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SECTION 3 POWER TRAIN SYSTEM

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1. STRUCTURE

This service manual has been prepared as an aid to improve the quality of repairs by giving the serviceman an accurate understanding of the product and by showing him the correct way to perform repairs and make judgements. Make sure you understand the contents of this manual and use it to full effect at every opportunity.

This service manual mainly contains the necessary technical information for operations performed in a service workshop.

For ease of understanding, the manual is divided into the following sections.

Structure and function

This group explains the structure and function of each component. It serves not only to give an understanding of the structure, but also serves as reference material for troubleshooting.

Operational checks and troubleshooting

This group explains the system operational checks and troubleshooting charts correlating problem to remedy.

Tests and adjustments

This group explains checks to be amide before and after performing repairs, as well as adjustments to be made at completion of the checks and repairs.

Disassembly and assembly

This section explains the order to be followed when removing, installing, disassembling or assembling each component, as well as precautions to be taken for these operations.

The specifications contained in this shop manual are subject to change at any time and without any advance notice. Contact your HD Hyundai Construction Equipment distributor for the latest

2. HOW TO READ THE SERVICE MANUAL

Distribution and updating

Any additions, amendments or other changes will be sent to HD Hyundai Construction Equipment distributors.
Get the most up-to-date information before you start any work.

Filing method

1. See the page number on the bottom of the page.
   File the pages in correct order.
2. Following examples shows how to read the page number.
   Example 1
   3 - 3
   Section number (3. Power train system)
   Consecutive page number for each section.
3. Additional pages : Additional pages are indicated by a hyphen(-) and number after the page number. File as in the example.
   10 - 4
   10 - 4 - 1
   10 - 4 - 2 Added pages
   10 - 5

Revised edition mark (①②③…)

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

Revisions

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

Symbols

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

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

3. CONVERSION TABLE

Method of using the Conversion Table

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

Example

1. Method of using the Conversion Table to convert from millimeters to inches
   Convert 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 5in the row across the top, take this as ⓑ, then draw a perpendicular line down from ⓑ.
   (3) Take the point where the two lines cross as ⓒ. This point ⓒ gives the value when converting from millimeters to inches. Therefore, 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

1mm = 0.03937 in

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

Millimeters to inches

1mm = 0.03937in

	0	1	2	3	4	5	6	7	8	9
0		0.039	0.079	0.118	0.157	0.197	0.236	0.276	0.315	0.354
10	0.394	0.433	0.472	0.512	0.551	0.591	0.630	0.669	0.709	0.748
20	0.787	0.827	0.866	0.906	0.945	0.984	1.024	1.063	1.102	1.142
30	1.181	1.220	1.260	1.299	1.339	1.378	1.417	1.457	1.496	1.536
40	1.575	1.614	1.654	1.693	1.732	1.772	1.811	1.850	1.890	1.929
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80	3.150	3.189	3.228	3.268	3.307	3.346	3.386	3.425	3.465	3.504
90	3.543	3.583	3.622	3.661	3.701	3.740	3.780	3.819	3.858	3.898

Kilogram to Pound

1kg = 2.2046lb

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

Liter to U.S. Gallon

1 ℓ = 0.2642 U.S.Gal

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

Liter to U.K. Gallon

1 ℓ = 0.21997 U.K.Gal

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

kgf · m to lbf · ft

1kgf · m = 7.233lbf · ft

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

kgf/cm2 to lbf/in2

1kgf / cm2 = 14.2233lbf / in2

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

TEMPERATURE

Fahrenheit-Centigrade Conversion.
A simple way to convert a fahrenheit temperature reading into a centigrade temperature reading or vice verse is to enter the accompanying table in the center or boldface column of figures.
These figures refer to the temperature in either Fahrenheit or Centigrade degrees.
If it is desired to convert from Fahrenheit to Centigrade degrees, consider the center column as a table of Fahrenheit temperatures and read the corresponding Centigrade temperature in the column at the left.
If it is desired to convert from Centigrade to Fahrenheit degrees, consider the center column as a table of Centigrade values, and read the corresponding Fahrenheit temperature on the right.

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

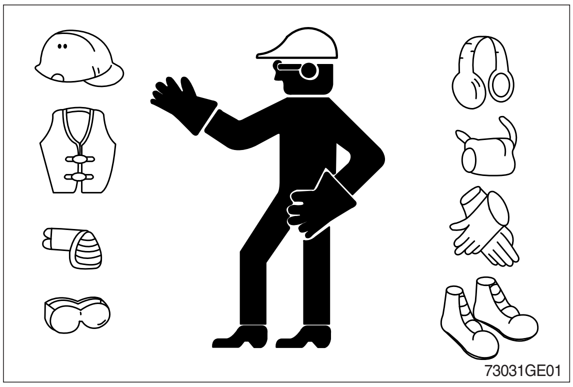
SECTION 1 GENERAL

GROUP 1 SAFETY HINTS

FOLLOW SAFE PROCEDURE

Unsafe work practices are dangerous. Understand service procedure before doing work; Do not attempt shortcuts.

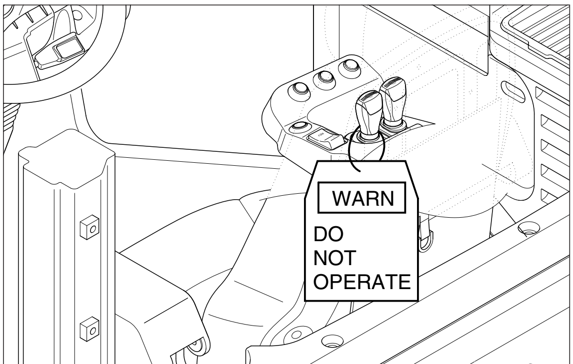
WEAR PROTECTIVE CLOTHING


73031GE01

Wear close fitting clothing and safety equipment appropriate to the job.

- Do not wear loose clothing and accessories. Secure long hair. These items can snag on controls or on other parts of equipment.
- Do not wear oily clothes. They are highly flammable.
- Wear a hard hat, safety shoes, safety goggles, mask, leather gloves, earplugs and other protective equipment, as required.
- While working on machine, never use inadequate tools. They could break or slip, or they may not adequately perform intended.

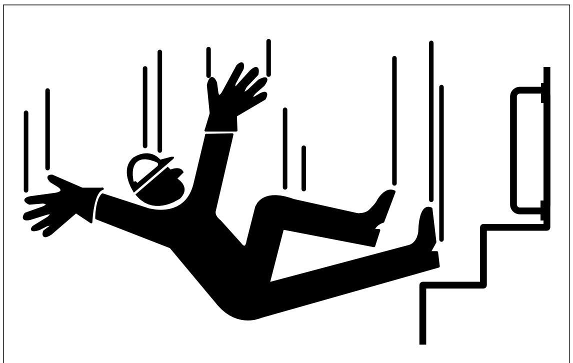
WARN OTHERS OF SERVICE WORK



760F1GE01

Unexpected machine movement can cause serious injury.
Before performing any work on the wheel loader, attach a 「**Do Not Operate**」 tag on the right side controller lever.

USE HANDHOLDS AND STEPS


73032E01

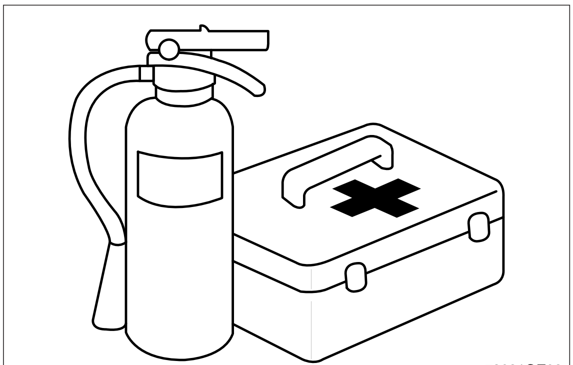
Falling is one of the major causes of personal injury.
When you get on and off the machine, always maintain a three point contact with the steps and handrails and face the machine. Do not use any controls as handholds.
Never jump on or off the machine. Never mount or dismount a moving machine.
Be careful of slippery conditions on platforms, steps, and handrails when leaving the machine.

PREPARE FOR EMERGENCIES

Be prepared if a fire starts.

Keep a first aid kit and fire extinguisher handy.

Keep emergency numbers for doctors, ambulance service, hospital, and fire department near your telephone.

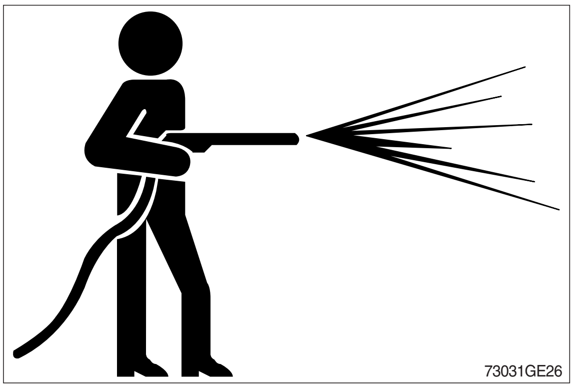


73031GE03

WORK IN CLEAN AREA

Before starting a job :

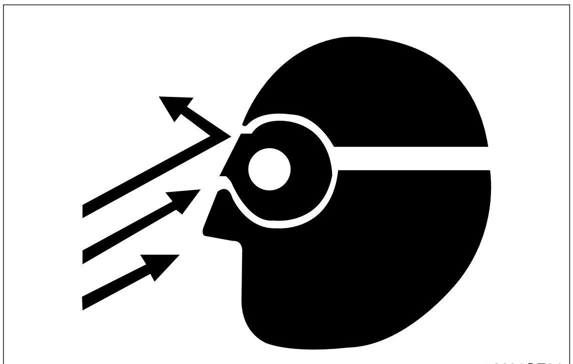
· Clean work area and machine.
· Make sure you have all necessary tools to do your job.
· Have the right parts on hand.
· Read all instructions thoroughly; Do not attempt shortcuts.



73031GE26

PROTECT AGAINST FLYING DEBRIS

Guard against injury from flying pieces of metal or debris; Wear goggles or safety glasses.

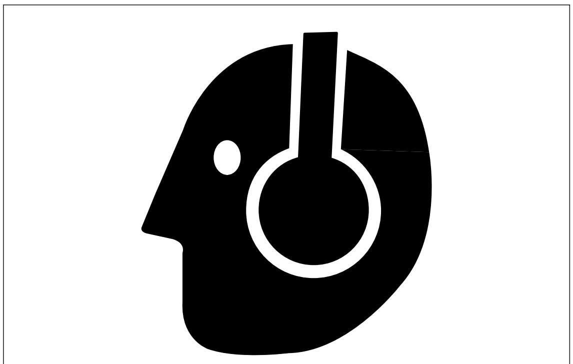


73031GE04

PROTECT AGAINST NOISE

Prolonged exposure to loud noise can cause impairment or loss of hearing.

Wear a suitable hearing protective device such as earmuffs or earplugs to protect against objectionable or uncomfortable loud noises.

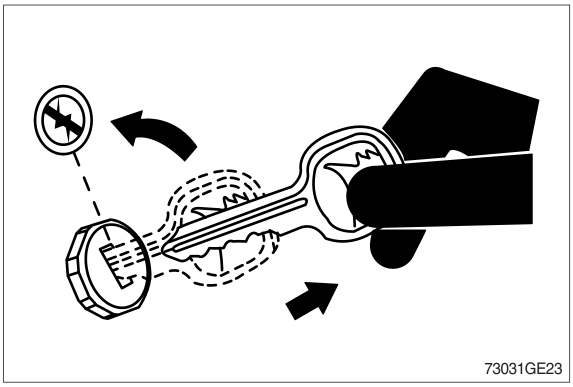


73031GE05

PARK MACHINE SAFELY

Before working on the machine:

- Park machine on a level surface.
- Lower bucket to the ground.
- Turn key switch to OFF to stop engine. Remove key from switch.
- Move pilot control shutoff lever to locked position.
- Allow engine to cool.

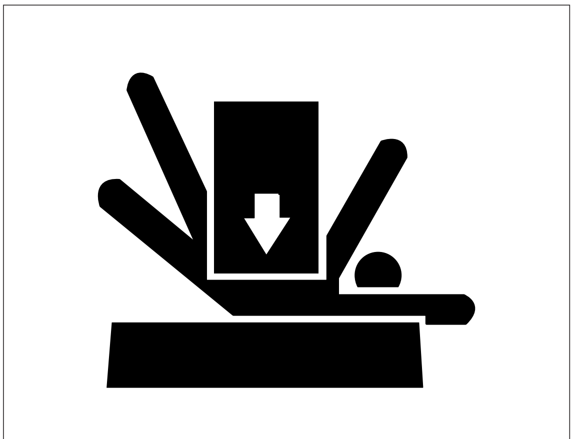


73031GE23

SUPPORT MACHINE PROPERLY

Always lower the attachment or implement to the ground before you work on the machine. If you must work on a lifted machine or attachment, securely support the machine or attachment.

Do not support the machine on cinder blocks, hollow tiles, or props that may crumble under continuous load.
Do not work under a machine that is supported solely by a jack. Follow recommended procedures in this manual.

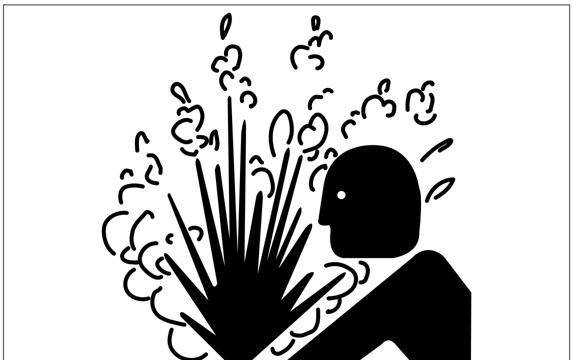


73031GE06

SERVICE COOLING SYSTEM SAFELY

Explosive release of fluids from pressurized cooling system can cause serious burns.

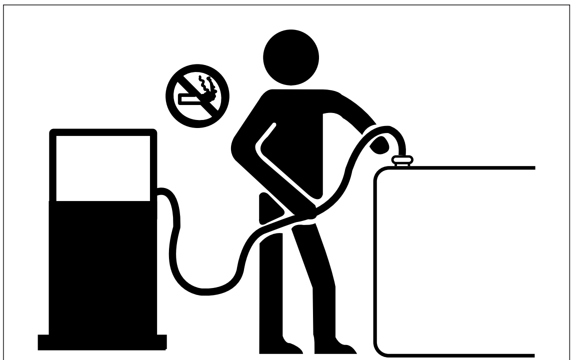
Shut off engine. Only remove filler cap when cool enough to touch with bare hands.



73031GE07

HANDLE FLUIDS SAFELY-AVOID FIRES

Handle fuel with care; It is highly flammable. Do not refuel the machine while smoking or when near open flame or sparks. Always stop engine before refueling machine.
Fill fuel tank outdoors.



73031GE08

Store flammable fluids away from fire hazards. Do not incinerate or puncture pressurized containers.

Make sure machine is clean of trash, grease, and debris.

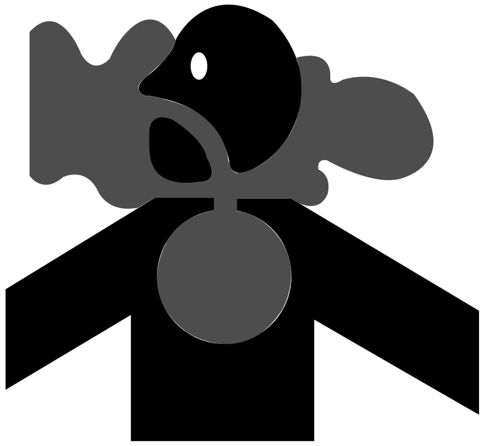
Do not store oily rags ; They can ignite and burn spontaneously.

73031GE09

BEWARE OF EXHAUST FUMES

Prevent asphyxiation. Engine exhaust fumes can cause sickness or death.

If you must operate in a building, be positive there is adequate ventilation. Either use an exhaust pipe extension to remove the exhaust fumes or open doors and windows to bring enough outside air into the area.



73031GE10

REMOVE PAINT BEFORE WELDING OR HEATING

Avoid potentially toxic fumes and dust.

Hazardous fumes can be generated when paint is heated by welding, soldering, or using a torch.

Do all work outside or in a well ventilated area. Dispose of paint and solvent properly.

Remove paint before welding or heating:

· If you sand or grind paint, avoid breathing the dust. Wear an approved respirator.
· If you use solvent or paint stripper, remove stripper with soap and water before welding. Remove solvent or paint stripper containers and other flammable material from area. Allow fumes to disperse at least 15 minutes before welding or heating.

ILLUMINATE WORK AREA SAFELY

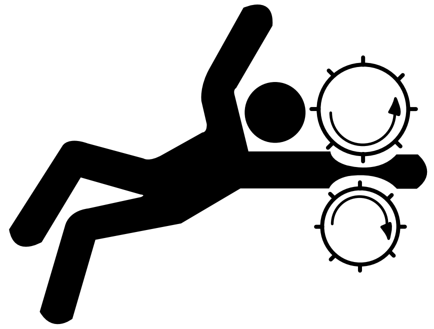
Illuminate your work area adequately but safely. Use a portable safety light for working inside or under the machine. Make sure the bulb is enclosed by a wire cage. The hot filament of an accidentally broken bulb can ignite spilled fuel or oil.

73031GE11

SERVICE MACHINE SAFELY

Tie long hair behind your head. Do not wear a necktie, scarf, loose clothing or necklace when you work near machine tools or moving parts. If these items were to get caught, severe injury could result.

Remove rings and other jewelry to prevent electrical shorts and entanglement in moving parts.

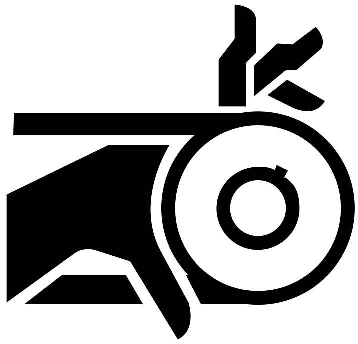


73031GE12

STAY CLEAR OF MOVING PARTS

Entanglements in moving parts can cause serious injury.

To prevent accidents, use care when working around rotating parts.



73031GE13

AVOID HIGH PRESSURE FLUIDS

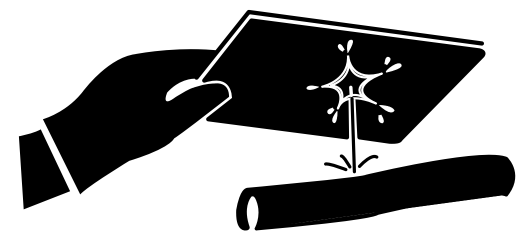
Escaping fluid under pressure can penetrate the skin causing serious injury.

Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure.

Search for leaks with a piece of cardboard. Protect hands and body from high pressure fluids.

If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result.

73031GE14



73031GE15

AVOID HEATING NEAR PRESSURIZED FLUID LINES

Flammable spray can be generated by heating near pressurized fluid lines, resulting in severe burns to yourself and bystanders. Do not heat by welding, soldering, or using a torch near pressurized fluid lines or other flammable materials.

Pressurized lines can be accidentally cut when heat goes beyond the immediate flame area. Install fire resisting guards to protect hoses or other materials.

73031GE16

PREVENT BATTERY EXPLOSIONS

Keep sparks, lighted matches, and flame away from the top of battery. Battery gas can explode.

Never check battery charge by placing a metal object across the posts. Use a volt-meter or hydrometer.

Do not charge a frozen battery; It may explode. Warm battery to 16˚C (60˚F).

73031GE17

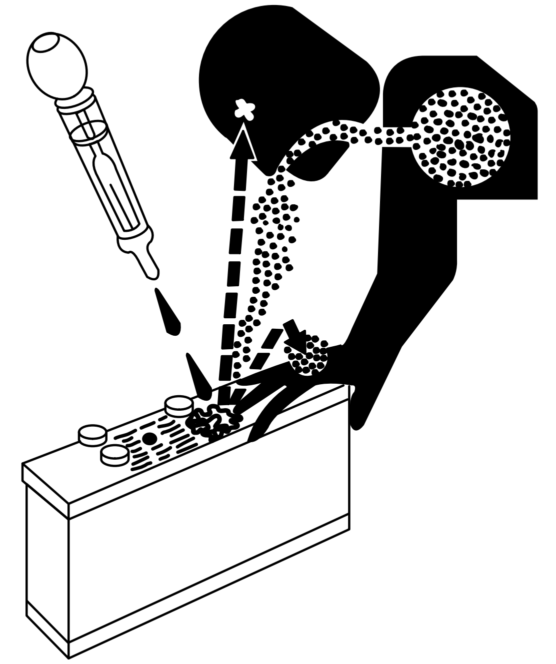
PREVENT ACID BURNS

Sulfuric acid in battery electrolyte is poisonous. It is strong enough to burn skin, eat holes in clothing, and cause blindness if splashed into eyes.

1. Avoid the hazard by:
2. Filling batteries in a well-ventilated area.
3. Wearing eye protection and rubber gloves. Avoiding breathing fumes when electrolyte is added.
4. Avoiding spilling of dripping electrolyte.
5. Use proper jump start procedure.

1. If you spill acid on yourself:
2. Flush your skin with water. Apply baking soda or lime to help neutralize the acid.
3. Flush your eyes with water for 10-15 minutes. Get medical attention immediately.

1. If acid is swallowed:
2. Drink large amounts of water or milk. Then drink milk of magnesia, beaten eggs, or vegetable oil.
3. Get medical attention immediately.



73031GE18

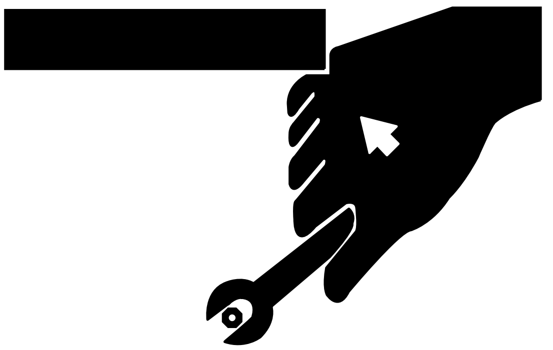
USE TOOLS PROPERLY

Use tools appropriate to the work. Makeshift tools, parts, and procedures can create safety hazards.

Use power tools only to loosen threaded tools and fasteners.

For loosening and tightening hardware, use the correct size tools. Avoid bodily injury caused by slipping wrenches.

Use only recommended replacement parts. (See Parts catalogue.)



73031GE19

SERVICE TIRES SAFELY

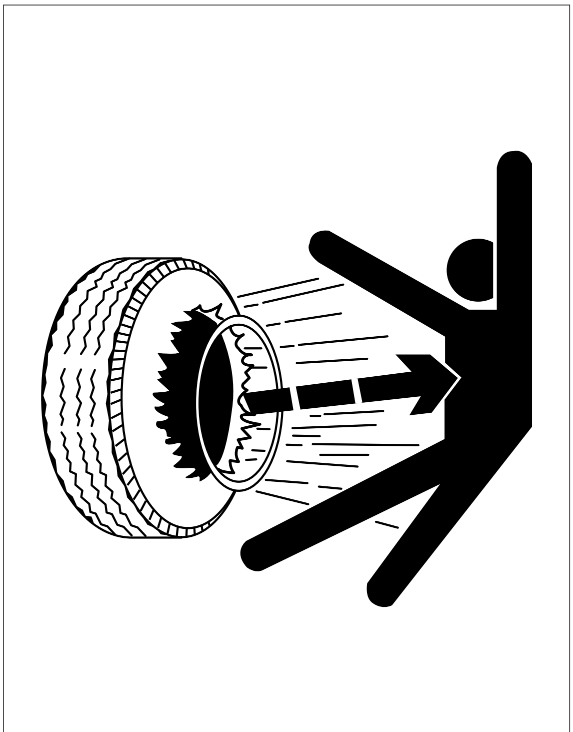
Explosive separation of a tire and rim parts can cause serious injury or death.

Do not attempt to mount a tire unless you have the proper equipment and experience to perform the job.

Always maintain the correct tire pressure. Do not inflate the tires above the recommended pressure. Never weld or heat a wheel and tire assembly. The heat can cause an increase in air pressure resulting in a tire explosion.
Welding can structurally weaken or deform the wheel.

When inflating tires, use a clip-on chuck and extension hose long enough to allow you to stand to one side and not in front of or over the tire assembly. Use a safety cage if available.

Check wheels for low pressure, cuts, bubbles, damaged rims or missing lug bolts and nuts.

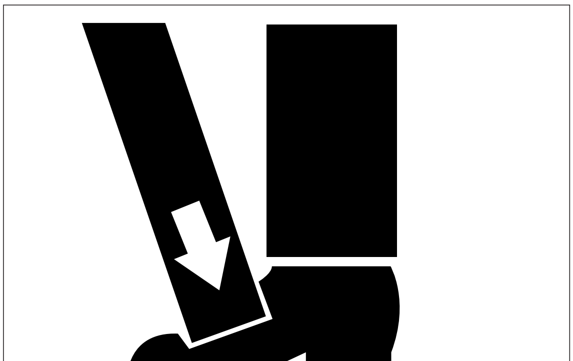


73031GE24

USE PROPER LIFTING EQUIPMENT

Lifting heavy components incorrectly can cause severe injury or machine damage.

Follow recommended procedure for removal and installation of components in the manual.



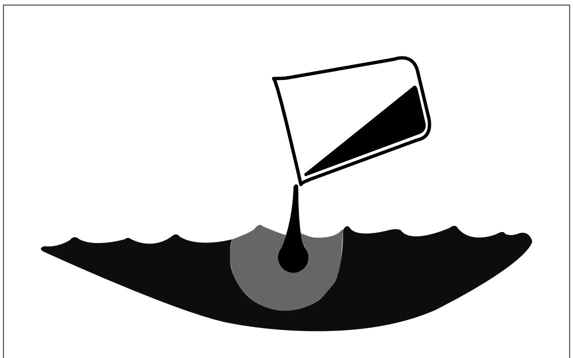
73031GE25

DISPOSE OF FLUIDS PROPERLY

Improperly disposing of fluids can harm the environment and ecology. Before draining any fluids, find out the proper way to dispose of waste from your local environmental agency.

Use proper containers when draining fluids. Do not use food or beverage containers that may mislead someone into drinking from them.

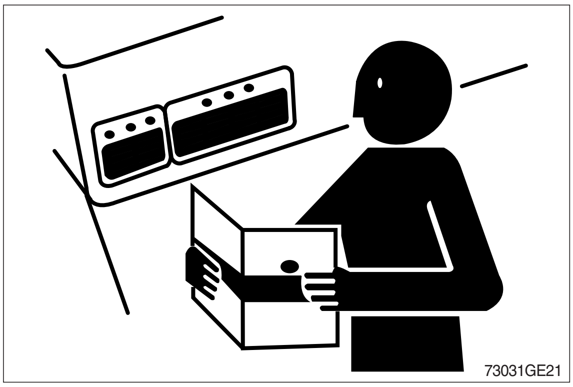
DO NOT pour oil into the ground, down a drain, or into a stream, pond, or lake. Observe relevant environmental protection regulations when disposing of oil, fuel, coolant, brake fluid, filters, batteries, and other harmful waste.



73031GE20

REPLACE SAFETY SIGNS

Replace missing or damaged safety signs. See the machine operator's manual for correct safety sign placement.


73031GE21

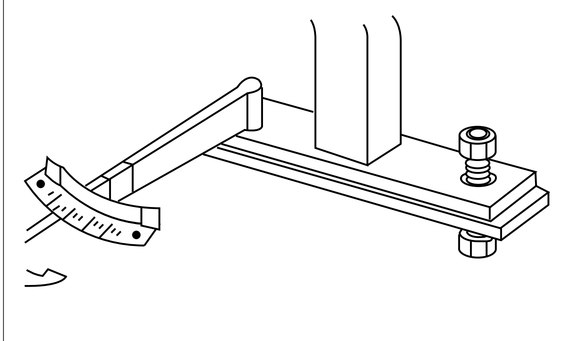
LIVE WITH SAFETY

Before returning machine to customer, make sure machine is functioning properly, especially the safety systems. Install all guards and shields.

KEEP ROPS INSTALLED PROPERLY

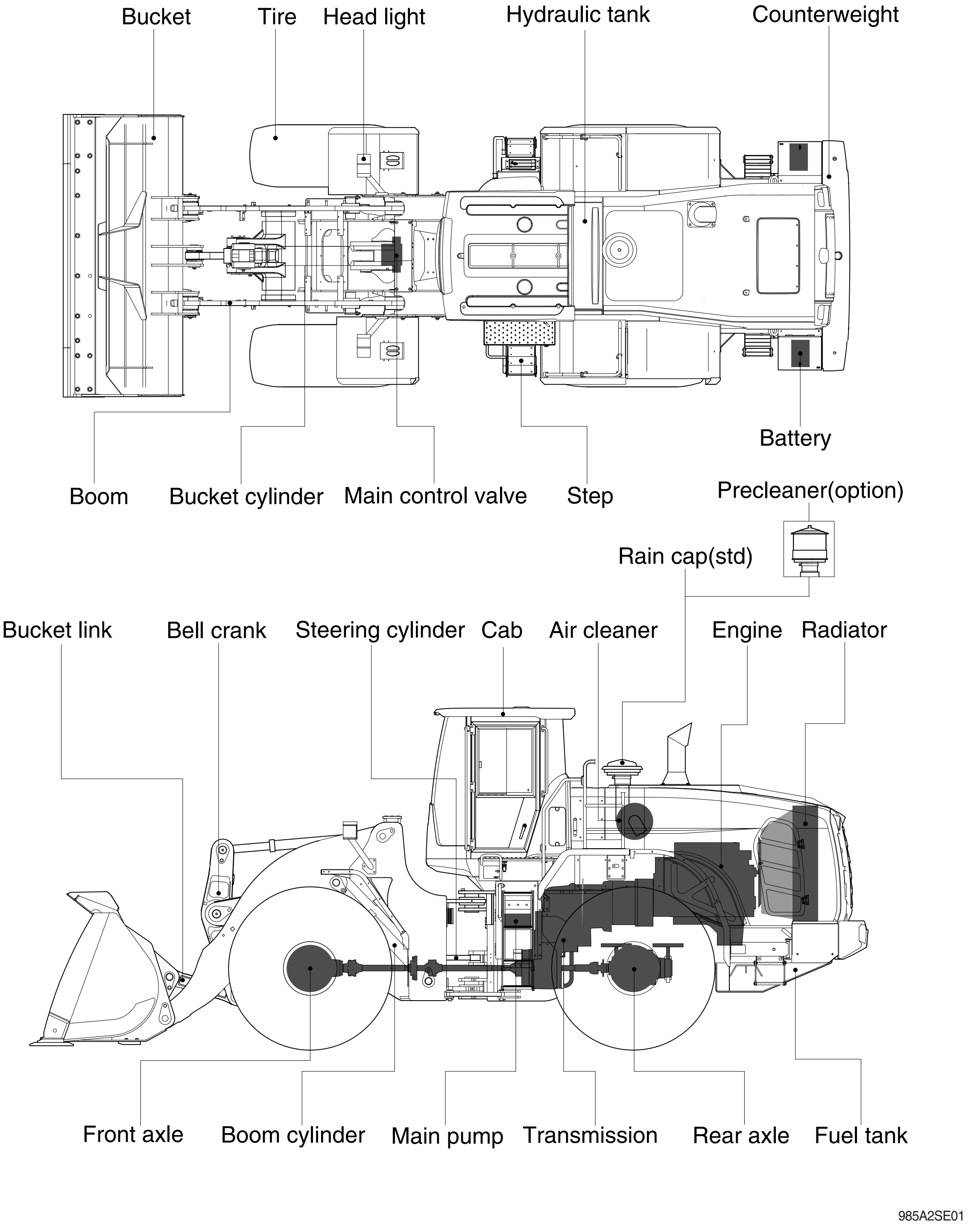
Make certain all parts are reinstalled correctly if the roll-over protective structure (ROPS) is loosened or removed for any reason. Tighten mounting bolts to proper torque.

The protection offered by ROPS will be impaired if ROPS is subjected to structural damage, is involved in an overturn incident, or is in any way altered by welding, bending, drilling, or cutting. A damaged ROPS should be replaced, not reused.


73031GE22

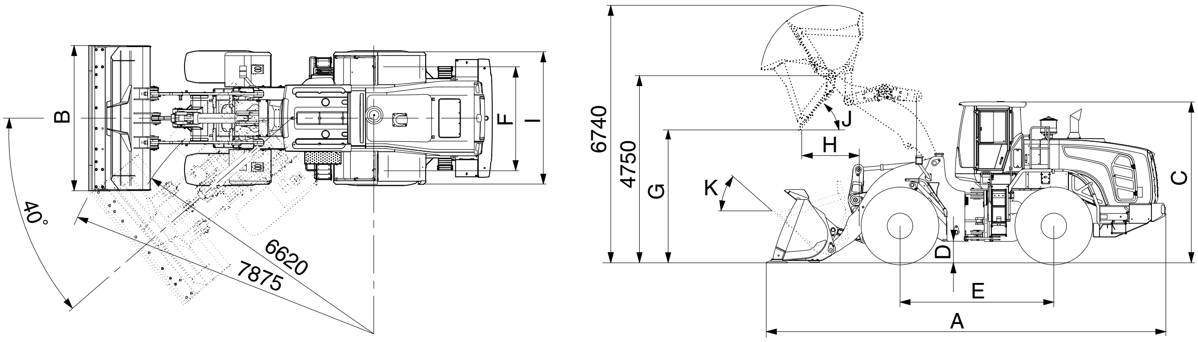
GROUP 2 SPECIFICATIONS

1. MAJOR COMPONENT



2. SPECIFICATIONS

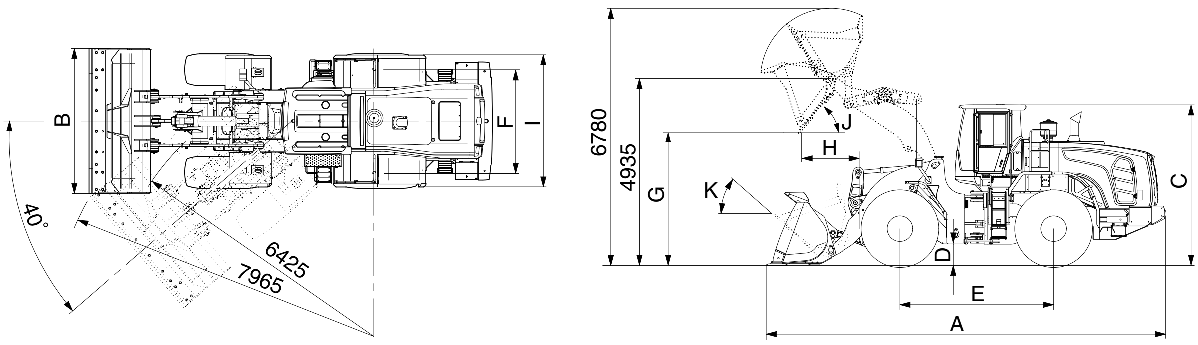
1) WITH BOLT-ON CUTTING EDGE TYPE BUCKET (HL985A)



985A2SE03

Description			Unit	Specification
Operating weight			kg (lb)	33800 (74520)
Bucket capacity		Struck	m^3 (yd^3)	5.6 (7.3)
		Heaped		6.5 (8.5)
Overall length		A	mm (ft-in)	10000 (32' 10")
Overall width		B		3600 (11' 10")
Overall height		C		3865 (12' 8")
Ground clearance		D		495 (1' 7")
Wheelbase		E		3800 (12' 6")
Tread		F		2540 (8' 4")
Dump clearance at 45°		G		3360 (11' 0")
Dump reach (full lift)		H		1550 (5' 1")
Width over tires		I		3420 (11' 3")
Dump angle		J	degree (°)	48
Rollback angle (carry position)		K		47
Cycle time		Lift (with load)	sec	6.1
		Dump (with load)		1.7
		Lower (empty)		4.3
Maximum travel speed			km/hr (mph)	40.0 (24.9)
Braking distance			m (ft-in)	13.3 (43' 8")
Minimum turning radius (center of outside tire)				6.62 (21' 9")
Gradeability			degree (°)	30
Breakeout force			kg (lb)	28400 (62615)
Travel speed	Forward	First gear	km/hr (mph)	6.2 (3.9)
		Second gear		12.0 (7.5)
		Third gear		18.6 (11.6)
		Fourth/Fifth gear		27.2(16.9)/40.0 (24.9)
	Reverse	First gear		6.2 (3.9)
		Second gear		12.0 (7.5)
		Third gear		27.2 (16.9)

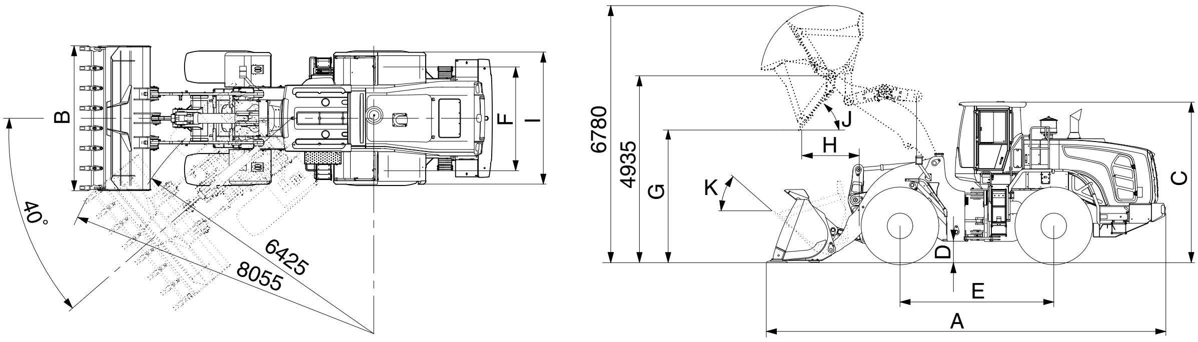
WITH BOLT-ON CUTTING EDGE TYPE BUCKET (HL985A)



985A2SE03-1

Description			Unit	Specification
Operating weight			kg (lb)	34080 (75135)
Bucket capacity		Struck	m^3 (yd^3)	5.9 (7.7)
		Heaped		7.0 (9.2)
Overall length		A	mm (ft-in)	10300 (32' 10")
Overall width		B		3600 (11' 10")
Overall height		C		3865 (12' 8")
Ground clearance		D		495 (1' 7")
Wheelbase		E		3800 (12' 6")
Tread		F		2540 (8' 4")
Dump clearance at 45˚		G		3145 (10' 4")
Dump reach (full lift)		H		1760 (5' 9")
Width over tires		I		3420 (11' 3")
Dump angle		J	degree (˚)	48
Rollback angle (carry position)		K		47
Cycle time		Lift (with load)	sec	6.1
		Dump (with load)		1.7
		Lower (empty)		4.3
Maximum travel speed			km/hr (mph)	40.0 (24.9)
Braking distance			m (ft-in)	13.3 (43' 8")
Minimum turning radius (center of outside tire)				6.62 (21' 9")
Gradeability			degree (˚)	30
Breakeout force			kg (lb)	23800 (52475)
Travel speed	Forward	First gear	km/hr (mph)	6.2 (3.9)
		Second gear		12.0 (7.5)
		Third gear		18.6 (11.6)
		Fourth/Fifth gear		27.2(16.9)/40.0 (24.9)
	Reverse	First gear		6.2 (3.9)
		Second gear		12.0 (7.5)
		Third gear		27.2 (16.9)

WITH 2-PIECE TOOTH & SEGMENT TYPE BUCKET (HL985A)



985A2SE04

Description			Unit	Specification
Operating weight			kg (lb)	34210 (75425)
Bucket capacity		Struck	m^3 (yd^3)	5.9 (7.7)
		Heaped		7.0 (9.2)
Overall length		A	mm (ft-in)	10495 (34' 5")
Overall width		B		3600 (11' 10")
Overall height		C		3865 (12' 8")
Ground clearance		D		495 (1' 7")
Wheelbase		E		3800 (12' 6")
Tread		F		2540 (8' 4")
Dump clearance at 45˚		G		2995 (9' 10")
Dump reach (full lift)		H		1885 (6' 2")
Width over tires		I		3420 (11' 3")
Dump angle		J	degree (˚)	48
Rollback angle (carry position)		K		47
Cycle time		Lift (with load)	sec	6.1
		Dump (with load)		1.7
		Lower (empty)		4.3
Maximum travel speed			km/hr (mph)	40.0 (24.9)
Braking distance			m (ft-in)	13.3 (43' 8")
Minimum turning radius (center of outside tire)				6.62 (21' 9")
Gradeability			degree (˚)	30
Breakeout force			kg (lb)	23800 (52475)
Travel speed	Forward	First gear	km/hr (mph)	6.2 (3.9)
		Second gear		12.0 (7.5)
		Third gear		18.6 (11.6)
		Fourth/Fifth gear		27.2(16.9)/40.0 (24.9)
	Reverse	First gear		6.2 (3.9)
		Second gear		12.0 (7.5)
		Third gear		27.2 (16.9)

3. WEIGHT

Item	kg	lb
Front frame assembly	3112	6865
Rear frame assembly	3346	7380
Front fender (LH/RH)	53/53	116/116
Rear fender (LH/RH)	86/86	190/190
Counterweight	2625	5790
Cab assembly	936	2065
Engine assembly	860	1895
Transmission assembly (5-speed)	816	1800
Driveshaft (front)	32	75
Driveshaft (center)	103	230
Driveshaft (rear)	31	70
Front axle (include differential)	1820	4015
Rear axle (include differential)	1820	4015
Tire (875/65 R29 L3 ★★)	860	1900
Hydraulic tank assembly	251	555
Fuel tank assembly	498	1100
Main pump assembly	65	145
Steering pump assembly	65	145
Fan & brake pump assembly	13	30
Main control valve (2 spool/3 spool)	95/110	210/245
Steering valve(Priority valve)	29	65
Boom assembly	2260	4985
Bell crank assembly	700	1545
Bucket link	103	227
5.6 m^3 bucket, with bolt on cutting edge	3080	6795
7.0 m^3 bucket, with bolt on cutting edge	3360	7410
7.0 m^3 bucket, with tooth and segment	3490	7695
Boom cylinder assembly (LH/RH)	326/326	660/660
Bucket cylinder assembly	330	730
Steering cylinder assembly (LH/RH)	62/62	135/135
Seat (Including suspension and armrest)	70	155
Battery (1EA)	53	120
Under guard kit	110	245
Engine hood assembly	473	1045
Mud guard assembly (LH/RH)	38/38	80/80

4. SPECIFICATION FOR MAJOR COMPONENTS

1) ENGINE

Item	Specification
Model	Cummins X12
Type	4-cycle turbocharged, charge air cooled electronic controlled diesel engine
Cooling method	Water cooled
Number of cylinders and arrangement	6 cylinders, in-line
Firing order	1-5-3-6-2-4
Combustion chamber type	Direct injection type
Cylinder bore × stroke	132 × 144 mm (5.2" × 5.7")
Piston displacement	11800 cc (720 cu in)
Compression ratio	17.0 : 1
Gross power	430 hp (321 kW) at 2100 rpm
Net power	420 hp (313 kW) at 2100 rpm
Maximum power	473 hp (353 kW) at 1700 rpm
Peak gross torque	235 kgf · m (1696 lbf · ft) at 1400 rpm
Engine oil quantity	34 ℓ (9.0 U.S. gal)
Wet weight	860 kg (1896 lb)
Starting motor	24 V - 7.5 kW
Alternator	28 V - 110 Amp
Battery	2 × 12 V × 220 Ah

2) MAIN PUMP

Item	Specification
Type	Load sensing hydraulic system
Pump	Variable displacement piston pump
Rated oil quantity	520 ℓ/min (137.4 U.S.gpm)
System pressure	315 kgf/cm^2 (4569 psi)

3) STEERING PUMP

Item	Specification
Type	Load sensing hydrostatic articulated steering
Pump	Variable displacement piston pump
Rated oil quantity	280 ℓ/min (74 U.S.gpm)
System pressure	210 kgf/cm^2 (3046 psi)

4) FAN + BRAKE PUMP

Item	Specification
Type	Variable piston pump
Capacity	28 cc/rev
Maximum operating pressure	250 kgf/cm^2 (3980 psi)
Rated oil quantity	74.3 ℓ/min (19.6 U.S.gpm)

5) MAIN CONTROL VALVE

Item	Specification
Type	2 spool / 3 spool
Operating method	Hydraulic pilot assist
Main relief valve pressure	315 kgf/cm^2 (4569 psi)
Overload relief valve pressure	365 kgf/cm^2 (5293 psi)

6) ELECTRO-HYDRAULIC BLOCK

Item	Specification
Type	Proportional pressure reducing valve
Control current	0~950 mA
Resistance	10.5 Ω
Normal flow	12 ℓ/min (3.17 U.S.gpm)

7) REMOTE CONTROL VALVE (EH TYPE)

Item	Specification
Type	Fingertip
Axle	Single axle for boom, bucket, auxiliary
Operating voltage	4.5~5.5 V
Output signal	0.5~4.5 V (neutral 2.5 V)

8) REMOTE CONTROL VALVE (FNR TYPE)

Item	Specification
Type	Joystick
Axle	Two axle for boom, bucket, roller for auxiliary
Operating type	CAN J1939
Baud rate	500 kbps

9) CYLINDER

Item		Specification
Boom cylinder	Bore dia × Rod dia × Stroke	Ø190 × Ø110 × 890 mm
Bucket cylinder	Bore dia × Rod dia × Stroke	Ø210 × Ø115 × 550 mm
Steering cylinder	Bore dia × Rod dia × Stroke	Ø110 × Ø60 × 460 mm

10) DYNAMIC POWER TRANSMISSION DEVICES

Item			Specification
5-speed transmission	Model		ZF 5WG 310
	Type	Converter	3-Elements, Single-stage, Single-phase
		Transmission	Full-automatic power shift
	Gear shift		Forward fifth gear, reverse third gear
	Control		Electrical single lever type, kick-down system Automatic kick down from 2nd to 1st gear FNR switch on joystick lever (option)
	Travel speed	Forward 1/2/3/4/5	6.2/12/18.6/27.2/40.0 km/hr
		Reverse 1/2/3	6.2/112/27.2 km/hr
Axle	Drive devices		4-wheel drive
	Front		Front fixed location
	Rear		Oscillation ±11˚ of center pin-loaded
Wheels	Tires		875/65 R29 L3 ★★
Brakes	Travel		Four-wheel, wet-disc type, full hydraulic
	Parking		Spring applied, hydraulic released brake on T/M
Steering	Type		Full hydraulic, articulated
	Steering angle		40˚ to both right and left angle, respectively

5. TIGHTENING TORQUE

Use following table for unspecified torque.

1) BOLT AND NUT

(1) Coarse thread

Bolt size	8.8T		10.9T		12.9T	
	kgf · m	lbf · ft	kgf · m	lbf · ft	kgf · m	lbf · ft
M 6×1.0	0.8 ~ 1.2	5.8 ~ 8.6	1.2 ~ 1.8	8.7 ~ 13.0	1.5 ~ 2.1	10.9 ~ 15.1
M 8×1.25	2.0 ~ 3.0	14.5 ~ 21.6	2.8 ~ 4.2	20.3 ~ 30.4	3.4 ~ 5.0	24.6 ~ 36.1
M10×1.5	4.0 ~ 6.0	29.0 ~ 43.3	5.6 ~ 8.4	40.5 ~ 60.8	6.8 ~ 10.0	49.2 ~ 72.3
M12×1.75	6.8 ~ 10.2	50.0 ~ 73.7	9.6 ~ 14.4	69.5 ~ 104	12.3 ~ 16.5	89.0 ~ 119
M14×2.0	10.9 ~ 16.3	78.9 ~ 117	16.3 ~ 21.9	118 ~ 158	19.5 ~ 26.3	141 ~ 190
M16×2.0	17.9 ~ 24.1	130 ~ 174	25.1 ~ 33.9	182 ~ 245	30.2 ~ 40.8	141 ~ 295
M18×2.5	24.8 ~ 33.4	180 ~ 241	34.8 ~ 47.0	252 ~ 340	41.8 ~ 56.4	302 ~ 407
M20×2.5	34.9 ~ 47.1	253 ~ 340	49.1 ~ 66.3	355 ~ 479	58.9 ~ 79.5	426 ~ 575
M22×2.5	46.8 ~ 63.2	339 ~ 457	65.8 ~ 88.8	476 ~ 642	78.9 ~ 106	570 ~ 766
M24×3.0	60.2 ~ 81.4	436 ~ 588	84.6 ~ 114	612 ~ 824	102 ~ 137	738 ~ 991
M30×3.5	120 ~161	868 ~ 1164	168 ~ 227	1216 ~ 1641	202 ~ 272	1461 ~ 1967

(2) Fine thread

Bolt size	8.8T		10.9T		12.9T	
	kgf · m	lbf · ft	kgf · m	lbf · ft	kgf · m	lbf · ft
M 8×1.0	2.1 ~ 3.1	15.2 ~ 22.4	3.0 ~ 4.4	21.7 ~ 31.8	3.6 ~ 5.4	26.1 ~ 39.0
M10×1.25	4.2 ~ 6.2	30.4 ~ 44.9	5.9 ~ 8.7	42.7 ~ 62.9	7.0 ~ 10.4	50.1 ~ 75.2
M12×1.25	7.3 ~ 10.9	52.8 ~ 78.8	10.3 ~ 15.3	74.5 ~ 110	13.1 ~ 17.7	94.8 ~ 128
M14×1.5	12.4 ~ 16.6	89.7 ~ 120	17.4 ~ 23.4	126 ~ 169	20.8 ~ 28.0	151 ~ 202
M16×1.5	18.7 ~ 25.3	136 ~ 182	26.3 ~ 35.5	191 ~ 256	31.6 ~ 42.6	229 ~ 308
M18×1.5	27.1 ~ 36.5	196 ~ 264	38.0 ~ 51.4	275 ~ 371	45.7 ~ 61.7	331 ~ 446
M20×1.5	37.7 ~ 50.9	273 ~ 368	53.1 ~ 71.7	384 ~ 518	63.6 ~ 86.0	460 ~ 622
M22×1.5	51.2 ~ 69.2	370 ~ 500	72.0 ~ 97.2	521 ~ 703	86.4 ~ 116	625 ~ 839
M24×2.0	64.1 ~ 86.5	464 ~ 625	90.1 ~ 121	652 ~ 875	108 ~ 146	782 ~ 1056
M30×2.0	129 ~ 174	933 ~ 1258	181 ~ 245	1310 ~ 1772	217 ~ 294	1570 ~ 2126

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

5) TIGHTENING TORQUE OF MAJOR COMPONENT

No.	Descriptions		Bolt size	Torque	
				kgf · m	lbf · ft
1	Engine	Engine mounting bolt, nut (rubber, 4EA)	M24×3.0	76.5 ± 7.7	553 ± 55.7
2		Engine mounting bolt (bracket, 16EA)	M14×2.0	18.4 ± 2.8	133 ± 20.3
3		Fan motor mounting bolt	M12×1.75	12.8 ± 3.0	92.6 ± 21.7
4		Radiator mounting bolt	M16×2.0	29.7 ± 5.9	215 ± 42.7
5		Fuel tank mounting bolt, nut	M16×2.0	29.7 ± 4.5	215 ± 32.5
6	Hydraulic system	Main pump mounting bolt	M14×2.0	19.6 ± 2.9	142 ± 21.0
7		Steering pump mounting bolt	M14×2.0	19.6 ± 2.9	142 ± 21.0
8		Fan & Brake pump mounting bolt	M14×2.0	19.6 ± 2.9	142 ± 21.0
9		Main control valve mounting bolt	M12×1.75	12.8 ± 3.0	92.6 ± 21.7
10		Steering unit mounting bolt	M10×1.5	6.9 ± 1.4	50 ± 10.1
11		Flow amplifier mounting bolt	M10×1.5	6.9 ± 1.4	50 ± 10.1
12		Brake valve mounting bolt	M8×1.25	2.5 ± 0.5	18.1 ± 3.6
13		Cut-off valve mounting bolt	M8×1.25	2.5 ± 0.5	18.1 ± 3.6
14		EH control block mounting bolt	M8×1.25	2.5 ± 0.5	18.1 ± 3.6
15		Safety valve mounting bolt	M10×1.5	6.9 ± 1.4	50 ± 10.1
16		Hydraulic oil tank mounting bolt	M16×2.0	29.7 ± 4.5	215 ± 32.5
17	Power train system	Transmission mounting bolt, nut (rubber, 4EA)	M24×3.0	76.5 ± 7.7	553 ± 55.7
18		Transmission mounting bolt (bracket, 12EA)	M20×2.5 M14×2.0	56.1 ± 8.4 18.4 ± 2.8	406 ± 60.8 133 ± 20.3
19		Front axle mounting bolt, nut	M36×3.0	280 ± 30	2025 ± 217
20		Rear axle support mounting bolt, nut	M36×3.0	280 ± 30	2025 ± 217
21		Tire mounting nut	M22×1.5	60 ± 2.0	433 ± 14.5
22		Drive shaft joint mounting bolt	1/2-20UNF	15 ± 2.0	108 ± 14.5
23	Others	Counterweight mounting bolt	M30×3.5 M24×3.0	199 ± 30 100 ± 15	1439 ± 216 723 ± 108
24		Operator's seat mounting bolt	M8×1.25	3.4 ± 0.8	24.6 ± 5.0
25		ROPS Cab mounting bolt (4EA)	M30×3.5	199 ± 30	1440 ± 216
		ROPS Cab mounting nut (4EA)	M16×2.0	20.5 ± 4.7	148 ± 34

6) NEW MACHINE

New machine used and filled with following lubricants.

Description	Specification
Engine oil (API CJ-4)	SAE 15W-40, ★2SAE 5W-40
DEF/AdBlue®	ISO 22241 (32.5% high-purity urea and 67.5 deionized water)
Hydraulic oil	HD Hyundai Construction Equipment genuine long life (ISO VG 46, VG 68 only) Conventional (ISO VG15★2) HD Hyundai Construction Equipment Bio Hydraulic Oil (HBHO, ISO VG 46)
Transmission oil	SAE 15W-40 (Oils of the API CI-4+, CJ-4, CK-4, SM, or ACEA specification, Category E9 are not permitted to use for the transmission)
Axle oil	★Refer to below list
Grease	Lithium base grease NLGI No. 2
Fuel	ASTM D975-No. 2, ★1Ultra low sulfur diesel
Coolant	ASTM D6210 Mixture of 50% ethylene glycol base antifreeze and 50% water Mixture of 60% ethylene glycol base antifreeze and 40% water★2

SAE : Society of Automotive Engineers
API : American Petroleum Institute
ISO : International Organization for Standardization
NLGI : National Lubricating Grease Institute
ASTM : American Society of Testing and Material
DEF : Diesel Exhaust Fluid
DEF compatible with AdBlue®

★ Recommended oil list
- Gear oil with limited-slip additive
- Viscosity grades: SAE 75W-90/75W-110/
75W-140 /80W-90/85W-90
- Universal axle and transmission oil
- Premium universal axle and transmission oil

★1 Ultra low sulfur diesel
- sulfur content ≤ 15 ppm

★2 Cold region
Russia, CIS, Mongolia

2) RECOMMENDED OILS

HD Hyundai Construction Equipment genuine lubricating oils have been developed to offer the best performance and service life for your equipment. These oils have been tested according to the specifications of HD Hyundai Construction Equipment and, therefore, will meet the highest safety and quality requirements.
We recommend that you use only HD Hyundai Construction Equipment genuine lubricating oils and grease officially approved by HD Hyundai Construction Equipment.

※ Using any lubricating oils other than HD Hyundai Construction Equipment genuine products may lead to a deterioration of performance and cause damage to major components.

※ Do not mix HD Hyundai Construction Equipment genuine oil with any other lubricating oil as it may result in damage to the systems of major components.

※ Do not use any engine oil other than that specified above, as it may clog the diesel particulate filter(DPF).

※ For HD Hyundai Construction Equipment genuine lubricating oils and grease for use in regions with extremely low temperatures, please contact HD Hyundai Construction Equipment dealers.

Service point	Kind of fluid	Capacity ℓ (U.S. gal)	Ambient temperature ˚C(˚F) -50 (-58), -30 (-22), -20 (-4), -10 (14), 0 (32), 10 (50), 20 (68), 30 (86), 40 (104)
Engine oil pan	Engine oil	34 (9.0)	SAE 15W-40 ★2 SAE 5W-40 SAE 0W-40
DEF/ AdBlue® tank	Mixture of urea and deionized water	49.2 (13.0)	ISO 22241, High-purity urea + deionized water (32.5 : 67.5)
Transmission	Engine oil	56.2 (14.8)	SAE 10W-30 SAE 15W-40
Axle (with oil cooler)	UTTO	FR : 70.5 (18.6) RR: 68.7 (18.1)	★Refer to below list
Hydraulic tank	Hydraulic oil	Tank: 200 (52.8) System: 360 (95.1)	★2 ISO VG 15 ISO VG 46, HBHO VG 46★4 ISO VG 68
Fuel tank	Diesel fuel★1	440 (116.2)	★2 ASTM D975 NO.1 ASTM D975 NO.2
Fitting (grease nipple)	Grease	As required	★2 NLGI NO.1 NLGI NO.2
Radiator (reservoir tank)	Mixture of antifreeze and soft water★3	45.5 (12.0)	Ethylene glycol base permanent type (50 : 50) ★2 Ethylene glycol base permanent type (60 : 40)

SAE : Society of Automotive Engineers
API : American Petroleum Institute
ISO : International Organization for Standardization
NLGI : National Lubricating Grease Institute
ASTM : American Society of Testing and Material
UTTO : Universal Tractor Transmission Oil
DEF : Diesel Exhaust Fluid
DEF compatible with AdBlue®

★1 Ultra low sulfur diesel
- sulfur content ≤ 15 ppm

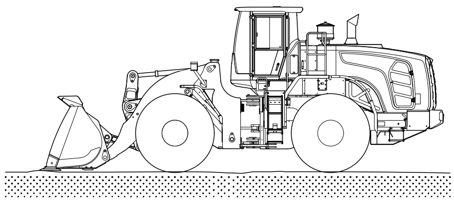
★ Recommended oil list
- Gear oil with limited-slip additive
- Viscosity grades: SAE 75W-90/75W-110/ 75W-140 /80W-90/85W-90
- Universal axle and transmission oil
- Premium universal axle and transmission oil

★2 Cold region : Russia, CIS, Mongolia
★3 Soft water : City water or distilled water
★4 Hyundai Bio Hydraulic Oil

GROUP 3 OPERATIONAL CHECKOUT RECORD SHEET

· Owner :
· Date :
· Hours :
· Serial No. :
· Technician :

※ Use this sheet to record operational checkout results.
Perform the operational check before installing any test equipment.


9801GE02

Item	OK	NOT OK	Comments

1. Monitor indicator and gauge checks (engine OFF)

· Hourmeter and gauge check	☐	☐	________
· Battery check	☐	☐	________
· Monitor indicator circuit check	☐	☐	________
· Cluster turn signals and warning indicator check	☐	☐	________

2. Transmission, axle and engine, neutral start switch and reverse warning alarm switch checks

· Transmission control lever and neutral	☐	☐	________
· Neutral start and reverse warning	☐	☐	________
· Alarm circuit checks	☐	☐	________

3. Monitor indicator and gauge checks (engine running)

· Monitor display and alternator output checks	☐	☐	________
· Monitor bypass circuit and seat belt indicator check	☐	☐	________
· Monitor primary and secondary level check	☐	☐	________
· Transmission oil warm up procedure	☐	☐	________
· Transmission temperature gauge check	☐	☐	________

4. Brake system and clutch cut off checks

- Park brake capacity check ☐ ☐ ____________________
- Park brake transmission lockout check ☐ ☐ ____________________
- Service brake pump flow check ☐ ☐ ____________________
- Service brake capacity check ☐ ☐ ____________________
- Brake accumulator precharge check ☐ ☐ ____________________
- Brake system leakage check ☐ ☐ ____________________
- Service brake pedal check ☐ ☐ ____________________
- Service and park brake system drag check ☐ ☐ ____________________
- Clutch cut off check ☐ ☐ ____________________

5. Driving checks

- Transmission oil warm up procedure ☐ ☐ ____________________
- Transmission noise check ☐ ☐ ____________________
- Speedometer check ☐ ☐ ____________________
- Transmission kick down system check ☐ ☐ ____________________
- 1st, 2nd, 3rd and 4th speed clutch pack drag check ☐ ☐ ____________________
- Transmission pressure, pump flow and leakage check ☐ ☐ ____________________
- Transmission shift modulation check ☐ ☐ ____________________
- Torque converter check ☐ ☐ ____________________
- Engine power check ☐ ☐ ____________________

6. Hydraulic system checks

- Hydraulic system warm up procedure ☐ ☐ ____________________
- Hydraulic pump performance check ☐ ☐ ____________________
- Pilot control valve boom float check ☐ ☐ ____________________
- Boom down solenoid valve check ☐ ☐ ____________________
- Control valve lift check ☐ ☐ ____________________
- Bucket rollback circuit relief valve check ☐ ☐ ____________________
- Bucket dump circuit relief
  - Low pressure check ☐ ☐ ____________________
  - High pressure check ☐ ☐ ____________________
- Boom and bucket cylinder drift check ☐ ☐ ____________________
- Boom down solenoid valve leakage check ☐ ☐ ____________________
- Pilot controller check ☐ ☐ ____________________
- Return to dig check ☐ ☐ ____________________
- Boom height kickout check-if equipped ☐ ☐ ____________________

7. Steering system checks

· Steering unit check ☐ ☐ ________
· Steering system leakage check ☐ ☐ ________
· Steering valve (EHPS)
 Low check pressure ☐ ☐ ________
 High check pressure ☐ ☐ ________

8. Accessory checks

· Operating lights check ☐ ☐ ________
· Work light check ☐ ☐ ________
· Brake light check ☐ ☐ ________
· Cab light check ☐ ☐ ________
· Horn circuit check ☐ ☐ ________
· Windshield washer and wiper check ☐ ☐ ________
· Defroster blower check ☐ ☐ ________
· Heater/Air conditioner blower check ☐ ☐ ________
· Heater functional check ☐ ☐ ________
· Air conditioner functional check ☐ ☐ ________
· Start aid system check ☐ ☐ ________

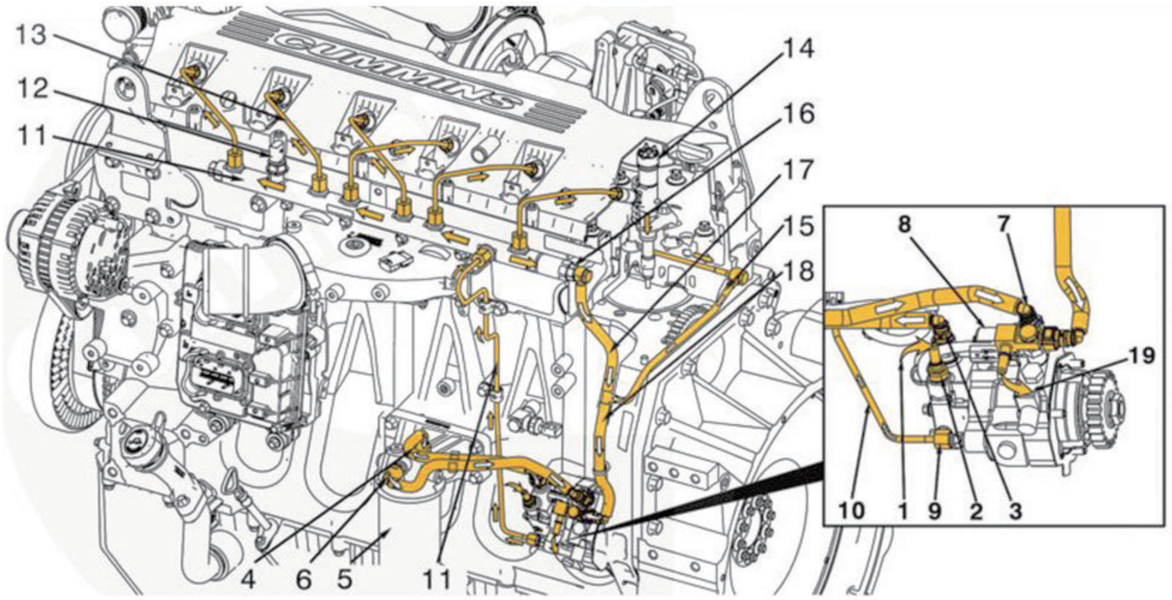
9. Cab components and vandal protection checks

· Cab door latch check ☐ ☐ ________
· Cab door hold open latch check ☐ ☐ ________
· Cab door release button check ☐ ☐ ________
· Cab door lock check ☐ ☐ ________
· Cab door window check ☐ ☐ ________
· Cab window latch check ☐ ☐ ________
· Steering column adjustment check ☐ ☐ ________
· Seat and seat belt check ☐ ☐ ________
· Air intake filter door check ☐ ☐ ________
· Engine side panels check ☐ ☐ ________
· Radiator cap access door check ☐ ☐ ________
· Frame locking bar check ☐ ☐ ________
· Boom lock check ☐ ☐ ________
· Service decal check ☐ ☐ ________

SECTION 2 ENGINE

GROUP 1 STRUCTURE AND FUNCTION

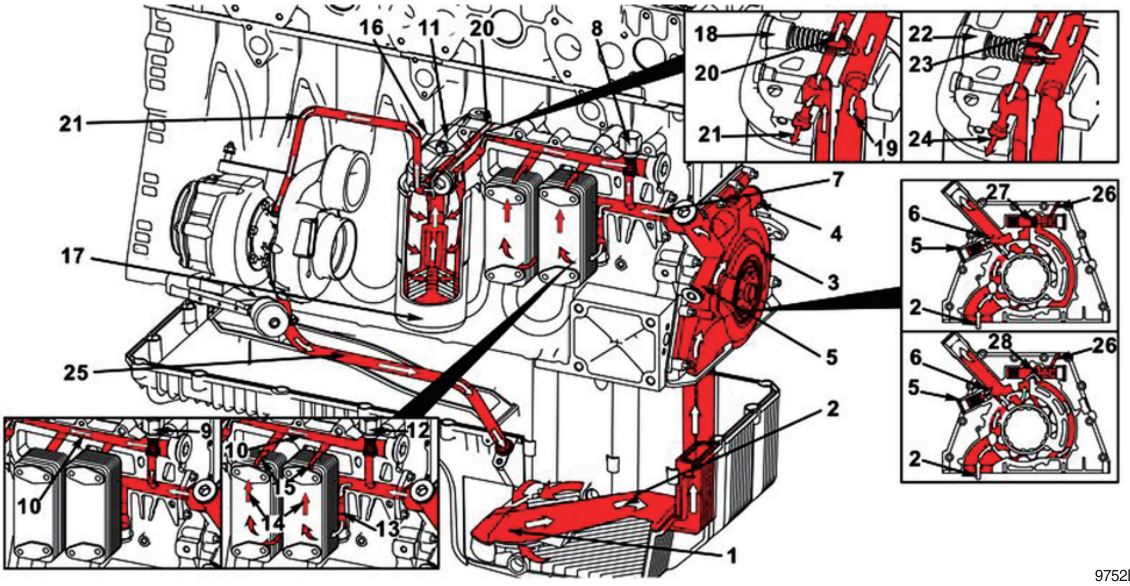
1. FUEL SYSTEM



9752EG03

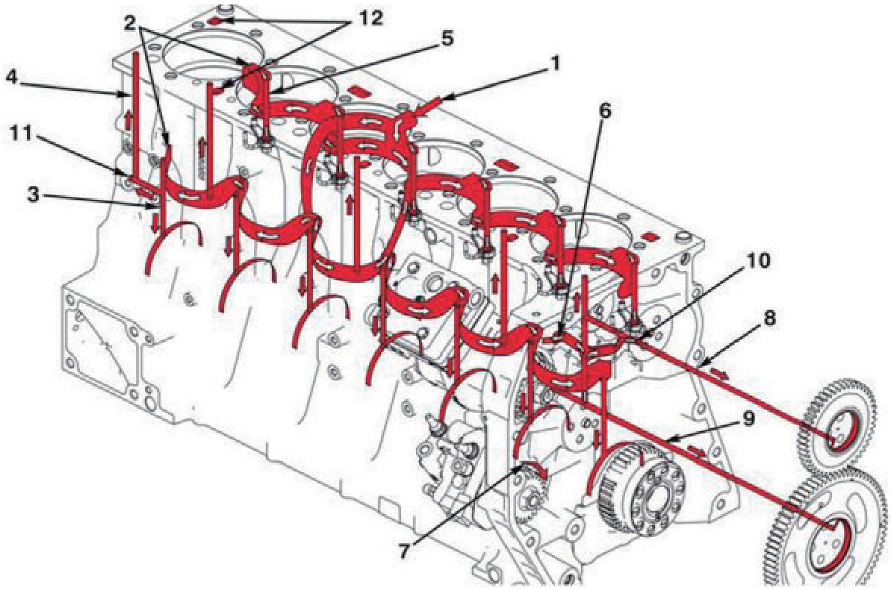
1	Fuel supply - from suction side filter	11	Fuel rail
2	Fuel pump gear pump inlet	12	Fuel rail pressure sensor
3	Fuel pump gear pump outlet	13	Injector supply lines
4	Pressure side fuel filter inlet	14	Injectors
5	Pressure side fuel filter	15	Fuel drain from injectors
6	Pressure side fuel filter outlet	16	Fuel pressure relief valve
7	High pressure fuel pump inlet	17	Fuel pressure relief valve drain
8	Fuel pump actuator	18	Fuel drain line
9	High pressure fuel pump outlet	19	Fuel return to tank.
10	Fuel rail supply line		

2. LUBRICATING OIL SYSTEM



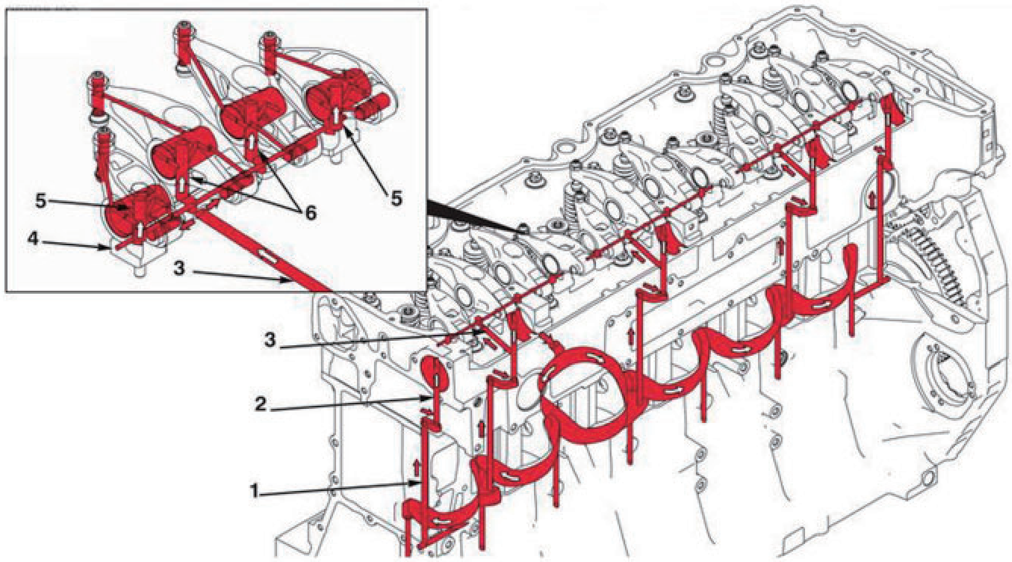
9752EG04

1 Flow from oil pan through suction tube
2 Flow from suction tube to lubricating oil pump
3 Lubricating oil pump
4 Lubricating oil pressure regulator valve
5 Lubricating oil high-pressure relief valve
6 Lubricating oil return to oil pan
7 Lubricating oil flow from lubricating oil pump to lubricating oil cooler module
8 Lubricating oil thermostat
9 Flow with lubricating oil thermostat open
10 Lubricating oil flow from lubricating oil cooler module main oil rifle to lubricating oil filter head
11 Lubricating oil filter head
12 Flow with lubricating oil thermostat closed
13 Lubricating oil flow to oil cooler
14 Lubricating oil flow through oil cooler elements
15 Lubricating oil flow from lubricating oil cooler to lubricating oil cooler main oil rifle
16 Lubricating oil filter bypass valve
17 Lubricating oil filter
18 Flow with lubricating oil filter bypass valve closed
19 Lubricating oil flow from filter head to filter
20 Filtered lubricating oil flow to engine block main oil rifle
21 Filtered lubricating oil flow to turbocharger
22 Flow with lubricating oil filter bypass valve open
23 Unfiltered lubricating oil flow to engine block main oil rifle
24 Unfiltered lubricating oil flow to turbocharger
25 Lubricating oil drain from turbocharger
26 Block oil riffle pressure sensing channel
27 Flow with pressure regulator valve closed
28 Flow with pressure regulator valve open



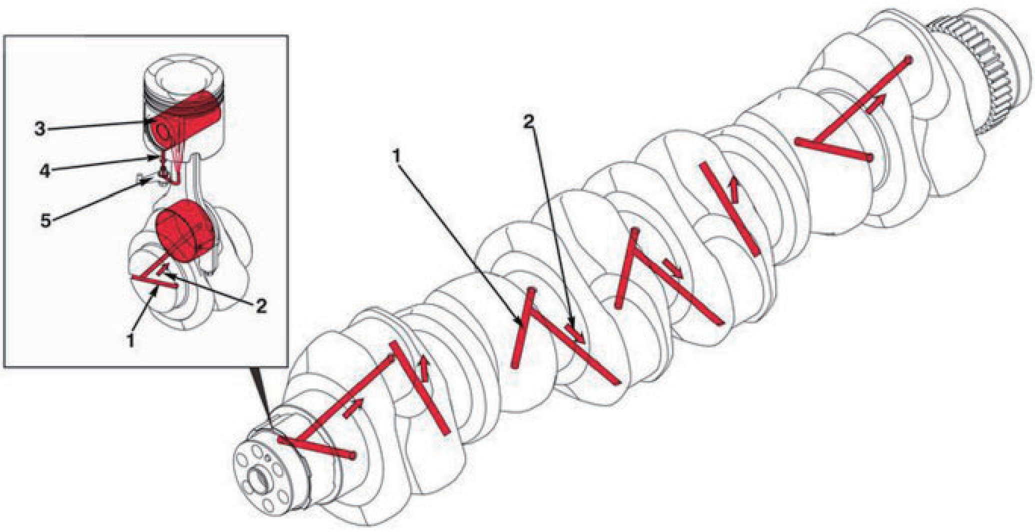
9752EG4-1

1 Lubricating oil flow from lubricating oil filter head to engine block main oil rifle
2 Main oil rifle
3 Flow to main bearings
4 Flow to cylinder head
5 Flow to piston cooling nozzle
6 Flow to air compressor
7 Flow to fuel pump
8 Flow to camshaft idler gear
9 Flow to crankshaft idler gear
10 Flow to REPTO idler gear (if applicable)
11 Block oil rifle pressure sensing channel
12 Oil drain to lubricating oil pan.



9752EG4-2

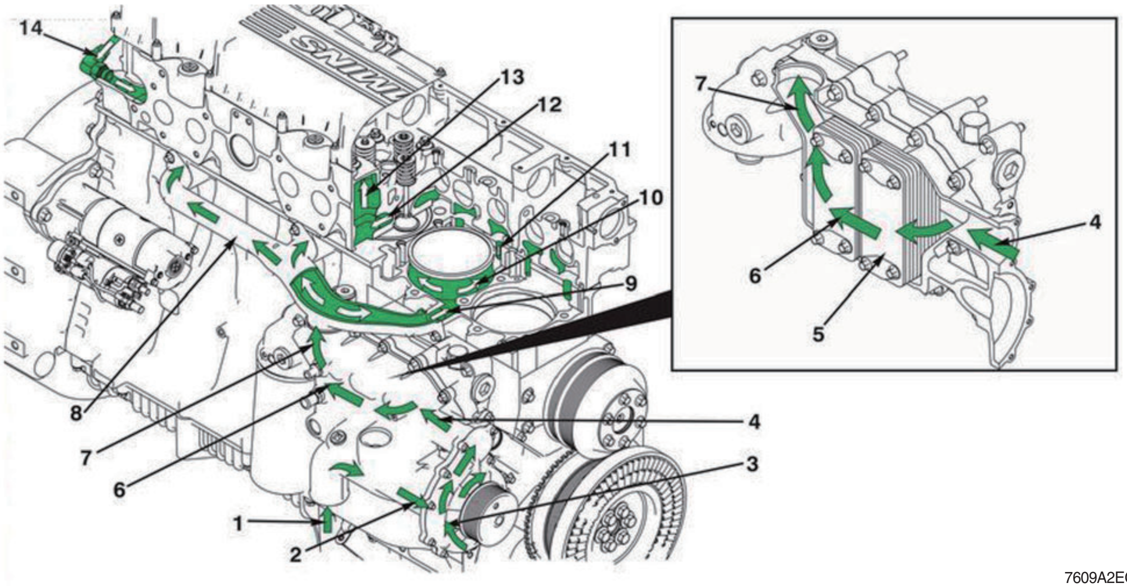
1 Flow from cylinder block to cylinder head
2 Flow to camshaft bushings
3 Flow to rocker lever shafts
4 Rocker lever shaft
5 Flow from rocker lever shaft to intake rocker levers
6 Flow from rocker lever shaft to exhaust rocker levers.



9752EG4-3

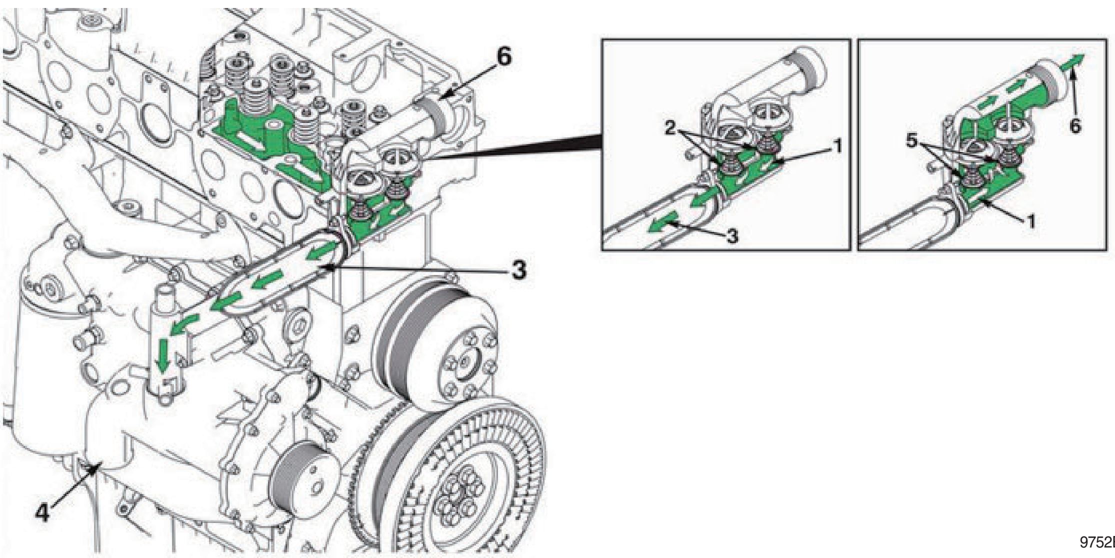
1 Main bearing flow from oil rifle
2 Flow to crankshaft connecting rod bearing
3 Piston pin
4 Flow from oil rifle to piston cooling nozzle
5 Piston cooling nozzle

3. COOLING SYSTEM



7609A2EG16

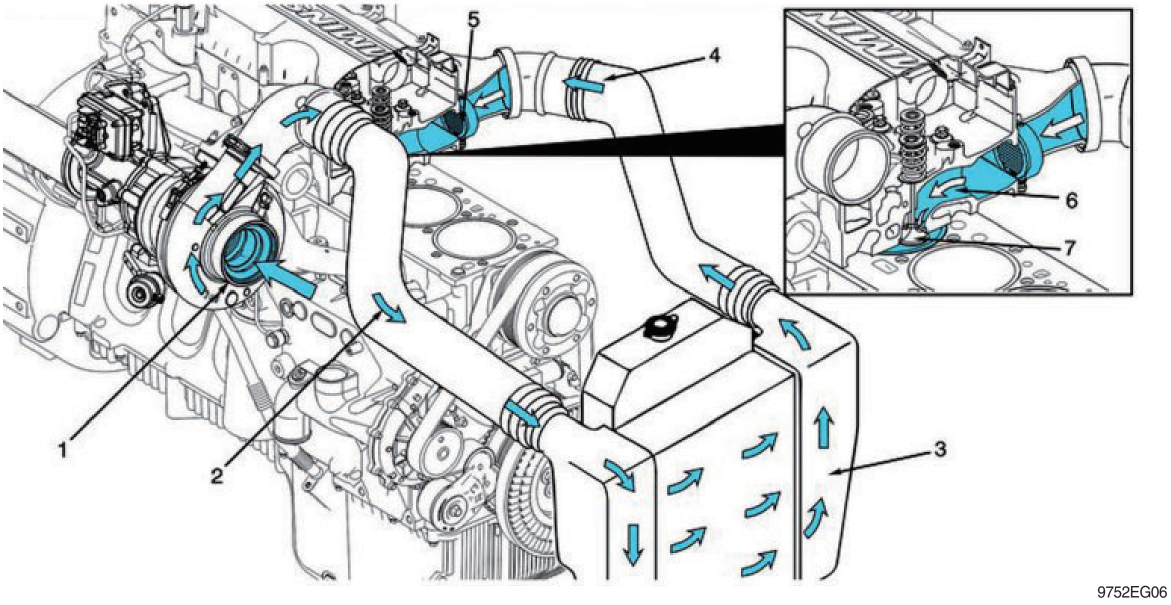
1 Coolant from radiator
2 Coolant flow to water pump
3 Water pump
4 Coolant flow from water pump to oil cooler module
5 Oil cooler element
6 Coolant flow around oil cooler element
7 Coolant flow from oil cooler module to coolant manifold
8 Coolant manifold
9 Coolant flow from coolant manifold to cylinder block
10 Coolant flow around cylinders
11 Coolant flow from cylinder block to lower cylinder head
12 Coolant flow to upper cylinder head
13 Coolant flow to rocker lever housing
14 Coolant flow from air compressor return line to cylinder head



9752EG5-1

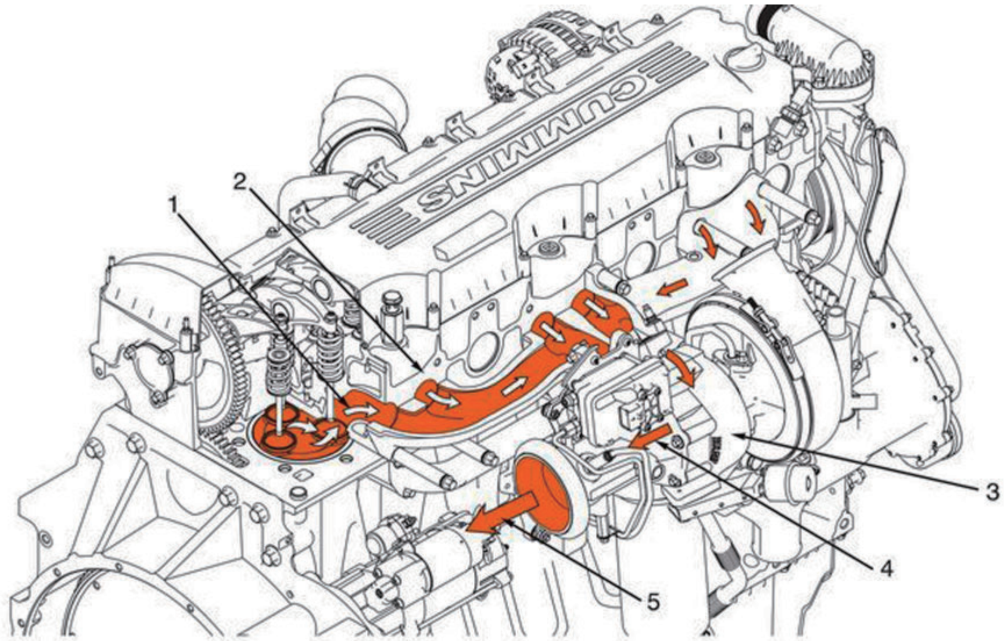
1 Coolant flow from rocker lever housing
2 Thermostat closed
3 Coolant flow through bypass tube to coolant inlet connection
4 Coolant inlet connection
5 Thermostat open
6 Coolant flow to radiator

4. AIR INTAKE SYSTEM



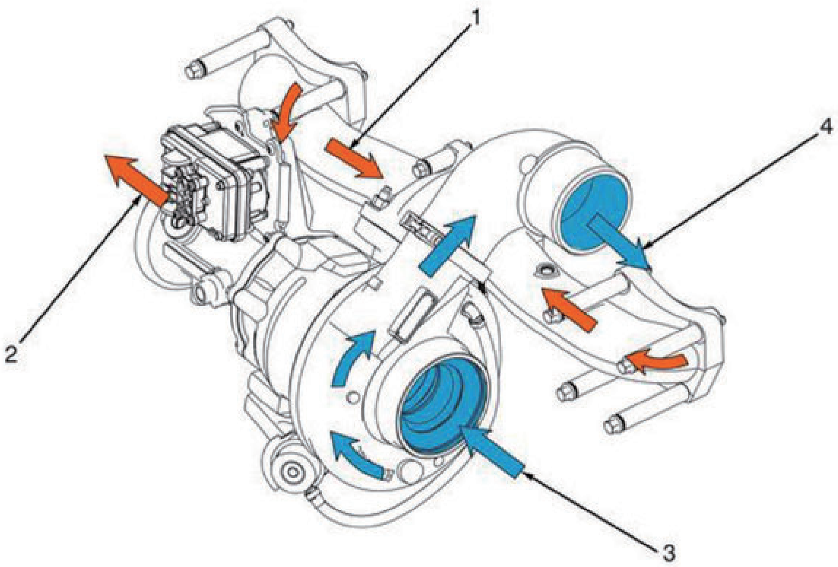
1	Intake air inlet to turbocharger	5	Cold starting aid
2	Turbocharger air to charge-air cooler	6	Intake port
3	Charge-air cooler	7	Intake valve
4	From charge-air cooler to intake air connection		

5. EXHAUST SYSTEM



9752EG07

1 Exhaust flow from cylinder
2 Exhaust manifold (pulse type)
3 Dual-entry turbocharger
4 Exhaust pressure regulator
5 Flow from exhaust pressure regulator



9752EG06-1

1 Exhaust gas inlet to turbocharger turbine housing
2 Exhaust gas outlet from exhaust pressure regulator
3 Intake air inlet to turbocharger compressor housing
4 Intake air outlet from compressor housing

GROUP 2 ENGINE SPEED & STALL RPM

1. TEST CONDITION

1) Normal temperature of the whole system
- Coolant : Approx 80˚C (176˚F) - Hydraulic oil : 45 ± 5˚C (113 ± 10˚F)
- Transmission oil : 75 ± 5˚C (167 ± 10˚F)

2) Normal operating pressure : See page 6-42.

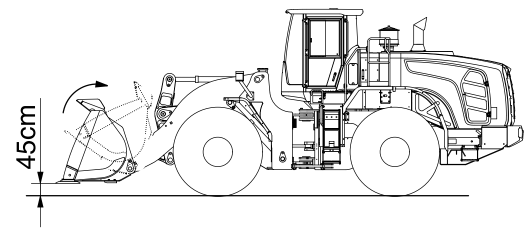
2. SPECIFICATION

Engine speed, rpm (P mode)						Remark
Low idle	High idle	Pump stall	Converter stall	Full stall	Fan motor	
800±25	2130±50	2150±70	2100±100	2090±100	950±50	

3. ENGINE RPM CHECK

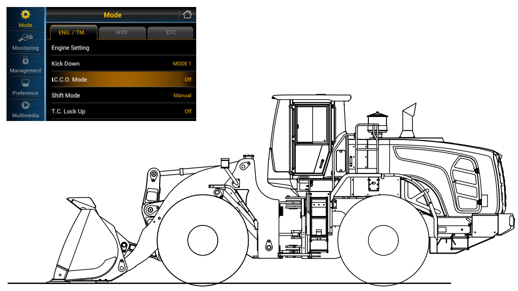
Remark : If the checked data is not normal, it indicates that the related system is not working properly. Therefore, it is required to check the related system pressure : See page 6-42.

1) Pump stall rpm
- Start the engine and raise the bucket approx 45 cm (1.5 ft) as the figure.
- Press the accelerator pedal fully and operate the bucket control lever to the retract position fully.
- Check the engine rpm at the above condition.



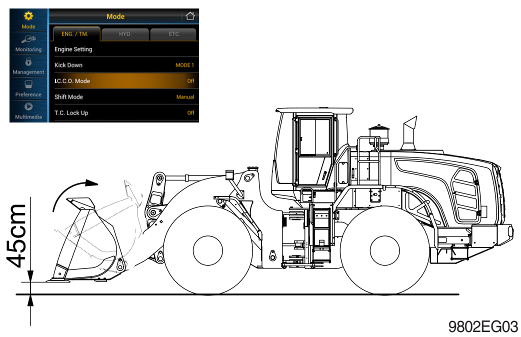
9802EG05

2) Convertor stall rpm
- Start the engine and lower the bucket on the ground as the figure.
- Set the clutch cut off mode at the OFF position.
- Press the brake pedal and accelerator pedal fully.
- Shift the transmission lever to the 4th forward position.
- Check the engine rpm at the above condition.



9802EG02

3) Full stall rpm
- Start the engine and raise the bucket approx 45 cm (1.5 ft) as the figure.
- Set the clutch cut off mode at the OFF position.
- Press the brake pedal and accelerator pedal fully .
- Shift the transmission lever to the 4th forward position and operate the bucket lever to the retract position fully.
- Check the engine rpm at the above condition.



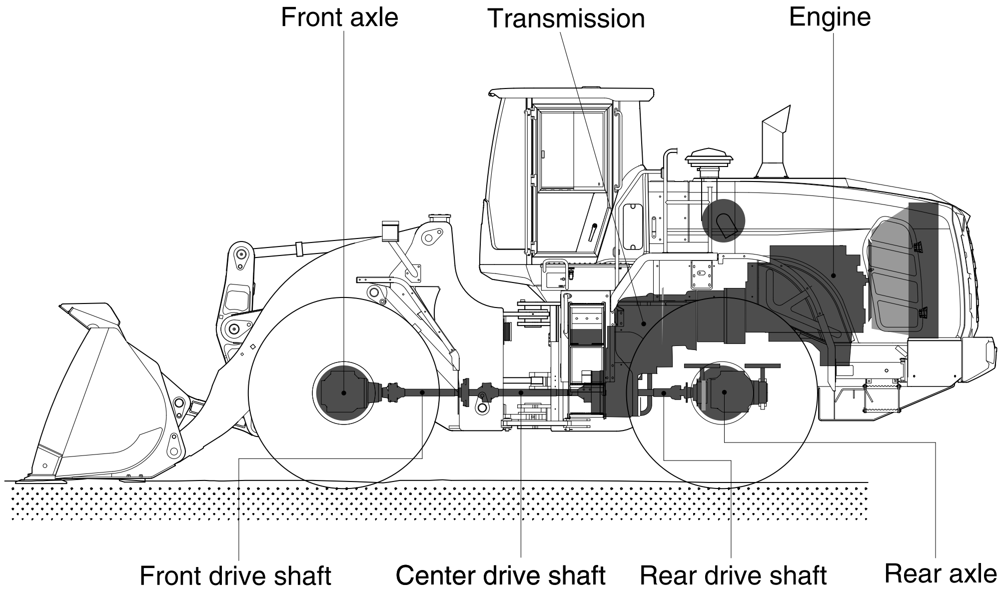
9802EG03

SECTION 3 POWER TRAIN SYSTEM

SECTION 3 POWER TRAIN SYSTEM

GROUP 1 STRUCTURE AND FUNCTION

1. POWER TRAIN COMPONENT OVERVIEW



985A3PT01

The power train consists of the following components:

· Transmission
· Front, center and rear drive shafts
· Front and rear axles

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

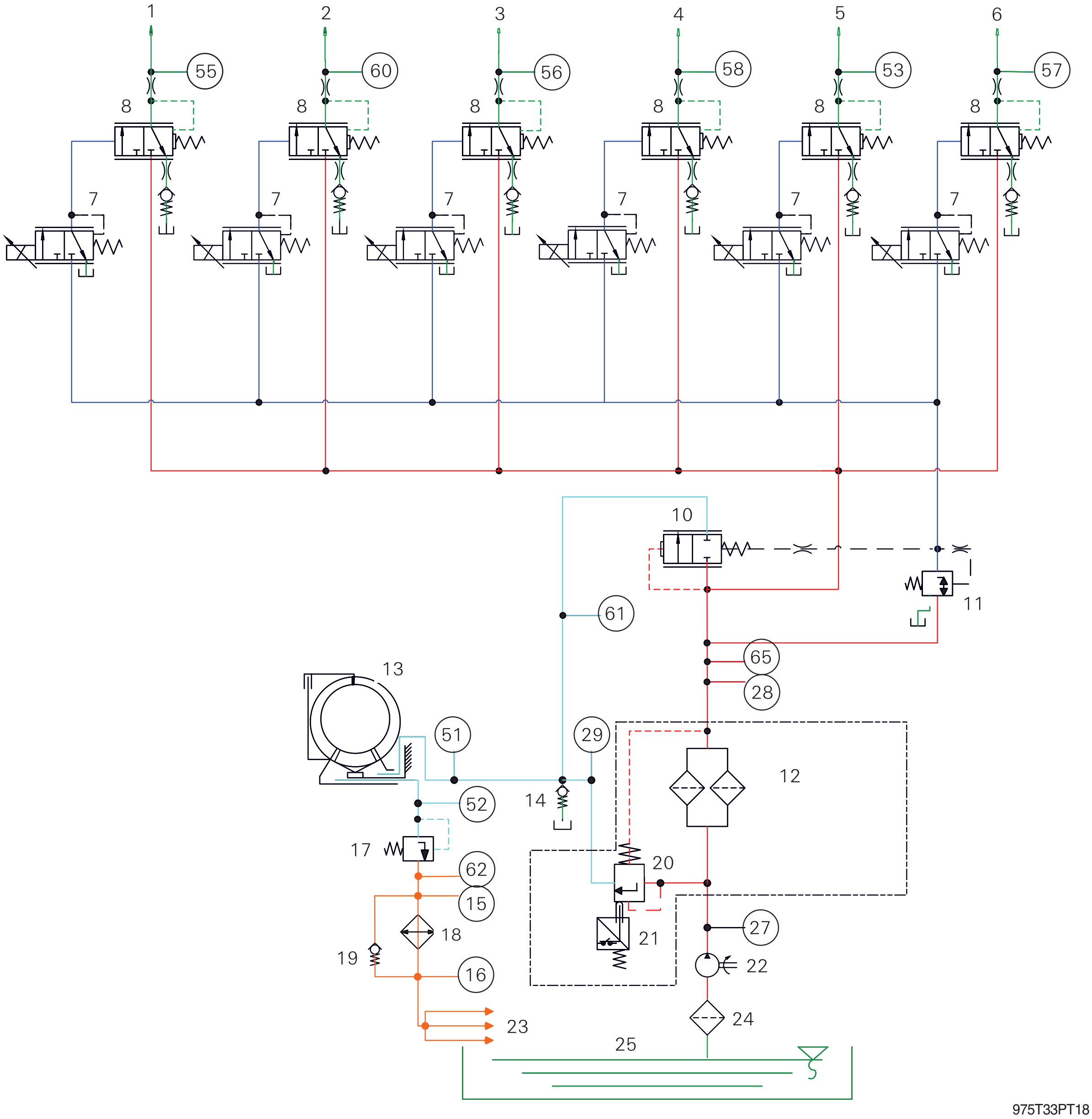
The transmission is a hydraulically engaged five speed forward, three speed reverse countershaft type power shift transmission. A calliper-disc type parking brake is located on the transmission.

The transmission outputs through universal joints to three drive shaft assemblies. The front drive shaft is a telescoping shaft which drives the front axle. The front axle is mounted directly to the loader frame.
The front axle is equipped with hydraulic lock differential as standard.
The rear axle is equipped with conventional differential as standard.
The rear axle is mounted on an oscillating pivot.

The power transmitted to front axle and rear axle is reduced by the pinion gear and ring gear of differential. It then passes from the differential to the sun gear shaft (axle shaft) of final drive.

The power of the sun gear is reduced by a planetary mechanism and is transmitted through the planetary hub to the wheel.

HYDRAULIC CIRCUIT



1 Return flow to sump

2 Pilot pressure

3 Main pressure

4 Lubrication

5 Converter pressure

Positions 15, 16, 27, 28, 29, 51, 52, 53, 55, 56, 57, 58, 60, 61, 62, 65 correspond to the numbers on the installation drawing.

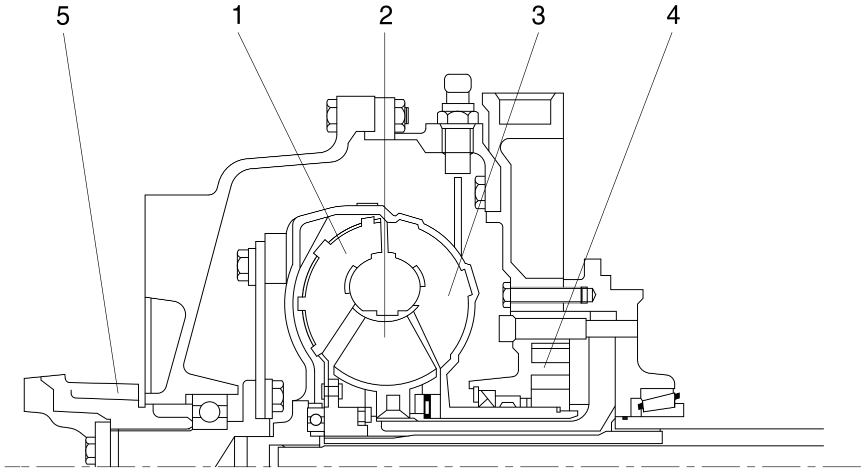
1 Clutch K1
2 Clutch KV (clutch forward)
3 Clutch K2
4 Clutch K3
5 Clutch K4
6 Clutch KR (clutch reverse)
7 Pilot valve
8 Downstream valve
10 Main pressure valve
11 Pressure reduction valve
12 Transmission pressure filter
13 Converter
14 Converter safety valve
15 Connection of pressure oil to oil cooler
16 Connection of pressure oil from oil cooler
17 Converter counter-pressure valve
18 Oil cooler (heat exchanger)
19 Oil cooler bypass valve
20 Filter bypass valve
21 Filter bypass switch
22 Transmission pump
23 Lubrication
24 Suction filter
25 Tank
27 Connection of pressure oil to filter
28 Connection of pressure oil from filter
29 Filter bypass connection
51 Measuring point of oil pressure before converter
52 Measuring point of oil pressure after converter
53 Measuring point of clutch pressure K4
55 Measuring point of clutch pressure K1
56 Measuring point of clutch pressure K2
57 Measuring point of clutch pressure KR
58 Measuring point of clutch pressure K3
60 Measuring point of clutch pressure KV
61 Temperature sensor for sump temperature
62 Temperature sensor for oil temperature after the converter
65 Measuring point of system pressure

Assignment of clutch and solenoid valve

		Live solenoid								
		Forward					Reverse			Neutral
Clutch	Solenoid valve	1	2	3	4	5	1	2	3	
KV	Y2	X	X		X					
KR	Y6						X	X	X	
K1	Y1	X					X			
K2	Y3		X	X				X		
K3	Y4			X	X				X	
K4	Y5		X		X					

2. TORQUE CONVERTER

1) FUNCTION



73033TM00

1	Turbine	3	Pump	5	Input flange
2	Stator	4	Transmission pump		

The converter is working according to the Trilok-system, i.e. it assumes at high turbine speed the characteristics, and with it the favorable efficiency of a fluid clutch.
The converter is designed according to the engine power so that the most favorable operating conditions are obtained for each installation case.

The Torque converter is composed of 3 main components :
Pump wheel - turbine wheel - stator (reaction member)

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

Pressure oil from the transmission pump is constantly streaming through the converter. In this way, the converter can fulfill its task to multiply the torque of the engine and at the same time, the heat created in the converter is dissipated via the escaping oil.
The oil which is streaming out of the pump wheel, enters the turbine wheel and is there inversed in the direction of flow.

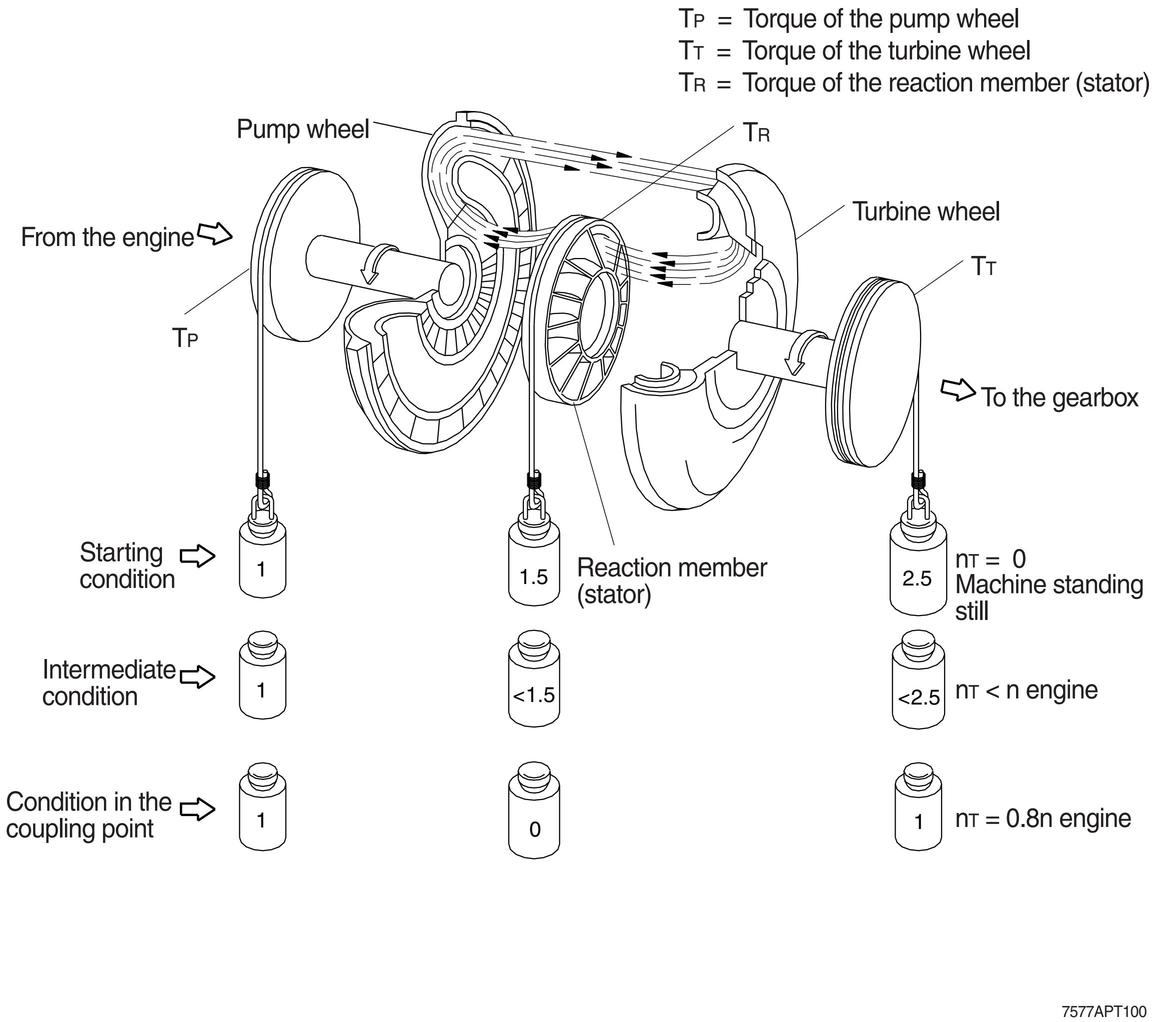
According to the rate of reversion, the turbine wheel and with it also the output shaft is receiving a more or less high reaction torque. The stator (reaction member), following the turbine, has the task to reverse the oil streaming out of the turbine once more and to deliver it under the suitable discharge direction to the pump wheel.
Due to the reversion, the stator receiving a reaction torque.
The relation turbine torque/pump torque is called torque multiplication.
This is the higher, the greater the speed difference of pump wheel and turbine wheel will be.

Therefore, the maximum torque multiplication is created at stationary turbine wheel.
With increasing output speed, the torque multiplication is decreasing. The adaption of the output speed to a certain required output torque will be infinitely variable and automatically achieved by the torque converter.

When the turbine speed is reaching about 80% of the pump speed, the torque multiplication becomes 1.0 i.e. the turbine torque becomes equal to that of the pump torque.
From this point on, the converter is working similar to a fluid clutch.

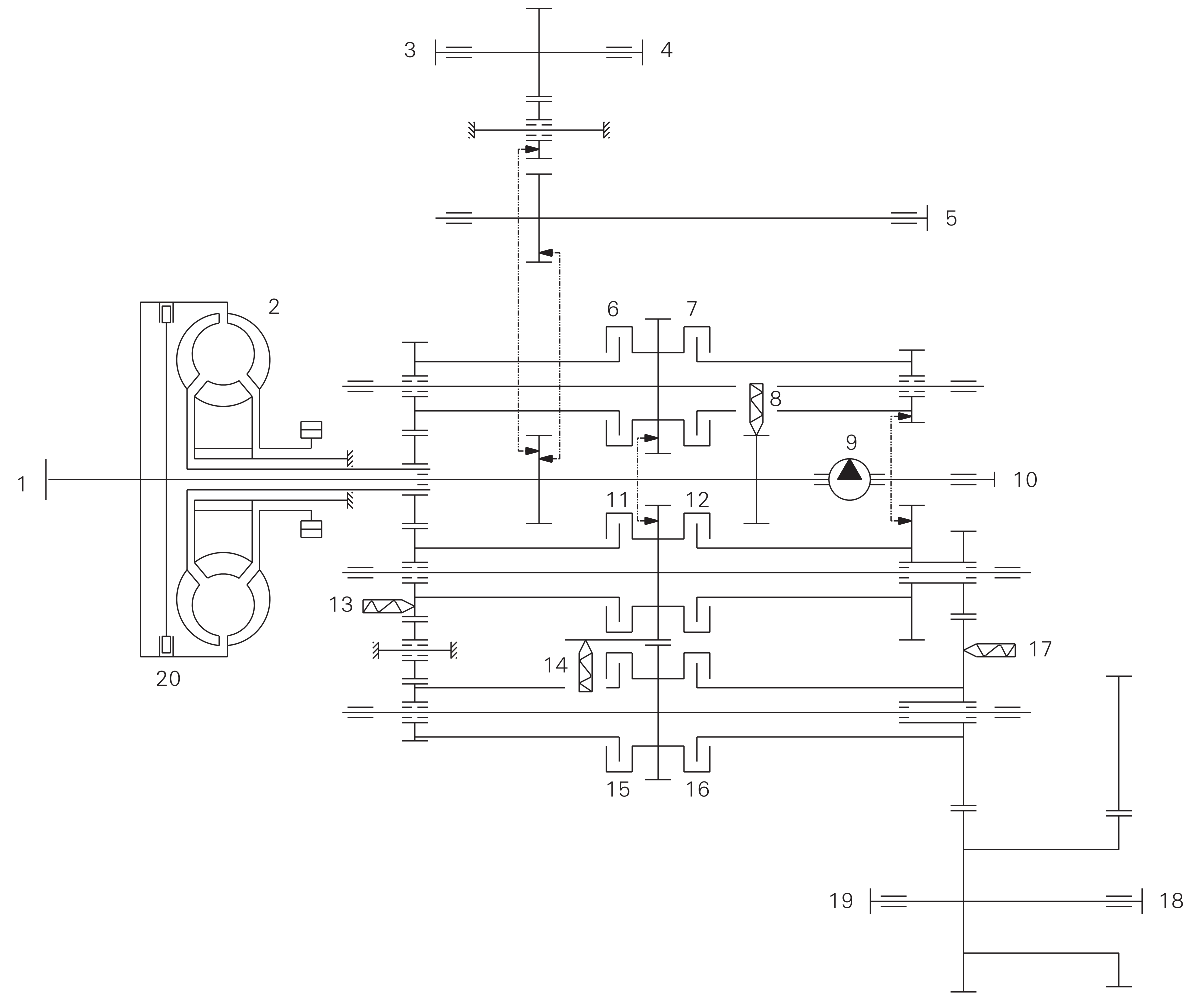
A stator freewheel serves to improve the efficiency in the upper driving range, in the torque multiplication range it is backing-up the torque upon the housing, and is released in the clutch range.
In this way, the stator can rotate freely.

Function of a hydrodynamic torque converter (schematic view)



3. TRANSMISSION

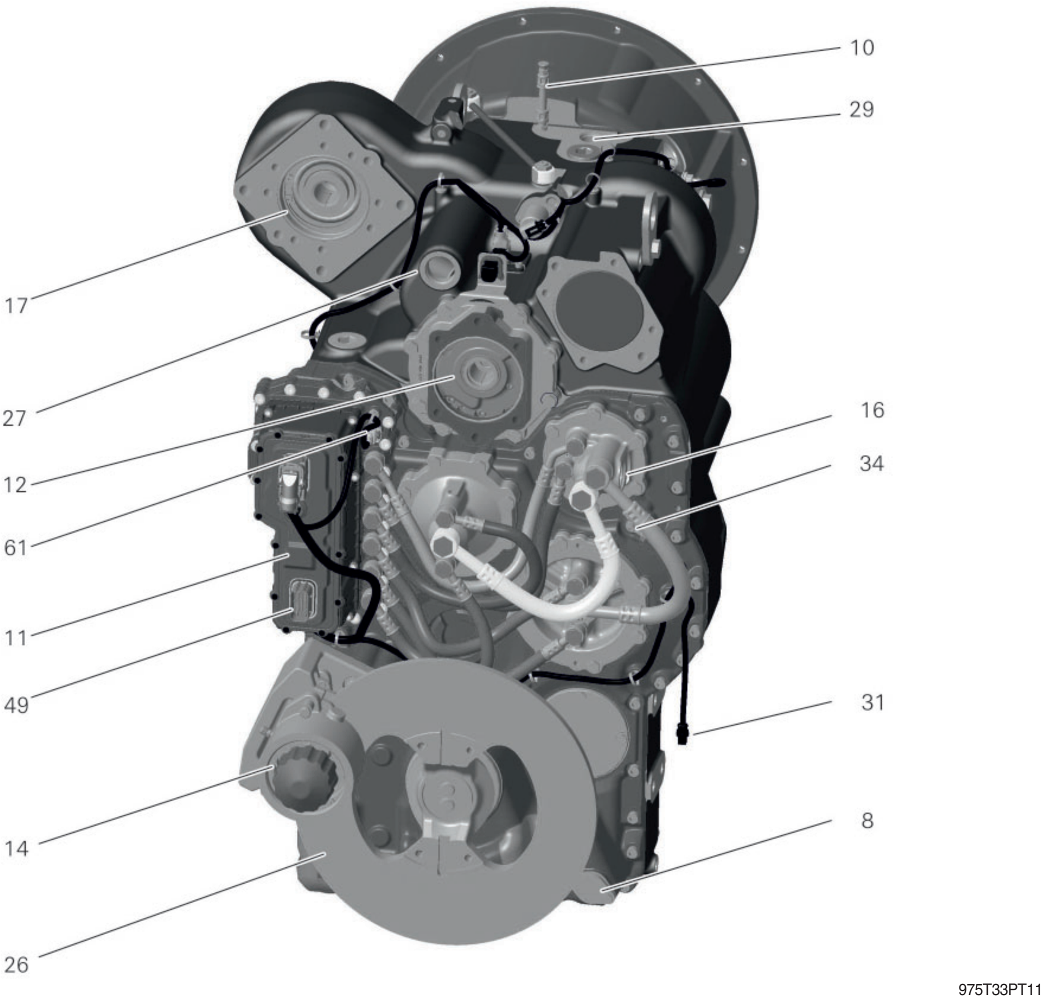
1) DIAGRAM



975T33PT10

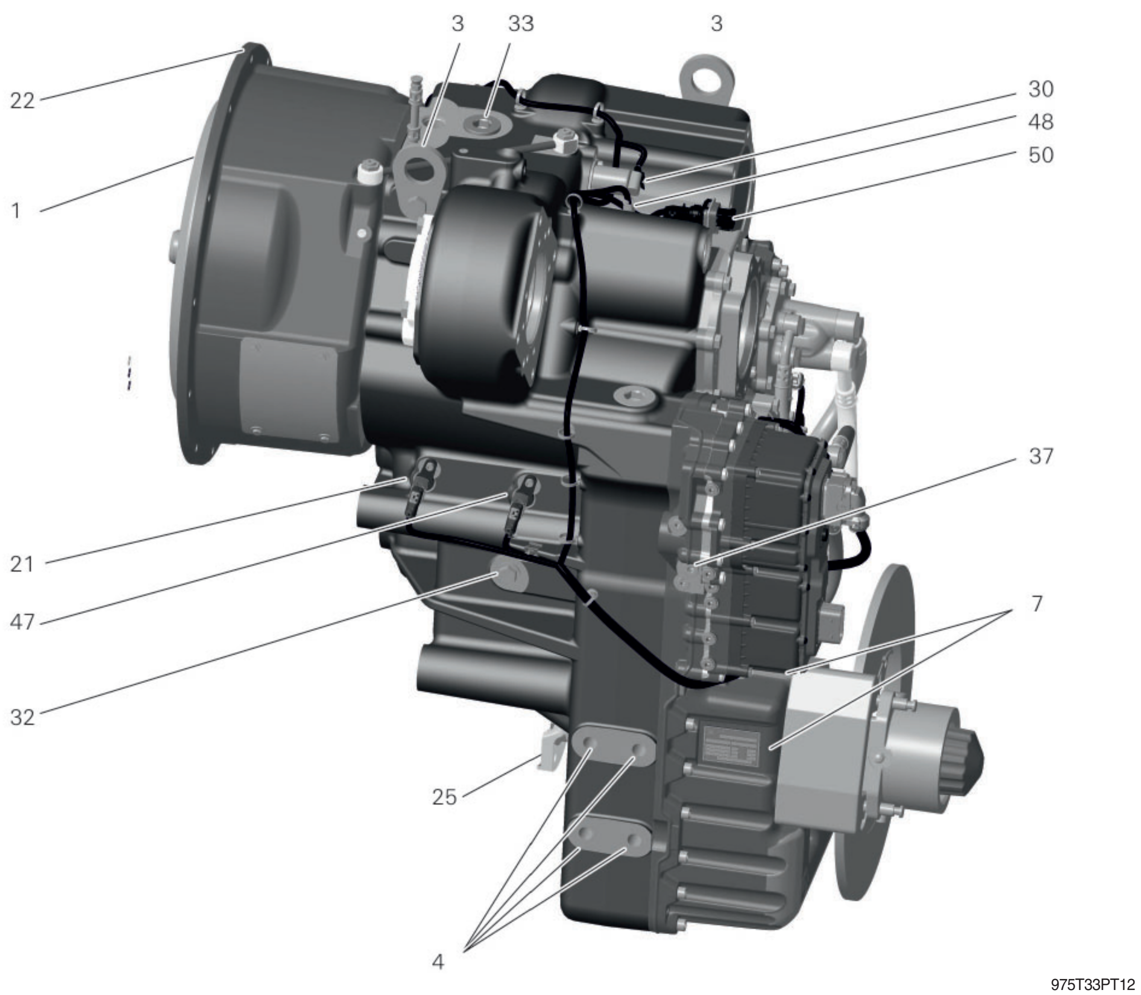
1	Input	2	Converter
3	PTO (if equipped)	4	PTO (if equipped)
5	PTO (if equipped)	6	Clutch KV (clutch forward)
7	Clutch K1	8	Inductive sensor for engine speed
9	Pump	10	Engine-dependent PTO
11	Clutch KR (clutch reverse)	12	Clutch K2
13	Inductive sensor for turbine speed	14	Inductive sensor for speed of central gear chain
14	Emergency steering pump (optional)		
15	Clutch K4	16	Clutch K3
17	Inductive sensor for the output speed	18	Output
19	Output	20	Lock-up clutch (not used)

2) INSTALLATION VIEW



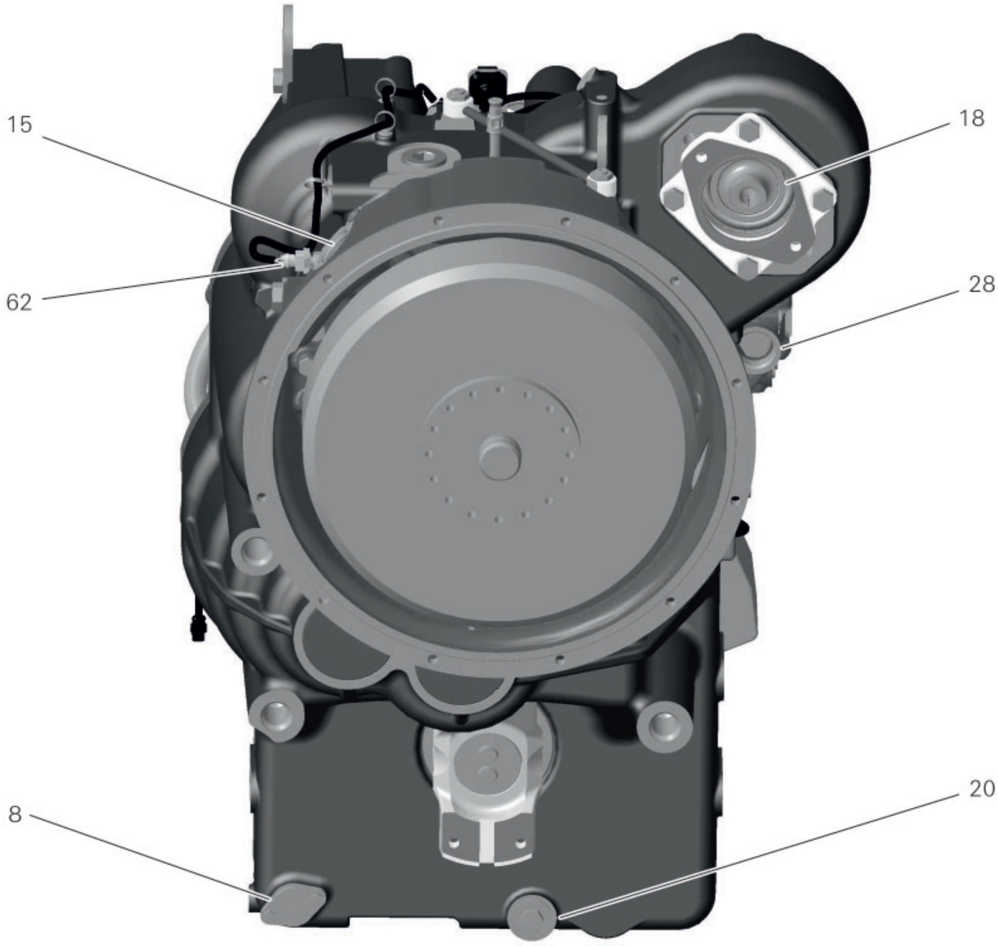
8	Connection for oil level gauge	31	Connector for filter bypass valve
10	Breather	34	Inductive sensor for output speed
11	Electro hydraulic transmission control unit	39	Connection of return flow to sump
12	Engine-dependent PTO	49	Machine connector
14	Parking brake - disc brake	61	Temperature sensor for oil temperature in sump
16	Connection from oil cooler		
17	PTO (if equipped)		
26	Output flange		
27	Connection to filter		
29	Connection from filter bypass		

INSTALLATION VIEW



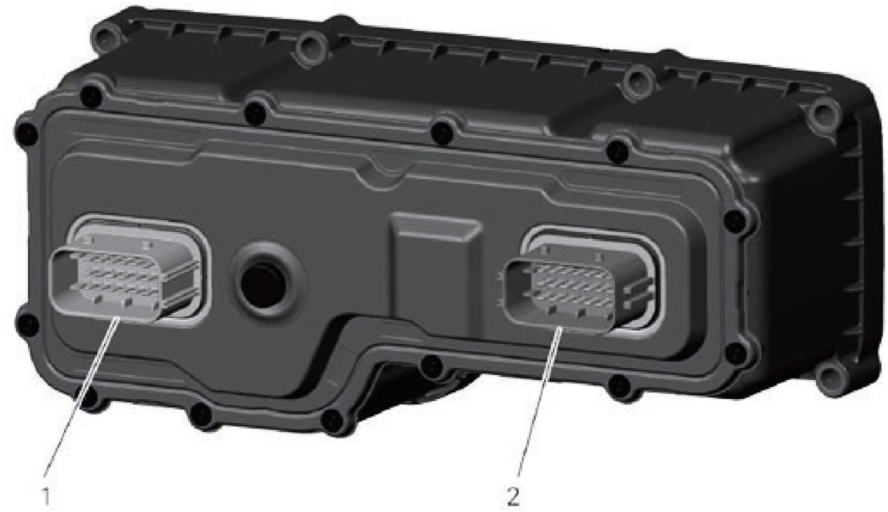
1 Converter	30 Solenoid valve for converter clutch (not used)
3 Lifting eye	32 Connection of return flow to sump M26X1.5
4 Transmission suspension holes	33 Oil filler plug M42X2 (Tightening torque 145 Nm)
7 Name plate	37 Connection for system pressure M16X1.5
15 Connection to heat exchanger	47 Inductive sensor for speed of central gear chain
21 Inductive sensor for turbine speed	48 Inductive sensor for engine speed
22 Connection to engine	50 Plug
25 Output flange	

INSTALLATION VIEW



8 Connection for oil level gauge
15 Connection to oil cooler
18 PTO (if equipped)
20 Oil drain plug M38X1.5
(Tightening torque 80 Nm)
28 Connection from filter
62 Temperature sensor for oil temperature after converter

3) ELECTRONIC TRANSMISSION CONTROL UNIT



960T33PT13

1 Transmission connector
2 Machine connector

The electronic transmission control unit controls the electro-hydraulic transmission control unit.

The electronic control unit (EC4A) is designed as on-site electronics. An internal plug connection and awiring harness (plug-in connector 1) connect the electronic transmission control unit and the internal elements of the transmission. A second slot is provided for the connection of the transmission to the machine (plug-in connector 2). This plug connection is responsible for the power supply via on-board supply system and the connection to the CAN communication network. At delivery the second plug connection is closed with a cap for protection against outside influences. Carefully remove the cap with as crewdriver or similar tool. Do not damage the detents on the plug.

4. FAULT CODE

1-1) MACHINE FAULT CODE

DTC		Diagnostic Criteria	Application		
HCESPN	FMI		G	C	S
101	3	10 seconds continuous, Hydraulic Oil Temp. Measurement Voltage > 3.95 V	●		
	4	10 seconds continuous, Hydraulic Oil Temp. Measurement Voltage < 0.3 V	●		
		(Results / Symptoms) 1. Monitor – Hydraulic Oil temperature display failure 2. Control Function – No warming up operation, No fuel warmer function operation, High hydraulic oil temperature warning failure (Checking list) 1. CN-58B (#23) – CD-01 (#2) Checking Open/Short 2. CN-58B (#25) – CD-01 (#1) Checking Open/Short			
202	0	10 seconds continuous, Steering main pump pressure Measurement Voltage > 5.3 V	●		
	4	10 seconds continuous, Steering main pump pressure Measurement Voltage < 0.3 V	●		
		(Results / Symptoms) 1. Monitor – Steering main pump press. Display failure 2. Control Function – No automatic Emergency steering operation, ECO gauge display failure 3. RMS – Working hours accumulation failure (Checking list) 1. CN-58B (#35) – CD-39 (B) Checking Open/Short 2. CN-58A (#11) – CD-39 (A) Checking Open/Short 3. CN-58B (#25) – CD-39 (C) Checking Open/Short			
204	0	10 seconds continuous, Boom cylinder 'head' pressure Measurement Voltage > 5.3 V	●		
	4	10 seconds continuous, Boom cylinder 'head' pressure Measurement Voltage < 0.3 V	●		
		(Results / Symptoms) 1. Monitor – Boom cylinder 'head' press. display failure 2. Control Function – No Boom pressure calibration function operation, workload measurement sys. operation failure (Checking list) 1. CN-58B (#29) – CD-80 (B) Checking Open/Short 2. CN-58A (#11) – CD-80 (A) Checking Open/Short 3. CN-58B (#25) – CD-80 (C) Checking Open/Short			

G : General C : Cummins Engine application equipment S : Scania Engine application equipment

DTC		Diagnostic Criteria	Application		
HCESPN	FMI		G	C	S
205	0	10 seconds continuous, Boom cylinder 'rod' pressure Measurement Voltage > 5.3V	●		
	4	10 seconds continuous, Boom cylinder 'rod' pressure Measurement Voltage < 0.3V	●		
	(Results / Symptoms) 1. Monitor – Boom cylinder 'rod' press. display failure 2. Control Function – No Boom pressure calibration function operation, workload measurement sys. operation failure (Checking list) 1. CN-58B(#36) – CD-81(B) Checking Open/Short 2. CN-58A(#11) – CD-81(A) Checking Open/Short 3. CN-58B(#25) – CD-81(C) Checking Open/Short				
301	3	10 seconds continuous, Fuel level Measurement Voltage > 3.8V	●		
	4	10 seconds continuous, Fuel level Measurement Voltage < 0.3V	●		
	(Results / Symptoms) 1. Monitor – Fuel level display failure 2. Control Function – Fuel level low warning operation failure (Checking list) 1. CN-58B (#22) – CD-02 (#2) Checking Open/Short 2. CN-58B (#25) – CD-02 (#1) Checking Open/Short				
318	8	(In the startup conditions) 30 seconds continuous, Fan speed < 10 rpm in the Remote cooling fan EPPR current reference value is in X Ma(differ by model)	●		
	(Results / Symptoms) 1. Monitor – Cooling Fan revolutions display failure (Checking list) 1. CN-58A (#15) – CD-73 (#1) Checking Open/Short 2. CN-58A (#18) – CD-73 (#2) Checking Open/Short				
339	3	10 seconds continuous, Accel pedal position 1 voltage Measurement Voltage > 5.0 V			●
	4	10 seconds continuous, Accel pedal position 1 voltage Measurement Voltage < 0.2 V			●
	(Results / Symptoms) 1. Monitor – Accel pedal position 1 voltage display failure 2. Control Function – Engine rpm control failure (Checking list) 1. CN-58B(#39) – CN-162(#2) Checking Open/Short 2. CN-58A(#6) – CN-162(#3) Checking Open/Short 3. CN-58A(#8) – CN-162(#1) Checking Open/Short				

G : General   C : Cummins Engine application equipment   S : Scania Engine application equipment

DTC		Diagnostic Criteria	Application		
HCESPN	FMI		G	C	S
343	3	10 seconds continuous, Accel pedal position 2 voltage Measurement Voltage > 5.0 V			●
	4	10 seconds continuous, Accel pedal position 2 voltage Measurement Voltage < 0.2 V			●
		(Results / Symptoms) 1. Monitor – Accel pedal position 2 voltage display failure 2. Control Function – Engine rpm control failure (Checking list) 1. CN-58B (#40) – CN-162 (#5) Checking Open/Short 2. CN-58A (#7) – CN-162 (#6) Checking Open/Short 3. CN-58A (#9) – CN-162 (#4) Checking Open/Short			
503	0	10 seconds continuous, Brake oil pressure Measurement Voltage > 5.3V	●		
	4	10 seconds continuous, Brake oil pressure Measurement Voltage < 0.3V	●		
		(Results / Symptoms) 1. Monitor – Brake oil press. display failure 2. Control Function – Brake oil pressure low warning display failure (Checking list) 1. CN-58B (#27) – CD-03 (B) Checking Open/Short 2. CN-58A (#11) – CD-03 (A) Checking Open/Short 3. CN-58B (#25) – CD-03 (C) Checking Open/Short			
507	0	10 seconds continuous, Parking oil pressure Measurement Voltage > 5.3V	●		
	4	10 seconds continuous, Parking oil pressure Measurement Voltage < 0.3V	●		
		(Results / Symptoms) 1. Monitor – Parking oil Press. display failure 2. Control Function – No judgment Parking status (Checking list) 1. CN-58B (#34) – CD-26 (B) Checking Open/Short 2. CN-58A (#11) – CD-26 (A) Checking Open/Short 3. CN-58B (#25) – CD-26 (C) Checking Open/Short			
557	0	10 seconds continuous, Brake oil charging priority pressure Measurement Voltage > 5.3V	●		
	4	10 seconds continuous, Brake oil charging priority pressure Measurement Voltage < 0.3V	●		
		(Results / Symptoms) 1. Monitor – Brake oil charging priority press. display failure 2. Control Function – Cooling fan revolutions control failure, Brake oil(Accumulator) charging failure (Checking list) 1. CN-58B (#38) – CD-31 (B) Checking Open/Short 2. CN-58A (#11) – CD-31 (A) Checking Open/Short 3. CN-58B (#25) – CD-31 (C) Checking Open/Short			

G : General C : Cummins Engine application equipment S : Scania Engine application equipment

DTC		Diagnostic Criteria	Application		
HCESPN	FMI		G	C	S
705	0	10 seconds continuous, Battery input Voltage > 35V	●		
	1	10 seconds continuous, Battery input Voltage < 18V	●		
		(Results / Symptoms) 1. Control Function – Disabled startup (Checking list) 1. Checking battery voltage 2. CN-58A (#1) – CN-36 (07 fuse) Checking Open/Short 3. CN-58A (#2) – CN-36 (07 fuse) Checking Open/Short			
707	1	(In the 500rpm or more) 10 seconds continuous, Alternator Node I Measurement Voltage < 18V	●		
		(Results / Symptoms) 1. Control Function – Battery charging circuit failure (Checking list) 1. CN-58B (#33) – CN-04 (#18) Checking Open/Short 2. CN-04 (#18) – CN-74 (#2) Checking Open/Short			
728	3	10 seconds continuous, Boom position sensor signal voltage Measurement Voltage > 5.0V	●		
	4	10 seconds continuous, Boom position sensor signal voltage Measurement Voltage < 0.3V	●		
		(Results / Symptoms) 1. Monitor – Boom position sensor signal voltage display failure 2. Control Function – No calibration angle sensor, No calibration boom pressure , Boom Detent operation failure, Soft end stop(Boom) operation failure, Lock-up clutch operation failure (Checking list) 1. CN-58B (#37) – CN-100 (B) Checking Open/Short 2. CN-58A (#5) – CN-100 (C) Checking Open/Short 3. CN-58B (#25) – CN-100 (A) Checking Open/Short			
729	3	10 seconds continuous, Bucket position sensor signal voltage Measurement Voltage > 5.0V	●		
	4	10 seconds continuous, Bucket position sensor signal voltage Measurement Voltage < 0.3V	●		
		(Results /Symptoms) 1. Monitor – Bucket position sensor signal voltage display failure 2. Control Function – No calibration angle sensor, Bucket Detent operation failure, Soft end stop(Bucket) operation failure (Checking list) 1. CN-58B(#30) – CN-101(B) Checking Open/Short 2. CN-58A(#5) – CN-101(C) Checking Open/Short 3. CN-58B(#25) – CN-101(A) Checking Open/Short			

G : General C : Cummins Engine application equipment S : Scania Engine application equipment

<table>
<tr><th colspan="2">DTC</th><th rowspan="2">Diagnostic Criteria</th><th colspan="3">Application</th></tr>
<tr><th>HCESPN</th><th>FMI</th><th>G</th><th>C</th><th>S</th></tr>
<tr><td rowspan="2">831</td><td>2</td><td>(When mounting the A/C Controller) 10 seconds continuous,
A/C controller Communication Data Error</td><td>●</td><td></td><td></td></tr>
<tr><td colspan="5">(Results / Symptoms)
1. Control Function – A/C Controller malfunction</td></tr>
<tr><td rowspan="2">841</td><td>2</td><td>10 seconds continuous, ECM Communication Data Error</td><td>●</td><td></td><td></td></tr>
<tr><td colspan="5">(Results /Symptoms)
1. Control Function – ECM operation failure</td></tr>
<tr><td rowspan="2">842</td><td>2</td><td>10 seconds continuous, TCU Communication Data Error</td><td>●</td><td></td><td></td></tr>
<tr><td colspan="5">(Results / Symptoms)
1. Control Function – TCU operation failure</td></tr>
<tr><td rowspan="2">844</td><td>2</td><td>10 seconds continuous, Monitor Communication Data Error</td><td>●</td><td></td><td></td></tr>
<tr><td colspan="5">(Results / Symptoms)
1. Control Function – Monitor operation failure</td></tr>
<tr><td rowspan="2">850</td><td>2</td><td>(When mounting the RMCU)
90 seconds continuous, RMCU Communication Data Error</td><td>●</td><td></td><td></td></tr>
<tr><td colspan="5">(Results / Symptoms)
1. Control Function – RMCU operation failure</td></tr>
<tr><td rowspan="2">861</td><td>2</td><td>(When mounting the EHCU)
10 seconds continuous, EHCU Communication Data Error</td><td>●</td><td></td><td></td></tr>
<tr><td colspan="5">(Results / Symptoms)
1. Control Function – EHCU operation failure</td></tr>
<tr><td rowspan="2">869</td><td>2</td><td>(When mounting the BKCU)
10 seconds continuous, BKCU Communication Data Error</td><td>●</td><td></td><td></td></tr>
<tr><td colspan="5">(Results / Symptoms)
1. Control Function – BKCU operation failure</td></tr>
</table>

G : General C : Cummins Engine application equipment S : Scania Engine application equipment

1-2) EHCU FAULT CODE

HCESPN	FMI	Description
2333	9	Communication timeout between EHCU and TCU
2331	9	Communication timeout between EHCU and MCU
2332	9	Communication timeout between EHCU and working joystick
2317	9	Communication timeout between EHCU and steering joystick
2319	2	Steering joystick position signal error
2320	2	Steering joystick - FNR enable switch error
2321	2	Steering joystick - foward switch error
2322	2	Steering joystick - neutral switch error
2323	2	Steering joystick - reverse switch error
2324	2	Steering joystick - kick down switch error
2325	2	Steering joystick - steering on switch error
2326	5	PVE coil power current below normal or open circuit
2326	6	PVE coil power current above normal or grounded circuit
2327	0	PVE coil PWM duty cycle input value above normal operation range
2327	1	PVE coil PWM duty cycle input value below normal operation range
2327	5	PVE coil PWM duty cycle current below normal or open circuit
2327	6	PVE coil PWM duty cycle current above normal or grounded circuit
2327	14	PVE coil PWM duty cycle control block parameter invalid
2311	2	Boom joystick position signal error
2311	0	Boom joystick position input value above normal operation range
2311	1	Boom joystick position input value below normal operation range
2311	3	Boom joystick position input voltage above normal or shorted to high source
2311	4	Boom joystick position input voltage below normal or shorted to low source
2311	13	Boom joystick position control block out of calibration
2311	14	Boom joystick position control block parameter invalid
2311	31	Boom joysitck position signal redundancy lost
2313	2	Bucket joystick position signal error
2313	0	Bucket joystick position input value above normal operation range
2313	1	Bucket joystick position input value below normal operation range
2313	3	Bucket joystick position input voltage above normal or shorted to high source
2313	4	Bucket joystick position input voltage below normal or shorted to low source
2313	13	Bucket joystick position control block out of calibration
2313	14	Bucket joystick position control block parameter invalid
2313	31	Bucket joysitck position signal redundancy lost
2315	2	Aux joystick position signal error
2315	0	Aux joystick position input value above normal operation range
2315	1	Aux joystick position input value below normal operation range

HCESPN	FMI	Description
2315	3	Aux joystick position input voltage above normal or shorted to high source
2315	4	Aux joystick position input voltage below normal or shorted to low source
2315	13	Aux joystick position control block out of calibration
2315	14	Aux joystick position control block parameter invalid
2315	31	Aux joysitck position signal redundancy lost
2304	0	Boom up EPPR valve input value above normal operation range
2304	1	Boom up EPPR valve input value below normal operation range
2304	5	Boom up EPPR valve input current below normal or open circuit
2304	6	Boom up EPPR valve input current above normal or grounded circuit
2304	14	Boom up EPPR valve block parameter invalid
2305	0	Boom down EPPR valve input value above normal operation range
2305	1	Boom down EPPR valve input value below normal operation range
2305	5	Boom down EPPR valve input current below normal or open circuit
2305	6	Boom down EPPR valve input current above normal or grounded circuit
2305	14	Boom down EPPR valve block parameter invalid
2306	0	Bucket in EPPR valve input value above normal operation range
2306	1	Bucket in EPPR valve input value below normal operation range
2306	5	Bucket in EPPR valve input current below normal or open circuit
2306	6	Bucket in EPPR valve input current above normal or grounded circuit
2306	14	Bucket in EPPR valve block parameter invalid
2307	0	Bucket dump EPPR valve input value above normal operation range
2307	1	Bucket dump EPPR valve input value below normal operation range
2307	5	Bucket dump EPPR valve input current below normal or open circuit
2307	6	Bucket dump EPPR valve input current above normal or grounded circuit
2307	14	Bucket dump EPPR valve block parameter invalid
2308	0	Aux. Up EPPR valve input value above normal operation range
2308	1	Aux. Up EPPR valve input value below normal operation range
2308	5	Aux. Up EPPR valve input current below normal or open circuit
2308	6	Aux. Up EPPR valve input current above normal or grounded circuit
2308	14	Aux. Up EPPR valve block parameter invalid
2309	0	Aux. Down EPPR valve input data above normal operation range
2309	1	Aux. Down EPPR valve input data below normal operation range
2309	5	Aux. Down EPPR valve input current below normal or open circuit
2309	6	Aux. Down EPPR valve input current above normal or grounded circuit
2309	14	Aux. Down EPPR valve block parameter invalid
2328	0	EHCU sensor power voltage high
2328	1	EHCU sensor power voltage low
2328	3	EHCU sensor power voltage above normal or shorted to high source

HCESPN	FMI	Description
2328	4	EHCU sensor power voltage below normal or shorted to low source
2329	0	EHCU power voltage high
2329	1	EHCU power voltage low
2329	11	EHCU safety cpu error
739	2	Armrest switch signal error
2334	0	Steering pilot pressure sensor data above normal range
2334	1	Steering pilot pressure sensor data below normal range
2335	2	Steering proportional valve moving position error
2335	14	Steering proportional valve start position error

1-3) AAVM FAULT CODE

Fault Code	Description
A01	AAVM Communication Error -AAVM
A02	AAVM Communication Error -Front Camera
A03	AAVM Communication Error -Rear Camera
A04	AAVM Communication Error -Left Camera
A05	AAVM Communication Error -Right Camera
A06	Manual Setting Fail
A07	No MCU CID
A08	MCU CID Format Error
A09	AAVM Hardware Error -AAVM
A10	AAVM Hardware Error -Front Camera
A11	AAVM Hardware Error -Rear Camera
A12	AAVM Hardware Error -Left Camera
A13	AAVM Hardware Error -Right Camera
A14	MCU CID Model is not registered
A15	MCU CID Model can’t be applied

2) ENGINE FAULT CODE

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
111 629 12	Engine control module critical internal failure - Bad intelligent device or component. Error internal to the ECM related to memory hardware failures or internal ECM voltage supply circuits.	Possible no noticeable performance effects, engine dying, or hard starting.
115 612 2	Engine magnetic crankshaft speed/position lost both of two signals - Data erratic, intermittent, or incorrect. The ECM has detected the primary and backup speed sensor signals are connected backwards.	The engine will shut down or will not start.
122 102 3	Intake manifold 1 pressure sensor circuit - Voltage above normal, or shorted to high source. High signal voltage detected at the intake manifold pressure circuit.	Engine power derate.
123 102 4	Intake manifold 1 pressure sensor circuit - Voltage below normal, or shorted to low Source. Low signal voltage or open circuit detected at the intake manifold pressure circuit.	Engine power derate.
124 102 16	Intake manifold 1 pressure - Data valid but above normal operational range - Moderately severe level. Intake manifold pressure is above the maximum operating limit.	Engine power derate.
125 102 18	Intake Manifold 1 Pressure - Data valid but below normal operating range - Moderately severe level. Intake manifold pressure is below the minimum operating limit.	Engine power derate.
131 91 3	Accelerator pedal or lever position sensor 1 circuit - Voltage above normal, or shorted to high source. High voltage detected at accelerator pedal position number 1 circuit.	The engine will operate in limp home mode.
132 91 4	Accelerator pedal or lever position sensor 1 circuit - Voltage below normal, or shorted to low source. Low voltage detected at accelerator pedal position number 1 signal circuit.	The engine will operate in limp home mode.
133 974 3	Remote accelerator pedal or lever position sensor 1 circuit - Voltage above normal, or shorted to high source. High voltage detected at remote accelerator pedal position signal circuit.	Remote accelerator will not operate.
134 974 4	Remote accelerator pedal or lever position sensor 1 circuit - Voltage below normal, or shorted to low source. Low voltage detected at remote accelerator pedal position signal circuit.	Remote accelerator will not operate.
143 100 18	Engine oil rifle pressure - Data valid but below normal operational range - Moderately severe level. Engine oil pressure signal indicates engine oil pressure is below the engine protection warning limit.	Engine power derate.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
144 110 3	Engine coolant temperature 1 sensor circuit - Voltage above normal, or shorted to high source. High signal voltage or open circuit detected at engine coolant temperature circuit.	Fan will stay ON if controlled by ECM.
145 110 4	Engine coolant temperature 1 sensor circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at engine coolant temperature circuit.	Fan will stay ON if controlled by ECM.
146 110 16	Engine coolant temperature - Data valid but above normal operational range - Moderately severe level. Engine coolant temperature is above engine protection warning limit.	Progressive power and/or speed derate increasing in severity from time of alert. If the engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red stop lamp starts flashing.
151 110 0	Engine coolant temperature - Data valid but above normal operational range - Most severe level. Engine coolant temperature signal indicates engine coolant temperature above engine protection critical limit.	Progressive power and/or speed derate increasing in severity from time of alert. If the engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red stop lamp starts flashing.
153 105 3	Intake manifold 1 temperature sensor circuit - Voltage above normal, or shorted to high source. High signal voltage detected at intake manifold air temperature circuit.	Fan will stay ON if controlled by ECM.
154 105 4	Intake manifold 1 temperature sensor circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at intake manifold air temperature circuit.	Fan will stay ON if controlled by ECM.
155 105 0	Intake manifold 1 temperature - Data valid but above normal operational range - Most severe level. Intake manifold air temperature signal indicates intake manifold air temperature above engine protection critical limit.	Progressive power and/or speed derate increasing in severity from time of alert. If the engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red stop lamp starts flashing.
175 3464 3	Electronic throttle control actuator driver circuit - Voltage above normal, or shorted to high source. A short circuit to battery or open circuit has been detected in the engine intake air throttle actuator signal circuit.	Possible reduced engine performance.
176 3464 4	Electronic throttle control actuator driver circuit - Voltage below normal, or shorted to low source. A short circuit to ground has been detected in the engine intake air throttle actuator signal circuit.	Possible reduced engine performance.
177 3464 7	Electronic throttle control actuator - Mechanical system not responding or out of adjustment. The engine intake air throttle actuator has failed the auto zero span check.	Possible reduced engine performance.
187 3510 4	Sensor supply 2 circuit - Voltage below normal, or shorted to low source. Low voltage detected at the sensor supply number 2 circuit.	Engine power derate.
195 111 3	Coolant level sensor 1 circuit - Voltage above normal, or shorted to high source. High signal voltage detected at engine coolant level circuit.	None on performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
196 111 4	Coolant level sensor 1 circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at engine coolant level circuit.	None on performance.
197 111 18	Coolant level - Data valid but below normal operational range - Moderately severe level. Low coolant level has been detected.	Engine power derate.
221 108 3	Barometric pressure sensor circuit - Voltage above normal, or shorted to high source. High signal voltage detected at barometric pressure circuit.	Engine power derate.
222 108 4	Barometric pressure sensor circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at barometric pressure circuit.	Engine power derate.
227 3510 3	Sensor supply 2 circuit - Voltage above normal, or shorted to high source. High voltage detected at sensor supply number 2 circuit.	Engine power derate.
234 190 0	Engine crankshaft speed/position - Data valid but above normal operational range - Most severe level. Engine speed signal indicates engine speed above engine protection limit.	Engine power derate.
238 3511 4	Sensor supply 3 circuit - Voltage below normal, or shorted to low source. Low voltage detected on the +5 volt sensor supply circuit to the engine speed sensor.	Engine may run rough, may stop running, may not start, or may be difficult to start.
239 3511 3	Sensor supply 3 circuit - Voltage above normal or shorted to high source. High voltage detected on the 5 volt sensor supply circuit to the engine speed sensor.	Engine may run rough, may stop running, may not start, or may be difficult to start.
241 84 2	Wheel-based vehicle speed - Data erratic, intermittent, or incorrect. The ECM lost the vehicle speed signal or is reading an erratic value.	Engine speed limited to ,maximum engine speed without VSS parameter value. Cruise control, gear-down protection, and road speed governor will not work.
245 647 4	Fan control circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at the fan control circuit when commanded on.	The fan may stay on continuously or not run at all.
249 171 3	Ambient air temperature sensor 1 circuit - Voltage above normal or shorted to high source. High signal voltage detected at ambient air temperature circuit.	Possible reduced engine performance.
256 171 4	Ambient air temperature sensor 1 circuit - Voltage below normal or shorted to low source. Low voltage detected at ambient air temperature circuit.	Possible reduced engine performance.
271 1347 4	Fuel pump pressurizing assembly 1 circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at the fuel pump actuator circuit.	Engine power derate.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
272 1347 3	Fuel pump pressurizing assembly 1 circuit - Voltage above normal, or shorted to high source. High signal voltage or open circuit detected at the fuel pump actuator circuit.	Engine may run rough, may stop running, may not start, or may be difficult to start.
285 639 9	SAE J1939 multiplexing PGN timeout error - Abnormal update rate. The ECM expected information from a multiplexed device but did not receive it soon enough or did not receive it at all.	At least one multiplexed device will not operate properly.
286 639 13	SAE J1939 multiplexing configuration error - Out of calibration. The ECM expected information from a multiplexed device but only received a portion of the necessary information.	At least one multiplexed device will not operate properly.
288 974 19	Sae J1939 multiplexing remote accelerator pedal or lever position sensor circuit - Received network data in error. The oem vehicle electronic control unit (VECM) detected a fault with the remote accelerator.	Remote accelerator will not operate.
295 108 2	Barometric pressure - Data erratic, intermittent, or incorrect. An error in the barometric pressure sensor signal was detected by the ECM.	Engine power derate.
322 651 5	Injector solenoid driver cylinder 1 circuit - Current below normal, or open circuit. Current detected at injector 1 when voltage is turned OFF.	Engine power derate.
323 655 5	Injector solenoid driver cylinder 5 circuit - Current below normal, or open circuit. Current detected at injector 5 when voltage is turned OFF.	The current to the injector is shut OFF. Engine power derate.
324 653 5	Injector solenoid driver cylinder 3 circuit - Current below normal, or open circuit. Current detected at injector 3 when voltage is turned OFF.	The current to the injector is shut OFF. Engine power derate.
325 656 5	Injector solenoid driver cylinder 6 circuit - Current below normal, or open circuit. Current detected at injector 6 when voltage is turned OFF.	The current to the injector is shut OFF. Engine power derate.
331 652 5	Injector solenoid driver cylinder 2 circuit - Current below normal, or open circuit. Current detected at injector 2 when voltage is turned OFF.	The current to the injector is shut OFF. Engine power derate.
332 654 5	Injector solenoid driver cylinder 4 circuit - Current below normal, or open circuit. Current detected at injector 4 when voltage is turned OFF.	The current to the injector is shut OFF. Engine power derate.
334 110 2	Engine coolant temperature - Data erratic, intermittent, or incorrect. The engine coolant temperature sensor is reading an erratic value at initial key ON.	None on performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
338 1267 3	Idle shutdown vehicle accessories relay driver circuit - Voltage above normal, or shorted to high source. Open circuit or short to voltage source detected at the idle shutdown vehicle accessory/ignition bus relay circuit.	Vehicle accessories or ignition bus loads controlled by the idle shutdown relay will not power up.
339 1267 4	Idle shutdown vehicle accessories relay driver circuit - Voltage below normal, or shorted to low source. Low voltage detected at the idle shutdown vehicle accessory or ignition bus relay circuit when commanded ON.	Vehicle accessories or ignition bus loads controlled by the idle shutdown relay will not power up.
343 629 12	Engine control module warning internal hardware failure - Bad intelligent device or component. ECM power supply errors have been detected.	Engine power derate.
346 630 12	Engine control module calibration memory software - Bad intelligent device or component. Invalid switch configuration adjustable parameter setting have been detected by the engine control module (ECM).	Various optional switch inputs to the ECM may not operate correctly.
351 627 12	Injector power supply - Bad intelligent device or component. The ECM measured injector boost voltage is low.	Engine power derate.
352 3509 4	Sensor supply 1 circuit - Voltage below normal, or shorted to low source. Low voltage detected at sensor supply number 1 circuit.	Engine power derate.
383 729 5	Engine intake air heater 1 circuit - Current below normal or open circuit. A malfunctioning engine intake air heater circuit has been detected.	Engine may not start or may be difficult to start.
386 3509 3	Sensor supply 1 circuit - Voltage above normal, or shorted to high source. High voltage detected at sensor supply number 1 circuit.	Engine power derate.
415 100 1	Engine oil rifle pressure - Data valid but below normal operational range - Most severe level. Oil pressure signal indicates oil pressure below the engine protection critical limit.	Progressive power and/or speed derate increasing in severity from time of alert. If engine protection shutdown feature is enabled, engine will shut down 30 seconds after red stop lamp starts flashing.
418 97 15	Water in fuel indicator - Data valid but above normal operational range - Least severe level. water has been detected in the fuel filter.	None on performance.
427 639 9	J1939 data link - Abnormal update rate. Communication between the engine control module (ECM) and another device on the SAE J1939 data link has been lost.	Engine will only idle.
428 97 3	Water in fuel indicator sensor circuit - Voltage above normal, or shorted to high source. High voltage detected at the water in fuel circuit.	None on performance. No water in fuel warning available.
435 100 2	Engine oil rifle pressure - Data erratic, intermittent, or incorrect. The engine oil pressure sensor is reading an erratic value.	None on performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
436 105 2	Intake manifold 1 temperature - Data erratic, intermittent, or incorrect. The intake manifold temperature sensor is reading an erratic value at initial key on or while the engine is running.	Possible reduced engine performance.
441 168 18	Battery 1 voltage - Data valid but below normal operational range - Moderately severe level. ECM supply voltage is below the minimum system voltage level.	Engine may run rough, may stop running, may not start, or may be difficult to start.
442 168 16	Battery 1 Voltage - Data valid but above normal operational range - Moderately severe level. ECM supply voltage is above the maximum system voltage level.	None on performance.
451 157 3	Injector metering rail 1 pressure sensor circuit - Voltage above normal, or shorted to high source. High signal voltage detected at the rail fuel pressure sensor circuit.	Power and/or speed derate.
452 157 4	Injector metering rail 1 pressure sensor circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at the rail fuel pressure sensor circuit.	Power and/or speed derate.
483 1349 3	Injector metering rail 2 pressure sensor circuit - Voltage above normal or shorted to high source. High signal voltage detected at the fuel rail 2 pressure sensor circuit.	Possible reduced engine performance.
484 1349 4	Injector metering rail 2 pressure sensor circuit - Voltage below normal or shorted to low source. Low signal voltage detected at the fuel rail 2 pressure sensor circuit.	Possible reduced engine performance.
515 3514 3	Sensor supply 6 circuit - Voltage above normal or shorted to high source. High voltage detected on the +5 volt sensor supply circuit to the fuel rail pressure sensor.	Engine power derate.
516 3514 4	Sensor supply 6 circuit - Voltage below normal or shorted to low source. Low voltage detected on the +5 volt sensor supply circuit to the fuel rail pressure sensor.	Engine power derate.
553 157 16	Injector metering rail 1 pressure - Data valid but above normal operational range - Moderately severe level. The ECM has detected that fuel pressure is higher than commanded pressure.	Possible reduced engine performance.
555 101 16	Crankcase pressure - Data valid but above normal operational range - Moderately severe level. The crankcase breather filter requires maintenance.	None on performance.
556 101 0	Crankcase pressure - Data valid but above normal operational range - Most severe level. The crankcase breather filter requires maintenance.	None on performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
559 157 18	Injector metering rail 1 pressure - Data valid but below normal operational range - Moderately severe level. The ecm has detected that fuel pressure is lower than commanded pressure.	Possibly hard to start or low power. Engine could possibly **not** start.
584 677 3	Starter relay driver circuit - Voltage above normal, or shorted to high source. Open circuit or high voltage detected at starter lockout circuit.	Either the engine will not start or the engine will not have starter lockout protection.
585 677 4	Starter relay driver circuit - Voltage below normal, or shorted to low source. Low voltage detected at starter lockout circuit.	Either the engine will not start or the engine will not have starter lockout protection.
595 103 16	Turbocharger 1 speed - Data valid but above normal operating range - Moderately severe level. High turbocharger speed has been detected by the ecm.	Engine power derate.
596 167 16	Electrical charging system voltage - Data valid but above normal operational range - Moderately severe level. High battery voltage detected by the battery voltage monitor feature.	None on performance.
597 167 18	Electrical charging system voltage - Data valid but below normal operational range - Moderately severe level. Low battery voltage detected by the battery voltage monitor feature.	None on performance.
649 1378 31	Engine oil change interval - Condition exists. Change engine oil and filter.	None on performance.
687 103 18	Turbocharger 1 speed - Data valid but below normal operational range - Moderately severe level. Low turbocharger speed detected by the ECM.	Engine power derate. The ECM uses an estimated turbocharger speed.
689 190 2	Engine crankshaft speed/position - Data erratic, intermittent, or incorrect. The ECM has detected an error in the engine speed signal.	Possible reduced engine performance.
691 1172 3	Turbocharger 1 compressor inlet temperature sensor circuit - Voltage above normal, or shorted to high source. High signal voltage detected at turbocharger compressor inlet air temperature circuit.	Engine power derate.
692 1172 4	Turbocharger 1 compressor inlet temperature circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at turbocharger compressor inlet air temperature circuit.	Engine power derate.
693 1172 2	Turbocharger 1 compressor intake temperature - Data erratic, intermittent, or incorrect. A temperature too high or low for the operating conditions has been detected by the turbocharger compressor intake temperature sensor.	Possible reduced engine performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
731 723 7	Engine speed / position camshaft and crankshaft misalignment - Mechanical system not responding properly or out of adjustment. Engine position signal from the crankshaft position sensor and camshaft position sensor do not match.	Engine power derate.
755 157 7	Injector metering rail 1 pressure - Mechanical system not responding or out of adjustment. The ecm has detected a difference in the 2 fuel rail pressure signals.	Possible reduced engine performance.
778 723 2	Engine camshaft speed / position sensor - Data erratic, intermittent, or incorrect. The ECM has detected an error in the camshaft position sensor signal.	Possible reduced engine performance.
784 1590 2	Adaptive cruise control mode - Data erratic, intermittent, or incorrect. Loss of communication with adaptive cruise control.	Adaptive cruise control will not operate. Standard cruise control may not operate.
1117 627 2	Power supply lost with ignition on - Data erratic, intermittent, or incorrect. Supply voltage to the ECM fell below 6.2 volts momentarily, or the ECM was not allowed to power down correctly (retain battery voltage for 30 seconds after key OFF).	Possible no noticeable performance.
1139 651 7	Injector solenoid driver cylinder 1 - Mechanical system not responding or out of adjustment. The ECM has detected an error with the injection timing or quantity.	Possible reduced engine performance.
1141 652 7	Injector solenoid driver cylinder 2 - Mechanical system not responding or out of adjustment. The ECM has detected an error with the injection timing or quantity.	Possible reduced engine performance.
1142 653 7	Injector solenoid driver cylinder 3 - Mechanical system not responding or out of adjustment. The ECM has detected an error with the injection timing or quantity.	Possible reduced engine performance.
1143 654 7	Injector solenoid driver cylinder 4 - Mechanical system not responding or out of adjustment. The ECM has detected an error with the injection timing or quantity.	Possible reduced engine performance.
1144 655 7	Injector solenoid driver cylinder 5 - Mechanical system not responding or out of adjustment. The ECM has detected an error with the injection timing or quantity.	Possible reduced engine performance.
1145 656 7	Injector solenoid driver cylinder 6 - Mechanical system not responding or out of adjustment. The ECM has detected an error with the injection timing or quantity.	Possible reduced engine performance.
1228 27 2	Egr valve position - Data erratic, intermittent, or Incorrect. The EGR valve is unable to meet commanded position.	Possible reduced engine performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
1239 2623 3	Accelerator pedal or lever position sensor 2 circuit - Voltage above normal or shorted to high source. High voltage detected at accelerator pedal position number 2 signal circuit.	The engine will operate in limp home mode.
1241 2623 4	Accelerator pedal or lever position sensor 2 circuit - Voltage below normal or shorted to low source. Low voltage detected at accelerator pedal position number 2 signal circuit.	The engine will operate in limp home mode.
1242 91 2	Accelerator pedal or lever position sensor 1 and 2 - Data erratic, intermittent, or incorrect. Accelerator position sensor number 1 and number 2 are reading different values.	The engine will only idle.
1515 91 19	Sae J1939 multiplexed accelerator pedal or lever sensor system - Received network data in error. The J1939 multiplexing controller has indicated a malfunction of the multiplexed accelerator pedal.	The engine will only idle.
1654 1323 31	Engine misfire cylinder 1- Condition exists. Engine misfire has been detected in cylinder number 1.	Possible reduced engine performance.
1655 1324 31	Engine misfire cylinder 2 - Condition exists. Engine misfire has been detected in cylinder number 2.	Possible reduced engine performance.
1656 1325 31	Engine misfire cylinder 3 - Condition exists. Engine misfire has been detected in cylinder number 3.	Possible reduced engine performance.
1657 1326 31	Engine misfire cylinder 4 - Condition exists. Engine misfire has been detected in cylinder number 4.	Possible reduced engine performance.
1658 1327 31	Engine misfire cylinder 5 - Condition exists. Engine misfire has been detected in cylinder number 5.	Possible reduced engine performance.
1659 1328 31	Engine misfire cylinder 6 - Condition exists. Engine misfire has been detected in cylinder number 6.	Possible reduced engine performance.
1668 1761 4	Aftertreatment diesel exhaust fluid tank level sensor circuit - Voltage below normal or shorted to low source. Low signal voltage detected at the aftertreatment diesel exhaust fluid tank level sensor circuit.	Possible reduced engine performance.
1669 1761 3	Aftertreatment diesel exhaust fluid tank level sensor circuit - Voltage above normal or shorted to high source. High signal voltage detected at the catalyst tank level sensor circuit.	Possible reduced engine performance.
1673 1761 1	Aftertreatment diesel exhaust fluid tank level - Data valid but below normal operating range - Most severe level. The aftertreatment diesel exhaust fluid tank level has fallen below the critical warning level.	Possible reduced engine performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
1677 3031 4	Aftertreatment diesel exhaust fluid tank temperature sensor - Voltage below normal or shorted to low source. Low signal voltage detected at the diesel exhaust fluid tank temperature sensor circuit.	Possible reduced engine performance.
1678 3031 3	Aftertreatment diesel exhaust fluid tank temperature sensor - Voltage above normal or shorted to high source. High signal voltage or open circuit detected at the diesel exhaust fluid tank temperature sensor circuit.	Possible reduced engine performance.
1679 3031 2	Aftertreatment diesel exhaust fluid tank temperature - Data erratic, intermittent, or incorrect. The diesel exhaust fluid tank temperature sensor has indicated a tank temperature too high or too low for the ambient conditions.	Possible reduced engine performance.
1682 3362 31	Aftertreatment diesel exhaust fluid dosing unit input lines - Condition exists. The aftertreatment diesel exhaust fluid dosing unit is unable to prime.	Possible reduced engine performance.
1683 3363 3	Aftertreatment diesel exhaust fluid tank heater - Voltage above normal or shorted to high source. High signal voltage detected at the aftertreatment diesel exhaust fluid tank heater circuit.	Possible reduced engine performance.
1684 3363 4	Aftertreatment diesel exhaust fluid tank heater - Voltage below normal, or shorted to low source. Low signal voltage detected at the aftertreatment diesel exhaust fluid tank heater circuit.	Possible reduced engine performance.
1691 100 18	Aftertreatment diesel oxidation catalyst conversion efficiency - Data valid but below normal operating range - Moderately severe level. The temperature increase across the aftertreatment catalyst is lower than expected.	Possible frequent need for aftertreatment regeneration.
1695 3513 3	Sensor supply 5 - Voltage above normal or shorted to high source. High voltage detected at sensor supply 5 circuit in the oem harness.	the engine will operate in limp home mode.
1696 3513 4	Sensor supply 5 - Voltage below normal or shorted to low source. Low voltage detected at sensor supply number 5 circuit in the oem harness.	the engine will operate in limp home mode.
1712 3363 18	Aftertreatment diesel exhaust fluid tank heater - Data valid but below normal operating range - Moderately severe level. The aftertreatment diesel exhaust fluid tank heater is unable to thaw the frozen diesel exhaust fluid.	Possible reduced engine performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
1713 3363 16	Aftertreatment diesel exhaust fluid tank heater - Data valid but above normal operating range - Moderately severe level. The diesel exhaust fluid tank heater is continuously in the on position.	None on performance.
1718 1322 31	Engine misfire for multiple cylinders - Condition exists. Engine misfire has been detected in multiple cylinder numbers.	Possible reduced engine performance.
1776 2634 3	Power relay driver circuit - Voltage above normal or shorted to high source. High voltage detected at power relay driver circuit.	Possible reduced engine performance.
1777 2634 4	Power relay driver circuit - Voltage below normal or shorted to low source. An open circuit or low voltage has been detected at the power relay circuit.	Possible reduced engine performance.
1843 101 3	Crankcase pressure circuit - Voltage above normal or shorted to high source. High signal voltage detected at the crankcase pressure circuit.	None on performance.
1844 101 4	Crankcase pressure circuit - Voltage below normal or shorted to low source. Low signal voltage detected at the crankcase pressure circuit.	None on performance.
1866 411 2	Exhaust gas recirculation valve delta pressure - Data erratic, intermittent, or incorrect. An error in the egr delta pressure signal was detected at initial key on or the sensor failed the autozero test.	possible reduced engine performance.
1867 412 2	Engine gas recircuilation temperature - Data erratic, intermittent, or incorrect. Engine misfire has been detected in multiple cylinder numbers.	Possible reduced engine performance.
1879 3251 3	Aftertreatment diesel particulate filter differential pressure sensor circuit - Voltage above normal or shorted to high source. High signal voltage detected at the aftertreatment differential pressure sensor circuit.	possible reduced engine performance.
1881 3251 4	Aftertreatment diesel particulate filter differential pressure sensor circuit - Voltage below normal or shorted to low source. Low signal voltage or open circuit detected at the aftertreatment differential pressure sensor circuit.	possible reduced engine performance.
1883 3251 2	Aftertreatment diesel particulate filter differential pressure sensor - Data erratic, intermittent, or incorrect. The aftertreatment diesel particulate filter differential pressure sensor is reading an erratic value at initial key on or during engine operation.	possible reduced engine performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
1885 3216 4	Aftertreatment intake NOx sensor circuit - Voltage below normal or shorted to low source. An internal circuit error has been detected by the aftertreatment intake NOx sensor.	Possible reduced engine performance.
1887 3226 4	Aftertreatment outlet NOx sensor circuit - Voltage below normal or shorted to low source. An internal circuit error has been detected by the aftertreatment outlet NOx sensor.	Possible reduced engine performance.
1896 2791 13	EGR valve controller - Out of calibration. The EGR valve has failed the automatic calibration procedure at initial key ON.	Possible reduced engine performance.
1921 3251 0	Aftertreatment diesel particulate filter differential pressure - Data valid but above normal operating range - Moderately severe level. The soot load of the aftertreatment diesel particulate filter has exceeded the recommended limits.	Possible reduced engine performance.
1922 3251 0	Aftertreatment diesel particulate filter differential pressure - Data valid but above normal operating range - Most severe level. The soot load of the aftertreatment diesel particulate filter has exceeded the recommended limits. Engine protection derate is enabled.	Possible reduced engine performance.
1938 3597 1	Ecu power output supply voltage 1 - Data valid but below normal operational range - Moderately severe level. Low battery voltage detected by the VGT actuator.	Possible reduced engine performance.
1942 101 2	Crankcase pressure - Data erratic, intermittent, or incorrect. The ECM has detected that the crankcase pressure signal is reading an erratic value at initial key ON or during engine operation.	None on performance.
1961 2791 0	EGR valve control circuit calculated over temperature - Data valid but above normal operational range - Least severe level. High EGR valve driver temperature has been detected.	Possible reduced engine performance.
1962 641 0	VGT Actuator driver over temperature (calculated) - Data valid but above normal operating range - Least severe level. High internal VGT actuator temperature has been detected.	None on performance.
1974 101 16	Crankcase pressure - Data valid but above normal operating range - Moderately severe level. The crankcase breather filter requires maintenance.	None on performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
1993 4795 31	Aftertreatment diesel particulate filter missing - Condition exists. The aftertreatment diesel particulate filter in the exhaust system is not present.	Active aftertreatment diesel particulate filter regeneration will be disabled.
2185 3512 3	Sensor supply 4 circuit - Voltage above normal, or shorted to high source. High voltage detected at 5 VDC sensor supply circuit to the accelerator pedal position sensor.	Engine will only idle.
2186 3512 4	Sensor supply 4 circuit - Voltage below normal, or shorted to low source. Low voltage detected at 5 VDC sensor supply circuit to the accelerator pedal position sensor.	Engine will only idle.
2198 641 11	VGT Actuator driver circuit - Root cause not known. Intermittent communication between the smart VGT controller and the ECM has been detected. The VGT controller is not interpreting the J1939 message from the ECM correctly.	Possible reduced engine performance.
2272 27 4	EGR Valve position circuit - Voltage below normal or shorted to low source. Low signal voltage has been detected at the EGR valve position sensor circuit	Possible reduced engine performance.
2273 411 3	Exhaust gas recirculation valve delta pressure sensor circuit - Voltage above normal or shorted to high source. High signal voltage detected at the EGR differential pressure sensor circuit.	Possible reduced engine performance.
2274 411 4	Exhaust gas recirculation valve delta pressure sensor circuit - Voltage below normal or shorted to low source. Low signal voltage detected at the EGR differential pressure sensor circuit.	Possible reduced engine performance.
2288 103 15	Turbocharger 1 speed - Data valid but above normal operating range - Least severe level. High turbocharger speed has been detected by the ECM.	Possible reduced engine performance.
2311 633 31	Electronic fuel injection control valve circuit - Condition exists. Fuel pump actuator circuit resistance too high or too low, or an intermittent connection has been detected.	Possible reduced engine performance.
2322 723 2	Engine camshaft speed / position sensor - Data erratic, intermittent, or incorrect. Camshaft engine speed sensor intermittent synchronization.	None on performance.
2349 2791 5	EGR Valve control circuit - Current below normal or open circuit. Motor terminal or motor coil open circuit has been detected by the ECM.	Possible reduced engine performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
2353 2791 6	EGR Valve control circuit - Current above normal or grounded circuit. A short circuit to ground has been detected in the EGR valve motor circuit.	Possible reduced engine performance.
2372 95 16	Fuel filter differential pressure - Data valid but above normal operational range - Moderately severe level. Excessive fuel flow restriction to the high pressure fuel pump has been detected.	Possible reduced engine performance.
2373 1209 3	Exhaust gas pressure sensor circuit - Voltage above normal or shorted to high source. High signal voltage detected at the exhaust gas pressure circuit.	Possible reduced engine performance.
2374 1209 4	Exhaust gas pressure sensor circuit - Voltage below normal or shorted to low source. Low signal voltage detected at the exhaust gas pressure circuit.	Possible reduced engine performance.
2375 412 3	Exhaust gas recirculation temperature sensor circuit - Voltage above normal or shorted to high source. High signal voltage detected at EGR temperature circuit.	Possible reduced engine performance.
2376 412 4	Exhaust gas recirculation temperature sensor circuit - Voltage below normal or shorted to low source. Low signal voltage detected at EGR temperature circuit.	Possible reduced engine performance.
2377 647 3	Fan control circuit - Voltage above normal, or shorted to high source. Open circuit or high voltage detected at the fan control circuit.	The fan can stay on continuously or not run at all.
2387 641 7	VGT Actuator driver circuit (motor) - Mechanical system not responding or out of adjustment. The smart VGT controller has detected incorrect stop limits, or the VGT is unable to move to the closed position.	Possible reduced engine performance.
2398 171 2	Ambient air temperature - Data erratic, intermittent, or incorrect. The ambient air temperature sensor is reading an erratic value.	Possible reduced engine performance.
2448 111 17	Coolant level - Data valid but below normal operational range - Least severe level. Low engine coolant level detected.	none on performance.
2449 641 13	Vgt actuator controller - Out of calibration. The VGT actuator has been installed incorrectly.	Possible reduced engine performance.
2468 102 3	Engine crankshaft speed/position - Data valid but above normal operating range - Moderately severe level. The engine speed has exceeded a critical limit.	Engine will be shut down.
2554 1209 2	Exhaust gas pressure - Data erratic, intermittent or incorrect. The exhaust gas pressure sensor is reading an erratic value.	possible reduced engine performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
2555 729 3	Intake air heater 1 circuit - Voltage above normal, or shorted to high source. High voltage detected at the intake air heater signal circuit.	The intake air heaters may be ON or OFF all the time.
2556 729 4	Intake air heater 1 circuit - Voltage below normal, or shorted to low source. Low voltage detected at the intake air heater signal circuit.	The intake air heaters may be ON or OFF all the time.
2634 641 12	VGT Actuator controller - Bad intelligent device or component. An internal error has been detected by the smart VGT controller.	Possible reduced engine performance.
2636 641 9	VGT Actuator driver circuit - abnormal update rate. No communications on the J1939 data link between the engine ECM and the smart VGT controller.	Possible reduced engine performance.
2638 5298 17	Aftertreatment diesel oxidation catalyst conversion efficiency - Data valid but below normal operating range - Least severe level. The temperature increase across the aftertreatment diesel oxidation catalyst is lower than expected.	Possible frequent need for aftertreatment regeneration.
2639 3251 15	Aftertreatment diesel particulate filter differential pressure - Data valid but above normal operating range - Least severe level. The soot load of the aftertreatment diesel particulate filter has exceeded the recommended limits.	Possible reduced engine performance.
2646 110 32	Engine coolant temperature - Condition exists. The EGR valve was closed to reduce engine coolant temperature.	Possible reduced engine performance.
2718 520325 31	Brake switch and accelerator pedal position incompatible - Condition exists. The ECM has detected the brake pedal and accelerator pedal were depressed simultaneously.	The engine will operate in limp home mode.
2771 3226 9	Aftertreatment outlet NOx sensor - Abnormal update rate. No communications or an invalid data transfer rate detected on the J1939 data link between the ECM and the aftertreatment outlet NOx sensor.	Possible reduced engine performance.
2777 3703 31	Particulate trap active regeneration inhibited due to inhibit switch - Condition exists. Regeneration of the diesel particulate filter has been prevented due to the permit switch being disabled.	Possible frequent need for aftertreatment regeneration.
2961 412 15	Exhaust gas recirculation temperature - Data valid but above normal operational range - Least severe level. EGR temperature has exceeded the engine protection limit.	Possible reduced engine performance.
2962 412 16	Exhaust gas recirculation temperature - Data valid but above normal operational range - Moderately severe level. EGR temperature has exceeded the engine protection limit.	Possible reduced engine performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
2963 110 15	Engine coolant temperature - Data valid but above normal operational range - Least severe level. Engine coolant temperature is above the engine protection warning limit.	Progressive power and/or speed derate increasing in severity from time of alert. If the Engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red STOP lamps starts flashing.
2964 105 15	Intake manifold 1 temperature - Data valid but above normal operational range - Least severe level. Intake manifold air temperature signal indicates intake manifold air temperature is above engine protection warning limit.	Progressive power and/or speed derate increasing in severity from time of alert. If the Engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red STOP lamps starts flashing.
2973 102 2	Intake manifold 1 pressure - Data erratic, intermittent, or incorrect. The intake manifold pressure sensor is reading an erratic value.	Possible reduced engine performance.
2976 3361 2	Aftertreatment diesel exhaust fluid dosing unit temperature - Data erratic, intermittent, or incorrect. An internal error has been detected in the aftertreatment diesel exhaust fluid dosing unit.	Possible reduced engine performance.
3133 3610 3	Aftertreatment diesel particulate filter outlet pressure sensor circuit - Voltage above normal, or shorted to high source. High signal voltage detected at the aftertreatment diesel particulate filter outlet pressure sensor circuit.	Possible reduced engine performance.
3134 3610 4	Aftertreatment diesel particulate filter outlet pressure sensor circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at the aftertreatment diesel particulate filter outlet pressure sensor circuit.	Possible reduced engine performance.
3135 3610 2	Aftertreatment diesel particulate filter outlet pressure - Data erratic, intermittent or incorrect. The aftertreatment diesel particulate filter outlet pressure sensor is reading an erratic value at initial key ON or during engine operation.	Possible reduced engine performance.
3146 4363 3	Aftertreatment SCR outlet temperature sensor circuit - Voltage above normal or shorted to high source. High signal voltage detected at the SCR outlet temperature sensor circuit.	Possible reduced engine performance.
3147 4363 4	Aftertreatment SCR outlet temperature sensor circuit - Voltage below normal or shorted to low source. Low signal voltage detected at the SCR outlet temperature sensor circuit.	Possible reduced engine performance.
3148 4363 2	Aftertreatment SCR outlet temperature sensor - Data erratic, intermittent, or incorrect. The SCR outlet temperature sensor is not changing with engine operating conditions.	Possible reduced engine performance.
3151 4794 31	Aftertreatment SCR catalyst system missing - Condition exists. The aftertreatment SCR catalyst in the exhaust system is not present.	Possible reduced engine performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
3165 4363 0	Aftertreatment SCR outlet temperature - Data valid but above normal operational range - Most severe level. The SCR outlet temperature sensor reading has exceeded the maximum engine protection temperature limit.	Possible reduced engine performance.
3168 3936 16	Aftertreatment diesel particulate filter system - Data valid but above normal operating range - Moderately severe level. The system has detected a malfunction in the filtering capability of the aftertreatment diesel particulate filter.	None on performance.
3186 1623 9	Tachograph output shaft speed - Abnormal update rate. No communication or an invalid data transfer rate has been detected on the J1939 data link between the ECM and the tachograph output shaft speed sensor.	None on performance.
3213 1623 19	Tachograph output shaft speed - Received network data in error. The J1939 multiplexing controller has indicated a malfunction of the tachograph output shaft speed sensor.	None on performance.
3228 3216 2	Aftertreatment Intake NOx sensor - Data erratic, intermittent, or incorrect. An incorrect NOx sensor reading has been detected by the aftertreatment intake NOx sensor.	Possible reduced engine performance.
3232 3216 9	Aftertreatment Intake NOx sensor - Abnormal update rate. No communication or an invalid data transfer rate has been detected on the J1939 data link between the ECM and the aftertreatment intake NOx sensor.	Possible reduced engine performance.
3235 4363 16	Aftertreatment SCR outlet temperature - Data valid but above normal operating range - Moderately severe level. The SCR outlet temperature sensor reading has exceeded the maximum temperature limit.	Possible reduced engine performance.
3237 4340 3	Aftertreatment diesel exhaust fluid line heater 1 circuit - Voltage above normal or shorted to high source. High signal voltage detected at the diesel exhaust fluid line heater 1 circuit.	Possible reduced engine performance.
3238 4340 4	Aftertreatment diesel exhaust fluid line heater 1 circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at the diesel exhaust fluid line heater 1 circuit.	Possible reduced engine performance.
3239 4342 3	Aftertreatment diesel exhaust fluid line heater 2 circuit - Voltage above normal or shorted to high source. High signal voltage detected at the diesel exhaust fluid line heater 2 circuit.	Possible reduced engine performance.
3241 4342 4	Aftertreatment diesel exhaust fluid line heater 2 circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at the diesel exhaust fluid line heater 2 circuit.	Possible reduced engine performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
3242 3363 7	Aftertreatment diesel exhaust fluid tank heater - Mechanical system not responding or out of adjustment. The aftertreatment diesel exhaust fluid temperature did not increase when the aftertreatment diesel exhaust fluid tank heater was commanded ON.	Possible reduced engine performance.
3243 3060 18	Engine cooling system monitor - Data valid but below normal operating range - Moderately severe level. The engine is not warming up as expected.	None on performance.
3251 4765 16	Aftertreatment diesel oxidation catalyst intake temperature - Data valid but above normal operating range - Moderately severe level. The diesel oxidation catalyst intake temperature sensor reading has exceeded the maximum temperature limit.	Progressive power and/or speed derate increasing in severity from time of alert. If the Engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red STOP lamps starts flashing.
3253 3242 16	Aftertreatment diesel particulate filter intake temperature - Data valid but above normal operating range - Moderately severe level. The aftertreatment diesel particulate filter intake temperature sensor reading has exceeded the maximum engine protection temperature limit.	Progressive power and/or speed derate increasing in severity from time of alert. If the Engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red STOP lamps starts flashing.
3254 3242 15	Aftertreatment diesel particulate filter intake temperature - Data valid but above normal operating range - Least severe level. The aftertreatment diesel particulate filter intake temperature sensor reading has exceeded the maximum engine protection temperature limit.	Possible reduced engine performance.
3255 3246 16	Aftertreatment diesel particulate filter outlet temperature - Data valid but above normal operating range - Moderately severe level. The aftertreatment diesel particulate filter outlet temperature sensor reading has exceeded the maximum engine protection temperature limit.	Progressive power and/or speed derate increasing in severity from time of alert. If the engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red STOP lamps starts flashing.
3256 3246 15	Aftertreatment diesel particulate filter outlet temperature - Data valid but above normal operating range - Least severe level. The aftertreatment diesel particulate filter outlet temperature sensor reading has exceeded the maximum engine protection temperature limit.	Possible reduced engine performance.
3258 4340 5	Aftertreatment diesel exhaust fluid line heater 1 circuit - Current below normal or open circuit. Open circuit detected in the diesel exhaust fluid line heater 1.	Possible reduced engine performance.
3261 4342 5	Aftertreatment diesel exhaust fluid line heater 2 circuit - Current below normal or open circuit. Open circuit detected in the diesel exhaust fluid line heater 2.	Possible reduced engine performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
3311 3242 0	Aftertreatment diesel particulate filter intake temperature - Data valid but above normal operating range - Most severe level. The aftertreatment diesel particulate filter intake temperature sensor reading has exceeded the maximum engine protection temperature limit.	Progressive power and/or speed derate increasing in severity from time of alert. If the engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red STOP lamps starts flashing.
3312 3246 0	Aftertreatment diesel particulate filter outlet temperature - Data valid but above normal operating range - Most severe level. The aftertreatment diesel particulate filter outlet temperature sensor reading has exceeded the maximum engine protection temperature limit.	Progressive power and/or speed derate increasing in severity from time of alert. If the engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red STOP lamps starts flashing.
3313 4765 4	Aftertreatment diesel oxidation catalyst intake temperature sensor circuit - Voltage below normal or shorted to low source. Low signal voltage detected at the catalyst intake sensor circuit.	Possible reduced engine performance.
3314 4765 3	Aftertreatment diesel oxidation catalyst intake temperature sensor circuit - Voltage above normal or shorted to high source. High signal voltage detected at the catalyst intake temperature sensor circuit.	Possible reduced engine performance.
3315 4765 2	Aftertreatment diesel oxidation catalyst intake temperature - Data erratic, intermittent, or incorrect. The aftertreatment diesel oxidation catalyst intake temperature sensor is not changing with engine operating conditions.	Possible reduced engine performance.
3316 3242 4	Aftertreatment diesel particulate filter intake temperature sensor circuit - Voltage below normal or shorted to low source. Low signal voltage detected at the aftertreatment diesel particulate filter intake temperature sensor circuit.	Possible reduced engine performance.
3317 3242 3	Aftertreatment diesel particulate filter intake temperature sensor circuit - Voltage above normal or shorted to high source. High signal voltage or open circuit detected at the aftertreatment diesel particulate filter intake temperature sensor circuit.	Possible reduced engine performance.
3318 3242 2	Aftertreatment diesel particulate filter intake temperature - Data erratic, intermittent, or incorrect. The aftertreatment diesel particulate filter intake temperature is not changing with engine operating conditions.	Possible reduced engine performance.
3319 3246 3	Aftertreatment diesel particulate filter outlet temperature sensor circuit - Voltage above normal or shorted to high source. High signal voltage or open circuit detected at the aftertreatment diesel particulate filter outlet temperature sensor circuit.	Possible reduced engine performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
3321 3246 4	Aftertreatment diesel particulate filter outlet temperature sensor circuit - Voltage below normal or shorted to low source. Low signal voltage detected at the aftertreatment diesel particulate filter outlet temperature sensor circuit.	Possible reduced engine performance.
3322 3246 2	Aftertreatment diesel particulate filter outlet temperature - Data erratic, intermittent, or incorrect. The aftertreatment diesel particulate filter outlet temperature is not changing with engine operating conditions.	Possible reduced engine performance.
3326 91 9	SAE J1939 Multiplexed accelerator pedal or lever sensor system - Abnormal update rate. The ECM expected information from a multiplexed accelerator pedal or lever sensor but did not receive it soon enough or did not receive it at all.	Engine will only idle.
3328 191 9	Transmission output shaft speed - Abnormal update rate. No communication or an invalid data transfer rate has been detected on the J1939 data link between the ECM and the transmission output shaft speed sensor.	None on performance.
3342 4752 18	Engine exhaust gas recirculation cooler efficiency - Data valid but below normal operating range - Moderately severe level. The EGR cooler is not cooling the recirculated exhaust gas sufficiently.	None on performance.
3343 5285 18	Engine charge-air cooler efficiency - Data valid but below normal operating range - Moderately severe level. The engine charge air cooler is not cooling the intake air flow sufficiently.	None on performance.
3361 102 10	Intake manifold 1 pressure - Abnormal rate of change. The VGT position reading is stuck.	Possible reduced engine performance.
3366 111 18	Coolant level - Data valid but below normal operating range - Moderately severe level. Very low engine coolant level detected.	None on performance.
3374 1818 31	Roll over protection brake control active - Condition exists. The ECM received a message from the anti-lock braking (ABS) controller, inhibiting cruise control operation.	Cruise control could possibly not operate.
3375 5397 31	Aftertreatment diesel particulate filter regeneration too frequent - Condition exists. The system has detected the need for an active regeneration has occurred too soon following the last active regeneration.	None on performance.
3376 5319 31	Aftertreatment diesel particulate filter incomplete regeneration - Condition exists. The system has detected that the aftertreatment diesel particulate filter differential pressure is too high following an active regeneration.	Possible frequent need for aftertreatment regeneration.

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Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
3382 3058 18	Engine exhaust gas recirculation (EGR) system - Data valid but below normal operating range - Moderately severe level. Measured egr flow is lower than commanded.	Possible reduced engine performance.
3383 3058 16	Engine exhaust gas recirculation (EGR) system - Data valid but above normal operating range - Moderately severe Level. Measured EGR flow is higher than commanded.	Possible reduced engine performance.
3394 4766 18	Aftertreatment 1 diesel oxidation catalyst outlet gas temperature - Data valid but below normal operating range - Moderately severe level. The diesel oxidation catalyst outlet Temperature is below the operating limit	Possible frequent need for aftertreatment regeneration.
3396 3750 31	Diesel particulate filter 1 conditions not met for active regeneration - Condition exists. The aftertreatment temperatures are not warm enough for aftertreatment injection.	Possible frequent need for aftertreatment regeneration.
3418 191 19	Transmission output shaft speed - Received network data in error. The J1939 multiplexing controller has indicated a malfunction of the transmission output shaft speed sensor.	None on performance.
3422 4344 3	Aftertreatment diesel exhaust fluid line heater 3 circuit - Voltage above normal or shorted to high source. High signal voltage detected at the diesel exhaust fluid line heater 3 circuit.	Possible reduced engine performance.
3423 4344 4	Aftertreatment diesel exhaust fluid line heater 3 circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at the diesel exhaust fluid line heater 3 circuit.	Possible reduced engine performance.
3425 4344 5	Aftertreatment diesel exhaust fluid line heater 3 circuit - Current below normal or open circuit. Open circuit detected in the diesel exhaust fluid line heater 3.	Possible reduced engine performance.
3488 563 9	Anti-lock braking (ABS) controller - Abnormal update rate. No communication or an invalid data transfer rate has been detected on the J1939 data link between the ECM and the anti-lock braking (ABS) controller.	None on performance.
3492 251 10	Real time clock - Abnormal rate of change. The real time clock indicates a stuck engine off timer.	None on performance.
3494 1081 7	Engine wait to start lamp - Mechanical system not responding or out of adjustment. Wait to Start lamp has malfunction.	None on performance.
3497 1761 17	Aftertreatment diesel exhaust fluid tank level - Data valid but below normal operating range - Least severe level. The aftertreatment diesel exhaust fluid tank level is low.	None on performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
3498 1761 18	Aftertreatment diesel exhaust fluid tank level - Data valid but below normal operating range - Moderately severe level. The aftertreatment diesel exhaust fluid tank level is very low.	None on performance.
3525 84 19	Wheel-based vehicle speed - Received network data in error. The J1939 multiplexing controller has indicated a malfunction of the wheel-based vehicle speed sensor.	Engine speed limited to maximum engine speed without VSS parameter value. Cruise control, gear-down protection, and road speed governor will not work.
3526 84 9	Wheel-Based vehicle speed - Abnormal update rate. No communication or an invalid data transfer rate has been detected on the J1939 data link between the ECM and the wheel-based vehicle speed sensor.	Engine speed limited to maximum engine speed without VSS parameter value. Cruise control, gear-down protection, and road speed governor will not work.
3527 558 19	Accelerator pedal or lever idle validation switch - Received network data in error. The J1939 multiplexing controller has indicated a malfunction of the accelerator pedal or lever idle validation switch.	The engine will only idle.
3528 558 9	Accelerator pedal or lever idle validation switch - Abnormal update rate. No communication or an invalid data transfer rate has been detected on the J1939 data link between the ECM and the accelerator pedal or lever idle validation switch.	Engine will only idle.
3531 171 9	Ambient air temperature - Abnormal update rate. No communication or an invalid data transfer rate has been detected on the J1939 data link between the ECM and the ambient air temperature sensor.	Possible reduced engine performance.
3532 171 19	Ambient air temperature - Received network data in error. The J1939 multiplexing controller has indicated a malfunction of the ambient air temperature sensor.	Possible reduced engine performance.
3539 51 3	Engine intake throttle actuator position sensor circuit - Voltage above normal, or shorted to high source. High signal voltage detected at the engine intake air throttle position sensor circuit.	Possible reduced engine performance.
3541 51 4	Engine intake throttle actuator position sensor circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at the engine intake air throttle position sensor circuit.	Possible reduced engine performance.
3542 51 2	Engine intake throttle actuator position sensor - Data erratic, intermittent or incorrect. The engine intake air throttle posistion feedback is erratic or incorrect.	Possible reduced engine performance.
3545 3226 10	Aftertreatment outlet NOx sensor circuit - Abnormal rate of change. The aftertreatment outlet NOx sensor reading is not valid.	None on performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
3547 4096 31	Aftertreatment diesel exhaust fluid tank empty - Condition exists. The diesel exhaust fluid tank is empty.	Possible reduced engine performance.
3555 1081 9	Engine wait to start lamp - Abnormal update rate. A loss of communication has been detected.	None on performance.
3556 1081 19	Engine wait to start lamp - Received network data in error. The ECM received an invalid signal on the SAE J1939 datalink.	None on performance.
3558 3361 3	Aftertreatment diesel exhaust fluid dosing unit - Voltage above normal or shorted to high source. High signal voltage detected at the aftertreatment diesel exhaust fluid dosing unit.	Possible reduced engine performance.
3559 3361 4	Aftertreatment diesel exhaust fluid dosing unit - Voltage below normal or shorted to low source. Low signal voltage detected at the aftertreatment diesel exhaust fluid dosing unit.	Possible reduced engine performance.
3562 5491 3	Aftertreatment diesel exhaust fluid line heater relay - Voltage above normal or shorted to high source. High signal voltage detected at the diesel exhaust fluid line heater relay.	Possible reduced engine performance.
3563 5491 4	Aftertreatment diesel exhaust fluid line heater relay - Voltage below normal or shorted to low source. Low signal voltage detected at the diesel exhaust fluid line heater relay.	Possible reduced engine performance.
3567 5394 5	Aftertreatment diesel exhaust fluid dosing valve - Current below normal or open circuit. A circuit error has been detected in the aftertreatment diesel exhaust fluid dosing valve circuit.	Possible reduced engine performance.
3568 5394 7	Aftertreatment diesel exhaust fluid (DEF) Dosing valve - Mechanical system not responding or out of adjustment. A mechanical malfunction has been detected in the DEF dosing valve.	Possible reduced engine performance.
3571 4334 3	Aftertreatment diesel exhaust fluid pressure sensor - Voltage above normal or shorted to high source. High signal voltage detected at the aftertreatment diesel exhaust fluid pressure sensor circuit.	Possible reduced engine performance.
3572 4334 4	Aftertreatment diesel exhaust fluid pressure sensor - Voltage below normal or shorted to low source. Low signal voltage detected at the diesel exhaust fluid pressure sensor circuit.	Possible reduced engine performance.
3574 4334 18	Aftertreatment diesel exhaust fluid pressure sensor - Data valid but below normal operating range - Moderately severe level. Low diesel exhaust fluid pressure has been detected in the dosing unit.	Possible reduced engine performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
3575 4334 16	Aftertreatment diesel exhaust fluid pressure sensor - Data valid but above normal operating range - Moderately severe level. The diesel exhaust fluid dosing unit has detected a blockage in the diesel exhaust fluid return flow.	Possible reduced engine performance.
3577 4376 3	Aftertreatment diesel exhaust fluid return valve - Voltage above normal or shorted to high source. High signal voltage detected at the aftertreatment diesel exhaust fluid return valve.	Possible reduced engine performance.
3578 4376 4	Aftertreatment diesel exhaust fluid return valve - Voltage below normal, or shorted to low source. Low signal voltage detected at the diesel exhaust fluid return valve.	Possible reduced engine performance.
3582 4364 18	Aftertreatment SCR catalyst conversion efficiency - Data valid but below normal operating range - Moderately severe level. NOx conversion across the SCR catalyst is too low.	Possible reduced engine performance.
3583 5031 10	Aftertreatment outlet NOx sensor heater - Abnormal rate of change. The aftertreatment outlet NOx sensor heater is unable to maintain its normal operating temperature.	None on performance.
3596 4334 2	Aftertreatment diesel exhaust fluid pressure sensor - Data erratic, intermittent, or incorrect. The diesel exhaust fluid pressure sensor has reported a reading too high or low for the operating conditions.	Possible reduced engine performance.
3649 5024 10	Aftertreatment Intake NOx sensor heater - Abnormal rate of change. The aftertreatment intake NOx sensor heater is unable to maintain its normal operating temperature.	None on performance.
3681 3228 2	Aftertreatment outlet NOx sensor power supply - Data erratic, intermittent, or incorrect. The aftertreatment outlet NOx sensor indicates that the power supply to the sensor is incorrect.	None on performance.
3682 3218 2	Aftertreatment Intake NOx sensor power supply - Data erratic, entermittent or encorrect. The aftertreatment intake NOx sensor indicates that the power supply to the sensor is incorrect.	None on performance.
3697 630 12	Engine control module calibration memory - Bad intelligent device or component. Error internal to the ECM related to engine software failures.	Engine may not start or may be difficult to start.
3712 5246 0	Aftertreatment SCR operator inducement - Data valid but above normal operational range - Most severe level. Critical SCR related fault codes have been active for an extended period of time and require immediate attention.	Vehicle speed will be limited to 8 ㎞ [5 miles] per hour.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
3714 1569 31	Engine protection torque derate - Condition exists. Critical fault codes related to engine operation are active.	Possible reduced engine performance.
3715 188 16	Engine speed at idle - Data valid but below normal operating range - Moderately severe level. The engine speed at idle has exceeded the governed idle speed.	Possible reduced engine performance.
3716 188 18	Engine speed at idle - Data valid but below normal operational range - Moderately severe level. Engine is not maintaining the governed idle speed.	None on performance.
3717 3226 13	Aftertreatment outlet NOx sensor - Out of calibration. A calibration mismatch between the aftertreatment outlet NOx sensor and the ECM has been detected.	None on performance.
3718 3216 13	Aftertreatment intake NOx - Out of calibration. A calibration mismatch between the aftertreatment intake NOx sensor and the ECM has been detected.	None on performance.
3724 168 17	Battery 1 voltage - Data valid but below normal operating range - Least severe level. Low voltage to the EGR valve device driver has been detected.	Possible reduced engine performance.
3725 3216 10	Aftertreatment Intake NOx sensor - Abnormal rate of change. The aftertreatment intake NOx sensor reading is not valid.	None on performance.
3727 5571 7	High pressure common rail fuel pressure relief valve - Mechanical system not responding or out of adjustment. The fuel rail high-pressure relief valve has opened at a lower than expected pressure.	Possible reduced engine performance.
3737 1675 31	Engine starter mode overcrank protection - Condition exists. The starter motor has been temporarily disabled in order to prevent starter damage.	Starter operation is prohibited until the starter motor has adequately cooled.
3741 5571 0	High pressure common rail fuel pressure relief valve - Data valid but above normal operational range - Most severe level. The fuel rail pressure relief valve has opened due to high fuel rail pressure.	Engine may run rough, may stop running, may not start, or may be difficult to start.
3749 3226 20	Aftertreatment outlet NOx sensor - Data not rational - Drifted high. An offset in the outlet NOx sensor reading has been detected.	None on performance.
3838 2978 9	Estimated engine parasitic losses - Percent torque - Abnormal update rate. A loss of communication has been detected.	None on performance.
3843 5603 9	Cruise control disable command - Abnormal update rate. No communication or an invalid data transfer rate has been detected on the J1939 data link between the ECM and the cruise control.	None on performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
3844 5605 31	Cruise control pause command - Condition exists. The adaptive cruise control has dropped out and must be manually engaged.	Cruise control could possibly not operate.
3845 5603 31	Cruise control disable command - Condition exists. The adaptive cruise control has dropped out and must be manually engaged.	Cruise control could possibly not operate.
3899 5848 4	Aftertreatment 1 SCR Intermediate NH3 sensor - Voltage below normal, or shorted to low source. A circuit error has been detected in the NH3 sensor.	None on performance.
3911 5848 9	Aftertreatment SCR Intermediate NH3 sensor - Abnormal update rate. Loss of communication with the aftertreatment SCR intermediate NH3 sensor.	Possible reduced engine performance.
3912 5853 10	Aftertreatment SCR Intermediate NH3 sensor heater - Abnormal rate of change. A malfunction of the aftertreatment SCR intermediate NH3 sensor heater has been detected.	Possible reduced engine performance.
3932 5851 16	Aftertreatment SCR Intermediate NH3 gas sensor power supply - Data valid but above normal operating range - Moderately severe level. High battery voltage supply detected at the aftertreatment SCR intermediate NH3 sensor.	Possible reduced engine performance.
3933 5851 18	Aftertreatment SCR Intermediate NH3 gas sensor power supply - Data valid but below normal operating range - Moderately severe level. Low battery voltage supply detected at the aftertreatment SCR intermediate NH3 sensor.	Possible reduced engine performance.
3934 5851 2	Aftertreatment SCR Intermediate NH3 gas sensor power supply - Data erratic, intermittent or incorrect. Intermittent battery voltage supply detected at the aftertreatment SCR intermediate NH3 sensor.	Possible reduced engine performance.
3935 5848 13	Aftertreatment SCR Intermediate NH3 sensor - Out of calibration. Incorrect trim resistance has been detected in the aftertreatment SCR intermediate NH3 sensor.	Possible reduced engine performance.
3936 5848 12	Aftertreatment SCR Intermediate NH3 sensor - Bad intelligent device or component. An internal error of the aftertreatment SCR intermediate NH3 sensor has been detected.	Possible reduced engine performance.
3937 5848 10	Aftertreatment 1 SCR Intermediate NH3 sensor - Abnormal rate of change. The aftertreatment SCR intermediate NH3 sensor reading is NOT valid.	Possible reduced engine performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
4149 2623 8	Accelerator pedal or lever position sensor 2 circuit frequency - Abnormal frequency or pulse width or period. The accelerator pedal position sensor reading is out of range.	The engine will operate in Limp Home mode.
4151 5742 9	Aftertreatment diesel particulate filter temperature sensor module - Abnormal update rate. No communications on the J1939 data link between the ECM and the aftertreatment diesel particulate filter temperature sensor module.	Possible reduced engine performance.
4152 5743 9	Aftertreatment selective catalytic reduction temperature sensor module - Abnormal update rate. No communications on the J1939 data link between the ECM and the aftertreatment SCR temperature sensor module.	Possible reduced engine performance.
4155 5746 3	Aftertreatment 1 diesel exhaust fluid dosing unit heater relay - Voltage above normal, or shorted to high source. High signal voltage detected at the aftertreatment diesel exhaust fluid dosing unit heater relay circuit.	Possible reduced engine performance.
4156 5746 4	Aftertreatment 1 diesel exhaust fluid dosing unit heater relay - Voltage below normal, or shorted to low source. Low signal voltage detected at the aftertreatment diesel exhaust fluid dosing unit heater relay circuit.	Possible reduced engine performance.
4157 4376 7	Aftertreatment diesel exhaust fluid return valve - Mechanical system not responding or out of adjustment. A stuck aftertreatment diesel exhaust fluid return valve has been detected.	None on performance.
4158 5742 12	Aftertreatment diesel particulate filter temperature sensor module - Bad intelligent device or component. An internal error has been detected in the aftertreatment diesel particulate filter temperature sensor module.	Possible reduced engine performance.
4159 5743 12	Aftertreatment selective catalytic reduction temperature sensor module - Bad intelligent device or component. An internal error has been detected in the aftertreatment SCR temperature sensor module.	Possible reduced engine performance.
4161 5742 3	Aftertreatment diesel particulate filter temperature sensor module - Voltage above normal, or shorted to high source. High battery supply voltage detected at the aftertreatment diesel particulate filter temperature sensor module.	Possible reduced engine performance.
4162 5742 4	Aftertreatment diesel particulate filter temperature sensor module - Voltage below normal, or shorted to low source. Low battery supply voltage detected at the aftertreatment diesel particulate filter temperature sensor module.	Possible reduced engine performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
4163 5742 16	Aftertreatment diesel particulate filter temperature sensor module- Data valid but above normal operating range - Moderately severe level. High internal temperature detected in the aftertreatment diesel particulate filter temperature sensor module.	Possible reduced engine performance.
4164 5743 3	Aftertreatment selective catalytic reduction temperature sensor module - Voltage above normal, or shorted to high source. High battery supply voltage detected at the aftertreatment SCR temperature sensor module.	Possible reduced engine performance.
4165 5743 4	Aftertreatment selective catalytic reduction temperature sensor module - Voltage below normal, or shorted to low source. Low battery supply voltage detected at the aftertreatment SCR temperature sensor module.	Possible reduced engine performance.
4166 5743 16	Aftertreatment selective catalytic reduction temperature sensor module - Data valid but above normal operating range - Moderately severe level. High internal temperature detected in the aftertreatment SCR temperature sensor module.	Possible reduced engine performance.
4168 5745 3	Aftertreatment diesel exhaust fluid dosing unit heater - Voltage above normal, or shorted to high source. The aftertreatment diesel exhasut fluid dosing unit heater is detected to be stuck on.	None on performance.
4169 5745 5	Aftertreatment diesel exhaust fluid dosing unit heater - Voltage below normal, or shorted to low source. The aftertreatment diesel exhasut fluid dosing unit heater is detected to be stuck off.	Possible reduced engine performance.
4171 5745 18	Aftertreatment diesel exhaust fluid dosing unit heater - Data valid but below normal operating range - Moderately severe level. The aftertreatment diesel exhaust fluid dosing unit failed to thaw.	Possible reduced engine performance.
4213 3695 2	Aftertreatment diesel particulate filter regeneration inhibit switch - Data erratic, intermittent or incorrect. The diesel particulate filter regeneration permit switch is stuck in the OFF or INHIBIT position.	Possible frequent need for aftertreatment regeneration.
4215 563 31	Anti-lock braking (ABS) Active - Condition exists. Cruise control was paused due to an anti-wheel slip message from teh ABS controller.	Adaptive cruise control will not operate. Standard cruise control may not operate.
4244 4337 2	Aftertreatment diesel exhaust fluid dosing temperature - Data erratic, intermittent or incorrect. The aftertreatment diesel exhaust fluid dosing temperature is irrational.	None on performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
4245 5798 2	Aftertreatment diesel exhaust fluid dosing unit heater temperature - Data erratic, intermittent or incorrect. The aftertreatment diesel exhaust fluid dosing unit heater temperature is irrational.	None on performance.
4249 4337 10	Aftertreatment diesel exhaust fluid dosing temperature - Abnormal rate of change. The aftertreatment diesel exhaust fluid dosing unit temperature is stuck.	None on performance.
4251 5798 10	Aftertreatment 1 diesel exhaust fluid dosing unit heater temperature - Abnormal rate of change. The aftertreatment diesel exhaust fluid dosing unit heater temperature sensor reading is stuck.	None on performance.
4252 1081 31	Engine wait to start lamp - Condition exists. The received signal does not match the commanded signal.	None on performance.
4259 5742 11	Aftertreatment diesel particulate filter temperature sensor module - Root cause not known. Intermittent battery voltage supply detected at the aftertreatment diesel particulate filter temperature sensor module.	Possible reduced engine performance.
4261 5743 11	Aftertreatment selective catalytic reduction temperature sensor module - Root cause not known. Intermittent battery voltage supply detected at the aftertreatment SCR temperature sensor module.	Possible reduced engine performance.
4279 5848 21	Aftertreatment 1 SCR Intermediate NH3 - Data not rational - Drifted low. An in range low failure has been detected.	Possible reduced engine performance.
4281 5848 2	Aftertreatment SCR Intermediate NH3 - Data erratic, intermittent or incorrect. The aftertreatment SCR intermediate NH3 sensor reading is stuck.	None on performance.
4284 5793 9	Desired engine fueling state - Abnormal update rate. A valid message from the transmission ECU has NOT been received.	Engine may not start or may be difficult to start.
4289 91 8	Accelerator pedal or lever position sensor 1 circuit frequency - Abnormal frequency or pulse width or period. The accelerator pedal position sensor reading is out of range.	The engine will operate in limp home mode.
4452 520668 31	Aftertreatment outlet NOx sensor closed loop operation - Condition exists. The maximum dosing adjustment has been reached.	Possible reduced engine performance.
4453 520669 31	Aftertreatment intermediate NH3 sensor closed loop operation - Condition exists. The maximum dosing adjustment has been reached.	None on performance.
4517 237 13	Vehicle Identification number - Out of calibration. The vehicle identification number has not been programmed into the ECM.	None on performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
4518 5862 3	Aftertreatment SCR Intermediate gas temperature sensor circuit - Voltage above normal, or shorted to high source. High signal voltage detected at the aftreatment SCR intermediate temperature sensor circuit.	Possible reduced engine performance.
4519 5862 4	Aftertreatment SCR Intermediate gas temperature sensor circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at the aftertreatment SCR intermediate temperature sensor circuit.	Possible reduced engine performance.
4521 5862 2	Aftertreatment SCR Intermediate gas temperature sensor - Data erratic, intermittent or incorrect. The aftertreatment SCR intermediate temperature sensor reading is irrational.	Possible reduced engine performance.
4524 5862 0	Aftertreatment SCR intermediate gas temperature - Data valid but above normal operational range - Most severe level. The aftertreatment SCR intermediate temperature sensor reading is above the engine protection limit.	Progressive power and/or speed derate increasing in severity from time of alert. If the engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red STOP lamps starts flashing.
4525 5862 16	Aftertreatment 1 SCR intermediate gas temperature - Data valid but above normal operating range - Moderately severe level. High SCR Intermediate temperature detected.	Progressive power and/or speed derate increasing in severity from time of alert. If the engine protection shutdown feature is enabled, the engine will shut down 30 seconds after the red STOP lamps starts flashing.
4526 521 2	Brake pedal position - Data erratic, intermittent or incorrect. The values of the 2 brake switch signals do not match.	None on performance.
4572 3031 9	Aftertreatment diesel exhaust fluid tank temperature - Abnormal update rate. The ECM lost communication with the aftertreatment diesel exhaust fluid tank temperature sensor.	Possible reduced engine performance.
4584 3936 14	Aftertreatment diesel particulate filter system - Special instructions. The incorrect aftertreatment diesel particulate filter system has been installed with the engine.	Engine will be shut down.
4585 4792 14	Aftertreatment 1 SCR catalyst system - Special instructions. The incorrect SCR system has been Installed.	Engine will be shut down.
4612 520701 31	Engine intake manifold pressure system monitor - Condition exists. The engine is unable to meet the air handling system commands.	Possible reduced engine performance.
4658 4331 18	Aftertreatment SCR actual dosing reagent quantity - Data valid but below normal operating range - Moderately severe level. Low aftertreatment diesel exhaust fluid flow detected.	Possible reduced engine performance.

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Reason	Effect (only when fault code is active)
4691 5585 18	Engine injector metering rail 1 cranking pressure - Data valid but below normal operating range - Moderately severe level. The fuel rail pressure during cranking is too low for the engine to start.	Engine may not start or may be difficult to start.
4713 5357 31	Engine fuel injection quantity error for multiple cylinders - Condition exists. A malfunction of all fuel injectors has been detected.	Engine may run rough, may stop running, may not start, or may be difficult to start.
4726 1239 16	Engine fuel leakage - Data valid but above normal operating range - Moderately severe level. Fuel rail pressure decay has been detected.	Engine may run rough, may stop running, may not start, or may be difficult to start.
4727 157 15	Injector metering rail 1 pressure - Data valid but above normal operating range - Least severe level. A self pumping condition has been detected in the fuel system.	Possible reduced engine performance.
4731 3031 13	Aftertreatment diesel exhaust fluid tank temperature sensor - Out of calibration. The received datalink message was not valid.	Possible reduced engine performance.
4732 1761 13	Aftertreatment diesel exhaust fluid tank level sensor - Out of calibration. The received datalink message was not valid.	None on performance.
4739 1761 11	Aftertreatment 1 diesel exhaust fluid tank level sensor - Root cause not known. An unknown error has been detected with the aftertreatment diesel exhaust fluid tank level sensor.	Possible reduced engine performance.
4769 1761 10	Aftertreatment 1 diesel exhaust fluid tank level sensor - Abnormal rate of change. A valid diesel exhaust fluid tank level reading has NOT been received.	Possible reduced engine performance.
4865 6303 3	Engine coolant level 2 sensor circuit - Voltage above normal, or shorted to high source. High signal voltage detected at the engine coolant level 2 circuit.	None on performance.
4866 6303 4	Engine coolant level 2 sensor circuit - Voltage below normal, or shorted to low source. Low signal voltage detected at the engine coolant level 2 circuit.	None on performance.
4956 520750 13	Engine variable geometry turbo (VGT) software - Out of calibration. VGT software does not match application.	Possible reduced engine performance.
4957 520750 31	Engine variable geometry turbo (VGT) software - Condition exists. The VGT actuator and ECM software is not compatible.	Possible reduced engine performance.

※ Some fault codes are not applied to this machine.

3) DEFINITION OF OPERATING MODES

(1) Normal

There's no failure detected in the transmission system or the failure has no or slight effects on transmission control. TCU will work without or in special cases with little limitations. (See following table)

(2) Substitute clutch control

TCU can't change the gears or the direction under the control of the normal clutch modulation.

TCU uses the substitute strategy for clutch control. All modulations are only time controlled. (Comparable with EST 25)

(3) Limp-home

The detected failure in the system has strong limitations to transmission control. TCU can engage only one gear in each direction. In some cases only one direction will be possible.

TCU will shift the transmission into neutral at the first occurrence of the failure. First, the operator must shift the gear selector into neutral position.

If output speed is less than a threshold for neutral to gear and the operator shifts the gear selector into forward or reverse, the TCU will select the limp-home gear.

If output speed is less than a threshold for reversal speed and TCU has changed into the limp-home gear and the operator selects a shuttle shift, TCU will shift immediately into the limp-home gear of the selected direction.

If output speed is greater than the threshold, TCU will shift the transmission into neutral.

The operator has to slow down the vehicle and must shift the gear selector into neutral position.

(4) Transmission-shutdown

TCU has detected a severe failure that disables control of the transmission.

TCU will shut off the solenoid valves for the clutches and also the common power supply (VPS1).

Transmission shifts to neutral.

The park brake will operate normally, also the other functions which use ADM1 to ADM8.

The operator has to slow down the vehicle. The transmission will stay in neutral.

(5) TCU-shutdown

TCU has detected a severe failure that disables control of system.

TCU will shut off all solenoid valves and also both common power supplies (VPS1, VPS2).

The park brake will engage, also functions are disabled which use ADM 1 to ADM 8.

The transmission will stay in neutral.

※ **Abbreviations**

OC : Open circuit
SC : Short circuit
OP mode : Operating mode
TCU : Transmission control unit
EEC : Electronic engine controller
PTO : Power take off

4) TRANSMISSION FAULT CODES

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
523000	1	Battery low undervoltage	Trm Shutdown	The control unit detects a voltage of < 7.00 volt (12 V device) or < 9.00 volt (24 volt device) on the supply input of terminal 30. 1. The alternator control unit has an internal defect. 2. Vehicle battery not sufficiently charged. 3. Wiring or plug connection defective (supply or ground cable). 4. Control unit parameters incorrectly set.	The cause of the missing or insufficient voltage on terminal 30 must be located. 1. Check the fuse of the terminal 30 control units. 2. If the error occurs after a (sluggish) vehicle start, check the vehicle battery. Recharge the battery to ensure that it is sufficiently charged. 3. Make sure that the control unit has a stable voltage supply. Check the stability of the voltage with Testman. 4. Check the wiring between the alternator and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. Pay special attention to the ground wiring. 5. Check the function of the alternator as well as the settings of the alternator control unit and replace both if necessary.
523000	3	Battery overvoltage	Trm Shutdown	The control unit detects a voltage of > 18.00 volt (12 volt device) or > 32.50 volt (24 volt device) on the supply input terminal 30. 1. The alternator control unit has an internal defect. 2. Wiring or plug connection defective (supply or ground cable). 3. Control unit parameters incorrectly set.	The cause of the excessive voltage on terminal 30 must be located. 1. Make sure that the control unit has a stable voltage supply. Check the voltage on the terminal tester with a voltmeter. · Target voltage ignition ON: Vehicle power supply. · Target voltage ignition OFF: Vehicle power supply. 2. With the ignition off, use a voltmeter to check the voltage on the connection of terminal 30 (steady plus) to terminal 31 (ground). The measured voltage must correspond to the vehicle power supply. 3. With the engine running, check the voltage in the same manner as described in the point above. The measured voltage must correspond to the vehicle power supply. 4. Check the wiring between the alternator and the

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
					control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. Pay special attention to the ground wiring. 5. Check the function of the alternator as well as the settings of the alternator control unit and replace both if necessary.
523000	4	Battery undervoltage	Trm Shutdown	The control unit detects a voltage of < 9.00 volt (12 V device) or < 16.00 volt (24 volt device) on the supply input terminal 30. 1. The alternator control unit has an internal defect. 2. Vehicle battery not sufficiently charged. 3. Wiring or plug connection defective (supply or ground cable). 4. Control unit parameters incorrectly set.	The cause of the missing or insufficient voltage on terminal 30 must be located. 1. Check the fuse of the terminal 30 control units. 2. If the error occurs after a (sluggish) vehicle start, check the vehicle battery. Recharge the battery to ensure that it is sufficiently charged. 3. Make sure that the control unit has a stable voltage supply. Check the stability of the voltage with Testman. 4. Check the wiring between the alternator and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. Pay special attention to the ground wiring. 5. Check the function of the alternator as well as the settings of the alternator control unit and replace both if necessary.
523020	3	EC3: Supply for speed sensors (AU3) overvoltage	Trm Shutdown	The measured voltage is too high. 1. Wiring or plug connection is defective. 2. Sensor has an internal defect. 3. Control unit has an internal defect.	The cause of the incorrect voltage must be located. 1. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Check the correct wiring of the pins. 3. Check the function of the sensor or replace the sensor. 4. Replace the control unit if the error continues to occur.
523020	4	EC3: Supply for speed	Trm Shutdown	The measured voltage is too low.	The cause of the incorrect voltage must be located.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
		sensors (AU3) undervoltage		1. Wiring or plug connection is defective. 2. Sensor has an internal defect. 3. Control unit has an internal defect.	1. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Check the correct wiring of the pins. 3. Check the function of the sensor or replace the sensor. 4. Replace the control unit if the error continues to occur.
523020	6	EC3: Supply for speed sensors (AU3) short to ground	Trm Shutdown	The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too low. 1. Wiring or plug connection contacts vehicle ground. 2. Component has an internal defect. 3. Control unit has an internal defect. Note: If this error occurs, calculations are partially being made with replacement values. The transmission functions are limited and the shifting quality is reduced.	1. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 2. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 3. Check the function of the connected component and replace it if needed. 4. Replace the control unit if the error continues to occur.
523021	3	EC3: Supply for temperature sensors and oil filter restriction switch (AU2) overvoltage EC4: Supply for speed sensors (AU2) overvoltage	Trm Shutdown	The measured voltage is too high. 1. Wiring or plug connection is defective. 2. Sensor has an internal defect. 3. Control unit has an internal defect.	The cause of the incorrect voltage must be located. 1. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Check the correct wiring of the pins. 3. Check the function of the sensor or replace the sensor. 4. Replace the control unit if the error continues to occur.
523021	4	EC3: Supply for temperature sensors	Trm Shutdown	The measured voltage is too low. 1. Wiring or plug connection is defective.	The cause of the incorrect voltage must be located. 1. Check the wiring, in particular with regard to

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
		and oil filter restriction switch (AU2) undervoltage EC4: Supply for speed sensors (AU2) undervoltage		2. Sensor has an internal defect. 3. Control unit has an internal defect.	defective plug connections such as corroded or damaged plug contacts. 2. Check the correct wiring of the pins. 3. Check the function of the sensor or replace the sensor. 4. Replace the control unit if the error continues to occur.
523021	6	EC3: Supply for temperature sensors and oil filter restriction switch (AU2) short to ground EC4: Supply for speed sensors (AU2) short to ground	Trm Shutdown	The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too low. 1. Wiring or plug connection contacts vehicle ground. 2. Component has an internal defect. 3. Control unit has an internal defect. Note: If this error occurs, calculations are partially being made with replacement values. The transmission functions are limited and the shifting quality is reduced.	1. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 2. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 3. Check the function of the connected component and replace it if needed. 4. Replace the control unit if the error continues to occur.
523022	3	EC4: Supply for oil filter restriction switch (AU1) overvoltage	Limp Home	The measured voltage is too high. 1. Wiring or plug connection is defective. 2. Sensor has an internal defect. 3. Control unit has an internal defect.	The cause of the incorrect voltage must be located. 1. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Check the correct wiring of the pins. 3. Check the function of the sensor or replace the sensor. 4. Replace the control unit if the error continues to occur.
523022	4	EC4: Supply for oil filter restriction switch (AU1) undervoltage	Limp Home	The measured voltage is too low. 1. Wiring or plug connection is defective. 2. Sensor has an internal defect.	The cause of the incorrect voltage must be located. 1. Check the wiring, in particular with regard to defective plug connections such as corroded or

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
				3. Control unit has an internal defect.	damaged plug contacts. 2. Check the correct wiring of the pins. 3. Check the function of the sensor or replace the sensor. 4. Replace the control unit if the error continues to occur.
523022	6	EC4: Supply for oil filter restriction switch (AU1) short to ground	Limp Home	The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too low. 1. Wiring or plug connection contacts vehicle ground. 2. Component has an internal defect. 3. Control unit has an internal defect.	1. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 2. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 3. Check the function of the connected component and replace it if needed. 4. Replace the control unit if the error continues to occur.
523030	3	Propvalve power supply 1 (VPS1) overvoltage	TCU Shutdown	The measured voltage is too high. 1. Wiring or plug connection is defective. 2. Component has an internal defect. 3. Control unit has an internal defect.	The cause of the incorrect voltage must be located. 1. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Check the correct wiring of the pins. 3. Check the function of the connected component or replace the component. 4. Replace the control unit if the error continues to occur.
523031	3	Propvalve power supply 2 (VPS2) overvoltage	TCU Shutdown	The measured voltage is too high. 1. Wiring or plug connection is defective. 2. Component has an internal defect. 3. Control unit has an internal defect.	The cause of the incorrect voltage must be located. 1. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Check the correct wiring of the pins.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
					3. Check the function of the connected component or replace the component. 4. Replace the control unit if the error continues to occur.
523040	0	TCU overtemperature	TCU Shutdown	The measured temperature on the control unit of the transmission is too high. 1. Overheating due to outside influences. 2. Temperature sensor has an internal defect.	The cause of the increased temperature input in the control unit must be located. 1. Check if outside influences have caused the excessive temperature. 2. If the error continues to occur then the control unit needs to be replaced.
523040	2	TCU temperature invalid value	TCU Shutdown	The measured temperature on the control unit of the transmission is invalid. 1. Control unit has an internal defect.	1. Replace the control unit.
523044	12	Internal TCU Error 5	TCU Shutdown	There are 3 startup self-tests concerning power lines 1. Watch dog cut-off test – WD chip allow VPS to be enabled only if it is activated (armed) and disable all VPSs before it resets MCU. The self-test check it. 2. VPS cut off test – SW is able to control VPS via power supply manager component – self test check it 3.. OCG off test – it check if when VPS is on and OCG/AIM channels are disable (requested current = 0), there really is no current on the lines.	The cause of the incorrect behavour must be located. 1.Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2.Check the correct wiring of the pins. 3.Check the function of the connected component or replace the component. 4.Replace the control unit if the error continues to occur.
523045	12	Internal TCU Error 1	TCU Shutdown	The control unit detects an internal error.	Read out the operating data with Testman and send them to your ZF contact.
523046	12	Internal TCU Error 2	TCU Shutdown	The control unit detects an internal error.	Read out the operating data with Testman and send them to your ZF contact.
523049	12	Unknown transmission	TCU Shutdown	Wrong TCU mounted. The TCU doesn't fit to the	Contact your ZF representative.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
		controller hardware detected		application.	
523100	3	Speed sensor input 1 (EF1) overvoltage: Turbine speed	Limp Home	The measured voltage at the input is too high. 1. Wiring or plug connection is defective. 2. Component has an internal defect. 3. Control unit has an internal defect.	The cause of the incorrect voltage must be located. 1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 3. Check the correct wiring of the pins. 4. Check the function of the connected component or replace the component. 5. Replace the control unit if the error continues to occur.
523100	6	Speed sensor input 1 (EF1) open or short to ground: Turbine speed	Limp Home	The measured line resistance between the connected component and the control unit is too high. 1. Wiring or plug connection is defective. 2. Component has an internal defect. 3. Control unit has an internal defect.	1. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 2. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 3. Check the function of the connected component and replace it if needed. 4. Replace the control unit if the error continues to occur.
523100	8	Speed sensor input 1 (EF1) direction of rotation unknown: Turbine speed	Limp Home	The control unit does not recognize the rotational direction at the input. 1. Wiring or plug connection is defective. 2. Wiring or plug connection has a poor contact. 3. Distance sensor – sensor ring too large. 4. Sensor has an internal defect.	The cause of the unknown rotational direction must be located. 1. Check the wiring from the sensor to the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Check the function of the sensor and, if necessary, replace it.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
523100	9	Speed sensor input 1 (EF1) speed unknown: Turbine speed	Limp Home	The control unit does not recognize the speed at the input. 1. Wiring or plug connection is defective. 2. Wiring or plug connection has a poor contact. 3. Distance speed sensor – sensor ring too large. 4. Speed sensor has an internal defect.	The cause of the unknown speed must be located. 1. Check the wiring from the speed sensor to the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Check the function of the sensor and, if necessary, replace it.
523105	3	Speed sensor input 2 (EF2) overvoltage: Internal speed	Limp Home	The measured voltage at the input is too high. 1. Wiring or plug connection is defective. 2. Component has an internal defect. 3. Control unit has an internal defect.	The cause of the incorrect voltage must be located. 1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 3. Check the correct wiring of the pins. 4. Check the function of the connected component or replace the component. 5. Replace the control unit if the error continues to occur.
523105	6	Speed sensor input 2 (EF2) open or short to ground: Internal speed	Limp Home	The measured line resistance between the connected component and the control unit is too high. 1. Wiring or plug connection is defective. 2. Component has an internal defect. 3. Control unit has an internal defect.	1. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 2. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 3. Check the function of the connected component and replace it if needed. 4. Replace the control unit if the error continues to occur.
523105	8	Speed sensor input 2 (EF2) direction of	Limp Home	The control unit does not recognize the rotational direction at the input.	The cause of the unknown rotational direction must be located.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
		rotation unknown: Internal speed		1. Wiring or plug connection is defective. 2. Wiring or plug connection has a poor contact. 3. Distance sensor – sensor ring too large. 4. Sensor has an internal defect.	1. Check the wiring from the sensor to the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Check the function of the sensor and, if necessary, replace it.
523105	9	Speed sensor input 2 (EF2) speed unknown: Internal speed	Limp Home	The control unit does not recognize the speed at the input. 1. Wiring or plug connection is defective. 2. Wiring or plug connection has a poor contact. 3. Distance speed sensor – sensor ring too large. 4. Speed sensor has an internal defect.	The cause of the unknown speed must be located. 1. Check the wiring from the speed sensor to the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Check the function of the sensor and, if necessary, replace it.
523110	3	Speed sensor input 3 (EF3) overvoltage: Output speed	Limp Home	The measured voltage at the input is too high. 1. Wiring or plug connection is defective. 2. Component has an internal defect. 3. Control unit has an internal defect.	The cause of the incorrect voltage must be located. 1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 3. Check the correct wiring of the pins. 4. Check the function of the connected component or replace the component. 5. Replace the control unit if the error continues to occur.
523110	6	Speed sensor input 3 (EF3) open or short to ground: Output speed	Limp Home	The measured line resistance between the connected component and the control unit is too high. 1. Wiring or plug connection is defective. 2. Component has an internal defect. 3. Control unit has an internal defect.	1. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 2. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 3. Check the function of the connected component and

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
					replace it if needed. 4. Replace the control unit if the error continues to occur.
523110	8	Speed sensor input 3 (EF3) direction of rotation unknown: Output speed	Limp Home	The control unit does not recognize the rotational direction at the input. 1. Wiring or plug connection is defective. 2. Wiring or plug connection has a poor contact. 3. Distance sensor – sensor ring too large. 4. Sensor has an internal defect.	The cause of the unknown rotational direction must be located. 1. Check the wiring from the sensor to the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Check the function of the sensor and, if necessary, replace it.
523110	9	Speed sensor input 3 (EF3) speed unknown: Output speed	Limp Home	The control unit does not recognize the speed at the input. 1. Wiring or plug connection is defective. 2. Wiring or plug connection has a poor contact. 3. Distance speed sensor – sensor ring too large. 4. Speed sensor has an internal defect.	The cause of the unknown speed must be located. 1. Check the wiring from the speed sensor to the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Check the function of the sensor and, if necessary, replace it.
523115	3	Speed sensor input 4 (EF4) overvoltage: Engine speed	Limp Home	The measured voltage at the input is too high. 1. Wiring or plug connection is defective. 2. Component has an internal defect. 3. Control unit has an internal defect.	The cause of the incorrect voltage must be located. 1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 3. Check the correct wiring of the pins. 4. Check the function of the connected component or replace the component. 5. Replace the control unit if the error continues to occur.
523115	6	Speed sensor input 4 (EF4) open or short to ground: Engine speed	Limp Home	The measured line resistance between the connected component and the control unit is too high.	1. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
				1. Wiring or plug connection is defective. 2. Component has an internal defect. 3. Control unit has an internal defect.	2. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 3. Check the function of the connected component and replace it if needed. 4. Replace the control unit if the error continues to occur.
523115	8	Speed sensor input 4 (EF4) direction of rotation unknown: Engine speed	Limp Home	The control unit does not recognize the rotational direction at the input. 1. Wiring or plug connection is defective. 2. Wiring or plug connection has a poor contact. 3. Distance sensor – sensor ring too large. 4. Sensor has an internal defect.	The cause of the unknown rotational direction must be located. 1. Check the wiring from the sensor to the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Check the function of the sensor and, if necessary, replace it.
523115	9	Speed sensor input 4 (EF4) speed unknown: Engine speed	Limp Home	The control unit does not recognize the speed at the input. 1. Wiring or plug connection is defective. 2. Wiring or plug connection has a poor contact. 3. Distance speed sensor – sensor ring too large. 4. Speed sensor has an internal defect.	The cause of the unknown speed must be located. 1. Check the wiring from the speed sensor to the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Check the function of the sensor and, if necessary, replace it.
523140	3	Resistance sensor input 1 (ER1) open circuit or short to high source: Sump temperature	Normal	The measured line resistance between the connected component and the control unit is too high. 1. Wiring or plug connection is defective. 2. Component has an internal defect. 3. Control unit has an internal defect.	1. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 2. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 3. Check the function of the connected component and replace it if needed.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
					4. Replace the control unit if the error continues to occur.
523140	6	Resistance sensor input 1 (ER1) short to ground: Sump temperature	Normal	The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too low. 1. Wiring or plug connection contacts vehicle ground. 2. Component has an internal defect. 3. Control unit has an internal defect.	1. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 2. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 3. Check the function of the connected component and replace it if needed. 4. Replace the control unit if the error continues to occur.
523155	3	Current sensor input 2 (EI2) overvoltage: Oil Filter Restriction Switch	Normal	The measured voltage at the input is too high. 1. Wiring or plug connection is defective. 2. Component has an internal defect. 3. Control unit has an internal defect.	The cause of the incorrect voltage must be located. 1. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Check the correct wiring of the pins. 3. Check the function of the connected component or replace the component. 4. Replace the control unit if the error continues to occur.
523155	6	Current seonsr input 2 (EI2) open circuit or short to ground: Oil Filter Restriction Switch	Normal	The measured line resistance between the connected component and the control unit is too high. 1. Wiring or plug connection is defective. 2. Component has an internal defect. 3. Control unit has an internal defect.	1. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 2. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 3. Check the function of the connected component and replace it if needed.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
					4. Replace the control unit if the error continues to occur.
523160	3	Voltage sensor input 3 (EU3) overvoltage	TCU Shutdown	The measured voltage at the sensor input 3 is too high: cable is defective and is contacted to battery voltage clutch cut off / inch pedal sensor has an internal defect connector pin is contacted to battery voltage.	check the cable from TCU to the sensor check the connectors 3 check the sensor
523160	6	Voltage sensor input 3 (EU3) open or short to ground	TCU Shutdown	The measured voltage at the sensor input 3 is too low: cable is defective and is contacted to vehicle ground cable has no connection to TCU clutch cut off / inch pedal sensor has an internal defect connector pin is contacted to vehicle ground or is broken.	1 check the cable from TCU to the sensor 2 check the connectors 3 check the sensor
523160	12	Voltage sensor input 3 (EU3) defect	TCU Shutdown	The measured sensor voltage is out of the allowed thresholds.	check the cable from TCU to the sensor check the connectors check the sensor 4 Change the sensor
523165	3	Voltage sensor input 4 (EU4) overvoltage	Normal	The measured voltage at the sensor input 3 is too high: cable is defective and is contacted to battery voltage clutch cut off / inch pedal sensor has an internal defect connector pin is contacted to battery voltage.	1 check the cable from TCU to the sensor 2 check the connectors 3 check the sensor
523165	6	Voltage sensor input 4 (EU4) open or short to ground	Normal	The measured voltage at the sensor input 3 is too low: cable is defective and is contacted to vehicle ground cable has no connection to TCU clutch cut off / inch pedal sensor has an internal defect connector pin is contacted to vehicle ground or is broken.	1 check the cable from TCU to the sensor 2 check the connectors 3 check the sensor
523165	12	Voltage sensor input 4	Normal	The measured sensor voltage is out of the	check the cable from TCU to the sensor check the

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
		(EU4) defect		allowed thresholds.	connectors check the sensor 4 Change the sensor
523200	2	Current output driver 1 (AIM01) unknown electrical component	Trm Shutdown	If this error occurs, then an electrical component has been connected at the output although the input should not be used.	1. Using the circuit diagram, check if a component is assigned to the output. 2. Check the wiring, in particular that it is wired correctly. 3. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts 4. Replace the control unit if the error continues to occur.
523200	3	Current output driver 1 (AIM01) short to battery	Limp Home	The measured line resistance between the proportional valve and the control unit is too high or the voltage on the control unit output is too high. 1. Wiring or plug connection contacts battery voltage. 2. Proportional valve has an internal defect. 3. Control unit has an internal defect.	1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4. Check the function of the connected component and replace it if needed. 5. Replace the control unit if the error continues to occur.
523200	5	Current output driver 1 (AIM01) open circuit	Limp Home	The measured line resistance between the connected component and the control unit is too high. 1. Wiring or plug connection is defective. 2. Component has an internal defect. 3. Control unit has an internal defect.	1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
					or damaged plug contacts. 4. Check the function of the connected component and replace it if needed. 5. Replace the control unit if the error continues to occur.
523200	6	Current output driver 1 (AIM01) short to ground	TCU Shutdown	The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too low. 1. Wiring or plug connection contacts vehicle ground. 2. Component has an internal defect. 3. Control unit has an internal defect.	1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4. Check the function of the connected component and replace it if needed. 5. Replace the control unit if the error continues to occur.
523200	8	Current output driver 1 (AIM01) short to another valve	Trm Shutdown	The measured line resistance between the proportional valve and the control unit is too high or the voltage on the control unit output is too low. 1. Wiring or plug connection contacts another proportional valve. 2. Proportional valve has an internal defect. 3. Control unit has an internal defect.	1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Check if the error occurs with an additional proportional valve or with which valve the error is bypassed. 3. Check the wiring between the proportional valve and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4. Switch the ignition off, unplug the control unit, and measure the resistance of the proportional valve using a terminal tester. 5. Check the function of the proportional valve and

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
					replace it if needed. 6. Replace the control unit if the error continues to occur.
523205	2	Current output driver 2 (AIM02) unknown electrical component	Trm Shutdown	If this error occurs, then an electrical component has been connected at the output although the input should not be used.	1. Using the circuit diagram, check if a component is assigned to the output. 2. Check the wiring, in particular that it is wired correctly. 3. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts 4. Replace the control unit if the error continues to occur.
523205	3	Current output driver 2 (AIM02) short to battery	Limp Home	The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too high. 1. Wiring or plug connection contacts battery voltage. 2. Component has an internal defect. 3. Control unit has an internal defect.	1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4. Check the function of the connected component and replace it if needed. 5. Replace the control unit if the error continues to occur.
523205	5	Current output driver 2 (AIM02) open circuit	Limp Home	The measured line resistance between the connected component and the control unit is too high. 1. Wiring or plug connection is defective. 2. Component has an internal defect. 3. Control unit has an internal defect.	1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3. Check the wiring between the connected

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
					component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4. Check the function of the connected component and replace it if needed. 5. Replace the control unit if the error continues to occur.
523205	6	Current output driver 2 (AIM02) short to ground	TCU Shutdown	The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too low. 1. Wiring or plug connection contacts vehicle ground. 2. Component has an internal defect. 3. Control unit has an internal defect.	1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4. Check the function of the connected component and replace it if needed. 5. Replace the control unit if the error continues to occur.
523205	8	Current output driver 2 (AIM02) short circuit to another valve	Trm Shutdown	The measured line resistance between the proportional valve and the control unit is too high or the voltage on the control unit output is too low. 1. Wiring or plug connection contacts another proportional valve. 2. Proportional valve has an internal defect. 3. Control unit has an internal defect.	1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Check if the error occurs with an additional proportional valve or with which valve the error is bypassed. 3. Check the wiring between the proportional valve and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4. Switch the ignition off, unplug the control unit, and measure the resistance of the proportional valve using

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
					a terminal tester. 5. Check the function of the proportional valve and replace it if needed. 6. Replace the control unit if the error continues to occur.
523210	2	Current output driver 3 (AIM03) unknown electrical component	Trm Shutdown	If this error occurs, then an electrical component has been connected at the output although the input should not be used.	1. Using the circuit diagram, check if a component is assigned to the output. 2. Check the wiring, in particular that it is wired correctly. 3. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts 4. Replace the control unit if the error continues to occur.
523210	3	Current output driver 3 (AIM03) short to battery	Limp Home	The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too high. 1. Wiring or plug connection contacts battery voltage. 2. Component has an internal defect. 3. Control unit has an internal defect.	1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4. Check the function of the connected component and replace it if needed. 5. Replace the control unit if the error continues to occur.
523210	5	Current output driver 3 (AIM03) open circuit	Limp Home	The measured line resistance between the connected component and the control unit is too high. 1. Wiring or plug connection is defective.	1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Switch the ignition off, unplug the control unit and measure the resistance of the connected component

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
				2. Component has an internal defect. 3. Control unit has an internal defect.	using a terminal tester. 3. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4. Check the function of the connected component and replace it if needed. 5. Replace the control unit if the error continues to occur.
523210	6	Current output driver 3 (AIM03) short to ground	TCU Shutdown	The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too low. 1. Wiring or plug connection contacts vehicle ground. 2. Component has an internal defect. 3. Control unit has an internal defect.	1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4. Check the function of the connected component and replace it if needed. 5. Replace the control unit if the error continues to occur.
523210	8	Current output driver 3 (AIM03) short circuit to another valve	Trm Shutdown	The measured line resistance between the proportional valve and the control unit is too high or the voltage on the control unit output is too low. 1. Wiring or plug connection contacts another proportional valve. 2. Proportional valve has an internal defect. 3. Control unit has an internal defect.	1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Check if the error occurs with an additional proportional valve or with which valve the error is bypassed. 3. Check the wiring between the proportional valve and the control unit, in particular with regard to defective plug connections such as corroded or defective plug connections such as corroded or damaged plug contacts.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
					4. Switch the ignition off, unplug the control unit, and measure the resistance of the proportional valve using a terminal tester. 5. Check the function of the proportional valve and replace it if needed. 6. Replace the control unit if the error continues to occur.
523215	2	Current output driver 4 (AIM04) unknown electrical component	Trm Shutdown	If this error occurs, then an electrical component has been connected at the output although the input should not be used.	1. Using the circuit diagram, check if a component is assigned to the output. 2. Check the wiring, in particular that it is wired correctly. 3. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts 4. Replace the control unit if the error continues to occur.
523215	3	Current output driver 4 (AIM04) short to battery	Limp Home	The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too high. 1. Wiring or plug connection contacts battery voltage. 2. Component has an internal defect. 3. Control unit has an internal defect.	1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4. Check the function of the connected component and replace it if needed. 5. Replace the control unit if the error continues to occur.
523215	5	Current output driver 4 (AIM04) open circuit	Limp Home	The measured line resistance between the connected component and the control unit is too	1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
				high. 1. Wiring or plug connection is defective. 2. Component has an internal defect. 3. Control unit has an internal defect.	2. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4. Check the function of the connected component and replace it if needed. 5. Replace the control unit if the error continues to occur.
523215	6	Current output driver 4 (AIM04) short to ground	TCU Shutdown	The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too low. 1. Wiring or plug connection contacts vehicle ground. 2. Component has an internal defect. 3. Control unit has an internal defect.	1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4. Check the function of the connected component and replace it if needed. 5. Replace the control unit if the error continues to occur.
523215	8	Current output driver 4 (AIM04) short circuit to another valve	Trm Shutdown	The measured line resistance between the proportional valve and the control unit is too high or the voltage on the control unit output is too low. 1. Wiring or plug connection contacts another proportional valve. 2. Proportional valve has an internal defect.	1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Check if the error occurs with an additional proportional valve or with which valve the error is bypassed. 3. Check the wiring between the proportional valve and the control unit, in particular with regard to

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
				3. Control unit has an internal defect.	defective plug connections such as corroded or damaged plug contacts. 4. Switch the ignition off, unplug the control unit, and measure the resistance of the proportional valve using a terminal tester. 5. Check the function of the proportional valve and replace it if needed. 6. Replace the control unit if the error continues to occur.
523220	2	Current output driver 5 (AIM05) unknown electrical component	Trm Shutdown	If this error occurs, then an electrical component has been connected at the output although the input should not be used.	1. Using the circuit diagram, check if a component is assigned to the output. 2. Check the wiring, in particular that it is wired correctly. 3. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts 4. Replace the control unit if the error continues to occur.
523220	3	Current output driver 5 (AIM05) short to battery	Limp Home	The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too high. 1. Wiring or plug connection contacts battery voltage. 2. Component has an internal defect. 3. Control unit has an internal defect.	1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4. Check the function of the connected component and replace it if needed. 5. Replace the control unit if the error continues to occur.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
523220	5	Current output driver 5 (AIM05) open circuit	Limp Home	The measured line resistance between the connected component and the control unit is too high. 1. Wiring or plug connection is defective. 2. Component has an internal defect. 3. Control unit has an internal defect.	1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4. Check the function of the connected component and replace it if needed. 5. Replace the control unit if the error continues to occur.
523220	6	Current output driver 5 (AIM05) short to ground	TCU Shutdown	The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too low. 1. Wiring or plug connection contacts vehicle ground. 2. Component has an internal defect. 3. Control unit has an internal defect.	1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4. Check the function of the connected component and replace it if needed. 5. Replace the control unit if the error continues to occur.
523220	8	Current output driver 5 (AIM05) short circuit to another valve	Trm Shutdown	The measured line resistance between the proportional valve and the control unit is too high or the voltage on the control unit output is too low. 1. Wiring or plug connection contacts another	1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Check if the error occurs with an additional proportional valve or with which valve the error is bypassed.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
				proportional valve. 2. Proportional valve has an internal defect. 3. Control unit has an internal defect.	3. Check the wiring between the proportional valve and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4. Switch the ignition off, unplug the control unit, and measure the resistance of the proportional valve using a terminal tester. 5. Check the function of the proportional valve and replace it if needed. 6. Replace the control unit if the error continues to occur.
523225	2	Current output driver 6 (AIM06) unknown electrical component	Trm Shutdown	If this error occurs, then an electrical component has been connected at the output although the input should not be used.	1. Using the circuit diagram, check if a component is assigned to the output. 2. Check the wiring, in particular that it is wired correctly. 3. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts 4. Replace the control unit if the error continues to occur.
523225	3	Current output driver 6 (AIM06) short to battery	Limp Home	The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too high. 1. Wiring or plug connection contacts battery voltage. 2. Component has an internal defect. 3. Control unit has an internal defect.	1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4. Check the function of the connected component and replace it if needed.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
					5. Replace the control unit if the error continues to occur.
523225	5	Current output driver 6 (AIM06) open circuit	Limp Home	The measured line resistance between the connected component and the control unit is too high. 1. Wiring or plug connection is defective. 2. Component has an internal defect. 3. Control unit has an internal defect.	1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4. Check the function of the connected component and replace it if needed. 5. Replace the control unit if the error continues to occur.
523225	6	Current output driver 6 (AIM06) short to ground	TCU Shutdown	The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too low. 1. Wiring or plug connection contacts vehicle ground. 2. Component has an internal defect. 3. Control unit has an internal defect.	1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4. Check the function of the connected component and replace it if needed. 5. Replace the control unit if the error continues to occur.
523225	8	Current output driver 6 (AIM06) short circuit to another valve	Trm Shutdown	The measured line resistance between the proportional valve and the control unit is too high or the voltage on the control unit output is	1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Check if the error occurs with an additional

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
				too low. 1. Wiring or plug connection contacts another proportional valve. 2. Proportional valve has an internal defect. 3. Control unit has an internal defect.	proportional valve or with which valve the error is bypassed. 3. Check the wiring between the proportional valve and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4. Switch the ignition off, unplug the control unit, and measure the resistance of the proportional valve using a terminal tester. 5. Check the function of the proportional valve and replace it if needed. 6. Replace the control unit if the error continues to occur.
523230	2	Current output driver 7 (AIM07) unknown electrical component	Trm Shutdown	If this error occurs, then an electrical component has been connected at the output although the input should not be used.	1. Using the circuit diagram, check if a component is assigned to the output. 2. Check the wiring, in particular that it is wired correctly. 3. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts
523230	3	Current output driver 7 (AIM07) short to battery	Limp Home	The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too high. 1. Wiring or plug connection contacts battery voltage. 2. Component has an internal defect. 3. Control unit has an internal defect.	1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4. Check the function of the connected component and replace it if needed.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
					5. Replace the control unit if the error continues to occur.
523230	5	Current output driver 7 (AIM07) open circuit	Limp Home	The measured line resistance between the connected component and the control unit is too high. 1. Wiring or plug connection is defective. 2. Component has an internal defect. 3. Control unit has an internal defect.	1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4. Check the function of the connected component and replace it if needed. 5. Replace the control unit if the error continues to occur.
523230	6	Current output driver 7 (AIM07) short to ground	TCU Shutdown	The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too low. 1. Wiring or plug connection contacts vehicle ground. 2. Component has an internal defect. 3. Control unit has an internal defect.	1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 3. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4. Check the function of the connected component and replace it if needed. 5. Replace the control unit if the error continues to occur.
523230	8	Current output driver 7 (AIM07) short circuit to another valve	Trm Shutdown	The measured line resistance between the proportional valve and the control unit is too high or the voltage on the control unit output is	1. Switch the ignition off, wait 10 seconds and switch the ignition back on. Check if the error is still active. 2. Check if the error occurs with an additional

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
				too low. 1. Wiring or plug connection contacts another proportional valve. 2. Proportional valve has an internal defect. 3. Control unit has an internal defect.	proportional valve or with which valve the error is bypassed. 3. Check the wiring between the proportional valve and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 4. Switch the ignition off, unplug the control unit, and measure the resistance of the proportional valve using a terminal tester. 5. Check the function of the proportional valve and replace it if needed. 6. Replace the control unit if the error continues to occur.
523280	3	Digital current output driver 1 (ADM1) short to battery	Trm Shutdown	TCU detected a wrong voltage at the output pin, that looks like a s.c. to battery voltage cable is defective and is contacted to battery voltage device has an internal defect connector pin is contacted to battery voltage	check the cable from TCU to the device at ADM1 check the connectors check the resistance of the device at ADM1
523280	5	Digital current output driver 1 (ADM1) open circuit	Trm Shutdown	TCU detected a wrong voltage at the output pin, that looks like a o.c. for this output pin cable is defective and has no connection to TCU device has an internal defect connector has no connection to TCU	check the cable from TCU to the device at ADM1 check the connectors check the resistance of the device at ADM1
523280	6	Digital current output driver 1 (ADM1) short to ground	Trm Shutdown	TCU detected a wrong voltage at the output pin, that looks like a s.c. to vehicle ground cable is defective and is contacted to vehicle ground device has an internal defect connector pin is contacted to vehicle ground	check the cable from TCU to the device at ADM1 check the connectors check the resistance of the device at ADM1
523280	12	Digital current output driver 1 (ADM1) defect	Trm Shutdown	TCU detected overtemperature or an internal error at the digital output	Change TCU
523281	3	Digital current output	Trm Shutdown	TCU detected a wrong voltage at the output pin,	check the cable from TCU to the device at ADM2 check

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
		driver 2 (ADM2) short to battery		that looks like a s.c. to battery voltage cable is defective and is contacted to battery voltage device has an internal defect connector pin is contacted to battery voltage	the connectors check the resistance of the device at ADM2
523281	5	Digital current output driver 2 (ADM2) open circuit	Trm Shutdown	TCU detected a wrong voltage at the output pin, that looks like a o.c. for this output pin cable is defective and has no connection to TCU device has an internal defect connector has no connection to TCU	check the cable from TCU to the device at ADM2 check the connectors check the resistance of the device at ADM2
523281	6	Digital current output driver 2 (ADM2) short to ground	Trm Shutdown	TCU detected a wrong voltage at the output pin, that looks like a s.c. to vehicle ground cable is defective and is contacted to vehicle ground device has an internal defect connector pin is contacted to vehicle ground	check the cable from TCU to the device at ADM2 check the connectors check the resistance of the device at ADM2
523281	12	Digital current output driver 2 (ADM2) defect	Trm Shutdown	TCU detected overtemperature or an internal error at the digital output	Change TCU
523145	3	Resistance sensor input 2 (ER2) open circuit or short to high source: Torque converter temperature	Normal	The measured line resistance between the connected component and the control unit is too high. 1. Wiring or plug connection is defective. 2. Component has an internal defect. 3. Control unit has an internal defect.	1. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 2. Check the wiring between the connected component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 3. Check the function of the connected component and replace it if needed. 4. Replace the control unit if the error continues to occur.
523145	6	Resistance sensor input 2 (ER2) short to ground: Torque converter temperature	Normal	The measured line resistance between the connected component and the control unit is too high or the voltage on the control unit output is too low.	1. Switch the ignition off, unplug the control unit and measure the resistance of the connected component using a terminal tester. 2. Check the wiring between the connected

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
				1. Wiring or plug connection contacts vehicle ground. 2. Component has an internal defect 3. Control unit has an internal defect.	component and the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 3. Check the function of the connected component and replace it if needed. 4. Replace the control unit if the error continues to occur.
523125	3	Voltage sensor input 1 (EU1) overvoltage	Limp Home	The measured voltage at the sensor input 1 is too high: cable is defective and is contacted to battery voltage clutch cut off / inch pedal sensor has an internal defect connector pin is contacted to battery voltage	check the cable from TCU to the sensor check the connectors check the sensor
523125	6	Voltage sensor input 1 (EU1) open or short to ground	Limp Home	The measured voltage at the sensor input 1 is too low: cable is defective and is contacted to vehicle ground cable has no connection to TCU clutch cut off / inch pedal sensor has an internal defect connector pin is contacted to vehicle ground or is broken	check the cable from TCU to the sensor check the connectors check the sensor
523125	12	Voltage sensor input 1 (EU1) defect	Limp Home	The measured voltage from sensor output signal 1 and output signal 2 don’t match or are out of range. 1. Cable is defective 2. Sensor has an internal defect	check the cable from TCU to the sensor check the connectors check the sensor
523023	3	Supply for temperature sensors (AU_ER) overvoltage	Limp Home	The measured voltage is too high. 1. Wiring or plug connection is defective. 2. Sensor has an internal defect.	The cause of the incorrect voltage must be located. 1. Check the wiring, in particular with regard to defective plug connections such as corroded or

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
				3, Control unit has an internal defect.	damaged plug contacts. 2. Check the correct wiring of the pins. 3. Check the function of the sensor or replace the sensor. 4. Replace the control unit if the error continues to occur.
523023	4	Supply for temperature sensors (AU_ER) undervoltage	Limp Home	The measured voltage is too low. 1. Wiring or plug connection is defective. 2. Sensor has an internal defect. 3. Control unit has an internal defect.	The cause of the incorrect voltage must be located. 1. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Check the correct wiring of the pins. 3. Check the function of the sensor or replace the sensor. 4. Replace the control unit if the error continues to occur.
523130	3	Voltage sensor input 2 (EU2) overvoltage	Limp Home	The measured voltage at the sensor input 2 is too high: cable is defective and is contacted to battery voltage clutch cut off / inch pedal sensor has an internal defect connector pin is contacted to battery voltage	check the cable from TCU to the sensor check the connectors check the sensor
523130	6	Voltage sensor input 2 (EU2) open or short to ground	Limp Home	The measured voltage at the sensor input 2 is too low: cable is defective and is contacted to vehicle ground cable has no connection to TCU clutch cut off / inch pedal sensor has an internal defect connector pin is contacted to vehicle ground or is broken	1. Check the cable from TCU to the sensor 2. Check the connectors 3. Check the sensor

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
523130	12	Voltage sensor input 2 (EU2) defect	Limp Home	The measured voltage from sensor output signal 1 and output signal 2 don’t match or are out of range. 1. Cable is defective 2. Sensor has an internal defect	1. Check the cable from TCU to the sensor 2. Check the connectors 3. Check the sensor
523050	0	Internal TCU Error 6	TCU Shutdown		
523047	12	Internal TCU Error 3	TCU Shutdown	The control unit detects an internal error.	Read out the operating data with Testman and send them to your ZF contact.
523300	0	Transmission sump oil most severe overtemperature	Normal	The measured temperature in the oil sump of the transmission is too high. 1. The oil level is incorrect. 2. The cooling system is faulty. 3. Load is permanently too high.	The cause of the increased temperature input in the transmission must be located. 1. Check the oil level and correct it as needed. 2. Check the function of the cooler fan. 3. Check the transmission oil cooler for contaminants and damage. 4. Check the connection lines from the transmission to the transmission oil cooler for damage. 5. Check the transmission oil temperature using the diagnosis unit. If the measured oil temperature does not drop when the vehicle is operated at idle even after a longer period of time, then the temperature sensor needs to be replaced.
523300	16	Transmission sump oil moderately severe overtemperature	Normal	The measured temperature in the oil sump of the transmission is too high. 1. The oil level is incorrect. 2. The cooling system is faulty. 3. Load is permanently too high.	The cause of the increased temperature input in the transmission must be located. 1. Check the oil level and correct it as needed. 2. Check the function of the cooler fan. 3. Check the transmission oil cooler for contaminants and damage. 4. Check the connection lines from the transmission to the transmission oil cooler for damage. 5. Check the transmission oil temperature using the diagnosis unit. If the measured oil temperature does

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
					not drop when the vehicle is operated at idle even after a longer period of time, then the temperature sensor needs to be replaced.
523305	0	Oil Filter contaminated	Normal	1. Filter clogged. 2. Sensor has an internal defect.	If this error occurs while driving, then remain at a standstill, switch the ignition off, then on again and wait another 40 seconds. 1. Replace the filter. 2. Check the wiring of the switch, in particular with regard to defective plug connections such as corroded or damaged plug contacts.
523310	0	Transmission input torque too high	Normal	The control unit receives a transmission input torque via the CAN bus that exceeds the permissible maximum. 1. Engine torque too high. 2. CAN bus signal is faulty.	1. Reduce the applied engine torque. 2. If this error continues to occur, please contact your vehicle manufacturer.
523311	0	Transmission input power too high	Normal	TCU calculates an transmission input power above the defined thresholds	engine controller may ignore Torque or speedlimit command from TCU via TSC1 message
523320	15	Transmission output speed too high	Normal	The speed at the transmission output exceeds the permissible maximum.	The speed at the transmission output exceeds the permissible maximum.
523330	15	Transmission input speed too high	Trm Shutdown	The speed at the transmission input exceeds the permissible maximum.	Reduce the engine speed. In order to prevent long-term damage, stay within the permissible speed range.
523340	0	Transmission output torque too high	Trm Shutdown	The control unit calculates a torque at the transmission output that exceeds the permissible maximum. 1. Engine torque too high.	Reduce the applied engine torque.
523360	9	Clutch adjustment data invalid	Normal	The clutch calibration was not performed.	Perform the clutch calibration.
523361	13	Clutch calibration process failed	TCU Shutdown	The clutch calibration did fail	Check oil level and run calibration again.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
523400	9	Vehicle CAN failure	Trm Shutdown	An electrical error exists on the vehicle CAN bus. 1. Malfunction on the CAN bus. 2. ZF control unit has an internal defect.	If the control unit resets the error itself, then this is a matter of a sporadically occurring error. Check the following points only when the error is active. 1. Check the CAN connection for interruptions, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Replace the ZF control unit. 3. Check the terminating resistor of the CAN connection (CAN 1). Using an ohmmeter, also determine the resistance on the control unit and on the adapter when the ignition is off. The resistance value must be 120 Ohm ± 10 Ohm for each. 4. If this error continues to occur, please contact the vehicle manufacturer.
523402	9	ECU connection loss	Limp Home	The control unit no longer transfers any information. 1. Engine control unit has an internal defect.	The cause of the missing connection must be located. 1. If error vehicle can failure occurs, then repair this first. 2. If this error continues to be active, please contact your vehicle manufacturer.
523403	9	VCU connection loss	Trm Shutdown	No communication to the Vehicle Controller	Check CAN Connection, check source Adress of the VCU
523405	9	I/O-Extension connection loss	Trm Shutdown	The extension no longer transfers any information. 1. I/O extension has an internal defect.	The cause of the missing connection must be located. 1. If error vehicle can failure occurs, then repair this first. 2. If this error continues to be active, please contact your appropriate ZF service partner.
523411	9	Message ZFTC1 invalid or timeout	Trm Shutdown	The control unit does not receive the CAN message or the message contains faulty data. 1. Sporadic electrical error. 2. CAN bus overloaded.	If the control unit resets the error itself, then this is a matter of a sporadically occurring error or an excessive bus load. 1. If error VCU Connection loss occurs, then repair this

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
				3. Sending control unit has an internal defect. 4. Receiving control unit has an internal defect.	first. 2. If this error continues to be active, please contact your vehicle manufacturer.
523413	9	Message EEC1 invalid or timeout	Limp Home	The control unit does not receive the CAN message or the message contains faulty data. 1. Sporadic electrical error. 2. CAN bus overloaded. 3. Sending control unit has an internal defect. 4. Receiving control unit has an internal defect.	If the control unit resets the error itself, then this is a matter of a sporadically occurring error or an excessive bus load. 1. If error ECU Connection lost occurs, then repair this first. 2. If this error continues to be active, please contact your vehicle manufacturer.
523414	9	Message EEC2 invalid or timeout	Limp Home	The control unit does not receive the CAN message or the message contains faulty data. 1. Sporadic electrical error. 2. CAN bus overloaded. 3. Sending control unit has an internal defect. 4. Receiving control unit has an internal defect.	If the control unit resets the error itself, then this is a matter of a sporadically occurring error or an excessive bus load. 1. If error ECU Connection lost occurs, then repair this first. 2. If this error continues to be active, please contact your vehicle manufacturer.
523415	9	Message EEC3 invalid or timeout	Limp Home	The control unit does not receive the CAN message or the message contains faulty data. 1. Sporadic electrical error. 2. CAN bus overloaded. 3. Sending control unit has an internal defect. 4. Receiving control unit has an internal defect.	If the control unit resets the error itself, then this is a matter of a sporadically occurring error or an excessive bus load. 1. If error ECU Connection lost occurs, then repair this first. 2. If this error continues to be active, please contact your vehicle manufacturer.
523416	9	Message EC1 invalid or timeout	Limp Home	The control unit does not receive the CAN message or the message contains faulty data. 1. Sporadic electrical error. 2. CAN bus overloaded. 3. Sending control unit has an internal defect. 4. Receiving control unit has an internal defect.	If the control unit resets the error itself, then this is a matter of a sporadically occurring error or an excessive bus load. 1. If error ECU Connection lost occurs, then repair this first. 2. If this error continues to be active, please contact your vehicle manufacturer.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
523417	9	Message B invalid or timeout	Normal	The control unit does not receive the CAN message or the message contains faulty data. 1. Sporadic electrical error. 2. CAN bus overloaded. 3. Sending control unit has an internal defect. 4. Receiving control unit has an internal defect.	If the control unit resets the error itself, then this is a matter of a sporadically occurring error or an excessive bus load. 1. If error VCU connection lost occurs, then repair this first. 2. If this error continues to be active, please contact your vehicle manufacturer.
523418	9	Message EBC1 invalid or timeout	Normal	The control unit does not receive the CAN message or the message contains faulty data. 1. Sporadic electrical error. 2. CAN bus overloaded. 3. Sending control unit has an internal defect. 4. Receiving control unit has an internal defect.	1. If error VCU connection lost occurs, then repair this first. 2. If this error continues to be active, please contact your vehicle manufacturer.
523419	9	Signal actual engine torque or signal engine speed (EEC1) are defective	Limp Home	One or more signals of the messages from engine controller contains faulty data. 1. Incorrect software on the transmission control unit. 2. Incorrect software on the engine controller.	1. Check the software version of the transmission control unit and program the current software version if required. 2. If this error continues to occurs, please contact your vehicle manufacturer.
523420	9	Message CCVS invalid or timeout	Normal	The control unit does not receive the CAN message or the message contains faulty data. 1. Sporadic electrical error. 2. CAN bus overloaded. 3. Sending control unit has an internal defect. 4. Receiving control unit has an internal defect.	If the control unit resets the error itself, then this is a matter of a sporadically occurring error or an excessive bus load. 1. If error Vehicle CAN error occurs, then repair this first. 2. If this error continues to be active, please contact your vehicle manufacturer.
523426	9	Message JBERC1 invalid or timeout	Limp Home	The control unit does not receive the CAN message or the message contains faulty data. 1. Sporadic electrical error. 2. CAN bus overloaded. 3. Sending control unit has an internal defect. 4. Receiving control unit has an internal defect.	If the control unit resets the error itself, then this is a matter of a sporadically occurring error or an excessive bus load. 1. If error Vehicle CAN error occurs, then repair this first. 2. If this error continues to be active, please contact

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
					HCE.
523427	9	Message JBRC invalid or timeout	Limp Home	The control unit does not receive the CAN message or the message contains faulty data. 1. Sporadic electrical error. 2. CAN bus overloaded. 3. Sending control unit has an internal defect. 4. Receiving control unit has an internal defect.	If the control unit resets the error itself, then this is a matter of a sporadically occurring error or an excessive bus load. 1. If error Vehicle CAN error occurs, then repair this first. 2. If this error continues to be active, please contact HCE.
523470	19	Operation Mode command invalid	Trm Shutdown	The operating mode assigned by the vehicle control unit is invalid for the transmission. 1. Incorrect software on the transmission control unit. 2. Incorrect software on the vehicle computer.	1. Check the software version of the transmission control unit and program the current software version if required. 2. If this error continues to occurs, please contact HCE.
523471	19	Transmission command invalid	Trm Shutdown	The transmission mode assigned by the vehicle control unit is invalid for the transmission. 1. Incorrect software on the transmission control unit. 2. Incorrect software on the vehicle computer.	1. Check the software version of the transmission control unit and program the current software version if required. 2. If this error continues to occurs, please contact HCE.
523480	9	Machine configuration invalid	TCU Shutdown	The startup handshake has not been successful.	Check version of vehicle controller (it has to support handshaking).
523481	0	Testmode requested but conditions not complied	Trm Shutdown	The conditions for Testmode are not fulfilled	Take back the test mode request, set the conditions to the allowed thresholds and request the Test Mode again
523500	0	Overspeed engine	Normal	The control unit receives an engine speed via the CAN bus that exceeds the permissible maximum. 1. Engine speed too high. 2. CAN bus signal is faulty.	1. Reduce the engine speed. 2. If this error continues to occur, please contact your vehicle manufacturer. Note: In order to prevent permanent damage, stay within the permissible speed range.
523501	0	Engine speed limit request does not take effect	Normal	The transmission control unit requires a limited engine speed; the engine does not maintain the limit;	If this error continues to be active, please contact HCE.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
523502	0	Engine speed control request does not take effect	Normal	The transmission control unit requires a certain engine speed; the engine controller does not set this speed;	If this error continues to be active, please contact HCE.
523503	0	Engine torque limit request does not take effect	Normal	The transmission control unit requires a limited engine torque; the engine does not maintain the limit;	If this error continues to be active, please contact HCE.
523504	0	Engine torque control request does not take effect	Normal	The transmission control unit requires a certain engine torque;the engine controller does not set this torque;	If this error continues to be active, please contact HCE.
523600	0	Protection related error detected	Trm Shutdown	The control unit detects a safety-relevant error.	Read out the operating data with Testman and send them to your ZF contact.
523600	1	Protection Function 1 (SF01) Unwanted driveaway	TCU Shutdown	Unexpected vehicle movement detected	Read out the operating data with Testman and send them to your ZF contact.
523600	2	Protection Function 2 (SF02) Unwanted driving direction	Trm Shutdown	Driving in the wrong direction detected	Read out the operating data with Testman and send them to your ZF contact.
523600	3	Protection Function 3 (SF03) Safely limited acceleration (blocked Transmission)	Trm Shutdown	Transmission blocking detected	Read out the operating data with Testman and send them to your ZF contact.
523600	4	Protection Function 4 (SF04) Safely limited acceleration (Downshift)	Trm Shutdown	Unalowed speeds at transmission input detected	Read out the operating data with Testman and send them to your ZF contact.
523600	5	Protection Function 5 (SF05) Safe Output at reverse driving	Trm Shutdown	Wrong Reverse signal broadcasted	Read out the operating data with Testman and send them to your ZF contact.
523600	6	Protection Function 6 (SF06) Safely limited	Trm Shutdown	Unalowed speed or gear in Reverse detected	Read out the operating data with Testman and send them to your ZF contact.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
		speed in Reverse			
523600	7	Protection Function 7 (SF07) Unwanted direction change	Trm Shutdown	Unwanted change of driving direction detected	Read out the operating data with Testman and send them to your ZF contact.
523600	8	Protection Function 8 (SF08)	Trm Shutdown	Safely limited torque	Read out the operating data with Testman and send them to your ZF contact.
523600	9	Protection Function 9 (SF09) Safely limited torque	Trm Shutdown	Unalowed engine control request detected	Read out the operating data with Testman and send them to your ZF contact.
523600	10	Protection Function 10 (SF10) Delayed gear engagement	Trm Shutdown	Unalowed delayed get into gear detected	Read out the operating data with Testman and send them to your ZF contact.
523600	11	Protection Function 11 (SF11) Safe Difflock	Trm Shutdown	Unalowed Difflock acutation at too high speeds detected	Read out the operating data with Testman and send them to your ZF contact.
523600	12	Protection Function 12 (SF12) Safe Transmission Output Signals	TCU Shutdown	Safe Transmission Output	Read out the operating data with Testman and send them to your ZF contact.
523600	16	Protection Function 16 (SF16) Safe Inching Exit	TCU Shutdown	Safe Inchen Exit	Read out the operating data with Testman and send them to your ZF contact.
523600	18	Protection Function 18 (SF18) Safe Speedlimit	Trm Shutdown	Unallowed speed limit overrun	Read out the operating data with Testman and send them to your ZF contact.
523601	0	Protection related error in transmission detected	TCU Shutdown	The control unit detects a clutch shift although no gear change is requested. 1. Energization proportional valve faulty. 2. Proportional valve faulty. 3. Control unit has an internal defect.	1. Check the proportional valves. 2. If this error continues to occur, contact your ZF representative and give us the error code and the conditions under which the error occurs. Read out the operating data with Testman and send them to us.
523602	0	Protection related error in vehicle communication	TCU Shutdown	The control unit detects a faulty check sum, a faulty message counter, or a faulty requirement from the vehicle control unit.	1. Check if the TC1 CAN bus message is present. In addition, create a CAN bus measurement on the vehicle CAN.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
		detected		1. CAN bus message is faulty.	2. If this error continues to occur, please contact HCE.
523603	0	Protection error reaction failed	TCU Shutdown	The control unit requires that the internal supply voltage is switched off but this does not happen. 1. Control unit has an internal defect.	1. Replace the control unit.
523421	9	No response to request of Time and Date message	Normal	The control unit does not receive the CAN message or the message contains faulty data. 1. Sporadic electrical error. 2. CAN bus overloaded. 3. Sending control unit has an internal defect. 4. Receiving control unit has an internal defect.	If the control unit resets the error itself, then this is a matter of a sporadically occurring error or an excessive bus load. 1. If error Vehicle CAN error occurs, then repair this first. 2. If this error continues to be active, please contact your dealer.
523423	9	Message VehcCFG invalid or timeout	Trm Shutdown	The control unit does not receive the CAN message or the message contains faulty data. 1. Sporadic electrical error. 2. CAN bus overloaded. 3. Sending control unit has an internal defect. 4. Receiving control unit has an internal defect.	If the control unit resets the error itself, then this is a matter of a sporadically occurring error or an excessive bus load. 1. If error Vehicle CAN error occurs, then repair this first. 2. If this error continues to be active, please contact your dealer.
523424	9	Message CCSS or ZFCCSS invalid or timeout	Trm Shutdown	The control unit does not receive the CAN message or the message contains faulty data. 1. Sporadic electrical error. 2. CAN bus overloaded. 3. Sending control unit has an internal defect. 4. Receiving control unit has an internal defect.	If the control unit resets the error itself, then this is a matter of a sporadically occurring error or an excessive bus load. 1. If error Vehicle CAN error occurs, then repair this first. 2. If this error continues to be active, please contact your dealer.
523482	9	Application program verification failed	TCU Shutdown	The control unit does not receive the ZFVI or VI message or the message contains faulty data.	Read out the operating data with Testman and send them to your ZF contact.
523100	7	EF1 speed does not match with other speeds	Trm Shutdown	The control unit measures a speed at the input which does not agree with the other speeds. 1. Wiring or plug connection is defective.	The cause of the different speeds must be located. 1. Check the wiring from the speed sensor to the control unit, in particular with regard to defective plug

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
				2. Wiring or plug connection has a poor contact. 3. Distance speed sensor – sensor ring too large. 4. Speed sensor has an internal defect.	connections such as corroded or damaged plug contacts. 2. Check the function of the sensor and, if necessary, replace it.
523100	11	EF1 direction of rotation does not match with other directions of rotation	Limp Home	The control unit recognizes a rotational direction at the input, which does not agree with the other rotational directions. 1. Wiring or plug connection is defective. 2. Wiring or plug connection has a poor contact. 3. Distance speed sensor – sensor ring too large. 4. Speed sensor has an internal defect.	The cause of the different rotational directions must be located. 1. Check the wiring from the sensor to the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Check the function of the sensor and, if necessary, replace it.
523105	7	EF2 speed does not match with other speeds	Trm Shutdown	The control unit measures a speed at the input which does not agree with the other speeds. 1. Wiring or plug connection is defective. 2. Wiring or plug connection has a poor contact. 3. Distance speed sensor – sensor ring too large. 4. Speed sensor has an internal defect.	The cause of the different speeds must be located. 1. Check the wiring from the speed sensor to the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Check the function of the sensor and, if necessary, replace it.
523105	11	EF2 direction of rotation does not match with other directions of rotation	Limp Home	The control unit recognizes a rotational direction at the input, which does not agree with the other rotational directions. 1. Wiring or plug connection is defective. 2. Wiring or plug connection has a poor contact. 3. Distance speed sensor – sensor ring too large. 4. Speed sensor has an internal defect.	The cause of the different rotational directions must be located. 1. Check the wiring from the sensor to the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Check the function of the sensor and, if necessary, replace it.
523110	7	EF3 speed does not match with other speeds	Trm Shutdown	The control unit measures a speed at the input which does not agree with the other speeds. 1. Wiring or plug connection is defective. 2. Wiring or plug connection has a poor contact. 3. Distance speed sensor – sensor ring too large. 4. Speed sensor has an internal defect.	The cause of the different speeds must be located. 1. Check the wiring from the speed sensor to the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Check the function of the sensor and, if necessary,

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
					replace it.
523110	11	EF3 direction of rotation does not match with other directions of rotation	Trm Shutdown	The control unit recognizes a rotational direction at the input, which does not agree with the other rotational directions. 1. Wiring or plug connection is defective. 2. Wiring or plug connection has a poor contact. 3. Distance speed sensor – sensor ring too large. 4. Speed sensor has an internal defect.	The cause of the different rotational directions must be located. 1. Check the wiring from the sensor to the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Check the function of the sensor and, if necessary, replace it.
523115	7	EF4 speed does not match with other speeds	Limp Home	The control unit measures a speed at the input which does not agree with the other speeds. 1. Wiring or plug connection is defective. 2. Wiring or plug connection has a poor contact. 3. Distance speed sensor – sensor ring too large. 4. Speed sensor has an internal defect.	The cause of the different speeds must be located. 1. Check the wiring from the speed sensor to the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Check the function of the sensor and, if necessary, replace it.
523115	11	EF4 direction of rotation does not match with other directions of rotation	Normal	The control unit recognizes a rotational direction at the input, which does not agree with the other rotational directions. 1. Wiring or plug connection is defective. 2. Wiring or plug connection has a poor contact. 3. Distance speed sensor – sensor ring too large. 4. Speed sensor has an internal defect.	The cause of the different rotational directions must be located. 1. Check the wiring from the sensor to the control unit, in particular with regard to defective plug connections such as corroded or damaged plug contacts. 2. Check the function of the sensor and, if necessary, replace it.
523302	0	Torque converter oil temperature critical	Normal	The measured oil temperature at the converter is too high. 1. The oil level is incorrect. 2. The cooling system is faulty. 3. Load is permanently too high.	The cause of the increased temperature at the converter must be located. 1. Check the oil level and correct it as needed. 2. Check the function of the cooler fan. 3. Check the transmission oil cooler for contaminants and damage. 4. Check the connection lines from the transmission to the transmission oil cooler for damage. 5. Check the transmission oil temperature using the

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
					diagnosis unit. If the measured oil temperature does not drop when the vehicle is operated at idle even after a longer period of time, then the temperature sensor needs to be replaced.
523302	16	Torque converter oil overtemperature	Normal	The measured oil temperature at the converter is too high. 1. The oil level is incorrect. 2. The cooling system is faulty. 3. Load is permanently too high.	The cause of the increased temperature at the converter must be located. 1. Check the oil level and correct it as needed. 2. Check the function of the cooler fan. 3. Check the transmission oil cooler for contaminants and damage. 4. Check the connection lines from the transmission to the transmission oil cooler for damage. 5. Check the transmission oil temperature using the diagnosis unit. If the measured oil temperature does not drop when the vehicle is operated at idle even after a longer period of time, then the temperature sensor needs to be replaced.
523450	19	Engine reference torque signal invalid	Limp Home	Signal 'Engine Reference Torque from engine controller contains faulty data. 1 .Incorrect software on the transmission control unit. 2. Incorrect software on the engine controller.	1.Check the software version of the transmission control unit and program the current software version if required. 2.If this error continues to occurs, please contact HCE.
523451	19	Actual engine torque signal invalid	Limp Home	Signal 'Actual Engine Torque' from engine controller contains faulty data. 1 .Incorrect software on the transmission control unit. 2. Incorrect software on the engine controller.	1.Check the software version of the transmission control unit and program the current software version if required. 2.If this error continues to occurs, please contact HCE.
523452	19	Engine nominal friction torque signal invalid	Normal	Signal 'Engine Nominal Friction Torque' from engine controller contains faulty data. 1 .Incorrect software on the transmission control unit.	1.Check the software version of the transmission control unit and program the current software version if required. 2.If this error continues to occurs, please contact your

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
				2. Incorrect software on the engine controller.	HCE.
523454	19	Launch gear request invalid	Normal	Signal 'Requested Launch Gear' from vehicle controller contains faulty data. 1 .Incorrect software on the transmission control unit. 2. Incorrect software on the vehicle controller.	1.Check the software version of the transmission control unit and program the current software version if required. 2.If this error continues to occurs, please contact HCE.
523455	19	Message ZFSL1 invalid or timed out	Trm Shutdown	Shift Lever message is missing or provides wrong signals	Check CAN Bus, Check Shift Lever
523456	19	Invalid FNR extension switches signal	Trm Shutdown	Invalid output signals from FNR switch	Check Shift Lever, FNR switch
523650	0	Neutral selected while vehicle moves with overspeed	Normal	Shift Lever message is missing or provides wrong signals	Check CAN Bus, Check Shift Lever
523700	0	Clutch K1 slipping unintendedly	Limp Home	The TCU calculates a speed difference although the clutch is closed. If this value is too high, it is interpreted as slip on the clutch. 1. Insufficient pressure on the clutch. 2. Insufficient system pressure. 3. Filter clogged. 4. Clutch faulty. 5. Transmission input speed signal faulty. 6. Transmission output speed signal faulty. 7. Distance speed sensor – sensor ring too large. 8. Significant oscillation of the engine speed.	The cause of the occurring speed difference must be located. 1. Check the existing system pressure. 2. Check the filter and replace it if needed (compare error 195). 3. Check the function of the clutch. 4. Check the function of the proportional valves and replace them if needed. 5. Check if all speeds are present and correct. 6. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts.
523705	0	Clutch K2 slipping unintendedly	Limp Home	The TCU calculates a speed difference although the clutch is closed. If this value is too high, it is interpreted as slip on the clutch. 1. Insufficient pressure on the clutch. 2. Insufficient system pressure. 3. Filter clogged.	The cause of the occurring speed difference must be located. 1. Check the existing system pressure. 2. Check the filter and replace it if needed (compare error 195). 3. Check the function of the clutch.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
				4. Clutch faulty. 5. Transmission input speed signal faulty. 6. Transmission output speed signal faulty. 7. Distance speed sensor – sensor ring too large. 8. Significant oscillation of the engine speed.	4. Check the function of the proportional valves and replace them if needed. 5. Check if all speeds are present and correct. 6. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts.
523710	0	Clutch K3 slipping unintendedly	Limp Home	The TCU calculates a speed difference although the clutch is closed. If this value is too high, it is interpreted as slip on the clutch. 1. Insufficient pressure on the clutch. 2. Insufficient system pressure. 3. Filter clogged. 4. Clutch faulty. 5. Transmission input speed signal faulty. 6. Transmission output speed signal faulty. 7. Distance speed sensor – sensor ring too large. 8. Significant oscillation of the engine speed.	The cause of the occurring speed difference must be located. 1. Check the existing system pressure. 2. Check the filter and replace it if needed (compare error 195). 3. Check the function of the clutch. 4. Check the function of the proportional valves and replace them if needed. 5. Check if all speeds are present and correct. 6. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts.
523715	0	Clutch KV slipping unintendedly	Limp Home	The TCU calculates a speed difference although the clutch is closed. If this value is too high, it is interpreted as slip on the clutch. 1. Insufficient pressure on the clutch. 2. Insufficient system pressure. 3. Filter clogged. 4. Clutch faulty. 5. Transmission input speed signal faulty. 6. Transmission output speed signal faulty. 7. Distance speed sensor – sensor ring too large. 8. Significant oscillation of the engine speed.	The cause of the occurring speed difference must be located. 1. Check the existing system pressure. 2. Check the filter and replace it if needed (compare error 195). 3. Check the function of the clutch. 4. Check the function of the proportional valves and replace them if needed. 5. Check if all speeds are present and correct. 6. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts.
523720	0	Clutch K4 slipping	Limp Home	The TCU calculates a speed difference although	The cause of the occurring speed difference must be

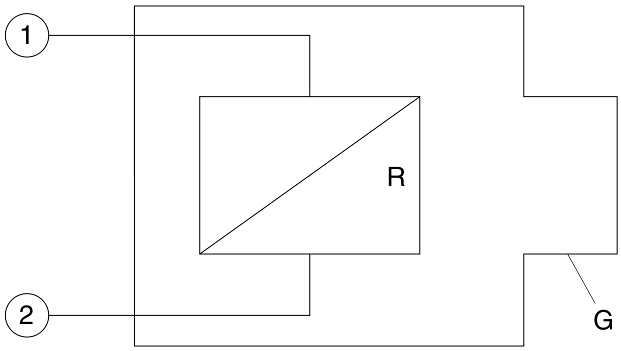
SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
		unintendedly		the clutch is closed. If this value is too high, it is interpreted as slip on the clutch. 1. Insufficient pressure on the clutch. 2. Insufficient system pressure. 3. Filter clogged. 4. Clutch faulty. 5. Transmission input speed signal faulty. 6. Transmission output speed signal faulty. 7. Distance speed sensor – sensor ring too large. 8. Significant oscillation of the engine speed.	located. 1. Check the existing system pressure. 2. Check the filter and replace it if needed (compare error 195). 3. Check the function of the clutch. 4. Check the function of the proportional valves and replace them if needed. 5. Check if all speeds are present and correct. 6. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts.
523725	0	Clutch KR slipping unintendedly	Limp Home	The TCU calculates a speed difference although the clutch is closed. If this value is too high, it is interpreted as slip on the clutch. 1. Insufficient pressure on the clutch. 2. Insufficient system pressure. 3. Filter clogged. 4. Clutch faulty. 5. Transmission input speed signal faulty. 6. Transmission output speed signal faulty. 7. Distance speed sensor – sensor ring too large. 8. Significant oscillation of the engine speed.	The cause of the occurring speed difference must be located. 1. Check the existing system pressure. 2. Check the filter and replace it if needed (compare error 195). 3. Check the function of the clutch. 4. Check the function of the proportional valves and replace them if needed. 5. Check if all speeds are present and correct. 6. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts.
523730	0	LUC slipping unintendedly	Normal	The TCU calculates a speed difference although the clutch is closed. If this value is too high, it is interpreted as slip on the clutch. 1. Insufficient pressure on the clutch. 2. Insufficient system pressure. 3. Filter clogged. 4. Clutch faulty. 5. Transmission input speed signal faulty.	The cause of the occurring speed difference must be located. 1. Check the existing system pressure. 2. Check the filter and replace it if needed (compare error 195). 3. Check the function of the clutch. 4. Check the function of the proportional valves and replace them if needed.

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
				6. Transmission output speed signal faulty. 7. Distance speed sensor – sensor ring too large. 8. Significant oscillation of the engine speed.	5. Check if all speeds are present and correct. 6. Check the wiring, in particular with regard to defective plug connections such as corroded or damaged plug contacts.
523385	0	Upshift by engine overspeed not supported in limphome	Trm Shutdown	Normally an upshift would have been necessary to protect the motor due to the increased motor speed. Since no shift can be performed in mode Limp Home, transmission shifts to neutral instead.	Do not overspeed engine in Limp Home. Use service brakes.
523355	0	Clutch KV temperature critical	Trm Shutdown	Failure related to overheated clutch KV	1. Wait for 20s to cool down clutches 2. Train operator to avoid unnecessary direction changes
523356	0	Clutch KR temperature critical	Trm Shutdown	Failure related to overheated clutch KR	1. Wait for 20s to cool down clutches 2. Train operator to avoid unnecessary direction changes
523171	12	CCO or inch pedal signals missmatch	Normal	The measured voltage of CCO and CCO2 signals don't match or are out of range. Or received signals via CAN do not correlate. 1. Cable is defective 2. Sensor has an internal defect	1. Check the cable from TCU to the sensor 2. Check connectors 3. Check sensor
523171	13	Inchpedal calibration failed	Normal	TCU was not able to read correct inchpedal adjustment parameters 1. Interference during saving data on non volatile memory 2. TCU is brand new, the inchpedal calibration was not performed	Perform the inchpedal calibration process.
523118	11	More than one internal speed sensors are defective	Trm Shutdown	More than one internal speed sensor is not working properly. In this case limp home mode is not possible anymore.	1. Check transmission harness, cables between TCU and speed sensors 2. Check connectors 3. Check sensor

SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
523431	19	Message ZFTC2 invalid or timed out	Trm Shutdown	ZFTC2 message is missing or provides wrong signals.	1. Check CAN bus 2. Check the software version of the transmission control unit and program the current software version if required. 3. If this error continues to occurs, please contact your vehicle manufacturer.
523432	19	Message ZFSL1_FNR invalid or timed out	Trm Shutdown	Shift Lever message is missing or provides wrong signals.	1. Check CAN bus 2. Check shift lever 3. Check the software version of the transmission control unit and program the current software version if required. 4. If this error continues to occurs, please contact your vehicle manufacturer.
523171	11	CCO or inch pedal signal fault during CCO or inching	Limp Home	A problem with the signals required for CCO or inching occured while the vehicle was in CCO or inching operation.	1. Check cable from TCU or the sensor 2. Check connectors 3. Check sensor

5) MEASURING OF RESISTANCE AT ACTUATOR/SENSOR AND CABLE

(1) Actuator



76043PT19

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

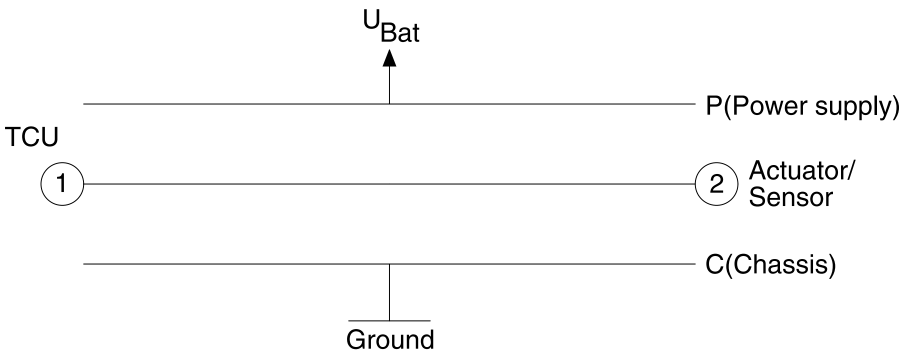
Short cut to ground $R_{12} = R$; $R_{1G} = 0$, $R_{2G} = R$ or $R_{1G} = R$, $R_{2G} = 0$

(For S.C. to ground, G is connected to vehicle ground)

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

(For S.C. to battery, G is connected to battery voltage)

(2) Cable



76043PT20

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

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

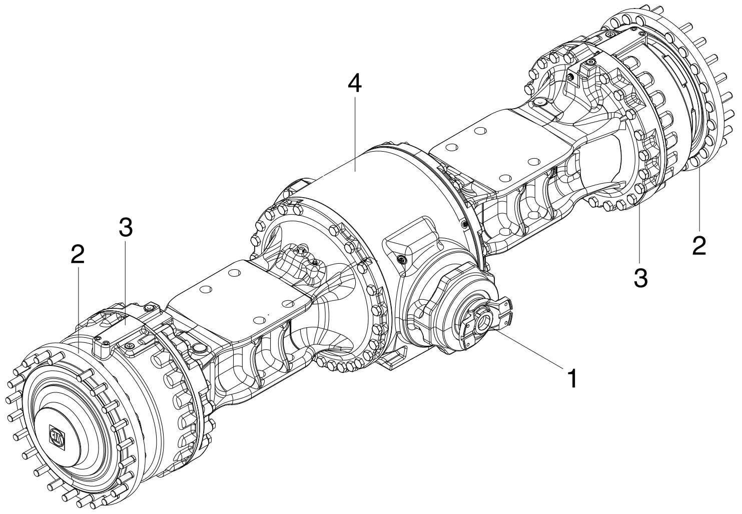
Short cut to battery $R_{12} = 0$; $R_{1C} = R_{2C} = 0$, $R_{1P} = R_{2P} = 0$

5. AXLE

1) OPERATION

- The power from the engine passes through torque converter, transmission and drive shafts, and is then sent to the front and rear axles.
- Inside the axles, the power passes from the bevel pinion to the bevel gear and is sent at right angles. At the same time, the speed is reduced and passes through the both differentials to the axle shafts. The power of the axle shafts is further reduced by planetary-gear-type final drives and is sent to the wheels.

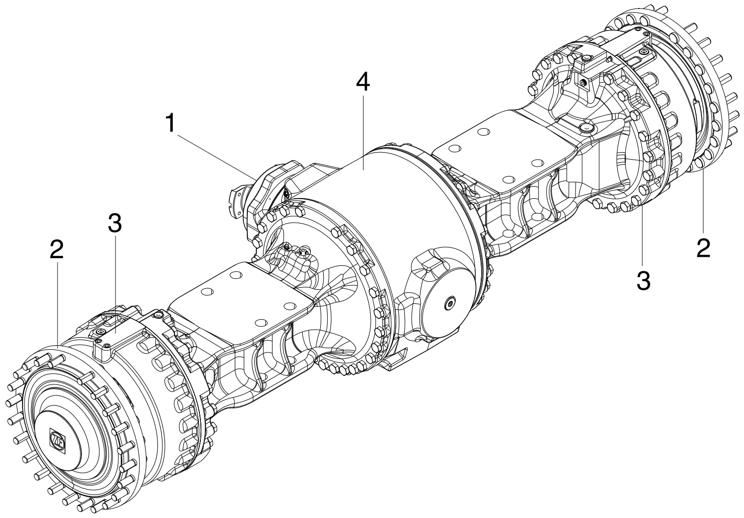
(1) Front axle



78093PT14

1	Input	2	Output	3	Brake
4	Axle housing				

(2) Rear axle



78093PT15

1	Input	2	Output	3	Brake
4	Axle housing				

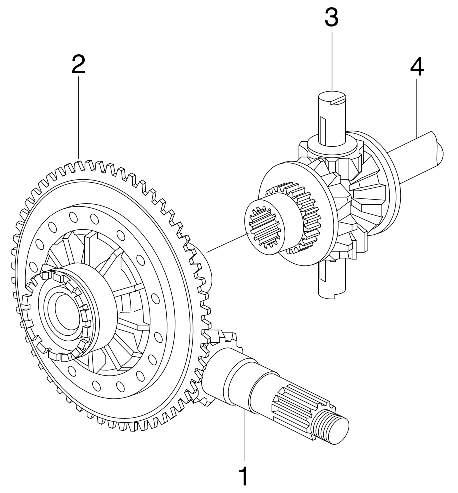
2) DIFFERENTIAL

(1) Description

When the machine makes a turn, the outside wheel must rotate faster than the inside wheel. A differential is a device which continuously transmits power to the right and left wheels while allowing them to turn a different speeds, during a turn.

The power from the drive shaft passes through bevel pinion (1) and is transmitted to the bevel gear (2). The bevel gear changes the direction of the motive force by 90 degree, and at the same time reduces the speed.

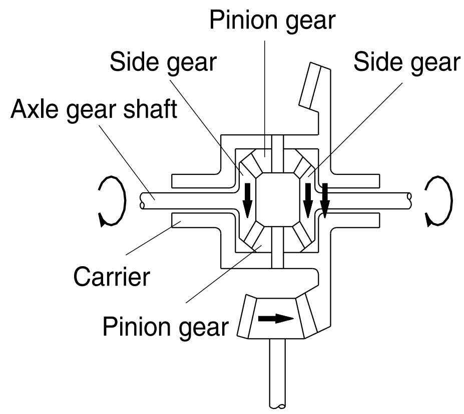
It then transmits the motive force through the differential (3) to the axle gear shaft (4).



770-3 [3-26(1)]

(2) When driving straight forward

When the machine is being driven straight forward and the right and left wheels are rotating at the same speed, so the pinion gear inside the differential assembly do not rotate. The motive force of the carrier is send through the pinion gear and the side gear, therefore the power is equally transmitted to the left and right axle gear shaft.

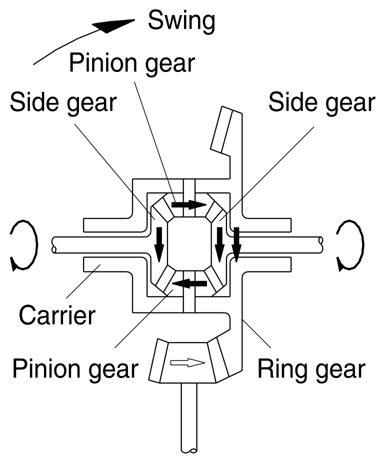


770-3 [3-26(2)]

(3) When turning

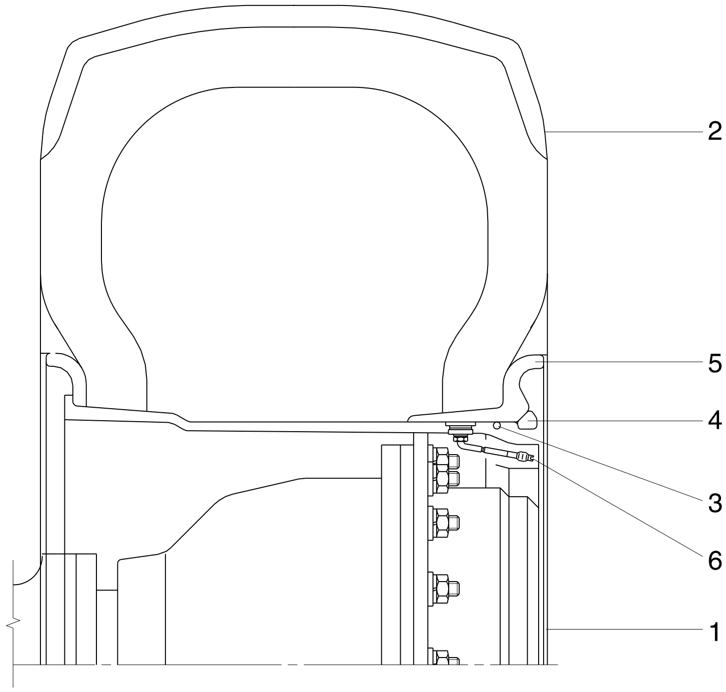
When turning, the rotating speed of the left and right wheels is different, so the pinion gear and side gear inside the differential assembly rotate in accordance with the difference between the rotating speed of the left and right wheels.

The power of the carrier is then transmitted to the axle gear shafts.



770-3 [3-26(3)]

6. TIRE AND WHEEL



7407APT10

1	Wheel rim	3	O-ring	5	Side ring
2	Tire	4	Lock ring	6	Valve assembly

1) The tire acts to absorb the shock from the ground surface to the machine, and at the same time they must rotate in contact with the ground to gain the power which drives the machine.

2) Various types of tires are available to suit the purpose. Therefore it is very important to select the correct tires for the type of work and bucket capacity.

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

1. POWER TRAIN OPERATIONAL CHECKS

This procedure is designed so that the mechanic can make a quick check of the system using a minimum amount of diagnostic equipment. If you need additional information, read Structure and function, Group 1.

A location will be required which is level and has adequate space to complete the checks.

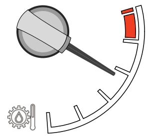
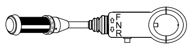
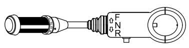
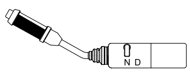
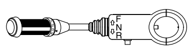
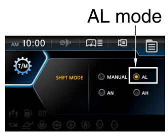
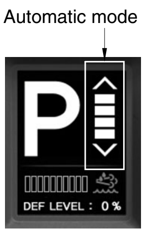
The engine and all other major components must be at operating temperature for some checks.

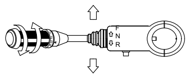
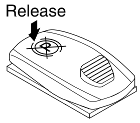
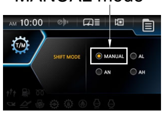
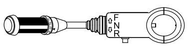
Locate system check in the left column and read completely, following the sequence from left to right. Read each check completely before performing.

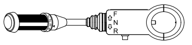
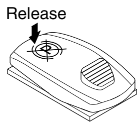
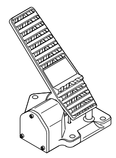
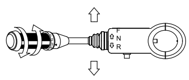
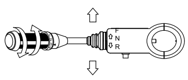
At the end of each check, if no problem is found(OK), that check is complete or an additional check is needed. If problem is indicated(NOT OK), you will be given repair required and group location.
If verification is needed, you will be given next best source of information :

Chapter 2 : Troubleshooting
Group 3 : Tests and adjustments

※ Transmission oil must be at operating temperature for these checks.

Item	Description	Service action
Transmission oil warm-up procedure	   Start engine. Apply service brakes and release parking brake. Select T/M shift mode to MANUAL mode. Move gear selector lever to 3rd speed. Move gear selector lever to forward "F" position. Increase engine speed to high idle for 30 seconds. Move gear selector lever to neutral "N" position and run for 15 seconds. Repeat procedure until transmission temperature gauge arrow points to bar above dial.	**OK** Check completed.
Gear selector lever and neutral lock latch checks Engine OFF.	  Move gear selector lever to each position. NOTE : Gear selector lever position changes slightly as steering column is tilted. FEEL : Lever must move freely through all positions. Engage neutral lock. Apply slight effort to move lever into forward (F) and reverse (R). LOOK : Neutral lock must stay engaged.	**OK** Check completed. **NOT OK** Repair lock or replace switch.
Automatic shifting check	   Start engine. Move gear selector lever to 4th speed. Select T/M shift mode to AL (auto light) mode. LOOK : Automatic sign on cluster. Move gear selector lever to forward or reverse position. Increase engine rpm. LOOK : Speed on cluster must vary with machine speed.	**OK** Check completed. **NOT OK** Go to transmission fault code group at page 3-50~3-66-31. Repair or replace the monitor or harness.

Item	Description	Service action
Transmission noise check Engine running.	 Run engine at approximately 1600 rpm. Drive unit with transmission in each forward and reverse speed. LISTEN : Transmission must not make excessive noise in any range. Engine rpm must not "lug down" as unit is shifted between gears.	**OK** Check completed. **NOT OK** Go to transmission makes excessive noise, chapter 2 in this group.
Transmission "quick shift" check Engine running.	  Release parking brake and select T/M shift mode to MANUAL mode. Shift to 2nd forward. Drive machine at approximately 5km/h and press gear selector lever kick down switch or RCV levers switch once. **LOOK/FEEL** : Transmission must shift to and remain in 1st gear. Press gear selector lever kick down switch once. **LOOK/FEEL** : Transmission must shift back to 2nd gear.  Shift to (3rd or 4th) gear and press gear selector lever kick down switch once. **LOOK/FEEL** : Transmission must not shift down.  Select T/M shift mode to AL (auto light) mode. Drive machine at approximately 90% speed of max speed in each gear (2nd or 3rd or 4th). Shift to (2nd or 3rd or 4th) gear in each forward and reverse speed and press gear selector kick down lever switch or RCV lever switch once. **LOOK/FEEL** : If shift down quickly from current gear to one step lower speed and recover to original speed quickly when push the switch one more time. (mode 1) If shifts down from current gear to one step lower speed when push the switch everytime and recover when push the switch in 1st gear. (mode 2)	**OK** Check completed. **NOT OK** Check connector at base of control valve. **IF OK** Go to transmission controller circuit in group 1.

Item	Description	Service action
Forward, reverse and 4th speed clutch pack drag check ※ Transmission must be warmed up for this check. Engine running.	   Park unit on level surface. Apply service brakes. Move gear selector lever to neutral. Move gear selector lever to 1st. Release parking brake and service brakes. Run engine at low idle. LOOK : Unit must not move in either direction. NOTE : If unit moves forward, either the forward pack or the 4th speed pack is dragging.	OK Check completed. NOT OK If unit moves, repair transmission.
Transmission shift modulation check Engine running.	 Run engine at approximately 1300 rpm. Put transmission in 1st forward, shift several times from forward to reverse and reverse to forward. Repeat check in 2nd gear. LOOK : Unit must slow down and change direction smoothly.	OK Check completed. NOT OK Go to unit shifts too fast, chapter 2 in this group.
Torque converter check	 Start engine. Apply service brakes and release parking brake. Move gear selector lever to 3rd speed. Move gear selector control lever to forward "F" position. Increase engine speed to high idle. LOOK : Torque converter stall rpm must be within the following range. Stall rpm : 2100±100 rpm Move gear selector control lever to neutral "N" position and run for 15 seconds.	OK Check completed. NOT OK If stall rpm are too low or too high, problem may be engine power or torque converter. IF OK Replace transmission torque converter.

2. TROUBLESHOOTING

1) TRANSMISSION

※ Diagnose malfunction charts are arranged from most probable and simplest to verify, to least likely, more difficult to verify. Remember the following steps when troubleshooting a problem :

Step 1. Operational check out procedure (See group 3 in section 1.)
Step 2. Operational checks (In this group.)
Step 3. Troubleshooting
Step 4. Tests and/or adjustments (See group 3.)

Problem	Cause	Remedy
Transmission slippage	Low oil level.	Add oil.
	Wrong oil grade.	Change oil.
	Restricted transmission pump suction screen.	Remove and clean screen.
	Leak in transmission control valve or gasket.	Remove valve and inspect gaskets.
	Low transmission pump flow due to worn pump.	Do transmission pump flow test.
	Weak or broken pressure regulating valve spring.	Do transmission system pressure test.
Error code on display	Something wrong in transmission.	Go to transmission fault code group at page 3-50~3-66-31.

Problem	Cause	Remedy
Machine will not move	Low oil level.	Add oil.
	Applied park brake.	Check parking brake fuse. Check continuity to parking brake switch.
	No power to transmission contro-ller.	Check transmission controller fuse.
	Malfunctioning parking brake solenoid valve.	Remove and inspect parking brake solenoid valve. Check for power to solenoid valve.
	Restricted orifice of PPC valve.	Remove orifice and check for contamination and/or plugging. (Do not remove valve housing for this purpose.)
	Excessive leakage in transmission element.	Do transmission element leakage test using system pressure.
	Worn clutch disks.	Repair transmission.
	Low or no transmission pressure.	See transmission pressure is low in this group.
	Service brake will not release.	Do brake pedal operational check. Do service and park system drag checks.
	Failed torque converter.	Do torque converter stall test. If engine pulldown in normal, torque converter is good.
	Broken shafts or gears.	Drain transmission to determine if large pieces of metal contamination are present.
	Broken drive shafts.	Inspect drive shafts and universal joints for external damage. Repair.
	Broken ring or pinion gear.	If drive shaft rotate with transmission in gear but machine does not move, a differential failure is indicated. Repair.
Machine does not engage in low gear	Malfunctioning transmission control solenoid valve.	Check solenoid valve.
	Stuck spool in transmission control valve.	Remove and inspect transmission control valve spools.
	Stuck PPC valve.	Remove end cover to inspect PPC valve. Replace if necessary.
	Malfunctioning transmission speed sensor.	Check speed sensor.

Problem	Cause	Remedy
Transmission pressure is low (all gears)	Low oil level.	Check transmission oil level and refill if necessary.
	Failed transmission pressure switch.	Verify transmission system pressure. Do transmission system pressure test.
	Plugged suction strainer.	Transmission pump may be noisy if transmission suction screen is clogged. Drain transmission. Remove and clean suction screen. Also, check condition of transmission filter.
	Stuck transmission pressure regulating valve or broken spring.	Remove transmission pressure regulating valve. Inspect for damage (See transmission control valve).
	Failed control valve gasket.	Inspect transmission control valve for external leakage. Remove control valve. Inspect or replace gasket.
	Stuck PPC valve.	Remove end cover to inspect modulation spool and check torque on cap screws retaining control valve to transmission.
Transmission system pressure is low (one or two gears)	Failed transmission pump.	Do pump flow test.
	Failed transmission control valve gasket.	Inspect transmission control valve for external leakage. Remove control valve. Inspect or replace gasket.
	Leakage in clutch piston or seal ring.	Disassemble and repair.
Transmission shifts too low	Low oil level (aeration of oil).	Add oil.
	Low transmission pressure.	Do transmission system pressure test.
	Restricted transmission pump suction screen.	Remove and clean screen.
	Low transmission pump flow.	Do transmission pump flow test.
	Excessive transmission element leakage.	Do transmission element leakage test using system pressure.
	Stuck PPC valve.	Remove end cover to inspect modulation spool. Replace if necessary.
	Restricted PPC valve orifice.	Remove orifice and inspect for contamination and /or plugging.
	Restricted oil passages between control valve and transmission elements.	Remove control valve and inspect oil passage.
	Incorrect transmission oil.	Change oil (SAE 10W-30/15W-40)

Problem	Cause	Remedy
Transmission shifts too fast	Wrong transmission controller.	Check if transmission controller has been changed
	System pressure too high.	Do transmission system pressure test.
	Stuck PPC valve.	Remove and inspect PPC valve. Replace if necessary. Also remove end cover to inspect PPC valve and control valve housing. Replace if necessary.
	Stuck or missing check valves.	Inspect transmission control valve.
	Missing O-ring from end of modulation orifice.	Remove orifice and inspect port for O-ring.
	Broken piston return spring.	Disassemble and inspect clutch.
	Incorrect transmission oil.	Change oil (SAE 10W-30/15W-40).
Machine "creeps" in neutral	Warped disks and plates in transmission.	Check transmission.
Transmission hydraulic system overheats	High oil level.	Transmission overfilled or hydraulic pump seal leaking.
	Low oil level.	Add oil.
	Wrong oil grade.	Change oil.
	Park brake dragging.	Check for heat in park brake area.
	Pinched, restricted or leaking lube lines.	Check cooler lines.
	Machine operated in too high gear range.	Operate machine in correct gear range.
	Malfunction in temperature gauge or sensor.	Install temperature sensor the verify temperature. Do tachometer/temperature reader installation procedure.
	Restricted air flow through oil cooler or radiator.	Do radiator air flow test.
	Failed oil cooler bypass valve (In thermal bypass valve).	Disassemble and inspect.
	Failed thermal bypass valve.	Remove thermal bypass valve and check to see if machine still overheats. Do transmission oil cooler thermal bypass valve test.
	Internally restricted oil cooler.	Do oil cooler restriction test.
	Leakage in transmission hydraulic system.	Do transmission system pressure, element leakage test.
	Malfunction in converter relief valve.	Do converter out pressure test.
	Low transmission pump output.	Do transmission pump flow test.

Problem	Cause	Remedy
Excessive transmission noise (Under load or no load)	Too low engine low idle.	Check engine low idle speed.
	Worn parts or damaged in transmission.	Remove transmission suction screen. Inspect for metal particles. Repair as necessary.
	Warped drive line between engine and torque converter.	Inspect drive line.
	Low or no lube.	Do converter-out and lube pressure test. Do transmission pump flow test.
Foaming oil	Incorrect type of oil.	Change oil.
	High oil level.	Transmission overfilled or hydraulic pump seal leaking.
	Low oil level.	Add oil.
	Air leak on suction side of pump.	Check oil pickup tube on side of transmission.
Oil ejected from dipstick	Plugged breather.	Inspect breather on top of transmission. Replace.
Machine vibrates	Aerated oil.	Add oil.
	Low engine speed.	Check engine speed.
	Failed universal joints on transmission drive shaft or differential drive shafts.	Check universal joints.
Machine lacks power and acceleration	Engine high idle speed set too low.	Check high idle adjustment.
	Incorrect transmission oil.	Change oil.
	Aerated oil.	Add oil.
	Low transmission pressure.	Do transmission system pressure test.
	Warped transmission clutch.	Do transmission clutch drag checks.
	Torn transmission control valve gasket.	Inspect gasket.
	Brake drag.	Do brake drag check.
	Failed torque converter.	Do torque converter stall speed test.
	Low engine power.	Do engine power test.
Torque converter stall RPM too high	Aerated oil.	Put clear hose on thermal bypass outlet port. Run machine to check for bubbles in oil.
	Stuck open converter relief valve.	Do converter-out pressure test.
	Leakage in torque converter seal.	Do converter-out pressure test.
	Torque converter not transferring power (Bent fins, broken starter).	Replace torque converter.

Problem	Cause	Remedy
Torque converter stall RPM too low	Low engine power.	Do engine power test.
	Mechanical malfunction.	Remove and inspect torque converter.
Transmission pressure light comes ON when shifting from forward to reverse (all other gears OK)	Low oil level.	Add oil.
	Cold oil.	Warm oil to specification.
	Leak in reverse pack.	Do transmission pressure, pump flow, and leakage check.
Transmission pressure light comes ON for each shift	Cold oil.	Warm oil to specification.
	No time delay in monitor.	Do monitor check.
	Restriction in modulation orifice.	Remove orifice and inspect for restriction and/or plugging.
	Stuck PPC valve.	Remove and inspect.
	Low transmission pressure circuit.	Do transmission system pressure test.
	Leak in transmission pressure circuit.	Do converter out pressure test.
	Failed transmission pump.	Do transmission pump flow test.
	Clogged filter.	Inspect filter. Replace.

2) DIFFERENTIAL / AXLE

Problem	Cause	Remedy
Differential low on oil	External leakage.	Inspect axle and differential for leaks.
Excessive differential and/or axle noise	Low oil level in differential.	Check oil. Remove drain plug and inspect for metal particles in differential case. Disassemble and determine cause.
	Incorrect type of oil.	Change oil
	Dragging brakes.	Do brake check.
	Failed pinion bearing.	Remove and inspect pinion. Check to ensure pinion housing was indexed.
	Incorrect gear mesh pattern between ring and pinion gear.	Remove pinion gear housing and inspect ring and pinion gear.
	Failed differential pinion gears and/or cross shafts.	Remove differential housing drain plug and inspect for metal particles. Disassemble and inspect.
	Failed axle bearing.	Do axle bearing adjustment check.
	Mechanical failure in axle planetary.	Remove differential. Inspect, repair.
Oil seeping from outer axle seal	Excessive end play in axle.	Do axle bearing adjustment check.
	Worn outer bearing and/or cup.	Disassemble and inspect outer axle bearing, cup, spacer, and seal. Replace, if necessary.
	Overfilled differential.	Check differential oil return system for excessive internal restriction.
Axle overheats	Low differential oil.	Add oil.
	Overfilled differential.	See differential overfills with oil in this group.
	Brake drag.	See brakes drag in this group.

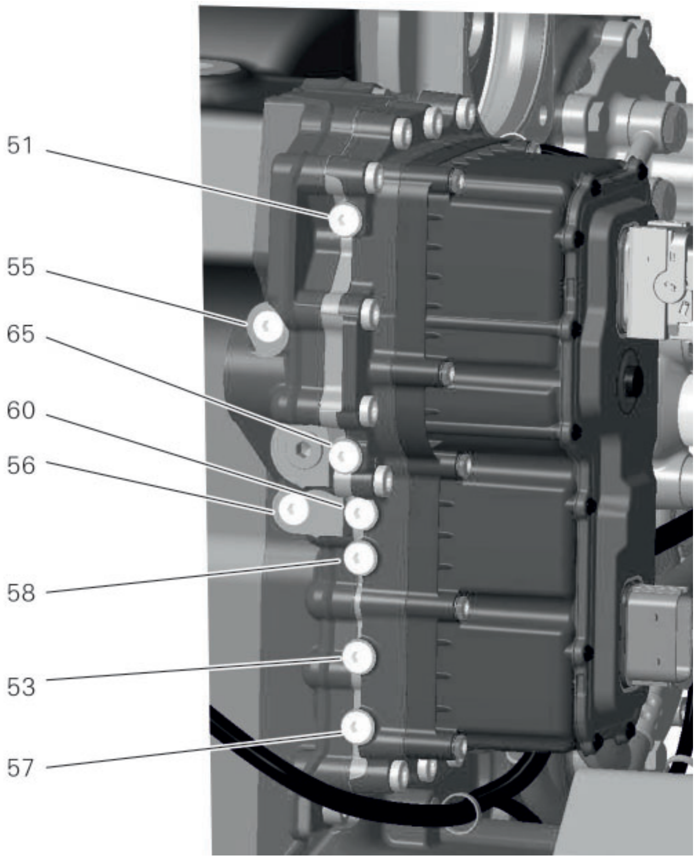
3) DRIVE LINE

Problem	Cause	Remedy
Excessive drive line vibration or noise	Yokes not in line on drive shafts.	Inspect. Align drive shaft yokes.
	Worn front drive line support bearing.	Inspect, repair.
	Bent drive shaft.	Inspect all drive shafts. Replace.
	Loose yoke retaining nuts (drive shafts wobble at high speed).	Inspect. Replace.
	Rear axle oscillating support.	Inspect, repair.
	Lack of lubrication.	Lubricate with proper grade of grease.

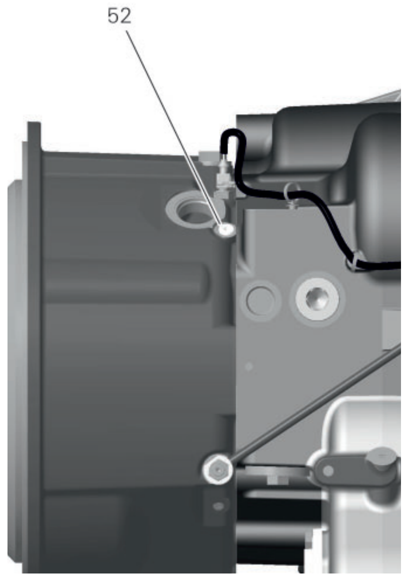
GROUP 3 TESTS AND ADJUSTMENTS

1. TRANSMISSION MEASURING POINTS AND CONNECTIONS

The measurements have to be carried out at hot transmission (about 80~95˚C).



975T33PT14



975T33PT15

Port	Description	Size
51	Pressure before converter (maximum 9+2 bar)	M12×1.5
52	Pressure after converter (5 bar)	M12×1.5
53	Shift pressure clutch K4 (16+2 bar)	M12×1.5
55	Shift pressure clutch K1 (16+2 bar)	M12×1.5
56	Shift pressure clutch K2 (16+2 bar)	M12×1.5
57	Shift pressure clutch KR (16+2 bar)	M12×1.5
58	Shift pressure clutch K3 (16+2 bar)	M12×1.5
60	Shift pressure clutch KV (16+2 bar)	M12×1.5
65	System pressure (16+2.5 bar)	M12×1.5

1.TRANSMISSION

Preparatory Activities

Mounting transmission on assembly truck

Special tools:
- 5870.350.071 Clamping bracket
- 5870.350.000 Assembly truck

1. **WARNING**

Risk of injury due to uncontrolled motion of the load.
Death or serious injury possible.
- ⇨ Only use the suspension points intended for transportation purposes.
- ⇨ Only use secure, permitted, and tested means of transport, chain hoist, and lifting equipment with sufficient load capacity and suitable lifting technology.
- ⇨ Ensure that lifting equipment such as ropes and belts are not in contact with sharp edges and are not knotted or twisted.
- ⇨ Properly attach lifting appliances to load.
- ⇨ Observe the load's center of gravity! The crane hook must be located above the load's center of gravity.
- ⇨ Lift load slowly and observe whether the load tilts or swivels out laterally. If required, immediately put down load and modify attachment.
- ⇨ Keep distance.
- ⇨ Do not walk under suspended loads.
- ⇨ Only ever move load under supervision.

Fix the transmission with 5870.350.071 [Clamping bracket] to 5870.350.000 [Assembly truck].

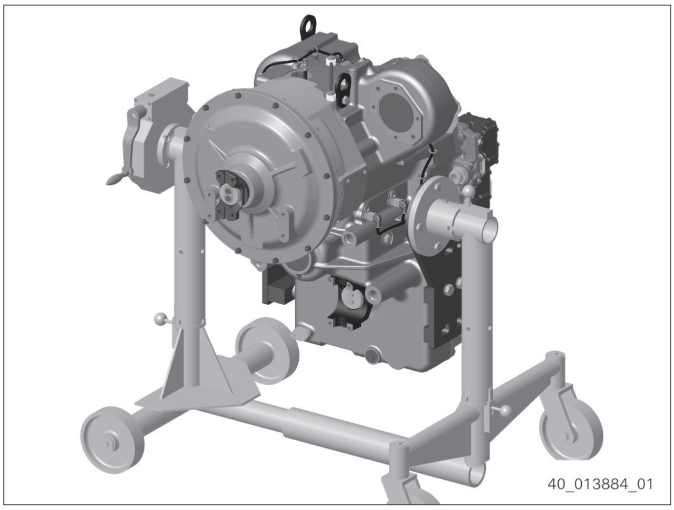


Fig. 21

Draining oil

Observe the environmental regulations *(refer to Section General safety instructions, page 8).*

1. Loosen screw plug (1).

2. Loosen the screw plug (2) and drain oil.

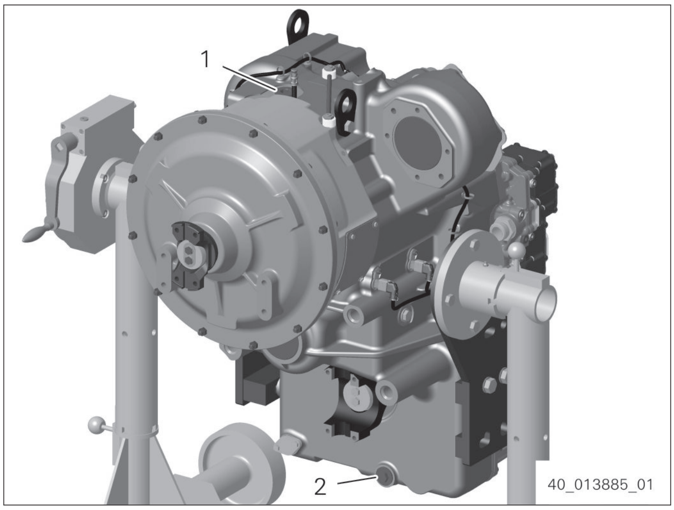


Fig. 22

Dismantling

Removing the pressure filters

1. Loosen the pressure filters (1)from the filter head.

2. Loosen the plunger switch (2).
   ※ The filter head is located near the transmission.

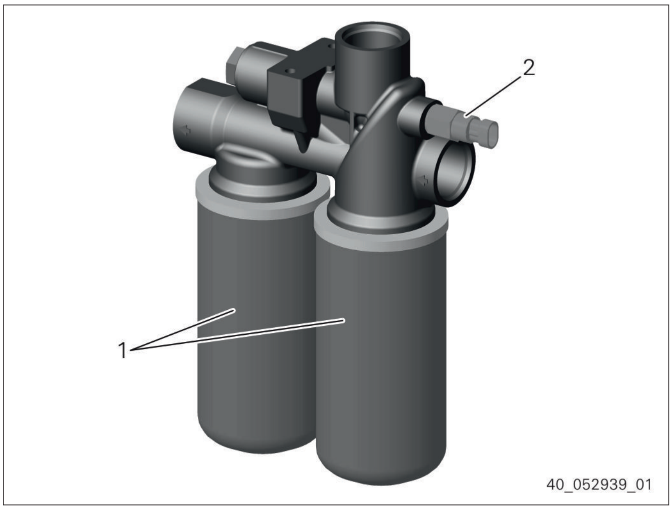


Fig. 23

Removing cover sheets (filler neck)

1. Loosen hexagon screws and remove cover sheet with seal (1).

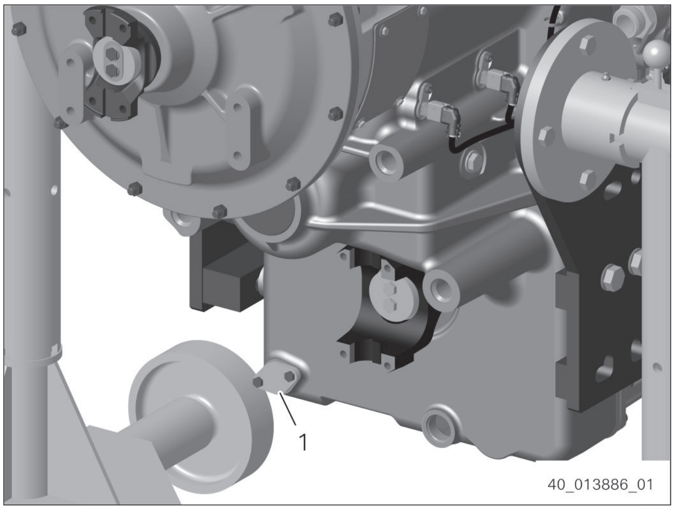


Fig. 24

2. Loosen hexagon screws and remove cover sheet with seal (1).

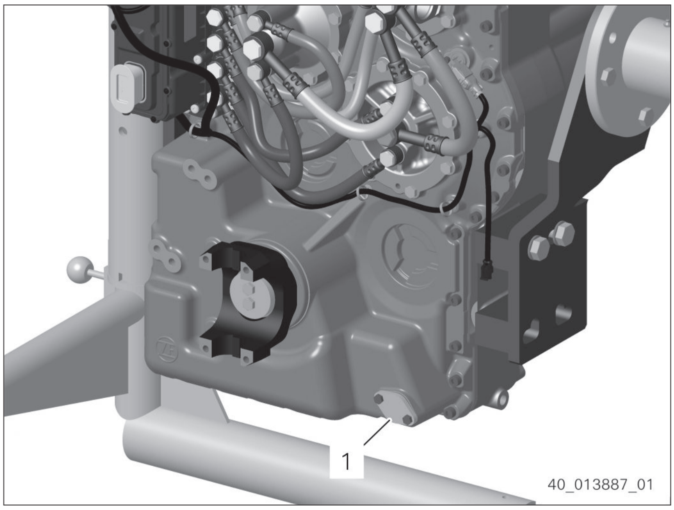


Fig. 25

Removing tube

1. Loosen hollow screws (1) and remove tube (2).

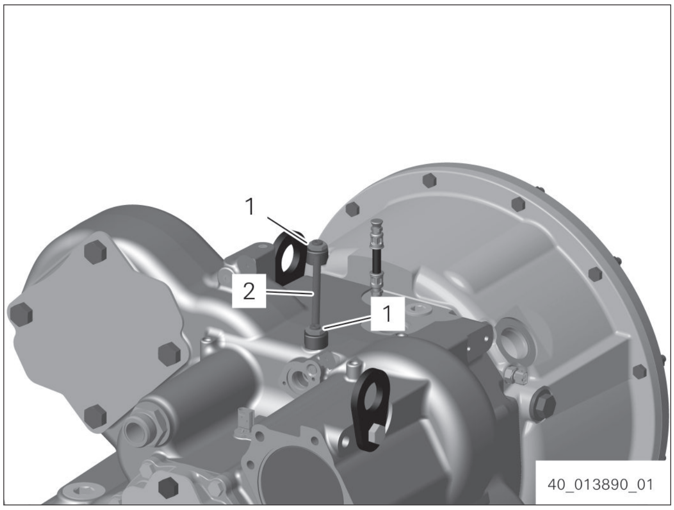


Fig. 28

Removing the hose assemblies

1. Loosen hollow screws and hose assemblies.

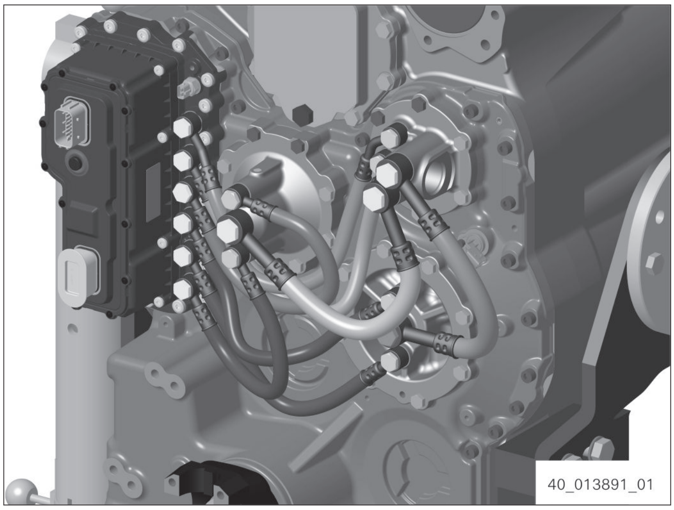


Fig. 29

Removing the speed sensors

1. Loosen the cap screw.

2. Pull the speed sensor (1) out of the cover.

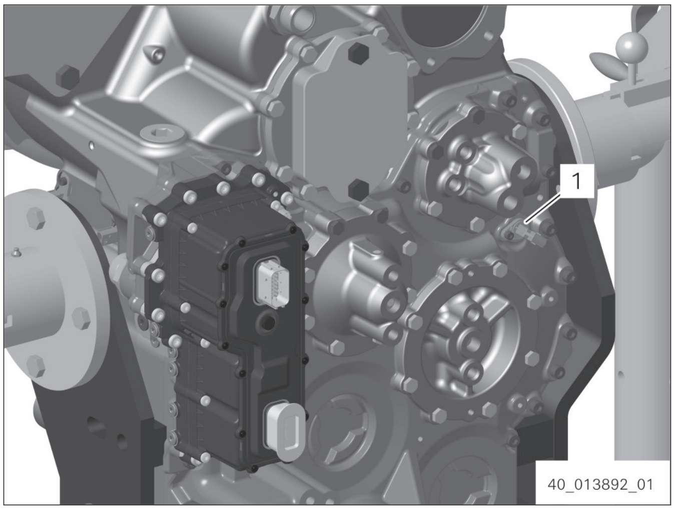


Fig. 30

3. Loosen cap screws.

4. Pull speed sensors (1) out of the housing.

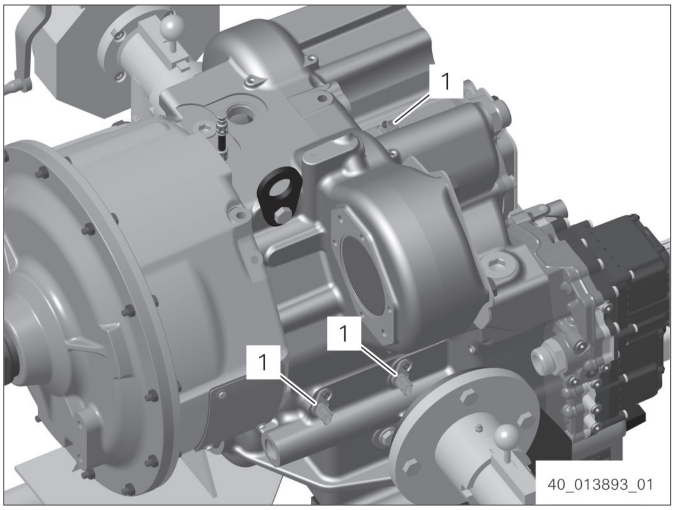


Fig. 31

Removing the temperature sensors and the breather

1. Loosen breather (1).
2. Loosen the temperature sensors (2).

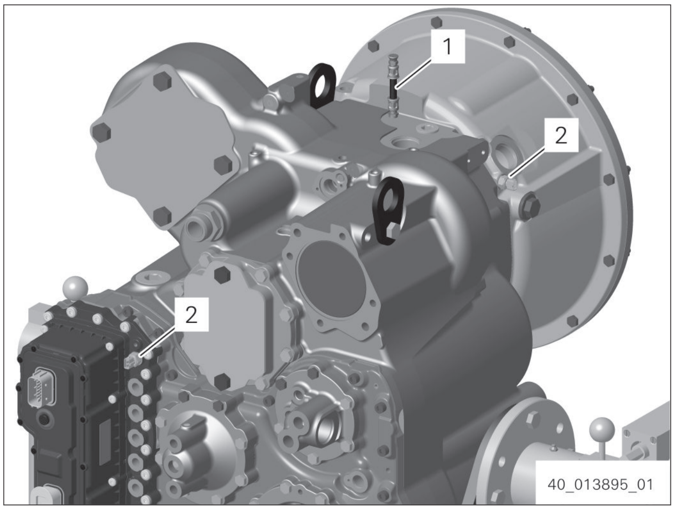


Fig. 32

Removing the converter pressure back-up valve

1. Loosen screw plug (1).

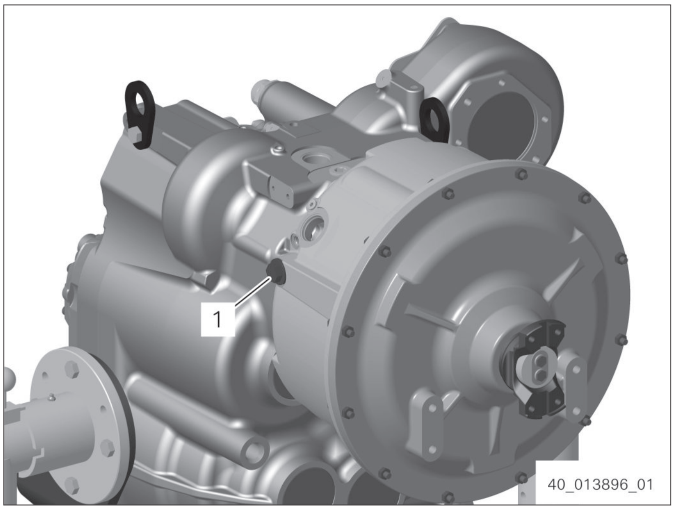


Fig. 33

2. Remove compression spring (1).

3. Pull the piston (2) from the torque converter bell housing.

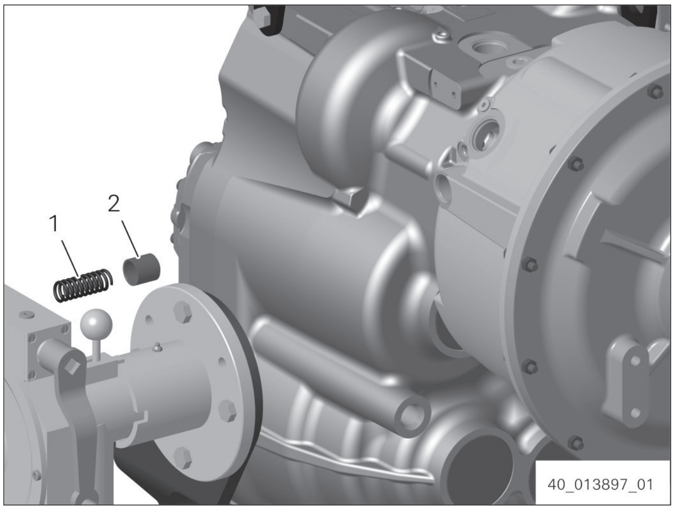


Fig. 34

Removing and dismantling shift system

Removing control unit (ECA4)

1. Loosen internal hexalobular bolts.

2. Remove control unit (1).

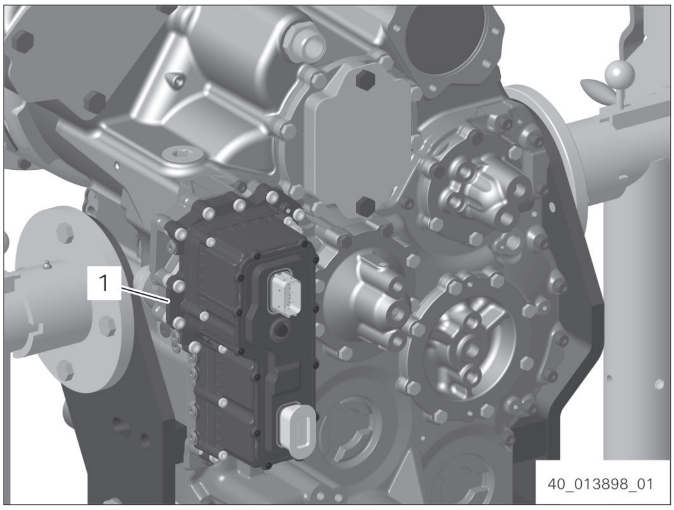


Fig. 35

Removing the pressure controllers

1. Separate plug connections (1) on the pressure controllers.

2. Loosen internal hexalobular bolts and remove fixing plate (3).

3. Remove cable (2).

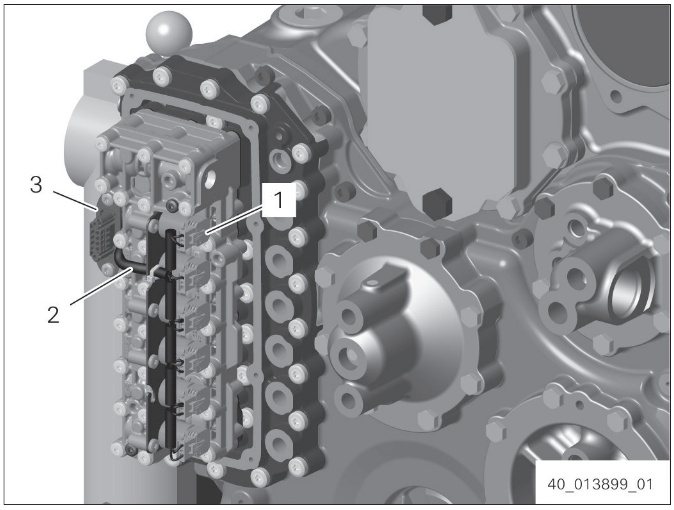


Fig. 36

4. Loosen internal hexalobular bolts and remove clamping plate (2).

5. Pull out the pressure controllers (1).

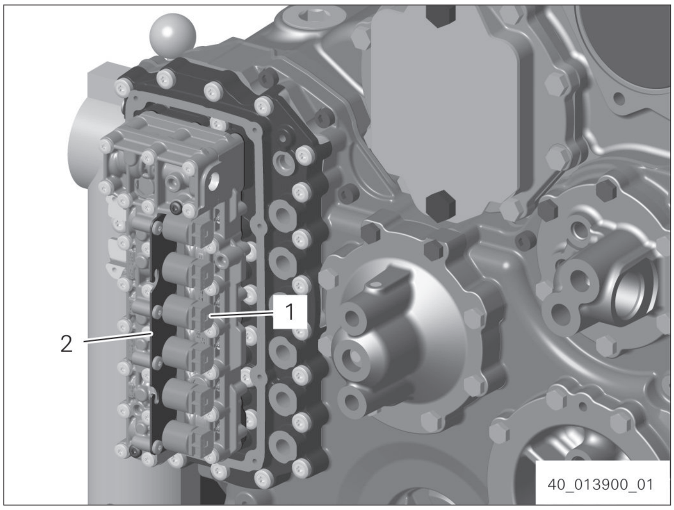


Fig. 37

Removing and dismantling valve blocks

Special tools:

- AA02.414.200 Driver tool
- AA02.416.754 Driver tool
- AA02.416.230 Driver tool

1. Loosen internal hexalobular bolts.
   Remove valve block (1) and intermediate plate.

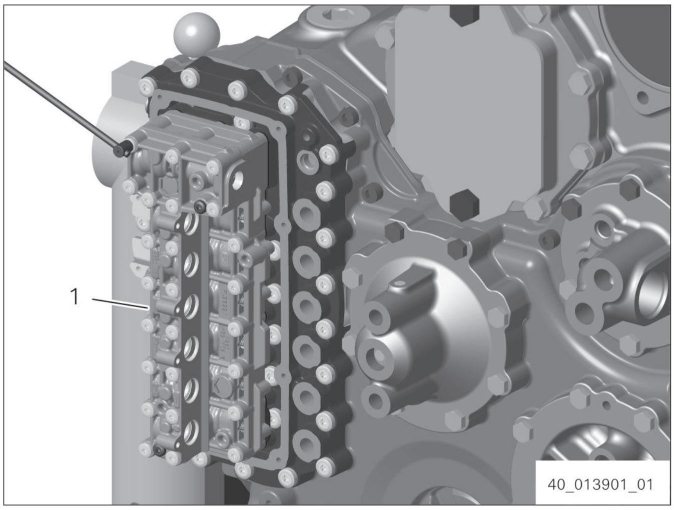


Fig. 38

2. Press the piston inwards with AA02.414.200 [Driver tool] and remove the fixing plate (1).

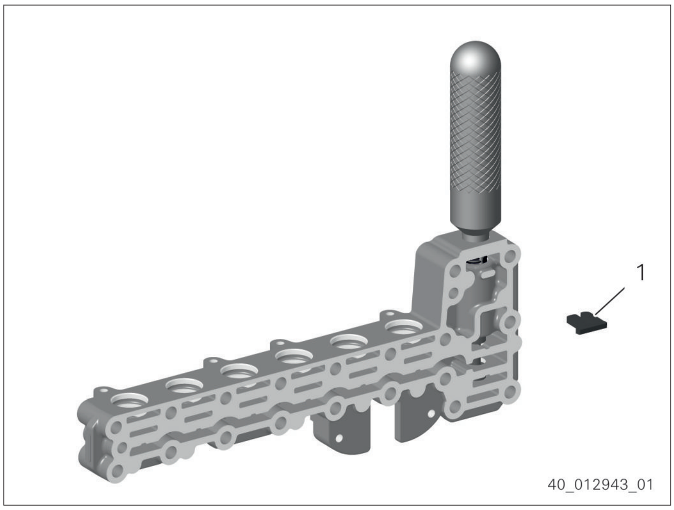


Fig. 39

3. Remove compression spring (2) and piston (1) from the hole.

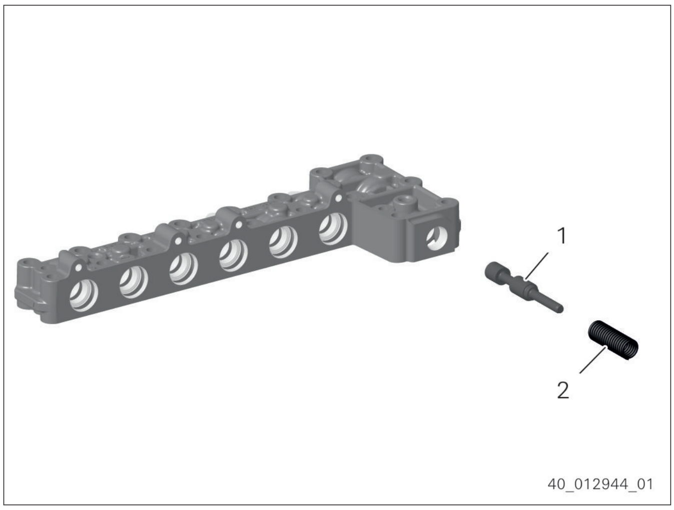


Fig. 40

4. Loosen internal hexalobular bolts. Remove valve block (1) and intermediate plate.

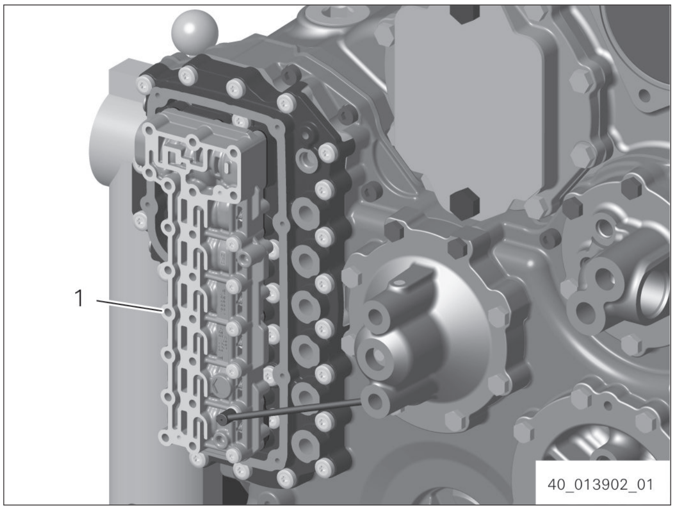


Fig. 41

5. Press the plug inwards with AA02.416.754 [Driver tool] and remove the spring clip (1).

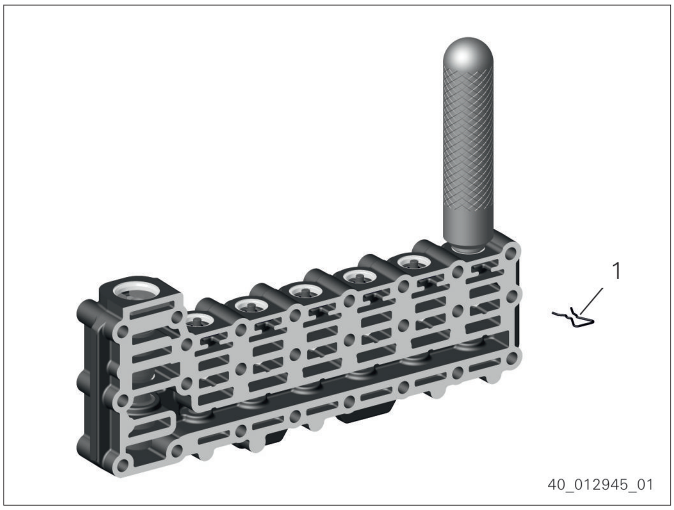


Fig. 42

6. Pull the plug (3) out of the hole.

7. Remove control piston (2) and compression spring (1) from the hole.

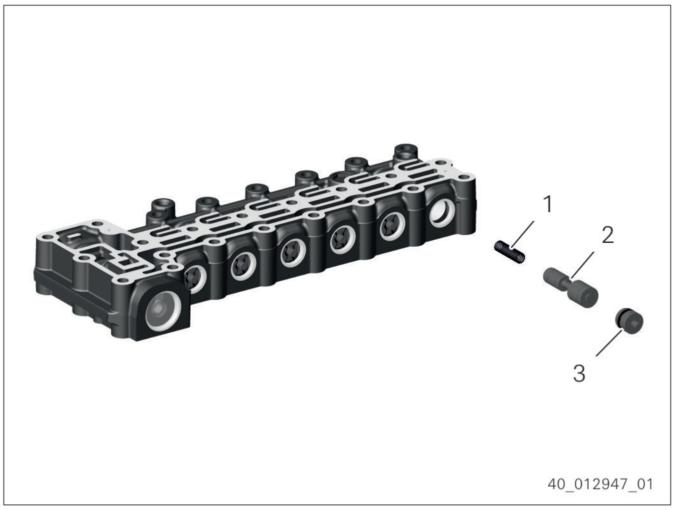


Fig. 43

8. Press the plug inwards using AA02.416.230 [Driver tool] and remove fixing plate (1).

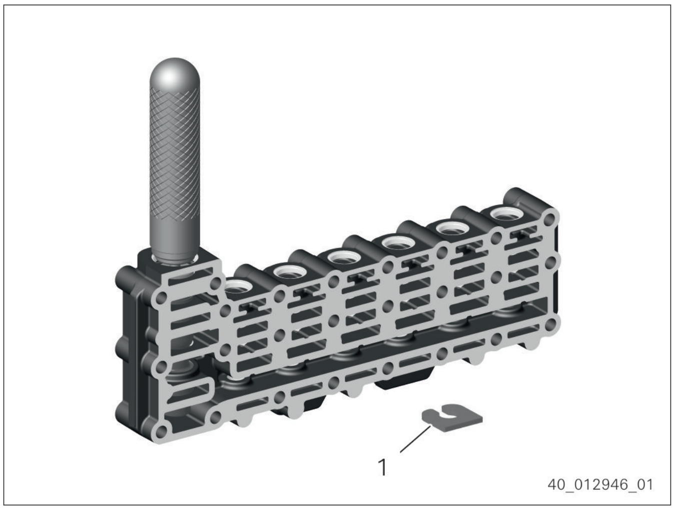


Fig. 44

9. Pull the plug (3) out of the hole.

10. Remove compression spring (2) and control piston (1) from the hole.

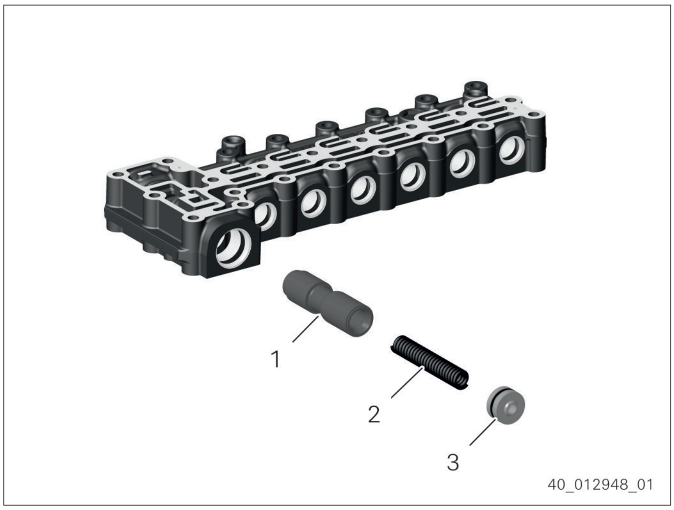


Fig. 45

Removing duct plate

1. Remove valves (1) from duct plate.

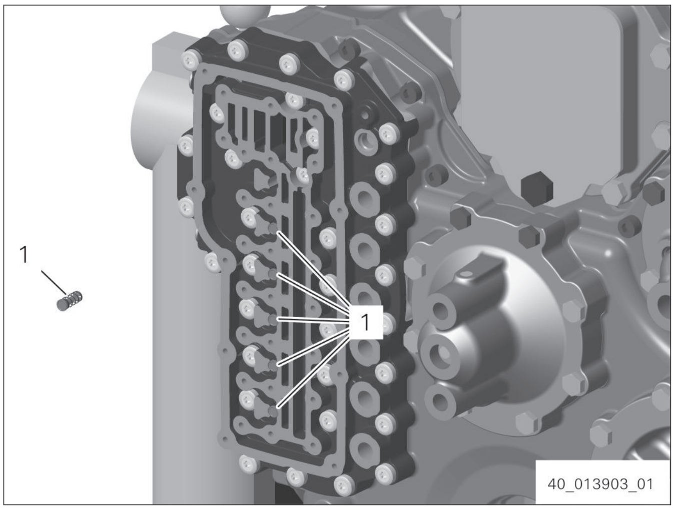


Fig. 46

2. Loosen internal hexalobular bolts.
   Remove duct plate (1) and seal.

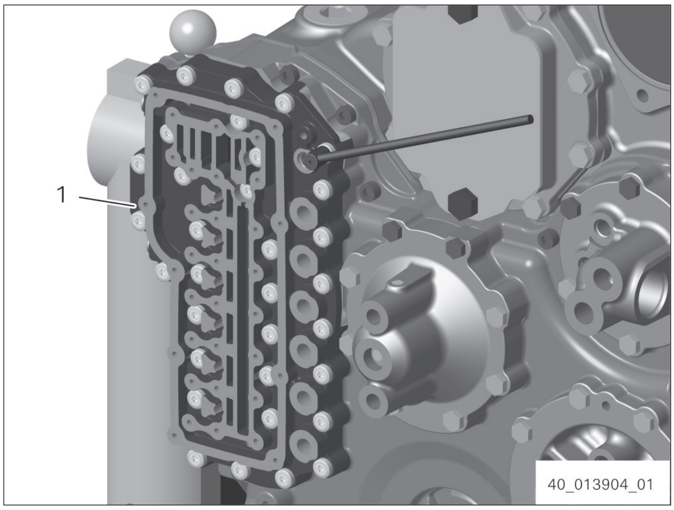


Fig. 47

3. Remove screw plugs (1) from duct plate.

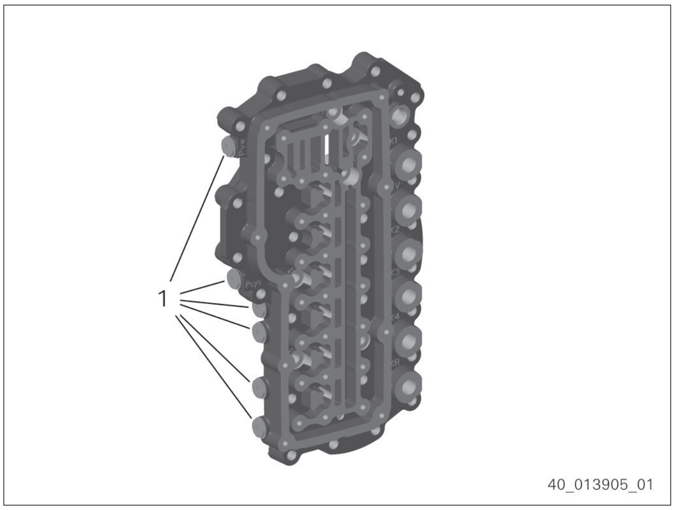


Fig. 48

Removing fixing plates

1. Loosen hexagon screws and remove fixing plates (1).

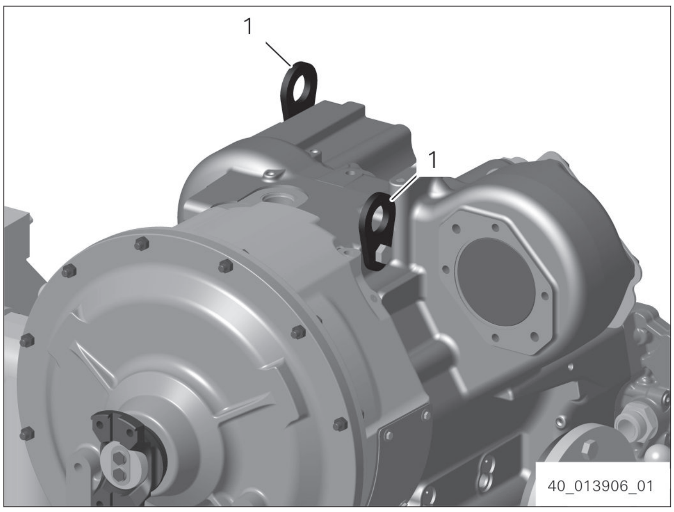


Fig. 49

Removing engine connection and converter

Special tools:

- AA02.676.915 Load ring

1. Mark installation position of the cover towards the torque converter bell housing.

2. Loosen hexagon nuts (1) and remove hexagon screws (2).

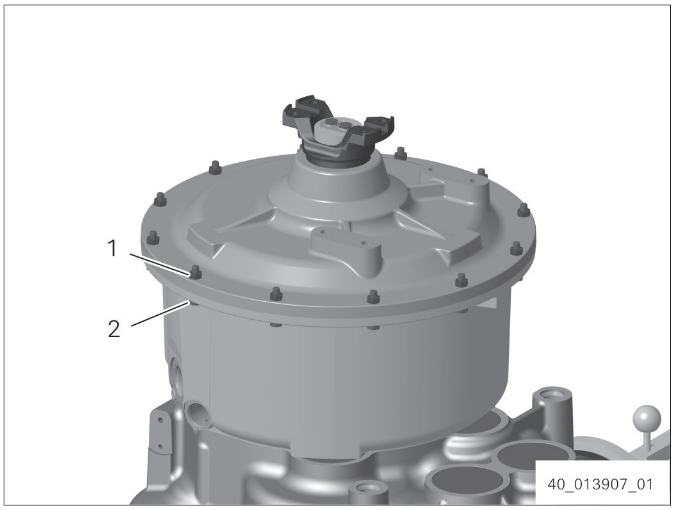


Fig. 50

3. **⚠ CAUTION**

   Risk of crushing due to moving parts.
   Slight or moderate injury possible.
   ⇨ Do not reach into danger area!

   Lift off the cover and the converter using two AA02.676.915 [Load ring] and the crane.

Fig. 51

4. Remove locking plate (1).

5. Loosen hexagon screws (2).

6. Remove washer (3).

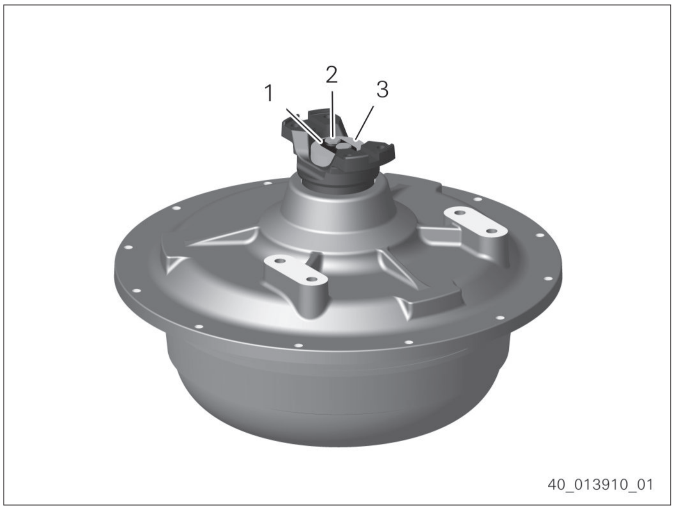


Fig. 52

7. Use two-armed extractor to pull output flange from flange shaft.

Fig. 53

8. ⚠ **CAUTION**

Risk of crushing due to hydraulic tool.
Slight to moderate injury possible.
⇨ Do not reach into danger area.

Force flange shaft and converter out of the cover.

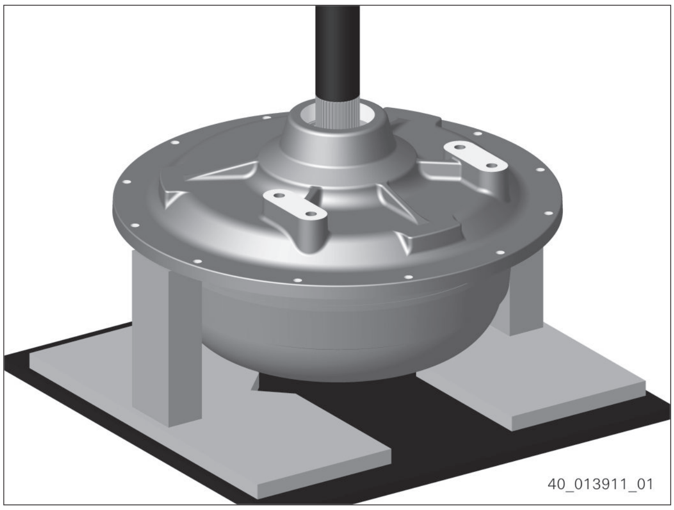


Fig. 54

9. Remove V-ring (1).

10. Pull the ball bearing (2) out of the cover.

Fig. 55

11. Remove R-ring (1).

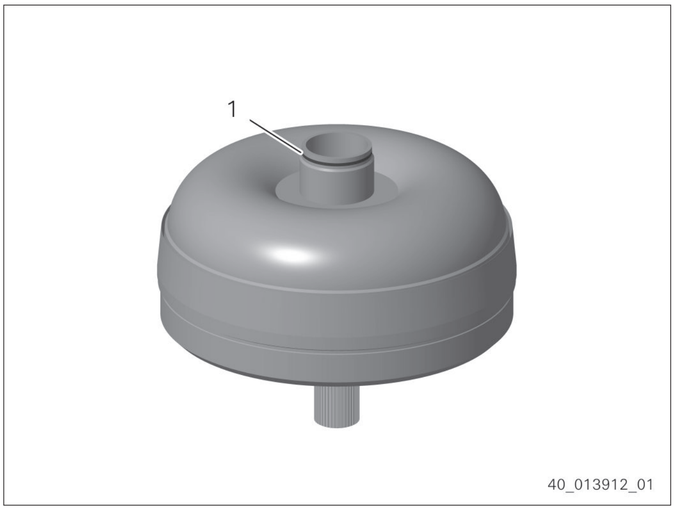


Fig. 56

12. Loosen hexagon screws (1).

13. Remove flange shaft (2).

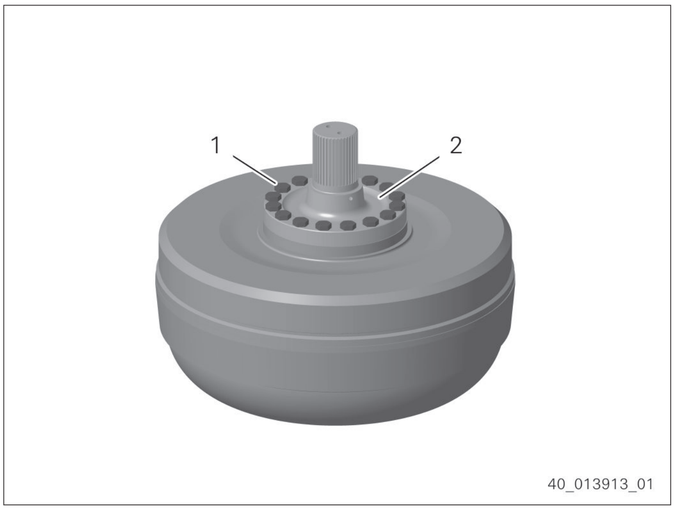


Fig. 57

Dismantling drive

Special tools:

- 5870.204.005 Hexagon screw
- 5870.000.089 Press-out device
- 5870.345.036 Pry bar
- AA02.247.426 Eyebolt

1. Loosen hollow screws (2).

2. Remove oil tube (1).

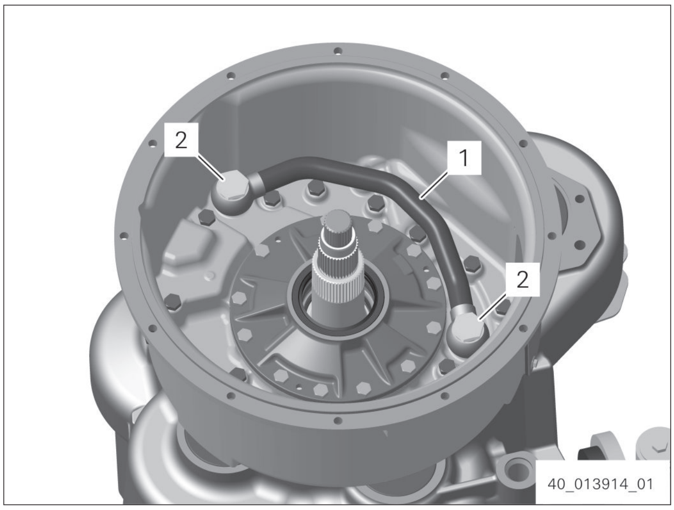


Fig. 58

3. Loosen hexagon screws.

4. Evenly pull off bearing cover with three 5870.204.005 [Hexagon screw].

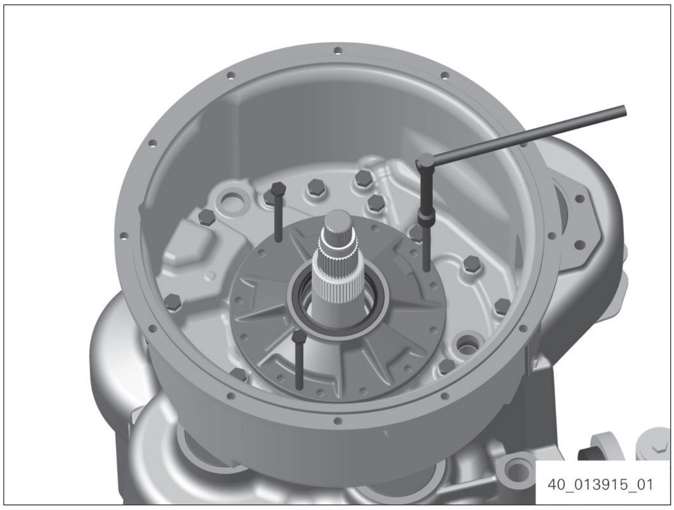


Fig. 59

5. Remove shaft sealing ring (1) from bearing cover.

6. Remove needle sleeve (2).

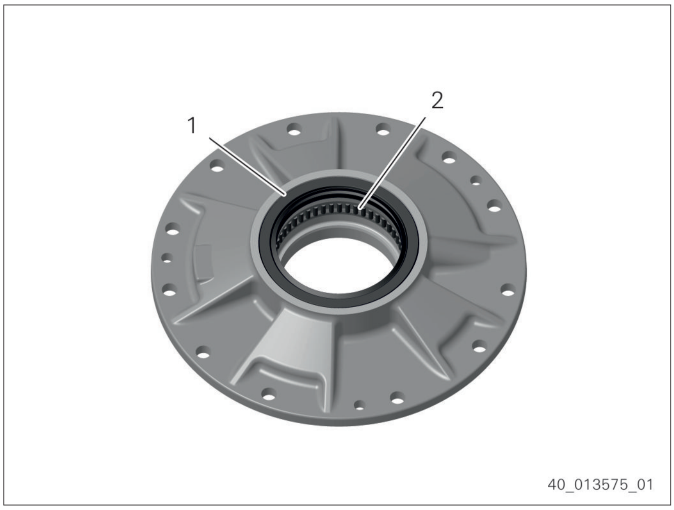


Fig. 60

7. Fasten 5870.000.089 [Press-out device] to the oil feed flange with two cap screws M12 x 50.

8. Pull oil feed flange evenly out of torque converter bell housing by means of 5870.000.089 [Press-out device].

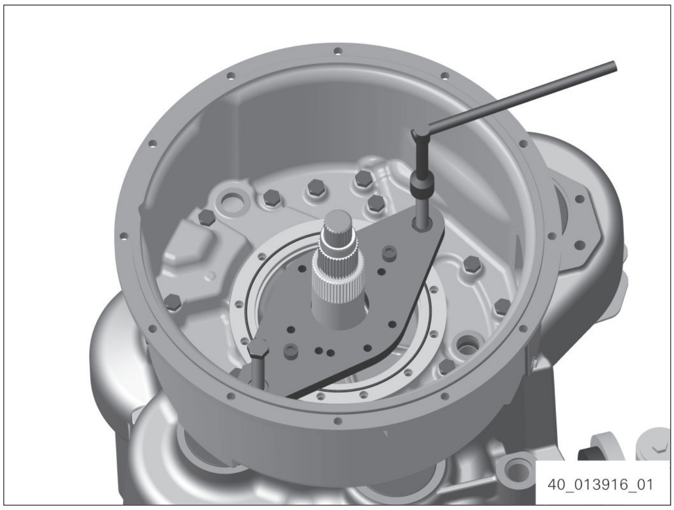


Fig. 61

9. Remove slotted pin (1).

10. Remove converter safety valve (2).

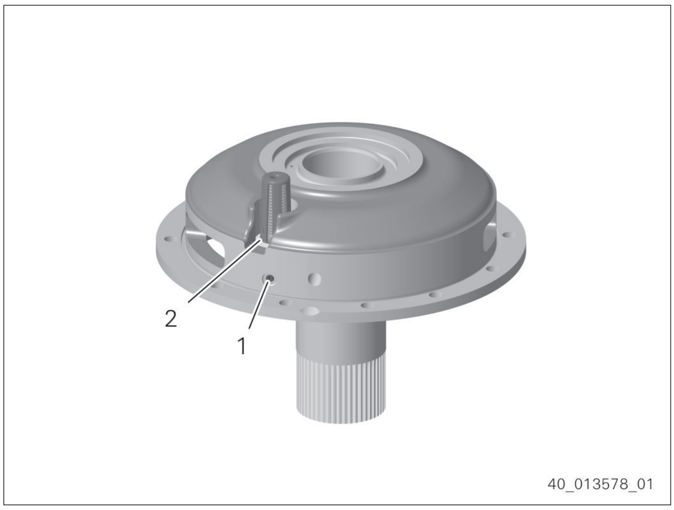


Fig. 62

11. Loosen hexagon screws.

12. Remove torque converter bell housing using 5870.345.036 [Pry bar], two AA02.247.426 [Eyebolt] and a crane.

13. Remove seal.

Fig. 63

14. Remove R-rings (1) from input shaft.

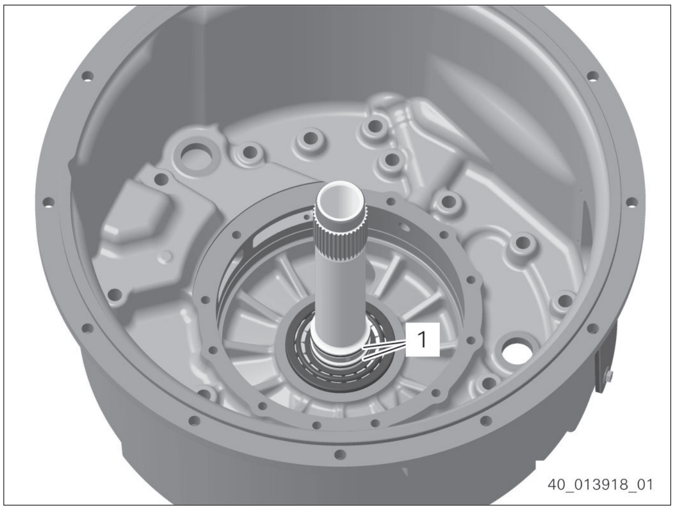


Fig. 64

15. **CAUTION**

Risk of crushing due to hydraulic tool.
Slight to moderate injury possible.
⇨ Do not reach into danger area.

Press out the input shaft.

16. Remove bearing inner ring (1).

17. Remove helical gear (2).

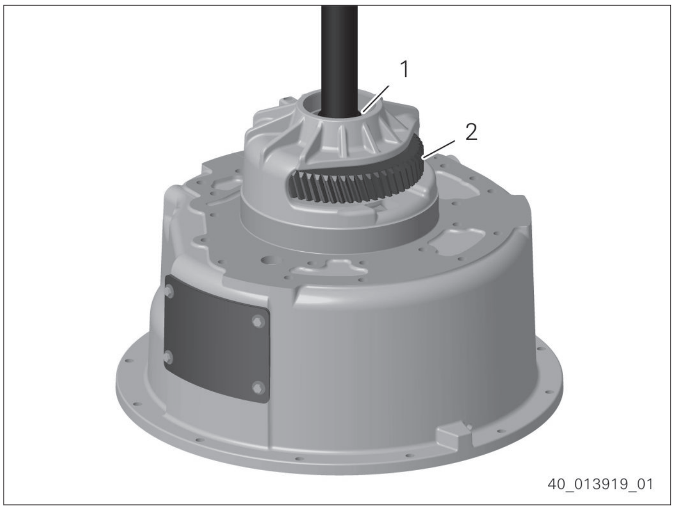


Fig. 65

18. Force bearing inner ring from input shaft.

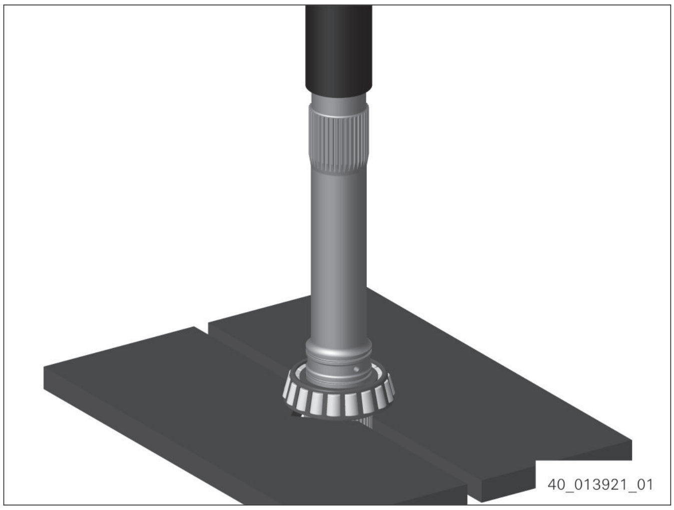


Fig. 66

19. Remove bearing outer rings (1).

20. Loosen the hexagon screws and remove the cover sheet (2) and the cover plate (3).

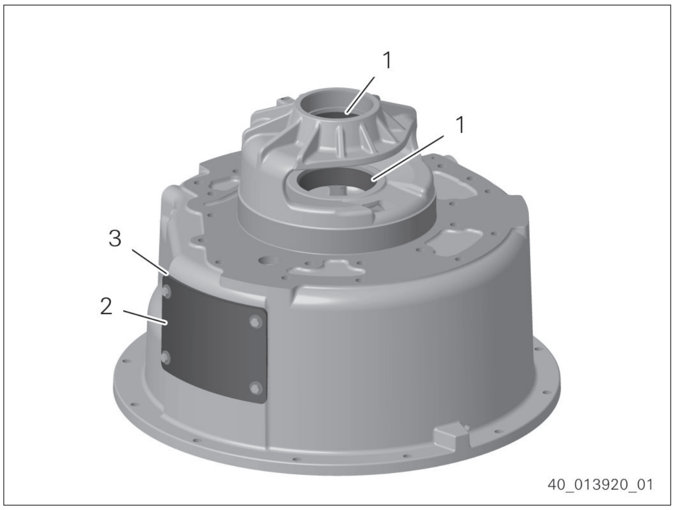


Fig. 67

21. Remove protection caps (1).

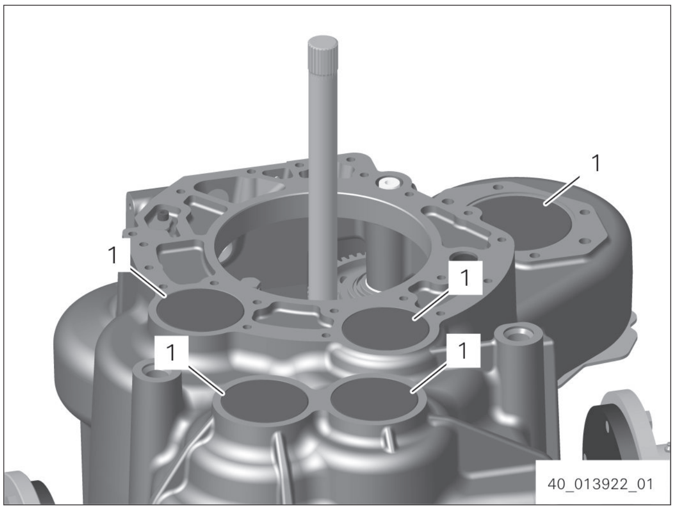


Fig. 68

Removing and dismantling the power take-offs (variant with PTO) 1, 3 and 4)

Removing shaft

Special tools:

- 5873.001.020 Gripping device
- 5873.001.000 Basic tool

1. Loosen hexagon screws and remove the cover (1).

2. Remove O-ring.

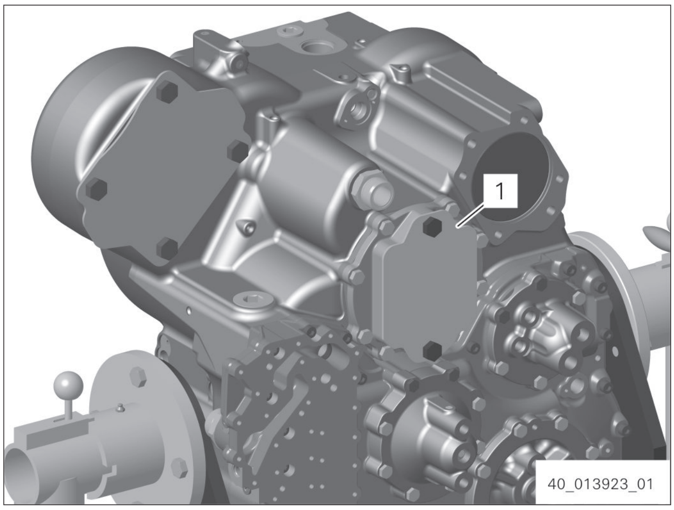


Fig. 69

3. Remove shaft with gear (1) from the transmission.

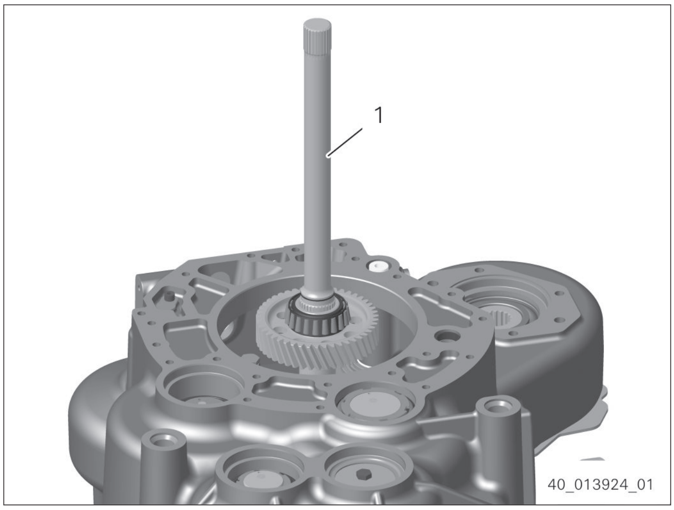


Fig. 70

4. Remove R-ring (1) from annular groove of the shaft.

5. Remove parallel key (2).

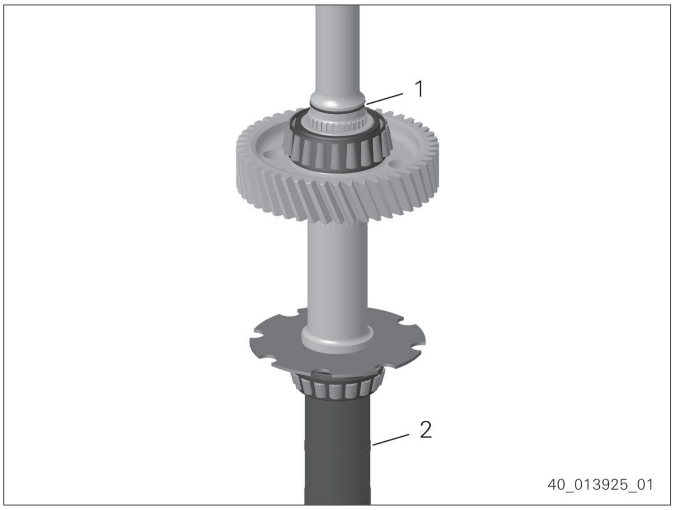


Fig. 71

6. Pull off gear (1).

7. Remove retaining ring (2).

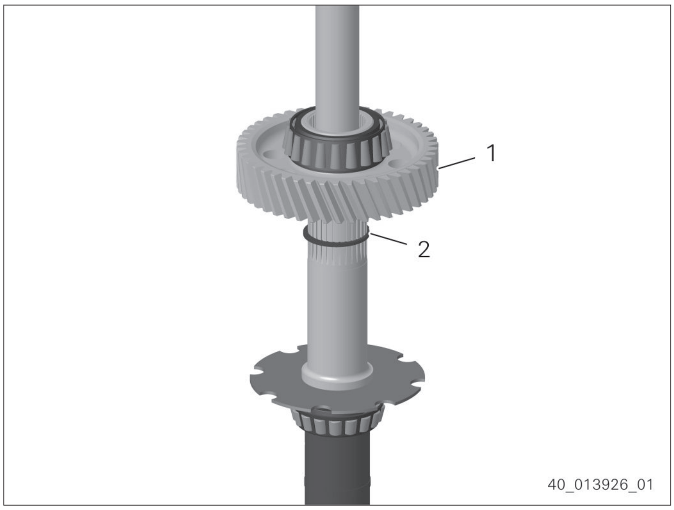


Fig. 72

8. Pull off bearing inner ring with 5873.001.020 [Gripping device] and 5873.001.000 [Basic tool] from gear.

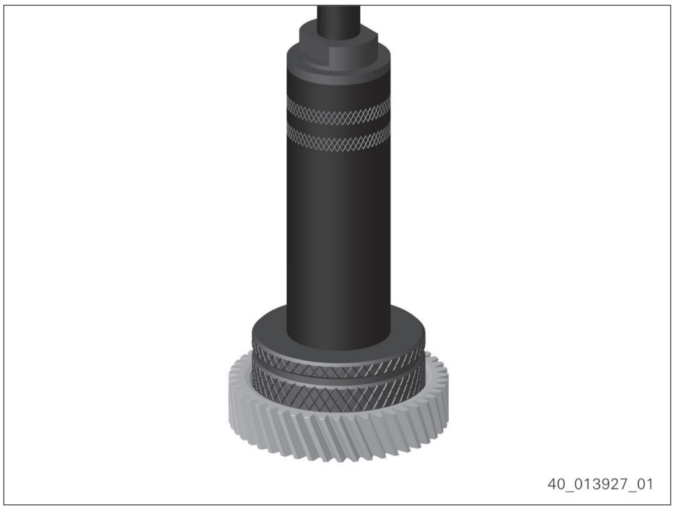


Fig. 73

9. Use protective chucks made from aluminum.

   Fix shaft in the vise.

10. Loosen the cap screw.

11. Remove spring washer.

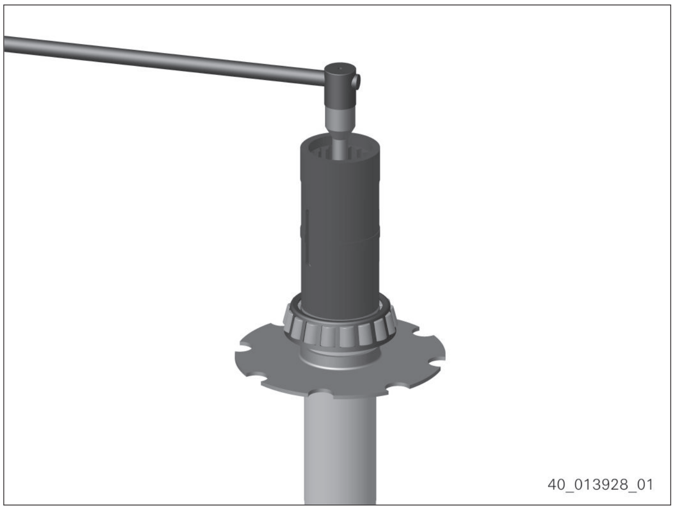


Fig. 74

12. Pull off bearing inner ring and driver with three-armed extractor from the shaft.

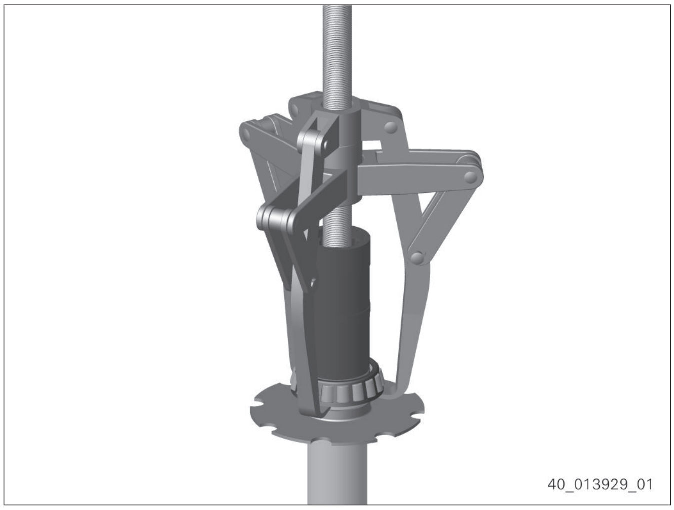


Fig. 75

13. Pull off the bearing inner ring and discs from the driver.

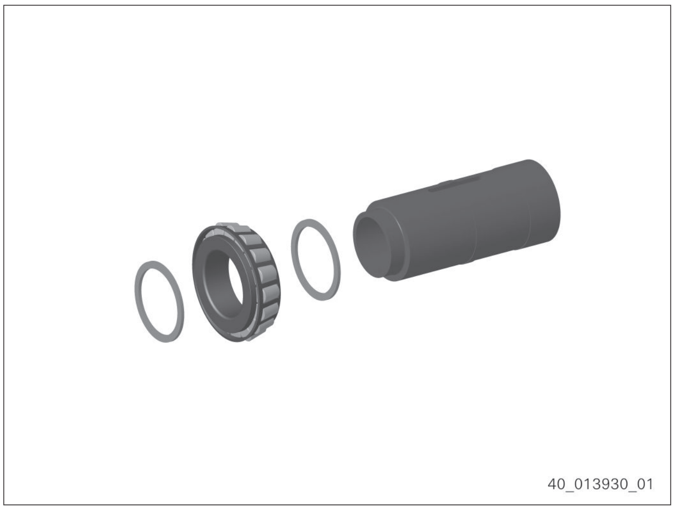


Fig. 76

Removing pressure oil pump

Special tools:

- AA02.813.910 Puller

1. Loosen hexagon screws.
2. Remove pump flange (1).
3. Remove O-ring.

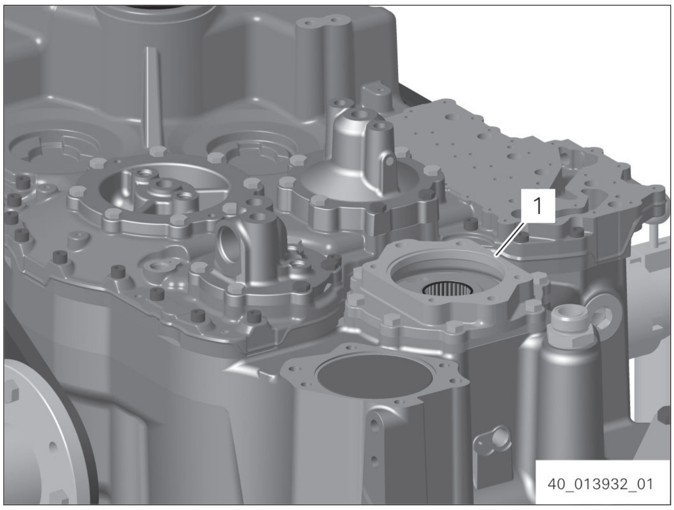


Fig. 77

4. Loosen cap screws (1).

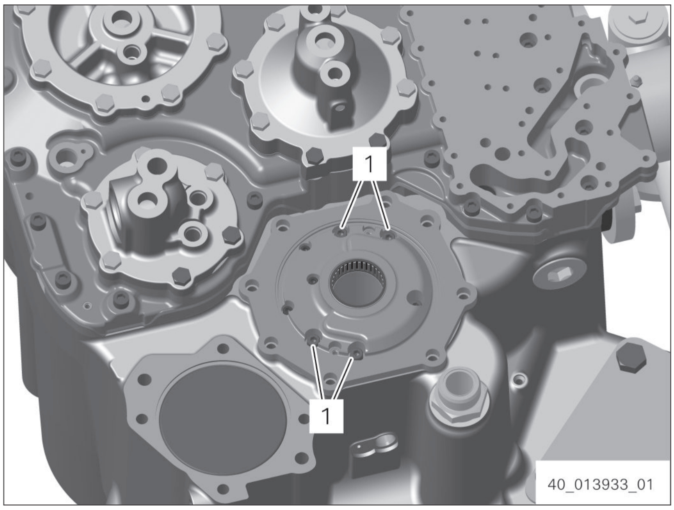


Fig. 78

5. Fasten AA02.813.910 [Puller] to gear pump with four cap screws M8 x 65.

6. Pull gear pump evenly out of housing hole by means of AA02.813.910 [Puller].

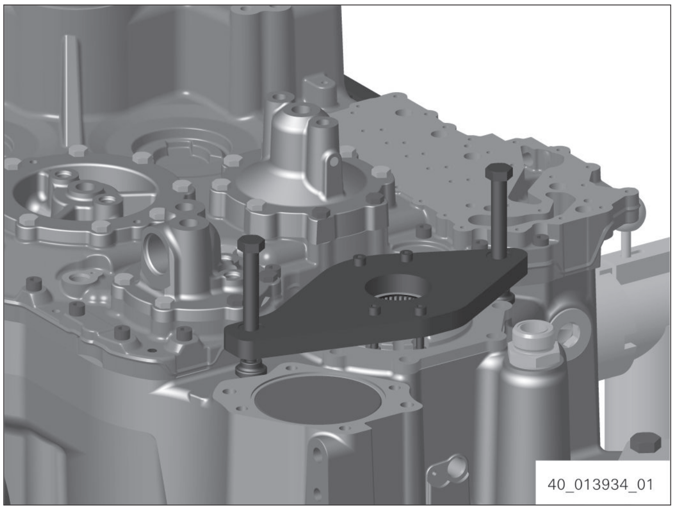


Fig. 79

7. Pull bearing outer ring (1) out of the gear pump.

8. Remove O-ring (2).

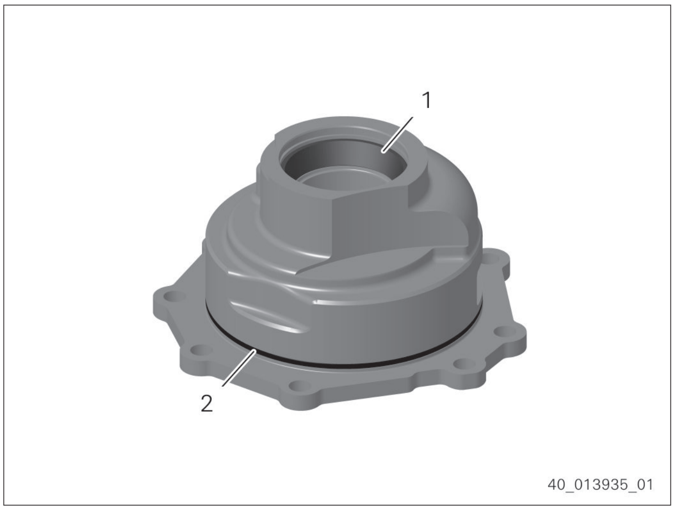


Fig. 80

Checking gear pump

9. Check individual parts of the gear pump for wear marks before assembling the transmission.

   The gear pump is only available as a complete unit.

   Loosen cap screws.

10. Remove cover (1).

11. Check the cover, outer rotor, inner rotor and the pump housing for wear marks.
    In case of any damage, install new gear pump.

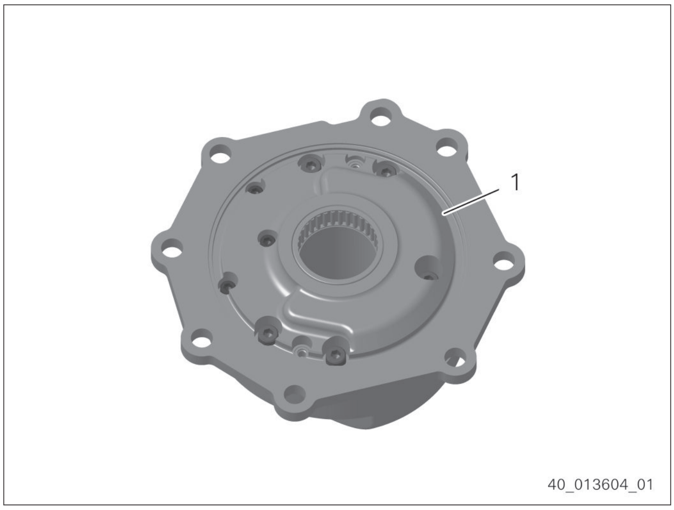


Fig. 81

12. Insert outer rotor and inner rotor, with the chamfered tooth side facing the pump housing.

13. Insert cylindrical pins until contact is obtained.

14. Place the cover.

15. Bolt in and tighten cap screws.
    Tightening torque: 23 Nm
    Tightening torque: 9.5 Nm

Removing PTOs 3 and 4

Special tools:

- AA02.242.247 Extracting device
- AA02.571.771 Adapter

1. Loosen hexagon screws and remove cover (1).

2. Remove O-ring.

3. Remove sealing cap (2) from the housing hole.

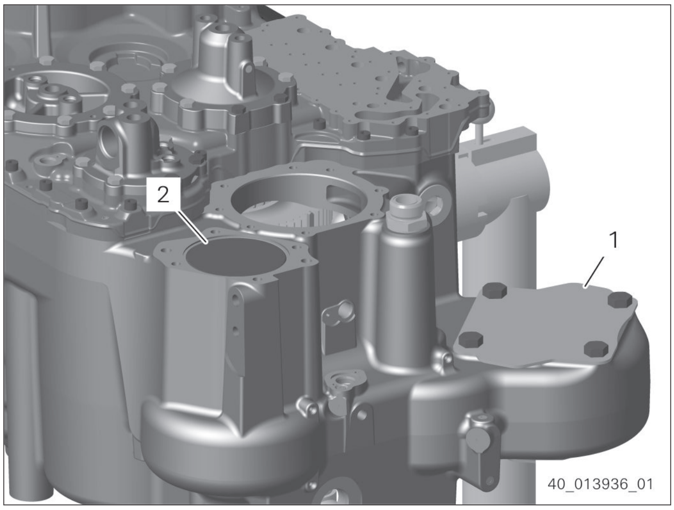


Fig. 82

4. Pull pin (1) with AA02.242.247 [Extracting device] and AA02.571.771 [Adapter] out of the housing hole.
   Remove gear (2), bearing inner rings and shim.

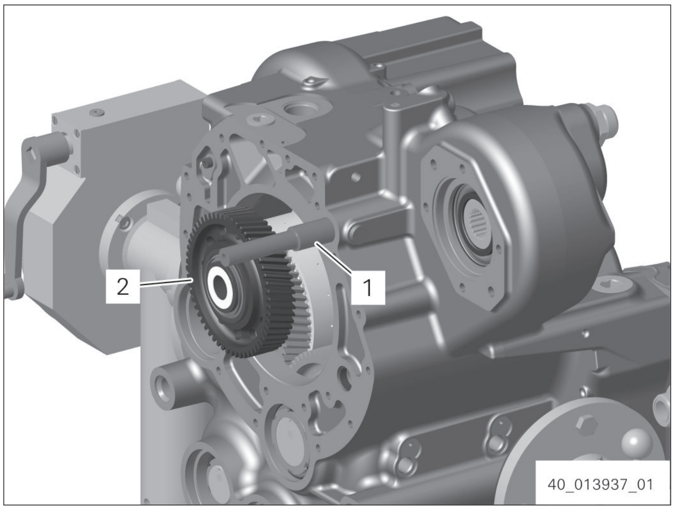


Fig. 83

5. Remove retaining ring (1).

6. Remove shim.

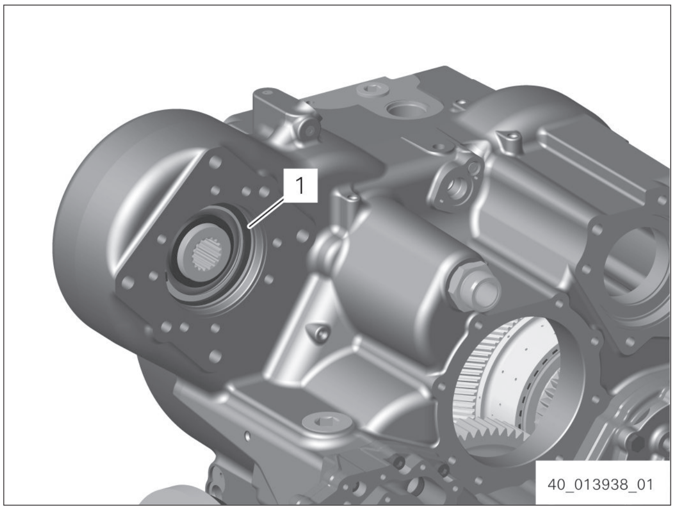


Fig. 84

7. Force out driver (1) and remove gear.

8. Remove both ball bearings.

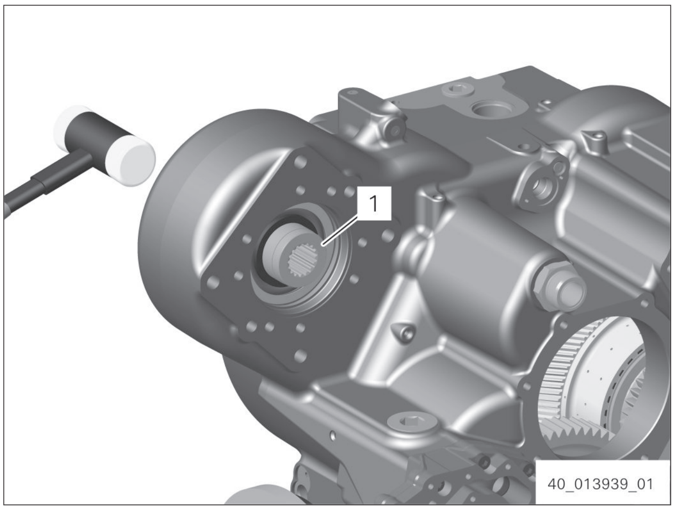


Fig. 85

Removing countershaft

Special tools:
- AA02.242.247 Extracting device
- AA02.242.584 Adapter

1. Remove cover.

2. Loosen hexagon screw (1).

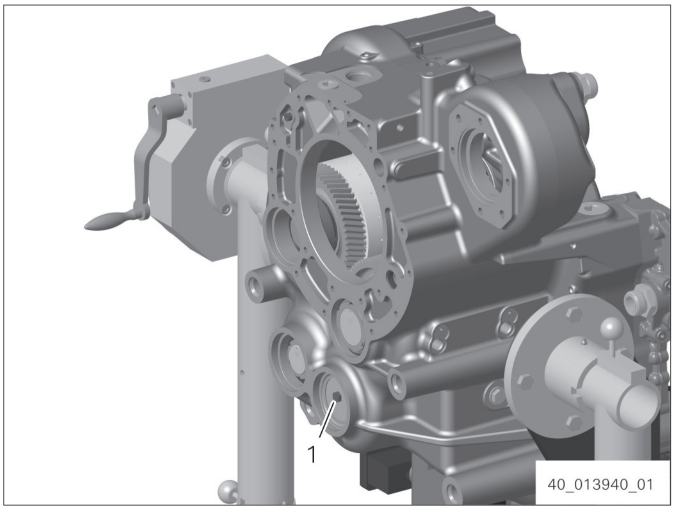


Fig. 86

3. Use AA02.242.247 [Extracting device] and AA02.242.584 [Adapter] to pull axle out of housing.

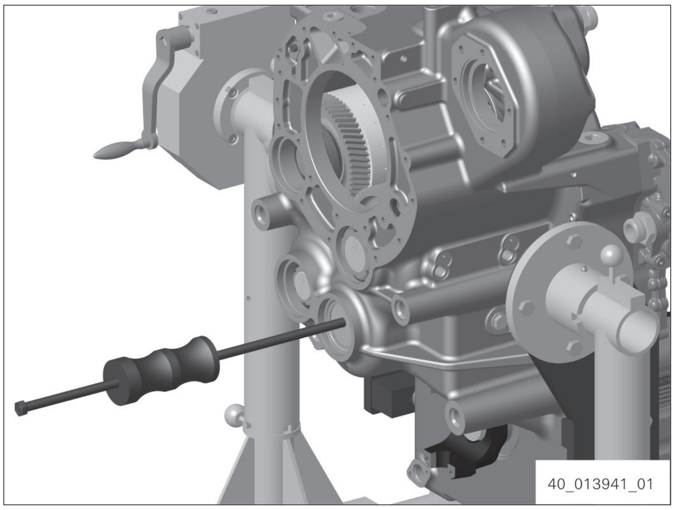


Fig. 87

Removing yokes

Removing yoke on converter side

1. Remove locking plate (1).
2. Loosen hexagon screws (2).
3. Remove washer (3).

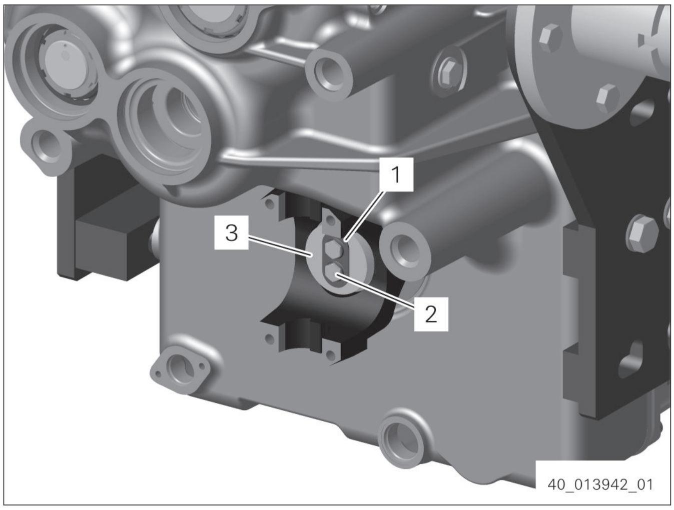


Fig. 88

4. Remove washer (1).
5. Remove O-ring (2).

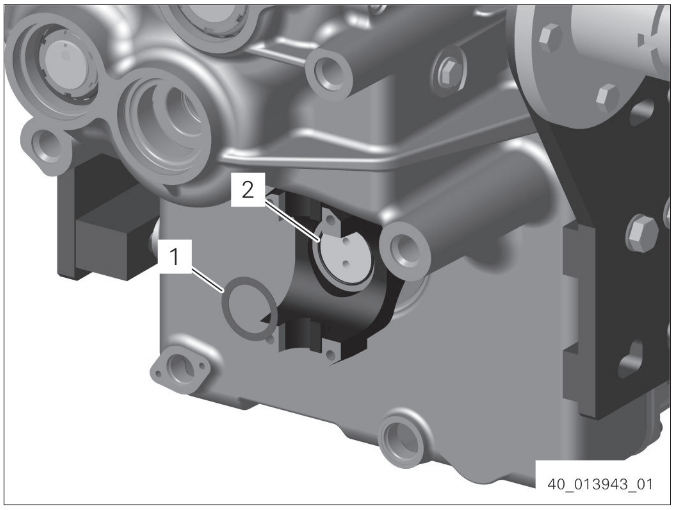


Fig. 89

6. Pull off yoke (1).

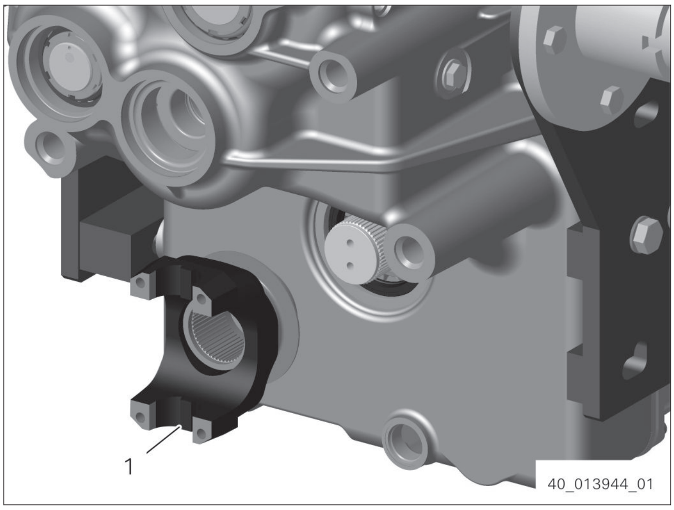


Fig. 90

7. Remove shaft sealing ring (1) from housing hole.

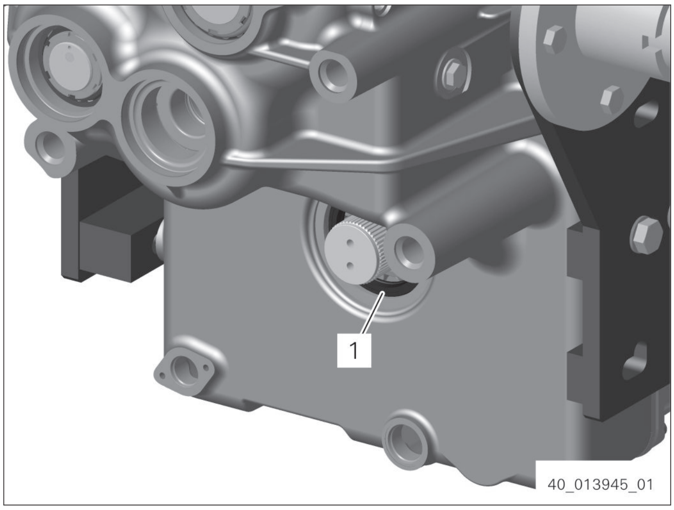


Fig. 91

Installing the yoke on the output side

8. Remove locking plate (1).

9. Loosen hexagon screws (2).

10. Remove washer (3).

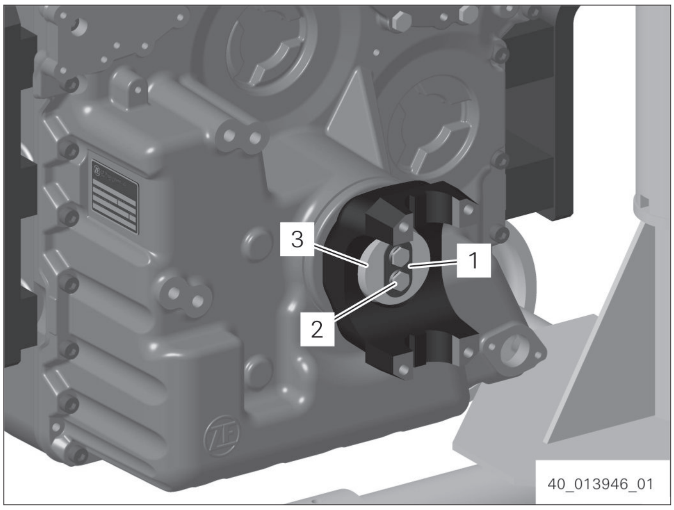


Fig. 92

11. Remove washer (2).

12. Remove O-ring (1).

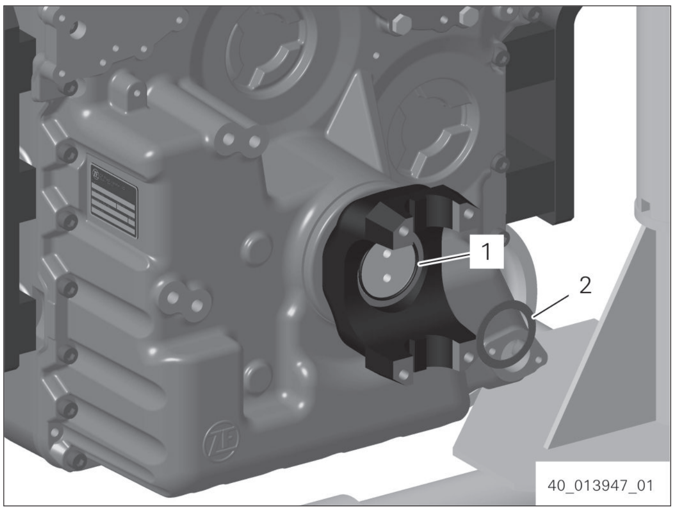


Fig. 93

13. Pull off yoke (1).

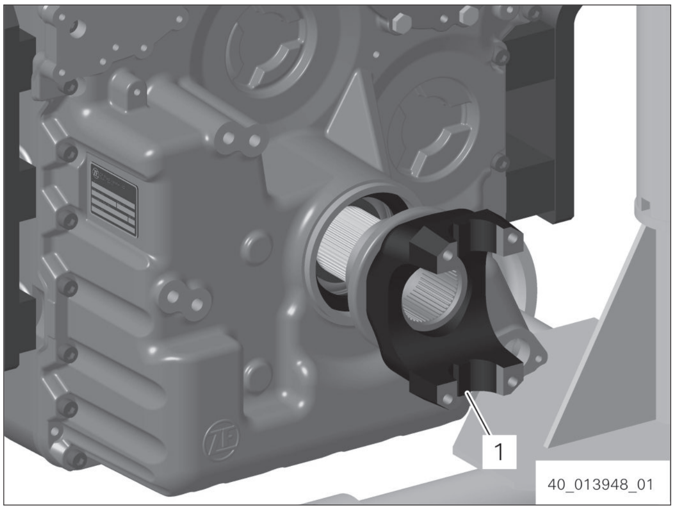


Fig. 94

14. Remove shaft sealing ring (1) from housing hole.

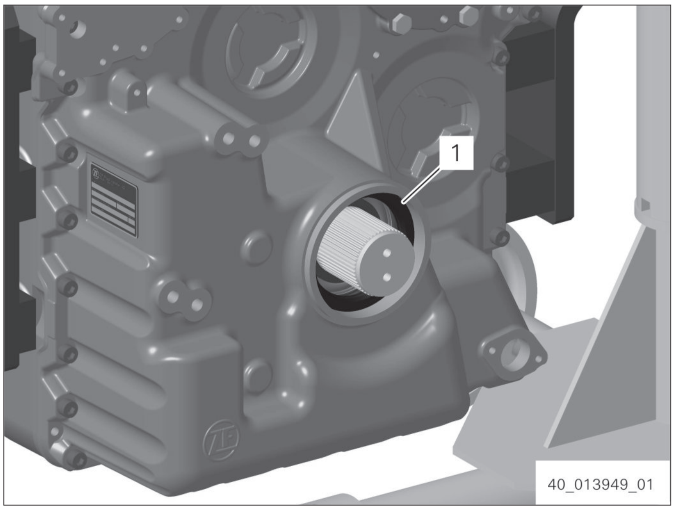


Fig. 95

Removing and dismantling clutches and output

Removing bearing cover and the covers

Special tools:

- 5870.204.069 Thread insert
- 5870.650.014 Extracting device
- 5870.204.005 Hexagon screw

1. Loosen hexagon screws.

2. Pull bearing cover K1/KV (1) with 5870.204.069 [Thread insert] and 5870.650.014 [Extracting device] out of cover hole.

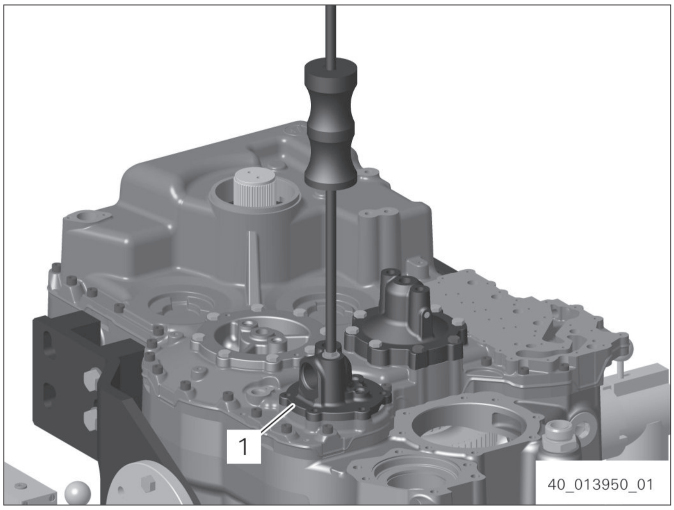


Fig. 96

3. Pull bearing outer ring (1) out of bearing cover.

4. Remove shim and ring.

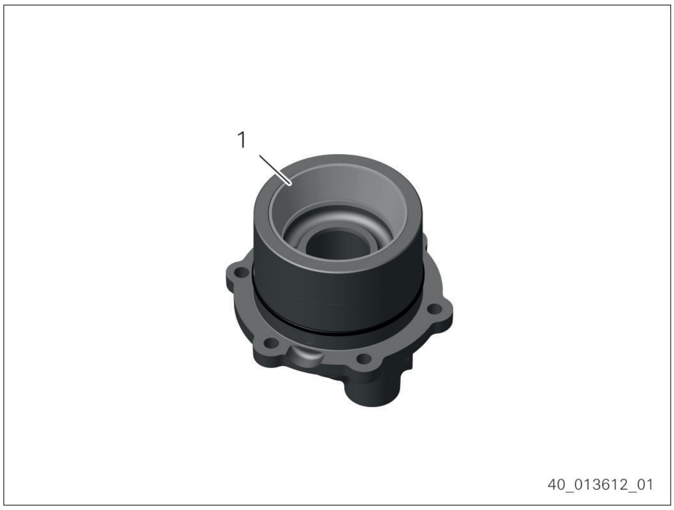


Fig. 97

5. Loosen hexagon screws.

6. Pull off cover K2/KR (1) using 5870.204.069 [Thread insert] and 5870.650.014 [Extracting device].

7. Remove shim and O-ring.

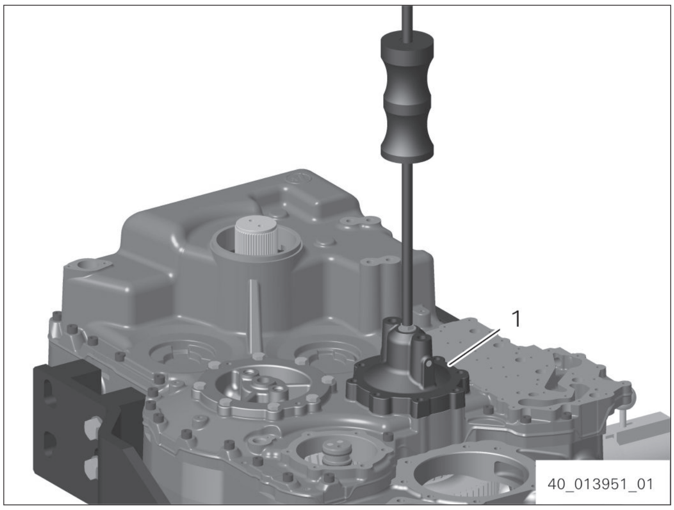


Fig. 98

8. Loosen hexagon screws.

9. Evenly pull cover K3/K4 (1) out of cover hole with two 5870.204.005 [Hexagon screw].

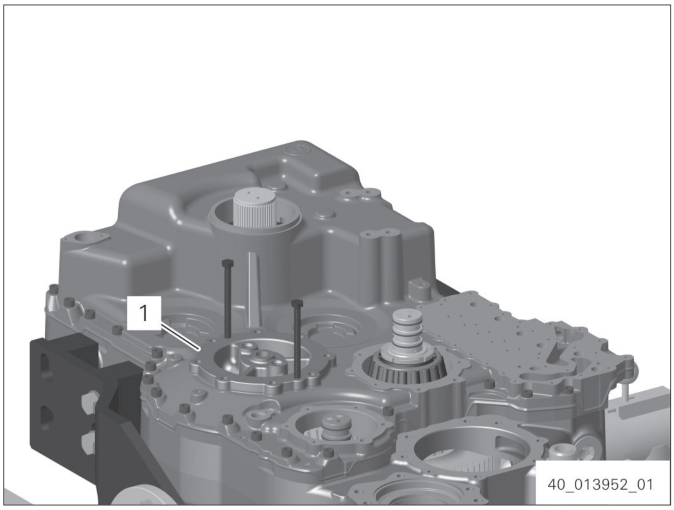


Fig. 99

10. Pull off bearing inner ring from cover using three-armed extractor.

11. Remove spacer washer.

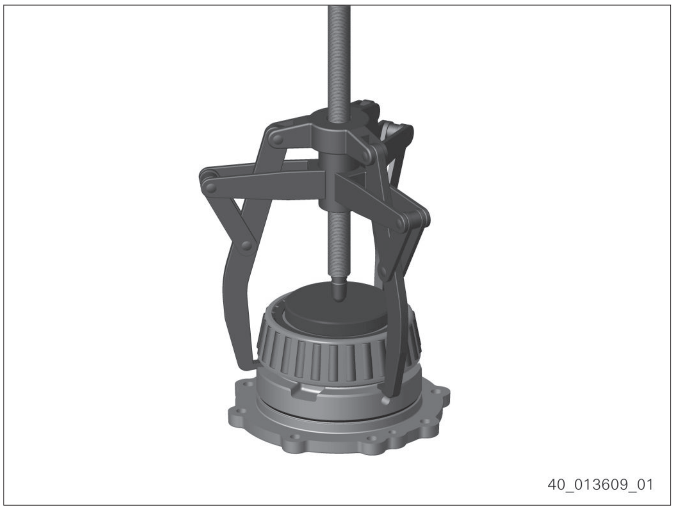


Fig. 100

Removing and dismantling the cover

Special tools:

- 5870.281.061 Load-lifting equipment
- 5870.204.005 Hexagon screw

1. Loosen cap screws.

2. Mount 5870.281.061 [Load-lifting equipment] (3) to cover (1).
   Turn hexagon screw (4) into output shaft until contact is obtained.

3. Turn two 5870.204.005 [Hexagon screw] (2) into the cover until contact is obtained.

4. Separate the cover evenly from the housing by means of two 5870.204.005 [Hexagon screw] and 5870.281.061 [Load-lifting equipment].

5. Lift off cover using 5870.281.061 [Load-lifting equipment] and a crane.

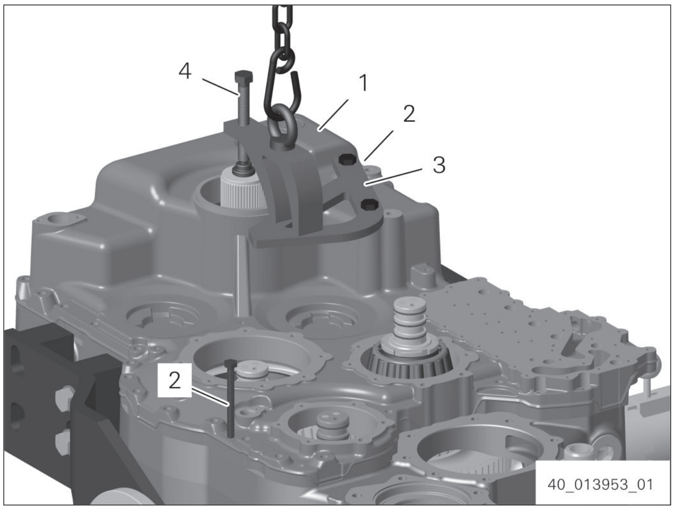


Fig. 101

6. Loosen the adapter (1).

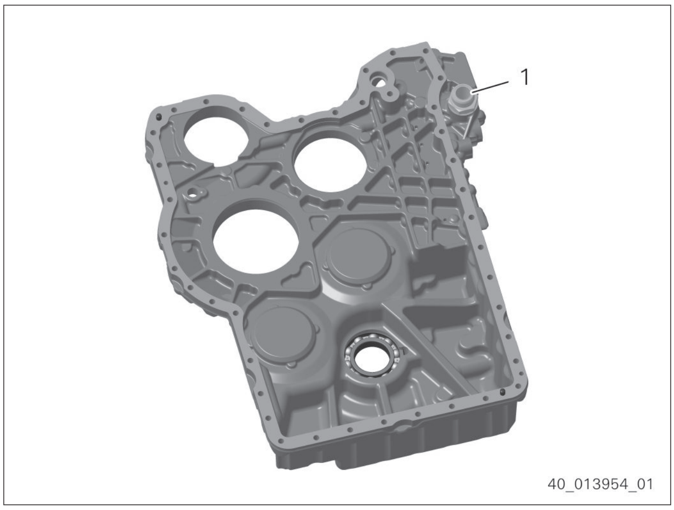


Fig. 102

7. Remove retaining ring (1).

8. Pull ball bearing (2) out of the cover hole.

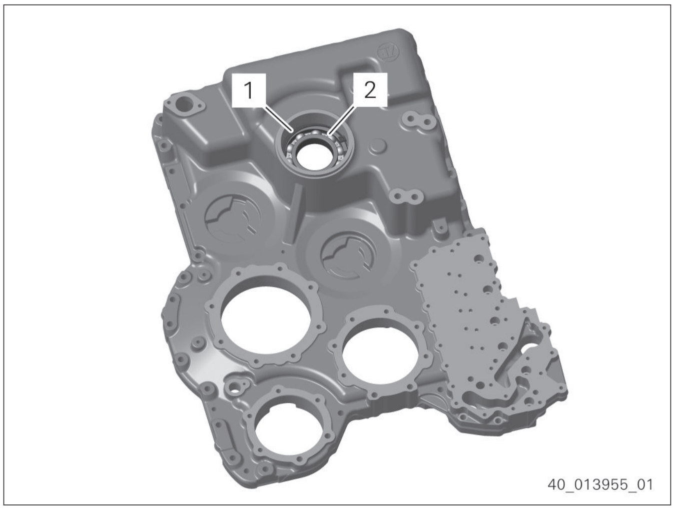


Fig. 103

Removing suction tube

1. Loosen cap screws (2).

2. Remove suction tube (1).

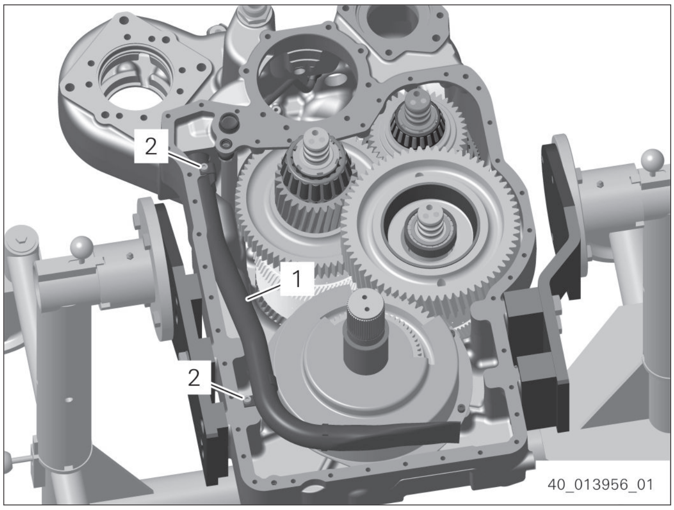


Fig. 104

Removing output shaft and output gear

Special tools:
- 5870.100.054 Stop washer
- 5870.204.002 Eyebolt

1. Remove shim (1).

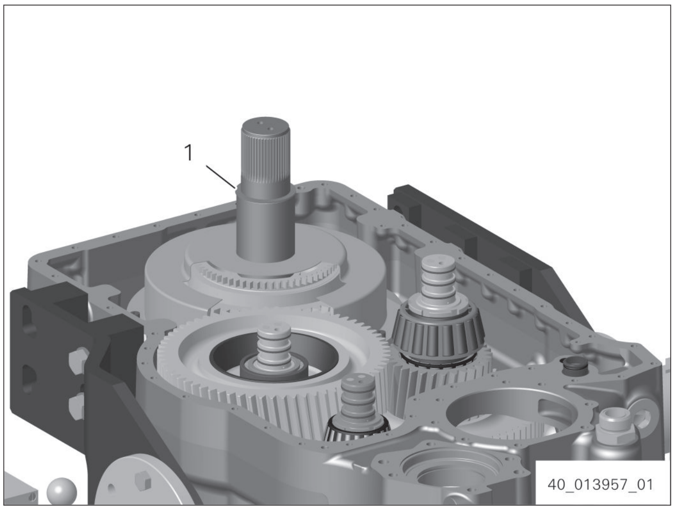


Fig. 105

2. Force output shaft (1) out of gear by means of a plastic hammer.

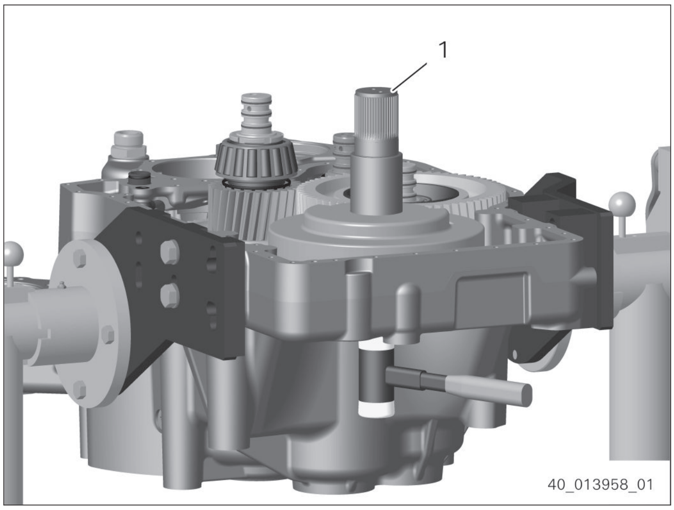


Fig. 106

3. Loosen cap screws.

4. Remove cover sheet (1).

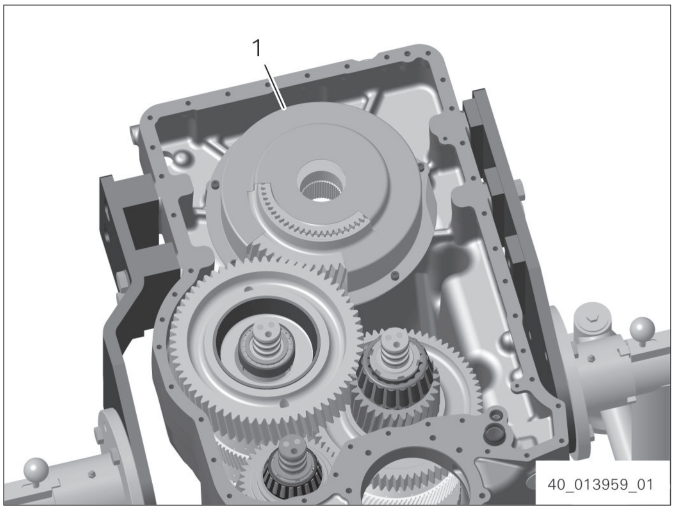


Fig. 107

5. **CAUTION**

Risk of crushing due to moving load.
Slight to moderate injury possible.

⇨ Move load slowly and carefully.

⇨ Do not reach into danger area.

Use 5870.100.054 [Stop washer], 5870.204.002 [Eyebolt] and crane to lift gear out of housing.

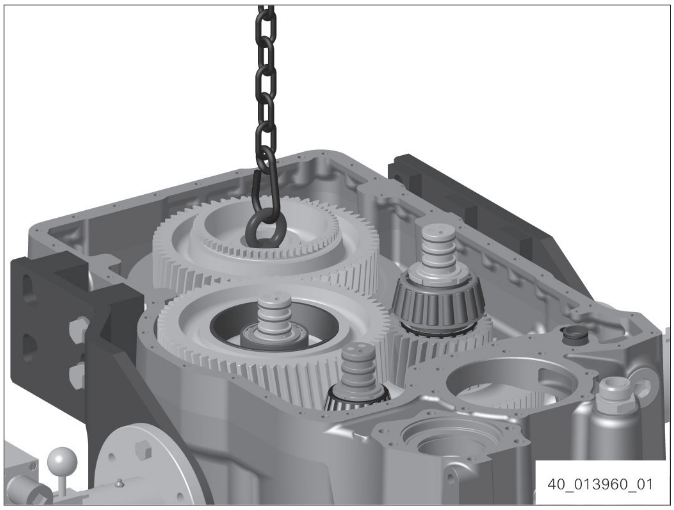


Fig. 108

6. Pull bearing inner ring from gear using a three-armed extractor and 5870.100.054 [Stop washer].

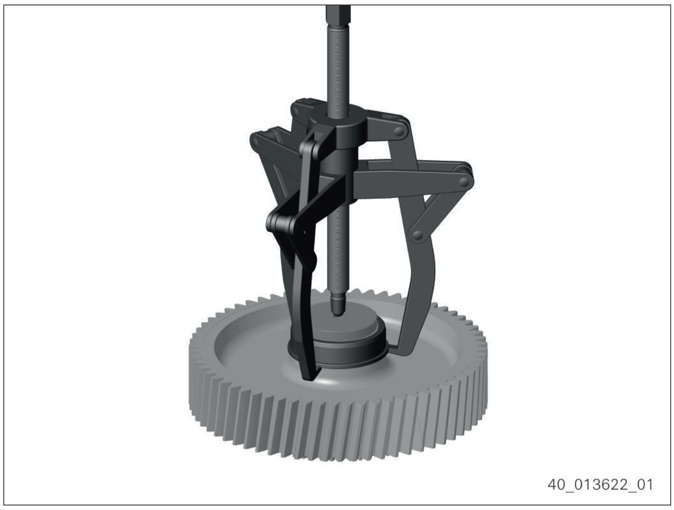


Fig. 109

7. Remove cover sheet (1).

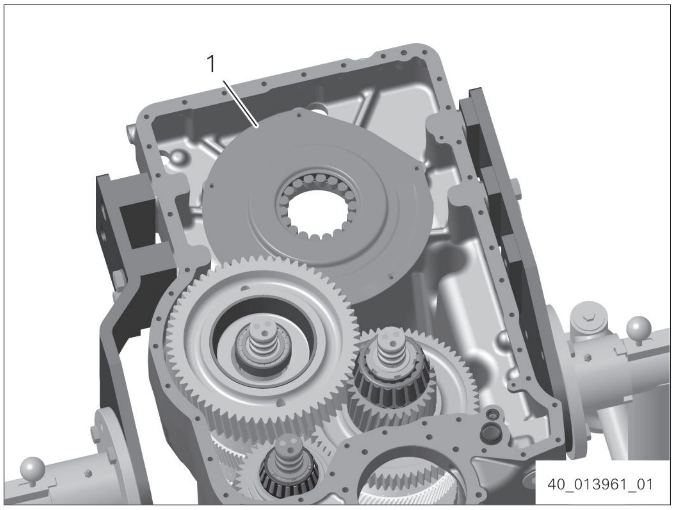


Fig. 110

8. Remove cylindrical roller bearing (1) from housing hole.

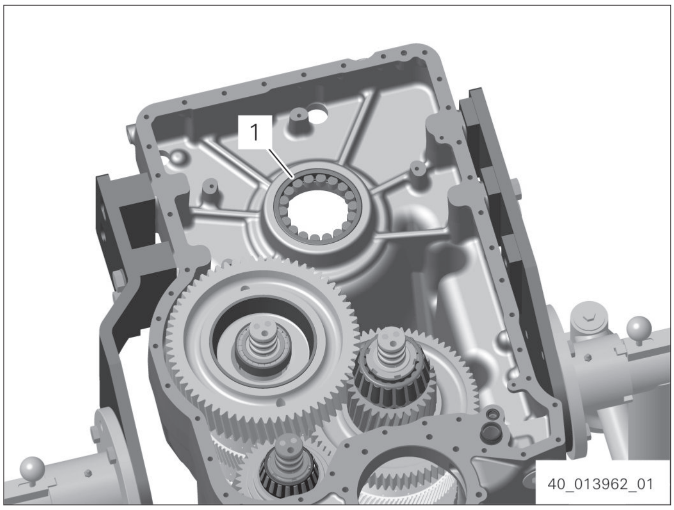


Fig. 111

Removing clutches

Special tools:

- 5870.204.002 Eyebolt

1. ⚠ **CAUTION**

   Risk of crushing due to moving load.
   Slight to moderate injury possible.
   ⇨ Move load slowly and carefully.
   ⇨ Do not reach into danger area.

   Slightly lift clutch KR/K2 (2) and move in direction of arrow.

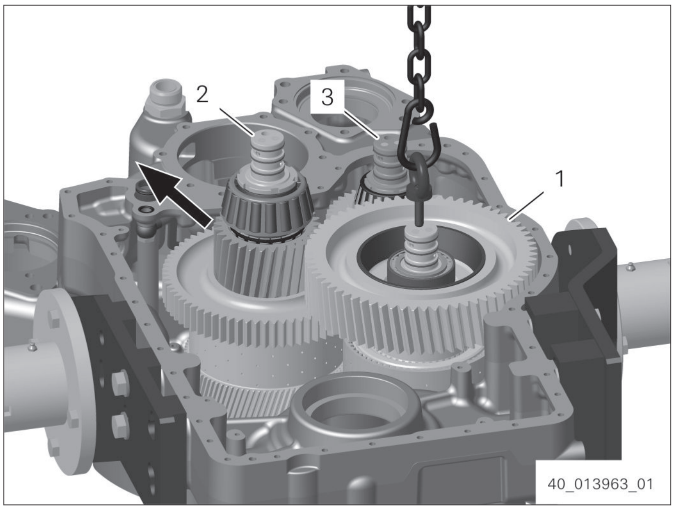


Fig. 112

2. Remove clutch K3/K4 (1) out of housing using 5870.204.002 [Eyebolt] and a crane.

3. Remove clutch KR/K2 (2) out of housing using 5870.204.002 [Eyebolt] and a crane.

4. Remove clutch KV/K1 (3) out of housing using 5870.204.002 [Eyebolt] and a crane.

5. Figure shows the disassembled clutches.
   - 1 = Clutch K1
   - 2 = Clutch KV
   - 3 = Clutch K2
   - 4 = Clutch KR
   - 5 = Clutch K3
   - 6 = Clutch K4

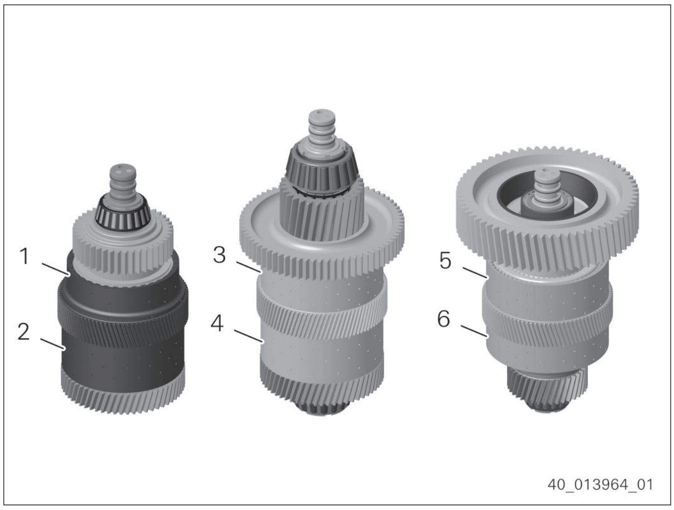


Fig. 113

Dismantling clutch K3/K4

Special tools:

- 5870.350.000 Assembly truck
- 5870.654.033 Assembly fixture
- AA02.778.672 Rapid grip
- 5873.002.001 Basic tool
- 5870.401.118 Groove nut wrench

- 5870.401.115 Groove nut wrench
- 5873.002.033 Gripping device
- 5870.345.072 Assembly fixture

1. Fasten clutch K3/K4 to 5870.350.000 [Assembly truck] by means of 5870.654.033 [Assembly fixture].

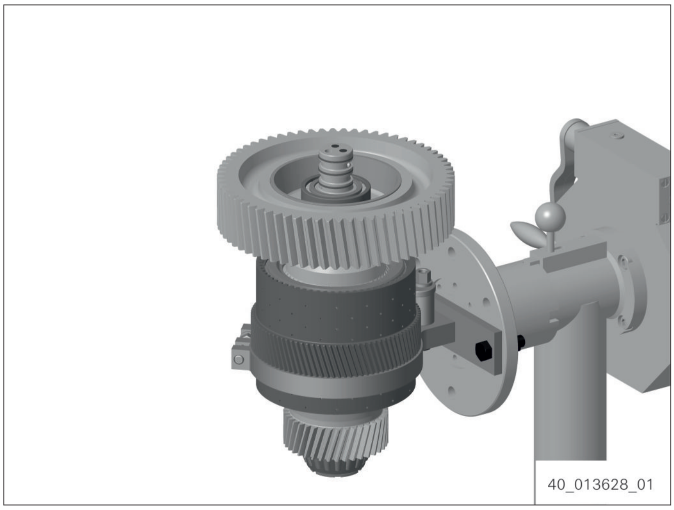


Fig. 114

2. Remove R-rings (1).

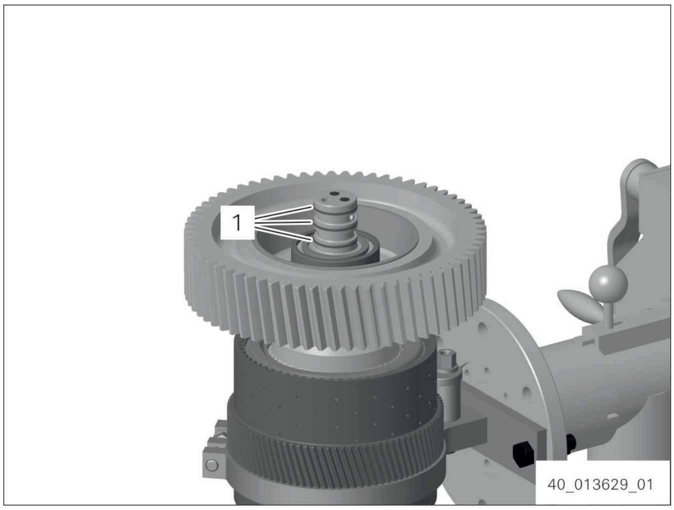


Fig. 115

Dismantling clutch K3

3. Pull roller bearing from disk carrier using a three-armed extractor.

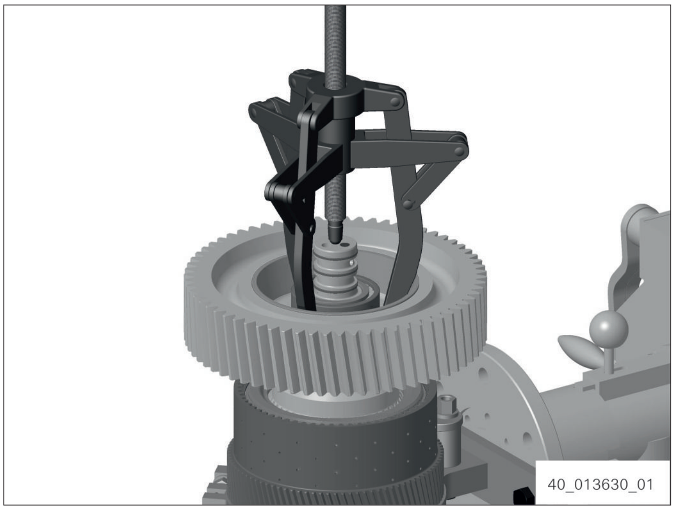


Fig. 116

4. Remove spur gear (1).

5. Remove bearing outer ring (2) from spur gear.

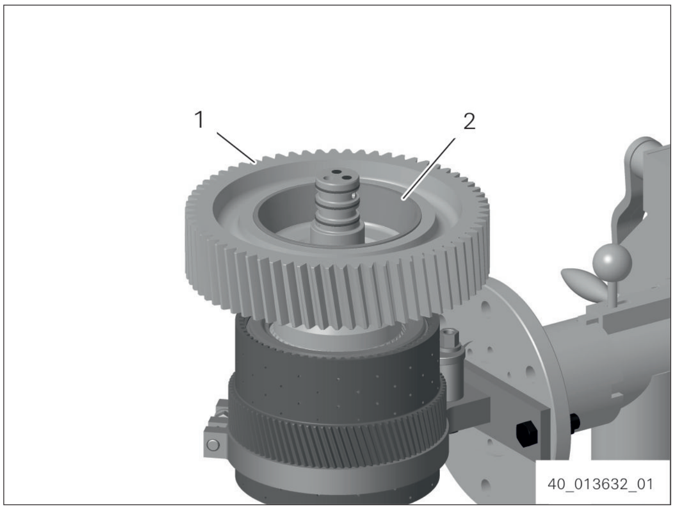


Fig. 117

6. Pull off bearing inner ring with AA02.778.672 [Rapid grip] and 5873.002.001 [Basic tool].

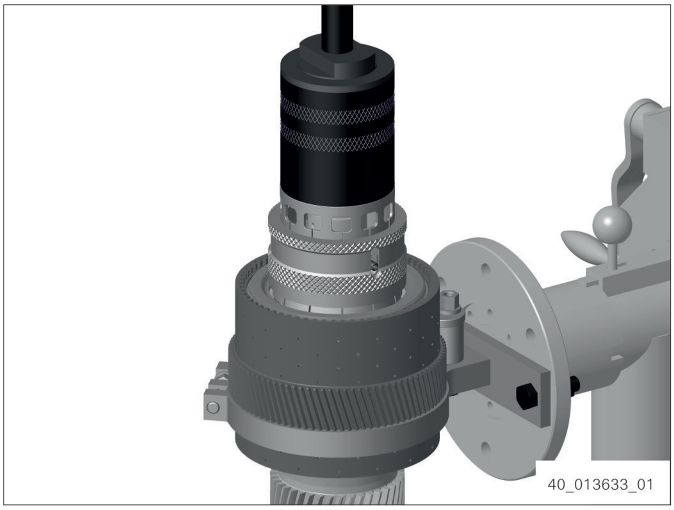


Fig. 118

7. Remove snap ring (1).

8. Remove end shim (2) from disk carrier.

9. Remove disk package (3).

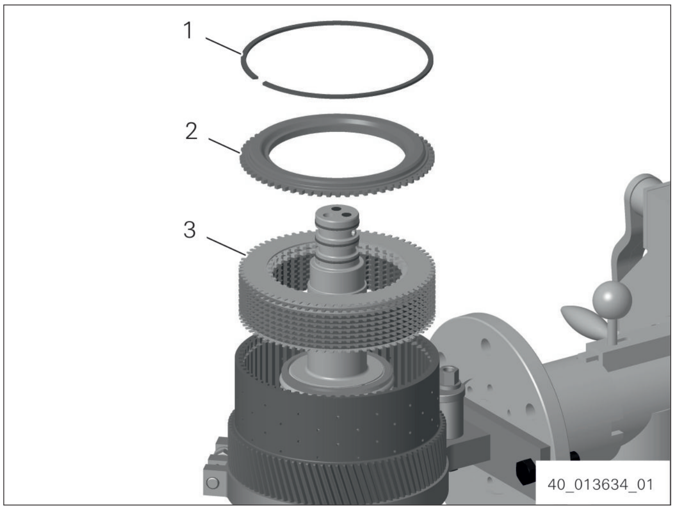


Fig. 119

Dismantling clutch K4

10. Turn disk carrier by 90°.

11. Loosen slotted nut with 5870.401.118 [Groove nut wrench] and 5870.401.115 [Groove nut wrench].

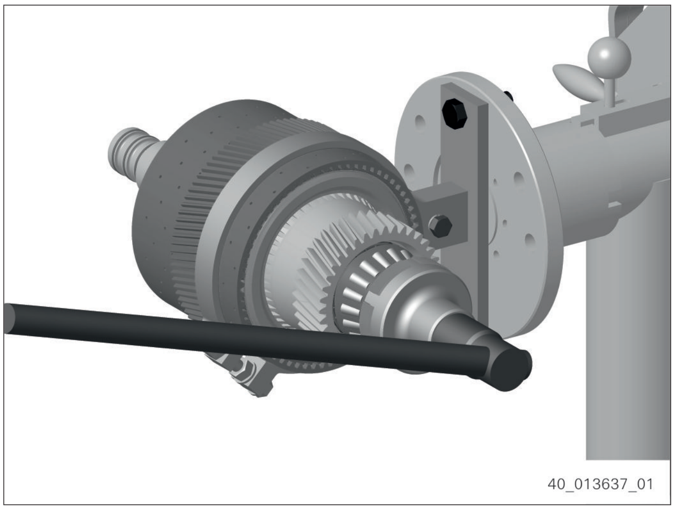


Fig. 120

12. Turn disk carrier by 90°.

13. Pull helical gear, bearing inner ring and taper roller bearing from disk carrier using the three-armed extractor.

14. Remove bearing outer rings from helical gear.

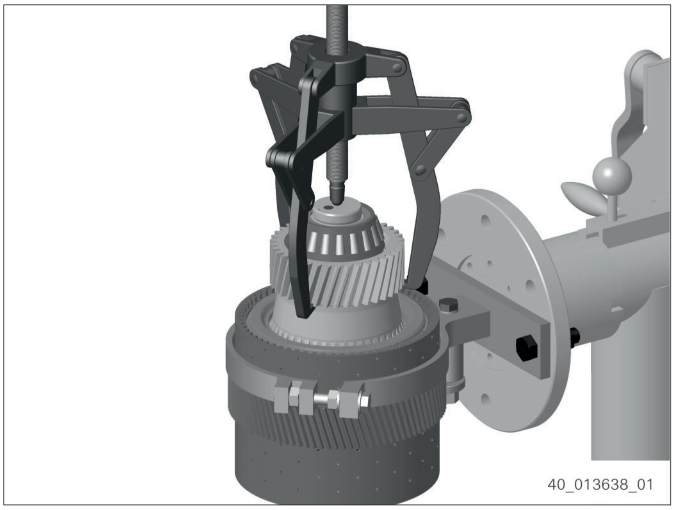


Fig. 121

15. Remove washer.

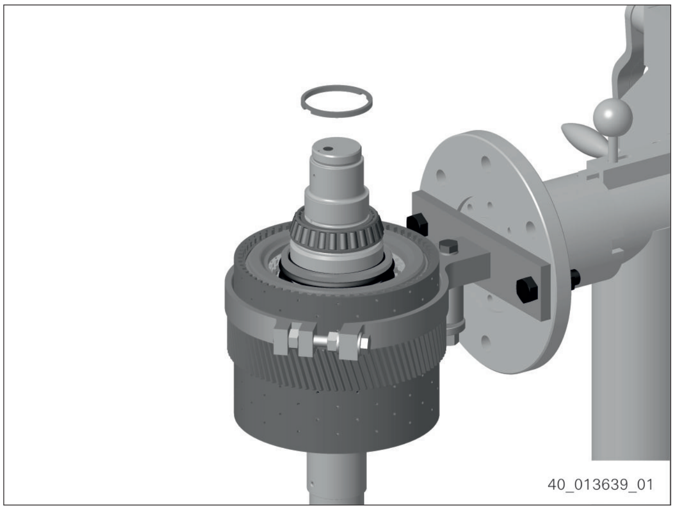


Fig. 122

16. Pull off bearing inner ring with 5873.002.033 [Gripping device] and 5873.002.001 [Basic tool].

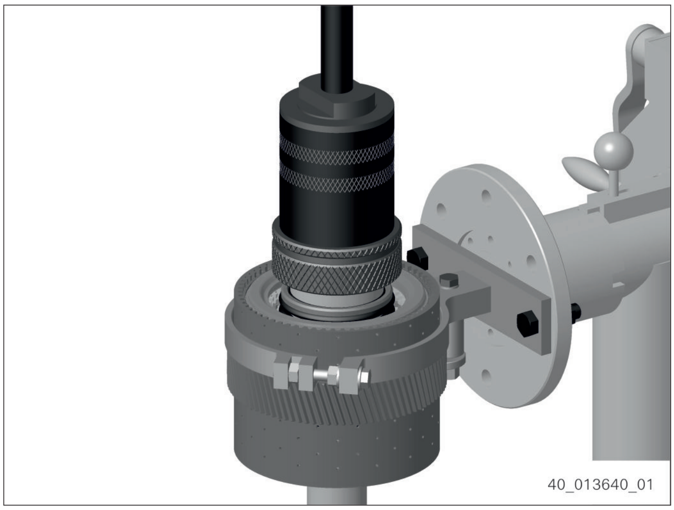


Fig. 123

17. Remove snap ring (1).

18. Remove end shim (2) from disk carrier.

19. Remove disk package (3).

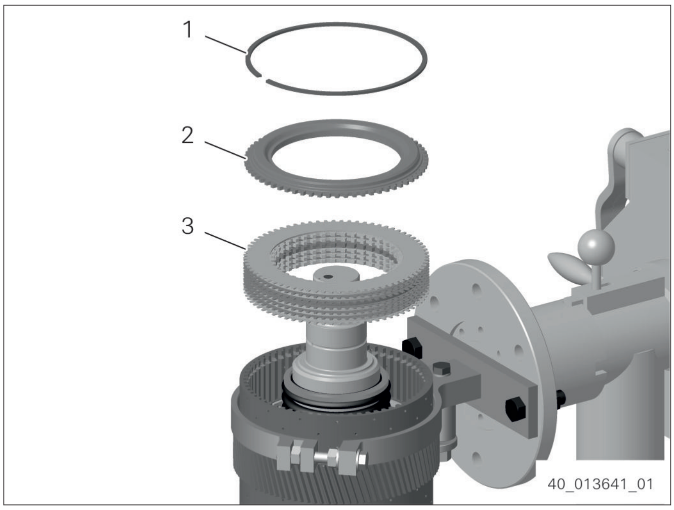


Fig. 124

20. Press guide ring downwards with 5870.345.072 [Assembly fixture] and hand-operated press and hold it there.
21. Remove snap ring.
22. Release hand-operated press.
23. Remove guide ring, compression spring and intermediate washer.
24. Turn disk carrier by 180°.
25. Press guide ring downwards with 5870.345.072 [Assembly fixture] and hand-operated press and hold it there.
26. Remove snap ring.
27. Release hand-operated press.
28. Remove guide ring, compression spring and intermediate washer.
29. Press both pistons out of disk carrier using compressed air.

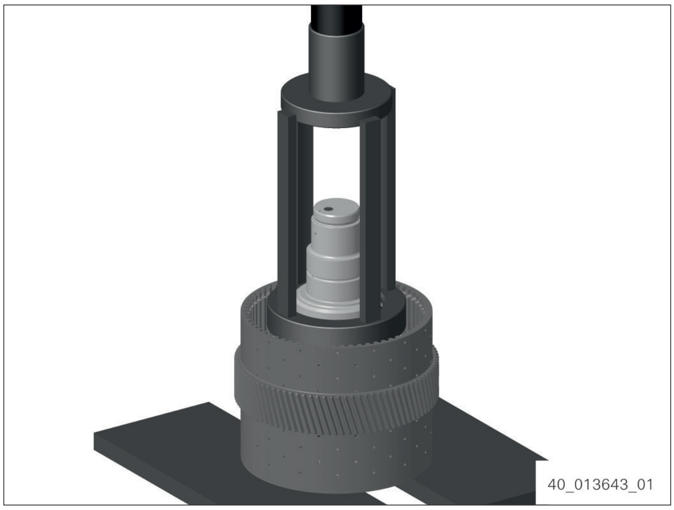


Fig. 125

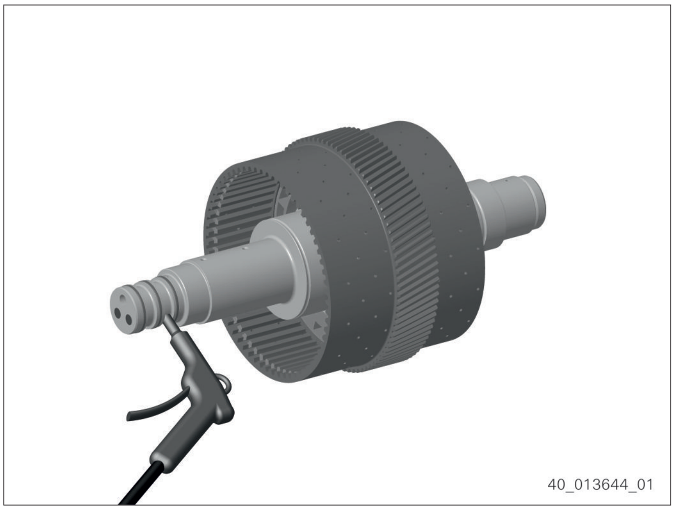


Fig. 126

Dismantling clutch KR/K2

Special tools:

- 5870.350.000 Assembly truck
- 5870.654.033 Assembly fixture
- AA02.769.745 Slotted nut wrench
- 5873.012.018 Rapid grip
- 5873.002.001 Basic tool

- 5873.012.019 Rapid grip
- 5873.002.000 Basic tool
- 5870.401.099 Groove nut wrench
- 5873.002.044 Gripping device
- 5870.654.045 Assembly fixture
- 5873.012.013 Rapid grip
- 5870.345.072 Assembly fixture

1. Fasten clutch KR/K2 to
   5870.350.000 [Assembly truck] using 5870.654.033 [Assembly fixture].

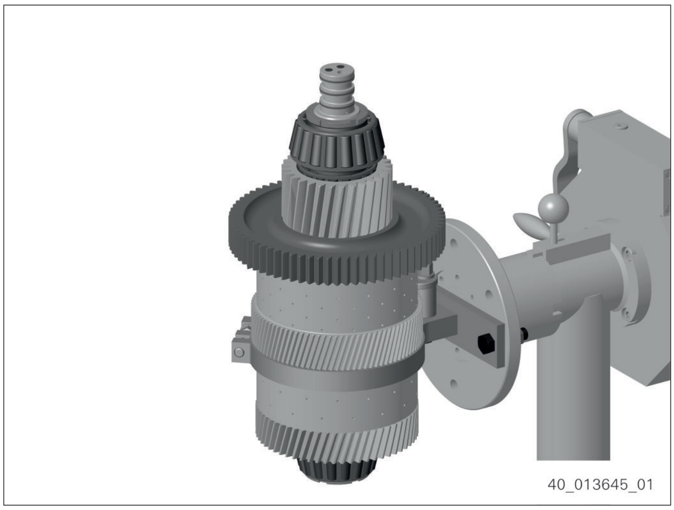


Fig. 127

2. Remove R-rings (1).

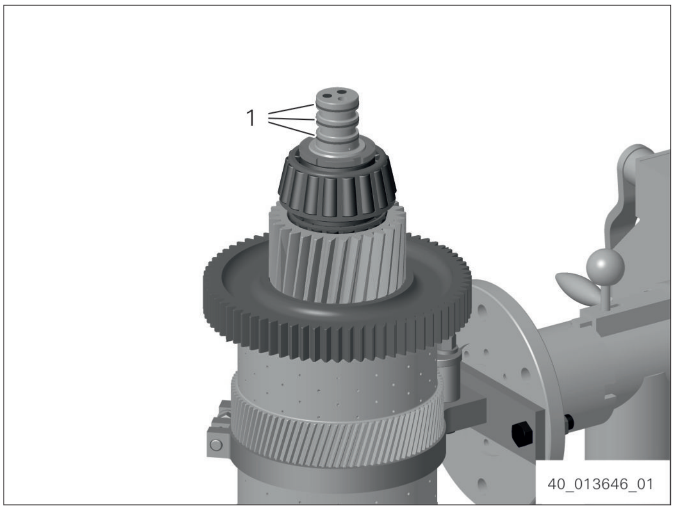


Fig. 128

Dismantling clutch K2

3. Turn disk carrier by 90°.

4. Loosen slotted nut with AA02.769.745 [Slotted nut wrench].

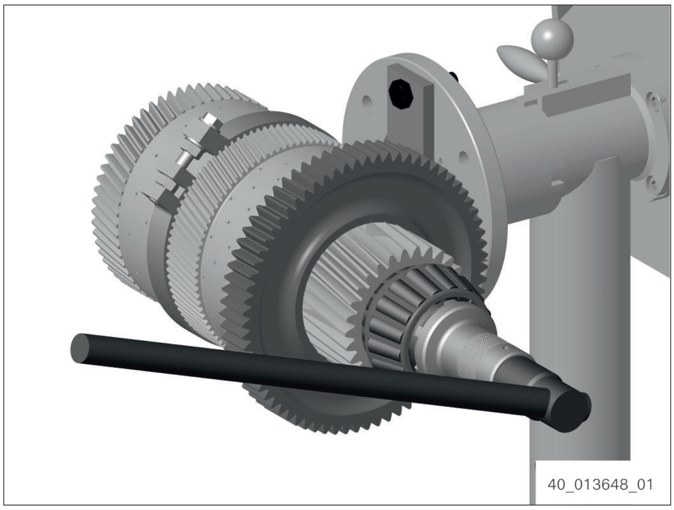


Fig. 129

5. Turn disk carrier by 90°.

6. Pull off bearing inner ring with 5873.012.018 [Rapid grip] and 5873.002.001 [Basic tool].

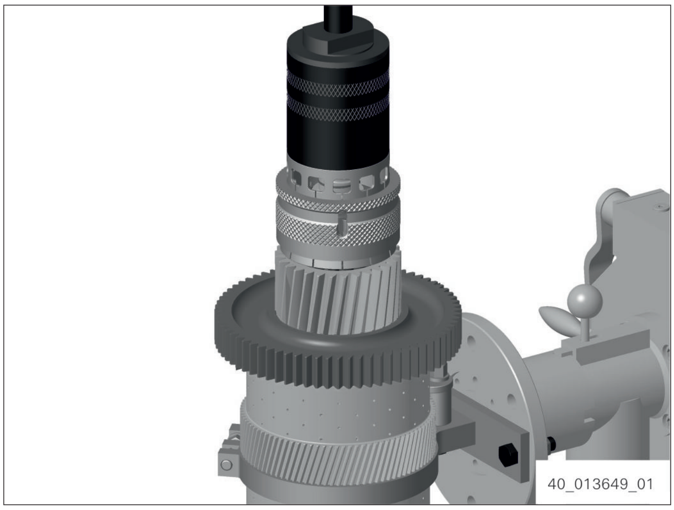


Fig. 130

7. Pull both gears and bearing inner ring from disk carrier using two-armed extractor.

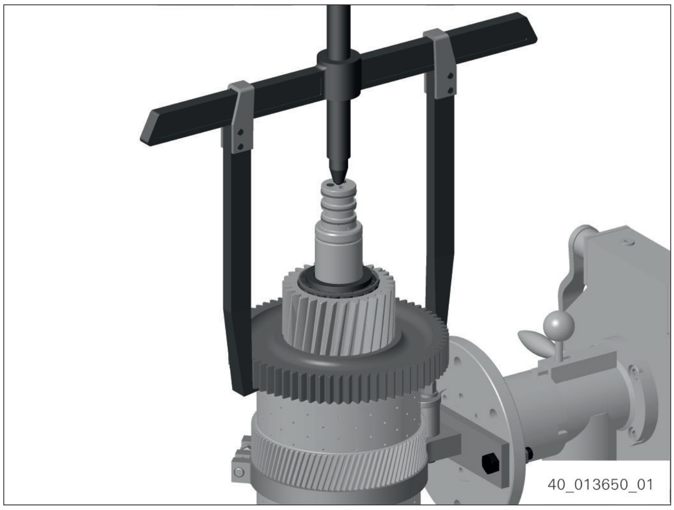


Fig. 131

8. Pull off bearing inner ring with 5873.012.019 [Rapid grip] and 5873.002.000 [Basic tool].

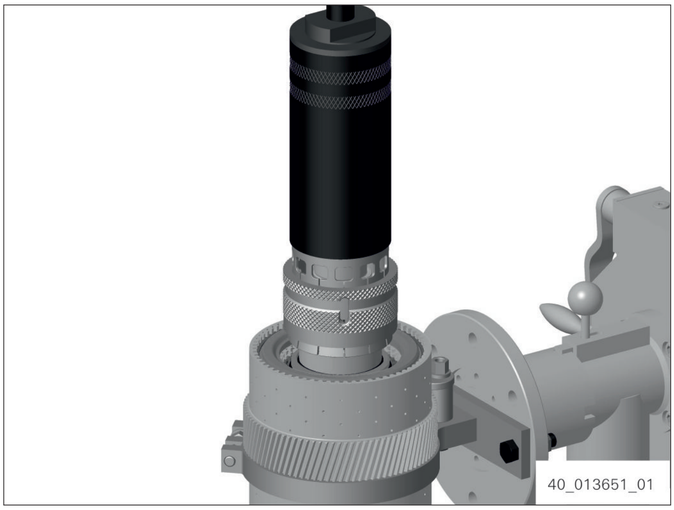


Fig. 132

9. Remove snap ring (1).

10. Remove end shim (2) from disk carrier.

11. Remove disk package (3).

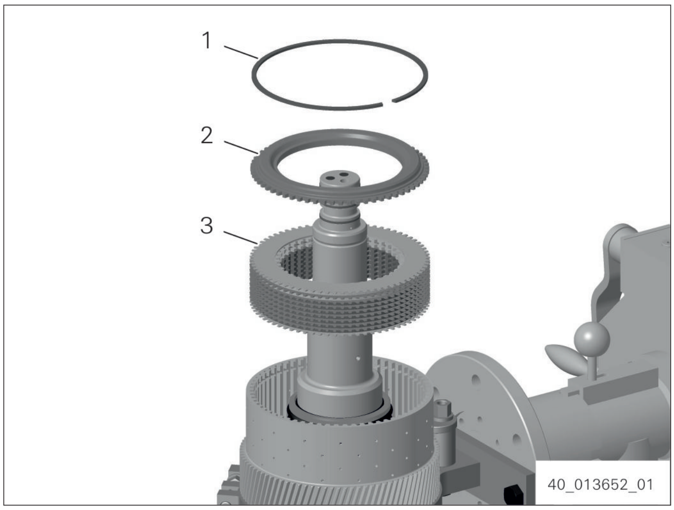


Fig. 133

Dismantling KR clutch

12. Turn disk carrier by 90°.

13. Loosen slotted nut with 5870.401.099 [Groove nut wrench].

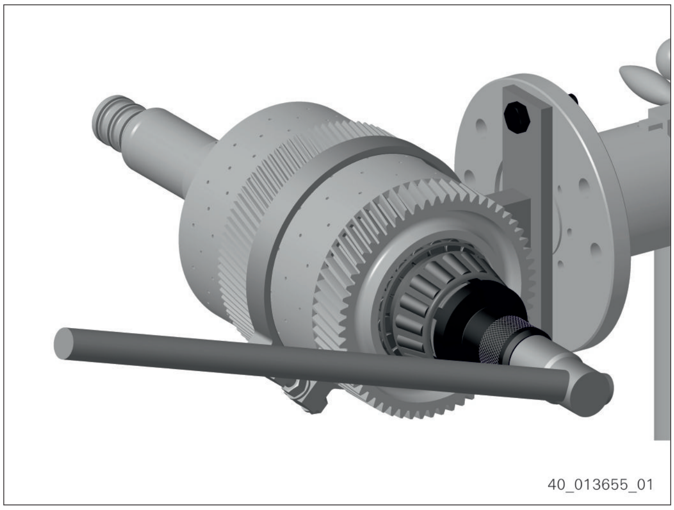


Fig. 134

14. Turn disk carrier by 90°.

15. Pull off bearing inner ring with 5873.002.044 [Gripping device] and 5873.002.001 [Basic tool].

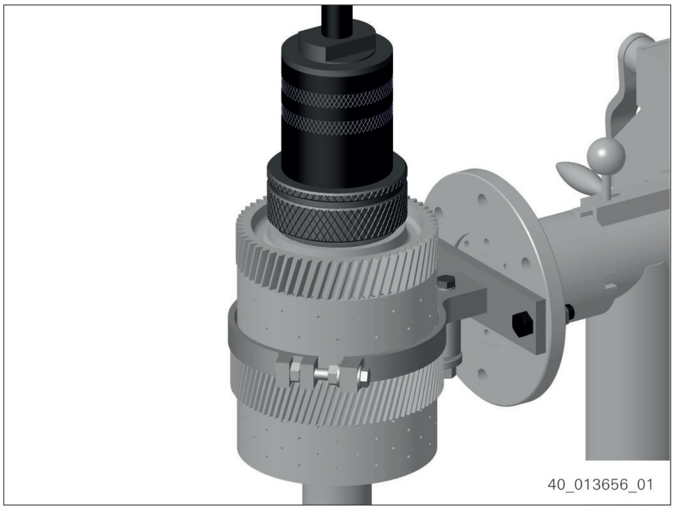


Fig. 135

16. Pull spur gear and bearing inner ring from disk carrier using 5870.654.045 [Assembly fixture] and three-armed puller.

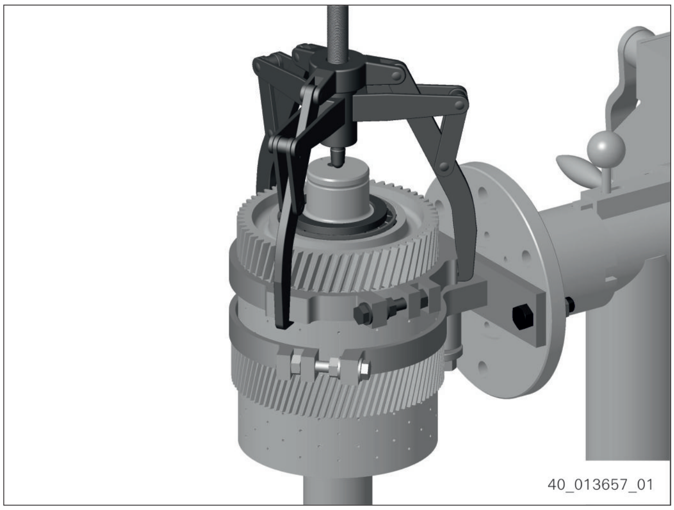


Fig. 136

17. Remove ring.

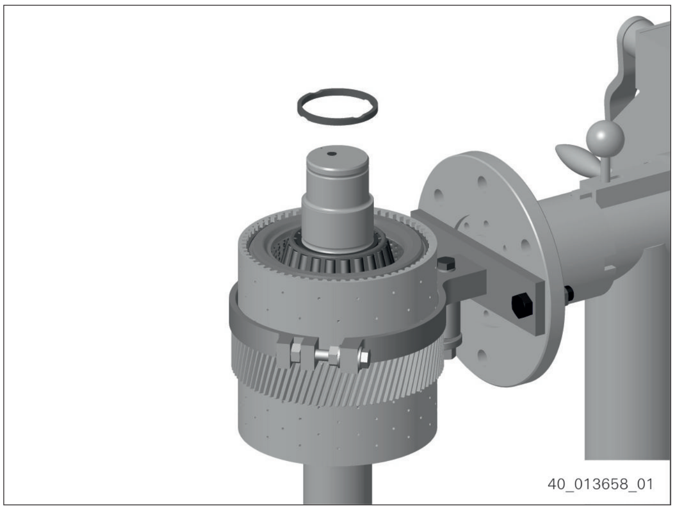


Fig. 137

18. Remove snap ring (1).

19. Remove end shim (2) from disk carrier.

20. Remove disk package (3).

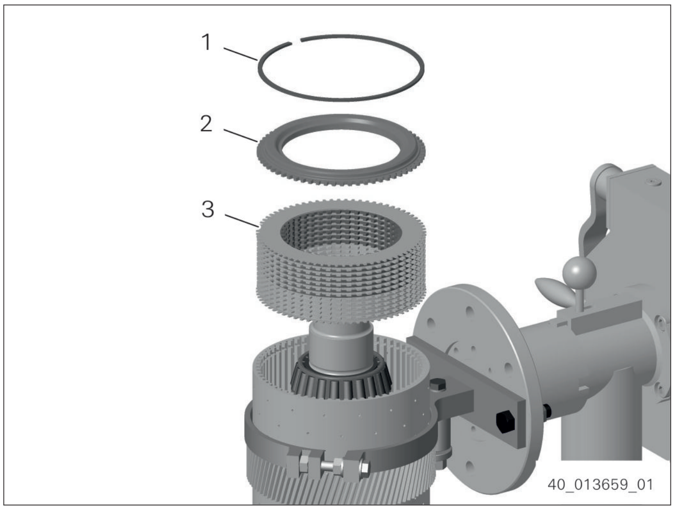


Fig. 138

21. Pull off bearing inner ring with 5873.012.013 [Rapid grip] and 5873.002.001 [Basic tool].

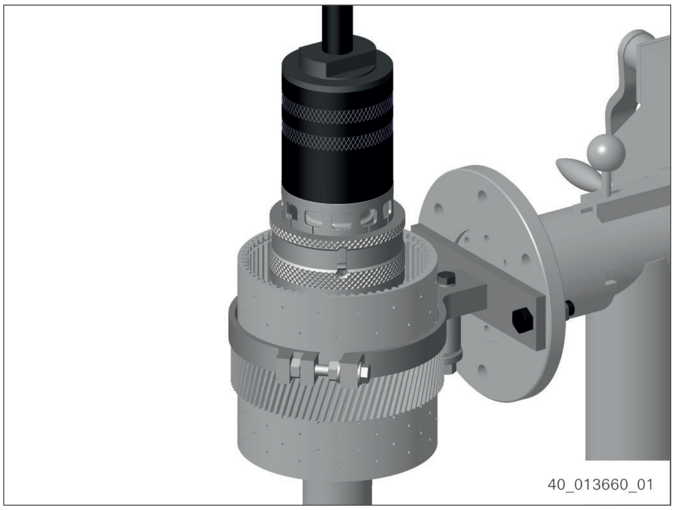


Fig. 139

22. Press guide ring downwards with 5870.345.072 [Assembly fixture] and hand-operated press and hold it there.

23. Remove snap ring.

24. Release hand-operated press.

25. Remove guide ring, compression spring and intermediate washer.

26. Turn disk carrier by 180°.

27. Press guide ring downwards with 5870.345.072 [Assembly fixture] and hand-operated press and hold it there.

28. Remove snap ring.

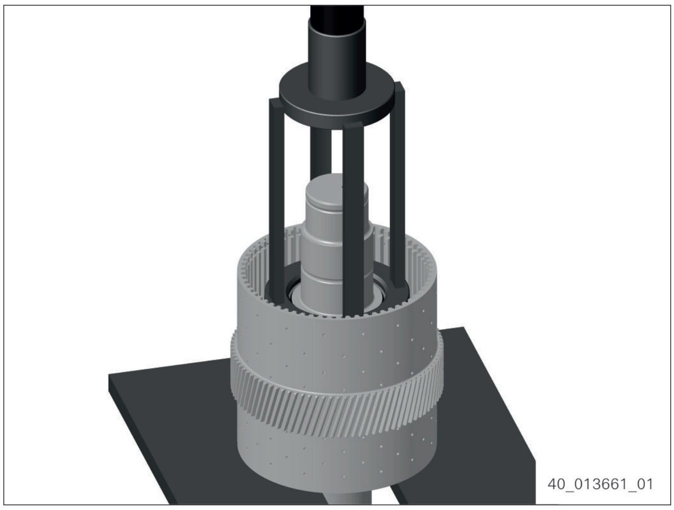


Fig. 140

29. Release hand-operated press.

30. Remove guide ring, compression spring and intermediate washer.

31. Press both pistons out of disk carrier using compressed air.

Fig. 141

Dismantling clutch KV/K1

Special tools:

- 5870.350.000 Assembly truck
- 5870.654.033 Assembly fixture
- 5870.401.118 Groove nut wrench
- 5870.401.115 Groove nut wrench
- 5873.001.023 Gripping device
- 5873.001.000 Basic tool
- 5870.345.036 Pry bar
- 5873.001.034 Gripping device
- 5870.654.045 Assembly fixture
- 5870.345.072 Assembly fixture

1. Fasten clutch KV/K1 to 5870.350.000 [Assembly truck] using 5870.654.033 [Assembly fixture].

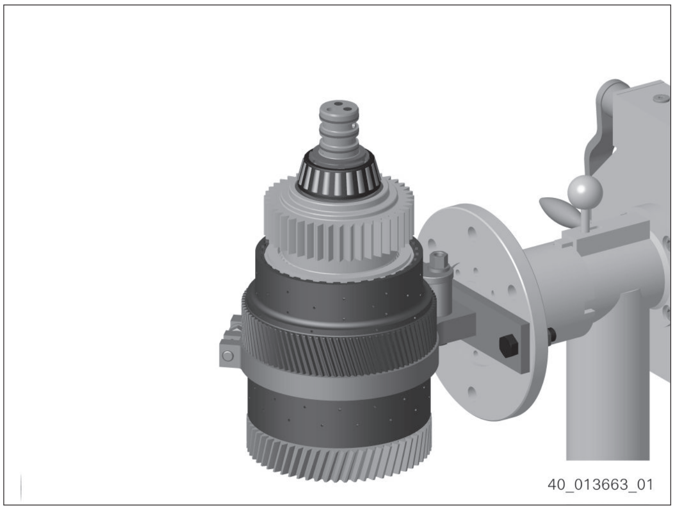


Fig. 142

2. Remove R-rings (1).

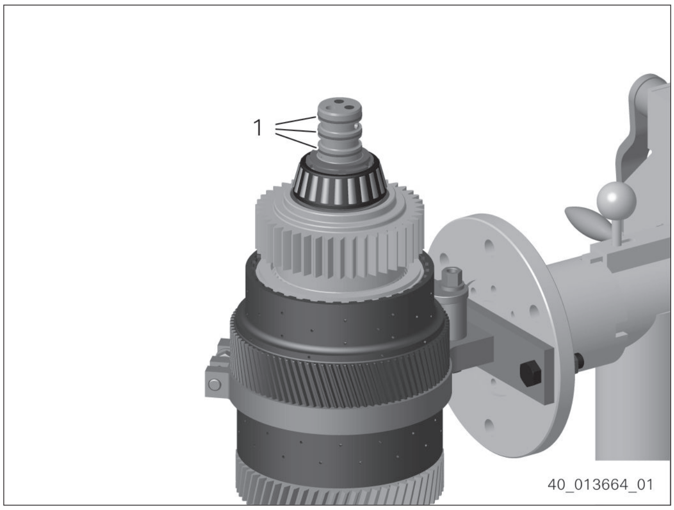


Fig. 143

Dismantling clutch K1

3. Turn disk carrier by 90°.

4. Loosen slotted nut with 5870.401.118 [Groove nut wrench] and 5870.401.115 [Groove nut wrench].

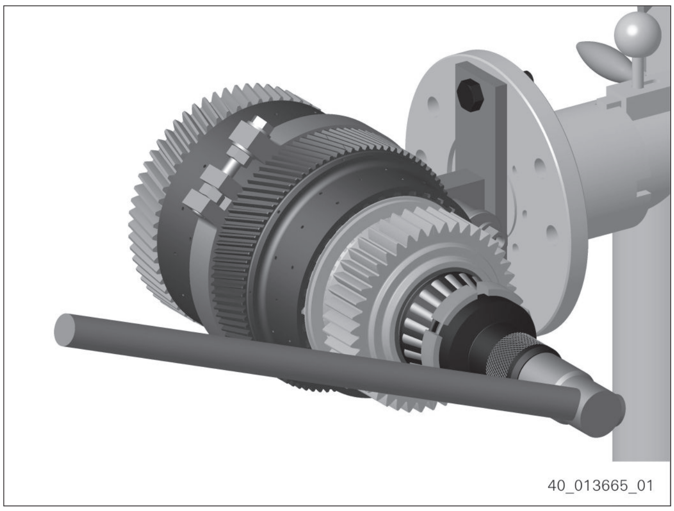


Fig. 144

5. Turn disk carrier by 90°.

6. Pull off bearing inner ring with 5873.001.023 [Gripping device] and 5873.001.000 [Basic tool].

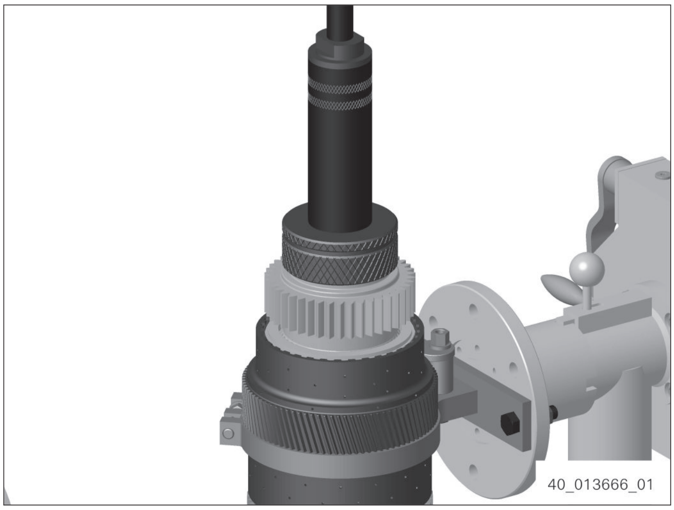


Fig. 145

7. Remove washer.

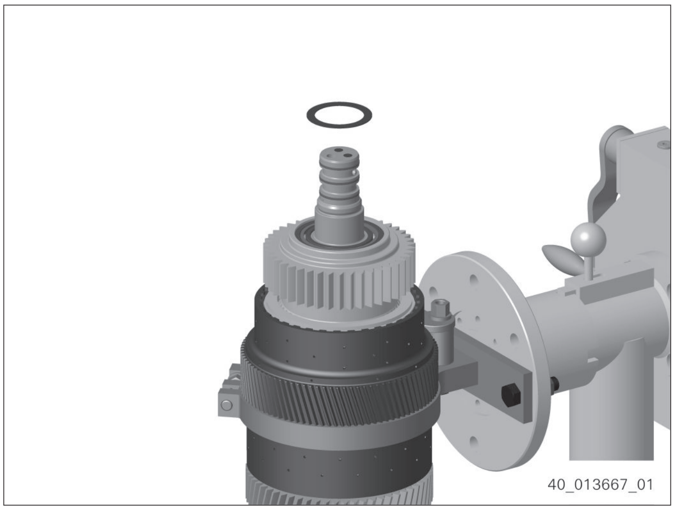


Fig. 146

8. Pull gear and parts of the angular ball bearing from disk carrier using the three-armed extractor.

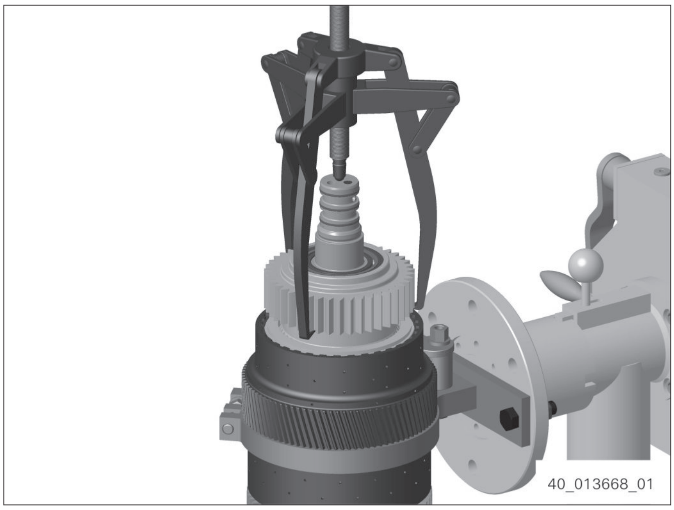


Fig. 147

9. Figure shows single parts of gear bearing.
   - 1 = angular ball bearing
   - 2 = Snap ring
   - 3 = gear

   The angular ball bearing is only available as complete unit.

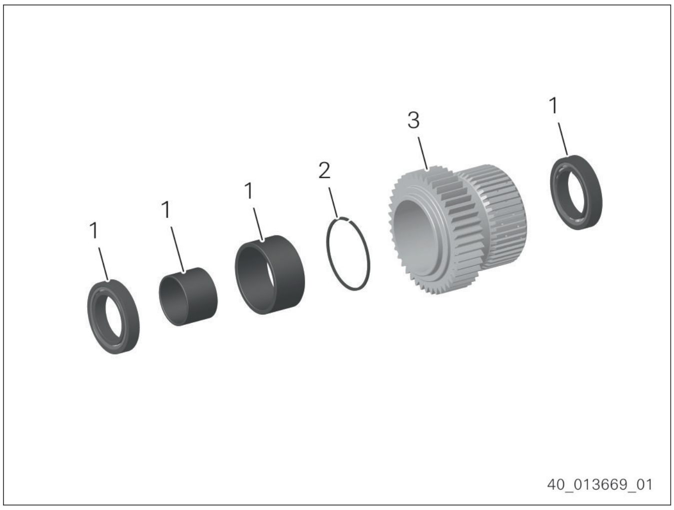


Fig. 148

10. Remove intermediate ring of angular ball bearing.

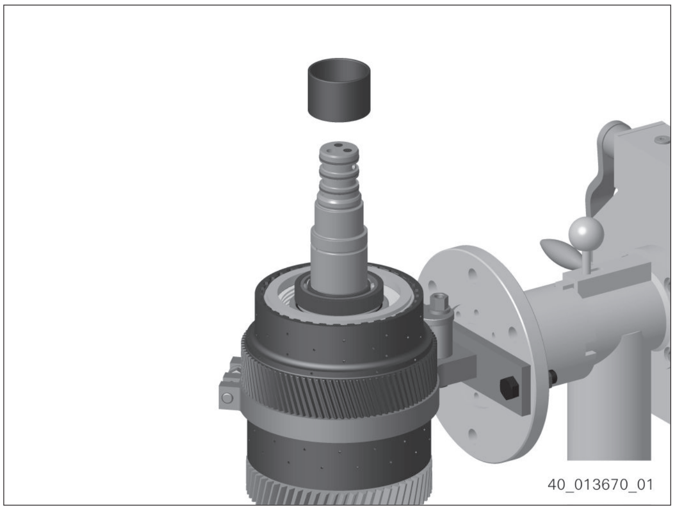


Fig. 149

11. Remove snap ring (1).

12. Remove end shim (2) from disk carrier.

13. Remove disk package (3).

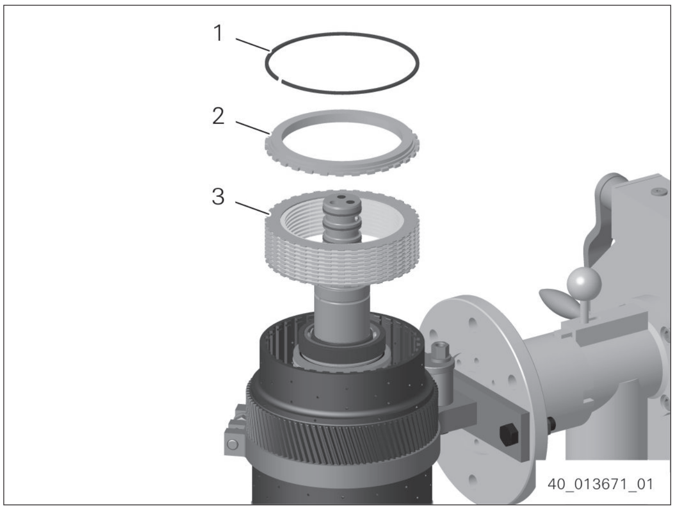


Fig. 150

14. Use 5870.345.036 [Pry bar] to pull the lower ball bearing of the angular ball bearing from the disk carrier and remove releasing balls.

    → The ball bearing is destroyed.

    The angular ball bearing is only available as complete unit.

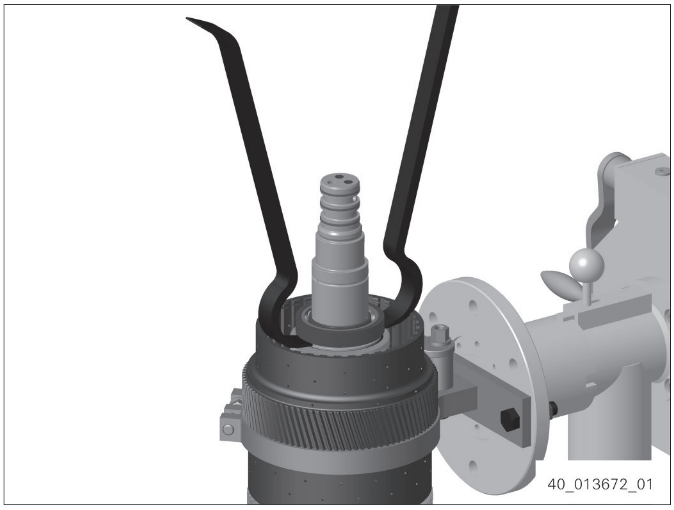


Fig. 151

Dismantling clutch KV

15. Turn disk carrier by 90°.

16. Loosen slotted nut with 5870.401.118 [Groove nut wrench] and 5870.401.115 [Groove nut wrench].

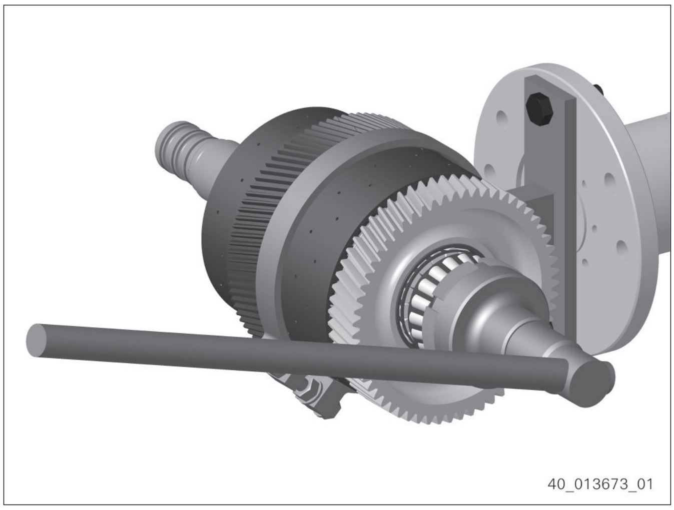


Fig. 152

17. Turn disk carrier by 90°.

18. Pull off bearing inner ring with 5873.001.034 [Gripping device] and 5873.001.000 [Basic tool].

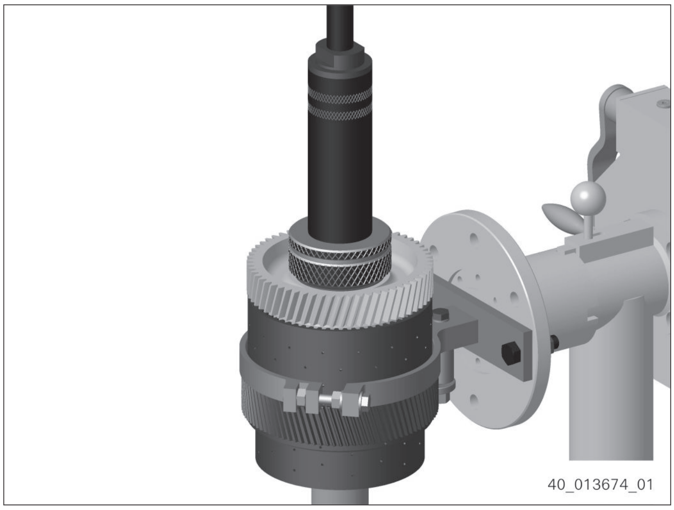


Fig. 153

19. Pull spur gear and bearing inner ring from disk carrier using 5870.654.045 [Assembly fixture] and three-armed puller.

20. Remove bearing outer rings from spur gear.

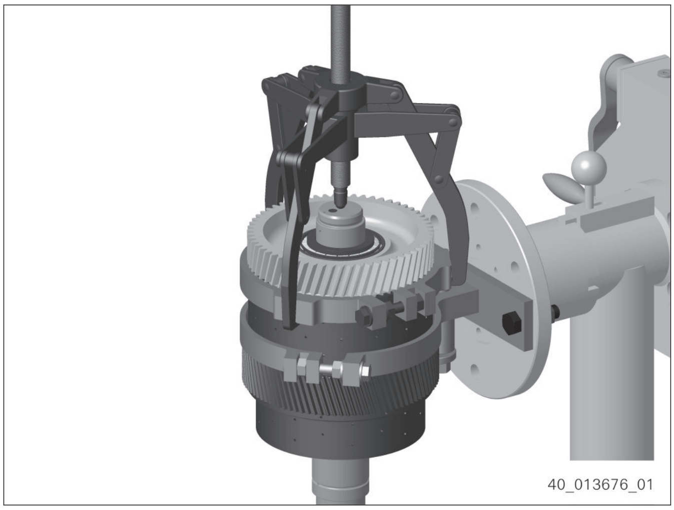


Fig. 154

21. Remove ring.

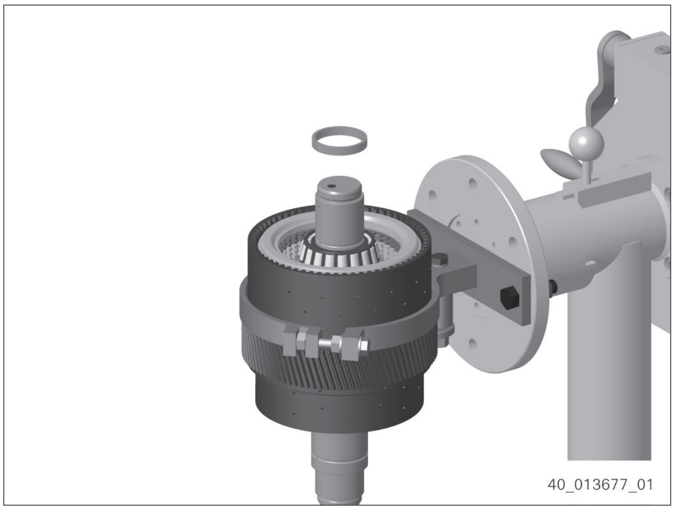


Fig. 155

22. Remove snap ring (1).

23. Remove end shim (2) from disk carrier.

24. Remove disk package (3).

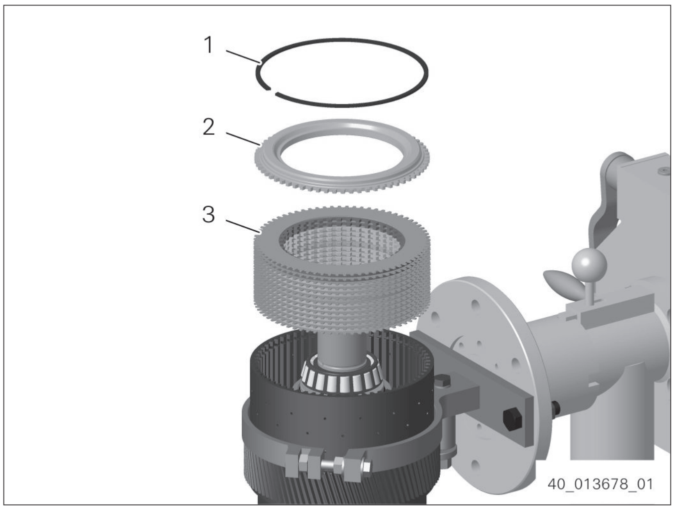


Fig. 156

25. Pull off bearing inner ring with 5873.001.034 [Gripping device] and 5873.001.000 [Basic tool].

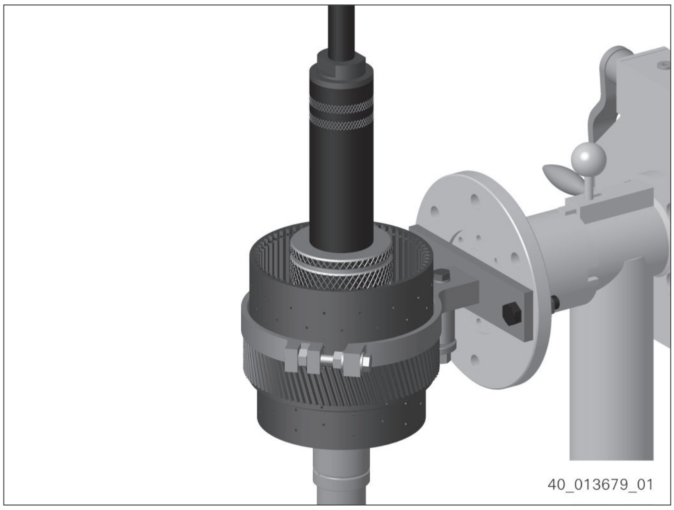


Fig. 157

26. Press guide ring downwards with 5870.345.072 [Assembly fixture] and hand-operated press and hold it there.

27. Remove snap ring.

28. Release hand-operated press.

29. Remove guide ring, compression spring and intermediate washer.

30. Turn disk carrier by 180°.

31. Press guide ring downwards with 5870.345.072 [Assembly fixture] and hand-operated press and hold it there.

32. Remove snap ring.

33. Release hand-operated press.

34. Remove guide ring, compression spring and intermediate washer.

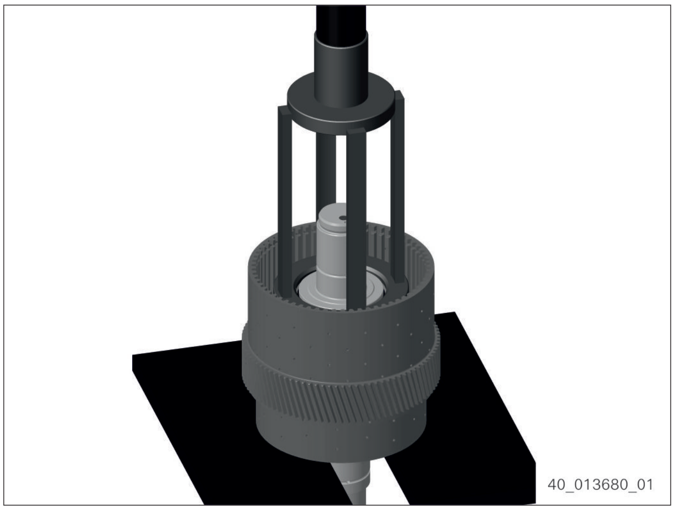


Fig. 158

35. Press both pistons out of disk carrier using compressed air.

Fig. 159

Disassembling the housing

1. Pull bearing outer rings out of housing holes. Figure shows the positions of the bearing outer rings.
   - 1 = clutch KV/K1
   - 2 = clutch K3/K4
   - 3 = clutch KR/K2

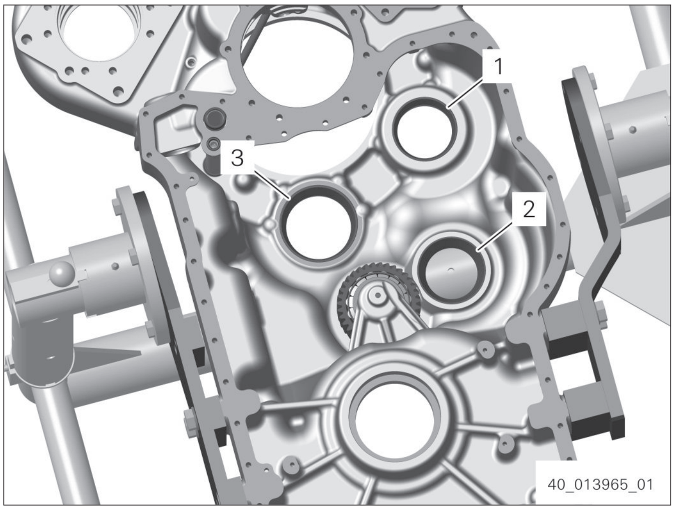


Fig. 160

2. Remove gear (1) with both tapered roller bearings (layshaft gear).

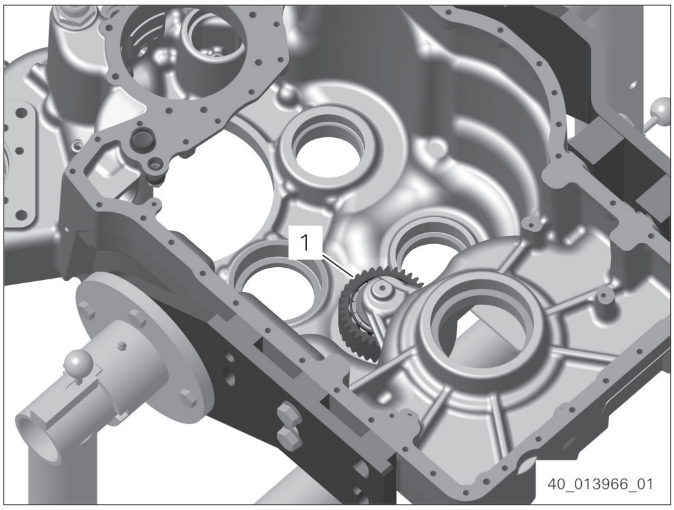


Fig. 161

3. Loosen the adapter (1).

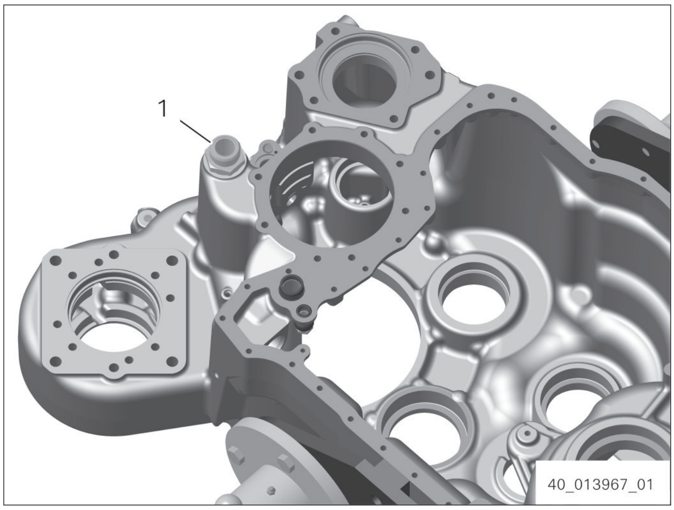


Fig. 162

4. Remove tube (1).

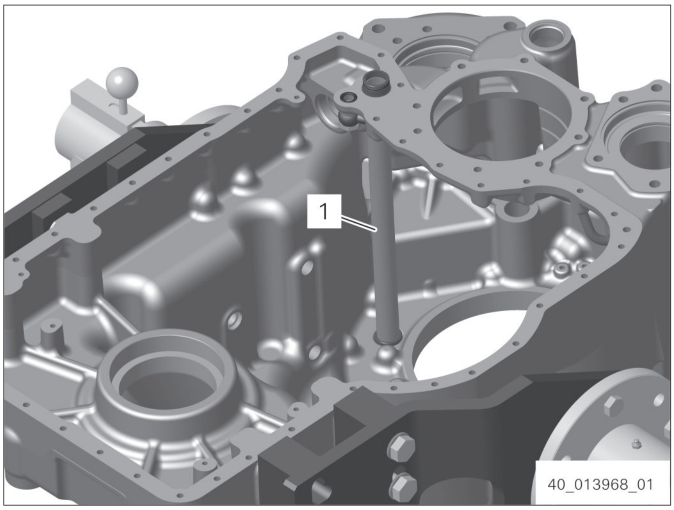


Fig. 163

5. Loosen hollow screws and tube.

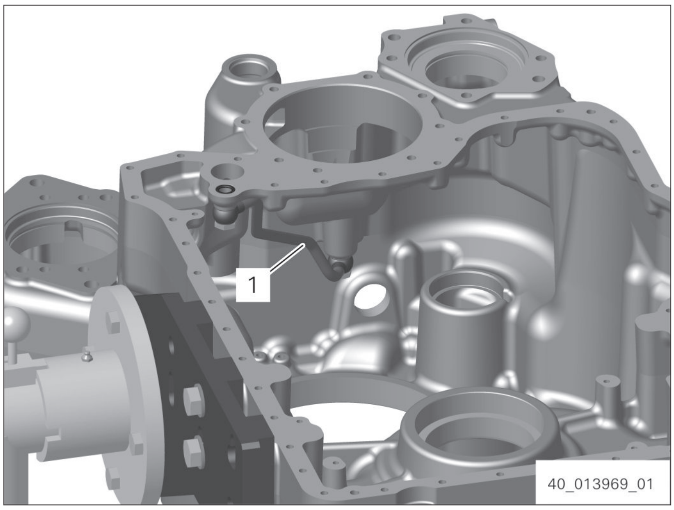


Fig. 164

Assembly

Assembling housing

1. Insert sealing rings between tube (2) and housing.

2. Push sealing rings onto the hollow screws.

3. Screw in the hollow screws with sealing ring (1) and tighten them.
Tightening torque: 45 Nm

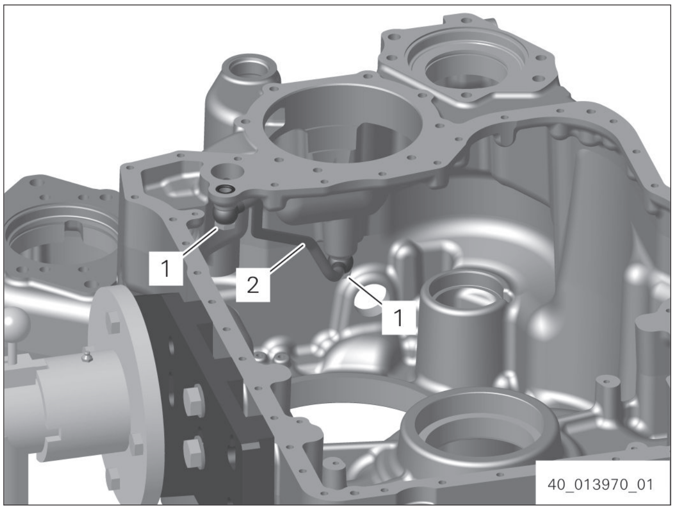


Fig. 165

4. Grease O-rings.

5. Insert O-rings (1) into annular grooves of the tube.

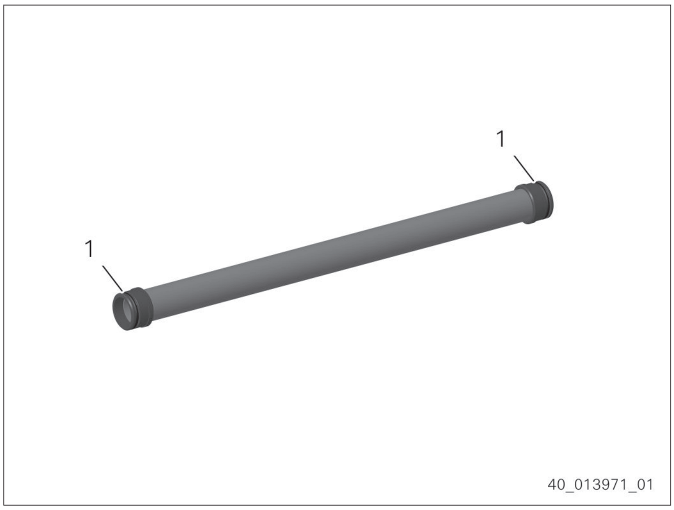


Fig. 166

6. Insert tube (1) into the housing.

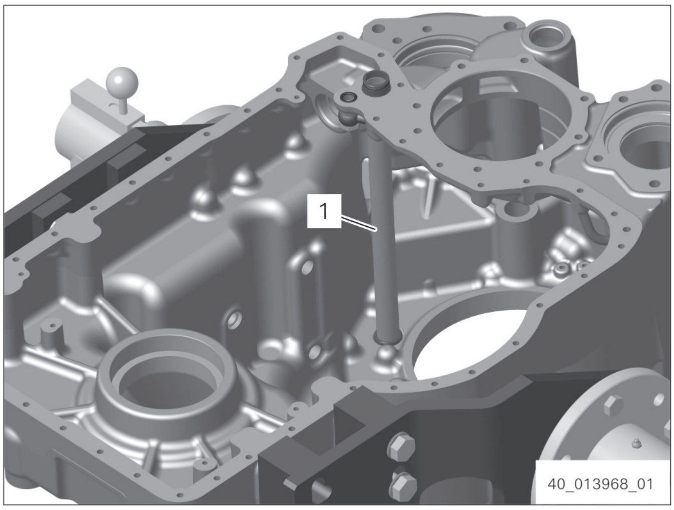


Fig. 167

7. Screw in the adapter with O-ring (1) and tighten.
   Tightening torque: 117 Nm

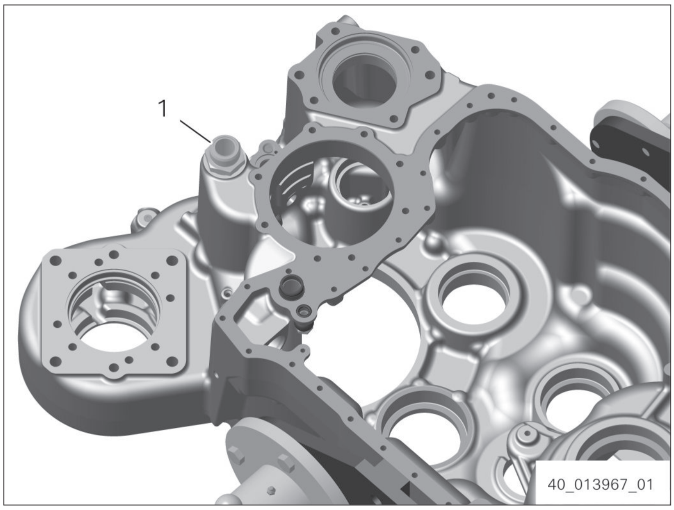


Fig. 168

8. Insert ring and both tapered roller bearings into gear (layshaft gear).

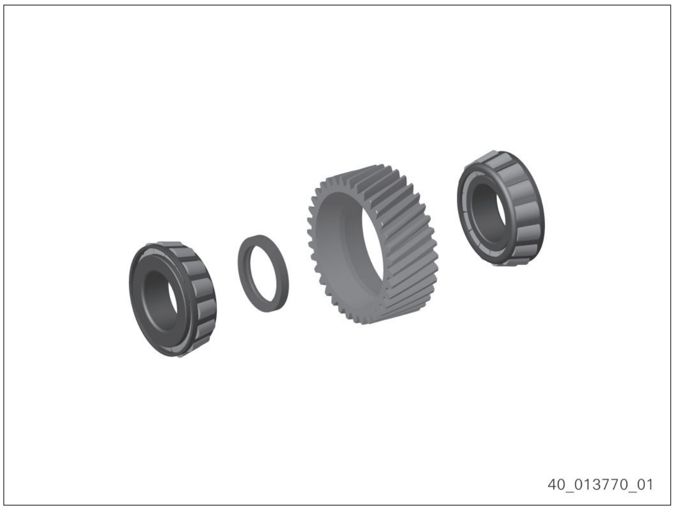


Fig. 169

9. Insert gear (1) into the housing.
   Countershaft cannot be inserted before installation of the clutches.

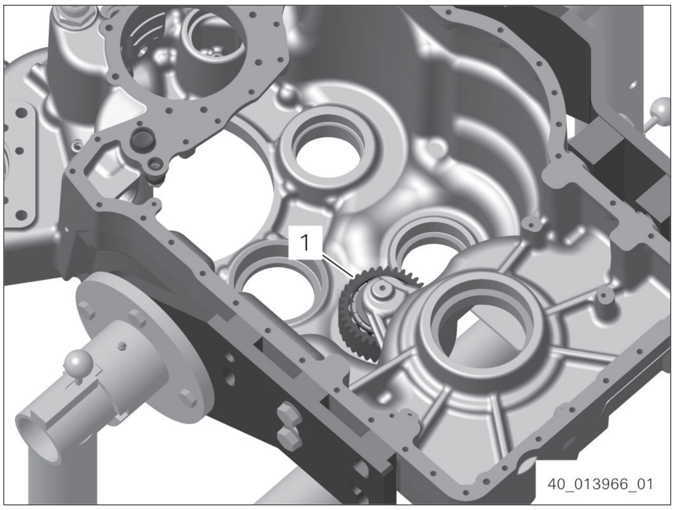


Fig. 170

10. Insert bearing outer rings in housing holes until contact is obtained.
    Figure shows the positions of the bearing outer rings.
    - 1 = clutch KV/K1
    - 2 = clutch K3/K4
    - 3 = clutch KR/K2

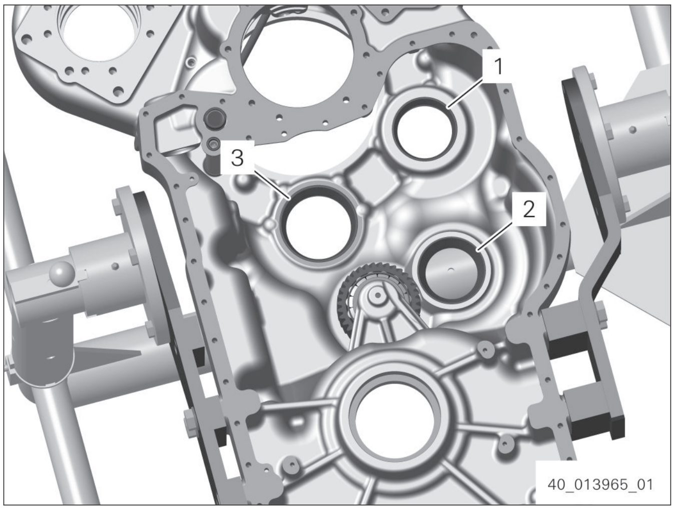


Fig. 171

Assembling and installing clutches and output

Assembling clutch KV/K1

Special tools:

- 5870.350.000 Assembly truck
- 5870.654.033 Assembly fixture
- 5870.320.014 Assembly fixture
- 5870.320.018 Inserting tool
- 5870.320.019 Press-in mandrel
- 5870.345.072 Assembly fixture
- 5870.401.118 Groove nut wrench
- 5870.401.115 Groove nut wrench

1. Fasten disk carrier to 5870.350.000 [Assembly truck] using 5870.654.033 [Assembly fixture].

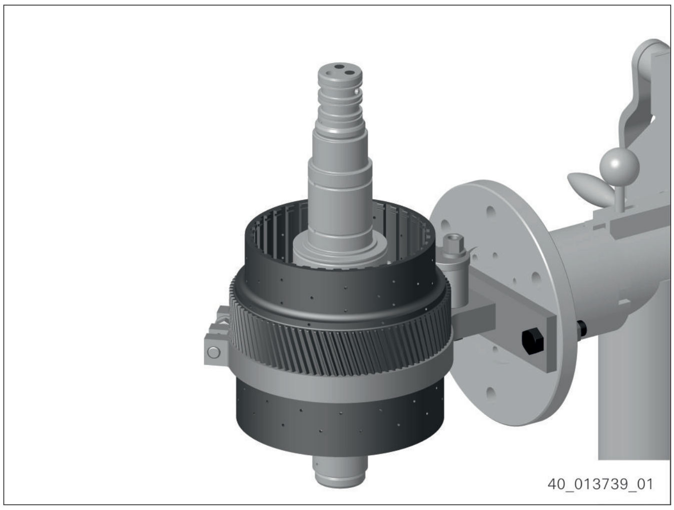


Fig. 172

Assembling disk carrier

2. Turn disk carrier by 180.

3. Insert sealing plug (1) into hole with 5870.320.014 [Assembly fixture] and 5870.320.018 [Inserting tool].

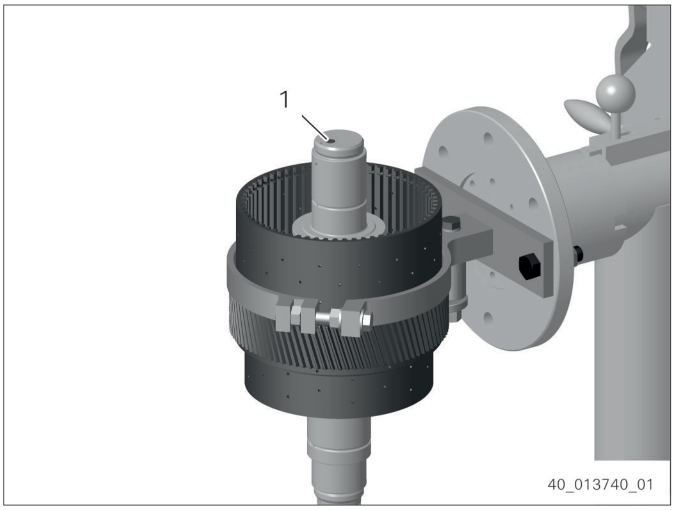


Fig. 173

4. Flush-mount valve (1) using 5870.320.019 [Press-in mandrel]. Insert valve with the chamfered side facing downwards.

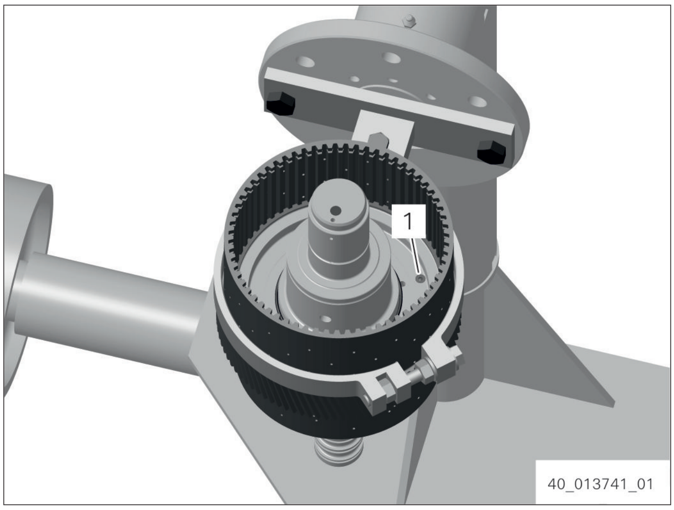


Fig. 174

5. Turn disk carrier by 180.

6. Insert sealing plugs (1) into holes using 5870.320.014 [Assembly fixture] and 5870.320.018 [Inserting tool].

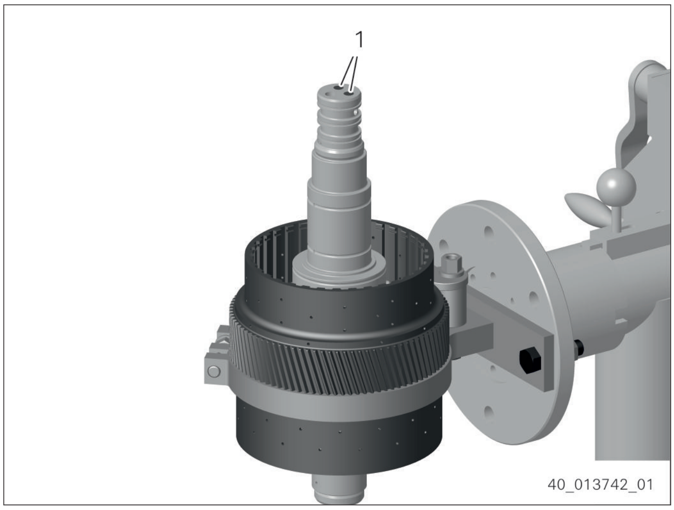


Fig. 175

7. Flush-mount valve (1) using 5870.320.019 [Press-in mandrel]. Insert valve with the chamfered side facing downwards.

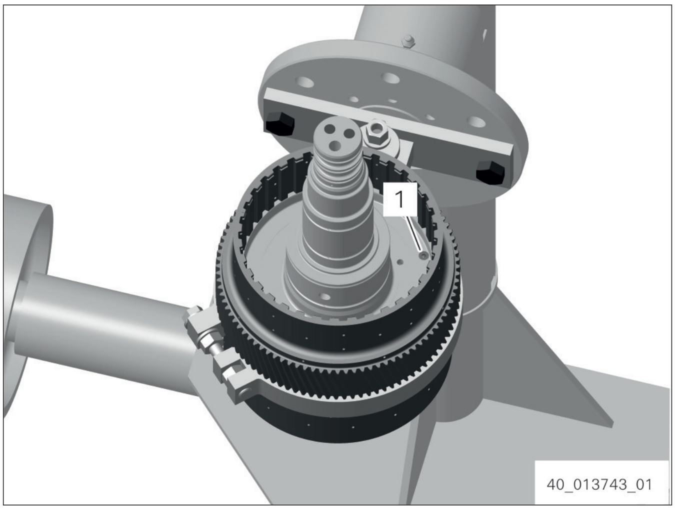


Fig. 176

8. Apply oil to O-rings (1) and insert them twist-free into annular grooves of the piston.

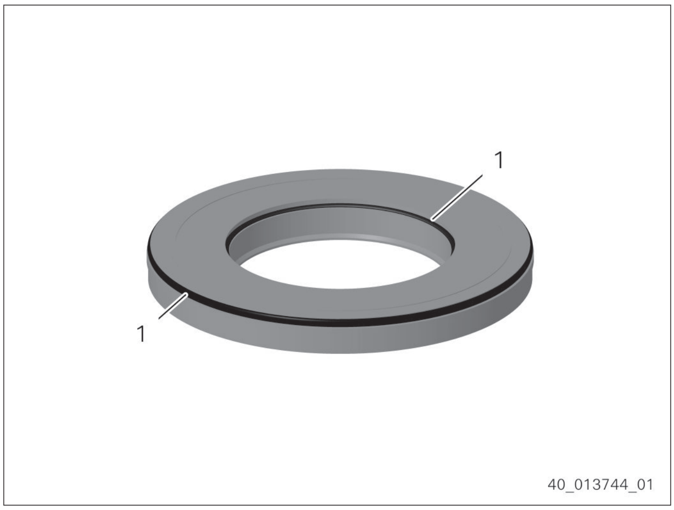


Fig. 177

9. Oil O-rings and piston bearing surfaces.

10. Insert piston (1) into the disk carrier until contact is obtained.

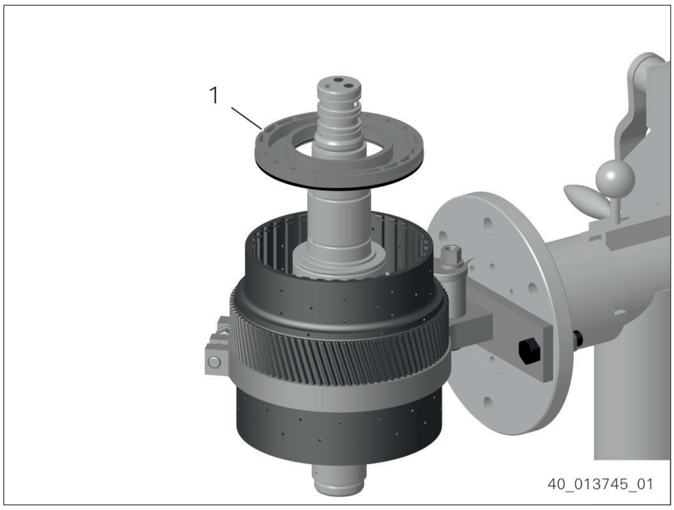


Fig. 178

11. Slide on intermediate washer (2) and compression spring (1).

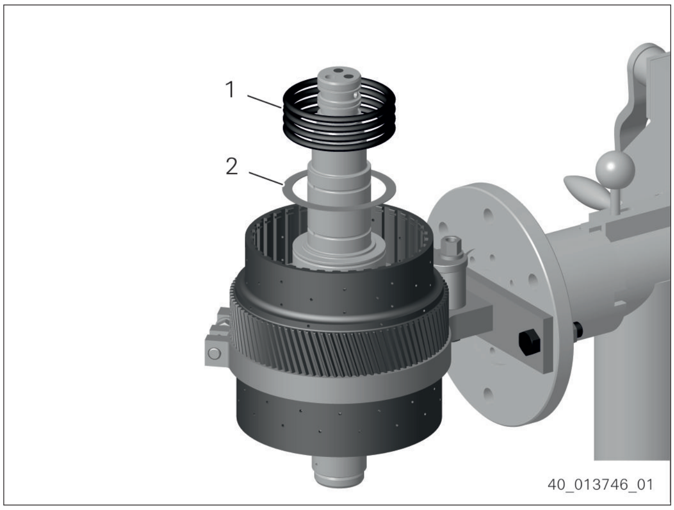


Fig. 179

12. Place guide ring (2) onto compression spring with chamfer facing upwards.

13. Slide on snap ring (1).

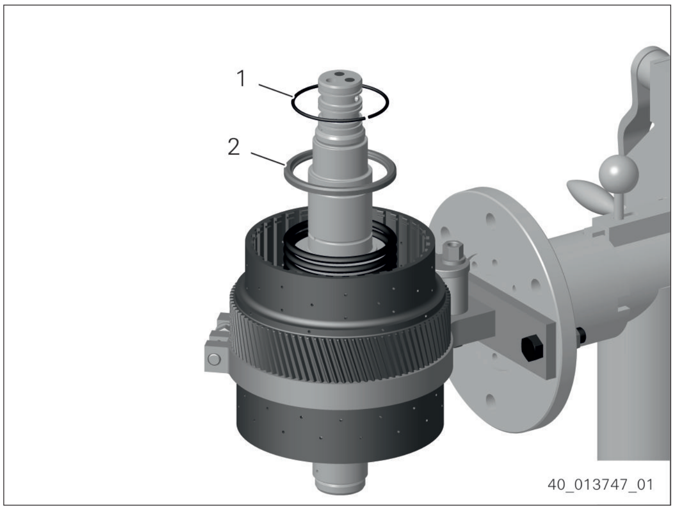


Fig. 180

14. Press guide ring downwards with 5870.345.072 [Assembly fixture] and hand-operated press and hold it there.

15. Insert snap ring into annular groove of disk carrier.

16. Release hand-operated press.

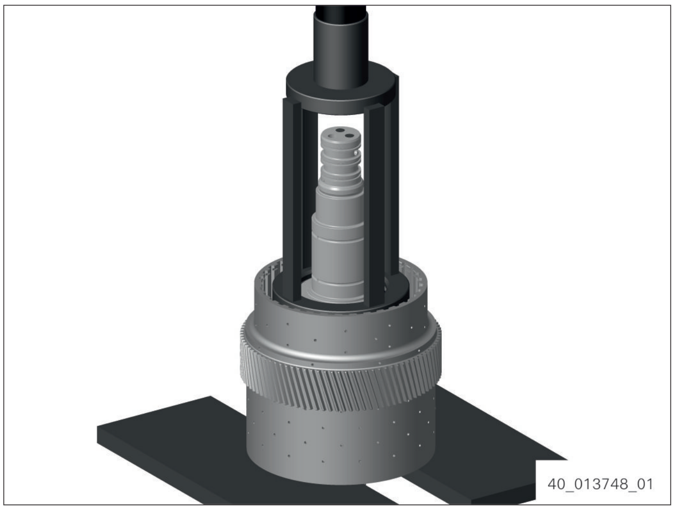


Fig. 181

17. Turn disk carrier by 180.

18. Apply oil to O-rings and insert them twist-free into annular grooves of the piston.

19. Oil O-rings and piston bearing surfaces.

20. Insert piston into the disk carrier until contact is obtained.

21. Slide on intermediate washer and compression spring.

22. Place guide ring onto compression spring with chamfer facing upwards.

23. Slide on snap ring.

24. Press guide ring downwards with 5870.345.072 [Assembly fixture] and hand-operated press and hold it there.

25. Insert snap ring into annular groove of disk carrier.

26. Release hand-operated press.

27. Fasten disk carrier to 5870.350.000 [Assembly truck] using 5870.654.033 [Assembly fixture].

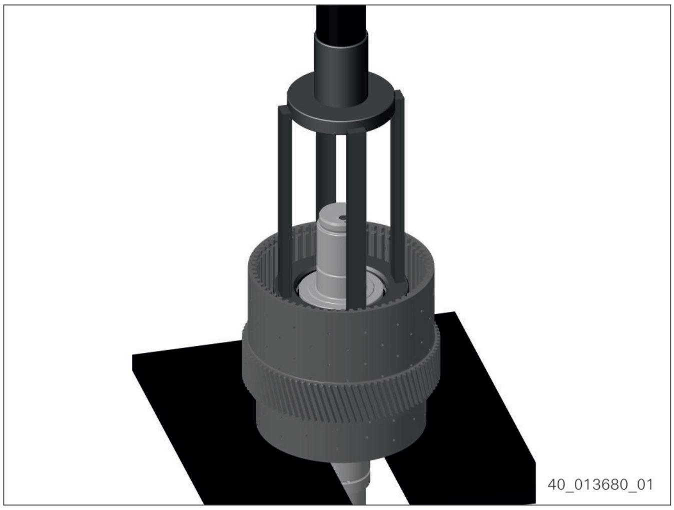


Fig. 182

Assembling clutch KV

28. To ensure a correct measuring result, install single parts without oil for the time being.

    Insert outer disks and inner disks.
    Insert first outer disk with the uncoated side facing the piston.
    Insert last outer disk with the uncoated side facing the end shim.

    For the arrangement refer to the current spare parts list.

    Thickness of the two optional inner disks must not differ by more than 0.7 mm.

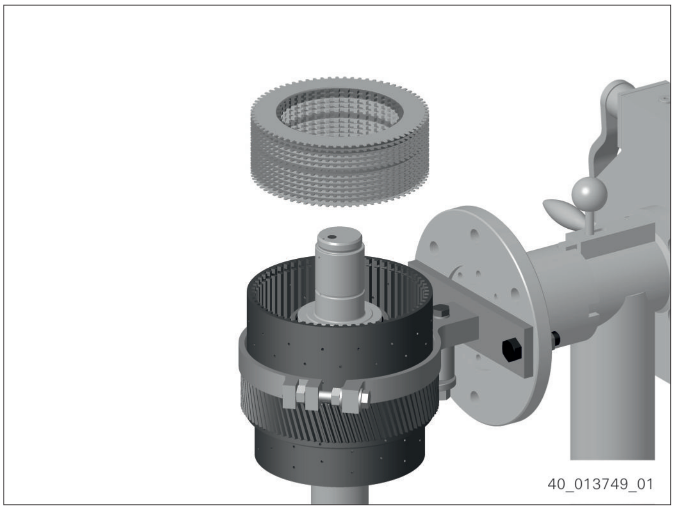


Fig. 183

29. Insert end shim (2).

30. Insert snap ring e. g. 2.60 mm (1).

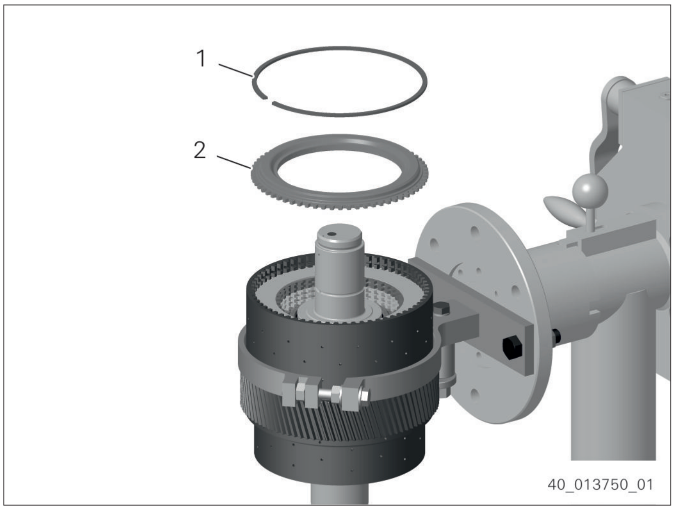


Fig. 184

31. Position dial gauge on the end shim.

32. Push end shim downwards with 100 N and set dial gauge to zero.

33. Lift end shim until contact with snap ring is obtained and check the necessary Disk clearance 2.8 mm to 3.0 mm.
If the disk clearance is too small, insert thinner inner disks or (and) a thinner snap ring.
If disk clearance is too big, install thicker inner disks or (and) and a thicker snap ring.

Thickness of the two optional inner disks must not differ by more than 0.7 mm.

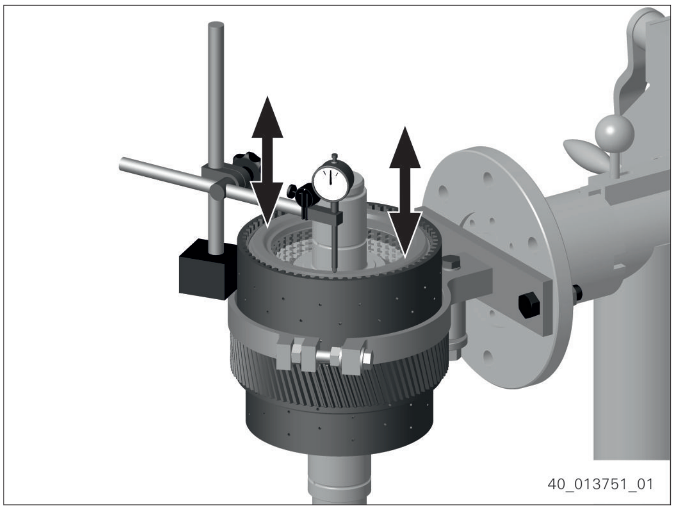


Fig. 185

34. Carry out the following two work steps immediately one after the other.

⚠ CAUTION

Risk of burn injuries due to contact with hot surfaces.
Slight or moderate injury possible.
⇨ Wear protective gloves.

Heat bearing inner ring.

35. Slide on bearing inner ring until contact is obtained.

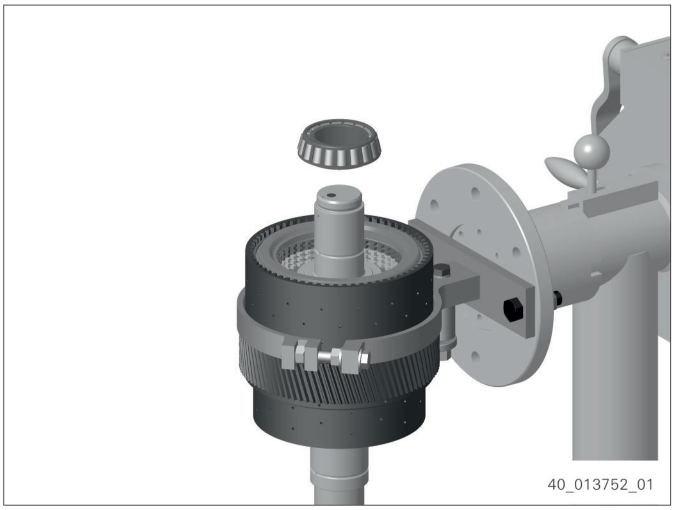


Fig. 186

36. Let bearing inner ring cool down.

37. Adjust bearing inner ring.

38. Slide on ring.

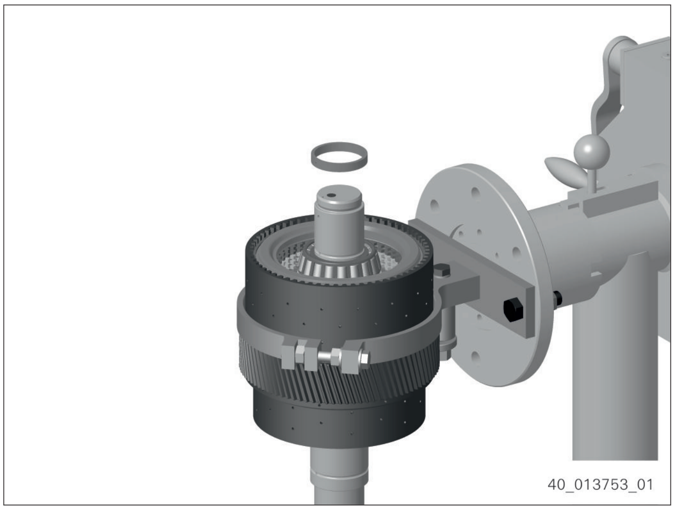


Fig. 187

39. Insert bearing outer rings into spur gear until contact is obtained.

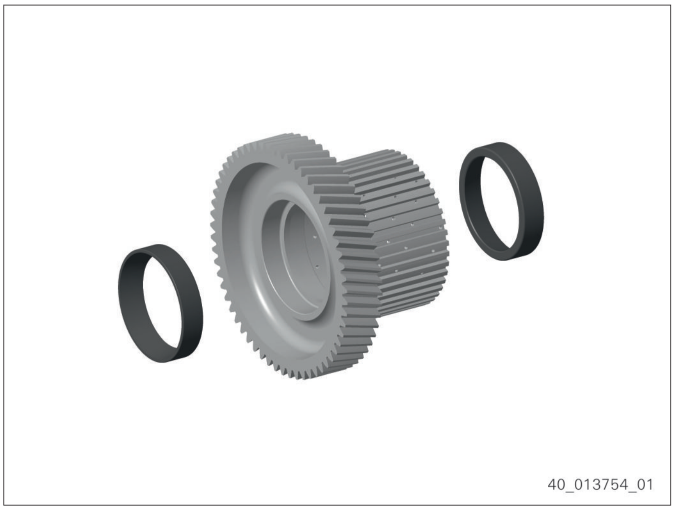


Fig. 188

40. Slide spur gear (1) onto shaft until contact is obtained. Insert spur gear into disk package by short mutual rotary motions.

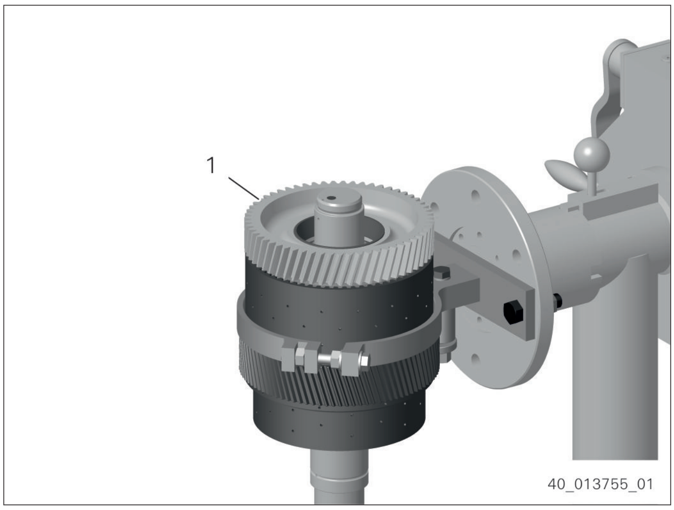


Fig. 189

41. Carry out the following two work steps immediately one after the other.

⚠ CAUTION

Risk of burn injuries due to contact with hot surfaces.
Slight or moderate injury possible.
⇨ Wear protective gloves.

Heat bearing inner ring.

42. Slide on bearing inner ring until contact is obtained.

43. Let bearing inner ring cool down.

44. Adjust bearing inner ring.

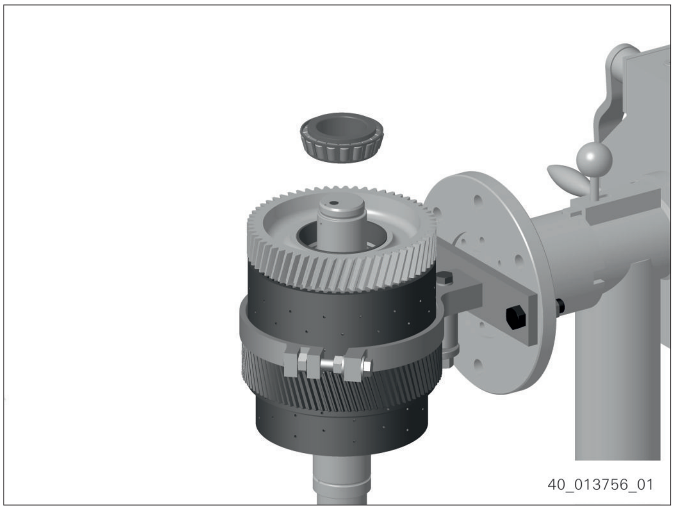


Fig. 190

45. Carry out the following two work steps immediately one after the other.

⚠ CAUTION

Risk of burn injuries due to contact with hot surfaces.
Slight or moderate injury possible.
⇨ Wear protective gloves.

Heat bearing inner ring.

46. Slide on bearing inner ring until contact is obtained.

47. Let bearing inner ring cool down.

48. Adjust bearing inner ring.

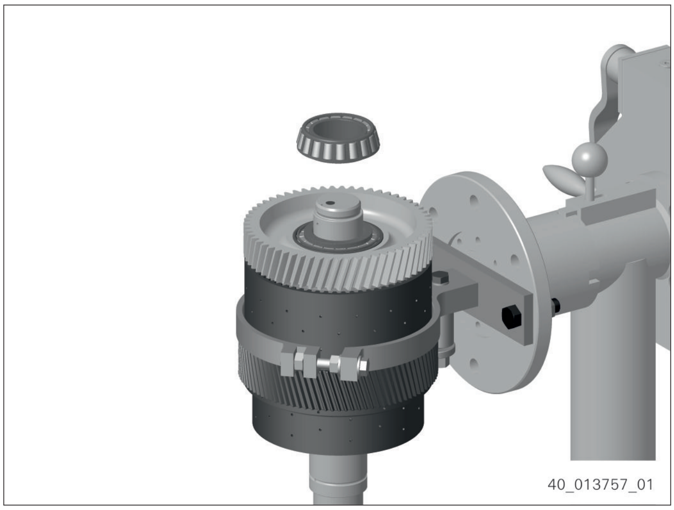


Fig. 191

49. Turn disk carrier by 90.

50. Use 5870.401.118 [Groove nut wrench] and 5870.401.115 [Groove nut wrench] to tighten the slotted nut.
Tightening torque: 550 Nm

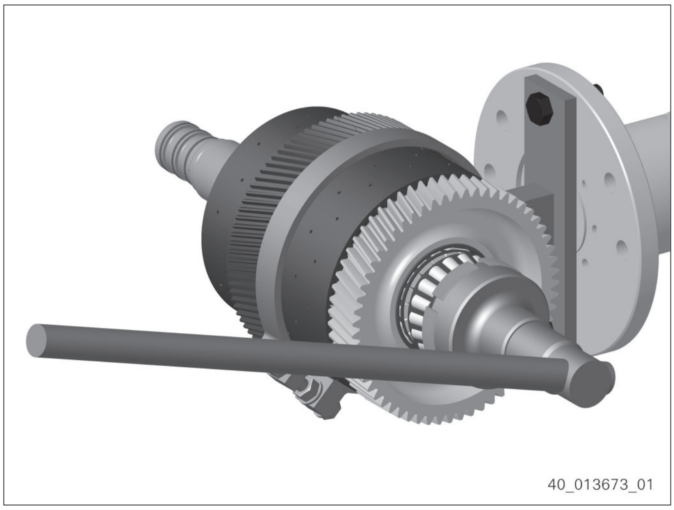


Fig. 192

Assembling clutch K1

51. Turn disk carrier by 90.

52. To ensure a correct measuring result, install single parts without oil for the time being.

Insert outer disks and inner disks.
Insert first outer disk with the uncoated side facing the piston.
Insert last outer disk with the uncoated side facing the end shim.

For the arrangement refer to the current spare parts list.

Thickness of the two optional inner disks must not differ by more than 0.7 mm.

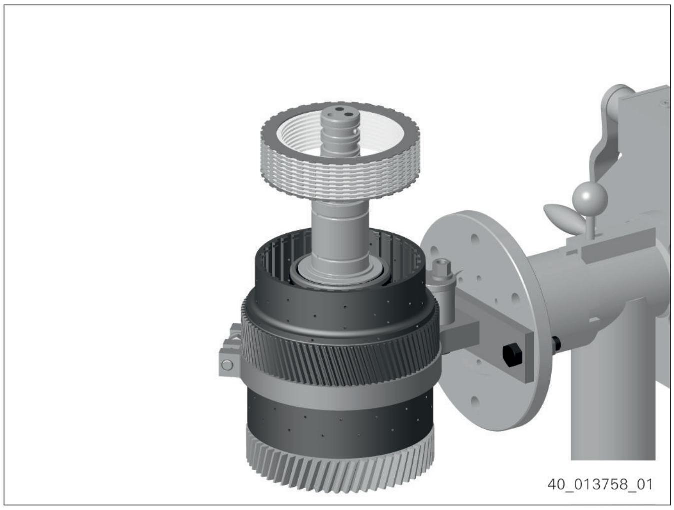


Fig. 193

53. Insert end shim (2).

54. Insert snap ring e. g. 2.30 mm (1).

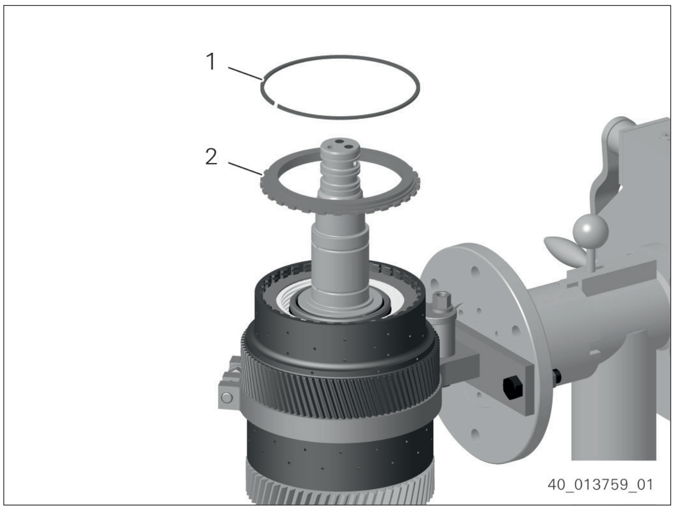


Fig. 194

55. Position dial gauge on the end shim.

56. Push end shim downwards with 100 N and set dial gauge to zero.

57. Lift end shim until contact with snap ring is obtained and check the necessary Disk clearance 2.2 mm to 2.4 mm.
If the disk clearance is too small, insert thinner inner disks or (and) a thinner snap ring.
If disk clearance is too big, install thicker inner disks or (and) and a thicker snap ring.

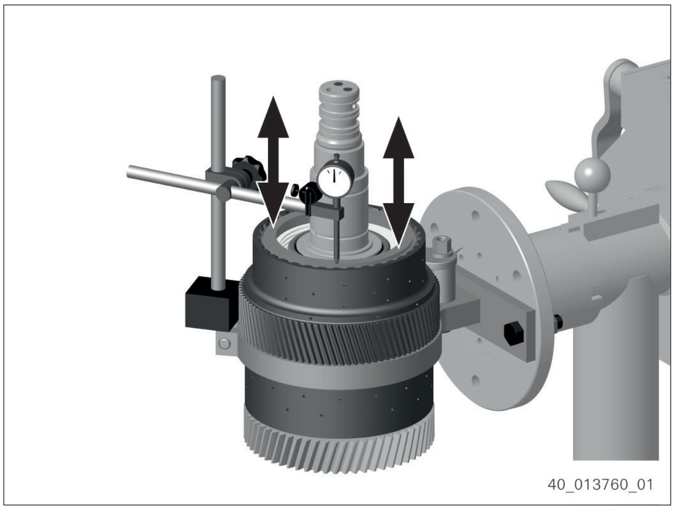


Fig. 195

Thickness of the two optional inner disks must not differ by more than 0.7 mm.

58. The angular ball bearing has not yet been installed in the gear.

Align disk package with the gear (1). Insert gear into the disk package by short mutual rotary motions.

59. Remove gear.

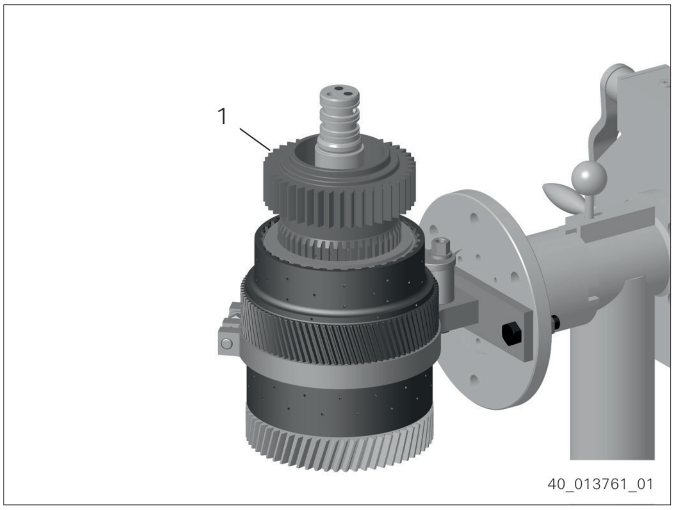


Fig. 196

60. Figure shows single parts of gear bearing.
    - 1 = Angular ball bearing
    - 2 = Snap ring
    - 3 = Gear

    The angular ball bearing is only available as complete unit.

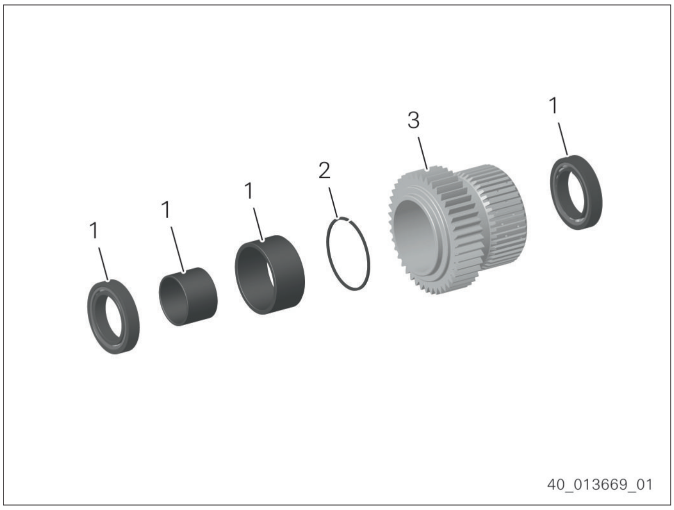


Fig. 197

61. Carry out the following two work steps immediately one after the other.

⚠ CAUTION

Risk of burn injuries due to contact with hot surfaces.
Slight or moderate injury possible.
⇨ Wear protective gloves.

Heat the ball bearing inner ring.

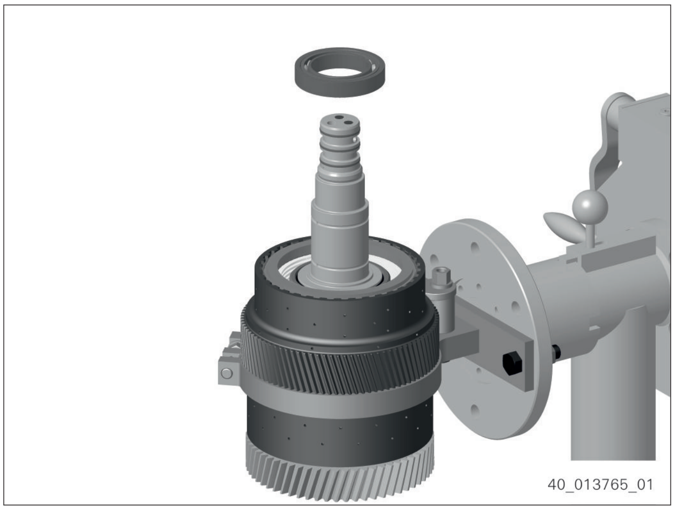


Fig. 198

62. Slide on the ball bearing with the lubricating groove facing upwards until contact is obtained.

63. Allow the ball bearing to cool down.

64. Adjust bearing inner ring.

65. Slide on intermediate ring.

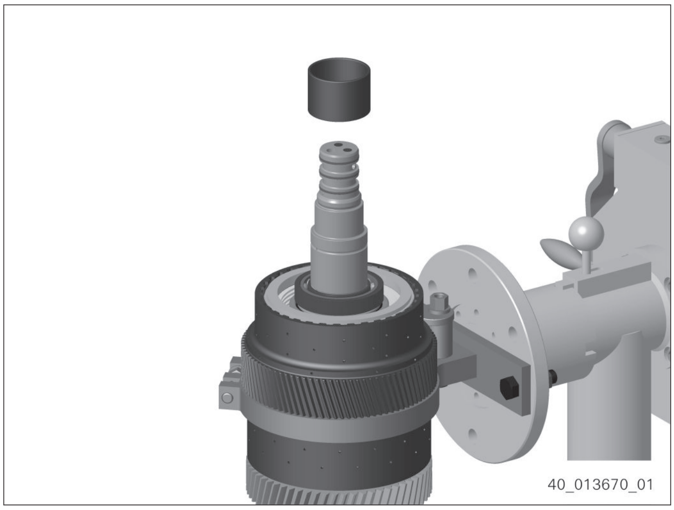


Fig. 199

66. Insert snap ring into annular groove of the gear.

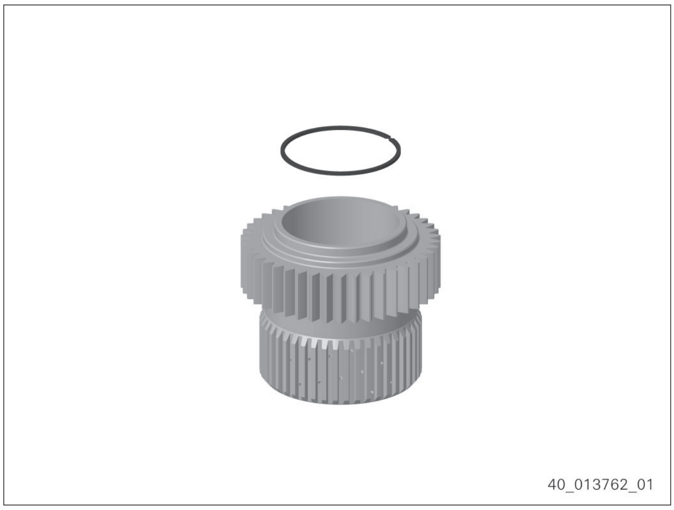


Fig. 200

67. Insert intermediate ring with the offset front face facing the snap ring.

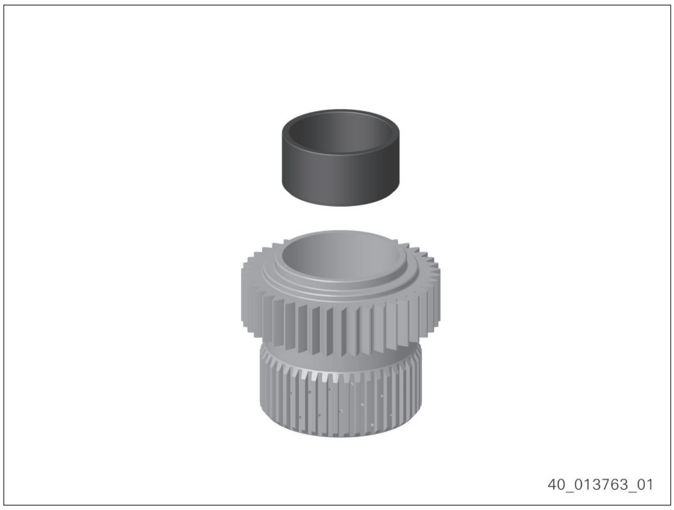


Fig. 201

68. Insert ball bearing with the lubricating groove facing downwards until contact is obtained.

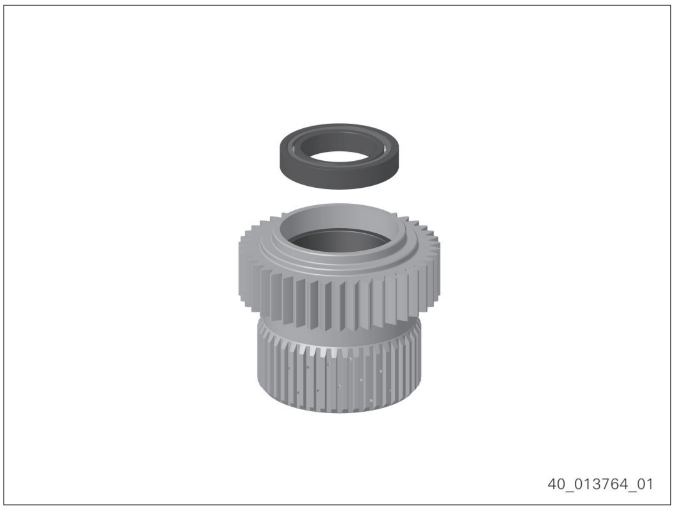


Fig. 202

69. Carry out the following two work steps immediately one after the other.

CAUTION

Risk of burn injuries due to contact with hot surfaces.
Slight or moderate injury possible.
⇨ Wear protective gloves.

Heat gear and ball bearing.

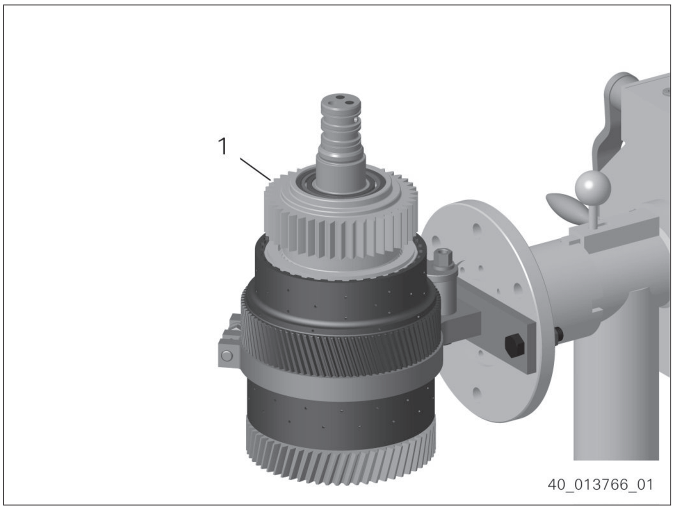


Fig. 203

70. Slide gear (1) onto shaft until contact is obtained. Insert gear into disk package.

71. Allow the ball bearing to cool down.

72. Adjust bearing inner ring.

73. Slide on shim.

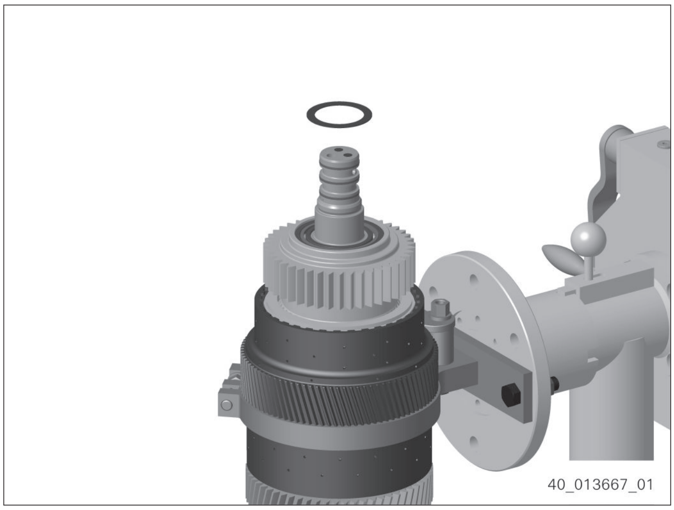


Fig. 204

74. Carry out the following two work steps immediately one after the other.

CAUTION

Risk of burn injuries due to contact with hot surfaces.
Slight or moderate injury possible.
⇨ Wear protective gloves.

Heat bearing inner ring.

75. Slide on bearing inner ring until contact is obtained.

76. Let bearing inner ring cool down.

77. Adjust bearing inner ring.

78. Turn disk carrier by 90.

79. Use 5870.401.118 [Groove nut wrench] and 5870.401.115 [Groove nut wrench] to tighten the slotted nut.
Tightening torque: 550 Nm

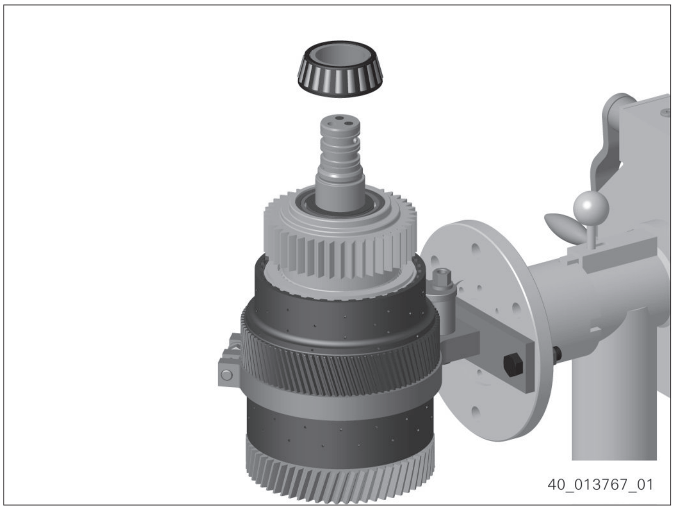


Fig. 205

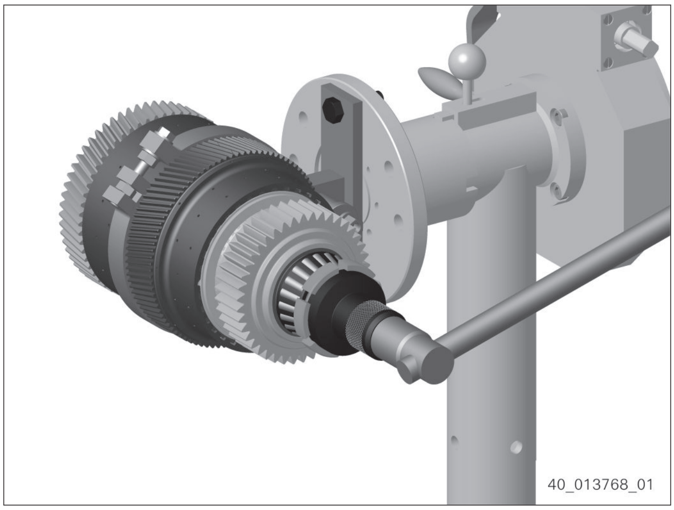


Fig. 206

80. Check function of the clutches by applying compressed air.

    → Closing and opening of the clutch is clearly audible.

    If closing and opening is not audible, disassemble and check clutch.

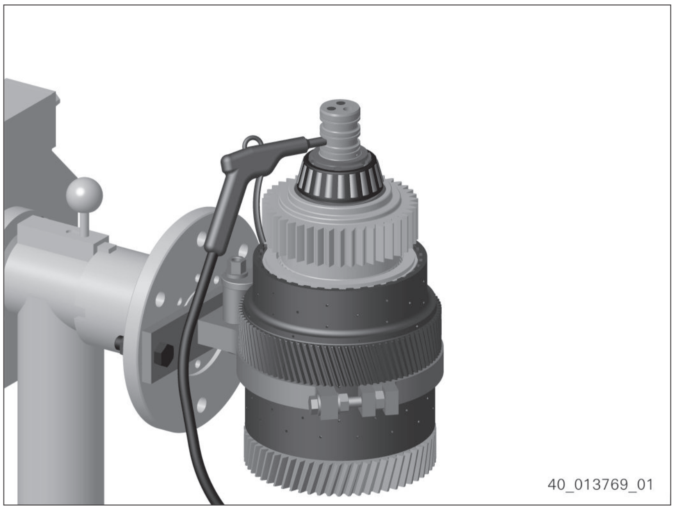


Fig. 207

81. Grease annular grooves of shaft.

82. Insert R-rings (1).

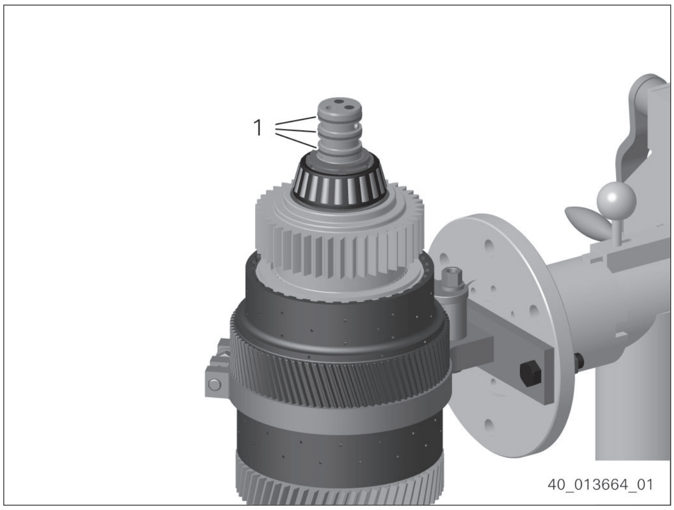


Fig. 208

Assembling clutch KR/K2

Special tools:

- 5870.350.000 Assembly truck
- 5870.654.033 Assembly fixture
- 5870.320.014 Assembly fixture
- 5870.320.018 Inserting tool
- 5870.320.019 Press-in mandrel
- 5870.345.072 Assembly fixture
- 5870.401.099 Groove nut wrench
- AA02.769.745 Slotted nut wrench

Assembly

1. Fasten disk carrier to 5870.350.000 [Assembly truck] using 5870.654.033 [Assembly fixture].

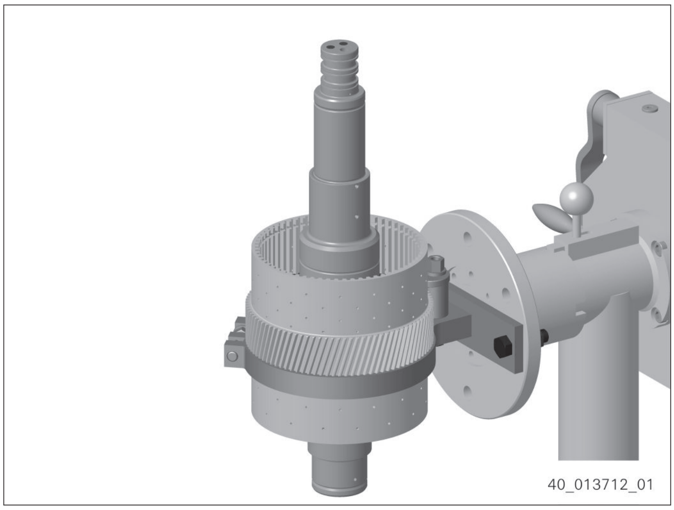


Fig. 209

Assembling disk carrier

2. Turn disk carrier by 180.

3. Insert sealing plug (1) into hole with 5870.320.014 [Assembly fixture] and 5870.320.018 [Inserting tool].

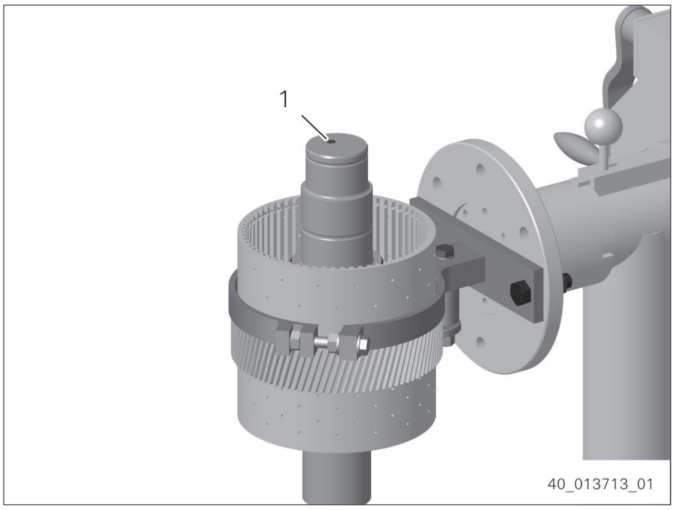


Fig. 210

4. Flush-mount valve (1) using 5870.320.019 [Press-in mandrel]. Insert valve with the chamfered side facing downwards.

Fig. 211

5. Turn disk carrier by 180.

6. Insert sealing plugs (1) into holes using 5870.320.014 [Assembly fixture] and 5870.320.018 [Inserting tool].

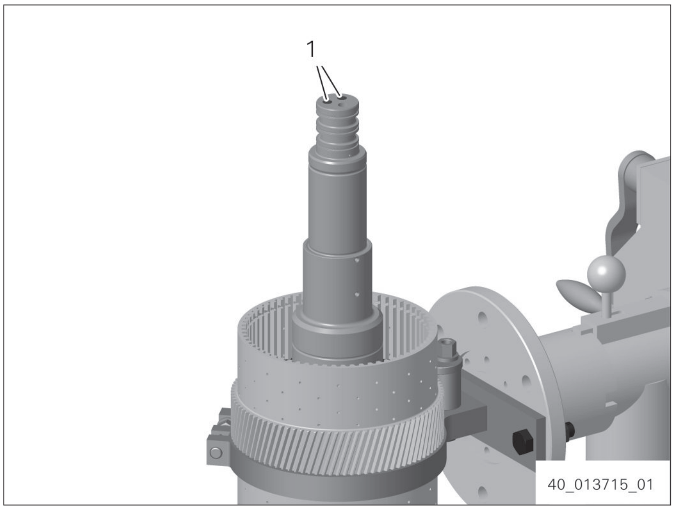


Fig. 212

7. Flush-mount valve (1) using 5870.320.019 [Press-in mandrel]. Insert valve with the chamfered side facing downwards.

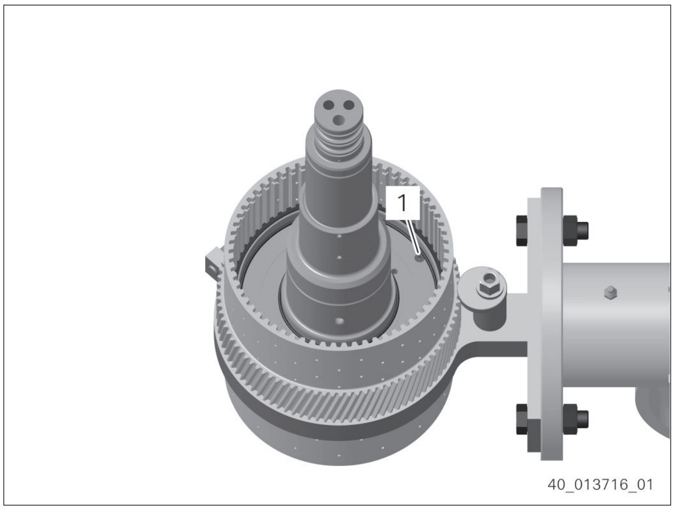


Fig. 213

8. Apply oil to O-rings (1) and insert them twist-free into annular grooves of the piston.

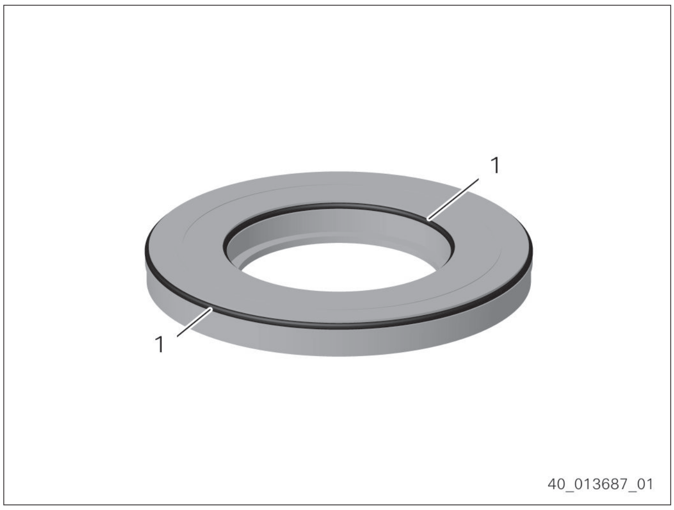


Fig. 214

9. Oil O-rings and piston bearing surfaces.

10. Insert piston (1) into the disk carrier until contact is obtained.

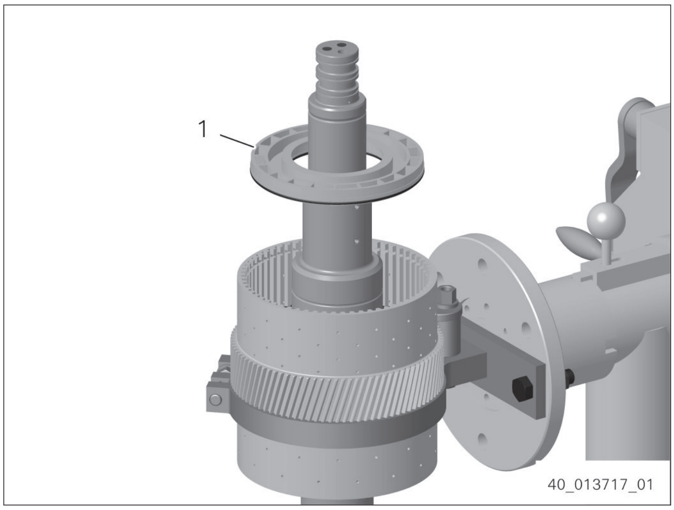


Fig. 215

11. Slide on intermediate washer (2) and compression spring (1).

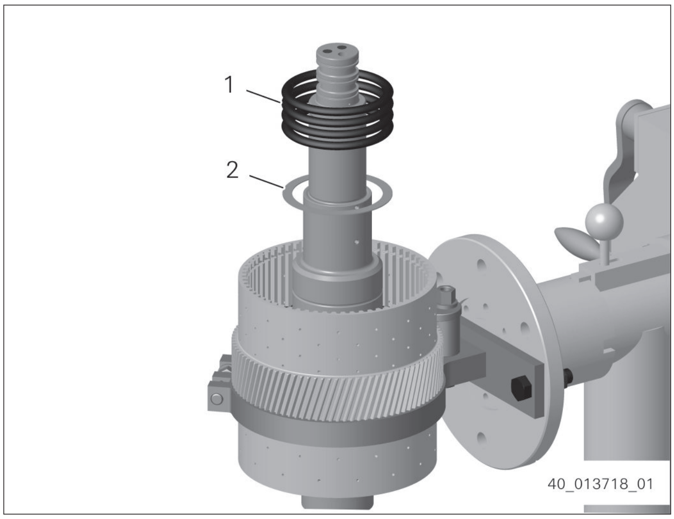


Fig. 216

12. Place guide ring (2) onto compression spring with chamfer facing upwards.

13. Slide on snap ring (1).

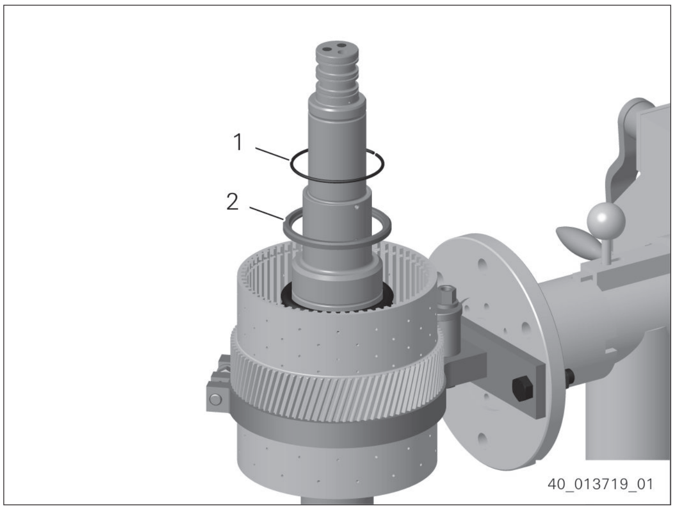


Fig. 217

14. Press guide ring downwards with 5870.345.072 [Assembly fixture] and hand-operated press and hold it there.

15. Insert snap ring into annular groove of disk carrier.

16. Release hand-operated press.

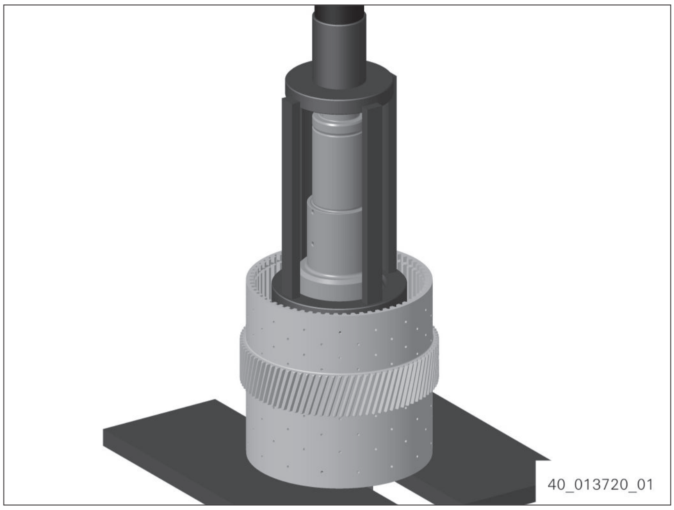


Fig. 218

17. Turn disk carrier by 180.

18. Apply oil to O-rings and insert them twist-free into annular grooves of the piston.

19. Oil O-rings and piston bearing surfaces.

20. Insert piston into the disk carrier until contact is obtained.

21. Slide on intermediate washer and compression spring.

22. Place guide ring onto compression spring with chamfer facing upwards.

23. Slide on snap ring.

24. Press guide ring downwards with 5870.345.072 [Assembly fixture] and hand-operated press and hold it there.

25. Insert snap ring into annular groove of disk carrier.

26. Release hand-operated press.

27. Fasten disk carrier to 5870.350.000 [Assembly truck] using 5870.654.033 [Assembly fixture].

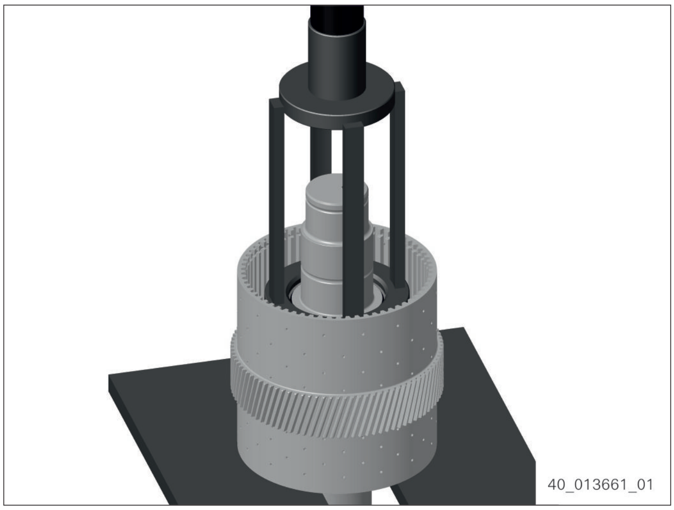


Fig. 219

Assembling clutch KR

28. To ensure a correct measuring result, install single parts without oil for the time being.

    Insert outer disks and inner disks.
    Insert first outer disk with the uncoated side facing the piston.
    Insert last outer disk with the uncoated side facing the end shim.
    For the arrangement refer to the current spare parts list.

    Thickness of the two optional inner disks must not differ by more than 0.7 mm.

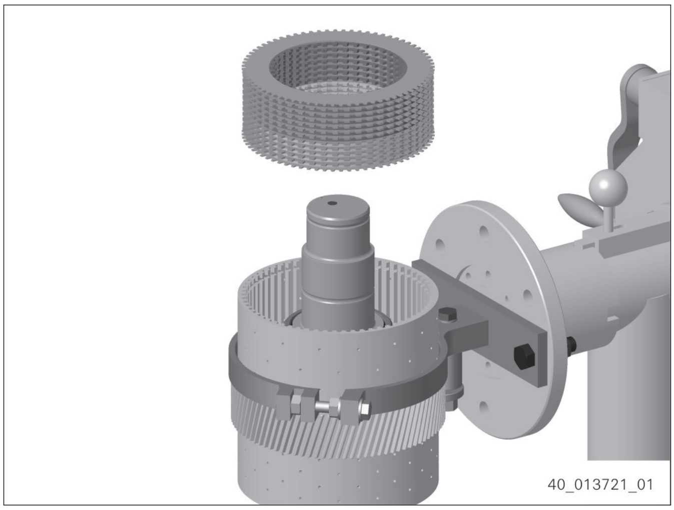


Fig. 220

29. Insert end shim (2).

30. Insert snap ring e. g. 2.60 mm (1).

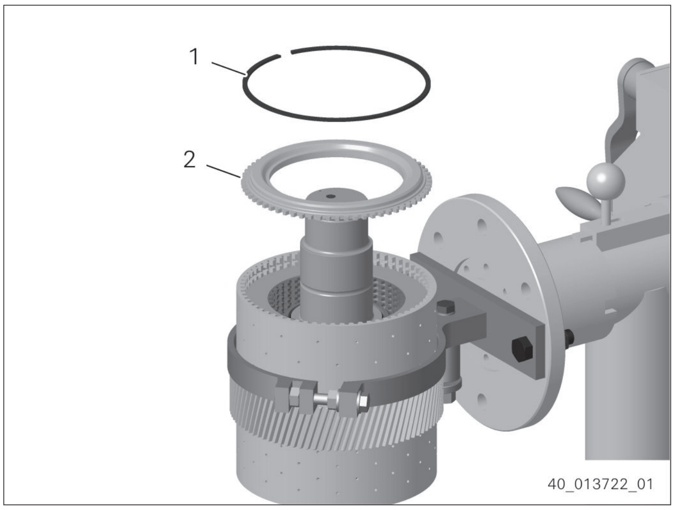


Fig. 221

31. Position dial gauge on the end shim.

32. Push end shim downwards with 100 N and set dial gauge to zero.

33. Lift end shim until contact with snap ring is obtained and check the necessary Disk clearance 2.8 mm to 3.0 mm.
    If the disk clearance is too small, insert thinner inner disks or (and) a thinner snap ring.
    If disk clearance is too big, install thicker inner disks or (and) and a thicker snap ring.

    Thickness of the two optional inner disks must not differ by more than 0.7 mm.

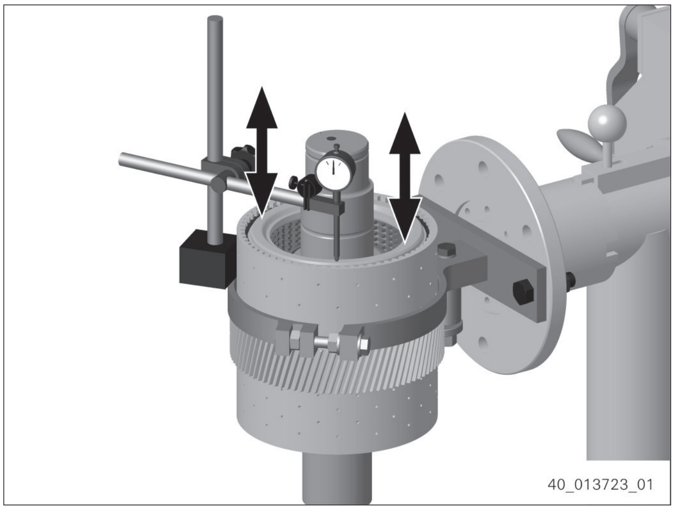


Fig. 222

34. Carry out the following two work steps immediately one after the other.

CAUTION

Risk of burn injuries due to contact with hot surfaces.
Slight or moderate injury possible.
⇨ Wear protective gloves.

Heat bearing inner ring.

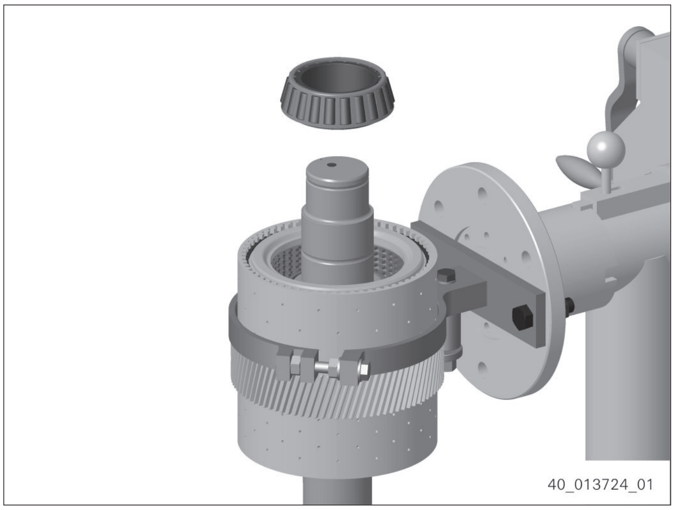


Fig. 223

35. Slide on bearing inner ring until contact is obtained.

36. Let bearing inner ring cool down.

37. Adjust bearing inner ring.

38. Slide spur gear (1) onto shaft until contact is obtained. Insert spur gear into disk package by short mutual rotary motions.

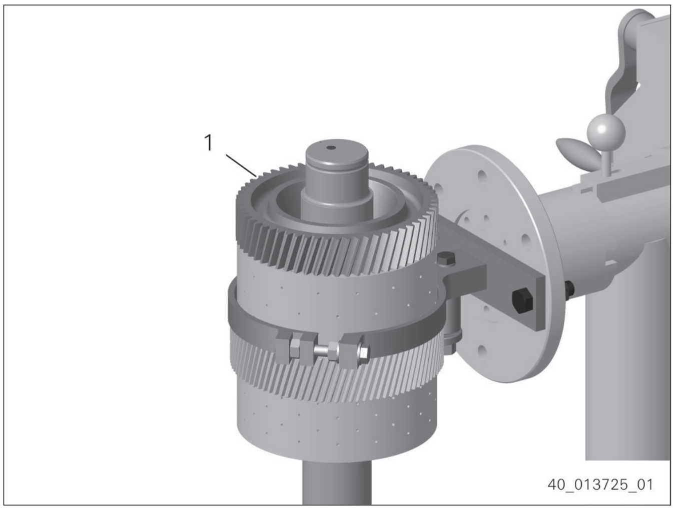


Fig. 224

39. Slide on ring with the recesses facing downwards.

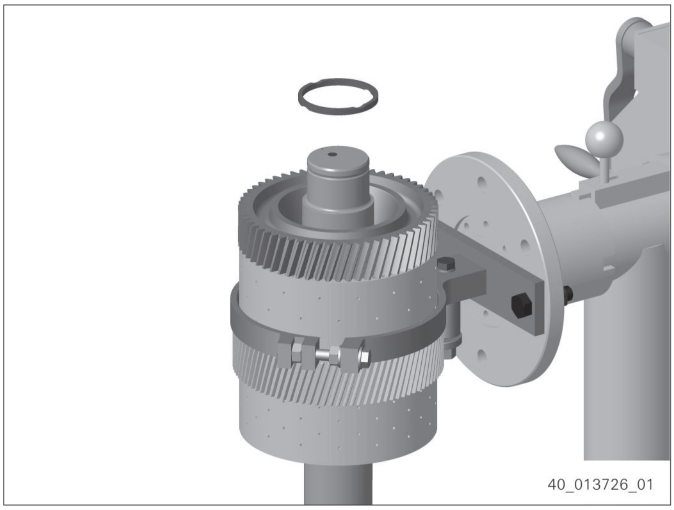


Fig. 225

40. Carry out the following two work steps immediately one after the other.

⚠ CAUTION

Risk of burn injuries due to contact with hot surfaces.
Slight or moderate injury possible.
⇨ Wear protective gloves.

Heat bearing inner ring.

41. Slide on bearing inner ring until contact is obtained.

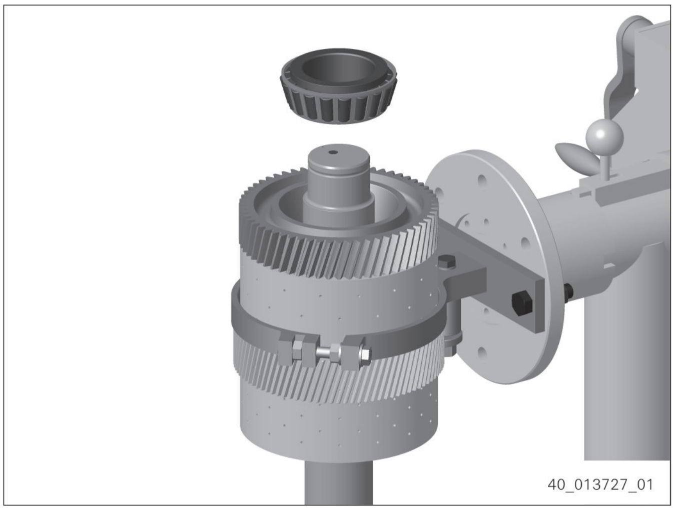


Fig. 226

42. Let bearing inner ring cool down.

43. Adjust bearing inner ring.

44. Carry out the following two work steps immediately one after the other.

⚠ CAUTION

Risk of burn injuries due to contact with hot surfaces.
Slight or moderate injury possible.
⇨ Wear protective gloves.

Heat bearing inner ring.

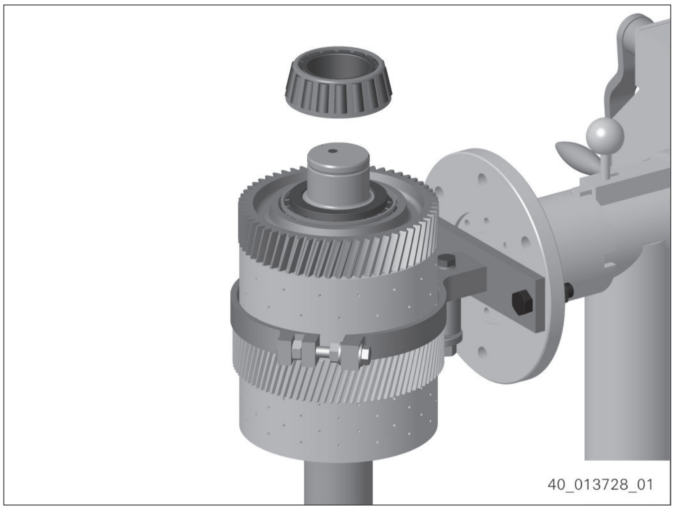


Fig. 227

45. Slide on bearing inner ring until contact is obtained.

46. Let bearing inner ring cool down.

47. Adjust bearing inner ring.

48. Turn disk carrier by 90.

49. Tighten slotted nut with 5870.401.099 [Groove nut wrench]. Tightening torque: 800 Nm

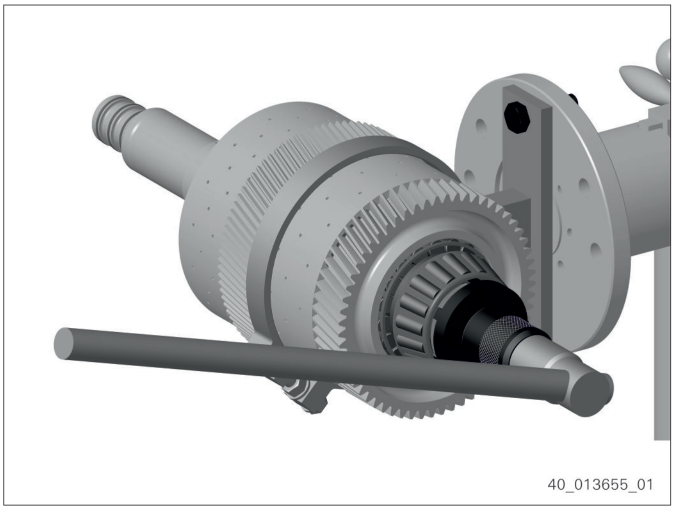


Fig. 228

Assembling clutch K2

50. Turn disk carrier by 90.

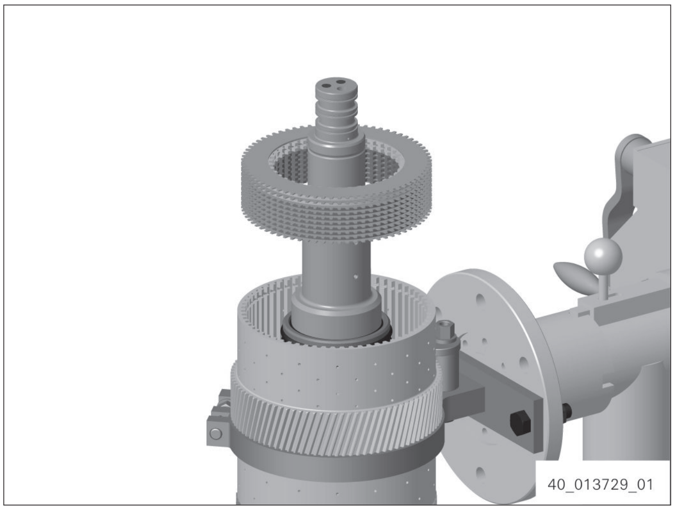


Fig. 229

51. To ensure a correct measuring result, install single parts without oil for the time being.

    Insert outer disks and inner disks.
    Insert first outer disk with the uncoated side facing the piston.
    Insert last outer disk with the uncoated side facing the end shim.

    For the arrangement refer to the current spare parts list.

    Thickness of the two optional inner disks must not differ by more than 0.7 mm.

52. Insert end shim (2).

53. Insert snap ring e. g. 2.60 mm (1).

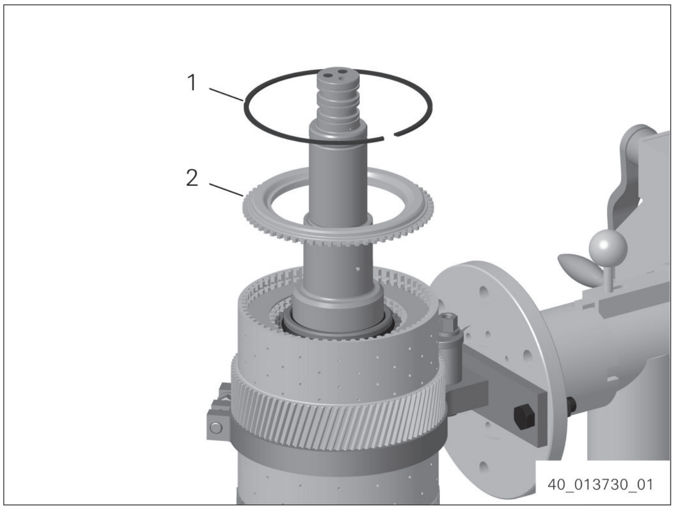


Fig. 230

54. Position dial gauge on the end shim.

55. Push end shim downwards with 100 N and set dial gauge to zero.

56. Lift end shim until contact with snap ring is obtained and check the necessary Disk clearance 2.2 mm to 2.4 mm.
    If the disk clearance is too small, insert thinner inner disks or (and) a thinner snap ring.
    If disk clearance is too big, install thicker inner disks or (and) and a thicker snap ring.

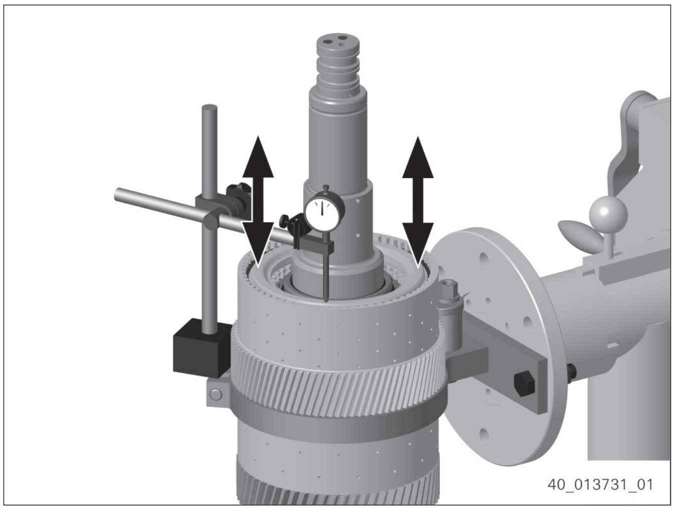


Fig. 231

Thickness of the two optional inner disks must not differ by more than 0.7 mm.

57. Carry out the following two work steps immediately one after the other.

⚠ CAUTION

Risk of burn injuries due to contact with hot surfaces.
Slight or moderate injury possible.
⇨ Wear protective gloves.

Heat bearing inner ring.

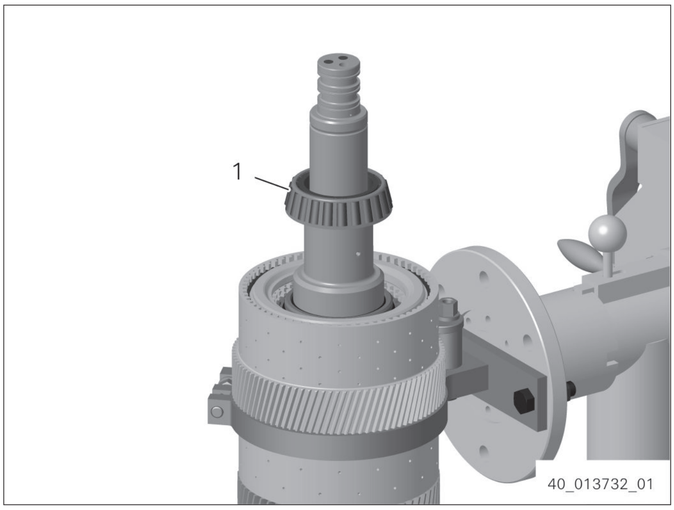


Fig. 232

58. Slide on bearing inner ring (1) until contact is obtained.

59. Let bearing inner ring cool down.

60. Adjust bearing inner ring.

61. **⚠ CAUTION**

Risk of burn injuries due to contact with cold surface.
Slight to moderate injury possible.
⇨ Wear protective gloves.

Undercool gear (1).

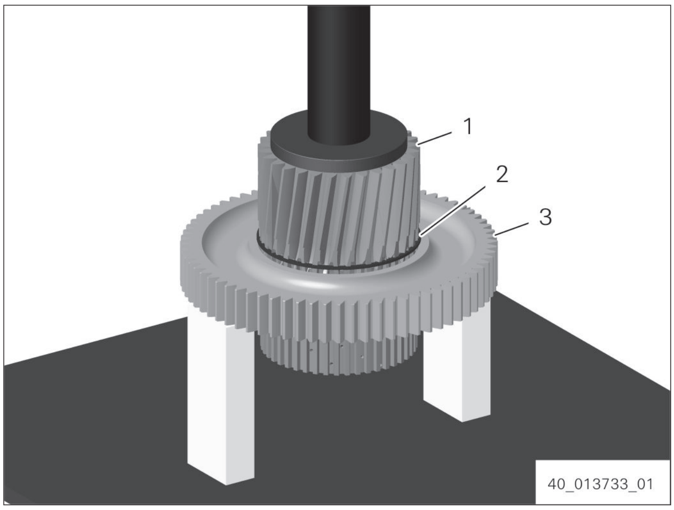


Fig. 233

62. **⚠ CAUTION**

Risk of burn injuries due to contact with hot surfaces.
Slight or moderate injury possible.
⇨ Wear protective gloves.

Heat up the gear (3).

63. Carry out the following three work steps immediately one after the other.

Insert snap ring (2) into annular groove of the gear (1).

64. Insert gear (1) into gear (3).

65. **CAUTION**

Risk of crushing due to hydraulic tool.
Slight to moderate injury possible.
⇨ Do not reach into danger area.

Push snap ring (2) into annular groove and force gear (1) into gear (3), until snap ring engages audibly.

66. Slide gear (1) onto shaft until contact is obtained. Insert gear into the disk package by short mutual rotary motions.

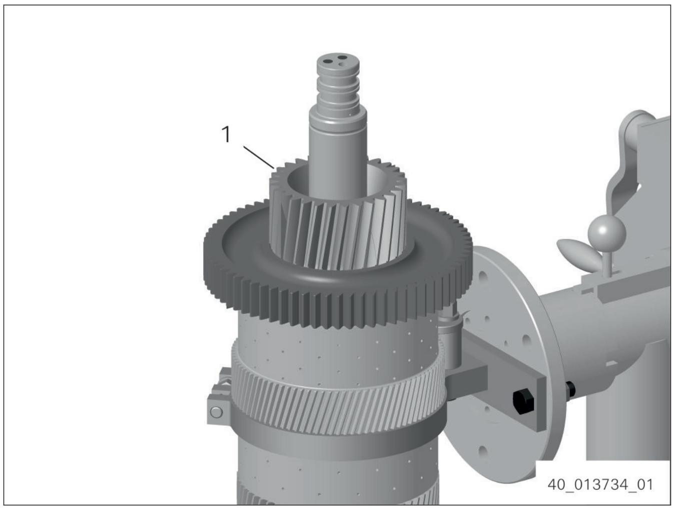


Fig. 234

67. Carry out the following two work steps immediately one after the other.

CAUTION

Risk of burn injuries due to contact with hot surfaces.
Slight or moderate injury possible.
⇨ Wear protective gloves.

Heat bearing inner ring.

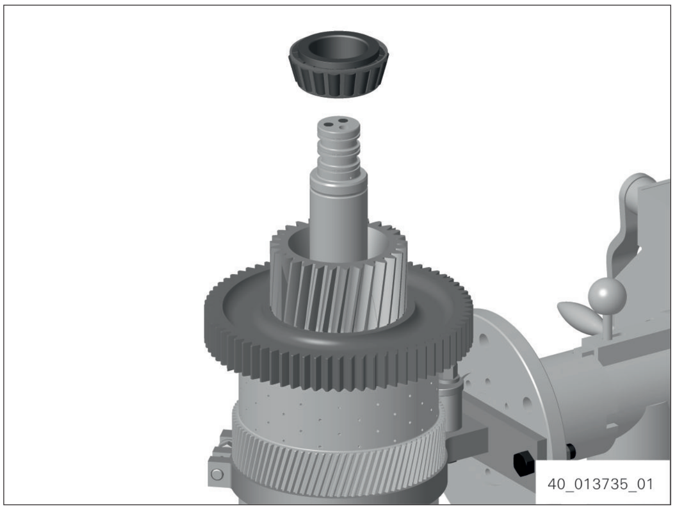


Fig. 235

68. Slide on bearing inner ring until contact is obtained.

69. Let bearing inner ring cool down.

70. Adjust bearing inner ring.

71. Carry out the following two work steps immediately one after the other.

CAUTION

Risk of burn injuries due to contact with hot surfaces.
Slight or moderate injury possible.
⇨ Wear protective gloves.

Heat bearing inner ring.

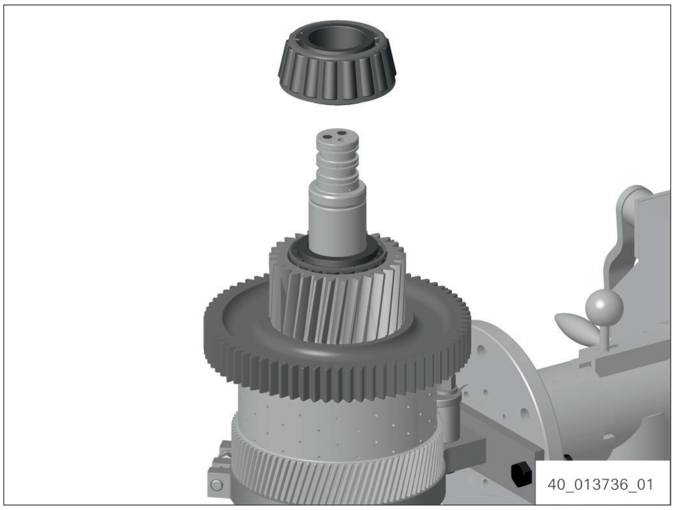


Fig. 236

72. Slide on bearing inner ring until contact is obtained.

73. Let bearing inner ring cool down.

74. Adjust bearing inner ring.

75. Turn disk carrier by 90.

76. Tighten slotted nut with AA02.769.745 [Slotted nut wrench].
Tightening torque: 800 Nm

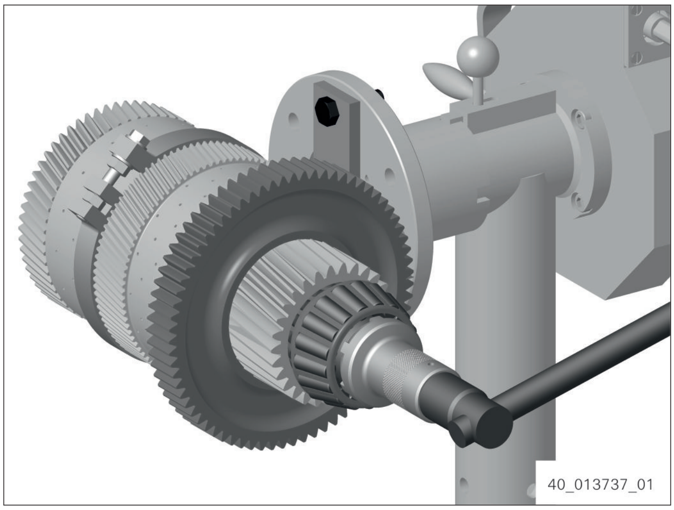


Fig. 237

77. Check function of the clutches by applying compressed air.

    → Closing and opening of the clutch is clearly audible.

    If closing and opening is not audible, disassemble and check clutch.

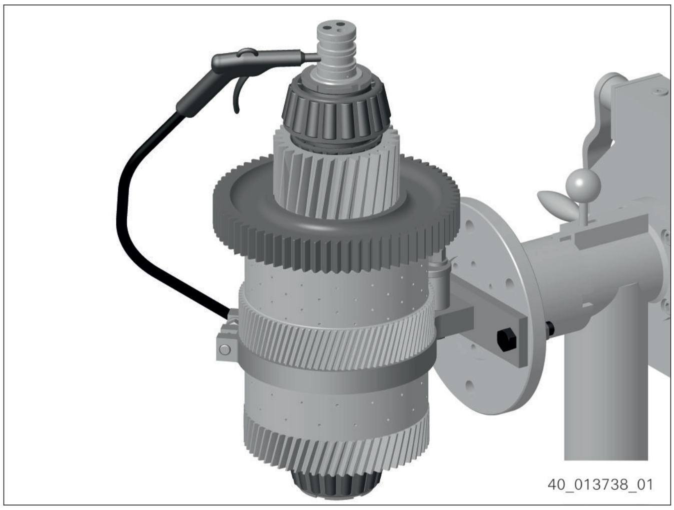


Fig. 238

78. Grease annular grooves of shaft.

79. Insert R-rings (1).

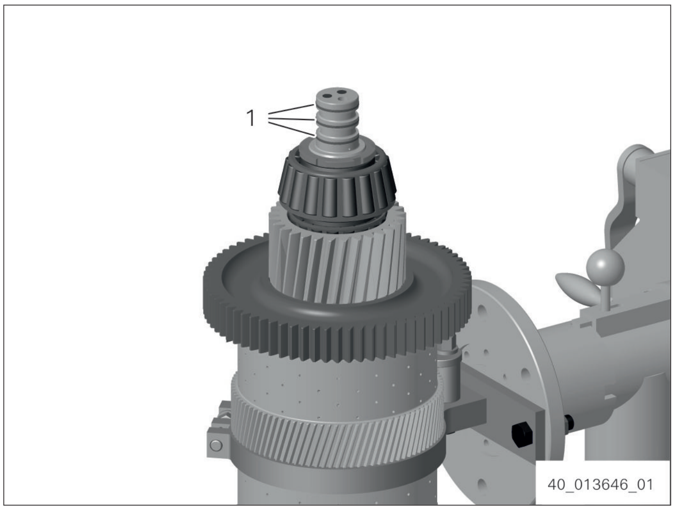


Fig. 239

Assembling clutch K3/K4

Special tools:

- 5870.350.000 Assembly truck
- 5870.654.033 Assembly fixture
- 5870.320.014 Assembly fixture
- 5870.320.018 Inserting tool
- 5870.320.019 Press-in mandrel
- 5870.345.072 Assembly fixture
- 5870.401.118 Groove nut wrench
- 5870.401.115 Groove nut wrench
- 5870.345.033 Assembly fixture
- AA00.317.255 Load ring

1. Fasten disk carrier to 5870.350.000 [Assembly truck] using 5870.654.033 [Assembly fixture].

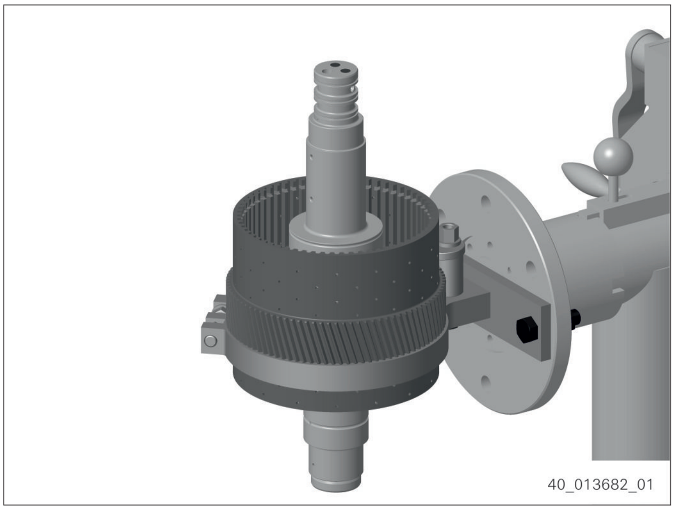


Fig. 240

Assembling disk carrier

2. Turn disk carrier by 180.

3. Insert sealing plug (1) into hole with 5870.320.014 [Assembly fixture] and 5870.320.018 [Inserting tool].

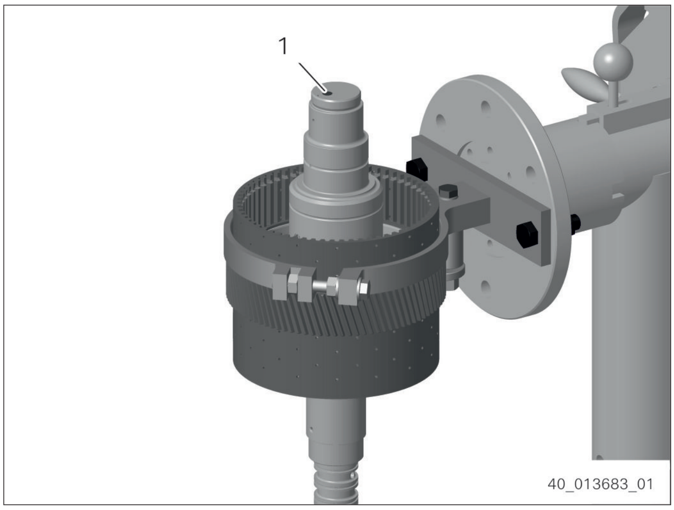


Fig. 241

4. Flush-mount valve (1) using 5870.320.019 [Press-in mandrel]. Insert valve with the chamfered side facing downwards.

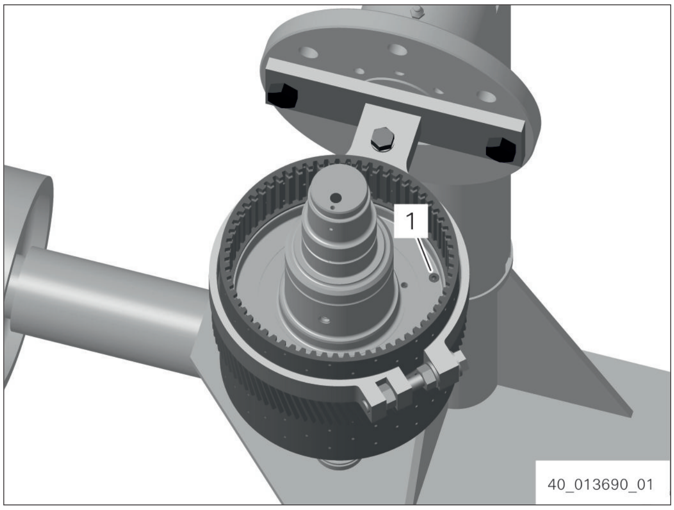


Fig. 242

5. Turn disk carrier by 180.

6. Insert sealing plugs (1) into holes using 5870.320.014 [Assembly fixture] and 5870.320.018 [Inserting tool].

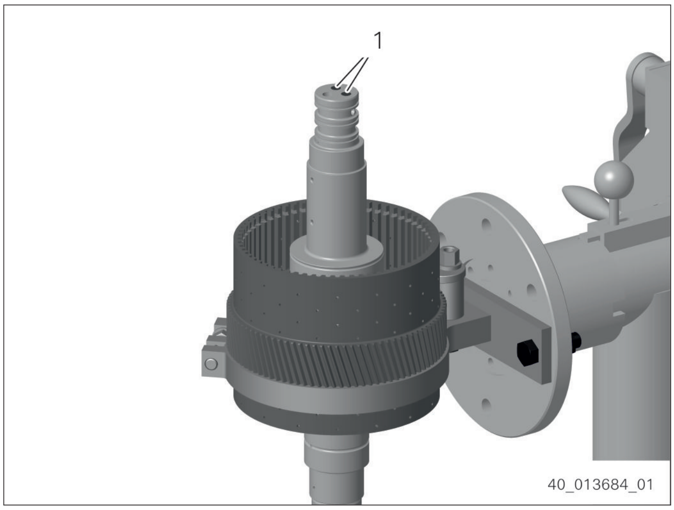


Fig. 243

7. Flush-mount valve (1) using 5870.320.019 [Press-in mandrel]. Insert valve with the chamfered side facing downwards.

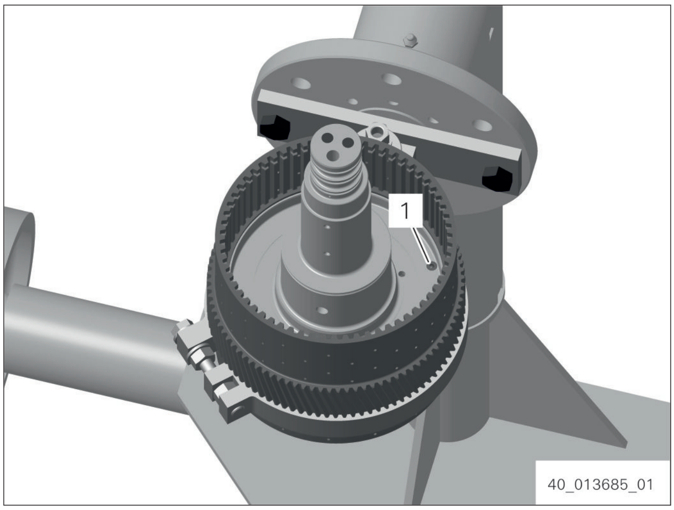


Fig. 244

8. Apply oil to O-rings (1) and insert them twist-free into annular grooves of the piston.

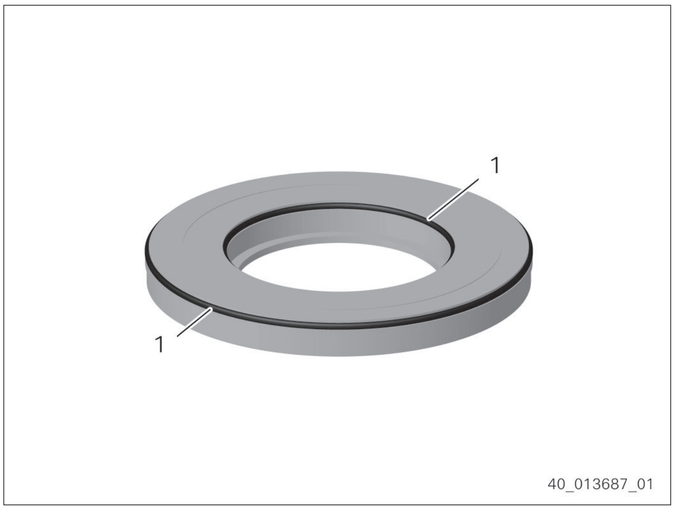


Fig. 245

9. Oil O-rings and piston bearing surfaces.

10. Insert piston (1) into the disk carrier until contact is obtained.

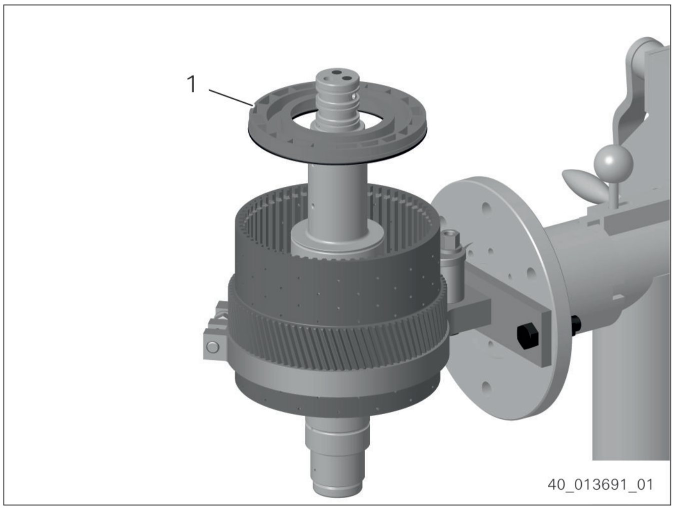


Fig. 246

11. Slide on intermediate washer (2) and compression spring (1).

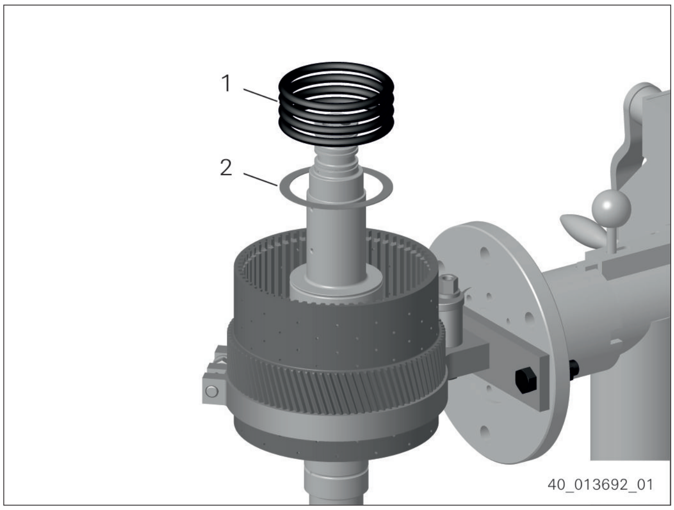


Fig. 247

12. Place guide ring (2) onto compression spring with chamfer facing upwards.

13. Slide on snap ring (1).

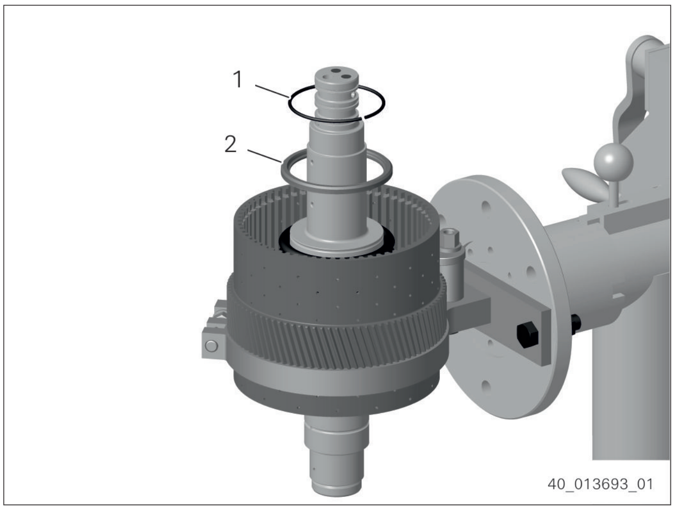


Fig. 248

14. Press guide ring downwards with 5870.345.072 [Assembly fixture] and hand-operated press and hold it there.

15. Insert snap ring into annular groove of disk carrier.

16. Release hand-operated press.

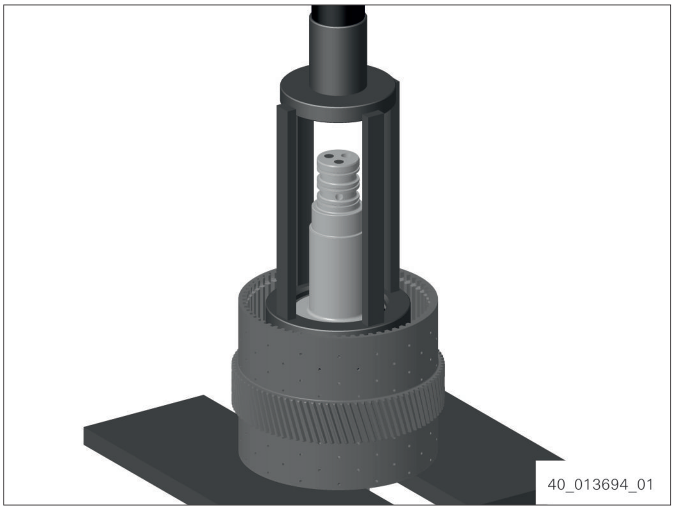


Fig. 249

17. Turn disk carrier by 180.

18. Apply oil to O-rings and insert them twist-free into annular grooves of the piston.

19. Oil O-rings and piston bearing surfaces.

20. Insert piston into the disk carrier until contact is obtained.

21. Slide on intermediate washer and compression spring.

22. Place guide ring onto compression spring with chamfer facing upwards.

23. Slide on snap ring.

24. Press guide ring downwards with 5870.345.072 [Assembly fixture] and hand-operated press and hold it there.

25. Insert snap ring into annular groove of disk carrier.

26. Release hand-operated press.

27. Fasten disk carrier to 5870.350.000 [Assembly truck] using 5870.654.033 [Assembly fixture].

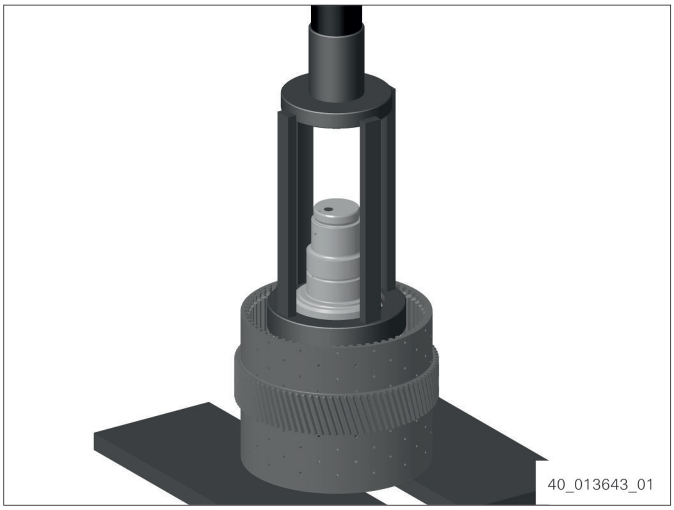


Fig. 250

Assembling clutch K4

28. To ensure a correct measuring result, install single parts without oil for the time being.

    Insert outer disks and inner disks.
    Insert first outer disk with the uncoated side facing the piston.
    Insert last outer disk with the uncoated side facing the end shim.

    For the arrangement refer to the current spare parts list.

    Thickness of the two optional inner disks must not differ by more than 0.7 mm.

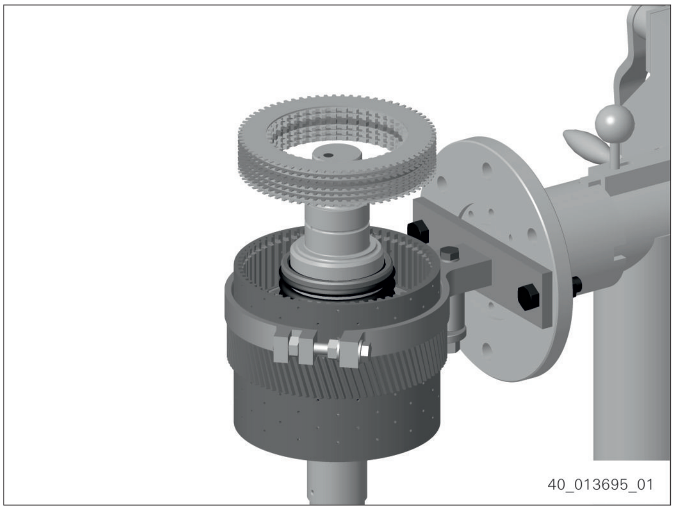


Fig. 251

29. Insert end shim (2).

30. Insert snap ring e. g. 2.60 mm (1).

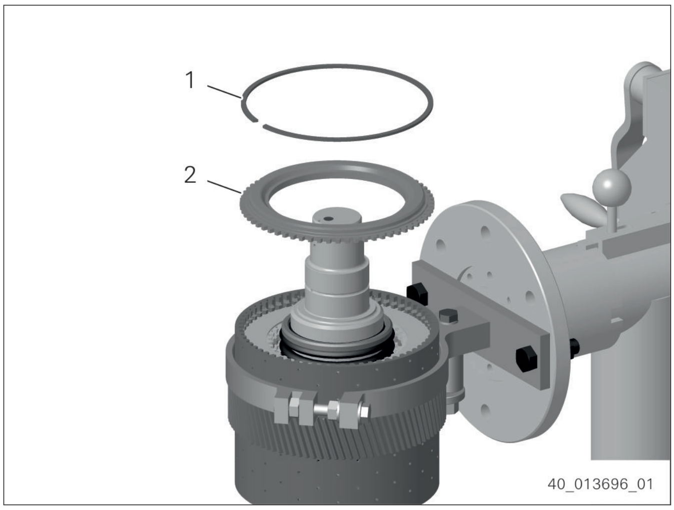


Fig. 252

31. Position dial gauge on the end shim.

32. Push end shim downwards with 100 N and set dial gauge to zero.

33. Lift end shim until contact with snap ring is obtained and check the necessary Disk clearance 2.2 mm to 2.4 mm.
    If the disk clearance is too small, insert thinner inner disks or (and) a thinner snap ring.
    If disk clearance is too big, install thicker inner disks or (and) and a thicker snap ring.

    Thickness of the two optional inner disks must not differ by more than 0.7 mm.

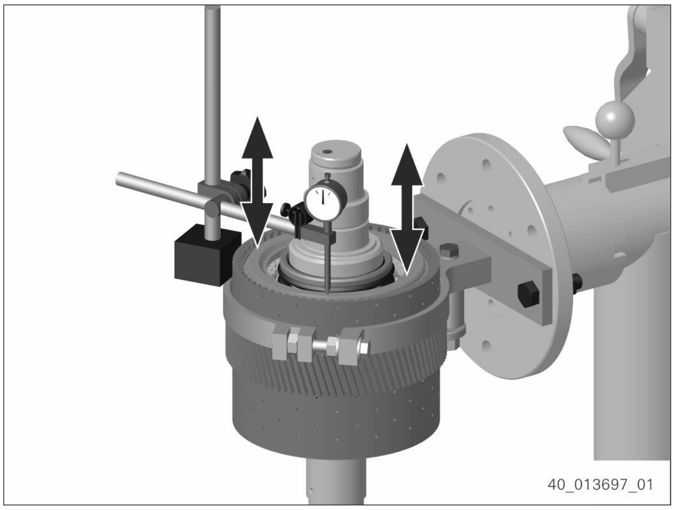


Fig. 253

34. Carry out the following two work steps immediately one after the other.

⚠ CAUTION

Risk of burn injuries due to contact with hot surfaces.
Slight or moderate injury possible.
⇨ Wear protective gloves.

Heat bearing inner ring.

35. Slide on bearing inner ring until contact is obtained.

36. Let bearing inner ring cool down.

37. Adjust bearing inner ring.

38. Slide on washer with recesses facing downwards.

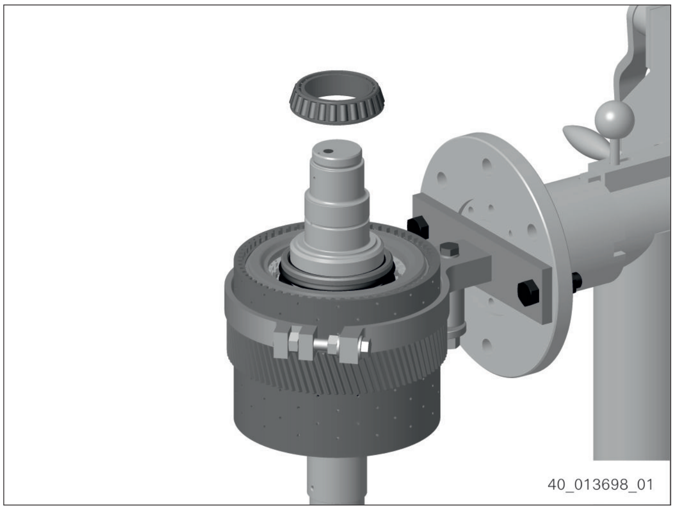


Fig. 254

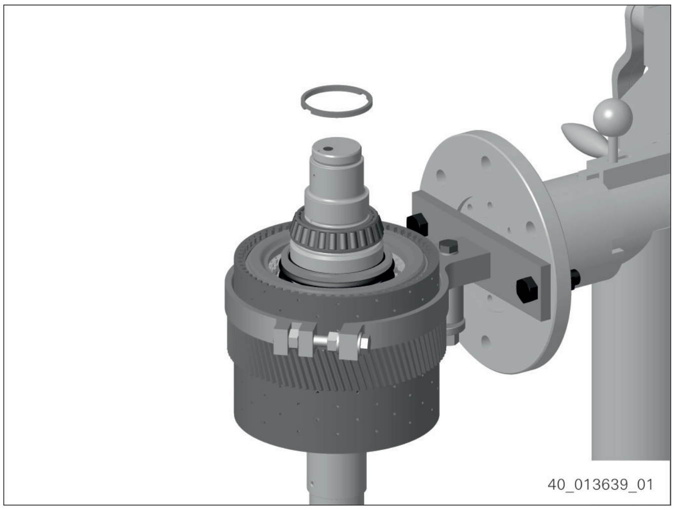


Fig. 255

39. Insert bearing outer rings into helical gear until contact is obtained.

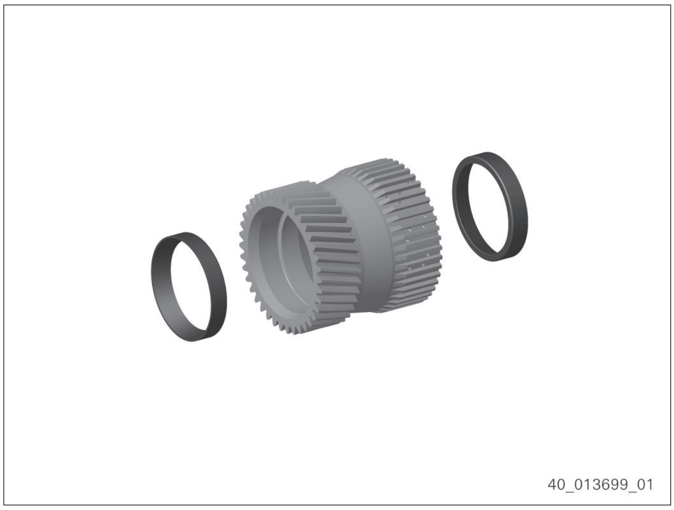


Fig. 256

40. Slide helical gear (1) onto shaft until contact is obtained. Insert helical gear into the disk package by short mutual rotary motions.

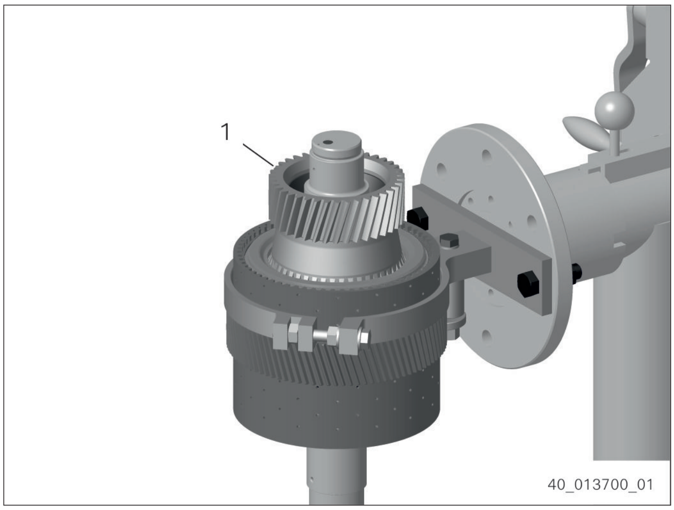


Fig. 257

41. Carry out the following two work steps immediately one after the other.

⚠ **CAUTION**

Risk of burn injuries due to contact with hot surfaces.
Slight or moderate injury possible.
⇨ Wear protective gloves.

Heat bearing inner ring.

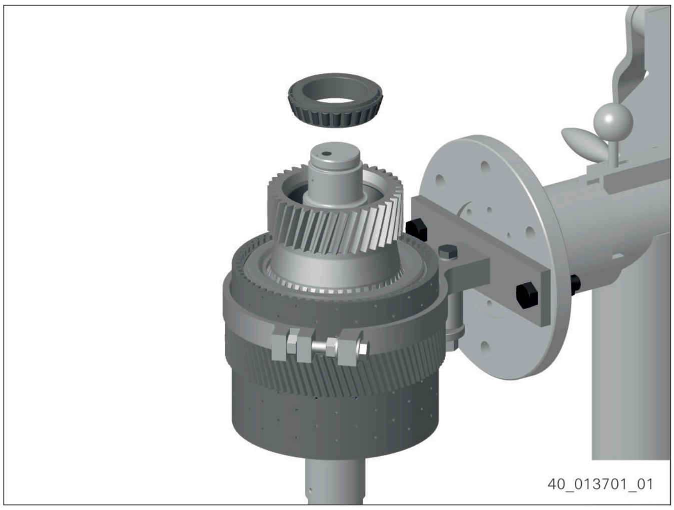


Fig. 258

42. Slide on bearing inner ring until contact is obtained.

43. Let bearing inner ring cool down.

44. Adjust bearing inner ring.

45. Carry out the following two work steps immediately one after the other.

CAUTION

Risk of burn injuries due to contact with hot surfaces.
Slight or moderate injury possible.
⇨ Wear protective gloves.

Heat bearing inner ring.

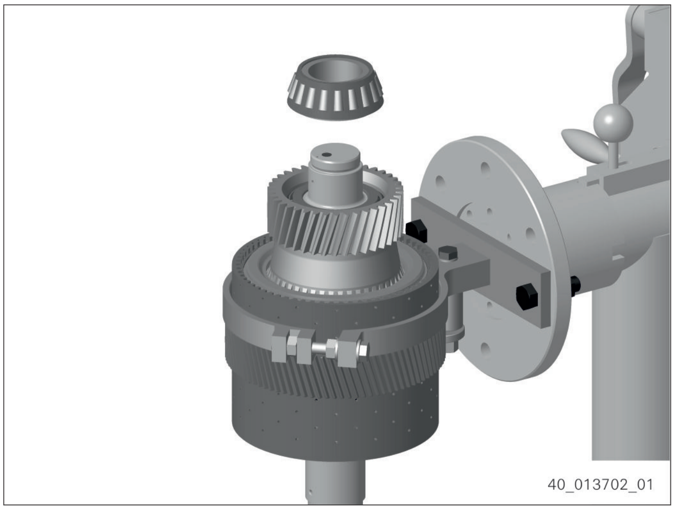


Fig. 259

46. Slide on bearing inner ring until contact is obtained.

47. Let bearing inner ring cool down.

48. Adjust bearing inner ring.

49. Turn disk carrier by 90.

50. Use 5870.401.118 [Groove nut wrench] and 5870.401.115 [Groove nut wrench] to tighten the slotted nut.
Tightening torque: 550 Nm

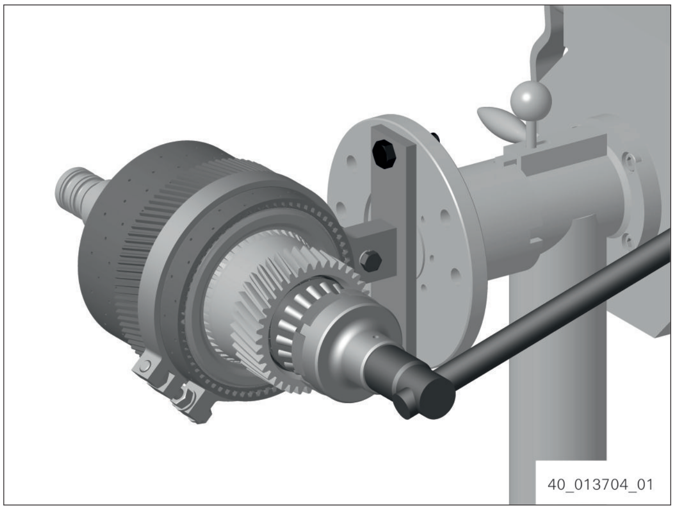


Fig. 260

Assembling clutch K3

51. Turn disk carrier by 90.

52. To ensure a correct measuring result, install single parts without oil for the time being.

Insert outer disks and inner disks.
Insert first outer disk with the uncoated side facing the piston.
Insert last outer disk with the uncoated side facing the end shim.

For the arrangement refer to the current spare parts list.

Thickness of the two optional inner disks must not differ by more than 0.7 mm.

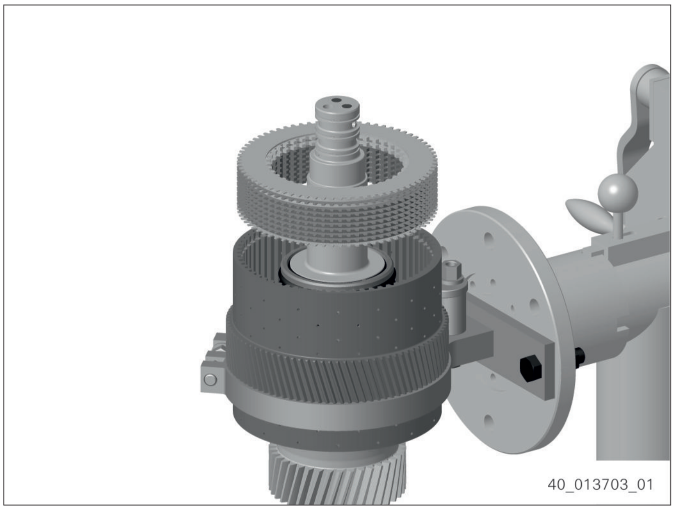


Fig. 261

53. Insert end shim (2).

54. Insert snap ring e. g. 2.60 mm (1).

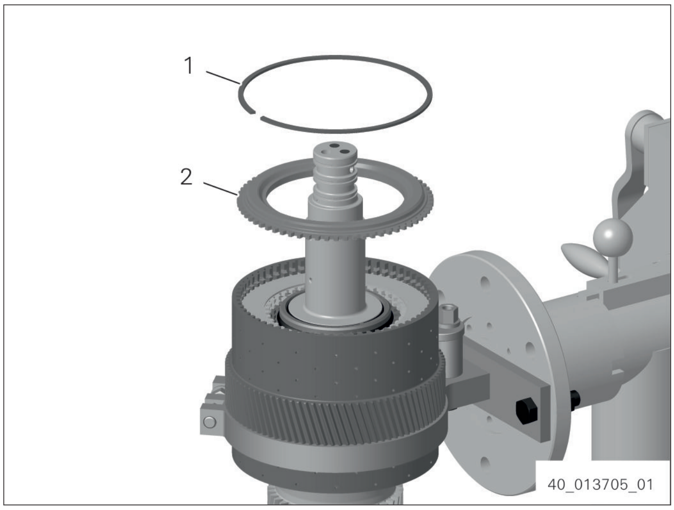


Fig. 262

55. Position dial gauge on the end shim.

56. Push end shim downwards with 100 N and set dial gauge to zero.

57. Lift end shim until contact with snap ring is obtained and check the necessary Disk clearance 2.2 mm to 2.4 mm.
If the disk clearance is too small, insert thinner inner disks or (and) a thinner snap ring.
If disk clearance is too big, install thicker inner disks or (and) and a thicker snap ring.

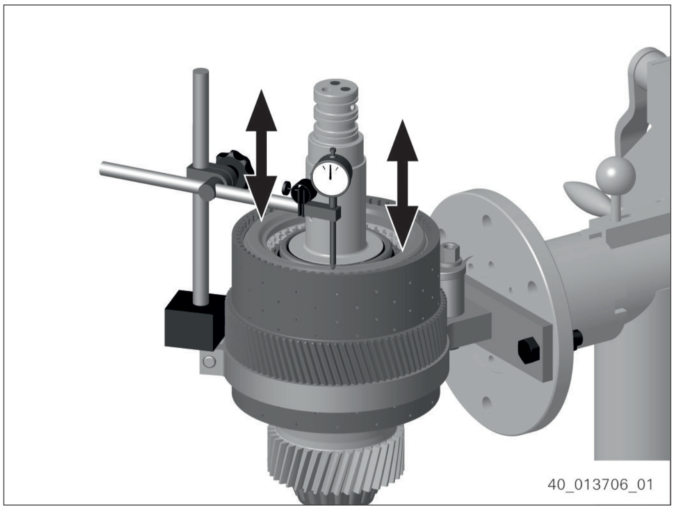


Fig. 263

Thickness of the two optional inner disks must not differ by more than 0.7 mm.

58. Carry out the following two work steps immediately one after the other.

⚠ CAUTION

Risk of burn injuries due to contact with hot surfaces.
Slight or moderate injury possible.
⇨ Wear protective gloves.

Heat bearing inner ring.

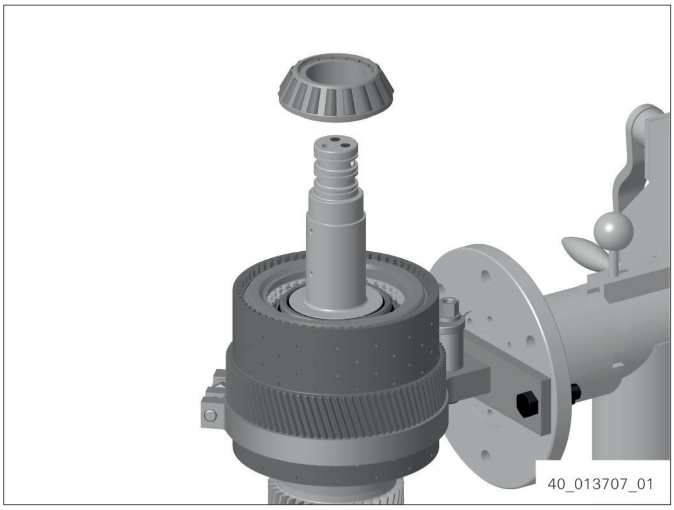


Fig. 264

59. Slide on bearing inner ring until contact is obtained.

60. Let bearing inner ring cool down.

61. Adjust bearing inner ring.

62. Insert bearing outer ring into spur gear until contact is obtained.

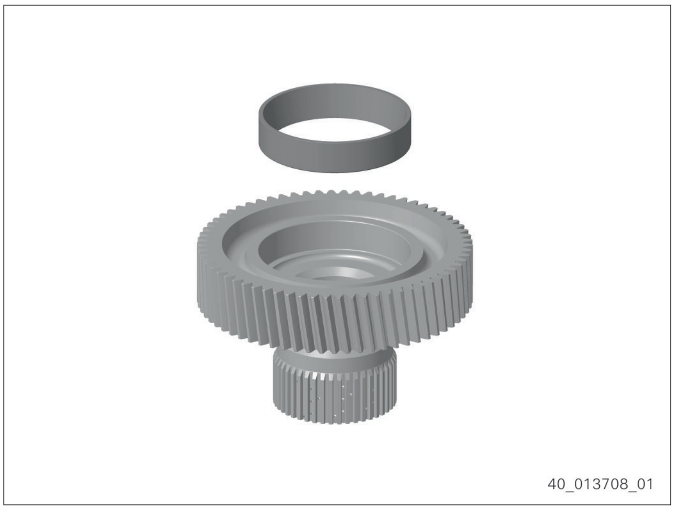


Fig. 265

63. Slide spur gear (1) onto shaft until contact is obtained. Insert spur gear into disk package by short mutual rotary motions.

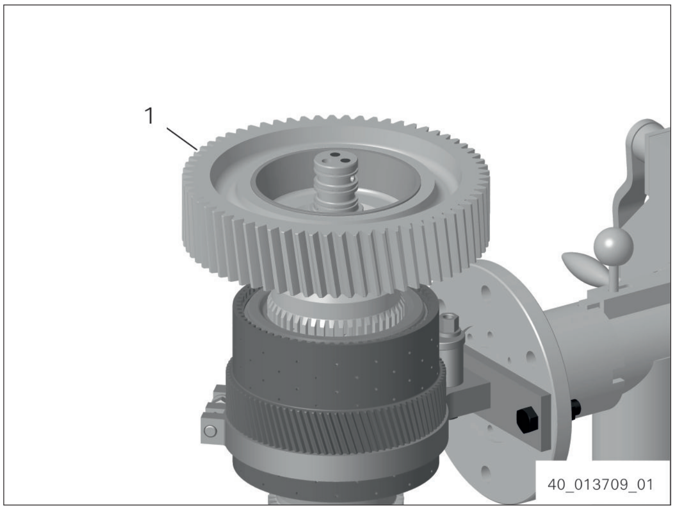


Fig. 266

64. Carry out the following two work steps immediately one after the other.

⚠ CAUTION

Risk of burn injuries due to contact with hot surfaces.
Slight or moderate injury possible.
⇨ Wear protective gloves.

Heat up roller bearing.

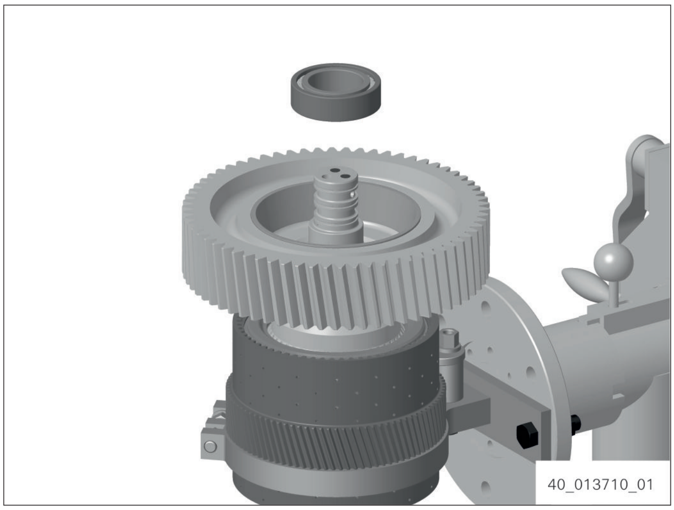


Fig. 267

65. Slide on roller bearing until contact is obtained.

66. Let the roller bearing cool down.

67. Adjust bearing inner ring.

68. Check function of the clutches by applying compressed air.

    → Closing and opening of the clutch is clearly audible.

    If closing and opening is not audible, disassemble and check clutch.

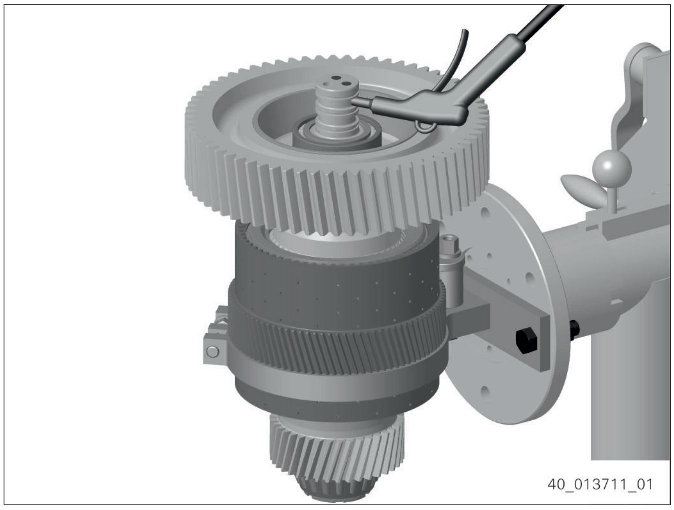


Fig. 268

69. Grease annular grooves of shaft.

70. Insert R-rings (1).

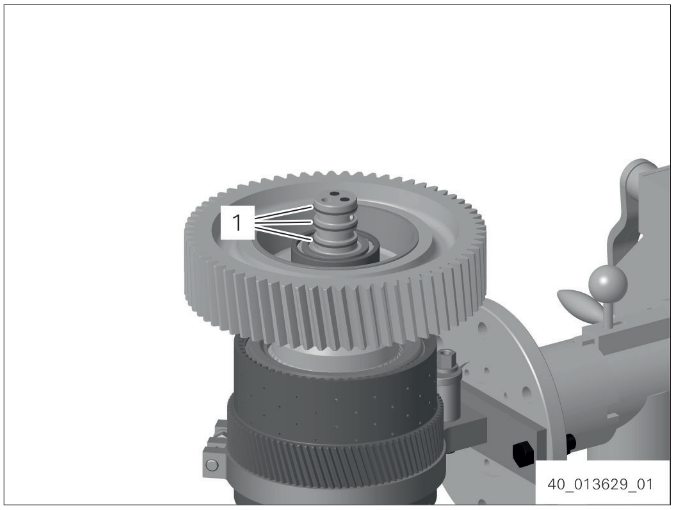


Fig. 269

71. Fix spur gear axially by means of 5870.345.033 [Assembly fixture] and AA00.317.255 [Load ring].

    → Spur gear has been fixed and cannot be pulled out of the disk package.

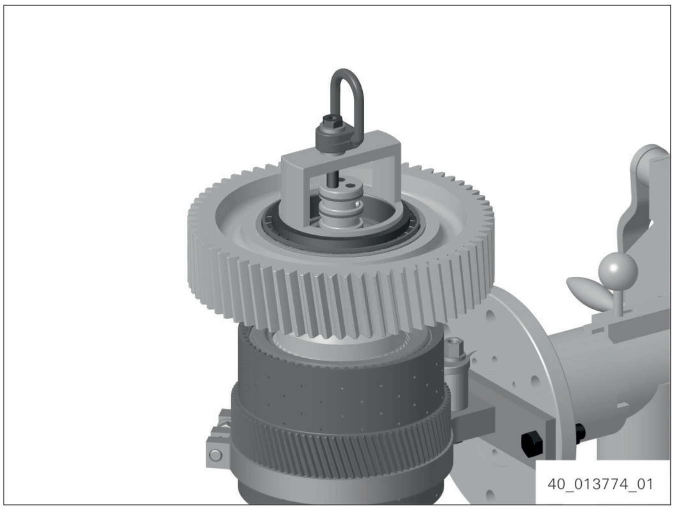


Fig. 270

Installing clutches

Special tools:
- 5870.204.002 Eyebolt
- 5870.345.033 Assembly fixture
- AA00.317.255 Load ring

1. ⚠ **CAUTION**

   Risk of crushing due to moving load.
   Slight to moderate injury possible.
   ⇨ Move load slowly and carefully.
   ⇨ Do not reach into danger area.

   Insert clutch KV/K1 into housing by means of 5870.204.002 [Eyebolt] and crane.

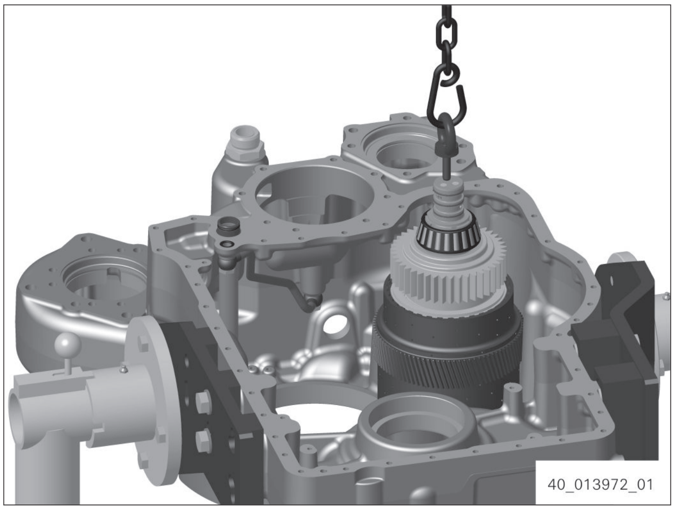


Fig. 271

2. ⚠ **CAUTION**

   Risk of crushing due to moving load.
   Slight to moderate injury possible.
   ⇨ Move load slowly and carefully.
   ⇨ Do not reach into danger area.

   Insert clutch KR/K2 by means of 5870.204.002 [Eyebolt] and crane.

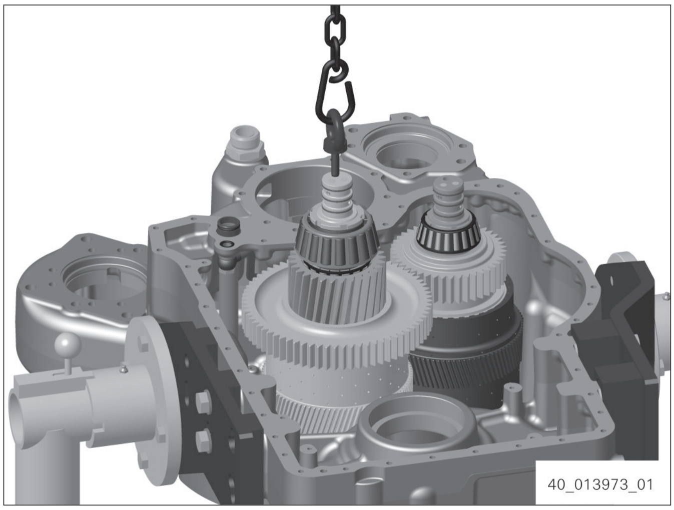


Fig. 272

3. Check position of gear (1). Flush-align tapered roller bearings and housing hole.

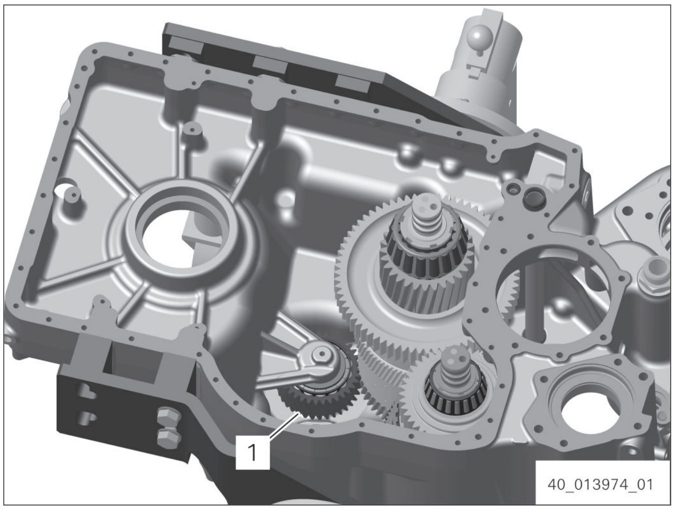


Fig. 273

4. ⚠ **CAUTION**

   Risk of crushing due to moving load.
   Slight to moderate injury possible.
   ⇨ Move load slowly and carefully.
   ⇨ Do not reach into danger area.

   Slightly lift clutch KR/K2 (1) and move in direction of arrow.

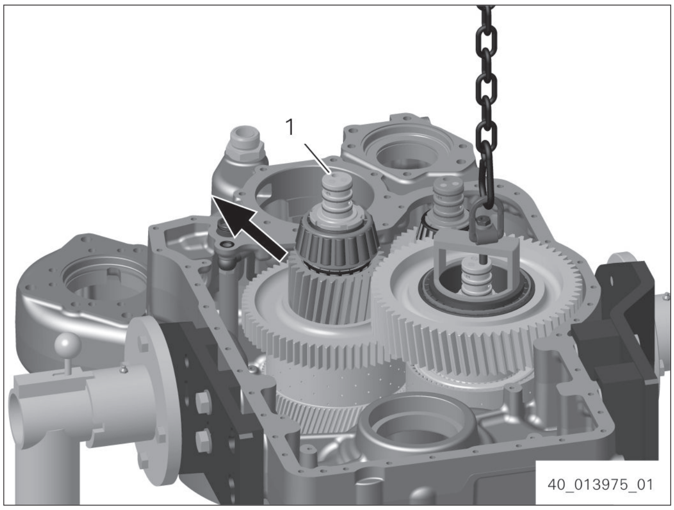


Fig. 274

5. Insert clutch K3/K4 into housing by means of 5870.345.033 [Assembly fixture], AA00.317.255 [Load ring] and crane.

6. Remove AA00.317.255 [Load ring] and 5870.345.033 [Assembly fixture].

Installing output gear

Special tools:

- 5870.100.054 Stop washer
- 5870.204.002 Eyebolt

1. Insert cylindrical roller bearing (1) into housing hole until contact is obtained.

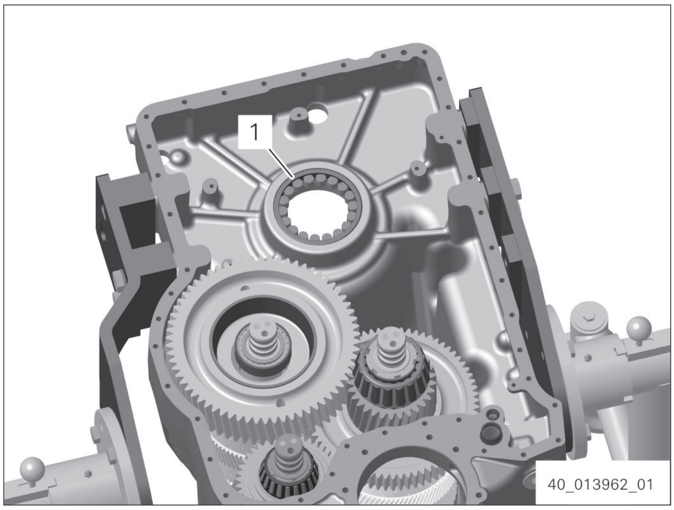


Fig. 275

2. Place cover sheet (1) into position.

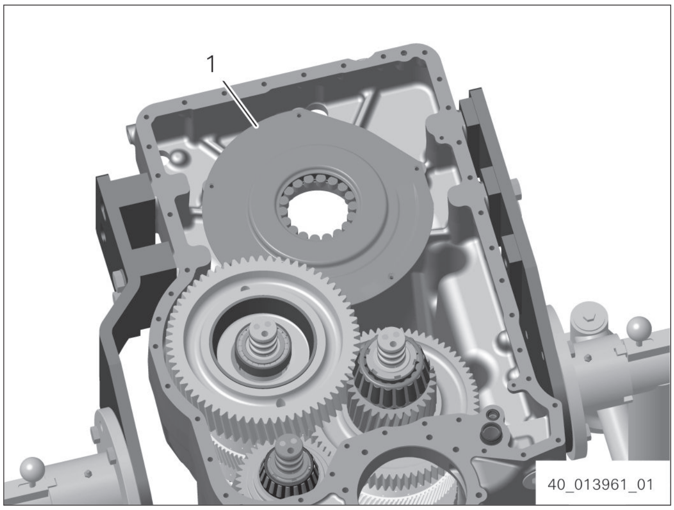


Fig. 276

3. Carry out the following two work steps immediately one after the other.

⚠ CAUTION

Risk of burn injuries due to contact with hot surfaces.
Slight or moderate injury possible.
⇨ Wear protective gloves.

Heat bearing inner ring.

4. Slide bearing inner ring onto gear until contact is obtained.

5. Let bearing inner ring cool down.

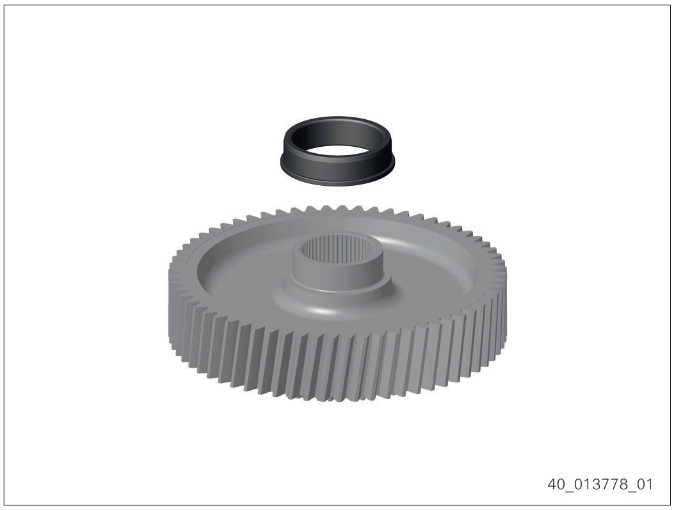


Fig. 277

6. Adjust bearing inner ring.

7. ⚠ **CAUTION**

   Risk of crushing due to moving load.
   Slight to moderate injury possible.
   ⇨ Move load slowly and carefully.
   ⇨ Do not reach into danger area.

   Use 5870.100.054 [Stop washer], 5870.204.002 [Eyebolt] and crane to insert gear into the housing. Insert gear into the cylindrical roller bearing until contact is obtained.

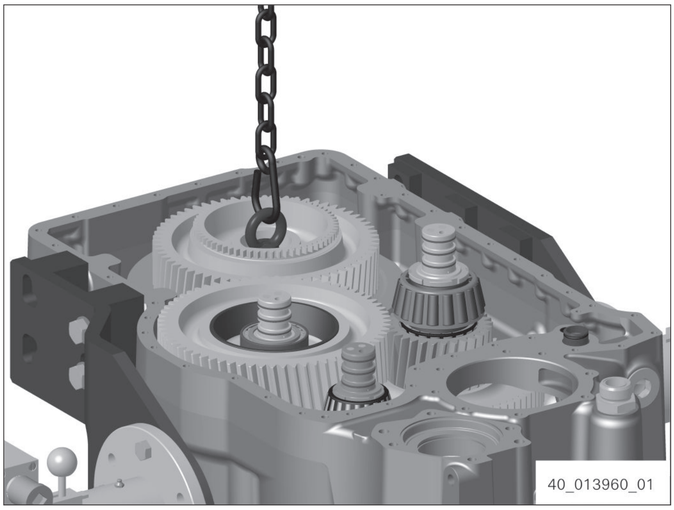


Fig. 278

8. Place cover sheet (1) into position.

9. Bolt in and tighten cap screws.
   Tightening torque: 23 Nm

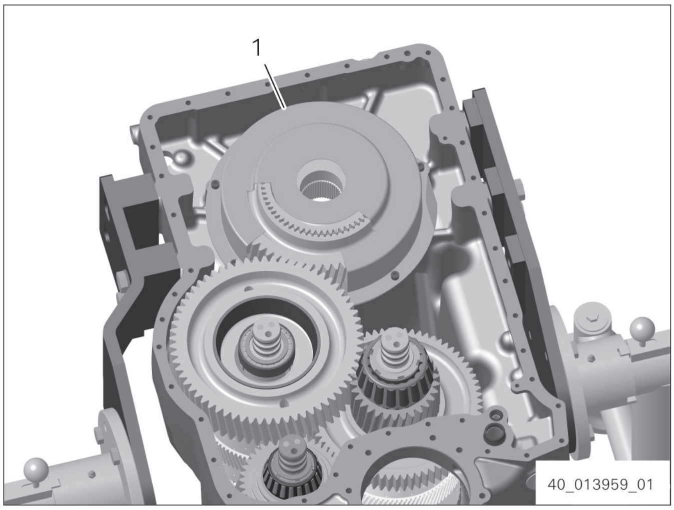


Fig. 279

Installing suction tube

1. Insert suction tube (1).

2. Bolt in and tighten cap screws (2).
   Tightening torque: 23 Nm

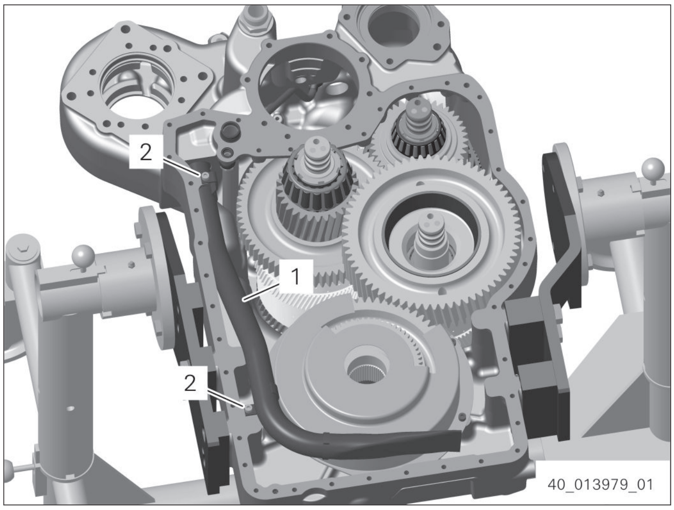


Fig. 280

Fitting the cover to the housing

Special tools:

- 5870.281.061 Load-lifting equipment

Operating supplies and auxiliary materials:

- 0666.790.033 LOCTITE 574

1. Screw in the adapter with O-ring (1) and tighten.
   Tightening torque: 117 Nm

2. Bolt in screw plugs with O-ring (2) and tighten.
   Tightening torque: 35 Nm

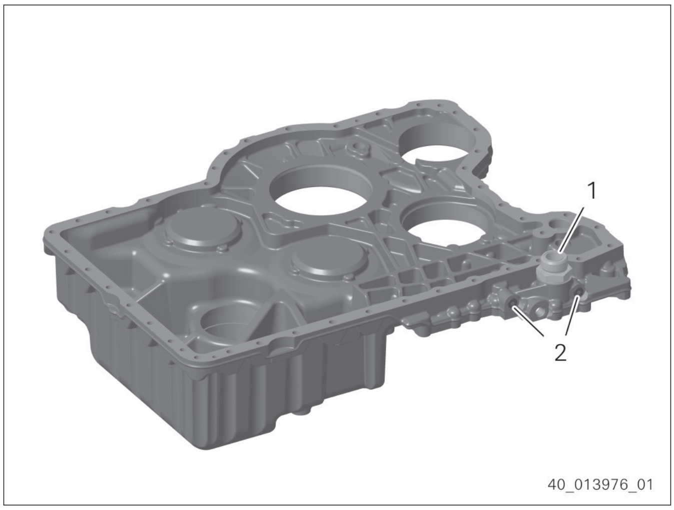


Fig. 281

3. Apply 0666.790.033 [LOCTITE 574] onto the mounting face (1).

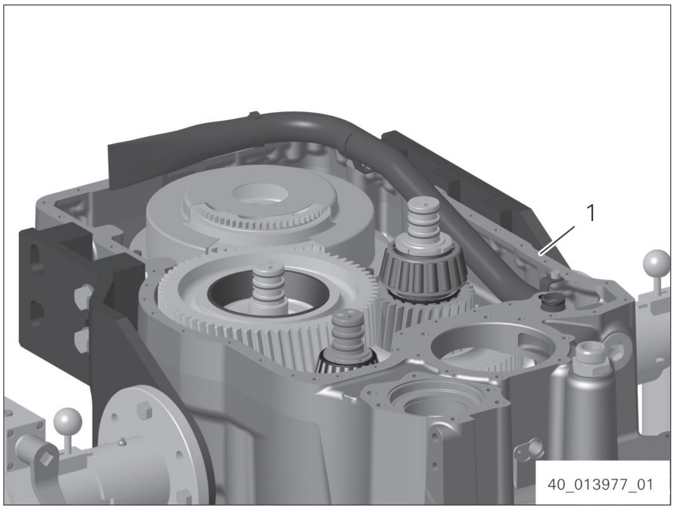


Fig. 282

4. Fit 5870.281.061 [Load-lifting equipment] to the cover.

5. ⚠ **CAUTION**

   Risk of crushing due to moving load.
   Slight to moderate injury possible.
   ⇨ Move load slowly and carefully.
   ⇨ Do not reach into danger area.

   Mount cover using a crane.

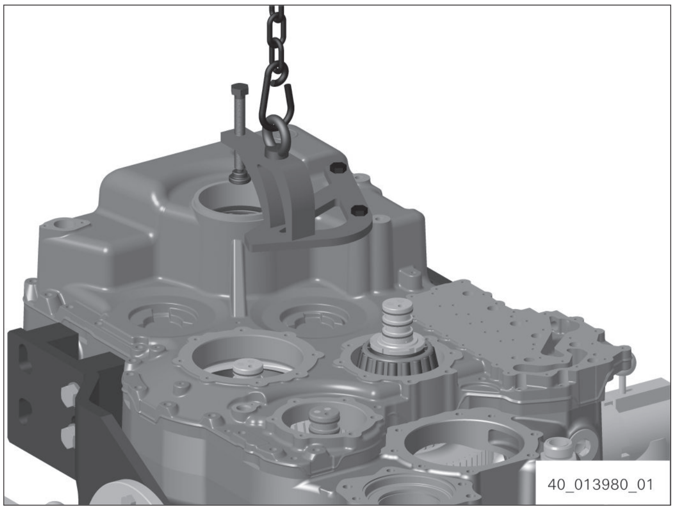


Fig. 283

6. ⚠ **CAUTION**

   Risk of injury due to parts flying away.
   Slight or moderate injury possible.
   ⇨ Wear protective goggles.

   Flush-mount both pins (1).

7. Bolt in and tighten cap screws.
   Tightening torque: 46 Nm

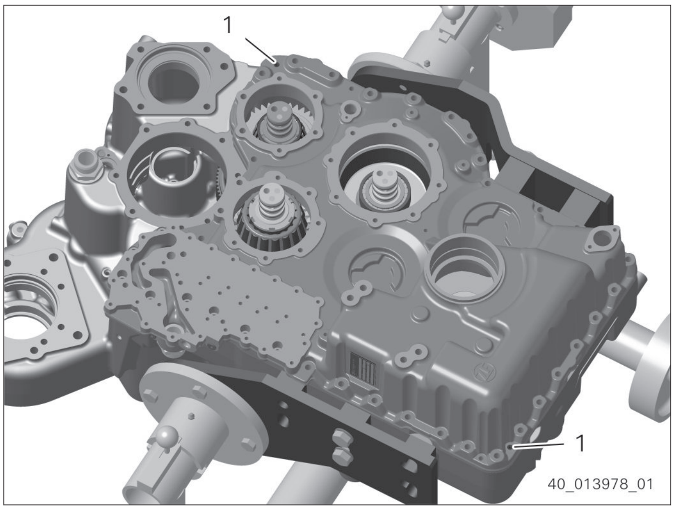


Fig. 284

Setting bearing preload of clutches

Special tools:
- 5870.320.014 Assembly fixture
- 5870.320.018 Inserting tool
- 5870.200.022 Straightedge
- 5870.204.007 Locating pin

Setting bearing preload of clutches K3/K4

1. Insert sealing plug (1) into hole of cover by means of 5870.320.014 [Assembly fixture] and 5870.320.018 [Inserting tool].

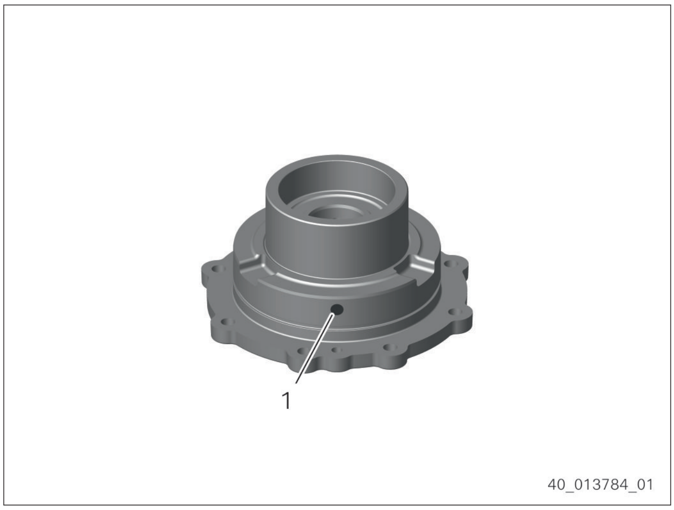


Fig. 285

2. Insert sealing plug (1) into hole with 5870.320.014 [Assembly fixture] and 5870.320.018 [Inserting tool].

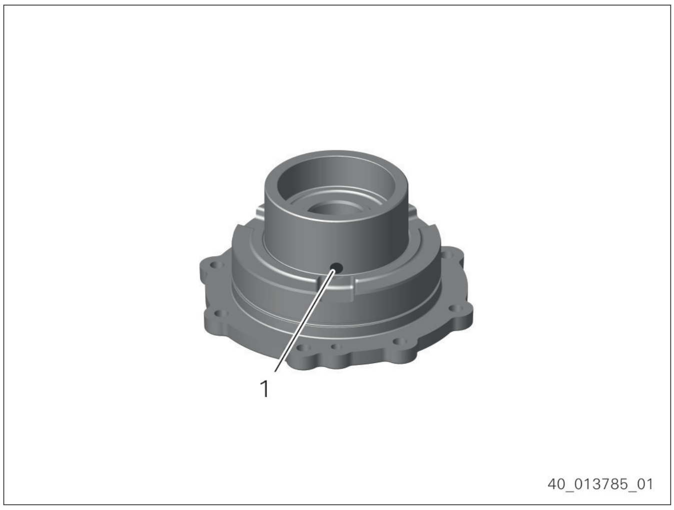


Fig. 286

3. Insert bearing inner ring (1) into bearing outer ring.

4. Rotate bearing inner ring in both directions several times.

5. Use depth gauge and 5870.200.022 [Straightedge] to measure the distance from mounting face to front face of the bearing inner ring.
   Distance A = e. g. 43.70 mm
      Measure at several points and calculate the average.

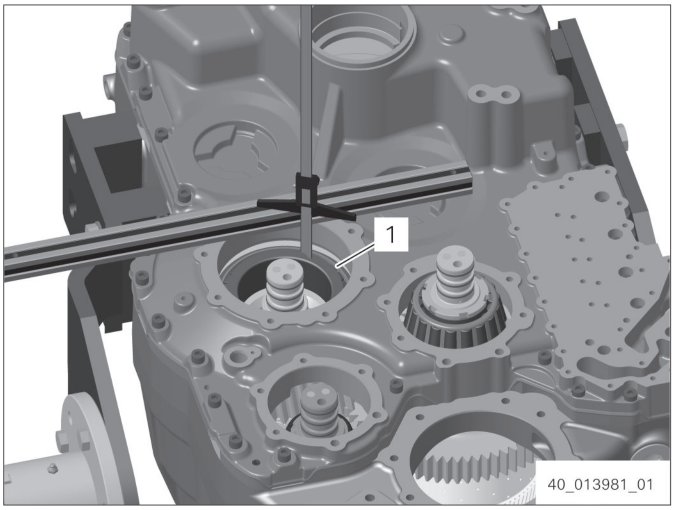


Fig. 287

6. Use depth gage, parallel gage blocks and 5870.200.022 [Straightedge] to measure distance from mounting face to contact face of bearing inner ring.
   Distance B = e.g. 42.20 mm

7. Calculate thickness of spacer washer for Bearing preload 0.12 mm to 0.18 mm.

   Calculation example:
   s = distance A – distance B + mean value of required bearing preload
   s = 43.70 mm – 42.20 mm + 0.15 mm
   s = 1.65 mm

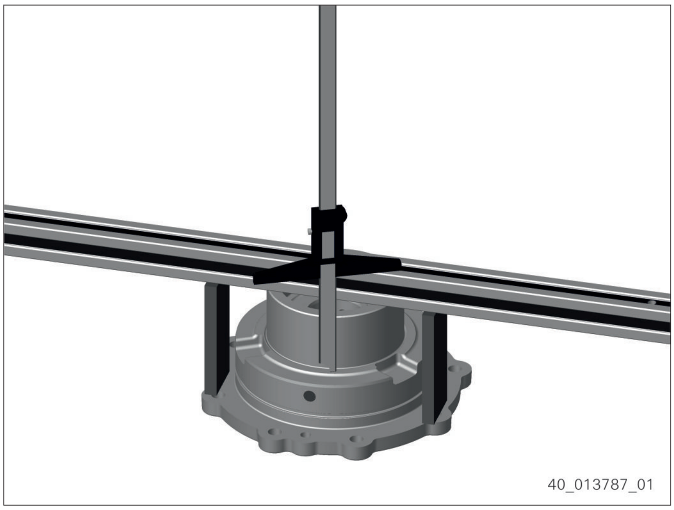


Fig. 288

8. Slide spacer washer with the calculated thickness, e. g. s = 1.65 mm onto the cover.

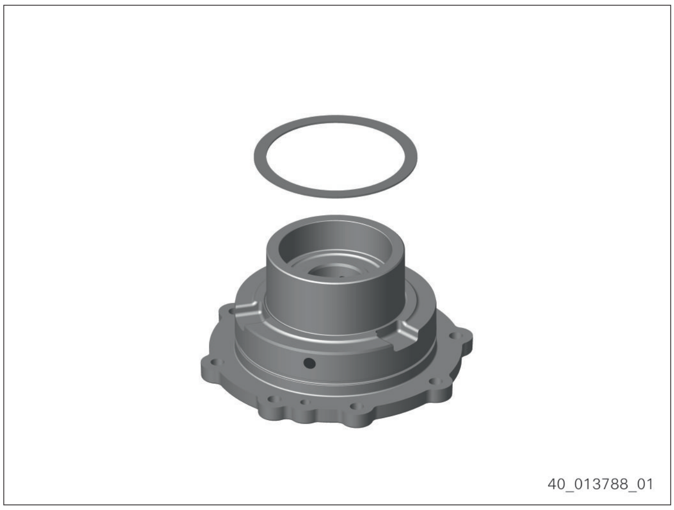


Fig. 289

9. Carry out the following two work steps immediately one after the other.

⚠ CAUTION

Risk of burn injuries due to contact with hot surfaces.
Slight or moderate injury possible.
⇨ Wear protective gloves.

Heat bearing inner ring.

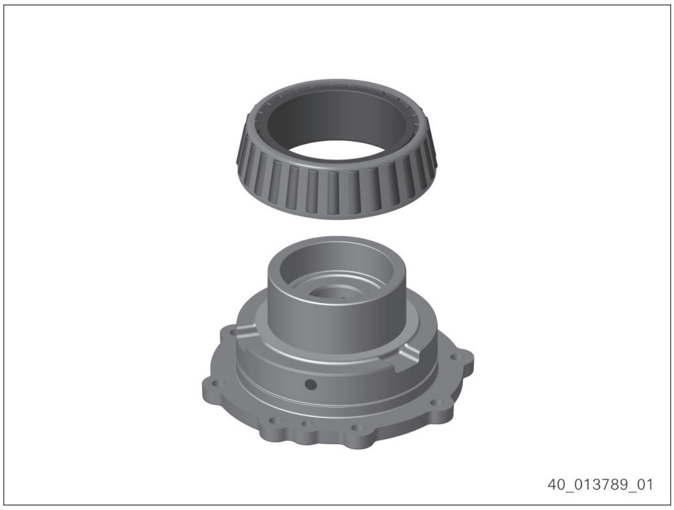


Fig. 290

10. Slide on bearing inner ring until contact is obtained.

11. Let bearing inner ring cool down.

12. Adjust bearing inner ring.

13. Turn two 5870.204.007 [Locating pin] into cover.

14. Center R-rings (1).

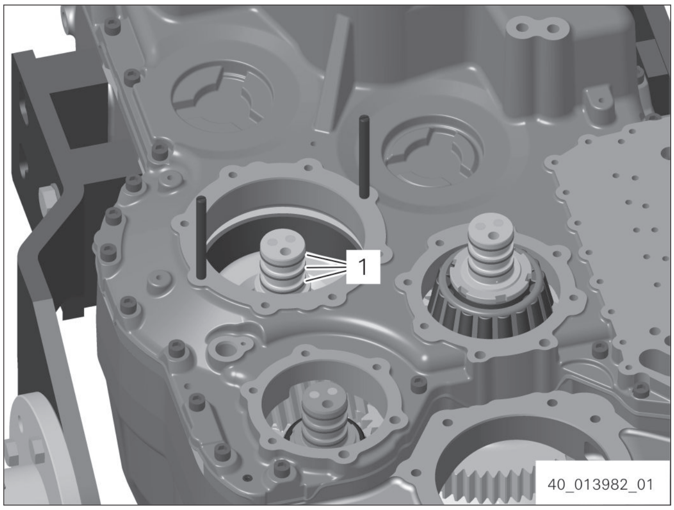


Fig. 291

15. Grease O-ring.

16. Insert O-ring (1) into annular groove.

17. Carry out the following three work steps immediately one after the other.

⚠ CAUTION

Risk of burn injuries due to contact with hot surfaces.
Slight or moderate injury possible.
⇨ Wear protective gloves.

Heat bearing hole.

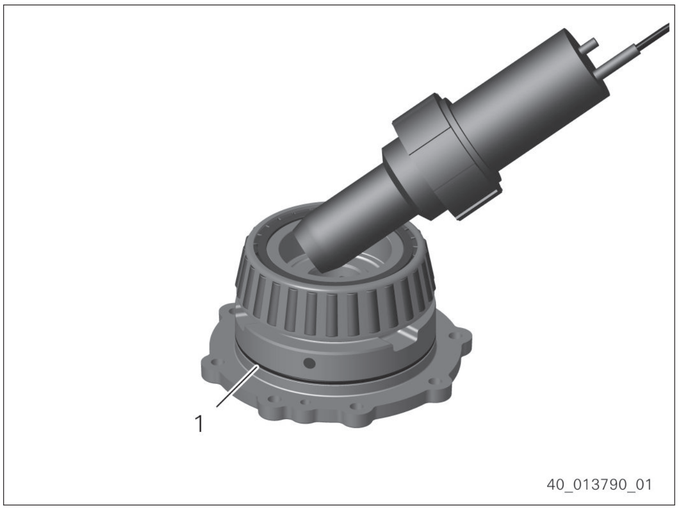


Fig. 292

18. Slide on cover (1).

19. Turn in and tighten hexagon screws evenly.
Tightening torque: 46 Nm

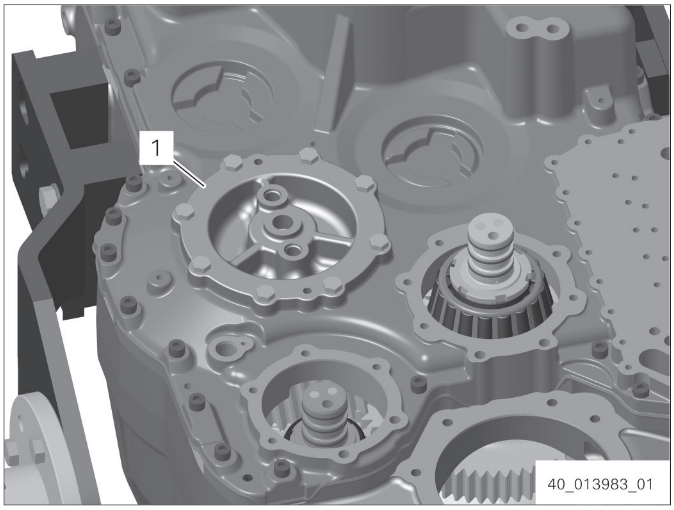


Fig. 293

20. Check function of the clutches by applying compressed air.

→ Closing and opening of the clutch is clearly audible.

If closing and opening is not audible, remove cover and check R-rings.

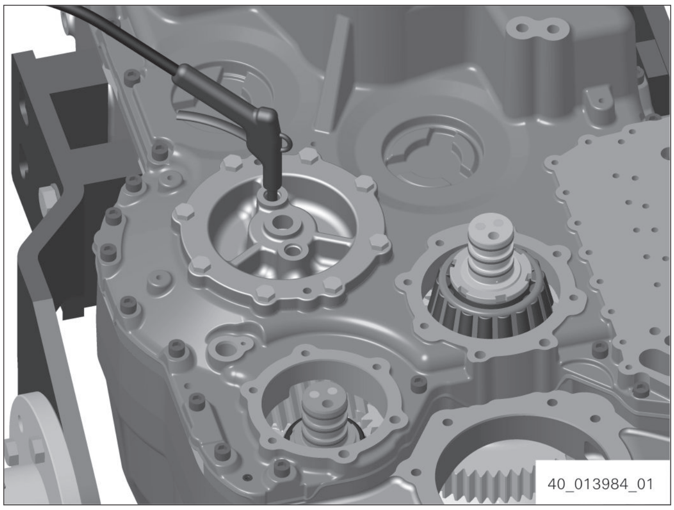


Fig. 294

Setting bearing preload of clutch KR/K2

21. Insert sealing plug (1) into hole of cover by means of 5870.320.014 [Assembly fixture] and 5870.320.018 [Inserting tool].

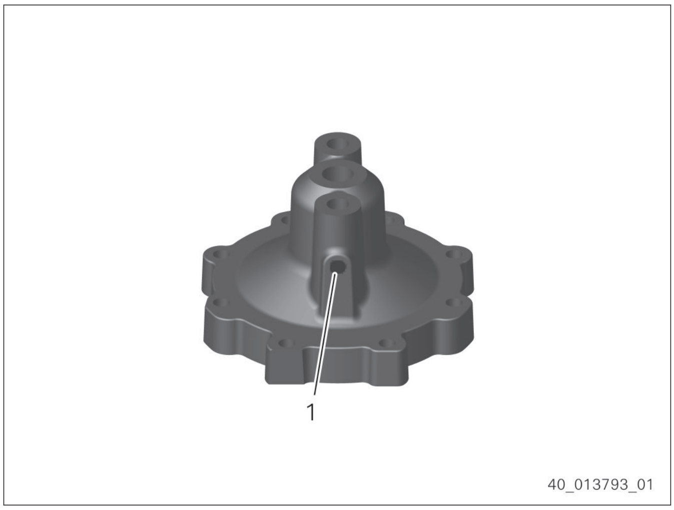


Fig. 295

22. Insert sealing plug (1) into hole with 5870.320.014 [Assembly fixture] and 5870.320.018 [Inserting tool].

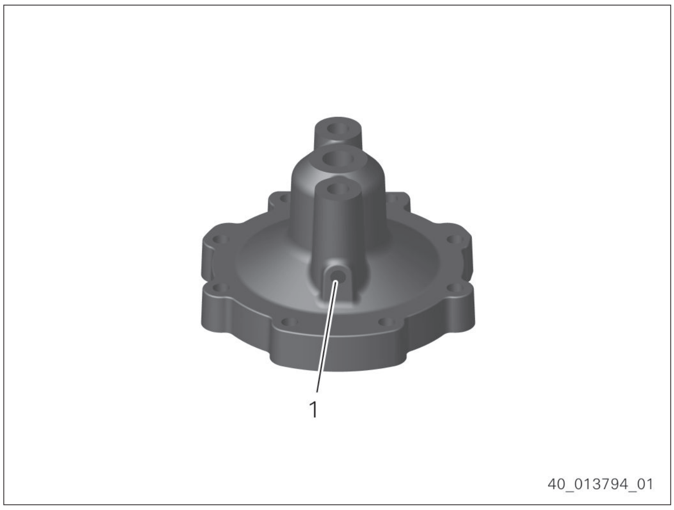


Fig. 296

23. Insert bearing outer ring (1) until contact is obtained.

24. Use depth gage to measure distance from front face of bearing outer ring to mounting face.
    Distance A = e. g. 16.20 mm

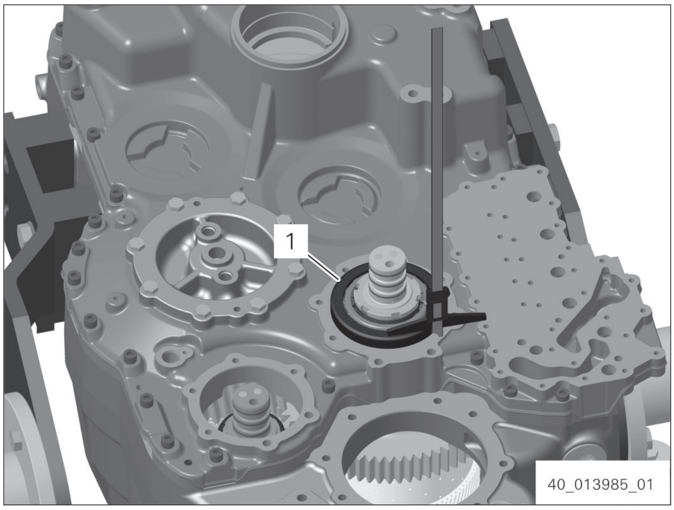


Fig. 297

25. Use depth gage to measure distance from mounting face to contact face of bearing inner ring.
    Distance B = e.g. 17.75 mm

26. Calculate thickness of shim for Bearing preload 0.12 mm to 0.18 mm.

    Calculation example:
    s = distance B – distance A + mean value of the required bearing preload
    s = 17.75 mm – 16.20 mm + 0.15 mm
    s = 1.70 mm

Fig. 298

27. Use grease to insert shim (1) with the calculated thickness, e. g. s = 1.70 mm into the cover.

28. Grease O-ring.

29. Insert O-ring (2) into annular groove.

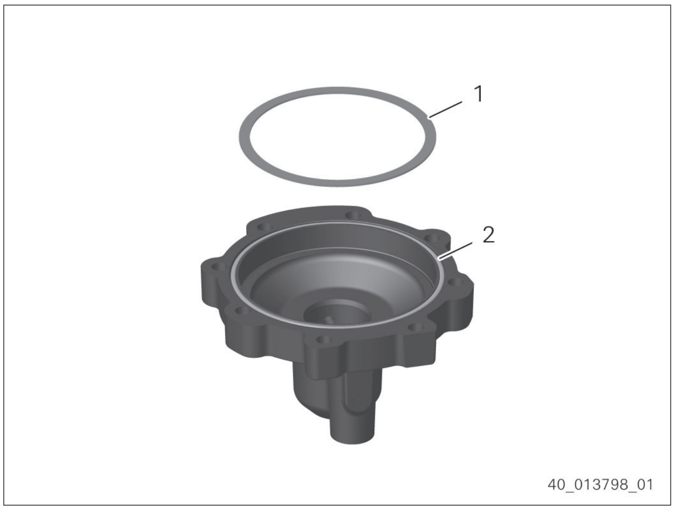


Fig. 299

30. Turn two 5870.204.007 [Locating pin] into cover.

31. Center R-rings (1).

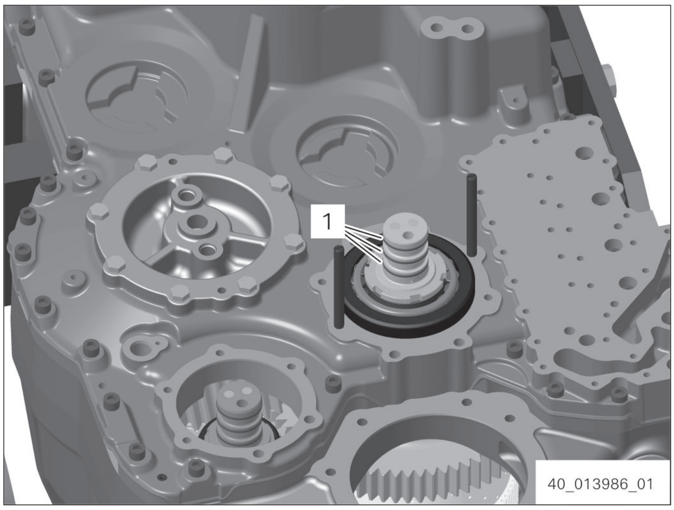


Fig. 300

32. Slide on cover (1).

33. Turn in and tighten hexagon screws evenly.
Tightening torque: 46 Nm

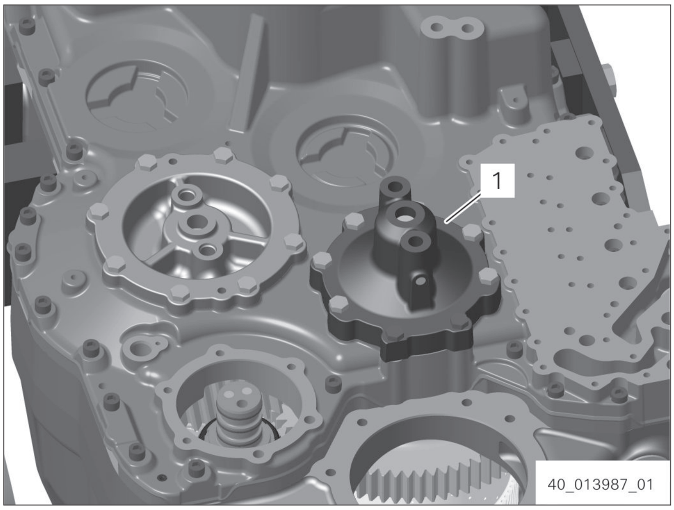


Fig. 301

34. Check function of the clutches by applying compressed air.

→ Closing and opening of the clutch is clearly audible.

If closing and opening is not audible, remove cover and check R-rings.

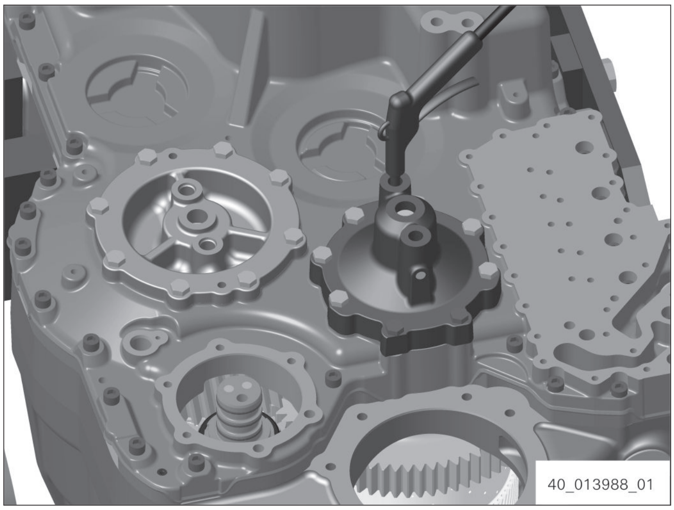


Fig. 302

Setting bearing preload of clutch KV/K1

35. Insert sealing plugs (1) into holes of the bearing cover using 5870.320.014 [Assembly fixture] and 5870.320.018 [Inserting tool].

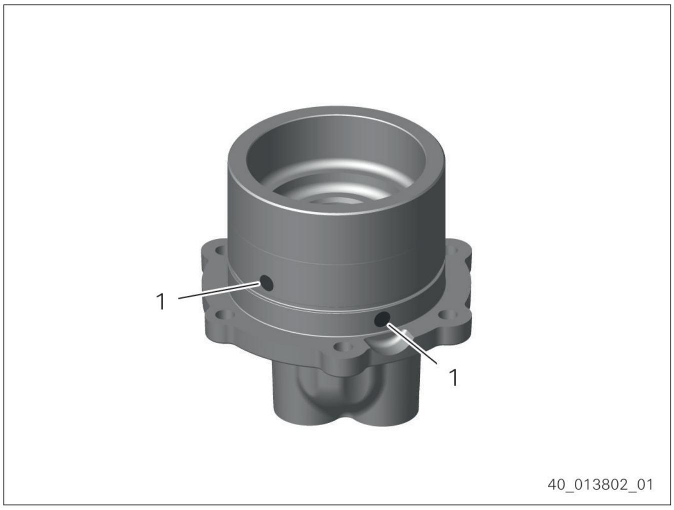


Fig. 303

36. Put on bearing outer ring (1).

37. Rotate bearing outer ring in both directions several times.

38. Use depth gage to measure distance from mounting face to front face of bearing outer ring.
Distance A = e. g. 52.60 mm
Measure at several points and calculate the average.

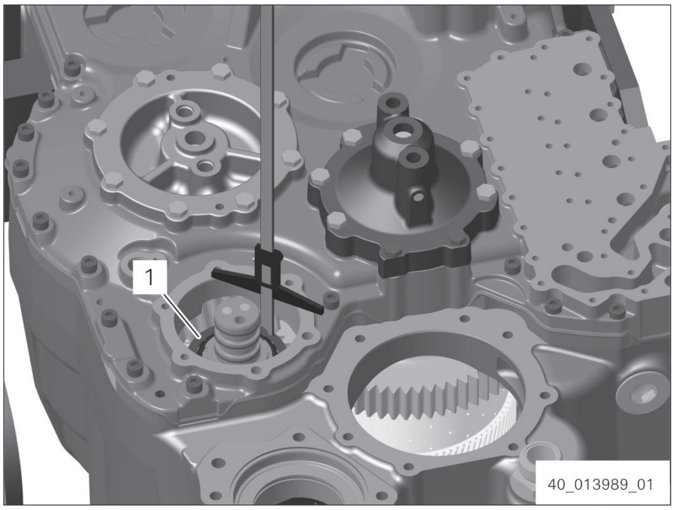


Fig. 304

39. Insert ring with chamfered side facing downwards into the bearing cover.

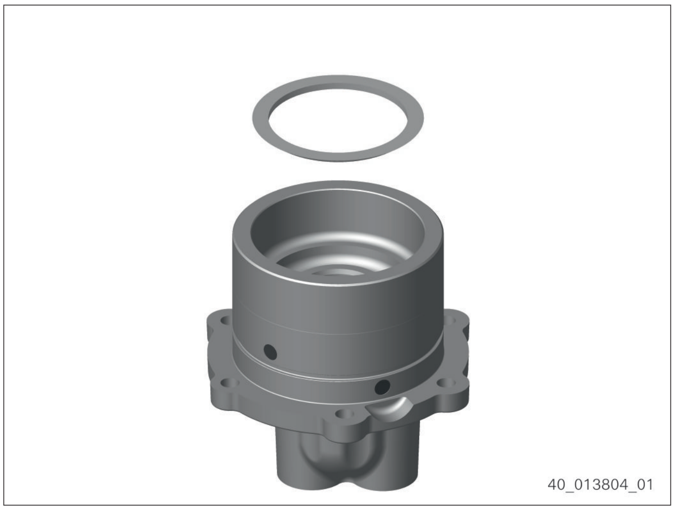


Fig. 305

40. Use depth gage to measure distance from mounting face to plane face of the ring.
Distance B = e.g. 50.75 mm

41. Calculate thickness of shim for Bearing preload 0.12 mm to 0.18 mm.

Calculation example:
s = distance A – distance B + mean value of required bearing preload
s = 52.60 mm – 50.75 mm + 0.15 mm
s = 2.00 mm

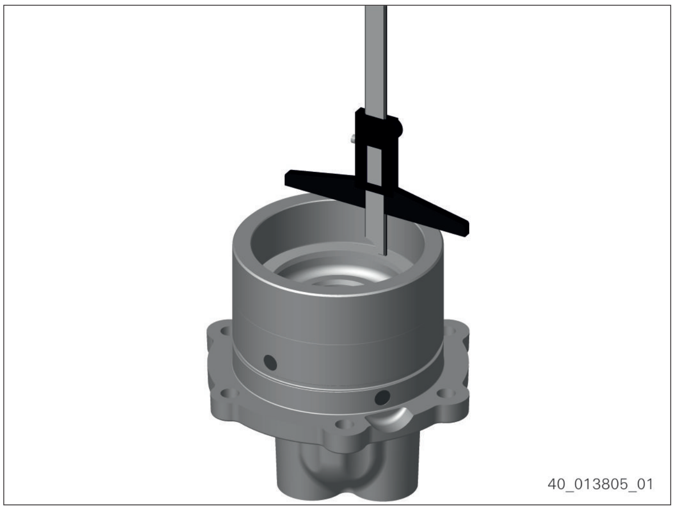


Fig. 306

42. Insert shim with the calculated thickness, e. g. s = 2.00 mm into the bearing cover.

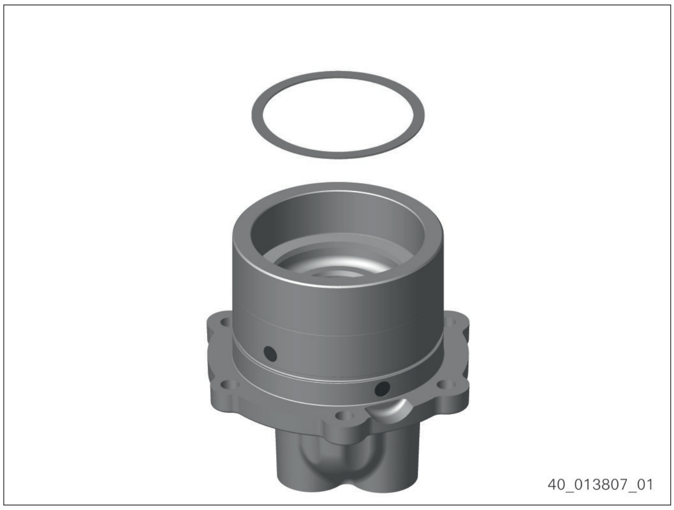


Fig. 307

43. Insert bearing outer ring (1) until contact is obtained.

44. Grease O-ring.

45. Insert O-ring (2) into annular groove.

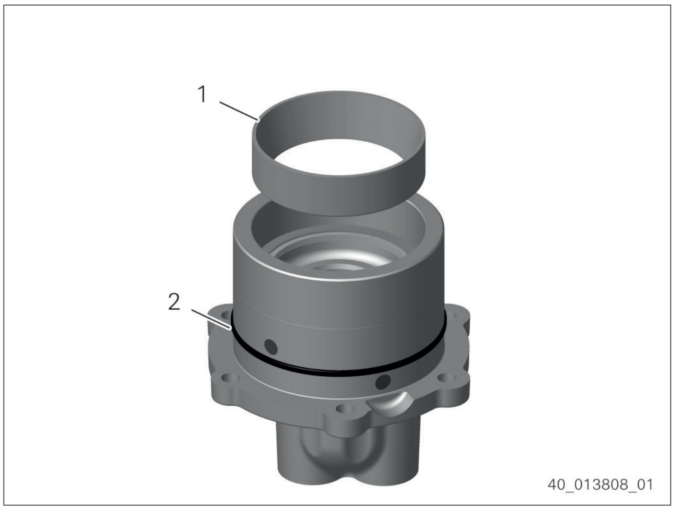


Fig. 308

46. Center R-rings (1).

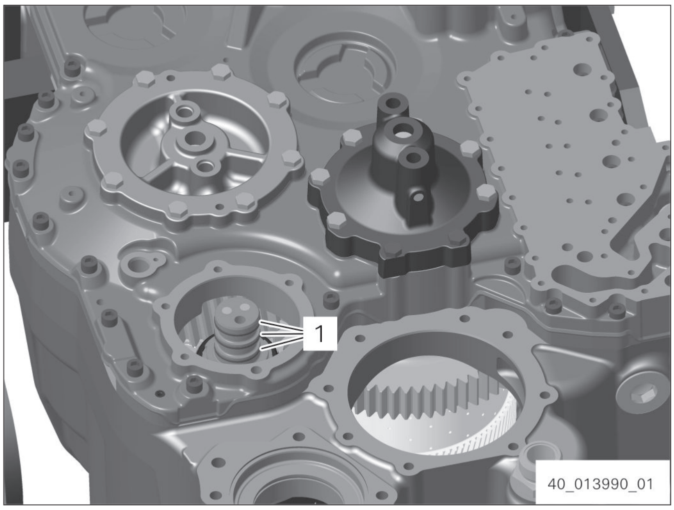


Fig. 309

47. Turn two 5870.204.007 [Locating pin] into cover.

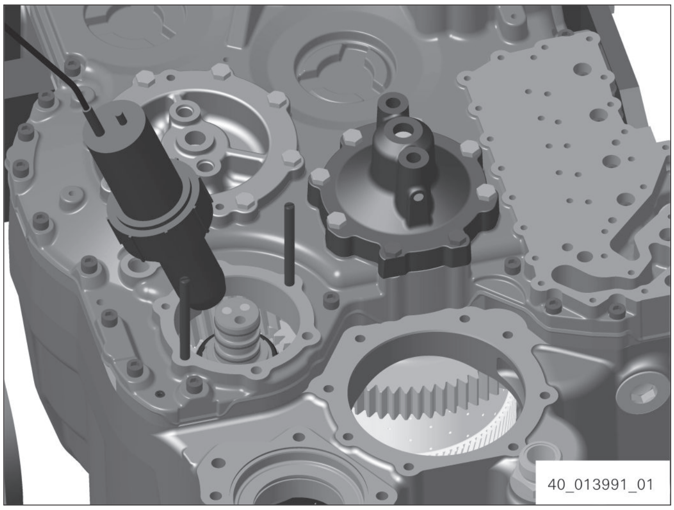


Fig. 310

48. Carry out the following three work steps immediately one after the other.

⚠ CAUTION

Risk of burn injuries due to contact with hot surfaces.
Slight or moderate injury possible.
⇨ Wear protective gloves.

Heat up hole.

49. Insert bearing cover (1).

50. Turn in and tighten hexagon screws evenly.
Tightening torque: 46 Nm

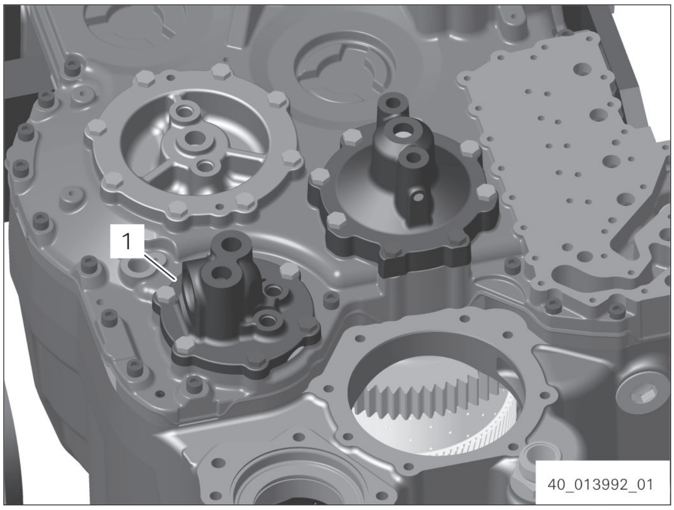


Fig. 311

51. Check function of the clutches by applying compressed air.

→ Closing and opening of the clutch is clearly audible.

If closing and opening is not audible, remove bearing cover and check R-rings.

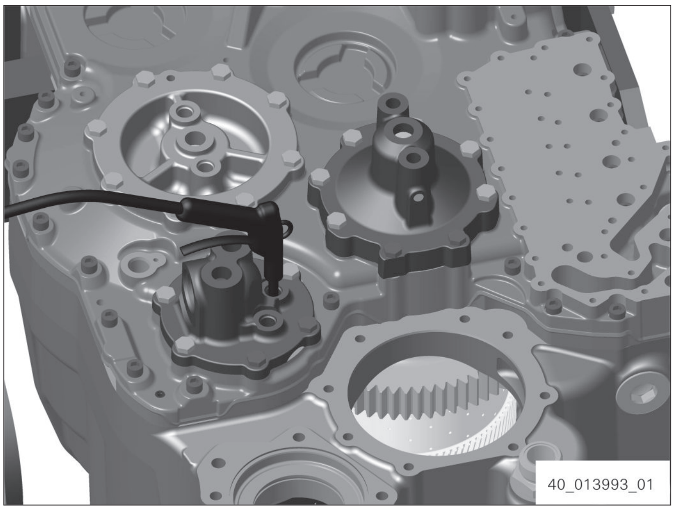


Fig. 312

10.3 Installing the output shaft

1. Carry out the following two work steps immediately one after the other.

⚠ CAUTION

Risk of burn injuries due to contact with hot surfaces.
Slight or moderate injury possible.
⇨ Wear protective gloves.

Heat up hole in gear.

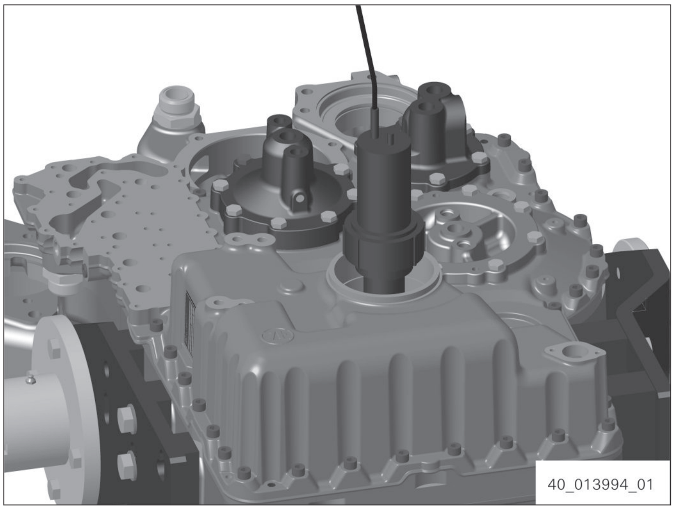


Fig. 313

2. Insert output shaft (1) with long toothing into gear until contact is obtained.
3. Let gear cool down.
4. Adjust output shaft.

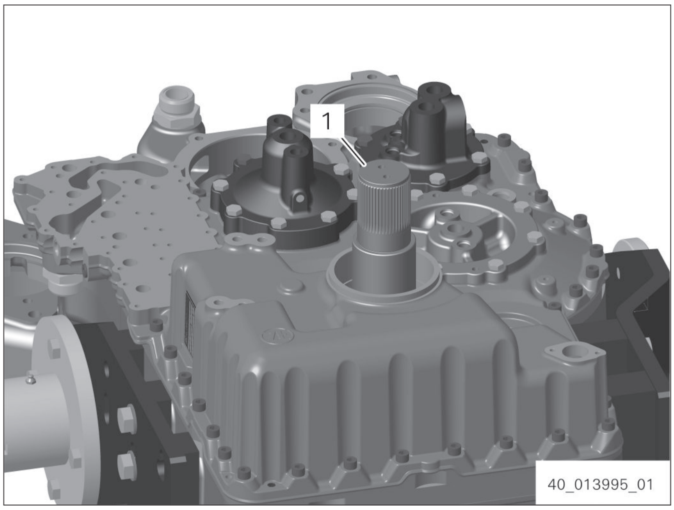


Fig. 314

Setting axial clearance of output shaft

5. Use depth gage to measure distance from front face of the cover to contact face of the shim.
Distance A = e. g. 66.90 mm

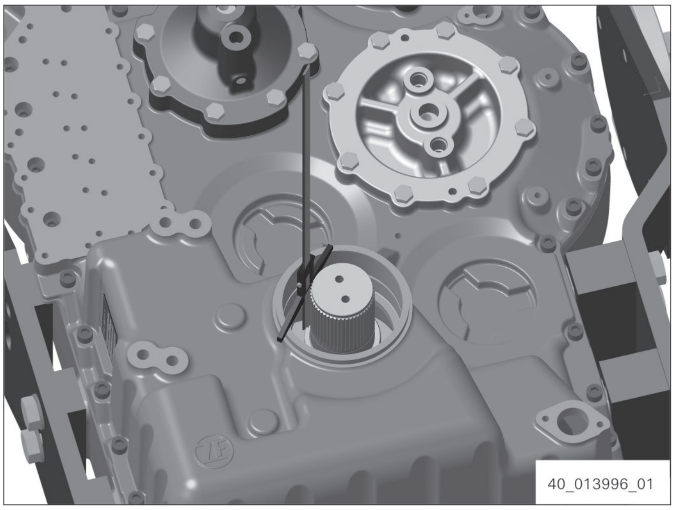


Fig. 315

6. Use depth gage to measure distance from front face of cover to contact face of ball bearing.
   Distance B = e.g. 64.20 mm

7. Calculate thickness of shim for Axial clearance of output shaft 0.30 mm to 0.50 mm.

   Calculation example:
   s = distance A – distance B – mean value of axial clearance
   s = 66.90 mm – 64.20 mm – 0.40 mm
   s = 2.30 mm

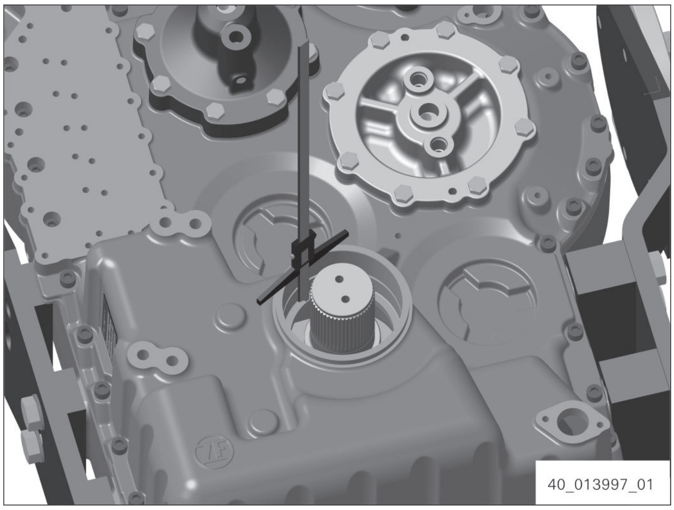


Fig. 316

8. Slide on shim (1) with the calculated thickness, e. g. s = 2.30 mm.

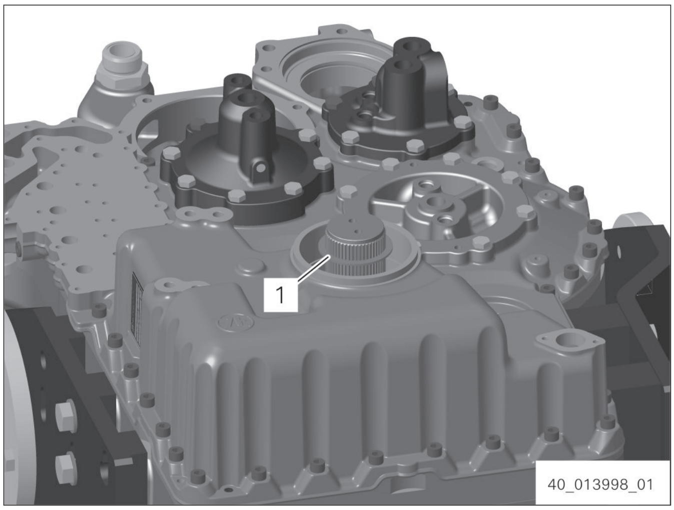


Fig. 317

9. Insert ball bearing (1) until contact is obtained.

10. Insert retaining ring (2) into annular groove.

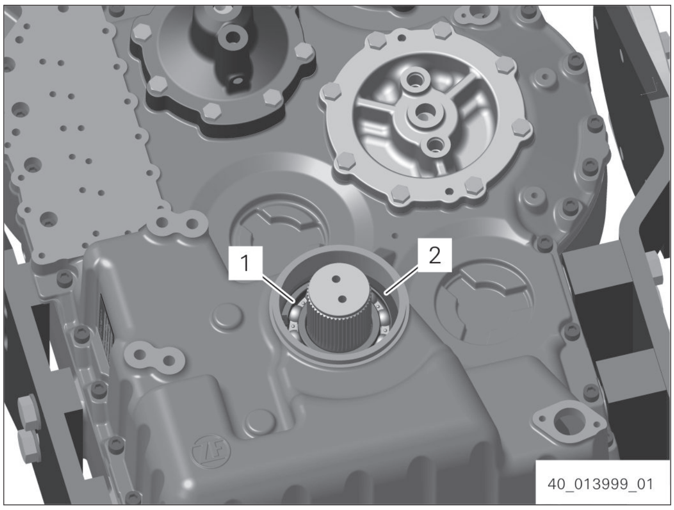


Fig. 318

Installing yokes

Special tools:
- 5870.048.290 Driver tool
- AA01.368.722 Press-in bush
- 5870.057.009 Driver tool
- 5870.260.002 Handle
- 5870.048.265 Driver tool

Operating supplies and auxiliary materials:
- 0666.690.191 PHÖNIX SPIRITUS

Installing yoke on output side

1. Carry out the following two work steps immediately one after the other.

   Apply 0666.690.191 [PHÖNIX SPIRITUS] to outer diameter of the shaft sealing ring.

2. Use 5870.048.290 [Driver tool] to insert shaft sealing ring (1) with seal lip facing the oil chamber.

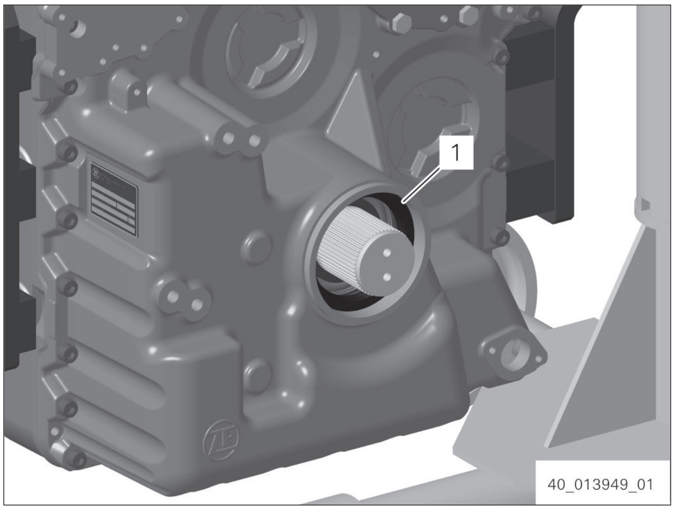


Fig. 319

3. Use AA01.368.722 [Press-in bush] to force screen sheet onto yoke until contact is obtained.

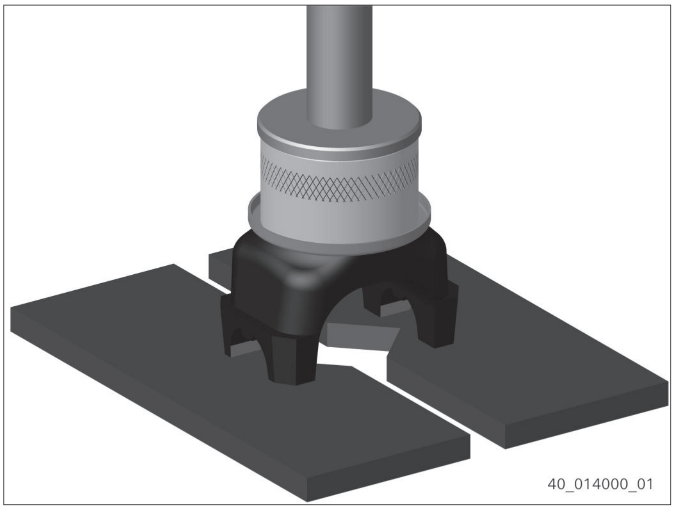


Fig. 320

4. Slide yoke (1) onto output shaft until contact is obtained.

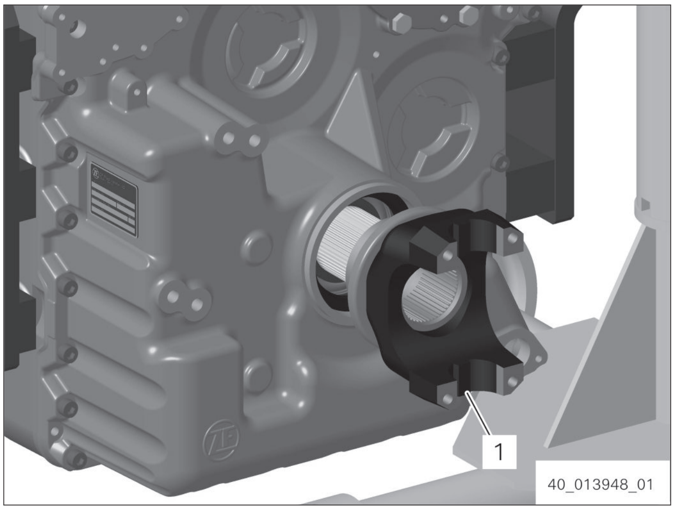


Fig. 321

5. Adjust the gap width (distance X).
   - 1 = Yoke
   - 2 = Washer
   - 3 = Output shaft
   - 4 = Washer
   - 5 = O-ring

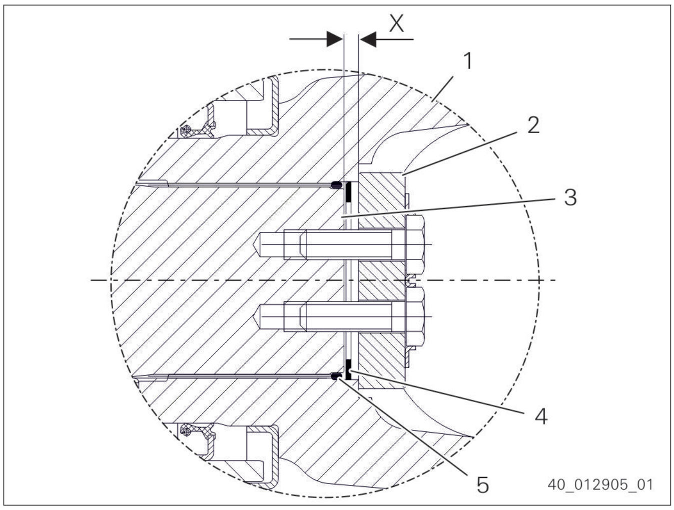


Fig. 322

6. Use depth gage to measure distance from front face of the yoke to front face of the output shaft.
   Distance A = e. g. 79.50 mm

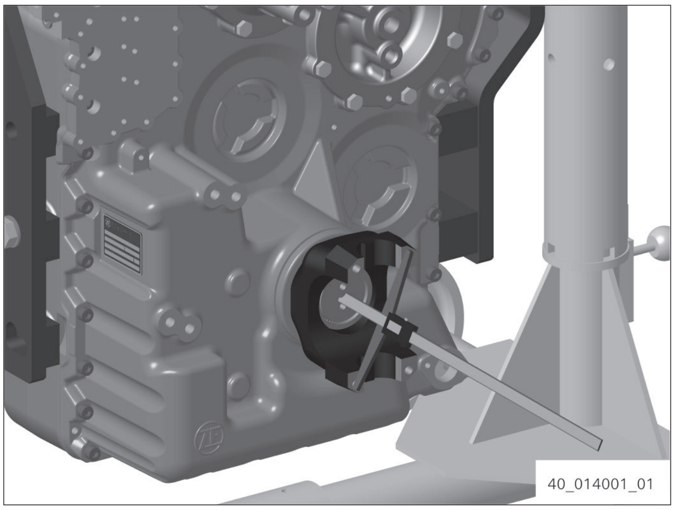


Fig. 323

7. Use depth gage to measure distance from front face to contact face of the washer on the yoke.
   Distance B = e.g. 78.00 mm

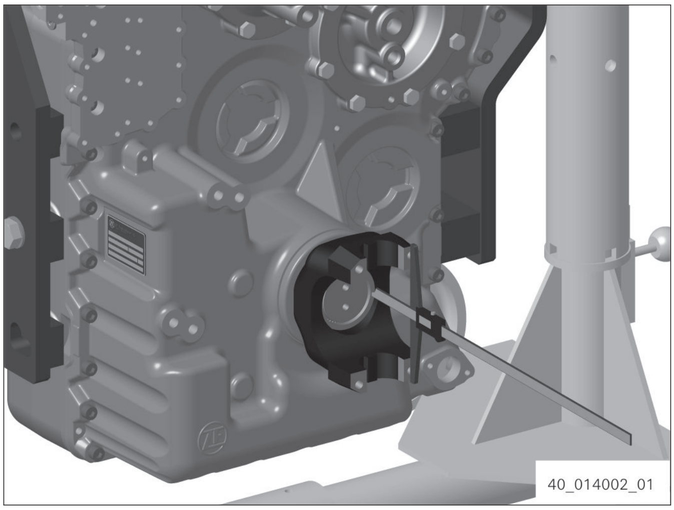


Fig. 324

8. Calculate thickness s of shim for setting Gap width of the output flange 0.30 mm to 0.80 mm to the output shaft.

   Calculation example:
   s = distance A – distance B – mean value of the required distance
   s = 79.50 mm – 78.00 mm – 0.50 mm
   s = 1.00 mm

9. Insert O-ring (1) in the space between output shaft and yoke.

10. Insert washer (2) with the calculated thickness, e. g. s = 1.00 mm.

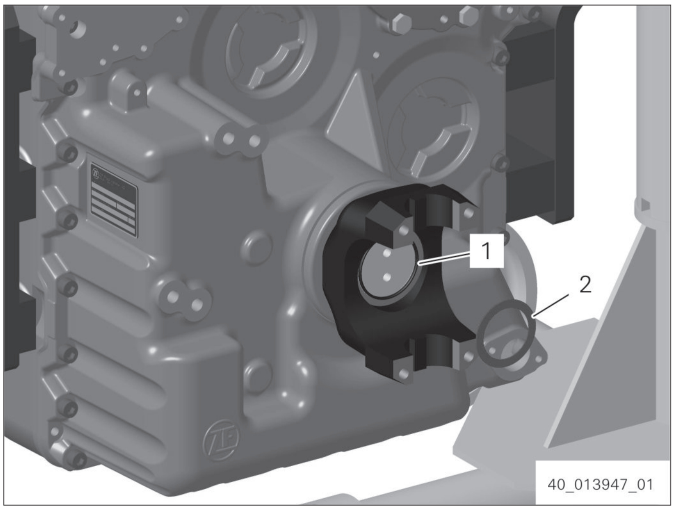


Fig. 325

11. Fix yoke with washer (3) and hexagon screws (2).
    Tightening torque: 46 Nm

12. ⚠ **CAUTION**

    Risk of injury due to parts flying away.
    Slight or moderate injury possible.
    ⇨ Wear protective goggles.

    Mount locking plate (1) using the 5870.057.009 [Driver tool] and 5870.260.002 [Handle] until contact is obtained.

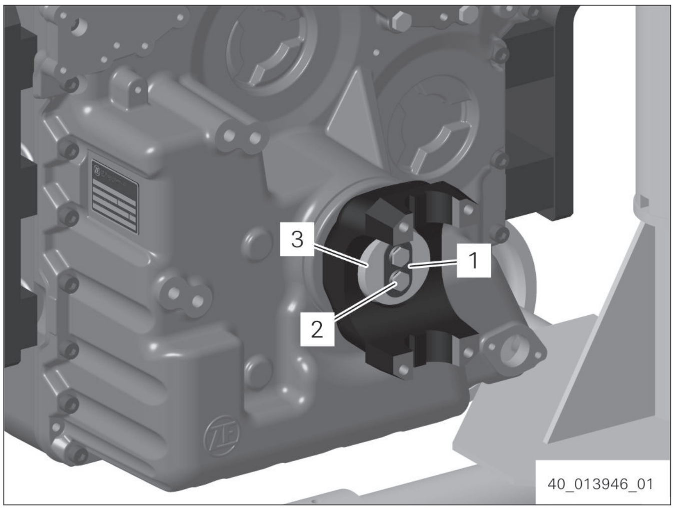


Fig. 326

Installing yoke on converter side

13. Carry out the following two work steps immediately one after the other.

    Apply 0666.690.191 [PHÖNIX SPIRITUS] to outer diameter of the shaft sealing ring.

14. Use 5870.048.265 [Driver tool] to insert shaft sealing ring (1) with seal lip facing the oil chamber.

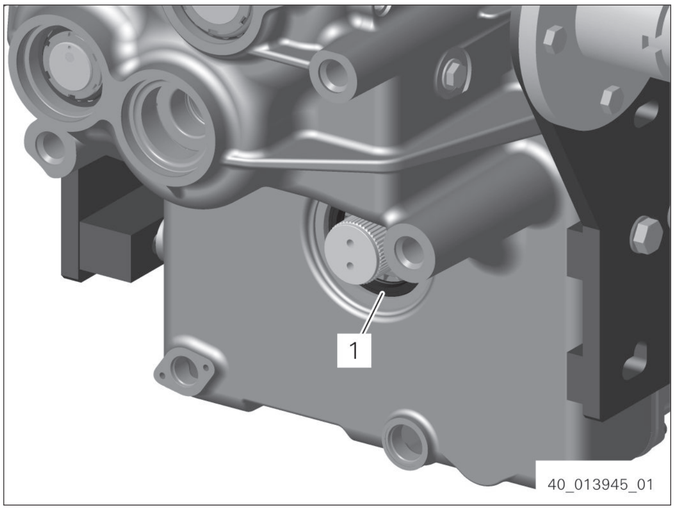


Fig. 327

15. Use AA01.368.722 [Press-in bush] to press protecting plate onto the yoke until contact is obtained.

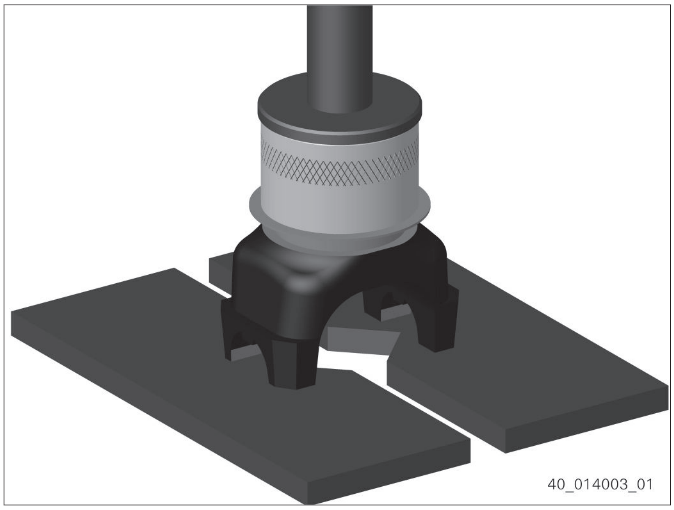


Fig. 328

16. Slide yoke (1) onto output shaft until contact is obtained.

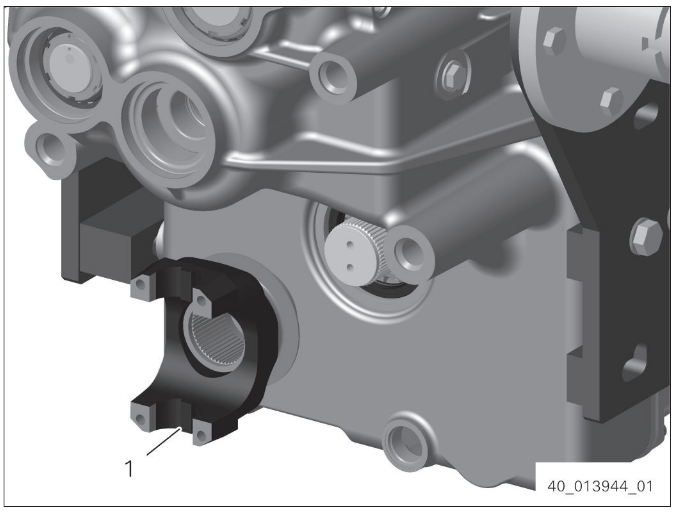


Fig. 329

17. Adjust the gap width (distance X).
    - 1 = Yoke
    - 2 = Washer
    - 3 = Output shaft
    - 4 = Washer
    - 5 = O-ring

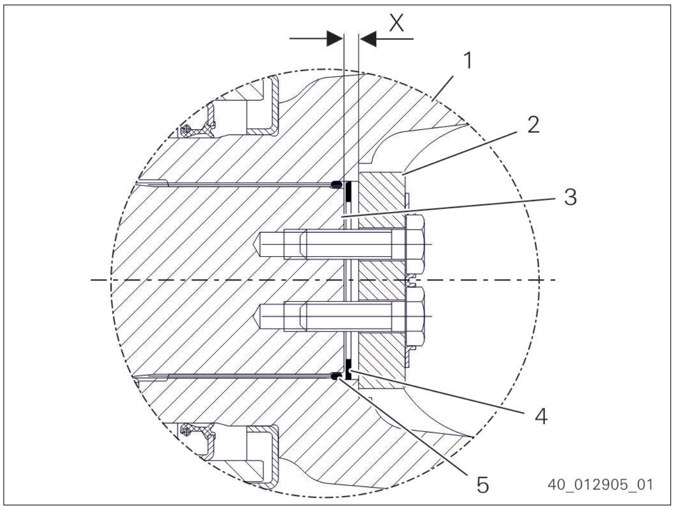


Fig. 330

18. Use depth gage to measure distance from front face of the yoke to front face of the output shaft.
    Distance A = e. g. 79.50 mm

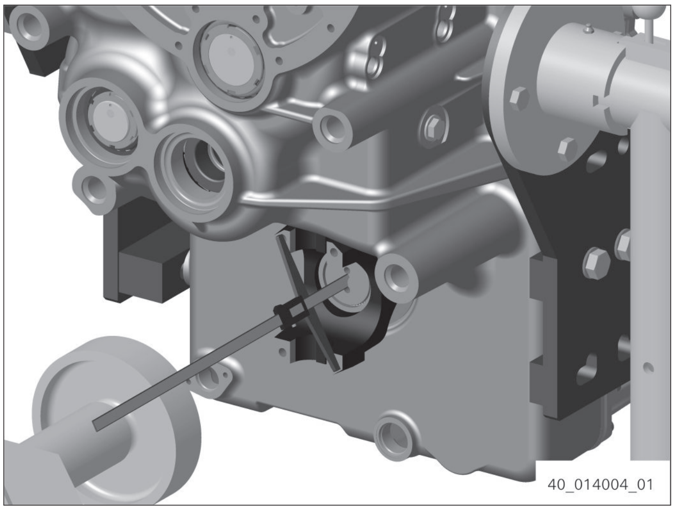


Fig. 331

19. Use depth gage to measure distance from front face to contact face of the washer on the yoke.
    Distance B = e.g. 78.00 mm

20. Calculate thickness s of shim for setting Gap width of the output flange 0.30 mm to 0.80 mm to the output shaft.

    Calculation example:
    s = distance A – distance B – mean value of the required distance
    s = 79.50 mm – 78.00 mm – 0.50 mm
    s = 1.00 mm

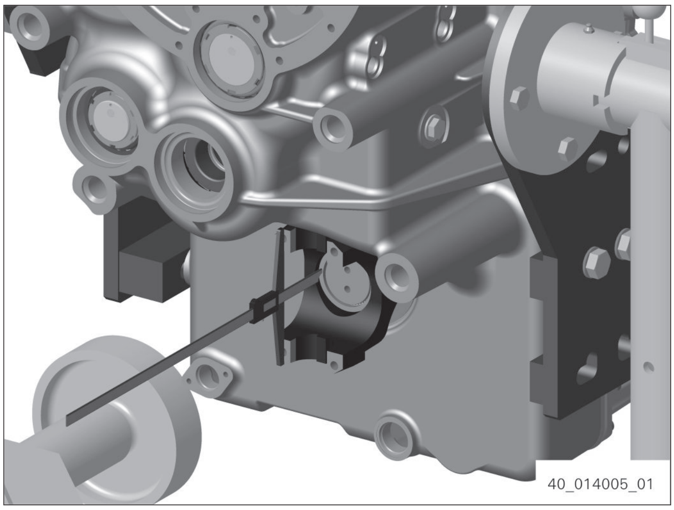


Fig. 332

21. Insert O-ring (2) in the space between output shaft and yoke.

22. Insert washer (1) with the calculated thickness, e. g. s = 1.00 mm.

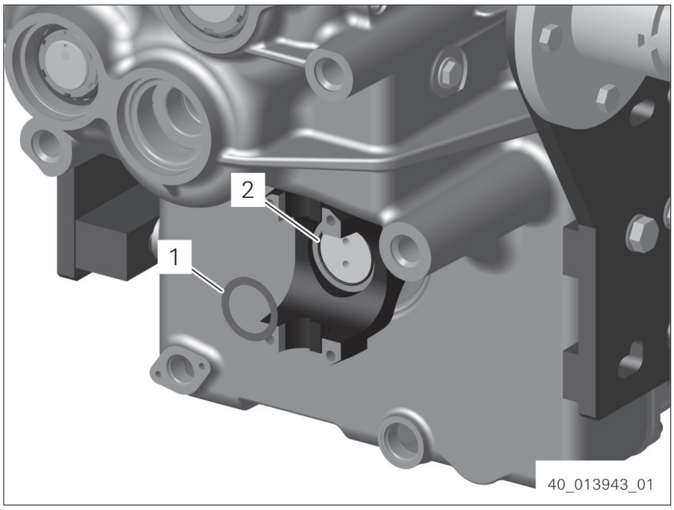


Fig. 333

23. Fix yoke with washer (3) and hexagon screws (2).
Tightening torque: 46 Nm

24. ⚠ **CAUTION**

Risk of injury due to parts flying away.
Slight or moderate injury possible.
⇨ Wear protective goggles.

Mount locking plate (1) using the 5870.057.009 [Driver tool] and 5870.260.002 [Handle] until contact is obtained.

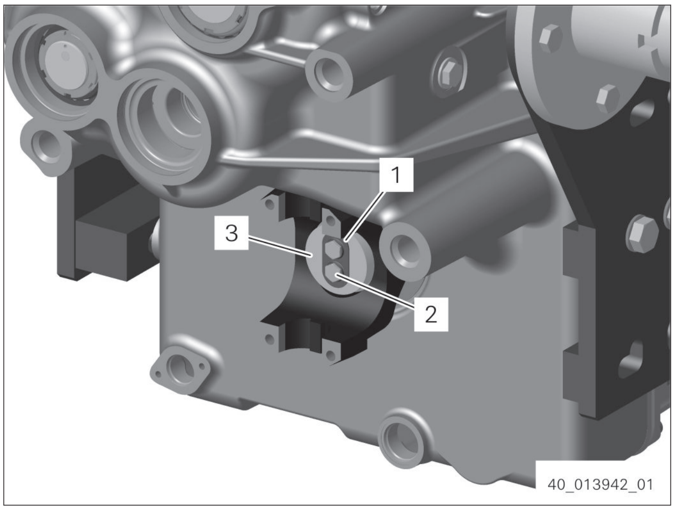


Fig. 334

Installing countershaft

Special tools:
- 5870.204.007 Locating pin

Operating supplies and auxiliary materials:
- 0666.690.248 LOCTITE 243
- 0666.690.191 PHÖNIX SPIRITUS

1. Center gear, bearing inner rings and ring.

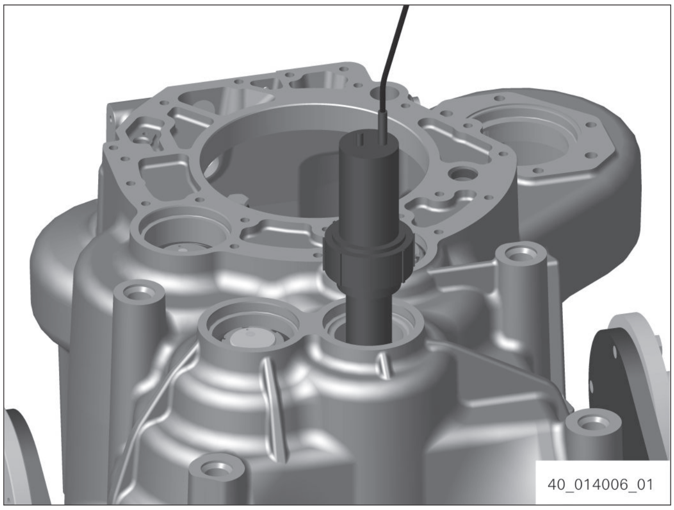


Fig. 335

2. Carry out the following three work steps immediately one after the other.

⚠ CAUTION

Risk of burn injuries due to contact with hot surfaces.
Slight or moderate injury possible.
⇨ Wear protective gloves.

Heat up bearing inner rings.

3. Bolt one 5870.204.007 [Locating pin] (1) into housing.

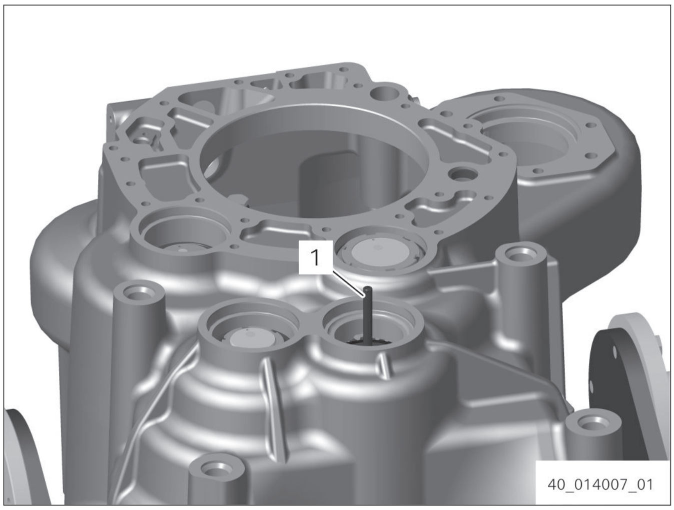


Fig. 336

4. Insert axle (1) until contact is obtained.

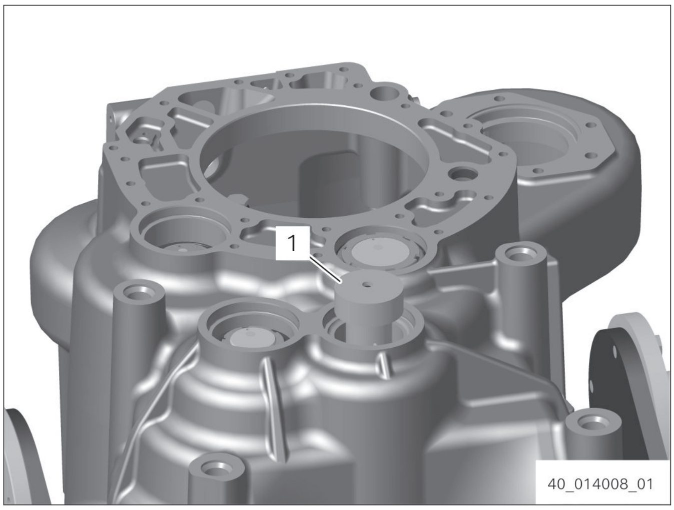


Fig. 337

5. Remove 5870.204.007 [Locating pin].

6. Apply 0666.690.248 [LOCTITE 243] to the thread of the hexagon screw.

7. Turn in and tighten hexagon screw (1).
   Tightening torque: 46 Nm

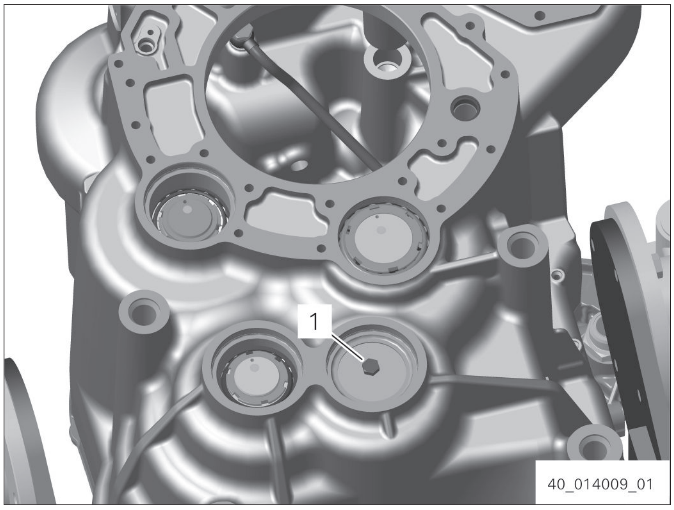


Fig. 338

8. Carry out the following two work steps immediately one after the other.

   Apply 0666.690.191 [PHÖNIX SPIRITUS] to the outer diameter of the protection cap.

9. Flush-mount protection cap (1) with the open side facing inwards into the housing hole.

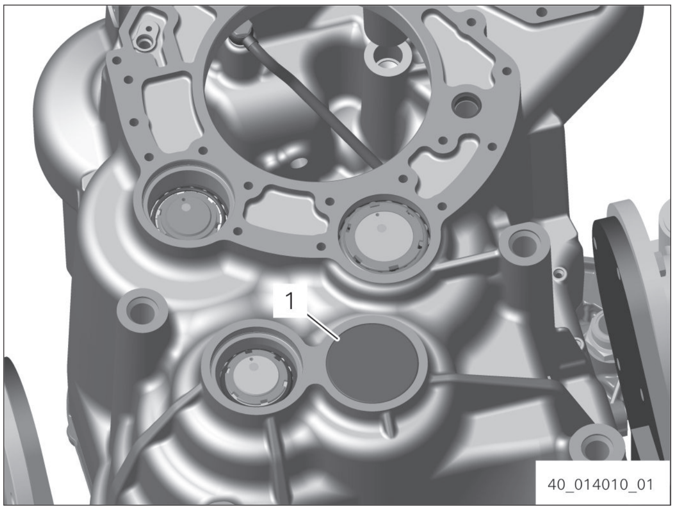


Fig. 339

Assembling and installing the power take-offs (variant with PTO) 1, 3 and 4)

Installing PTOs 3 and 4

Special tools:
- 5870.200.113 Feeler gauge

Operating supplies and auxiliary materials:
- 0666.690.191 PHÖNIX SPIRITUS

1. Insert plug with O-ring (1) into housing hole.

2. Fasten plug with cap screw.
Tightening torque: 23 Nm

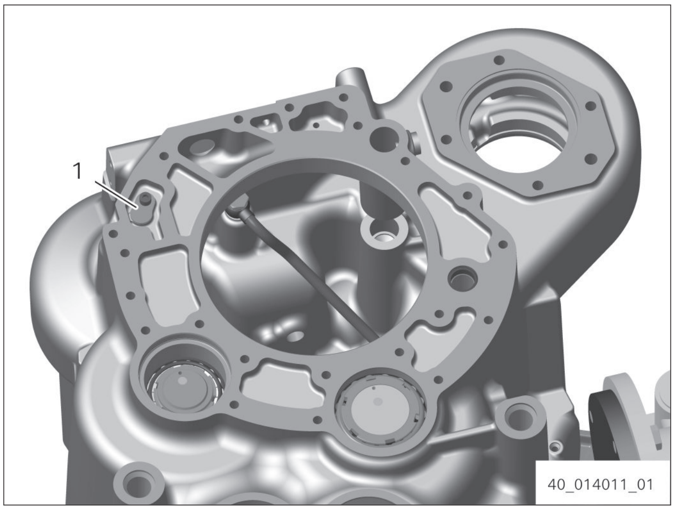


Fig. 340

3. Carry out the following two work steps immediately one after the other.

Apply 0666.690.191 [PHÖNIX SPIRITUS] to the outer diameter of the protection cap.

4. Flush-mount protection cap (2) with the open side facing inwards into the housing hole.

5. Insert the ball bearing (1) into the housing hole until contact is obtained.

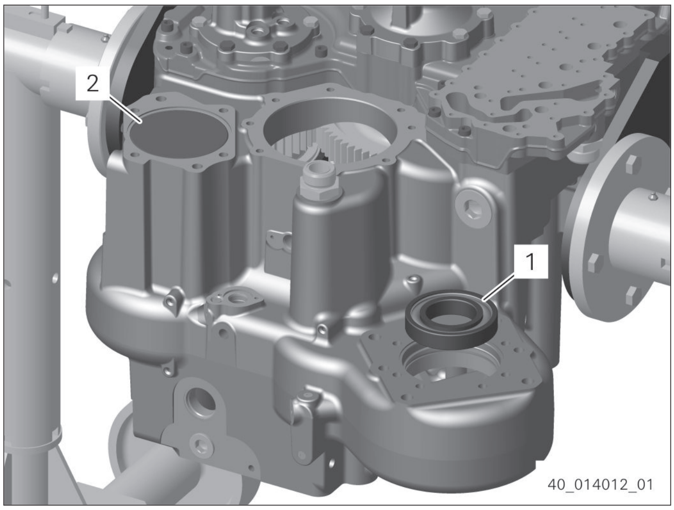


Fig. 341

6. Insert gear (1) with the short collar facing downwards into the housing.

7. Center gear.

8. Carry out the following two work steps immediately one after the other.

⚠ CAUTION

Risk of burn injuries due to contact with hot surfaces.
Slight or moderate injury possible.
⇨ Wear protective gloves.

Heat hole in the gear and bearing inner ring of the ball bearing.

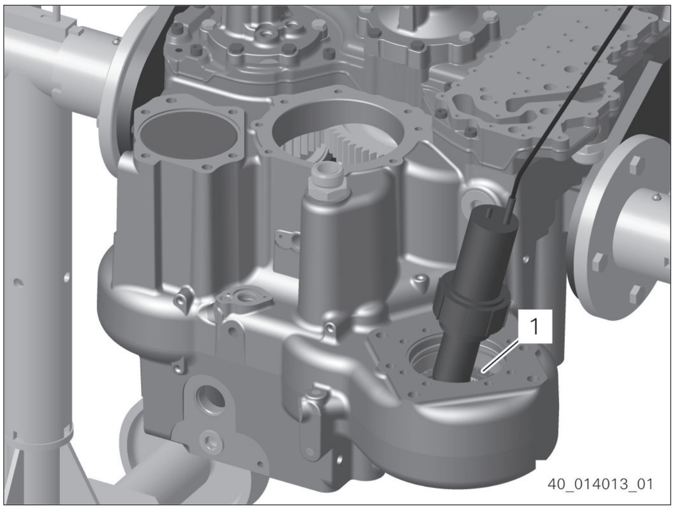


Fig. 342

9. Insert driver (1) with the short collar facing downwards until contact is obtained.

10. Let gear cool down.

11. Adjust the driver.

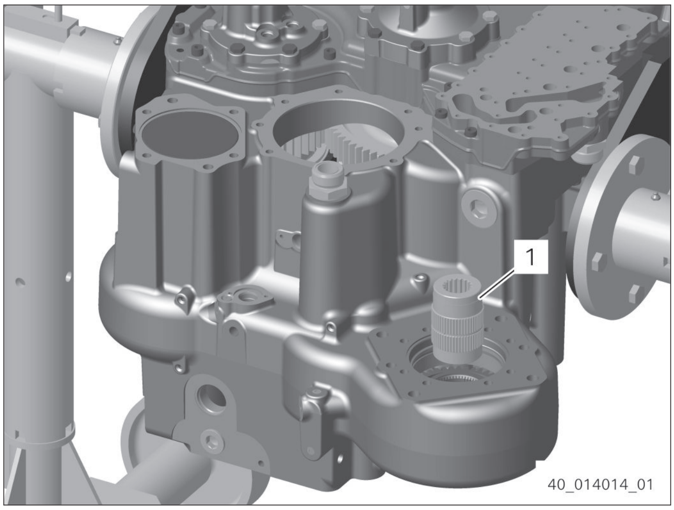


Fig. 343

Setting axial play of the gear bearing

12. Insert the ball bearing (3) into the housing hole until contact is obtained.

13. Insert shim (2) e. g. s = 1.40 mm.

14. Insert retaining ring (1) into annular groove.

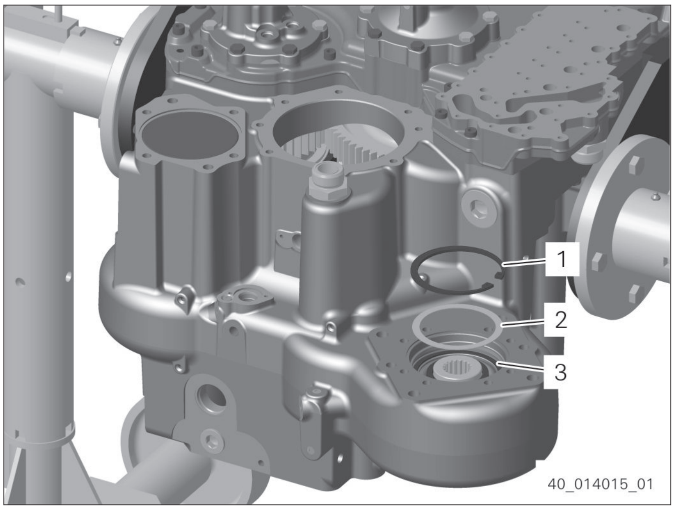


Fig. 344

15. Check Axial play gear bearing 0.20 mm to 0.30 mm with 5870.200.113 [Feeler gauge].
If the axial clearance is too small, install a thinner shim.
If the axial clearance is too large, install a thicker shim.

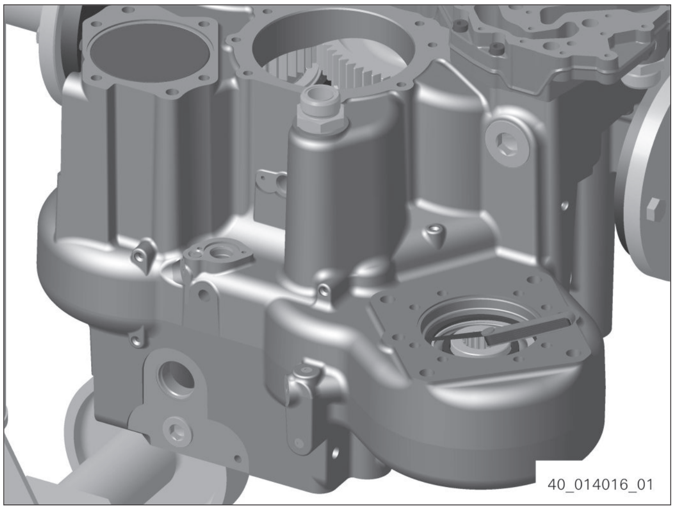


Fig. 345

16. Grease O-ring.

17. Insert the O-ring (1) into the countersink of the housing.

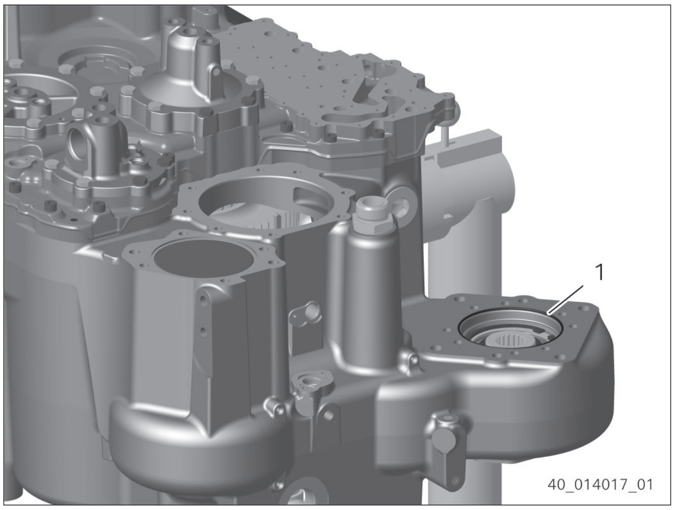


Fig. 346

18. Fix cover (1) with hexagon screws.
Tightening torque: 46 Nm

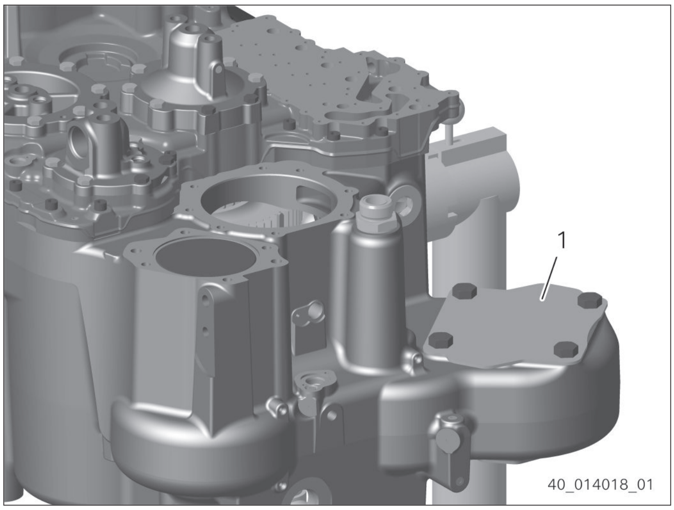


Fig. 347

19. Rotate transmission by 180.

20. Carry out the following two work steps immediately one after the other.

Apply 0666.690.191 [PHÖNIX SPIRITUS] to the outer diameter of the protection cap.

21. Flush-mount protection cap (1) with the open side facing inwards into the housing hole.

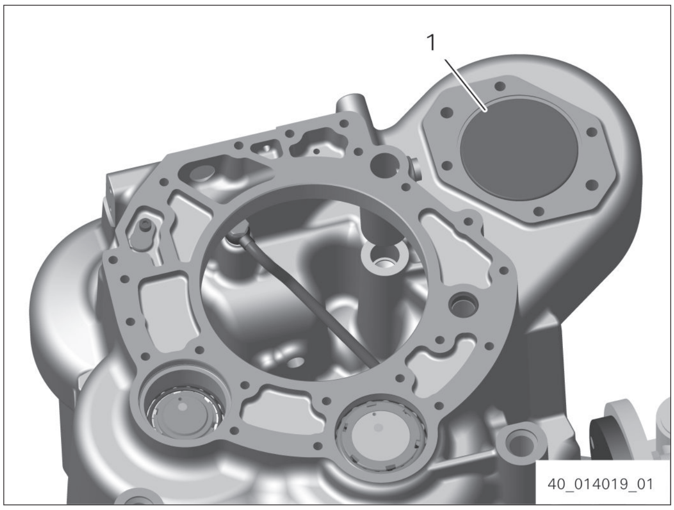


Fig. 348

22. Insert bearing outer rings into the gear until contact it obtained.

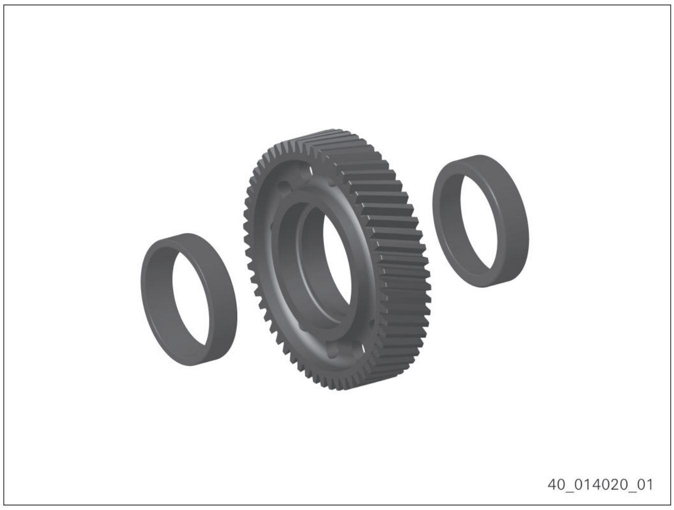


Fig. 349

23. Insert bearing inner rings into bearing outer rings.

24. Insert gear (1) into the housing.

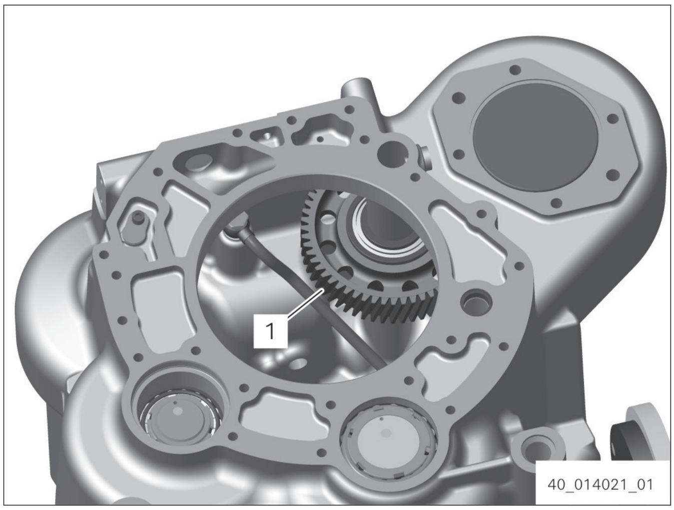


Fig. 350

Adjusting axial clearance of the gear bearing (intermediate gear)

25. Measure distance between housing and front side bearing inner ring with 5870.200.113 [Feeler gauge]. Distance = e. g. 1.45 mm

26. Calculate thickness of the shim for Axial clearance gear bearing (intermediate gear) 0.01 mm to 0.10 mm.

    Calculation example:
    s = distance – mean value of axial clearance
    s = 1.45 mm – 0.05 mm
    s = 1.40 mm

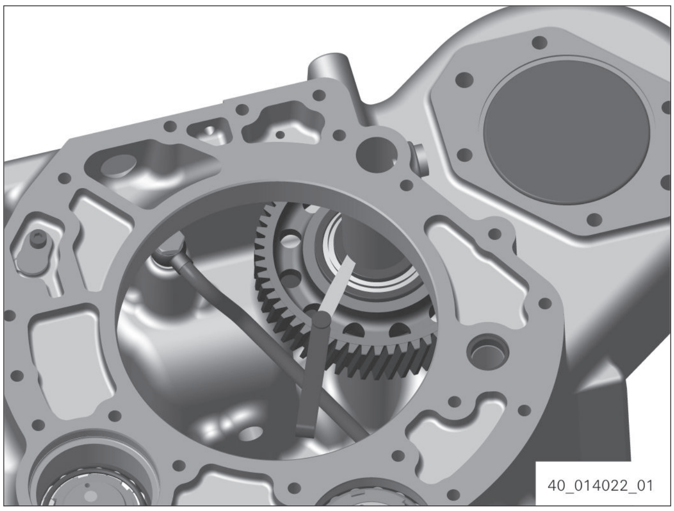


Fig. 351

27. Insert shim (1) with the calculated thickness e. g. s = 1.40 mm.

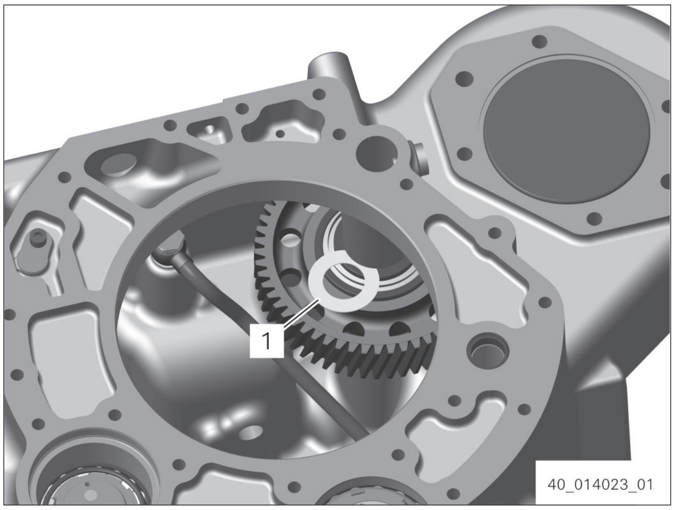


Fig. 352

28. Center gear and shim.

29. Carry out the following two work steps immediately one after the other.

CAUTION

Risk of burn injuries due to contact with cold surface.
Slight to moderate injury possible.
⇨ Wear protective gloves.

Undercool pin.

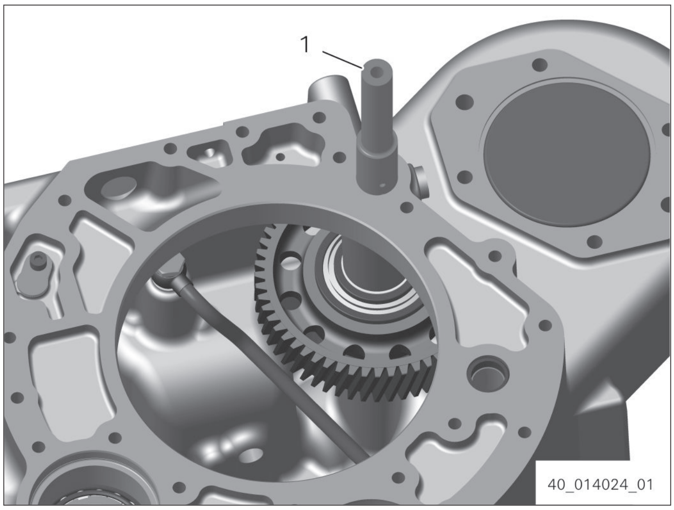


Fig. 353

30. Insert pin (1) into housing hole until contact is obtained.

Installing pressure oil pump

Special tools:
- 5870.801.006 Hot air pot
- 5870.204.021 Fixing pin

Checking gear pump

1. Check individual parts of the gear pump for wear marks before assembling the transmission.

   The gear pump is only available as a complete unit.

   Loosen cap screws.

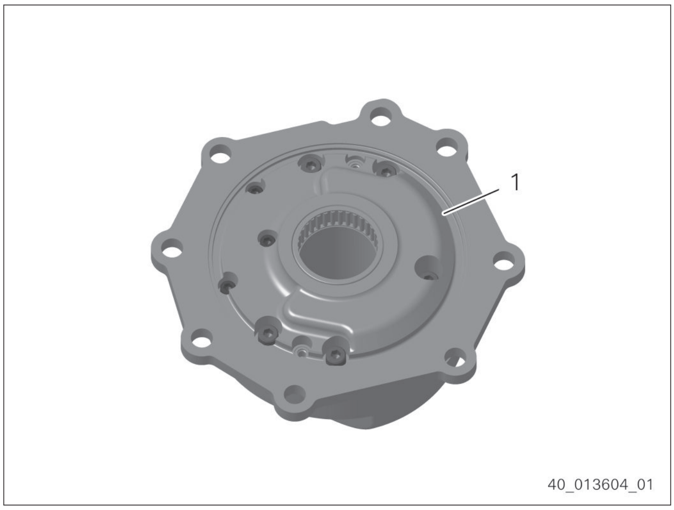


Fig. 354

2. Remove cover (1).

3. Check the cover, outer rotor, inner rotor and the pump housing for wear marks.
   In case of any damage, install new gear pump.

4. Insert outer rotor and inner rotor, with the chamfered tooth side facing the pump housing.

5. Insert cylindrical pins until contact is obtained.

6. Place the cover.

7. Bolt in and tighten cap screws.
   Tightening torque: 23 Nm
   Tightening torque: 9.5 Nm

8. Insert bearing outer ring (1) until contact is obtained.

9. Grease O-ring.

10. Insert O-ring (2) into annular groove.

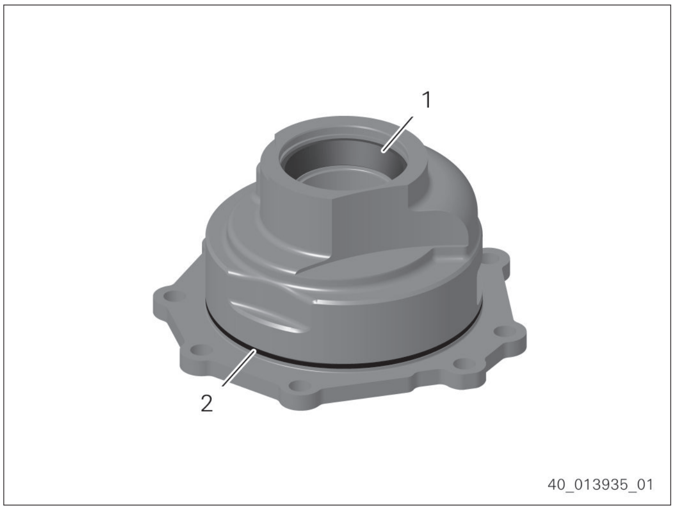


Fig. 355

11. Carry out the following three work steps immediately one after the other.

⚠ CAUTION

Risk of burn injuries due to contact with hot surfaces.
Slight or moderate injury possible.
⇨ Wear protective gloves.

Heat up housing hole by means of hot air blower and 5870.801.006 [Hot air pot].

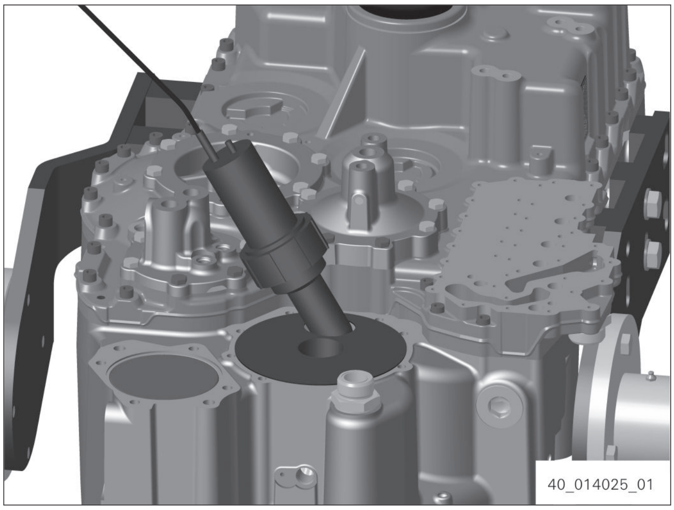


Fig. 356

12. Screw two 5870.204.021 [Fixing pin] into the housing.

13. Insert gear pump (1) into housing hole until contact is obtained.

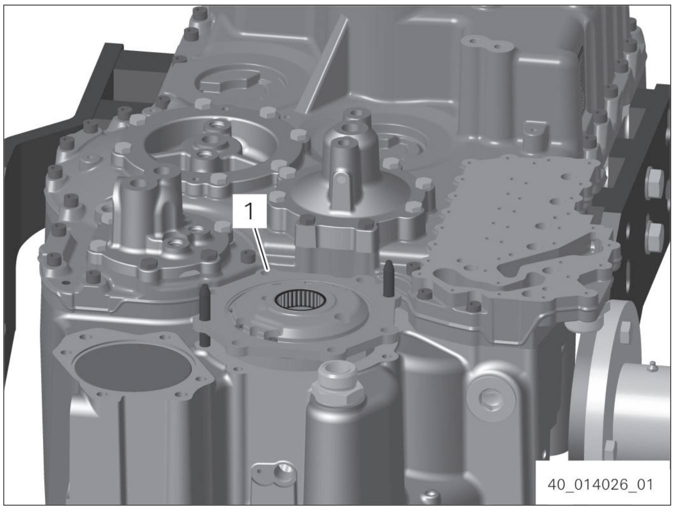


Fig. 357

14. Grease O-ring.

15. Slide O-ring (1) onto pump flange.

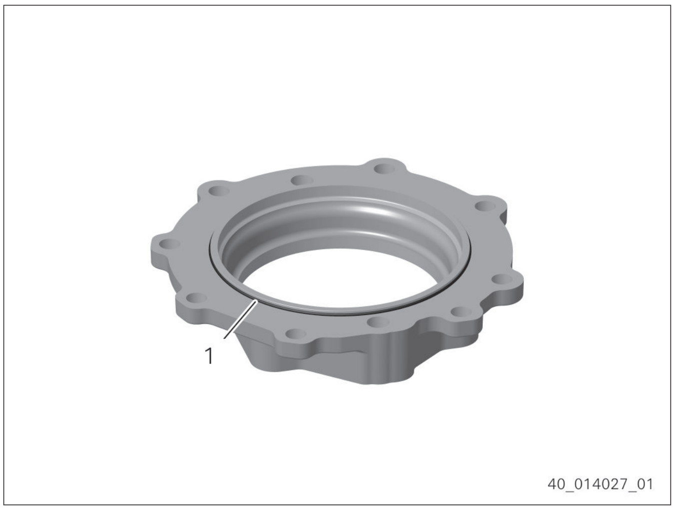


Fig. 358

16. Fit pump flange (1).

17. Fix pump flange and gear pump with hexagon screws.
Tightening torque: 79 Nm

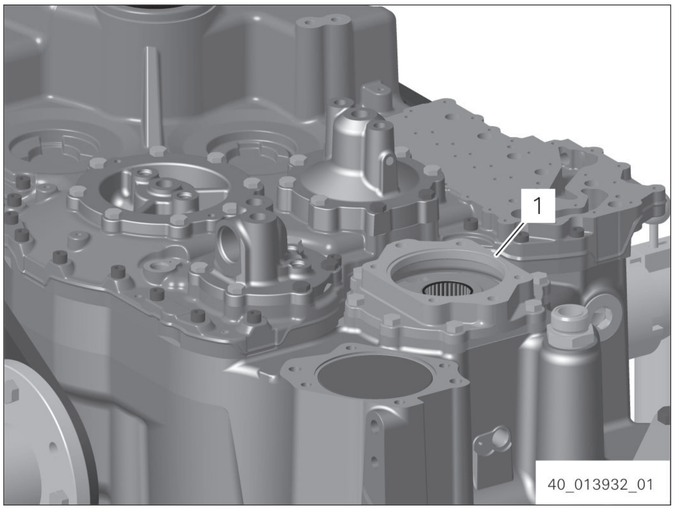


Fig. 359

Installing shaft

Operating supplies and auxiliary materials:
- 0666.690.248 LOCTITE 243

1. Slide shim (2) onto driver.

2. Carry out the following two work steps immediately one after the other.

⚠ CAUTION

Risk of burn injuries due to contact with hot surfaces.
Slight or moderate injury possible.
⇨ Wear protective gloves.

Heat bearing inner ring.

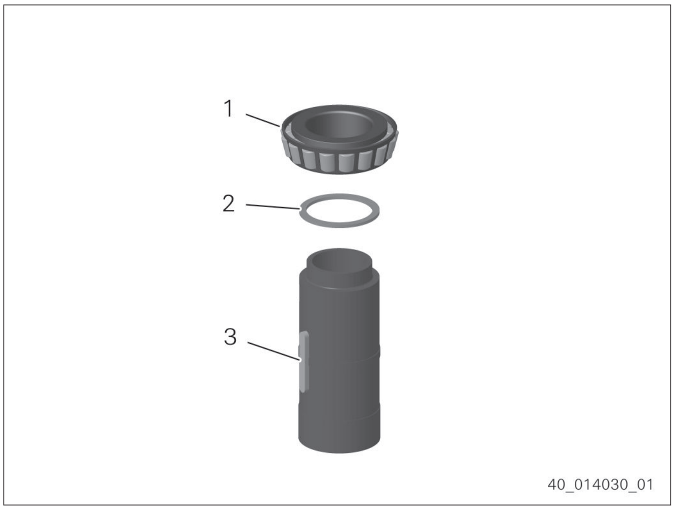


Fig. 360

3. Slide on bearing inner ring (1) until contact is obtained.

4. Let bearing inner ring cool down.

5. Adjust bearing inner ring.

6. Insert fitting key (3).

7. Slide washer onto shaft.

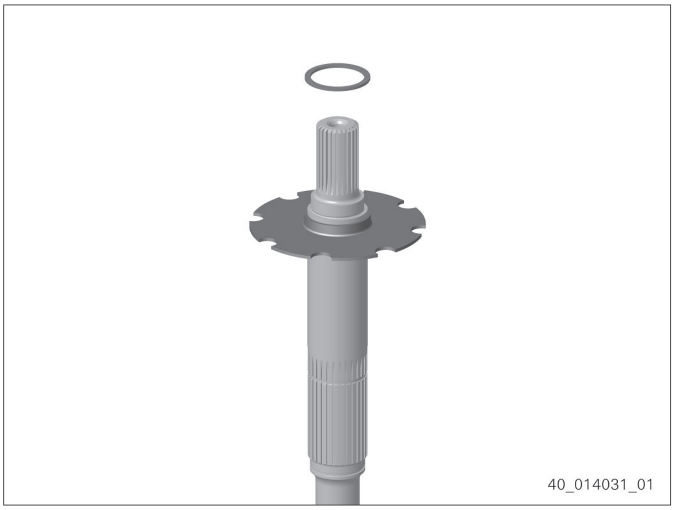


Fig. 361

8. Slide the driver (3) onto the shaft.

9. Insert spring washer (2) with the larger inner diameter facing upwards.

10. Apply 0666.690.248 [LOCTITE 243] to thread of cap screw.

11. Bolt in cap screw (1) and tighten.
Tightening torque: **46 Nm**

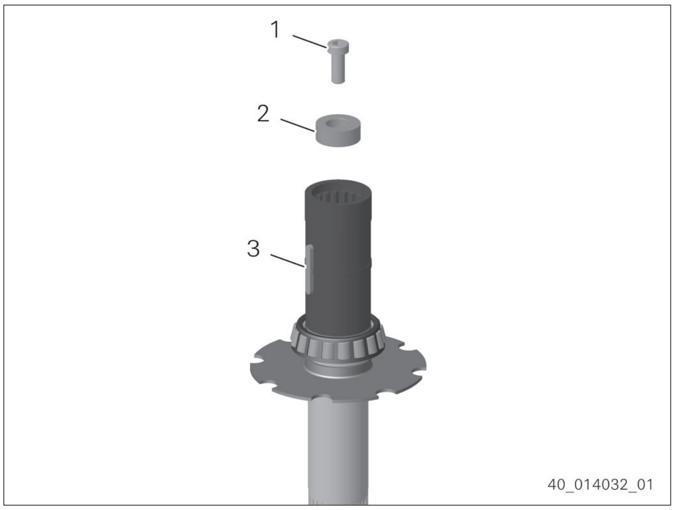


Fig. 362

12. Carry out the following two work steps immediately one after the other.

⚠ CAUTION

Risk of burn injuries due to contact with hot surfaces.
Slight or moderate injury possible.
⇨ Wear protective gloves.

Heat bearing inner ring.

13. Slide on bearing inner ring (1) onto the gear until contact is obtained.

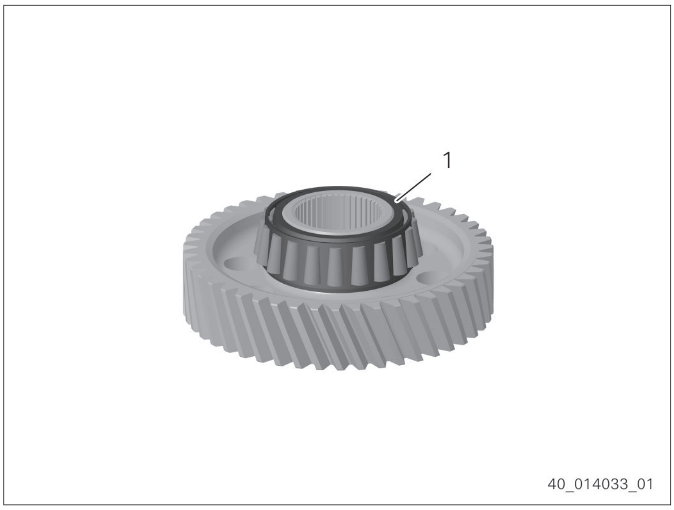


Fig. 363

14. Let bearing inner ring cool down.

15. Adjust bearing inner ring.

16. Insert retaining ring (2).

17. Slide on gear (1) until contact is obtained.

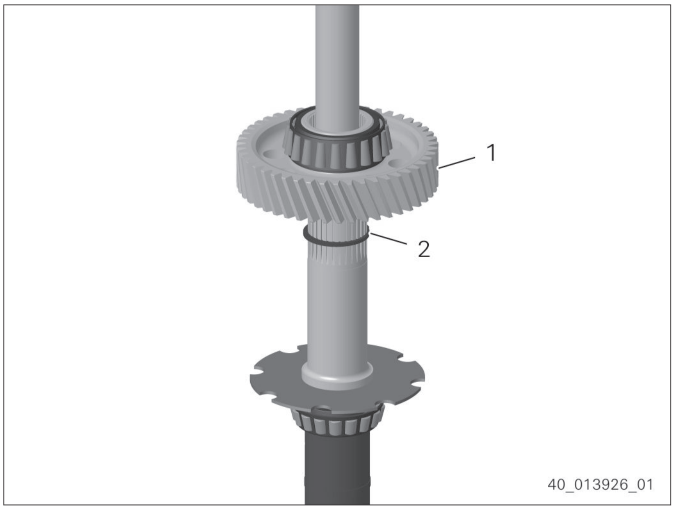


Fig. 364

18. Grease the annular groove on the shaft.

19. Insert and center R-ring (1).

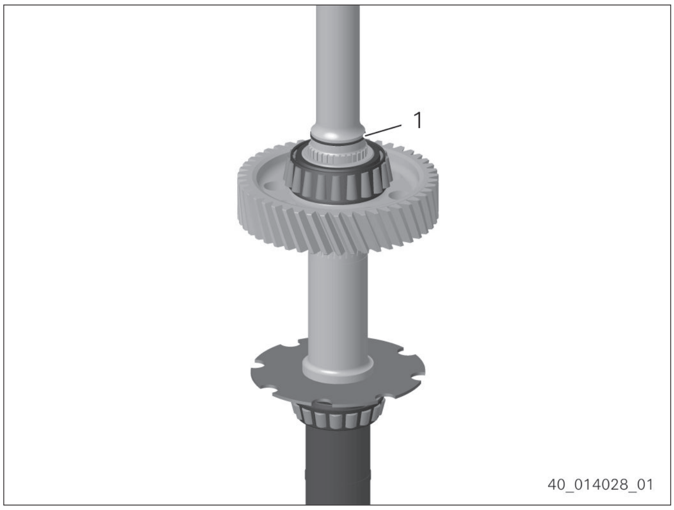


Fig. 365

20. Flush-align fitting key and fitting key groove.

21. Insert shaft (1) into the gear pump until contact is obtained.

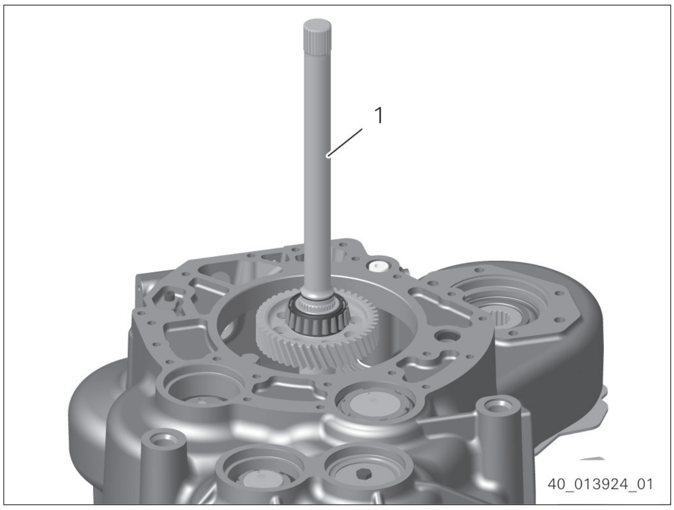


Fig. 366

22. Grease O-ring.

23. Insert the O-ring (1) into the countersink of the pump flange.

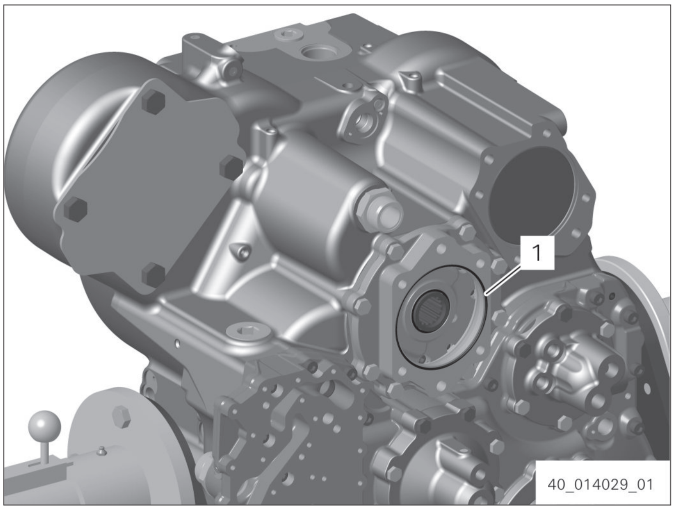


Fig. 367

24. Secure the cover (1) with hexagon screws. Tightening torque: 46 Nm

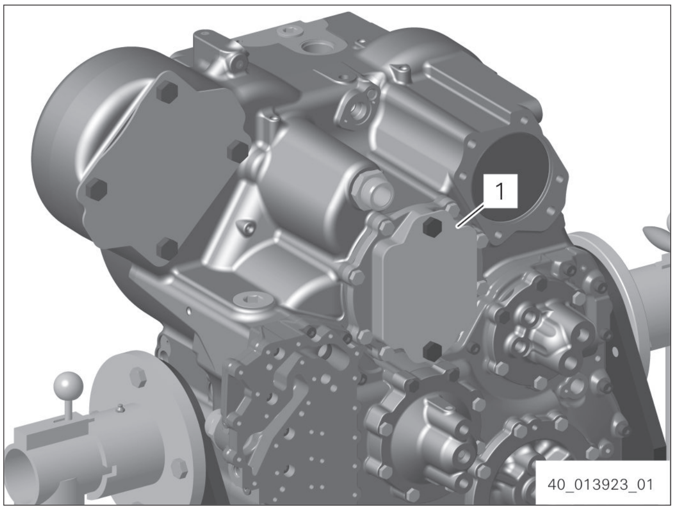


Fig. 368

Assembling drive

Special tools:

- 5870.320.016 Lever riveter
- 5870.801.006 Hot air pot
- 5870.204.007 Locating pin
- 5870.058.051 Driver tool
- 5870.260.002 Handle
- 5870.048.030 Driver tool
- 5870.204.021 Fixing pin
- AA02.247.426 Eyebolt

Operating supplies and auxiliary materials:

- 0666.690.191 PHÖNIX SPIRITUS

1. Insert sealing plugs (1) into holes using 5870.320.016 [Lever riveter].

2. Screw in and tighten screw plug with O-ring (2).
   Tightening torque: 35 Nm

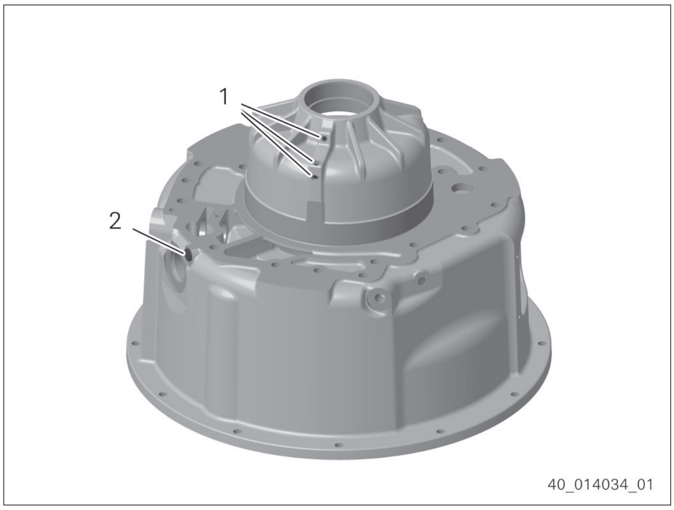


Fig. 369

3. Insert bearing outer ring (1) into bearing hole until contact is obtained.

4. Insert bearing inner ring (2).

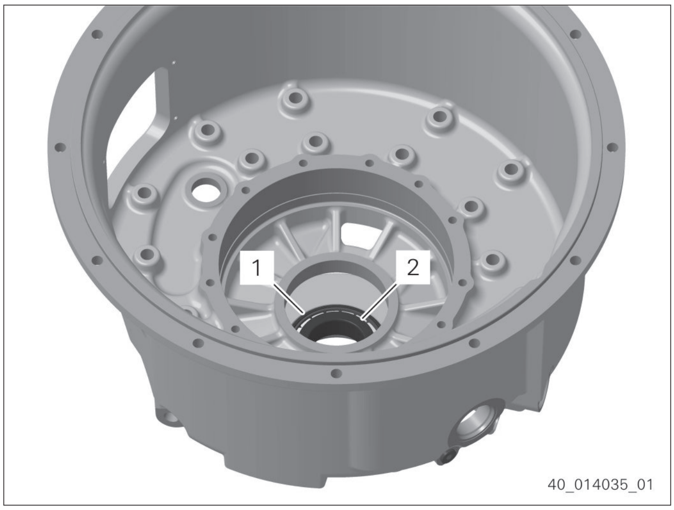


Fig. 370

5. Insert helical gear (1) with long collar facing upwards into torque converter bell housing.

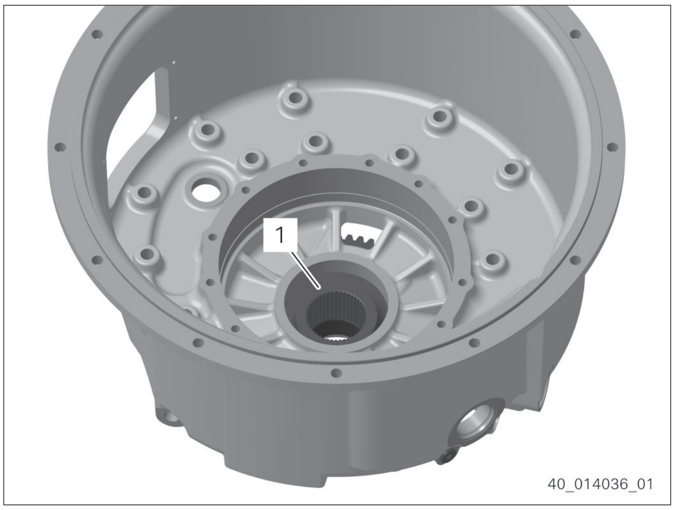


Fig. 371

6. Carry out the following two work steps immediately one after the other.

⚠ CAUTION

Risk of burn injuries due to contact with hot surfaces.
Slight or moderate injury possible.
⇨ Wear protective gloves.

Heat up hole in helical gear and bearing inner ring.

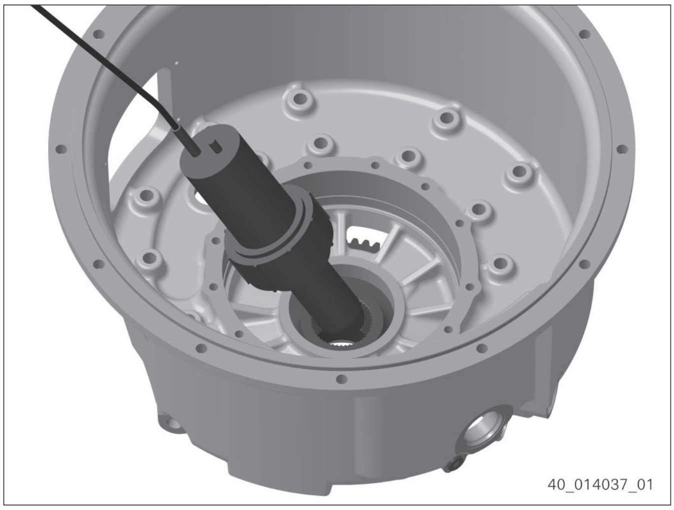


Fig. 372

7. Insert input shaft (1) until contact is obtained.

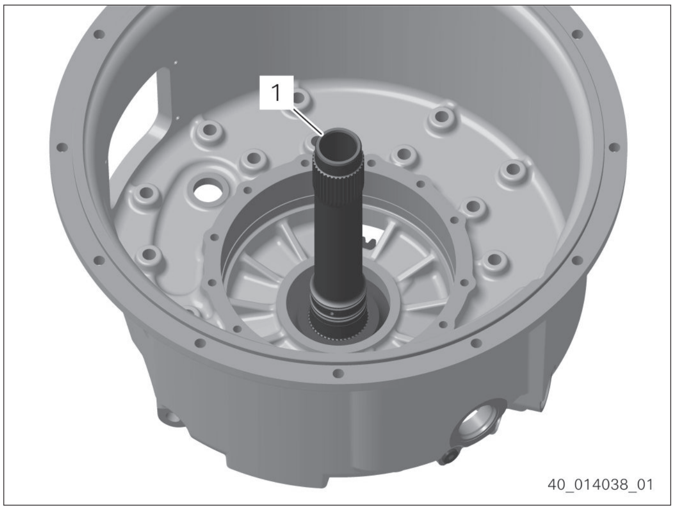


Fig. 373

8. Carry out the following two work steps immediately one after the other.

⚠ CAUTION

Risk of burn injuries due to contact with hot surfaces.
Slight or moderate injury possible.
⇨ Wear protective gloves.

Heat bearing inner ring.

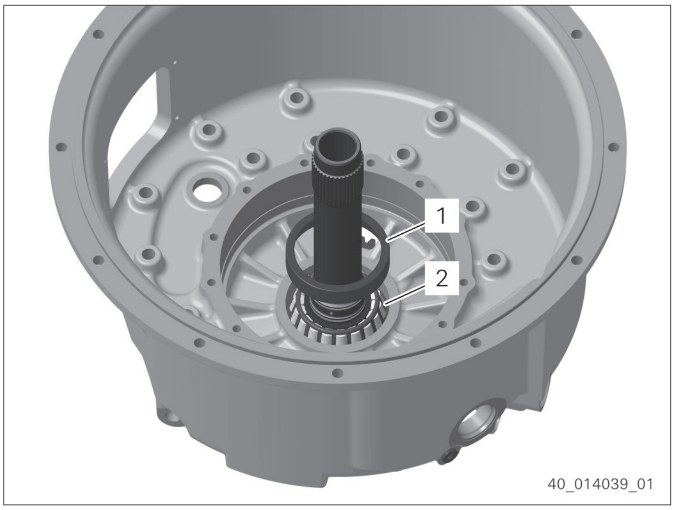


Fig. 374

9. Slide on bearing inner ring (2) until contact is obtained.

10. Let bearing inner ring cool down.

11. Adjust bearing inner ring.

12. Insert bearing outer ring (1) until contact is obtained.

13. Grease annular grooves of input shaft.

14. Insert and center R-rings (1).

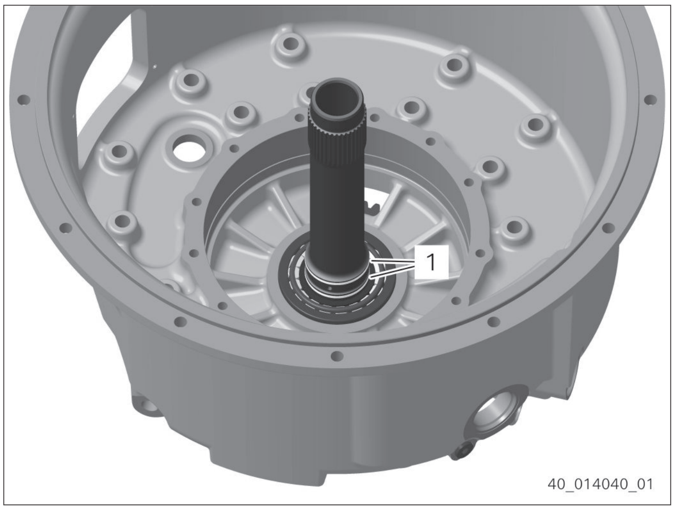


Fig. 375

15. Insert converter safety valve (2) into oil feed flange until contact is obtained.

16. **CAUTION**

Risk of injury due to parts flying away.
Slight or moderate injury possible.
⇨ Wear protective goggles.

Flush-mount slotted pin (1).

17. Grease O-ring.

18. Slide on O-ring (3).

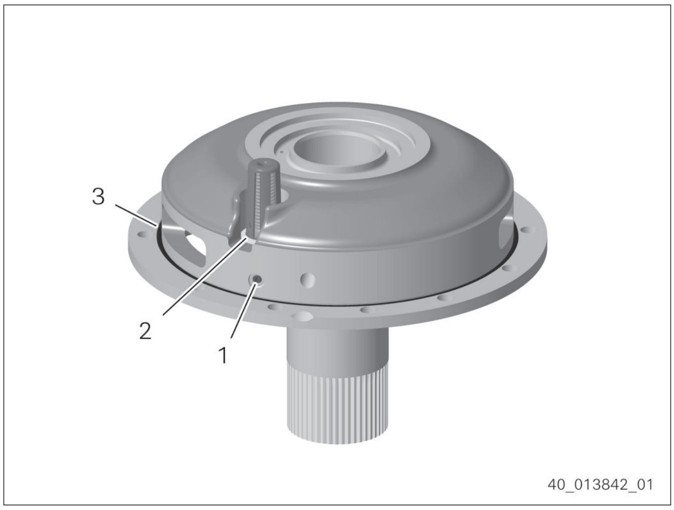


Fig. 376

19. Carry out the following three work steps immediately one after the other.

⚠ CAUTION

Risk of burn injuries due to contact with hot surfaces.
Slight or moderate injury possible.
⇨ Wear protective gloves.

Heat up hole with hot air blower and 5870.801.006 [Hot air pot].

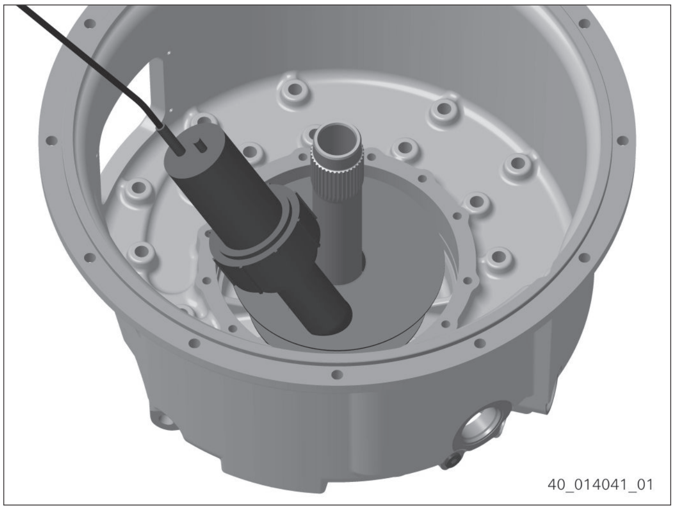


Fig. 377

20. Turn two 5870.204.007 [Locating pin] into torque converter bell housing.

21. Insert oil feed flange (1) into hole until contact is obtained.

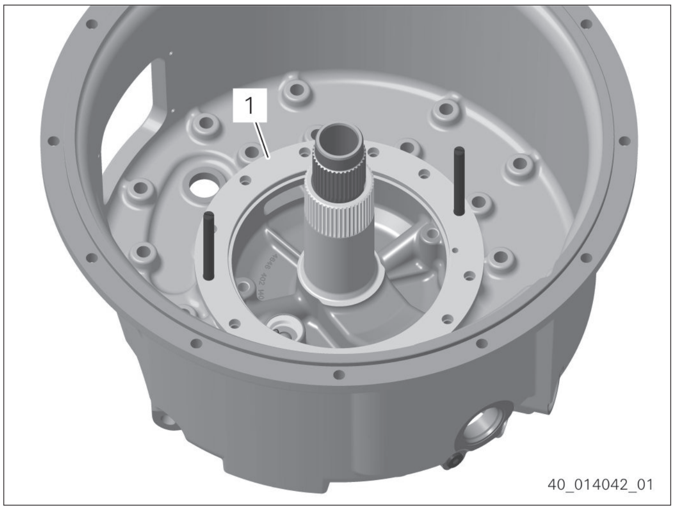


Fig. 378

22. Insert needle sleeve (1) into bearing cover using 5870.058.051 [Driver tool] and 5870.260.002 [Handle] until contact is obtained. Insert needle sleeve with marked front face showing upwards.

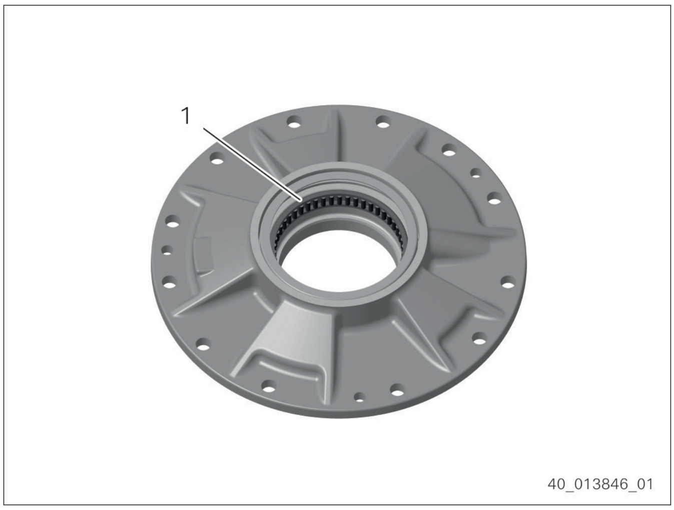


Fig. 379

23. Carry out the following two work steps immediately one after the other.

Apply 0666.690.191 [PHÖNIX SPIRITUS] to outer diameter of shaft sealing ring.

24. Insert shaft sealing ring (1) with 5870.048.030 [Driver tool].

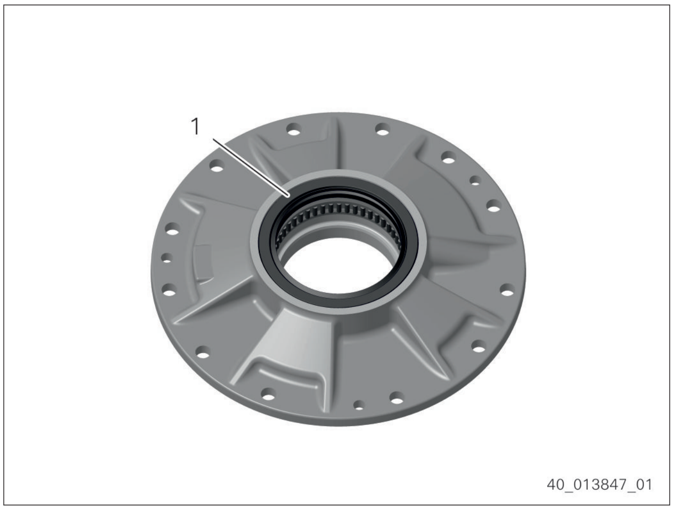


Fig. 380

25. Grease O-ring.

26. Fit O-ring (1).

Fig. 381

27. Fit bearing cover (1).

28. Turn in and tighten hexagon screws.
Tightening torque: 46 Nm

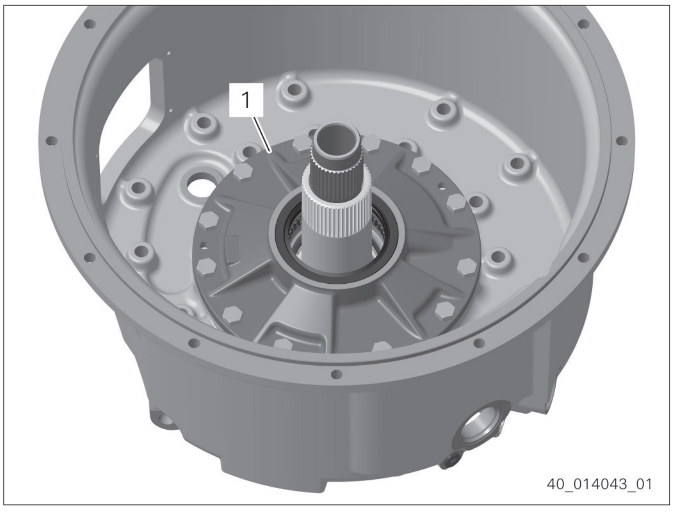


Fig. 382

29. Push washers onto hexagon screws.

30. Fix cover plate (1) and cover sheet (2) with hexagon screws.
Tightening torque: 2 Nm (±1 Nm)

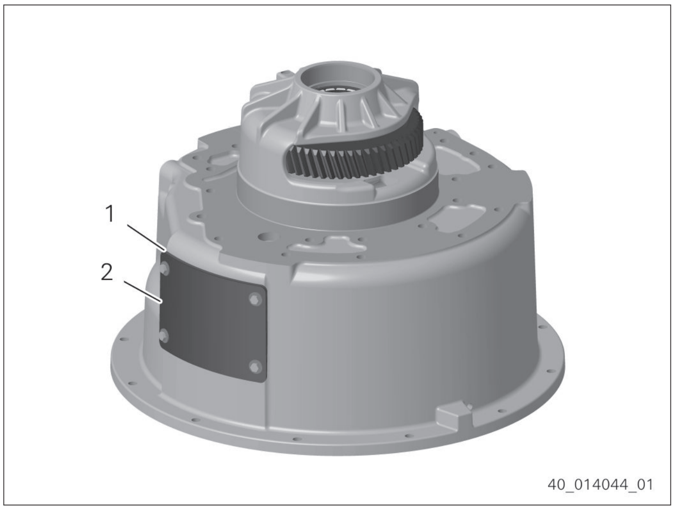


Fig. 383

31.

⚠ **CAUTION**
Risk of injury due to parts flying away. Slight or moderate injury possible. ⇨ Wear protective goggles.

Force in slotted pin until contact is obtained.

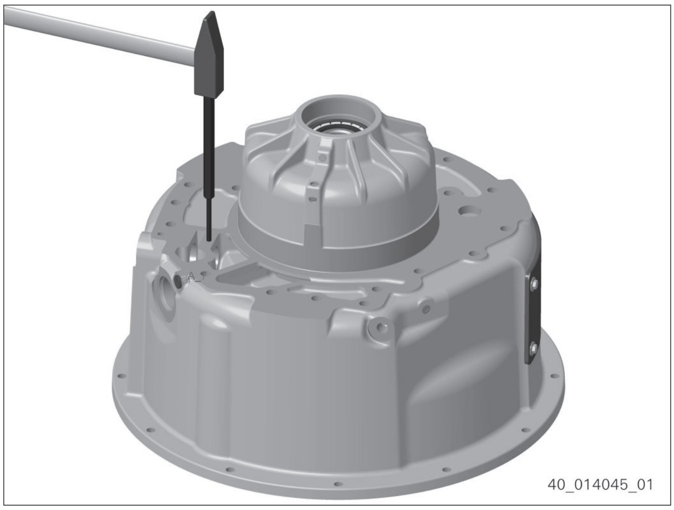


Fig. 384

32. Carry out the following two work steps immediately one after the other.

Apply 0666.690.191 [PHÖNIX SPIRITUS] to the outer diameter of the protection caps.

33. Flush-mount protection caps (1) with the open side facing inwards into housing holes.

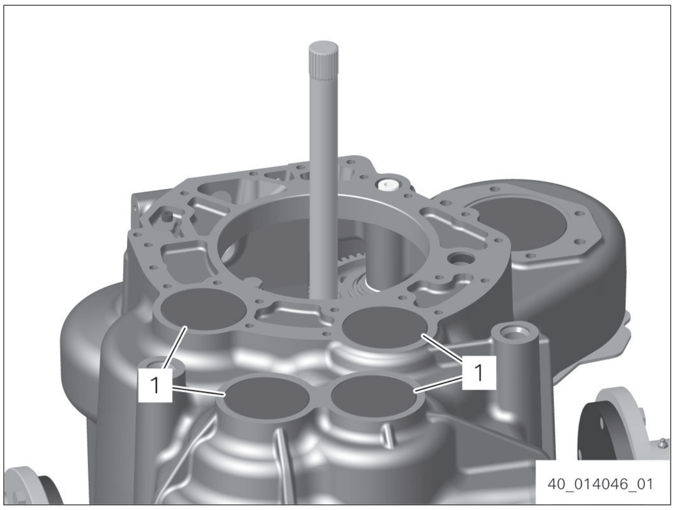


Fig. 385

34. Screw two 5870.204.021 [Fixing pin] into the housing.

35. Put on seal (1).

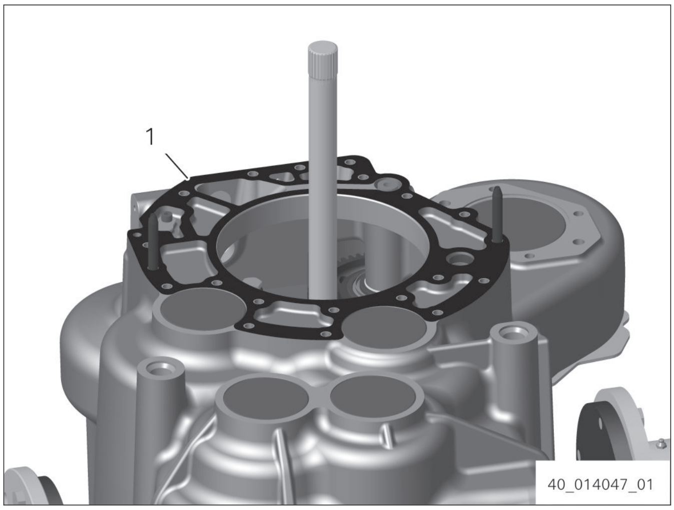


Fig. 386

36. ⚠ **CAUTION**

Risk of crushing due to moving load.
Slight to moderate injury possible.
⇨ Move load slowly and carefully.
⇨ Do not reach into danger area.

Mount torque converter bell housing with two AA02.247.426 [Eyebolt] and a crane.

Fig. 387

37. Turn in and tighten hexagon screws.
Tightening torque: 115 Nm

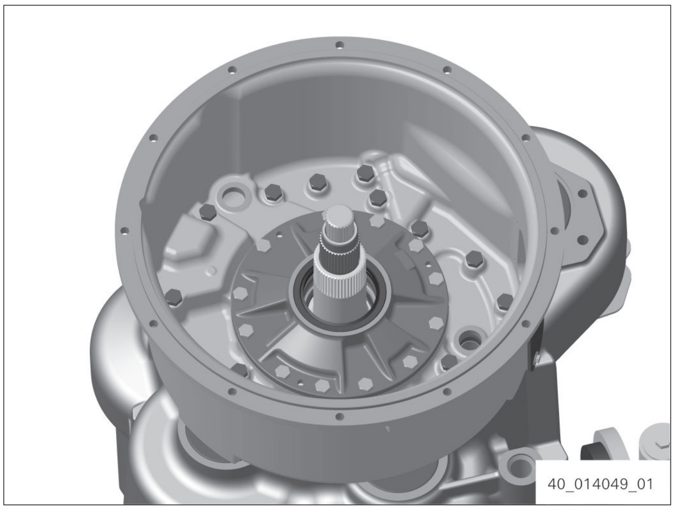


Fig. 388

38. Insert sealing rings between oil tube (1) and torque converter bell housing.

39. Slide sealing ring onto hollow screws (2).

40. Screw in the hollow screws with sealing ring (2) and tighten them.
    Tightening torque: 130 Nm

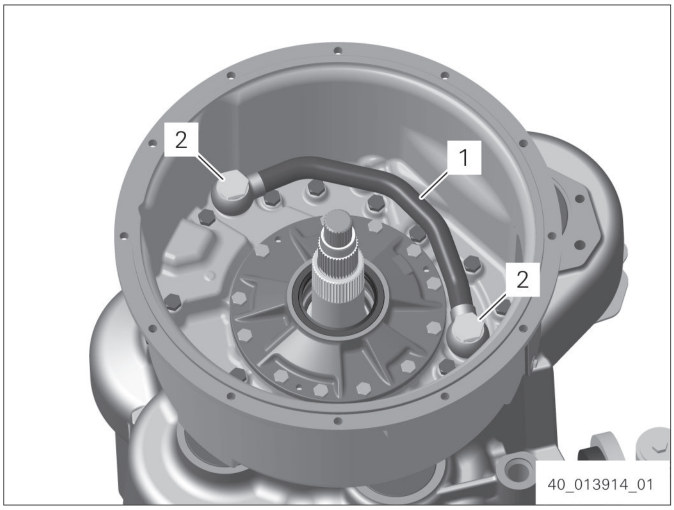


Fig. 389

Mounting engine connection and converter

Special tools:
- 5870.057.009 Driver tool
- 5870.260.002 Handle
- AA02.676.915 Load ring

Operating supplies and auxiliary materials:
- 0666.690.248 LOCTITE 243

1. Position flange shaft (2) onto converter.

2. Apply 0666.690.248 [LOCTITE 243] to thread of hexagon screws.

3. Screw in and tighten hexagon screws (1).
   Tightening torque: 68 Nm

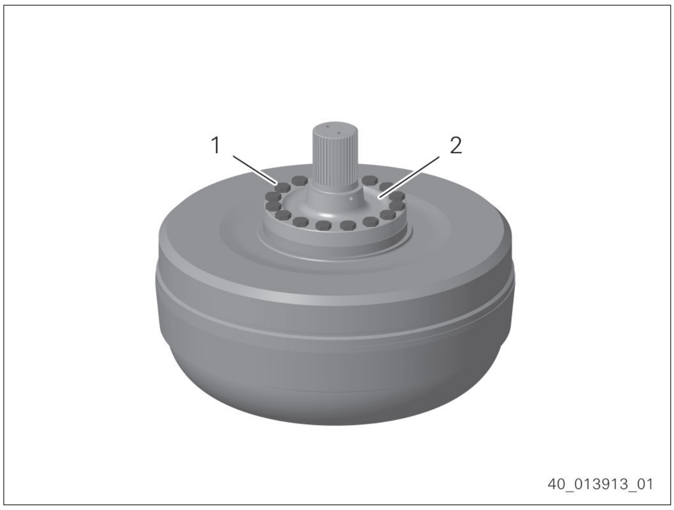


Fig. 390

4. Grease annular groove.

5. Insert and center R-ring (1).

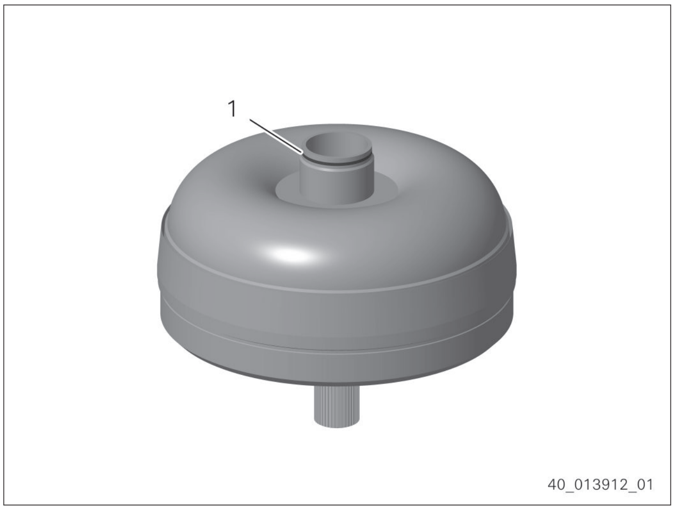


Fig. 391

6. Insert the ball bearing (2) in the cover until contact is obtained.

7. Insert V-ring (1).

Fig. 392

8. **CAUTION**

   Risk of crushing due to hydraulic tool.
   Slight to moderate injury possible.
   ⇨ Do not reach into danger area.

   Use suitable tools to press cover onto flange shaft until contact is obtained.

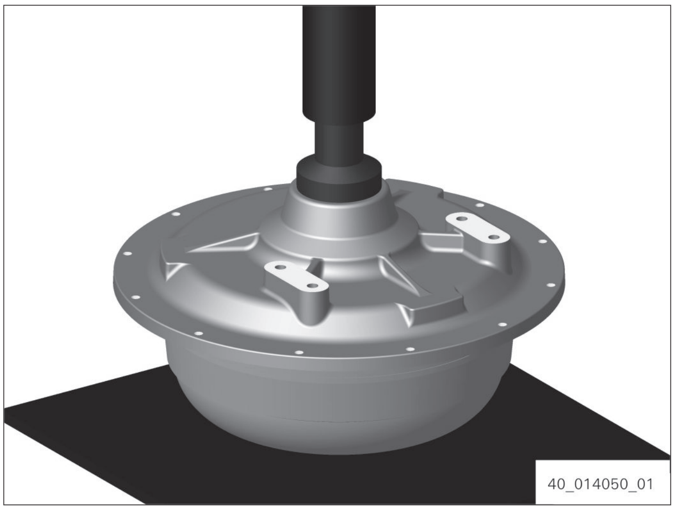


Fig. 393

9. Carry out the following two work steps immediately one after the other.

CAUTION

Risk of burn injuries due to contact with hot surfaces.
Slight or moderate injury possible.
⇨ Wear protective gloves.

Heat up internal spline.

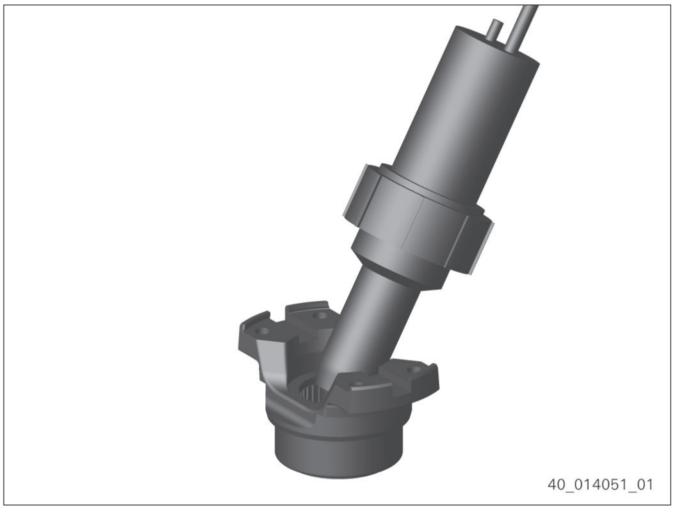


Fig. 394

10. Slide output flange (1) onto flange shaft until contact is obtained.

Fig. 395

11. Fix output flange with washer (3) and hexagon screws (2).
Tightening torque: **46 Nm**

12. **CAUTION**

Risk of injury due to parts flying away.
Slight or moderate injury possible.
⇨ Wear protective goggles.

Mount locking plate (1) using the 5870.057.009 [Driver tool] and 5870.260.002 [Handle] until contact is obtained.

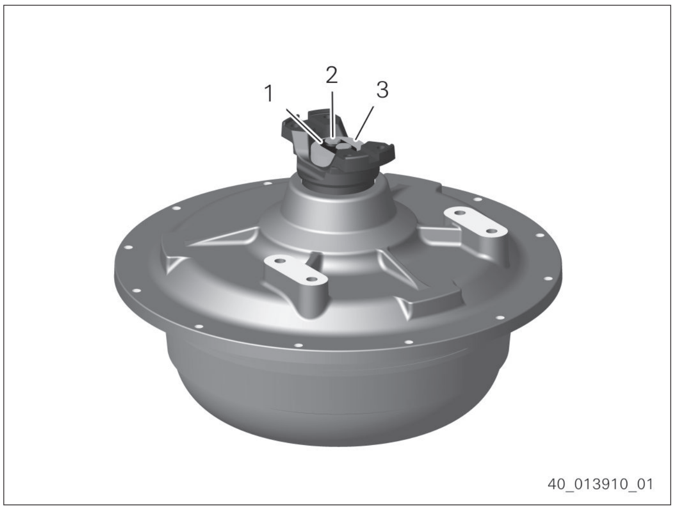


Fig. 396

13. ⚠ **CAUTION**

Risk of crushing due to moving parts.
Slight or moderate injury possible.
⇨ Do not reach into danger area!

Use two AA02.676.915 [Load ring] and crane to slide on cover and converter until contact is obtained. Mount the cover according to the marking.

Fig. 397

14. Insert hexagon screws (2) into holes and tighten nuts (1).
Tightening torque: 46 Nm

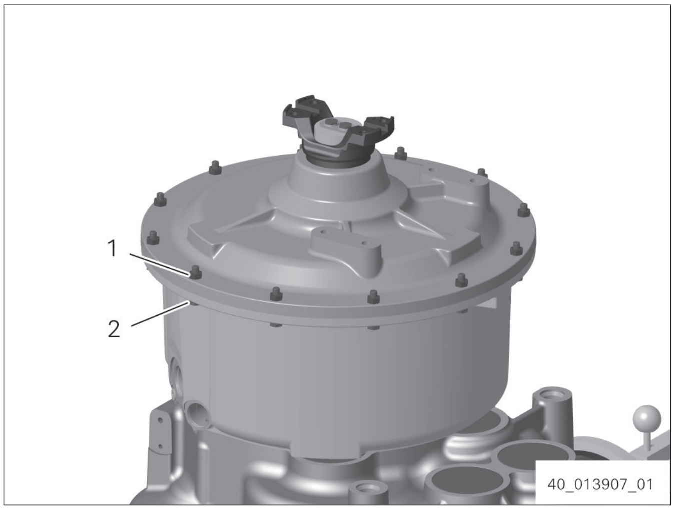


Fig. 398

Mounting the fixing plates

1. Fix the fixing plates (1) with hexagon screws.
Tightening torque: 195 Nm

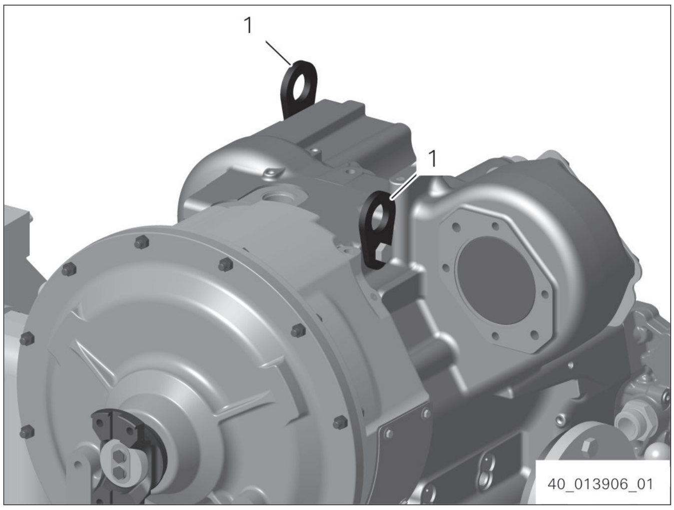


Fig. 399

Installing the torque converter pressure retaining valve

1. Insert the piston (2) into the torque converter bell housing.

2. Insert compression spring (1).

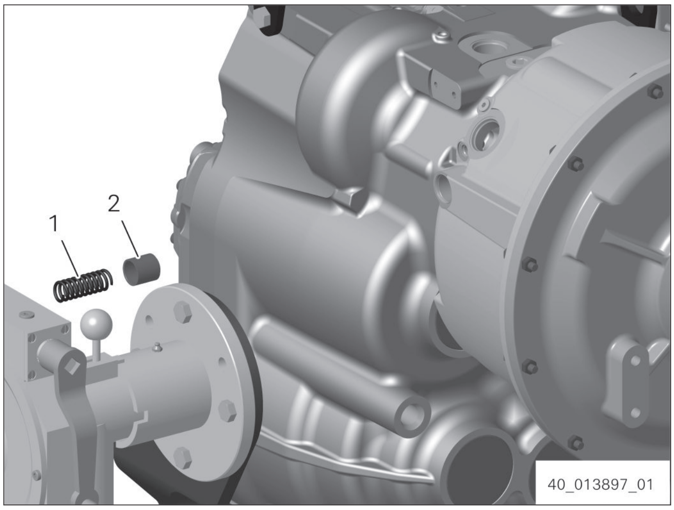


Fig. 400

3. Insert screw plug with O-ring (1) and tighten.
   Tightening torque: 130 Nm

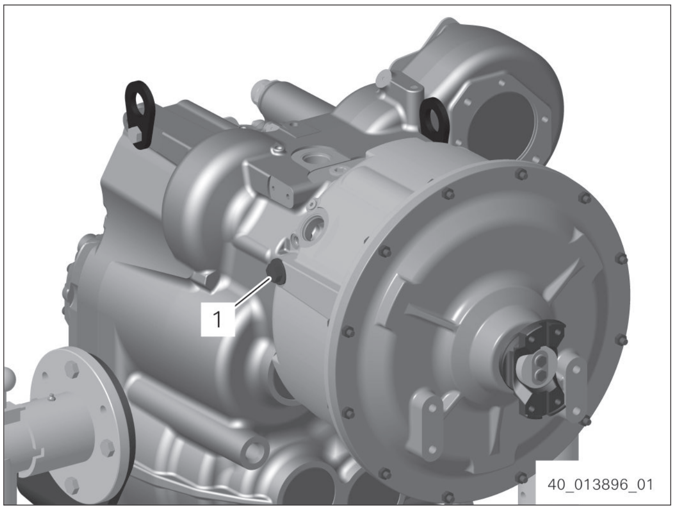


Fig. 401

Assembling and installing shift system

Installing duct plate

Special tools:

- 5870.204.037 Fixing pin

Assembly

1. Turn two 5870.204.037 [Fixing pin] into cover.

2. Slide on seal (1).

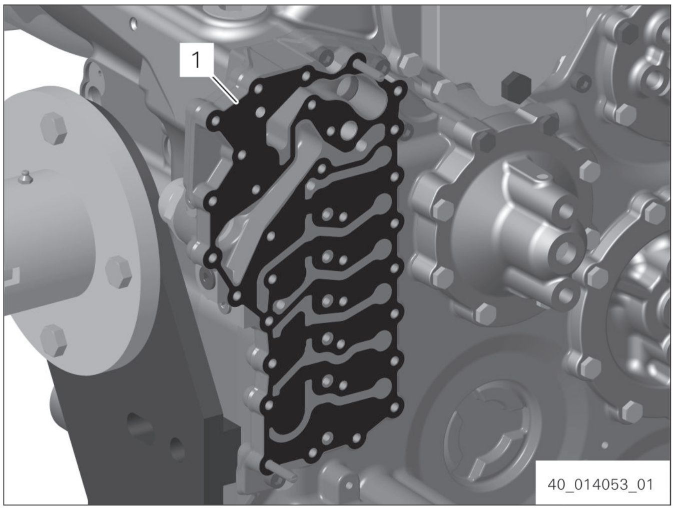


Fig. 402

3. Bolt in screw plugs (1) into duct plate and tighten.
   Tightening torque: 9.5 Nm

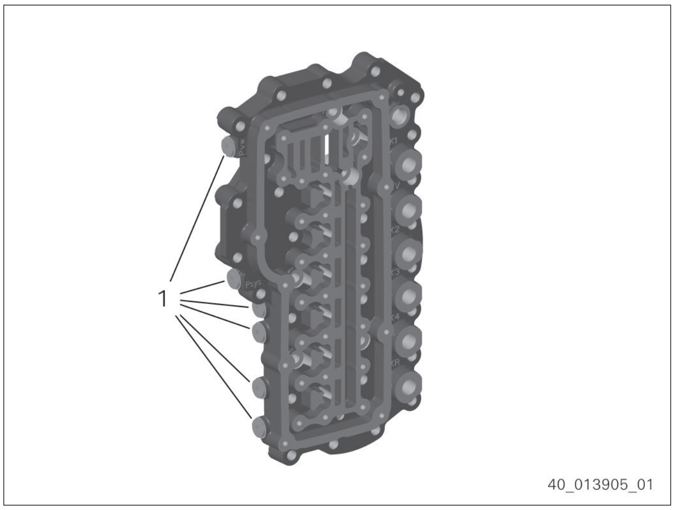


Fig. 403

4. Slide on duct plate (1).

5. Fix duct plate with internal hexalobular bolts in the specified order.
   Tightening torque: 23 Nm

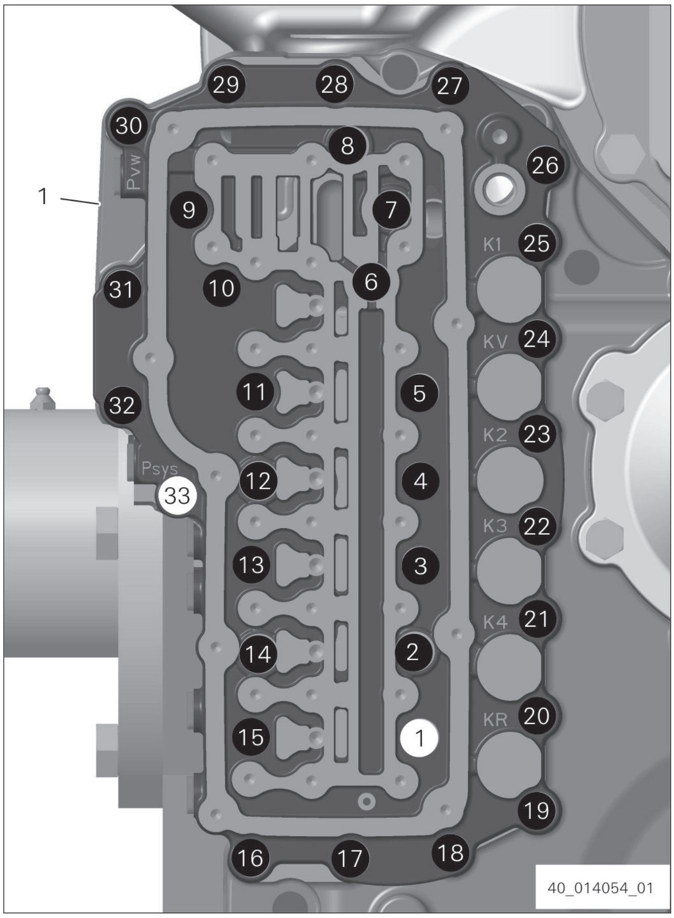


Fig. 404

6. Insert valves (1) in duct plate.

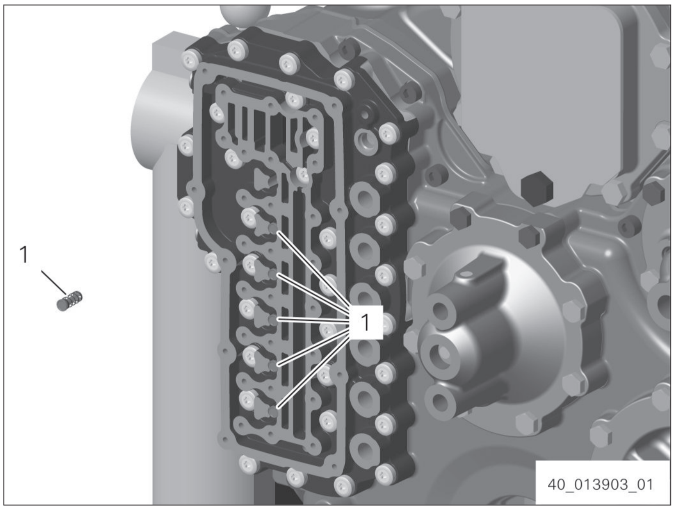


Fig. 405

Assembling and mounting valve blocks

Special tools:

- 5870.204.063 Fixing pin
- AA02.416.230 Driver tool
- AA02.416.754 Driver tool

Assembly

- AA02.414.200 Driver tool
- AA02.788.633 Torque wrench

1. Bolt two 5870.204.063 [Fixing pin] into the duct plate.

2. Slide on new intermediate plate (1).

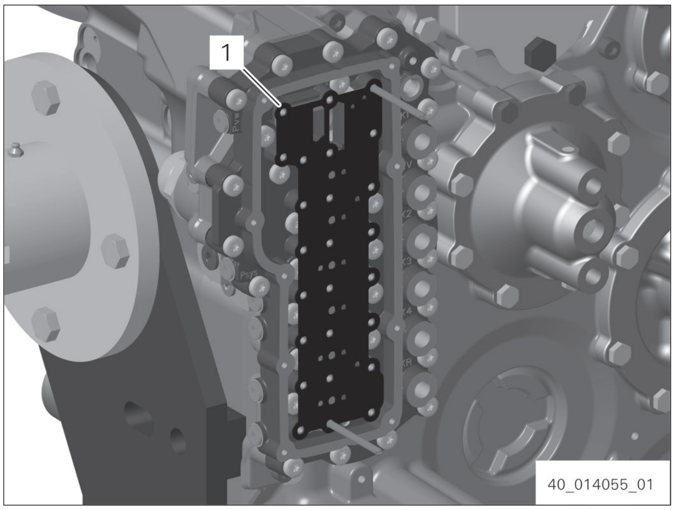


Fig. 406

3. Insert the control piston (1) in the hole.

4. Insert compression spring (2).

5. Oil O-ring.

6. Insert O-ring in the annular groove of the plug (3).

7. Insert the plug (3) in the hole.

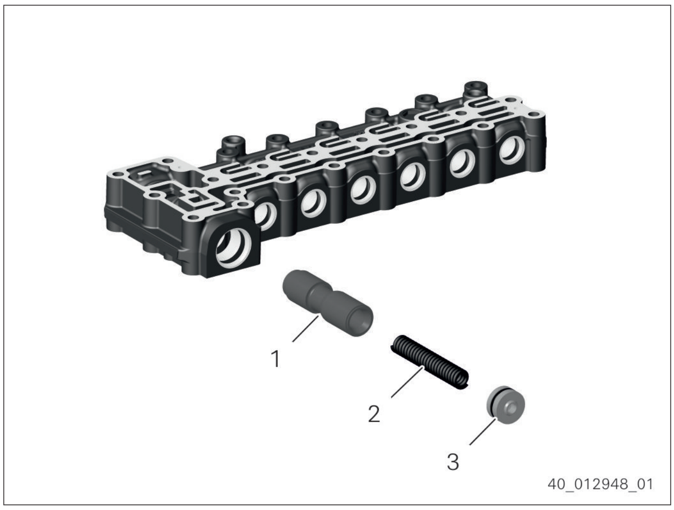


Fig. 407

8. Press the plug inwards with AA02.416.230 [Driver tool] until contact is obtained and insert fixing plate (1).

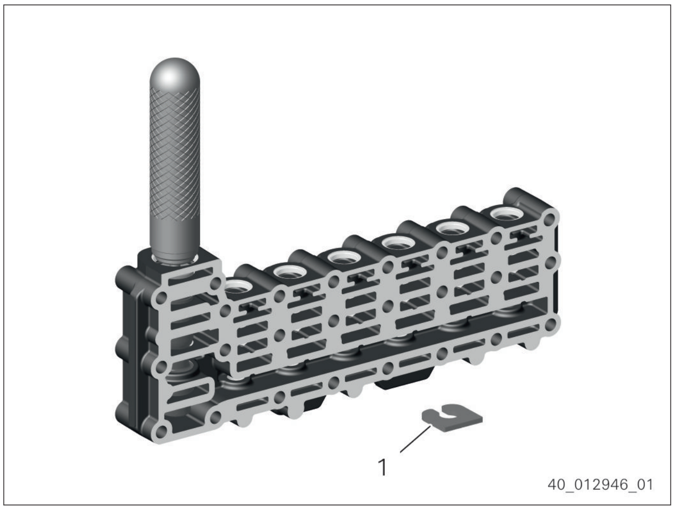


Fig. 408

9. Insert the compression spring (1) into the bore.

10. Insert the control piston (2).

11. Oil O-ring.

12. Insert O-ring in the annular groove of the plug (3).

13. Insert the plug (3) in the hole.

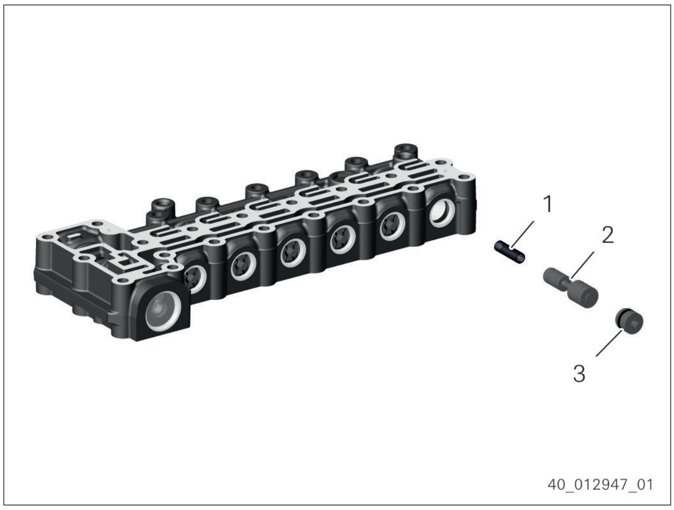


Fig. 409

14. Push the plug inwards with the AA02.416.754 [Driver tool] until contact is obtained and insert the spring clip (1).

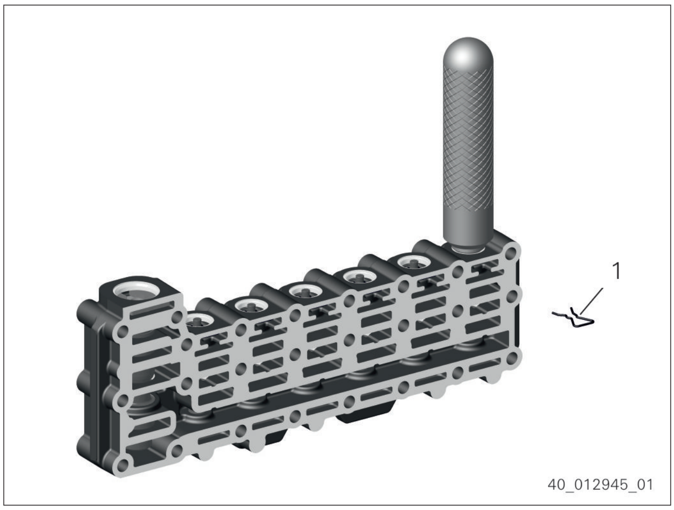


Fig. 410

15. Push on valve block (1).

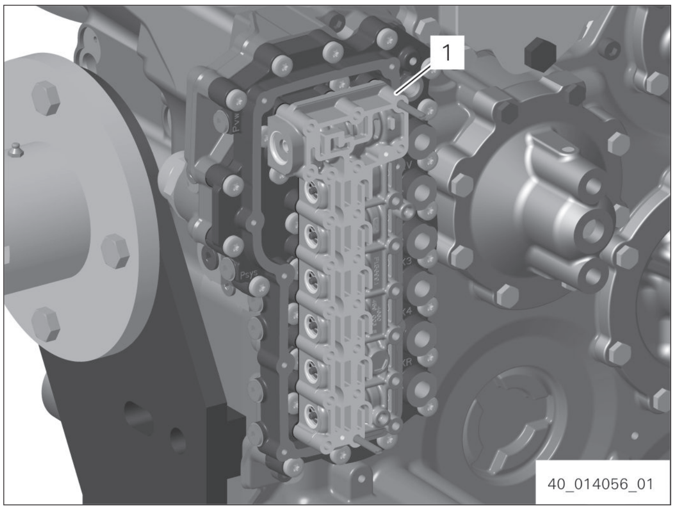


Fig. 411

16. Push on intermediate plate (1).

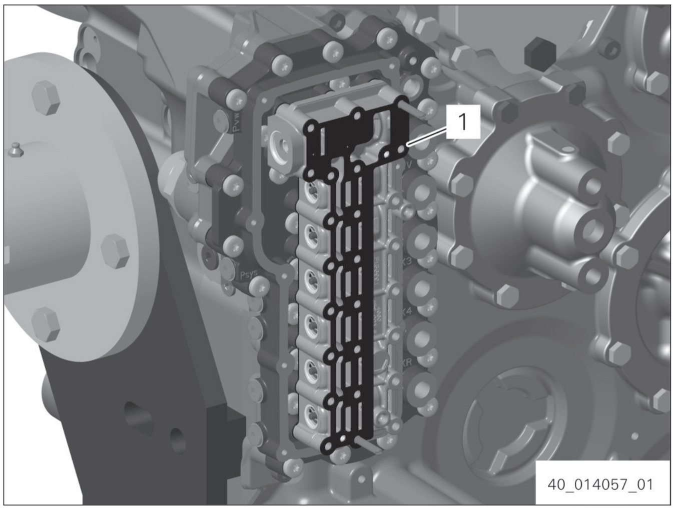


Fig. 412

17. Insert piston (1) in the hole.

18. Insert compression spring (2).

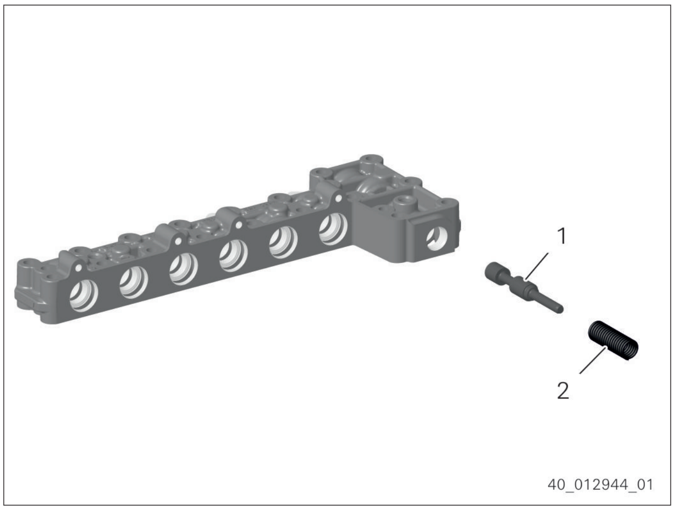


Fig. 413

19. Push the compression spring inwards with AA02.414.200 [Driver tool] until contact is obtained and insert the fixing plate (1).

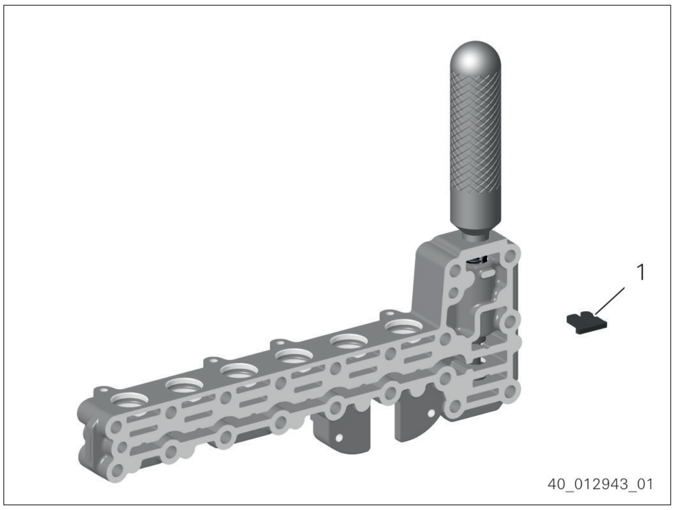


Fig. 414

20. Push on valve block (1).

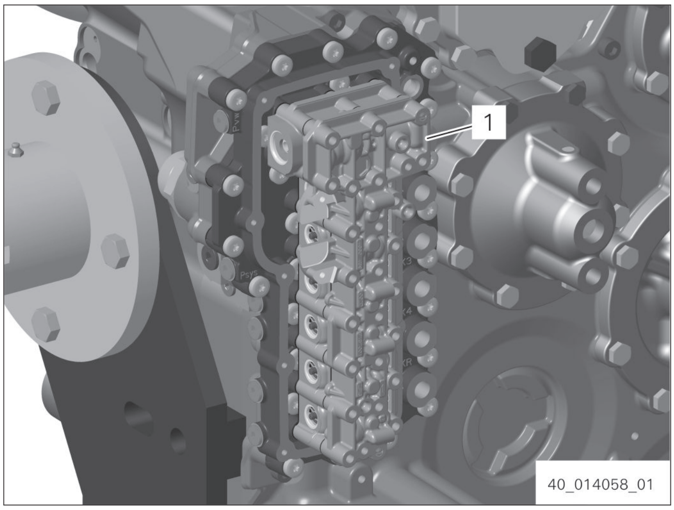


Fig. 415

21. Screw in and tighten the hexalobular driving screws (1).
Tightening torque: 3 Nm

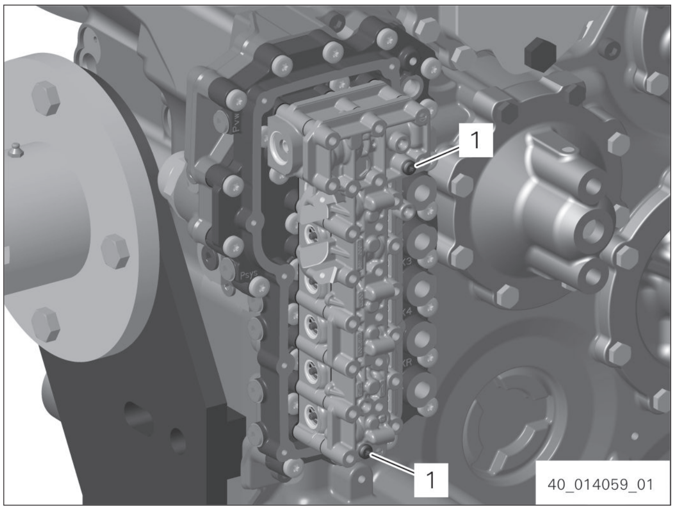


Fig. 416

Fixing valve blocks (Variant using the duct plate removed during disassembly)

22. Apply oil to the threads of the internal hexalobular bolts M 6x 85.

23. Bolt in internal hexalobular bolts M6 x 85 (1 bis 19) and tighten with AA02.788.633 [Torque wrench] in the specified order.
    Tightening torque: 2 Nm and 35° Additional tightening angle

24. Apply oil to the threads of the internal hexalobular bolts M 6x 50.

25. Bolt in internal hexalobular bolts M6 x 50 (20 bis 25) and tighten with AA02.788.633 [Torque wrench] in the specified order.
    Tightening torque: 2 Nm and 17° Additional tightening angle

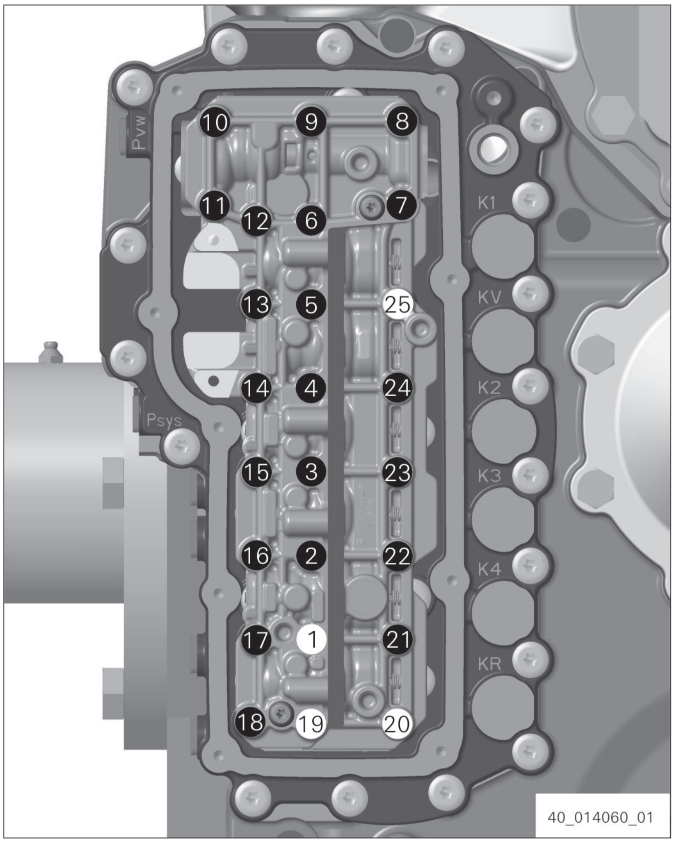


Fig. 417

Fixing valve blocks (Variant with new oil-free duct plate)

26. Bolt in new non-lubricated internal hexalobular bolts M6 x 85 (1 bis 19) and tighten with AA02.788.633 [Torque wrench] in the specified order.
    Tightening torque: 3 Nm and 60° Additional tightening angle

27. Bolt in new non-lubricated internal hexalobular bolts M6 x 50 (20 bis 25) and tighten with AA02.788.633 [Torque wrench] in the specified order.
    Tightening torque: 3 Nm and 45° Additional tightening angle

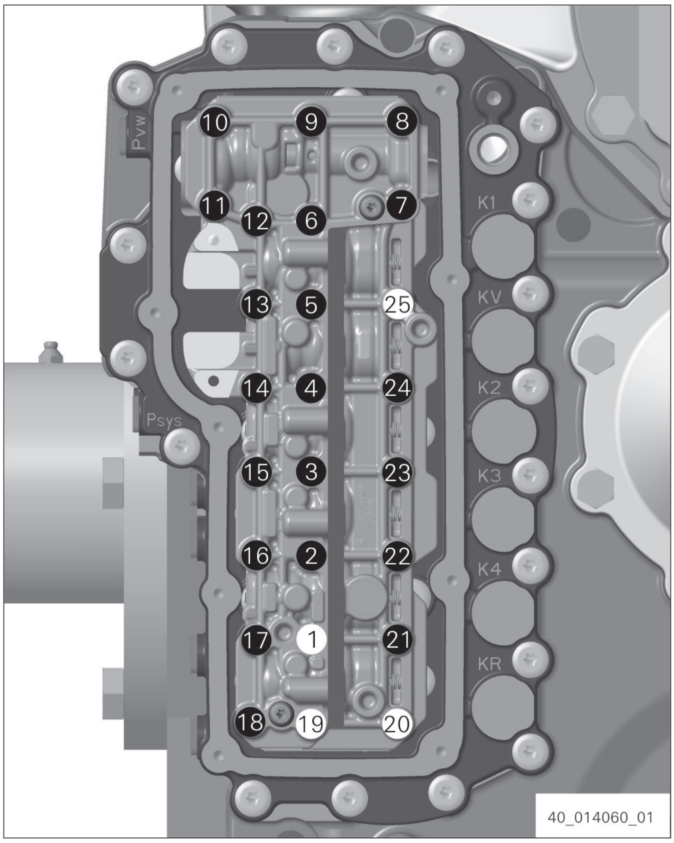


Fig. 418

Installing the pressure controllers

1. Pay attention to radial installation position of the pressure controllers.

   Insert pressure controllers with O-rings (2) in valve block.

2. Fix pressure controllers with clamping plate (1) and internal hexalobular bolts.
   Tightening torque: 9.5 Nm

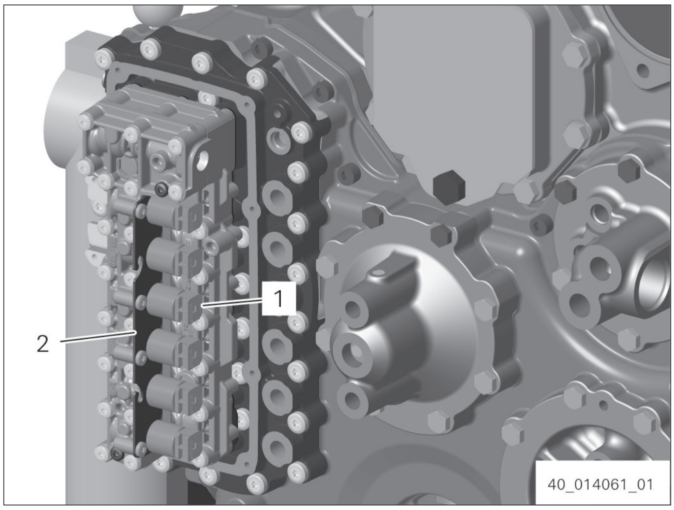


Fig. 419

3. Insert plugs (1) on the pressure controllers.

4. Fix plug (3) with fixing plate (4) and internal hexalobular bolts.
   Tightening torque: 9.5 Nm

5. Insert cable (2) in cable routing on the clamping plate.

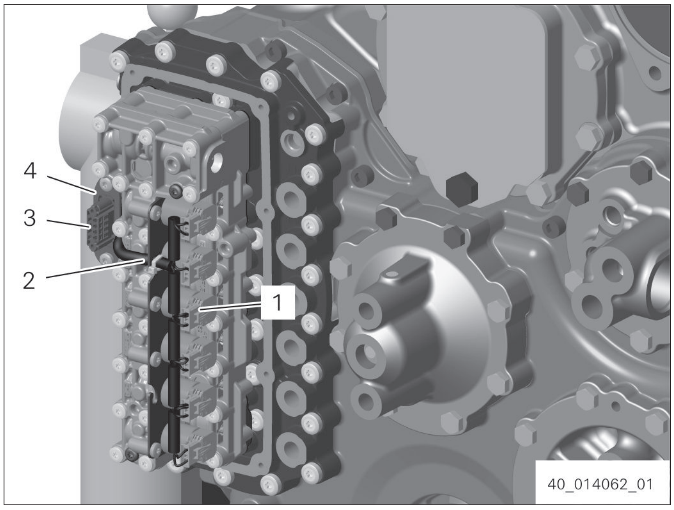


Fig. 420

Installing control unit (EC4A)

Special tools:
- 5870.204.063 Fixing pin

1. Insert seal (1) in control unit (2).

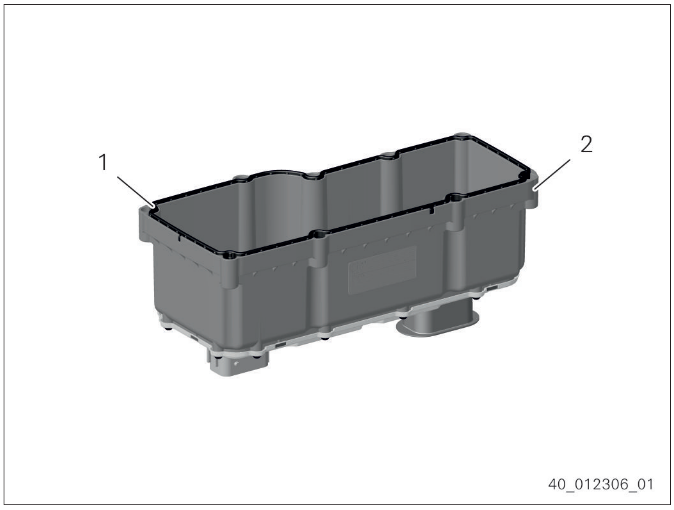


Fig. 421

2. Bolt two 5870.204.063 [Fixing pin] into the duct plate.

3. Slide on control unit.

4. Bolt in internal hexalobular bolts and tighten in the specified order.
   Tightening torque: 9.5 Nm

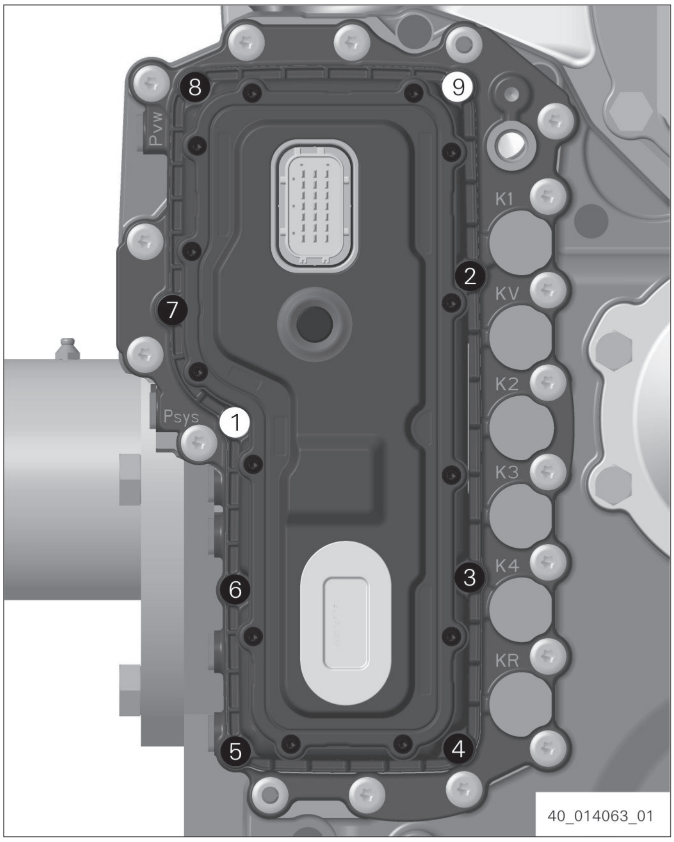


Fig. 422

Installing the temperature sensors and the breather

1. Bolt in breather (1) and tighten.
   Tightening torque: 12 Nm

2. Screw in and tighten temperature sensors with O-ring (2).
   Tightening torque: 25 Nm

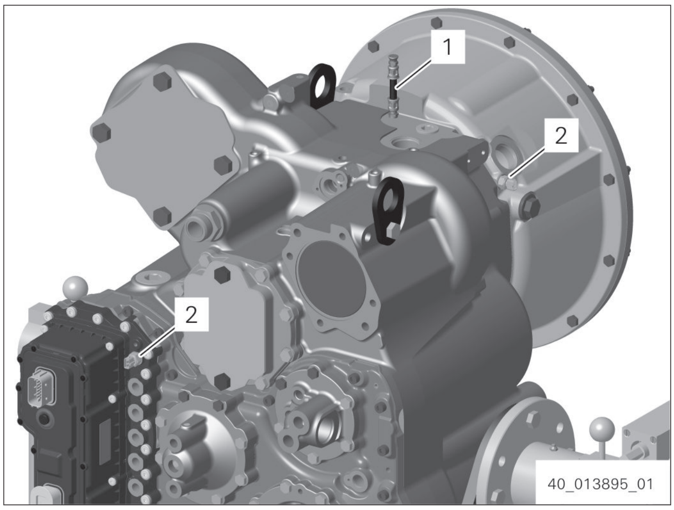


Fig. 423

Installing the speed sensors

1. Insert speed sensors with O-ring (1) in housing holes.

2. Fix speed sensors with cap screws.
Tightening torque: 9.5 Nm

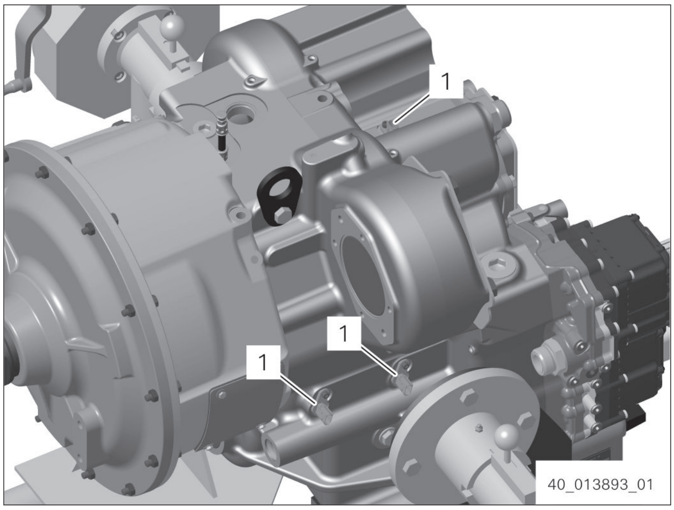


Fig. 424

3. Insert speed sensor with sealing element (1) into the housing hole.

4. Fasten speed sensor with cap screw.
Tightening torque: 9.5 Nm

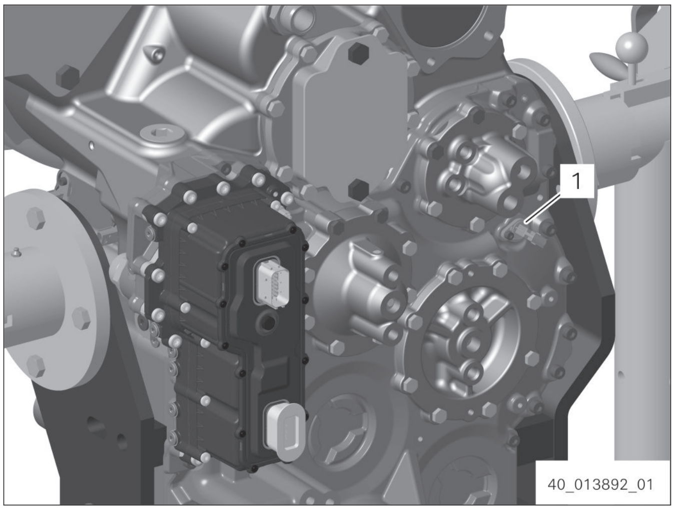


Fig. 425

Attaching the hose assemblies

Attaching the hose assembly K1

1. Insert the O-ring between the hose assembly (3) and the bearing cover (2).

2. Turn in hollow screw with O-ring (1) and tighten.
   Tightening torque: 45 Nm

3. Insert O-ring between hose assembly (3) and duct plate (5).

4. Turn in hollow screw with O-ring (4) and tighten.
   Tightening torque: 45 Nm

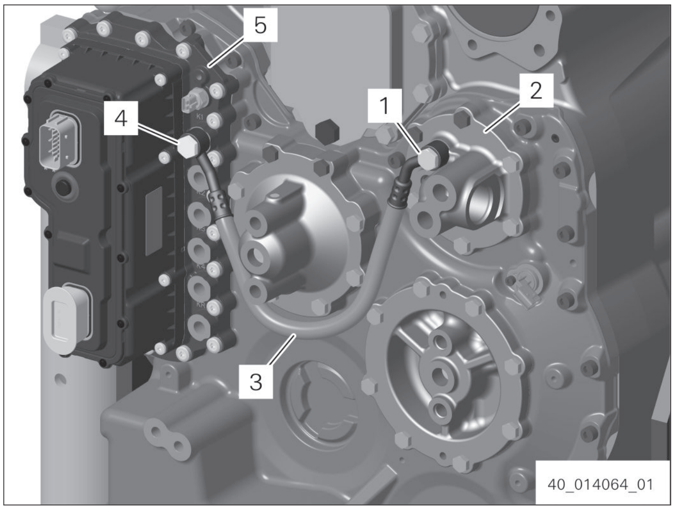


Fig. 426

Attaching the hose assembly KV

5. Insert the O-ring between the hose assembly (3) and the bearing cover (2).

6. Turn in hollow screw with O-ring (1) and tighten.
   Tightening torque: 45 Nm

7. Insert O-ring between hose assembly (3) and duct plate (5).

8. Turn in hollow screw with O-ring (4) and tighten.
   Tightening torque: 45 Nm

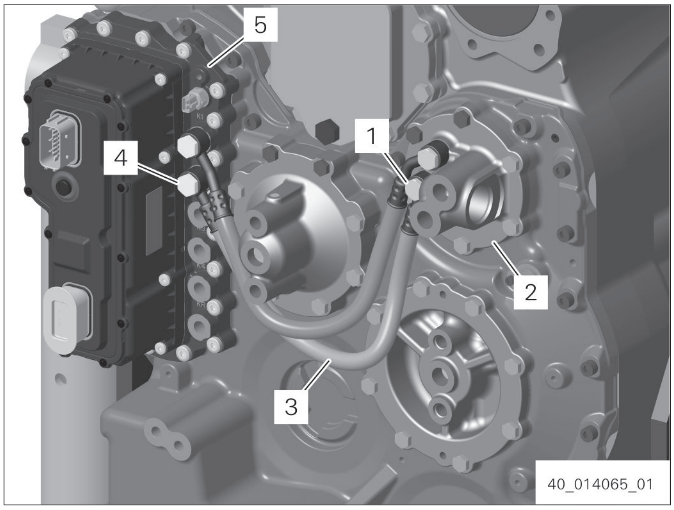


Fig. 427

Attaching the hose assembly K2

9. Insert O-ring between hose assembly (3) and the cover (2).

10. Turn in hollow screw with O-ring (1) and tighten.
Tightening torque: 45 Nm

11. Insert O-ring between hose assembly (3) and duct plate (5).

12. Turn in hollow screw with O-ring (4) and tighten.
Tightening torque: 45 Nm

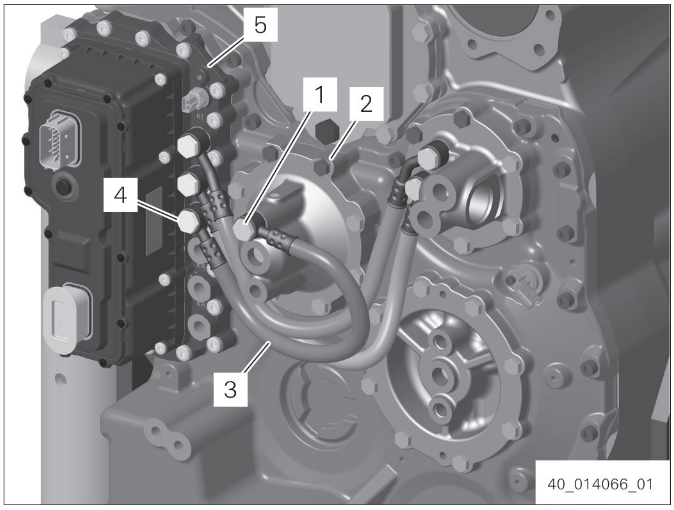


Fig. 428

Attaching the hose assembly K3

13. Insert O-ring between hose assembly (3) and the cover (2).

14. Turn in hollow screw with O-ring (1) and tighten.
Tightening torque: 45 Nm

15. Insert O-ring between hose assembly (3) and duct plate (5).

16. Turn in hollow screw with O-ring (4) and tighten.
Tightening torque: 45 Nm

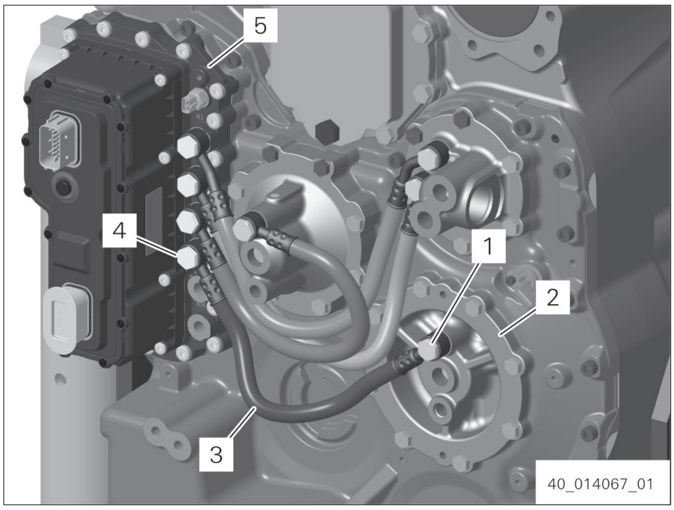


Fig. 429

Attaching the hose assembly K4

17. Insert O-ring between hose assembly (3) and the cover (2).

18. Turn in hollow screw with O-ring (1) and tighten.
    Tightening torque: 45 Nm

19. Insert O-ring between hose assembly (3) and duct plate (5).

20. Turn in hollow screw with O-ring (4) and tighten.
    Tightening torque: 45 Nm

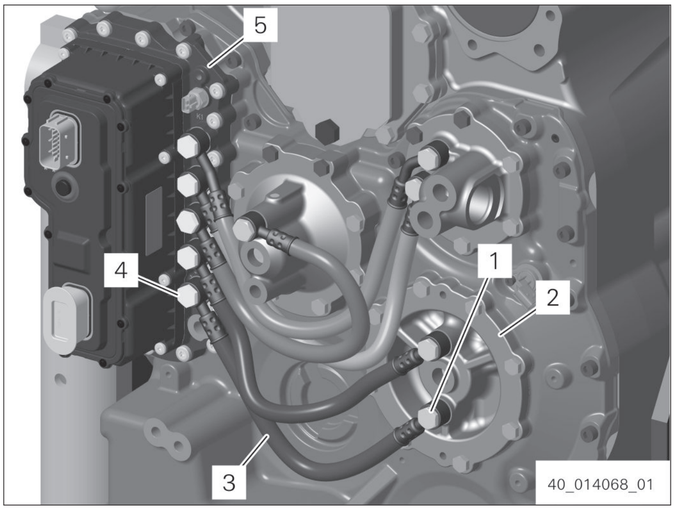


Fig. 430

Attaching the hose assembly KR

21. Insert O-ring between hose assembly (3) and the cover (2).

22. Turn in hollow screw with O-ring (1) and tighten.
    Tightening torque: 45 Nm

23. Insert O-ring between hose assembly (3) and duct plate (5).

24. Turn in hollow screw with O-ring (4) and tighten.
    Tightening torque: 45 Nm

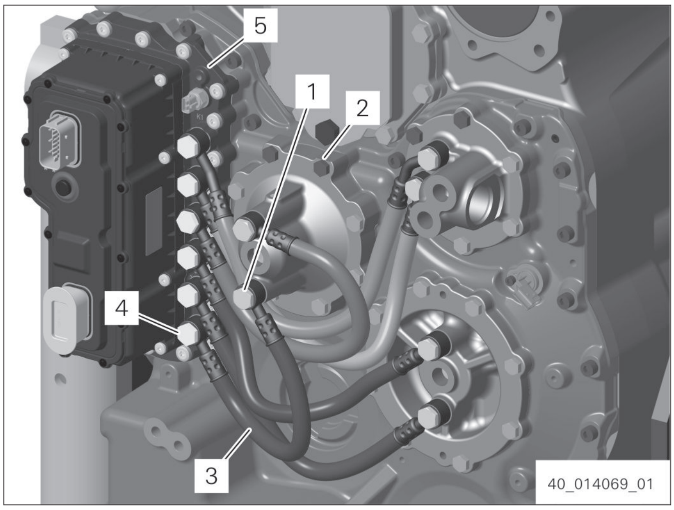


Fig. 431

Attaching the hose assembly S2

25. Insert the O-ring between the hose assembly (3) and the bearing cover (2).

26. Turn in hollow screw with O-ring (1) and tighten.
Tightening torque: 60 Nm

27. Insert O-ring between hose assembly (3) and the cover (5).

28. Turn in hollow screw with O-ring (4) and tighten.
Tightening torque: 60 Nm

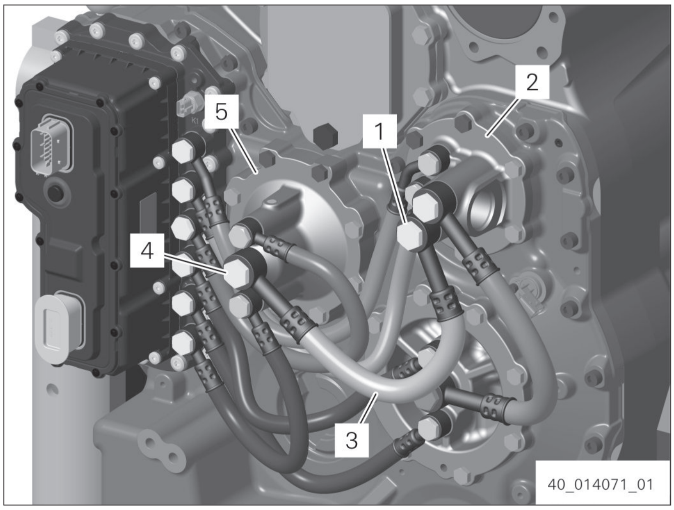


Fig. 432

Installing the tube

1. Insert sealing ring between tube (3) and housing.

2. Insert sealing ring between tube (3) and torque converter bell housing.

3. Bolt in hollow screws with O-ring (1) and tighten.
Tightening torque: 45 Nm

4. Bolt in screw plugs with O-ring (2) and tighten.
Tightening torque: 20 Nm

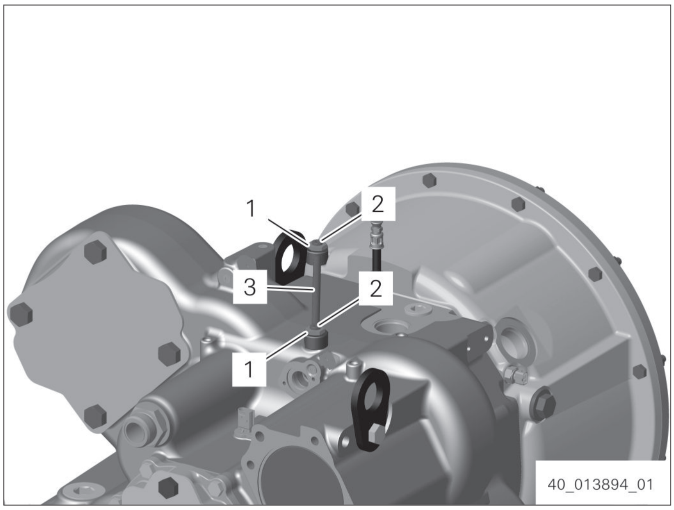


Fig. 433

Installing pressure controller (converter clutch valve)

1. Insert pressure controller with O-rings (1) into the housing hole.

2. Fix pressure controller with two cap screws. Tightening torque: 9.5 Nm

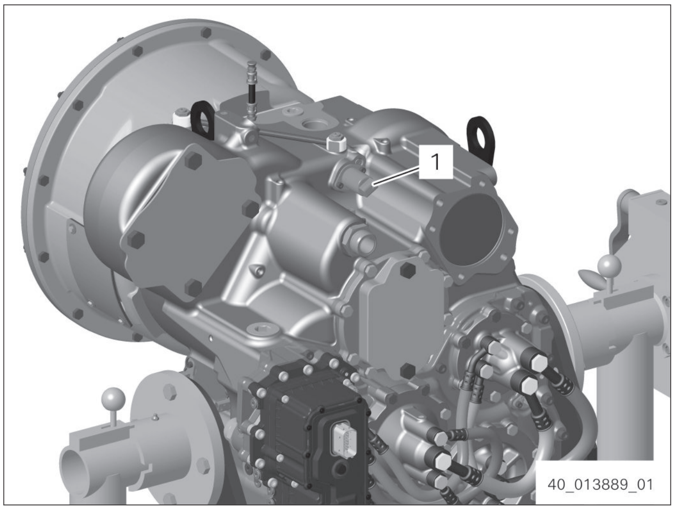


Fig. 434

3. Route cable (1) and insert plugs.

4. Fasten cable to the transmission with cable ties.

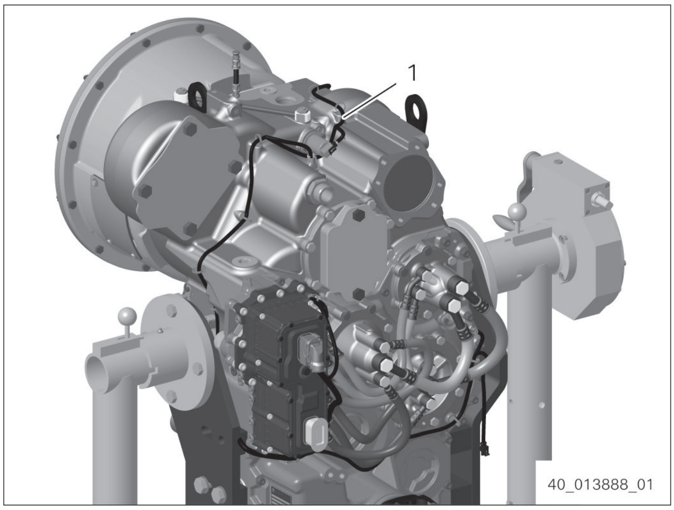


Fig. 435

Installing cover sheets (filler neck)

1. Put on seal and cover sheet (1).

2. Turn in and tighten hexagon screws.
   Tightening torque: 23 Nm

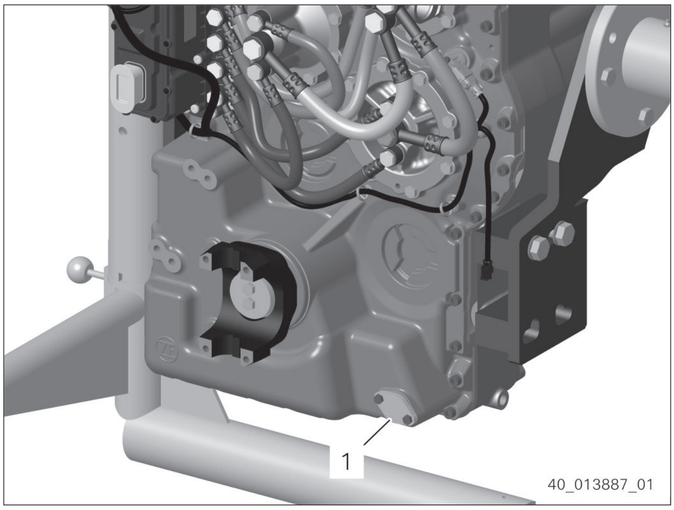


Fig. 436

3. Put on seal and cover sheet (1).

4. Turn in and tighten hexagon screws.
   Tightening torque: 23 Nm

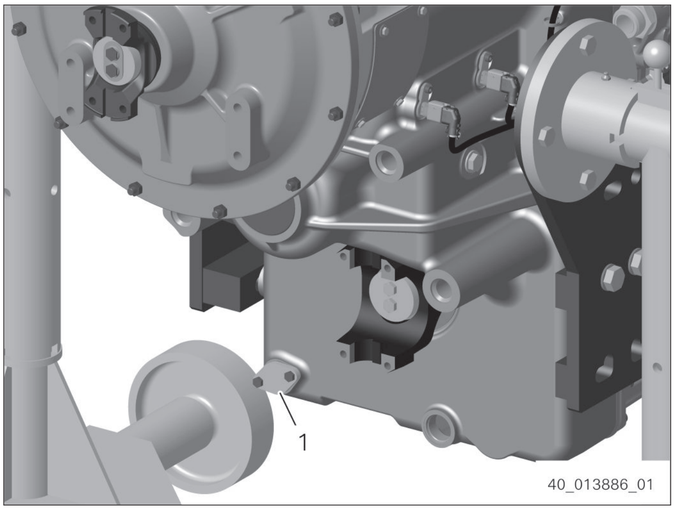


Fig. 437

Installing pressure filters

1. Apply a thin film of oil to the seal of the pressure filters.

2. Bolt in the pressure filters (1) until contact between the sealing face to the filter head is obtained.

3. Tighten the pressure filters (1).
Tightening torque: Contact sealing surface +90°to 180°
As an alternative, use a tool with torque display to tighten the pressure filters.
Tightening torque: 40 Nm

4. Screw in the plunger switch including the O-ring (2) and tighten it.
Tightening torque: 25 Nm (±5 Nm).
The filter head is located near the transmission.

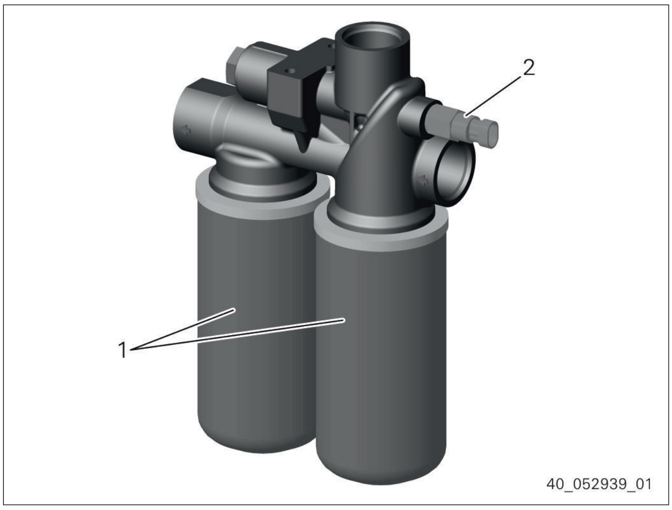


Fig. 438

Adding oil

1. Turn in screw plug with O-ring (2) and tighten.
Tightening torque: 80 Nm

2. Before starting the transmission, fill up with oil according to the Operating Instructions *(refer to Section Document overview, page 6)*.

3. Screw in and tighten screw plug with O-ring (1).
Tightening torque: 145 Nm

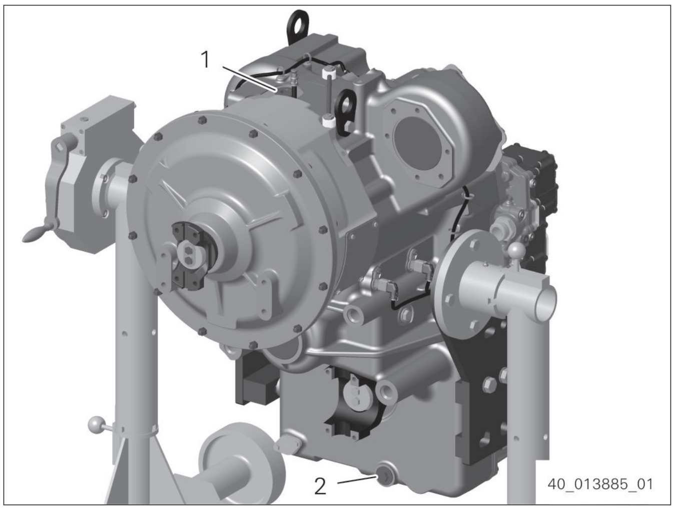


Fig. 439

2 AXLE

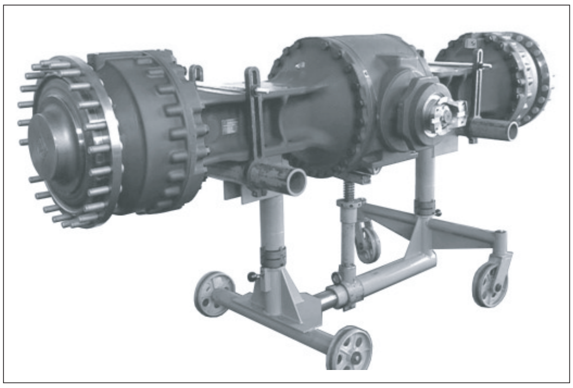
1) DISASSEMBLY

(1) Disassembly output and brake

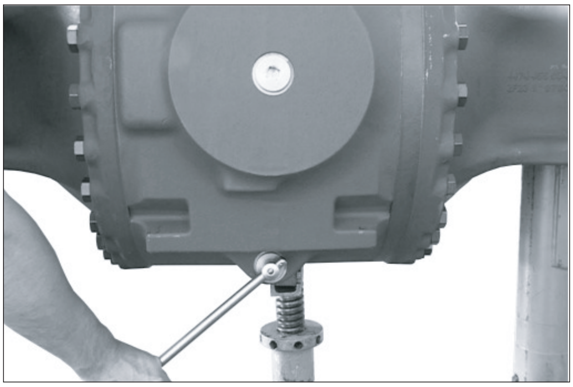
① Fix axle to assembly truck.

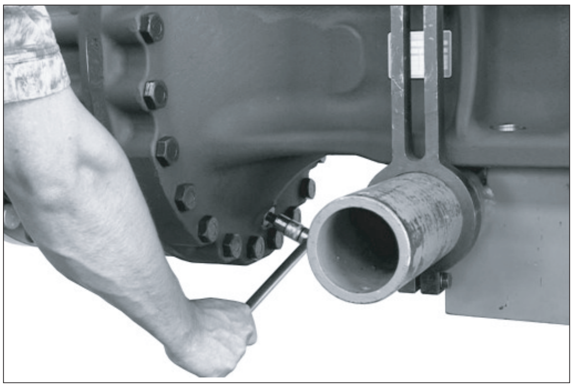
Assembly truck	5870 350 000
Fixtures	5870 350 077
Clamping brackets	5870 350 075
Support	5870 350 125

※ Before clamping the axle fully turn in the support.
Position axle first onto the two fixtures, secure with clamping brackets and then unbolt the support until contact with the axle is obtained.


7809AX01

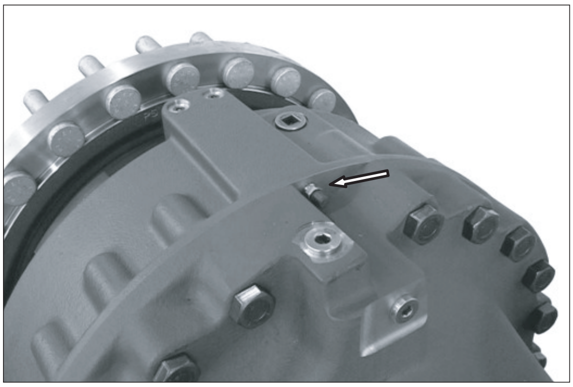
② Loosen screw plugs (3EA, see figure AX02 and AX03) and drain oil from the axle.


7809AX02


7809AX03

③ Remove the breather valve (see arrow).

※ To avoid any damage, the breather valve must be removed when separating the output.

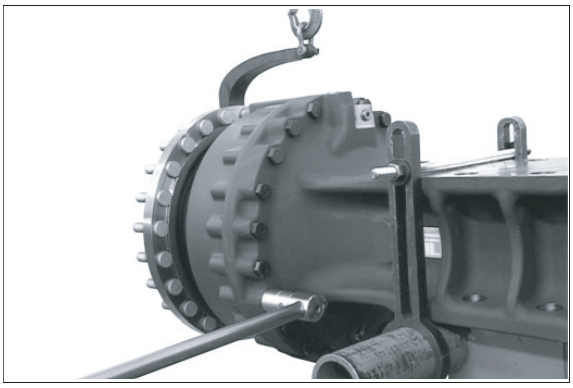


7809AX04

④ Secure the output with the lifting device and loosen hexagon screws.
Then separate the output assy from the axle housing.

Load carrying device	AA00 685 875

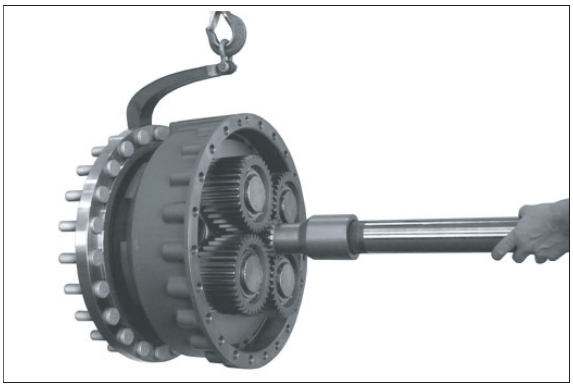
※ Fix the load carrying device with wheel nuts.



7809AX05

⑤ Pull stub shaft and sun gear shaft.

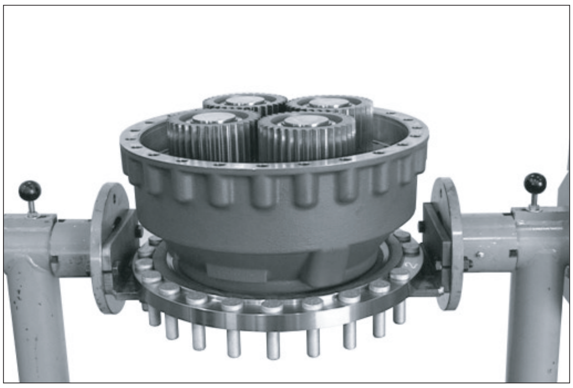
※ Pay attention to potentially releasing shim(s).



7809AX06

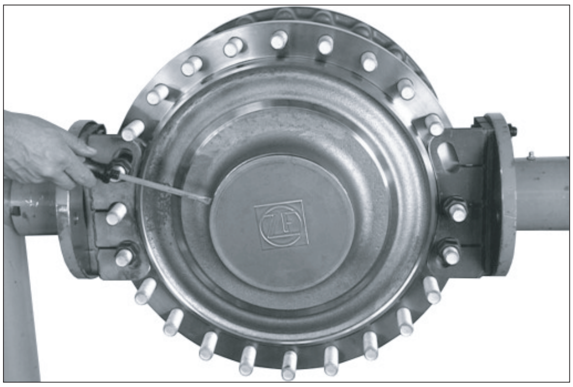
⑥ Fix output to assembly truck.

Assembly truck	5870 350 000
Fixtures (2EA)	5870 350 113



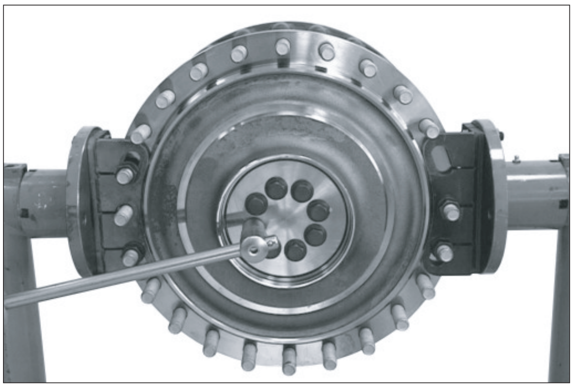
7809AX07

⑦ Use a lever to remove the cover from the output shaft.



7809AX08

⑧ Loosen locking screws and remove the releasing cover.



7809AX09

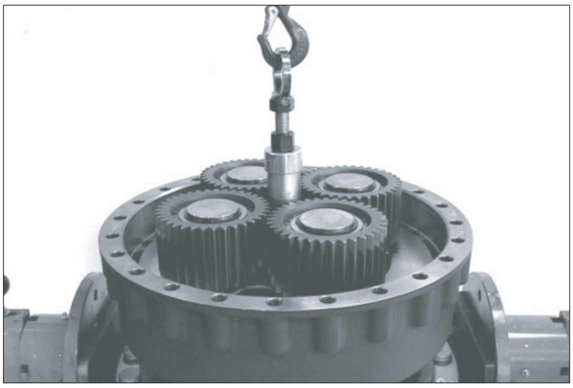
⑨ Lift the planetary carrier out of the brake housing by means of the lifting device.

· Rear axle (planetary carrier with 3 planetary gears)

Internal extractor	5870 300 019
Eye bolt	5870 204 073

· Front axle (planetary carrier with 4 planetary gears)

Internal extractor	5870 300 008
Eye nut	AA00 680 376



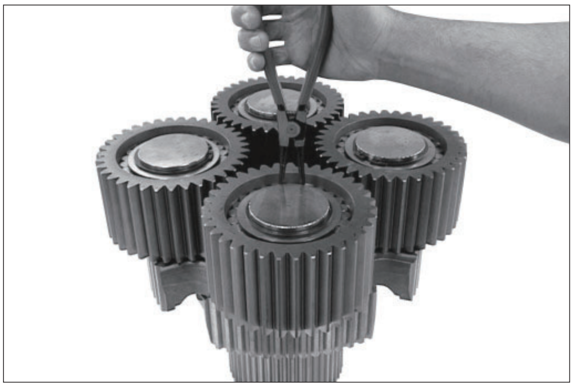
7809AX10

⑩ Pull the tapered roller bearing from the planetary carrier.

Rapid grip	AA00 693 459
Basic tool	5873 004 001
Clamping cylinder	5873 003 016
Pump	5870 287 010

7809AX70

⑪ Disengage retaining ring.



7809AX71

⑫ Pull off planetary gear.

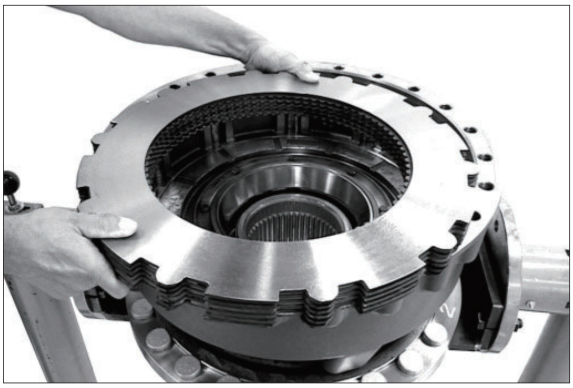
Extractor	AA00 696 012
Clamping cylinder	5873 003 016
Pump	5870 287 010

7809AX72

⑬ Lift the end plate out of the brake housing.

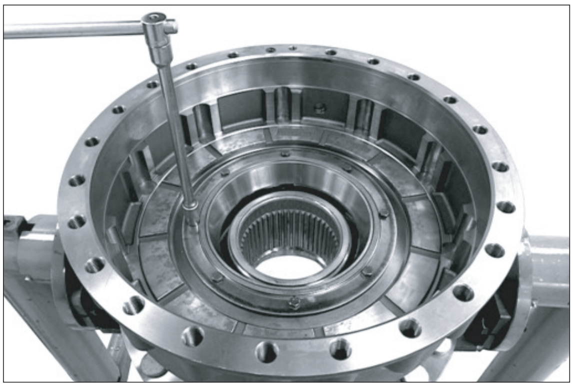
7809AX73

⑭ Lift the disk package out of the brake housing.



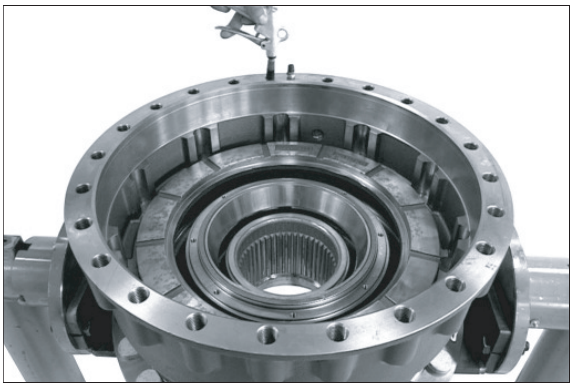
7809AX12

⑮ Loosen hexagon screws, remove releasing disk and cup spring.



7809AX13

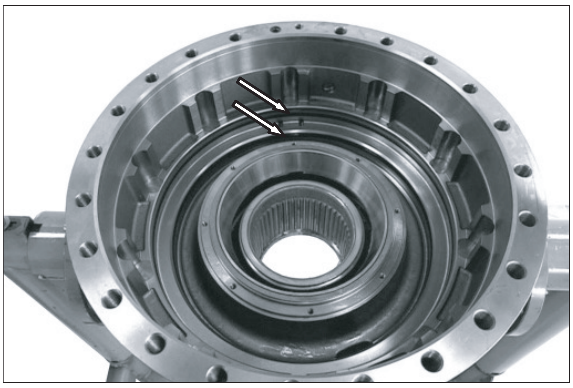
⑯ Mount breather valve and press piston out of the brake housing by means of compressed air.



7809AX14

⑰ If necessary, remove guide ring, back-up rings and grooved rings out of the annular grooves of the brake housing (see arrows).

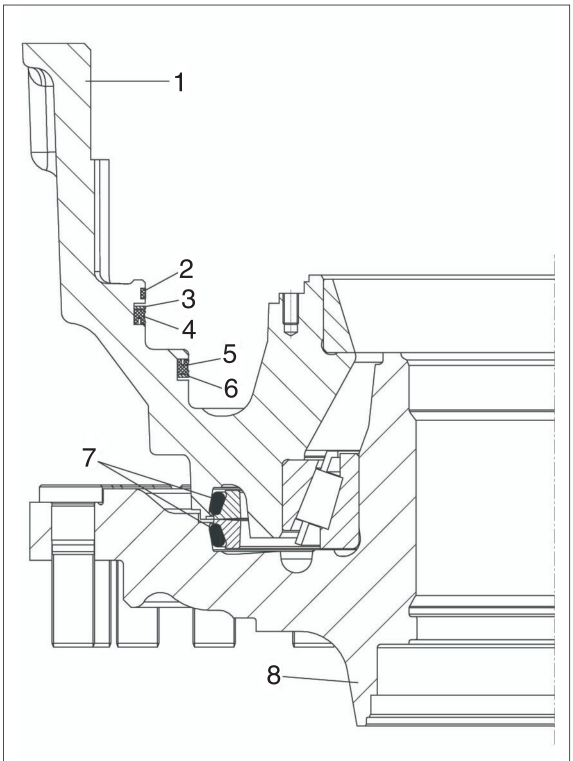
※ For the installation position of the single parts please also refer to the following sketch.



7809AX15

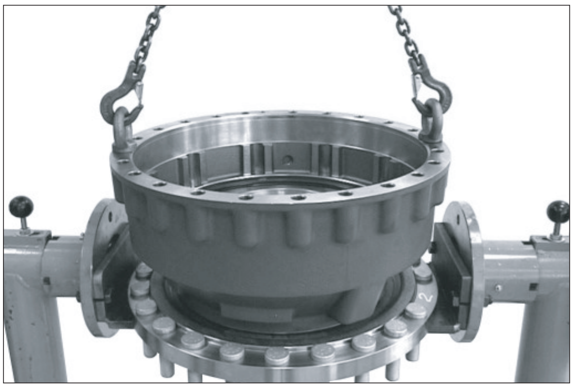
Legend to sketch :

1 = Brake housing
2 = Guide ring
3 = Back-up ring
4 = Grooved ring
5 = Grooved ring
6 = Back-up ring
7 = Slide ring seal
8 = Output shaft



7809AX16

⑱ Lift the brake housing from the output shaft by means of the lifting device.



7809AX17

⑲ Use a lever to remove the slide ring seal from the brake housing.

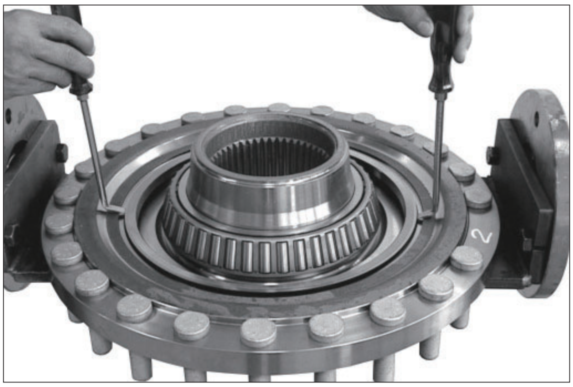
If necessary, force out both bearing outer rings.

Resetting device 5870 400 001

7809AX18

⑳ Use a lever to remove the slide ring seal from the output shaft.

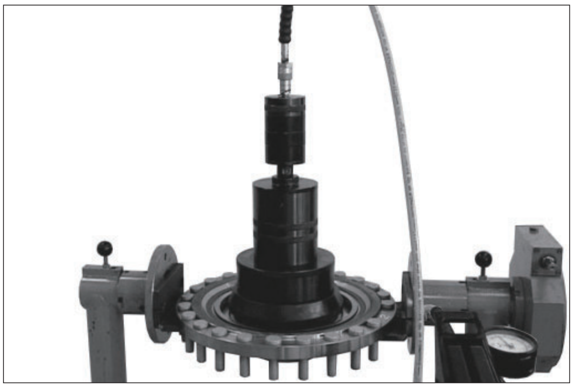
Resetting device	5870 400 001



7809AX74

㉑ Pull the tapered roller bearing from the output shaft.

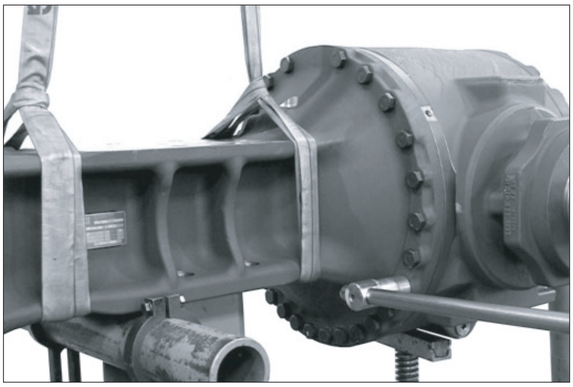
Gripping device	AA00 633 495
Adapter ring	AA00 633 500
Basic tool	5873 004 001
Pressure piece	AA00 696 181
Clamping cylinder	5873 003 016
Pump	5870 287 010



7809AX75

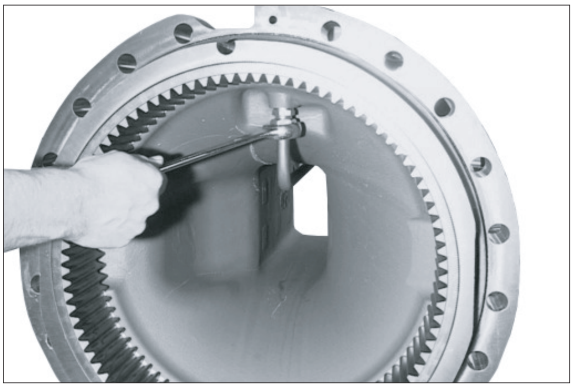
(2) Disassembly axle housing

① Secure axle housing with the lifting device and loosen the hexagon screws. Then separate the axle housing from the axle drive housing.



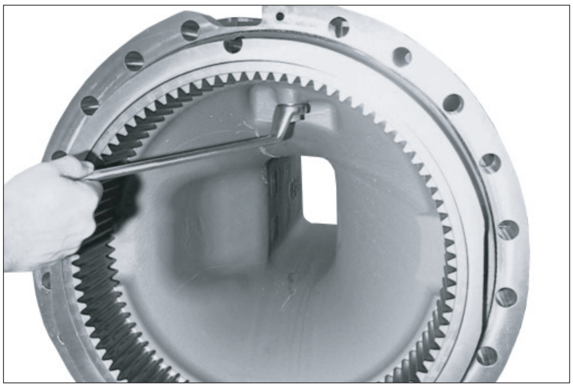
7809AX19

② Loosen the threaded connections and remove the releasing brake tube.



7809AX20

③ Loosen both screw necks.

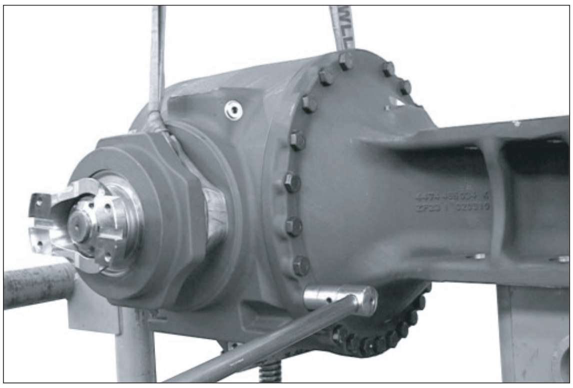


7809AX21

(3) Disassembly axle drive housing

① Secure axle drive housing with the lifting device and loosen the hexagon screws. Then separate the axle drive housing from the axle housing.

Eyebolt (M20)	5870 204 086
Thread insert	AA00 677 715



7809AX22

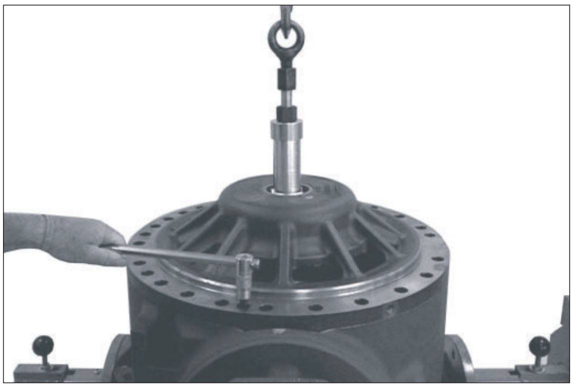
② Fix axle drive housing to the assembly truck.

Assembly truck	5870 350 000
Fixtures (2EA)	5870 350 113

7809AX76

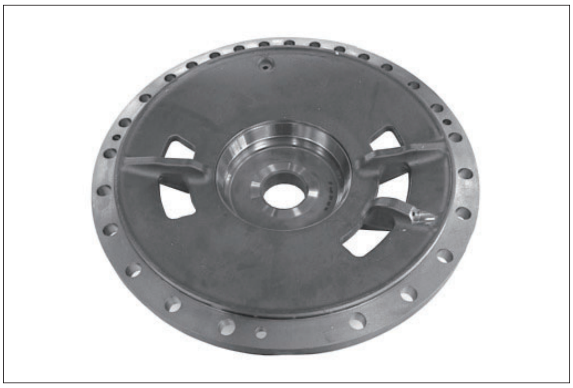
③ Loosen cylindrical screws and lift the releasing bearing housing with the lifting device.

Inner extractor	5870 300 008
Eye bolt	AA00 680 376



7809AX77

④ Pull the bearing outer ring (see arrow) out of the bearing hole and remove the shim behind.



7809AX78

⑤ Press the piston out of the bearing housing by means of compressed air.

7809AX79

⑥ Lift differential out of the axle drive housing with the lifting device.

Inner extractor	5870 300 008
Eye nut	AA00 680 376

※ Disassembly of the various differentials is described as of page 3-262.

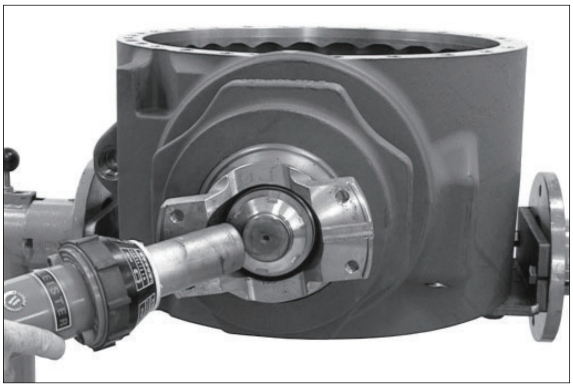

7809AX80

⑦ Pull the bearing outer ring (see arrow) out of the bearing hole and remove the shim behind.


7809AX81

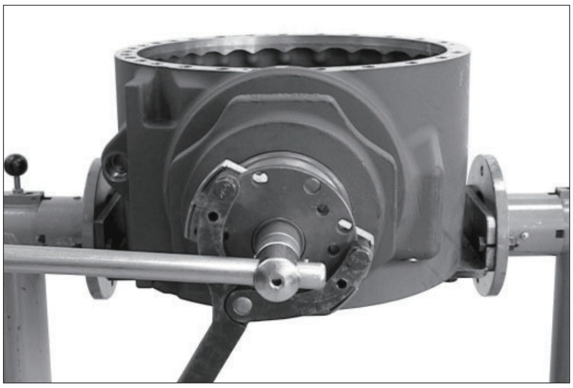
⑧ Heat slotted nut by means of hot-air blower.

※ Slotted nut is secured with Loctite # 262.


7809AX82

⑨ Loosen the slotted nut and remove the shim behind.

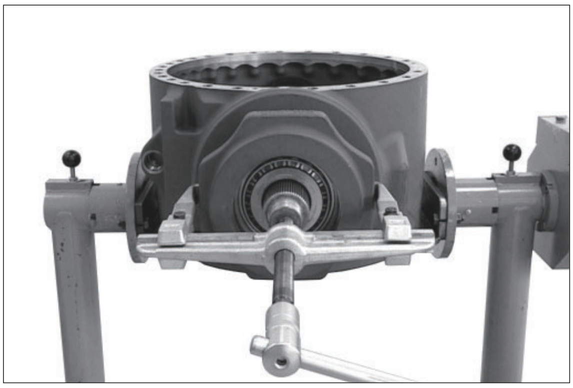
Wrench	5870 401 093
Fixing device	AA00 695 905
Clamping device	5870 240 002


7809AX83

⑩ Pull input flange from the input pinion and use a lever to lift the shaft seal ring behind out of the axle drive housing.

7809AX84

⑪ Use a two-armed puller to press the input pinion out of the axle drive housing and remove the releasing tapered roller bearing.



7809AX85

⑫ Remove the spacer and pull the tapered roller bearing from the input pinion.

Gripping device	AA00 253 881
Basic tool	5873 003 000
Clamping cylinder	5873 003 016
Pump	5870 287 010

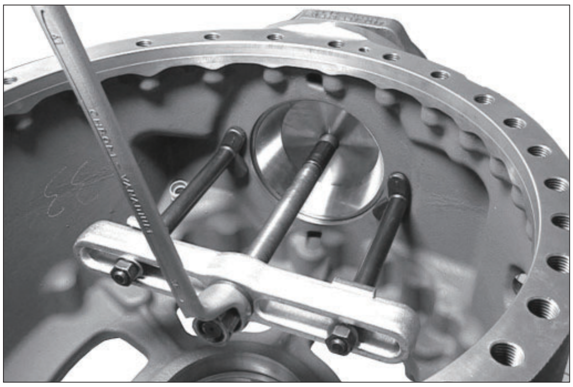
7809AX86

⑬ Loosen the threaded connection and remove the releasing oil tube.

7809AX87

⑭ If necessary pull the internal bearing outer ring out of the axle drive housing and remove the shim behind.

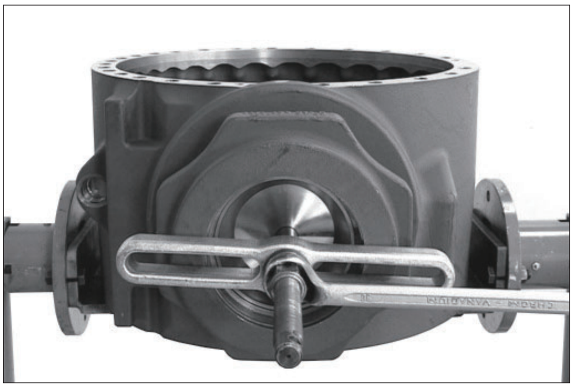
Assembly device	AA00 696 770
Counter support	5870 300 020



7809AX88

⑮ If necessary pull the external bearing ring out of the axle drive housing.

Assembly device	AA00 696 770
Counter support	5870 300 020

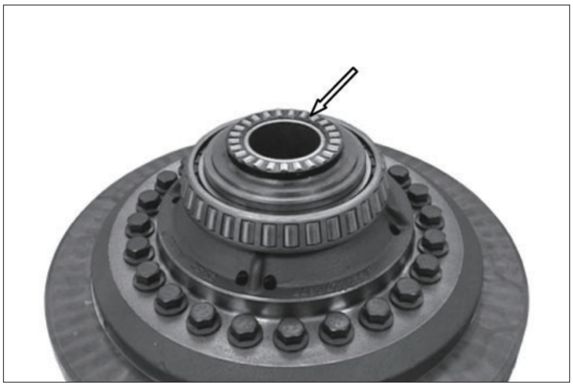


7809AX89

(4) Disassembly differentials

Disassembly multi-disk differential lock

① Remove axial roller cage (arrow).



7809AX90

② Pull both tapered roller bearings from the differential.

Crown wheel side

Rapid grip	AA00 303 274
Basic tool	5873 004 001
Pressure piece	AA00 694 360

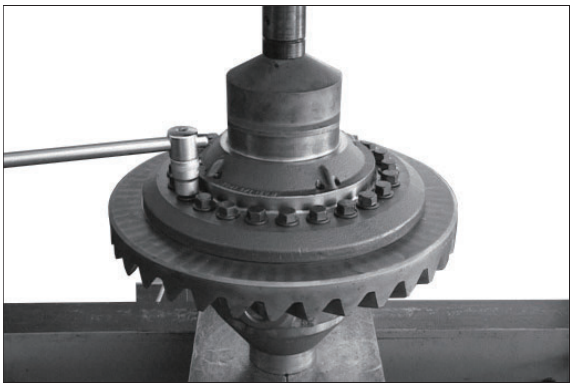
Opposite side

Grab sleeve	5873 004 026
Basic tool	5873 004 001
Clamping cylinder	5873 003 016
Pump	5870 287 010

7809AX91

③ Preload the differential by means of the press and loosen the locking screws.

Pressure piece	AA00 694 360



7809AX92

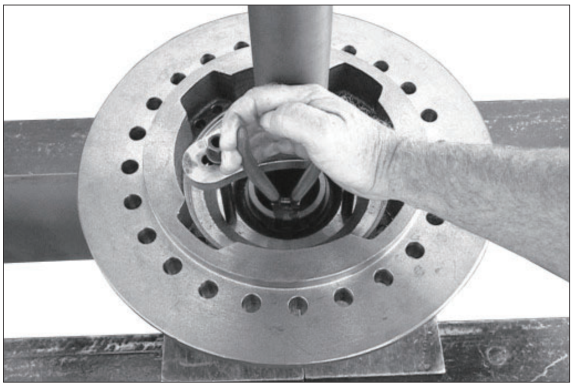
④ Lift the differential cover from the differential housing by means of the lifting device.

Inner extractor	5870 300 008
Eye nut	AA00 680 376

7809AX93

⑤ Preload the compression spring by means of the press and disengage the retaining ring.

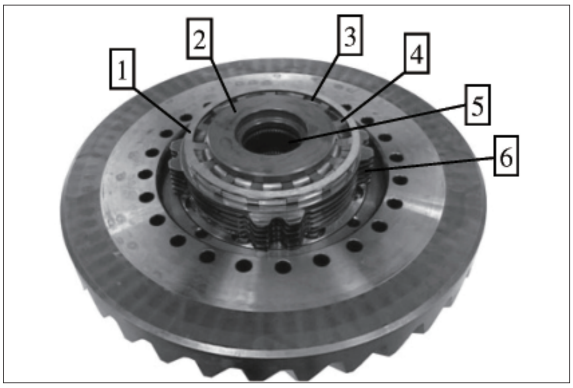
Then pull the sliding sleeve out of the differential cover and remove the releasing compression springs.



7809AX94

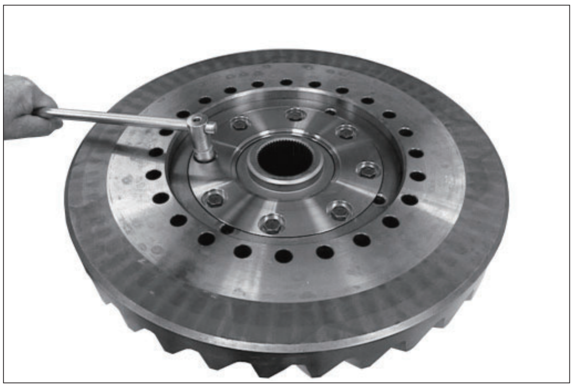
⑥ Remove single parts.

1 = Disk
2 = Pressure piece
3 = Cage
4 = Lever (15EA)
5 = Disk carrier
6 = Disk package



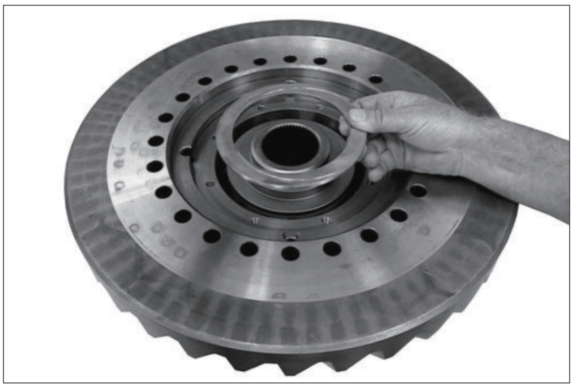
7809AX95

⑦ Loosen hexagon screws and remove the releasing disk.



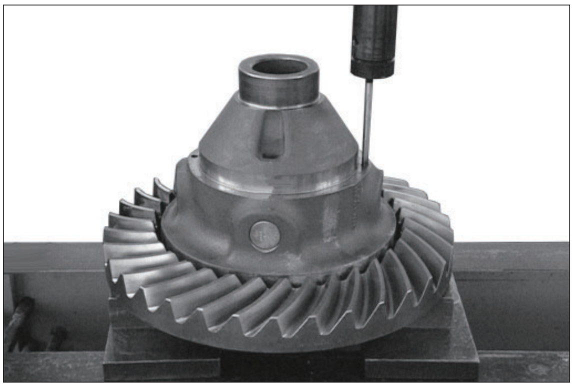
7809AX96

⑧ Remove thrust washer and axle bevel gear from the differential housing.



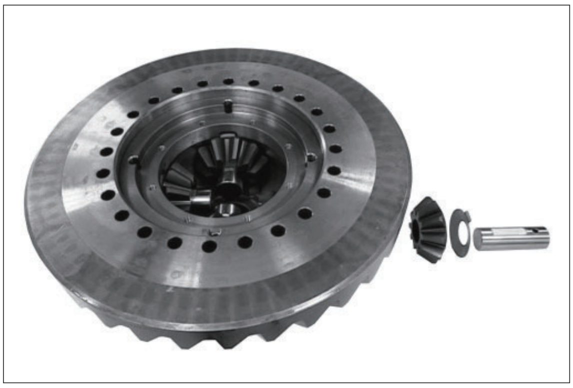
7809AX97

⑨ Force out slotted pins (4EA).



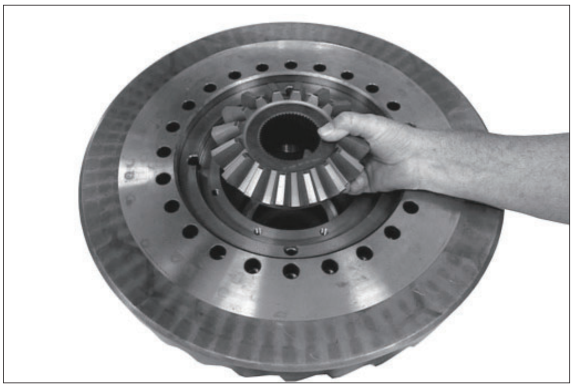
7809AX98

⑩ Pull spider shafts (4EA) and remove the releasing spider gears with the thrust washers from the differential housing.



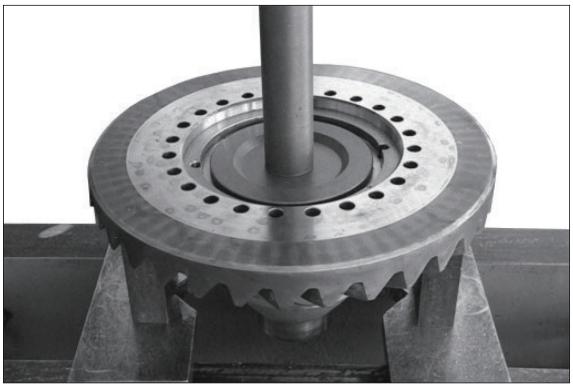
7809AX99

⑪ Remove the axle bevel gears and the shims behind.



7809AX100

⑫ Support the crown wheel and force out the differential housing.



7809AX101

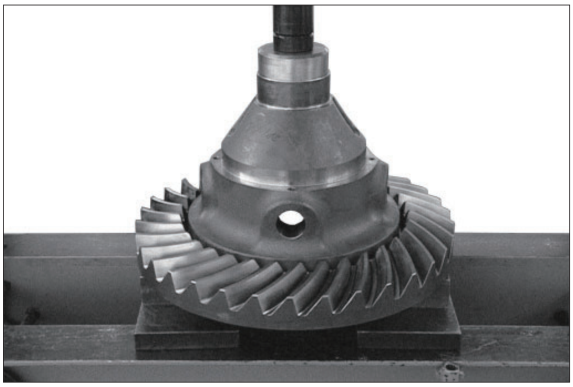
2) ASSEHBY

(1) Assembly differentials

Assembly multi-disk differential lock

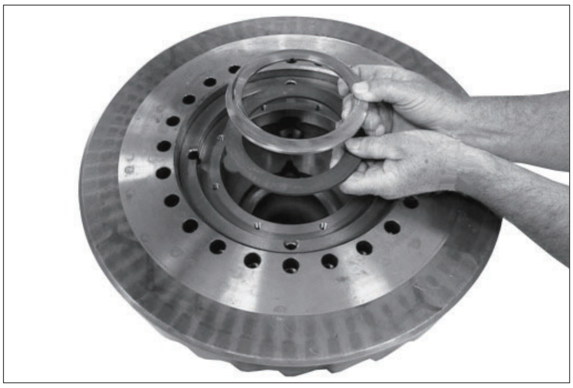
① Mount two adjusting screws and press the heated crown wheel onto the differential housing until contact is obtained.

Adjusting screws 5871 204 040



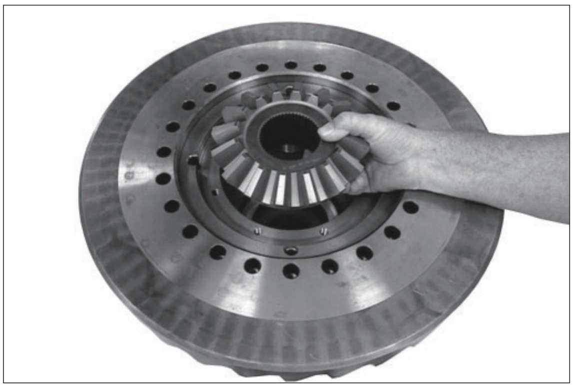
7809AX102

② Insert disk and thrust washer into the differential housing



7809AX103

③ Insert axle bevel gear.

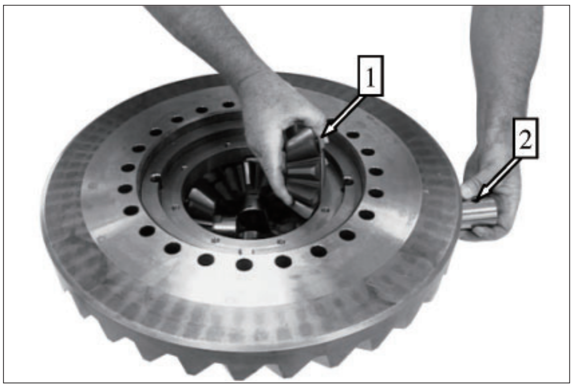


7809AX104

④ Insert spider gears with thrust washers into the differential housing and fix them with the spider shaft.

※ Thrust washers must be positioned with the tabs (see arrow 1) in the recesses of the differential housing.

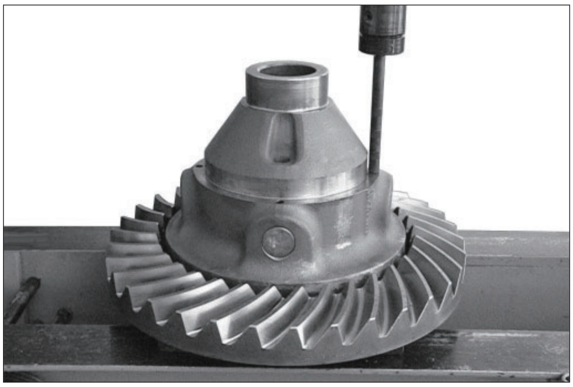
Pay attention to radial installation position of the spider shafts (fixing holes, arrow 2).



7809AX105

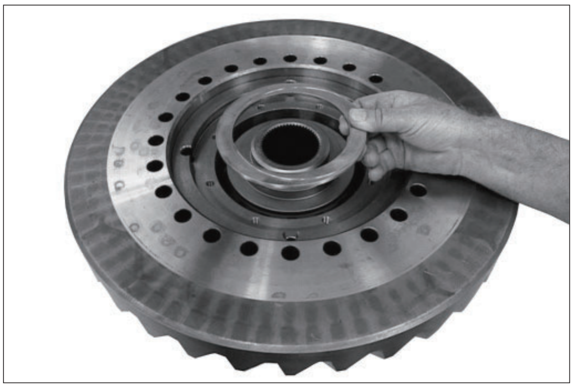
⑤ Fix spider shafts with slotted pins (2 pieces / hole).

※ Press the slotted pins with 180° offset openings into flush position.



7809AX106

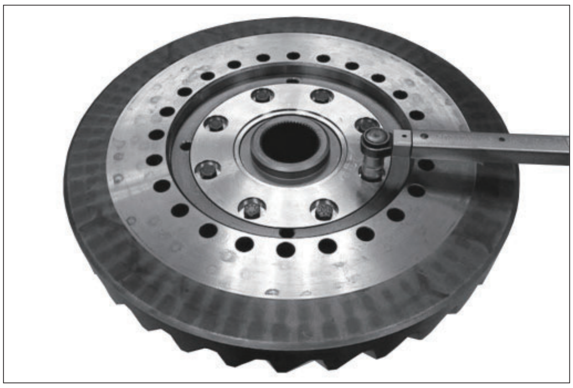
⑥ Mount second axle bevel gear and thrust washer.



7809AX107

⑦ Mount disk and fix it with hexagon screws.

· Tightening torque (M10/10.9) :
5.1 kgf · m (36.9 lbf · ft)

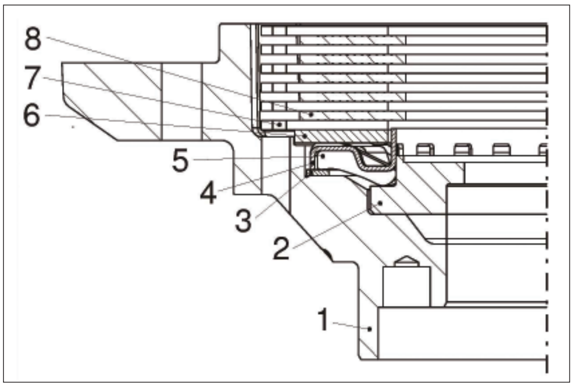


7809AX108

Setting of disk package

⑧ Premount single parts according to the adjacent sketch.

1 = Differential cover
2 = Pressure piece
3 = Disk
4 = Cage
5 = Lever (15EA)
6 = End plate
7 = Outer disks (optional)
8 = Inner disks

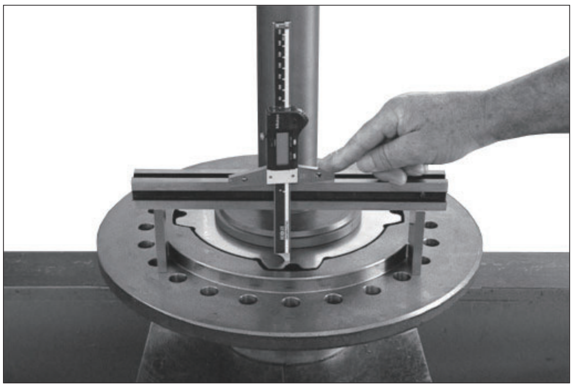


7809AX109

⑨ Preload disk package with an axial force of F = 7 ton.

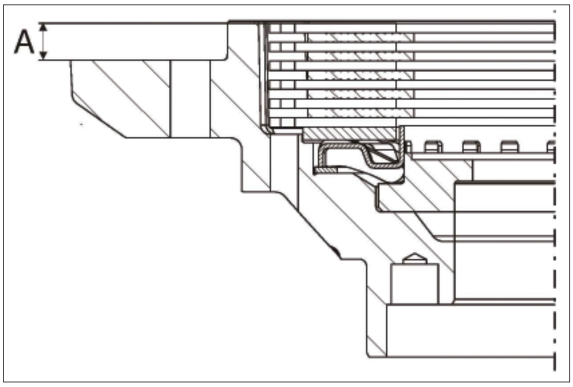
Then check the **setting dimension A = 15.5 $_{-0.2}$ mm** from the mounting face of the differential cover to the plane face of the outer disk (see also below sketch).

※ Any deviation from the specified setting dimension must be corrected with a corresponding outer disk.


7809AX110

Legend to sketch:

A = Setting dimension = 15.5 $_{-0.2}$ mm

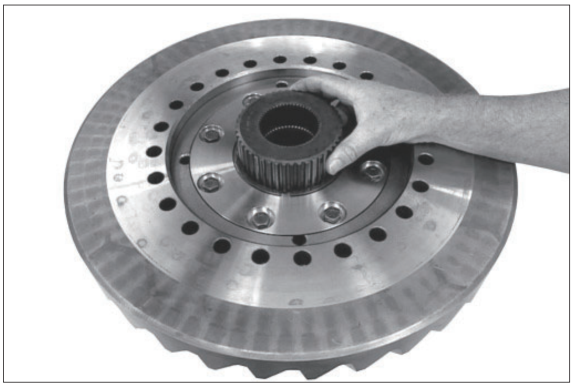


7809AX111

⑩ Engage the snap ring (see arrow) into the annular groove of the disk carrier.


7809AX112

⑪ Insert the premounted disk carrier onto the axle bevel gear.

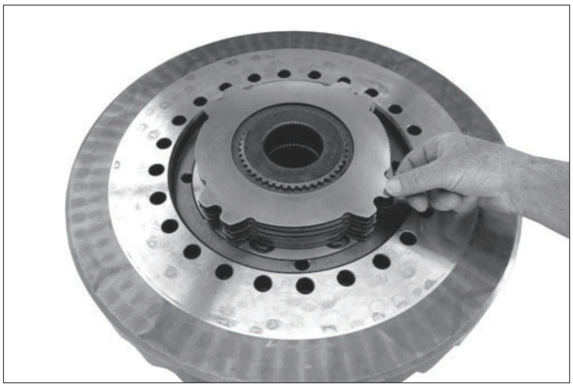


7809AX113

⑫ Mount outer and inner disks.

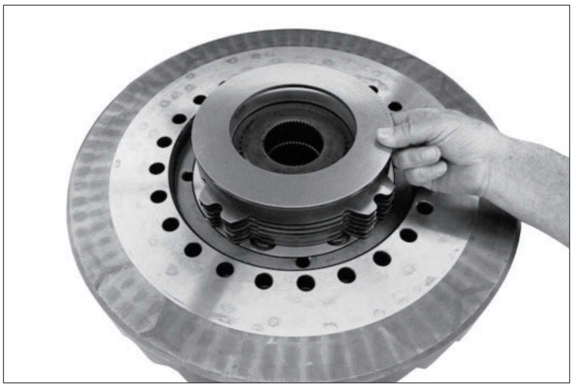
※ For the number of disks and disk arrangement please refer to the parts manual.

※ Pay attention to the radial installation position of the disk package, as shown on the adjacent figure.



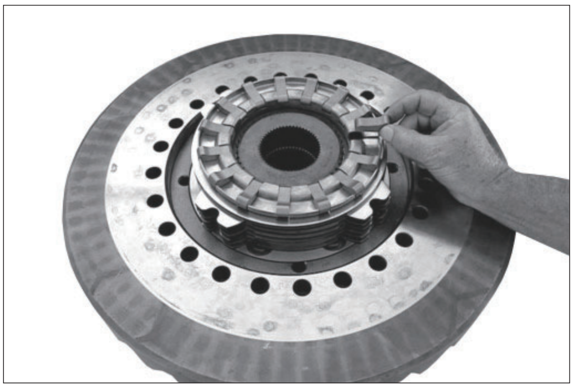
7809AX114

⑬ Insert end plate.



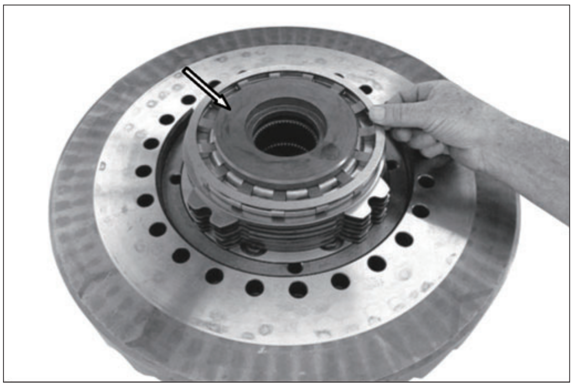
7809AX115

⑭ Mount cage and lever (15EA).



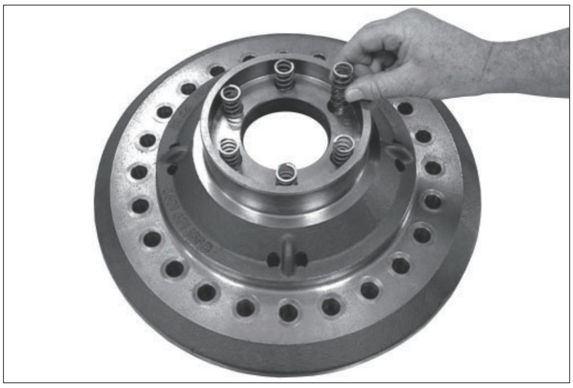
7809AX116

⑮ Insert pressure piece (see arrow) and install disk.



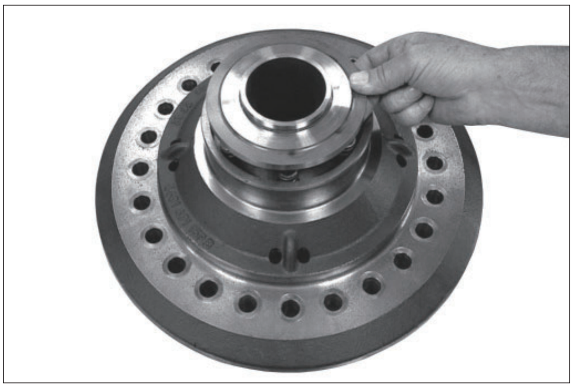
7809AX117

⑯ Insert compression springs (6EA) into the differential cover.



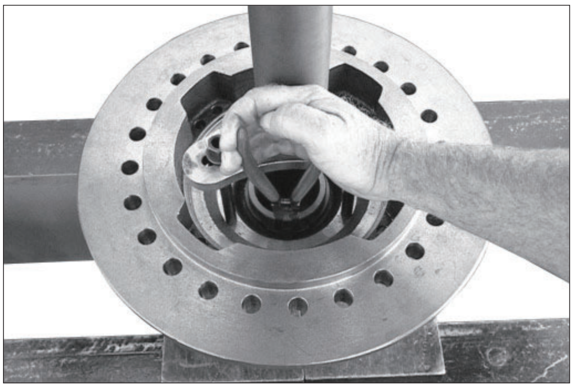
7809AX118

⑰ Insert sliding sleeve.



7809AX119

⑱ Preload the compression springs by means of the press and engage the retaining ring into the annular groove of the sliding sleeve.



7809AX120

⑲ Mount two adjusting screws and insert the differential cover by means of the lifting device.

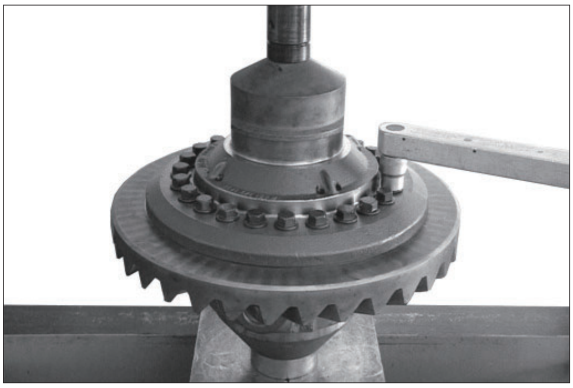
Adjusting screws	5870 204 040
Inner extractor	5870 300 008
Eye nut	AA00 680 376

7809AX121

⑳ Preload the differential by means of the press and bolt with **new** locking screws.

· Tightening torque (M16/12.9) :
40.7 kgf · m (295 lbf · ft)

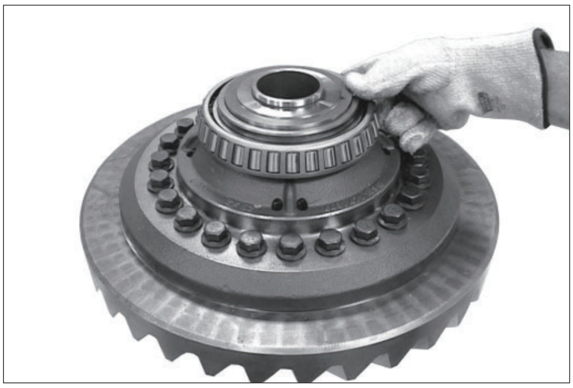
Pressure piece	AA00 694 360



7809AX122

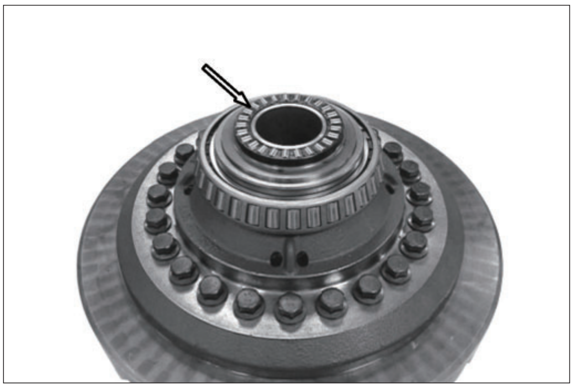
㉑ Heat both tapered roller bearings and insert until contact is obtained.

※ Adjust tapered roller bearing after cooling down.



7809AX123

㉒ Insert axial roller cage (see arrow).



7809AX124

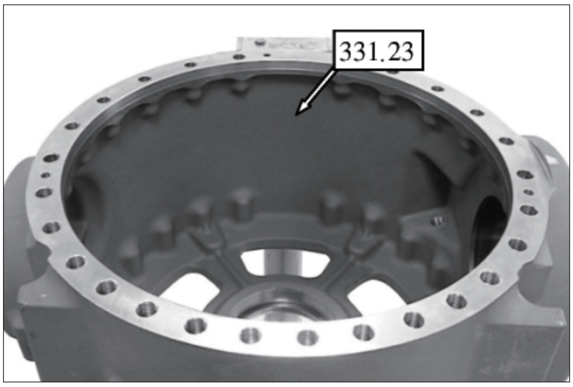
(2) Assembly axle drive housing

※ If crown wheel or input pinion are damaged, both parts must be jointly replaced.
In case of a new installation of a complete bevel gear set pay attention to an identical mating number of input pinion and crown wheel.

Determination of shim thickness to obtain a correct contact pattern

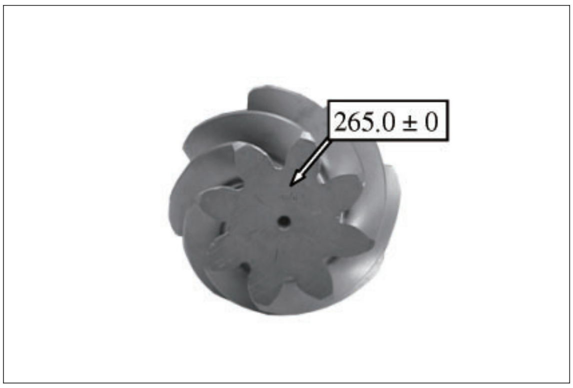
※ The following measuring procedures must be carried out with utmost accuracy.
Inaccurate measurements lead to an incorrect contact pattern requiring an additional disassembly and reassembly of input pinion and differential.

① Read dimension I from the axle drive housing.
Dimension I e.g .... 331.25 mm



7809AX125

② Read dimension II (pinion dimension).
Dimension II e.g .... 265.00 mm



7809AX126

③ Determine dimension III (bearing width).

Dimension III e.g. . . . . 63.60 mm

Calculation example A :

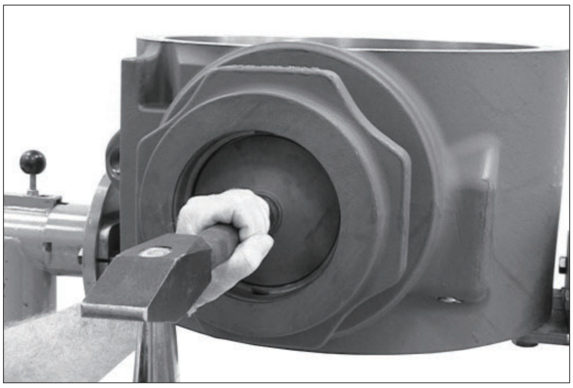
Dimension I	331.25 mm
Dimension II	- 265.00 mm
Dimension III	- 63.60 mm
Difference = shim	s = 2.60 mm


7809AX127

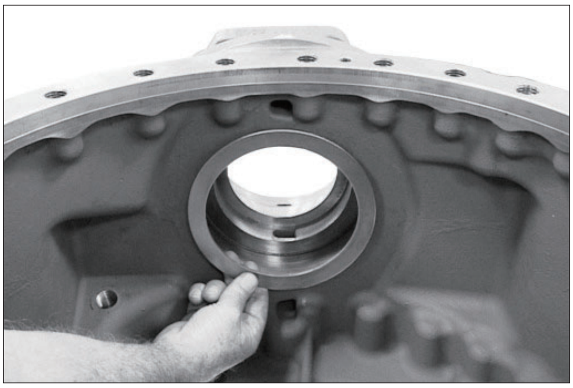
Reassembly of input pinion

① Undercool the external bearing outer ring and insert it into the axle drive housing until contact is obtained.

Driver tool	5870 050 007
Handle	5870 260 004

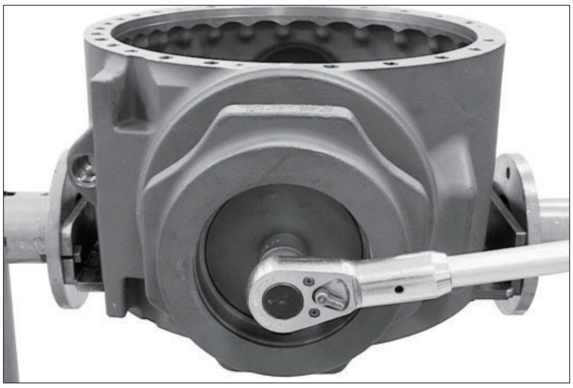

7809AX128

② Insert the determined shim e.g. s = 2.60 mm into the housing hole.

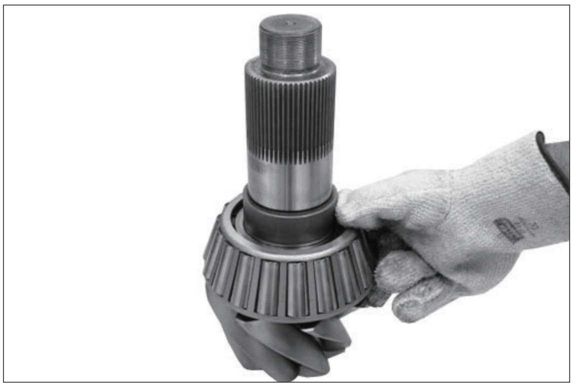

7809AX129

③ Undercool the internal bearing outer ring and bring it into contact position in the housing hole by using the assembly fixture.

Assembly fixture	AA00 623 955


7809AX130

④ Heat the tapered roller bearing and insert it into the input pinion until contact is obtained.

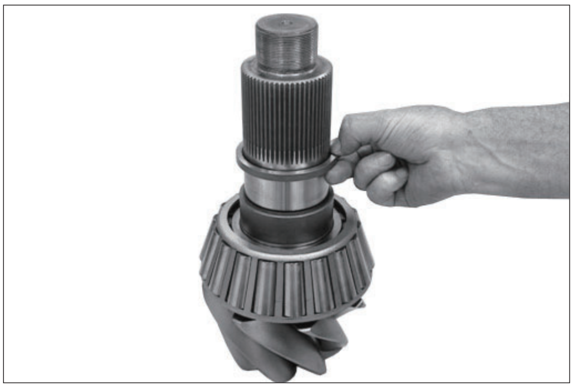


7809AX131

Setting of rolling torque of input pinion bearing 0.1~0.5 kgf·m (without shaft seal ring)

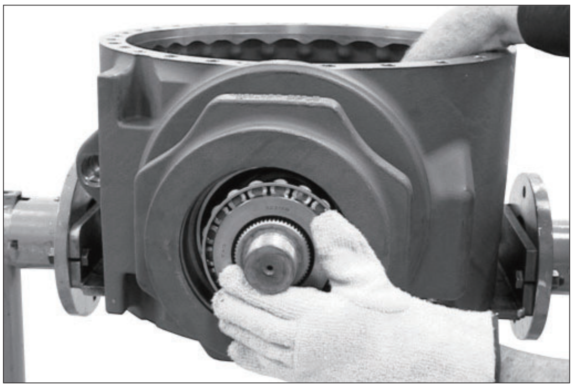
⑤ Insert spacer (e.g. s = 7.13 mm).

※ According to our experience the necessary rolling torque is obtained when reusing the spacer which has been removed during disassembly (e.g. s = 7.13 mm).
A later check of the rolling torque, however, is absolutely necessary.



7809AX132

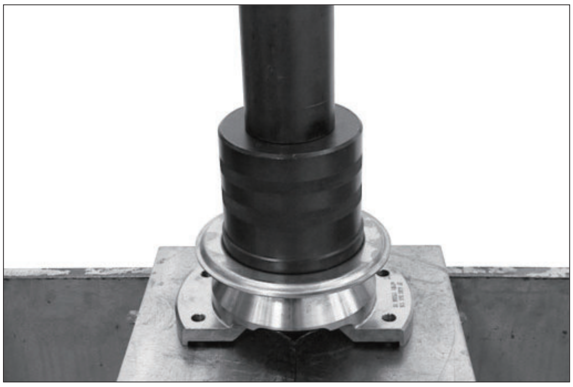
⑥ Insert the preassembled input pinion into the axle drive housing and insert the heated tapered roller bearing until contact is obtained.



7809AX133

⑦ Press the protection plate onto the input flange (see arrow) until contact is obtained.

※ Do not fit the shaft seal ring until the contact pattern has been checked.



7809AX134

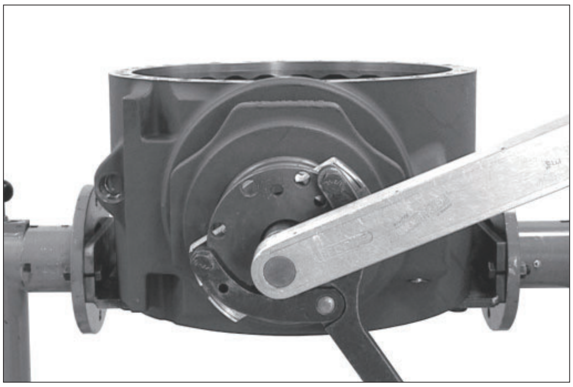
⑧ Insert input flange and fix it by means of disk and slotted nut.

· Tightening torque :
122 kgf · m (885 lbf · ft)

Wrench	5870 401 093
Fixing device	AA00 695 905
Clamping device	870 240 002

※ Preliminarily mount slotted nut without Loctite.

※ While tightening rotate the input pinion several times in both directions.

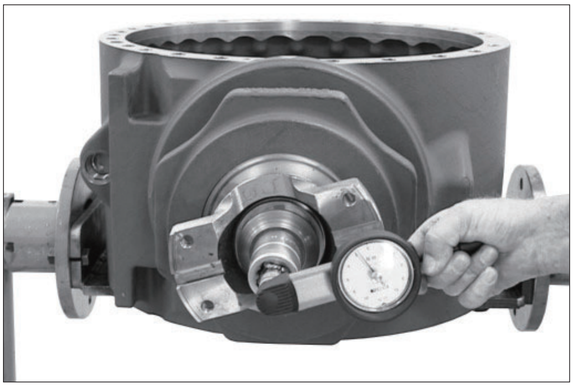


7809AX135

⑨ Check rolling torque (0.15~0.51 kgf·m without shaft seal ring).

※ When installing new bearings try to achieve the upper value of the rolling torque.

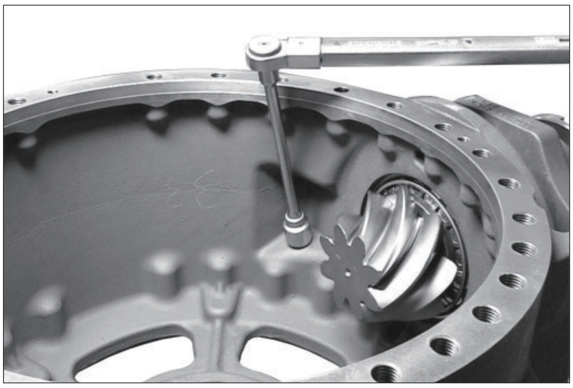
※ In case of deviations from the necessary rolling torque correct with a corresponding spacer (figure AX132) as specified below.
Insufficient rolling torque - install thinner spacer ring.
Excessive rolling torque - install thicker spacer ring.



7809AX136

⑩ Mount threaded connection.

· Tightening torque :
10.2 kgf · m (73.8 lbf · ft)



7809AX137

⑪ Mount oil tube.

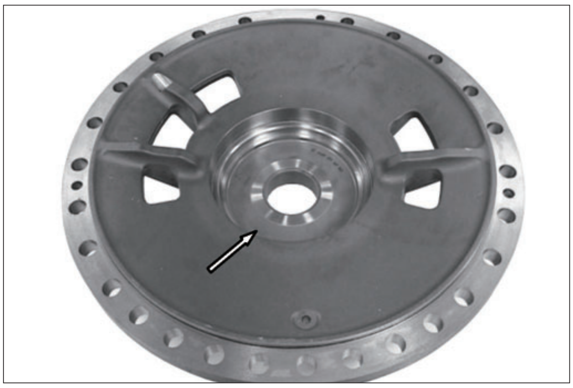
· Tightening torque :
10.2 kgf · m (73.8 lbf · ft)

7809AX138

⑫ Grease O-rings (see arrows) and insert them into the annular grooves of the piston.

7809AX139

⑬ Insert piston (see arrow) into the bearing housing until contact is obtained.



7809AX140

Determination of shims for setting of bearing rolling torque (differential housing) and backlash (bevel gear set)

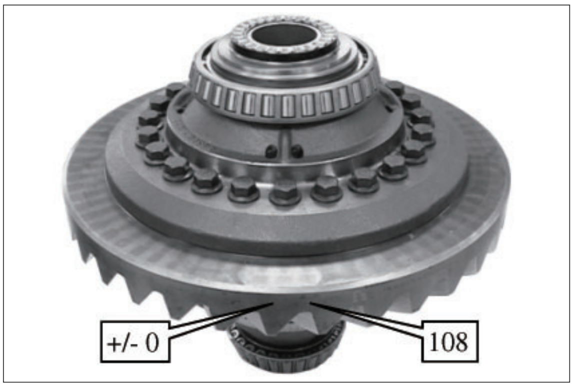
※ Determine the required shims on the basis of the read value (deviation/test dimension) and the corresponding specifications of the table below: (KRS – SET – RIGHT) (KRS = bevel gear set):

① Deviation see crown wheel rear side.

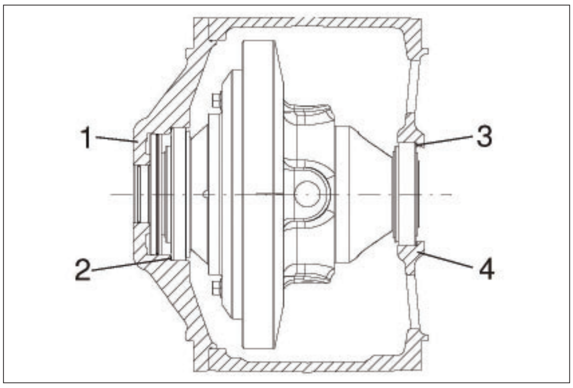
The test dimension 108 is stamped into the crown wheel rear side. If no + or – deviation is indicated, this value corresponds to the actual value 0 in the table below. According to this value, the required shims are allocated in the table below.

※ Any + or – deviation of the test dimension caused by production is also marked on the crown wheel rear side (e.g.- 20 or - 10 or 10 or 20) .
In accordance with this deviation, the required shims are allocated in the table below.

Legend to sketch:
1 = Bearing housing
2 = Shim (crown wheel side)
3 = Shim (differential carrier side)
4 = Axle drive housing



7809AX141



7809AX142

Shims for differential						
Crow wheel marking	- 30	- 20	- 10	0	10	20
Deviation	- 0.3	- 0.2	- 0.1	0	0.1	0.2
Shim diff cage side shim thickness	1.1	1.2	1.3	1.4	1.5	1.6
Shim P/No.	ZGAQ-03681	ZGAQ-03676	ZGAQ-03677	ZGAQ-03678	ZGAQ-03679	ZGAQ-03680
Shim crown wheel side shim thickness	1.7	1.6	1.5	1.4	1.3	1.2
Shim P/No.	ZGAQ-03687	ZGAQ-03686	ZGAQ-03685	ZGAQ-03684	ZGAQ-03683	ZGAQ-03682

② Insert the determined shim (e.g. s = 1.4 mm) into the hole of the axle drive housing and reset until contact with the bearing outer ring is obtained.

7809AX143

③ Cover some drive and coast flanks of the crown wheel with marking ink.
Then insert the premounted differential into the axle drive housing.

Inner extractor	5870 300 008
Eye nut	AA00 680 376

7809AX144

④ Insert the determined shim (e.g. s = 1.4 mm) into the bearing housing and reset the bearing outer ring until contact is obtained.

7809AX145

⑤ Place the premounted bearing housing onto the axle drive housing by means of the lifting device.

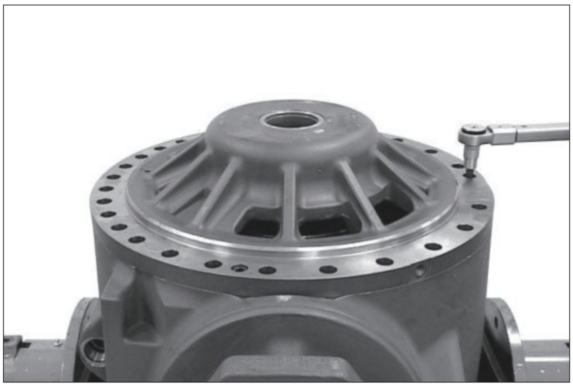
Inner extractor	5870 300 008
Eye nut	AA00 680 376

※ Preliminarily mount the bearing housing without O-ring.

7809AX146

⑥ Fix the bearing housing by means of cylindrical screws (3EA).

- Tightening torque (M12/10.9) :
  5.1 kgf · m (36.9 lbf · ft)

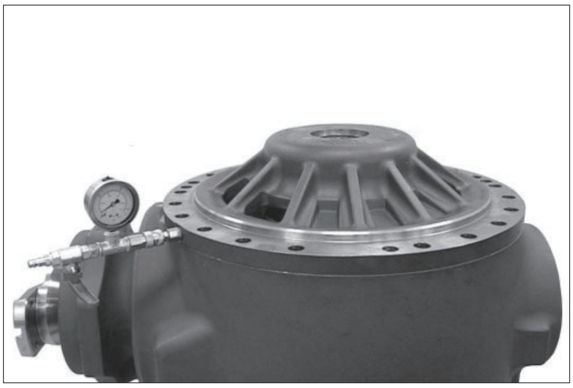


7809AX147

Leakage test of lock

⑦ Pressurize the lock (p = 1 bar), close shut-off valve and remove air line.

※ No noticeable pressure loss is allowed to occur within 10 sec.



7809AX148

⑧ By rotating the input flange, roll crown wheel over the input pinion in both directions several times.
Then remove the bearing housing again and lift the differential out of the axle drive housing.
Compare the obtained contact pattern with contact pattern.

※ In case of any contact pattern deviation, a measuring error was made when determining the shim (Figure AX129), which must be corrected by all means.

7809AX149

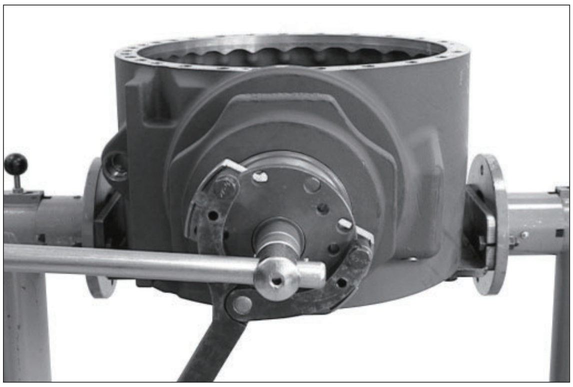
⑨ After the contact pattern check insert the differential again into the axle drive housing.

7809AX150

Reassembly of shaft seal ring (figure AX151~153)

⑩ Loosen slotted nut and pull the input flange from the input pinion.

Wrench	5870 401 093
Fixing device	AA00 695 905
Clamping device	5870 240 002



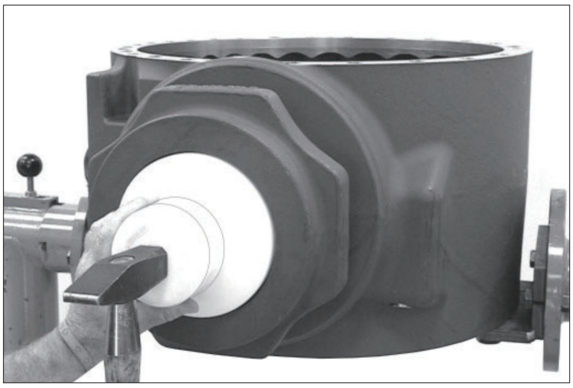
7809AX151

⑪ Mount the shaft seal ring with the seal lip showing to the oil chamber.

Driver tool	AA00 623 986

※ The exact installation position of the shaft seal ring is obtained when using the specified driver tool.

※ Wet the outer diameter of the shaft seal ring with spirit directly before installation and fill the space between seal and dust lip with grease.



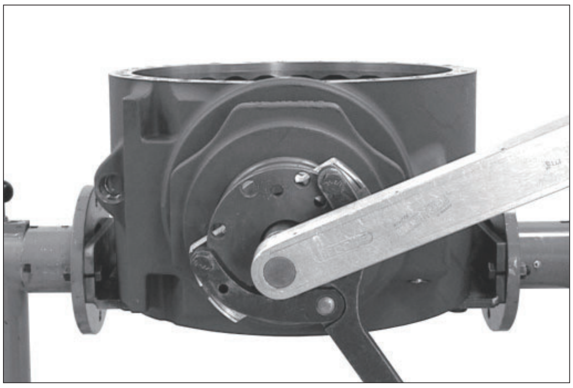
7809AX152

⑫ Insert input flange and finally tighten by means of disk and slotted nut.

· Tightening torque :
122 kgf · m (12.5 lbf · ft)

Wrench	5870 401 093
Fixing device	AA00 695 905
Clamping device	5870 240 002

※ Cover the thread of the slotted nut with loctite #262.



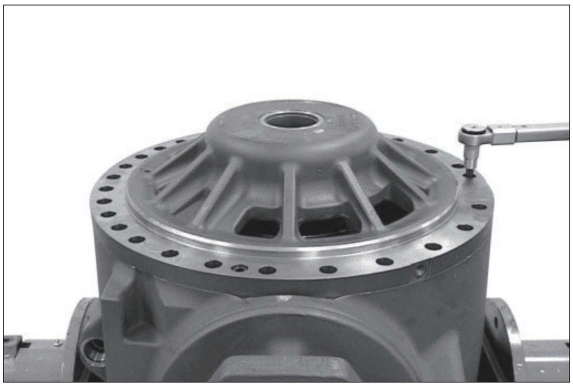
7809AX153

⑬ Grease O-ring (see arrow) and insert it into the annular groove of the bearing housing.

7809AX154

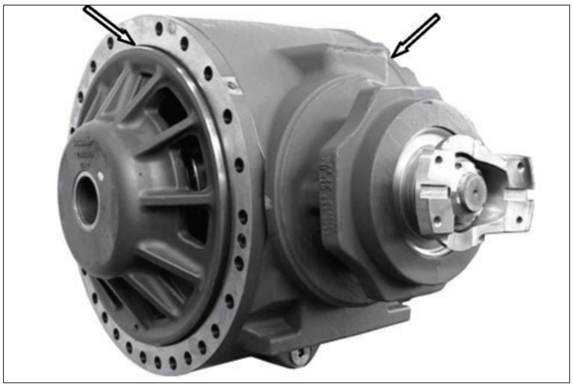
⑭ Insert the bearing housing by means of the lifting device and finally tighten it with cylindrical screws.

· Tightening torque (M12/10.9) :
5.1 kgf · m (36.9 lbf · ft)



7809AX155

⑮ Grease O-rings (see arrows) and insert them on both sides of the axle drive housing.

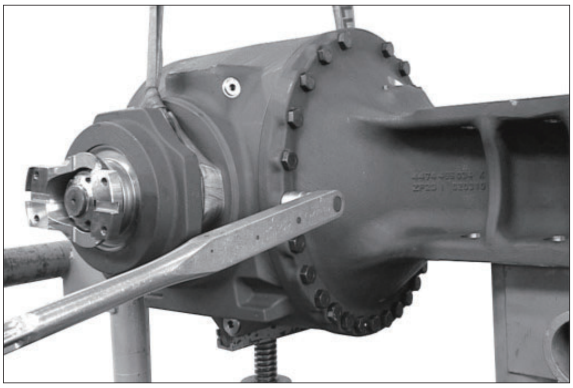


7809AX156

⑯ Mount two adjusting screws and bring axle drive housing in contact position with the axle housing by using the lifting device.
Then fix the axle drive housing with hexagon screws.

· Tightening torque (M20/10.9) :
57.1 kgf · m (413 lbf · ft)

Adjusting screws (M20)	5870 204 024
Eye bolt (M20)	5870 204 086
Thread insert	AA00 677 715



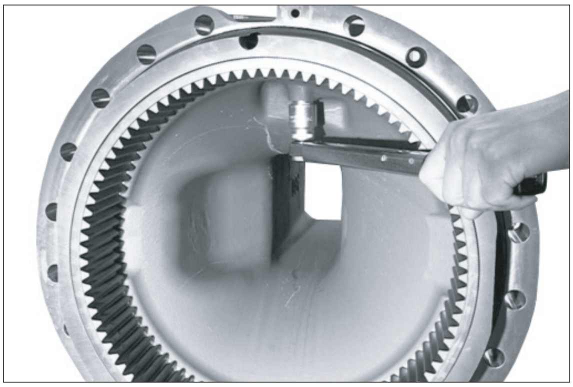
7809AX157

※ After mounting the axle drive housing unbolt the support until contact is obtained.

(3) Assembly axle housing

① Mount both fittings.

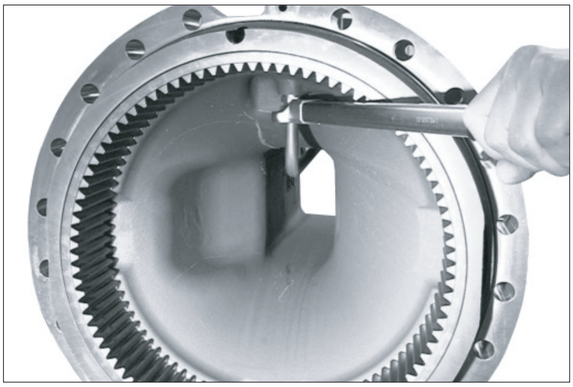
· Tightening torque : 3.67 kgf · m (26.6 lbf · ft)



7809AX158

② Mount brake tube.

· Tightening torque : 10.2 kgf · m (73.8 lbf · ft)



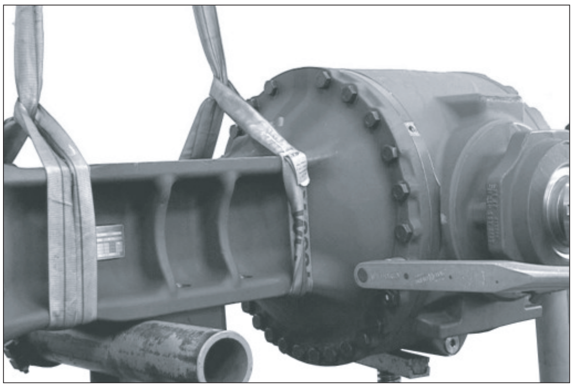
7809AX159

③ Mount two adjusting screws and bring the axle housing into contact position with the axle drive housing by using the lifting device.
Then fix the axle housing by means of hexagon screws.

· Tightening torque (M20/10.9) : 57.1 kgf · m (413 lbf · ft)

Adjusting screws (M20) 5870 204 024

※ After assembling the axle housing secure the axle with clamping brackets.



7809AX160

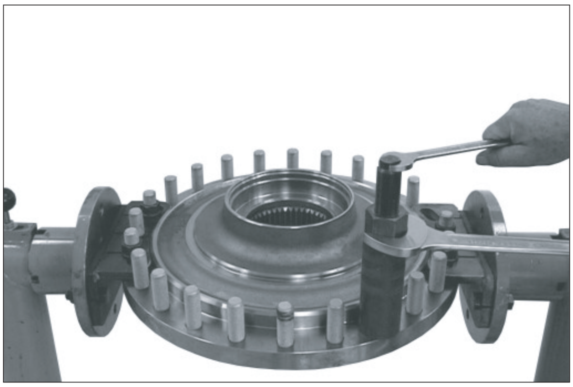
(4) Aeassembly output and brake

① Pull in wheel stud into the output shaft until contact is obtained.

Wheel stud puller - basic tool 5870 610 001

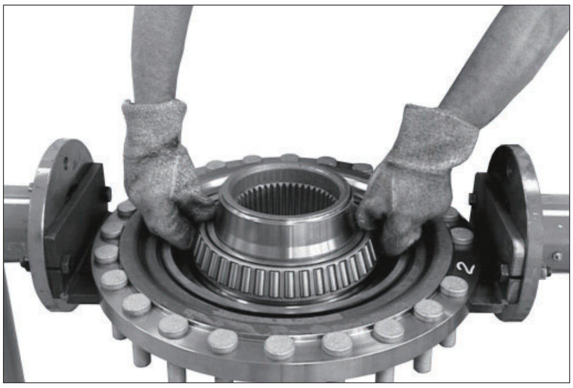
Insert (M22x1.5) 5870 610 002

※ Special tool may only be used for repair solution when exchanging individual wheel studs with mounted output shaft. When using a new output shaft, mount the wheel studs with the press.



7809AX28

② Heat tapered roller bearing and insert it into the output shaft until contact is obtained.

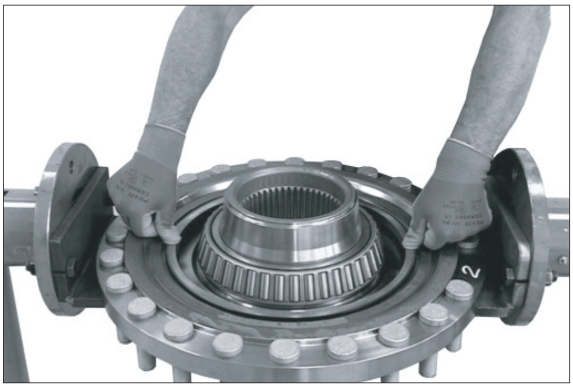


7809AX29

② Wet O-ring of the slide ring seal and locating hole with spirit.
Snap **new** slide ring seal (1) into the output shaft.
Then mount **new** slide ring seal (part 2) accordingly into the brake housing.

※ For the installation position of the seal please also refer to sketch AX34.

※ The surface of the slide ring seal may not have any grooves, scratches or other types of damage. Take care that the sealing surface is parallel to the housing face.
The O-rings must be mounted evenly into the locating hole and must not bulge out of the hole. Risk of injury - Metal rings have extremely sharp edges. Wear protective gloves.

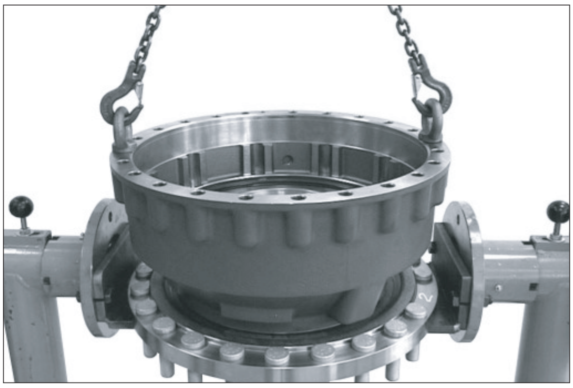


7809AX30

7809AX31

③ Insert the premounted brake housing by means of the lifting device over the output shaft until contact is obtained.

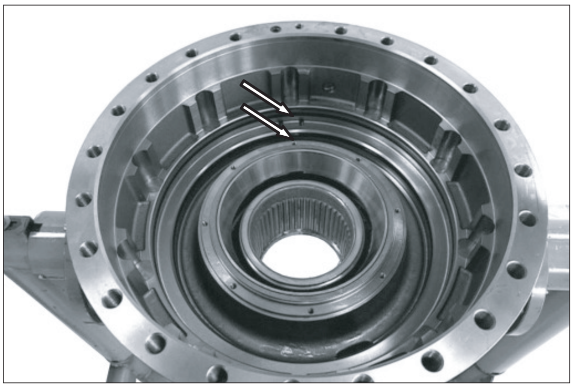
※ Before clamping the seal rings to installation dimension, clean the sliding surfaces and apply an oil film. We recommend to use a leather cloth soaked with oil.



7809AX31

④ Insert back-up rings and grooved rings into the annular grooves of the brake housing (see arrows).

※ Pay attention to the installation position; please also refer to sketch AX34.

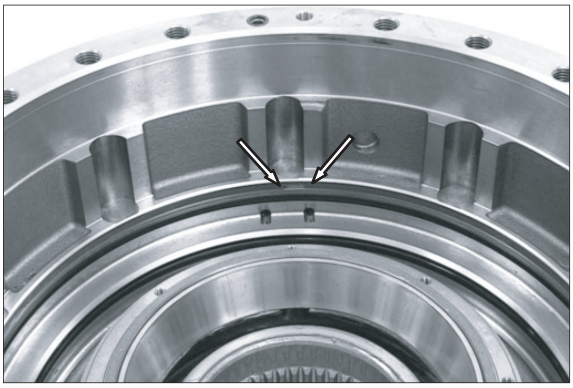


7809AX32

⑤ Clean the annular groove of the brake housing with spirit.
Then insert the guide ring into the annular groove (see also the following sketch) and fix it with loctite #415 at its extremities (see arrows).

※ The full circumference of the guide ring must be in an exact contact position.

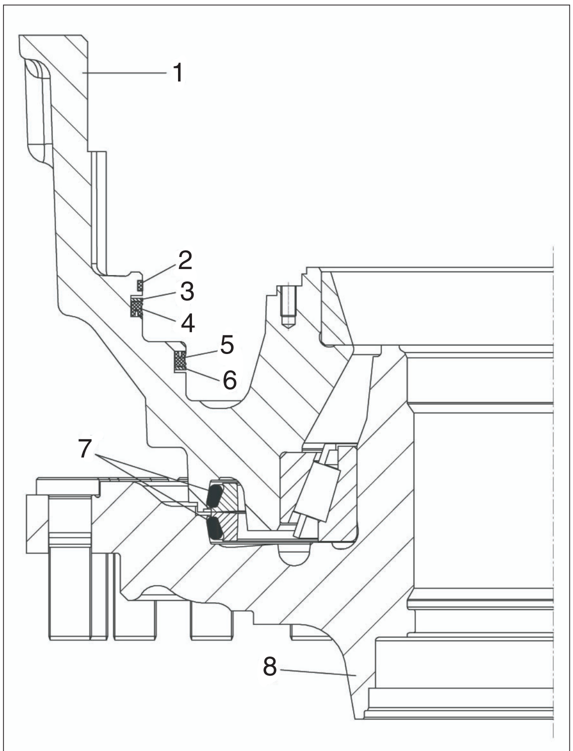
※ Upon installation the orifice of the guide ring must show upwards (12 o’clock).



7809AX33

Legend to sketch:

1 = Brake housing
2 = Guide ring
3 = Back-up ring
4 = Grooved ring
5 = Grooved ring
6 = Back-up ring
7 = Slide ring seal
8 = Output shaft

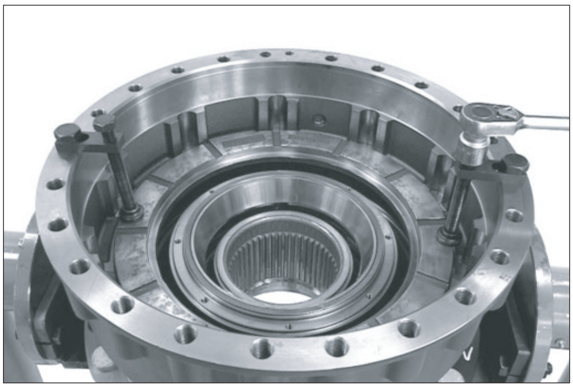


7809AX34

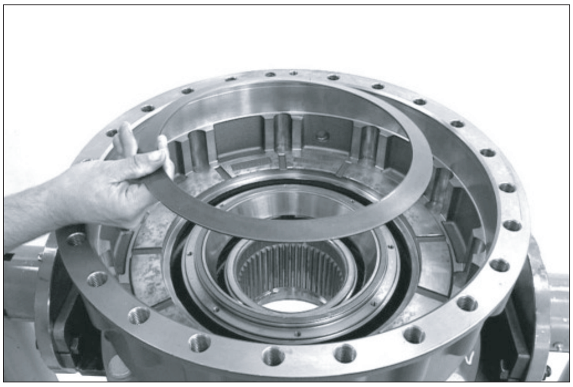
⑥ Insert the piston into the brake housing and carefully install with the fixing device until contact is obtained.

Fixing device AA00 680 530

※ Sufficiently oil seal surface of piston/ back-up rings, grooved rings and guide ring (W-10 oils to be used).

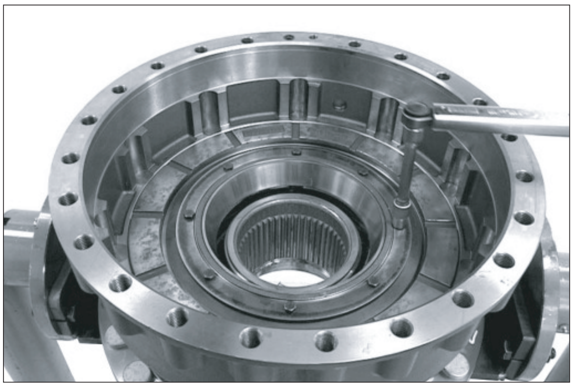

7809AX35

⑦ Insert cup spring into the piston with the convex side showing upwards.


7809AX36

⑧ Insert disk and fix it by means of hexagon screws.

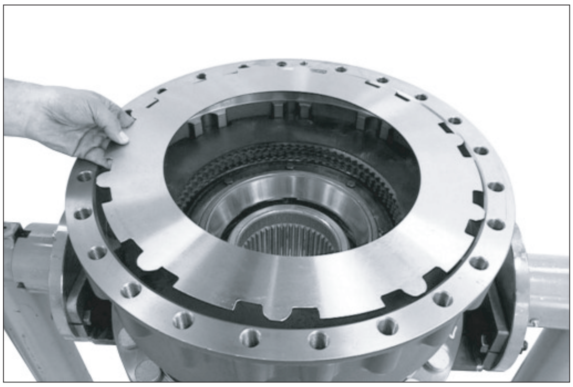
· Tightening torque (M8/10.9) :
3.47 kgf · m (25.1 lbf · ft)



7809AX37

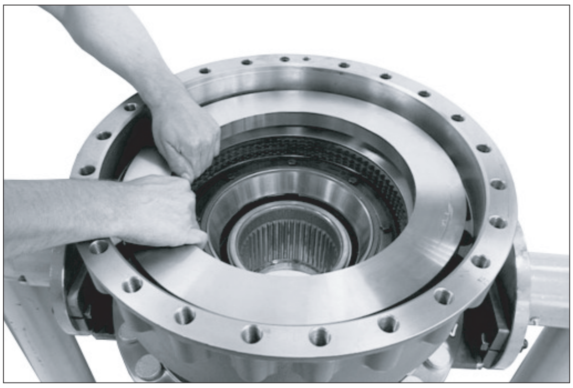
⑨ Mount outer and inner disks.

※ For the number of disks and the disk arrangement please refer to the relating spare parts list.



7809AX38

⑩ Insert end plate.



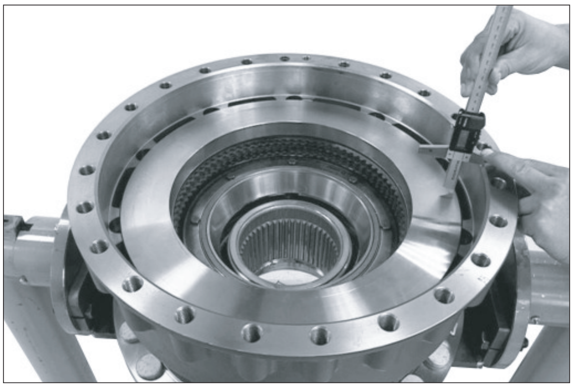
7809AX39

Setting of installation dimension 57.25~ 57.79 mm

⑪ Measure installation dimension from the mounting face of the brake housing to the front face of the end plate.

Installation dimension e.g . . . . . 57.50 mm

※ Any deviation from the necessary installation dimension must be corrected with an appropriate outer disk (see spare parts manual).

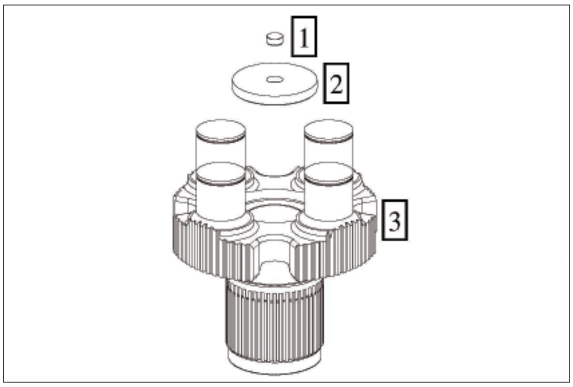


7809AX40

⑫ Press stop bolt into the cover until contact is obtained.

Then insert the premounted cover into the planetary carrier until contact is obtained.

Legend to sketch:
1 = Stop bolt
2 = Cover
3 = Planetary carrier

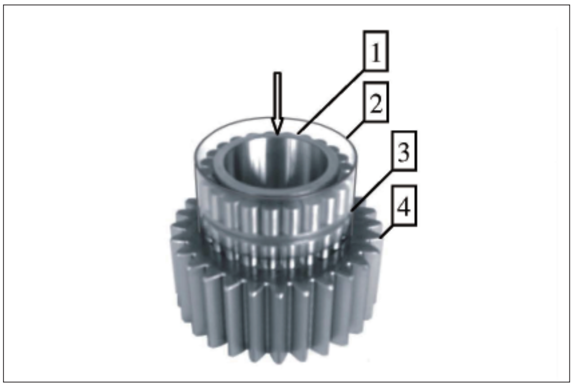


7809AX161

⑬ Insert the cylindrical roller bearing into the planetary gear – for this purpose press the cylindrical roller bearing through the packaging sleeve until the snap ring engages into the annular groove of the planetary gear.

※ Use packaging sleeve to facilitate assembly.

1 = Cylindrical roller bearing
2 = Packaging sleeve
3 = Snap ring
4 = Planetary gear

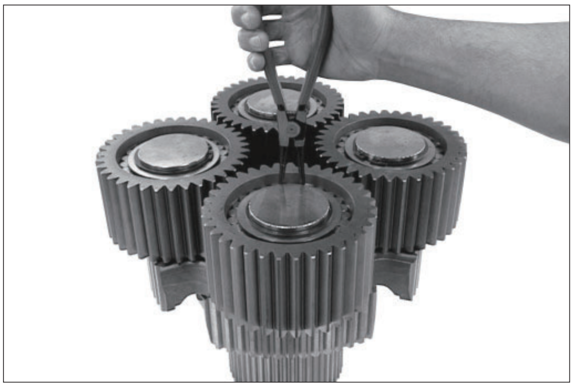


7809AX162

⑭ Heat bearing inner rings and insert the premounted planetary gears with large radius facing the planetary carrier (downwards) until contact is obtained.

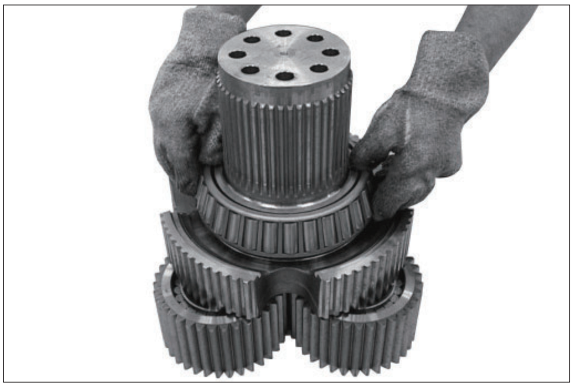
※ Adjust bearing inner rings after cooling down.

Then fix planetary gears by means of retaining rings.



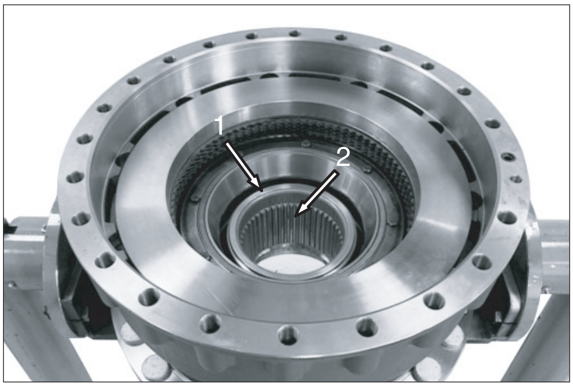
7809AX163

⑮ Heat tapered roller bearing and install it to the planetary carrier until contact is obtained.



7809AX164

⑯ Wet front face (contact face bearing inner ring, arrow 1) and profile (teeth, arrow 1) in the output shaft with anti-corrosive agent.

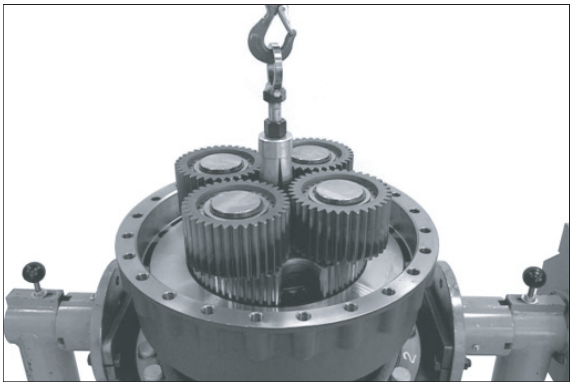


7809AX41

⑰ Align disk package centrally and radially. Then insert the planetary carrier by means of the lifting device into the teeth of the output shaft until contact is obtained.

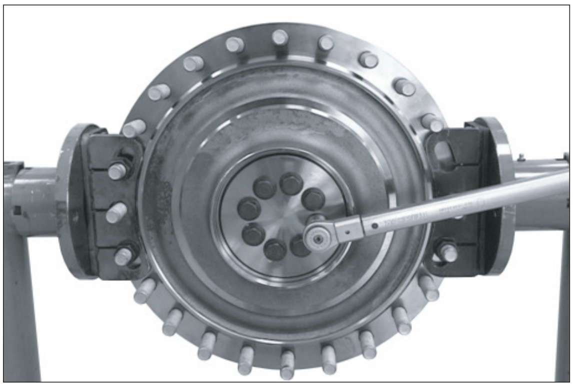
· Rear axle (planetary carrier with 3 planetary gears)
Inner extractor 5870 300 019
Eye bolt 5870 204 073

· Front axle (planetary carrier with 4 planetary gears)
Inner extractor 5870 300 008
Eye nut AA00 680 376


7809AX42

⑱ Pivot output 90°.
Insert disk and fix planetary carrier with new locking screws.

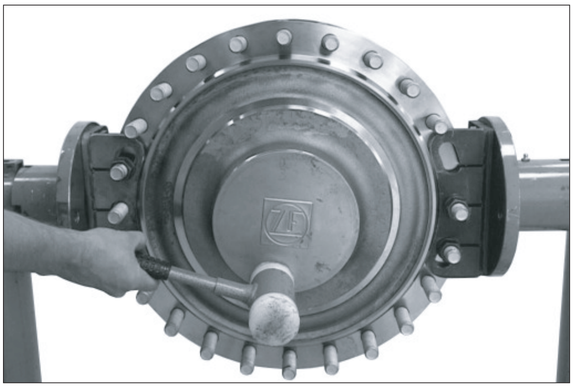
※ Tighten locking screws successively with a tightening torque of 20.4 kgf · m (147.5 lbf · ft).
Then retighten the locking screws successively with a tightening torque of 51 kgf · m (369 lbf · ft).


7809AX43

⑲ Install O-ring (see arrow) to the cover.

7809AX44

⑳ Insert the cover into the output shaft until contact is obtained.



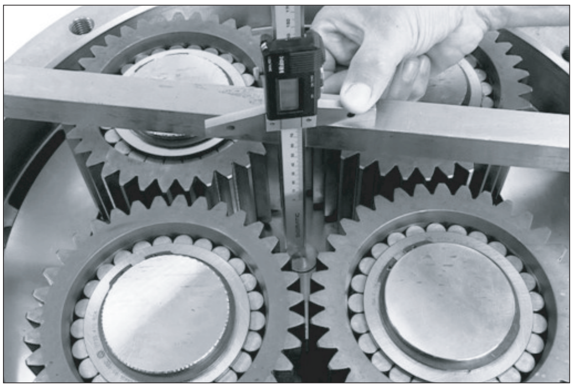
7809AX45

Set the axial play of the sun gear shaft 0.5~2.0 mm

⑳ Determine dimension I, from the mounting face of the brake housing to the front face of the stop bolt.

Dimension I e.g. . . . . 58.60 mm

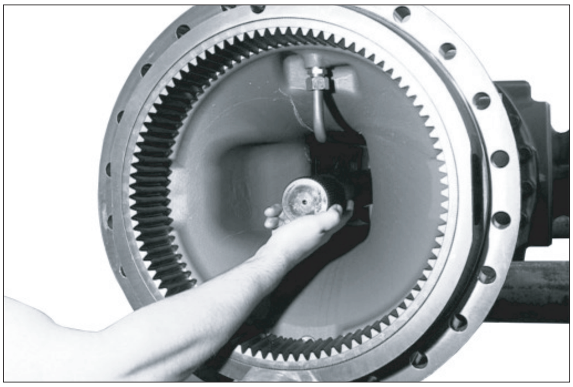
Gauge blocks	5870 200 066
Straightedge	5870 200 022



7809AX46

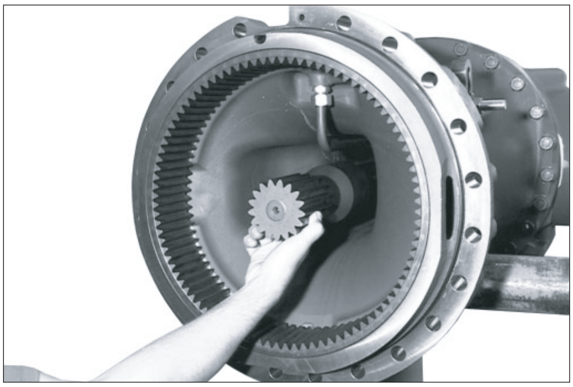
㉑ Insert stub shaft into the teeth of the axle bevel gear until contact is obtained.

※ Pay attention to the installation position; mount the stub shaft with the long teeth showing to the differential.



7809AX47

㉒ Insert the sun gear shaft until contact is obtained.



7809AX48

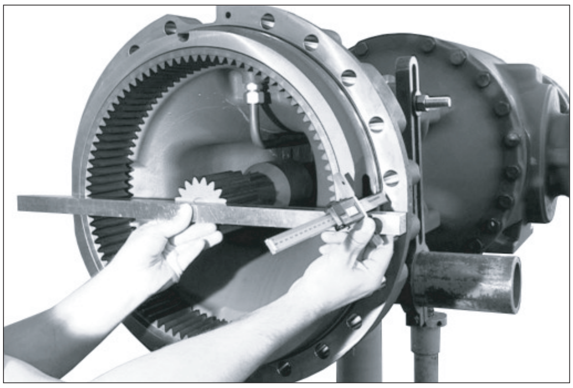
㉓ Measure dimension II, from the front face of the sun gear shaft to the mounting surface of the axle housing.

Dimension II e.g. . . . . 56.60 mm

Straightedge 5870 200 022

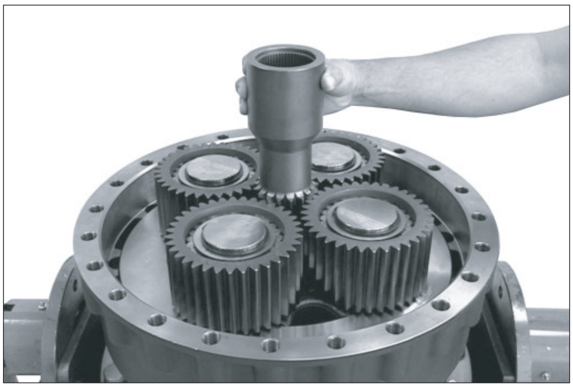
Calculation example :

Dimension I	58.60 mm
Dimension II	- 56.60 mm
Difference	2.00 mm
Required axial play e.g.	- 1.00 mm
Difference = shim e.g.	s = 1.00 mm



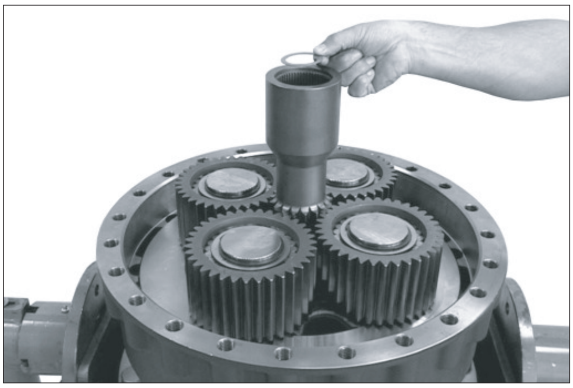
7809AX49

㉔ Insert sun gear shaft into the planetary carrier.



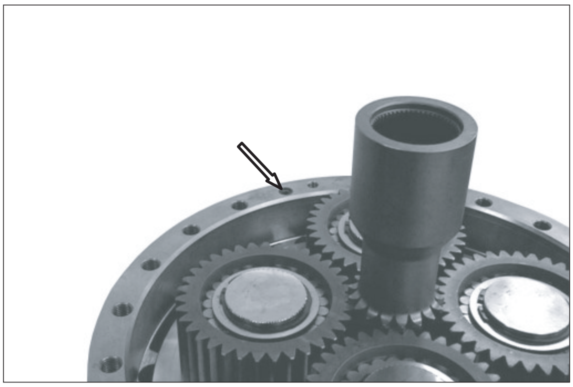
7809AX50

㉕ Fix determined shim e.g. s = 1.00 mm with grease into the sun gear shaft.



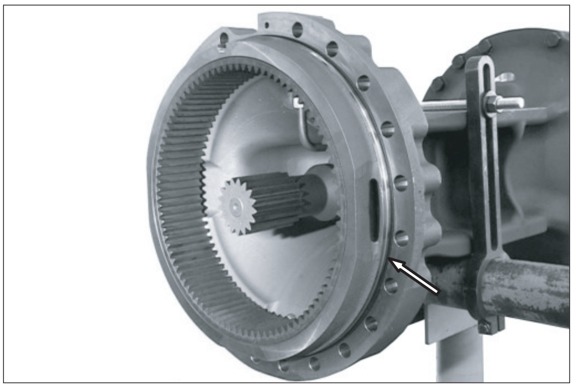
7809AX51

㉖ Fix O-ring (see arrow) with grease into the countersink of the brake housing.



7809AX52

㉗ Grease O-ring (see arrow) and install it to the axle housing.



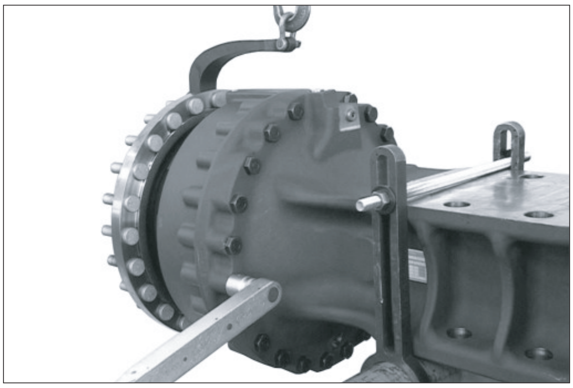
7809AX53

㉘ Mount two adjusting screws and use the lifting device to bring the output into contact position with the axle housing. Then fix the output by means of hexagon screws.

· Tightening torque (M20/10.9) ; 57.1 kgf · m (413 lbf · ft)

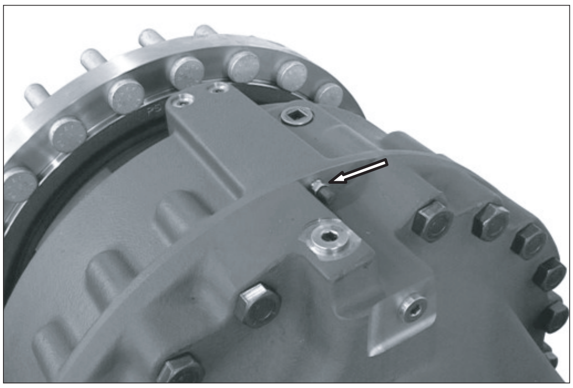
Adjusting screws (M20)	5870 204 024
Load-carrying device	AA00 685 875

※ Fix load carrying device with wheel stud.



7809AX54

㉙ Mount breather (see arrow).



7809AX55

㉚ Check brake hydraulics for leakages.

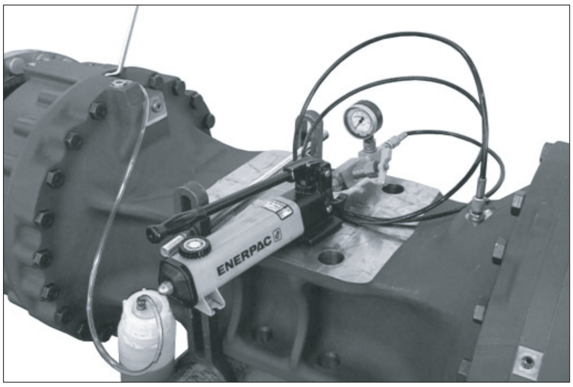
※ Before starting the test, completely breathe the brake hydraulics.
Then pressurize the brake temporarily (5EA) with p = 100 bar max.

High-pressure test :
Build up test pressure p = 100 $_{-10}$ bar max. and close connection to HP pump via shut-off valve.
A pressure drop of max. 2 % (2 bar) is permissible during a 5 minute testing time.

Low-pressure test :
Reduce test pressure p = 5 bar and close shut-off valve.
No pressure drop is allowed during a 5 minute testing time.

Test media :
Engine oils SAE 10-W

HP pump	5870 287 007
Clutch	0501 207 939
Reduction (M18x1.5)	5870 950 161
Oil collector bottle	5870 286 072


7809AX56

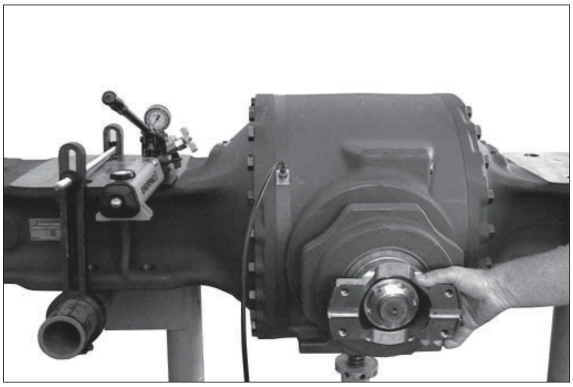
㉛ Check operability of differential hydraulic lock

Build up pressure p = 20 bar max. and close connection to HP pump via shut-off valve.

Lock on:
When rotating the input flange, both outputs must have the same direction of rotation.

Lock off:
When rotating the input flange one side holds or has the opposite direction of rotation.

※ Prior to putting the axle into operation, fill it with oil according to the related lubrication and maintenance instructions.


7809AX165

SECTION 4 BRAKE AND FAN SYSTEM

SECTION 4 BRAKE AND FAN SYSTEM

GROUP 1 STRUCTURE AND FUNCTION

1. OUTLINE

The variable displacement piston pump supplies the hydraulic oil that is required in order to operate the brake and the hydraulic fan system. Oil flows from pump to the cut-off valve.

The cut-off valve controls the flow of oil from the pump to the brake accumulators and also controls the flow of oil to the hydraulic fan motor.

The cut-off valve contains a priority valve. The brake system has priority. The oil flows to the brake accumulators while the accumulators are charged. After the accumulators are fully charged, the oil then flows to the hydraulic fan system.

The accumulator has pre-charged gas and an inlet check valve to maintain a pressurized volume of oil for reserving brake system.

The oil through the accumulator flows to the brake valves. The brake valve is a closed center design, dual circuit operated by a pedal.

The front and rear brakes will operate simultaneously with only one brake pedal depressed.

The hydraulic fan system is used to meet the cooling requirements. The hydraulic fan system controls the fan speed through the pump output pressure. The desired pressure level can be set by varying the solenoid current.

The hydraulic fan system contains directional valve that reverses the direction of fan.

The brake and hydraulic fan system contains the following components :

· Fan & brake pump
· Cut-off valve
· Brake valve
· Accumulators
· Pressure sensors and switch
· Fan motor
· Directional valve

FULL POWER HYDRAULIC BRAKE SYSTEM

ADVANTAGES - The full power hydraulic brake system has several advantages over traditional brake actuation systems. These systems are capable of supplying fluid to a range of very small and large volume service brakes with actuation that is faster than air brake systems. Figure represents a time comparison between a typical air/hydraulic and full power hydraulic brake actuation system.

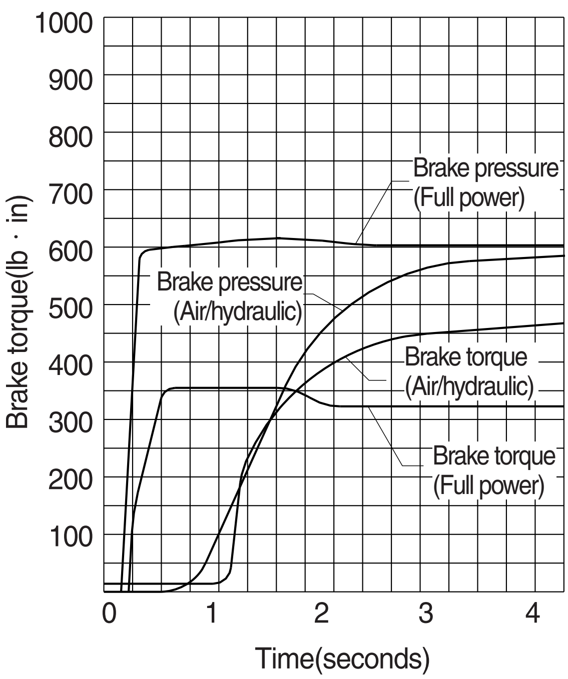
Full power systems can supply significantly higher brake pressures with relatively low reactive pedal forces. The reactive pedal force felt by the operator will be proportional to the brake line pressure being generated. This is referred to as brake pressure modulation.

Another key design feature of full power systems is the ability to control maximum brake line pressure. In addition, because these systems operate with hydraulic oil, filtration can be utilized to provide long component life and low maintenance operation.

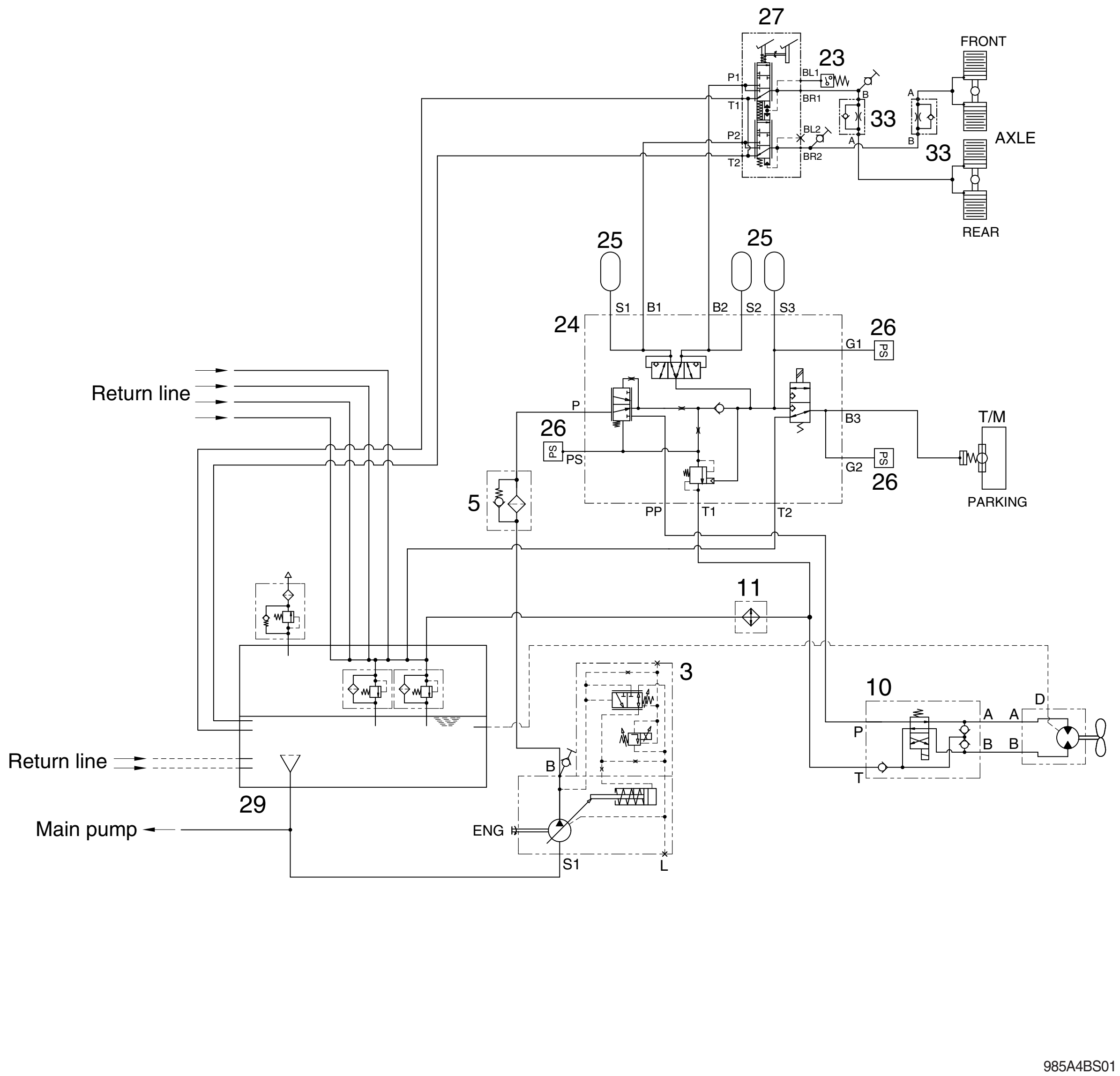
Because these systems are closed center, by using a properly sized accumulator, emergency power-off braking that is identical to power-on braking can be achieved. These systems can be either dedicated, where the brake system pump supplies only the demands of the brake system or non-dedicated, where the pump supplies the demands of the brake system as well as some secondary down stream hydraulic device.

Another important note is that all seals within these system must be compatible with the fluid medium being used.

Response time
Full power brake actuation VS
Air/Hydraulic brake actuation

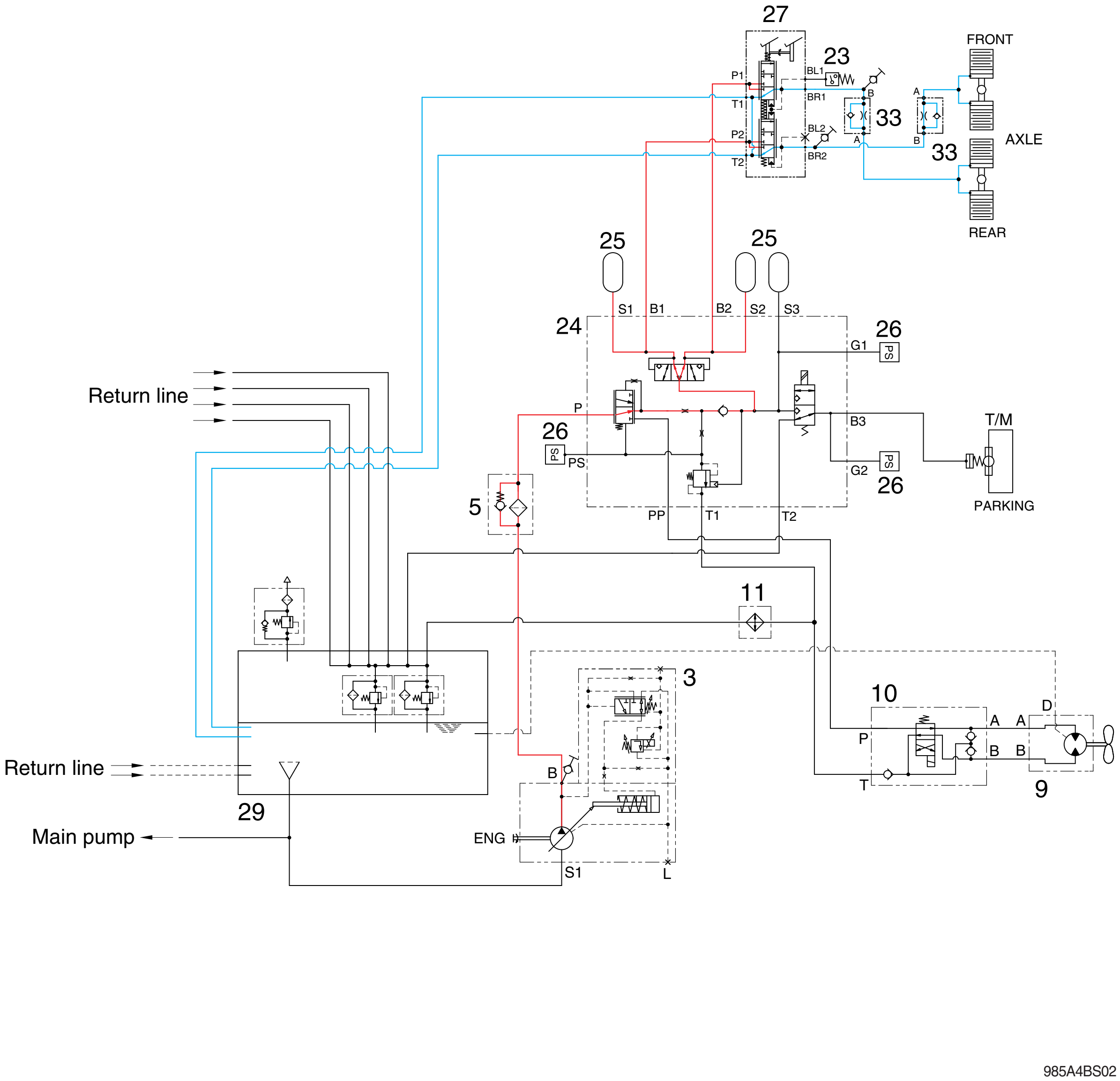


2. HYDRAULIC CIRCUIT



3	Fan & brake pump	23	Pressure switch	29	Hydraulic tank
5	Filter assembly	24	Cut-off valve	33	Orifice and check valve
9	Fan motor	25	Accumulator		
10	Directional valve	26	Pressure sensor		
11	Oil cooler	27	Brake valve		

1) SERVICE BRAKE RELEASED

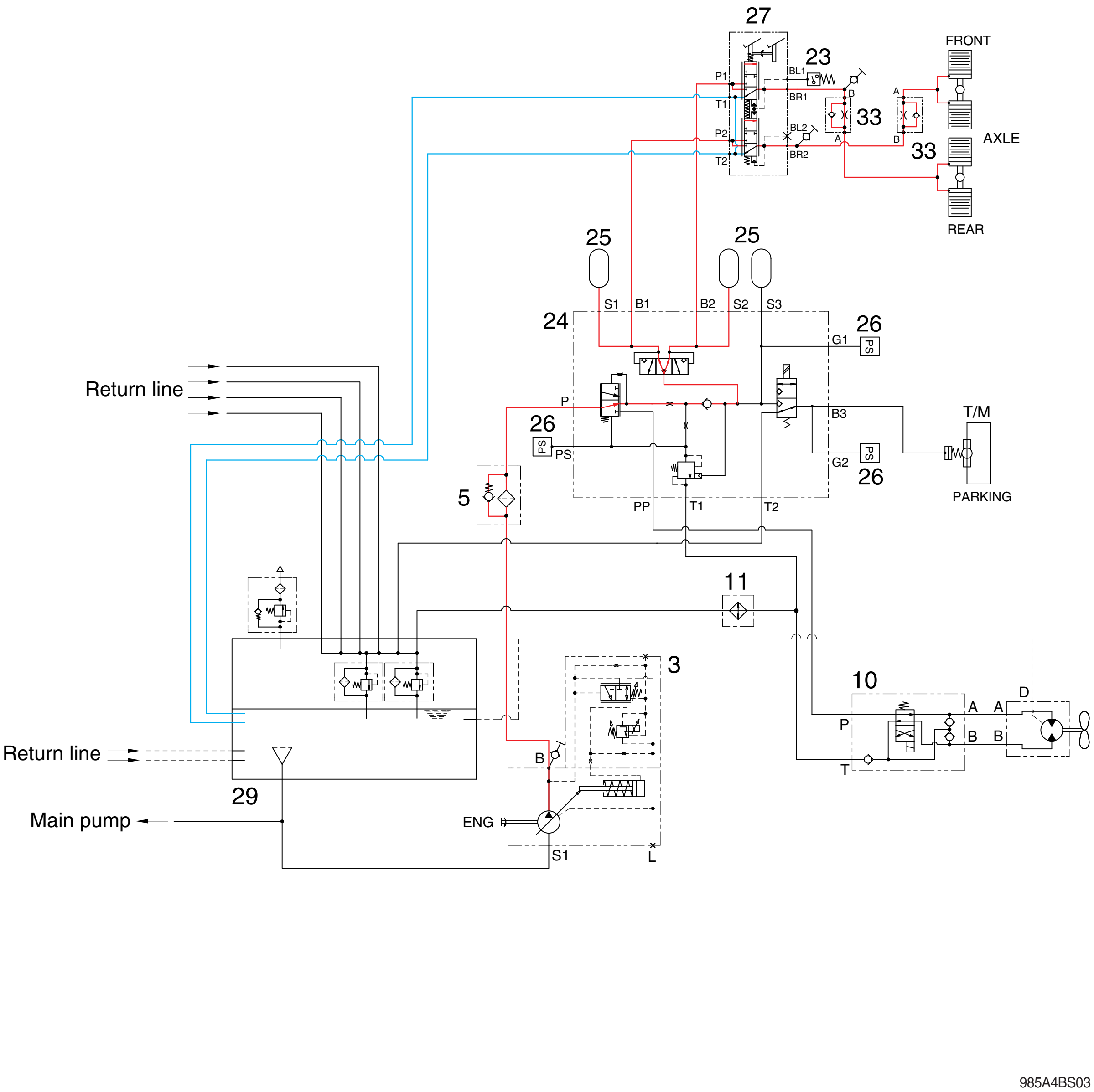


When the pedal of brake valve (27) is released, the operating force is eliminated by the force of the spring, and the spool is returned.

When the spool removes up, the drain port is opened and the hydraulic oil in the piston of axles return to the tank (29).

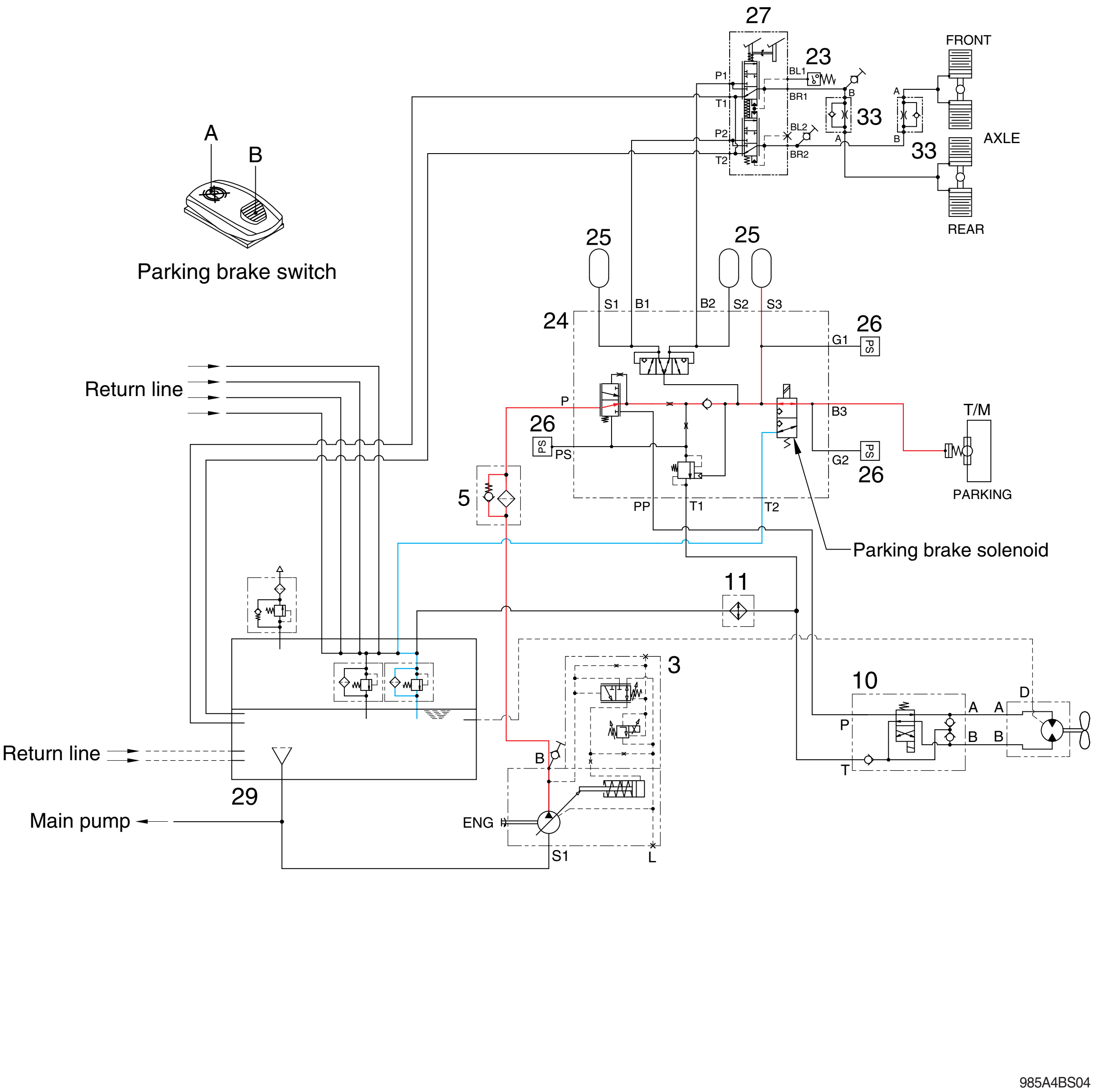
Therefore, the service brake is kept released.

2) SERVICE BRAKE OPERATED



When the pedal of brake valve (27) is depressed, the operating force overcomes the force of the spring, and is transmitted to the spool. When the spool moves down, the inlet port is opened, and at the same time the hydraulic oil controlled the pressure level by the cut-off valve (24) enters the piston in the front and rear axles. Therefore, the service brake is applied.

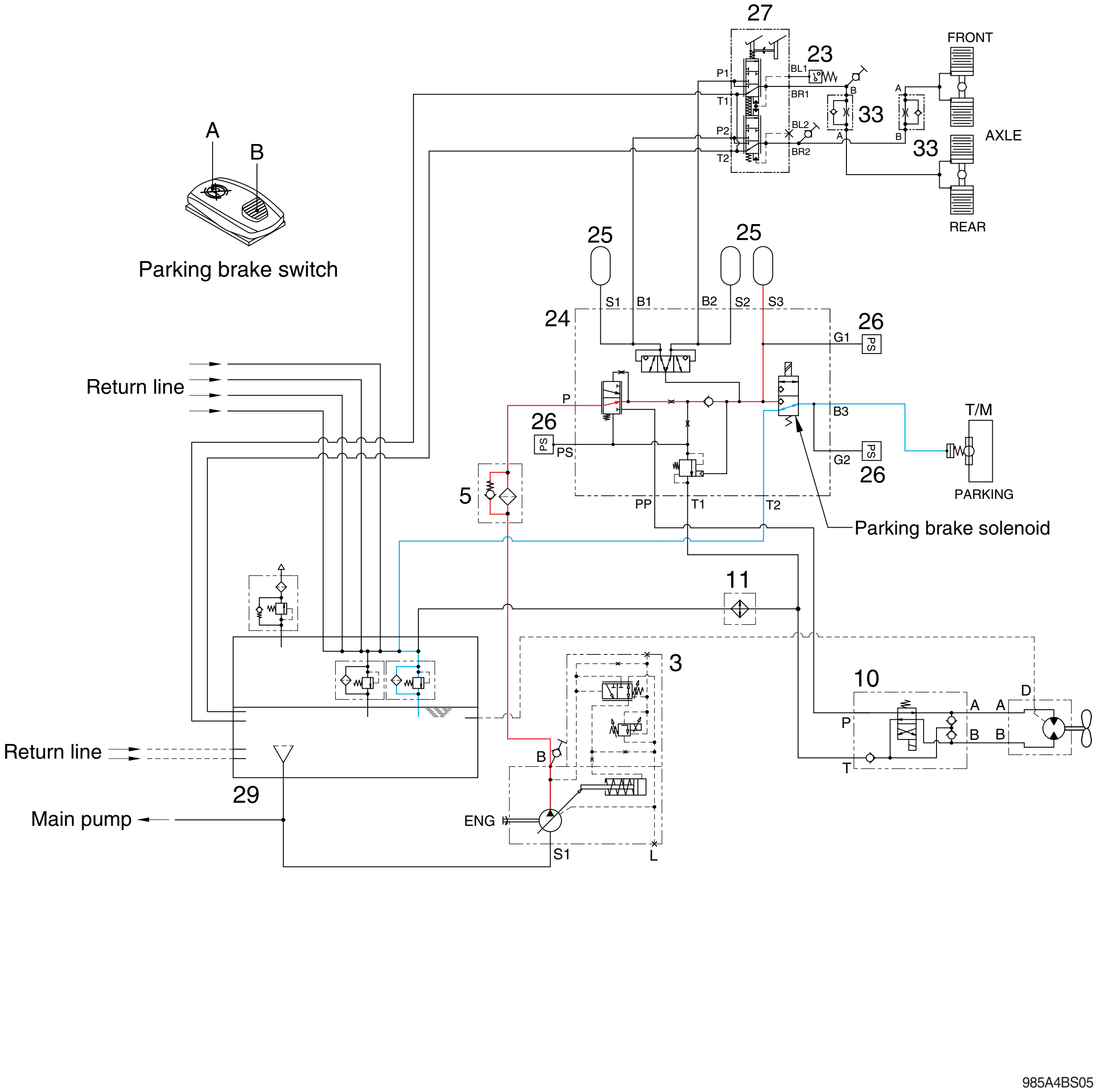
3) PARKING BRAKE RELEASED



When the parking brake switch is pressed A position, the solenoid valve is energized and the hydraulic oil controlled the pressure level by the cut-off valve enters the parking brake. It overcomes the force of the spring and pushes the piston rod. This releases the brake.

Therefore, the hydraulic oil pressure is applied to the parking brake piston through the solenoid valve and the parking brake is kept released.

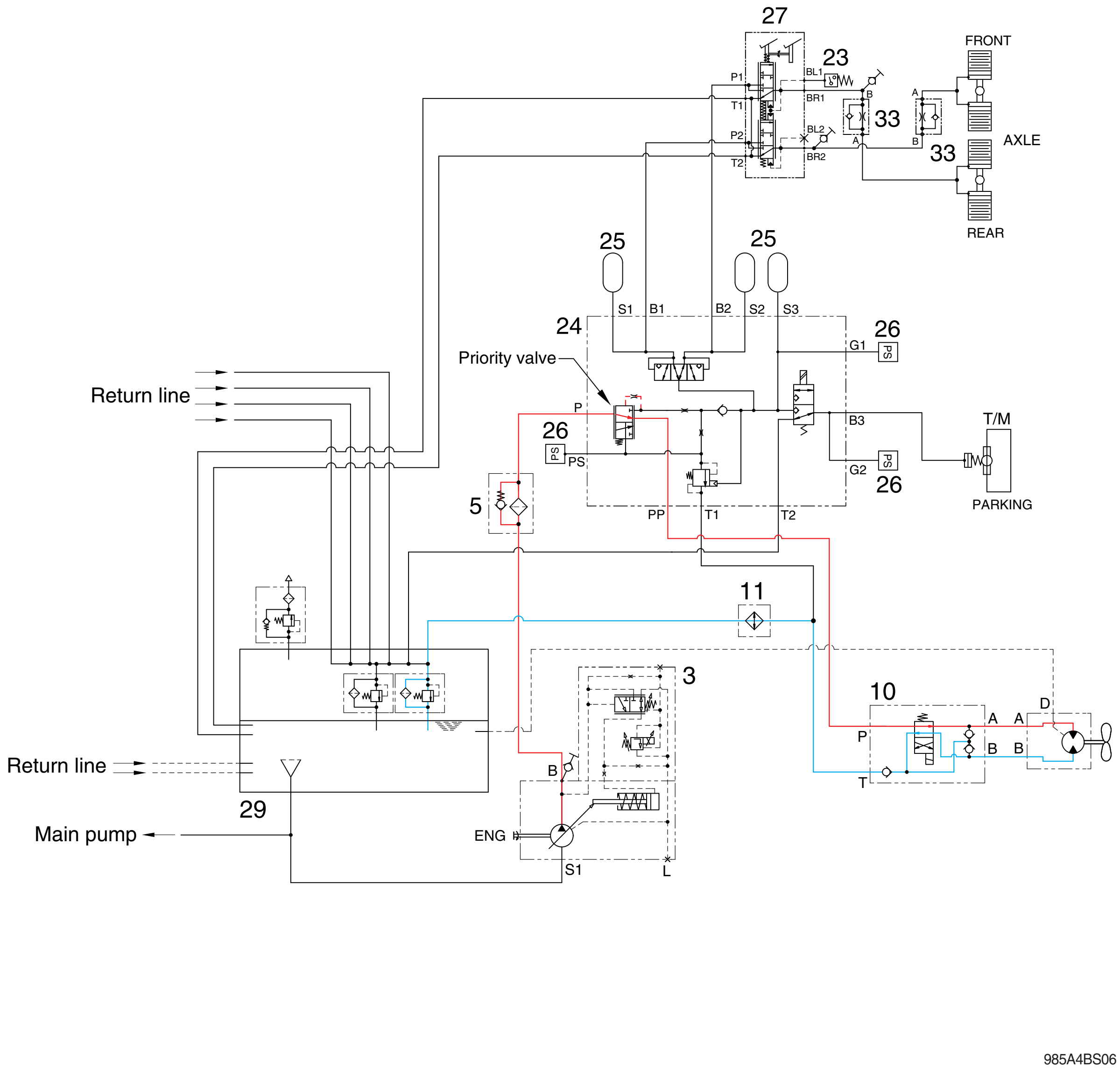
4) PARKING BRAKE OPERATED



When the parking brake switch is pressed B position, the solenoid valve is deenergized and the valve open the drain port.

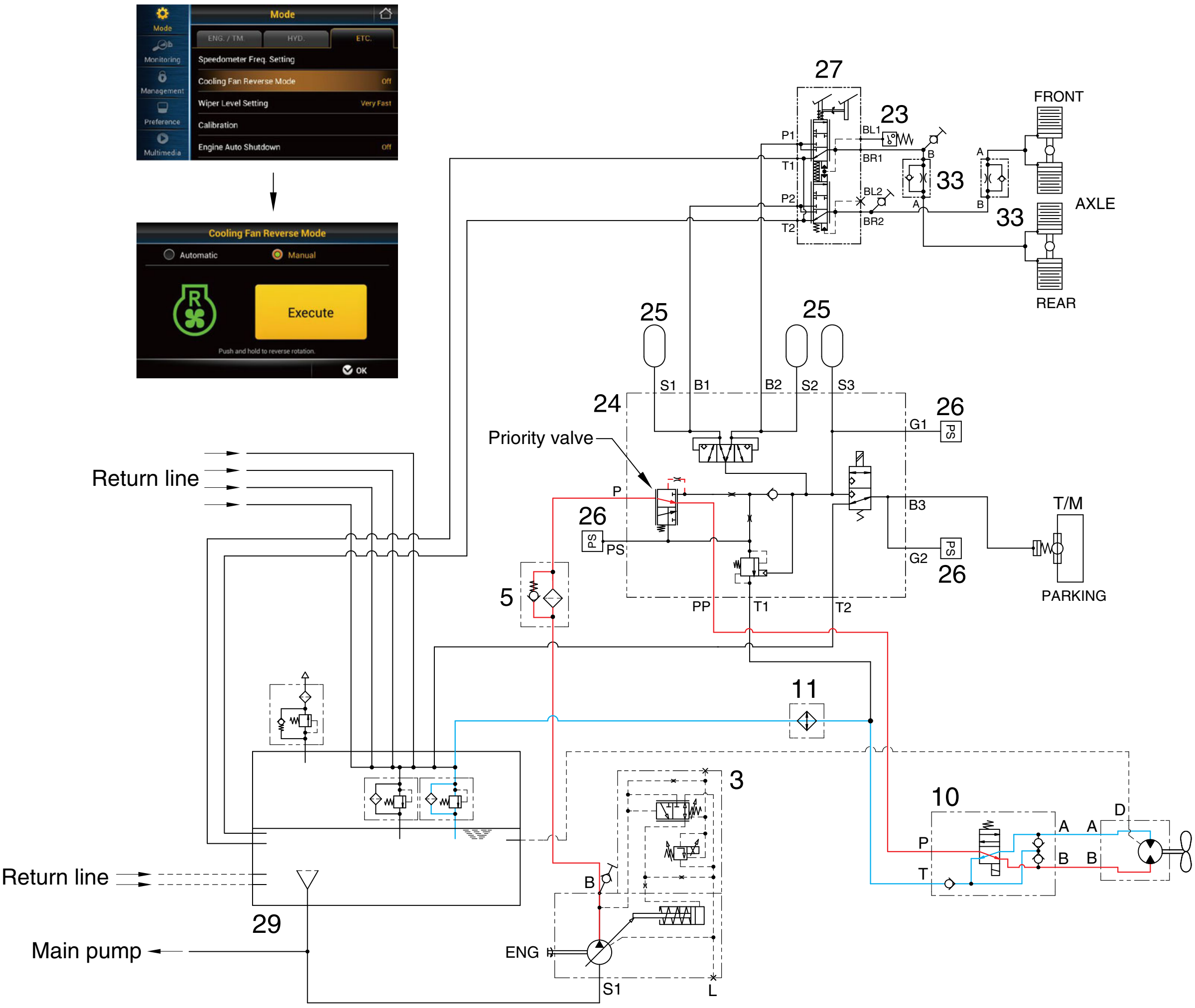
At the same time, the hydraulic oil in the parking brake return to the tank through the solenoid valve. When the piston rod is returned by the force of the spring, the parking brake is applied.

5) FAN MOTOR OPERATED



When the brake accumulators are fully charged, the priority valve switches position and the oil is directed to hydraulic fan motor through directional valve (10). The flow of the oil causes fan motor (9) to rotate the fan blade. The rotation of the fan forces cool air to flow through the cooler.

6) DIRECTIONAL VALVE OPERATED

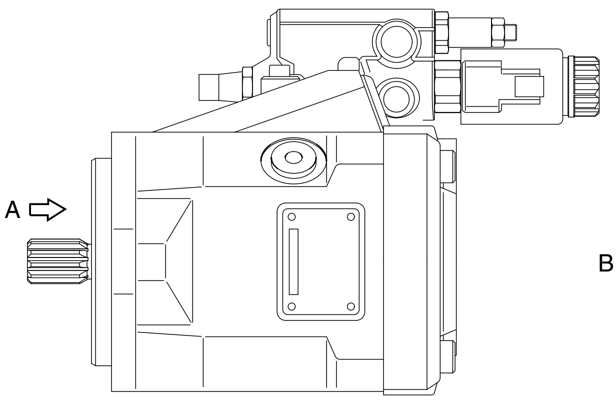


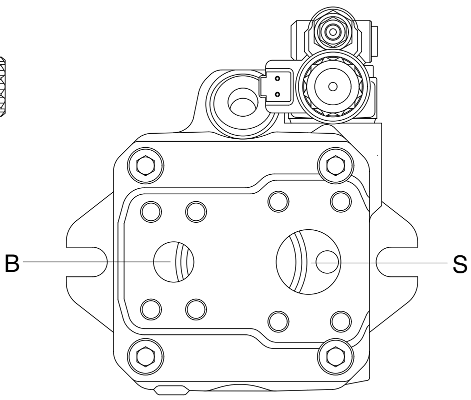
985A4BS07

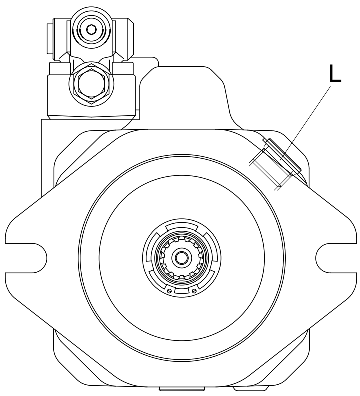
When the cooling fan reverse mode is selected manual or automatic mode, the solenoid valve in the directional valve (10) is energized and the flow of the oil is changed. The rotation of the fan is reversed to clear the radiators.

3. FAN AND BRAKE PUMP

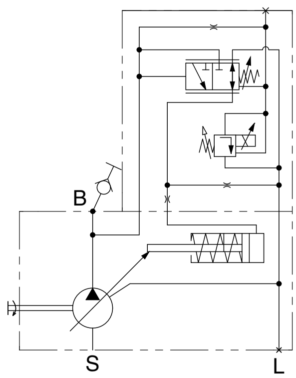
1) STRUCTURE







VIEW A

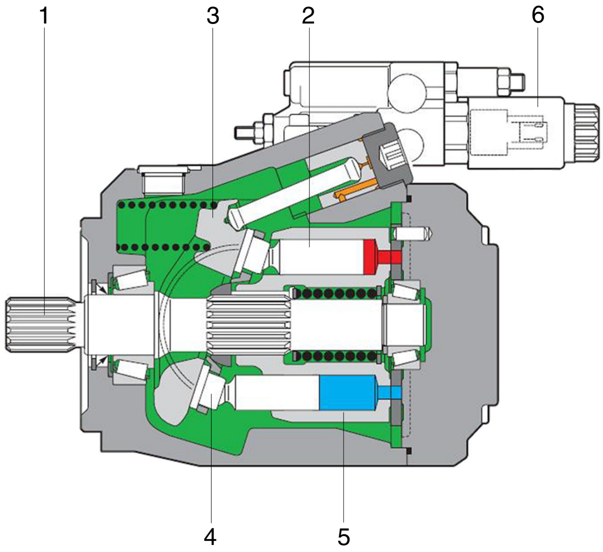


Hydraulic circuit

Port	Port name	Port size
B	Delivery port	SAE 3/4"
S	Suction port	SAE 1 1/4"
L	Drain port	3/4-16UNF-2B

7809A4BS30

2) OPERATION



7609A4BS31

The pump is a variable displacement piston pump. This pump has a maximum delivery pressure of 250 kgf/cm^2. The axial piston type pump is used to supply oil flow to the cut off valve. The oil is pressurized by the movement of rotary group in the pump.

When the engine is in operation, the drive shaft (1) is driven by the gears in the engine with rotary group. There are nine piston assemblies (2) in rotary group.
Each piston inside cylinder (5) is held against swashplate (3) by piston shoe (4). Swashplate can be any angle between the maximum angle and the neutral angle. The angle of swashplate determines the amount of oil that is pushed out of each cylinder.

The neutral angle is perpendicular with drive shaft (1). When swashplate(3) is at the neutral angle, pistons (2) do not move in and out of rotating cylinder. Therefore, no oil is drawn into the pump and no oil is pushed out of the pump. The pump has zero displacement and zero flow.

When swashplate (3) is at the maximum angle, pistons (2) move in and out of cylinder. The movement of the pistons allows the maximum amount of oil to be drawn into the cylinder. The pump will produce the maximum displacement.

The swashplate (3) angle is controlled by command current signal to control valve solenoid (6). The pump output pressure level can be set by the solenoid current. When the solenoid current signal drops toward a zero value, the pump output pressure level is the maximum.

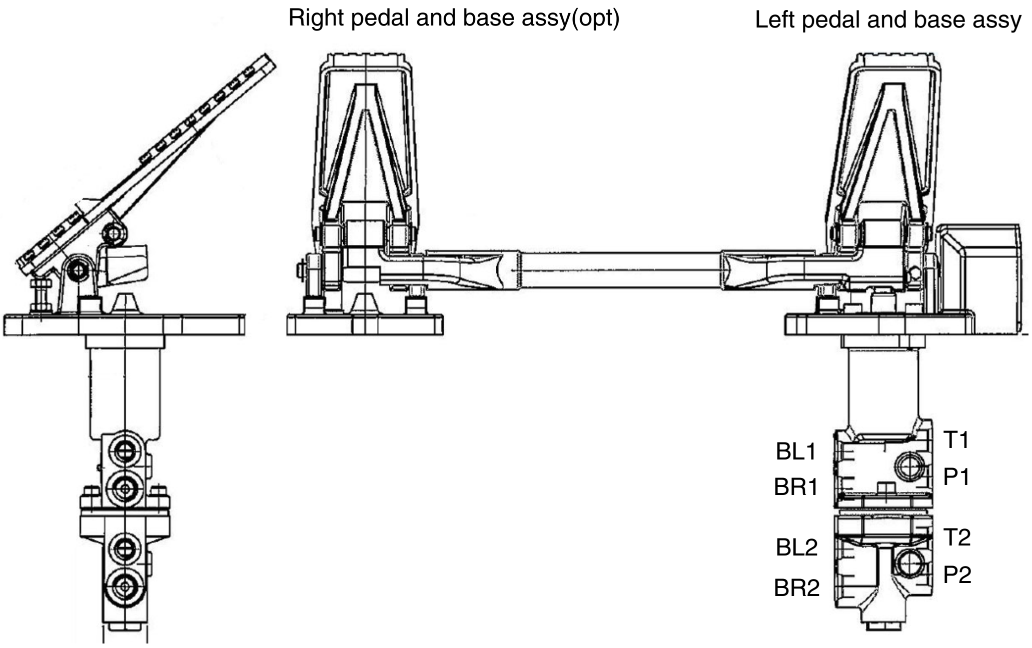
※ FAN SYSTEM OPERATION

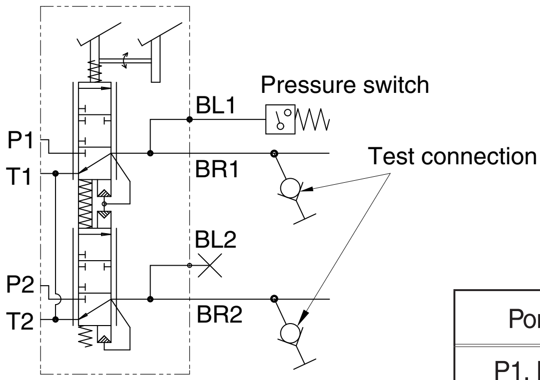
When the brake system pressure is below minimum pressure (125±5 bar), it has the high priority than the fan system. Pump flow to the fan motor is blocked while brake system is charged.
However, The fan system has controlled pump when the brake system pressure is charged.
The fan speed solenoid valve (6) controls the pressure (fan speed) of pump when the brake system is fully charged.
The fan speed solenoid valve (6) is a proportional solenoid. As current to the fan speed solenoid increases, pump output pressure decreased, therefore, the fan motor rotates slower.

When the current of the fan speed solenoid valve (6) is reduced, the output pressure is increased. The pump will be stroked and the pump will send maximum flow to the fan motor, thus, the fan motor is turning faster.

4. BRAKE VALVE

1) STRUCTURE





Hydraulic circuit

970A4BS08

Port	Port name	Port size
P1, P2	Pressure port	PF 3/8
T1, T2	Return port	PF 3/8
BR1, BR2	Brake cylinder port	PF 3/8
BL1, BL2	Pressure switch port	PF 1/4

· Brake pressure specification : 80±5 bar (1160±70 psi)

2) OPERATION

(1) Purpose

The purpose of the brake valve is to sensitively increase and decrease the braking pressure when the brake pedal is actuated.

(2) Ready position

When the braking system is ready for operation, its accumulator pressure acts directly on ports (P1, P2) of the brake valve. A connection is established between ports (BR1, BR2) and ports (T1, T2) so that the wheel brakes ports (BR1, BR2) are pressureless via the returns ports (T1, T2).

(3) Partial braking

When the brake valve is actuated, an amount of hydraulic pressure is output as a ratio of the foot force applied.

The spring assembly beneath base is designed in such a way that the braking pressure changes depending on the angle. In the lower braking pressure range, the machine can be slowed sensitively.

When the braking process is commenced, the upper spool is mechanically actuated via spring assembly, and the lower spool is actuated hydraulically by spool. As spools move downward, they will first close returns (T1, T2) via the control edges, thus establishing a connection between accumulator ports (P1, P2) and ports (BR1, BR2) for the wheel brake cylinders. The foot force applied now determines the output braking pressure. The control spools are held in the control position by the force applied (Spring assembly above the spools and the hydraulic pressure below the spool (Balance of forces).
After output of the braking pressure, spools are in a partial braking position, causing ports (P1, P2) and ports (T1, T2) to close and holding the pressure in ports (BR1, BR2).

(4) Full braking position

When pedal is fully actuated, end position of the brakes is reached and a connection established between accumulator ports (P1, P2) and brake cylinder ports (BR1, BR2). Returns (T1, T2) are closed at this point.

When the braking process is ended, a connection is once again established between brake cylinder ports (BR1, BR2) and return ports (T1, T2), closing accumulator ports (P1, P2).

The arrangement of spools in the valve ensures that even if one braking circuit fails the other remains fully operational. This is achieved by means of the mechanical actuation of both spools and requires slightly more pedal travel.

(5) Failure of a circuit

In the event of the lower circuit failing, the upper circuit will remain operational. Spring assembly will mechanically actuate spool.
In the event of the upper circuit failing, the lower circuit will remain operational since the lower spool is mechanically actuated by spring assembly and spool.

(6) Installation requirements

Return lines (T1, T2) must be connected directly to the tank.
The connecting lines must be installed is such a way as to permit proper bleeding.

(7) Maintenance of the brake valve

No special maintenance beyond the legal requirements is necessary.

When using high-pressure cleaners on the machine, please make sure that the water jet is not aimed directly at the brake valve (to prevent damaging the bellows).

△ **For safety reasons the whole of the brake valve must be replaced if parts other than those listed above are damaged.**

(8) Repair work

△ When working on the braking system, always make sure that there is absolutely no pressure in the system. Even when the engine is switched off there will be some residual pressure in the system.

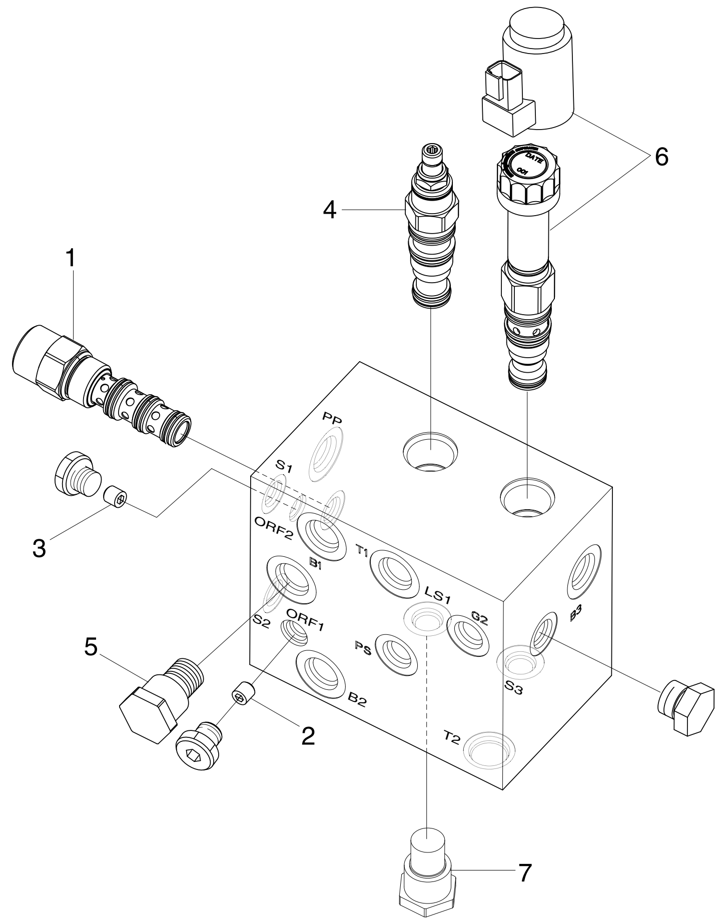
※ When doing repair work, make sure your environment is very clean.
Immediately close all open ports on the components and on pipes using plugs.

(9) Replacing the complete actuating mechanism

Carefully clamp the unit vertically in a fixture. The actuating mechanism can be removed by taking out the three bolts. Make sure that spring assembly does not fall out. When installing the new actuating mechanism, make sure that spring assembly is fitted in the right order.
Tighten the three bolts.

5. CUT-OFF VALVE

1) STRUCTURE



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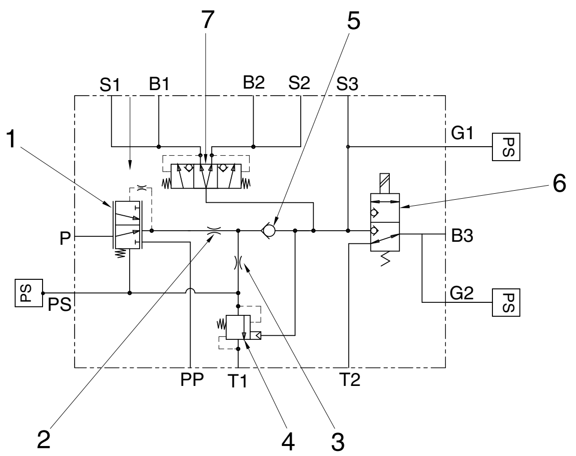


Hydraulic circuit

1 Priority valve
2 Orifice
3 Orifice
4 Pressure control valve
5 Check valve
6 Coil, Solenoid valve
7 Directional valve

2) OPERATION

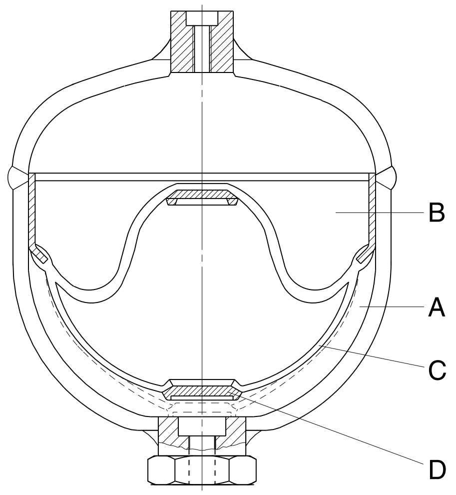
The pressure control valve (4) controls the minimum and maximum pressure of the braking system. When the service brake pressure is below the maximum pressure (125±5 bar), the pressure control valve (4) is blocked and PS pilot pressure (brake priority pressure) increases.

As soon as PS pilot pressure raises up above 15 bar, pump controller current is reduced by MCU (pressure sensor detects brake priority pressure, and pump supply flow and pressure in order to meet the brake system).

The pressure sensor at PS port detect whether brake system needs to be charged.
Priority valve spring and pilot pressure (brake priority pressure) pushed priority spool to the upward.
Therefore, full pump flow directly goes to the brake system in order to satisfy the demand of the brake system.
Pump flow goes through the following components : orifice (2), check valve (5), directional valve (7). Brake failure pressure sensor at G1 port detects pressure in the brake accumulators.
When the pressure is lower than 100 bar, the sensor activates warning lamp on the cluster in order to check brake system.
When brake system pressure reaches the maximum brake system pressure (150 bar±5 bar), pressure control valve (4) opens, pilot pressure (brake priority pressure) of priority valve is low by draining the spring side of priority valve (1) to hydraulic tank through valve (4).

6. BRAKE ACCUMULATOR

1) STRUCTURE



75794BS09

Item	31LL-40020 (item 25)
Diameter	167 mm
Mounting height	219 mm
Norminal volume	2.0 ℓ
Priming pressure	50 kgf/cm^2
Operating medium	Oil
Operating pressure	Max 210 kgf/cm^2
Thread	M22 × 1.5
Priming gas	Nitrogen

A Fluid portion
B Gas portion
C Diaphragm
D Valve disk

2) OPERATION

(1) Purpose

Fluids are practically incompressible and are thus incapable of accumulating pressure energy. In hydropneumatic accumulators, the compressibility of a gas is utilized to accumulate fluid. The compressible medium used in the accumulators is nitrogen.

In braking systems, the purpose of the accumulators is to store the energy supplied by the hydraulic pump. They are also used as an energy reserve when the pump is not working, as a compensator for any losses through leakage, and as oscillation dampers.

(2) Operation

The accumulator consists of a fluid portion (A) and a gas portion (B) with a diaphragm (C) as a gas-tight dividing element. The fluid portion (A) is connected to the hydraulic circuit, causing the diaphragm accumulator to be filled and the gas volume to be compressed as the pressure rises.

When the pressure falls, the compressed gas volume will expand, thus displacing the accumulated pressure fluid into the circuit.

The diaphragm bottom contains a valve disk (D) which, if the diaphragm accumulator is completely empty, closes the hydraulic outlet, thus preventing damage to the diaphragm.

(3) Installation requirements

The accumulators can be fitted in the hydraulic circuit, directly on a component or in blocks on suitable consoles.

They should be fitted in as cool a location as possible.

Installation can be in any position.

(4) Maintenance of the accumulator

No special maintenance beyond the legal requirements is necessary.

The accumulator should be checked annually. It should be replaced if the initial gas pressure has fallen by more than 30% (please refer to Performance testing and checking of the accumulator).

(5) Disposal of the accumulator

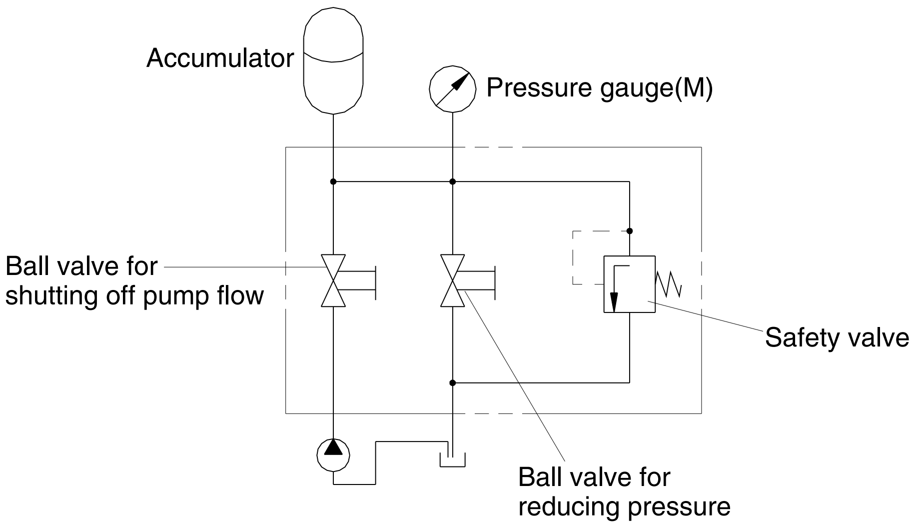
Before the accumulator is scrapped, its gas filling pressure must be reduced. For this purpose, drill a hole through gas chamber (B) using a drill approx. 3mm in diameter. The gas chamber is located on the side opposite the threaded port above the welding seam around the center of the accumulator.

※ Wear safety goggles when doing this job.

(6) Performance testing and checking of the accumulator

The accumulator is gradually pressurized via the test pump; until the initial gas pressure is reached, the hydraulic pressure in the accumulator will rise abruptly. This is apparent from gauge M. If the initial gas pressure is more than 30% below the prescribed value, the accumulator needs to be replaced. If the measuring process needs to be repeated, wait for intervals of 3 minutes between the individual tests. Any accumulator whose initial gas pressure is insufficient must be scrapped following the instructions under Disposal of the accumulator.

The amount of initial gas pressure can also be checked from the vehicle. Start the vehicle's engine. The pump will now supply oil to the accumulators. Until the initial gas pressure is reached, the hydraulic pressure in the accumulator will rise abruptly. This is apparent from the gauge in the cab. If the initial gas pressure is more than 30% below the prescribed value, that initial pressure lies outside the permissible range for at least one of the accumulators fitted in the vehicle. This accumulator can be traced only by using the method described above, i.e. all accumulators have to be individually tested. The accumulator whose initial gas pressure is insufficient must be replaced and scrapped following the instruction under Disposal of the accumulator.



(7) Repair work

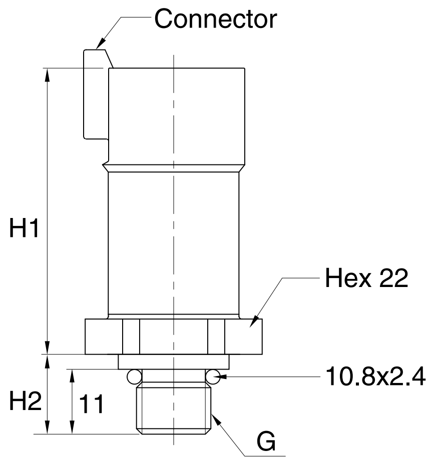
△ When working on the braking system, always make sure that there is absolutely no pressure in the system. Even when the engine in switched off there will be some residual pressure in the system.

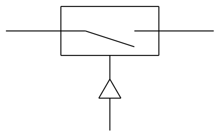
※ When doing repair work, make sure your environment is very clean.
Immediately close all open ports on the components and on pipes using plugs.

△ For safety reasons the accumulators need to be replaced as a whole if damaged.

7. PRESSURE SENSOR AND SWITCH

1) STRUCTURE





7609A4BS12

2) TECHNICAL DATA

Item	Type	Medium	G	H1 mm	H2 mm	Adjusting range kgf/cm^2	Actuating pressure kgf/cm^2	Voltage V
Parking pressure sensor	-	Oil	PF 1/4"	45	12.5	0 ~ 200	100 ± 5	Max 30
Charging pressure sensor	-	Oil	PF 1/4"	45	12.5	0 ~ 200	100 ± 5	Max 30
Brake priority pressure sensor	-	Oil	PF 1/4"	45	12.5	0 ~ 200	100 ± 5	Max 30
Brake stop pressure switch	NO	Oil	PF 1/4"	45	12.5	1 ~ 10	5 ± 1	Max 32

NO : Normally open

3) Tightening torque : 3.5 kgf · m (25.3 lbf · ft)

2) OPERATION

(1) Purpose

The pressure switches are used to visually or audibly warn the driver of the pressure within the system.

(2) Make contact / circuit closer

The pressure switch can be fitted in the braking system or directly on one of its components.

The system pressure acts on an absorption area within the switch, making an electrical contact as the pressure on that area is increased. The resulting current is used to activate a warning facility, for instance.

(3) Break contact / circuit breaker

The pressure switch can be fitted in the braking system or directly on one of its components.

The system pressure acts on a absorption area within the switch, breaking an electrical contact as the pressure on that area is increased. The current is now broken, e.g. to deactivate a warning facility.

(4) Installation requirements

No special measures need to be taken.

(5) Maintenance of the pressure switch

No special maintenance beyond the legal requirements is necessary.

When using high-pressure cleaners on the vehicle, please make sure that the water jet is not directed at the pressure switch (corrosion of contacts).

(6) Repair work

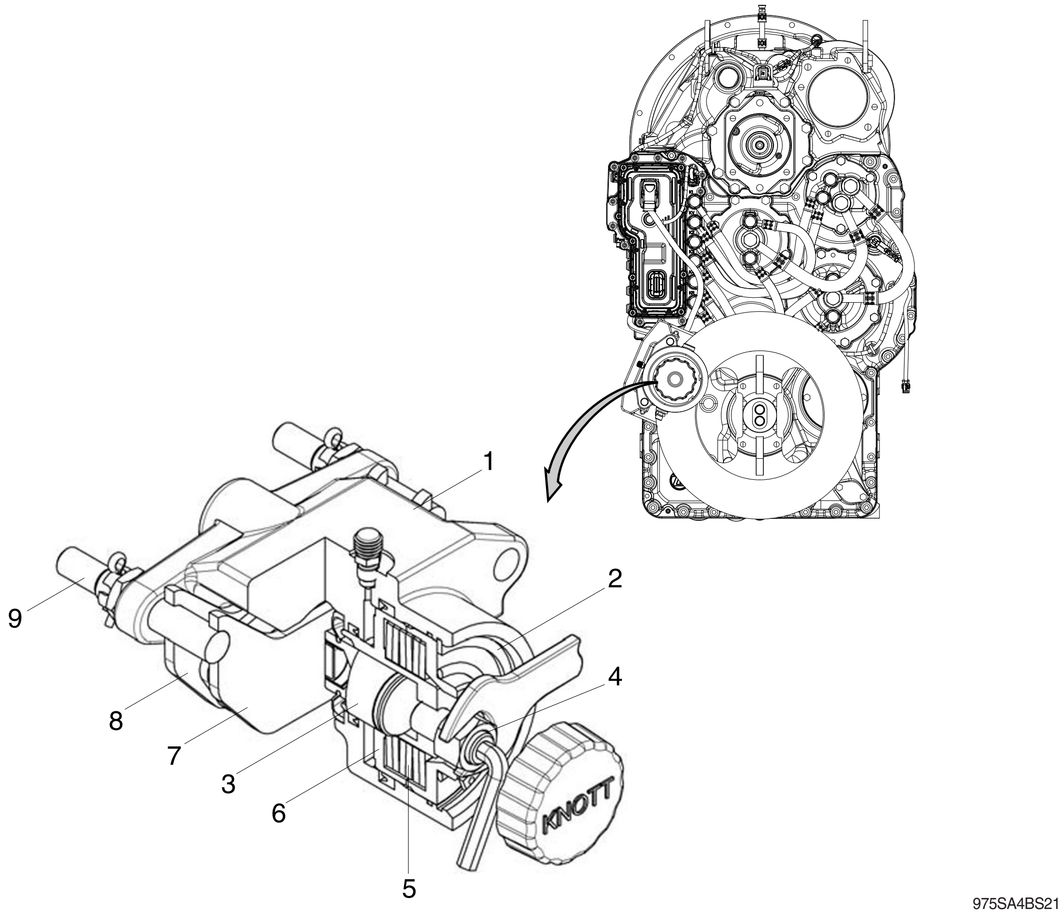
△ When working on the braking system, always make sure that there is absolutely no pressure in the system. Even when the engine is switched off there will be some residual pressure in the system.

※ When doing repair work, make sure your environment is very clean.
Immediately close all open ports on the components and on pipes using plugs.

※ For safety reasons the pressure switch needs to be replaced as a whole if damaged.

8. PARKING BRAKE SYSTEM

1) STRUCTURE



1	Housing	4	Adjust screw	7	Lining pad
2	Pressure ring	5	Bank of cup springs	8	Lining pad
3	Thrust bolt	6	Piston	9	Gliding bolt

2) OPERATION

The two identical brake pads and slide freely on the guide bolt, which is fastened in the housing. The guide bolts are guided in an additional brake anchor plate which in turn is screwed onto the vehicle, i.e. its axle.

On actuation, the brake generates a clamping force at the brake lining pads, which cause a tangential force/braking moment to be generated at the brake disk, the extent of which depends on the coefficients of friction generated by the linings.

The clamping force is generated by the bank of cup springs, during which the piston is moved together with the adjusting screw, the thrust bolt and the brake pad towards the brake disk.

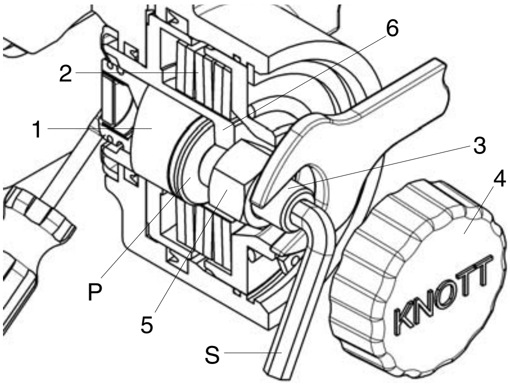
When the brake pad comes into contact with the brake disk, the reaction force shifts the housing onto the guide bolts until the brake pad is also pressed against the brake disk.

The brake is released by complete pre-tensioning of the bank of cup springs. During this process, through application of the necessary release pressure after overcoming the cup spring force, the piston must move back until it comes to rest against the pressure ring.

The clamping force diminishes with wear of the brake lining and brake disk. The brake must be adjusted at the latest at the times indicated by the adjusting specification followings.

3) MOUNTING AND BASIC SETTING REGULATIONS

Basic brake setting is required after mounting new brake lining plates or brake disks, as well as during all repair stages and in the event of insufficient braking performance.



100D7BS112

1	Thrust bolt	4	Screw cap	P	Even surface
2	Bank of cup springs	5	Lock nut	S	Socket wrench
3	Adjusting screw	6	Piston		

※ All mounting and basic setting work must be carried out on the brake when cold.

(1) Mounting the brake

① Stand the vehicle on an even surface and secure against rolling away.

② Release the screw cap.

③ Release the lock nut (size 24 or 30) and turn the adjusting screw anticlockwise using a size 8 or 10 socket wrench until the pressure bolt comes to rest against the even surface of the piston. In this status, the brake can be mounted onto the brake disk and fastened.

④ Mount the pressure connection again.
Apply the necessary release pressure to the brake until the bank of cup springs is completely pre-tensioned. Following carry out the following page basic setting regulation.

(2) Basic setting regulation

① Turn the adjusting screw manually clockwise until both brake pads make contact with the brake disk. Then it is not longer possible to turn the adjusting screw without exerting a major amount of force.

② Turn the adjusting screw anticlockwise in order to set the following rated clearances.

Adjusting screw	Clearance (mm)		Turns
M20 (SW 10)	Min.	1.0	2/5
	Clearance	2.0	4/5
	Max.	3.0	1 1/5

③ Hold the adjusting screw in position with a hexagonal socket wrench and lock with lock nut.

④ Mount the screw cap and tighten as far as possible manually.

⑤ Mount the pressure connection in accordance with the instructions of the axle.

※ For bleeding the piston chamber use the socket spanner size 13 for the bleeding valve.

(3) Adjusting regulations

During this adjusting process, the parking brake must be released, i.e. the bank of cup springs must be completely pre-tensioned.

① Stand the vehicle on an even surface and secure against rolling away.

② Release the parking brake by using the required release pressure.

③ Release the screw cap and unscrew.

④ Release the lock nut (size 24 or 30) and turn the adjusting screw with socket wrench size 8 or 10 manually clockwise until the two brake pads make contact with the brake disk.

⑤ Turn the adjusting screw anti-clockwise and set the clearance specified in the above table.

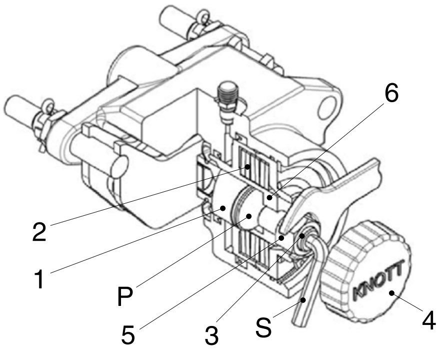
⑥ Hold the adjusting screw in position with the hexagonal socket wrench and lock with the lock nut.

⑦ Mount the screw cap and tighten as far as possible manually.

※ Actuate the brake valve several times and check the braking efficiency of the parking brake on a slope.

4) EMERGENCY RELEASE OF THE PARKING BRAKE

After the failure of the pressure release the parking brake by using following manual procedure.



100D7BS117

1	Thrust bolt	4	Screw cap	P	Even surface
2	Bank of cup springs	5	Lock nut	S	Socket wrench
3	Adjusting screw	6	Piston		

(1) The vehicle has to be secured against rolling away.

(2) Release the screw cap and unscrew

(3) Release the lock nut (size 24 or 30) and turn the adjusting screw with socket wrench size 8 or 10 manually counter-clockwise until the brake disc is free.

⚠ **For the emergency release is an actuation torque of 40Nm respectively 70Nm required.**

(4) Mount the lock nut and the screw cap and tighten both as far as possible manually. (protection against dirt)

⚠ **Now, the vehicle do not have any brake function. The vehicle must be secured against moving away with proper means. Before putting the vehicle into operation again, the brake has to be adjusted again. Refer to previous page. "Assembly and basic setting regulations".**

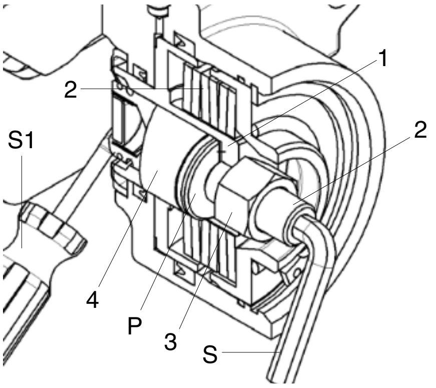
5) MAINTENANCE AND REPAIR WORK

(1) Maintenance and exchange of brake pads

The brake pads themselves are maintenance free. All that is required here is a check for damaged parts, as well as inspection to ensure that the brake disk remains easy running.

The thickness of the brake lining must be subjected to a visual inspection at regular intervals, which depend on vehicle usage, but every six months at the latest. In the event of a minimal residual lining thickness, these intervals must be reduced accordingly in order to avoid major damage to the brake or disk.

Min. residual thickness 2.0 ㎜ per lining pad (8 ㎜ carrier plate thickness).

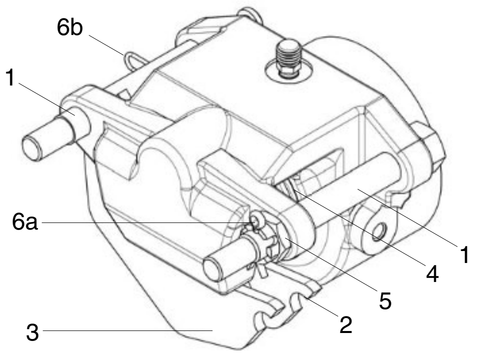


100D7BS113

1	Piston	S	Socket wrench
2	Adjusting screw	S1	Screwdriver
3	Lock nut	P	Inside of the piston
4	Thrust bolt		

※ Only original spare lining plates may be used. If any other spare parts are used, no warranty claims will be accepted either for the brakes or their functional characteristics.

① Stand the vehicle on an even surface and secure against rolling away.
② Release the parking brake by applying the required release pressure.
③ Release the screw cap and unscrew.
④ Release the lock nut (size 24 or 30) and turn the adjusting screw with socket wrench size 8 or 10 manually clockwise until it lies flush with the inside of the piston.
⑤ Press back the thrust bolt using a suitable screwdriver until it has contact with the piston.



100D7BS114

1	Guide bolt	5	Castellated nut
2	Lining pad	6a	Safety splint
3	Lining pad	6b	Safety clip
4	Permanent magnet		

⑥ Depending on the free space available, release one of the two guide bolts, removing the safety splint, unscrewing the castellated nut and pulling the guide bolt out of the brake anchor plate. Now, the brake lining pads can be removed tangentially to the brake disk.

※ In the event of minimal clearance, i.e. it is not possible for space reasons to exchange the brake lining plate in accordance with these instructions, the brake must be removed completely. To do this, pull both guide bolts out of the brake anchor plate.

▲ **Check the pressure hose. If the pressure hose is to short, it must be unscrewed to remove the brake. Before the pressure hose can be released the brake must be emergency released.**

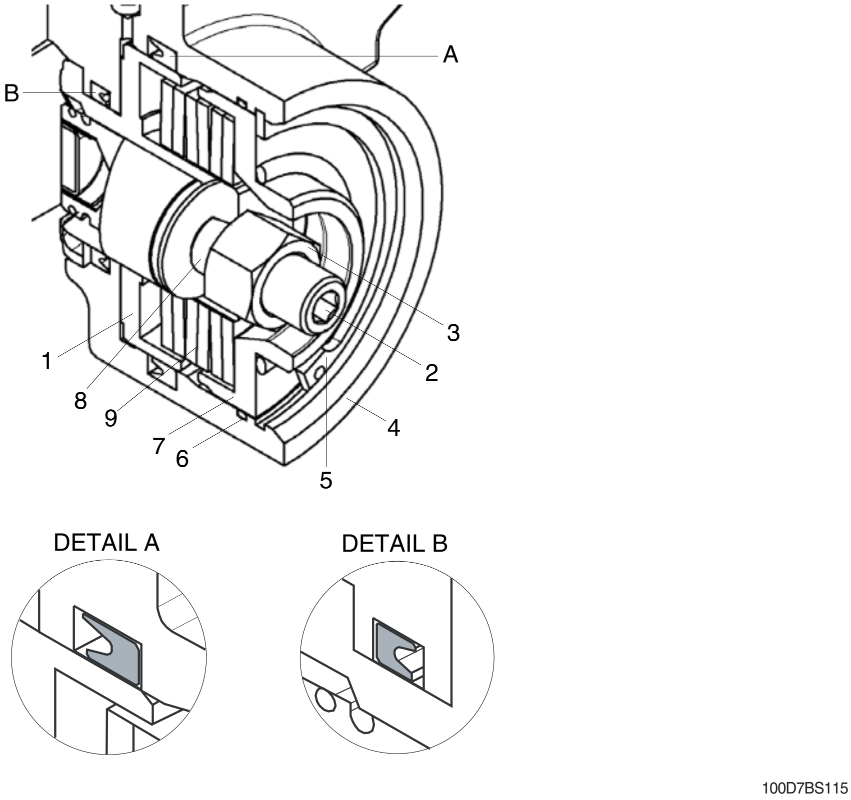
⑦ Exchange the brake pads and insert the guide bolts into the brake anchor plate. If you have removed the complete brake you have to amount the brake on both guide bolt again, now.

⑧ Check both permanent magnets if they still have sufficient magnetic force to hold the brake lining plates. Should this not be the case, the permanent magnets must also be changed by using a suitable screw driver.

⑨ Secure the guide bolt with the castellated nut and the safety splint respective safety clip.

▲ **After mounting new brake lining plates or their repair, the brake must be correctly set in accordance with the instructions "Adjusting regulations".**

(2) Changing the seal



1	Piston	5	Circlip	9	Bank of cup spring
2	Adjusting screw	6	Seal	A	Detail of the seal
3	Lock nut	7	Guide bolt	B	Detail of the seal
4	Housing	8	Thrust bolt		

※ Faulty seals must be exchanged in accordance with the instructions below.

① Stand the vehicle on an even surface and secure against rolling away.
② Release the parking brake by applying the necessary release pressure.
③ Release the screw cap and unscrew.
④ Release the lock nut (size 24 or 30) and turn the adjusting screw with socket wrench size 8 or 10 manually counter clockwise until the adjuster screw is flush with the inner side of the piston.
⑤ Push back the thrust bolt until it has contact with the piston. Following actuate the hand brake valve (no pressure must be in the piston chamber). The bank of cup springs is now completely depressurized.
⑥ Unscrew the pressure hose and remove the brake.
⑦ Release the circlip and remove the pressure ring of the housing.
⑧ Release the bank of cup spings and the piston.

⚠ Pay attention to the mounting direction of the seal rings, otherwise leaks can occur.

⚠ Use for mounting the new seal rings a suitable mounting needle with rounded edge.
Be careful.

⑨ Change all seals and mount the parts of the brake in other way round order. By mounting the piston, the sliding and sealing surfaces must be greased lightly using lubricating grease to DIN 51825. The dust protection cap is fitted with a vulcanized-in steel ring which is used to press it through the locating hole. For exchanging, "lever out" the ring using a suitable tool. The new dust protection cap must be pressed in with the aid of a suitable mounting ring and screw clamps or a lever press.

(2) General

Any discovered defects or damage to parts not listed here must naturally be repaired or replaced using original parts.

For any other information not contained in these instructions or for more detailed instructions, please contact HD Hyundai Construction Equipment dealer.

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

1. OPERATIONAL CHECKS

This procedure is designed so the mechanic can make a quick check of the system using a minimum amount of diagnostic equipment. If you need additional information, read **structure and function**, Group 1.
A location will be required which is level and has adequate space to complete the checks.

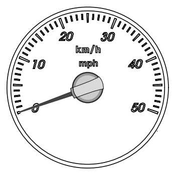
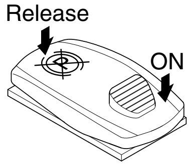
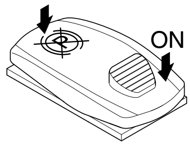
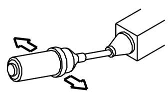
The engine and all other major components must be at operating temperature for some checks.

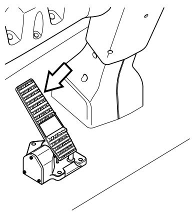
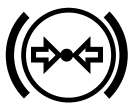
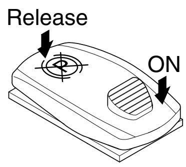
Locate system check in the left column and read completely, following the sequence from left to right. Read each check completely before performing.

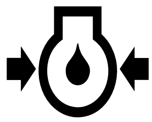
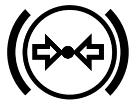
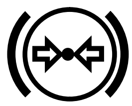
At the end of each check, if no problem is found (OK), that check is complete or an additional check is needed. If problem is indicated (NOT OK), you will be given repair required and group location.
If verification is needed, you will be given next best source of information:

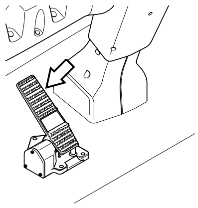
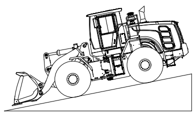
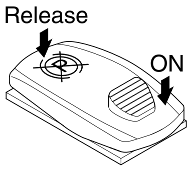
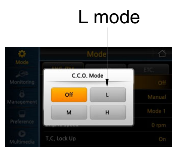
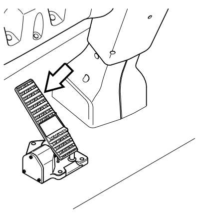
Chapter 2 : Troubleshooting
Group 3 : Tests and adjustments

※Hydraulic oil must be at operating temperature for these checks (refer to page 6-40).

Item	Description		Service action
Parking brake capacity check Seat belt must be worn while doing this check to prevent possible injury when machine stops suddenly.	  	Start engine. Fasten seat belt. Release parking brake and put transmission in 2nd gear forward. Drive machine at 8 km/hr and switch parking brake ON. **LOOK/FEEL** : Machine must come to a stop within 2 meters (6 feet) when parking brake is engaged at 8 km/hr. Transmission must shift to neutral.	**OK** Check completed. **NOT OK** Inspect parking brake. Go to group 3.
Parking brake transmission lockout check Engine running.	 	Turn parking brake to ON. Place transmission in 1st forward. Slowly increase engine speed to high idle. **LOOK** : Machine must not move.	**OK** Check completed. **NOT OK** Go to transmission control circuit in section 3.

Item	Description	Service action
Service brake pump flow check ※ Hydraulic oil must be at operating temperature for the check. Engine OFF.	  Stop engine. Operate brake pedal approximately 20 times. Start engine and run at low idle. Record number of seconds required for low brake pressure indicator lamp to go out. **LOOK** : Indicator lamp must go out in less than 4 seconds from time engine starts. **NOTE** : Indicator will not come on approximately 1 second after starting engine.	**OK** Check completed. **NOT OK** Check for brake circuit leakage. Go to next page. **IF OK** Install a cap on line connected to inlet of brake valve and repeat pump flow check. If time does not decrease, check for worn brake pump.
Service brake capacity check Engine running.	  Select clutch cut-off mode to OFF. Apply service brakes, release park brake and put transmission in 2nd forward. Increase engine speed to high idle. **LOOK** : Machine may not move or move at a very slow speed. Repeat check three times to ensure accurate results.	**OK** Check completed. **NOT OK** Check brake pressure. **IF OK** Inspect brake disk.

Item	Description	Service action
Brake accumulator precharge check ※The axles and hydraulic oil must be at operating temperature for this check.	  Start and run engine for 30 seconds. Stop engine and turn start switch to ON and wait 5 seconds. **NOTE** : Engine oil pressure lamp will be on due to no engine oil pressure. Count the number of times the brake pedal can be fully depressed before the low brake pressure warning lamp comes ON. **LOOK** : Warning lamp should not come ON in 1~5 applications. Start engine and operate at low idle. Observe cluster while applying brake pedal with maximum force. **LOOK/LISTEN** : Brake pressure indicator must not come ON.	**OK** Check completed. **NOT OK** Make sure brake pedal is not binding and keeping brakes partially engaged. Bleed brakes in group 3. Check brake system pressure. **NOT OK** If light comes ON with engine running, accumulator has lost it's charge. Inspect and recharge accumulator.
Brake system leakage check	 Start engine and wait 30 seconds. Stop engine. Wait 2 minutes. Turn start switch to ON and wait 5 seconds. **LOOK** : Brake oil pressure warning lamp must not come ON within 2 minutes after stopping engine.	**OK** Check completed. **NOT OK** If brake leakage is indicated with brakes released, check leakage at accumulator inlet check valve and brake valve. If brake leakage is indicated with brakes applied, check for leakage at brake valve and brake pistons. Check individual component leakage.

Item		Description	Service action
Service brake pedal check		Slowly depress brake pedal. Listen for a hissing noise that indicates oil is flowing to brake pistons. LISTEN/FEEL : A hissing noise must be heard when pedal is depressed.	**OK** Check completed. **NOT OK** Inspect for debris under brake pedal.
Service and parking brake system drag checks Engine running	 	Position machine on gradual slope. Lower bucket approximately 50 mm (2 in) from ground. Release parking and service brakes. LOOK : Machine must move or coast. NOTE : If machine does not move, check brake pedals to be sure they fully release when feet are removed from pedals. Drive machine at high speed for about 5 minutes. Brake drag is indicated if brake areas in differential case are hot. NOTE : Observe parking brake. If disk is hot, parking brake drag is indicated.	**OK** Check completed. **NOT OK** Adjust park brake. **NOT OK** Check floor mat interference to pedal or debris build-up. **IF OK** Check for brake pressure when brake is released. Go to brake pressure test.
Clutch cut-off check	 	Select clutch cut-off mode to L mode. Release parking brake. Run engine at half speed in 1st forward. Firmly depress brake pedal. FEEL : Transmission must disengage when brake pedal is depressed at 30% of pedal stroke. NOTE : Clutch cut-off mode can be selected to operator preference to match your loading needs.	**OK** Check completed. **NOT OK** Adjust clutch cut-off mode.

2. TROUBLESHOOTING

1) SERVICE BRAKE

Diagnose malfunction charts are arranged from most probable and simplest to verify, to least likely, more difficult to verify. Remember the following steps when troubleshooting a problem :

Step 1. Operational check out procedure (see section 1)
Step 2. Operational checks (in this group)
Step 3. Troubleshooting
Step 4. Tests and adjustments (see group 3)

Problem	Cause	Remedy
Poor or no brakes	Brake accumulator charge low.	Do brake accumulator check.
	Brake pump standby pressure low.	Do brake pump standby pressure test.
	Brake pressure low.	Do brake valve pressure test.
	Air in system.	Bleed brakes.
	Worn brake surface material.	Inspect brake surface material.
	Leakage in brake valve.	Do brake valve leakage test.
	Leakage in brake piston seal.	Check for an over filled differential. Apply brakes and check for leakage from check plug. ※ It is normal for the oil level to be slightly above the check plug.
Aggressive brakes	Internal restriction in circuit.	Remove lines and components.
	Brake valve malfunction.	Disassemble and inspect.
	Low oil level.	Check oil level.
Brakes drag	Brake pedal not returning properly.	Inspect floor mat and pedal.
	Debris holding valve partially open in brake valve.	Do brake valve pressure test.
	Warped brake disk.	Inspect brake disk.
	Stuck brake piston.	Repair.
Brakes lock up	Brake valve malfunction.	Clean or replace brake valve.

Problem	Cause	Remedy
Brakes chatter	Air in brake system.	Do brake bleed procedure.
	Worn brake surface material.	Inspect brake surface material.
	Wrong oil in differential.	Drain. Refill.
Hissing noise when brake pedal is held with engine stopped	Leakage in brake valve, or brake piston.	Do brake system leakage test.
Brake pressure warning light will not go out or stays on excessively long after start-up	Malfunction in brake low pressure warning switch.	Replace switch.
	Brake accumulator pressure too low.	Recharge accumulator.
	Low brake pump standby pressure setting.	Do brake pump standby pressure test.
	Leakage in pressure reducing manifold block.	Do pressure reducing valve manifold leakage test.
	Leakage in brake system.	Do brake system components leakage tests.
	Worn brake pump.	Do brake pump flow test.
	Leakage in parking brake solenoid.	Do parking brake pressure test.

2) PARKING BRAKE MALFUNCTIONS

Problem	Cause	Remedy
Brake will not hold	Pads not adjusted correctly.	Adjust parking brake.
	Malfunctioning parking brake solenoid.	Inspect and replace.
	Worn brake disk and / or brake pads.	Disassemble, inspect, repair.
	Brake piston hangs up in bore.	Remove and inspect. Repair.
Brake disk overheats	Pads out of adjustment.	Adjust parking brake.
	Brake not released.	Release parking brake. Disassemble, inspect brake. Repair if necessary. Inspect for loosen or broken lines between brake pressure switch and indicator on dash.
Parking brake indicator in monitor does not come on when brake applied	Faulty wiring or switch.	Inspect for loose or broken lines between brake pressure switch and indicator on dash. Inspect for a faulty indicator on dash. Replace if necessary.
Brake will not apply	Pads out of adjustment.	Adjust parking brake.
	Malfunctioning wiring, switch, or solenoid.	Check electric circuit.
	Restriction between brake valve and brake.	Remove hose and inspect. Replace.

1. PARKING BRAKE PERFORMANCE

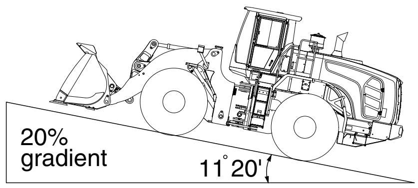
1) MEASUREMENT CONDITION

(1) Tire inflation pressure : Specified pressure

(2) Road surface : Flat, dry, paved surface with 1/5 (11˚20') gradient.

(3) Machine : In operating condition

Item	Standard valve
Parking brake performance	Keep machine on 20% (11˚20') gradient



9804BS17

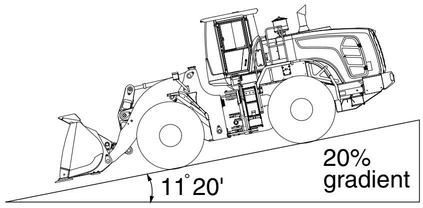
2) MEASURING PROCEDURE

(1) Start the engine and drive the machine straight up a 1/5 gradient with the bucket unloaded.

(2) Depress the service brake, place the gear selector lever in neutral, then stop the engine.

(3) Turn the parking brake switch ON, then slowly release the service brake pedal and the machine must be kept stopped.

※ The measurement must be made with the machine facing either up or down the slope.



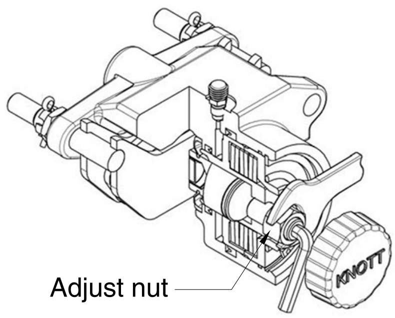
9804BS18

2. ADJUSTMENT OF PARKING BRAKE

(1) External brake inspection

· Inspect for wear of brake pad

(2) Refer to the PARKING BRAKE SYSTEM on the page 4-21.



75794BS22

3. HYDRAULIC BRAKE BLEEDING PROCEDURE

⚠ Escaping fluid under pressure can penetrate the skin causing serious injury. Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Search for leaks with a piece of cardboard. Protect hands and body from high pressure fluids.

※ If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source. Two people are required to bleed brake system oil, one to operate brake valve and other to open and close bleed screws.

1) Install frame locking bar. Engage parking brake.

2) Put a clear plastic tube on bleed screw to route low to hydraulic oil tank filler tube or container (A).

3) Start engine and run at low idle.

4) Push and hold brake pedal down until brake bleeding procedure is complete.

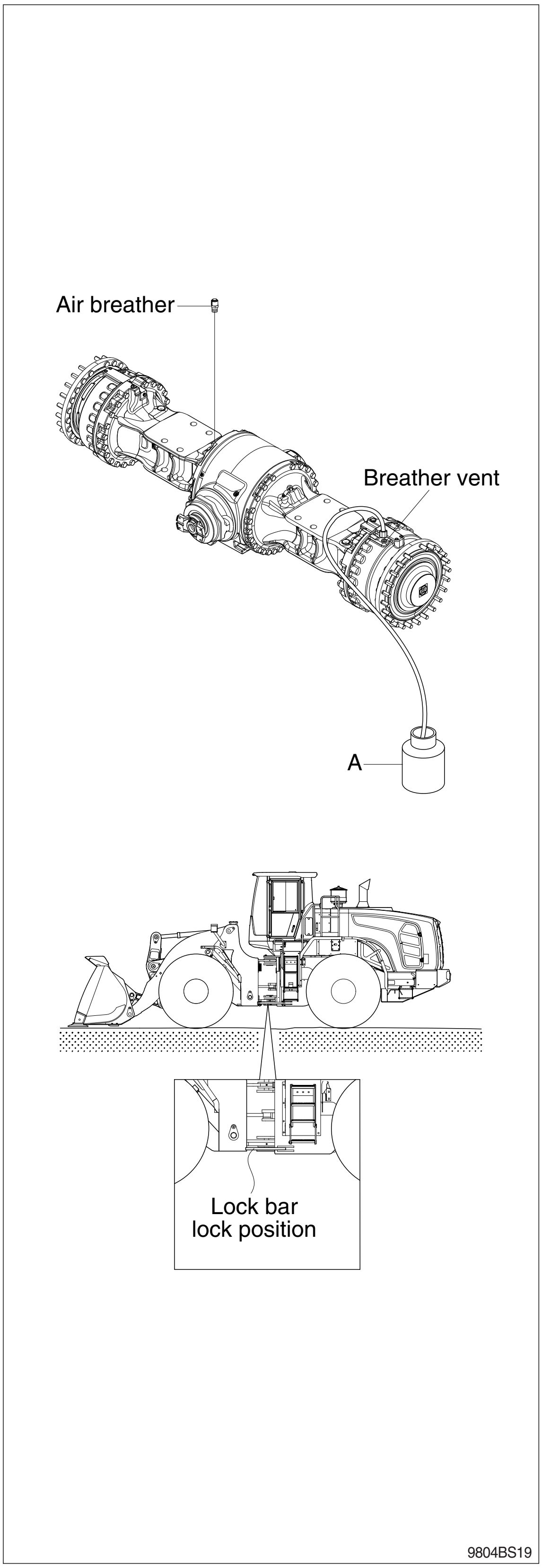
※ If bubbles continue for more than 2 minutes, stop bleeding procedure. Check for and correct problem, then continue.

5) Open on bleed screw on differential and axle assembly until hydraulic oil starts to flow. Close bleed screw when oil is free of air. Release brake pedal.

6) Repeat steps 1)~5) for each bleed screw.

7) Push either brake pedal and hold down.

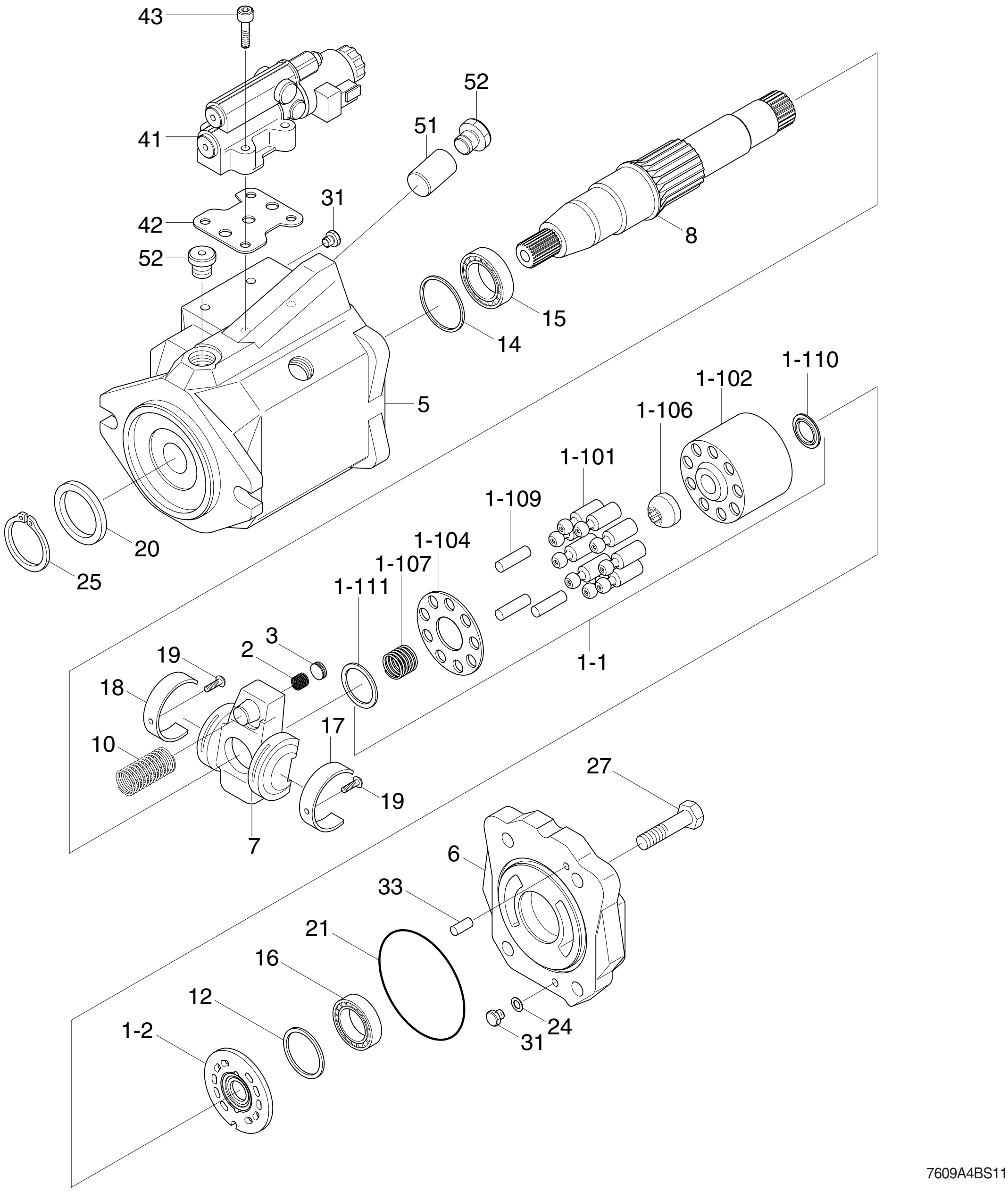
8) Check hydraulic oil level.



GROUP 4 DISASSEMBLY AND ASSEMBLY

1. FAN AND BRAKE PUMP

1) STRUCTURE



1-1	Rotary group	5	Pump housing	20	Shaft seal ring
1-101	Piston	6	Port plate	21	O-ring
1-102	Cylinder	7	Swash plate	24	Kantseal ring
1-104	Retaining plate	8	Drive shaft	25	Retaining ring
1-106	Retaining ball	10	Spring	27	Socket screw
1-107	Spring	12	Adjustment shim	31	Plug
1-109	Pressure pin	14	Stop ring	33	Cylinder pin
1-110	V-ring	15	Tapered roller bearing	41	Control valve
1-111	Back-up plate	16	Tapered roller bearing	42	Gasket
1-2	Control plate	17	Liner bearing	43	Socket screw
2	Pressure spring	18	Liner bearing	51	Control piston
3	Stop	19	Flat screw	52	Locking screw

2) GENERAL REPAIR GUIDELINES

※ Observe the following guidelines when carrying out repairs on hydraulic pumps.

(1) Close off all openings of the hydraulic unit.

(2) Replace all of the seals.
Use only original spare parts.

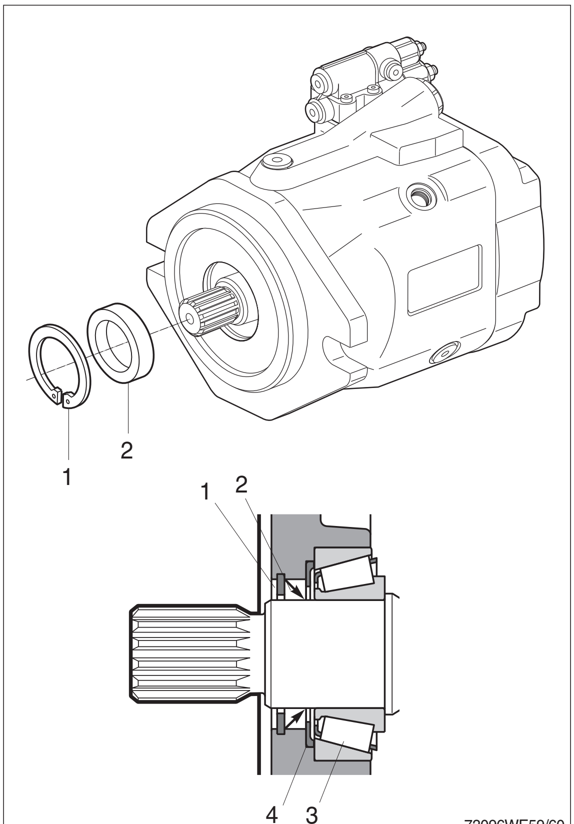
(3) Check all sealing and sliding surfaces for wear.

※ Re-work of the sliding surfaces by using, for example abrasive paper, can damage the surface.

(4) Fill the hydraulic pump with hydraulic oil before commissioning.

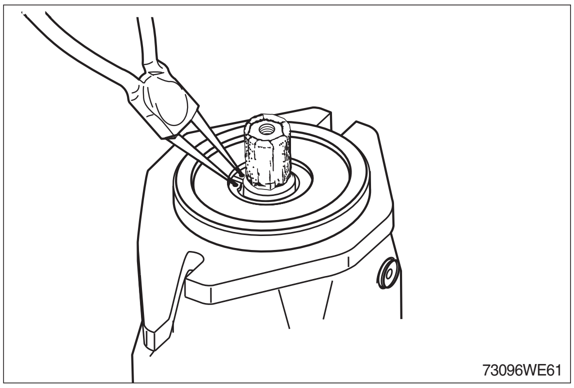
3) SEALING THE DRIVE SHAFT

1	Retaining ring	2	Shaft seal
3	Bearing	4	Stop ring

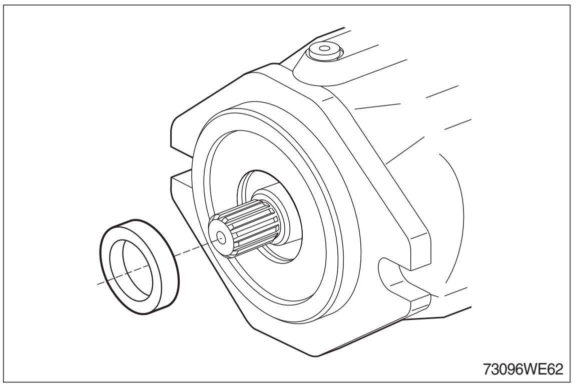


73096WE59/60

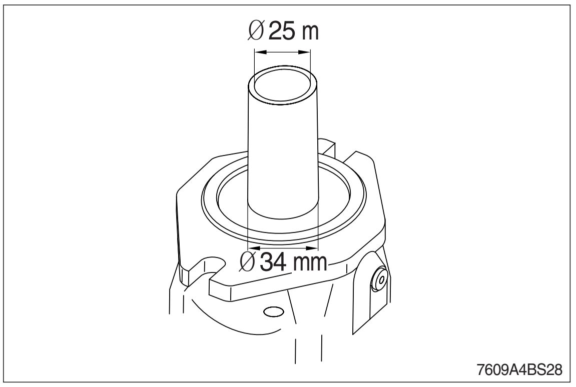
(1) Protect the drive shaft.
Wrap the drive shaft with tape.
Remove the retaining ring.
Remove shaft seal to front.


73096WE61

※ Change the shaft seal and check its sliding surface (drive shaft) and housing, grease the sealing ring.
Visual check shaft seal and housing.

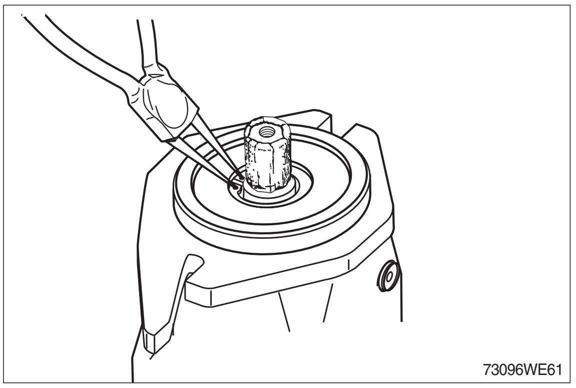

73096WE62

(2) Assembling of the sealing ring carefully down to the stop ring.



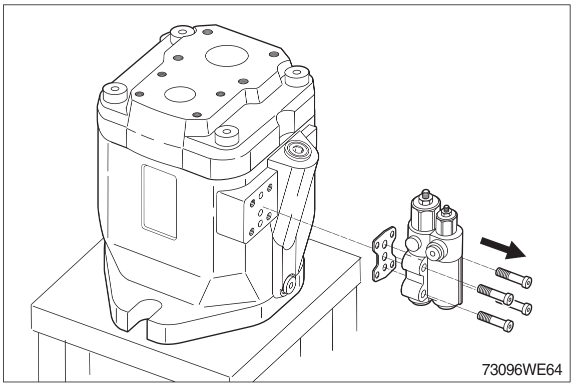
7609A4BS28

(3) Assemble the retaining ring (circlip).
※ Visual check to ensure that the circlip is correctly located in the groove.

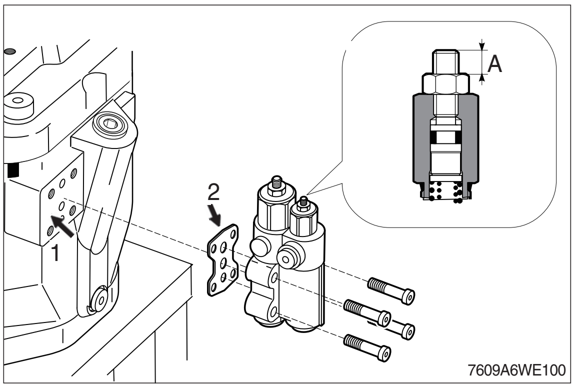

73096WE61

4) SEALING THE CONTROL VALVE

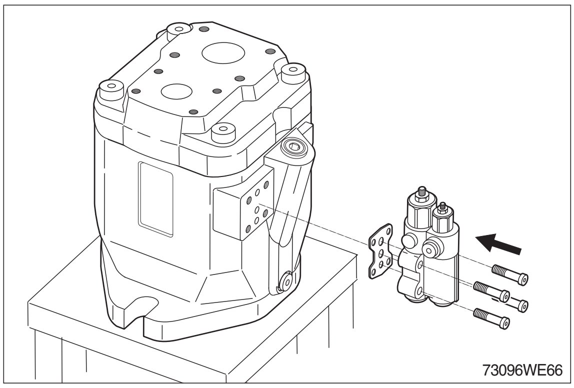
(1) Remove the control valve.


73096WE64

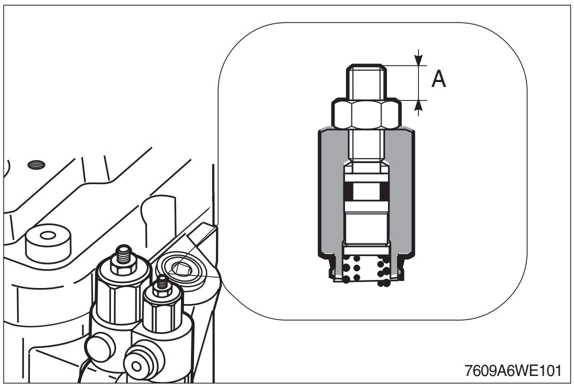
(2) Measure dimension A and note down.
Check sealing surface (1).
Replace gasket (2).



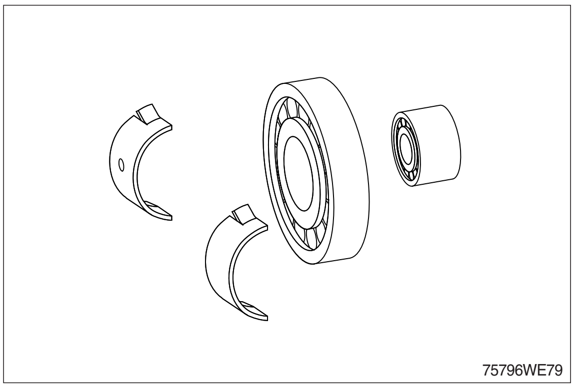
(3) Assemble control valve.
Tighten the bolts.
· Tightening torque : 1.58 kgf · m
(11.4 lbf · ft)



(4) Check dimension A.

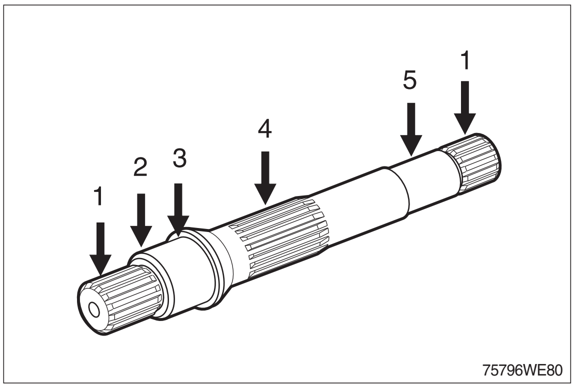


5) INSPECT HINTS
(1) Renew all bearings.



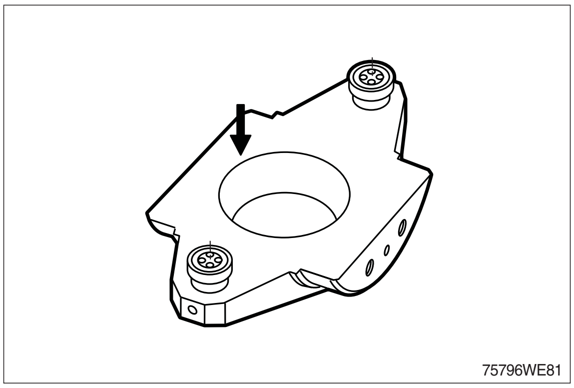
(2) Check :

1 Wear on splines, rust
2 Drive shaft seal wear grooves
3 Bearing seat
4 Splines for cylinder drive
5 Bearing seat

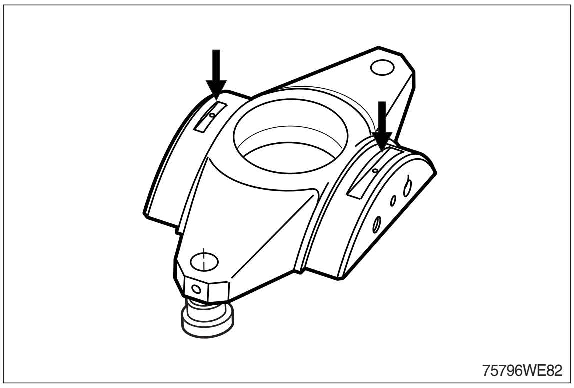


75796WE80

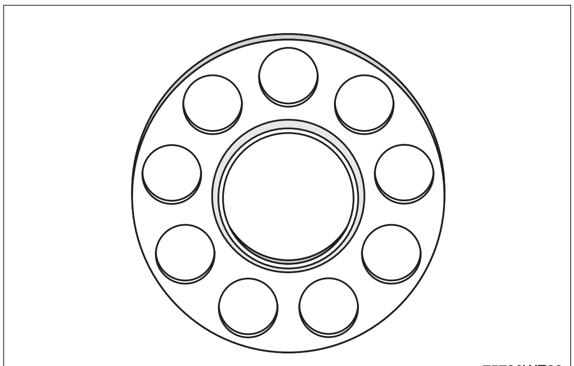
(3) Check :
Sliding surface free of grooves.


75796WE81

(4) Check :
Bearing surfaces.

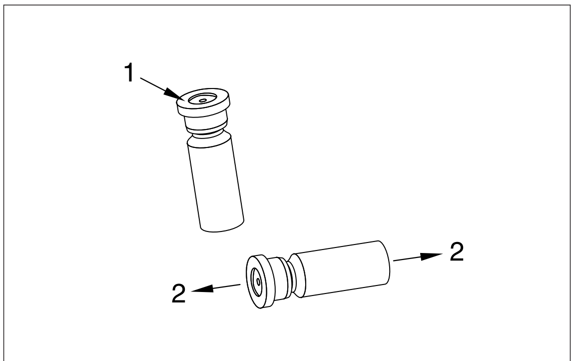

75796WE82

(5) Check :
That the retaining plate is free of grooves and that there is no wear in the slipper pad area.


75796WE83

(6) Check :

Check to see that there are no scratches or metal deposits on the sliding surface (1) and that there is no axial play (2) (Pistons must only be replaced as a set).

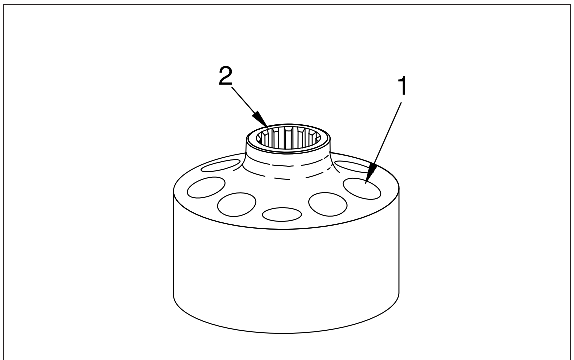


75796WE84

(7) Check :

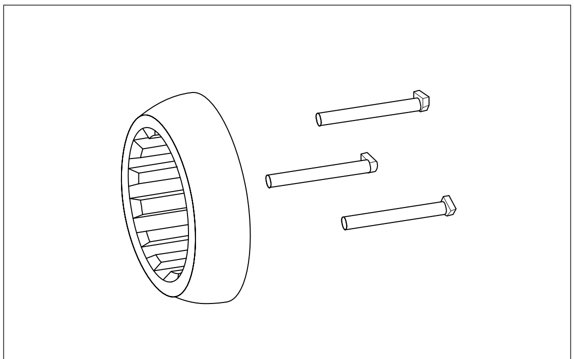
1 Cylinder bores

2 Splines



75796WE85

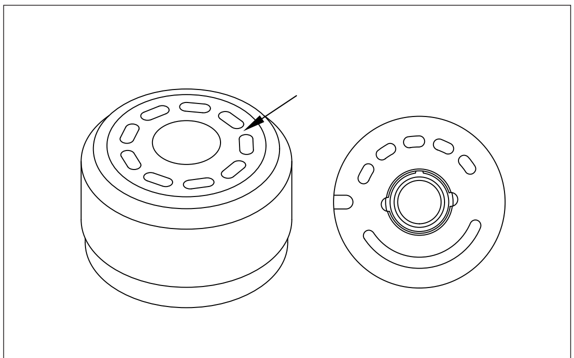
(8) Free of grooves, no signs of wear.



75796WE86

(9) Check :

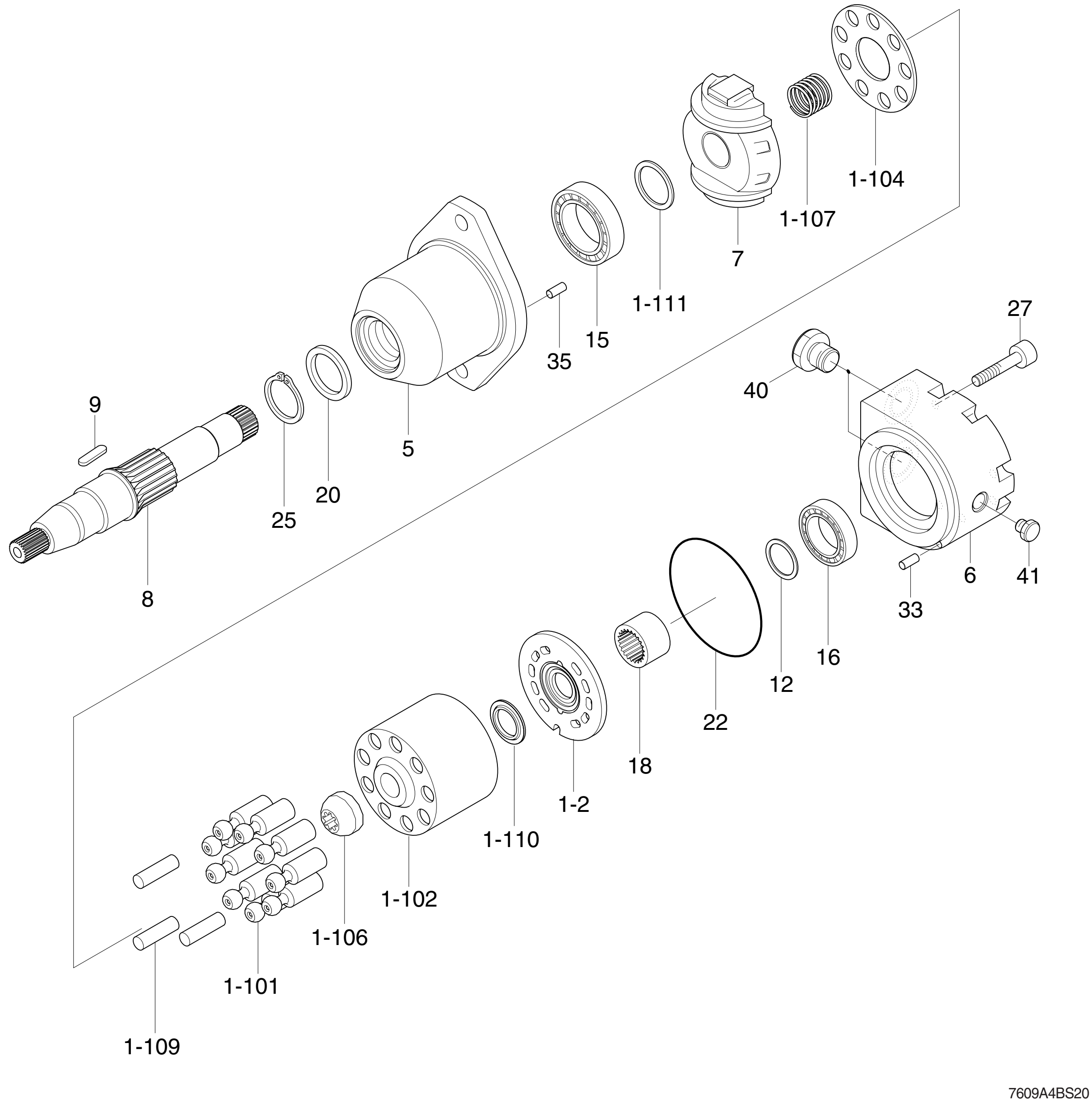
Cylinder sliding surface free of grooves, no wear, no embedded foreign particles. That there are no scratches on the control plate. (Only replace them as a set).



75796WE87

2. FAN MOTOR

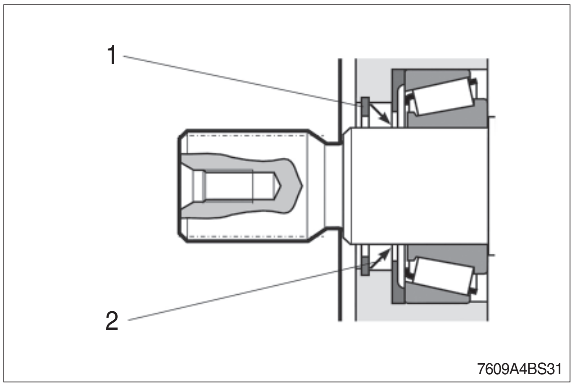
1) STRUCTURE



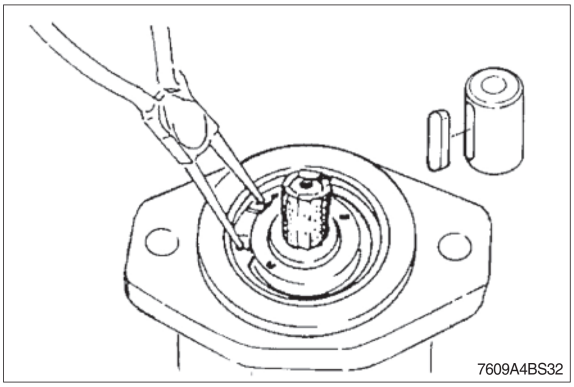
1-1	Rotary group	1-2	Control plate	18	Bearing bushing
1-101	Piston	5	Motor housing	20	Shaft seal
1-102	Cylinder	6	Port plate	22	O-ring
1-104	Retaining plate	7	Cam plate (swash plate)	25	Retaining ring (circlip)
1-106	Retaining ball	8	Drive shaft	27	Socket bolt
1-107	Spring	9	Shaft key	33	Cylinder pin
1-109	Pressure pin	12	Adjustment shim	35	Cylinder pin
1-110	V-ring	15	Tapered roller bearing	40	Screw
1-111	Back-up plate	16	Tapered roller bearing	41	Screw

2) SEALING THE DRIVE SHAFT

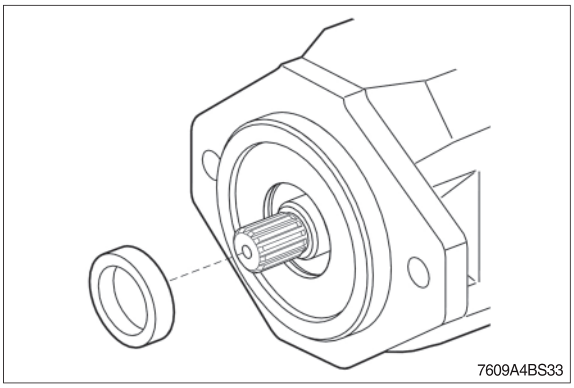
(1) 1 Circlip
2 Shaft seal



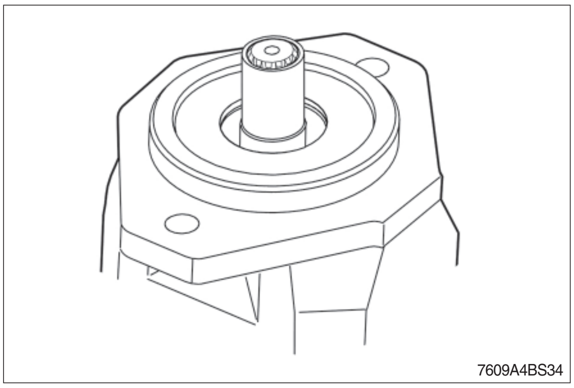
(2) Remove key.
Protect the drive shaft.
Remove the circlip.



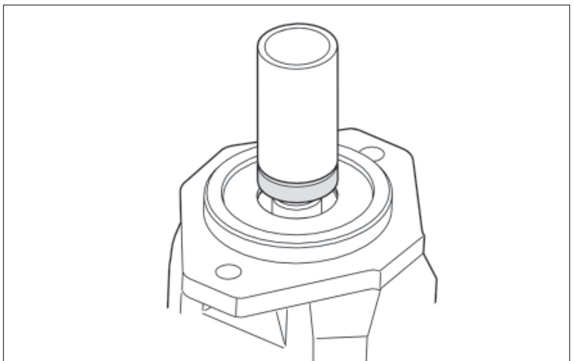
(3) Change the shaft seal and check its sliding surface (drive shaft) and housing, grease the sealing ring.



(4) Use installation tool or plastic strip for assembling seal.

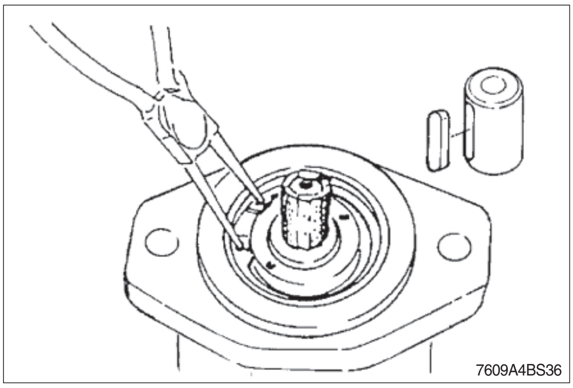


(5) Use a suitable pipe to mount the shaft seal, but don't push it too deep. If the shaft ring touches the bearing ring you will damage the seal ring.



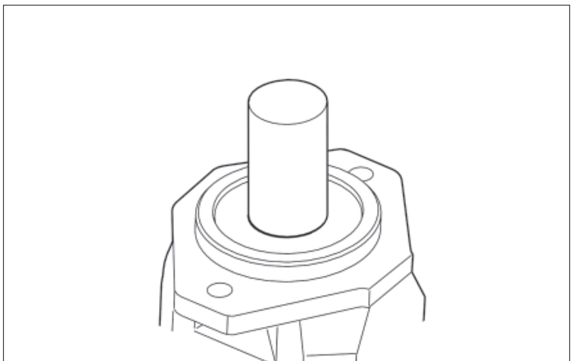
7609A4BS35

(6) Assemble the circlip.



7609A4BS36

(7) Assemble the circlip in the correct position.

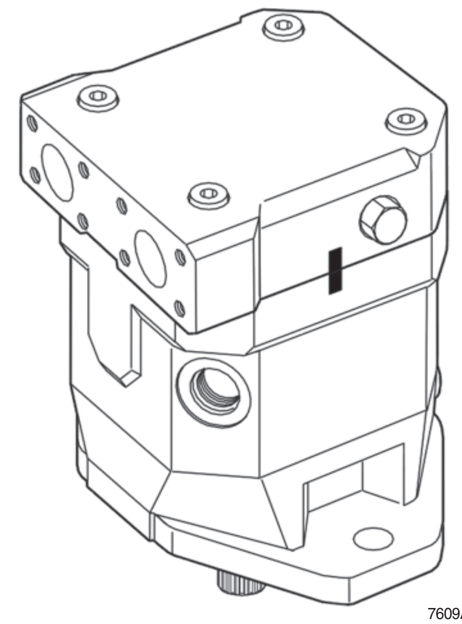


7609A4BS37

※ This discription showes how th change the drive shaft seal but it isn't the way of serial assembly.
The seal is assembled together with the taper roller bearing from inside the motor housing normally to get a secure sealing condition. If you decide to repair the motor in the shown way be very careful while handling so that the drive shaft wouldn't be damaged during disassembly of the shaft seal.

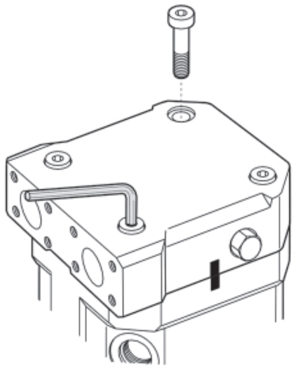
3) DISASSEMBLE THE MOTOR

(1) Disassembly position.
Mark the location of the port plate on the housing.



7609A4BS38

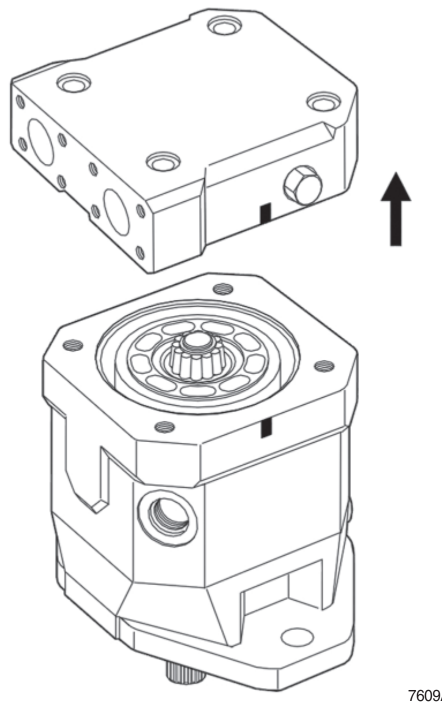
(2) Remove the port plate fixing bolts crosswise.



7609A4BS39

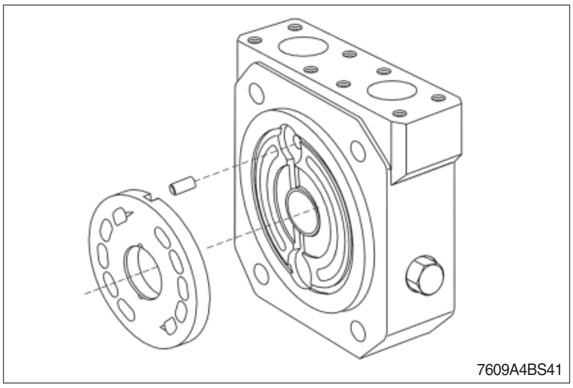
(3) Remove the port plate.

※ Control plate can drop down-hold tight.

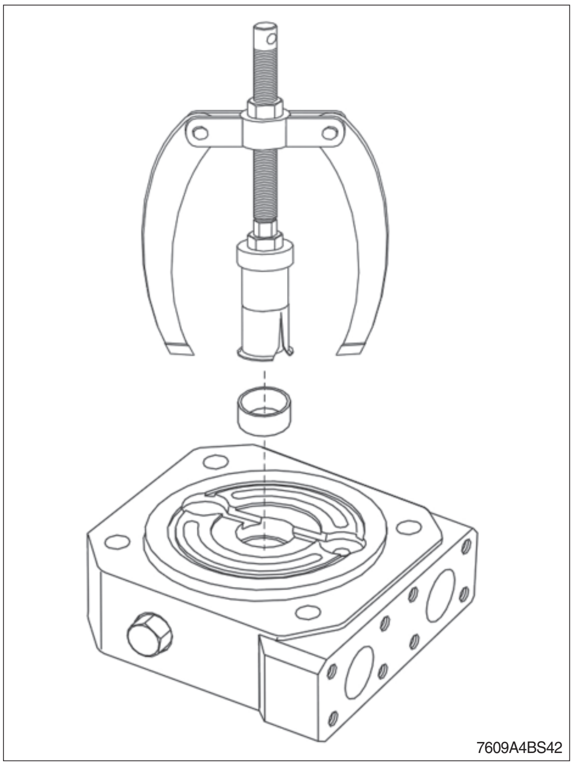


7609A4BS40

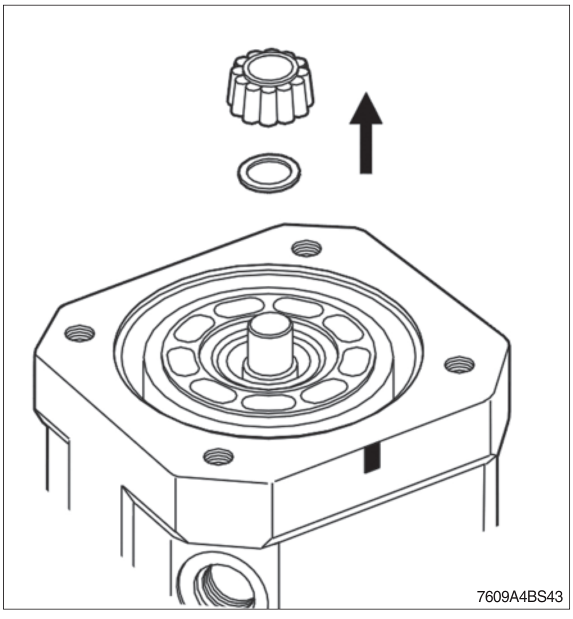
(4) Remove control plate.



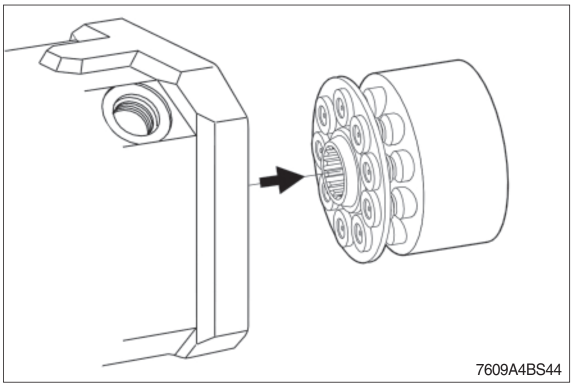
(5) Remove bearing outer ring with withdrawal tool.
Do not damage the sealing surface.



(6) Disassemble the taper roller bearing (near by port plate).
Remove the adjustment shim.

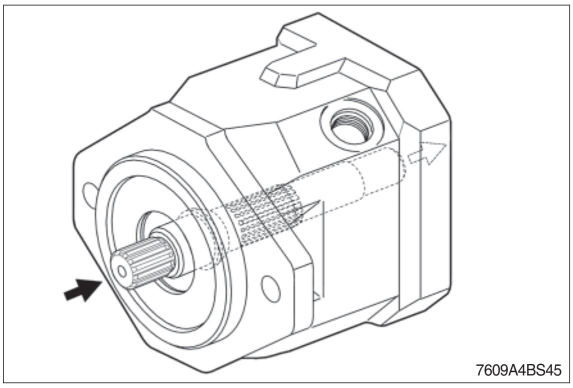


(7) Remove the rotary group in a horizontal position.



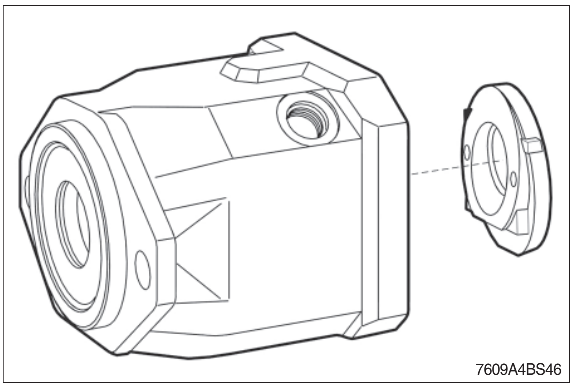
7609A4BS44

(8) Remove the drive shaft to rear side.



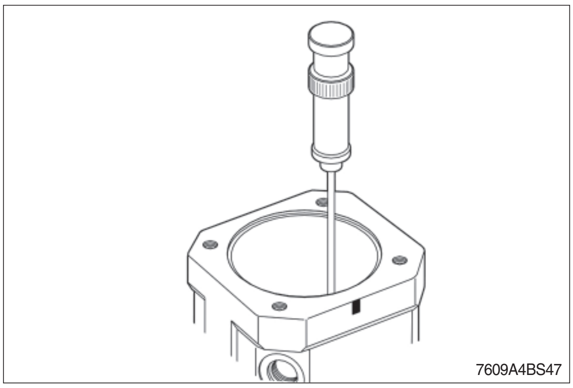
7609A4BS45

(9) Remove swash plate with special tool (see the next figure).



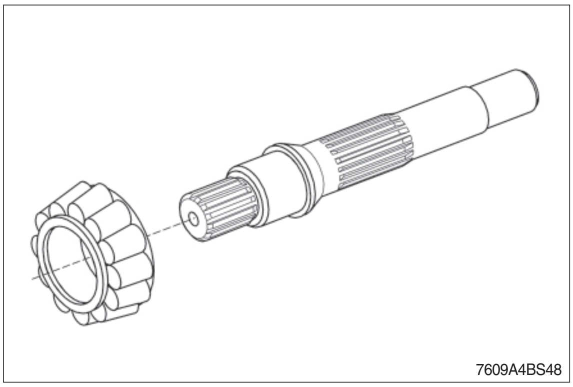
7609A4BS46

(10) Loosen the swash plate with a slide hammer (a small hook - diameter 6 mm - catches the end of the swash plate at the bottom).

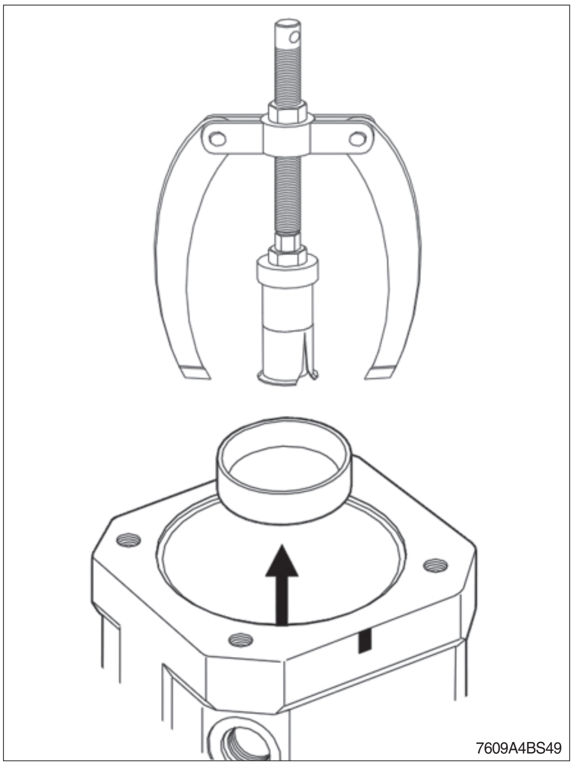


7609A4BS47

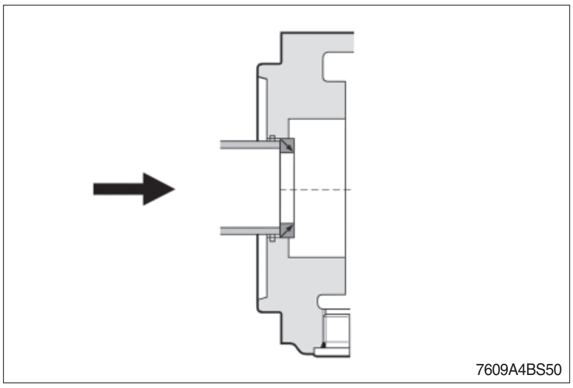
(11) Press down bearing.



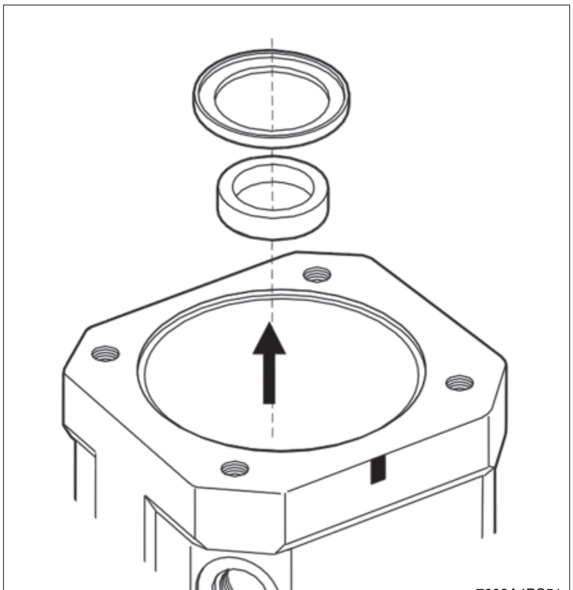
(12) The external front bearing ring is pulled out of the pump housing.



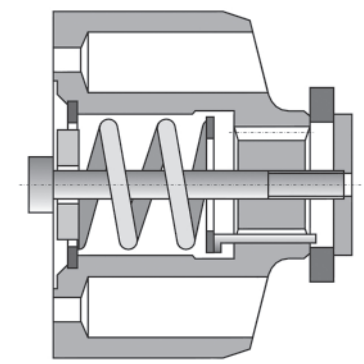
(13) Disassemble circlip and shaft seal.



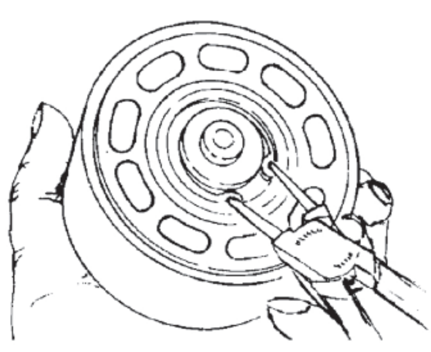
(14) Remove shaft seal and shim.


7609A4BS51

(15) Pre-tension the spring using a suitable device.

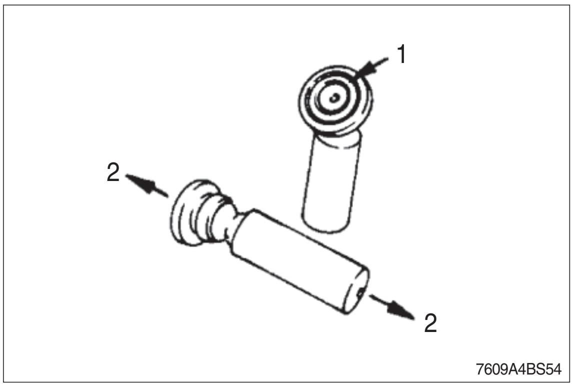

7609A4BS52

(16) Remove circlip.
Remove spring and pressure pins.

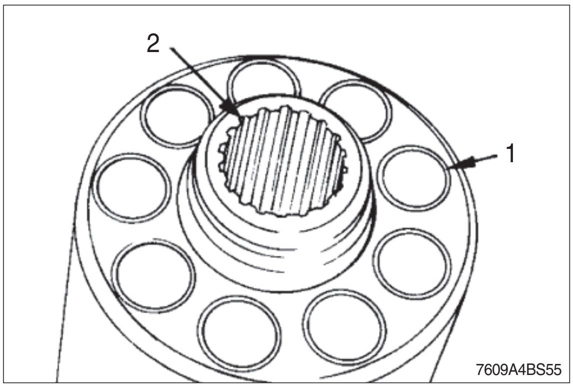

7609A4BS53

4) INSPECTION HINTS

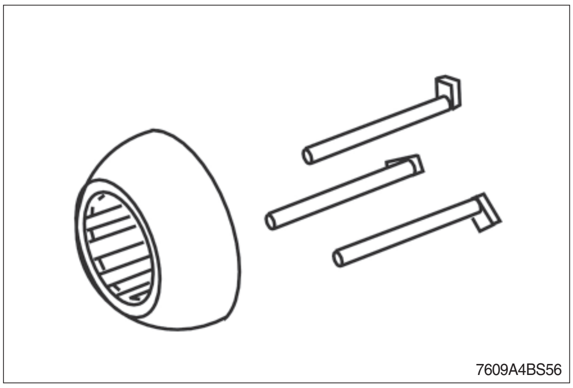
(1) Check to see that there are no scratches or metal deposits on the sliding surface (1), and that there is no axial play (2), (pistons must only be replaced as a set).



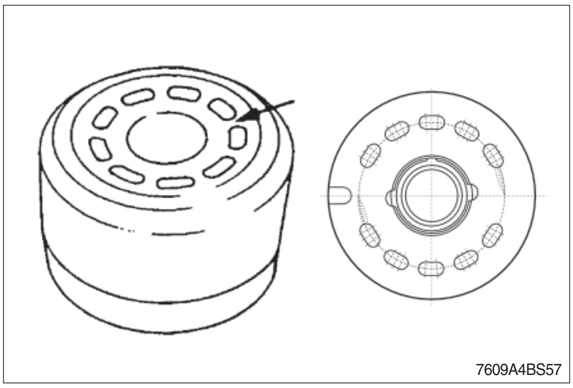
(2) Check cylinder bores (1) and splines (2).



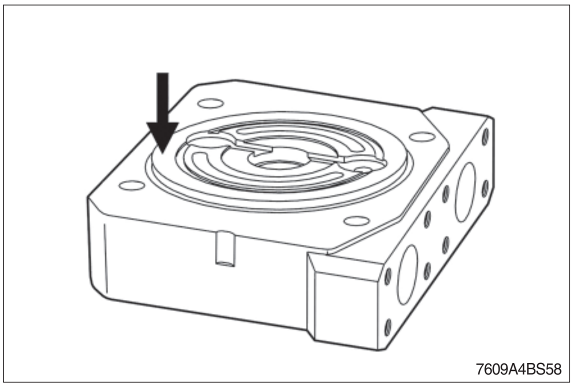
(3) Free of grooves, no signs of wear.



(4) Cylinder sliding surface free of grooves, no wear, no embedded foreign particles. That there are no scratches on the control plate. (Only replace them as a set).

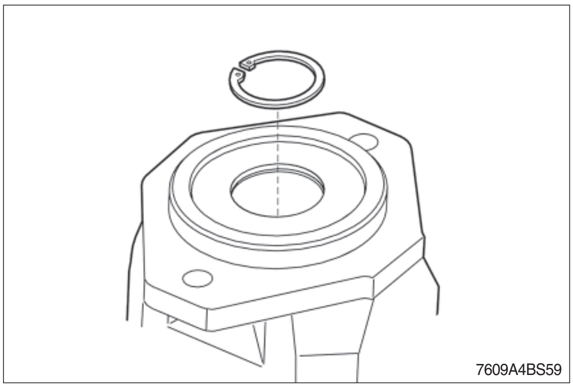


(5) Mounting surface - control plate undamaged.

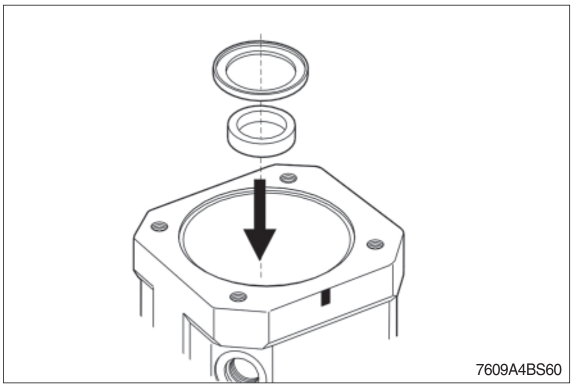

7609A4BS58

5) MOTOR ASSEMBLY

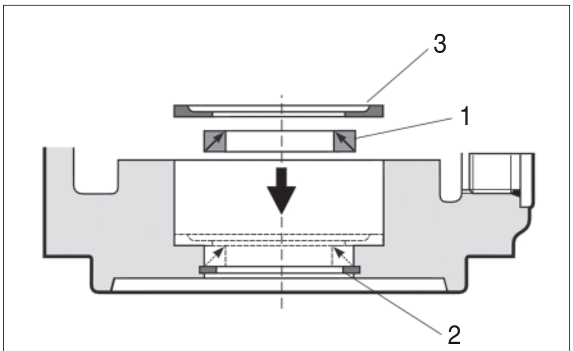
(1) Fit the circlip into the housing.


7609A4BS59

(2) Assemble shaft seal and shim against circlip.


7609A4BS60

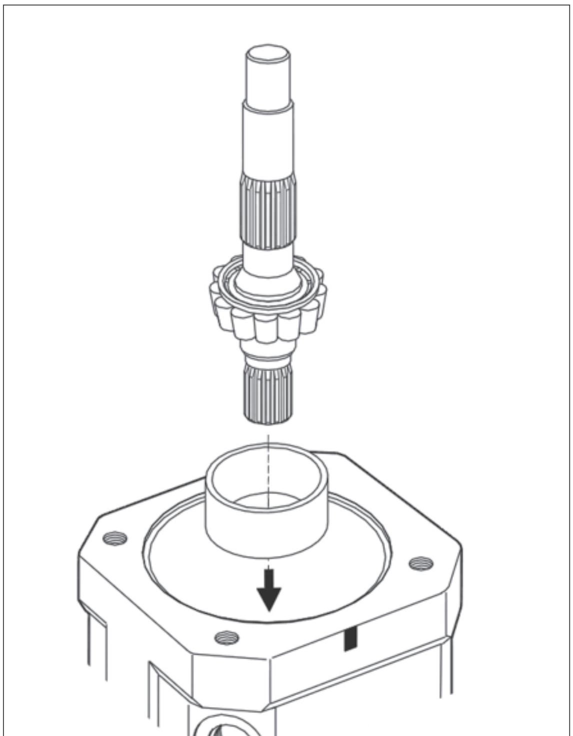
(3) Assembly of the shaft seal (1) against the safety ring (2) back up the shim (3) down to the seal ring.



7609A4BS61

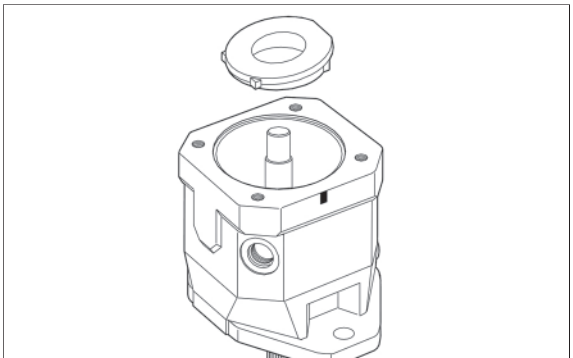
(4) Press outer bearing ring into housing.
Shaft seal with pre-assembled bearing into housing.

※ Protect splines of the shaft with plastic strip against damage of the seal lip.



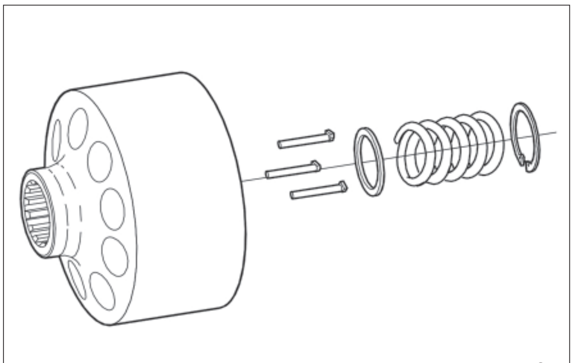
7609A4BS62

(5) Assemble swash plate.



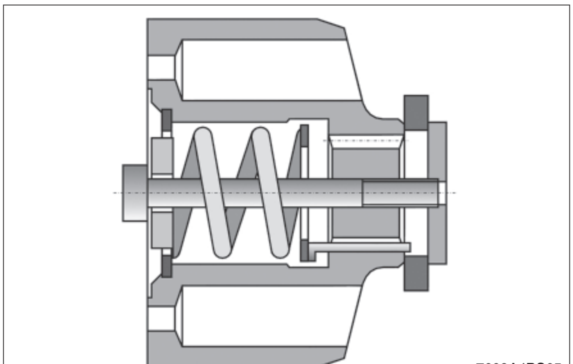
7609A4BS63

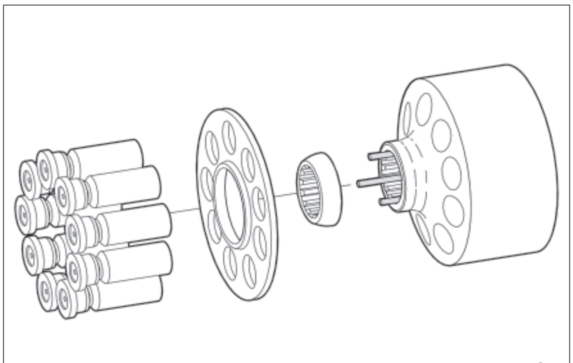
(6) Fit pressure pins using an assembly aid.



7609A4BS64

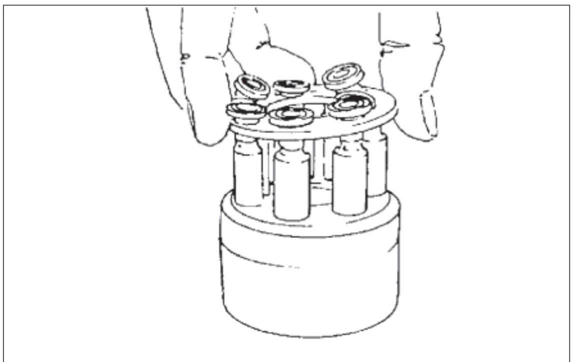
(7) Pre-tension the spring using a suitable device.


7609A4BS65


7609A4BS66

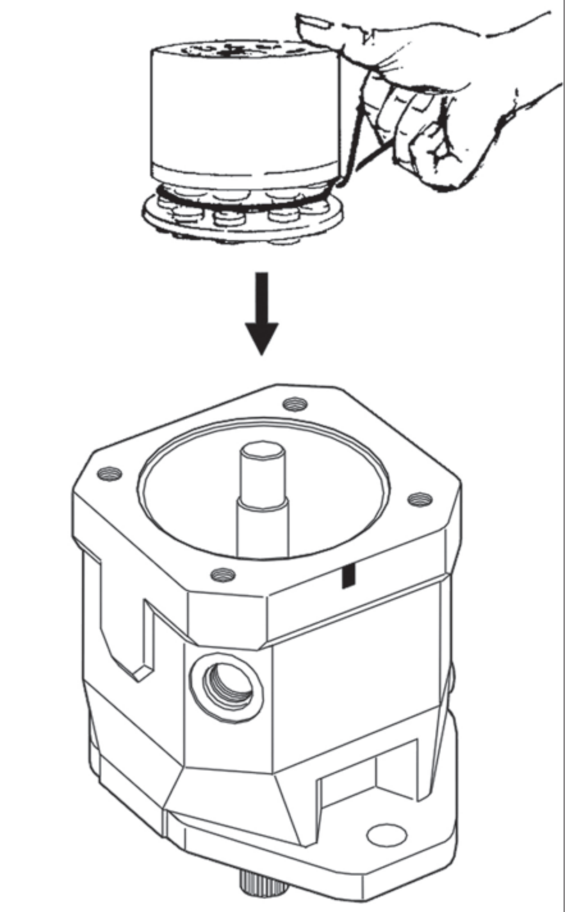
(8) Assemble piston with retaining plate.

※ Oil piston and slipper pad.


7609A4BS67

(9) Fit rotary group.

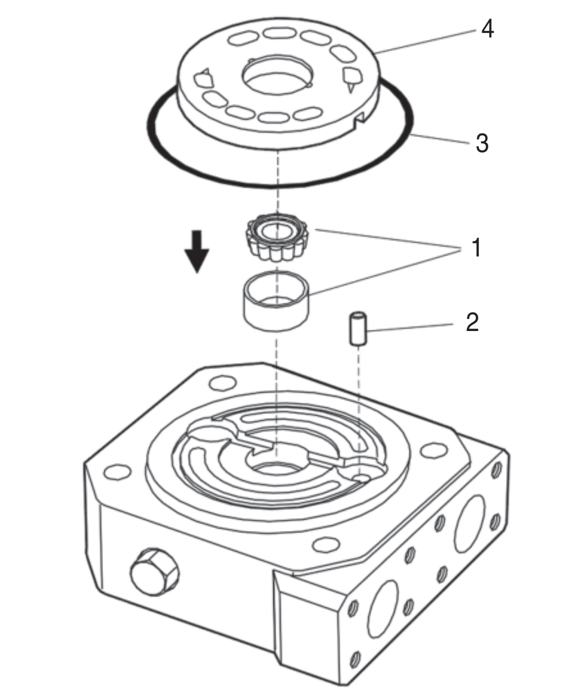
※ Assembly aid :
Hold the pistons by using an O-ring.



7609A4BS68

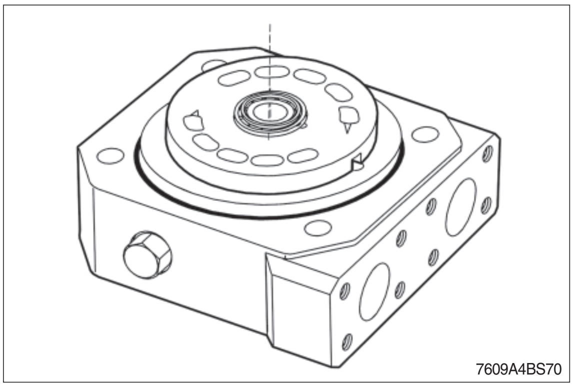
(10) Fit bearing (1) in port plate.
Fit cyilindrical pin (2).
Fit O-ring (3).
Fit control plate (4).

※ Assembly :
Hold the components in place with grease.

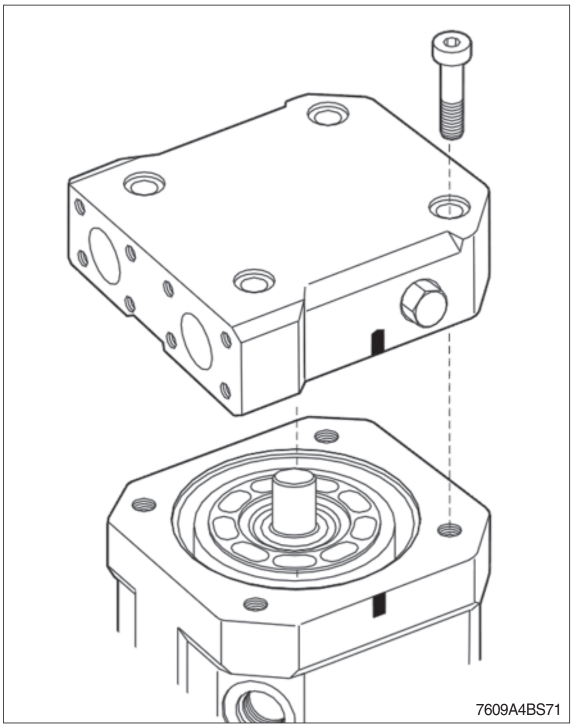


7609A4BS69

(11) Fit control plate.
Assembly aid : Grease



(12) Fit the port plate and fix it with the bolts crosswise.



SECTION 5 STEERING SYSTEM

SECTION 5 STEERING SYSTEM

GROUP 1 STRUCTURE AND FUNCTION

1. OUTLINE

The steering system of this machine consists of a variable displacement piston pump supplying a load sensing steering system and a closed center loader system.
This system offers faster response from the priority valve of flow amplifier and the pump. Also if offers advantages in connection with cold start up and improvements in system stability.

The components of the steering system are :

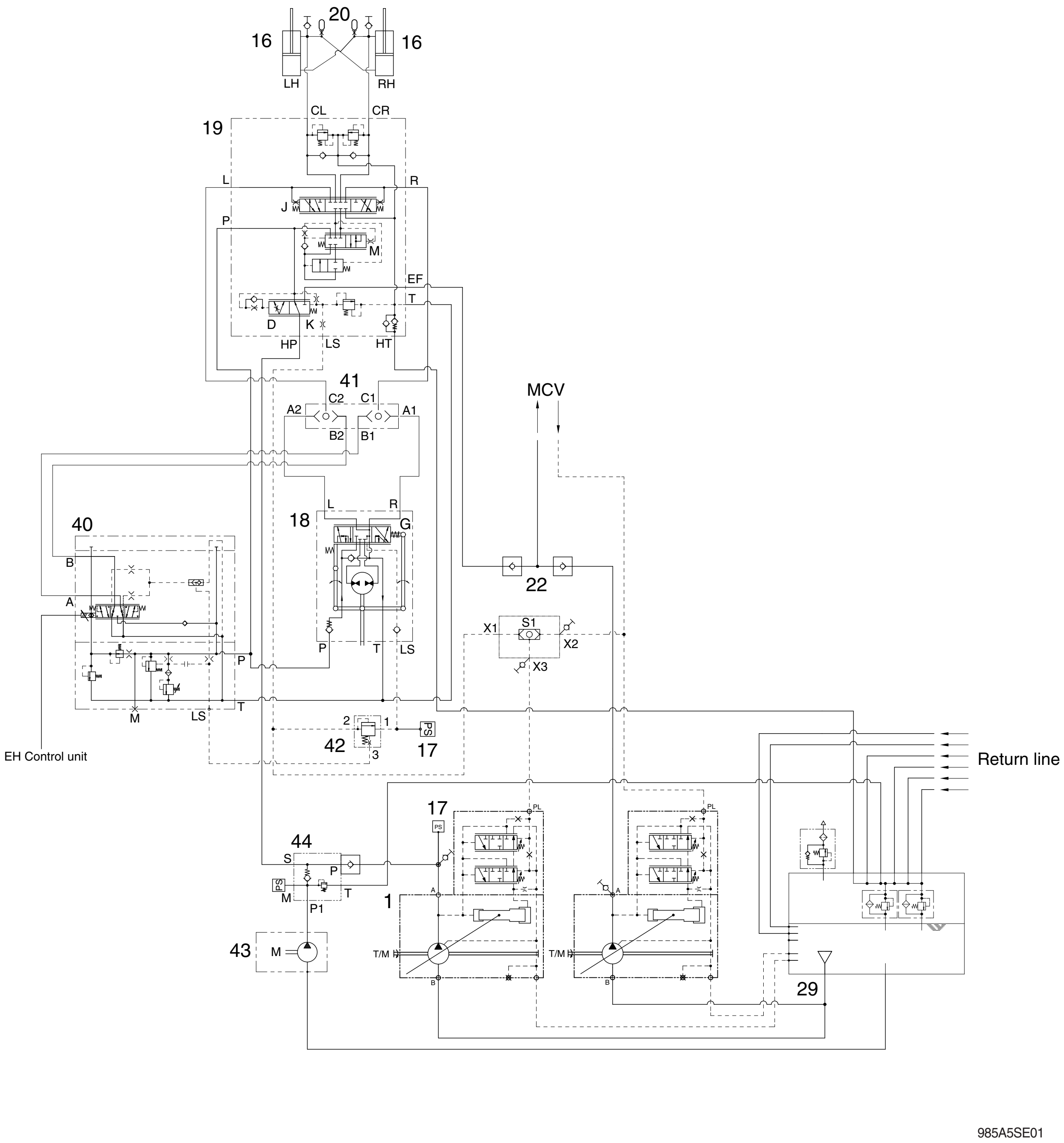
· Steering pump
· Flow amplifier
· Steering unit
· Accumulators
· Steering cylinders

The flow amplifier contain a directional valve, an amplification stage, a priority valve, a pilot pressure relief valve and shock and suction valve.
The steering pump draws hydraulic oil from the hydraulic tank.
Outlet flow from the pump flows to the priority valve of flow amplifier. The priority valve of flow amplifier preferentially supplies flow, on demand, to the steering unit. When the machine is steered, the steering unit routes flow to the steering cylinders to articulate the machine.

When the machine is not being steered, or if pump flow is greater than steering flow, the priority valve supplies flow to the loader system.

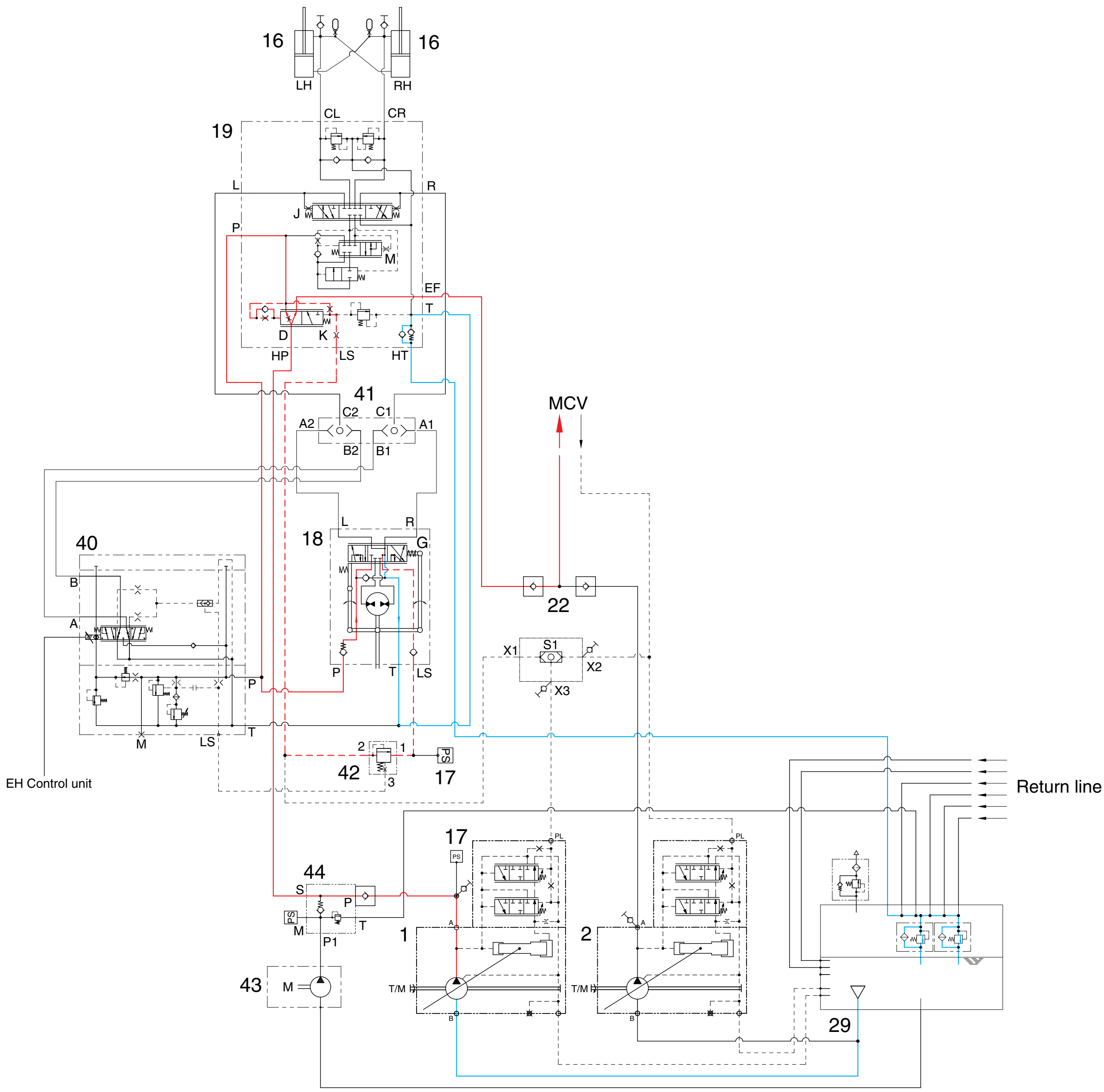
That is, output flow from the steering pump enters into the main control valve for the operation of the attachment.

2. HYDRAULIC CIRCUIT



1	Steering pump	20	Accumulator	42	LS compensating valve (option)
16	Steering cylinder	22	Check valve	43	Motor pump (option)
17	Pressure sensor	29	Hydraulic tank	44	Check block (option)
18	Steering unit	40	Proportional valve (option)		
19	Flow amplifier	41	Shuttle valve		

1) NEUTRAL



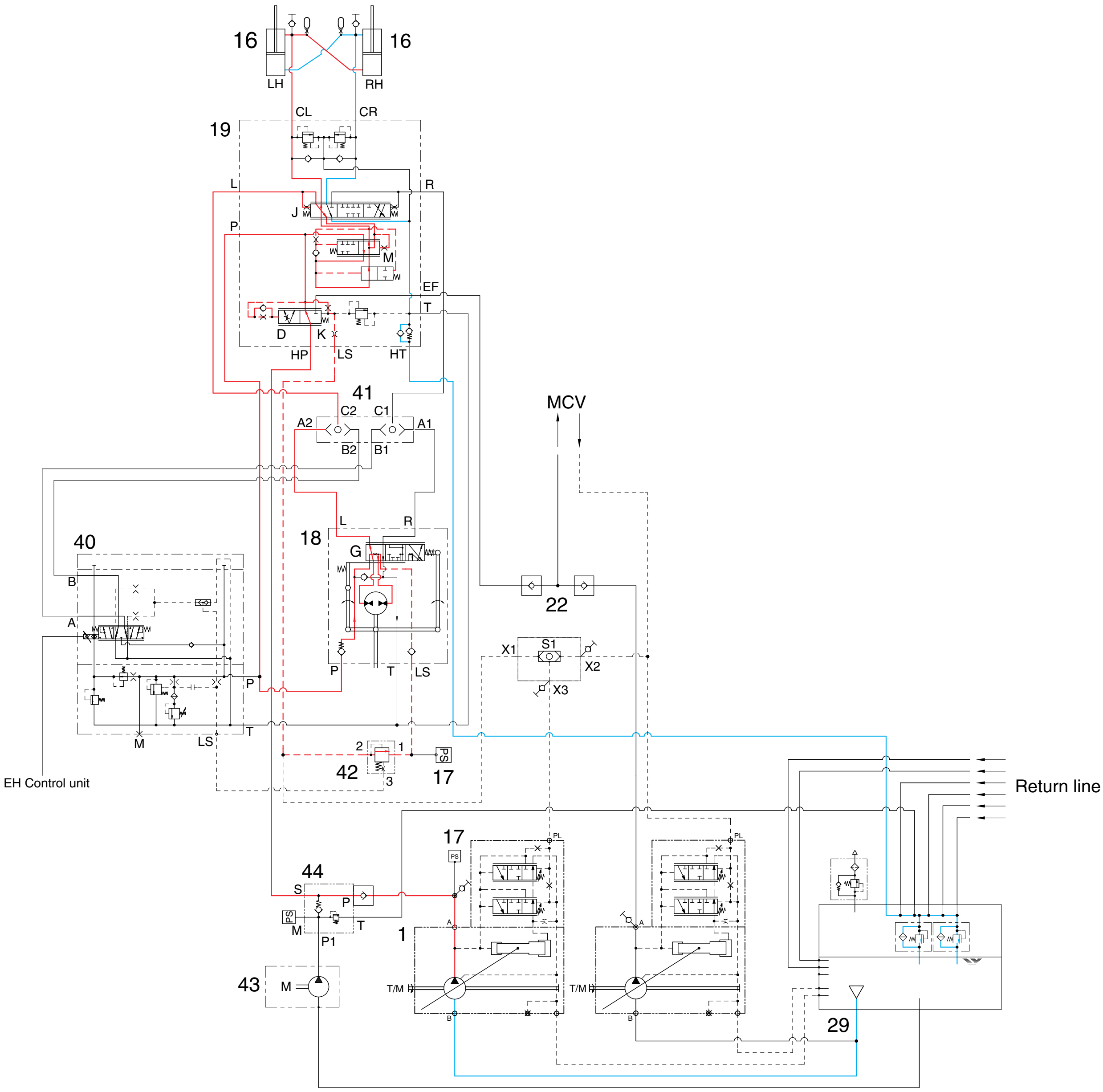
985A5SE02

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

· The oil from the steering pump enters port HP of the priority valve of flow amplifier and the inlet pressure oil moves the spool (D) to the right.

· Almost all of pump flow goes to the loader system (main control valve) through the EF port and partly flows into the hydraulic tank (29) through the control spool (G).
  This small flow is useful to prevent the thermal shock problem of the steering unit (18).

2) LEFT TURN



985A5SE03

· When the steering wheel is turned to the left, the spool (G) within steering unit (18) connected with steering column shaft is pushed to the right direction.

· The oil discharged from the pump flows into HP port of flow amplifier (19).

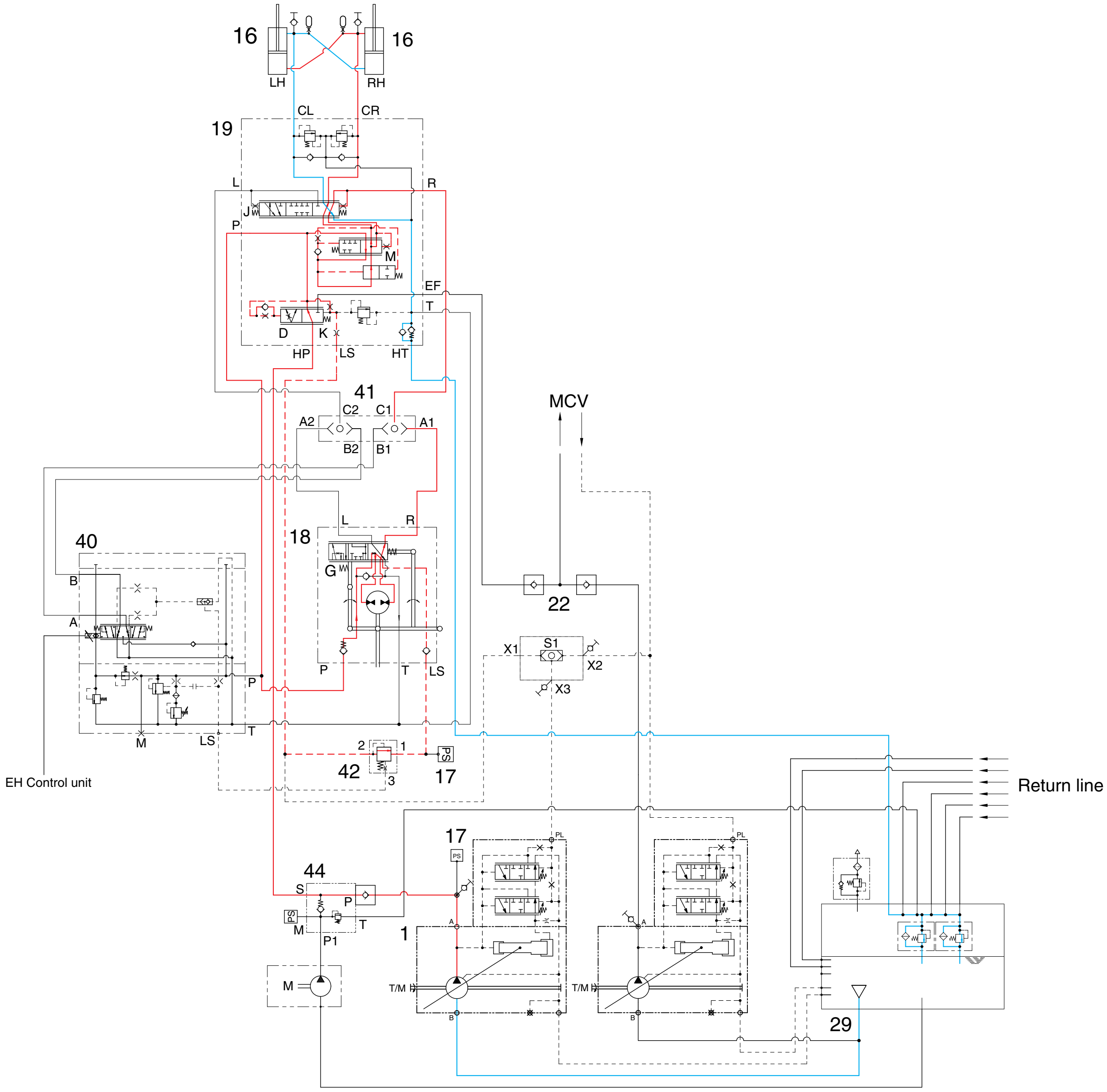
· The delivered oil passes through the main orifice of steering unit (8), through the priority valve spool (D) of flow amplifier (19). The position of priority spool (D) is determined when the pressure difference between front and rear of main orifice is balanced with control spring (K) force.

· The oil supplied through the directional spool (J) from the steering unit is combined with the direct oil from the priority valve spool (D) in the amplifier spool (M). The amplified oil flows into the small chamber of the left steering cylinder and large chamber of the right steering cylinder respectively.

· Oil returned from left and right cylinders returns to hydraulic tank through directional spool (J) of flow amplifier (19).

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

3) RIGHT TURN



985A5SE04

· When the steering wheel is turned to the right, the spool (G) within steering unit (18) connected with steering column shaft is pushed to the right direction.

· The oil discharged from the pump flows into HP port of flow amplifier (19).

· The delivered oil passes through the main orifice of steering unit (8), through the priority valve spool (D) of flow amplifier (19). The position of priority spool (D) is determined when the pressure difference between front and rear of main orifice is balanced with control spring (K) force.

· The oil supplied through the directional spool (J) from the steering unit is combined with the direct oil from the priority valve spool (D) in the amplifier spool (M). The amplified oil flows into the small chamber of the right steering cylinder and large chamber of the left steering cylinder respectively.

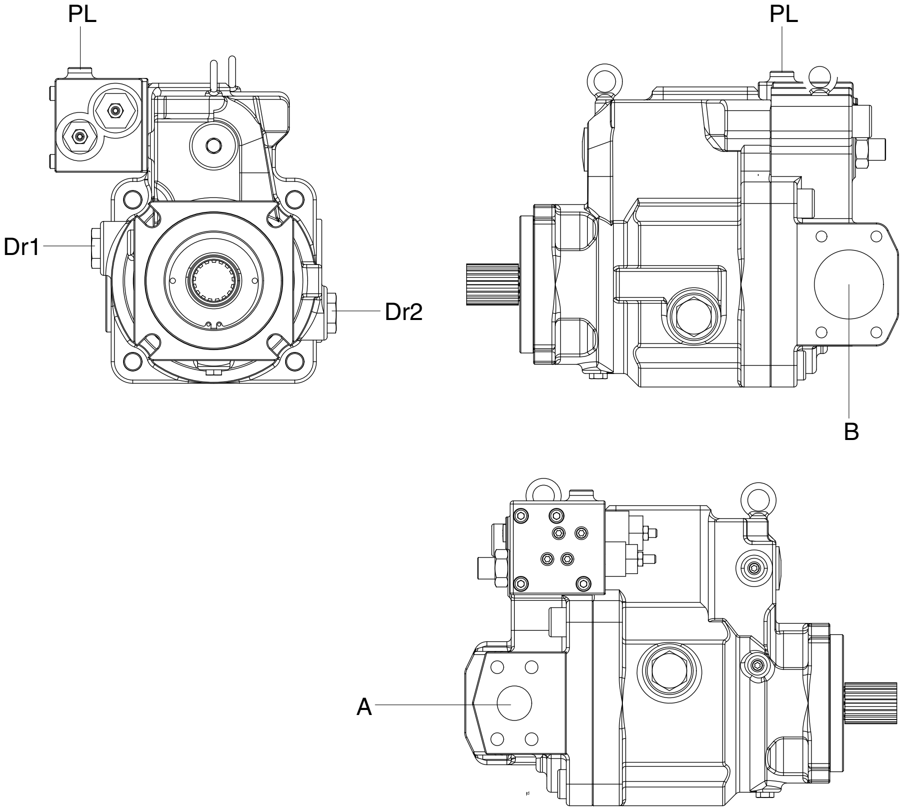
· Oil returned from left and right cylinder returns to hydraulic tank through directional spool (J) of flow amplifier (19).

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

3. STEERING PUMP

1) STRUCTURE (1/3)

This steering pump is variable displacement piston pump.

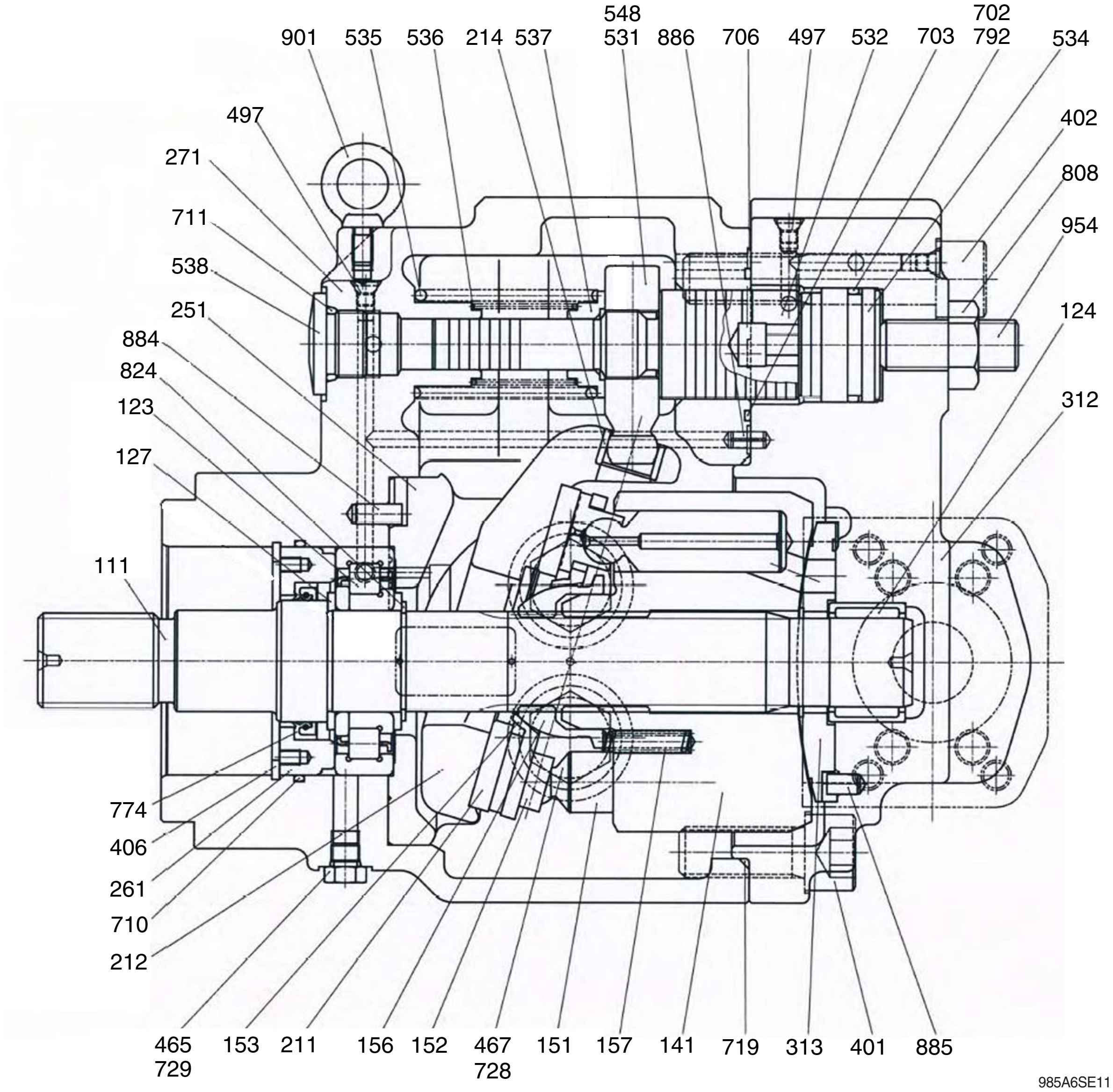


985A6SE10

Port	Port name	Port size
A	Pressure port	SAE 1 1/4"
B	Suction port	SAE 2 1/2"
Dr1, Dr2	Drain port	1 1/16-12UN
PL	Load sensing port	7/16-20UNF

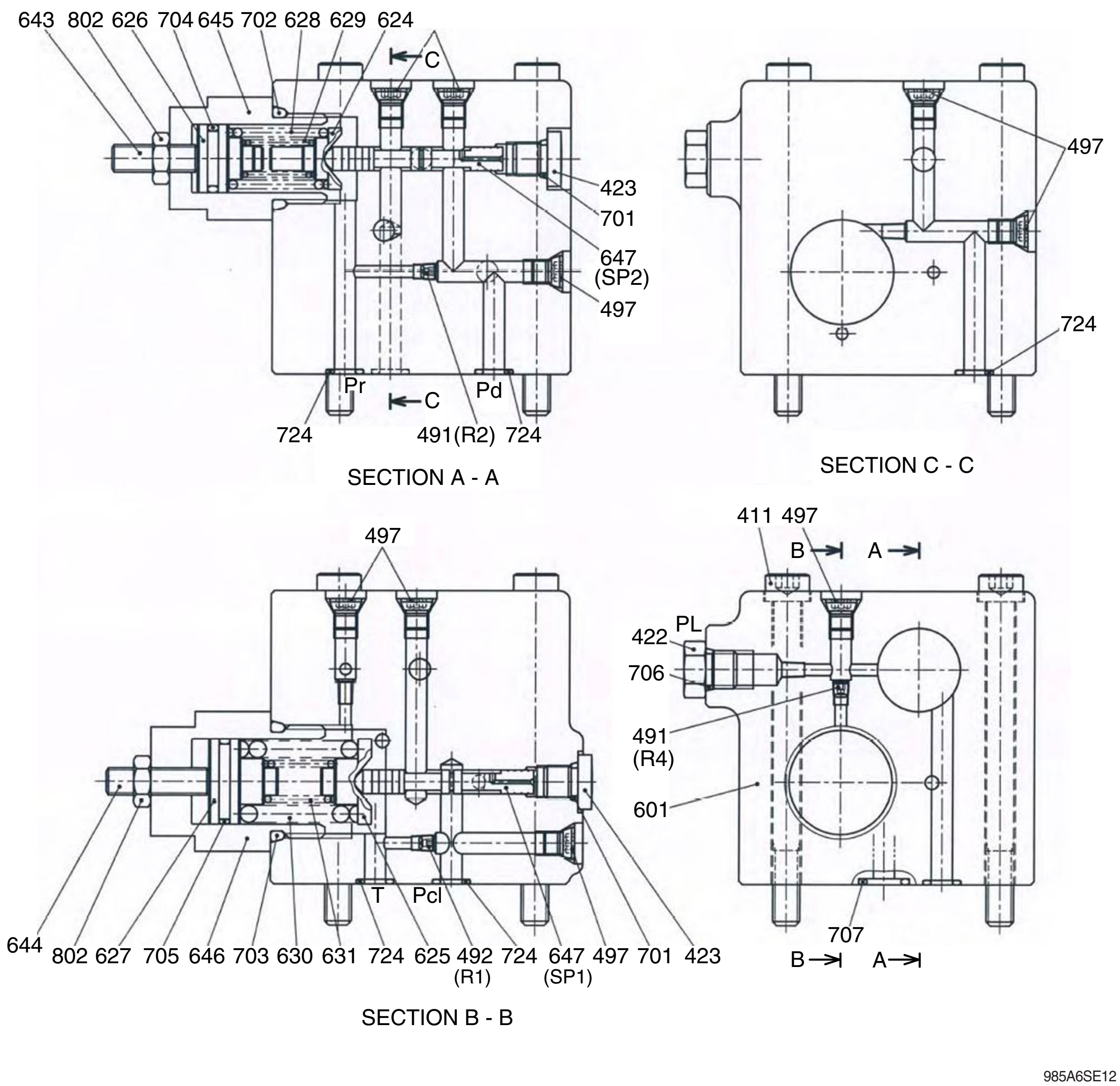
※ **Function, disassembly and assembly :** Refer to page 6-10 and 6-48.

STRUCTURE (2/3)



111	Drive shaft	261	Seal cover	536	Inner spring
123	Roller bearing	271	Pump casing	537	Spring seat
124	Needle bearing	312	Valve cover	538	Plug
127	Bearing spacer	313	Valve plate(R)	548	Feed back pin
141	Cylinder block	401	Socket bolt	702~729	O-ring
151	Piston	402	Socket bolt	774	Oil seal
152	Shoe	406	Retaining ring	792	Back up ring
153	Set plate	465	Plug	808	Nut
156	Spherical bush	467	Plug	824	Snap ring
157	Cylinder spring	497	Plug	884	Pin
211	Shoe plate	531	Tilting pin	885	Valve plate pin
212	Swash plate	532	Servo piston	886	Spring pin
214	Tilting bush	534	Stopper(L)	901	Eye bolt
251	Support	535	Outer spring	954	Set screw

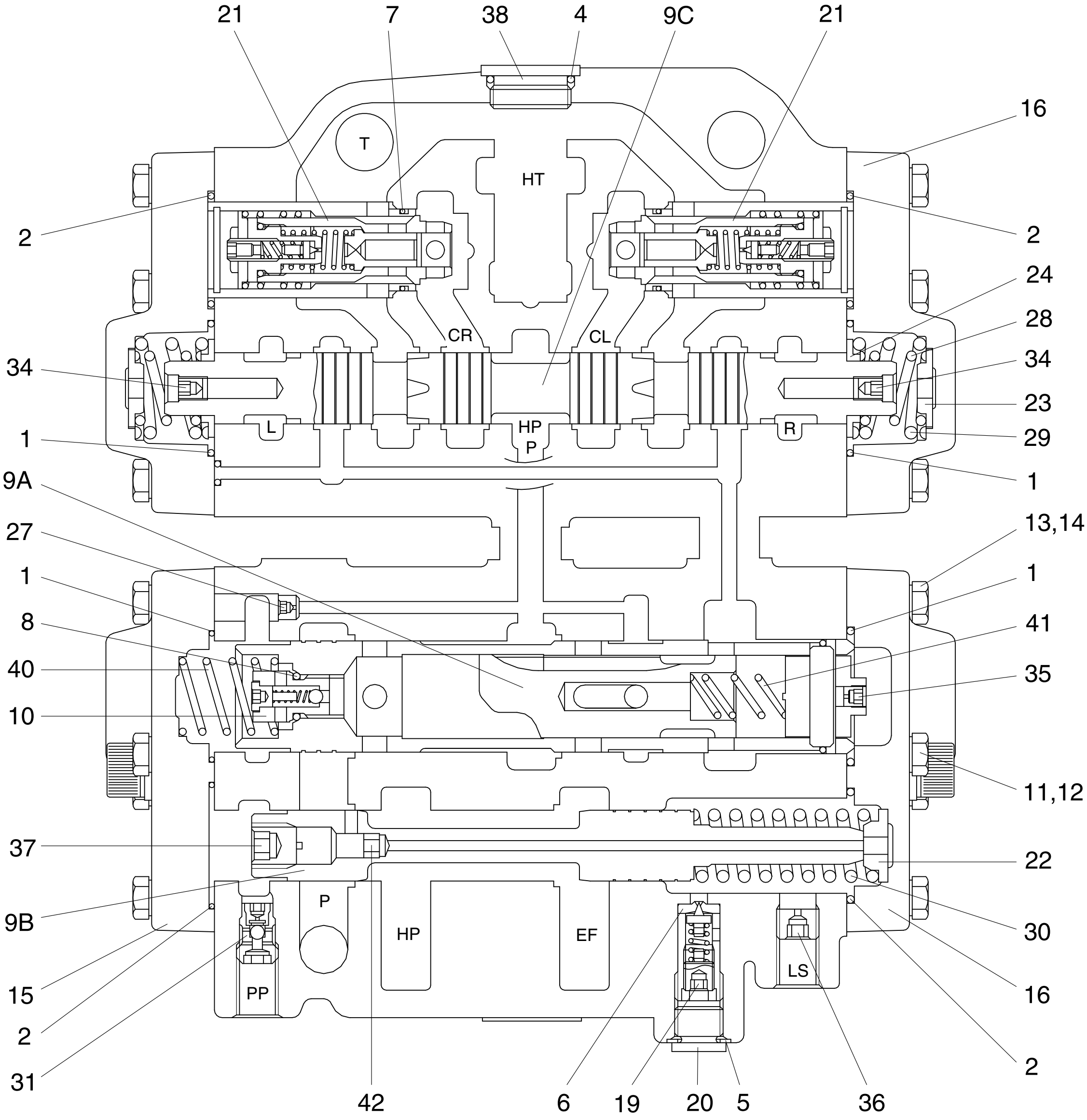
STRUCTURE (3/3)



411	Screw	628	Spring	703	O-ring
422	Plug	629	Spring	704	O-ring
423	Plug	630	Spring	705	O-ring
491	Plug	631	Spring	706	O-ring
492	Restrictor	643	Set screw	707	O-ring
497	Plug	644	Set screw	724	Square ring
601	Casing	645	Plug	802	Nut
624	Spring seat	646	Plug		
625	Spring seat	647	Spool		
626	Stopper	701	O-ring		
627	Stopper	702	O-ring		

4. FLOW AMPLIFIER

1) STRUCTURE



(770-7) 5-6

1	O-ring	12	Spring washer	28	Spring
2	O-ring	13	Screw	29	Spring
4	O-ring	14	Spring washer	30	Spring
5	Washer	15	End cover	31	Throttle check valve
6	Washer	16	End cover	34	Orifice
7	O-ring	19	Relief valve	35	Orifice
8	O-ring	20	Plug	36	Orifice
9A	Amplifier valve	21	Shock, suction valve	37	Plug
9B	Priority valve	22	Spring seat	38	Plug
9C	Directional valve	23	Spring seat	40	Spring
10	Check valve	24	Spring guide	41	Spring
11	Screw	27	Orifice	42	Orifice

2) OPERATION

(1) Introduction

The flow amplifier contain a directional valve, an amplification stage, a priority valve, a pilot pressure relief valve and shock and suction valves.

The flow amplifier amplifies the oil flow from the steering unit cylinder ports L or R by an amplification factor of 8. The amplified oil flow is directed from the flow amplifier ports CL or CR to the steering cylinder. The amplified flow is proportional to the rate of the steering wheel rotation. If the oil flow from the pump fails, the flow amplifier cuts off the amplification.

(2) Priority valve

The priority valve is used in load sensing systems where the same pump supplies oil to both steering system and working hydraulics.

The steering system always has first priority.

The pressure on the LS connection is almost zero during measuring (steering unit in neutral position).

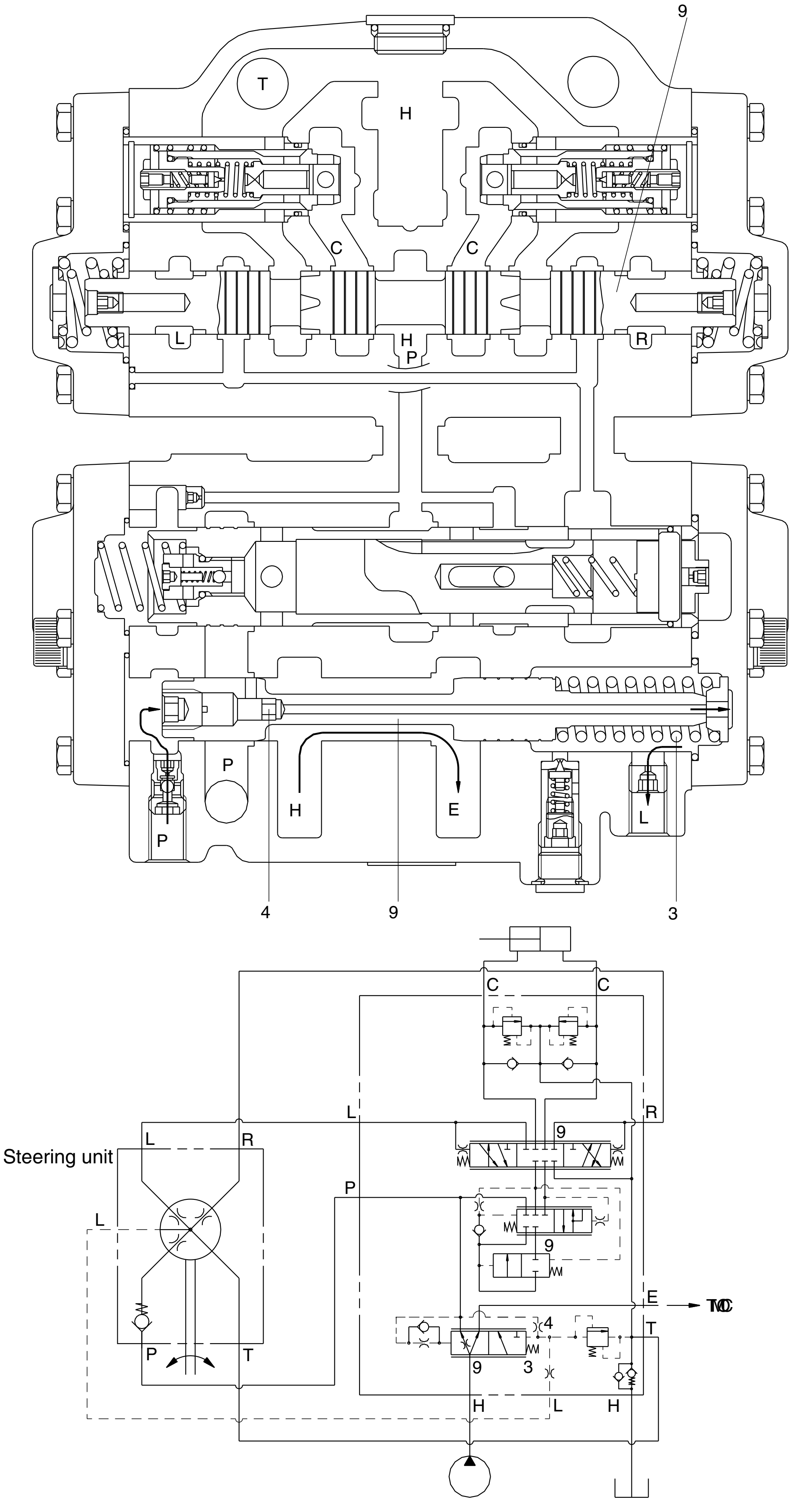
(3) Shock valves

The shock valves protect the flow amplifier against shock from external forces on the steering cylinders. The shock valves in flow amplifier limit the maximum pressure drop from CL to HT and from CR to HT.

(4) HP-HT ports characteristic

The pilot pressure relief valve protects the steering unit against excess pressure. The pilot pressure relief valve together with the priority valve limit the maximum steering pressure HP-HT.

(5) Neutral



980A5SE100

In neutral position, the oil passes from the pump across the integrated priority valve (9B) in the flow amplifier for discharge through the EF port. With the steering unit in neutral, flow through it is blocked and all flow through the priority valve (9B) in flow amplifier is directed out the EF port to the loader control valve.

With the engine off, the priority valve spool (9B) is pushed to the left by the spring (30). The passage to the EF port is blocked while the passage to the P port is open.

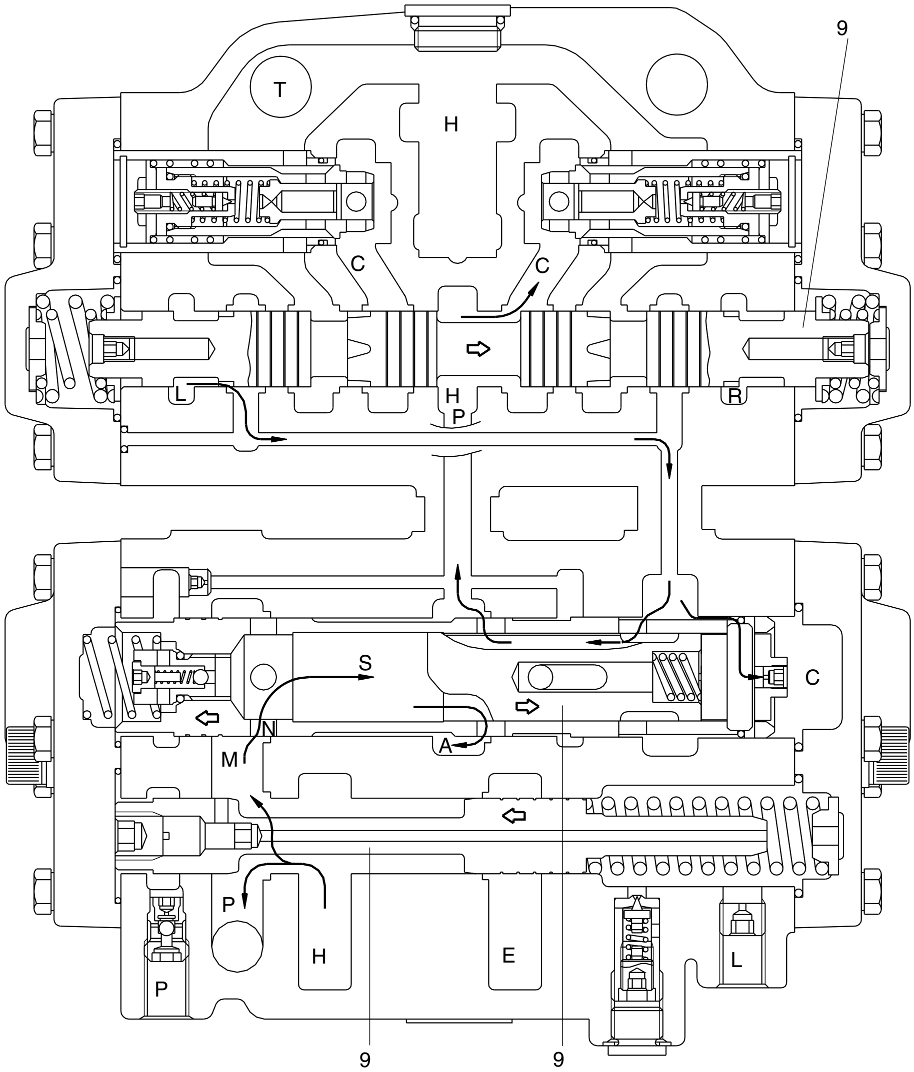
When the machine is first started, all pump flow is routed to the steering unit which blocks the flow. With the flow blocked, the pressure increases.
Steering inlet pressure is supplied through the dynamic orifice (42) in the spool. This causes the priority valve spool (9B) to shift to the right against the spring (30) and open the EF port.
As long as the steering unit is in neutral, just enough pressure is maintained at the steering unit to keep the priority valve spool (9B) shifted to the right.

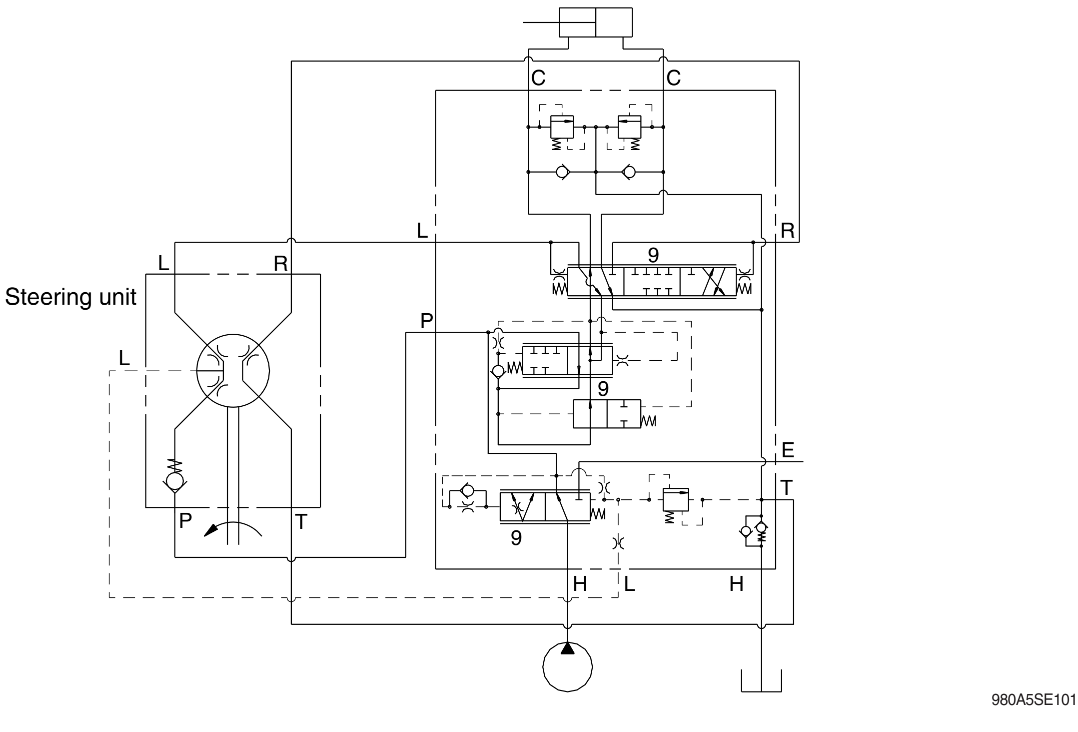
The operating pressure in the loader system has no effect on the operation of the priority valve (9B) of flow amplifier. With the loader actuated in relief, the priority valve (9B) will not shift until the machine is steered.

Flow through the priority valve spool (9B) passes from the P port through the orifice (42) and into the LS port. It flows through the steering unit LS passage which is routed to return when the steering unit is in neutral. This provides a warm-up circuit for the steering unit to prevent binding of the steering unit due to oil temperature extremes.

In neutral position, also the directional valve (9C) is in its center position.
This means that knock and impacts from the cylinder are not transmitted to the steering unit. The flow amplifier is thus of the non-reaction type.

(6) Mid-turn





980A5SE101

If the steering wheel is turned to the left, a LS signal is passed to the priority valve (9B). The priority valve (9B) is reversed so that more oil is passed across the P port to the steering unit for discharge through the L port of the flow amplifier.

The directional valve (9C) is reversed through the pressure being transmitted across the boring in the spool whereby the spool is moved the right.

The opening shall allow connection between the pilot flow and the pressure control/amplifier valve (9A).

The pilot pressure from the orifice in chamber C moves the valve to the left and passage for the pilot flow therefore is possible out of hole F.

The main flow passes from the priority valve (9B) to the circular channel M.   As the amplifier spool is moved to the left, the passage will now be open across the holes N to the chamber S.

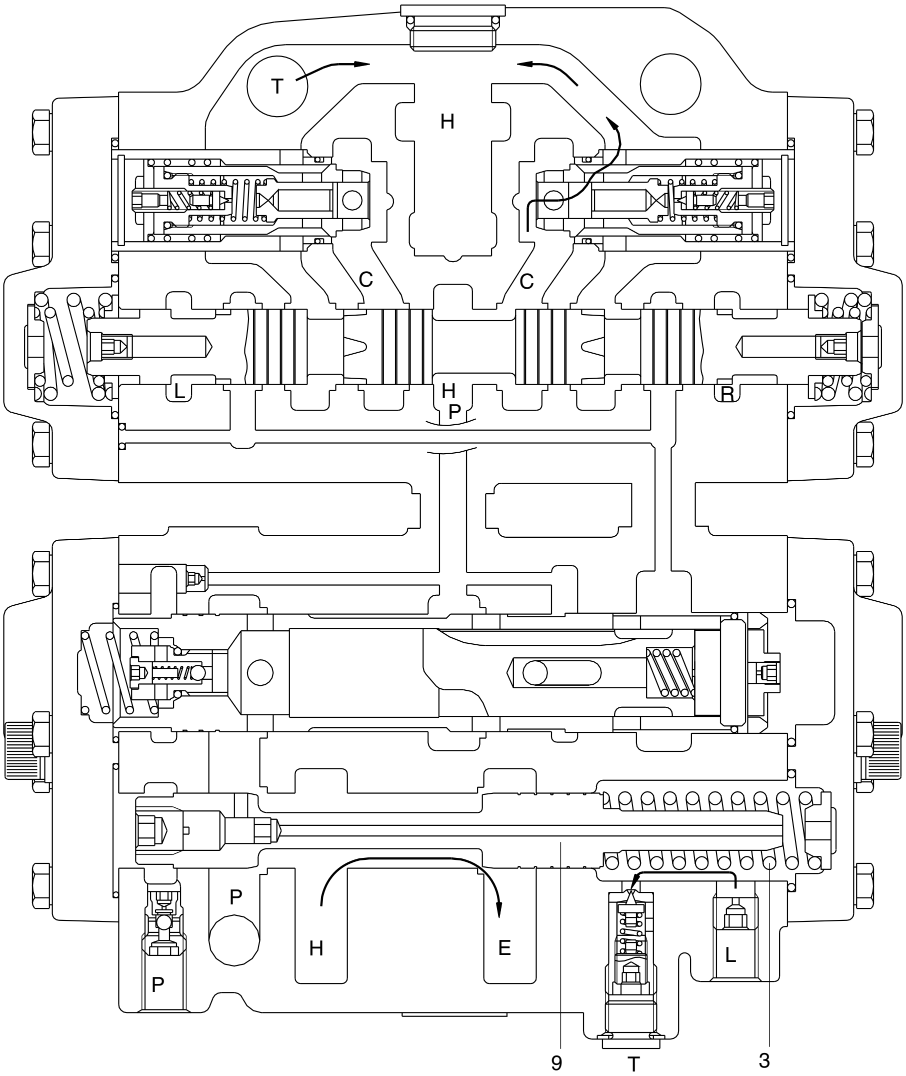
The spool goes to a position so that the pressure in chamber S equals the pressure in chamber C.

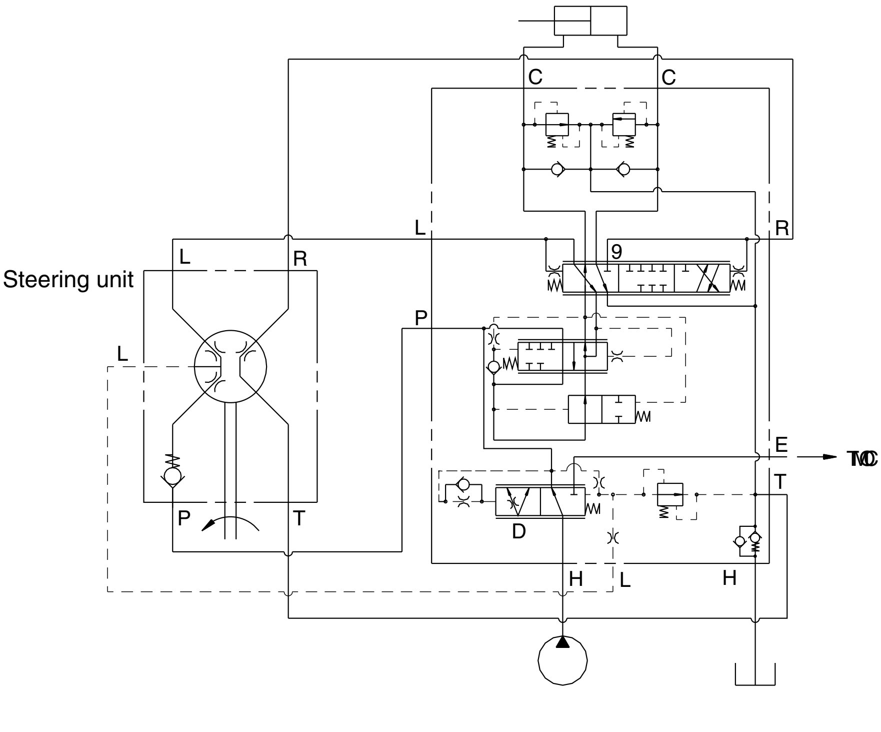
The passage is now open for the main flow through the priority valve (9B) across the holes A.

The main flow and pilot flow merge and is passed across the directional valve (9C) to the steering cylinder through CL port.

The return oil passes across the directional valve (9C) to the hydraulic tank.

(7) Full turm





980A5SE102

When the machine is steered to a full turn, the frames bottom against the steering stops. To limit steering system pressure, a relief system is built into the priority valve assembly (9B).

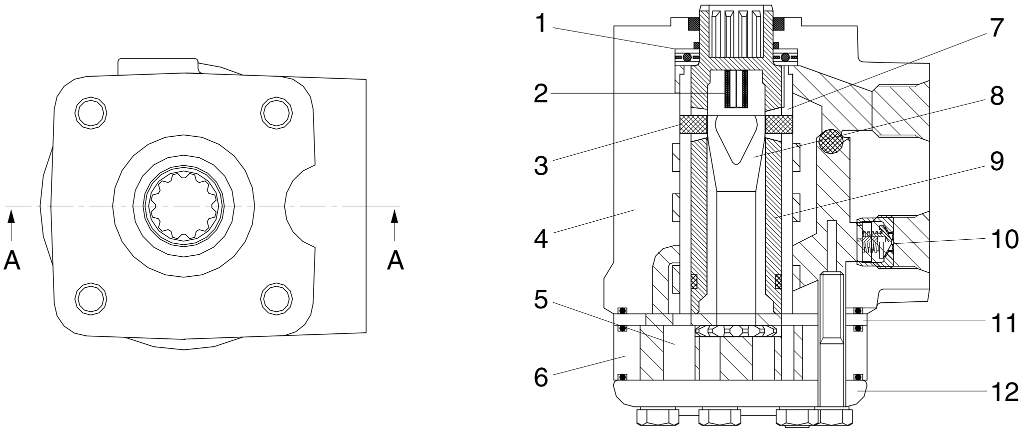
When the frames bottom is stopped, the pressure in the steering cylinders increases. This pressure is sensed at the LS port. When the pressure in the LS port increases enough to push priority valve spool (9B) off its seat, oil in the load sensing circuit flows to return through the T port. Load sensing pressure is limited to the pressure setting of the relief valve.

Pressure to the steering unit (pilot pressure), which is sensed at the left end of the priority valve spool (9B) in flow amplifier, continues to increase until it can move the spool to the right against the load sensing pressure plus spring (30) force. At this time, all oil flows out of the EF port to the loader control valve.

If the loader attachment is being operated while steering, the loader function will slow until the machine reaches the steering stops. At that time, the loader cycle speed will increase until the machine is steered again.

4. STEERING UNIT

1) STRUCTURE



SECTION A - A

7607SE17

1	Bearing	5	Gear wheel	9	Spool
2	Neutral position spring	6	Gear rim	10	Check valve
3	Cross pin	7	Sleeve	11	Distributor plate
4	Housing	8	Cardan shaft	12	End cover

2) OPERATION

The steering unit consists of a rotary valve and a rotary meter.

Via a steering column the steering unit is connected to the steering wheel of the machine.

When the steering wheel is turned, oil is directed from the steering system pump via the rotary valve (spool and sleeve) and rotary meter (gear wheel set) to the cylinder ports L or R, depending on the direction of turn. The rotary meter meters the oil flow to the steering cylinder in proportion to the angular rotation of the steering wheel.

Spool (9) is connected directly to the drive shaft of steering wheel. It is connected to sleeve (7) by cross pin (3) (not in contact with the spool when the steering wheel is at neutral) and neutral position spring (2).

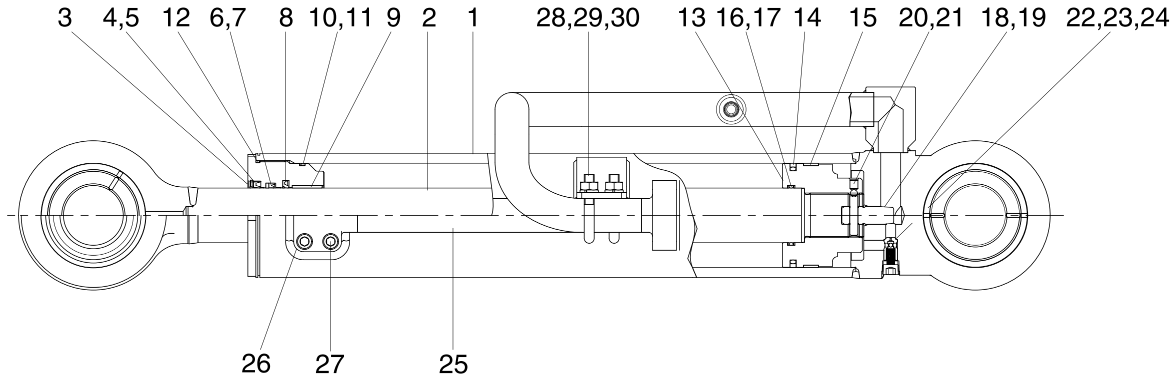
Cardan shaft(8) is meshed at the top with cross pin (3) and forms one unit with sleeve (7).

At the same time, it is meshed with gear rim (5) of the gerotor set by spline.

There are four ports in valve body. They are connected to the pump circuit, tank circuit, and the head, and left and right steering cylinder. In addition, the pump port and tank port are connected inside the body by the check valve. Therefore, if there is any failure in the pump of engine, oil can be sucked in directly from the tank through the check valve.

5. STEERING CYLINDER

1) STRUCTURE



9805SE05

1	Tube assembly	12	O-ring	23	Spring
2	Rod assy	13	Piston	24	Socket plug
3	Gland	14	Piston seal	25	Pipe assembly
4	Dust wiper	15	Wear ring	26	O-ring
5	Retaining ring	16	O-ring	27	Hexagon bolt
6	Rod seal	17	Back-up ring	28	U-bolt
7	Back-up ring	18	Cushion plunger	29	Hexagon nut
8	Buffer ring	19	Paraller pin	30	Spring washer
9	Bearing	20	Steel ball	31	Bearing
10	O-ring	21	Set screw	32	Retaining ring
11	Back-up ring	22	Check valve		

2) OPERATION

This machine use to cross connected cylinder for steering operation.

The steering cylinder use a gland (3) to remove piston and sealed seals. Dust wiper (4) located on the inside of the gland protects cylinder inner parts from dust. The piston (13) is fastened to the rod (2).

The piston uses a single wear ring (15) with a piston seal (14) to seal between the piston and tube. The gland seals against the tube with two O-rings. The rod is sealed against the gland with a rod seal (6).

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

1. OPERATIONAL CHECKS

This procedure is designed so the service man can make a quick check of the steering system using a minimum amount of diagnostic equipment. If you need additional information, prefer to structure and function in group 1.

A location will be required which is level and has adequate space to complete the checks.

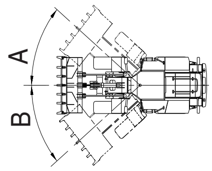
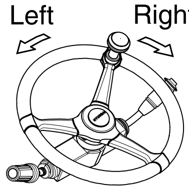
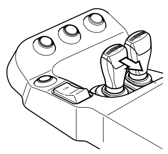
The engine and all other major components must be at operating temperature for some checks.

Locate system check in the left column and read completely, following this sequence from left to right. Read each check completely before performing.

At the end of each check, if no problem is found (OK), that check is complete or an additional check is needed. If problem is indicated (NOT OK), you will be give repair required and group location. If verification is needed, you will be give next best source of information :

· Chapter 2 : Troubleshooting
· Group 3 : Tests and adjustments

※Hydraulic oil must be at operating temperature for these checks (refer to page 6-40).

Item	Description	Service action
Steering unit check	 Run engine at low idle. Turn steering wheel until frames are at maximum right (A) and then left (B) positions. **LOOK** : Frames must move smoothly in both directions. When steering wheel is stopped, frames must stop. **FEEL** : Excessive effort must not be required to turn steering wheel. **NOTE** : It is normal for steering to drift from stops when steering wheel is released.	**OK** Check completed. **NOT OK** Go to next check.
Steering system leakage check Heat hydraulic oil to operating temperature. Run engine at high idle.	 Turn steering wheel rapidly until frames are against stop. Hold approximately 2 kg on steering wheel. Count steering wheel revolutions for 1 minute. Repeat test in opposite direction. **LOOK** : Steering wheel should rotate less than 7 rpm. **NOTE** : Use good judgment; Excessive steering wheel rpm does not mean steering will be affected.	**OK** Check completed. **NOT OK** Do steering system leakage test in group 3 to isolate the leakage.
Priority valve (in flow amplifier) low pressure check	Park machine on a hard surface. Hold brake pedal down. Run engine at high idle. Steer machine to the right and left as far as possible. **LOOK** : Machine must turn at least half way to the right and left stops.	**OK** Check completed. **NOT OK** Do flow amplifier pressure test in group 3.
Priority valve (in flow amplifier) high pressure check Run engine at high idle.	 Steer to steering stop and release steering wheel. Roll bucket back and hold over relief and observe engine rpm. Turn steering wheel to steering stop and hold, observe engine rpm. **LOOK** : Steering stall engine rpm must be higher than hydraulic stall rpm.	**OK** Check completed. **NOT OK** Priority pressure is set too high. Do flow amplifier pressure test in group 3.

2. TROUBLESHOOTING

※ Diagnose malfunction charts are arranged from most probable and simplest to verify, to least likely, more difficult to verify. Remember the following steps when troubleshooting a problem :

Step 1. Operational check out procedure (see group 3 in section 1)

Step 2. Operational checks (in this group)

Step 3. Troubleshooting

Step 4. Tests and adjustments (see group 3)

Problem	Cause	Remedy
No steering	Low oil level.	Add recommended oil.
	Failed steering pump.	Remove and inspect return filter for metal pump particles.
	Failed main pump drive.	Do main pump flow test.
	Stuck priority valve spool.	Remove and inspect priority valve spool.
	Broken priority valve spring.	Remove and inspect spring.
	Relief valve in flow amplifier stuck open.	Do relief cartridge leakage test in group 3.
No hydraulic functions steering normal	Stuck open system relief valve.	Replace relief valve.
	Locked safety valve.	Unlock safety valve.
	Plugged pilot line filter.	Inspect and replace.
	Failed hydraulic pump.	Remove and inspect the pump.
	Low secondary pressure of RCV.	Check the pressure and replace if necessary.

Problem	Cause	Remedy
Slow or hard steering	Too much friction in the mechanical parts of the machine.	Lubricate bearings and joints of steering column or repair if necessary. Check steering column installation.
	Cold oil.	Warm the hydraulic oil.
	Low priority valve pressure setting.	Do priority valve pressure test. Clean or replace cartridge in flow amplifier.
	Worn hydraulic pump.	Do hydraulic pump performance check .
	Sticking priority valve spool.	Remove and inspect.
	Broken priority valve spring.	Remove and inspect.
Constant steering to maintain straight travel	Air in system.	Check for foamy oil.
	Leakage in steering system.	Do steering system leakage check.
	Worn steering unit.	Do steering system leakage check. Do steering unit neutral leakage test in group 3.
	Leaf spring without spring force or broken.	Replace leaf springs.
	Spring in double shock valve broken.	Replace shock valve.
	Gear wheel set worn.	Replace gear wheel set.
	Cylinder seized or piston seals worn.	Replace defects parts.
Slow steering wheel movement will not cause any frame movement	Leakage in steering unit gerotor.	Do steering system leakage check.
	Worn steering unit gerotor.	Do steering leakage check.
Steering wheel can be turned with frames against steering stop	Leakage in steering system.	Do steering system leakage check.
Steering wheel turns with no resistance and causes no frame movement	Broken steering column or splined coupling.	Remove and inspect.
	Lack of oil in steering unit.	Start engine and check steering operation.
	Leakage in steering system.	Do steering system leakage test in group 3.

Problem	Cause	Remedy
Erratic steering	Air in oil.	Check for foamy oil.
	Low oil level.	Add recommended oil.
	Sticking priority valve spool.	Remove and inspect spool.
	Loose cylinder piston.	Remove rod to inspect piston.
	Damaged steering unit.	Remove and inspect.
Spongy or soft steering	Air in oil.	Check for foamy oil.
	Low oil level.	Add recommended oil.
Free play at steering wheel	Loose steering wheel nut.	Tighten.
	Worn or damaged splines on steering column or unit.	Inspect.
Steering unit binding or steering wheel does not immediately return to neutral when released	Binding in steering column or misalignment of column.	Inspect.
	High return pressure.	Check for a pinched or damaged return line.
	Contamination in steering unit.	Inspect hydraulic filter for contamination. Repair cause of contamination. Flush hydraulic system.
	Large particles of contamination in steering unit.	Inspect hydraulic filter for contamination. Repair cause of contamination. Flush hydraulic system.
Steering unit locks up	★ Thermal shock	Do priority valve LS port flow test in group 5. This oil flow provides a warm -up flow to steering unit when not using the steering.
	Worn or damaged steering unit.	Repair or replace steering unit.
Abrupt steering wheel oscillation	Improperly timed gerotor gear in steering unit.	Time gerotor gear.
Steering wheel turns by itself	Lines connected to wrong port.	Reconnect lines.
Vibration in steering system or hoses jump	High priority valve setting.	Do priority valve pressure test.
Neutral position of steering wheel cannot be obtained, i.e. there is a tendency towards "motoring"	Steering column and steering unit out of line.	Align the steering column with steering unit.
	Too little or no play between steering column and steering unit input shaft.	Adjust the play and, if necessary, shorten the splines journal.
	Pinching between inner and outer spools.	Contact the nearest service shop.

★ Thermal shock is caused by a large temperature differential(Approx. 30˚C, 50˚F) between the steering valve and hydraulic oil. If the steering is not operated for a long period of time and the orifice in the bottom of the priority valve spool is plugged, the steering valve may bind up when the steering is operated if the hydraulic oil is hot enough.

Problem	Cause	Remedy
"Motoring" effect. The steering wheel can turn on its own.	Leaf springs are stuck or broken and have therefore reduced spring force.	Replace leaf springs.
	Inner and outer spools pinch, possibly due to dirt.	Clean steering unit or contact the nearest service shop.
	Return pressure in connection with the reaction between differential cylinder and steering unit too high.	Reduce return pressure.
	Oil is needed in the tank.	Fill with clean oil and bleed the system.
	Steering cylinder worn.	Replace or repair cylinder.
	Gear wheel set worn.	Replace gear wheel set.
	Spacer across cardan shaft forgotten.	Install spacer.

Problem	Cause	Remedy
Backlash	Cardan shaft fork worn or broken.	Replace cardan shaft.
	Leaf springs without spring force or broken.	Replace leaf springs.
	Worn splines on the steering column.	Replace steering column.
"Shimmy" effect. The steered wheels vibrate. (Rough tread on tires gives vibrations)	Air in the steering cylinder.	Bleed cylinder. Find and remove the reason for air collection.
	Mechanical connections or wheel bearings worn.	Replace worn parts.
	High priority valve setting pressure.	Set pressure as regular value.
Steering wheel can be turned slowly in one or both directions without the steered wheels turning.	One or both shock valves are leaky or are missing in steering valve.	Clean or replace defective of missing valves.
Steering is too slow and heavy when trying to turn quickly.	Insufficient oil supply to steering unit, pump defective or number of revolutions too low.	Replace pump or increase number of revolutions.
	Relief valve setting too low.	Adjust valve to correct setting.
	Relief valve sticking owing to dirt.	Clean the valve.
	Spool in priority valve sticking owing to dirt.	Clean the valve, check that spool moves easily without spring.
	Too weak spring in priority valve.	Replace spring by a stronger.
"Kick back" in steering wheel from system. Kicks from wheels.	Fault in the system.	Contact authorized man or shop.

Problem	Cause	Remedy
Heavy kick-back in steering wheel in both directions.	Wrong setting of cardan shaft and gearwheel set.	Correct setting as shown in this manual.
urning the steering wheel activates the steered wheels opposite.	Hydraulic hoses for the steering cylinders have been switched around.	Connect lines to correct ports.
Hard point when starting to turn the steering wheel	Spring force in priority valve too weak. Oil is too thick (cold).	Replace spring by a stronger. Let motor run until oil is warm.
Too little steering force (possibly to one side only).	Pump pressure too low. Too little steering cylinder. Piston rod area of the differential cylinder too large compared with piston diameter.	Correct pump pressure. Fit a larger cylinder. Fit cylinder with thinner piston rod or 2 differential cylinders.
Leakage at either input shaft, end cover, gearwheel set, housing or top part.	Shaft defective. Screws loose. Washers or O-rings defective.	Replace shaft seal. Tighten screws. Replace.

GROUP 3 TESTS AND ADJUSTMENTS

1. HYDRAULIC OIL CLEAN UP PROCEDURE USING PORTABLE FILTER CADDY

※ Service equipment and tool.

- · Portable filter caddy
- · Two 3658 mm (12 ft) × 1" I.D. 100R1 hoses with 3/4 M NPT ends
- · Quick disconnect fittings
- · Discharge wand
- · Various size fittings and hoses

※ Brake system uses oil from hydraulic oil tank. Flush all lines in the steering system.
Disassemble and clean major components for steering system.
Steering components may fail if steering system is not cleaned after hydraulic oil tank contamination.

1) If hydraulic system is contaminated due to a major component failure, remove and disassemble steering cylinders to clean debris from cylinders.

2) Install a new return filter element. Clean filter housing before installing new element.

※ For a failure that creates a lot of debris, remove access cover from hydraulic oil tank. Drain and clean hydraulic oil tank of fill the specified oil to hydraulic oil tank through upper cover.

3) To minimize oil loss, pull a vacuum in hydraulic oil tank using a vacuum pump. Connect filter caddy suction line to drain port at bottom of hydraulic oil tank using connector. Check to be sure debris has not closed drain port.

4) Put filter caddy discharge line into hydraulic oil tank filter hole so end is as far away from drain port as possible to obtain a through cleaning of oil.

5) Start the filter caddy. Check to be sure oil is flowing through the filters.
   Operate filter caddy approximately 10 minutes so oil in hydraulic oil tank is circulated through filter a minimum of four times.
※ Hydraulic oil tank capacity 200 ℓ (52.8 U.S. gal).
   Leave filter caddy operating for the next steps.

6) Start the engine and run it at high idle.
※ For the most effective results, cleaning procedure must start with the smallest capacity circuit then proceed to the next largest capacity circuit.

7) Operate all functions, one at a time, through a complete cycle in the following order: clam, steering, bucket, and boom. Also include all auxiliary hydraulic functions.

   Repeat procedure until the total system capacity has circulated through filter caddy seven times, approximately 30 minutes.
   Each function must go through a minimum of three complete cycles for a through cleaning for oil.

※ Filtering time for machines with auxiliary hydraulic functions must be increased because system capacity is larger.

8) Stop the engine. Remove the filter caddy.

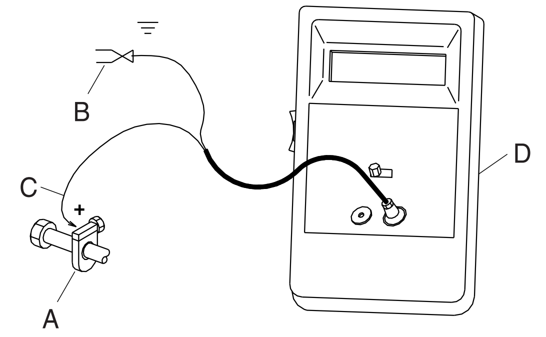
9) Install a new return filter element.

10) Check oil level in hydraulic oil tank ; Add oil if necessary.

2. TEST TOOLS

1) CLAMP-ON ELECTRONIC TACHOMETER INSTALLATION

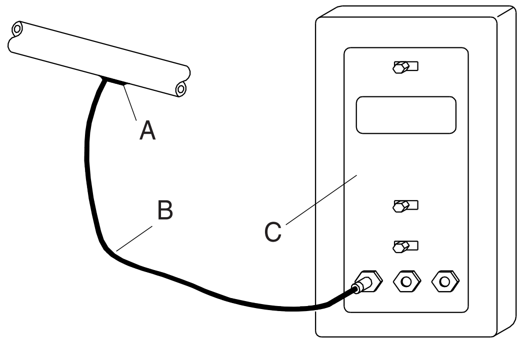
· Service equipment and tools
  Tachometer
  A : Clamp on tachometer.
  Remove paint using emery cloth and connect to a straight section of injection line within 100 mm (4in) of pump. Finger tighten only-do not over tighten.
  B : Black clip (-). Connect to main frame.
  C : Red clip (+). Connect to transducer.
  D : Tachometer readout. Install cable.



(770-3ATM) 5-30

2) DIGITAL THERMOMETER INSTALLATION

· Service equipment and tools
  Digital thermometer
  A : Temperature probe.
  Fasten to a bare metal line using a tie band. Wrap with shop towel.
  B : Cable.
  C : Digital thermometer.



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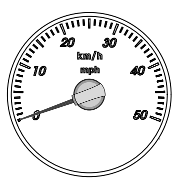
3) DISPLAY MONITOR TACHOMETER

The display monitor tachometer is accurate enough for test work.



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3. STEERING SYSTEM RESTRICTION TEST

· **SPECIFICATION**

Oil temperature	45±5˚C (113±9˚F)
Engine speed	High idle
Maximum pressure at flow amplifier	2.1MPa (21 bar, 300psi)

· **GAUGE AND TOOL**

Gauge 0~7 MPa (0~70 bar, 0~1000 psi) 2EA

· This test will check for restrictions in the steering system which can cause overheating of hydraulic oil.

1) Install temperature reader.
(see temperature reader installation procedure in this group).

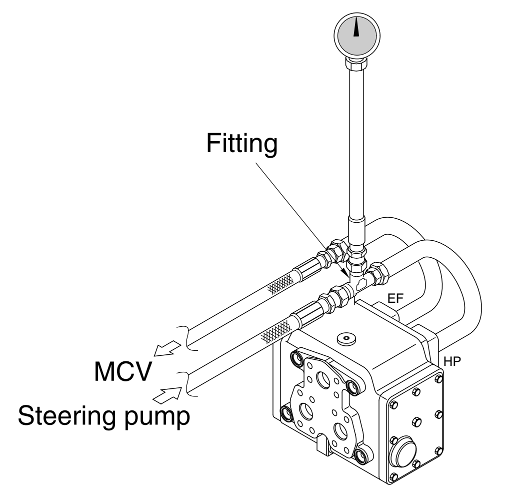
2) Heat hydraulic oil to specifications.
(see hydraulic oil warm up procedure at page 6-40).

3) Connect fitting and install gauge.

⚠ **Do not operate steering or loader functions or test gauge may be damaged.**

4) Run engine at specification and read pressure gauges.

If pressure is more than specification at the flow amplifier, inspect flow amplifier for a priority valve spool. Make sure orifice plugs installed in ends of priority valve spool.
Check for plugged orifice in flow amplifier LS port.



4. STEERING UNIT LEAKAGE TEST

· **SPECIFICATION**

Oil temperature 45±5˚C (113±9˚F)
Engine speed High idle
Maximum leakage 7.5 ℓ/min (2 gpm)

· **GAUGE AND TOOL**

Temperature reader
Measuring container (approx. 20 ℓ)
Stop watch

1) Install frame locking bar to prevent machine from turning.

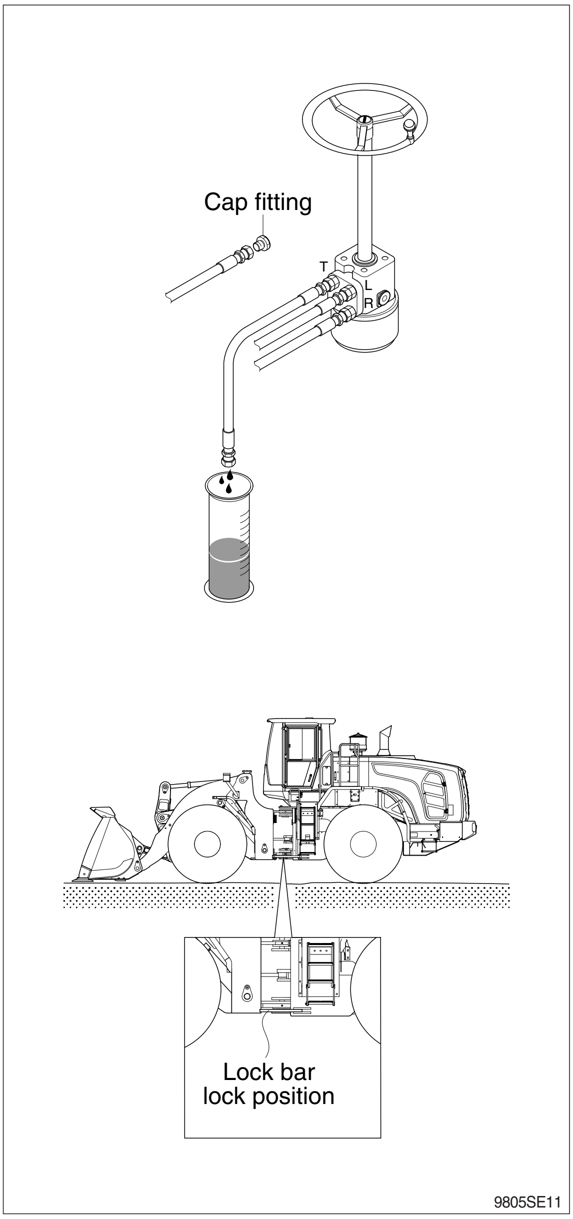
2) Install temperature reader.
(see temperature reader installation procedure in this group).

3) Heat hydraulic oil to specifications.
(see hydraulic oil warm up procedure at page 6-40).

4) Disconnect return hose from fitting.
Install cap fitting.

5) Run engine at specifications. Rotate steering wheel against locking bar using approximately 1.2 kgf · m of force.
Measure oil flow from return hose for 1 minute.

6) Leakage is greater than specifications, repair or replace steering unit.



5. FLOW AMPLIFIER PRESSURE TEST

· SPECIFICATION

Oil temperature	45±5˚C (113±9˚F)
Engine speed	High idle
Oil pressure	20.1~21.1 MPa (205~215 bar, 2900~3100 psi)

· GAUGE AND TOOL

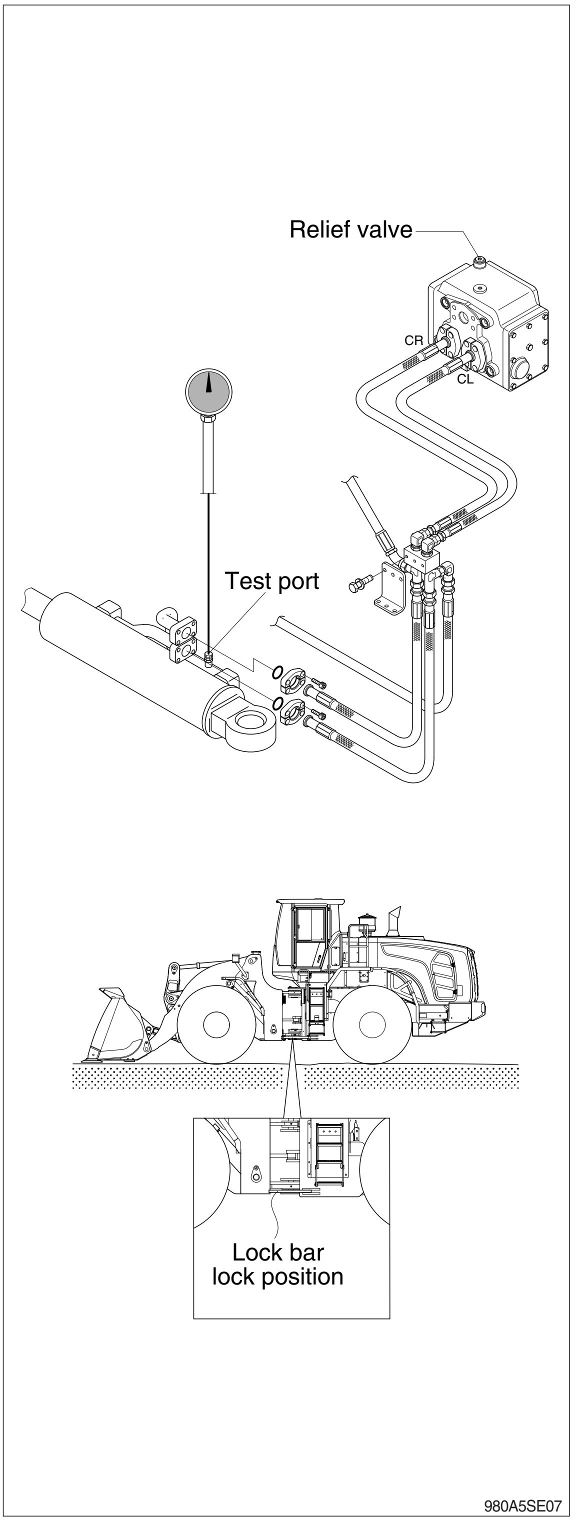
Gauge 0~35 MPa (0~350 bar, 0~5000 psi)
Temperature reader

1) Connect gauge to test port.
2) Install temperature reader (see installation procedure in this group).
3) Install frame locking bar.
4) Heat hydraulic oil to specifications. (see hydraulic oil warm up procedure at page 6-40)
5) Run engine at specifications and turn steering wheel rapidly hold approximately 22N (5lb force) pressure on wheel with frames locked.

※ If steering wheel is turned slowly, it will continue to with the frames locked.
This will give an incorrect pressure reading.
If steering wheel continues to turn rapidly with the frames locked, steering system leakage is indicated.

6) Read pressure gauge. This is the flow amplifier relief pressure.
7) If pressure in not to specification, turn adjusting screw in relief cartridge using a hex head wrench to adjust pressure.

If pressure cannot be adjusted to specification, disassemble and inspect flow amplifier.



6. FLOW AMPLIFIER LS PORT FLOW TEST

· SPECIFICATION

Oil temperature	45±5˚C (113±9˚F)
Engine speed	Low idle
LS port flow (approx.)	1 mℓ/min

· GAUGE AND TOOL

Temperature reader
Measuring container
Stop watch

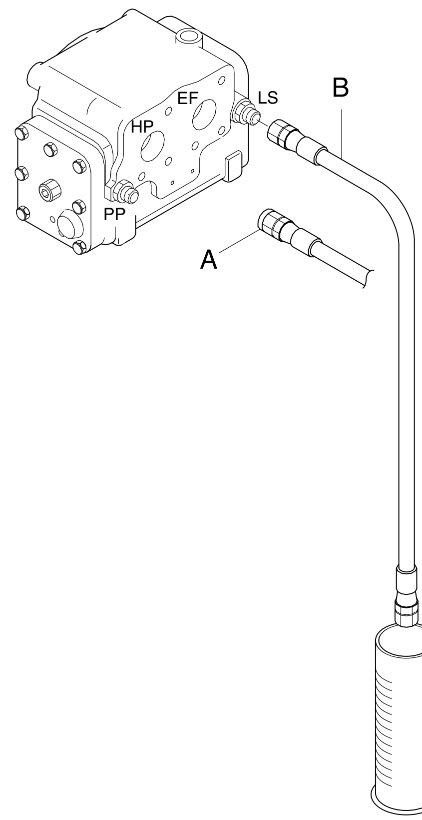
Flow amplifier LS port flow test will check for a plugged or missing orifice in the bottom of the priority valve spool. A plugged orifice will block warm up flow to the steering unit which can cause thermal shock (see for an explanation of thermal shock page 5-22).

A missing orifice can cause the pump to be loaded to high pressure at all times causing overheating.

1) Install temperature reader (see temperature reader installation procedure in this group.)
2) Heat hydraulic oil to specifications (see hydraulic oil warm up procedure at page 6-54).
3) Disconnect line from LS port and install plug (A).
4) Connect line (B) to flow amplifier.
5) Start engine and run at specification.
6) Measure flow from LS port for 1 minute.
7) If flow is low, low steering system neutral pressure or a plugged orifice in bottom priority valve spool is indicated.

   If flow is high, remove priority valve spool and inspect for a missing orifice.

   Do hydraulic system restriction test in this group.



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7. FLOW AMPLIFIER RELIEF CARTRIDGE LEAKAGE TEST

· SPECIFICATION

Oil temperature 45±5˚C (113±9˚F)

Engine speed High idle

Maximum leakage 1 mℓ/min (16 drops per min)

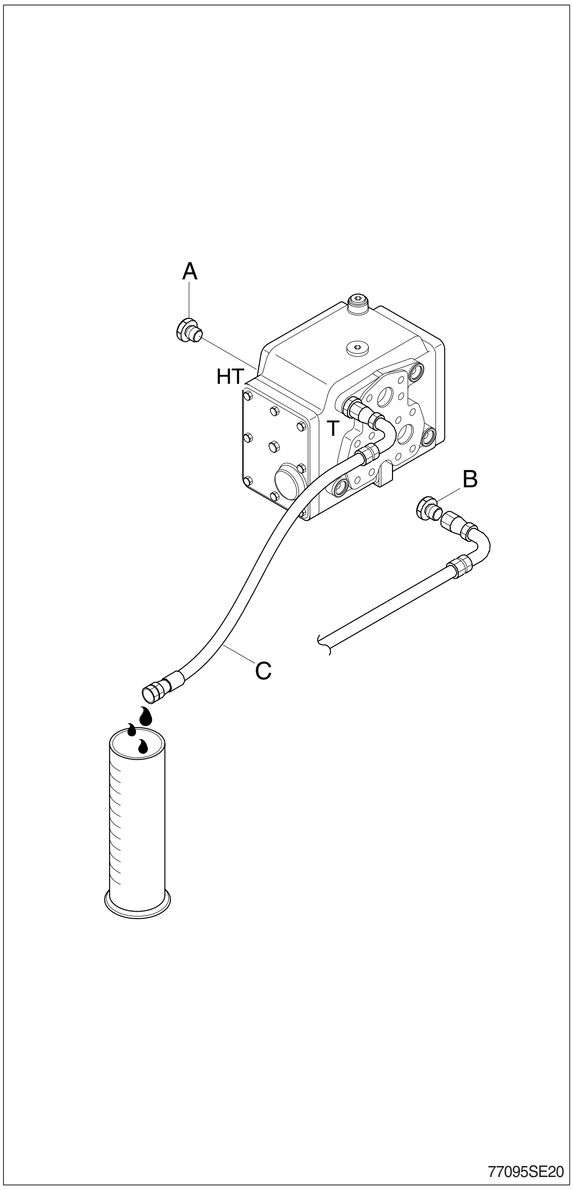
· GAUGE AND TOOL

Temperature reader

Measuring container

Stop watch

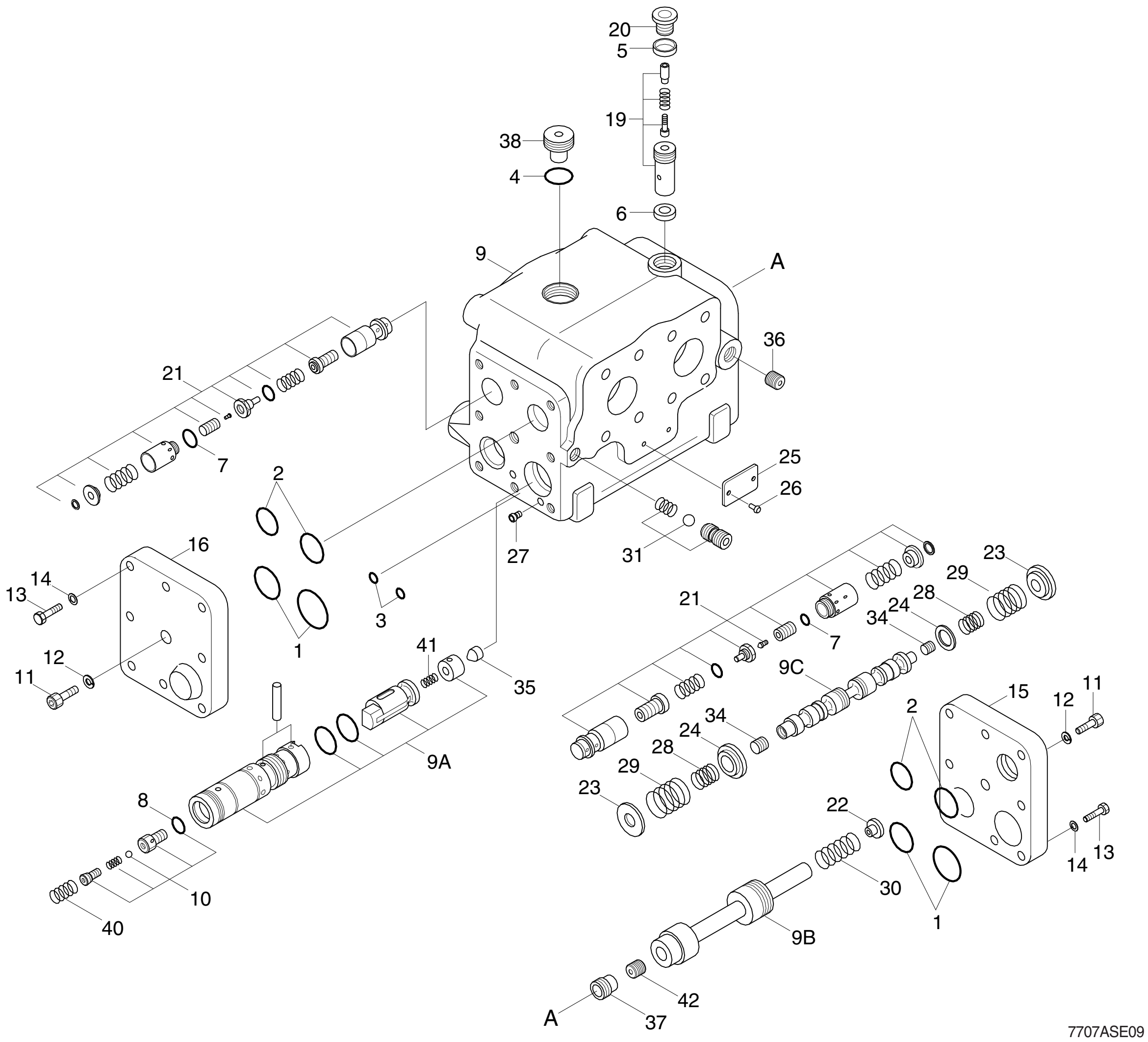
1) Install temperature reader.
   (see temperature reader installation procedure in this group).
2) Heat hydraulic oil to specifications.
   (see hydraulic oil warm up procedure at page 6-40).
3) Install plug (A) in HT port.
   Disconnect line from T port on flow amplifier. Install plug (B) in line.
4) Connect line (C) to flow amplifier.
5) Start engine and run at specification.
6) Measure oil leakage from T port.
7) If leakage is more than specification, disassemble and inspect cartridge for damage or debris.



GROUP 4 DISASSEMBLY AND ASSEMBLY

1. FLOW AMPLIFIER

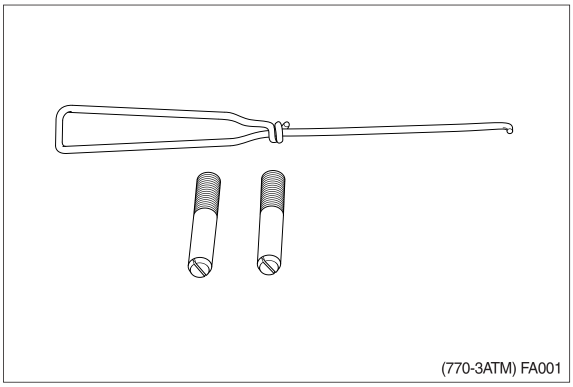
1) STRUCTURE



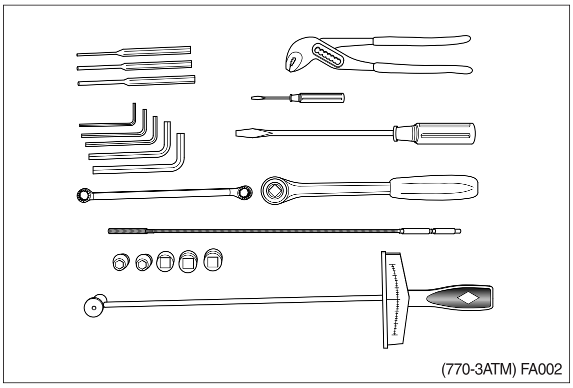
1	O-ring	12	Spring washer	28	Spring
2	O-ring	13	Screw	29	Spring
3	O-ring	14	Spring washer	30	Spring
4	O-ring	15	End cover	31	Throttle check valve
5	Washer	16	End cover	34	Orifice
6	Washer	19	Relief valve	35	Orifice
7	O-ring	20	Plug	36	Orifice
8	O-ring	21	Shock, suction valve	37	Plug
9	Housing	22	Spring seat	38	Plug
9A	Amplifier valve	23	Spring seat	40	Spring
9B	Priority valve	24	Spring guide	41	Spring
9C	Directional valve	26	Name plate	42	Orifice
10	Check valve	27	Orifice		
11	Screw				

2) TOOLS

· Guide screws : M8×1.0
· Hook : Wire


(770-3ATM) FA001

· Hexagon keys : 4, 5, 6, 8 and 10 mm
· Ratchet for socket spanners
· Hex socket for external : 13, 17 & 19 mm
· Hex socket for internal : 8 & 10 mm
· Multigrip pliers
· Ring spanner : 13 mm
· Screwdrivers : 3 and 10 mm
· Steel Mandrels : 3, 5 and 8 mm
· Torque wrench : 12.2 kgf · m (88 lbf · ft)
· Magnetic rod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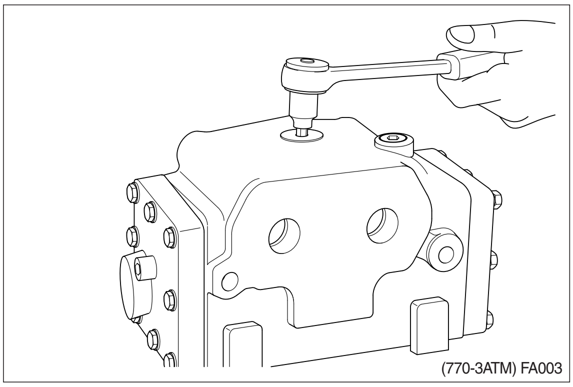
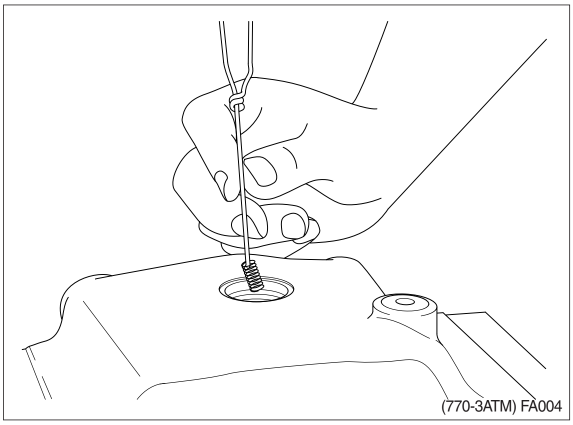
3) DISASSEMBLY

(1) Disassembly counter pressure valve

① Unscrew plug with O-ring (hexagon socket for 8 mm internal hexagon).


(770-3ATM) FA003

② Take out small spring (hook).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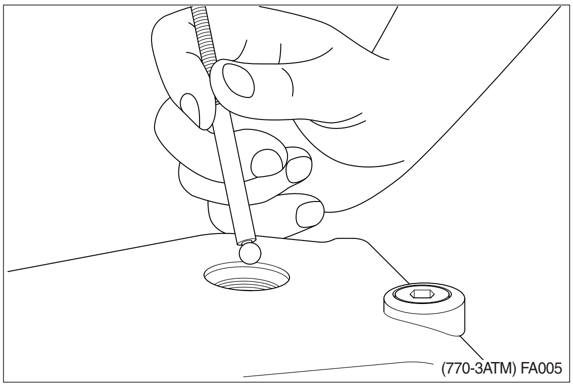
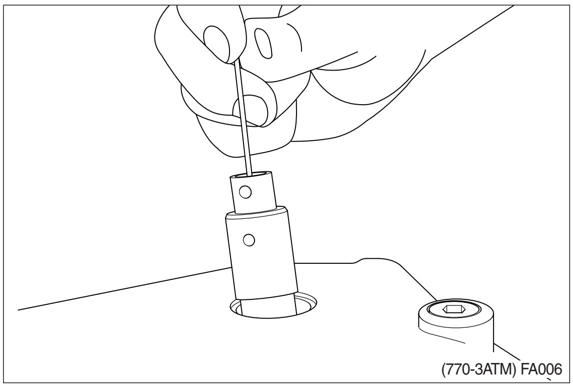
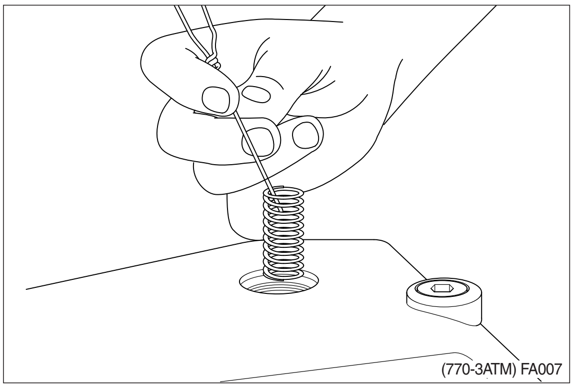
③ Take out ball (magnetic rod).



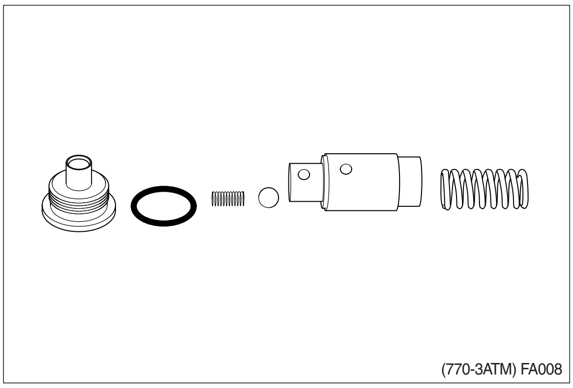
④ Take out piston.



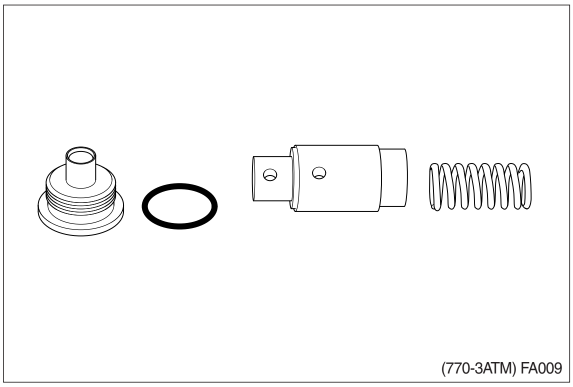
⑤ Take out spring.



⑥ Counter pressure valve shown disassembled.



⑦ Counter pressure valve with orifice shown disassembled.



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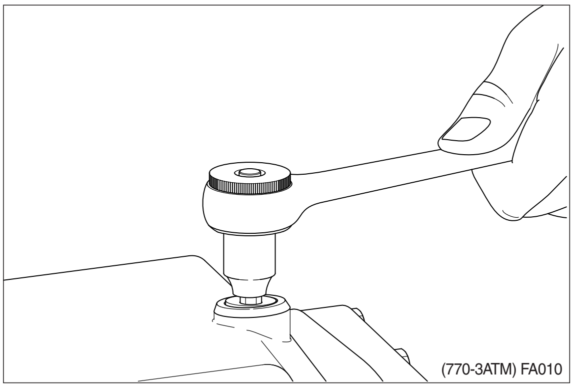
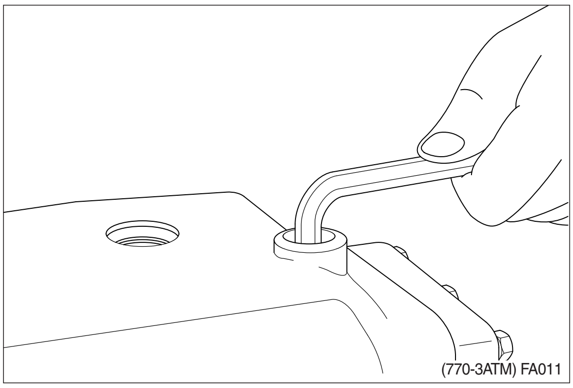
(2) Removing pressure relief valve

① Unscrew plug with washer (hexagon socket for 8 ㎜ internal hexagon).



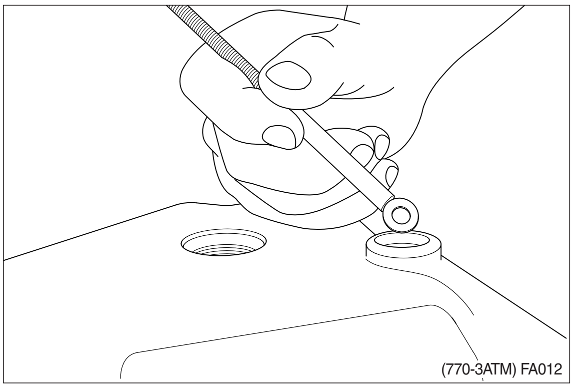
(770-3ATM) FA010

② Screw pressure relief valve out (10 ㎜ hexagon key).



(770-3ATM) FA011

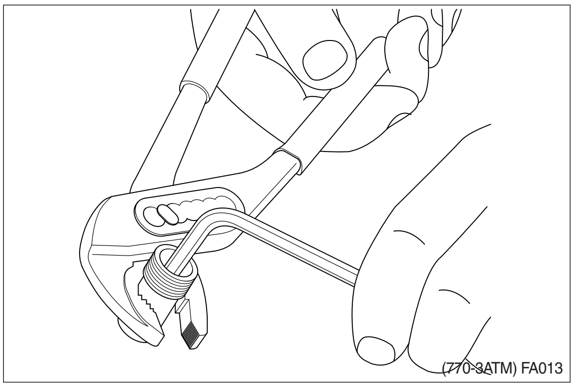
③ Take out washer (magnetic rod).



(770-3ATM) FA012

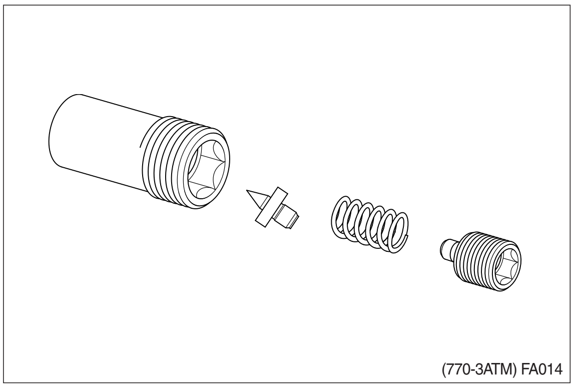
(3) Disassembly pressure relief valve

① Hold cartridge (multigrip pliers) and screw the adjustment screw out (5 mm hexagon key).



(770-3ATM) FA013

② Pressure relief valve shown disassembled.



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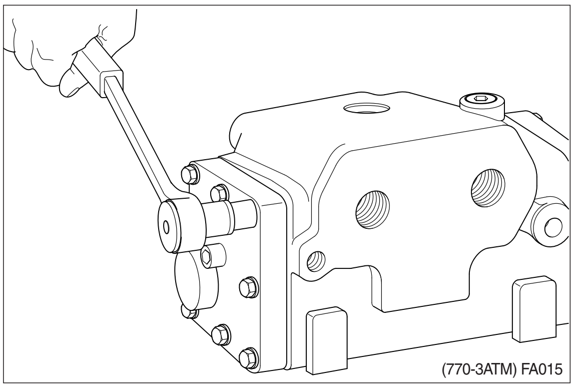
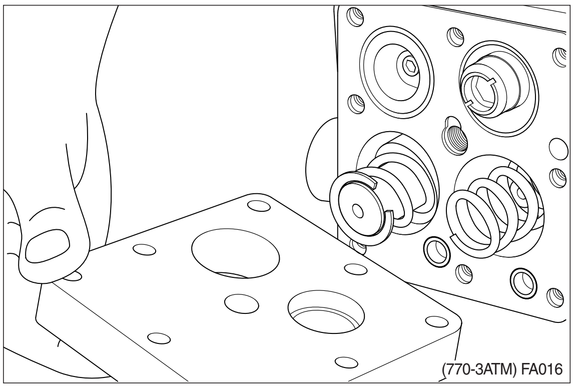
(4) Removing end cover at PP-connection

① Unscrew screws with spring washer using hexagon socket for 13 mm external hexagon and 10 mm internal hexagon.



(770-3ATM) FA015

② Remove end cover.



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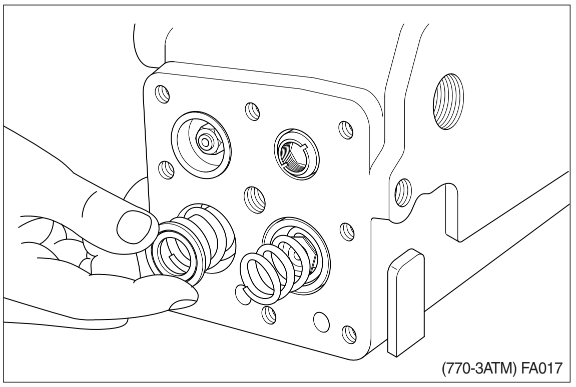
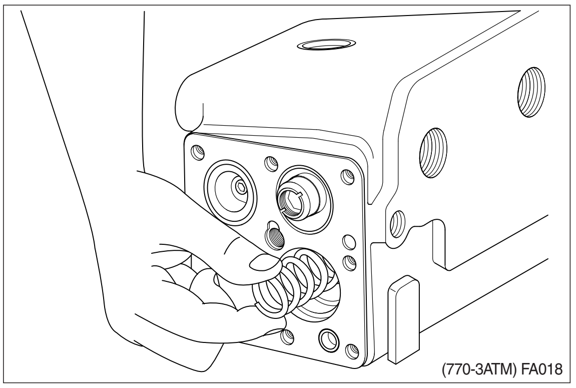
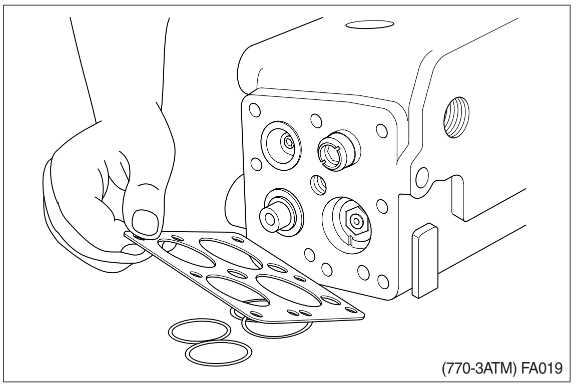
③ Remove stop and 2 springs.



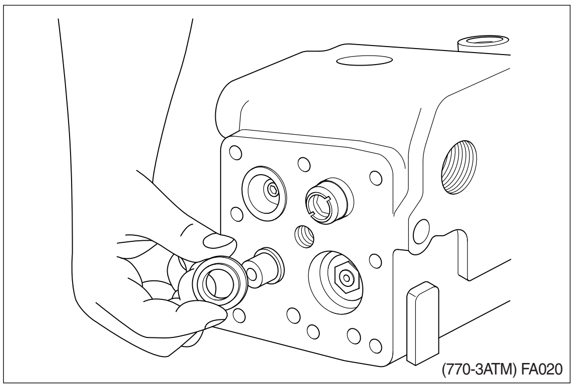
④ Remove spring.



③ Remove plate and 6 O-rings.

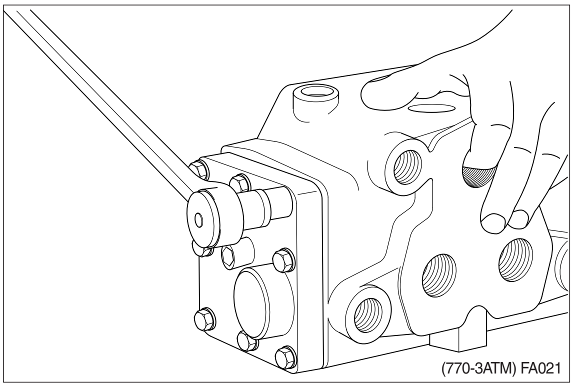


④ Remove spring guide.



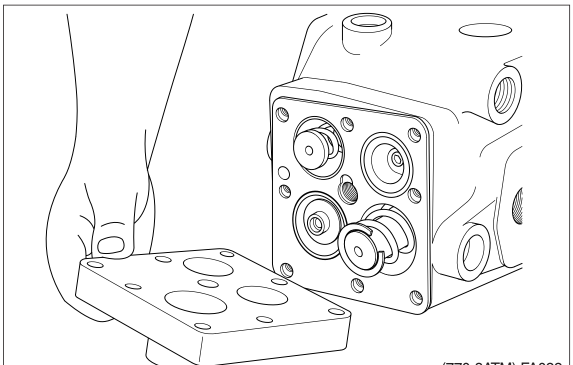
(5) Removing end cover at LS-connection

① Unscrew screws with spring washer using hexagon socket for 13 mm external hexagon and 10 mm internal hexagon.



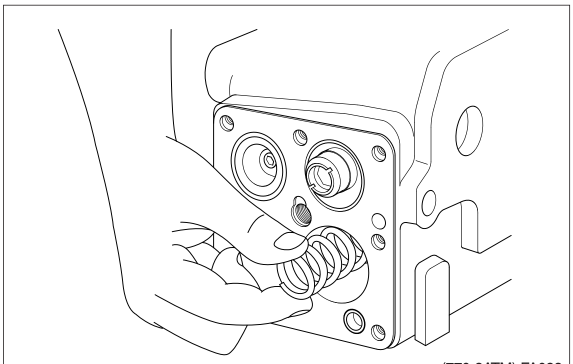
(770-3ATM) FA021

② Remove end cover.



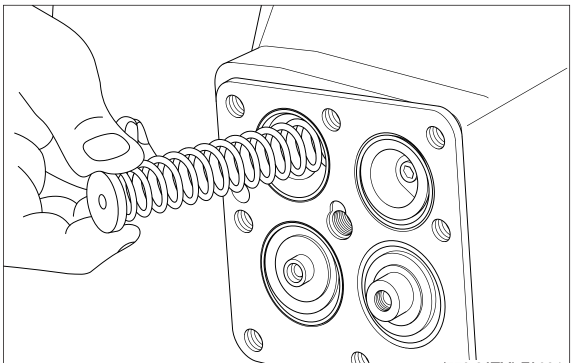
(770-3ATM) FA022

③ Remove stop and 2 springs.



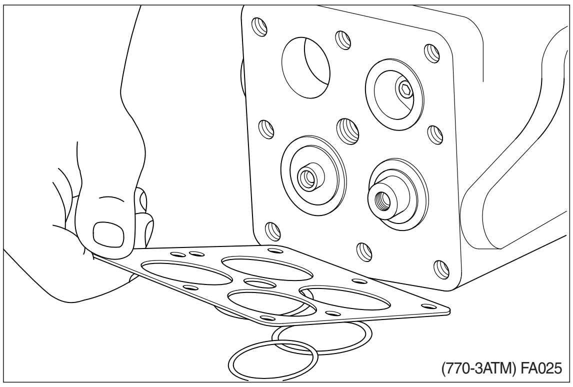
(770-3ATM) FA023

④ Remove stop and spring.

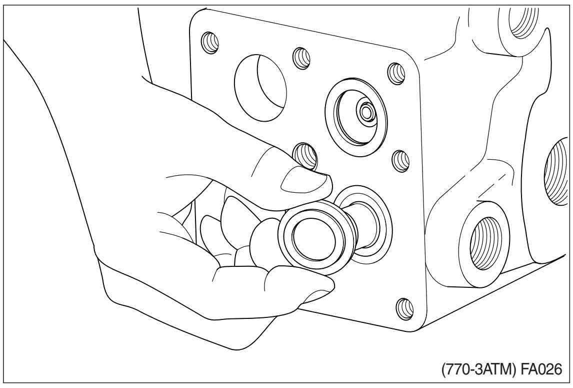


(770-3ATM) FA024

⑤ Remove plate and 4 O-rings.

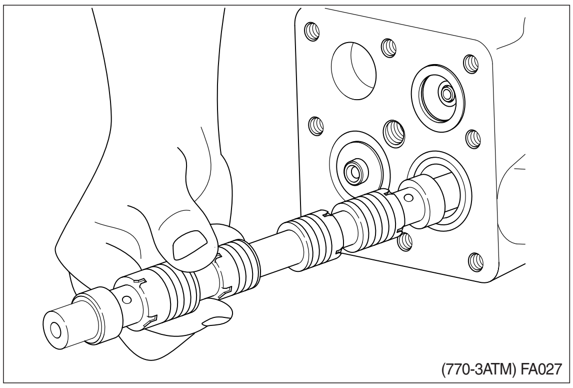


⑥ Remove spring guide.

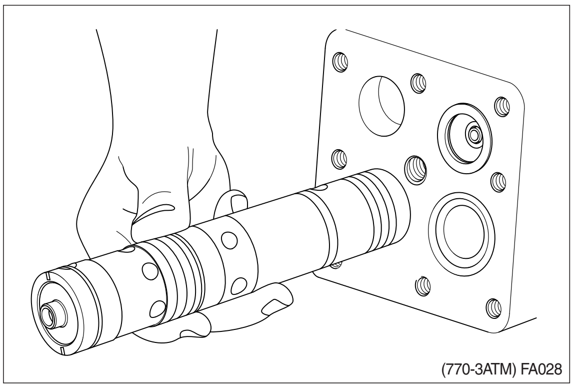


(6) Removing spools

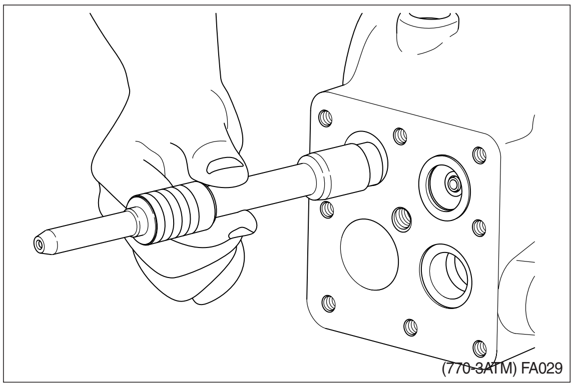
① Remove directional spool.



② Remove amplifier spool.



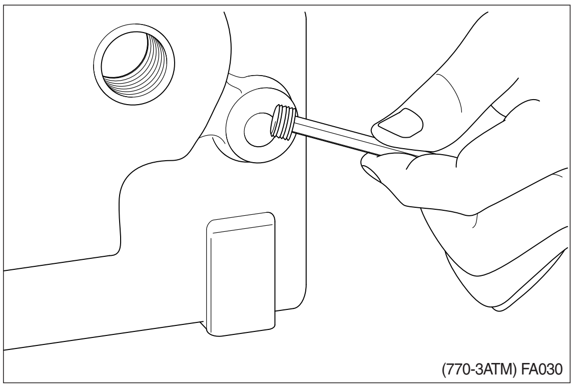
③ Remove priority valve spool.



(770-3ATM) FA029

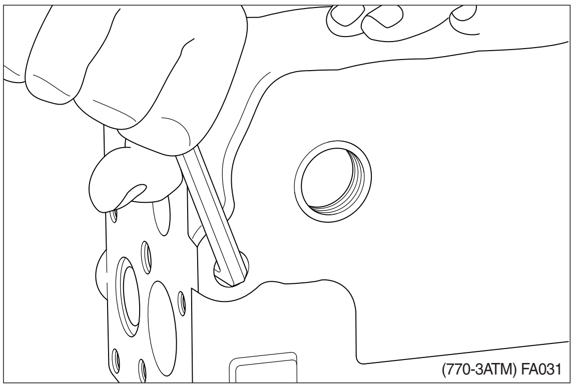
(7) Removing orifices and throttle check valve

① Unscrew orifice in LS-connection with 6 ㎜ hexagon key.



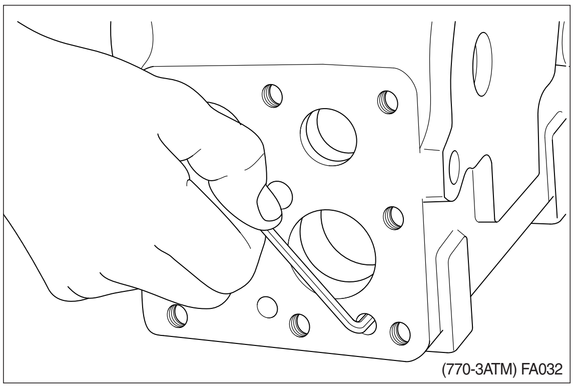
(770-3ATM) FA030

② Unscrew throttle check valve in PP-connection with 6㎜ hexagon key.



(770-3ATM) FA031

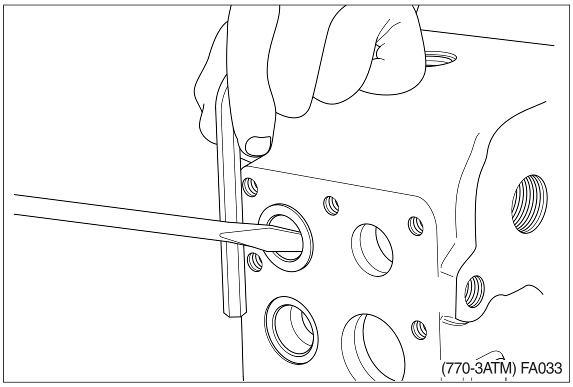
③ Unscrew orifice in housing with 4 ㎜ hexagon key.



(770-3ATM) FA032

(8) Removing shock valves

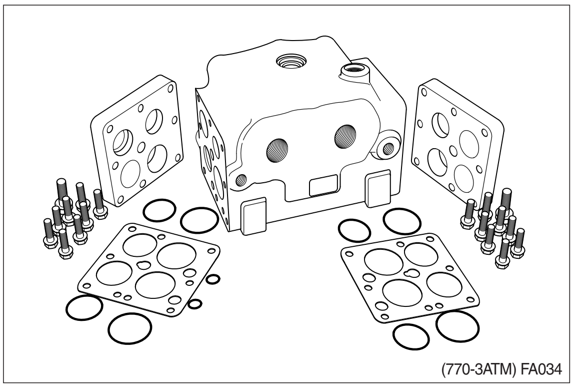
① Remove shock valve with screwdriver and hexagon key.



(770-3ATM) FA033

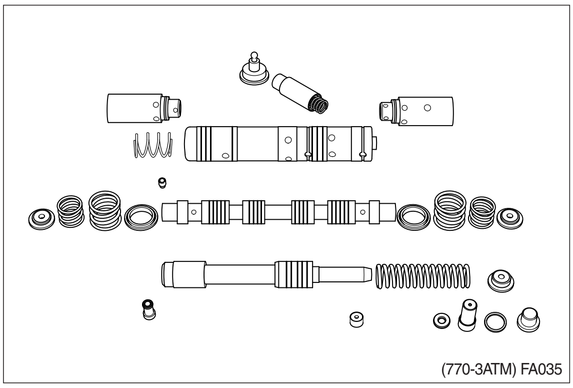
(9) Overview of disassembled parts

① Housing and end cover with accessories.



(770-3ATM) FA034

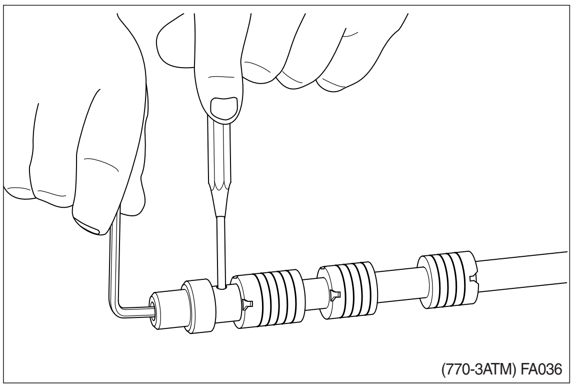
② Spool with accessories.



(770-3ATM) FA035

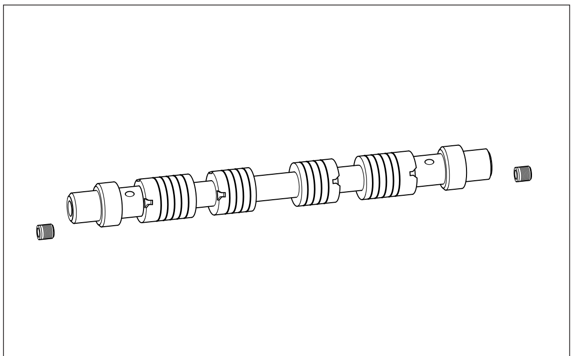
(10) Disassembly of directional spool

① Unscrew orifice with 4mm hexagon key. Use a mandrel.



(770-3ATM) FA036

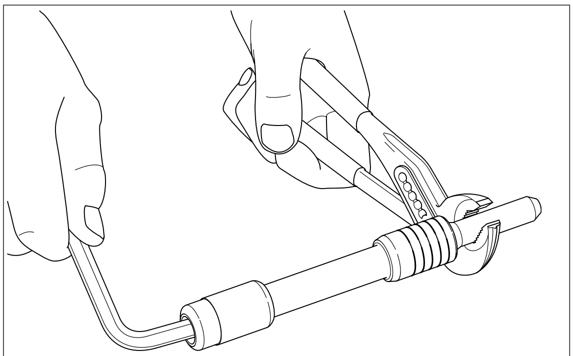
② Directional spool shown disassembled.



(770-3ATM) FA037

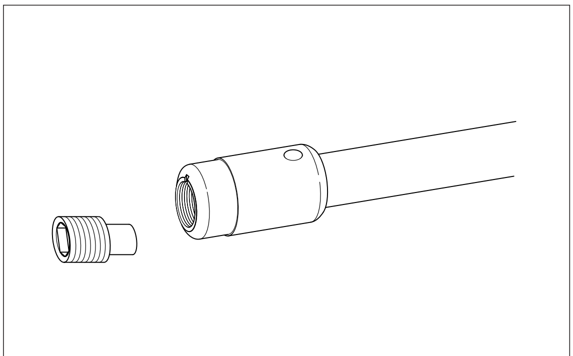
(11) Disassembly of priority valve spool

① Unscrew plug or throttle check valve with 8 ㎜ hexagon key.



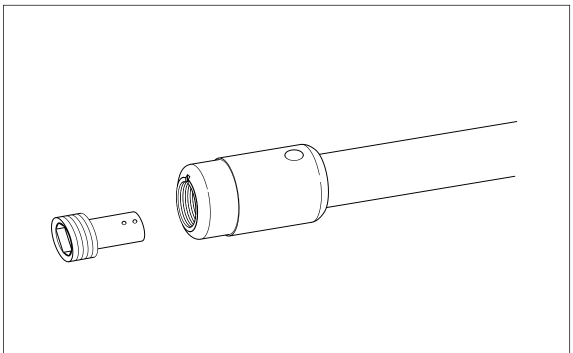
(770-3ATM) FA038

② Priority valve spool with plug for external PP shown disassembled.



(770-3ATM) FA039

③ Priority valve spool with throttle check valve for internal PP shown disassembled.

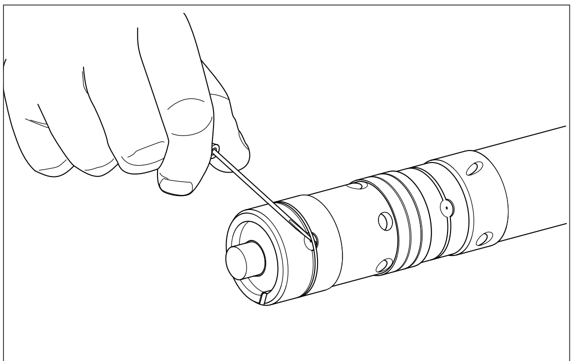


(770-3ATM) FA040

(12) Disassembly of amplifier spool

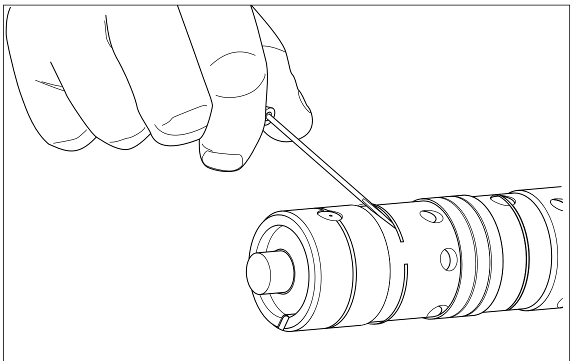
① Carefully remove the spring ring from the recess with 3mm screwdriver.

※ Avoid damage to the spring ring.



(770-3ATM) FA041

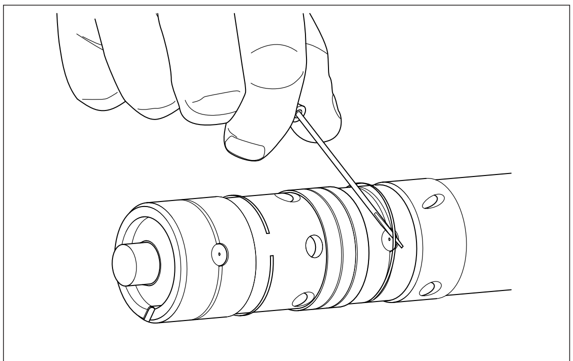
② Carefully guide the spring ring back.



(770-3ATM) FA042

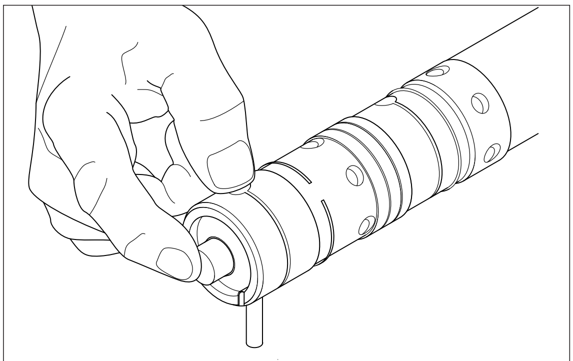
③ Carefully take the spring ring from the recess and guide it back with 3mm screwdriver.

※ Avoid damage to the spring ring.



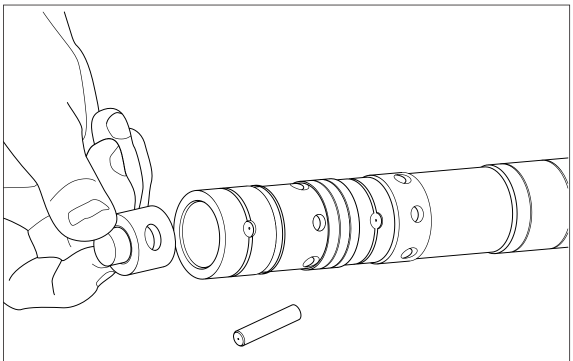
(770-3ATM) FA043

④ Press pin out gently with finger.



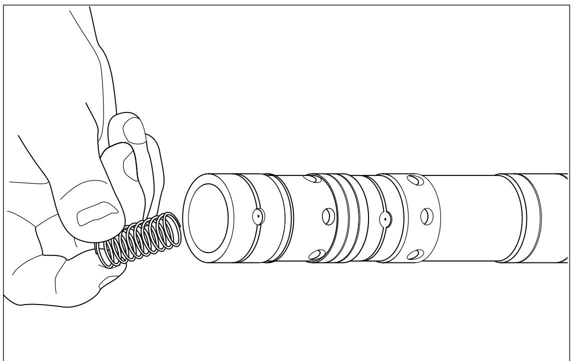
(770-3ATM) FA044

⑤ Take out plug.



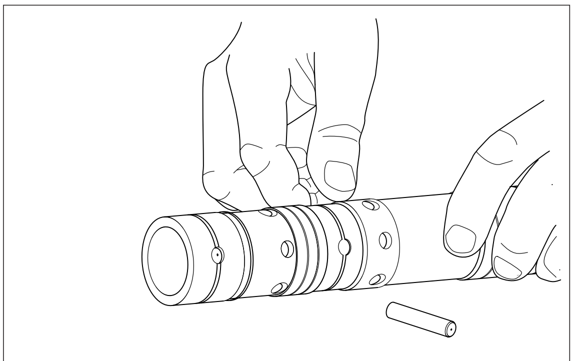
(770-3ATM) FA045

⑥ Take out spring.



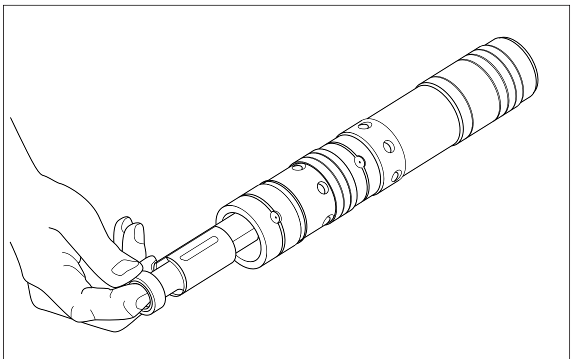
(770-3ATM) FA046

⑦ Take out pin 3㎜ screwdriver.



(770-3ATM) FA047

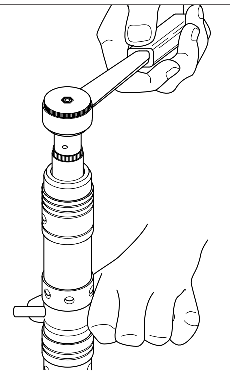
⑧ Take out inner spool.



(770-3ATM) FA048

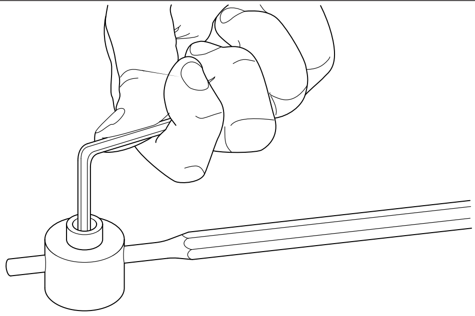
⑨ Unscrew check valve with hexagon socket for 17 mm external hexagon and mandrel in the pin hole.

※ Avoid damaging the spool surface.



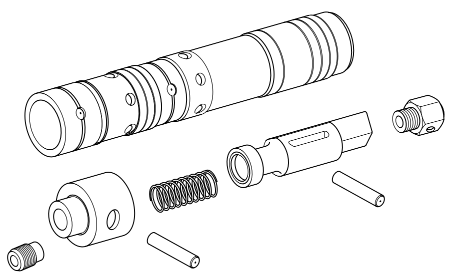
(770-3ATM) FA049

⑩ Unscrew orifice out of plug with 4 mm hexagon key. Use a mandrel.



(770-3ATM) FA050

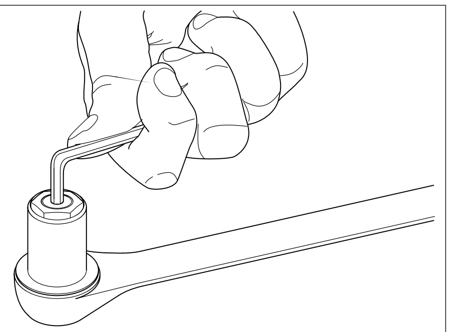
⑪ Amplifier spool shown disassembled.



(770-3ATM) FA051

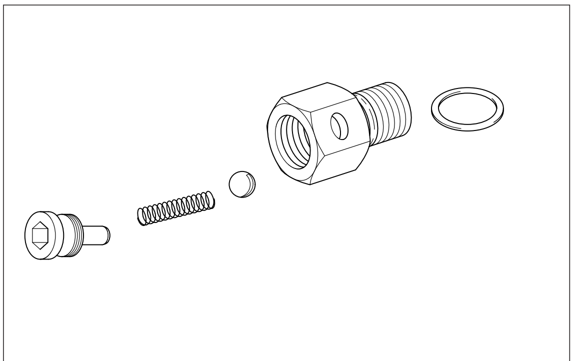
(13) Disassembly of check valve

① Unscrew plug with 4 mm hexagon key and hexagon socket for 17 mm external hexagon.



(770-3ATM) FA052

② Check valve shown disassembled.

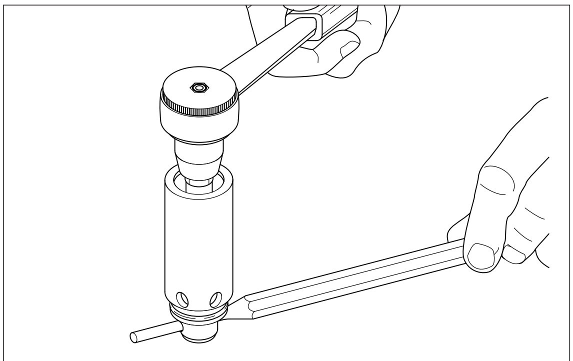


(770-3ATM) FA053

(14) Disassembly of shock valve / suction valve

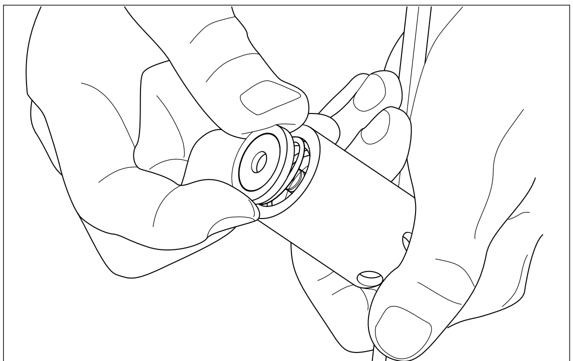
① Unscrew locknut with hexagon socket for 13 mm external hexagon. Use a mandrel.

※ When readjusting shock valve hold locknut with 13 mm ring spanner.



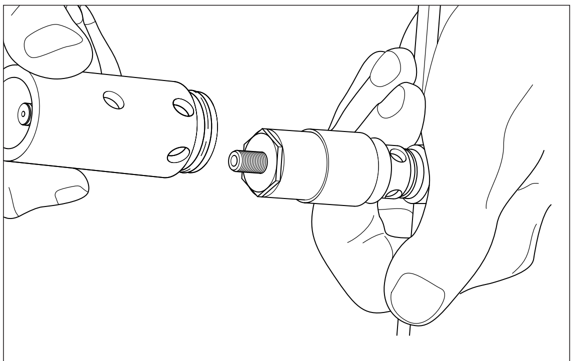
(770-3ATM) FA054

② Take out disc and spring.



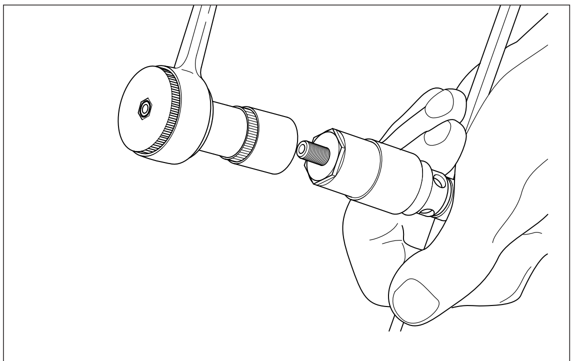
(770-3ATM) FA055

③ Take off housing.



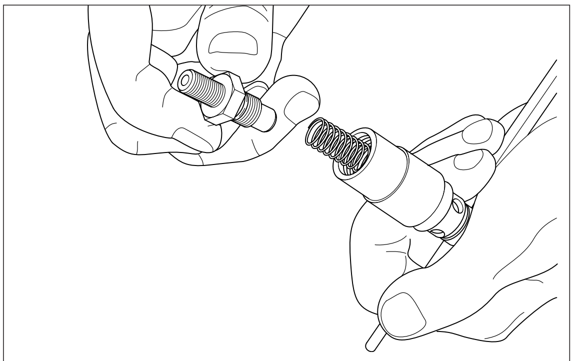
(770-3ATM) FA056

④ Unscrew pilot valve with hexagon socket for 19 mm external hexagon. Use a mandrel.



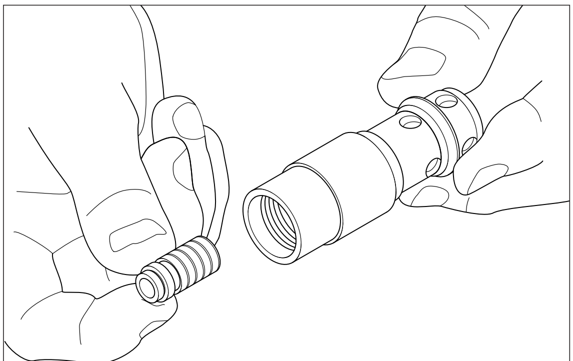
(770-3ATM) FA057

⑤ Take out pilot valve and spring.



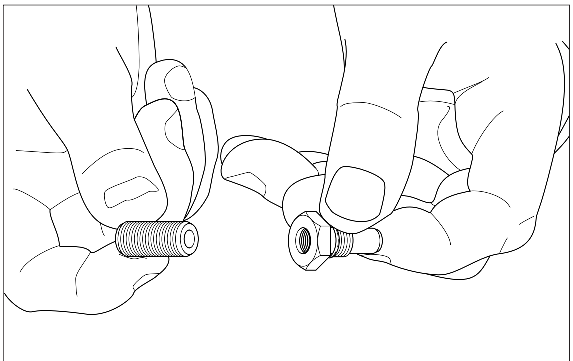
(770-3ATM) FA058

⑥ Take out spool.



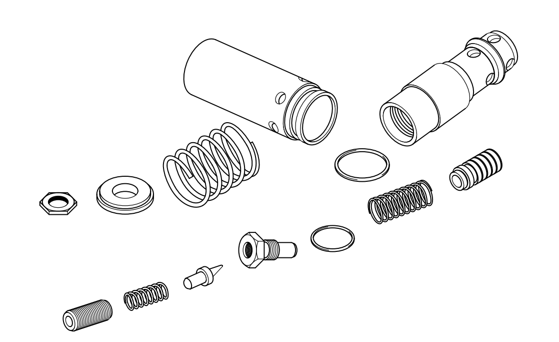
(770-3ATM) FA059

⑦ Unscrew adjustment screw and take out spring and ball.



(770-3ATM) FA060

⑧ Shock valve / suction valve shown disassembled.



(770-3ATM) FA061

※ Cleaning
Clean all parts carefully with low aromatic kerosene.

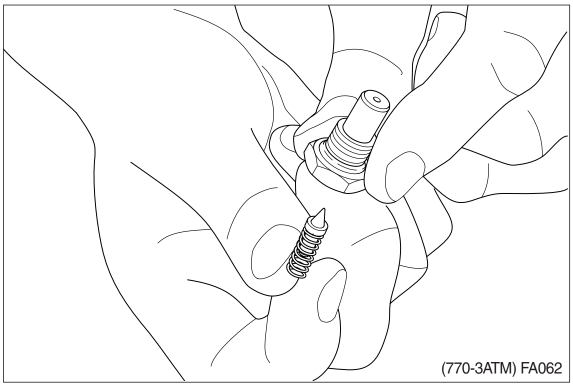
※ Inspection and replacement
Replace all gaskets and sealing washers. Check all other parts carefully and replace if necessary.

※ Lubrication
Before assembly, lubricate all parts with hydraulic oil.

4) ASSEMBLY

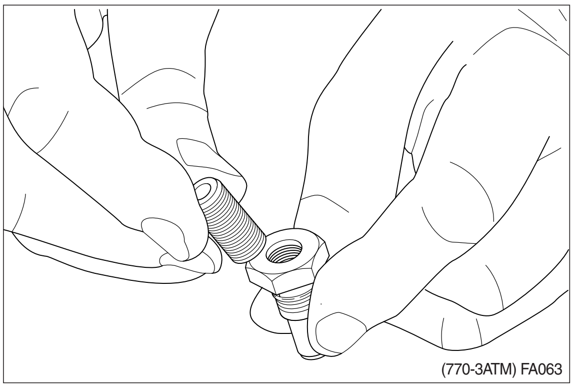
(1) Assembly of shock valve / suction valve

① Guide spring with cone into housing.



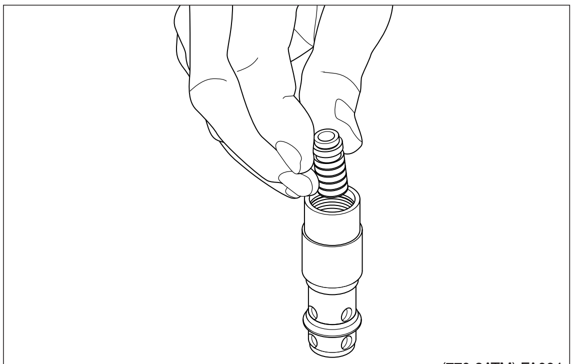
(770-3ATM) FA062

② Fit adjustment screw.



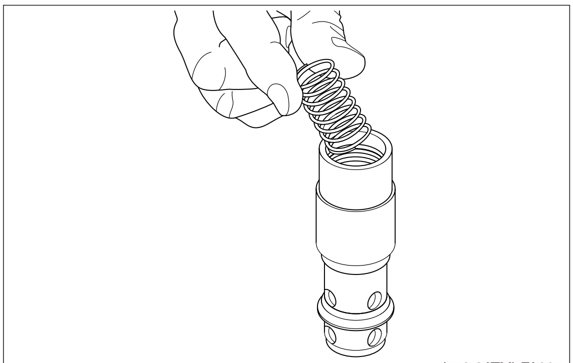
(770-3ATM) FA063

③ Fit spool.



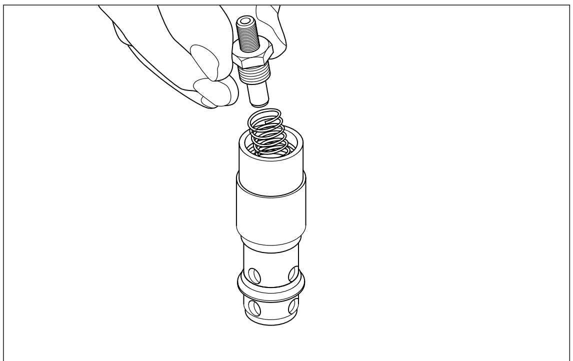
(770-3ATM) FA064

④ Fit spring.

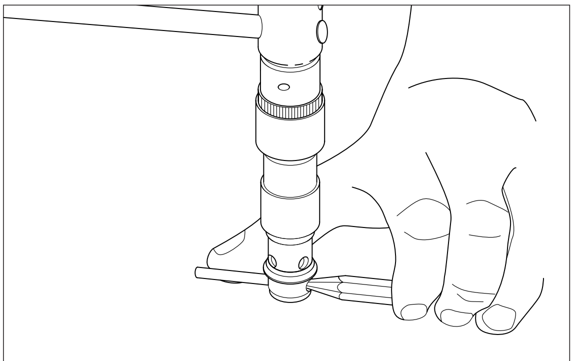


(770-3ATM) FA065

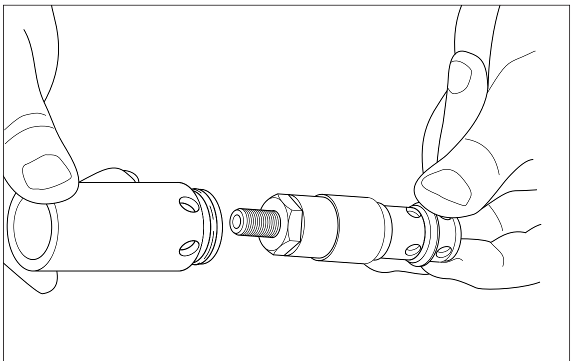
⑤ Fit pilot valve.
Remember O-ring.


(770-3ATM) FA066

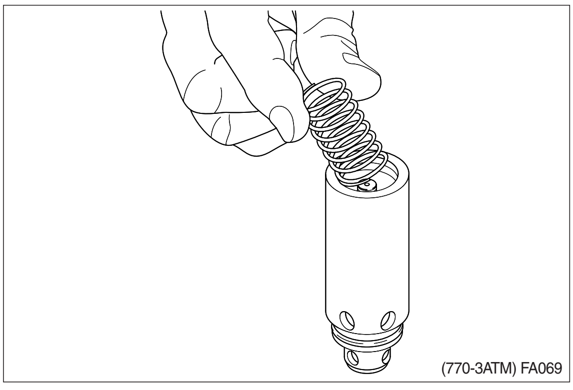
⑥ Tighten with torque wrench for 19 mm external hexagon. Use a mandrel.
· Tightening torque : 2±0.5 kgf · m
(14.5±3.6 lbf · ft)


(770-3ATM) FA067

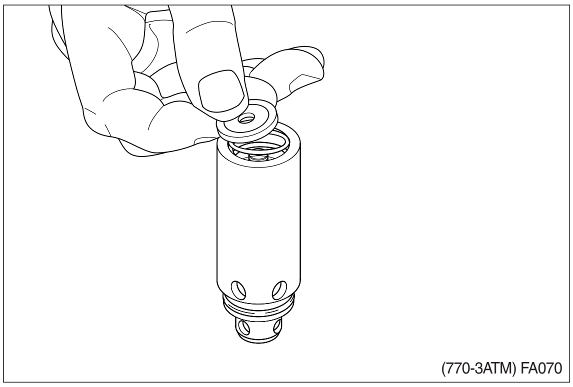
⑦ Fit housing.


(770-3ATM) FA068

⑧ Fit spring.

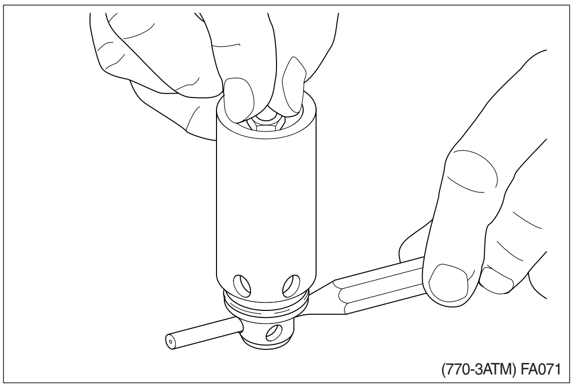

(770-3ATM) FA069

⑨ Fit disc.



⑩ Fit locknut.

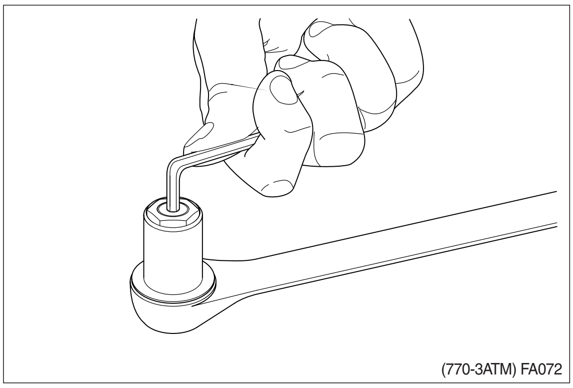
· Tightening torque : 1.5±0.2 kgf · m
(10.8±1.4 lbf · ft)



(2) Assembly of check valve

① Fit ball, spring and plug.

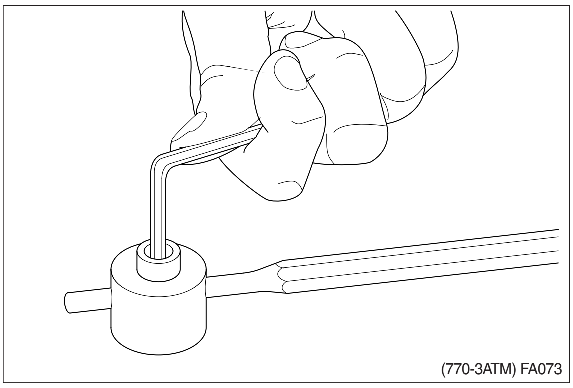
· Tightening torque : 0.5±0.1 kgf · m
(3.6±0.7 lbf · ft)



(3) Assembly of amplifier spool

① Fit orifice in plug.

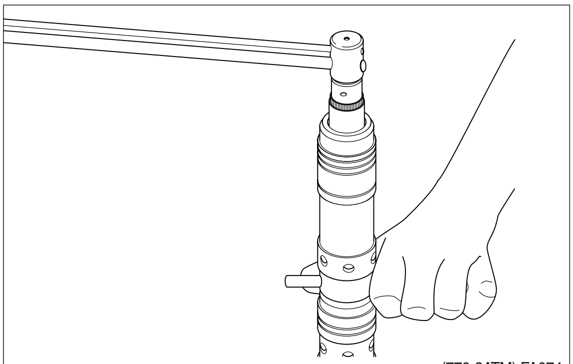
· Tightening torque : 0.5±0.1 kgf · m
(3.6±0.7 lbf · ft)



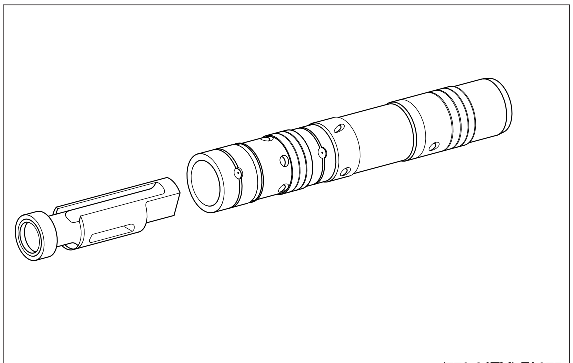
② Fit check valve.

· Tightening torque : 2±0.3 kgf · m (14.5±2.2lbf · ft)

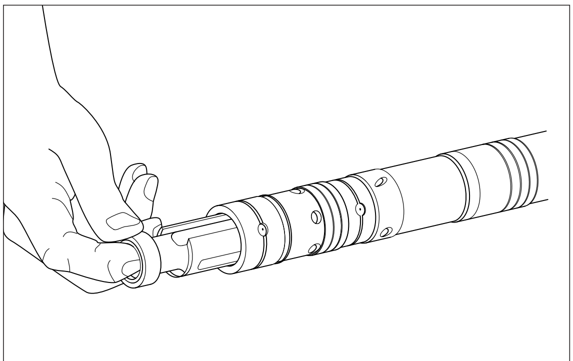
※ Avoid damaging spool surface.
Remember O-ring.


(770-3ATM) FA074

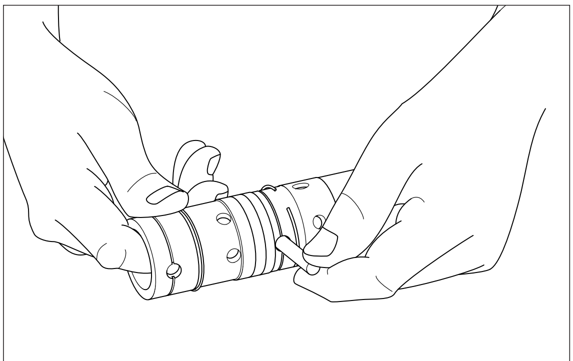
③ Place inner spool in the correct position.


(770-3ATM) FA075

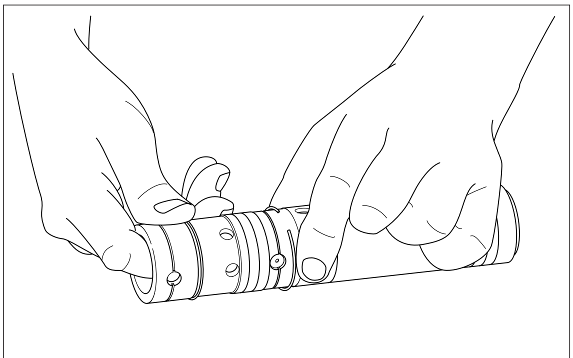
④ Guide inner spool in.


(770-3ATM) FA076

⑤ Fit pin.

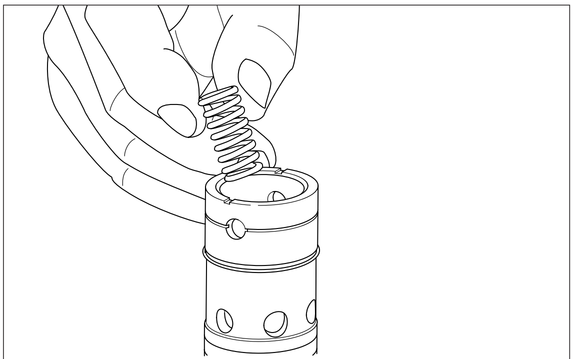

(770-3ATM) FA077

⑥ Push spring ring into position. Place spring ring into the recess with ends facing away from pin holes.



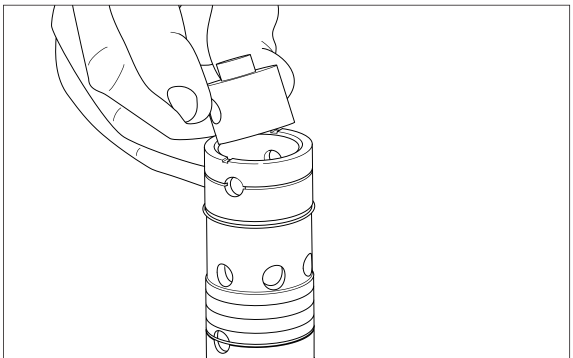
(770-3ATM) FA078

⑦ Fit spring.



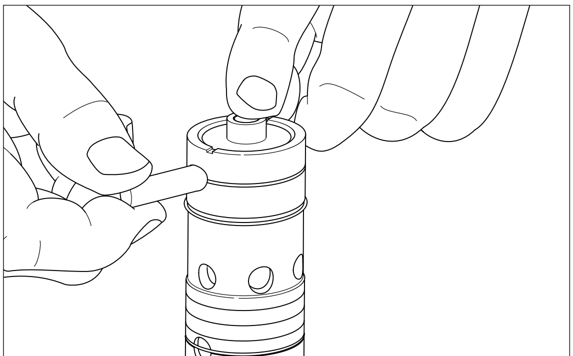
(770-3ATM) FA079

⑧ Fit plug.



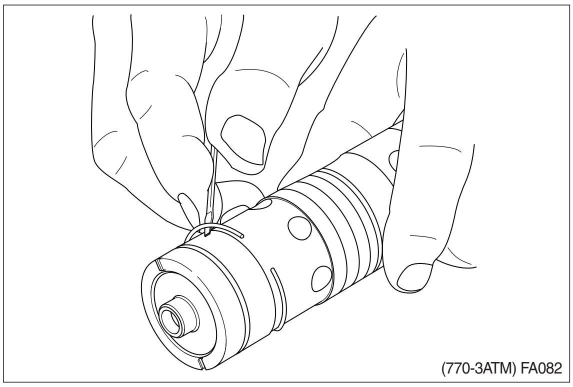
(770-3ATM) FA080

⑨ Fit pin.



(770-3ATM) FA081

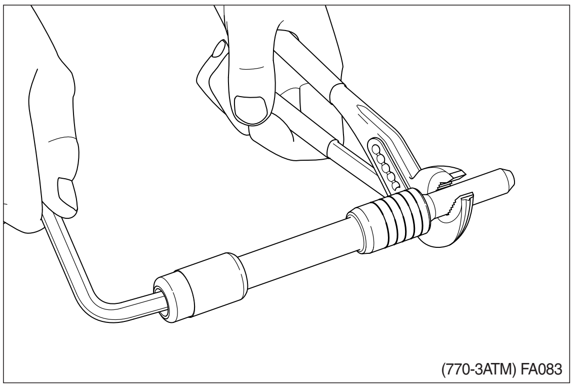
⑩ Push spring ring into position. Place spring ring into the recess with ends facing away from pin holes.



(770-3ATM) FA082

(4) Assembly of priority valve spool

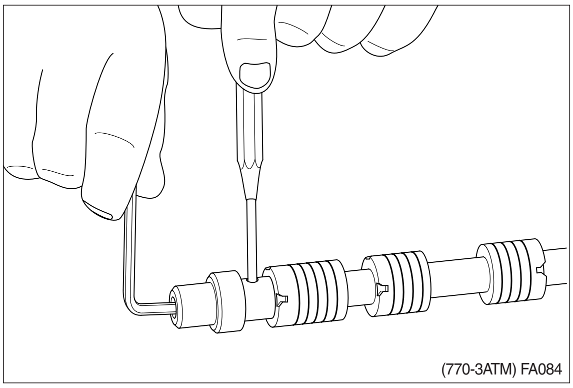
① Fit plug or throttle check valve.
External PP : Plug.
Internal PP : Throttle check valve.
· Tightening torque : 1±0.3 kgf · m
(7.2±2.2 lbf · ft)



(770-3ATM) FA083

(5) Assembly of directional spool

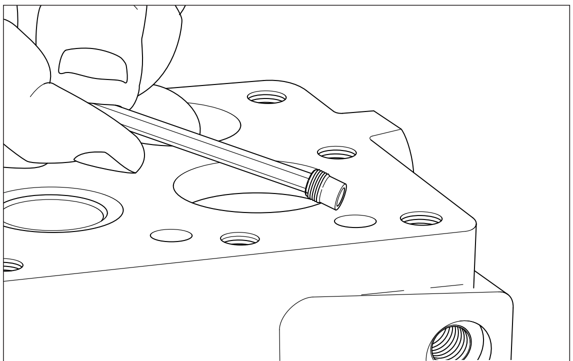
① Screw in orifice.
· Tightening torque : 0.5±0.1 kgf · m
(3.6±0.7 lbf · ft)



(770-3ATM) FA084

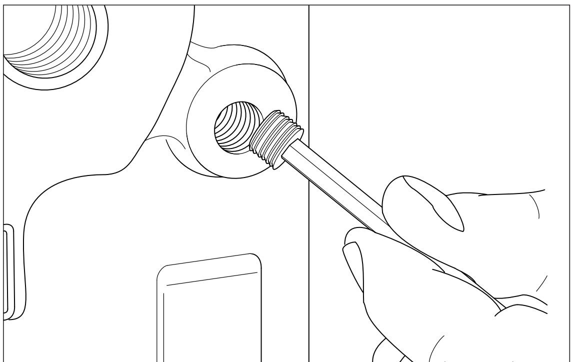
(6) Installation of orifice and throttle check valve

① Fit orifice in housing.
· Tightening torque : 0.5±0.1 kgf · m
(3.6±0.7 lbf · ft)

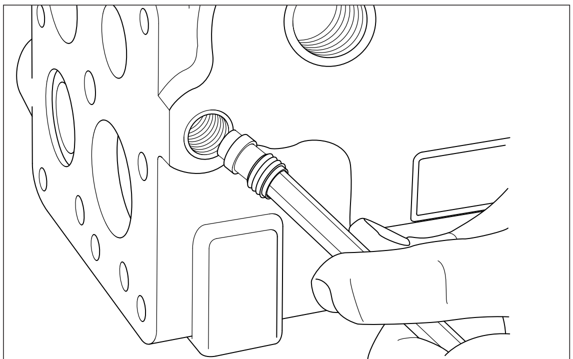


(770-3ATM) FA085

② Fit orifice in LS - connection.
· Tightening torque : 1±0.3 kgf · m
(7.2±2.2 lbf · ft)


(770-3ATM) FA086

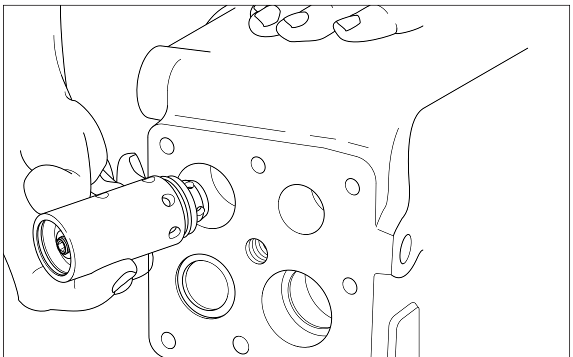
③ Fit throttle check valve in PP - connection.
· Tightening torque : 1±0.3 kgf · m
(7.2±2.2 lbf · ft)


(770-3ATM) FA087

※ Comments on flow amplifiers with internal PP :
1. 1/4 BSP. F in PP - connection.
Fit washer and plug.
· Tightening torque : 4.1±0.3 kgf · m
(29.7±2.2 lbf · ft)
2. 7/16 - 20 UNF in PP - connection.
Fit O-ring and plug.
· Tightening torque : 1.5±0.5 kgf · m
(10.8±3.6 lbf · ft)

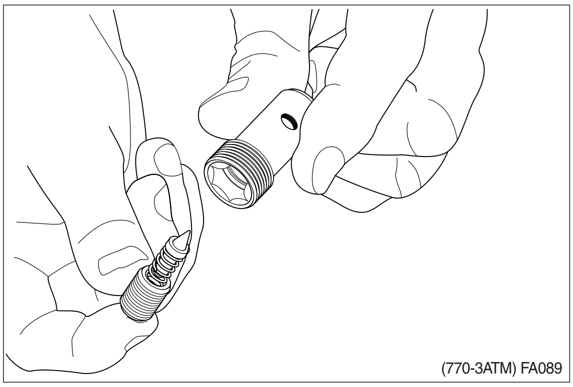
(7) Installation of shock valves

① Guide shock valve in and secure it by hand.
Remember O-ring.


(770-3ATM) FA088

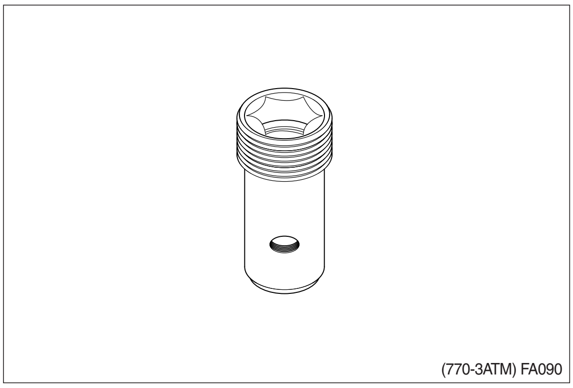
(8) Assembly of pressure relief valve

① Guide adjustment screw, spring and cone up into the cartridge.



(770-3ATM) FA089

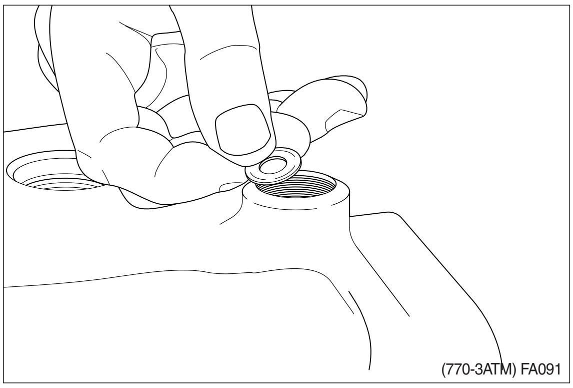
② Screw the adjustment screw so far in that the 10 mm hexagon key fully engages.



(770-3ATM) FA090

(9) Installation of pressure relief valve

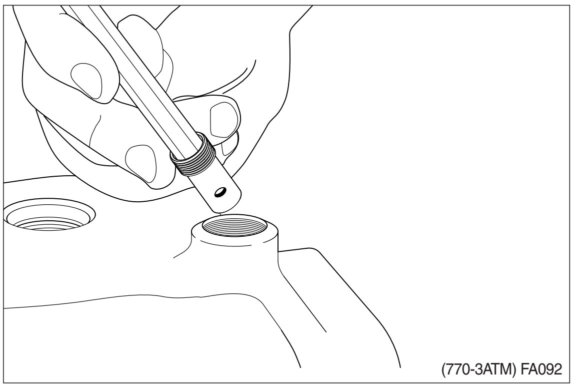
① Let the washer drop into the hole.



(770-3ATM) FA091

② Fit pressure relief valve.

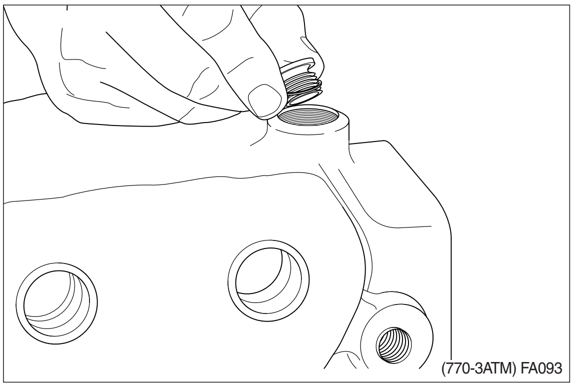
· Tightening torque : 3.1±0.3 kgf · m (22.4±2.2 lbf · ft)



(770-3ATM) FA092

③ Fit plug with washer.

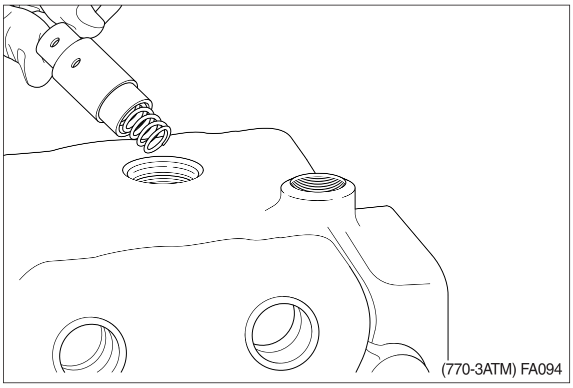
· Tightening torque : 6±0.5 kgf · m
(44.1±3.6 lbf · ft)



(770-3ATM) FA093

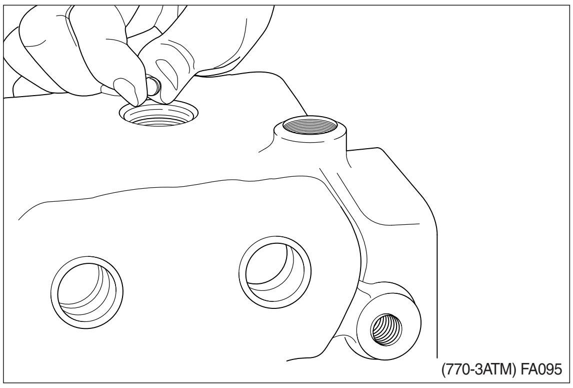
(10) Installation of back pressure valve

① First fit spring in piston with vaseline.
Fit assembled piston and spring.



(770-3ATM) FA094

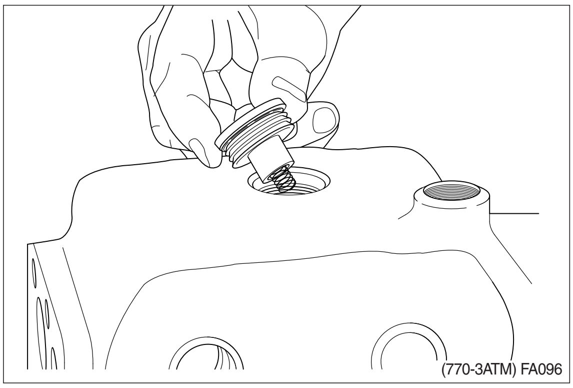
② Let the ball drop down.



(770-3ATM) FA095

③ Fit spring in plug with vaseline.
Fit assembled plug and spring.
Remember O-ring.

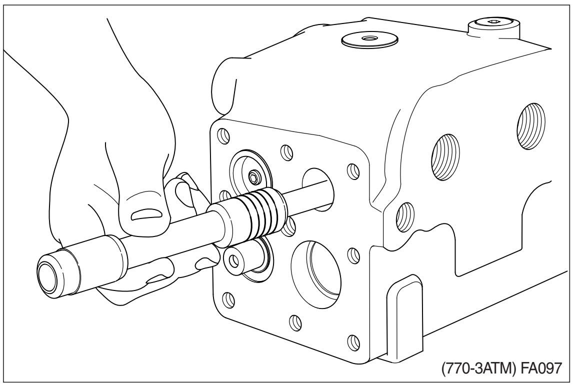
· Tightening torque : 2.6±0.3 kgf · m
(18.8±2.2 lbf · ft)



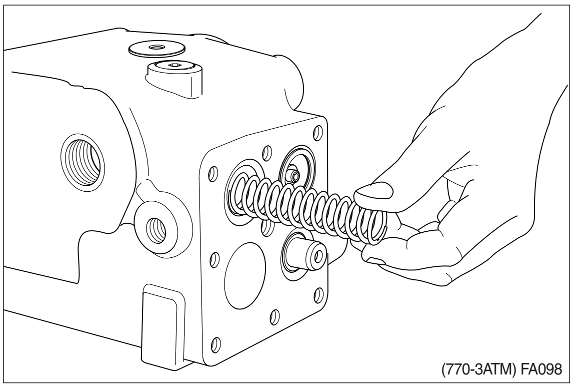
(770-3ATM) FA096

(11) Installation of spools

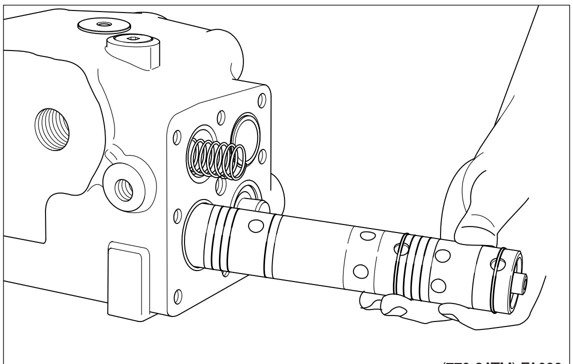
① Fit directional spool.
Fit priority valve spool.
※ Spring control must be placed in correct position against LS - connection.


(770-3ATM) FA097

② Fit spring.
※ Spring must be by the LS - connection.

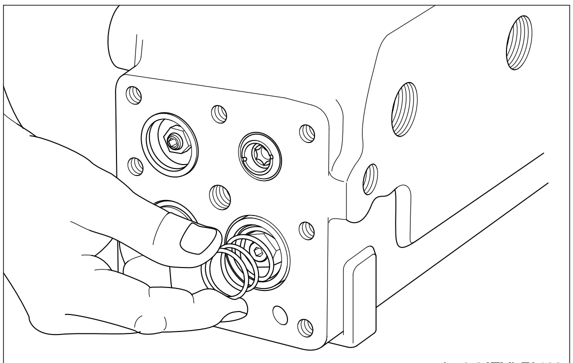

(770-3ATM) FA098

③ Fit amplifier spool.
※ The orifice must be placed in correct position against LS - connection.

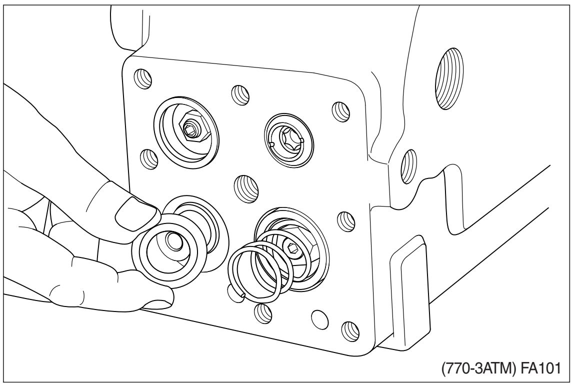

(770-3ATM) FA099

(12) Installation of end cover at PP - connection

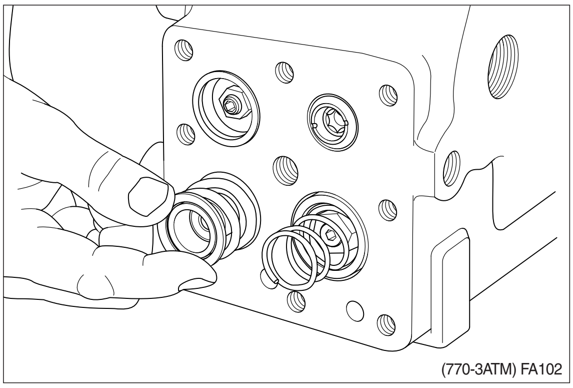
① Fit spring with vaseline on amplifier
※ spool.
The spring must be fitted at the PP - connection.


(770-3ATM) FA100

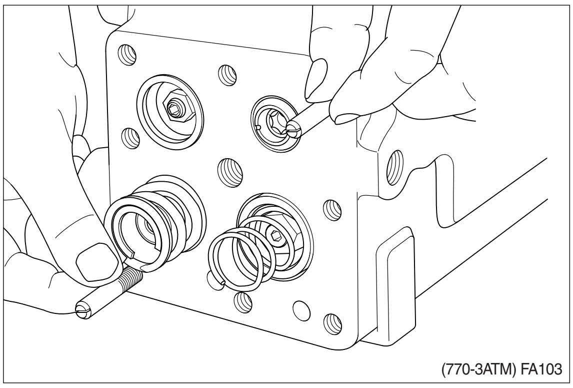
② Fit spring guide with vaseline.



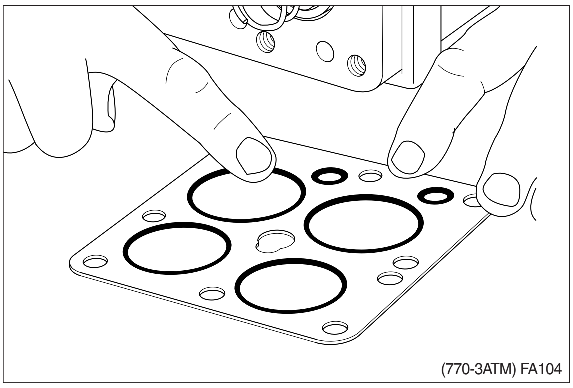
③ Fit large and small springs with vaseline.



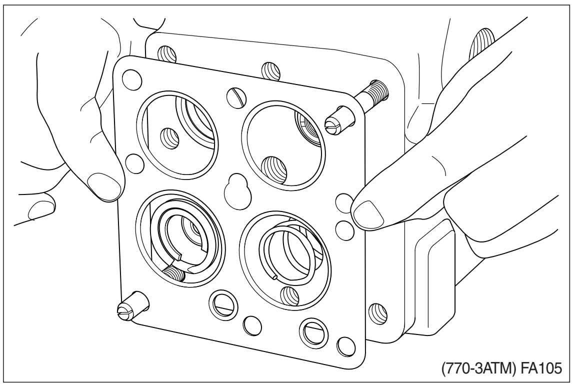
④ Fit guide screws.



⑤ Fit 4 large and 2 small O-rings.

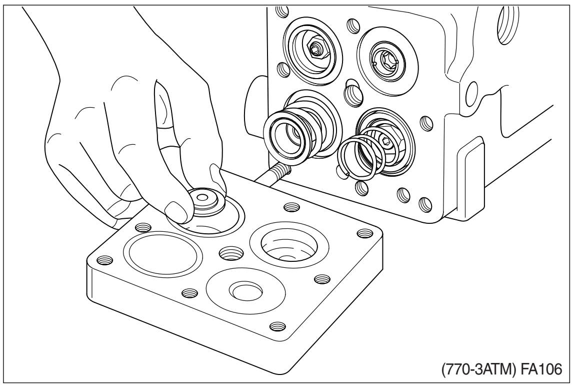


⑥ Guide plate in.



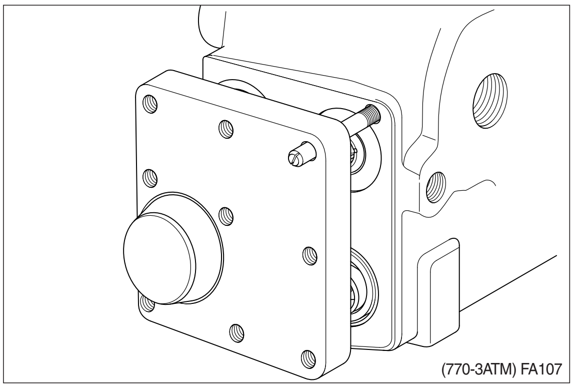
(770-3ATM) FA105

⑦ Fit stop (thickness : 5 ㎜) in end cover with vaseline.



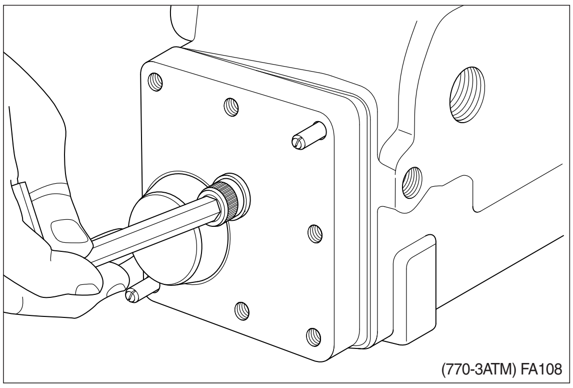
(770-3ATM) FA106

⑧ Guide end cover in.



(770-3ATM) FA107

⑨ Fit screw with spring washer.

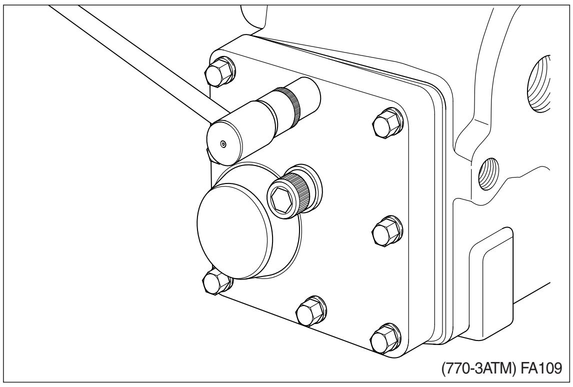


(770-3ATM) FA108

⑩ Fit screws with spring washer.

· Tightening torque : 2.6±0.5 kgf · m (18.8±3.6 lbf · ft)

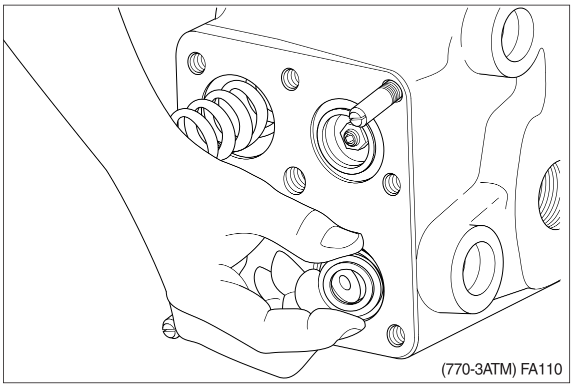
· Tightening torque : 8.2±1 kgf · m for large screw (59.3±7.2 lbf · ft)



(770-3ATM) FA109

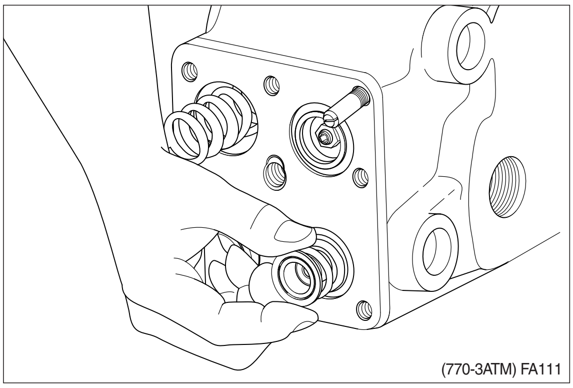
(13) Installation of end cover at LS - connection

① Fit guide screws.
Fit remote control with vaseline.



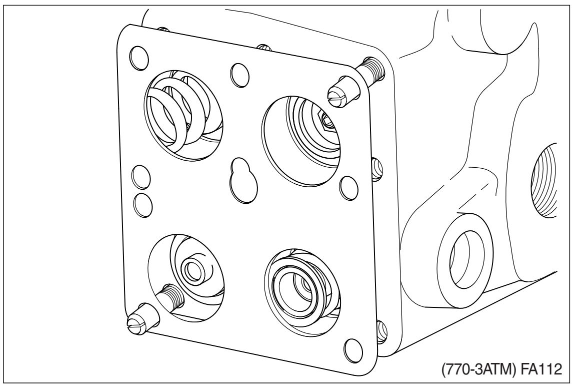
(770-3ATM) FA110

② Fit large and small springs with vaseline.



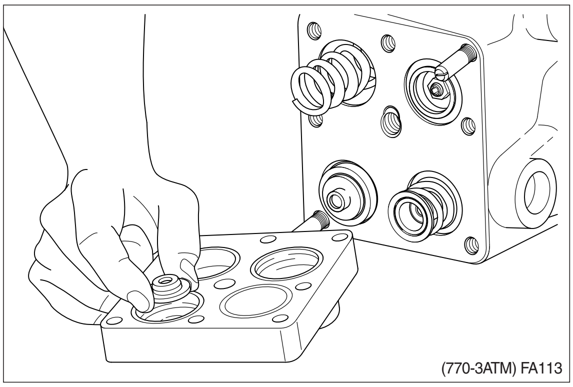
(770-3ATM) FA111

③ Guide in plate with 4 O-rings.



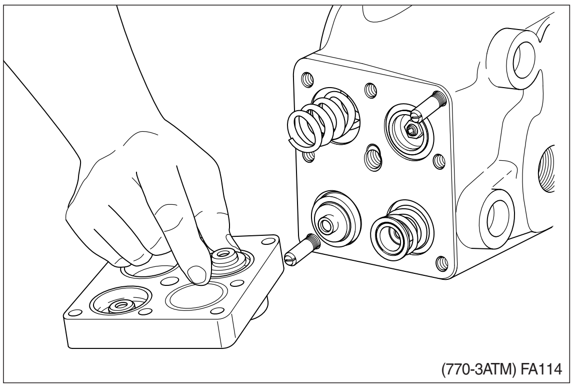
(770-3ATM) FA112

④ Fit stop for priority valve spool (thickness : 8 mm) with vaseline.



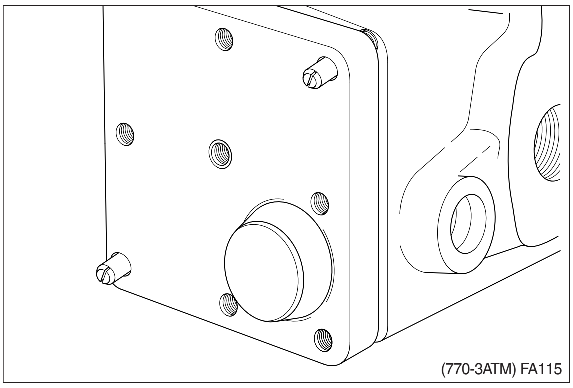
(770-3ATM) FA113

⑤ Fit stop for directional spool (thickness : 5 mm) with vaseline.



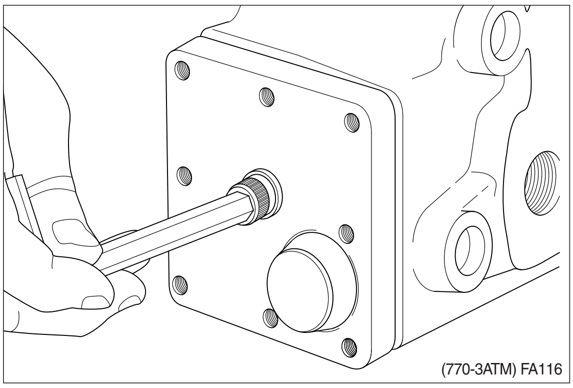
(770-3ATM) FA114

⑥ Guide in end cover.



(770-3ATM) FA115

⑦ Fit large screw with spring washer.

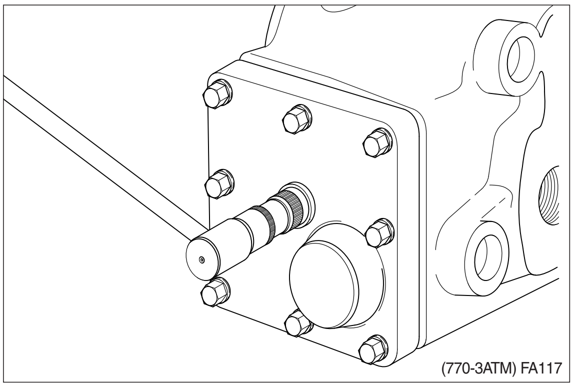


(770-3ATM) FA116

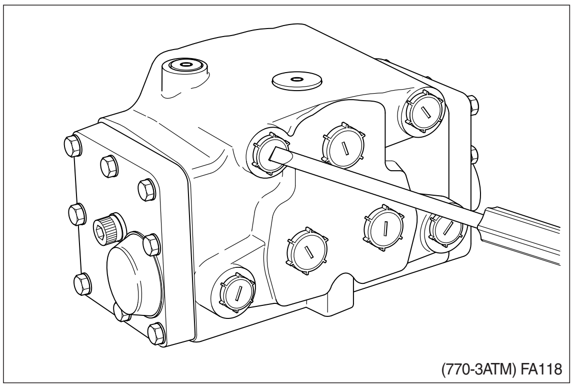
⑧ Fit screws with spring washers.

· Tightening torque : 2.6±0.5 kgf · m (18.8±3.6 lbf · ft)

· Tightening torque : 8.2±1 kgf · m for large screw (59.3±7.2 lbf · ft)


(770-3ATM) FA117

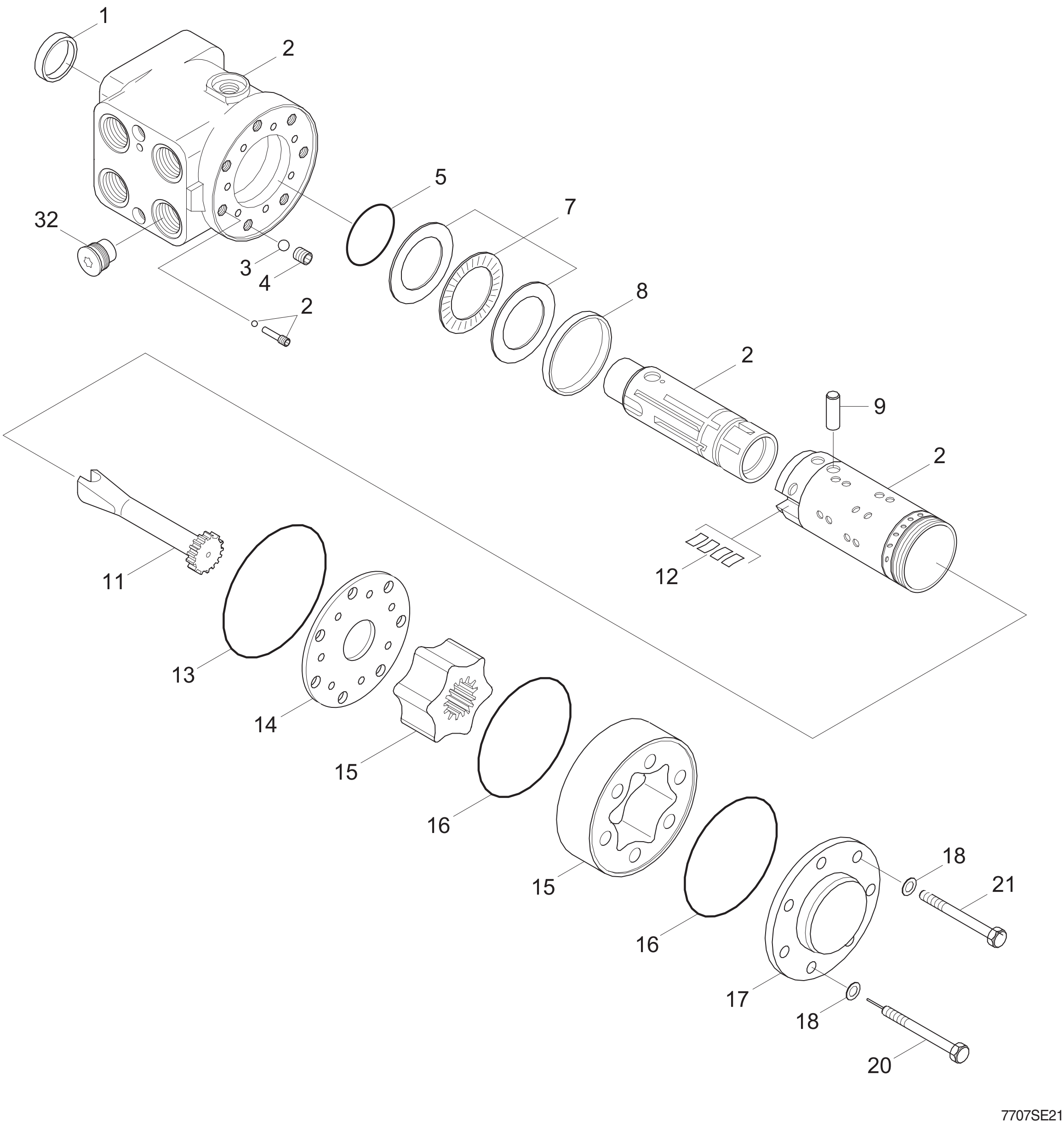
⑨ Fit plastic plugs.


(770-3ATM) FA118

This completes assembly.

2. STEERING UNIT

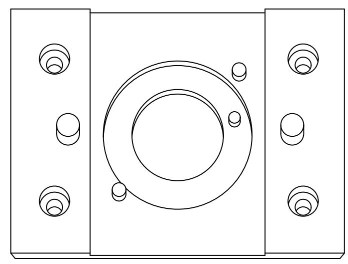
1) STRUCTURE



1	Dust seal ring	9	Cross pin	17	End cover
2	Housing, Spool, sleeve	11	Shaft	18	Washer
3	Ball	12	Spring set	20	Pin screw
4	Bushing	13	O-ring	21	Screw
5	Lip seal	14	Distributor plate	32	Check valve
7	Bearing assy	15	Gearwheel set		
8	Ring	16	O-ring		

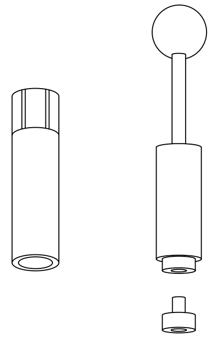
2) TOOLS

(1) Holding tool.



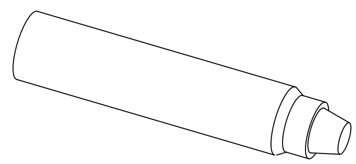
(770-3ATM) 5-69(1)

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



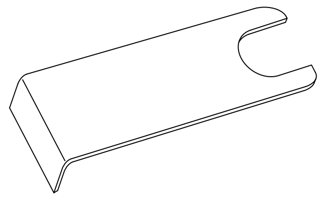
(770-3ATM) 5-69(2)

(3) Assembly tool for lip seal.



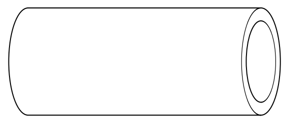
(770-3ATM) 5-69(3)

(4) Assembly tool for cardan shaft.



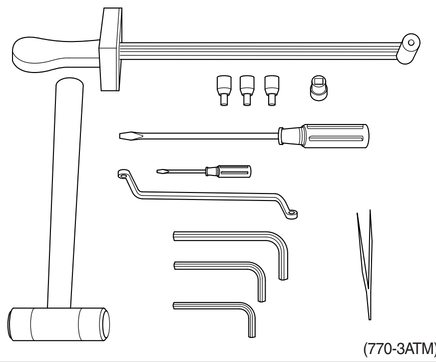
(770-3ATM) 5-69(4)

(5) Assembly tool for dust seal.



(770-3ATM) 5-70(1)

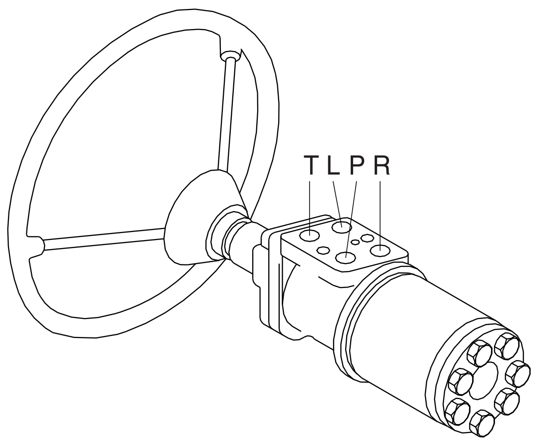
(6) Torque wrench 0~7.1 kgf · m
(0~54.4 lbf · ft)
13 mm socket spanner
6, 8 mm and 12 mm hexagon sockets
12 mm screwdriver
2 mm screwdriver
13 mm ring spanner
6, 8 and 12 mm hexagon socket spanners
Plastic hammer
Tweezers



(770-3ATM) 5-70(2)

3) TIGHTENING TORQUE AND HYDRAULIC CONNECTIONS

(1) Hydraulic connections



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

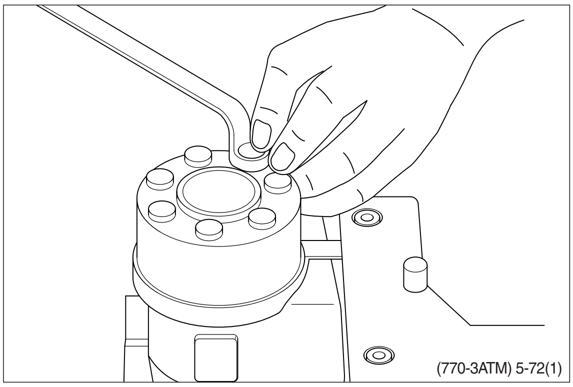
(770-3ATM) 5-71

(2) Tightening torque

Screwed connection	Max. tightening torque [kgf · m (lbf · ft)]			
	With cutting edge	With copper washer	With aluminum washer	With O - ring
1/4 BSP.F	4.1 (29.7)	2.0 (14.5)	3.1 (22.4)	-
3/8 BSP.F	6.1 (44.1)	2.0 (14.5)	5.1 (36.9)	-
1/2 BSP.F	10.2 (73.8)	3.1 (22.4)	8.2 (59.3)	-
7/16-20 UNF	-	-	-	2.0 (14.5)
3/4-16 UNF	-	-	-	6.1 (44.1)
M 12×1.5	4.1 (29.7)	2.0 (14.5)	3.1 (22.4)	2.0 (14.5)
M 18×1.5	7.1 (51.4)	2.0 (14.5)	5.1 (36.9)	5.1 (36.9)
M 22×1.5	10.2 (73.8)	3.1 (22.4)	8.2 (59.3)	7.1 (51.4)

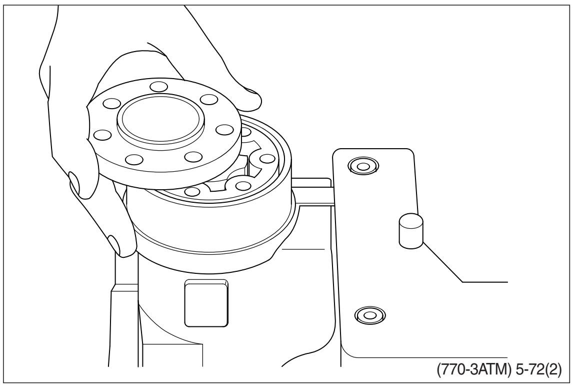
4) DISASSEMBLY

(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).



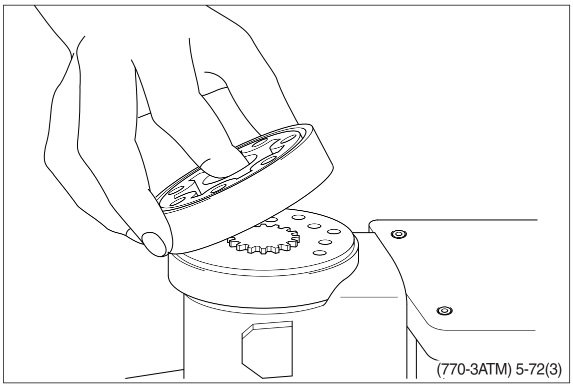
(770-3ATM) 5-72(1)

(2) Remove the end cover, sideways.



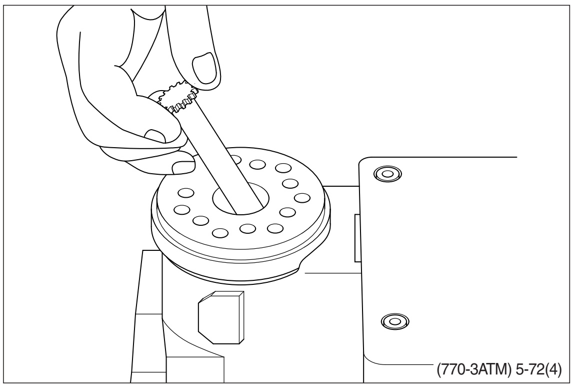
(770-3ATM) 5-72(2)

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



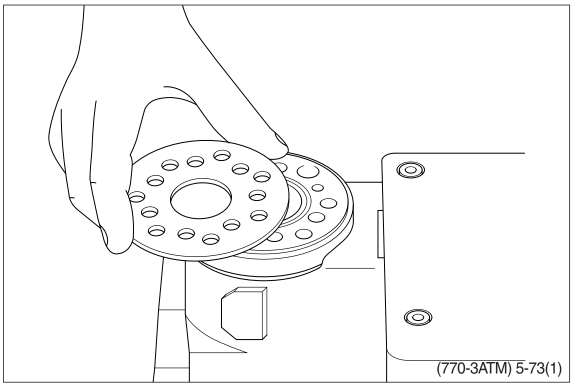
(770-3ATM) 5-72(3)

(4) Remove cardan shaft.



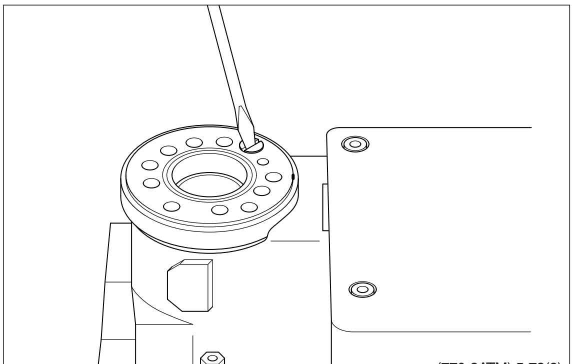
(770-3ATM) 5-72(4)

(5) Remove distributor plate.



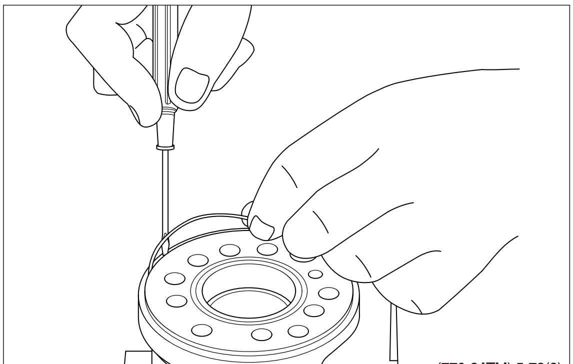
(770-3ATM) 5-73(1)

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



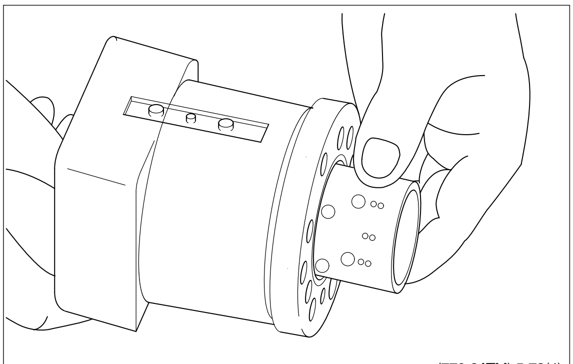
(770-3ATM) 5-73(2)

(7) Remove O-ring.



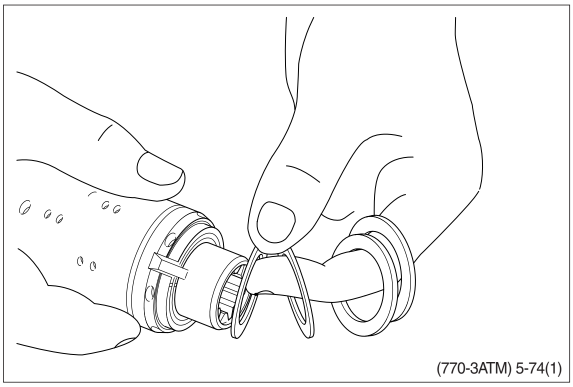
(770-3ATM) 5-73(3)

(8) 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 needle bearing will be pushed out of the housing together.



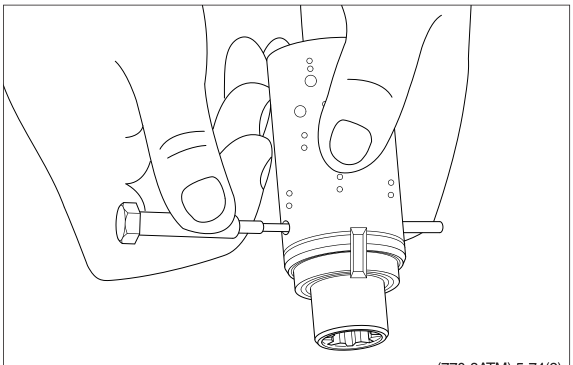
(770-3ATM) 5-73(4)

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



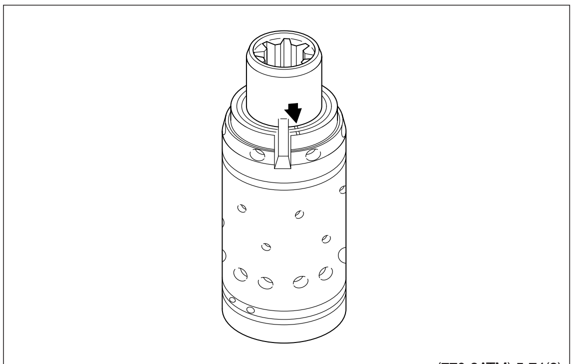
(770-3ATM) 5-74(1)

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



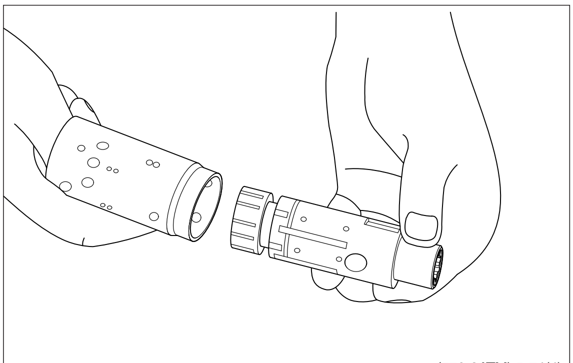
(770-3ATM) 5-74(2)

※ 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.



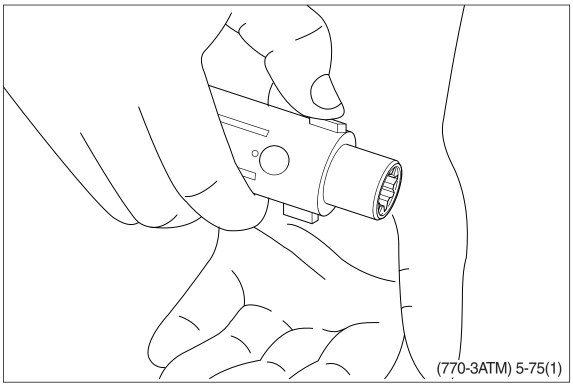
(770-3ATM) 5-74(3)

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



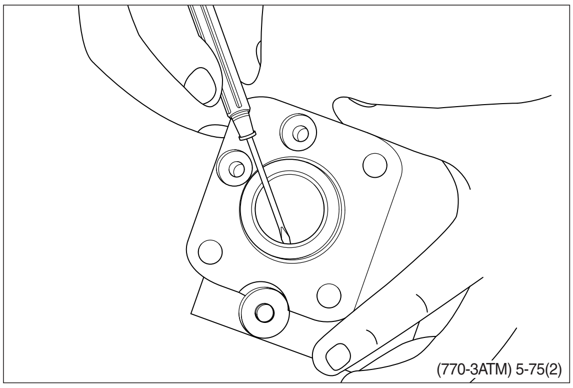
(770-3ATM) 5-74(4)

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



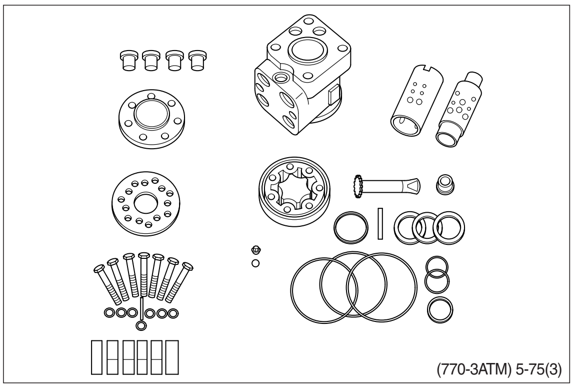
(770-3ATM) 5-75(1)

(13) Remove dust seal and O-ring.



(770-3ATM) 5-75(2)

(14) The steering unit is now completely disassembled.



(770-3ATM) 5-75(3)

※ Cleaning
Clean all parts carefully in Shellsol K or the like.

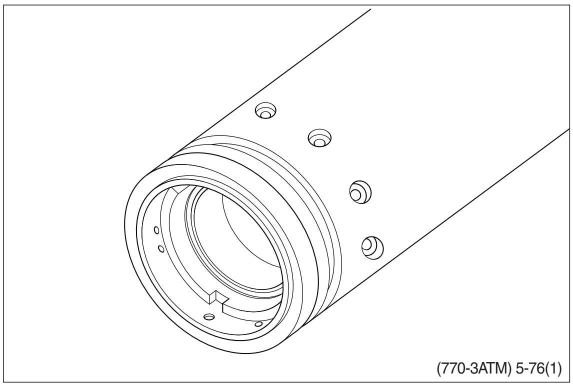
※ Inspection and replacement
Replace all seals and washers. Check all parts carefully and make any replacements necessary.

※ Lubrication
Before assembly, lubricate all parts with hydraulic oil.

5) ASSEMBLY

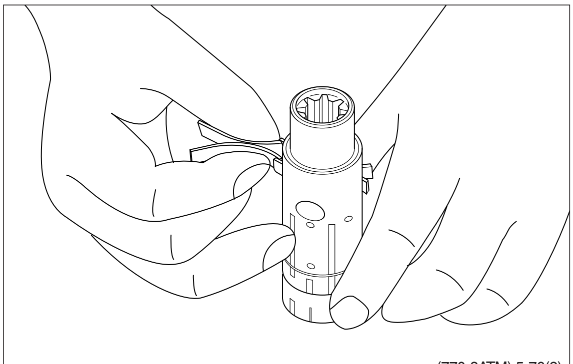
(1) Assemble spool and sleeve.

※ 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.


(770-3ATM) 5-76(1)

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

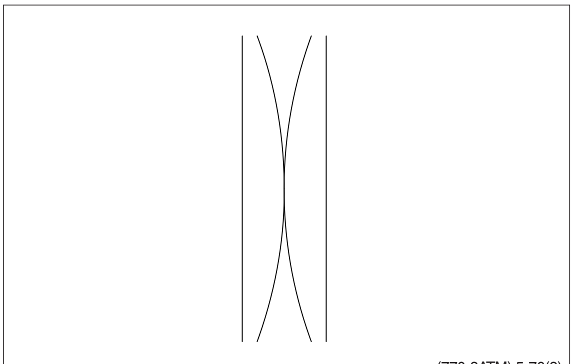
Place the curved springs between the flat ones and press them into place (see assembly pattern).


(770-3ATM) 5-76(2)

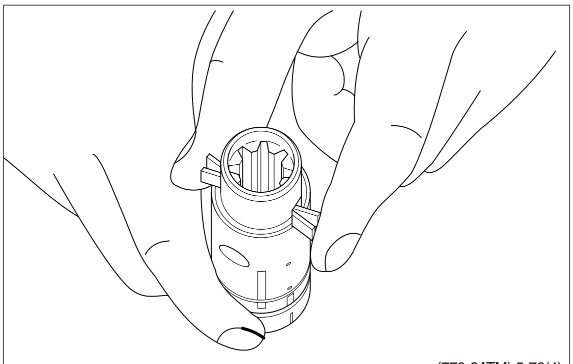
※ Assembly pattern.

· Weak springs (blue)
2 - off flat, blue : Part no. 150-0748
2 - off curved, blue : Part no. 150-0749

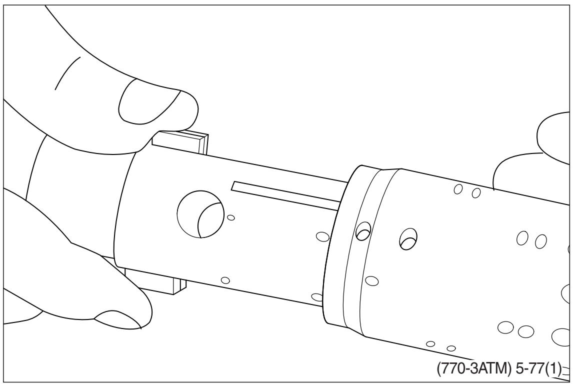
· Blue set
Spare set : Part no. 150-4265


(770-3ATM) 5-76(3)

(3) Line up the spring set.

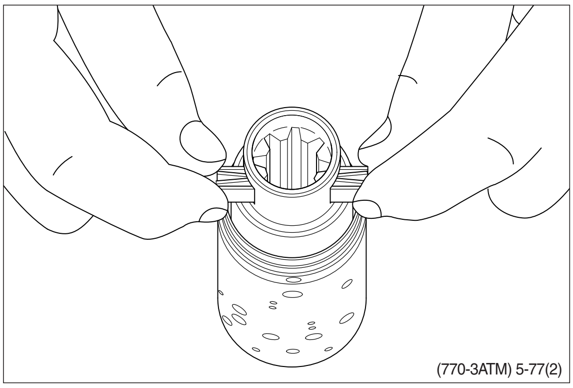

(770-3ATM) 5-76(4)

(4) Guide the spool into the sleeve. Make sure that spool and sleeve are placed correctly in relation to each other (see page 3-76, No.(1)).



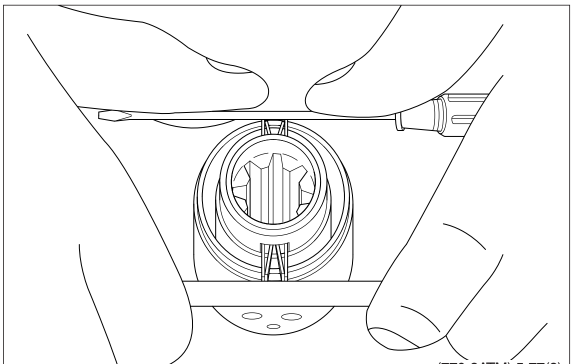
(770-3ATM) 5-77(1)

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



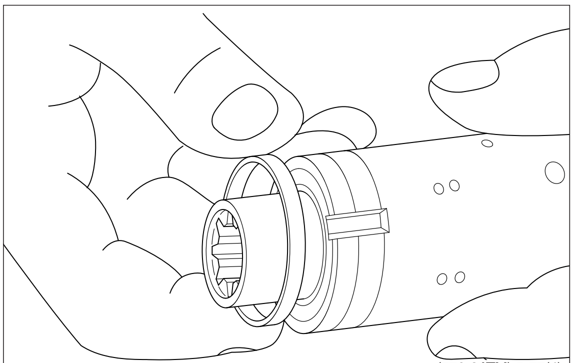
(770-3ATM) 5-77(2)

(6) Line up the springs and center them.



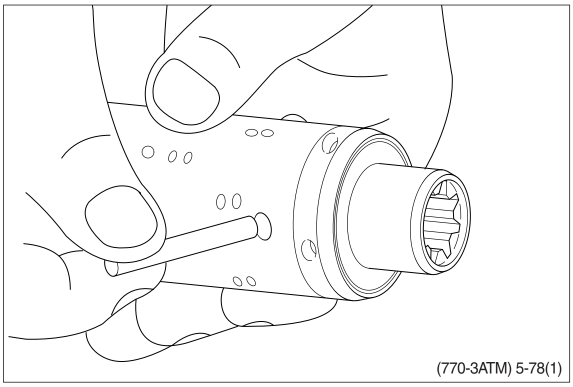
(770-3ATM) 5-77(3)

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



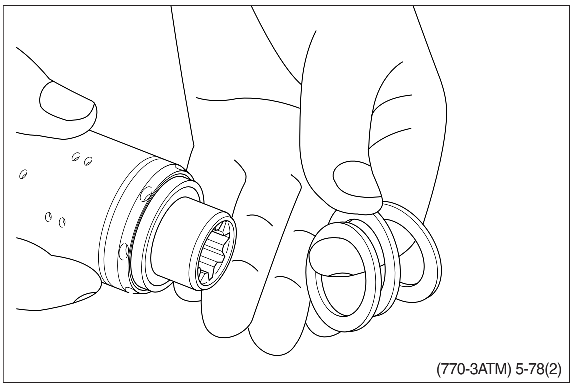
(770-3ATM) 5-77(4)

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



(770-3ATM) 5-78(1)

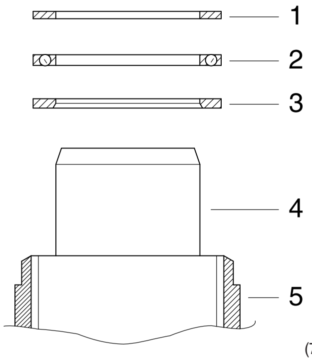
(9) Fit bearing races and needle bearing as shown on below drawing.



(770-3ATM) 5-78(2)

※ Assembly pattern for standard bearings

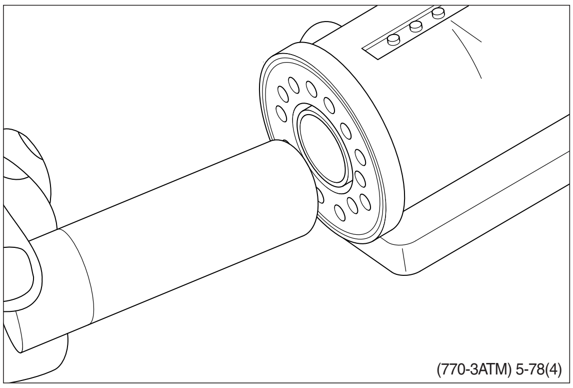
1 Outer bearing race
2 Needle bearing
3 Inner bearing race
4 Spool
5 Sleeve



(770-3ATM) 5-78(3)

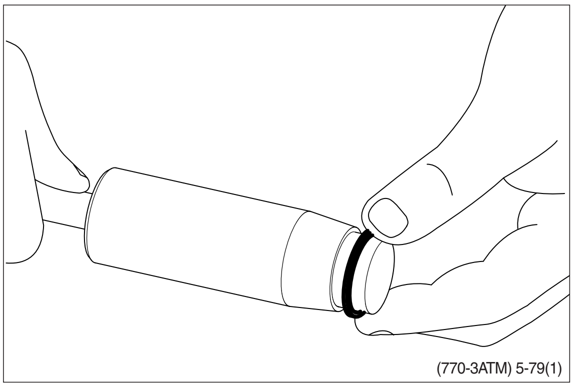
Installation instruction for O-ring

(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.

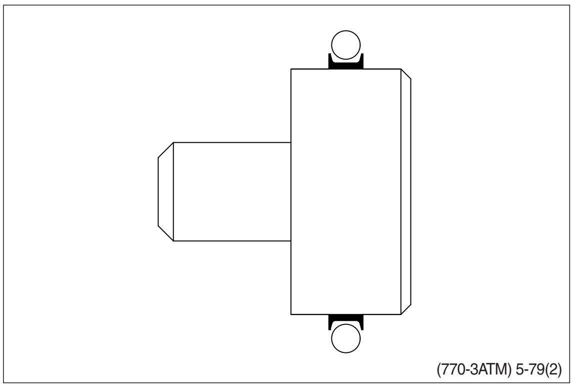


(770-3ATM) 5-78(4)

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

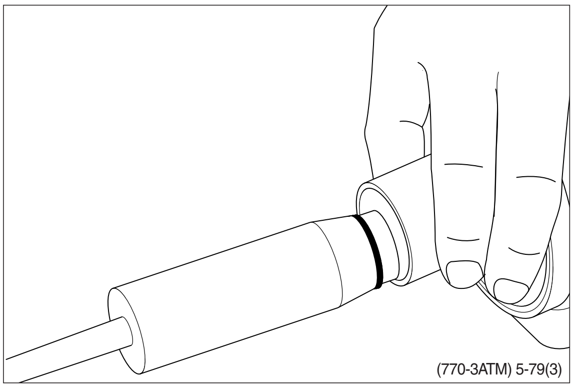


(770-3ATM) 5-79(1)



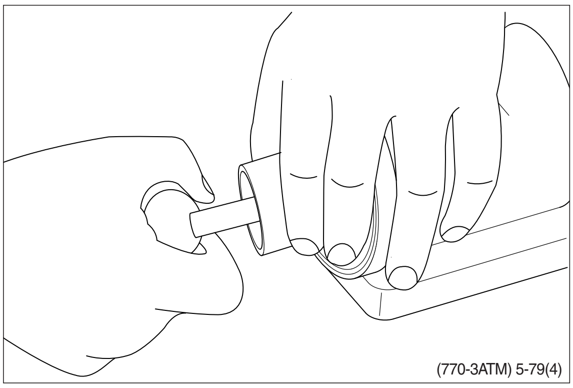
(770-3ATM) 5-79(2)

(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.



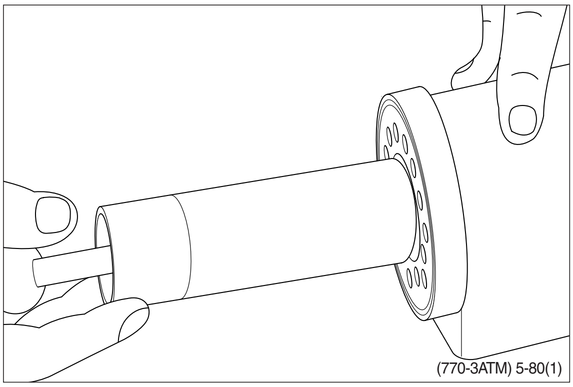
(770-3ATM) 5-79(3)

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



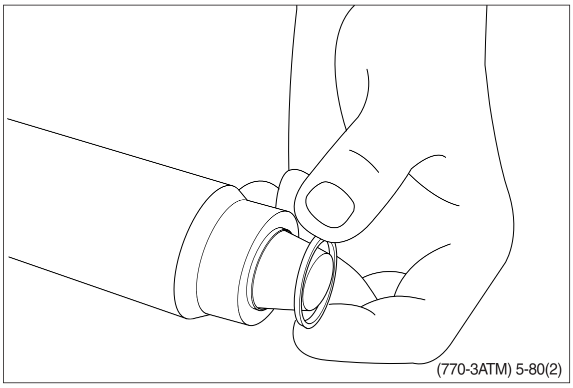
(770-3ATM) 5-79(4)

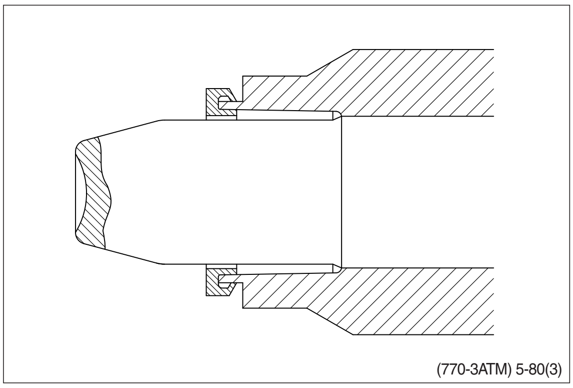
(14) Draw the inner and outer parts of the assembly tool out of the steering unit bore, leaving the guide from the inner part in the bore.


(770-3ATM) 5-80(1)

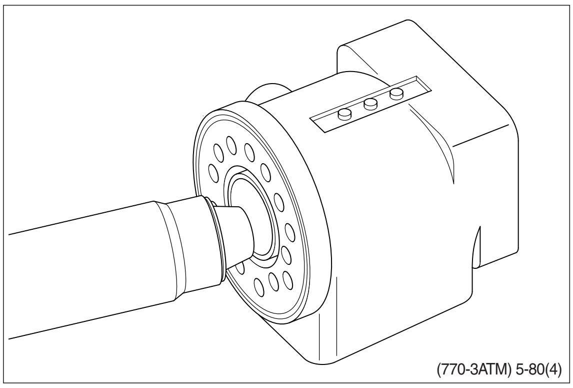
Installation instructions for lip seal

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

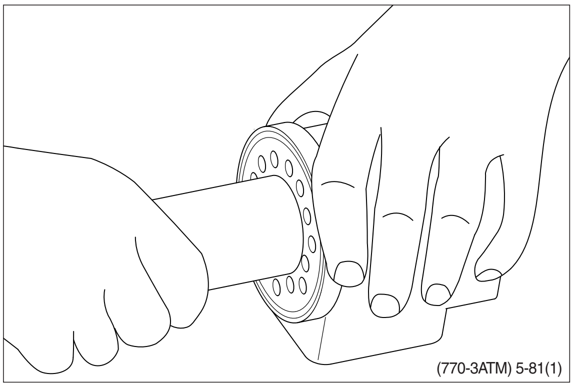

(770-3ATM) 5-80(2)


(770-3ATM) 5-80(3)

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


(770-3ATM) 5-80(4)

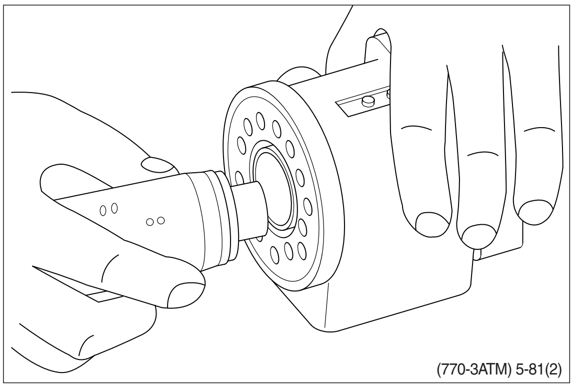
(17) Press and turn the lip seal into place in the housing.



(770-3ATM) 5-81(1)

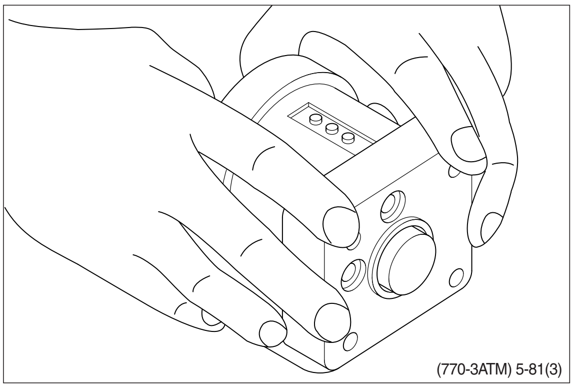
(18) With a light turning movement, guide the spool and sleeve into the bore.

※ Fit the spool set holding the cross pin horizontal.



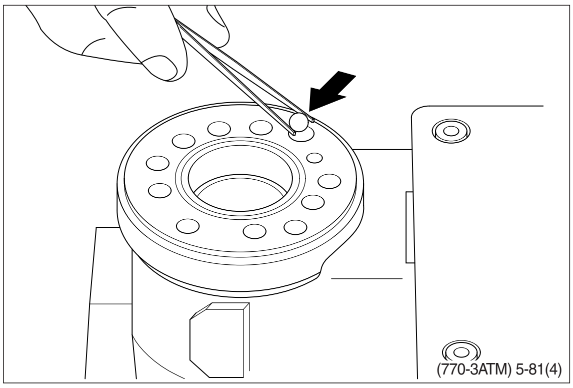
(770-3ATM) 5-81(2)

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



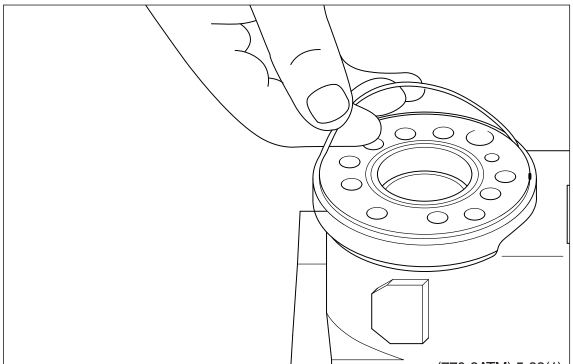
(770-3ATM) 5-81(3)

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



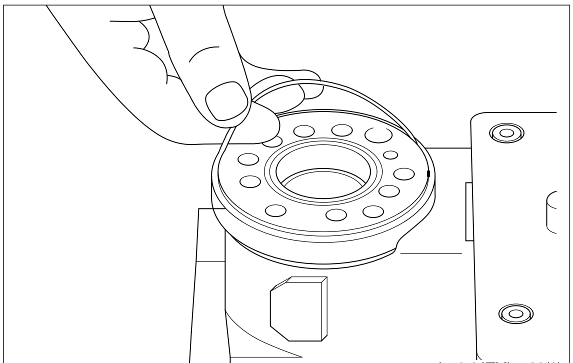
(770-3ATM) 5-81(4)

(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.



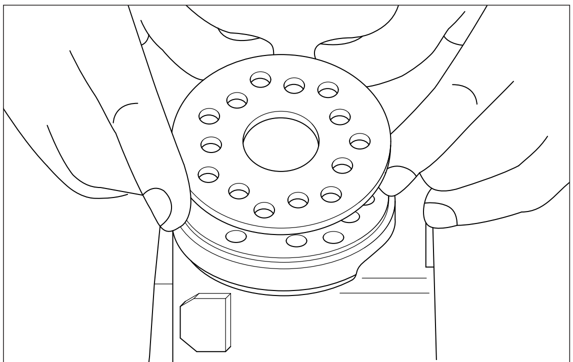
(770-3ATM) 5-82(1)

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



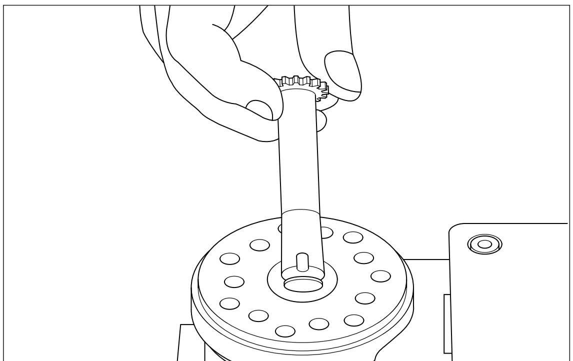
(770-3ATM) 5-82(2)

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



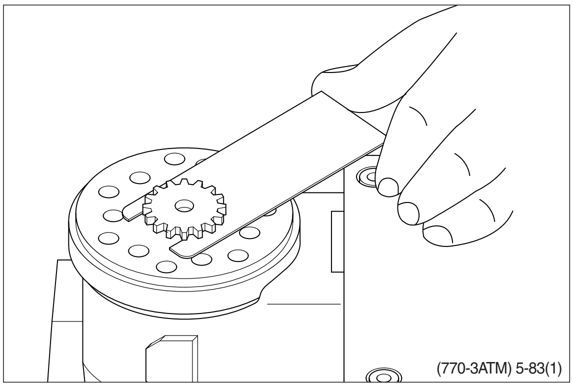
(770-3ATM) 5-82(3)

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



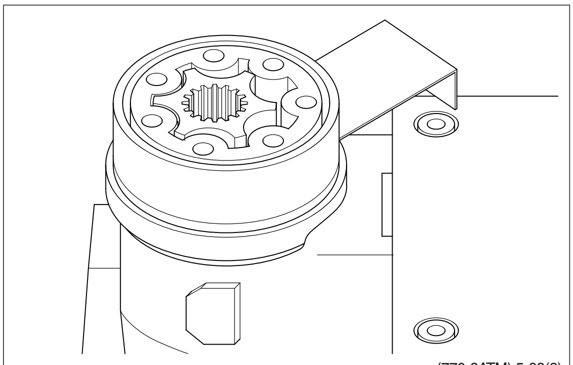
(770-3ATM) 5-82(4)

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



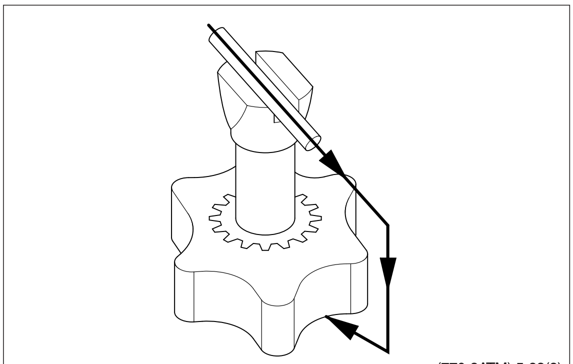
(770-3ATM) 5-83(1)

(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.



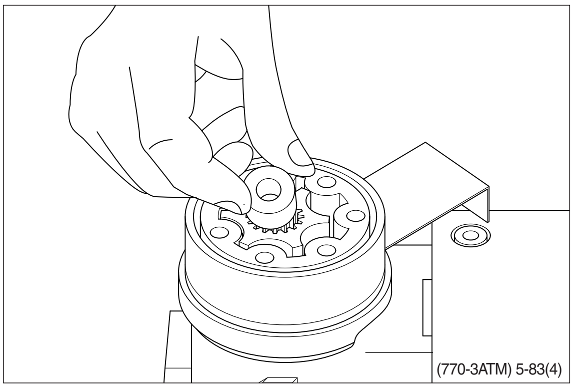
(770-3ATM) 5-83(2)

(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.



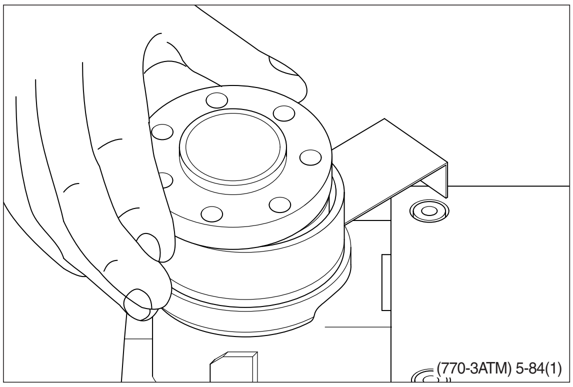
(770-3ATM) 5-83(3)

(28) Fit the spacer, if any.

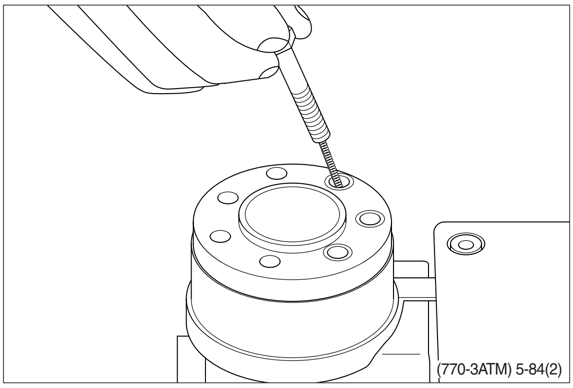


(770-3ATM) 5-83(4)

(29) Place the end cover in position.

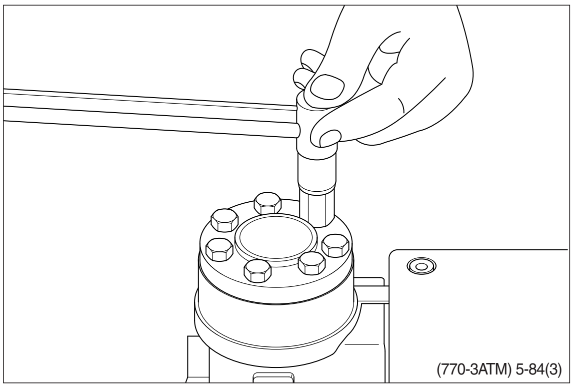

(770-3ATM) 5-84(1)

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

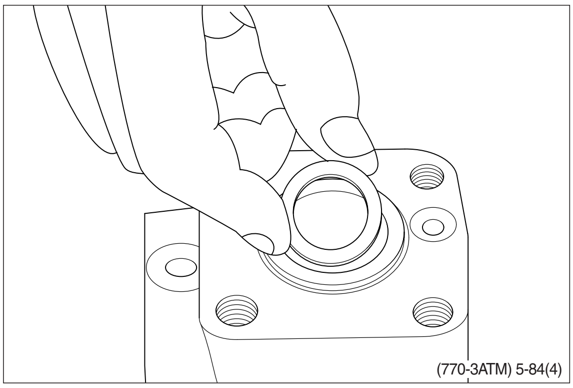

(770-3ATM) 5-84(2)

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

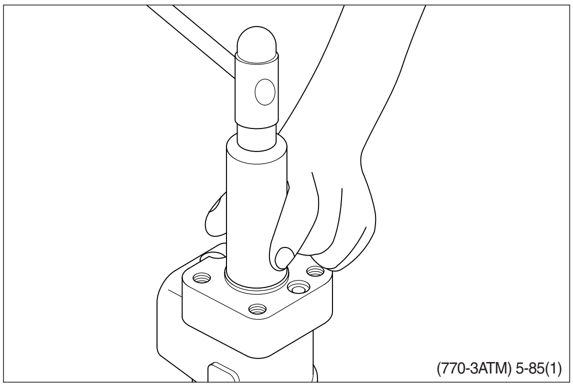
· Tightening torque : 3.1±0.6 kgf · m (22.4±4.3 lbf · ft)


(770-3ATM) 5-84(3)

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

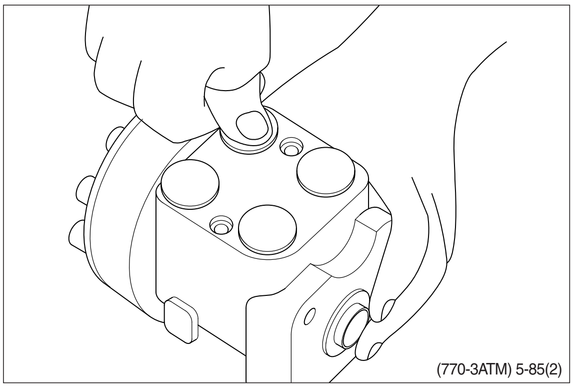

(770-3ATM) 5-84(4)

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


(770-3ATM) 5-85(1)

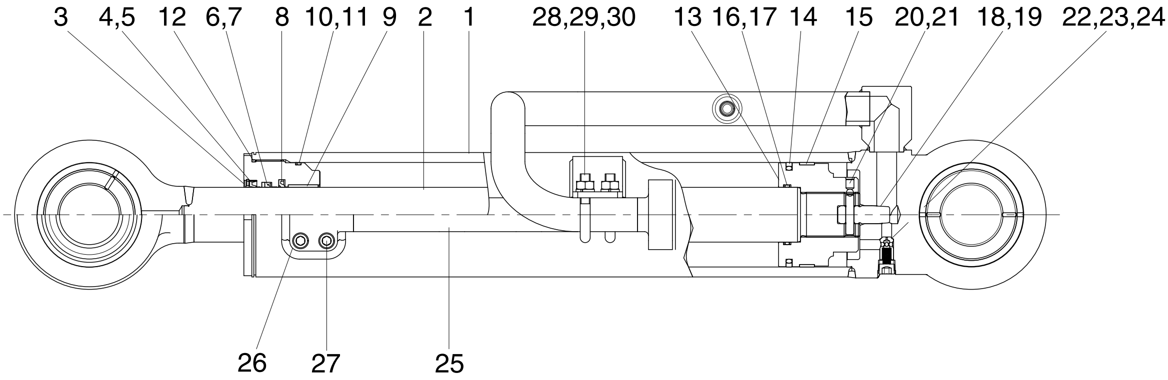
(34) Press the plastic plugs into the connection ports.

※ Do not use a hammer!


(770-3ATM) 5-85(2)

3. STEERING CYLINDER

1) STRUCTURE

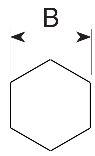


78095SE05

1	Tube assembly	12	O-ring	23	Spring
2	Rod assy	13	Piston	24	Plug
3	Gland	14	Piston seal	25	Pipe assy
4	Dust wiper	15	Wear ring	26	O-ring
5	Retaining ring	16	O-ring	27	Hexagon nut
6	Rod seal	17	Back-up ring	28	U-bolt
7	Back-up ring	18	Cushion plunger	29	Hexagon nut
8	Buffer ring	19	Parallel pin	30	Spring washer
9	Bushing	20	Steel ball	31	Spherical bearing
10	O-ring	21	Set screw	32	Retaining ring
11	Back-up ring	22	Check valve		

2) TOOLS AND TIGHTENING TORQUE

(1) Tools

Tool name	B	Remark
L-wrench	5	
Spanner	70	
Wrench	For gland	
(-) Driver	Small and large sizes	
Torque wrench	Capable of tightening with the specified torques	

(2) Tightening torque

Part name	Item	Size	Torque	
			kgf · m	lbf · ft
Gland	3	M115×2	70±7	506±51
Piston	13	M 50×2	125±12.5	904±90
Set screw	21	M 8×1.25	2.7±0.3	19.5±2.2
Plug	24	PT 3/8	12±1.2	86.8±8.7

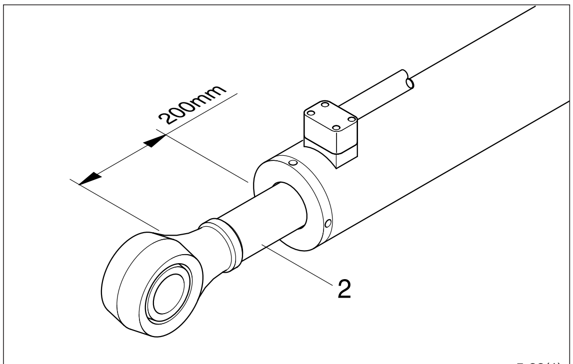
3) DISASSEMBLY

(1) Remove cylinder head and piston rod

① Hold the clevis section of the tube in a vise.

※ Use mouth pieces so as not to damage the machined surface of the cylinder tube. Do not make use of the outside piping as a locking means.

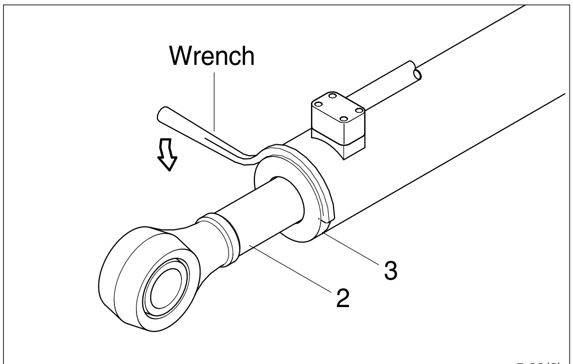
② Pull out piston rod (2) about 200 ㎜ (7.8 in). Because the piston rod is rather heavy, finish extending it with air pressure after the oil draining operation.



5-88(1)

③ Loosen and remove the gland (3).

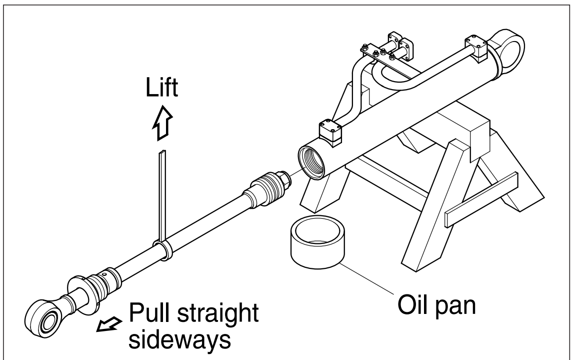
※ Cover the extracted piston rod (2) with rag to prevent it from being accidentally damaged during operation.



5-88(2)

④ Draw out gland (3) and piston rod (2) assembly together from cylinder tube (1).

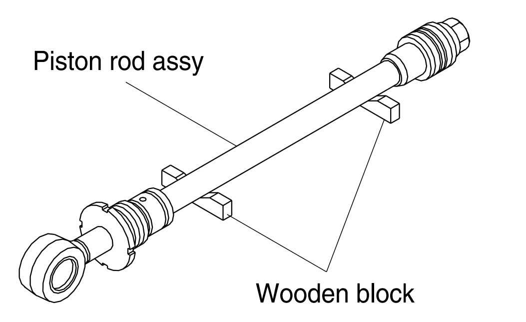
※ Since the piston rod assembly is heavy in this case, lift the tip of the piston rod (2) with a crane or some means and draw it out. However, when piston rod(2) has been drawn out to approximately two thirds of its length, lift it in its center to draw it completely.



5-88(3)

※ Note that the plated surface of piston rod (2) is to be lifted. For this reason, do not use a wire sling and others that may damage it, but use a strong cloth belt or a rope.

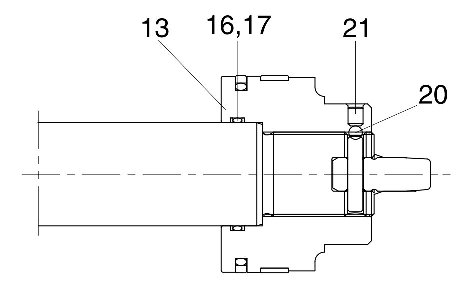
⑤ Place the removed piston rod assembly on a wooden V-block that is set level.
※ Cover a V-block with soft rag.



5-89(1)

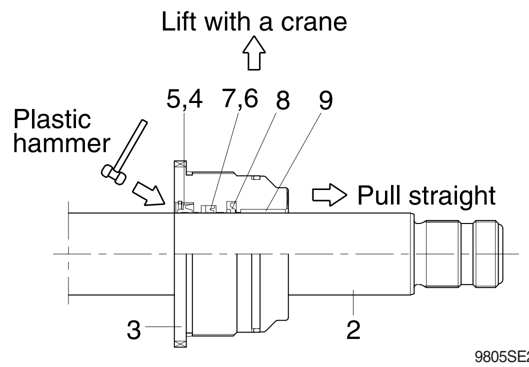
(2) Remove piston and gland assembly

① Remove the set screw (21) and steel ball (20).
② Remove piston assembly (13), back up ring (17) and O-ring (16).



9805SE09

③ Remove the gland (3) assembly from piston rod (2).
※ If it is too heavy to move, move it by striking the flanged part of gland (3) with a plastic hammer.
※ Pull it straight with gland assembly lifted with a crane.
Exercise care so as not to damage the lip of rod bushing (9) and packing (4,5,6,7,8) by the threads of piston rod (2).

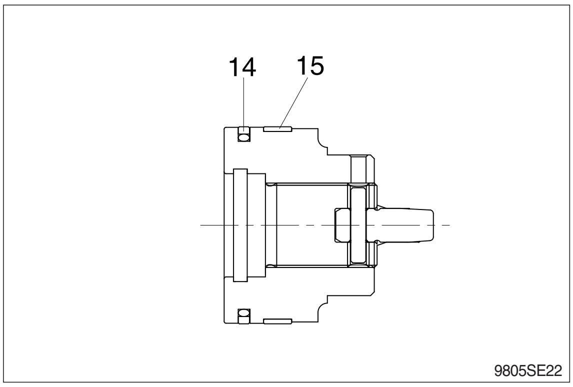


9805SE21

(3) Disassemble the piston assembly

① Remove wear ring (15) and piston seal (14).

※ Exercise care in this operation not to damage the grooves.



(4) Disassemble gland assembly

① Remove back up ring (11), and O-ring (10).

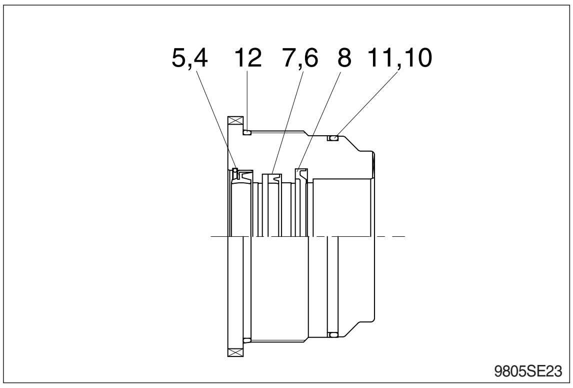
② Remove O-ring (12).

③ Remove retaining ring (5) and dust wiper (4).

④ Remove back up ring (7), rod seal (6) and buffer ring (8).

※ Exercise care in this operation not to damage the grooves.

※ Do not remove seal and ring, if does not damaged.

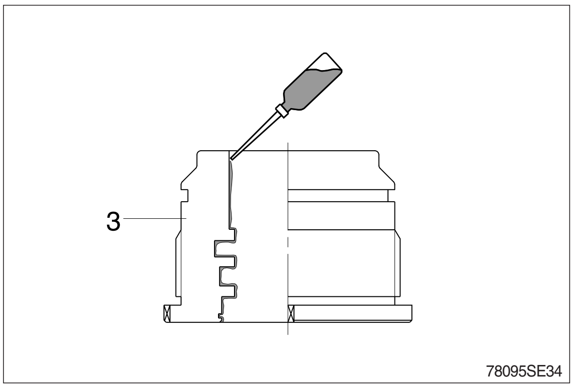


4) ASSEMBLY

(1) Assemble gland assembly

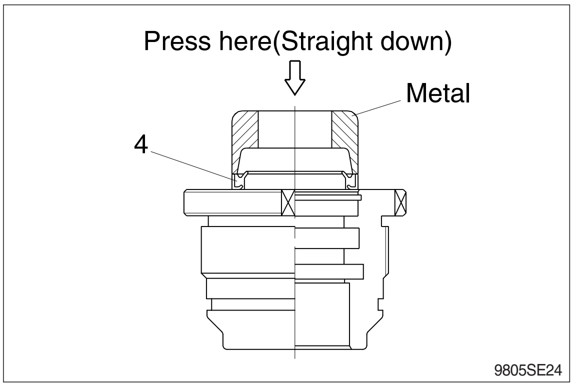
※ Check for scratches or rough surfaces if found smooth with an oil stone.

① Coat the inner face of gland (3) with hydraulic oil.



② Coat dust wiper (4) with grease and fit dust wiper (4) to the bottom of the hole of dust wiper.
At this time, press a pad metal to the metal ring of dust seal.

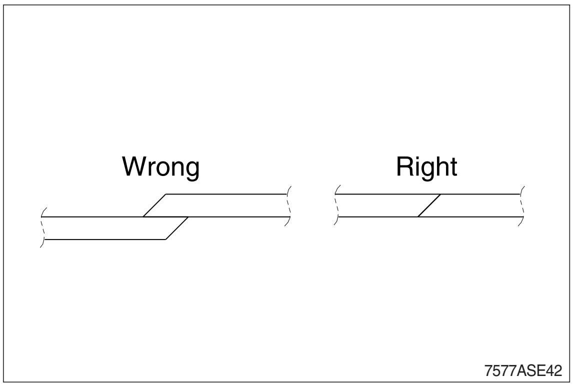
③ Fit retaining ring (5) to the stop face.



④ Fit back up ring (7) and rod seal (6), and buffer ring (8) to corresponding grooves, in that order.

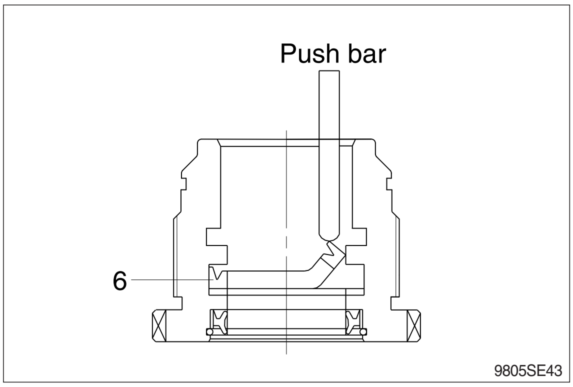
※ Coat each packing with hydraulic oil before fitting it.

※ Insert the backup ring until onside of it is inserted into groove.



※ Rod seal (6) has its own fitting direction. Therefore, confirm it before fitting them.

※ Fitting rod seal (6) up side down may damage its lip. Therefore check the correct direction that is shown in figure.

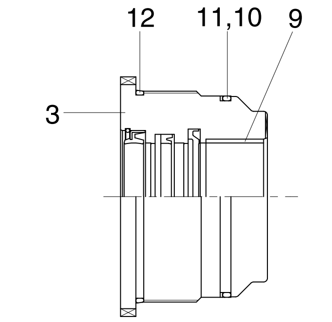


⑤ Fit back up ring (10) to gland (3).

※ Put the backup ring in the warm water of 30~50˚C.

⑥ Fit O-ring (10,12) to gland (3).

⑦ Fit bushing (9) to gland (3).

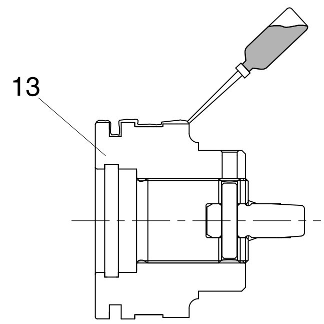


9805SE25

(2) Assemble piston assembly

※ Check for scratches or rough surfaces.

① If found smooth with an oil stone.
Coat the outer face of piston (13) with hydraulic oil.

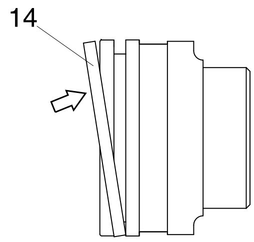


9805SE26

② Fit piston seal (14) to piston

※ Put the piston seal in the warm water of 60~100˚C for more than 5 minutes.

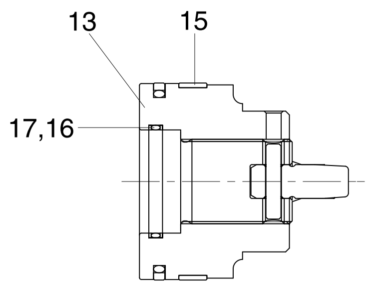
※ After assembling the piston seal, press its outer diameter to fit in.



9805SE27

③ Fit wear ring (15) to piston (13).

④ Fit back up ring (17) and O-ring (16) to piston (13).



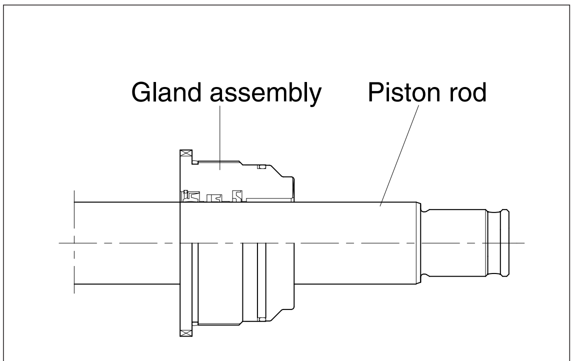
9805SE28

(3) Install piston and gland assembly

① Fix the piston rod assembly to the work bench.

② Apply hydraulic oil to the outer surface of piston rod (2), the inner surface of piston and gland.

③ Insert gland assembly to piston rod (2).



9805SE29

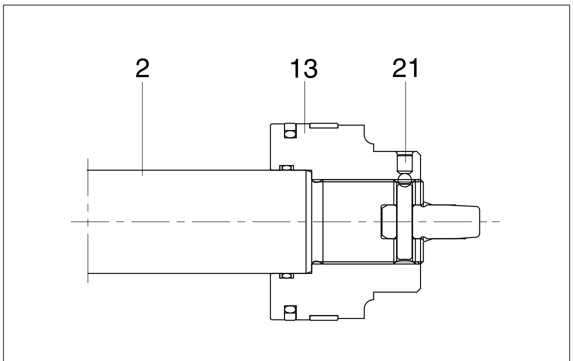
④ Fit piston assembly to piston rod.

⑤ Tighten piston (13) to piston rod (2).

· Tightening torque : 125 ± 12.5 kgf · m
(904 ± 90 lbf · ft)

⑥ Tighten set screw (21) to piston (13).

· Tightening torque : 2.7 ± 0.3 kgf · m
(19.5 ± 2.2 lbf · ft)



9805SE30

(4) Overall assemble

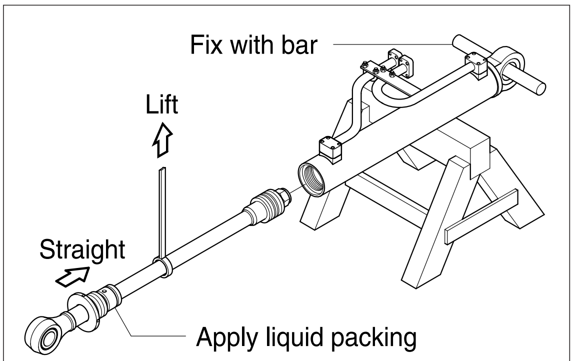
① Place a V-block on a rigid work bench. Mount the cylinder tube assembly on it and fix the assembly by passing a bar through the clevis pin hole to lock the assembly.

② Insert the piston rod assembly in to the cylinder tube assembly, while lifting and moving the piston rod assembly with a crane.

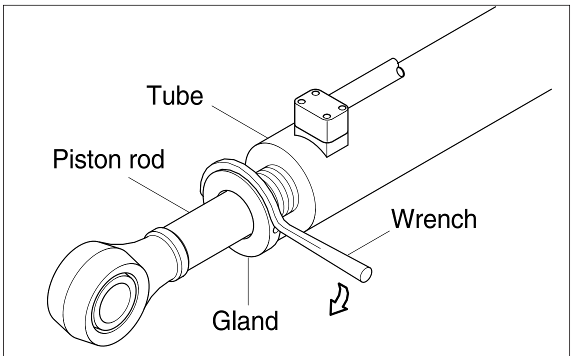
※ Be careful not to damage piston seal by thread of cylinder tube.

③ Fit gland to the tube.

· Tightening torque : 70 ± 7 kgf · m
(506 ± 51 lbf · ft)



5-94(1)

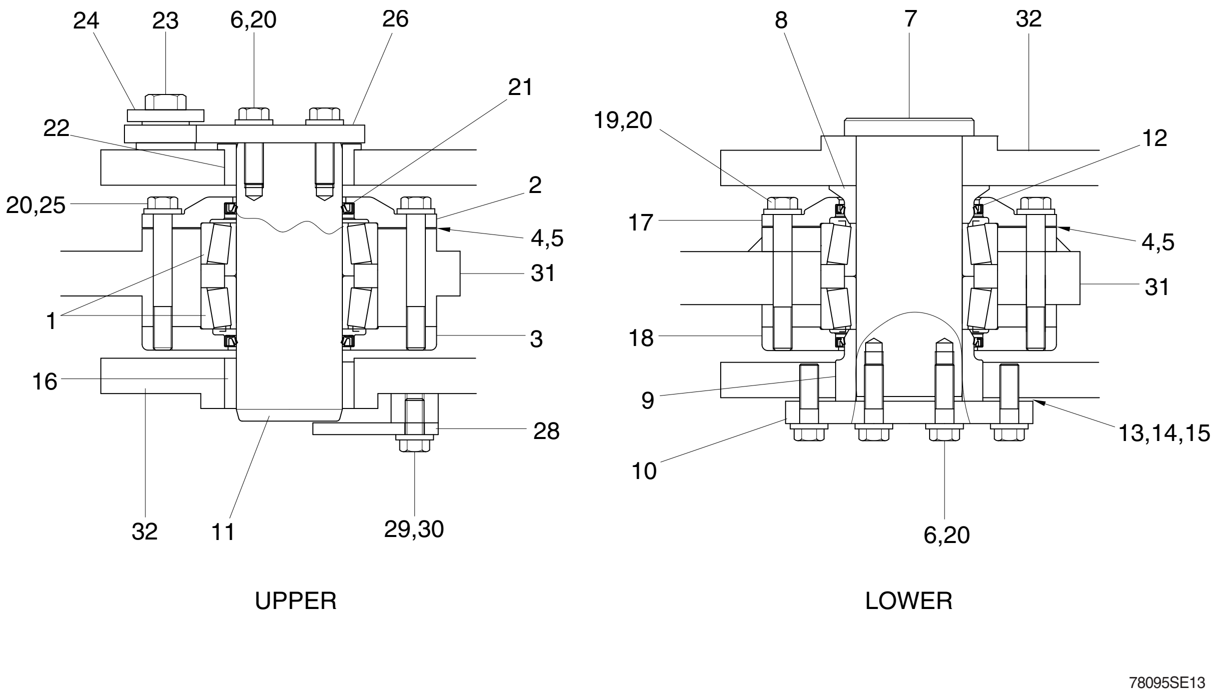


5-94(2)

4. CENTER PIVOT PIN

1) CONSTRUCTION

Figure shows the construction of the center pivot pin assembly. This assembly serves to connect the front frame with the rear frame; two sets of assemblies are provided, one each for the upper and lower parts. The numbers in parentheses following the parts name denote the item numbers shown in the figure in the disassembly and assembly procedures.



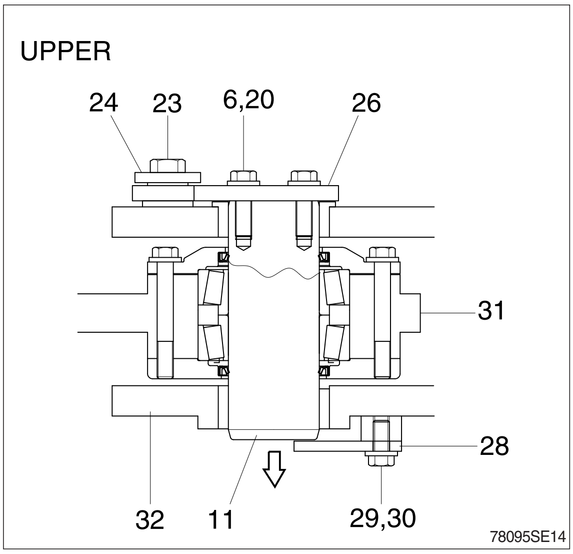
1	Bearing	12	Dust seal	23	Hexagon bolt
2	Cover	13	Shim (0.1 t)	24	Hardened washer
3	Cover	14	Shim (0.5 t)	25	Hexagon bolt
4	Shim (0.1 t)	15	Shim (2.0 t)	26	Plate
5	Shim (0.5 t)	16	Bushing	28	Plate
6	Hexagon bolt	17	Cover	29	Hexagon bolt
7	Pin	18	Cover	30	Hardened washer
8	Collar	19	Hexagon bolt	31	Front frame
9	Collar	20	Hardened washer	32	Rear frame
10	Plate	21	Dust seal		
11	Pin	22	Bushing		

2) DISASSEMBLY

After supporting the front frame and the rear frame as horizontally as possible using wood blocks and jacks, disassemble as follows: In order to facilitate the disassembly/assembly of the center pivot pins, remove the drive shaft, hydraulic line and steering cylinder first.

(1) Maintain the horizontal level of front frame (31) and rear frame (32), and then remove hexagon bolt (6, 23, 29), washer (20, 24) and plate (26, 28).

(2) Take out upper pin (11) to the downside using a metal punch.



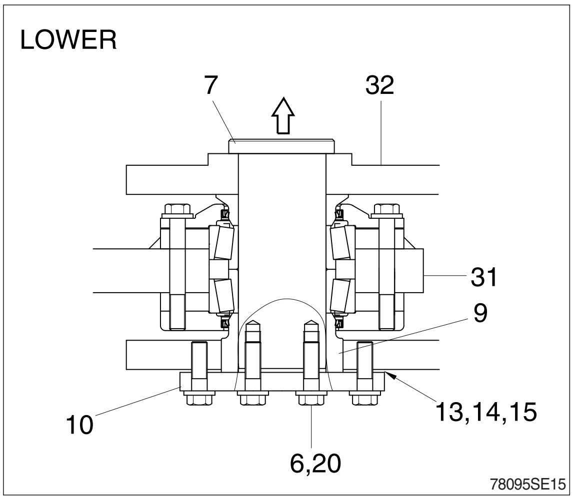
(3) Maintain the front frame horizontal level, remove hexagon bolts (6) and then remove the plate (10) and shims (13, 14, 15).

(4) Take out lower pin (7) to the upside using a metal punch carefully.

(5) Jack up or lifting the front frame (31) slightly, the collar (9) protrudes over the rear frame.
Remove the collar (9).

(6) Lift the frame by passing the slinging wire rope at four positions of front frame, in order to separate it from the rear frame.

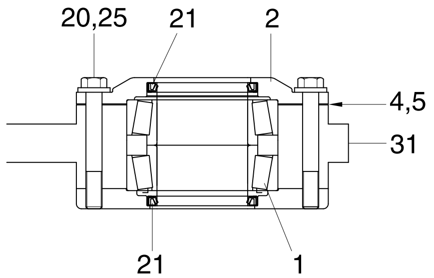
(7) Support the front frame safely.



(8) Remove bolt (25), washer (20) and then take out cover (2) and shims (4, 5).

(9) Take out dust seal (21) from the cover (2).

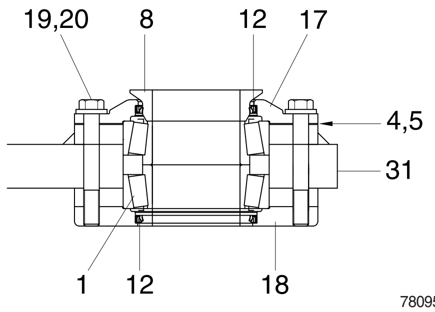
(10) Remove the bearing (1), and dust seal (21).



(11) Remove bolt (19), washer (20) and then take out cover (17, 18) and shims (4, 5).

(12) Take out the dust seal (12) from the cover (17, 18).

(13) Remove the bearing (1) and collar (8).



3) INSPECTION

(1) Check the bearing sliding surface for excessive wear, scorching or scratches; replace if necessary.

(2) Replace all dust seals (12, 21) with new ones.

(3) Grind any pins (7, 11) dented with an oilstone or replace any pins abrasive excessively.

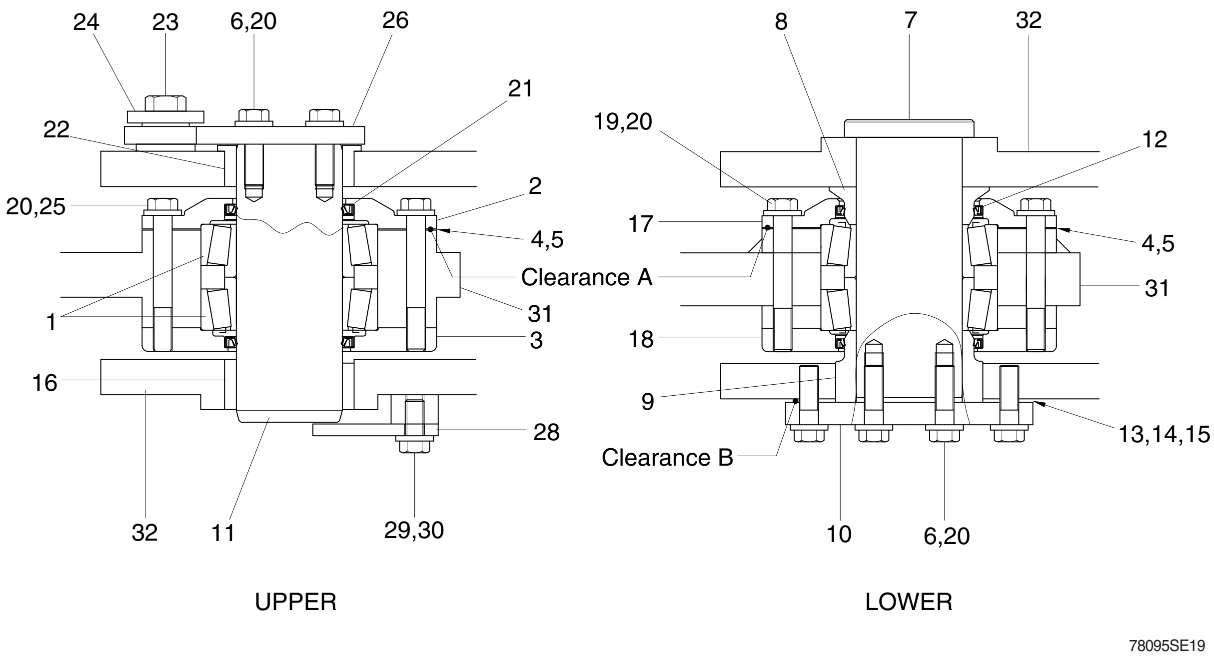
(4) Check inside cover (2, 3, 17, 18) and collar (8, 9) for dents or scratches; if any damage is found, correct with a grinder or replace.

(5) The serviceable limit of pins and bushings is shown in the table below.

Unit : mm

Item No.	Name	Std dimension	Serviceable limit			Remedy
			Outer dia	Inner dia	Clearance	
7, 11	Pin	Upper :100 Lower : 105	99.5/104.5		0.8	Replace
1	Tapered roller bearing			100.5/105.5		
8, 9	Collar			100.5/105.5		
12, 21	Dust seal	When removed				Replace

4) ASSEMBLY



Assemble the center pivot group by reversing the order of disassembly while paying close attention to the following.

(1) Put the dust seal (12,21) into cover (2, 3, 17, 18).

※ Apply grease to the lip of the dust seal. Insert the dust seal so that the dust seal lip faces out and punch four places on the outer circumference of the seal to lock it.

(2) Lower the temperature of the lower bearing cup to -75±5˚C (-103±9˚F) and install it to front frame until it contacts the bottom of the frame.

(3) Place the cover (3, 18).

(4) Coat lightly with oil and install lower bearing in bore in front frame. Coat lightly with oil and install upper bearing in bore in upper front frame.

(5) Place the cover (2, 17) and hold in place with bolt (19, 25). At this time, adjust shims (4, 5) to press the shoulder of bearing (1) against retainer.

· **Adjustment method of clearance A**

① Install bearing (1) and cover (2, 17) without shim (4, 5)
Install four of bolt (19, 25) so that each bolt is separated by 90 degrees.
- Tightening torque : 2.0~3.0 kgf · m (14.5~21.7 lbf · ft)

② Adjust shims (4, 5) in order to control the clearance A.
- Clearance A : Below 0.1 mm
- Shim thickness : 0.1 mm, 0.5 mm

③ Measure bearing preload and confirm the value.
- Bearing preload : 1.2~2.5 kgf · m (8.7~18.1 lbf · ft)

(5) Apply grease to lower collar (8) and insert it to the lower of roller bearing.

(6) After setting the bearing so that its upper surface is horizontal, tighten the all the bolt (19, 25). After tightening, confirm that tapered roller bearing moves lightly ; if does not move smoothly, add shims (4, 5).

- Tightening Torque : 35~43 kgf · m (253~311 lbf · ft)
- Apply loctite #243.

(7) Move the front frame and join it to the rear frame so that match the pin hole at the center.

(8) Apply grease to pin (11), bushing (22) and insert it into tapered roller bearing (1).

(9) Apply grease to lower collar (9) and insert it to the lower of roller bearing through rear frame (32).

(10) Apply grease to pin (7) and insert it into tapered roller bearing (1).

(11) Before tightening bolt (6), adjust shims (13, 14, 15) in order to control the clearance between the plate (21) and rear frame (32).

- **Adjustment method of clearance B**

① Install pin (7) and plate (10) without shim (13, 14, 15).
Install four of bolt (6) so that each bolt is separated by 90 degrees.

- Tightening torque : 2.0~3.0 kgf · m (14.5~21.7 lbf · ft)

② Adjust shims in order to control the clearance B.

- Clearance B : 0.1~0.2 mm
- Shim thickness : 0.1 mm, 0.5 mm, 2.0 mm

(12) Tighten the all the bolts (6).

- Tightening Torque : 35~43 kgf · m (253~311 lbf · ft)
- Apply loctite #243.

5) TROUBLESHOOTING

Trouble	Probable cause	Remedy
Shock is felt when steering	Capscrew for fixing steering valve is loose	Retighten
	Faulty center pivot pin mounting bolts	Retighten
	Center pivot pins have worn out	Readjust or replace
	Faulty hydraulic system	See hydraulic system
Shock is felt when moving backward or forward	Fault fixing of connecting capscrews	Retighten
	Center pins have worn out	Readjust or replace
	Bearings of support unit have worn out	Retighten
	Drive shaft damaged	See drive system
	Faulty transmission	See transmission system

SECTION 6 WORK EQUIPMENT

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GROUP 1 STRUCTURE AND FUNCTION

1. HYDRAULIC SYSTEM OUTLINE

The loader hydraulic system is a pilot operated, closed center system which is supplied with flow from the variable displacement piston main hydraulic pump.

The loader system components are :

· Loader pump
· Main control valve
· Bucket cylinder
· Boom cylinders
· Remote control valve (Pilot control valve, EH type)
· Safety valve

Flow from the steering pump not used by the steering system leaves the flow amplifier EF port.
It flows to the inlet port plate of two section or three section block type main control valve.

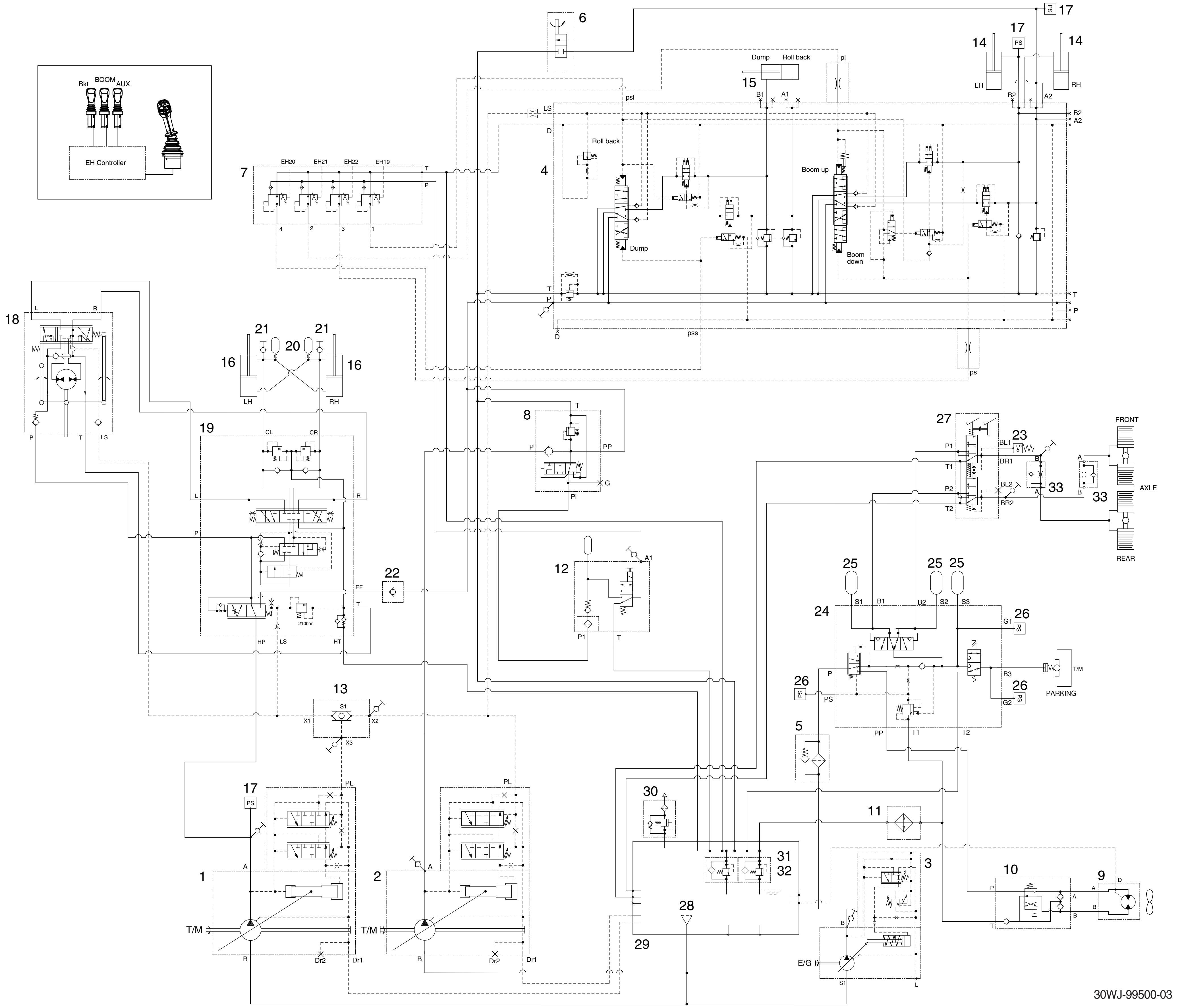
The main control valve is load pressure independent flow distribution system which routes flow to the boom, bucket or auxiliary cylinders (not shown) when the respective spools are shifted.

Flow from the loader pump is routed to the main control valve where pump outlet pressure is reduced to pilot circuit pressure. The main control valve flow to the remote control valve.
The remote control valve routed flow to either end of each spool valve section in the main control valve to control spool stroke.

A accumulator mounted on safety valve supplies a secondary pressure source to operated remote control valve so the boom can be lowered if the engine is off.

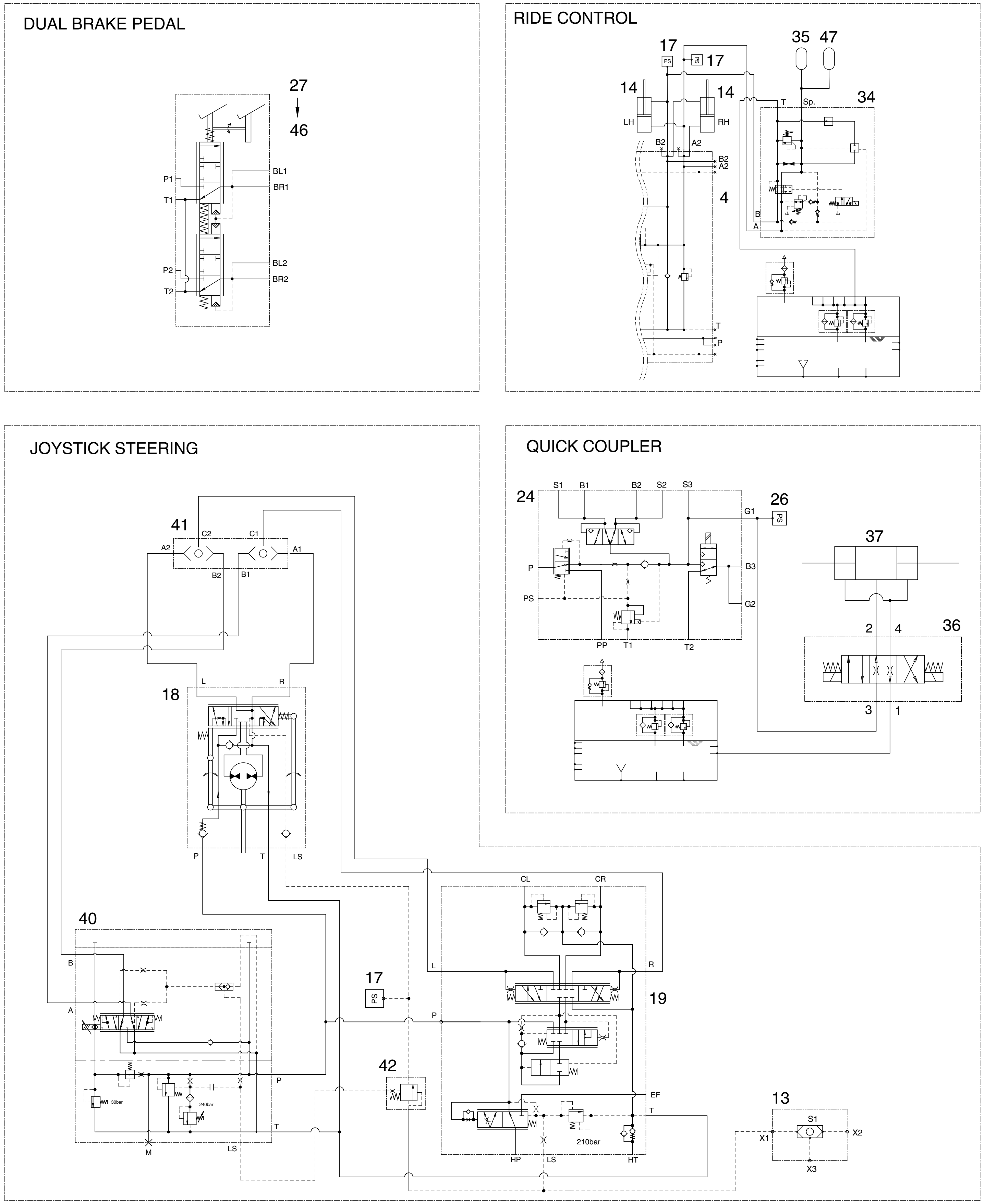
The return circuit for the main hydraulic system have return filter inside the hydraulic tank. The return filter uses a filter element and a bypass valve. The bypass valve is located in the upside of filter.

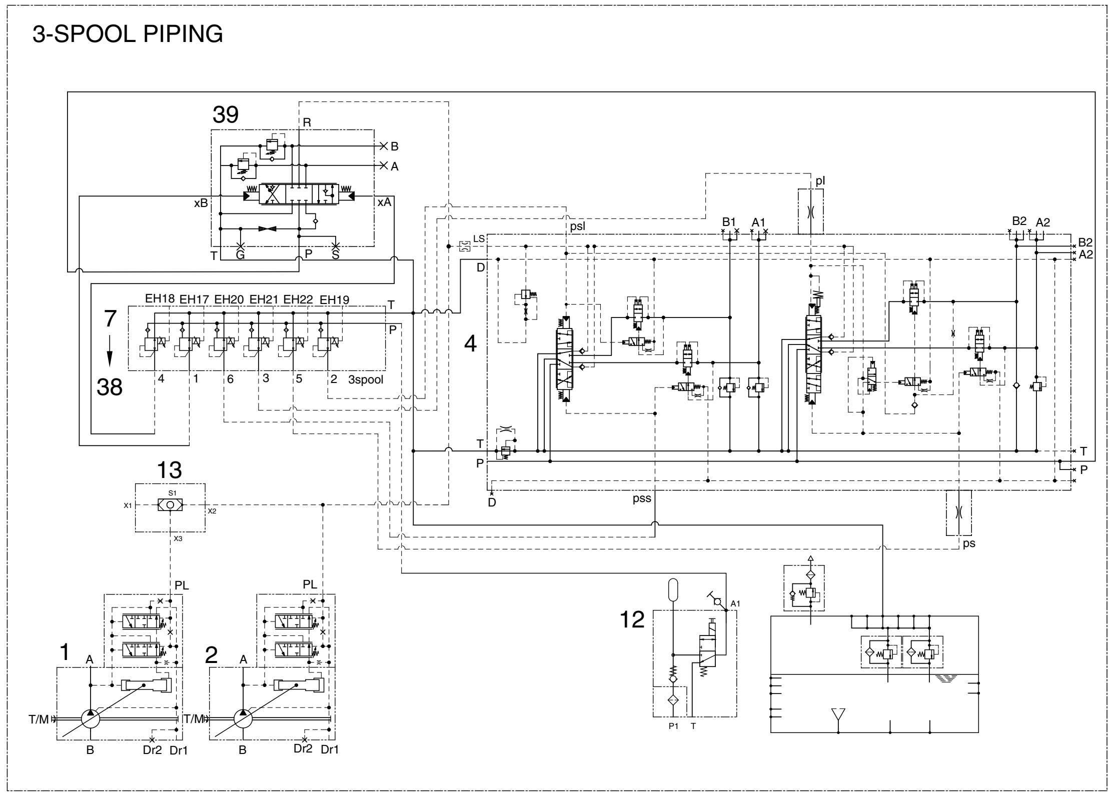
2. HYDRAULIC CIRCUIT (1/2)

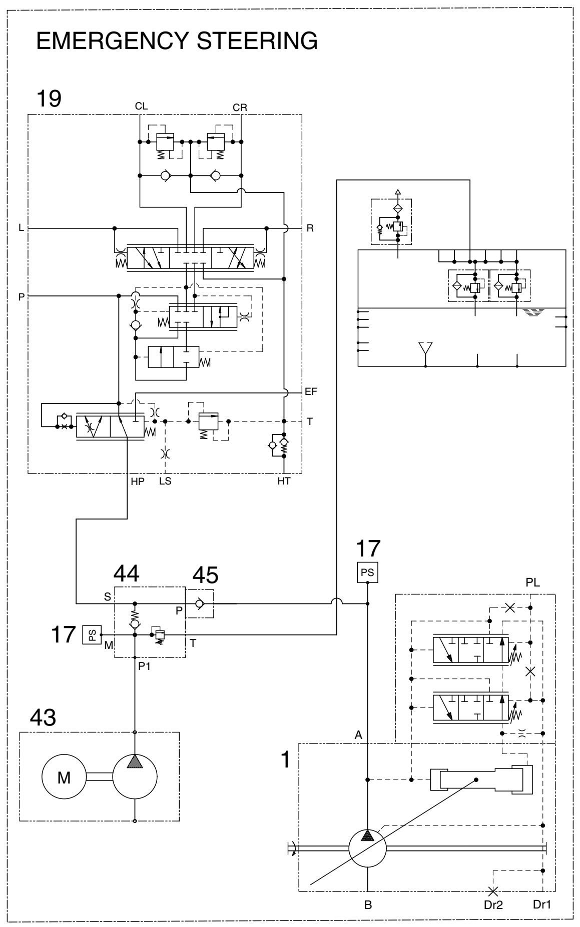


1 Steering pump
2 Main pump
4 Main control valve
5 Filter assy
6 Boom lowering valve
7 Remote control block
8 Function valve
9 Fan motor
10 Directional valve
11 Hyd oil cooler
12 Safety valve
12-1 Filter element
13 Shuttle valve
14 Boom cylinder
15 Bucket cylinder
16 Steering cylinder
17 Pressure sensor
18 Steering unit
19 Flow amplifier
20 Accumulator
21 Orifice
22 Check valve
23 Pressure switch
24 Cut off valve
25 Accumulator
26 Pressure sensor
27 Brake valve
28 Strainer
29 Hydraulic tank
30 Air breather
31 Return filter
32 Bypass valve
33 Orifice check

HYDRAULIC CIRCUIT (2/2)



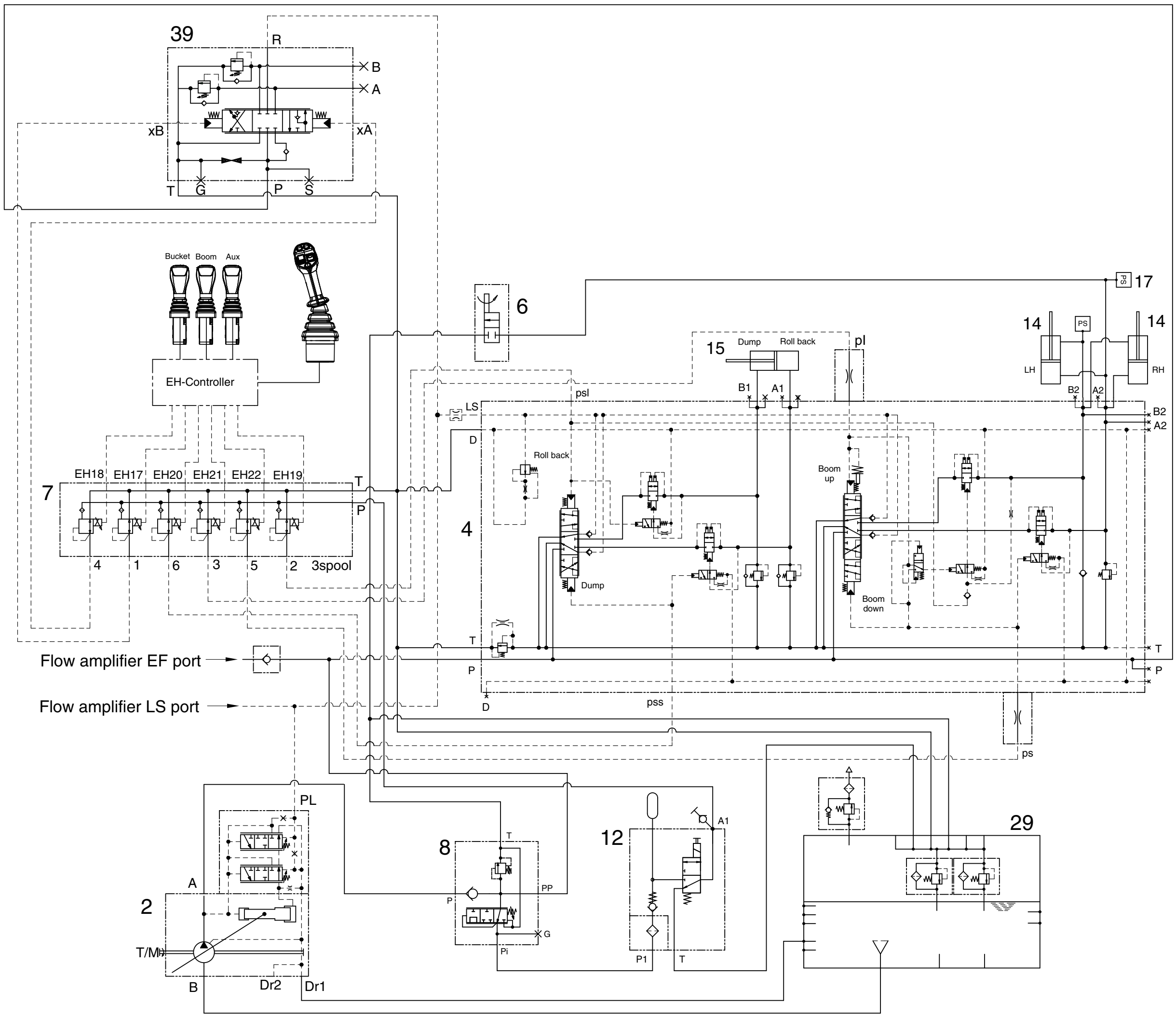




17 Pressure sensor
35 Accumulator
36 Solenoid valve
37 Quick coupler cylinder
38 Remote control block
39 Aux MCV
40 Proportional valve
41 Shuttle valve
42 LS compensating valve
43 Motor pump assy
44 Check vavle
45 Check valve
46 Dual brake valve
47 Accumulator

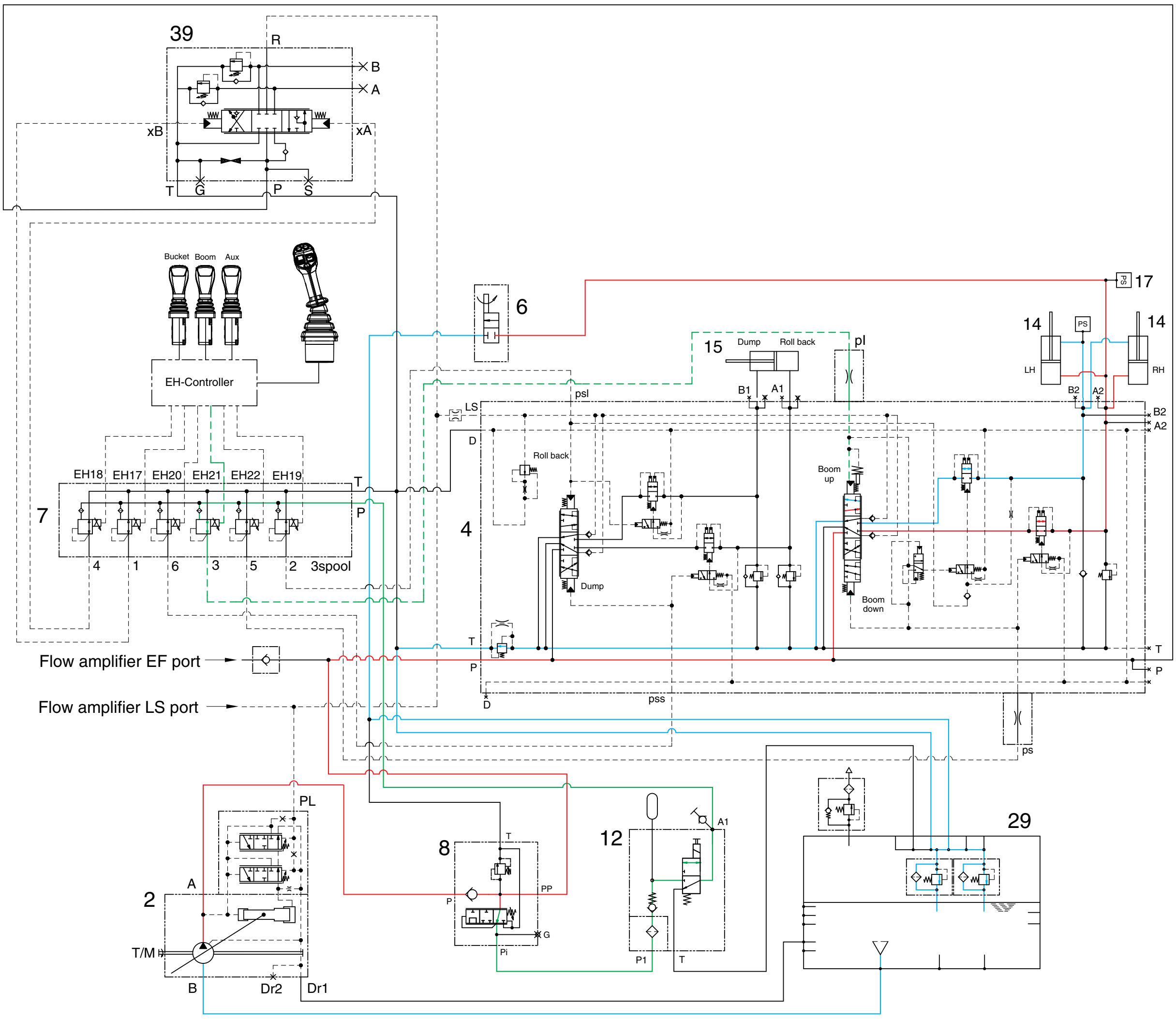
30WJ-99500-03

3. WORK EQUIPMENT HYDRAULIC CIRCUIT



2	Loader pump	14	Boom cylinder
4	Main control valve	15	Bucket cylinder
6	Boom lowering valve	17	Pressure sensor
7	EH control block	29	Hydraulic tank
8	Function valve	39	Auxiliary main control valve (opt)
12	Safety valve		

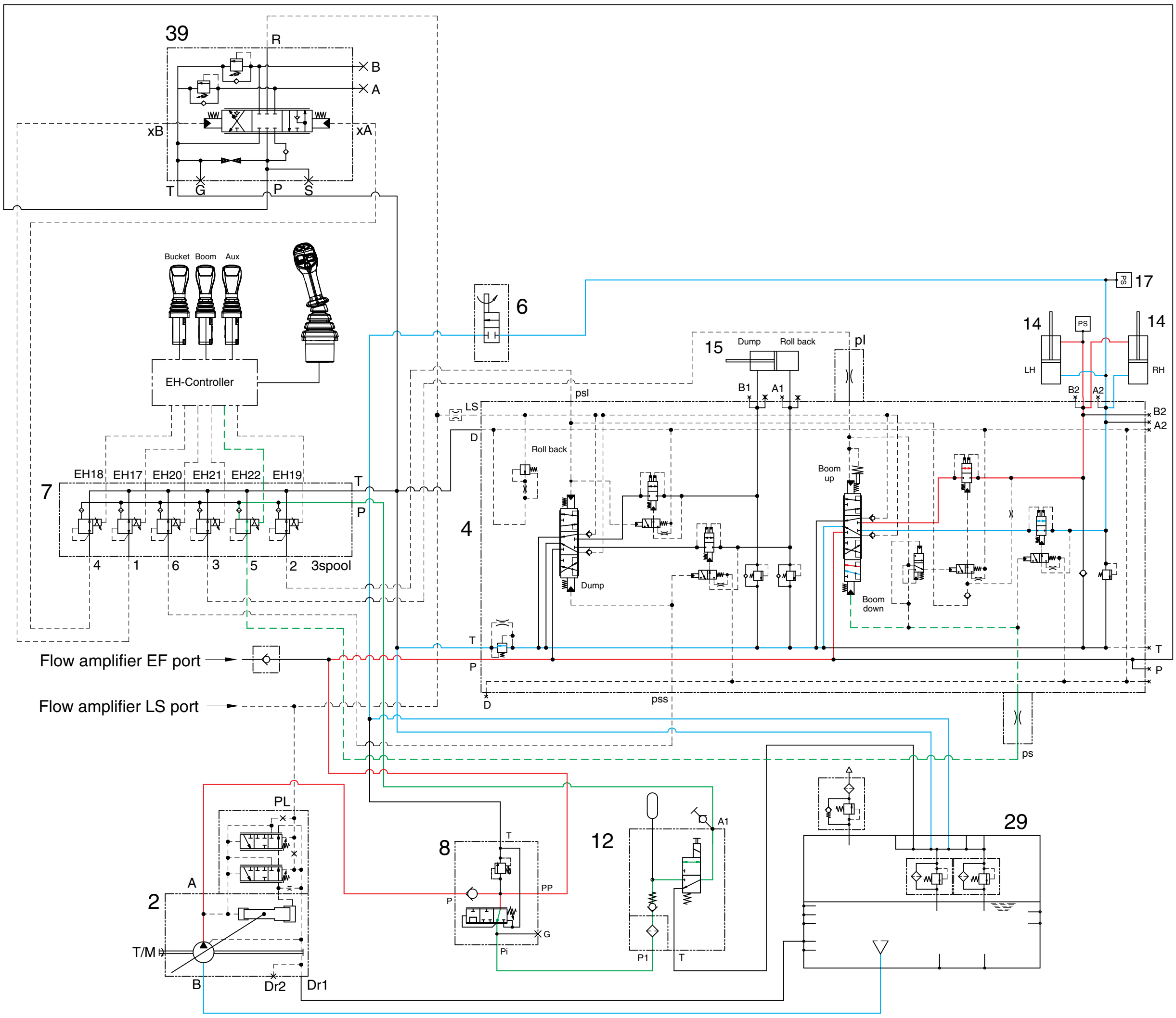
1) WHEN THE RCV LEVER IS IN THE RAISE POSITION



985A6WE03

- When the EH RCV lever (boom) is pulled back, the boom spool is moved to raise position by pilot oil pressure from EH control block (7).
- The oil from loader pump flows into main control valve (4) and then goes to the large chamber of boom cylinder (14).
- The oil from the small chamber of boom cylinder (14) returns to hydraulic oil tank (29) through the boom spool at the same time.
- When this happens, the boom goes up.

2) WHEN THE RCV LEVER IS IN THE LOWER POSITION



985A6WE04

· When the EH RCV lever (boom) is pushed forward, the boom spool is moved to lower position by pilot pressure from EH control block.

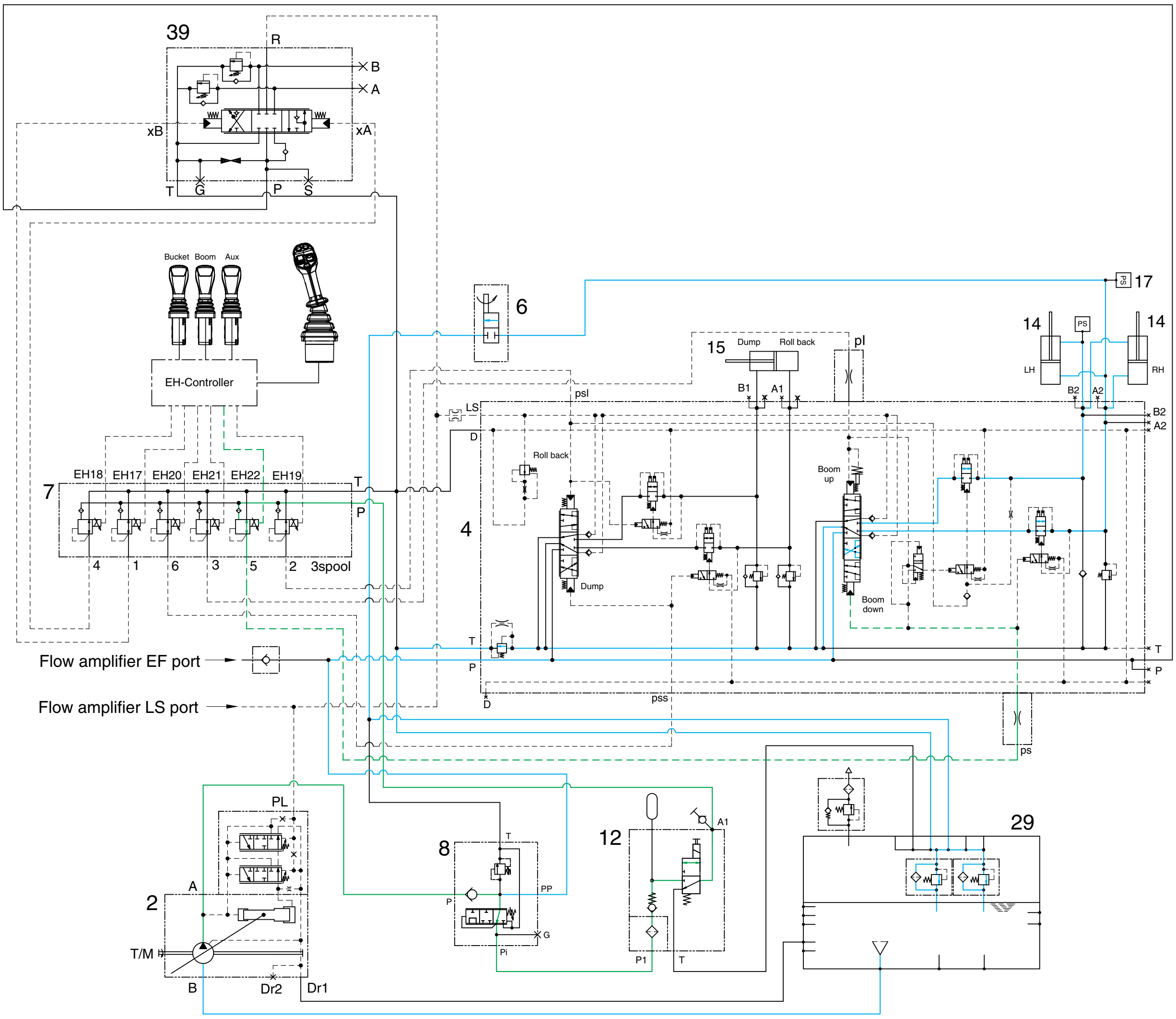
· The oil from loader pump flows into main control valve (4) and then goes to small chamber of boom cylinder (14) by pushing the load check valve of the boom spool.

· The oil returned from large chamber of boom cylinder (14) returns to hydraulic tank (29) through the boom spool at the same time.

· When the lowering speed of boom is faster, the return oil from the large chamber of boom cylinder combines with the oil from the pump through the regeneration check valve, and flows into the small chamber of the cylinder.

  This prevents cylinder cavitation by the negative pressure when the pump flow cannot match the boom down speed.

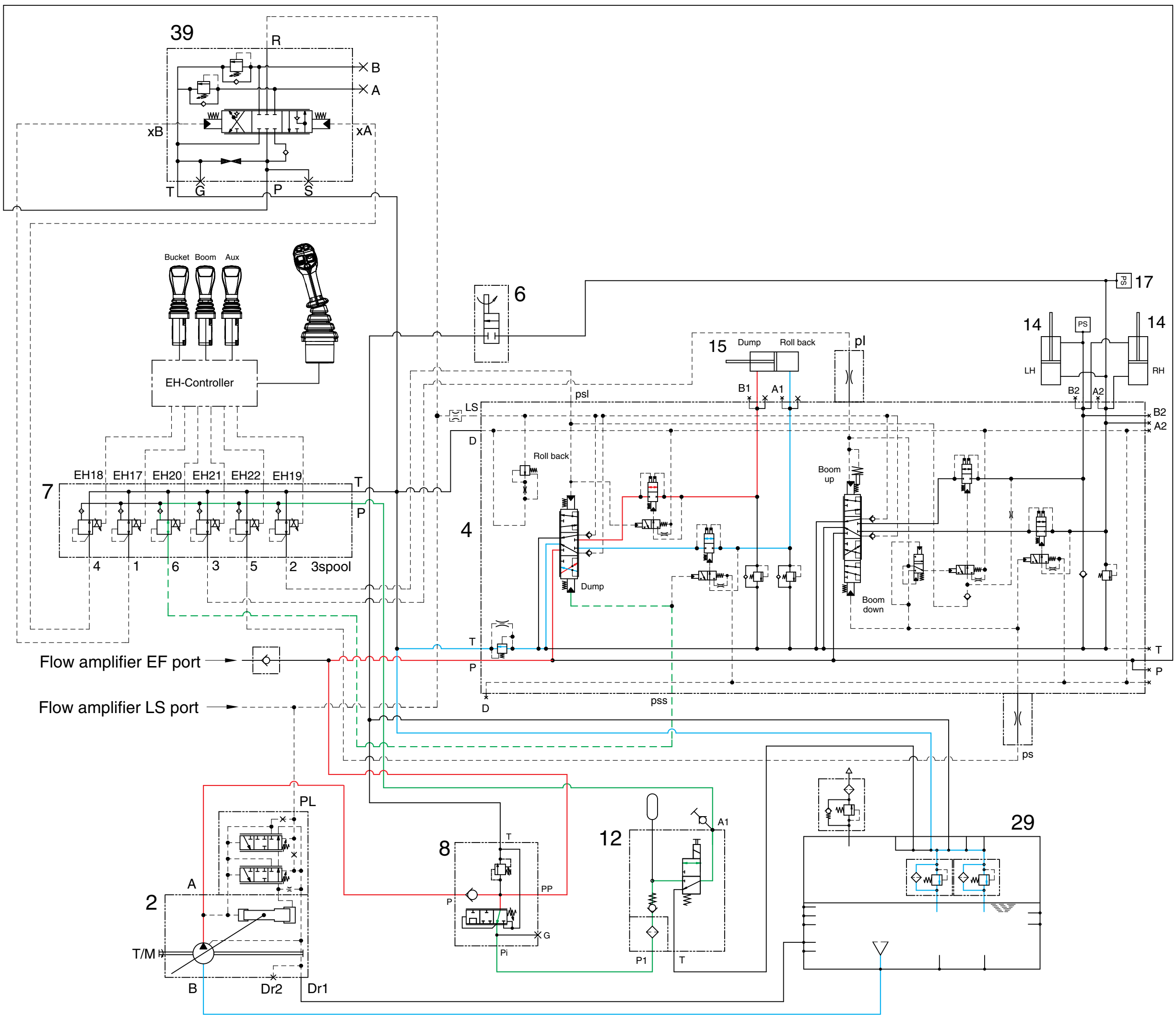
3) WHEN THE RCV LEVER IS IN THE FLOAT POSITION



985A6WE05

- When the EH RCV lever (boom) is pushed further forward from the lower position, the pilot pressure reaches to 13~15bar, then the boom spool is moved to floating position.
- The work ports (A2), (B2), (A3), (B3) and the small chamber and the large chamber are connected to the return passage, so the boom will be lowered due to it's own weight.
- In this condition, when the bucket is in contact with the ground, it can be move up and down in accordance with the shape of the ground.

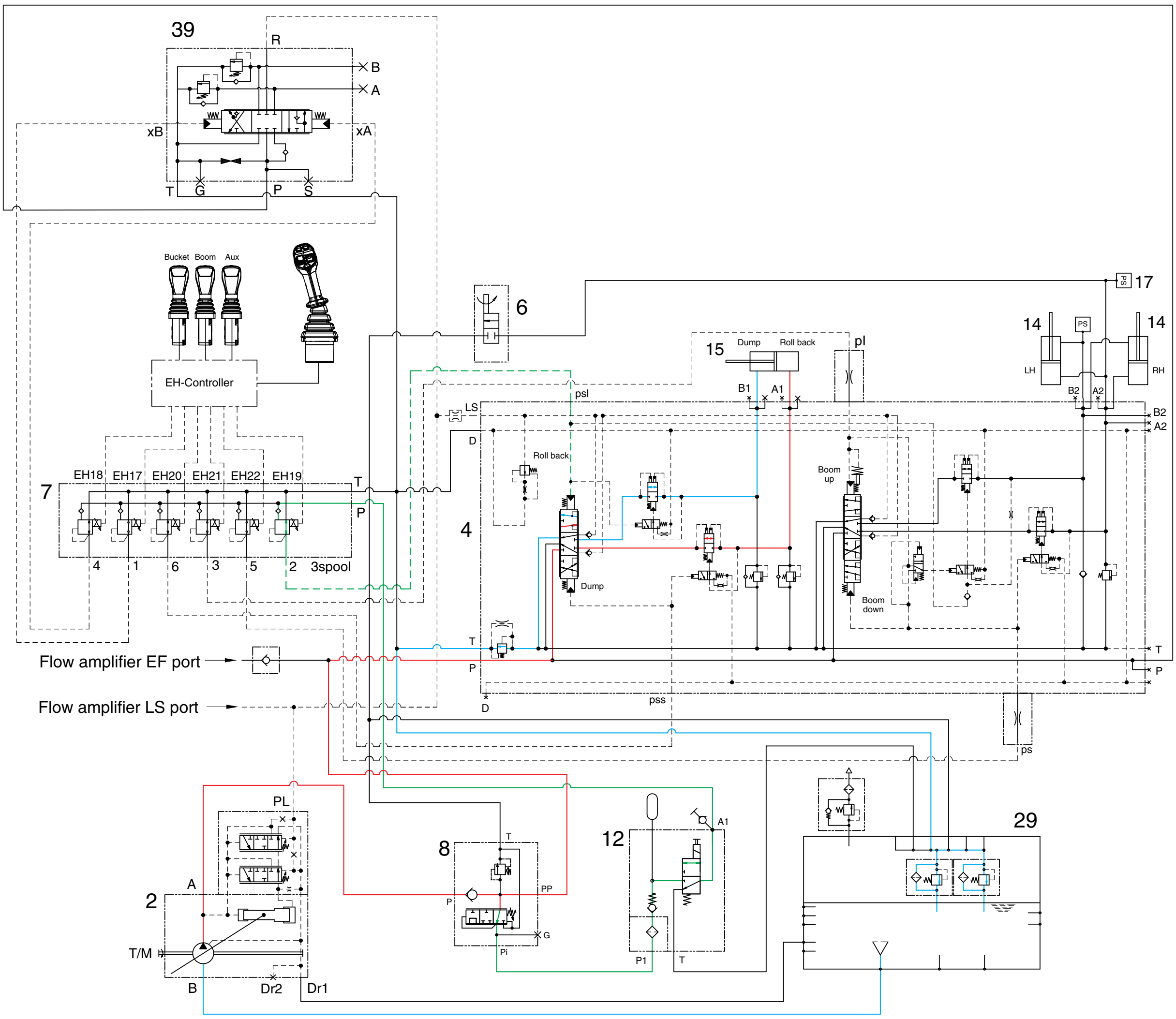
4) WHEN THE RCV LEVER IS IN THE DUMP POSITION



985A6WE06

- If the EH RCV lever (bucket) is pushed right, the bucket spool is moved to dump position by pilot oil pressure from EH control block.
- The oil from loader pump flows into main control valve (4) and then goes to the small chamber of bucket cylinder (15) by pushing the load check valve of the bucket spool.
- The oil at the large chamber of bucket cylinder (15) returns to hydraulic tank (29).
- When this happens, the bucket is dumped.
- When the dumping speed of bucket is faster, the oil returned from the large chamber of bucket cylinder combines with the oil from the pump, and flows into the small chamber of the cylinder.
  This prevents cylinder cavitation by the negative pressure when the pump flow cannot match the bucket dump speed.

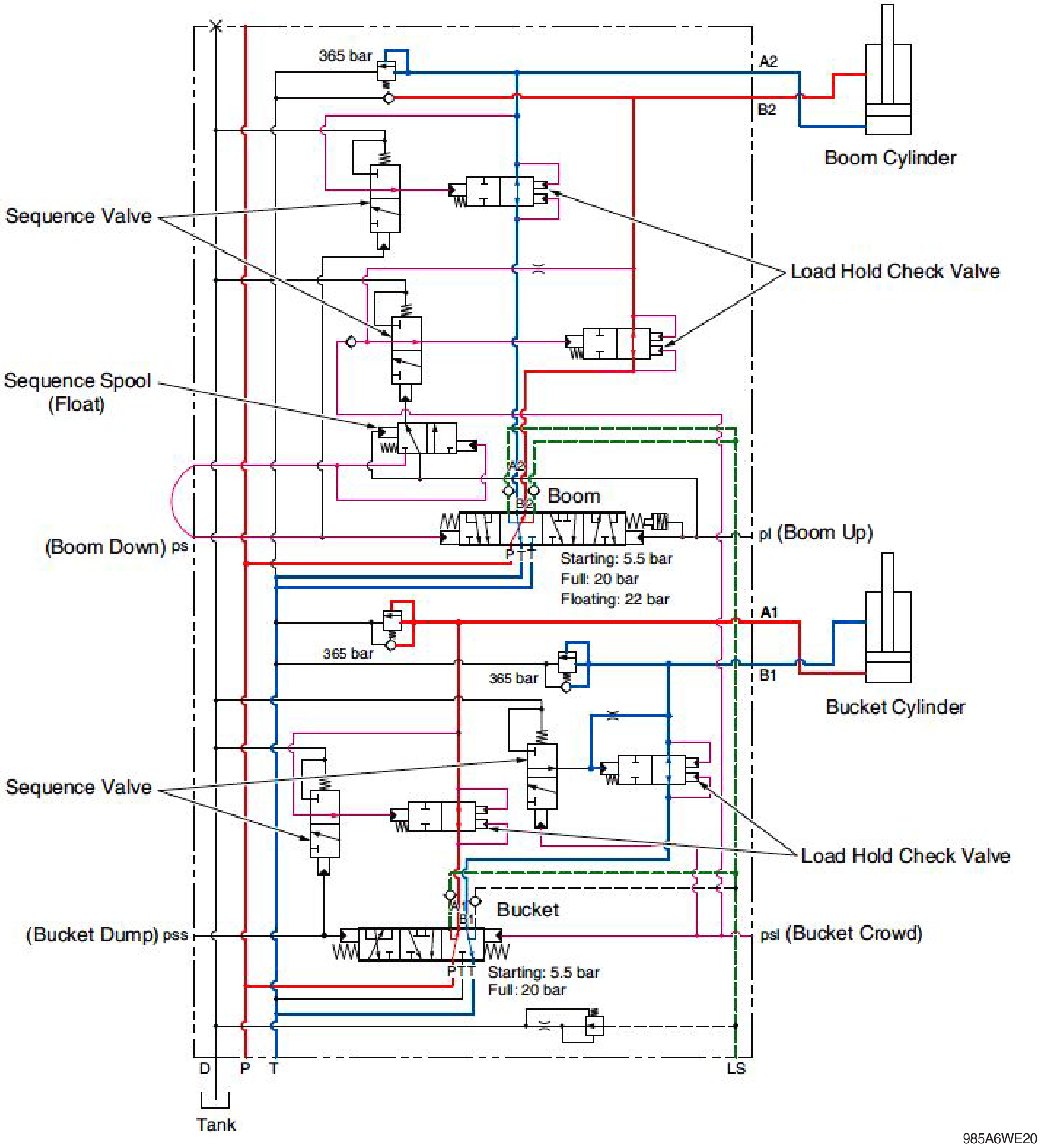
5) WHEN THE RCV LEVER IS IN THE ROLL BACK (retract) POSITION



985A6WE07

· If the EH RCV lever (bucket) is pulled left, the bucket spool is moved to roll back position by pilot oil pressure from EH control block.
· The oil from loader pump flows into main control valve (4) and then goes to the large chamber of bucket cylinder by pushing the load check valve of the bucket spool.
· The oil at the chamber of bucket cylinder (15) returns to hydraulic tank (29).
· When this happens, the bucket roll back.

6) COMBINED BUCKET ROLL BACK AND BOOM DOWN

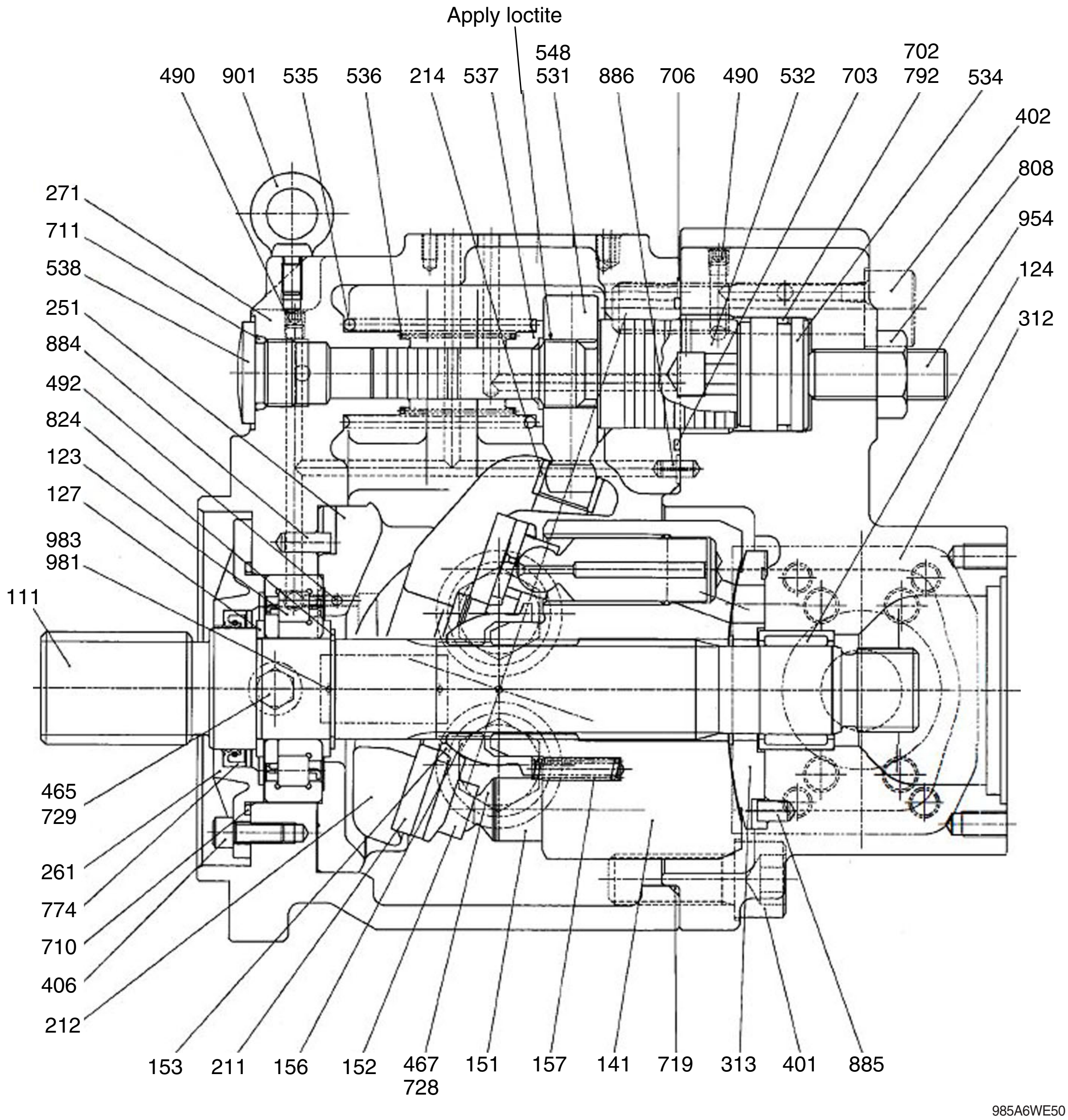


· When the operator activates the joystick lever to operate 'Bucket roll back' and 'Boom down' at the same time, the boom spool (ps port) and the bucket spool (psl port) of the main control valve begin to move, and hydraulic power from the main pump (P port) is supplied to the boom cylinder rod (B2 port) and the bucket cylinder head (A1) by the load hold valve.

· The hydraulic pilot flowed in the bucket spool (psl port) passes through the sequence valve and the boom load hold valve in adjusting the flow to the boom cylinder rod and supplying hydraulic power to the bucket cylinder head for efficient bucket crowd operation on the ground (combined movements).

4. MAIN PUMP (LOADER PUMP)

1) STRUCTURE



111	Shaft	166	Bushing	401	Screw
115	Key	211	Shoe plate	402	Screw
123	Roller bearing	212	Plate	406	Screw
124	Bearing steel	214	Bushing	465	Plug
127	Bearing spacer	251	Support	467	Plug
141	Cylinder block	261	Seal cover	490	Plug
151	Piston	271	Casing	492	Plug
153	Plate	312	Cover	531	Pin
162	Shoe	313	Plate	534	Stopper(L)

536	Spring	711	O-ring	824	Snap ring
537	Seat	719	O-ring	884	Pin
538	Plug	728	O-ring	885	Pin
648	Pin	729	O-ring	886	Pin
702	O-ring	774	Seal	901	Bolt
703	O-ring	792	Back-up ring	964	Screw
706	O-ring	808	Nut	981	Plate
710	O-ring	824	Snap ring	983	Pin

2) FUNCTION

The components of this pump are roughly divided into the rotary group doing rotary motion as main part of pump, the swash plate group to vary the delivery rate, and the valve cover group for switching between oil suction and delivery.

The rotary group is composed of the drive shaft (111), cylinder block (141), piston (151), shoes (152), set plate (153), spherical bush (156), and cylinder spring (157).
The drive shaft is supported at both its ends by bearings (123,124). The shoe is caulked over the end of piston, to form a spherical joint, and in addition, it has a pocket to balance hydraulic pressure so as to be allowed to slide lightly on the shoe plate (211) by reducing thrust due to applied pressure. The subgroup composed of pistons and shoes are pressed against the shoe plate by the cylinder spring through the set plate and spherical bush. The cylinder block is also pressed against the valve plate (313) similarly by the cylinder spring.

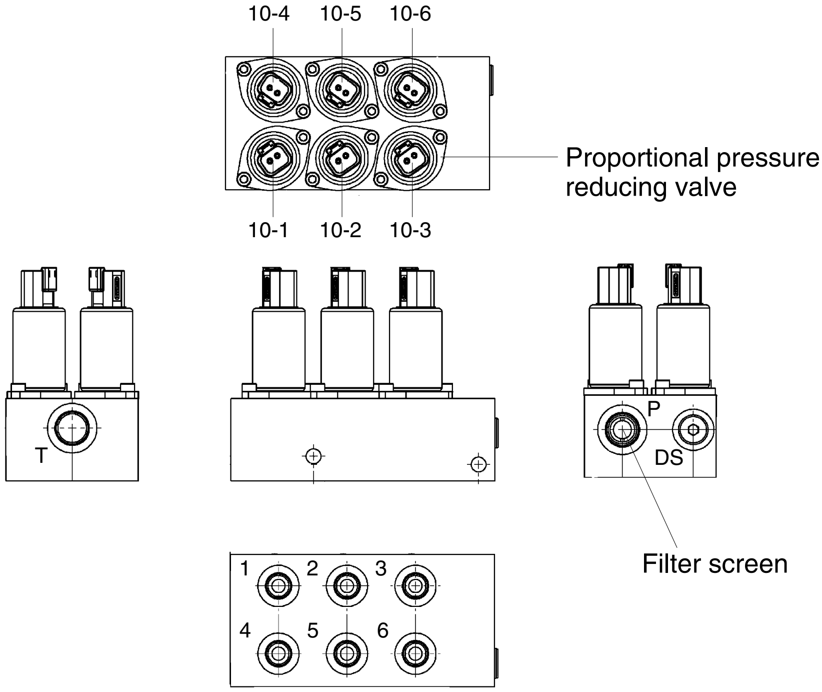
Thes swash plate group is composed of the swash plate (212), shoe plate (211), swash plate support (251), tilting bush (214), tilting pin (531) and servo piston (532). Swash plate is supported by the swash plate support on its cylindrical portion formed on the opposite side to the sliding plate face for shoes. When the servo piston moves right and left according to the conduction of hydraulic pressure controlled by the regulator into the pressure chambers provided on both the sides of the servo piston, the swash plate swings on the swash plate support through the spherical portion of the tilting pin and thus the tilting angle(a) can be varied.

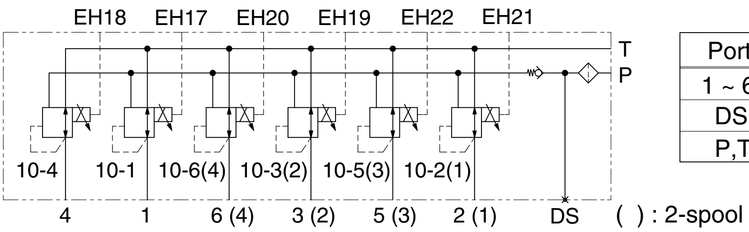
The valve cover group is composed of valve cover (312), valve plate (313) and valve plate pin (855). The valve plate with two melon-shaped ports is installed onto the valve cover, and, serves to supply oil to the cylinder block and withdraw it. The oil passage switched by the valve plate is connected to the external piping through the valve cover.

Now, when the drive shaft is driven by a prime mover(motor, engine, etc.), the cylinder block is rotated concurrently through spline coupling. If the swash plate is tilting, the pistons arranged in the cylinder block reciprocate relatively to the cylinder while they are rotating together with cylinder block.
Accordingly, paying attention to the one of the pistons, the piston do motion of going away from the valve plate (Oil suction stroke) for 180 degrees during one rotation of the cylinder block and do motion of approaching the valve plate (Oil delivery stroke) for the rest 180 degrees. If the tilting angle of the swash plate is zero, the piston makes no stroke and delivers no oil.

5. EH (electro hydraulic) CONTROL BLOCK

1) STRUCTURE





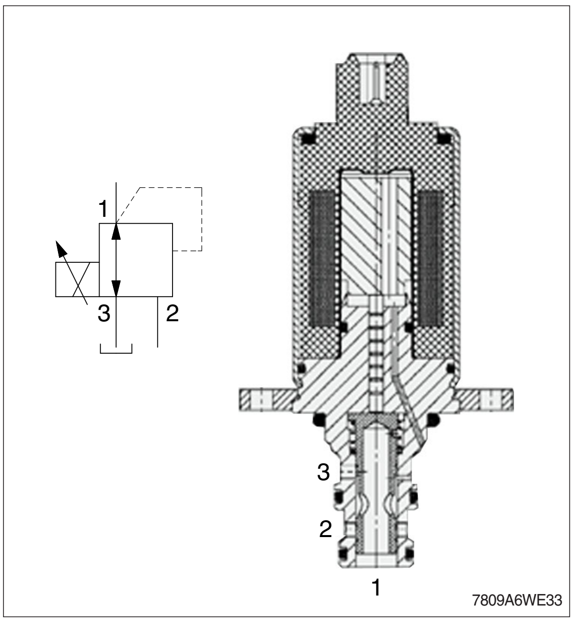
Hydraulic circuit

Port	Size
1 ~ 6	9/16-18UNF
DS	9/16-18UNF
P,T	3/4-16UNF

760F6WE33

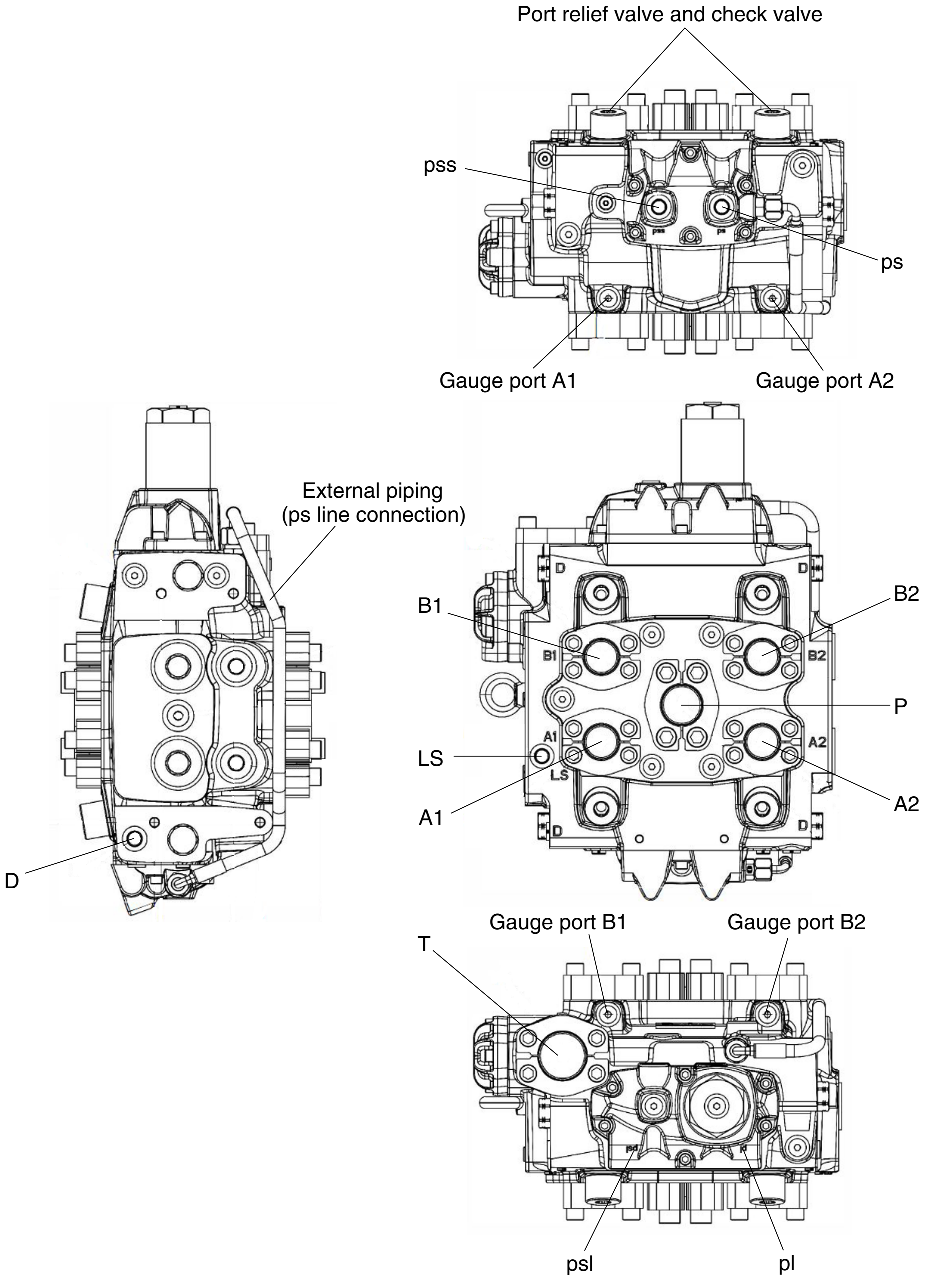
2) OPERATION

The proportional pressure reducing valve (10-1~6) is a direct-acting spool-type valve. When de-energized, port 2 is closed and port 1 (delivery) is connected to port 3 (tank). When the inlet pressure fluctuates it provides an almost constant outlet pressure-depending on the energization of the coil. When the control current increases, the coil solenoid exerts a force on the control piston which is proportional to the control current and thereby defines the regulated pressure at port 1. This setting is proportional to the control current. Pressures at tank port 3 are additive to the set pressure. If, as a result of external factors, the pressure at port 1 rises above the preset pressure, the valve opens from port 1 to tank port 3.



6. MAIN CONTROL VALVE

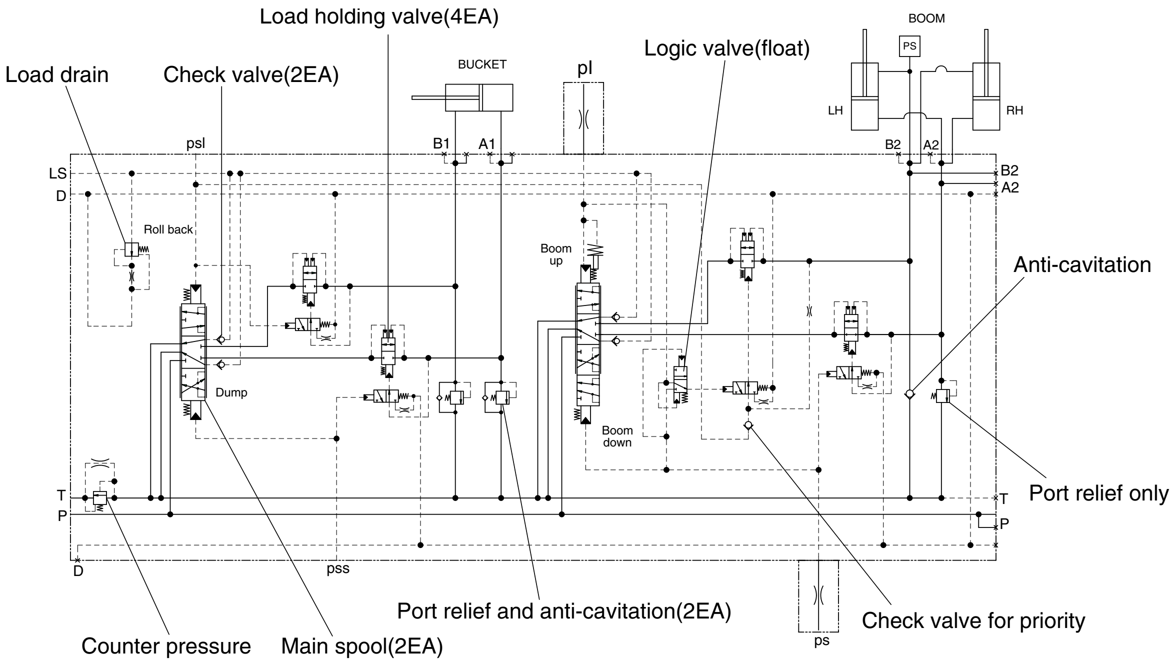
1) STRUCTURE (1/3)



985A6WE51

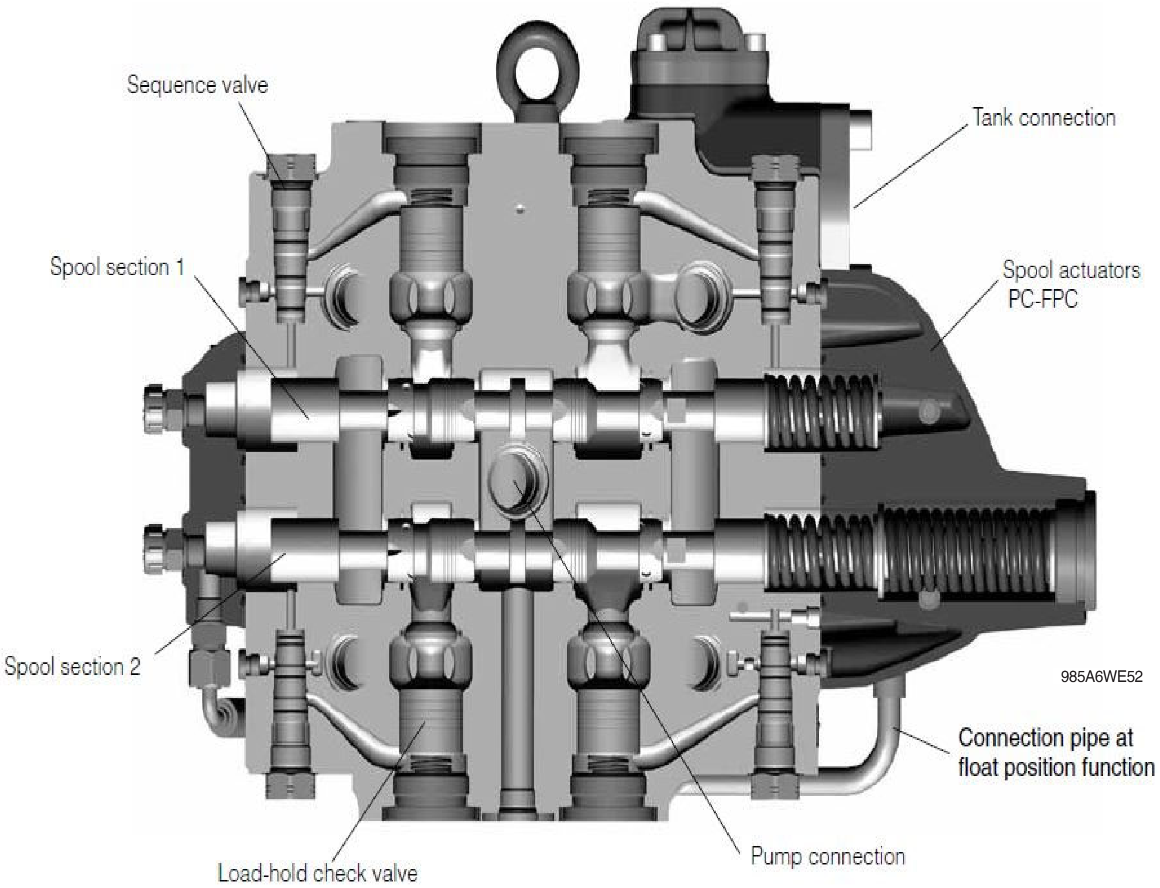
Port	Port name	Port size
P	From main pump	SAE 1 1/4"
T	To hydraulic tank	SAE 1 1/2"
A2, B2	To boom cylinder ports	SAE 1"
A1, B1	To bucket cylinder ports	SAE 1"
LS, D, pss, ps, psl, pl	LS, D, pss, ps, psl, pl ports	9/16-18UNF-2B
Gauge ports	A1, B1, A2, B2 ports	9/16-18UNF-2B

2) HYDRAULIC CIRCUIT



985A6WE52

3) SECTION VIEW



985A6WE55

4) LOAD SENSING

The pump control system operates with the LS-method. The pump is controlled by sensing the movements of the spool and using the difference between pump pressure (at the entry of the spool of pump) and LS pressure (at the actuator after spool).

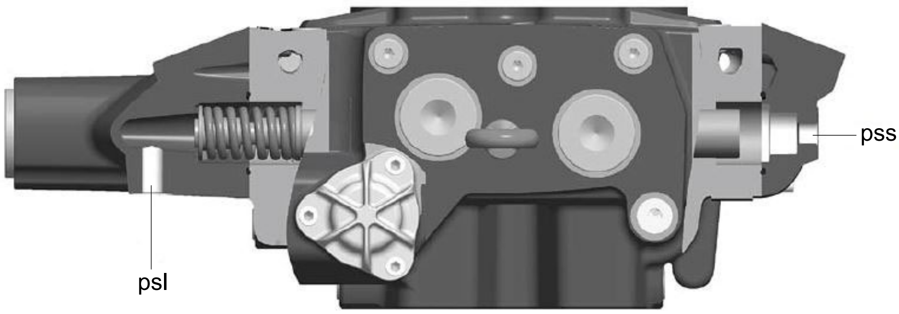
When the spool moves a little, the pressure difference between the pump and the LS increases whereas the hydraulic flow from the pump decreases; conversely, when the spool moves a lot, the pressure difference between the pump and the LS decreases whereas the hydraulic flow increases.

A. Description of functions

1. Spool control

1) Bucket spool

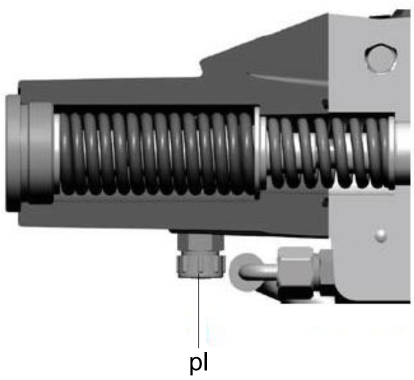
- Break away pressure : 5.5 bar
- Final pressure : 20 bar (max 35 bar)



985A6WE56

2) Boom spool

- Break away pressure : 5.5 bar
- Final pressure : 20 bar
- Pressure for float position : Min 22 bar (Max 35 bar)



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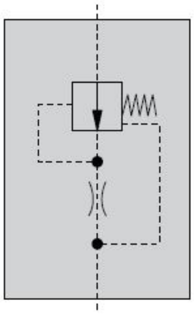
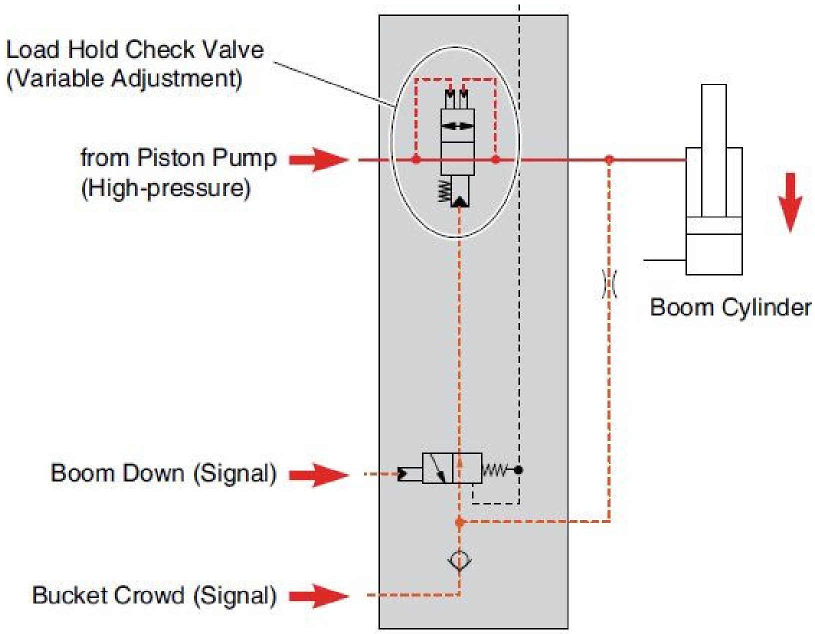
2. LS drain valve

The LS input signals activate a constant amount of hydraulic flow by the LS drain valve to the tank. When thelever is returned to the neutral position, LS pressure is to be bled off (drained into the tank).



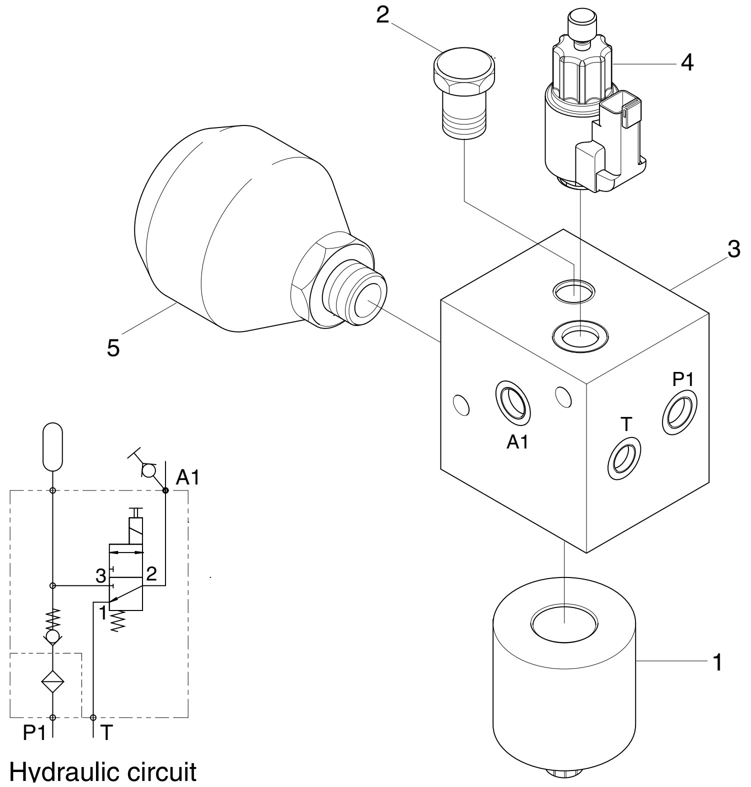
3. Prioritizing function (prior control function with simultaneous movements)

When operating boom down (small load) and bucket crowd (heavy load) simultaneously in the empty bucket state, the hydraulic power supplied to the boom cylinder is controlled by pilot signal input.



7. SAFETY VALVE

1) STRUCTURE



Hydraulic circuit

Port	Port name	Port size
P1	From MCU	PF 3/8"
A1	Supply to RCV lever	PF 1/4"
T	To hydraulic tank	PF 1/4"

75796WE16

1 Bowl and element assy
2 Check valve
3 Cartridge
4 Solenoid valve
5 Accumulator

2) OPERATION

This valve is used to cut off the pilot circuit.

When the pilot cut off switch in the cab is pressed to ON position, the solenoid valve is activated and then the pilot oil flow into the pilot circuit.

The accumulator satisfied short term peak power demands and is a source of emergency power in case of main circuit pressure failures.

8. BOOM AND BUCKET CYLINDER

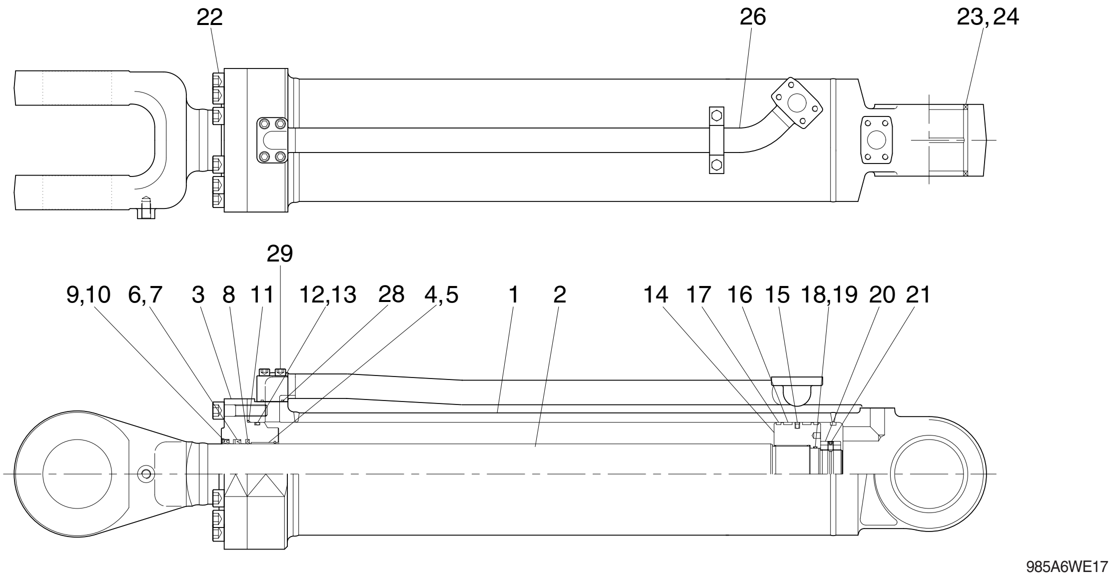
The boom cylinders are two unit and the bucket cylinder is one unit. They use a bolt on rod guide.

The piston (14) threads on to the rod (2) and is retained by a nut (20) and set screw (21).

The piston seals against the tube (1) with piston seal (15). Two wear rings (16) are located on each side of the piston seal.

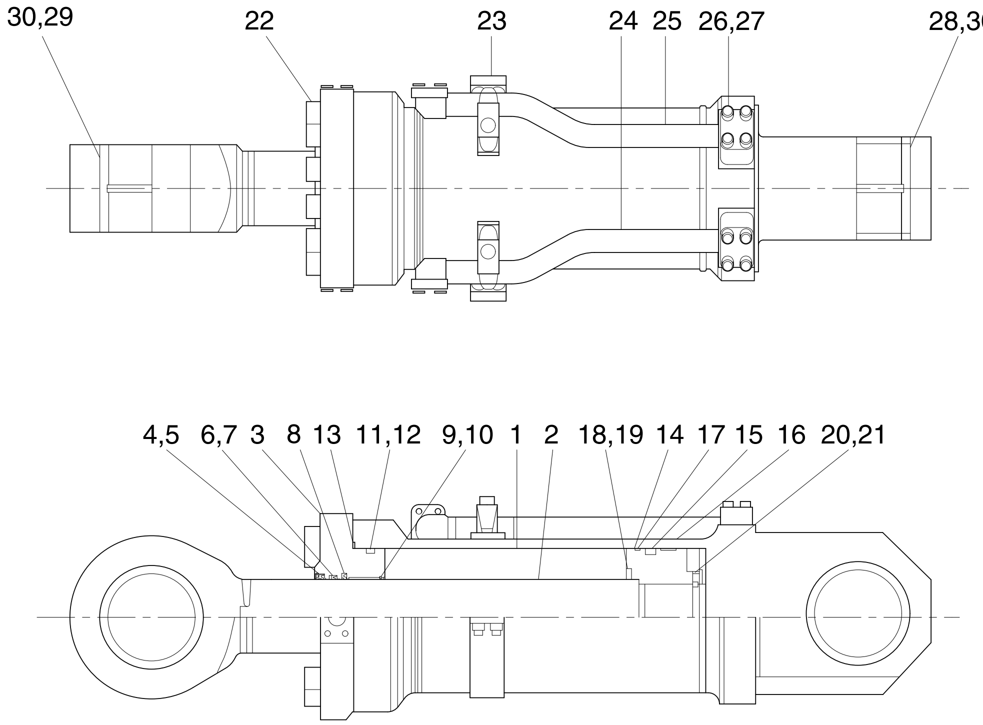
The gland (3, the rod guide) seals against the tube with an O-ring (12). The cylinder thread seals against the rod with a lip type buffer ring (8) and a rod seal (5). A dust wiper (9) cleans the rod when it is retracted.

1) BOOM CYLINDER



1	Tube assembly	11	O-ring	21	Set screw
2	Rod assembly	12	O-ring	22	Bolt
3	Gland	13	Back up ring	23	Bushing
4	Bushing	14	Piston	24	Dust seal
5	Snap ring	15	Piston seal	26	Pipe assembly
6	Rod seal	16	Wear ring	28	O-ring
7	Back up ring	17	Dust ring	29	Bolt
8	Buffer ring	18	O-ring		
9	Dust wiper	19	Back up ring		
10	Snap ring	20	Lock nut		

2) BUCKET CYLINDER



9806WE18

1	Tube assembly	11	O-ring	21	Set screw
2	Rod assembly	12	Back up ring	22	Bolt
3	Gland	13	O-ring	23	Band assembly
4	Dust wiper	14	Piston	24	Pipe assembly
5	Snap ring	15	Piston seal	25	Pipe assembly
6	Rod seal	16	Wear ring	26	Bolt
7	Back up ring	17	Dust ring	27	O-ring
8	Buffer ring	18	O-ring	28	Pin bushing
9	Bushing	19	Back up ring	29	Pin bushing
10	Snap ring	20	Steel ball	30	Dust seal

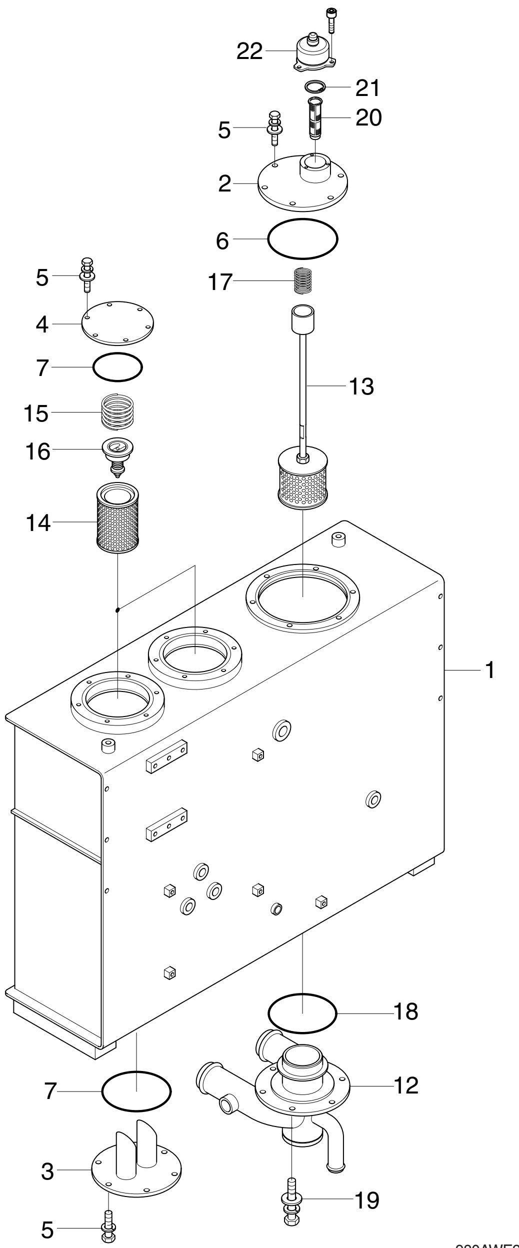
9. HYDRAULIC OIL TANK

1) STRUCTURE

· The oil from the hydraulic tank is sent from the pump through main control valve to the cylinders. In the return circuit, the oil from various parts merges.

· A part of oil is cooled in the oil cooler, passes through the hydraulic filter and returns to the hydraulic tank (1).

· If the hydraulic return oil filter becomes clogged, return filter bypass valve (16) acts to allow the oil to return directly to the hydraulic tank (1). This prevents damage to the hydraulic filter (14). The bypass valve (16) is also actuated when negative pressure is generated in the circuit.



980AWE22

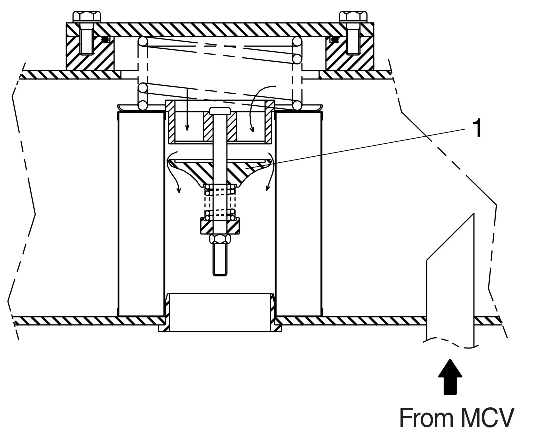
1	Hydraulic tank wa
2	Cover
3	Cover
4	Cover
5	Bolt
6	O-ring
7	O-ring
8	Bolt
12	Suction pipe
13	Strainer
14	Return filter
15	Spring
16	Bypass valve
17	Spring
18	O-ring
19	Bolt
20	Strainer
21	Retaining ring
22	Air breather

2) RETURN OIL FILTER BYPASS VALVE

(1) When the filter is clogged

Bypass valve (1) is opened and the oil returns directly to the tank without passing through the filter.

· Bypass valve set pressure : 1.36 kg/cm^2 (19.3 psi)



770-3ATM (6-33)

3) AIR BREATHER

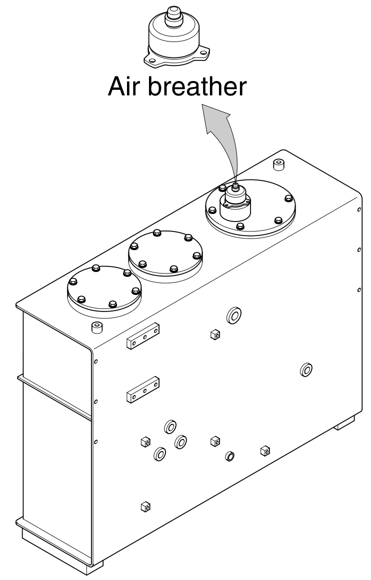
The air breather is equipped with the capacity to perform three functions simultaneously-as an air filter, breathing valve, and as a lubrication opening.

(1) Preventing negative pressure inside the tank

The tank is a pressurized sealed type, so negative pressure is formed inside the hydraulic tank when the oil level drops during operations. When this happens, the difference in pressure between the tank and the outside atmospheric pressure opens the poppet in the breather, and air from the outside is let into the tank or prevent negative pressure.

(2) Preventing excessive pressure inside the tank

When the hydraulic cylinder is being used, the oil level in the hydraulic system increases and as temperature rises. If the hydraulic pressure rises above the set pressure, breather is actuated to release the hydraulic pressure inside the tank.

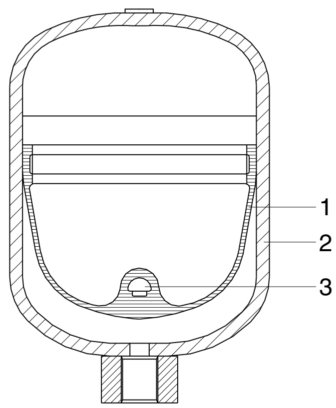


980A6WE23

10. ACCUMULATOR

The accumulator is installed at the safety valve. When the boom is left the raised position, and the control levers are operated with the engine stopped the pressure of the compressed nitrogen gas inside the accumulator sends pilot pressure to the control valve to actuate it and allow the boom and bucket to come down under their own weight.

Type of gas	Nitrogen gas (N_2)
Volume of gas	0.75 ℓ (0.2 U.S.gal)
Charging pressure of gas	16 kg/cm^2 (228 psi)
Max actuating pressure	128 kg/m^2 (1820 psi)



1 Diaphragm
2 Steel pressure vessel
3 Closure button

7803AWE56

11. RIDE CONTROL SYSTEM (option)

1) ACCUMULATORS

(1) Pre-charging

Use an inert gas such as nitrogen for pre-charging accumulator.

※ **Do not use oxygen or shop air.**

※ **Nitrogen source and all components must be rated for a pressure at least as high as the nitrogen source.**

Accumulator having gas valve as per figure 1.

① Remove gas valve guard and gas valve cap.

② Back gas chuck "T" handle (A) all the way out (counter clockwise) before attaching charging & gauging kit to accumulator gas valve.

③ Close bleed valve (B).

④ Making sure not to loop or twist the hose, attach swivel nut (C) to gas valve and tighten 11.5~17 kgf·cm (10~15 lbf·ft).

⑤ Turn gas chuck "T" handle (A) until the gauge starts showing the pressure in the accumulator. Do not turn the "T" handle all the way down, as it will damage the valve core.

⑥ Crack open nitrogen bottle valve (D) and **slowly** fill accumulator. Shut off when gauge indicates desired pre-charge.

⑦ Let the pre-charge set for 10 to 15 minutes. This will allow the gas temperature to stabilize. If the desired pre-charge is exceeded, close nitrogen bottle valve (D), then slowly open bleed valve (B). Do not reduce pre-charge by depressing valve core with a foreign object. High pressure may rupture rubber valve seat.

⑧ When finished pre-charging accumulator, turn "T" handle (A) all the way out on gas chuck, then open bleed valve (B).

⑨ Hold gas valve to keep from turning, loosen swivel nut (C), remove assembly. Check for pre -charge leak using a common leak reactant.

⑩ Replace gas valve cap 11.5~17 kgf·cm (10~15 lbf·ft) and valve guard. (Gas valve cap serves as a secondary seal.)

(2) Pre-charge checking procedure

Using appropriate valve in the hydraulic system, discharge all oil from accumulator and allow piston to bottom against hydraulic end cap.

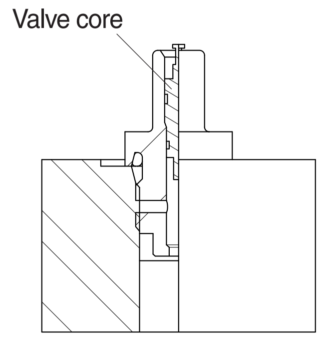
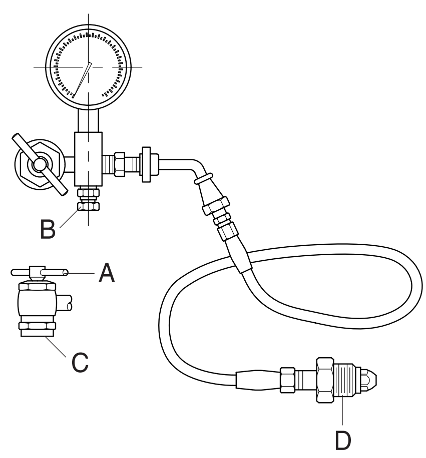


Figure 1

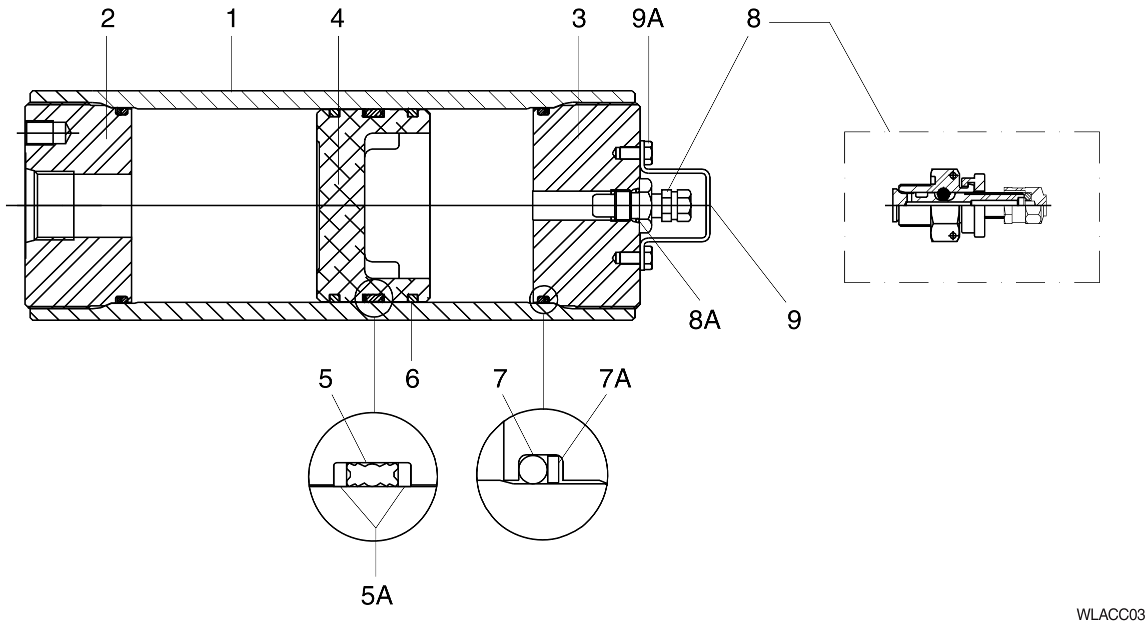
WLACC01



Charging and gauging kit (31LM-90100)

WLACC02

(3) Structure

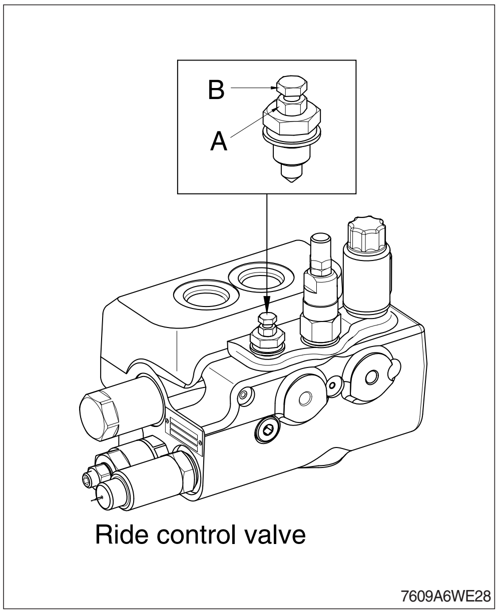


1	Body	5A	V-O-ring back-up washers	8A	Gas valve O-ring
2	Hydraulic cap	6	Piston ring (piston)	9	Gas valve guard
3	Gas cap	7	O-ring	9A	Screw
4	Piston	7A	O-ring back-up washer		
5	V-O-ring	8	Gas valve		

2) REMOVE FROM HYDRAULIC SYSTEM

⚠ Attention

1) Before carrying out any maintenance work the accumulators must be unloaded (zero pressure).
2) For this, loosen the nut (4) and bolt (B) counterclockwise with 10 mm spanner.
※ The accumulator will be unloaded (zero pressure) in less than a minute.
3) The lifting system must firstly be secured against lowering.
4) After carrying out maintenance work, screw the bolt (B) and nut (A).
   · Tightening torque
   A : 2.04 kgf · m (14.8 lbf · ft)



Ride control valve

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

1. OPERATIONAL CHECKS

This procedure is designed so the mechanic can make a quick check of the system using a minimum amount of diagnostic equipment. If you need additional information, read structure and function, Group 1.
A location will be required which is level and has adequate space to complete the checks.

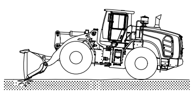
The engine and all other major components must be at operating temperature for some checks.

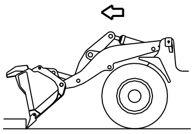
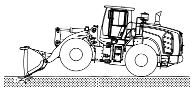
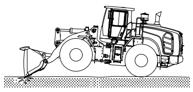
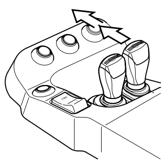
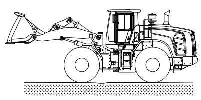
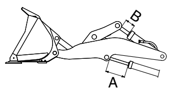
Locate system check in the left column and read completely, following the sequence from left to right. Read each check completely before performing.

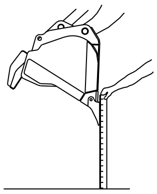
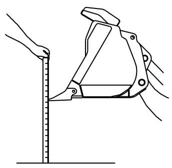
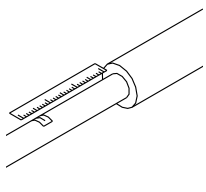
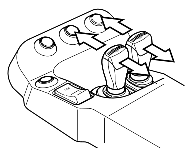
At the end of each check, if no problem is found (OK), that check is complete or an additional check is needed. If problem is indicated (NOT OK), you will be given repair required and group location.
If verification is needed, you will be given next best source of information:

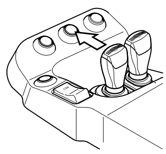
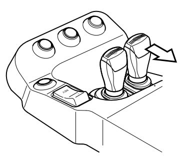
· Chapter 2 : Troubleshooting
· Group 3 : Tests and adjustments

※Hydraulic oil must be at operating temperature for these checks (refer to page 6-40).

Item	Description		Service action
Hydraulic system warm-up procedure Run engine at high idle.		Hold a hydraulic function over relief to heat oil. (don't keep relief condition over 5 seconds at a time) Periodically cycle all hydraulic functions to distribute warm oil. Repeat procedure until oil is at operating temperature. **FEEL** : Hydraulic reservoir must be uncomfortable to hold your hand against. (approximately 40 ~50˚C)	**OK** Check completed.
Hydraulic pump performance check Heat hydraulic oil to operating temperature. Run engine at high idle.		With bucket flat on ground, actuate boom raise. Time how long it takes to raise boom to full height. **LOOK** : Boom must raise to full height in less than 7 seconds.	**OK** Check completed. **NOT OK** Go to priority valve (in flow amplifier) high pressure check at page 5-31. **IF OK** Do steering system leakage check at page 5-30. **IF OK** Do main hydraulic pump flow test at page 6-41.
Control valve lift check Run machine at low idle.		With bucket partially dumped, lower boom to raise front of machine. Slowly move boom control lever (RCV lever) to boom lower position. Slowly move bucket control lever to bucket dump position. **LOOK** : Boom must not raise before moving down. Bucket must not rollback before dumping.	**OK** Check complete. **NOT OK** Repair lift checks in loader control valve.

Item	Description	Service action
Bucket rollback circuit relief valve check	 Position bucket at a 45˚ angle against an immovable object. Engage transmission in 3rd speed forward. **LOOK** : Bucket angle must not change.	**OK** Check complete. **NOT OK** Replace boom lower check valve.
Bucket dump circuit relief valve low pressure check	 Raise front of machine which bucket at 45˚ angle. Backdrag with bucket while observing bucket angle. **LOOK** : Bucket must not rollback	**OK** Go to next check. **NOT OK** Do loader system and circuit relief valve test at page 6-42.
Pilot control valve float check Run engine at low idle.	 With the bucket partially dumped, lower boom to raise front of machine. Push control lever to the float detent position and release lever.  **LOOK** : Front of machine lower to the ground and valve must remain in float position when lever is released.	**OK** Check complete. **NOT OK** Do pilot control valve pressure test in group 3.
Boom cylinder and bucket cylinder drift check Heat hydraulic oil to operating temperature.	 Set the boom and bucket horizontal, then stop the engine. Stop the engine, wait for 5 minutes, then start measuring. Measure the amount the lift and dump cylinder rods retract during 15 minutes. (unloaded bucket)  A : Retraction of boom cylinder rod B : Retraction of bucket cylinder rod Boom cylinder must drift less than 30 mm Bucket cylinder must drift less than 20 mm	**OK** Check complete. **NOT OK** Go to next check.

Item	Description	Service action
Boom cylinder leakage check Heat hydraulic oil to operating temperature.	 Dump bucket until teeth or cutting edge is perpendicular to the ground. Raise boom until cutting edge is about 1 m (3 ft) above ground. Stop engine. Measure drift from tooth or cutting edge to ground for 1 minute. Wait 10 minutes. Measure drift from tooth or cutting edge to ground for 1 minute. **LOOK** : Compare the drift rate between the first measurement and the second measurement.	**OK** Drift is approximately the same between first and second measurement. Repair loader control valve or circuit relief valve. **NOT OK** If drift is considerably less on second measurement, repair cylinder.
Bucket cylinder leakage check Heat hydraulic oil to operating temperature.	 Raise bucket about 1 m (3 ft) off ground with bucket level. Stop engine. Place a support under boom. Measure drift from tooth or cutting edge to ground for 1 minute. Wait 10 minutes. Measure drift from tooth or cutting edge to ground for 1 minute. **LOOK** : Compare the drift rates between the first measurement and the second measurement.	**OK** Drift is approximately the same between first and second measurement. Repair loader control valve or circuit relief valve at page 6-59. **NOT OK** Drift is considerably less on second measurement. Repair cylinder.
Check valve of safety valve leakage check Heat hydraulic oil to operating temperature.	 Put bucket level and position about 1.2 m (4 ft) above ground. Place a piece of tape on cylinder rod at least 51 mm (2 in) from rod guide. Run engine at low idle in safety-release position. **LOOK** : Bucket must not drift up.	**OK** Check complete. **NOT OK** Check or replace safety valve.
Pilot control valve (RCV lever) check	 Stop engine. Turn key switch to OFF position. Move control lever to all positions and then release. **LOOK** : Lever must return to neutral when released from all positions.	**OK** Check completed. **NOT OK** Repair pilot control valve.

Item	Description		Service action
Bucket leveler (positioner) check Run engine at low idle.		Position bucket fully dumped just above ground level. Move control lever to bucket leveler detent position and release. **LOOK** : Bucket must rollback to the level position and control lever must return to neutral. If bucket is in a rolled back position when key is turned ON, control lever must be returned to neutral manually if placed in the bucket leveler detent position. After bucket is dumped once, bucket leveler will work normally.	**OK** Check complete. **NOT OK** Do bucket leveler checks.
Boom height kickout check Run engine at low idle.		Position bucket flat on ground. Move control lever to boom raise detent position and release. **LOOK** : Boom must raise to the set height and stop. Control lever must return to neutral.	**OK** Check complete. **NOT OK** Do boom height kickout check.
Cycle time check Heat hydraulic oil to operating temperature. Run engine at high idle.	Function	Operating condition.	Maximum cycle time
	Boom raise	Bucket flat on ground to full height.	6.1 sec
	Boom lower	Full height to level ground.	4.3 sec
	Bucket dump	Boom at full height.	1.7 sec
	Bucket rollback	Boom at full height.	2.2 sec
	Steering [No. of turns]	Frame stop to frame stop.	4.3 turns
			OK Check complete. **NOT OK** Go to slow hydraulic functions in group 2.

※MEASURING BOOM AND BUCKET CYCLE TIME

1) MEASUREMENT CONDITION

- Coolant temperature : Inside operating range
- Steering position : Neutral
- Hydraulic temperature : 40~50˚C
- Bucket : Unloaded
- Engine speed : High idling

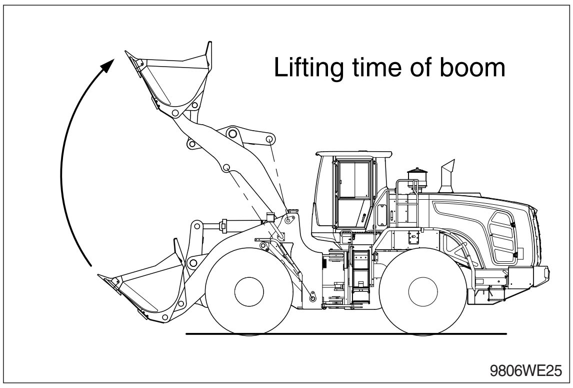
2) MEASURING TOOL

- Stop watch (1EA)

3) MEASURING PROCEDURE

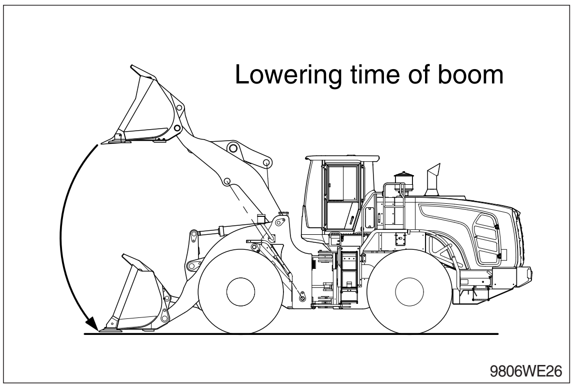
(1) LIFTING TIME OF BOOM

Set the bucket near the maximum tilt back position and at the lowest position on the ground. Raise the bucket and measure the time taken for bucket to reach the maximum height of the boom.



(2) LOWERING TIME OF BOOM

Set the bucket horizontal with the boom at the maximum height, lower the bucket and measure the taken for the bucket to reach the lowest position on the ground.

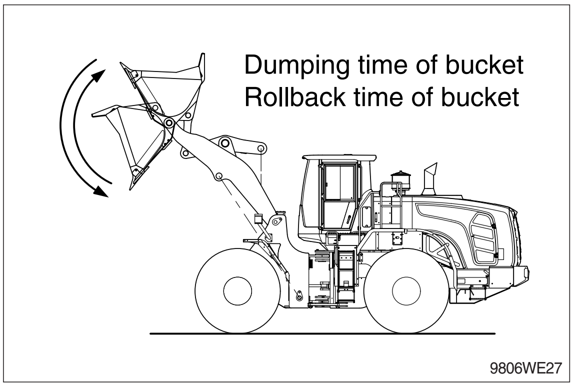


(3) DUMPING TIME OF BUCKET

Raise the boom to the maximum height and measure the time taken for the bucket to move from the maximum tilt back position to the maximum dump position

(4) ROLL BACK TIME OF BUCKET

Raise the boom to the maximum height and measure the time taken for the bucket to reach the maximum tilt back position.



2. TROUBLESHOOTING

※ Diagnose malfunction charts are arranged from most probable and simplest to verify, to least likely, more difficult to verify. Remember the following steps when troubleshooting a problem :

Step 1. Operational check out procedure (see section 1)
Step 2. Operational checks (see group 2)
Step 3. Troubleshooting
Step 4. Tests and adjustments (see group 3)

Problem	Cause	Remedy
Noisy hydraulic pump	Low oil supply or wrong viscosity.	Fill reservoir with recommended oil.
	Plugged or pinched suction line.	Clean or replace line.
	Air in oil.	Check for foamy oil. Tighten connections. Replace O-rings and or lines.
	Plugged suction strainer.	Inspect and clean strainer in reservoir.
	Loose or missing hydraulic line clamps.	Tighten or replace clamps.
	Hydraulic lines in contract with frame.	Inspect and repair.
	Worn or damaged pump.	Do hydraulic pump performance check in group 2. Do hydraulic pump flow test in group 3.
No or Slow hydraulic functions	Failed or worn hydraulic pump.	Do performance check.
	Cold oil.	Warm oil up.
	Slow engine speed.	Adjust engine speed. Check high idle speed.
	Suction line air leak.	Check for foamy oil.
	Low oil supply.	Add recommended oil.
	Wrong oil viscosity.	Use recommended oil.
	Oil leaking past cylinders or control valve.	Check cylinder drift in group 2.
	Blocked or damaged line.	Inspect lines.
	Faulty pilot control valve (RCV).	Do pilot control valve (RCV) pressure test in group 3.
	Binding loader control valve (MCV) spool.	Inspect valve.
	Faulty flow amplifier.	Check priority valve, orifice of flow amplifier specification.

Problem	Cause	Remedy
No steering or hydraulic function	Low oil level.	Add recommended oil.
	Failed hydraulic pump.	Remove and inspect return filter for metal pump particles.
No hydraulic functions steering normal	Failed hydraulic pump.	Remove and inspect return filter for metal pump particles, or replace the pump.
	Failed line filter.	Remove and inspect line filter for RCV.
	Faulty safety valve.	Safety valve leakage test or ON, OFF function test.
	Stuck open port relief valve.	Replace relief valve.
Boom float function does not work	Low pilot control pressure.	Do pressure reducing valve pressure test in group 3.
	Faulty pilot control valve (RCV).	Replace relief valve.
	Loader control valve (MCV) spool binding in bore.	Do pressure reducing valve pressure test in group 3.
One hydraulic function does not work.	Faulty pilot control valve (RCV).	Do pilot control valve pressure test. Inspect and repair valve.
	Stuck open port relief valve.	Replace relief valve.
	Oil leaking past cylinder packings.	Do boom and bucket cylinder leakage test in group 3.
	Blockage in oil lines or valve.	Inspect lines for damage. Disconnect and inspect lines for internal blockage.
	Loader control valve (MCV) spool stuck in bore.	Inspect and repair valve.
Low hydraulic power	Leakage within work circuit.	Do cylinder drift check in group 2.
	Low system relief valve (main relief valve) setting.	Do loader system and port relief valve pressure test in group 3.
	Low port relief valve setting.	Do loader system and port relief valve pressure test in group 3.
	Leaking system relief valve.	Remove and inspect valve.
	Worn hydraulic pump.	Do hydraulic pump performance check in group 2.
	Faulty pilot control valve (RCV).	Do pilot control valve pressure test in group 3.

Problem	Cause	Remedy
Function drifts down	Leaking cylinders.	Do cylinder leakage checks in group 3.
	Leaking seals in circuit relief valve (port relief valve) or valve stuck open.	Inspect seals. Replace relief valve.
	Leaking loader control valve (MCV).	Repair or replace valve section.
Boom drifts up	Leakage in boom down spool.	Remove and inspect boom down spool.
Boom down does not work (engine off)	Safety valve not operated.	Operate valve.
	Stuck pilot control valve.	Inspect.
	Faulty line filter.	Remove and inspect filter.
	Accumulation not operated.	Inspect.
	MCV spool stuck.	Inspect and repair valve.
Oil overheats	Low oil viscosity in hot weather.	Use recommended oil.
	Excessive load.	Reduce load.
	Holding hydraulic system over relief.	Reduce load.
	Leakage in work circuit.	Do boom and bucket cylinder leakage test in group 3.
	Plugged fins in oil cooler.	Inspect and clean oil cooler.
	Internally plugged oil cooler.	Do hydraulic oil cooler restriction test.
	Incorrect system or circuit relief valve setting.	Do loader system and circuit relief valve pressure test in group 3.
	Restriction in oil lines or loader control valve (MCV).	Inspect for dented or kinked lines.
	Malfunctioning steering valve.	Do hydraulic system restriction test in group 3.
	Leaking system main relief valve.	Do hydraulic system restriction test in group 3. Remove and inspect valve and seals.
	Worn hydraulic pump (internal leakage).	Do hydraulic pump performance check in group 2.
Function drops before raising when valve is activated	Stuck open lift check valve.	Do control valve lift check in group 2.

Problem	Cause	Remedy
Hydraulic oil foams	Low oil level.	Add recommended oil.
	Wrong oil.	Change to recommended oil.
	Water in oil.	Change oil.
	Loose or faulty suction lines (air leak in system).	Tighten or install new lines.
Remote control valve (RCV) leaking	Leaking plunger seals.	Remove, inspect and replace plunger seals.

※ Followings are general precautions for the hydraulic system and equipment.

1) Every structure has its limit of strength and durability. The relief valve is installed to limit the pressure on the hydraulic equipment and protect various parts of the wheel loader from possible damage. Therefore, never change the preset pressure of the relief valve unless absolutely necessary.

2) Since the hydraulic equipment is built with precision, the presence of only the slightest amount of dust and / or other particles in the hydraulic circuit might cause wear and/or damage, resulting in unstable functions and/or damage, resulting in unstable functions and/or unexpected accidents. Therefore, always keep hydraulic oil clean. Periodically, check the filter in the return circuit and replace the element as necessary.

3) Extract about 200cc of hydraulic oil from the tank as a sample every 6 months. If possible, have it analyzed by a specialist to confirm that the oil can still be used. Never extract the oil for sampling until the oil temperature has become the normal operating temperature. Since the replacement period varies depending on operating conditions, refer to **Operator's Manual** and change oil.

4) Should the equipment get damaged due to the presence of metal particles and/or foreign matter in the circuit drain out the hydraulic oil and carry out flushing. Also, replace the filter element and clean the hydraulic tank. Change the hydraulic oil entirely.

5) When checking the filter, if found metal particles in the element, drain out the hydraulic oil entirely, flush the whole circuit, and then fill with new oil. The presence of metal particles may indicate internal damage to the equipment. In such a case, check carefully before flushing, and repair or replace as required.

6) To add and/or change the hydraulic oil, always use recommended oil. (Refer to the list of recommended oils and lubricants at page 1-20, **Recommended lubricants.**) Never mix oil of different makes of kinds.

7) To change the hydraulic oil, use a clean vessel and funnel for pouring it into the tank. Never use cloth because it might cause the presence of lint in the circuit.

8) When removing the hydraulic equipment, be sure to put plugs or caps on hoses, tube lines and ports. Also, enter mating marks for later identification.

9) Disassemble and/or assemble the hydraulic equipment only in a clean place free of dust. When disassembling, be careful about the interchangeability of parts, and clean the disassembled parts with pure and clean mineral cleansing oil. Clean the internal passages as well. After the parts have dried, wipe them off with a clean lint-free cloth.

10) When overhauling the hydraulic equipment replace all O-rings, backup rings, etc. with new ones. Assemble O-rings with grease or vaseline applied.

11) After installing the equipment, add more hydraulic oil to make up for that lost during disassembly.

12) Tighten joints correctly. Loose joints will cause the hydraulic oil to leak. If the oil leaks, the tank oil level drops and air gets sucked in, so the pump will break down. Also loose joints in suction lines will take air in and might cause abnormal noise, malfunction or damage to pumps.

GROUP 3 TESTS AND ADJUSTMENTS

1. HYDRAULIC OIL CLEAN UP PROCEDURE USING PORTABLE FILTER CADDY

※ Service equipment and tool

- · Portable filter caddy
- · Two 4000 ㎜ × 1in 100R1 Hoses
- · Quick disconnect fittings.
- · Discharge wand
- · Various size fittings.

※ Brake system uses oil from hydraulic oil tank. Flush all lines in the brake, pilot, steering system and cut off system. Disassemble and clean major components for brake and steering system. Remove and clean pilot caps from main control valve.
Brake and steering components may fail if brake and steering system is not cleaned after hydraulic oil tank contamination.

1) If hydraulic system is contaminated due to a major component failure, remove and disassemble steering cylinders to clean debris from cylinders.

2) Install a new return filter element. Inspect filter housing before installing new element.

※ For a failure that creates a lot of debris, remove access cover from hydraulic oil tank. Drain and clean hydraulic oil tank of fill the specified oil to hydraulic oil tank through upper cover.

3) To minimize oil loss, pull a vacuum in hydraulic oil tank using a vacuum pump. Connect filter caddy suction line to drain port at bottom of hydraulic oil tank using connector. Check to be sure debris has not closed drain port.

4) Put filter caddy discharge line into hydraulic oil tank filler hole so end is as far away from drain port as possible to obtain a thorough cleaning of oil.

5) Start the filter caddy. Check to be sure oil is flowing through the filters.
Operate filter caddy approximately 10 minutes so oil in hydraulic oil tank is circulated through filter a minimum of four times.
※ Hydraulic oil tank capacity : 200 ℓ (52.8 U.S. gal)
Leave filter caddy operation for the next steps.

6) Start the engine and run it at high idle.
※ For the most effective results, cleaning procedure must start with the smallest capacity circuit then proceed to the next largest capacity circuit.

7) Operate all functions, one at a time, through a complete cycle in the following order: Clam, steering, bucket, and boom. Also include all auxiliary hydraulic functions.
Repeat procedure until the total system capacity has circulated through filter caddy seven times, approximately 30 minutes.
Each function must go through a minimum of three complete cycles for a through cleaning for oil.
※ Filtering time for machines with auxiliary hydraulic functions must be increased because system capacity is larger.

8) Stop the engine. Remove the filter caddy.

9) Install a new return filter element.

10) Check oil level in reservoir; Add oil if necessary.

2. BOOM HEIGHT KICKOUT ADJUSTMENT

The bucket can be adjusted to a height desired by using the boom kick-out device.

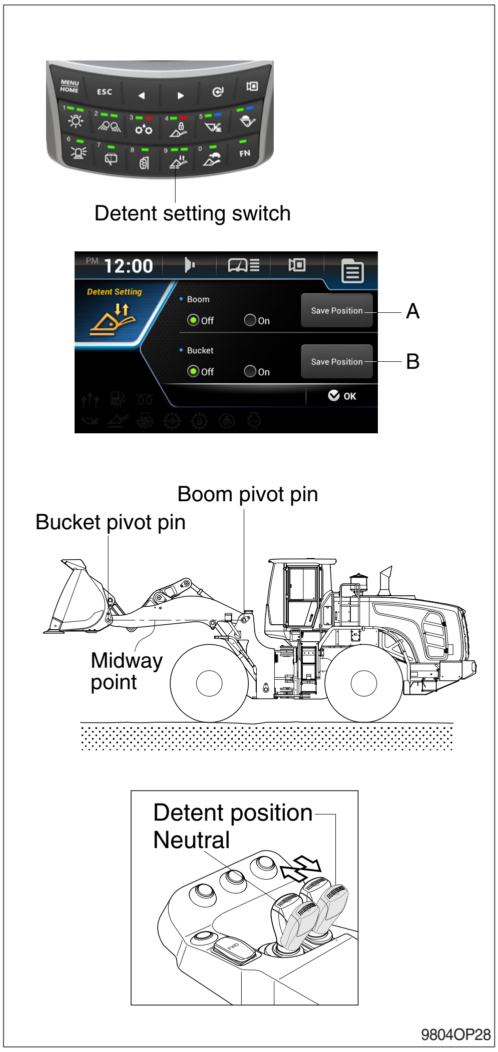
⚠ Park the machine on level ground and block the tires to prevent sudden movement of the machine.

⚠ Press the parking brake switch.

⚠ Fix the front and rear frames by using the safety lock bar.

⚠ Do not work underneath the work equipment.

1) ADJUSTMENT OF THE BOOM KICKOUT AND BUCKET LEVELER



(1) Lift kickout position

To set the lift kickout, raise the bucket to the desired position above the midway point. Then push icon (Save Position , A) for 2~3 seconds. The boom will return to the programmed position when the raise detent is activated and the boom is below the kickout position.

(2) Lower kickout position

To set the lower kickout, lower the bucket to the desired position below the midway point. Then push icon (Save Position , A) for 2~3 seconds. The boom will return to the programmed position when the float detent is activated and the boom is at least a foot above the kickout position.

(3) Bucket leveler position

To set the bucket leveler, roll back the bucket to the desired position. Then push icon (Save Position , B) for 2~3 seconds. The bucket will return to the programmed position when the roll back detent is activated and the bucket is below the leveler position.

3. TEST TOOLS

1) CLAMP-ON ELECTRONIC TACHOMETER INSTALLATION

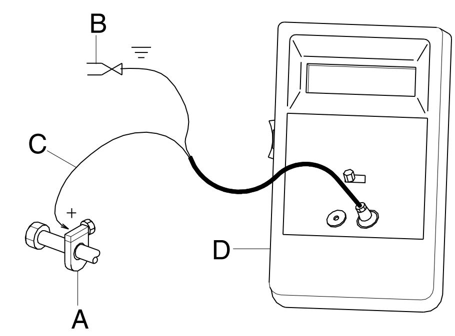
· Service equipment and tools
Tachometer

A : Clamp on tachometer.
Remove paint using emery cloth and connect to a straight section of injection line within 100 mm (4 in) of pump. Finger Tighten only-do not over tighten.

B : Black clip (-). Connect to main frame.

C : Red clip (+). Connect to transducer.

D : Tachometer readout. Install cable.



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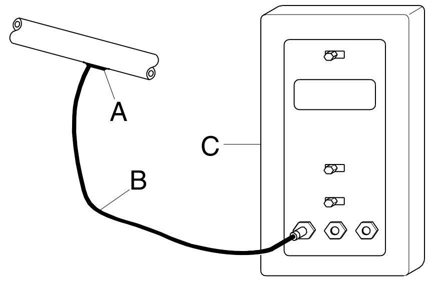
2) DIGITAL THERMOMETER INSTALLATION

· Service equipment and tools
Digital thermometer

A : Temperature probe.
Fasten to a bare metal line using a tie band. Wrap with shop towel.

B : Cable.

C : Digital thermometer.



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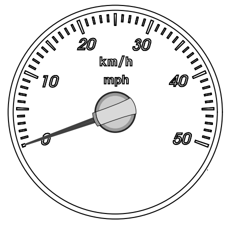
3) DISPLAY MONITOR TACHOMETER

The display monitor tachometer is accurate enough for test work.



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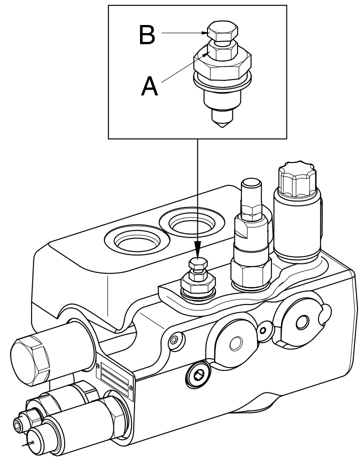
4. HYDRAULIC OIL WARM UP PROCEDURE

1) Install temperature reader (see temperature reader installation procedure in this group).
2) Run engine at high idle.
3) Hold a hydraulic function over relief to heat the oil.
4) Periodically cycle all hydraulic functions to distribute warm oil.
5) Heat oil to test specification (approx. 45˚C).

※ RIDE CONTROL SYSTEM (OPTION)

⚠ Attention

1) Before carrying out any maintenance work the accumulators must be unloaded (zero pressure).
2) For this, loosen the nut (4) and bolt (B) counterclockwise with 10 mm spanner.
※ The accumulator will be unloaded (zero pressure) in less than a minute.
3) The lifting system must firstly be secured against lowering.
4) After carrying out maintenance work, screw the bolt (B) and nut (A).
   · Tightening torque
   A : 2.04 kgf · m (14.8 lbf · ft)



Ride control valve

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5. MAIN HYDRAULIC PUMP FLOW TEST

· SPECIFICATION

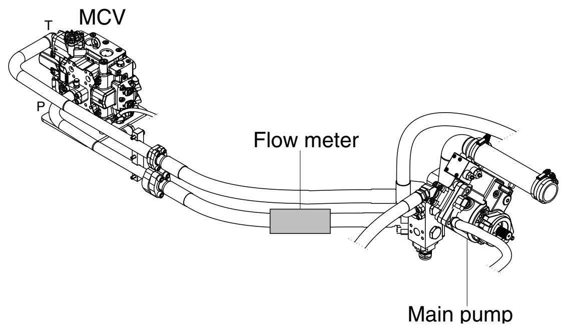
Oil temperature	45±5˚C (113±9˚F)
Engine speed	2100±25 rpm
Test pressure	315±5 bar
Maximum pump flow	520 ℓ/min (137 gpm)

(steering+loader pump)

· FLOW METER, GAUGE AND TOOL

Gauge 0~35 MPa (0~350 bar, 0~5000 psi)
Temperature reader

1) Make test connections.
2) Install temperature reader.
   (see temperature reader installation procedure in this group)
3) Heat hydraulic oil to specifications.
   (see hydraulic oil warm up procedure in this group)
4) Run engine at test specifications.
5) Close flow meter loading valve to increase pressure to test specifications.
6) Read flow meter.
7) If flow is below specifications, check suction line and suction pressure for abnormality before removing pump.



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6. LOADER SYSTEM AND PORT RELIEF VALVE PRESSURE TEST

· SPECIFICATION

Oil temperature (40~50˚C)

Relief valve	Engine speed	Relief pressure
System (M)	Low	315±5 kg/cm^2 (4570±70 psi)
Boom raise (U)	Low	365±10 kg/cm^2 (5290±140 psi)
Bucket rollback (R)	Low	365±10 kg/cm^2 (5290±140 psi)
Bucket dump (D)	Low	365±10 kg/cm^2 (5290±140 psi)

· Gauge and tool

Gauge 0~35 MPa (0~350 bar, 0~5000 psi)
M : System (main) relief valve
R : Bucket rollback relief
D : Bucket dump relief
U : Boom raise relief

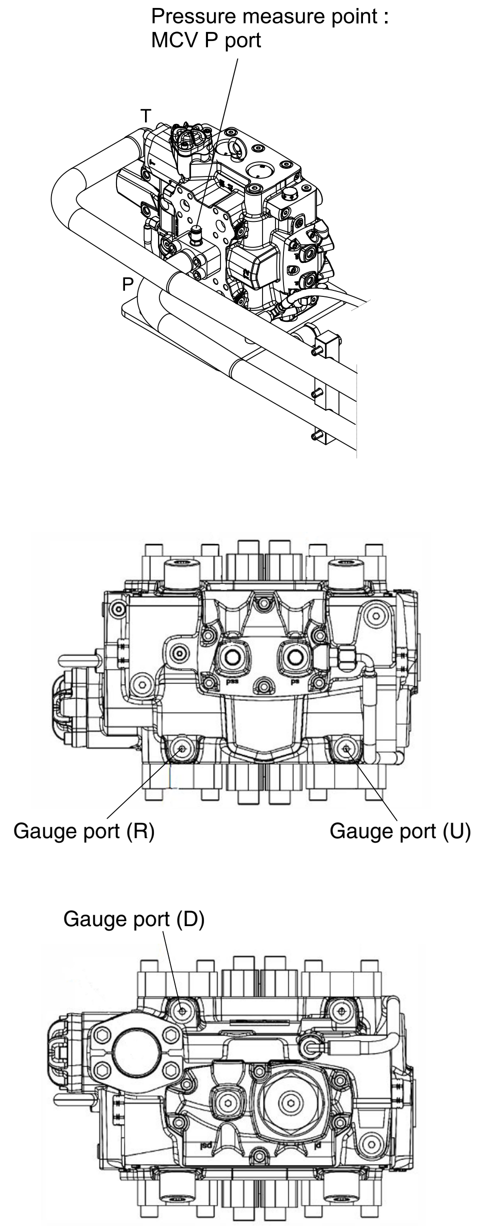
1) Install fitting and pressure gauge to test port in pump delivery line.

2) Install temperature reader.
(see temperature reader installation procedure in this group)

3) Heat hydraulic oil to specifications.
(see hydraulic oil warm up procedure in this group)

4) To check the system relief (M), run engine at low idle. Lower boom to bottomed position.
Slowly activate boom down function while watching pressure gauge. If pressure is not to specification, loosen lock nut on system relief valve (M) and adjust to specification.

※ Do not adjust the system relief valve above 315 kg/cm^2 (4570 psi). Damage to the pump will result from excessive pressure settings.



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7. LOADER CYLINDER DRIFT TEST

· **SPECIFICATION**

Oil temperature 45±5˚C (113±9˚F)
Boom horizontal
Bucket horizontal
Bucket unloaded

Item	Standard value
Retraction of boom cylinder rod	30 mm
Retraction of bucket cylinder rod	20 mm

· **GAUGE AND TOOL**

Stop watch
Temperature reader

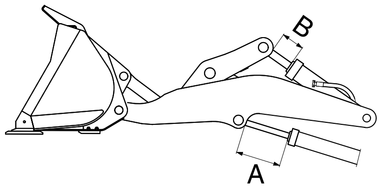
⚠ Put the safety lock lever in the lock position.

⚠ Do not go under the work equipment.

1) Set the boom and bucket horizontal, then stop the engine.

2) Stop the engine, wait for 5 minutes, then start measuring.

3) Measure the amount the boom and bucket cylinder rods retract during 15 minutes.



A : Retraction of boom cylinder rod
B : Retraction of bucket cylinder rod

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8. BOOM AND BUCKET CYLINDER LEAKAGE TEST

· SPECIFICATION

Oil temperature	45±5°C(113±9°F)
Engine speed	Low idle
Maximum leakage	15 mℓ/min (1/2 oz/min)

· GAUGE AND TOOL

Temperature reader
Stop watch
Measuring container

1) Fasten temperature sensor to head end port of cylinder to be tested. Cover sensor with a shop towel.

2) Heat hydraulic oil to specifications (see hydraulic oil warm up procedure in this group).

⚠ **Never work under raised equipment unless it is supported with a hoist or support stands.**

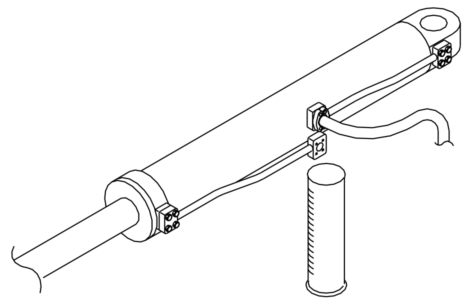
3) Full extend the cylinder to be tested. If testing the boom cylinders, restrain boom in the fully raised position using a hoist or a stand.

※ Check cylinders for leakage in the fully extended position only. In the retracted position contacts the end of the cylinder and seals off piston seal leakage.

4) Remove and plug cylinder rod end hose or line.

5) Run engine at slow idle. Activate control lever to extend cylinder for 1 minute over relief while measuring leakage for open port.

If leakage is within specification, excessive cylinder drift is caused by leakage in the loader control valve or circuit relief valve.



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9. PILOT CONTROL VALVE (EH CONTROL BLOCK) PRESSURE TEST

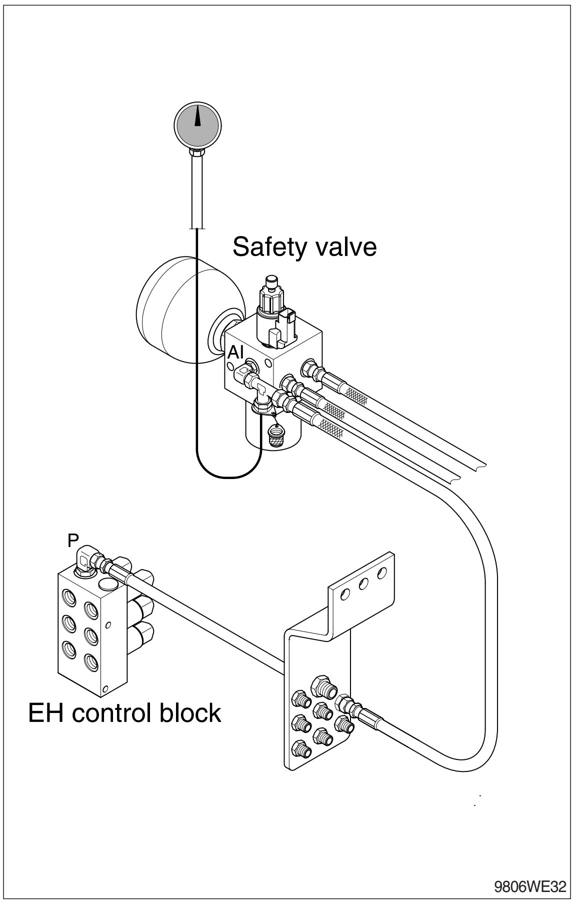
· SPECIFICATION

Oil temperature	45±5˚C (113±9˚F)
Engine speed	High idle
Maximum pressure	3.0 MPa (30 bar, 427 psi)

· GAUGE AND TOOL

Gauge 0~7 MPa (0~70 bar, 0~1000 psi)

1) Lower boom to ground.
2) Connect gauge to the pilot pressure port of function to be checked.
3) Install temperature reader (see temperature reader installation procedure in this group).
4) Heat hydraulic oil to specification (see hydraulic oil warm up procedure in this group).



10. CYCLE TIME TEST

· **SPECIFICATION**

Oil temperature —— 45±5˚C (113±9˚F)

Engine speed —— High idle

Function	Operating conditions	Maximum cycle time (seconds)
Boom raise	Bucket flat on ground to full height	6.1
Boom lower (float)	Full height to ground level	4.3
Bucket dump	Boom at full height	1.7
Bucket rollback	Boom at full height	2.2
Steering (number of turns)	Frame stop to stop	4.3 turns

11. HYDRAULIC OIL FILTER INSPECTION PROCEDURE

1) Lower the bucket to the ground, stop the engine, move the control lever back and forth several times, and clean all over the upper surface of the hydraulic oil tank.

2) Remove the bolts and take out the filter case cover and O-ring.

3) Remove the spring and bypass valve.

4) Remove the filter element from the tank.

5) Check the element and the filter case bottom for debris. Excessive amounts of brass and steel particles can indicate a failed hydraulic pump or a pump failure in process. A rubber type of material can indicated cylinder packing or other packing failure.

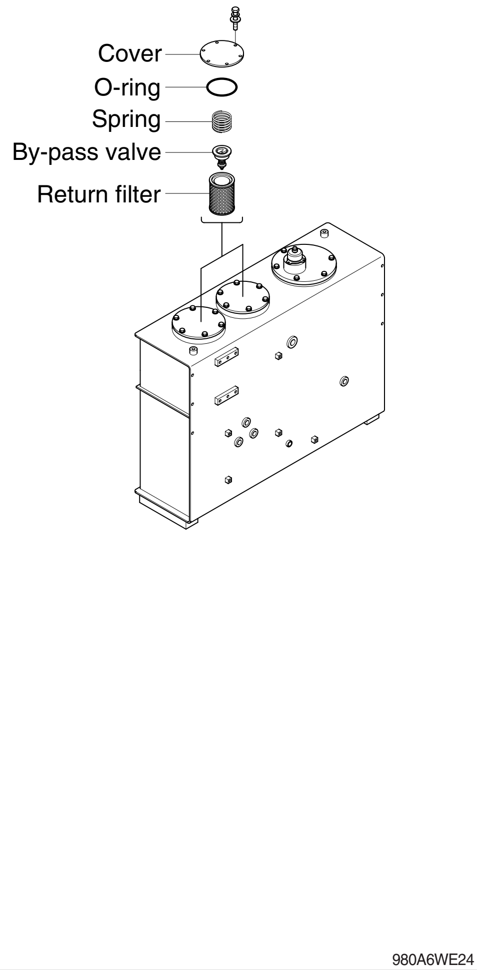
※ The hydraulic oil filter in the filter case of the hydraulic oil tank should be replaced every 250 operating hours or more often. When the filter element is replaced, please keep as follows.

(1) Clean the inside of the filter case.

(2) Place new element in the proper positions inside the filter case.

(3) Install the bypass valve and spring. Make sure the element stand upright, and check for complete contact of the element bottom with the filter case bottom.

(4) Install the O-ring and filter case covers. Tighten them with bolt. Replace the O-ring with new one if damaged.



GROUP 4 DISASSEMBLY AND ASSEMBLY

1. MAIN PUMP

1) DISASSEMBLY

(1) Select an appropriate place to disassemble.

※ The place must be clean.

※ Spread a rubber sheet, cloth, etc. to prevent parts from being damaged.

(2) Remove dust, rust and so on from the surface of the pump with cleaning solvent.

(3) Remove the drain plug (467) and drain hydraulic oil out pump casing (271).

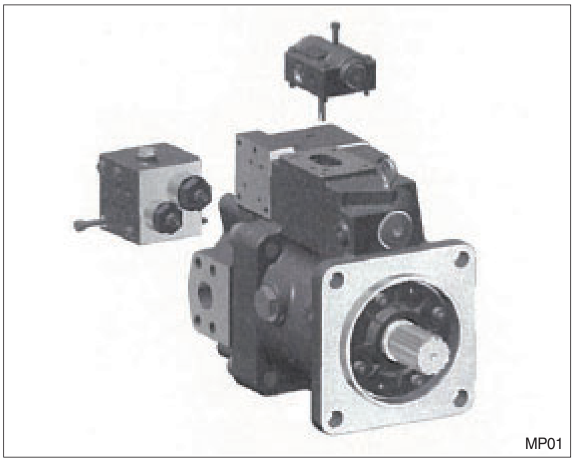
※ Drain off as much as possible.

(4) Remove hexagon socket head bolt (M6) and then remove the regulator from the pump.

※ When disassembling the regulator, refer to the regulator manual.

※ Be careful not to lose the O-rings from the sealing surface of the regulator.

※ Prevent dust from entering into the regulator.



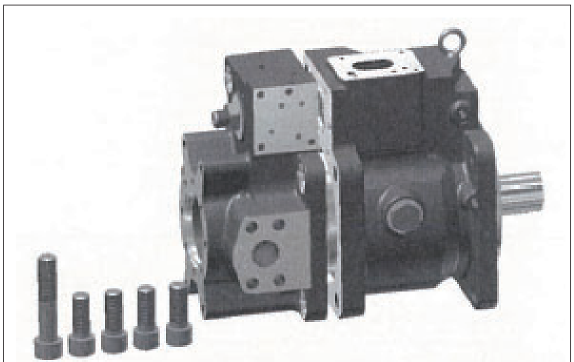
MP01

(5) Loosen hexagon socket head bolts (401, 402), holding valve cover (312) and the pump casing (271) together.

※ Remove the regulator before loosening the bolts.

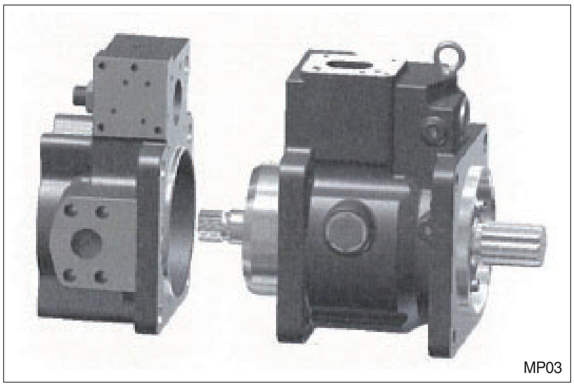
※ If through drive kit is installed, remove sub-plate adapter (317) and coupling (116) beforehand.

※ Oil will come out from between the pump casing (271) and the valve cover (312). Be careful and remove oil to keep the area clean.



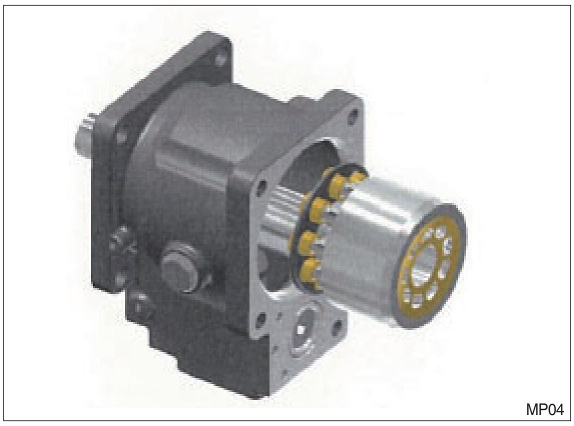
MP02

(6) Place the pump horizontally on workbench.
Separate pump casing (271) from valve cover (312).
※ Pull out valve cover perpendicular to the direction of the shaft. (In order to prevent damage of needle bearing and the contacting surface of the shaft.)
※ Be careful not to damage the contacting surfaces between the valve cover and the pump casing.
※ When removing valve cover, valve plate comes out attached to valve cover.
Valve plate may easily detach from the valve cover and fall down.
Be careful not to damage the valve plate.



(7) When necessary, remove needle bearing (124) and valve plate from valve cover (312).
※ Do not remove the needle bearing unless the bearing is considered to be near the end of its expected life.
※ Do not loosen nut (808).
※ Delivery flow rate will change when nut is loosened.

(8) Pull cylinder out from pump casing straight over drive shaft.
Pull out piston-sub (011), set plate (153), spherical bushing (156), cylinder springs (157) at the same time.
※ Be careful not to damage sliding surfaced of cylinder, spherical bushing (156), piston-sub (011), and swash plate-sub (030).
※ Be careful not to damage surface of the shaft contacting needle bearing.

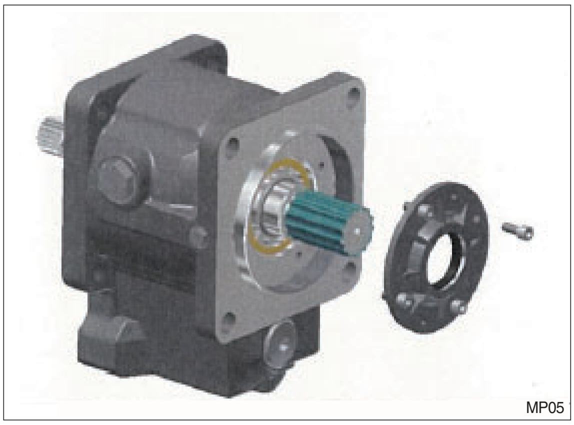


(9) Remove retaining ring (406) or hexagon socket head bolts (406). Remove seal cover (261).

※ To remove seal cover, insert two bolts into the female thread holes and pull.

※ Be careful not to damage oil seal (774) on seal cover (261).

※ In case of spline shaft, cover splines with plastic tape so as not to damage oil seal. In case of key shaft, remove key before seal cover is removed.



MP05

(10) Tap drive shaft (111) lightly on the end of valve cover side with a plastic hammer to extract drive shaft from pump casing.

※ Hold front side of shaft when tapping to prevent shaft from flying out.

※ Tap shaft horizontally (in accordance with shaft direction) not to damage front roller bearing.

※ Do not remove front roller bearing unless it is considered to be near the end of its expected life, because front roller bearing and shaft are fit tightly (shrinkage fit).

MP06

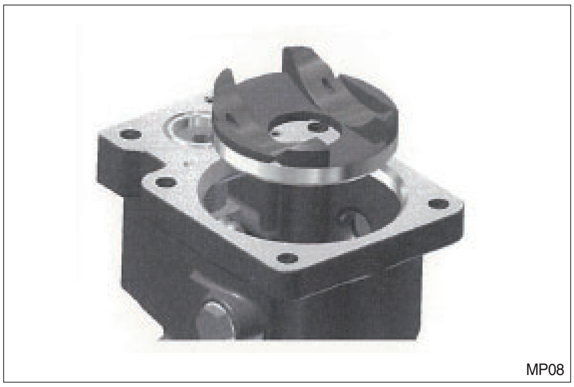
(11) Push down servo piston (532) to remove swash plate-sub (030) and shoe plate (211) from pump casing.

※ Be careful not to damage the shoe plate, and the sliding round surface of the swash plate.

MP07

(12) Remove swash plate support (251) from pump casing (271).

※ Use both hands to lift up swash plate support (251).



(13) Only when necessary, remove servo piston (532), tilting pin (530), outer/inner servo bias springs (535 and 536), spring seat (537), and plug (538).

※ When removing servo piston, use a special jig not to damage head part of tilting pin-sub.

※ Adhesive (Three bond No. 1305B) has been applied on the connecting part between tilting pin-sub and servo piston. Be careful not to damage servo piston.

※ Be careful not to pinch fingers in springs when removing tilting pin-sub form pump casing.

2) ASSEMBLY

(1) General precautions

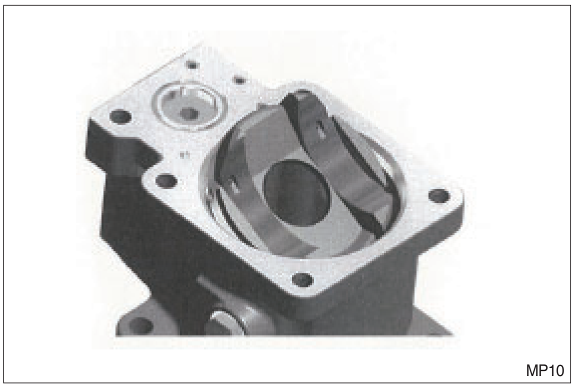
When assembling, the order of procedures is the reverse of disassembly.
Be careful with the next items.

① Before assembling, make sure that all parts are prepared and all damaged parts are fixed or replaced with new ones.
② Before assembling, wash each part with cleaning solvent and dry it with compressed air.
Select an appropriate clean place to assemble. When dust enters, it may cause trouble.
③ When assembling, apply clean working fluid on the sliding surfaces and bearings.
④ Do not reuse O-ring, oil seal, and other seal parts.
Replace with new ones.
⑤ When assembling parts that easily detach, like an O-ring, apply clean grease to prevent them from falling off.
⑥ Tighten bolts and plugs using a torque wrench with standard torque setting shown on each pump size drawing.

(2) Select an appropriate place to assemble.
※ The place must be clean.
※ Spread a rubber sheet, cloth, etc. to prevent part from being damaged.

(3) If servo piston, titling pin, servo bias springs, spring seat, and plug were removed, reinstall all parts before inserting swash plate support.
※ Be careful not to injure fingers when installing springs.
※ Use special jig not to damage head of tilting pin and feed-back pin.
Apply adhesive (Three bond NO.1305B) on thread of servo piston.

(4) Fit swash plate support (251) in pump casing (271).
※ Pin (884) has been installed on the inside surface of pump casing.
When installing the swash plate support, make sure that the pin enters into the slit of swash plate support (251).
※ Be careful not to install swash plate support crooked.
※ In case of K3VL200, fix the swash plate support by tightening hexagon socket head bolts (407) with a standard torque.

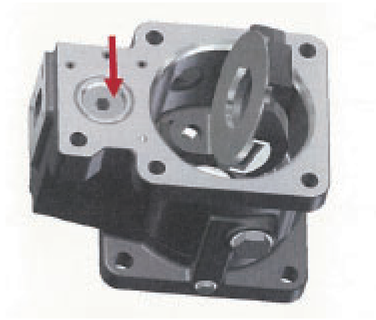


MP10

(5) Insert the swash plate-sub (030) into the tilting pin (530) of the servo piston (532), then install swash plate-sub, and shoe plate (211) in pump casing (271).

※ While pushing down on the servo piston, insert swash plate-sub into tilting pin and insert swash plate-sub into groove of swash plate support correctly.

※ It is easier to install swash plate and swash plate support if grease is applied to their sliding surfaces.



MP11

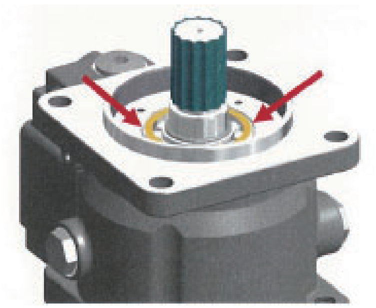
(6) Insert drive shaft (111) into pump casing (271) tapping shaft lightly so that height of surface of the pump casing and height of end of roller bearing are nearly the same.

※ When tapping shaft, keep the shaft vertical.

If tapped strongly, roller bearing may break.

※ Be careful not to push the top surface of roller bearing deeper than the surface of pump casing.

If the top surface is deeper than the surface of pump casing, there is a possibility for swash plate support to be detached.

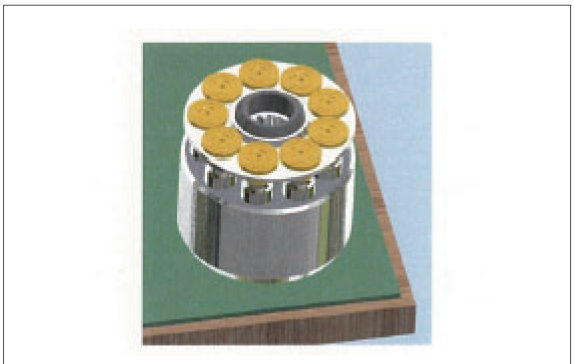


MP12

(7) Tape the splined or keyed area of the shaft.
Insert seal cover (261) slightly into pump casing.
※ Tighten hexagon socket head bolts (406) uniformly to stopping position of the seal cover and then tighten bolts with a standard torque.
Use the hammer to lightly tap the seal cover to the position where the groove for locking ring can be seen and then install retaining ring (406).
※ Apply a little grease on lip of seal installed in seal cover.
※ Be careful not to damage lip of oil seal.
※ Make sure to tighten the four hexagon socket head screws evenly.


MP13

(8) Assemble cylinder, piston-sub (011) spherical bushing (156), set plate (153), and cylinder springs (157) into the sub assembly.
※ Be careful not to damage sliding surface between piston and cylinder bore, and between cylinder and valve plate.


MP14

(9) Place pump casing (271) horizontally, with surface of regulator downward.
Install piston-cylinder sub-assembly into pump casing.
※ Be careful not to drop parts for piston-cylinder sub-assembly such as cylinder spring and roller.
※ Be careful not to damage bearing-contacting surface of the shaft when installing a piston-cylinder sub-assembly.


MP15

(10) Install valve plate on valve cover (312).

※ In case that stopper (534), max flow set screw (954), and max flow set screw lock nut (808) have been removed, install these parts on valve cover (312) beforehand.

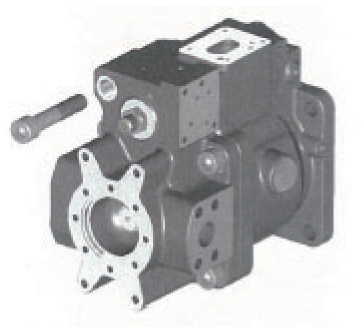
※ Do not mistake suction/delivery direction of valve plate.
When installing valve plate, make sure that pin (885) enters into the slit of valve plate.

※ It is easier to install valve cover (312) if grease is applied to contacting surfaces of valve cover and valve plate.

MP16

(11) Install valve cover (312) on pump casing (271).
Tighten hexagon socket head bolts (411 and 412).

※ While assembling valve cover, be careful not to damage shaft and contacting surface of needle bearing.



MP17

(12) Install regulators on the valve cover (312) or pump casing (271).
When installing torque limit regulator, make sure that feed back lever of regulator is engaged with feed back pin of tilting pin (530).

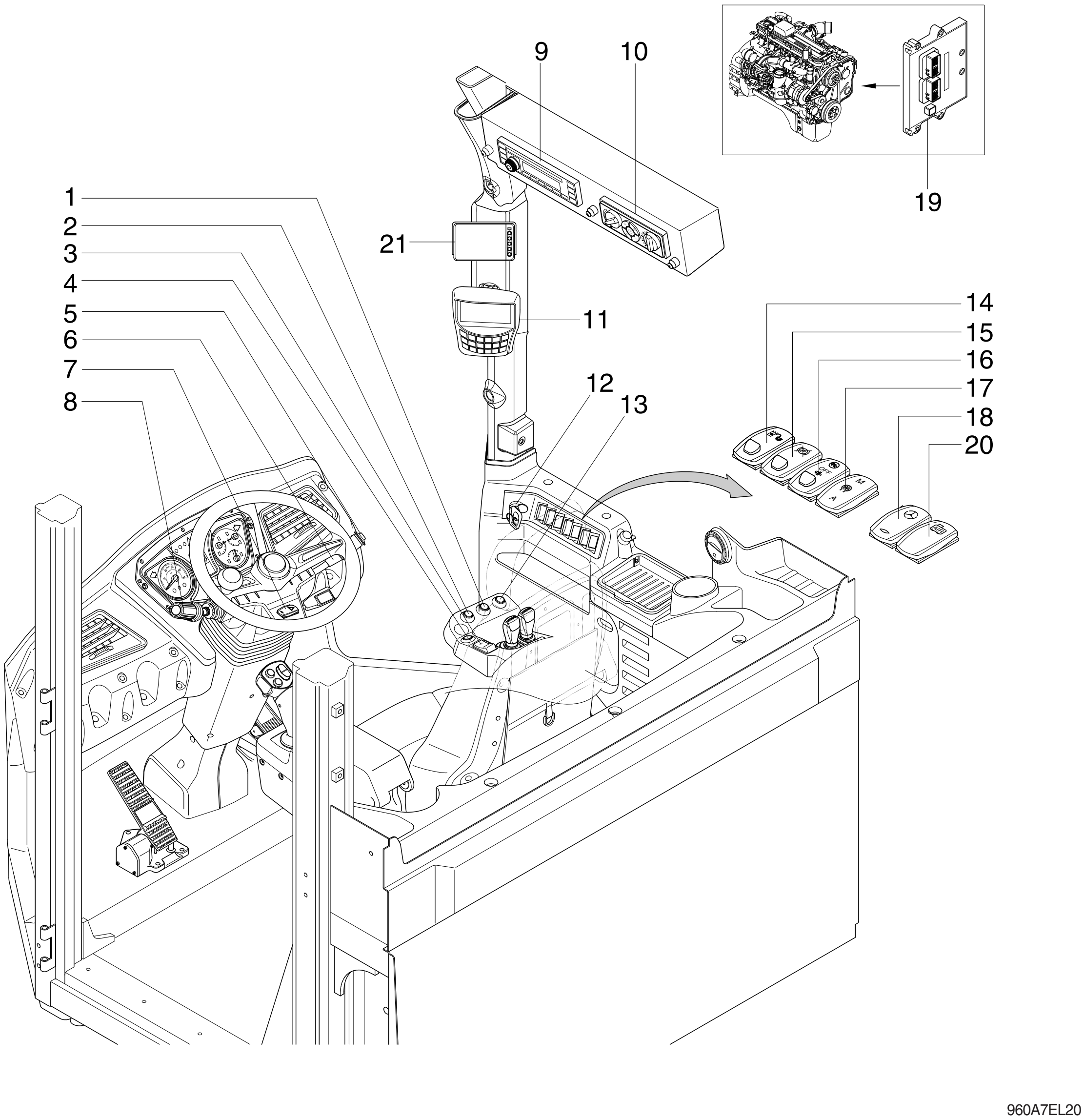
※ Make sure that O-rings on the sealing surface of regulator do not drop out.

MP18

SECTION 7 ELECTRICAL SYSTEM

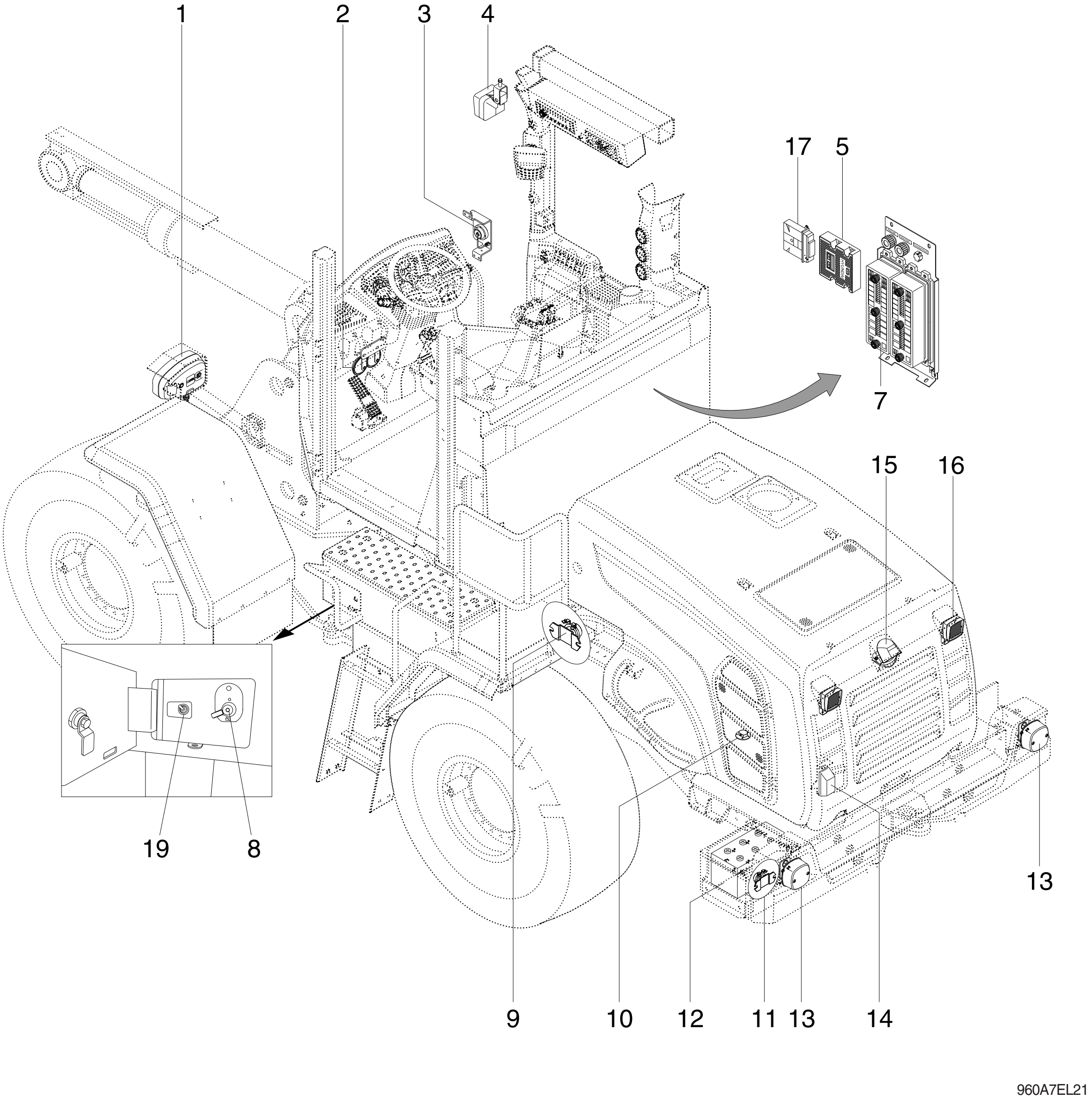
GROUP 1 COMPONENT LOCATION

1. LOCATION 1



1	Kick down button	8	Gear select lever	14	Pilot cut off switch
2	Horn button	9	Radio & USB player	15	Parking brake switch
3	FNR switch	10	Aircon & heater switch	16	SCR switch
4	FNR select button	11	Monitor	17	Differential lock switch (opt)
5	Hone button	12	Starting switch	18	Emergency test switch
6	Multi function switch		Starting button (opt)	19	Engine control unit (ECU)
7	Hazard switch	13	Work load button	20	Air compressor switch (opt)
				21	Camera monitor

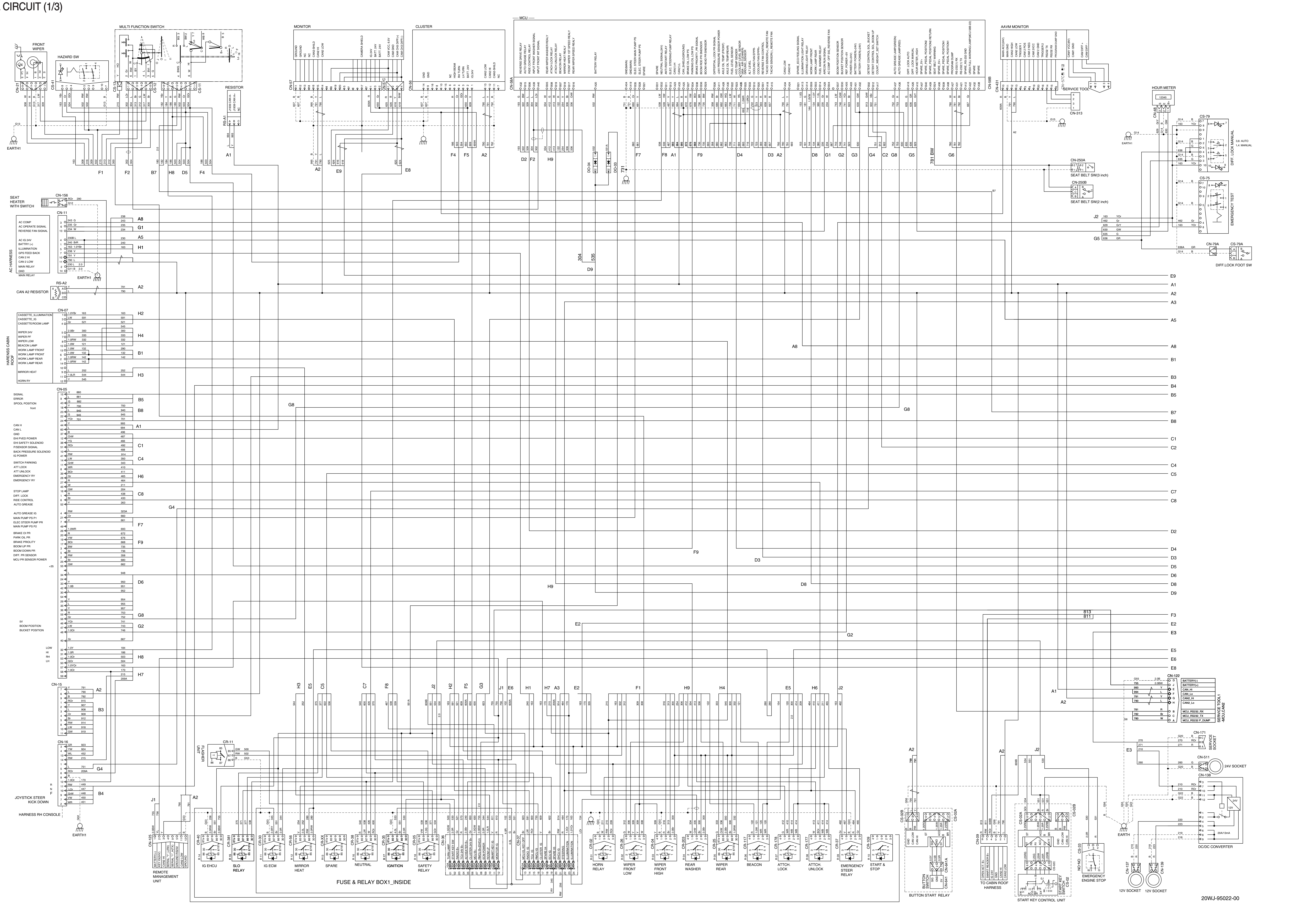
2. LOCATION 2



1	Head lamp	9	Start relay	16	Work lamp
2	Horn	10	Fuel sender	17	Control unit (electro hydraulic & joystick steering)
3	Angle sensor	11	Battery relay	19	Engine hood open switch
4	Work lamp	12	Battery		
5	Machine control unit (MCU)	13	Rear combi lamp		
7	Fuse and relay box	14	Number plate lamp		
8	Master switch	15	Camera (opt)		

GROUP 2 ELECTRICAL CIRCUIT

· ELECTRICAL CIRCUIT (1/3)



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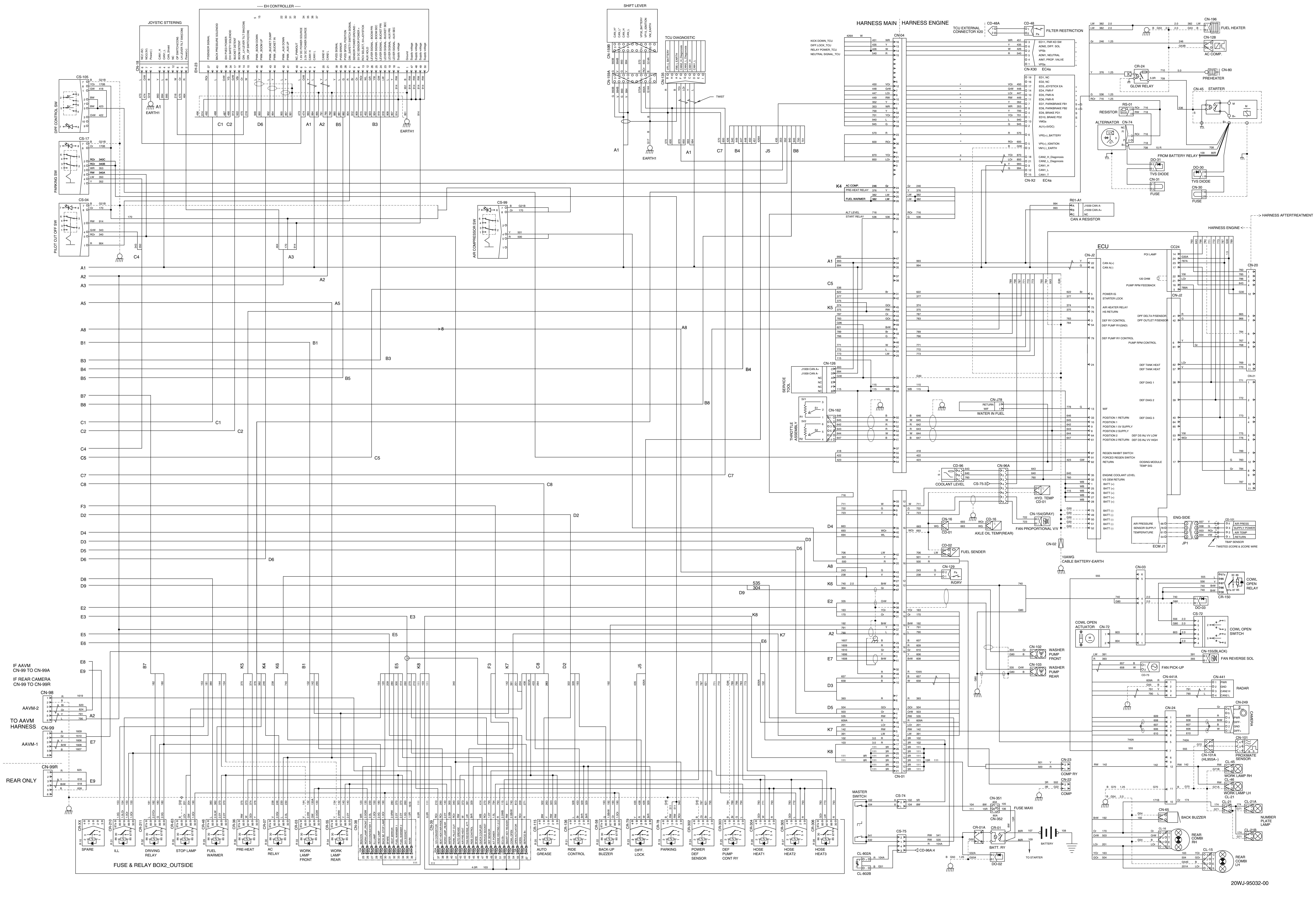
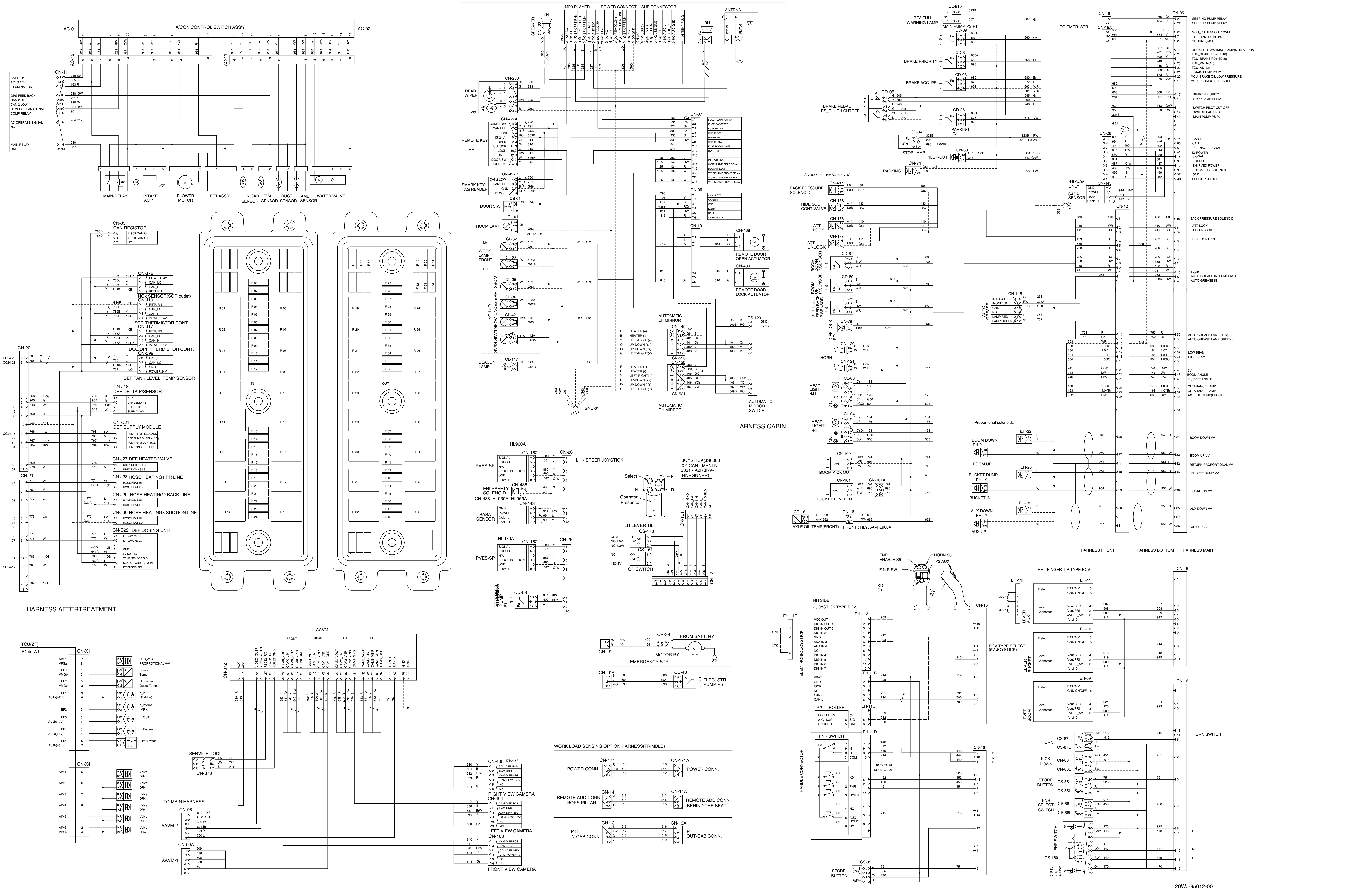
· ELECTRICAL CIRCUIT (2/3)



· ELECTRICAL CIRCUIT (3/3)



MEMORANDUM

1. ILLUMINATION CIRCUIT

1) OPERATING FLOW

Main light switch on monitor → Switch ON, Select position lamp → MCU [CN-58A (A13)]

→ Illumination relay [CR-210 (87)]

- → Fuse box [CN-37 (23)]
  - → Switch and button indicator lamp
  - → Cigar lighter lamp [CL-02]
  - → I/conn [CN-01 (31)]
    - → I/conn [CN-24 (10)] → Number plate lamp [CL-21 (2)]
    - → RH Combi clearance lamp ON [CL-16 (4)]
  - → I/conn [CN-05 (58)] → LH Head lamp ON [CL-03 (3)]
- → Fuse box [CN-37 (24)]
  - → Switch indicator lamp
  - → Radio & USB player [CL-27 (9)]
  - → I/conn [CN-01 (36)] → LH Combi clearance lamp ON [CL-15 (4)]
  - → I/conn [CN-05 (57)] → RH Head lamp ON [CN-04 (3)]

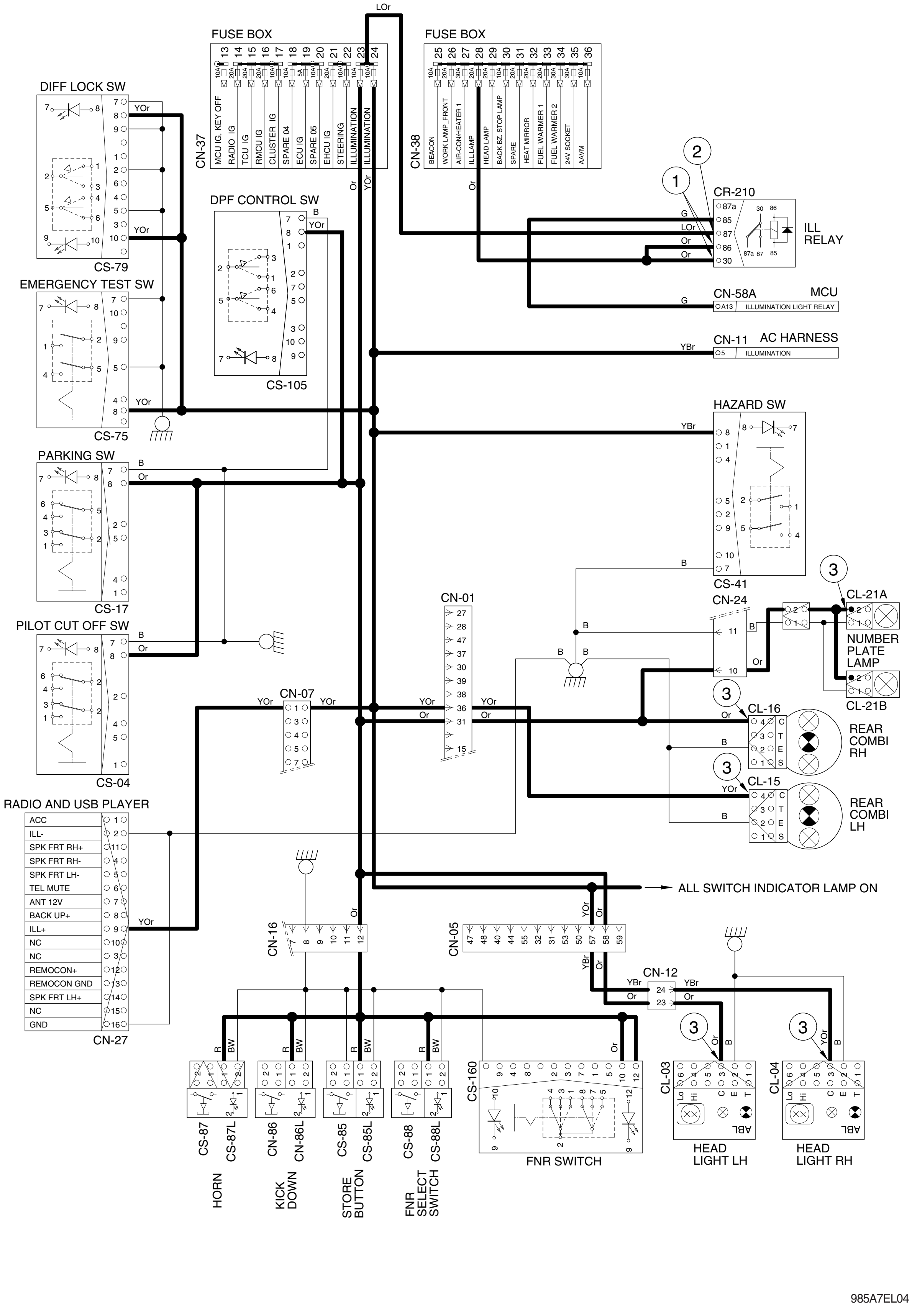
2) CHECK POINT

Engine	Key switch	Check point	Voltage
OFF	ON	① - GND (relay input) ② - GND (relay output) ③ - GND (to light)	20~25V

※ GND : Ground

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

ILLUMINATION CIRCUIT

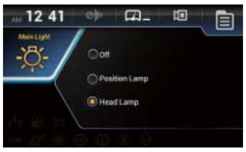


※ The circuit diagram may differ from the equipment, so please check before a repair.

2. HEAD LIGHT CIRCUIT

1) OPERATING FLOW

Main light switch on monitor → Switch ON, Select head lamp → MCU [CN-58A (A14)]
→ Driving relay [CR-211 (87)] → Multi function switch [CS-11(8)]
→ Multi function switch MIDDLE [CS-11(7)] → I/conn [CN-05 (32)]
→ LH Head light low beam ON [CL-03 (6)]
→ RH Head light low beam ON [CL-04 (6)]
→ Multi function switch DOWN [CS-11(6)] → I/conn [CN-05 (31)]
→ LH Head light high beam ON [CL-03 (4)]
→ RH Head light high beam ON [CL-04 (4)]
→ Cluster high beam pilot lamp ON [CN-56 (5)]



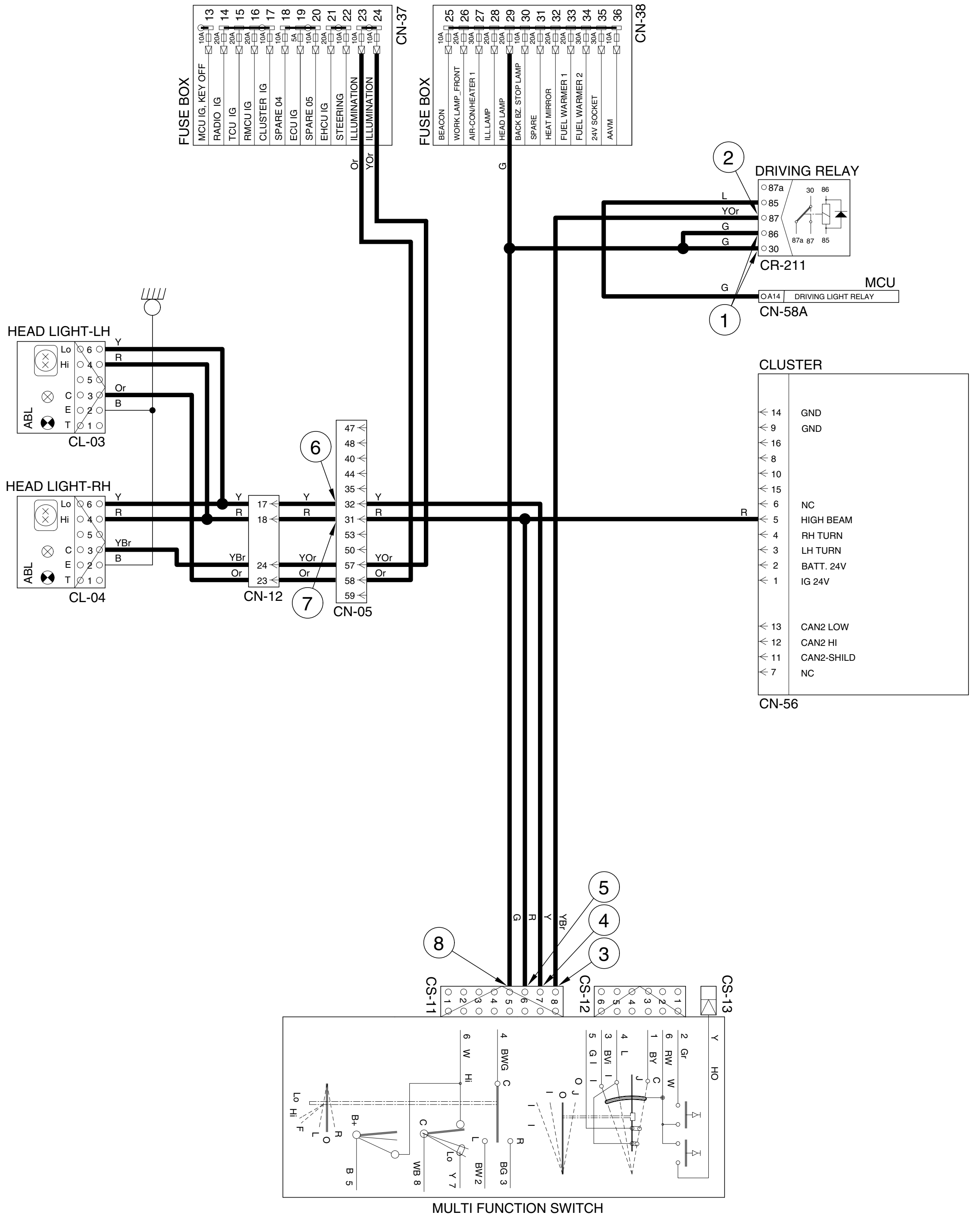
2) CHECK POINT

Engine	Key switch	Check point	Voltage
OFF	ON	① - GND (relay input) ② - GND (relay output) ③ - GND (multi function input) ④ - GND (multi function output) ⑤ - GND (multi function output) ⑥ - GND (low beam) ⑦ - GND (high beam) ⑧ - GND (passing B^+)	20~25V

※ GND : Ground

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

HEAD LIGHT CIRCUIT



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

3. WORK LIGHT SWITCH

1) OPERATING FLOW

※ Main light switch on monitor : Select position lamp.

(1) **Work lamp switch** (select Front)

MCU [CN-58B (B09)] → Front work lamp relay [CR-03 (87)] → I/conn [CN-07 (06)]

→ LH Front work lamp ON [CL-32 (1)]

→ RH Front work lamp ON [CL-33 (1)]

(2) **Work lamp switch** (select Rear)

MCU [CN-58B (B03)] → Rear work lamp relay [CR-55 (87)] → I/conn [CN-01 (05)]

→ I/conn [CN-24 (12)] → LH Rear work lamp ON [CL-46 (1)]

→ RH Rear work lamp ON [CL-45 (1)]

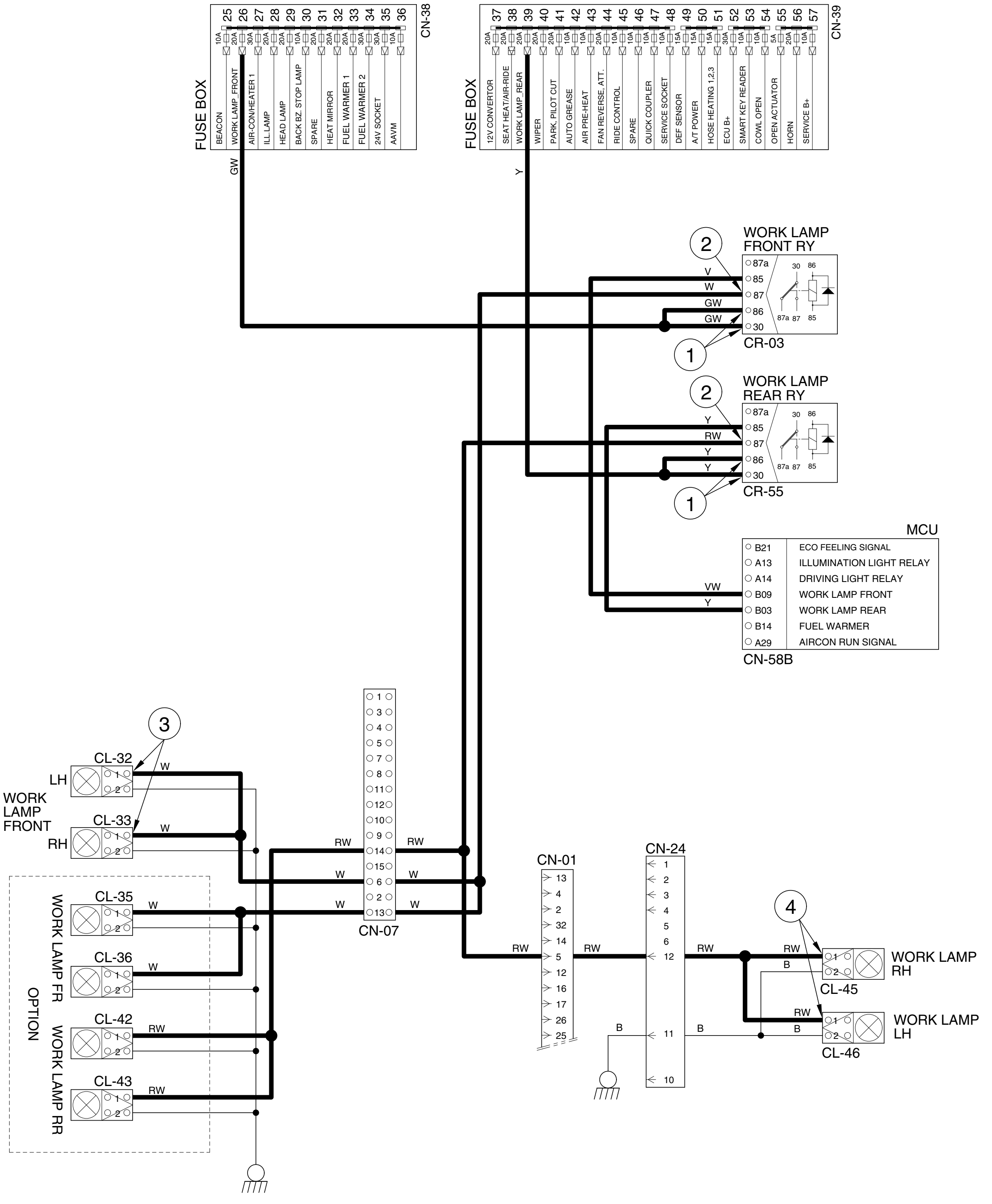
2) CHECK POINT

Engine	Key switch	Check point	Voltage
OFF	ON	① - GND (work lamp power input) ② - GND (work lamp power output) ③ - GND (front work lamp) ④ - GND (rear work lamp)	20~25V

※ GND : Ground

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

WORK LIGHT SWITCH



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

4. STARTING CIRCUIT

1) OPERATING FLOW

Battery(+) terminal → Fusible link [CN-351 (40A)] → Master switch [CS-74 (1) → (2)]
→ I/conn [CN-01 (16, 17)] → Fuse box [CN-36] → Start switch [CS-02 (1)]
→ ECM power relay [CR-30 (30)]
→ Power relay [CR-35 (30)]

※ The gear selector lever is neutral position. It is necessary condition before the starting.
The gear selector has an output signal which is activated whenever the shift lever is in the neutral position. This signal can be used to control a relay and prevent engine from starting whenever the shift lever is not in the neutral position.

(1) When start key switch is in ON position
Start switch ON [CS-02 (2, 3)] → I/conn [CN-01(2)] → Master switch [CS-75 (1) → (2)]
→ Battery relay [CR-1]
→ Battery relay operating (All power is supplied with the electric component)
→ ECM power relay [CR-30 (30) → (87)] → Fuse box [CN-37 (19)]
→ I/conn [CN-04 (31)] → ECM [CN-J2 (5)]
→ Fuse box [CN-37 (13)] → MCU [CN-58A (A03)]
→ Power relay [CR-35 (30) → (87)] → Fuse box [CN-37 (15)]
→ TCU [CN-X2 (5)]

(2) When start key switch is in START position
Start switch START [CS-2 (6)] → Start safety relay [CR-05 (30) → (87)] → I/conn [CN-04 (20)] →
Starter (terminal B^+ and M connector of start motor)

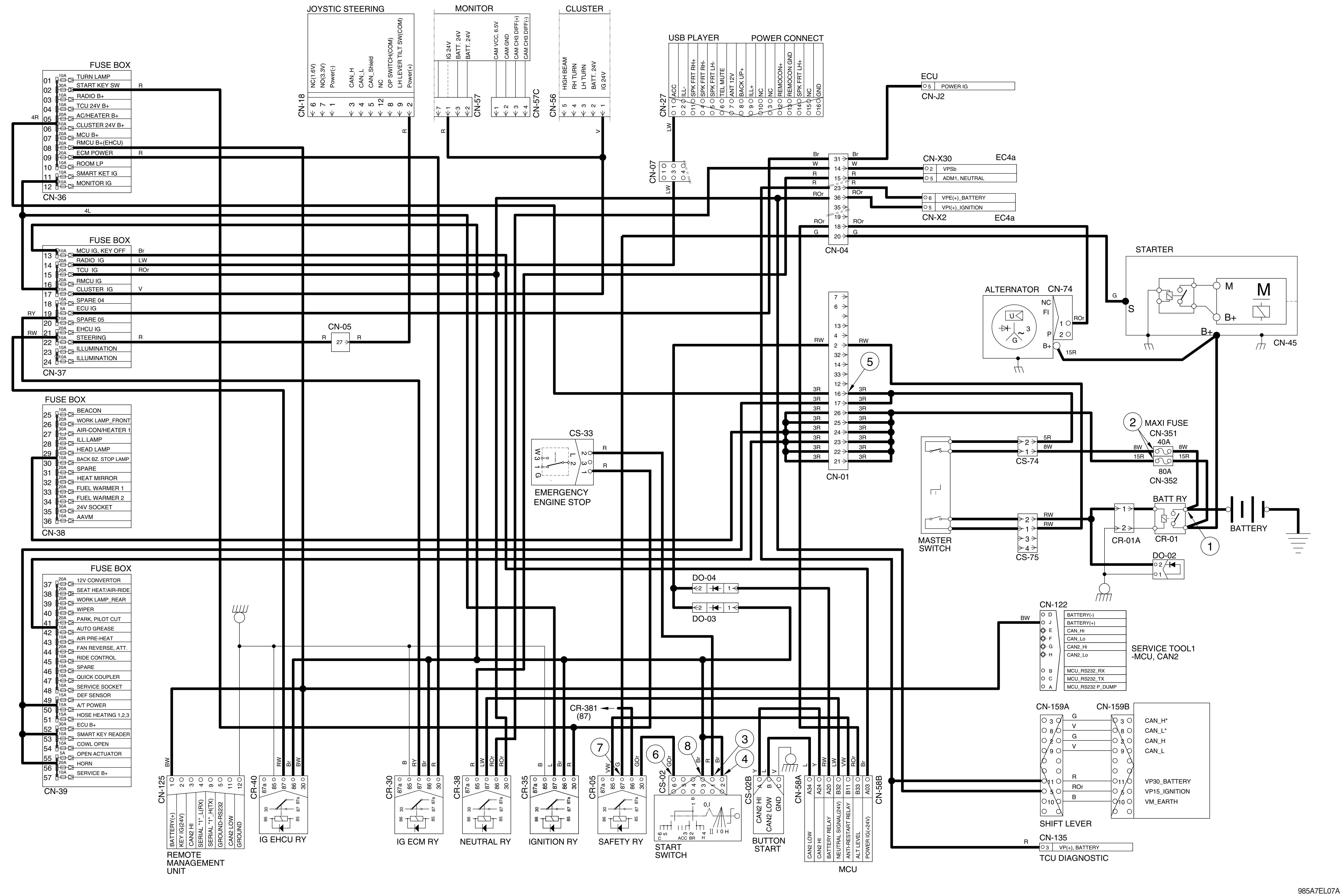
2) CHECK POINT

Engine	Key switch	Check point	Voltage
Running	ON	① - GND (battery B^+) ② - GND (fusible link) ③ - GND (start key B terminal) ④ - GND (start key BR terminal) ⑤ - GND (i/conn CN-01 (16)) ⑥ - GND (start key C terminal) ⑦ - GND (start safety relay output) ⑧ - GND (start key ACC terminal)	20~25 V

※ GND : Ground
※ ECM : Electronic control module
※ MCU : Machine control unit
※ TCU : Transmission control unit

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

STARTING CIRCUIT



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

5. CHARGING CIRCUIT

When the starter is activated and the engine is started, the operator releases the key switch to the ON position.

Charging current generated by operating alternator flows into the battery through the battery relay (CR-01).

The current also flows from alternator to each electrical component and controller through the fuse box.

1) OPERATING FLOW

(1) Warning flow

Altermator [CN-74 (1)] → I/conn [CN-04 (18)] → MCU [CN-58B (B33)]
→ Cluster charge warning lamp ON

(2) Charging flow

Alternator → Starter [CN-45 (B^+)] → Battery relay [CR-01]
→ Battery (+) terminal → Charging
→ Fusible link [CN-351 (40A)] → Master switch [CS-74 (1)→(2)] → I/conn [CN-01 (16, 17)]
→ Fuse box [CN-36, 39]
→ Fusible link [CN-352 (80A)] → I/conn [CN-01 (21~26)] → Fuse box [CN-38, 39]

2) CHECK POINT

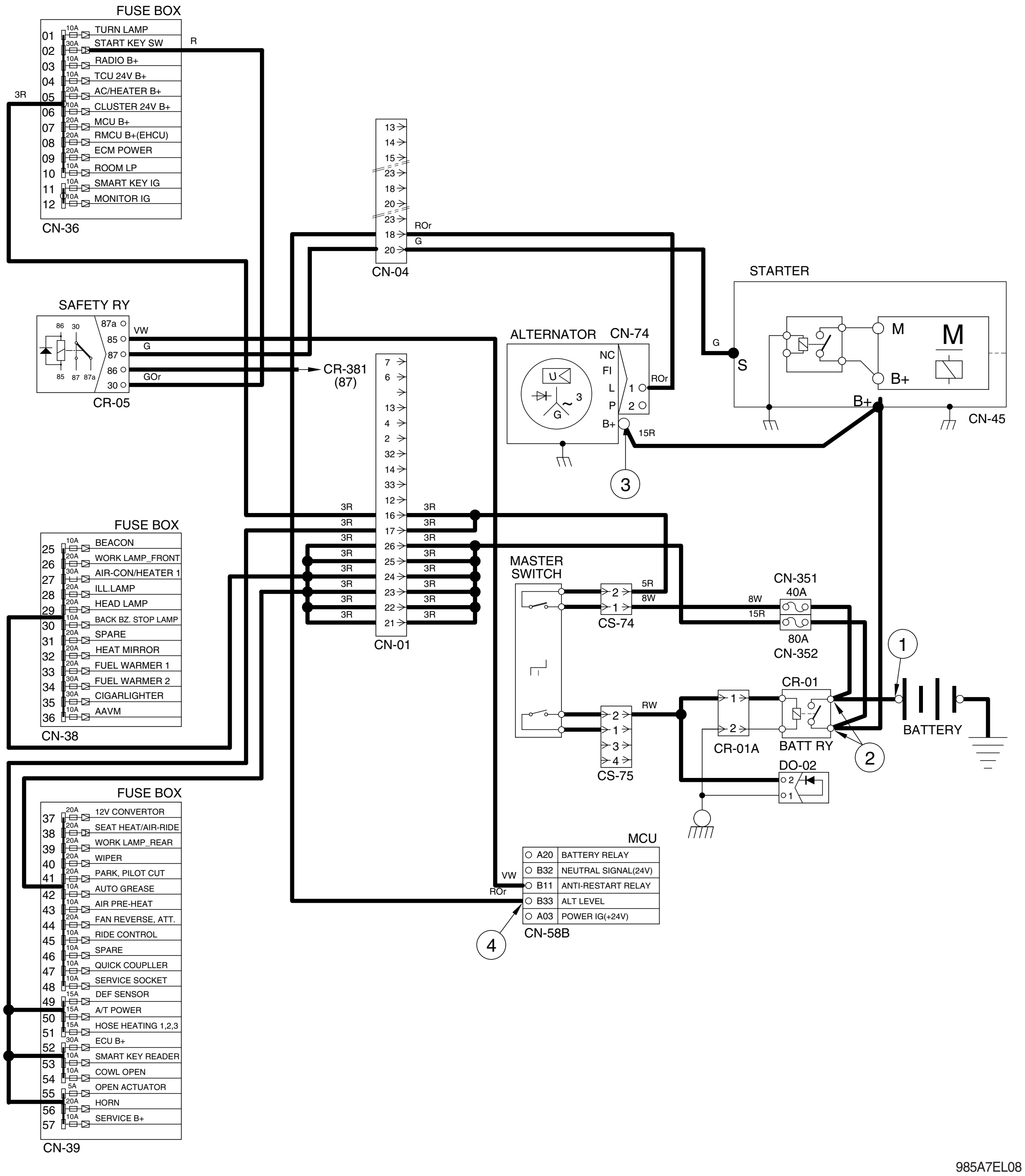
Engine	Key switch	Check point	Voltage
OFF	ON	① - GND (battery) ② - GND (battery relay) ③ - GND (alternator B^+) ④ - GND (MCU)	20~28V

※ GND : Ground

※ MCU : Machine control unit

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

CHARGING CIRCUIT



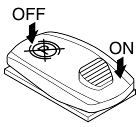
※ The circuit diagram may differ from the equipment, so please check before a repair.

6. ELECTRIC PARKING, PILOT CUT OFF CIRCUIT

1) OPERATING FLOW

(1) Parking OFF

Fuse box [CN-39 (41)] → Parking switch OFF → [CS-17 (5)→(4)] → I/conn [CN-05 (14)]
→ I/conn [CN-12 (13)]
→ Parking solenoid ON (activated)
→ Parking brake released (by hydraulic pressure)
→ [CS-17 (2)→(1)] → T/M control unit [CN-X2 (7)]



(2) Parking ON

Fuse box [CN-39 (41)] → Parking switch ON → Parking solenoid [CN-71] OFF
→ Parking brake applied [By spring force]

(3) Pilot cut off ON

Fuse box [CN-39 (41)] → Pilot cut off switch ON → Pilot cut off switch [CS-4 (5)→(4)]
→ I/conn [CN-05 (11)] → I/conn [CN-12 (12)] → Pilot cut off solenoid ON [CN-68] (activate)
→ Pilot cut off released

(4) Pilot cut off OFF

Fuse box [CN-39 (41)] → Pilot cut off switch OFF → Pilot cut off solenoid [CN-68] OFF
→ Pilot cut off applied

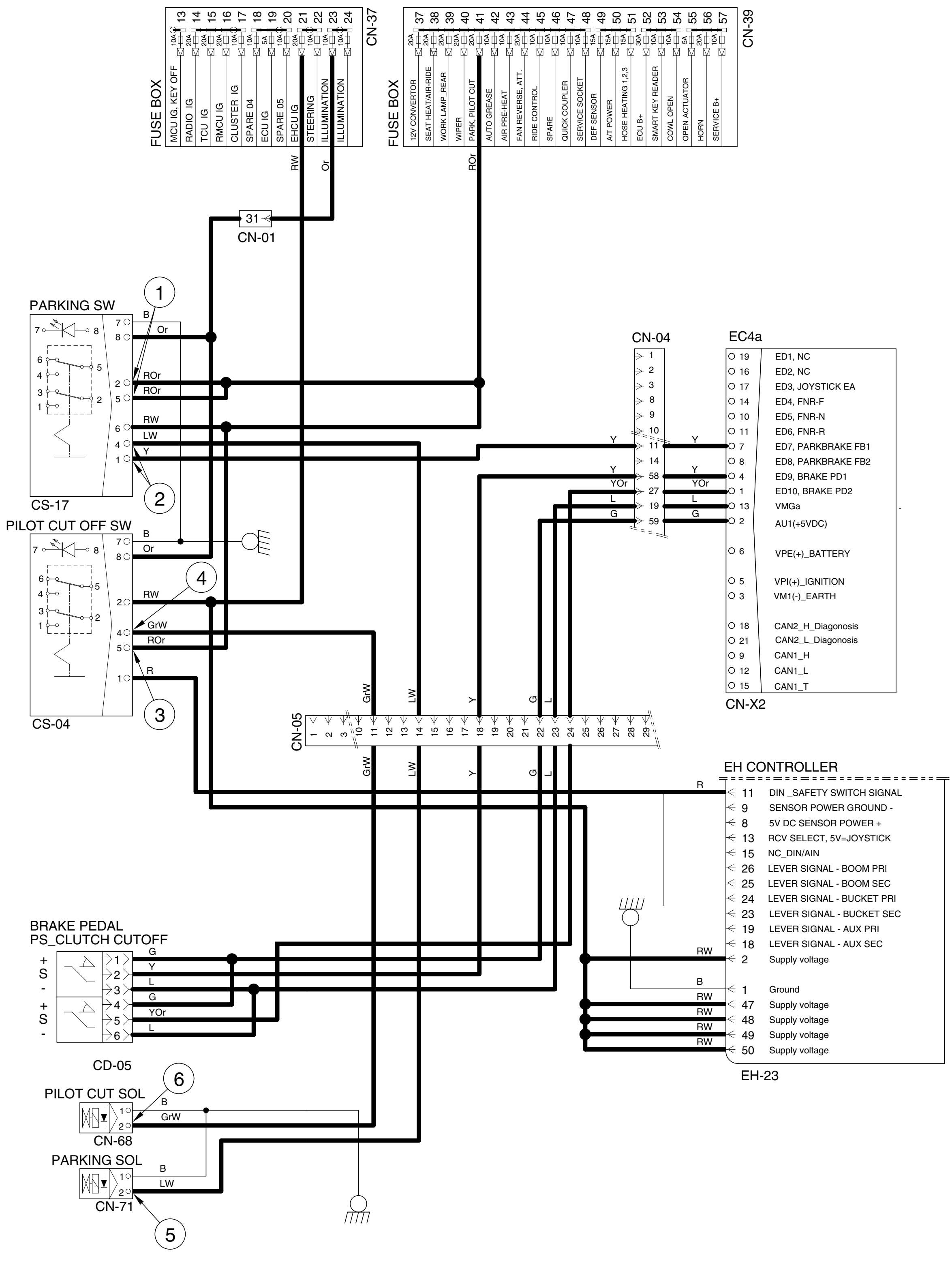
2) CHECK POINT

Engine	Key switch	Check point	Voltage
Running	ON	① - GND (parking switch input) ② - GND (parking switch output) ③ - GND (pilot cut off switch input) ④ - GND (pilot cut off switch output) ⑤ - GND (parking solenoid) ⑥ - GND (pilot cut off solenoid)	20~25V

※ GND : Ground

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

ELECTRIC PARKING, PILOT CUT OFF CIRCUIT



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

7. WIPER AND WASHER CIRCUIT

1) OPERATING FLOW

Fuse box [CN-39 (40)]
- → Wiper relay Hi [CR-4 (3)→(4)]
  - → Front wiper motor [CN-21 (1)]
  - → Wiper relay Lo [CR-26 (5), (2)]
- → Multi function switch [CS-12 (6)]
- → Rear washer relay [CR-203 (2, 3)]
- → Rear wiper relay [CS-25 (2, 5)]
- → I/conn [CN-07 (5)] → Rear wiper motor [CN-203 (1)]

(1) Front washer switch ON

① Washer switch ON [CS-12(6)→(2)]
- → Front washer [CN-102 (1)] → Washer operating
- → MCU [CN-58A (A39)→(B17)] → Front wiper relay Lo [CR-26 (5)→(3)] → Front wiper motor [CN-21 (5)] → Wiper motor operating (low)

(2) Front wiper switch ON

① INT position

Wiper switch ON [CS-12 (6)→(1)] → MCU [CN-58A (A40)→(B17)] → Wiper relay Lo [CR-26 (5)→(3)] → Front wiper motor [CN-21(5)] → Front wiper motor intermittently operating

② Lo position

Wiper switch ON [CS-12 (6)→(4)] → Wiper relay Lo [CR-26 (4)→(3)] → Front wiper motor [CN-21 (5)] → Front wiper motor operating (low)

③ Hi position

Wiper switch ON [CS-12 (6)→(3)] → Wiper relay Hi [CR-4(3)→(5)] → Front wiper motor [CN-21(4)] → Front wiper motor operating (high)

(3) Auto-parking (when switch OFF)

Switch OFF → Fuse box [CN-39 (40)] → Wiper relay Hi [CR-4 (3)→(4)] → Front wiper motor [CN-21 (1)→(2)] → Multi function switch [CS-12 (5)→(4)] → Wiper relay Lo [CR-26 (4)→(3)] → Front wiper motor [CN-21 (5)] → Wiper motor stop

(4) Rear wiper and washer switch

Rear wiper switch on monitor
- → MCU [CN-58B (B16)] → Rear wiper relay [CR-25 (5)→(3)] → I/conn [CN-07 (8)] → Rear wiper motor [CN-203 (5)] → Rear wiper motor operating
- → MCU [CN-58B (B05)] → Rear washer relay [CR-203 (3)→(5)] → I/conn [CN-01 (39)] → Rear washer pump [CN-103 (1)] → Washer operating

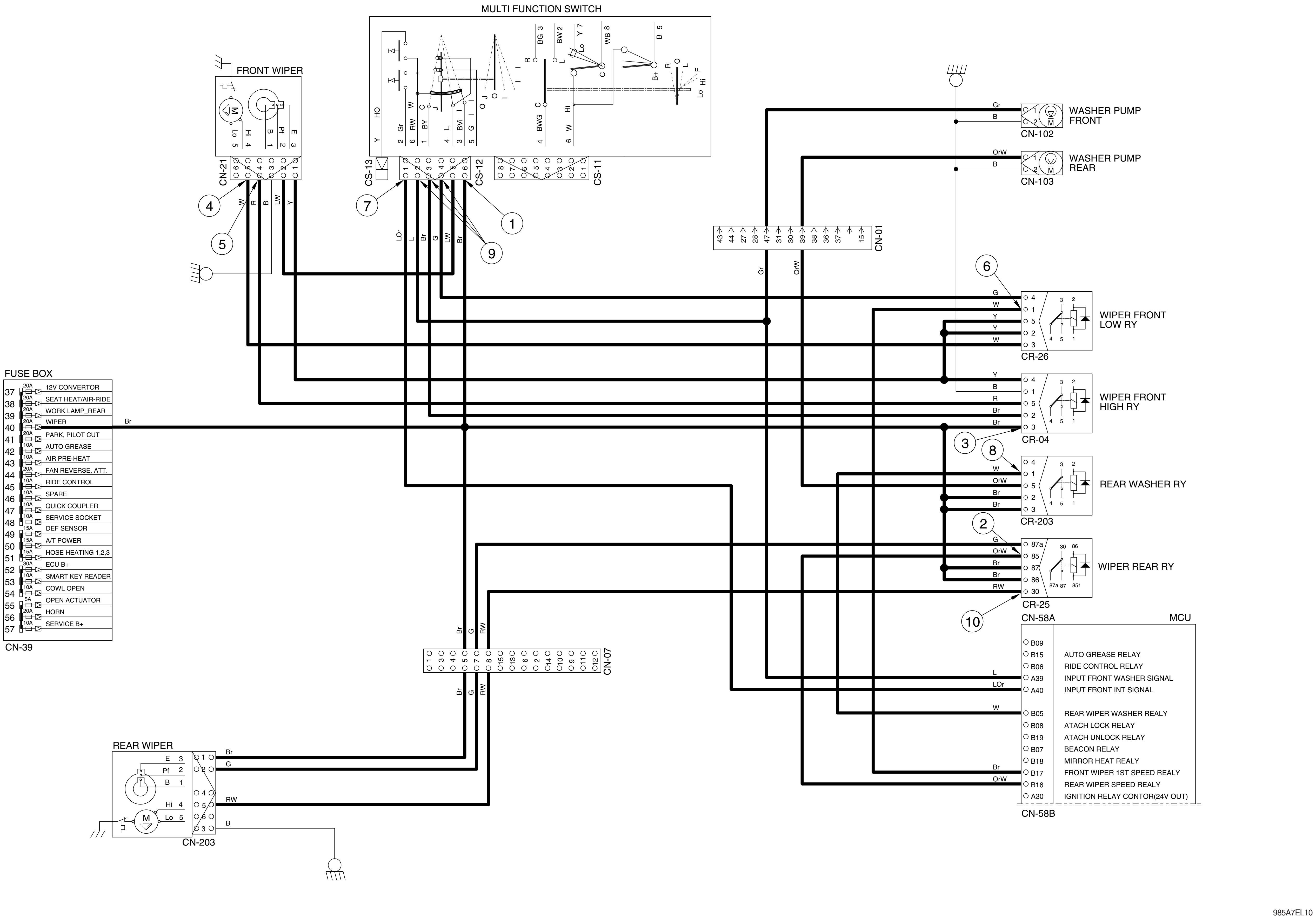
2) CHECK POINT

Condition	Check point	
Engine : Stop Key switch : ON Voltage : 20~25V	① - GND (front wiper switch power input)	⑥ - GND (wiper relay power input)
	② - GND (rear wiper relay power input)	⑦ - GND (front washer power output)
	③ - GND (wiper relay power input)	⑧ - GND (rear washer power output)
	④ - GND (front wiper motor Lo power input)	⑨ - GND (front wiper motor power output)
	⑤ - GND (front wiper motor High power input)	⑩ - GND (rear wiper motor power output)

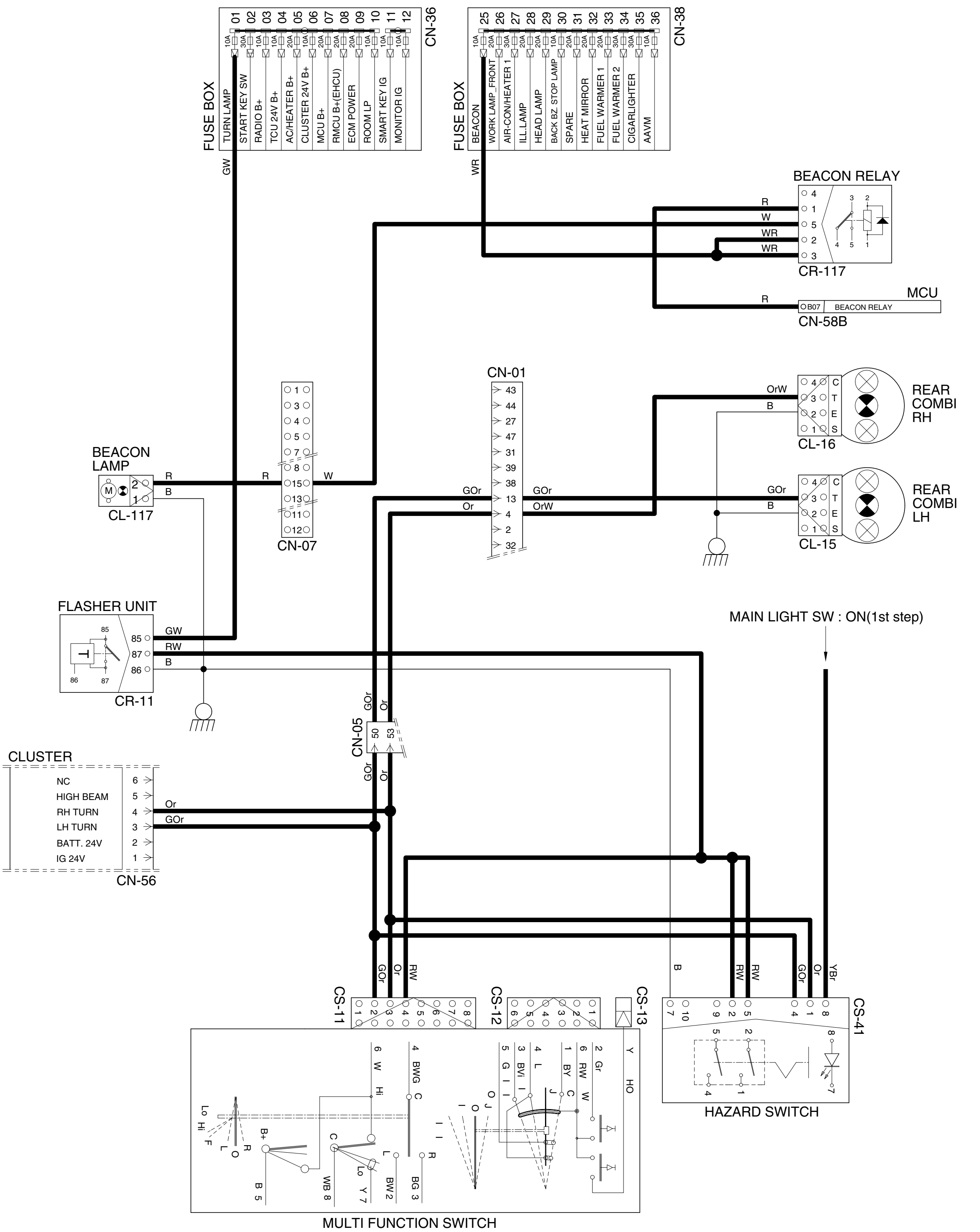
※ GND : Ground

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

WIPER AND WASHER CIRCUIT

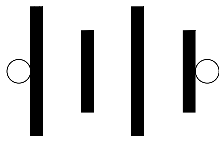
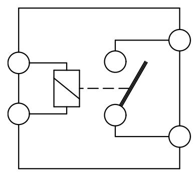
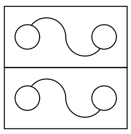
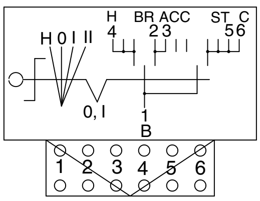
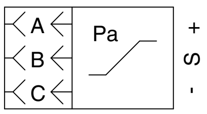
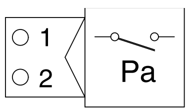


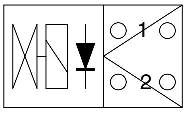
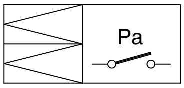
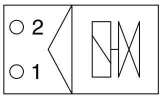
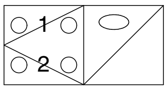
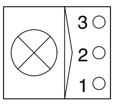
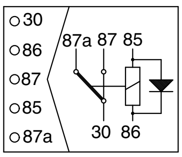
HAZARD, TURN AND ROTARY CIRCUIT

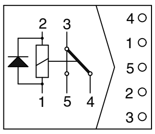
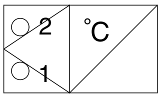
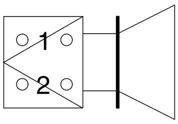
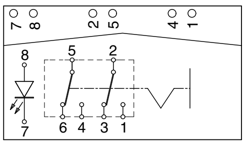
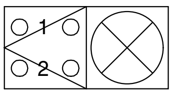
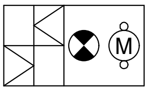


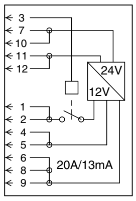
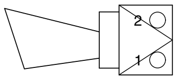
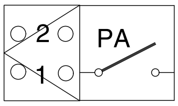
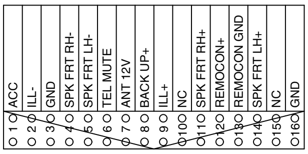
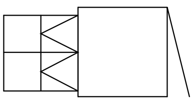
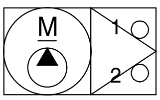
※ The circuit diagram may differ from the equipment, so please check before a repair.

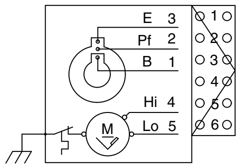
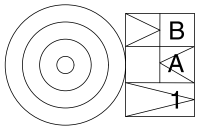
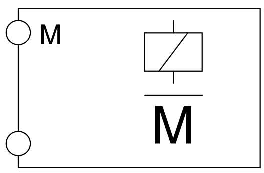
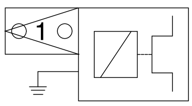
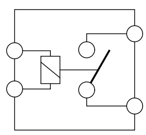
GROUP 3 ELECTRICAL COMPONENT SPECIFICATION

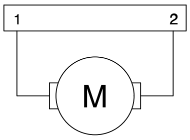
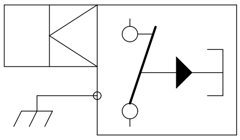
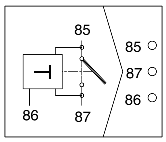
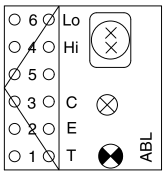
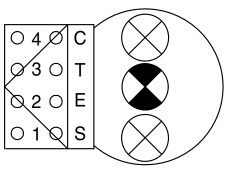
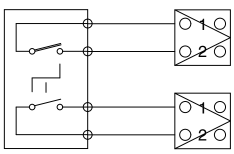
Part name	Symbol	Specifications	Check item
Battery		12V × 220Ah (2EA)	Gravity 1.280 over : over charged 1.280 ~ 1.250 : normal 1.250 below : discharged
Battery relay	 CR-1	Rated load : 24V 100A (continuity) 1000A (30seconds)	Coil resistance breaked : approx 50Ω connected : ∞ Ω
Fusible link	 CN-351 (40A), CN-352 (80A)	24V	Resistance between ring terminal and each connector pin 0Ω : normal
Start key	 CS-2	B-BR : 24V 1A B-ACC : 24V 10A B-ST : 20V 40A	Resistance between each pin Key off : ∞ Ω (for each pin) Key on : 0Ω (for pin 1-2 & 1-3) Start : 0Ω (for pin 1-5)
Pressure switch	 CD-3 CD-26 CD-31 CD-39 CD-40 CD-58 CD-79 CD-80 CD-81	N.C Type	Resistance 0Ω : normal (close)
Pressure switch	 CD-48 CD-129	N.O Type	Resistance ∞ Ω : normal (open)

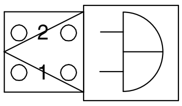
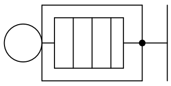
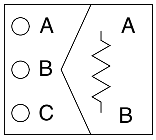
Part name	Symbol	Specifications	Check item
Pilot cut off, parking brake, diff lock, attach lock, unlock solenoid	 CN-68 CN-177 CN-71 CN-178 CN-79	24V 1A	Resistance normal : 15~25Ω
Air cleaner pressure switch	 CD-10	Max load : 6W N.O Type	Resistance ∞Ω : normal (open)
Lock-up, Ride control valve / Fan sole- noid	 CN-43 CN-136 CN-154 CN-155	24V 1.2A	※ Check LED lamp ※ Check resistance about 24Ω
Fuel sender	 CD-2	-	Resistance at fuel levels full level : 200Ω 9/12 level : 500Ω 6/12 level : 800Ω 3/12 level : 1100Ω empty : 1300Ω
Room lamp	 CL-1	24V 10W	Resistance normal : 1.2Ω
Relay (5pin)	 CR-3 CR-5 CR-7 CR-30 CR-35 CR-36 CR-38 CR-40 CR-46 CR-55 CR-56 CR-63 CR-210 CR-211 CR-381	24V 20A	Resistance normal : about 160Ω (for pin 85~86) 0Ω (for pin 30~87) ∞Ω (for pin 30~87)

Part name	Symbol	Specifications	Check item
Relay (5 pin)	 CR-2 CR-4 CR-25 CR-26 CR-37 CR-58 CR-79 CR-115 CR-117 CR-136 CR-302 CR-303	24V 20A	Resistance normal : about 160Ω (for pin 1~2) 0Ω (for pin 3~4) ∞Ω (for pin 3~5)
Hydraulic, transmission temperature	 CD-1 CD-49	–	Resistance normal : ∞Ω 105。C over : 0Ω
Speaker	 CN-123 (LH) CN-124 (RH)	4Ω 20W	Resistance normal : 4Ω
Switch (Locking type)	 CS-4 CS-17 CS-75	24V 8A	Resistance at switch off position ∞Ω between pin 1-5 and 2-6 0Ω between pin 5-7 and 6-8
Work lamp, Number plate lamp	 CL-21 CL-32 CL-33 CL-35 CL-36 CL-42 CL-43 CL-45 CL-46	Work lamp 24V 70W Number plate lamp 24V 10W	Resistance normal : 1.2Ω
Beacon lamp	 CL-117	24V 70W (H1 TYPE)	Resistance normal : 1.1Ω

Part name	Symbol	Specifications	Check item
DC/DC Converter	 CN-138	12V 3A	Resistance 8.8Ω (for pin A-B) 7.7Ω (for pin B-C)
Horn	 CN-120 CN-121	24V 2A	Operation by external power source - conncet 24V power to (+) terminal - ground the (-) terminal
Receiver dryer	 CN-29	24V 2.5A	Resistance 0Ω : 2.1±0.3~27±2kgf/cm² ∞Ω : ~2.1±0.3, 27±2~kgf/cm²
Radio & USB player	 CN-27	24V 20W+20W	Resistance Power ON : 4Ω+4Ω (for pin 1-6, 4-8)
Back up buzzer	 CN-65	24V 0.5A 110dB	Resistance normal : 5.2Ω
Washer pump	 CN-102 (FR) CN-103 (RR)	24V 2.5A	Resistance normal : 26.4 Ω (for pin1-2)

Part name	Symbol	Specifications	Check item
Wiper motor	 CN-21 (FR) CN-102 (RR)	24V 1.5A 2-speed Auto parking	-
Cigar lighter	 CL-2	24V 5A 1.4W	Coil resistance normal : about 1MΩ
Starter	 CN-45	24V-7.5kW	Operating or not
Aircon compressor	 CR-23	24V 79W	Resistance normal : 13.4Ω
Start relay	 CN-28	24V 300A	Coil resistance normal : 1-2Ω Switch connection ∞Ω at normal open position 0Ω when engaged

Part name	Symbol	Specifications	Check item
Blower motor		24V 9.5A	Resistance at each switch position normal : 0.5-2Ω
Door switch	 CS-1 CS-55	24V 2W	Resistance normal : about 5MΩ
Flasher unit	 CR-11	24V 85 ~ 190 C/M 50dB	-
Head lamp	 CL-3 CL-4	24V 75W/70W (H4 TYPE) 24V 4W (T4W)	Resistance normal : a fewΩ
Combi lamp (rear)	 CL-15 CL-16	24V 5W (R5W) 2×24V 21W (P21W)	-
Master switch	 CS-74 CS-75	Continuous capacity : 180Amp Push in capacity : 1000Amp	-

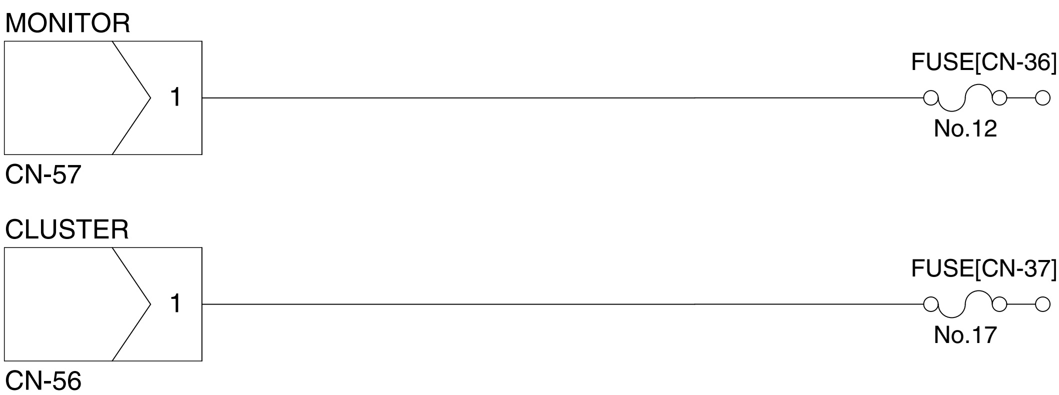
Part name	Symbol	Specifications	Check item
Warning buzzer	 CN-26	24V 200mA 90 ± 5dB (ℓ m)	-
Preheater	 CN-80	24V 200A	Resistance 0.25~0.12Ω
Resistor	 CN-99	4W	Resistance A - B : 120Ω

1. WHEN STARTING SWITCH IS TURNED ON, CLUSTER AND MONITOR LAMP DOES NOT LIGHT UP

· Before carrying out below procedure, check all the related connectors are properly inserted and the fuse No.12, 17 are not blown out and ON/OFF of bulb.

· After checking, connect the disconnected connectors again immediately unless otherwise specified.

Check	Result	Cause	Remedy
Check voltage between CN-56 (1), CN-57(1) and chassis	YES	Defective cluster Defective monitor	Replace Replace
	NO	Disconnection in wiring harness or poor contact between CN-56 (1), CN-57 (1) and fuse No. 12, 17	Repair or replace (after clean)



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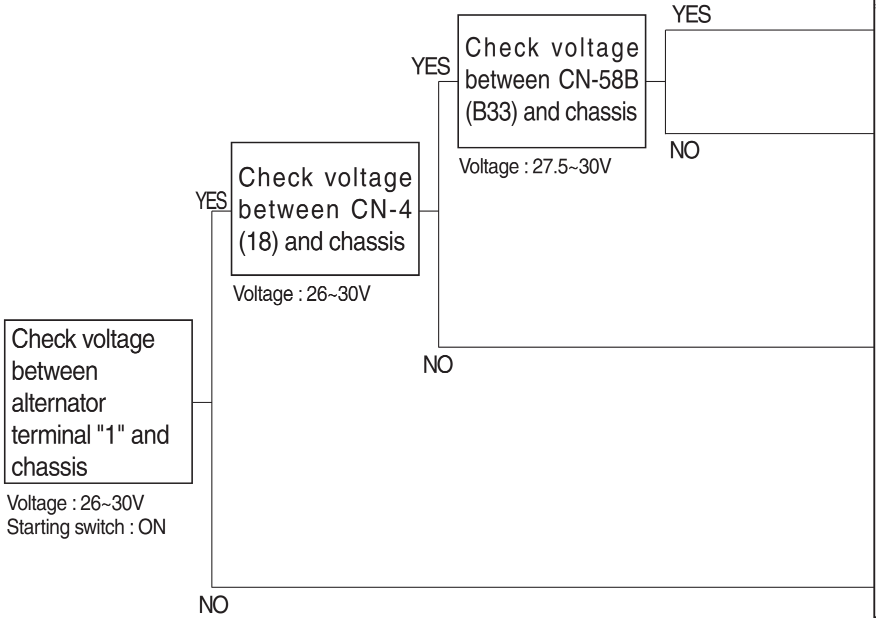
Check voltage

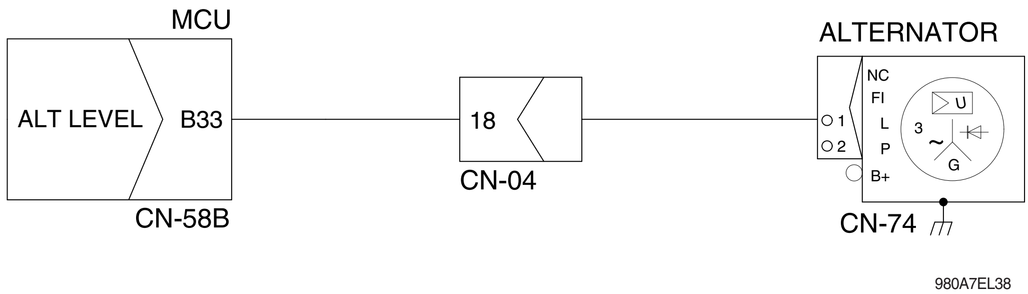
YES	20 ~ 30 V
NO	0 V

2. WHEN BATTERY LAMP LIGHTS UP (engine is started)

· Before carrying out below procedure, check all the related connectors are properly inserted.
· After checking, connect the disconnected connectors again immediately unless otherwise specified.



Cause	Remedy
Defective controller	Replace
Disconnection in wiring harness or poor contact between CN-58B (B33) and CN-4 (18)	Repair or replace (after clean)
Disconnection in wiring harness or poor contact between CN-14 (18) and alternator terminal " 1 "	Repair or replace (after clean)
Defective alternator	Replace



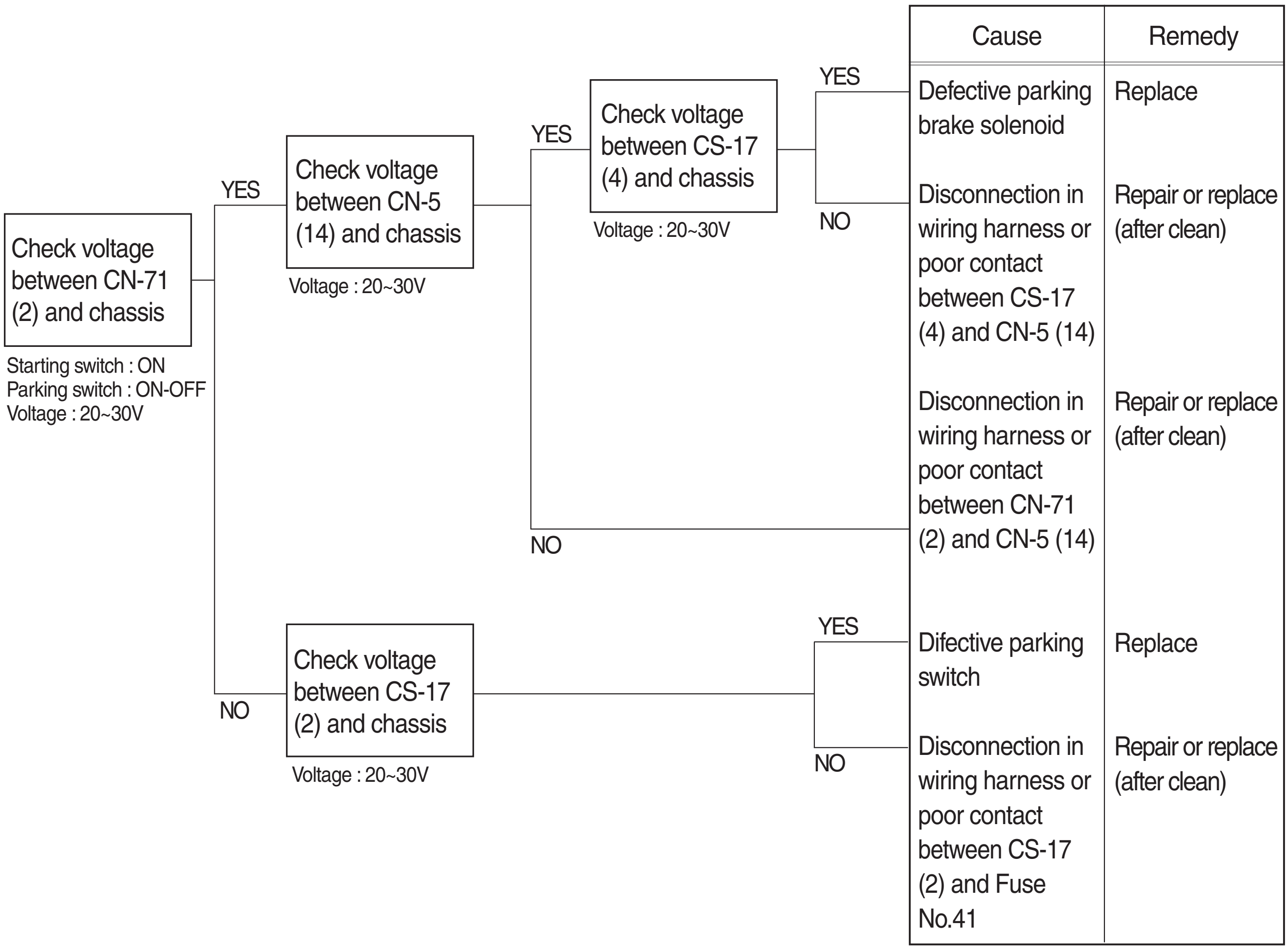
Check valtage

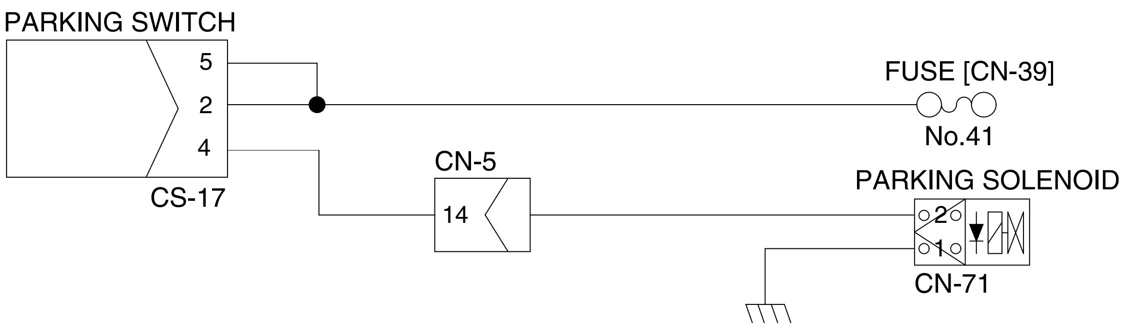
YES	20 ~ 30 V
NO	0 V

3. WHEN PARKING SOLENOID DOES NOT WORK

· Before carrying out below procedure, check all the related connectors are properly inserted and the fuse No.41 is not blown out.

· After checking, connect the disconnected connectors again immediately unless otherwise specified.



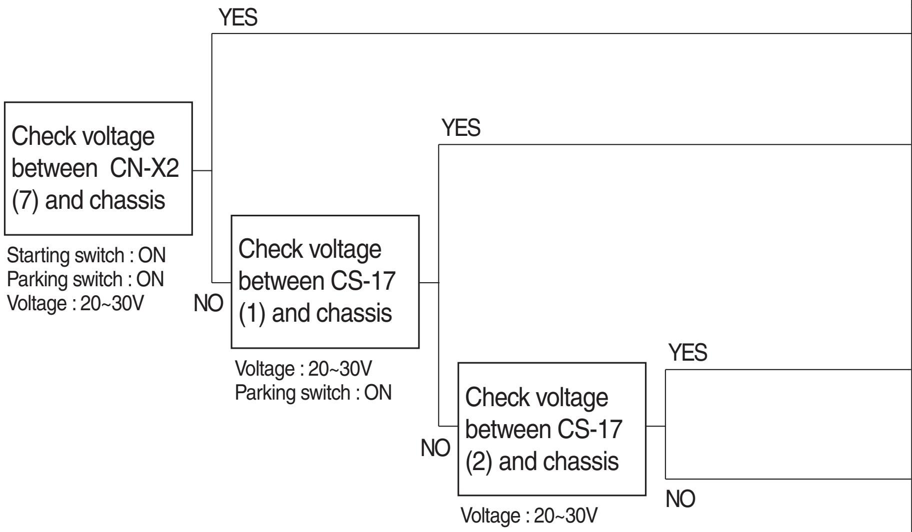


960A7EL39

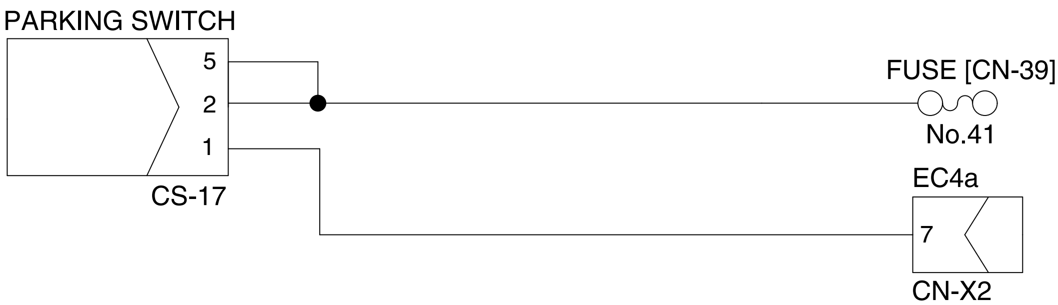
4. TRANSMISSION IS NOT RETURNED TO NEUTRAL WHEN PARKING BRAKE IS APPLIED

· Before carrying out below procedure, check all the related connectors are properly inserted and the fuse No.15 (transmission control unit) and No.41 are not blown out.

· After checking, connect the disconnected connectors again immediately unless otherwise specified.



Cause	Remedy
Defective T/M control unit	Replace
Disconnection in wiring harness or poor contact between CN-X2 (7) and CS-17(1)	Repair or replace (after clean)
Defective switch	Replace
Disconnection in wiring harness or poor contact between CS-17 (2) and fuse No.41	Repair or replace (after clean)



Check resistance

YES	MAX 1Ω
NO	MIN 1MΩ

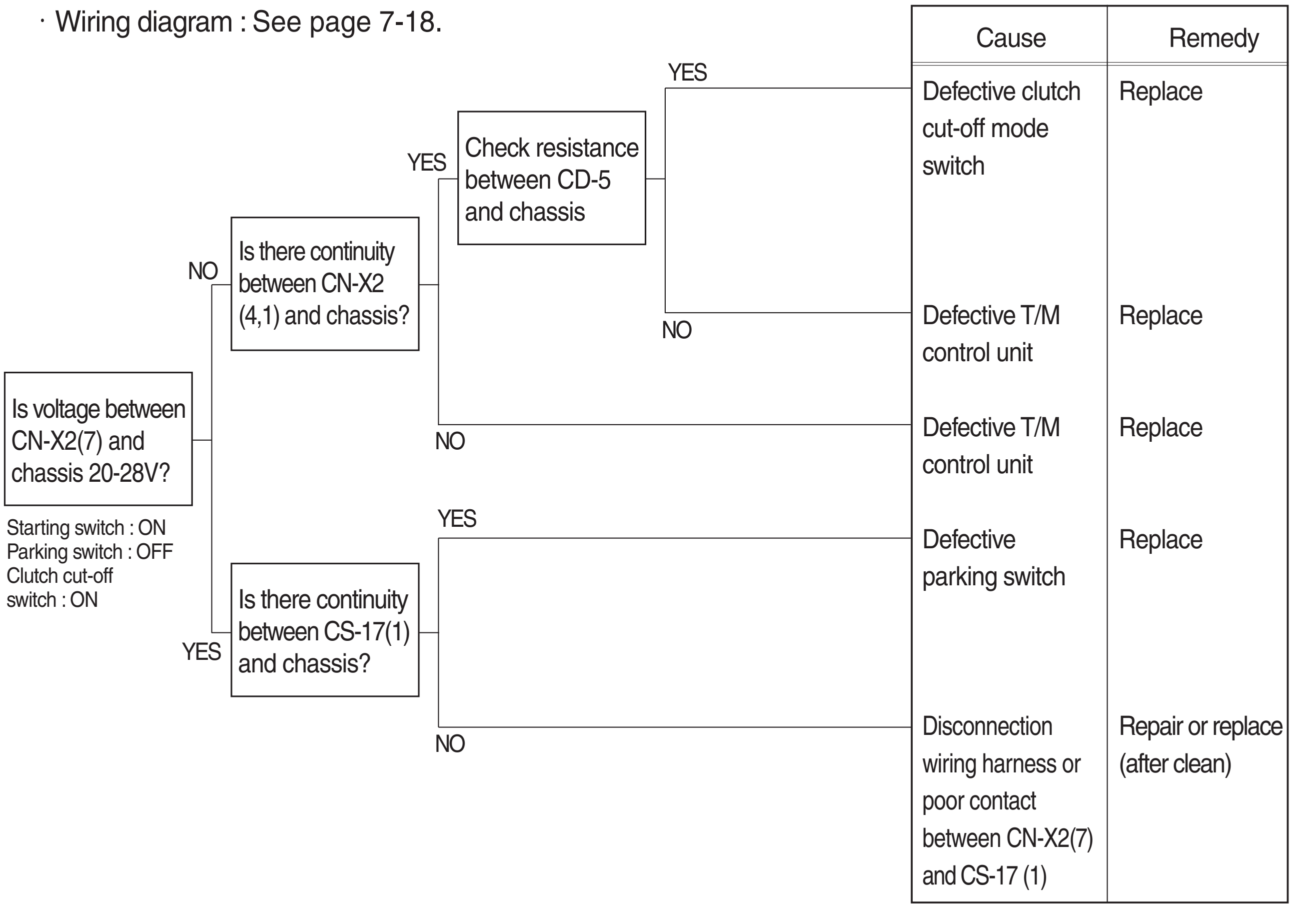
985A7EL40

5. MACHINE DOES NOT TRAVEL

· Before carrying out below procedure, check all the related connectors are properly inserted and the fuse No.15 (transmission control unit) is not blown out.

· After checking, connect the disconnected connectors again immediately unless otherwise specified.

· Wiring diagram : See page 7-18.



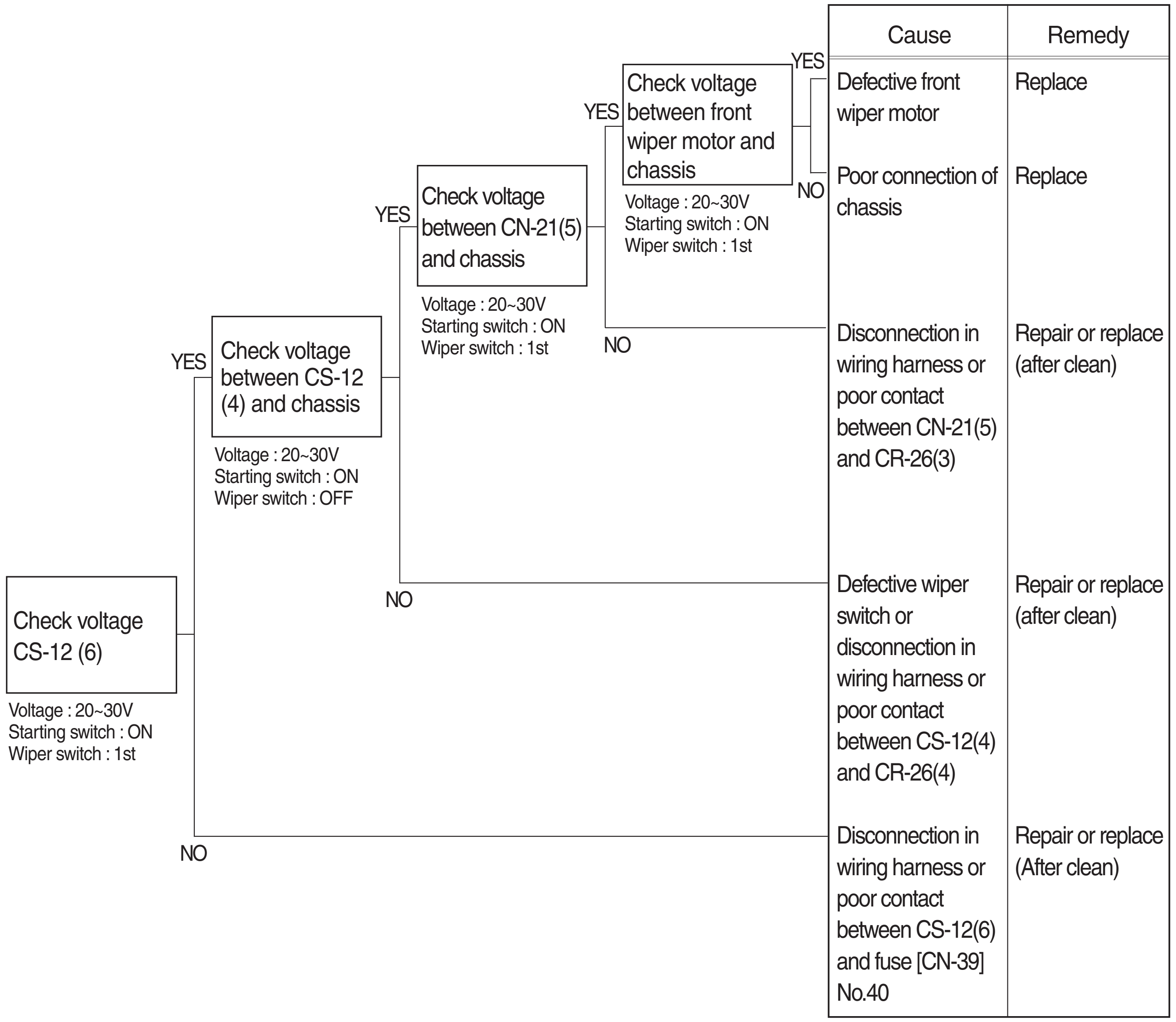
Check resistance

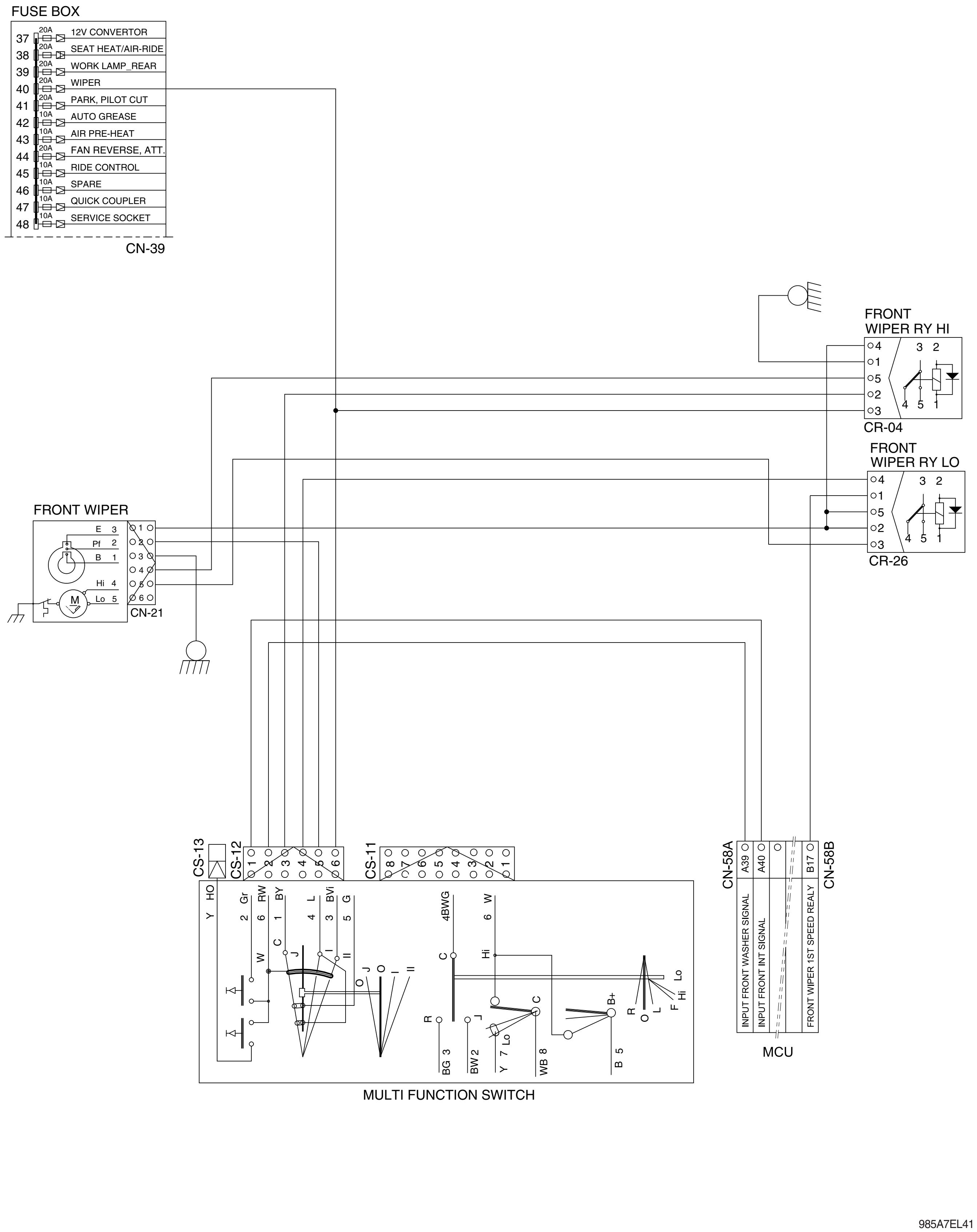
YES	MAX 1Ω
NO	MIN 1MΩ

6. WHEN STARTING SWITCH IS TURNED ON, WIPER MOTOR DOES NOT OPERATE

· Before carrying out below procedure, check all the related connectors are properly inserted and the fuse No.40 is not blown out.

· After checking, connect the disconnected connectors again immediately unless otherwise specified.





7. WHEN STARTING SWITCH "ON" DOES NOT OPERATE

· Before carrying out below procedure, check all the related connectors are properly inserted the fuse No.2 is not blown out.

· After checking, connect the disconnected connectors again immediately unless otherwise specified.

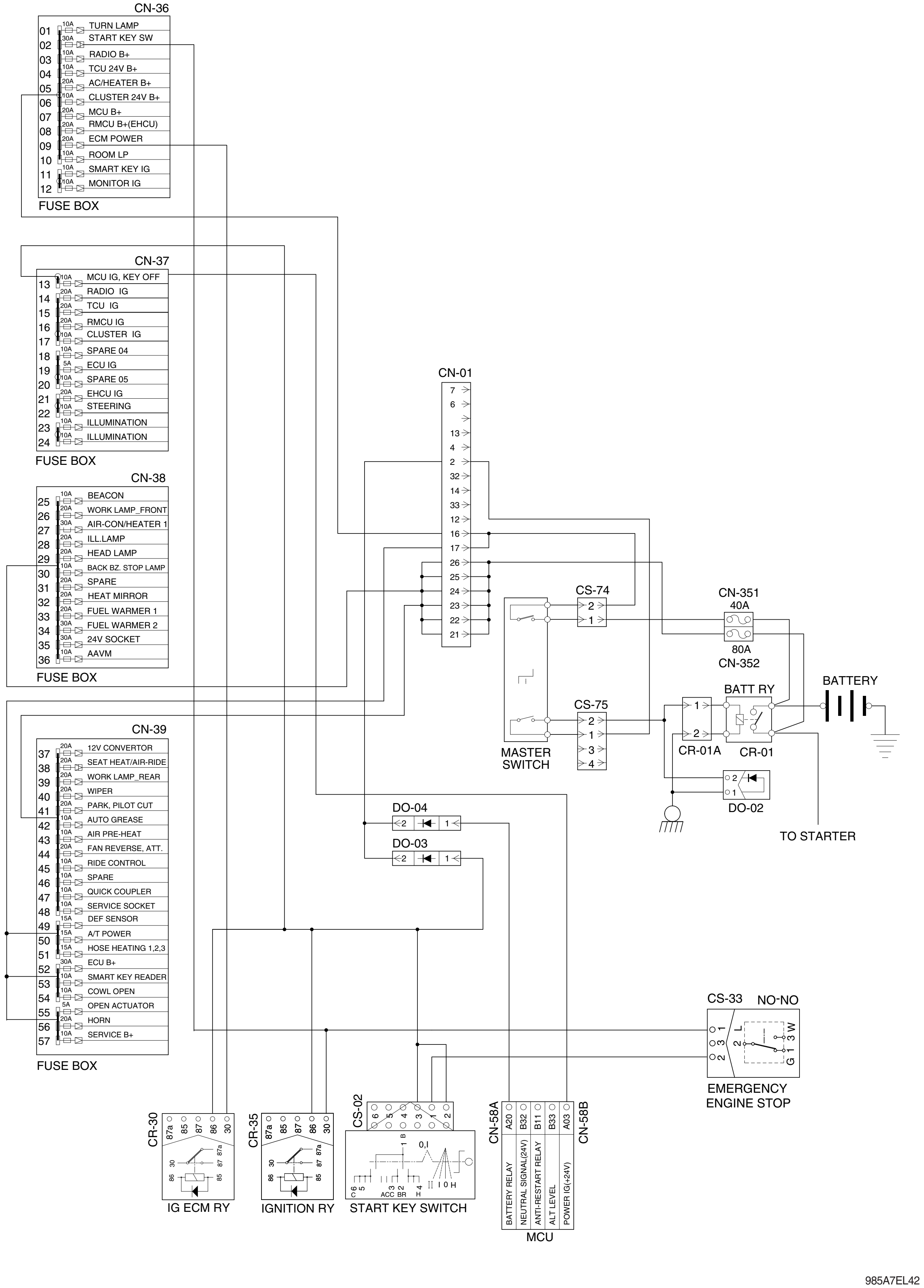
Check voltage and specific gravity of battery
Specific gravity : MIN 1.28
Voltage : MIN 24V

YES → Check voltage between CS-2 (1)[and CS-2(2)] and chassis
Voltage : 20~30V

YES → Check voltage between CR-1 and chassis
Voltage : 20~30V

YES → Check voltage between CN-351 and chassis
Voltage : 20~30V

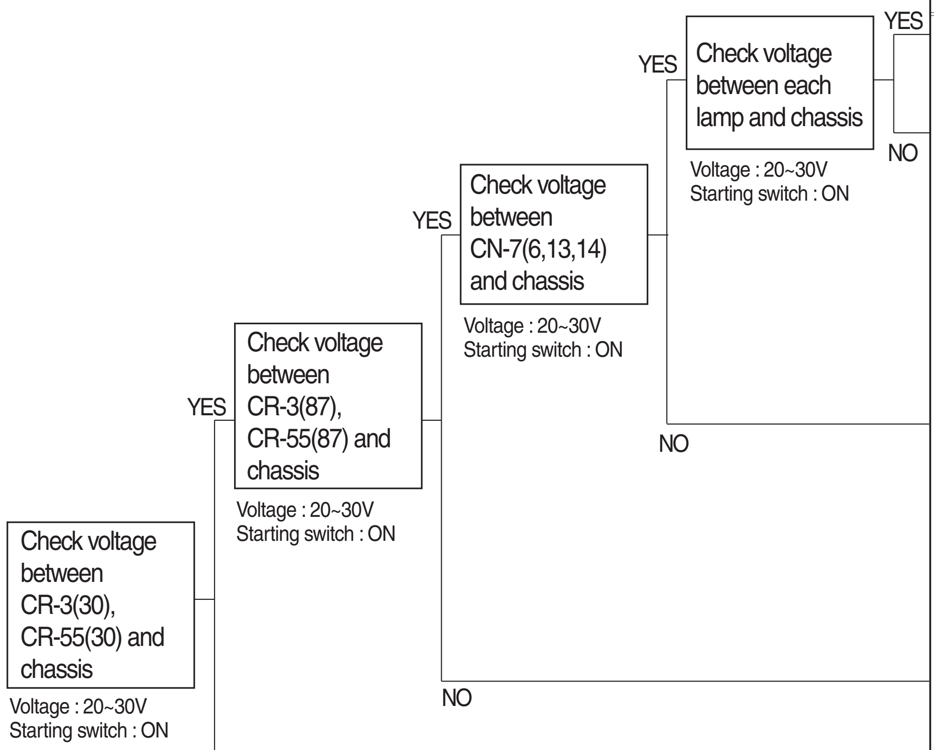
Cause	Remedy
YES: Defective cable assembly	Repair or replace (after clean)
NO: Short circuit or defect of fusible link or defective battery relay	Replace
NO: Disconnection in wiring harness or poor contact between CS-2 (2) - CN-1(2)- CS-75-CR-1.	Repair or replace (after clean)
NO: Disconnection in wiring harness or poor contact between fuse No. 2 and CS-2 (1) or defect of start switch	Repair or replace (after clean)
NO: Battery capacity too low	Repair or replace (after clean)



8. WHEN STARTING SWITCH IS TURNED ON, WORK LAMP DOES NOT LIGHTS UP

· Before carrying out below procedure, check all the related connectors are properly inserted, and the fuse No.26, 39 is not blown out.

· After checking, connect the disconnected connectors again immediately unless otherwise specified.



Cause	Remedy
Defective lamp	Replace
Disconnection in wiring harness or poor contact between CL-32 (2), CL-33(2), CL-45 (2), CL-46 (2) and CN-7 (6,13)	Repair or replace (after clean)
Disconnection in wiring harness or poor contact between CN-7 (14) -CR-55 (87) and CN-7 (13) - CR-3 (87)	Repair or replace (after clean)
Defective work lamp relay	Replace relay
Disconnection in wiring harness or poor contact between CR-3 (87), CR-55 (87) and fuse No.26, 39	Repair or replace (after clean)
Short circuit of fuse	Replace