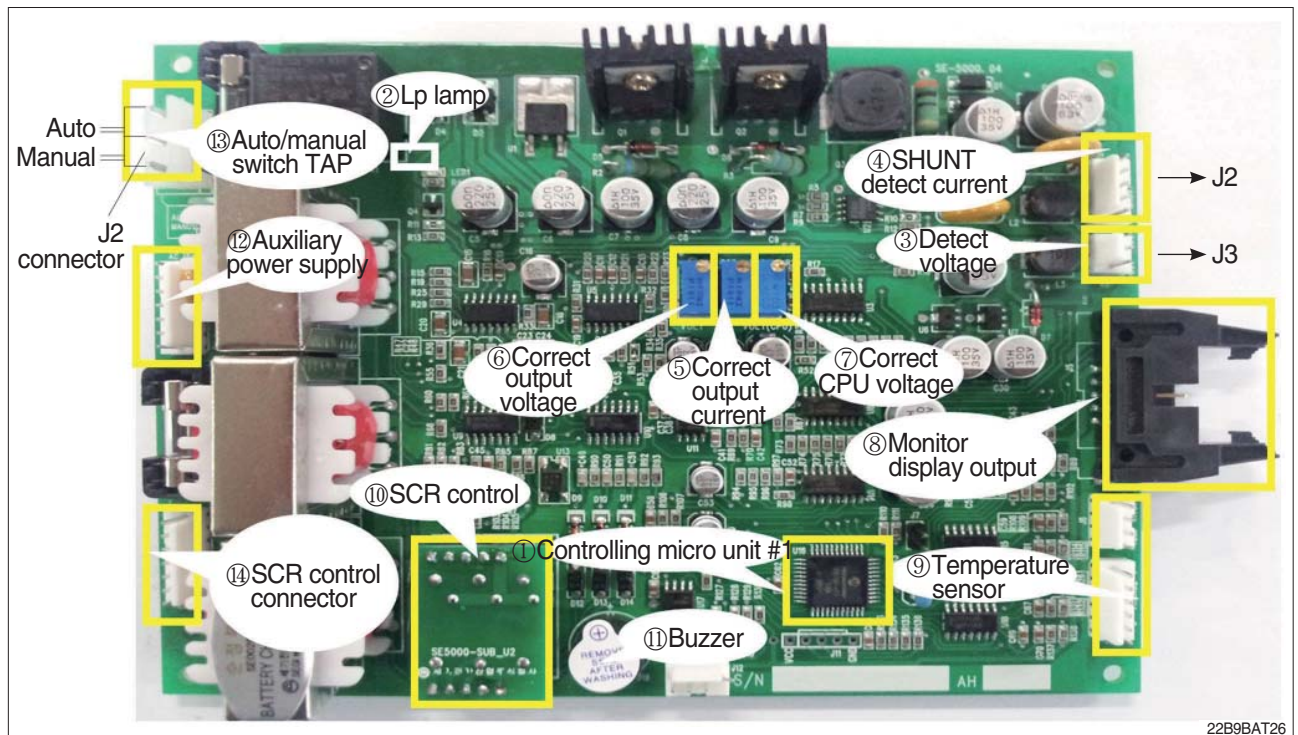
22B9BAT26

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		

22B9BAT27

7-108
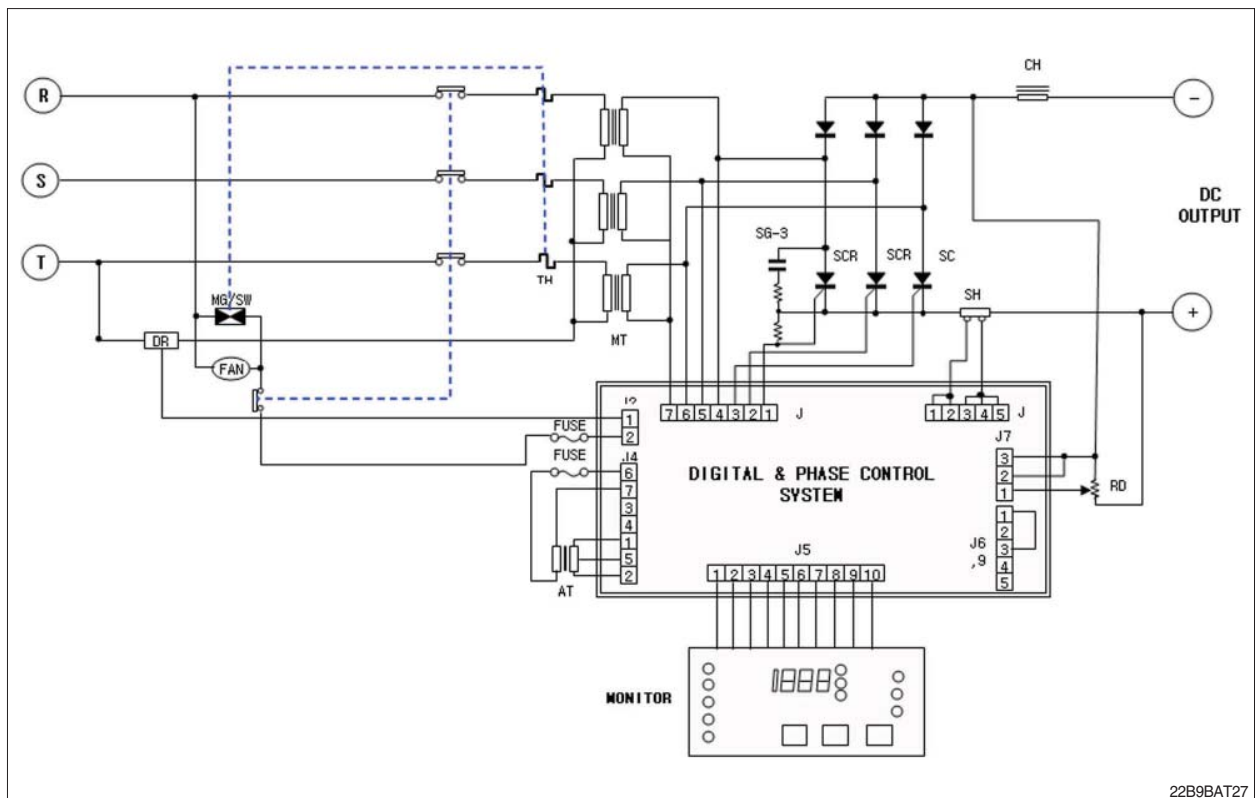
CHARGER INTERIOR PARTS
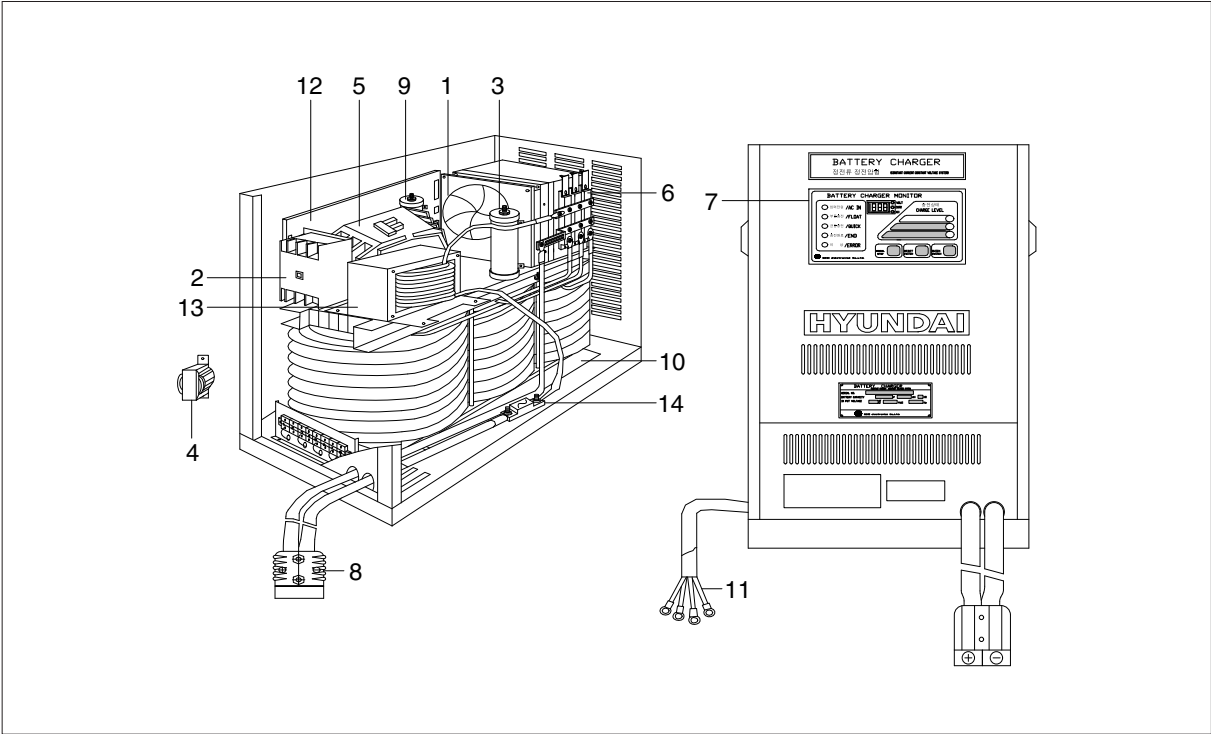
22B9BAT28

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. 3 STAGE MAST (TF MAST)

CARRIAGE

FREE LIFT
CYLINDER

LIFT
CYLINDER
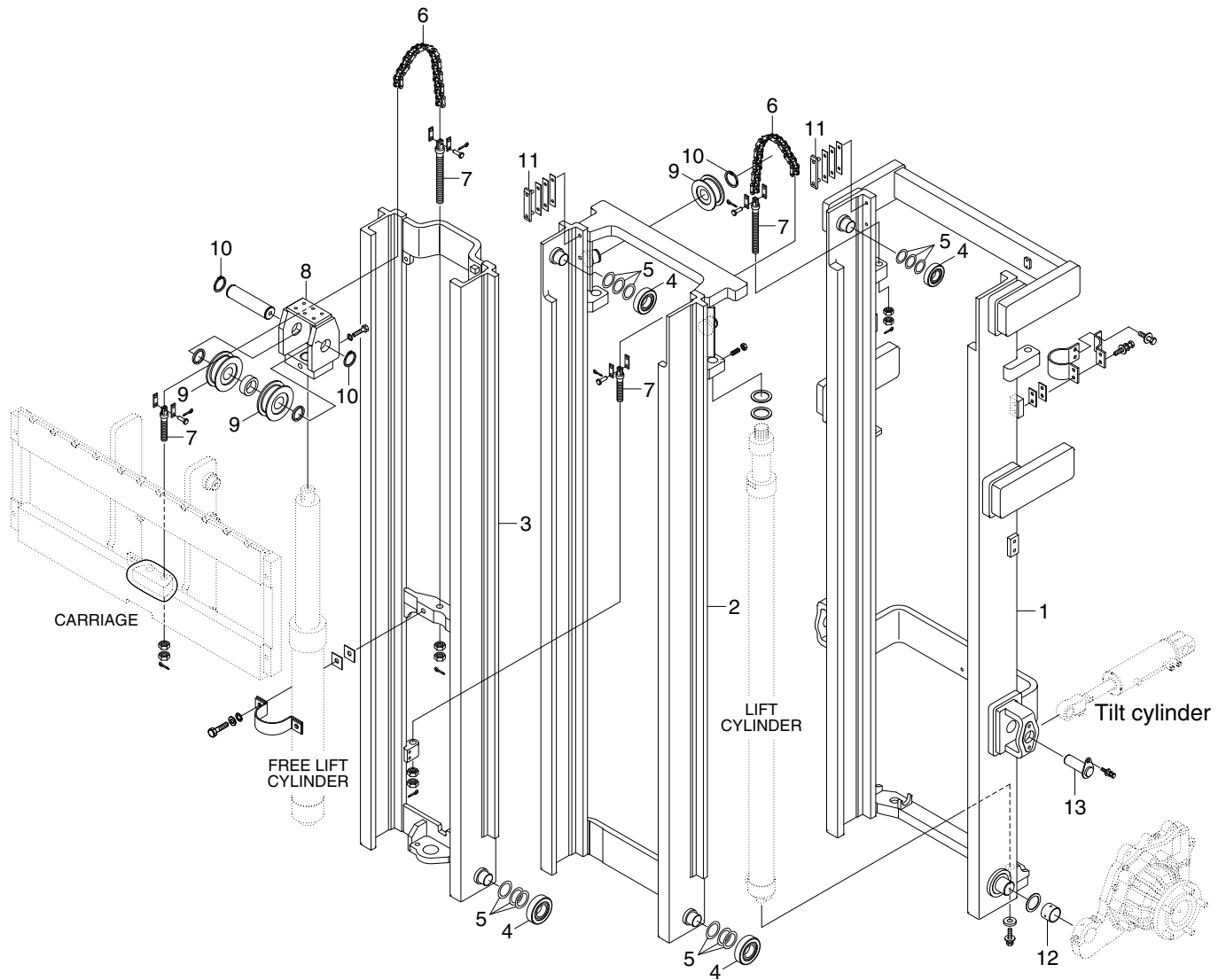
Tilt cylinder

18BCS9MS03

1	Outer mast	6	Lift chain	11	Back up liner
2	Middle mast	7	Anchor bolt	12	Bushing
3	Inner mast	8	Sheave bracket	13	Tilt cylinder mounting pin
4	Roller	9	Sheave		
5	Shim (0.5, 1.0t)	10	Retaining ring		

2. CARRIAGE, BACKREST AND FORK
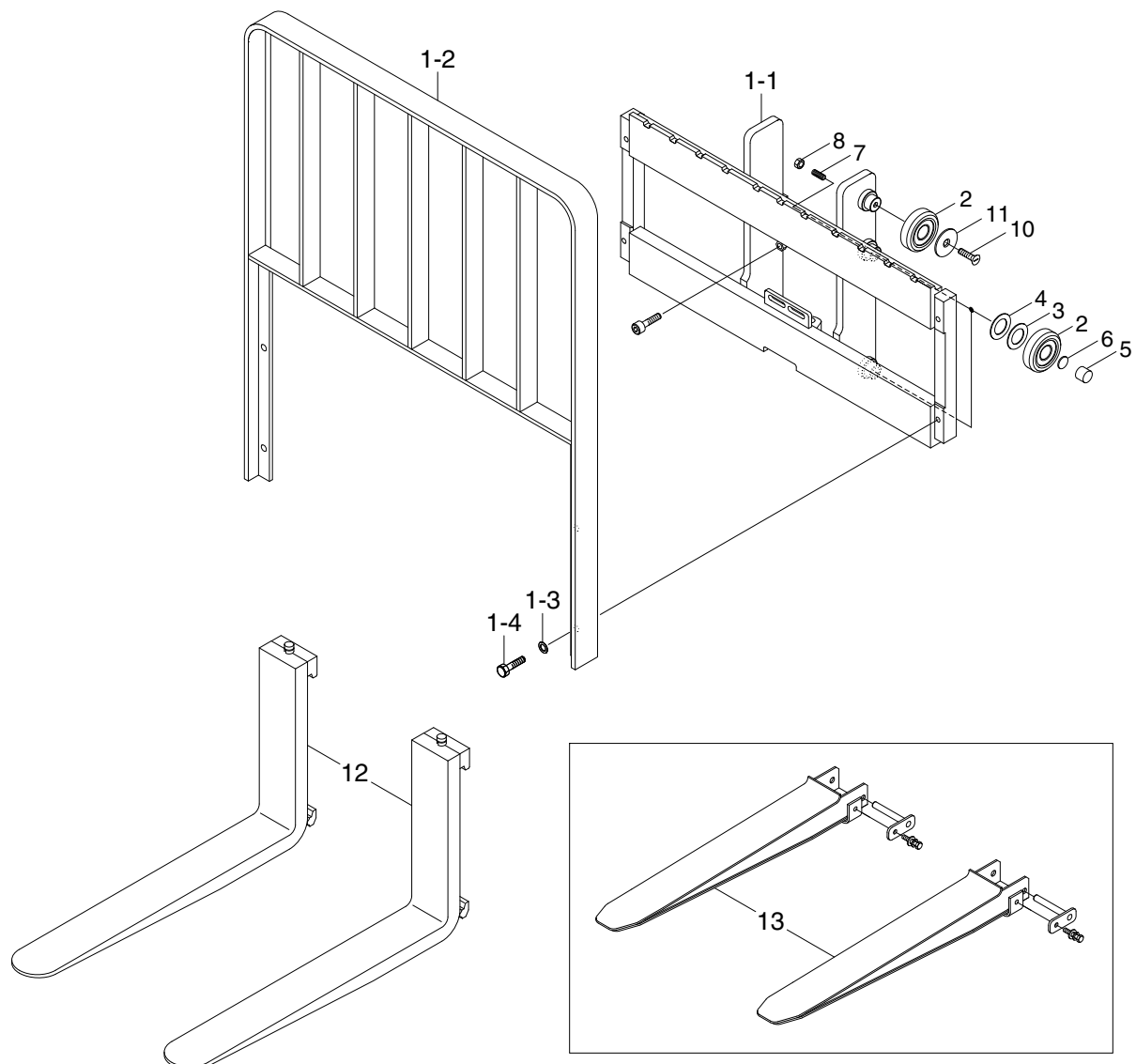
18BCS9MS05

|							
1-1	Carriage	4	Shim (1.0t)	10	Flat head bolt
1-2	Backrest	5	Bushing	11	Retaining washer
1-3	Hardened washer	6	Back plate	12	Fork assy
1-4	Hexagon bolt	7	Socket bolt	13	Extention fork
2	Road roller	8	Hexagon nut		
3	Shim (0.5t)	9	Socket bolt		

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 = 1050 mm (41.3 in)

mm (in)

STD Fork assy	Applicable model	Standard	Limit
64HM-11040	15/18/20BCS-9	40 (1.6)	36 (1.4)

Thickness

B153FK01
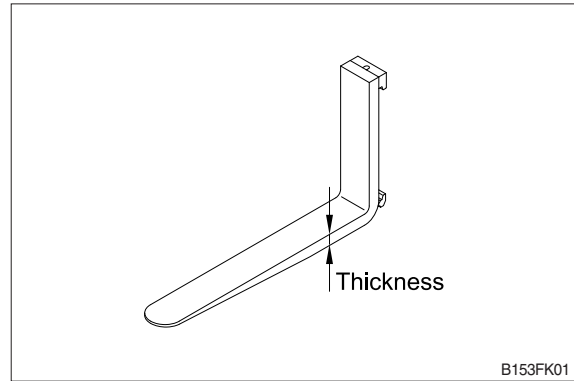
(2) Set forks in middle and measure difference in height at top of forks.

Model	Fork length (mm)	Height difference (mm)
15/18BCS-9 20BCS-9	equal or below 1500	3
	above 1500	4

Difference in height at tip of forks

D255FK02
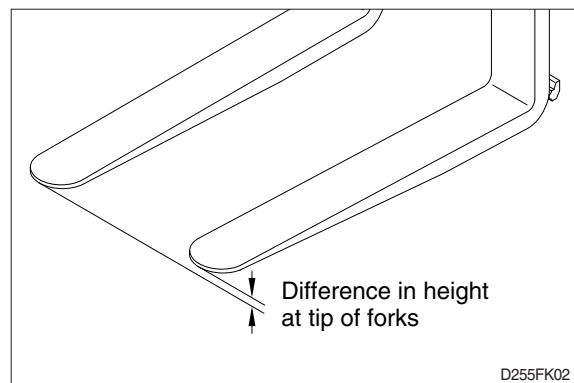
(3) Most force is concentrated at root of fork and at hook, so use crack detection method to check cracks.

2. MAST

1) Check for cracks at mast stay, tilt cylinder bracket, guide bar, fork carriage and roller shaft weld. Check visually or use crack detection method. Repair any abnormality.

2) Set mast vertical, raise forks about 10cm from ground and check front-to-rear clearance and left-to-right clearance between inner mast and fork carriage, and between outer mast and inner mast. Use these figures to judge if there is any play at roller or rail.
   · Front-to-rear clearance : Within 2.0 mm (0.08 in)
   · Left-to-right clearance : Within 2.5 mm (0.10 in)

3) Check that there is an oil groove in bushing at mast support.

4) Set mast vertical, raise forks about 10 cm 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. · Faulty hydraulic equipment.	· Disassembly, repair or replace. · See Troubleshooting Hydraulic Cylinders, pump and control valve in section 6, hydraulic system.
	· Damaged load and side rollers. · Unequal chain tension between LH & RH sides. · LH & RH mast inclination angles are unequal. (Mast assembly is twisted when tilted)	· Replace. · Adjust chains. · Adjust tilt cylinder rods.
Abnormal noise is produced when mast is lifted and lowered.	· Broken load roller bearings. · Broken side roller bearings. · Deformed masts. · Bent lift cylinder rod. · Deformed carriage. · Broken sheave bearing.	· Replace. · Replace. · Disassemble, repair or replace. · Replace. · Replace. · Replace.
Abnormal noise is produced during tilting operation.	· Insufficient lubrication of anchor pin, or worn bushing and pin. · Bent tilt cylinder rod.	· Lubricate or replace. · Replace.

2) FORKS

Problem	Cause	Remedy
Abrasion	Long-time operations causes the fork to wear and reduces the thickness of the fork. Inspection for thickness is needed. · Wear limit : Must be 90% of fork thickness	If the measured value is below the wear limit, replace fork.
Distortion	Forks are bent out of shape by a number of reasons such as overloading, glancing blows against walls and objects, and picking up load unevenly. · Difference in fork tip height 	If the measured value exceeds the allowance, replace fork.
Fatigue	Fatigue failure may result from the fatigue crack even though the stress to fork is below the static strength of the fork. Therefore, a daily inspection should be done. · Crack on the fork heel. · Crack on the fork weldments.	Repair fork by expert. In case of excessive distortion, replace fork.

Difference in fork tip height:

| Fork length (mm)	Height difference (mm)
equal or below 1500	3
above 1500	4

GROUP 3 ADJUSTMENT

1. MAST LOAD ROLLER (TF MAST)

1) INNER AND MIDDLE MAST ROLLER CLEARANCE ADJUSTMENT

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

(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 = 0.3~0.6 mm
　· Shim thickness　　　　0.5, 1.0 mm

(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.

15L7MS06
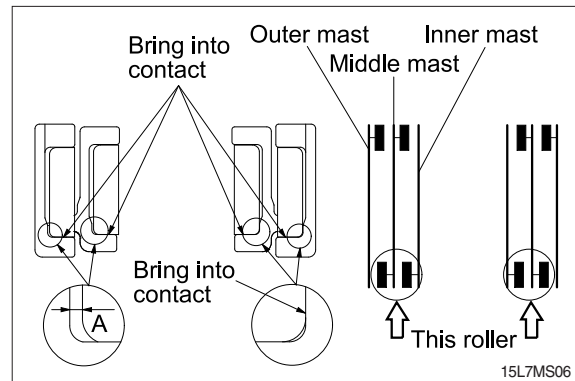
2) OUTER AND MIDDLE MAST UPPER ROLLER CLEARANCE ADJUSTMENT.

(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 = 0.3~0.6 mm
　· Shim thickness　　　　0.5, 1.0 mm

15L7MS07

(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.
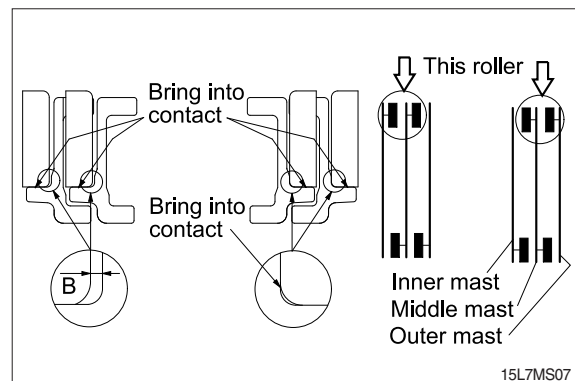
3) CARRIAGE LOAD ROLLER

(1) Measure the clearance when the center of the carriage upper roller is 100 mm 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 mm
· Shim thickness   0.5, 1.0 mm

(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.
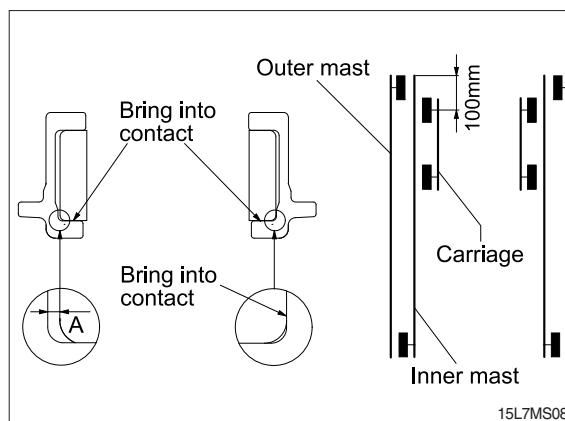
4) MAST BACK UP LINER

(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 mm
· Shim thickness   0.5, 1.0 mm

(3) After the adjustment, the mast should move smoothly.
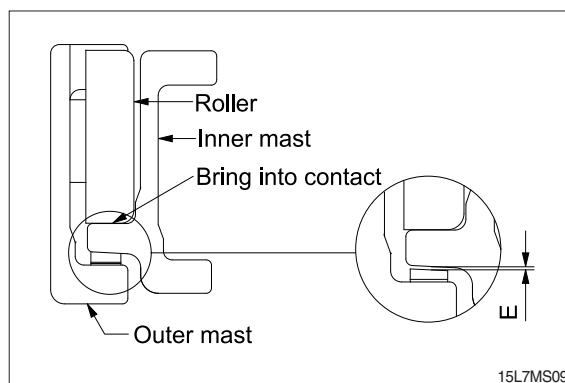
GROUP 4 REMOVAL AND INSTALLATION

1. FORKS

1) Lower the fork carriage until the forks are approximately 25 mm (1 inch) 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.

15BT9MS10
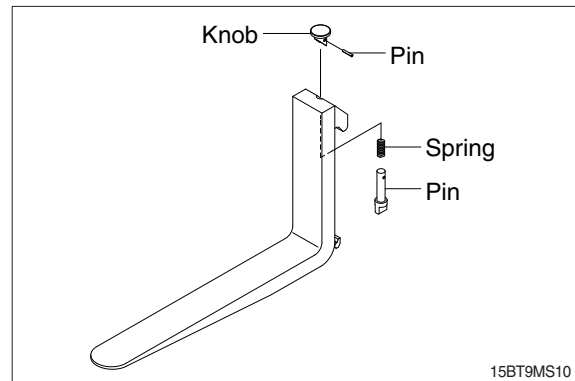
2. BACKREST

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.

18BCS9RE03
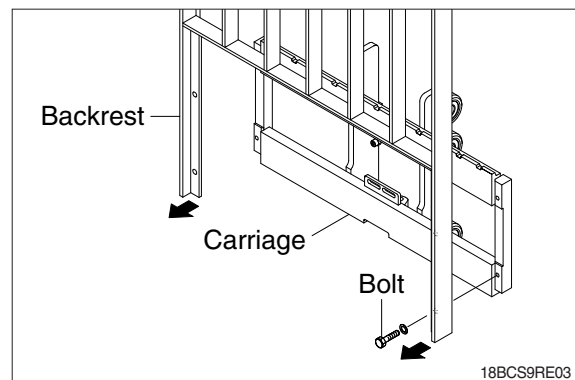
3. CARRIAGE ASSEMBLY

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.

Carriage load roller

18BCS9MS05-1
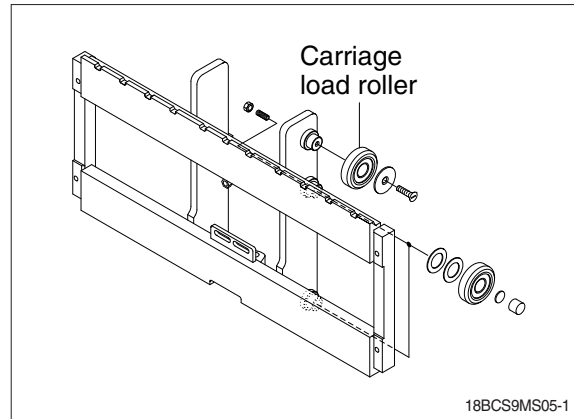
3) MAST LOAD ROLLER AND BACK UP LINER

(1) 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.

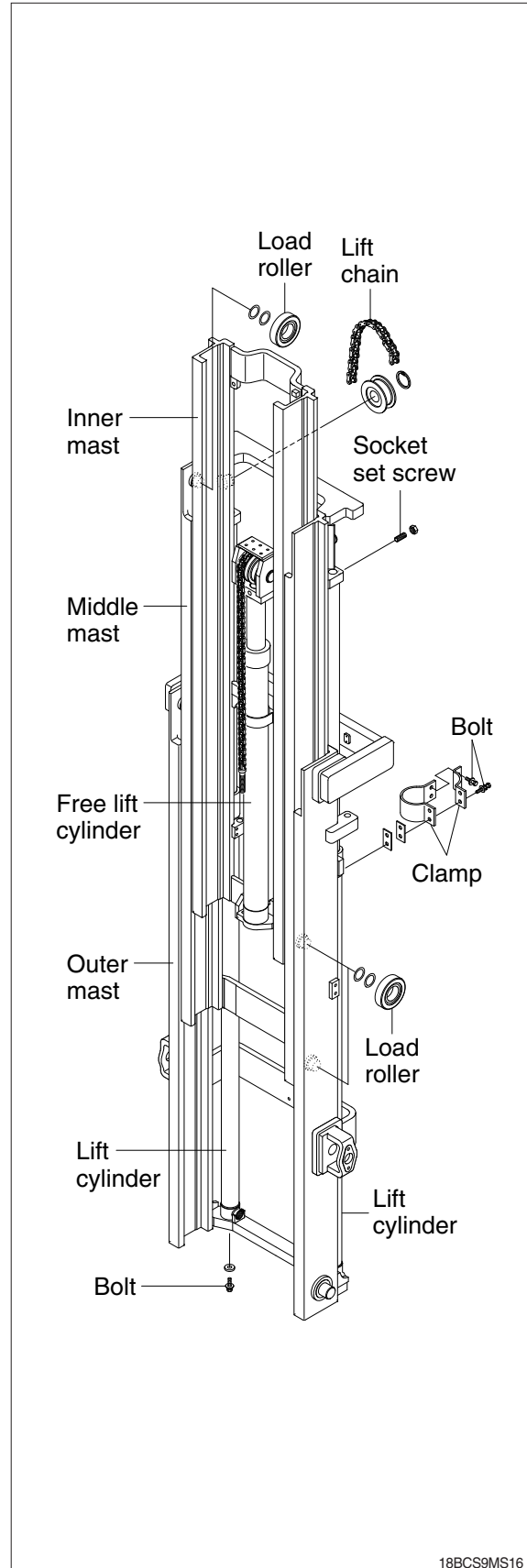④ Attach chains or sling to the inner and middle mast section at top crossmember. Using an overhead hoist, slowly raise the uprights high enough to clear lift cylinder.

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 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) 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.

Free lift chain
Inner mast
Lift chain
Carriage
Free lift cylinder
Middle mast
Outer mast

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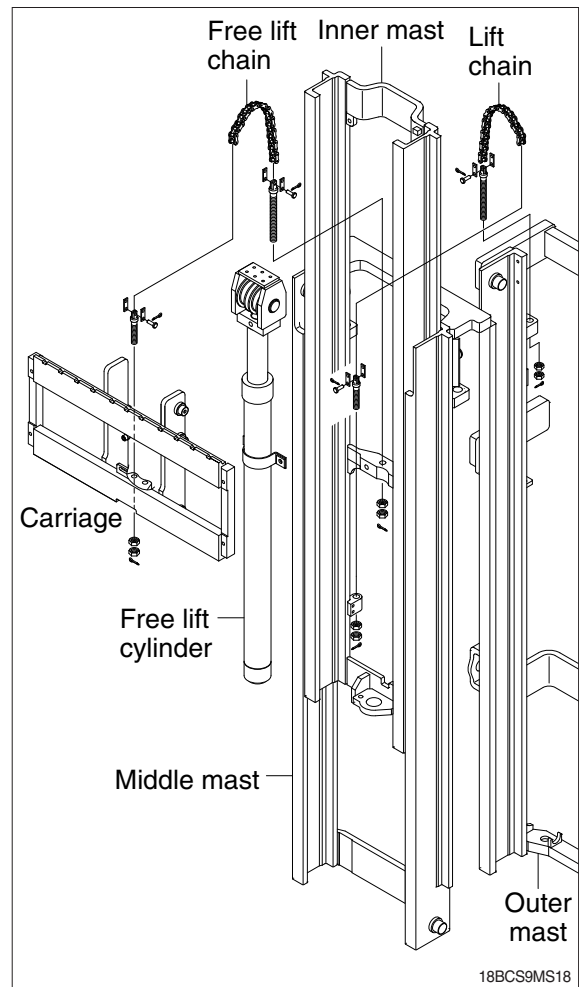
(2) Chain wheel bearing support(TF mast)

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.

(3) 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.

(4) 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.

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

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

(6) 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.