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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 Hyundai distributor for the latest information.

2. HOW TO READ THE SERVICE MANUAL

Distribution and updating

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

Filing method

1. See the page number on the bottom of the page.
   File the pages in correct order.
2. Following examples shows how to read the page number.
   Example 1
   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
50	1.969	2.008	2.047	2.087	2.126	2.165	2.205	2.244	2.283	2.323
60	2.362	2.402	2.441	2.480	2.520	2.559	2.598	2.638	2.677	2.717
70	2.756	2.795	2.835	2.874	2.913	2.953	2.992	3.032	3.071	3.110
80	3.150	3.189	3.228	3.268	3.307	3.346	3.386	3.425	3.465	3.504
90	3.543	3.583	3.622	3.661	3.701	3.740	3.780	3.819	3.858	3.898

Kilogram to Pound

1kg = 2.2046lb

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

Liter to U.S. Gallon

1 ℓ = 0.2642 U.S.Gal

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

Liter to U.K. Gallon

1 ℓ = 0.21997 U.K.Gal

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

kgf · m to lbf · ft

1kgf · m = 7.233lbf · ft

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

kgf/cm² to lbf/in²

1kgf / cm² = 14.2233lbf / in²

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

TEMPERATURE

Fahrenheit-Centigrade Conversion.

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

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

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

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

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

SECTION 1 GENERAL

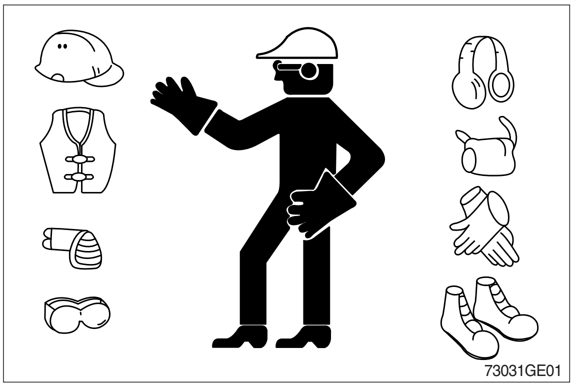
GROUP 1 SAFETY HINTS

FOLLOW SAFE PROCEDURE

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

WEAR PROTECTIVE CLOTHING

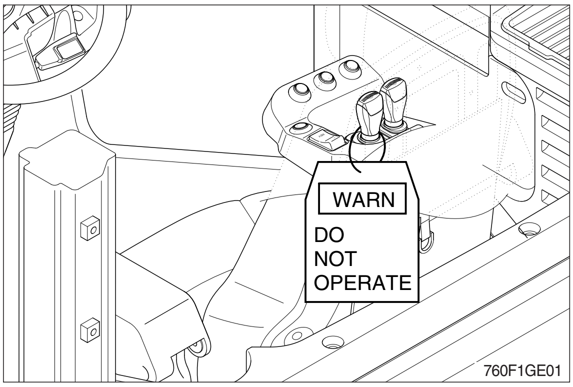
Wear close fitting clothing and safety equipment appropriate to the job.



73031GE01

WARN OTHERS OF SERVICE WORK

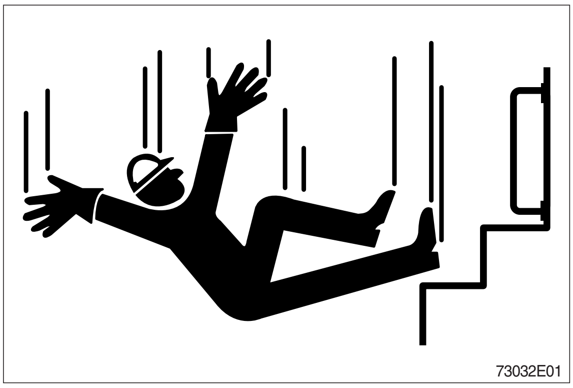
Unexpected machine movement can cause serious injury.
Before performing any work on the wheel loader, attach a 「**Do Not Operate**」 tag on the right side controller lever.



760F1GE01

USE HANDHOLDS AND STEPS

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.



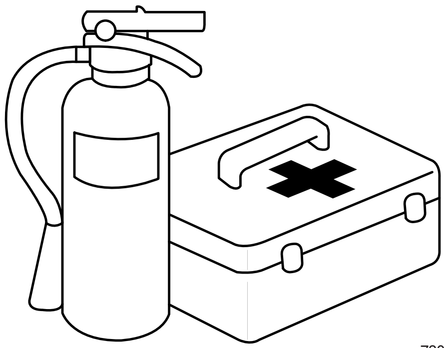
73032E01

PREPARE FOR EMERGENCIES

Be prepared if a fire starts.

Keep a first aid kit and fire extinguisher handy.

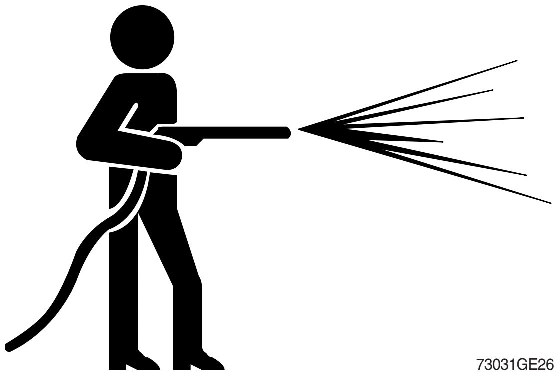
Keep emergency numbers for doctors, ambulance service, hospital, and fire department near your telephone.


73031GE03

WORK IN CLEAN AREA

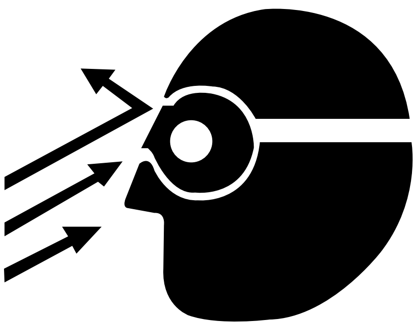
Before starting a job :

· 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.

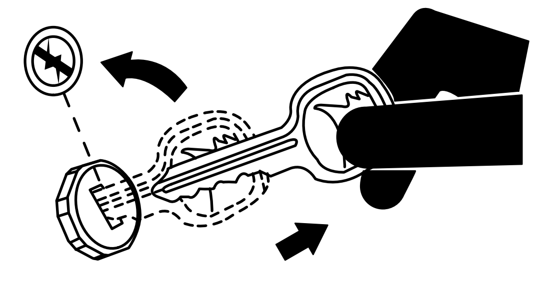
Wear a suitable hearing protective device such as earmuffs or earplugs to protect against objectionable or uncomfortable loud noises.


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.

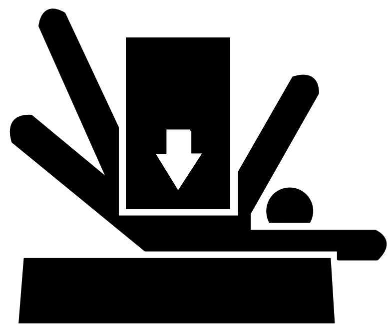


73031GE23

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

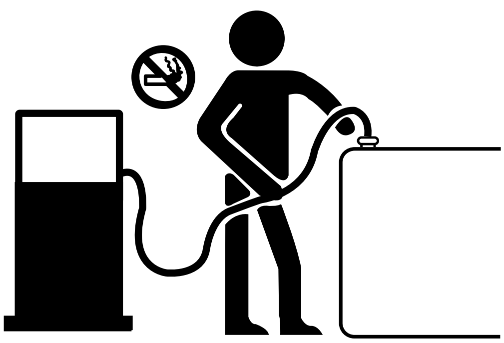
Explosive release of fluids from pressurized cooling system can cause serious burns.

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.

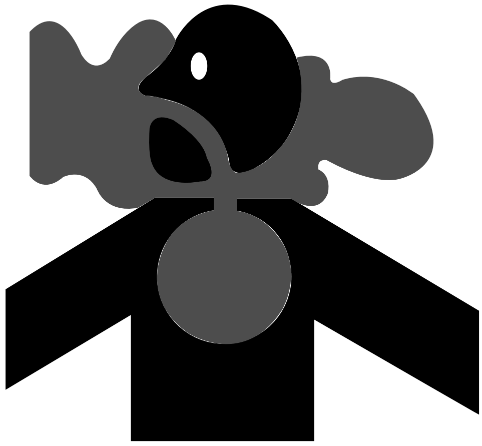
Do not store oily rags ; They can ignite and burn spontaneously.

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

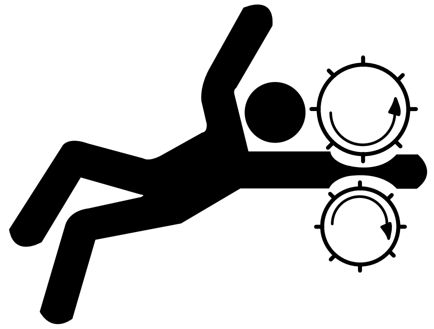
Illuminate your work area adequately but safely. Use a portable safety light for working inside or under the machine. Make sure the bulb is enclosed by a wire cage. The hot filament of an accidentally broken bulb can ignite spilled fuel or oil.

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.

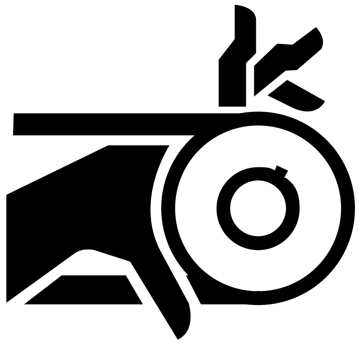


73031GE12

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

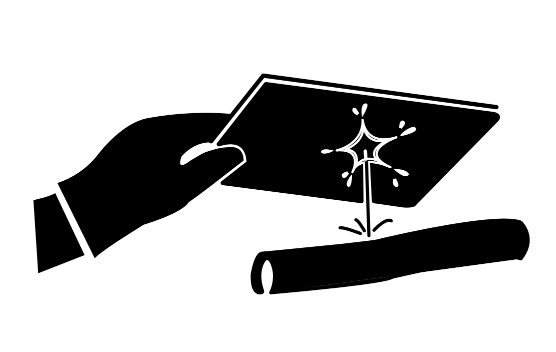
Escaping fluid under pressure can penetrate the skin causing serious injury.

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.

Avoid the hazard by:

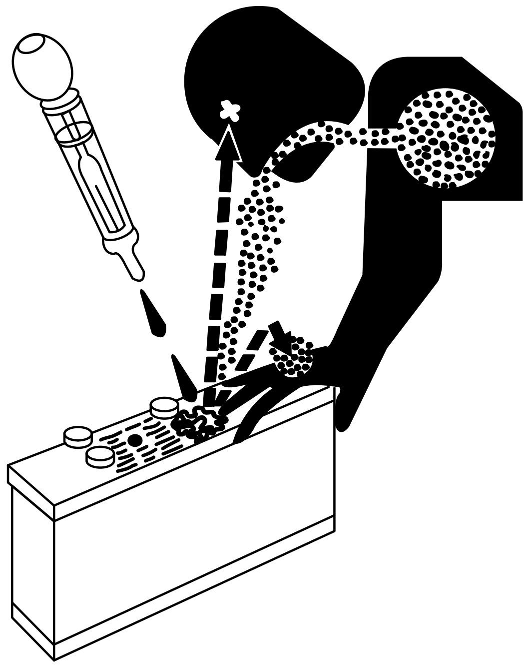
1. Filling batteries in a well-ventilated area.
2. Wearing eye protection and rubber gloves.
3. Avoiding breathing fumes when electrolyte is added.
4. Avoiding spilling of dripping electrolyte.
5. Use proper jump start procedure.

If you spill acid on yourself:

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

If acid is swallowed:

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



73031GE18

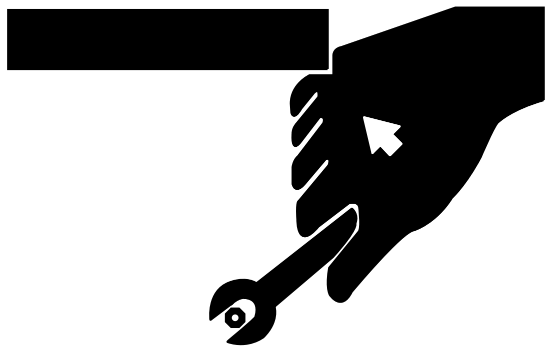
USE TOOLS PROPERLY

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

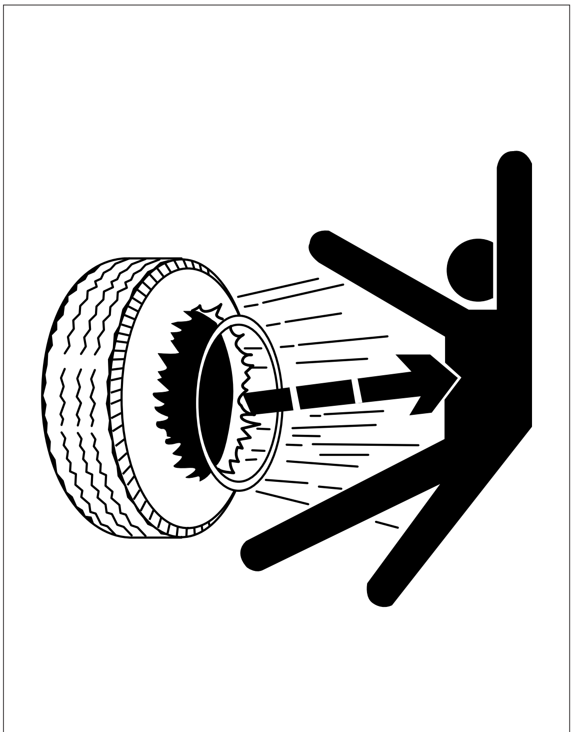
Explosive separation of a tire and rim parts can cause serious injury or death.

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.

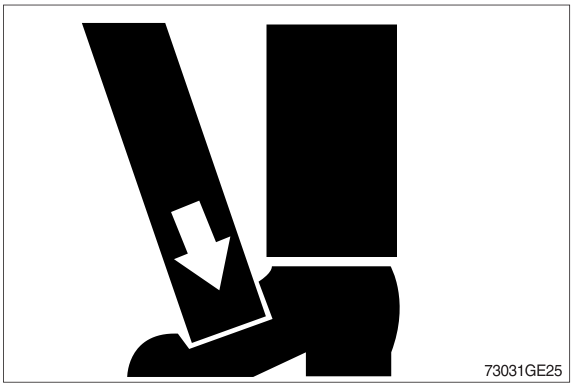
Check wheels for low pressure, cuts, bubbles, damaged rims or missing lug bolts and nuts.


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.

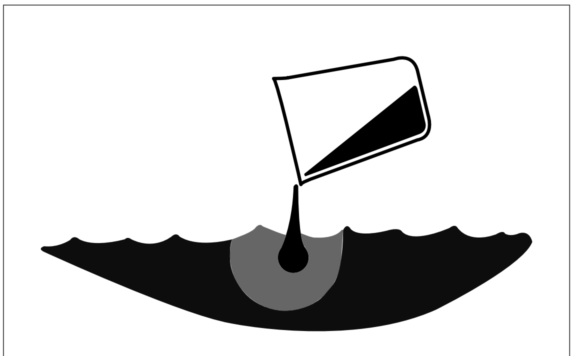

73031GE25

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.

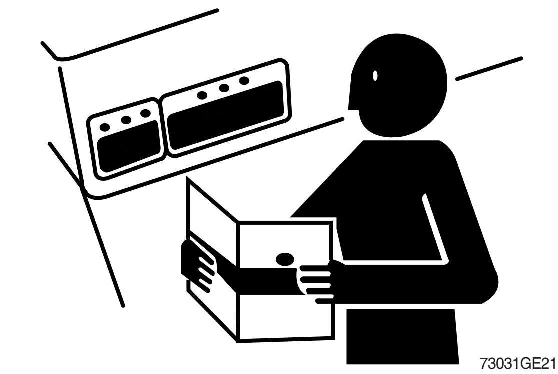
Use proper containers when draining fluids. Do not use food or beverage containers that may mislead someone into drinking from them.

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

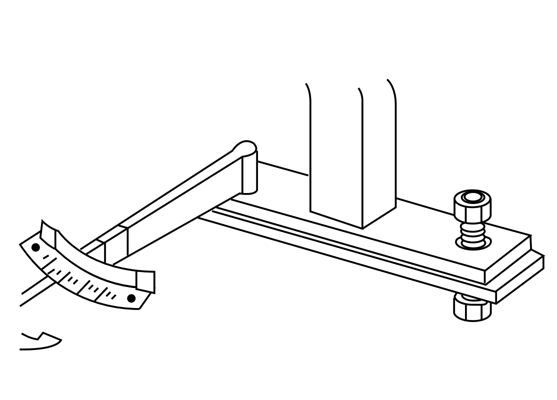
LIVE WITH SAFETY

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.

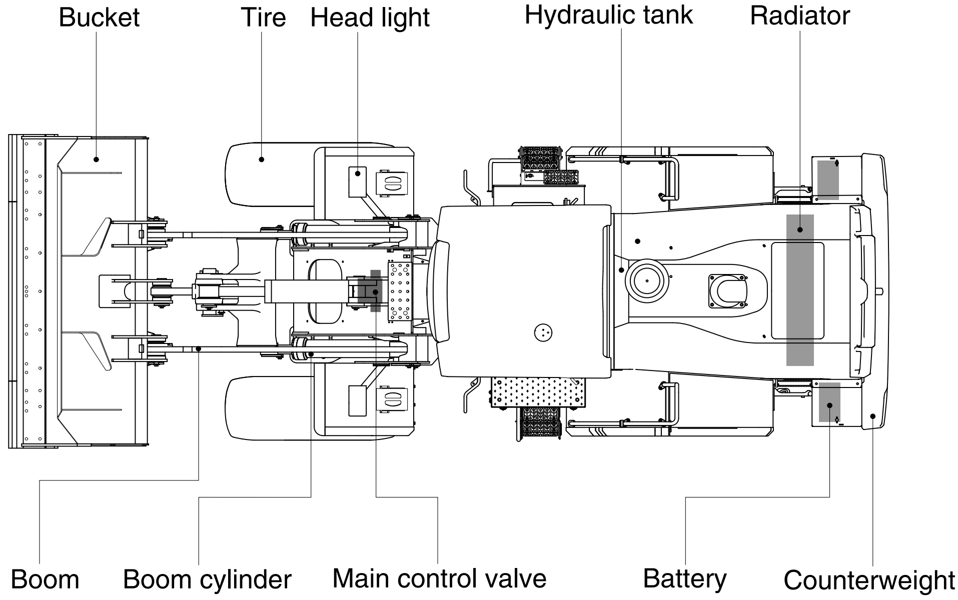
The protection offered by ROPS will be impaired if ROPS is subjected to structural damage, is involved in an overturn incident, or is in any way altered by welding, bending, drilling, or cutting.
A damaged ROPS should be replaced, not reused.

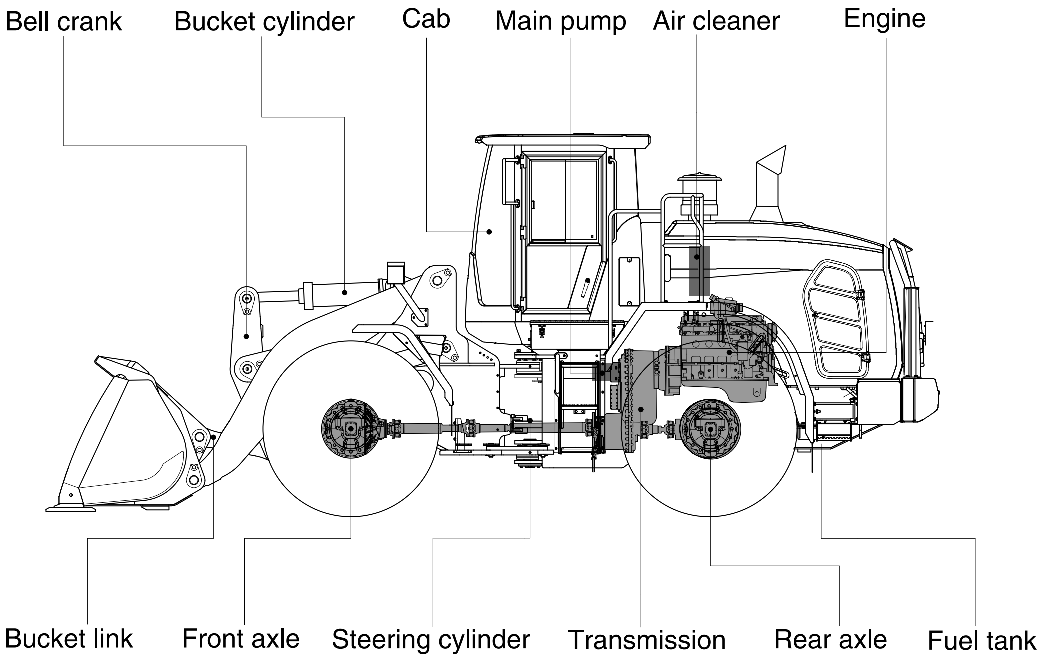


73031GE22

GROUP 2 SPECIFICATIONS

1. MAJOR COMPONENT

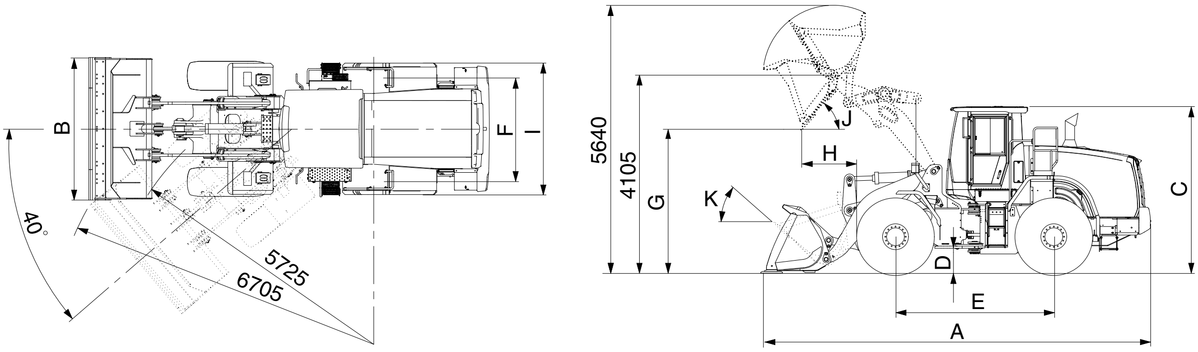




960A2SE01

2. SPECIFICATIONS

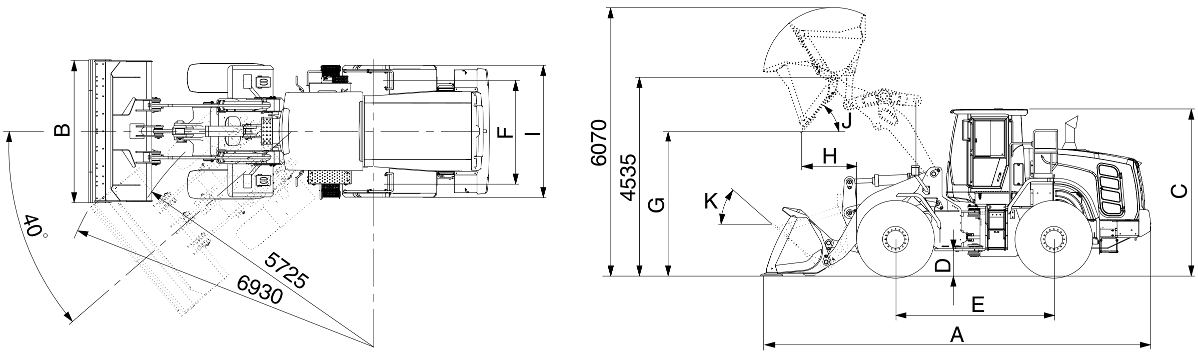
1) WITH BOLT-ON CUTTING EDGE TYPE BUCKET (HL960 T3)



960A2SE03

Description			Unit	Specification
Operating weight			kg (lb)	18900 (41670)
Bucket capacity		Struck	m^3 (yd^3)	2.9 (3.8)
		Heaped		3.3 (4.3)
Overall length		A	mm (ft-in)	8140 (26' 8")
Overall width		B		2900 (9' 6")
Overall height		C		3450 (11' 4")
Ground clearance		D		410 (1' 4")
Wheelbase		E		3300 (10' 10")
Tread		F		2160 (7' 1")
Dump clearance at 45˚		G		2935 (9' 8")
Dump reach (full lift)		H		1285 (4' 2")
Width over tires		I		2770 (9' 1")
Dump angle		J	degree (˚)	50
Rollback angle (carry position)		K		47
Cycle time		Lift (with load)	sec	5.8
		Dump (with load)		2.0
		Lower (empty)		3.7
Maximum travel speed			km/hr (mph)	37.9 (23.5)
Minimum turning radius (center of outside tire)				5.72 (18' 9")
Gradeability			degree (˚)	30
Breakout force			kg (lb)	16670 (36750)
Travel speed	Forward	First gear	km/hr (mph)	6.2 (3.9)
		Second gear		11.7 (7.3)
		Third gear		23.5 (14.6)
		Fourth gear		37.9 (23.5)
	Reverse	First gear		6.5 (4.0)
		Second gear		12.3 (7.6)
		Third gear		24.8 (15.4)

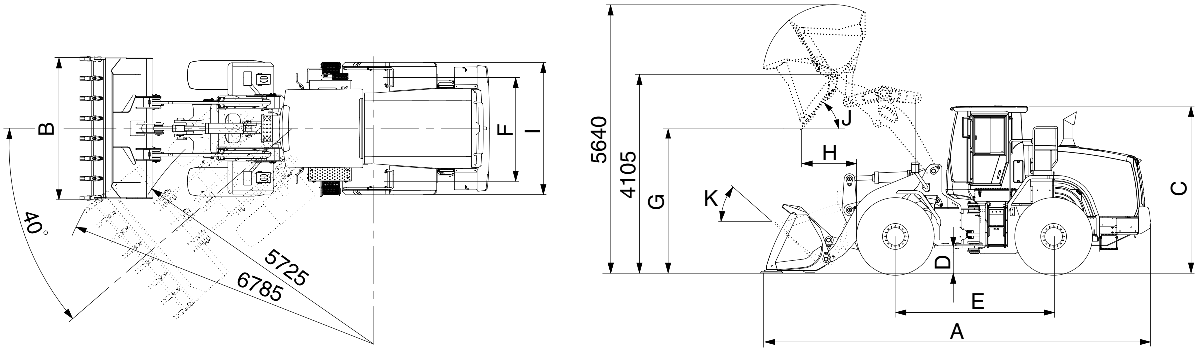
WITH BOLT-ON CUTTING EDGE TYPE BUCKET (HL960XT T3)



960A2SE03-1

Description			Unit	Specification
Operating weight			kg (lb)	19730 (43500)
Bucket capacity		Struck	m^3 (yd^3)	2.9 (3.8)
		Heaped		3.3 (4.3)
Overall length		A	mm (ft-in)	8695 (28' 6")
Overall width		B		2900 (9' 6")
Overall height		C		3450 (11' 4")
Ground clearance		D		410 (1' 4")
Wheelbase		E		3300 (10' 10")
Tread		F		2160 (7' 1")
Dump clearance at 45˚		G		3365 (11' 0")
Dump reach (full lift)		H		1380 (4' 6")
Width over tires		I		2770 (9' 1")
Dump angle		J	degree (˚)	50
Rollback angle (carry position)		K		47
Cycle time		Lift (with load)	sec	5.8
		Dump (with load)		2.0
		Lower (empty)		3.7
Maximum travel speed			km/hr (mph)	37.9 (23.5)
Minimum turning radius (center of outside tire)				5.72 (18' 9")
Gradeability			degree (˚)	30
Breakout force			kg (lb)	16430 (36220)
Travel speed	Forward	First gear	km/hr (mph)	6.2 (3.9)
		Second gear		11.7 (7.3)
		Third gear		23.5 (14.6)
		Fourth gear		37.9 (23.5)
	Reverse	First gear		6.5 (4.0)
		Second gear		12.3 (7.6)
		Third gear		24.8 (15.4)

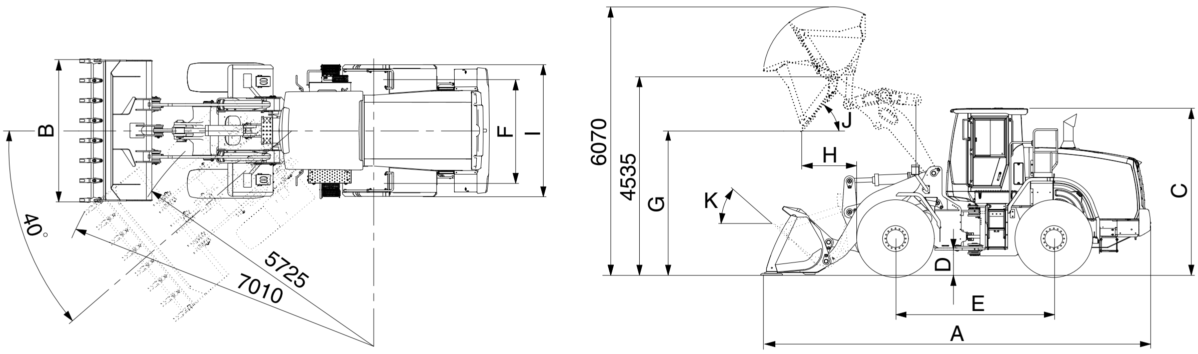
2) WITH TOOTH TYPE BUCKET (HL960 T3)



960A2SE02

Description			Unit	Specification
Operating weight			kg (lb)	18825 (41505)
Bucket capacity		Struck	m^3 (yd^3)	2.8 (3.6)
		Heaped		3.2 (4.2)
Overall length		A	mm (ft-in)	8290 (27' 2")
Overall width		B		2950 (9' 8")
Overall height		C		3450 (11' 4")
Ground clearance		D		410 (1' 4")
Wheelbase		E		3300 (10' 10")
Tread		F		2160 (7' 1")
Dump clearance at 45˚		G		2810 (9' 3")
Dump reach (full lift)		H		1370 (4' 6")
Width over tires		I		2770 (9' 1")
Dump angle		J	degree (˚)	50
Rollback angle (carry position)		K		47
Cycle time		Lift (with load)	sec	5.8
		Dump (with load)		2.0
		Lower (empty)		3.7
Maximum travel speed			km/hr (mph)	37.9 (23.5)
Minimum turning radius (center of outside tire)				5.72 (18' 9")
Gradeability			degree (˚)	30
Breakout force			kg (lb)	17705 (39030)
Travel speed	Forward	First gear	km/hr (mph)	6.2 (3.9)
		Second gear		11.7 (7.3)
		Third gear		23.5 (14.6)
		Fourth gear		37.9 (23.5)
	Reverse	First gear		6.5 (4.0)
		Second gear		12.3 (7.6)
		Third gear		24.8 (15.4)

WITH TOOTH TYPE BUCKET (HL960XT T3)



960A2SE02-1

Description			Unit	Specification
Operating weight			kg (lb)	19655 (43330)
Bucket capacity		Struck	m^3 (yd^3)	2.8 (3.6)
		Heaped		3.2 (4.2)
Overall length		A	mm (ft-in)	8845 (29' 0")
Overall width		B		2950 (9' 8")
Overall height		C		3450 (11' 4")
Ground clearance		D		410 (1' 4")
Wheelbase		E		3300 (10' 10")
Tread		F		2160 (7' 1")
Dump clearance at 45˚		G		3240 (10' 8")
Dump reach (full lift)		H		1465 (4' 9")
Width over tires		I		2770 (9' 1")
Dump angle		J	degree (˚)	50
Rollback angle (carry position)		K		47
Cycle time		Lift (with load)	sec	5.8
		Dump (with load)		2.0
		Lower (empty)		3.7
Maximum travel speed			km/hr (mph)	37.9 (23.5)
Minimum turning radius (center of outside tire)				5.72 (18' 9")
Gradeability			degree (˚)	30
Breakout force			kg (lb)	17465 (38500)
Travel speed	Forward	First gear	km/hr (mph)	6.2 (3.9)
		Second gear		11.7 (7.3)
		Third gear		23.5 (14.6)
		Fourth gear		37.9 (23.5)
	Reverse	First gear		6.5 (4.0)
		Second gear		12.3 (7.6)
		Third gear		24.8 (15.4)

3. WEIGHT

Item		kg	lb
Front frame assembly		1608	3550
Rear frame assembly		1928	4255
Front fender (LH & RH)		31	70
Rear fender (LH & RH)		53	120
Counterweight	HL960 T3	870	1920
	HL960XT T3	1500	3310
Cab assembly		818	1805
Engine assembly		552	1220
Transmission assembly (4-speed)		505	1115
Driveshaft (front)		28	65
Driveshaft (center)		22	50
Driveshaft (rear)		12	30
Front axle (include differential)		1020	2250
Rear axle (include differential)		1090	2405
Tire (23.5 R25, ★★, L3), 1EA		1076	2375
Hydraulic tank assembly		182	405
Fuel tank assembly		331	729
Main pump assembly		22	50
Steering pump assembly		35	80
Main control valve	2-spool/3-spool	90/104	200/230
Steering valve (priority valve)		6	15
Boom assembly	HL960 T3	1250	2760
	HL960XT T3	1420	3135
Bell crank assembly		360	795
Bucket link		65	145
3.3 m^3 bucket, with bolt on cutting edge		1825	4025
3.3 m^3 bucket, with bolt on cutting edge for Quick coupler		1740	3840
3.2 m^3 bucket, with 1-piece tooth		1750	3860
3.2 m^3 bucket, with 2-piece tooth		1750	3860
3.3 m^3 bucket, with 1-piece tooth and segment		1900	4190
Boom cylinder assembly (LH & RH)		148	330
Bucket cylinder assembly	HL960 T3	175	390
	HL960XT T3	190	420
Steering cylinder assembly (LH & RH)		30	70
Seat (including suspension and armrest)		72	160
Battery (1EA)		40	90
Under guard kit		52	115
Engine hood assembly		360	795
Mud guard assemblt (LH & RH)		52	115

4. SPECIFICATION FOR MAJOR COMPONENTS

1) ENGINE

Item	Specification
Model	HYUNDAI HE6.7
Type	4-cycle turbocharged, charge air cooled diesel engine
Control type	Electronic control
Cooling method	Water cooling
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	107×124 mm (4.2"×4.9")
Piston displacement	6700 cc (408 cu in)
Compression ratio	17.2 : 1
Gross power	215 hp (160 kW) at 2100 rpm
Net power	210 hp (157 kW) at 2100 rpm
Maximum power	217 hp (162 kW) at 1900 rpm
Peak gross torque	949 N · m (700 lbf · ft) at 1400 rpm
Engine oil quantity	18 ℓ (4.8 U.S. gal)
Wet weight	552 kg (1216 lb)
Starting motor	24V-4.8kW
Alternator	24V-70Amp
Battery	2×12V×150Ah

2) MAIN PUMP

Item	Specification
Type	Load sensing hydraulic system
Pump	Variable displacement piston pump
Rated oil quantity	245 ℓ/min (64.7 U.S.gpm)
System pressure	280 bar (4061 psi)

3) STEERING PUMP

Item	Specification
Type	Variable displacement piston pump
Rated oil quantity	159 ℓ/min (42 U.S.gpm)
System pressure	210 bar (3046 psi)

4) MAIN CONTROL VALVE

Item	Specification
Type	2 spool (bucket, boom), 3 spool (bucket, boom, aux)
Operating method	Hydraulic pilot assist
System pressure	280 kgf/cm^2 (3980 psi)
Overload relief valve pressure	340 kgf/cm^2 (4840 psi)

5) 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)

6) CYLINDER

Item		Specification
Boom cylinder	Bore dia × Rod dia × Stroke	Ø140 × Ø80 × 765 mm
Bucket cylinder (HL960 T3)	Bore dia × Rod dia × Stroke	Ø160 × Ø85 × 530 mm
Bucket cylinder (HL960XT T3)	Bore dia × Rod dia × Stroke	Ø160 × Ø85 × 530 mm
Steering cylinder	Bore dia × Rod dia × Stroke	Ø 80 × Ø45 × 424 mm

9) DYNAMIC POWER TRANSMISSION DEVICES

Item			Specification
4-speed transmission	Model		ZF 4WG 210
	Type	Converter	Single-stage, single-phase
		Transmission	Full-automatic power shift
	Gear shift		Forward fourth gear, reverse third gear
	Control		Electrical single lever type, kick-down system
	Travel speed		Forward 1/2/3/4 : 6.2 / 11.7 / 23.5 / 37.9 km/hr Reverse 1/2/3 : 6.5/12.3/24.8 km/hr
Axle	Drive devices		4-wheel drive
	Front		Front fixed location
	Rear		Oscillation ±12˚ of center pin-loaded
Wheels	Tires		23.5 R25, ★★, L3
Brakes	Travel		Four-wheel, wet-disc type, full hydraulic
	Parking		Spring applied, hydraulic released brake on transmission
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, 2EA)	M20×2.5	57.9 ± 8.7	419 ± 63
2		Engine mounting bolt (bracket, 8EA)	M12×1.75	11.7 ± 1.8	84.6 ± 13.0
3		Engine mounting bolt (T/C housing, 4EA)	M10×1.5	6.9 ± 1.4	50 ± 10.1
4		Engine mounting bolt (flywheel, 4EA)	M10×1.5	6.9 ± 1.4	50 ± 10.1
5		Fan motor mounting bolt	M12×1.75	12.8 ± 3.0	92.6 ± 21.7
6		Radiator mounting bolt	M16×2.0	29.7 ± 5.9	215 ± 42.7
7		Fuel tank mounting bolt, nut	M16×2.0	29.7 ± 4.5	215 ± 32.5
8	Hydraulic system	Main pump housing mounting bolt	M16×2.0	29.7 ± 4.5	215 ± 32.5
9		Fan & brake pump housing mounting bolt	M10×1.5	6.9 ± 1.4	50 ± 10.1
10		Main control valve mounting bolt	M12×1.75	12.8 ± 3.0	92.6 ± 21.7
11		Steering unit mounting bolt	M10×1.5	6.9 ± 1.4	50 ± 10.1
12		Steering valve (EHPS) mounting bolt	M8×1.25	2.5 ± 0.5	18.1 ± 3.6
13		Brake valve mounting bolt	M8×1.25	2.5 ± 0.5	18.1 ± 3.6
14		Cut-off valve mounting bolt	M8×1.25	2.5 ± 0.5	18.1 ± 3.6
15		EH control block mounting bolt	M8×1.25	2.5 ± 0.5	18.1 ± 3.6
16		Safety valve	M10×1.5	6.9 ± 1.4	50 ± 10.1
17		Hydraulic oil tank mounting bolt	M16×2.0	29.7 ± 4.5	215 ± 32.5
18	Power train system	Transmission mounting bolt, nut (rubber, 2EA)	M24×3.0	100 ± 15	723 ± 108
19		Transmission mounting bolt (bracket, 6EA)	M20×2.5	56.1 ± 8.4	406 ± 60.8
20		Transmission mounting bolt (bracket, 8EA)	M20×2.5	11.7 ± 1.8	84.6 ± 13.0
21		Front axle mounting bolt, nut	M33×2.0	225 ± 20	1627 ± 145
22		Rear axle support mounting bolt, nut	M36×3.0	280 ± 30	2025 ± 217
23		Tire mounting nut	M22×1.5	79 ± 2.5	571 ± 18.1
24		Drive shaft joint mounting bolt	1/2-20UNF	15 ± 2.0	108 ± 14.5
25	Others	Counterweight mounting bolt	M30×3.5	199 ± 30	1439 ± 216
			M24×3.0	100 ± 15	723 ± 108
26		Operator's seat mounting bolt	M8×1.25	3.4 ± 0.8	24.6 ± 5
27		ROPS Cab mounting bolt (4EA)	M30×3.5	199 ± 29.9	1440 ± 216
		ROPS Cab mounting nut (4EA)	M16×2.0	20.5 ± 4.7	148 ± 34

6. SPECIFICATION OF FUEL, COOLANT AND LUBRICANTS

1) NEW MACHINE

New machine used and filled with following lubricants.

Description	Specification
Engine oil (API CH-4)	SAE 15W-40, ★2SAE 5W-40
Hydraulic oil	Hyundai genuine long life hydraulic oil (ISO VG 46, VG 68 only) Conventional hydraulic oil (ISO VG15★2)
Transmission oil	SAE 15W-40
Axle oil	★Refer to below list
Grease	Lithium base grease NLGI No. 2
Fuel	ASTM D975-No. 2
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

★ Recommended oil list
- BP TERRAC SUPER TRANSMISSION 10W-30
- CASTROL AGRI TRANS PLUS 10W-30
- MOBILFLUID 426
- SHELL DONAX TD 10W-30
- TOTAL DYNATRANS MPV

★2 Cold region

2) RECOMMENDED OILS

HYUNDAI 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 HYUNDAI and, therefore, will meet the highest safety and quality requirements.
We recommend that you use only HYUNDAI genuine lubricating oils and grease officially approved by HYUNDAI.

※ Using any lubricating oils other than HYUNDAI genuine products may lead to a deterioration of performance and cause damage to major components.
※ Do not mix HYUNDAI 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 HYUNDAI genuine lubricating oils and grease for use in regions with extremely low temperatures, please contact HYUNDAI 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	18 (4.8)	SAE 15W-40 ★2 SAE 5W-40 SAE 0W-40
Transmission	Engine oil	44 (11.6)	SAE 10W-30 SAE 15W-40
Axle ★4	UTTO	FR : 35 (9.2) RR : 35 (9.2)	★Refer to below list
Hydraulic tank	Hydraulic oil	Tank: 110 (29.1) System: 200 (52.8)	★2 ISO VG 15 ISO VG 46 ISO VG 68
Fuel tank	Diesel fuel	260 (68.7)	★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	42.5 (11.2)	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

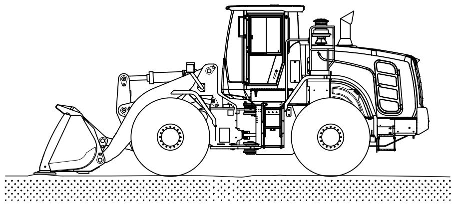
★ Recommended oil list
- BP TERRAC SUPER TRANSMISSION 10W-30
- CASTROL AGRI TRANS PLUS 10W-30
- MOBILFLUID 426
- SHELL DONAX TD 10W-30
- TOTAL DYNATRANS MPV

★2 Cold region
★3 Soft water : City water or distilled water
★4 If the machine is equipped with axle oil cooler, refer to page 6-38 in operator's manual.

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.



760F1GE02

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	☐	☐	______

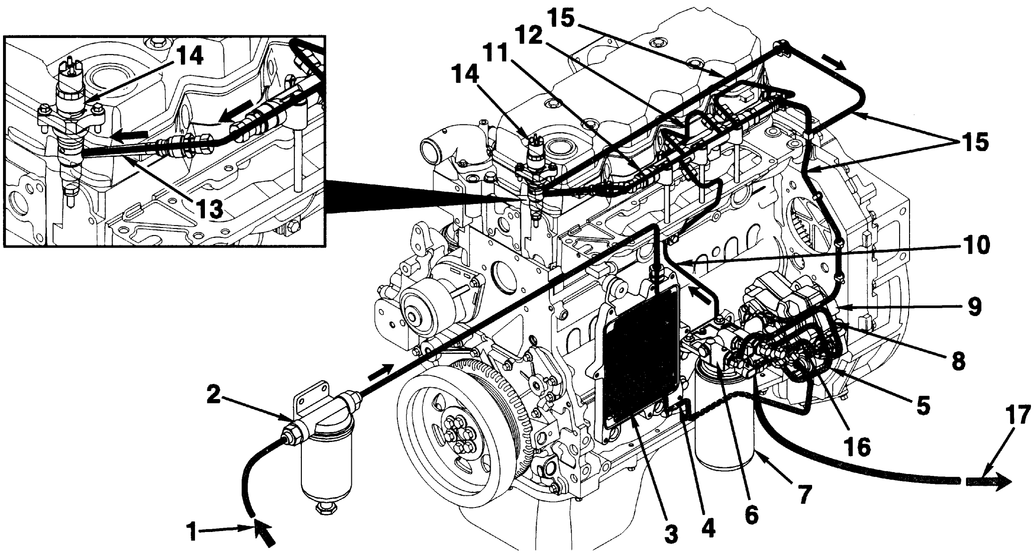
SECTION 2 ENGINE

GROUP 1 STRUCTURE AND FUNCTION

1. SYSTEM DIAGRAMS

The following drawings show the flow through the engine systems.

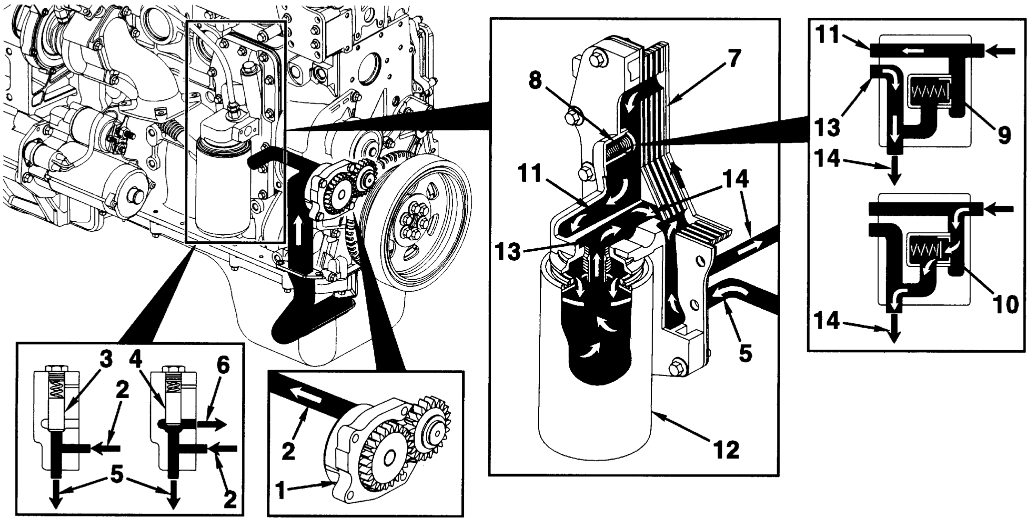
1) FUEL SYSTEM



7607AEG02

1	From fuel tank	11	Fuel rail
2	Water/fuel separator (not mounted on engine)	12	To injectors
3	ECM cooling plate	13	High-pressure connector
4	To fuel gear pump	14	Injector
5	To fuel filter	15	Fuel return from injectors and fuel rail to fuel filter head
6	Fuel filter head	16	Fuel return from high-pressure pump to fuel filter head
7	Fuel filter	17	To fuel tank
8	To high-pressure pump		
9	High-pressure pump		
10	To fuel rail		

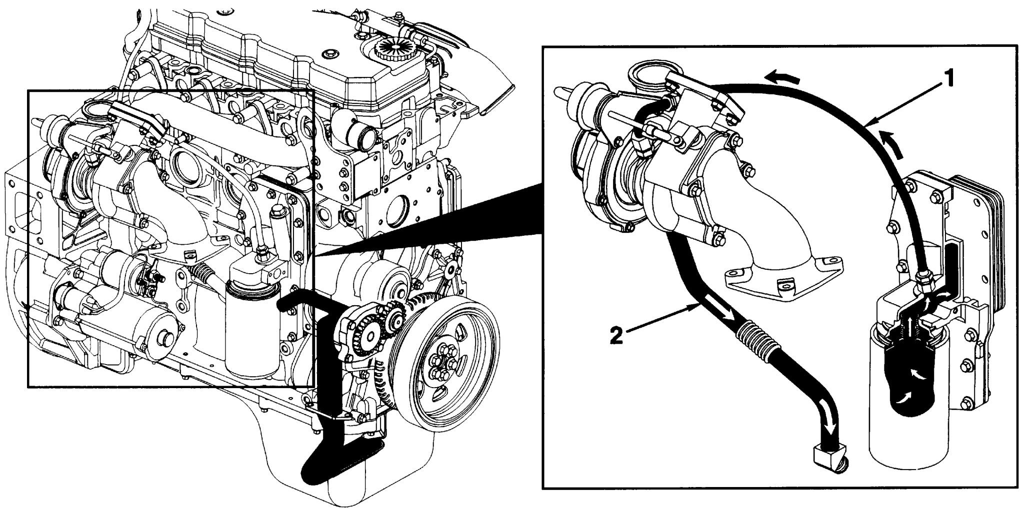
2) LUBRICATING OIL SYSTEM



7607AEG03

1	Gerotor lubricating oil pump	8	Filter bypass valve
2	From lubricating oil pump	9	Filter bypass valve closed
3	Pressure regulating valve closed	10	Filter bypass valve open
4	Pressure regulating valve open	11	To lubricating oil filter
5	To lubricating oil cooler	12	Full-flow lubricating oil filter
6	To lubricating oil pump supply	13	From lubricating oil filter
7	Lubricating oil cooler	14	Main lubricating oil rifle

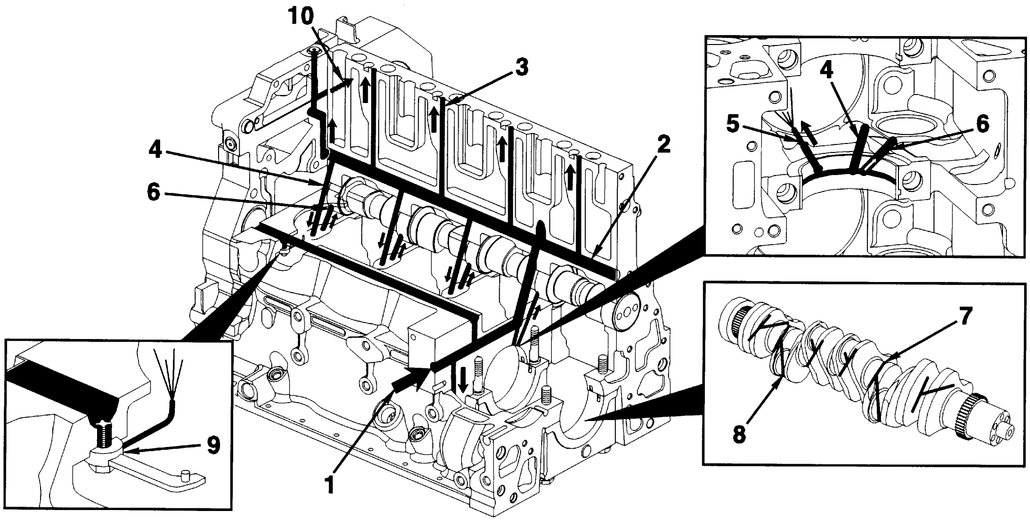
(1) Lubrication for the turbocharger



7607AEG04

1	Turbocharger lubricating oil supply	2	Turbocharger lubricating oil drain

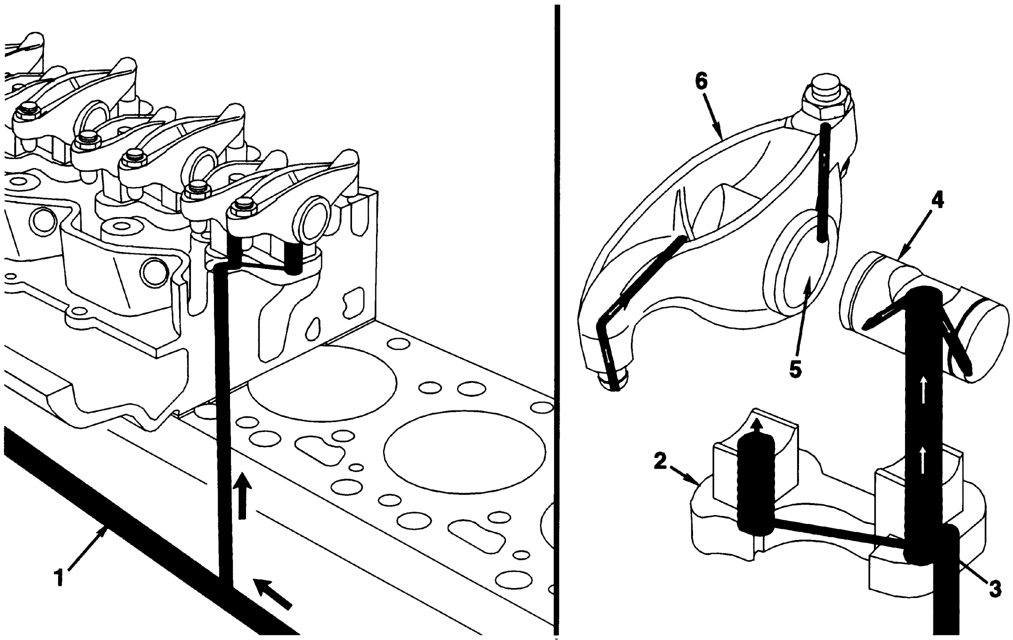
(2) Lubrication for the power components



7607AEG05

1	From lubricating oil cooler	6	To camshaft
2	Main lubricating oil rifle	7	Crankshaft main journal
3	To valve train	8	Oil supply to rod bearings
4	From main lubricating oil rifle	9	Directed piston-cooling nozzle
5	To piston-cooling nozzle	10	To internal lubrication of air compressor

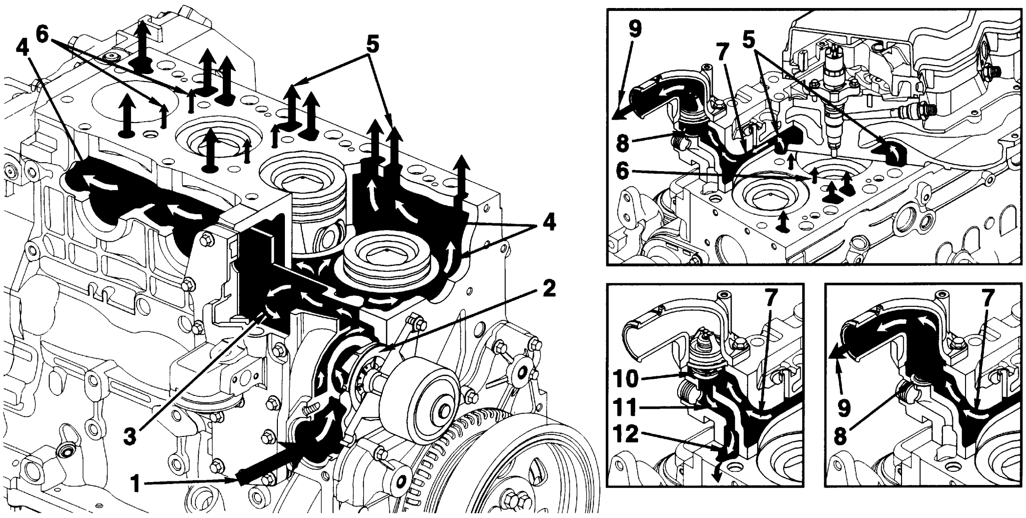
(3) Lubrication for the overhead



7607AEG06

1	Main lubricating oil rifle	4	Rocker lever shaft
2	Rocker lever support	5	Rocker lever bore
3	Transfer slot	6	Rocker lever

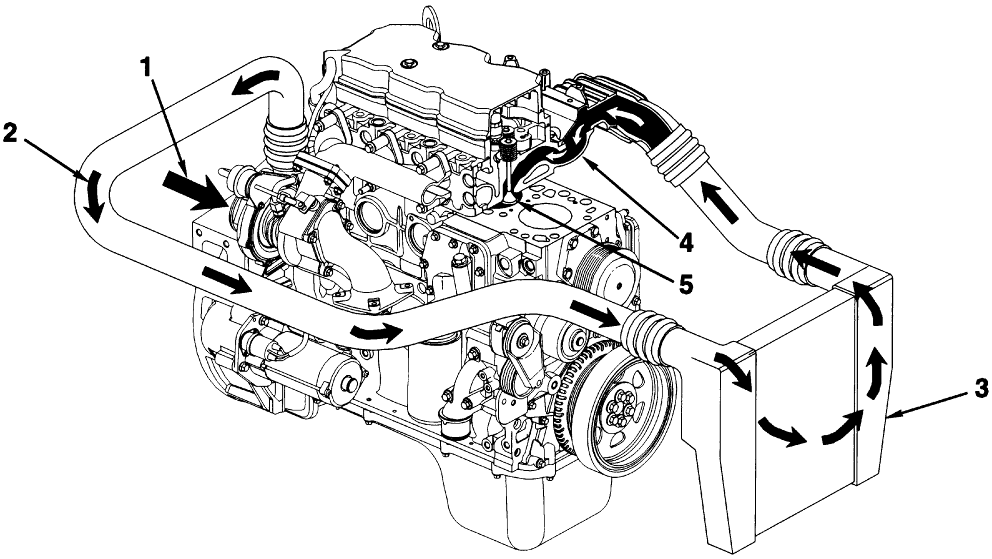
3) COOLING SYSTEM



7607AEG07

1	Coolant inlet	7	Coolant flow to thermostat housing
2	Pump Impeller	8	Coolant bypass passage
3	Coolant flow past lubricating oil cooler	9	Coolant flow back to radiator
4	Coolant flow past cylinders	10	Bypass closed
5	Coolant flow from cylinder block to cylinder head	11	Coolant bypass in cylinder head
6	Coolant flow between cylinders	12	Coolant flow to water pump inlet

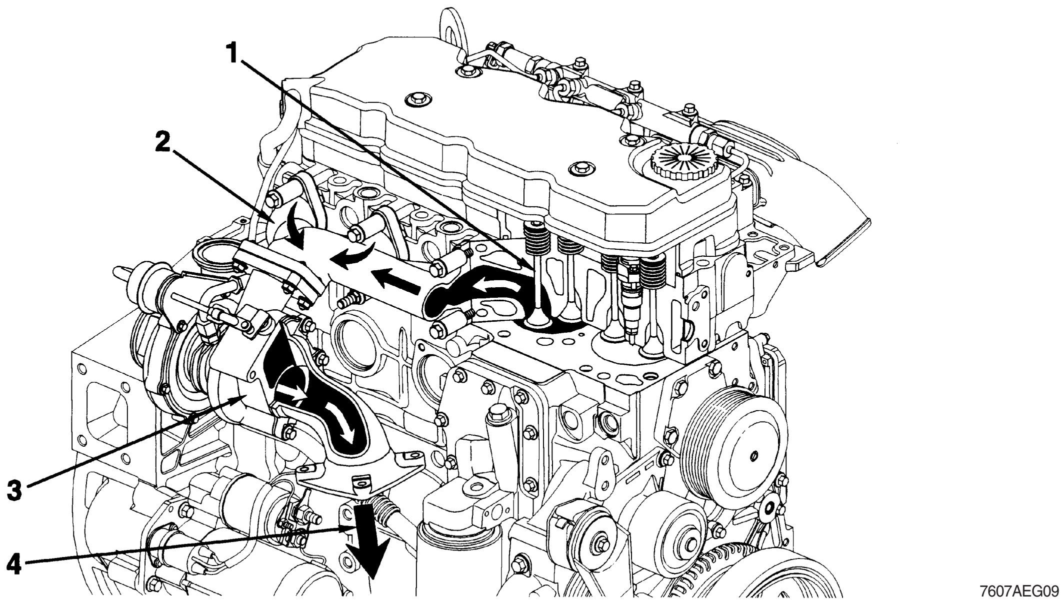
4) AIR INTAKE SYSTEM



7607AEG08

1	Intake air inlet to turbocharger	4	Intake manifold (Integral part of cylinder head)
2	Turbocharger air to charge air cooler		
3	Charge air cooler	5	Intake valve

5) EXHAUST SYSTEM



1	Exhaust valve	3	Turbocharger
2	Exhaust manifold	4	Turbocharger exhaust outlet

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 6-51.

2. SPECIFICATION

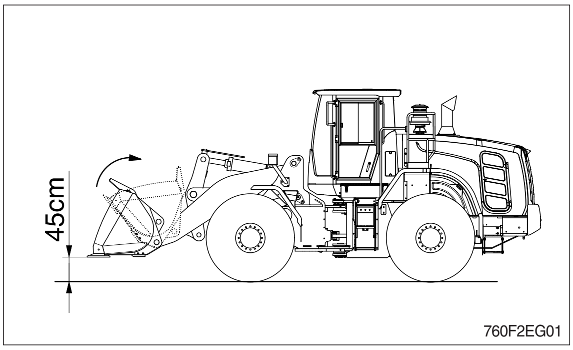
Engine speed, rpm (P mode)						Remark
Low idle	High idle	Pump stall	Converter stall	Full stall	Fan motor	
950±25	2150±50	2150±70	1960±70	1920±100	850±50	

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 6-51.

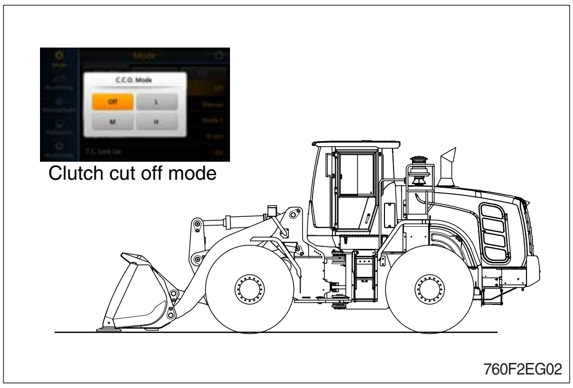
1) Pump stall rpm

- 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.



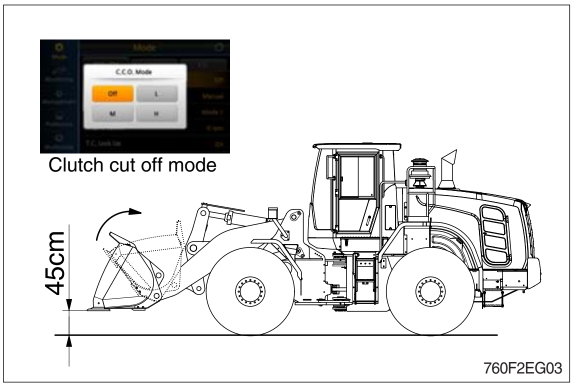
2) Convertor stall rpm

- 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.



3) Full stall rpm

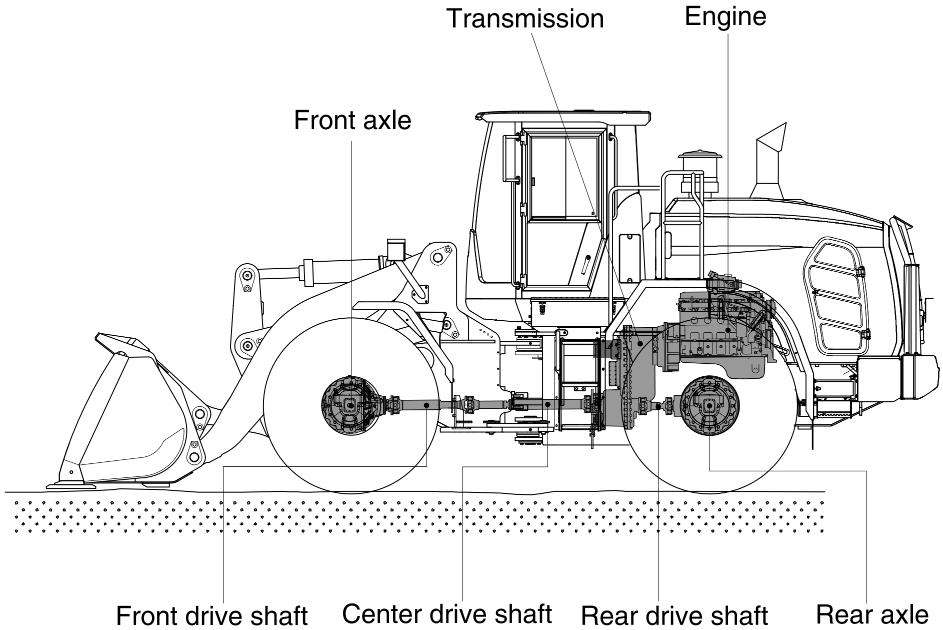
- Start the engine and raise the bucket approx 45 cm (1.5 ft) as the figure.
- Set the clutch cut off mode at the OFF position.
- Press the brake pedal and accelerator pedal fully .
- Shift the transmission lever to the 4th forward position and operate the bucket lever to the retract position fully.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



SECTION 3 POWER TRAIN SYSTEM

GROUP 1 STRUCTURE AND FUNCTION

1. POWER TRAIN COMPONENT OVERVIEW



960A3PT01

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.

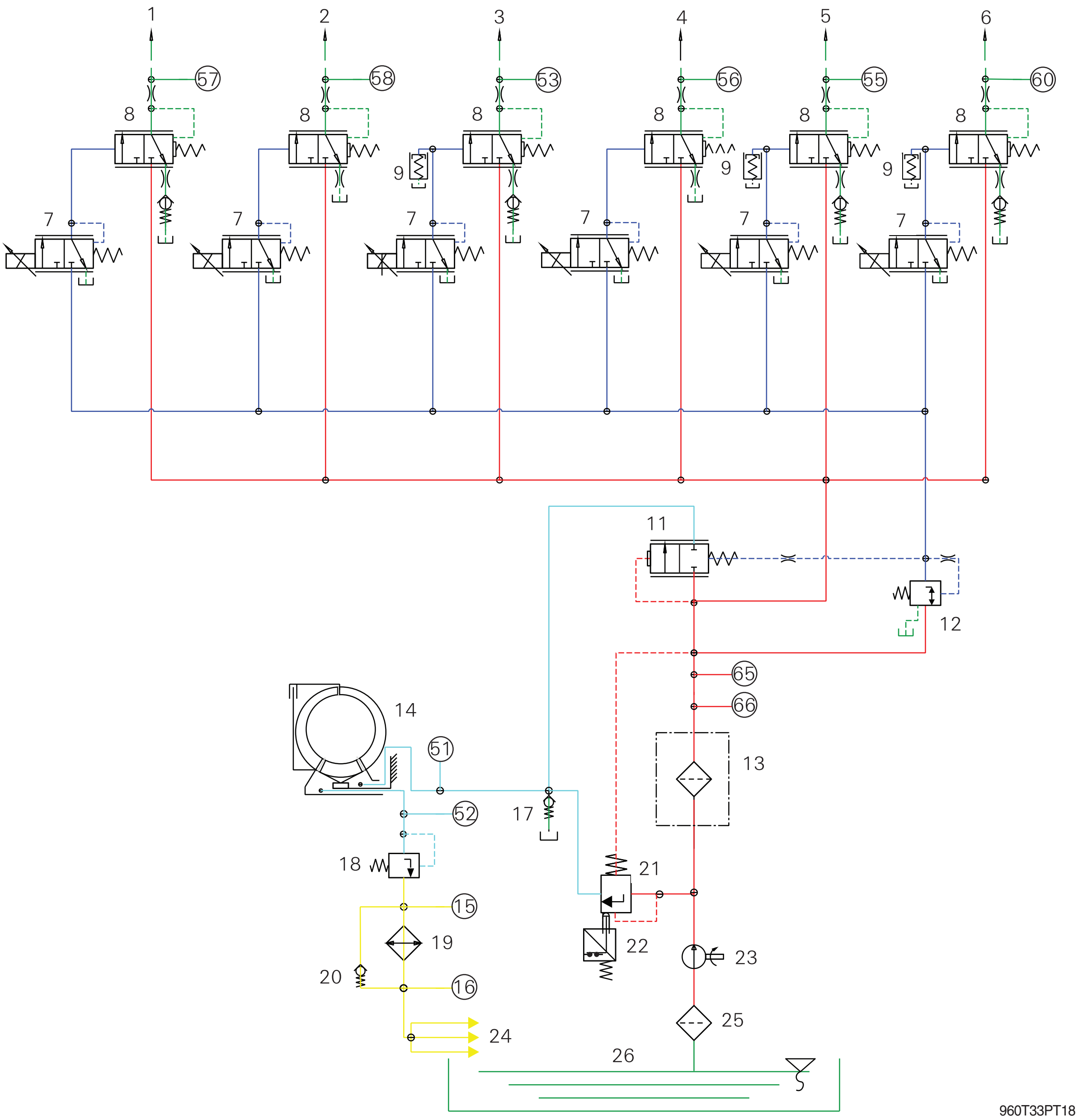
The transmission is a hydraulically engaged four speed forward, three speed reverse countershaft type power shift transmission. A calliper-disc type parking brake is located on the transmission.

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 conventional differential as standard (option : Limited slip, Hyd lock differential).
The rear axle is equipped with conventional differential as standard (option : Limited slip differential)
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 Main pressure
2 Controlled main pressure
3 Converter input pressure
4 Lubrication
5 Return flow to sump
6 Pilot pressure

Positions 15, 16, 51, 52, 53, 55, 56, 57, 58, 60, 65, 66, 67 correspond to the numbers on the installation drawing.

1 Clutch K2
3 Clutch KV (clutch forward)
5 Clutch KR (clutch reverse)
7 Pilot valve
9 Damper piston
11 Main pressure valve
13 Transmission pressure filter
15 Connection of pressure oil to heat exchanger
17 Converter safety valve
19 Heat exchanger
21 Filter bypass valve
23 Transmission pump
25 Suction filter
51 Measuring point of oil pressure before converter
53 Measuring point of clutch pressure KV
56 Measuring point of clutch pressure K1
58 Measuring point of clutch pressure K3
65 Measuring point of system pressure

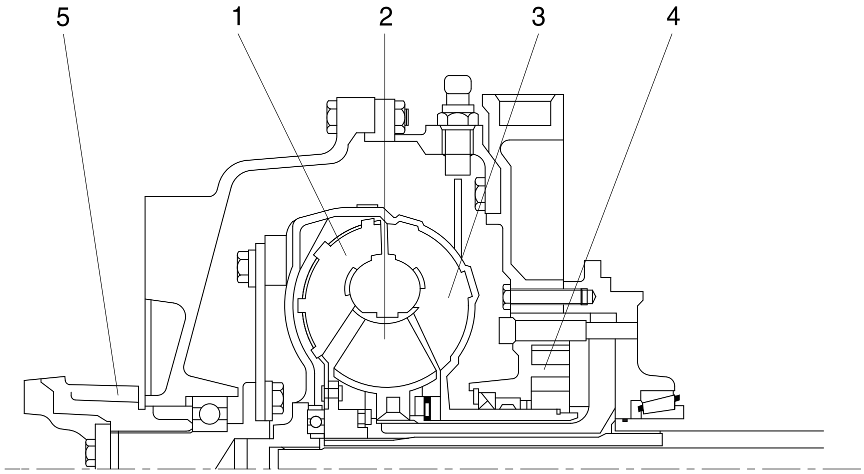
2 Clutch K3
4 Clutch K1
6 Clutch K4
8 Downstream valve
12 Pressure reduction valve
14 Converter
16 Connection of pressure oil from heat exchanger
18 Converter counter-pressure valve
20 Heat exchanger bypass valve
22 Filter bypass switch
24 Lubrication
26 Tank
52 Temperature sensor for oil temperature after the converter
55 Measuring point of clutch pressure KR
57 Measuring point of clutch pressure K2
60 Measuring point of clutch pressure K4
66 Temperature sensor for sump temperature

Assignment of clutch and solenoid valve

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

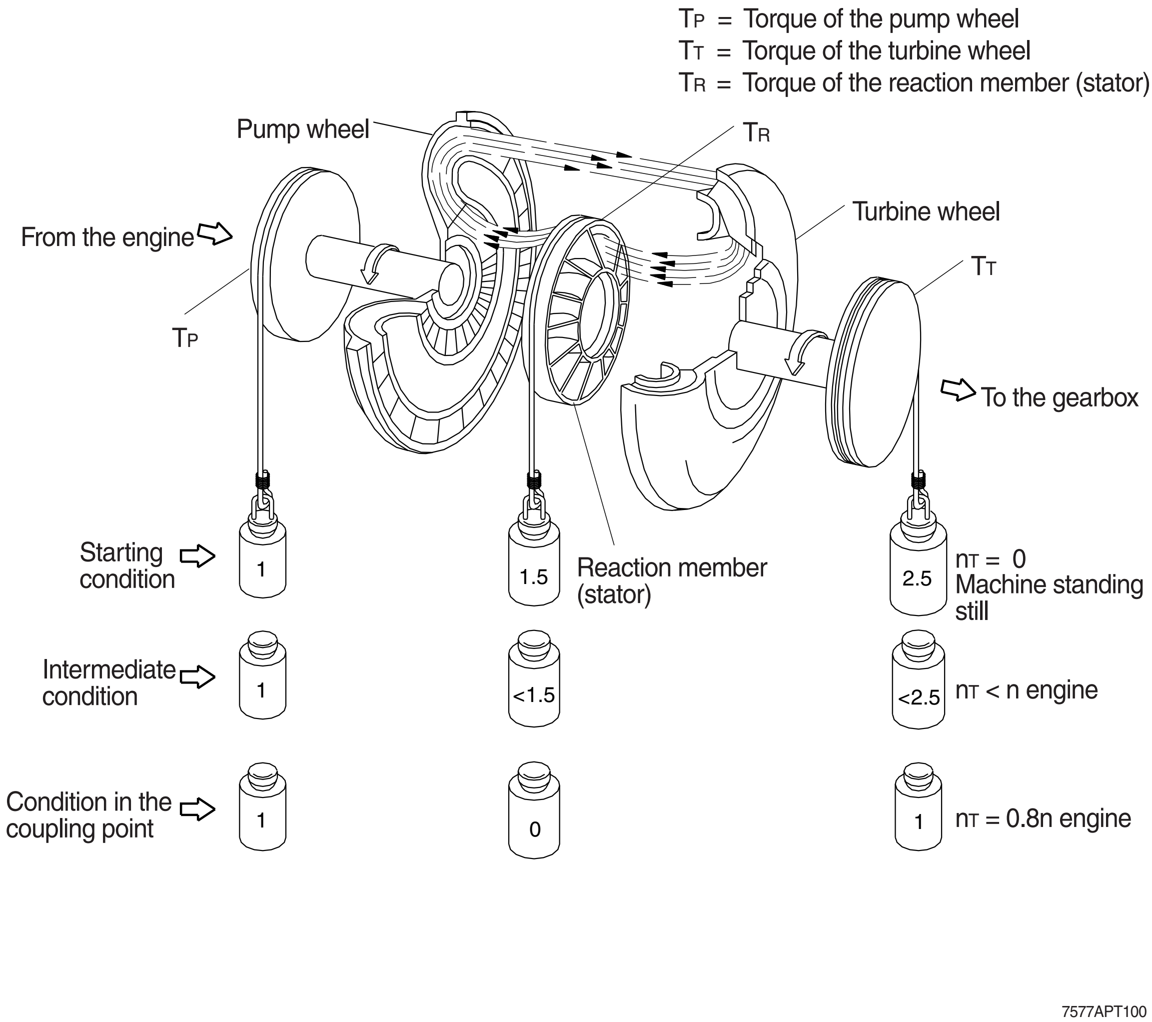
According to the rate of reversion, the turbine wheel and with it also the output shaft is receiving a more or less high reaction torque. The stator (reaction member), following the turbine, has the task to reverse the oil streaming out of the turbine once more and to deliver it under the suitable discharge 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.

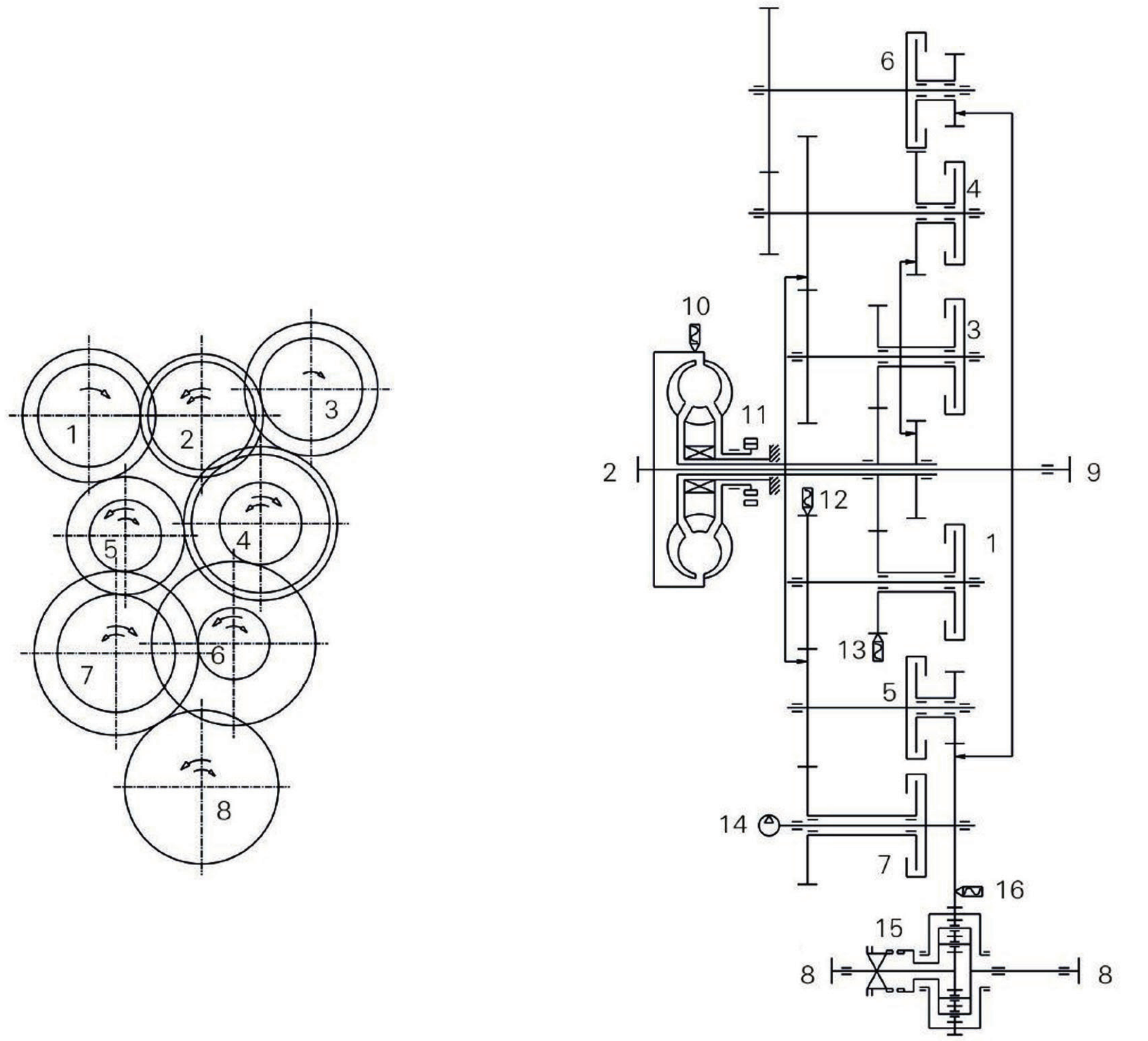
A stator freewheel serves to improve the efficiency in the upper driving range, in the torque multiplication range it is backing-up the torque upon the housing, and is released in the clutch range.
In this way, the stator can rotate freely.

Function of a hydrodynamic torque converter (schematic view)



3. TRANSMISSION

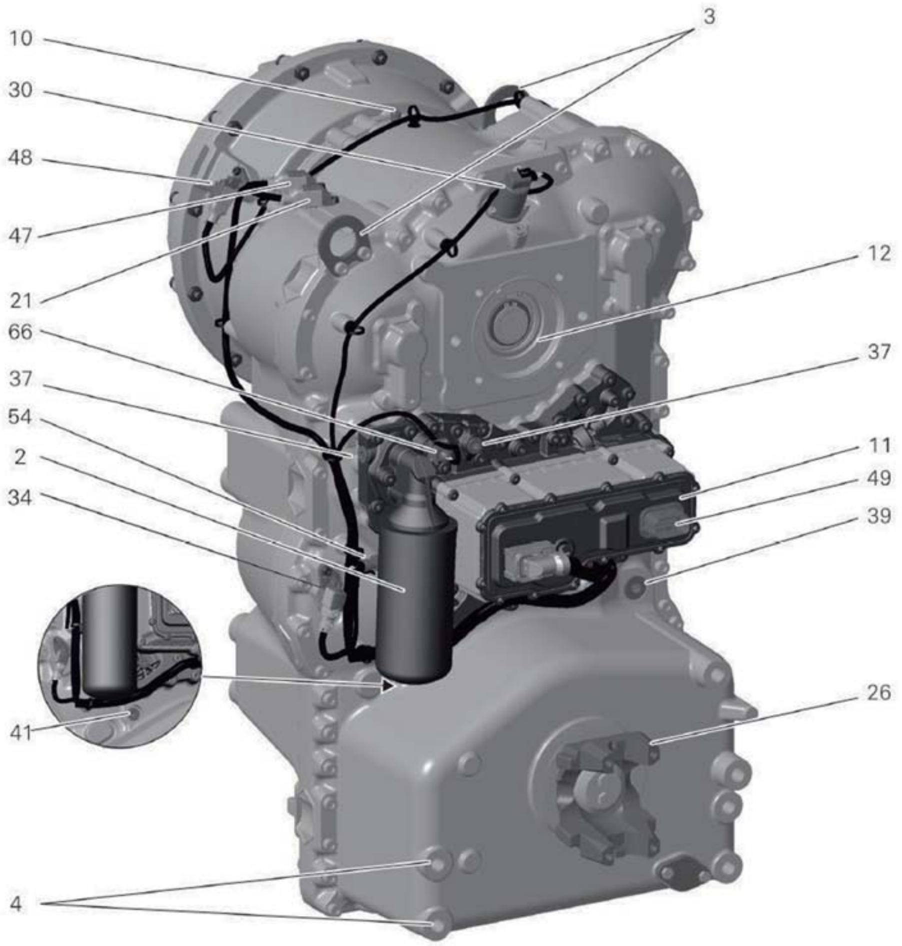
1) DIAGRAM



960T33PT10

1 Clutch KV (clutch forward)
2 Input
3 Clutch KR (clutch reverse)
4 Clutch K4
5 Clutch K2
6 Clutch K1
7 Clutch K3
8 Output
9 Engine-dependent PTO
10 Inductive sensor for engine speed
11 Pump
12 Inductive sensor for speed of central gear chain
13 Inductive sensor for turbine speed
14 Emergency steering pump (optional)
15 Differential
16 Speed sensor for output speed

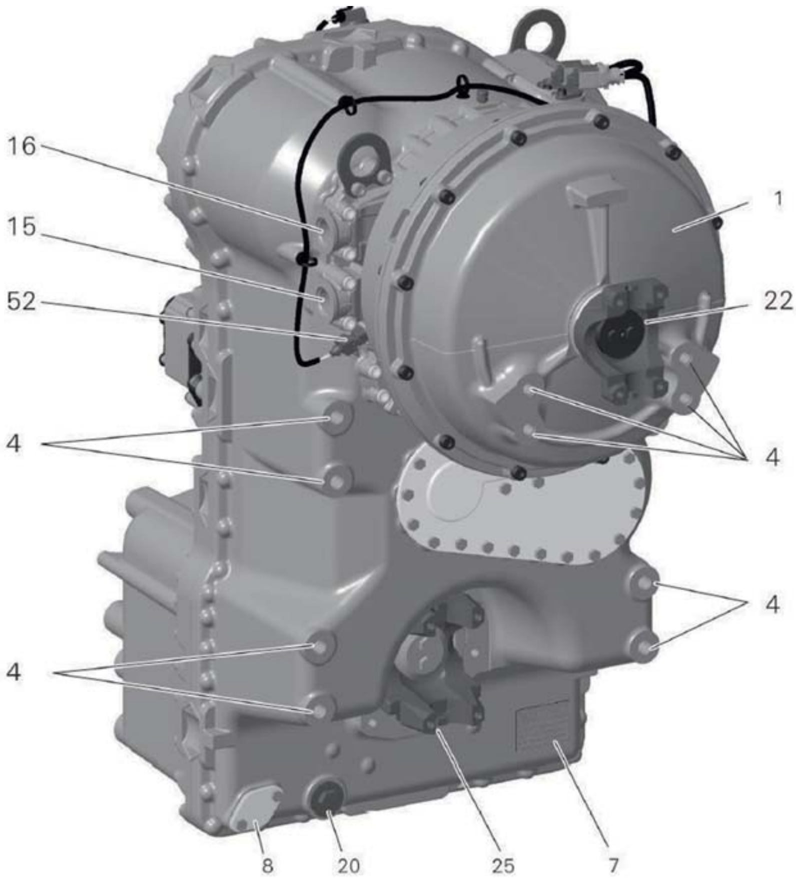
2) INSTALLATION VIEW



960T33PT11

3	Lifting eye	12	PTO coaxial, engine-dependent
37	System pressure connection M16 x 1.5	11	Electrohydraulic transmission control unit
49	Machine connector	39	Connection of return flow to sump
26	Output flange	4	Transmission suspension holes
41	Closing components speedometer	34	Inductive sensor for output speed
54	Differential pressure switch for pressure filter	2	Full flow filter
37	System pressure connection M16 x 1.5	66	Temperature sensor for sump temperature
21	Inductive sensor for turbine speed	47	Inductive sensor for speed of central gear chain
48	Inductive sensor for engine speed	30	Solenoid valve for torque converter lock-up clutch (not used)
10	Breather		

INSTALLATION VIEW



960T33PT12

1 Converter
4 Transmission suspension holes
25 Output flange on torque converter side
8 Connection for oil level measurement
15 Connection to heat exchanger
22 Input flange
7 Name plate
20 Oil drain plug M38 x 1.5
Tightening torque 80 Nm
52 Temperature sensor for oil temperature after the converter
16 Connection from heat exchanger

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

<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="3">101</td><td>3</td><td>10 seconds continuous, Hydraulic Oil Temp. Measurement Voltage > 3.95 V</td><td>●</td><td></td><td></td></tr>
<tr><td>4</td><td>10 seconds continuous, Hydraulic Oil Temp. Measurement Voltage < 0.3 V</td><td>●</td><td></td><td></td></tr>
<tr><td colspan="5">(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</td></tr>
<tr><td rowspan="3">202</td><td>0</td><td>10 seconds continuous, Steering main pump pressure Measurement Voltage > 5.3 V</td><td>●</td><td></td><td></td></tr>
<tr><td>4</td><td>10 seconds continuous, Steering main pump pressure Measurement Voltage < 0.3 V</td><td>●</td><td></td><td></td></tr>
<tr><td colspan="5">(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</td></tr>
<tr><td rowspan="3">204</td><td>0</td><td>10 seconds continuous,
Boom cylinder 'head' pressure Measurement Voltage > 5.3 V</td><td>●</td><td></td><td></td></tr>
<tr><td>4</td><td>10 seconds continuous,
Boom cylinder 'head' pressure Measurement Voltage < 0.3 V</td><td>●</td><td></td><td></td></tr>
<tr><td colspan="5">(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</td></tr>
</table>

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="3">205</td><td>0</td><td>10 seconds continuous,
Boom cylinder ‘rod’ pressure Measurement Voltage > 5.3V</td><td>●</td><td></td><td></td></tr>
<tr><td>4</td><td>10 seconds continuous,
Boom cylinder ‘rod’ pressure Measurement Voltage < 0.3V</td><td>●</td><td></td><td></td></tr>
<tr><td colspan="5">(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</td></tr>
<tr><td rowspan="3">301</td><td>3</td><td>10 seconds continuous, Fuel level Measurement Voltage > 3.8V</td><td>●</td><td></td><td></td></tr>
<tr><td>4</td><td>10 seconds continuous, Fuel level Measurement Voltage < 0.3V</td><td>●</td><td></td><td></td></tr>
<tr><td colspan="5">(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</td></tr>
<tr><td rowspan="2">318</td><td>8</td><td>(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)</td><td>●</td><td></td><td></td></tr>
<tr><td colspan="5">(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</td></tr>
<tr><td rowspan="3">339</td><td>3</td><td>10 seconds continuous,
Accel pedal position 1 voltage Measurement Voltage > 5.0 V</td><td></td><td></td><td>●</td></tr>
<tr><td>4</td><td>10 seconds continuous,
Accel pedal position 1 voltage Measurement Voltage < 0.2 V</td><td></td><td></td><td>●</td></tr>
<tr><td colspan="5">(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</td></tr>
</table>

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				

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<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="3">705</td><td>0</td><td>10 seconds continuous, Battery input Voltage > 35V</td><td>●</td><td></td><td></td></tr>
<tr><td>1</td><td>10 seconds continuous, Battery input Voltage < 18V</td><td>●</td><td></td><td></td></tr>
<tr><td colspan="5">(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</td></tr>
<tr><td rowspan="2">707</td><td>1</td><td>(In the 500rpm or more) 10 seconds continuous,
Alternator Node I Measurement Voltage < 18V</td><td>●</td><td></td><td></td></tr>
<tr><td colspan="5">(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</td></tr>
<tr><td rowspan="3">728</td><td>3</td><td>10 seconds continuous,
Boom position sensor signal voltage Measurement Voltage > 5.0V</td><td>●</td><td></td><td></td></tr>
<tr><td>4</td><td>10 seconds continuous,
Boom position sensor signal voltage Measurement Voltage < 0.3V</td><td>●</td><td></td><td></td></tr>
<tr><td colspan="5">(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</td></tr>
<tr><td rowspan="3">729</td><td>3</td><td>10 seconds continuous,
Bucket position sensor signal voltage Measurement Voltage > 5.0V</td><td>●</td><td></td><td></td></tr>
<tr><td>4</td><td>10 seconds continuous,
Bucket position sensor signal voltage Measurement Voltage < 0.3V</td><td>●</td><td></td><td></td></tr>
<tr><td colspan="5">(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</td></tr>
</table>

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<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.

※ Some fault codes are not applied to this machine.

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.

(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.

(3) Limp home

This mode is intended to allow the driver to leave area of work or area of danger. If an error is detected whichs error reaction is limp home, the transmission shifts to neutral. The driver can reengage the gear if he selects neutral with the shift lever. The first possible gear in the desired direction will be engaged on a driving request. The transmission is not able to shift into other gears in Limp Home mode. To perform reversals the driver has to shift to neutral and then to the opposite direction.

(4) Transmission shutdown (Trm shutdown)

This mode is intended to put the transmission into safe state if an error occurs whichs error reaction is transmission shutdown. The transmission shifts to neutral and no driving is possible as long as the failure is active. The driver has to shift to neutral to get into normal operation after the failure went inactive.

(5) TCU shutdown

This mode is intended put the transmission into safe state if an erro occurs whichs erro reaction is tcu shutdown. In this operation mode no driving is possible. The driver has to shift to neutral and run a power off-on cycle to get into normal operation mode after the failure went inactive.

※ 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 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

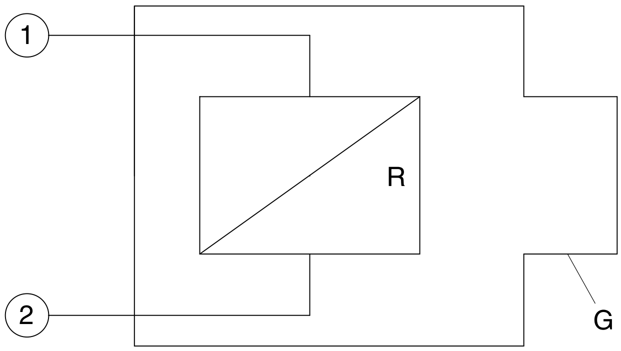
SPN	FMI	FaultDescription	OpMode	Cause	PossibleSteptoRepair
		unintendedly		the clutch is closed. If this value is too high, it is interpreted as slip on the clutch. 1. Insufficient pressure on the clutch. 2. Insufficient system pressure. 3. Filter clogged. 4. Clutch faulty. 5. Transmission input speed 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



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

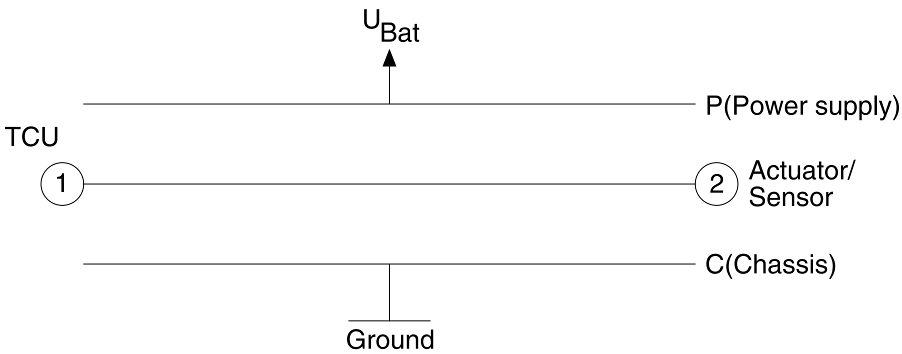
Short cut to ground $R_{12} = R$; $R_{1G} = 0$, $R_{2G} = R$ or $R_{1G} = R$, $R_{2G} = 0$

(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



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

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

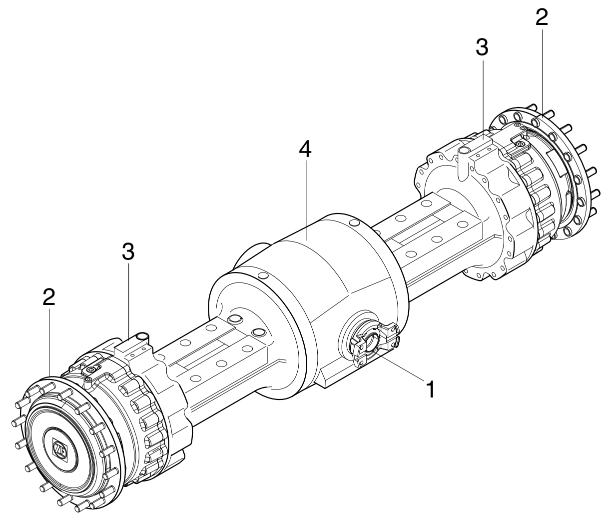
Short cut to battery $R_{12} = 0$; $R_{1C} = R_{2C} = 0$, $R_{1P} = R_{2P} = 0$

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.

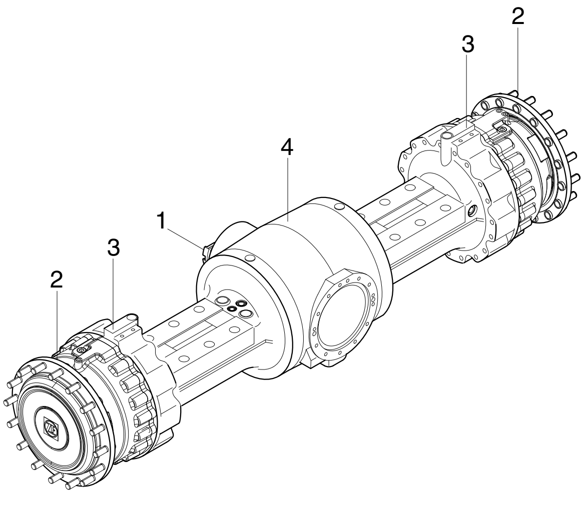
(1) Front axle



7609A3PT15

1	Input	2	Output	3	Brake
4	Axle housing				

(2) Rear axle



7609A3PT16

1	Input	2	Output	3	Brake
4	Axle housing				

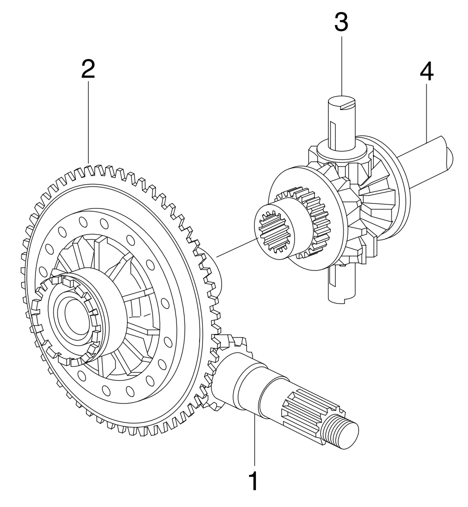
2) DIFFERENTIAL

(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.

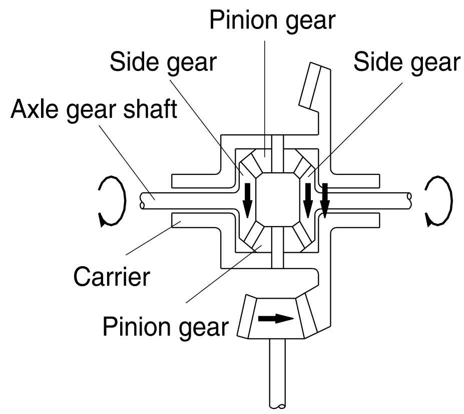
It then transmits the motive force through the differential (3) to the axle gear shaft (4).



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.

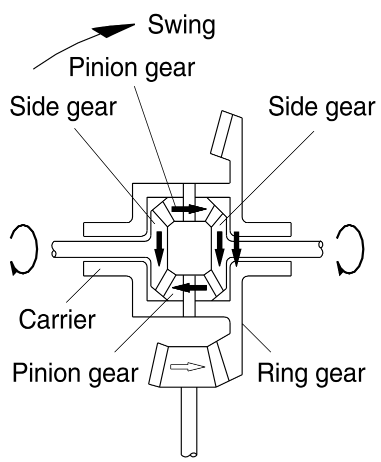


770-3 [3-26(2)]

(3) When turning

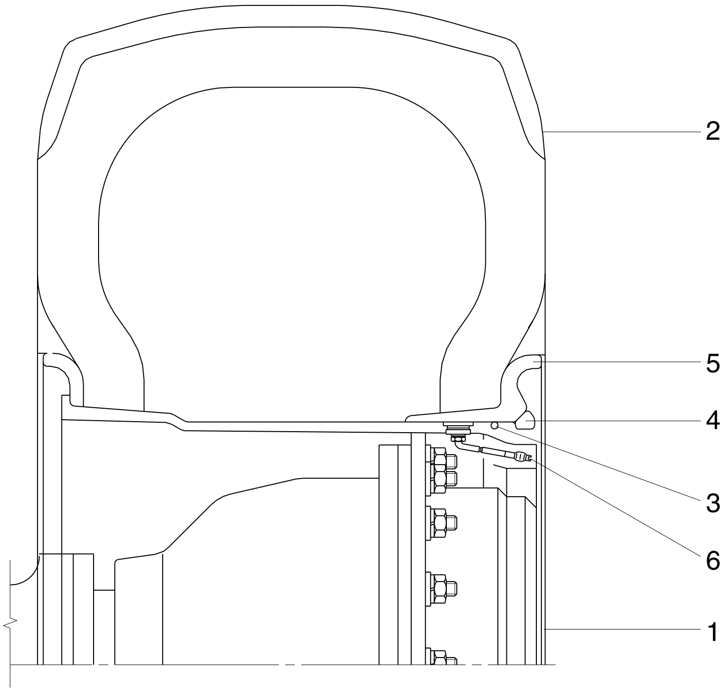
When turning, the rotating speed of the left and right wheels is different, so the pinion gear and side gear inside the differential assembly rotate in accordance with the difference between the rotating speed of the left and right wheels.

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.

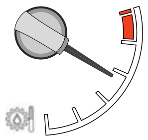
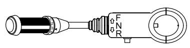
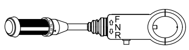
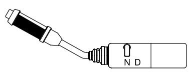
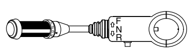
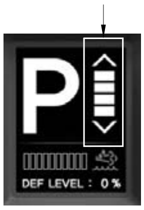
The engine and all other major components must be at operating temperature for some checks.

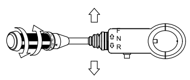
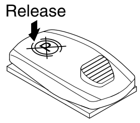
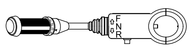
Locate system check in the left column and read completely, following the sequence from left to right. Read each check completely before performing.

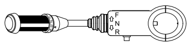
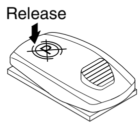
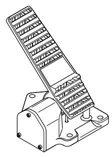
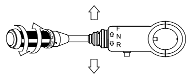
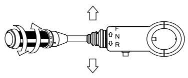
At the end of each check, if no problem is found(OK), that check is complete or an additional check is needed. If problem is indicated(NOT OK), you will be given repair required and group location.
If verification is needed, you will be given next best source of information :

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	 MANUAL mode   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	 AL mode  Automatic mode  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. 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  MANUAL mode   AL mode  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 : 1960±70 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.

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 controller.	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

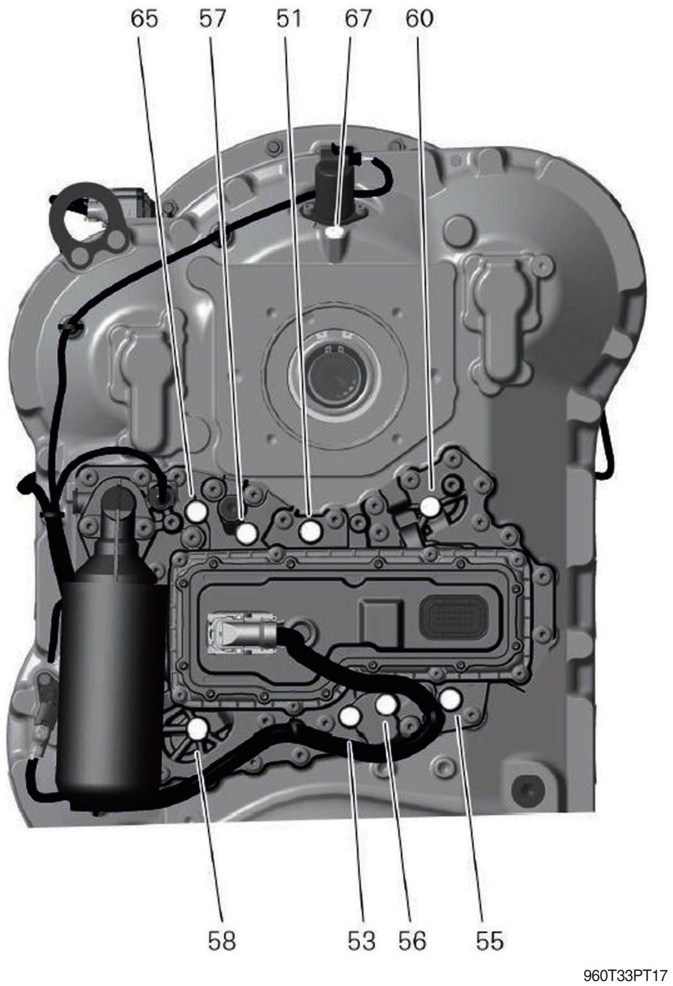
Problem	Cause	Remedy
Differential low on oil	External leakage.	Inspect axle and differential for leaks.
Excessive differential and/or axle noise	Low oil level in differential.	Check oil. Remove drain plug and inspect for metal particles in differential case. Disassemble and determine cause.
	Incorrect 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.

1. TRANSMISSION MEASURING POINTS AND CONNECTIONS

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



Measuring point	Measurement variable pressure/ temperature
51	11 + 2 bar
52 (not shown)	4.3 + 3 bar
53	16 + 3 bar
55	16 + 3 bar
56	16 + 3 bar
57	16 + 3 bar
58	16 + 3 bar
60	16 + 3 bar
65	16 + 3 bar
67	15 + 1 bar

51 Measuring point for pressure before converter, M12 x 1.5
53 Measuring point for clutch KV, M12 x 1.5
55 Measuring point for pressure oil of clutch KR, M12 x 1.5
56 Measuring point for pressure oil of clutch K1, M12 x 1.5
57 Measuring point for pressure oil of clutch K2, M12 x 1.5
58 Measuring point for pressure oil of clutch K3, M12 x 1.5
60 Measuring point for pressure oil of clutch K4, M12 x 1.5
65 Measuring point for system pressure, M12 x 1.5
67 Measuring point for pressure in torque converter lock-upclutch, M12 x 1.5 (not used)

GROUP 4 DISASSEMBLY AND ASSEMBLY

1. AXLE

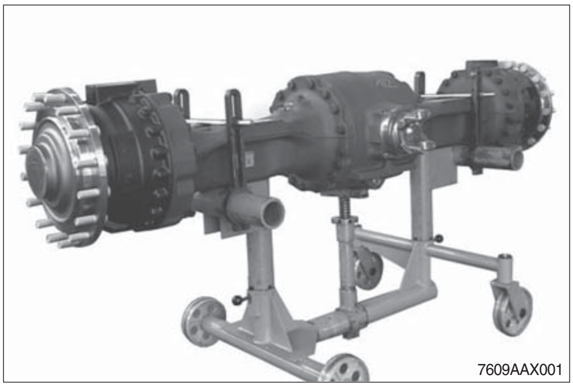
1) DISASSEMBLY

(1) Disassembly output and brake

① Fix axle to assembly truck.

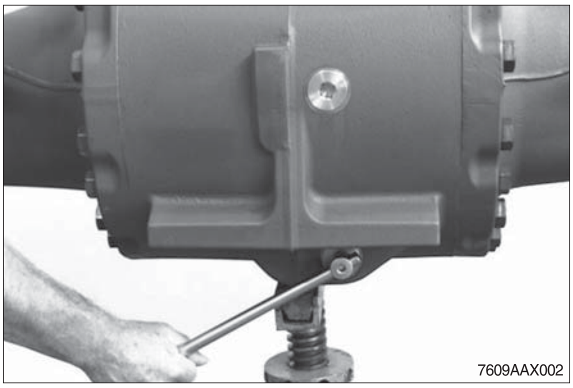
Assembly truck	5870 350 000
Fixtures	5870 350 077
Clamping brackets	5870 350 075
Support	5870 350 125

※ 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.

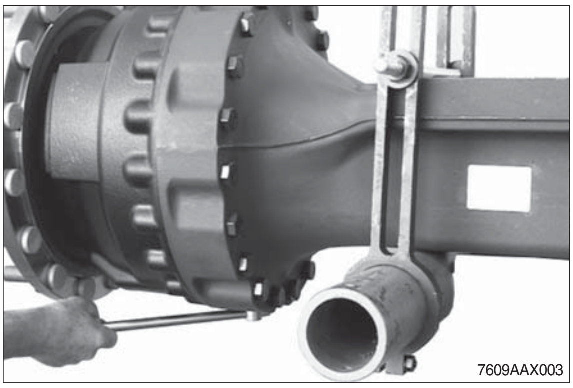


7609AAX001

② Loosen screw plugs (3EA, see AX002 and AX003) and drain oil from the axle.



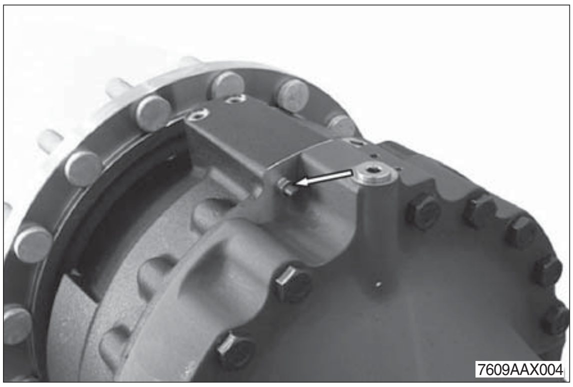
7609AAX002



7609AAX003

③ Remove the breather valve (see arrow).

※ To avoid any damage, the breather valve must be removed when separating the output.

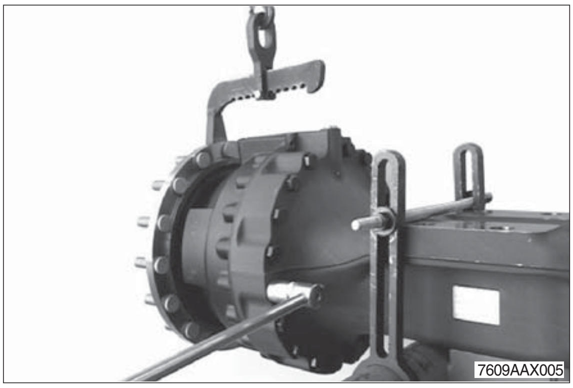


④ Secure the output with the lifting device and loosen hexagon screws.

Then separate the output assy from the axle housing.

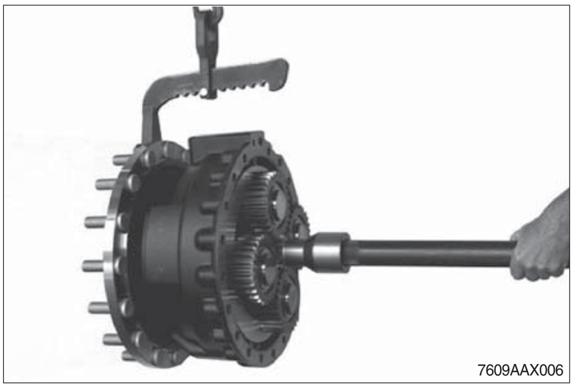
Load carrying device	5870 281 043

※ Fix the load carrying device with a wheel nut.



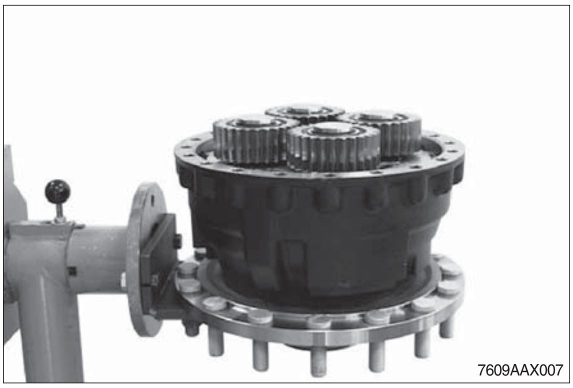
⑤ Pull stub shaft and sun gear shaft.

※ Pay attention to potentially releasing shim.

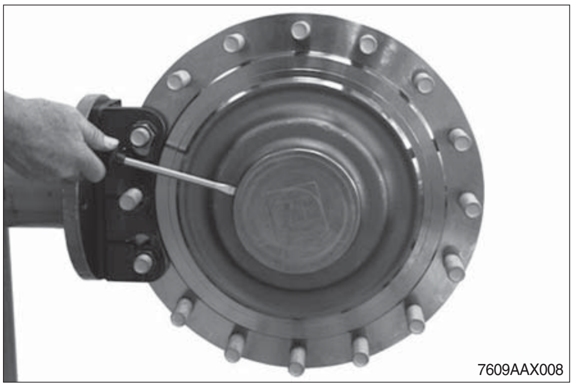


⑥ Fix output to assembly truck.

Assembly truck	5870 350 000
Fixture	5870 350 113

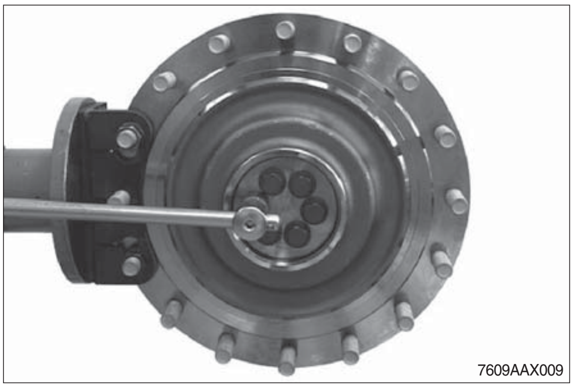


⑦ Use a lever to remove the cover from the output shaft.



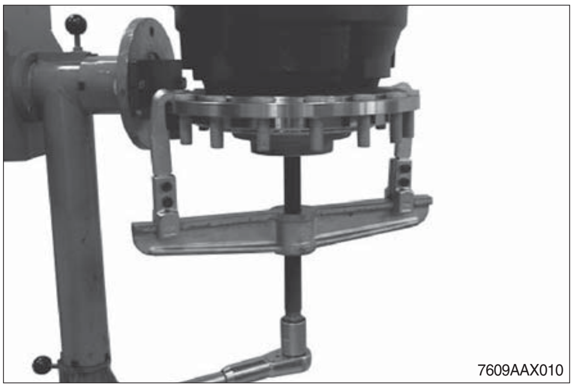
7609AAX008

⑧ Loosen locking screws and remove the releasing cover.



7609AAX009

⑨ Press planetary carrier with a two-armed puller out of the profile of the output shaft.



7609AAX010

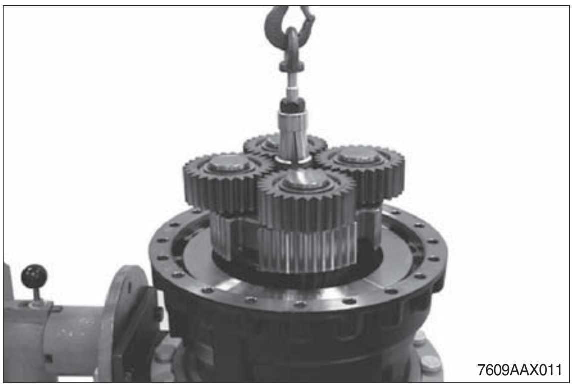
⑩ Lift the planetary carrier out of the brake housing by means of the lifting device.

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 300 017
Eye nut	5870 204 076



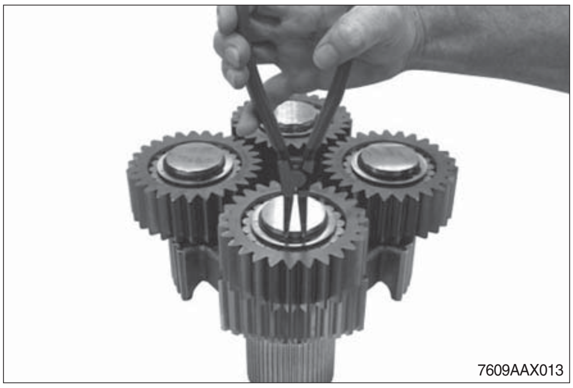
7609AAX011

⑪ Pull the tapered roller bearing from the planetary carrier.

Rapid grip	5873 014 016
Basic tool	5873 004 001

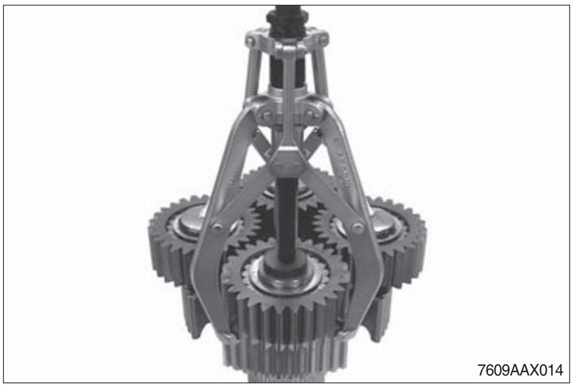
7609AAX012

⑫ Disengage retaining ring.



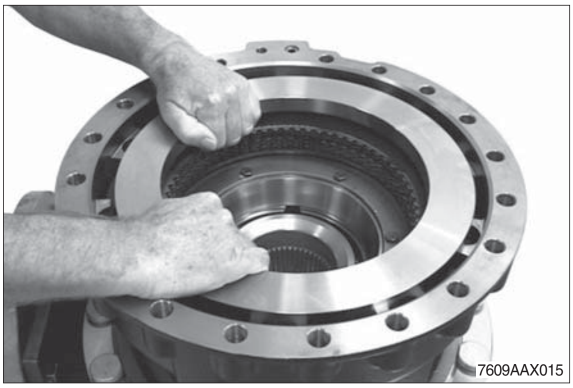
7609AAX013

⑬ Pull off planetary gear.



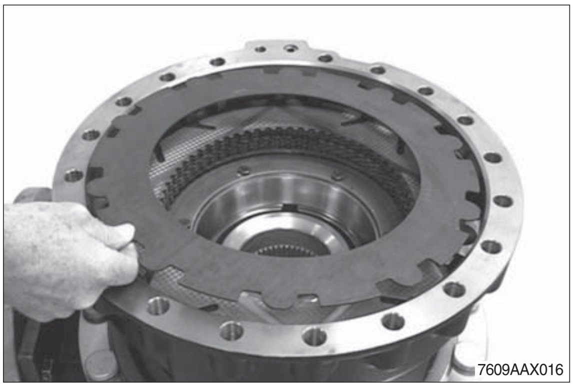
7609AAX014

⑭ Lift the end plate out of the brake housing.



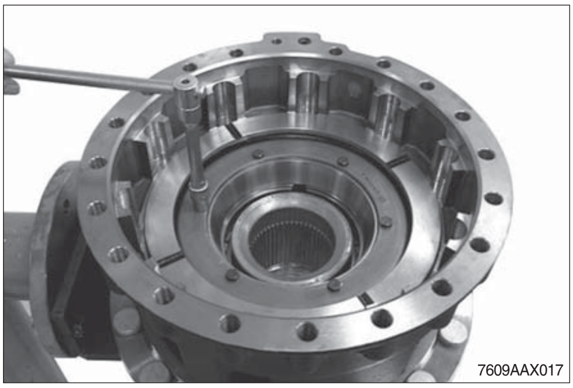
7609AAX015

⑮ Lift the disk package out of the brake housing.



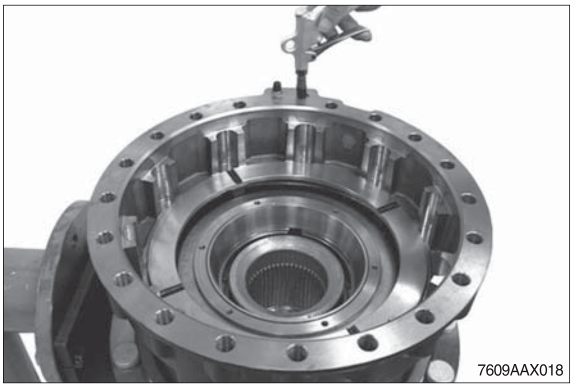
7609AAX016

⑯ Loosen hexagon screws, remove releasing cover and cup spring.



7609AAX017

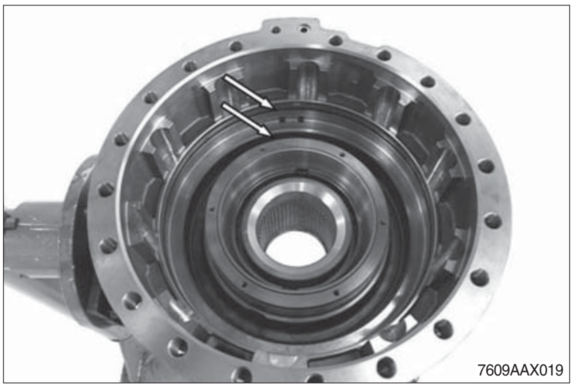
⑰ Mount breather valve and press piston out of the brake housing by means of compressed air.



7609AAX018

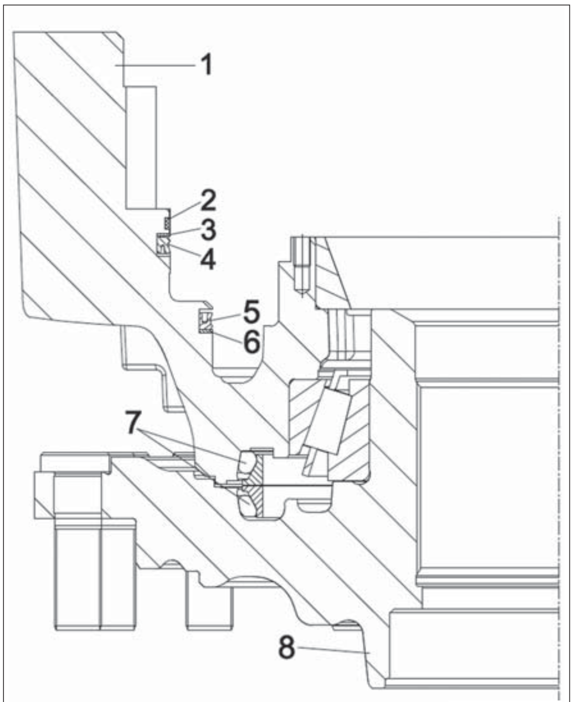
⑱ If necessary, remove guide ring, back-up rings and grooved rings out of the annular grooves of the brake housing (see arrows).

※ For the installation position of the single parts please also refer to the following sketch.



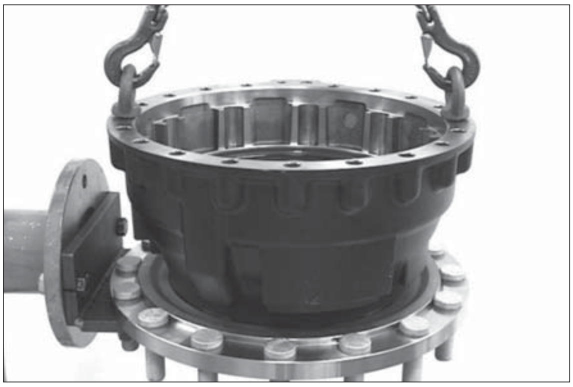
7609AAX019

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



7609AAX020

⑲ Lift the brake housing from the output shaft by means of the lifting device.


7609AAX021

⑳ Use a lever to remove the slide ring seal from the brake housing.

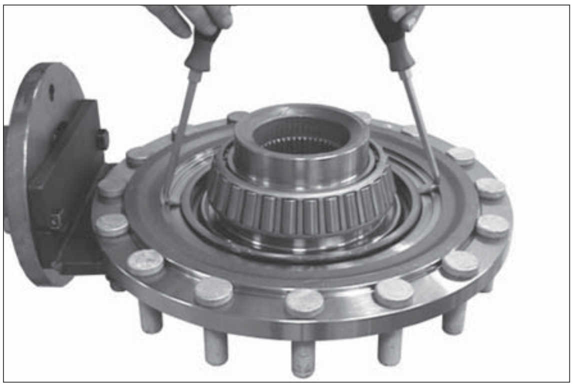
If necessary, force out both bearing outer rings.

Resetting device 5870 400 001


7609AAX022

㉑ Use a lever to remove the slide ring seal from the output shaft.

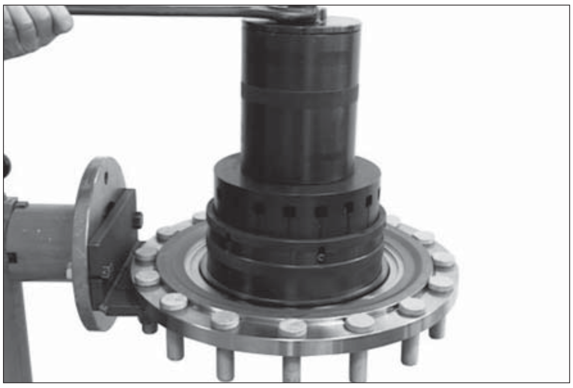
Resetting device	5870 400 001



7609AAX023

㉒ Pull the tapered roller bearing from the output shaft.

Rapid grip	5873 014 013
Basic tool	5873 004 001



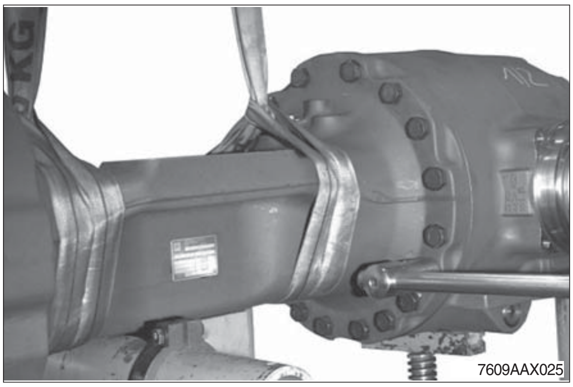
7609AAX024

(2) Disassembly axle housing

① Secure axle housing with the lifting device and loosen the hexagon screws.

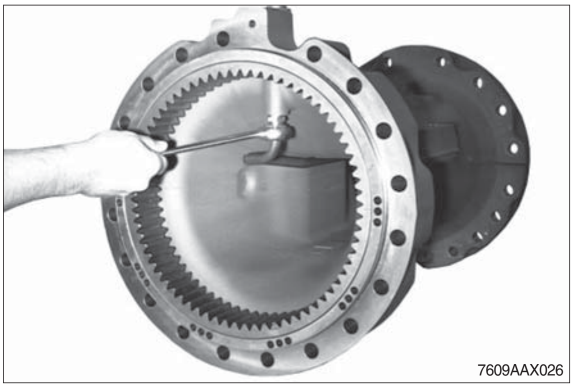
Then separate the axle housing from the axle drive housing.

※ Pay attention to releasing differential.



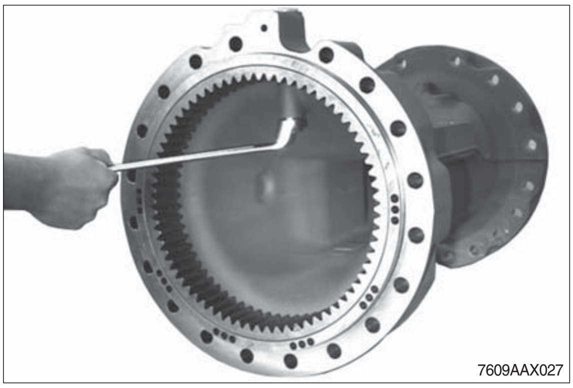
7609AAX025

② Loosen the threaded connections and remove the releasing brake tube.



7609AAX026

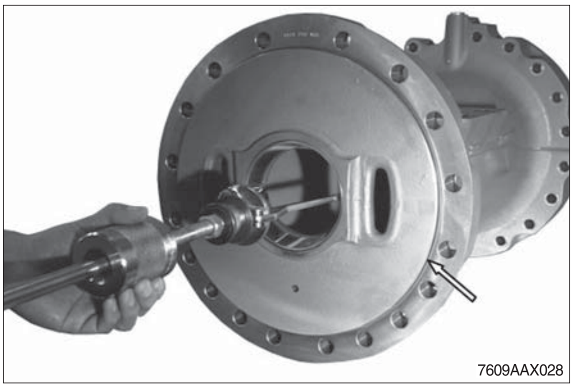
③ Loosen screw neck.



7609AAX027

④ Pull the bearing outer ring out of the bearing hole and remove the shim behind.

Then remove the O-ring (see arrow).



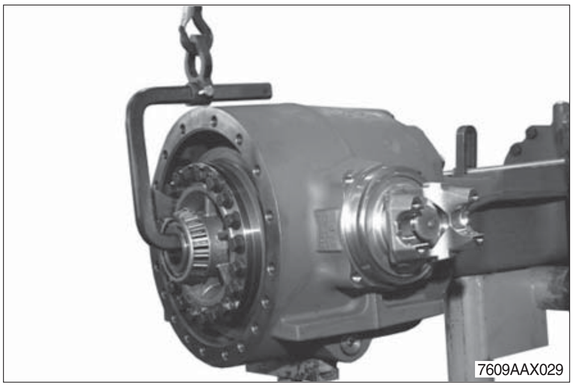
7609AAX028

(3) Disassembly input

① Use the lifting device to lift the differential out of the axle drive housing.

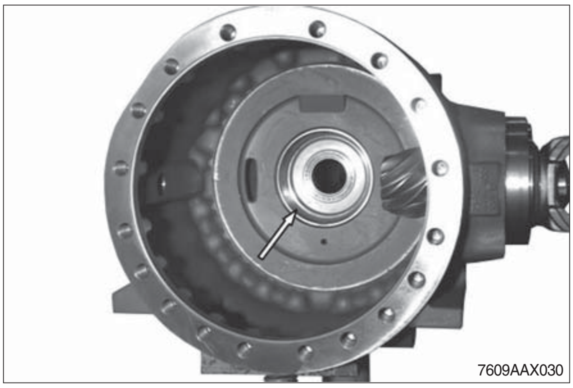
Load carrying fixture 5870 281 083

※ Disassembly of the differential is described as of page 3-95.



7609AAX029

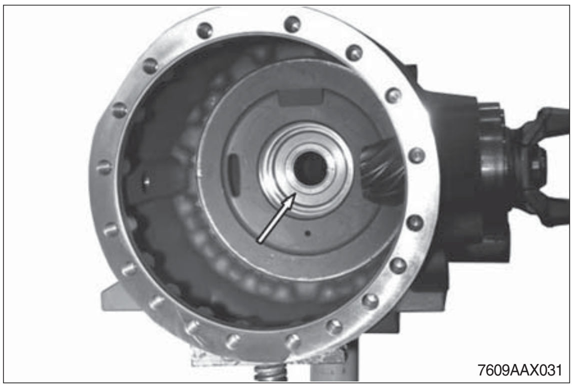
② Pull the bearing outer ring (see arrow) out of the housing hole and remove the shim behind.



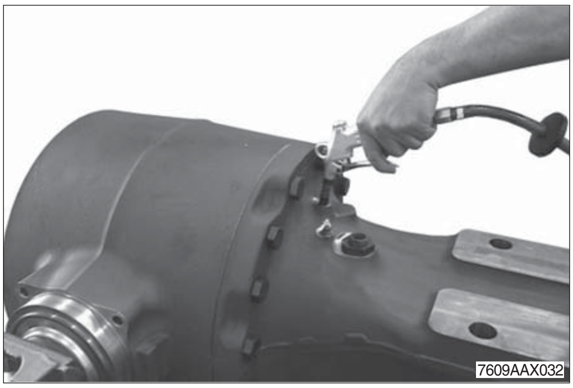
7609AAX030

③ Press piston (see arrow) out of the axle housing (see subsequent figure) by means of compressed air.

※ This operation is only necessary for the hydraulic lock differential (option).



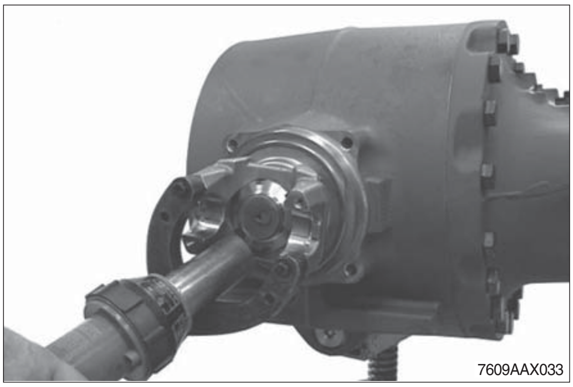
7609AAX031



7609AAX032

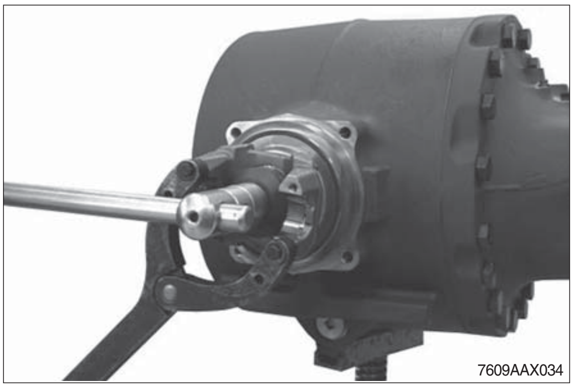
④ Heat slotted nut by means of hot air blower.

※ Slotted nut is secured with loctite (type No. : 262).

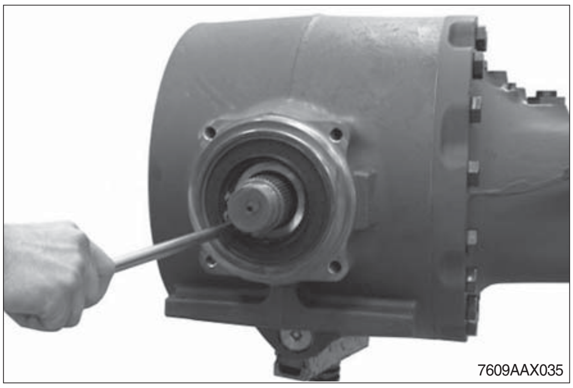


⑤ Loosen slotted nut and remove the shim behind.

Slotted nut wrench	5870 401 139
Clamping device	5870 240 002

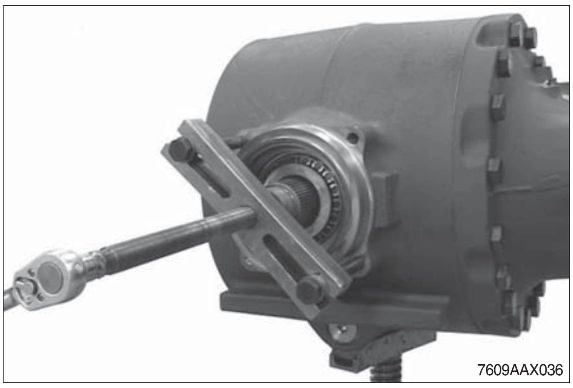


⑥ Pull the input flange from the input pinion and use a lever to remove the shaft seal behind from the axle drive housing.



⑦ Press input pinion from the axle drive housing and remove the releasing tapered roller bearing.

Extractor	5870 000 065
Hexagon screw (2EA)	AA00 331 360

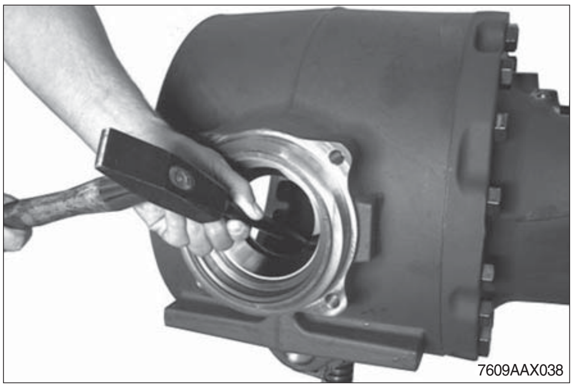


⑧ Remove spacer ring and pull the tapered roller bearing from the input pinion.

Gripping device	AA00 684 425
Basic tool	5873 002 000

7609AAX037

⑨ If necessary, force both bearing outer rings out of the axle drive housing.



7609AAX038

(4) Disassembly differentials

Disassembly hydraulic lock differential (option)

① Remove axial roller cage (arrow).


7609AAX039

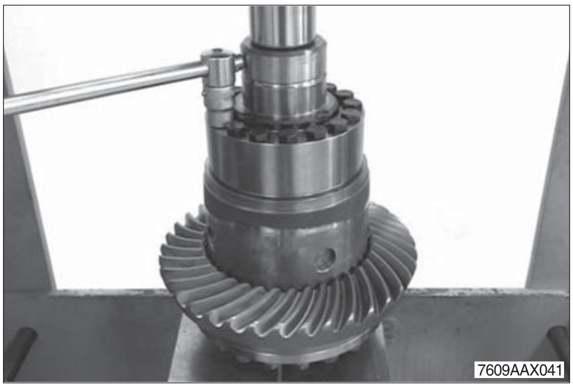
② Pull both tapered roller bearings from the differential.

Crown wheel side	
Grab sleeve	5873 012 016
Basic tool	5873 002 001
Opposite side	
Grab sleeve	5873 003 029
Basic tool	5873 002 001
Reduction	5873 003 011
Pressure piece	5870 100 075


7609AAX040

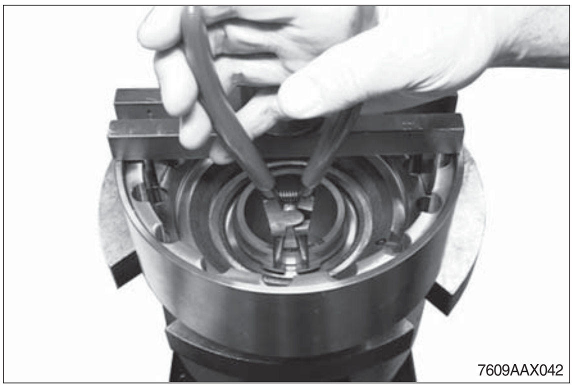
③ Preload the differential by means of the press, loosen the hexagon screws and remove the releasing housing cover.

Pressure piece 5870 100 075


7609AAX041

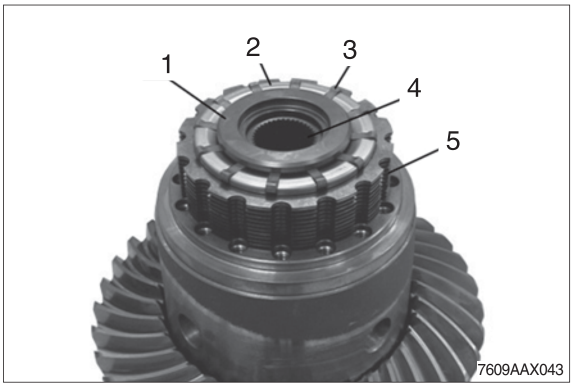
④ Preload the housing cover/compression spring by means of the press and disengage the retaining ring.

Then remove sliding sleeve and compression spring from the housing cover.

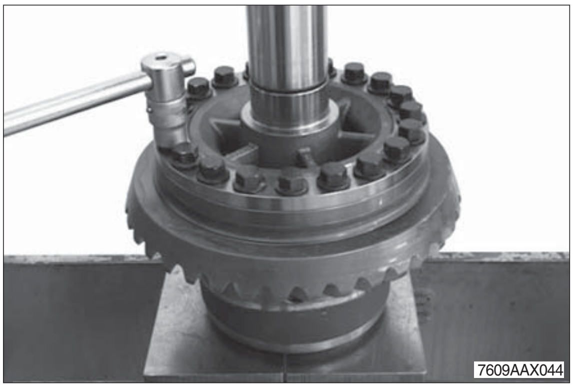

7609AAX042

⑤ Remove single parts.

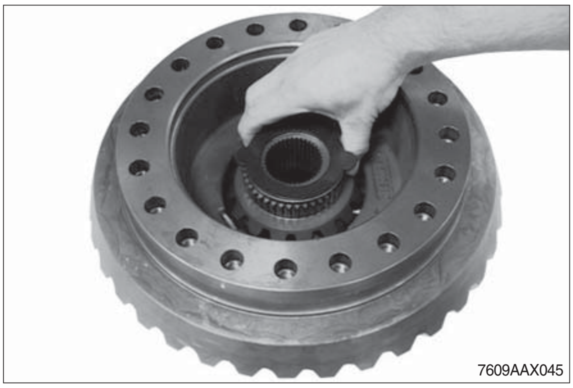
1 Pressure piece
2 Cage
3 Lever (12EA)
4 Disk carrier
5 Disk package



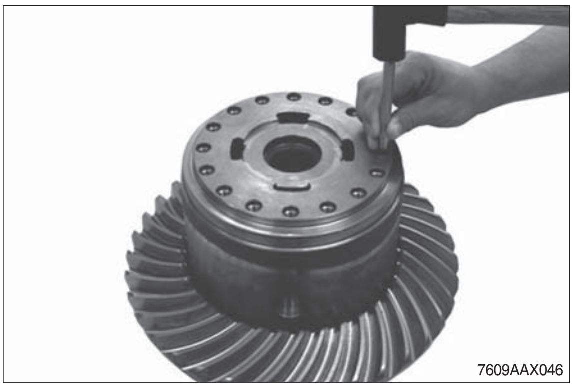
⑥ Preload differential by means of the press, loosen locking screws and housing cover.



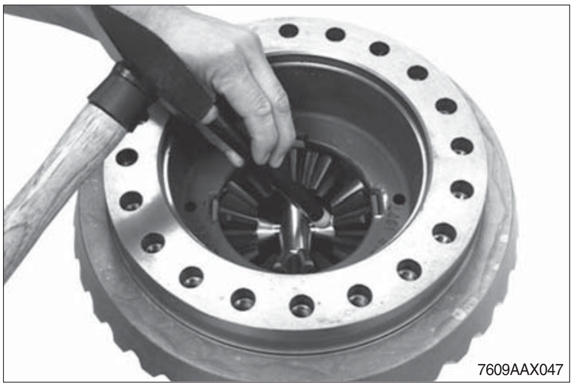
⑦ Remove axle bevel gear with thrust washers from the differential housing.



⑧ Force out both slotted pins.



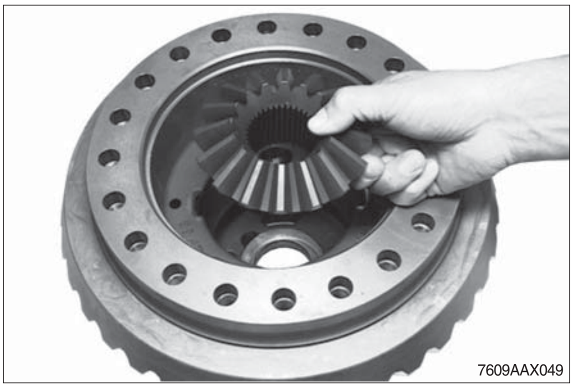
⑨ Force out both differential axles (short) and remove the releasing spider gears with thrust washers from the differential housing.


7609AAX047

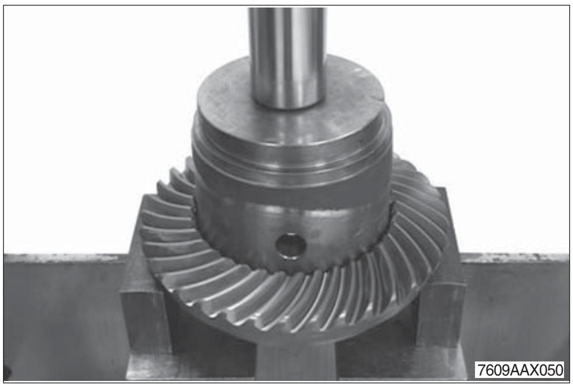
⑩ Pull the differential axle (long) and remove the releasing spider gears with thrust washers from the differential housing.


7609AAX048

⑪ Remove the axle bevel gear and the shim behind.


7609AAX049

⑫ Press crown wheel from the differential carrier.


7609AAX050

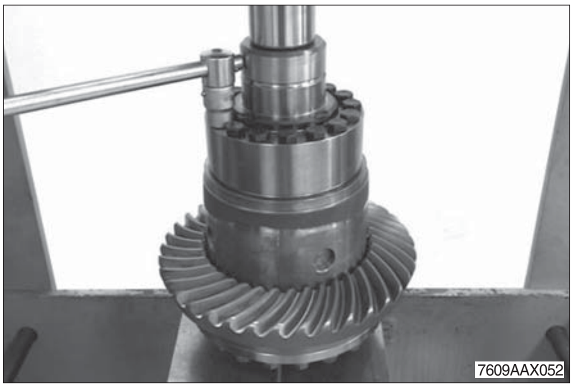
Disassembly conventional differential (standard)

① Pull both tapered roller bearings from the differential.

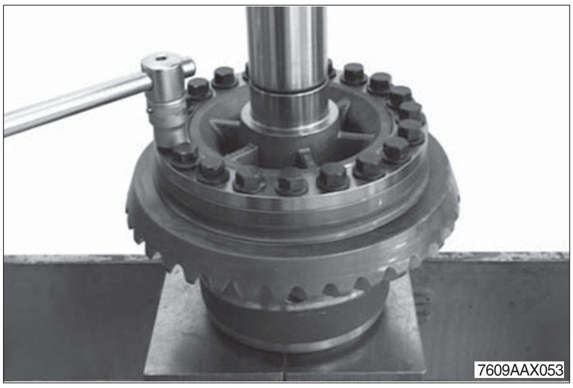
Grab sleeve	5873 012 016
Basic tool	5873 002 001


7609AAX051

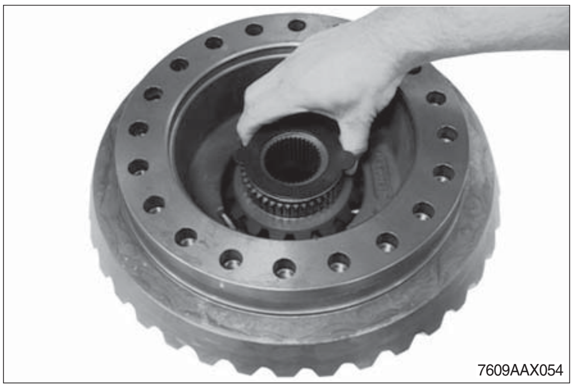
② Preload the differential by means of the press, loosen the hexagon screws and remove the releasing housing cover.


7609AAX052

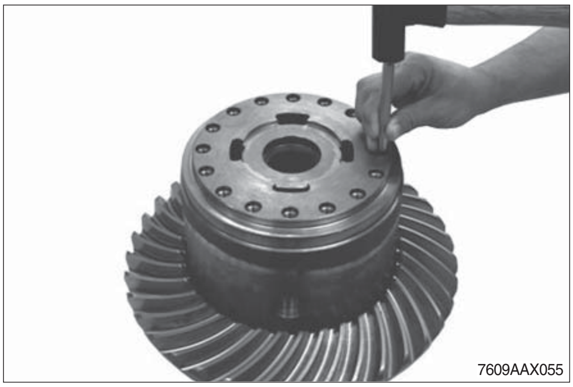
③ Preload the differential by means of the press, loosen locking screws and housing cover.


7609AAX053

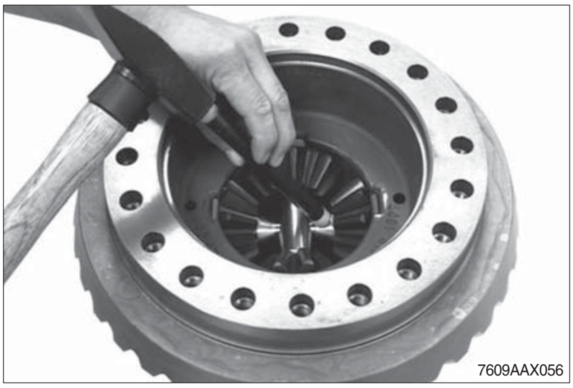
④ Remove axle bevel gear with thrust washers from the differential housing.


7609AAX054

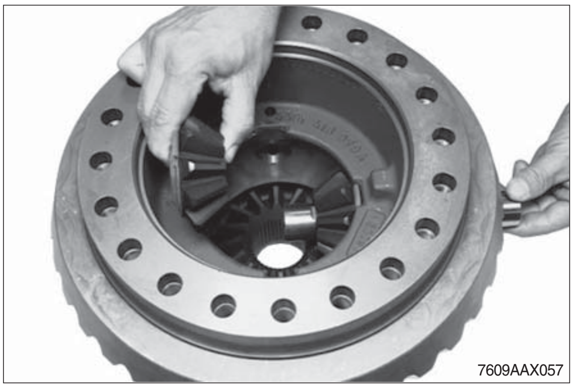
⑤ Force out both slotted pins.


7609AAX055

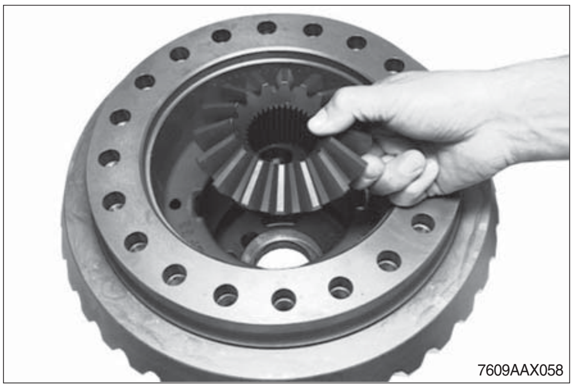
⑥ Force out both differential axles (short) and remove the releasing spider gears with thrust washers from the differential housing.


7609AAX056

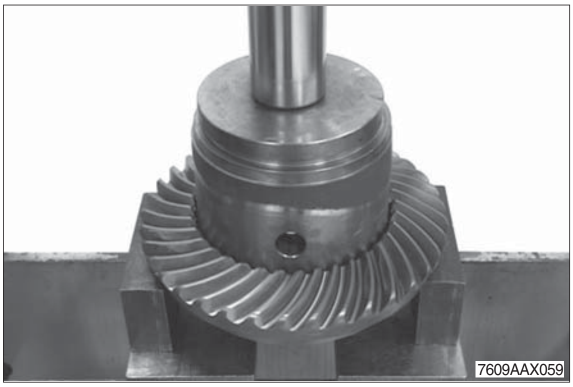
⑦ Pull the differential axle (long) and remove the releasing spider gears with thrust washers from the differential housing.


7609AAX057

⑧ Remove the axle bevel gear and the shim behind.


7609AAX058

⑨ Press crown wheel from the differential carrier.

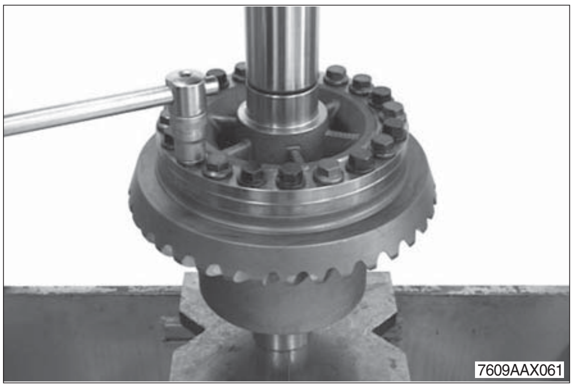


Disassembly limited slip differential (option)

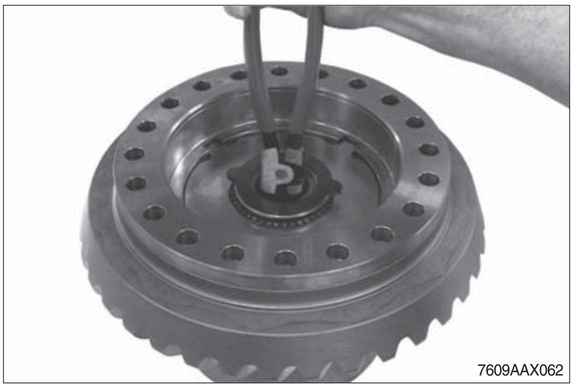
① Pull both tapered roller bearings from the differential.

Grab sleeve	5873 012 016
Basic tool	5873 002 001

② Preload the differential by means of the press, loosen locking screws and housing cover.



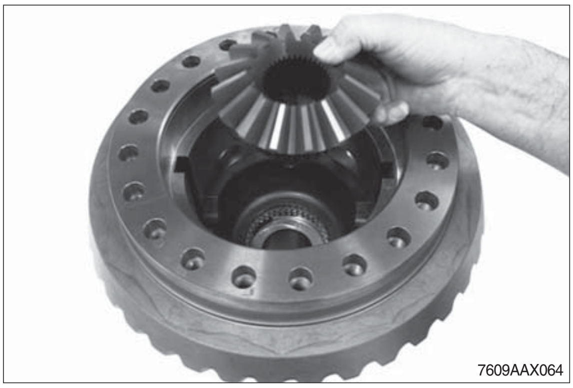
③ Lift the axle bevel gear with pressure ring, disk package and thrust washers out of the differential housing.



④ Remove spider shafts and axle bevel gears (see figure) out of the differential housing.

7609AAX063

⑤ Remove the second axle bevel gear.

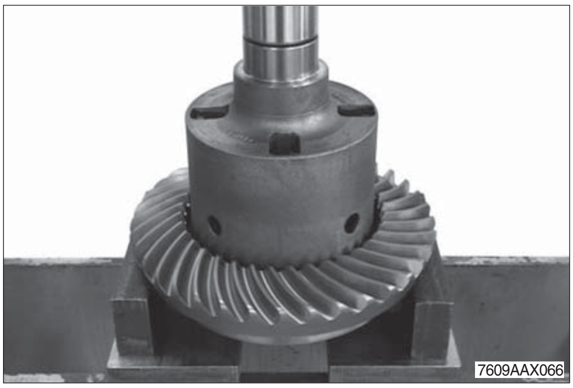


7609AAX064

⑥ Lift the pressure ring out of the differential housing and remove the disk package and thrust washers behind.

7609AAX065

⑦ Press crown wheel from the differential carrier.



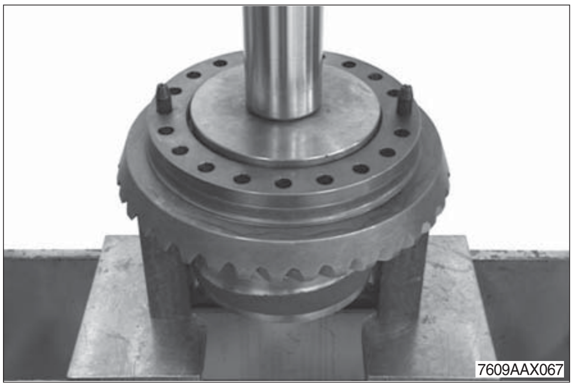
7609AAX066

(5) Reassembly differentials

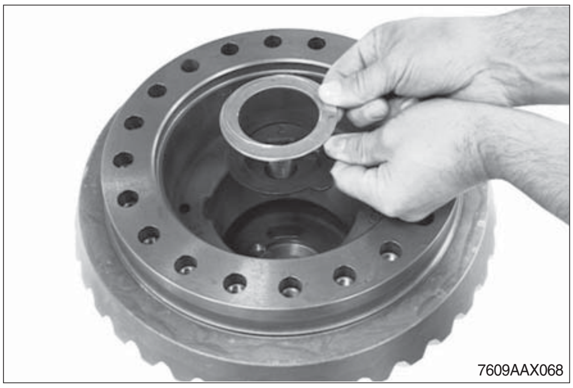
Reassembly hydraulic lock differential (option)

① Mount two locating pins and press the heated crown wheel onto the differential housing until contact is obtained.

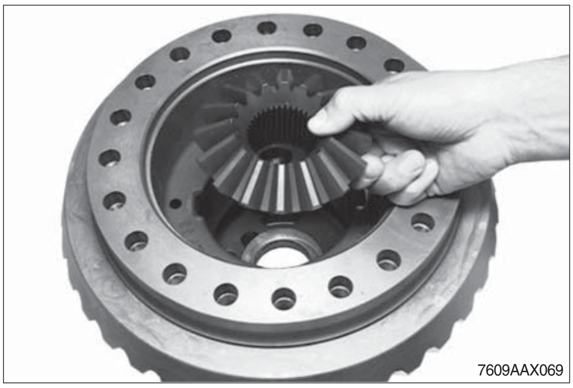
Locating pins	5870 204 040



② Insert thrust washer into the differential housing.

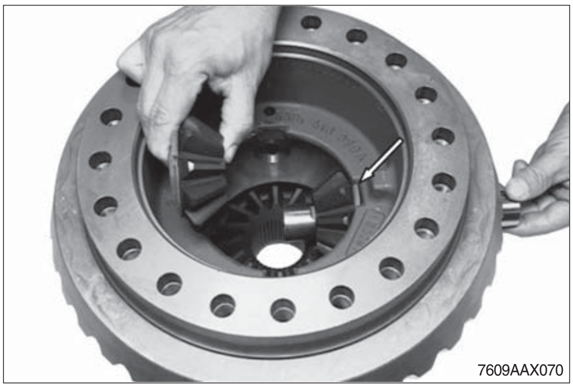


③ Insert axle bevel gear.



④ Insert spider gears with thrust washers into the differential housing and fix them with the spider shaft (long).

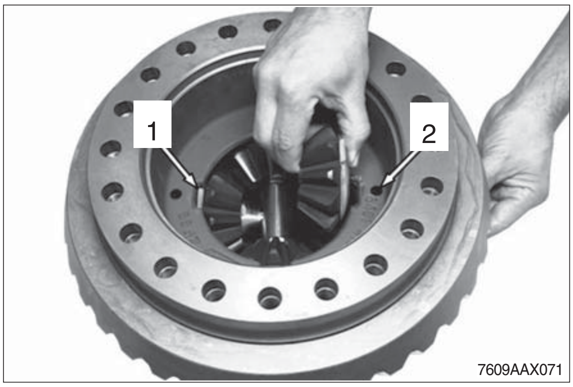
※ Thrust washers must be positioned with the tabs (see arrow) being located in the recesses of the differential housing.



⑤ Insert spider gears with thrust washers into the differential housing and fix them with the two spider shafts (short).

※ Thrust washers must be positioned with the tabs (see arrow 1) being located in the recesses of the differential housing.

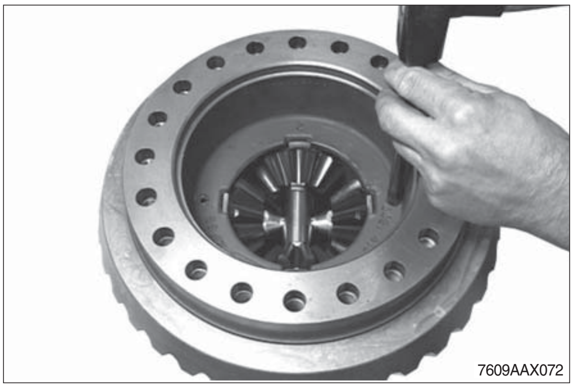
※ Pay attention to radial installation position of the spider shafts (fixing holes, arrow 2).



7609AAX071

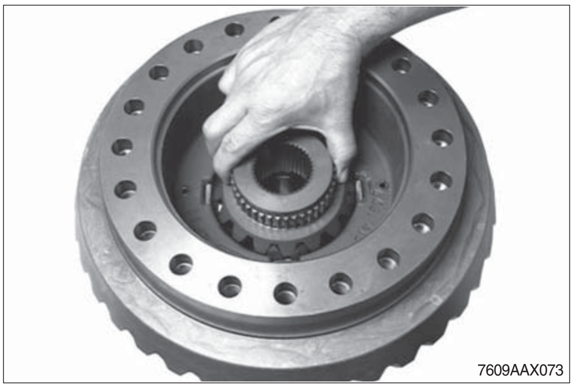
⑥ Fix spider shafts (short) with slotted pins.

※ Flush mount slotted pins.



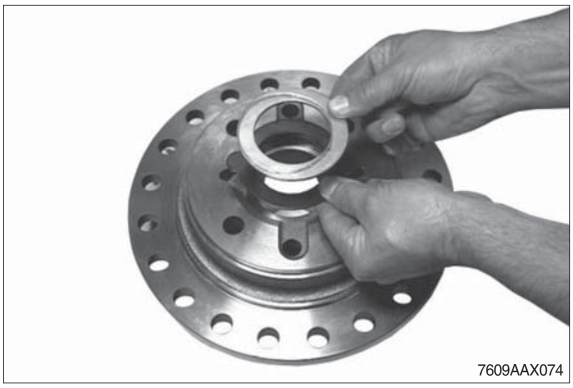
7609AAX072

⑦ Mount second axle bevel gear.



7609AAX073

⑧ Fix the thrust washers into the housing cover by means of grease.



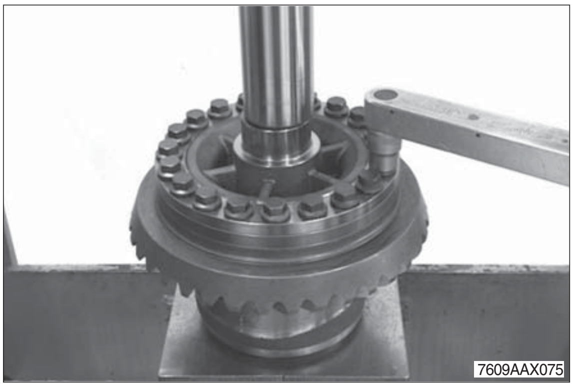
7609AAX074

⑨ Mount two adjusting screws and insert the housing cover until contact with the differential housing is obtained.

Locating pins 5870 204 040

Preload the differential by means of the press and bolt with new locking screws.

· Tightening torque (M16/12.9) :
40.8 kgf · m (295 lbf · ft)

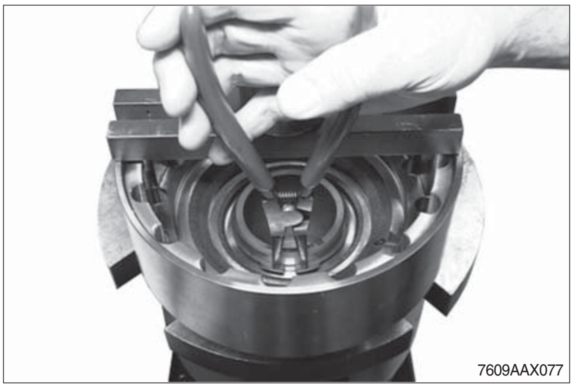

7609AAX075

⑩ Install compression spring onto the sliding sleeve.


7609AAX076

⑪ Insert the premounted sliding sleeve into the housing cover.

Preload the compression spring by means of the press and engage the retaining ring into the annular groove of the sliding sleeve.

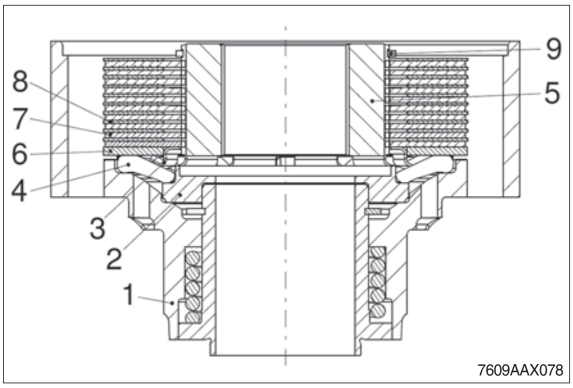

7609AAX077

Setting of disk package

⑫ Premount single parts according to the adjacent sketch.

1 Housing cover
2 Pressure piece
3 Cage
4 Lever (12EA)
5 Disk carrier
6 Pressure ring
7 Inner disks
8 Outer disks (optional)
9 Snap ring

※ For the number of disks and the disk arrangement please refer to the relating parts manual.

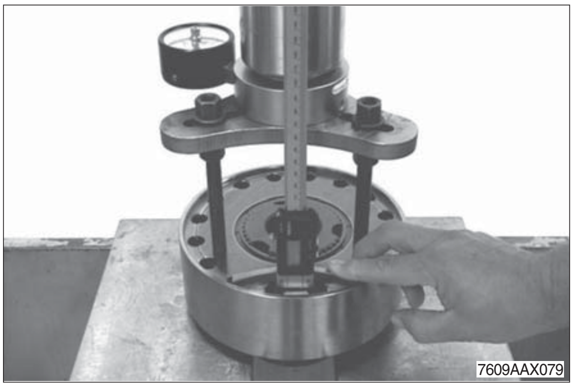


7609AAX078

⑬ Preload disk package with an axial force of F = 50^{+30} kN.
Then check the setting dimension "A" = 1.05±0.1 mm from the collar of the differential cover to the plane face of the outer disk (see also below sketch).

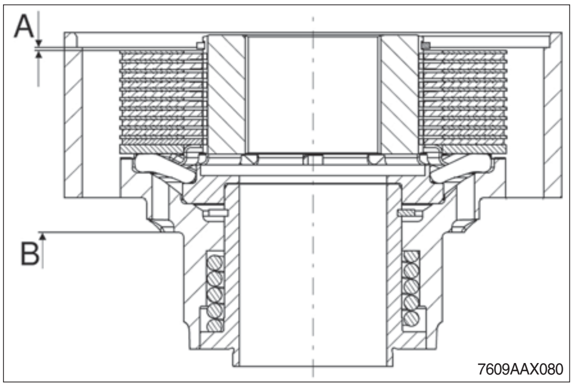
Pressure piece	5870 100 069
Load cell	5870 700 004

※ Any deviation from the specified setting dimension must be corrected with a corresponding outer disk.


7609AAX079

A = Setting dimension = 1.05±0.1 mm
B = Contact face

⑭ To obtain a correct measuring result :
The housing cover may only be supported on the contact face (B).
Ensure that the assembly fixture is only supported on the disk package and not on the disk carrier (5).



7609AAX080

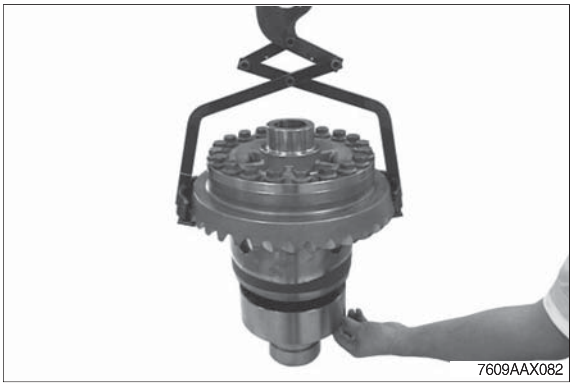
⑮ Position housing cover onto pressure piece (see arrow).
Insert two hexagon screws into the housing cover to radially fix the disk package.

Pressure piece	5870 100 075


7609AAX081

⑯ Position the premounted differential with the lifting device onto the housing cover and preliminarily fix with hexagon screws.

Lifting device	AA00 331 446

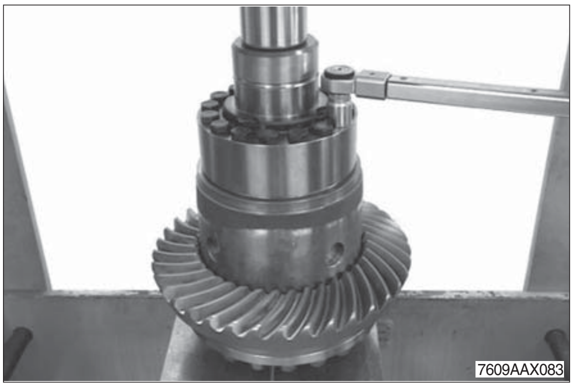

7609AAX082

⑰ Preload the differential by means of the press and the pressure piece.

Then finally tighten the housing cover with hexagon screws.

· Tightening torque (M14/10.9) :
18.9 kgf · m (136 lbf · ft)

Pressure piece 5870 100 075

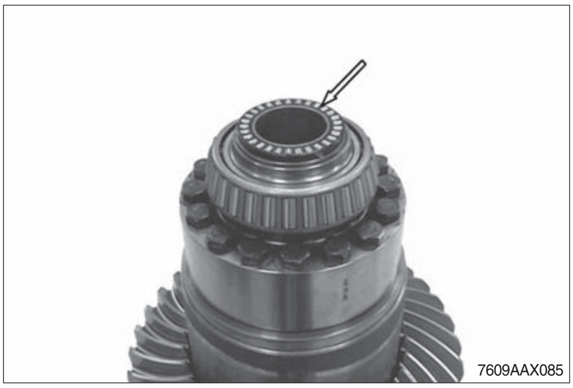

7609AAX083

⑱ Heat both tapered roller bearings and insert until contact is obtained.

※ Adjust tapered roller bearing after cooling down.


7609AAX084

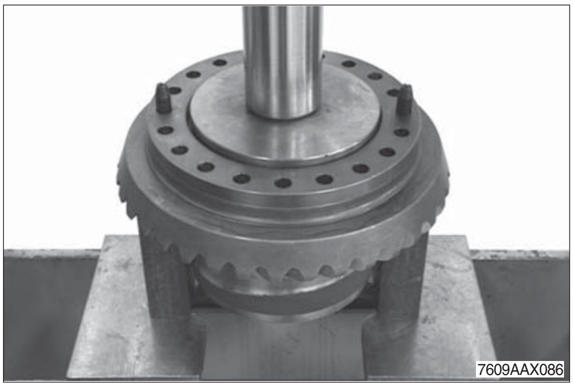
⑲ Fix axial roller cage (see arrow) to the sliding sleeve by means of grease.


7609AAX085

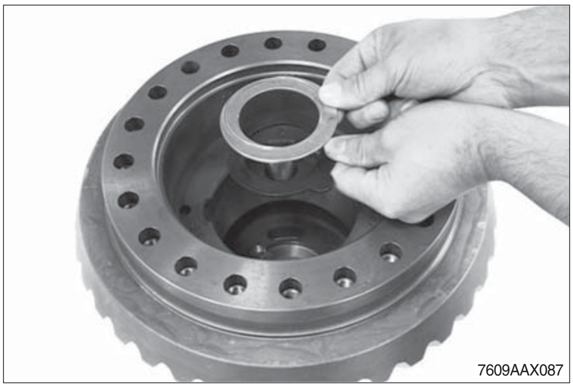
Reassembly conventional differential (standard)

① Mount two locating pins and press the heated crown wheel onto the differential housing until contact is obtained.

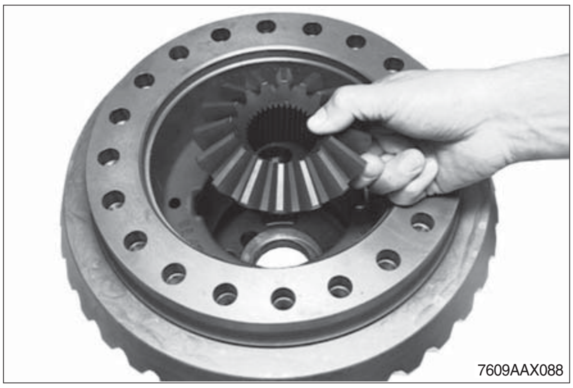
Locating pins 5870 204 040



② Insert thrust washer into the differential housing.

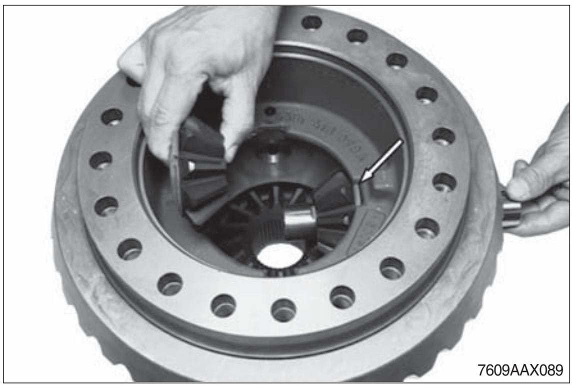


③ Insert axle bevel gear.



④ Insert spider gears with thrust washers into the differential housing and fix them with the spider shaft (long).

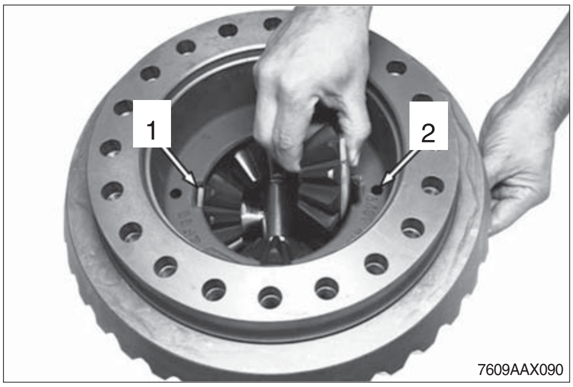
※ Thrust washers must be positioned with the tabs (see arrow) being located in the recesses of the differential housing.



⑤ Insert spider gears with thrust washers into the differential housing and fix them with the two spider shafts (short).

※ Thrust washers must be positioned with the tabs (see arrow 1) being located in the recesses of the differential housing.

※ Pay attention to radial installation position of the spider shafts (fixing holes, arrow 2).



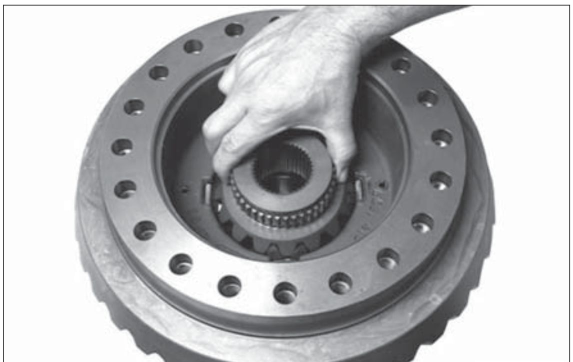
7609AAX090

⑥ Fix spider shafts (short) with slotted pins.

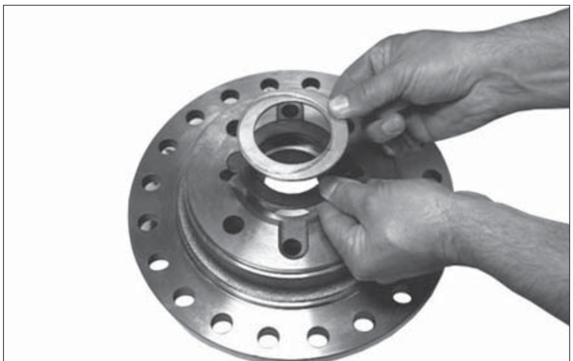
※ Flush mount slotted pins.


7609AAX091

⑦ Mount second axle bevel gear.


7609AAX092

⑧ Fix the thrust washers into the housing cover by means of grease.

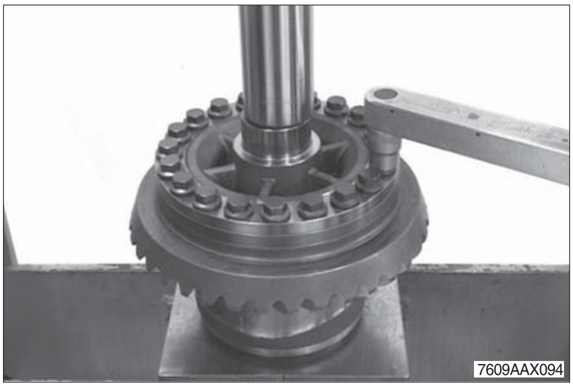

7609AAX093

⑨ Mount two adjusting screws and insert the housing cover until contact with the differential housing is obtained.

Locating pins 5870 204 040

Preload the differential by means of the press and bolt with new locking screws.

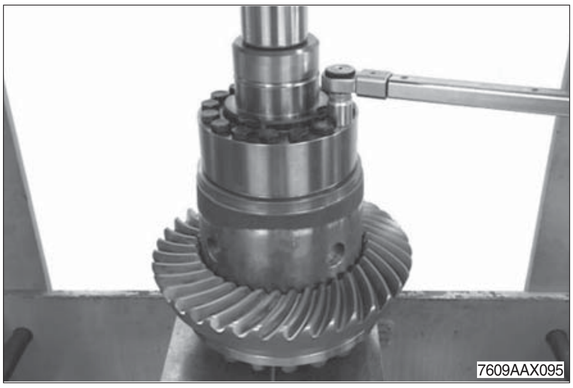
· Tightening torque (M16/12.9) :
40.8 kgf · m (295 lbf · ft)



⑩ Attach the housing cover and preload the differential with the press.

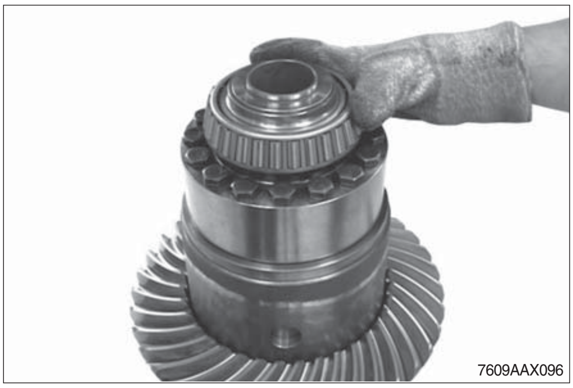
Then fix the housing cover with hexagon screws.

· Tightening torque (M14/10.9) :
18.9 kgf · m (136 lbf · ft)



⑪ Heat both tapered roller bearings and insert until contact is obtained.

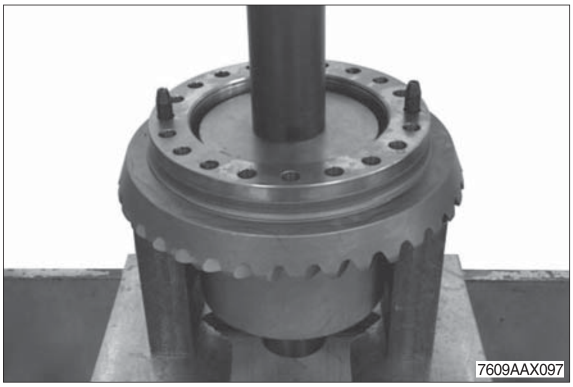
※ Adjust tapered roller bearing after cooling down.



Reassembly limited slip differential (option)

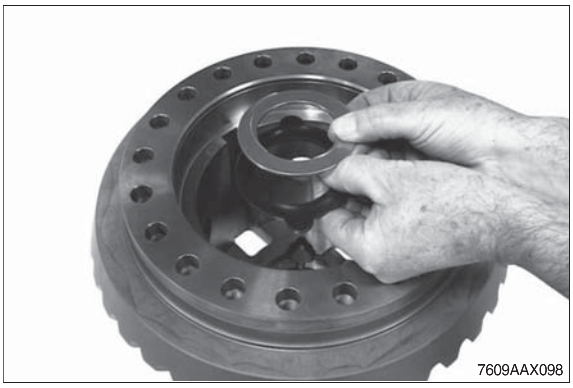
① Mount two locating pins and press the heated crown wheel onto the differential housing until contact is obtained.

Locating pins 5870 204 040



7609AAX097

② Insert thrust washer into the differential housing.

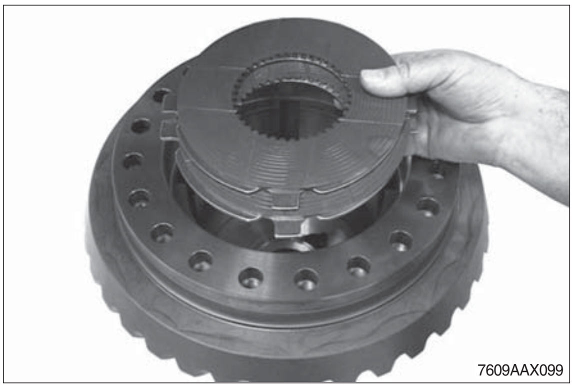


7609AAX098

③ Mount outer and inner disks in alternating order, starting with an outer disk.

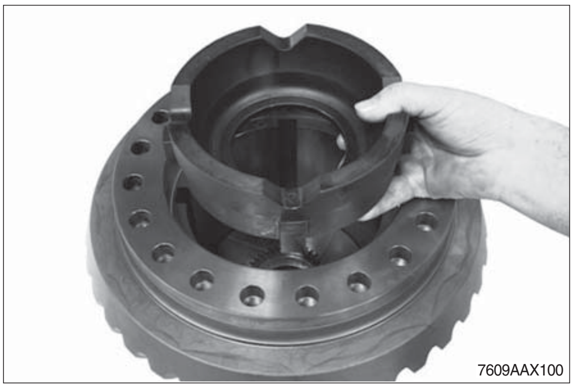
※ The installation clearance of the internal parts is corrected by mounting outer disks with different thicknesses.

⚠ **The difference in thickness between the left and the right disk package must only be 0.1 mm at maximum.**



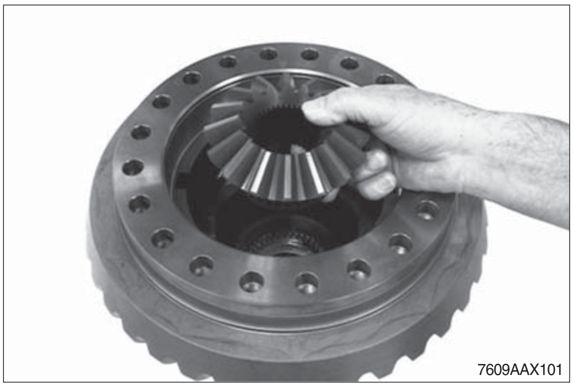
7609AAX099

④ Place the pressure ring.

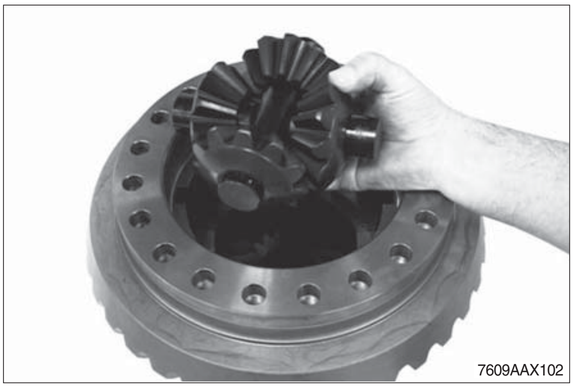


7609AAX100

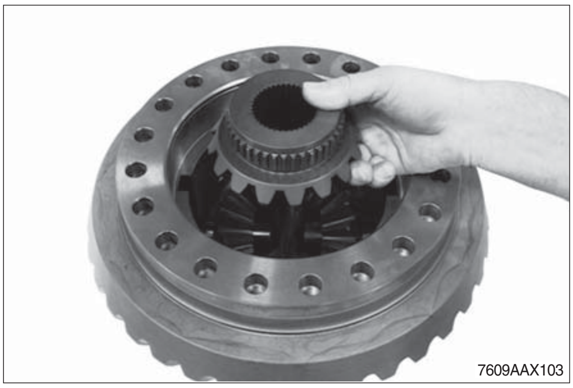
⑤ Insert the axle bevel gear until contact is obtained and install the inner disks with the teeth.


7609AAX101

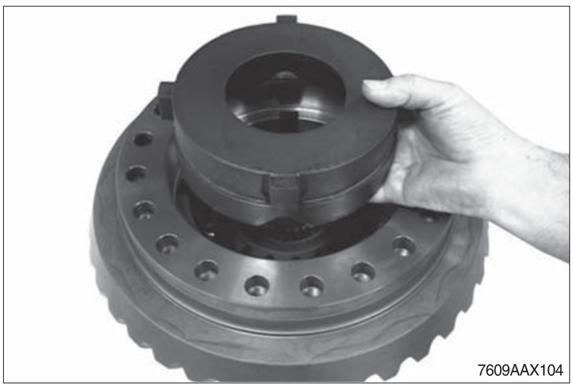
⑥ Preassemble the differential spider and insert it into the differential housing/into the pressure ring.


7609AAX102

⑦ Mount second axle bevel gear.


7609AAX103

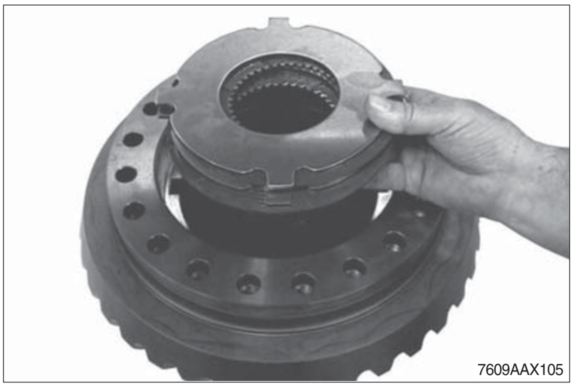
⑧ Insert the second pressure ring into the differential housing.


7609AAX104

⑨ Mount outer and inner disks in alternating order, starting with an inner disk.

The installation clearance of the internal parts is corrected by mounting outer disks with different thicknesses.

⚠ **The difference in thickness between the left and the right disk package must only be 0.1 mm at maximum.**

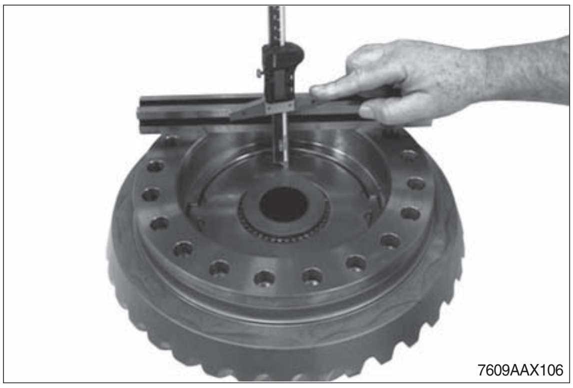


7609AAX105

Determine the installation clearance 0.2~0.7 mm

⑩ Measure dimension I, from the mounting face of the differential housing to the plane face of the outer disk.

Dimension I e.g. . . . . 44.30 mm



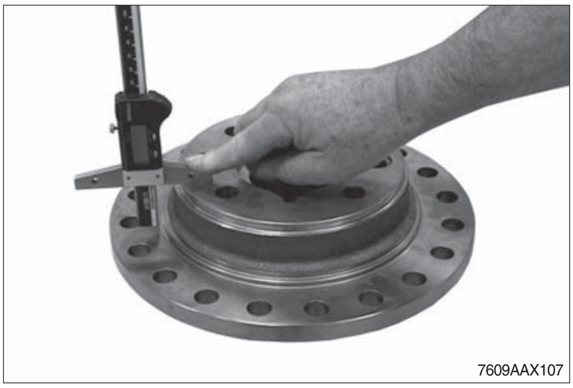
7609AAX106

⑪ Measure dimension II, from the contact face of the outer disk to the mounting face on the housing cover.

Dimension II e.g. . . . . 43.95 mm

CALCULATION EXAMPLE :

Dimension I	44.30 mm
Dimension II	- 43.95 mm
Difference = disk clearance =	0.35 mm



7609AAX107

※ Any deviation from the required installation clearance is to be corrected with corresponding outer disks (s = 2.7, s = 2.9, s = 3.0, s = 3.1, s = 3.2, s = 3.3 or s = 3.5 mm), taking care that the difference in thickness between the left and the right disk package must only be 0.1 mm at maximum.

⑫ Fix the thrust washers into the housing cover by means of grease.

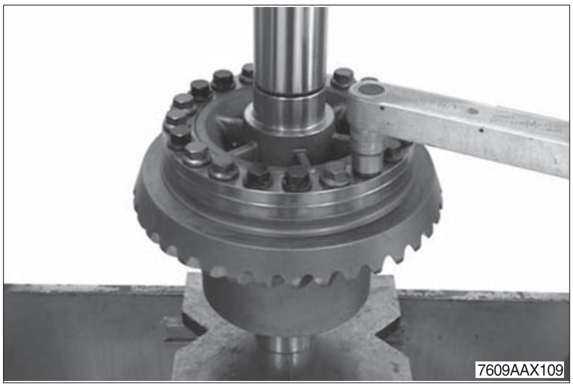
7609AAX108

⑬ Mount two adjusting screws and insert the housing cover until contact with the differential housing is obtained.

Locating pins 5870 204 040

Preload the differential by means of the press and bolt with new locking screws.

· Tightening torque (M16/12.9) :
40.8 kgf · m (295 lbf · ft)



7609AAX109

⑭ Heat both tapered roller bearings and insert until contact is obtained.

※ Adjust tapered roller bearing after cooling down.

7609AAX110

(6) Reassembly input

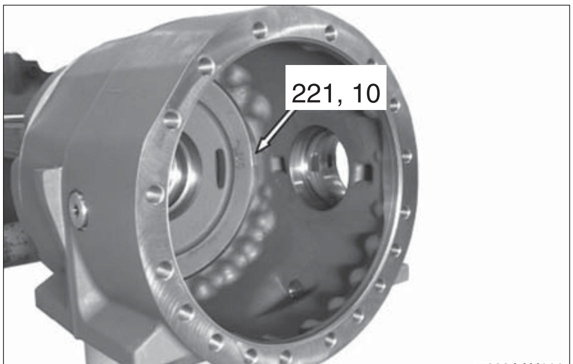
※ If crown wheel or input pinion are damaged, both parts must be jointly replaced.
In case of a new installation of a complete bevel gear set pay attention to an identical mating number of input pinion and crown wheel.

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. .... 221.10 mm



7609AAX111

② Read dimension II (pinion dimension).

Dimension II e.g. .... 181.00 mm

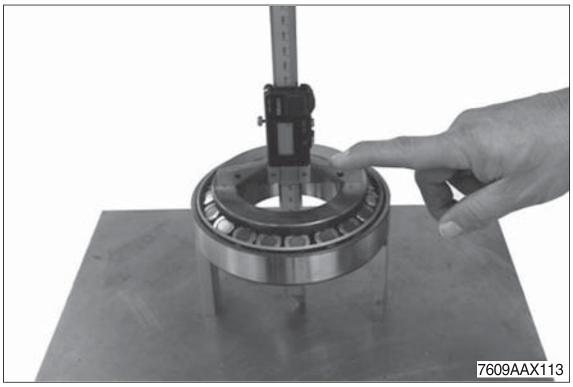
7609AAX112

③ Determine dimension III (bearing width).

Dimension III e.g. . . . . 39.10 mm

CALCULATION EXAMPLE "A„ :

Dimension I	221.10 mm
Dimension II	- 181.00 mm
Dimension III	- 39.10 mm
Difference = shim	**s = 1.00 mm**

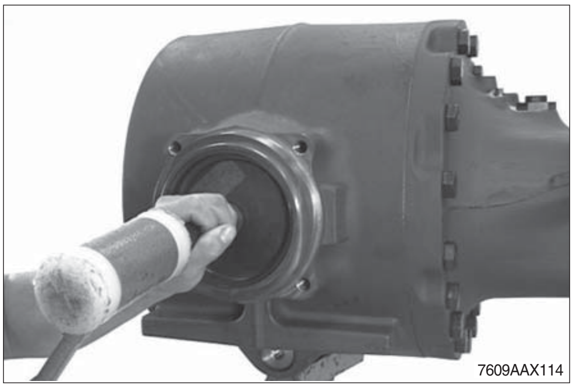


7609AAX113

Reassembly of input pinion

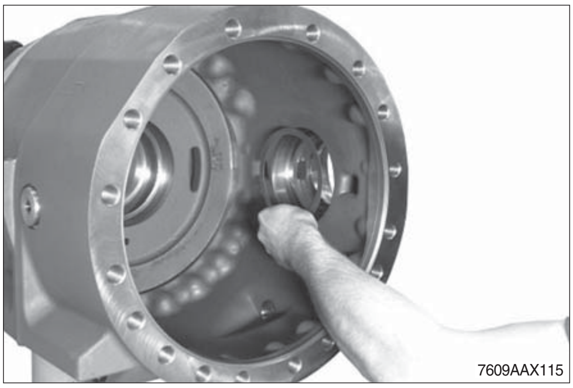
④ Undercool the external bearing outer ring and insert it into the axle drive housing until contact is obtained.

Driver tool	5870 058 079
Handle	5870 260 004



7609AAX114

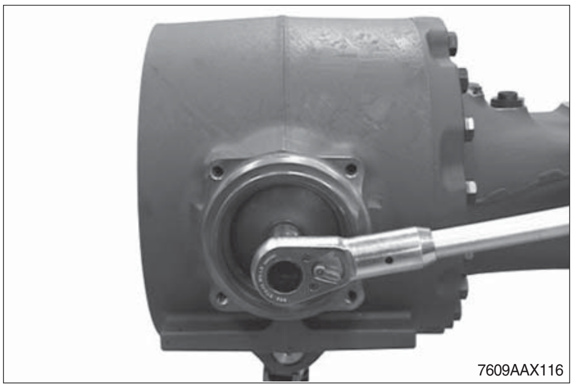
⑤ Insert the determined shim e.g. s = 1.00 mm into the housing hole.



7609AAX115

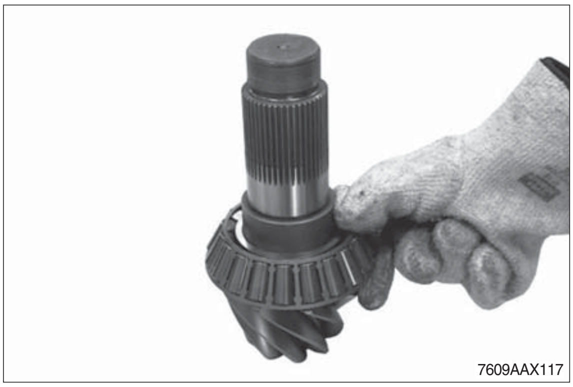
⑥ Undercool the internal bearing outer ring and bring it into contact position in the housing hole by using the assembly fixture.

Assembly fixture	5870 345 080



7609AAX116

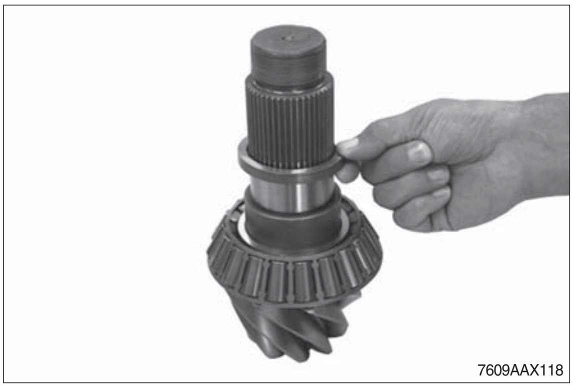
⑦ Heat the tapered roller bearing and insert it into the input pinion until contact is obtained.



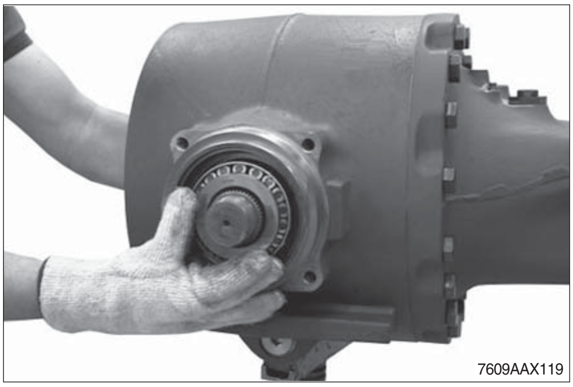
Setting of rolling torque of input pinion bearing 0.15~0.41 kgf · m (1.11~2.95 lbf · ft) (without shaft seal)

⑧ Insert spacer (e.g. s = 8.18 mm).

※ According to our experience the necessary rolling torque is obtained when reusing the spacer which has been removed during disassembly (e.g. s = 8.18 mm).
A later check of the rolling torque, however, is absolutely necessary.

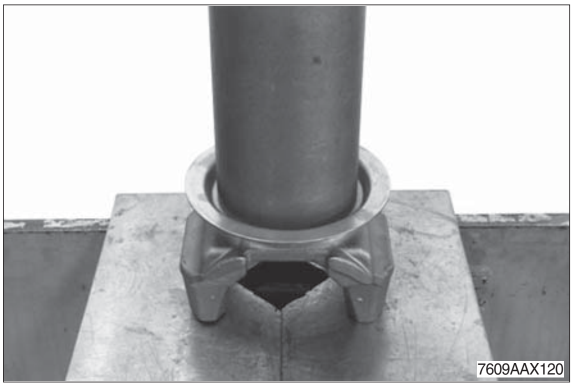


⑨ Insert the preassembled input pinion into the axle drive housing and insert the heated tapered roller bearing until contact is obtained.



⑩ Press the protection plate onto the input flange (see arrow) until contact is obtained.

※ Do not fit the shaft seal until the contact pattern has been checked.



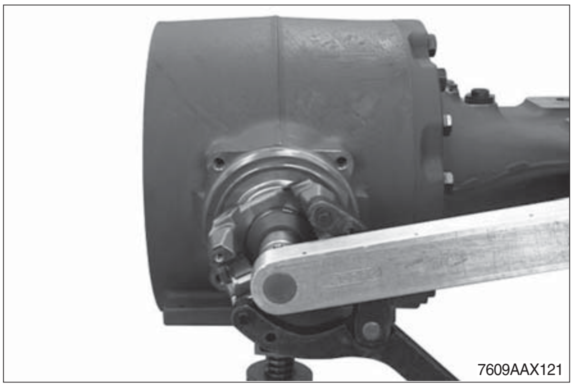
⑪ Insert input flange and fix it by means of disk and slotted nut.

· Tightening torque :
122 kgf · m (885 lbf · ft)

Slotted nut wrench	5870 401 139
Clamping device	5870 240 002

※ Preliminarily mount slotted nut without loctite.

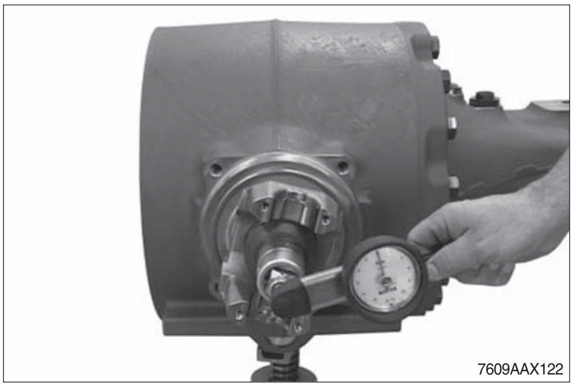
⚠ While tightening rotate the input pinion several times in both directions.


7609AAX121

⑫ Check rolling torque (0.15~0.41 kgf · m) without shaft seal).

※ 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 (AX118, page 3-116) as specified below.
Insufficient rolling torque
install thinner spacer ring
Excessive rolling torque
install thicker spacer ring

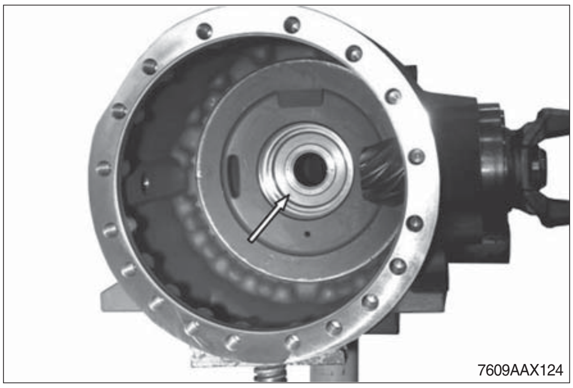

7609AAX122

⑬ Grease O-rings (2EA, see arrows) and insert them into the annular grooves of the piston.

※ Operation figure AX123 and AX124 is only necessary for hydraulic lock differential (option).

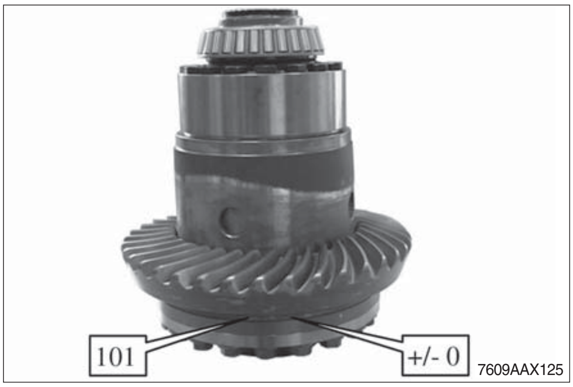

7609AAX123

⑭ Insert piston (see arrow) into the bearing housing until contact is obtained.


7609AAX124

Determination of shims for setting of bearing rolling torque (differential housing) and backlash (bevel gear set)

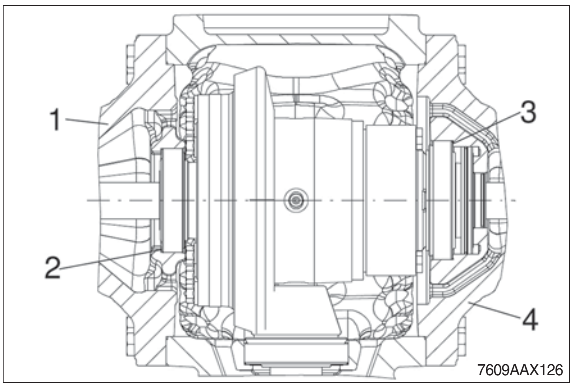
※ Determine the required shims on the basis of the read value (deviation/test dimension) and the corresponding specifications of the table below :
(KRS – SET – RIGHT)
(KRS = bevel gear set)



⑮ Deviation see crown wheel rear side.

※ The test dimension “101„ 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.

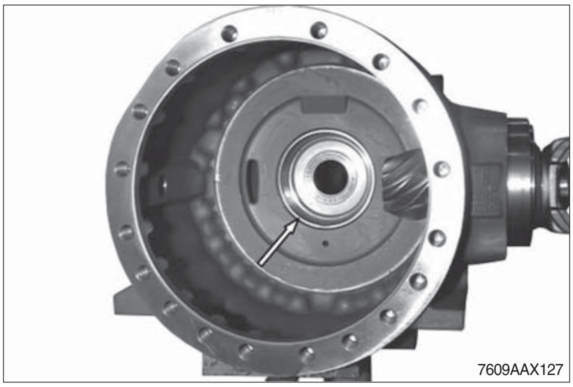
Any + or – deviation of the test dimension caused by production is also marked on the crown wheel rear side (e.g. - 20 or - 10 or 10 or 20).
In accordance with this deviation, the required shims are allocated in the table below.



1 Axle housing
2 Shim (crown wheel side)
3 Shim (differential carrier side)
4 Axle housing

Shims for differential				
Crown wheel marking	- 20	- 10	-	10
Deviation	- 0.2	- 0.1	0	0.1
Shim **Differential cage side** Shim thickness	**0.7**	**0.8**	**0.9**	**1.0**
Shim Hydraulic lock differential	ZGAQ-04367	ZGAQ-04167	ZGAQ-04168	ZGAQ-04169
Shim Conventional, L/slip differential	ZGAQ-04368	ZGAQ-03896	ZGAQ-03897	ZGAQ-03898
Shim **Crown wheel side** Shim thickness	**1.3**	**1.2**	**1.1**	**1.0**
Shim	ZGAQ-04369	ZGAQ-03900	ZGAQ-03899	ZGAQ-03898

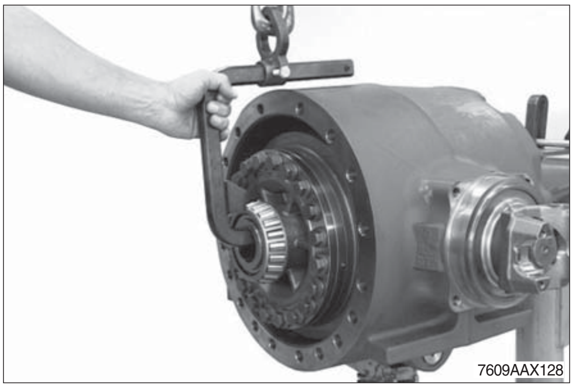
⑯ Insert the determined shim (e.g. s = 0.9 mm) into the hole of the axle housing and adjust the bearing outer ring (see arrow) until contact is obtained.


7609AAX127

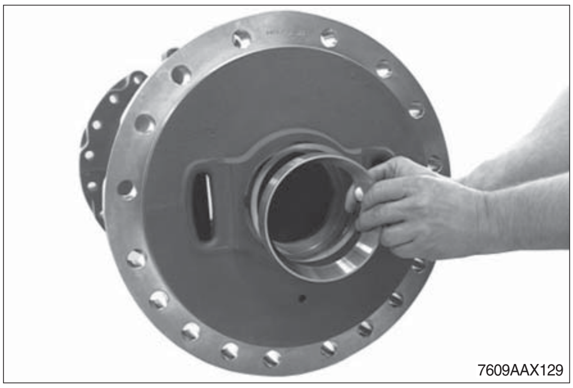
⑰ Cover some drive and coast flanks of the crown wheel with marking ink.

Then insert the premounted differential into the axle drive housing.

Load carrying device 5870 281 083


7609AAX128

⑱ Insert the determined shim (e.g. s = 1.1 mm) into the hole of the axle housing and adjust the bearing outer ring (see arrow) until contact is obtained.


7609AAX129

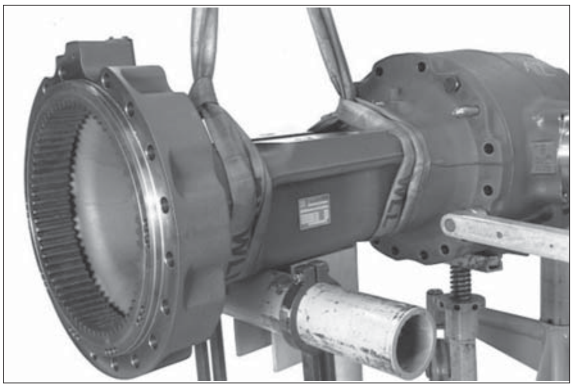
⑲ Mount two locating pins and bring the axle housing into contact position with the axle drive housing by means of the lifting device.

Locating pins 5870 204 024

Then preliminarily fix the axle housing with 4 hexagon screws.

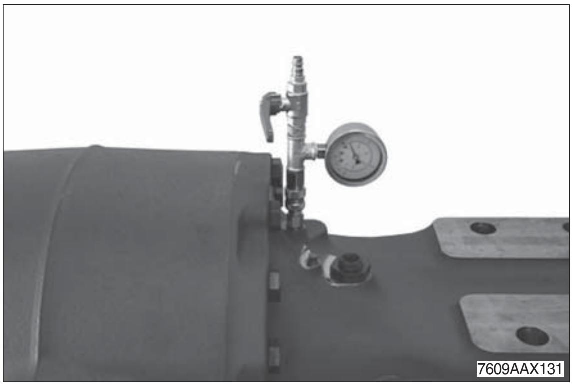
· Tightening torque (M20/10.9) :
57.1 kgf · m (413 lbf · ft)

※ Preliminarily mount the axle housing without O-ring.


7609AAX130

Leakage test of lock

⑳ Pressurize the lock (p = 1 bar), close shut-off valve and remove air line.



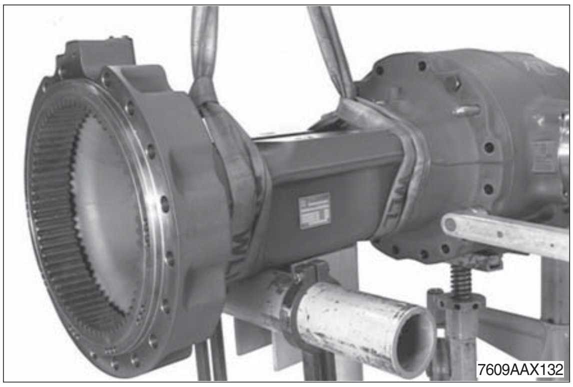
⚠ **No noticeable pressure loss is allowed to occur within 10 sec.**

※ This operation is only necessary for hydraulic lock diferential (option).

㉑ By rotating the input flange, roll crown wheel over the input pinion in both directions several times.

Then remove the axle housing again and lift the differential out of the axle drive housing.

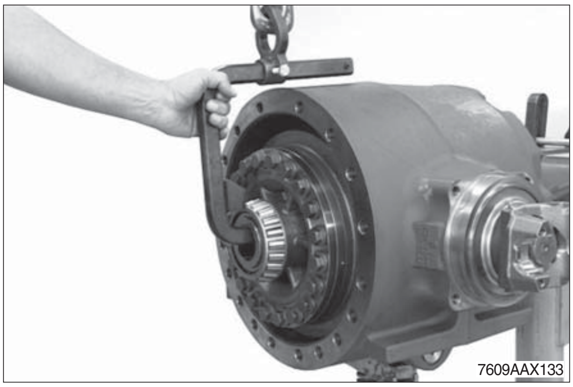
Compare the obtained contact pattern.



⚠ **In case of any contact pattern deviation, a measuring error was made when determining the shim (AX115, page 3-233), which must be corrected by all means.**

㉒ After the contact pattern check insert the differential again into the axle drive housing.

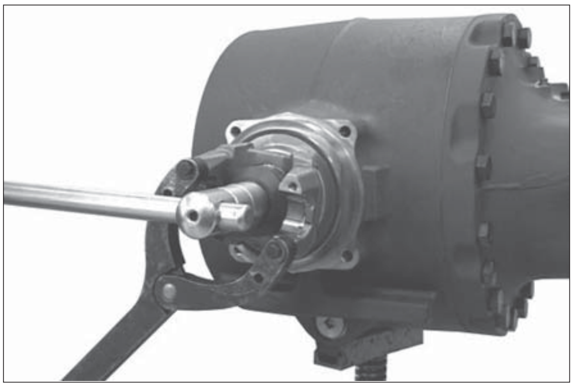
Load carrying device 5870 281 083



Reassembly of shaft seal (figure AX134~136)

㉓ Loosen the slotted nut and pull the input flange from the input pinion.

Slotted nut wrench	5870 401 139
Clamping device	5870 240 002



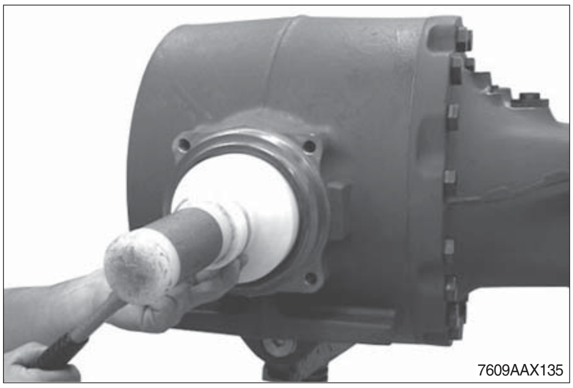
7609AAX134

㉔ Mount the shaft seal with the seal lip showing to the oil chamber.

Driver tool	5870 048 233

※ The exact installation position of the shaft seal is obtained when using the specified driver tool.

※ Wet the outer diameter of the shaft seal with spirit directly before installation and fill the space between seal and dust lip with grease.



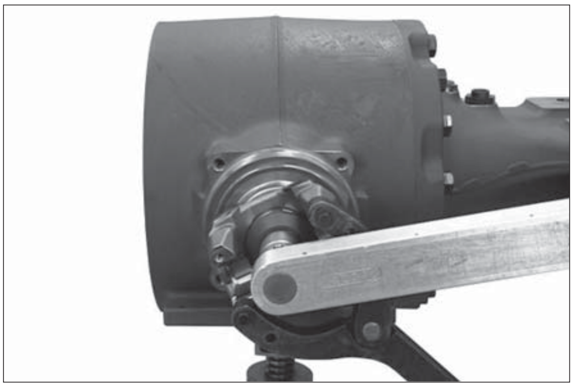
7609AAX135

㉕ Insert input flange and finally tighten by means of disk and slotted nut.

· Tightening torque : 122 kgf · m (885 lbf · ft)

Slotted nut wrench	5870 401 139
Clamping device	5870 240 002

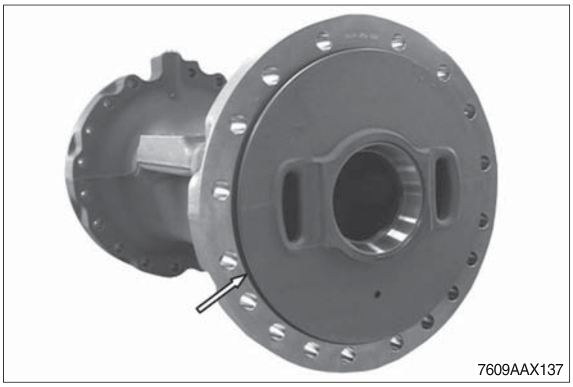
※ Cover the thread of the slotted nut with loctite (type no. : 262).



7609AAX136

(7) Reassembly axle housing

① Grease O-ring (see arrow) and insert it into the axle housing.



7609AAX137

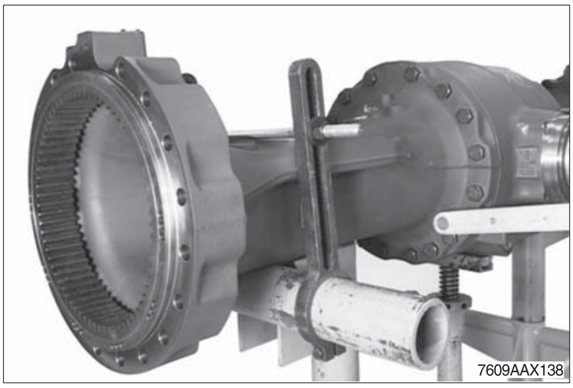
② Mount two locating pins and bring the axle housing into contact position with the axle drive housing by using the lifting device.

Then fix the axle housing by means of hexagon screws.

· Tightening torque (M20/10.9) :
57.1 kgf · m (413 lbf · ft)

Locating pins 5870 204 024

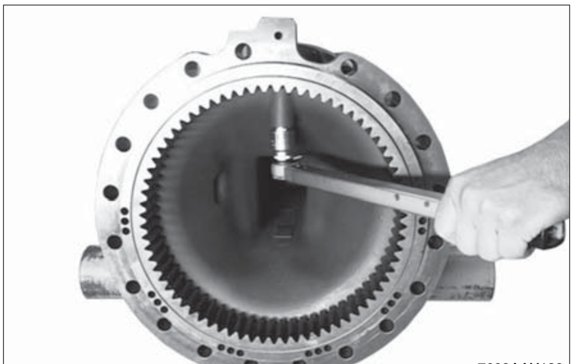
※ After assembling the axle housing secure the axle with clamping brackets.



7609AAX138

③ Mount fitting.

· Tightening torque :
3.67 kgf · m (26.6 lbf · ft)



7609AAX139

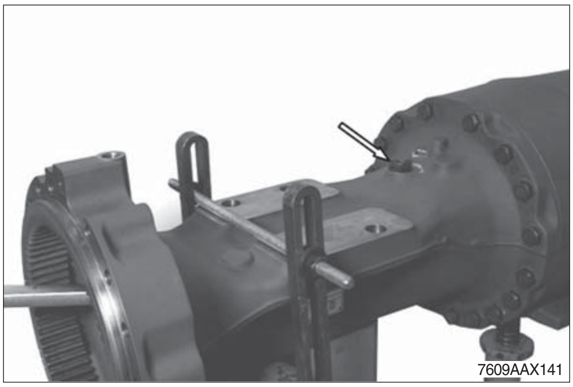
④ Grease O-ring and insert it into the annular groove of the brake tube (see arrow).

7609AAX140

⑤ Mount brake tube with threaded connection and hexagon nut (see arrow).

· Tightening torque :

10.2 kgf · m (73.8 lbf · ft)



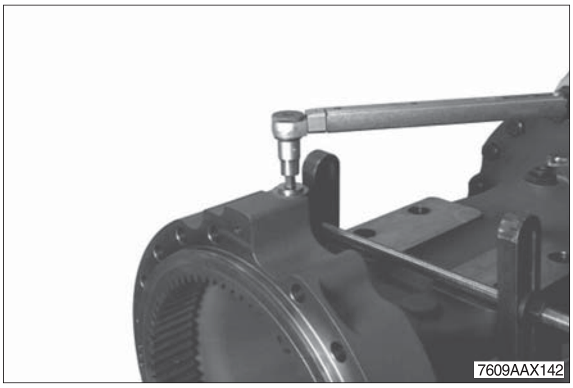
7609AAX141

⑥ Provide screw plug with a new O-ring and fit it.

Flush mount slotted pins.

· Tightening torque :

5.1 kgf · m (36.9 lbf · ft)



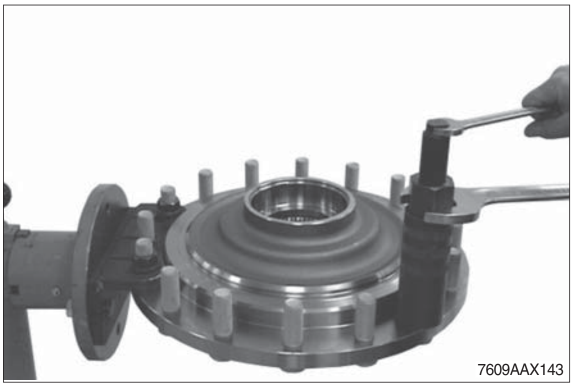
7609AAX142

(8) Reassembly output and brake

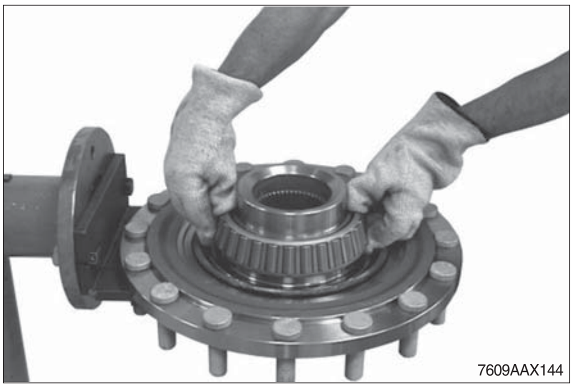
① Pull in wheel stud into the output shaft until contact is obtained.

Wheel stud puller-basic tool 5870 610 001
Insert (M22×1.5) 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.


7609AAX143

② Heat tapered roller bearing and insert it into the output shaft until contact is obtained.

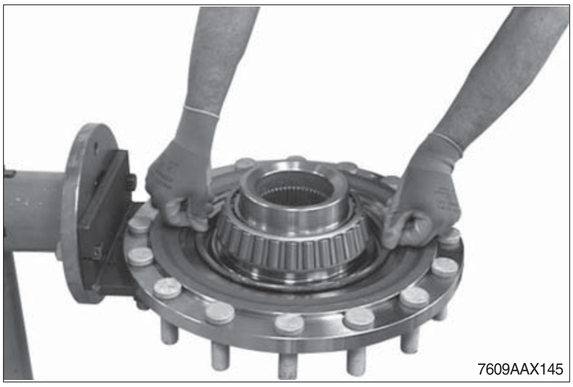

7609AAX144

③ Wet O-ring of slide ring seal and locating hole with spirit.

Snap **new** slide ring seal (part 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, page 3-126.


7609AAX145

※ 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.

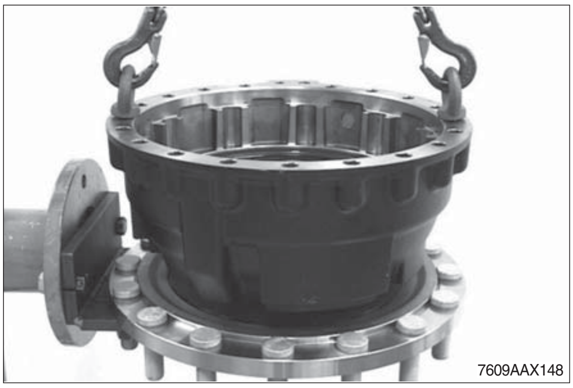

7609AAX146

④ Insert both bearing outer rings (see arrows) into the brake housing until contact is obtained.

7609AAX147

⑤ Insert the premounted brake housing by means of the lifting device over the output shaft until contact is obtained.

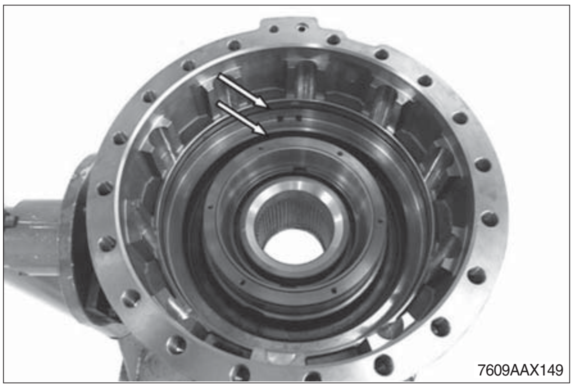
※ Before clamping the seal rings (slide ring seal) to installation dimension, clean the sliding surfaces and apply an oil film.
We recommend to use a leather cloth soaked with oil.



7609AAX148

⑥ 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, page 3-126.



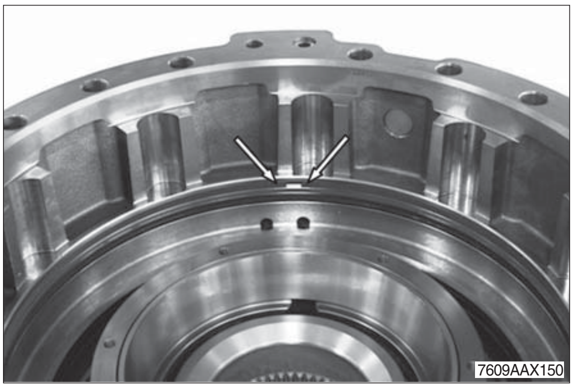
7609AAX149

⑦ 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 (type No. : 415) at its extremities (see arrows).

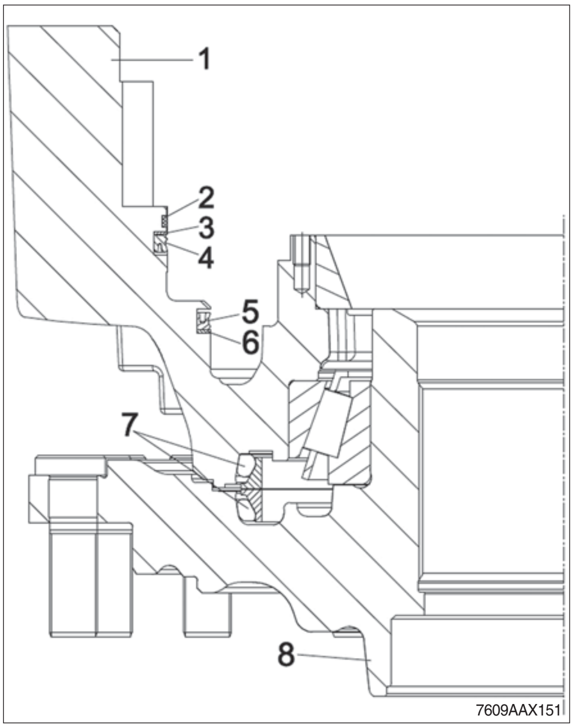
※ The full circumference of the guide ring must be in an exact contact position.

※ Upon installation the orifice of the guide ring must show upwards (12 o'clock).



7609AAX150

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

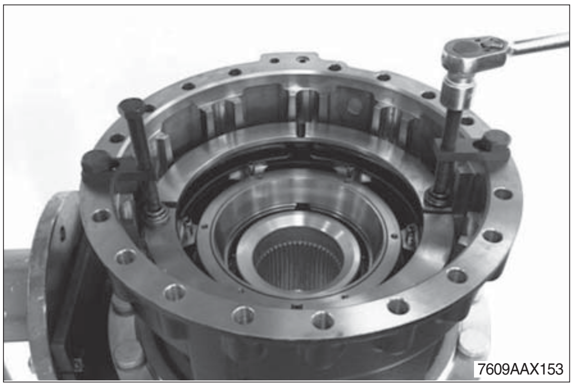


⑧ Flush-mount the slotted pins (6EA) into the holes of the piston.

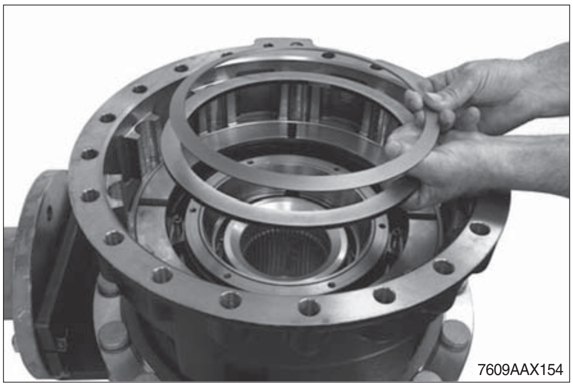
⑨ Insert the piston into the brake housing and carefully install with the fixing device until contact is obtained.

Fixing device AA00 680 530

※ Sufficiently oil seal surface of piston/ back-up rings, grooved rings and guide ring.



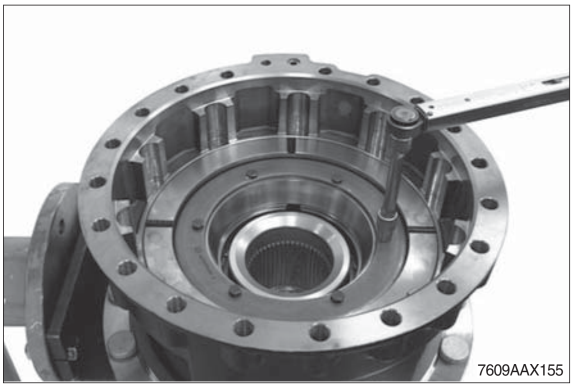
⑩ Insert disk and cup spring with the convex side showing upwards into the piston.



7609AAX154

⑪ Insert cover and fix it by means of hexagon screws.

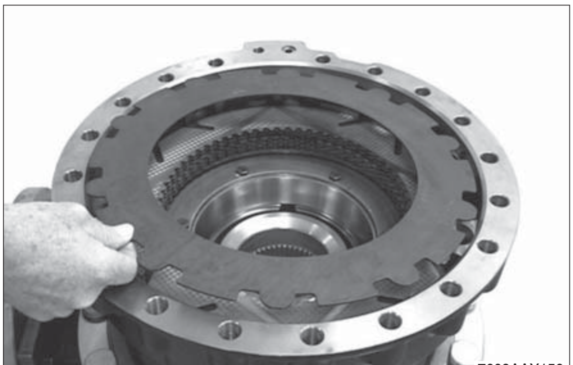
· Tightening torque (M8/10.9) :
3.47 kgf · m (25.1 lbf · ft)



7609AAX155

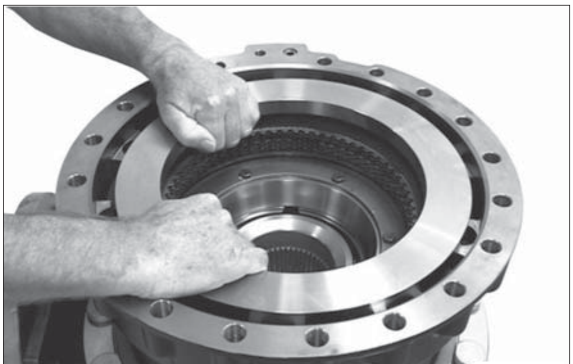
⑫ Mount outer and inner disks.

※ For the number of disks and the disk arrangement please refer to the relating parts manual.



7609AAX156

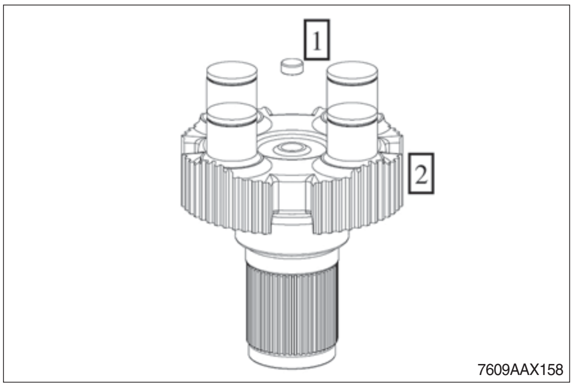
⑬ Insert end plate.



7609AAX157

⑭ Press stop bolt into the planetary carrier until contact is obtained.

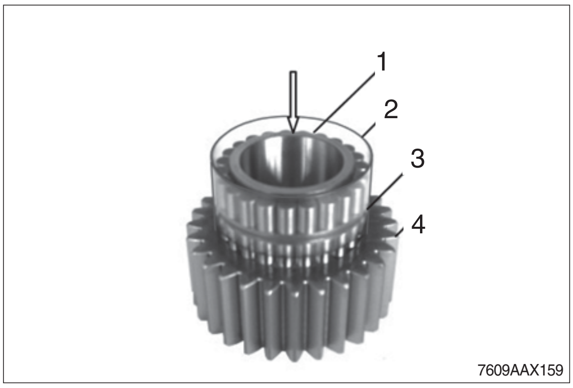
1 Stop bolt
2 Planetary carrier



⑮ 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.

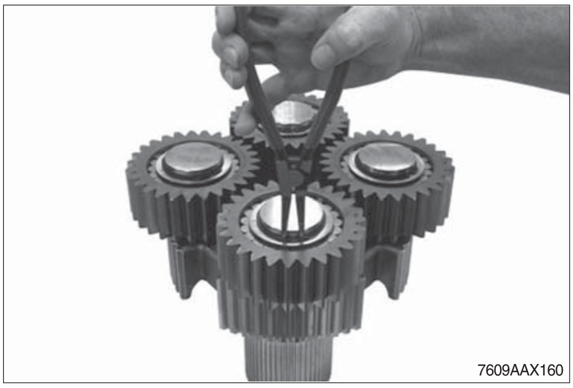
1 Cylindrical roller bearing
2 Packaging sleeve
3 Snap ring
4 Planetary gear



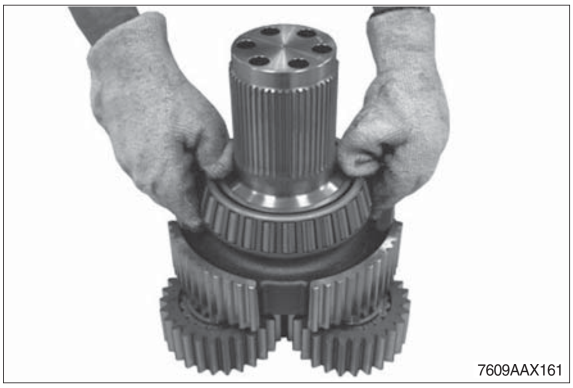
⑯ Heat bearing inner rings and insert the premounted planetary gears with large radius facing the planetary carrier (downwards) until contact is obtained.

※ Adjust bearing inner rings after cooling down.

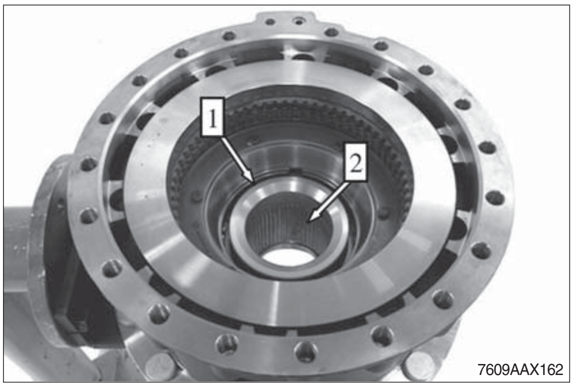
Then fix planetary gears by means of retaining rings.



⑰ Heat tapered roller bearing and install it to the planetary carrier until contact is obtained.



⑱ Wet front face (contact face bearing inner ring, arrow 1) and profile (teeth, arrow 2) in the output shaft with anti-corrosive agent.



⑲ Align disk package centrally and radially.

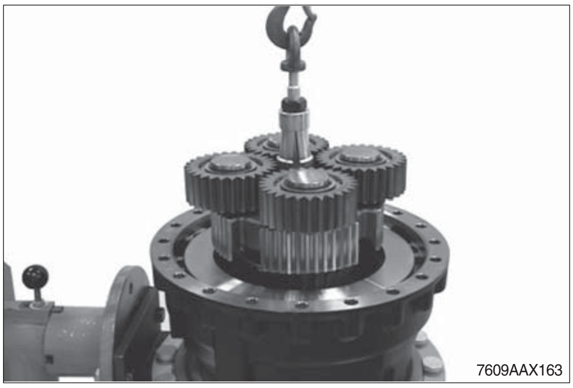
Then insert the planetary carrier by means of the lifting device into the teeth of the output shaft.

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 300 017
Eye nut	5870 204 076

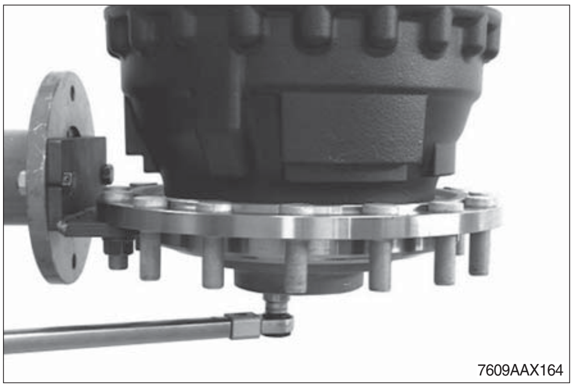


Setting of gap width output shaft / planetary carrier

⑳ Bring planetary carrier with measuring disk and three old locking screws, which were removed during disassembly, into contact position.

· Tightening torque :
20.4 kgf · m (148 lbf · ft)

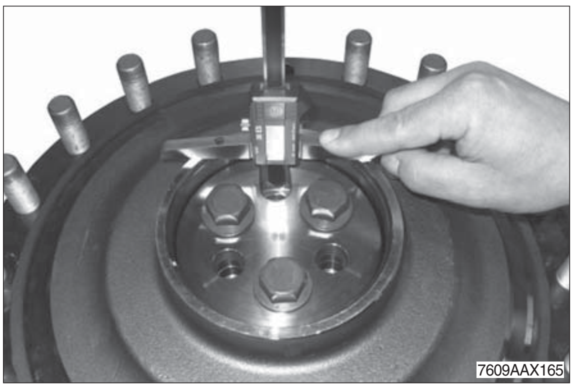
Measuring disk AA00 360 730



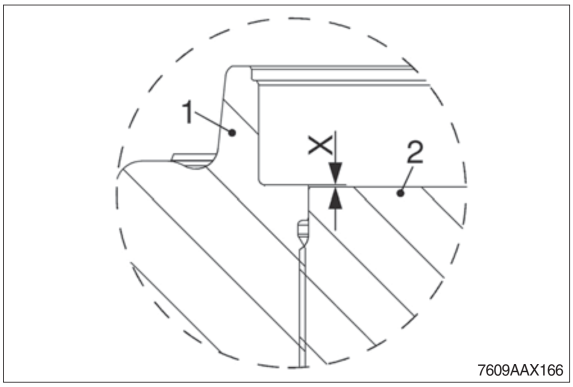
㉑ Pivot output 180˚ and measure gap width from the output shaft to the planetary carrier (see also subsequent sketch).

Gap width e.g. .... 0.21 mm

Then remove the locking screws and the measuring disk again.



1 Planetary carrier
2 Output shaft
X Gap width



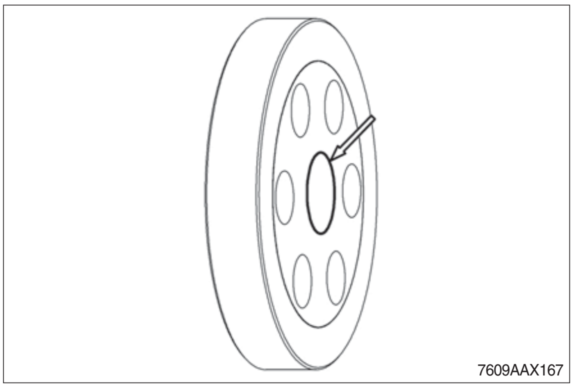
7609AAX166

㉒ Select the cover (optional) on the basis of the following table.

Determined gap width (Delta)	Offset to be used on the cover	P/No.
0.30~0.24 mm	0.13±0.01 mm	ZGAQ-04137
0.239~0.18 mm	0.07±0.01 mm	ZGAQ-04370
0.179~0.10 mm	0.0 mm	ZGAQ-03909

※ Cover (ZGAQ-04370) has an offset of 0.07 mm on one side and an offset of 0.13 mm on the other side.

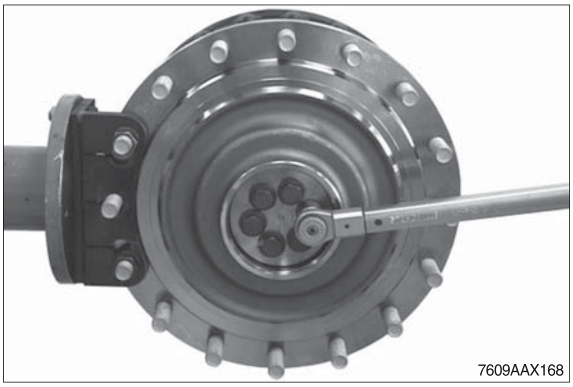
※ Offset 0.13 mm is visually marked with an annular groove (see arrow).


7609AAX167

㉓ Insert the cover with the offset e.g. 0.07 mm showing to the planetary carrier and tighten with **new** locking screws.

※ When using the cover with offset 0.07 mm, the groove (figure AX167) must be visible when the cover is installed.

※ Tighten locking screws successively with a tightening torque of 20.4 kgf · m (148 lbf · ft).
Then retighten the locking screws successively with a tightening torque of 51 kgf · m (369 lbf · ft).


7609AAX168

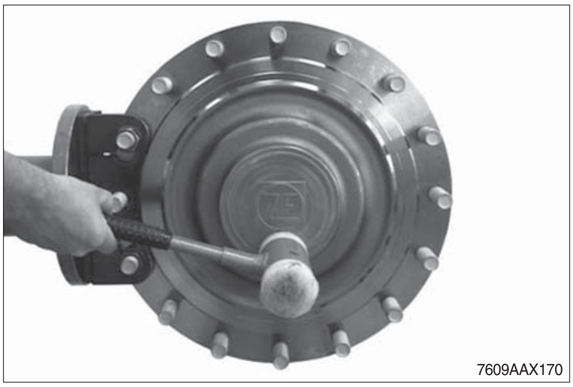
㉔ Install O-ring (see arrow 1) to the cover.

Then wet contact face (arrow 2).

※ Use new cover and O-ring.

7609AAX169

㉕ Insert the cover into the output shaft until contact is obtained.

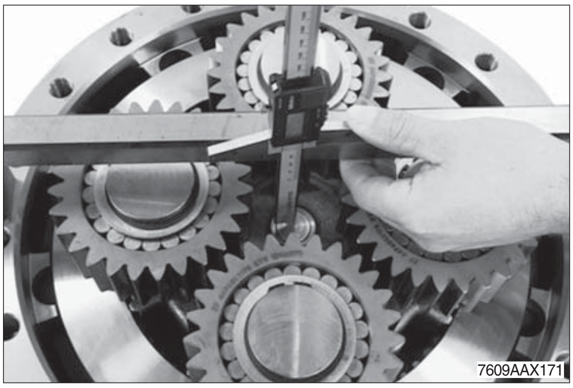


Set the axial play of the sun gear shaft 0.5~2.0 mm

㉖ Determine dimension I, from the mounting face of the brake housing to the front face of the stop bolt.

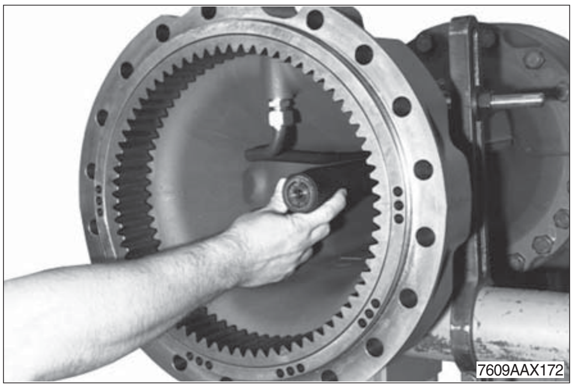
Dimension I e.g. .... 19.75 mm

Gauge blocks	5870 200 066
Straightedge	5870 200 022

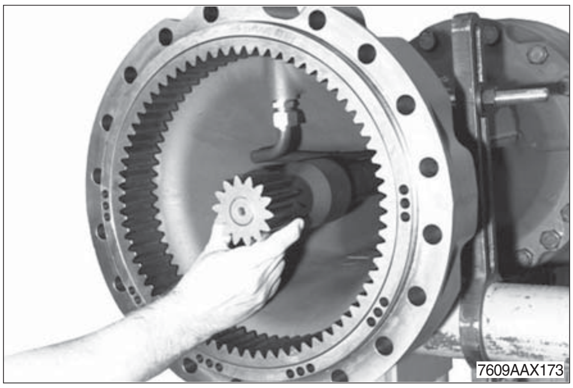


㉗ Insert stub shaft into the teeth of the axle bevel gear until contact is obtained.

※ Pay attention to the installation position ; mount the stub shaft with the long teeth showing to the differential.



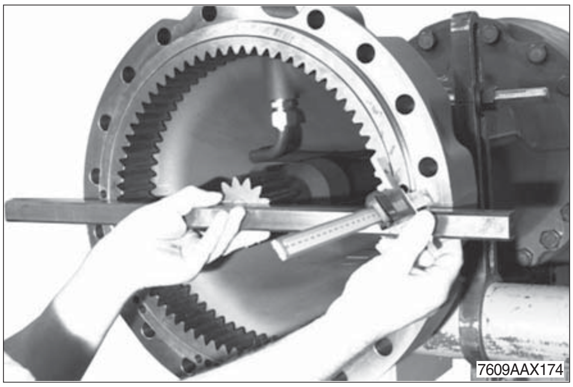
㉘ Insert the sun gear shaft until contact is obtained.



㉙ Measure dimension II, from the front face of the sun gear shaft to the mounting surface of the axle housing.

Dimension II e.g. .... 17.15 mm

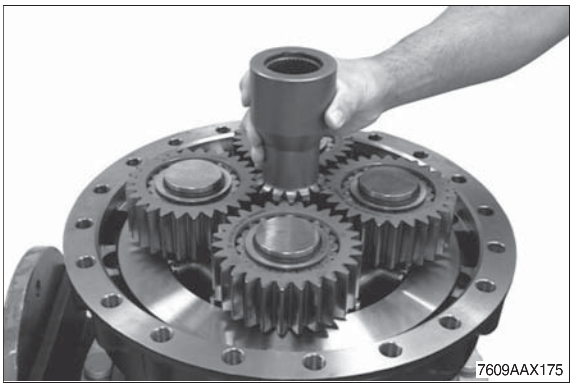
Straightedge 5870 200 022


7609AAX174

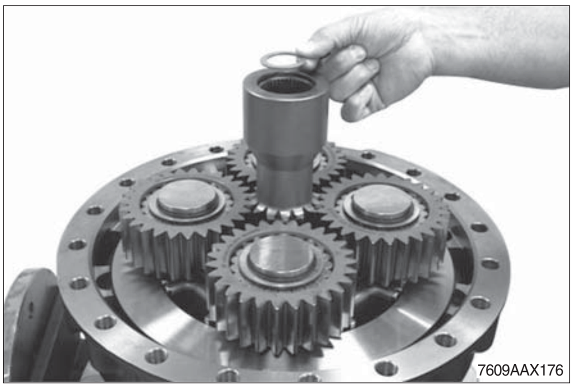
CALCULATION EXAMPLE :

Dimension I	19.75 mm
Dimension II	- 17.15 mm
Difference	2.60 mm
Required axial play e.g.	- 1.00 mm
Difference = shim e.g.	s = 1.60 mm

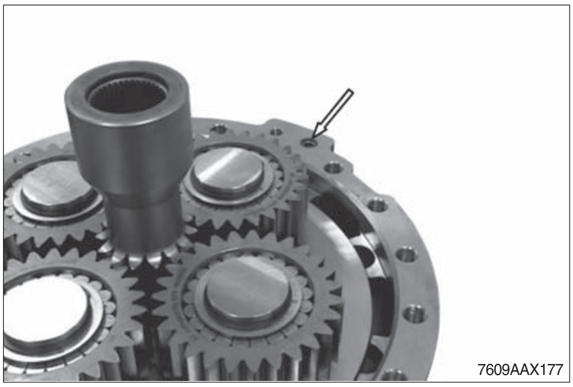
㉚ Insert sun gear shaft into the planetary carrier.


7609AAX175

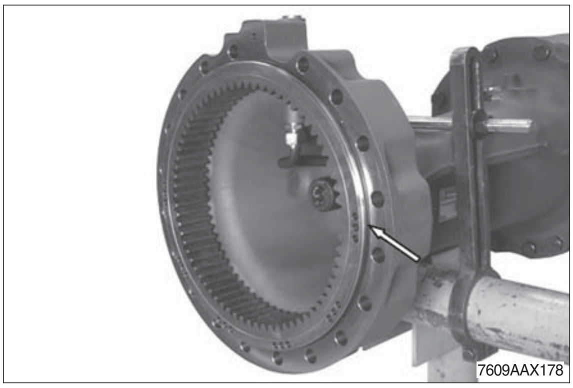
㉛ Fix determined shim (s) e.g. s = 1.60 mm with grease into the sun gear shaft.


7609AAX176

㉜ Fix O-ring (see arrow) with grease into the countersink of the brake housing.



㉝ Grease O-ring (see arrow) and install it to the axle housing.



㉞ Mount two adjusting screws and use the lifting device to bring the output into contact position with the axle housing.

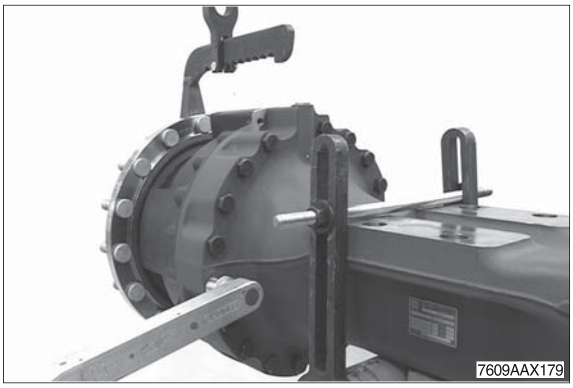
Then fix the output by means of hexagon screws.

· Tightening torque (M18/10.9) :
39.8 kgf · m (288 lbf · ft)

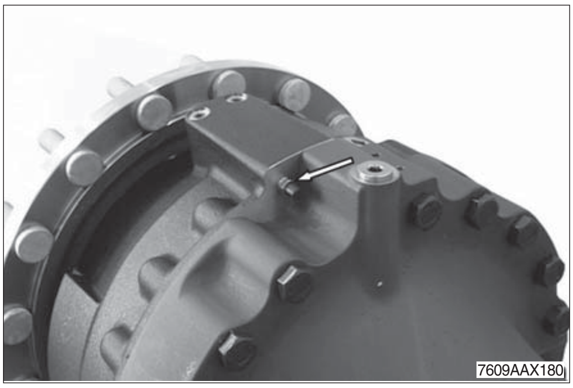
Adjusting screws (M18×15) 5870 204 029

Load carrying device 5870 281 043

※ Fix load carrying device with wheel stud.



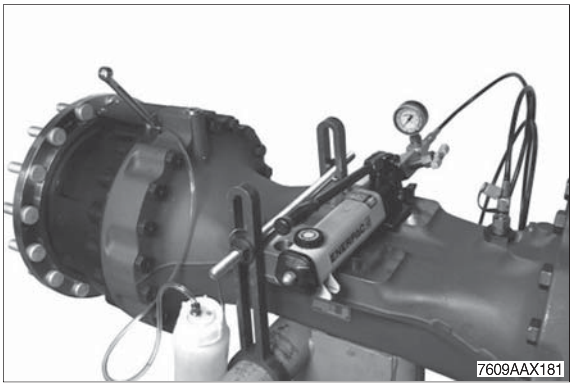
㉟ Mount breather (see arrow).



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.



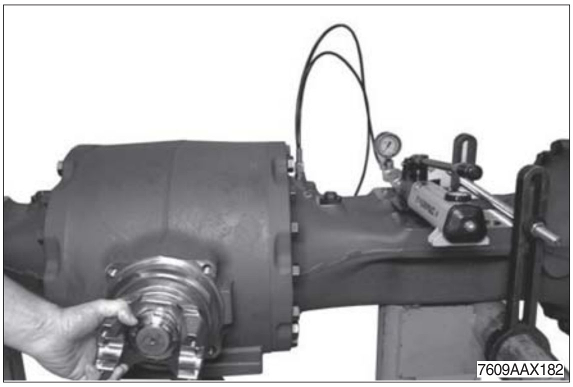
High-pressure test :
Build up test pressure p = 100_{-10} bar max and close connection to HP pump via shut-off valve.
A pressure drop of max 2 % (2 bar) is permissible during a 5-minute testing time.

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 oil SAE 10W

HP pump	5870 287 007
Clutch	0501 207 939
Reduction (M18×1.5)	5870 950 161
Oil collector bottle	5870 286 072

Check operability of hydraulic lock differential (opt)
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 has no movement 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.

2. TRANSMISSION

Preparatory Activities

Mounting transmission on assembly truck

Special tools:
- 5870.350.090 Connection plate
- 5870.350.063 Clamping plate
- 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.

   Use 5870.350.090 [Connection plate] and 5870.350.063 [Clamping plate] to fix transmission to 5870.350.000 [Assembly truck].

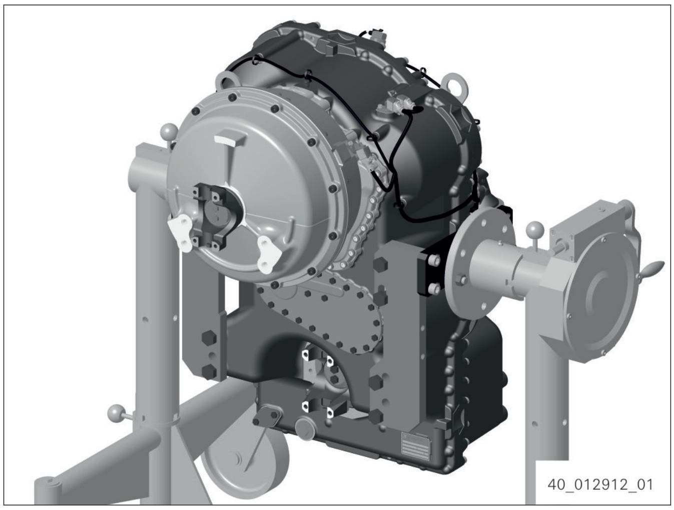


Fig. 21

Draining oil

⚠ Observe the environmental regulations *(see General safety instructions)*.

1. Loosen screw plug (1) and drain oil from the transmission.

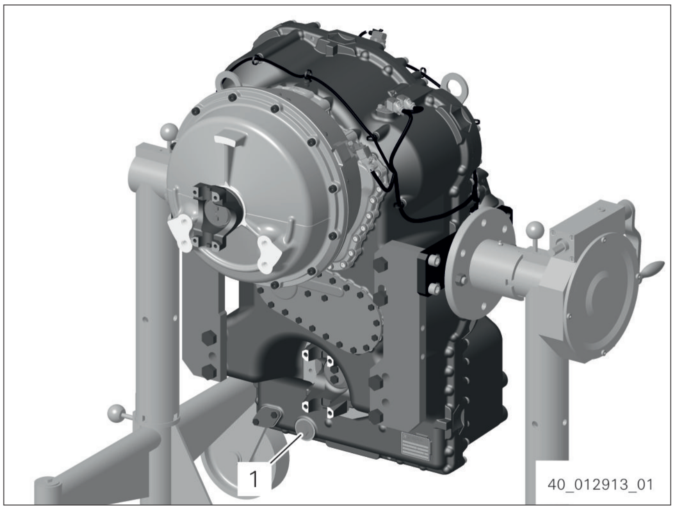


Fig. 22

Dismantling

Removing pressure filter

1. Loosen pressure filter (1).

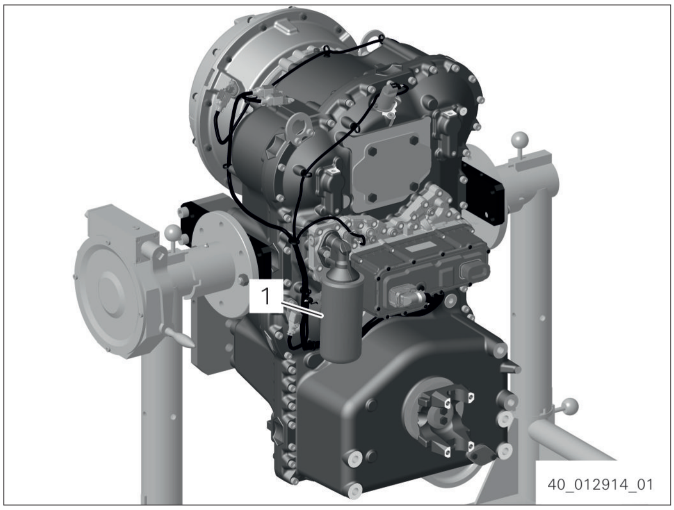


Fig. 23

2. Loosen Torx screws and remove filter head (1).

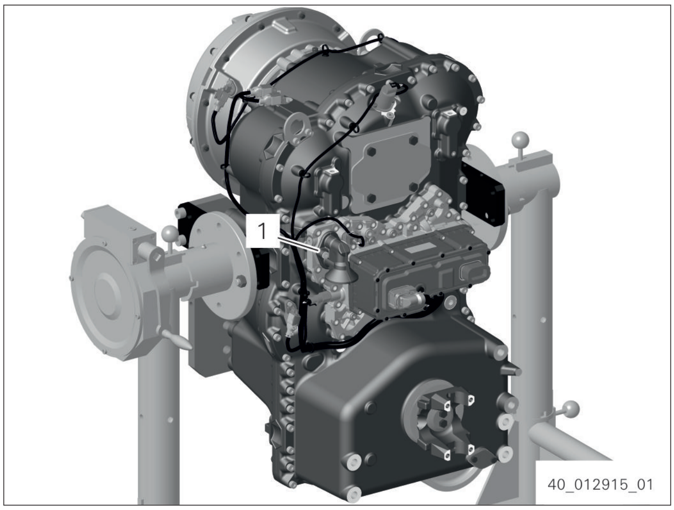


Fig. 24

Removing cover sheets (filler neck)

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

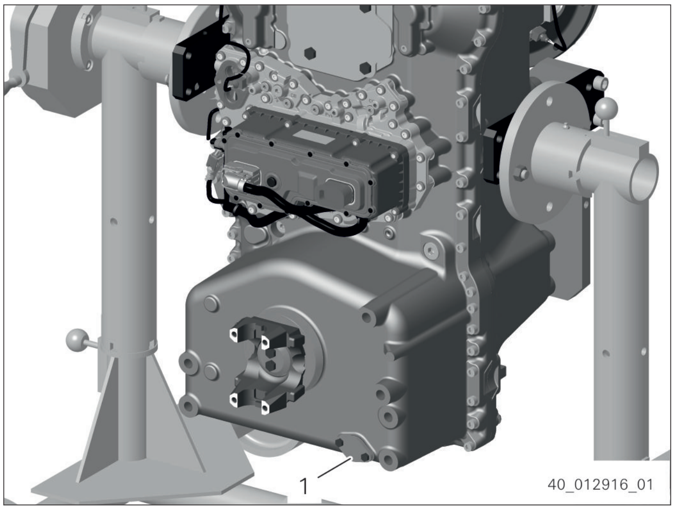


Fig. 25

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

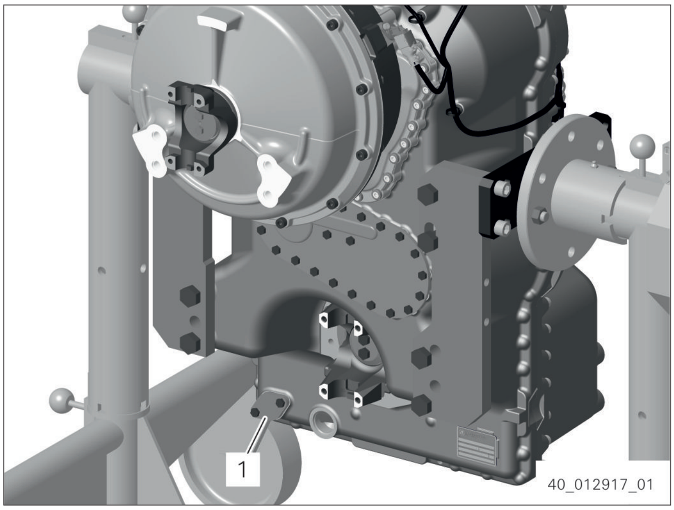


Fig. 26

Removing pressure controller and speed sensors

1. Remove cable ties.
2. Disconnect plug connections and remove cable (1).

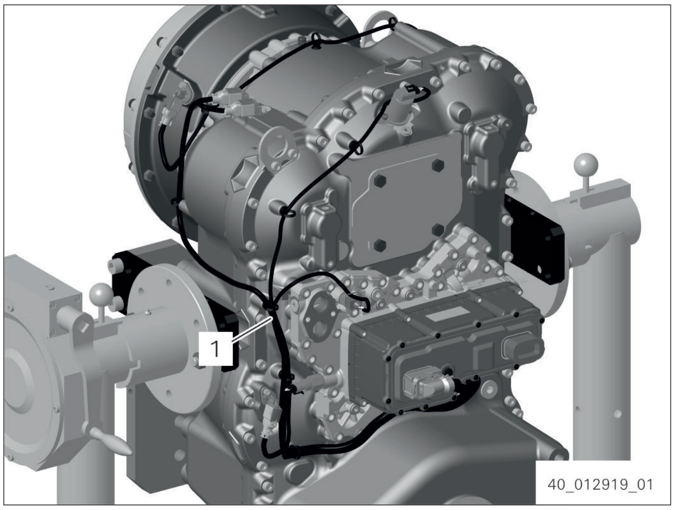


Fig. 27

3. Loosen cap screws.
4. Pull the pressure controller (1) out of the housing hole.

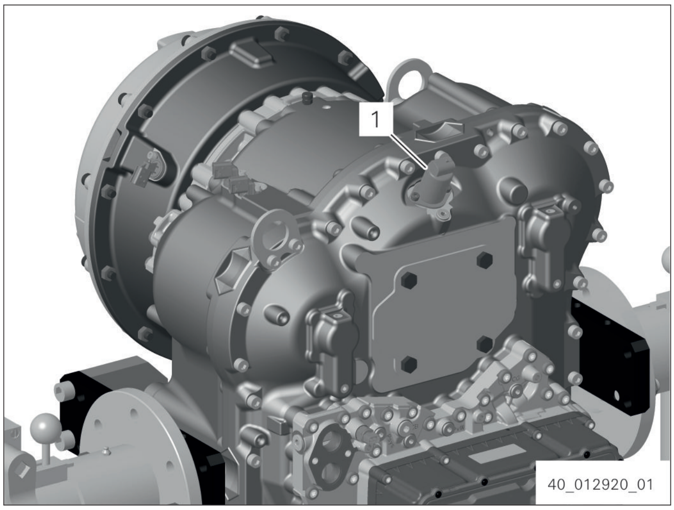


Fig. 28

5. Loosen cap screws.
6. Pull the speed sensors (1) out of the housing holes.

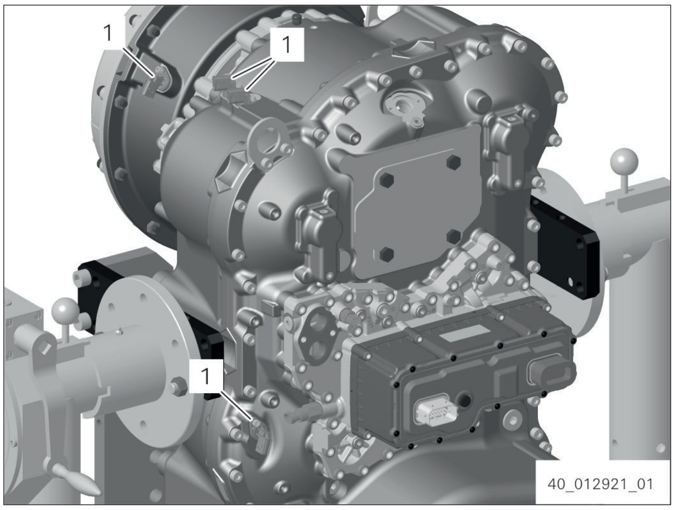


Fig. 29

Removing temperature sensors and the breather

1. Loosen breather (1).

2. Loosen the temperature sensors (2).

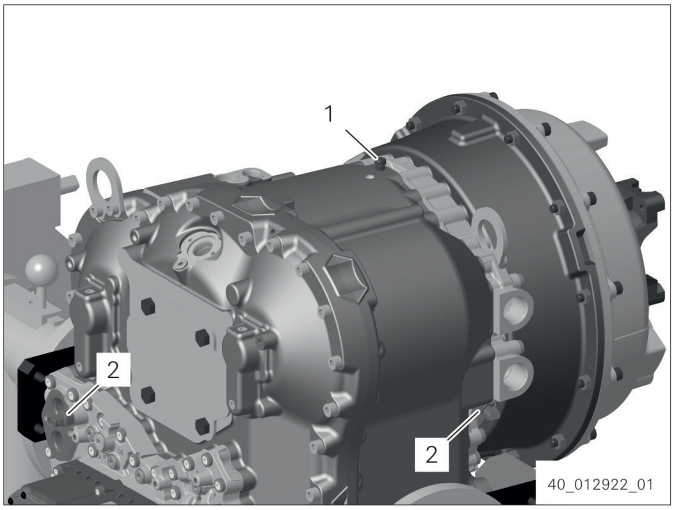


Fig. 30

Removing output flanges

Removing output flange on input side

1. Loosen hexagon screws (1).

2. Remove washer (2).

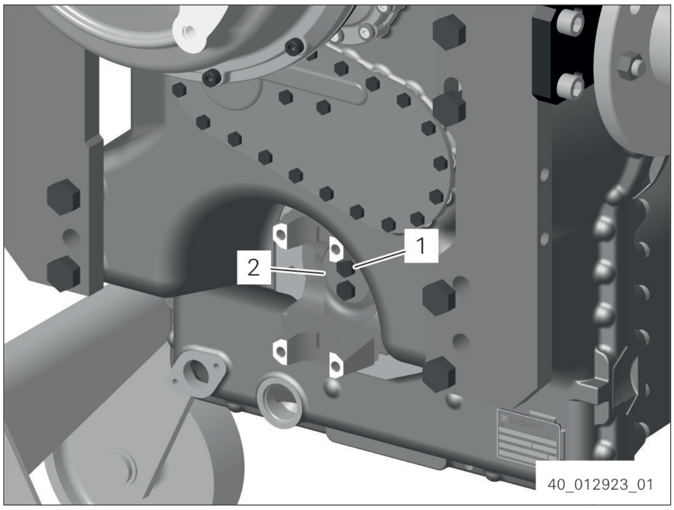


Fig. 31

3. Remove O-ring (1).

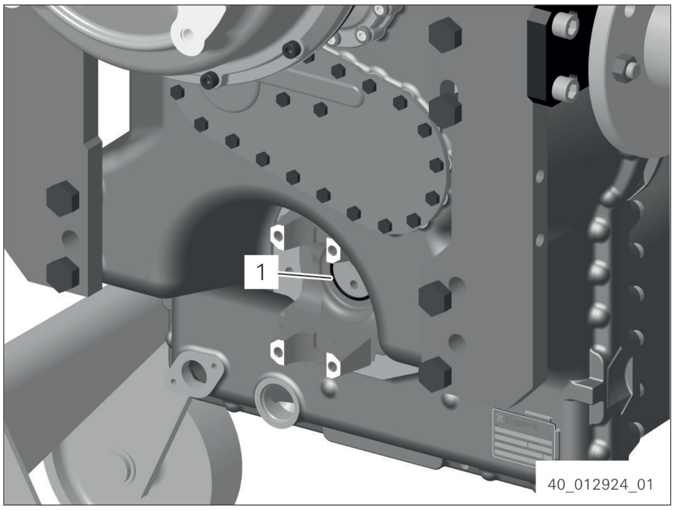


Fig. 32

4. Pull off the output flange (1).

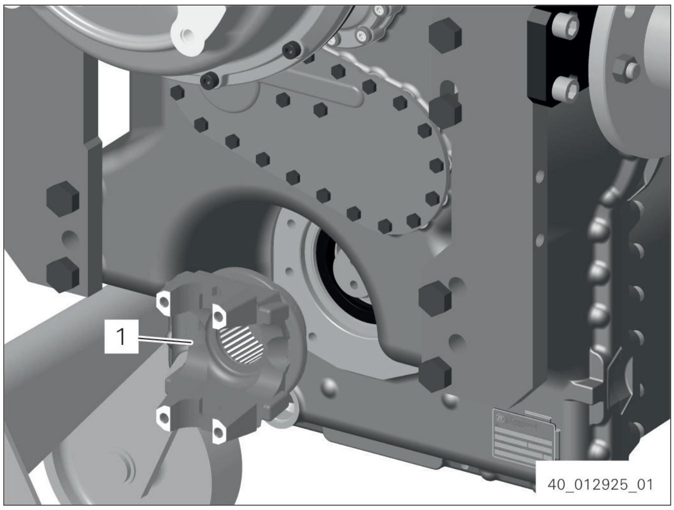


Fig. 33

5. Remove shaft seal (1) from the housing hole.

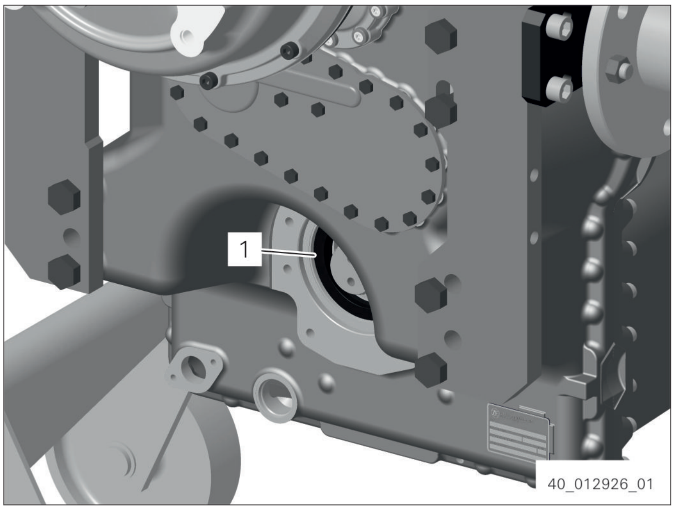


Fig. 34

Removing output flange on gearshift side

6. Loosen hexagon screws (1).

7. Remove washer (2).

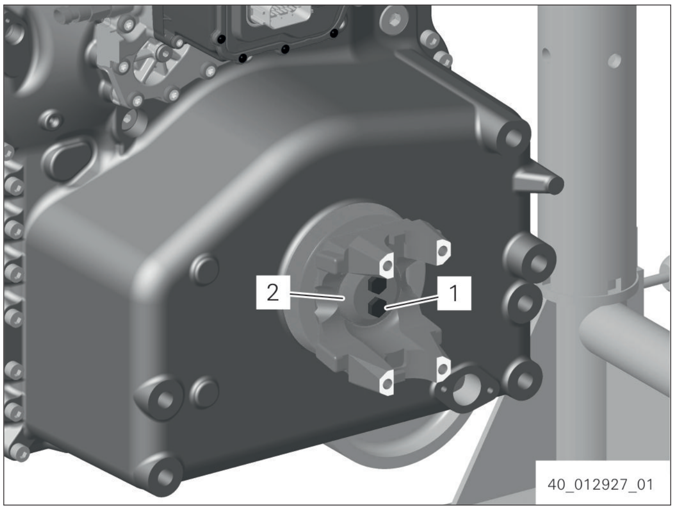


Fig. 35

8. Remove O-ring (1).

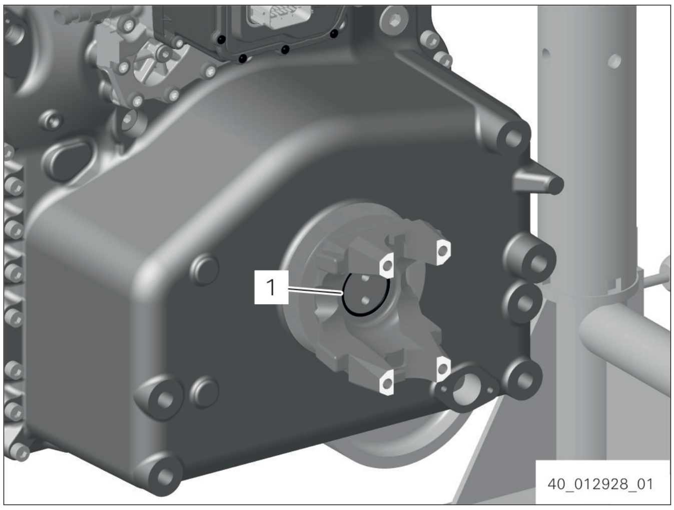


Fig. 36

9. Pull off the output flange (1).

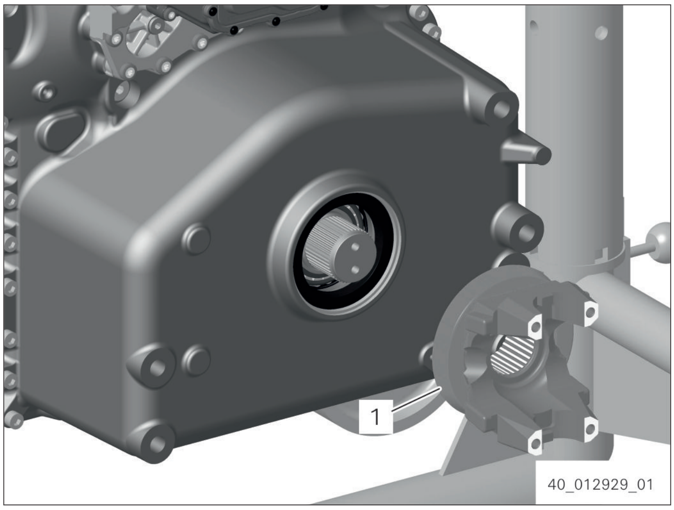


Fig. 37

10. Remove shaft seal (1) from the housing hole.

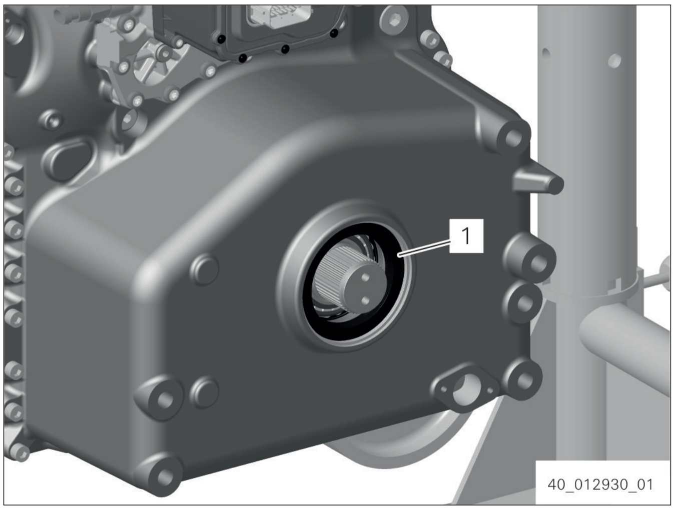


Fig. 38

Removing and dismantling shift system

Removing filter bypass valve

1. Loosen tappet switch (1).

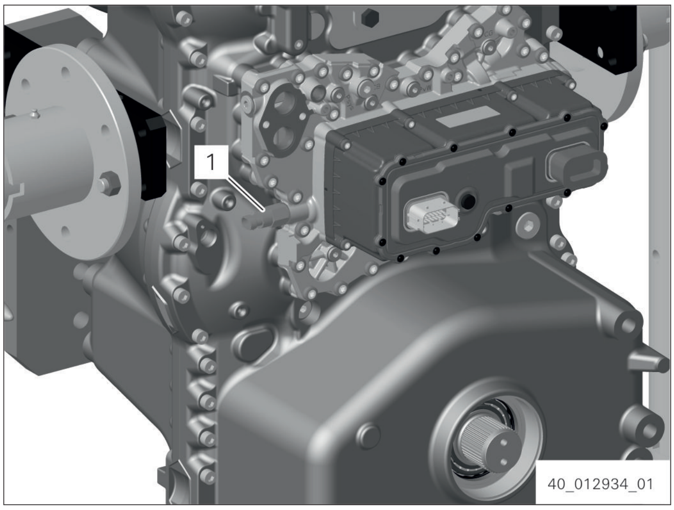


Fig. 39

2. Remove piston (3) from hole (1).

3. Remove compression spring (2) from hole (1).

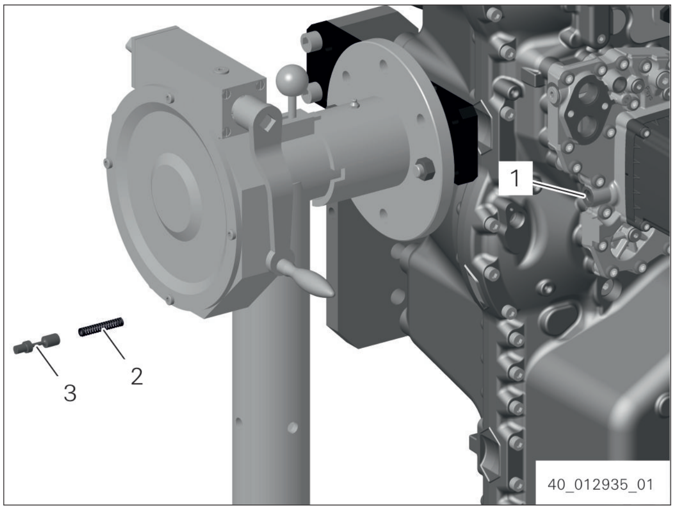


Fig. 40

Removing control unit (ECA4)

1. Loosen Torx screws.

2. Remove control unit (1).

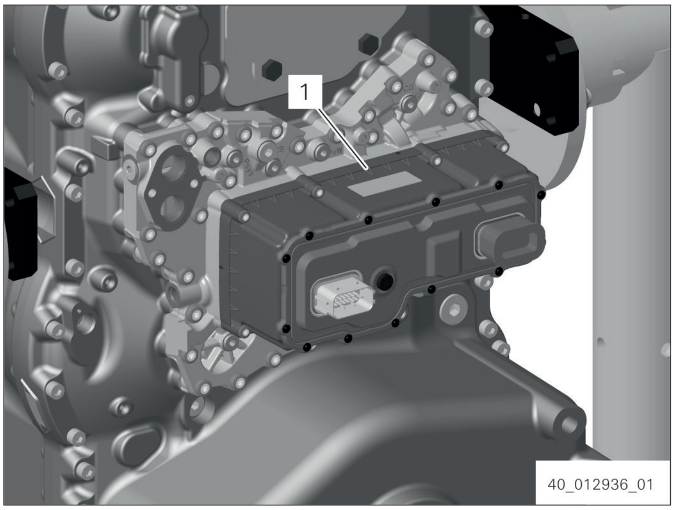


Fig. 41

Removing pressure controllers

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

2. Loosen Torx screws and remove fixing plate (3).

3. Remove cable (2).

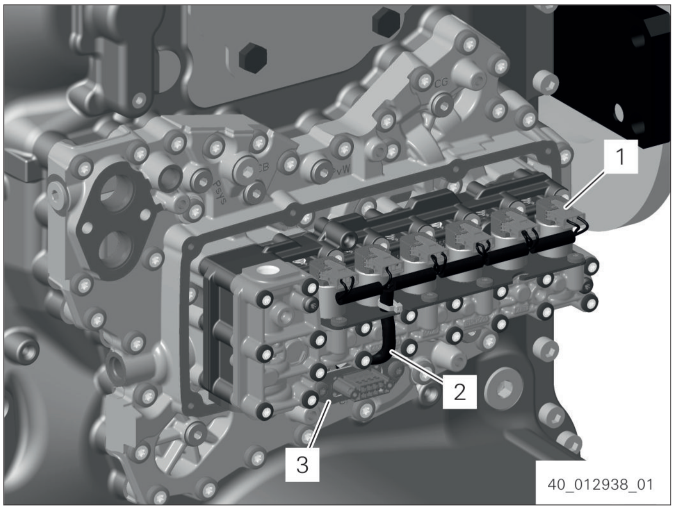


Fig. 42

4. Loosen Torx screws and remove clamping plate (1).

5. Pull out the pressure controllers (2).

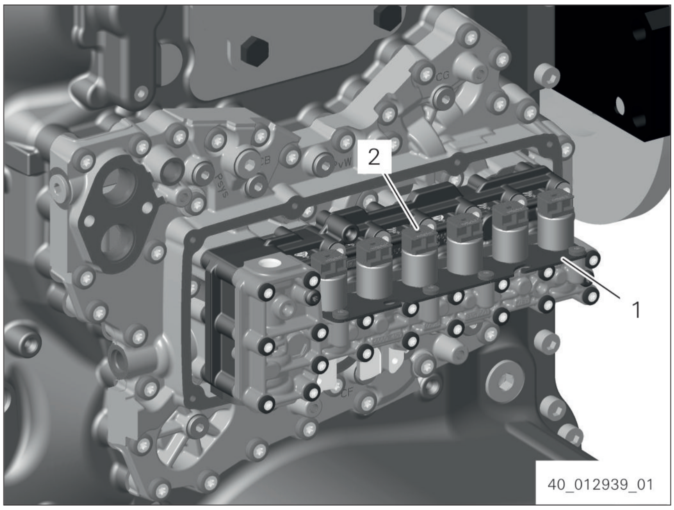


Fig. 43

Removing and dismantling valve blocks

Special tools:

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

1. Loosen Torx screws.
   Remove valve block (1) and intermediate plate.

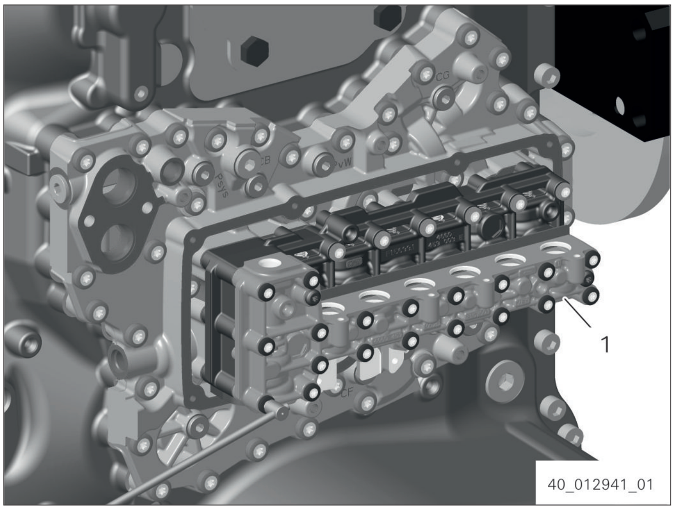


Fig. 44

2. Press the piston inwards with AA02.414.200 [Driver tool] and remove the retaining plate.

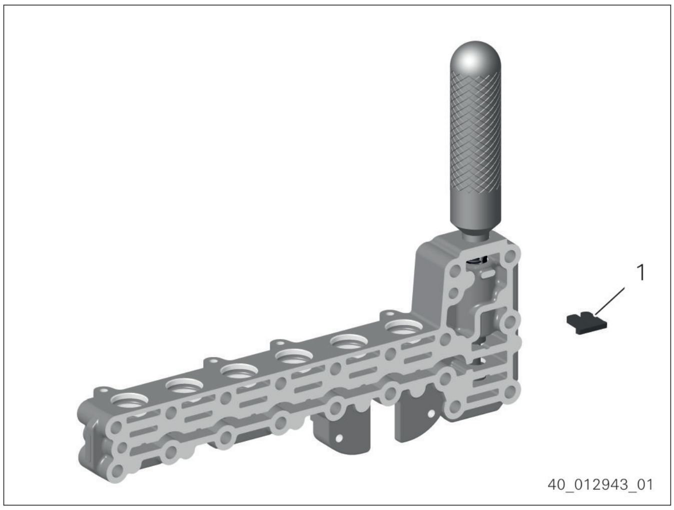


Fig. 45

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

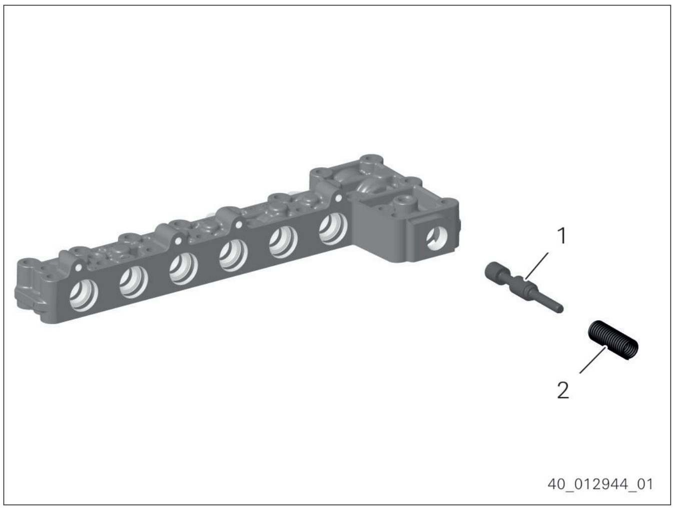


Fig. 46

4. Loosen Torx screws.
   Remove valve block (1) and intermediate plate.

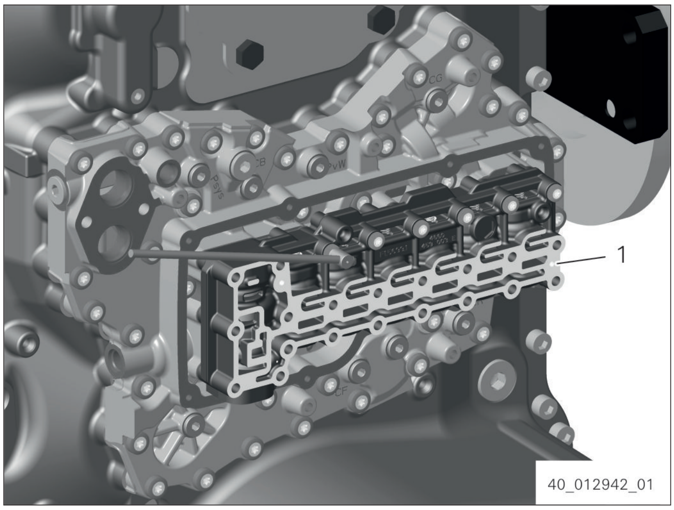


Fig. 47

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

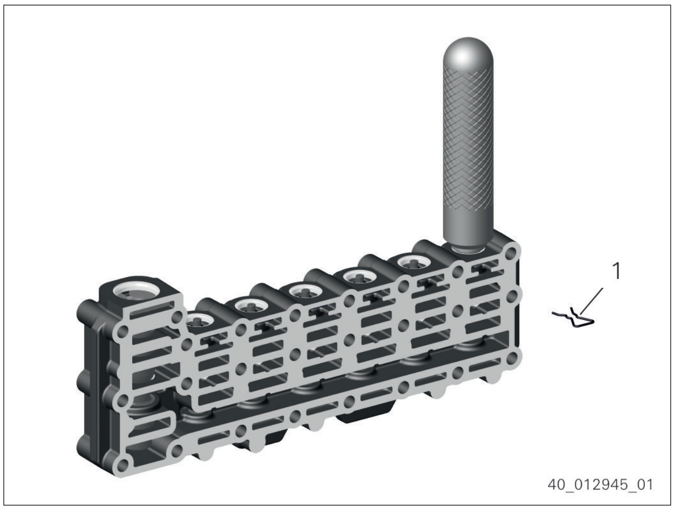


Fig. 48

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

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

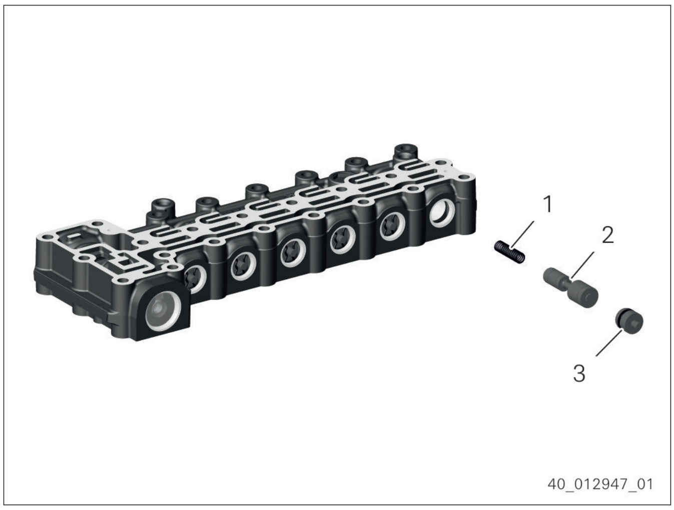


Fig. 49

8. Press plug inwards by means of AA02.416.230 [Driver tool] and remove the retaining plate (1).

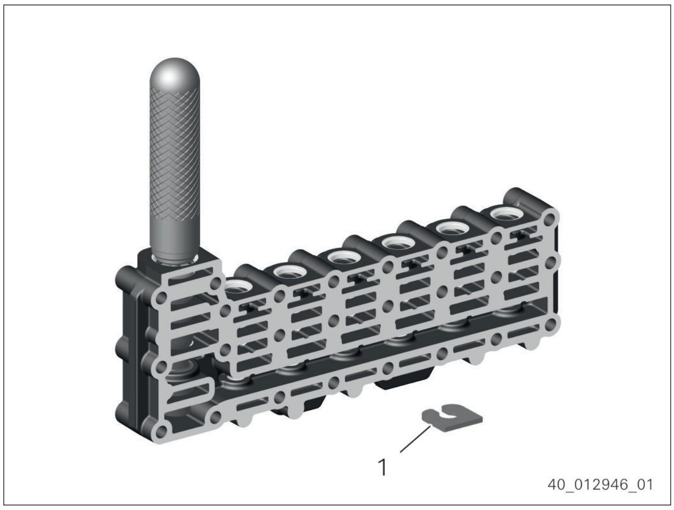


Fig. 50

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

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

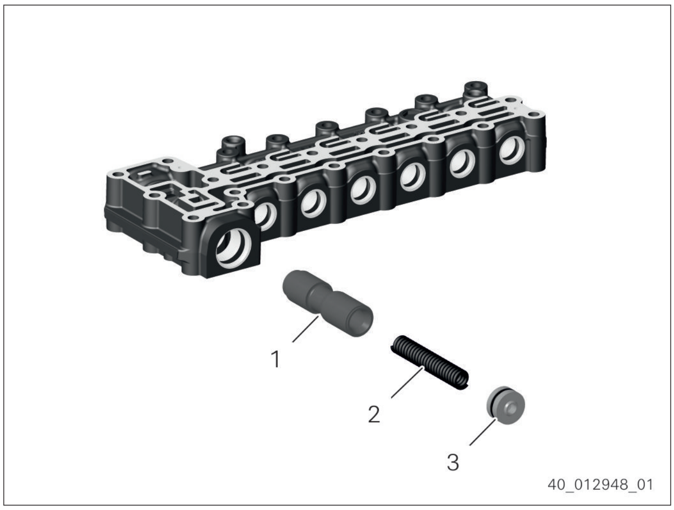


Fig. 51

Removing duct plate

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

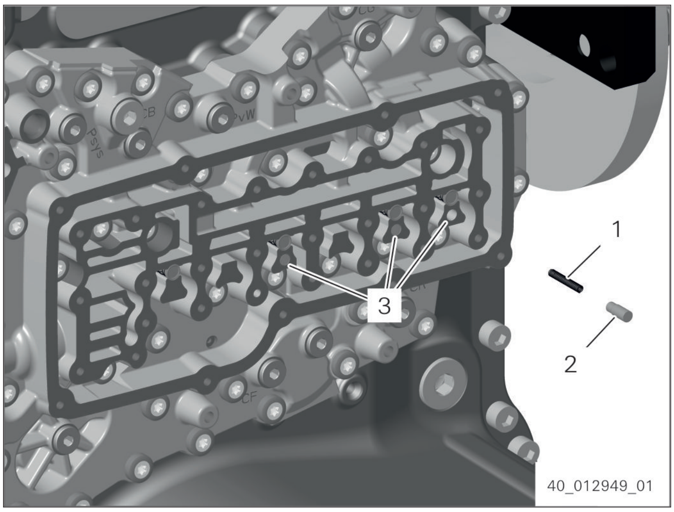


Fig. 52

2. Remove valves (1) from duct plate.

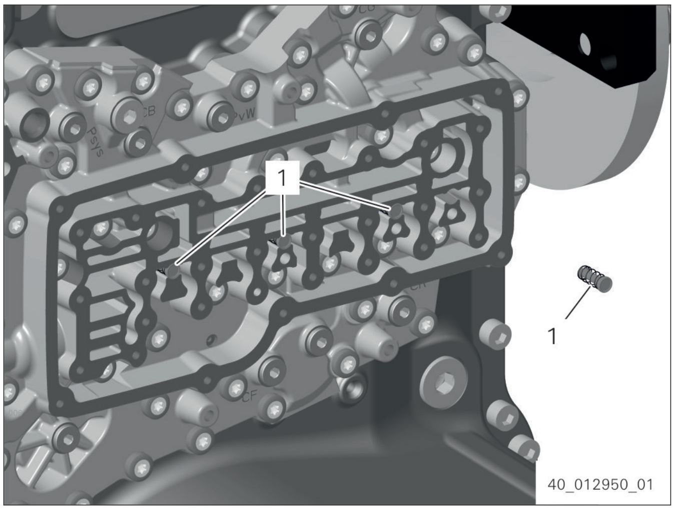


Fig. 53

3. Loosen Torx screws.
   Remove duct plate and seal.

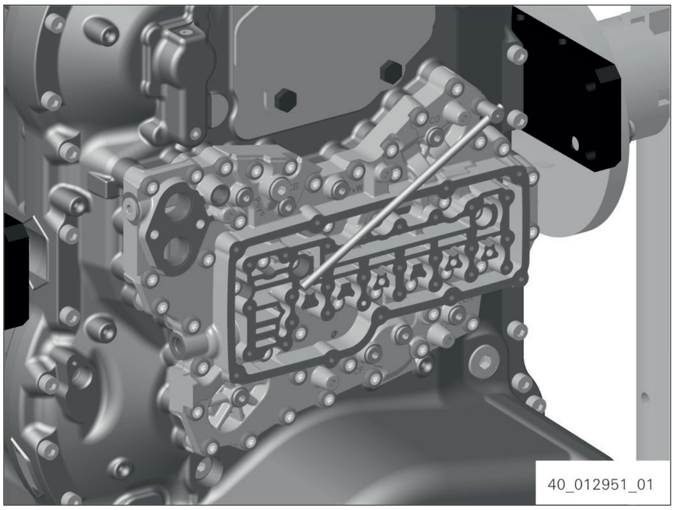


Fig. 54

4. Remove screw plugs from duct plate.

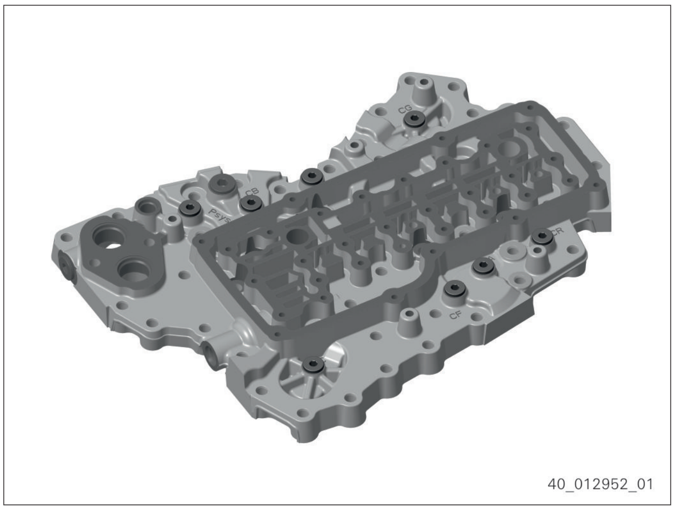


Fig. 55

Removing cover plate (PTO)

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

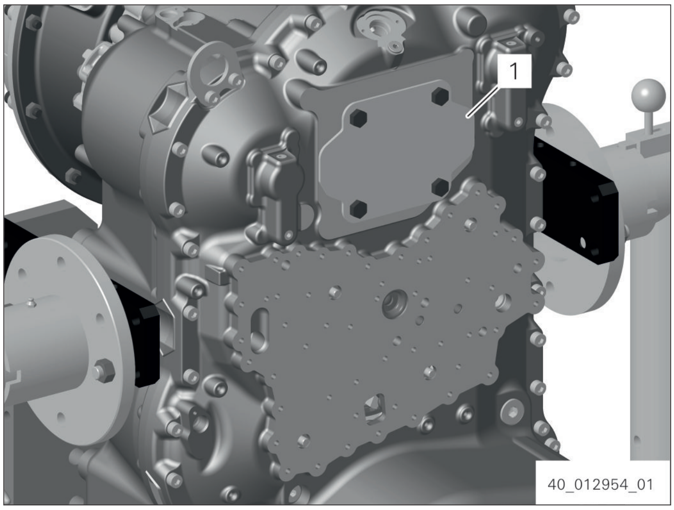


Fig. 56

2. Remove O-ring (1).

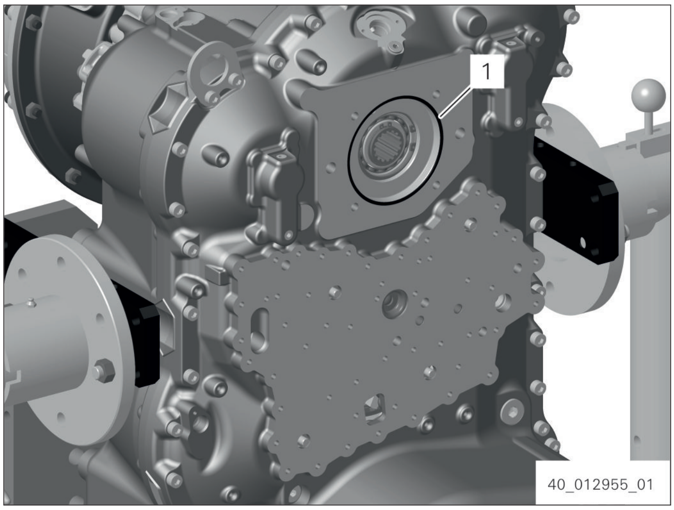


Fig. 57

Removing and dismantling engine connection

Removing 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 (2).

3. Remove cap screws (1).

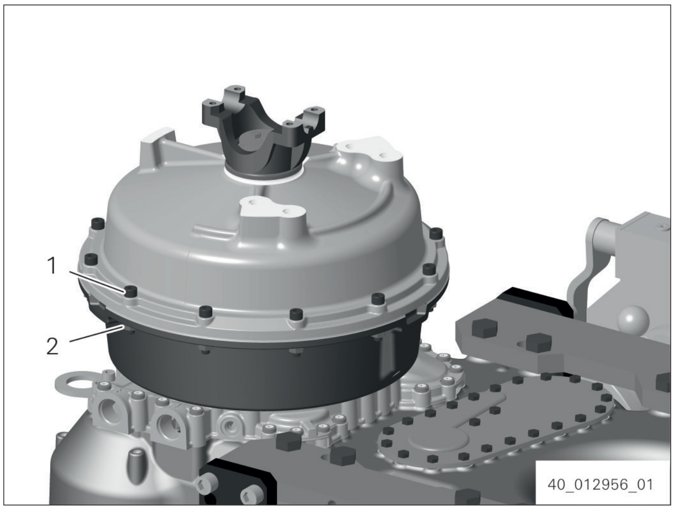


Fig. 58

4. ⚠ **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.

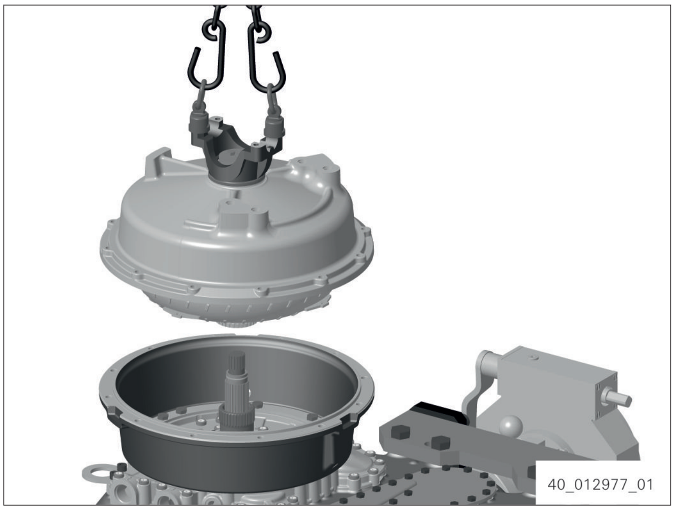


Fig. 59

5. Loosen hexagon screws.

6. Remove disk.

7. Use two-armed extractor to pull yoke off the input shaft.

Fig. 60

8. ⚠ **CAUTION**

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

   Force input shaft and converter out of the cover.

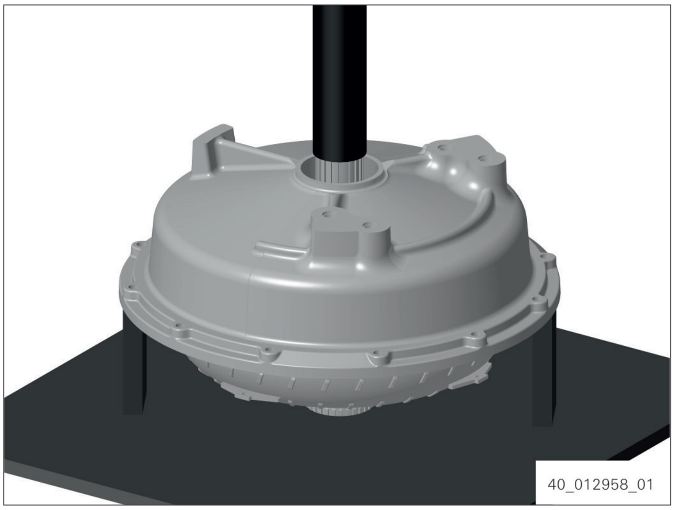


Fig. 61

9. Remove V-ring (1).
10. Pull the ball bearing (2) out of the cover.

Fig. 62

11. Loosen hexagon screws (1).
12. Remove input shaft with flexplates (2).

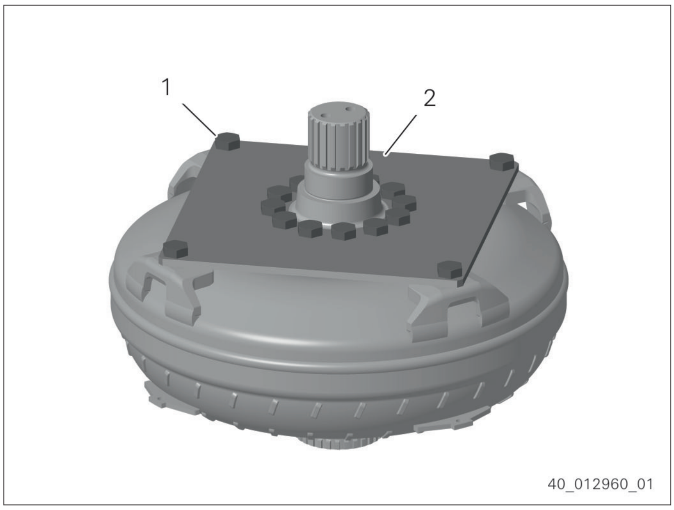


Fig. 63

13. Loosen hexagon screws.

14. Remove flexplates (1).

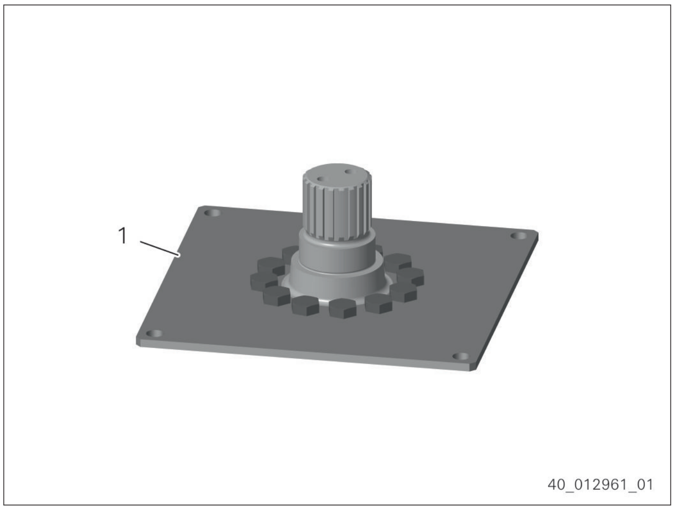


Fig. 64

Removing torque converter bell housing

Special tools:

- AA02.247.426 Eyebolt

1. Loosen hexagon screws (1).

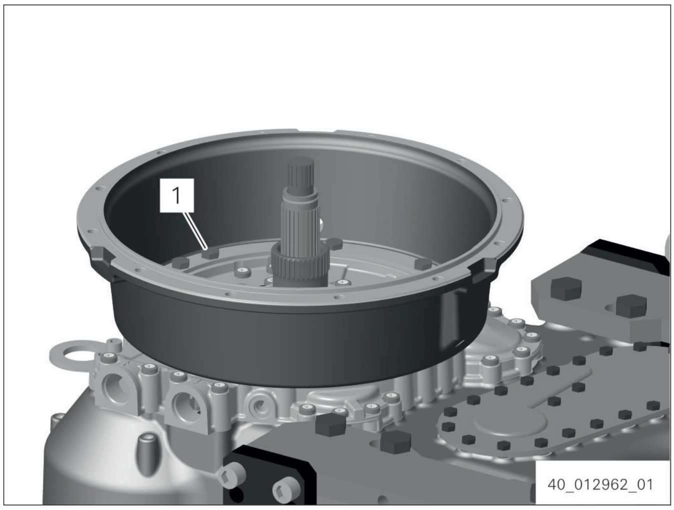


Fig. 65

2. Lift torque converter bell housing with two AA02.247.426 [Eyebolt] and a crane.

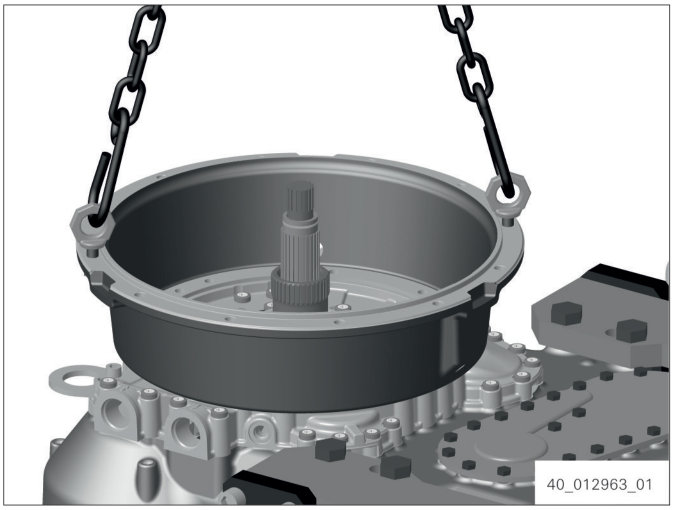


Fig. 66

Removing the oil feed housing and pressure oil pump

Special tools:

- 5870.345.036 Pry bar
- 5870.450.003 Magnetic holder

1. Loosen Torx screws.

2. Loosen cap screws and remove the retaining plate (1).

3. Loosen cap screws (2).

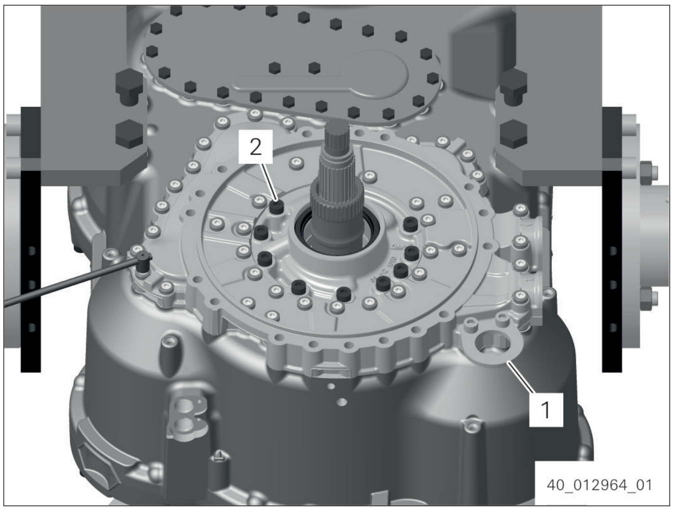


Fig. 67

4. Pull off the oil feed housing and gear pump evenly with 5870.345.036 [Pry bar].

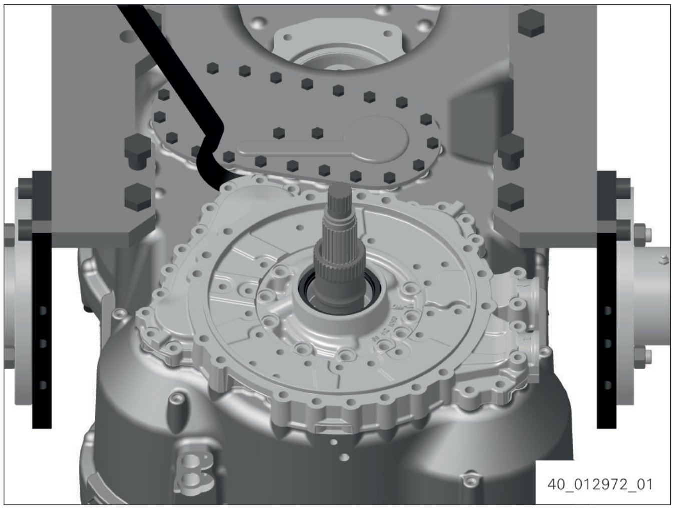


Fig. 68

5. Place the oil feed housing on 5870.450.003 [Magnetic holder].

6. Force out the gear pump.

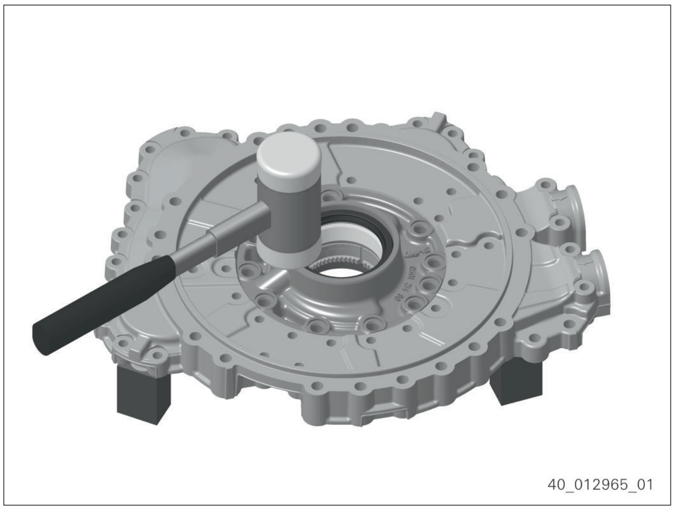


Fig. 69

7. Push pressure plate inwards with a mandrel and remove retaining plate (1).

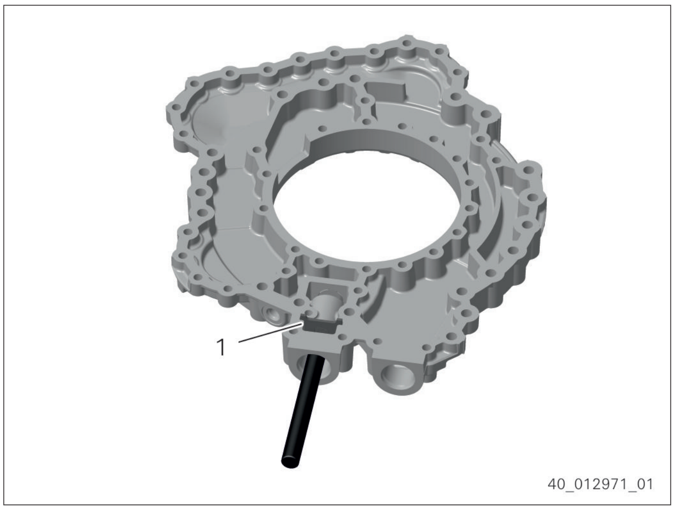


Fig. 70

8. Remove pressure plate (3).

9. Remove compression spring (2) and piston (1) from housing hole.

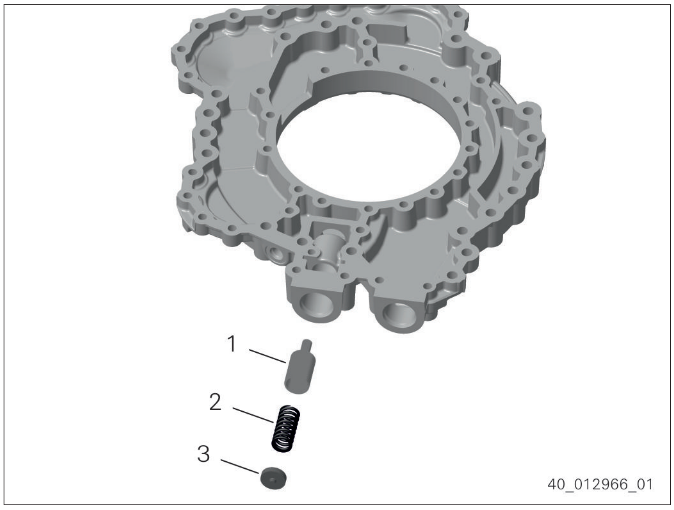


Fig. 71

Checking gear pump

10. Remove shaft seal (1).

11. Remove O-ring (2).

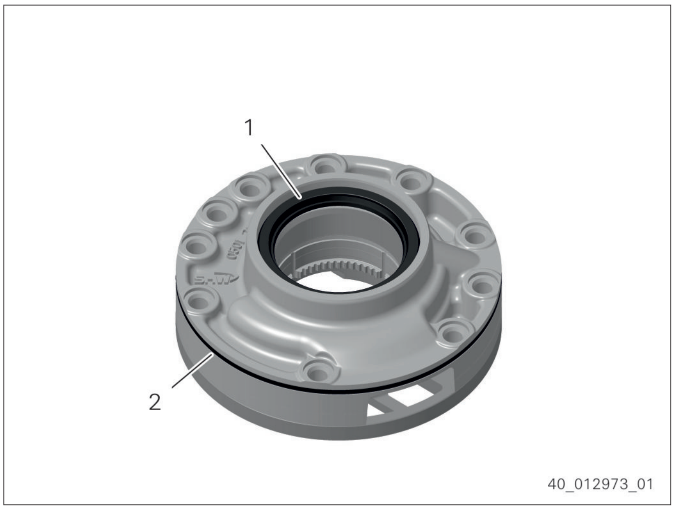


Fig. 72

12. ※ 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 (1).

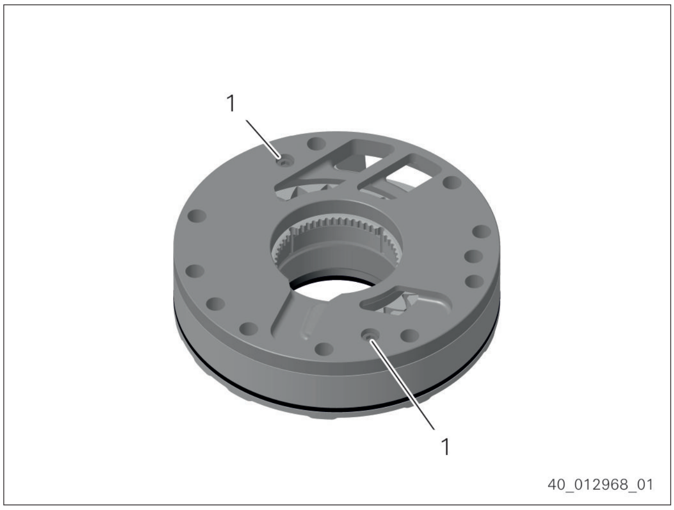


Fig. 73

13. Lift off cover (1).

14. Check the cover (1), outer rotor (2), inner rotor (3) and the housing (4) for wear marks. In case of any damage, install new gear pump.

15. Insert the outer rotor (2) and inner rotor (3) with the chamfered tooth side facing the housing (4).

16. Place the cover (1).

17. Bolt in cap screws by hand until contact is obtained and loosen again by 180°.

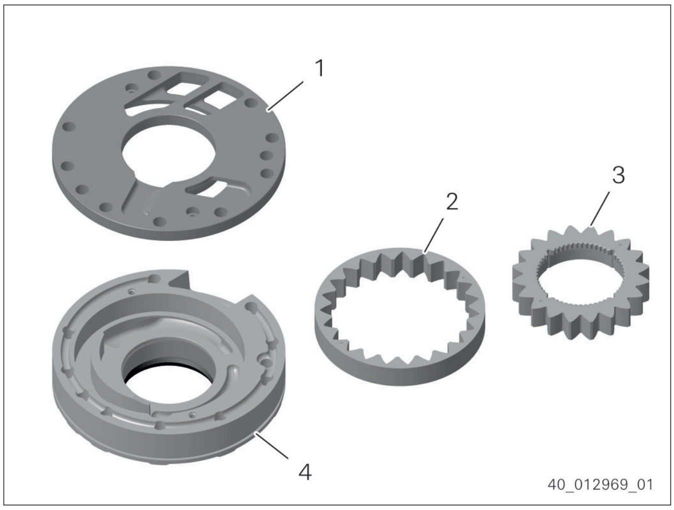


Fig. 74

18. Remove seal (1).

19. Remove stator shaft (2).

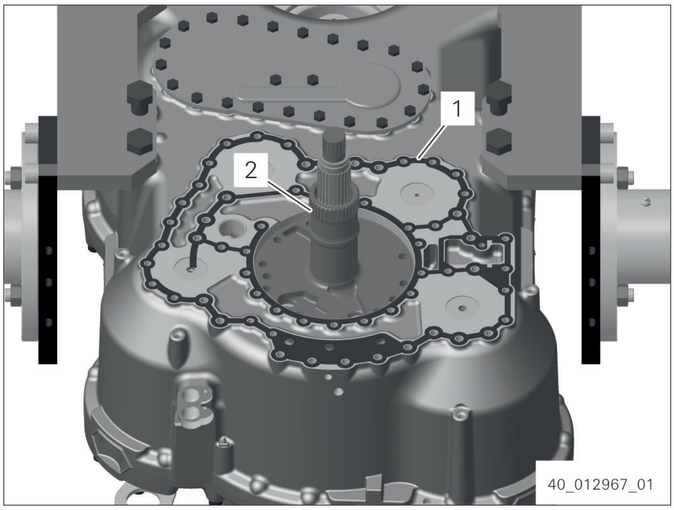


Fig. 75

Removing pump shaft

1. Remove retaining ring.

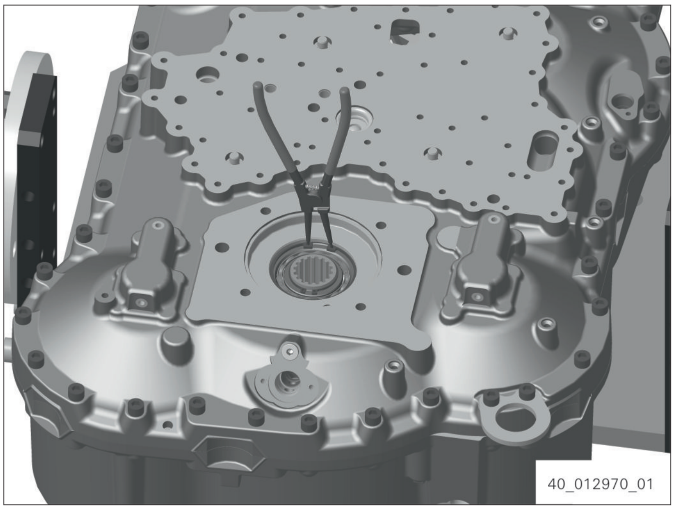


Fig. 76

2. Pull pump shaft (1) out of the transmission.

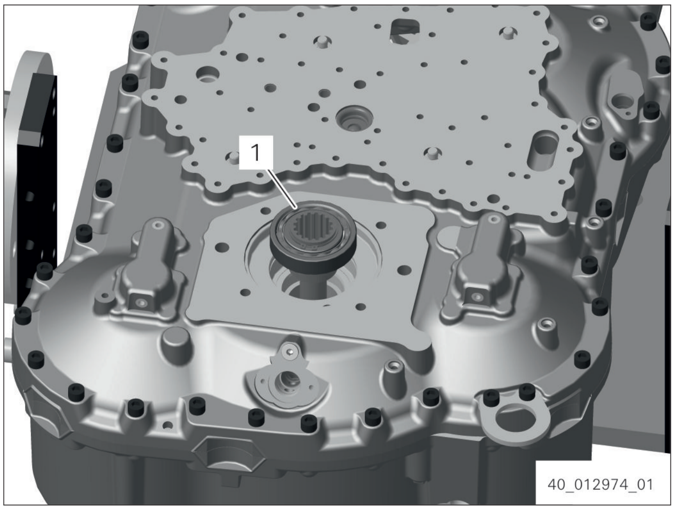


Fig. 77

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

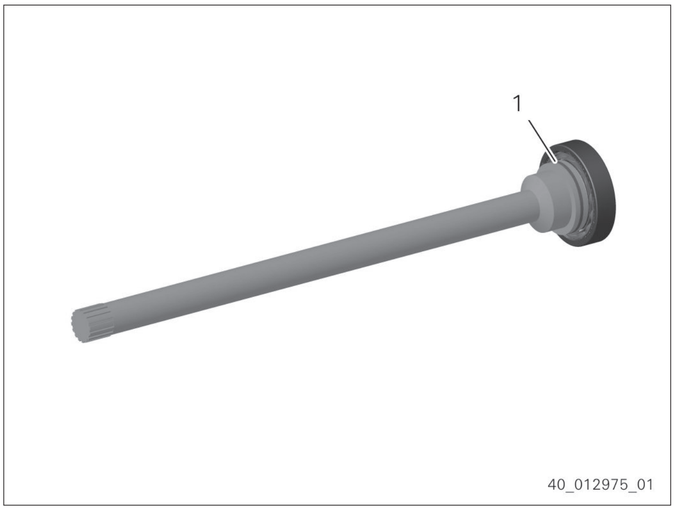


Fig. 78

4. Remove retaining ring (1).

5. Press off the ball bearing (2).

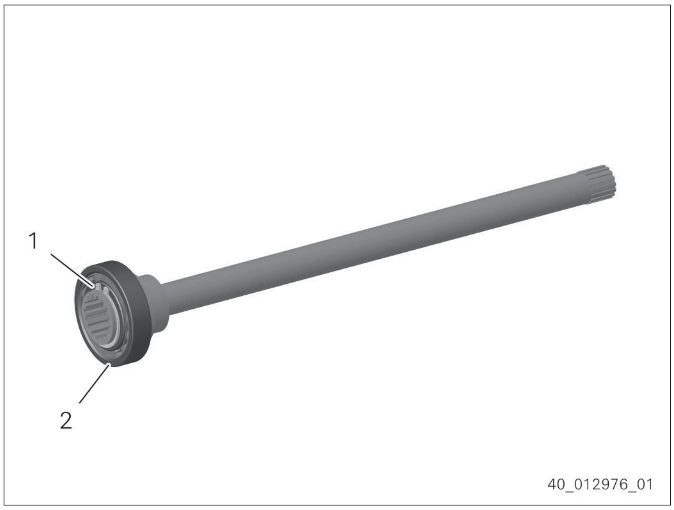


Fig. 79

Removing cover (emergency steering pump)

1. Loosen hexagon screws.

2. Remove cover (1).

3. Remove seal.

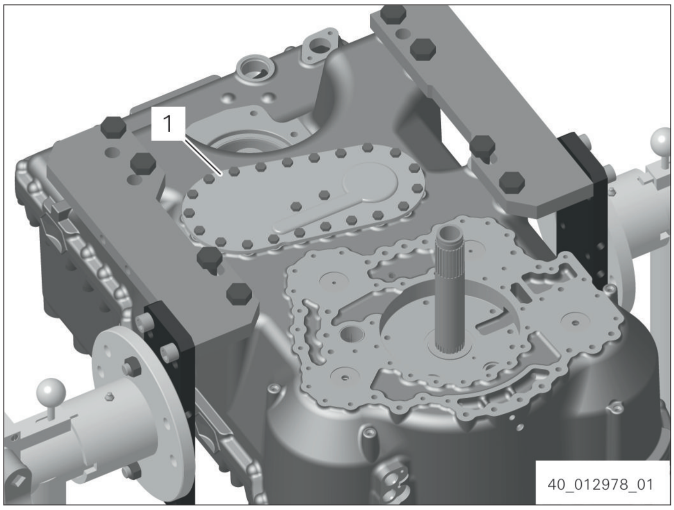


Fig. 80

Separating the housings

Special tools:
- AA02.691.822 Handle
- 5870.204.083 Eyebolt
- 5870.204.086 Eyebolt

1. ⚠ **CAUTION**

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

   Force out both cylindrical pins.

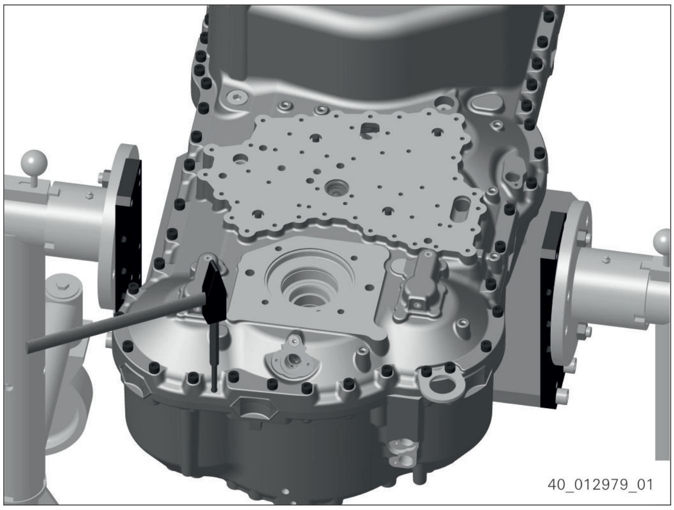


Fig. 81

2. Loosen cap screws (1).

3. Remove fixing plate (2).

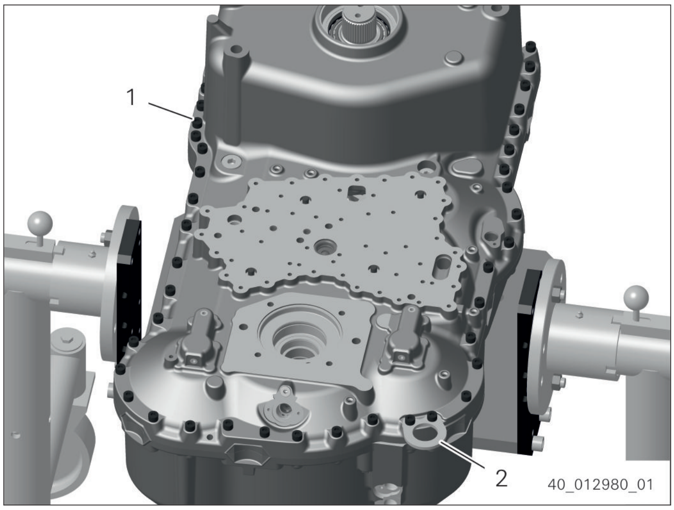


Fig. 82

4. Fix clutches K1, K2, K3 and K4 with AA02.691.822 [Handle] in the housing rear part.

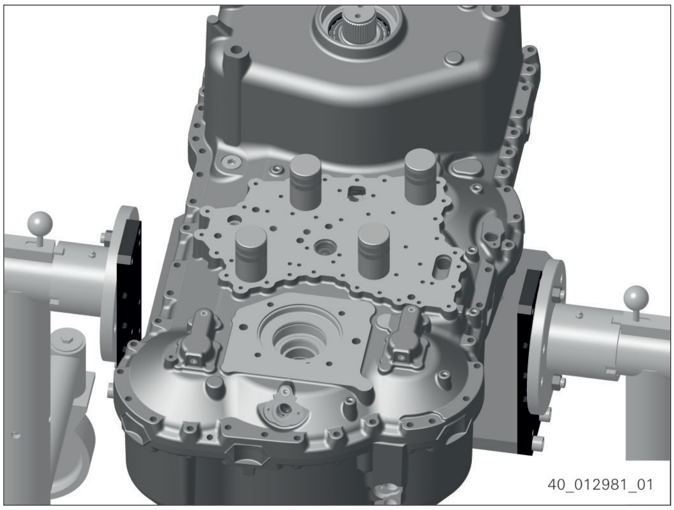


Fig. 83

5. Bolt two 5870.204.083 [Eyebolt] into the housing rear part.

6. Bolt in two 5870.204.086 [Eyebolt].

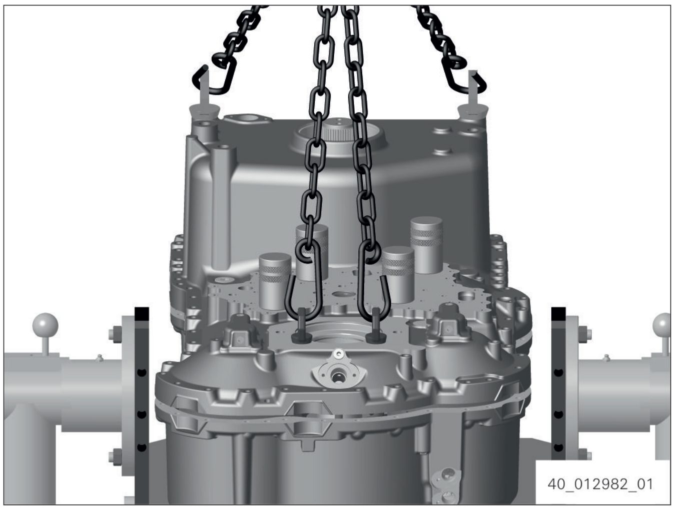


Fig. 84

7. ⚠ **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.

Lift off housing rear part and clutches using a crane.

Removing and dismantling output shaft

Special tools:

- AA01.230.960 Eyebolt
- 5873.002.038 Gripping device
- 5873.002.001 Basic tool

1. Loosen cap screws.

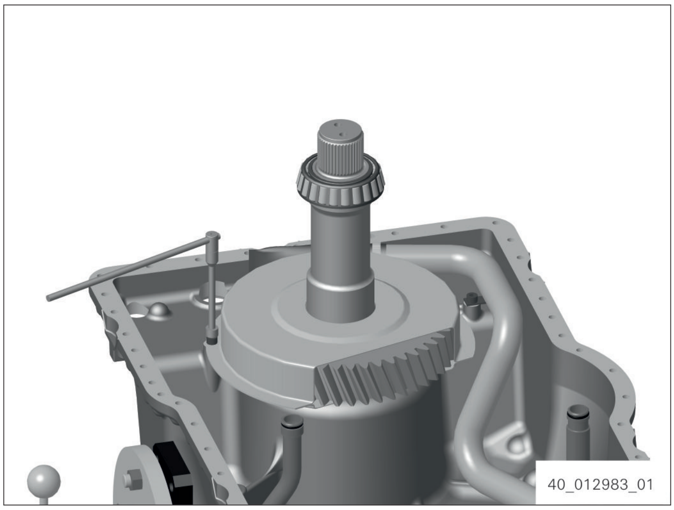


Fig. 85

2. Remove output shaft from the front part of the housing using AA01.230.960 [Eyebolt] and crane.

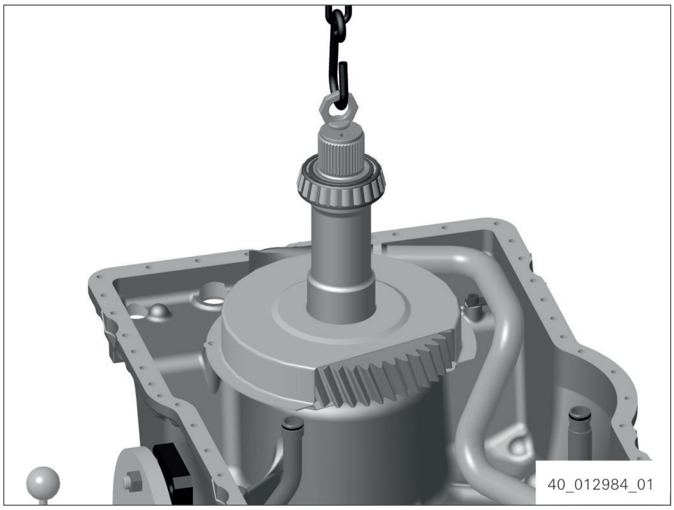


Fig. 86

3. Use 5873.002.038 [Gripping device] and 5873.002.001 [Basic tool] to pull off both bearing inner rings from the output shaft.

4. Remove screen sheet (1).

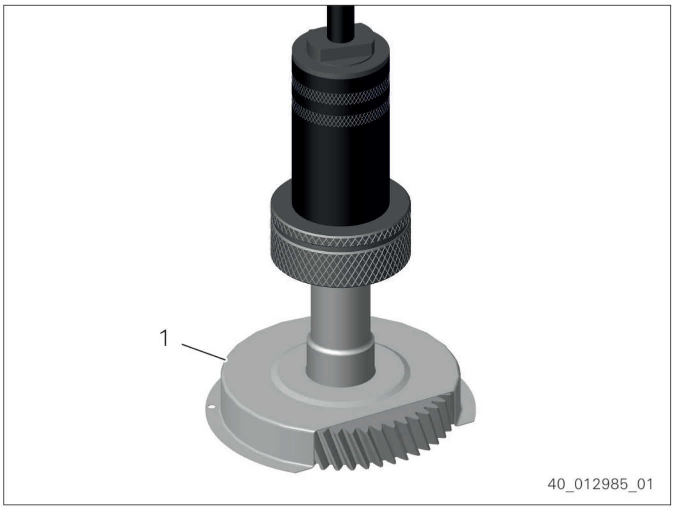


Fig. 87

Dismantling housing front part

1. Remove screen sheet (1).
2. Remove oil tube (2).
3. Remove tube (3).

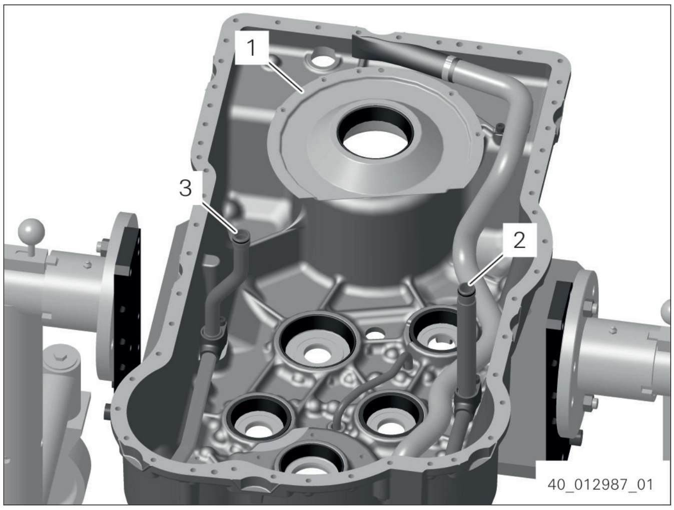


Fig. 88

4. Loosen cap screws.
5. Remove oil tubes (2).

   The suction tube (1) and oil tube (3) are rolled up and cannot be removed.

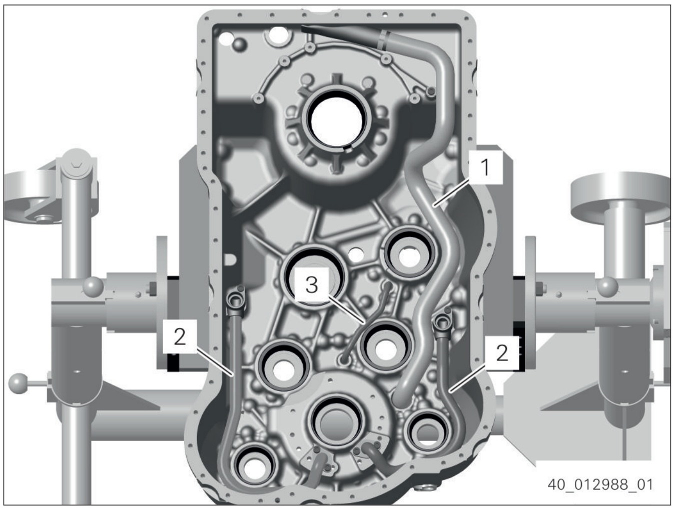


Fig. 89

6. Pull bearing outer rings out of housing holes. The Figure shows the positions of the bearing outer rings.
   - 1 = Output shaft
   - 2 = Clutch K3
   - 3 = Clutch K2
   - 4 = Clutch KV
   - 5 = Input shaft
   - 6 = Clutch KR
   - 7 = Clutch K4
   - 8 = Clutch K1

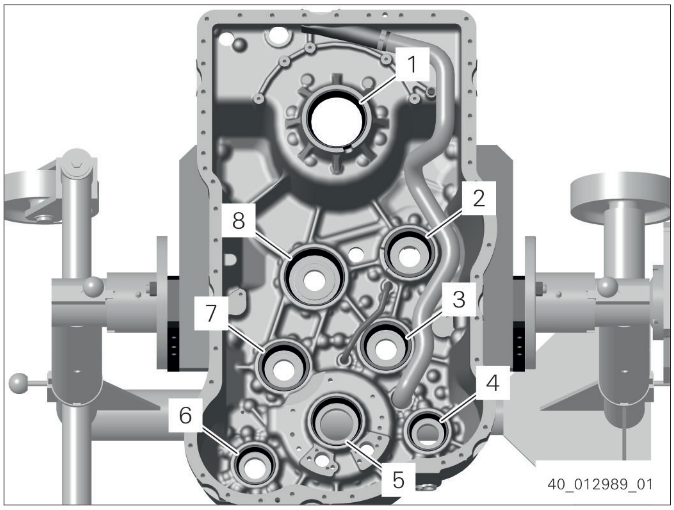


Fig. 90

Removing and dismantling clutches and input shaft

Removing clutches

Special tools:

- AA02.415.533 Assembly fixture
- 5870.350.000 Assembly truck
- AA02.691.822 Handle

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.

Secure the housing rear part with AA02.415.533 [Assembly fixture] to the 5870.350.000 [Assembly truck].

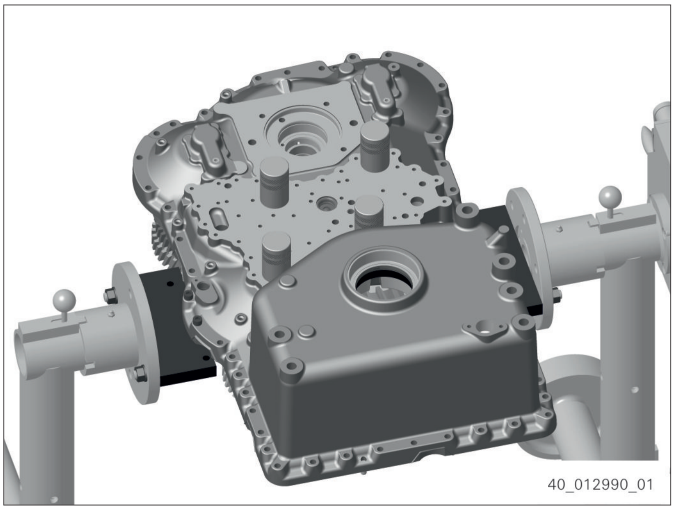


Fig. 91

2. Rotate the housing rear part 180.

3. Remove four AA02.691.822 [Handle].

4. Remove clutches from the housing rear part in the sequence specified.
   - 1 = Clutch K1
   - 2 = Clutch K2
   - 3 = Clutch K3
   - 4 = Clutch K4
   - 5 = Clutch KR
   - 6 = Clutch KV
   - 7 = Input shaft

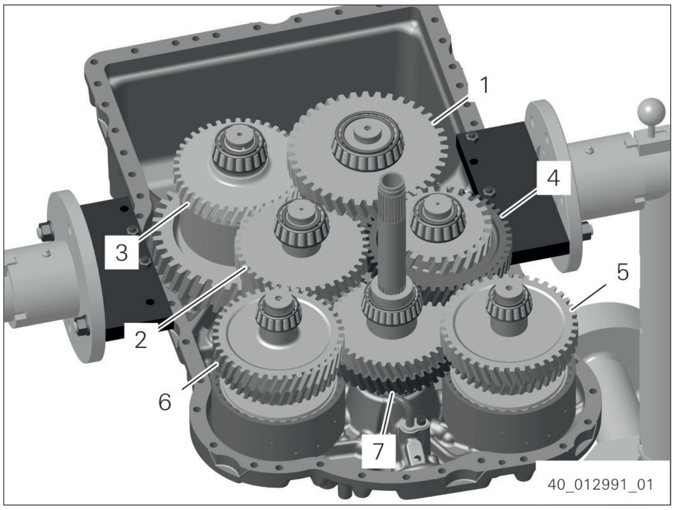


Fig. 92

9.15.2 Dismantling clutch KV

Special tools:
- 5873.001.057 Gripping device
- 5873.001.001 Basic tool
- 5870.345.088 Assembly fixture
- 5870.300.024 Disassembly device
- 5870.300.033 Extractor

1. Remove stud bolt (1).

2. Remove piston ring (2).

Fig. 93

3. Pull off bearing inner ring with 5873.001.057 [Gripping device] and 5873.001.001 [Basic tool].

Fig. 94

4. Remove retaining ring.

Fig. 95

5. Pull off clutch from shaft.

Fig. 96

6. Remove snap ring.

7. Remove end shim and disk package from the disk carrier.

Fig. 97

8. Preload compression spring with 5870.345.088 [Assembly fixture] and press.

9. Remove L-ring.

10. Remove support shim, compression spring and shim.

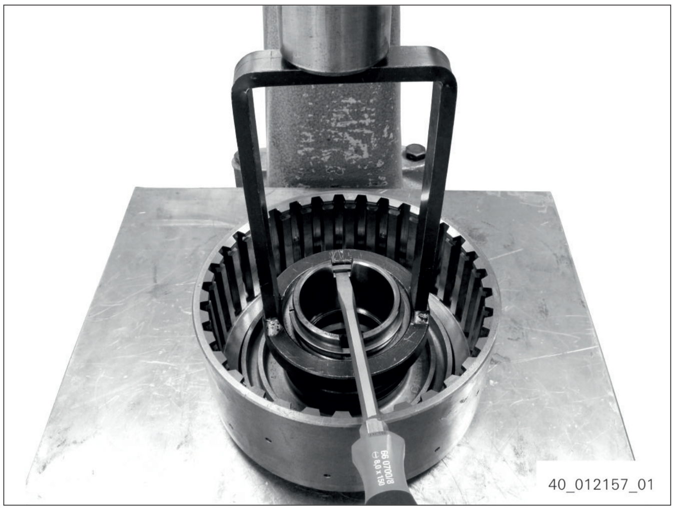


Fig. 98

11. Press the piston out of the disk carrier using compressed air.

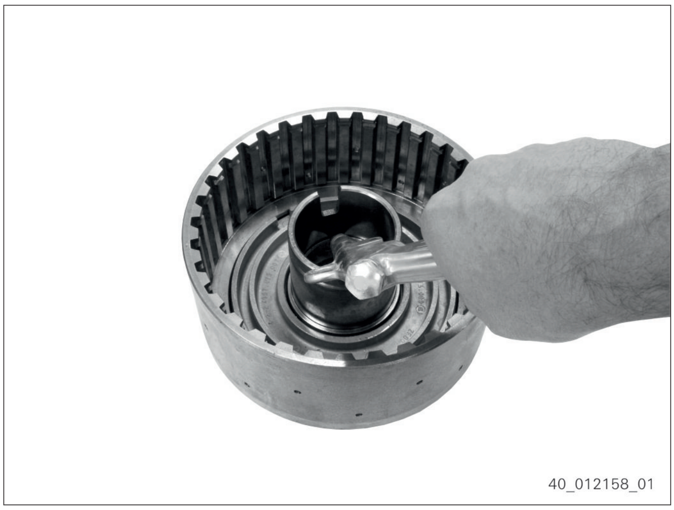


Fig. 99

12. Pull off idler gear from shaft with 5870.300.024 [Disassembly device] and 5870.300.033 [Extractor].

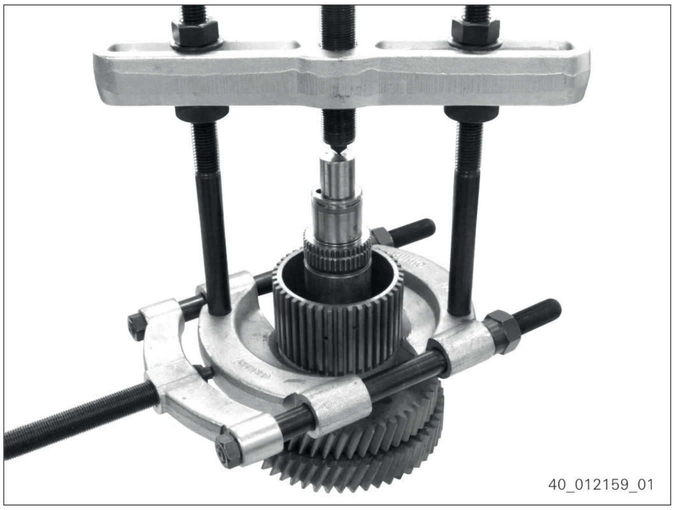


Fig. 100

13. Remove retaining ring.

14. Pull out the ball bearing (1).

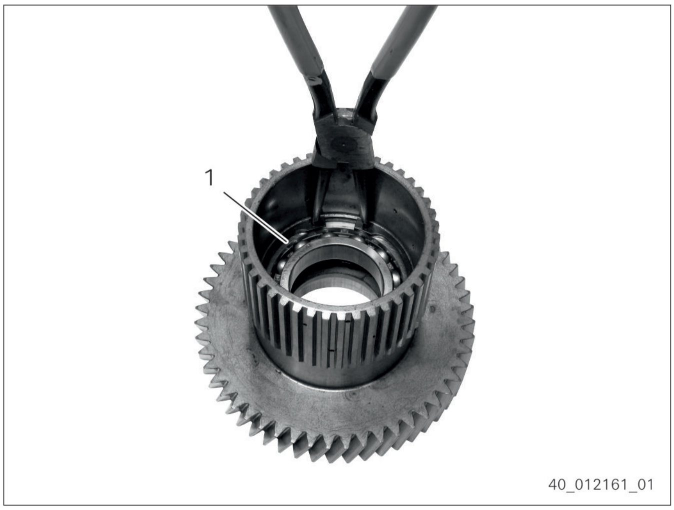


Fig. 101

15. Remove needle ring (1).

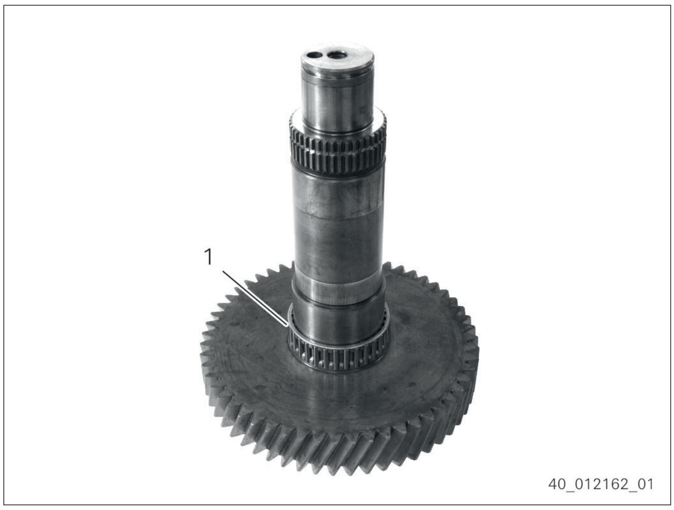


Fig. 102

16. Remove piston ring (1).

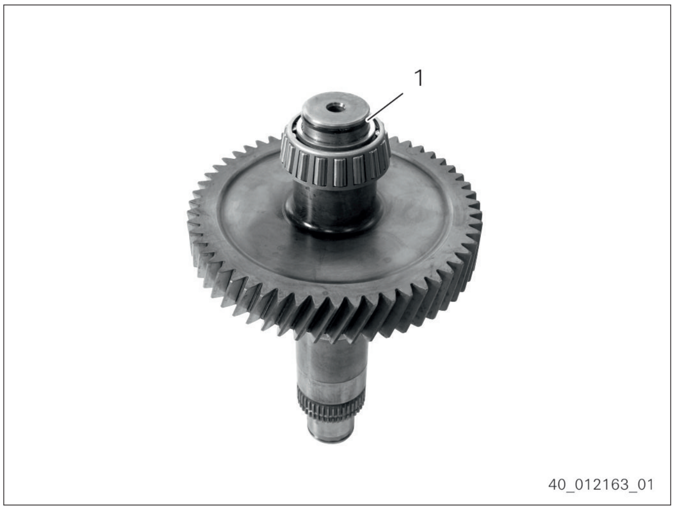


Fig. 103

17. Pull off bearing inner ring with 5873.001.057 [Gripping device] and 5873.001.001 [Basic tool].

Fig. 104

Dismantling clutch KR

Special tools:

- AA00.391.590 Gripping device
- 5873.001.001 Basic tool
- 5870.345.088 Assembly fixture
- 5870.300.024 Disassembly device
- 5870.300.033 Extractor
- 5873.001.057 Gripping device

1. Remove stud bolt (1).

2. Remove piston ring (2).

Fig. 105

3. Pull off bearing inner ring with AA00.391.590 [Gripping device] and 5873.001.001 [Basic tool].

Fig. 106

4. Remove retaining ring.

Fig. 107

5. Pull off clutch from shaft.

Fig. 108

6. Remove snap ring.

7. Remove end shim and disk package from the disk carrier.

Fig. 109

8. Preload compression spring with 5870.345.088 [Assembly fixture] and press.

9. Remove L-ring.

10. Remove supporting ring, compression spring and shim.

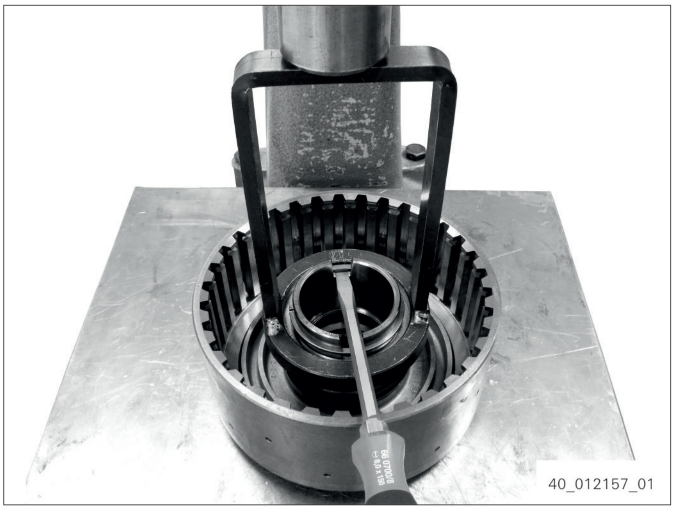


Fig. 110

11. Press the piston out of the disk carrier using compressed air.

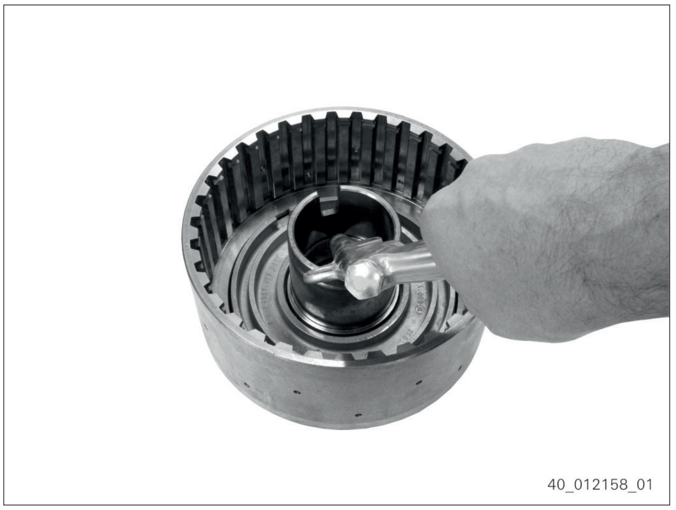


Fig. 111

12. Pull off idler gear from shaft with 5870.300.024 [Disassembly device] and 5870.300.033 [Extractor].

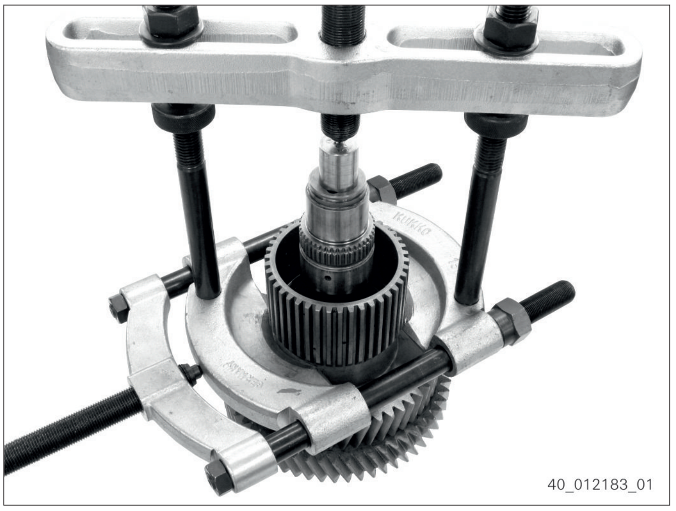


Fig. 112

13. Remove retaining ring.

14. Pull out the ball bearing (1).

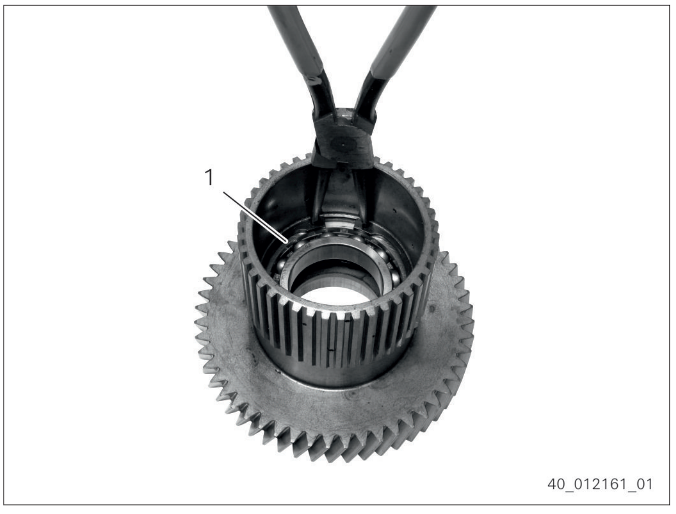


Fig. 113

15. Remove needle cage (1).

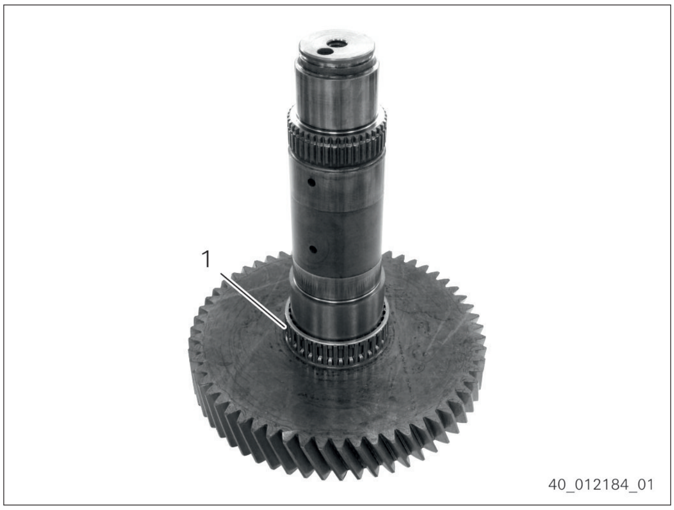


Fig. 114

16. Remove piston ring (1).

Fig. 115

17. Pull off bearing inner ring with 5873.001.057 [Gripping device] and 5873.001.001 [Basic tool].

Fig. 116

Dismantling clutch K1

Special tools:
- AA00.391.590 Gripping device
- 5873.001.001 Basic tool
- 5870.345.088 Assembly fixture
- 5873.002.038 Gripping device
- 5873.002.001 Basic tool

1. Remove stud bolt (1).

2. Remove piston ring (2).

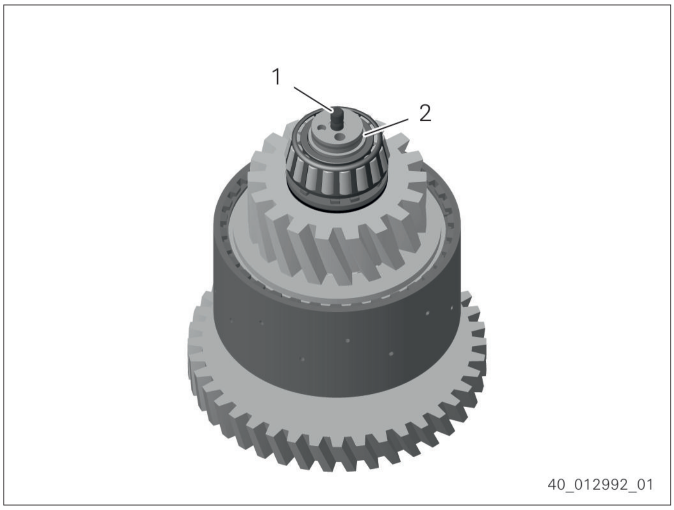


Fig. 117

3. Pull off bearing inner ring with AA00.391.590 [Gripping device] and 5873.001.001 [Basic tool].

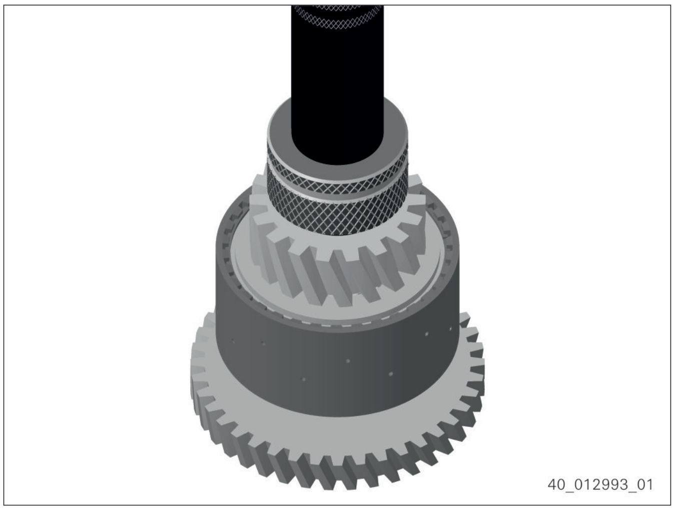


Fig. 118

4. Remove retaining ring.

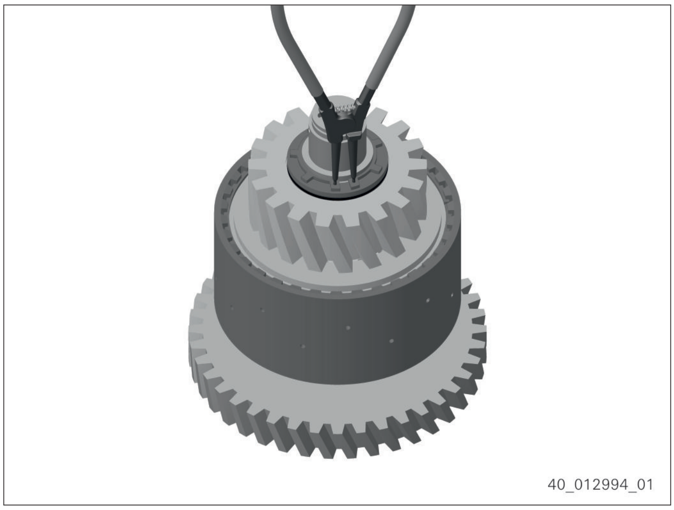


Fig. 119

5. Remove thrust washer (1), axial needle cage (2) and axial washer (3).

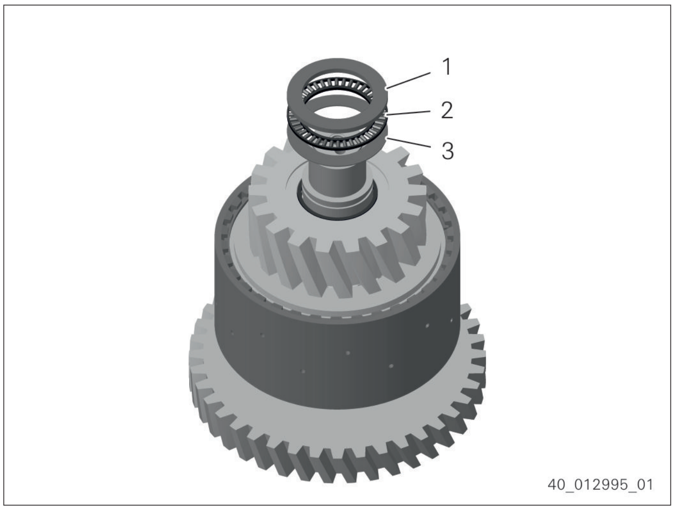


Fig. 120

6. Remove idler gear (1).

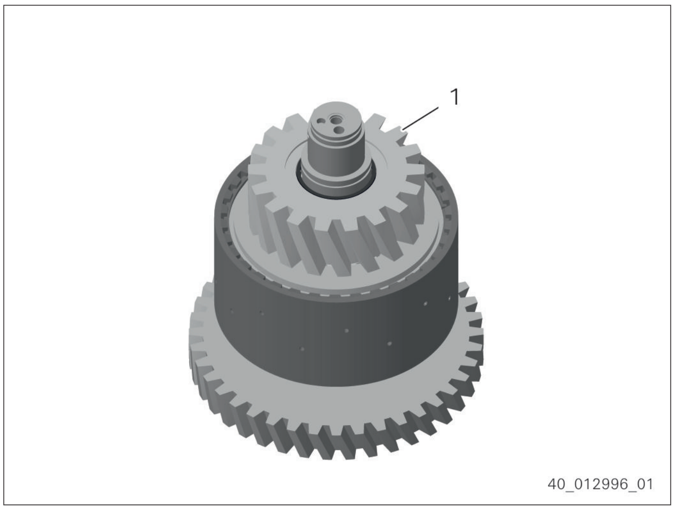


Fig. 121

7. Remove needle cage (1).

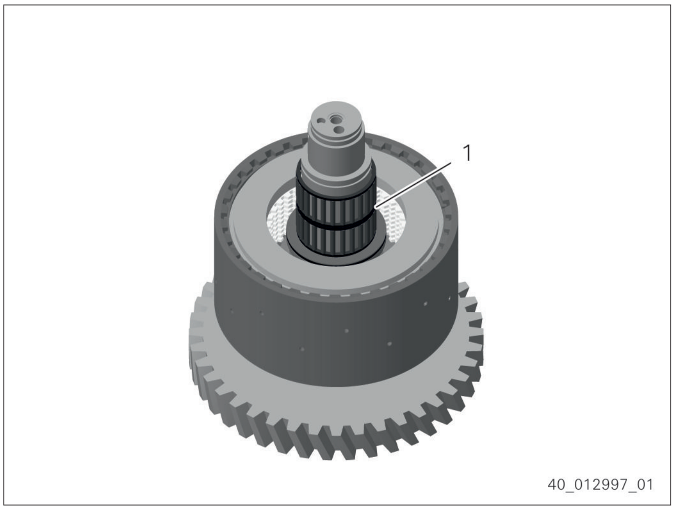


Fig. 122

8. Remove axial washer (1), axle needle cage (2) and thrust washer (3).

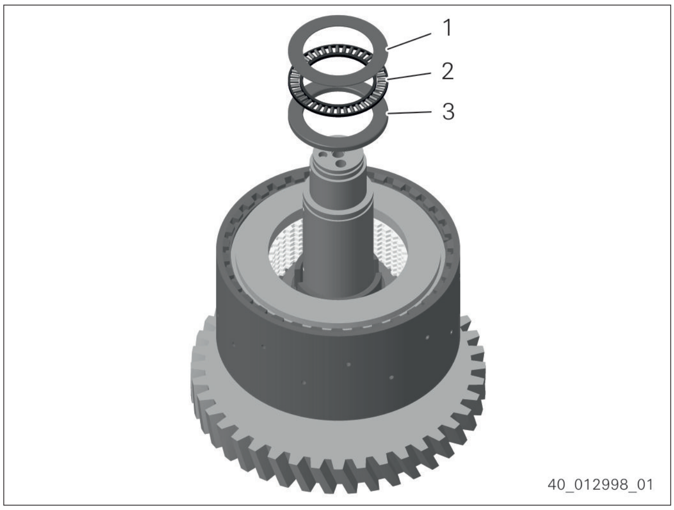


Fig. 123

9. Pull off clutch from shaft.

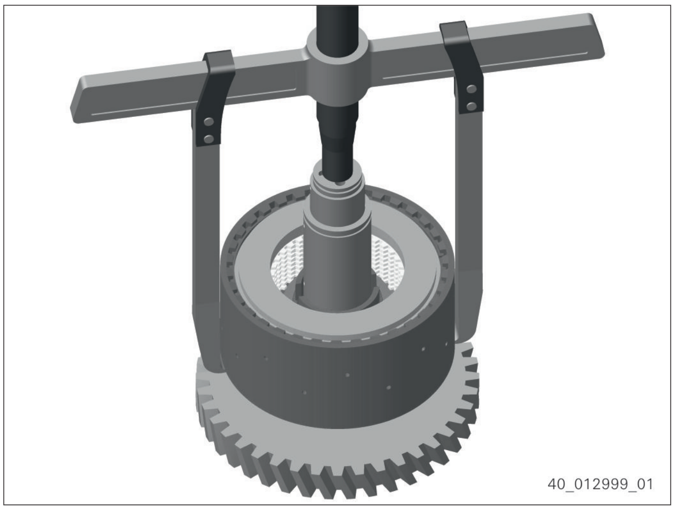


Fig. 124

10. Remove snap ring (1).

11. Remove end shim from the disk carrier.

12. Remove disk package.

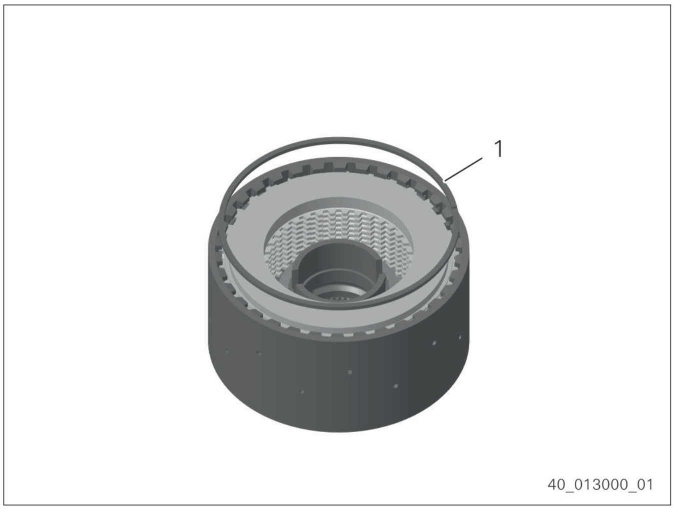


Fig. 125

13. Preload the cup springs with 5870.345.088 [Assembly fixture] and press.

14. Remove L-ring (1).

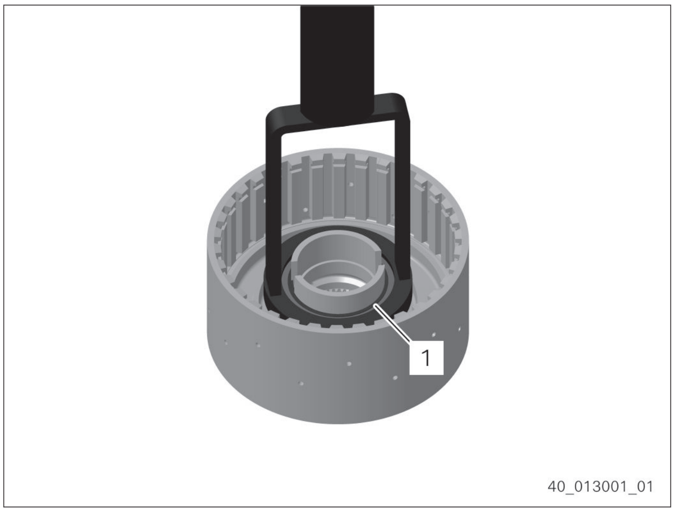


Fig. 126

15. Remove cup springs.

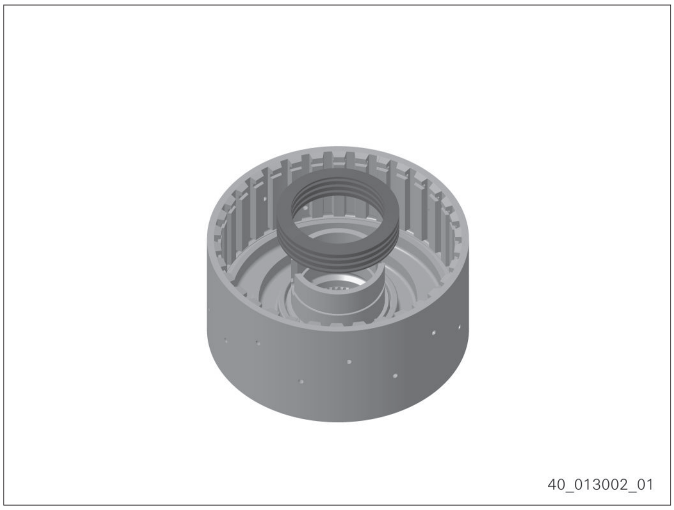


Fig. 127

16. Press the piston (1) out of the disk carrier using compressed air.

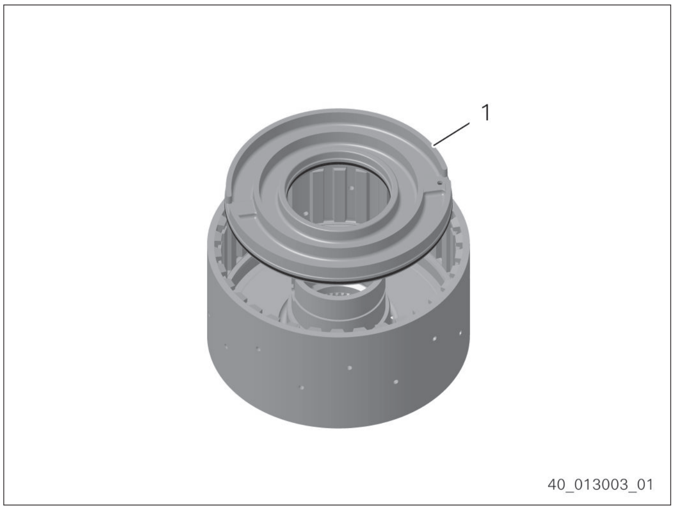


Fig. 128

17. Remove piston ring (1).

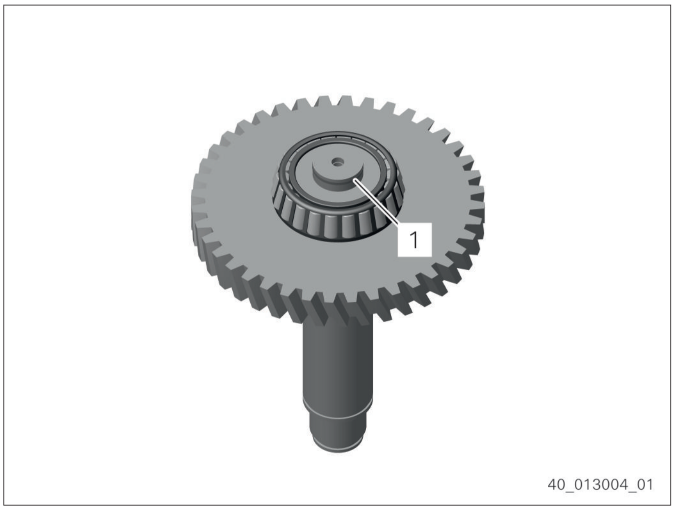


Fig. 129

18. Pull off bearing inner ring with 5873.002.038 [Gripping device] and 5873.002.001 [Basic tool].

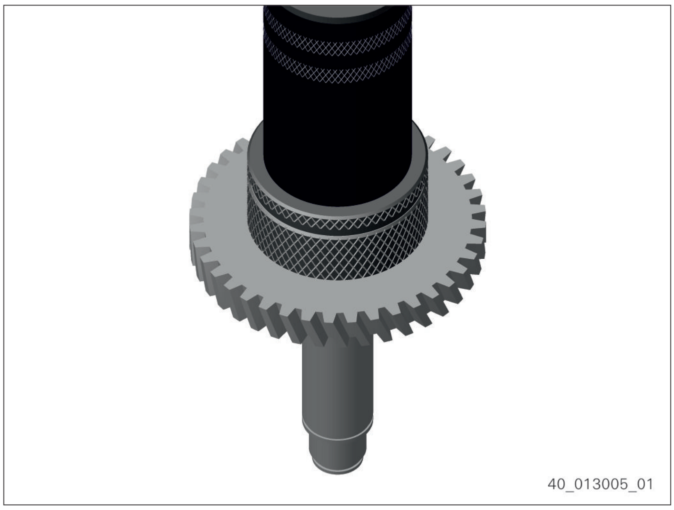


Fig. 130

Dismantling clutch K2

Special tools:
- AA00.391.590 Gripping device
- 5873.001.001 Basic tool
- 5870.345.088 Assembly fixture

1. Remove stud bolt (1).

2. Remove piston ring (2).

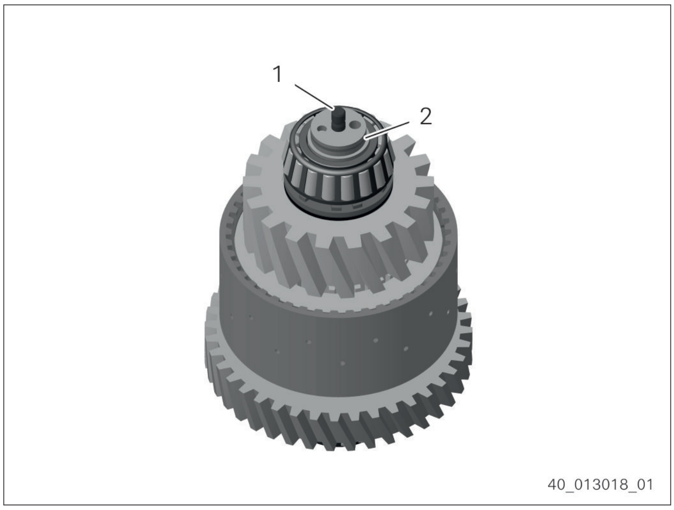


Fig. 131

3. Pull off bearing inner ring with AA00.391.590 [Gripping device] and 5873.001.001 [Basic tool].

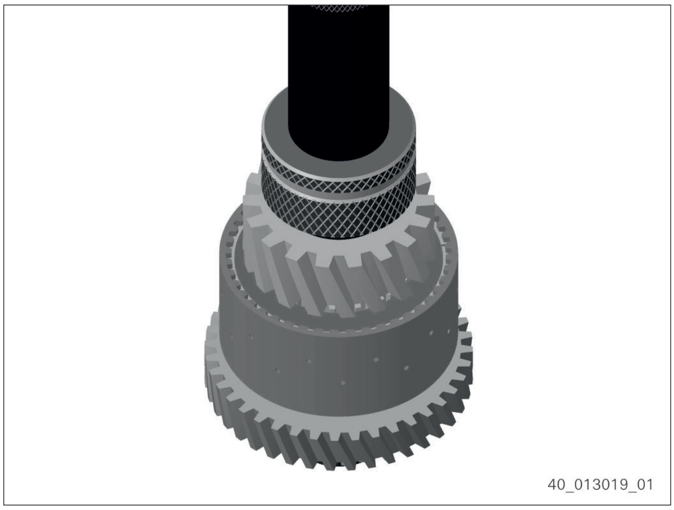


Fig. 132

4. Remove retaining ring.

Fig. 133

5. Remove thrust washer (1), axial needle cage (2) and axial washer (3).

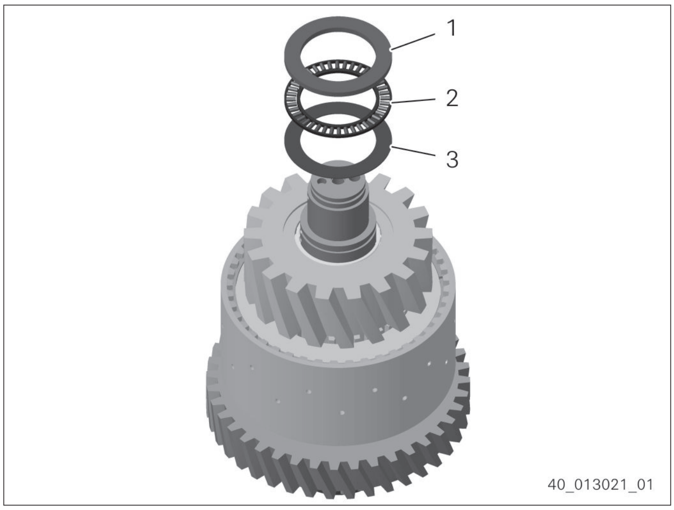


Fig. 134

6. Remove idler gear (1).

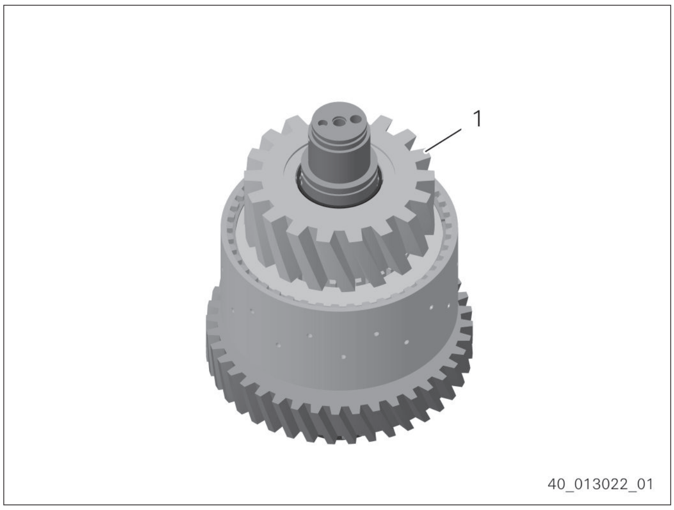


Fig. 135

7. Remove needle cage (1).

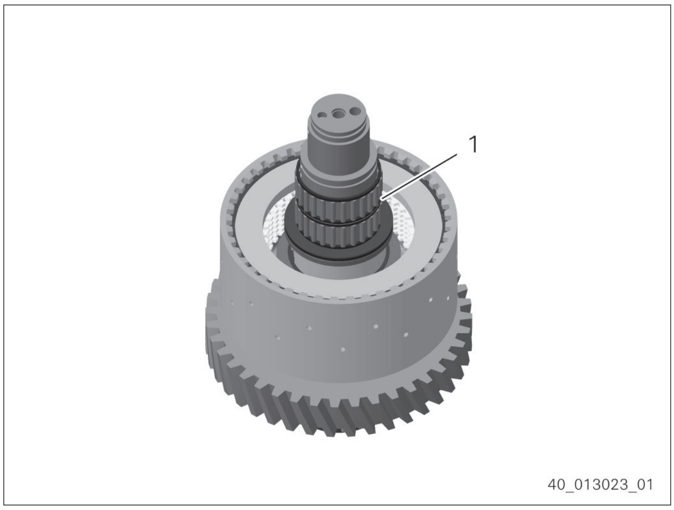


Fig. 136

8. Remove axial washer (1), axle needle cage (2) and thrust washer (3).

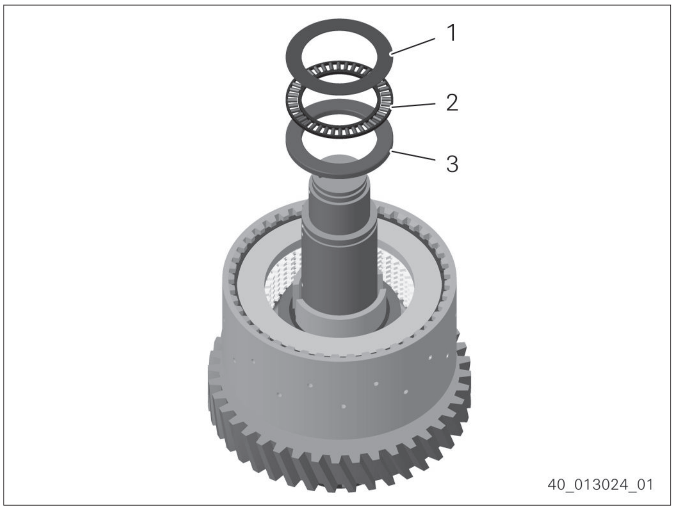


Fig. 137

9. Pull off clutch from shaft.

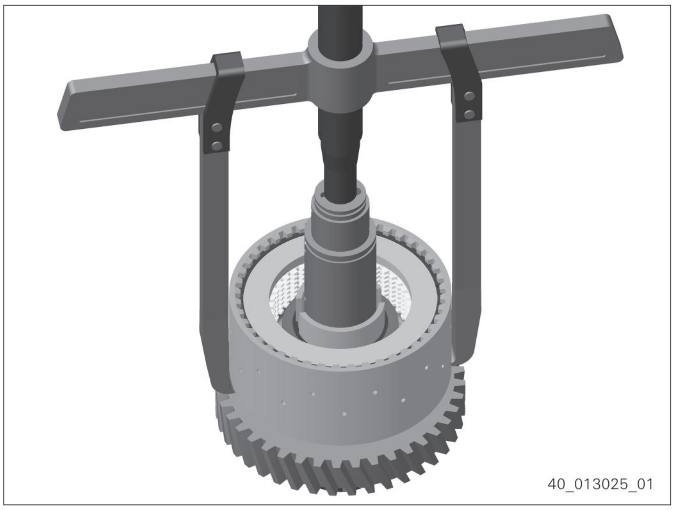


Fig. 138

10. Remove snap ring (1).

11. Remove end shim from the disk carrier.

12. Remove disk package.

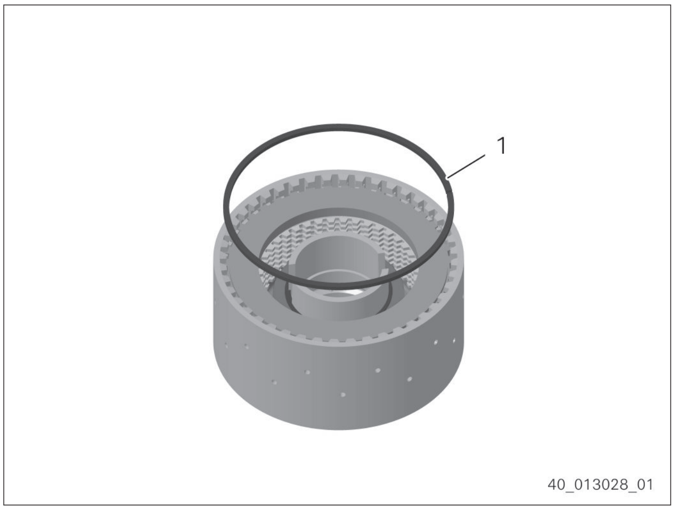


Fig. 139

13. Preload the cup springs with 5870.345.088 [Assembly fixture] and press.

14. Remove L-ring (1).

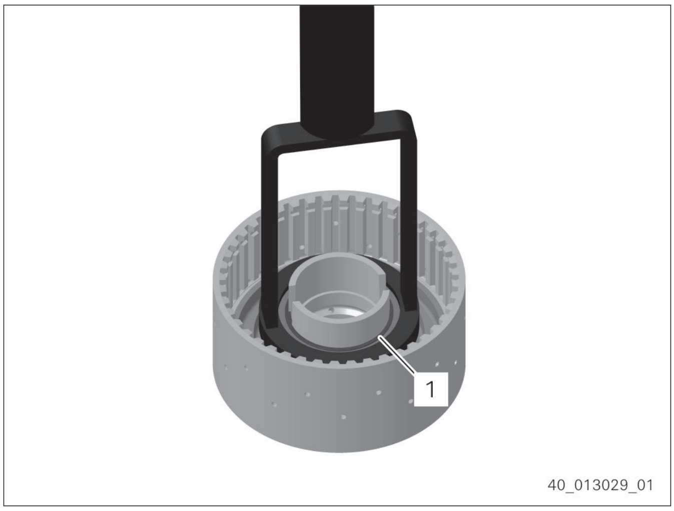


Fig. 140

15. Remove cup springs.

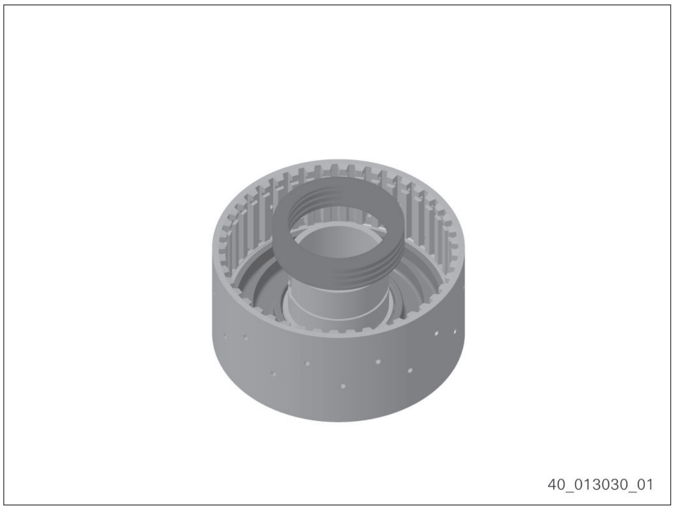


Fig. 141

16. Press the piston (1) out of the disk carrier using compressed air.

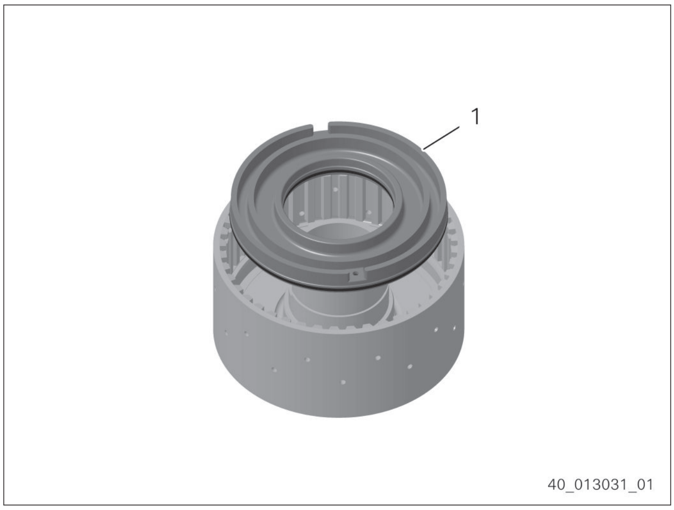


Fig. 142

17. Remove piston ring (1).

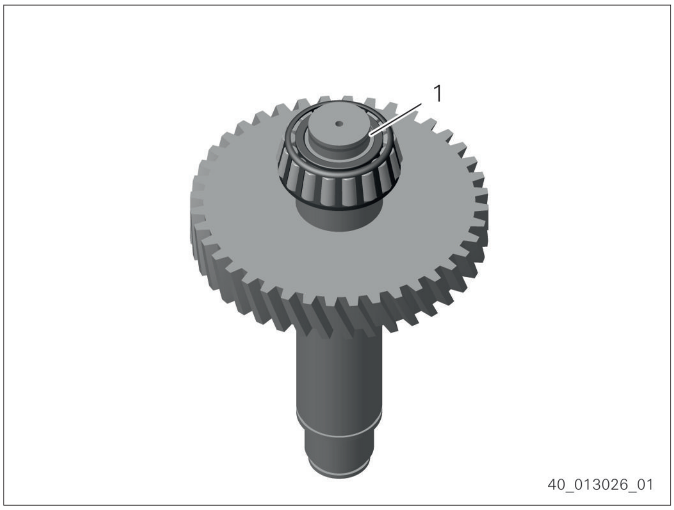


Fig. 143

18. Pull off bearing inner ring with AA00.391.590 [Gripping device] and 5873.001.001 [Basic tool].

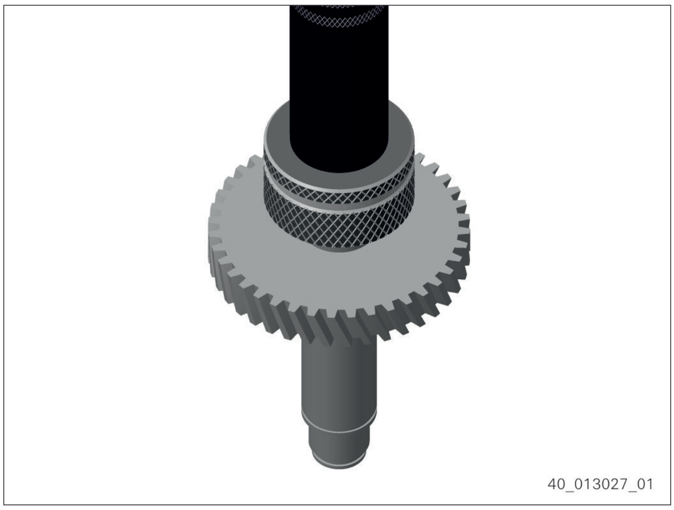


Fig. 144

Dismantling clutch K3

Special tools:
- 5873.002.038 Gripping device
- 5873.002.001 Basic tool
- AA00.391.590 Gripping device
- 5873.001.001 Basic tool
- 5870.345.088 Assembly fixture

1. Remove stud bolt (1).

2. Remove piston ring (2).

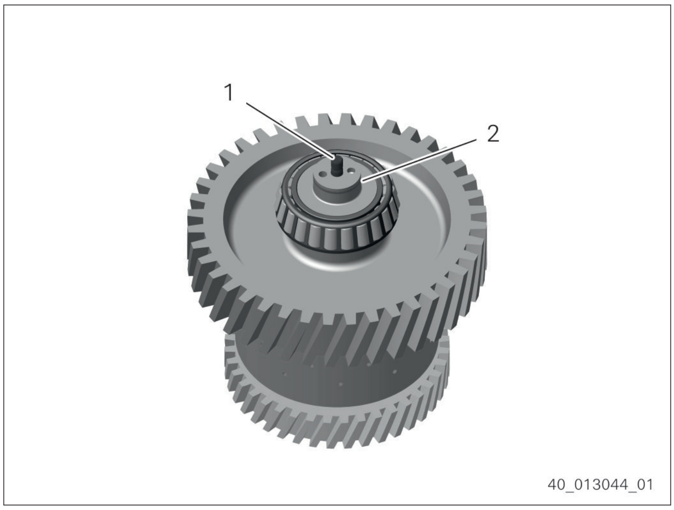


Fig. 145

3. Pull off bearing inner ring with 5873.002.038 [Gripping device] and 5873.002.001 [Basic tool].

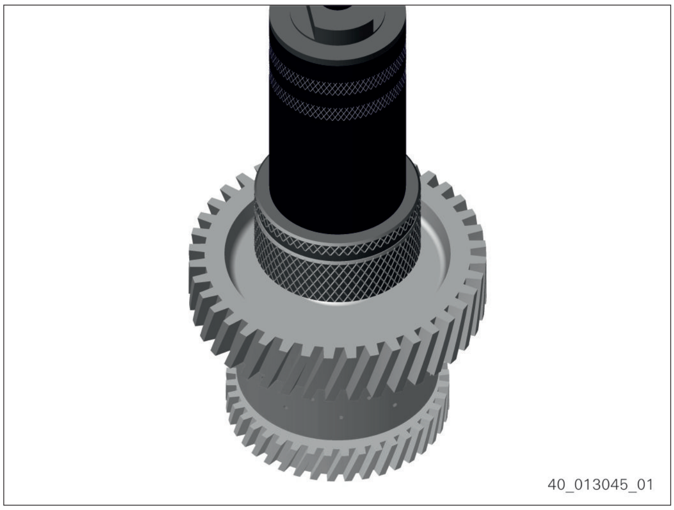


Fig. 146

4. Remove piston ring (1).

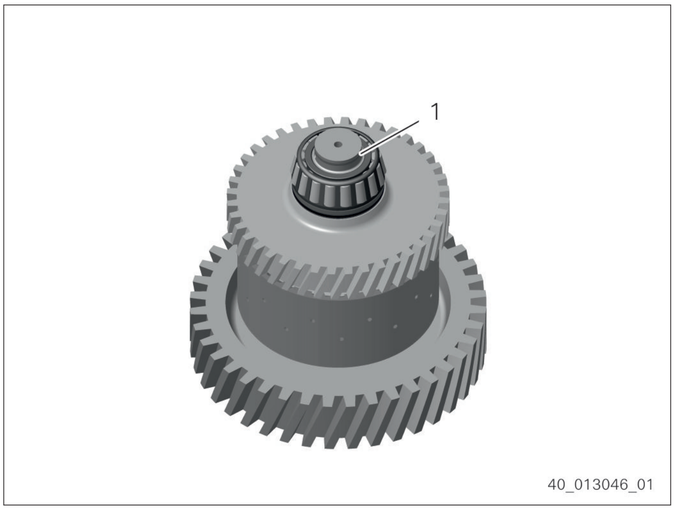


Fig. 147

5. Pull off bearing inner ring with AA00.391.590 [Gripping device] and 5873.001.001 [Basic tool].

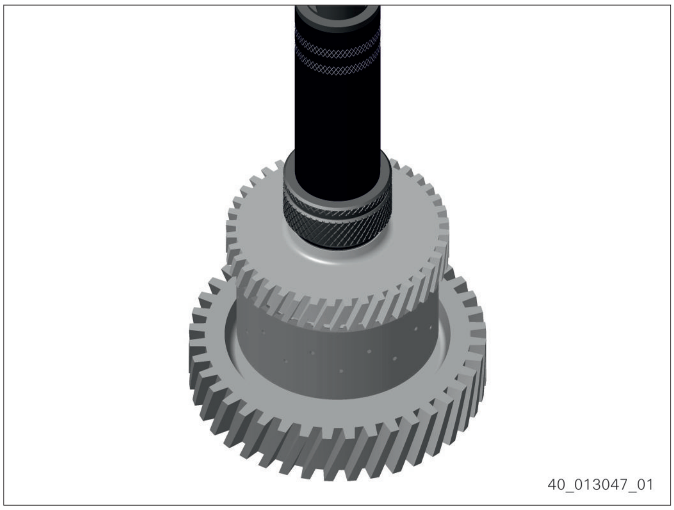


Fig. 148

6. Remove thrust washer (1), axial needle cage (2) and axial washer (3).

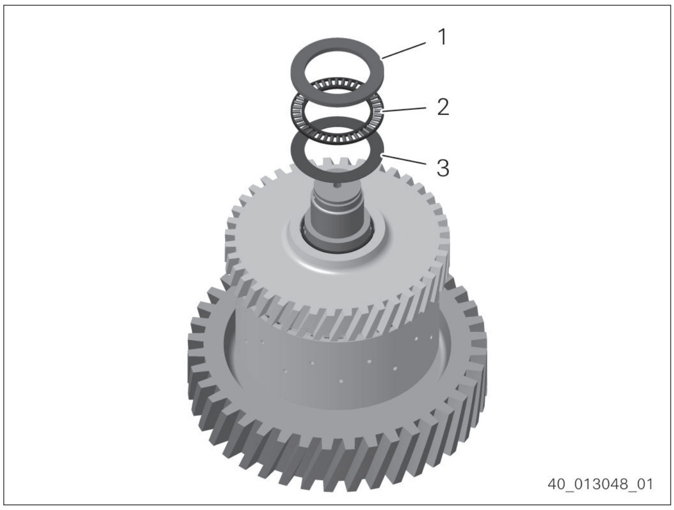


Fig. 149

7. Remove idler gear (1).

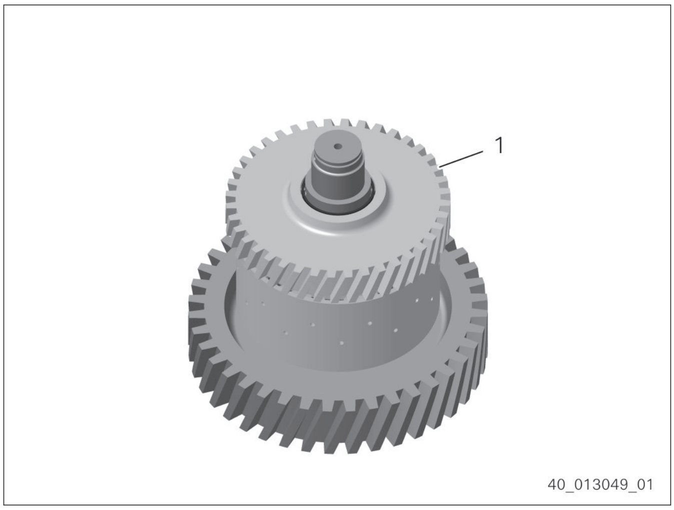


Fig. 150

8. Remove needle cage (1).

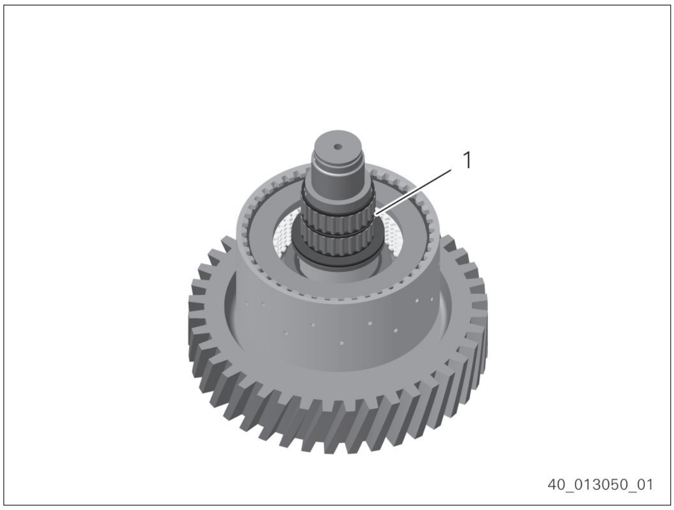


Fig. 151

9. Remove axial washer (1), axle needle cage (2) and thrust washer (3).

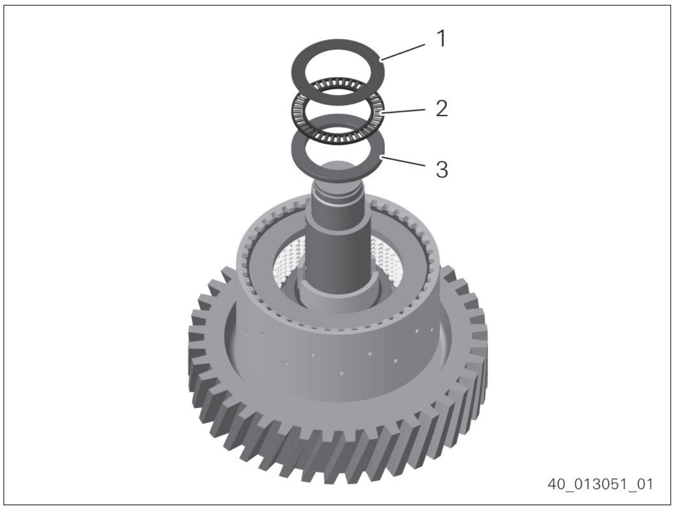


Fig. 152

10. Pull off clutch from shaft.

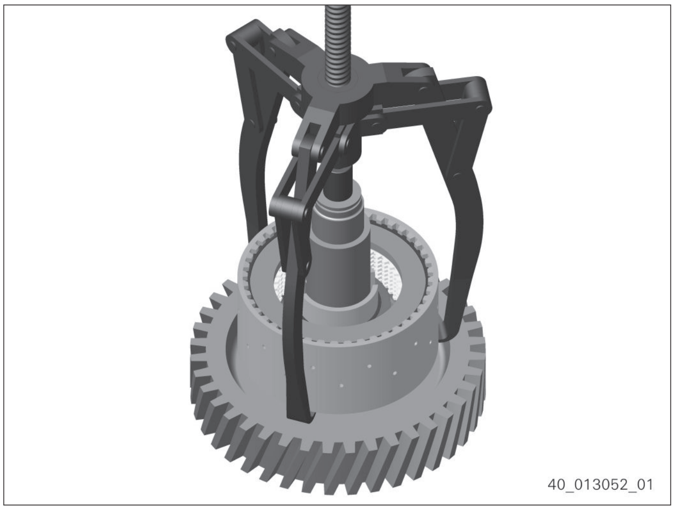


Fig. 153

11. Remove snap ring (1).

12. Remove end shim from the disk carrier.

13. Remove disk package.

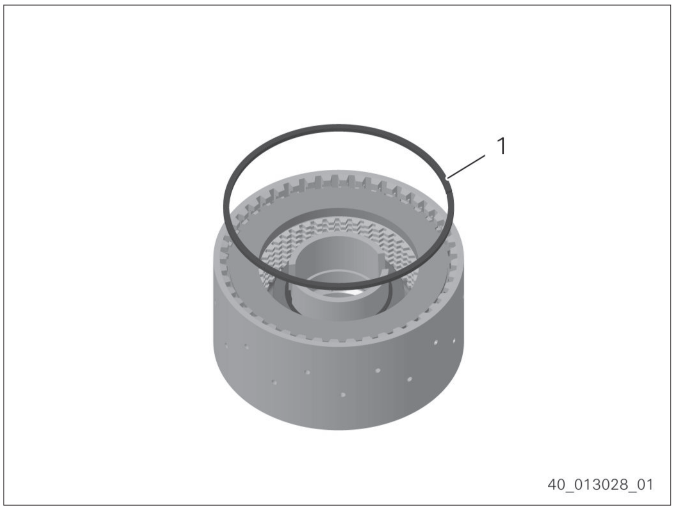


Fig. 154

14. Preload the cup springs with 5870.345.088 [Assembly fixture] and press.

15. Remove L-ring (1).

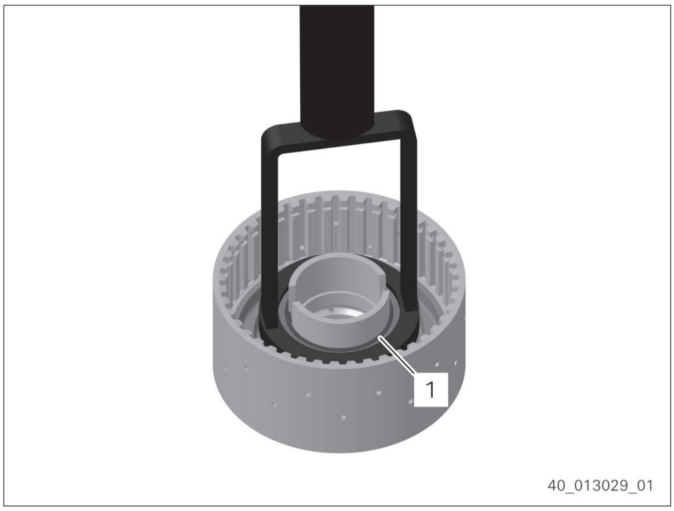


Fig. 155

16. Remove cup springs.

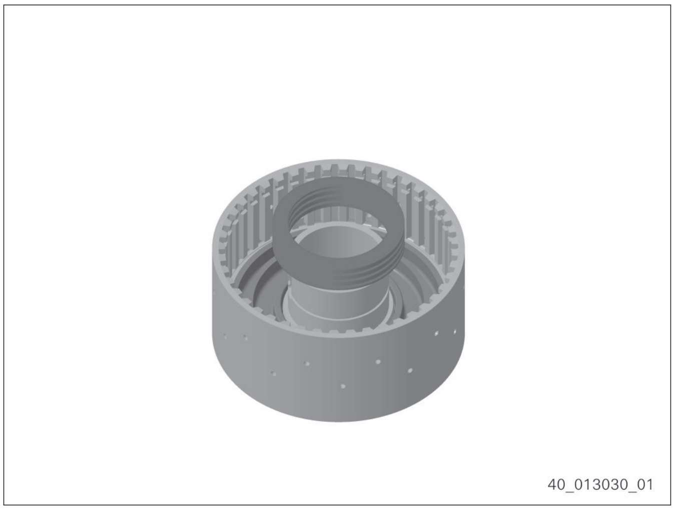


Fig. 156

17. Press the piston (1) out of the disk carrier using compressed air.

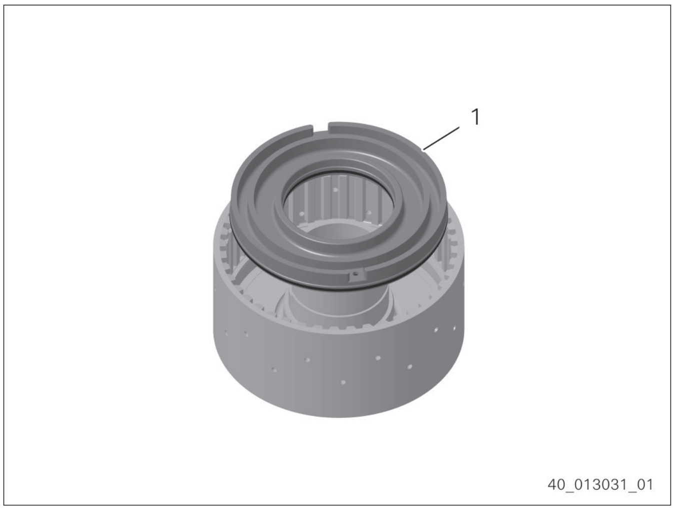


Fig. 157

Dismantling clutch K4

Special tools:

- 5873.001.057 Gripping device
- 5873.001.001 Basic tool
- 5870.345.088 Assembly fixture
- AA00.391.590 Gripping device

Dismantling

1. Remove stud bolt (1).

2. Remove piston ring (2).

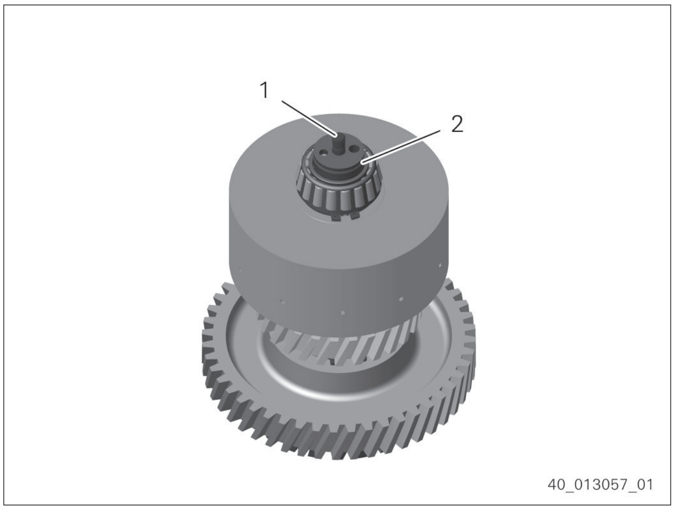


Fig. 158

3. Pull off bearing inner ring with 5873.001.057 [Gripping device] and 5873.001.001 [Basic tool].

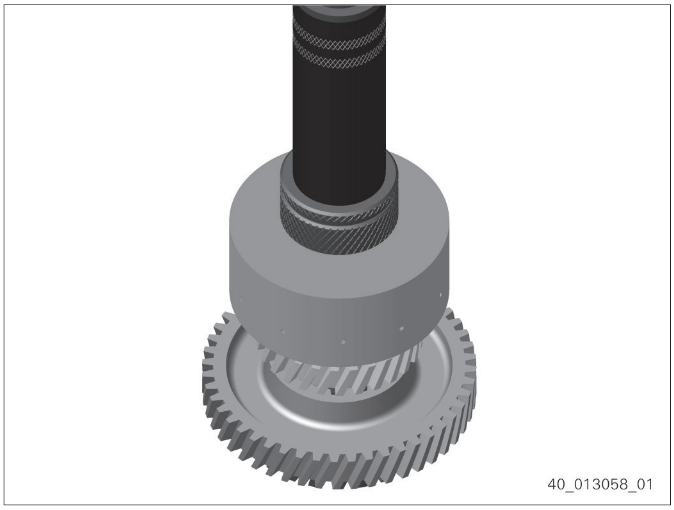


Fig. 159

4. Remove retaining ring.

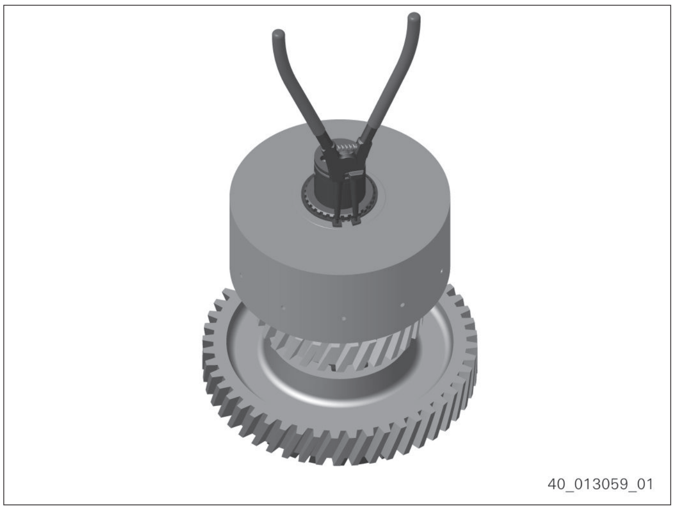


Fig. 160

5. Pull off clutch from shaft.

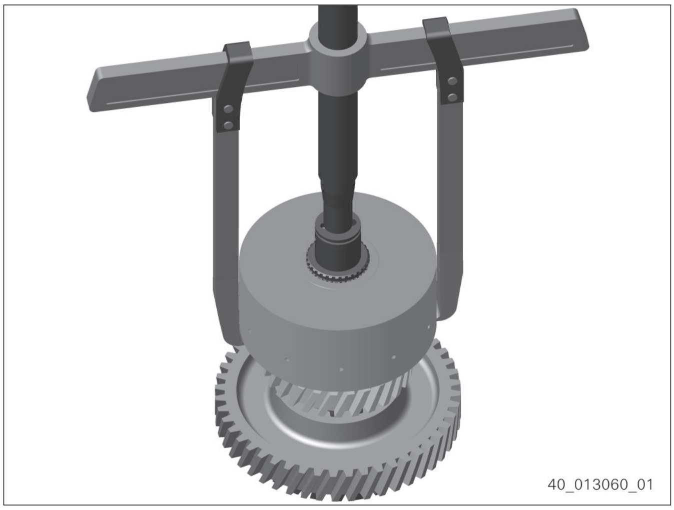


Fig. 161

6. Remove snap ring (1).

7. Remove end shim from the disk carrier.

8. Remove disk package.

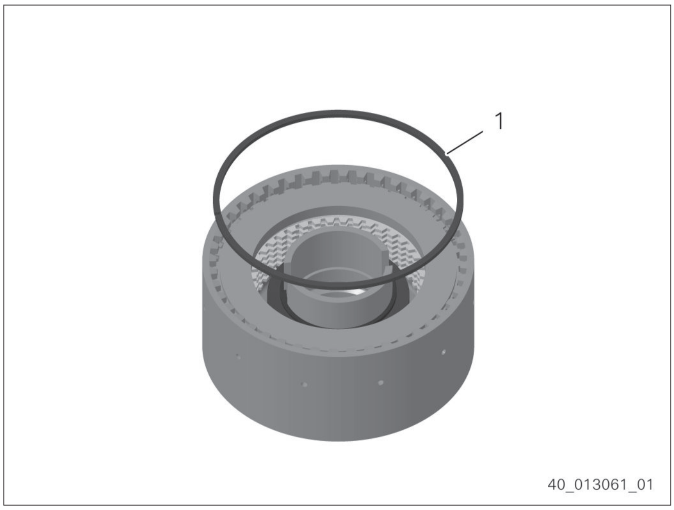


Fig. 162

9. Preload the cup springs with 5870.345.088 [Assembly fixture] and press.

10. Remove L-ring (1).

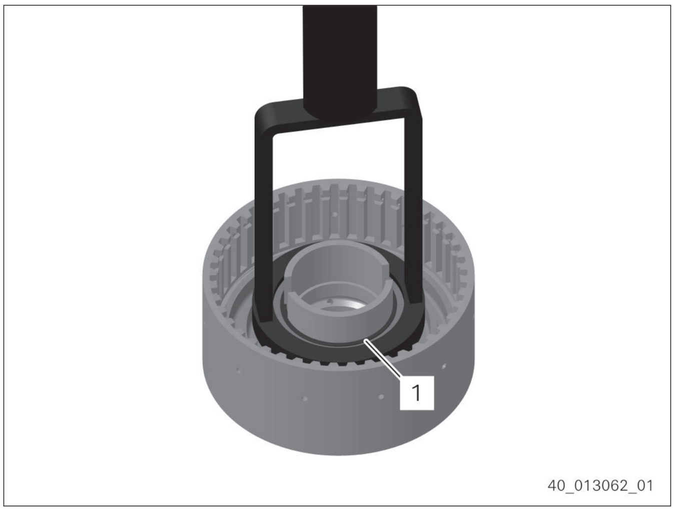


Fig. 163

11. Remove cup springs.

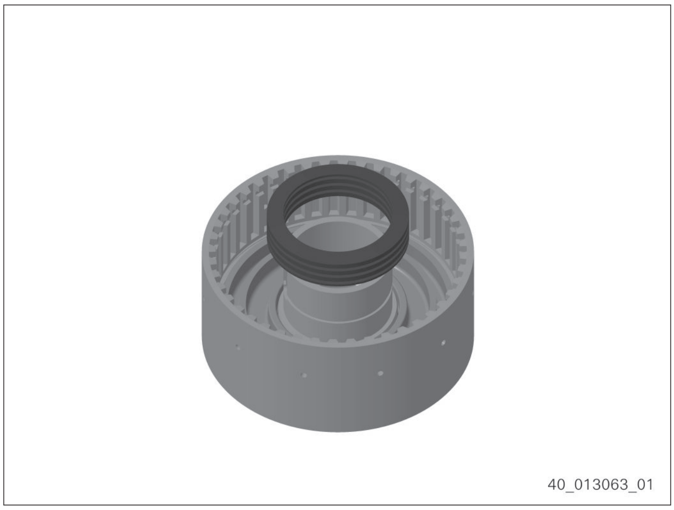


Fig. 164

12. Press the piston (1) out of the disk carrier using compressed air.

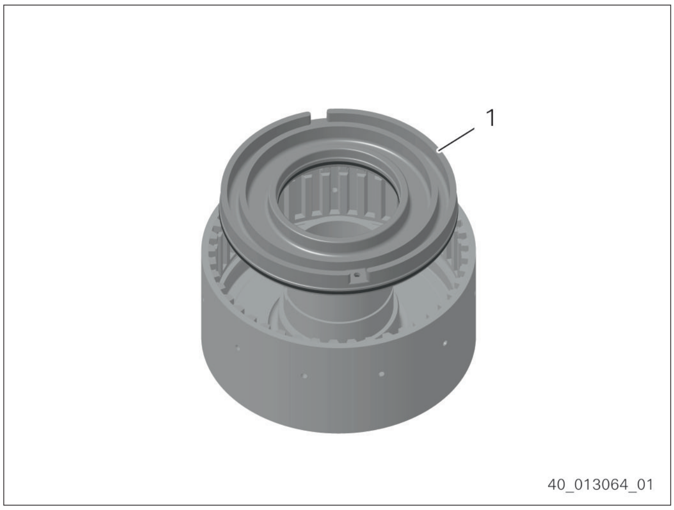


Fig. 165

13. Remove thrust washer (1), axial needle cage (2) and axial washer (3).

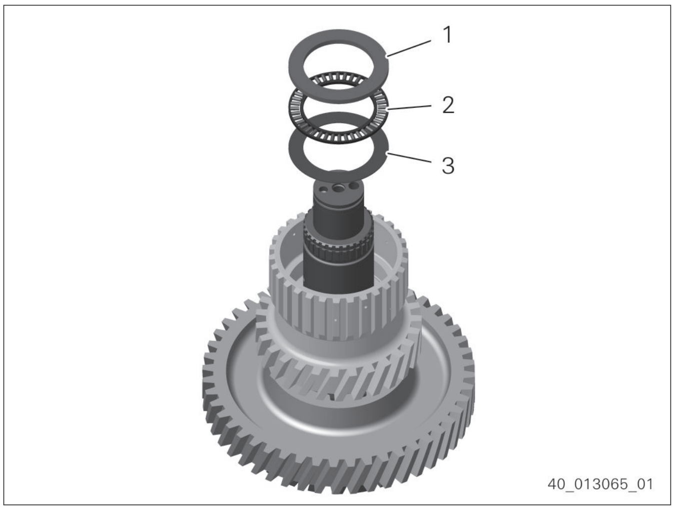


Fig. 166

14. Remove idler gear (1).

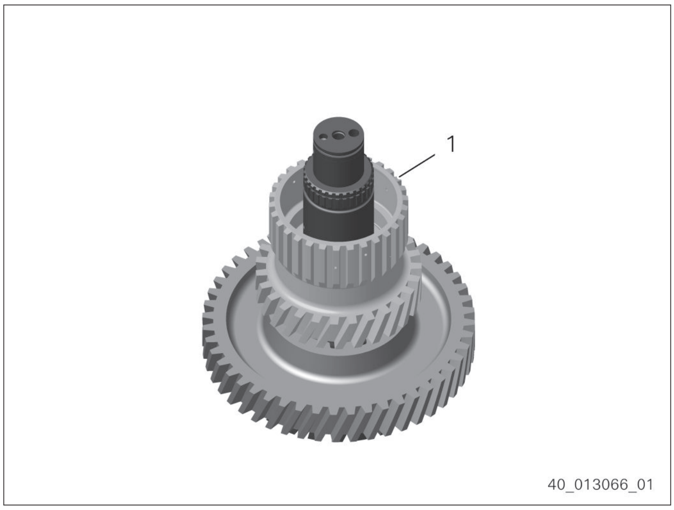


Fig. 167

15. Remove needle cage (1).

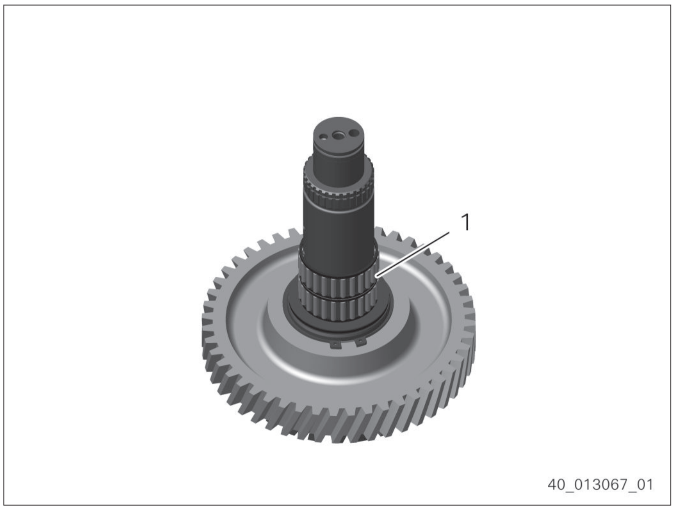


Fig. 168

16. Remove axial washers (1) and axial needle cage (2).

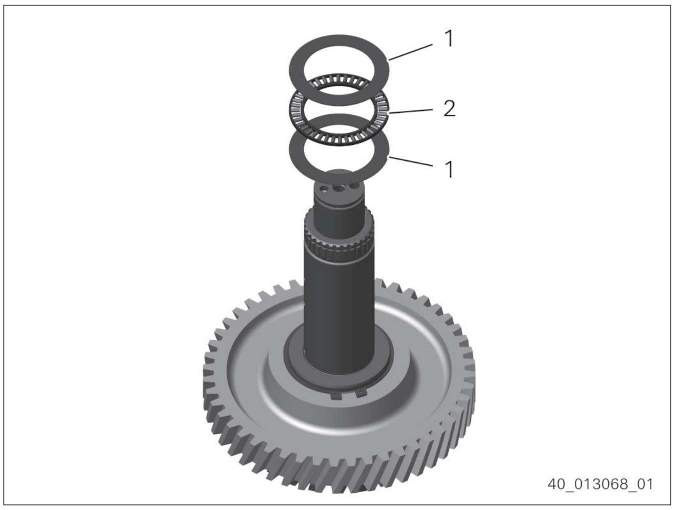


Fig. 169

17. Remove piston ring (1).

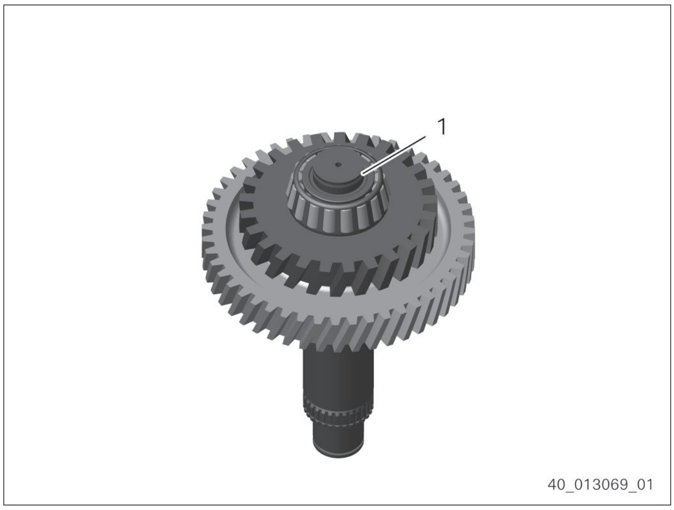


Fig. 170

18. Pull off bearing inner ring with AA00.391.590 [Gripping device] and 5873.001.001 [Basic tool].

    No further dismantling possible.

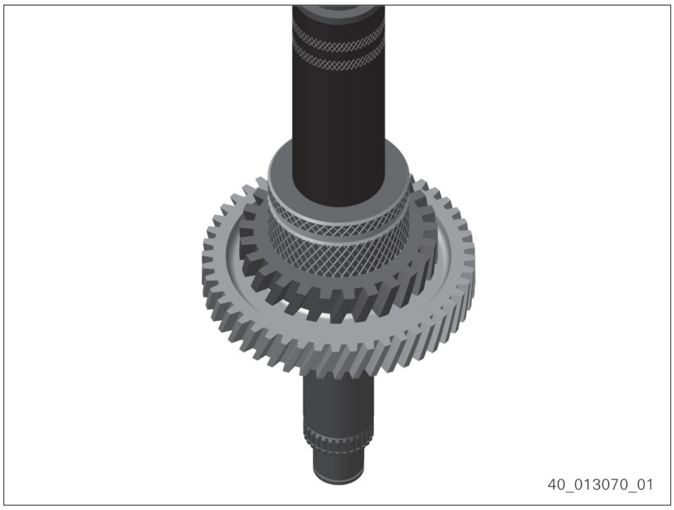


Fig. 171

Dismantling input shaft

Special tools:

- 5873.001.058 Gripping device
- 5873.001.001 Basic tool

1. Remove R-rings (1).

2. Pull off the bearing inner rings (2) with 5873.001.058 [Gripping device] and 5873.001.001 [Basic tool].

   No further dismantling possible.

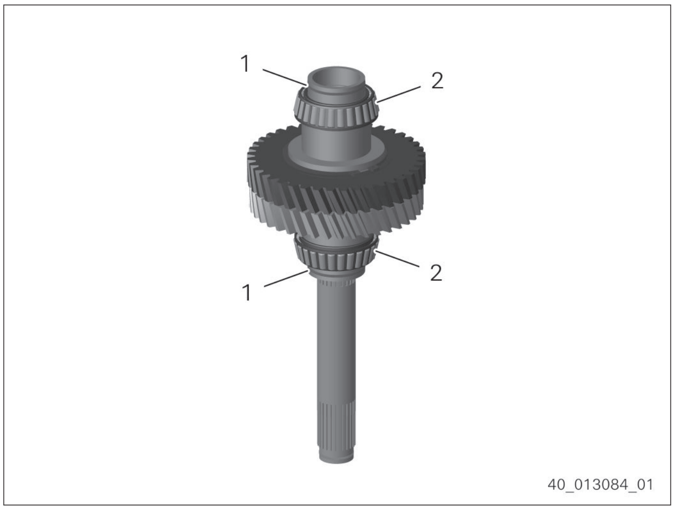


Fig. 172

Dismantling housing rear part

1. Force the converter safety valve out of the housing hole.

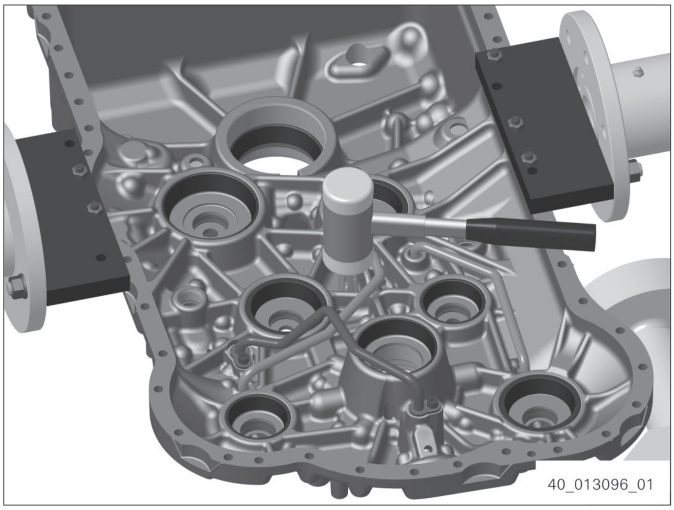


Fig. 173

2. Pull bearing outer rings out of housing holes. The Figure shows the positions of the bearing outer rings.
   - 1 = Output shaft
   - 2 = Clutch K1
   - 3 = Clutch K4
   - 4 = Clutch KR
   - 5 = Input shaft
   - 6 = Clutch KV
   - 7 = Clutch K2
   - 8 = Clutch K3

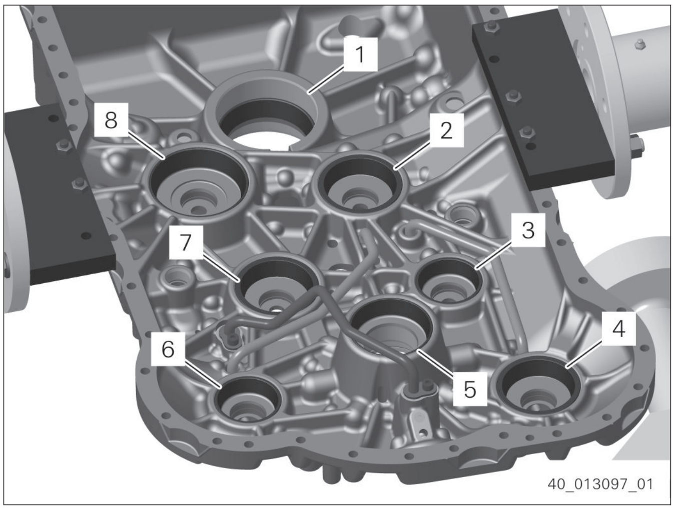


Fig. 174

3. Loosen cap screws.

4. Remove oil tube (1)

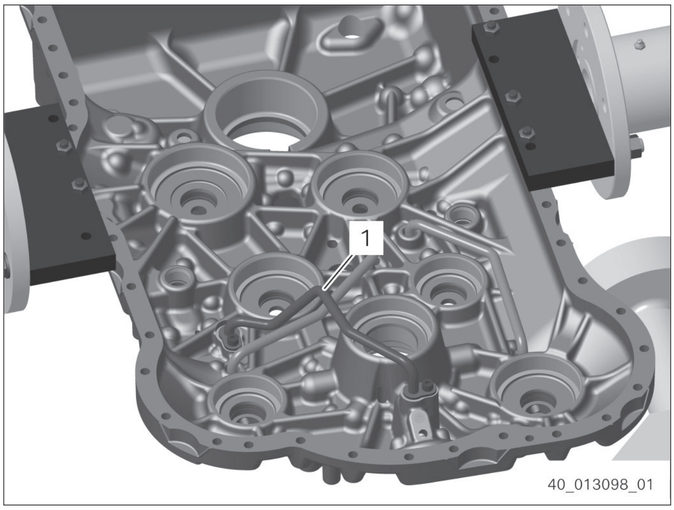


Fig. 175

Assembly

Assembling housing rear part

1. Grease O-rings.

2. Slide O-rings (1) onto oil tube

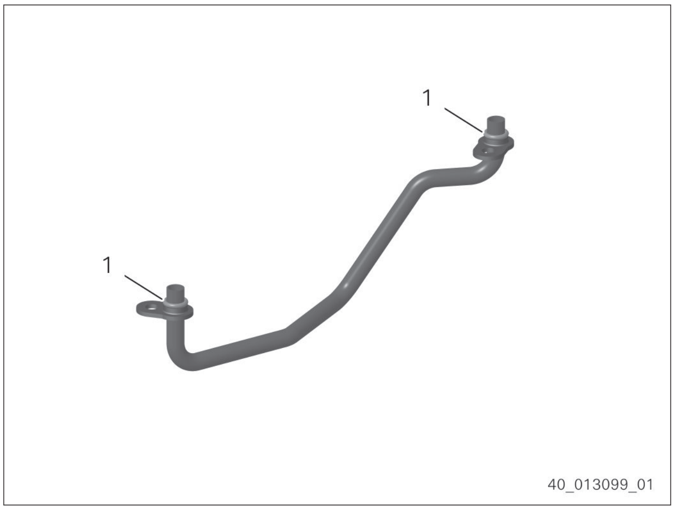


Fig. 176

3. Insert oil tube (1) into housing holes.

4. Fix oil tube with cap screws.
   Tightening torque: 23 Nm

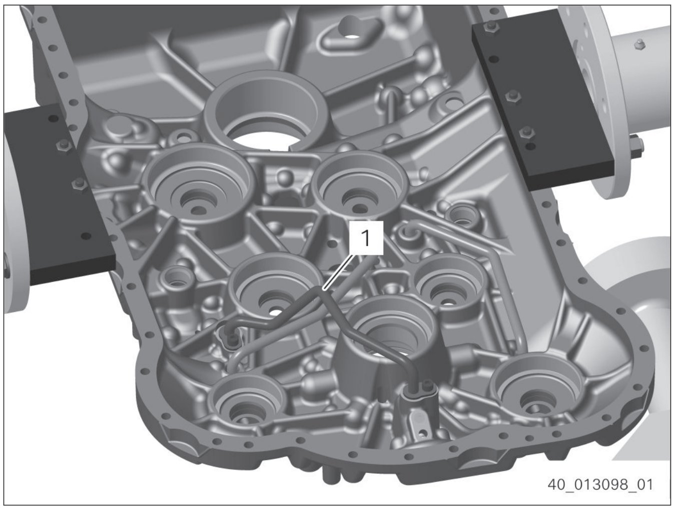


Fig. 177

5. Insert bearing outer rings into housing holes until contact is obtained.
   The Figure shows the positions of the bearing outer rings.
   - 1 = Output shaft
   - 2 = Clutch K1
   - 3 = Clutch K4
   - 4 = Clutch KR
   - 5 = Input shaft
   - 6 = Clutch KV
   - 7 = Clutch K2
   - 8 = Clutch K3

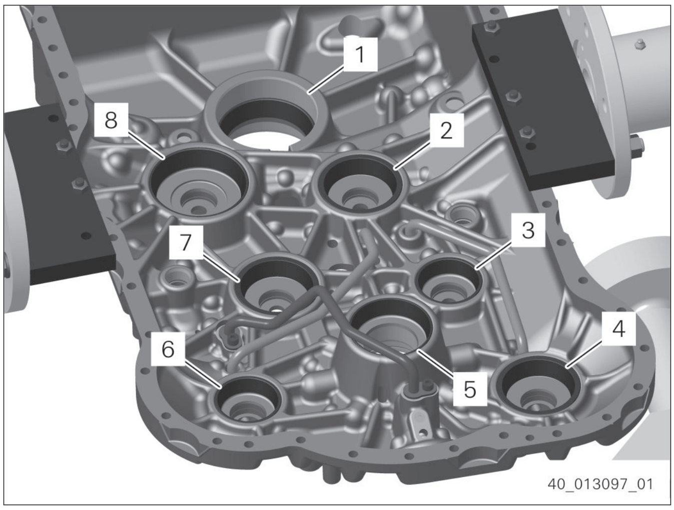


Fig. 178

Assembling and installing clutches and input shaft

Assembling clutch KV

Special tools:
- 5870.345.124 Assembly fixture
- 5870.345.088 Assembly fixture

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 bearing inner ring.

Fig. 179

2. Slide bearing inner ring onto shaft until contact is obtained.

3. Let bearing inner ring cool down.

4. Adjust bearing inner ring.

5. Insert piston ring (1).

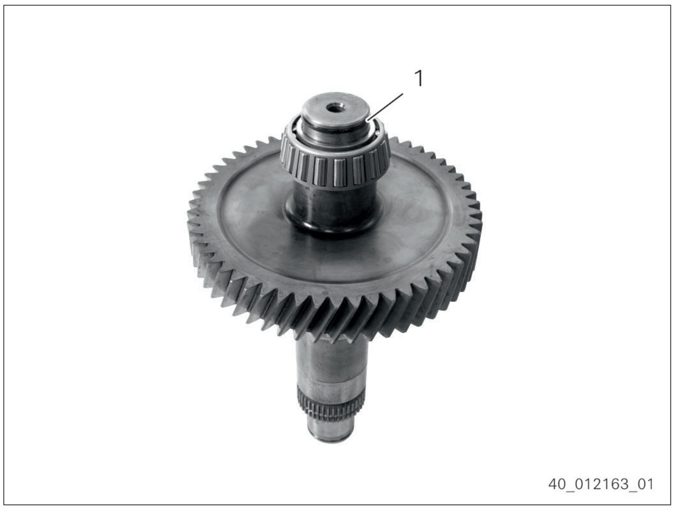


Fig. 180

6. Slide on needle cage (1).

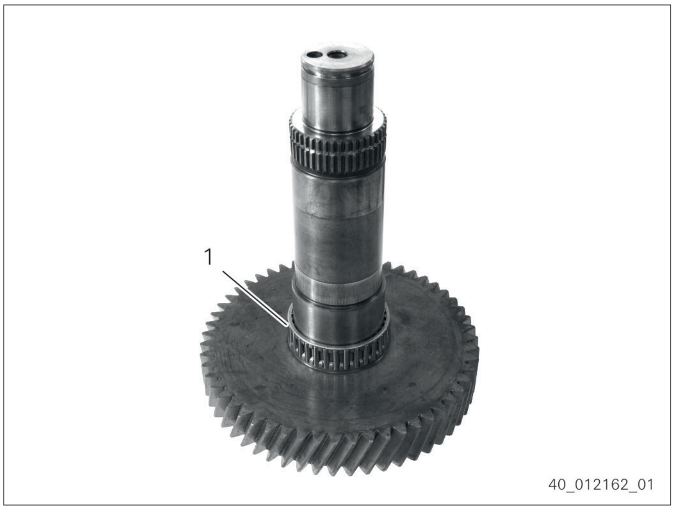


Fig. 181

7. Insert ball bearing (1) into idler gear until contact is obtained.

8. Insert retaining ring.

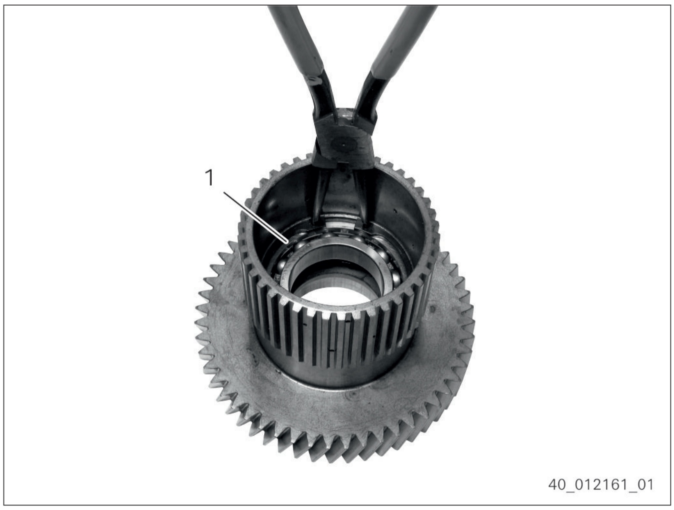


Fig. 182

9. Press idler gear onto the shaft until contact is obtained.

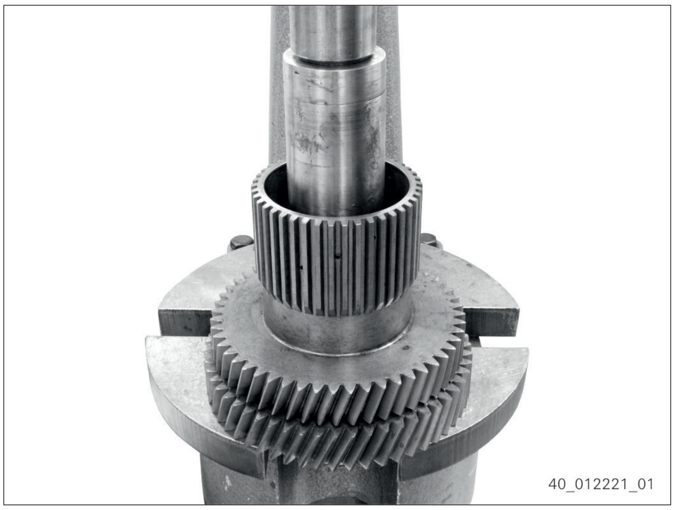


Fig. 183

10. Check clearance of the ball in the drain valve (1).

11. Grease O-rings (2) and insert them twist-free in the annular grooves.

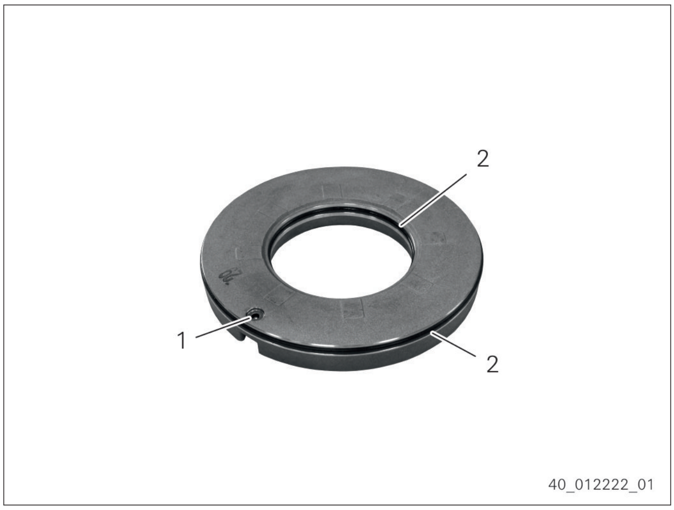


Fig. 184

12. Oil O-rings and piston bearing surfaces.

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

Fig. 185

14. Insert shim (1) and compression spring (2).

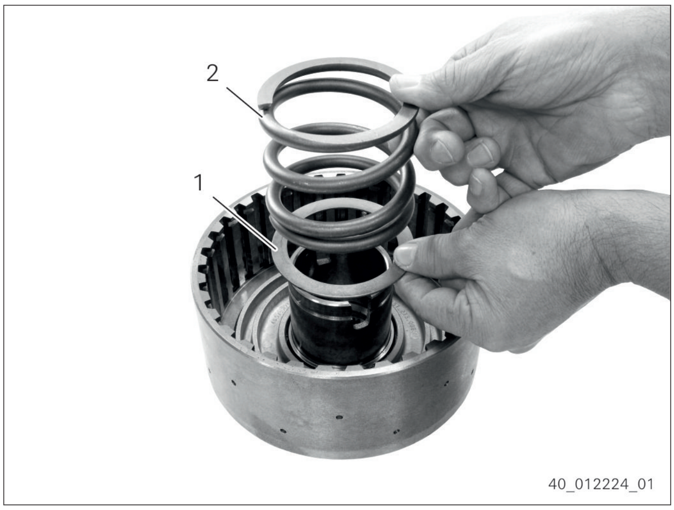


Fig. 186

15. Insert 5870.345.124 [Assembly fixture] (1) into disk carrier.

16. Slide on supporting ring (2).

17. Slide on new L-ring (3) with the offset front face facing downwards.

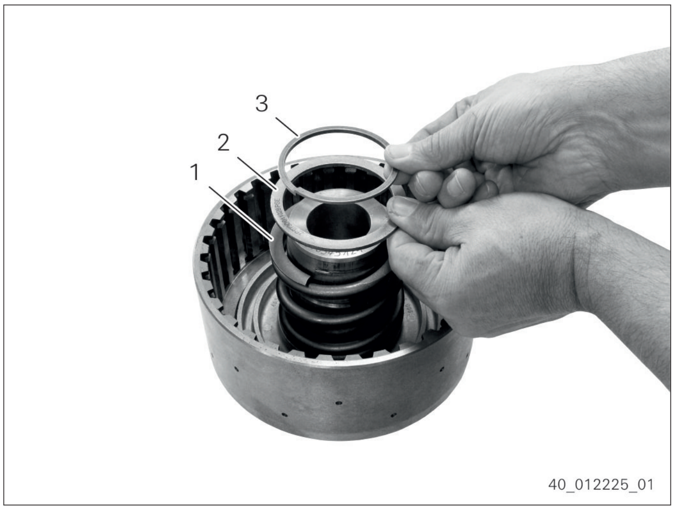


Fig. 187

18. Push L-ring downwards with 5870.345.124 [Assembly fixture] and 5870.345.088 [Assembly fixture] until it engages in the annular groove of the disk carrier.

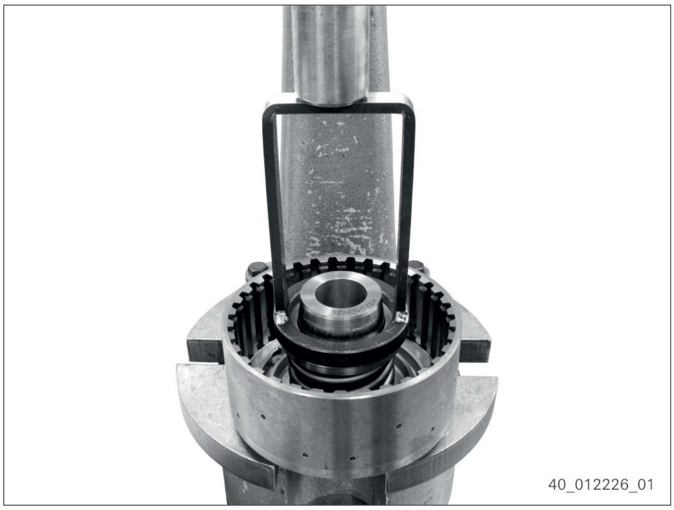


Fig. 188

Setting disk clearance

19. Insert friction disk with the uncoated side showing to the piston.

Fig. 189

20. Insert inner disks and outer disks.

    For the arrangement refer to the current spare parts list.

Fig. 190

21. Insert end shim.

22. Insert snap ring e. g. 2.70 mm.

Fig. 191

23. Position dial gauge at end shim.

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

25. Lift end shim on the snap ring until contact is obtained and check the necessary Disk clearance 2.65 mm until 2.95 mm.
    If the disk clearance is too small, install a thinner snap ring.
    If the disk clearance is too big, install a thicker snap ring.

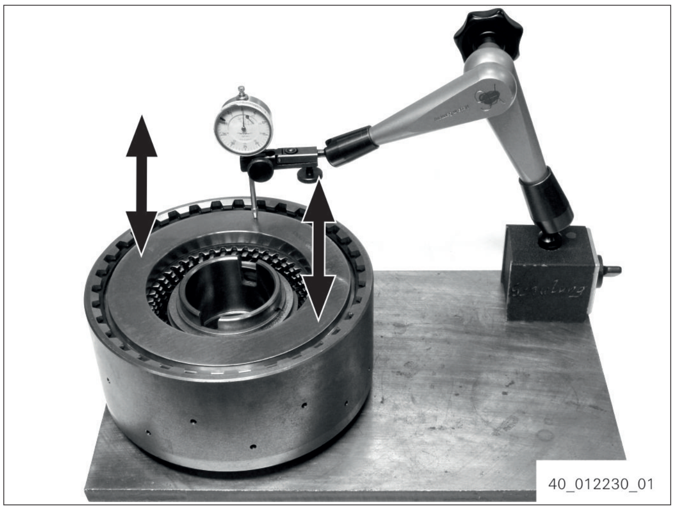


Fig. 192

26. 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 internal spline of the disk carrier.

Fig. 193

27. Slide clutch onto shaft until contact is obtained. Insert idler gear into the disk package by short mutual rotary motions.

Fig. 194

28. Insert retaining ring into the shaft.

Fig. 195

29. 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. 196

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

31. Let bearing inner ring cool down.

32. Adjust bearing inner ring.

33. Screw in stud bolt (1) and tighten.
Tightening torque: 17 Nm

34. Insert piston ring (2).

Fig. 197

35. Check function of the clutch with compressed air.

    → Closing and opening of the clutch is clearly audible.

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

Fig. 198

Assembling clutch KR

Special tools:
- 5870.345.124 Assembly fixture
- 5870.345.088 Assembly fixture

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 bearing inner ring.

Fig. 199

2. Slide bearing inner ring onto shaft until contact is obtained.

3. Let bearing inner ring cool down.

4. Adjust bearing inner ring.

5. Insert piston ring (1).

Fig. 200

6. Slide on needle cage (1).

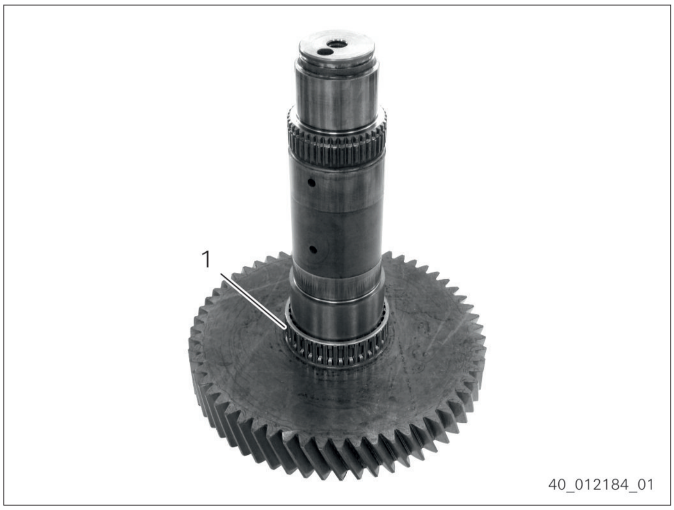


Fig. 201

7. Insert ball bearing (1) into idler gear until contact is obtained.

8. Insert retaining ring.

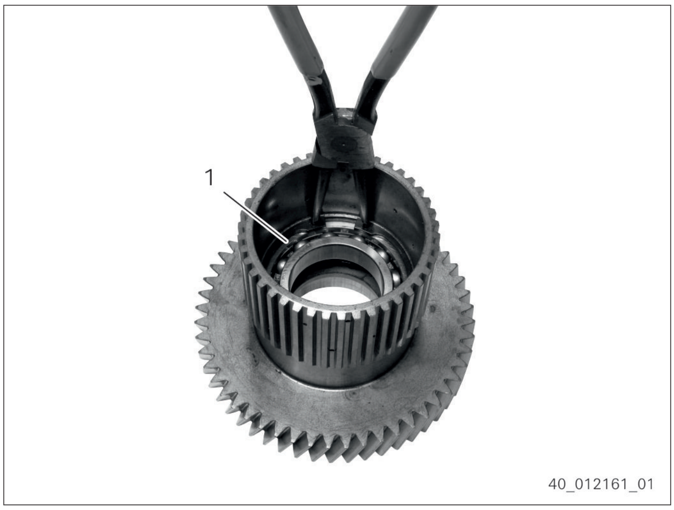


Fig. 202

9. Press idler gear onto the shaft until contact is obtained.

Fig. 203

10. Check clearance of the ball in the drain valve (1).

11. Grease O-rings (2) and insert them twist-free in the annular grooves.

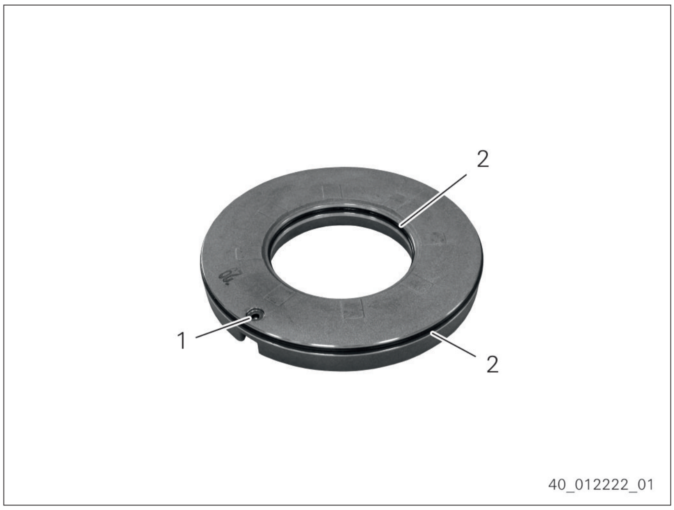


Fig. 204

12. Oil O-rings and piston bearing surfaces.

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

Fig. 205

14. Insert shim (1) and compression spring (2).

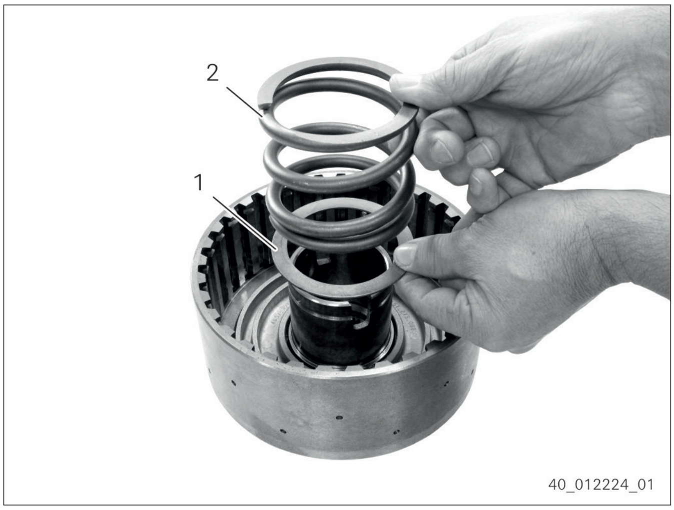


Fig. 206

15. Insert 5870.345.124 [Assembly fixture] (1) into disk carrier.

16. Slide on supporting ring (2).

17. Slide on new L-ring (3) with the offset front face facing downwards.

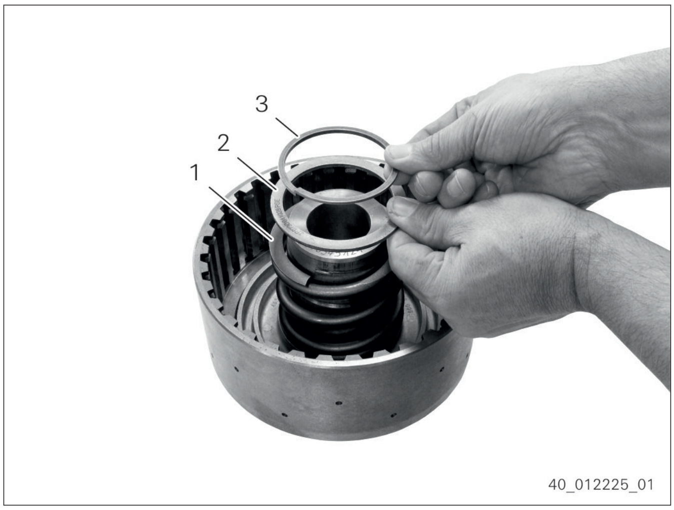


Fig. 207

18. Push L-ring downwards with 5870.345.124 [Assembly fixture] and 5870.345.088 [Assembly fixture] until it engages in the annular groove of the disk carrier.

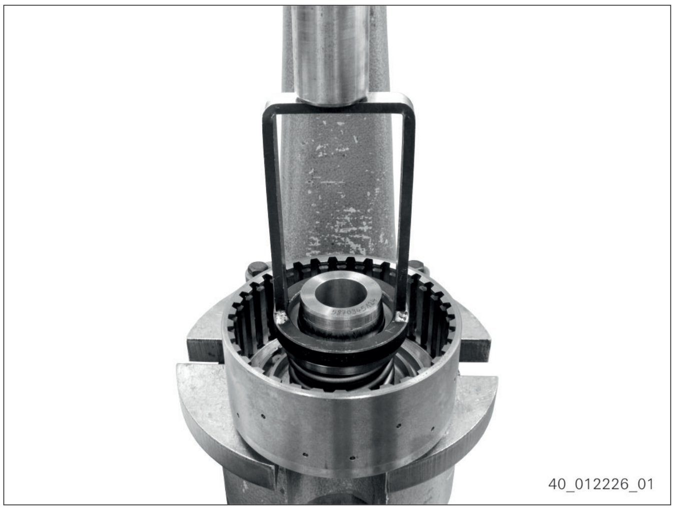


Fig. 208

Setting disk clearance

19. Insert friction disk with the uncoated side showing to the piston.

Fig. 209

20. Insert inner disks and outer disks.
    For the arrangement refer to the current spare parts list.

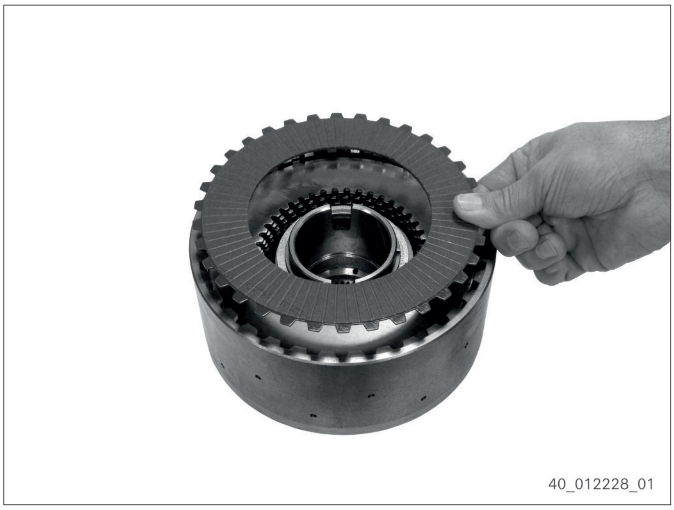


Fig. 210

21. Insert end shim.

22. Insert snap ring e. g. 2.70 mm.

Fig. 211

23. Position dial gauge at end shim.

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

25. Lift end shim on the snap ring until contact is obtained and check the necessary Disk clearance 2.65 mm until 2.95 mm.
If the disk clearance is too small, install a thinner snap ring.
If the disk clearance is too big, install a thicker snap ring.

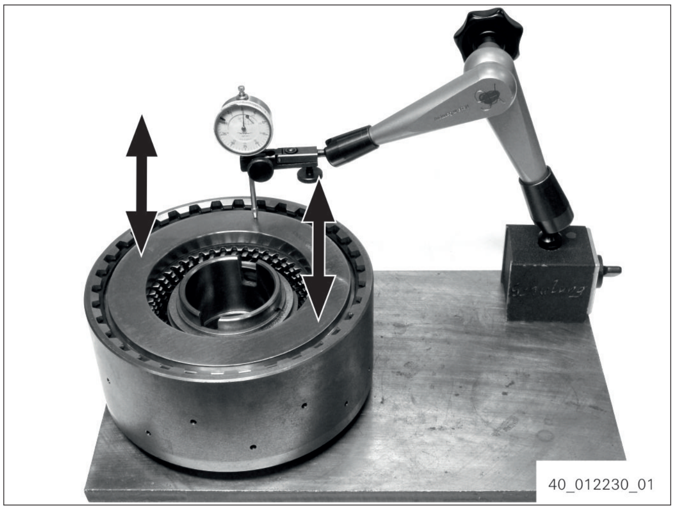


Fig. 212

26. 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 internal spline of the disk carrier.

Fig. 213

27. Slide clutch onto shaft until contact is obtained. Insert idler gear into the disk package by short mutual rotary motions.

Fig. 214

28. Insert retaining ring into the shaft.

Fig. 215

29. 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.

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

Fig. 216

31. Let bearing inner ring cool down.

32. Adjust bearing inner ring.

33. Screw in stud bolt (1) and tighten.
    Tightening torque: 17 Nm

34. Insert piston ring (2).

Fig. 217

35. Check function of the clutch with compressed air.

    → Closing and opening of the clutch is clearly audible.

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

Fig. 218

Assembling clutch K1

Special tools:

- 5870.345.124 Assembly fixture
- 5870.345.088 Assembly fixture

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 bearing inner ring.

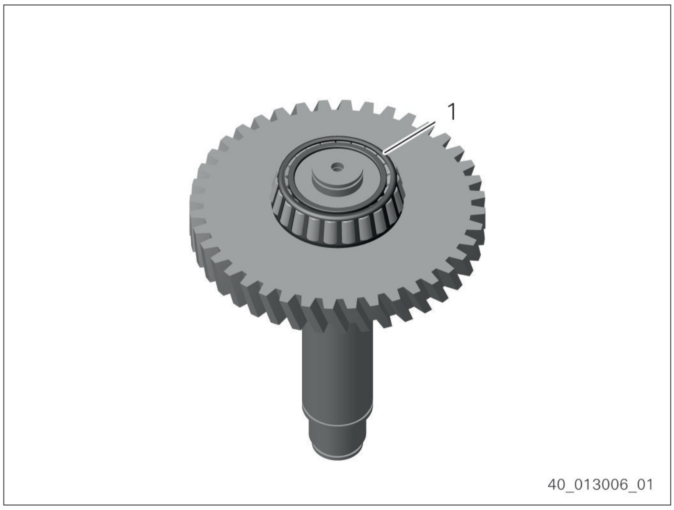


Fig. 219

2. Slide bearing inner ring (1) onto shaft until contact is obtained.
3. Let bearing inner ring cool down.
4. Adjust bearing inner ring.
5. Insert piston ring (1).

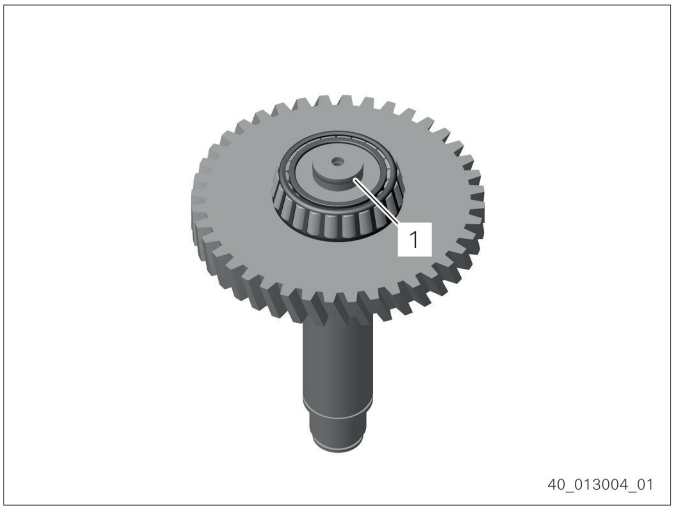


Fig. 220

6. Check clearance of the ball in the drain valve (1).

7. Grease O-rings (2) and insert them twist-free in the annular grooves.

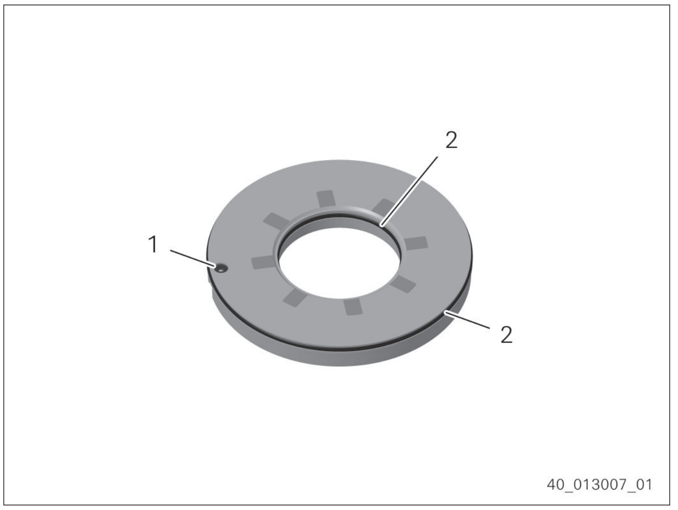


Fig. 221

8. Oil O-rings and piston bearing surfaces.

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

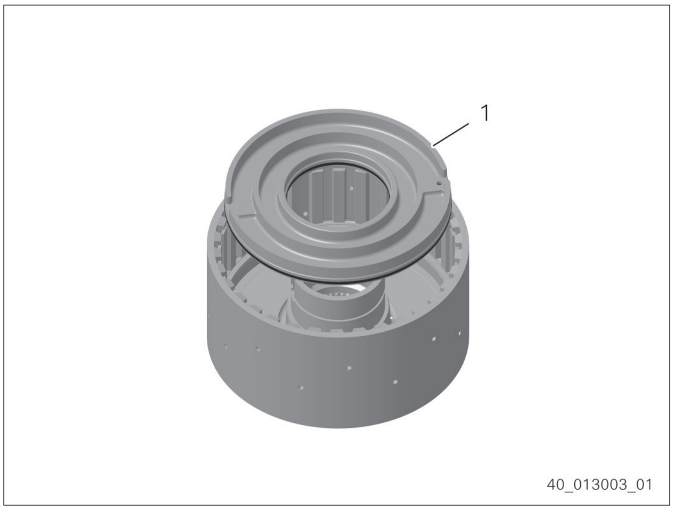


Fig. 222

10. Insert 5870.345.124 [Assembly fixture] (3) into disk carrier.

11. Slide on cup springs (2).

12. Slide on new L-ring (1) with the offset front face facing downwards.

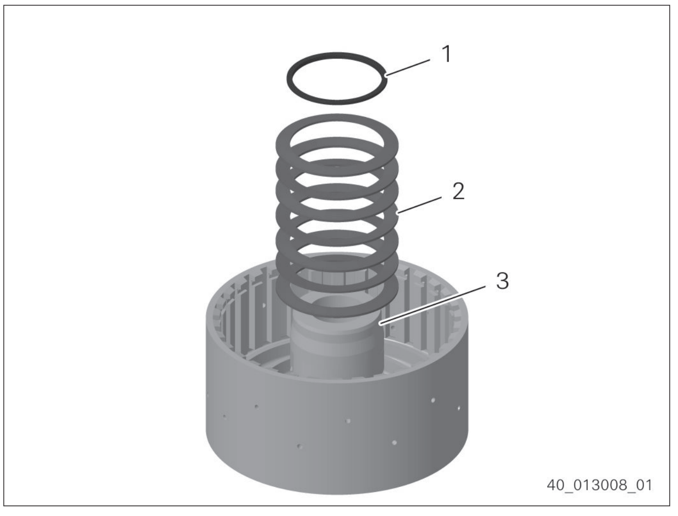


Fig. 223

13. Push L-ring downwards with 5870.345.124 [Assembly fixture] and 5870.345.088 [Assembly fixture] until it engages in the annular groove of the disk carrier.

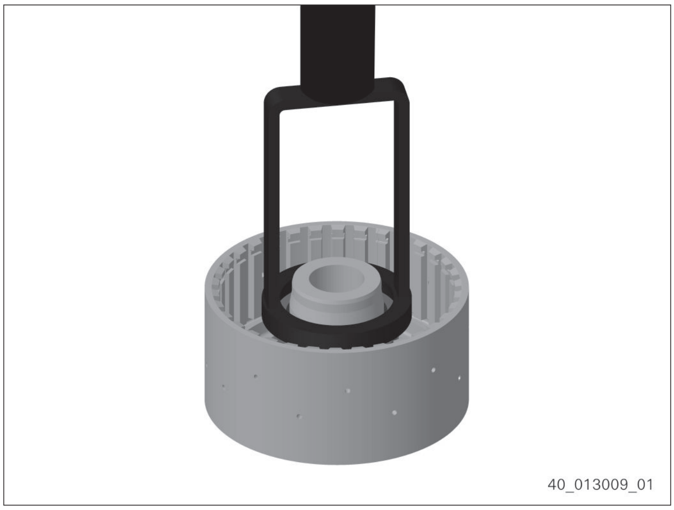


Fig. 224

Setting disk clearance

14. Insert friction disk (1) with the uncoated side facing the piston.

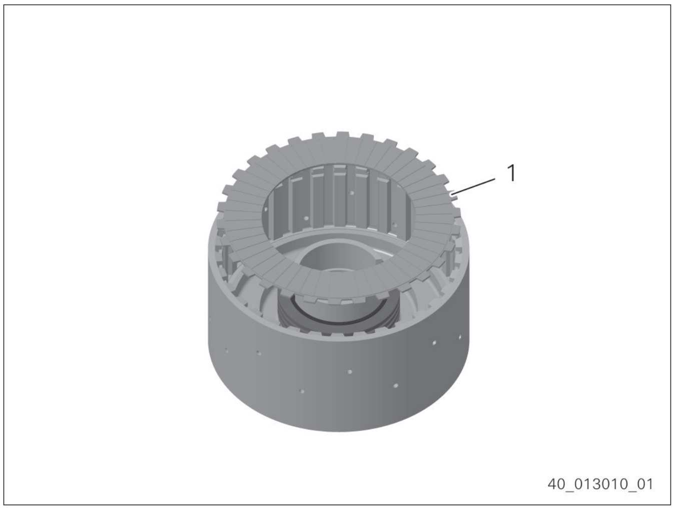


Fig. 225

15. Insert inner disks and outer disks.

    For the arrangement refer to the current spare parts list.

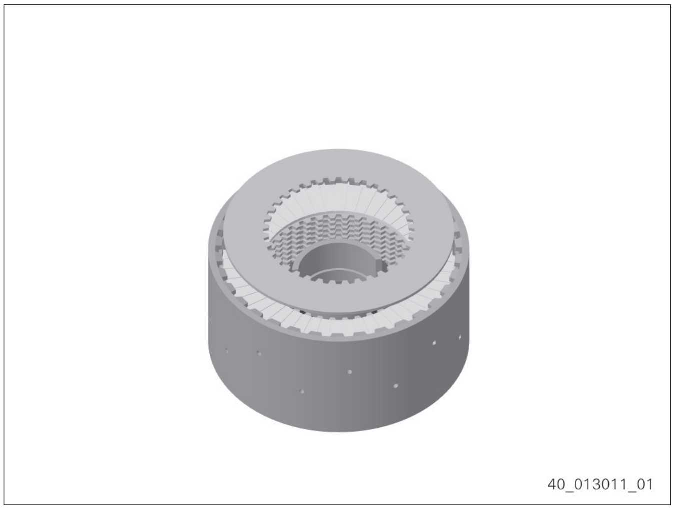


Fig. 226

16. Insert end shim (1).

17. Insert snap ring e. g. 2.85 mm.

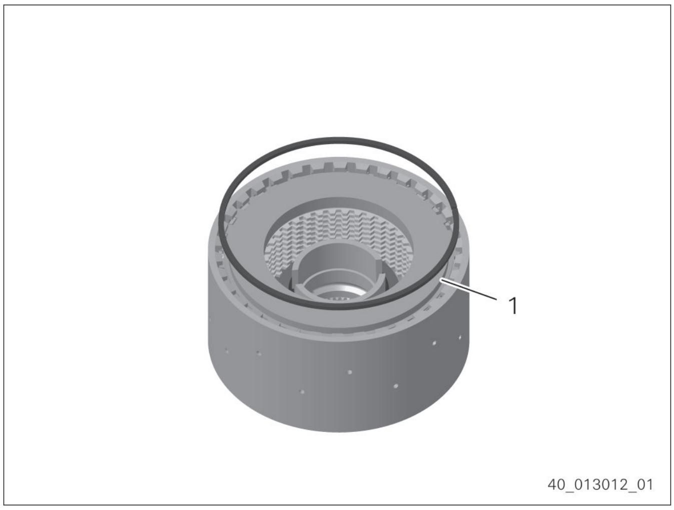


Fig. 227

18. Position dial gauge at end shim.

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

20. Lift end shim on the snap ring until contact is obtained and check the necessary Disk clearance 2.35 mm until 2.65 mm.
If the disk clearance is too small, install a thinner snap ring.
If the disk clearance is too big, install a thicker snap ring.

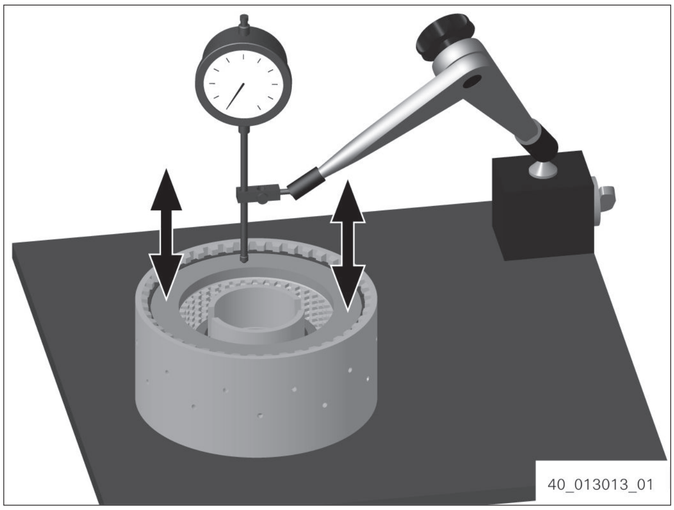


Fig. 228

21. 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 internal spline of the disk carrier.

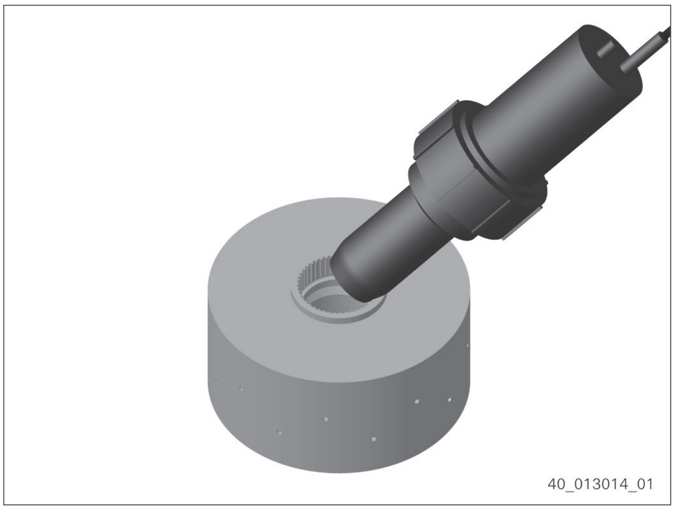


Fig. 229

22. Slide clutch onto shaft until contact is obtained.

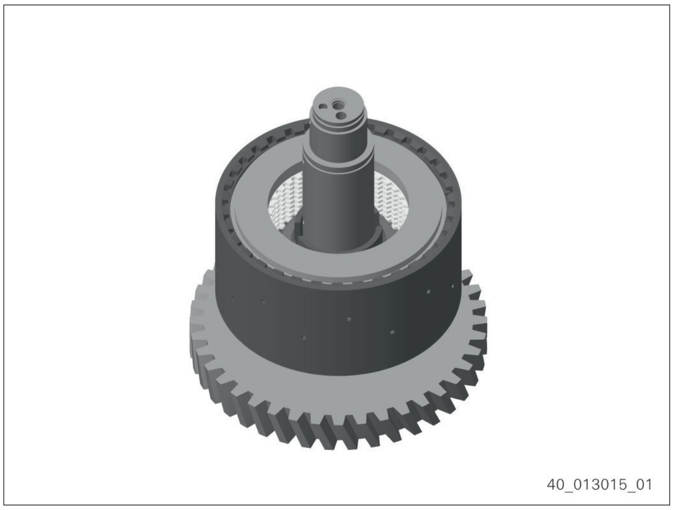


Fig. 230

23. Slide on thrust washer (3) with the chamfer facing towards the axle needle cage.

24. Slide on axial needle cage (2).

25. Slide on axial washer (1).

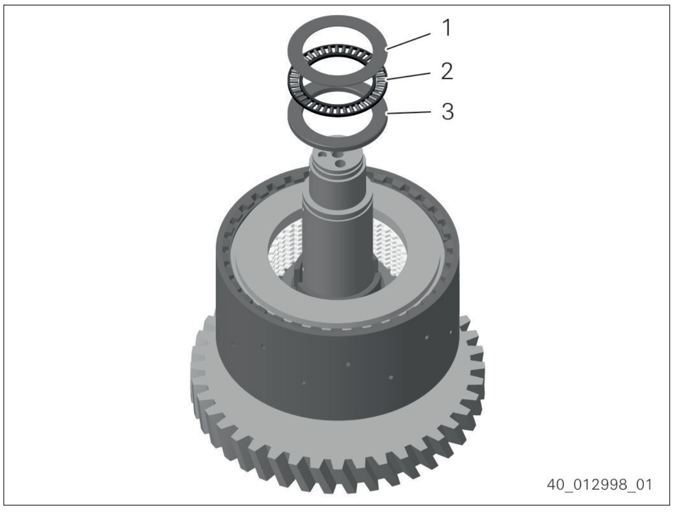


Fig. 231

26. Slide on needle cage (1).

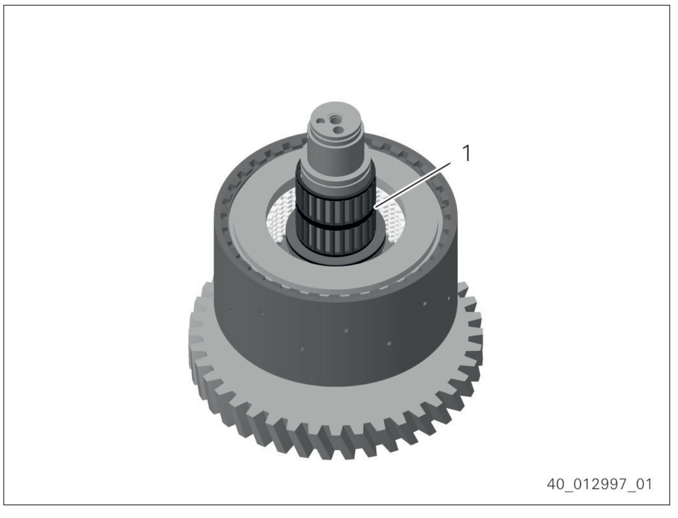


Fig. 232

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

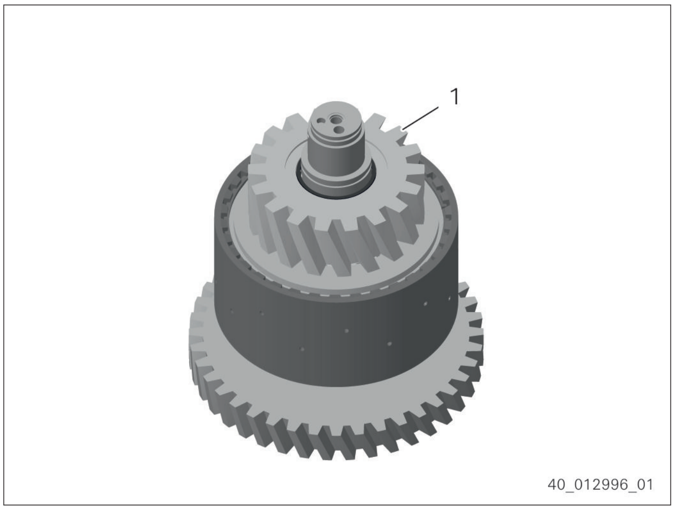


Fig. 233

28. Slide on axial washer (3).

29. Slide on axial needle cage (2).

30. Slide on thrust washer (1) with the chamfer facing towards the axle needle cage.

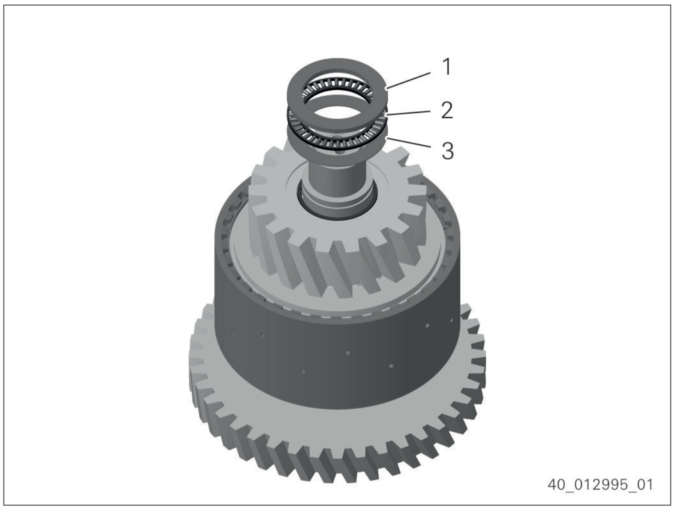


Fig. 234

31. Insert retaining ring into the shaft.

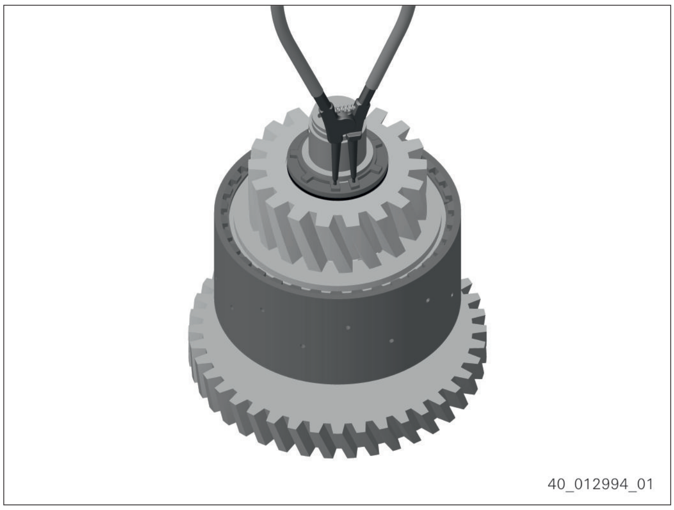


Fig. 235

32. 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.

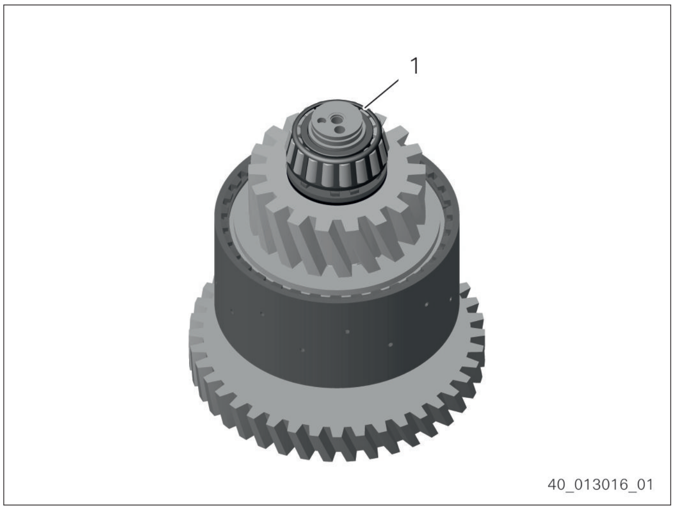


Fig. 236

33. Slide bearing inner ring (1) onto shaft until contact is obtained.

34. Let bearing inner ring cool down.

35. Adjust bearing inner ring.

36. Screw in stud bolt (1) and tighten.
Tightening torque: 17 Nm

37. Insert piston ring (2).

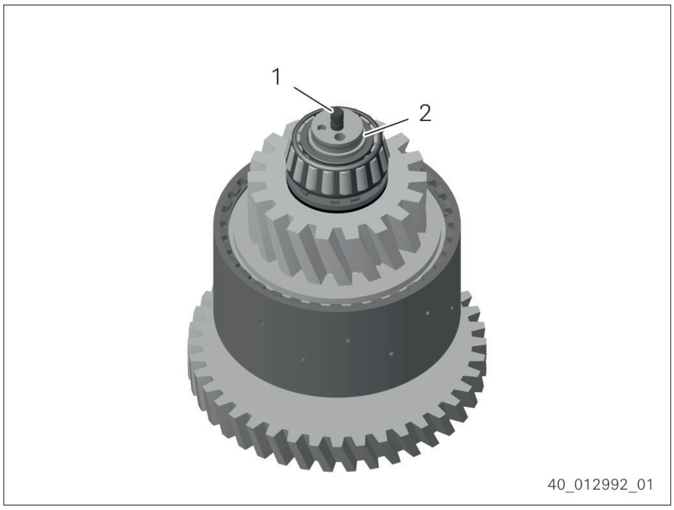


Fig. 237

38. Check function of the clutch with compressed air.

 → Closing and opening of the clutch is clearly audible.

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

Fig. 238

Assembling clutch K2

Special tools:
- 5870.345.124 Assembly fixture
- 5870.345.088 Assembly fixture

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 bearing inner ring.

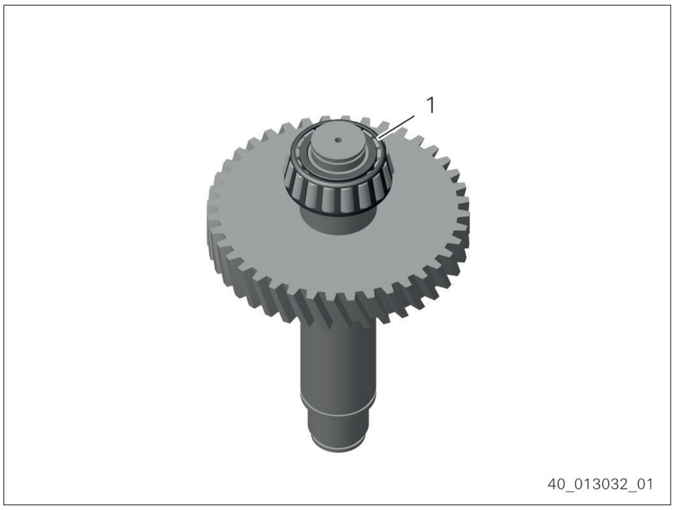


Fig. 239

2. Slide bearing inner ring (1) onto shaft until contact is obtained.

3. Let bearing inner ring cool down.

4. Adjust bearing inner ring.

5. Insert piston ring (1).

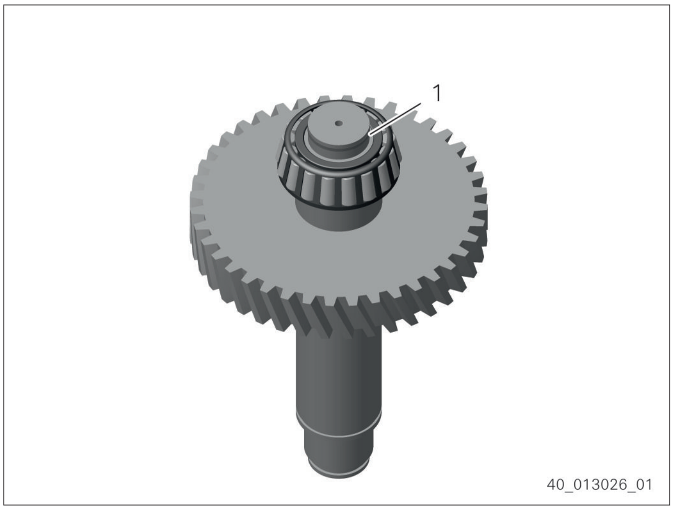


Fig. 240

6. Check clearance of the ball in the drain valve (2).

7. Grease O-rings (1) and insert them twist-free in the annular grooves.

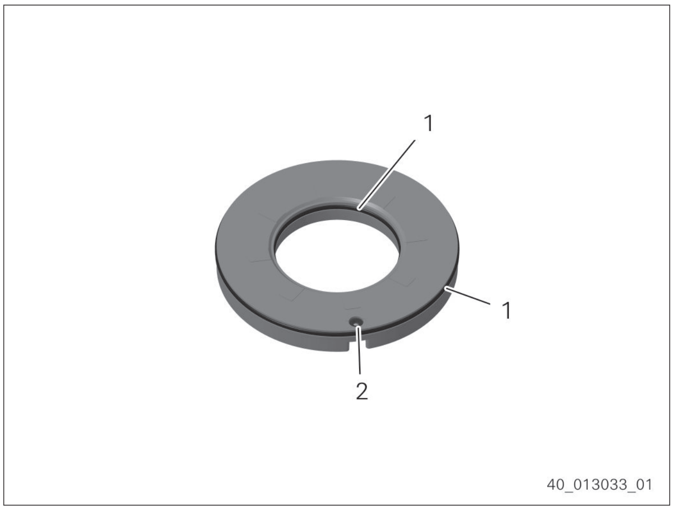


Fig. 241

8. Oil O-rings and piston bearing surfaces.

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

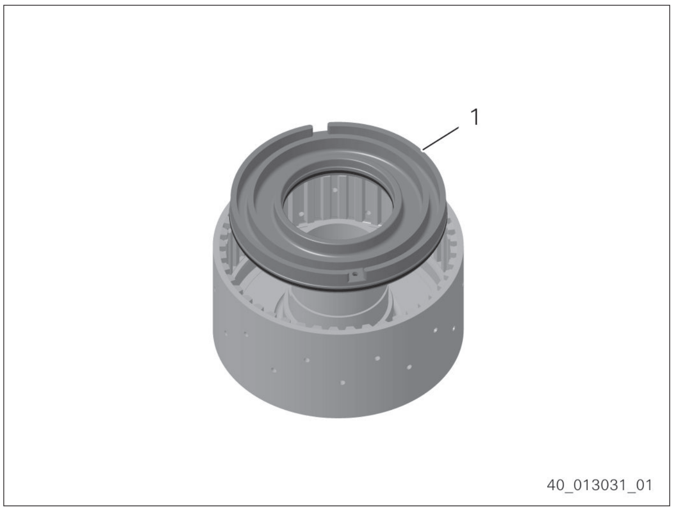


Fig. 242

10. Insert 5870.345.124 [Assembly fixture] (3) into disk carrier.

11. Slide on cup springs (2).

12. Slide on new L-ring (1) with the offset front face facing downwards.

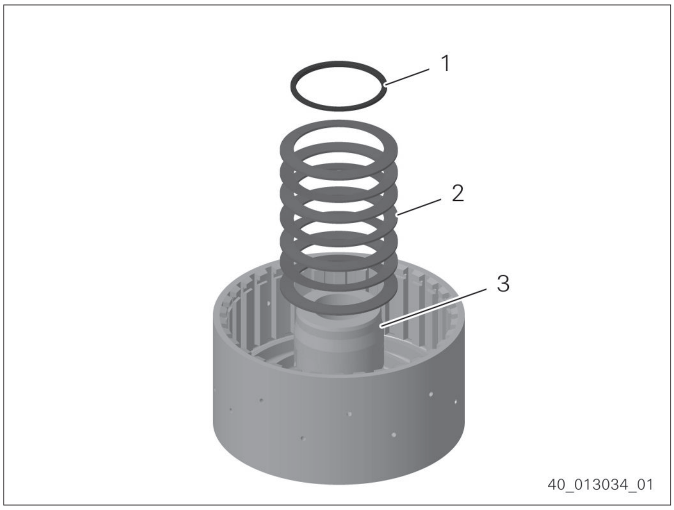


Fig. 243

13. Push L-ring downwards with 5870.345.124 [Assembly fixture] and 5870.345.088 [Assembly fixture] until it engages in the annular groove of the disk carrier.

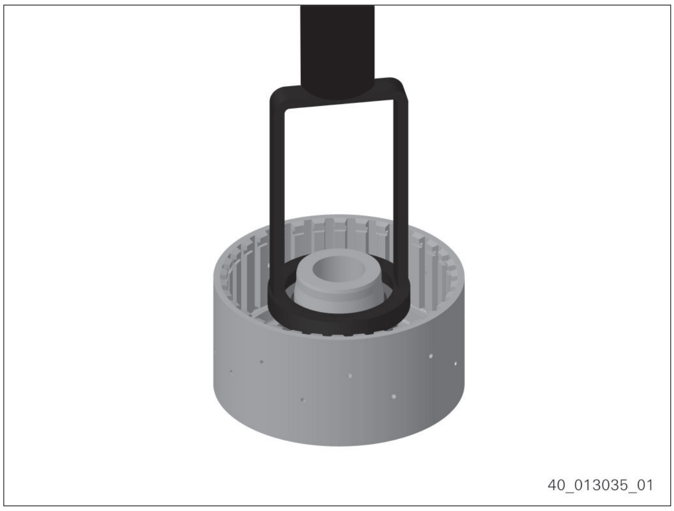


Fig. 244

Setting disk clearance

14. Insert outer disk (1) with the uncoated side facing the piston.

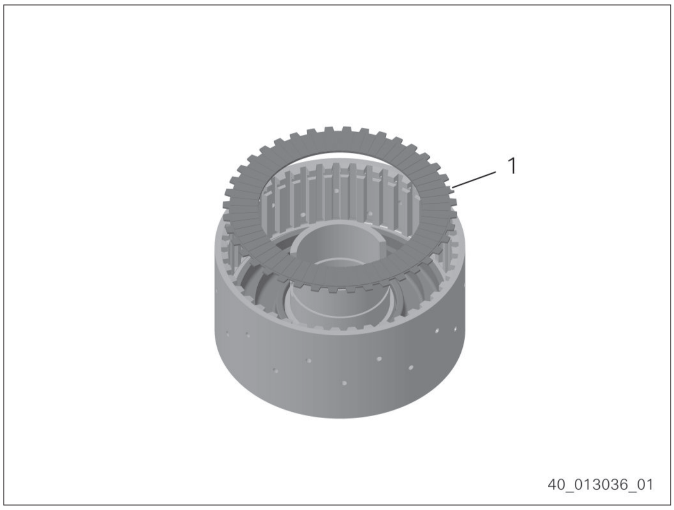


Fig. 245

15. Insert inner disks and outer disks.

    For the arrangement refer to the current spare parts list.

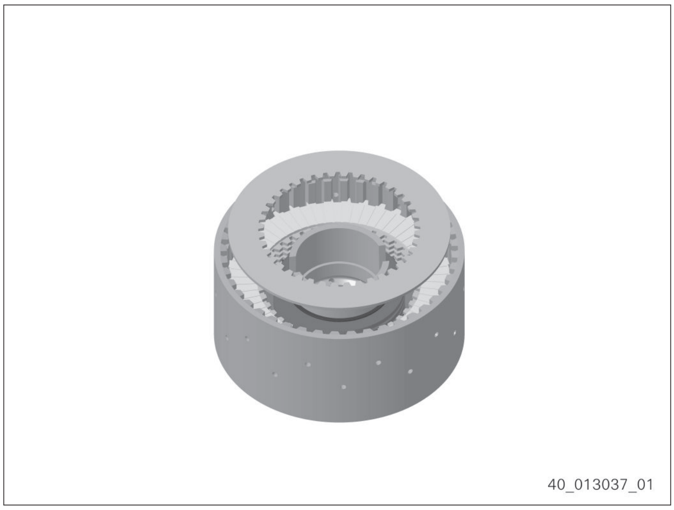


Fig. 246

16. Insert end shim (1).

17. Insert snap ring e. g. 3.15 mm.

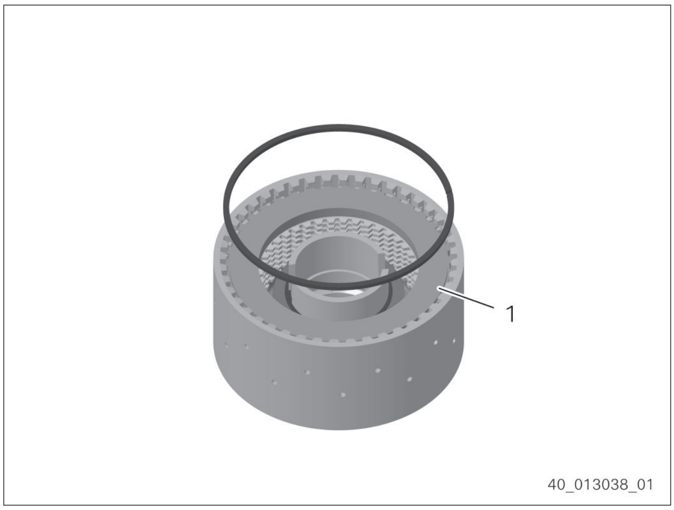


Fig. 247

18. Position dial gauge at end shim.

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

20. Lift end shim on the snap ring until contact is obtained and check the necessary Disk clearance 1.75 mm until 2.05 mm.
    If the disk clearance is too small, install a thinner snap ring.
    If the disk clearance is too big, install a thicker snap ring.

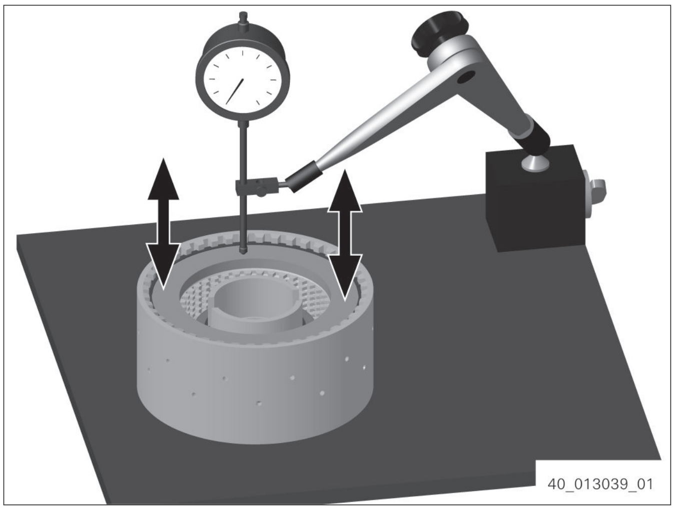


Fig. 248

21. 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 internal spline of the disk carrier.

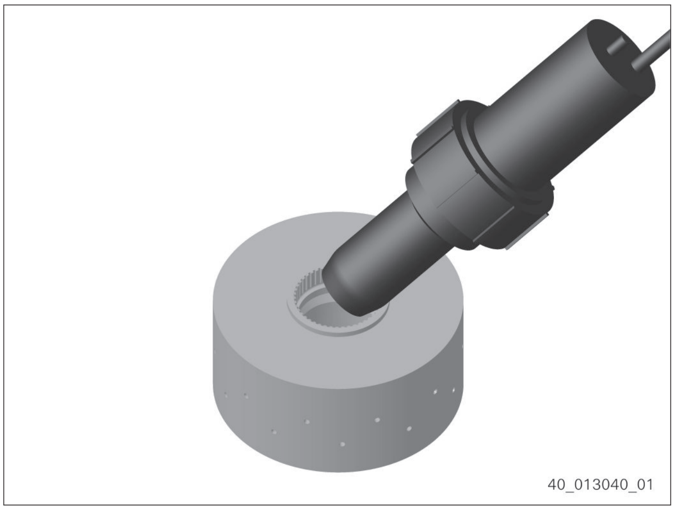


Fig. 249

22. Slide clutch onto shaft until contact is obtained.

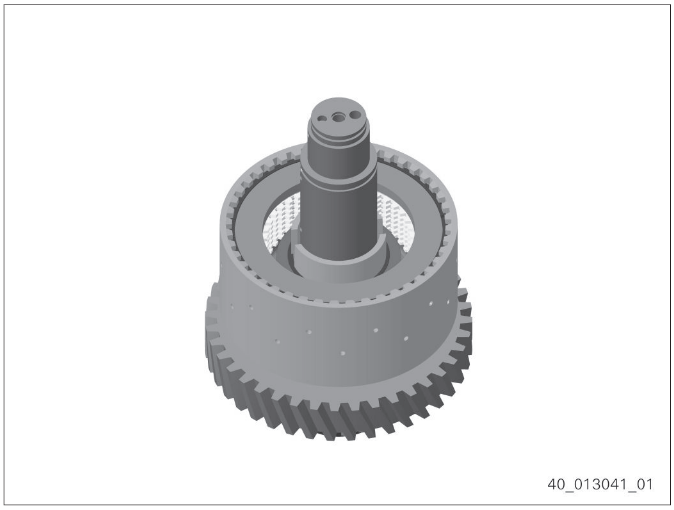


Fig. 250

23. Slide on thrust washer (3) with the chamfer facing towards the axle needle cage.
24. Slide on axial needle cage (2).
25. Slide on axial washer (1).

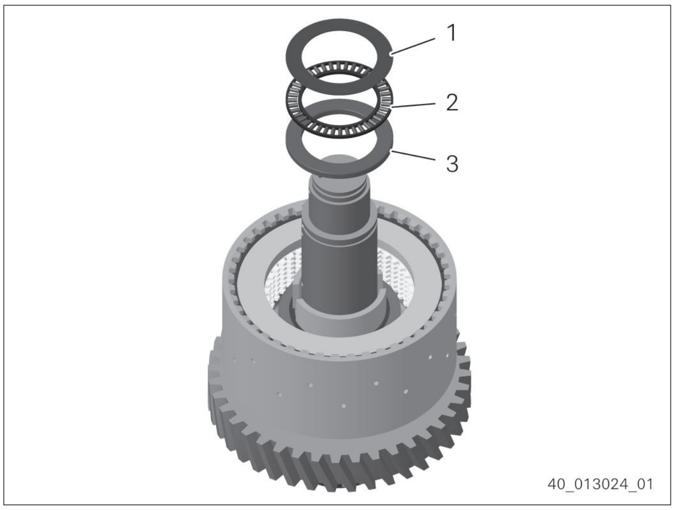


Fig. 251

26. Slide on needle cage (1).

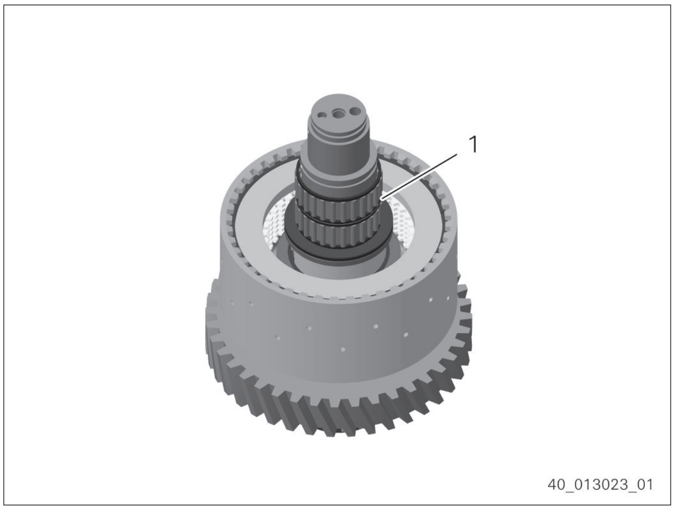


Fig. 252

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

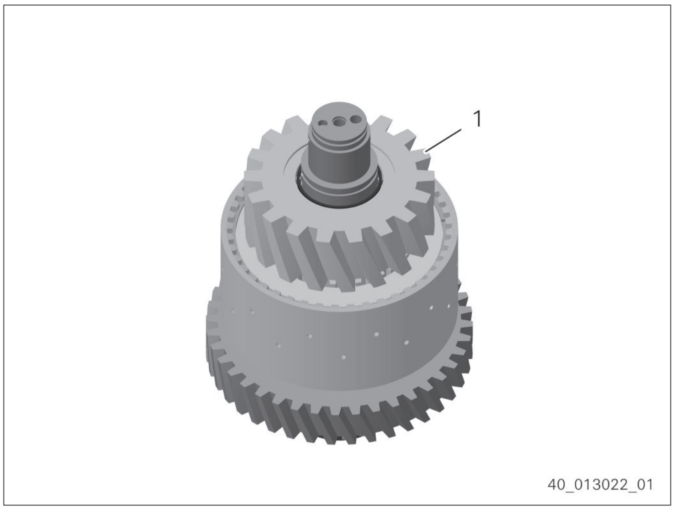


Fig. 253

28. Slide on axial washer (3).

29. Slide on axial needle cage (2).

30. Slide on thrust washer (1) with the chamfer facing towards the axle needle cage.

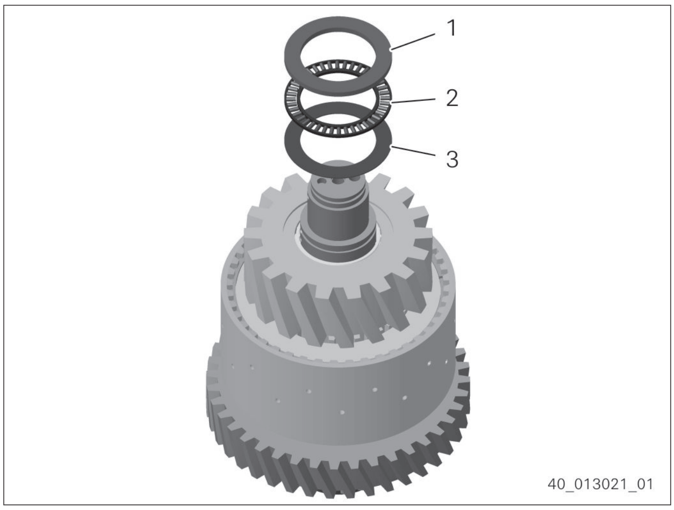


Fig. 254

31. Insert retaining ring into the shaft.

Fig. 255

32. 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.

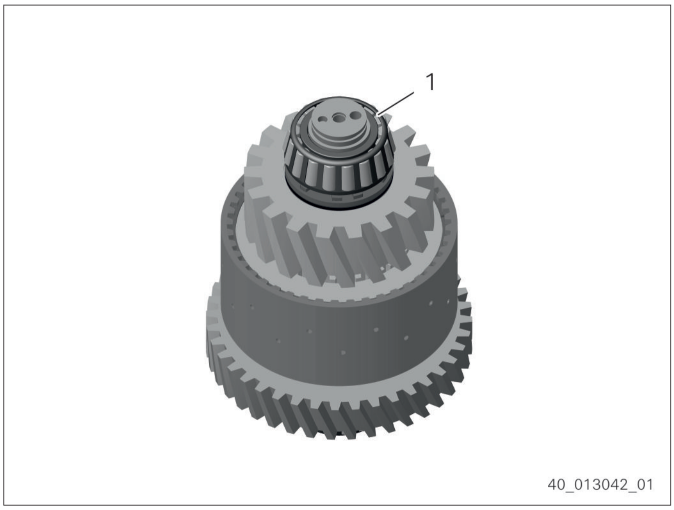


Fig. 256

33. Slide bearing inner ring (1) onto shaft until contact is obtained.

34. Let bearing inner ring cool down.

35. Adjust bearing inner ring.

36. Screw in stud bolt (1) and tighten.
    Tightening torque: 17 Nm

37. Insert piston ring (2).

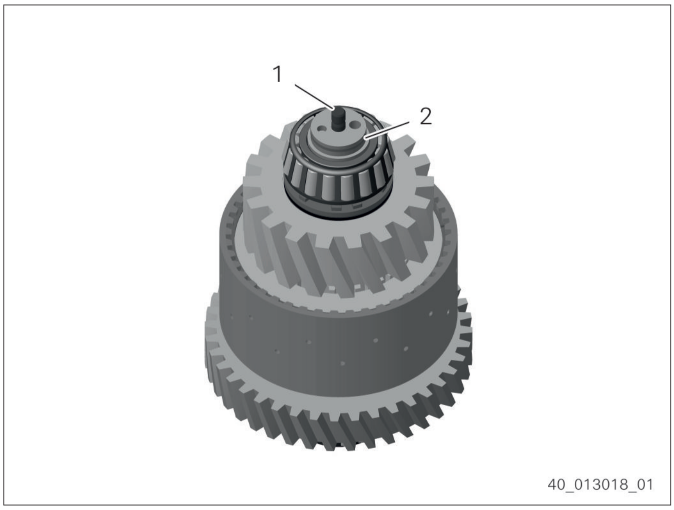


Fig. 257

38. Check function of the clutch with compressed air.

    → Closing and opening of the clutch is clearly audible.

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

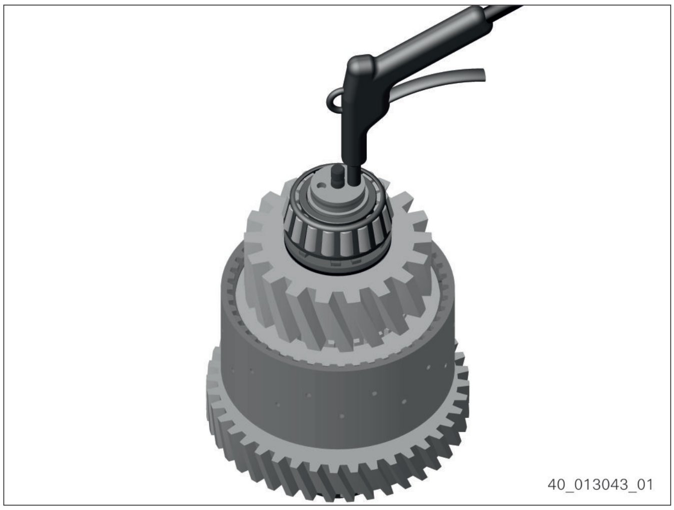


Fig. 258

Assembling clutch K3

Special tools:

- 5870.345.124 Assembly fixture
- 5870.345.088 Assembly fixture

Assembly

1. Check clearance of the ball in the drain valve (2).

2. Grease O-rings (1) and insert them twist-free in the annular grooves.

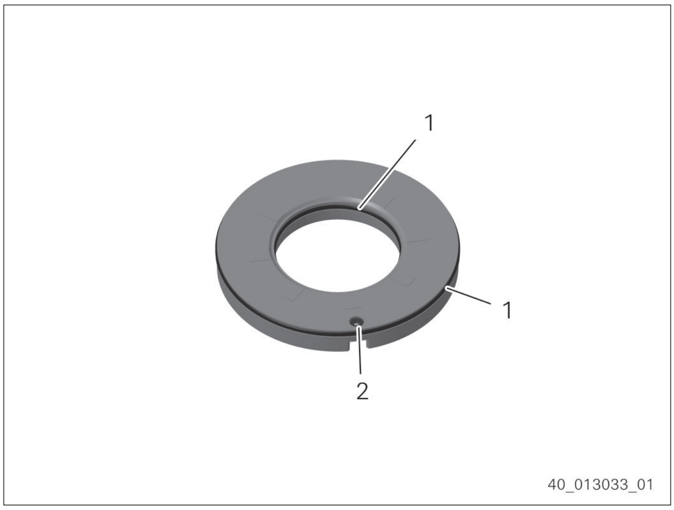


Fig. 259

3. Oil O-rings and piston bearing surfaces.

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

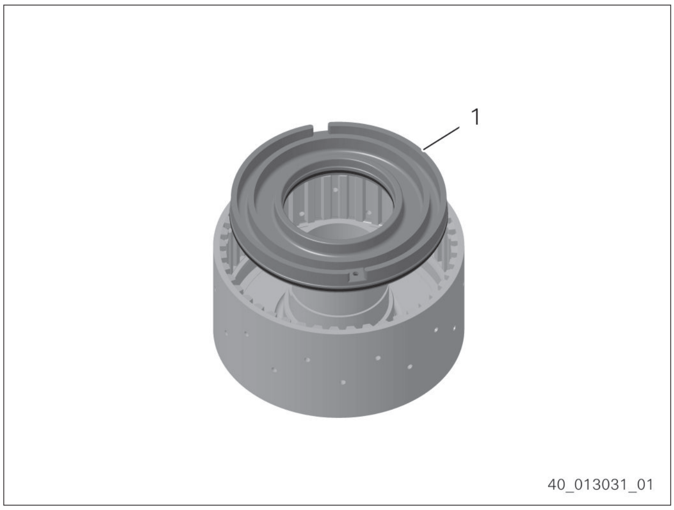


Fig. 260

5. Insert 5870.345.124 [Assembly fixture] (3) into disk carrier.

6. Slide on cup springs (2).

7. Slide on new L-ring (1) with the offset front face facing downwards.

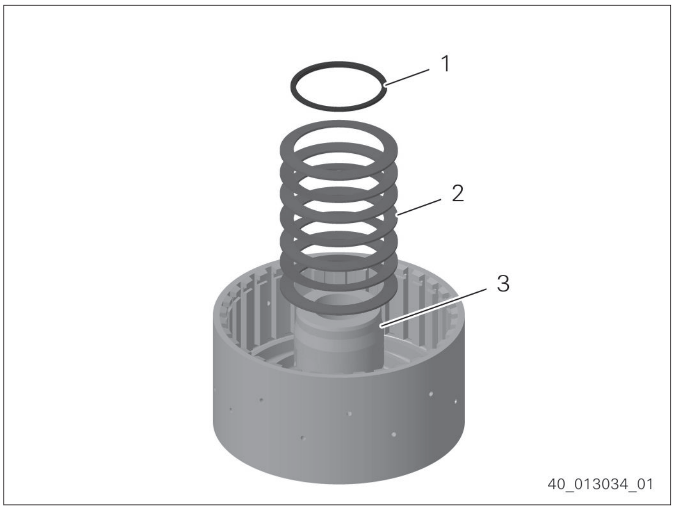


Fig. 261

8. Push L-ring downwards with 5870.345.124 [Assembly fixture] and 5870.345.088 [Assembly fixture] until it engages in the annular groove of the disk carrier.

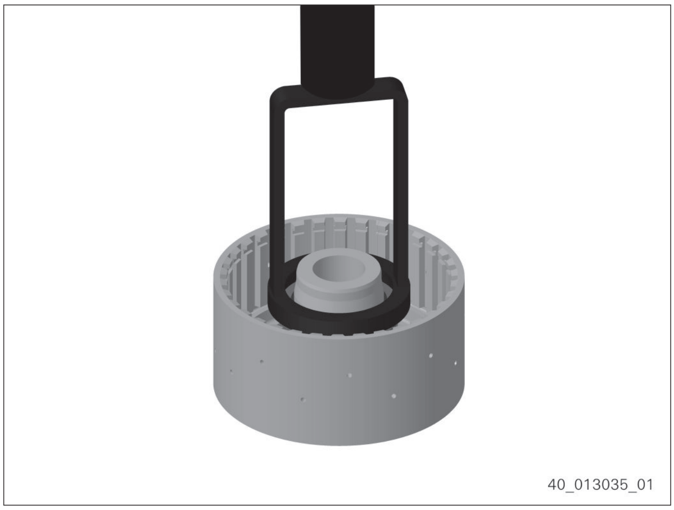


Fig. 262

Setting disk clearance

9. Insert outer disk (1) with the uncoated side facing the piston.

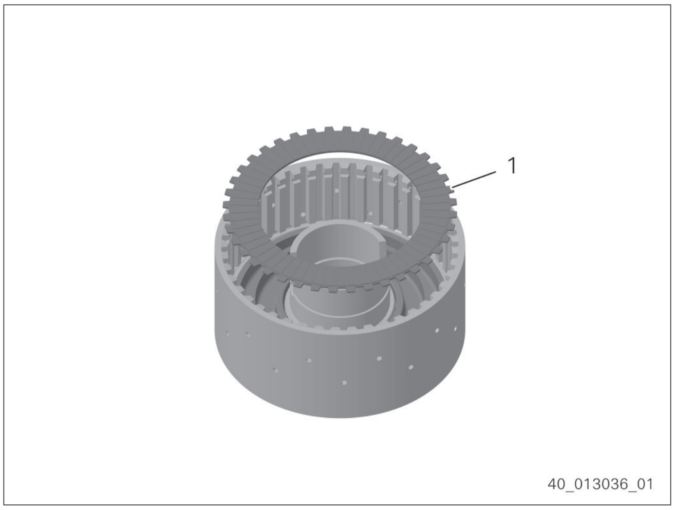


Fig. 263

10. Insert inner disks and outer disks.

    For the arrangement refer to the current spare parts list.

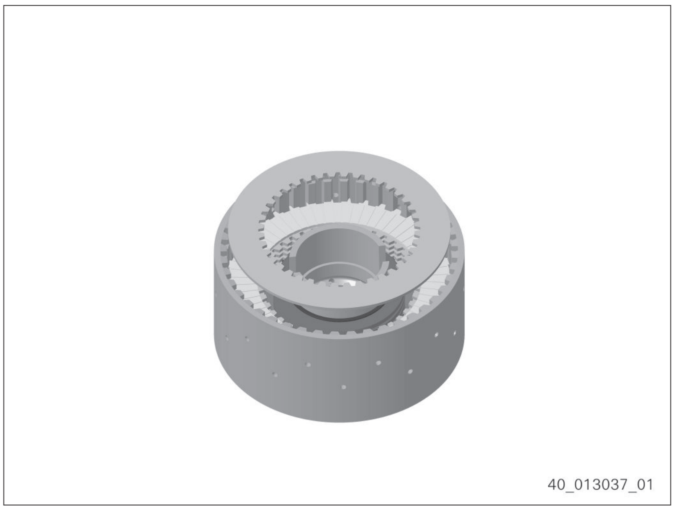


Fig. 264

11. Insert end shim (1).

12. Insert snap ring e. g. 3.15 mm.

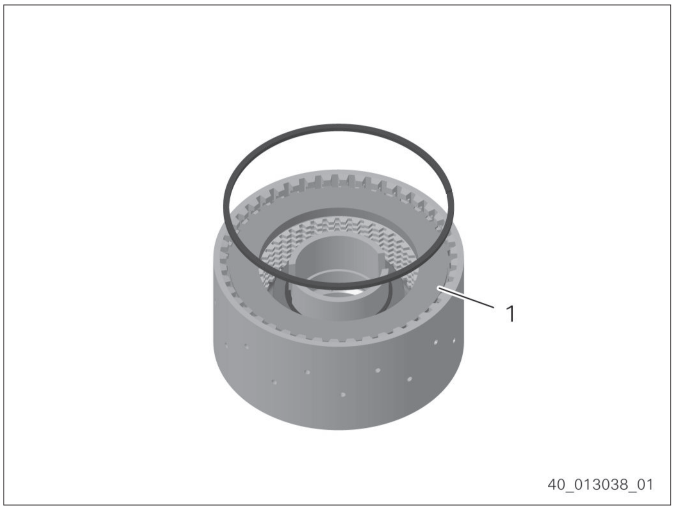


Fig. 265

13. Position dial gauge at end shim.

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

15. Lift end shim on the snap ring until contact is obtained and check the necessary Disk clearance 1.75 mm until 2.05 mm.
If the disk clearance is too small, install a thinner snap ring.
If the disk clearance is too big, install a thicker snap ring.

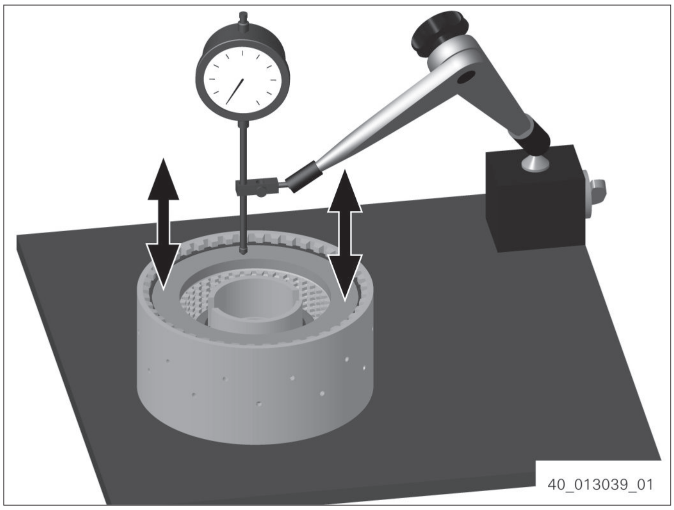


Fig. 266

16. 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 internal spline of the disk carrier.

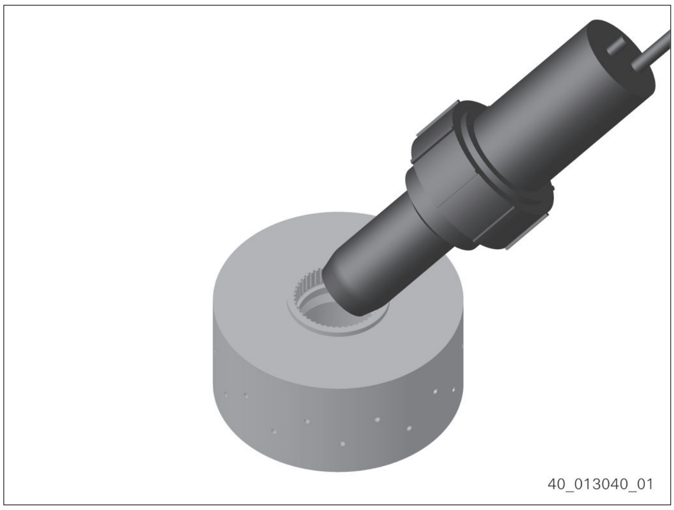


Fig. 267

17. Slide clutch onto shaft until contact is obtained.

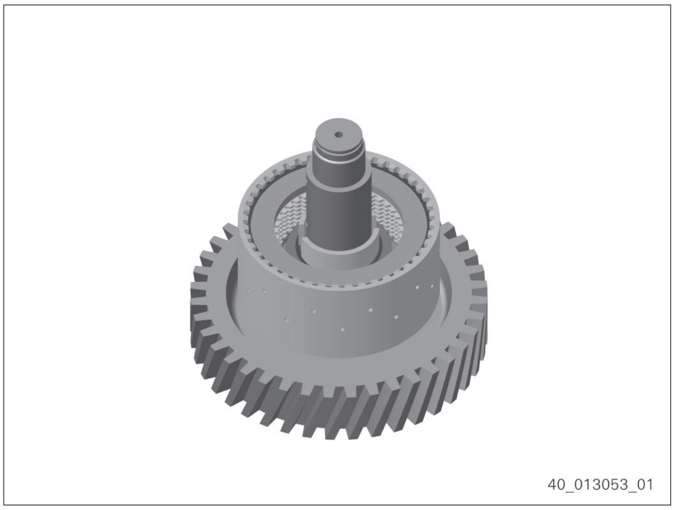


Fig. 268

18. Slide on thrust washer (3) with the chamfer facing towards the axle needle cage.

19. Slide on axial needle cage (2).

20. Slide on axial washer (1).

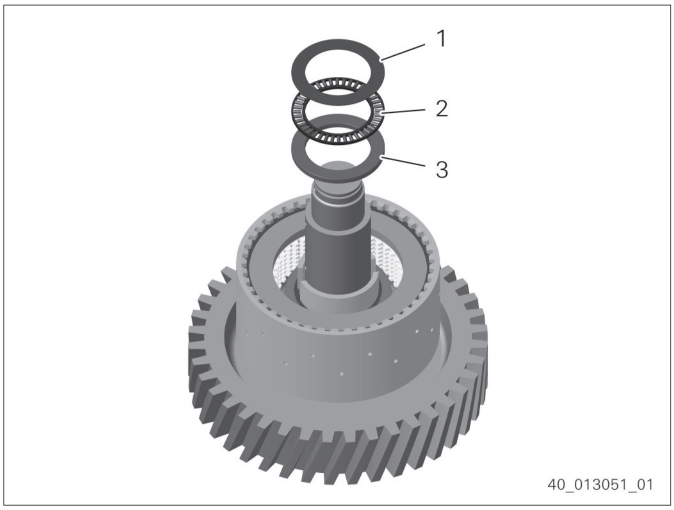


Fig. 269

21. Slide on needle cage (1).

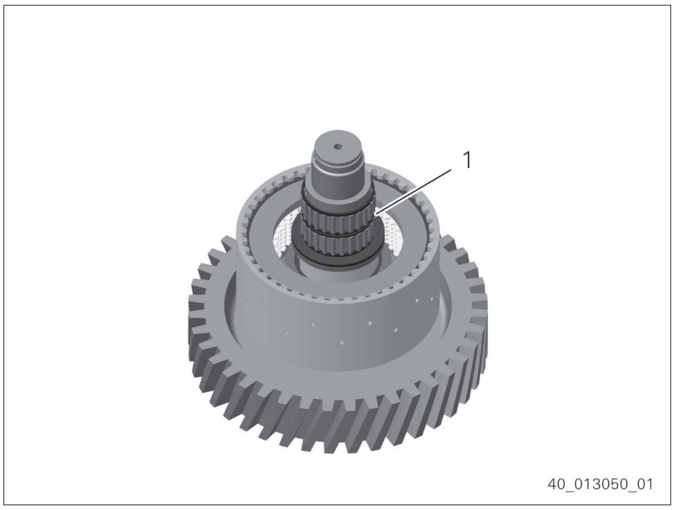


Fig. 270

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

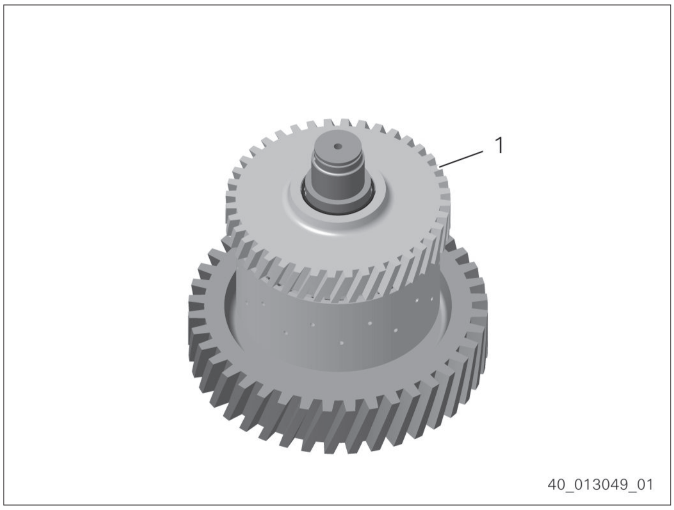


Fig. 271

23. Slide on axial washer (3).

24. Slide on axial needle cage (2).

25. Slide on thrust washer (1) with the chamfer facing towards the axle needle cage.

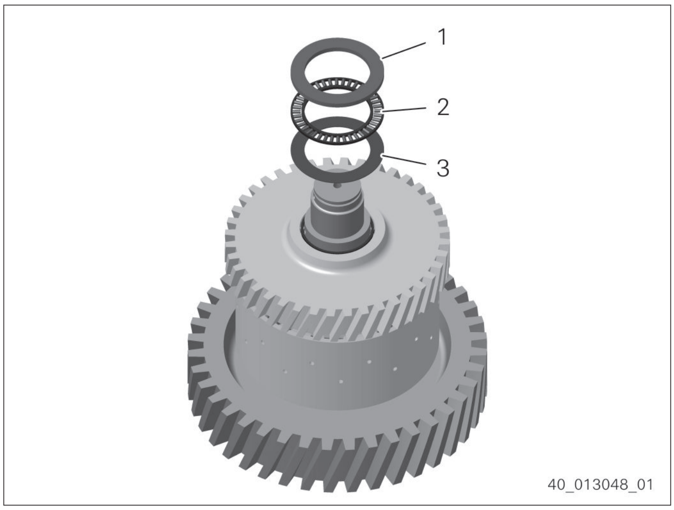


Fig. 272

26. 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.

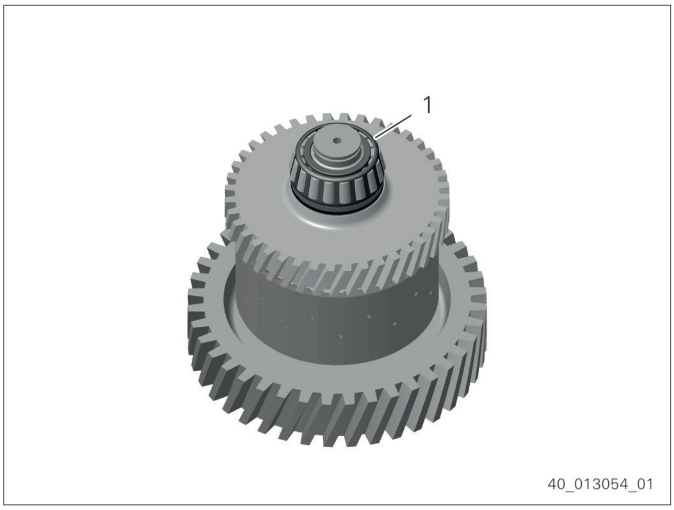


Fig. 273

27. Slide bearing inner ring (1) onto shaft until contact is obtained.

28. Let bearing inner ring cool down.

29. Adjust bearing inner ring.

30. Insert piston ring (1).

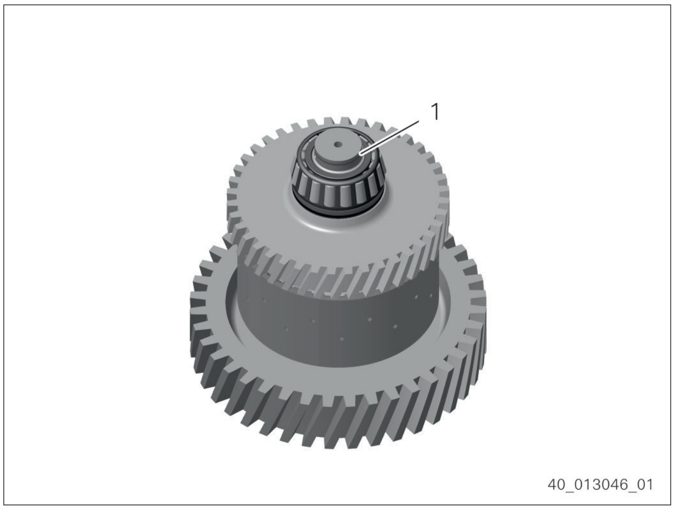


Fig. 274

31. 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.

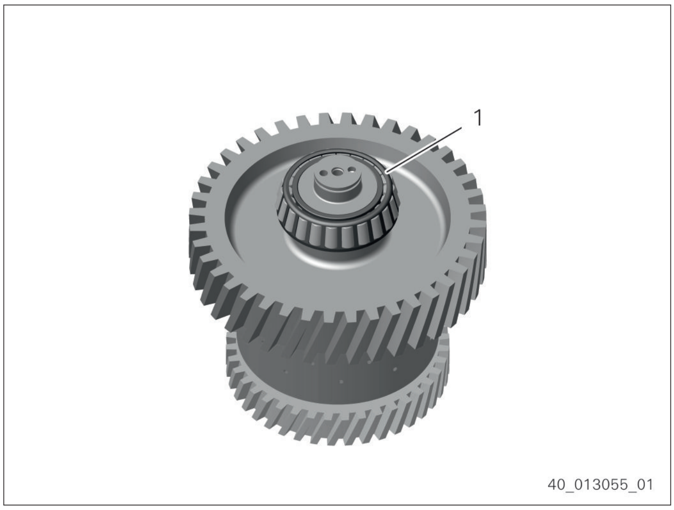


Fig. 275

32. Slide bearing inner ring (1) onto shaft until contact is obtained.

33. Let bearing inner ring cool down.

34. Adjust bearing inner ring.

35. Screw in stud bolt (1) and tighten.
    Tightening torque: 17 Nm

36. Insert piston ring (2).

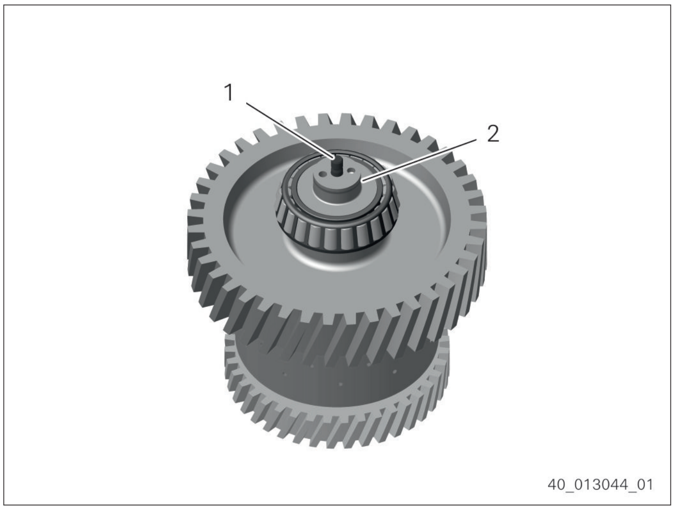


Fig. 276

37. Check function of the clutch with compressed air.

    → Closing and opening of the clutch is clearly audible.

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

Fig. 277

Assembling clutch K4

Special tools:

- 5870.345.124 Assembly fixture
- 5870.345.088 Assembly fixture

1. Carry out the following three 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.

Cool down shaft.

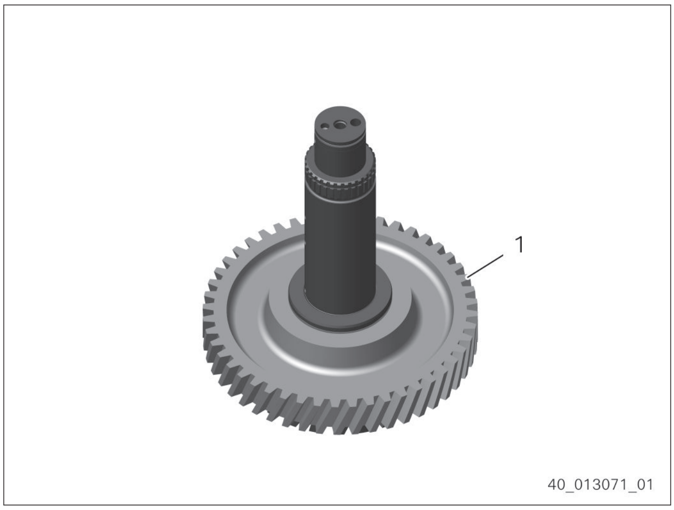


Fig. 278

2. **⚠ CAUTION**

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

Heat up gear.

3. Slide gear (1) onto shaft until contact is obtained.

4. Insert retaining ring into the shaft.

Fig. 279

5. 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.

6. Slide bearing inner ring (1) onto shaft until contact is obtained.

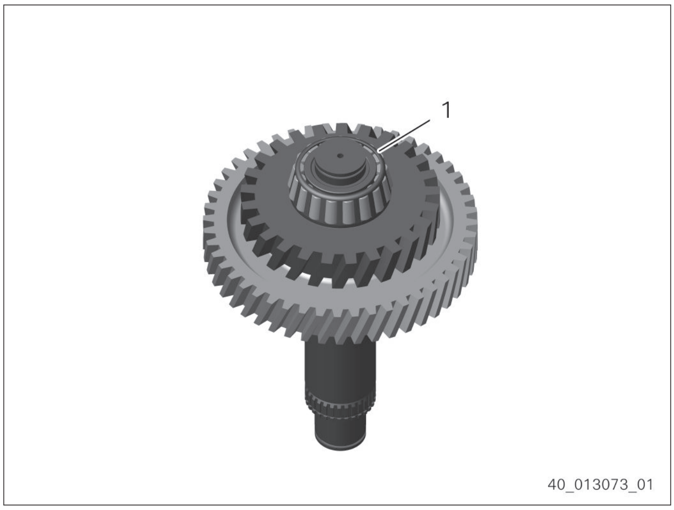


Fig. 280

7. Let bearing inner ring cool down.

8. Adjust bearing inner ring.

9. Insert piston ring (1).

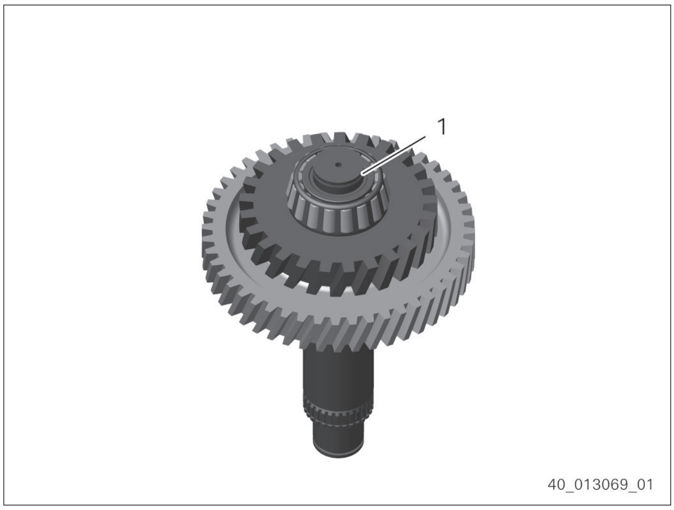


Fig. 281

10. Slide on axial washer (1).

11. Slide on axial needle cage (2).

12. Slide on axial washer (1).

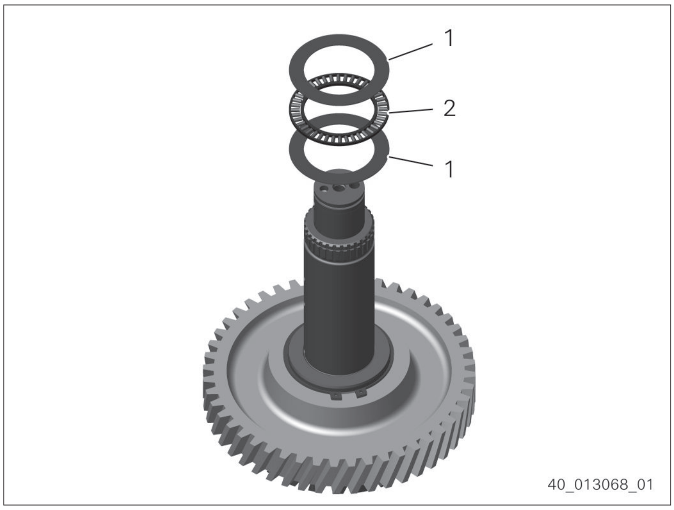


Fig. 282

13. Slide on needle cage (1).

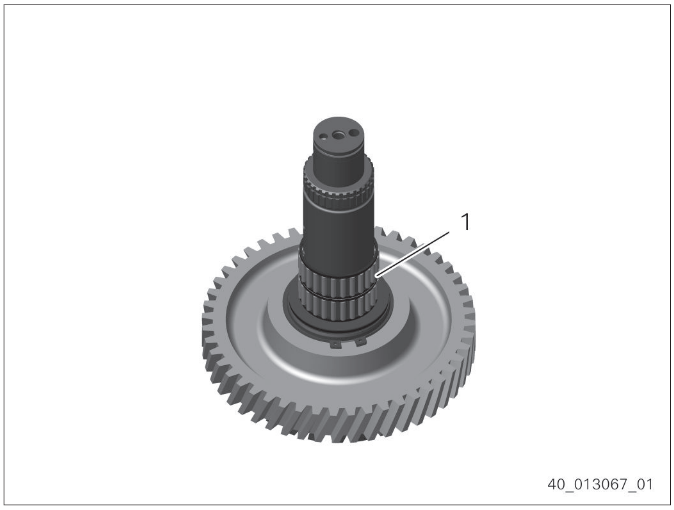


Fig. 283

14. Slide on idler gear (1).

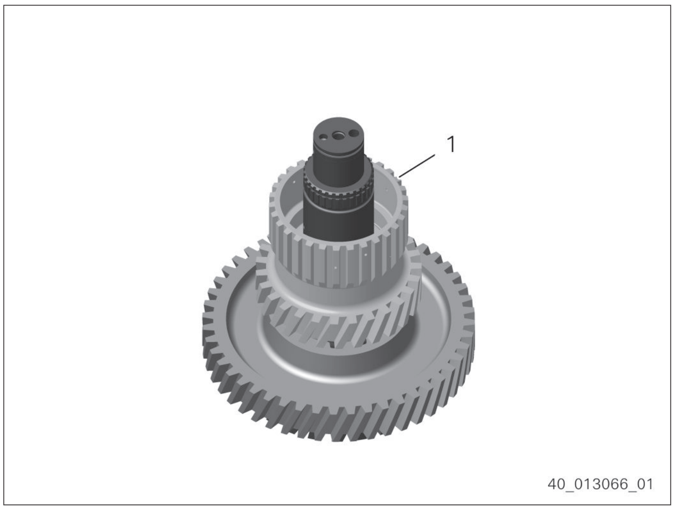


Fig. 284

15. Slide on axial washer (3).

16. Slide on axial needle cage (2).

17. Slide on thrust washer (1) with the chamfer facing towards the axle needle cage.

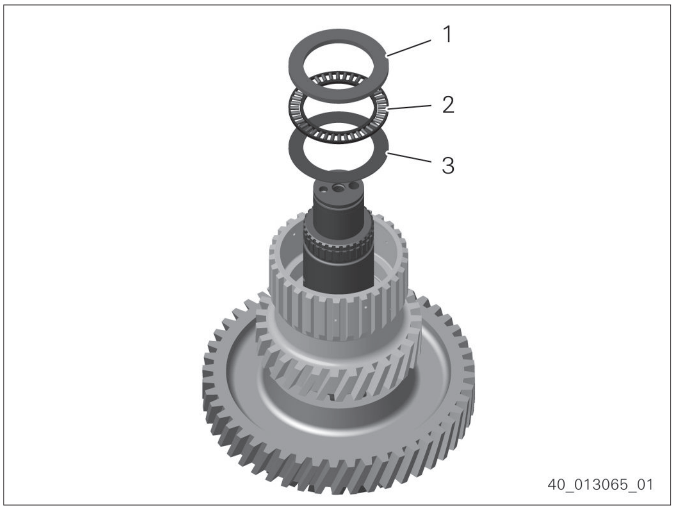


Fig. 285

18. Check clearance of the ball in the drain valve (2).

19. Grease O-rings (1) and insert them twist-free in the annular grooves.

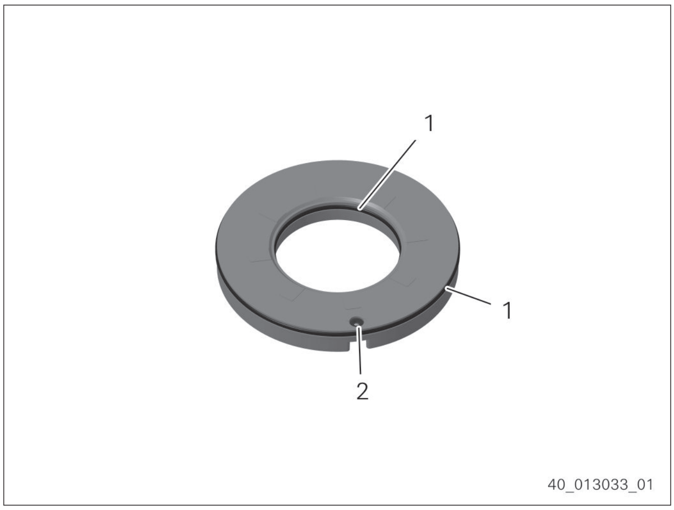


Fig. 286

20. Oil O-rings and piston bearing surfaces.

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

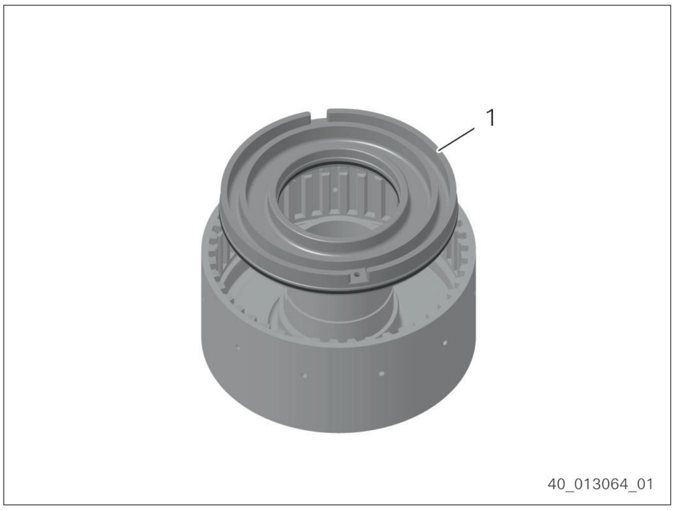


Fig. 287

22. Insert 5870.345.124 [Assembly fixture] (3) into disk carrier.

23. Slide on cup springs (2).

24. Slide on new L-ring (1) with the offset front face facing downwards.

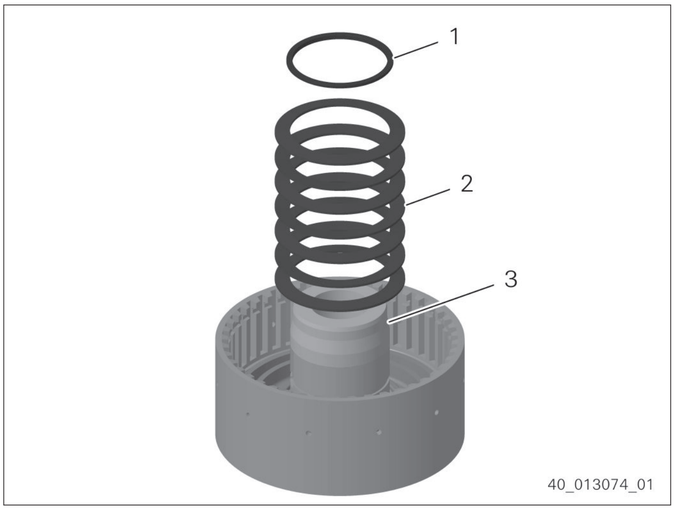


Fig. 288

25. Push L-ring downwards with 5870.345.124 [Assembly fixture] and 5870.345.088 [Assembly fixture] until it engages in the annular groove of the disk carrier.

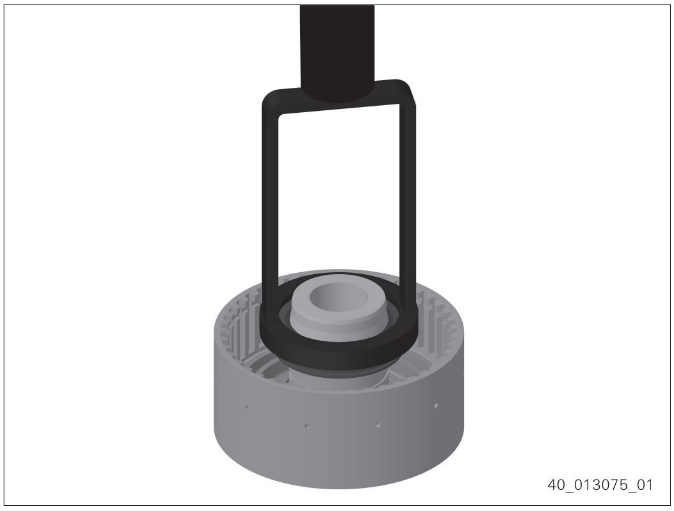


Fig. 289

Setting disk clearance

26. Insert outer disk (1) with the uncoated side facing the piston.

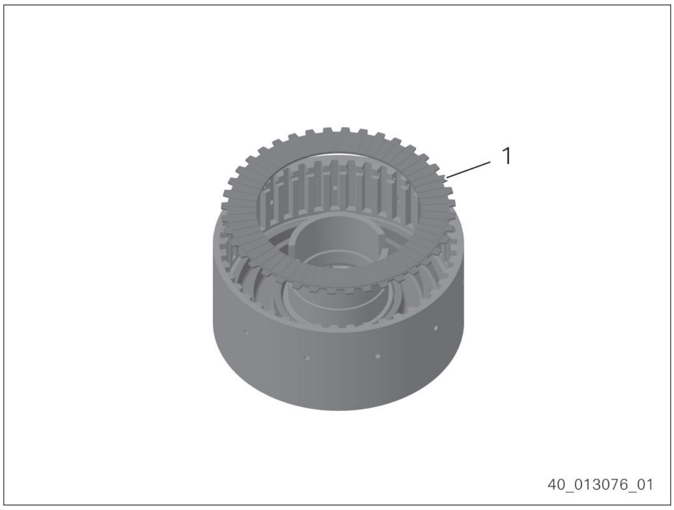


Fig. 290

27. Insert inner disks and outer disks.

    For the arrangement refer to the current spare parts list.

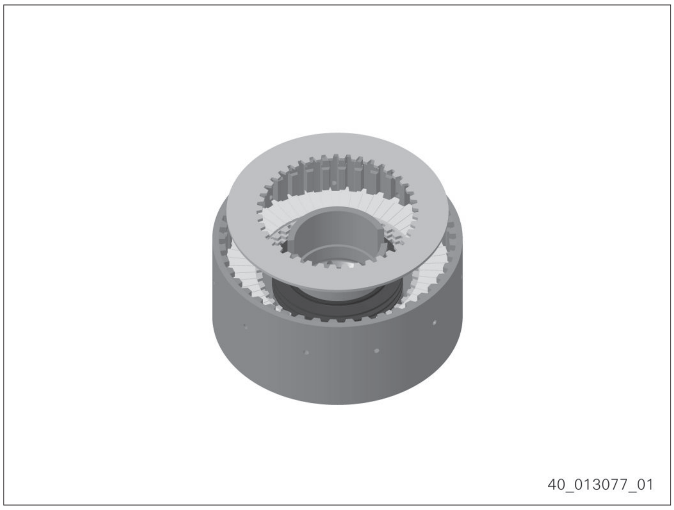


Fig. 291

28. Insert end shim (1).

29. Insert snap ring e. g. 3.15 mm.

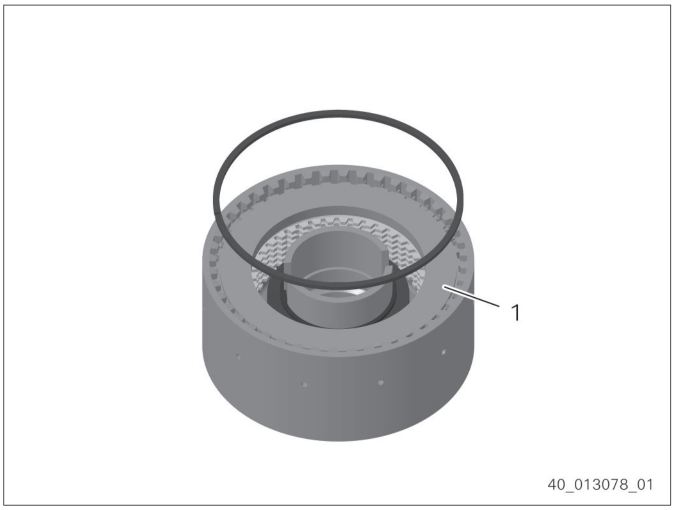


Fig. 292

30. Position dial gauge at end shim.

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

32. Lift end shim on the snap ring until contact is obtained and check the necessary Disk clearance 1.35 mm until 1.65 mm.
    If the disk clearance is too small, install a thinner snap ring.
    If the disk clearance is too big, install a thicker snap ring.

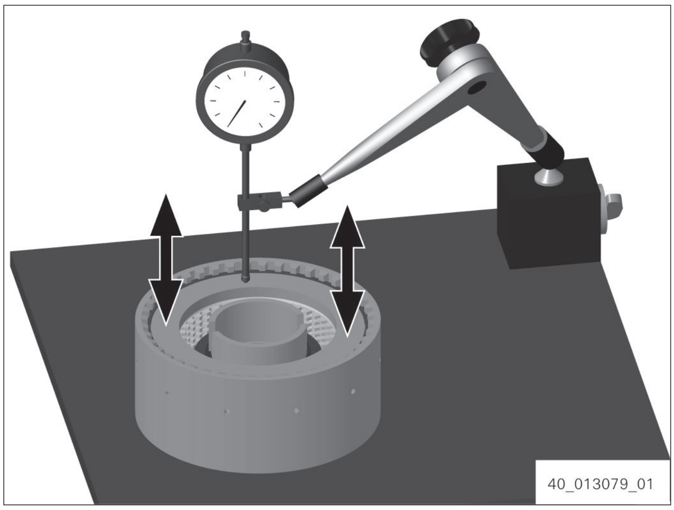


Fig. 293

33. 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 internal spline of the disk carrier.

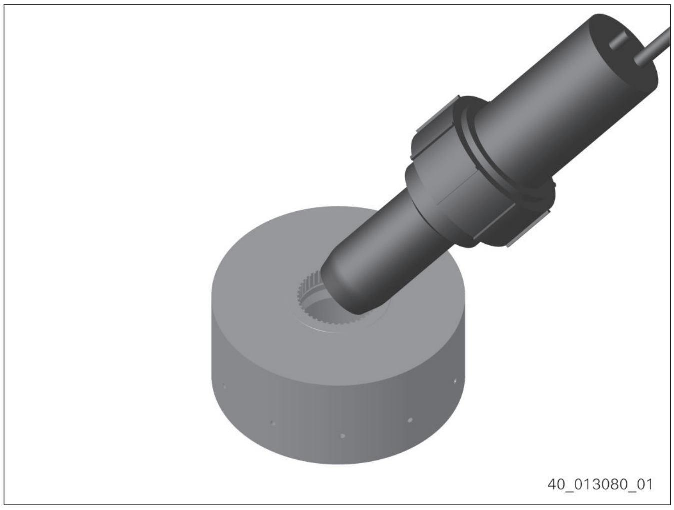


Fig. 294

34. Slide clutch onto shaft until contact is obtained. Insert idler gear into the disk package by short mutual rotary motions.

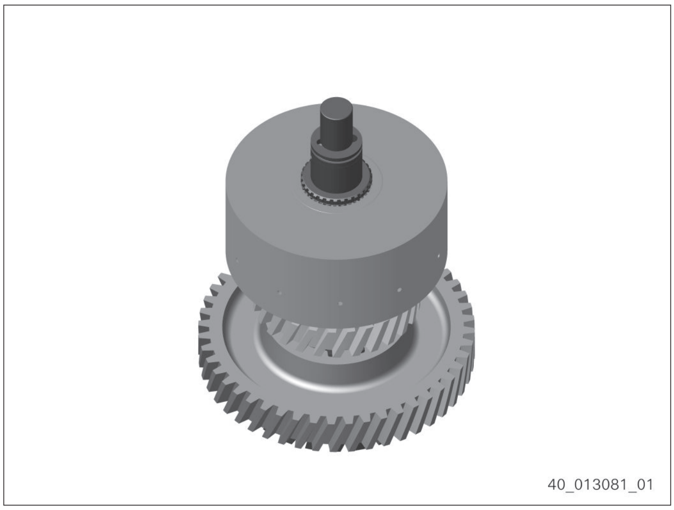


Fig. 295

35. Insert retaining ring into the shaft.

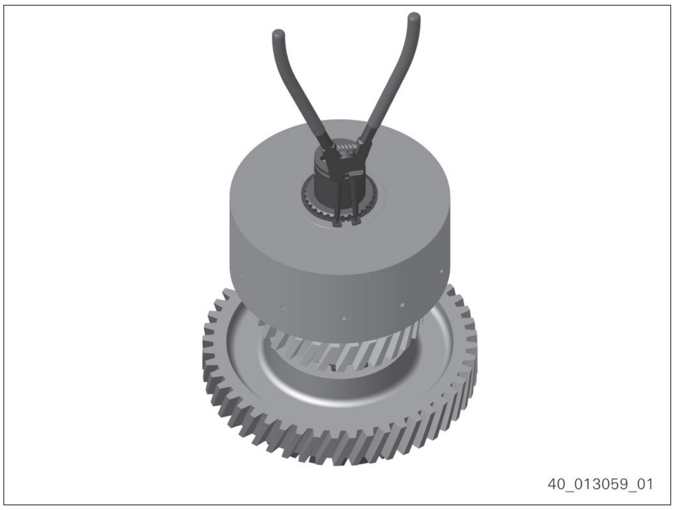


Fig. 296

36. 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.

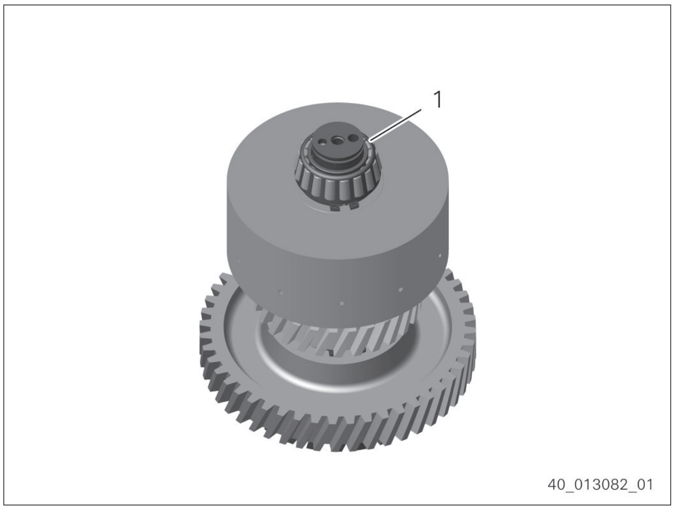


Fig. 297

37. Slide bearing inner ring (1) onto shaft until contact is obtained.
38. Let bearing inner ring cool down.
39. Adjust bearing inner ring.
40. Screw in stud bolt (1) and tighten.
Tightening torque: 17 Nm
41. Insert piston ring (2).

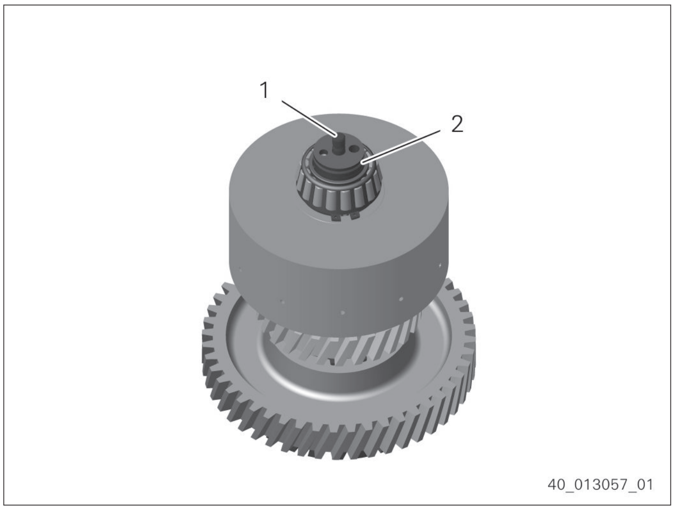


Fig. 298

42. Check function of the clutch with compressed air.

    → Closing and opening of the clutch is clearly audible.

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

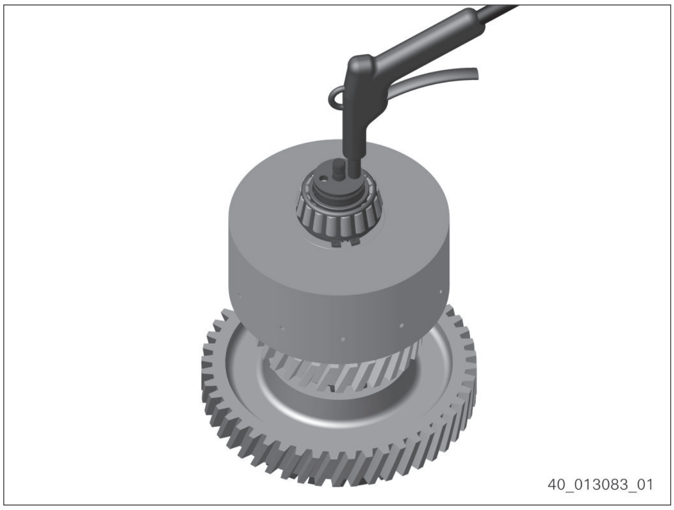


Fig. 299

Assembling input shaft

1. Carry out the following three 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.

Cool down input shaft.

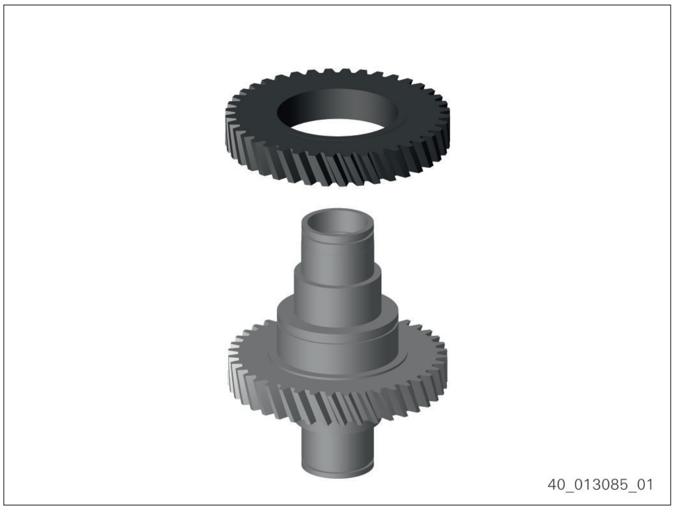


Fig. 300

2. ⚠ **CAUTION**

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

Heat up input gear.

3. Slide input gear (1) onto input shaft until contact is obtained.

4. Insert retaining ring (1) into the input shaft.

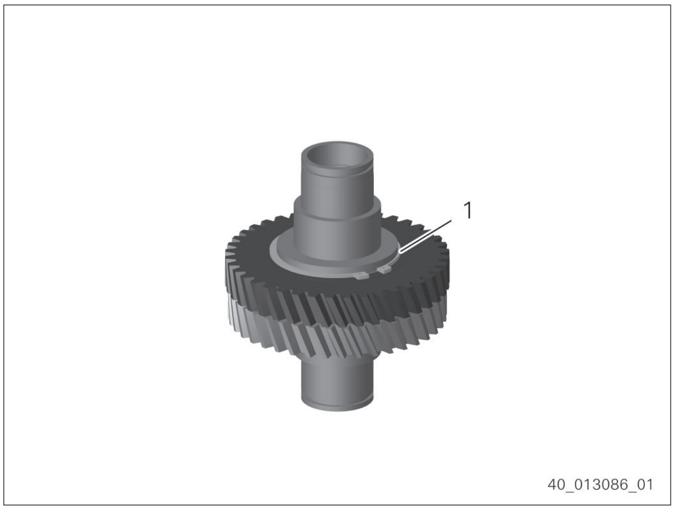


Fig. 301

5. Grease O-ring.

6. Insert O-ring (1) into annular groove of the input shaft.

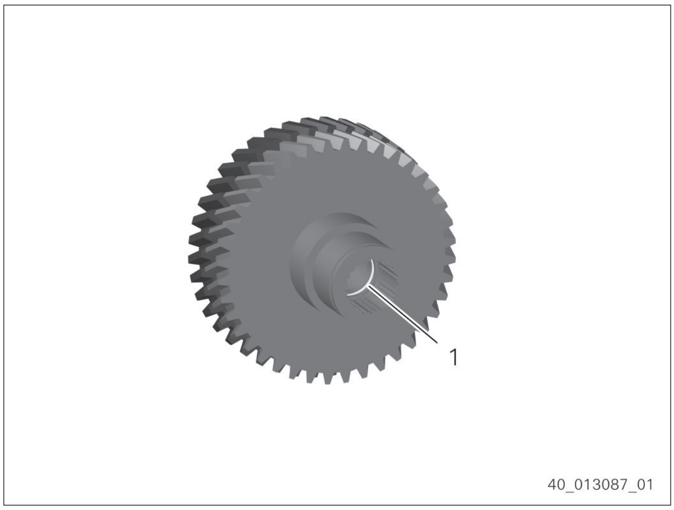


Fig. 302

7. Insert snap ring into annular groove of the turbine shaft.

Fig. 303

8. Insert turbine shaft in the input shaft until the snap ring audibly engages.

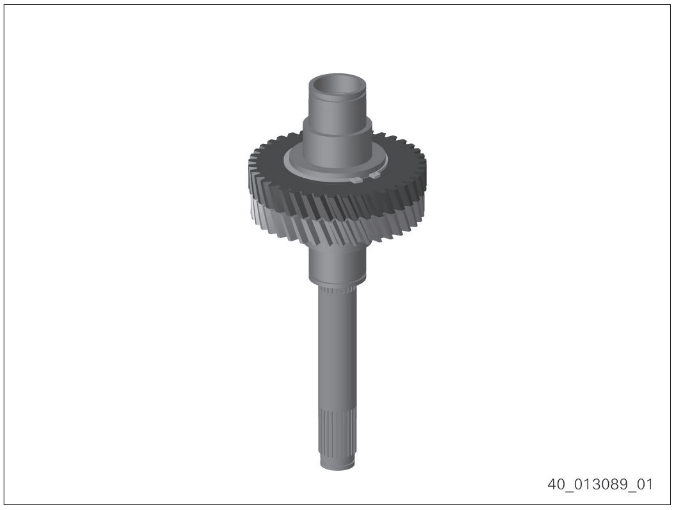


Fig. 304

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 bearing inner rings.

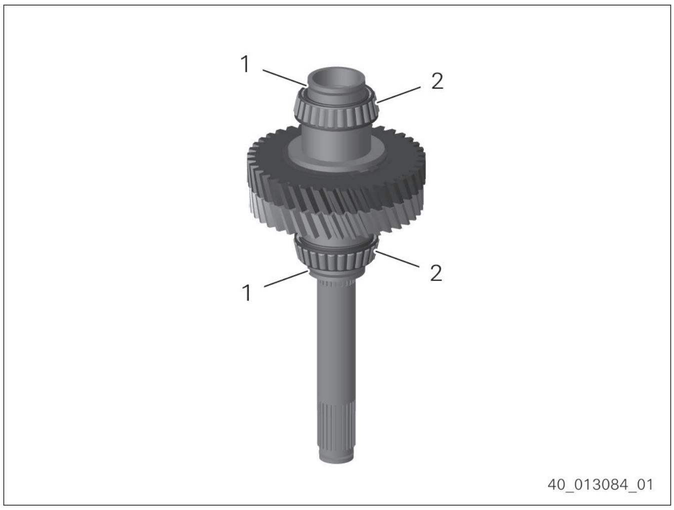


Fig. 305

10. Slide bearing inner rings (2) onto input shaft until contact is obtained.

11. Let bearing inner rings cool down.

12. Adjust bearing inner rings.

13. Insert R-rings (1).

Installing clutches

Special tools:
- AA02.691.822 Handle

Assembly

1. Insert clutch KV (1), input shaft (2) and clutch KR (3) together in the rear part of the housing.

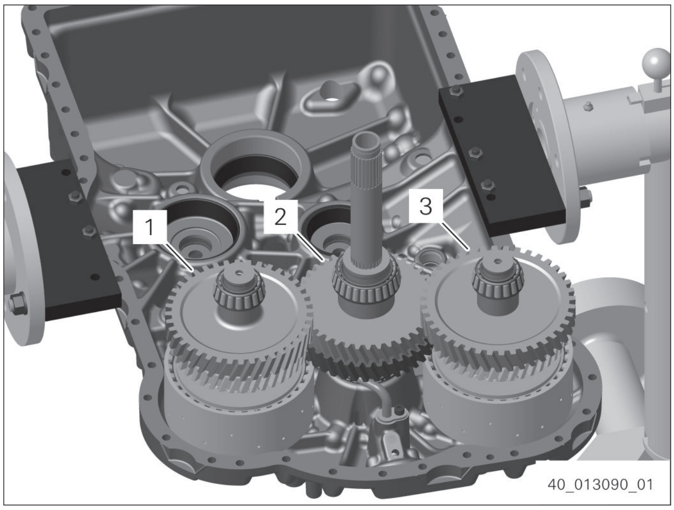


Fig. 306

2. Insert clutch K4 (1).

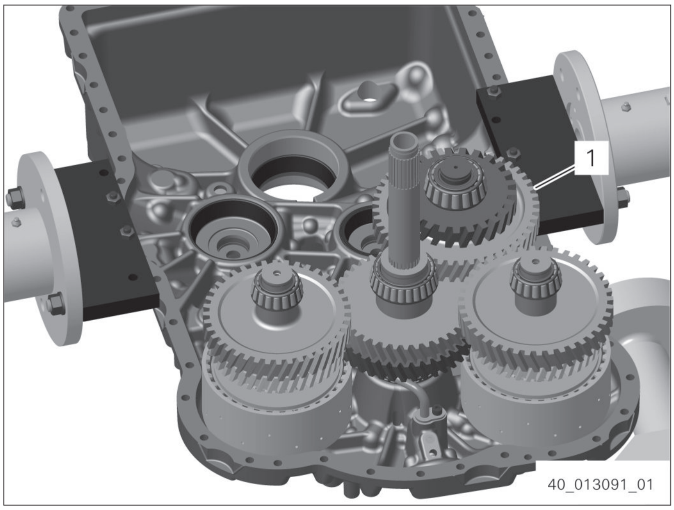


Fig. 307

3. Insert clutch K3 (1).

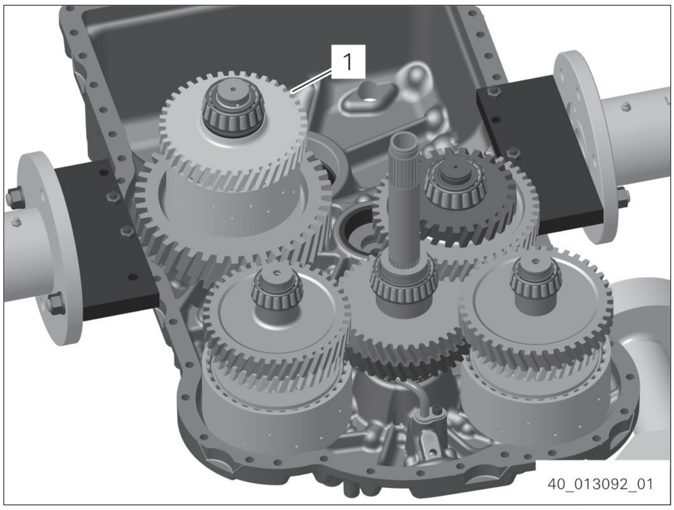


Fig. 308

4. Insert clutch K2 (1).

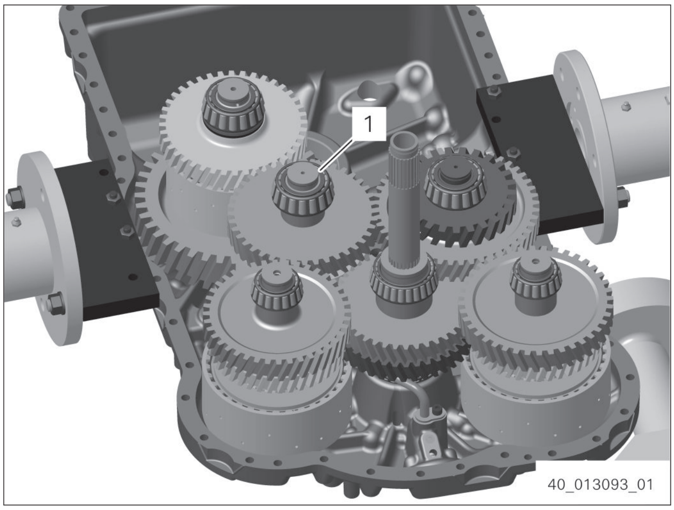


Fig. 309

5. Lift up clutch K4 (2) slightly and insert clutch K1 (1).

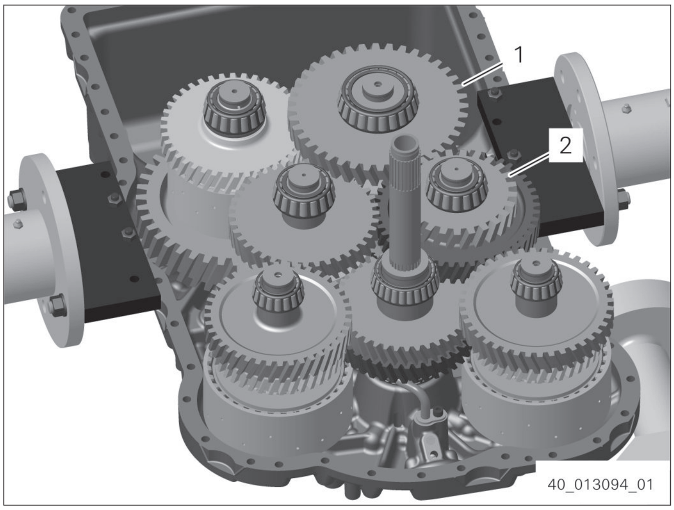


Fig. 310

6. Fix clutches K1, K2, K3 and K4 with AA02.691.822 [Handle] in the housing rear part.

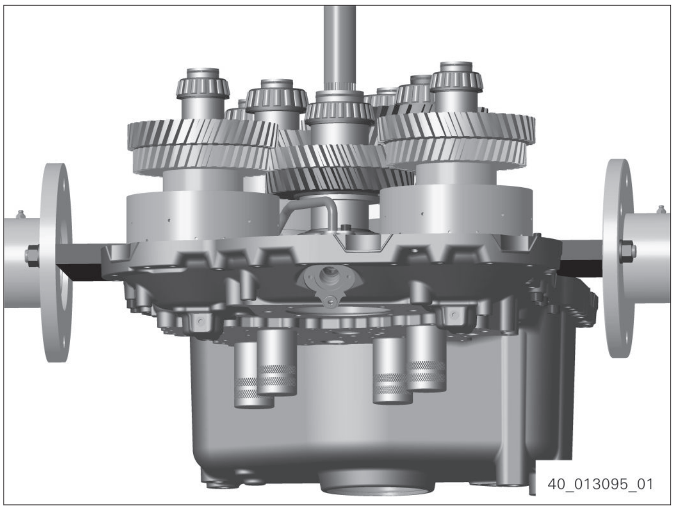


Fig. 311

Assembling housing front part

Special tools:

- AA02.068.532 Pipe roller

1. Insert suction tube (1) into housing front part.

2. Fasten suction tube with cap screw.
   Tightening torque: 23 Nm

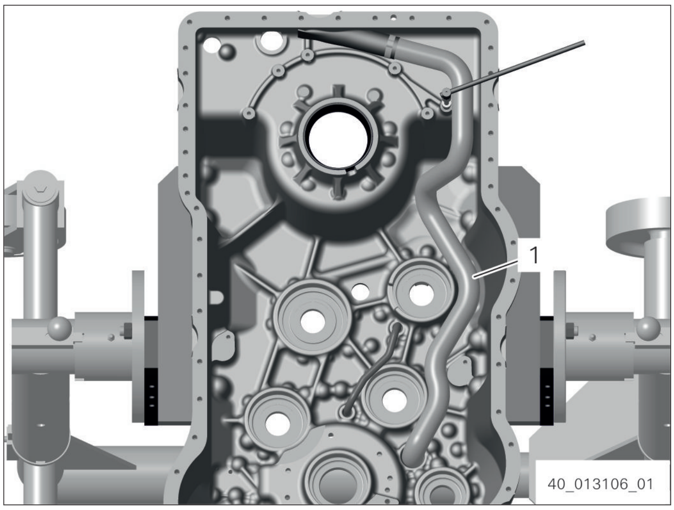


Fig. 312

3. Apply oil to inner diameter of the suction tube and to rollers of AA02.068.532 [Pipe roller].

4. Insert AA02.068.532 [Pipe roller] in suction tube.

5. Fasten suction tube with AA02.068.532 [Pipe roller] in the front part of the housing.
   Tightening torque: 40 Nm

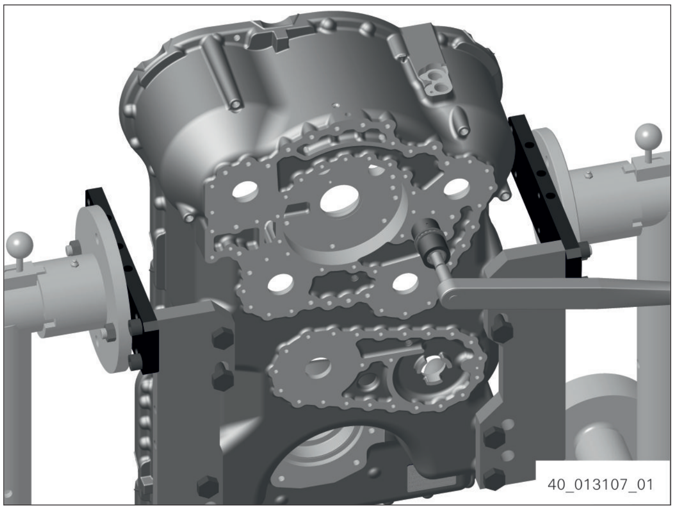


Fig. 313

6. Grease O-ring.

7. Insert O-ring (1) into annular groove of the oil tube.

Fig. 314

8. Grease O-ring.

9. Insert O-ring (1) into annular groove of the oil tube.

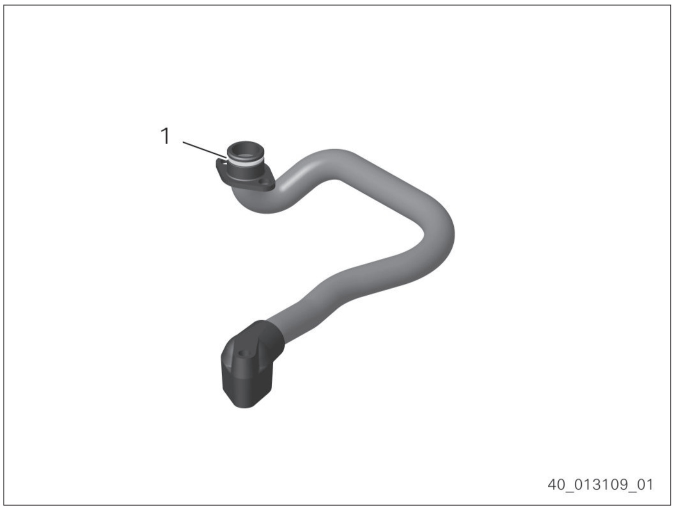


Fig. 315

10. Insert oil tubes (1).

11. Fix oil tubes with cap screws.
    Tightening torque: 23 Nm

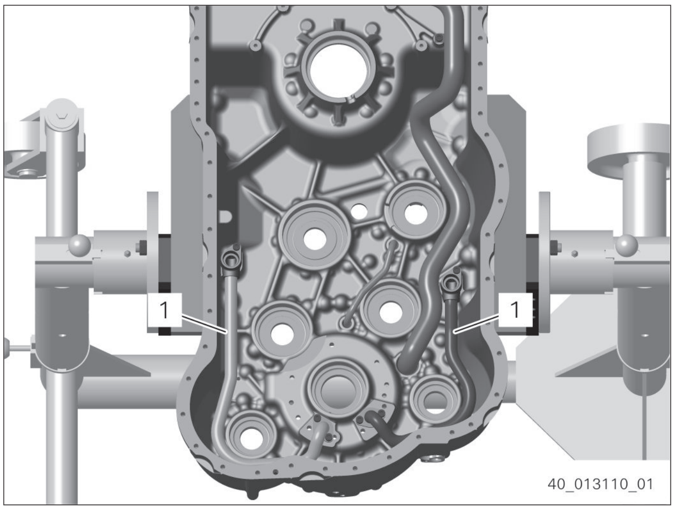


Fig. 316

12. Grease O-rings.

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

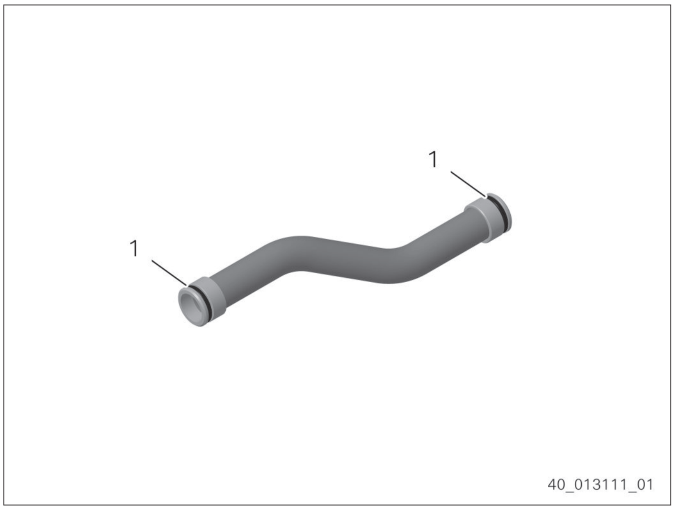


Fig. 317

14. Grease O-rings (1).

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

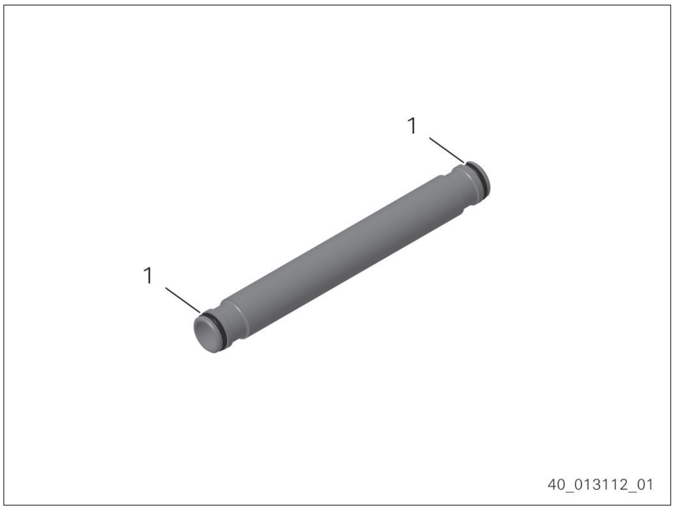


Fig. 318

16. Insert tube (1) into the oil tube until contact is obtained.

17. Insert oil tube (2) until contact is obtained.

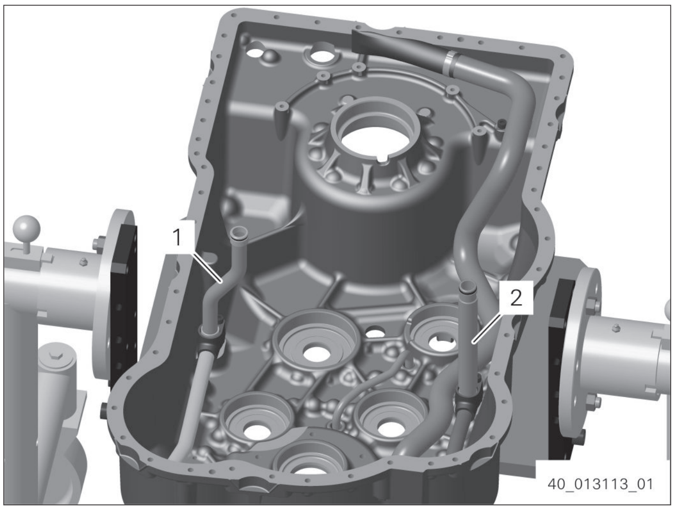


Fig. 319

18. Insert bearing outer rings into housing holes until contact is obtained.
    The Figure shows the positions of the bearing outer rings.
    - 1 = Output shaft
    - 2 = Clutch K3
    - 3 = Clutch K2
    - 4 = Clutch KV
    - 5 = Input shaft
    - 6 = Clutch KR
    - 7 = Clutch K4
    - 8 = Clutch K

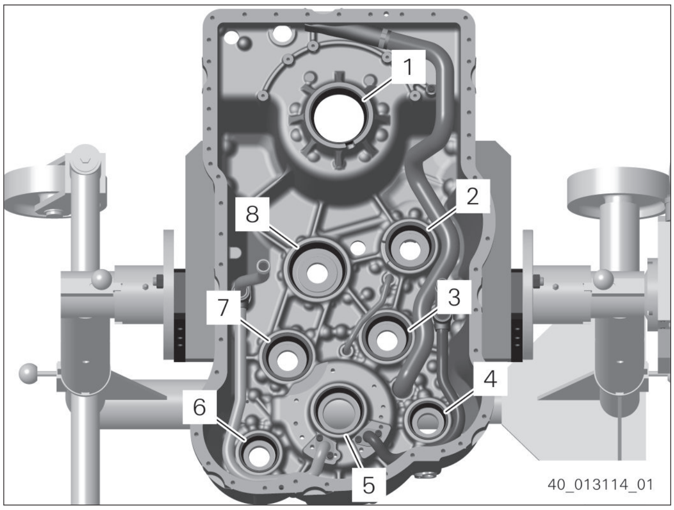


Fig. 320

Assembling and installing output shaft

Special tools:
- AA01.230.960 Eyebolt

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 bearing inner ring.

2. Slide bearing inner ring (1) onto the output shaft until contact is obtained.

3. Let bearing inner ring cool down.

4. Adjust bearing inner ring.

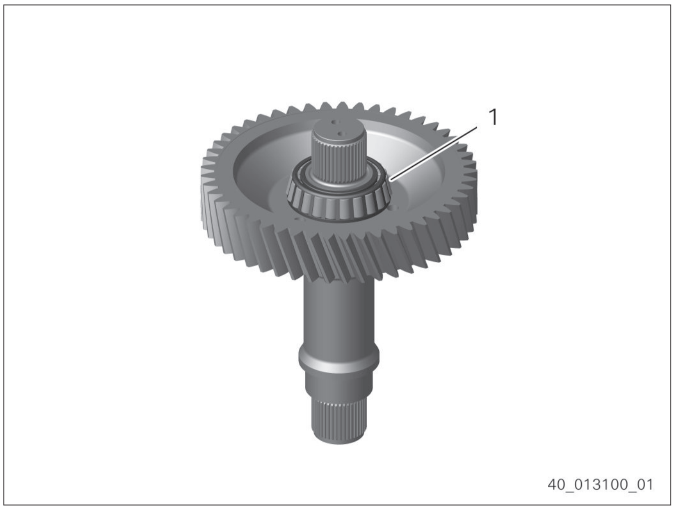


Fig. 321

5. Slide on screen sheet (1).

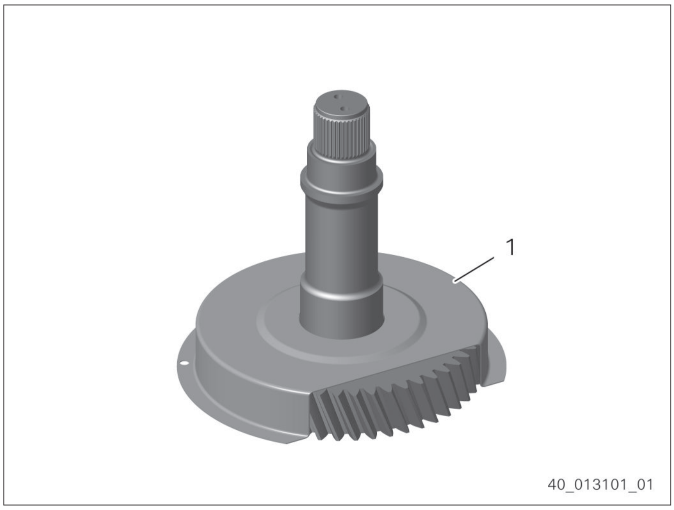


Fig. 322

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 bearing inner ring.

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

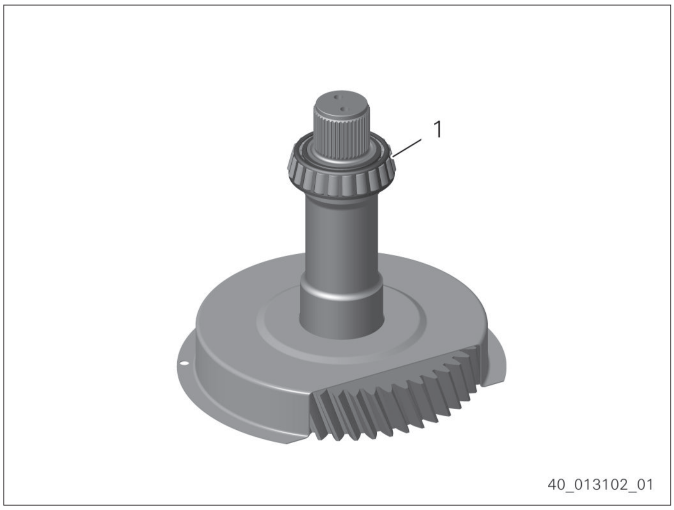


Fig. 323

8. Let bearing inner ring cool down.

9. Adjust bearing inner ring.

10. Place on screen sheet (1).

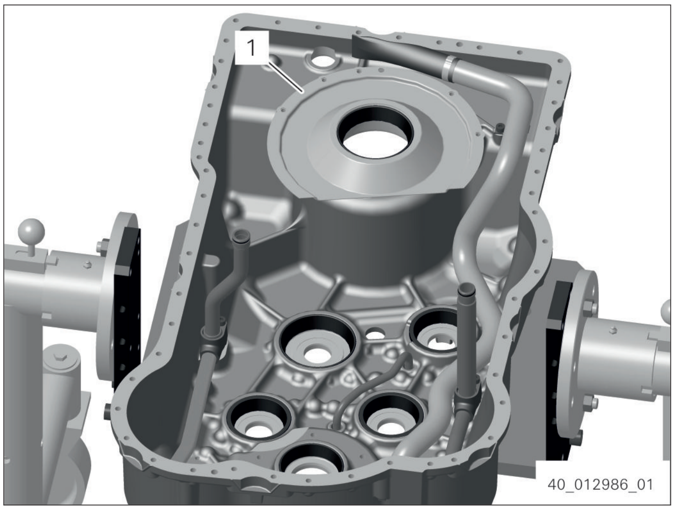


Fig. 324

11. Insert output shaft with AA01.230.960 [Eyebolt] and crane.

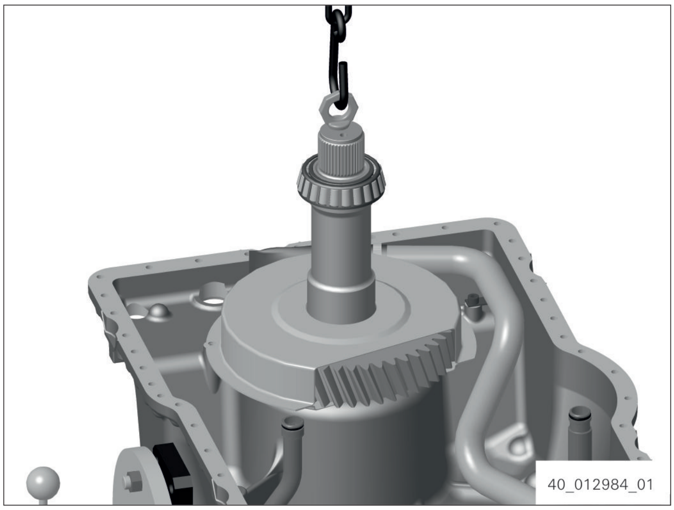


Fig. 325

12. Fasten screen sheets with cap screws. Tightening torque: 23 Nm

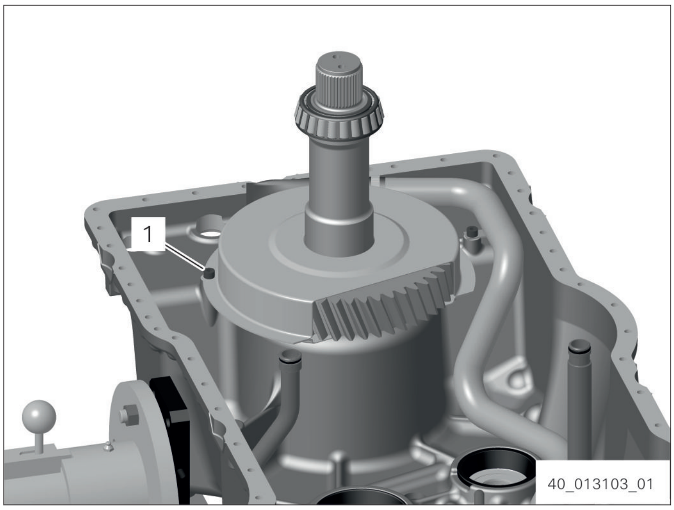


Fig. 326

Assembling housings

Special tools:
- 5870.204.083 Eyebolt
- 5870.204.086 Eyebolt
- AA02.691.822 Handle

Operating supplies and auxiliary materials:
- 0666.790.033 LOCTITE 574

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

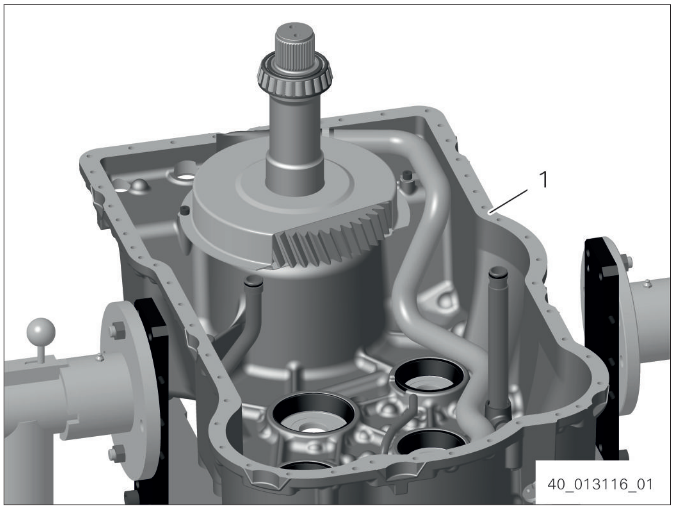


Fig. 327

2. Bolt two 5870.204.083 [Eyebolt] into the housing rear part.

3. Bolt in two 5870.204.086 [Eyebolt].

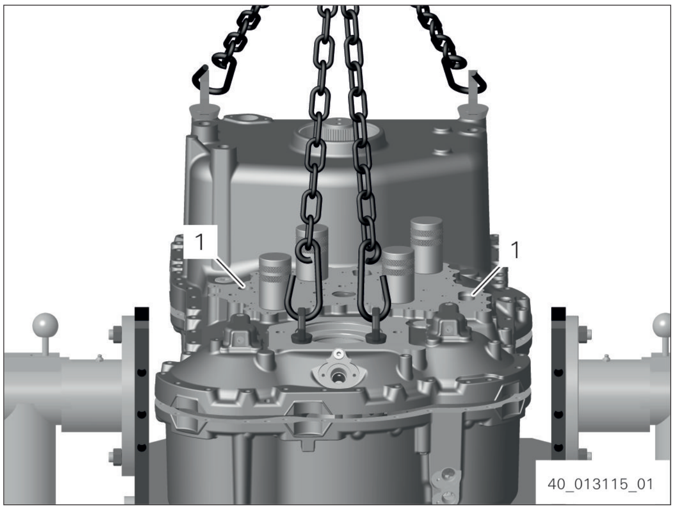


Fig. 328

4. ⚠ **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.

   Install housing rear part and clutches with a crane.
   Insert tube and oil tube in the housing holes (1).

5. Remove four AA02.691.822 [Handle].

6. ⚠ **CAUTION**

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

   Insert both cylindrical pins centrally.

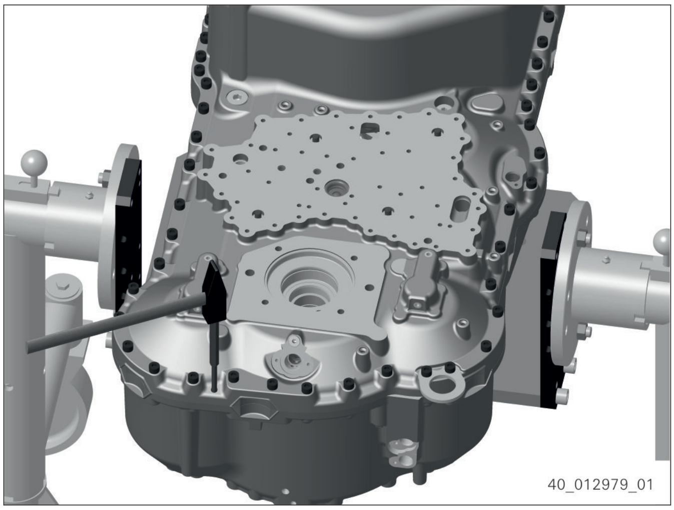


Fig. 329

7. Bolt in and tighten the cap screws (1).
   Tightening torque: 46 Nm

8. Fasten retaining plate (2) with cap screws.
   Tightening torque: 46 Nm

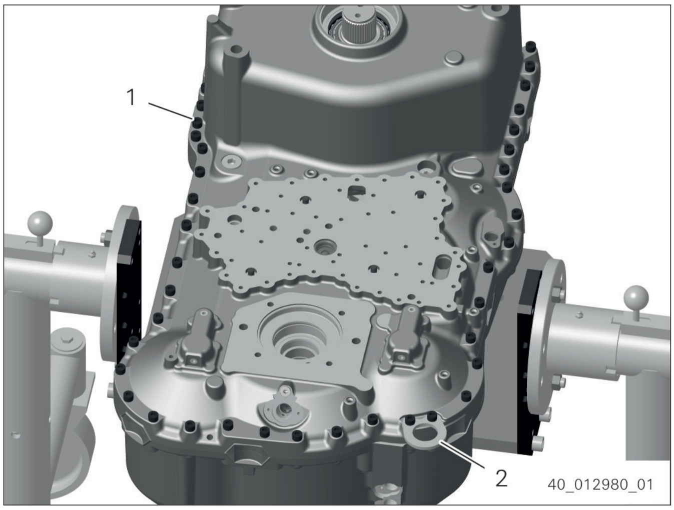


Fig. 330

Mounting cover (emergency steering pump)

Special tools:
- 5870.204.011 Fixing pin

1. Bolt two pieces of 5870.204.011 [Fixing pin] into the housing.

2. Put on seal (1).

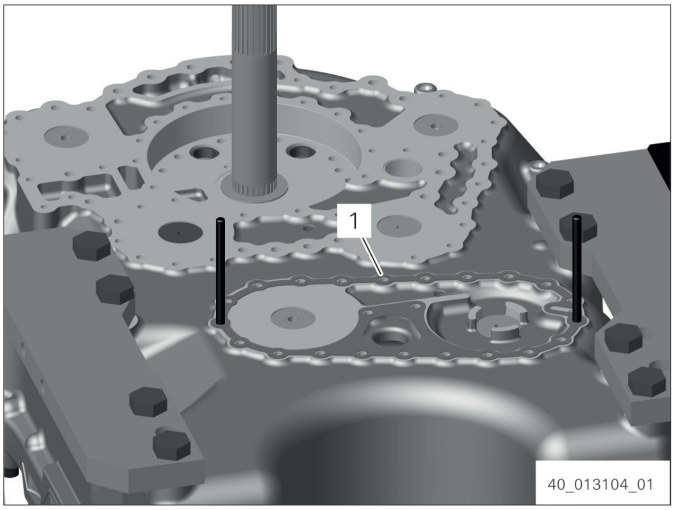


Fig. 331

3. Place the cover (1).

4. Fasten cover with hexagon screws.
   Tightening torque: 23 Nm

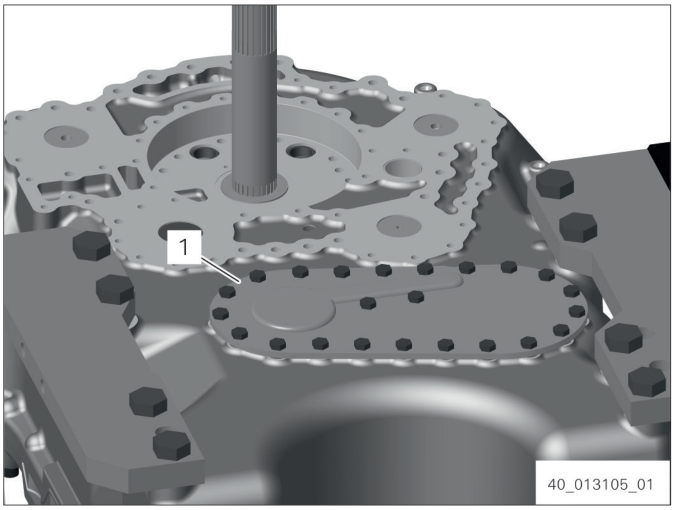


Fig. 332

Mounting the oil feed housing and oil pressure pump

Special tools:
- 5870.204.007 Locating pin
- 5870.204.011 Locating pin
- 5870.055.070 Driver tool
- 5870.260.002 Handle
- 5870.345.126 Assembly fixture

Operating supplies and auxiliary materials:
- 0666.690.191 PHÖNIX SPIRITUS

1. Bolt two pieces of 5870.204.007 [Locating pin] into the housing.

2. Insert the stator shaft (1).
   Observe radial installation position.

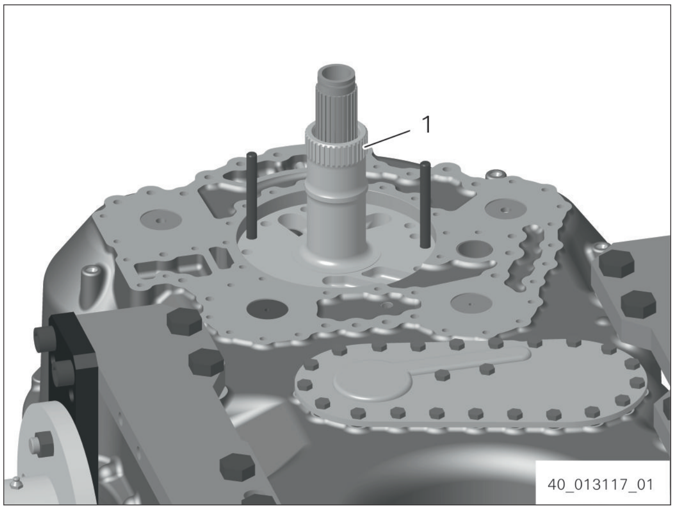


Fig. 333

3. Bolt in four 5870.204.011 [Locating pin].

4. Put on seal (1).

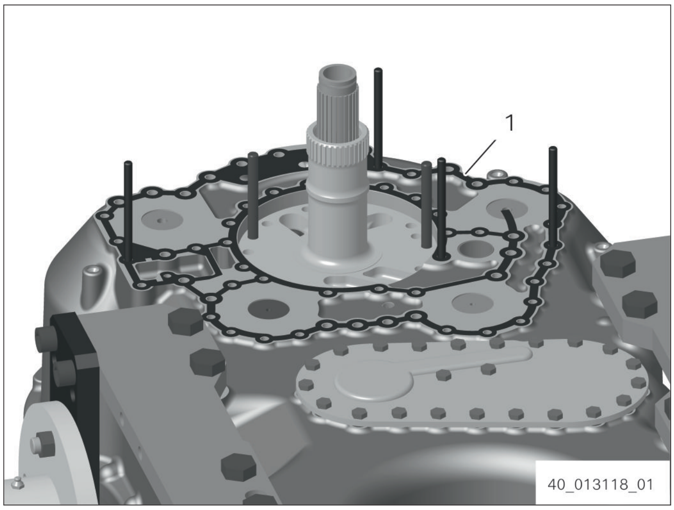


Fig. 334

5. Insert the piston (1) into the oil feed housing.

6. Insert compression spring (2).

7. Insert pressure plate (3).

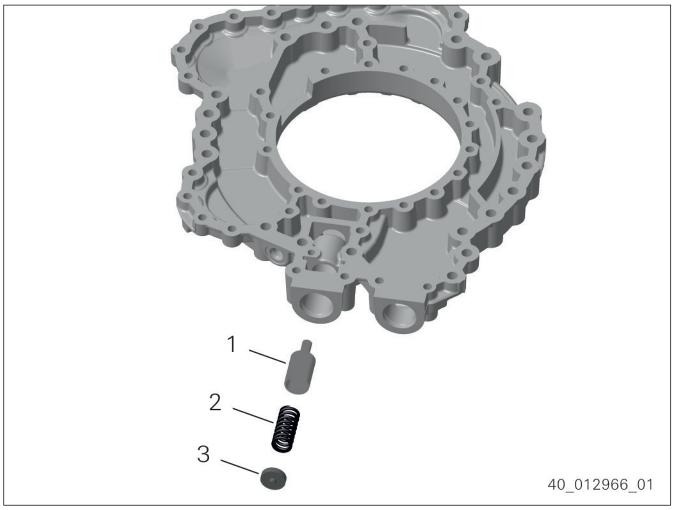


Fig. 335

8. Push pressure plate inwards with a mandrel and insert retaining plate (1).

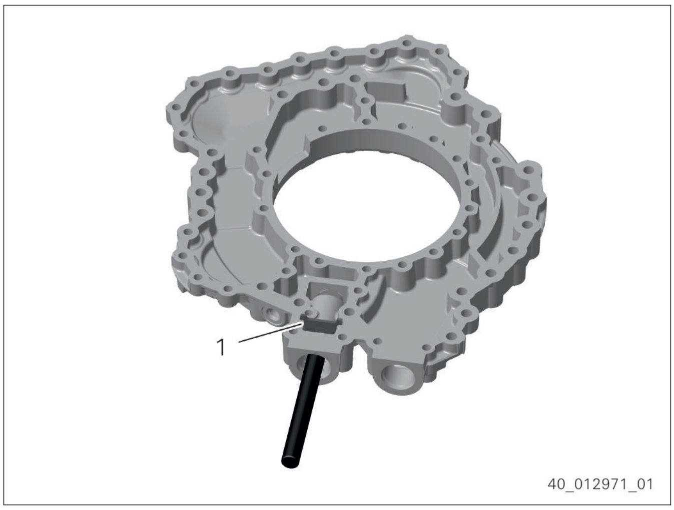


Fig. 336

9. Slide on the oil feed housing (1).

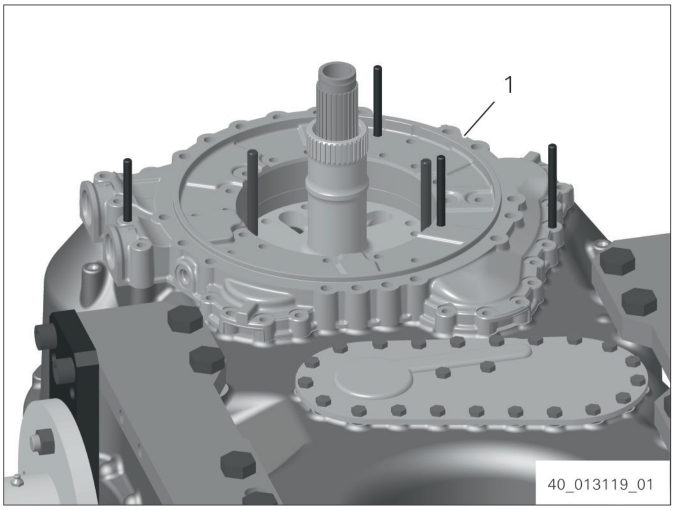


Fig. 337

Checking gear pump

10. Remove shaft seal (1).

11. Remove O-ring (2).

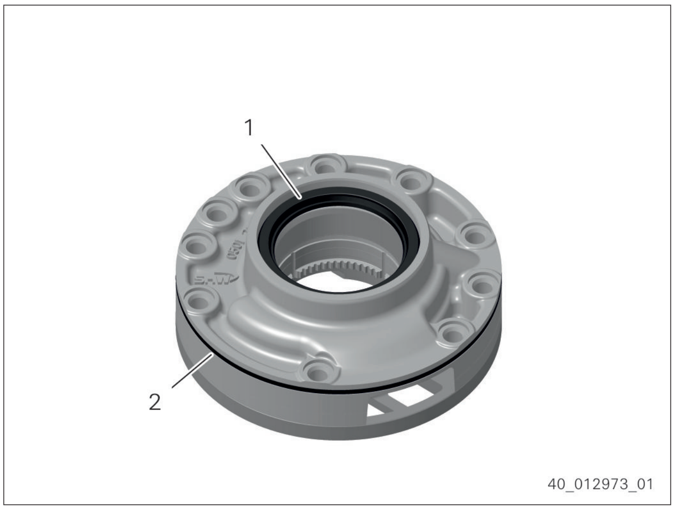


Fig. 338

12. 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 (1).

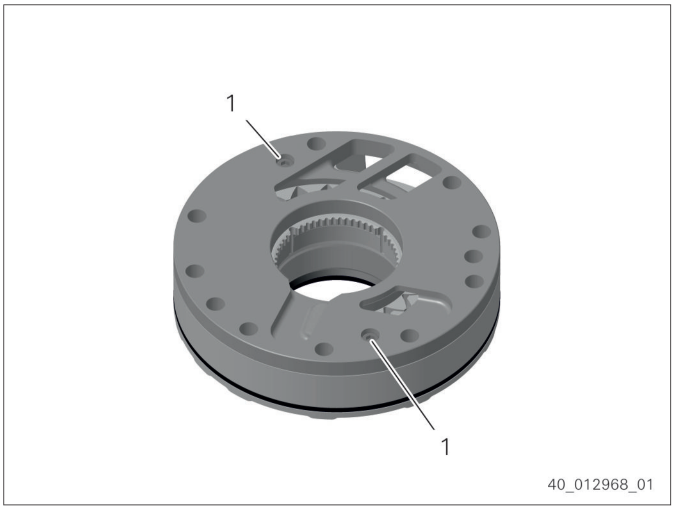


Fig. 339

13. Lift off cover (1).

14. Check the cover (1), outer rotor (2), inner rotor (3) and the housing (4) for wear marks. In case of any damage, install new gear pump.

15. Insert the outer rotor (2) and inner rotor (3) with the chamfered tooth side facing the housing (4).

16. Place the cover (1).

17. Bolt in cap screws by hand until contact is obtained and loosen again by 180 °.

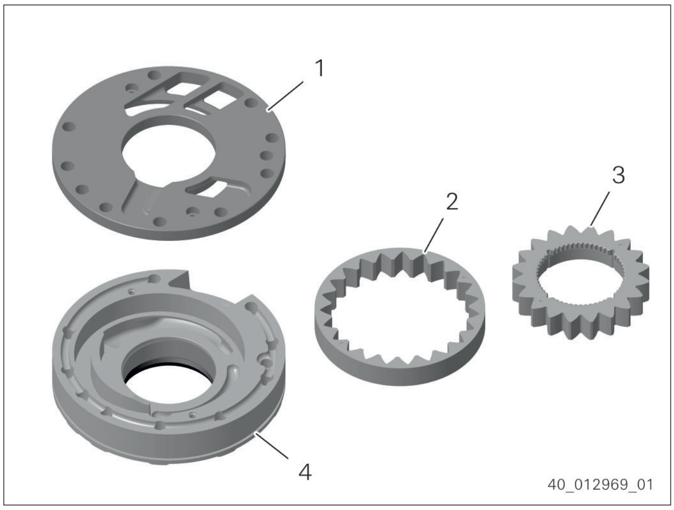


Fig. 340

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

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

19. Use 5870.055.070 [Driver tool] and 5870.260.002 [Handle] to insert shaft seal (1) with the seal lip facing the oil chamber.

20. Apply oil to O-ring.

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

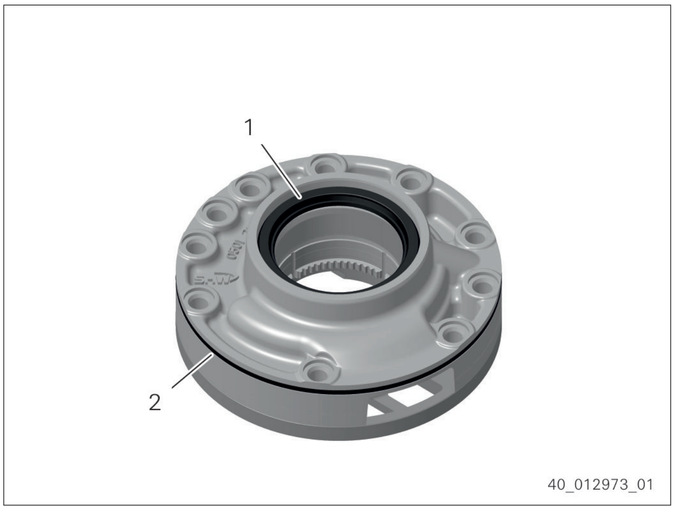


Fig. 341

22. Insert gear pump with 5870.345.126 [Assembly fixture] into oil feed housing until contact is obtained.

    Observe radial installation position.

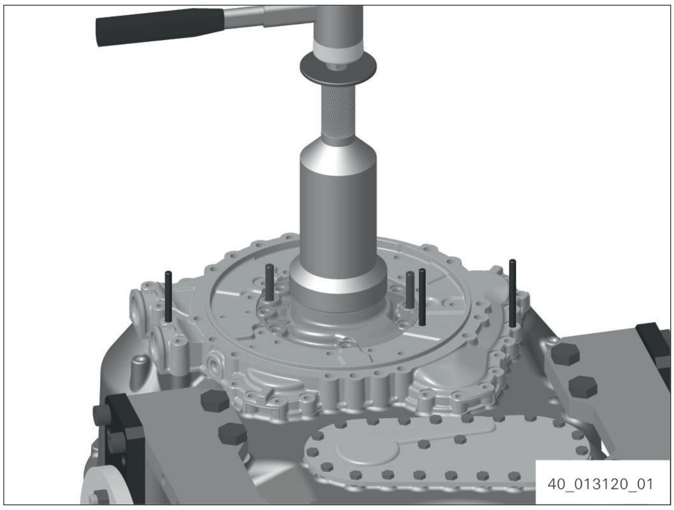


Fig. 342

23. Slide O-rings onto cap screws.

24. Fasten gear pump (1) with cap screws.
Tightening torque: 46 Nm

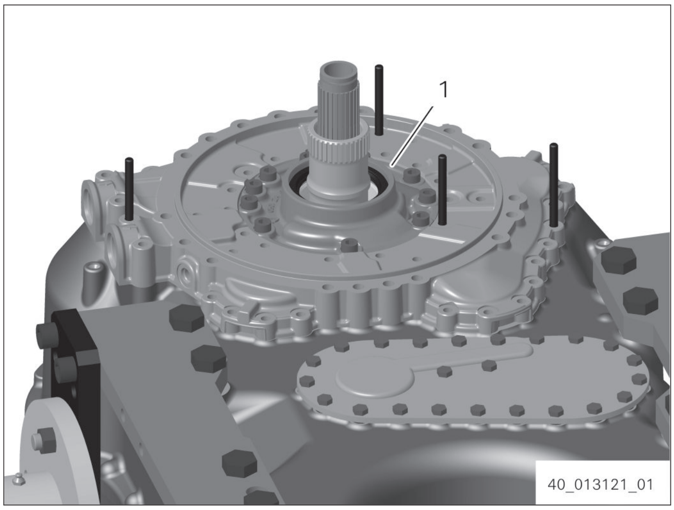


Fig. 343

25. Fasten the oil feed housing (1) with Torx screws.
Tightening torque: 23 Nm

26. Fasten retaining plate (2) with cap screws.
Tightening torque: 46 Nm

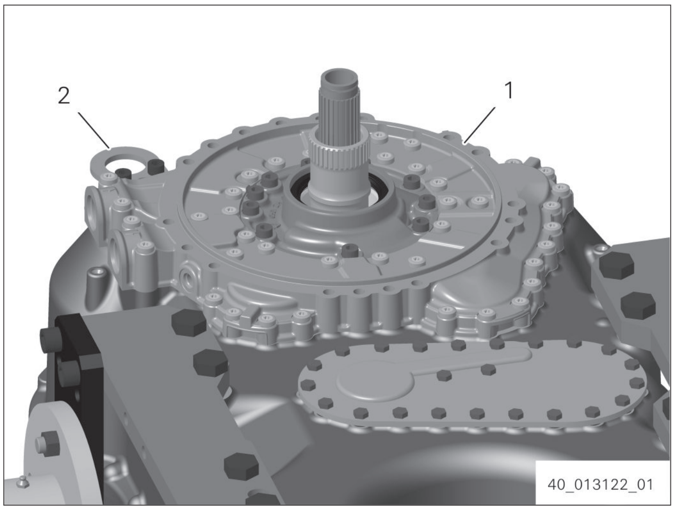


Fig. 344

Assembling and mounting motor connection

Installing torque converter bell housing

Special tools:
- 5870.204.007 Locating pin
- AA02.247.426 Eyebolt

1. Bolt in two 5870.204.007 [Locating pin].

2. Mount torque converter bell housing with two AA02.247.426 [Eyebolt] and a crane.

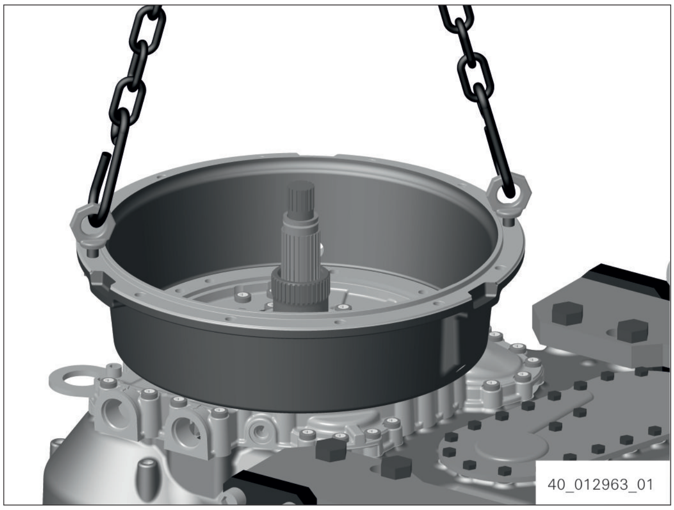


Fig. 345

3. Screw in and tighten the hexagon screws (1). Tightening torque: 65 Nm

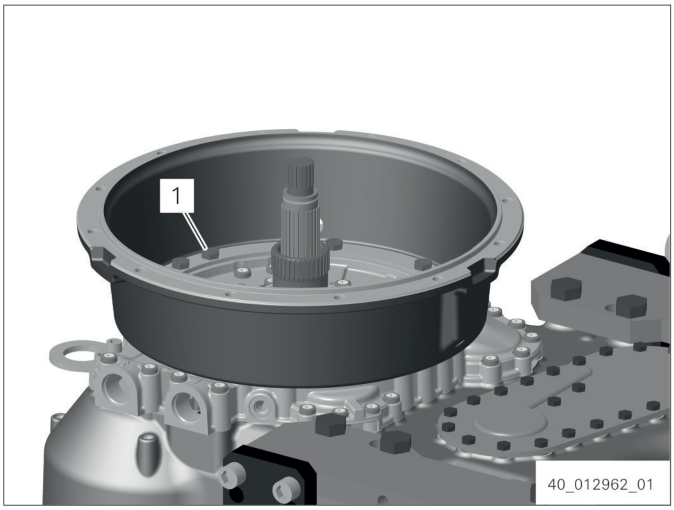


Fig. 346

Installing converter

Special tools:

- AA02.676.915 Load ring

Operating supplies and auxiliary materials:

- 0666.690.022 LOCTITE 262

1. Position flexplate (1) onto the input shaft.

2. Apply 0666.690.022 [LOCTITE 262] to threads of the hexagon screws.

3. Turn in and tighten hexagon screws.
Tightening torque: 115 Nm

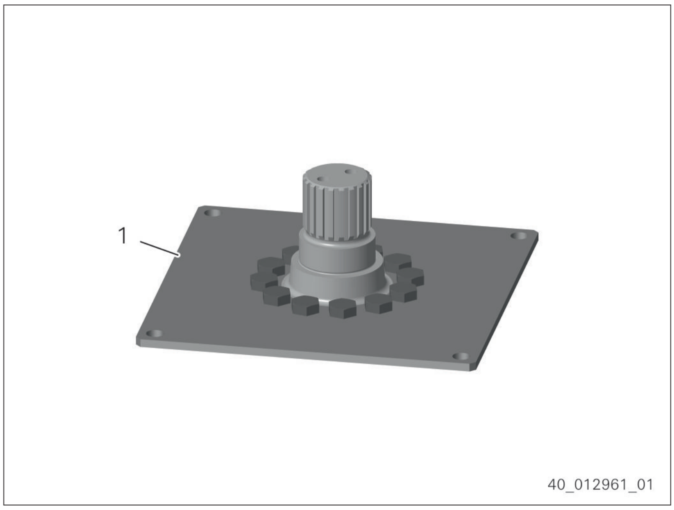


Fig. 347

4. Place the input shaft with flexplate (2) onto the converter.

5. Apply 0666.690.022 [LOCTITE 262] to threads of the hexagon screws.

6. Screw in and tighten the hexagon screws (1).
Tightening torque: 115 Nm

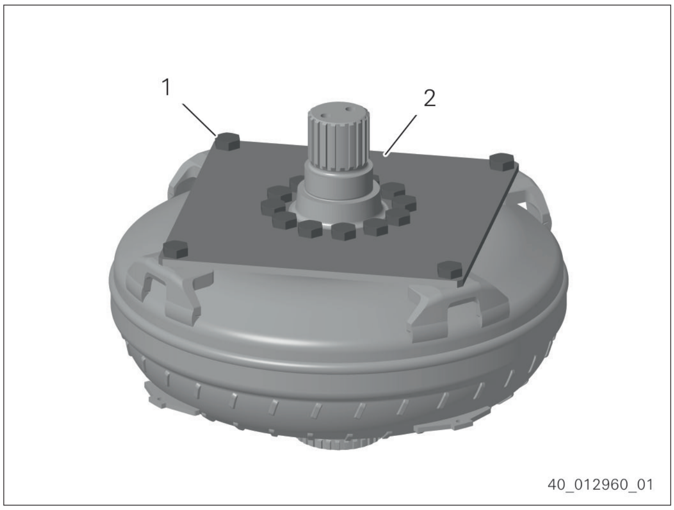


Fig. 348

7. Insert the ball bearing (2) into the cover until contact is obtained.

8. Insert V-ring (1).

Fig. 349

9. **⚠ CAUTION**

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

   Use suitable tool to force the cover onto input shaft until contact is obtained.

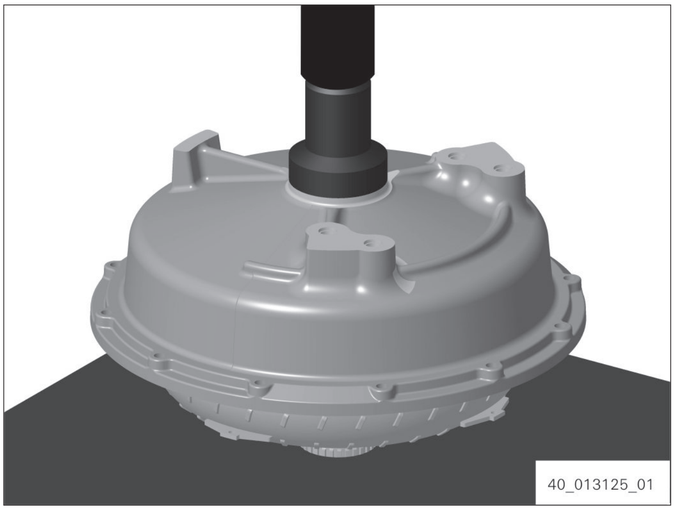


Fig. 350

10. Force screen sheet (1) onto yoke until contact is obtained.

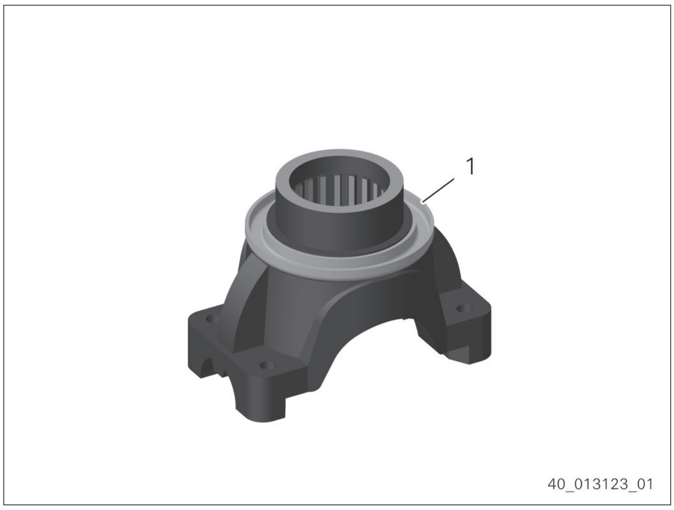


Fig. 351

11. 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 internal spline of the yoke.

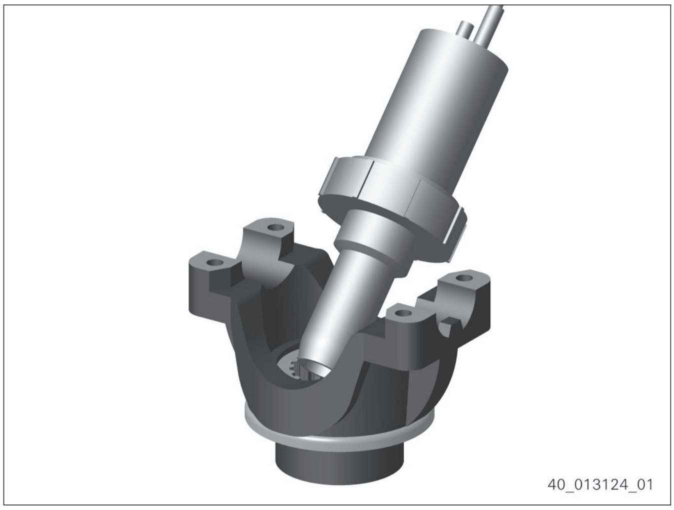


Fig. 352

12. Slide yoke (1) onto input shaft until contact is obtained.

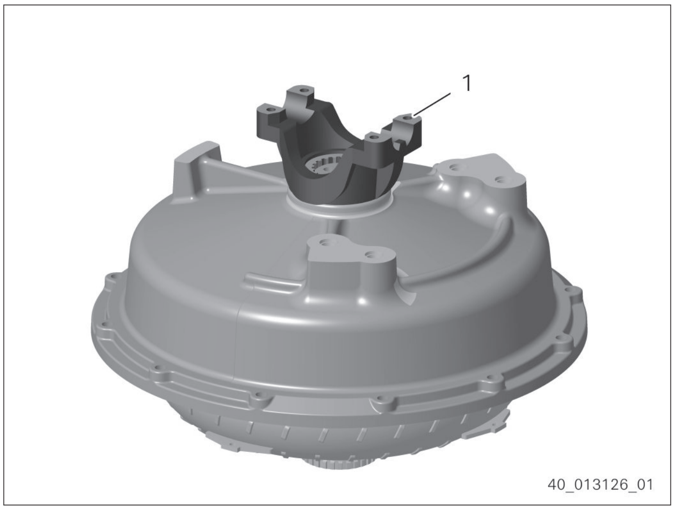


Fig. 353

13. Position washer (1).

14. Screw in and tighten hexagon screws (2).
Tightening torque: 40 Nm

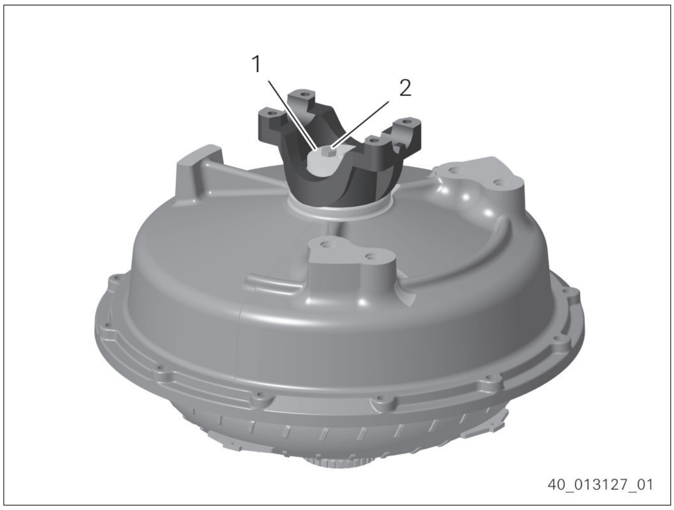


Fig. 354

15. ⚠ **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 a crane to slide on the converter. Mount the cover according to the marking.

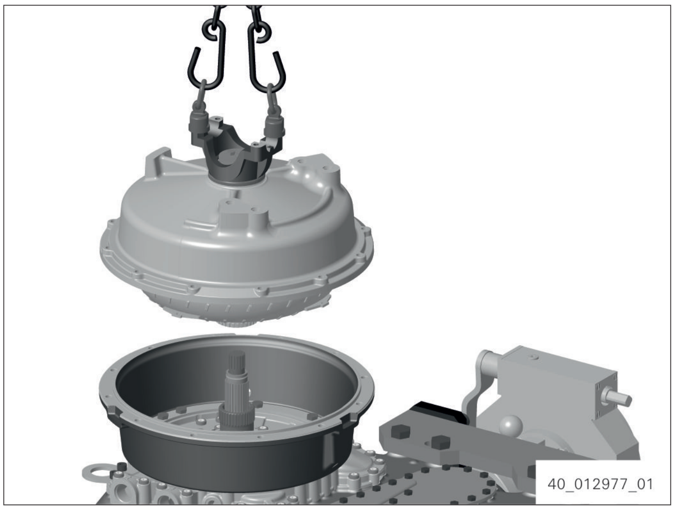


Fig. 355

16. Insert cap screws (1) into the holes and tighten nuts.
Tightening torque: 46 Nm

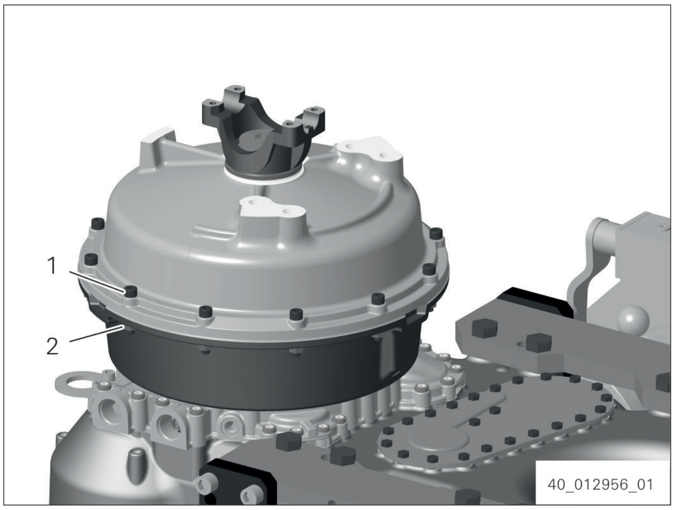


Fig. 356

Installing pump shaft

1. Press ball bearing (2) onto pump shaft until contact is obtained.

2. Set Axial clearance of the ball bearing 0.00 mm to 0.05 mm.
Insert retaining ring e. g. 2.35 mm (1) into annular groove of the pump shaft.

3. Check play-free seating of the retaining ring.
If retaining ring has play, install thicker retaining ring.
If retaining ring cannot be inserted into annular groove, use thinner retaining ring.

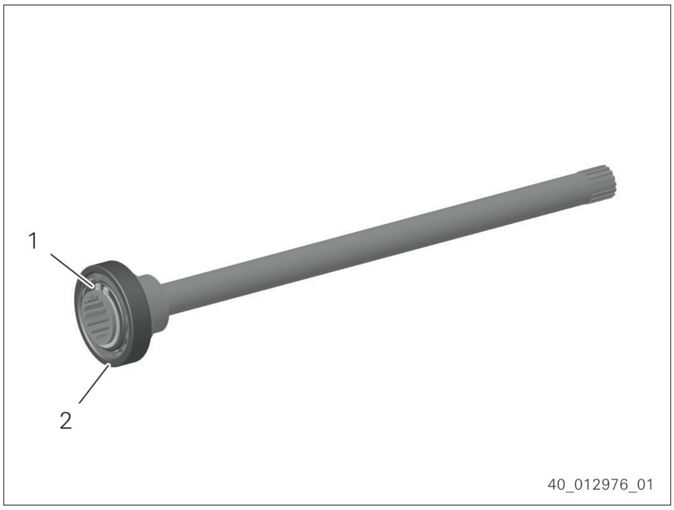


Fig. 357

4. Insert R-ring (1) into annular groove.

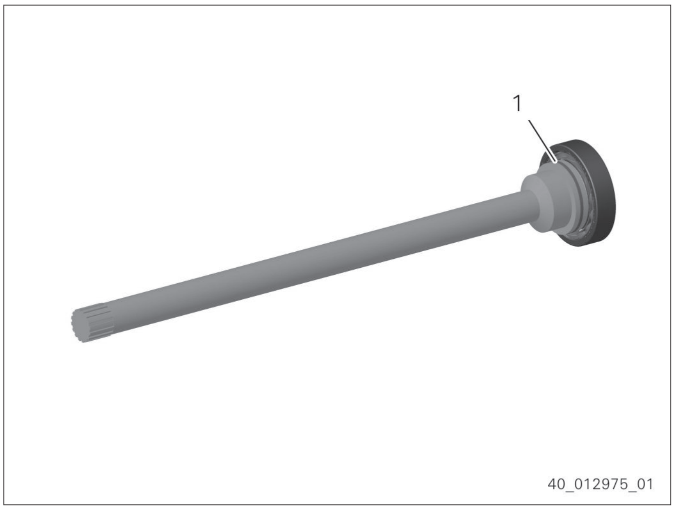


Fig. 358

5. Insert pump shaft (1) into the transmission until contact is obtained. Insert the pump shaft in the gearing of the converter.

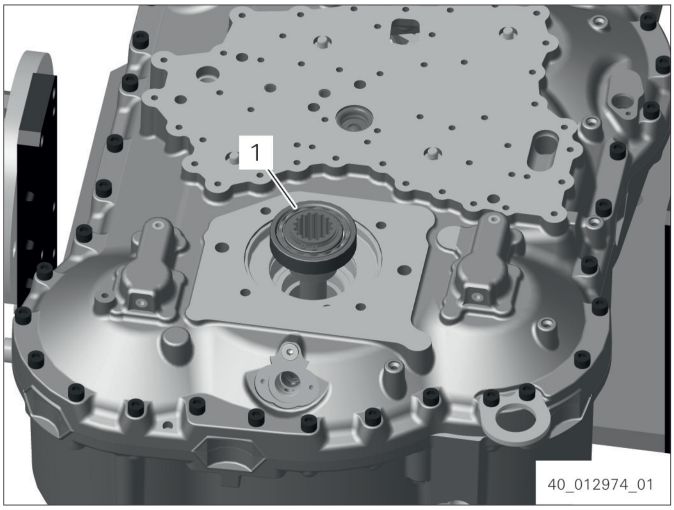


Fig. 359

6. Insert retaining ring.

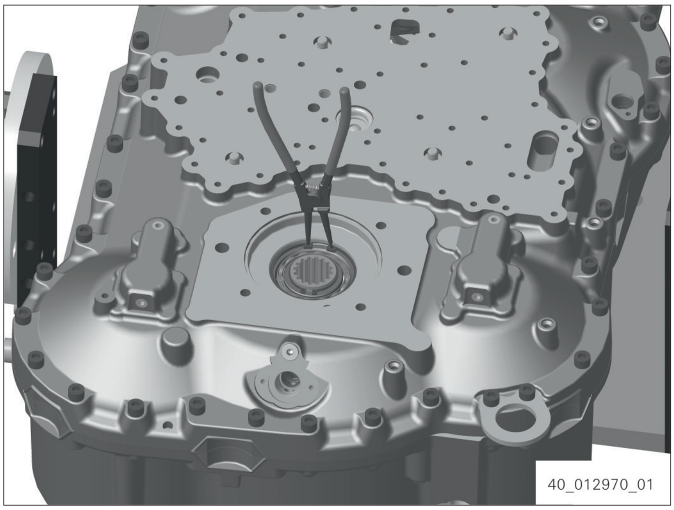


Fig. 360

Mounting cover plate (PTO)

1. Grease O-ring.

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

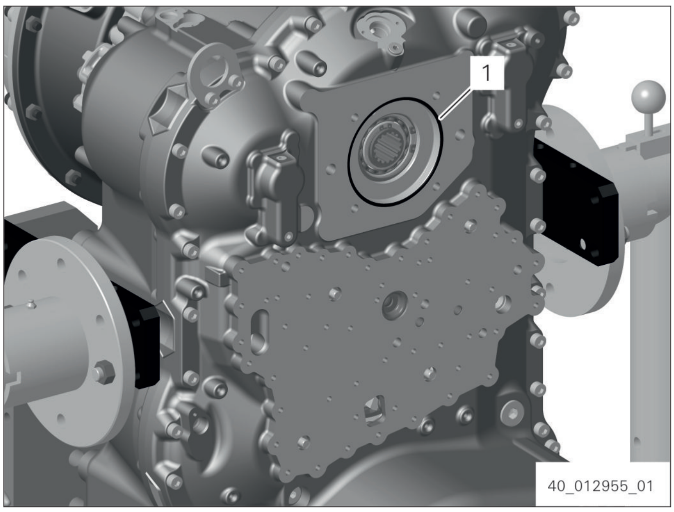


Fig. 361

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

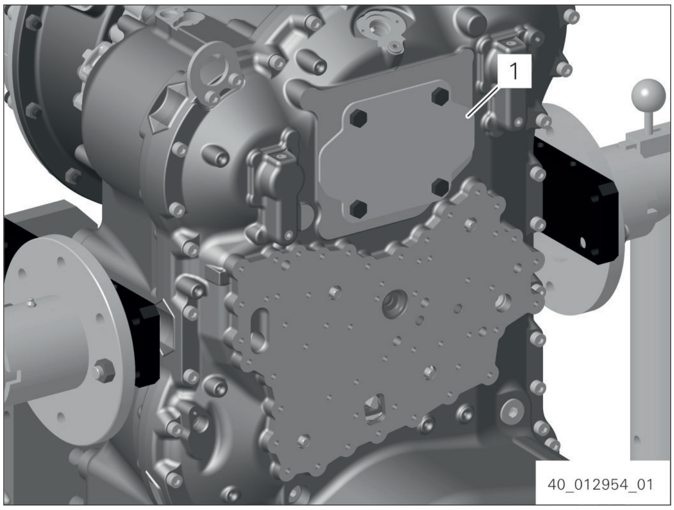


Fig. 362

Assembling and installing shift system

Installing duct plate

Special tools:

- 5870.204.037 Fixing pin

1. Insert converter safety valve (1) into the housing hole until contact is obtained.

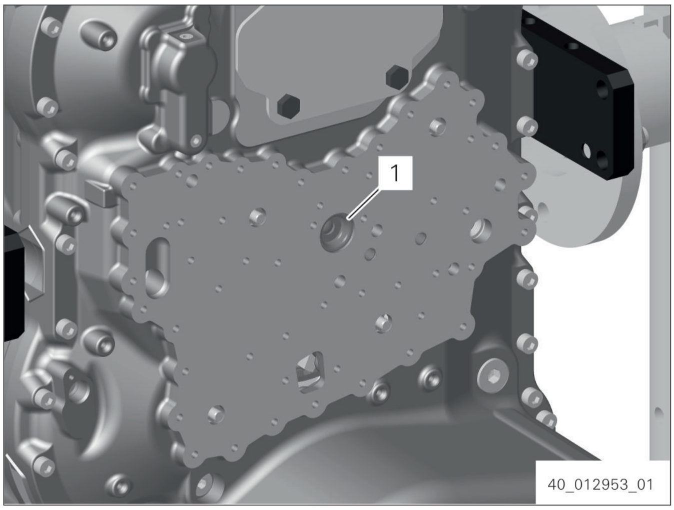


Fig. 363

2. Bolt in screw plugs into the duct plate and tighten.
   Tightening torque: 25 Nm
   Tightening torque: 30 Nm

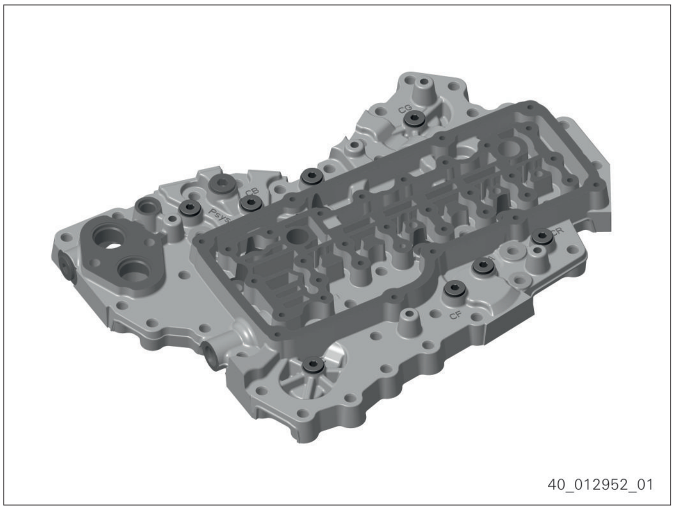


Fig. 364

3. Bolt in two 5870.204.037 [Fixing pin].

4. Slide on seal (1).

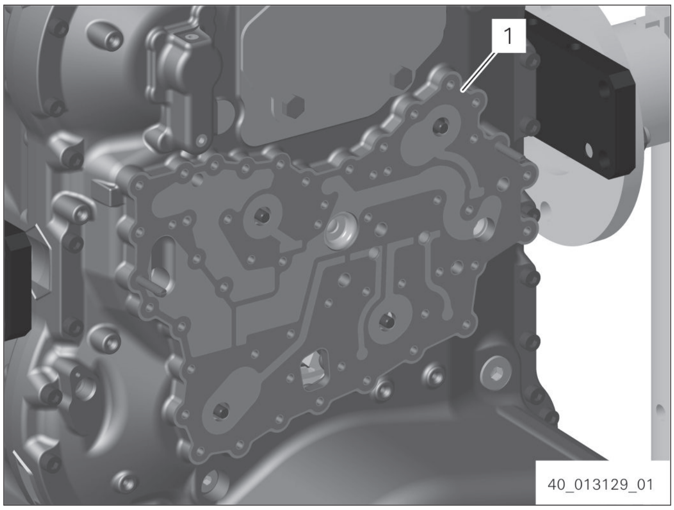


Fig. 365

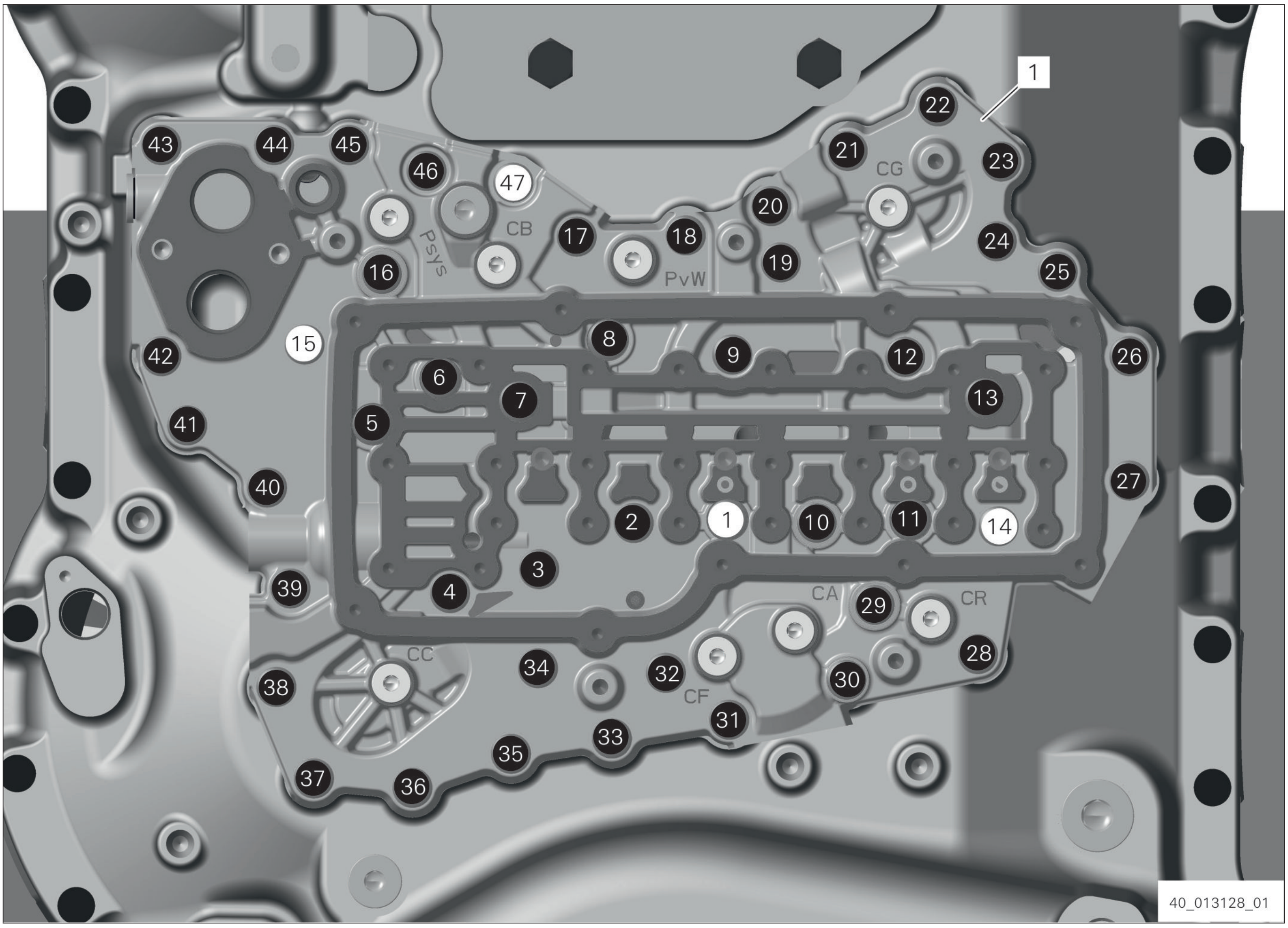


Fig. 366

5. Slide on duct plate (1).

6. Fix duct plate with Torx screws in the specified order.
   Tightening torque: 23 Nm

7. Insert valves (1) into duct plate.

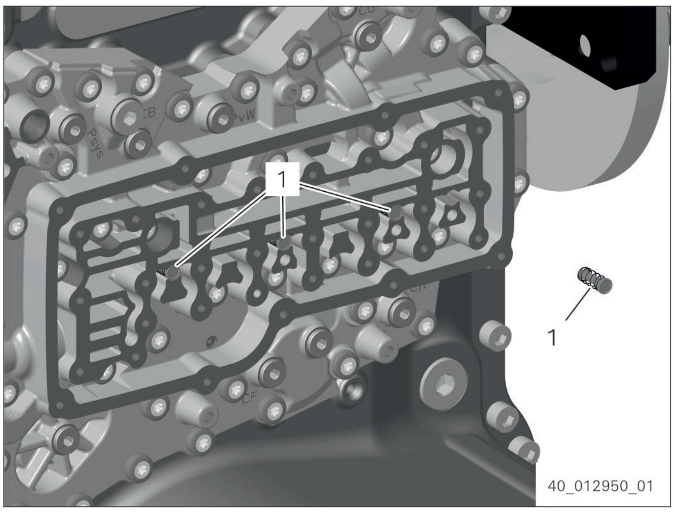


Fig. 367

8. Insert compression springs (1) into holes (3).

9. Insert pistons (2) into holes (3).

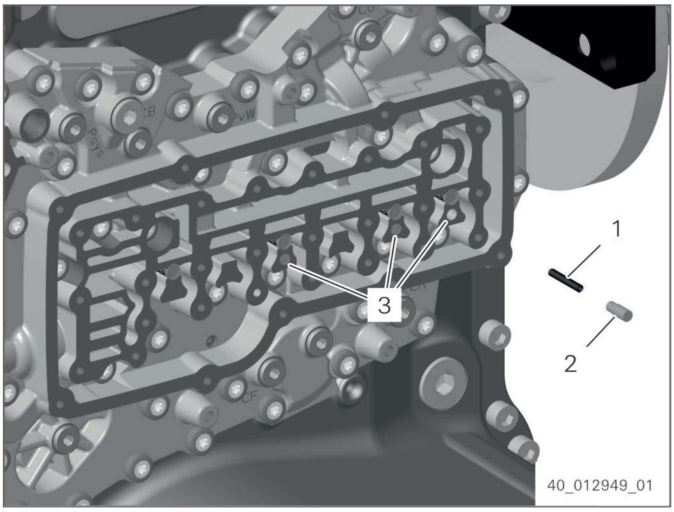


Fig. 368

Assembling and mounting valve blocks

Special tools:
- 5870.204.063 Fixing pin
- AA02.416.230 Driver tool
- AA02.416.754 Driver tool
- AA02.414.200 Driver tool
- AA02.318.019 Torque wrench

1. Bolt two 5870.204.063 [Fixing pin] into the duct plate.

2. Slide on intermediate plate (1).

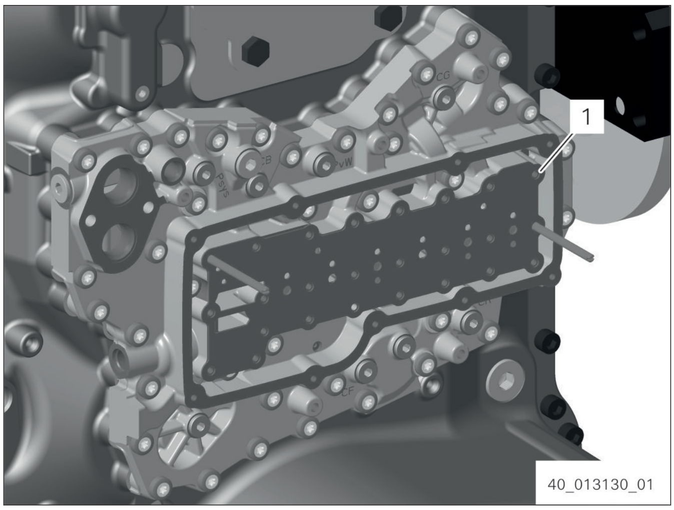


Fig. 369

3. Insert control piston (1) into the hole.
4. Insert compression spring (2).
5. Oil O-ring.
6. Insert O-ring into annular groove of the plug (3).
7. Insert plug (3) into the hole.

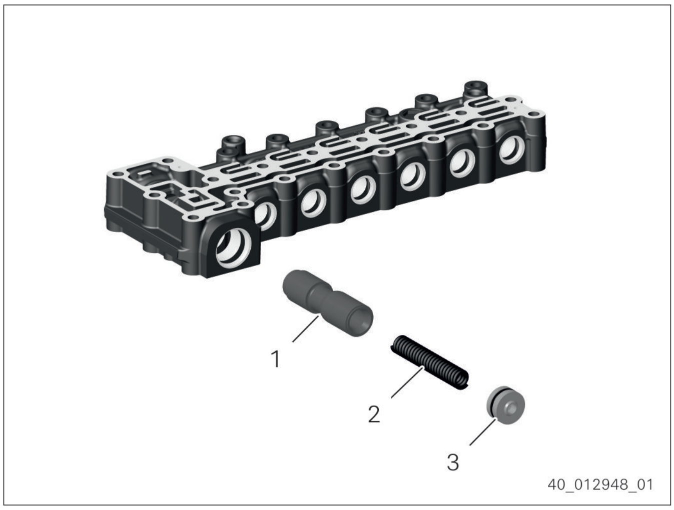


Fig. 370

8. Press plug inwards with AA02.416.230 [Driver tool] until contact is obtained and insert retaining plate (1).

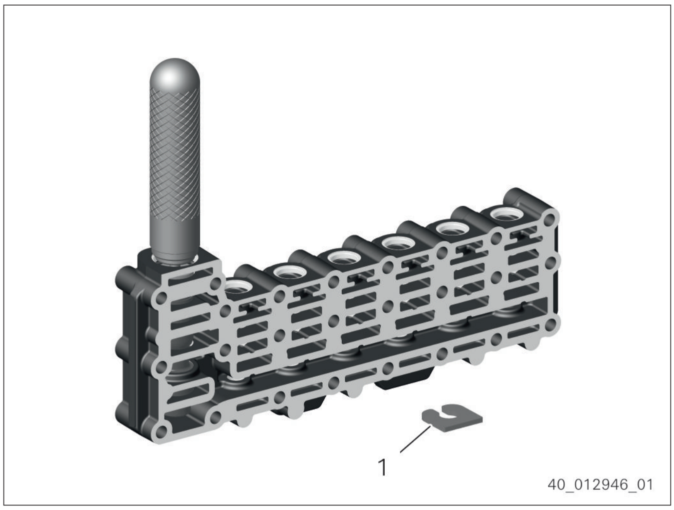


Fig. 371

9. Insert compression spring (1) into hole.
10. Insert control piston (2).
11. Oil O-ring.
12. Insert O-ring into annular groove of the plug (3).
13. Insert plug (3) into the hole.

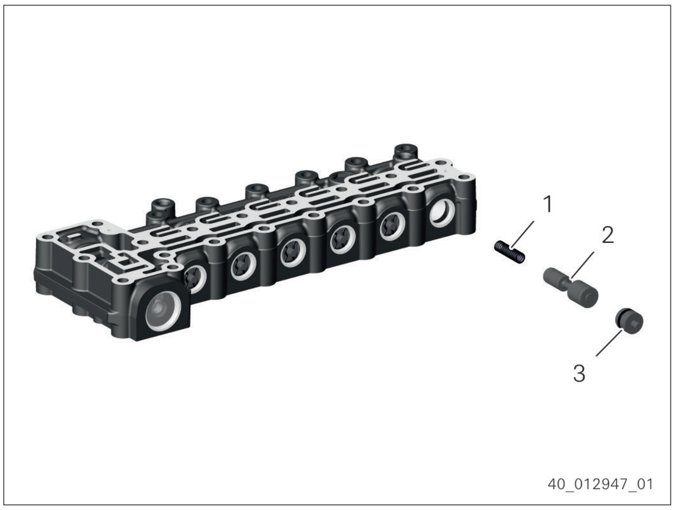


Fig. 372

14. Push the plug inwards with the AA02.416.754 [Driver tool] until contact is obtained and insert the spring clip (1).

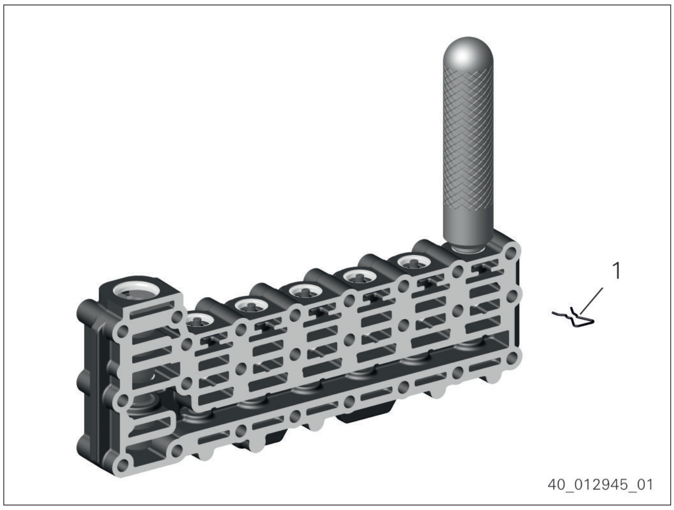


Fig. 373

15. Slide on valve block (1).

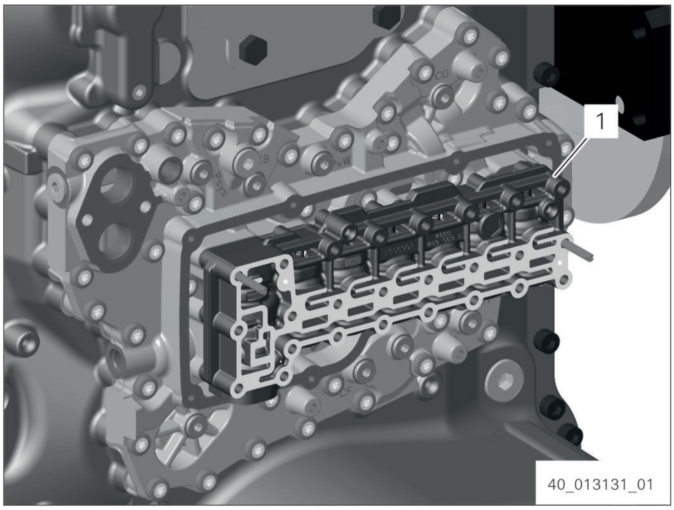


Fig. 374

16. Slide on intermediate plate (1).

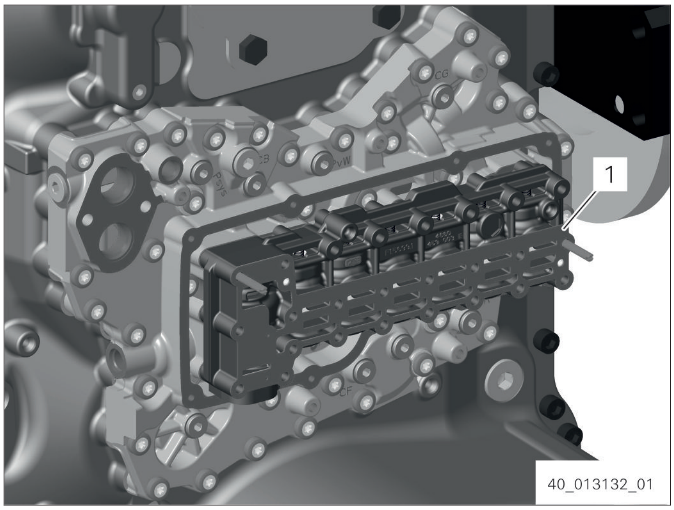


Fig. 375

17. Insert piston (1) into the hole.

18. Insert compression spring (2).

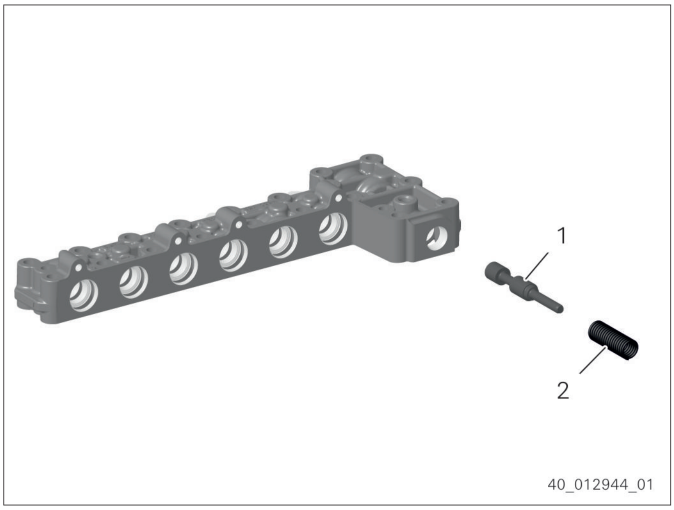


Fig. 376

19. Push the compression spring inwards with AA02.414.200 [Driver tool] until contact is obtained and insert the retaining plate (1).

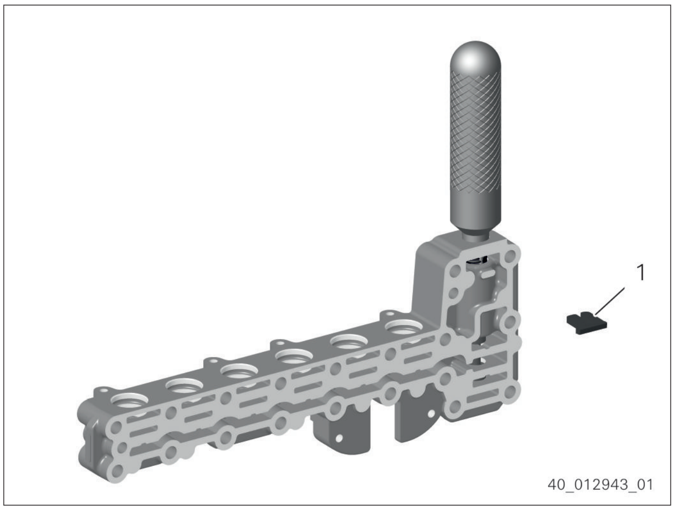


Fig. 377

20. Slide on valve block (1).

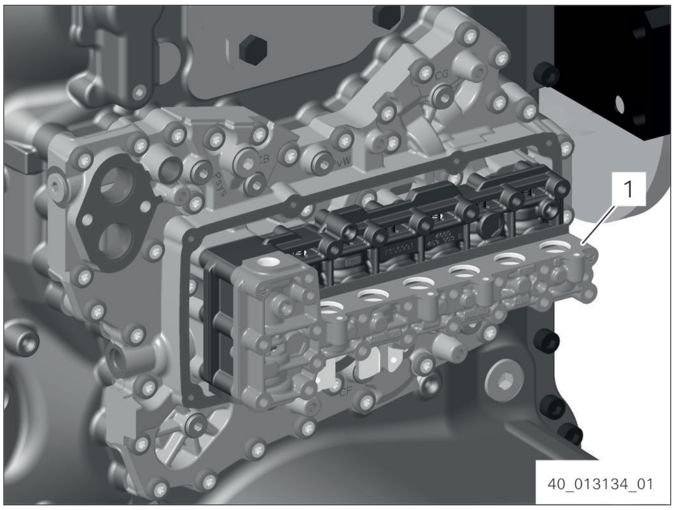


Fig. 378

21. Screw in and tighten the hexalobular driving screws (1).
    Tightening torque: 3 Nm

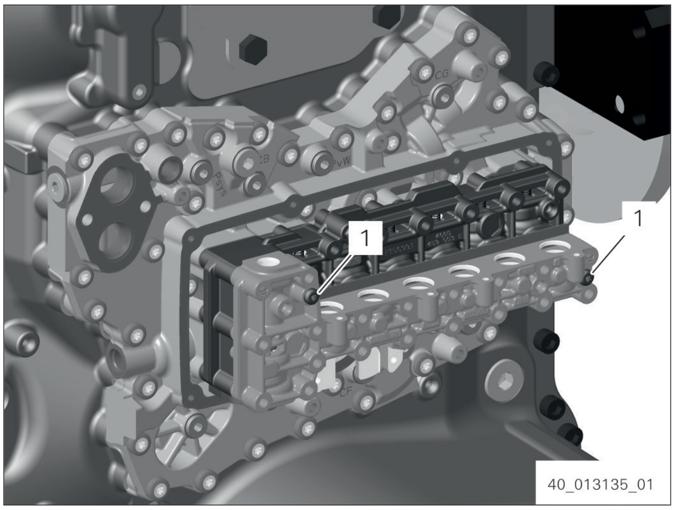


Fig. 379

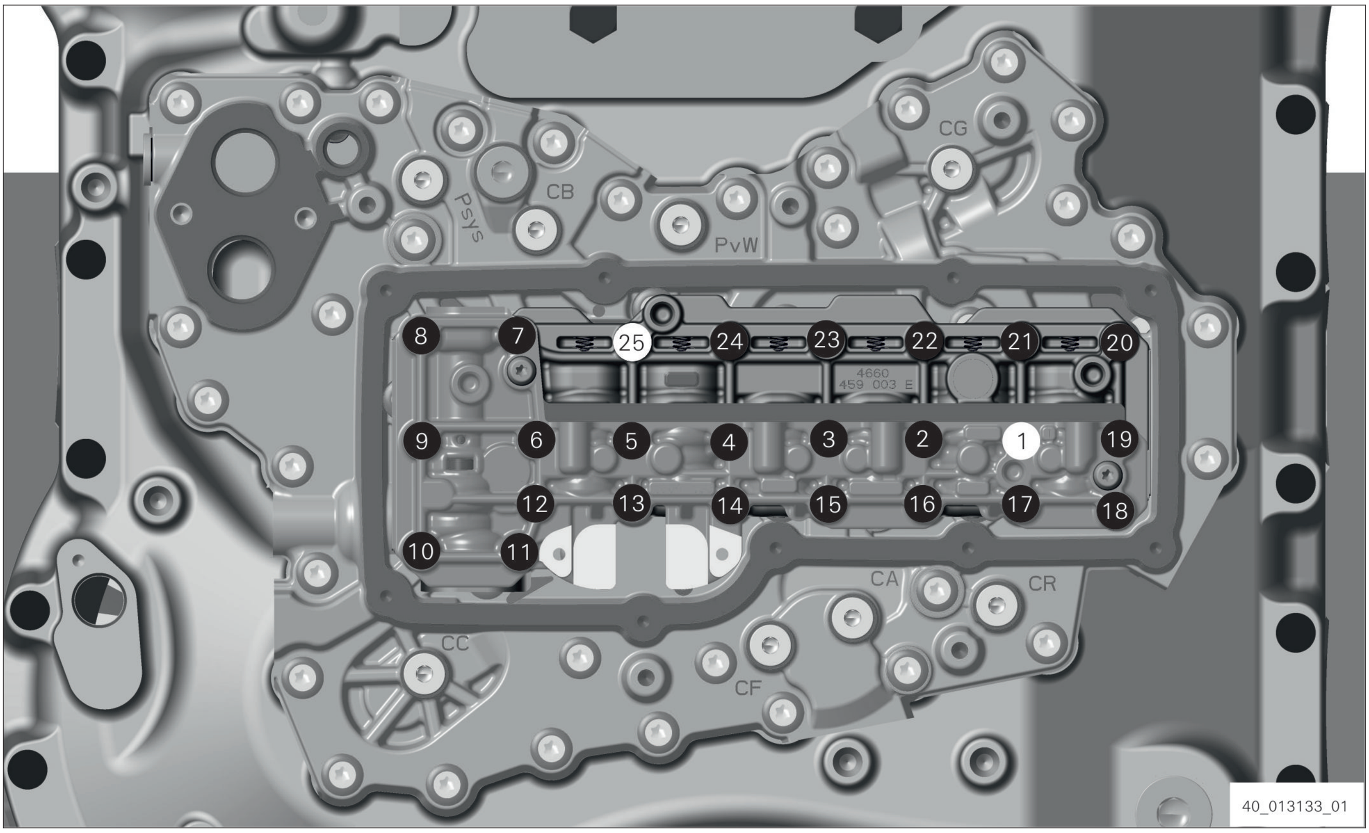


Fig. 380

22. Bolt in Torx screws (1) to (19) and tighten with AA02.318.019 [Torque wrench] in the specified order.
    Tightening torque: 3 Nm and 60° additional angle (tightening torque must be between 7 Nm and 13 Nm)Cap screw

    If the tightening torque is not within the range specified, fit a new screw.

23. Bolt in Torx screws (20) to (25) and tighten with AA02.318.019 [Torque wrench] in the specified order.

Tightening torque: 3 Nm and 45° additional angle (tightening torque must to be between 7 Nm and 13 Nm)

If the tightening torque is not within the range specified, fit a new screw.

Installing pressure controllers

1. Pay attention to radial installation position of the pressure controllers.

   Insert pressure controllers with O-rings (2) into valve block.

2. Fix pressure controllers with clamping plate (1) and Torx screws.
   Tightening torque: 9.5 Nm

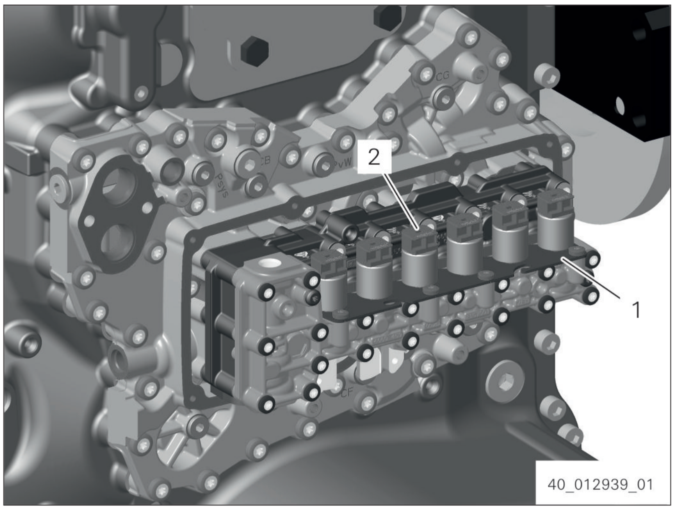


Fig. 381

3. Insert plugs (1) on the pressure controllers.

4. Fix plug (3) with retaining plate (4) and Torx screws.
   Tightening torque: 9.5 Nm

5. Insert cable (3) into cable routing on the clamping plate.

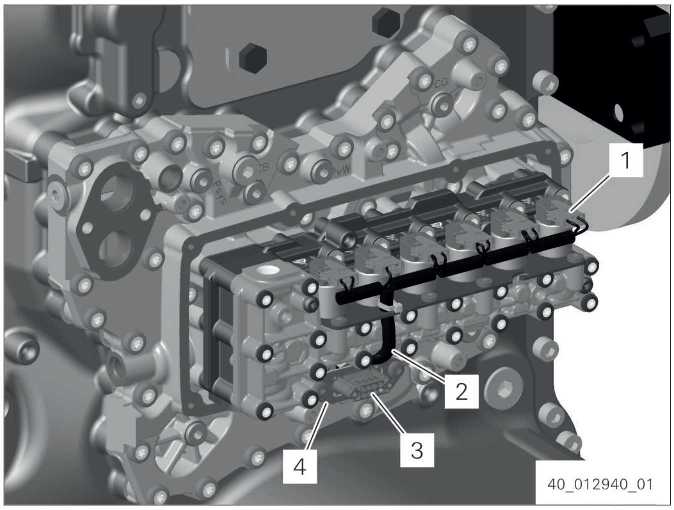


Fig. 382

Installing control unit (EC4A)

Special tools:

- 5870.204.063 Fixing pin

1. Insert seal (1) into control unit (2).

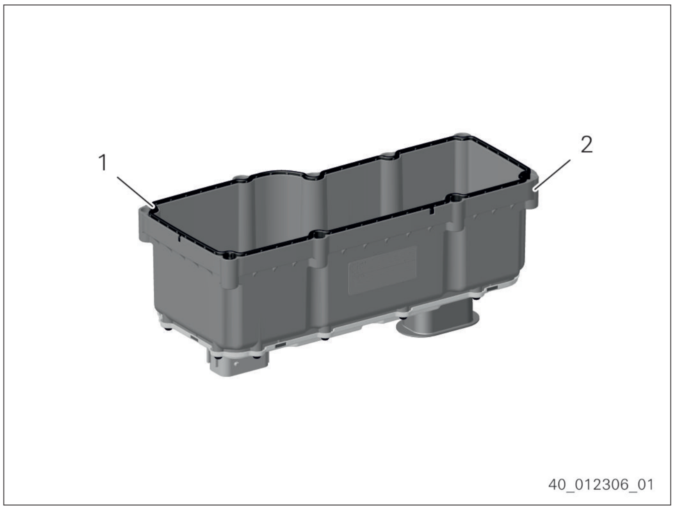


Fig. 383

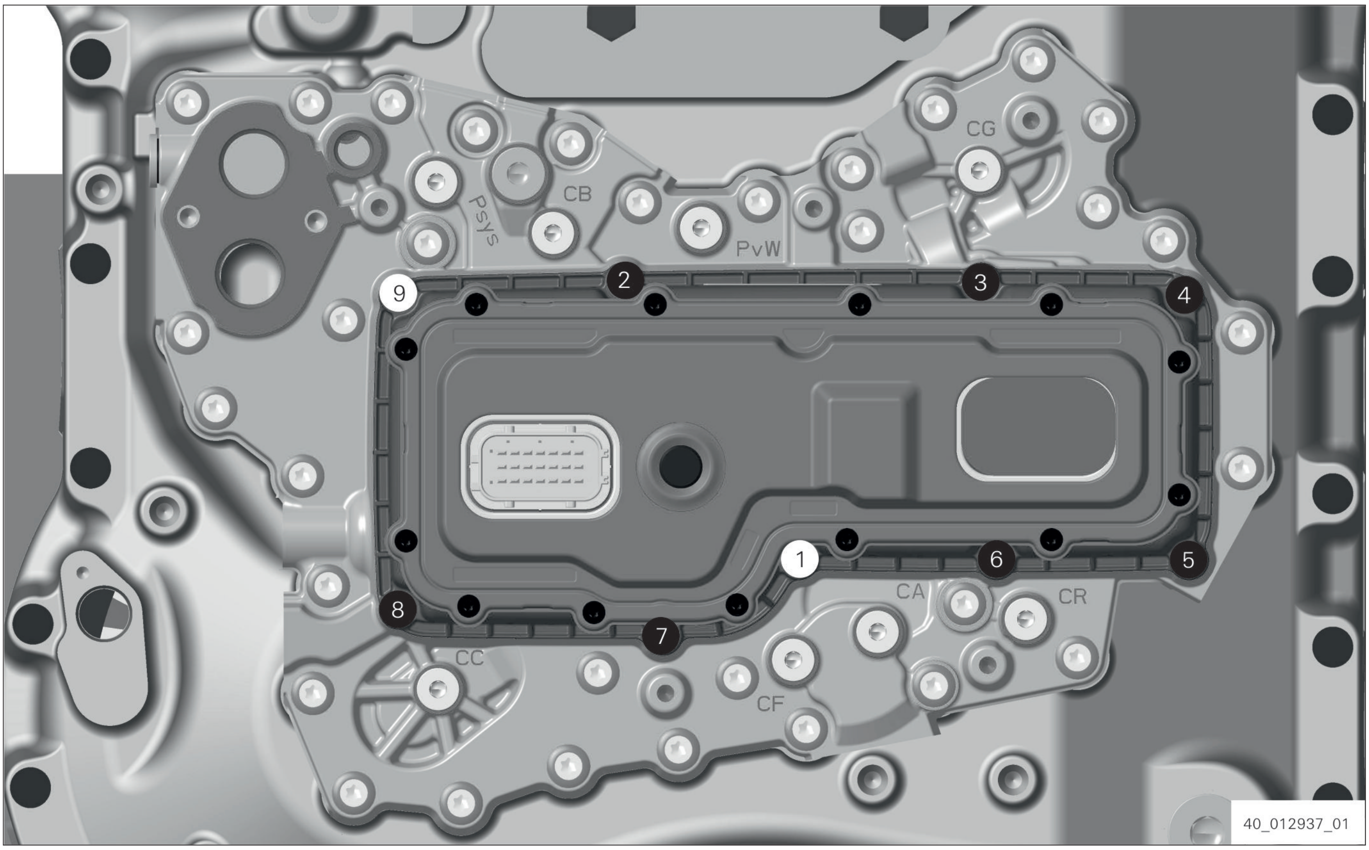


Fig. 384

2. Bolt two 5870.204.063 [Fixing pin] into the duct plate.

3. Slide on control unit.

4. Bolt in Torx screws and tighten in the specified order.
   Tightening torque: 9.5 Nm

Installing filter bypass valve

1. Insert compression spring (2) and piston (3) into the hole (1).

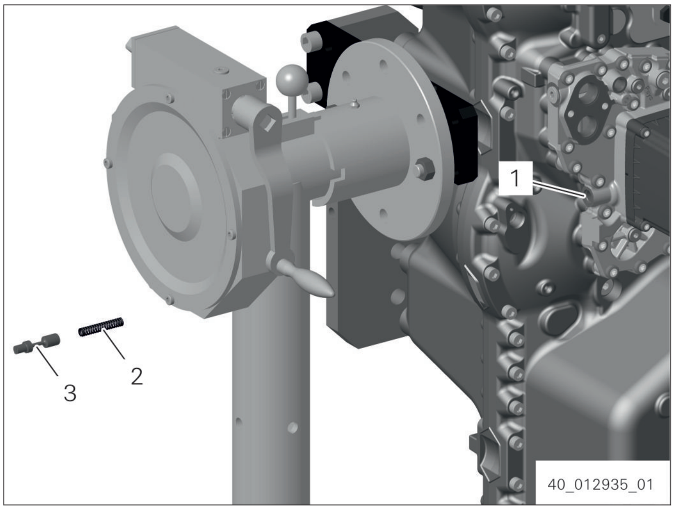


Fig. 385

2. Turn in tappet switch with O-ring (1) and tighten.
   Tightening torque: 30 Nm

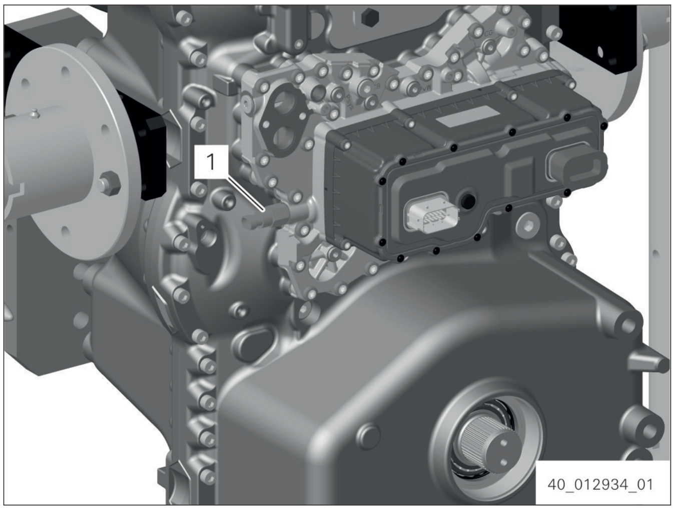


Fig. 386

Installing output flanges

Special tools:

- 5870.048.237 Driver tool

Operating supplies and auxiliary materials:

- 0666.690.191 PHÖNIX SPIRITUS

Installing output flange on gearshift 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 seal.

2. Use 5870.048.237 [Driver tool] to insert shaft seal (1) with seal lip facing the oil chamber.

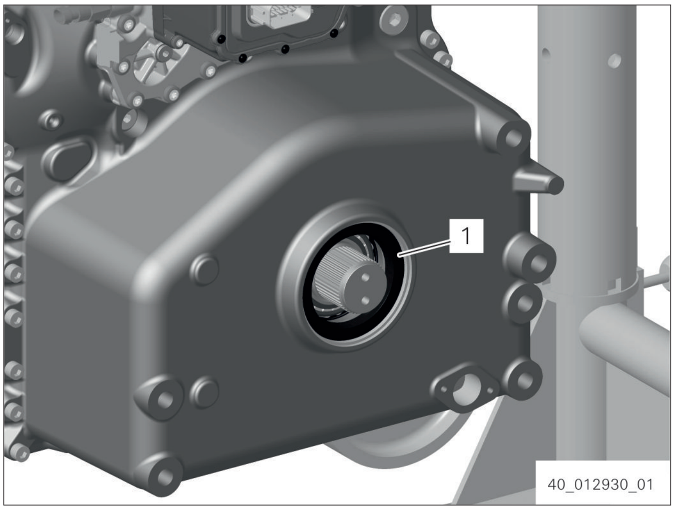


Fig. 387

3. Press screen sheet (1) onto the output flange (2) until contact is obtained.

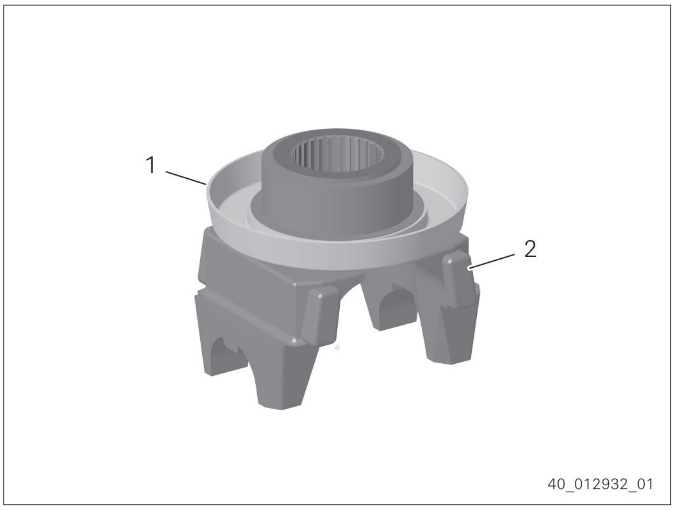


Fig. 388

4. Push the output flange (1) onto the output shaft until contact is obtained.

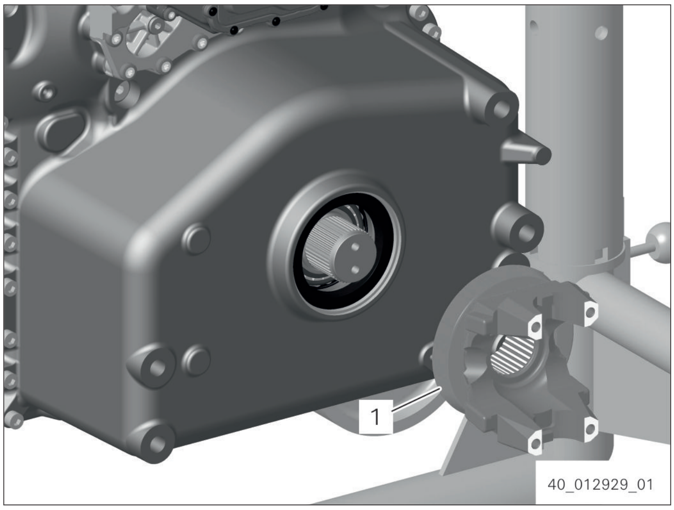


Fig. 389

5. Insert O-ring (1) into the space between output shaft and output flange.

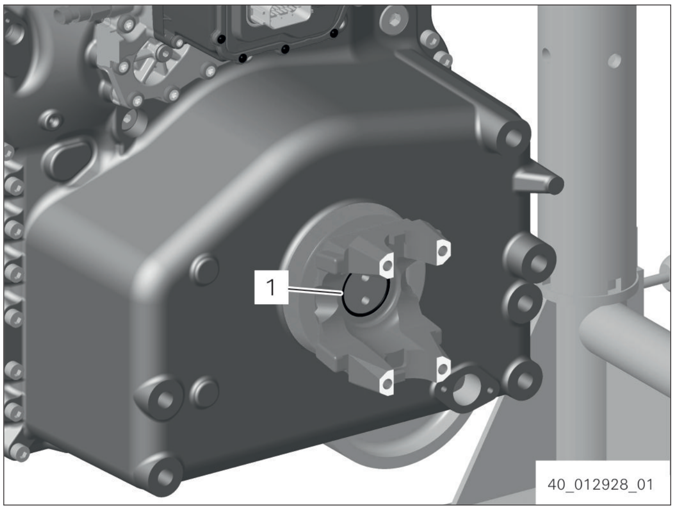


Fig. 390

6. Fix output flange with washer (2) and hexagon screws (1).
Tightening torque: 68 Nm

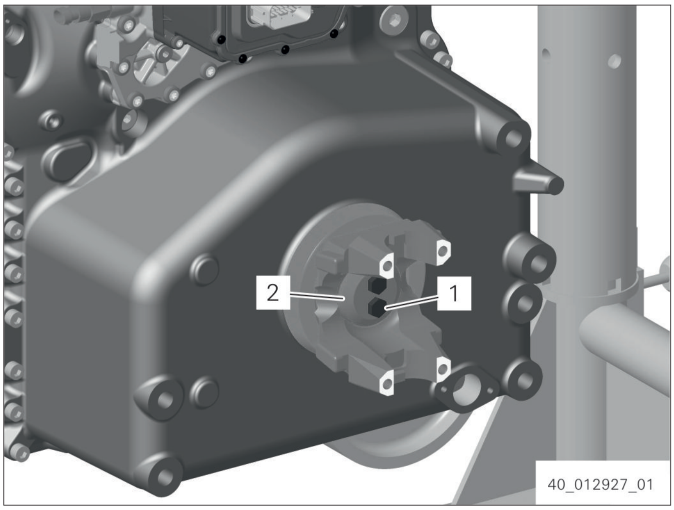


Fig. 391

Installing output flange on input side

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

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

8. Use 5870.048.237 [Driver tool] to insert shaft seal (1) with seal lip facing the oil chamber.

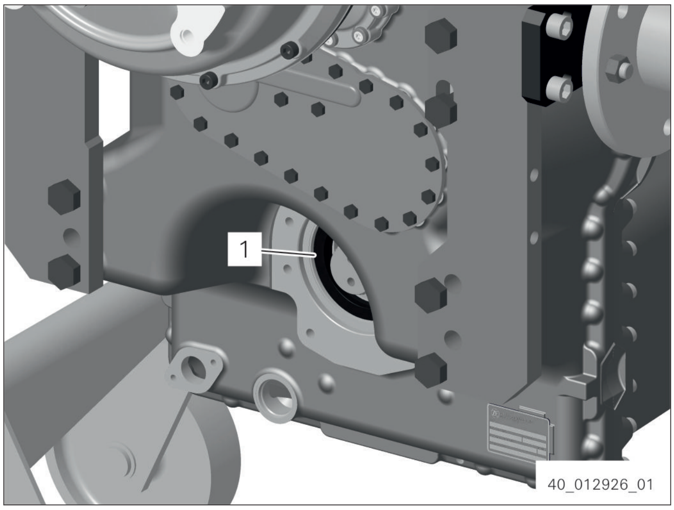


Fig. 392

9. Press screen sheet (1) onto the output flange (2) until contact is obtained.

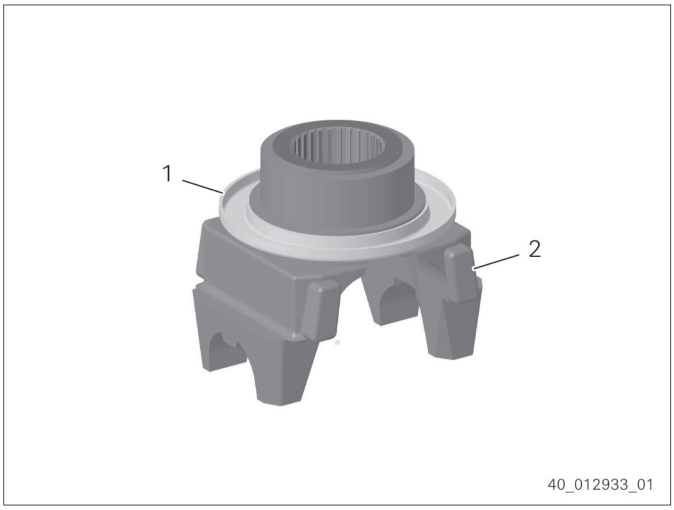


Fig. 393

10. Push the output flange (1) onto the output shaft until contact is obtained.

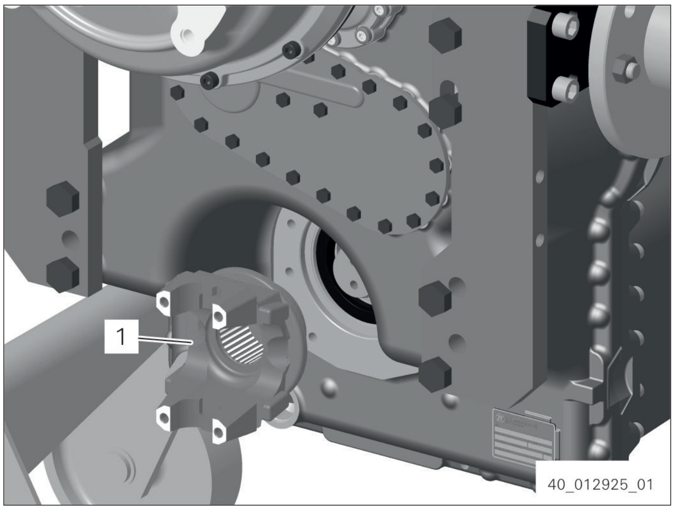


Fig. 394

11. Insert O-ring (1) into the space between output shaft and output flange.

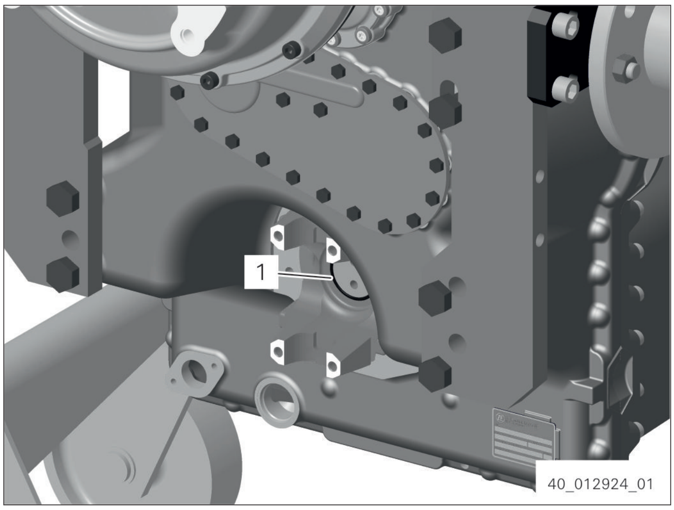


Fig. 395

12. Fix output flange with washer (2) and hexagon screws (1).
    Tightening torque: 68 Nm

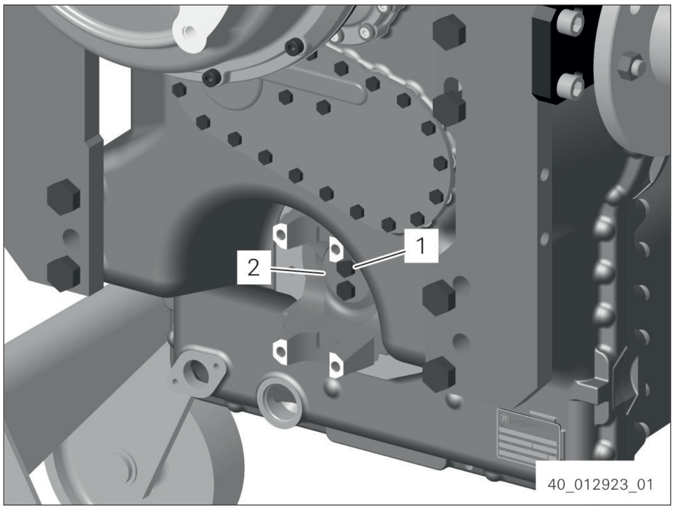


Fig. 396

Installing temperature sensors and breather

1. Bolt in breather (1) and tighten.
   Tightening torque: 12 Nm

2. Bolt in and tighten temperature sensors with O-ring (2).
   Tightening torque: 25 Nm

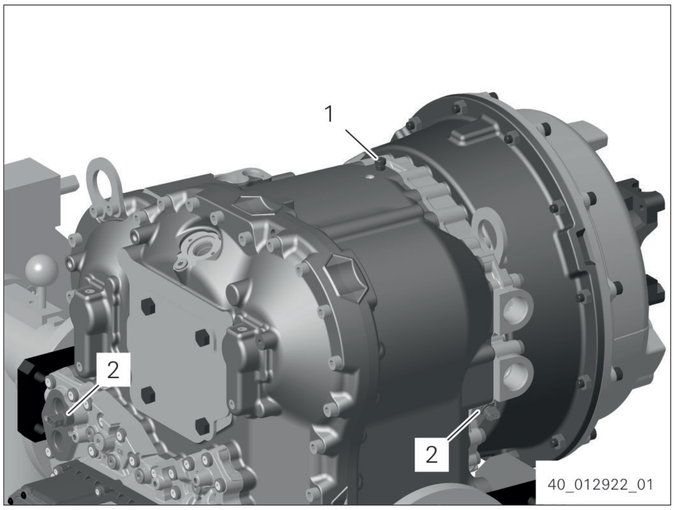


Fig. 397

Installing speed sensors and pressure controller

1. Insert speed sensors with sealing element (1) into housing holes.

2. Fix speed sensors with cap screws.
   Tightening torque: 9.5 Nm

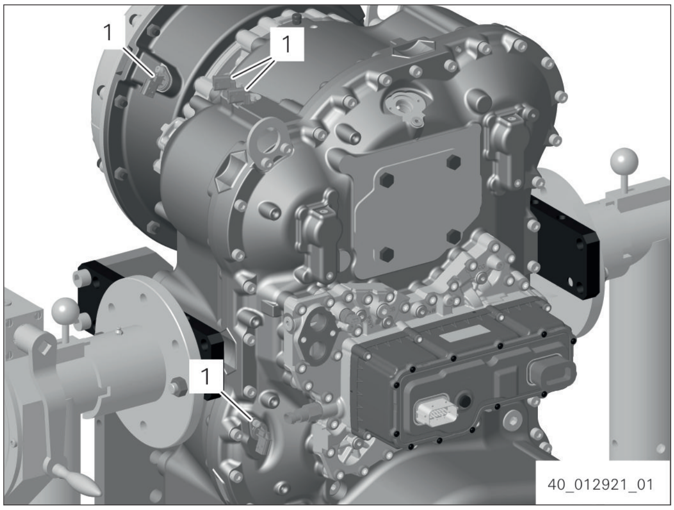


Fig. 398

3. Insert pressure controller with mit O-rings (1) into the housing hole.

4. Fix pressure controller with cap screws.
   Tightening torque: 9.5 Nm

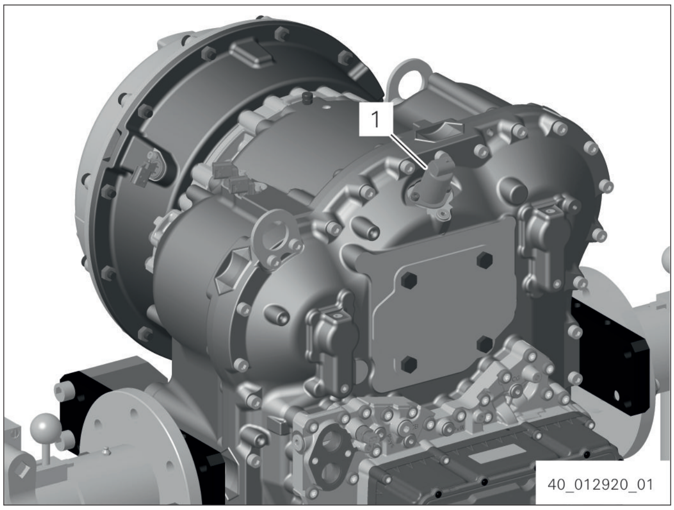


Fig. 399

5. Route cable (1) and insert plugs.

6. Fix cable with cable ties to transmission.

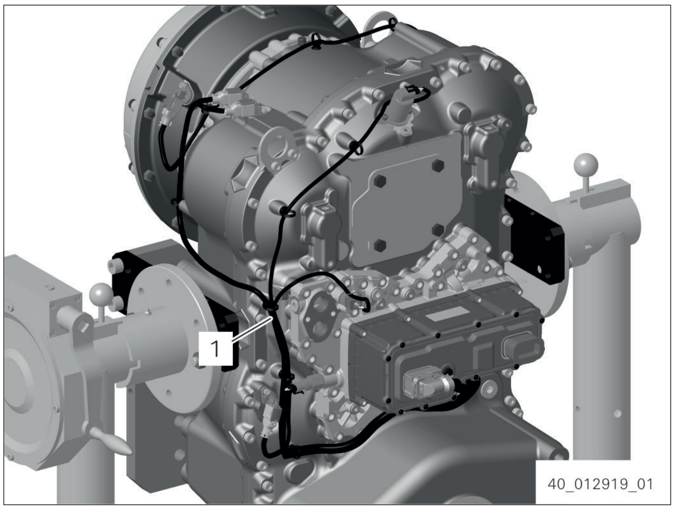


Fig. 400

Installing cover sheets (filler neck)

1. Put on seal and cover sheet (1).

2. Screw in and tighten hexagon screws.
   Tightening torque: 23 Nm

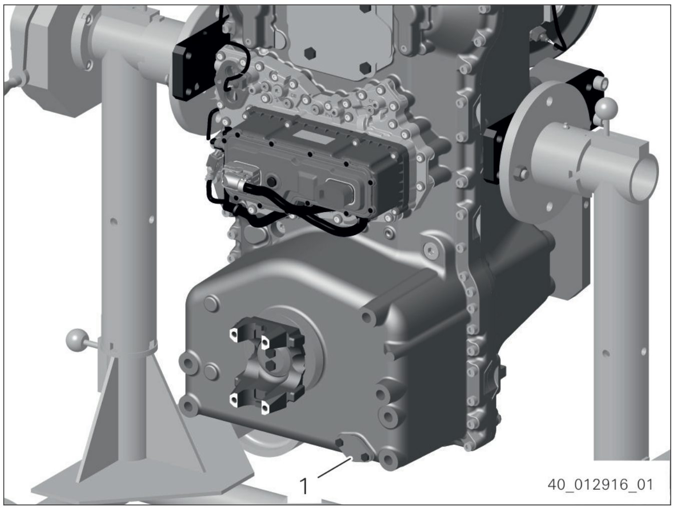


Fig. 401

3. Put on seal and cover sheet (1).

4. Screw in and tighten hexagon screws.
   Tightening torque: 23 Nm

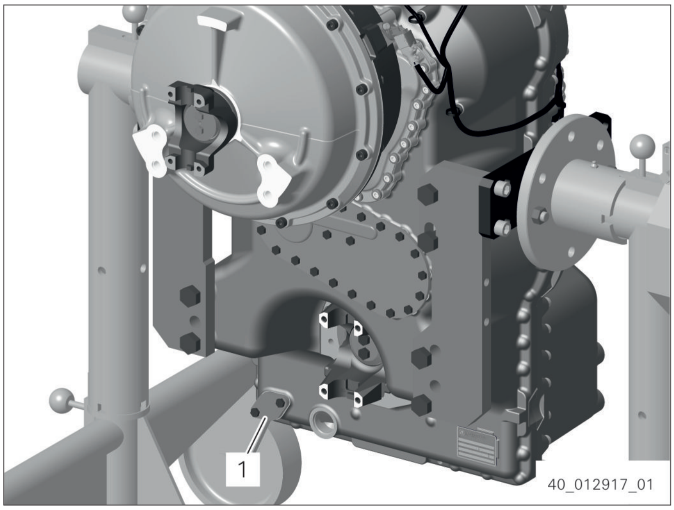


Fig. 402

Installing pressure filter

1. Oil O-rings (1) and insert them in annular grooves of filter head.

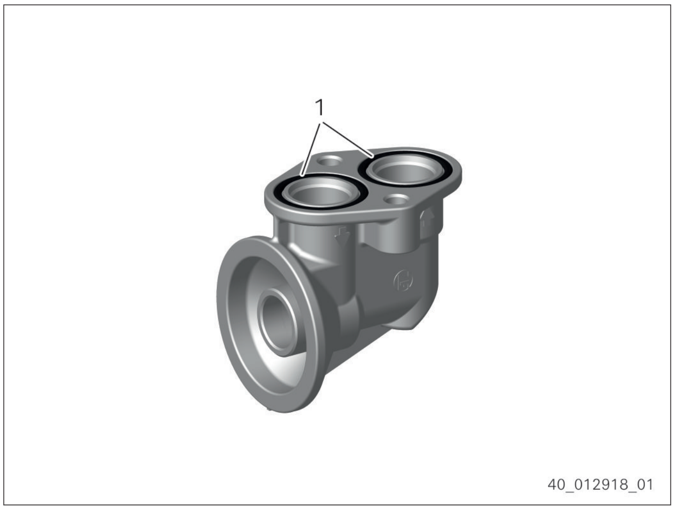


Fig. 403

2. Fix filter head (1) with Torx screws.
   Tightening torque: 34 Nm

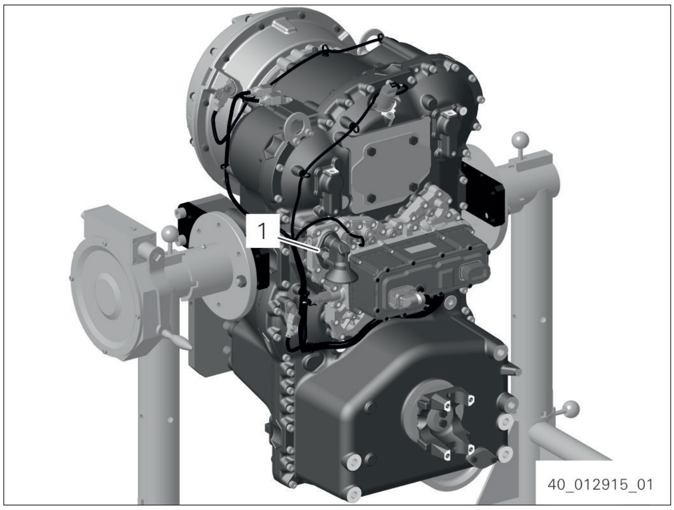


Fig. 404

3. Slightly oil the seal of the pressure filter.

4. Bolt in pressure filter (1) until contact with the sealing surface on the filter head is obtained.

5. Tighten the pressure filter.
   Tightening torque: Contact sealing surface +90° to 180°
   As an alternative use a tool with torque indicator to tighten.
   Tightening torque: 40 Nm

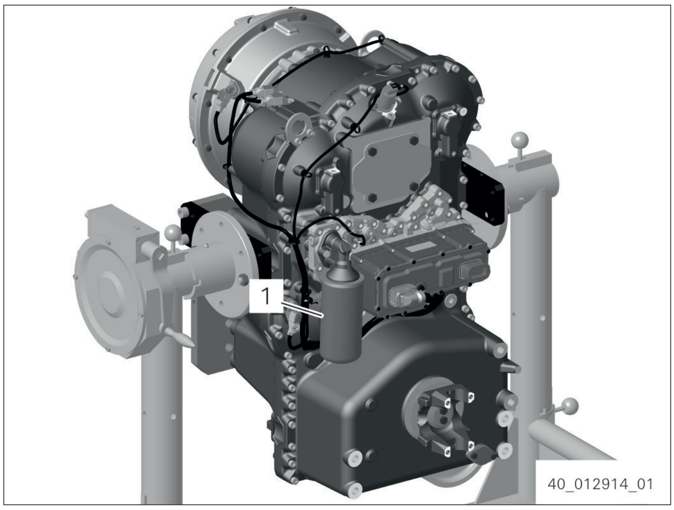


Fig. 405

Adding oil

1. Bolt in screw plug with O-ring (1) and tighten.
   Tightening torque: 80 Nm

2. Prior to initial operation, fill transmission with oil according to Operating Instructions.

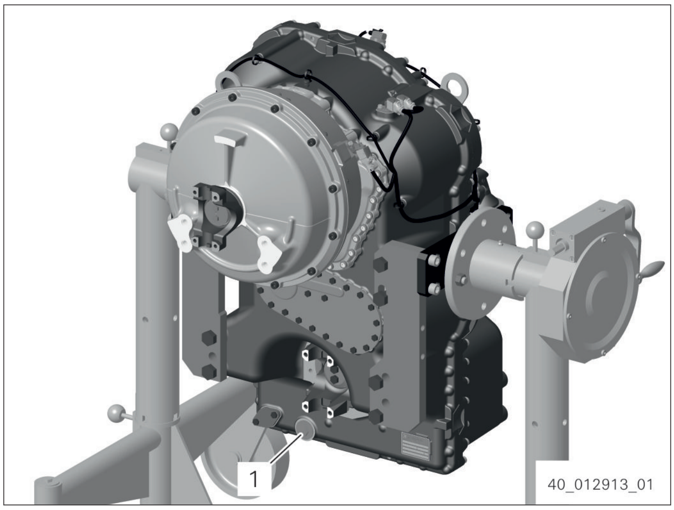


Fig. 406

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

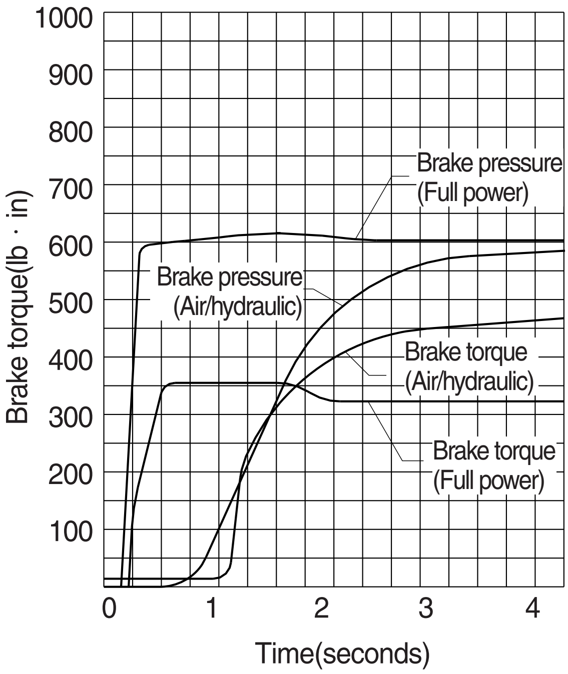
FULL POWER HYDRAULIC BRAKE SYSTEM

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.

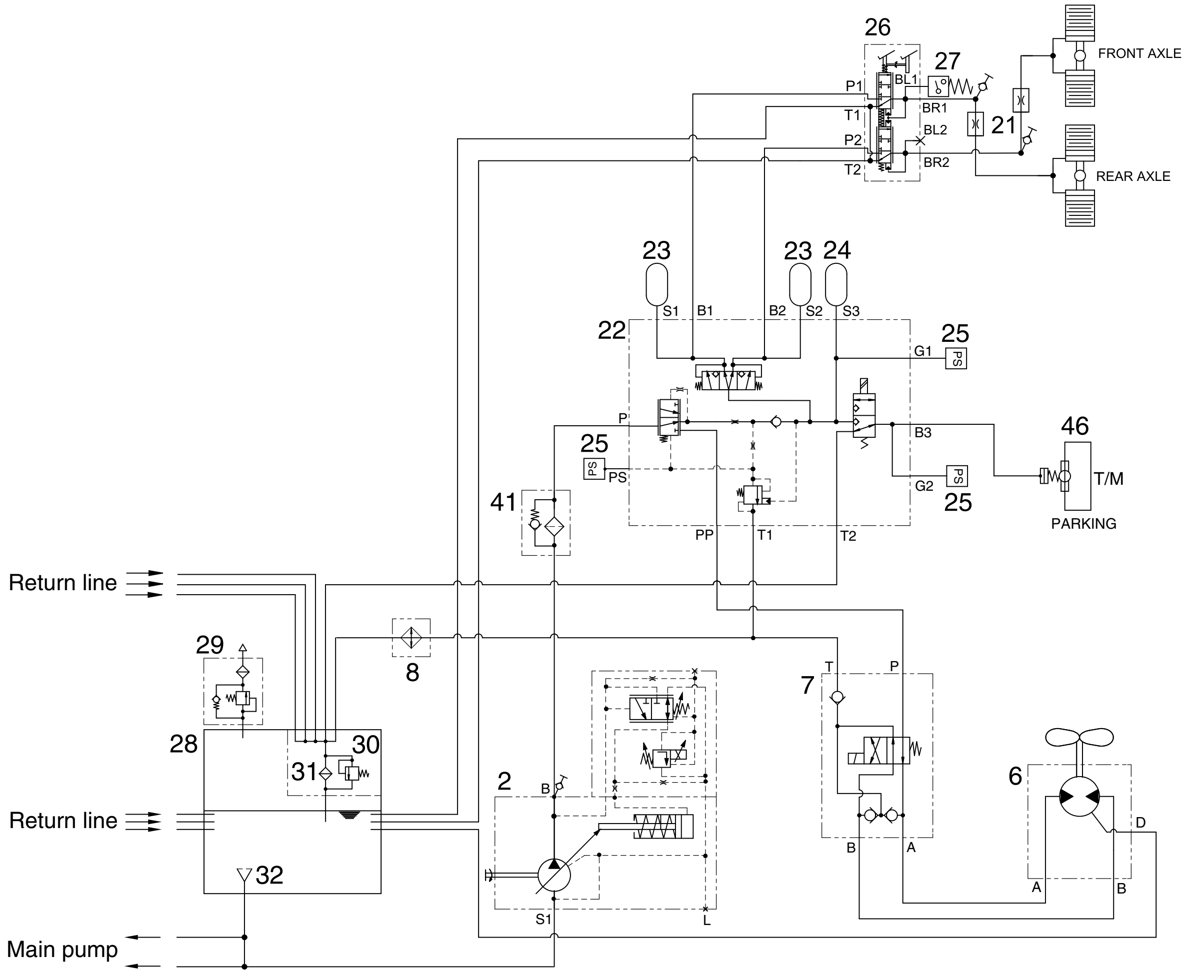
Full power systems can supply significantly higher brake pressures with relatively low reactive pedal forces. The reactive pedal force felt by the operator will be proportional to the brake line pressure being generated.
This is referred to as brake pressure modulation.
Another key design feature of 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

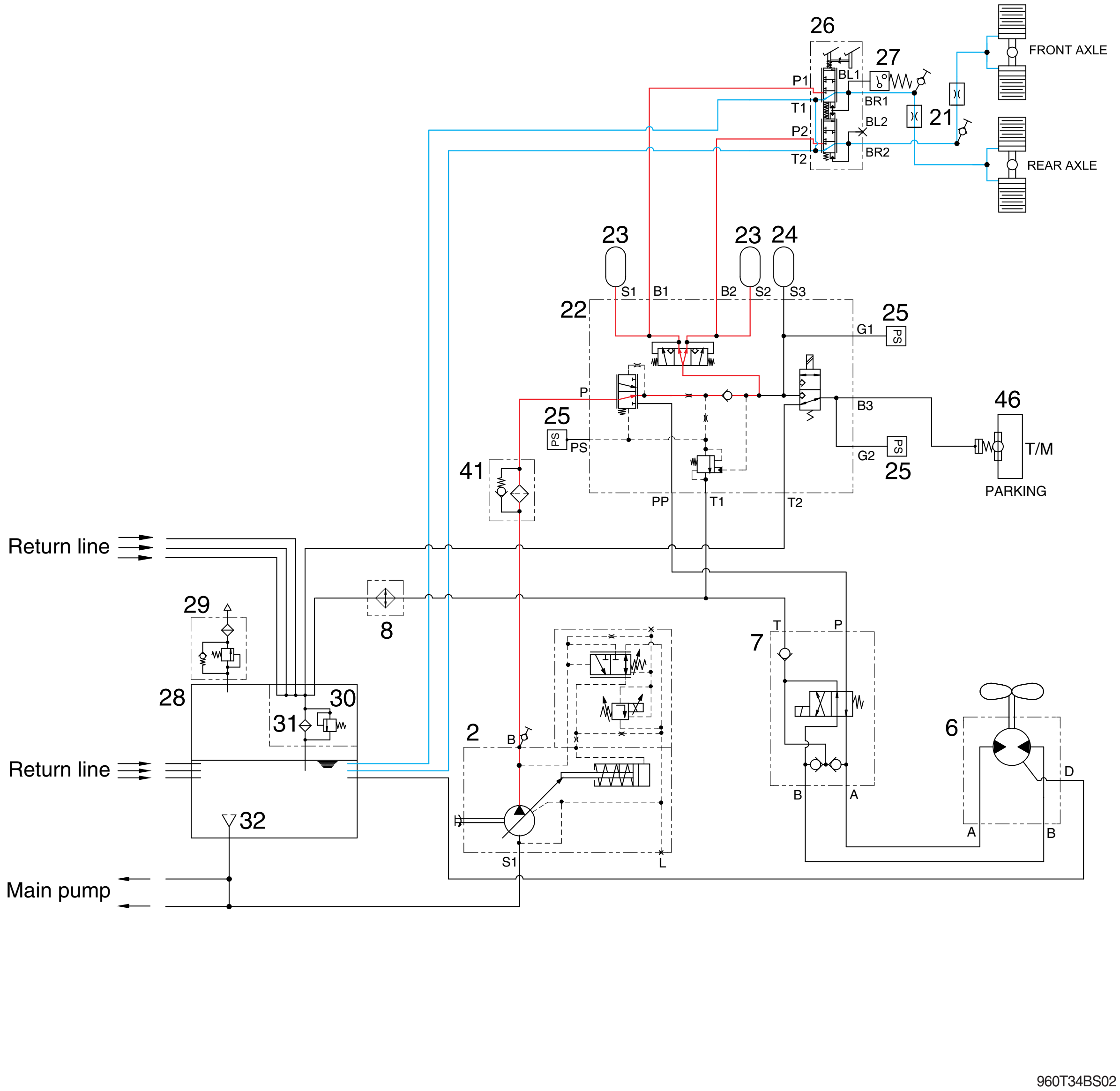


2. HYDRAULIC CIRCUIT



2	Fan & brake pump	24	Accumulator	31	Bypass valve
6	Fan motor	25	Pressure sensor	32	Strainer
7	Directional valve	26	Brake valve	41	Filter
8	Oil cooler	27	Pressure switch	46	Parking brake at T/M
21	Orifice	28	Hydraulic tank		
22	Cut-off valve	29	Air breather		
23	Accumulator	30	Return filter		

1) SERVICE BRAKE RELEASED

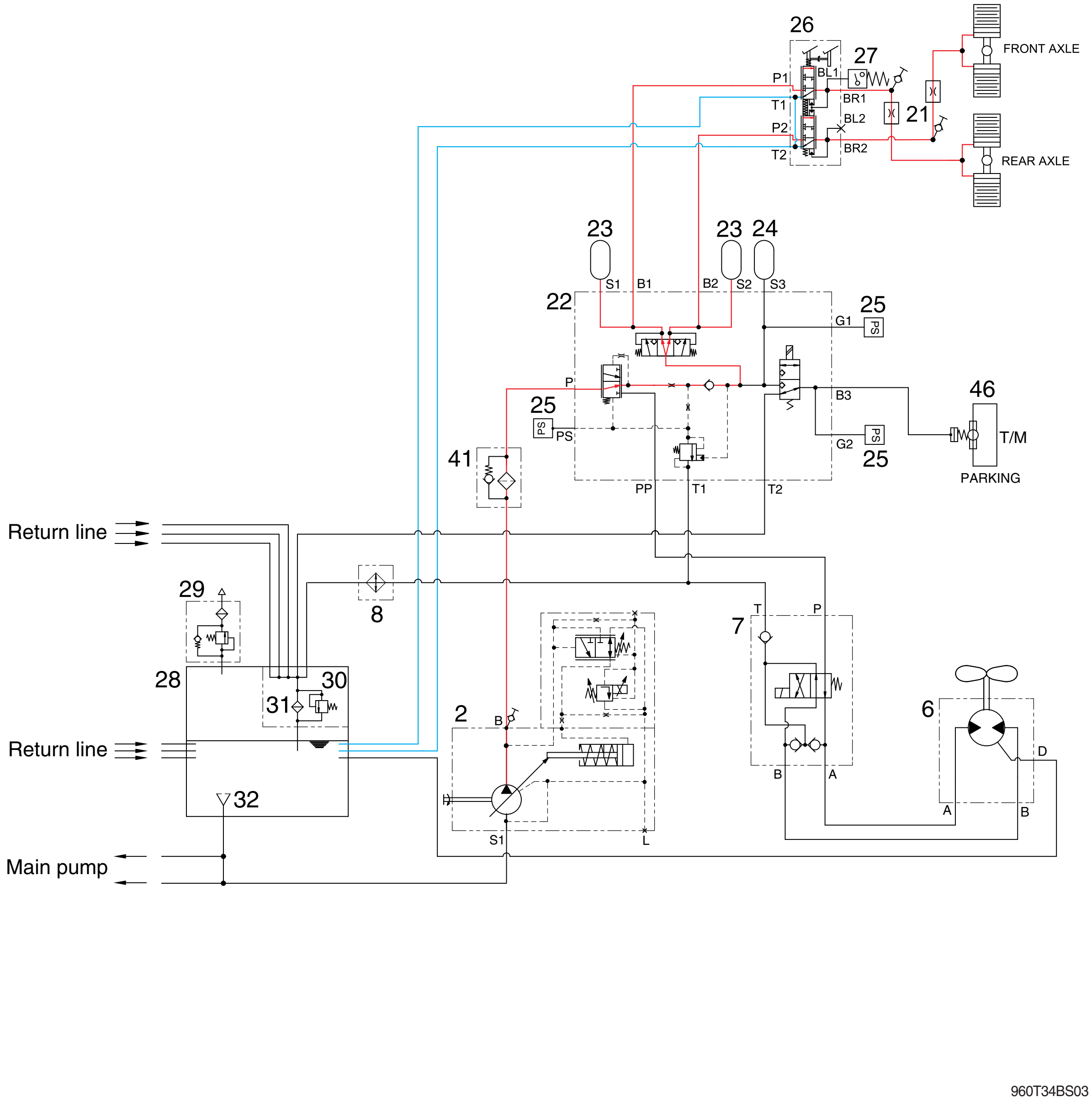


When the pedal of brake valve (26) is released, the operating force is eliminated by the force of the spring, and the spool is returned.

When the spool removes up, the drain port is opened and the hydraulic oil in the piston of axles return to the tank (28).

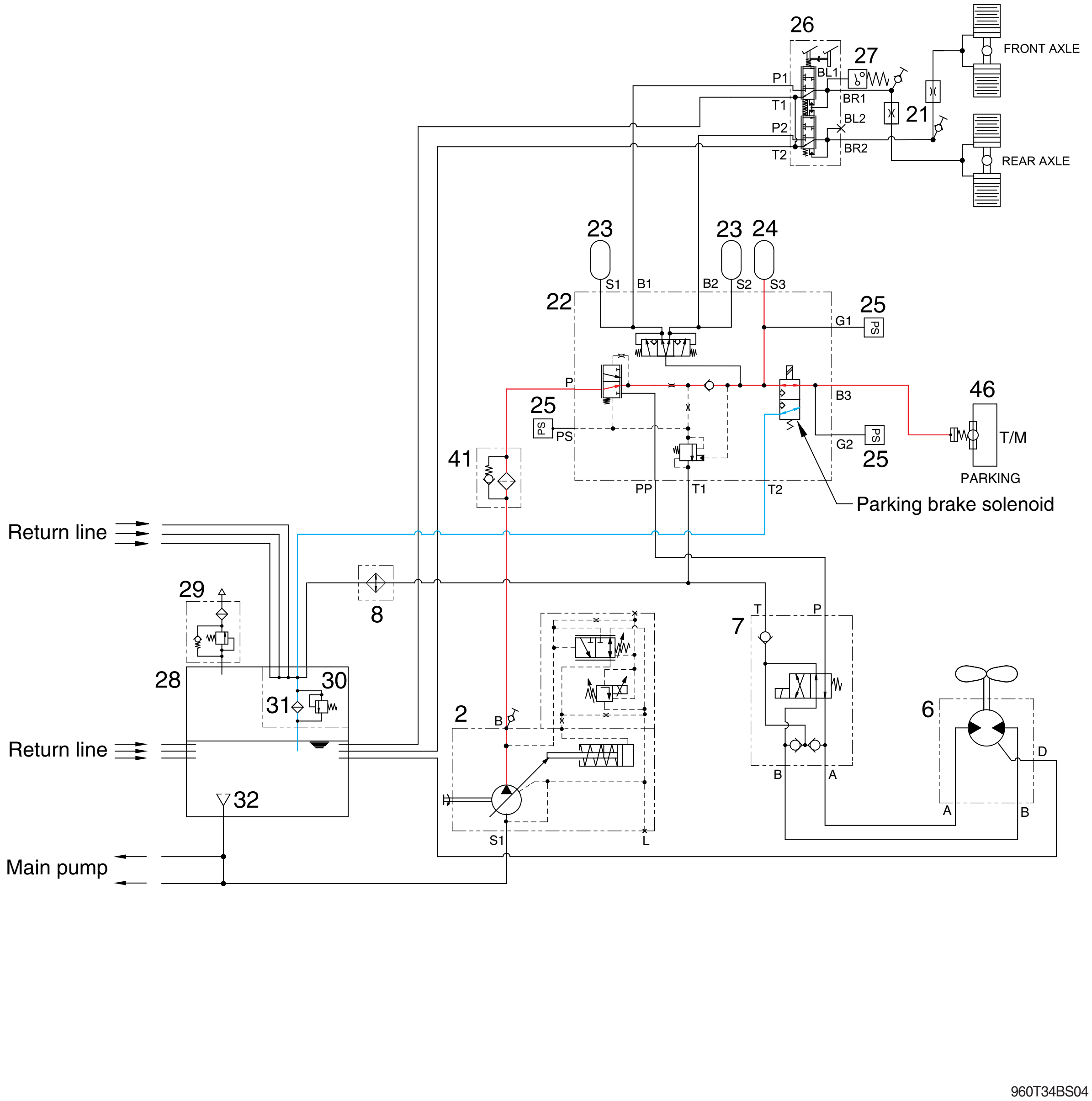
Therefore, the service brake is kept released.

2) SERVICE BRAKE OPERATED



When the pedal of brake valve (26) 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 (22) enters the piston in the front and rear axles. Therefore, the service brake is applied.

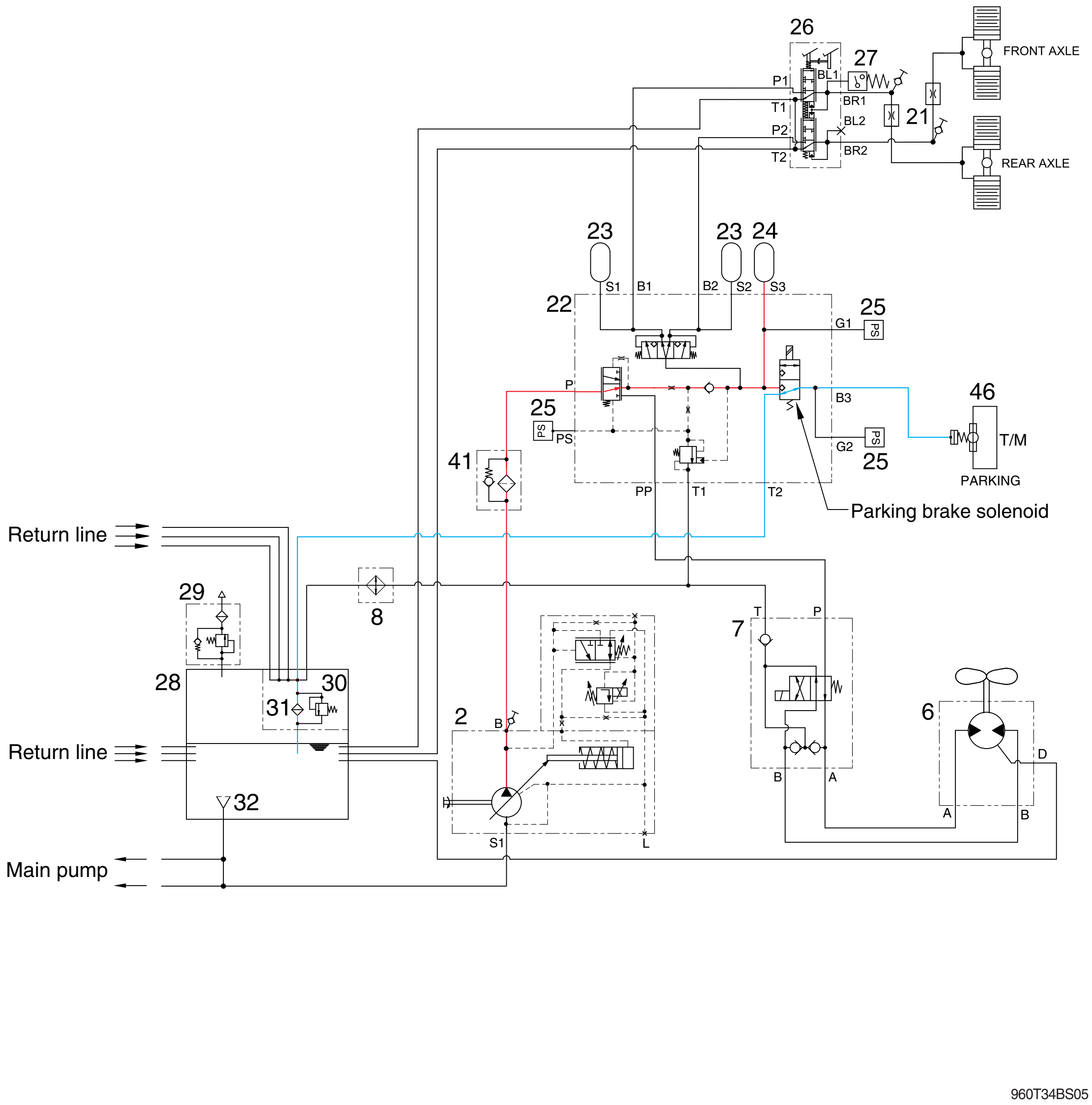
3) PARKING BRAKE RELEASED



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.

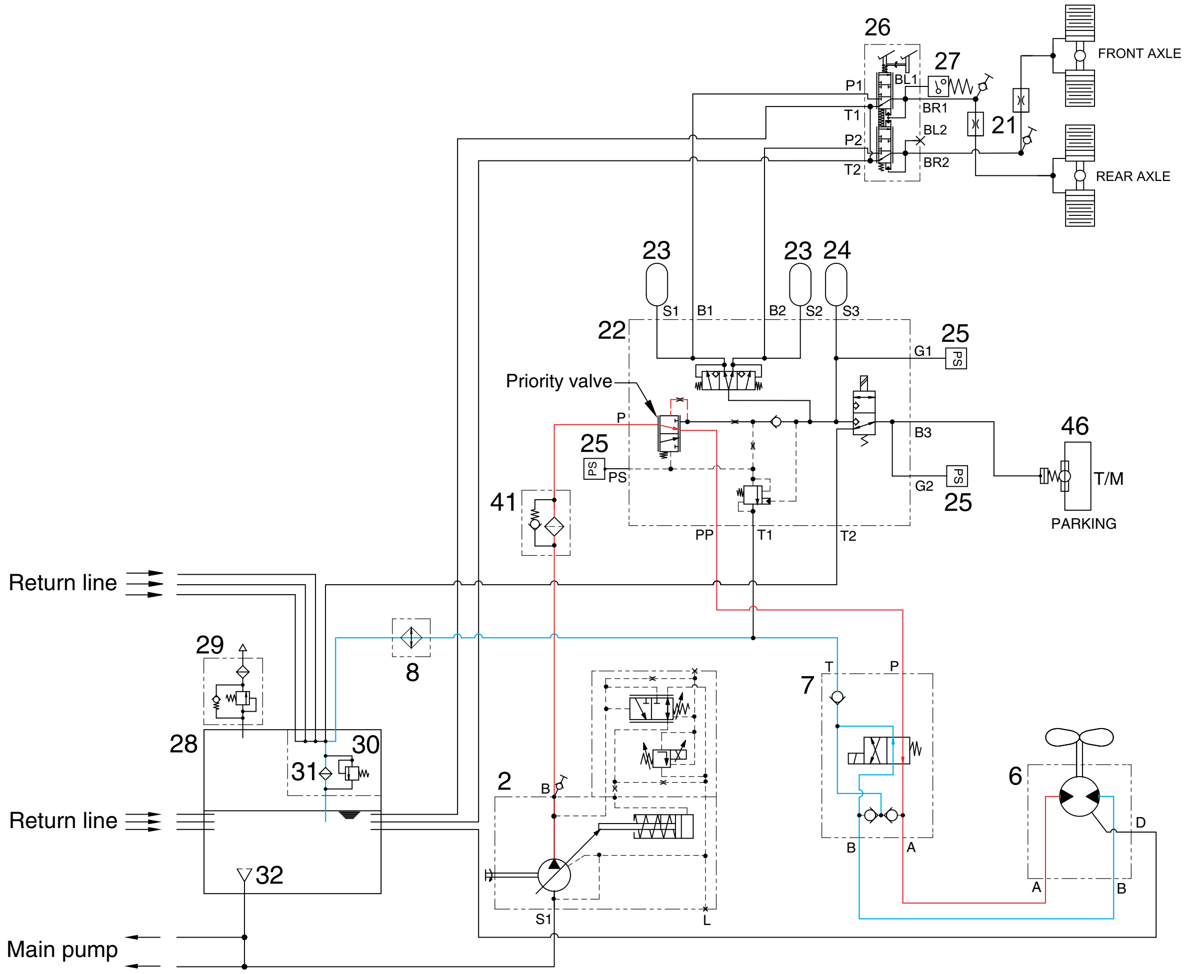
4) PARKING BRAKE OPERATED



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



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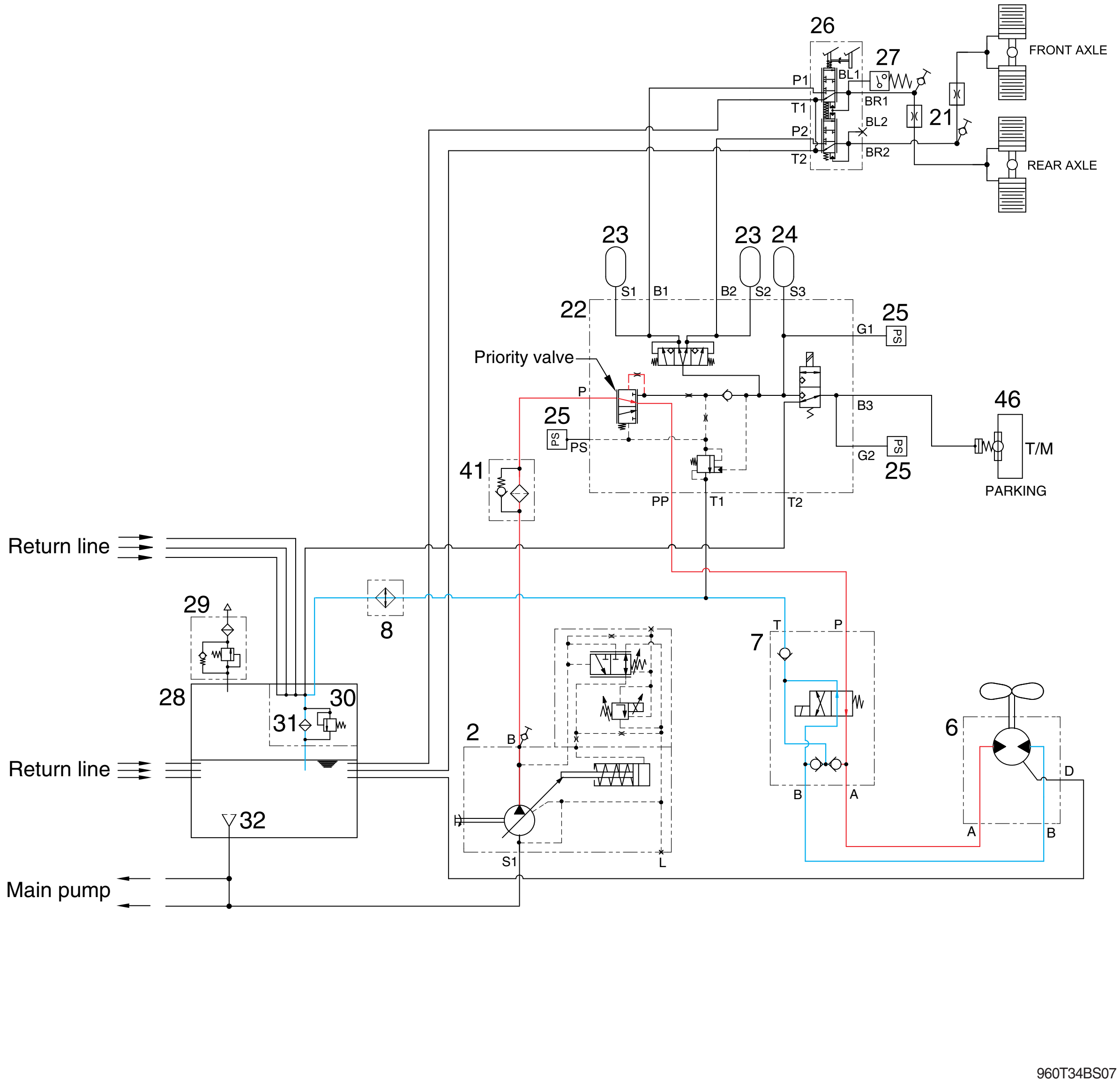
When the brake accumulators are fully charged, the priority valve switches position and the oil is directed to hydraulic fan motor through directional valve (7). The flow of the oil causes fan motor (6) to rotate the fan blade. The rotation of the fan forces cool air to flow through the cooler.

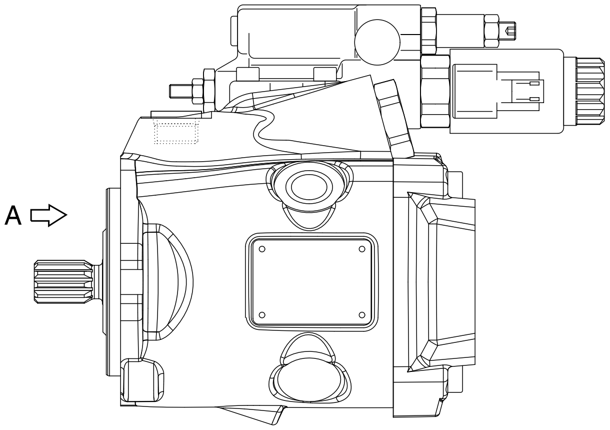
6) DIRECTIONAL VALVE OPERATED

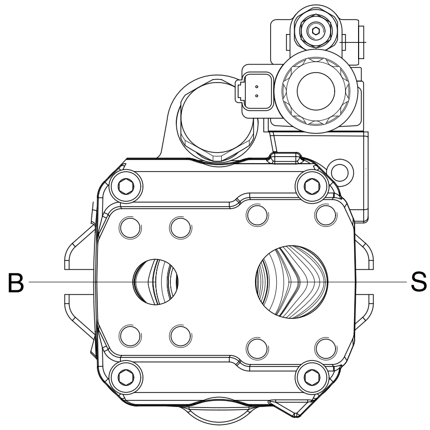


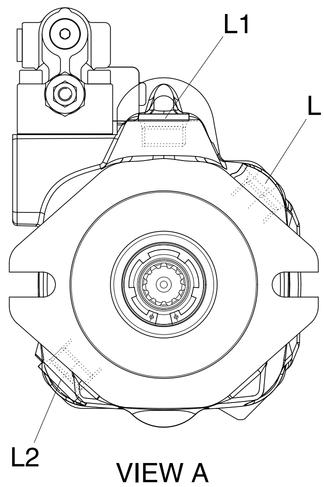
When the cooling fan reverse mode is selected manual or automatic mode, the solenoid valve in the directional valve (7) is energized and the flow of the oil is changed. The rotation of the fan is reversed to clear the radiators.

3. FAN AND BRAKE PUMP

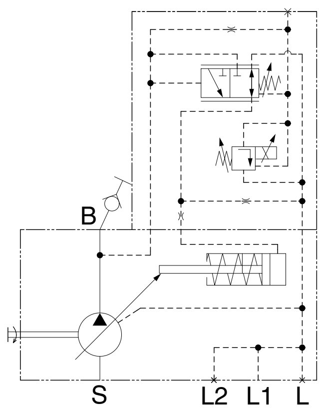
1) STRUCTURE







VIEW A



Hydraulic circuit

Port	Port name	Port size
B	Delivery port	SAE 3/4"
S	Suction port	SAE 1 1/4"
L, L1, L2	Drain port	3/4-16UNF-2B

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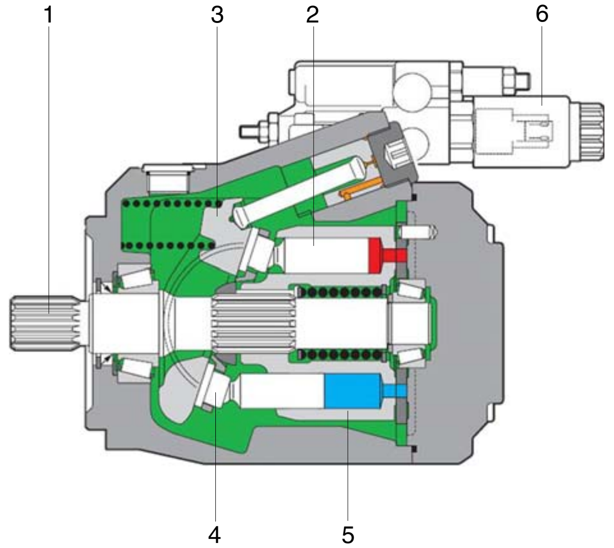
2) OPERATION



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.

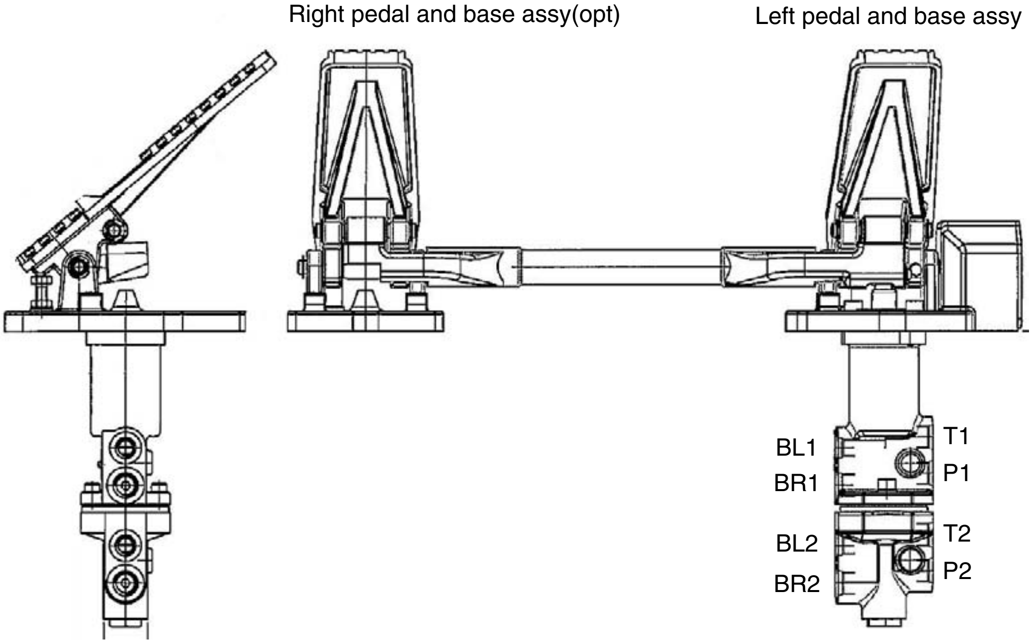
※ FAN SYSTEM OPERATION

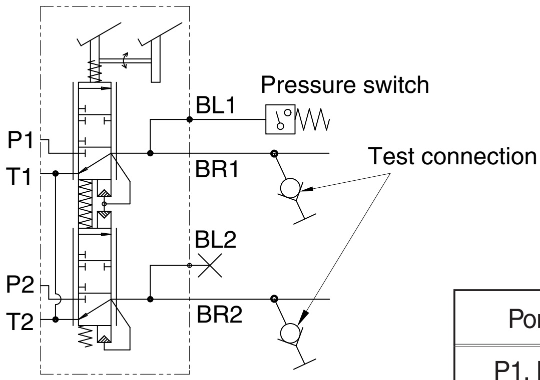
When the brake system pressure is below minimum pressure (125±5 bar), it has the high priority than the fan system. Pump flow to the fan motor is blocked while brake system is charged.
However, The fan system has controlled pump when the brake system pressure is charged.
The fan speed solenoid valve (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

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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.

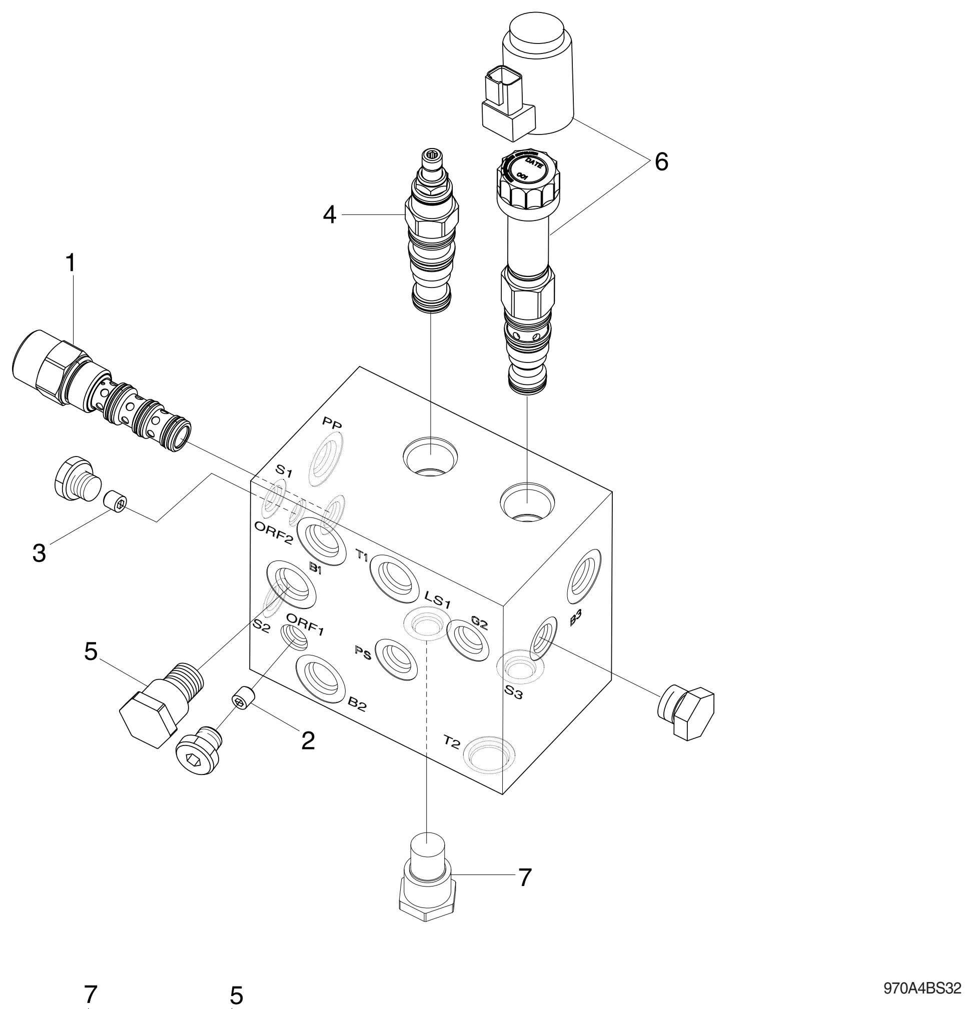
※ When doing repair work, make sure your environment is very clean.
Immediately close all open ports on the components and on pipes using plugs.

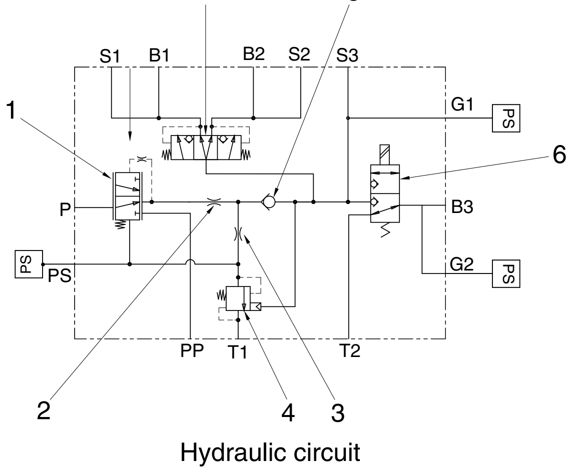
(9) **Replacing the complete actuating mechanism**

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





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

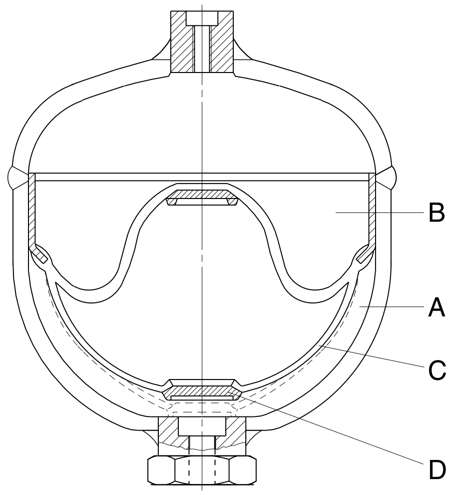
The pressure control valve (4) controls the minimum and maximum pressure of the braking system. When the service brake pressure is below the maximum pressure (125±5 bar), the pressure control valve (4) is blocked and PS pilot pressure (brake priority pressure) increases.

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



Item	31LL-40020 (item24)	31AC-10030 (item23)
Diameter	167 mm	136 mm
Mounting height	219 mm	159 mm
Norminal volume	2.0 ℓ	1.0 ℓ
Priming pressure	50 kgf/cm^2	50 kgf/cm^2
Operating medium	Oil	Oil
Operating pressure	Max 210 kgf/cm^2	Max 200 kgf/cm^2
Thread	M22 × 1.5	M22 × 1.5
Priming gas	Nitrogen	Nitrogen

A Fluid portion
B Gas portion
C Diaphragm
D Valve disk

75794BS09

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

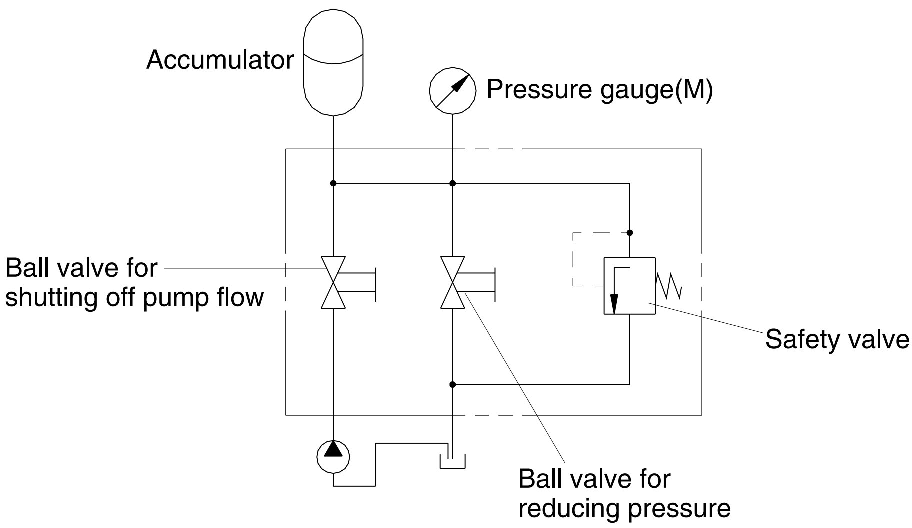
Before the accumulator is scrapped, its gas filling pressure must be reduced. For this purpose, drill a hole through gas chamber (B) using a drill approx. 3mm in diameter. The gas chamber is located on the side opposite the threaded port above the welding seam around the center of the accumulator.

※ 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.



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(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.

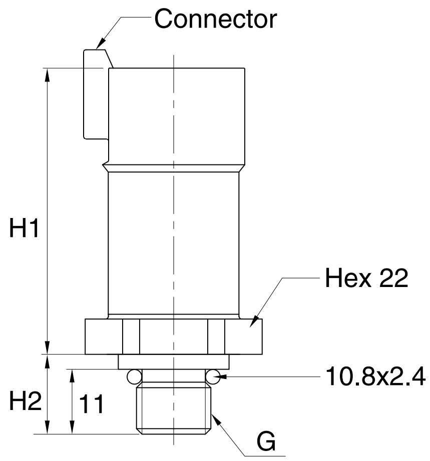
※ When doing repair work, make sure your environment is very clean.

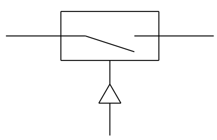
Immediately close all open ports on the components and on pipes using plugs.

△ For safety reasons the accumulators need to be replaced as a whole if damaged.

7. PRESSURE SENSOR AND SWITCH

1) STRUCTURE





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2) TECHNICAL DATA

Item	Type	Medium	G	H1 mm	H2 mm	Adjusting range kgf/cm²	Actuating pressure kgf/cm²	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

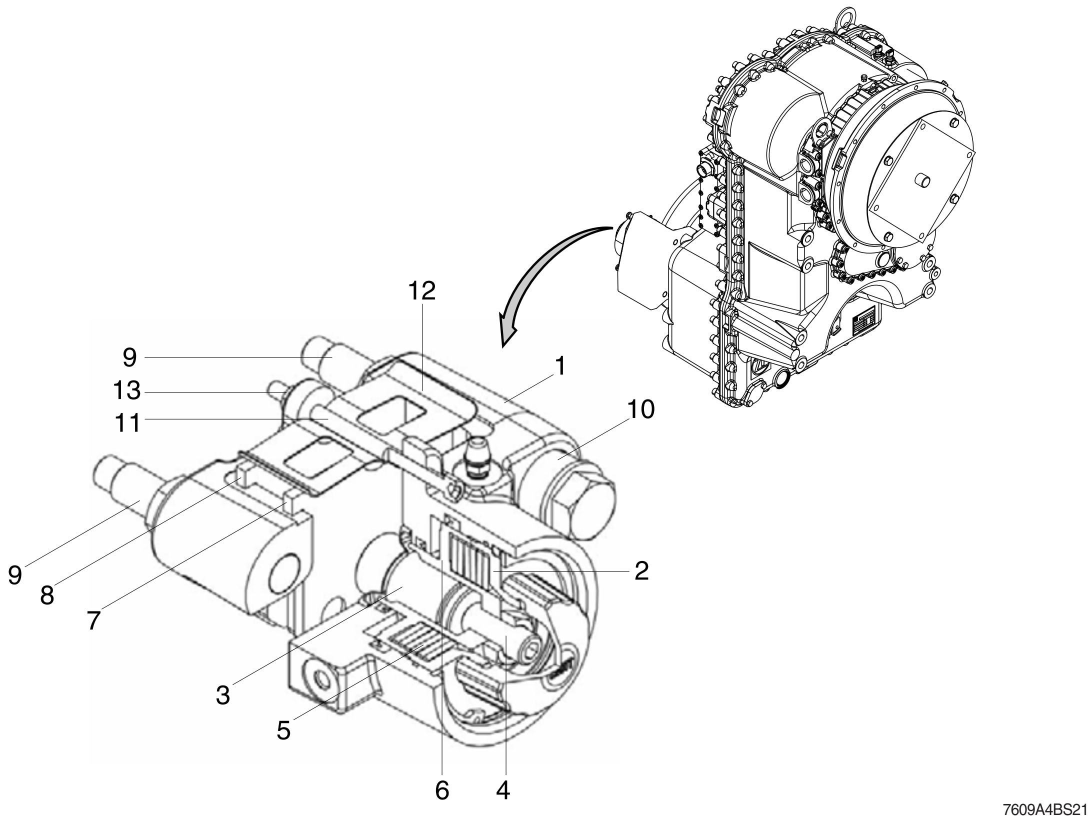
△ When working on the braking system, always make sure that there is absolutely no pressure in the system. Even when the engine is switched off there will be some residual pressure in the system.

※ 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	6	Piston	11	Adjusting screw
2	Pressure ring	7	Lining pad	12	Lining spring
3	Pressure bolt	8	Lining pad	13	Counter nut
4	Setting screw	9	Guiding pin		
5	Plate spring pack	10	Rubber buffer		

2) OPERATION

The two identical lining pads (7, 8) slide on the guide surfaces on the top of the housing and are held in position by a lining spring (12). The brake itself is directly fixed on the gearbox with the two guide pins (9).

The brake is positioned axially using the rubber buffers (10) between the brake housing (1) and the guide pins (9), and the setting screw (11).

When the brake is actuated (= closed) a clamping force is created on the lining pads (7, 8) which is transmitted to the brake disc. Under the force of the plate spring pack (5), the piston (6), together with the adjusting screw (4), the pressure bolt (3) and the lining pad (7) are moved towards the brake disc. When the lining pad (7) comes into contact with the brake disc, the reaction force displaces the brake on the guide pins (9), against the spring force of the rubber buffers (10), until the second lining pad (8) is also pressed against the brake disc.

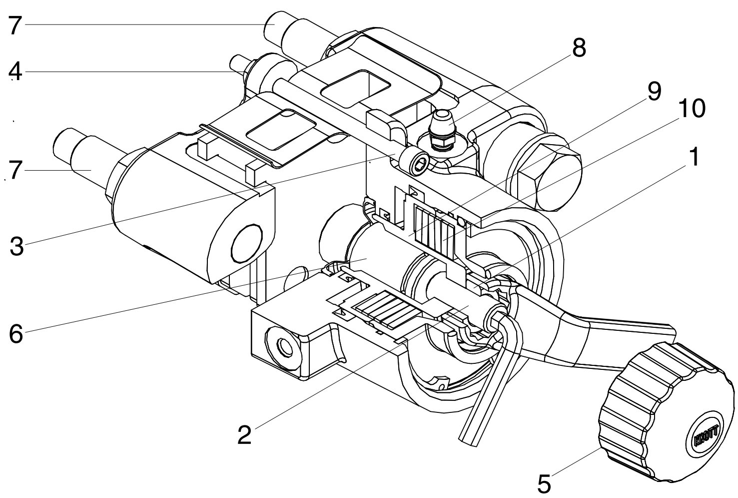
The braking effect (braking torque) is dependent upon the frictional values of the brake linings.

The brake is released by complete pretensioning of the plate spring pack (5). The piston (6) is moved back by the required minimum release pressure to the stop on the pressure ring (2).

During this process the brake positions itself, depending upon the setting, by the two rubber buffers (10) up to contact with the setting screw (11). An equal air gap must be guaranteed on both sides of the brake disc when set correctly.

The clamping force is reduced by wear of the lining pads (7, 8) and the brake disc.
The brake must then be readjusted.

3) FITTING AND SETTING INSTRUCTIONS



7609A4BS22

1	Lock nut	5	Screw cap	9	Piston
2	Setting screw	6	Pressure bolt	10	Spring pack
3	Adjusting screw	7	Guiding bolt		
4	Counter nut	8	Bleeding screw		

※ The fitting or adjusting must always be carried out when the brake is cold.

(1) Fitting the brake

① Rotate the screw cap (5) in a counter-clockwise direction and unscrew it.

② Release the lock nut (1) and turn the adjusting screw (2) counter-clockwise until the pressure bolt (6) contacts the piston (9) with the flat surface.

③ Slide the brake over the brake disc in this condition.

④ Screw the two guide pins (7) into the gearbox in accordance with the fitting instructions. Refer to page 3-171.

⑤ Connect the pressure.

⑥ Apply the required release pressure (min. 130 bar) to the brake in order to pre-tension the plate spring pack (10) completely, up to the stop.

⑦ Carry out bleeding of the brake using the bleed valve (8) .

(2) Clearance adjusting

① Insert a setting gauge on both sides between the brake lining carrier and brake disc and hold them in position.

※ **The thickness of the setting gauge must be adjusted to the desired air gap.**

Clearance		Setting gauge
Min.	0.5 mm	0.25 mm
Nominal clearance	1.0 mm	0.50 mm
Max.	1.5 mm	0.75 mm

② Turn the adjusting screw (2) in a clockwise direction until the two setting gauges are clamped between the brake lining carriers and the brake disc.

③ Hold the adjusting screw (2) in position and lock using the lock nut (1).

※ **The application pressure for clamping the setting gauges must be selected so that both gauges can be removed using a small amount of force after locking in position.**

④ Release the counter nut (4) and then turn the setting screw (3) in a clockwise direction until the end surface of the setting screw (3) is in contact with the surface provided for setting.

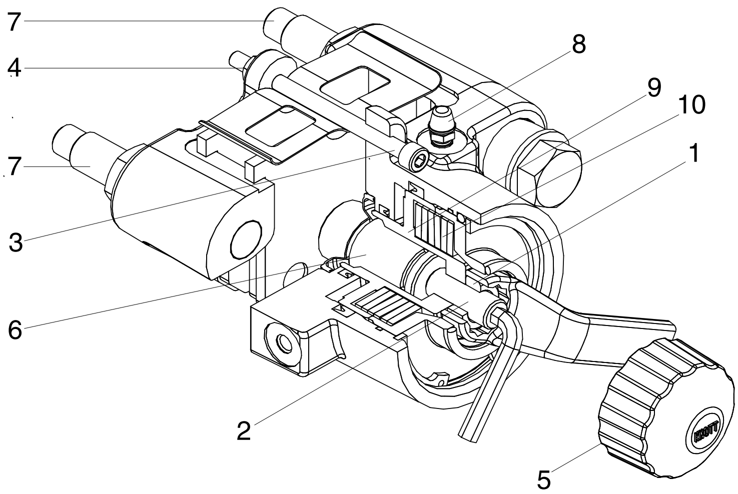
⑤ Hold the setting screw (3) in position and lock using the counter nut (4).

⑥ Remove the setting gauges from both sides of the brake disc.

※ **The fitting procedure for the brake and the setting of the desired air gap is now complete. The brake is ready for use.**

⑦ Turn the screw cap (5) in a clockwise direction and tighten hand-tight.

※ **The brake should be actuated and released several times to check that it is functioning properly.**



7609A4BS22

(3) Adjusting instructions

① Place the machine on flat ground and secure against rolling away.

② Release the parking brake by application of the required release pressure (min. 130 bar).

③ Rotate the screw cap (5) in a counter-clockwise direction and unscrew it.

④ Release the lock nut (1) of the setting screw (2).

⑤ Insert a setting gauge on both sides between the brake lining carrier and brake disc and hold them in position.

※ **The setting gauge must be selected in accordance with the table under (2) "Clearance adjusting".**

⑥ Turn the setting screw (2) in a clockwise direction until the two setting gauges are clamped between the brake lining carriers and the brake disc.

⑦ Apply the lock nut (1) to the setting screw (2).

※ **The application pressure for clamping the setting gauges must be selected so that both gauges can be removed using a small amount of force after locking in position.**

⑧ Release the counter nut (4) and then turn the adjusting screw (3) in a clockwise direction until the end surface of the adjusting screw (3) is in contact with the surface provided for setting.

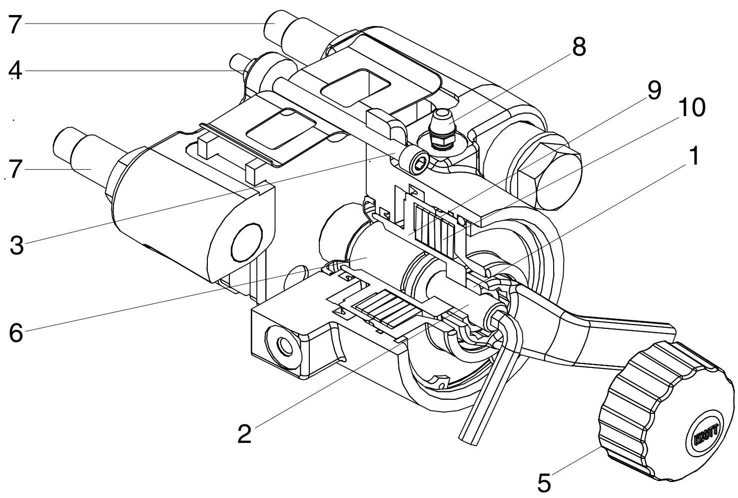
⑨ Hold the adjusting screw (3) in position and lock using the counter nut (4).

⑩ Remove the setting gauge from both sides of the brake disc.

※ **The adjustment of the desired air gap is now complete. The brake is ready for use.**

⑪ Turn the screw cap (5) in a clockwise direction and tighten hand-tight.

※ **Actuate the brake valve several times and check the holding effect of the parking brake on a suitable incline or a suitable gradient.**



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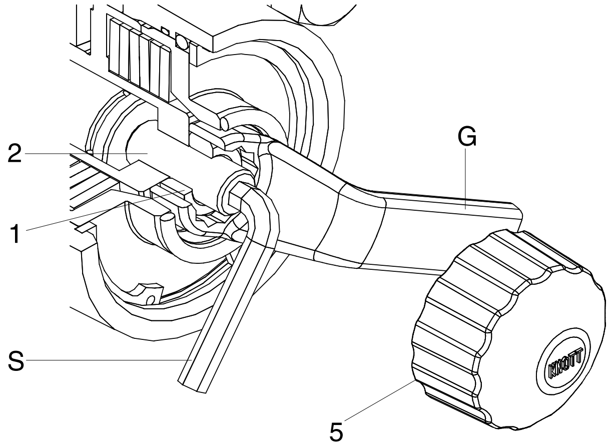
4) EMERGENCY RELEASE OF THE PARKING BRAKE

In the event of a failure in pressure supply the parking brake can be released mechanically in the following way :



7609A4BS23

1	Lock nut	S	Peg spanner
2	Setting screw	G	Ring spanner
5	Screw cap		

(1) Secure the machine against rolling away.
(2) Rotate the screw cap (5) in a counter-clockwise direction and unscrew it.
(3) Release the lock nut (1) and unscrew it back to the end of the setting screw (2).
(4) Rotate the setting screw (2) in a clockwise direction until the brake disc is completely free.

※ **For emergency release a torque of min 7.1 kgf·m (51.6 lbf·ft) is required on the setting screw (2).**

(5) Screw on the lock nut (1) up to contact with the piston and apply a slight locking force to the setting screw (2).
(6) Screw on the screw cap (5) in a clockwise direction by a few threads. (dirt ingress protection)

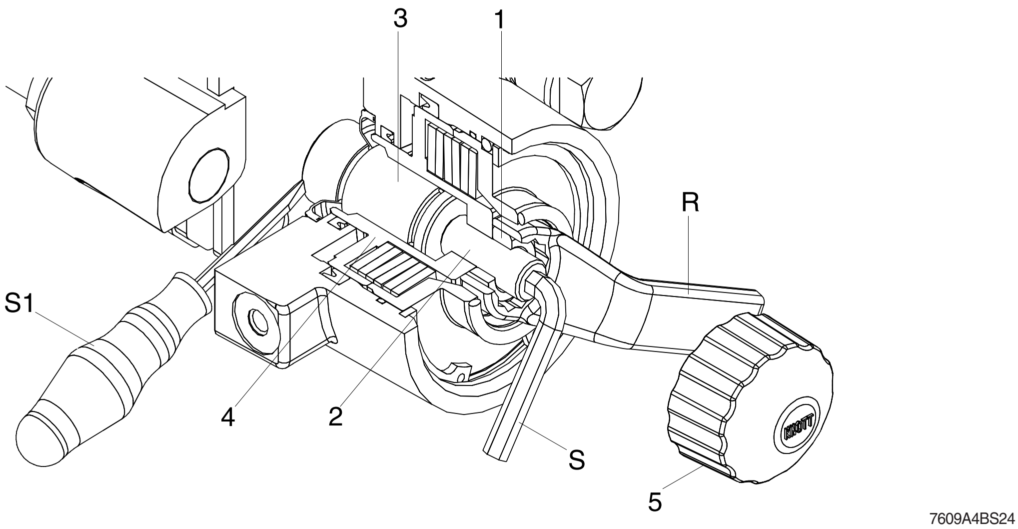
※ **In this condition the machine has no parking brake facility and thus must be protected from rolling away by different means. The brake must be adjusted before recommissioning.**

5) MAINTENANCE AND REPAIR WORK

(1) Maintenance and replacement of the lining pads

The brake, particularly the brake lining carriers, must be visually inspected at regular intervals.
If the remaining lining thickness is too thin, these intervals must be reduced accordingly to prevent extensive damage to the brake or the brake disc.

Once the minimum remaining lining thickness of 1.0 ~ 1.5 mm per brake lining carrier is reached, the brake lining carrier must be replaced in accordance with the following instructions :



1	Lock nut	5	Screw cap
2	Setting screw	S	Peg spanner
3	Pressure bolt	S1	Screwdriver
4	Piston	R	Ring spanner

① Place the machine on flat ground and secure against rolling away.

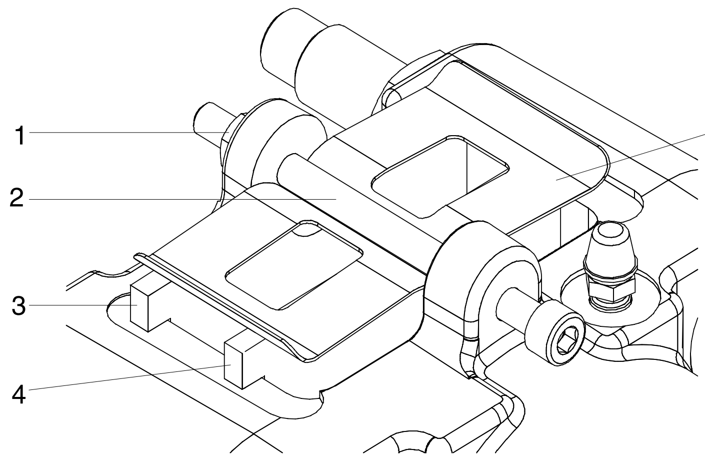
② Release the parking brake by application of the required release pressure (min. 130 bar).

③ Rotate the screw cap (5) in a counter-clockwise direction and unscrew it.

④ Release the lock nut (1) of the setting screw (2).

⑤ Rotate the setting screw (2) in an counter-clockwise direction until the pressure bolt (3) can be pushed completely into the piston (4) .

⑥ Unscrew (lever) the pressure bolt (3) with a suitable screwdriver until it contacts the piston (4).



1 Counter nut
2 Adjusting screw
3 Lining pad
4 Lining pad
5 Lining spring

⑦ Release the counter nut (1) and unscrew the adjusting screw (2) from the brake housing.

※ **The lining spring (5) is pre-tensioned. The lining spring (5) must be held in position with a suitable tool whilst removing the adjusting screw (2).**

⑧ Remove the lining spring (5).

⑨ Remove the two lining pads (3, 4) from the lining compartment in the brake housing.

※ **If there is no possibility of changing the brake lining carriers (3, 4) as described above (not enough space), the brake must be removed completely. The procedure for removing the brake from the gearbox can be taken from the fitting instructions. Refer to page 3-93.**

※ **Check the pressure line. A pressure line which is too short must be unscrewed in order to permit removal of the brake.**
An emergency release of the parking brake must be carried out before releasing the pressure line.

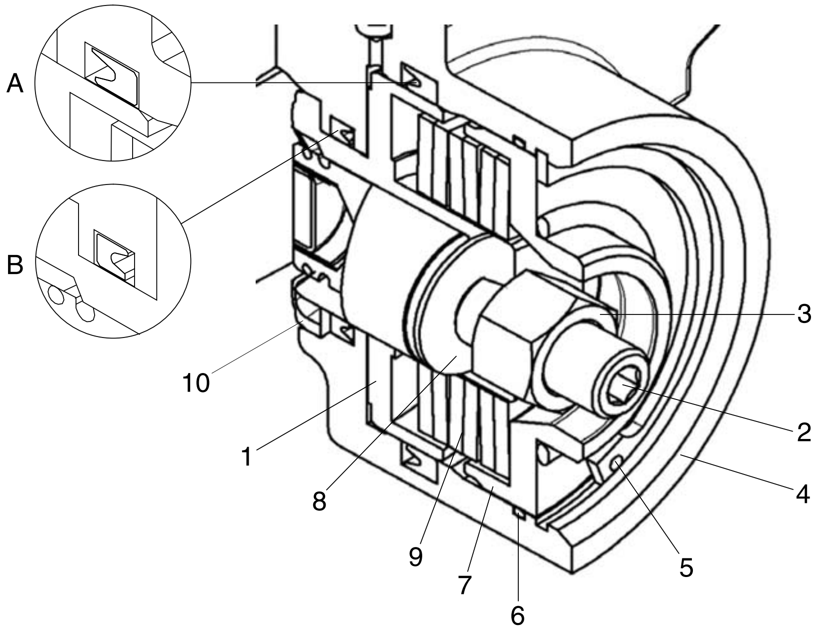
⑩ Replace the lining pads (3, 4).

⑪ The lining spring (5) must be pushed in position with a suitable tool whilst screwing in the adjusting screw (2).

※ **If you removed the brake completely because of a lack of space you must carry out fitting of the brake in accordance with the fitting instructions. Refer to page 3-171.**

※ **After changing the lining pads (3, 4), or repair to them, the brake must be adjusted in accordance with 3) FITTING AND SETTING INSTRUCTION.**

(2) Replacing the seals



7609A4BS26

1	Piston	5	Circlip	9	Plate spring pack
2	Setting screw	6	Sealring	10	Dust protection cap
3	Lock nut	7	Pressure ring	A	Detail sealring
4	Housing	8	Pressure bolt	B	Detail sealring

Leaking seals must be replaced in accordance with the following instructions :

① Place the machine on flat ground and secure against rolling away.
② Release the parking brake by application of the required release pressure (min. 130 bar).

※ **If the brake cannot be pressurised with the required release pressure (min. 130 bar) because of excessive leaks, the parking brake MUST be released using the emergency procedure. See 4) Emergency release of the parking brake.**

③ Rotate the screw cap in a counter-clockwise direction and unscrew it.
④ Release the lock nut (3) of the setting screw (2).
⑤ Rotate the setting screw (2) in an counter-clockwise direction until the pressure bolt (8) can be pushed completely into the piston (1).
⑥ Unscrew (lever) the pressure bolt (8) with a suitable screwdriver until it contacts the piston (1).
⑦ Actuate the brake valve and dissipate the existing release pressure down to 0 bar.

※ **The plate spring pack (9) is now fully de-tensioned.**

⑧ Unscrew the pressure line and remove the brake completely.
⑨ Remove the circlip (5) and remove the pressure ring (7) from the housing (4).
⑩ Remove the plate spring pack (9) and the piston (1).
⑪ Always replace both the seals (A, B).

※ Observe the fitting direction of the grooved rings and use a suitable fitting needle with rounded edges to fit the new grooved rings. Take care - there is a danger of injury.

※ Carry out re-fitting of the individual parts into the brake in reverse order. Apply a light coat of fitting fluid lubricant to the sliding and sealing surfaces of the piston when fitting.

⑫ If necessary, also replace the dust protection cap (10).

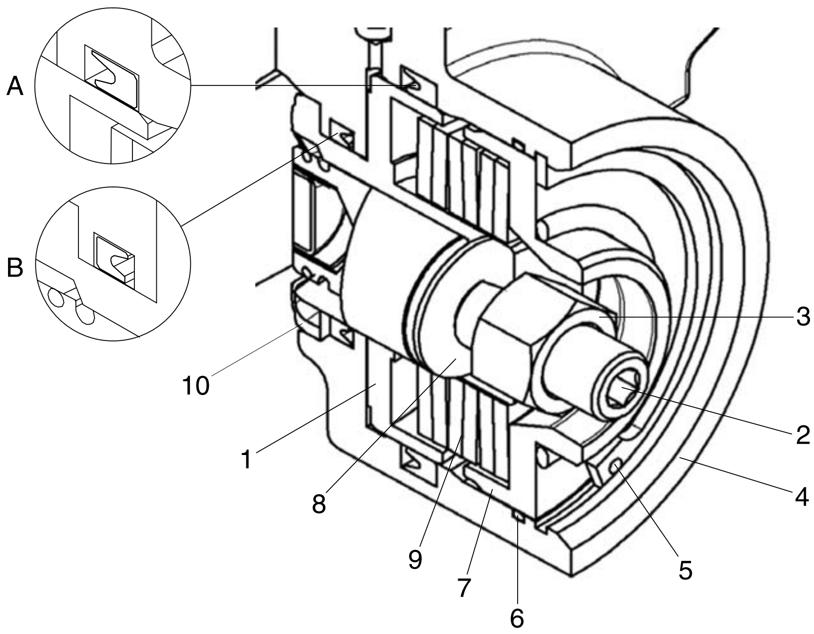
※ The dust protection cap (10) has a vulcanised-in steel ring which is used to press it into the opening in the brake housing (4).

In order to replace this you will need to "lever it out" with a suitable tool and then replace with a fitting fixture by pressing it into the housing (4).

⑬ Fit the brake onto gearbox in accordance with the fitting instructions. Refer to page 3-171.

(3) General instructions

Any faults or damage detected on parts not listed here must, of course, be rectified or replaced by genuine parts.



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MEMORANDUM

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.

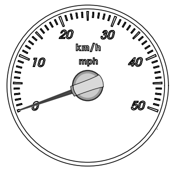
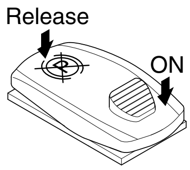
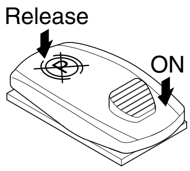
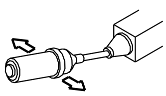
The engine and all other major components must be at operating temperature for some checks.

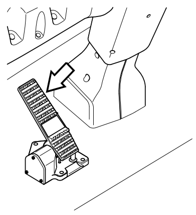
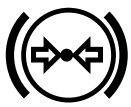
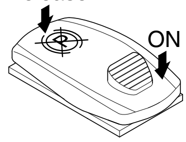
Locate system check in the left column and read completely, following the sequence from left to right. Read each check completely before performing.

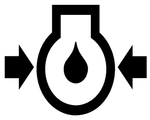
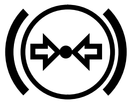
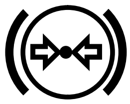
At the end of each check, if no problem is found (OK), that check is complete or an additional check is needed. If problem is indicated (NOT OK), you will be given repair required and group location.
If verification is needed, you will be given next best source of information:

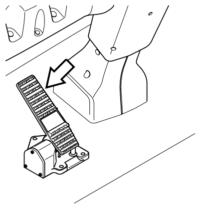
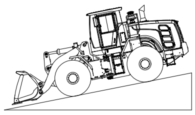
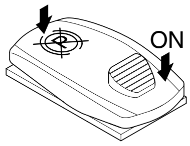
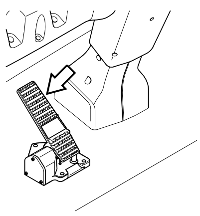
Chapter 2 : Troubleshooting
Group 3 : Tests and adjustments

※Hydraulic oil must be at operating temperature for these checks (refer to page 6-49).

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.

GROUP 3 TESTS AND ADJUSTMENTS

1. PARKING BRAKE PERFORMANCE

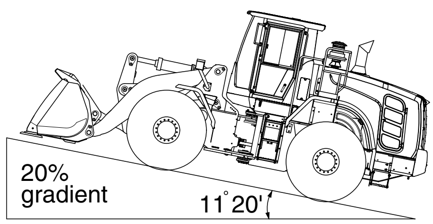
1) MEASUREMENT CONDITION

(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



760F4BS17

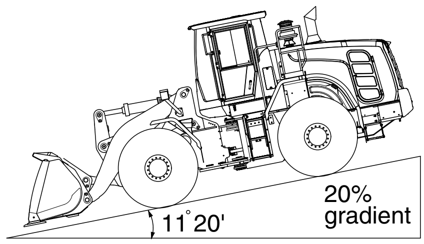
2) MEASURING PROCEDURE

(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.



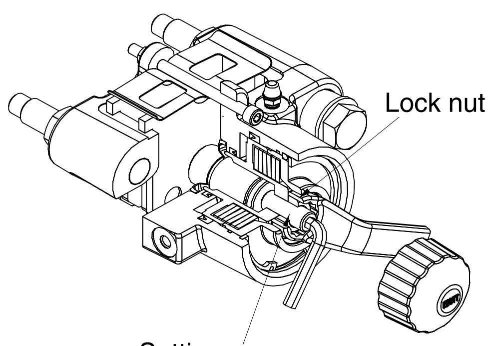
760F4BS18

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.



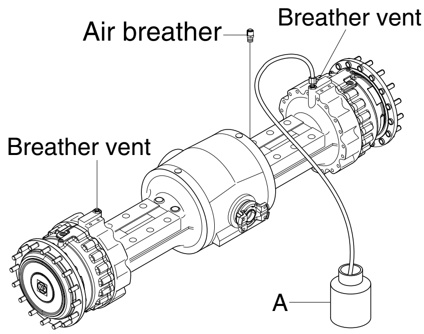
7609A4BS27

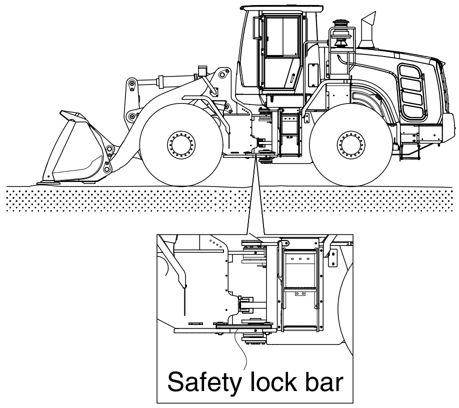
3. HYDRAULIC BRAKE BLEEDING PROCEDURE

⚠ 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.



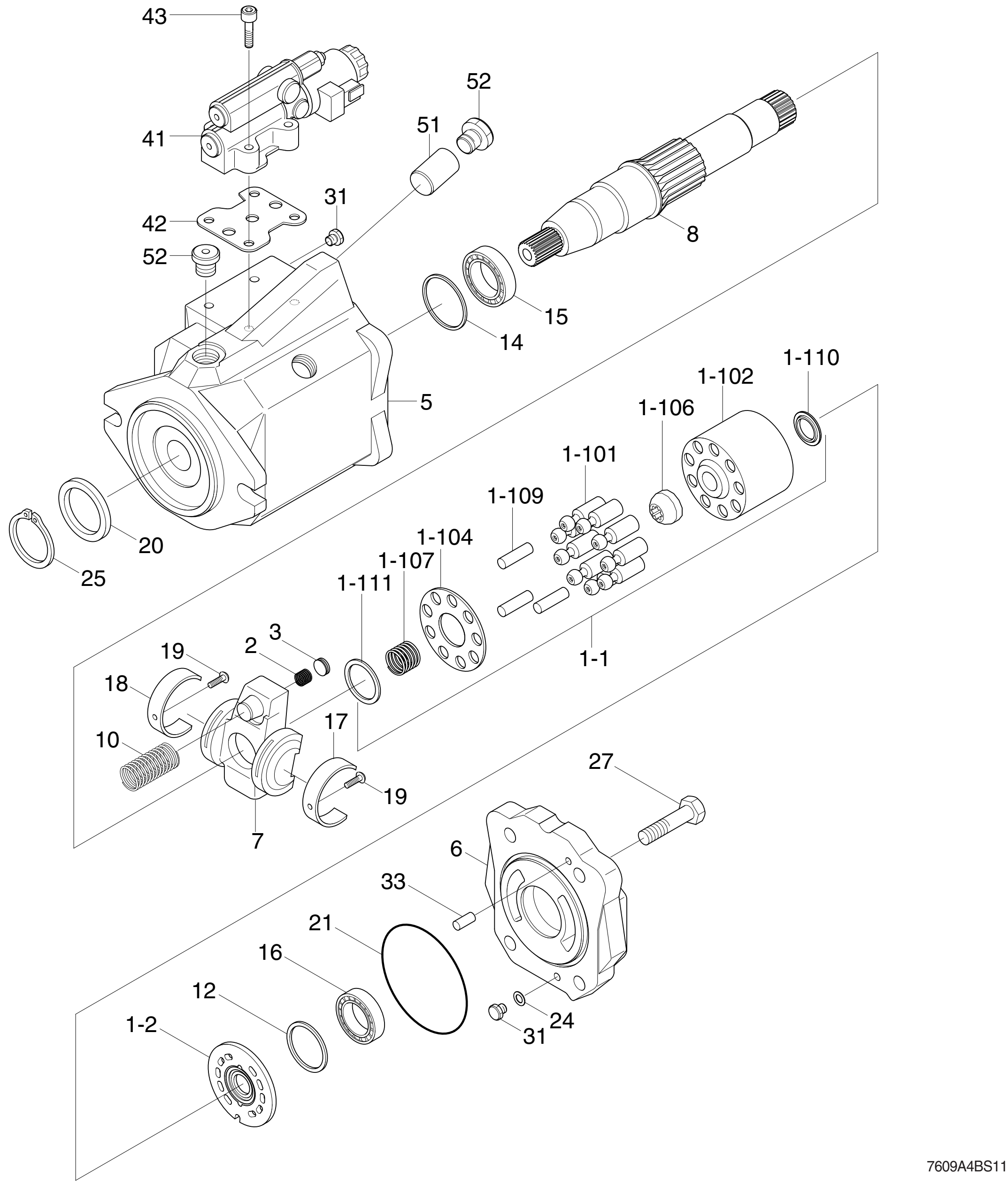


760F4BS19

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.

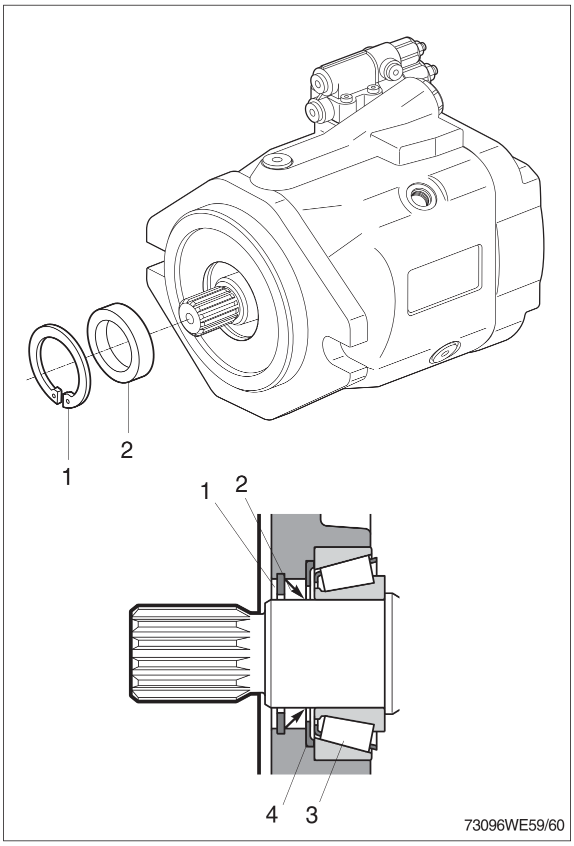
(3) Check all sealing and sliding surfaces for wear.

※ Re-work of the sliding surfaces by using, for example abrasive paper, can damage the surface.

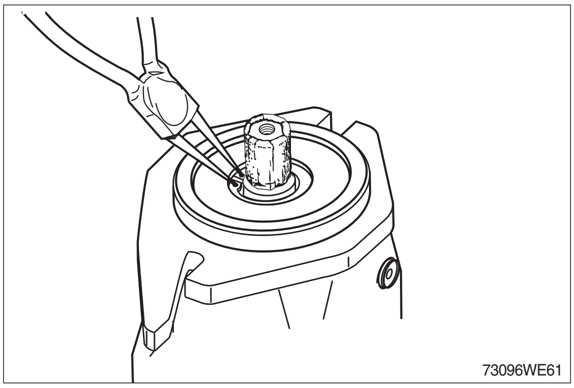
(4) Fill the hydraulic pump with hydraulic oil before commissioning.

3) SEALING THE DRIVE SHAFT

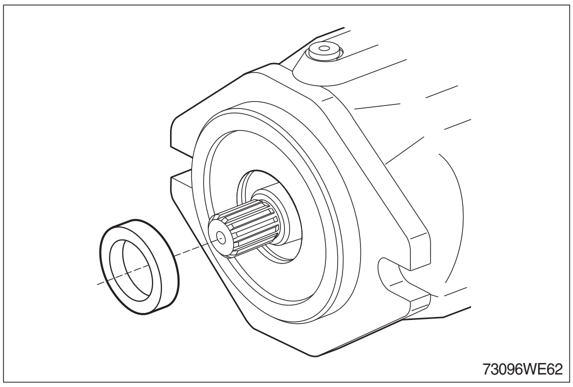
1	Retaining ring	2	Shaft seal
3	Bearing	4	Stop ring



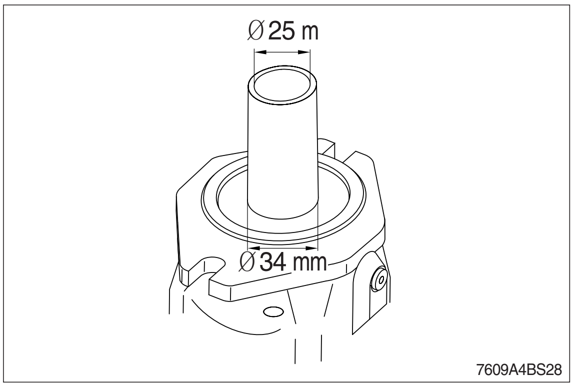
(1) Protect the drive shaft.
Wrap the drive shaft with tape.
Remove the retaining ring.
Remove shaft seal to front.



※ Change the shaft seal and check its sliding surface (drive shaft) and housing, grease the sealing ring.
Visual check shaft seal and housing.

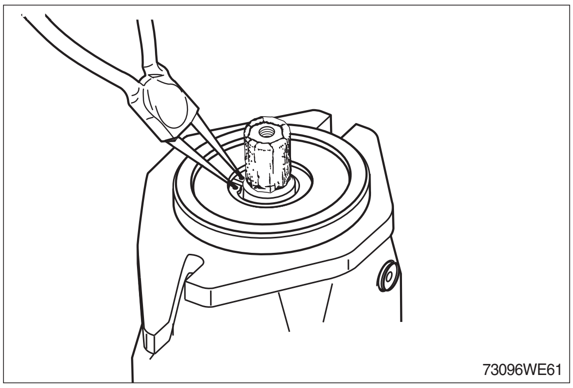

73096WE62

(2) Assembling of the sealing ring carefully down to the stop ring.



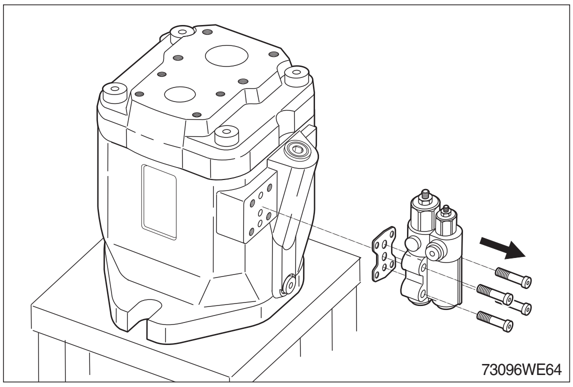
7609A4BS28

(3) Assemble the retaining ring (circlip).
※ Visual check to ensure that the circlip is correctly located in the groove.

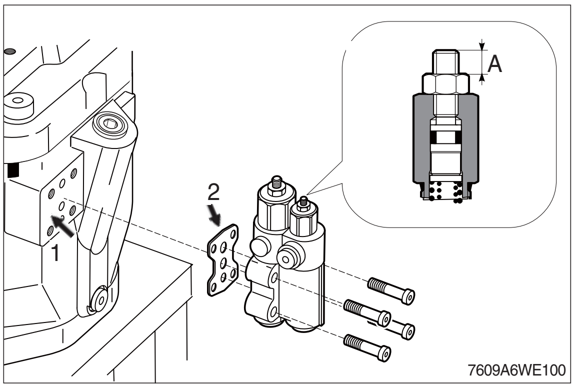

73096WE61

4) SEALING THE CONTROL VALVE

(1) Remove the control valve.

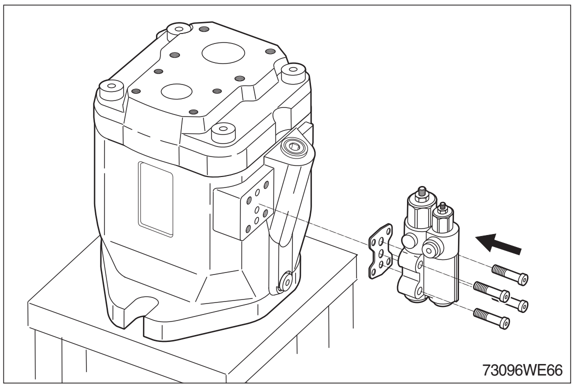

73096WE64

(2) Measure dimension A and note down.
Check sealing surface (1).
Replace gasket (2).

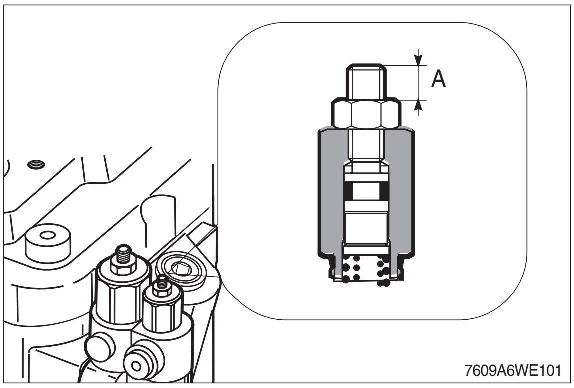


7609A6WE100

(3) Assemble control valve.
Tighten the bolts.
· Tightening torque : 1.58 kgf · m (11.4 lbf · ft)


73096WE66

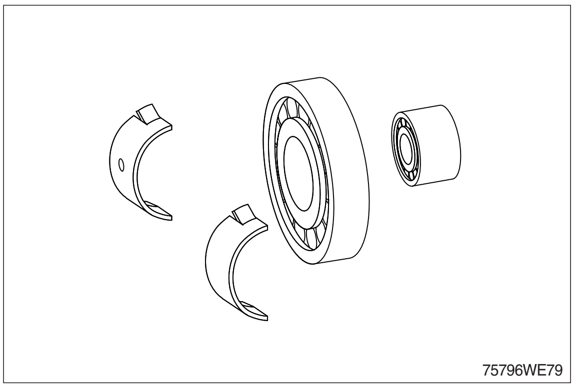
(4) Check dimension A.



7609A6WE101

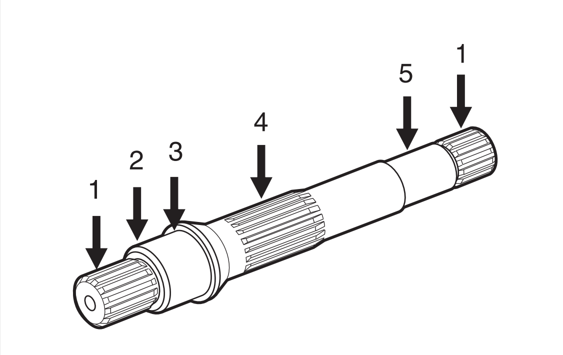
5) INSPECT HINTS

(1) Renew all bearings.


75796WE79

(2) Check :

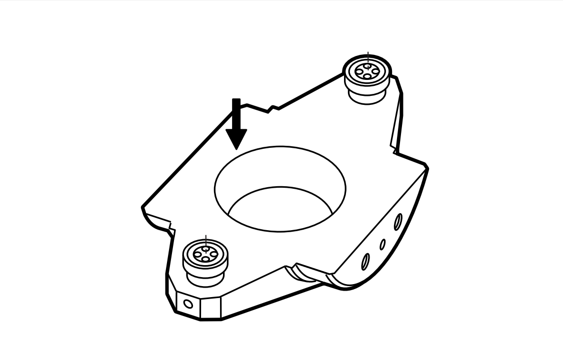
1 Wear on splines, rust
2 Drive shaft seal wear grooves
3 Bearing seat
4 Splines for cylinder drive
5 Bearing seat



75796WE80

(3) Check :

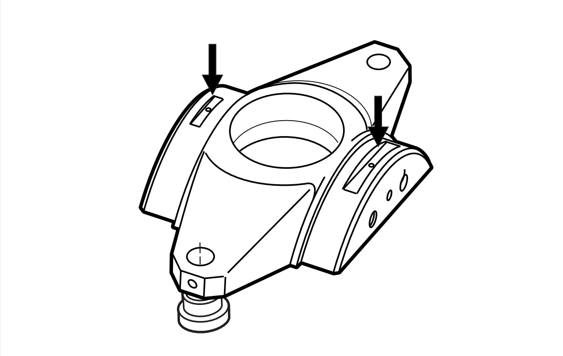
Sliding surface free of grooves.



75796WE81

(4) Check :

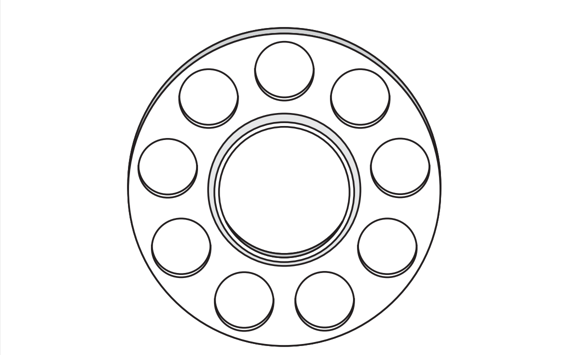
Bearing surfaces.



75796WE82

(5) Check :

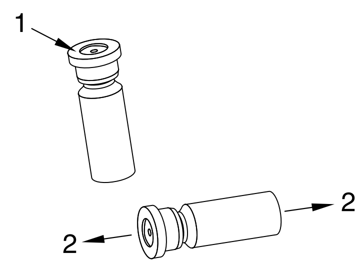
That the retaining plate is free of grooves and that there is no wear in the slipper pad area.



75796WE83

(6) Check :

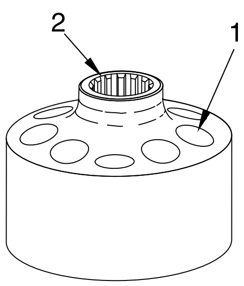
Check to see that there are no scratches or metal deposits on the sliding surface (1) and that there is no axial play (2) (Pistons must only be replaced as a set).



75796WE84

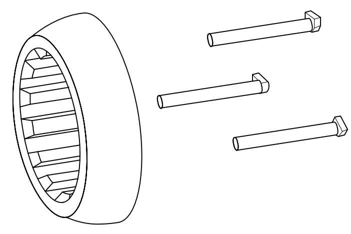
(7) Check :

1 Cylinder bores
2 Splines



75796WE85

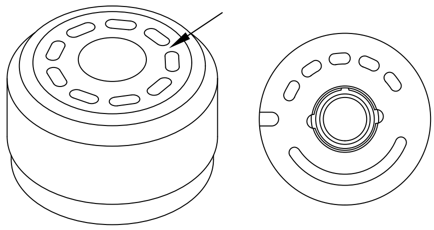
(8) Free of grooves, no signs of wear.



75796WE86

(9) Check :

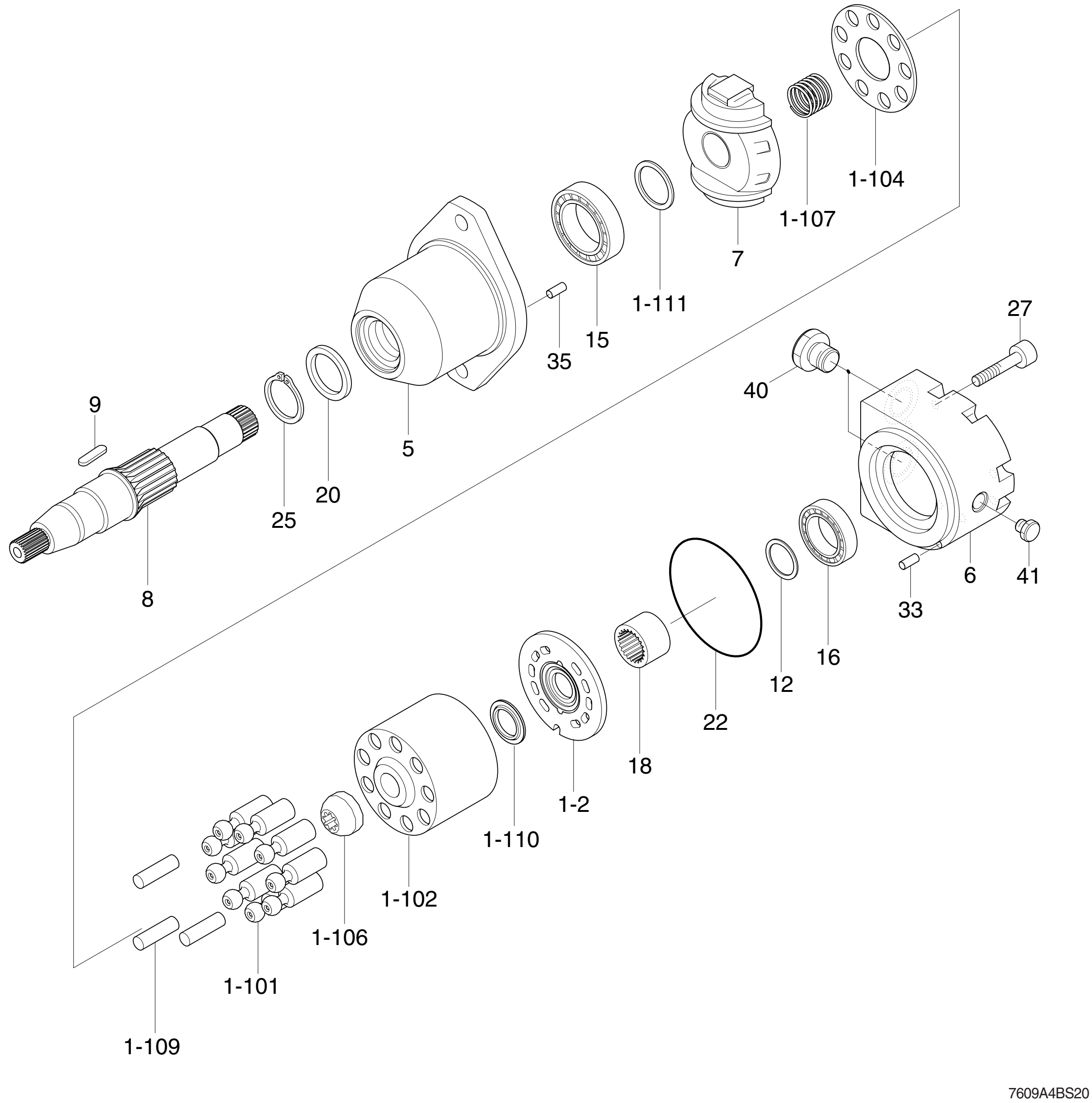
Cylinder sliding surface free of grooves, no wear, no embedded foreign particles. That there are no scratches on the control plate. (Only replace them as a set).



75796WE87

2. FAN MOTOR

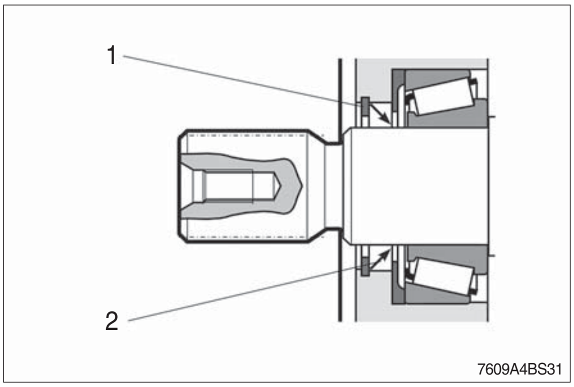
1) STRUCTURE



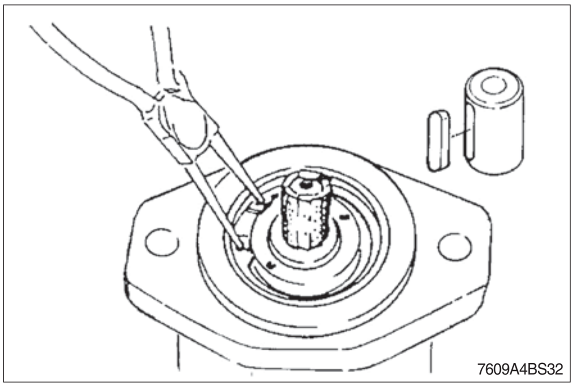
1-1	Rotary group	1-2	Control plate	18	Bearing bushing
1-101	Piston	5	Motor housing	20	Shaft seal
1-102	Cylinder	6	Port plate	22	O-ring
1-104	Retaining plate	7	Cam plate (swash plate)	25	Retaining ring (circlip)
1-106	Retaining ball	8	Drive shaft	27	Socket bolt
1-107	Spring	9	Shaft key	33	Cylinder pin
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

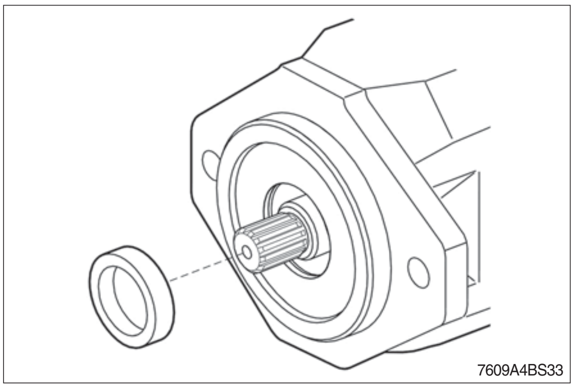
(1) 1 Circlip
2 Shaft seal



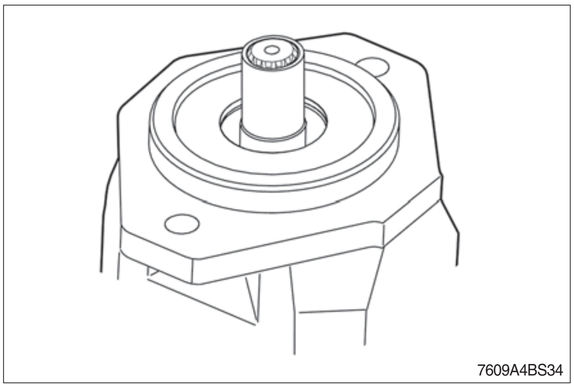
(2) Remove key.
Protect the drive shaft.
Remove the circlip.



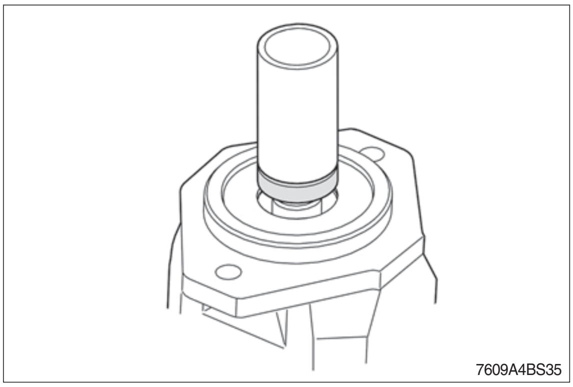
(3) Change the shaft seal and check its sliding surface (drive shaft) and housing, grease the sealing ring.



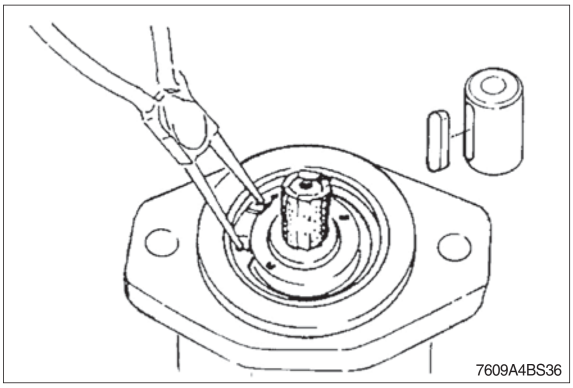
(4) Use installation tool or plastic strip for assembling seal.



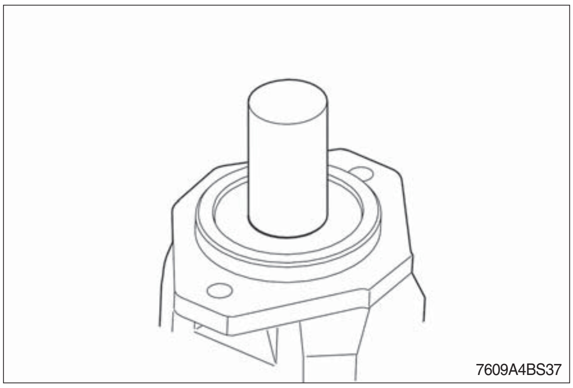
(5) Use a suitable pipe to mount the shaft seal, but don't push it too deep. If the shaft ring touches the bearing ring you will damage the seal ring.


7609A4BS35

(6) Assemble the circlip.


7609A4BS36

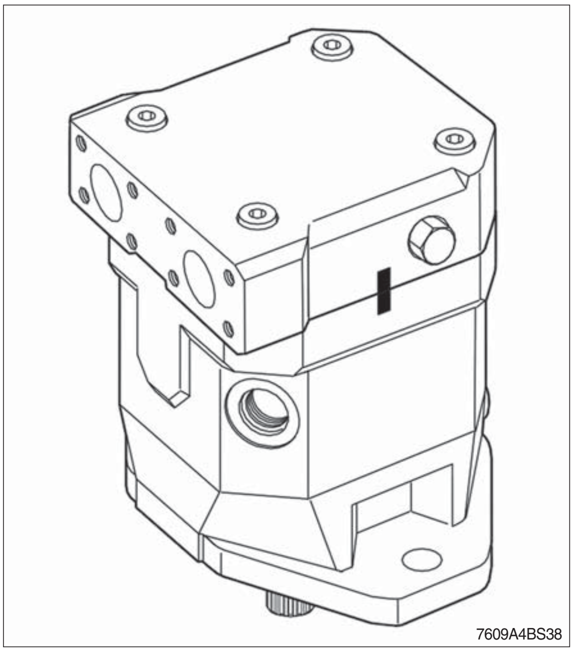
(7) Assemble the circlip in the correct position.


7609A4BS37

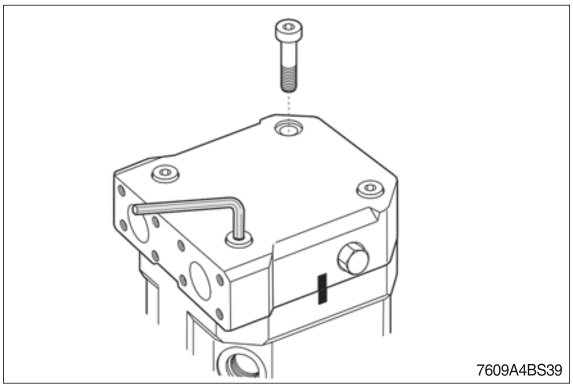
※ This discription showes how th change the drive shaft seal but it isn't the way of serial assembly.
The seal is assembled together with the taper roller bearing from inside the motor housing normally to get a secure sealing condition. If you decide to repair the motor in the shown way be very careful 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.

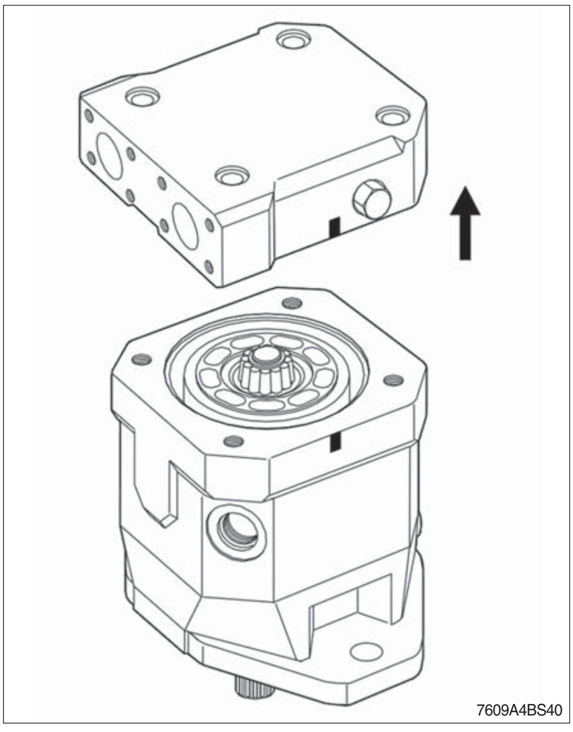


(2) Remove the port plate fixing bolts crosswise.

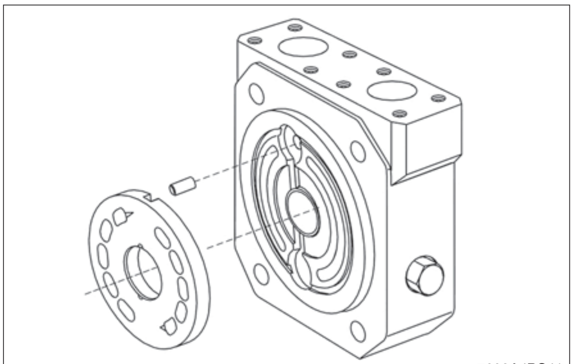


(3) Remove the port plate.

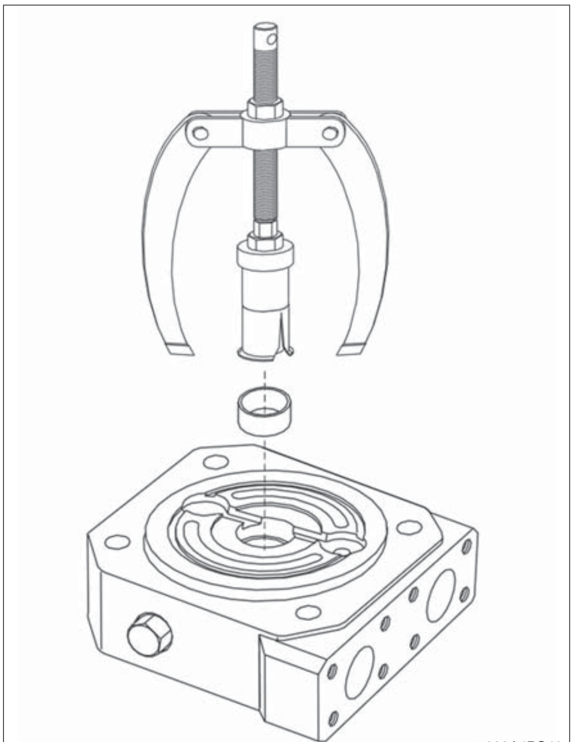
※ Control plate can drop down-hold tight.



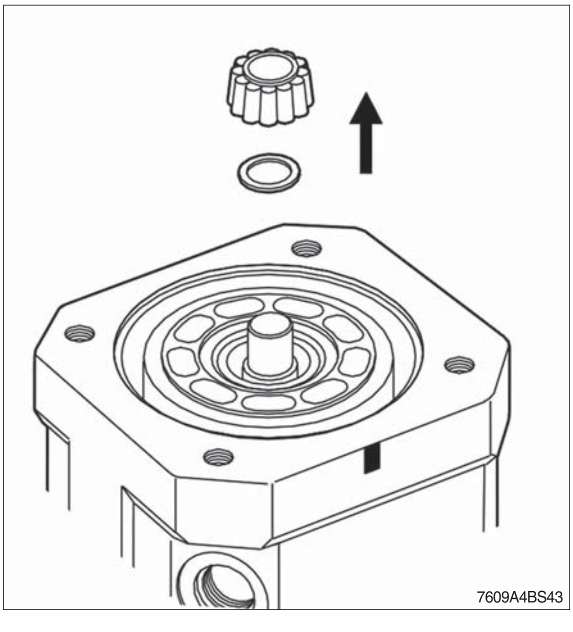
(4) Remove control plate.


7609A4BS41

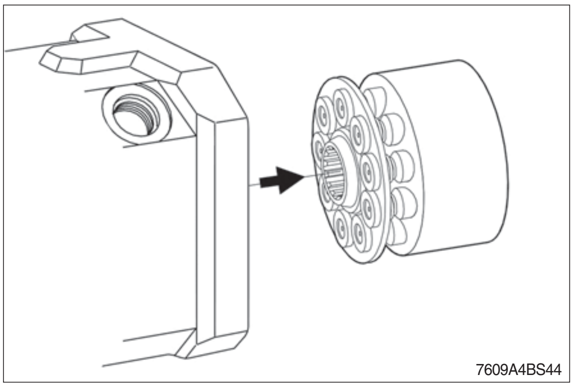
(5) Remove bearing outer ring with withdrawal tool.
Do not damage the sealing surface.


7609A4BS42

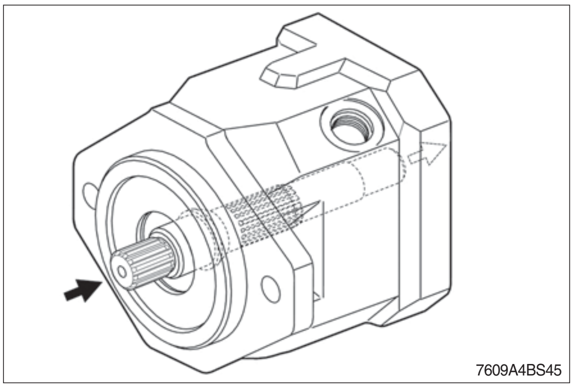
(6) Disassemble the taper roller bearing (near by port plate).
Remove the adjustment shim.


7609A4BS43

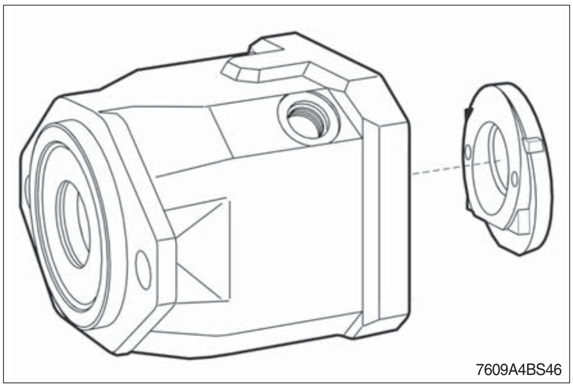
(7) Remove the rotary group in a horizontal position.


7609A4BS44

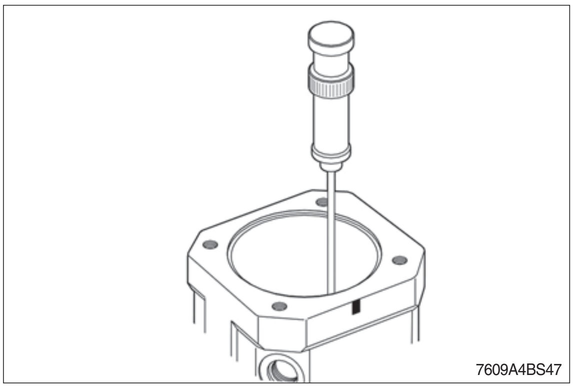
(8) Remove the drive shaft to rear side.


7609A4BS45

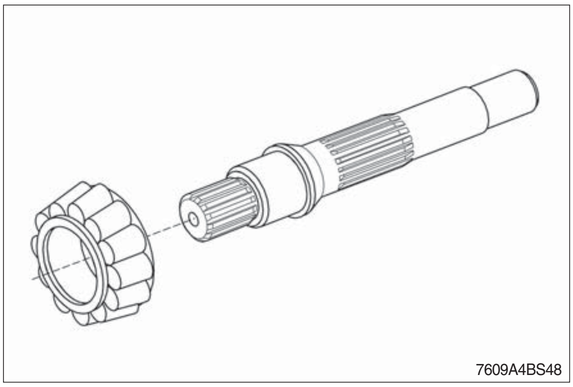
(9) Remove swash plate with special tool (see the next figure).


7609A4BS46

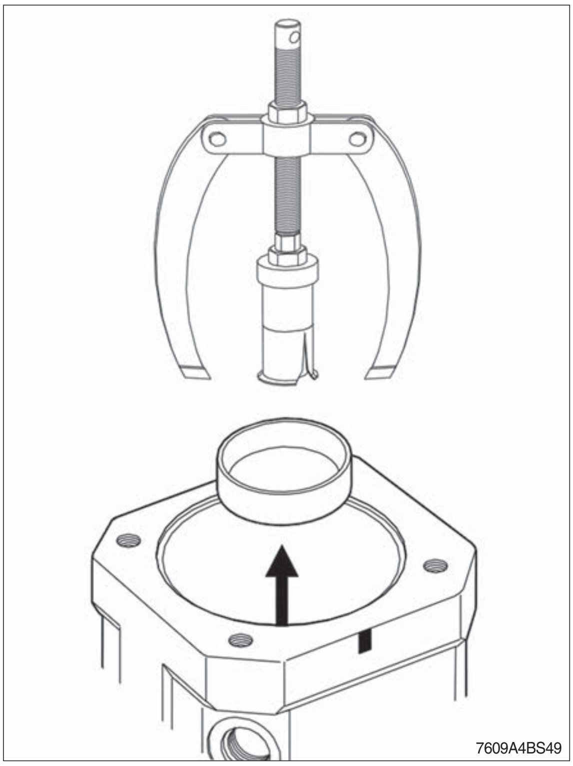
(10) Loosen the swash plate with a slide hammer (a small hook - diameter 6 mm - catches the end of the swash plate at the bottom).


7609A4BS47

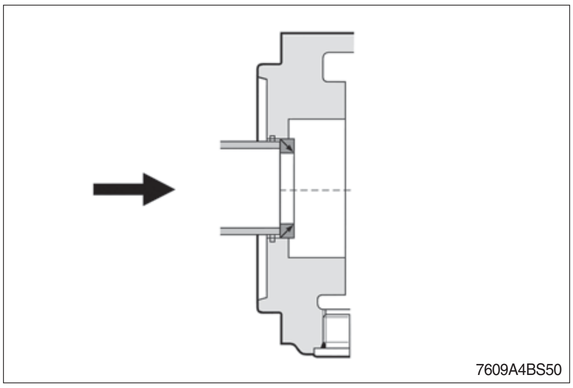
(11) Press down bearing.



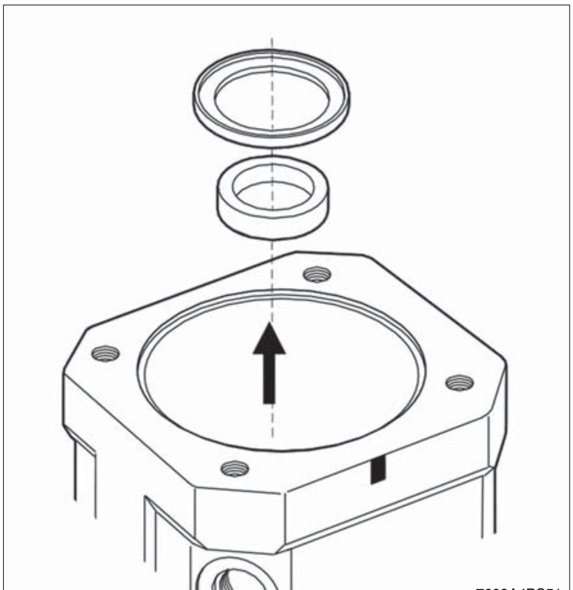
(12) The external front bearing ring is pulled out of the pump housing.



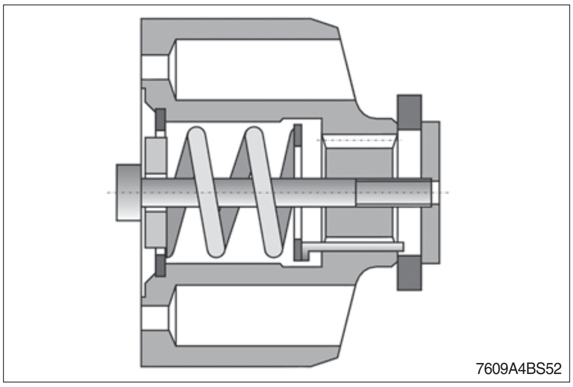
(13) Disassemble circlip and shaft seal.



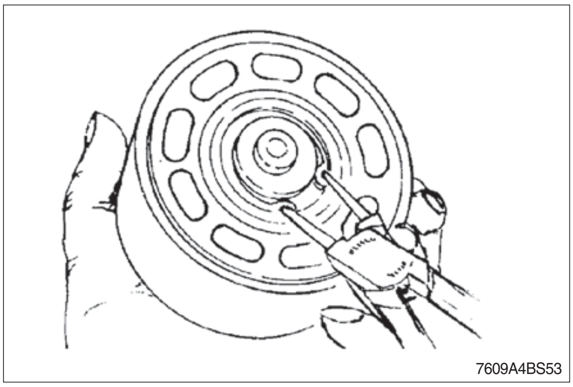
(14) Remove shaft seal and shim.


7609A4BS51

(15) Pre-tension the spring using a suitable device.

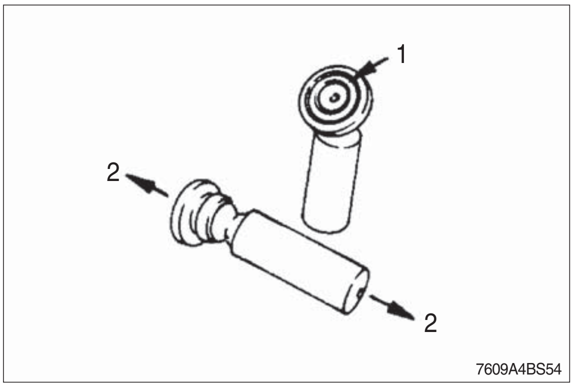

7609A4BS52

(16) Remove circlip.
Remove spring and pressure pins.

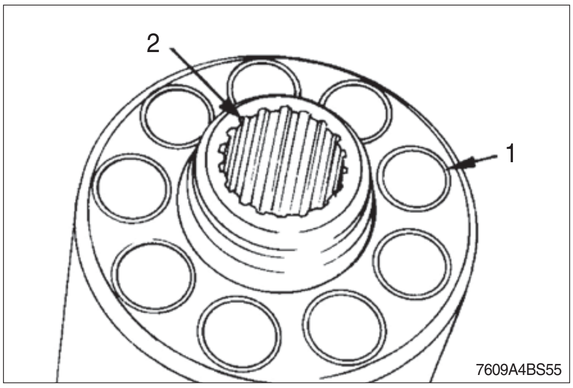

7609A4BS53

4) INSPECTION HINTS

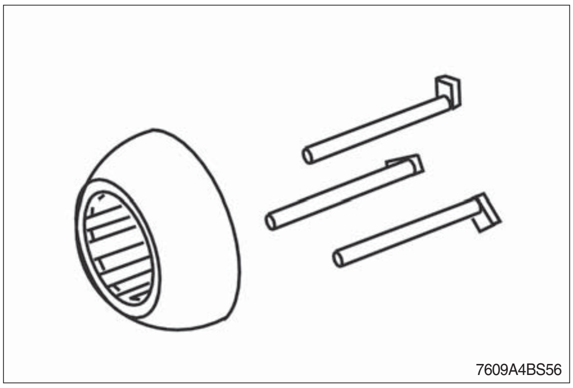
(1) Check to see that there are no scratches or metal deposits on the sliding surface (1), and that there is no axial play (2), (pistons must only be replaced as a set).



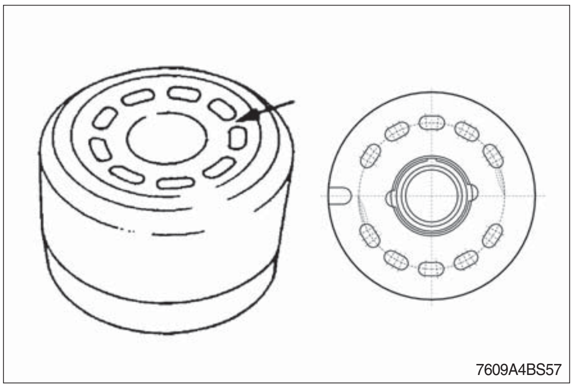
(2) Check cylinder bores (1) and splines (2).



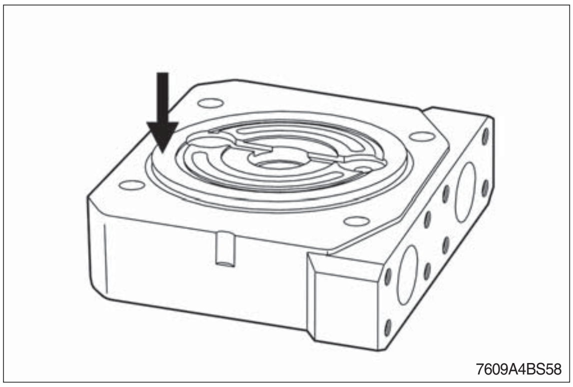
(3) Free of grooves, no signs of wear.



(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).



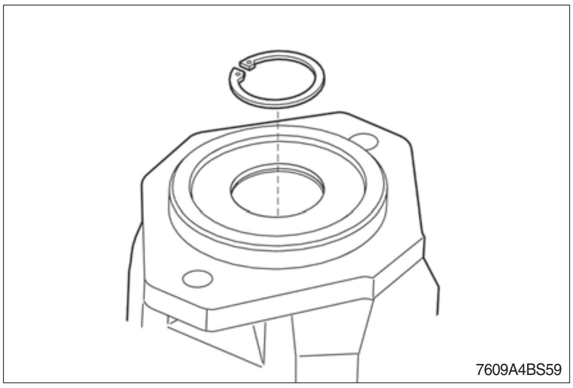
(5) Mounting surface - control plate undamaged.



7609A4BS58

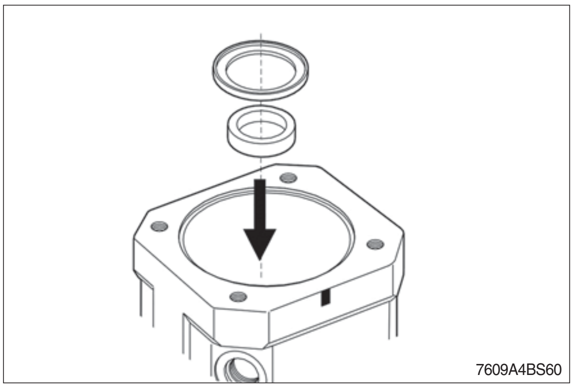
5) MOTOR ASSEMBLY

(1) Fit the circlip into the housing.



7609A4BS59

(2) Assemble shaft seal and shim against circlip.



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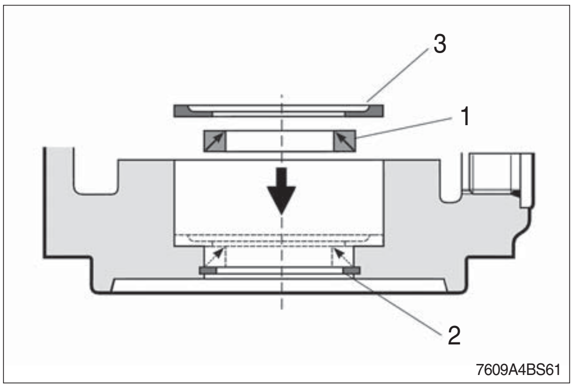
(3) Assembly of the shaft seal (1) against the safety ring (2) back up the shim (3) down to the seal ring.



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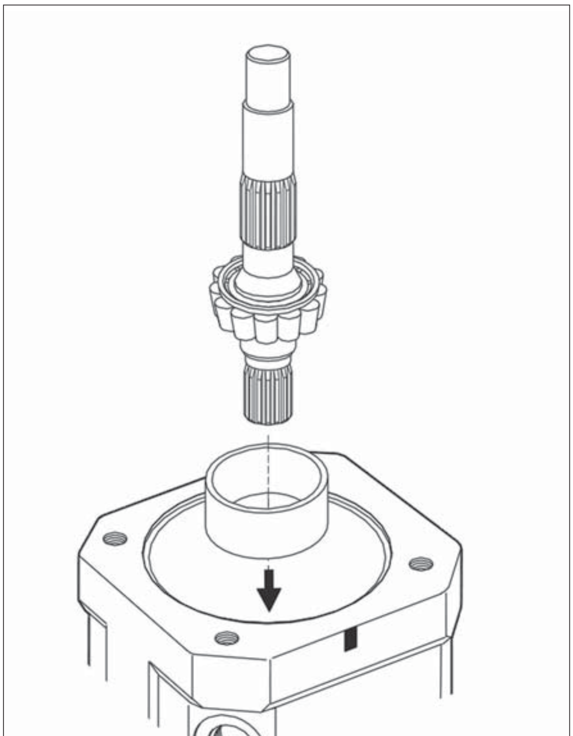
(4) Press outer bearing ring into housing.
Shaft seal with pre-assembled bearing into housing.

※ Protect splines of the shaft with plastic strip against damage of the seal lip.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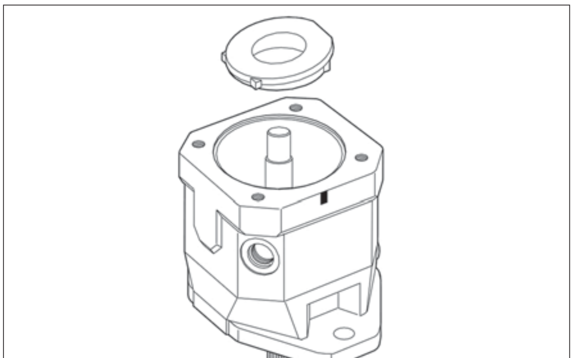
(5) Assemble swash plate.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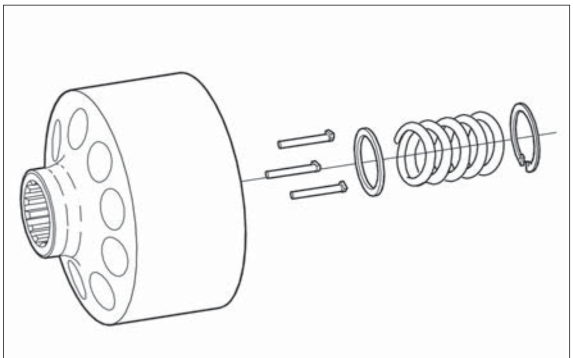
(6) Fit pressure pins using an assembly aid.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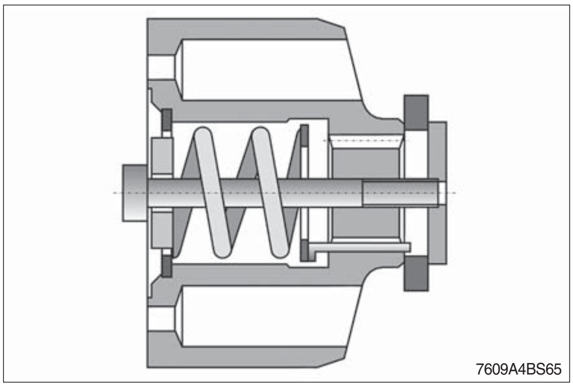
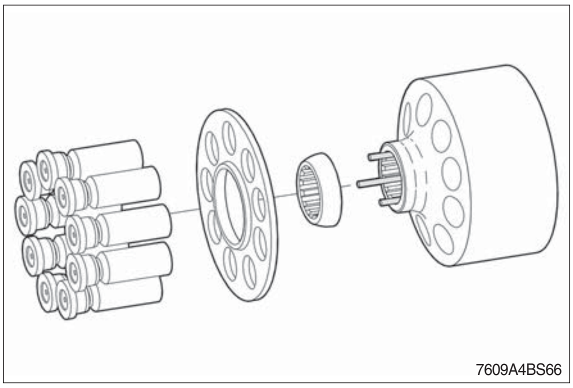
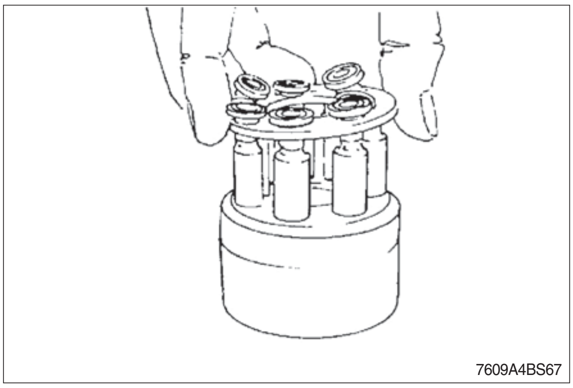
(7) Pre-tension the spring using a suitable device.





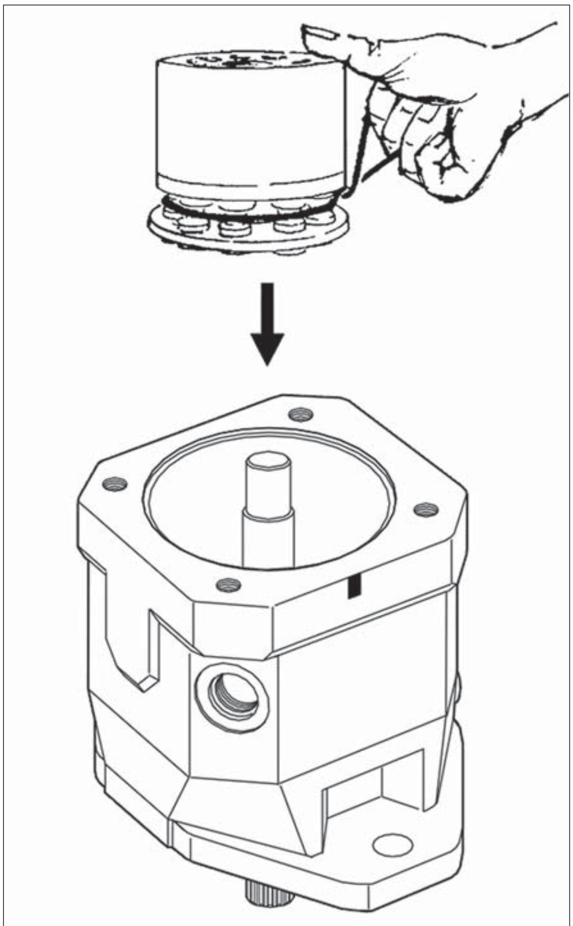
(8) Assemble piston with retaining plate.

※ Oil piston and slipper pad.



(9) Fit rotary group.

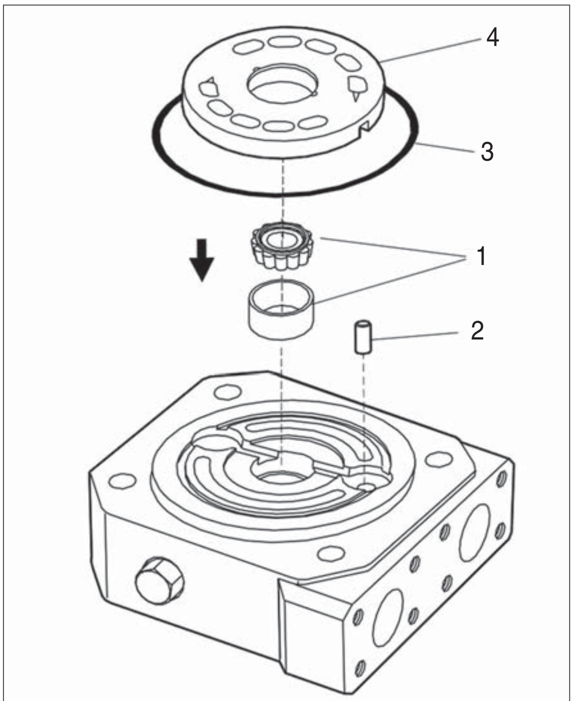
※ Assembly aid :
Hold the pistons by using an O-ring.



7609A4BS68

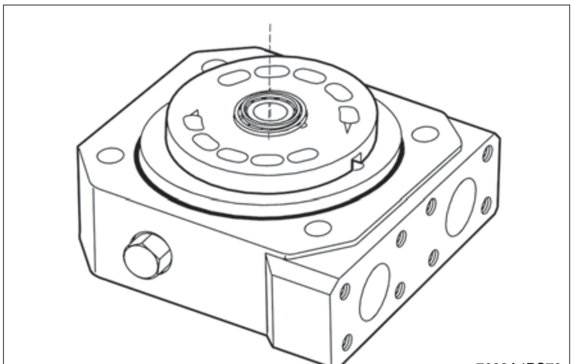
(10) Fit bearing (1) in port plate.
Fit cyilindrical pin (2).
Fit O-ring (3).
Fit control plate (4).

※ Assembly :
Hold the components in place with grease.

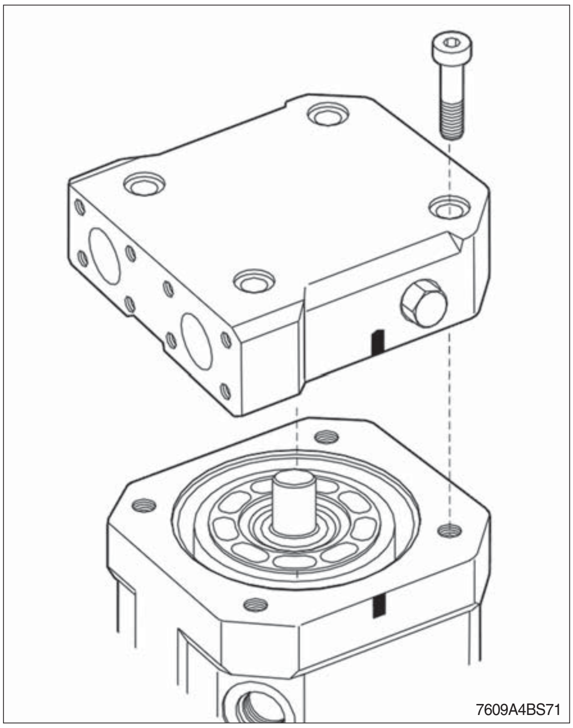


7609A4BS69

(11) Fit control plate.
Assembly aid : Grease


7609A4BS70

(12) Fit the port plate and fix it with the bolts crosswise.


7609A4BS71

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 an closed center loader system.

The components of the steering system are :

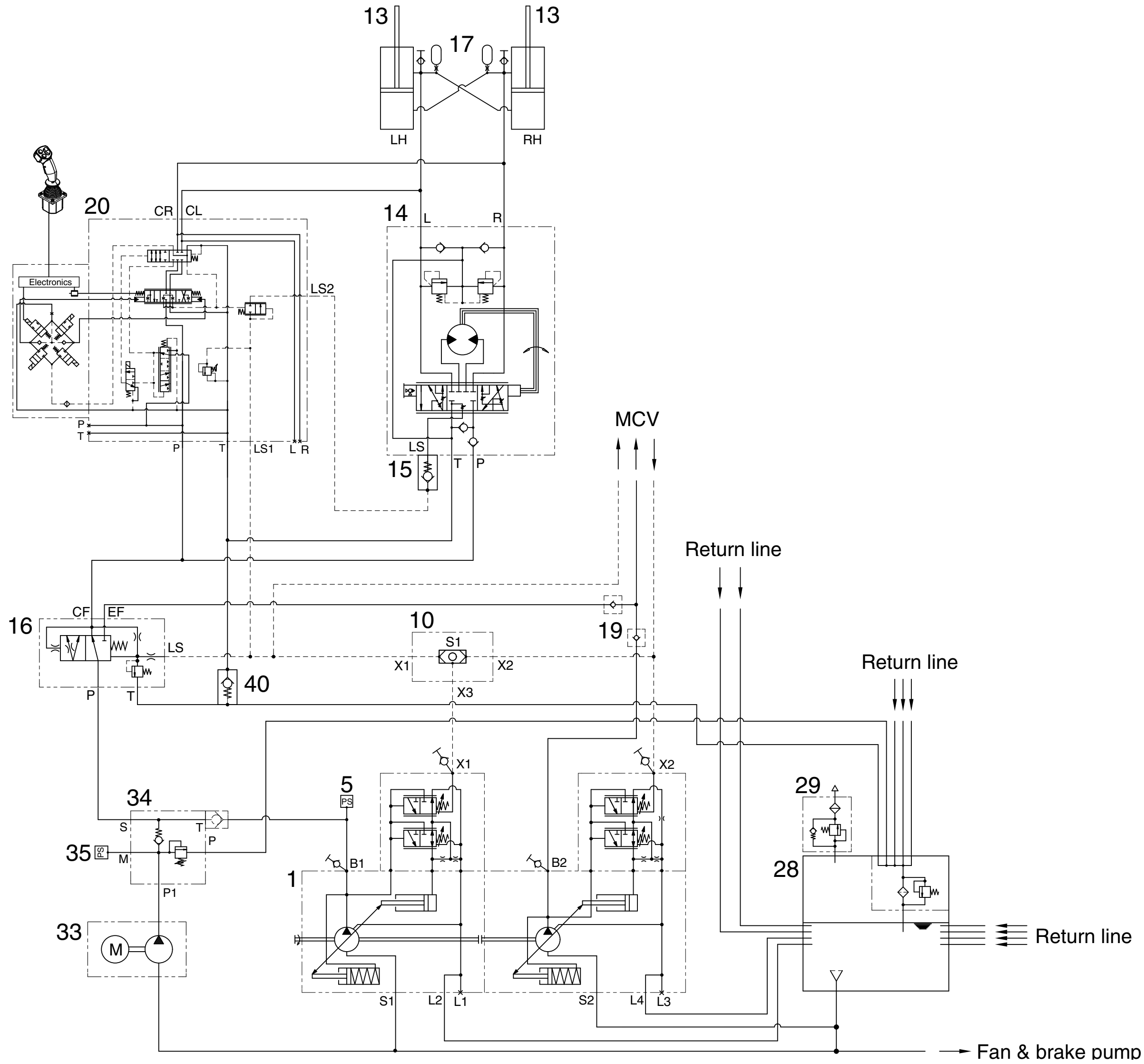
· Steering pump
· Priority valve
· Steering unit
· Accumulators
· Steering cylinders

The steering pump, the first pump of main pump, draws hydraulic oil from the hydraulic tank.
Outlet flow from the pump flows to the priority valve. The priority valve 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.

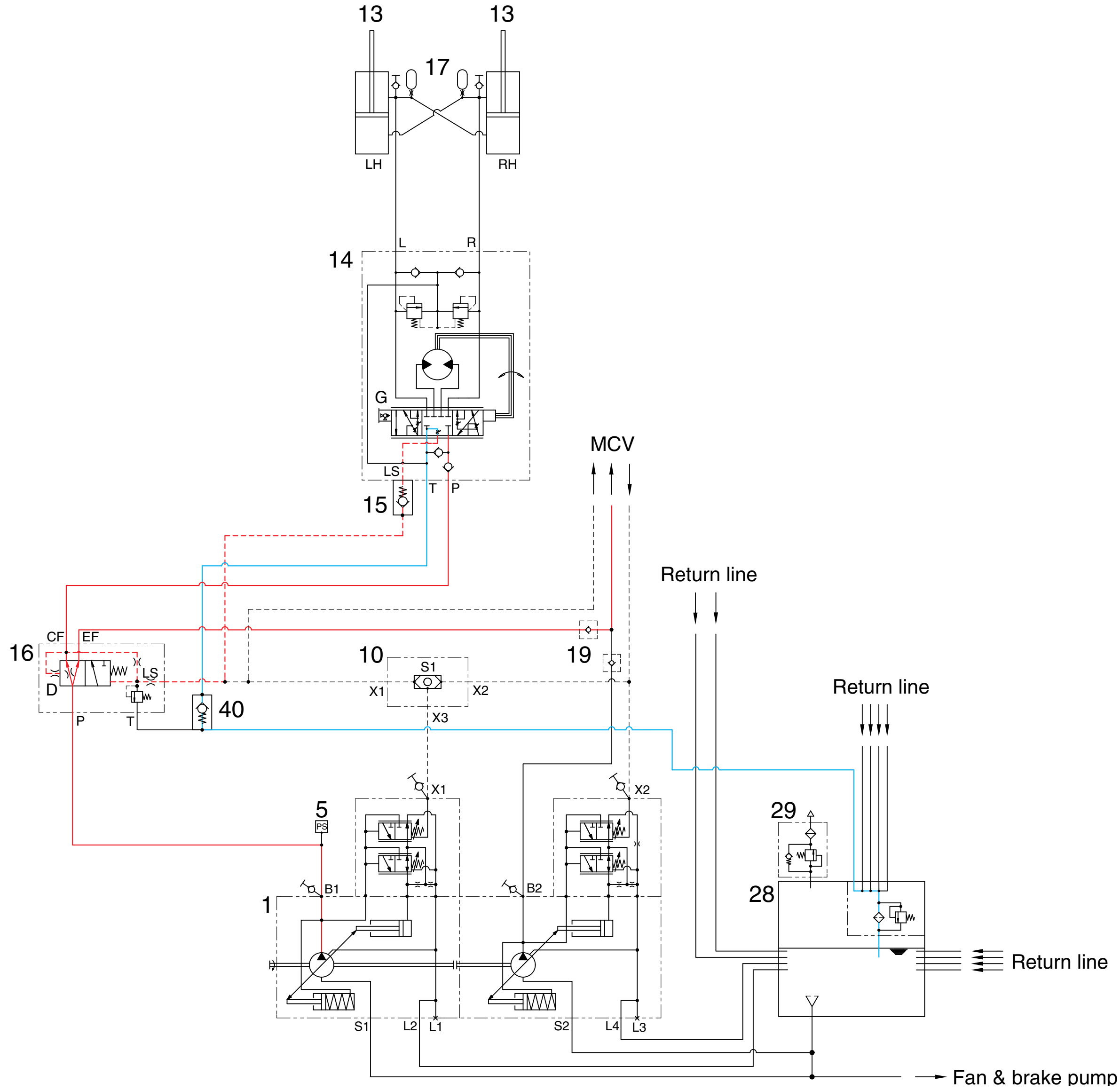
2. HYDRAULIC CIRCUIT



960A5SE01

1	Main (steering) pump	16	Priority valve	29	Air breather
5	Pressure sensor	17	Accumulator	33	Motor pump (option)
10	Shuttle valve	19	Check valve	34	Check block (option)
13	Steering cylinder	20	Steering valve (option) (Joystick steering)	35	Pressure sensor (option)
14	Steering unit			40	Check valve
15	Line check valve	28	Hydraulic tank		

1) NEUTRAL



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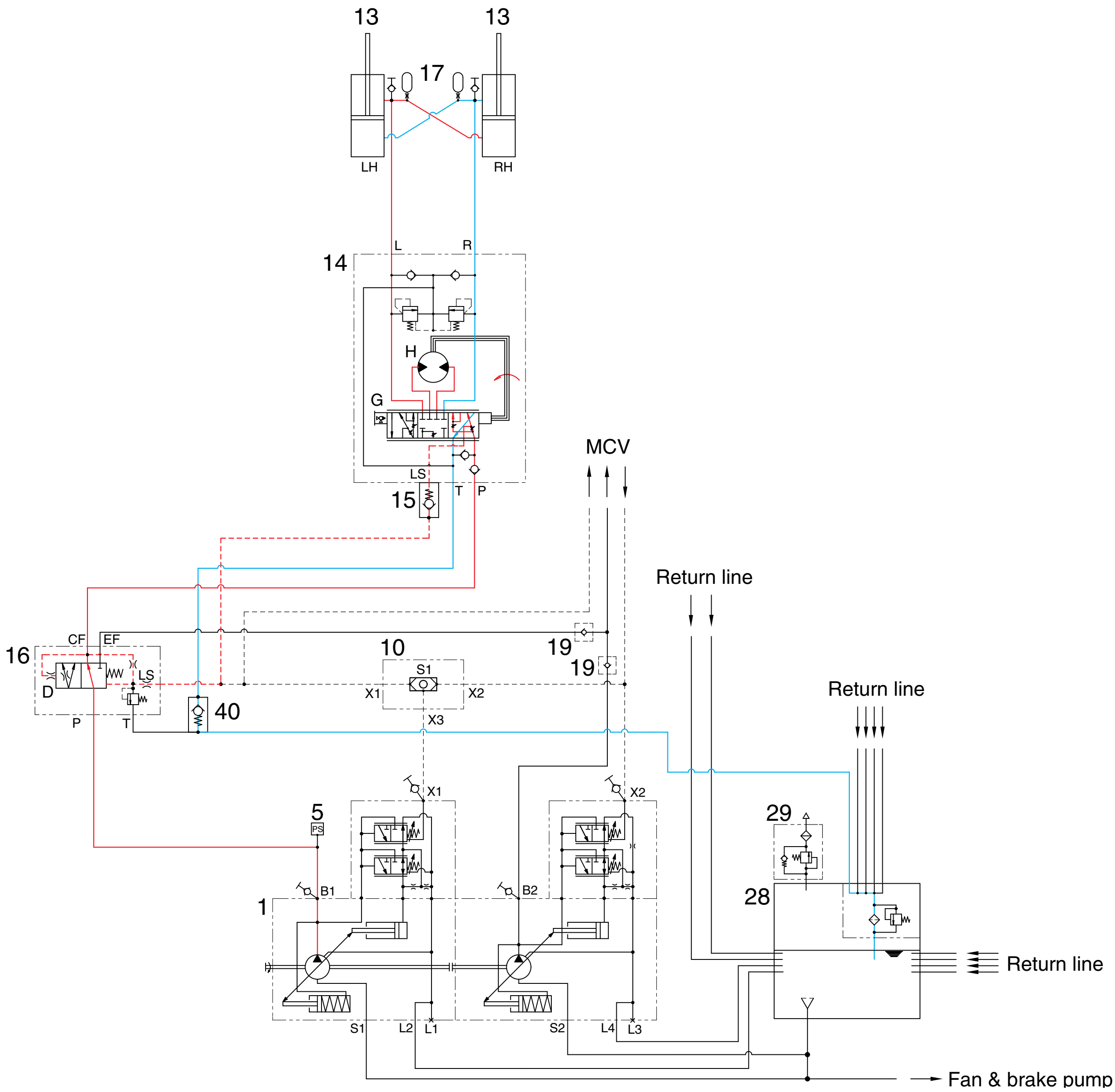
- The steering wheel is not being operated so control spool (G) does not move.
- The oil from the steering pump enters port P of the priority valve (16) and the inlet pressure oil moves the spool (D) to the right.
- Almost all of pump flow goes to the loader system (main control valve) through the EF port and partly flows into the hydraulic tank (28) through the spool (D).

2) LEFT TURN



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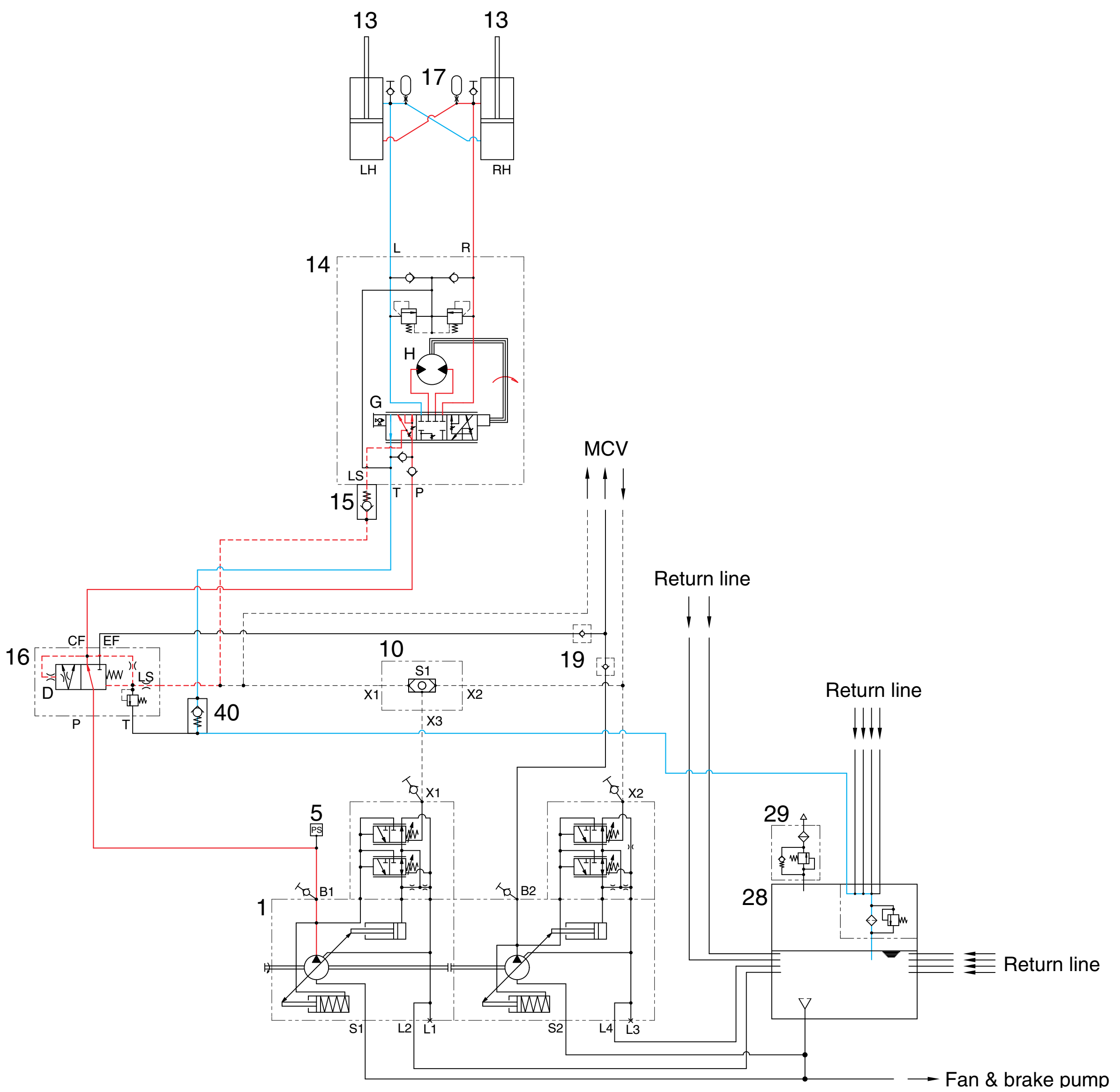
- When the steering wheel is turned to the left, the spool (G) within the steering unit (14) connected with steering column turns in left hand direction.
- At this time, the oil discharged from the pump flows into the spool (G) of the steering unit (14) through the spool (D) of priority valve (16) and flows into the gerotor (H).
- Oil flow from the gerotor flows back into the spool (G) where it is directed out the left work port (L) to the respective chamber of the steering cylinders (13).
- Oil returned from left and right cylinder returns to hydraulic tank through the spool (G) of the steering unit.

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

3) RIGHT TURN

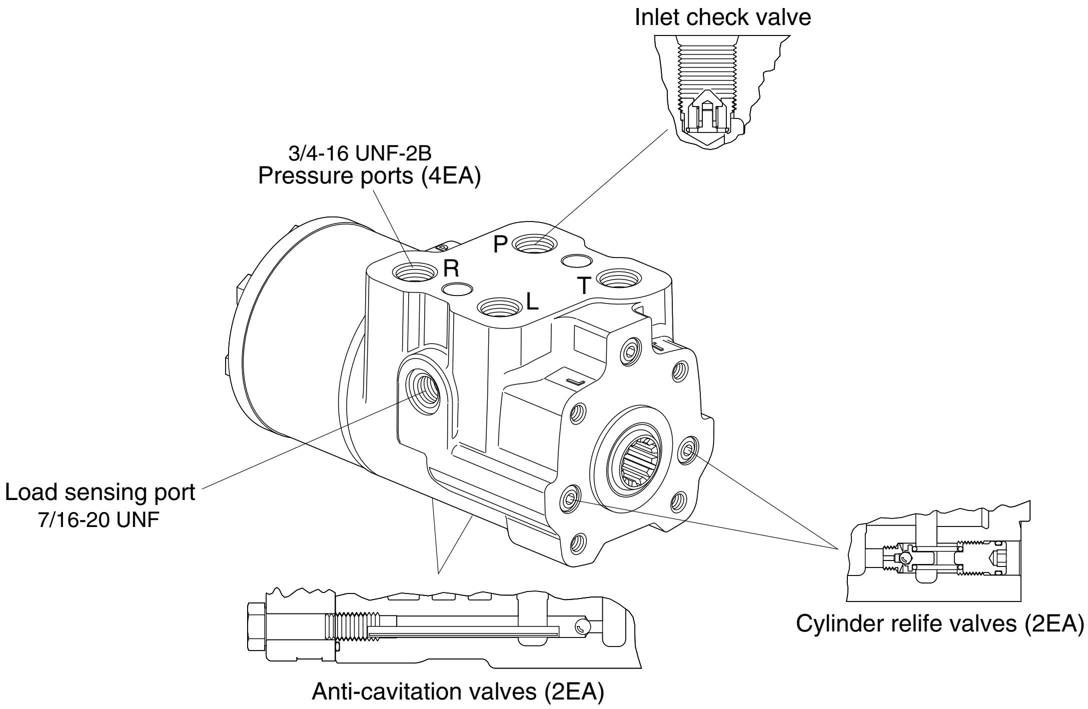


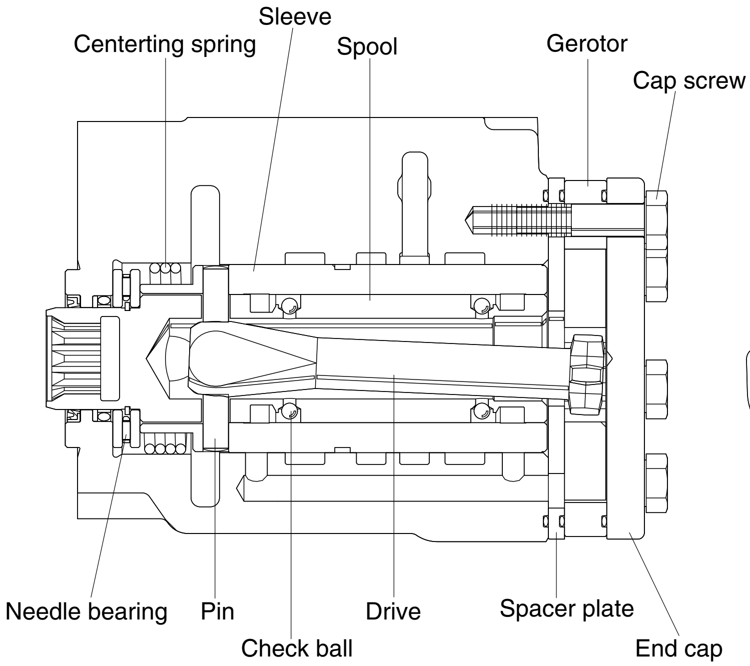
960A5SE04

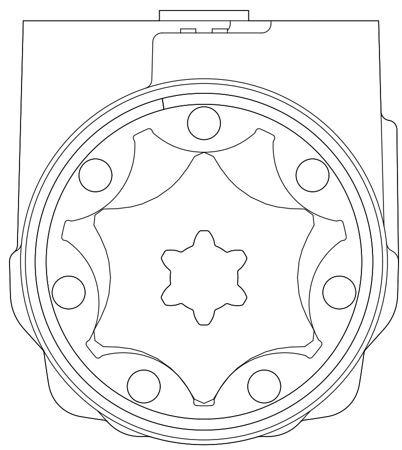
- When the steering wheel is turned to the right, the spool (G) within the steering unit (14) connected with steering column turns in right hand direction.
- At this time, the oil discharged from the pump flows into the spool (G) of the steering unit (14) through the spool (D) of priority valve (16) and flows into the gerotor (H).
- Oil flow from the gerotor flows back into the spool (G) where it is directed out the right workport to the respective chamber of the steering cylinders (13).
- Oil returned from left and right cylinder returns to hydraulic tank through the spool (G) of the steering unit.

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

3. STEERING UNIT





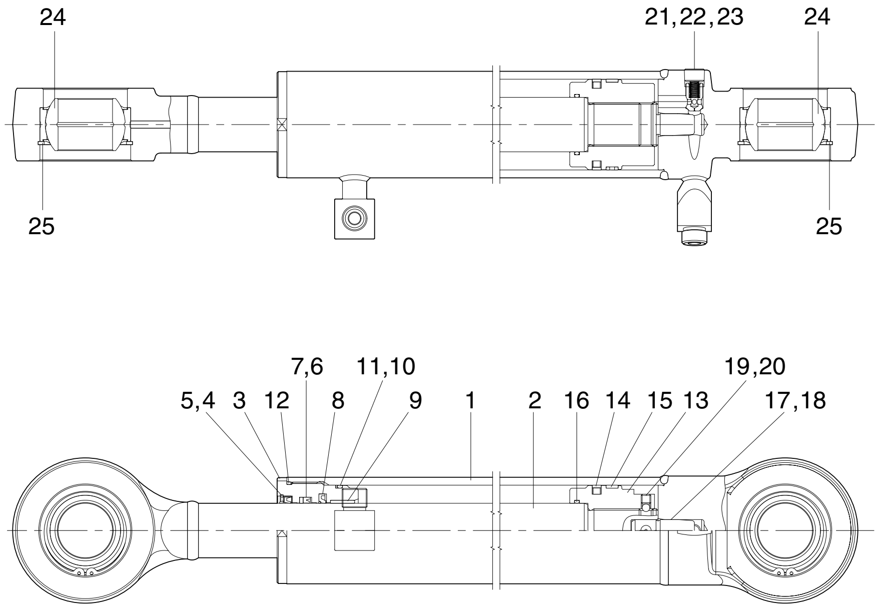


View of Gerotor Section

960A5SE13

4. STEERING CYLINDER

1) STRUCTURE



960A5SE05

1	Tube assembly	10	O-ring	19	Steel ball
2	Rod assembly	11	Back up ring	20	Set screw
3	Gland	12	O-ring	21	Check valve
4	Dust wiper	13	Piston	22	Coil spring
5	Retaining ring	14	Piston seal	23	Hexagon socket plug
6	Rod seal	15	Wear ring	24	Spherical bearing
7	Back up ring	16	O-ring	25	Retaining ring
8	Buffer ring	17	Cushion plunger		
9	Du bushing	18	Parallel pin		

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 in side 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.

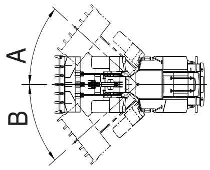
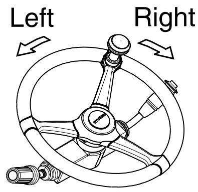
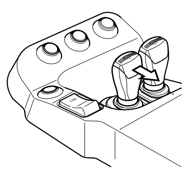
The engine and all other major components must be at operating temperature for some checks.

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 6-49).

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 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 priority valve pressure test.
Priority valve 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 priority valve 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.
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 steering valve.
	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	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.

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. Leaf springs without spring force or broken. Worn splines on the steering column.	Replace cardan shaft. Replace leaf springs. Replace steering column.
"Shimmy" effect. The steered wheels vibrate. (Rough tread on tires gives vibrations)	Air in the steering cylinder. Mechanical connections or wheel bearings worn. High priority valve setting pressure.	Bleed cylinder. Find and remove the reason for air collection. Replace worn parts. 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. Relief valve setting too low. Relief valve sticking owing to dirt. Spool in priority valve sticking owing to dirt. Too weak spring in priority valve.	Replace pump or increase number of revolutions. Adjust valve to correct setting. Clean the valve. Clean the valve, check that spool moves easily without spring. 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 gear-wheel 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, gear-wheel 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 110 ℓ (29.1 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.

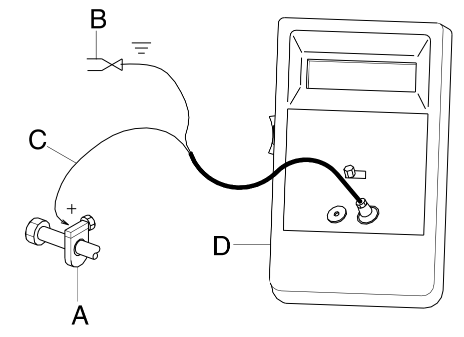
9) Install a new return filter element.

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.



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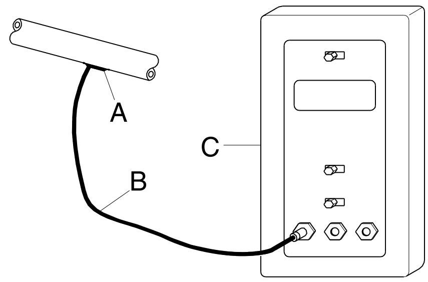
2) DIGITAL THERMOMETER INSTALLATION

· 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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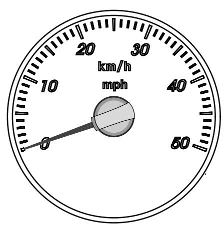
3) DISPLAY MONITOR TACHOMETER

The display monitor tachometer is accurate enough for test work.



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3. STEERING SYSTEM RESTRICTION TEST

· SPECIFICATION

Oil temperature	45±5˚C (113±9˚F)
Engine speed	High idle
Maximum pressure at steering unit	210 bar (3046 psi)

· GAUGE AND TOOL

Gauge

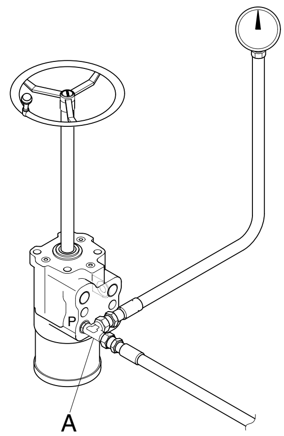
· This test will check for restrictions in the steering system which can cause overheating of hydraulic oil.

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 6-49).
3) Connect fitting (A) 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 steering unit, inspect priority valve spool for a stuck spool. Make sure orifice plugs installed in ends of priority valve spool.



Steering unit

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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)

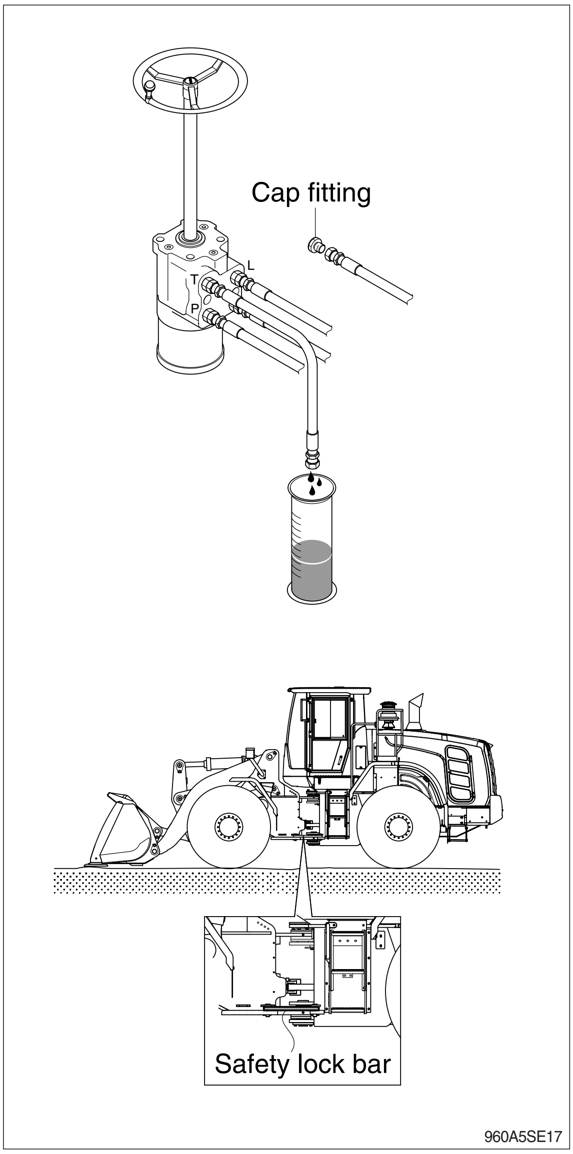
· GAUGE AND TOOL

Temperature reader

Measuring container (approx. 20 ℓ)

Stop watch

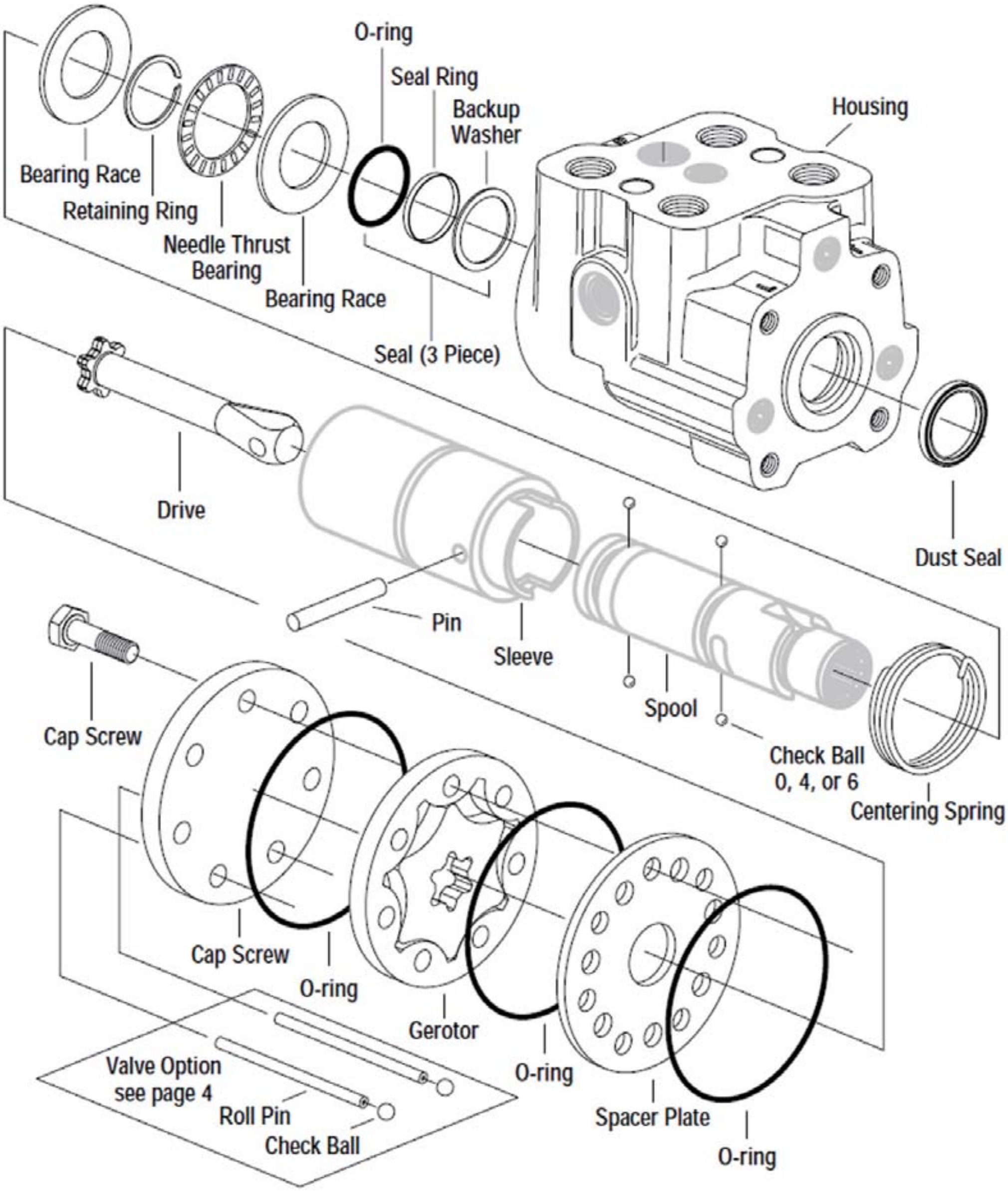
1) Install frame locking bar to prevent machine from turning.
2) Install temperature reader.
   (see temperature reader installation procedure in this group).
3) Heat hydraulic oil to specifications.
   (see hydraulic oil warm up procedure at page 6-49).
4) Disconnect return hose from fitting.
   Install 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.



GROUP 4 DISASSEMBLY AND ASSEMBLY

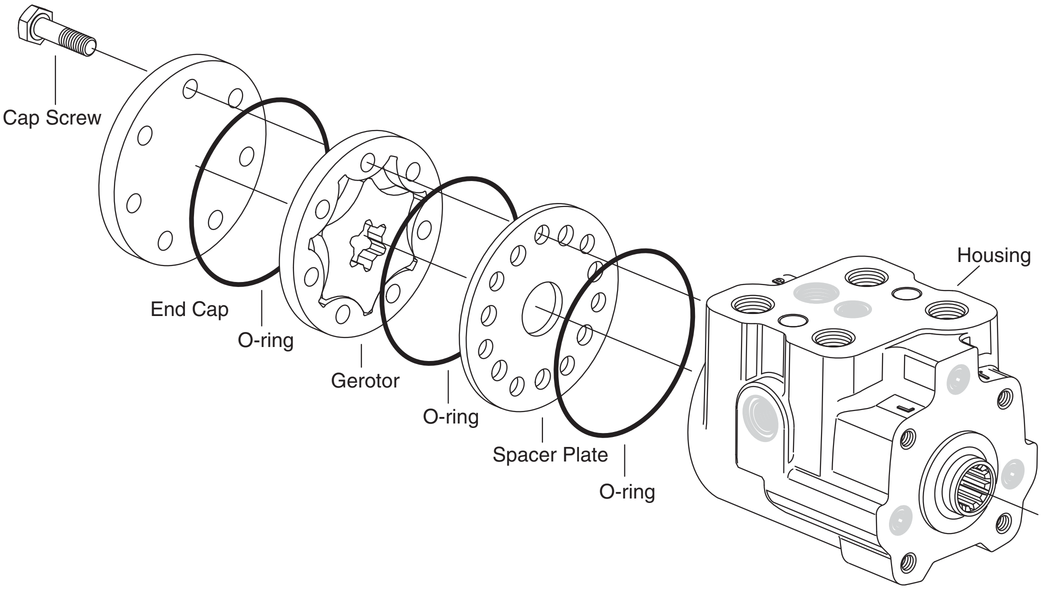
1. STEERING UNIT

1) STRUCTURE



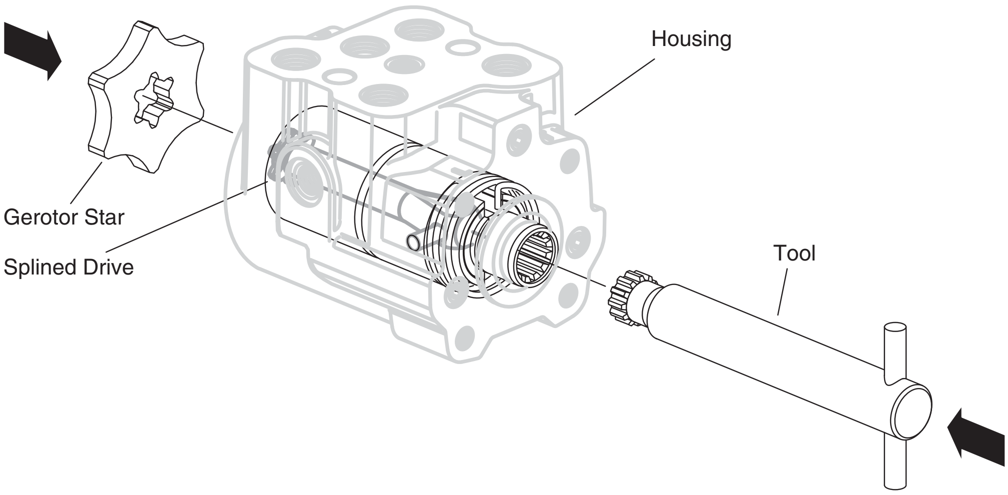
960A5SE33

2) DISASSEMBLY



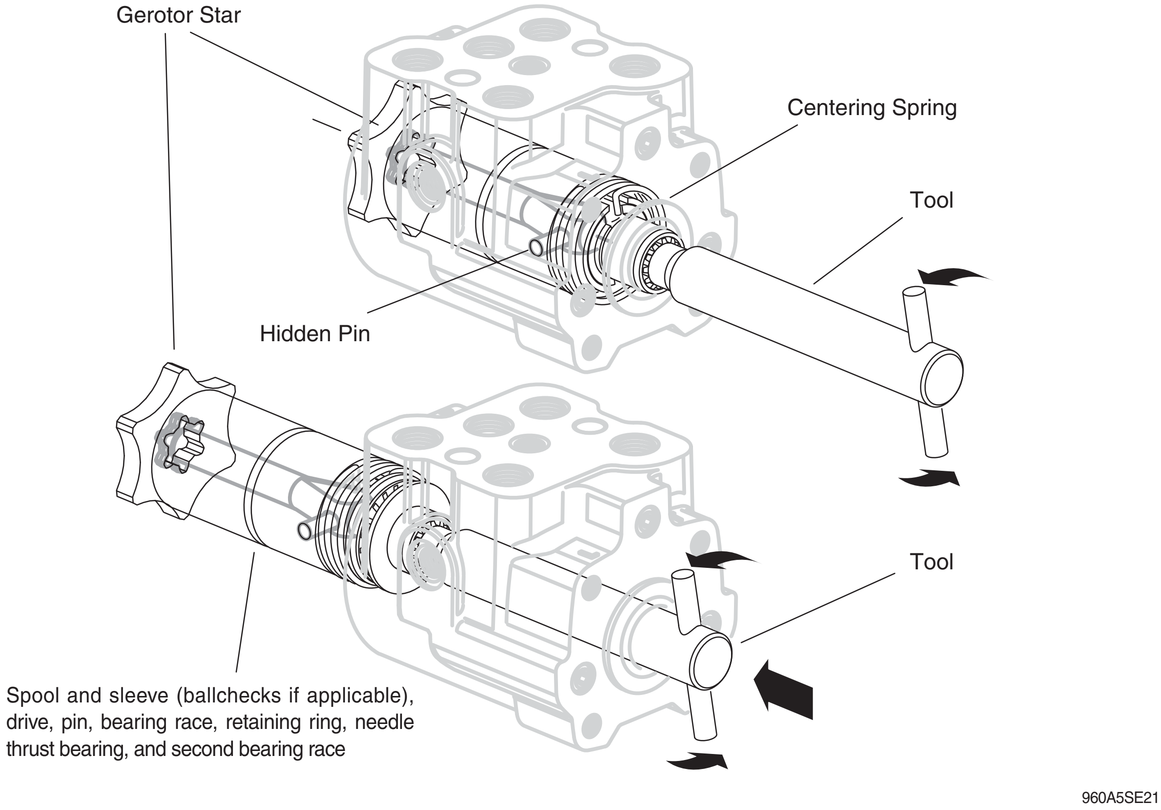
960A5SE19

(1) Remove the seven cap screws, end cap, O-ring, gerotor, O-ring spacer plate and O-ring.



960A5SE20

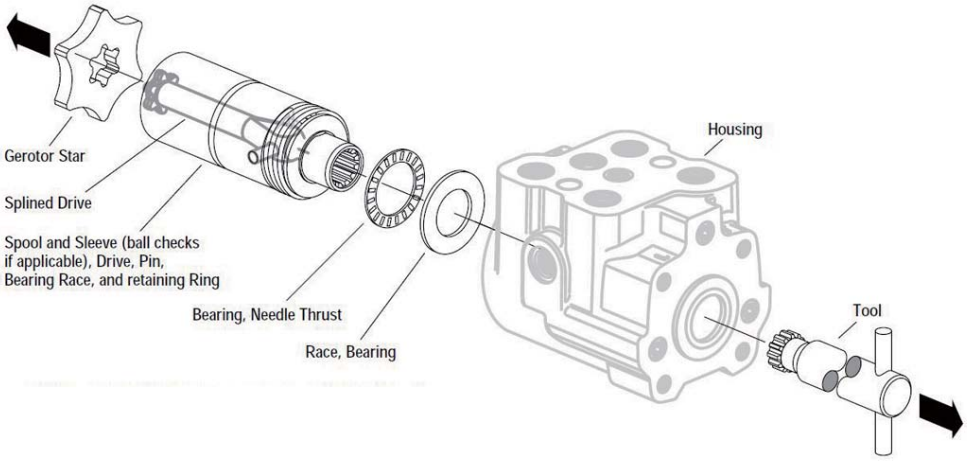
(2) Engage tool with splined end of spool.



(3) Protect gerotor star and hand with shop towel, hold gerotor star and splined drive from turning.

(4) Twist tool to compress centering spring radially CW or CCW, decreasing the coil diameter of the centering spring allowing it to be removed along with the spool and sleeve (ball checks if applicable), drive, pin, bearing race (2), retaining ring, and needle thrust bearing.
(Bearing races, retaining ring, and needle thrust bearing, not shown on drawing (left). Centering spring shown compressed.)

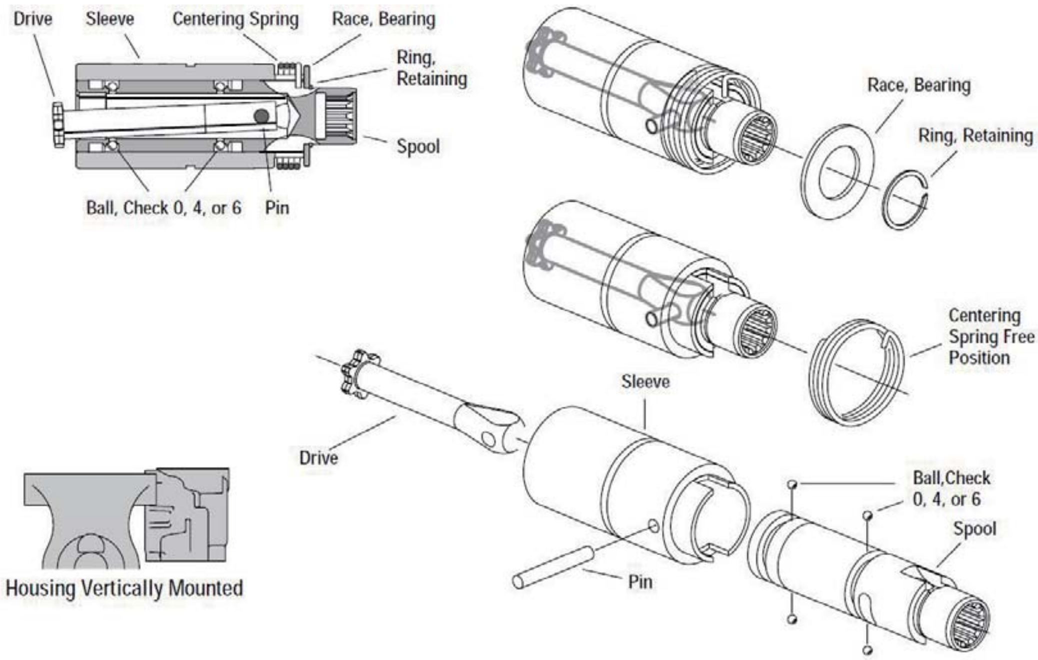
(5) With drive held stationary and centering spring compressed, carefully push these assembled parts out of housing.



960A5SE22

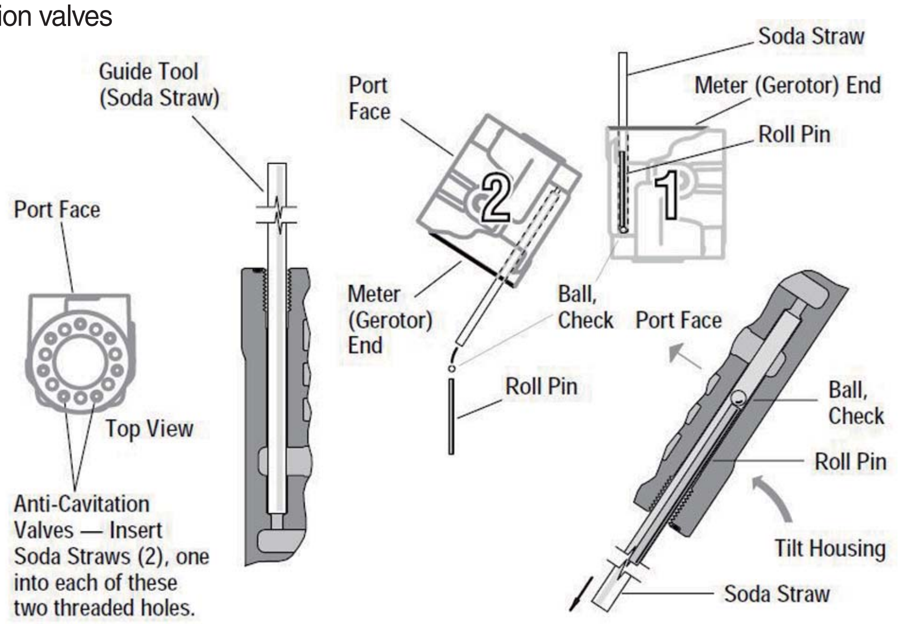
(6) Remove the thrust bearing race and needle thrust bearing.

(7) Remove the retaining ring (use retaining ring pliers), bearing race, centering spring, pin, drive, spool, sleeve, and ball checks if applicable.



960A5SE23

Anti-cavitation valves



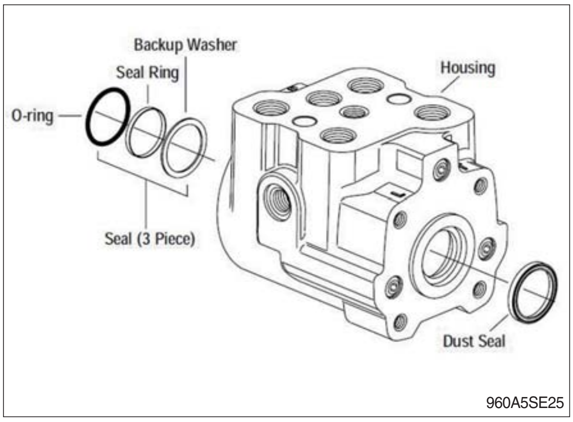
960A5SE24

(8) Insert two soda straws, one in each of two threaded holes, as a safety measure for removal of two small ball check valves and roll pins (correct threaded holes identified in illustration).
Remove housing from vise, tilt the housing and bring the port face upward. Continue turning the housing until the roll pins and ball checks slide through the straws from the meter (gerotor) end of the housing.

(9) Remove the shaft seal. These three parts may or may not still be in the housing. These parts include O-ring, seal ring, and backup washer.

(10) Using a small blade screw driver, carefully pry the dust seal from the housing.

※ Do not damage the dust seal seat.

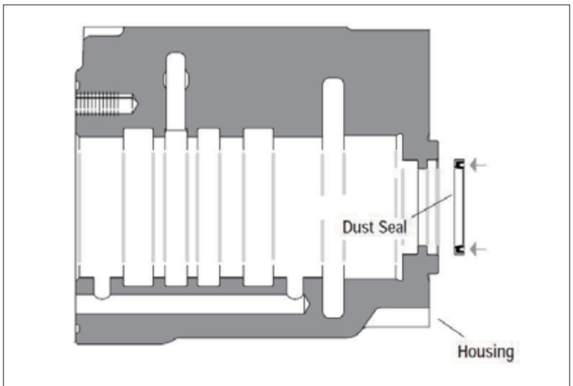


960A5SE25

3) ASSEMBLY

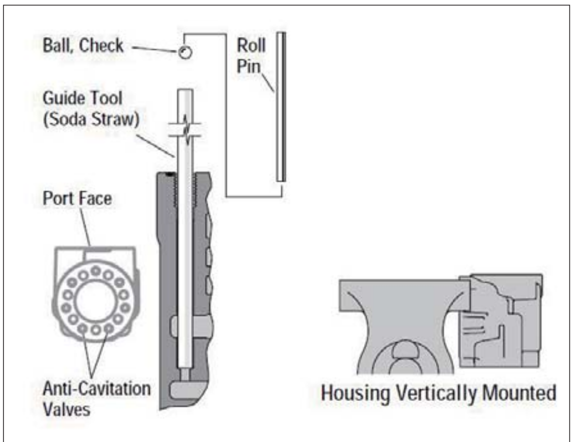
※ During assembly lubricate the new seals with a petroleum jelly such as vaseline.
Also lubricate machineds urfaces with clean hydraulic fluid.

(1) Lubricate and install the dust seal (see drawing (right) for correct seal orientation).



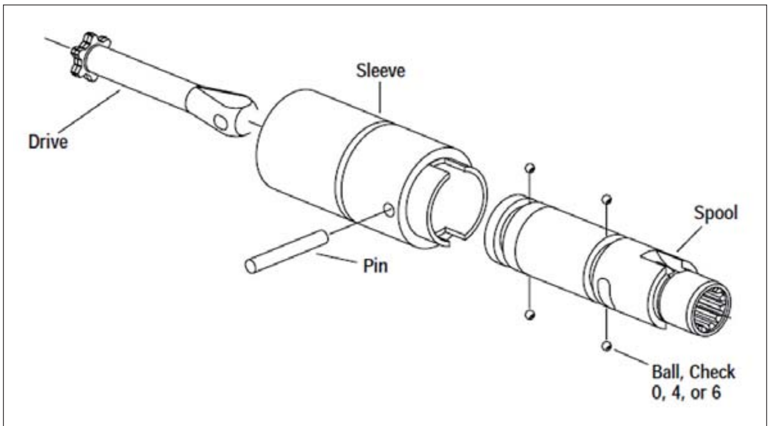
960A5SE26

(2) Installing the anti-cavitation ball checks seems simple enough. However, a word of caution : use a soda straw as a guide tool. Drop the straw into the hole to the bottom of bore, then drop ball through straw.
Pull straw and use the same procedure in second ball seat. Check each bore with small light to make sure each ball is in the correct place. Add roll pin in each bore.



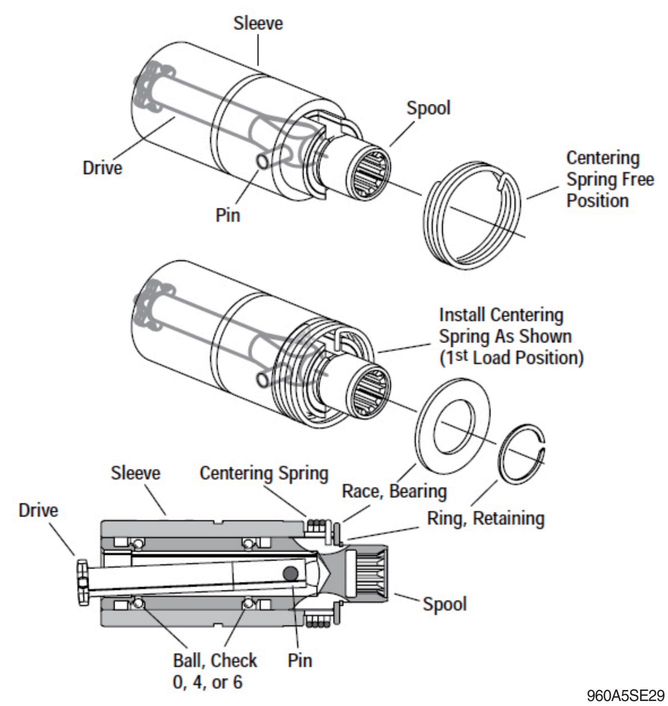
960A5SE27

(3) Apply a light coating of clean hydraulic fluid to the spool and slide itinto the sleeve along with the ball checks if applicable.

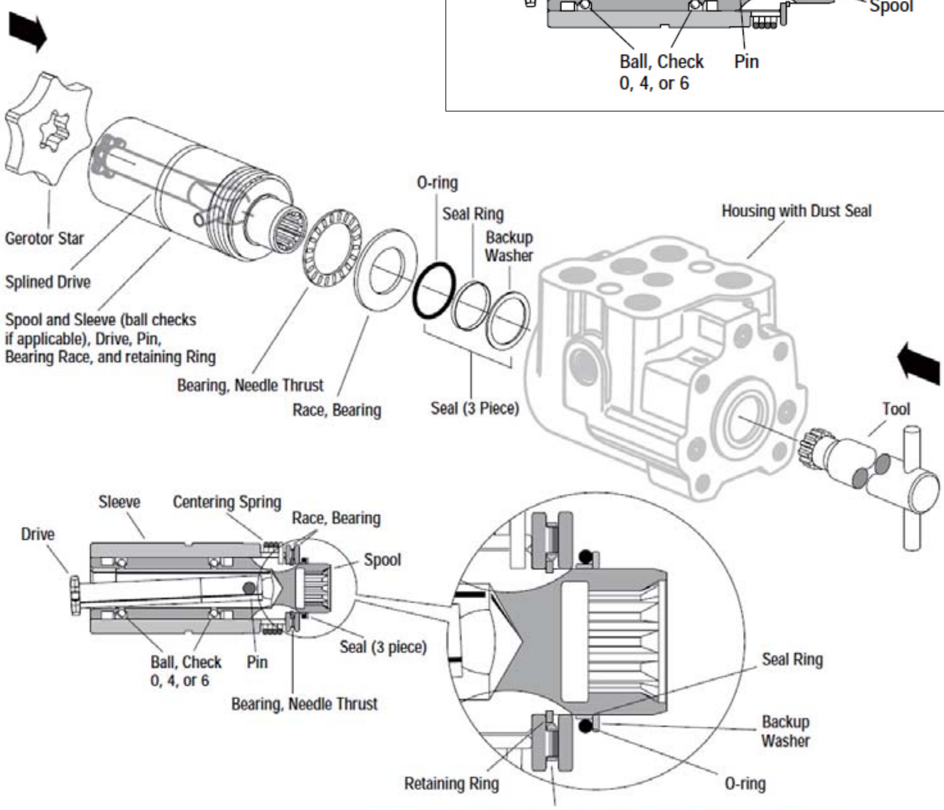


960A5SE28

(4) Install the drive and pin.
(5) Install the centering spring. Position one end of spring in slotted end of spooland sleeve, and compress the spring radially (CCW) to engage free end of spring.
(6) Install the bearing race and retaining ring (use retaining ring pliers) onto spool.



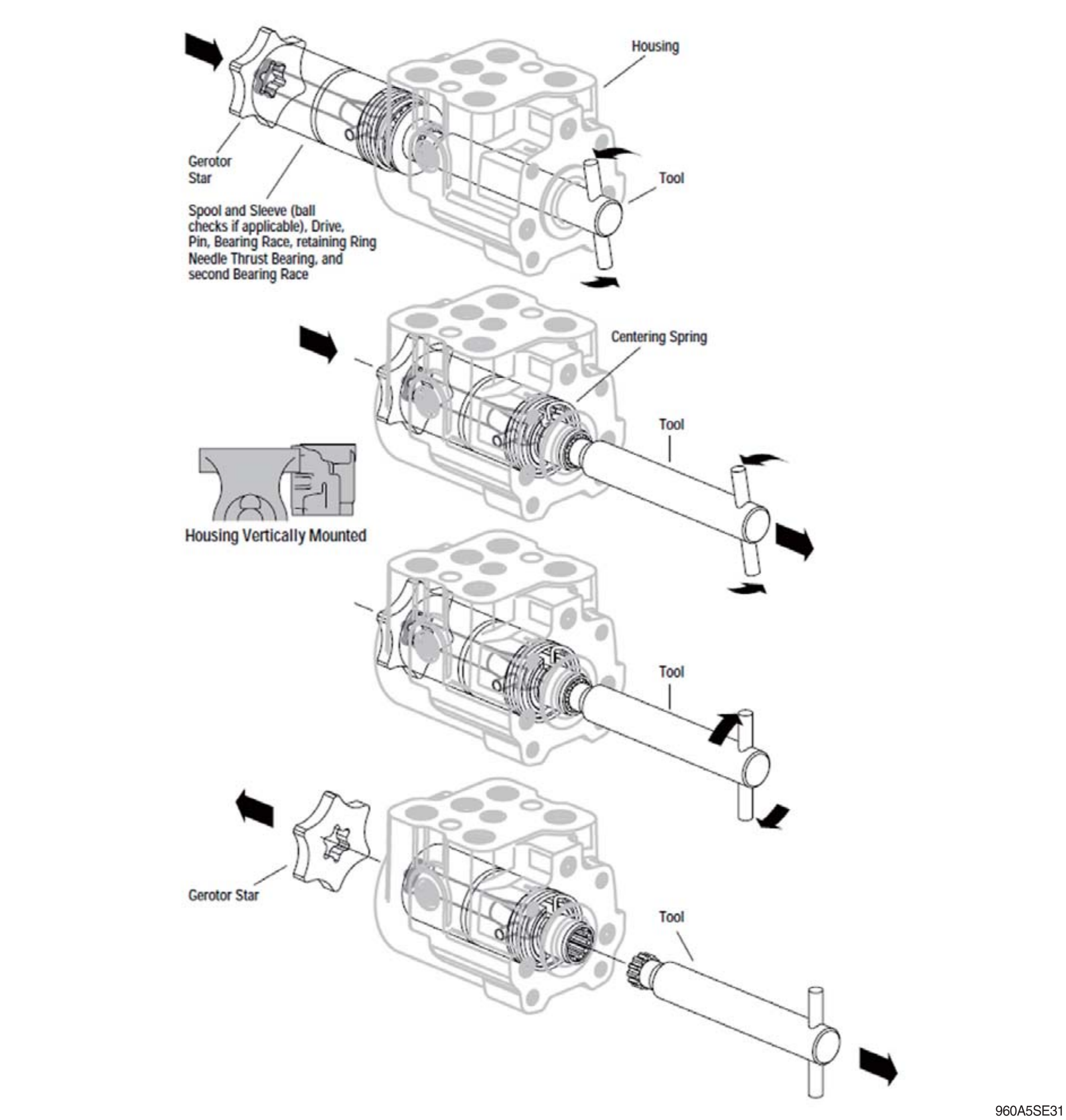
960A5SE29



Note: Needle Thrust Bearing MUST Be Centered Around Retaining Ring.
Use Petroleum Jelly to Hold Parts in Place.

960A5SE30

(7) Apply a light coating of petroleum jelly to the inside diameter of the previously mounted dust seal in the housing.
(8) Apply a light coating of petroleum jelly to the needle thrust bearing, second bearing race, and three part shaft seal. Position each part onto the spool as shown in enlarged section drawing.
The needle thrust bearing goes between the two bearing races and must be centered around retaining ring.
(9) Apply a light coating of clean hydraulic fluid to the spool and sleeve assembly and slide it into the housing. See steps (10)~(15).
※ Do not damage the dust or shaft seals.



(10) Protect gerotor star and hand with shop towel, hold gerotor star and splined end of drive to keep it from turning.

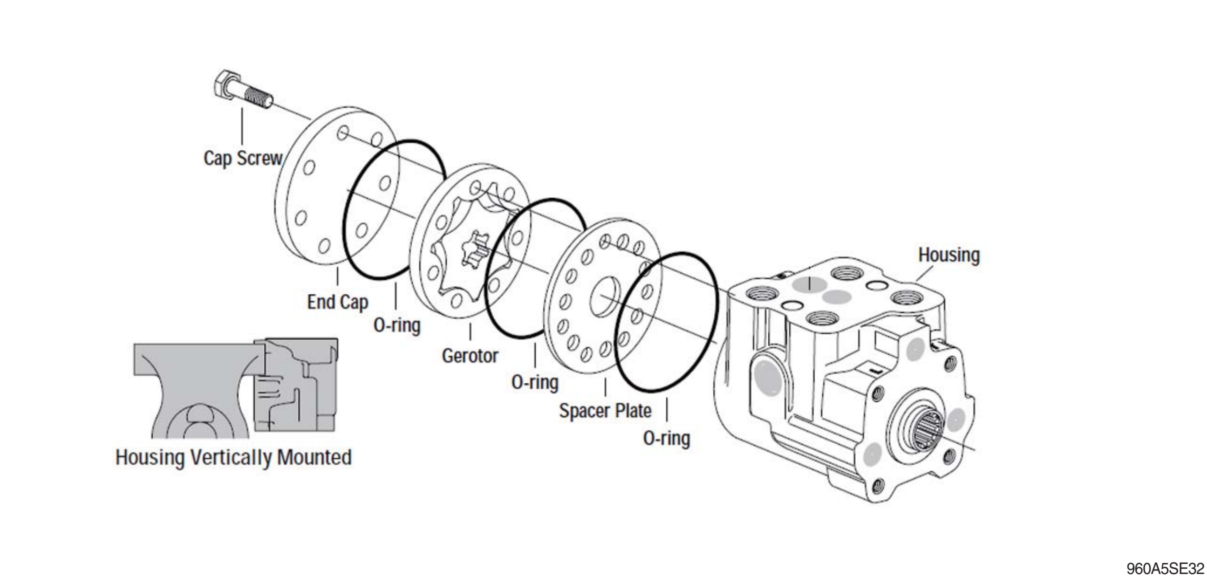
(11) Insert tool through housing; engage with splined end of spool assembled inside of sleeve along with ball checks (if applicable), centering spring, drive, pin, bearing race, retaining ring, needle thrust bearing, second bearing race, shaft seals and backup washer. Twist tool to compress spring coils radially CW or CCW.

※ If by some chance this unit is in the horizontal position keep pin nearly horizontal. If tension on this pin is released before these parts are fully engaged and the pin is not horizontal, the pin can drop and lockup can occur like a deadbolt.

(12) Keep centering spring compressed, and carefully insert these assembled parts into housing.
DO NOT FORCE. (Bearing races, retaining ring, needle thrust bearing, shaft seals and backup washer not shown on drawing. Centering spring shown compressed)

(13) Release centering spring tension.

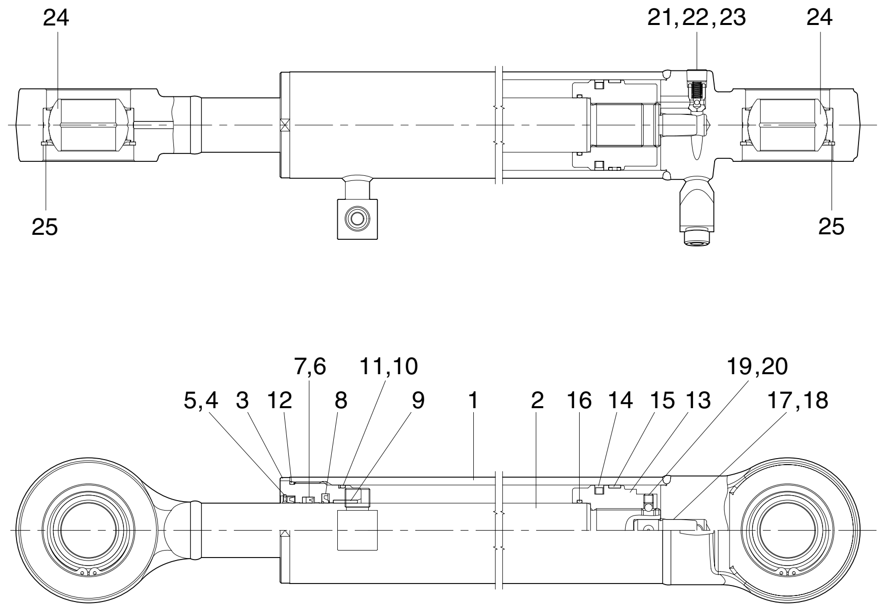
(14) Remove gerotor star and tool.



(15) Lubricate and install a new O-ring seal in the groove in the housing.
(16) Install the wear plate O-ring groove up and align the holes in the wear plate with threaded holes in the housing.
(17) Lubricate and install a new O-ring seal in the groove in the wear plate.
(18) Install the gerotor and align the screw holes.
(19) Lubricate and install a new O-ring seal in the groove in the gerotor ring.
(20) Install the end cap and seven cap screws.
Pretighten the cap screws, in a crisscross pattern, to 1.73 kgf · m (12.5 lbf · ft).
Finally, in acrisscross pattern, tighten cap screws to 3.46 kgf · m (25.0 lbf · ft).

2. STEERING CYLINDER

1) STRUCTURE



960A5SE05

1 Tube assembly
2 Rod assembly
3 Gland
4 Dust wiper
5 Retaining ring
6 Rod seal
7 Back up ring
8 Buffer ring
9 Du bushing
10 O-ring
11 Back up ring
12 O-ring
13 Piston
14 Piston seal
15 Wear ring
16 O-ring
17 Cushion plunger
18 Parallel pin
19 Steel ball
20 Set screw
21 Check valve
22 Coil spring
23 Hexagon socket plug
24 Spherical bearing
25 Retaining ring

2) TOOLS AND TIGHTENING TORQUE

(1) Tools

Tool name	Remark
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	M85×2	68±6.8	492±49.2
Piston	13	M36×2	90±9	650±65.1
Set screw	20	M 6×1.0	0.8±0.1	5.8±0.7

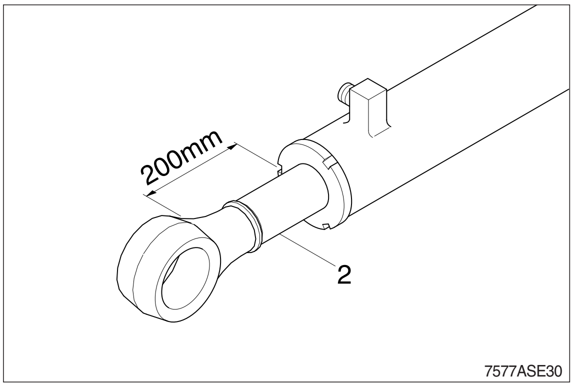
3) DISASSEMBLY

(1) Remove cylinder head and piston rod

① Hold the clevis section of the tube in a vise.

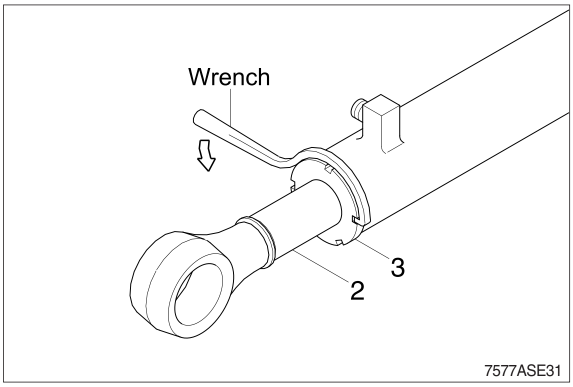
※ Use mouth pieces so as not to damage the machined surface of the cylinder tube. Do not make use of the outside piping as a locking means.

② Pull out piston rod (2) about 200 mm (7.8 in). Because the piston rod is rather heavy, finish extending it with air pressure after the oil draining operation.



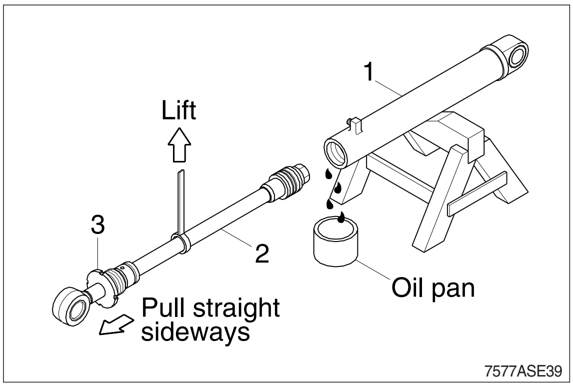
③ Loosen and remove the gland (3).

※ Cover the extracted piston rod (2) with rag to prevent it from being accidentally damaged during operation.



④ Draw out gland (3) and piston rod (2) assembly together from cylinder tube (1).

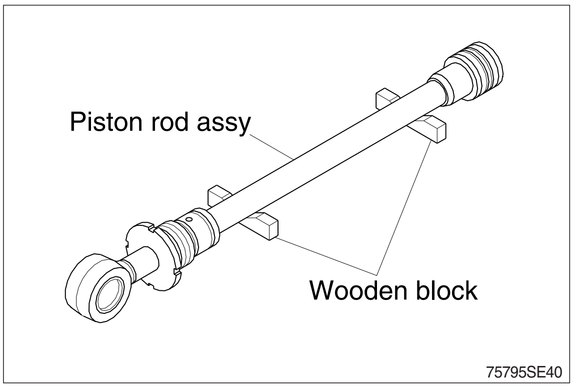
※ Since the piston rod assembly is heavy in this case, lift the tip of the piston rod (2) with a crane or some means and draw it out. However, when piston rod (2) has been drawn out to approximately two thirds of its length, lift it in its center to draw it completely.



※ 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.

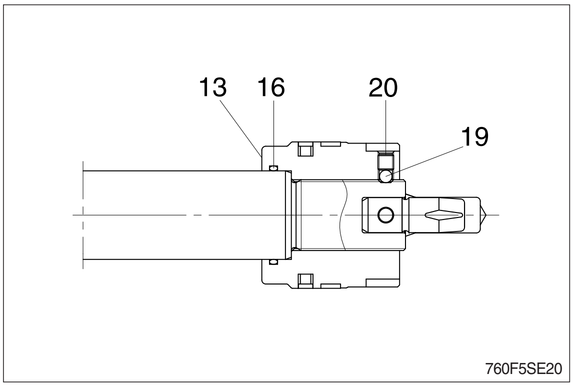
※ Cover a V-block with soft rag.



(2) Remove piston and gland assembly

① Remove the set screw (20) and steel ball (19).

② Remove piston assembly (13) and O-ring (16).

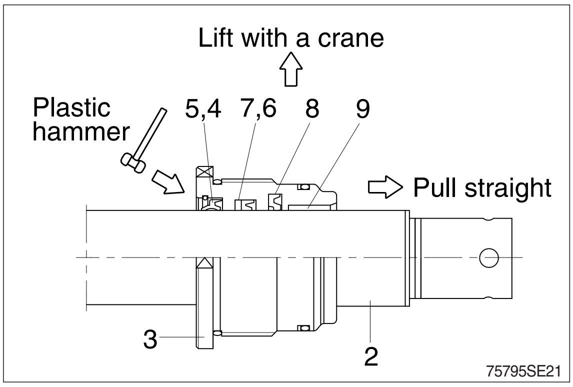


③ Remove the gland (3) assembly from piston rod (2).

※ 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.

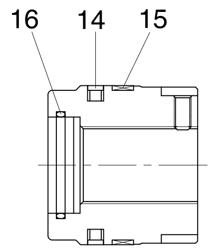
Exercise care so as not to damage the lip of rod bushing (9) and packing (4, 5, 6, 7, 8) by the threads of piston rod (2).



(3) Disassemble the piston assembly

① Remove wear ring (15) and piston seal (14).
Remove O-ring (16).

※ Exercise care in this operation not to damage the grooves.



76095SE23

(4) Disassemble gland assembly

① Remove back up ring (11), and O-ring (10).

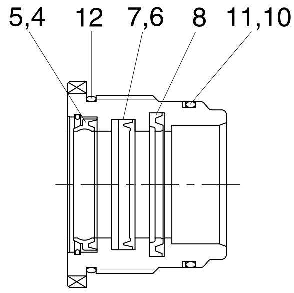
② Remove O-ring (12).

③ Remove snap 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.



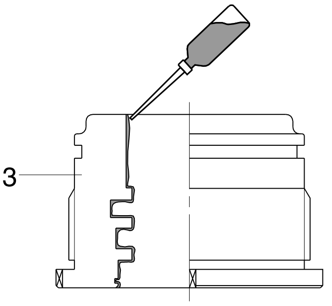
75795SE23

4) ASSEMBLY

(1) Assemble gland assembly

※ Check for scratches or rough surfaces if found smooth with an oil stone.

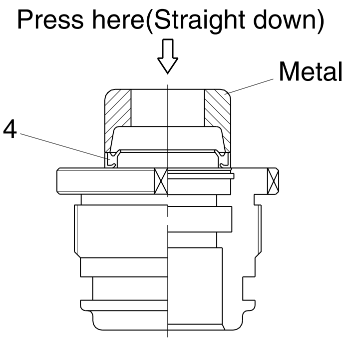
① Coat the inner face of gland (3) with hydraulic oil.



7577ASE34

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 snap ring (5) to the stop face.

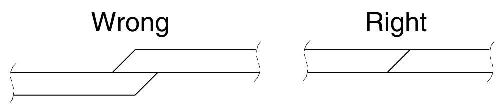


75795SE24

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.

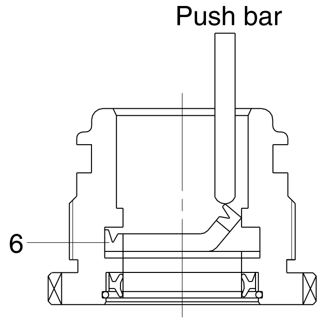
※ Insert the backup ring until onside of it is inserted into groove.



7577ASE42

※ 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.



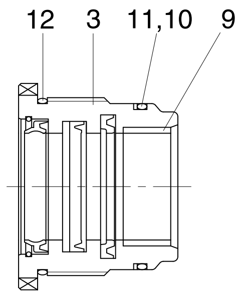
7577ASE43

⑤ Fit back up ring (11) to gland (3).

※ Put the back up 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).

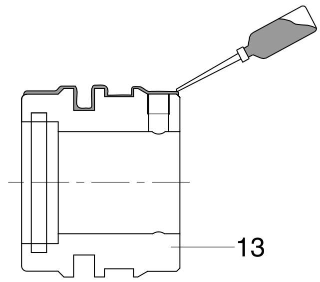


76095SE25

(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.

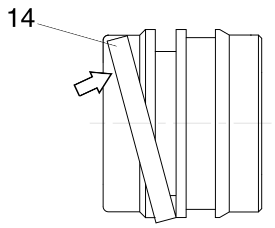


75795SE26

② Fit piston seal (14) to piston.

※ Put the piston seal in the warm water of 60~100˚C for more than 5 minutes.

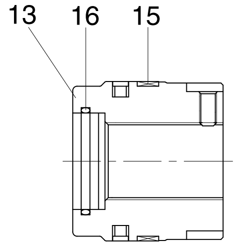
※ After assembling the piston seal, press its outer diameter to fit in.



75795SE27

③ Fit wear ring (15) to piston (13).

④ Fit O-ring (16) to piston (13).



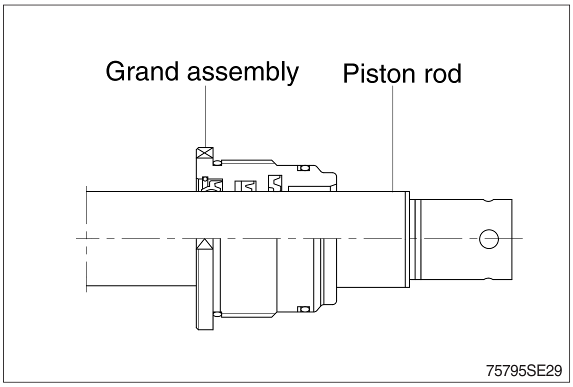
76095SE24

(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).

③ Insert gland assembly to piston rod (2).



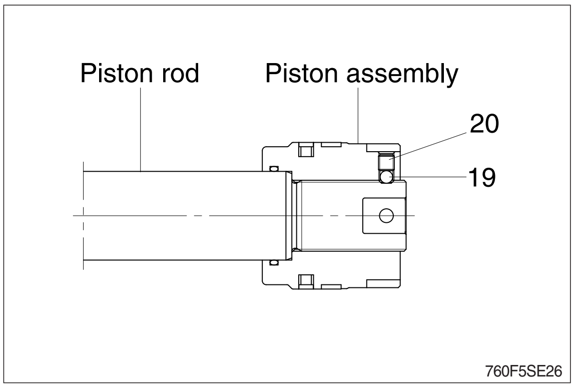
75795SE29

④ Fit piston assembly to piston rod.

· Tightening torque : 90±9 kgf · m (651±65 lbf · ft)

⑤ Insert the steel ball (19) and the set screw (20).

· Tightening torque : 0.8±0.1 kgf · m (5.8±0.7 lbf · ft)



760F5SE26

(4) Overall assembly

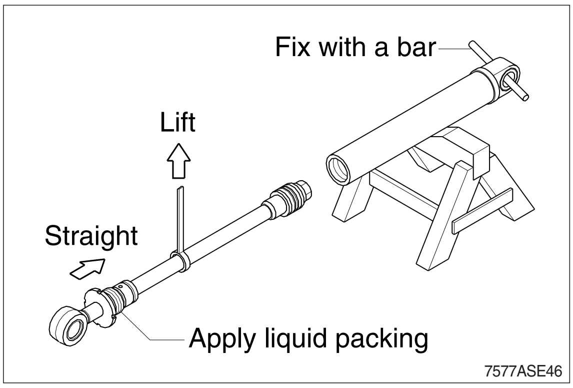
① Place a V-block on a rigid work bench. Mount the cylinder tube assembly on it and fix the assembly by passing a bar through the clevis pin hole to lock the assembly.

② Insert the piston rod assembly in to the cylinder tube assembly, while lifting and moving the piston rod assembly with a crane.

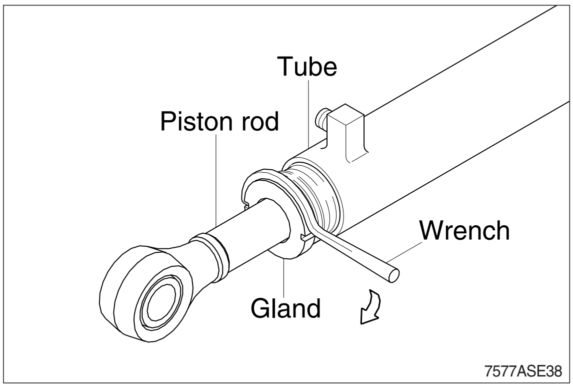
※ Be careful not to damage piston seal by thread of cylinder tube.

③ Fit gland to the tube.

· Tightening torque : 68±6.8 kgf · m (492±49.2 lbf · ft)



7577ASE46

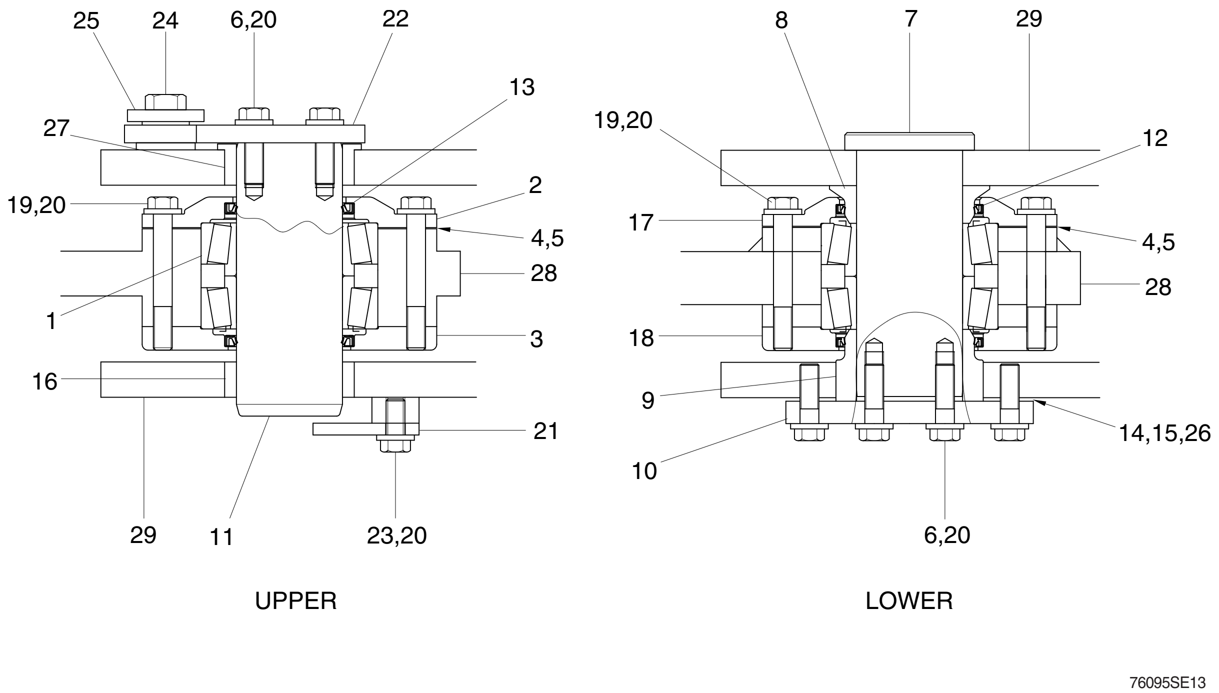


7577ASE38

3. 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.



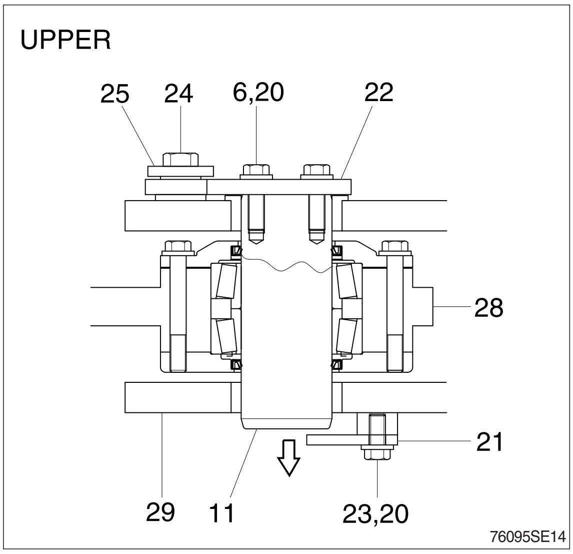
1	Bearing	11	Pin	21	Plate
2	Cover	12	Seal	22	Plate
3	Cover	13	Seal	23	Hexagon bolt
4	Shim (0.1 t)	14	Shim (0.1 t)	24	Hexagon bolt
5	Shim (0.5 t)	15	Shim (0.5 t)	25	Hardened washer
6	Hexagon bolt	16	Bushing	26	Shim (2.0 t)
7	Pin	17	Cover	27	Bushing
8	Collar	18	Cover	28	Front frame
9	Collar	19	Hexagon bolt	29	Rear frame
10	Plate	20	Hardened washer		

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 (28) and rear frame (29), and then remove hexagon bolt (6, 23, 24), washer (20, 25) and plate (21,22).

(2) Take out upper pin (11) to the downside using a metal punch.



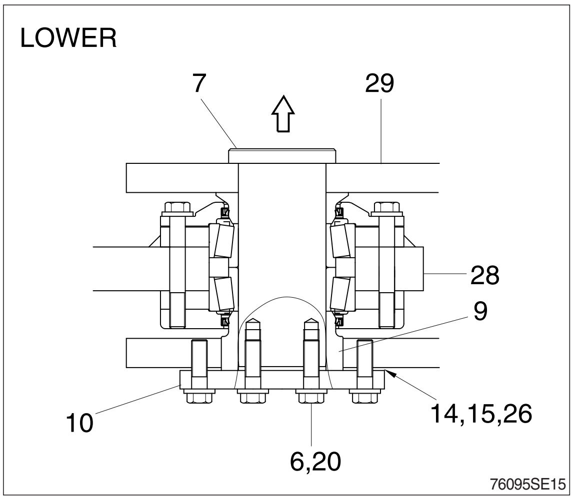
(3) Maintain the front frame horizontal level, remove hexagon bolts (6) and then remove the plate (10) and shims (14, 15, 26).

(4) Take out lower pin (7) to the upside using a metal punch carefully.

(5) Jack up or lifting the front frame (28) 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.

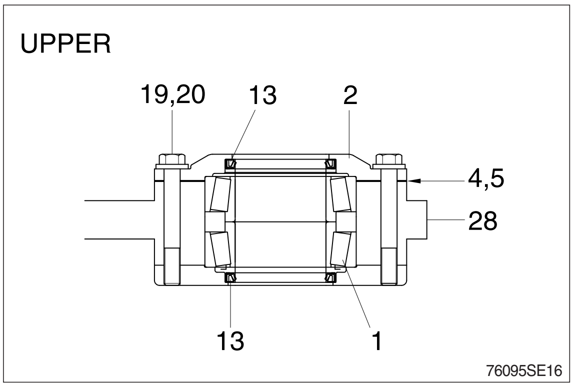
(7) Support the front frame safely.



(8) Remove bolt (19), washer (20) and then take out cover (2) and shims (4, 5).

(9) Take out dust seal (13) from the cover (2).

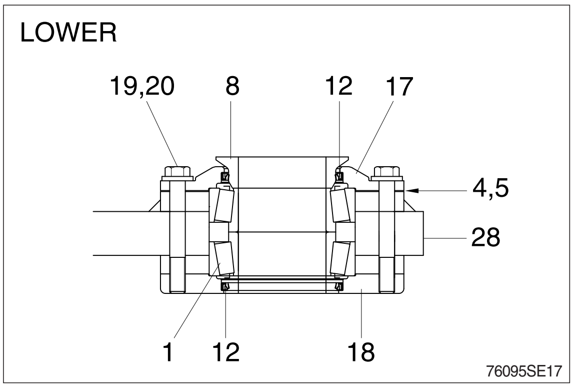
(10) Remove the bearing (1), and dust seal (13).



(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 (12,13) with new ones.

(3) Grind any pins (7, 11) dented with an oilstone or replace any pins abrasive excessively.

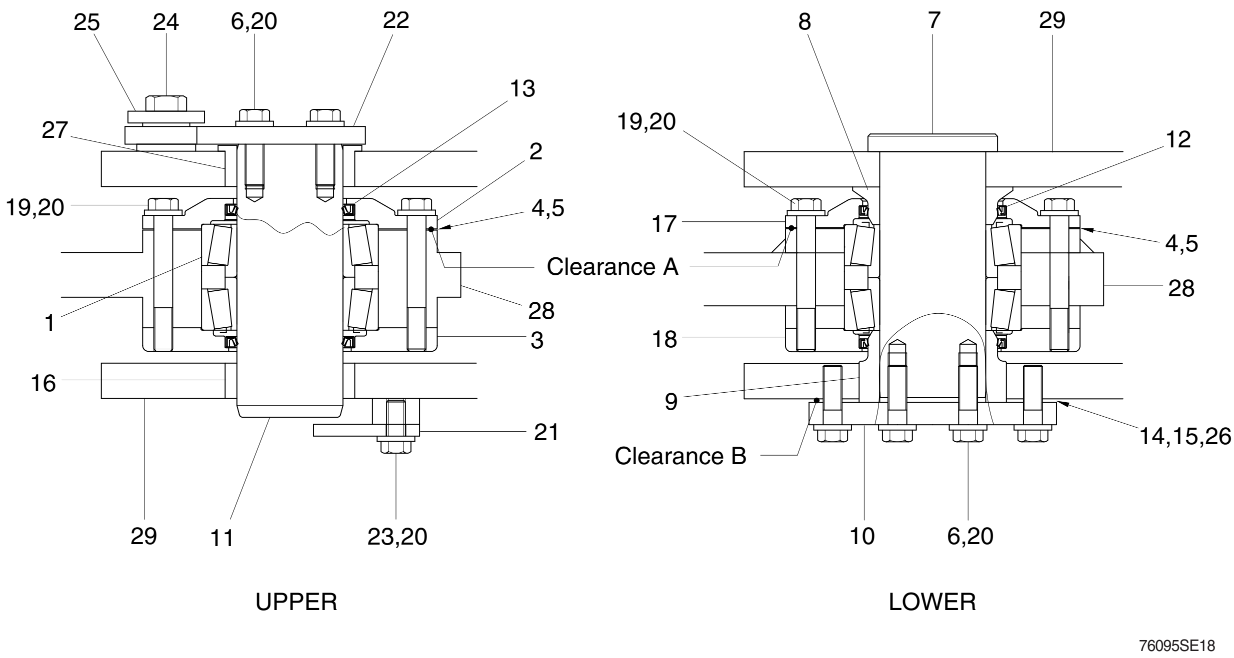
(4) Check inside cover (2, 3, 17, 18) and collar (8, 9) for dents or scratches; if any damage is found, correct with a grinder or replace.

(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	90	89.5	-	0.8	Replace
1	Tapered roller bearing		-	90.5		
8, 9	Collar		-	90.5		
12, 13	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 (12,13) 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). 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) so that each bolt is separated by 90 degrees.
- Tightening torque : 1.5~1.7 kgf · m (10.8~12.3 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 : 0.7~1.2 kgf · m (5.1~8.7 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).
After tightening, confirm that tapered roller bearing moves lightly ; if does not move smoothly, add shims (4, 5).
- Tightening Torque : 25.4~34.2 kgf · m (184~247 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 (27) 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 (29).

(10) Apply grease to pin (7) and insert it into tapered roller bearing (1).

(11) Before tightening bolt (6), adjust shims (14, 15) in order to control the clearance between the plate (21) and rear frame (29).
- **Adjustment method of clearance B**

① Install pin (7) and plate (21) without shim (14,15, 27).
Install four of bolt (6) so that each bolt is separated by 90 degrees.
- Tighting torque : 1.5~1.7 kgf · m (10.8~12.3 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 : 25.4~34.2 kgf · m (184~247 lbf · ft)
- Apply loctite #243.

5) TROUBLESHOOTING

Trouble	Probable cause	Remed
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

SECTION 6 WORK EQUIPMENT

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 :

· Main pump
· Main control valve
· Bucket cylinder
· Boom cylinders
· Remote control valve
· Safety valve

Flow from the main hydraulic pump not used by the steering system leaves the priority valve EF port. It flows to the inlet port plate of two section or three section block type main control valve.

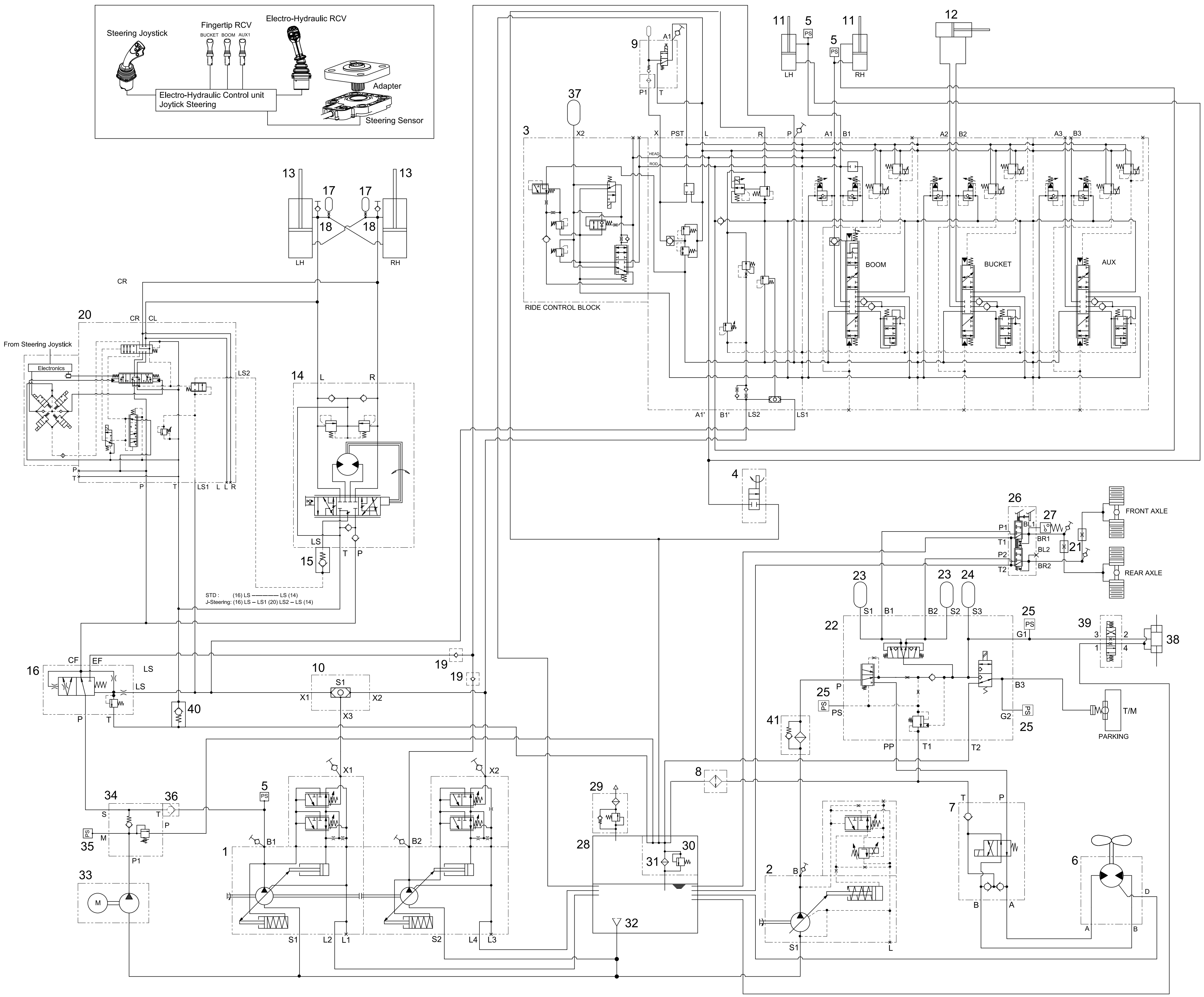
The main control valve is load pressure independent flow distribution system which routes flow to the boom, bucket or auxiliary cylinders (not shown) when the respective spools are shifted.

Flow from the main 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 Main pump
2 Fan & brake pump
3 Main control valve
4 Boom lowering valve
5 Pressure sensor
6 Fan motor
7 Directional valve
8 Hyd oil cooler
9 Safety valve
10 Shuttle valve
11 Boom cylinder
12 Bucket cylinder
13 Steering cylinder
14 Steering unit
15 Line check valve
16 Priority valve
17 Accumulator
18 Orifice
19 Check valve
20 Joystick steering valve (opt)
22 Cut off valve
23 Accumulator
24 Accumulator
25 Pressure sensor
26 Brake valve
27 Pressure sensor
28 Hydraulic tank
29 Air breather
30 Stop valve assy
31 Bypass valve
32 Strainer assy
33 Motor pump (opt)
34 Check block (opt)
35 Pressure sensor (opt)
36 Check valve (opt)
37 Accumulator (opt)
38 Quick coupler cylinder (opt)
39 Solenoid valve (opt)
40 Check valve
41 Filter assy

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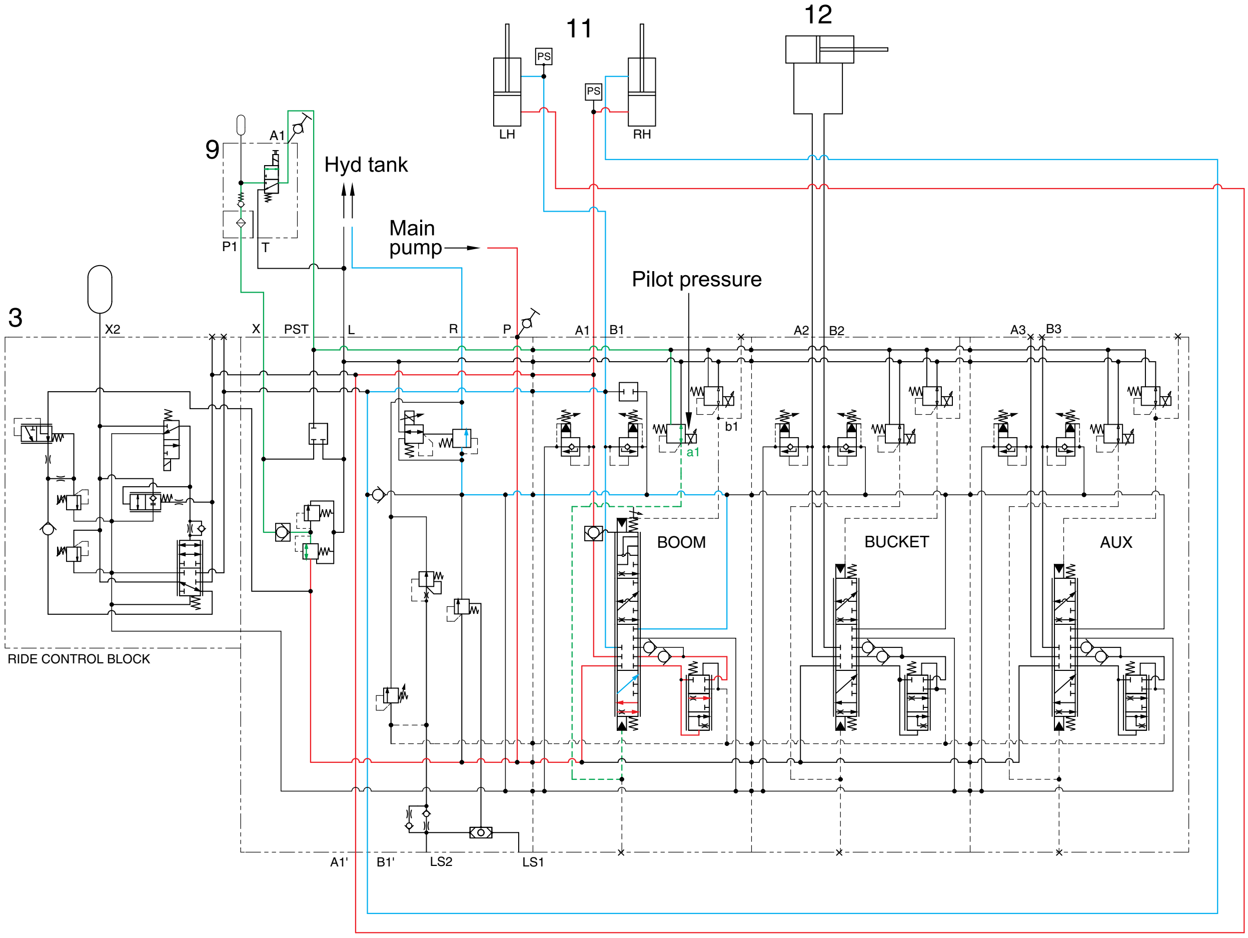
3. WORK EQUIPMENT HYDRAULIC CIRCUIT

1) WHEN THE RCV LEVER IS IN THE BOOM RAISE POSITION



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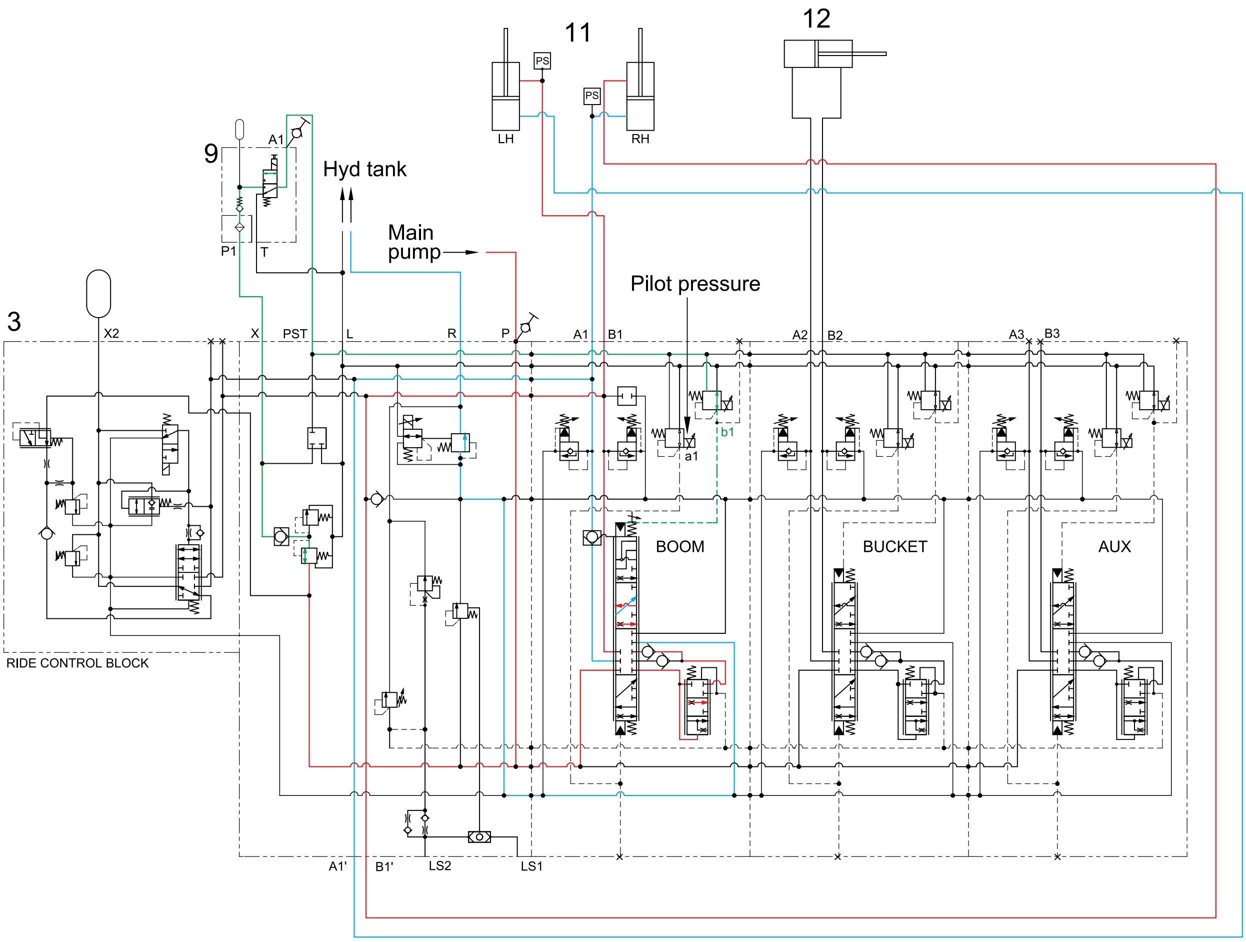
- When the RCV lever is pulled back, the boom spool is moved to raise position by pilot pressure from EPPR valve.
- The oil from main pump flows into main control valve (3) and then goes to the large chamber of boom cylinder (11).
- The oil from the small chamber of boom cylinder (11) returns to hydraulic oil tank through the boom spool at the same time.
- When this happens, the boom goes up.

2) WHEN THE RCV LEVER IS IN THE BOOM LOWER POSITION

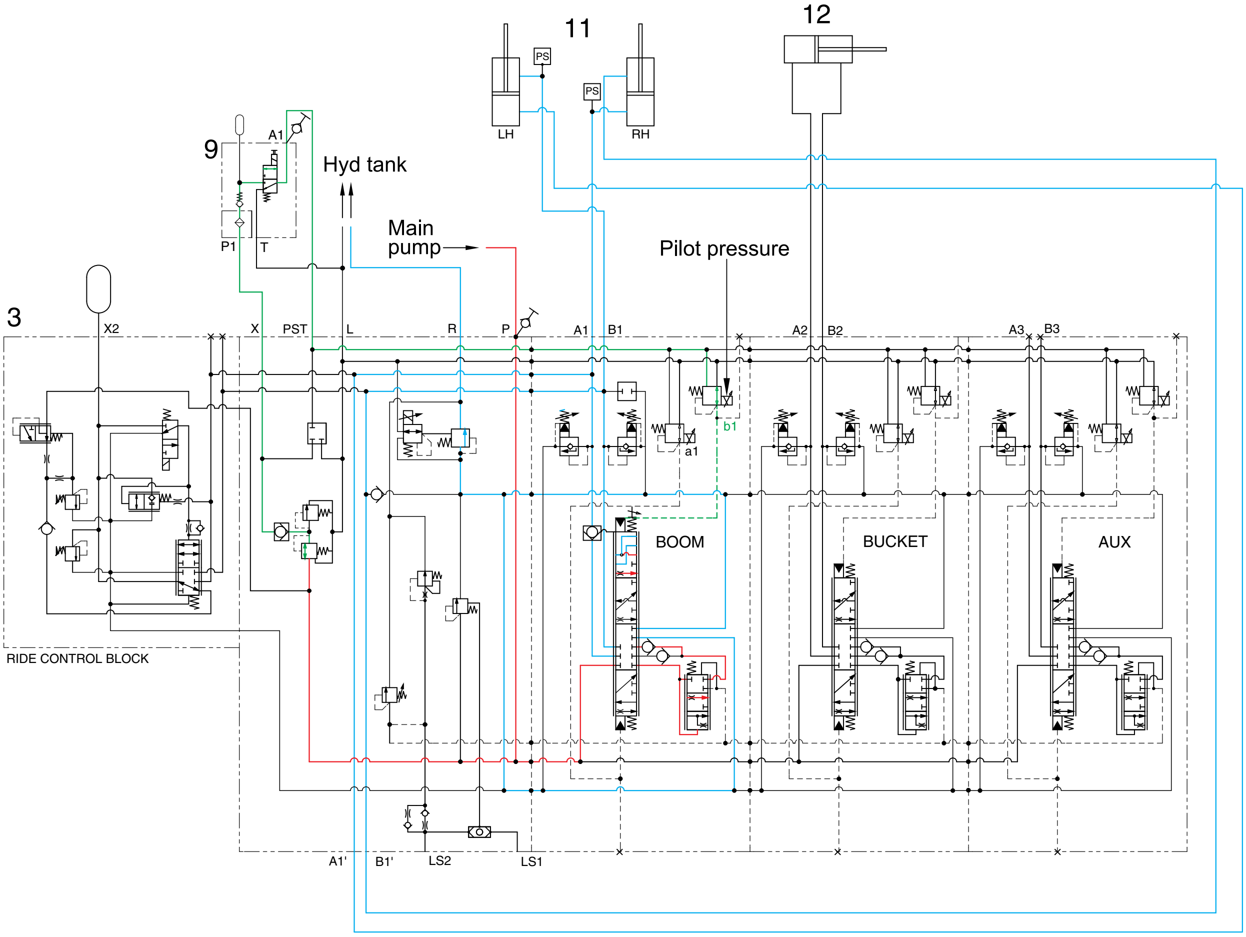


960A6WE03

- When the RCV lever is pushed forward, the boom spool is moved to lower position by pilot pressure from EPPR valve.
- The oil from main pump flows into main control valve (3) and then goes to small chamber of boom cylinder (11).
- The oil returned from large chamber of boom cylinder (11) returns to hydraulic tank 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.

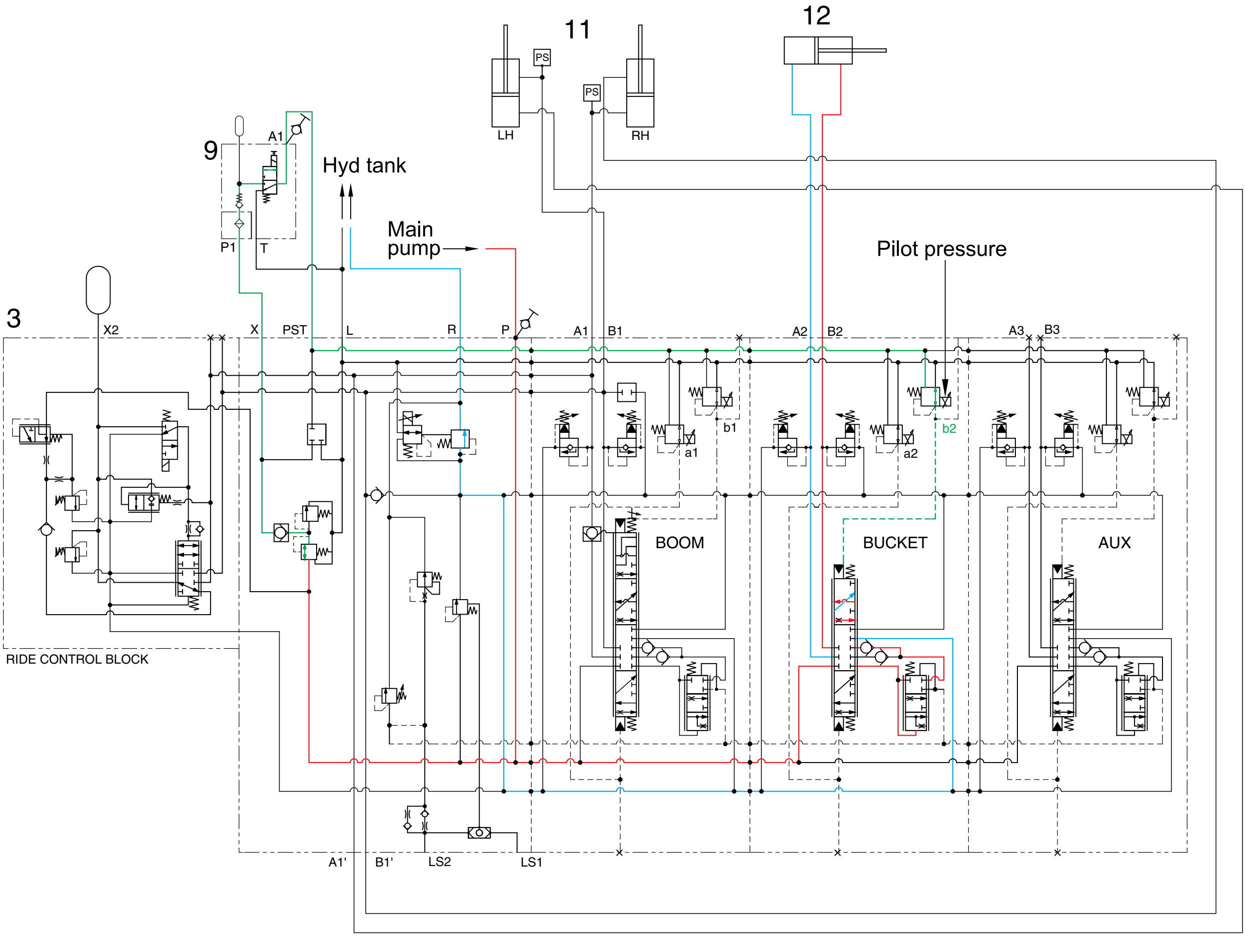
3) WHEN THE RCV LEVER IS IN THE BOOM FLOAT POSITION



960A6WE04

· When the RCV lever is pushed further forward from the lower position, the pilot pressure reaches to 13~15 bar, then the boom spool is moved to floating position.
· The work ports (A1), (B1) 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 BUCKET DUMP POSITION



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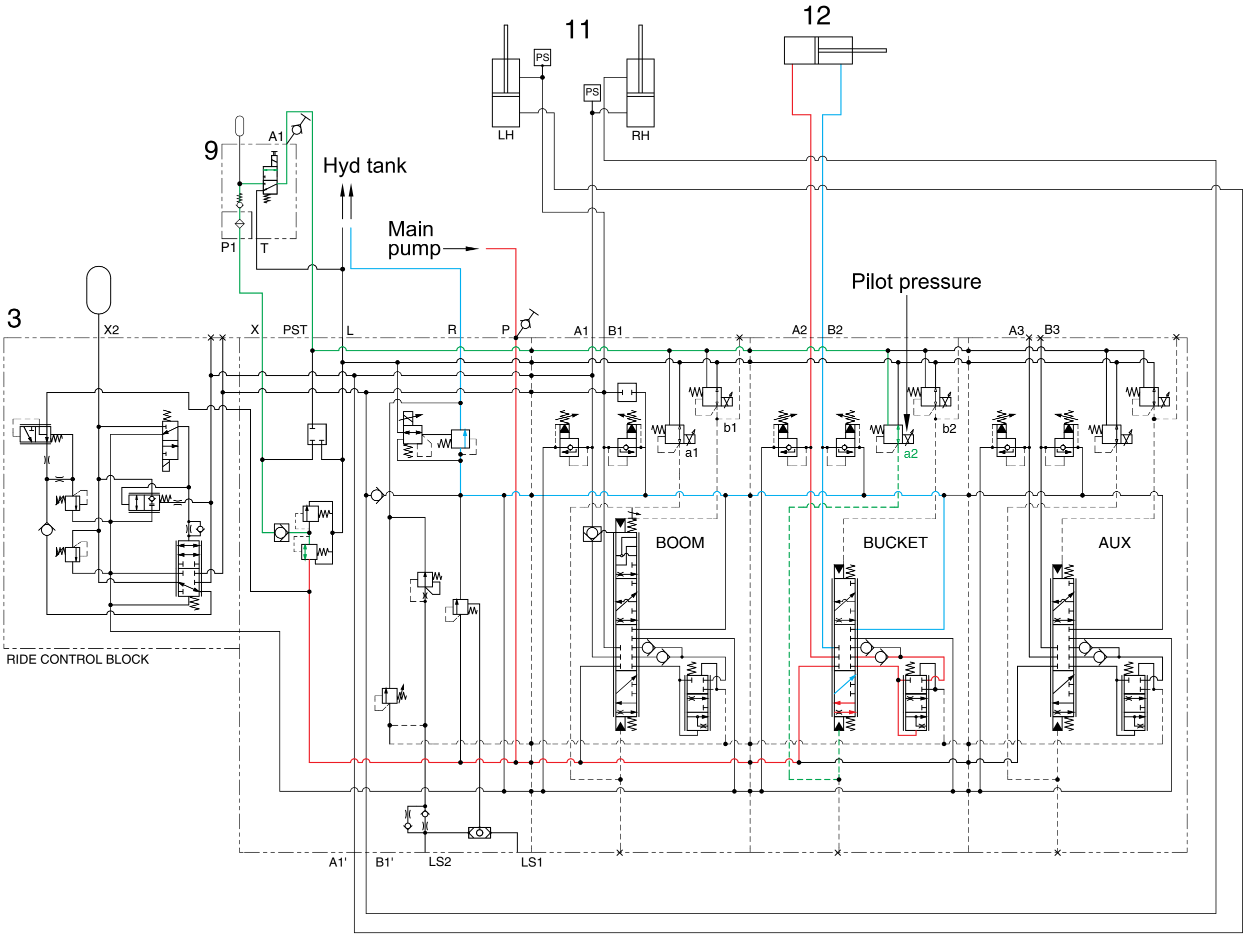
· If the RCV lever is pushed right, the bucket spool is moved to dump position by pilot pressure from EPPR valve.
· The oil from main pump flows into main control valve (3) and then goes to the small chamber of bucket cylinder (12).
· The oil at the large chamber of bucket cylinder (12) returns to hydraulic tank.
· 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 BUCKET ROLL BACK (retract) POSITION



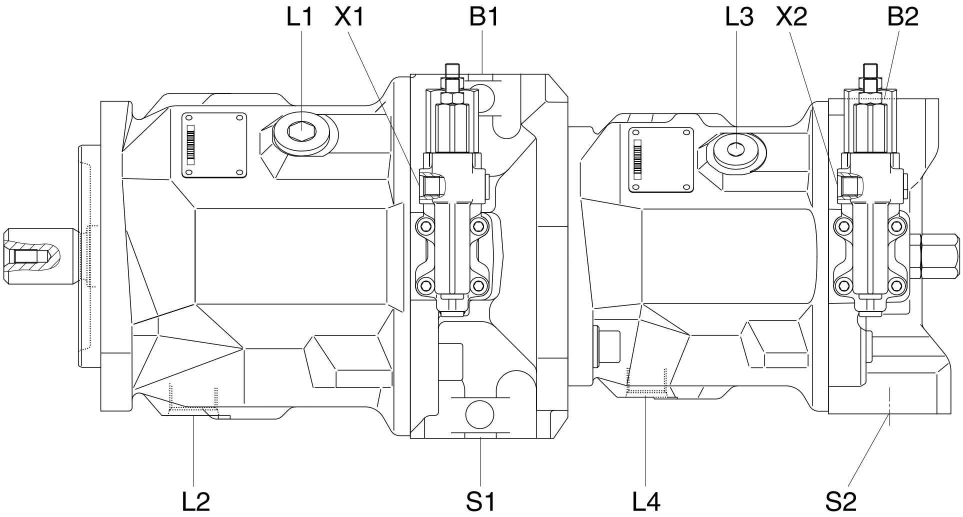
960A6WE06

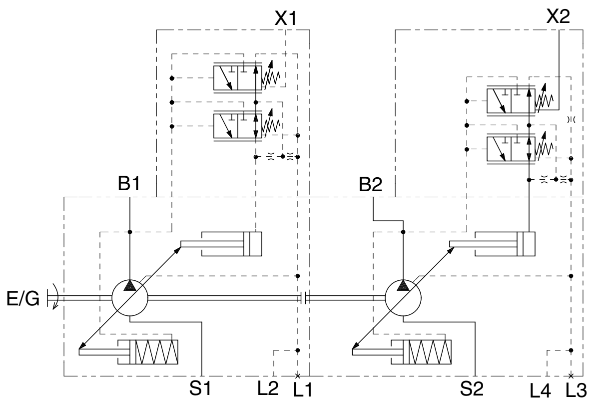
- If the RCV lever is pulled left, the bucket spool is moved to roll back position by pilot oil pressure from EPPR valve.
- The oil from main pump flows into main control valve (3) and then goes to the large chamber of bucket cylinder.
- The oil at the chamber of bucket cylinder (12) returns to hydraulic tank.
- When this happens, the bucket roll back.

4. MAIN PUMP

1) STRUCTURE (1/2)

This variable displacement piston pump consists of steering pump and loader pump.



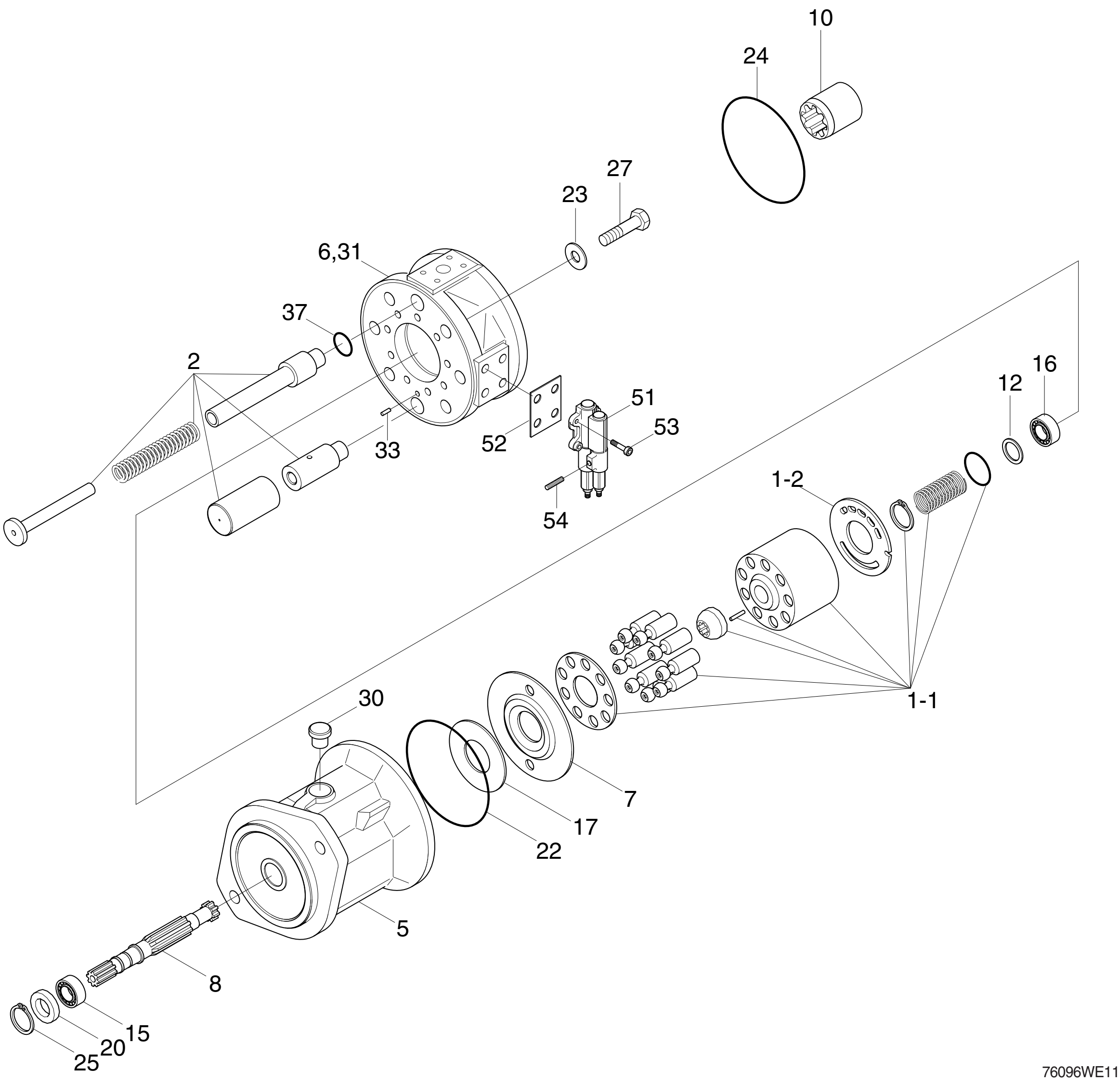


Hydraulic circuit

76096WE88

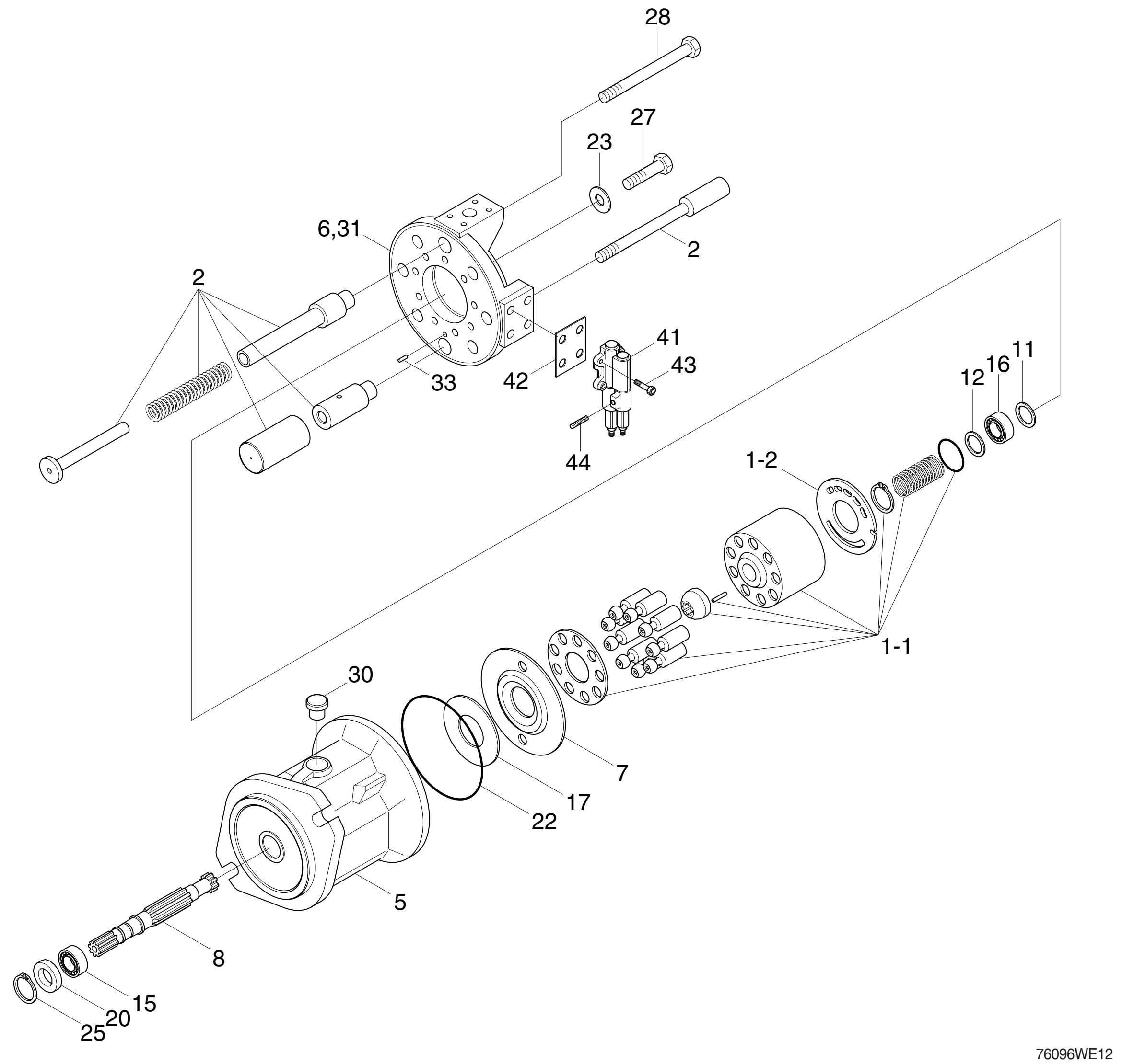
Port	Port name	Port size
B1	Pressure port	SAE 1"
B2	Pressure port	SAE 1"
S1	Suction port	SAE 2"
S2	Suction port	SAE 2"
L1, L2	Case drain port	1 1/16-12UN-2B
L3, L4	Case drain port	1 1/16-12UN-2B
X1, X2	Pilot pressure port	7/16-20UNF-2B

· **MAIN PUMP** (1/2, STEERING)



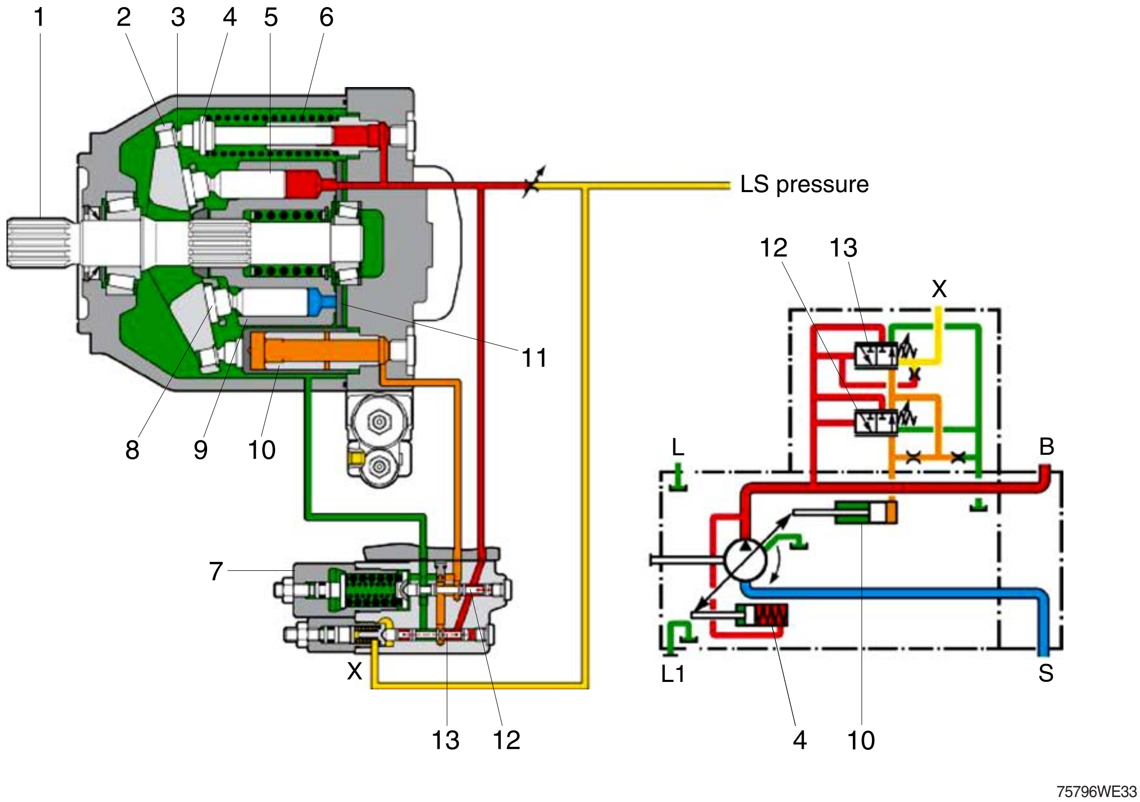
1	Rotary group	12	Adjustment shim	27	Socket screw
1-1	High speed rotary group	15	Taper roller bearing	30	Locking screw
1-2	Control plate	16	Taper roller bearing	31	Double break-off pin
2	Adjusting piece	17	Bearing liner	33	Cylinder pin
5	Pump housing	20	Shaft seal ring	37	Side mark ring
6	Port plate	22	O-ring	51	Control valve
7	Swash plate	23	O-ring	52	Gasket
8	Drive shaft	24	O-ring	53	Socket head screw
10	Splined hub	25	Retaining ring	54	Locking screw

· MAIN PUMP (2/2, LOADER)



1	Rotary group	12	Adjustment shim	28	Locking screw
1-1	High speed rotary group	15	Taper roller bearing	30	Locking screw
1-2	Control plate	16	Taper roller bearing	31	Double break-off pin
2	Adjusting piece	17	Bearing liner	33	Cylinder pin
5	Pump housing	20	Shaft seal ring	41	Control valve
6	Port plate	22	O-ring	42	Gasket
7	Swash plate	23	O-ring	43	Socket screw
8	Drive shaft	25	Retaining ring	44	Locking screw
11	Adjustment shim	27	Socket screw		

2) FUNCTION



1	Drive shaft	6	Counter spring	11	Control plate
2	Swash plate	7	Pressure & flow compensator valve	12	Pressure compensator spool
3	Shoe plate	8	Piston shoe	13	Flow compensator spool
4	Counter piston	9	Cylinder		
5	Piston	10	Control piston		

The steering pump and loader pump are variable displacement piston pump. The steering pump and loader pump are flow controlled by LS signal. When the steering and loader are not being used, the pumps are at low pressure standby.

The load sensing pressure that is sensed from steering and loader hydraulic systems flows to flow compensator spool (13). This spool keeps the pump output at a level that is necessary to fulfill the requirements for the system flow and for the pressure.

The pressure compensator spool (12) also limits maximum system pressure. The pressure compensator spool (12) prevents damage to the steering and loader hydraulic components from excessive pressure.

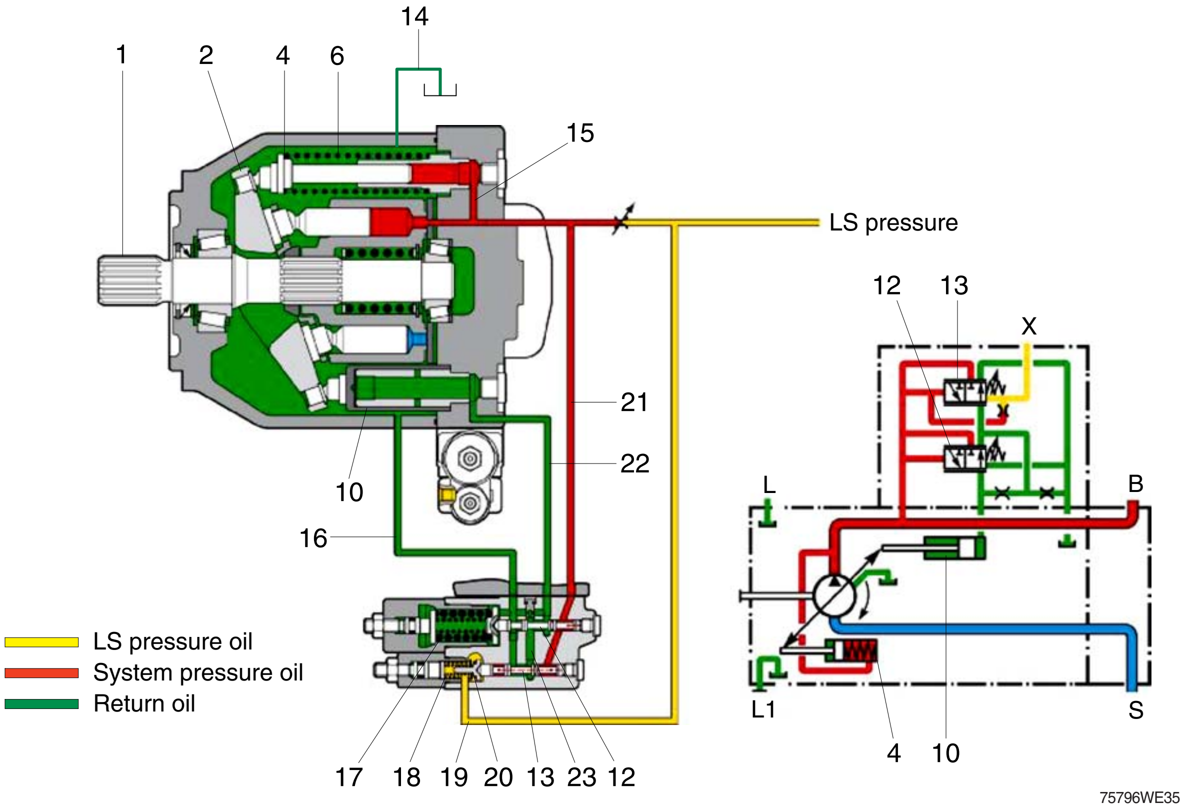
The swivel angle of the pumps is controlled by counter piston (4) and control piston (10). Counter spring (6) cause swash plate (2) to move at maximum displacement or causes swash plate (2) to upstroke.

Control piston (10) has a larger area (diameter) than counter piston (4). Control piston (10) causes swash plate (2) to destroke the pump.
Flow compensator spool (13) and/or pressure compensator spool (12) changes pump output by regulating the pump discharge pressure that is acting on control piston (10).

Control piston (10) diameter is larger than counter piston (4) diameter, the oil pressure that is acting against control piston (10) overcomes the force of counter spring (6). The oil pressure than causes the pump to destoke.

Pressure and flow compensator valve (7) also controls the maximum output of pump pressure. When steering and loader pressure rises above pressure compensator setting, pressure compensator spool (12) overrides flow compensator spool (13). This causes the pump to destroke.

(1) Upstroking



1	Drive shaft	13	Flow compensator spool	19	LS line from the metering pump
2	Swash plate	14	Case drain	20	Cavity
4	Counter piston	15	Passage	21	Passage
6	Counter spring	16	Passage	22	Passage
10	Control piston	17	Spring	23	Cavity
12	Pressure compensator spool	18	Spring		

Upstroking of the pump occurs as flow demand from loader and steering system.
The increased flow demand causes a LS pressure in LS line (19). The LS pressure in LS line (19) combines with the force of spring (18) in cavity (20).
The force of spring (18) causes pump pressure to be higher than the LS pressure (19).
If the combination of LS pressure and of spring force is greater than the pump discharge pressure, this difference pressure causes spool (13) to move right. As spool (13) moves right, the spool (13) blocks the flow of supply oil to control piston (10). Pump swash plate (2) is controlled by pressure and flow as much as hydraulic system requests.

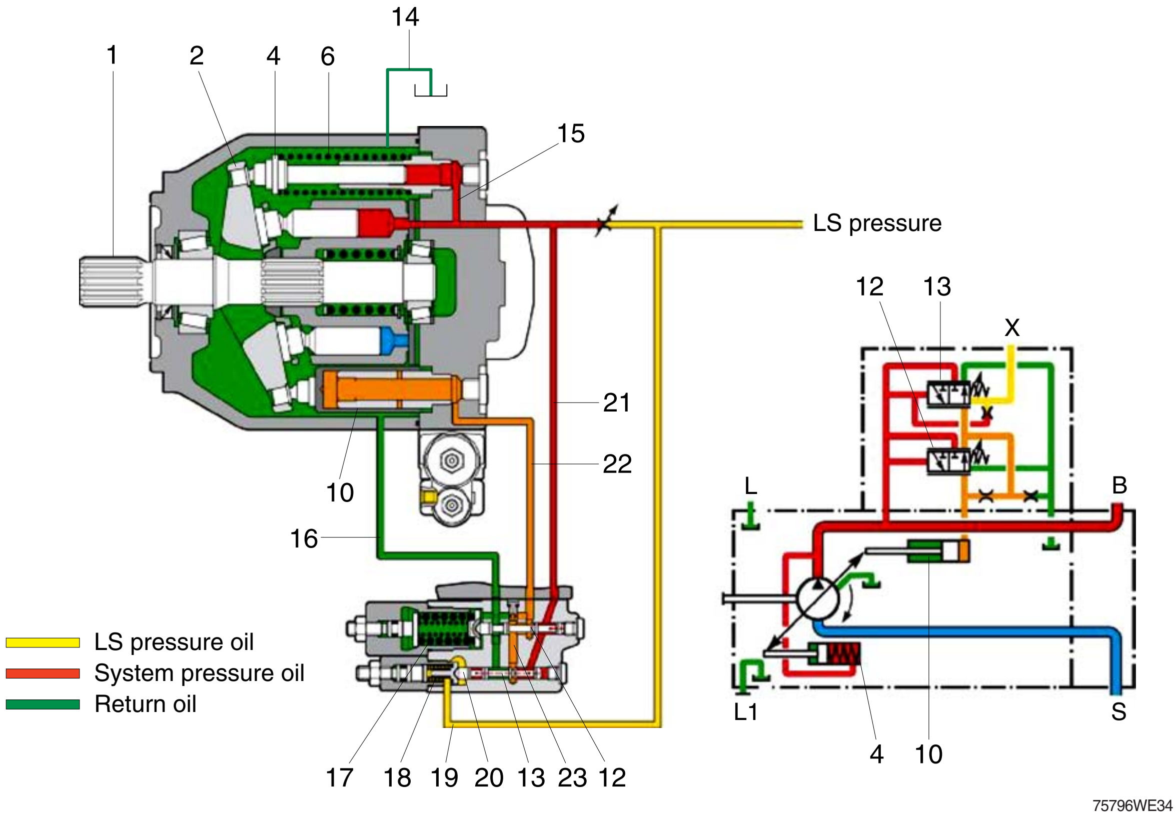
When the oil flow to control piston (10) is blocked, the pilot oil in passage (22) drains to passage (23). The oil then flows past pressure compensator spool (12) and through passage (16) into the housing and via the drain line (14) to tank.

Supply oil flows through passage (15) to counter piston (4). The oil acts against counter piston (4). The oil combines with the force of counter spring (6). This causes swash plate (2) to upstroke.

This also causes the pump flow to increase. As flow requirements are satisfied, the pump output pressure increase. The pressure increases until the pressure in passage (15) moves flow compensator spool (13) up to be satisfied with system requirement for pressure and flow.

· Pump discharge pressure = force of spring (18) + LS pressure (19)

(2) Destroking



1	Drive shaft	13	Flow compensator spool	19	LS line from the metering pump
2	Swash plate	14	Case drain	20	Cavity
4	Counter piston	15	Passage	21	Passage
6	Counter spring	16	Passage	22	Passage
10	Control piston	17	Spring	23	Cavity
12	Pressure compensator spool	18	Spring		

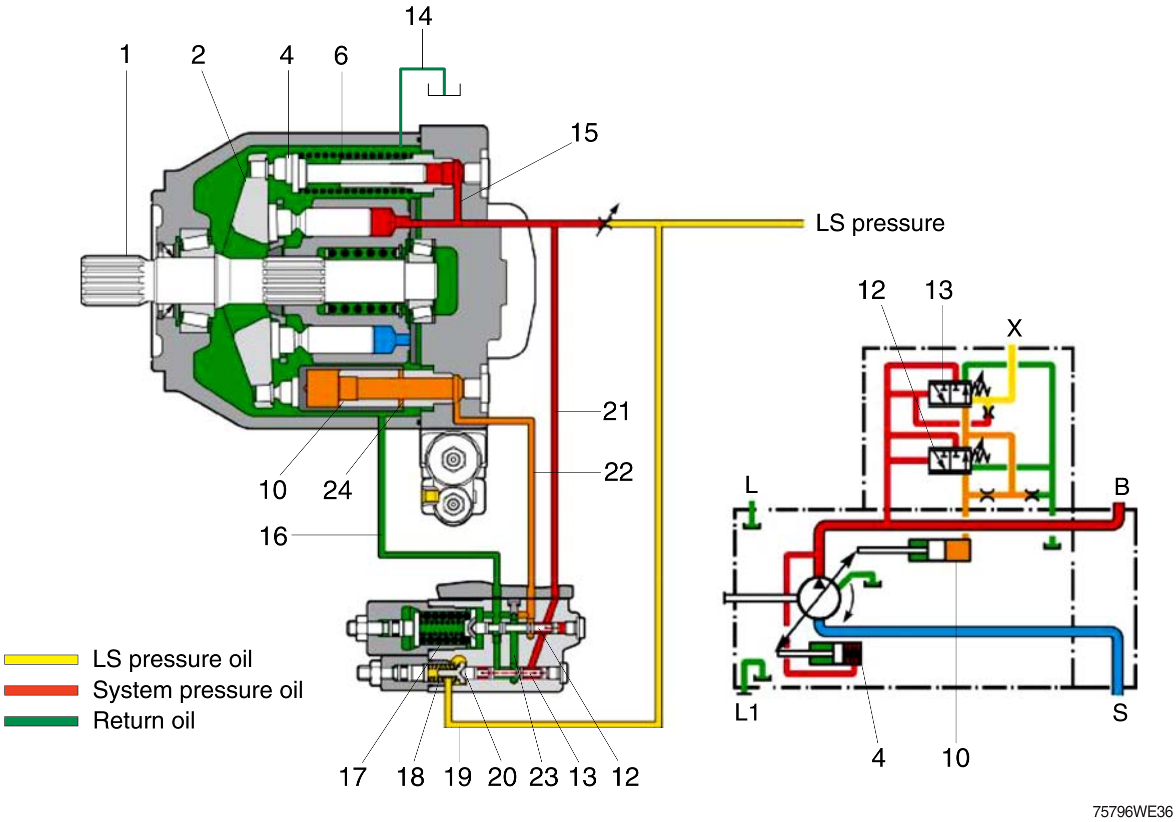
The decreased flow demand causes a LS pressure in line (19). The LS pressure in line (19) combines with the force of spring (18) in cavity (20).
This combination of LS pressure and of spring force is less than the pump pressure in passage (21). This causes flow compensator spool (13) to move left.
Pump oil now flows through passage (15). The oil then flows past flow compensator spool (13), through passage (22), and then to control piston (10).

The pump pressure behind control piston (10) is now greater than the combined force of counter piston(4) and of counter spring (6). The angle of swash plate (2) decreases.
This decreases the pump output and the system pressure.

When the lower flow requirements are met, flow compensator spool (13) moves right up to the balanced position. Swash plate (2) maintains an angle that is sufficient to provide the lower required pressure. If the operator does not turn the steering wheel and does not move RCV, then the pump will return to low pressure standby.

※ Control piston → Changes pump displacement ; influenced by controller.
Counter piston → Helps to change pump displacement but no possible to control this piston.

(3) Low pressure standby



1	Drive shaft	13	Flow compensator spool	19	LS line from the metering pump
2	Swash plate	14	Case drain	20	Cavity
4	Counter piston	15	Passage	21	Passage
6	Counter spring	16	Passage	22	Passage
10	Control piston	17	Spring	23	Cavity
12	Pressure compensator spool	18	Spring	24	Cross-drilled hole

Low pressure standby constitutes the following condition: a running engine and inactive steering and loader. There are no flow demands on the pump or pressure demands on the pump. Therefore, there is no LS pressure in line (19).
Before you start the engine, counter spring (6) holds swash plate (2) at the maximum angle. As the pump begins to turn, oil begins to flow and pressure increases in the system.
Because of close centered steering control valve and close centered loader hydraulic system.

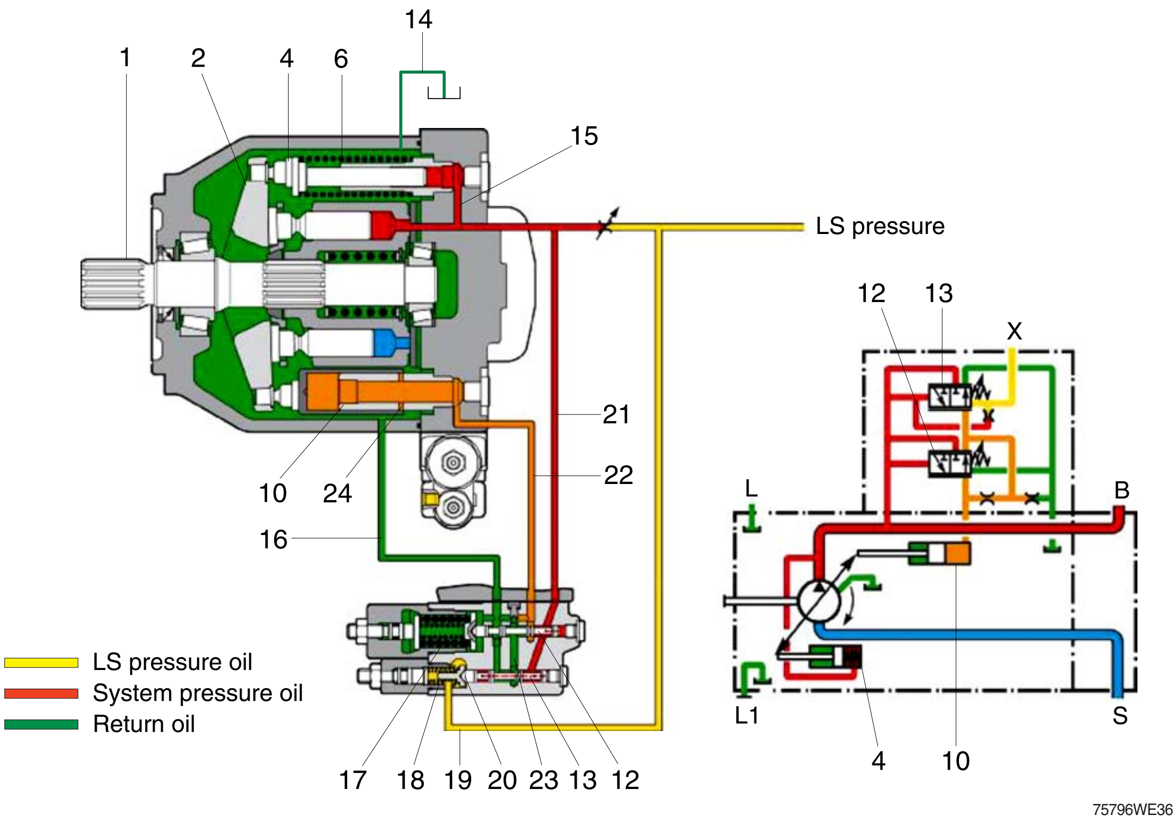
As this pressure increase, the pressure pushes flow compensator spool (13) against spring (18). This causes flow compensator spool (13) to move left. This opens passage (23) in order to allow pressure oil to flow to control piston (10).

The oil acts against control piston (10) in order to overcome the force of counter spring (6). The oil causes control piston (10) to move to the left.
When control piston (10) moves to the left, the piston moves swash plate (2) toward the minimum angle. Control piston (10) continues to move to the left until cross-drilled hole (24) allows the oil to drain to the case.

Cross-drilled hole (24) limits the maximum travel of control piston (10) to the left. The pump supplies a sufficient amount of flow that compensates for system leakage. The pump also supplies a sufficient of flow that compensates for leakage to the pump case. The leakage to the pump case is a result of the cross-drilled hole. The pump maintains low pressure standby. Low pressure standby pressure should not exceed 40 bar (580 psi).

※ Low pressure standby will vary in the same pump as the system leakage or the pump leakage increases. The pump will upstroke slightly in order to compensate for the increasing leakage. Control piston (10) will cover more of the cross-drilled hole.

(4) High pressure stall



1	Drive shaft	13	Flow compensator spool	19	LS line from the metering pump
2	Swash plate	14	Case drain	20	Cavity
4	Counter piston	15	Passage	21	Passage
6	Counter spring	16	Passage	22	Passage
10	Control piston	17	Spring	23	Cavity
12	Pressure compensator spool	18	Spring		

When the hydraulic system stalls under load or when the cylinders reach the end of the stroke, the main system pressure increases. But LS pressure (19) is regulated by LS relief valve on steering system and loader system. The pressure difference between discharged pump and LS pressure equal to spring (18). It means no flow is necessary. Therefore, discharged pressure push flow compensator spool (13) left . Supply oil now flows past flow compensator spool (13) and through passage (23). The oil flows past flow compensator spool (13) and into passage (22). The oil then flows to control piston (10).

Pump swash plate (2) will be minimum displacement if the operator does not turn the steering wheel and RCV, then the pump will return to low pressure standby.

(5) Adjustment of flow control

Flow compensator setting must be carried out following procedures and conditions.

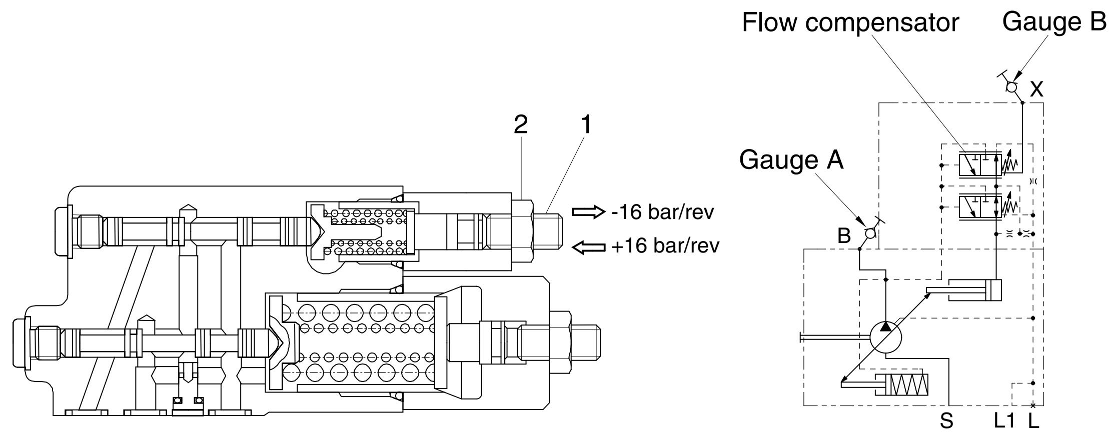
① Conditions

- Engine is running (at high or low idle).
- RCV is operated slowly (example : Boom up).
- Pressure gauges are installed.

※ Discharge pump flow should be less than max pump flow.

② Procedures

- Loosening the hexagon nut (2).
- Adjusting screw (1) of flow controller by tightening or loosing the screw (1).
  · Flow setting : ΔP = Gauge A - Gauge B
  · Specification : Steering pump (23 bar)/Loader pump (19 bar)



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(6) Adjustment of pressure control

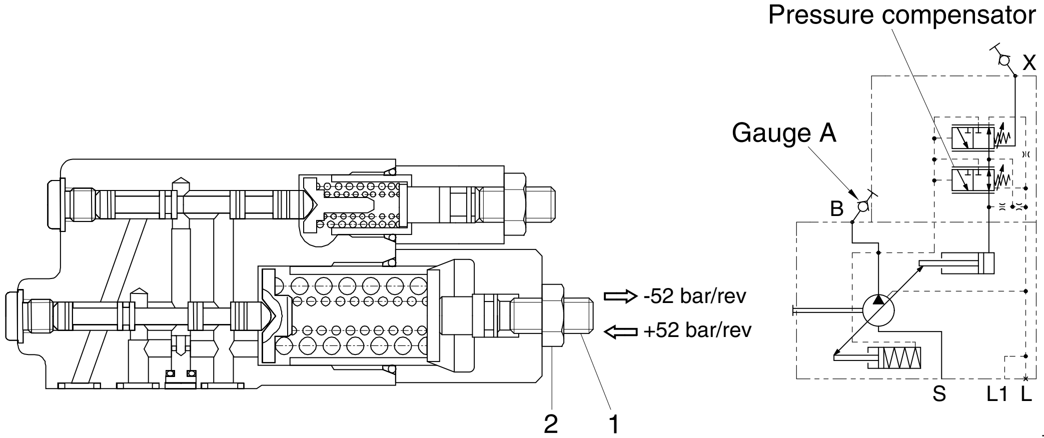
Pressure compensator setting must be carried out following procedures and conditions.

① Conditions

- Engine is running.
- System is at relief condition.

② Procedures

- Loosening the hexagon nut (2).
- Adjusting screw (1) of pressure controller by tightening or loosing the screw (1).
  · Maximum pressure setting = Gauge A
  · Specification : Steering pump (250 bar)/Loader pump (300 bar)



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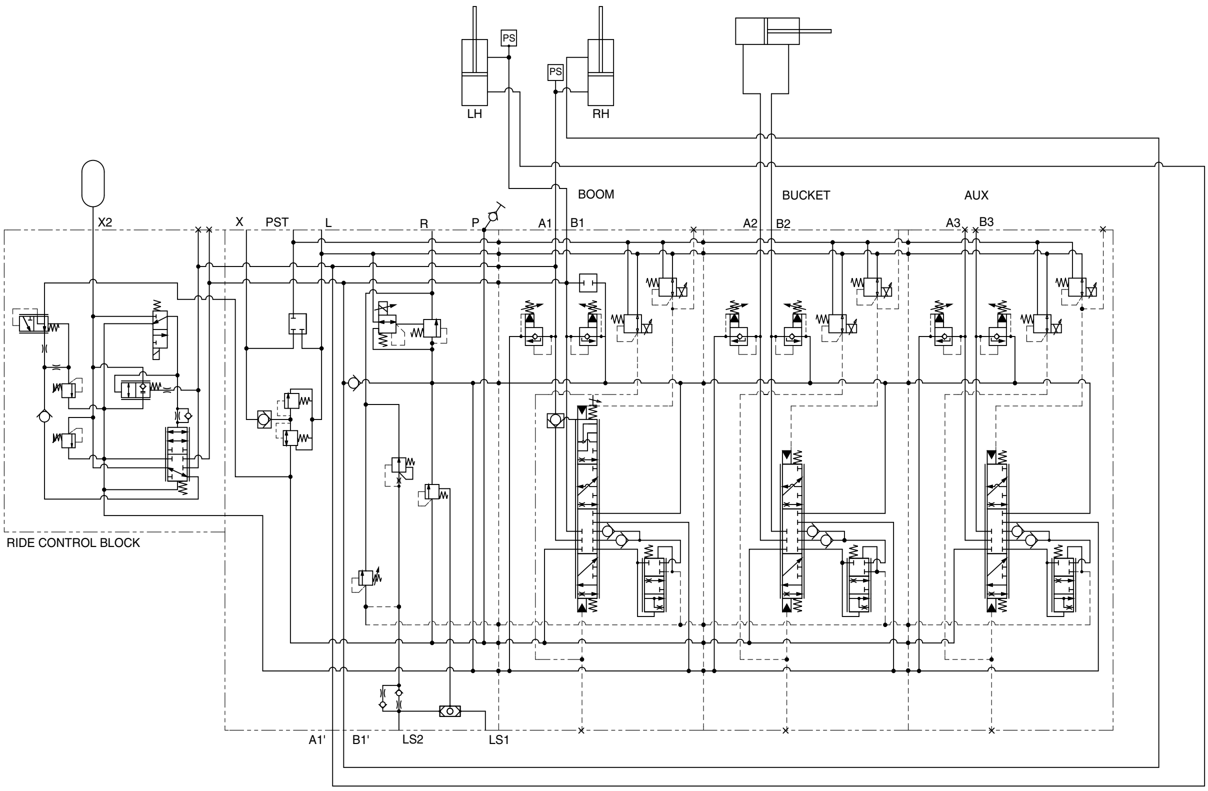
5. MAIN CONTROL VALVE

1) HYDRAULIC CIRCUIT



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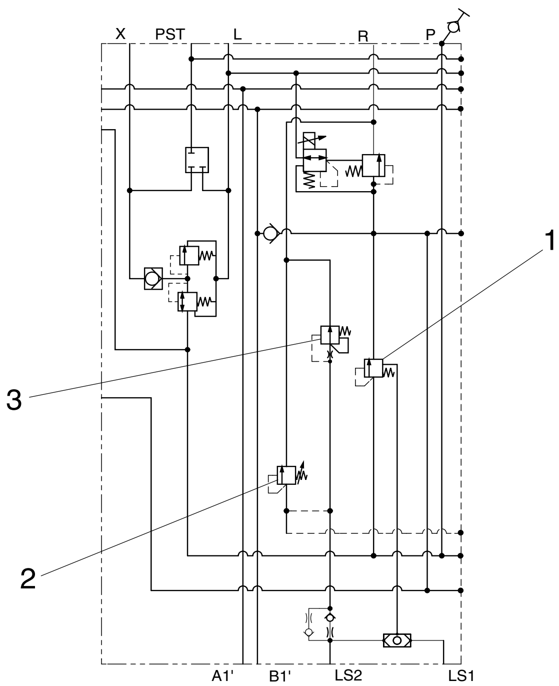
2) INLET ELEMENT DESCRIPTION

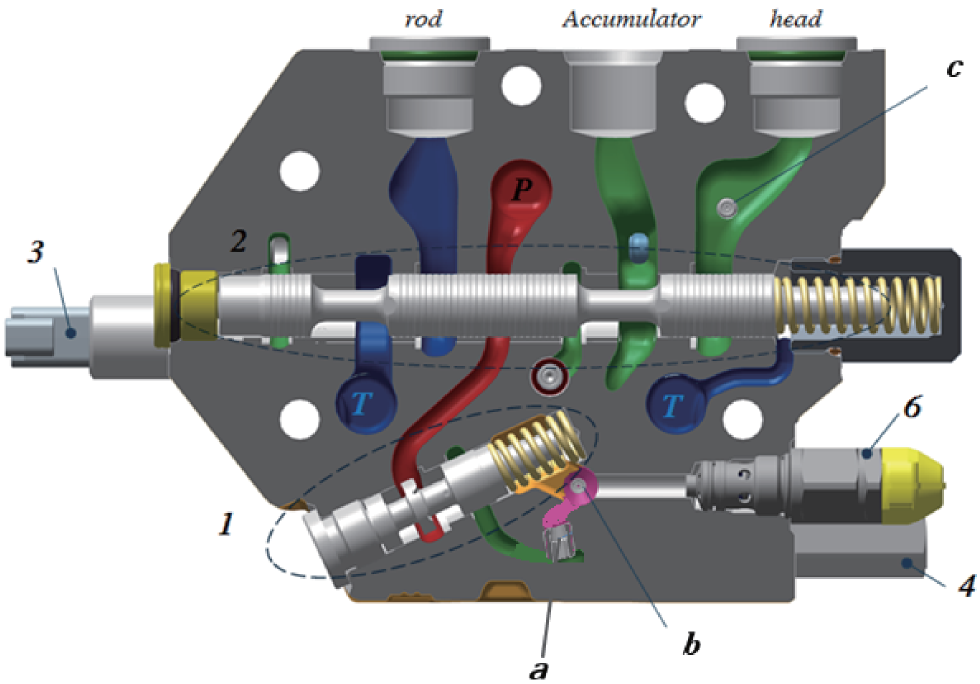
(1) The inlet element moreover comprises all components necessary for the system function : One flow control valve (1) for the controlled unloading of the LS line and one LS pressure relief valve (2) to limit the maximum system pressure.

(2) Protection of the system by means of LS pressure relief valve (2) combined with flushing valve (3).

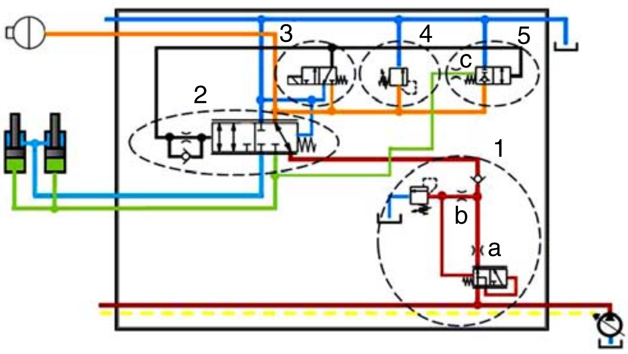


960A6WE11

3) RIDE CONTROL VALVE STRUCTURE



960A6WE12



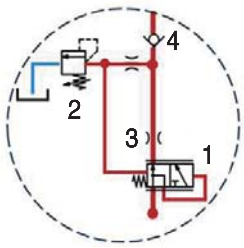
1 Accumulator loading
2 Main spool
3 Activation of RSM
4 Accumulator relief valve
5 Accumulator balancing
6 Accumulator loading pressure relief valve
a Loading flow limitation orifice
b LS orifice
c Balancing damping orifice

960A6WE14

4) RIDE CONTROL VALVE FUNCTION

(1) The LS compensator in the loading function is limiting the loading flow in combination with the loading orifice (3). In under saturation, the loading flow is reduced.

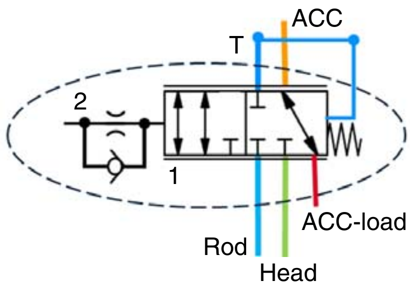
As soon as the pressure setting of the pressure relief valve (2) is reached (120 bar), the pressur compensator will close as the pump pressure is higher.
The charging stops automatically.



960A6WE15

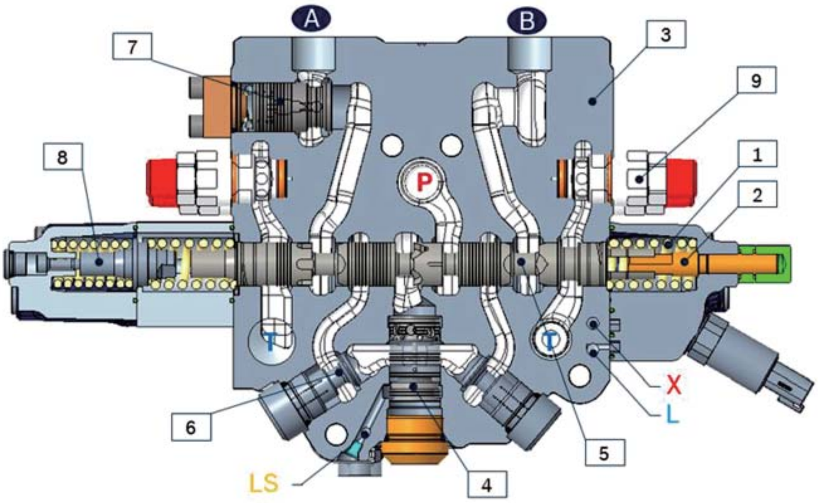
(2) When switching on the ride control valve, the rod side of the boom cylinder is connected with the tank and the head side is connected to the accumulator. The loading of the accumulator is disconnected when ride control is activated.

The shuttle valve (2) guaranties that balancing of the accumulator pressure with the current cylinder pressure is finished before head side and accumulator are connected.



960A6WE16

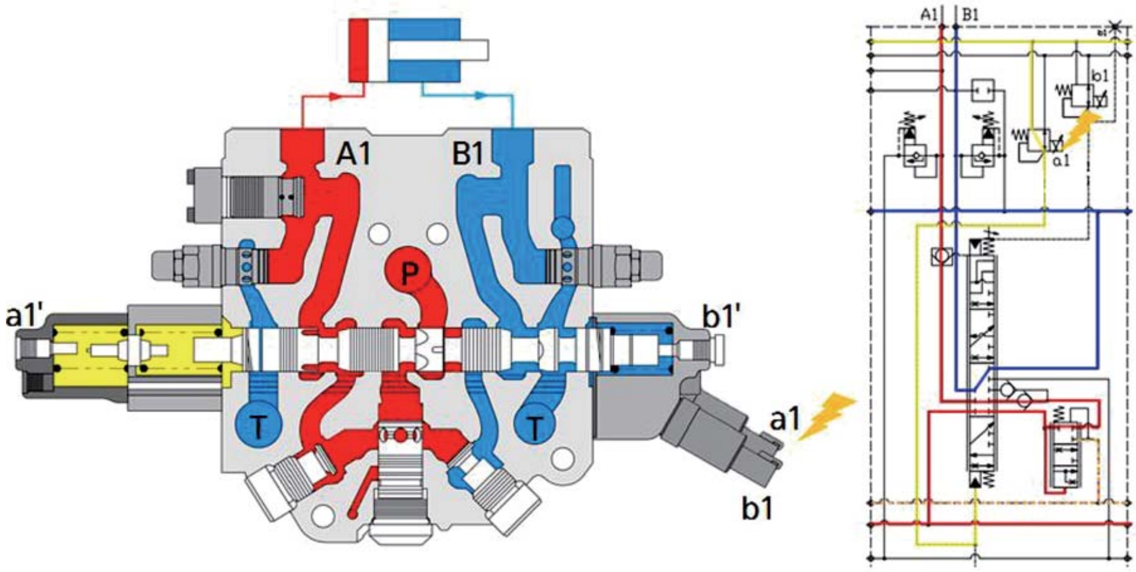
5) BOOM SECTION DESCRIPTION



960A6WE17

1	Spring	6	Load holding check valve
2	Anti rotation device	7	Anti drift poppet
3	Housing	8	4th position device
4	Pressure compensator	9	Port relief valve
5	Spool		

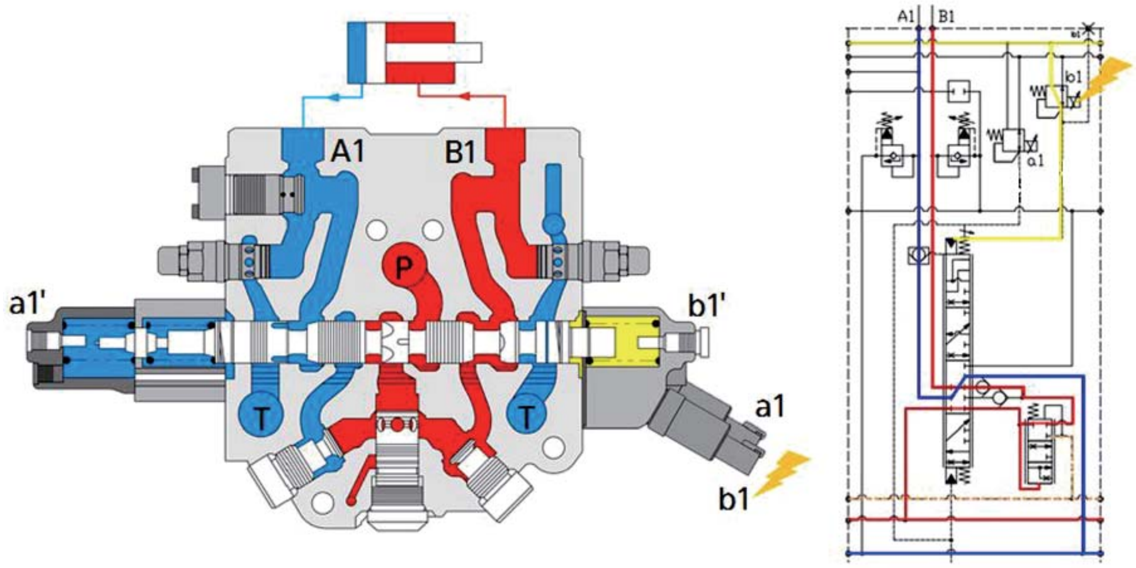
6) BOOM UP DESCRIPTION



960A6WE18

When the pilot pressure from EPPR valve (a1) is led to the port a1', the oil from the pump flows to the boom cylinder (LC) port A1 and oil from the boom cylinder (SC) flows into the tank through the boom cylinder (SC) port B1.

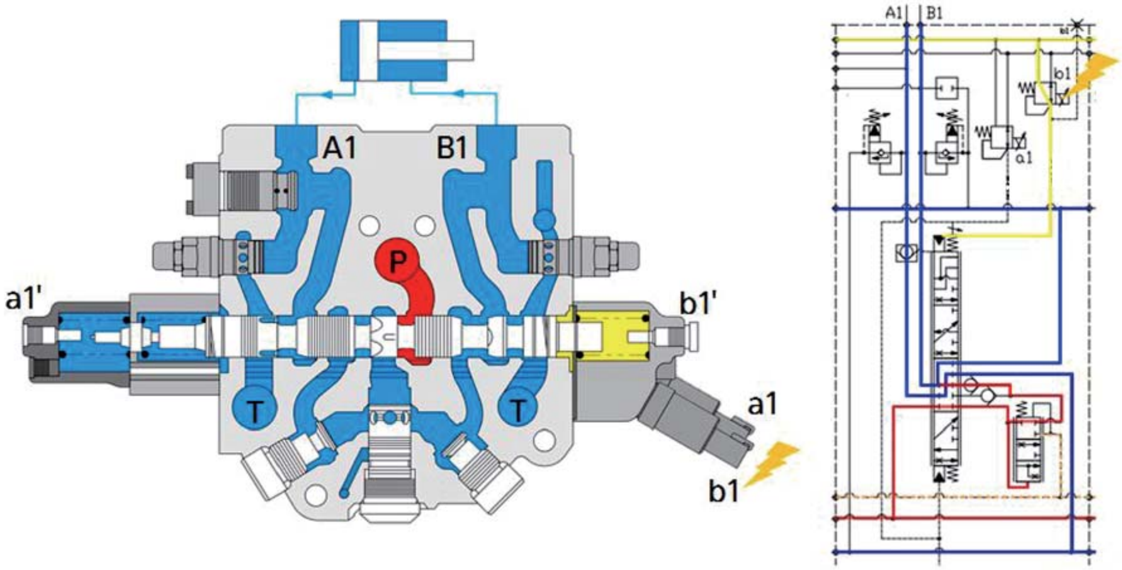
7) BOOM DOWN DESCRIPTION



960A6WE19

When the pilot pressure from EPPR valve (b1) is led to the port b1', the oil from the pump flows to the boom cylinder (SC) port B1 and oil from the boom cylinder (LC) flows into the tank through the boom cylinder (LC) port A1.

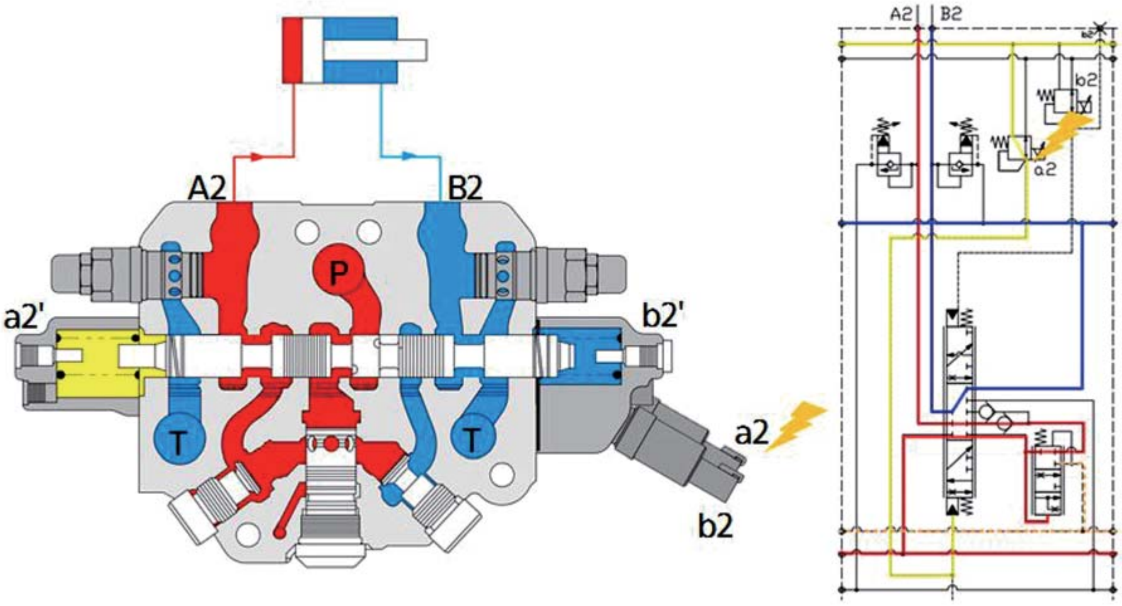
8) BOOM FLOATING DESCRIPTION



960A6WE20

When the pilot pressure from EPPR valve (b1) is led to the port b1' to maximal pressure, the spool is in the forth position. The pump is in low pressure stand-by while port A1 and B1 are connected to tank.

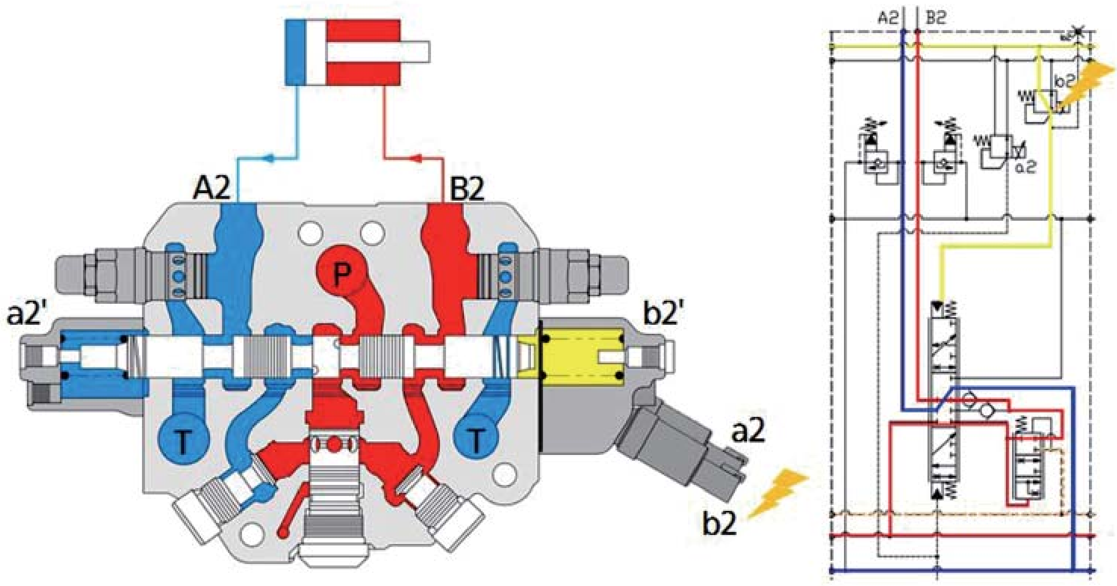
9) BUCKET ROLL BACK DESCRIPTION



960A6WE21

When the pilot pressure from EPPR valve (a2) is led to the port a2', the oil from the pump flows to the bucket cylinder (LC) port A2 and oil from the bucket cylinder (SC) flows into the tank through the bucket cylinder (sc) port B2.

10) BUCKET DUMP DESCRIPTION

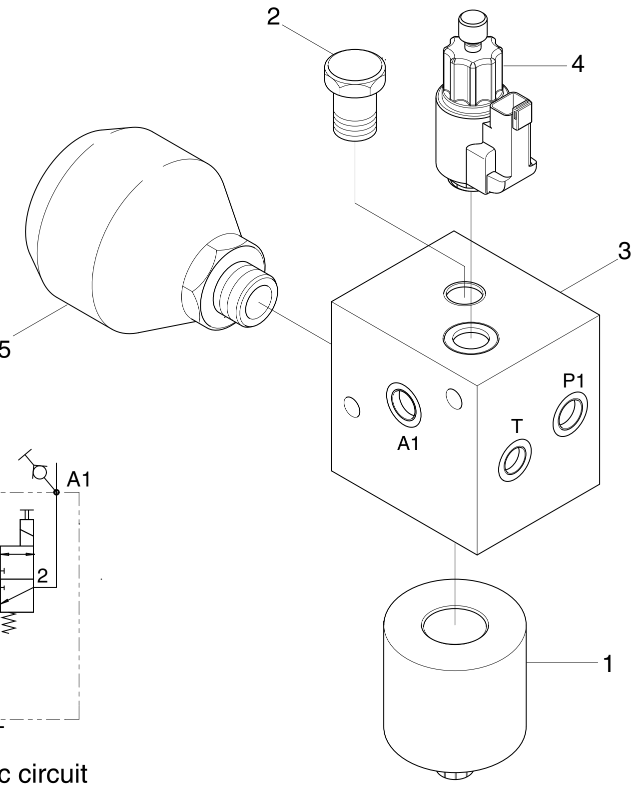


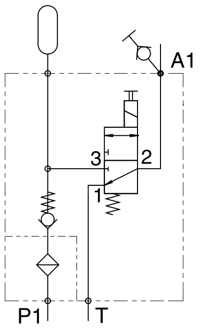
960A6WE22

When the pilot pressure from EPPR valve (b2) is led to the port b3', the oil from the pump flows to the bucket cylinder (SC) port B2 and oil from the bucket cylinder (LC) flows into the tank through the bucket cylinder (LC) port A2.

6. SAFETY VALVE

1) STRUCTURE





Hydraulic circuit

Port	Port name	Port size
P1	From MCV	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.

7. BOOM AND BUCKET CYLINDER

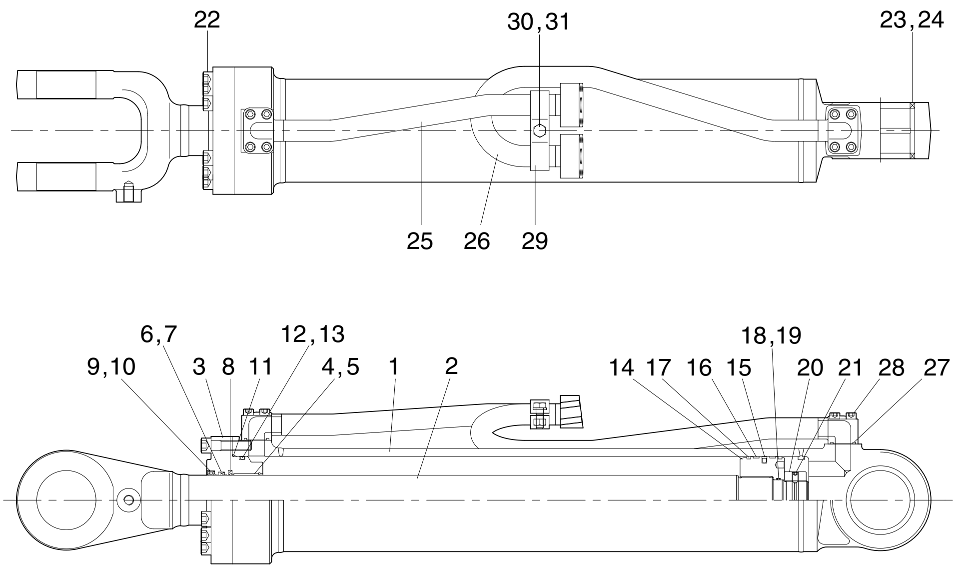
The boom cylinders are two unit and the bucket cylinder is one unit. They use a bolt on rod guide.

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 (6). A dust wiper (9) cleans the rod when it is retracted.

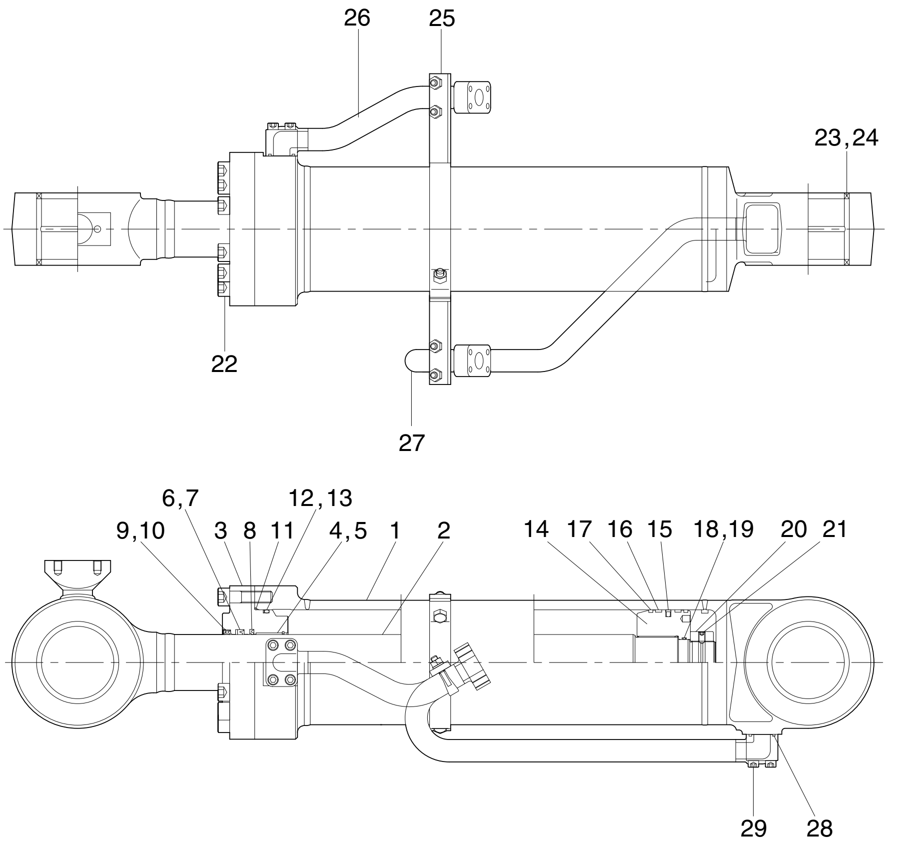
1) BOOM CYLINDER



760F6WE17

1	Tube assembly	12	O-ring	23	Pin bushing
2	Rod assembly	13	Back up ring	24	Dust seal
3	Gland	14	Piston	25	Pipe assembly
4	Bushing	15	Piston seal	26	Pipe assembly
5	Snap ring	16	Wear ring	27	O-ring
6	Rod seal	17	Dust ring	28	Socket bolt
7	Back up ring	18	O-ring	29	Band assembly
8	Buffer ring	19	Back up ring	30	Hexagon bolt
9	Dust wiper	20	Lock nut	31	Spring washer
10	Snap ring	21	Set screw		
11	O-ring	22	Socket bolt		

2) BUCKET CYLINDER



760F6WE18

1	Tube assembly	11	O-ring	21	Set screw
2	Rod assembly	12	O-ring	22	Socket bolt
3	Gland	13	Back up ring	23	Pin bushing
4	Bushing	14	Piston	24	Dust seal
5	Snap ring	15	Piston seal	25	Band assembly
6	Rod seal	16	Wear ring	26	Pipe assembly
7	Back up ring	17	Dust ring	27	Pipe assembly
8	Buffer ring	18	O-ring	28	O-ring
9	Dust wiper	19	Back up ring	29	Socket bolt
10	Snap ring	20	Lock nut		

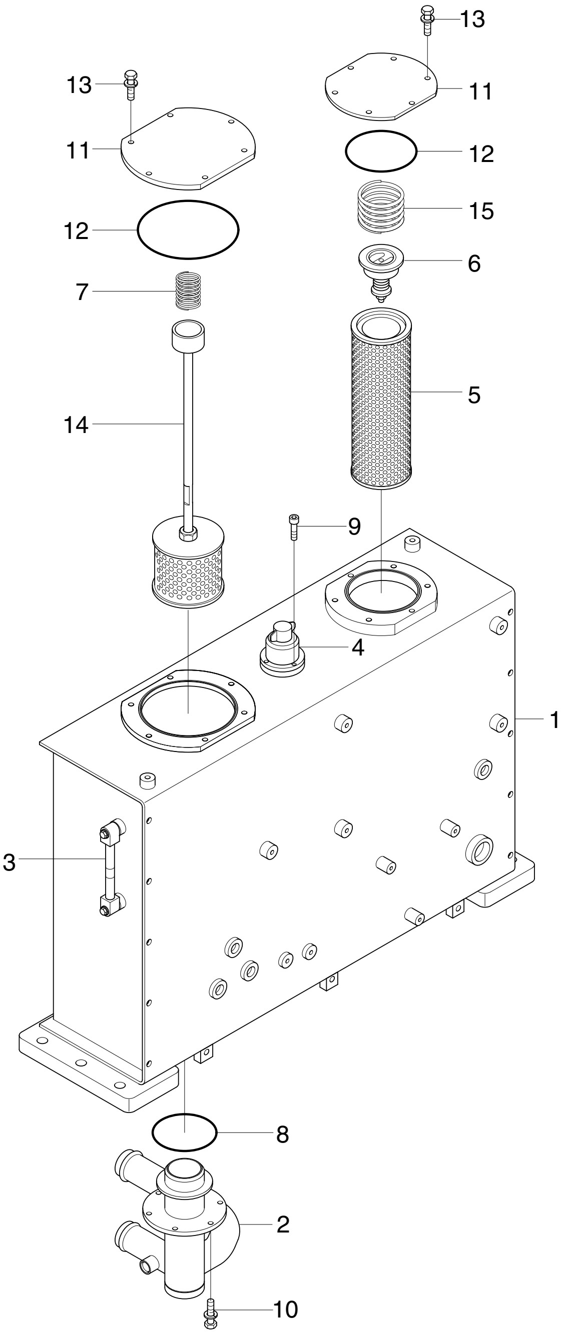
8. HYDRAULIC OIL TANK

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 (6) acts to allow the oil to return directly to the hydraulic tank (1). This prevents damage to the hydraulic filter (5). The bypass valve (6) is also actuated when negative pressure is generated in the circuit.



960A6WE21

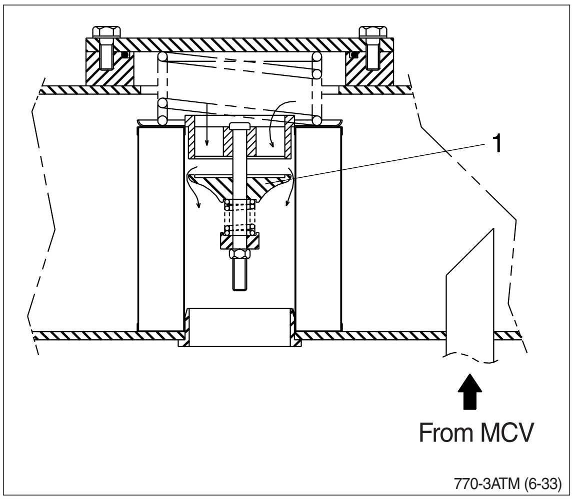
1	Hydraulic tank wa
2	Pipe wa
3	Sight gauge
4	Air breather
5	Element assembly
6	Bypass valve
7	Spring
8	O-ring
9	Socket bolt
10	Bolt
11	Cover
12	O-ring
13	Bolt
14	Strainer
15	Spring

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)



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.

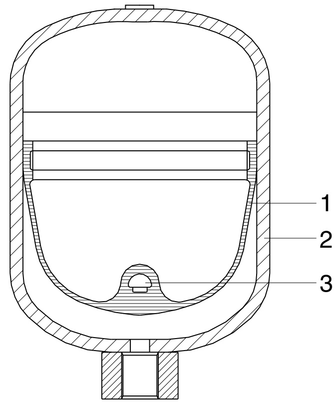
(2) Preventing excessive pressure inside the tank

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.

9. 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/cm² (228 psi)
Max actuating pressure	128 kg/m² (1820 psi)



1 Diaphragm
2 Steel pressure vessel
3 Closure button

7803AWE56

10. 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.)

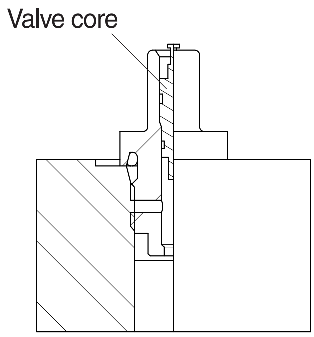
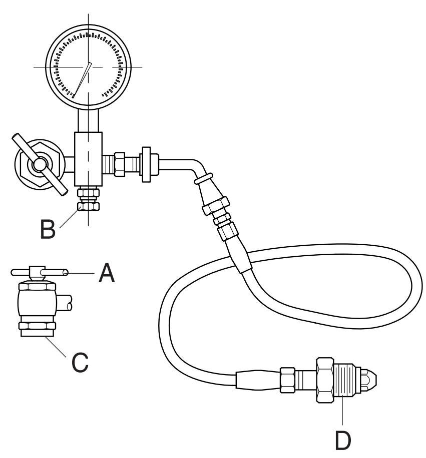


Figure 1

WLACC01



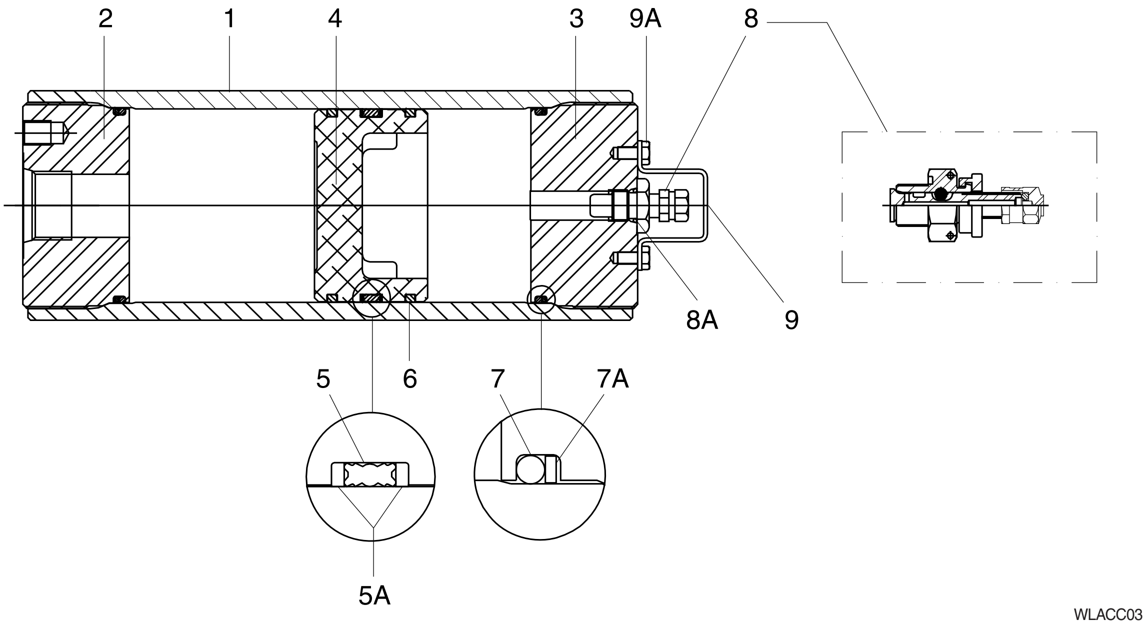
Charging and gauging kit (31LM-90100)

WLACC02

(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.

(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

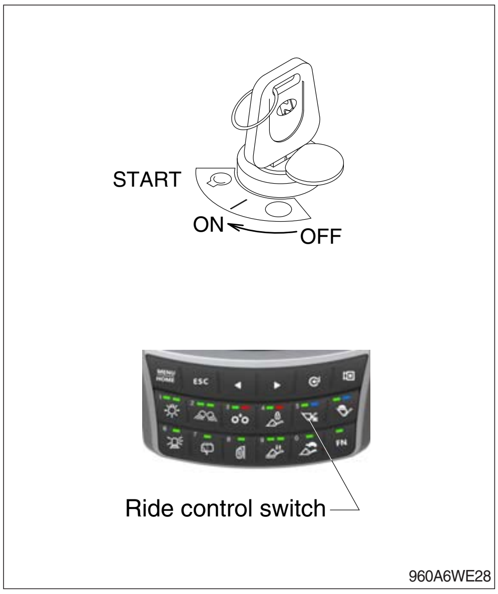
⚠ Attention

※ Before carrying out any maintenance work the accumulators must be unloaded (zero pressure).

1) Bucket should be lade on the ground.

2) Turn the starting switch to ON position and press the ride control switch on monitor to operate ride control function.

3) Lower the boom to the postion of down or floating to release the charged oil in accumulators.



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.

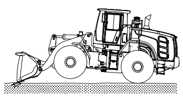
The engine and all other major components must be at operating temperature for some checks.

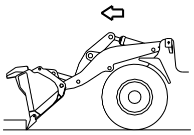
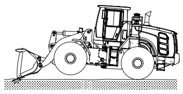
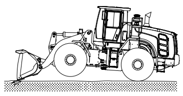
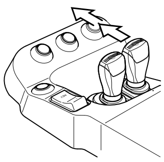
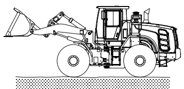
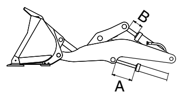
Locate system check in the left column and read completely, following the sequence from left to right. Read each check completely before performing.

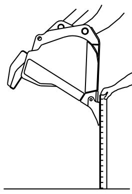
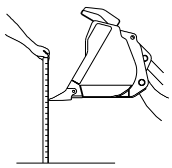
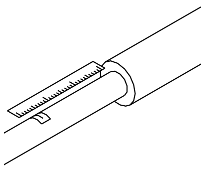
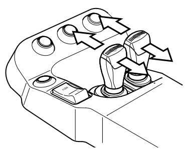
At the end of each check, if no problem is found (OK), that check is complete or an additional check is needed. If problem is indicated (NOT OK), you will be given repair required and group location.
If verification is needed, you will be given next best source of information:

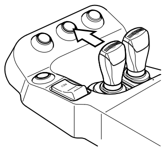
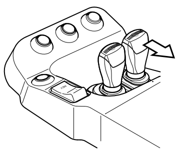
- · Chapter 2 : Troubleshooting
- · Group 3 : Tests and adjustments

※ Hydraulic oil must be at operating temperature for these checks (refer to page 6-49).

Item	Description	Service action
Hydraulic system warm-up procedure Run engine at high idle. Refer to page 6-55.	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** Do priority valve high pressure check. **IF OK** Do steering system leakage check at page 5-20. **IF OK** Do main hydraulic pump flow test at page 6-49.
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 6-51.
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.
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 10 mm Bucket cylinder must drift less than 23 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 6-51. **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. Boom raise: Bucket flat on ground to full height. Boom lower: Full height to level ground. Bucket dump: Boom at full height. Bucket rollback: Boom at full height. Steering [No. of turns]: Frame stop to frame stop.	Maximum cycle time 5.9sec 3.7sec 2.0sec 2.0sec 3.9 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

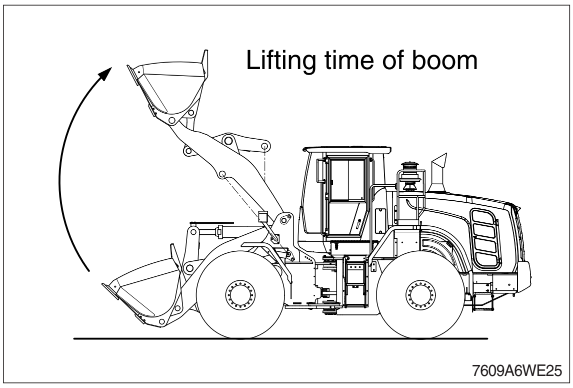
2) MEASURING TOOL

· 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.



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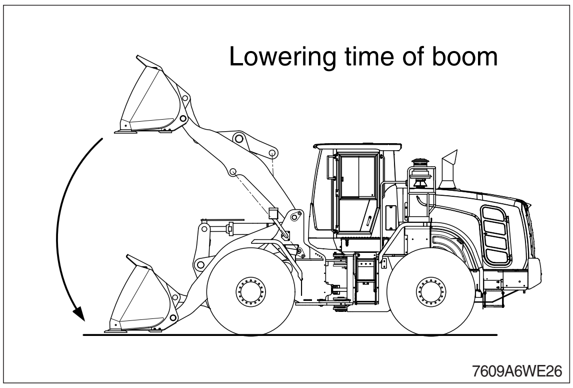
(2) LOWERING TIME OF BOOM

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.



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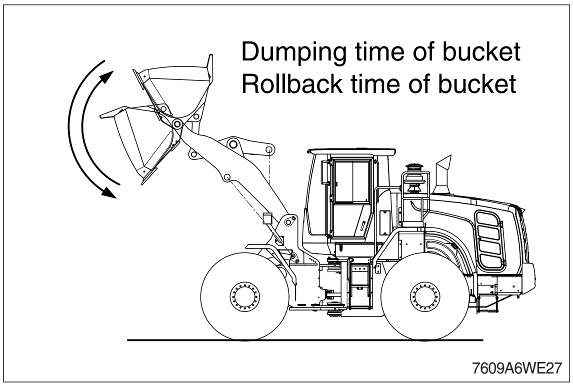
(3) DUMPING TIME OF BUCKET

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.



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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 hydrualic 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.
	Binding loader control valve (MCV) spool.	Inspect valve.
	Faulty steering unit.	Check priority valve, orifice of steering unit 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).	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.

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 1-22, **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 mm × 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 : 110 ℓ (29.1 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.

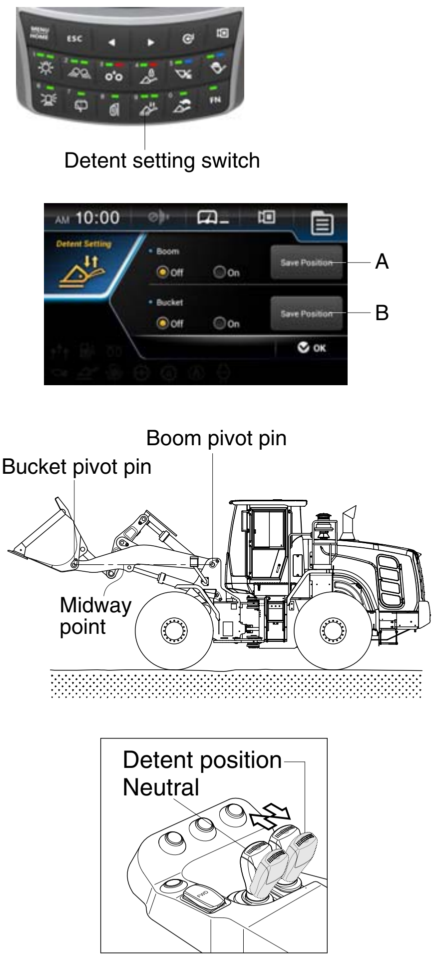
⚠ Park the machine on level ground and block the tires to prevent sudden movement of the machine.

⚠ 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



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(1) Lift kickout position

To set the lift kickout, raise the bucket to the desired position above the midway point. Then push icon (, 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 (, 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 (, 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

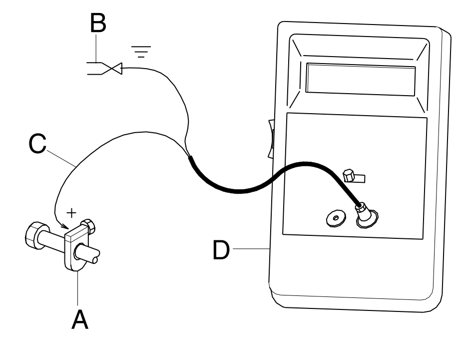
· Service equipment and tools
Tachometer

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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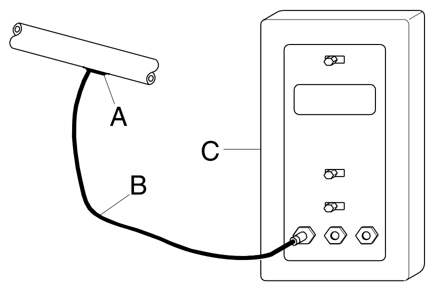
2) DIGITAL THERMOMETER INSTALLATION

· 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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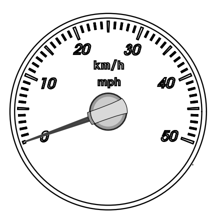
3) DISPLAY MONITOR TACHOMETER

The display monitor tachometer is accurate enough for test work.



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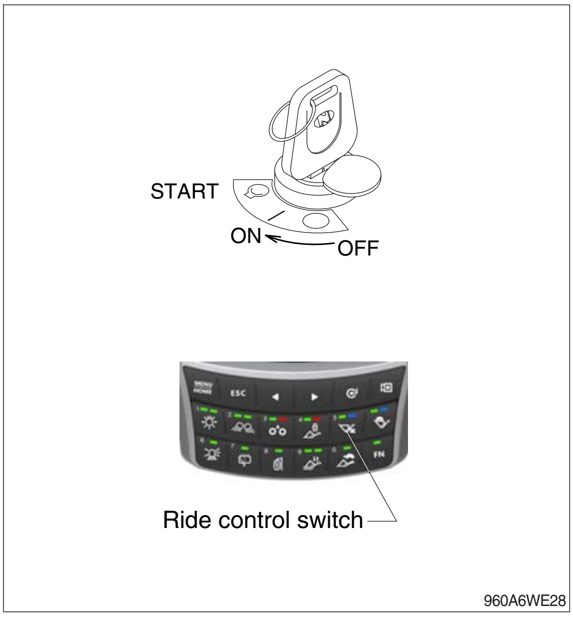
4. HYDRAULIC OIL WARM UP PROCEDURE

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) Bucket should be lade on the ground.
3) Turn the starting switch to ON position and press the ride control switch on monitor to operate ride control function.
4) Lower the boom to the postion of down or floating to release the charged oil in accumulators.



5. MAIN HYDRAULIC PUMP FLOW TEST

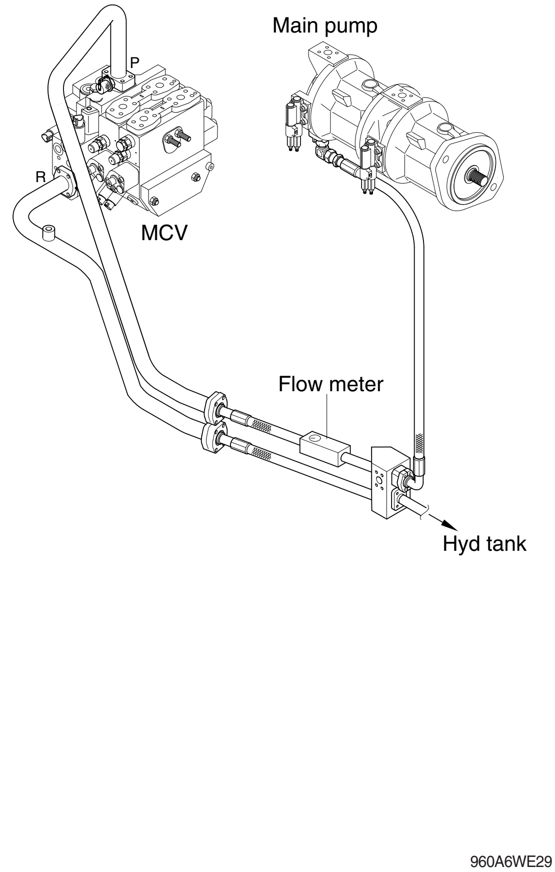
· **SPECIFICATION**

Oil temperature	45±5˚C (113±9˚F)
Engine speed	2100±25rpm
Test pressure	280±5 bar (4060 psi)
Maximum pump flow	245 ℓ/min (64.7 gpm)

· **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.



6. LOADER SYSTEM AND PORT RELIEF VALVE PRESSURE TEST

· SPECIFICATION

Oil temperature (40~50˚C)

Relief valve	Engine speed	Relief pressure
System (M)	High	280±5 kg/cm² (3980±70 psi)
Boom raise (U)	Low	340±10 kg/cm² (4840±140 psi)
Boom down (W)	Low	340±10 kg/cm² (4840±140 psi)
Bucket rollback (R)	Low	340±10 kg/cm² (4840±140 psi)
Bucket dump (D)	Low	340±10 kg/cm² (4840±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
W: Boom down relief

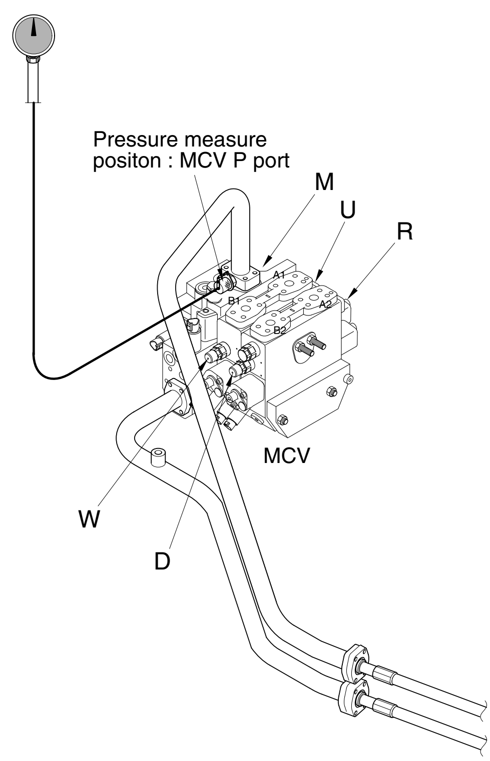
1) Install fitting and pressure gauge to test port in pump delivery line.

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 high 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 280 kg/cm² (3980 psi). Damage to the pump will result from excessive pressure settings.



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7. HYDRAULIC SYSTEM RESTRICTION TEST

· SPECIFICATION

Oil temperature 45±5˚C (113±9˚F)
Engine speed High idle
Maximum pressure 4.5 MPa (45 bar, 640 psi) at steering unit.
Maximum pressure at main control valve
1 MPa (10 bar, 145 psi)

· GAUGE AND TOOL

Gauge 0~7 MPa (0~70 bar, 0~1000 psi) 2EA

This test will check for restrictions in the hydraulic 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 in this group)

3) Connect fitting and gauge to steering unit.

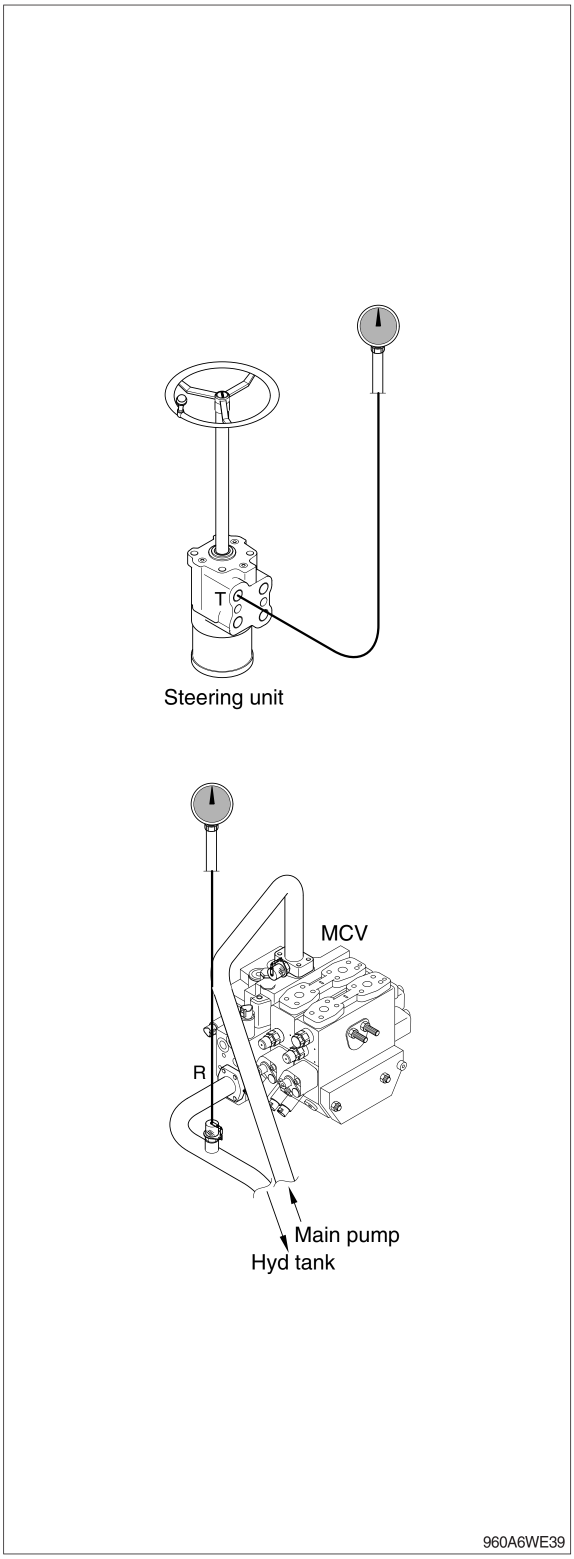
4) Connect fitting and gauge to main control valve.

⚠ **Do not operate steering or loader funct-ions or test gauge may be damaged.**

5) Run engine at specification and read pressure gauges.

If pressure is more than specification at the loader control valve, check for a kinked, dented or obstructed hydraulic line. Check loader control valve for a binding spool.

If pressure is more than specification at the steering unit, inspect neutral condition of the steering unit for a stuck spool. Make sure orifice plugs are installed in ends of priority valve spool. Check for plugged orifice in priority valve and dynamic signal orifice on steering unit body.



8. 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	10 mm
Retraction of bucket cylinder rod	23 mm

· GAUGE AND TOOL

Stop watch
Temperature reader

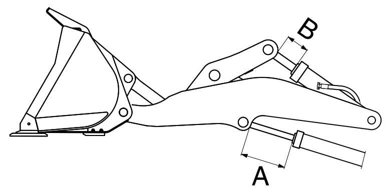
⚠ Put the pilot cut off switch in the OFF position.

⚠ 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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9. 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.**

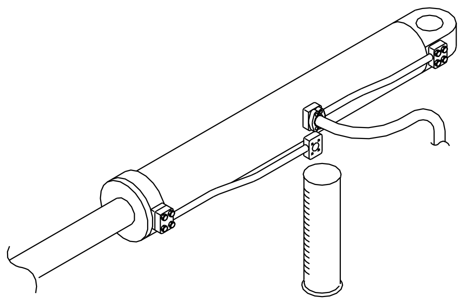
3) Full extend the cylinder to be tested. If testing the boom cylinders, restrain boom in the fully raised position using a hoist or a stand.

※ 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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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	5.9
Boom lower (float)	Full height to ground level	3.7
Bucket dump	Boom at full height	2.0
Bucket rollback	Boom at full height	2.0
Steering (No. of turns)	Frame stop to stop	3.9 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.

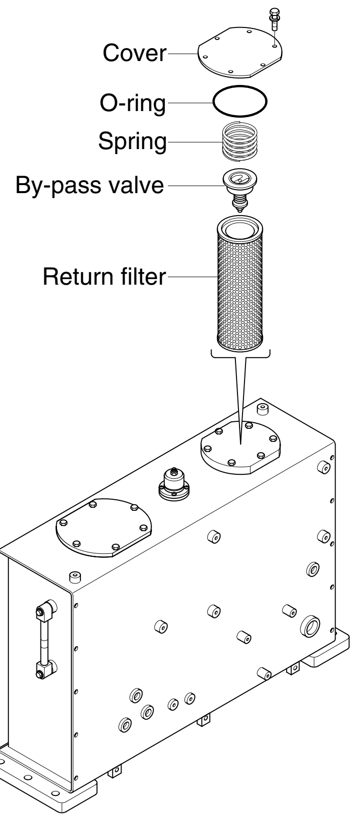
※ The hydraulic oil filter in the filter case of the hydraulic oil tank should be replaced every 1000 operating hours or more often. When the filter element is replaced, please keep as follows.

(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.

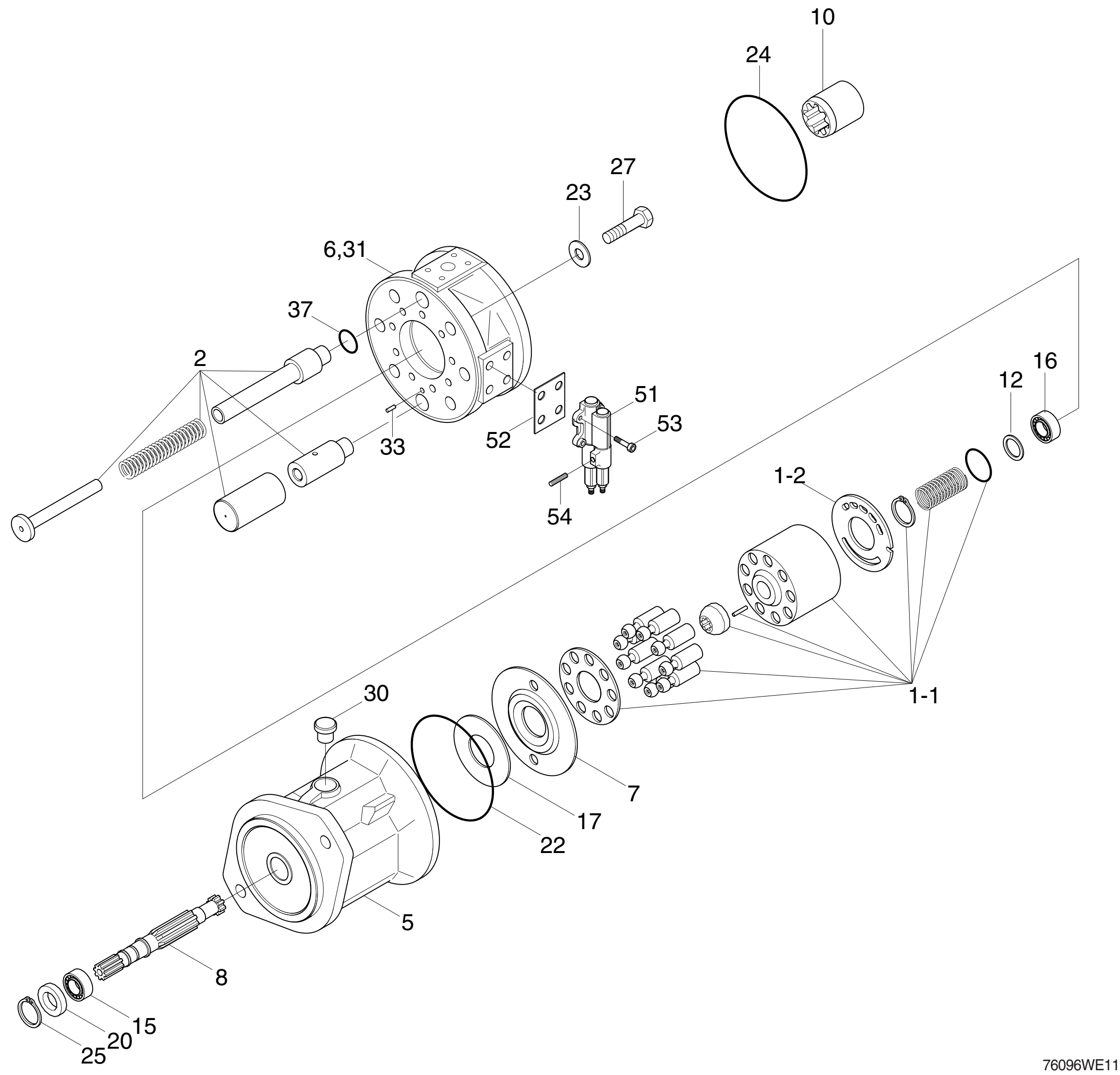
(4) Install the O-ring and filter case covers. Tighten them with bolt. Replace the O-ring with new one if damaged.



GROUP 4 DISASSEMBLY AND ASSEMBLY

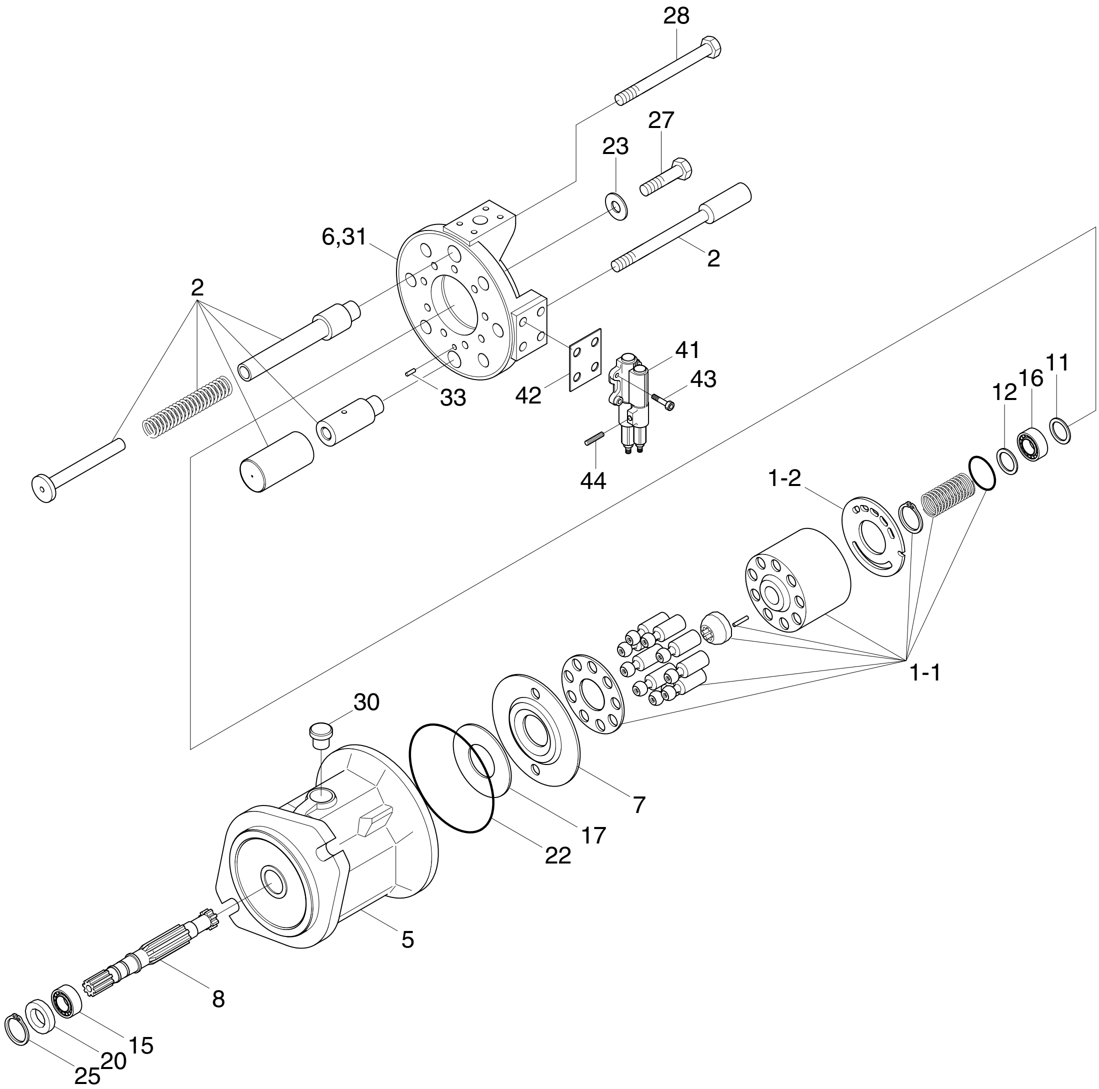
1. MAIN PUMP

1) STEERING (1/2)



1	Rotary group	12	Adjustment shim	27	Socket screw
1-1	High speed rotary group	15	Taper roller bearing	30	Locking screw
1-2	Control plate	16	Taper roller bearing	31	Double break-off pin
2	Adjusting piece	17	Bearing liner	33	Cylinder pin
5	Pump housing	20	Shaft seal ring	37	Side mark ring
6	Port plate	22	O-ring	51	Control valve
7	Swash plate	23	O-ring	52	Gasket
8	Drive shaft	24	O-ring	53	Socket head screw
10	Splined hub	25	Retaining ring	54	Locking screw

LOADER (2/2)



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1	Rotary group	12	Adjustment shim	28	Locking screw
1-1	High speed rotary group	15	Taper roller bearing	30	Locking screw
1-2	Control plate	16	Taper roller bearing	31	Double break-off pin
2	Adjusting piece	17	Bearing liner	33	Cylinder pin
5	Pump housing	18	Shaft seal ring	41	Control valve
6	Port plate	22	O-ring	42	Gasket
7	Swash plate	23	O-ring	43	Socket screw
8	Drive shaft	25	Retaining ring	44	Locking screw
11	Adjustment shim	27	Socket 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.

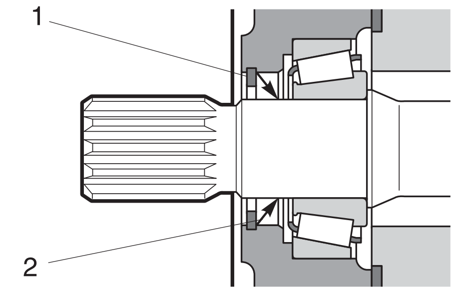
※ Re-work of the sliding surfaces by using, for example abrasive paper, can damage the surface.

(4) Fill the hydraulic pump with hydraulic oil before commissioning.

3) SEALING THE DRIVE SHAFT

(1) Protect the drive shaft.
Remove the circlip.
Remove the shaft seal.

1 Circlip 2 Shaft seal



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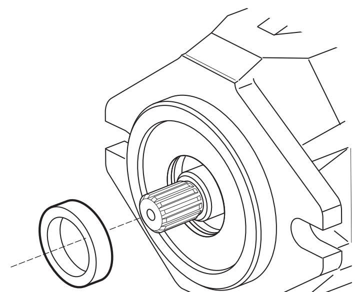
(2) Change the shaft seal and check its sliding surface (drive shaft) and housing, grease the sealing ring.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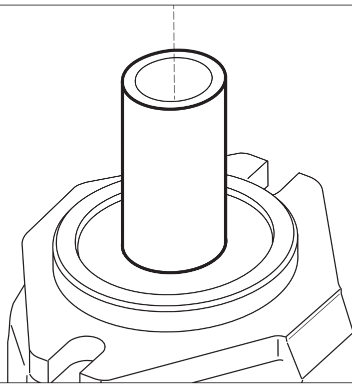
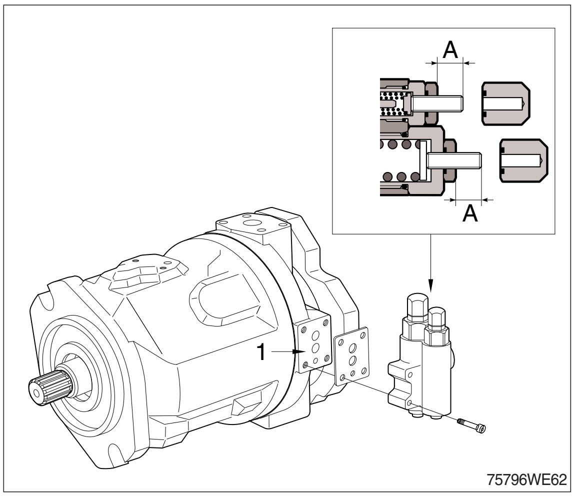
(3) Assemble the sealing ring, fitting tool holds the correct position of the sealing ring in the pump housing.
Assemble the circlip in the correct position.


75796WE59

4) SEALING / CLEANING THE CONTROL VALVE

(1) Disassemble the control valve.

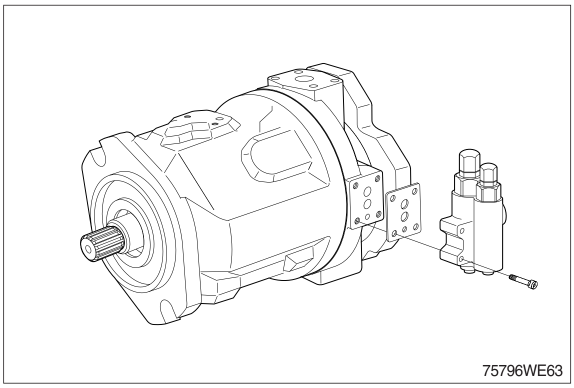
※ Measure dimension A and note down. Check sealing surface (1).



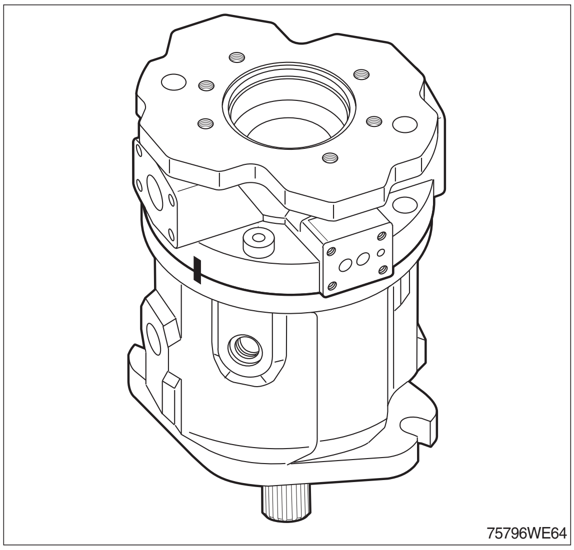
75796WE62

5) DISASSEMBLE THE PUMP

(1) Remove the control valve.

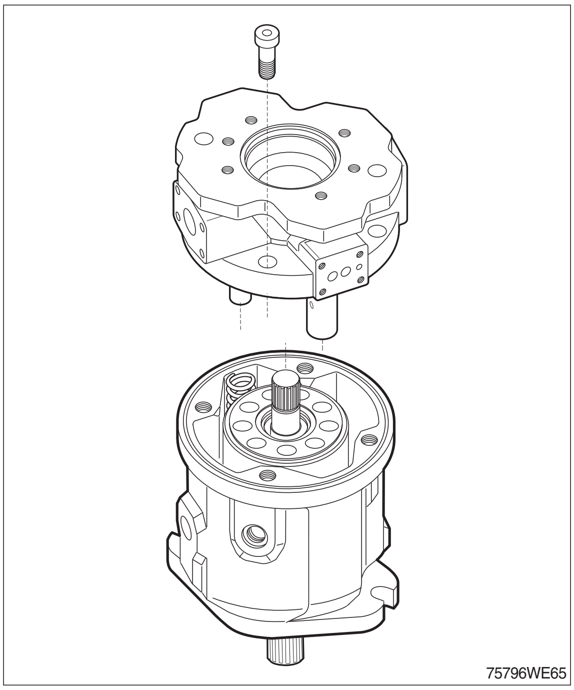

75796WE63

(2) Mark the location of the connection plate on the housing.


75796WE64

(3) Remove the connection plate fixing bolts and the connection plate.

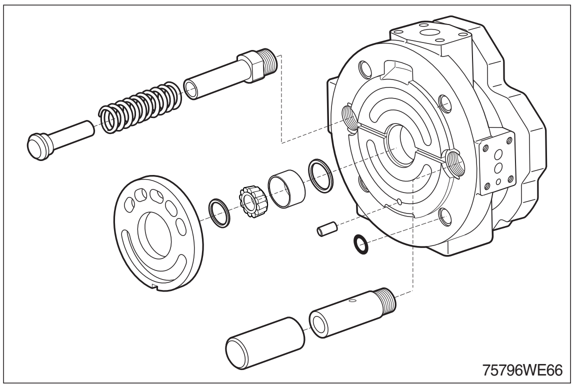
※ Distributor plate and adjustment piston can drop down.



75796WE65

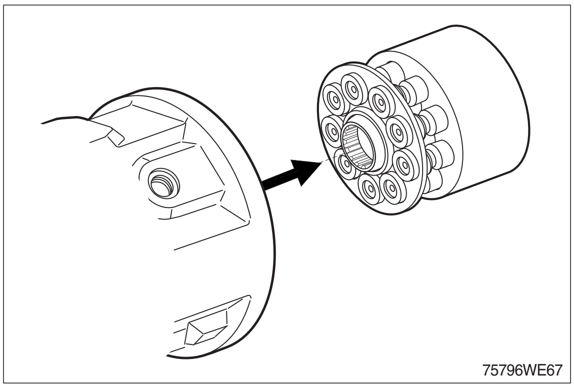
(4) Remove distributor plate.
Take note of the orientation.

※ Remove bearing with withdrawal tool.
Do not damage the sealing surface.



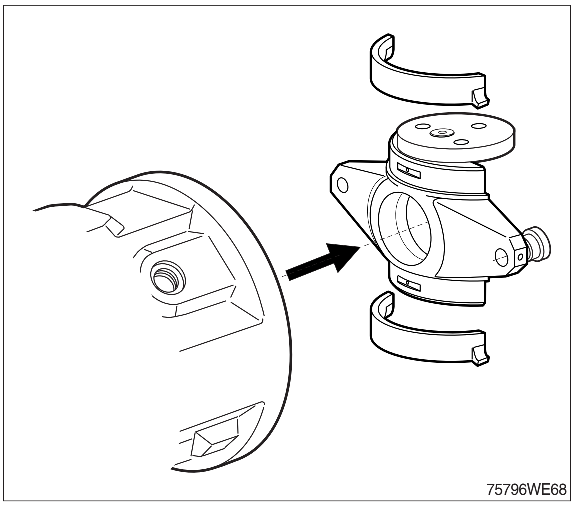
75796WE66

(5) Remove the rotary group in a horizontal position.

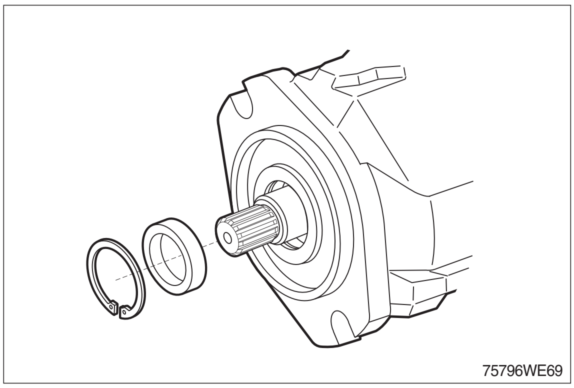


75796WE67

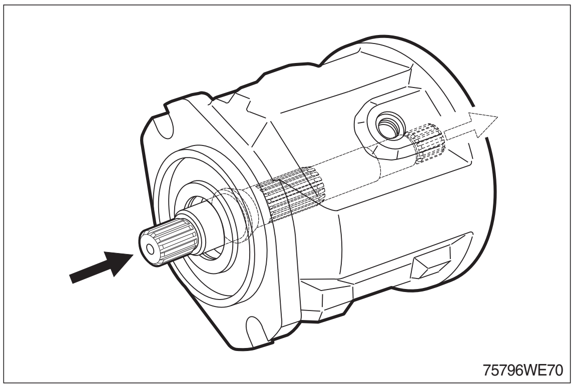
(6) Remove swash plate and bearing shells.



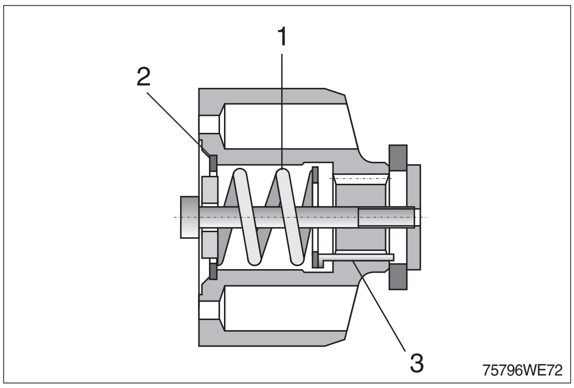
(7) Remove the circlip and the shaft seal.



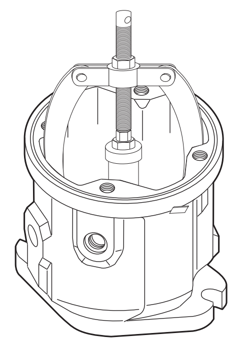
(8) Remove the drive shaft through rear side.



(9) Pre-tension the spring (1) using a suitable device.
Remove circlip (2).
Remove spring (1) and pressure pins (3).

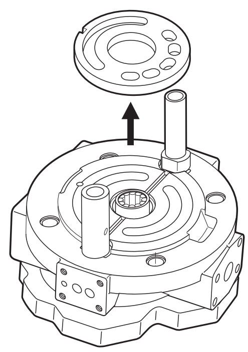


(10) Use bearing puller to remove outer bearing race of front bearing out of housing press seat.



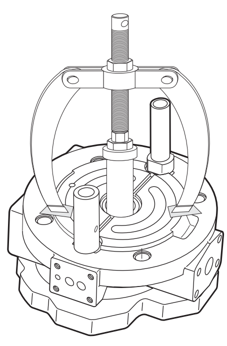
75796WE74

(11) Remove the control plate.



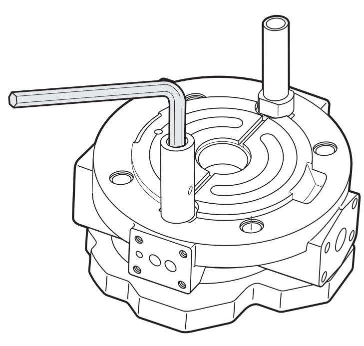
75796WE75

(12) Use bearing puller to remove outer bearing race of rear bearing - press seat.



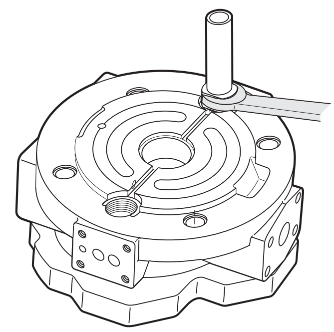
75796WE76

(13) Disassemble the guide of control piston (Mounting position: pilot valve side).



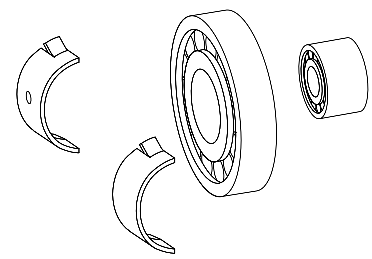
75796WE77

(14) Disassemble the guide of the opposite piston.


75796WE78

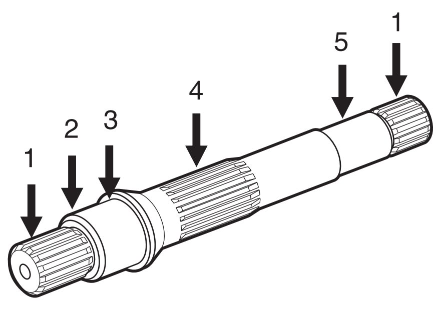
6) INSPECT HINTS

(1) Renew all bearings.


75796WE79

(2) Check :

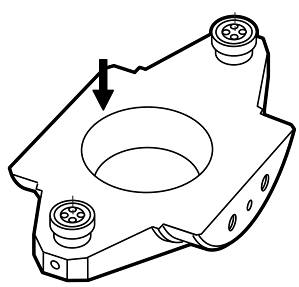
1 Wear on splines, rust
2 Drive shaft seal wear grooves
3 Bearing seat
4 Splines for cylinder drive
5 Bearing seat



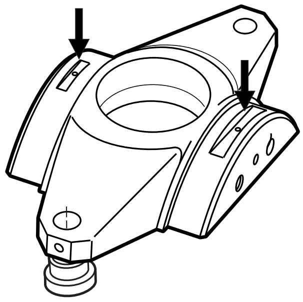
75796WE80

(3) Check :

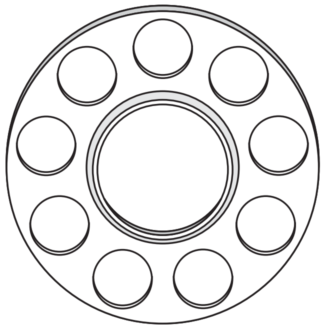
Sliding surface free of grooves.


75796WE81

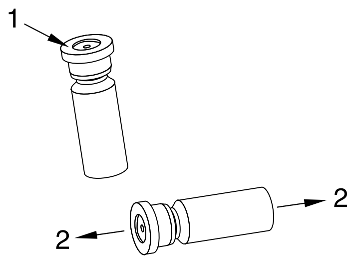
(4) Check :
Bearing surfaces.


75796WE82

(5) Check :
That the retaining plate is free of grooves and that there is no wear in the slipper pad area.


75796WE83

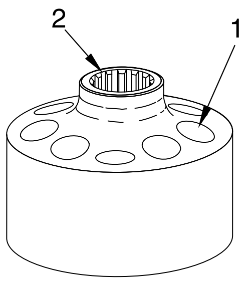
(6) Check :
Check to see that there are no scratches or metal deposits on the sliding surface (1) and that there is no axial play (2) (Pistons must only be replaced as a set).



75796WE84

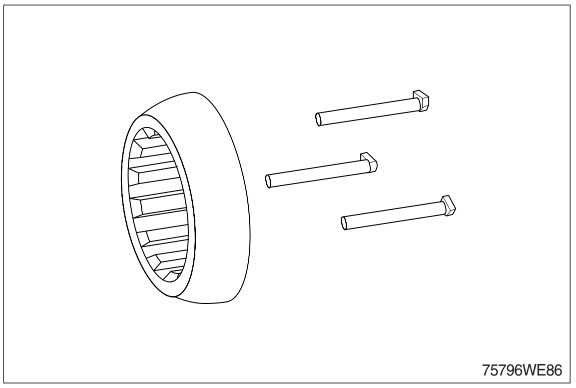
(7) Check :

1 Cylinder bores
2 Splines

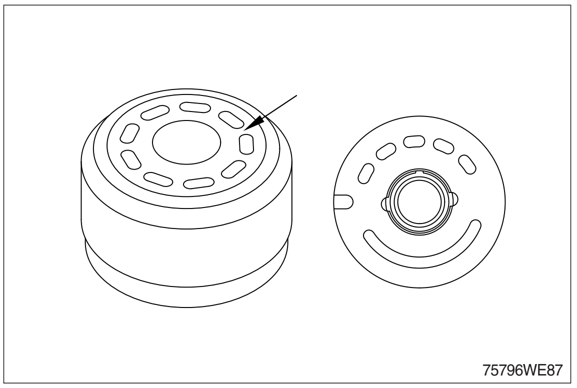


75796WE85

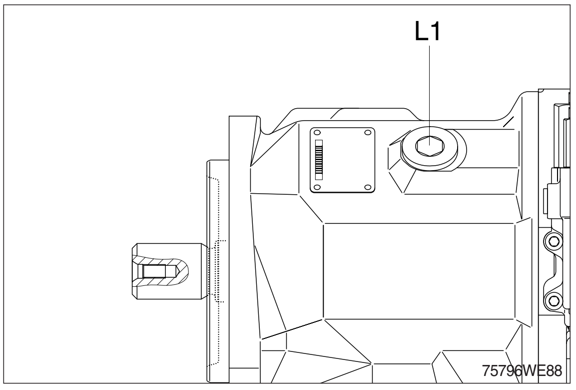
(8) Free of grooves, no signs of wear.



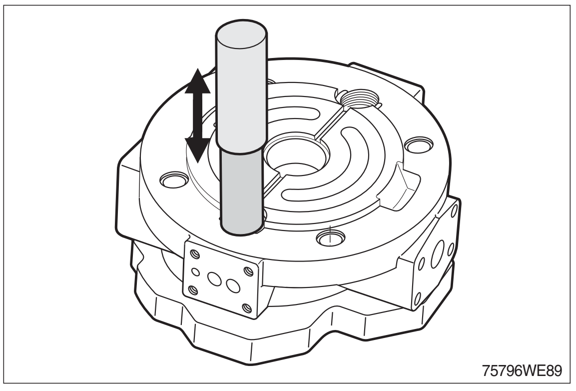
(9) Check :
Cylinder sliding surface free of grooves, no wear, no embedded foreign particles. That there are no scratches on the control plate. (Only replace them as a set).



(10) Check :
Mounting surface - control plate undamaged.

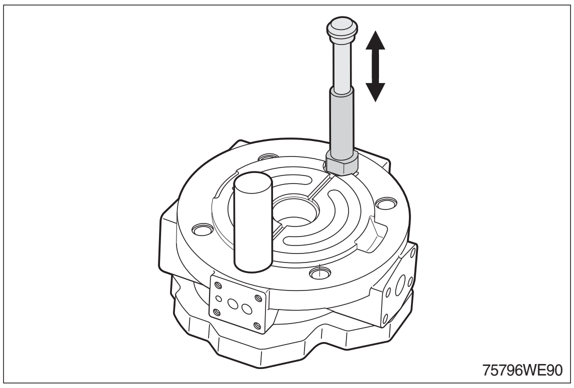


(11) Check :
Check running conditions of the control piston.



(12) Check :

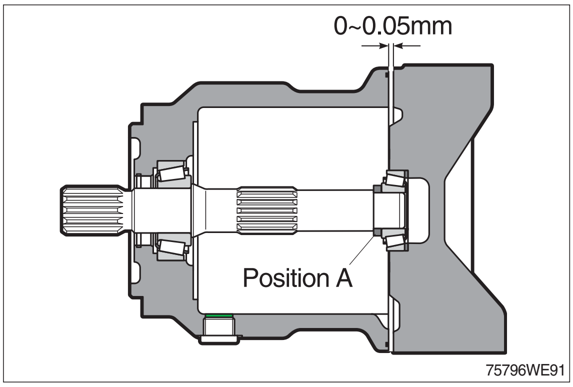
Check running conditions of the opposite piston.



75796WE90

7) ADJUSTMENT OF TAPER ROLLER BEARING SET

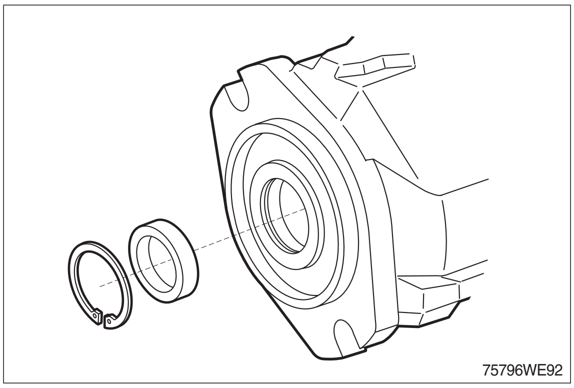
(1) Cast iron housing must have initial tension of the bearings: 0~0,05 mm, grind position A if necessary.



75796WE91

8) PUMP ASSEMBLY

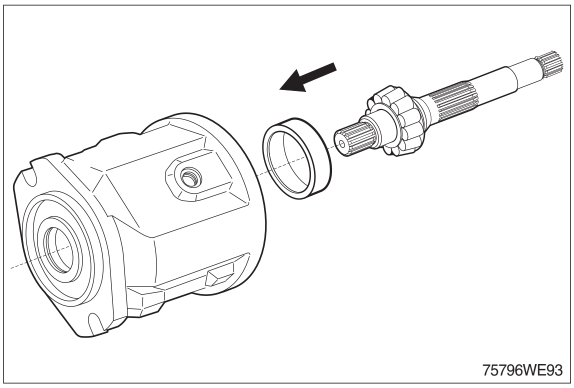
(1) Fit the seal into the housing.
Fit the circlip.



75796WE92

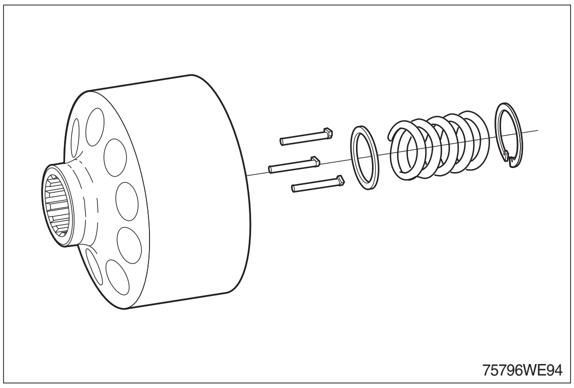
(2) Fit the drive with bearing from rear end.

※ Do not touch seal lip with edge of keyway or spline.

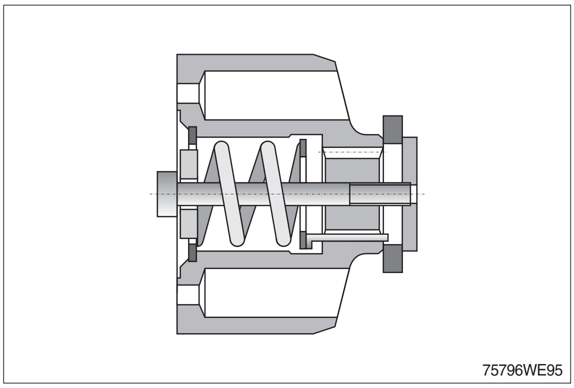


75796WE93

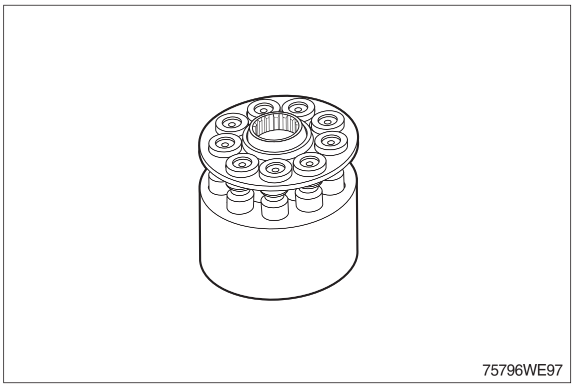
(3) Fit pressure pins using an assembly aid.



(4) Pre-tension the spring using a suitable device.

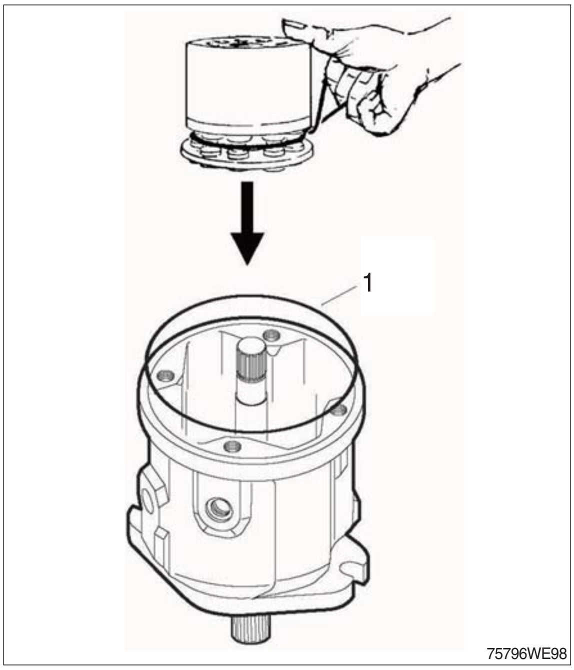


(5) Assemble piston with retaining plate.
※ Oil piston and slipper pad.



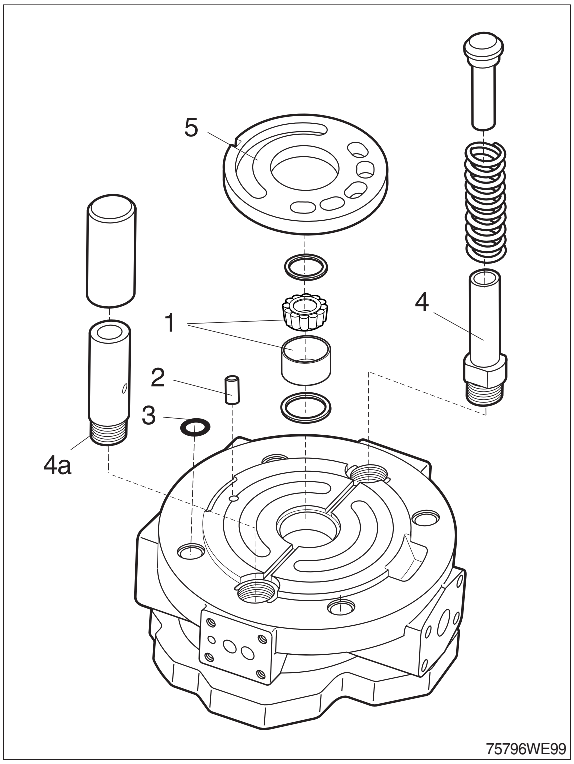
(6) Fit rotary group.

※ Hold the piston by using an O-ring.
Fit O-ring (1).



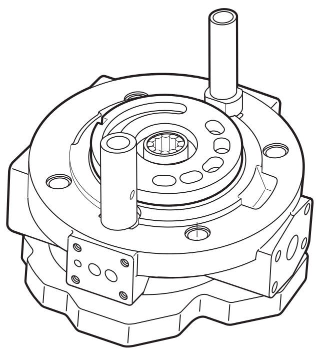
(7) Fit bearing (1) in connection plate.
Fit cyilindrical pin (2).
Fit O-rings (3) 4 pieces.
Fit adjustment spool (4) and guide piston (4a).
Fit distributor plate (5) (direction of rotation dependent)

※ Assembly.
Hold the components in place with grease.



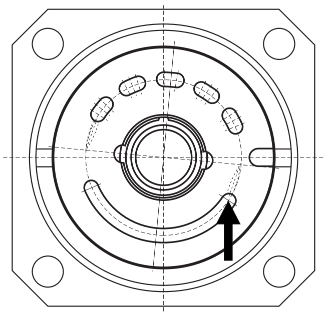
(8) Fit distributor plate.

※ Assembly aid : Grease



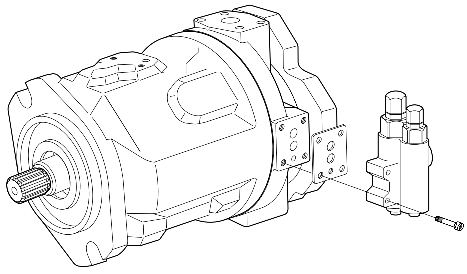
75796WE100

(9) For clockwise rotation pumps the distributor plate is off-set by 4˚ to the right from the centre position.
(Clockwise and anti-clockwise rotation distributor plates are not identical).



75796WE101

(10) Fit connection plate and control valve.

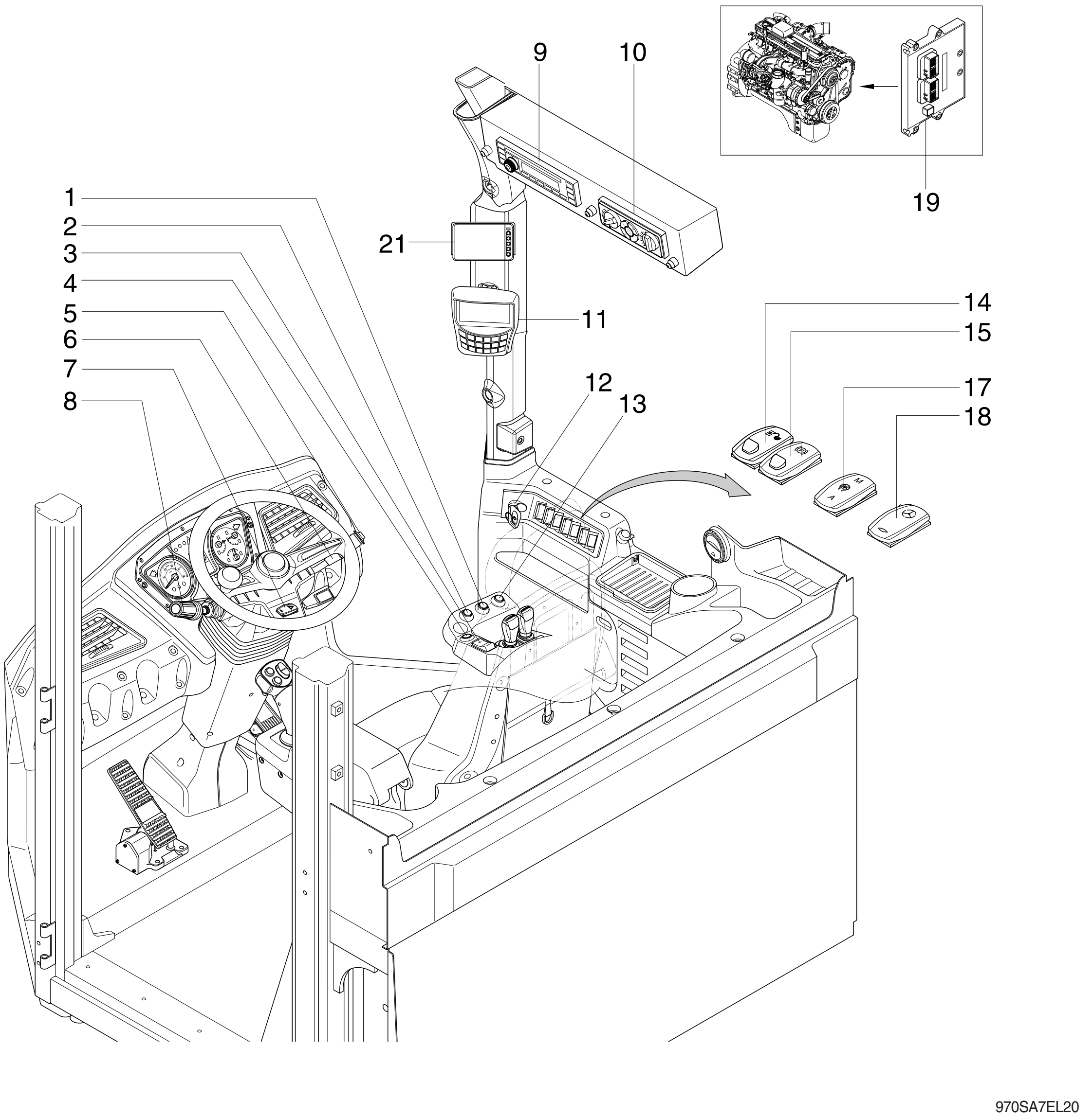


75796WE63

SECTION 7 ELECTRICAL SYSTEM

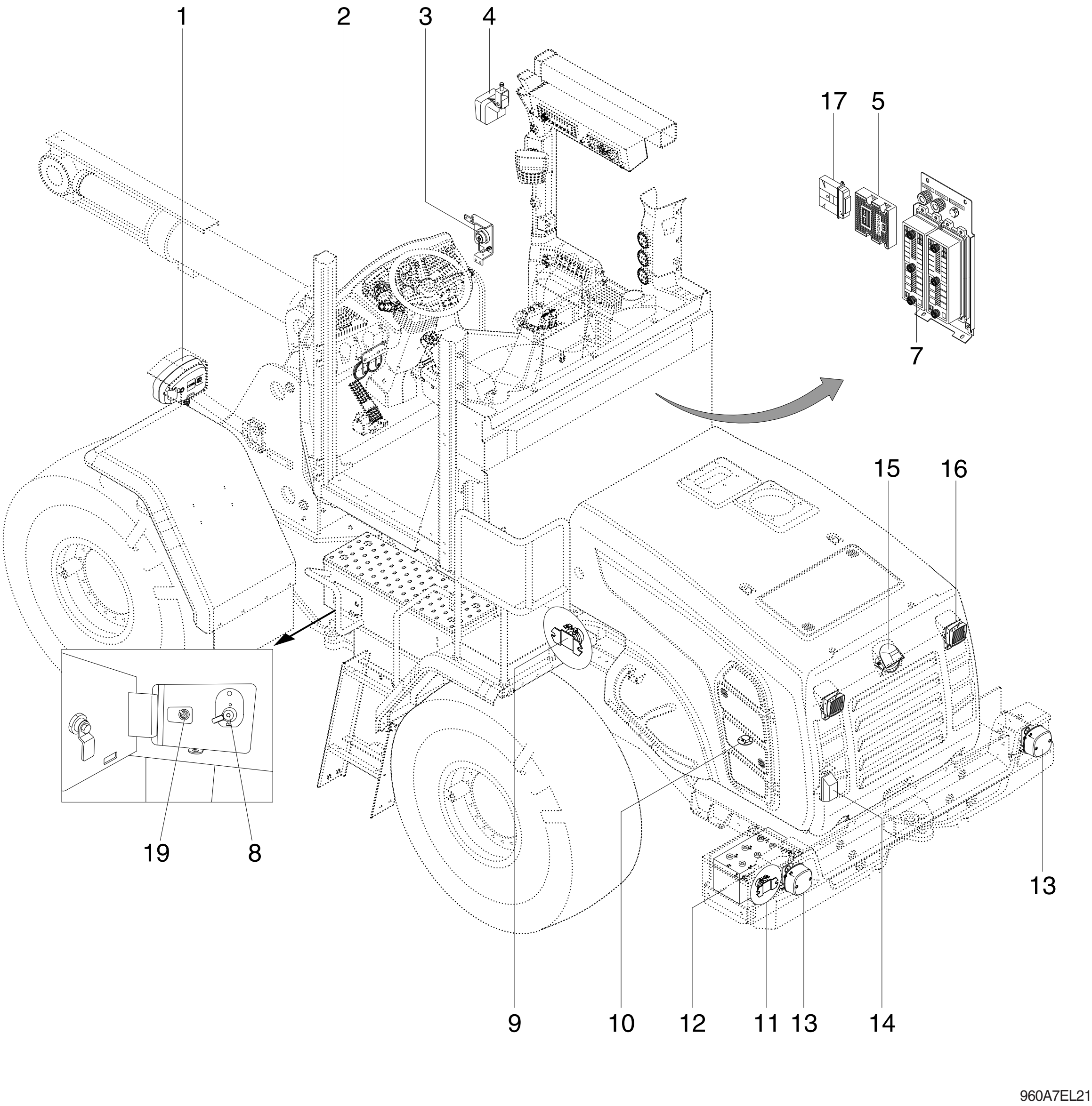
GROUP 1 COMPONENT LOCATION

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	17	Differential lock switch (opt)
4	FNR select button	11	Monitor	18	Emergency test switch
5	Hone button	12	Starting switch	19	Engine control unit (ECU)
6	Multi function switch		Starting button (opt)	21	Camera monitor
7	Hazard switch	13	Work load button		

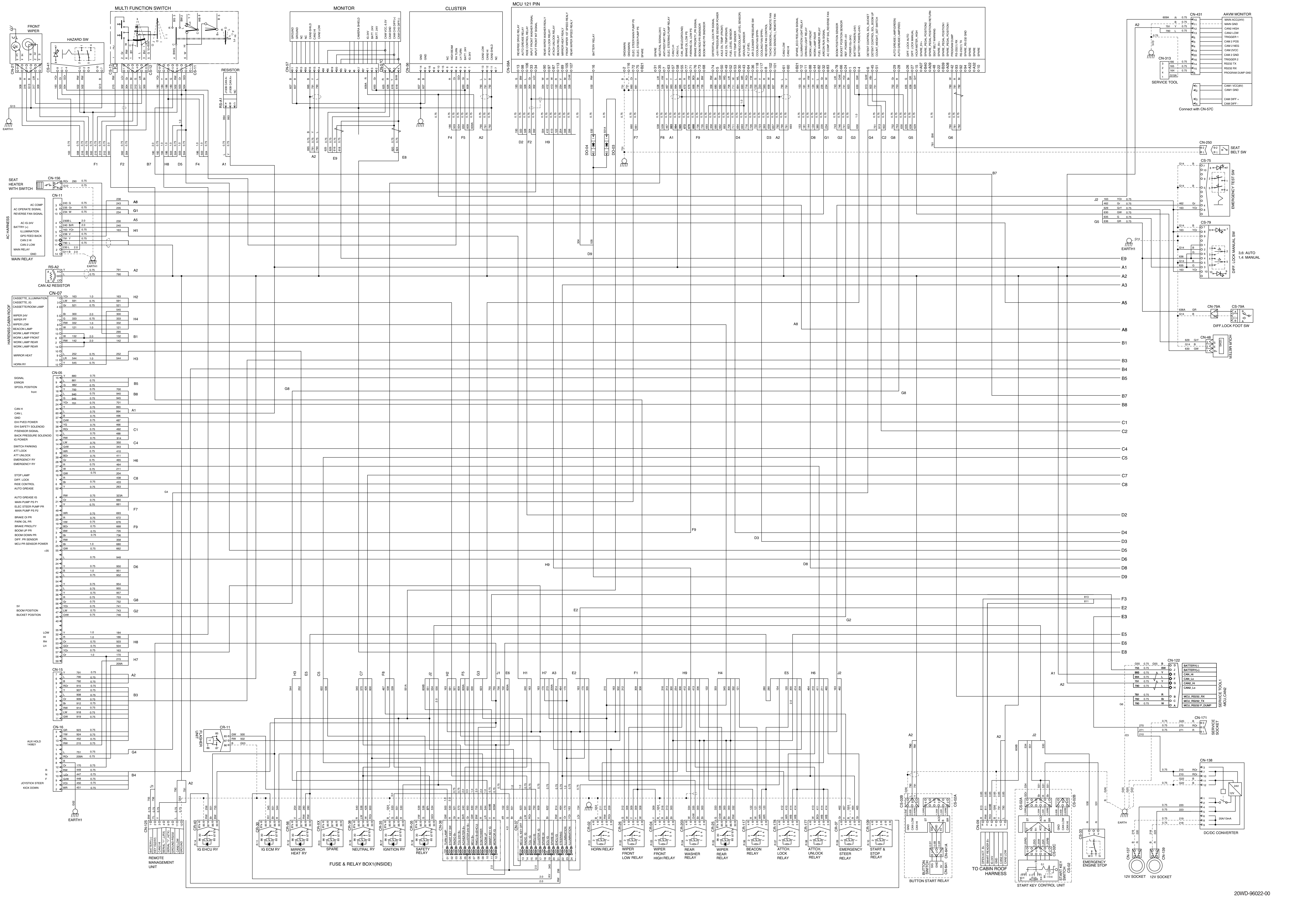
2. LOCATION 2



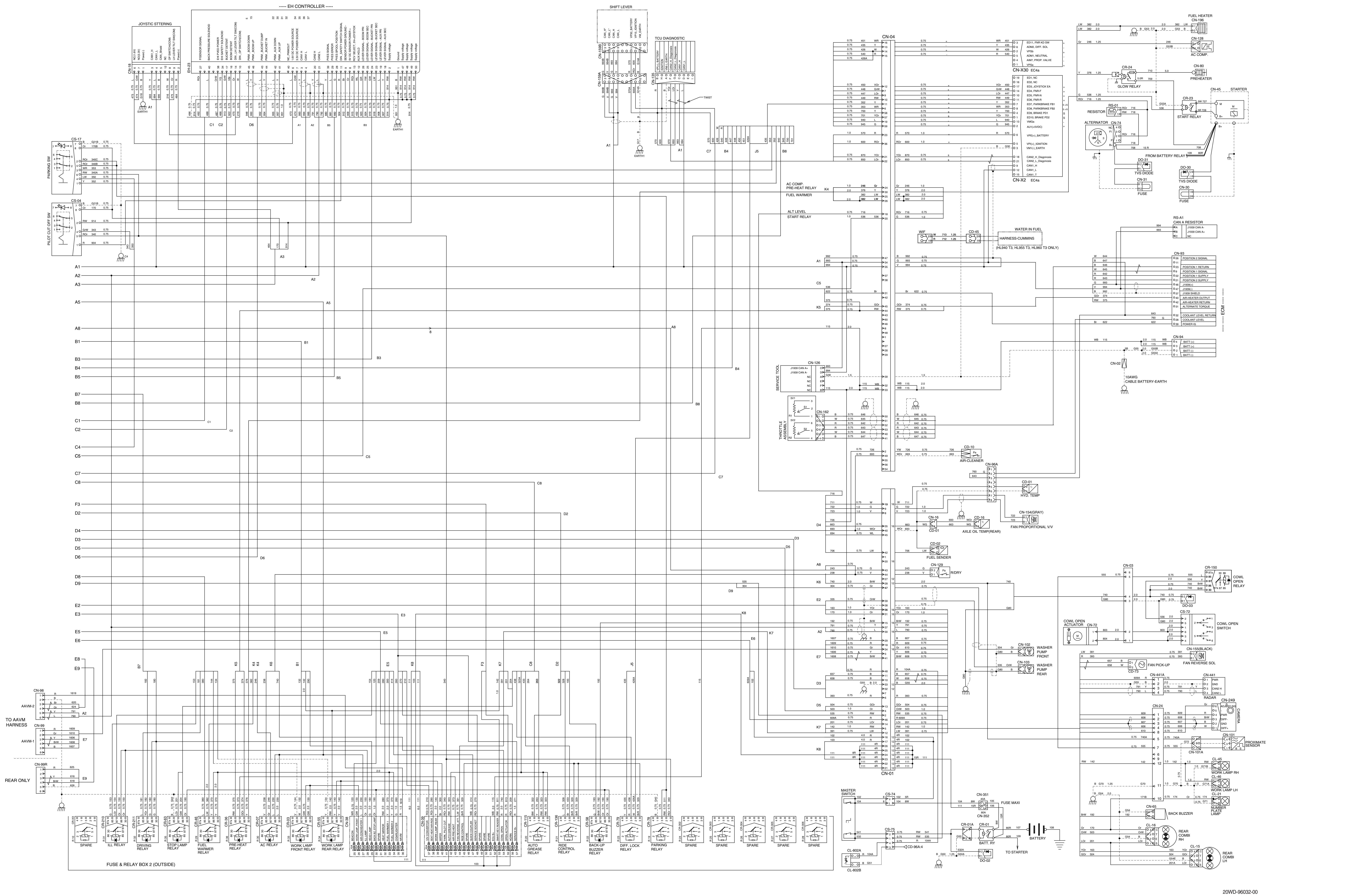
1	Head lamp	8	Master switch	15	Camera (opt)
2	Horn	9	Start relay	16	Work lamp
3	Angle sensor	10	Fuel sender	17	Control unit (electro hydraulic & joystick steering)
4	Work lamp	11	Battery relay	19	Engine hood open switch
5	Machine control unit (MCU)	12	Battery		
7	Fuse and relay box	13	Rear combi lamp		
		14	Number plate lamp		

GROUP 2 ELECTRICAL CIRCUIT

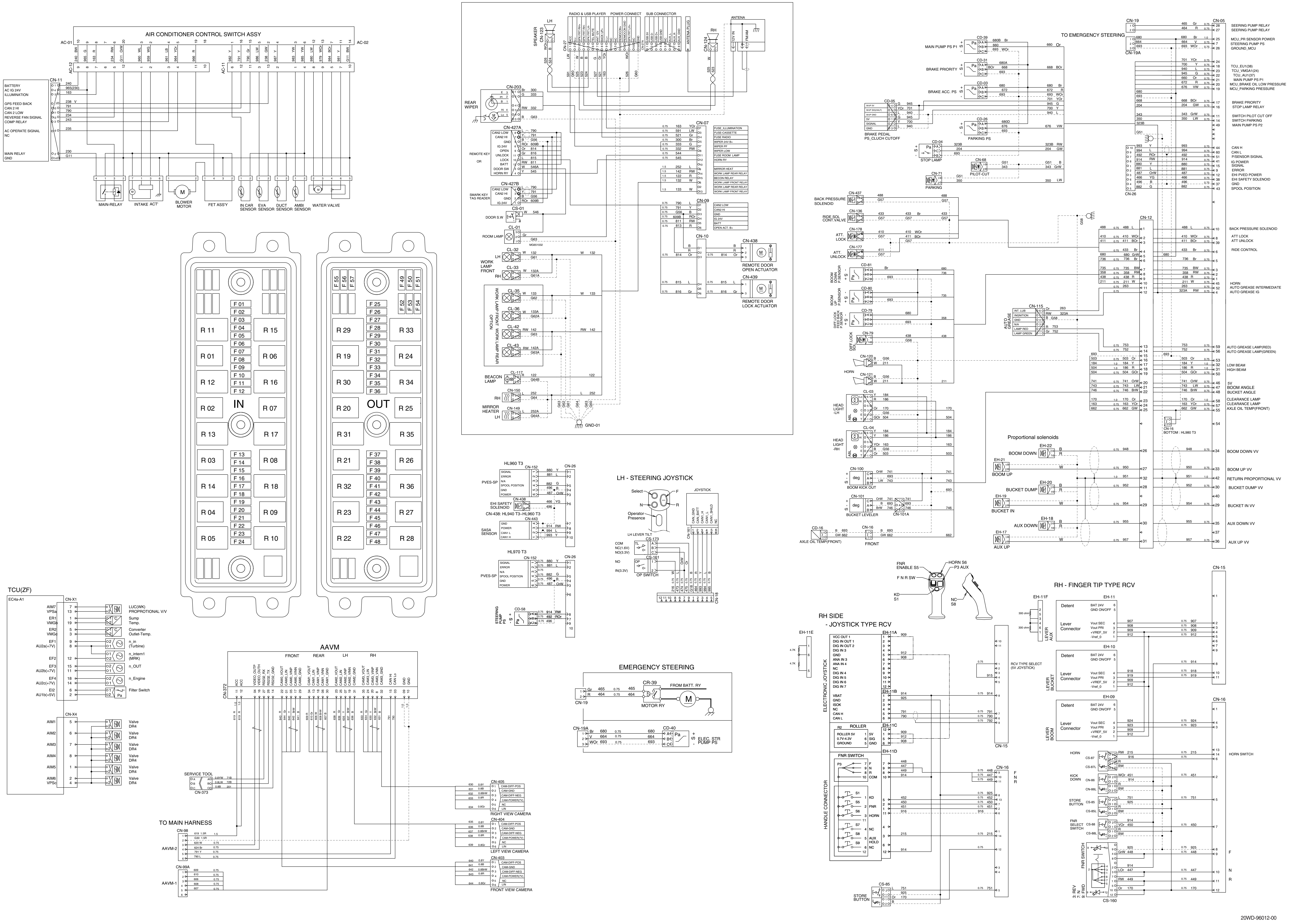
· ELECTRICAL CIRCUIT (1/3)



· ELECTRICAL CIRCUIT (2/3)



· ELECTRICAL CIRCUIT (3/3)



20WD-96012-00

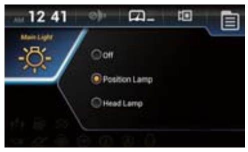
MEMORANDUM

1. ILLUMINATION CIRCUIT

1) OPERATING FLOW

Main light switch on monitor → Switch ON, Select position lamp → MCU [CN-58A (12)]

→ 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)]

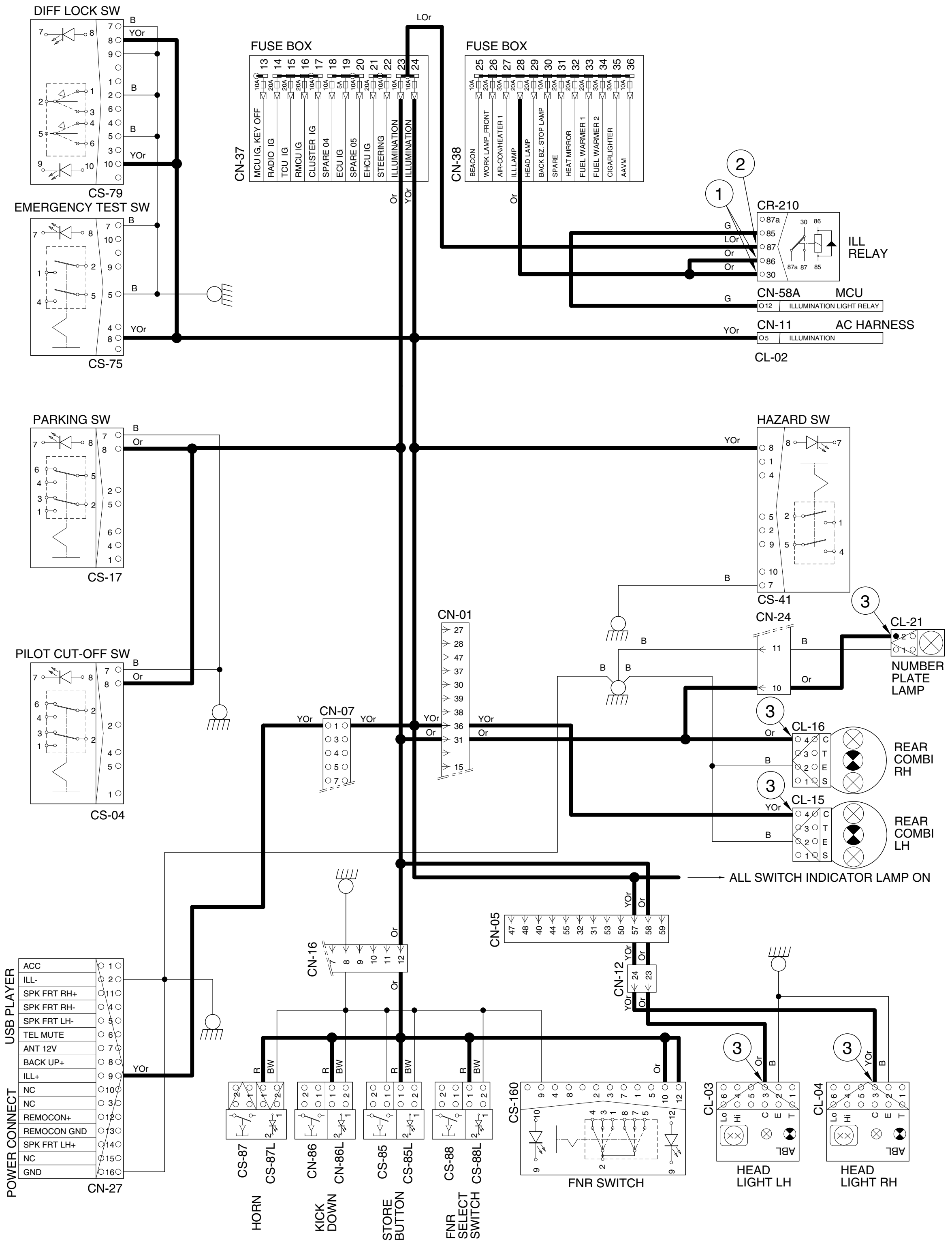
2) CHECK POINT

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



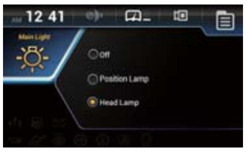
960SA7EL04

※ 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 (11)]
→ Driving relay [CR-211 (87)] → Multi function switch [CS-11(8)]
→ Multi function switch MIDDLE [CS-11(7)] → I/conn [CN-05 (32)] → I/conn [CN-12 (17)]
→ 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)] → I/conn [CN-12 (18)]
→ 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)]



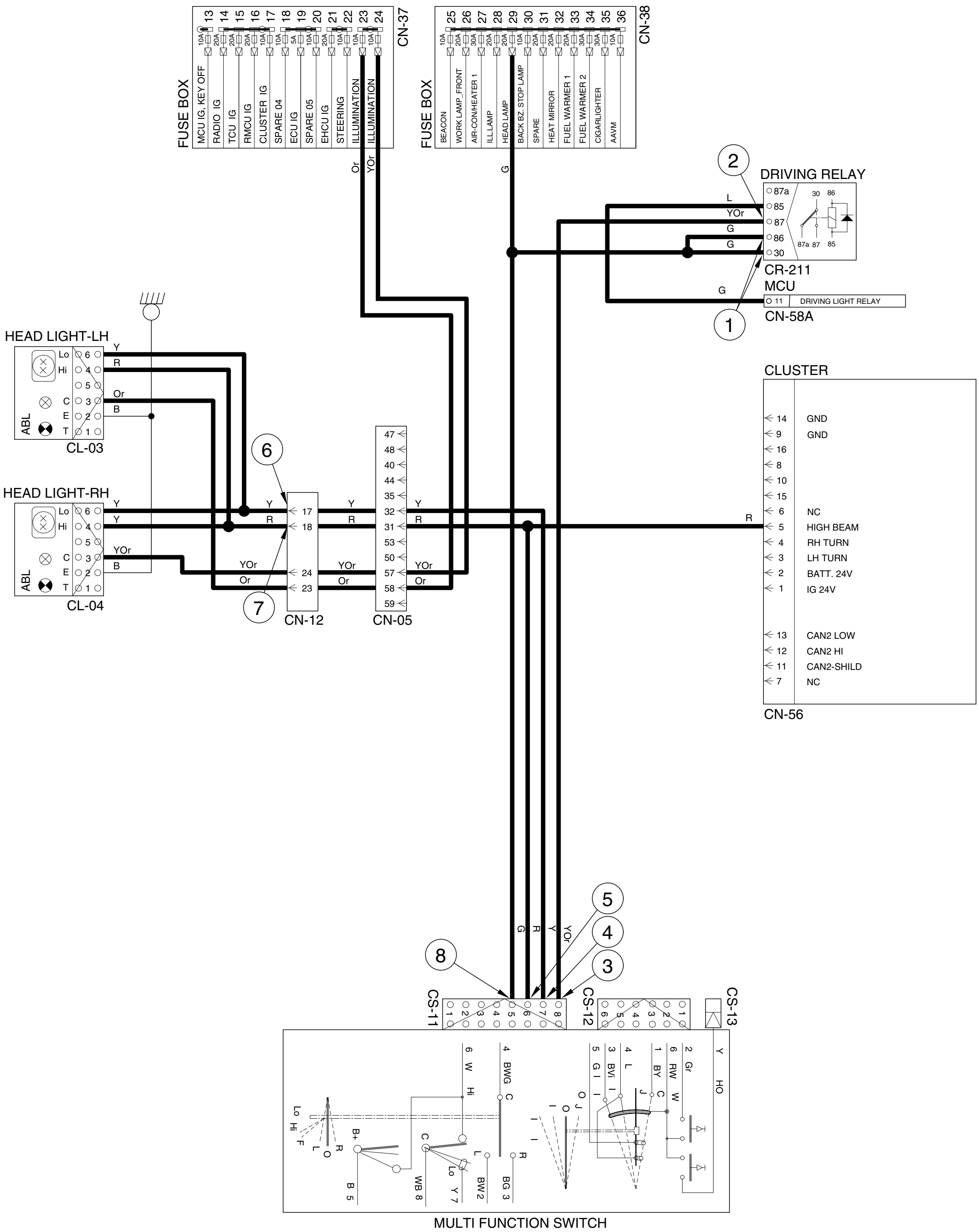
2) CHECK POINT

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



960SA7EL05

※ 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-58A (88)] → 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-58A (44)] → 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)]

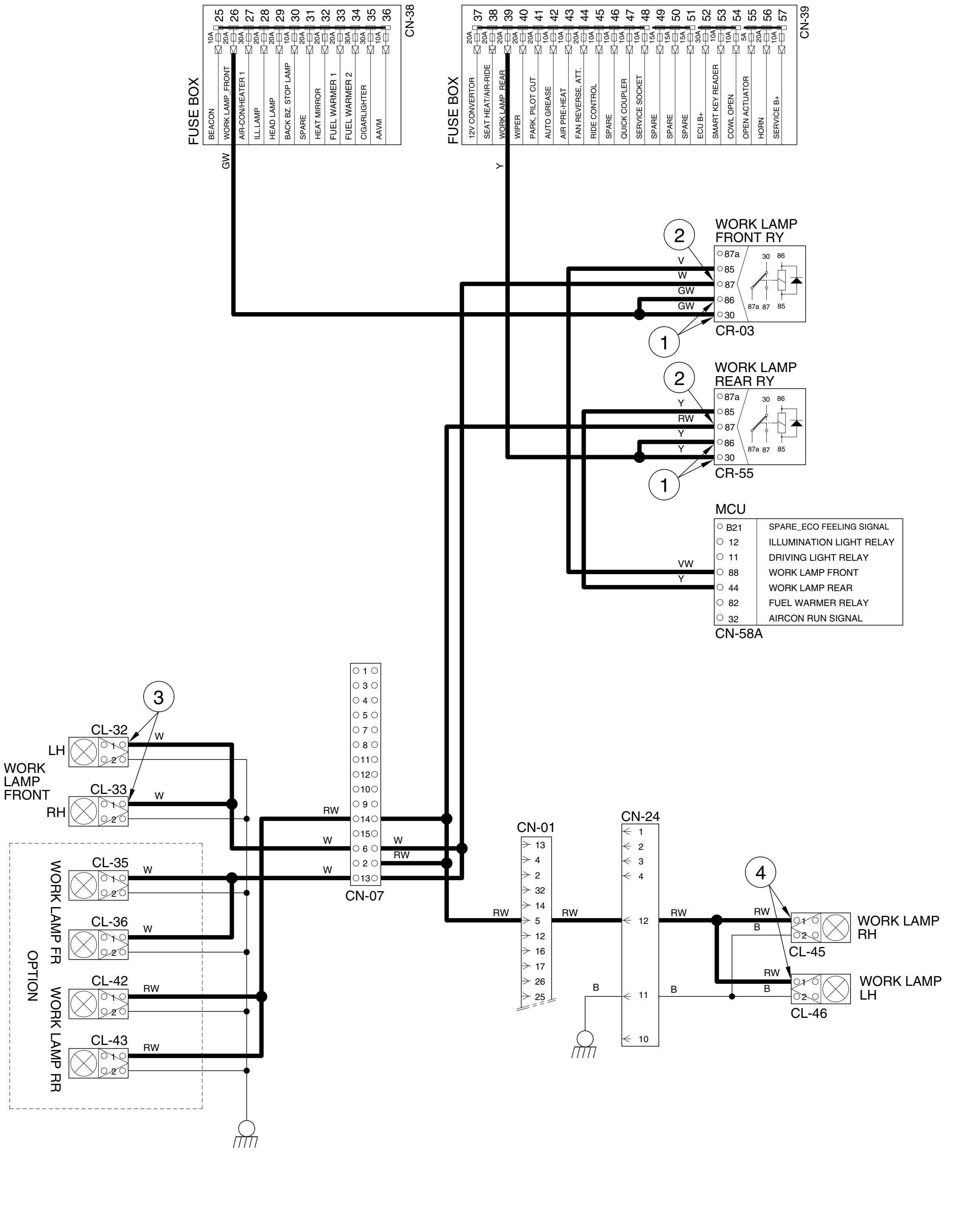
2) CHECK POINT

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-02A (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-02C (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-93 (39)]
→ Fuse box [CN-37 (13)] → MCU [CN-58A (A03)]
→ Power relay [CR-35 (30) → (87)] → Fuse box [CN-37 (15)]
→ TCU DIAGNOSTIC [CN-135 (H)]

(2) When start key switch is in START position
Start switch START [CS-2C (6)] → Start safety relay [CR-05 (30) → (87)] → I/conn [CN-04 (20)]
→ Start relay [CR-23] → Starter (terminal B^+ and M connector of start motor)

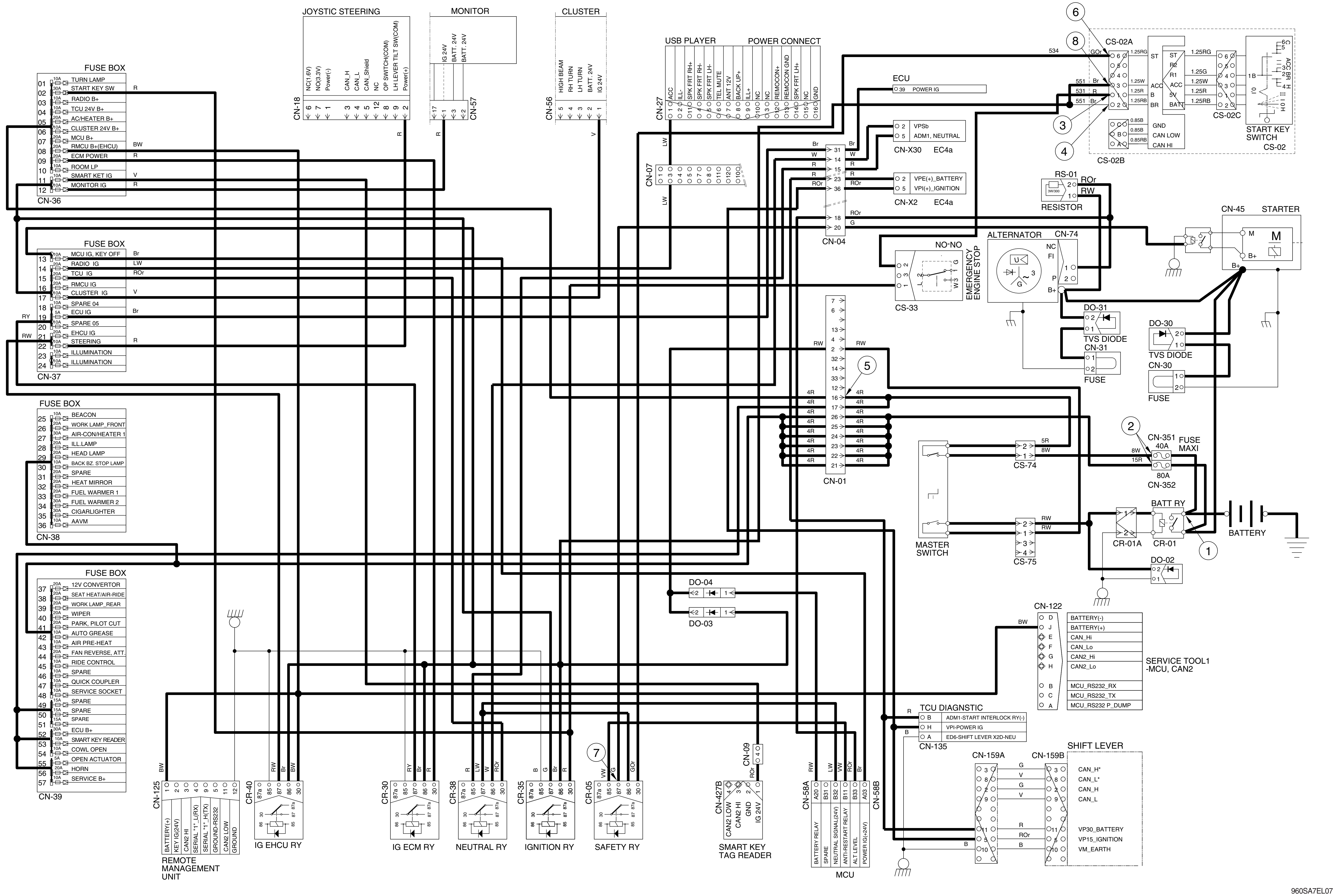
2) CHECK POINT

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-58A (64)]
→ 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

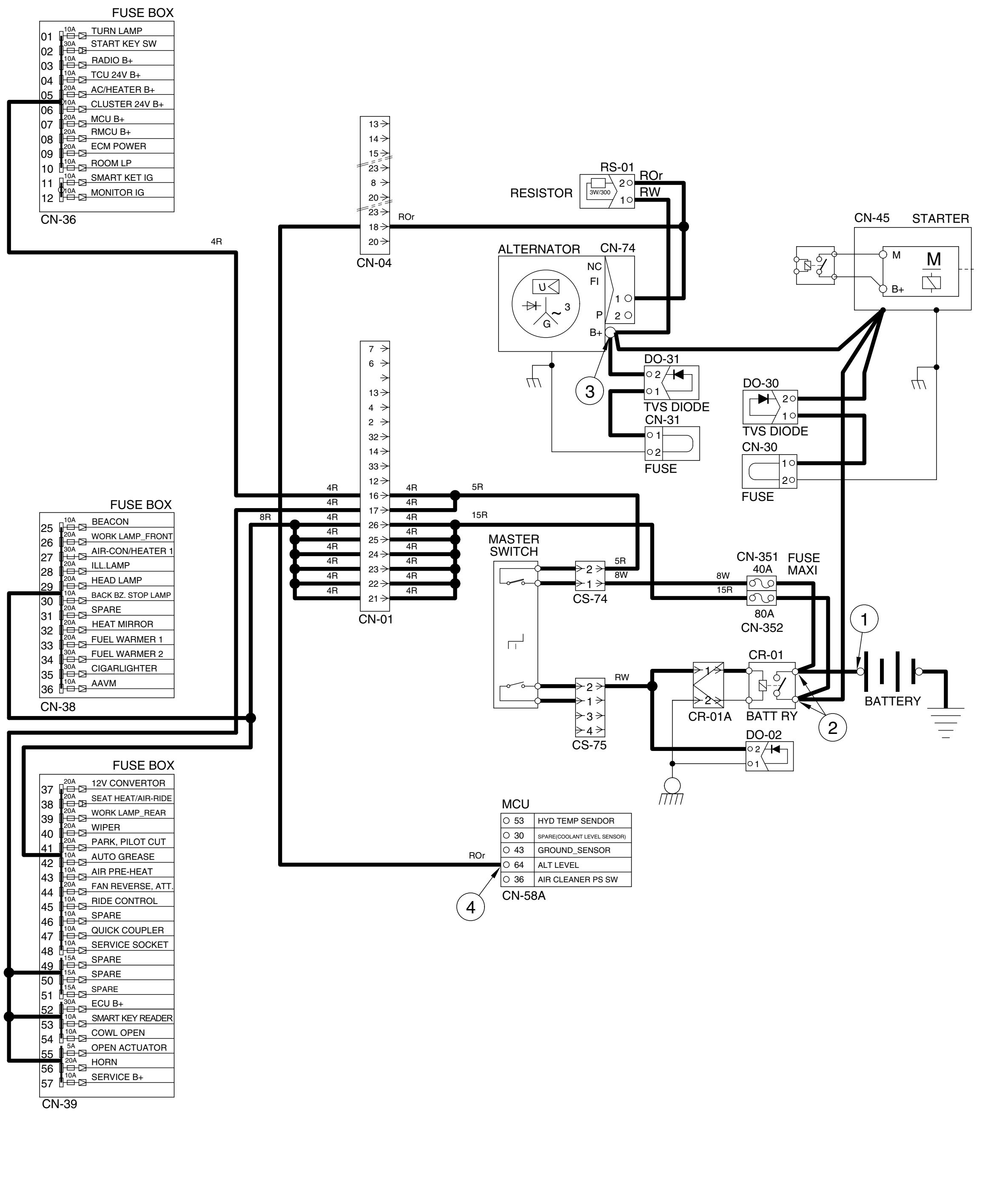
Engine	Key switch	Check point	Voltage
OFF	ON	① - GND (battery) ② - GND (battery relay) ③ - GND (alternator B+) ④ - GND (MCU)	20~28V

※ GND : Ground

※ MCU : Machine control unit

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

CHARGING CIRCUIT



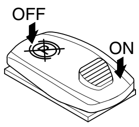
※ The circuit diagram may differ from the equipment, so please check before a repair.

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)]
→ Parking solenoid ON (activated)
→ Parking brake released (by hydraulic pressure)



→ [CS-17 (2)→(1)] → T/M control unit [CN-157 (21)]

(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

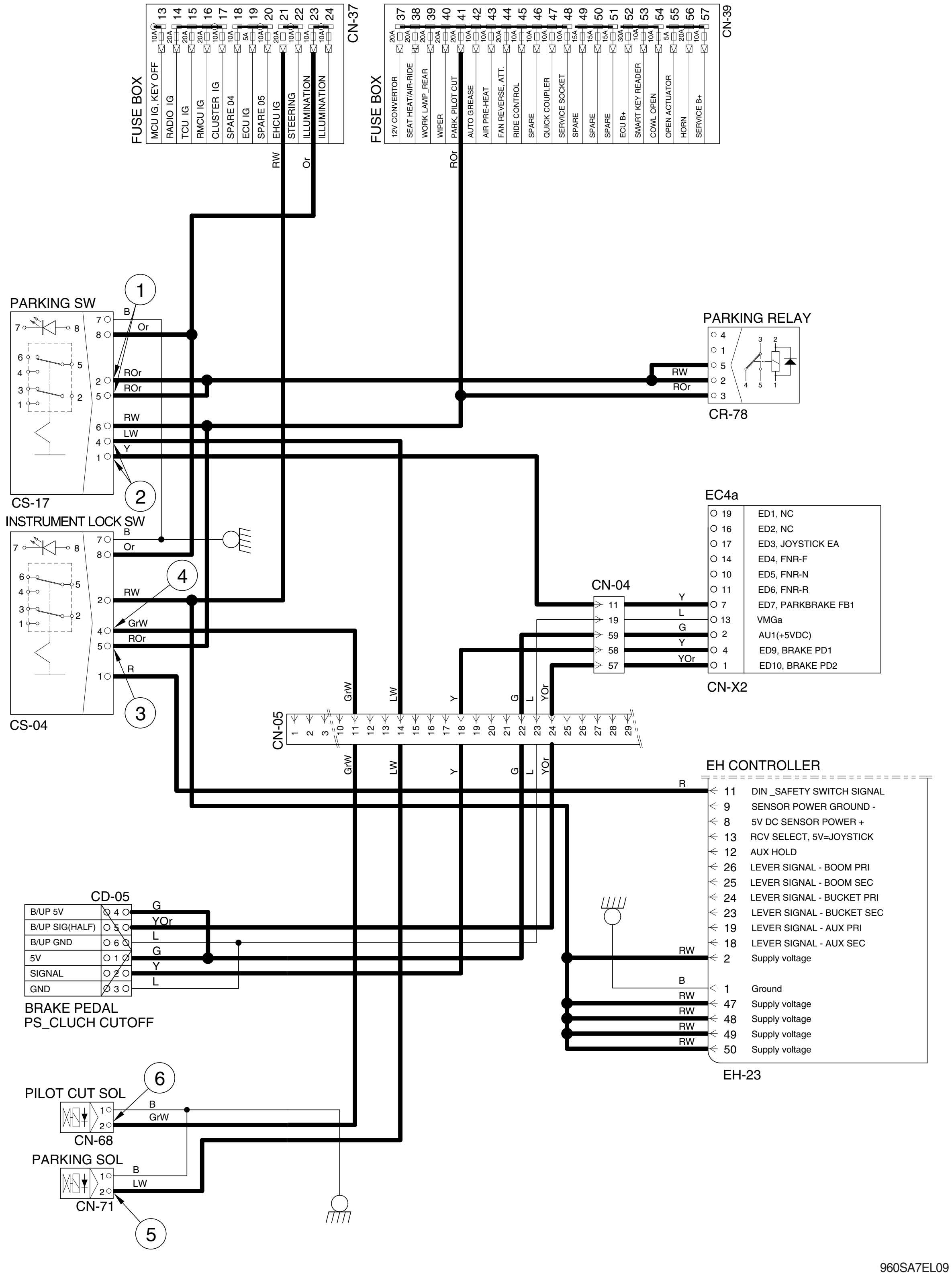
2) CHECK POINT

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

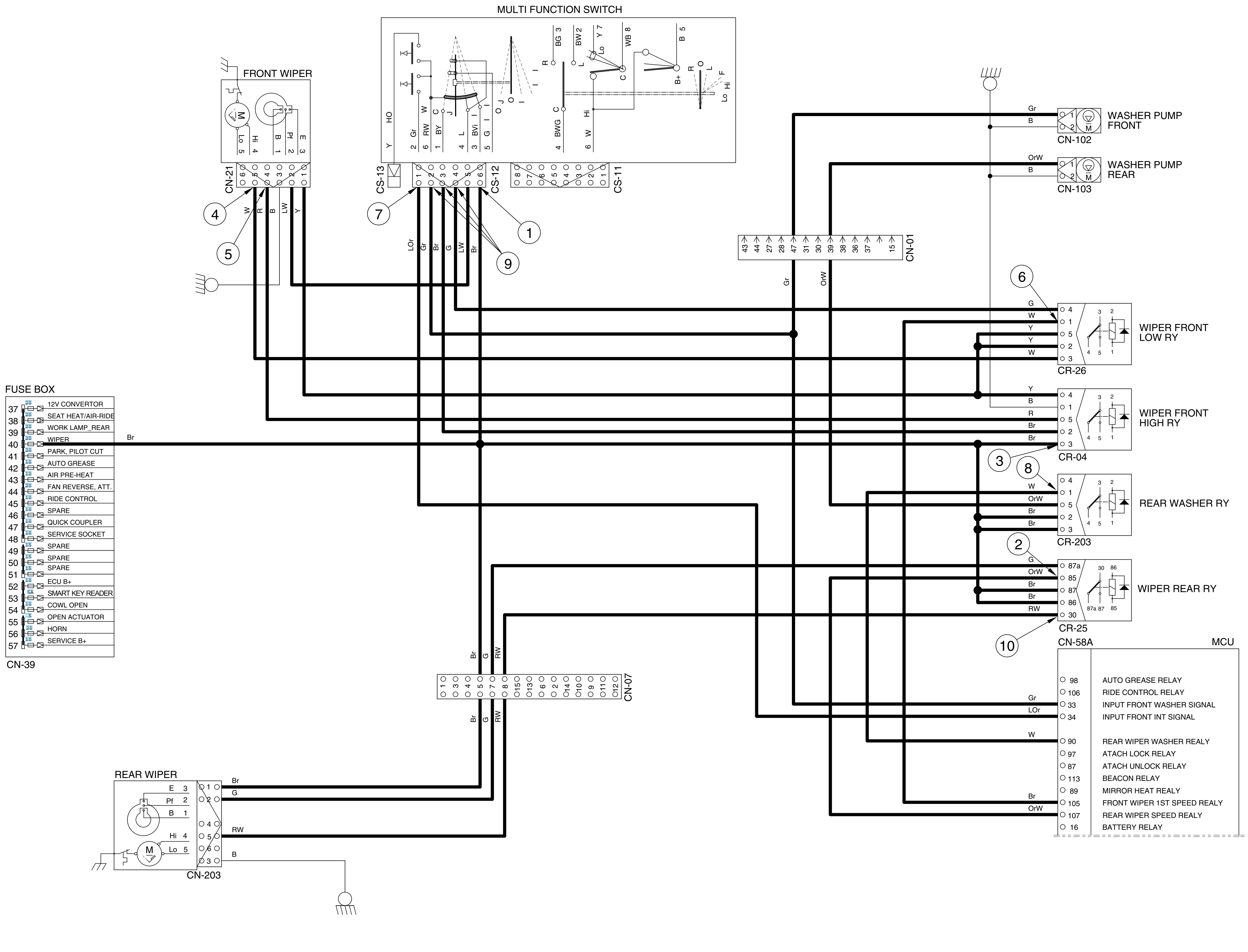
2) CHECK POINT

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

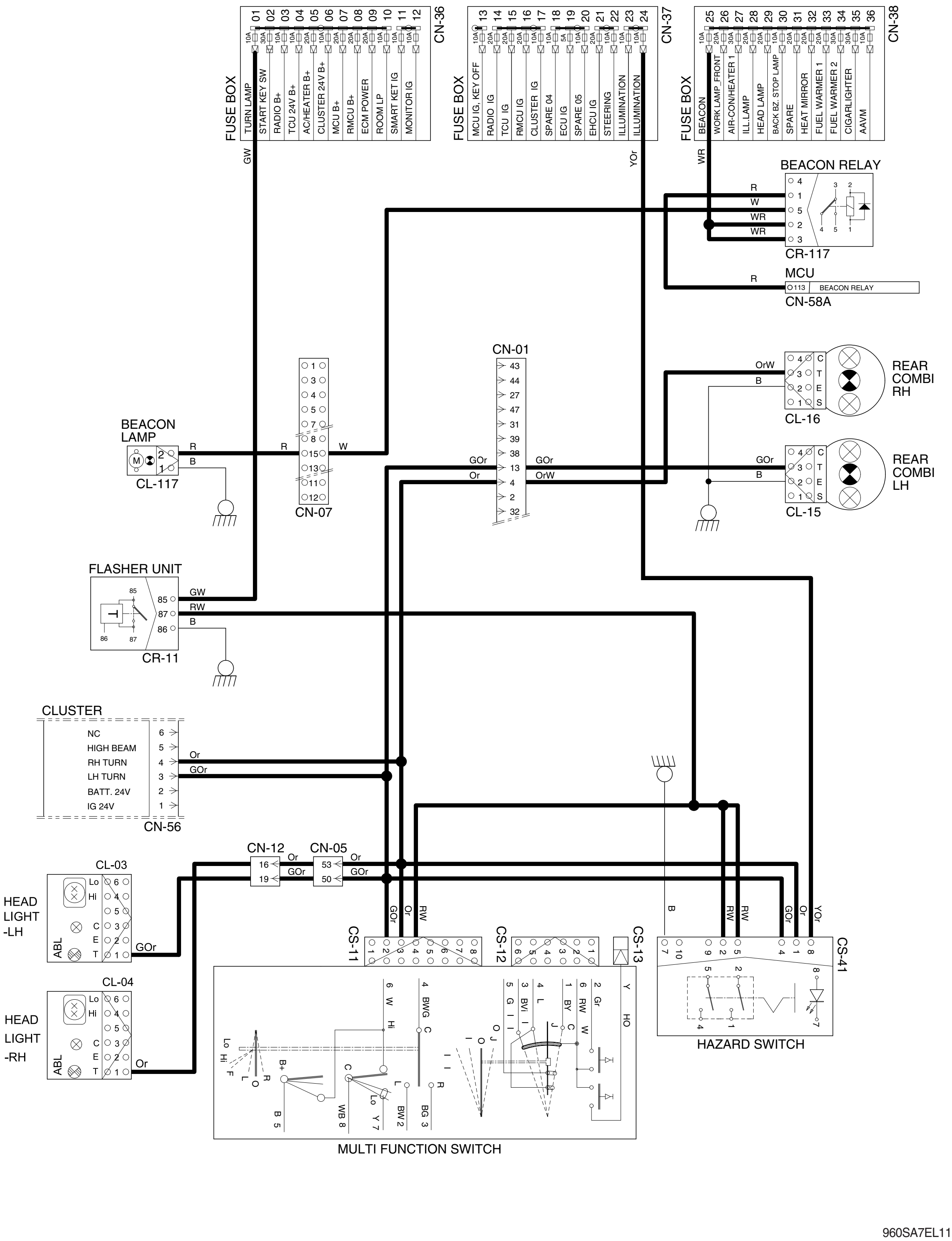
※ The circuit diagram may differ from the equipment, so please check before a repair.

WIPER AND WASHER CIRCUIT



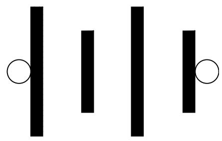
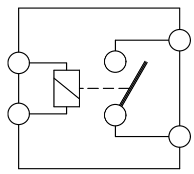
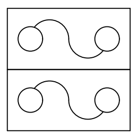
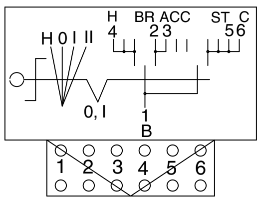
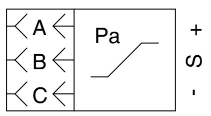
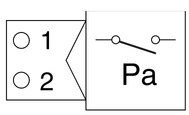
※ The circuit diagram may differ from the equipment, so please check before a repair.

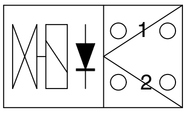
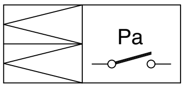
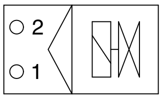
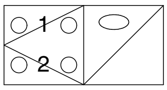
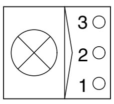
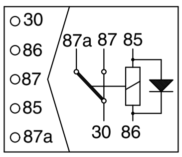
HAZARD, TURN AND ROTARY CIRCUIT

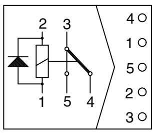
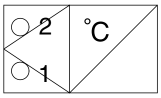
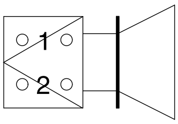
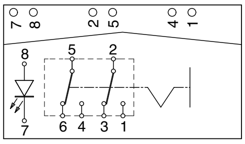
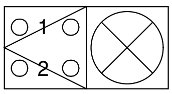
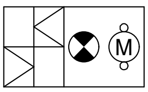


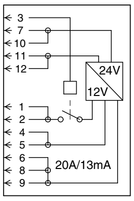
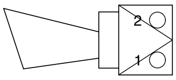
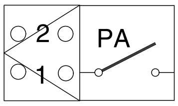
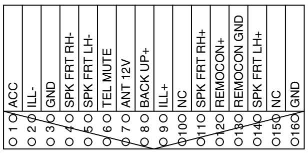
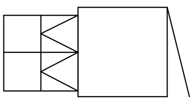
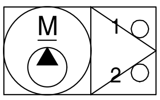
※ The circuit diagram may differ from the equipment, so please check before a repair.

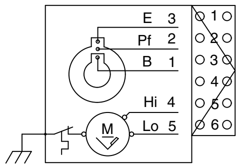
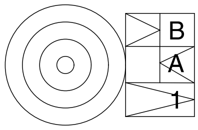
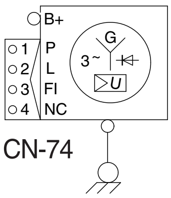
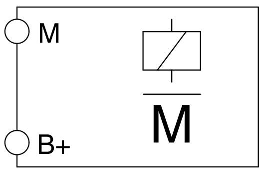
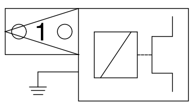
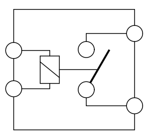
GROUP 3 ELECTRICAL COMPONENT SPECIFICATION

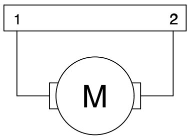
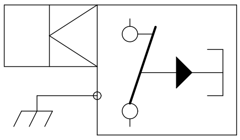
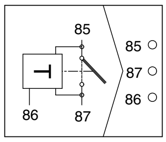
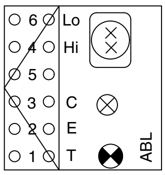
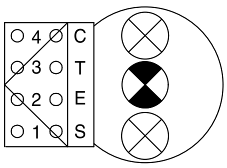
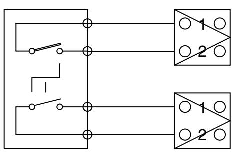
Part name	Symbol	Specifications	Check item
Battery		12V × 150Ah (2EA)	Gravity 1.280 over : over charged 1.280 ~ 1.250 : normal 1.250 below : discharged
Battery relay	 CR-1	Rated load : 24V 100A (continuity) 1000A (30seconds)	Coil resistance breaked : approx 50Ω connected : ∞ Ω
Fusible link	 CN-351 (40A), 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)

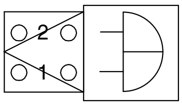
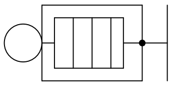
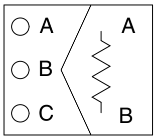
Part name	Symbol	Specifications	Check item
Pilot cut off, parking brake, diff lock, attach lock, unlock solenoid	 CN-68 CN-177 CN-71 CN-178 CN-79	24V 1A	Resistance normal : 15~25Ω
Air cleaner pressure switch	 CD-10	Max load : 6W N.O Type	Resistance ∞Ω : normal (open)
Lock-up, Ride control valve / Fan 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
Alternator	 CN-74	24V 70A	Voltage normal : 24~28V
Starter	 CN-45	24V-4.8kW	Operating or not
Aircon compressor	 CN-28	24V 79W	Resistance normal : 13.4Ω
Start relay	 CR-23	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

GROUP 4 CONNECTORS

1. CONNECTOR DESTINATION

Connector number	Type	No. of pin	Destination	Connector part No.	
				Female	Male
CN-1	DEUTSCH	48	I/conn (Frame harness-Main harness)	DRB16-48SAE-L018	DRB12-48PAE-L018
CN-2	DEUTSCH	60	I/conn (Front harness-Main harness)	DRB12-60SBE-L018	DRB12-60PBE-L018
CN-4	DEUTSCH	60	I/conn (Engine harness-Main harness)	DRB16-60SAE-L018	DRB12-60PAE-L018
CN-5	DEUTSCH	60	I/conn (Bottom harness-Main harness)	DRB16-60SBE-L018	DRB12-60PBE-L018
CN-7	AMP	15	I/conn (Main harness-Cab harness)	2-85262-1	368301-1
CN-9	AMP	6	I/conn (Main harness-Cab harness)	174264-2	174262-2
CN-11	AMP	15	I/conn (Main harness-Aircon harness)	HDP26-24-35SN	HDP24-24-35PN
CN-12	DEUTSCH	35	I/conn (Front harness-Bottom harness)	2-85262-1	368301-1
CN-14	DEUTSCH	12	I/conn (Frame harness-Grill harness)	DT06-12S	DT04-12P
CN-15	KET	11	I/conn (RH console harness-Main harness)	MG651350	MG641353
CN-16	KET	14	I/conn (RH console harness-Main harness)	MG651110	MG641113
CN-18	DEUTSCH	12	LH seat console	DT06-12S	DT04-12P
CN-19	DEUTSCH	2	I/conn (Emer steer harness-Bottom harness)	DT04-2S	DT04-2P
CN-21	AMP	6	Front wiper motor	936257-1	-
CN-22	DEUTSCH	2	Compressor	DTP06-2S	
CN-24	DEUTSCH	12	Grill harness	DT06-12S	-
CN-26	TYCO	10	EHI unit	174655-2	174657-2
CN-26A	AMP	10	Joystick steering	-	174657-2
CN-27	MK II	16	Radio and USB player	PK145-16017	-
CN-27A	MK II	8	USB connector	174984-2	-
CN-31	DEUTSCH	3	Brake priority	DT06-3S	-
CN-36~39	-	-	Fuse box	21WB-16031	-
CN-43	AMP	2	Lock-up	282028	-
CN-45	Ring term	-	Starter	R14-12	ST 710246-2
CN-48	AMP	1	Hour meter	2-520193-2	-
CN-51	AMP	34	MCU	4-1437290-1	-
CN-52	AMP	34	MCU	2-1437285-3	-
CN-53	AMP	26	MCU	1473416-1	
CN-54	AMP	34	MCU	4-1437290-1	
CN-56	KUM	16	Cluster	KPK145-16017	-
CN-57	AMP	20	Monitor	174047-2	-
CN-64	MOLEX	4	Smart key	39012040	-
CN-65	DEUTSCH	2	Back up buzzer	DT06-2S	-
CN-68	DEUTSCH	2	Pilot cut off	DT06-2S	-
CN-71	DEUTSCH	2	Parking solenoid	DT06-2S	-
CN-72	DEUTSCH	2	Cowl open activator	DT06-2S	-

Connector number	Type	No. of pin	Destination	Connector part No.	
				Female	Male
CN-74	PACKARD	4	Alternator	1218-6568	-
CN-79	DEUTSCH	2	Differential lock solenoid	DT06-2S	-
CN-79A	DEUTSCH	2	Differential lock solenoid	DT06-2S	DT04-2D-E005
CN-93	DEUTSCH	50	ECM (engine control module)	DRC26-505-04	-
CN-94	DEUTSCH	4	ECM power	DT06-4S	-
CN-101,101	DEUTSCH	3	Boom kick out, Bucket leveler	DT06-3S	-
CN-102	KET	2	Front washer tank	MG640605	-
CN-103	KET	2	Rear washer tank	MG640605	-
CN-112	-	16	Gear box	21L7-60290	-
CN-115	DEUTSCH	6	Auto grease	DT06-6S	DT04-6P
CN-120,121	DEUTSCH	2	Horn	DT06-2S	-
CN-122	DEUTSCH	9	Machine service tool	HD10-9-96P	-
CN-123	KET	2	Speaker (LH)	7123-1520	-
CN-124	KET	2	Speaker (RH)	7123-1520	-
CN-125	DEUTSCH	12	RMCU(remote management control unit)	DT06-12S	DT04-12P
CN-126	DEUTSCH	9	Engine service tool	HD10-9-96P	-
CN-128	NMWP	1	Aircon compressor	PB625-01027	-
CN-129	KET	2	Receiver drier	MG640795	-
CN-134	DEUTSCH	9	Diagnostic (TCU)	HD10-9-96P	-
CN-136	DEUTSCH	2	Ride control solenoid	DT06-2	-
CN-136A	Econoseal J	2	I/conn (Ride control harness-Front harness)	S816-002002	S816-102002
CN-137	AMP	1	12V socket	172434-2	-
CN-138	AMP	12	DC/DC Converter	1-967622-1	-
CN-139	AMP	2	12V socket	172434-2	-
CN-149	DEUTSCH	2	Mirror heat (LH)	DT06-2S	DT04-2P
CN-150	DEUTSCH	2	Mirror heat (RH)	DT06-2S	DT04-2P
CN-152	AMP	4	Proportional valve	2-967059-1	-
CN-154	DEUTSCH	2	Fan speed solenoid	DT06-2S	-
CN-155	DEUTSCH	2	Fan reverse solenoid	DT06-2S	-
CN-156	DEUTSCH	2	Seat heat (with switch)	-	DT04-2P-E005
CN-157	AMP	68	T/M control unit	963598-1	-
CN-158	PACKARD	4	Gear shift lever	1201-0974	-
CN-159A	DEUTSCH	12	Gear shift lever	DT06-12S	-
CN-160	CARLING	12	FNR joystick lever	LC3-01	-
CN-162	AMP	6	Pedal	174262-2	-
CN-163	AMP	2	ECO feeling switch	174352-2	-
CN-171	AMP	1	Service socket	172434-2	-
CN-177	DEUTSCH	2	Quick coupler unlock solenoid	DT06-2S	-

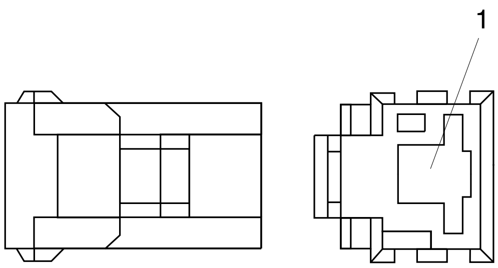
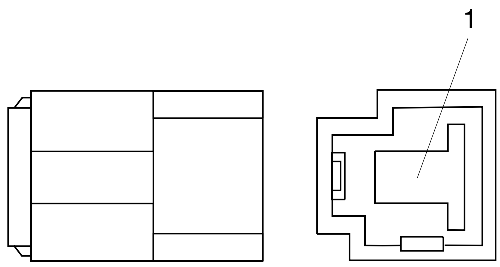
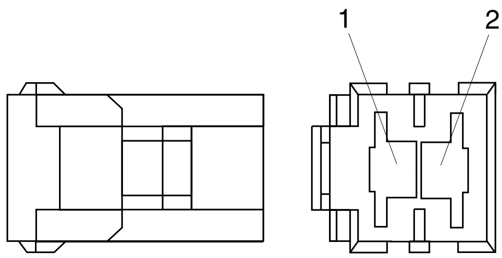
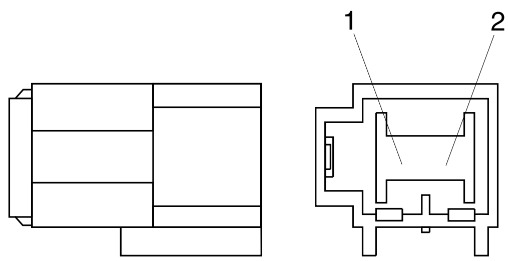
Connector number	Type	No. of pin	Destination	Connector part No.	
				Female	Male
CN-177A	Econoseal J	3	I/conn (Front harness-Quick coupler harness)	S816-003002	S816-103002
CN-178	DEUTSCH	2	Quick coupler lock solenoid	DT06-2S	-
CN-196	PACKARD	4	Fuel heater	2-967325-3	-
CN-203	AMP	6	Rear wiper motor	936257-1	-
CN-246	KET	1	PTC power	-	MG620659-5
CN-249	DEUTSCH	6	Camera	DT06-4S	DT04-6P
CN-250	DEUTSCH	2	Seat belt alarm	DT06-2S-EP06	-
CN-252	TYCO	6	Differential lock	S816-006602	S816-106602
CN-313	DEUTSCH	6	AAVM monitor service tool	DT06-4S-EP06	DT06-4S-EP06
CN-399	AMP	4	DEF sensor	1-967325-1	-
CN-431	KET	20	AAVM monitor	MG635026	-
CN-437	DEUTSCH	2	Back pressure solenoid	DT06-3S-EP06	-
CN-X30	TYCO	6	TCU (transmission control unit)	1-1418469-1	-
CN-X2	TYCO	21	TCU (transmission control unit)	3-1534127-1	-
Relay					
CR-1	Ring term	-	Battery relay	S820-104002	-
CR-2	AMP	5	Horn relay	VCFM-1002	-
CR-3	AMP	5	Front work lamp relay	VCFM-1002	-
CR-4	AMP	5	Wiper relay (Hi)	VCFM-1002	-
CR-5	HELLA	5	Safety relay	8JA003526-001	-
CR-7	AMP	5	Aircon relay	VCFM-1002	-
CR-11	250	-	Flasher unit	S810-003702	-
CR-23	Ring term	-	Start relay	ST 710289-2	ST 710384-2
CR-24	Shur	1	Preheater relay	S822-014000	-
CR-25	AMP	5	Rear wiper relay	VCFM-1002	-
CR-26	AMP	5	Wiper relay (low)	VCFM-1002	-
CR-30	HELLA	5	ECM power relay	8JA003526-001	-
CR-36	AMP	5	Preheater relay	VCFM-1002	-
CR-39	-	2	Emergency steering pump relay	S820-104000	-
CR-40	KET	5	EHCU power relay	MG610047-1	-
CR-46	HELLA	5	Fuel warmer relay	8JA003526-001	-
CR-55	AMP	5	Rear work lamp relay	VCFM-1002	-
CR-56	KET	5	Mirror heat relay	MG610047-1	-
CR-58	AMP	5	Back up relay	VCFM-1002	-
CR-63	AMP	5	Stop lamp relay	VCFM-1002	-

Connector number	Type	No. of pin	Destination	Connector part No.	
				Female	Male
Switch					
CS-1	AMP	1	Door switch	ST730018-3	-
CS-2	KET	6	Start key switch	MG610335-5	-
CS-4	CARLING	10	Pilot cut off switch	VC2-01	-
CS-11	KET	8	Multi function switch	MG610339-5	-
CS-12	KET	6	Multi function switch	MG610339-5	-
CS-13	KET	1	Multi function switch	ST730018-3	-
CS-17	CARLING	10	Parking switch	VC2-01	-
CS-33	AMP	6	Engine stop switch	174262-2	-
CS-41	CARLING	10	Hazard switch	VC2-01	-
CS-74	DEUTSCH	2	Master switch	DT06-2S	-
CS-75	CARLING	10	Emergency steering test switch	VC2-01	-
CS-79	CARLING	10	Differential lock switch	VC2-01	-
CS-85, 85L	KET	2	Workload switch	MG610070	MG620074
CS-86, 86L	KET	2	Kick down switch	MG610070	MG620074
CS-87, 87L	KET	2	Horn switch	MG610070	MG620074
CS-88, 88L	KET	2	FNR select switch	MG610070	MG620074
CS-105	CARLING	10	SCR switch	VC2-01	-
Light					
CL-1	KET	3	Room lamp	MG651032	-
CL-3	DEUTSCH	6	Head light (LH)	DT06-6S-EP06	-
CL-4	DEUTSCH	6	Head light (RH)	DT06-6S-EP06	-
CL-15	YAZAKI	4	Combi lamp (RR, LH)	7232-7444	-
CL-16	YAZAKI	4	Combi lamp (RR, RH)	7232-7444	-
CL-21	SWP	2	Number plate lamp	S814-002000	-
CL-22	DEUTSCH	2	Work light (LH)	DT06-2S	-
CL-23	DEUTSCH	2	Work light (RH)	DT06-2S	-
CL-32	DEUTSCH	2	Rear work light (RH)	DT06-2S	DT04-2P
CL-33	DEUTSCH	2	Rear work light (LH)	DT06-2S	DT04-2P
CL-42	DEUTSCH	2	Rear work light (opt)	DT06-2S	DT04-2P
CL-45	DEUTSCH	2	Work light (RH)	DT06-2S-EP06	-
CL-46	DEUTSCH	2	Work light (LH)	DT06-2S-EP06	-
CL-117	AMP	2	Beacon lamp	174198-2	-

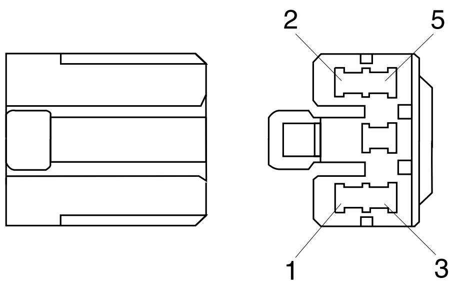
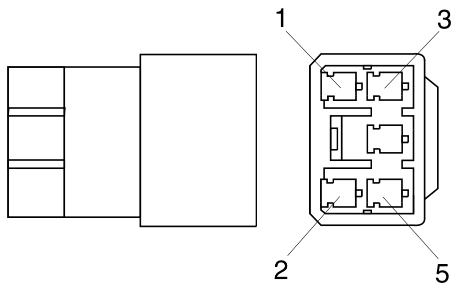
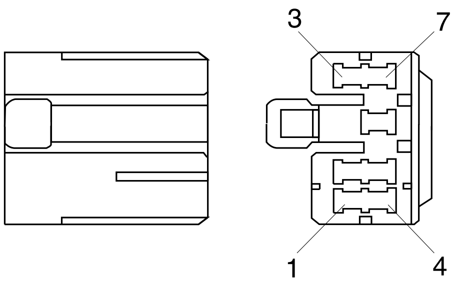
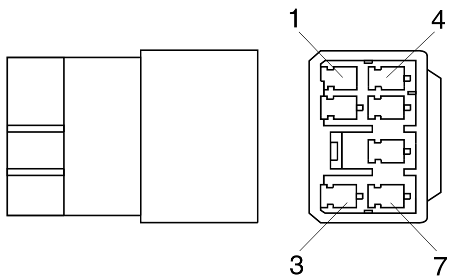
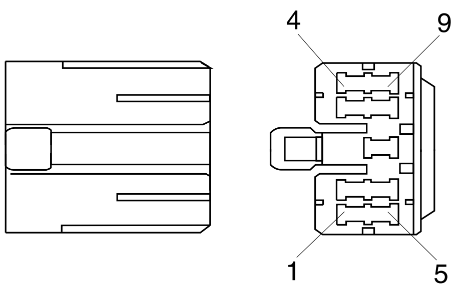
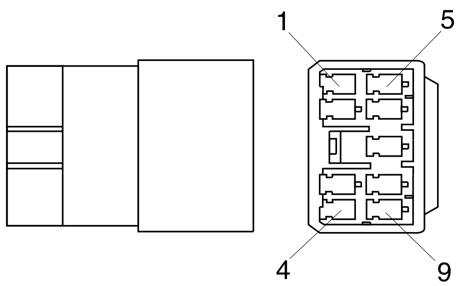
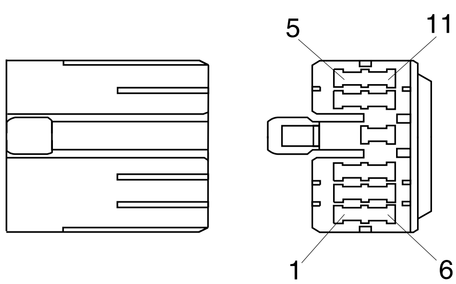
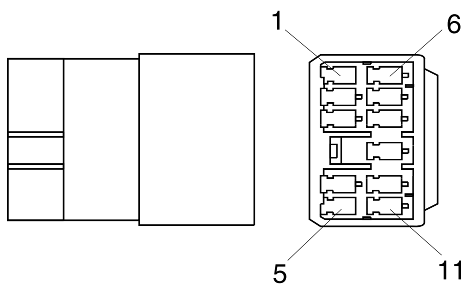
Connector number	Type	No. of pin	Destination	Connector part No.	
				Female	Male
Sensor, sender					
CD-1	AMP	2	Hyduaulic oil temp sendor	85202-1	-
CD-2	YAZAKI	2	Fuel sendor	7123-7424	-
CD-3	DEUTSCH	3	Brake fail pressure switch	DT06-3S	-
CD-4	DEUTSCH	3	Stop lamp pressure switch	DT06-3S	-
CD-5	PACKARD	3	Clutch cut off pressure switch	-	1215793
CD-10	AMP	2	Air cleaner switch	85202-1	-
CD-17	AMP	2	Engine pick-up sensor	85202-1	-
CD-26	DEUTSCH	3	Parking pressure switch	DT06-3S	-
CD-27	AMP	2	Turbin pick up sensor	85202-1	-
CD-31	DEUTSCH	3	Brake priority pressure switch	DT06-3S	-
CD-39	DEUTSCH	3	Main pump pressure switch	DT06-3S	-
CD-40	DEUTSCH	3	Steering pump pressure switch	DT06-3S	-
CD-43	AMP	2	Lock up proportional valve	282027	-
CD-45	DEUTSCH	2	WIF sensor	DT06-2S-EP06	-
CD-46	AMP	3	Output speed sensor	282087	-
CD-47	AMP	2	Gear chain sensor	85202-5	-
CD-48	AMP	2	Oil filter restriction sensor	282080	-
CD-49	AMP	2	Converter temp sensor	85202-1	-
CD-73	AMP	2	Speed sendsor	174352-2	-
CD-79	DEUTSCH	3	Diff lock feed back sensor	DT06-3S	-
CD-80	DEUTSCH	3	Boom positioner sensor	DT06-3S	-
CD-81	DEUTSCH	3	Bucket positioner sensor	DT06-3S	-
CD-96	PACKARD	3	Coolant level sensor	12110293	-
CD-101	SUMITOMO	4	TBAP sensor	6098-0144	-

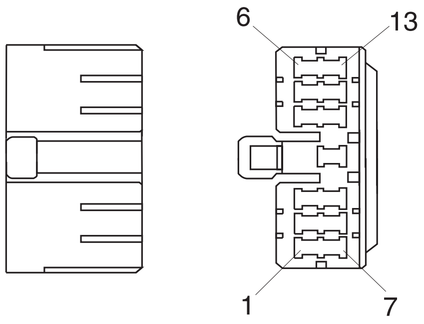
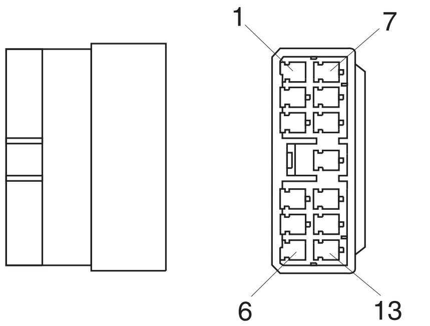
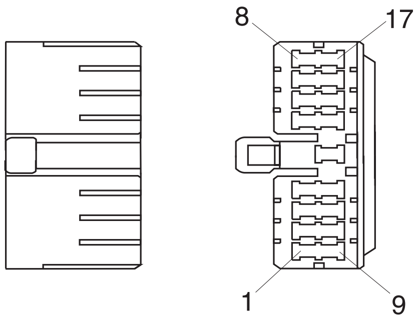
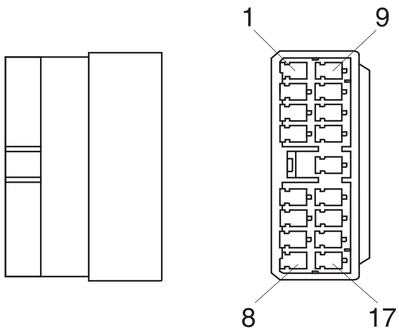
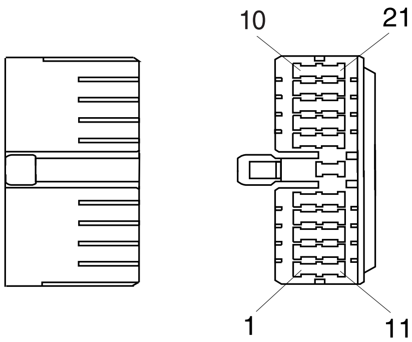
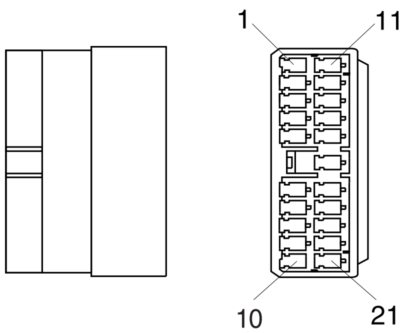
2. CONNECTION TABLE FOR CONNECTORS

1) 58-L TYPE CONNECTOR

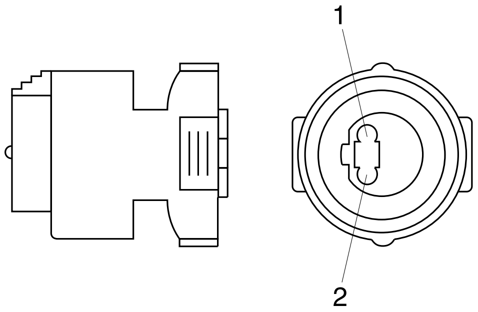
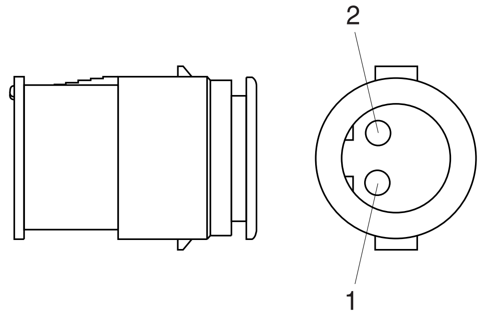
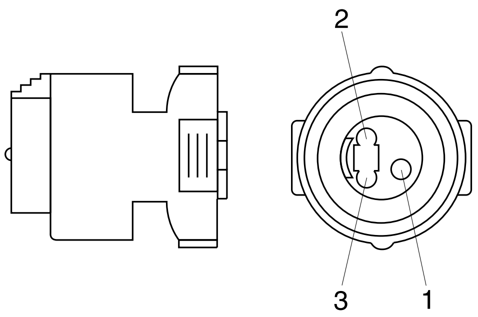
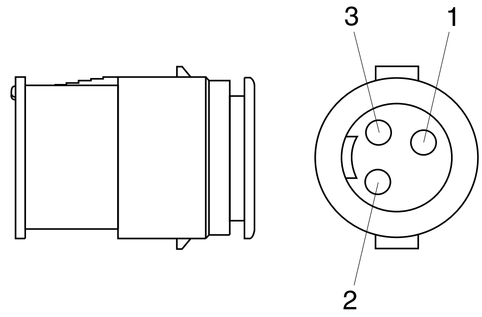
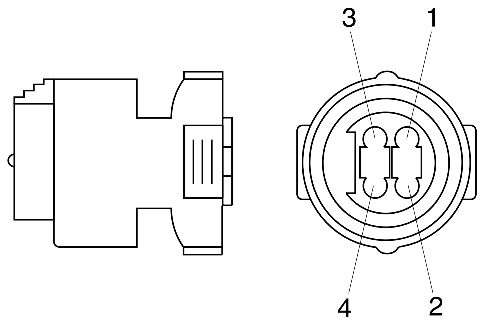
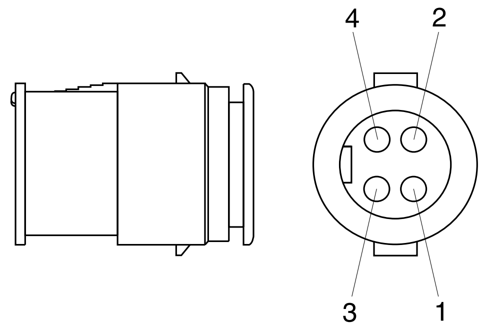
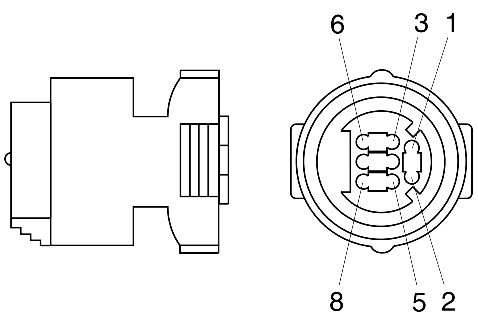
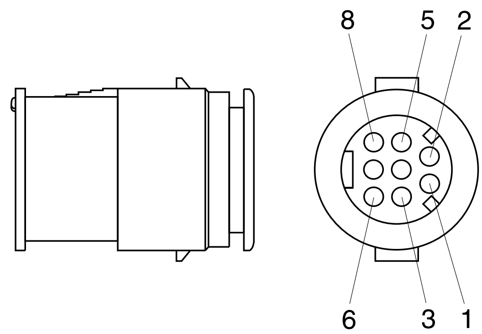
No. of pin	Receptacle connector (female)	Plug connector (male)
1	 S813-030100	 S813-130100
2	 S813-030200	 S813-130200

2) PA TYPE CONNECTOR

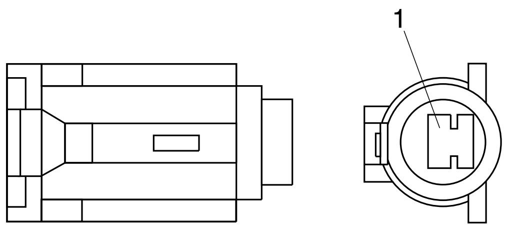
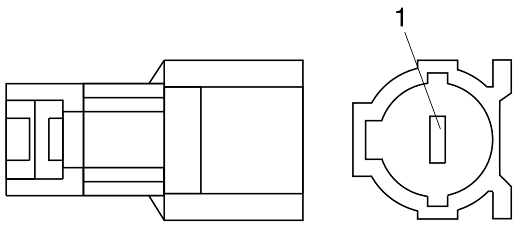
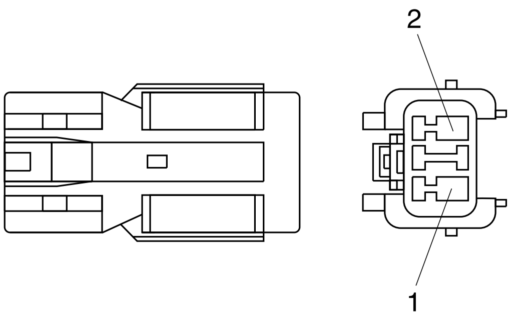
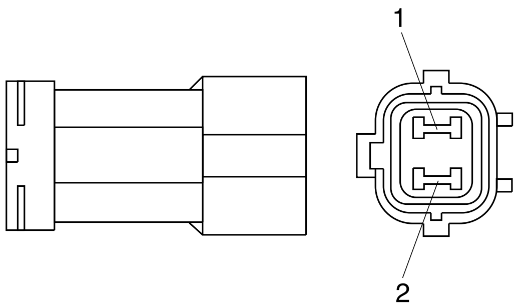
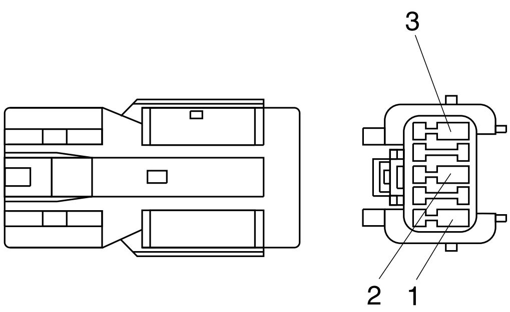
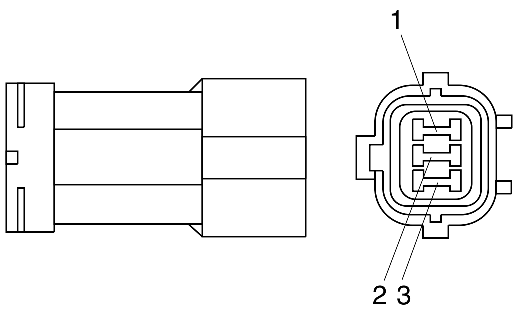
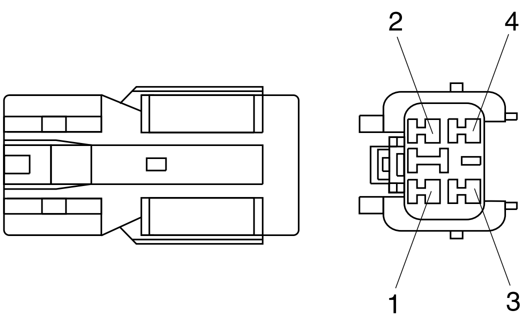
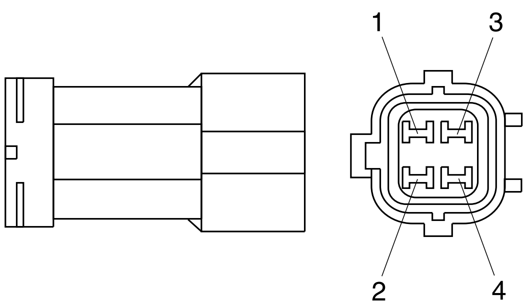
No. of pin	Receptacle connector (female)	Plug connector (male)
5	 S811-005002	 S811-105002
7	 S811-007002	 S811-107002
9	 S811-009002	 S811-109002
11	 S811-011002	 S811-111002

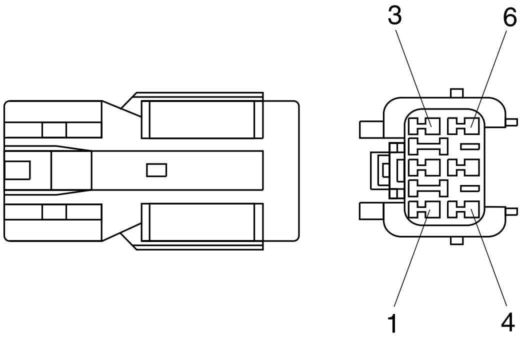
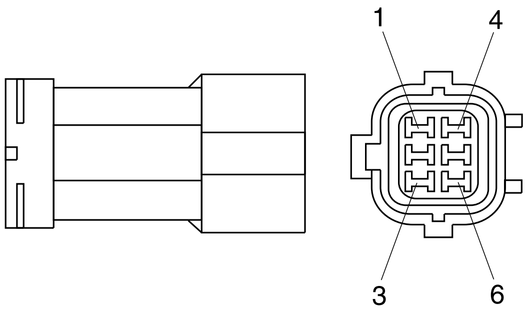
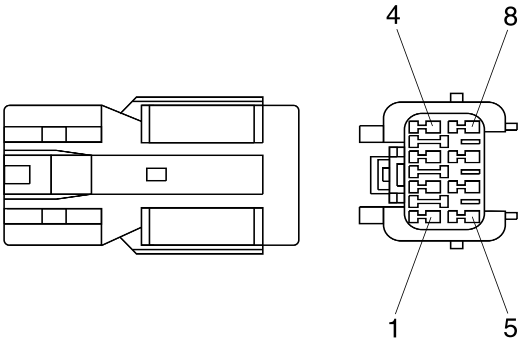
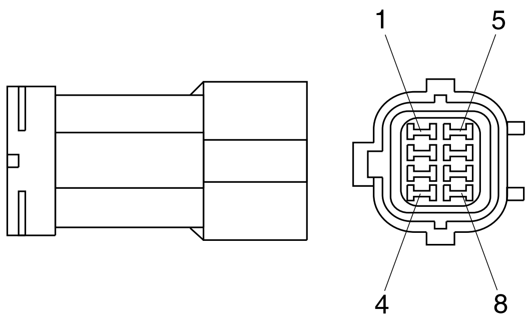
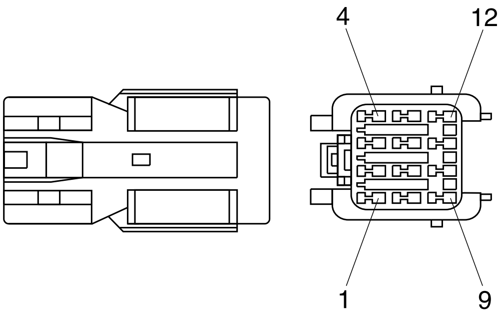
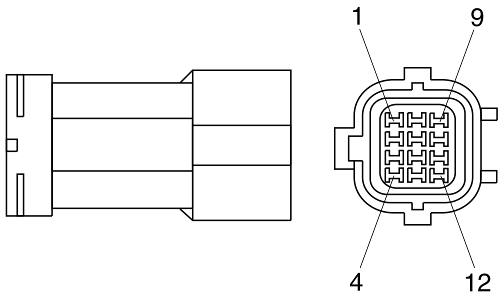
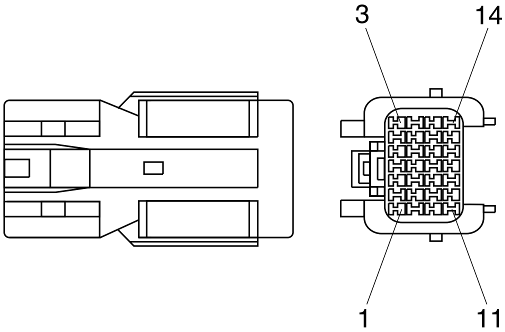
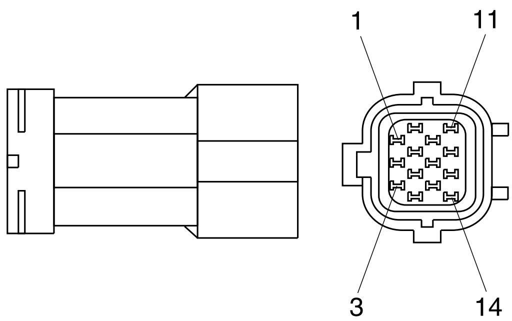
No. of pin	Receptacle connector (female)	Plug connector (male)
13	 S811-013002	 S811-113002
17	 S811-017002	 S811-117002
21	 S811-021002	 S811-121002

3) J TYPE CONNECTOR

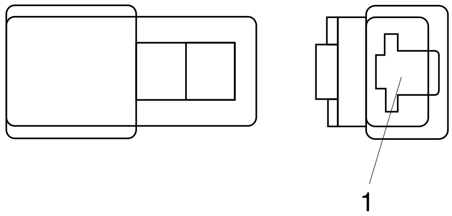
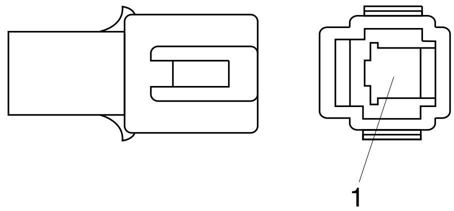
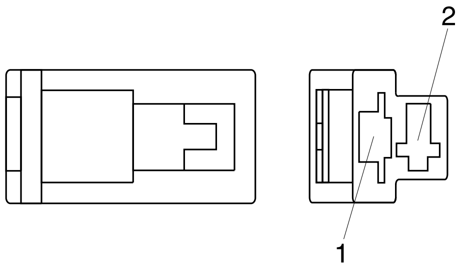
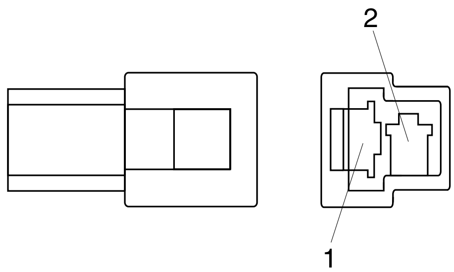
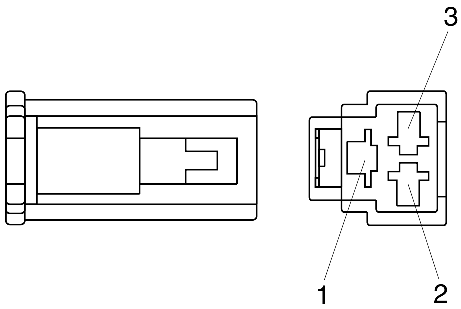
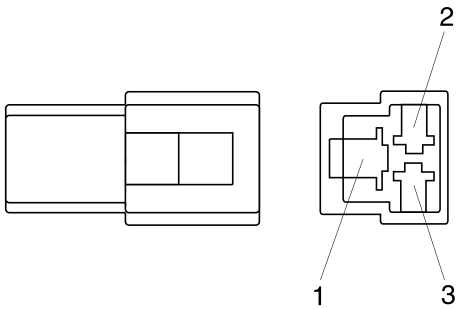
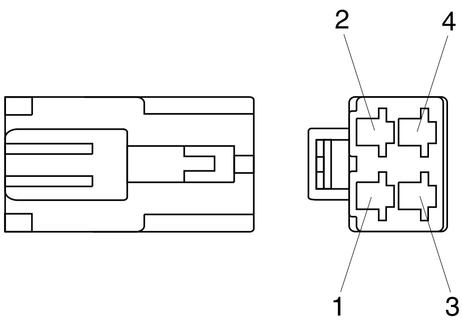
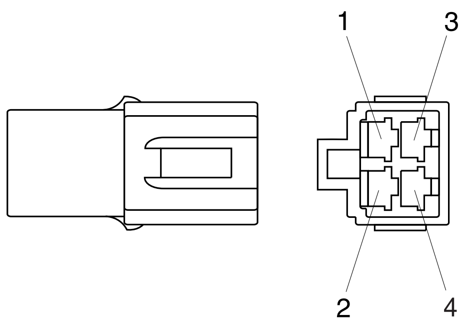
No. of pin	Receptacle connector (female)	Plug connector (male)
2	 S816-002001	 S816-102001
3	 S816-003001	 S816-103001
4	 S816-004001	 S816-104001
8	 S816-008001	 S816-108001

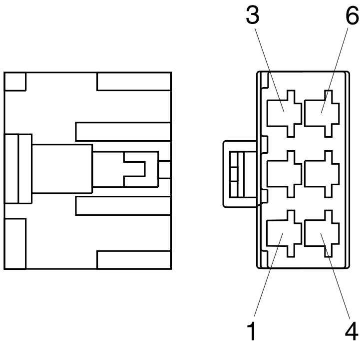
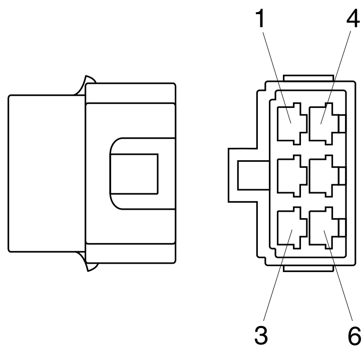
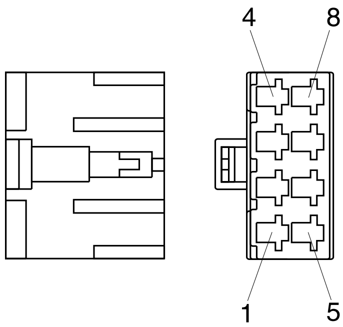
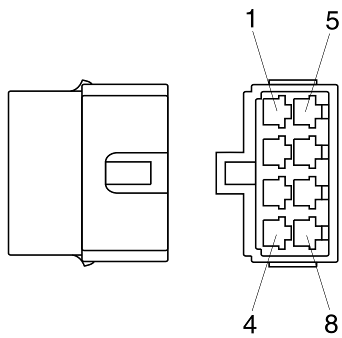
4) SWP TYPE CONNECTOR

No. of pin	Receptacle connector (Female)	Plug connector (male)
1	 S814-001000	 S814-101000
2	 S814-002000	 S814-102000
3	 S814-003000	 S814-103000
4	 S814-004000	 S814-104000

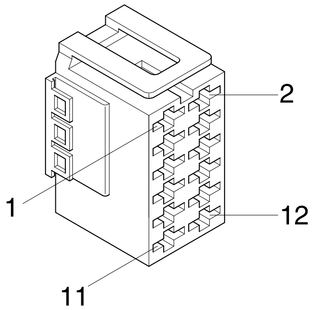
No. of pin	Receptacle connector (female)	Plug connector (male)
6	 S814-006000	 S814-106000
8	 S814-008000	 S814-108000
12	 S814-012000	 S814-112000
14	 S814-014000	 S814-114000

5) CN TYPE CONNECTOR

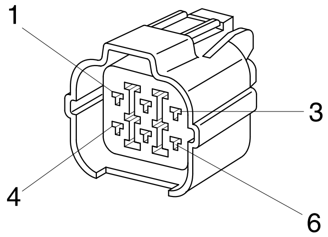
No. of pin	Receptacle connector (female)	Plug connector (male)
1	 S810-001202	 S810-101202
2	 S810-002202	 S810-102202
3	 S810-003202	 S810-103202
4	 S810-004202	 S810-104202

No. of pin	Receptacle connector (female)	Plug connector (male)
6	 S810-006202	 S810-106202
8	 S810-008202	 S810-108202

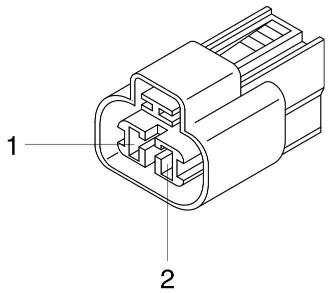
6) ITT SWF CONNECTOR

No. of pin	Receptacle connector (female)	Plug connector (male)
10	 SWF589790	

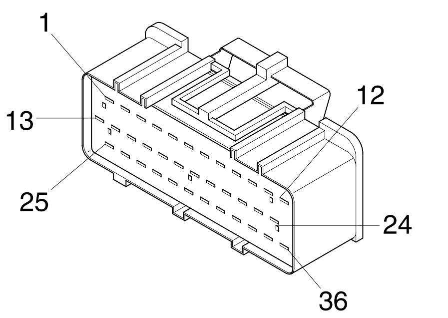
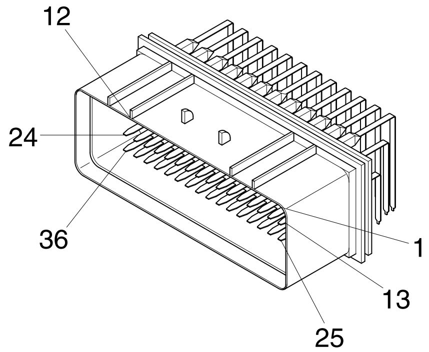
7) HW090 SEALED CONNECTOR

No. of pin	Receptacle connector (female)	Plug connector (male)
6	 6189-0133	

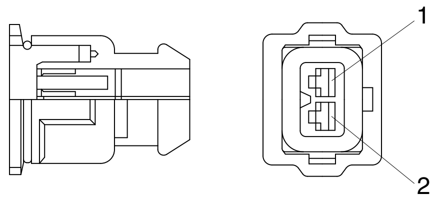
8) MWP02F-B CONNECTOR

No. of pin	Receptacle connector (female)	Plug connector (male)
2	 PH805-02028	

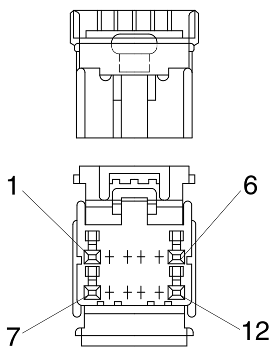
9) AMP ECONOSEAL CONNECTOR

No. of pin	Receptacle connector (female)	Plug connector (male)
36	 344111-1	 344108-1

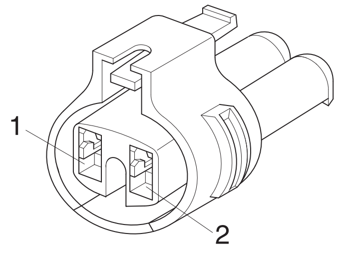
10) AMP TIMER CONNECTOR

No. of pin	Receptacle connector (female)	Plug connector (male)
2	 85202-1	

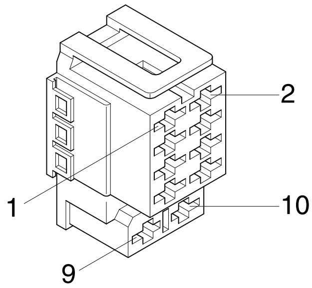
11) AMP 040 MULTILOCK CONNECTOR

No. of pin	Receptacle connector (female)	Plug connector (male)
12	 174045-2	

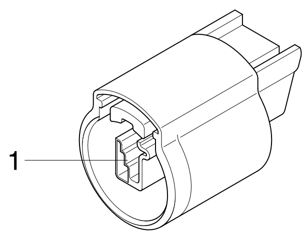
12) KET 090 WP CONNECTORS

No. of pin	Receptacle connector (female)	Plug connector (male)
2	 MG640795	

13) ITT SWF CONNECTOR

No. of pin	Receptacle connector (female)	Plug connector (male)
10	 SWF593757	

14) MWP NMWP CONNECTOR

No. of pin	Receptacle connector (female)	Plug connector (male)
1	 NMWP01F-B	

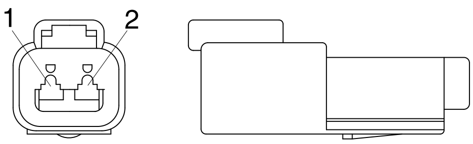
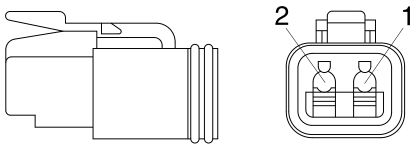
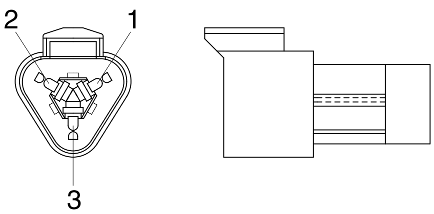
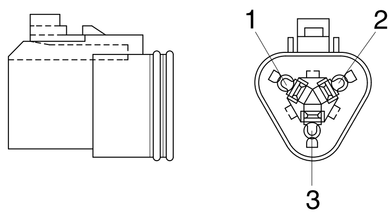
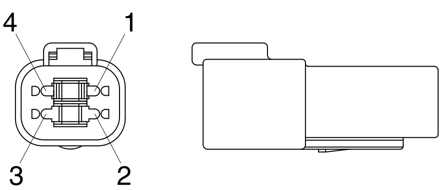
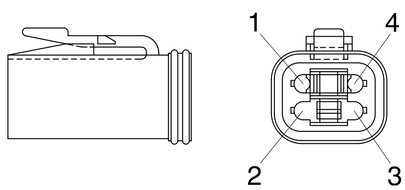
15) DEUTSCH DT CONNECTORS

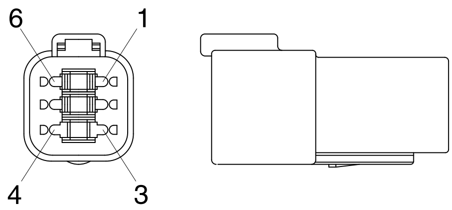
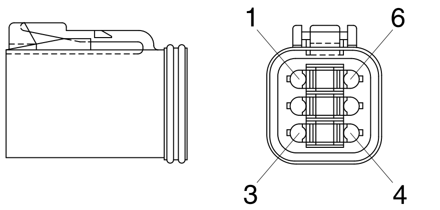
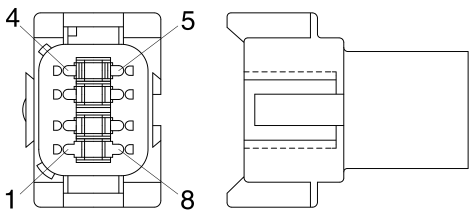
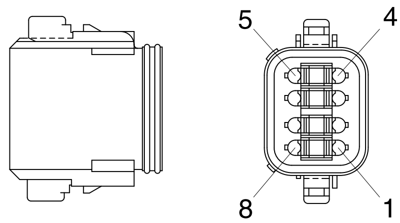
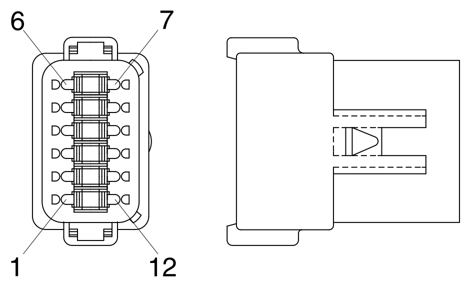
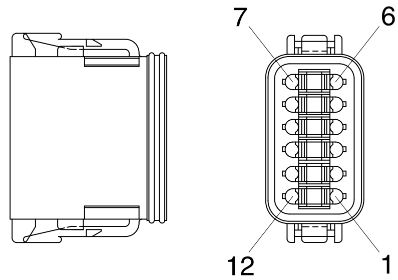
DT 06 - 3S - ★★★★

- ★★★★ : Modifications (see below)
- 3S : Number of contacts (P : Pin, S : Socket)
- 06 : 04 : Receptacle, 06 : Plug
- DT : Deutsch connetors

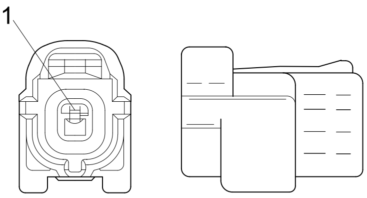
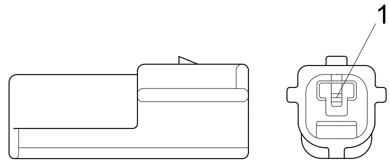
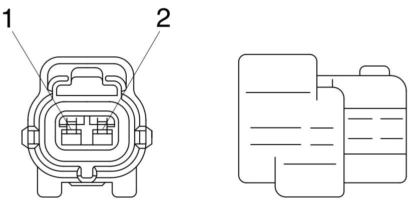
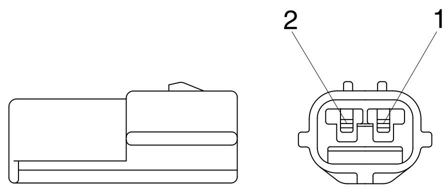
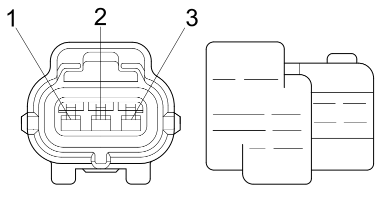
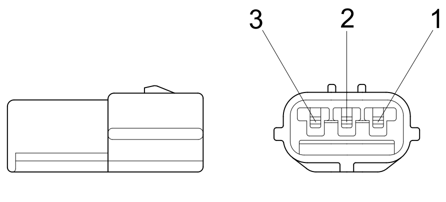
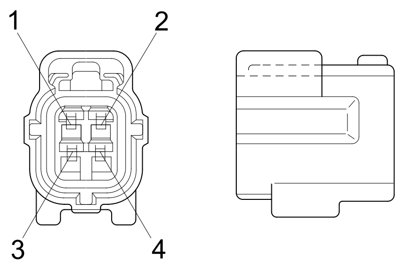
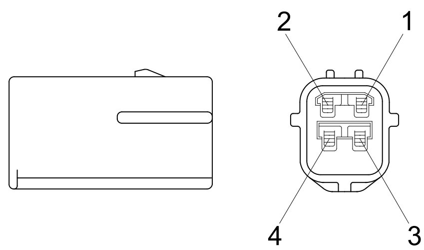
※ Modification

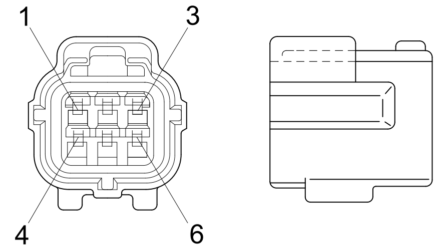
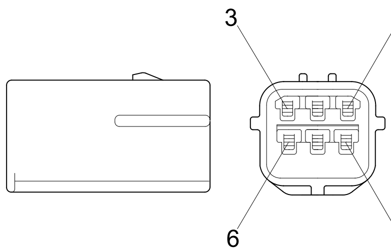
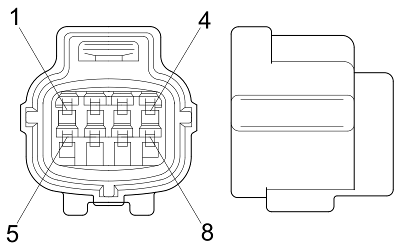
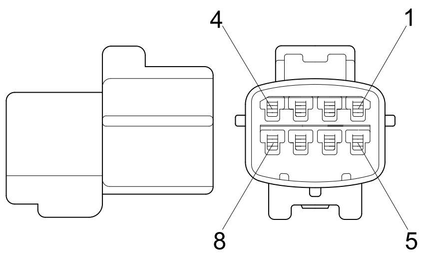
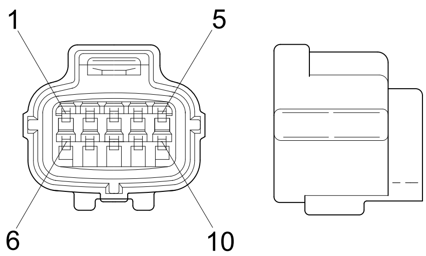
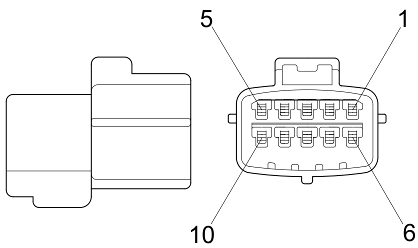
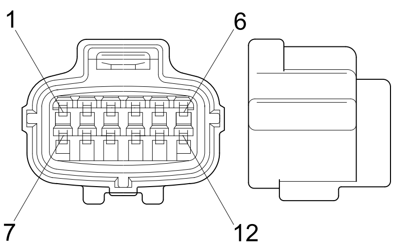
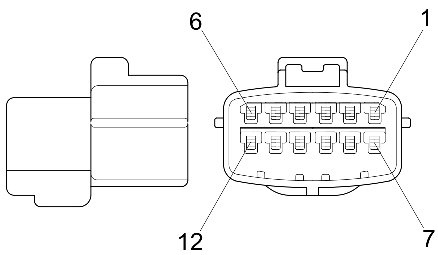
E003 : Standard end cap - gray
E004 : Color of connector to be black
E005 : Combination - E004 & E003
EP04 : End cap
EP06 : Combination P012 & EP04
P012 : Front seal enhancement - connectors color to black for 2, 3, 4 & 6pin

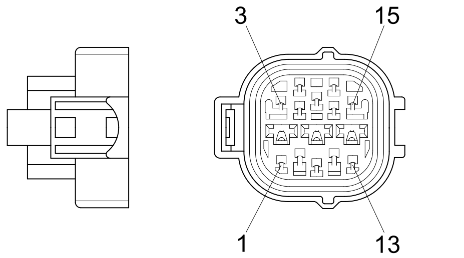
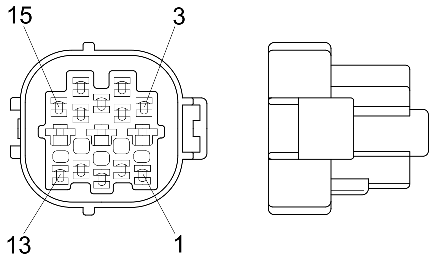
No. of pin	Receptacle connector (female)	Plug connector (male)
2	 DT06-2S	 DT04-2P
3	 DT06-3S	 DT04-3P
4	 DT06-4S	 DT04-4P

No. of pin	Receptacle connector (female)	Plug connector (male)
6	 DT06-6S	 DT04-6P
8	 DT06-8S	 DT04-8P
12	 DT06-12S	 DT04-12P

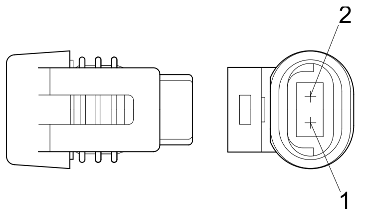
16) ECONOSEAL J TYPE CONNECTORS

No. of pin	Receptacle connector (female)	Plug connector (male)
1	 S816-001002	 S816-101002
2	 S816-002002	 S816-102002
3	 S816-003002	 S816-103002
4	 S816-004002	 S816-104002

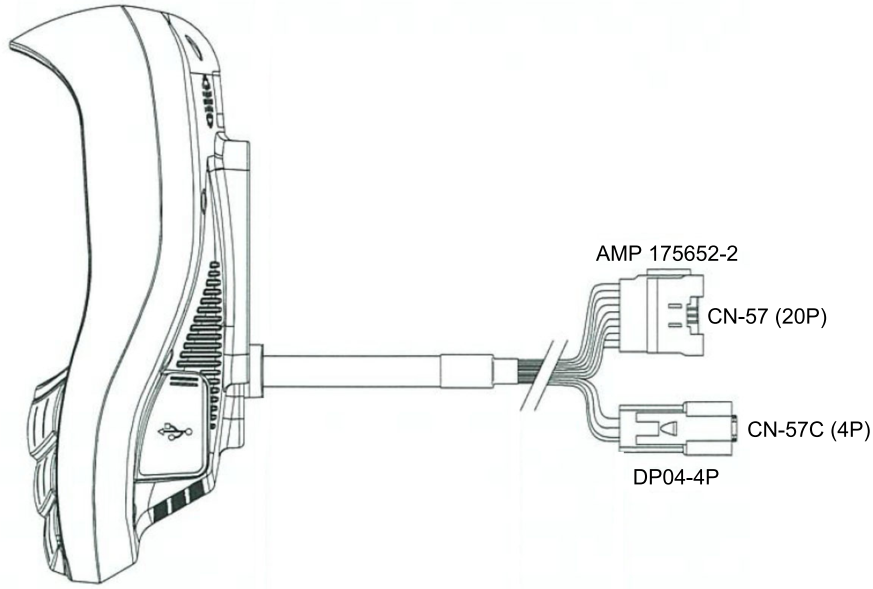
No. of pin	Receptacle connector (female)	Plug connector (male)
6	 S816-006002	 S816-106002
8	 S816-008002	 S816-108002
10	 S816-010002	 S816-110002
12	 S816-012002	 S816-112002

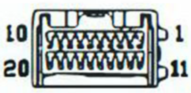
No. of pin	Receptacle connector (female)	Plug connector (male)
15	 368301-1	 2-85262-1

17) METRI-PACK TYPE CONNECTOR

No. of pin	Receptacle connector (female)	Plug connector (male)
2	 12040753	

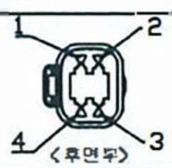
18) MONITOR CONNECTOR (21WD-11400)





PART NO. : AMP 175652-2

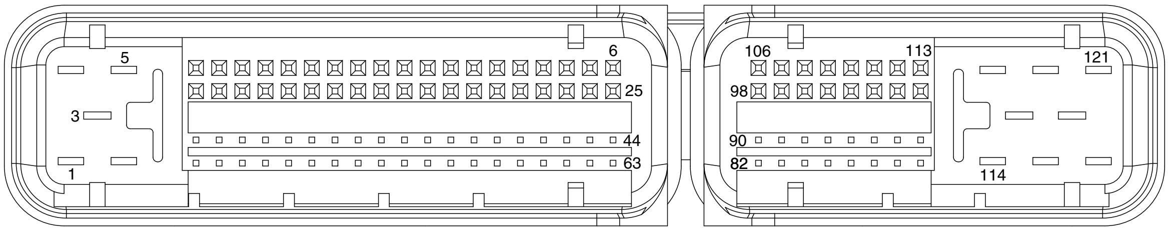
NO	PIN NAME	NO	PIN NAME
1	IG 24V	11	GND
2	BATTERY 24V	12	GND
3	BATTERY 24V	13	N.C
4	CAMERA CH1 (SINGLE)	14	CAN2 L
5	CAMERA CH3 DIFF−	15	CAN2 H
6	CAMERA VCC (8V OUTPUT)	16	CAN2 SHIELD
7	N.C	17	CAMERA SHIELD
8	N.C	18	N.C
9	CAMERA CH2 DIFF−(OPTIONAL)	19	N.C
10	CAMERA CH2 DIFF+(OPTIONAL)	20	CAMERA CH3 DIFF+



PART NO. : DT04-4P

NO	PIN NAME	NO	PIN NAME
1	CAM VCC (8V OUTPUT)	3	CAM CH3 DIFF+
2	CAM GND	4	CAM CH3 DIFF−

19) MCU



CN-58A

O 13	REVERSE DRIVE RELAY
O 98	AUTO GREASE RELAY
O 106	RIDE CONTROL RELAY
O 33	INPUT FRONT WASHER SIGNAL
O 34	INPUT FRONT INT SIGNAL
O 90	REAR WIPER WASHER REALY
O 97	ATACH LOCK RELAY
O 87	ATACH UNLOCK RELAY
O 113	BEACON RELAY
O 89	MIRROR HEAT REALY
O 105	FRONT WIPER 1ST SPEED REALY
O 107	REAR WIPER SPEED REALY
O 16	BATTERY RELAY
O 2	GND(MAIN)
O 116	GND(MAIN)
O 72	ELEC. STEER MAIN PUMP PS
O 75	ELEC. STEER PUMP PS
O B21	SPARE
O 31	SPARE
O 35	NEUTRAL SIGNAL(24V)
O 7	ANTI-RESTART RELAY
O 63	ELEC. STEERING PUMP RELAY
O 57	CAN(1)-H
O 58	CAN(1)-L
O 55	CAN_SHIELD(GROUND)
O 77	BRAKE OIL LOW PS
O 71	PARKING OIL LOW PS
O 76	BRAKE PRIORITY_PR SIGNAL
O 73	BOOM ROD PR SNENSOR
O 68	BOOM HEAD PR SNENSOR
O 74	DIFFERTIAL LOCK PR SIGNAL
O 5	+24V PRESSURE SENSOR POWER
O 50	AXLE OIL TEMP (FRONT)
O 49	AXLE OIL TEMP(REAR)
O 52	FUEL LEVEL SENSOR
O 53	HYD TEMP SENDER
O 30	SPARE(COOLANT LEVEL SENSOR)
O 43	GROUND_SENSOR
O 64	ALT LEVEL
O 36	AIR CLEANER PRESSURE SW
O 118	COOLING FAN EPPR-
O 117	COOLING FAN EPPR+
O 8	REVERSE FAN CONTROL
O 102	TACHO SENSOR(+)_REMOTE FAN
O 101	TACHO SENSOR(-)_REMOTE FAN

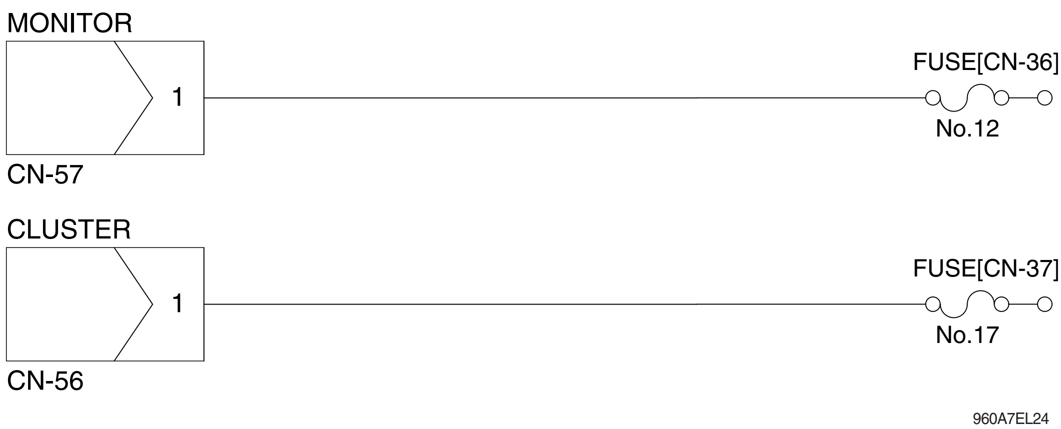
O 61	CAN2 LOW
O 60	CAN2 HI
O B21	SPARE_ECO FEELING SIGNAL
O 12	ILLUMINATION LIGHT RELAY
O 11	DRIVING LIGHT RELAY
O 88	WORK LAMP FRONT
O 44	WORK LAMP REAR
O 82	FUEL WARMER RELAY
O 32	AIRCON RUN SIGNAL
O 83	AC COMP. OFF SIG_REVERSE FAN
O	
O 78	BOOM POSITION SENSOR
O 66	BUCKET POSITION SENSOR
O 24	REF. POWER +5V
O 1	POWER IG(+24V)
O 3	BATTERY POWER(+24V)
O 4	BATTERY POWER(+24V)
O 6	DETENT CONTROL SOL_BUCKET
O 45	DETENT CONTROL SOL_BOOM UP
O 51	COUNT_WEIGHT_SET SWITCH
O 29	AUTO GREASE LAMP(GREEN)
O 28	AUTO GREASE LAMP(RED)
O 26	DIFF. LOCK AUTO
O 27	DIFF. LOCK MANUAL
O 15	HOUR METER_HIGH
O A07	SPARE_5V+
O B40	SPARE_PEDAL POSITION2
O A09	SPARE_PEDAL POSITION2 RETURN
O 48	SEAT BELT WARNING
O 22	SPARE_5V+
O B39	SPARE_PEDAL POSITION1
O A08	SPARE_PEDAL POSITION1
O 42	PROGRAM DUMP
O 93	RS-232(1) RX
O 92	RS-232(1) TX
O 94	SPARE_RS-232 GND
O A22	SPARE
O A32	SPARE
O 10	SPARE

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.

		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)



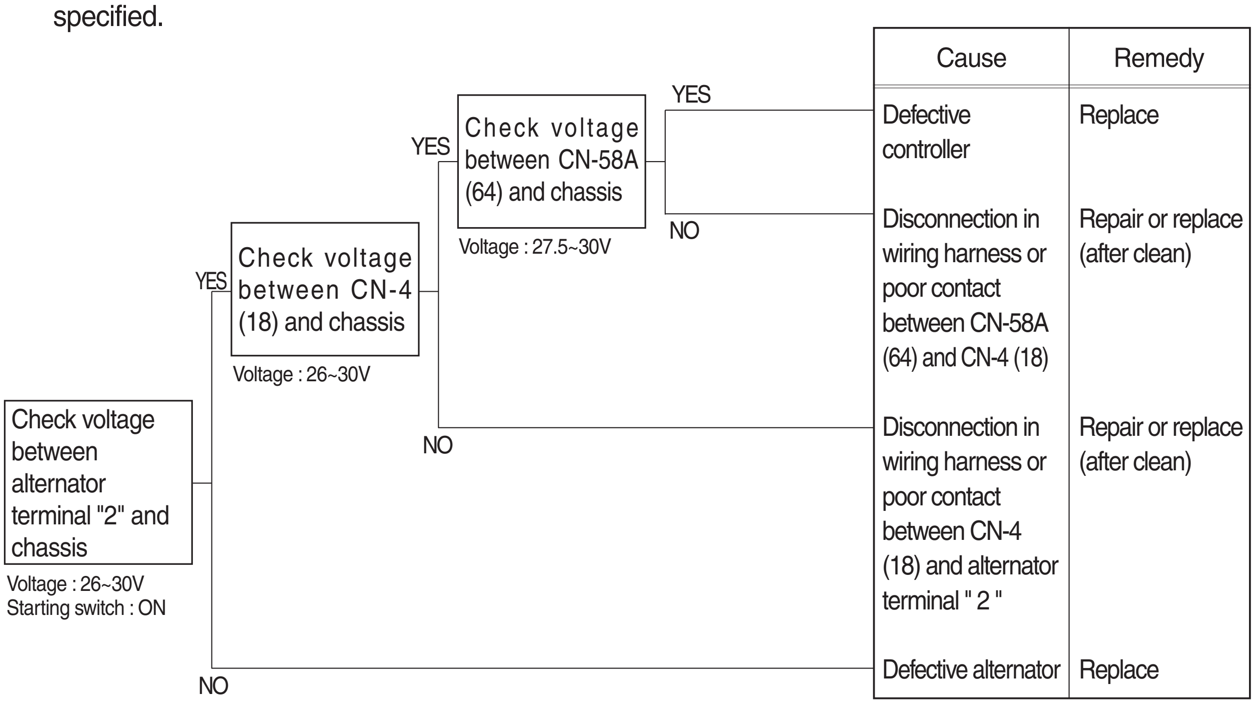
Check voltage

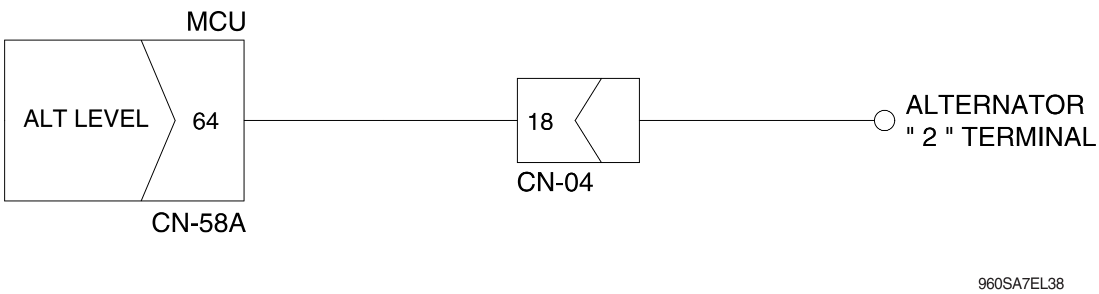
YES	20 ~ 30 V
NO	0 V

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.





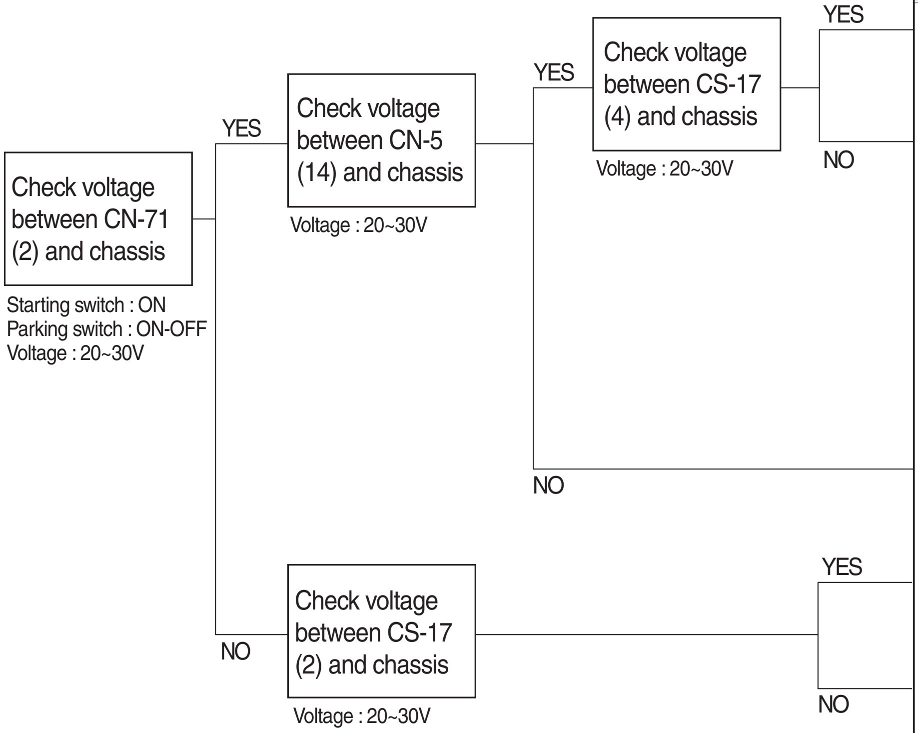
Check valtage

YES	20 ~ 30 V
NO	0 V

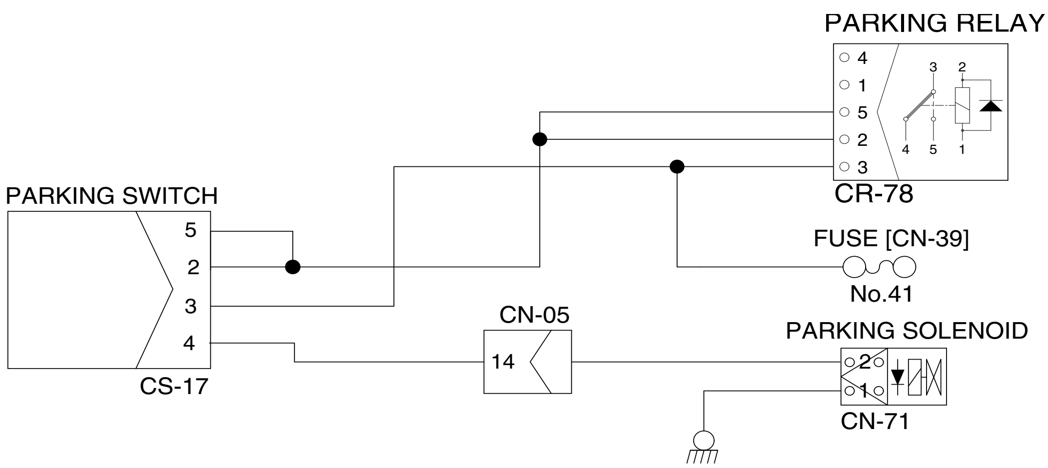
3. WHEN PARKING SOLENOID DOES NOT WORK

· 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.



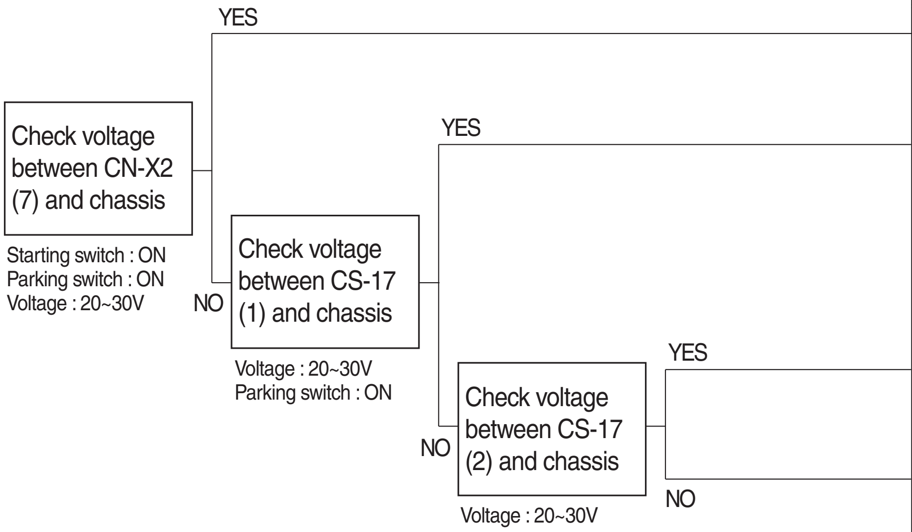
Cause	Remedy
Defective parking brake solenoid	Replace
Disconnection in wiring harness or poor contact between CS-17 (4) and CN-5 (14)	Repair or replace (after clean)
Disconnection in wiring harness or poor contact between CN-71 (2) and CN-5 (14)	Repair or replace (after clean)
Difective parking switch	Replace
Disconnection in wiring harness or poor contact between CS-17 (2) and Fuse No.41	Repair or replace (after clean)



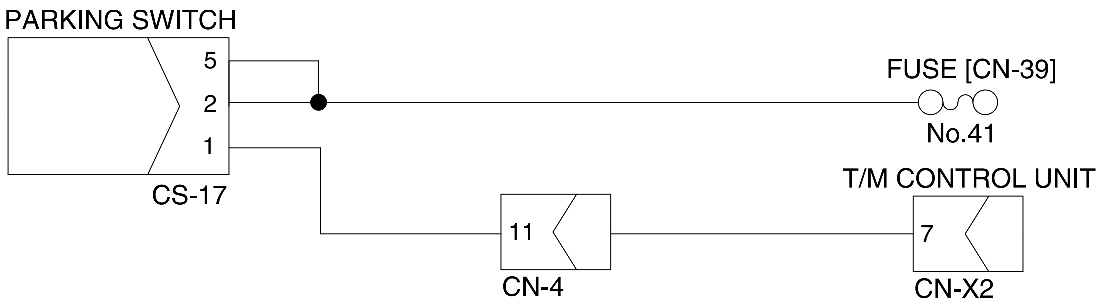
960SA7EL39

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)



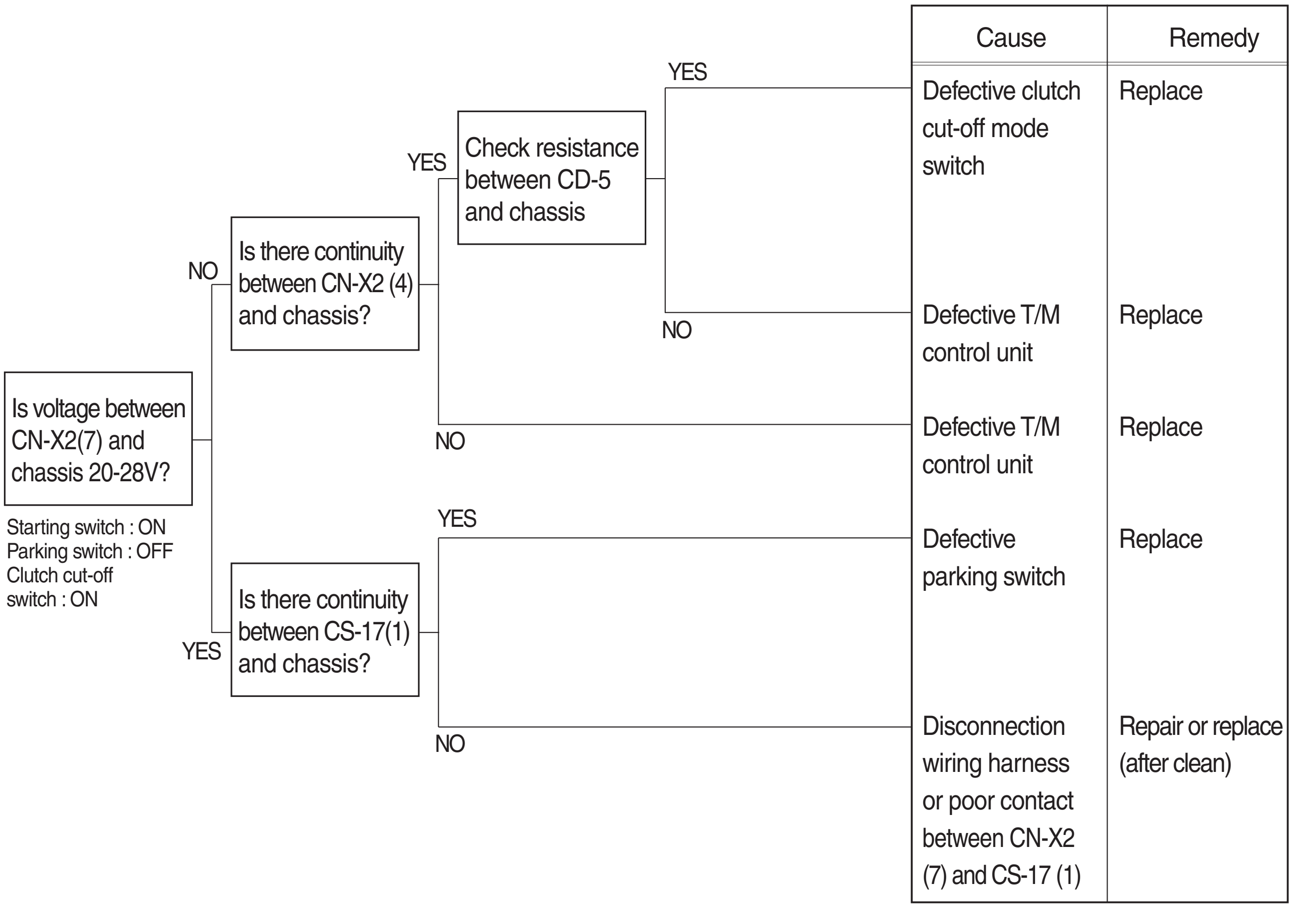
960SA7EL40

Check resistance

YES	MAX 1Ω
NO	MIN 1MΩ

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.



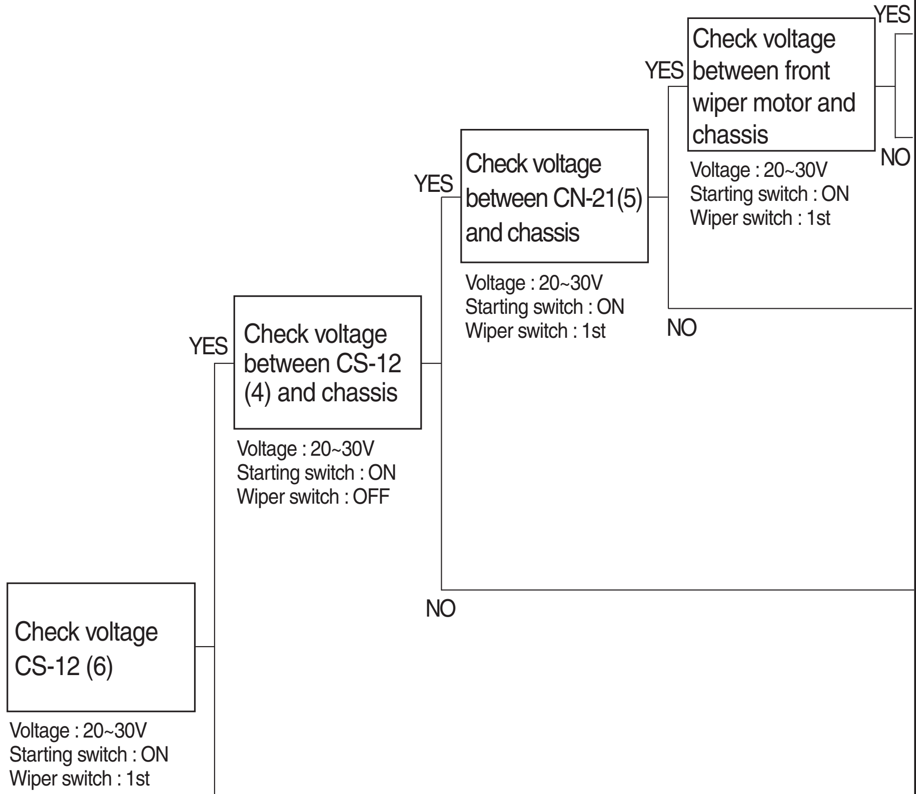
Check resistance

YES	MAX 1Ω
NO	MIN 1MΩ

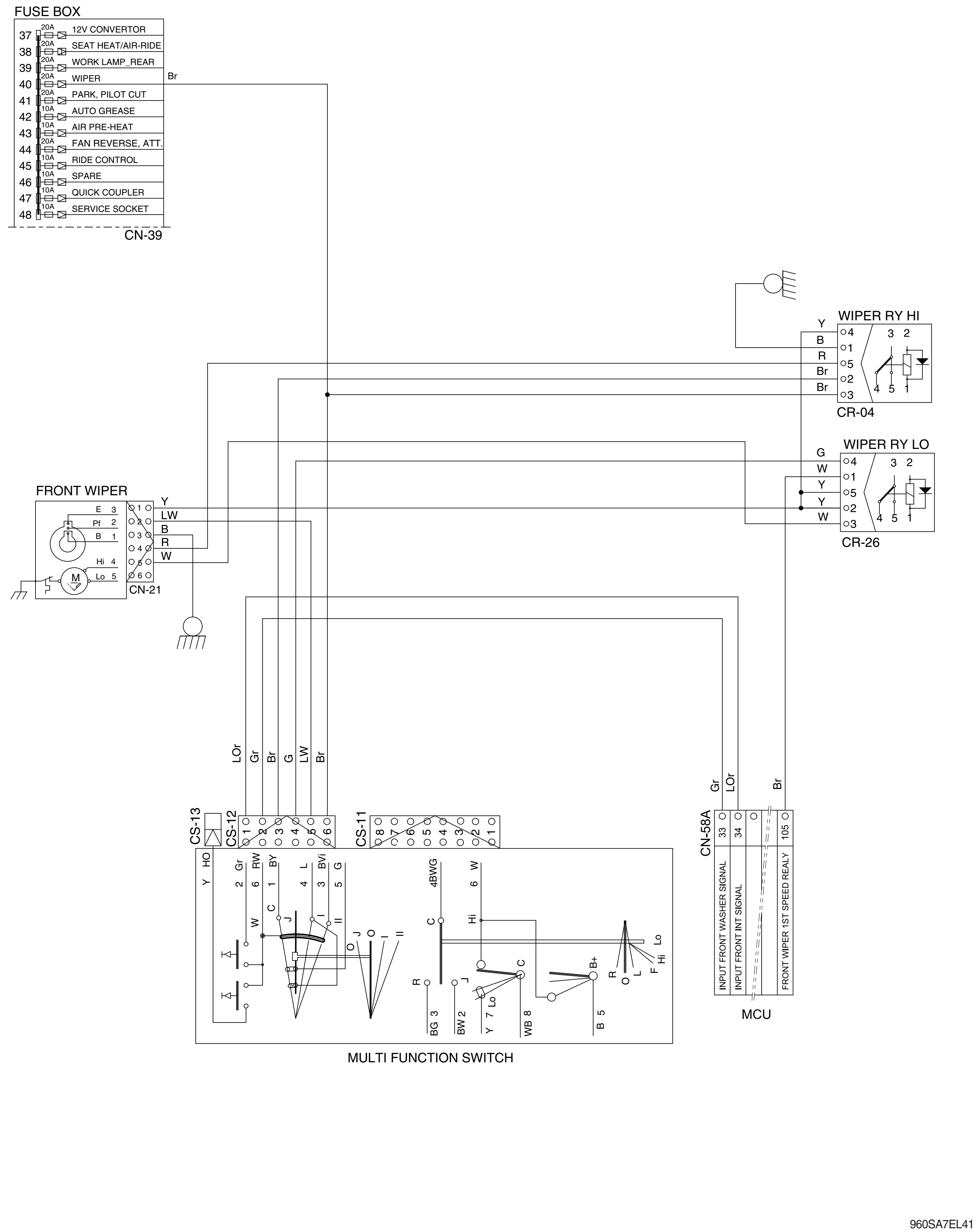
6. WHEN STARTING SWITCH IS TURNED ON, WIPER MOTOR DOES NOT OPERATE

· 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.



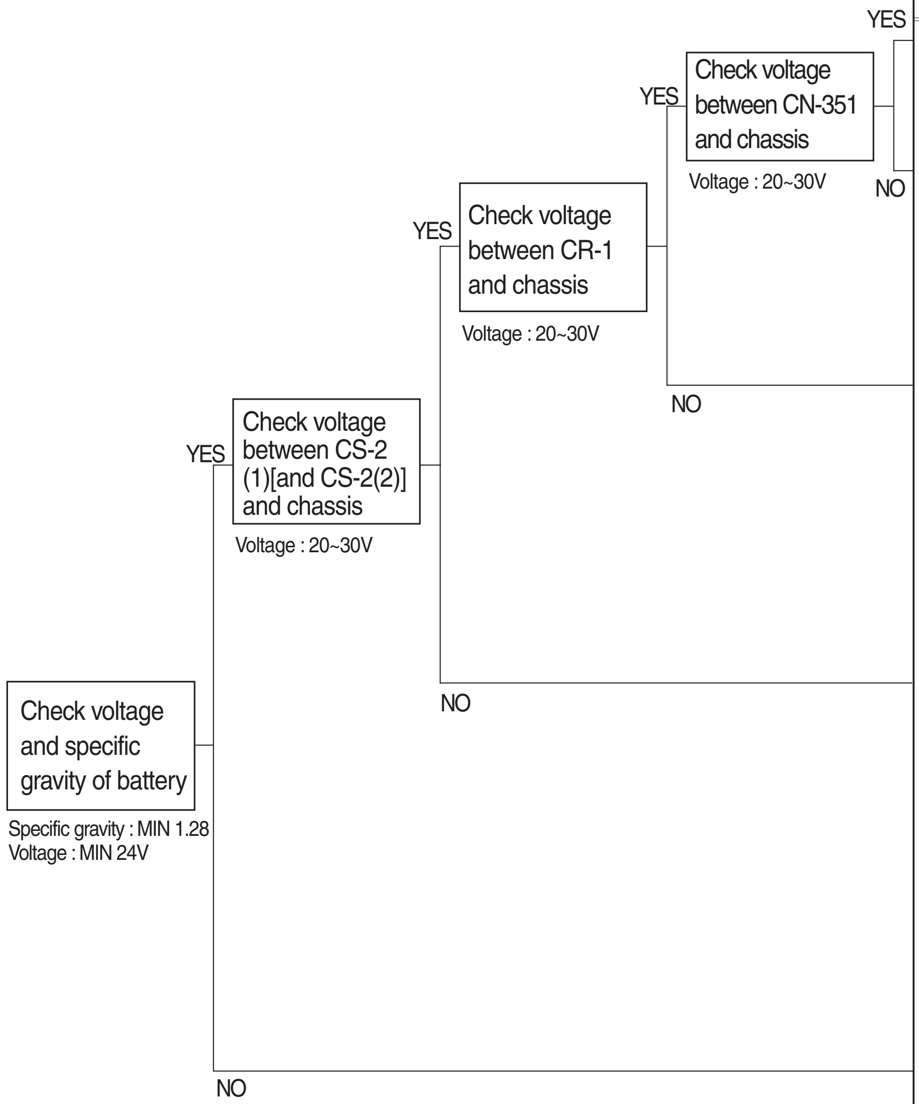
Cause	Remedy
Defective front wiper motor	Replace
Poor connection of chassis	Replace
Disconnection in wiring harness or poor contact between CN-21(5) and CR-26(3)	Repair or replace (after clean)
Defective wiper switch or disconnection in wiring harness or poor contact between CS-12(4) and CR-26(4)	Repair or replace (after clean)
Disconnection in wiring harness or poor contact between CS-12(6) and fuse [CN-39] No.40	Repair or replace (After clean)



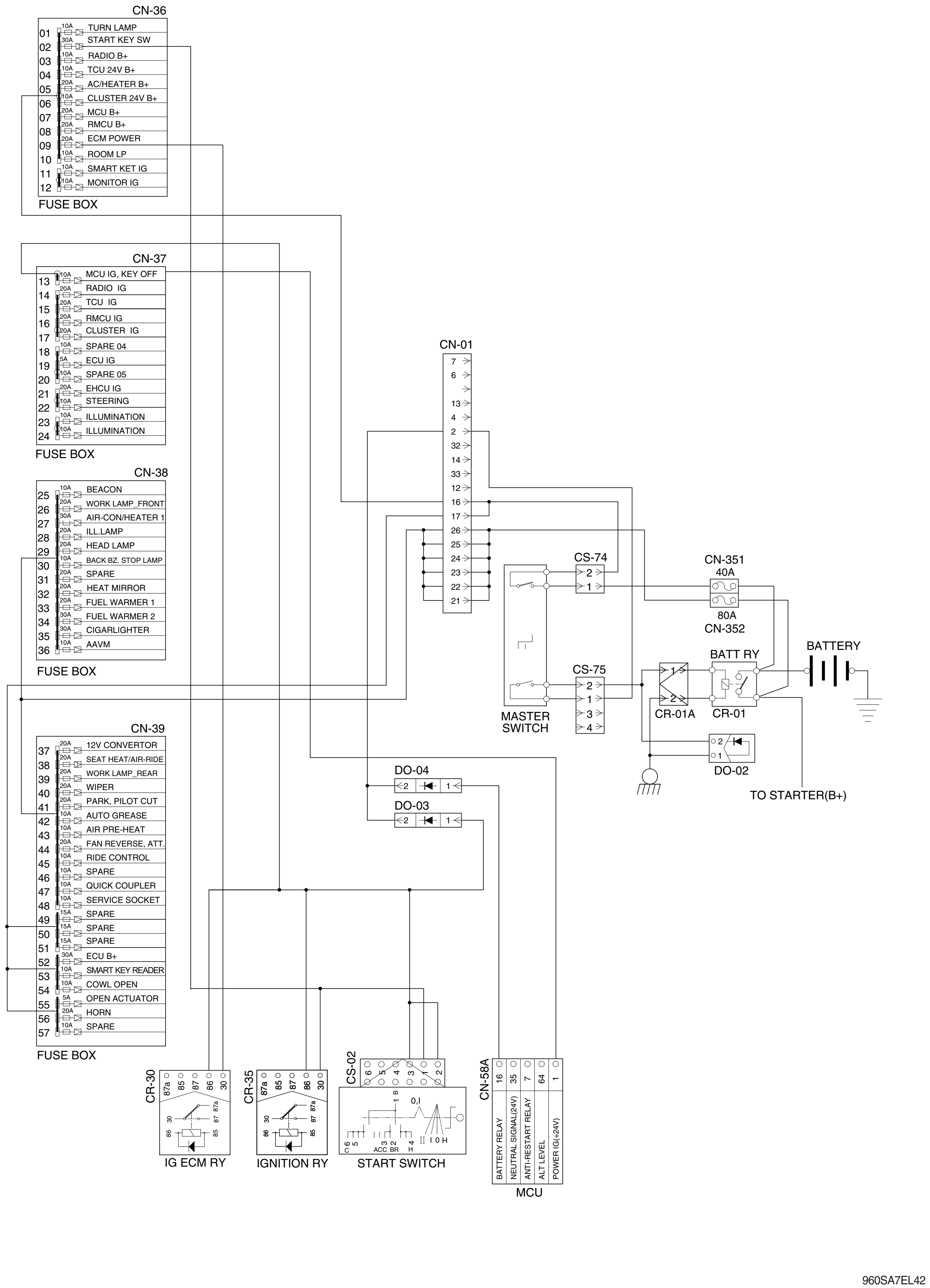
7. WHEN STARTING SWITCH "ON" DOES NOT OPERATE

· 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.



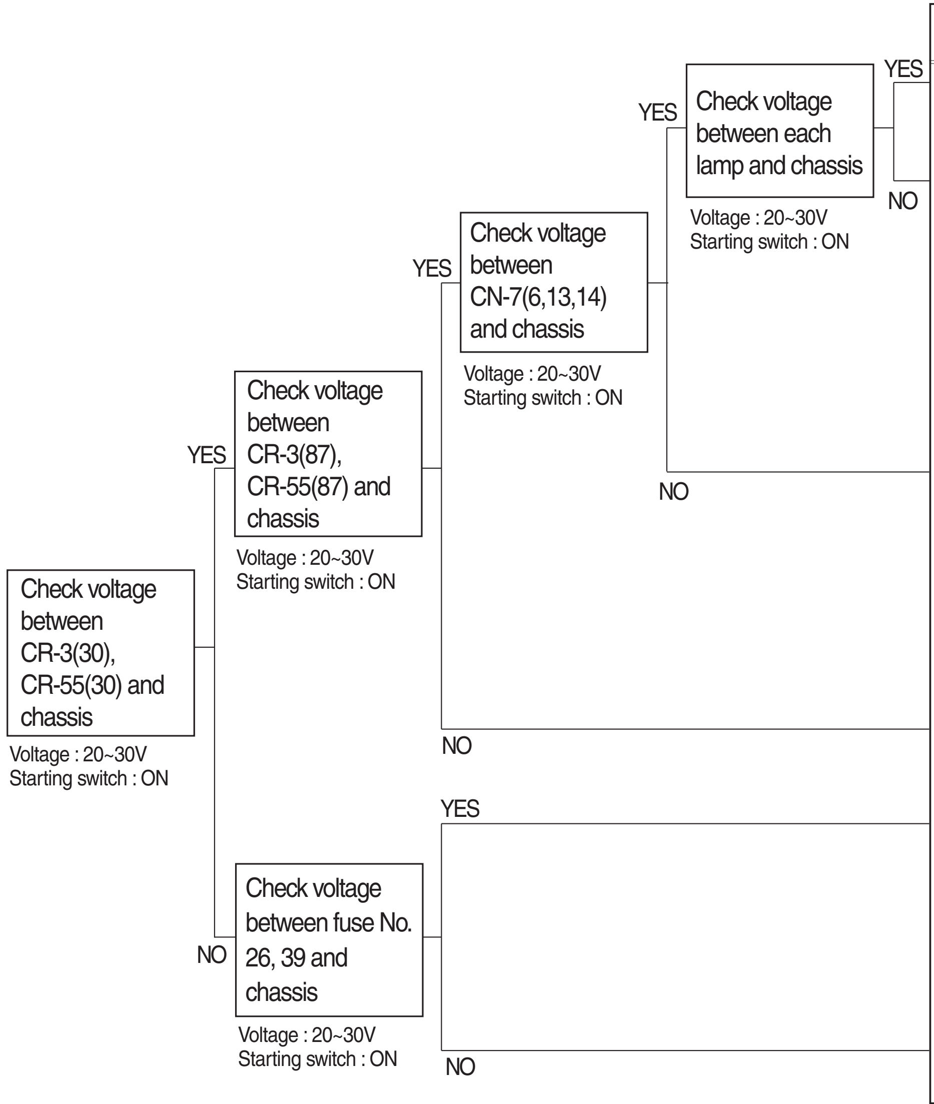
Cause	Remedy
Defective cable assembly	Repair or replace (after clean)
Short circuit or defect of fusible link or defective battery relay	Replace
Disconnection in wiring harness or poor contact between CS-2 (2) - CN-1(2)-CS-75-CR-1.	Repair or replace (after clean)
Disconnection in wiring harness or poor contact between fuse No. 2 and CS-2 (1) or defect of start switch	Repair or replace (after clean)
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