SECTION 3 POWER TRAIN SYSTEM

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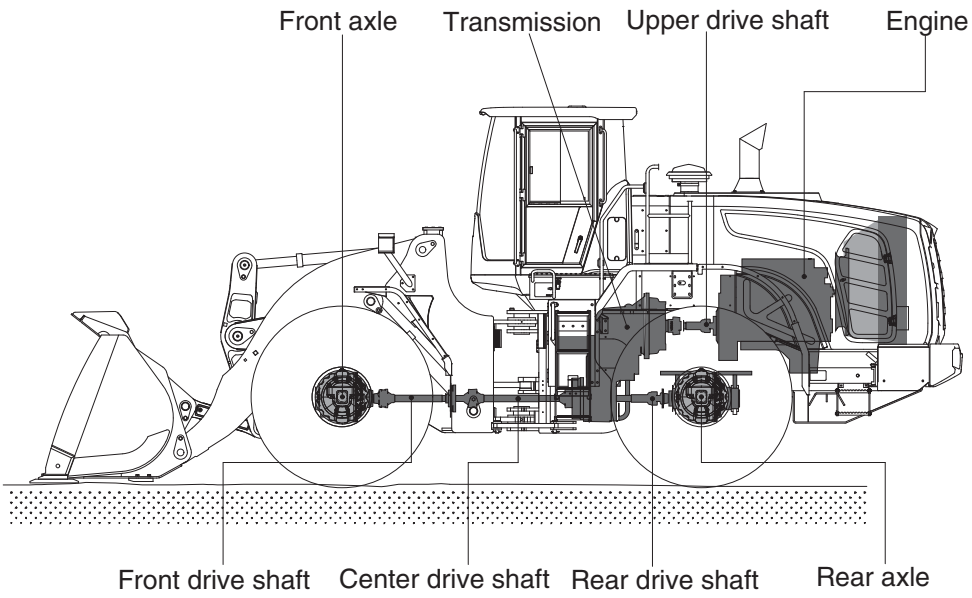
GROUP 1 STRUCTURE AND FUNCTION

1. POWER TRAIN COMPONENT OVERVIEW



9803PT01

The power train consists of the following components:

- Transmission
- Front, center, rear and upper drive shafts
- Front and rear axles

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

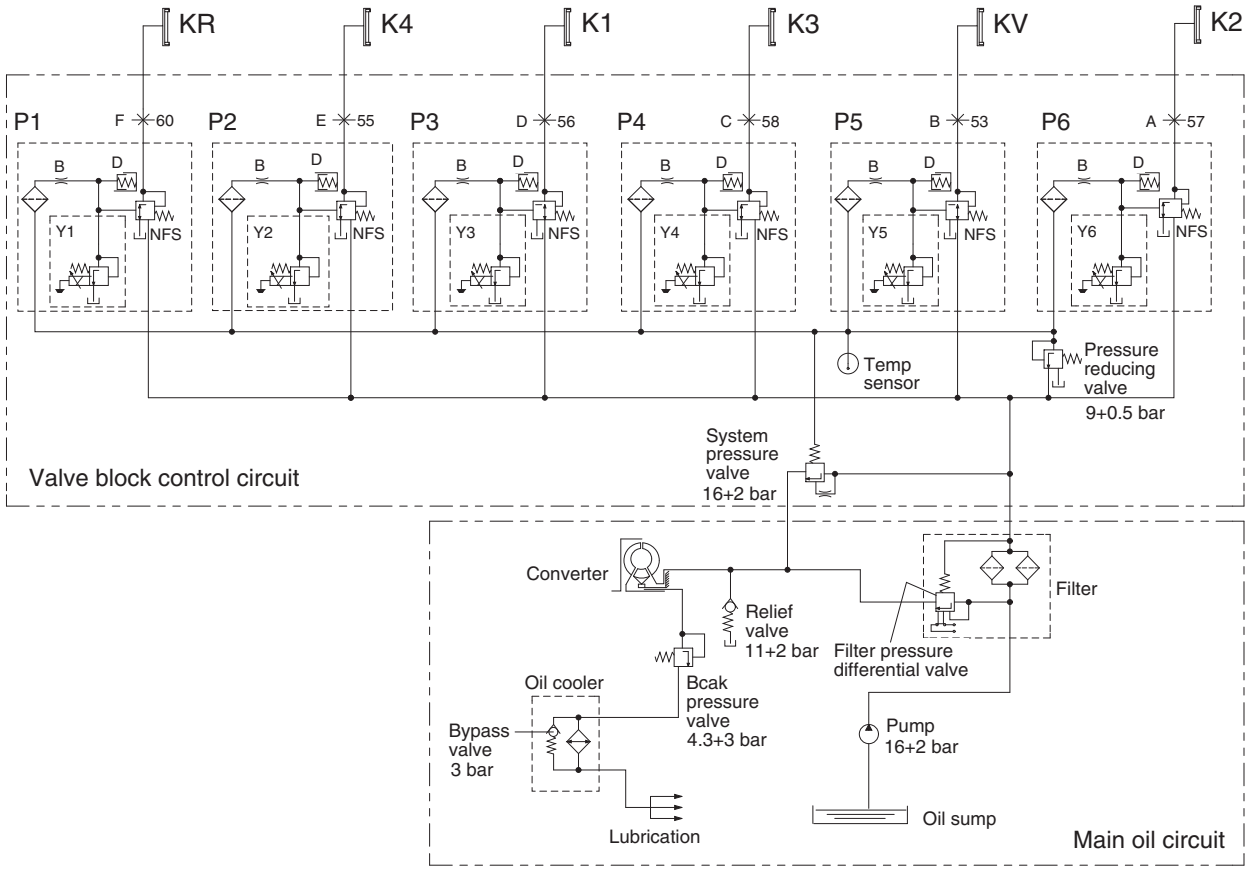
The transmission is a hydraulically engaged four speed forward, three speed reverse countershaft type power shift transmission. A calliper-disc type parking brake is located on the transmission.

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

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

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

HYDRAULIC CIRCUIT (4-speed transmission)



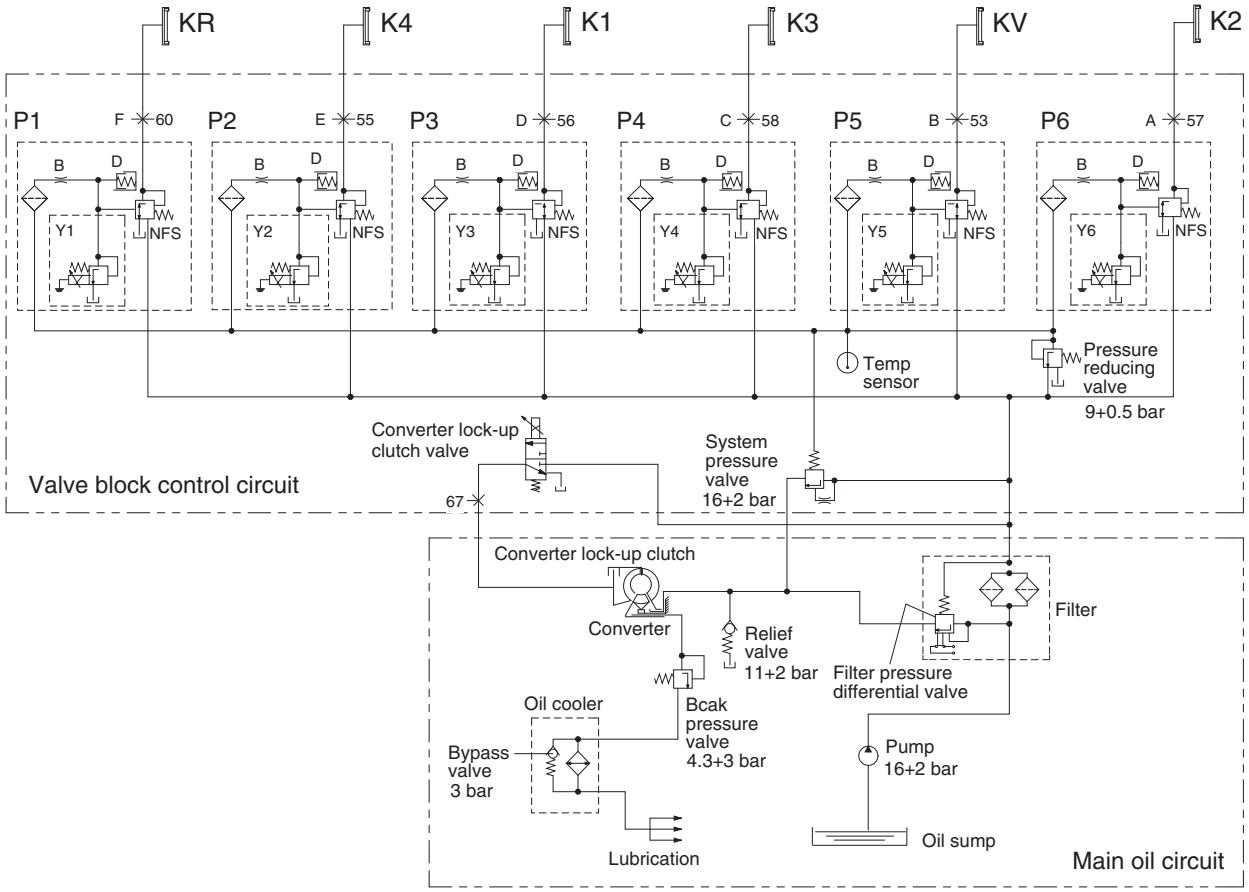
7707APT09

NFS	Follow-on slide	P3	Proportional valve clutch K1
D	Oscillation damper	P4	Proportional valve clutch K3
B	Orifice	P5	Proportional valve clutch KV
P1	Proportional valve clutch KR	P6	Proportional valve clutch K2
P2	Proportional valve clutch K4	Y1~Y6	Pressure regulator valve with filter

Speed	Forward				Reverse			Neutral	Engaged clutch	Positions on the valve block	Current No. of the measuring points
	1	2	3	4	1	2	3				
Y1					X	X	X		KR	F	55
Y2			X	X					K4	E	60
Y3	X				X				K1	D	56
Y4				X			X		K3	C	58
Y5	X	X							KV	B	53
Y6		X	X			X			K2	A	57
Engaged clutch	K1,KV	KV,K2	K4,K2	K4,K3	KR,K1	KR,K2	KR, K3		-	-	-

X : Pressure regulator under voltage

HYDRAULIC CIRCUIT (5-speed transmission)



7709A3PT09

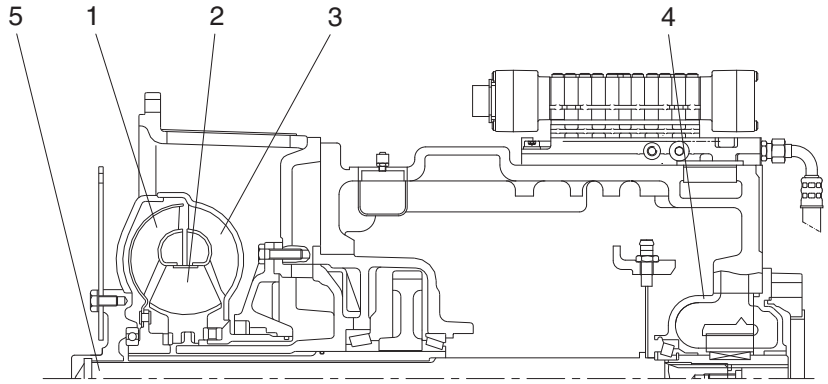
NFS	Follow-on slide	P3	Proportional valve clutch K1
D	Oscillation damper	P4	Proportional valve clutch K3
B	Orifice	P5	Proportional valve clutch KV
P1	Proportional valve clutch KR	P6	Proportional valve clutch K2
P2	Proportional valve clutch K4	Y1~Y6	Pressure regulator with filter

Speed	Forward					Reverse			Neutral	Engaged clutch	Positions on the valve block	Current No. of the measuring points
	1	2	3	4	5	1	2	3				
Y1						X	X	X		KR	F	55
Y2			X		X					K4	E	60
Y3	X					X				K1	D	56
Y4				X	X			X		K3	C	58
Y5	X	X		X						KV	B	53
Y6		X	X				X			K2	A	57
Engaged clutch	K1,KV	KV,K2	K2,K4	KV,K3	K3,K4	KR,K1	KR,K2	KR,K3		-	-	-

X : Pressure regulator under voltage

2. TORQUE CONVERTER

1) FUNCTION



7704PT03

1	Turbine	3	Pump	5	Input shaft
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 will be defined according to the engine power so that the most favorable operating conditions for each installation case are given.

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 is constantly streaming out of the transmission pump 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 through the escaping oil.
The oil, escaping out of the pump wheel, enters the turbine wheel and is there inversed in the direction of flow.

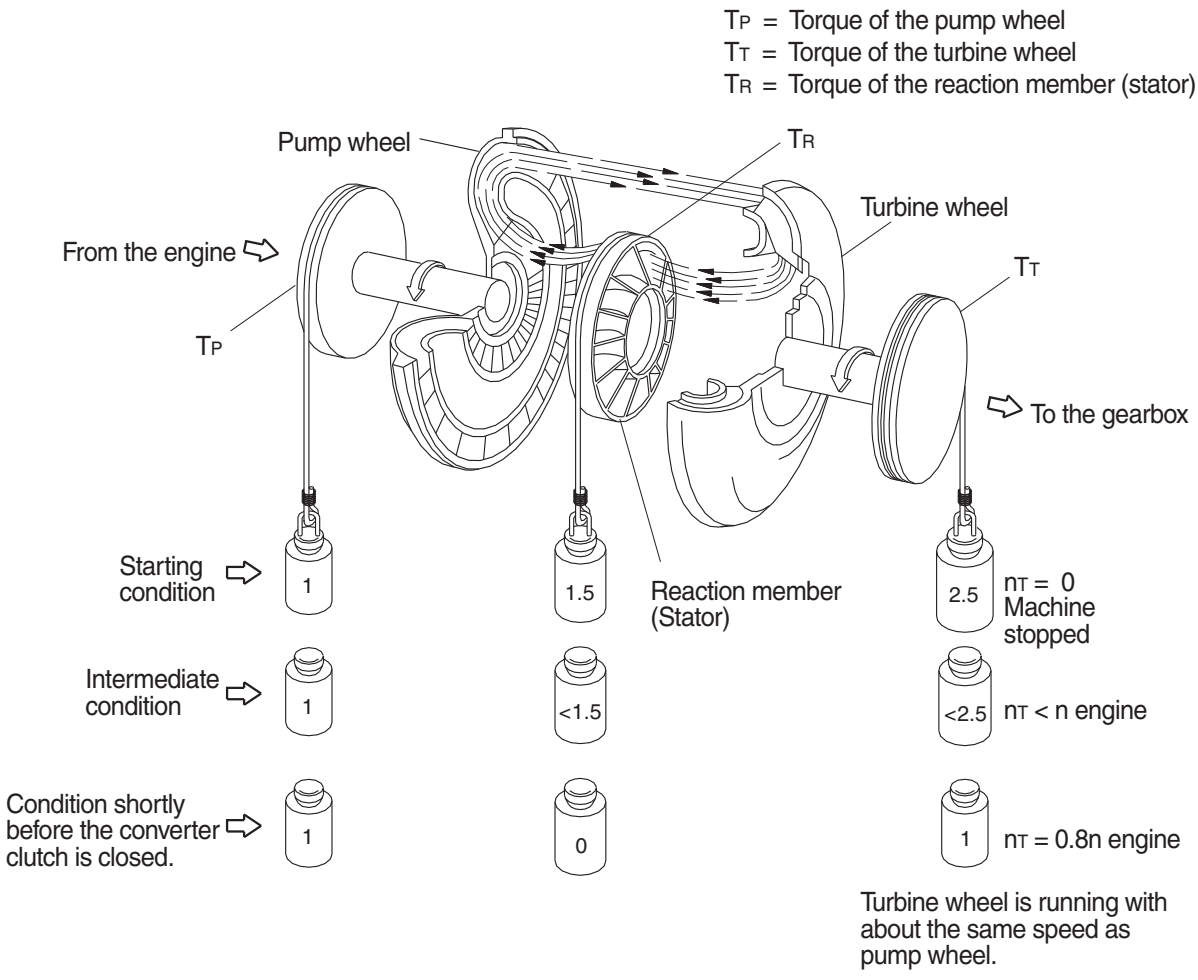
According to the rate of inversion, the turbine wheel and with it also the output shaft, receive a more or less high reaction moment. The stator (reaction member), following the turbine, has the task to inverse again the oil which is escaping out of the turbine and to delivery it under the suitable discharge direction to the pump wheel.
Due to the inversion, the stator receives a reaction moment.
The relation turbine moment/pump moment is called torque conversion. This is the higher the greater the speed difference of pump wheel and turbine wheel will be.

Therefore, the maximum conversion is created at standing turbine wheel.
With increasing output speed, the torque conversion is decreasing. The adoption of the output speed to a certain required output moment is infinitely variable and automatically achieved by the torque converter.

If the turbine speed is reaching about 80% of the pump speed, the conversion becomes 1.0 i.e. the turbine moment becomes equal to that of the pump moment.
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, it is backing up in the conversion range the moment upon the housing, and is released in the coupling range.
In this way, the stator can rotate freely.

Function of a hydrodynamic torque converter (schematic view)



3-4(770-3)

2) CONVERTER LOCK-UP CLUTCH (5-speed transmission)

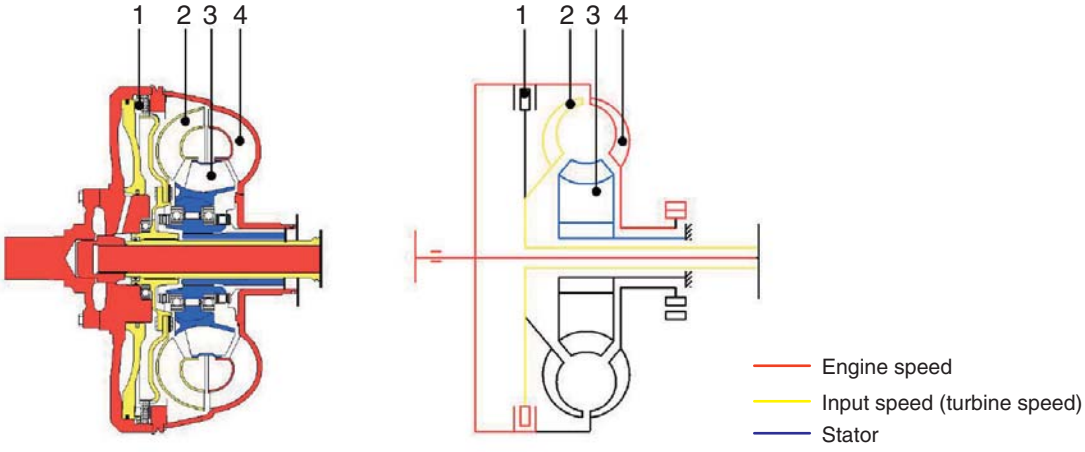


Figure A

7609A3PT22

1 Converter lock-up clutch
2 Turbine wheel
3 Stator
4 Circuit cover/pump wheel
5 Proportional valve
6 Measuring point "Lock-up clutch"
7 Cover
8 System pressure to lock-up clutch valve
9 System pressure from lock-up clutch valve to lock-up clutch

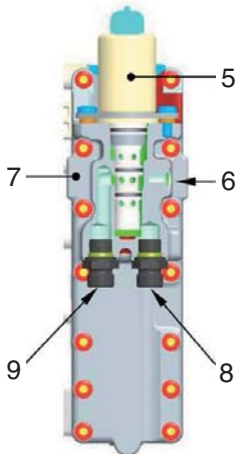


Figure B

7609A3PT23

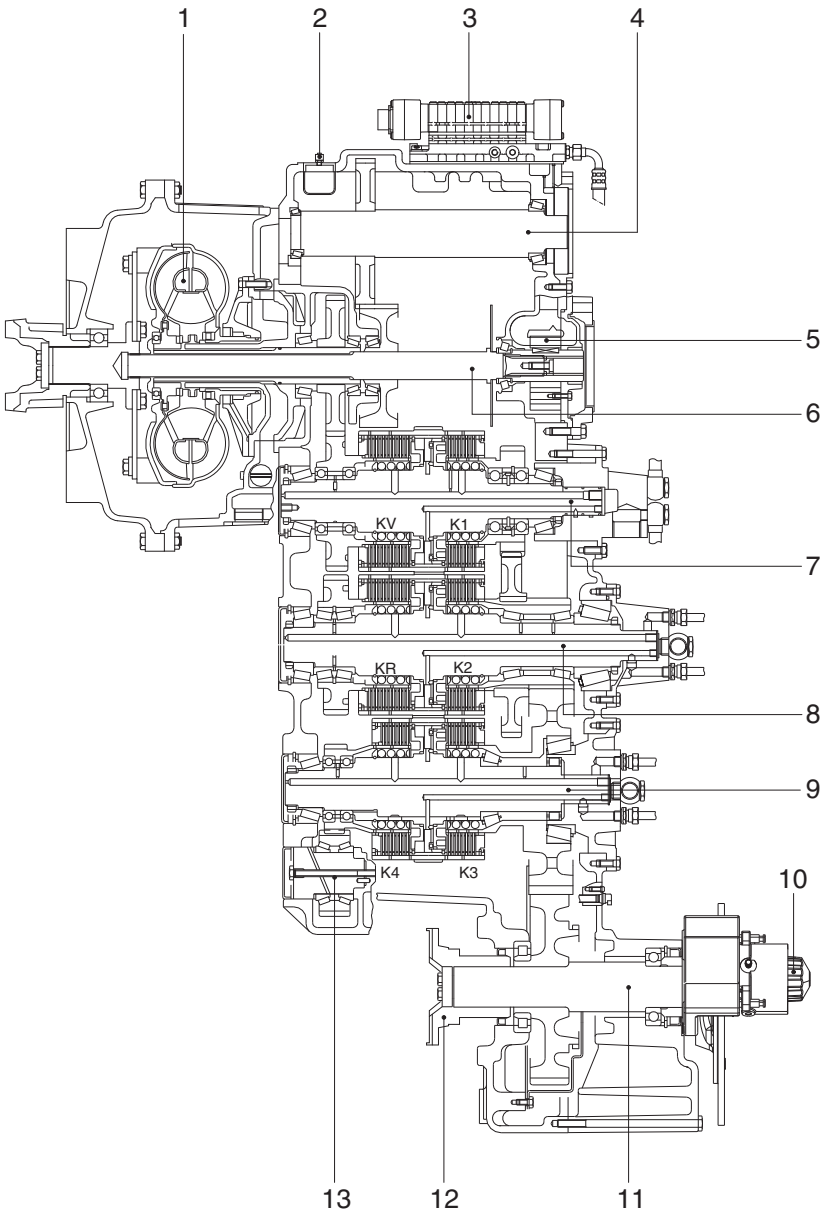
With closed converter lock-up clutch the slip between pump and turbine wheel and consequently the hydraulic loss in the converter is equal to "zero" (see figure A).

According to the turbine speed the converter lock-up clutch is shifted automatically.

Via a proportional valve the pilot pressure is applied to the actuating piston, which compresses the disc set (see figure B, lock-up clutch valve).

3. TRANSMISSION

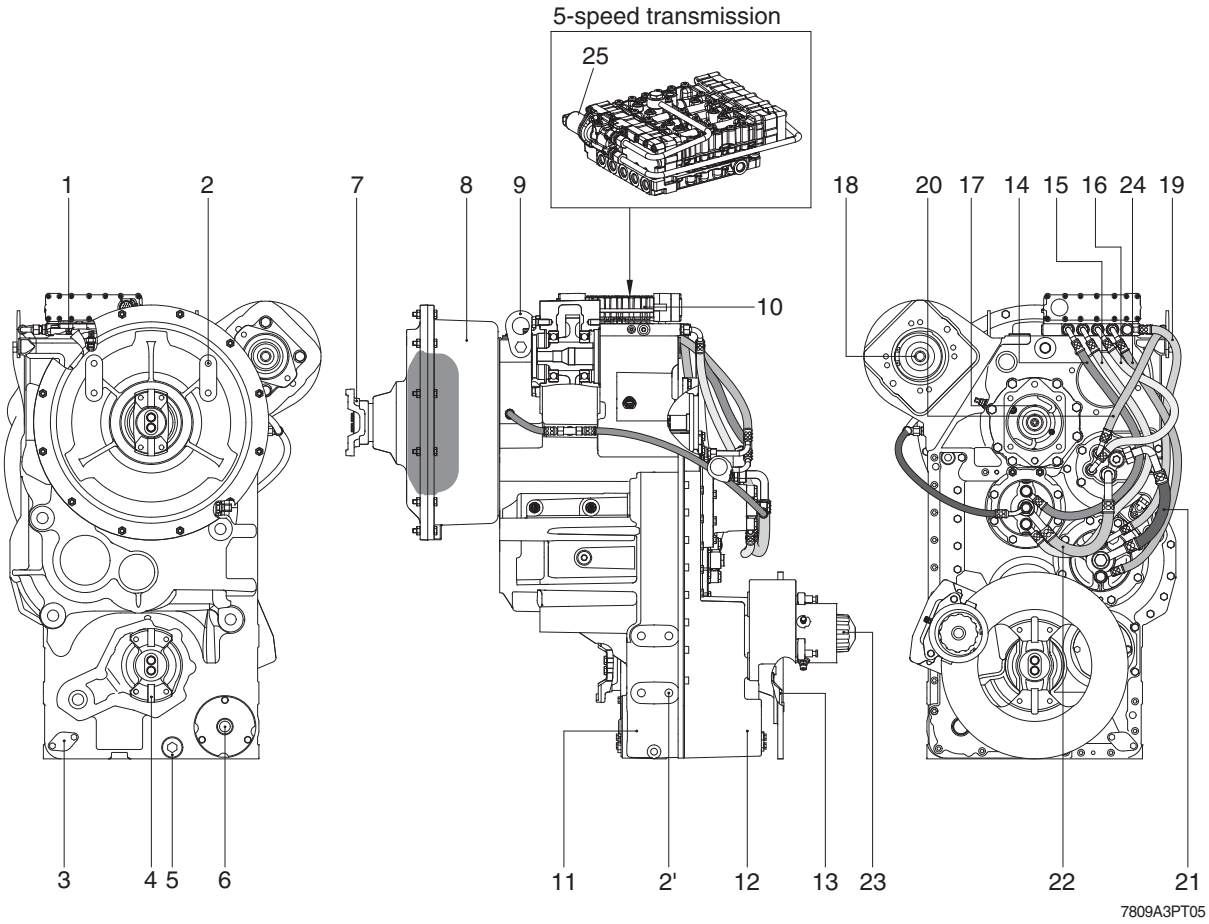
1) LAYOUT



78093PT03

1	Torque converter	8	Clutch axle-KR/K2
2	Breather	9	Clutch axle-K4/K3
3	Electro-hydraulic shift control	10	Parking brake
4	2nd power take off	11	Output shaft
5	Transmission pump	12	Output flange (converter side)
6	1st power take off	13	Countershaft
7	Clutch axle-KV/K1		

2) INSTALLATION VIEW



1 Breather
2 Transmission suspension M16
2' Transmission suspension M20
3 Attachment possibility for an oil filler tube with oil dipstick.
4 Output flange
5 Oil drain plug
6 Coarse filter
7 Input flange
8 Converter bell
9 Lifting lug
10 Electrohydraulic shift controller
11 Gearbox housing
12 Cover
13 Output flange
14 Pressure oil line clutch K2
15 Pressure oil line clutch KR
16 Pressure oil line clutch KV
17 1st power take off
18 2nd power take off
19 Pressure oil line clutch K3
20 Pressure oil line clutch K1
21 Lubricating oil line S2 clutch K4/K3
22 Lubricating oil line S1 clutch KR/K2
23 Parking brake
24 Pressure oil line clutch K4
25 Solenoid valve for converter lock-up clutch (5-speed transmission only)

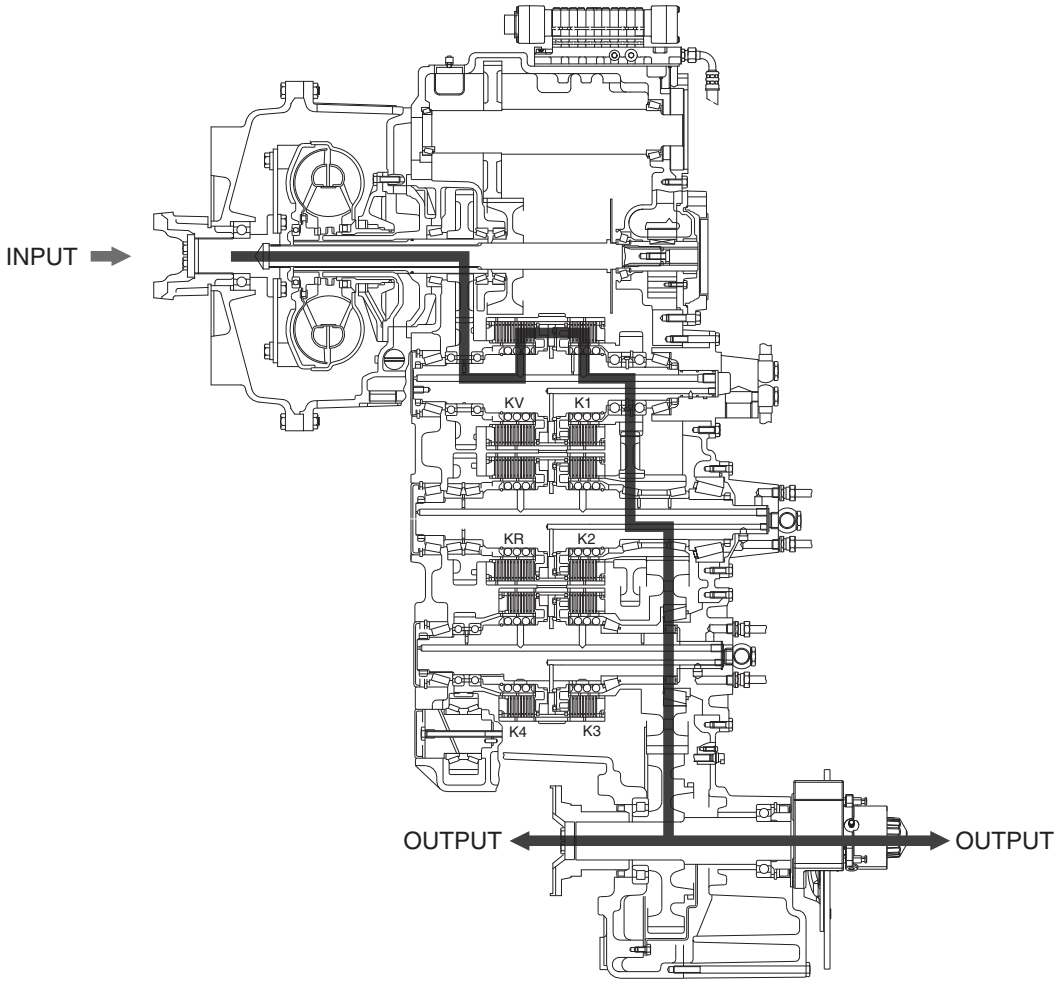
3) OPERATION OF TRANSMISSION (4-speed transmission)

(1) Forward

① Forward 1st

In 1st forward, forward clutch and 1st clutch are engaged.

Forward clutch and 1st clutch are actuated by the hydraulic pressure applied to the clutch piston.

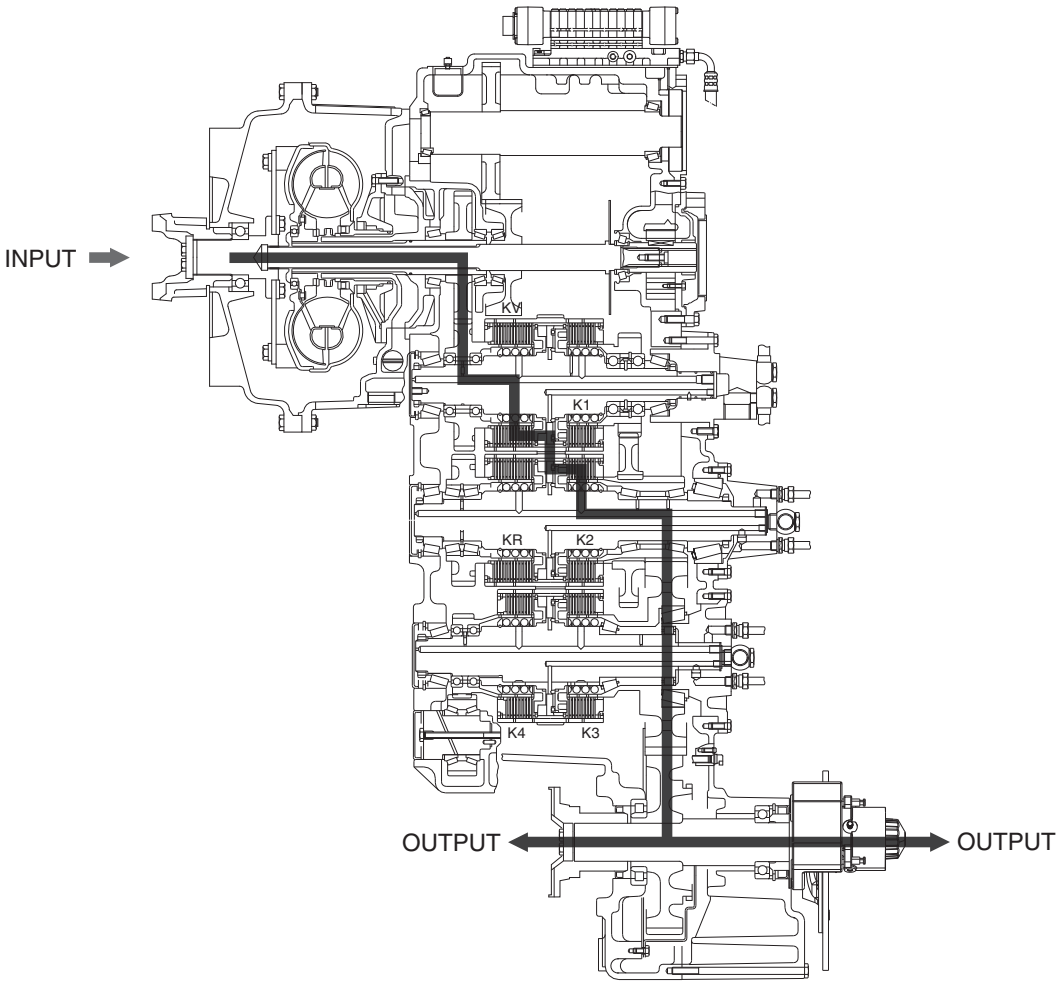


78093PT07

② Forward 2nd

In 2nd forward, forward clutch and 2nd clutch are engaged.

forward clutch and 2nd clutch are actuated by the hydraulic pressure applied to the clutch piston.

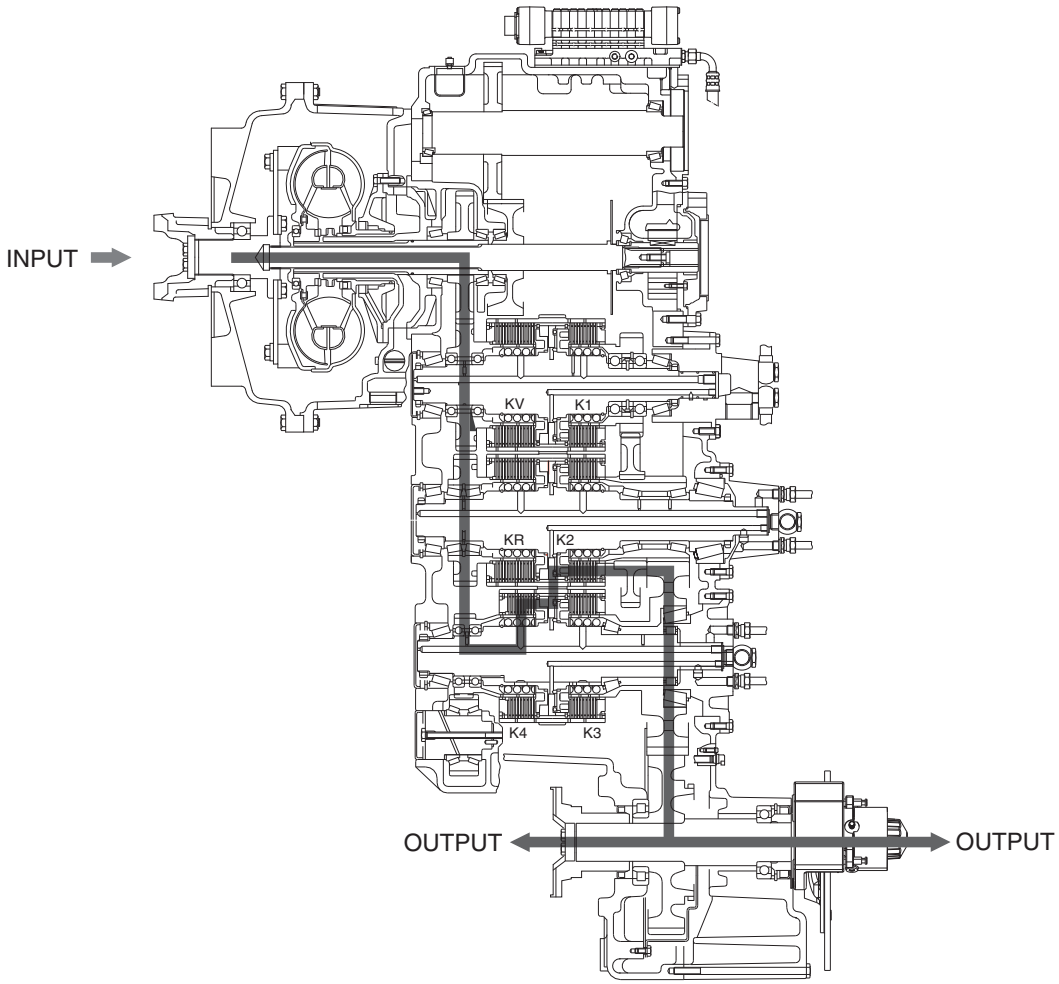


78093PT08

③ Forward 3rd

In 3th forward, 4th clutch and 2nd clutch are engaged.

4th clutch and 2nd clutch are actuated by the hydraulic pressure applied to the clutch piston.

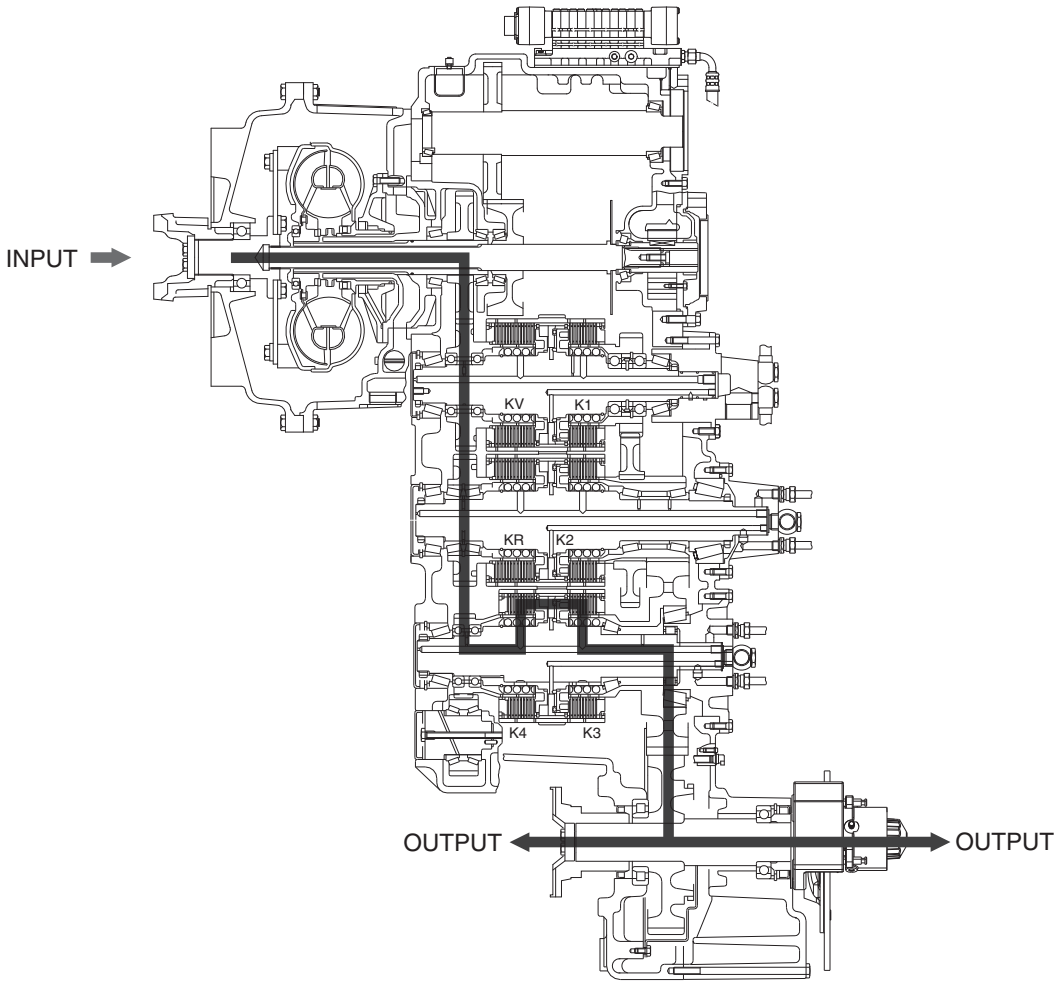


78093PT09-1

④ Forward 4th

In 4th forward, 4th clutch and 3rd clutch are engaged.

4th clutch and 3rd clutch are actuated by the hydraulic pressure applied to the clutch piston.



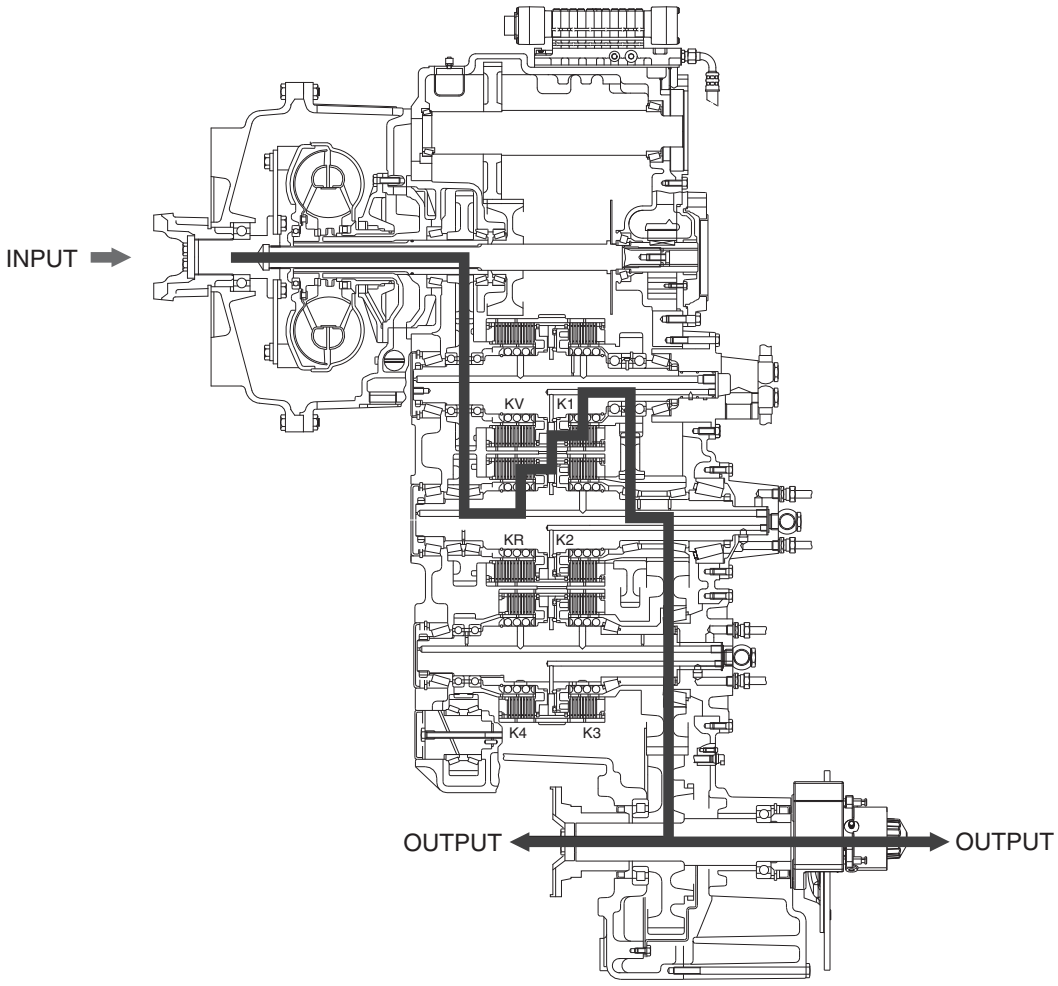
78093PT10

(2) Reverse

① Reverse 1st

In 1st reverse, reverse clutch and 1st clutch are engaged.

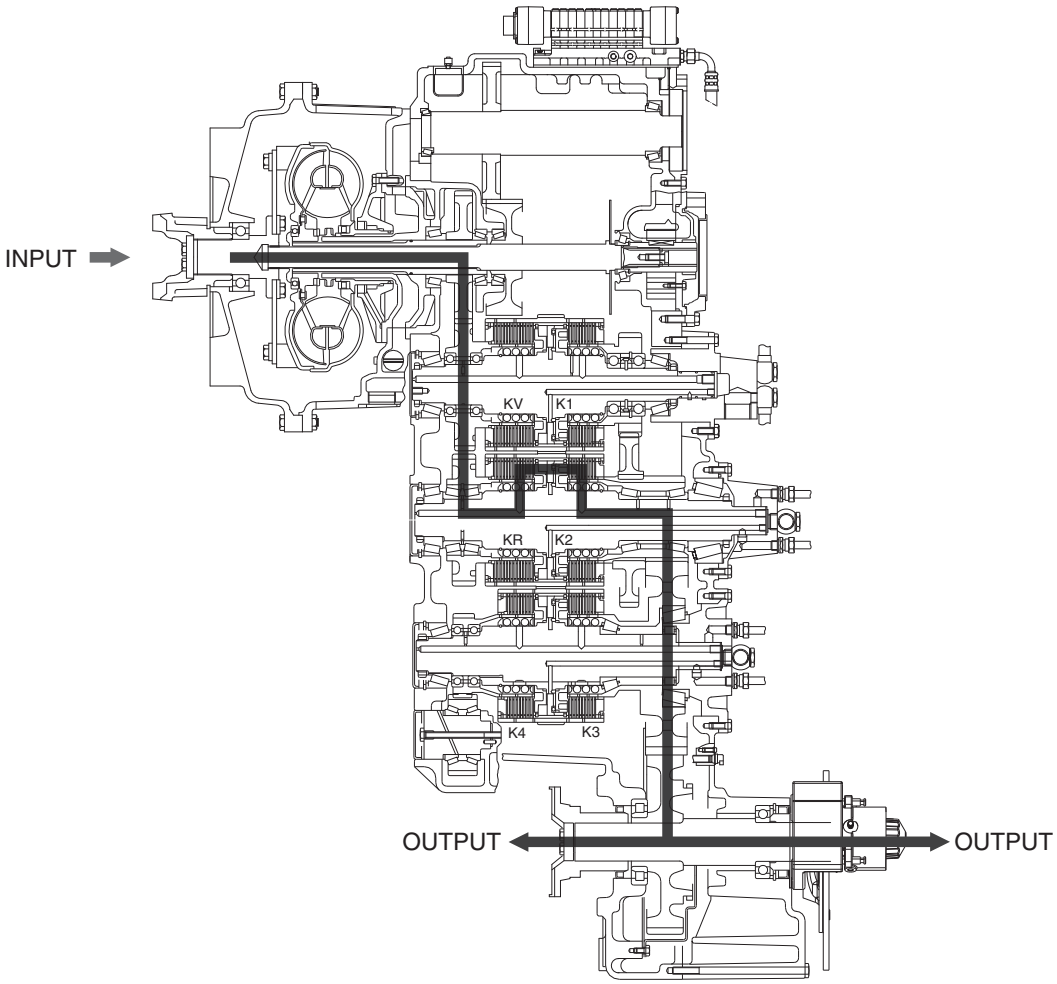
reverse clutch and 1st clutch are actuated by the hydraulic pressure applied to the clutch piston.



78093PT11

② Reverse 2nd

In 2nd reverse, reverse clutch and 2nd clutch are engaged.
reverse clutch and 2nd clutch are actuated by the hydraulic pressure applied to the clutch piston.

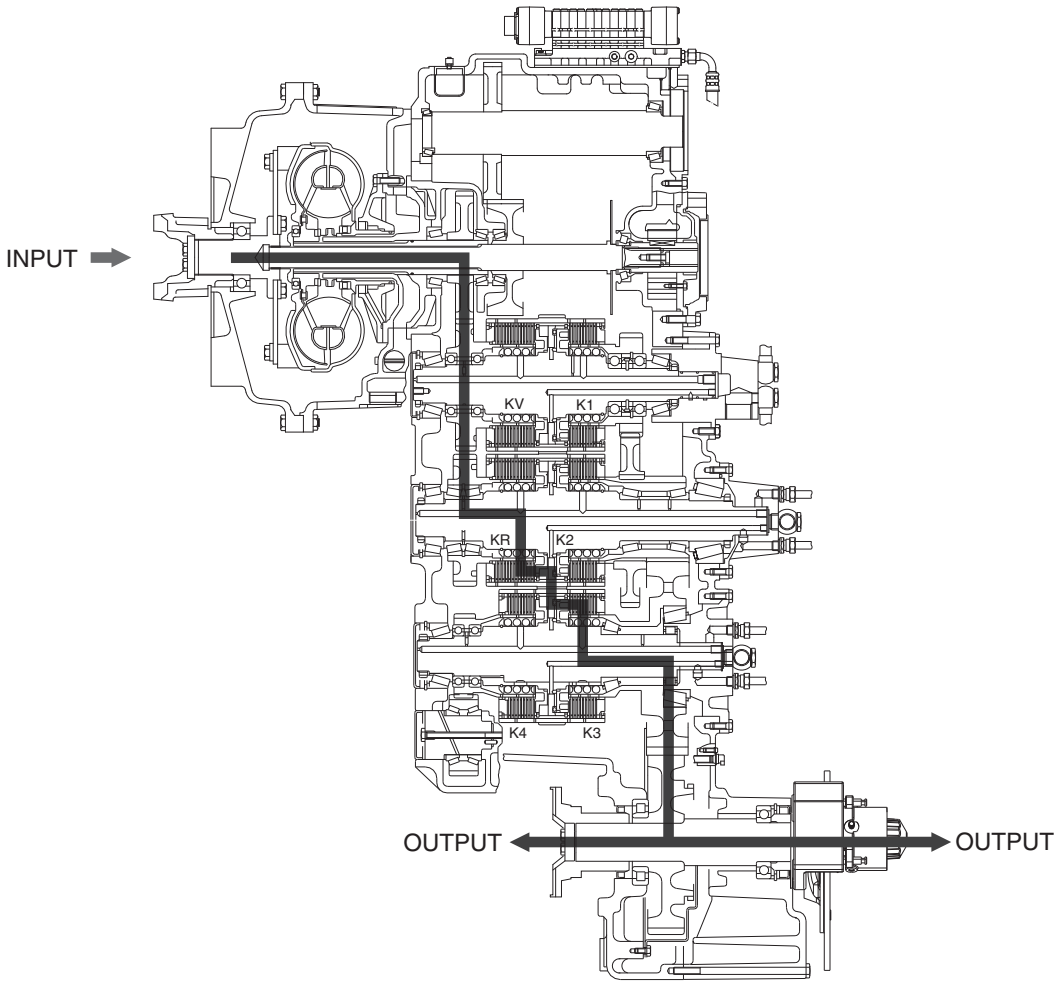


78093PT12

③ Reverse 3rd

In 3rd reverse, reverse clutch and 3rd clutch are engaged.

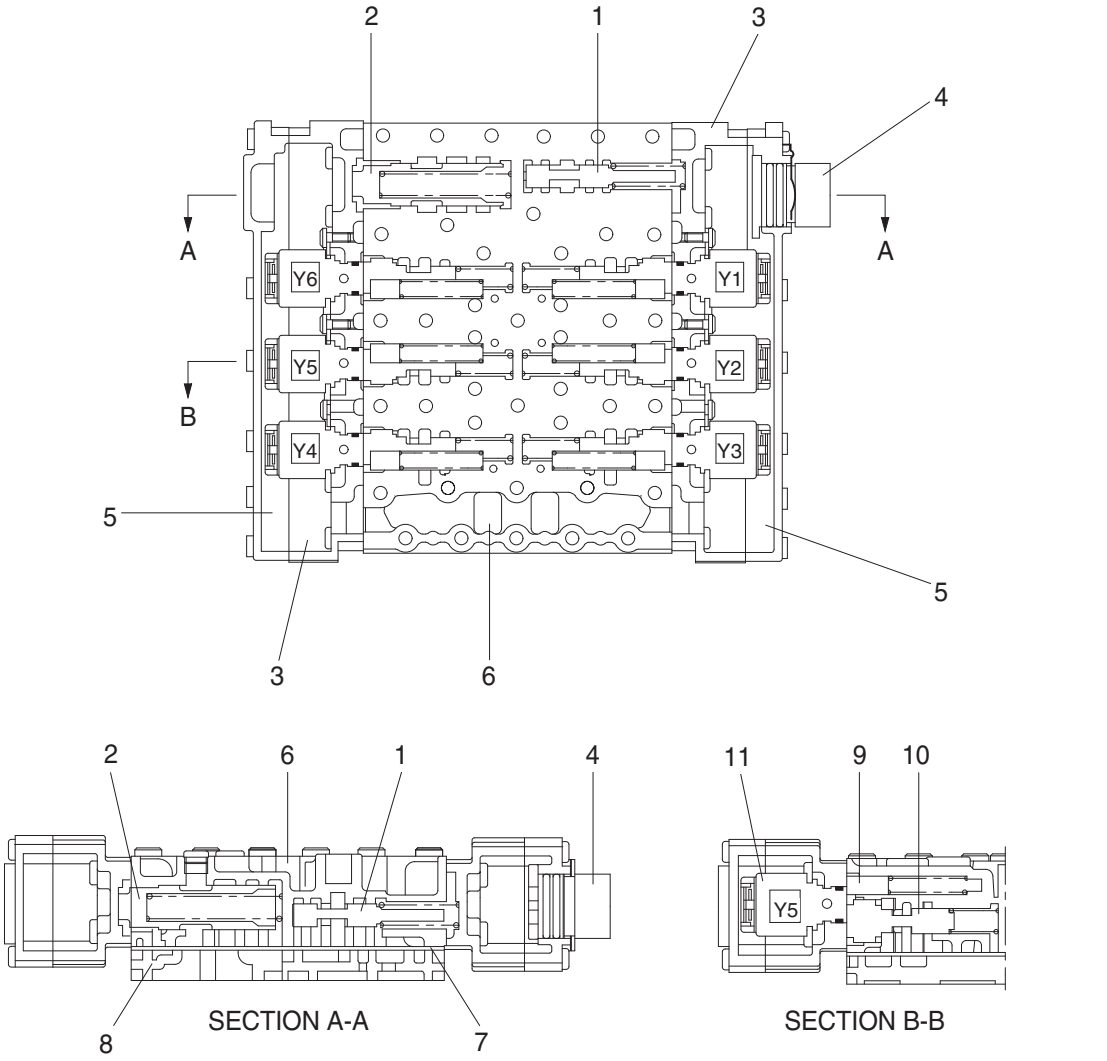
reverse clutch and 3rd clutch are actuated by the hydraulic pressure applied to the clutch piston.



78093PT13

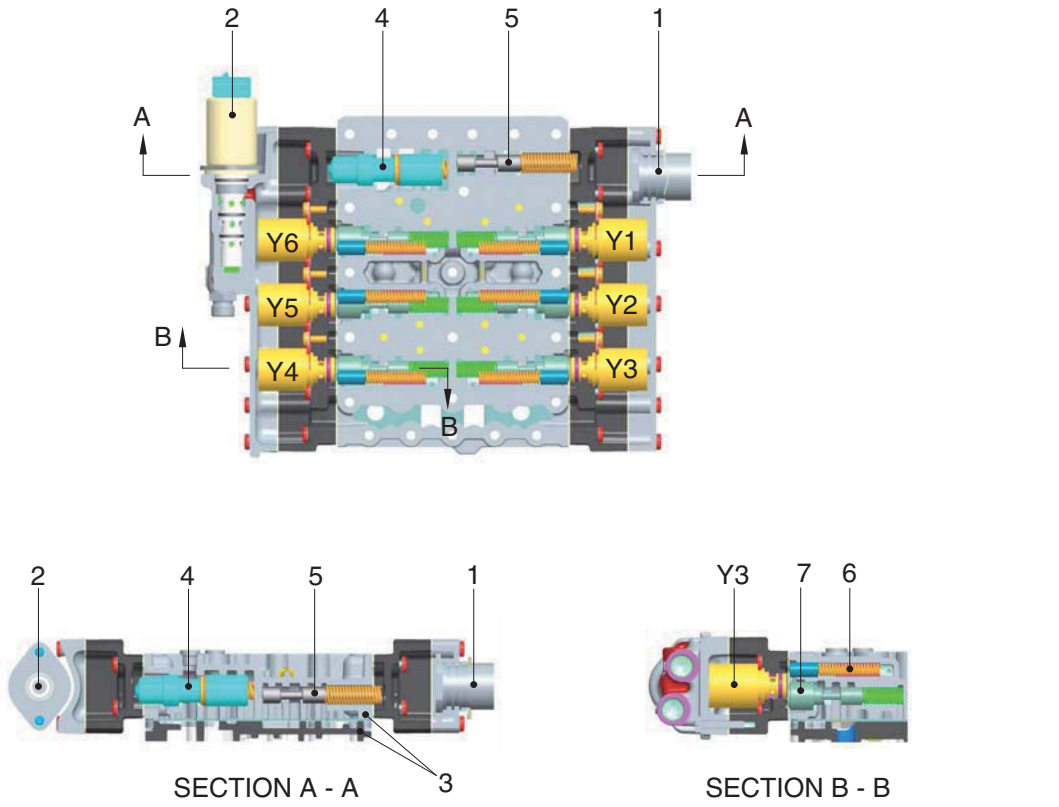
4) ELECTRO-HYDRAULIC SHIFT CONTROL WITH PROPORTIONAL VALVE

(1) 4-speed transmission



1	Pressure reducing valve (9+0.5 bar)	7	Intermediate sheet
2	System pressure valve (16+2 bar)	8	Duct plate
3	Housing	9	Oscillation damper
4	Cable harness	10	Follow-on slide
5	Cover	11	Pressure regulator
6	Valve block		

(2) 5-speed transmission



1	Cable harness	5	Pressure reducing valve (9+0.5 bar)
2	Proportional valve	6	Vibration damper
3	Intermediate plate/duct plate	7	Follow-on slide
4	System pressure valve (16+2 bar)	Y1~Y6	Proportional valve

Transmission control, see schedule of hydraulic circuit, electro-hydraulic control unit and measuring points at page 3-2, 3-16, 3-17 and 3-98.

The six clutches of the transmission are selected via the 6 proportional valves P1 to P6. The proportional valve (pressure regulator unit) is composed of pressure regulator (e.g. Y1), follow-on slide and vibration damper.

The control pressure of 9 bar for the actuation of the follow-on slides is created by the pressure reducing valve. The pressure oil (16+2 bar) is directed via the follow-on slide to the respective clutch.

Due to the direct proportional selection with separated pressure modulation for each clutch, the pressures to the clutches, which are engaged in the gear change, will be controlled. In this way, a hydraulic intersection of the clutches to be engaged and disengaged becomes possible.

This is creating spontaneous shiftings without traction force interruption.

At the shifting, the following criteria are considered:
- Speed of engine, turbine, central gear train and output.
- Transmission temperature.
- Shifting mode (Up-, down-, reverse shifting and speed engagement out of neutral).
- Load condition (full and part load, traction, overrun inclusive consideration of load cycles during the shifting).

The main pressure valve is limiting the maximum control pressure to 16+2 bar and releases the main stream to the converter and lubricating circuit.
In the inlet to the converter, a converter safety valve is installed which protects the converter from high internal pressures (opening pressure 11+2 bar).
Within the converter, the oil serves to transmit the power according to the well-known hydrodynamic principle (see torque converter, page 3-3).
To avoid cavitation, the converter must be always completely filled with oil.
This is achieved by a converter back pressure back-up valve, rear-mounted to the converter, with an opening pressure of at least 4.3bar.
The oil, escaping out of the converter, is directed to a oil cooler.

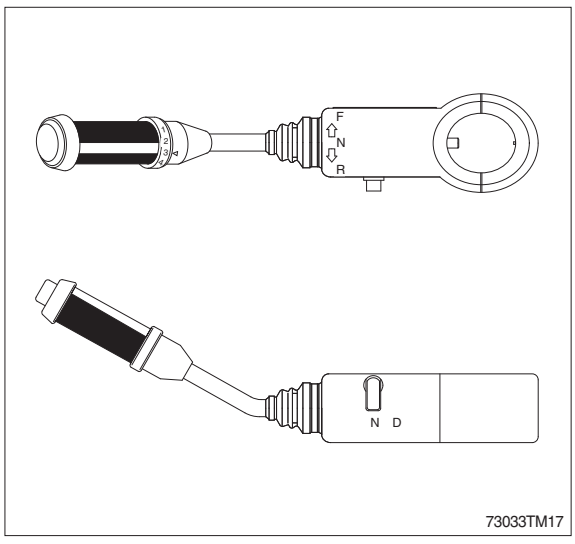
The oil is directed from the oil cooler to the transmission and from there to the lubricating oil circuit, so that all lubricating points are supplied with cooled oil.

In the electro-hydraulic control unit are 6 pressure regulators installed.

5) GEAR SELECTOR (DW-3)

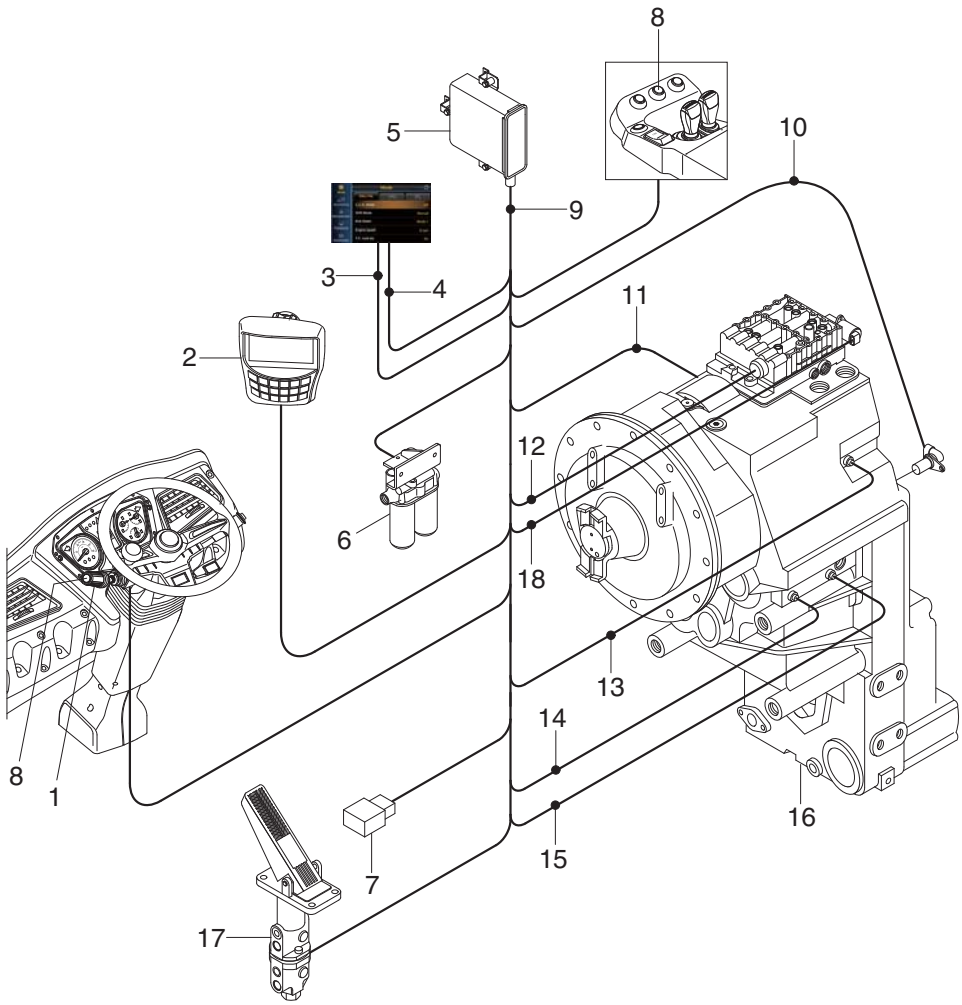
The gear selector is designed for the mounting on the left side of the steering column. The positions (speeds) 1 to 4 are selected by a rotary motion, the driving direction Forward (F)-Neutral (N)-Reverse (R) by tilting the gear selector lever.
The gear selector is also available with integrated kickdown push button.

For the protection from unintended start off, a neutral interlock is installed.
Position N - Gear selector lever blocked in this position.
Position D - Driving.



6) ELECTRIC CONTROL UNIT

(1) Complete system



9803PT23

1 Gear selector (DW-3)
2 Monitor
3 Clutch cut off mode switch
4 Transmission shift mode switch
5 Control unit (EST-37)
6 Filter
7 Power supply connection
8 Kickdown switch
9 Wiring
10 Cable to speed sensor output and speedometer
11 Cable to temperature measuring point behind the converter
12 Cable to plug connection on the electrohydraulic control unit
13 Cable to inductive transmitter speed engine
14 Cable to inductive transmitter speed turbine
15 Cable to inductive transmitter speed central gear train
16 Transmission
17 Brake pressure sensor / Load sensor
18 Cable to lock-up clutch valve (5-speed transmission)

(2) Description of the basic functions

The powershift transmission will be equipped with the electronic transmission control unit (EST-37), developed for it.

The system is processing the desire of the driver according to the following criteria.

· Protection from operating errors as far as necessary, is possible via electronic protection (programming).
· Protection from over-speeds (On the basis of engine and turbine speed).
· Automatic reversing (Driving speed-dependent).
· Pressure cut-off possible (Disconnecting of the drive train for maximum power on the power take-off).
· Change-over possibility for Auto-/Manual mode.
· Kick down functions possible.

(3) Driving and shifting

- Neutral position :

  Neutral position will be selected via the controller.
  After the ignition is switched on, the electronics remains in the waiting state. By the position NEUTRAL of the controller, resp. by pressing the pushbutton NEUTRAL, the EST-37A becomes ready for operation.
  Now, a gear can be engaged.

- Starting :

  The starting of the engine has always to be carried out in the NEUTRAL POSITION of the controller.
  For safety reasons it is to recommend to brake the machine securely in position with the parking brake prior to start the engine.
  After the starting of the engine and the preselection of the driving direction and the gear, the machine can be set in motion by acceleration.

  At the start off, the converter takes over the function of a master clutch.
  On a level road it is possible to start off also in higher gears.

- Upshifting under load

  Upshifting under load will be then realized if the machine can still accelerate by it.

- Downshifting under load

  Downshifting under load will be realized if more traction force is needed.

- Upshifting in overrunning condition

  In the overrunning mode, the upshifting will be suppressed by accelerator pedal idling position, if the speed of the machine on a downgrade should not be further increased.

- Downshifting in overrunning condition

  Downshiftings in overrunning mode will be then carried out if the machine should be retarded.

  If the machine will be stopped and is standing with running engine and engaged transmission, the engine cannot be stalled. On a level and horizontal roadway it is possible that the machine begins to crawl, because the engine is creating at idling speed a slight drag torque via the converter.
  It is convenient to brake the machine at every stop securely in position with the parking brake.
  At longer stops, the controller has to be shifted to the NEUTRAL POSITION.

  At the start off, the parking brake has to be released. We know from experience that at a converter transmission it might not immediately be noted to have forgotten this quite normal operating step because a converter, due to its high ratio, can easily overcome the braking torque of the parking brake.

Temperature increases in the converter oil as well as overheated brakes will be the consequences to be find out later.
Neutral position of the selector switch at higher machine speeds (above stepping speed) is not admissible.
Either a suitable gear is to be shifted immediately, or the machine must be stopped at once.

(4) Independent calibration of the shifting elements (AEB)

The AEB has the task to compensate tolerances (plate clearance and pressure level) which are influencing the filling procedure of the clutches. For each clutch, the correct filling parameters are determined in one test cycle for :

- Period of the quick-filling time
- Level of the filling compensating pressure

The filling parameters are stored, together with the AEB-program and the driving program in the transmission electronics. Because the electronics will be separately supplied, the AEB-cycle must be started only after the installation of both components in the machine, thus ensuring the correct mating (Transmission and electronics).

※ It is imperative, to respect the following test conditions :
- Shifting position neutral
- Engine in idling speed
- Parking brake actuated
- Transmission in operating temperature

※ After a replacement of the transmission, the electrohydraulic control or the TCU in the machine, the AEB-cycle must be as well carried out again.

The AEB-cylcle continues for about 3 to 4 minutes. The determined filling parameters are stored in the EEProm of the electronics. In this way, the error message F6 shown on the display will be cancelled also at non-performed AEB.

(5) Pressure cut-off

In order to provide the full engine power for the hydraulic system, the control can be enlarged for the function of a pressure cut-off in the 1st and 2nd speed. In this way, the pressure in the powershift clutches will be cut-off, and the torque transmission in the drive train will be eliminated by it. This function will be released at the actuation of a switch, arranged on the brake pedal.
For a soft restart, the pressure will be build-up via a freely programmable characteristic line.

4. FAULT CODE

1-1) MACHINE FAULT CODE

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

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

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

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

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

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

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

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

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

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	Name	Description
12D1 46 1	Pnuematic supply pressure	Low air pressure signal from APS
12D4 46 19	Pnuematic supply pressure	CAN message timeout from APS
2123 51 3	Engine throttle valve position	Throttle Position Sensor 1, short circuit to +24
2122 51 4	Engine throttle valve position	Throttle Position Sensor 1, short circuit to ground
2121 51 7	Engine throttle valve position	Throttle Position Sensor, not plausible
1091 51 8	Engine throttle valve position	Endpoints of throttle position sensor are out of range
2138 51 9	Engine throttle valve position	Throttle Position Sensor, correlation error
16C9 91 2	Accelerator pedal position	Auxiliary accelerator pedal is used due to other fault
16C8 91 9	Accelerator pedal position	Accelerator pedal faulty or error via can
D415 91 10	Accelerator pedal position	Accelerator pedal not plausible, faulty
D414 91 19	Accelerator pedal position	Accelerator pedal value out of range via CAN
1100 94 0	Engine fuel deliver pressure	Accumulator pressure is too high
250A 98 2	Engine oil level	Oil level sensor, faulty
250D 98 3	Engine oil level	Oil level sensor, short circuit to +24V
250C 98 4	Engine oil level	Oil level sensor, short circuit to ground
1715 98 10	Engine oil level	Oil level sensor stuck

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Name	Description
0524 100 1	Engine oil pressure	Oil pressure sensor, pressure too low
0521 100 2	Engine oil pressure	Oil pressure sensor, faulty
0523 100 3	Engine oil pressure	Oil pressure sensor, short circuit to +24V
0522 100 4	Engine oil pressure	Oil pressure sensor, short circuit to ground
1522 100 13	Engine oil pressure	Oil pressure sensor, pressure not plausible
1520 100 16	Engine oil pressure	Oil pressure sensor, pressure above normal
134F 100 17	Engine oil pressure	Oil pressure sensor, pressure too low and engine protective action
1521 100 18	Engine oil pressure	Oil pressure sensor, pressure below normal
0234 102 0	Engine intake manifold pressure	Boost pressure higher than reference
0299 102 1	Engine intake manifold pressure	Boost pressure lower than reference
0108 102 3	Engine intake manifold pressure	Boost pressure sensor, short circuit to +24V
0107 102 4	Engine intake manifold pressure	Boost pressure sensor, short circuit to ground
2262 102 7	Engine intake manifold pressure	Boost pressure, too low
1081 102 8	Engine intake manifold pressure	Boost pressure sensor, faulty
107C 102 9	Engine intake manifold pressure	Boost pressure, not plausible
006C 102 10	Engine intake manifold pressure	Boost pressure sensor, faulty

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Name	Description
006B 102 15	Engine intake manifold pressure	Boost pressure sensor and exhaust pressure sensor do not correlate
1234 102 16	Engine intake manifold pressure	Boost pressure above normal
1299 102 18	Engine intake manifold pressure	Boost pressure, lower than reference at part load
1066 102 20	Engine intake manifold pressure	Boost pressure, too high not plausible
1067 102 21	Engine intake manifold pressure	Boost pressure, too low not plausible
1683 103 0	Engine turbocharger speed	Turbine excessive overspeed
2579 103 2	Engine turbocharger speed	Turbine speed sensor, faulty
2581 103 3	Engine turbocharger speed	Turbine speed sensor, short circuit to +24V
2580 103 4	Engine turbocharger speed	Turbine speed sensor, short circuit to ground
2578 103 5	Engine turbocharger speed	Turbine speed sensor, open load
150B 103 9	Engine turbocharger speed	Turbine speed not plausible
1506 103 20	Engine turbocharger speed	Turbine speed sensor above model, not plausible
1504 103 21	Engine turbocharger speed	Turbine speed sensor below model, not plausible
16EA 105 0	Engine intake manifold temperature	Boost temp sensor excessive high
16EB 105 1	Engine intake manifold temperature	Boost temp sensor excessive low
0096 105 2	Engine intake manifold temperature	Boost temp sensor, faulty

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Name	Description
0098 105 3	Engine intake manifold temperature	Boost temp sensor, short circuit to +24V
0097 105 4	Engine intake manifold temperature	Boost temp sensor, short circuit to ground
16EE 105 9	Engine intake manifold temperature	Boost temperature above ambient, not plausible
16F3 105 15	Engine intake manifold temperature	Boost temperature to high for longer period
16C3 105 16	Engine intake manifold temperature	Boost temperature above normal
16EF 105 17	Engine intake manifold temperature	Boost temperature below ambient, not plausible
16F0 105 20	Engine intake manifold temperature	Boost temperature to high, not plausible
16F1 105 21	Engine intake manifold temperature	Boost temperature to low, not plausible
1422 107 1	Engine air filter pressure	Air filter clogged
1423 107 2	Engine air filter pressure	Air filter control switch broken
2226 108 2	Barometric pressure	Ambient Pressure Sensor Error via CAN
16DB 108 3	Barometric pressure	Ambient Pressure Sensor, short circuit to +24V
16DA 108 4	Barometric pressure	Ambient Pressure Sensor, short circuit to ground
106C 108 15	Barometric pressure	Ambient Pressure Sensor and Exhaust Pressure Sensor do not correlate
006D 108 16	Barometric pressure	Ambient Pressure above normal
1064 108 20	Barometric pressure	Ambient Pressure too high, not plausible

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Name	Description
1065 108 21	Barometric pressure	Ambient Pressure too low, not plausible
1133 110 0	Engine coolant temperature	Engine temperature, excessive high
1128 110 1	Engine coolant temperature	Engine temperature too low
1136 110 2	Engine coolant temperature	Engine temp sensor fault
0118 110 3	Engine coolant temperature	Engine temp sensor, short circuit to +24V
0117 110 4	Engine coolant temperature	Engine temp sensor, short circuit to ground
0115 110 8	Engine coolant temperature	Engine temp sensor, stuck
0116 110 9	Engine coolant temperature	Engine temp sensor, faulty
1135 110 10	Engine coolant temperature	Engine temperature is not plausble
1132 110 16	Engine coolant temperature	Engine temperature, too high
1130 110 17	Engine coolant temperature	Engine temp sensor, temp below normal or VGT-temp above normal
1131 110 18	Engine coolant temperature	Engine temp sensor, temp above normal or VGT-temp below normal
0217 110 20	Engine coolant temperature	Engine Coolant Water Temperature Too High
0128 110 21	Engine coolant temperature	Coolant Temperature Below Thermostat Regulating Temperature
2560 111 1	Engine coolant level	Coolant level too low
2556 111 3	Engine coolant level	Coolant level sensor, short circuit to +24

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Name	Description
2558 111 4	Engine coolant level	Coolant level sensor, short circuit to ground
107D 131 2	Engine exhaust back pressure	Exhaust pressure sensor, not plausible
0473 131 3	Engine exhaust back pressure	Exhaust pressure sensor, short circuit to +24V
0472 131 4	Engine exhaust back pressure	Exhaust pressure sensor, short circuit to ground or open load
106B 131 7	Engine exhaust back pressure	Exhaust pressure sensor and boost pressure sensor do not correlate
1078 131 8	Engine exhaust back pressure	Exhaust pressure sensor, faulty
16CC 131 9	Engine exhaust back pressure	Exhaust pressure sensor, stuck
106D 131 10	Engine exhaust back pressure	Exhaust pressure sensor and ambient pressure sensor do not correlate
1414 131 15	Engine exhaust back pressure	Exhaust pressure, high exhaust pressure during normal fueling
1413 131 16	Engine exhaust back pressure	Exhaust pressure, high exhaust pressure during motoring, no fueling
1415 131 18	Engine exhaust back pressure	Exhaust pressure, low exhaust pressure during exhaust brake
1068 131 20	Engine exhaust back pressure	Exhaust pressure too high, not plausible
106A 131 21	Engine exhaust back pressure	Exhaust pressure too low, not plausible
0103 132 0	Engine intake air mass flow rate	Mass flow sensor, short circuit to +24V
0102 132 1	Engine intake air mass flow rate	Mass flow sensor, short circuit to ground or open load
0101 132 2	Engine intake air mass flow rate	Mass flow sensor, faulty

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Name	Description
1187 132 3	Engine intake air mass flow rate	Mass flow sensor, supply
1189 132 4	Engine intake air mass flow rate	Mass flow sensor, adaptation under low threshold
1188 132 5	Engine intake air mass flow rate	Mass flow sensor, adaptation over high threshold
0100 132 7	Engine intake air mass flow rate	Mass flow sensor, stuck
0088 156 0	Engine injector timing rail pressure	Fuel rail pressure is excessively above command
0087 156 1	Engine injector timing rail pressure	Fuel rail pressure is excessively below command
0191 156 2	Engine injector timing rail pressure	Fuel rail pressure sensor, faulty
0193 156 3	Engine injector timing rail pressure	Fuel rail pressure sensor, short circuit to +24V or open load
0192 156 4	Engine injector timing rail pressure	Fuel rail pressure sensor, short circuit to ground
0190 156 8	Engine injector timing rail pressure	Fuel rail pressure sensor, stuck
1090 156 9	Engine injector timing rail pressure	Fuel rail pressure is lagging
1087 156 18	Engine injector timing rail pressure	Fuel rail pressure is too low during cranking
1060 167 2	Charging system potential	Alternator actuator, faulty
1063 167 3	Charging system potential	Alternator actuator, short circuit to +24V
1062 167 4	Charging system potential	Alternator actuator, short circuit to ground
1061 167 5	Charging system potential	Alternator actuator, open load

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Name	Description
063A 167 9	Charging system potential	Alternator 1, signal not plausible
160B 167 10	Charging system potential	Alternator 2, signal not plausible
1565 168 0	Battery potential	Battery voltage above 47 V for 1 s
1564 168 1	Battery potential	Battery voltage below 9 V for 0.5 s
1507 168 4	Battery potential	Battery voltage 1 for engine control unit is low
1509 168 5	Battery potential	Battery voltage 2 for engine control unit is low
2064 168 15	Battery potential	Battery voltage too high for SCR main unit
0563 168 16	Battery potential	Battery voltage above 32 V
2063 168 17	Battery potential	Battery voltage too low for SCR main unit
0562 168 18	Battery potential	Battery voltage below 21 V
1074 171 0	Ambient air temperature	Ambient temperature sensors correlation error
1271 171 1	Ambient air temperature	Ambient temperature low or boost temperature high
11B0 171 2	Ambient air temperature	Ambient temperature sensor, faulty
1073 171 3	Ambient air temperature	Ambient temperature sensor error via CAN
1075 171 4	Ambient air temperature	Ambient temperature sensor error via CAN
1077 171 7	Ambient air temperature	Ambient temperature sensor stuck

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Name	Description
D104 171 9	Ambient air temperature	CAN message AMBIENT CONDITION from coordinator timeout
1076 171 15	Ambient air temperature	Ambient temperature sensors correlation error
1270 171 16	Ambient air temperature	Ambient temperature high or boost temperature low
1071 171 17	Ambient air temperature	Ambient temperature sensors correlation error
1072 171 18	Ambient air temperature	Ambient temperature sensors correlation error
1070 171 19	Ambient air temperature	Ambient temperature sensor signal defect
0070 171 20	Ambient air temperature	Temperature sensor before compressor low or ambient temperature sensor high
0071 171 21	Ambient air temperature	Temperature sensor before compressor high or ambient temperature sensor low
0111 172 2	Engine air intake temperature	Air inlet temp sensor, faulty
0113 172 3	Engine air intake temperature	Air inlet temp sensor, short circuit to +24V
0112 172 4	Engine air intake temperature	Air inlet temp sensor, short circuit to ground
0114 172 7	Engine air intake temperature	Air inlet temp sensor, stuck
0198 175 3	Engine oil temperature	Oil temp sensor, short circuit to +24V
0197 175 4	Engine oil temperature	Oil temp sensor, short circuit to ground
0195 175 11	Engine oil temperature	Oil temp sensor, faulty
16C2 188 14	Engine speed at idle	Idle due to other fault

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Name	Description
1205 190 0	Engine speed	Severe overspeed has occured
1201 190 10	Engine speed	Overspeed protection, fast over speed
1321 190 15	Engine speed	Engine speed has been above the limit
1202 190 16	Engine speed	Overspeed protection, over speed
0219 190 20	Engine speed	Engine overspeed, value to high
C10F 234 2	Software identification	The EMS and EEC control units are incompatible
D10B 234 19	Software identification	Wrong CAN version transmitted by COO
16C1 532 14	Engine speed at high idle	Increased idle due to other fault
D109 558 2	Accelerator pedal - low idle switch	Low idle switch error state from coordinator
D107 559 2	Accelerator pedal kickdown switch	Kickdown signal defect via CAN
1550 559 9	Accelerator pedal kickdown switch	Accelerator pedal kickdown CAN message, faulty
D418 559 10	Accelerator pedal kickdown switch	Accelerator pedal/kick down switch, EMS and coordinator do not agree
D105 597 2	Brake switch	Brake pedal signal defect via CAN
D106 598 2	Clutch switch	Clutch pedal signal defect via CAN
0811 598 7	Clutch switch	Excessive clutch slip
D10D 598 19	Clutch switch	CAN-signal or engine shut-down command from OPC for automatic clutch failure, timeout

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Name	Description
1214 636 1	Engine position sensor	Camshaft position sensor, faulty
0344 636 2	Engine position sensor	Camshaft position sensor, intermittent fault
0343 636 3	Engine position sensor	Camshaft position sensor, short circuit to +24V
0342 636 4	Engine position sensor	Camshaft position sensor, short circuit to ground
0340 636 5	Engine position sensor	Camshaft position sensor, open circuit
0016 636 7	Engine position sensor	Engine speed detected by flywheel sensor, but no signal from camshaft sensor
0341 636 8	Engine position sensor	Camshaft Pulse Pattern, Gap or Sync Error or other fault
16E7 641 2	Engine turbocharger actuator	VGT internal temperature sensor stuck
1686 641 4	Engine turbocharger actuator	VGT voltage supply open load
16B5 641 5	Engine turbocharger actuator	VGT internal temperature sensor open circuit
168B 641 7	Engine turbocharger actuator	VGT motion limited or restricted
168E 641 8	Engine turbocharger actuator	VGT reference or position not found
1134 641 9	Engine turbocharger actuator	VGT temperature sensor value not plausible
168C 641 10	Engine turbocharger actuator	VGT motion error, span too large
1689 641 11	Engine turbocharger actuator	VGT actuator faulty
1693 641 12	Engine turbocharger actuator	VGT internal fault

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Name	Description
16DF 641 13	Engine turbocharger actuator	VGT actuator installation procedure was not completed
1685 641 15	Engine turbocharger actuator	VGT error
1684 641 16	Engine turbocharger actuator	VGT temperature too high
1690 641 19	Engine turbocharger actuator	VGT timeout on CAN
D101 645 19	Engine tachometer	CAN message TCO1 from tachograph timeout
11A1 651 1	Engine injector cylinder 1	Two or more injectors with the same trim code, injector cyl. 1
1178 651 2	Engine injector cylinder 1	Injector trim code, checksum error injector cyl. 1
0261 651 4	Engine injector cylinder 1	Injector 1 cable short circuit to ground
0201 651 5	Engine injector cylinder 1	Injector cyl. 1 cable/injector open load
115F 651 6	Engine injector cylinder 1	Injector cyl. 1 cable/injector short circuit
1150 651 7	Engine injector cylinder 1	Injection error, physical cylinder 1
118F 651 8	Engine injector cylinder 1	Injector cyl. 1, over or under fueling
12C0 651 10	Engine injector cylinder 1	Fault with sensors/actuators for the particulate filter
1199 651 13	Engine injector cylinder 1	Injector trim code version error, injector cyl. 1
11E0 651 15	Engine injector cylinder 1	Cylinder 1 torque error
11D0 651 16	Engine injector cylinder 1	Cylinder 1 injector fault, high torque

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Name	Description
11D8 651 18	Engine injector cylinder 1	Cylinder 1 injector fault, low torque
0263 651 20	Engine injector cylinder 1	Cylinder 1 balancing min or max
11E8 651 21	Engine injector cylinder 1	Cylinder balancing, not plausible
11A2 652 1	Engine injector cylinder 2	Two or more injectors with the same trim code, injector cyl. 2
1179 652 2	Engine injector cylinder 2	Injector trim code, checksum error injector cyl. 2
0264 652 4	Engine injector cylinder 2	Injector 2 cable short circuit to ground
0202 652 5	Engine injector cylinder 2	Injector cyl. 2 cable/injector open load
1161 652 6	Engine injector cylinder 2	Injector cyl. 2 cable/injector short circuit
1151 652 7	Engine injector cylinder 2	Injection error, physical cylinder 2
1190 652 8	Engine injector cylinder 2	Injector cyl. 2, over or under fueling
12C1 652 10	Engine injector cylinder 2	Fault with sensors/actuators for the particulate filter
119A 652 13	Engine injector cylinder 2	Injector trim code version error, injector cyl. 2
11E1 652 15	Engine injector cylinder 2	Cylinder 2 torque error
11D1 652 16	Engine injector cylinder 2	Cylinder 2 injector fault, high torque
11D9 652 18	Engine injector cylinder 2	Cylinder 2 injector fault, low torque
0266 652 20	Engine injector cylinder 2	Cylinder 2 balancing min or max

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Name	Description
11A3 653 1	Engine injector cylinder 3	Two or more injectors with the same trim code, injector cyl. 3
117A 653 2	Engine injector cylinder 3	Injector trim code, checksum error injector cyl. 3
0267 653 4	Engine injector cylinder 3	Injector 3 cable short circuit to ground
0203 653 5	Engine injector cylinder 3	Injector cyl. 3 cable/injector open load
1164 653 6	Engine injector cylinder 3	Injector cyl. 3 cable/injector short circuit
1152 653 7	Engine injector cylinder 3	Injection error, physical cylinder 3
1191 653 8	Engine injector cylinder 3	Injector cyl. 3, over or under fueling
12C2 653 10	Engine injector cylinder 3	Fault with sensors/actuators for the particulate filter
119B 653 13	Engine injector cylinder 3	Injector trim code version error, injector cyl. 3
11E2 653 15	Engine injector cylinder 3	Cylinder 3 torque error
11D2 653 16	Engine injector cylinder 3	Cylinder 3 injector fault, high torque
11DA 653 18	Engine injector cylinder 3	Cylinder 3 injector fault, low torque
0269 653 20	Engine injector cylinder 3	Cylinder 3 balancing min or max
11A4 654 1	Engine injector cylinder 4	Two or more injectors with the same trim code, injector cyl. 4
117B 654 2	Engine injector cylinder 4	Injector trim code, checksum error injector cyl. 4
0270 654 4	Engine injector cylinder 4	Injector 4 cable short circuit to ground

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Name	Description
0204 654 5	Engine injector cylinder 4	Injector cyl. 4 cable/injector open load
1167 654 6	Engine injector cylinder 4	Injector cyl. 4 cable/injector short circuit
1153 654 7	Engine injector cylinder 4	Injection error, physical cylinder 4
1192 654 8	Engine injector cylinder 4	Injector cyl. 4, over or under fueling
12C3 654 10	Engine injector cylinder 4	Fault with sensors/actuators for the particulate filter
119C 654 13	Engine injector cylinder 4	Injector trim code version error, injector cyl. 4
11E3 654 15	Engine injector cylinder 4	Cylinder 4 torque error
11D3 654 16	Engine injector cylinder 4	Cylinder 4 injector fault, high torque
11DB 654 18	Engine injector cylinder 4	Cylinder 4 injector fault, low torque
0272 654 20	Engine injector cylinder 4	Cylinder 4 balancing min or max
11A5 655 1	Engine injector cylinder 5	Two or more injectors with the same trim code, injector cyl. 5
117C 655 2	Engine injector cylinder 5	Injector trim code, checksum error injector cyl. 5
0273 655 4	Engine injector cylinder 5	Injector 5 cable short circuit to ground
0205 655 5	Engine injector cylinder 5	Injector cyl. 5 cable/injector open load
116E 655 6	Engine injector cylinder 5	Injector cyl. 5 cable/injector short circuit
1154 655 7	Engine injector cylinder 5	Injection error, physical cylinder 5

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Name	Description
1193 655 8	Engine injector cylinder 5	Injector cyl. 5, over or under fueling
12C4 655 10	Engine injector cylinder 5	Fault with sensors/actuators for the particulate filter
119D 655 13	Engine injector cylinder 5	Injector trim code version error, injector cyl. 5
11E4 655 15	Engine injector cylinder 5	Cylinder 5 torque error
11D4 655 16	Engine injector cylinder 5	Cylinder 5 injector fault, high torque
11DC 655 18	Engine injector cylinder 5	Cylinder 5 injector fault, low torque
0275 655 20	Engine injector cylinder 5	Cylinder 5 balancing min or max
11A6 656 1	Engine injector cylinder 6	Two or more injectors with the same trim code, injector cyl. 6
117D 656 2	Engine injector cylinder 6	Injector trim code, checksum error injector cyl. 6
0206 656 5	Engine injector cylinder 6	Injector cyl. 6 cable/injector open load
1171 656 6	Engine injector cylinder 6	Injector cyl. 6 cable/injector short circuit
1155 656 7	Engine injector cylinder 6	Injection error, physical cylinder 6
1194 656 8	Engine injector cylinder 6	Injector cyl. 6, over or under fueling
119E 656 13	Engine injector cylinder 6	Injector trim code version error, injector cyl. 6
11E5 656 15	Engine injector cylinder 6	Cylinder 6 torque error
11D5 656 16	Engine injector cylinder 6	Cylinder 6 injector fault, high torque

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Name	Description
11DD 656 18	Engine injector cylinder 6	Cylinder 6 injector fault, low torque
0278 656 20	Engine injector cylinder 6	Cylinder 6 balancing min or max
11A7 657 1	Engine injector cylinder 7	Two or more injectors with the same trim code, injector cyl. 7
117E 657 2	Engine injector cylinder 7	Injector trim code, checksum error injector cyl. 7
0207 657 5	Engine injector cylinder 7	Injector cyl. 7 cable/injector open load
1174 657 6	Engine injector cylinder 7	Injector cyl. 7 cable/injector short circuit
1156 657 7	Engine injector cylinder 7	Injection error, physical cylinder 7
1195 657 8	Engine injector cylinder 7	Injector cyl. 7, over or under fueling
119F 657 13	Engine injector cylinder 7	Injector trim code version error, injector cyl. 7
11E6 657 15	Engine injector cylinder 7	Cylinder 7 torque error
11D6 657 16	Engine injector cylinder 7	Cylinder 7 injector fault, high torque
11DE 657 18	Engine injector cylinder 7	Cylinder 7 injector fault, low torque
0281 657 20	Engine injector cylinder 7	Cylinder 7 balancing min or max
11A8 658 1	Engine injector cylinder 8	Two or more injectors with the same trim code, injector cyl. 8
117F 658 2	Engine injector cylinder 8	Injector trim code, checksum error injector cyl. 8
0208 658 5	Engine injector cylinder 8	Injector cyl. 8 cable/injector open load

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Name	Description
1177 658 6	Engine injector cylinder 8	Injector cyl. 8 cable/injector short circuit
1157 658 7	Engine injector cylinder 8	Injection error, physical cylinder 8
1196 658 8	Engine injector cylinder 8	Injector cyl. 8, over or under fueling
11A0 658 13	Engine injector cylinder 8	Injector trim code version error, injector cyl. 8
11E7 658 15	Engine injector cylinder 8	Cylinder 8 torque error
11D7 658 16	Engine injector cylinder 8	Cylinder 8 injector fault, high torque
11DF 658 18	Engine injector cylinder 8	Cylinder 8 injector fault, low torque
0284 658 20	Engine injector cylinder 8	Cylinder 8 balancing min or max
160D 677 0	Engine starter motor relay	Unintentional starter activation while moving or idling
160C 677 2	Engine starter motor relay	Starter actuator, faulty
1645 677 3	Engine starter motor relay	Starter actuator, short circuit to +24V
1646 677 4	Engine starter motor relay	Starter actuator, short circuit to ground
0512 677 5	Engine starter motor relay	Starter actuator, open load
1670 677 7	Engine starter motor relay	Starter actuator, blind start
D108 677 19	Engine starter motor relay	Starter motor demand defect via CAN
1319 723 2	Engine speed	Engine position sensor 2, faulty

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Name	Description
1312 723 4	Engine speed	Engine position sensor 2, too weak signal
1212 723 7	Engine speed	Engine position sensor 2, faulty
1330 723 8	Engine speed	Engine position sensor 2, Gap Puls or Sync error
1318 723 9	Engine speed	Engine position sensor 2, Time out
1311 723 10	Engine speed	Engine position sensor 2, position diff
1317 723 14	Engine speed	Engine position sensor 2 error torque limit
16C6 974 0	Remote accelerator pedal position	Signal level from redundant gas pedal above high limit
16C5 974 1	Remote accelerator pedal position	Signal level from redundant gas pedal below low limit
1602 986 2	Requested % fan speed	Fan actuator, faulty
0692 986 3	Requested % fan speed	Fan actuator, short circuit to +24V
0691 986 4	Requested % fan speed	Fan actuator, short circuit high to ground
0480 986 5	Requested % fan speed	Fan actuator, open load
1603 986 7	Requested % fan speed	Fan coupling unit, bad performance
12D3 1086 2	Parking and/or trailer pressure	Electrical fault on the parking brake pressure sensor
16C0 1108 14	Engine protection system timer override	Overridden due to other fault
16BF 1110 14	Engine protection system has shutdown engine	Engine Stop due to other fault

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Name	Description
0094 1239 7	Engine fuel leakage	Fuel Rail pressure, small volume leak
0300 1322 7	Engine misfire for multiple cylinders	Random/Multiple Cylinder Misfire Detected
0301 1323 7	Engine misfire cylinder 1	Cylinder 1 Misfire Detected
0302 1324 7	Engine misfire cylinder 2	Cylinder 2 Misfire Detected
0303 1325 7	Engine misfire cylinder 3	Cylinder 3 Misfire Detected
0304 1326 7	Engine misfire cylinder 4	Cylinder 4 Misfire Detected
0305 1327 7	Engine misfire cylinder 5	Cylinder 5 Misfire Detected
1183 1442 2	Engine fuel valve position	Inlet metering valve 1, faulty
1184 1442 3	Engine fuel valve position	Inlet metering valve 1, short circuit to +24V
1182 1442 5	Engine fuel valve position	Inlet metering valve 1, short circuit to ground
11B8 1442 7	Engine fuel valve position	Inlet metering valve 1, stuck
11B1 1442 8	Engine fuel valve position	Inlet metering valve 1, plausible leakage
118E 1442 10	Engine fuel valve position	Inlet metering valve 1, calculated resistance error
1080 1443 1	Engine fuel valve position	Mechanical dump valve, opened
118B 1443 6	Engine fuel valve position	Mechanical dump valve, tripped
1605 1483 2	Source address of engine control device	EMS internal error

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Name	Description
1606 1483 2	Source address of engine control device	EMS Memory Error
1610 1483 2	Source address of engine control device	EMS Memory Error
1607 1483 8	Source address of engine control device	EMS Memory or TPU Error
160F 1483 8	Source address of engine control device	EMS memory or TPU error
16D7 1483 9	Source address of engine control device	Camshaft TPU Supervision Error
160A 1483 11	Source address of engine control device	Software Watchdog Reset
1604 1483 12	Source address of engine control device	Hardware watchdog error
D100 1484 9	Other control are reporting faults affecting the engine	CAN message DLN1 from coordinator timeout
D102 1484 10	Other control are reporting faults affecting the engine	CAN message CRUISE CONTROL/ VEHICLE SPEED from coordinator timeout
D113 1484 16	Other control are reporting faults affecting the engine	CAN message from EMSX, invalid data
D112 1484 18	Other control are reporting faults affecting the engine	CAN message from EMSX, invalid data
D103 1484 19	Other control are reporting faults affecting the engine	CAN message DLN6 from coordinator timeout
D111 1484 20	Other control are reporting faults affecting the engine	CAN message timout from EMSX
D110 1484 21	Other control are reporting faults affecting the engine	CAN message timout from EMSX
20EA 1485 16	ECM main relay	SCR main unit, power switched off too early
20EB 1485 18	ECM main relay	SCR main unit, power switched off too late

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Name	Description
16BE 1569 14	Engine protection torque derate	Torque reduction due to other fault
16F9 1639 3	Fan speed	Fan speed sensor, short circuit to +24V
0526 1639 4	Fan speed	Fan speed sensor supply too low
0528 1639 8	Fan speed	Fan speed sensor circuit no signal
D10F 1675 2	Engine starter mode	Immobiliser - EMS and EMSX
C426 1675 9	Engine starter mode	Invalid Data Received From Vehicle Control Module
D10A 1675 12	Engine starter mode	Immobiliser error
C326 1675 13	Engine starter mode	Software Incompatibility With Vehicle Immoblilizer Control Module
C167 1675 19	Engine starter mode	Lost Communication With Vehicle Immobilizer Control Module
1704 1761 1	After treatment diesel exhaust fluid level	Reductant tank, empty
203C 1761 2	After treatment diesel exhaust fluid level	Reductant tank level sensor, short circuit to ground
203A 1761 3	After treatment diesel exhaust fluid level	Reductant tank level sensor, short circuit to +24V
203D 1761 5	After treatment diesel exhaust fluid level	Reductant tank level sensor, open circuit
203F 1761 18	After treatment diesel exhaust fluid level	Reductant tank, low level
1600 2609 2	Cab A/C outlet pressure	AC compressor actuator, faulty
2521 2609 3	Cab A/C outlet pressure	AC compressor actuator, short circuit to +24V

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Name	Description
2520 2609 4	Cab A/C outlet pressure	AC compressor actuator, short circuit to ground
2519 2609 5	Cab A/C outlet pressure	AC compressor actuator, open load
042F 2791 2	Engine EGR valve control	EGR actuator, control error
0490 2791 3	Engine EGR valve control	EGR actuator, short circuit to +24V
0489 2791 4	Engine EGR valve control	EGR actuator, short circuit to ground
1400 2791 5	Engine EGR valve control	EGR actuator, stuck open
0488 2791 7	Engine EGR valve control	EGR actuator, stuck close
1424 2791 8	Engine EGR valve control	The EGR valve is responding too slow
2BAB 2791 10	Engine EGR valve control	NOx Exceedence - Incorrect EGR Flow
0400 2791 11	Engine EGR valve control	EGR system faulty
2BAC 2791 16	Engine EGR valve control	NOx Exceedence - Deactivation of EGR
0402 2791 20	Engine EGR valve control	EGR higher than desired
0401 2791 21	Engine EGR valve control	EGR lower than desired
115D 2797 2	Engine injector group 1	Injector group A, short circuit to other bank
115C 2797 3	Engine injector group 1	Injector group A, short circuit to +24V
115B 2797 4	Engine injector group 1	Injector group A, short circuit to ground

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Name	Description
1692 2797 5	Engine injector group 1	Injector drive voltage, faulty
115A 2797 8	Engine injector group 1	Injector group A, injection error
116D 2798 2	Engine injector group 2	Injector group B, short circuit to other bank
116C 2798 3	Engine injector group 2	Injector group B, short circuit +24V
116B 2798 4	Engine injector group 2	Injector group B, short circuit ground
116A 2798 8	Engine injector group 2	Injection error, group B
1608 2858 13	Machine data config. 1	EMS, Default EOL Data in E2
1609 2859 13	Machine data config. 2	EMS, Default Barcoding Data in E2
1697 2860 13	Machine data config. 3	EMS internal software error
1613 2861 13	Machine data config. 4	EMS Configuration for Automatic Clutch Faulty
9999 2862 13	Machine data config. 5	Internal software error
1038 3031 0	After treatment diesel exhaust fluid tank temperature	SCR main unit, high temperature low limit exceedence
2215 3216 4	After treatment - intake Nox	NOx sensor upstream, internal fault or open circuit
2213 3216 5	After treatment - intake Nox	NOx sensor upstream, open circuit
2214 3216 7	After treatment - intake Nox	NOx sensor upstream, internal fault
100B 3216 8	After treatment - intake Nox	NOx sensor upstream of catalytic converter

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Name	Description
100E 3216 9	After treatment - intake Nox	NOx sensor upstream of catalytic converter
16CF 3216 10	After treatment - intake Nox	NOx sensor upstream, stuck
16F4 3216 17	After treatment - intake Nox	NOx sensor upstream, low signal
16D8 3216 18	After treatment - intake Nox	NOx sensor upstream, too low value
12CA 3216 19	After treatment - intake Nox	NOx sensor upstream error via CAN
16FA 3216 20	After treatment - intake Nox	NOx sensor upstream, not plausible
2202 3226 4	After treatment - outlet Nox	NOx sensor downstream, internal fault or open circuit
2200 3226 5	After treatment - outlet Nox	NOx sensor downstream, open circuit
2201 3226 7	After treatment - outlet Nox	NOx sensor downstream, internal fault
12C9 3226 8	After treatment - outlet Nox	NOx sensor downstream error via CAN
100F 3226 9	After treatment - outlet Nox	NOx sensor downstream of the SCR catalytic converter
16CE 3226 10	After treatment - outlet Nox	NOx sensor downstream, stuck
16F2 3226 17	After treatment - outlet Nox	NOx sensor downstream, low signal
16D9 3226 18	After treatment - outlet Nox	NOx sensor downstream, too low value
100A 3226 19	After treatment - outlet Nox	NOx sensor downstream of the catalytic converter
16FB 3226 20	After treatment - outlet Nox	NOx sensor downstream, not plausible

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Name	Description
0426 3241 2	After treatment - exhaust gas temperature	Upstream catalyst temperature sensor not plausible.
104D 3241 3	After treatment - exhaust gas temperature	Upstream catalyst temperature sensor not plausible, too high
0427 3241 4	After treatment - exhaust gas temperature	Upstream catalyst temperature sensor not plausible, short circuit
0425 3241 5	After treatment - exhaust gas temperature	Upstream catalyst temperature sensor not plausible, open circuit
104F 3241 8	After treatment - exhaust gas temperature	Upstream catalyst temperature sensor not plausible, too high
16CD 3241 10	After treatment - exhaust gas temperature	Upstream catalyst temperature sensor not plausible.
20ED 3241 16	After treatment - exhaust gas temperature	Upstream catalyst temperature too high
104E 3241 18	After treatment - exhaust gas temperature	Upstream catalyst temperature sensor not plausible, too low
16FF 3241 19	After treatment - exhaust gas temperature	CAN Error from Exhaust Temperature Sensors
1803 3242 0	After treatment - DPF intake gas temp.	Upstream DPF temperature sensor, too high
16FC 3242 7	After treatment - DPF intake gas temp.	Upstream DPF temperature sensor, not plausible
2080 3242 9	After treatment - DPF intake gas temp.	Upstream DPF temperature sensor, not plausible
200F 3242 10	After treatment - DPF intake gas temp.	Upstream DPF temperature too high during normal condition
200E 3242 16	After treatment - DPF intake gas temp.	Upstream DPF temperature too high during regeneration
12CF 3245 19	After treatment - exhaust gas temperature	Auxiliary Temperature Sensor Error on CAN
12CB 3246 2	After treatment - DPF outlet gas temp.	Downstream DPF temperature sensor error

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Name	Description
042C 3246 3	After treatment - DPF outlet gas temp.	Exhaust temperature sensor after SCR catalytic converter, short circuit
042D 3246 4	After treatment - DPF outlet gas temp.	Exhaust temperature sensor after SCR catalytic converter, open circuit
242B 3246 9	After treatment - DPF outlet gas temp.	Downstream exhaust temperature sensor, not plausible
200D 3246 15	After treatment - DPF outlet gas temp.	Downstream DPF temperature too high during normal condition
200C 3246 16	After treatment - DPF outlet gas temp.	Downstream DPF temperature too high during regeneration
16E3 3251 2	After treatment - DPF differential pressure	Particulate filter is missing
16D6 3251 7	After treatment - DPF differential pressure	Differential pressure sensor over particulate filter, faulty
16E4 3251 7	After treatment - DPF differential pressure	Particulate filter is damaged or cracked
12D2 3251 8	After treatment - DPF differential pressure	Differential pressure sensor not plausible
16D5 3251 9	After treatment - DPF differential pressure	Differential pressure sensor over particulate filter, not plausible
16ED 3340 1	Engine CAC intake pressure	Intercooler temperature, too low
1111 3340 3	Engine CAC intake pressure	Intercooler pressure sensor, short circuit to ground
1112 3340 4	Engine CAC intake pressure	Intercooler pressure sensor, short circuit to +24V
1079 3340 7	Engine CAC intake pressure	Intercooler pressure sensor, stuck
107E 3340 9	Engine CAC intake pressure	Intercooler pressure sensor, not plausible
107F 3340 10	Engine CAC intake pressure	Intercooler pressure sensor, not plausible

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Name	Description
106F 3340 15	Engine CAC intake pressure	Intercooler pressure, above normal
106E 3340 16	Engine CAC intake pressure	Intercooler pressure, above normal
107A 3340 20	Engine CAC intake pressure	Intercooler pressure too high
107B 3340 21	Engine CAC intake pressure	Intercooler pressure too low
16DD 3360 0	After treatment - Diesel exhaust fluid controller	SCR system adaptation have reached max values
16DE 3360 1	After treatment - Diesel exhaust fluid controller	SCR system adaptation have reached min values
12C7 3360 2	After treatment - Diesel exhaust fluid controller	EEC3 System has demanded "SCR Hazardous major functional failure" actions
20A3 3360 3	After treatment - Diesel exhaust fluid controller	SCR main unit, ventilation valve test, short to battery
1033 3360 4	After treatment - Diesel exhaust fluid controller	SCR main unit, internal supply voltage low
20A0 3360 5	After treatment - Diesel exhaust fluid controller	SCR main unit, ventilation valve test, open load
1047 3360 6	After treatment - Diesel exhaust fluid controller	SCR main unit, system voltage error
1022 3360 7	After treatment - Diesel exhaust fluid controller	SCR main unit, ignition switch plausible error
12C6 3360 9	After treatment - Diesel exhaust fluid controller	EEC3 has demanded "SCR Major functional failure reductant dosing stopped" actions
12C8 3360 10	After treatment - Diesel exhaust fluid controller	EEC3 System has demanded "SCR minor functional failure" actions
16AA 3360 12	After treatment - Diesel exhaust fluid controller	SCR main unit, error
1032 3360 16	After treatment - Diesel exhaust fluid controller	SCR main unit, internal supply voltage high

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Name	Description
100C 3360 19	After treatment - Diesel exhaust fluid controller	SCR main unit, communication error
2049 3361 3	After treatment - Diesel exhaust fluid dosing unit	SCR reductant dosing valve, short circuit to battery
2047 3361 5	After treatment - Diesel exhaust fluid dosing unit	SCR reductant dosing valve, open circuit
208E 3361 10	After treatment - Diesel exhaust fluid dosing unit	SCR main unit, reductant pressure not plausible
202D 3362 2	After treatment - Diesel exhaust fluid dosing unit input lines	SCR reductant pressure, error
20C0 3363 0	After treatment - Diesel exhaust fluid tank heater	SCR main unit, reductant heater, circuit high
20BD 3363 2	After treatment - Diesel exhaust fluid tank heater	SCR main unit, reductant heater, open load
20C4 3363 3	After treatment - Diesel exhaust fluid tank heater	SCR main unit, internal heating pump, short circuit to battery
2044 3363 4	After treatment - Diesel exhaust fluid tank heater	SCR main unit, reductant temperature sensor circuit low
20C1 3363 5	After treatment - Diesel exhaust fluid tank heater	SCR main unit, internal heating pump, open load
20BE 3363 8	After treatment - Diesel exhaust fluid tank heater	SCR main unit, reductant heater, circuit performance
1054 3363 15	After treatment - Diesel exhaust fluid tank heater	SCR reagent tank temperature too high
101A 3363 16	After treatment - Diesel exhaust fluid tank heater	SCR main unit, high temperature high limit exceeded
209F 3363 17	After treatment - Diesel exhaust fluid tank heater	SCR reductant tank temperature too low
2045 3363 18	After treatment - Diesel exhaust fluid tank heater	SCR main unit, low temperature limit exceeded
0638 3464 2	Engine throttle actuator control command	Throttle, control error

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Name	Description
2103 3464 3	Engine throttle actuator control command	Throttle Actuator, short circuit to +24V
2102 3464 4	Engine throttle actuator control command	Throttle Actuator, short circuit
2101 3464 5	Engine throttle actuator control command	Throttle Actuator, slow response
2106 3464 6	Engine throttle actuator control command	Throttle Actuator Control System - Forced Limited Power
2111 3464 7	Engine throttle actuator control command	Throttle, stuck in open position
2112 3464 8	Engine throttle actuator control command	Throttle, stuck in closed position
20CA 3485 1	After treatment - supply air pressure	SCR main unit, air pressure too low
209A 3485 2	After treatment - supply air pressure	SCR main unit, air pressure sensor after orifice circuit supply
209D 3485 3	After treatment - supply air pressure	SCR main unit, air pressure sensor after orifice circuit high
209C 3485 4	After treatment - supply air pressure	SCR main unit, air pressure sensor after orifice circuit low
1014 3485 7	After treatment - supply air pressure	SCR, air circuit blocked
209B 3485 9	After treatment - supply air pressure	SCR main unit, air pressure sensor after orifice performance
1045 3485 18	After treatment - supply air pressure	EEC, air supply low
209E 3485 20	After treatment - supply air pressure	SCR main unit, air pressure sensor after orifice plausible error
1082 3563 11	Engine intake manifold pressure	Boost pressure sensor and ambient pressure sensor do not correlate
1069 3563 15	Engine intake manifold pressure	Boost pressure sensor and ambient pressure sensor do not correlate

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Name	Description
0069 3563 17	Engine intake manifold pressure	Boost pressure sensor and ambient pressure sensor do not correlate
F001 3607 2	Engine emergency shutdown	Incorrect EMS shutdown
2128 3673 3	Engine throttle valve position	Throttle Position Sensor 2, short circuit to +24V
2127 3673 4	Engine throttle valve position	Throttle Position Sensor 2, short circuit to ground
0406 3822 3	Engine EGR valve position	EGR position sensor, short circuit to +24V
0405 3822 4	Engine EGR valve position	EGR position sensor, short circuit to ground
1405 3822 7	Engine EGR valve position	EGR SRA reports a warning during Learn Stops.
049D 3822 8	Engine EGR valve position	EGR position sensor, outside the permitted range
1404 3822 12	Engine EGR valve position	EGR SRA reports it has a continuous fault.
1705 3822 13	Engine EGR valve position	EGR position sensor, not plausible
1406 3822 16	Engine EGR valve position	EGR SRA reports a running conditions warning for high temp or low voltage.
1402 3822 19	Engine EGR valve position	EGR CAN timeout
1813 3822 20	Engine EGR valve position	EGR position sensor, voltage shows large variation in open position
1814 3822 21	Engine EGR valve position	EGR position sensor, voltage shows large variation in closed position
244B 3936 2	After treatment - DPF filter	Particulate filter, clogged
242F 3936 6	After treatment - DPF filter	Particulate filter, ash level too high

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Name	Description
1802 3936 10	After treatment - DPF filter	Exhaust temperature sensors, not plausible
1049 4090 0	Nox limit exceeded	NOx level after catalytic converter too high
2BAD 4090 11	Nox limit exceeded	NOx Exceedence - Root Cause Unknown
20EE 4090 16	Nox limit exceeded	SCR main unit, NOx level too high
2BA8 4095 2	Nox limit exceeded	NOx Exceedence - Interruption of Reagent Dosing Activity
2BA7 4096 2	Nox limit exceeded	NOx Exceedence - Empty Reagent Tank
1309 4201 2	Engine speed	Engine position sensor 1, faulty
1302 4201 4	Engine speed	Engine position sensor 1, too weak signal
1213 4201 7	Engine speed	Engine position sensor 1, faulty
1303 4201 8	Engine speed	Engine position sensor 1, Gap Puls or Sync error
1308 4201 9	Engine speed	Engine position sensor 1, time out
1301 4201 10	Engine speed	Engine position sensor 1, position diff
0726 4202 2	Engine speed	Engine speed sensor faulty
2BAE 4225 2	Nox limit exceeded	Failure in the NOx control monitoring system
1040 4334 0	After treatment Diesel exhaust fluid pressure	SCR reductant pressure error
12C5 4334 1	After treatment Diesel exhaust fluid pressure	EEC3 has demanded "SCR Hazardous functional failure reductant dosing stopped" actions

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Name	Description
103D 4334 2	After treatment Diesel exhaust fluid pressure	Urea pressure sensor, plausible error during start-up
204D 4334 3	After treatment Diesel exhaust fluid pressure	Urea pressure sensor, SCR high
204C 4334 4	After treatment Diesel exhaust fluid pressure	Urea pressure sensor, SCR low
204B 4334 8	After treatment Diesel exhaust fluid pressure	Urea pressure sensor, pressure too high not plausible
1031 4374 0	After treatment - Diesel exhaust fluid pump	Reductant pump fault, pump speed too high
1030 4374 1	After treatment - Diesel exhaust fluid pump	Reductant pump fault, pump speed too low
16AC 4782 0	DPF soot density	Particulate filter is clogged, hazardous
16AB 4782 16	DPF soot density	Particulate filter is clogged, major
12CC 4809 2	After treatment - DOC intake temp.	Upstream exhaust temperature sensor error
16E0 4809 7	After treatment - DOC intake temp.	Upstream exhaust temperature sensor, stuck
12CE 4809 8	After treatment - DOC intake temp.	Upstream exhaust temperature sensor error
16FD 4809 9	After treatment - DOC intake temp.	Upstream exhaust temperature sensor, not plausible
1700 4809 16	After treatment - DOC intake temp.	Upstream exhaust temperature sensor, above limit
1701 4809 18	After treatment - DOC intake temp.	Upstream exhaust temperature sensor, below limit
16B1 4810 9	After treatment - DOC outlet temp	Particulate filter, temperature drop not plausible
2423 4810 18	After treatment - DOC outlet temp	Upstream exhaust temperature too low during regeneration

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Name	Description
2601 4814 2	Engine coolant pump	Coolant water pump actuator, faulty
2603 4814 3	Engine coolant pump	Coolant water pump actuator, short circuit on high side
2602 4814 4	Engine coolant pump	Coolant water pump actuator, short circuit on low side
1811 4814 7	Engine coolant pump	Coolant pump speed sensor, stuck
00B7 4814 8	Engine coolant pump	Electrically controlled coolant pump
1810 4814 10	Engine coolant pump	Coolant pump speed sensor, no signal
16EC 5285 1	Engine CAC efficiency	Boost temperature to high, not plausible
245B 5401 2	Engine Turbocharger Turbine Bypass Actuator	EGR bypass actuator, faulty
245D 5401 3	Engine Turbocharger Turbine Bypass Actuator	EGR bypass actuator, short circuit high to +24V
245C 5401 4	Engine Turbocharger Turbine Bypass Actuator	EGR bypass actuator, short circuit high to ground
245A 5401 5	Engine Turbocharger Turbine Bypass Actuator	EGR bypass actuator, open load
1717 5419 2	Engine Throttle Actuator	Throttle M42, CAN interface fault
1707 5419 3	Engine Throttle Actuator	Throttle M42, supply voltage fault
1716 5419 5	Engine Throttle Actuator	Throttle M42, current limited
170A 5419 6	Engine Throttle Actuator	Throttle M42, overload
1708 5419 9	Engine Throttle Actuator	Throttle M42 has detected a CAN timeout

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Name	Description
170B 5419 10	Engine Throttle Actuator	Throttle M42, control error
1710 5419 11	Engine Throttle Actuator	Throttle M42, internal fault
1711 5419 12	Engine Throttle Actuator	Throttle M42, software execution error
170D 5419 13	Engine Throttle Actuator	Throttle M42, unsuccessful learning of the reference position
1709 5419 14	Engine Throttle Actuator	Throttle M42 has detected a CAN timeout
1706 5419 16	Engine Throttle Actuator	Throttle M42, too high temperature
1714 5419 19	Engine Throttle Actuator	Throttle M42, CAN timeout
170F 5419 31	Engine Throttle Actuator	Throttle M42, service mode enabled
1426 5421 3	Engine Turbocharger Wastegate Actuator	Wastegate actuator, short circuit to +24V
0249 5421 4	Engine Turbocharger Wastegate Actuator	Wastegate actuator, short circuit
1425 5421 5	Engine Turbocharger Wastegate Actuator	Wastegate actuator, short circuit to ground
0247 5421 6	Engine Turbocharger Wastegate Actuator	Wastegate actuator, short circuit
1407 5543 2	Engine Exhaust Brake Actuator Command	Exhaust brake actuator, control fault
0478 5543 3	Engine Exhaust Brake Actuator Command	Exhaust brake actuator, short circuit to +24V
0477 5543 4	Engine Exhaust Brake Actuator Command	Exhaust brake actuator, short circuit to ground
1427 5543 5	Engine Exhaust Brake Actuator Command	Exhaust brake actuator, stuck in open position

※ Some fault codes are not applied to this machine.

Fault code J1939 SPN J1939 FMI	Name	Description
0475 5543 6	Engine Exhaust Brake Actuator Command	Exhaust brake actuator, faulty
1411 5543 7	Engine Exhaust Brake Actuator Command	Exhaust brake actuator, stuck in closed position
1428 5543 12	Engine Exhaust Brake Actuator Command	Exhaust brake actuator, control fault
1408 5543 13	Engine Exhaust Brake Actuator Command	Exhaust brake actuator, fault with stop position
1409 5543 16	Engine Exhaust Brake Actuator Command	Exhaust brake actuator, over temperature
1403 5543 19	Engine Exhaust Brake Actuator Command	Exhaust brake actuator, CAN timeout
0476 5543 21	Engine Exhaust Brake Actuator Command	Exhaust brake actuator, error
205B 5743 2	Aftertreatment SCR Temperature	Reductant tank temperature sensor, not plausible
205C 5743 4	Aftertreatment SCR Temperature	Reductant tank temperature sensor, short circuit
205A 5743 5	Aftertreatment SCR Temperature	Reductant tank temperature sensor, open load
202C 5745 3	Aftertreatment Diesel Exhaust Fluid Dosing Unit Heater	SCR water valve, short circuit to battery
202A 5745 5	Aftertreatment Diesel Exhaust Fluid Dosing Unit Heater	SCR water valve, open load
207F 5841 1	Diesel Exhaust Fluid Quality Malfunction	SCR main unit, reductant quality too low

※ Some fault codes are not applied to this machine.

3) DEFINITION OF OPERATING MODES

(1) Normal

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

(2) Substitute clutch control

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

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

(3) Limp-home

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

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

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

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

If output speed is greater than the threshold, TCU will shift the transmission into neutral. The operator has to slow down the vehicle and must shift the gear selector into neutral position.

(4) Transmission-shutdown

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

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

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

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

(5) TCU-shutdown

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

TCU will shut off all solenoid valves and also both common power supplies (VPS1, VPS2). The park brake will engage, also functions are disabled which use ADM 1 to ADM 8.

The transmission will stay in neutral.

※ Abbreviations

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

4) TRANSMISSION FAULT CODES

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
10	Logical error at direction select signal 3rd shift lever TCU detected a wrong signal combination for the direction · Cable from shift lever 3 to TCU is broken · Cable is defective and is contacted to battery voltage or vehicle ground · Shift lever is defective	TCU shifts transmission to neutral if selector active OP mode : Transmission shutdown if selector active	· Check the cables from TCU to shift lever 3 · Check signal combinations of shift lever positions F-N-R · If shift lever is a CAN shift lever check CAN cable/shifter/device ※ Fault is cleared if TCU detects a valid neutral signal for the direction at the shift lever
11	Logical error at gear range signal TCU detected a wrong signal combination for the gear range · Cable from shift lever to TCU is broken · Cable is defective and is contacted to battery voltage or vehicle ground · Shift lever is defective	TCU shifts transmission to neutral OP mode : Transmission shutdown	· Check the cables from TCU to shift lever · Check signal combinations of shift lever positions for gear range ※ Failure cannot be detected in systems with DW2/DW3 shift lever. Fault is taken back if TCU detects a valid signal for the position
12	Logical error at direction select signal TCU detected a wrong signal combination for the direction · Cable from shift lever to TCU is broken · Cable is defective and is contacted to battery voltage or vehicle ground · Shift lever is defective	TCU shifts transmission to neutral OP mode : Transmission shutdown	· Check the cables from TCU to shift lever · Check signal combinations of shift lever positions F-N-R ※ Fault is taken back if TCU detects a valid signal for the direction at the shift lever
13	Logical error at engine derating device TCU detected no reaction of engine while derating device active	After selecting neutral, TCU change to OP mode limp home	· Check engine derating device ※ This fault is reset after power up of TCU
15	Logical error at direction select signal 2 shift lever TCU detected a wrong signal combination for the direction · Cable from shift lever 2 to TCU is broken · Cable is defective and is contacted to battery voltage or vehicle ground · Shift lever is defective	TCU shifts transmission to neutral if selector active OP mode : Transmission shutdown if elector active	· Check the cables from TCU to shift lever 2 · Check signal combinations of shift lever positions F-N-R ※ Fault is taken back if TCU detects a valid neutral signal for the direction at the shift lever
17	S.C. to ground at customer specific function No. 1 (ride control) 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 · Customer specific function No. 1 device has an internal defect · Connector pin is contacted to vehicle ground	Customer specific	· Check the cable from TCU to customer specific function No. 1 device · Check the connectors from customer specific function No. 1 to TCU · Check the resistance of customer specific function No. 1 device

※ Some fault codes are not applied to this machine.

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
18	S.C. to battery voltage at customer specific function No. 1 (ride control) 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 · Customer specific function No. 1 device has an internal defect · Connector pin is contacted to battery voltage	Customer specific	· Check the cable from TCU to customer specific function No. 1 device · Check the connectors from customer specific function No. 1 to TCU · Check the resistance of customer specific function No. 1 device
19	O.C. at customer specific function No. 1 (ride control) 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 · Customer specific function No. 1 device has an internal defect · Connector has no connection to TCU	Customer specific	· Check the cable from TCU to customer specific function No. 1 device · Check the connectors from customer specific function No. 1 device to TCU · Check the resistance of customer specific function No. 1 device
21	S.C. to battery voltage at clutch cut off input The measured voltage is too high: · Cable is defective and is contacted to battery voltage · Clutch cut off sensor has an internal defect · Connector pin is contacted to battery voltage	Clutch cut off function is disabled OP mode : Normal	· Check the cable from TCU to the sensor · Check the connectors · Check the clutch cut off sensor
22	S.C. to ground or O.C. at clutch cut off input The measured voltage is too low: · Cable is defective and is contacted to vehicle ground · Cable has no connection to TCU · Clutch cut off sensor has an internal defect · Connector pin is contacted to vehicle ground or is broken	Clutch cut off function is disabled OP mode : Normal	· Check the cable from TCU to the sensor · Check the connectors · Check the clutch cut off sensor
25	S.C. to battery voltage or O.C. at transmission sump temperature sensor input The measured voltage is too high: · Cable is defective and is contacted to battery voltage · Cable has no connection to TCU · Temperature sensor has an internal defect · Connector pin is contacted to battery voltage or is broken	No reaction, TCU use default temperature OP mode : Normal	· Check the cable from TCU to the sensor · Check the connectors · Check the temperature sensor

※ Some fault codes are not applied to this machine.

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
26	S.C. to battery voltage or O.C. at transmission sump temperature sensor input The measured voltage is too low: · Cable is defective and is contacted to vehicle ground · Temperature sensor has an internal defect · Connector pin is contacted to vehicle ground	No reaction, TCU uses default temperature OP mode : Normal	· Check the cable from TCU to the sensor · Check the connectors · Check the temperature sensor
27	S.C. to battery voltage or O.C. at retarder temperature sensor input The measured voltage is too high: · Cable is defective and is contacted to battery voltage · Cable has no connection to TCU · Temperature sensor has an internal defect · Connector pin is contacted to battery voltage or is broken	No reaction, TCU uses default temperature OP mode : Normal	· Check the cable from TCU to the sensor · Check the connectors · Check the temperature sensor
28	S.C. to ground at retarder temperature sensor input The measured voltage is too low: · Cable is defective and is contacted to vehicle ground · Temperature sensor has an internal defect · Connector pin is contacted to vehicle ground	No reaction, TCU uses default temperature OP mode : Normal	· Check the cable from TCU to the sensor · Check the connectors · Check the temperature sensor
31	S.C. to battery voltage or O.C. at engine speed input TCU measures a voltage higher than 7.00V at speed input pin · Cable is defective and is contacted to battery voltage · Cable has no connection to TCU · Speed sensor has an internal defect · Connector pin is contacted to battery voltage or has no contact	OP mode : Substitute clutch control	· Check the cable from TCU to the sensor · Check the connectors · Check the speed sensor
32	S.C. to ground at engine speed input TCU measures a voltage less than 0.45V at speed input pin · Cable/connector is defective and is contacted to vehicle ground · Speed sensor has an internal defect	OP mode : Substitute clutch control	· Check the cable from TCU to the sensor · Check the connectors · Check the speed sensor
33	Logical error at engine speed input TCU measures a engine speed over a threshold and the next moment the measured speed is zero · Cable/connector is defective and has bad contact · Speed sensor has an internal defect · Sensor gap has the wrong size	OP mode : Substitute clutch control	· Check the cable from TCU to the sensor · Check the connectors · Check the speed sensor · Check the sensor gap ※ This fault is reset after power up of TCU

※ Some fault codes are not applied to this machine.

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
34	S.C. to battery voltage or O.C. at turbine speed input TCU measures a voltage higher than 7.00V at speed input pin · Cable is defective and is contacted to vehicle battery voltage · Cable has no connection to TCU · Speed sensor has an internal defect · Connector pin is contacted to battery voltage or has no contact	OP mode : Substitute clutch control If a failure is existing at output speed, TCU shifts to neutral OP mode : Limp home	· Check the cable from TCU to the sensor · Check the connectors · Check the speed sensor
35	S.C. to ground at turbine speed input TCU measures a voltage less than 0.45V at speed input pin · Cable/connector is defective and is contacted to vehicle ground · Speed sensor has an internal defect	OP mode : Substitute clutch control If a failure is existing at output speed, TCU shifts to neutral OP mode : Limp home	· Check the cable from TCU to the sensor · Check the connectors · Check the speed sensor ※ This fault is reset after power up of TCU
36	Logical error at turbine speed input TCU measures a turbine speed over a threshold and at the next moment the measured speed is zero · Cable/connector is defective and has bad contact · Speed sensor has an internal defect · Sensor gap has the wrong size	OP mode : Substitute clutch control If a failure is existing at output speed, TCU shifts to neutral OP mode : Limp home	· Check the cable from TCU to the sensor · Check the connectors · Check the speed sensor · Check the sensor gap
37	S.C. to battery voltage or O.C. at internal speed input TCU measures a voltage higher than 7.00V at speed input pin · Cable is defective and is contacted to vehicle battery voltage · Cable has no connection to TCU · Speed sensor has an internal defect · Connector pin is contacted to battery voltage or has no contact	OP mode : Substitute clutch control	· Check the cable from TCU to the sensor · Check the connectors · Check the speed sensor
38	S.C. to ground at turbine speed input TCU measures a voltage less than 0.45V at speed input pin · Cable/connector is defective and is contacted to vehicle ground · Speed sensor has an internal defect	OP mode : Substitute clutch control	· Check the cable from TCU to the sensor · Check the connectors · Check the speed sensor
39	Logical error at internal speed input TCU measures a internal speed over a threshold and at the next moment the measured speed is zero · Cable/connector is defective and has bad contact · Speed sensor has an internal defect · Sensor gap has the wrong size	OP mode : Substitute clutch control	· Check the cable from TCU to the sensor · Check the connectors · Check the speed sensor · Check the sensor gap ※ This fault is reset after power up of TCU
3A	S.C. to battery voltage or O.C. at output speed input TCU measures a voltage higher than 12.5V at speed input pin · Cable is defective and is contacted to battery voltage · Cable has no connection to TCU · Speed sensor has an internal defect · Connector pin is contacted to battery voltage or has no contact	Special mode for gear selection OP mode : Substitute clutch control If a failure is existing at turbine speed, TCU shifts to neutral OP mode : Limp home	· Check the cable from TCU to the sensor · Check the connectors · Check the speed sensor

※ Some fault codes are not applied to this machine.

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
3B	S.C. to ground at output speed input TCU measures a voltage less than 1.00V at speed input pin · Cable/connector is defective and is contacted to vehicle ground · Speed sensor has an internal defect	Special mode for gear selection OP mode : Substitute clutch control If a failure is existing at turbine speed, TCU shifts to neutral OP mode : Limp home	· Check the cable from TCU to the sensor · Check the connectors · Check the speed sensor
3C	Logical error at output speed input TCU measures a turbine speed over a threshold and at the next moment the measured speed is zero · Cable/connector is defective and has bad contact · Speed sensor has an internal defect · Sensor gap has the wrong size	Special mode for gear selection OP mode : Substitute clutch control If a failure is existing at turbine speed, TCU shifts to neutral OP mode : Limp home	· Check the cable from TCU to the sensor · Check the connectors · Check the speed sensor · Check the sensor gap ※ This fault is reset after power up of TCU
3D	Turbine speed zero doesn't fit to other speed signals	-	· Not used
3E	Output speed zero doesn't fit to other speed signals If transmission is not neutral and the shifting has finished, TCU measures output speed zero and turbine speed or internal speed not equal to zero. · Speed sensor has an internal defect · Sensor gap has the wrong size	Special mode for gear selection OP mode : Substitute clutch control If a failure is existing at turbine speed, TCU shifts to neutral OP mode : Limp home	· Check the sensor signal of output speed sensor · Check the sensor gap of output speed sensor · Check the cable from TCU to the sensor ※ This fault is reset after power up of TCU
54	DCT1 timeout Timeout of CAN-message DCT1 from display computer · Interference on CAN-Bus · CAN wire/connector is broken · CAN wire/connector is defective and has contact to vehicle ground or battery voltage	OP mode : Normal	· Check display computer · Check wire of CAN-Bus · Check cable to display computer
55	JSS timeout Timeout of CAN-message JSS from joystick steering controller · Interference on CAN-Bus · CAN wire/connector is broken · CAN wire/connector is defective and has contact to vehicle ground or battery voltage	TCU shifts to neutral while joystick steering is active OP mode : Normal	· Check joystick steering controller · Check wire of CAN-Bus · Check cable to joystick steering controller
56	Engine CONF timeout Timeout of CAN-message engine CONF from engine controller · Interference on CAN-Bus · CAN wire/connector is broken · CAN wire/connector is defective and has contact to vehicle ground or battery voltage	OP mode : Substitute clutch control	· Check engine controller · Check wire of CAN-Bus · Check cable to engine controller

※ Some fault codes are not applied to this machine.

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
57	EEC1 timeout Timeout of CAN-message EEC1 from EEC controller · Interference on CAN-Bus · CAN wire/connector is broken · CAN wire/connector is defective and has contact to vehicle ground or battery voltage	OP mode : Substitute clutch control	· Check EEC controller · Check wire of CAN-Bus · Check cable to EEC controller
58	EEC3 timeout Timeout of CAN-message EEC3 from EEC controller · Interference on CAN-Bus · CAN wire/connector is broken · CAN wire/connector is defective an has contact to vehicle ground or battery voltage	OP mode : Substitute clutch control	· Check EEC controller · Check wire of CAN-Bus · Check cable to EEC controller
5C	Auto downshift signal CAN signal for automatic downshift is defective · Cluster controller is defective · Interference on CAN-Bus	No reaction	· Check cluster controller · Check wire of CAN-Bus · Check cable to cluster controller
5D	Manual downshift signal CAN signal for manual downshift is defective · Cluster controller is defective · Interference on CAN-Bus	No reaction	· Check cluster controller · Check wire of CAN-Bus · Check cable to controller
5E	CCO request signal CAN signal for CCO request is defective · Cluster controller is defective · Interference on CAN-Bus	No reaction	· Check cluster controller · Check wire of CAN-Bus · Check cable to controller
61	AEB request signal CAN signal for AEB request is defective · I/O controller is defective · Interference on CAN-Bus	No reaction OP mode : Normal	· Check I/O controller, Omron master · Check wire of CAN-Bus · Check cable to I/O controller, Omron master
64	Sarting gear signal CAN signal for starting gear is defective · I/O controller is defective (illegal starting gear) · Interference on CAN-Bus	No reaction. TCU uses default starting gear OP mode : Normal	· Check I/O controller · Check wire of CAN-Bus · Check cable to I/O controller
65	Engine torque signal CAN signal for engine torque is defective · Engine controller is defective · Interference on CAN-Bus	OP mode : Substitute clutch control	· Check engine controller · Check wire of CAN-Bus · Check cable to engine controller
69	Reference engine torque signal CAN signal for reference of engine torque is defective · Engine controller is defective · Interference on CAN-Bus	OP mode : Substitute clutch control	· Check engine controller · Check wire of CAN-Bus · Check cable to engine controller
6A	Actual engine torque signal CAN signal for actual engine torque is defective · Engine controller is defective · Interference on CAN-Bus	OP mode : Substitute clutch control	· Check engine controller · Check wire of CAN-Bus · Check cable to engine controller

※ Some fault codes are not applied to this machine.

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
6E	EEC2 timeout Timeout of CAN-message EEC2 from EEC controller · Interference on CAN-Bus · CAN wire/connector is broken · CAN wire/connector is defective and has contact to vehicle ground or battery voltage	No reaction, TCU uses default signal accelerator pedal in idle position OP mode : Normal	· Check EEC controller · Check wire of CAN-Bus · Check cable to EEC controller
71	S.C. to battery voltage at clutch K1 The measured resistance value of the valve is out of limit, the voltage at K1 valve is too high · Cable/connector is defective and has contact to battery voltage · Cable/connector is defective and has contact to another regulator output of the TCU · Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	· Check the cable from TCU to the gearbox · Check the connectors from TCU to the gearbox · Check the regulator resistance* · Check internal wire harness of the gearbox * See page 3-82
72	S.C. to ground at clutch K1 The measured resistance value of the valve is out of limit, the voltage at K1 valve is too low · Cable/connector is defective and has contact to vehicle ground · Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	· Check the cable from TCU to the gearbox · Check the connectors from gearbox to TCU · Check the regulator resistance* · Check internal wire harness of the gearbox * See page 3-82
73	O.C. at clutch K1 The measured resistance value of the valve is out of limit · Cable/connector is defective and has no contact to TCU · Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	· Check the cable from TCU to the gearbox · Check the connectors from gearbox to TCU · Check the regulator resistance* · Check internal wire harness of the gearbox * See page 3-82
74	S.C. to battery voltage at clutch K2 The measured resistance value of the valve is out of limit, the voltage at K2 valve is too high · Cable/connector is defective and has contact to battery voltage · Cable/connector is defective and has contact to another regulator output of the TCU · Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	· Check the cable from TCU to the gearbox · Check the connectors from gearbox to TCU · Check the regulator resistance* · Check internal wire harness of the gearbox * See page 3-82
75	S.C. to ground at clutch K2 The measured resistance value of the valve is out of limit, the voltage at K2 valve is too low · Cable/connector is defective and has contact to vehicle ground · Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	· Check the cable from TCU to the gearbox · Check the connectors from gearbox to TCU · Check the regulator resistance* · Check internal wire harness of the gearbox * See page 3-82

※ Some fault codes are not applied to this machine.

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
76	O.C. at clutch K2 The measured resistance value of the valve is out of limit · Cable/connector is defective and has no contact to TCU · Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	· Check the cable from TCU to the gearbox · Check the connectors from gearbox to TCU · Check the regulator resistance* · Check internal wire harness of the gearbox * See page 3-82
77	S.C. to battery voltage at clutch K3 The measured resistance value of the valve is out of limit, the voltage at K3 valve is too high · Cable/connector is defective and has contact to battery voltage · Cable/connector is defective and has contact to another regulator output of the TCU · Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	· Check the cable from TCU to the gearbox · Check the connectors from gearbox to TCU · Check the regulator resistance* · Check internal wire harness of the gearbox * See page 3-82
78	S.C. to ground at clutch K3 The measured resistance value of the valve is out of limit, the voltage at K3 valve is too low · Cable/connector is defective and has contact to vehicle ground · Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	· Check the cable from TCU to the gearbox · Check the connectors from gearbox to TCU · Check the regulator resistance* · Check internal wire harness of the gearbox * See page 3-82
79	O.C. at clutch K3 The measured resistance value of the valve is out of limit · Cable/connector is defective and has no contact to TCU · Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	· Check the cable from TCU to the gearbox · Check the connectors from gearbox to TCU · Check the regulator resistance* · Check internal wire harness of the gearbox * See page 3-82
7D	S.C. ground at engine derating device · Cable is defective and is contacted to vehicle ground · Engine derating device has an internal defect · Connector pin is contacted to vehicle ground	Engine derating will be on until TCU power down even if fault vanishes (Loose connection) OP mode : Normal	· Check the cable from TCU to the engine derating device · Check the connectors from engine derating device to TCU · Check the resistance* of engine derating device ※ Not used * See page 3-82
7E	S.C. battery voltage at engine derating device · Cable/connector is defective and is contacted to battery voltage · Engine derating device has an internal defect	No reaction OP mode : Normal	· Check the cable from TCU to the engine derating device · Check the connectors from backup alarm device to TCU · Check the resistance* of backup alarm device * See page 3-82

※ Some fault codes are not applied to this machine.

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
7F	O.C. at engine derating device 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 · Engine derating device has an internal defect · Connector has no connection to TCU	No reaction OP mode : Normal	· Check the cable from TCU to the engine derating device · Check the connectors from engine derating device to TCU · Check the resistance* of engine derating device * See page 3-82
81	S.C. to battery voltage at clutch K4 The measured resistance value of the valve is out of limit, the voltage at K4 valve is too high · Cable/connector is defective and has contact to battery voltage · Cable/connector is defective and has contact to another regulator output of the TCU · Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	· Check the cable from TCU to the gearbox · Check the connectors from gearbox to TCU · Check the regulator resistance* · Check internal wire harness of the gearbox * See page 3-82
82	S.C. to ground at clutch K4 The measured resistance value of the valve is out of limit, the voltage at K4 valve is too low · Cable/connector is defective and has contact to vehicle ground · Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	· Check the cable from TCU to the engine derating device · Check the connectors from gearbox to TCU · Check the regulator resistance* · Check internal wire harness of the gearbox * See page 3-82
83	O.C. at clutch K4 The measured resistance value of the valve is out of limit · Cable/connector is defective and has contact to TCU · Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	· Check the cable from TCU to the gearbox · Check the connectors from gearbox to TCU · Check the regulator resistance* · Check internal wire harness of the gearbox * See page 3-82
84	S.C. to battery voltage at clutch KV The measured resistance value of the valve is out of limit, the voltage at KV valve is too high · Cable/connector is defective and has contact to battery voltage · Cable/connector is defective and has contact to another regulator output of the TCU · Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	· Check the cable from TCU to the gearbox · Check the connectors from gearbox to TCU · Check the regulator resistance* · Check internal wire harness of the gearbox * See page 3-82
85	S.C. to ground at clutch KV The measured resistance value of the valve is out of limit, the voltage at KV valve is too low · Cable/connector is defective and has contact to vehicle ground · Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	· Check the cable from TCU to the gearbox · Check the connectors from gearbox to TCU · Check the regulator resistance* · Check internal wire harness of the gearbox * See page 3-82

※ Some fault codes are not applied to this machine.

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
86	O.C. at clutch KV The measured resistance value of the valve is out of limit · Cable/connector is defective and has contact to TCU · Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	· Check the cable from TCU to the gearbox · Check the connectors from gearbox to TCU · Check the regulator resistance* · Check internal wire harness of the gearbox * See page 3-82
87	S.C. to battery voltage at clutch KR The measured resistance value of the valve is out of limit, the voltage at KR valve is too high · Cable/connector is defective and has contact to battery voltage · Cable/connector is defective and has contact to another regulator output of the TCU · Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	· Check the cable from TCU to the gearbox · Check the connectors from gearbox to TCU · Check the regulator resistance* · Check internal wire harness of the gearbox * See page 3-82
88	S.C. to ground at clutch KR The measured resistance value of the valve is out of limit, the voltage at KR valve is too low · Cable/connector is defective and has contact to vehicle ground · Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	· Check the cable from TCU to the gearbox · Check the connectors from gearbox to TCU · Check the regulator resistance* · Check internal wire harness of the gearbox * See page 3-82
89	O.C. at clutch KR The measured resistance value of the valve is out of limit · Cable/connector is defective and has no contact to TCU · Regulator has an internal defect	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	· Check the cable from TCU to the gearbox · Check the connectors from gearbox to TCU · Check the regulator resistance* · Check internal wire harness of the gearbox * See page 3-82
91	S.C. to ground at relay reverse warning alarm TCU detected a wrong voltage at the output pin, that looks like a S.C. to vehicle ground · Cable is defective and is contact to vehicle ground · Backup alarm device has an internal defect · Connector pin is contacted to vehicle ground	Backup alarm will be on until TCU power down even if fault vanishes(Loose connection) OP mode : Normal	· Check the cable from TCU to the backup alarm device · Check the connectors from backup alarm device to TCU · Check the resistance* of backup alarm device * See page 3-82
92	S.C. to battery voltage at relay reverse warning alarm 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 · Backup alarm device has an internal defect · Connector pin is contacted to battery voltage	No reaction OP mode : Normal	· Check the cable from TCU to the backup alarm device · Check the connectors from backup alarm device to TCU · Check the resistance* of backup alarm device * See page 3-82

※ Some fault codes are not applied to this machine.

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
93	O.C. at relay reverse warning alarm 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 · Backup alarm device has an internal defect · Connector has no connection to TCU	No reaction OP mode : Normal	· Check the cable from TCU to the backup alarm device · Check the connectors from backup alarm device to TCU · Check the resistance* of backup alarm device * See page 3-82
94	S.C. to ground at relay starter interlock TCU detected a wrong voltage at the output pin, that looks like a S.C. to vehicle ground · Cable is defective and is connection to vehicle ground · Starter interlock relay has an internal defect · Connector pin is contacted to vehicle ground	No reaction OP mode : Normal	· Check the cable from TCU to the stater interlock relay · Check the connectors from starter interlock relay to TCU · Check the resistance* of starter interlock relay * See page 3-82
95	S.C. to battery voltage at relay starter interlock TCU detected a wrong voltage at the output pin, that looks like a S.C. to battery voltage · Cable is defective and has no connection to battery voltage · Starter interlock relay has an internal defect · Connector pin is contacted to battery voltage	No reaction OP mode : Normal	· Check the cable from TCU to the starter interlock relay · Check the connectors from starter interlock relay to TCU · Check the resistance* of starter interlock relay * See page 3-82
96	O.C. at relay starter interlock 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 · Starter interlock relay has an internal defect · Connector has no connection to TCU	No reaction OP mode : Normal	· Check the cable from TCU to the starter interlock relay · Check the connectors from starter interlock relay to TCU · Check the resistance* of starter interlock relay * See page 3-82
9A	S.C. to ground at converter lock up clutch solenoid 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 · Converter clutch solenoid has an internal defect · Connector pin is contacted to vehicle ground	No reaction OP mode : Normal	· Check the cable from TCU to the converter clutch solenoid · Check the connectors from converter clutch solenoid to TCU · Check the resistance* of converter clutch solenoid * See page 3-82

※ Some fault codes are not applied to this machine.

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
9B	O.C. at converter lock up clutch solenoid 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 · Converter clutch solenoid has an internal defect · Connector has no connection to TCU	Converter clutch always open, retarder not available OP mode : Normal	· Check the cable from TCU to the converter clutch solenoid · Check the connectors from converter clutch solenoid to TCU · Check the resistance* of converter clutch solenoid * See page 3-82
9C	S.C. to battery voltage at converter lock up clutch solenoid TCU detected a wrong voltage at the output pin, that looks like a S.C. to battery voltage · Cable is defective and has no contacted to battery voltage · Converter clutch solenoid has an internal defect · Connector pin is contacted to battery voltage	No reaction OP mode : Normal	· Check the cable from TCU to the converter clutch solenoid · Check the connectors from converter clutch solenoid to TCU · Check the resistance* of converter clutch solenoid * See page 3-82
A1	S.C. to ground at difflock or axle connection solenoid 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 · Difflock solenoid has an internal defect · Connector pin is contacted to vehicle ground	No reaction OP mode : Normal	· Check the cable from TCU to the difflock solenoid · Check the connectors from difflock solenoid to TCU · Check the resistance* of difflock solenoid * See page 3-82
A2	S.C. to battery voltage at difflock or axle connection solenoid TCU detected a wrong voltage at the output pin, that looks like a S.C. to battery voltage · Cable is defective and has no connection to battery voltage · Difflock solenoid has an internal defect · Connector pin is contacted to battery voltage	No reaction OP mode : Normal	· Check the cable from TCU to the difflock solenoid · Check the connectors from difflock solenoid to TCU · Check the resistance* of difflock solenoid * See page 3-82
A3	O.C. at difflock or axle connection solenoid 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 · Difflock solenoid has an internal defect · Connector has no connection to TCU	No reaction OP mode : Normal	· Check the cable from TCU to the difflock solenoid · Check the connectors from difflock solenoid to TCU · Check the resistance* of difflock solenoid * See page 3-82

※ Some fault codes are not applied to this machine.

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
A4	S.C. to ground at warning signal output 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 · Warning device has an internal defect · Connector pin is contacted to vehicle ground	No reaction OP mode : Normal	· Check the cable from TCU to the warning device · Check the connectors from warning device to TCU · Check the resistance* of warning device * See page 3-82
A5	O.C. voltage at warning signal output 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 · Warning device has an internal defect · Connector has no connection to TCU	No reaction OP mode : Normal	· Check the cable from TCU to the warning device · Check the connectors from warning device to TCU · Check the resistance* of warning device * See page 3-82
A6	S.C. to battery voltage at warning signal output TCU detected a wrong voltage at the output pin, that looks like a S.C. to battery voltage · Cable is defective and has is contacted to battery voltage · Warning device has an internal defect · Connector pin is contacted to battery voltage	No reaction OP mode : Normal	· Check the cable from TCU to the warning device · Check the connectors from warning device to TCU · Check the resistance* of warning device * See page 3-82
B1	Slippage at clutch K1 TCU calculates a differential speed at closed clutch K1. If this calculated value is out of range, TCU interprets this as slipping clutch · Low pressure at clutch K1 · Low main pressure · Wrong signal at internal speed sensor · Wrong signal at output speed sensor · Wrong size of the sensor gap · Clutch is defective	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	· Check pressure at clutch K1 · Check main pressure in the system · Check sensor gap at internal speed sensor · Check sensor gap at output speed sensor · Check signal at internal speed sensor · Check signal at output speed sensor · Replace clutch
B2	Slippage at clutch K2 TCU calculates a differential speed at closed clutch K2. If this calculated value is out of range, TCU interprets this as slipping clutch · Low pressure at clutch K2 · Low main pressure · Wrong signal at internal speed sensor · Wrong signal at output speed sensor · Wrong size of the sensor gap · Clutch is defective	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	· Check pressure at clutch K2 Check main pressure in the system · Check sensor gap at internal speed sensor · Check sensor gap at output speed sensor · Check signal at internal speed sensor · Check signal at output speed sensor · Replace clutch

※ Some fault codes are not applied to this machine.

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
B3	Slippage at clutch K3 TCU calculates a differential speed at closed clutch K3. If this calculated value is out of range, TCU interprets this as slipping clutch · Low pressure at clutch K3 · Low main pressure · Wrong signal at internal speed sensor · Wrong signal at output speed sensor · Wrong size of the sensor gap · Clutch is defective	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	· Check pressure at clutch K3 · Check main pressure in the system · Check sensor gap at internal speed sensor · Check sensor gap at output speed sensor · Check signal at internal speed sensor · Check signal at output speed sensor Replace clutch
B4	Slippage at clutch K4 TCU calculates a differential speed at closed clutch K4. If this calculated value is out of range, TCU interprets this as slipping clutch · Low pressure at clutch K4 · Low main pressure · Wrong signal at internal speed sensor · Wrong signal at turbine speed sensor · Wrong size of the sensor gap · Clutch is defective	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	· Check pressure at clutch K4 Check main pressure in the system · Check sensor gap at internal speed sensor · Check sensor gap at turbine speed sensor · Check signal at internal speed sensor · Check signal at turbine speed sensor Replace clutch
B5	Slippage at clutch KV TCU calculates a differential speed at closed clutch KV. If this calculated value is out of range, TCU interprets this as slipping clutch · Low pressure at clutch KV · Low main pressure · Wrong signal at internal speed sensor · Wrong signal at turbine speed sensor · Wrong size of the sensor gap · Clutch is defective	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	· Check pressure at clutch KV · Check main pressure in the system · Check sensor gap at internal speed sensor · Check sensor gap at turbine speed sensor · Check signal at internal speed sensor · Check signal at turbine speed sensor · Replace clutch
B6	Slippage at clutch KR TCU calculates a differential speed at closed clutch KR. If this calculated value is out of range, TCU interprets this as slipping clutch · Low pressure at clutch KR · Low main pressure · Wrong signal at internal speed sensor · Wrong signal at turbine speed sensor · Wrong size of the sensor gap · Clutch is defective	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	· Check pressure at clutch KR Check main pressure in the system · Check sensor gap at internal speed sensor · Check sensor gap at turbine speed sensor · Check signal at internal speed sensor · Check signal at turbine speed sensor · Replace clutch
B7	Overtemp sump TCU measured a temperature in the oil sump that is over the allowed threshold.	No reaction OP mode : Normal	· Cool down machine · Check oil level · Check temperature sensor
B9	Overspend engine	Retarder applies OP mode : Normal	-
BA	Differential pressure oil filter TCU measured a voltage at differential pressure switch out of the allowed range · Oil filter is polluted · Cable/connector is broken or cable/connector is contacted to battery voltage or vehicle ground · Differential pressure switch is defective	No reaction OP mode : Normal	· Check oil filter · Check wiring from TCU to differential pressure switch · Check differential pressure switch(Measure resistance)

※ Some fault codes are not applied to this machine.

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
BB	Slippage at converter lockup clutch TCU calculates a differential speed at closed converter lockup clutch. If this calculated value is out of range, TCU interprets this as slipping clutch · Low pressure at converter lockup clutch · Low main pressure · Wrong signal at engine speed sensor · Wrong signal at turbine speed sensor · Wrong size of the sensor gap · Clutch is defective	No reaction OP mode : Normal	· Check pressure at converter lockup clutch · Check main pressure in the system · Check sensor gap at engine speed sensor · Check sensor gap at turbine speed sensor · Check signal at engine speed sensor · Check signal at turbine speed sensor · Replace clutch
C0	Engine torque or engine power overload TCU calculates an engine torque or engine power above the defined thresholds	OP mode : Normal	
C1	Transmission output torque overload TCU calculates an transmission output torque above the defined threshold	OP mode : Normal	
C2	Transmission input torque overload TCU calculates an transmission input torque above the defined threshold	programmable : No reaction or shift to neutral OP mode : Normal	
C3	Overtemp converter output TCU measured a oil temperature at the converter output that is the allowed threshold	No reaction OP mode : Normal	· Cool down machine · Check oil level · Check temperature sensor
C4	S.C. to ground at joystick status indicator 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 · Joystick status indicator has an internal defect · Connector pin is contacted to vehicle ground	No reaction OP mode : Normal	· Check the cable from TCU to joystick status indicator · Check the connectors from joystick status indicator to TCU · Check the resistance* of joystick status indicator * See page 3-82
C5	S.C. to battery voltage at joystick status indicator 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 · Joystick status indicator has an internal defect · Connector pin is contacted to battery voltage	No reaction OP mode : Normal	· Check the cable from TCU to joystick status indicator · Check the connectors from joystick status indicator to TCU · Check the resistance* of joystick status indicator * See page 3-82

※ Some fault codes are not applied to this machine.

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
C6	O.C. at joystick status indicator 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 · Joystick status indicator has an internal defect · Connector pin has no connection to TCU	No reaction OP mode : Normal	· Check the cable from TCU to joystick status indicator · Check the connectors from joystick status indicator to TCU · Check the resistance* of joystick status indicator * See page 3-82
D1	S.C. to battery voltage at power supply for sensors TCU measures more than 6V at the pin AU1 (5V sensor supply)	See fault codes No.21 to 2C	· Check cables and connectors to sensors, which are supplied from AU1 · Check the power supply at the pin AU1(Should be appx. 5V) · Fault codes No.21 to No.2C may be reaction of this fault
D2	S.C. to ground at power supply for sensors TCU measures less than 4V at the pin AU1 (5V sensor supply)	See fault codes No.21 to 2C	· Check cables and connectors to sensors, which are supplied from AU1 · Check the power supply at the pin AU1(Should be appx. 5V) · Fault codes No.21 to No.2C may be reaction of this fault
D3	Low voltage at battery Measured voltage at power supply is lower than 18V(24V device)	Shift to neutral OP mode : TCU shutdown	· Check power supply battery · Check cables from batteries to TCU · Check connectors from batteries to TCU
D4	High voltage at battery Measured voltage at power supply is higher than 32.5V(24V device)	Shift to neutral OP mode : TCU shutdown	· Check power supply battery · Check cables from batteries to TCU · Check connectors from batteries to TCU
D5	Error at valve power supply VPS1 TCU switched on VPS1 and measured VPS1 is off or TCU switched off VPS1 and measured VPS1 is still on · Cable or connectors are defect and are contacted to battery voltage · Cable or connectors are defect and are contacted to vehicle ground · Permanent power supply KL30 missing · TCU has an internal defect	Shift to neutral OP mode : TCU shutdown	· Check fuse · Check cables from gearbox to TCU · Check connectors from gearbox to TCU · Replace TCU
D6	Error at valve power supply VPS2 TCU switched on VPS2 and measured VPS2 is off or TCU switched off VPS2 and measured VPS2 is still on · Cable or connectors are defect and are contacted to battery voltage · Cable or connectors are defect and are contacted to vehicle ground · Permanent power supply KL30 missing · TCU has an internal defect	Shift to neutral OP mode : TCU shutdown	· Check fuse · Check cables from gearbox to TCU · Check connectors from gearbox to TCU · Replace TCU

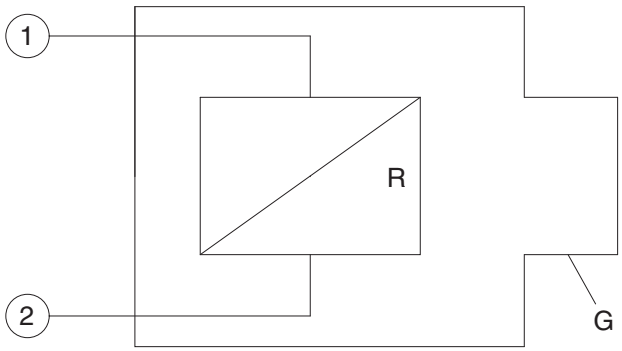
※ Some fault codes are not applied to this machine.

Fault code (Hex)	Meaning of the fault code possible reason for fault detection	Reaction of the TCU	Possible steps to repair
E3	S.C. to battery voltage at display output TCU sends data to the display and measures always a high voltage level on the connector · Cable or connectors are defective and are contacted to battery voltage · Display has an internal defect	No reaction OP mode : Normal	· Check the cable from TCU to the display · Check the connectors at the display · Change display
E4	S.C. to ground at display output TCU sends data to the display and measures always a high voltage level on the connector · Cable or connectors are defective and are contacted to battery voltage · Display has an internal defect	No reaction OP mode : Normal	· Check the cable from TCU to the display · Check the connectors at the display · Change display
E5	Communication failure on DeviceNet	Shift to neutral OP mode : TCU shutdown	· Check Omron master · Check wire of DeviceNet-Bus · Check cable to Omron master
F1	General EEPROM fault TCU can't read non volatile memory · TCU is defective	No reaction OP mode : Normal	· Replace TCU ※ Often shown together with fault code F2
F2	Configuration lost TCU has lost the correct configuration and can't control the transmission · Interference during saving data on non volatile memory · TCU is brand new or from another vehicle	Transmission stay neutral OP mode : TCU shutdown	· Reprogram the correct configuration for the vehicle (e.g. with cluster controller,...)
F3	Application error Something of this application is wrong	Transmission stay neutral OP mode : TCU shutdown	· Replace TCU ※ This fault occurs only if an test engineer did something wrong in the application of the vehicle
F5	Clutch failure AEB was not able to adjust clutch filling parameters · One of the AEB-Values is out of limit	Transmission stay neutral OP mode : TCU shutdown	· Check clutch ※ TCU shows also the affected clutch on the display
F6	Clutch adjustment data lost TCU was not able to read correct clutch adjustment parameters · Interference during saving data on non volatile memory · TCU is brand new	No reaction, Default values : 0 for AEB Offsets used OP mode : Normal	· Execute AEB and brake sensor calibration
F7	Substitute clutch control · Transmission input torque wrong · Engine retarder torque wrong · Speed signal (s) defective	OP mode : Substitute clutch control	· Check engine retarder torque · Check speed sensors

※ Some fault codes are not applied to this machine.

5) MEASURING OF RESISTANCE AT ACTUATOR/SENSOR AND CABLE

(1) Actuator



76043PT19

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

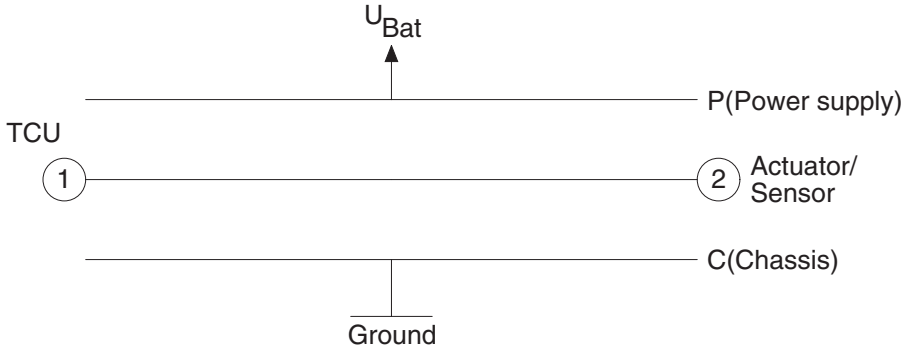
Short cut to ground $R_{12} = R$; $R_{1G} = 0$, $R_{2G} = R$ or $R_{1G} = R$, $R_{2G} = 0$

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

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

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

(2) Cable



76043PT20

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

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

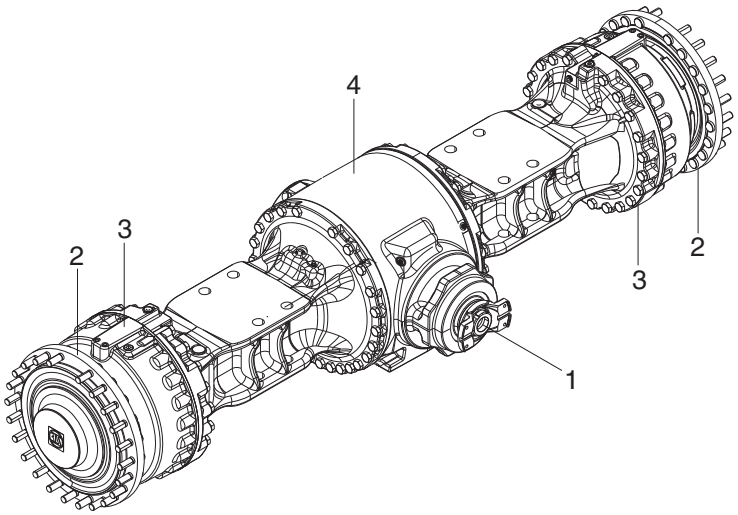
Short cut to battery $R_{12} = 0$; $R_{1C} = R_{2C} = 0$, $R_{1P} = R_{2P} = 0$

5. AXLE

1) OPERATION

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

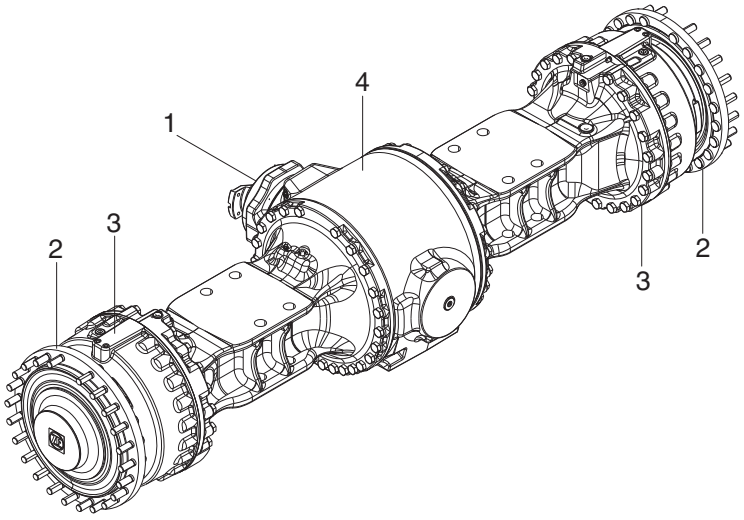
(1) Front axle



78093PT14

1 Input 2 Output 3 Brake
4 Axle housing

(2) Rear axle



78093PT15

1 Input 2 Output 3 Brake
4 Axle housing

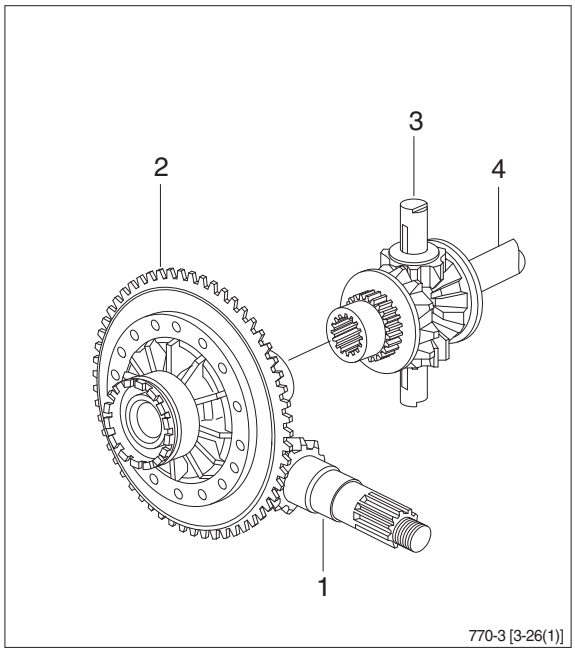
2) DIFFERENTIAL

(1) Description

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

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

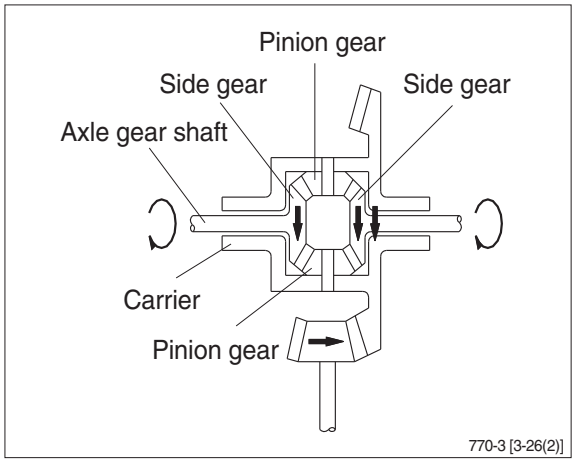
It then transmits the motive force through the differential (3) to the axle gear shaft (4).



770-3 [3-26(1)]

(2) When driving straight forward

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

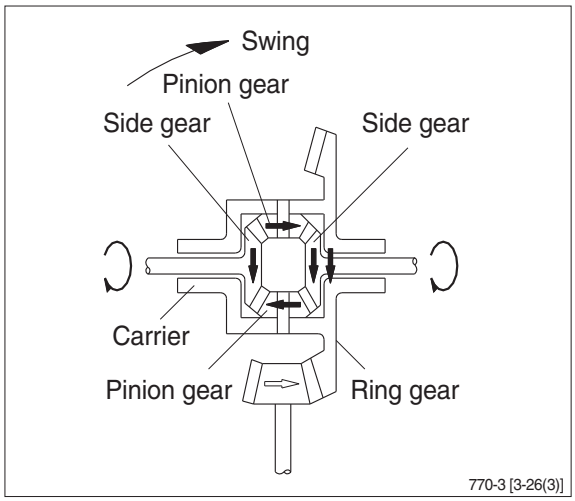


770-3 [3-26(2)]

(3) When turning

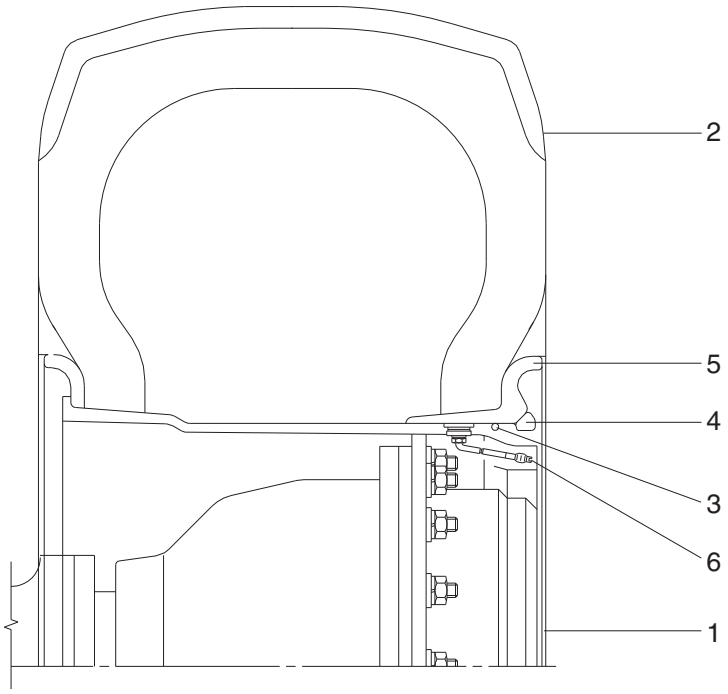
When turning, the rotating speed of the left and right wheels is different, so the pinion gear and side gear inside the differential assembly rotate in accordance with the difference between the rotating speed of the left and right wheels.

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



770-3 [3-26(3)]

6. TIRE AND WHEEL



7407APT10

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

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

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

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

1. POWER TRAIN OPERATIONAL CHECKS

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

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

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

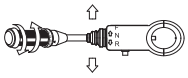
Locate system check in the left column and read completely, following the sequence from left to right. Read each check completely before performing.

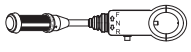
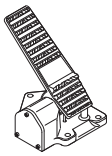
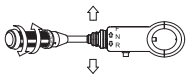
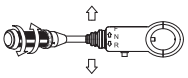
At the end of each check, if no problem is found(OK), that check is complete or an additional check is needed. If problem is indicated(NOT OK), you will be given repair required and group location.
If verification is needed, you will be given next best source of information :

Chapter 2 : Troubleshooting
Group 3 : Tests and adjustments

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

Item	Description	Service action
Transmission oil warm-up procedure	 Start engine. Apply service brakes and release parking brake. Select T/M shift mode to MANUAL mode. Move gear selector lever to 3rd speed. MANUAL mode  Move gear selector lever to forward "F" position. Increase engine speed to high idle for 30 seconds.  Move gear selector lever to neutral "N" position and run for 15 seconds. Repeat procedure until transmission temperature gauge arrow points to bar above dial.	**OK** Check completed.
Gear selector lever and neutral lock latch checks Engine OFF.	 Move gear selector lever to each position. **NOTE** : Gear selector lever position changes slightly as steering column is tilted. **FEEL** : Lever must move freely through all positions.  Engage neutral lock. Apply slight effort to move lever into forward (F) and reverse (R). **LOOK** : Neutral lock must stay engaged.	**OK** Check completed. **NOT OK** Repair lock or replace switch.
Automatic shifting check	 Start engine. Move gear selector lever to 4th speed. AL mode  Select T/M shift mode to AL (auto light) mode. **LOOK** : Automatic sign on cluster. Move gear selector lever to forward or reverse position. Automatic mode  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 3-65~ 3-81. 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 : 2050±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 3-65~3-81.

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.

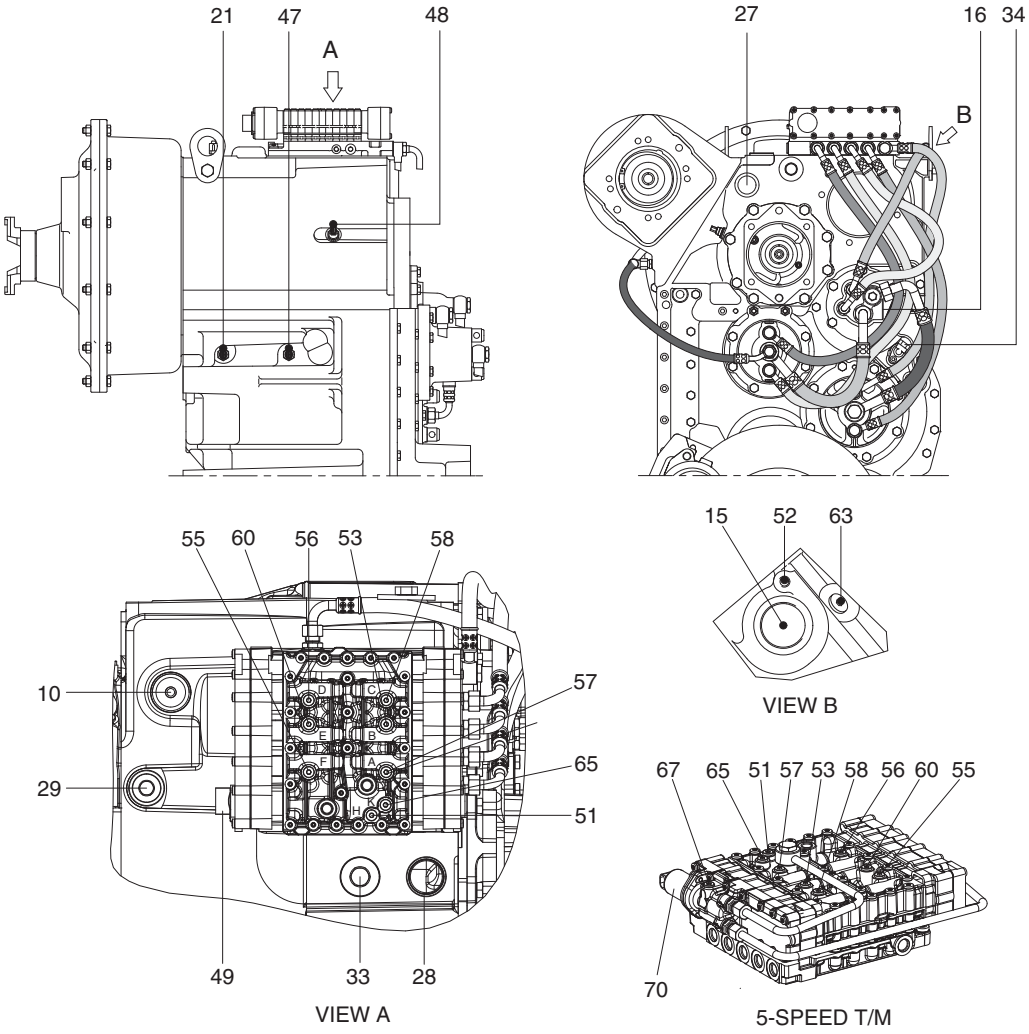
3) DRIVE LINE

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.

GROUP 3 TESTS AND ADJUSTMENTS

1. TRANSMISSION MEASURING POINTS AND CONNECTIONS

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



7809A3PT17

1) OIL PRESSURE AND TEMPERATURE

Port	Description			Size
51	In front of the converter-opening pressure (11bar)		H	M10×1.0
52	Behind the converter-opening pressure (5bar)			M14×1.5
53	Forward clutch (16+2bar)	KV	B	M10×1.0
55	Reverse clutch (16+2bar)	KR	F	M10×1.0
56	1st clutch (16+2bar)	K1	D	M10×1.0
57	2nd clutch (16+2bar)	K2	A	M10×1.0
58	3rd clutch (16+2bar)	K3	C	M10×1.0
60	4th clutch (16+2bar)	K4	E	M10×1.0
63	Behind the converter temperature 100˚C, short-time 120˚C			M14×1.5
65	System pressure (16+2bar)		K	M10×1.0
*67	Lock-up clutch pressure (12+2bar)			M10×1.0

* : 5-speed transmission

2) DELIVERY RATES

Port	Description	Size
10	Breather	M10×1.0
15	Connection to the oil cooler	-
16	Connection from the oil cooler	-
27	Connection to the filter	M42×2.0
28	Connection from the filter	M42×2.0
29	Connection from the filter bypass	M42×2.0
33	Connection oil filler plug	M42×2.0
49	Plug connection on the electro-hydraulic control unit	-

3) INDUCTIVE TRANSMITTER AND SPEED SENSOR

Port	Description		Size
21	Inductive transmitter	n Turbine	M18×1.5
34	Speed sensor	n Output and speedometer	-
47	Inductive transmitter	n Central gear train	M18×1.5
48	Inductive transmitter	n Engine	M18×1.5

4) SOLENOID VALVE (5-speed transmission)

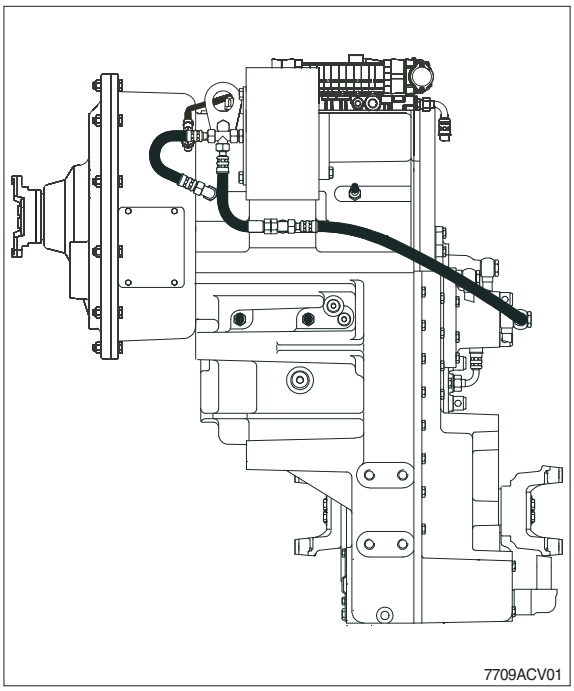
Item	Description	Size
70	Converter lock-up clutch	AMP 282080-1

1. CONTROL VALVE

1) DISASSEMBLY

(1) Attach transmission to assembly truck.

Assembly truck	5870 350 000
Holding fixture	5870 350 071



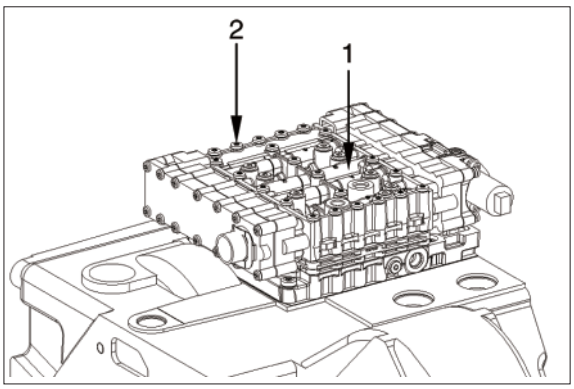
※ Drain oil prior to starting disassembly.

※ Disposal of oil according to legal requirements.

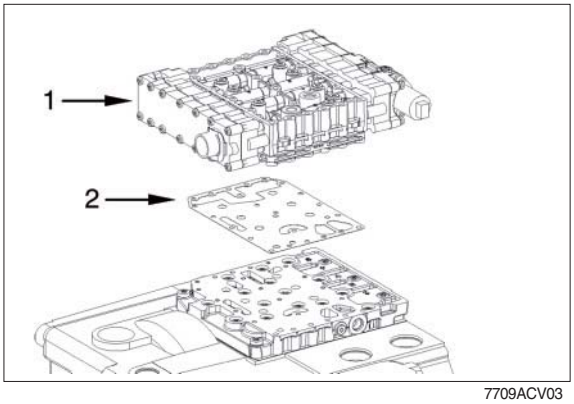
Removal of electric gear-shift control

(2) Remove alll oil pipes.
Remove gear-shift control (1).
Loosen torx screws (2).

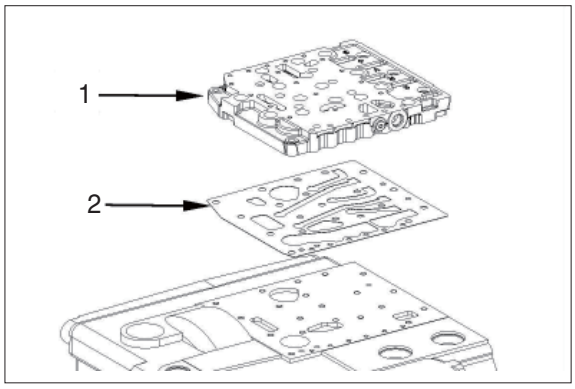
Socket wrench TX-27	5873 042 002
Adjusting screws M6	5870 204 063



(3) Remove gear-shift control assy (1) and gasket (2).

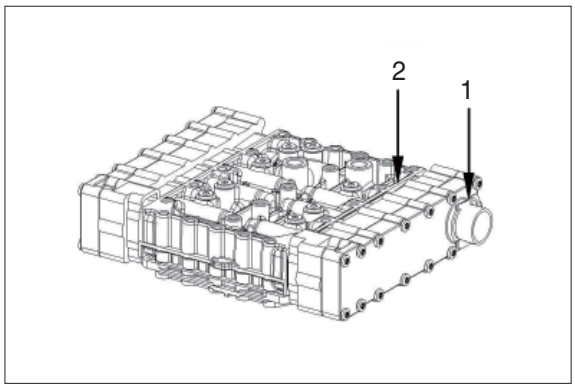


(4) Loosen torx screws and separate duct plate (1) and gasket (2) from gearbox housing.



7709ACV04

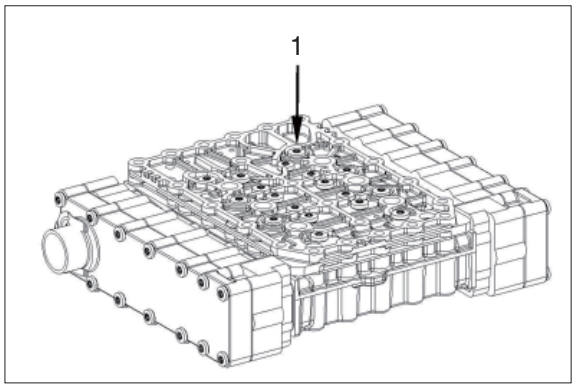
(5) Mark installation position of wiring harness (1) towards valve block (2).



7709ACV05

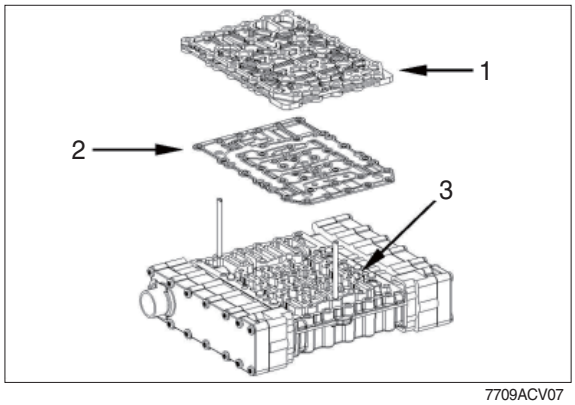
(6) Loosen torx screws (1).

Socket wrench TX-27 5873 042 002



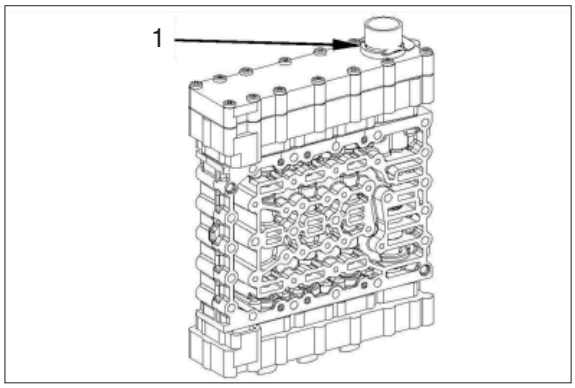
7709ACV06

(7) Separate duct plate (1) and sealing plate (2) from valve block (3).



7709ACV07

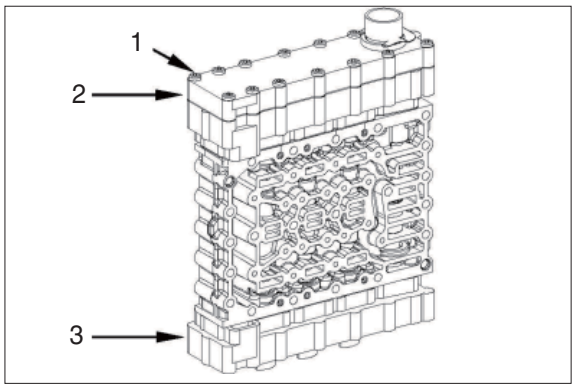
(8) Remove retaining clamp (1).



7709ACV08

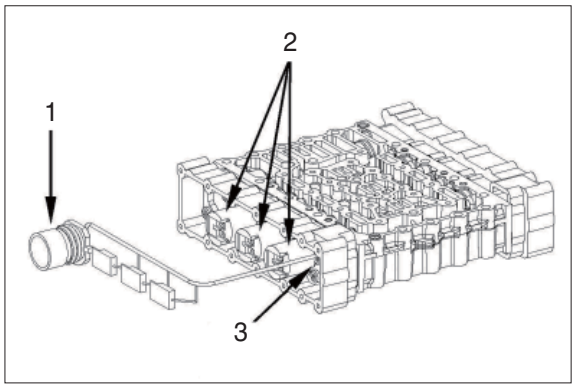
(9) Loosen torx screws (2) and remove cover (2). Remove opposite cover (3) in the same way.

Socket wrench TX-27 5873 042 002



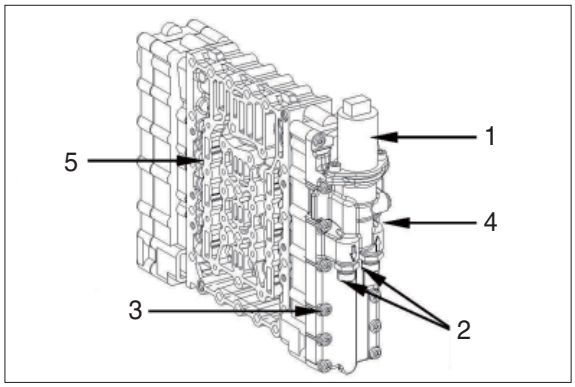
7709ACV09

(10) Remove wiring harness (1).
Loosen cylindrical screws (3), remove fixing plates and remove pressure controllers (2).



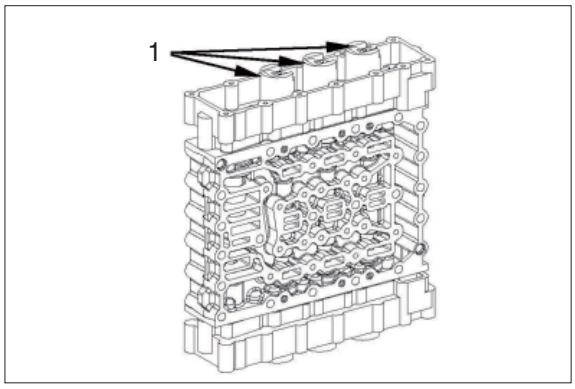
7709ACV10

(11) **Lock-up clutch solenoid valve (5-speed transmission)**
Mark installation position of connecting housing (4) towards valve block (5).
Loosen cylindrical screws (1) and remove lock-up clutch valve.
Loosen screws neck (2) and remove O-rings.
Loosen torx screws (3) and remove connecting housing.



7709ACV11

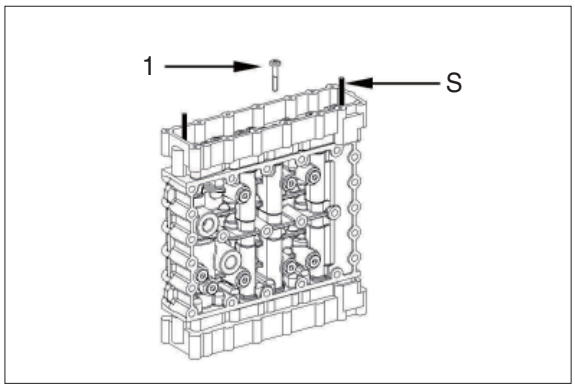
(12) Loosen cylindrical screws, remove fixing plates and remove pressure controllers (1) on opposite side.



7709ACV12

(13) Loosen torx screws (1) and preliminarily fix housing by means adjusting screws (S). (Housing is spring-loaded.) Then loosen remaining torx screws.

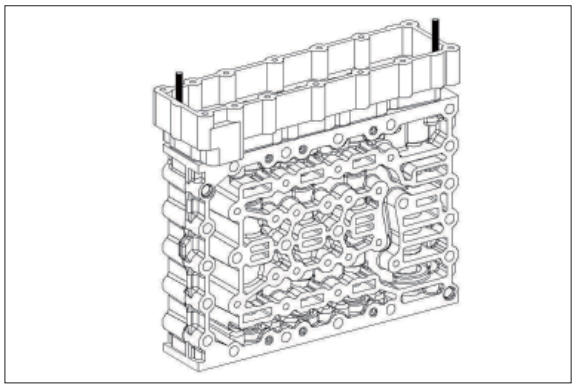
Adjusting screws 5870 204 036



7709ACV13

(14) Separate housing from valve housing by loosening the adjusting screws equally.

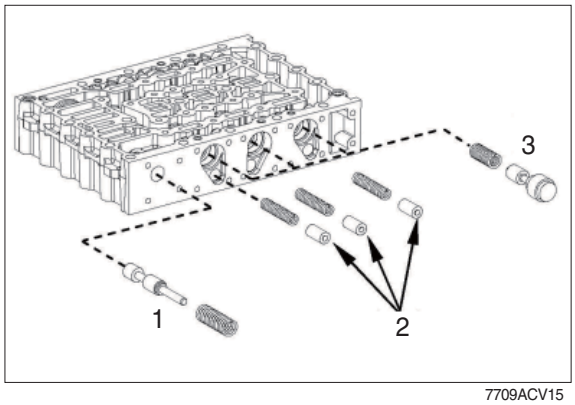
Adjusting screws 5870 204 036



7709ACV14

(15) Remove individual parts :

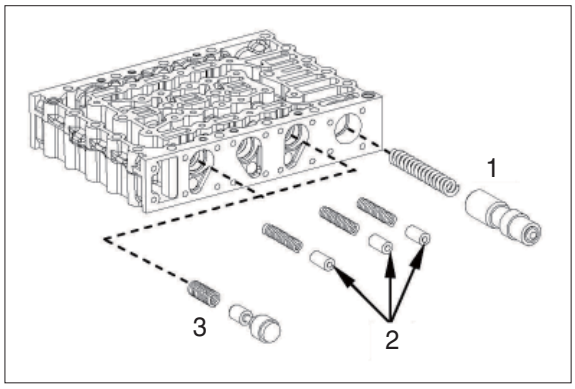
1 Pressure reducing valve
2 Vibration dampers
3 Follow-on silde



7709ACV15

(16) Remove individual parts of opposite side analogously :

1 Main pressure valve
2 Vibration dampers
3 Follow-on silde

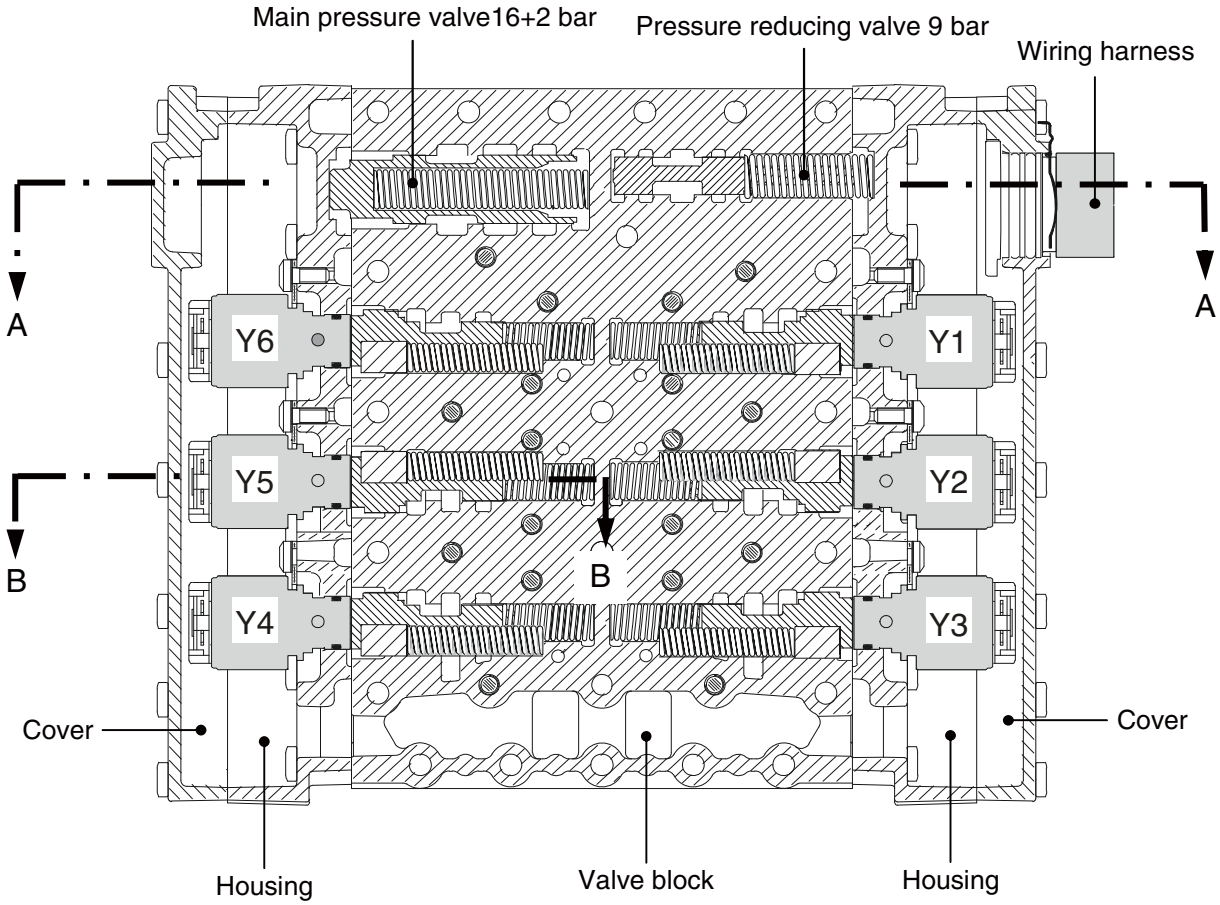


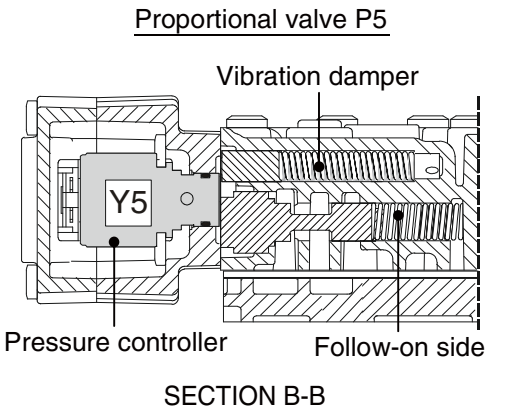
7709ACV16

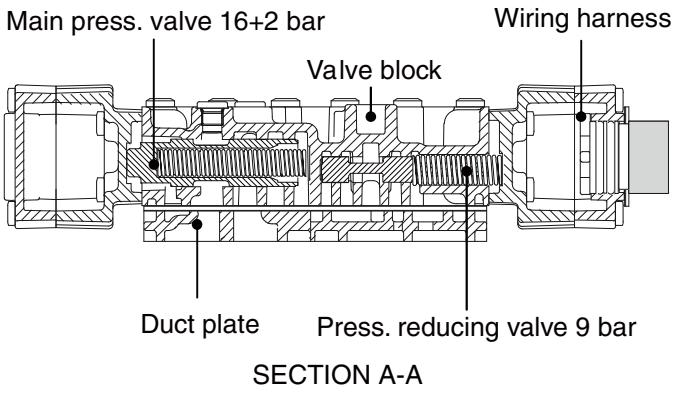
2) REASSEMBLY

Electro-hydraulic control with proportional valves :

※ The following sketches show the sectional views of the electro-hydraulic control.





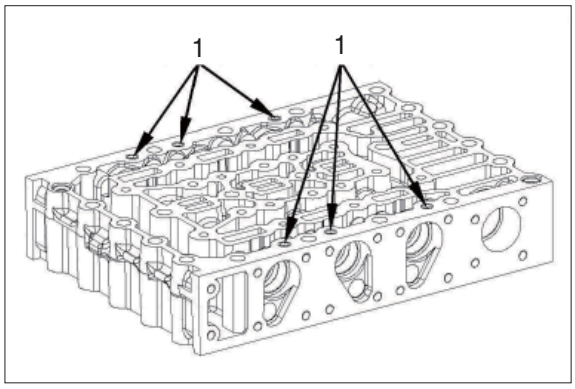


(1) **Fitting of electric control**

※ All single parts are to be checked for damage and replaced, if required.
Ensure free travel of the moving parts in the valve block prior to installation. Pistons can be exchanged individually.
Prior to the installation, oil single part.

① With the concave side showing upwards, insert orifice (1) until contact is obtained.

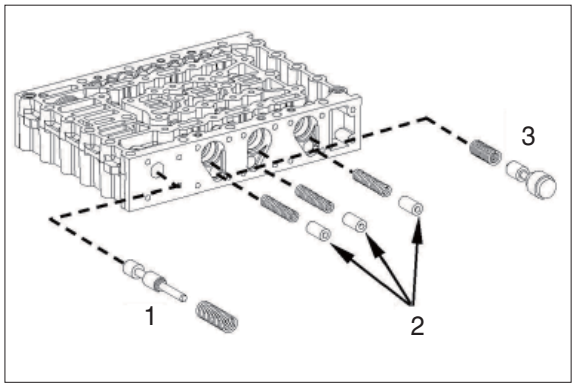
※ See arrows for installation position.



7709ACV20

② The opposite figure shows the following single parts :

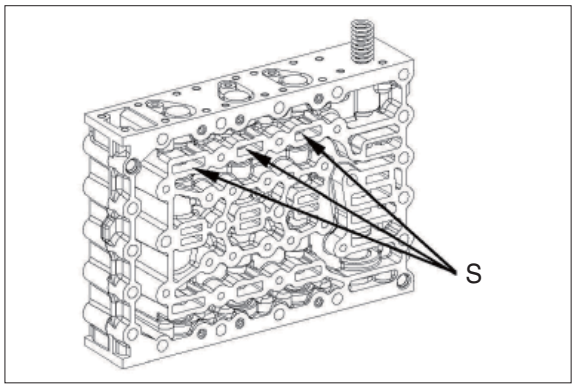
1 Pressure reducing valve
(1EA, piston and compression spring)
2 Vibration damper
(3EA, piston and compression spring)
3 Follow-on slide
(3EA, piston and compression spring)



7709ACV21

③ Install the single parts according to figure CV21.

※ Preload compression springs of the follow-on slides and preliminarily fix pistons by means of cylindrical pins Ø5.0 mm (assembly aid), see arrows (S).

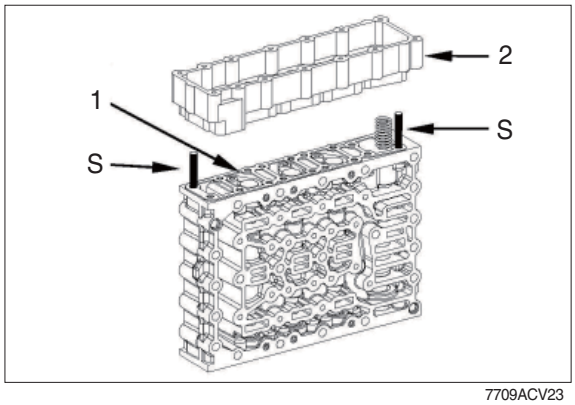


7709ACV22

④ Fit two adjusting screws.

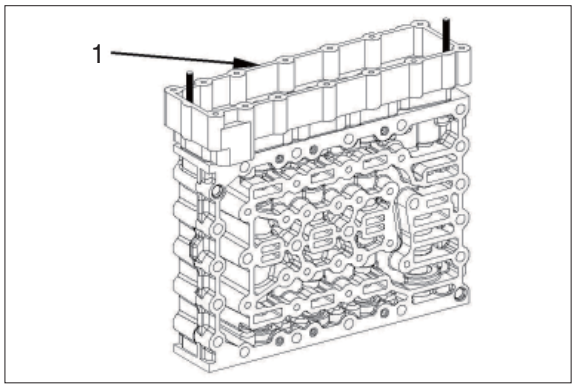
Mount seal (1) and housing (2).
Then position housing equally by means of adjusting screws until contact is obtained.

Adjusting screws (S) 5870 204 036



7709ACV23

⑤ Bring housing (1) into contact position by means of the torx screws. This will preload the pistons, and you can remove the cylindrical pins (assembly aid).

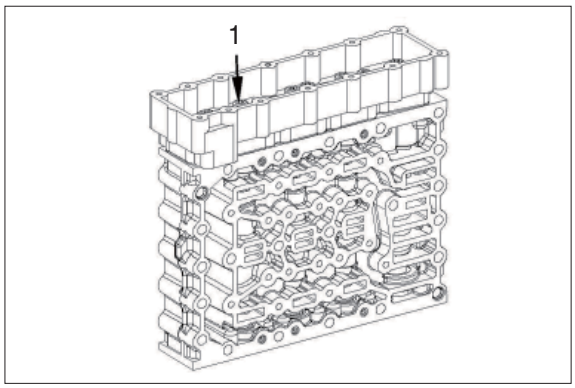


7709ACV24

⑥ Fix housing by means of the torx screws (1).

· Tightening torque (M5/10.9×30) :
0.56 kgf · m (4.06 lbf · ft)

Reducing adapter	5870 656 056
Socket wrench TX-27	5873 042 002



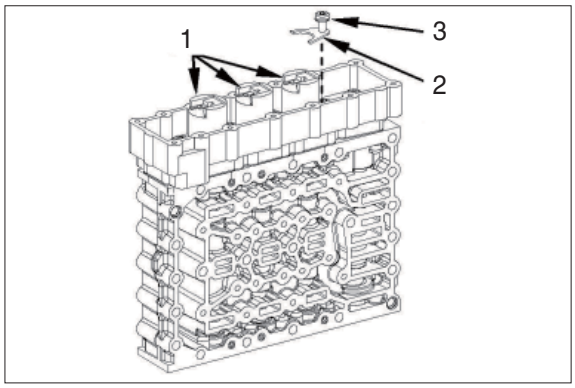
7709ACV25

⑦ Monut pressure controllers with O-ring 13.5×2 (1) and fasten them by means of fixing plates (2) and torx screws (3).

※ Install the fixing plate, with the claw showing downwards.
Pay attention to the radial installation position of pressure controllers, see figure.

· Tightening torque (M5/8.8×12) :
0.56 kgf · m (4.06 lbf · ft)

Reducing adapter	5870 656 056
Socket wrench TX-27	5873 042 002

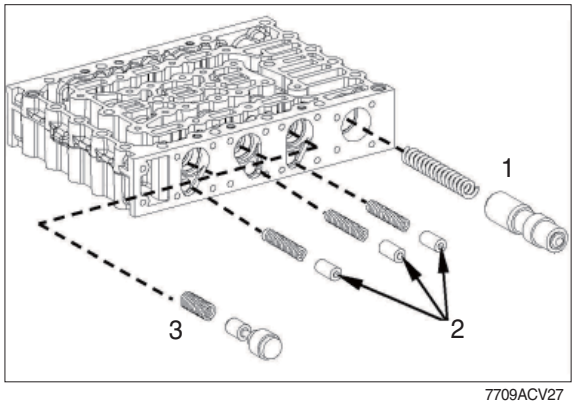


7709ACV26

Preassemble the opposite side

⑧ The figure on the right shows the following single parts :

1 Main pressure valve
(1EA, piston and compression spring)
2 Vibration damper
(3EA, piston and compression spring)
3 Follow-on slide
(3EA, piston and compression spring)



7709ACV27

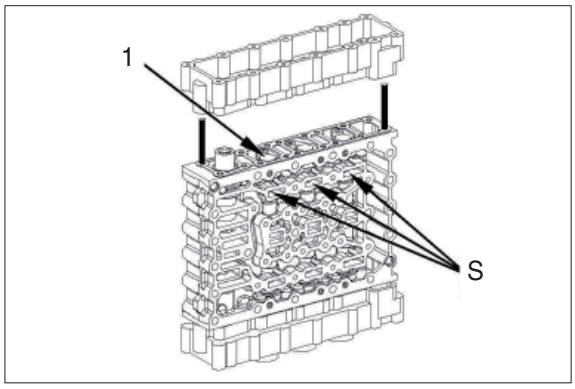
⑨ Install the single parts according to figure CV27.

※ Preload the compression springs of the follow-on slides and fasten the pistons preliminarily by means of cylindrical pins (S) Ø5.0 mm (assembly aid), see arrows (S).

Install two adjusting screws.

Adjusting screws M5 5870 204 036

Assemble flat gasket (1) and housing cover. Then place the housing cover by means of adjusting screws equally until contact.

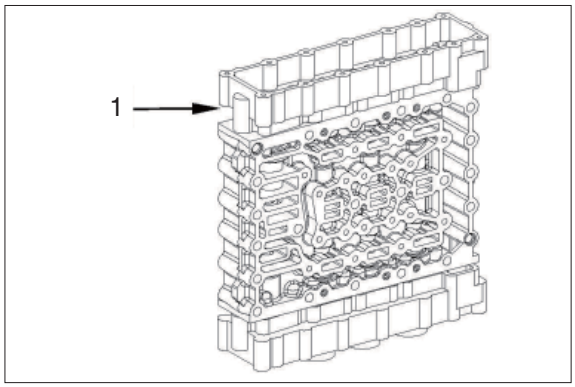


7709ACV28

⑩ Preload the position with torx screws and remove the cylindrical pins (assembly aid) again.
Then fasten the housing cover by means of torx screws (1).

· Tightening torque (M5/10.9×30) :
0.56 kgf · m (4.06 lbf · ft)

Adjusting screws	5870 204 036
Reducer	5870 656 056
Socket spanner TX-27	5873 042 002

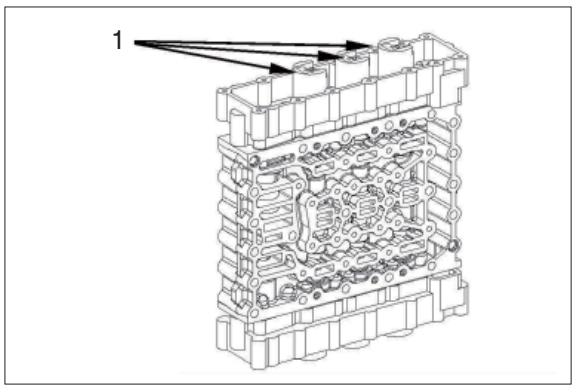


7709ACV29

⑪ Monut the pressure regulators with O-ring 13.5×2 (1) and fasten them by means of fixing plates and cap screws.

※ Install the fixing plate with the neck showing downwards.
Observe radial installation position of the pressure regulators, see figure.

· Tightening torque (M5/8.8×12) :
0.56 kgf · m (4.06 lbf · ft)

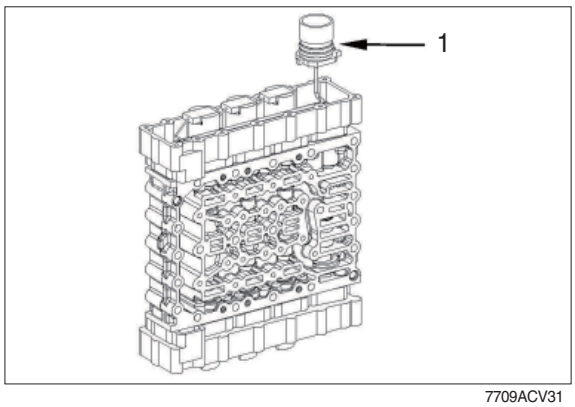


7709ACV30

⑫ Assemble the wiring harness (1) and connect the pressure regulators (6EA).

※ See figure CV01 for installation position of pressure regulators.

※ Pay attention to the installation position of the wiring harness, also see markings (figure CV05).

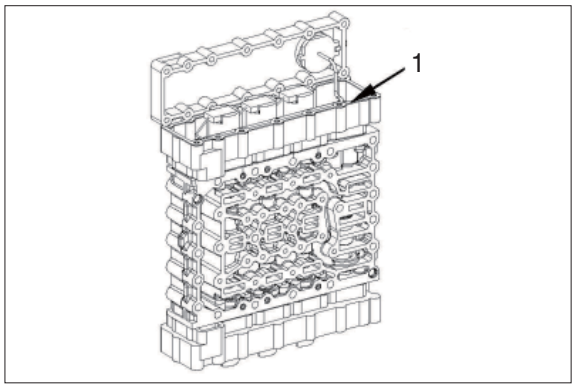


7709ACV31

⑬ Put on the flat gasket (1).
Assemble the plug socket with the slot showing to the lug of the cover until contact.
Fasten the cover by means of cap screws.

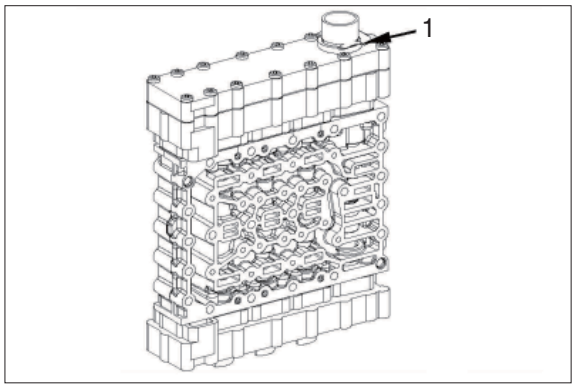
· Tightening torque (M5/10.9×30) :
0.56 kgf · m (4.06 lbf · ft)

Reducer	5870 656 056
Socket spanner TX-27	5873 042 002



7709ACV32

⑭ Fix the wiring harness by means of retaining clamp (1).



7709ACV33

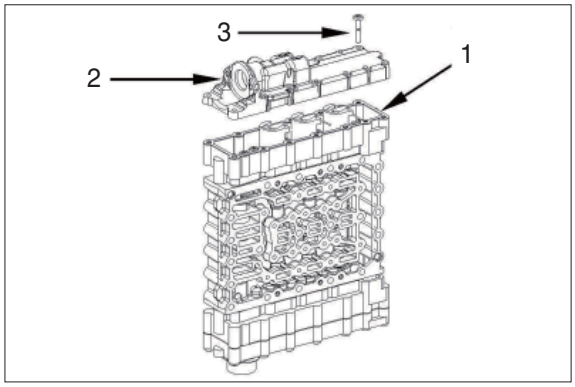
⑮ **Lock-up clutch solenoid valve (5-speed transmission)**

a. Place gasket (1).
Fix connecting housing (2) by means of torx screws (3).

· Tightening torque (M5/10.9×30) :
0.56 kgf · m (4.06 lbf · ft)

Torque wrench	5870 203 031
Socket wrench TX-27	5873 042 002
Reducing adapter	5870 656 056

※ Pay attention to installation position of connection housing, see the markings applied during disassembly.



7709ACV34

b. Fix pressure controller (1) by means of cylindrical screws (2).

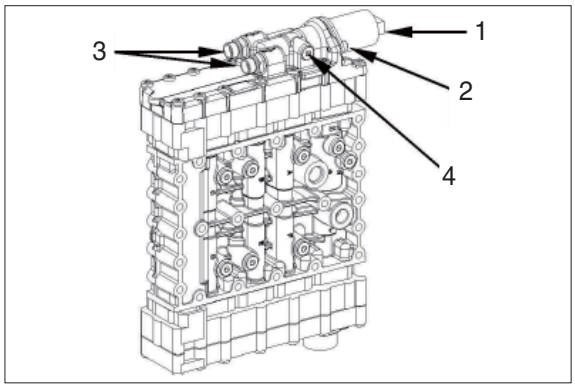
· Tightening torque (M6/8.8×12) :
1.02 kgf · m (7.38 lbf · ft)

Fit screw necks with O-ring 11.3×2.4 (3).

· Tightening torque :
2.55 kgf · m (18.4 lbf · ft)

Fit screw plug with O-ring 8×1.5 (4).

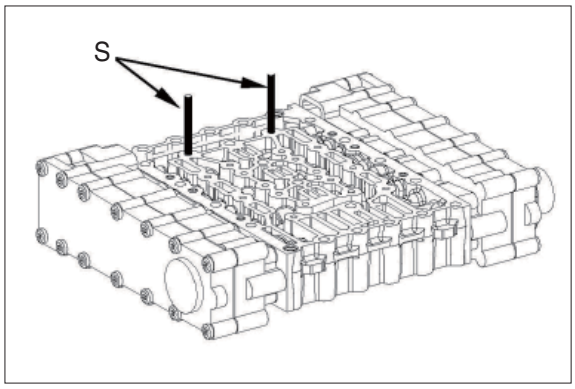
· Tightening torque (M10×1) :
1.02 kgf · m (7.38 lbf · ft)



7709ACV35

⑯ Install two adjusting screws (S).

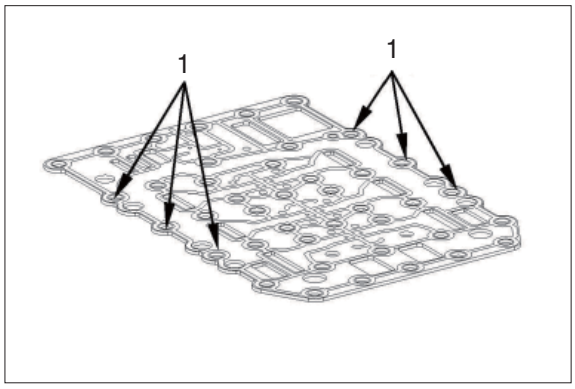
Adjusting screws 5870 204 063



7709ACV36

⑰ Flush-mount screens (1) into the holes of the sealing plate, see arrows.

※ Pay attention to the installation position - screens to show upwards (towards the duct plate).

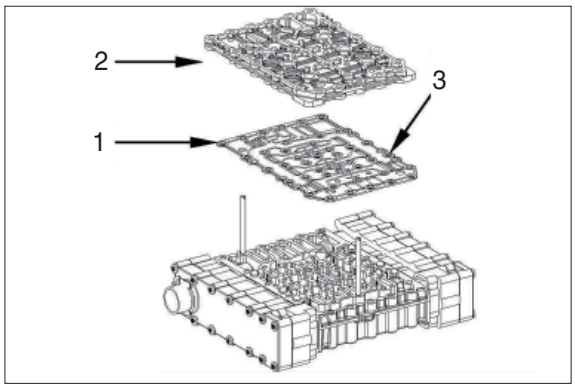


7709ACV37

⑱ Put on sealing plate (1) and duct plate (2).

※ Screens (3) to show upwards.

※ It is not permitted to reassemble the seal plate after opening the threaded joint shift unit/duct plate.
In case of repair it is always necessary to mount a new seal plate.

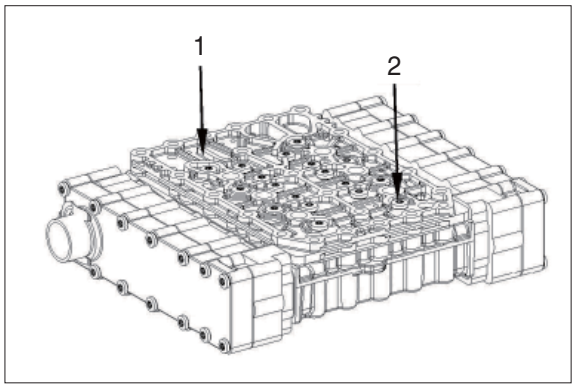


7709ACV38

⑲ Place duct plate (1) and fix it equally by means of torx screws (2).

· Tightening torque (M6/10.9×23) :
1.07 kgf · m (7.74 lbf · ft)

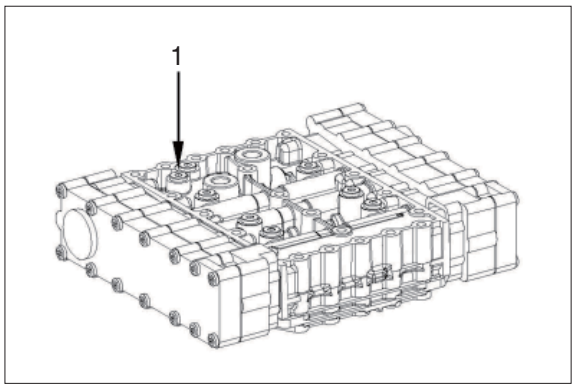
Socket wrench TX-27 5873 042 002



7709ACV39

⑳ Provide the screw plugs M10×1 with O-rings 8×1.5 (1) and install them.

· Tightening torque :
0.61 kgf · m (4.43 lbf · ft)

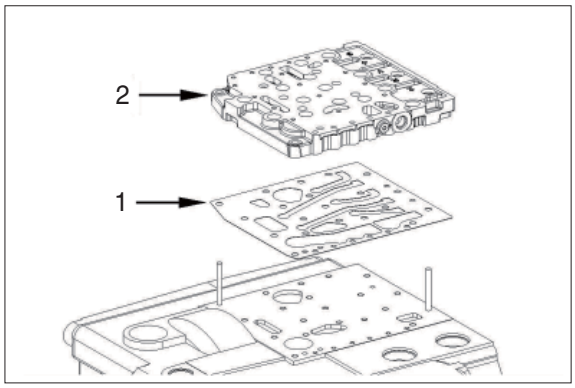


7709ACV40

㉑ Fit two adjusting screws.

Adjusting screws 5870 204 011

Place gasket (1) and duct plate (2) at the gearbox housing part until contact is obtained.



7709ACV41

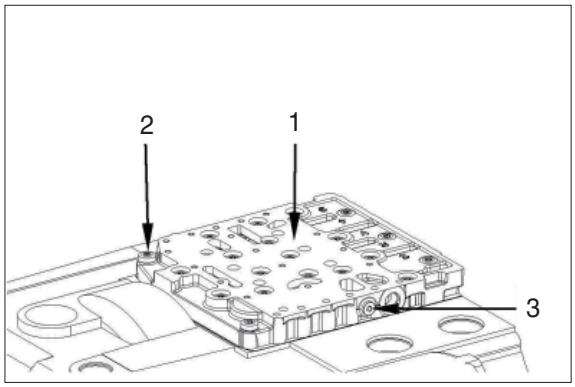
㉒ Fix duct plate (1) by means of torx screws (2).

· Tightening torque (M8/10.9×35) :
2.35 kgf · m (17.0 lbf · ft)

Mount screw plug with O-ring 8×1.5 (3).

· Tightening torque (M10×1) :
0.61 kgf · m (4.43 lbf · ft)

Socket wrench TX-40 5873 042 004



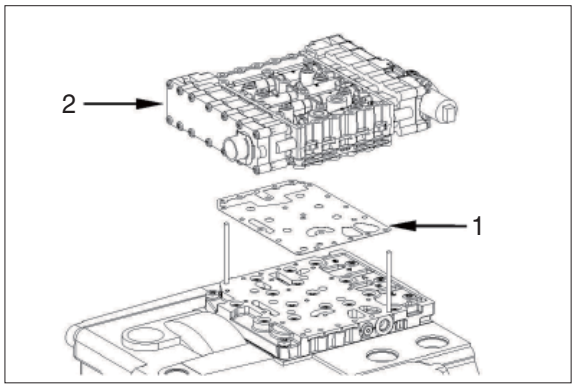
7709ACV42

㉓ Fit two adjusting screws.

Adjusting screws 5870 204 063

Mount sealing plate (1) and electro-hydraulic control unit (2).

※ It is not permitted to reassemble the seal plate after opening the threaded joint shift unit/gearbox housing.
In case of repair it is always necessary to mount a new seal plate.

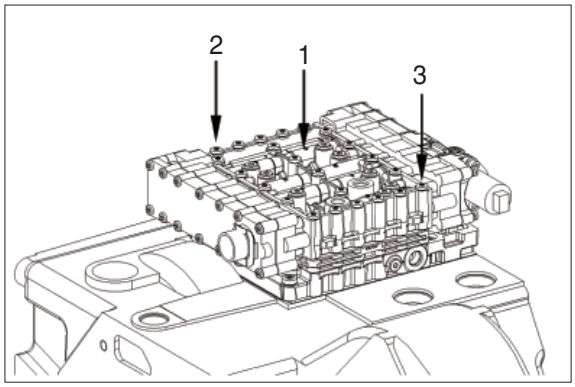


7709ACV43

㉔ Fix electro-hydraulic control unit (1) equally by means of torx screws (2 and 3)

· Tightening torque (M6/10.9×76) :
0.97 kgf · m (7.01 lbf · ft)
· Tightening torque (M6/10.9×100) :
0.97 kgf · m (7.01 lbf · ft)

Socket wrench TX-27 5873 042 002
Reducing adapter 5870 656 056



7709ACV44

Pipe - System pressure to lock-up clutch valve (5-speed transmission)

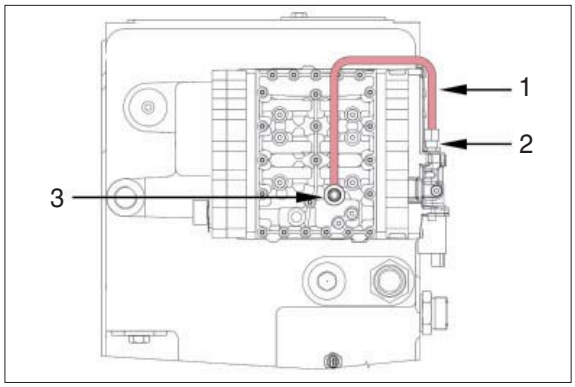
㉕ Fix pipes (1) with hollow screws (3) and O-rings and screw nut (2).

Fit O-ring 13×2 on hollow screw (3), insert into eye of pipes, mount O-ring 18×2.5.

· Tightening torque :
4.59 kgf · m (33.2 lbf · ft)

Fixing of screw nut (2).

· Tightening torque :
3.57 kgf · m (25.8 lbf · ft)



7709ACV45

Pipes - System pressure from lock-up clutch valve to lock-up clutch (5-speed transmission)

㉖ Fix pipe union (1).

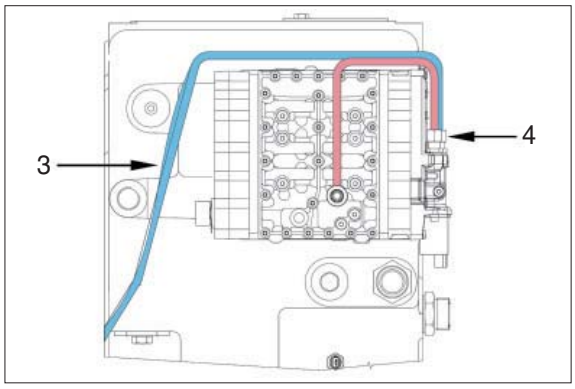
· Tightening torque :
4.08 kgf · m (29.5 lbf · ft)

Fix connection socket (2).

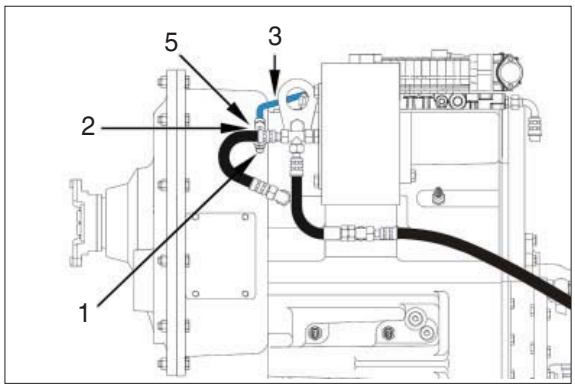
· Tightening torque :
3.57 kgf · m (25.8 lbf · ft)

Fix pipes (3) with screw nut (4 and 5).

· Tightening torque :
3.57 kgf · m (25.8 lbf · ft)

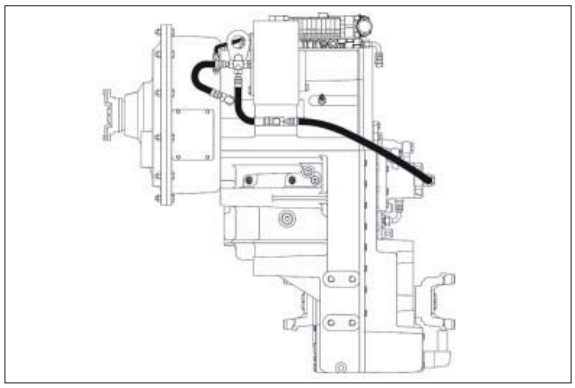


7709ACV46



7709ACV47

※ Before putting the transmission into operation, fill it with oil according to operation manual.


7709ACV48

2. TRANSMISSION

1) DISASSEMBLY

(1) Fasten the complete transmission to the assembly truck.

※ Special tool

Assembly truck	5870 350 000
Holding fixture	5870 350 071

Figure 1

(2) Remove the plug (arrow) and drain the oil. Then remove the oil cylinder.

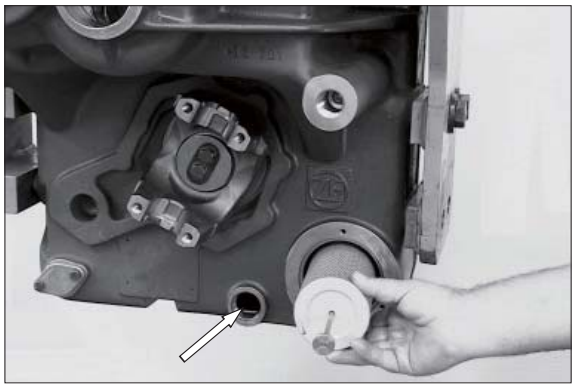


Figure 2

(3) Remove all oil pipes, the complete gear shift system and the duct plate.

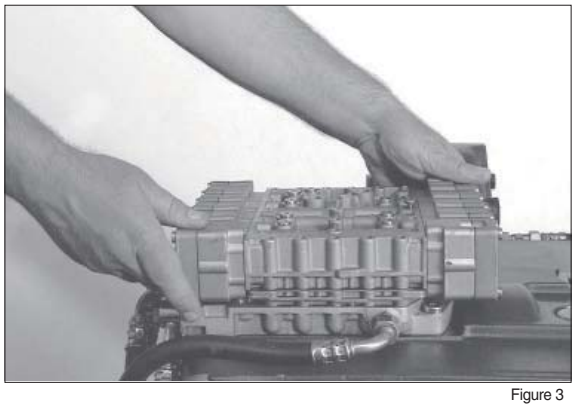


Figure 3

Converter drive

(1) By means of the lifting tackle separate the torque converter from the transmission.

※ Special tool

Eybolts assortment	5870 204 002
Lifting chain	5870 281 047

Figure 4

(2) Loosen the bolt connection and by means of the forcing screws (3EA) separate the cover from the converter bell.

※ Special tool

Forcing screws	5870 204 005

Figure 5

(3) By means of the extractor pull the oil supply flange out of the converter bell.

※ Special tool

Extractor	5870 000 089

Figure 6

(4) Remove the converter safety valve (arrow 1), if required.

※ Converter safety valve is fixed by means of slotted pin (arrow 2).

Figure 7

(5) Loosen the bolt connection (M8 and M12) and by means of lifting tackle and pry bar set separate the coverter bell from the transmission housing.

※ Special tool

Eyebolts assortment	5870 204 002
Pry bar set	5870 345 036
Lifting chain	5870 281 047

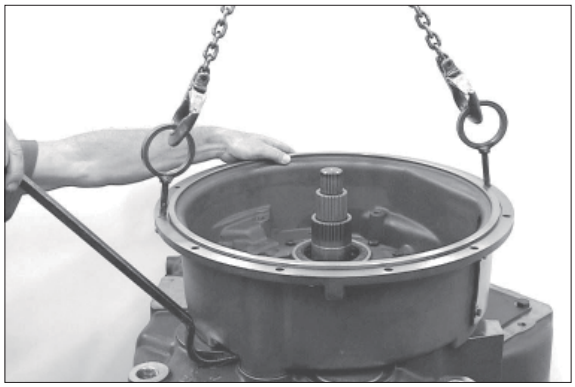


Figure 8

(6) Remove the rectangular ring (arrow).

Figure 9

(7) Press the input shaft out of the spur gear bearing. Remove the released bearing inner ring and the spur gear.

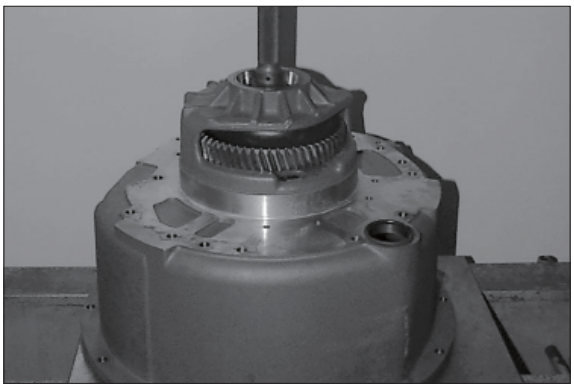


Figure10

(8) Press off the bearing inner ring from the spur gear.

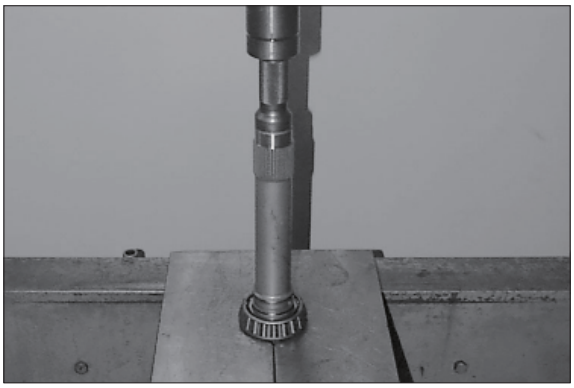


Figure11

(9) Remove the converter pressure back-up valve.

Figure 12

(10) Remove the inductive transmitter.
9 = n - Engine

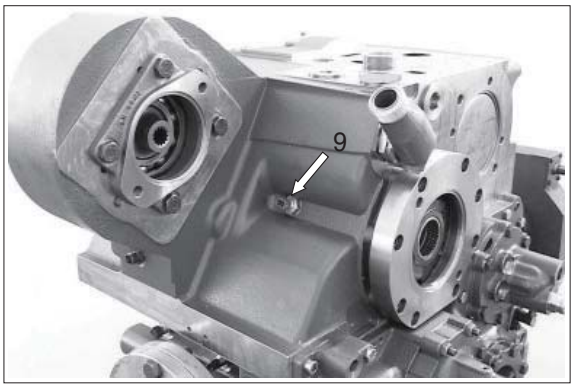


Figure 13

Input shaft-pump/power take-off (the 1st power take-off)

(1) Loosen the cap screw.

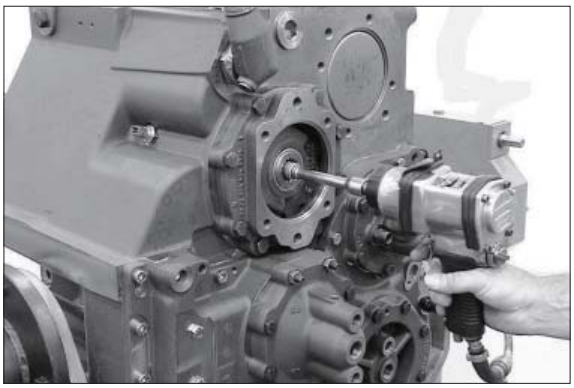


Figure 21

(2) Remove the cap screw and clamping plate.


Figure 22

(3) Press the input shaft out of the bearing.

※ Pay attention to released input shaft as well as shims.

※ Special tool
Extractor 5870 000 065


Figure 23

(4) Snap out the rectangular ring (arrow 1) and remove both shims (arrow 2).

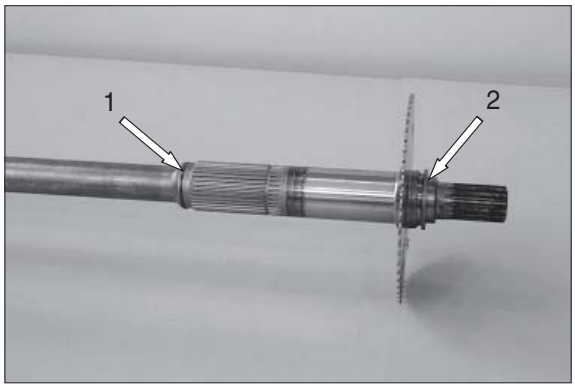


Figure 24

Transmission pump

(1) Loosen the cap and hexagon screws (depending on the version) respectively and separate the pump flange from the housing.

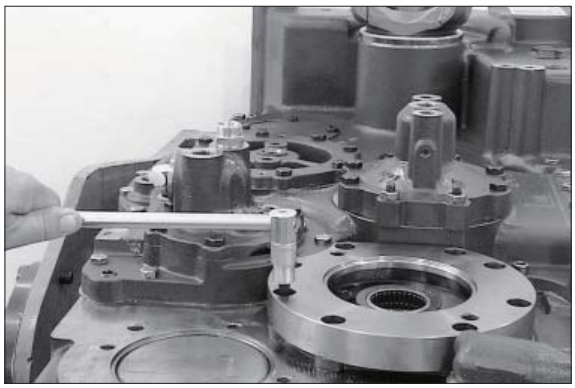


Figure 25

(2) Loosen the cap screws (4EA / M8). Position the extractor on the transmission pump and fasten it by means of screws (M8 × 65) to the transmission pump. Then pull out the pump from the housing bore.

※ Extracting is supported by slightly tapping onto the transmission housing.

※ Special tool

Extractor	5870 000 089

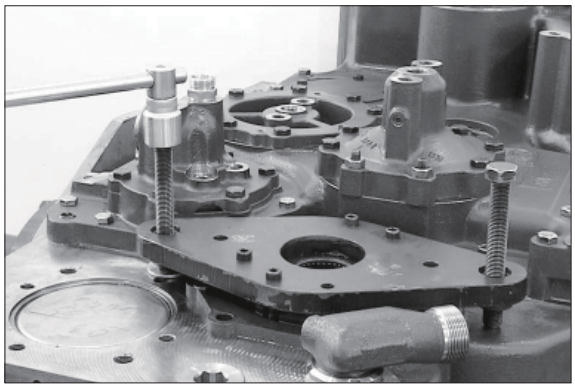


Figure 26

Remove the bearing outer ring (2nd/3rd and 4th power take-off)

(3) Pull out the bearing outer ring from the bore.

※ Special tool

Internal extractor	5870 300 017
Counter-support	5870 300 009

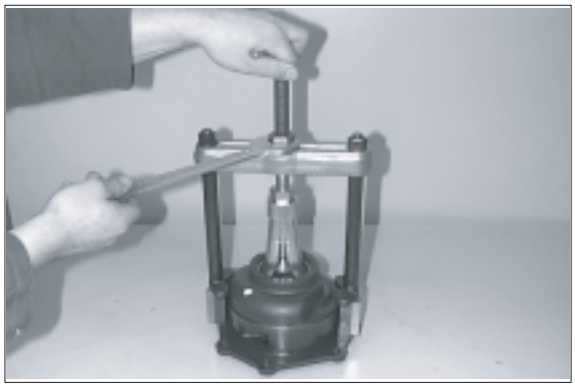


Figure 27

Remove the ball bearing and the driver
(1st power take-off, figure 28~29)

(4) Snap out the retaining ring.

Figure 28

(5) Press out the driver with ball bearing from the bearing bore.
Then separate the ball bearing from the driver.

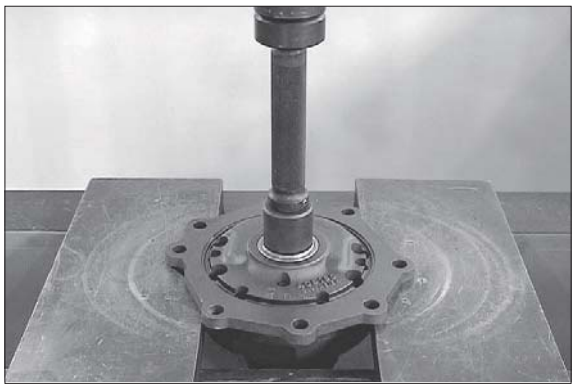


Figure 29

(6) Loosen the cap screws, take off the pump cover and remove the rotor set.

⚠ **If marks due to running-in are found on the pump housing or housing cover, the complete pump is to be replaced.**

Then assemble the rotor set with the chamfer on the tooth tip showing downwards and install the housing cover again.

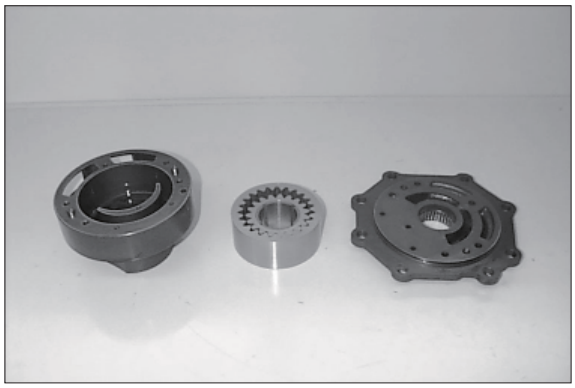


Figure 30

- Torque limit (M8/8.8) :
  2.35 kgf · m (17.0 lbf · ft)
- Torque limit (M6/8.8) :
  0.97 kgf · m (7.01 lbf · ft)

3rd/and 4th power take-off

(7) Remove the screw-in sleeve (arrow).

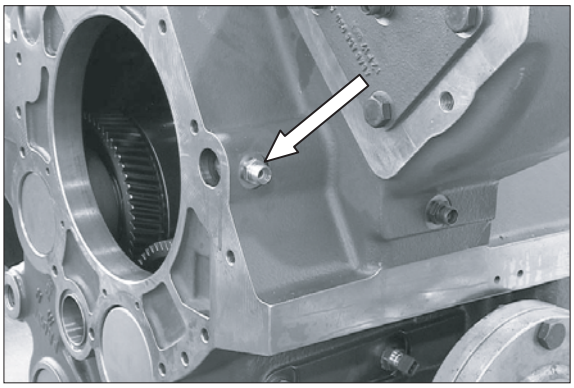


Figure 31

(8) Sealing cap is to be drilled centrically and thread M8 to be cut.
By means of the striker expel the sealing cap from the housing bore.

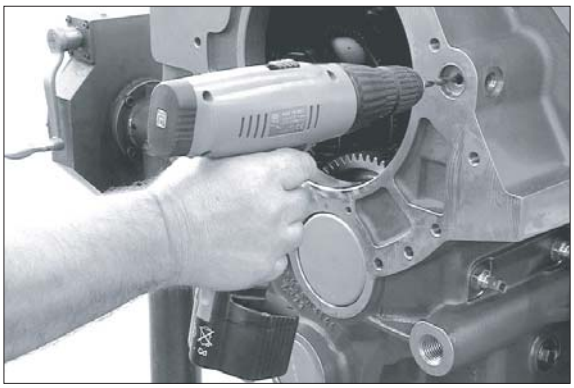


Figure 32

(9) By means of the striker expel the pin from the housing bore (figure 33) and remove the complete spur gear (figure 34).

※ Pay attention to released shim (2).

Striker 5870 650 001

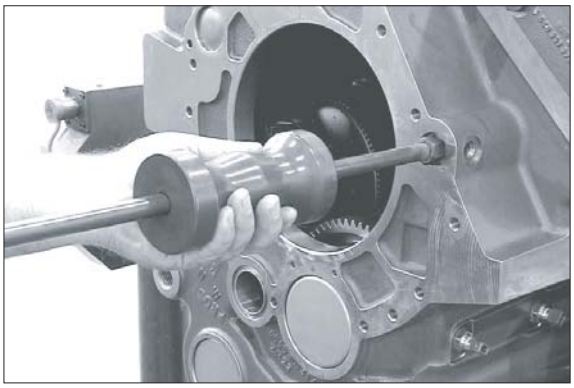


Figure 33

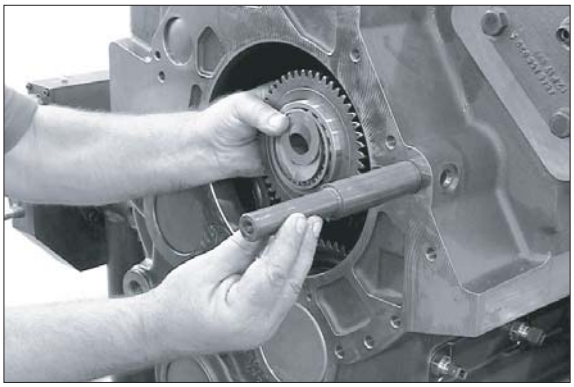


Figure 34

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

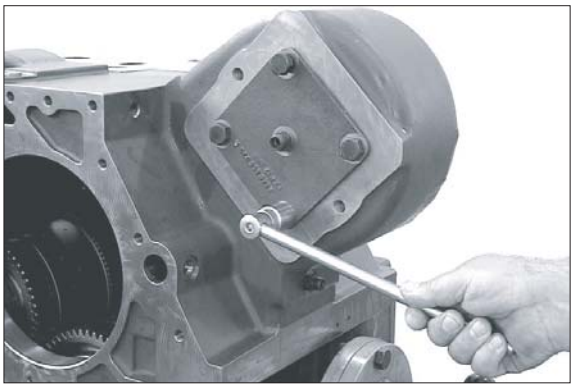


Figure 35

(11) Remove the pump flange on the rear side and snap out the retaining ring.

Clamping pliers 5870 900 021

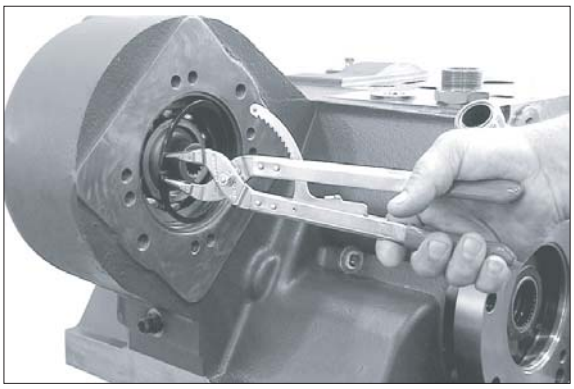


Figure 36

(12) Expel the driver from the bearing bore and remove the released single components.

Plastic hammer 5870 280 004

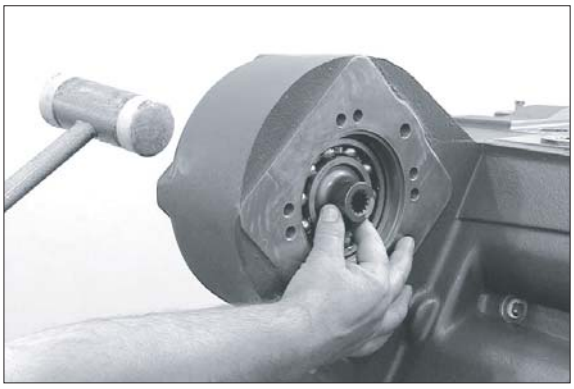


Figure 37

Layshaft

(1) Remove the sealing cover and loosen the hexagon screw.

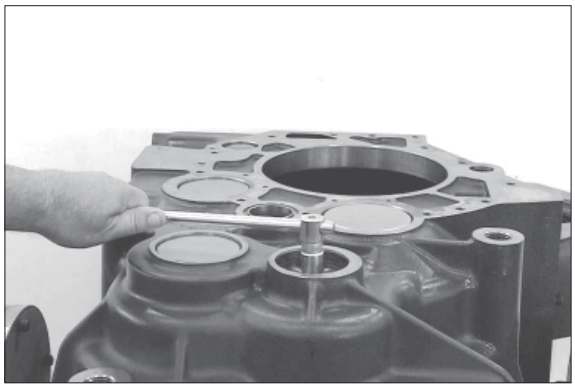


Figure 38

(2) Expel the idler shaft by means of the striker from the housing bore and layshaft bearing respectively.

Striker 5870 650 014

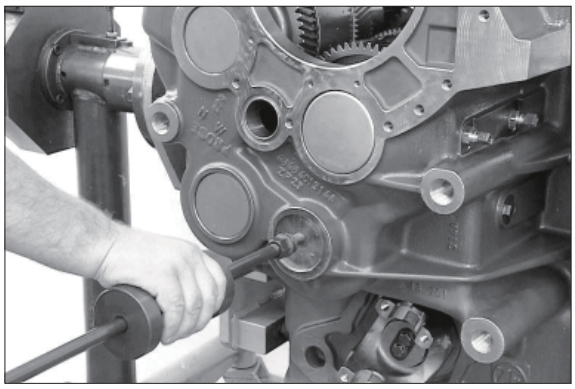


Figure 39

Removal of inductive and speed transmitter (figure 40~41)

14 = n - Turbine
5 = n - Internal speed input
13 = n - Output (speed transmitter)

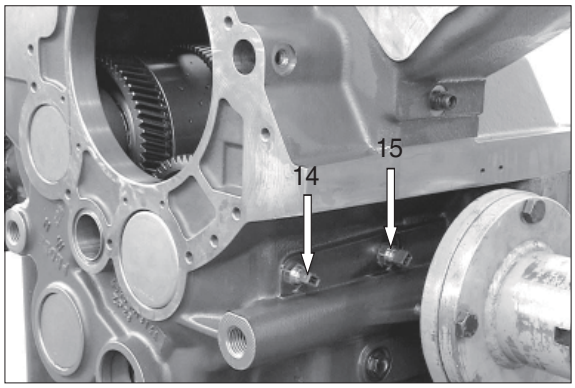


Figure 40

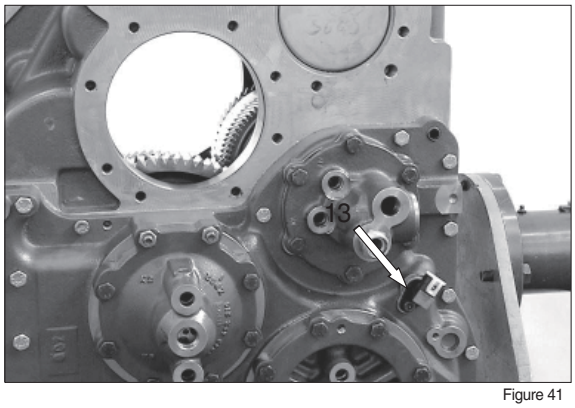


Figure 41

Output

Converter side :

Remove the lock plate. Loosen hexagon screws and take off the output flange.

Rotate the housing by 180˚ and remove the output flange on the housing rearside.

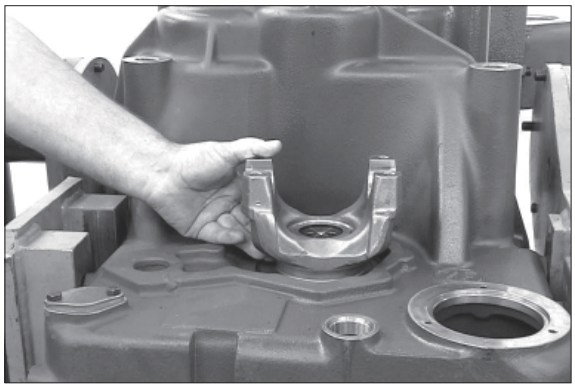


Figure 42

Transmission rearside

⚠ For working on the brake system observe the instructions and specifications of the brake manufacturer.

(1) Unscrew the screw cap.

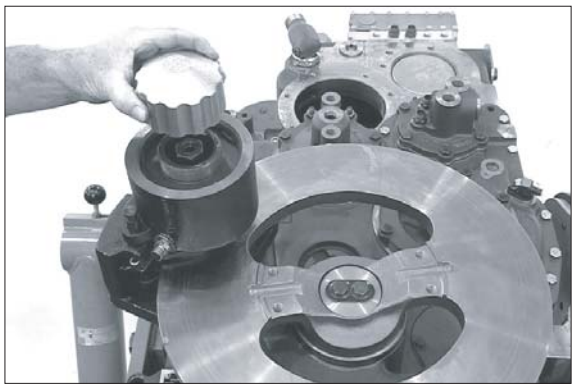


Figure 43

(2) Loosen the counternut and unscrew the adjusting screw in counterclockwise direction until the brake disc is released.

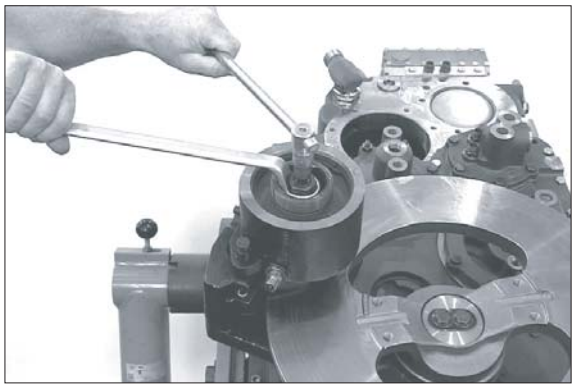


Figure 44

(3) Loosen the cap screws and separate the complete brake from the transmission housing.

Remove the lock plate. Loosen the hexagon screws and separate the output flange/brake disc from the output shaft.

※ (S) Socket spanner 5870 656 047

Figure 45

Removal of the clutches and layshaft

(1) Loosen the hexagon screws and expel the bearing cover KV/K1 by means of the striker from the housing bore.
Remove the bearing cover KR/K2 (arrow) analogously.

※ Mark the installation location of the bearing cover.

※ Special tool

Threaded insert	5870 204 069
Striker	5870 650 014

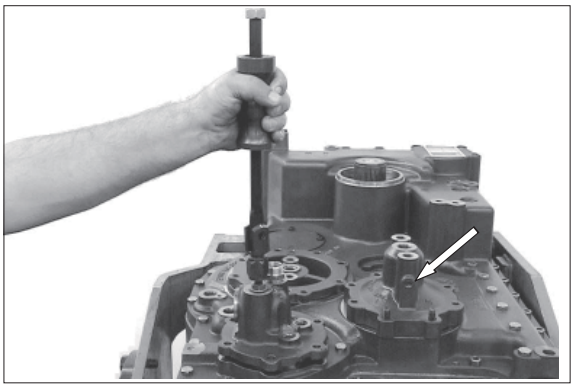


Figure 46

(2) Pull out the bearing cover K4/K3 by means of the forcing screws from the housing bore.

※ Special tool

Forcing screws	5870 204 005

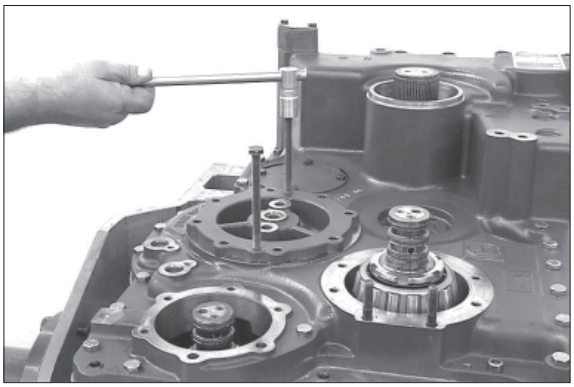


Figure 47

(3) Separate the bearing inner ring from bearing cover K4/K3.

※ Special tool

Three-armed puller	5870 971 003

Figure 48

(4) Loosen the bolt connection.
Separate the housing cover from the housing by equally tightening both forcing screws (arrow 1 and 2) as well as the threaded spindle (arrow 3).

※ Special tool

Internal hex spanner, size 8	5870 290 003
Forcing screws	5870 204 005
Lifting tackle	5870 281 061

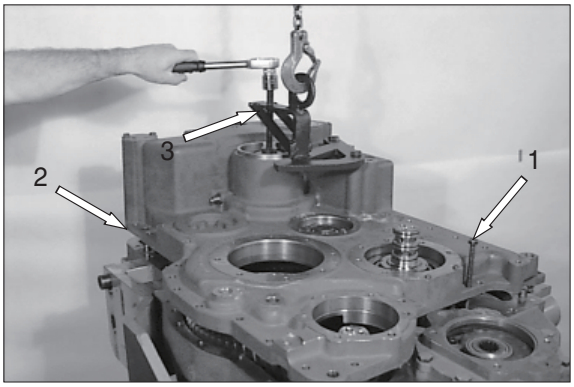


Figure 49

(5) Expel the output shaft from the output gear.

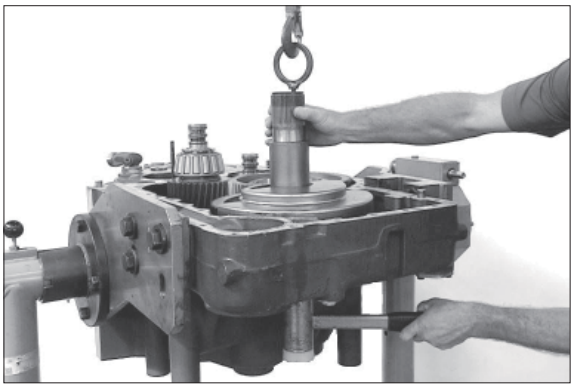


Figure 50

(6) Loosen the hexagon screws and remove the oil baffle.

Lift the output gear out of the transmission housing (figure).

※ Special tool

Stop washer	5870 100 054
Eyebolts assortment	5870 204 002

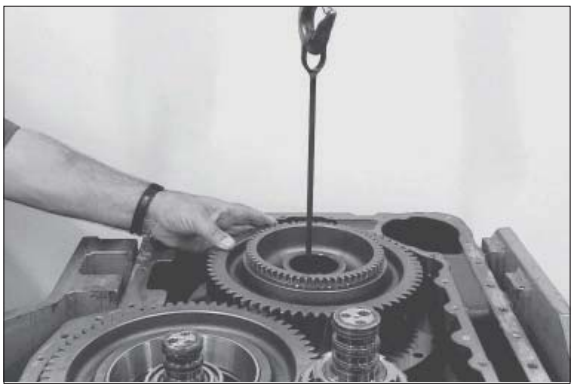


Figure 51

(7) Remove the bearing inner ring from the output gear.

※ Special tool

Three-armed puller	5870 971 003

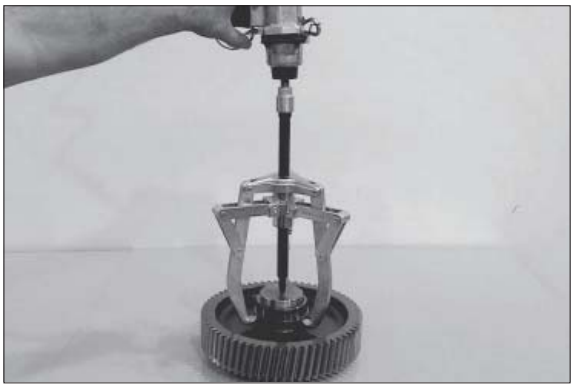


Figure 52

(8) Take the roller bearing out of the housing bore and remove the oil baffle (arrow).

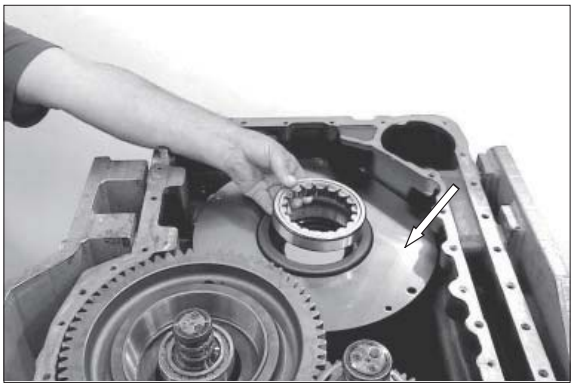


Figure 53

Remove the multi-disc clutches

※ For removal of the single clutches observe the following sequence :
K4/K3 → KR/K2 → KV/K1.
For removal of clutch K4/K3, lift the clutch KR/K2 slightly and move it in direction of the arrow, see figure.

※ Special tool
Eyebolts assortment 5870 204 002

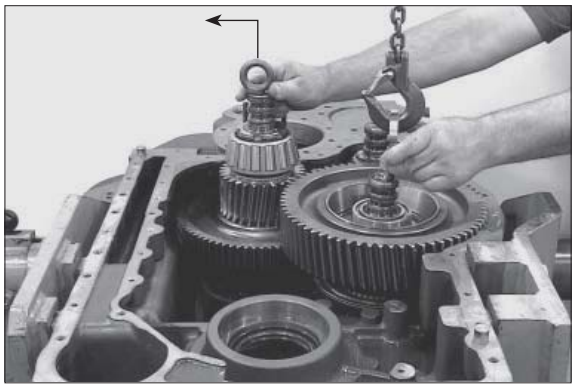


Figure 54

(9) Opposite figure shows the clutches when removed.

Figure 55

(10) Remove the layshaft gear.

Figure 56

Dismantling of the Multi-Disc Clutch K3/K4

(1) By means of clamping ring (S) fasten the clutch to the assembly truck.

※ Special tool
Clamping ring 5870 654 033

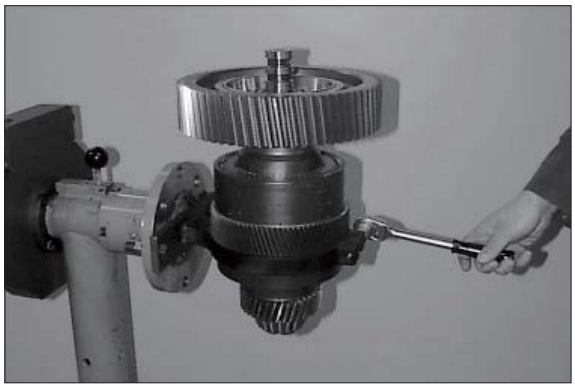


Figure 62

(2) Pull off the roller bearing from the disc carrier.

※ Special tool
Three-armed puller 5870 971 002

Figure 63

(3) Separate spur gear K3 from the disc carrier.

Figure 64

(4) Pull off the bearing inner ring from the disc carrier.

※ Special tool
Rapid grip 5873 012 012
Basic tool 5873 002 001

Figure 65

(5) Squeeze out the snap ring.
Remove the end shim and disc set K3.

Figure 66

(6) Rotate disc carrier by 90˚.
Loosen the slotted nut.

※ Special tool

Slotted nut wrench	5870 401 118
Slotted nut wrench	5870 401 115

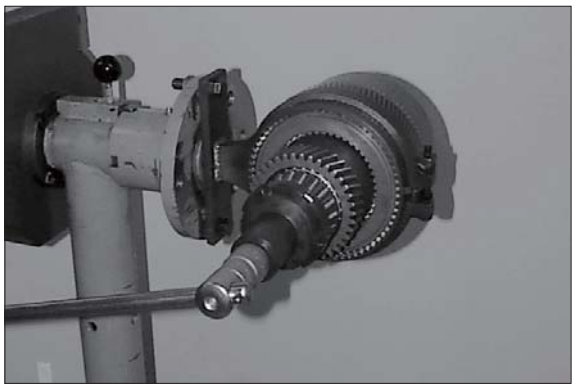


Figure 67

(7) Rotate disc carrier by 90˚.
Pull off the taper roller bearing.

※ Special tool

Gripping insert	5873 011 012
Basic tool	5873 001 000

Figure 68

(8) Pull off the spur gear K4 from the disc carrier.

※ Special tool

Three-armed puller	5870 971 003

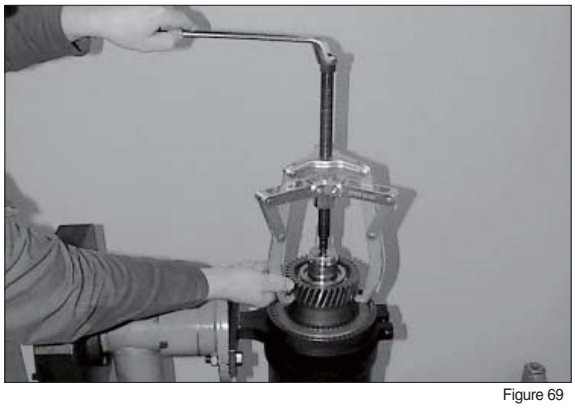


Figure 69

(9) Remove the ring.

Figure 70

(10) Pull off the taper roller bearing.

※ Special tool
Three-armed puller 5870 971 002

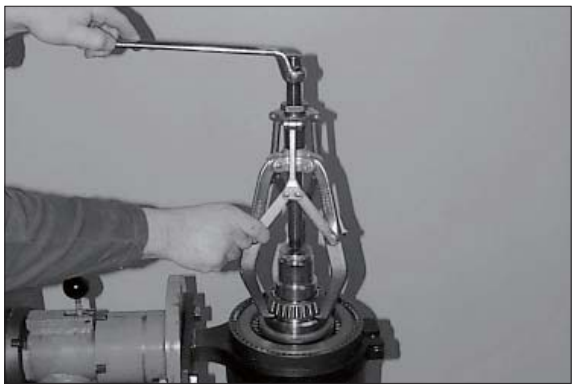


Figure 71

(11) Squeeze out the snap ring.
Remove the end shim and the disc set K4.

Figure 72

(12) Preload the compression spring by means of fixture.
Squeeze out the snap ring and the released single components.
Remove the opposite single components (K3 side) analogously.

※ Special tool
Pressure piece 5870 345 072

Figure 73

(13) Separate both pistons by means of compressed air from the disc carrier.

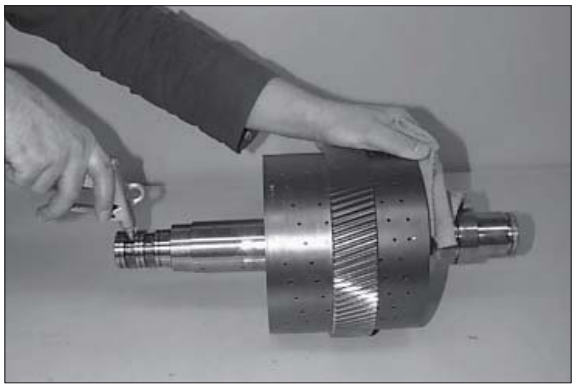


Figure 74

Dismantling of the multi-disc clutch KR/K2

(1) Fasten the clutch by means of clamping ring (arrow) on the assembly truck.

※ Special tool

Clamping ring	5870 654 033

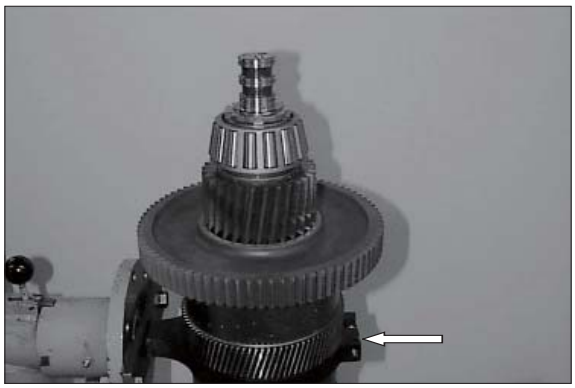


Figure 75

(2) Rotate disc carrier by 90˚.
Loosen the slotted nut.

※ Special tool

Slotted nut wrench	5870 401 099

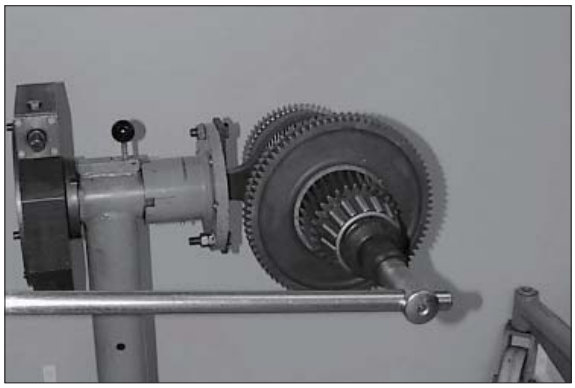


Figure 76

(3) Pull off the taper roller bearing from the disc carrier.

※ Special tool

Gripping insert	5873 012 018
Basic tool	5873 002 001

Figure 77

(4) Press off the spur gear K2 from the disc carrier.

⚠ **Pay attention to released disc carrier.**

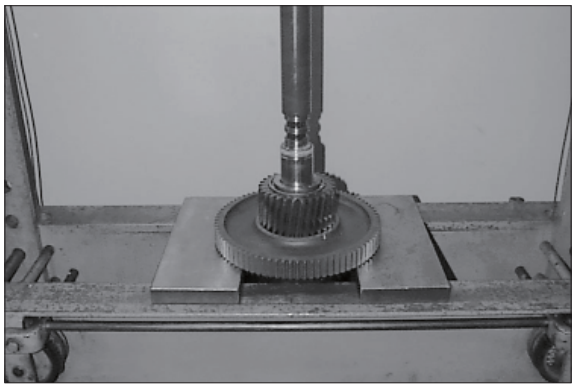


Figure 78

(5) Fasten the disc carrier by means of clamping ring.
Pull off the taper roller bearing from the disc carrier.

※ Special tool

Clamping ring	5870 654 033
Gripping insert	5873 012 019
Basic tool	5873 002 001

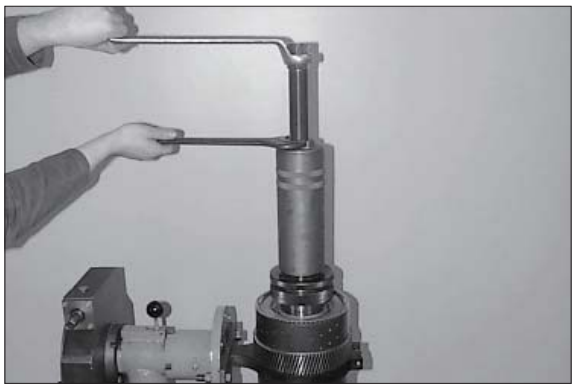


Figure 79

(6) Squeeze out the snap ring.
Remove the end shim and disc set K2.

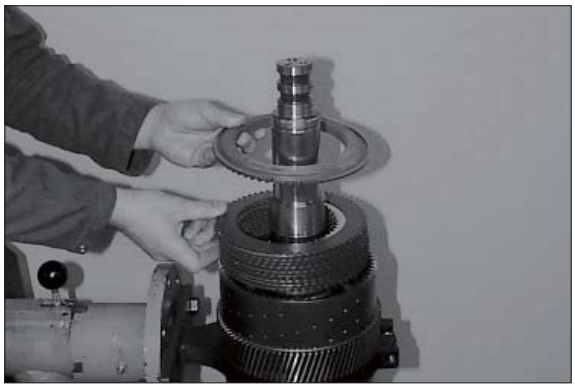


Figure 80

(7) Rotate disc carrier by 90˚.
Loosen the slotted nut.

※ Special tool

Slotted nut wrench	5870 401 099

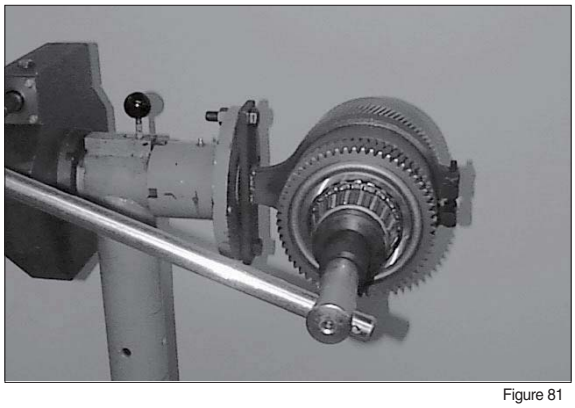


Figure 81

(8) Pull off the taper roller bearing from the disc carrier.

※ Special tool

Gripping insert	5873 002 044
Basic tool	5873 002 001

Figure 82

(9) Fasten spur gear KR by means of clamping ring (arrow) and pull it from the disc carrier.

※ Collar of the clamping ring must show upwards (to the spur gear).

※ Special tool

Three-armed puller	5870 971 003
Clamping ring	5870 654 045

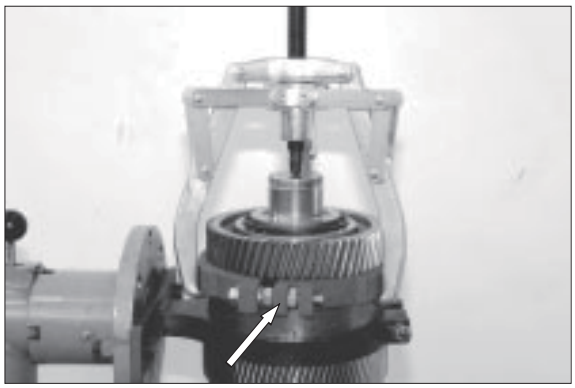


Figure 83

(10) Remove the ring.

Figure 84

(11) Squeeze out the snap ring.
Remove end shim and disc set KR.

Figure 85

(12) Pull off the taper roller bearing from the disc carrier.

※ Special tool

Gripping insert	5873 012 013
Basic tool	5873 002 001

Remove both piston (like described in figure 73 and 74)

Figure 86

Dismantling of the multi-disc clutch KV/K1

(1) Fasten clutch by means of clamping ring to the assembly truck.
Loosen the slotted nut (figure 87).

※ Special tool

Clamping ring	5870 654 033
Slotted nut wrench	5870 401 118
Slotted nut wrench	5870 401 099

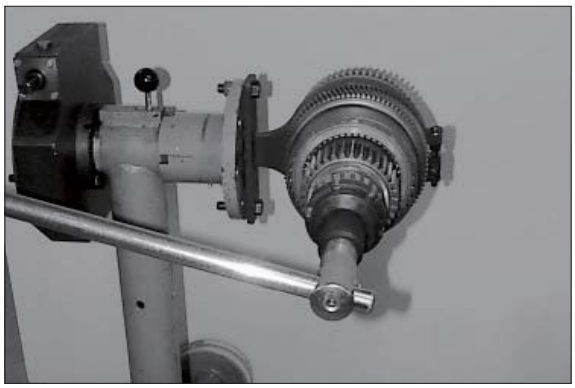


Figure 87

(2) Pull off the taper roller bearing from the disc carrier.

※ Special tool

Gripping insert	5873 001 023
Basic tool	5873 001 000

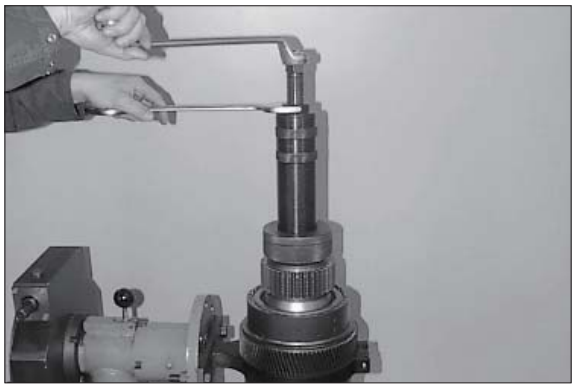


Figure 88

(3) Remove the shim.

Figure 89

(4) Pull off spur gear K1 from the disc carrier.

※ Special tool
Three-armed puller 5870 971 003

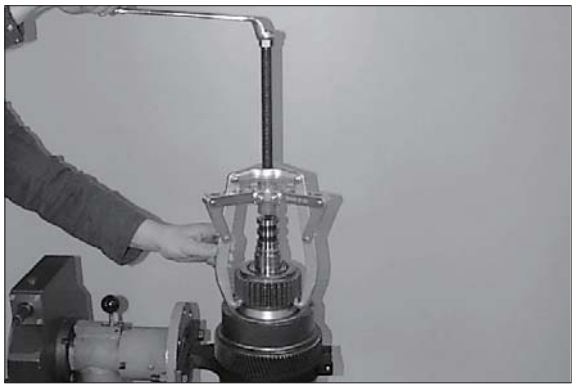


Figure 90

(5) Opposite figure shows the spur gear bearing K1.
Bearing (1) can only be obtained as complete part.

⚠ **If it is necessary to remove the clutch-pack-sided ball bearing (arrow or Figure 93 and 94), the complete bearing (1) has to be removed.**

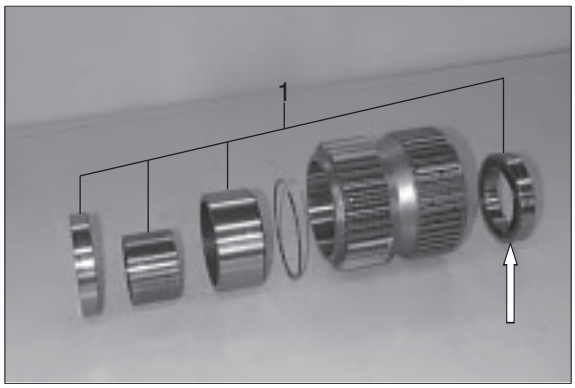


Figure 91

(6) Take off the bush.

Figure 92

(7) Pull off the ball bearing from the disc carrier (figure 93 and 94).

※ Pay attention to released balls.

Figure 93

Figure 94

(8) Squeeze out the snap ring.
Remove end shim and disc set K1.

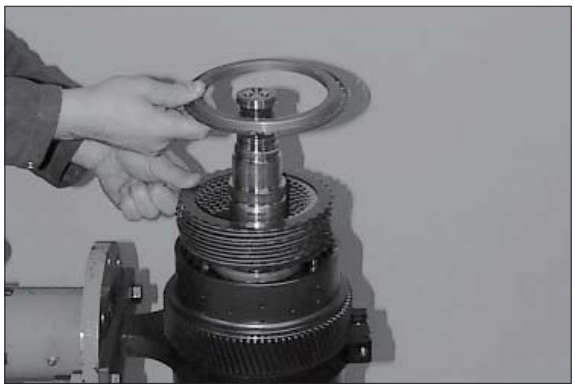


Figure 95

(9) Rotate disc carrier by 90˚.
Loosen the slotted nut.

※ Special tool

Slotted nut wrench	5870 401 118
Slotted nut wrench	5870 401 115

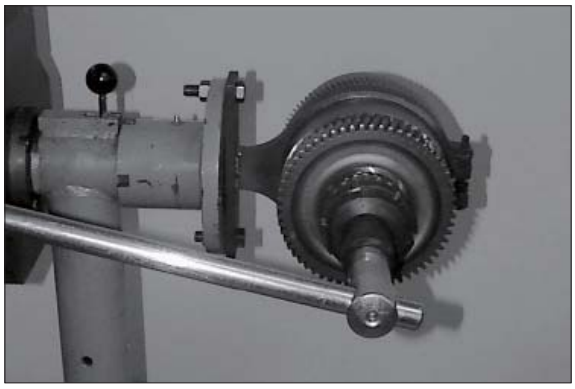


Figure 96

(10) Pull off the taper roller bearing from the disc carrier.

※ Special tool

Gripping insert	5873 001 034
Basic tool	5873 001 000

Figure 97

(11) Pull off spur gear KV from the disc carrier.

※ Special tool

Three-armed puller	5870 971 003

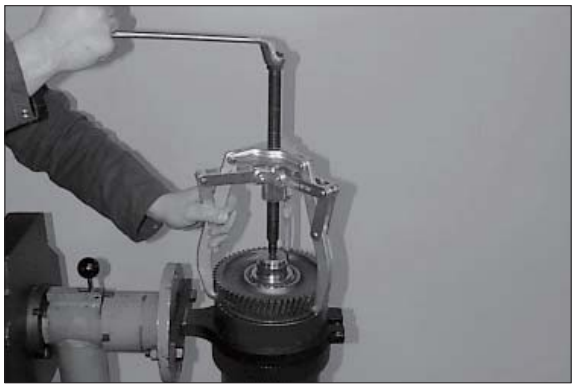


Figure 98

(12) Remove the ring.

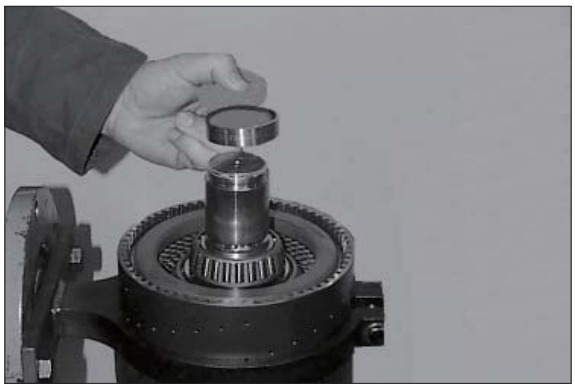


Figure 99

(13) Pull off the taper roller bearing from the disc carrier (figure 100).
Squeeze out the snap ring.
Remove end shim and disc set KV.
Remove both pistons (like described in Figure 73 and 74).

※ Special tool

Gripping insert	5873 001 034
Basic tool	5873 001 000

Figure 100

2) ASSEMBLY

3rd/4th power take-off

1 = Ball bearing
2 = Spur gear
3 = Driver
4 = Ball bearing
5 = Pump flange
6 = Cover
7 = Intermediate gear
8 = Shim
9 = Pin
10 = Sealing cover
11 = Orifice

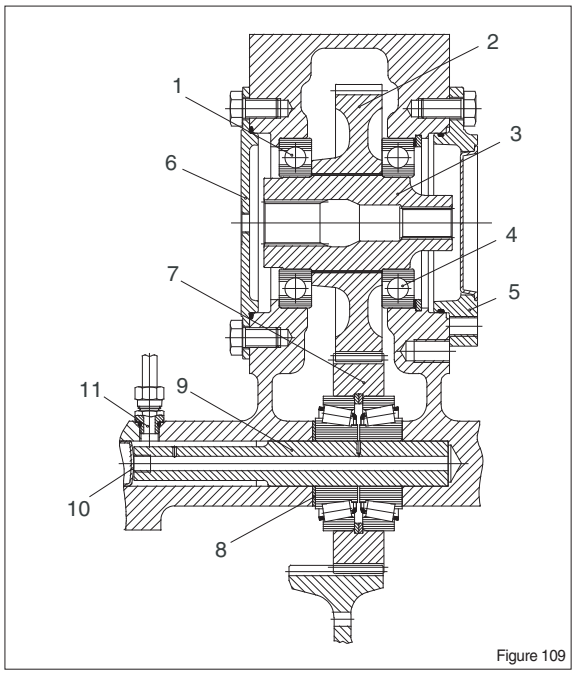


Figure 109

(1) Insert the ball bearing (1) into the housing bore until contact.

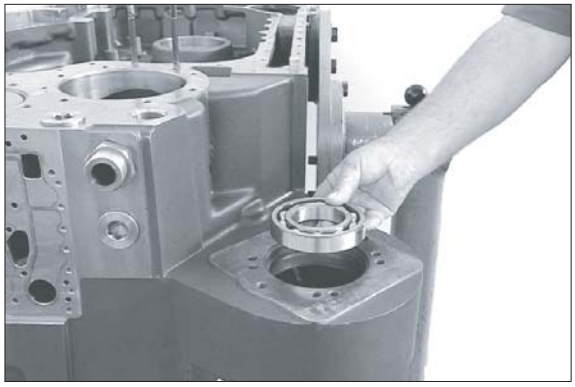


Figure 110

(2) Position spur gear (2).

※ Pay attention to the installation position, see sketch (figure 109).

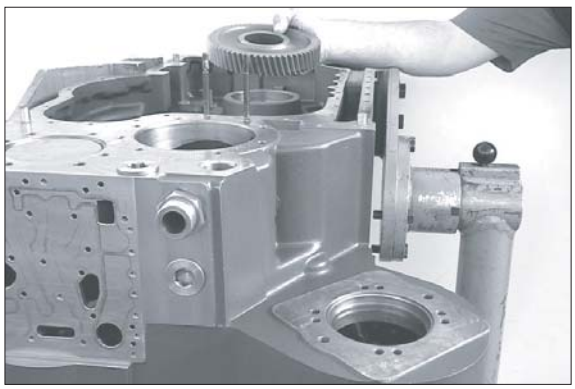


Figure 111

(3) Heat the ball bearing (inner ring) and bore of the gear respectively.

※ (S) Hot-air blower 230V 5870 221 500
Hot-air blower 115V 5870 221 501

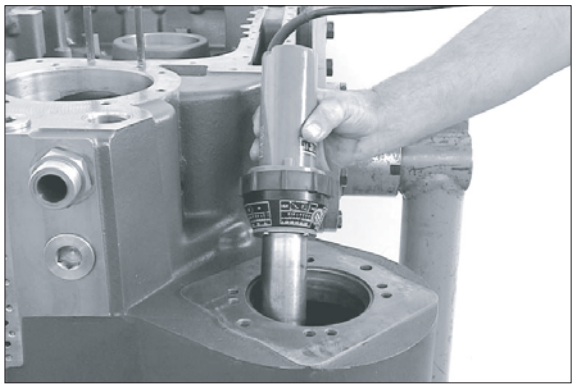


Figure 112

(4) Align the spur gear centrally and insert the driver (3) until con-tact.

※ Pay attention to the installation position, also see sketch (figure 109).

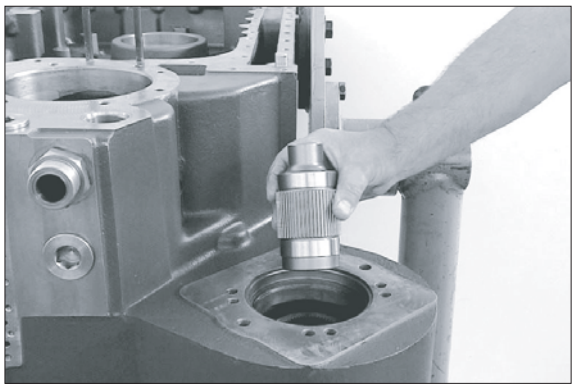


Figure 113

(5) Install the ball bearing (4) by means of fixture until contact.

※ Pay attention to perfect contact of the ball bearing.

Fixture 5870 000 083

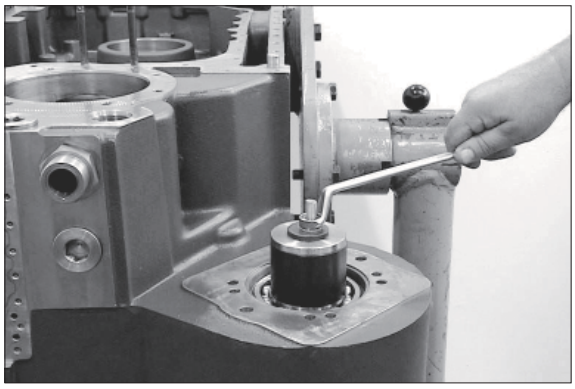


Figure 114

Adjust the axial play of power take-off bearing = 0.2~0.3 mm (figure 115~116)

(6) Fasten ball bearing by means of shim s = 1.80 mm (empirical value) and retaining ring.

Clamping pliers 5870 900 021

Figure 115

(7) Check the axial play by means of feeler gauge.

※ If different from the required axial play = 0.2~0.3 mm this is tobe corrected with the corresponding shim.

Feeler gauge 5870 200 112

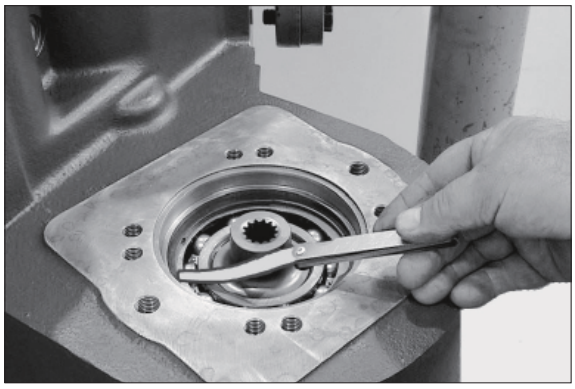


Figure 116

(8) Place the O-ring (arrow) in the annular groove of the pumpflange (5) and grease it.

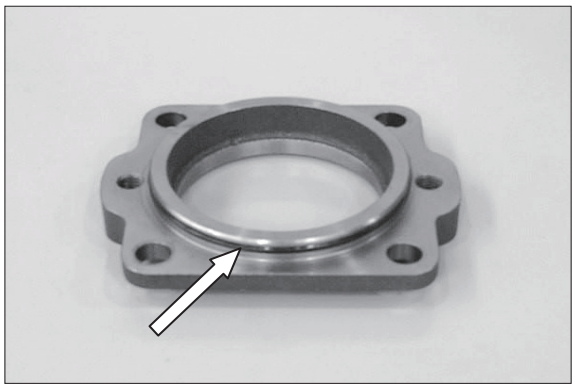


Figure 117

(9) Fasten the pump flange (5) by means of hexagon screws.

Tightening torque (M14/8.8) : 12.7 kgf · m (92.2 lbf · ft)

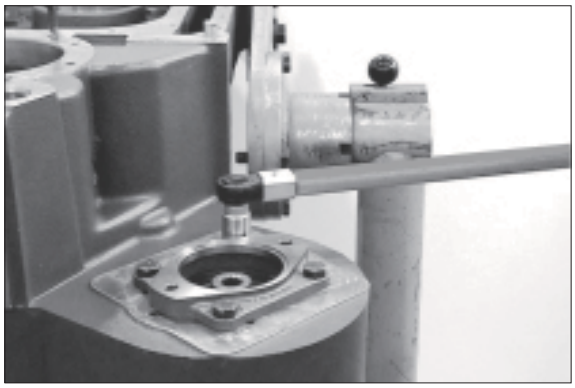


Figure 118

Converter side

(10) Place the O-ring (arrow) with assembly grease in the recess ofthe housing bore.

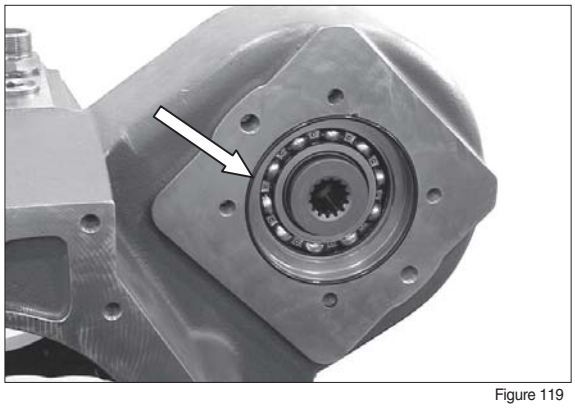


Figure 119

(11) Fasten the cover (6) with hexagon screws.

Tightening torque (M14/8.8) : 12.7 kgf · m
(92.2 lbf · ft)

Provide the orifice (arrow) with a new sealing ring (CU) andinstall it.

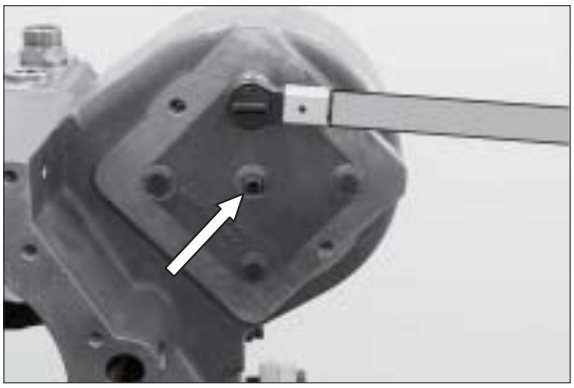


Figure 120

(12) Preassemble the intermediate gear (7) according to figure 121.

※ Exact locating of the single components to be ensured bypressing

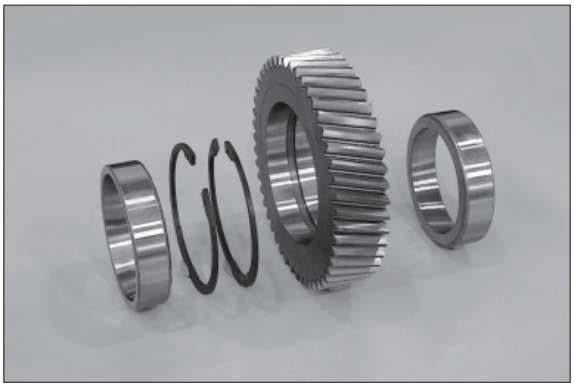


Figure 121

(13) Put in the bearing inner rings and position the intermediate gear (7), see arrow.

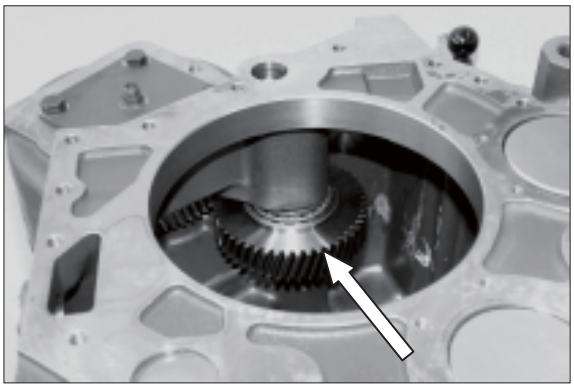


Figure 122

(14) Adjust the axial play-intermediate gear bearing max. 0.1 mm (figure 123~124)

Determine the gap size by means of feeler gauge (arrow).

Dim I e.g. ..... 1.25 mm

Example

Dim I (gap size) ..... 1.25 mm
Axial play (0~0.1 mm) e.g. ..... - 0.05 mm
resulting shim e.g. s = 1.20 mm

Feeler gauge 5870 200 112

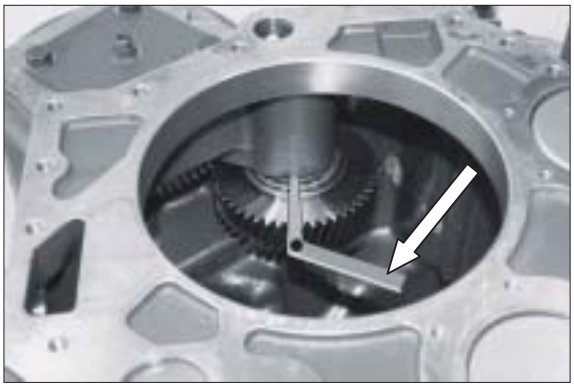


Figure 123

(15) Install the corresponding shim (8) e.g. s = 1.20 mm (arrow).

※ Install shim on the converter side

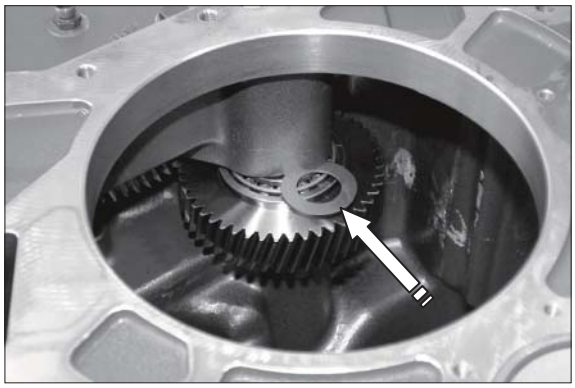


Figure 124

(16) Align the single components centrically. Undercool the pin (9) and install it until contact.

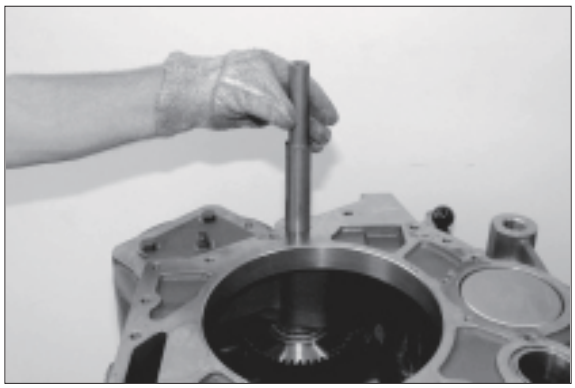


Figure 125

(17) Flush-mount the sealing cover (10) with the concave side showing upwards (arrow 1).

※ Wet contact face of the sealing cover with loctite (type No.262).

※ Provide orifice (11) with a new O-ring and install it (arrow 2).

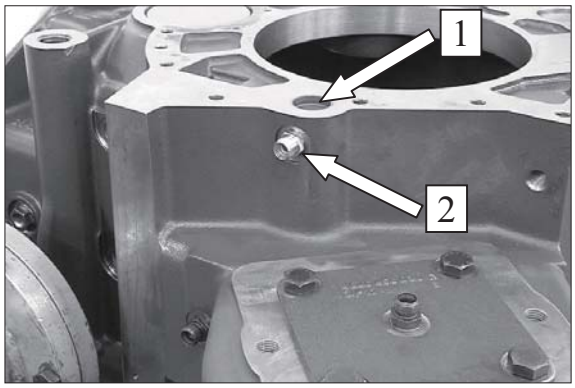


Figure 126

Assembly of the multi-disc clutch K4/K3

The following sketch shows the clutch sectioning

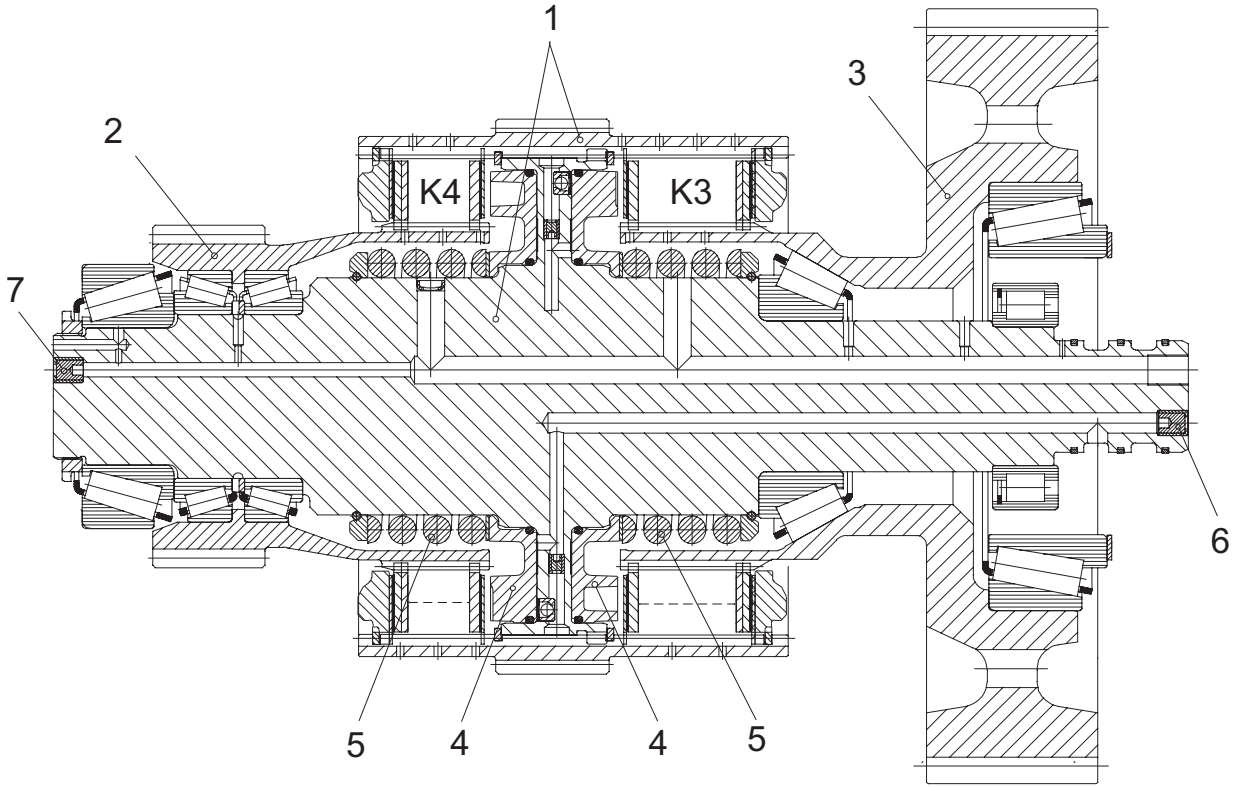


Figure 127

1	Disc carrier(assy)	K4	Multi-disc clutch K4	5	Compression spring
2	Spur gear K4	K3	Multi-disc clutch K3	6	Plug 2EA
3	Spur gear K3	4	Piston	7	Plug 1EA

※ Observe the installation position of the single components for the following assembly.

(1) Lift the disc carrier with the K4-side showing downwards into the clamping ring and fasten it.
Rotate disc carrier by 180˚.

※ Special tool
Clamping ring 5870 654 033

⚠ **To install new disc carriers the finished bores have to be sealed with plugs. Installation position, see arrow, figure128 and 129.**

※ Special tool
Hand inserting tool 5870 320 014
Ratchet spanner 5870 320 018


Figure 128


Figure 129

(2) Flush-mount the drain valve (arrow) with the chamfer showing downwards.

※ Special tool
Inserting tool 5870 320 019

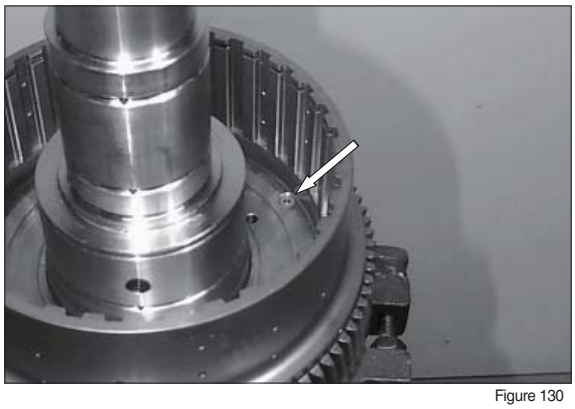


Figure 130

(3) Put both O-rings **scroll-free** into the annular grooves of the piston, see arrows.

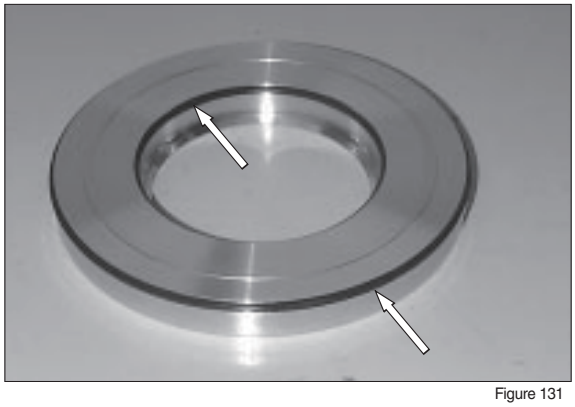


Figure 131

(4) Oil the O-rings and the piston contact surface.
Install K3 piston **equally** until contact.

※ Observe the installation position of the piston, see figure.

Figure 132

(5) Install spacer and compression spring.

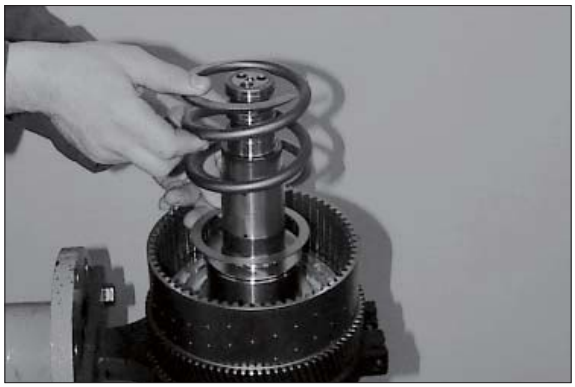


Figure 133

(6) Place guide ring, with the chamfer (arrow) showing upwards, over the compression spring and install the snap ring.

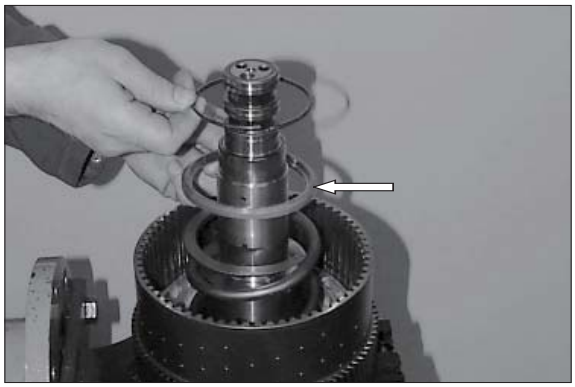


Figure 134

(7) Lift the disc carrier out of the clamping ring. Preload the compression spring by means of fixture and engage the snap ring into the annular groove of the disc carrier (arrow), see figure 135.

※ Special tool

Fixture	5870 345 072
Clamping fixture	5870 654 036

Install the drain valve, piston and compression spring on the opposite side (clutch K4) analogously (figure 130~135).
Then lift the disc carrier with the K4-side showing downwards into the clamping ring and fasten it. Rotate disc carrier by 180˚.

Figure 135

Disc Components K4

※ Below sketch or table shows the standard version as to the installation position of the single components. Obligatory is the respective spare parts list.

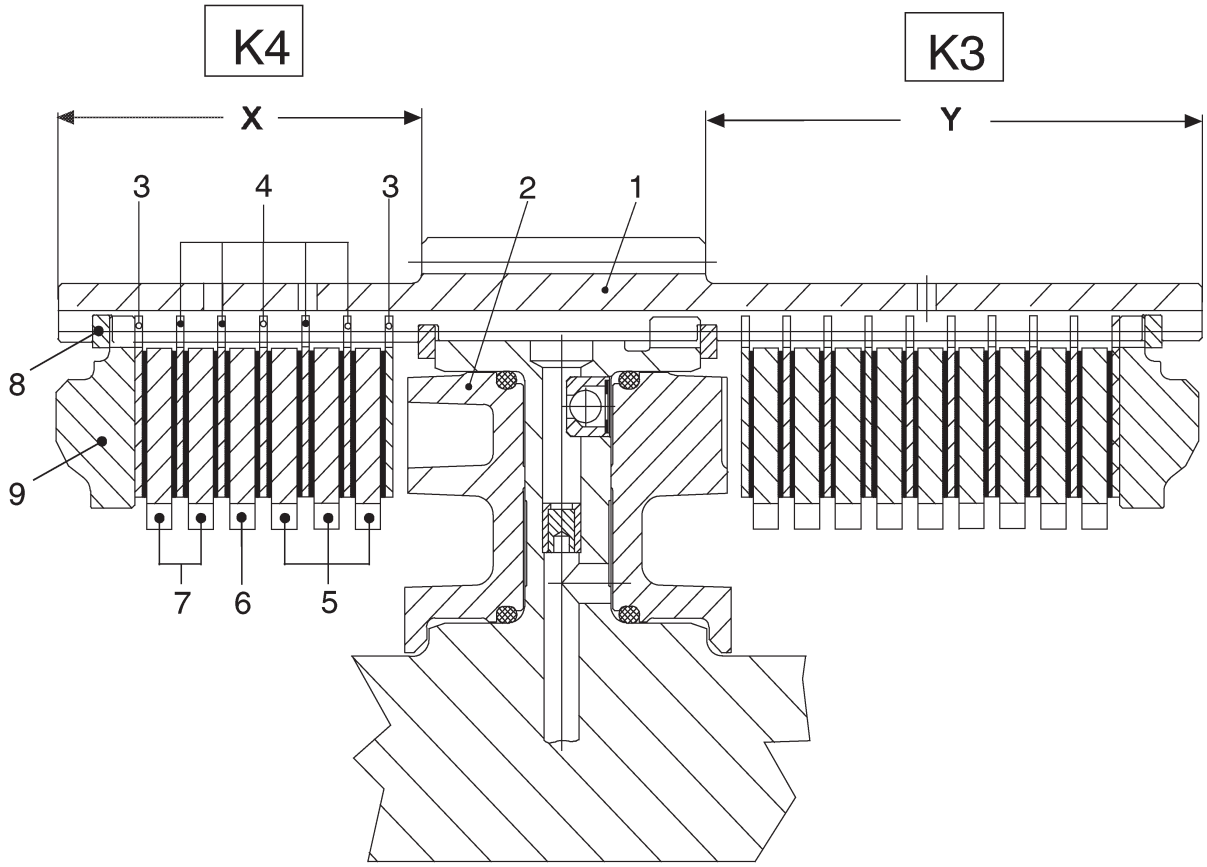


Figure 136

Position	Description	Quantity	s (mm)	Remarks
1	Disc carrier	1		
2	Piston	1		
3	Outer clutch disc	2	1.85	Coated on one side
4	Outer clutch disc	5	2.5	Coated on both sides
5	Inner clutch disc	3	3.5	
6	Inner clutch disc	1	4.0	
7	Inner clutch disc	2	2.5~4.0	Optional
8	Snap ring	1	2.10~3.10	Optional
9	End shim	1		
Number of friction surfaces : 12				
Disc clearance : 2.2 ~ 2.4 mm				

※ Install the outer clutch discs position 3 with uncoated side showing to the piston and end shim respectively. The respective clutch side can be seen on the length of the disc carrier, see sketch.

K4 Dimension X (short disc carrier side)

K3 Dimension Y (long disc carrier side)

Check disc clearance K4=2.2~2.4 mm
(figure 137~139)

※ In order to ensure a perfect measuring result, the disc set is first of all to be installed without oil.

(1) Install disc set according to sketch or table (figure 136).

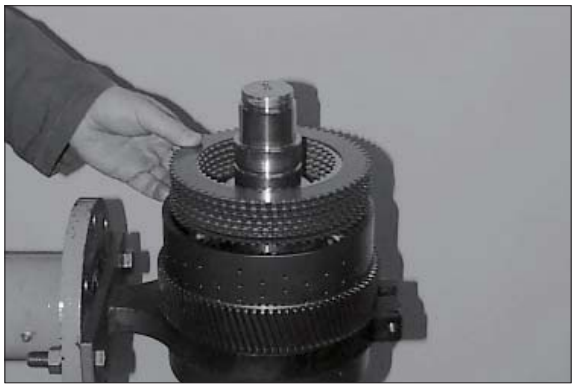


Figure137

(2) Install the end shim and fasten it by means of the snap ring.

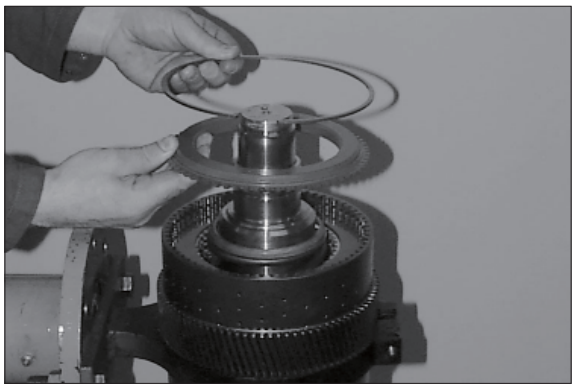


Figure138

(3) Press on end shim with approximately 100N (10 kg) and set dial indicator to "Zero".
Then press end shim against snap ring (upwards) and read disc clearance on the dial indicator.

※ If the required disc clearance differs, it has to be corrected with the adequate inner clutch disc or/and snap ring, see table/ position 7 and position 8.

Upon setting of disc clearance, remove the disc set, oil the clutch discs and reinstall them.

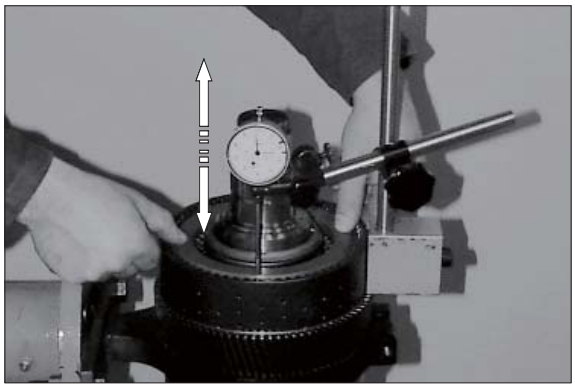


Figure139

※ Special tool

Magnetic stand	5870 200 055
Dial indicator	5870 200 057

Preassemble and install spur gear K4 (figure 140~144) :

(1) Opposite figure shows the single components of spur gear K4.
   1 Bearing inner ring
   2 Bearing outer ring
   3 Ring
   4 Spur gear

   Locate both bearing outer rings (2) until contact.

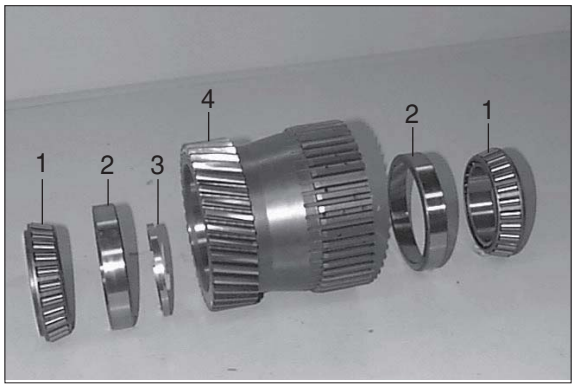


Figure140

(2) Heat the bearing inner ring and install it until contact.


Figure141

(3) Install the ring (3).


Figure142

(4) Assemble the spur gear until all inner clutch discs are located.


Figure143

(5) Heat the bearing inner ring (spur gear bearing) and locate it until contact.

⚠ **Use safety gloves.**

Figure144

(6) Heat the bearing inner ring (clutch bearing) and install it until contact.

⚠ **Use safety gloves.**

Figure145

Clutch Components K3

※ Below sketch or table shows the standard version as to the installation position of the single components. Obligatory is the respective spare parts list.

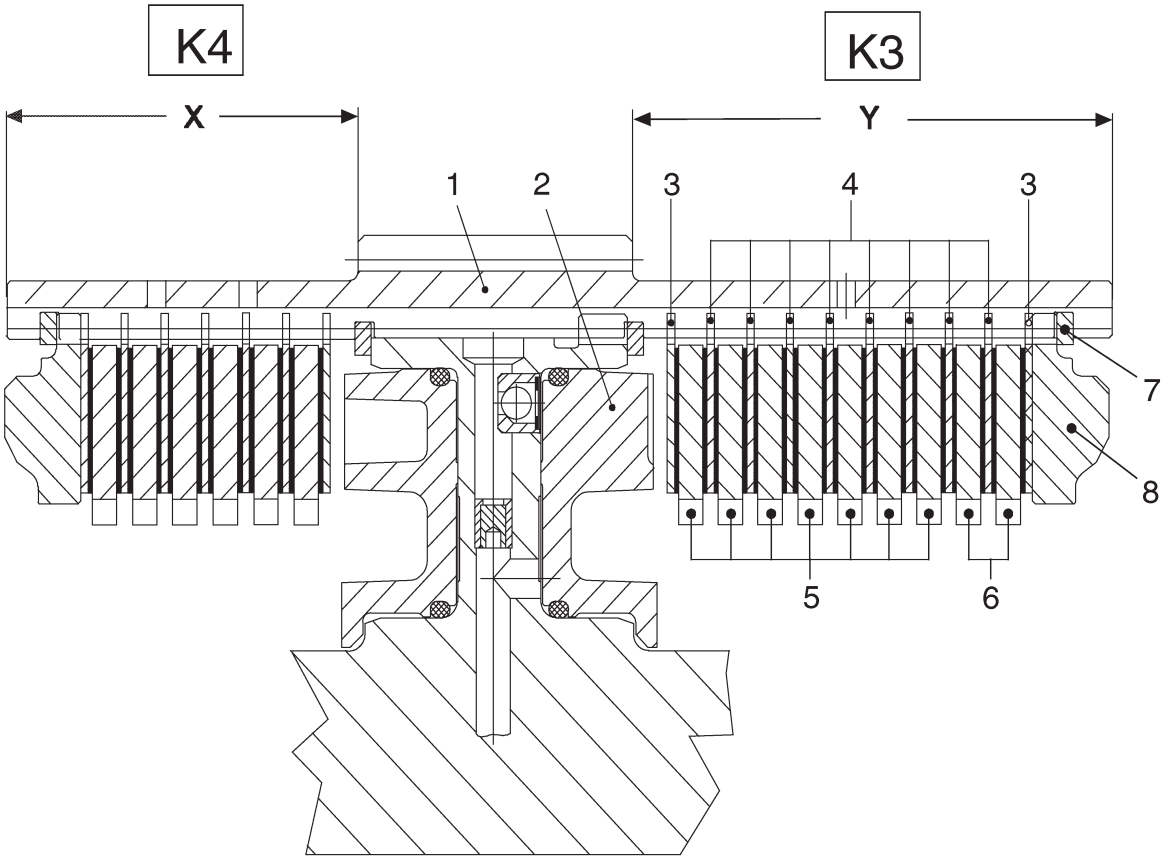


Figure146

Position	Description	Quantity	s(mm)	Remarks
1	Disc carrier	1		
2	Piston	1		
3	Outer clutch disc	2	1.85	Coated on one side
4	Outer clutch disc	8	2.5	Coated on both sides
5	Inner clutch disc	7	3.0	
6	Inner clutch disc	2	2.5~4.0	Optional
7	Snap ring	1	2.10~3.10	Optional
8	End shim	1		
Number of friction surfaces : 18				
Disc clearance : 2.6 ~ 2.8 mm				

※ Install the outer clutch discs position 3 with uncoated side showing to the piston and end shim respectively. The respective clutch side can be seen on the length of the disc carrier, see sketch.

K3 Dimension Y (long disc carrier side)

K4 Dimension X (short disc carrier side)

Check disc clearance K3=2.6~2.8 mm
(figure 147~149)

※ In order to ensure a perfect measuring result, the disc set is first of all to be installed without oil.

(1) Install disc set according to sketch or table (figure 146).

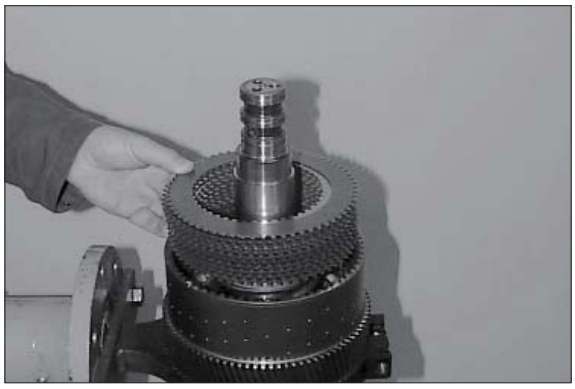


Figure 147

(2) Install the end shim and fasten it by means of the snap ring.

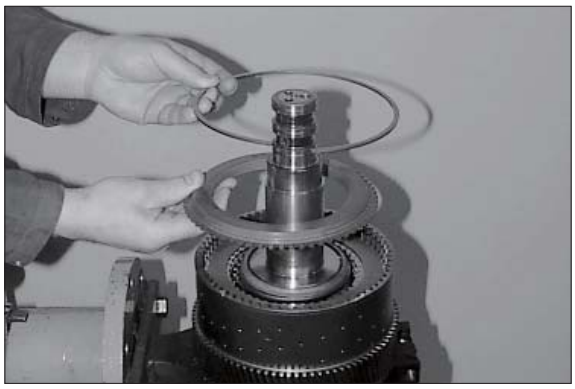


Figure 148

(3) Press on end shim with approximately 100N (10 kg) and set dial indicator to "Zero".
Then press end shim against snap ring (upwards) and read disc clearance on the dial indicator.

※ If the required disc clearance differs, it has to be corrected with the adequate inner clutch disc or/and snap ring, see table/ position 6 and position 7.

Upon setting of disc clearance, remove the disc set, oil the clutch discs and reinstall them.

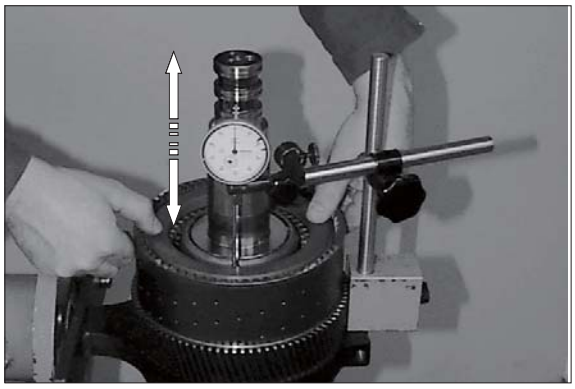


Figure 149

※ Special tool

※ Magnetic stand	5870 200 055
Dial indicator	5870 200 057

(4) Heat the bearing inner ring and install it until contace.

⚠ **Use safety gloves.**

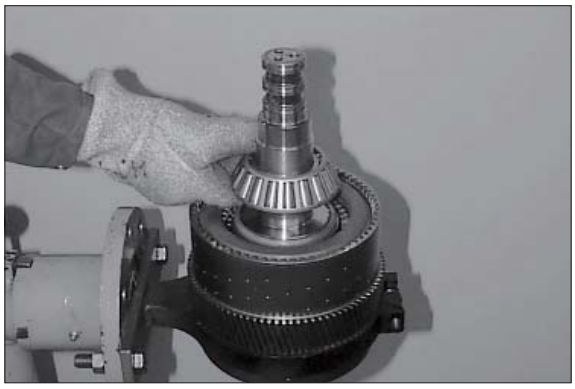


Figure 150

(5) Lift the disc carrier out of the clamping ring (S).
To ensure the exact locating of the single components, preload the bearing with 100KN (10 t) (figure 151)

⚠ Support on the lower as well as upper **bearing inner ring.**
Use pressure pieces.

※ Special tool

Pressure piece	5870 506 096

Figure 151

(6) Lift the disc carrier with the K4-side showing downwards into the clamping ring (S) and fasten it.
Rotate disc carrier by 90˚.
Install the slotted nut.

※ Observe installation position of the slotted nut. Collar (ø 60 mm) must show to the bearing inner ring, also see sketch (Figure 127). Oil the thread.

· Tightening torque : 56.1 kgf · m (406 lbf · ft)

※ Special tool

Clamping ring	5870 654 033
Slotted nut wrench	5870 401 118
Slotted nut wrench	5870 401 115

Figure 152

(7) Install the bearing outer ring into spur gear K3 until contact.

Figure 153

(8) Assemble the spur gear until all inner clutch discs are located.

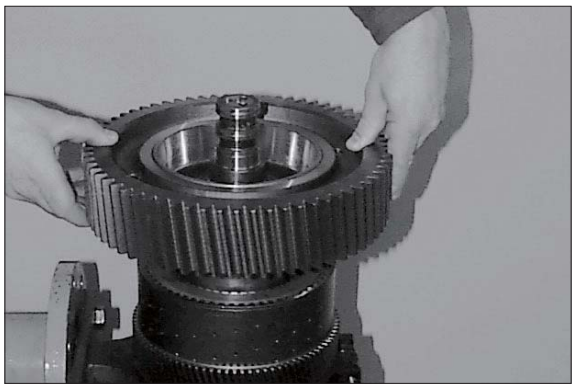


Figure 154

(9) Heat the roller bearing and locate it until contact.

⚠ **Use safety gloves.**

Figure 155

(10) Install the bearing inner ring.

Figure 156

(11) Check function of the clutches K3 and K4 by means of compressed air.

※ Closing or opening of the clutches is clearly audible when the single parts have been installed adequately.

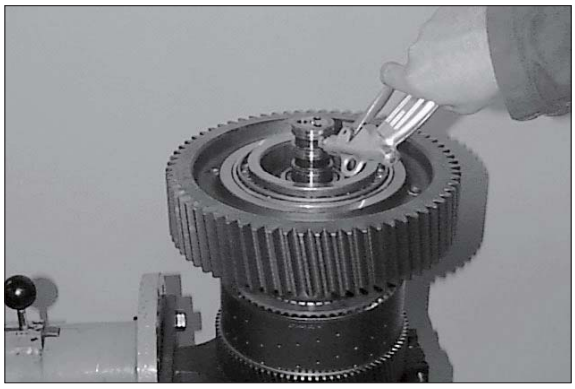


Figure 157

(12) Snap-in and lock the rectangular rings (3EA, see arrows).

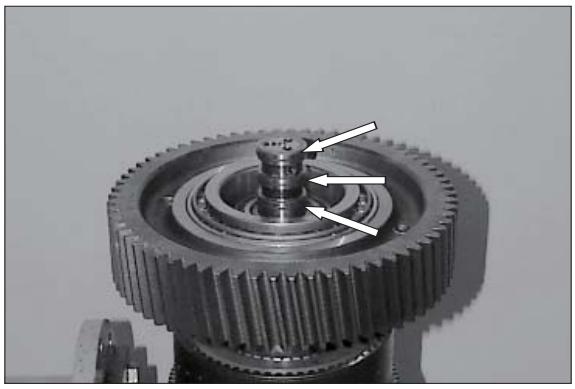


Figure 158

Assembly of the multi-disc clutch KR/K2

The following sketch shows the clutch sectioning.

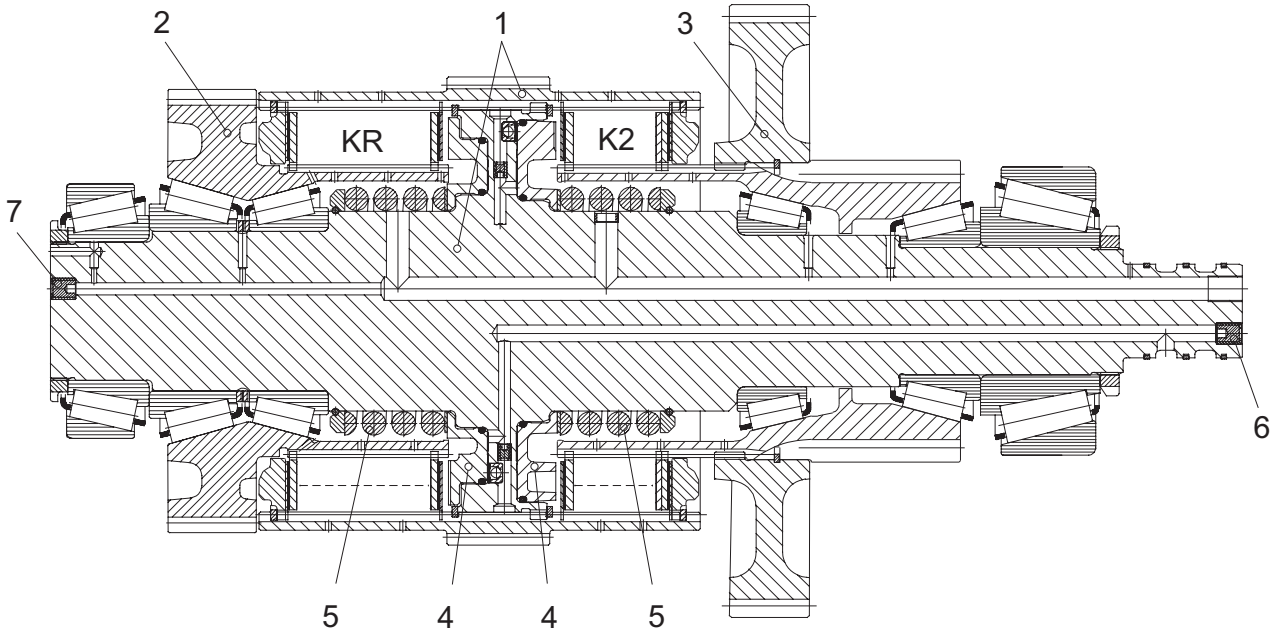


Figure159

1	Disc carrier	K4	Multi-disc clutch KR	5	Compression spring
2	Spur gear KR	K2	Multi-disc clutch K2	6	Plug 2EA
3	Spur gear K2	4	Piston	7	Plug 1EA

※ Observe the installation position of the single components for the following assembly.

(1) Lift the disc carrier with the KR-side showing downwards into the clamping ring and fasten it.
Then rotate disc carrier by 180˚.

⚠ **To install new disc carriers the finished bores have to be sealed with plugs. Installation position, see arrow, figure 160~161.**

※ Special tool

Clamping ring	5870 654 033
Hand mounting tool	5870 320 014
Ratchet	5870 320 018

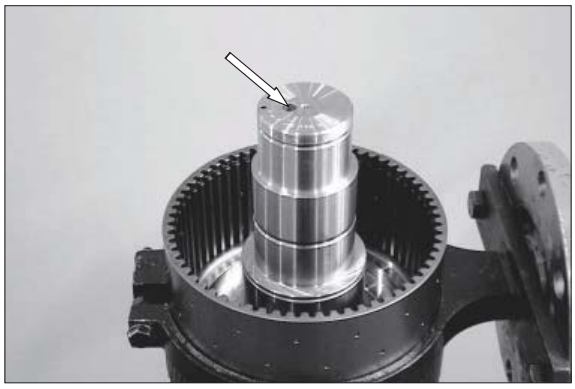


Figure 160

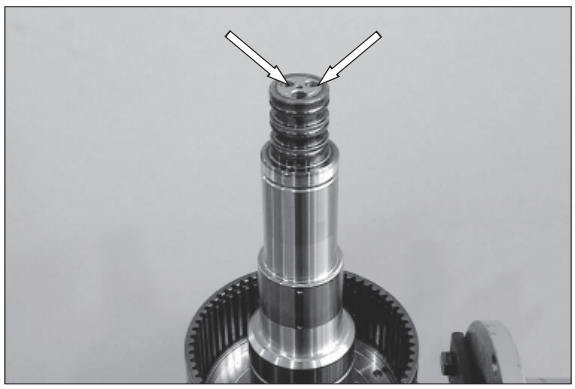


Figure 161

(2) Flush-mount the drain valve (arrow) with the chamfer showing downwards.

※ Special tool

Inserting tool	5870 320 019

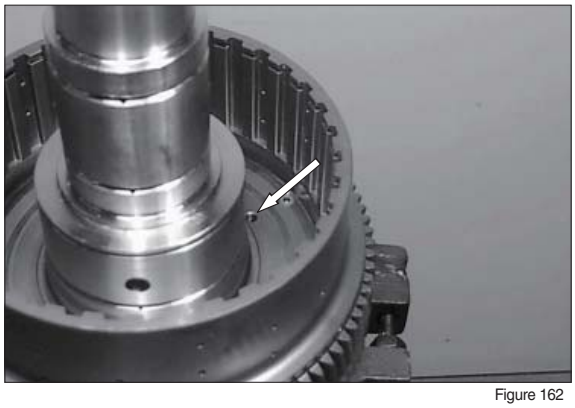


Figure 162

(3) Put both O-rings **scroll-free** into the annular grooves of the piston, see arrows.

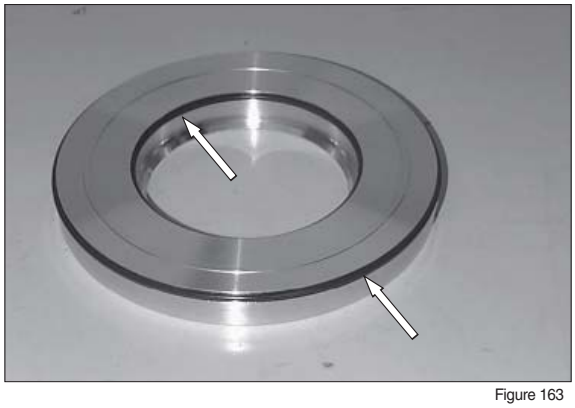


Figure 163

(4) Oil the O-rings and the piston contact surface.
Install K2 piston **equally** until contact.

※ Observe the installation position of the piston, see figure.

Figure 164

(5) Install spacer and compression spring.

Figure 165

(6) Place guide ring, with the chamfer (arrow) showing upwards, over the compression spring and install the snap ring.

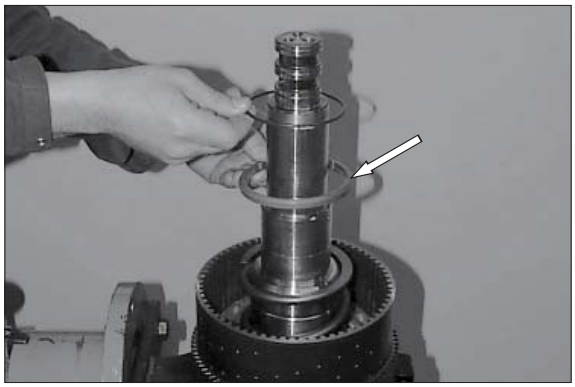


Figure 166

(7) Lift the disc carrier out of the clamping ring. Preload the compression spring by means of fixture and engage the snap ring into the annular groove of the disc carrier (arrow), see figure 167.
Install the drain valve, piston and compression spring on the opposite side(clutch KR) analogously (like figure 162~167).
Then lift the disc carrier with the KR-side showing downwards into the clamping ring and fasten it. Rotate disc carrier by 180˚.

※ Special tool

Pressure piece	5870 345 072
Clamping fixture	5870 654 036

Figure 167

Disc Components KR

※ Below sketch or table shows the standard version as to the installation position of the single components. Obligatory is the respective spare parts list.

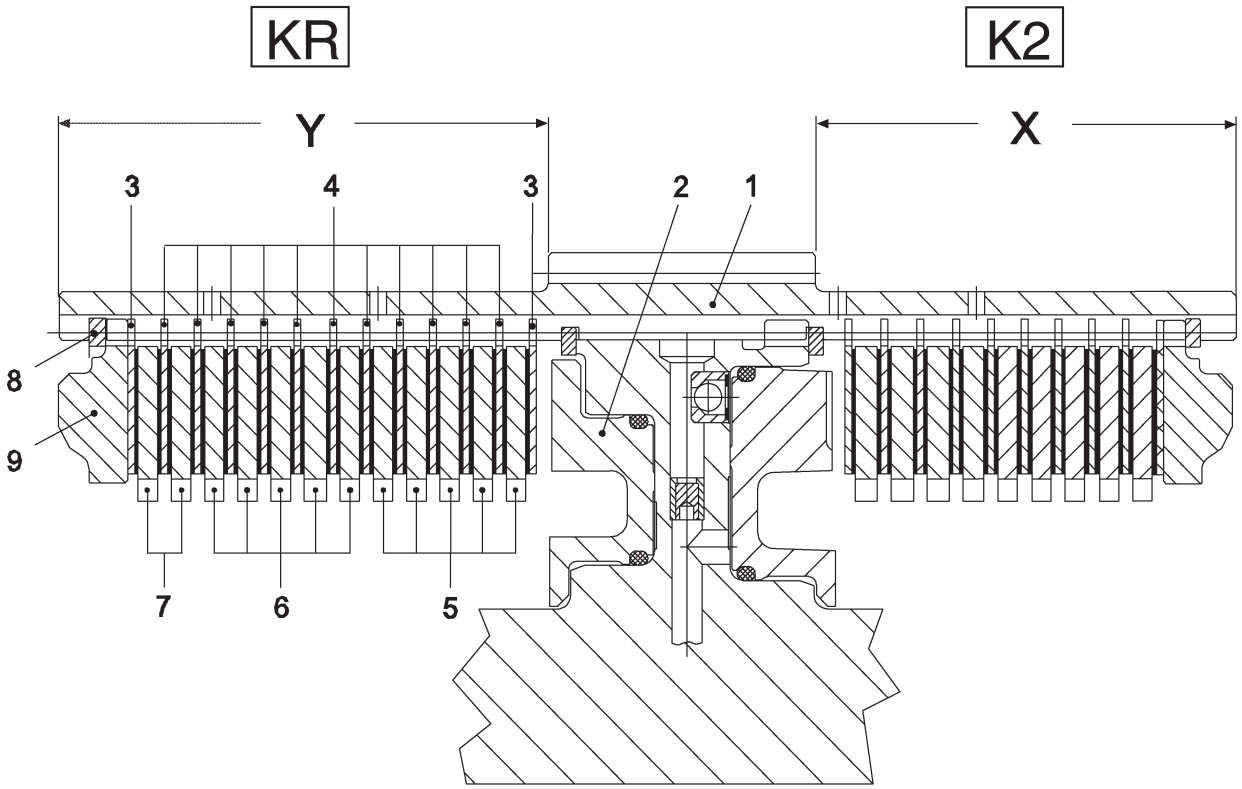


Figure 168

Position	Description	Quantity	s (mm)	Remarks
1	Disc carrier	1		
2	Piston	1		
3	Outer clutch disc	2	1.85	Coated on one side
4	Outer clutch disc	11	3.35	Coated on both sides
5	Inner clutch disc	5	2.5	
6	Inner clutch disc	5	3.0	
7	Inner clutch disc	2	2.5~4.0	Optional
8	Snap ring	1	2.10~3.10	Optional
9	End shim	1		
Number of friction surfaces : 24				
Disc clearance : 2.8 ~ 3.0 mm				

※ Install the outer clutch discs position 3 with uncoated side showing to the piston and end shim respectively. The respective clutch side can be seen on the length of the disc carrier, see sketch.

KR Dimension X (long disc carrier side)

K2 Dimension Y (short disc carrier side)

Check disc clearance KR=2.8~3.0 mm
(figure 169~171)

※ In order to ensure a perfect measuring result, the disc set is first of all to be installed without oil.

(1) Install disc set according to sketch or table.

Figure 169

(2) Install the end shim and fasten it by means of the snap ring.

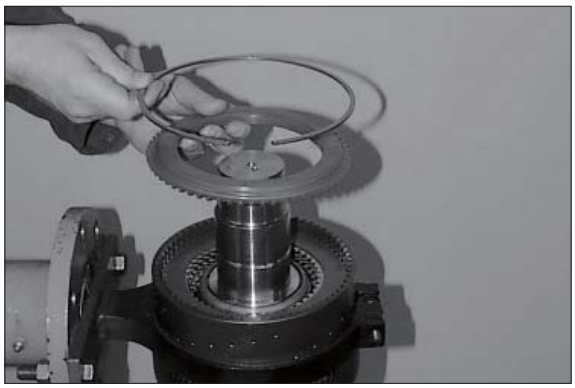


Figure 170

(3) Press on end shim with approximately 100N (10 kg) and set dial indicator to "Zero".
Then press end shim against snap ring (upwards) and read disc clearance on the dial indicator.

※ If the required disc clearance differs, it has to be corrected with the adequate inner clutch disc or/and snap ring, see table/ position 7 and Position 8.

Upon setting of disc clearance, remove the disc set, oil the clutch discs and reinstall them.

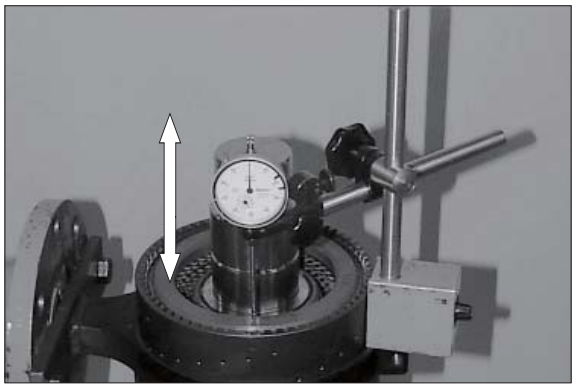


Figure 171

※ Special tool

Magnetic stand	5870 200 055
Dial indicator	5870 200 057

Preassemble and install spur gear KR (figure 172~176) :

(1) Opposite figure shows the single components of spur gear KR.
   1 Bearing inner ring (75×37 mm)
   2 Ring
   3 Spur gear
   4 Bearing inner ring (75×41 mm)

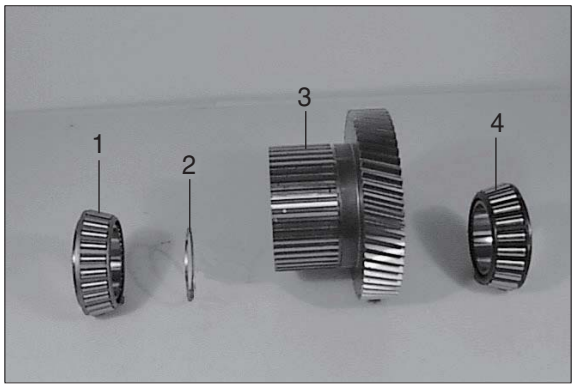


Figure 172

(2) Heat the bearing inner ring (75×37 mm) and install it until contact.

⚠ Use safety gloves.


Figure 173

(3) Assemble the spur gear until all inner clutch discs are located.

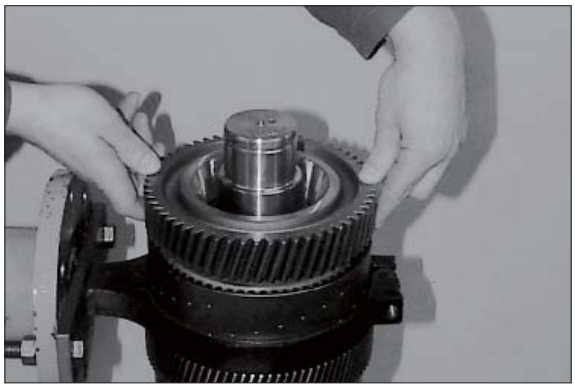


Figure 174

(4) Install the ring.

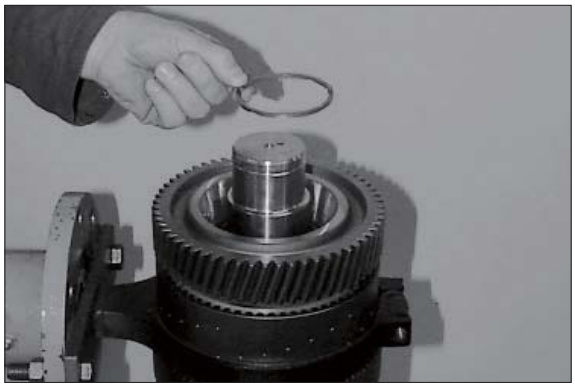


Figure 175

(5) Heat the bearing inner ring (75×41 ㎜) and locate it until contact.

⚠ Use safety gloves.

Figure 176

(6) Heat the bearing inner ring (clutch bearing) and locate it until contact.

⚠ Use safety gloves.

Figure 177

Disc Components K2

※ Below sketch or table shows the standard version as to the installation position of the single components. Obligatory is the respective spare parts list.

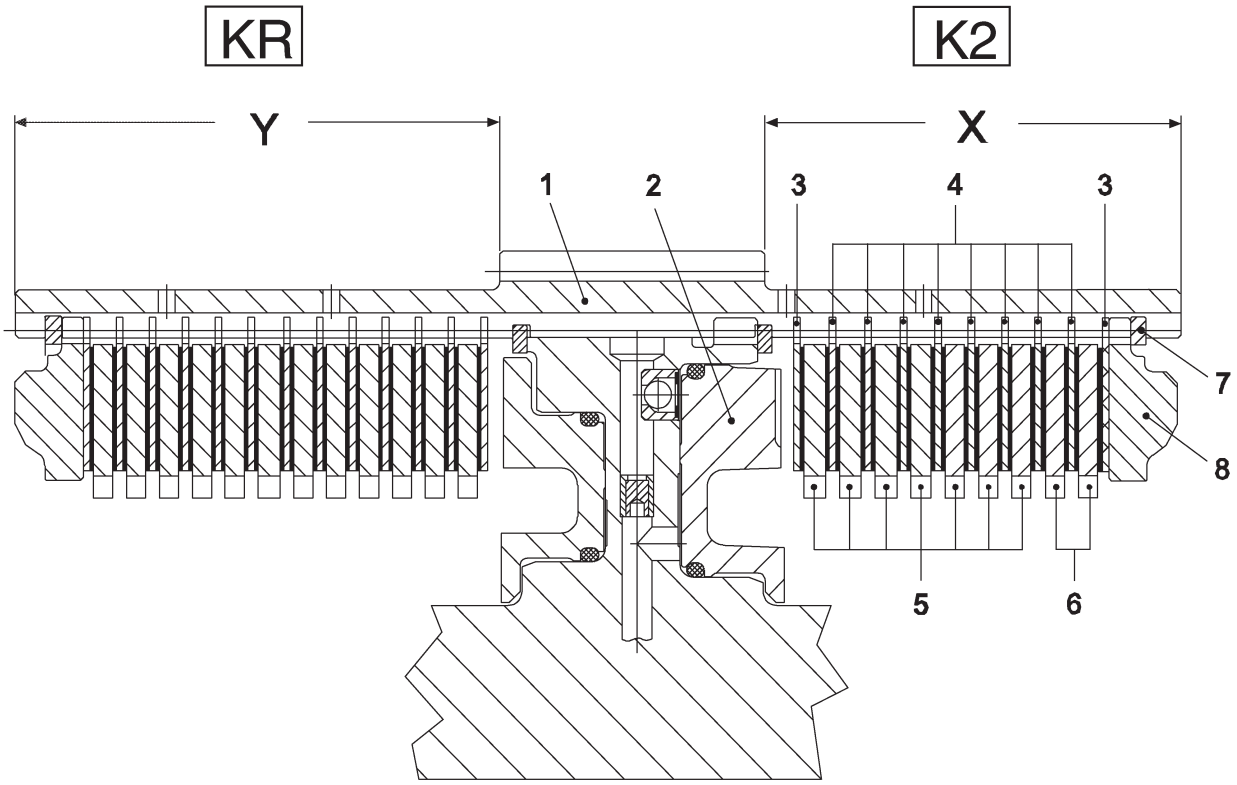


Figure 178

Position	Description	Quantity	s (mm)	Remarks
1	Disc carrier	1		
2	Piston	1		
3	Outer clutch disc	2	1.85	Coated on one side
4	Outer clutch disc	8	2.5	Coated on both sides
5	Inner clutch disc	7	3.0	
6	Inner clutch disc	2	2.5~4.0	Optional
7	Snap ring	1	2.10~3.10	Optional
8	End shim	1		
Number of friction surfaces : 18				
Disc clearance : 2.6 ~ 2.8 mm				

※ Install the outer clutch discs position 3 with uncoated side showing to the piston and end shim respectively. The respective clutch side can be seen on the length of the disc carrier, see sketch.

K2 Dimension X (short disc carrier side)

KR Dimension Y (long disc carrier side)

Check disc clearance K2=2.6~2.8 mm (figure 179~181)

※ In order to ensure a perfect measuring result, the disc set is first of all to be installed without oil.

(1) Install disc set according to sketch or table (figure 178).

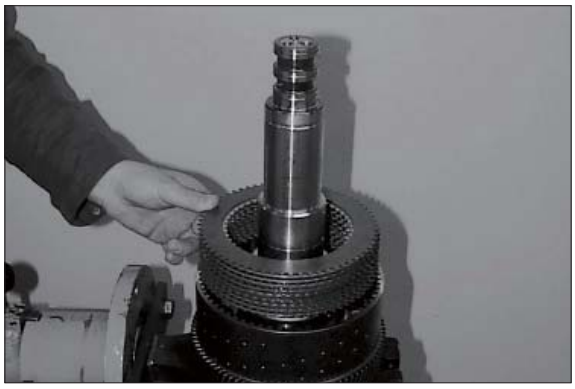


Figure 179

(2) Install the end shim and fasten it by means of the snap ring.

Figure 180

(3) Press on end shim with approximately 100N (10 kg) and set dial indicator to "Zero".
Then press end shim against snap ring (upwards) and read disc clearance on the dial indicator.

※ If the required disc clearance differs, it has to be corrected with the adequate inner clutch disc or/and snap ring, see table/ position 6 and position 7.

Upon setting of disc clearance, remove the disc set, oil the clutch discs and reinstall them.

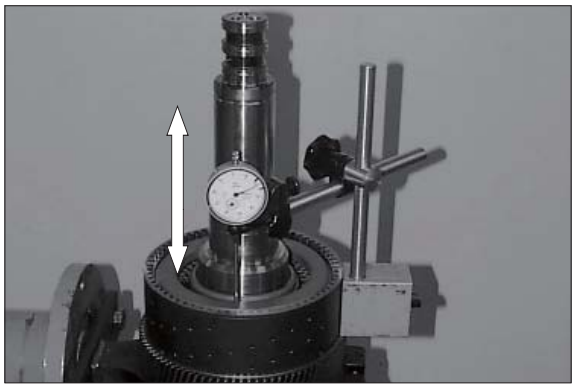


Figure 181

※ Special tool

Magnetic stand	5870 200 055
Dial indicator	5870 200 057

Preassemble and install spur gear K2 (figure182~186) :

(1) Undercool gear 1 (approx -80˚C) and heat gear 2 (approx 120˚C).
Engage the snap ring(arrow), preload it and join both components by means of hydraulic press until the snap ring engages into the annular groove of gear 2.

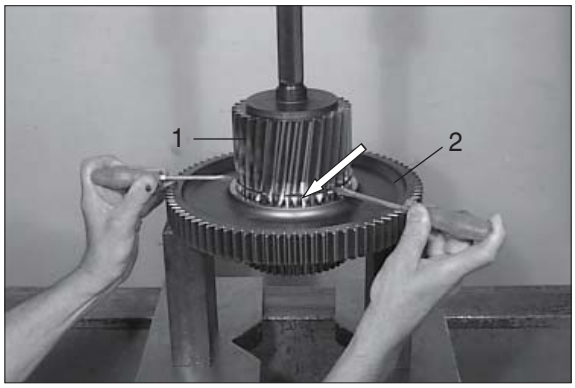


Figure 182

(2) Opposite figure shows the single components of the spur gear bearing.

1 Bearing inner ring
2 Spur gear assy
3 Bearing inner ring

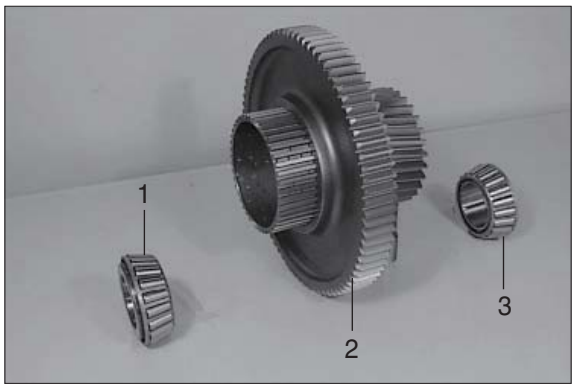


Figure 183

(3) Heat the bearing inner ring and install it until contact.

⚠ Use safety gloves.


Figure 184

(4) Assemble the spur gear until all inner clutch discs are located.

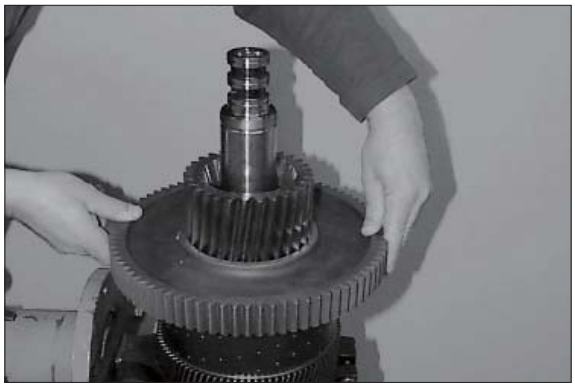


Figure 185

(5) Heat the bearing inner ring (spur gear bearing) and install it until contact.

⚠ **Use safety gloves.**

Figure 186

(6) Heat the bearing inner ring (clutch bearing) and locate it until contact.

⚠ **Use safety gloves.**

Figure 187

(7) Lift the disc carrier out of the clamping ring.
To ensure the exact locating of the single components, preload the bearing with 100 KN (10t) (figure 188)

⚠ **Support on the lower as well as upper bearing inner ring.**
Use pressure pieces.

※ Special tool
Pressure piece 5870 506 096

Figure 188

(8) Lift the disc carrier into the clamping ring and fasten it.
Rotate disc carrier by 90˚.
K2-side :
Install the slotted nut.

※ Observe installation position of the slotted nut. Chamfer must show to the bearing inner ring, also see sketch (figure 159).
Oil the thread.

· Torque limit : 81.6 kgf · m (590 lbf · ft)

※ Special tool

Clamping ring	5870 654 033
Slotted nut wrench	5870 401 099

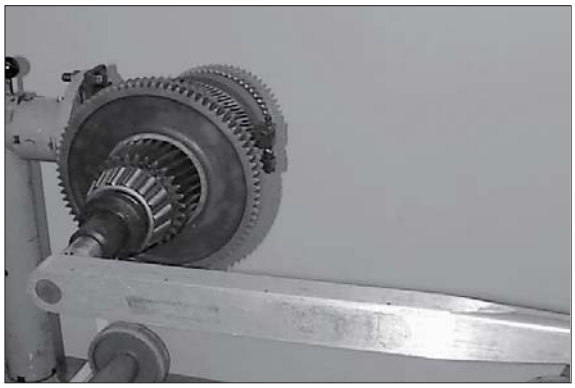


Figure 189

KR-side :
Install the slotted nut.

※ Observe installation position of the slotted nut. Collar (ø 76 mm) must show to the bearing inner ring, also see sketch (figure 159). Oil the thread.

· Torque limit : 81.6 kgf · m (590 lbf · ft)

※ Special tool

Slotted nut wrench	5870 401 099


Figure 190

(9) Check function of the clutches K3 and K4 by means of compressed air (figure 191).

※ Closing or opening of the clutches is clearly audible when the single parts have been installed adequately.

Snap-in and lock the rectangular rings (3EA, see arrows).

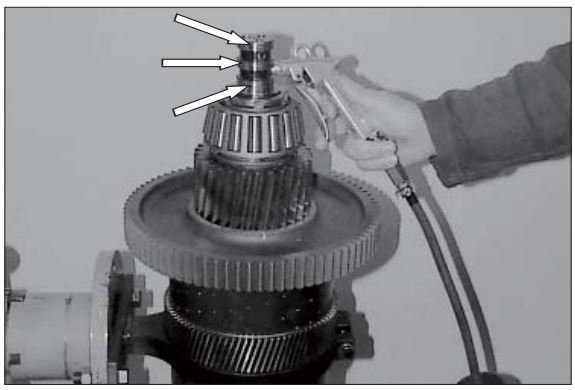


Figure 191

Assembly of the multi-disc clutch KV/K1

The following sketch shows the clutch sectioning

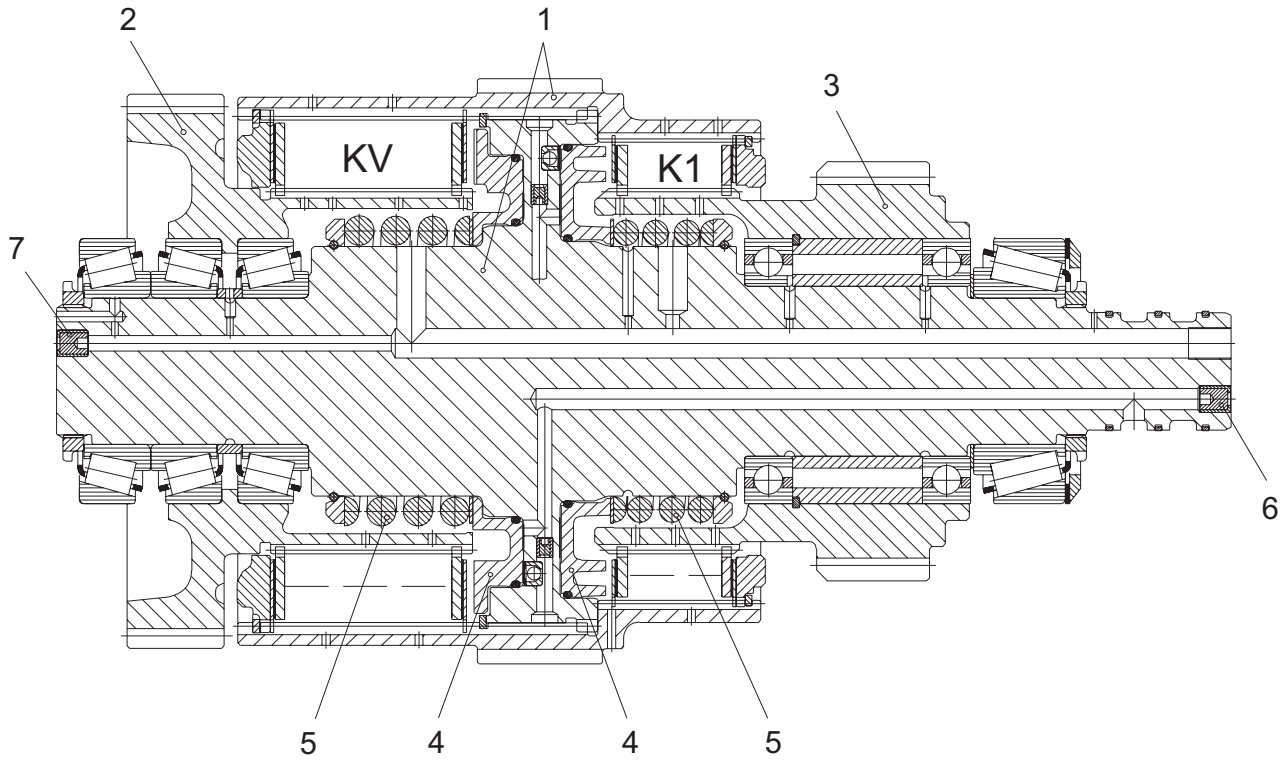


Figure 192

1	Disc carrier	KV	Multi-disc clutch KV	5	Compression spring
2	Spur gear KV	K1	Multi-disc clutch K1	6	Plug 2EA
3	Spur gear K1	4	Piston	7	Plug 1EA

※ Observe the installation position of the single components for the following assembly.

(1) Lift the disc carrier with the KV-side showing downwards into the clamping ring(S) and fasten it.
Then rotate disc carrier by 180˚.

⚠ **To install new disc carriers the finished bores have to be sealed with plugs.**
Installation position, see arrow, figure193~194.

※ Special tool

Hand mounting tool	5870 320 014
Ratchet spanner	5870 320 018

Figure 193

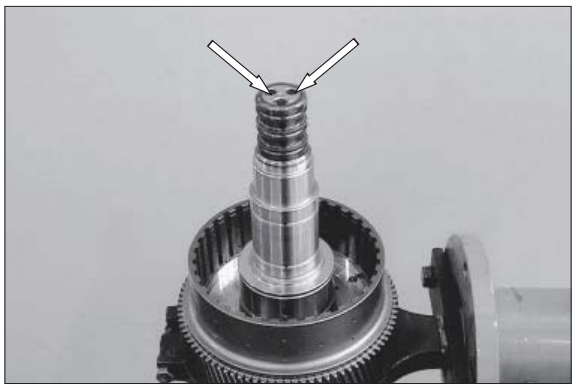


Figure 194

(2) Flush-mount the drain valve (arrow) with the chamfer showing downwards.

※ Special tool

Inserting tool	5870 320 019

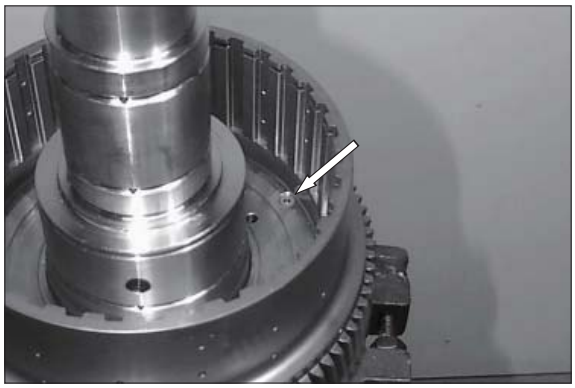


Figure 195

(3) Put both O-rings **scroll-free** into the annular grooves of the piston, see arrows.

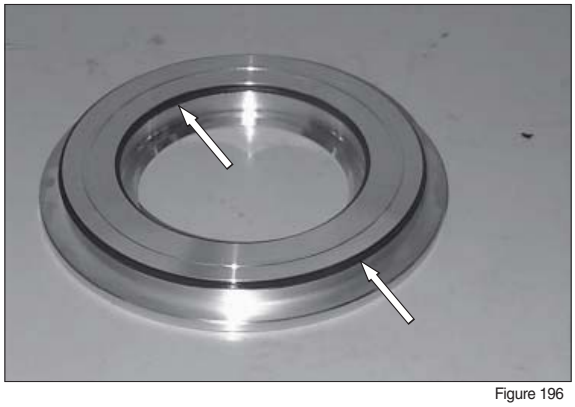


Figure 196

(4) Oil the O-rings and the piston contact surface.
Install K1 piston **equally** until contact.

※ Observe the installation position of the piston, see figure.

Figure 197

(5) Install spacer and compression spring.

Figure 198

(6) Place guide ring, with the chamfer (arrow) showing upwards, over the compression spring and install the snap ring.

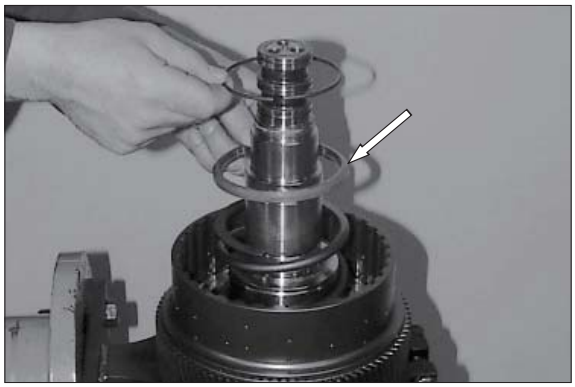


Figure 199

(7) Lift the disc carrier out of the clamping ring. Preload the compression spring by means of fixture and engage the snap ring into the annular groove of the disc carrier (arrow), see figure 200.
Install the drain valve, piston and compression spring on the opposite side (clutch KV) analogously.
Then lift the disc carrier with the KV-side showing downwards into the clamping ring and fasten it.
Rotate disc carrier by 180˚.

※ Special tool

Pressure piece	5870 345 072
Clamping fixture	5870 654 036

Figure 200

Disc Components KV

※ Below sketch or table shows the standard version as to the installation position of the single components. Obligatory is the respective spare parts list.

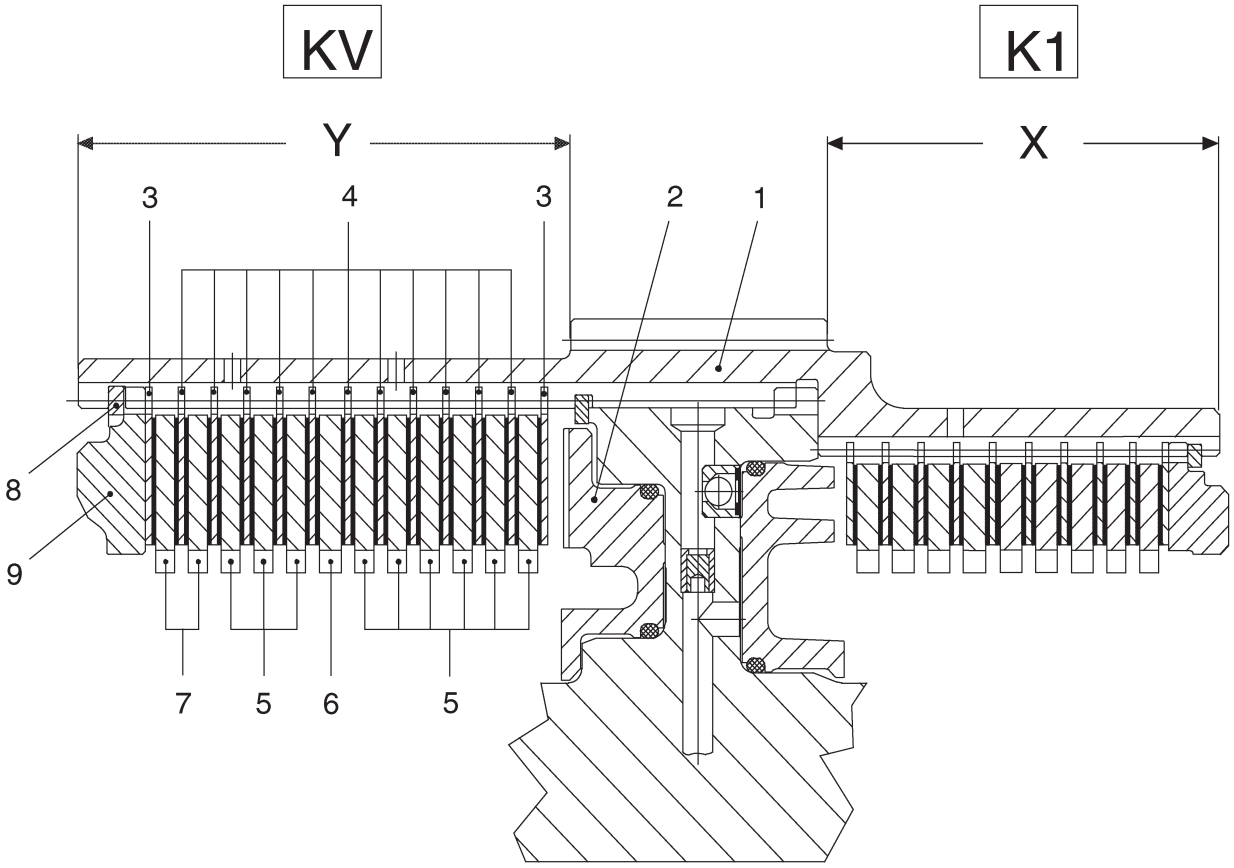


Figure 201

Position	Description	Quantity	s (mm)	Remarks
1	Disc carrier	1		
2	Piston	1		
3	Outer clutch disc	2	1.85	Coated on one side
4	Outer clutch disc	11	2.5	Coated on both sides
5	Inner clutch disc	9	3.5	
6	Inner clutch disc	1	4.0	
7	Inner clutch disc	2	2.5~4.0	Optional
8	Snap ring	1	2.10~3.10	Optional
9	End shim	1		
Number of friction surfaces : 24				
Disc clearance : 2.8 ~ 3.0 mm				

※ Install the outer clutch discs position 3 with uncoated side showing to the piston and end shim respectively. The respective clutch side can be seen on the length and ø of the disc carrier respectively, see sketch.

KV Dimension Y (long disc carrier side and large ø respectively)

K1 Dimension X (short disc carrier side and small ø respectively)

Check disc clearance KV=2.8~3.0 mm
(figure 202~204)

※ In order to ensure a perfect measuring result, the disc set is first of all to be installed without oil.

(1) Install disc set according to sketch or table (figure 201).

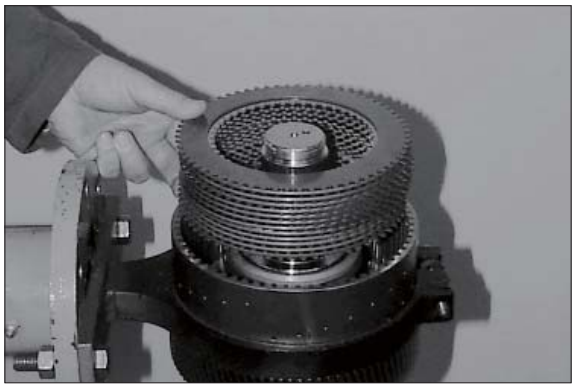


Figure 202

(2) Install the end shim and fasten it by means of the snap ring.

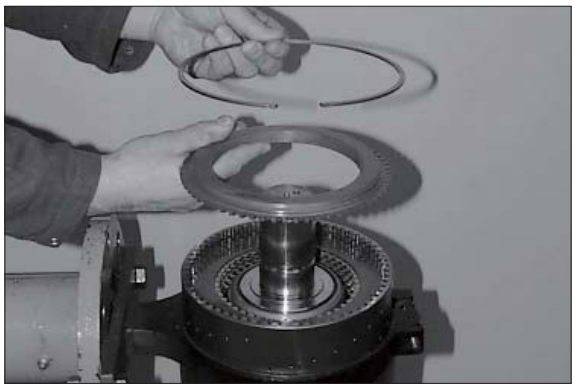


Figure 203

(3) Press on end shim with approximately 100N (10 kg) and set dial indicator to "Zero".
Then press end shim against snap ring (upwards) and read disc clearance on the dial indicator.

※ If the required disc clearance differs, it has to be corrected with the adequate inner clutch disc or/and snap ring, see table/ position 7 and position 8.

Upon setting of disc clearance, remove the disc set, oil the clutch discs and reinstall them.

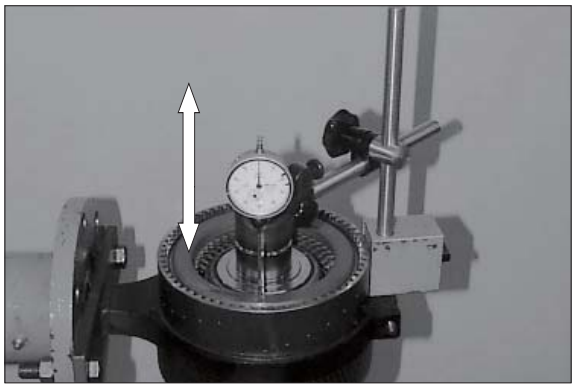


Figure 204

※ Special tool

Magnetic stand	5870 200 055
Dial indicator	5870 200 057

Preassemble and install spur gear KV (figure 205~209) :

(1) Opposite figure shows the single components of spur gear KV.

1 Bearing inner ring
2 Bearing outer ring
3 Ring
4 Spur gear

Install both bearing outer rings (2) until contact.

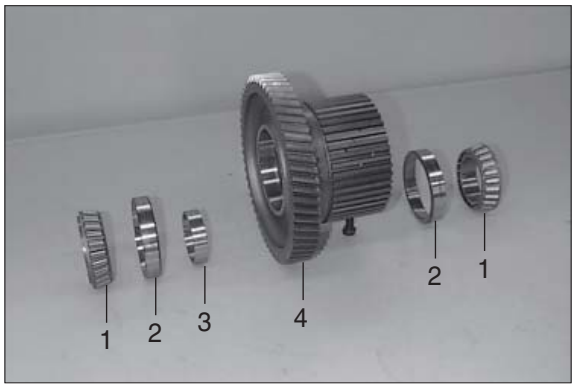


Figure 205

(2) Heat the bearing inner ring and install it until contact.

⚠ **Use safety gloves.**


Figure 206

(3) Install the ring.

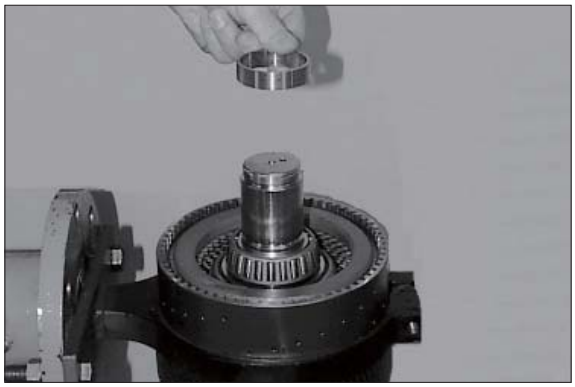


Figure 207

(4) Assemble the spur gear until all inner clutch discs are located.

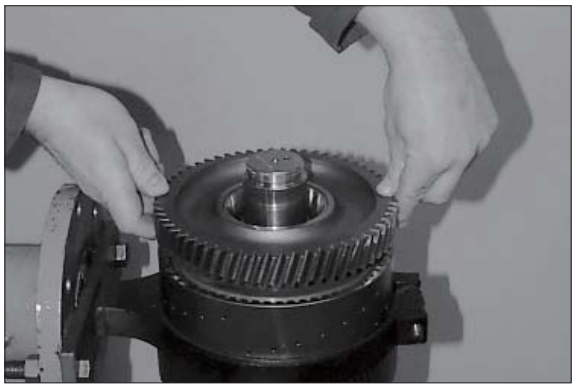


Figure 208

(5) Heat the bearing inner ring (spur gear bearing) and locate it until contact.

⚠ Use safety gloves.

Figure 209

(6) Heat the bearing inner ring (clutch bearing) and locate it until contact.

⚠ Use safety gloves.

Rotate disc carrier by 180˚.

Figure 210

Disc Components K1

※ Below sketch or table shows the standard version as to the installation position of the single components. Obligatory is the respective spare parts list.

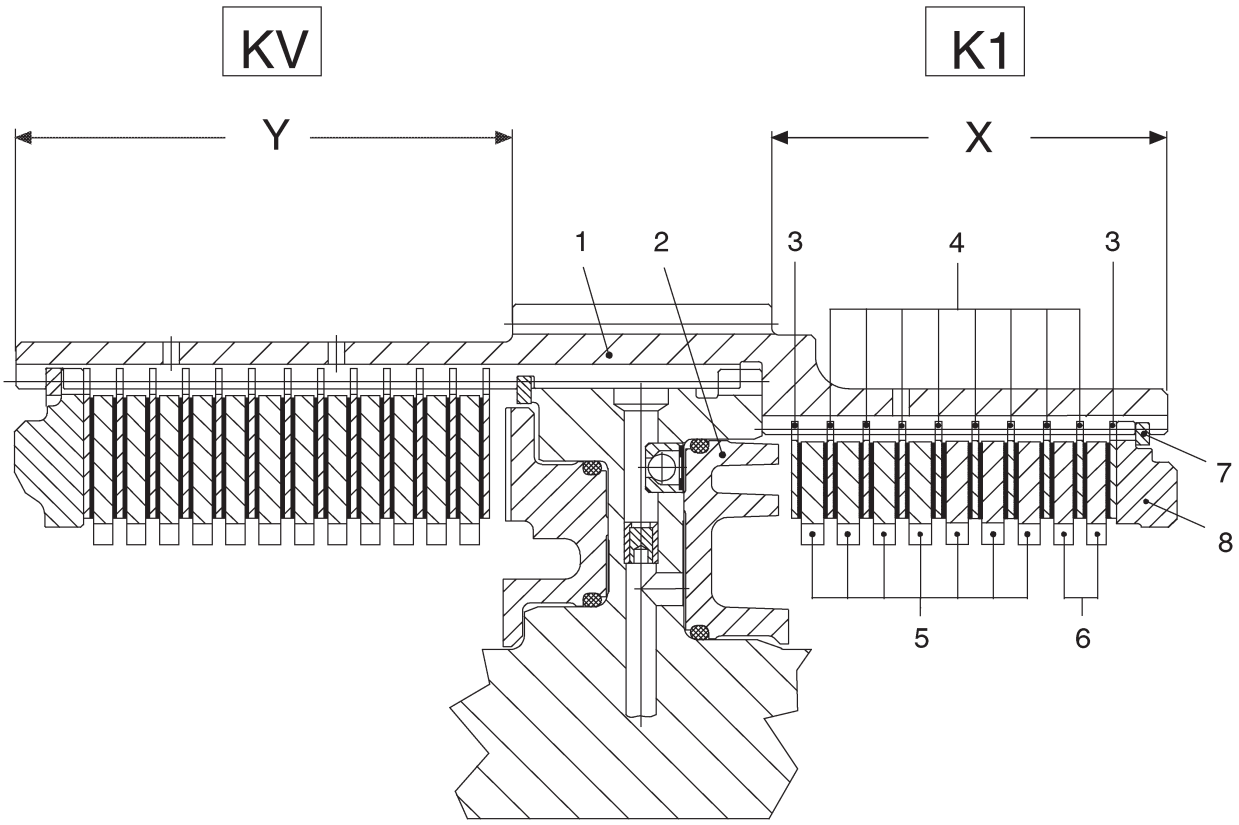


Figure 211

Position	Description	Quantity	s (mm)	Remarks
1	Disc carrier	1		
2	Piston	1		
3	Outer clutch disc	2	1.85	Coated on one side
4	Outer clutch disc	8	2.5	Coated on both sides
5	Inner clutch disc	7	2.5	
6	Inner clutch disc	2	2.5~4.0	Optional
7	Snap ring	1	2.1~2.5	Optional
8	End shim	1		
Number of friction surfaces : 18				
Disc clearance : 2.6 ~ 2.8 mm				

※ Install the outer clutch discs position 3 with uncoated side showing to the piston and end shim respectively. The respective clutch side can be seen on the length and ø of the disc carrier respectively, see sketch.

K1 Dimension X (short disc carrier side and small ø respectively)

KV Dimension Y (long disc carrier side and large ø respectively)

Check disc clearance KV=2.6~2.8 mm
(figure 212~214)

※ In order to ensure a perfect measuring result, the disc set is first of all to be installed without oil.

(1) Install disc set according to sketch or table (figure 211).

Figure 212

(2) Install the end shim and fasten it by means of the snap ring.

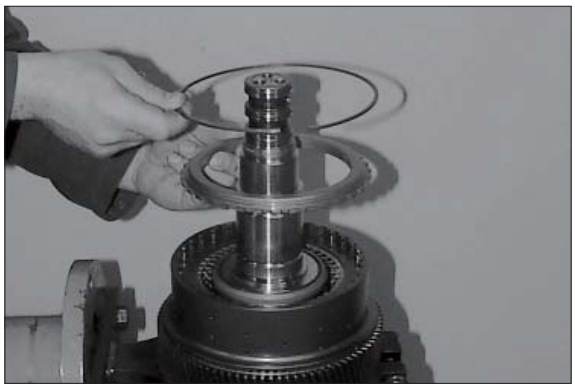


Figure 213

(3) Press on end shim with approximately 100N (10 kg) and set dial indicator to "Zero".
Then press end shim against snap ring (upwards) and read disc clearance on the dial indicator.

※ If the required disc clearance differs, it has to be corrected with the adequate inner clutch disc or/and snap ring, see table/ position 7 and position 8.

Upon setting of disc clearance, remove the disc set, oil the clutch discs and reinstall them.

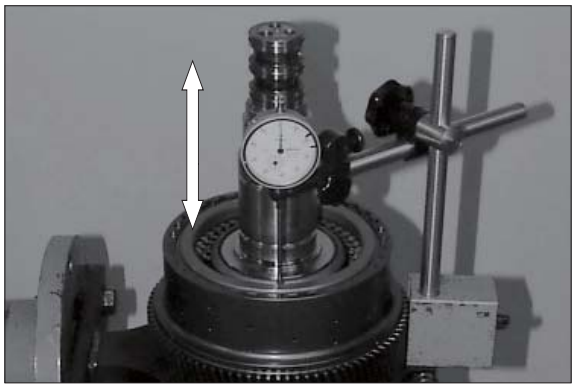


Figure 214

※ Special tool

Magnetic stand	5870 200 055
Dial indicator	5870 200 057

Preassemble and install spur gear K1 (figure 215~222) :

(1) Opposite figure shows the single components of spur gear K1.

1 Ball bearing (assy)
2 Snap ring
3 Spur gear

※ Prior to installation of the single components, align the disc set by means of the spur gear radially and center it, see figure 216.

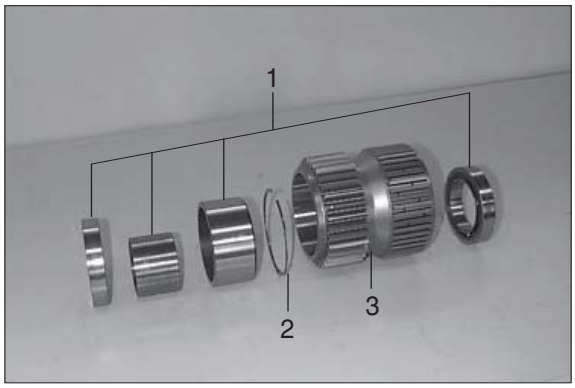


Figure 215


Figure 216

(2) Install the ring.

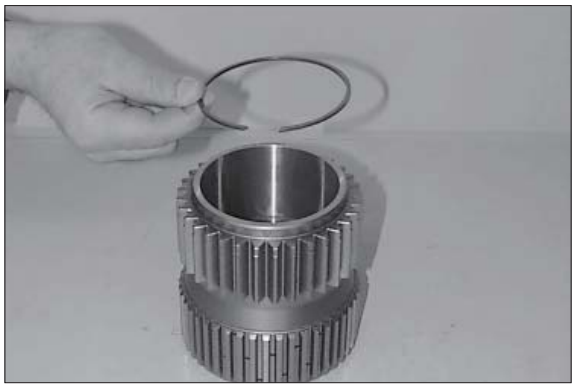


Figure 217

(3) Install the bush with collar (arrow) on face end showing to the snap ring.


Figure 218

(4) Press in the ball bearing until contact.

※ Install the ball bearing with the lubricating groove (arrow) showing downwards.
Put the press-in tool only to te bearing outer ring.

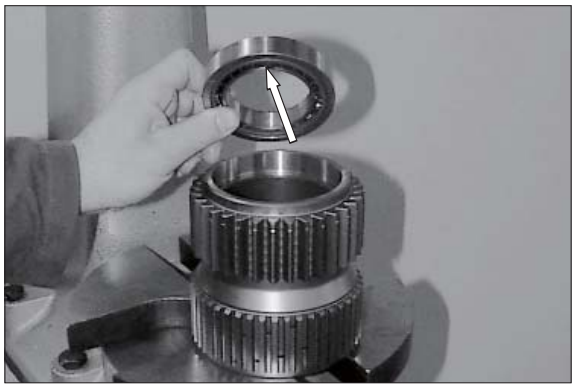


Figure 219

(5) Heat the second ball bearing and install it until contact.

※ Lubricating groove (arrow), must show upwards.

⚠ **Use safety gloves.**

Figure 220

(6) Assemble the bush.

Figure 221

(7) Heat the spur gear to approximately 120˚C and assemble it until all inner clutch discs are located.

⚠ **Use safety gloves.**

Figure 222

(8) Install shim s = 1.20 mm

Figure 223

(9) Heat the bearing inner ring and install it until contact.

⚠ **Use safety gloves.**

Figure 224

(10) Lift the disc carrier out of the clamping ring. To ensure the exact locating of the single components, preload the bearing with 100KN (10 t) (figure 225).

⚠ **Support on the lower as well as upper bearing inner ring.**
Use pressure pieces.

※ Special tool
Pressure pieces 5870 506 096

Figure 225

(11) Lift the disc carrier into the clamping ring. Rotate disc carrier by 90˚.
Install the slotted nut.

※ Observe installation position of the slotted nut. Collar (ø 60 mm) must show to the taper roller bearing also see sketch (figure 192). Oil the thread.

· Torque limit : 56.1 kgf · m (406 lbf · ft)

※ Special tool

Slotted nut wrench	5870 401 118
Slotted nut wrench	5870 401 099

Install the opposite slotted nut (KV-side) analogously.

※ Special tool

Slotted nut wrench	5870 401 118
Slotted nut wrench	5870 401 115

Figure 226

(12) Check function of the clutches KV and K1 by means of compressed air.

※ Closing or opening of the clutches is clearly audible when the single parts have been installed adequately.

Figure 227

(13) Snap-in and lock the rectangular rings (3EA, see arrows).

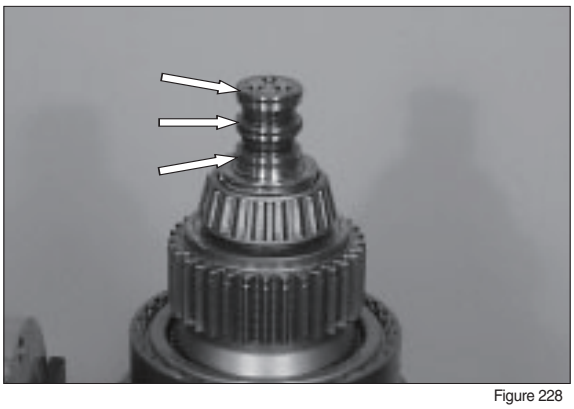


Figure 228

Installation of layshaft gear, multi-disc clutches and output gear

(1) Opposite figure shows the single components of the layshaft gear bearing.

1 Bearing inner ring (2EA)
2 Ring
3 Layshaft gear

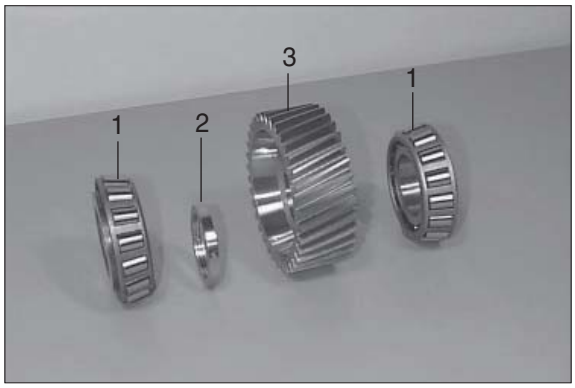


Figure 229

(2) Position layshaft gear (assy) in the housing.

※ Only when the clutches are installed, the idler shaft can be mounted.

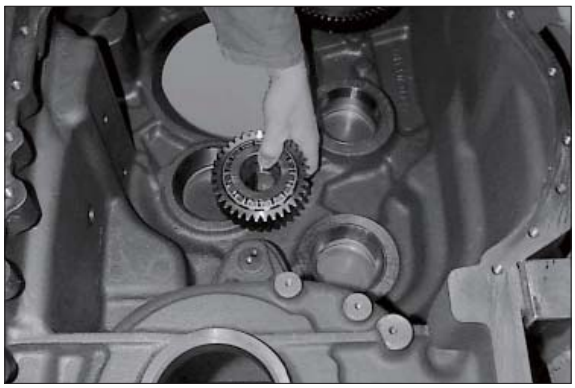


Figure 230

(3) Insert the bearing outer rings KV/K1, KR/K2 and K3/K4 into the housing bores until contact, see arrows.

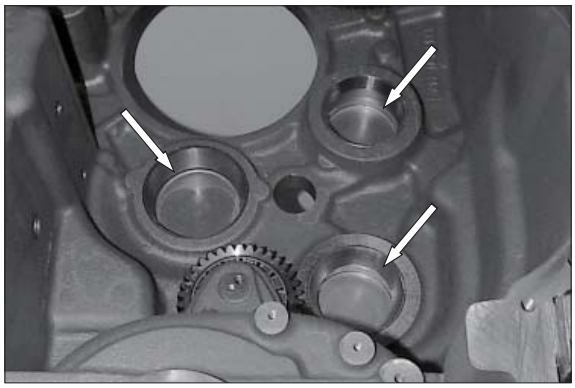


Figure 231

(4) Position clutch KV/K1 by means of lifting tackle.

※ Special tool
Eyebolts assortment 5870 204 002


Figure 232

(5) Position clutch KR/K2.

※ Special tool

Eyebolts assortment	5870 204 002

Figure 233

(6) Check the installation position of the layshaft gear (arrow) once again and correct it, if required.

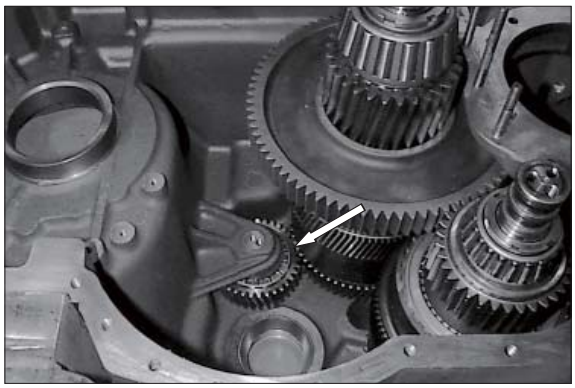


Figure 234

(7) Fasten the spur gear K3 by means of fixture and eyebolt (arrow) axially.

※ Spur gear fixing prevents the clutch discs from dislocating when the clutch is lifted in.

※ Special tool

Assembly fixture	5870 345 033
Eyebolt	5870 204 066

Figure 235

(8) Lift the clutch KR/K2 slightly, move it in direction of the arrow and position clutch K3/K4.

Then remove the fixture (figure 235) again.

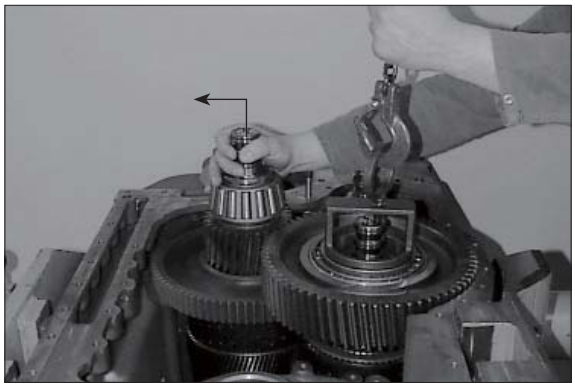


Figure 236

(9) Insert the bearing outer ring into the housing bore until contact.

Figure 237

(10) Heat the bearing inner ring and install it until contact.

⚠ **Use safety gloves.**

※ Observe installation position-collar (arrow) shows to the spur gear. Install the bearing inner ring after cooling down subsequently (press).

Figure 238

(11) Position the oil baffle.

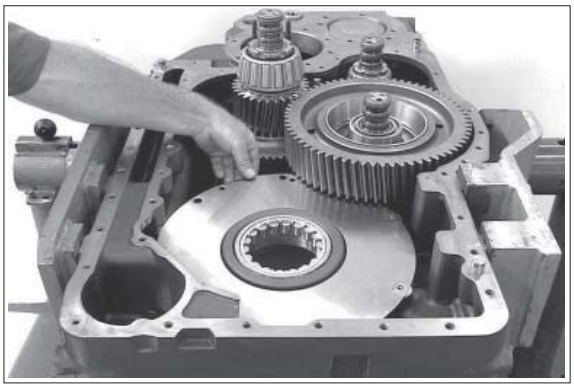


Figure 239

(12) Install the output gear by means of lifting tackle.

※ Special tool

Stop washer	5870 100 054
Eyebolts assortment	5870 204 002

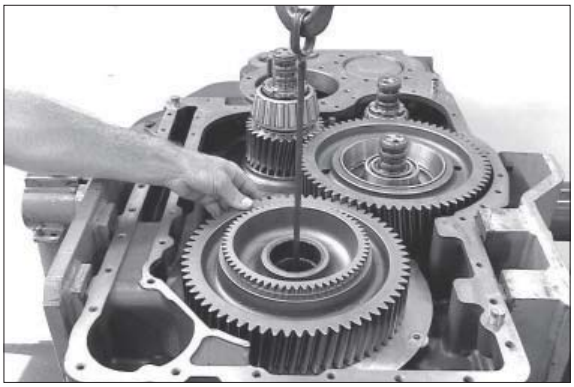


Figure 240

(13) Position upper oil baffle and fasten both plates by means of hexagon screws (4EA).

※ Install washers.
Secure hexagon screws with loctite (type No.243).
· Torque limit : 2.35 kgf · m (16.7 lbf · ft)

Figure 241

Preassembly and mounting of the housing cover

Note to figure 242 and 243 :
Depending on the transmission version, differences as regards the single components and their installation position are possible.
Obligatory is the respective parts list.

(1) Install the sealing cover (arrow).

※ Wet the sealing surface with loctite (type No.262).

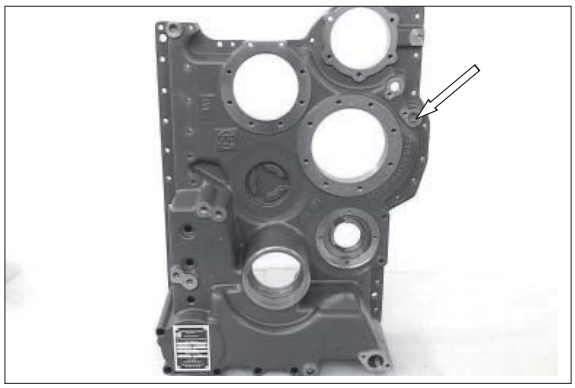


Figure 242

(2) Insert the O-ring into the annular groove of the cover and fasten the cover by means of hexagon screws.

※ Wet the thread of the hexagon screws with loctite (type No.574). Observe the installation position of the cover, see figure.
· Torque limit : 2.35 kgf · m (16.7 lbf · ft)

Figure 243

(3) Wet the mounting face with sealing compound (loctite, type No.574).
By means of the lifting tackle place the housing cover on the transmission housing until contact.

※ Special tool
Lifting tackle 5870 281 055

Figure 244

(4) Install both cylindrical pins (arrow 1 and 2) and the slotted pin (arrow 3).
Then fasten the housing cover by means of hexagon and cap screws.
· Torque limit M10/8.8 :
4.69 kgf · m (33.9 lbf · ft)

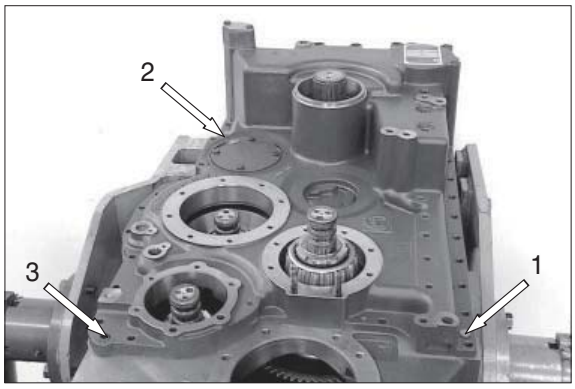


Figure 245

Adjust the bearing preload of clutch K4/K3 = 0.0~0.05 mm (figure 248~250)

※ For installation of a new bearing cover, both finished bores have to be sealed by means of a plug.
Finished bores are located opposite (180˚) to each other, also see arrow/figure 246 and 247.

1 Bearing cover-K4/K3
2 Plug (konig)
(S) Special tool

※ Special tool

Hand mounting tool	5870 320 014
Ratchet spanner	5870 320 018

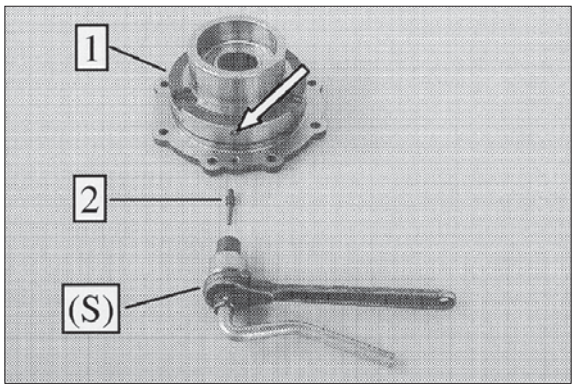


Figure 246

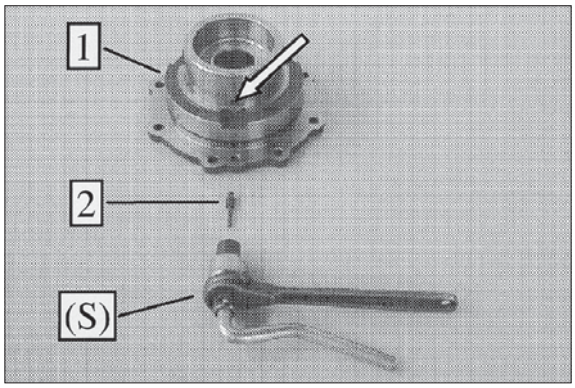


Figure 247

Housing dimension :

(1) Press on equally the bearing inner ring and detemine Dimension I, from the mounting face to the bearing inner ring.
Dimension I e.g ····· 43.65 mm

※ Take several measuring points and determine the mean value.

Then remove the bearing inner ring again.

※ Special tool

Measuring shaft	5870 200 022
Digital depth gauge	5870 200 072

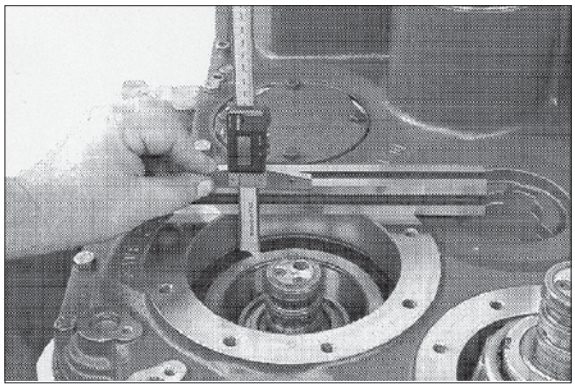


Figure 248

Cover dimension :

(2) Determine Dimension II, from the mounting face until contact/bearing inner ring.
Dimension II e.g ····· 42.12 mm

※ Special tool

Straightedge	5870 200 022
Gauge blocks	5870 200 067
Digital depth gauge	5870 200 072

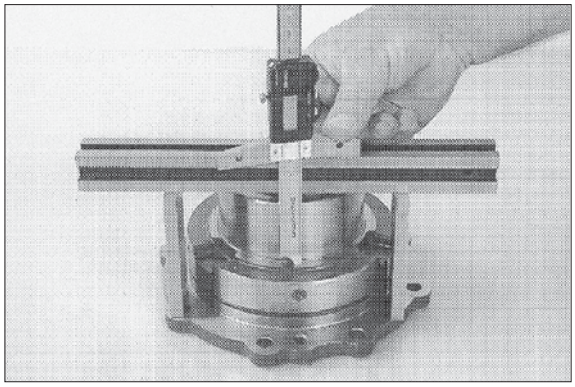


Figure 249

Example :

Dimension I ·····		43.65 mm
Dimension II ·····		- 42.12 mm
Difference ·····		= 1.53 mm
Bearing preload ·····	e.g.	+ 0.02 mm
Resulting shim(s) ·····	s	= 1.55 mm

(3) Put on the shim.

Figure 250

(4) Heat the bearing inner ring and place it until contact.

⚠ **Use safety gloves.**

※ Install the bearing inner ring after cooling down subsequently (press).

Figure 251

(5) Grease the rectangular rings (3EA, arrows) and centrally align them.

Figure 252

(6) Install the O-ring (arrow) and grease it.
Heat the inner diameter of the bearing cover (bearing seat).

※ Special tool

Hot-air blower 230V	5870 221 500
Hot-air blower 115V	5870 221 501

Figure 253

(7) Install two adjusting screws.
Assemble the bearing cover and tighten it equally until contact by means of hexagon screws.

· Torque limit (M10/8.8) :
4.69 kgf · m (33.9 lbf · ft)

※ Observe the radial installation position.

※ Special tool

Adjusting screws	5870 204 007

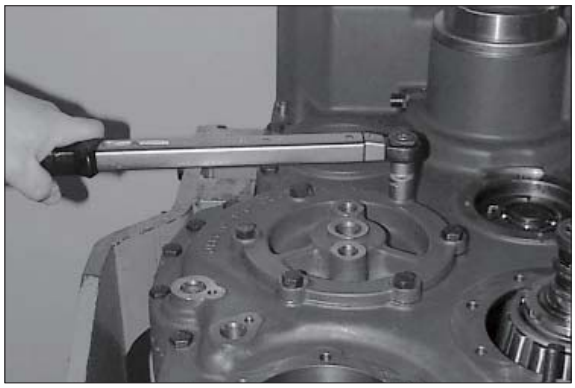


Figure 254

(8) Check the function of **both** clutches by means of compressed air.

※ In case of a decisive pressure loss, the possible cause might be the breakage of one or several rectangular rings (see arrow , figure 252).
Replace the rectangular rings, if required.

Figure 255

Adjust the bearing preload of clutch KR/K2 = 0.0~0.05 mm (figure 258~262)

※ For installation of a new bearing cover, both finished bores have to be sealed by means of a plug.
Finished bores are located opposite (18˚) to each other, also see arrow/Figure 256 and 257.

1 Bearing cover-KR/K2
2 Plug
(S) Special tool

※ Special tool

Hand mounting tool	5870 320 014
Ratchet spanner	5870 320 018

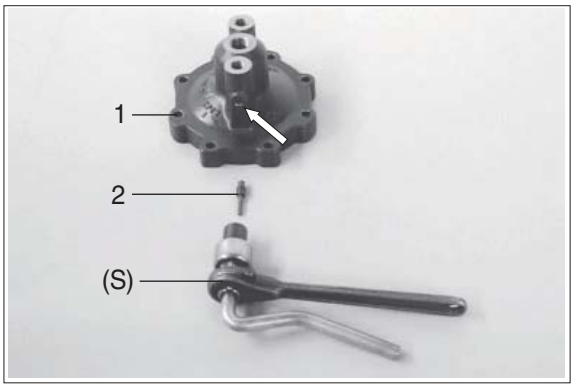


Figure 256

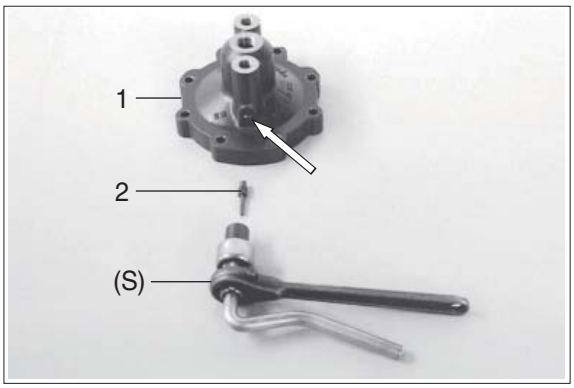


Figure 257

(1) Install both studs (arrows).

※ Wet the thread with loctite (type No. 243).
· Torque limit (M10) :
1.33 kgf · m (9.59 lbf · ft)

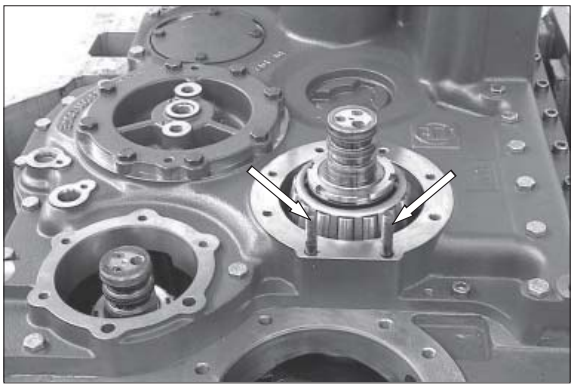


Figure 258

(2) Install the bearing outer ring until contact.

※ Pay attention to exact contact.

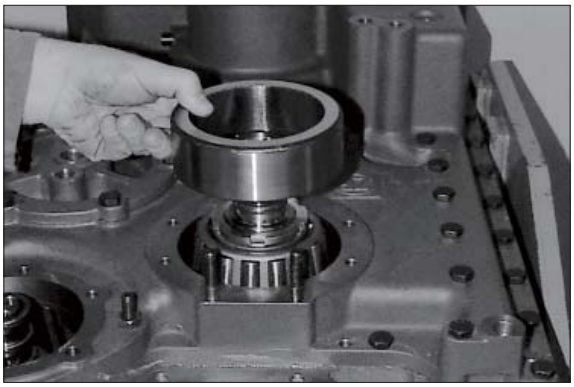


Figure 259

Housing dimension :

(3) Determine Dimension I, from the bearing outer ring to the mounting face.
Dimension I e.g ····· 16.13 mm

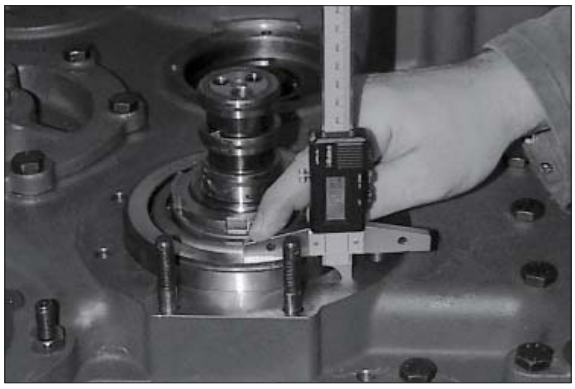


Figure 260

Cover dimension :

(4) Determine Dimension II, from the contact/ bearing outer ring to the mounting face.
Dimension II e.g ····· 17.75 mm

※ Special tool
Digital depth gauge 5870 200 072

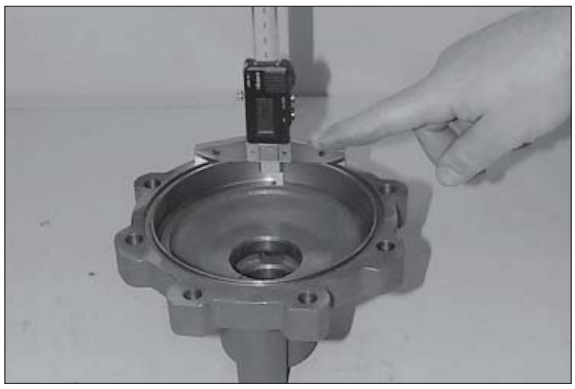


Figure 261

Example :

Dimension II ·····		17.75 mm
Dimension I ·····		- 16.13 mm
Difference ·····		= 1.62 mm
Bearing preload ·····	e.g.	+ 0.03 mm
Resulting shim (s) ·····	s	= 1.65 mm

(5) Fix the shim with assembly grease into the cover. Install the O-ring (arrow).

Figure 262

(6) Grease the rectangular rings (arrows) and centrally align them.

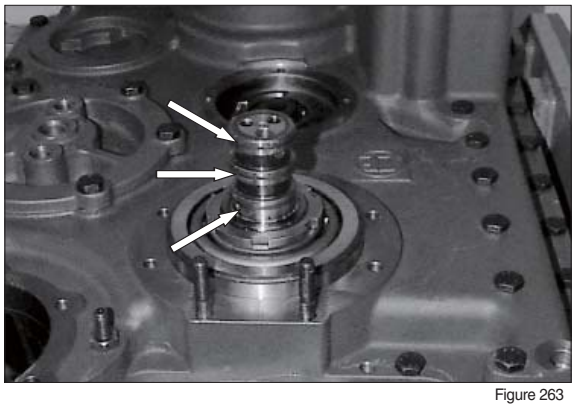


Figure 263

(7) Pull the bearing cover equally until contact.

· Torque limit (M10/8.8) :

4.69 kgf · m (33.9 lbf · ft)

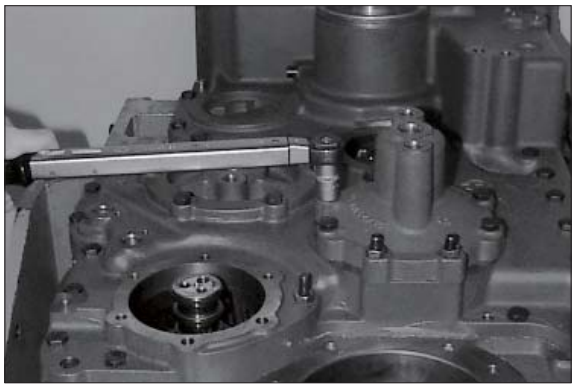


Figure 264

(8) Check the function of both clutches by means of compressed air.

※ In case of a decisive pressure loss, the possible cause might be the breakage of one or several rectangular rings (see figure 263).

Replace the rectangular rings, if required.

Figure 265

Adjust the bearing preload of clutch KV/K1 = 0.0~0.05 mm (figure 267~270)

※ For installation of a new bearing cover, both finished bores have to be sealed by means of a plug.
Installation position, see arrows/figure 266.

1 Bearing cover-KV/K1
2 Plug
(S) Special tool

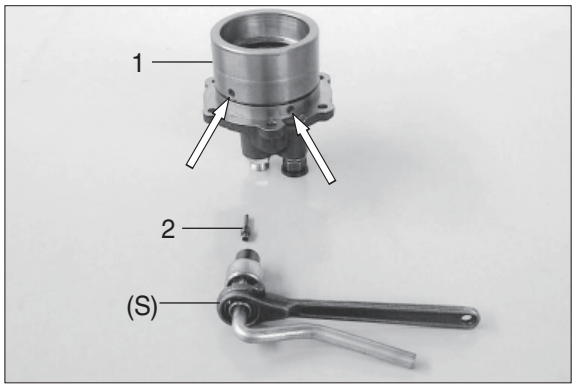


Figure 266

※ Special tool

Hand mounting tool	5870 320 014
Ratchet spanner	5870 320 018

(1) Put the bearing outer ring over the bearing inner ring.

Housing dimension :
Press on equally the bearing outer ring and determine Dimension I, from the mounting face to the bearing outer ring.

Dimension I e.g ····· 52.67 mm

※ Take several measuring points and determine the mean value.

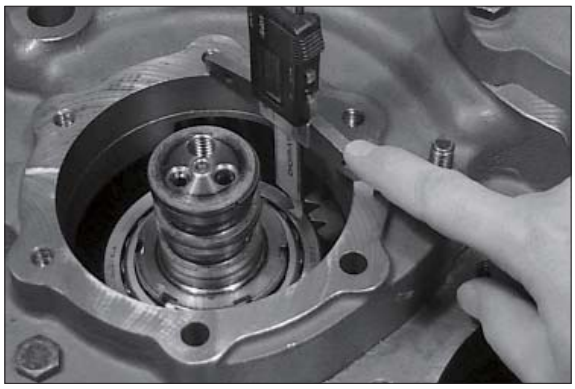


Figure 267

(2) Put the ring with the chamfer showing downwards into the bearing cover.


Figure 268

Cover dimension :

(3) Determine Dimension II, from the mounting face to the ring.
Dimension II e.g ····· 50.75 mm

※ Special tool

Digital depth gauge	5870 200 072
Gauge blocks	5870 200 067

Figure 269

Example :

Dimension I ·····		52.67 mm
Dimension II ·····		- 50.75 mm
Difference ·····	e.g.	1.92 mm
Bearing preload ·····		+ 0.03 mm
Resulting shim (s) ·····	s	= 1.95 mm

(4) Put in the shim.

Figure 270

(5) Install the bearing outer ring until contact. Assemble the O-ring (arrow).

Figure 271

(6) Grease the rectangular rings (arrows) and centrally align them.

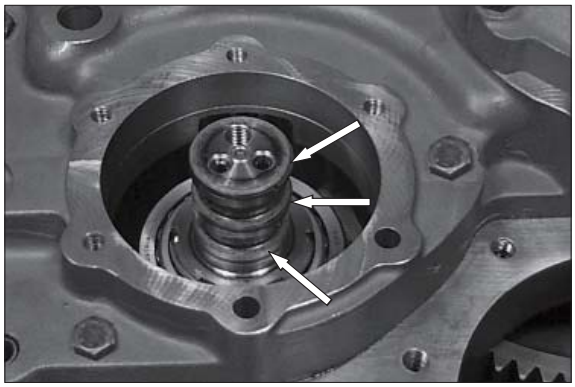


Figure 272

(7) Heat the bearing bore.

※ Special tool

Hot-air blower 230V	5870 221 500
Hot-air blower 115V	5870 221 501

Figure 273

(8) Install two adjusting screws.
Place the bearing cover until contact and fasten it by means of hexagon screws.

※ Observe the radial installation position, see figure.

※ Special tool

Adjusting screws	5870 204 007

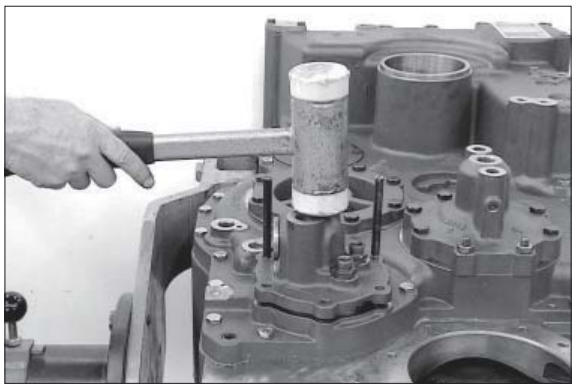


Figure 274

(9) Check the function of both clutches by means of compressed air.

※ In case of a decisive pressure loss, the possible cause might be the breakage of one or several rectangular rings (see arrow, figure 272).
Replace the rectangular ring (s), if required.

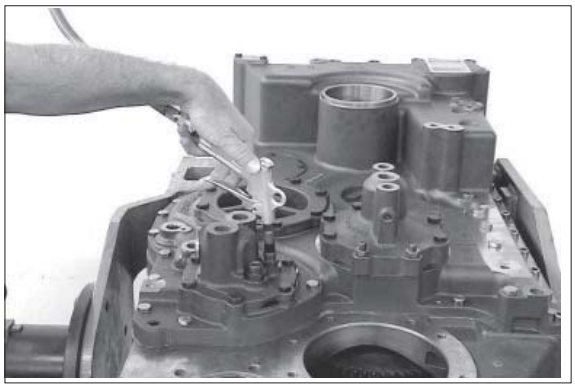


Figure 275

Output

Installation of the output shaft

(1) Heat the inner diameter of the output gear.

※ Special tool

Hot-air blower 230V	5870 221 500
Hot-air blower 115V	5870 221 501

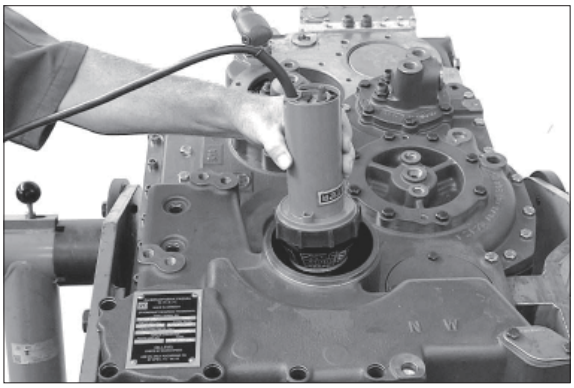


Figure 276

(2) Assemble the output shaft with the long gearing showing downwards until contact.

Figure 277

(3) Rotate the transmission housing into the vertical position (90˚).
By means of the mounting tool the output shaft has preliminarily to be fixed axially (figure 278 and 279) at the convert-er side.

※ Special tool

Mounting tool	5870 048 265

Then rotate the transmission housing back again (90˚).

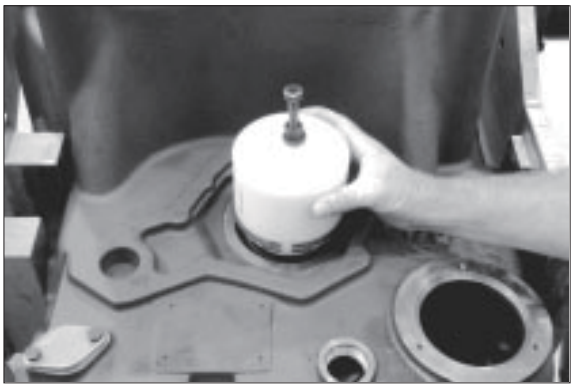


Figure 278

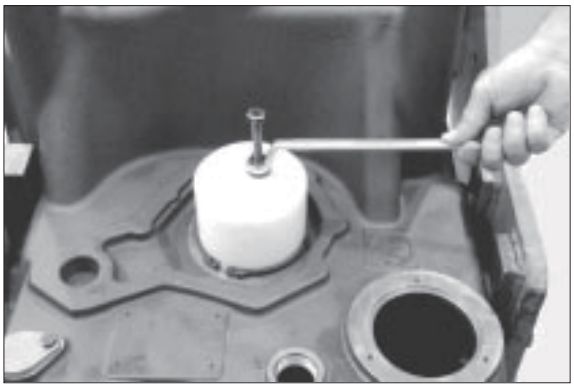


Figure 279

Adjust the axial play of the output bearing = 0.3~0.5 mm (figure 280~282)

(4) Determine Dimension I, from plane face/ housing to end face/output shaft.

Dimension I e.g ····· 66.90 mm

※ Special tool
Digital depth gauge 5870 200 072

Figure 280

(5) Measure Dimension II, from plane face/ housing to contact face/ball bearing.

Dimension II e.g ····· 64.20 mm

Example :

Dimension I ·····		66.90 mm
Dimension II ·····		- 64.20 mm
Difference ·····		= 2.70mm
Required axial play ·····	e.g.	- 0.40 mm
		(0.3~0.5 mm)
Resulting shim ·····	s	= 2.30 mm

Figure 281

(6) Install the shim.

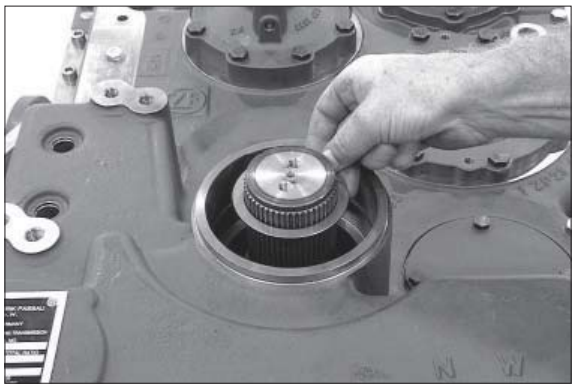


Figure 282

(7) Install the ball bearing (figure 283) and pull it until contact by means of the output flange (figure 284).

Then remove the output flange again.

Figure 283

Figure 284

(8) Fasten the ball bearing by means of retaining ring.

※ Clamping pliers 5870 900 021

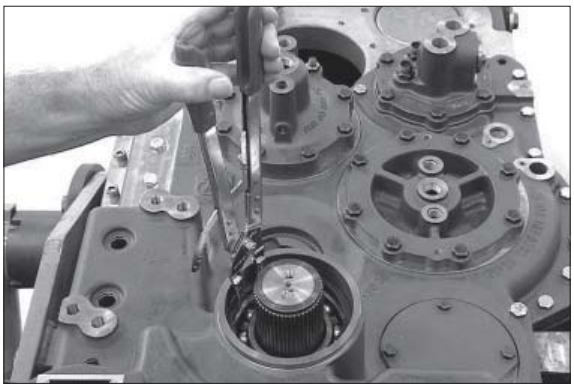


Figure 285

(9) Remove the converter-side mounting tool again.
Install the shaft seal, (arrow) with the sealing lip showing to the oil sump.

※ Using of the specified mounting tool (S), results in the exact installation position (without retaining ring = 20 mm).
Grease the sealing lip.

※ Special tool
Mounting tool 5870 048 265

※ Depending on the version different shaft seals can be used :
Outer diameter rubber-coated-wet it with spirit. Outer diameter metallic-wet it with sealing compound (loctite, type No. 574).

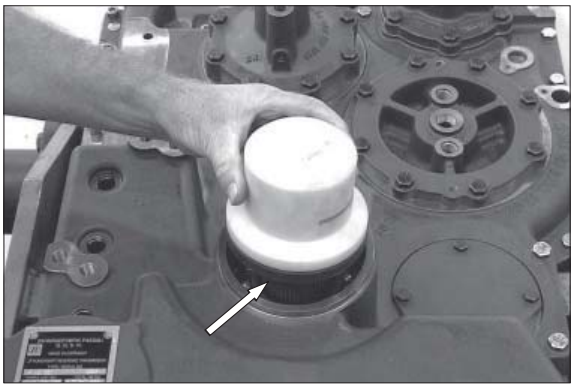


Figure 286

Adjust gap size X = 0.3~0.8 mm (figure 289~292) :

X Gap size
1 Shim
2 O-ring.

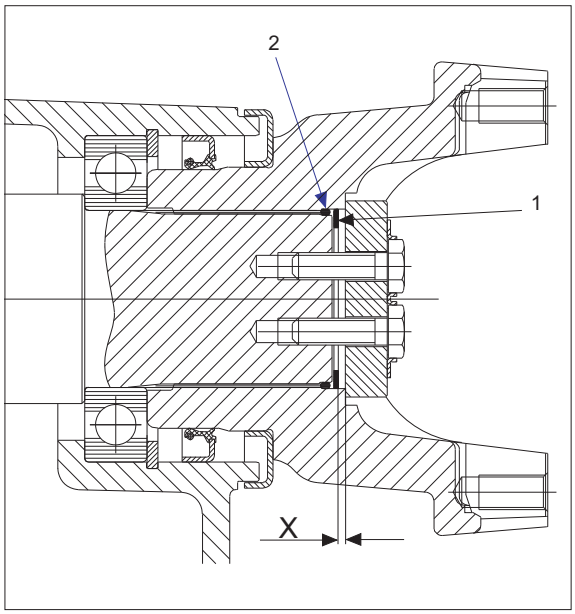


Figure 289

(1) Install the output flange until contact.

Measure Dimension I, from the plane face of the output flange to the end face of the output shaft.

Dimension I e.g ·····37.00 mm

※ Special tool
Digital depth gauge 5870 200 072

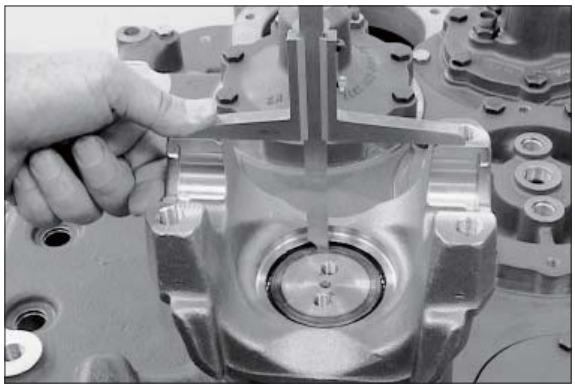


Figure 290

(2) Measure Dimension II, from the plane face to the collar of the output flange.

Dimension II e.g. ····· 36.00 mm

Example :
Dimension I ····· 37.00 mm
Dimension II ····· - 36.00 mm
Difference ····· = 1.00 mm
Gap size X ····· e.g. - 0.50 mm
(0.3~0.8 mm)
Resulting shim ····· s = 0.50 mm

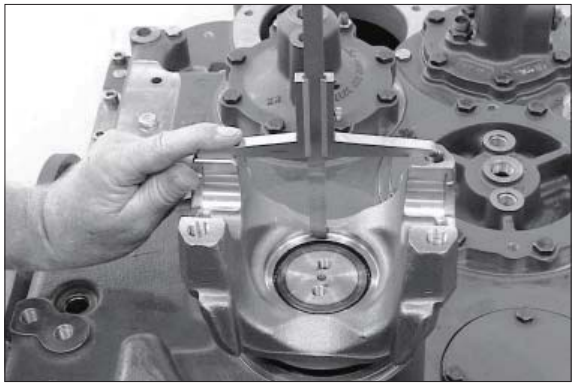


Figure 291

(3) Place the O-ring (arrow) into the space between output flange and shaft (see also figure 289) and put on the shim.

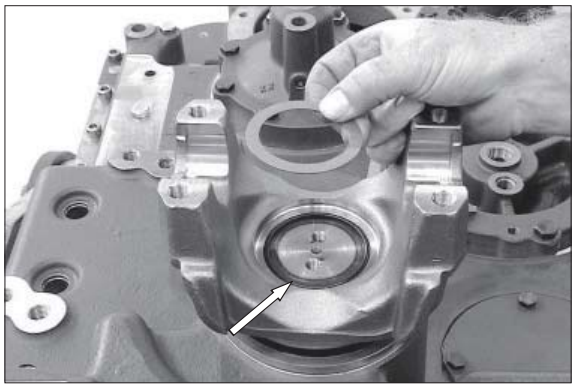


Figure 292

(4) Put on the washer and fasten the output flange by means of hexagon screws.

· Torque limit (M10/8.8) :
4.69 kgf · m (33.9 lbf · ft)

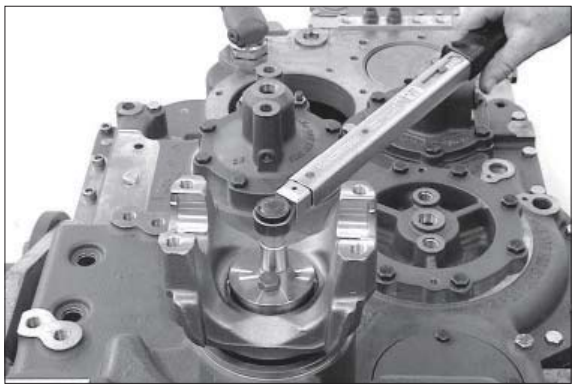


Figure 293

(5) Fasten the hexagon screws by means of the lock plate.

※ Specail tool

Mounting tool	5870 057 009
Handle	5870 260 002

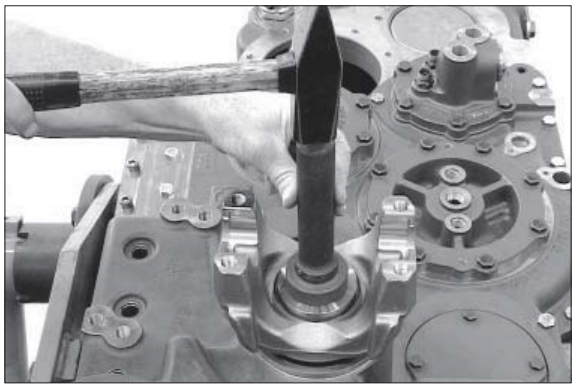


Figure 294

Output flange - parking brake

(1) Press on the screen sheet (arrow) until contact.

※ The installation position of the screen sheet is identical with the output flange.

Pressing bush 5870 506 138

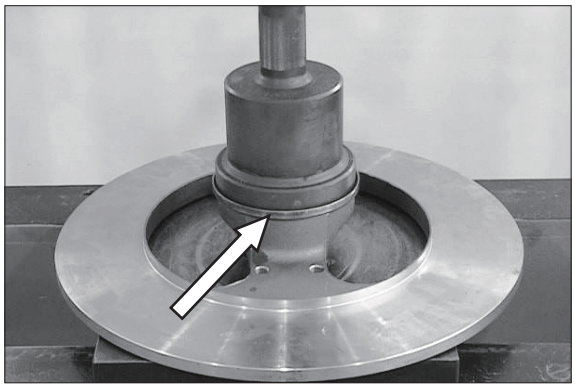


Figure 295

(2) Install the output flange-brake disk until contact.

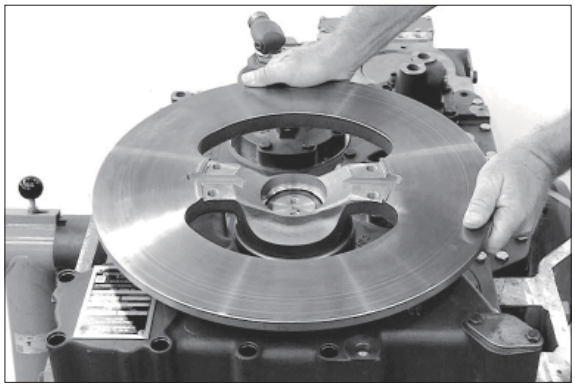


Figure 296

Mount the brake (figure 297~301)

⚠ **For working on the brake system, the instructions and specifications of the brake manufacturer are mandatory.**

(3) Remove the screw cap and loosen the locking nut (wrench size 30).
Unscrew the adjusting screw in counterclockwise direction until a demension > 13.0 mm (brake disc shim) results (figure 297).

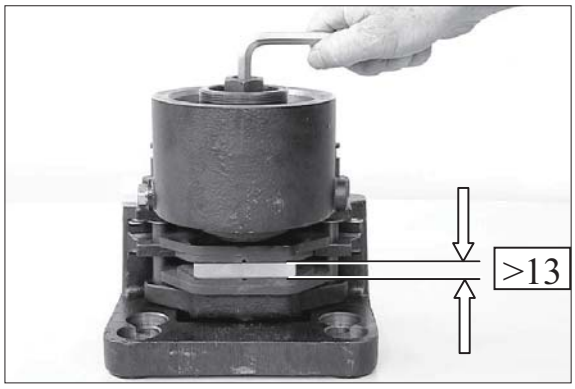


Figure 297

(4) Position the brake and fasten it with cap screws.

Tightening torque M14/8.8) : 12.7 kgf · m
(92.2 lbf · ft)

Socket spanner 5870 656 047

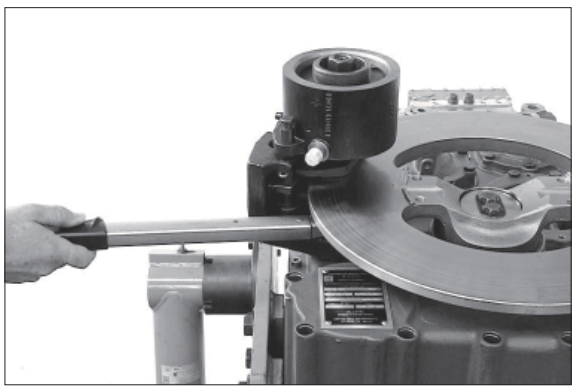


Figure 298

Adjust the nominal clearance = 2.0 mm (figure 299~301)

(5) Make the pressure connection and apply the required release pressure = 150 bar to the brake (cup spring set preloaded). Fasten the adjusting screw in clockwise direction until both brake lining carriers contact the brake disc (turning of the adjusting screw is then not possible or admissible any more without a higher application of force).

Then turn back the adjusting screw by 4/5 turns in counterclockwise direction. 4/5 turns is equal to a nominal clearance of 2.0 mm.

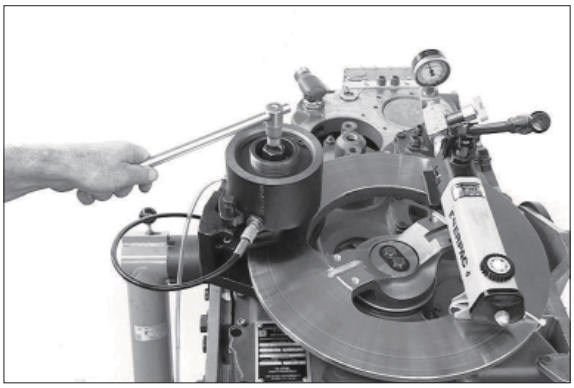


Figure 299

(6) Keep the adjusting screw positioned and fix it by means of a lock nut.

HP-Pump	5870 287 007
Mini-measuring hub	5870 950 102

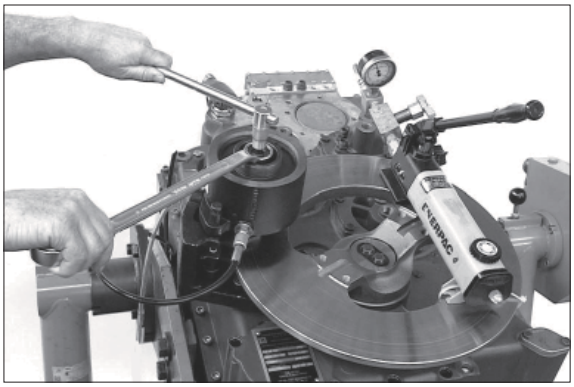


Figure 300

(7) Put new O-Ring into the screw cap and grease it.
Install the screw cap.

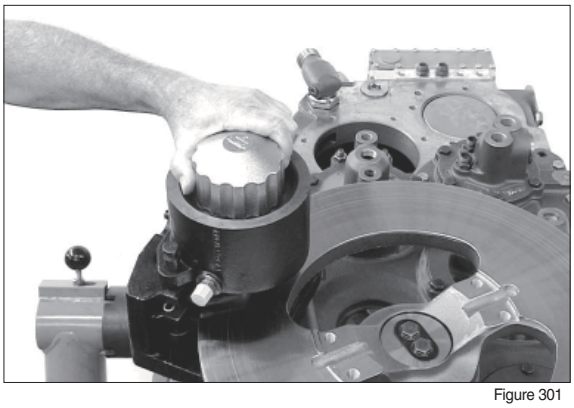


Figure 301

Output Flange (converter side)

(1) Install the shaft seal (arrow) with the sealing lip showing to the oil sump.

※ Using of the specified mounting tool, results in the exact installation position (with retaining ring = 7.0 mm).
Grease the sealing lip.

※ Special tool
Mounting tool 5870 048 265

※ Depending on the version different shaft seals can be used :
Outer diameter rubber-coated-wet it with spirit. Outer diameter metallic-wet it with sealing compound (loctite, type No. 574).

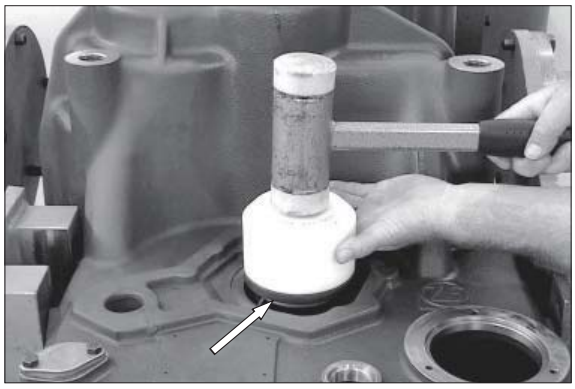


Figure 302

(1) Press the screen sheet (arrow) over the collar of the output flange until contact.

※ Observe the installation position, see figure 304.

※ Special tool
Pressing bush 5870 506 138

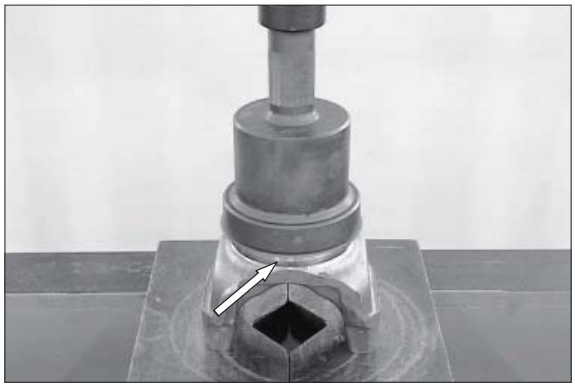


Figure 303

1 Screen sheet
2 Output flange

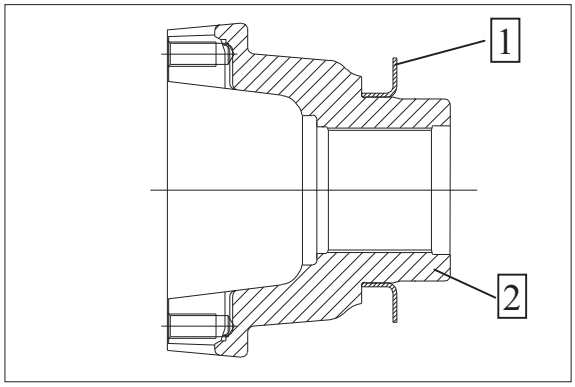


Figure 304

(2) Install the output flange until contact.

※ Setting of the gap size as well as fixing of the output flange is identical with the installation of the output flange at the transmission rearside, see figure 289~294.

Figure 305

Installation of the idler shaft

(1) Align the layshaft gear and the single components centrically.
Heat the layshaft gearing (figure 306).

※ Special tool

Hot-air blower 230V	5870 221 500
Hot-air blower 115V	5870 221 501

Figure 306

(2) Install the adjusting screw.

※ Special tool

Adjusting screws	5870 204 007

Figure 307

(3) Install the idler shaft until contact.

Figure 308

(4) Remove the adjusting screw and fasten the axle by means of hexagon screw.

※ Wet the thread of the hexagon screw with Loctite (type No. 243).

· Torque limit (M10/8.8) :
4.69 kgf · m (33.9 lbf · ft)

Figure 309

(5) Insert the sealing covers (arrow), with the concave side showing downwards, flush to the housing surface.

※ Wet contact face with loctite (type No. 262).

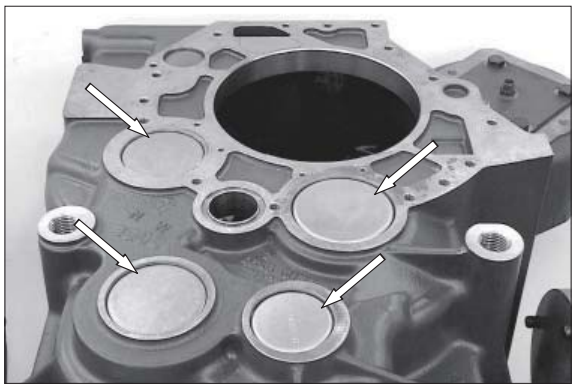


Figure 310

Transmission pump

(with 2nd/3rd or 4th power take-off)

(1) Press the needle sleeve (arrow), with the reinforced coating towards the press-in tool until contact.

Mounting tool	5870 058 041
Handle	5870 260 002

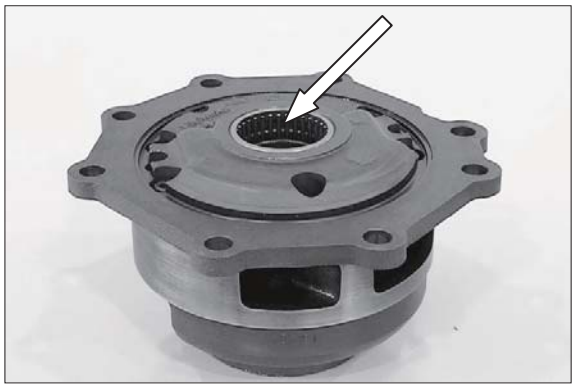


Figure 311

(2) Locate the bearing outer ring until contact.

Figure 312

(3) Install the O-Ring (arrow) and grease it.

Figure 313

(4) Heat the housing bore.

Preheating bush	5870 801 006
Hot-air blower 230 V	5870 221 500
Hot-air blower 115 V	5870 221 501

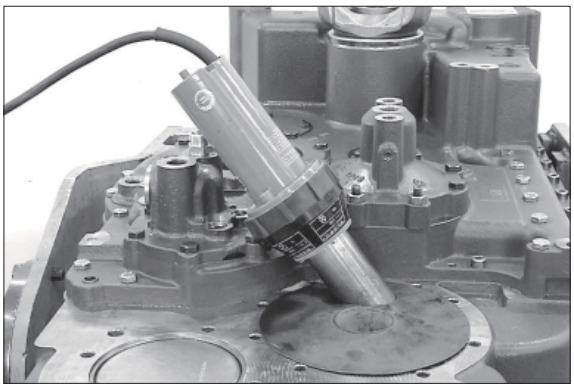


Figure 314

(5) Install two adjusting screws and assemble the pump until contact.

※ Observe the radial installation position.

Adjusting screws	5870 204 021

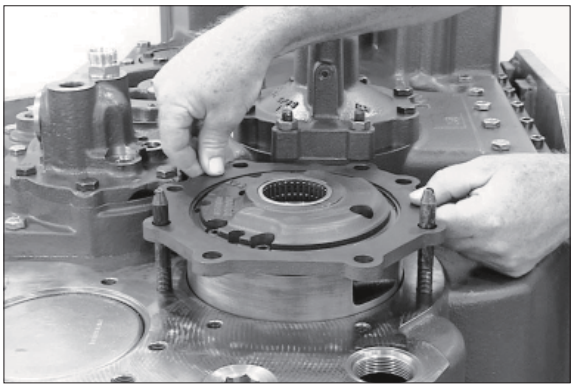


Figure 315

(6) Put the O-Ring (arrow) into the annular groove of the pump flange.

※ Depending on the transmission version, differences as regards the version and fastening of the pump flange are possible. Obligatory is the respective parts list.

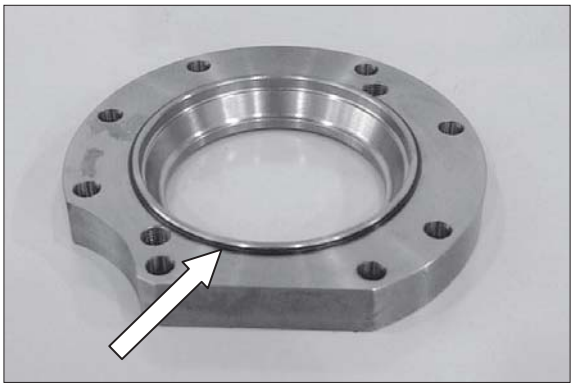


Figure 316

(7) Fasten the pump flange and pump respectively by means of cap screws.

※ Wet thread of both cap screws (position, see arrows) with loctite, type No. 574 (through holes).

※ Tightening torque (M12/8.8) : 8.06 kgf · m (58.3 lbf · ft)

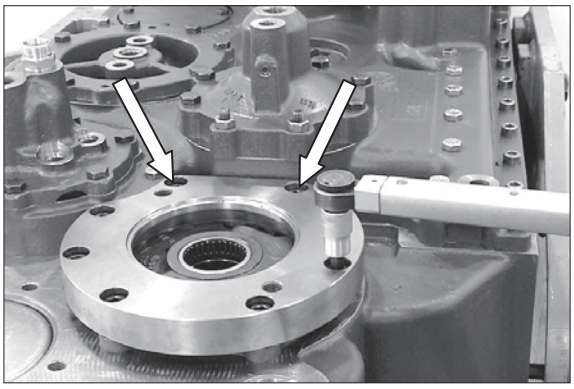


Figure 317

(8) Rotate the transmission housing by 180˚.

Snap the V-rings (3X) into the recess of the driver (internal gearing).
Install the key (arrow).

Figure 318

(9) Install shim s = 2.0 mm and locate the bearing inner ring until contact.

Figure 319

(10) Install shim s = 2.0 mm.

Figure 320

(11) Install the driver by means of clamping plate until contact and fasten it by means of cap screw.

※ Tightening torque M10/8.8, DIN 6912) :
3.26 kgf · m (23.6 lbf · ft)

※ Wet thread of the cap screw with loctite (Type No. 243).

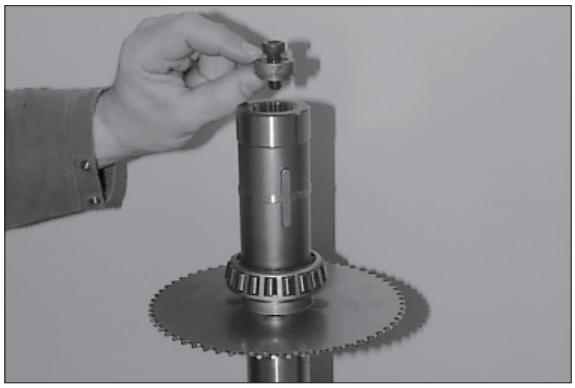


Figure 321

(12) Press the bearing inner ring until contact.

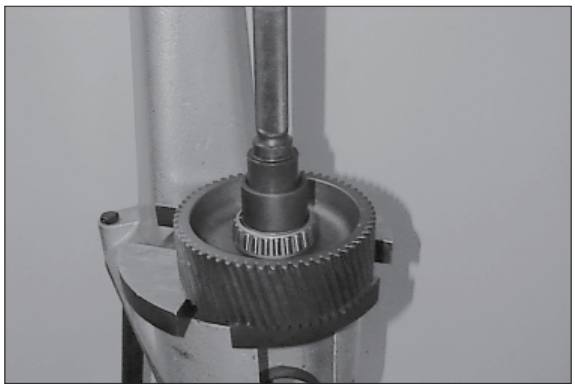


Figure 322

(13) Snap in the retaining ring (arrow) and install the input gear.

Set of external pliers 5870 900 015

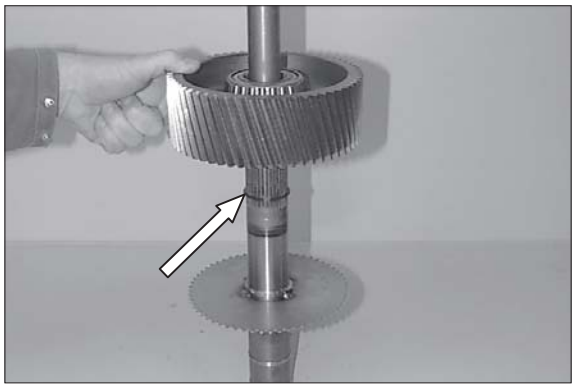


Figure 323

(14) Snap-in and lock the rectangular ring (arrow).

Figure 324

(15) Install the preassembled input shaft until contact.

※ Pay attention to align the key to the keyway.

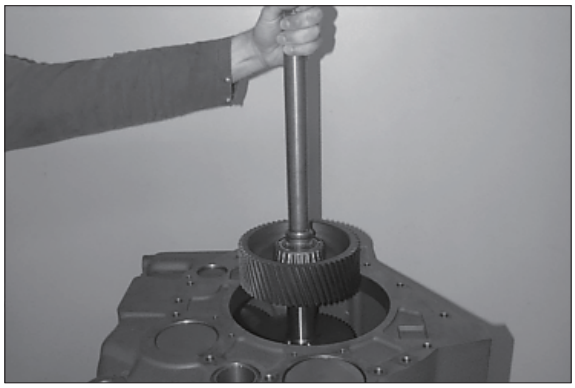


Figure 325

Adjust the axial play of the input shaft bearing = 0.0~0.05 mm (figure 326~328) :

(16) Put on the gasket.

Put on the bearing outer ring, press it on equally and determine Dim. I, from the mounting face (gasket) to the bearing outer ring.

Dim I e.g. ..... 128.50 mm

※ Take several measuring points and determine the mean value.

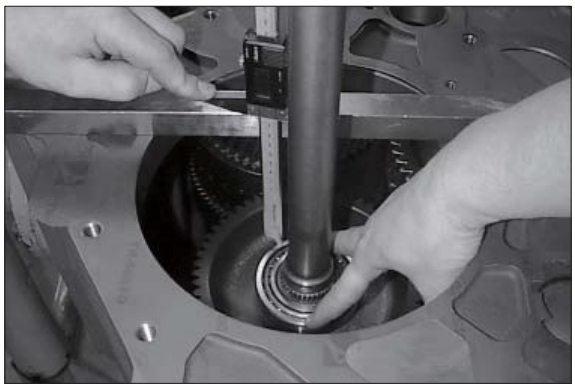


Figure 326

(17) Measure Dim II, from the mounting face/ converter bell to the mounting face/ bearing outer ring.

Dim II e.g. ..... 127.46 mm

Straightedge	5870 200 022
Gauge blocks	5870 200 080
Digital depth gauge	5870 200 072

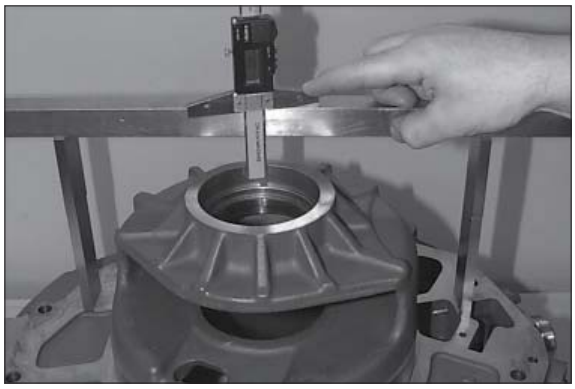


Figure 327

Example :

Dim I		128.50 mm
Dim II	-	127.46 mm
Difference	=	1.04 mm
Axial play	-	0.04 mm
resulting shim(s) s	**=**	**1.00 mm**

Put in the shim and locate the bearing inner ring until contact.

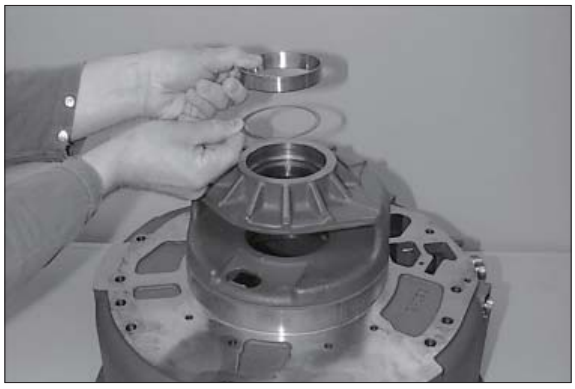


Figure 328

Transmission pump

(with 1st power take-off)

(1) Press the needle sleeve (arrow), with the reinforced coating towards the press-in tool until contact.

※ Special tool

Mounting tool	5870 058 041
Handle	5870 260 002

Figure 329

(2) Snap the V-Rings (3EA) into the recess of the driver (internal gearing).
Install the key (arrow).

Figure 330

(3) Press the ball bearing over the collar of the driver until contact.

Figure 331

(4) Install the ball bearing and driver respectively and press it until contact.

※ Pay attention to align the key to the keyway.

Figure 332

(5) Fasten the ball bearing by means of retaining ring.

※ Special tool

Set of internal pliers	5870 900 013

Figure 333

(6) Install the O-ring (arrow) and grease it.

Figure 334

(7) Heat the housing bore.

※ Special tool

Preheating bush	5870 801 006
Hot-air blower 230V	5870 221 500
Hot-air blower 115V	5870 221 501

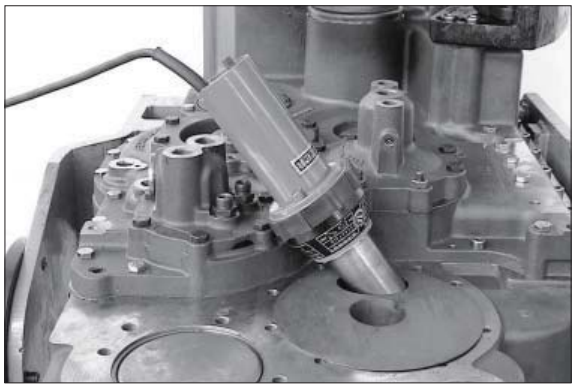


Figure 335

(8) Install two adjusting screws and assemble the pump until contact.

※ Observe the radial installation position.

※ Special tool

Adjusting screws	5870 204 021

Figure 336

(9) Put the O-ring (arrow) into the annular groove of the pump flange.

※ Depending on the transmission version, differences as regards the version and fastening of the pump flange are possible. Obligatory is the respective parts list.

Figure 337

(10) Fasten the pump flange and the pump respectively by means of hexagon screws.

※ Wet thread of both hexagon screws (position, see arrows) with Loctite, Type No. 574 (through holes).

· Torque limit (M12/8.8) :
8.06 kgf · m (58.3 lbf · ft)

Then rotate the transmission housing by 90˚.

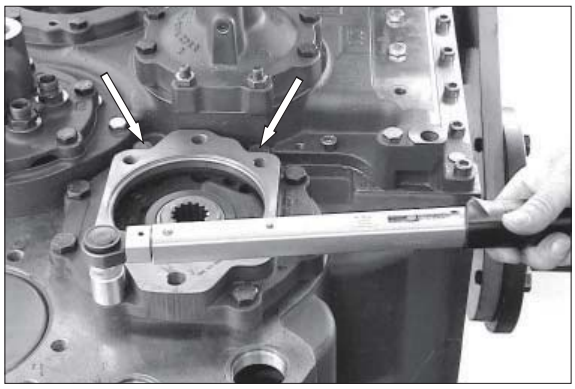


Figure 338

(11) Snap-in and lock the rectangular ring (arrow).

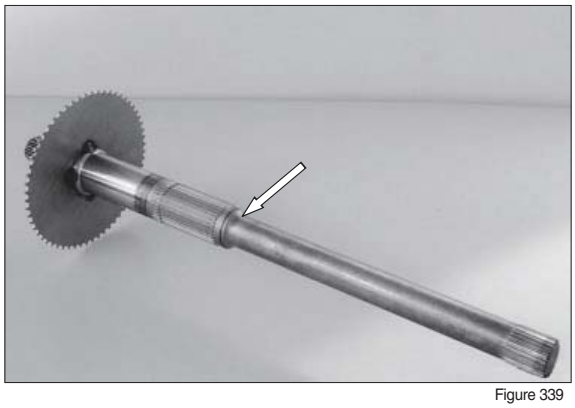


Figure 339

(12) Install both shims (each 2.0 mm thick)

※ Use assembly grease.

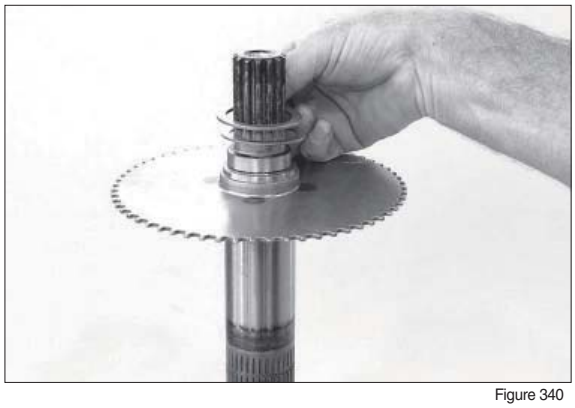


Figure 340

(13) Heat the bevel bearing inner ring.

※ Special tool

Hot-air blower 230V	5870 221 500
Hot-air blower 115V	5870 221 501

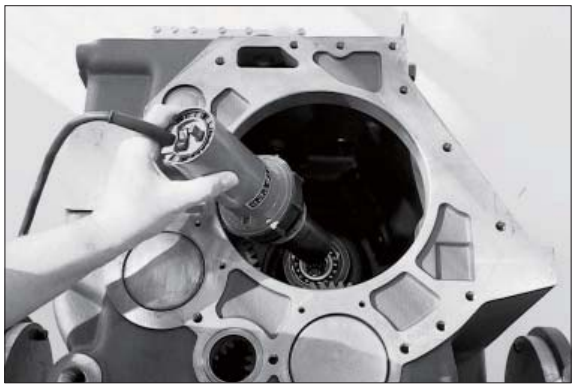


Figure 341

(14) Install the input shaft until contact.

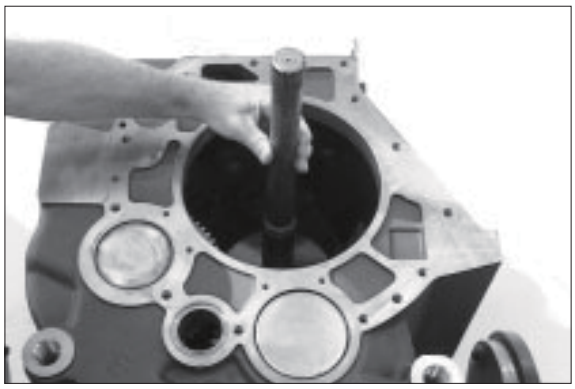


Figure 342

(15) Fasten the input shaft by means of clamping plate and cap screw (arrow).

· Torque limit (M10/8.8) :
3.26 kgf · m (23.6 lbf · ft)

※ Wet thread of the cap screw with loctite (type No. 243).

Figure 343

Input-Converter Bell

※ To install a new converter bell the finished bores (3EA) have to be sealed with plugs. Installation position, see arrow, figure 344.

※ Special tool

Lever riveting tongs	5870 320 016

Figure 344

(1) Locate the bearing outer ring into the housing bore until contact and install the bearing inner ring, see arrow.

Figure 345

(2) Install the spur gear (arrow) with the long collar showing upwards and position it.

Figure 346

(3) Heat the spur gear bore (arrow).

※ Special tool

Hot-air blower 230V	5870 221 500
Hot-air blower 115V	5870 221 501

Figure 347

(4) Install the input shaft until contact.

Figure 348

(5) Heat the bearing inner ring and install it until contact.

⚠ **Use safety gloves.**

Figure 349

(6) Install the bearing outer ring until contact.

Figure 350

(7) Snap in the rectangular ring (arrow) into the annular groove of the input shaft and lock it.
Then grease the rectangular ring and centrally align it.

Figure 351

(8) Install the converter safety valve (arrow 1) and fasten it by means of slotted pin (arrow 2).

※ Flush-mount slotted pin to recess.

Put the O-ring (arrow 3) into the annular groove.

Figure 352

(9) Press the needle bearing (arrow), with the reinforced coating towards the press-in tool into the bore of the bearing cover until contact.

※ Special tool

Mounting tool	5870 058 051
Handle	5870 260 002


Figure 353

(10) Flush-mount the shaft seal (arrow) with the sealing lip showing (downwards) to the oil sump.

※ Wet the outer diameter with spirit.
Grease the sealing lip.

※ Special tool

Mounting tool	5870 048 030


Figure 354

※ Make the following steps (figure 355~358) in direct time sequence to secure the precise contact of the oil supply flange.

(11) Heat the housing bore.

※ Special tool

Preheating bush	5870 801 006
Hot-air blower	5870 221 500
Hot-air blower	5870 221 501


Figure 355

(12) Install two adjusting screws and put in the oil supply flange until contact.

※ Observe the radial installation position.

※ Special tool
Adjusting screws 5870 204 007

Figure 356

(13) Place the O-ring (arrow) with assembly grease into the annular groove of the bearing cover.

Figure 357

(14) Put on the bearing cover and fasten it by means of hexagon screws.

· Torque limit (M10/8.8) :
4.69 kgf · m (33.9 lbf · ft)

Figure 358

(15) Install the single components according to the opposite figure.

1 Screw plug : 15.3 kgf · m (110 lbf · ft)
2 Screw plug : 2.55 kgf · m (18.4 lbf · ft)
3 Temperature sensor :
2.55 kgf · m (18.4 lbf · ft)
and screw plug respectively(depending on the version) : 3.57 kgf · m (25.8 lbf · ft)

※ Always install new O-ring.

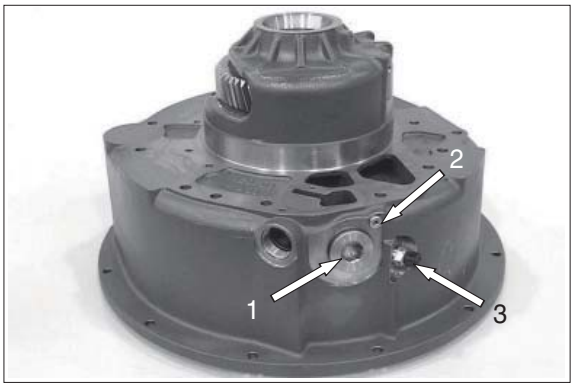


Figure 359

Converter pressure back-up valve
(figure 360~361)

(1) Install the slotted pin (6×50 mm) until contact.

Figure 360

(2) Assemble piston and compression spring. Provide screw plug with a new O-ring and install it.

· Torque limit (M36×1.5) :
13.3 kgf · m (95.9 lbf · ft)

Figure 361

(3) Fasten the gasket and cover plate by means of hexagon screws (install the washers).

· Torque limit (M6/8.8) :
0.97 kgf · m (7.0 lbf · ft)

Figure 362

(4) Install two adjusting screws and put on the gasket (arrow 1). Put the O-ring (arrow 2) into the annular groove.

※ Special tool
Adjusting screws 5870 204 021

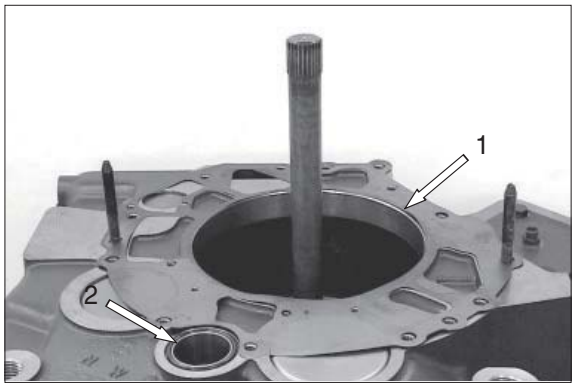


Figure 363

(5) Install the converter bell by means of lifting tackle until contact.

※ Slight rotary motions of the input shaft facilitate the installation (protect teeth from damage). Observe the radial installation position.

※ Special tool

Lifting tackle	5870 281 047
Eyebolts assortment	5870 204 002

Figure 364

(6) Fasten the converter bell by means of hexagon screws.

· Torque limit (M8/10.9) :
3.47 kgf · m (25.1 lbf · ft)

· Torque limit (M12/10.9) :
11.7 kgf · m (84.8 lbf · ft)

Figure 365

(7) Fasten flexible plate (3EA) by means of hexagon screws (install the washers).

※ Wet thread of the hexagon screws with Loctite (type No. 243).

· Torque limit (M10/8.8) :
4.69 kgf · m (33.9 lbf · ft)

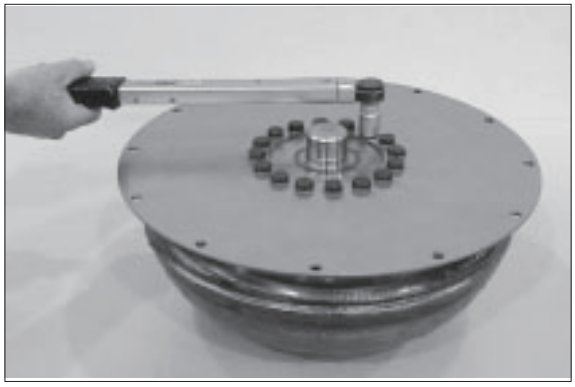


Figure 366

(8) Install the rectangular ring (arrow) into the annular groove and lock it.
Then grease the rectangular ring and centrally align it.

Figure 367

(9) Assemble converter by means of lifting tackle until contact (figure 368).

※ At a control dimension < 43 mm, the exact installation position of the converter is ensured, see Figure 369.

※ Special tool

Eyebolts assortment	5870 204 002
Lifting chain	5870 281 047

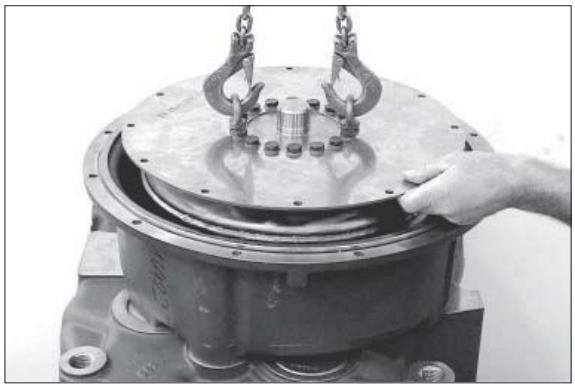


Figure 368

Figure 369

⚠ **Until installation of the transmission, fix the converter axially, see figure 370.**

Figure 370

Coarse Filter

(1) Install filter (assy) into the housing bore.

※ Oil the sealing (arrow).

Figure 371

(2) Fasten the cover by means of hexagon screws (install the washers).

※ Install the new O-ring (arrow).

· Torque limit (M8/8.8) :
2.35 kgf · m (17.0 lbf · ft)

Figure 372

Inductive and speed transmitters

(1) Following sketches show the installation position of the single inductive and speed transmitters.

14	Inductive transmitter	n-Turbine
9	Inductive transmitter	n-Engine
5	Inductive transmitter	n-Intenal
13	Speed transmitter	speed input n-Output

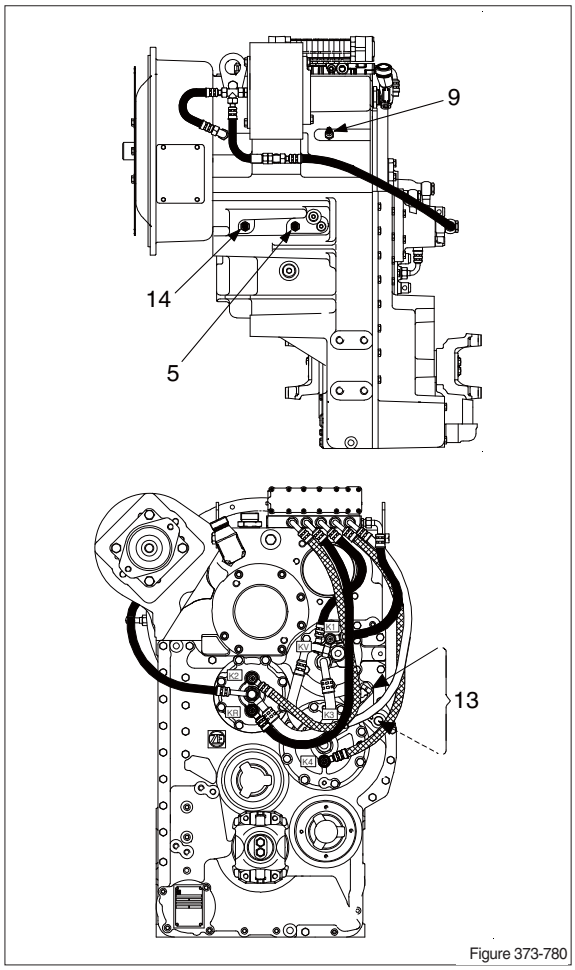


Figure 373-780

※ The following figures describe the installation and setting respectively of the inductive transmitter n-Engine (9).
Installation of the inductive transmitter n-Turbine (14) and n-internal speed input (5) is to be made analogously.

Observe the different setting dimensions "X" :

⚠ **Inductive transmitter n-Engine (9)**
X = 0.5$^{+0.3}$ mm
Inductive transmitter n-Turbine (14)
X = 0.5$^{+0.3}$ mm
Induct. transmitter n-int. speed input (5)
X = 0.3±0.1 mm

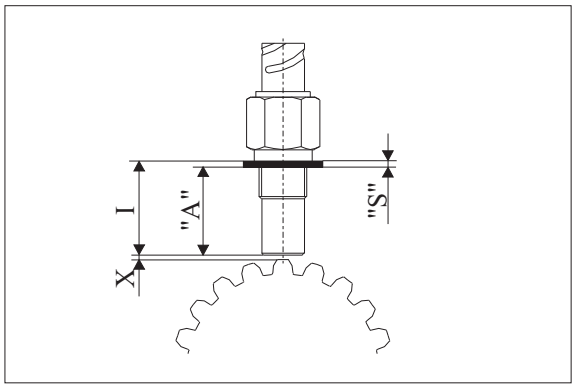


Figure 375

Adjust Dimension "X" by means of shim ring (s) (figure 376~381)

(1) Measure Dimension I on the inductive transmitter, from contact face to screw-in face.

※ Dimension I e.g ····· 30.00 mm

Figure 376

(2) Turn in the counting disc radially until one tooth tip is centrally to the inductive transmitter bore.

Turn the plug gauge until contact.
Locate anvil at the tooth tip and lock it by means of threaded pin (figure 377 and 378).

※ Special tool
Plug gauge 5870 200 104

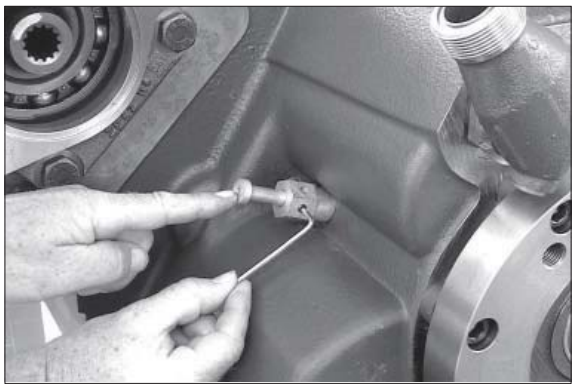


Figure 377

※ Special tool
Plug gauge 5870 200 104

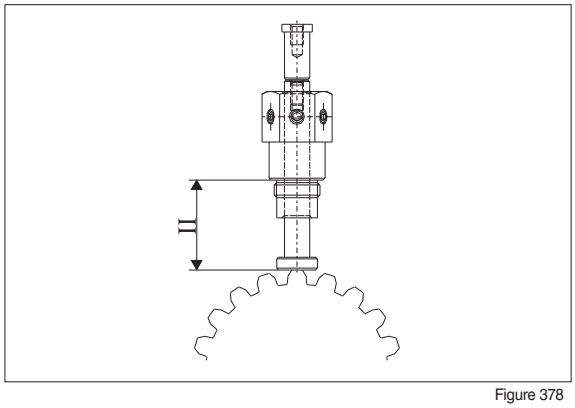


Figure 378

(3) Turn out the plug gauge and determine Dimension II (also see figure 378).

Dimension II e.g ····· 30.10 mm

Figure 379

Example "A_1" :

Dimension II	30.10 mm
Dimension X ($0.5^{+0.3}$ mm)	- 0.60 mm
Results in installation dimension A	= 29.50 mm

Example "A_2" :

Dimension I	30.00 mm
Installation dimension A	- 29.50 mm
Results in shim ring (s)	s = 0.50 mm

(4) Install the adequate shim ring (s) and wet the thread (arrow) with Loctite (type No. 574).

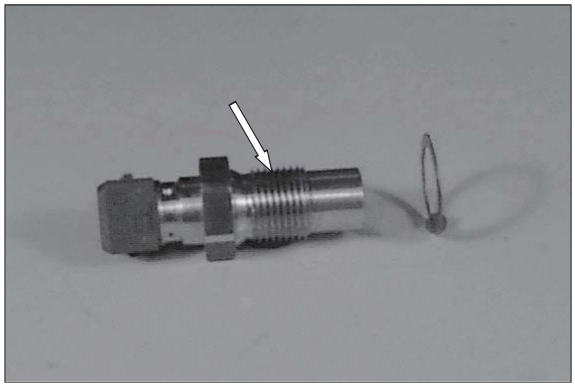


Figure 380

(5) Install the inductive transmitter n-Engine (9), see arrow.

· Torque limit : 3.06 kgf · m (22.1 lbf · ft)

Set and install the inductive transmitter n-Turbine (14) and n-internal speed input (5) analogously.

※ Observe the different setting dimensions. Installation position of the single inductive transmitters, also see figure 373.

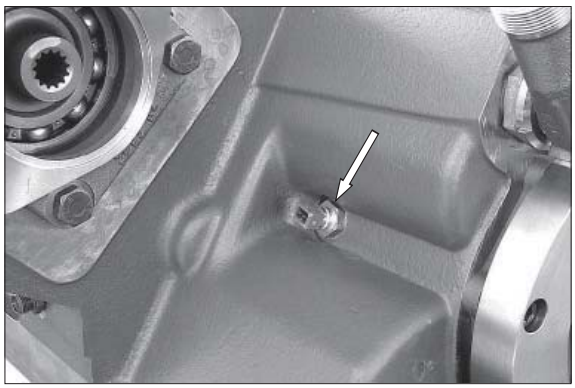


Figure 381

Install speed transmitter n-Output/Speedo (13) (figure 382~387)

1 Housing
2 Spur gear K3
3 Disc carrier
13 Speed transmitter (hall sensor)
X **Setting dimension "X" =1.0+0.5 mm**

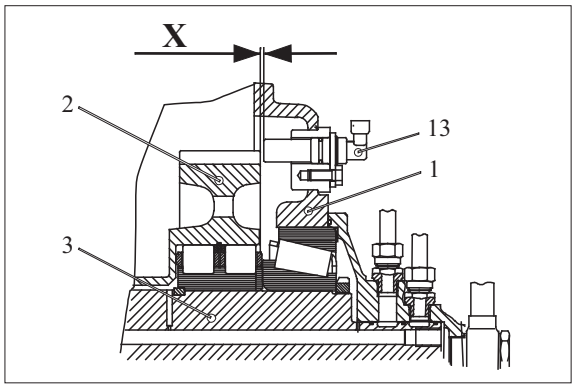


Figure 382

(1) Opposite figure shows the speed transmitter (hall sensor).


Figure 383

(2) Determine Dimension I, from the housing face to spur gear K3.

Dimension I e.g ····· 39.70 mm

※ Special tool
Digital depth gauge 5870 200 072


Figure 384

(3) Measure Dimension II, from the contact face to the mounting face.

Dimension II e.g ····· 40.00 mm

※ Special tool
Digital depth gauge 5870 200 072


Figure 385

Example "B_1" :

Dimension I	39.70 mm
Dimension X($1.0^{+0.5}$mm)	- 1.20 mm
Results in installation dimension	= 38.50 mm

Example "B_2" :

Dimension II	40.00 mm
Installation dimension A	- 38.50 mm
Results in shim(s)	s = 1.50 mm

(4) Install shims (3EA, s = 0.50 mm) and grease the O-ring (arrow).

Figure 386

(5) Fasten the speed transmitter by means of cap screw.

· Torque limit (M8/8.8) :
2.35 kgf · m (17.0 lbf · ft)

※ Installation position of the speed transmitter, also see figure 382.

Figure 387

3. AXLE

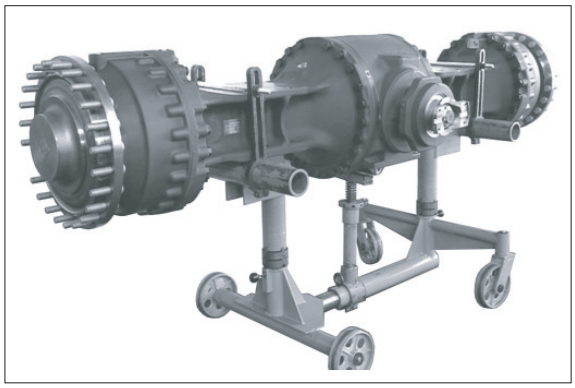
1) DISASSEMBLY

(1) Disassembly output and brake

① Fix axle to assembly truck.

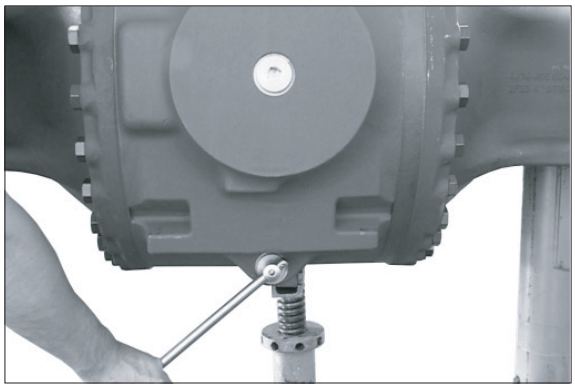
Assembly truck	5870 350 000
Fixtures	5870 350 077
Clamping brackets	5870 350 075
Support	5870 350 125

※ Before clamping the axle fully turn in the support.
Position axle first onto the two fixtures, secure with clamping brackets and then unbolt the support until contact with the axle is obtained.

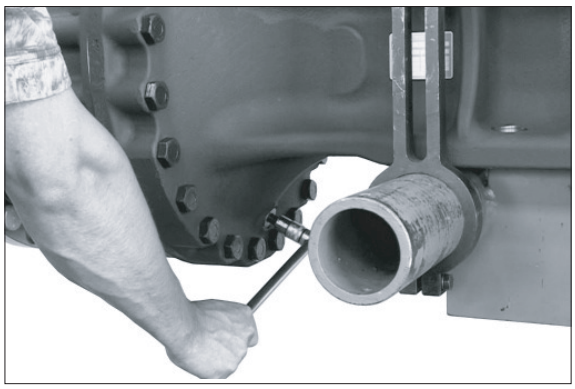


7809AX01

② Loosen screw plugs (3EA, see figure AX02 and AX03) and drain oil from the axle.



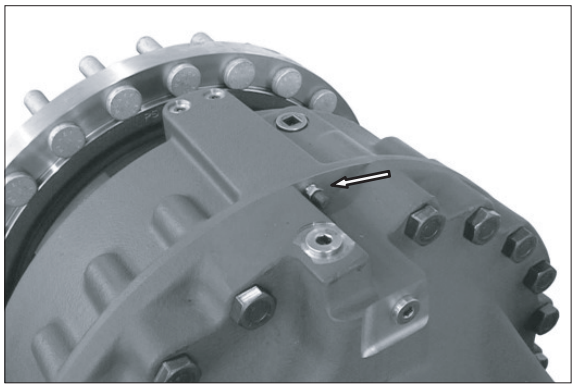
7809AX02



7809AX03

③ Remove the breather valve (see arrow).

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

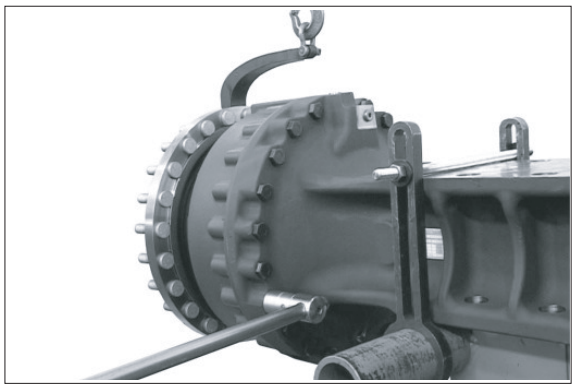


7809AX04

④ Secure the output with the lifting device and loosen hexagon screws.
Then separate the output assy from the axle housing.

Load carrying device AA00 685 875

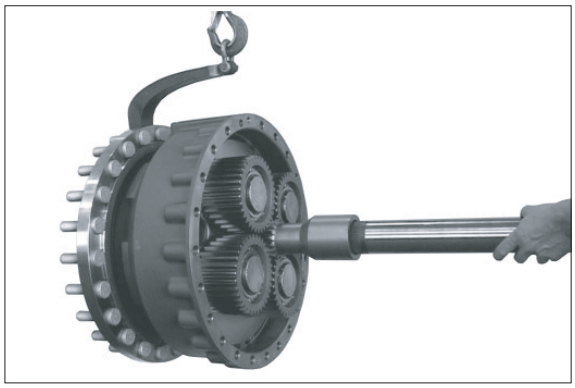
※ Fix the load carrying device with wheel nuts.



7809AX05

⑤ Pull stub shaft and sun gear shaft.

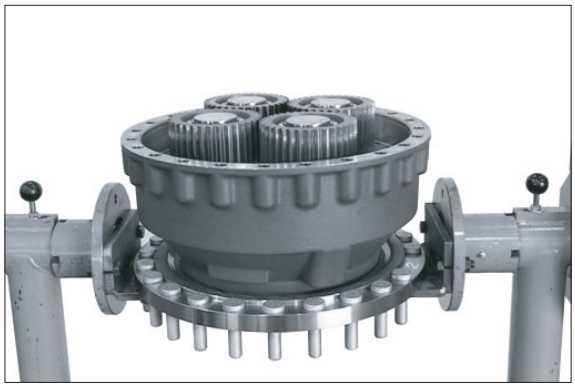
※ Pay attention to potentially releasing shim(s).



7809AX06

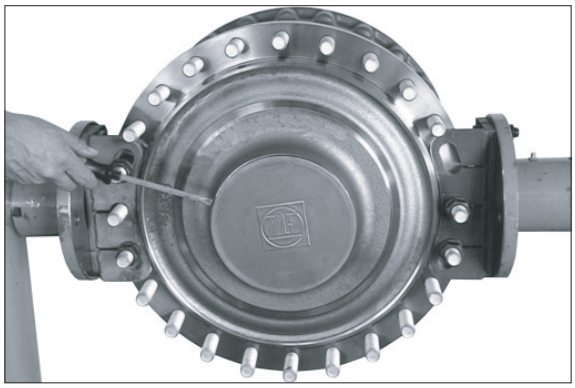
⑥ Fix output to assembly truck.

Assembly truck	5870 350 000
Fixtures (2EA)	5870 350 113



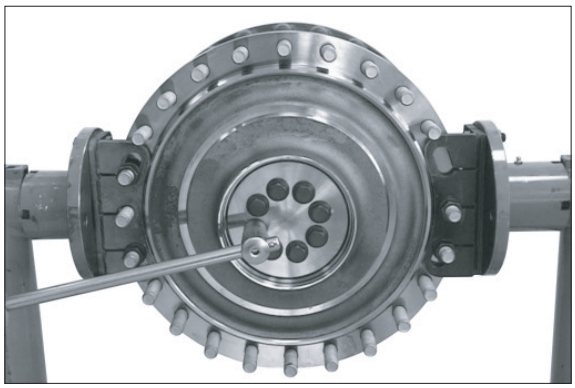
7809AX07

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



7809AX08

⑧ Loosen locking screws and remove the releasing cover.



7809AX09

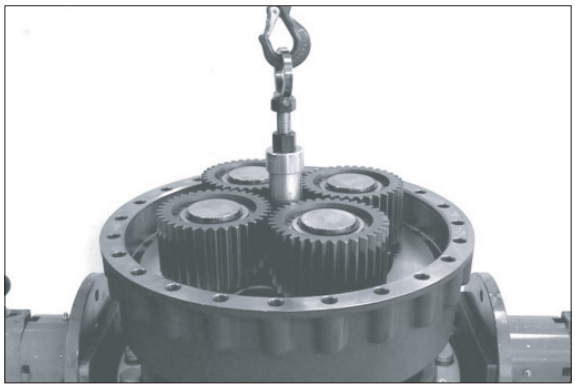
⑨ Lift the planetary carrier out of the brake housing by means of the lifting device.

- Rear axle (planetary carrier with 3 planetary gears)

Internal extractor	5870 300 019
Eye bolt	5870 204 073

- Front axle (planetary carrier with 4 planetary gears)

Internal extractor	5870 300 008
Eye nut	AA00 680 376



7809AX10

⑩ Pull the tapered roller bearing from the planetary carrier.

Rapid grip	AA00 693 459
Basic tool	5873 004 001
Clamping cylinder	5873 003 016
Pump	5870 287 010

7809AX70

⑪ Disengage retaining ring.

7809AX71

⑫ Pull off planetary gear.

Extractor	AA00 696 012
Clamping cylinder	5873 003 016
Pump	5870 287 010

7809AX72

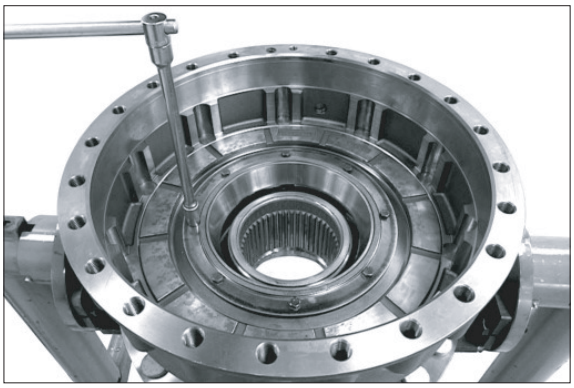
⑬ Lift the end plate out of the brake housing.

7809AX73

⑭ Lift the disk package out of the brake housing.

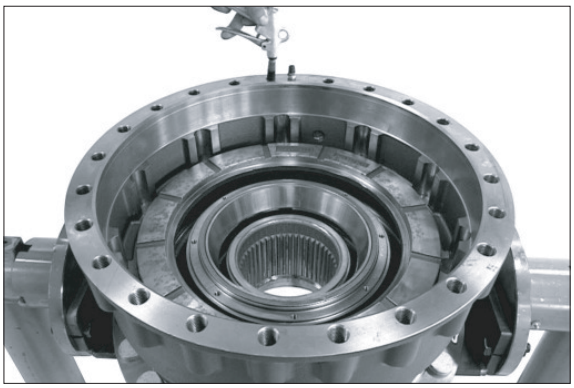
7809AX12

⑮ Loosen hexagon screws, remove releasing disk and cup spring.



7809AX13

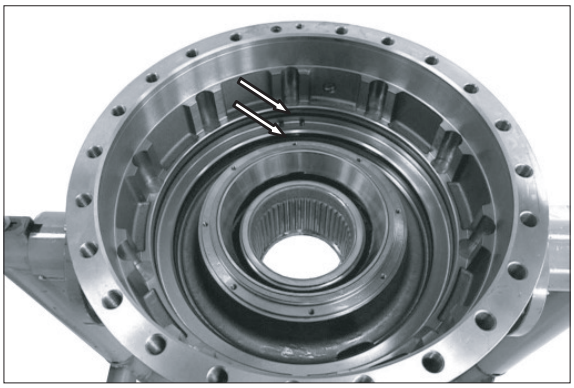
⑯ Mount breather valve and press piston out of the brake housing by means of compressed air.



7809AX14

⑰ If necessary, remove guide ring, back-up rings and grooved rings out of the annular grooves of the brake housing (see arrows).

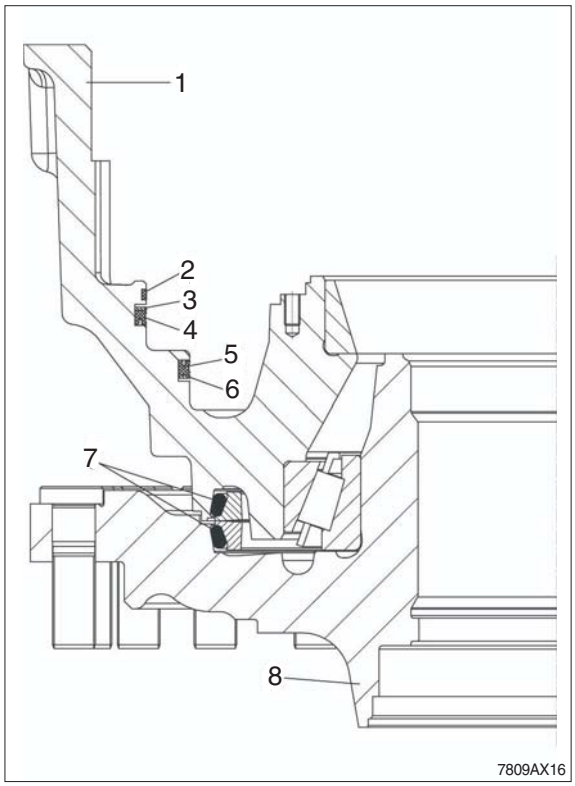
※ For the installation position of the single parts please also refer to the following sketch.



7809AX15

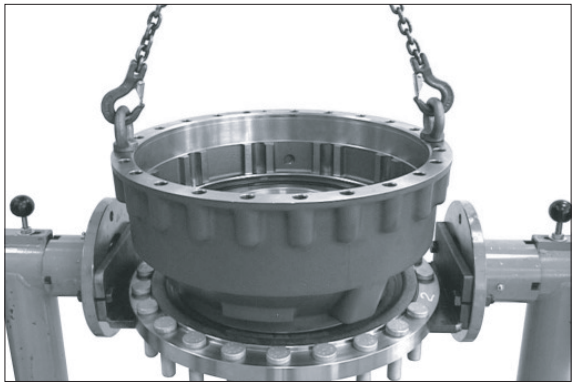
Legend to sketch :

1 = Brake housing
2 = Guide ring
3 = Back-up ring
4 = Grooved ring
5 = Grooved ring
6 = Back-up ring
7 = Slide ring seal
8 = Output shaft



7809AX16

⑱ Lift the brake housing from the output shaft by means of the lifting device.


7809AX17

⑲ Use a lever to remove the slide ring seal from the brake housing.

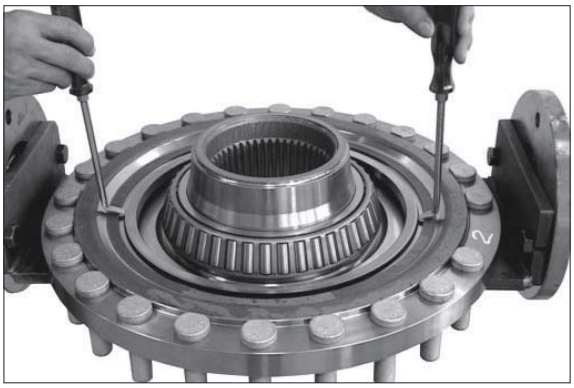
If necessary, force out both bearing outer rings.

Resetting device 5870 400 001


7809AX18

⑳ Use a lever to remove the slide ring seal from the output shaft.

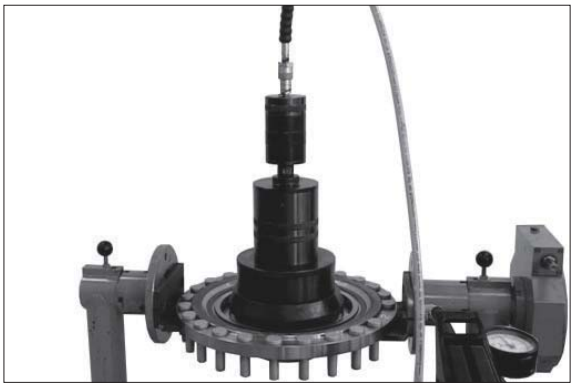
Resetting device	5870 400 001



7809AX74

㉑ Pull the tapered roller bearing from the output shaft.

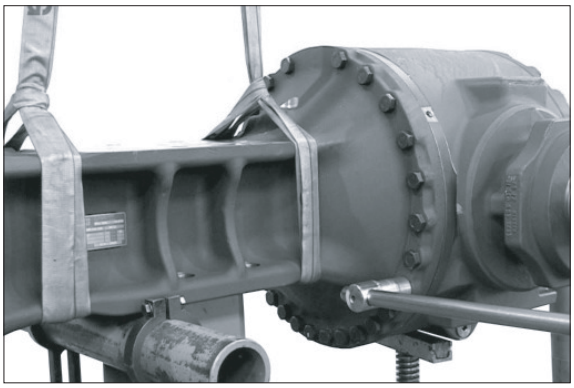
Gripping device	AA00 633 495
Adapter ring	AA00 633 500
Basic tool	5873 004 001
Pressure piece	AA00 696 181
Clamping cylinder	5873 003 016
Pump	5870 287 010



7809AX75

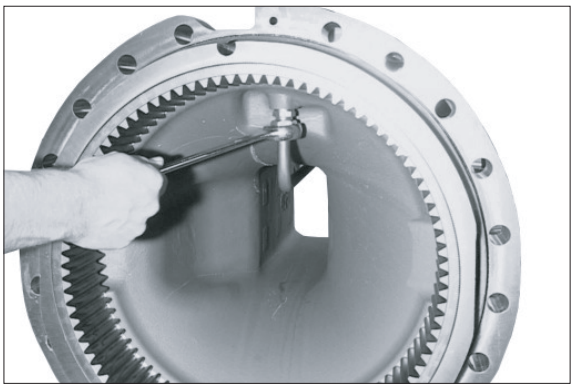
(2) Disassembly axle housing

① Secure axle housing with the lifting device and loosen the hexagon screws. Then separate the axle housing from the axle drive housing.



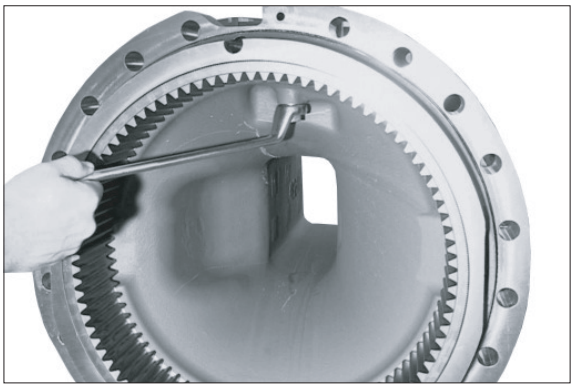
7809AX19

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



7809AX20

③ Loosen both screw necks.

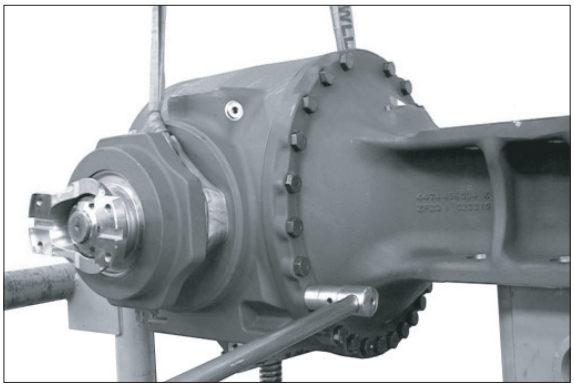


7809AX21

(3) Disassembly axle drive housing

① Secure axle drive housing with the lifting device and loosen the hexagon screws. Then separate the axle drive housing from the axle housing.

Eyebolt (M20)	5870 204 086
Thread insert	AA00 677 715



7809AX22

② Fix axle drive housing to the assembly truck.

Assembly truck	5870 350 000
Fixtures (2EA)	5870 350 113

7809AX76

③ Loosen cylindrical screws and lift the releasing bearing housing with the lifting device.

Inner extractor	5870 300 008
Eye bolt	AA00 680 376

7809AX77

④ Pull the bearing outer ring (see arrow) out of the bearing hole and remove the shim behind.

7809AX78

⑤ Press the piston out of the bearing housing by means of compressed air.

7809AX79

⑥ Lift differential out of the axle drive housing with the lifting device.

Inner extractor	5870 300 008
Eye nut	AA00 680 376

※ Disassembly of the various differentials is described as of page 3-234.

7809AX80

⑦ Pull the bearing outer ring (see arrow) out of the bearing hole and remove the shim behind.

7809AX81

⑧ Heat slotted nut by means of hot-air blower.

※ Slotted nut is secured with Loctite # 262.

7809AX82

⑨ Loosen the slotted nut and remove the shim behind.

Wrench	5870 401 093
Fixing device	AA00 695 905
Clamping device	5870 240 002

7809AX83

⑩ Pull input flange from the input pinion and use a lever to lift the shaft seal ring behind out of the axle drive housing.

7809AX84

⑪ Use a two-armed puller to press the input pinion out of the axle drive housing and remove the releasing tapered roller bearing.

7809AX85

⑫ Remove the spacer and pull the tapered roller bearing from the input pinion.

Gripping device	AA00 253 881
Basic tool	5873 003 000
Clamping cylinder	5873 003 016
Pump	5870 287 010

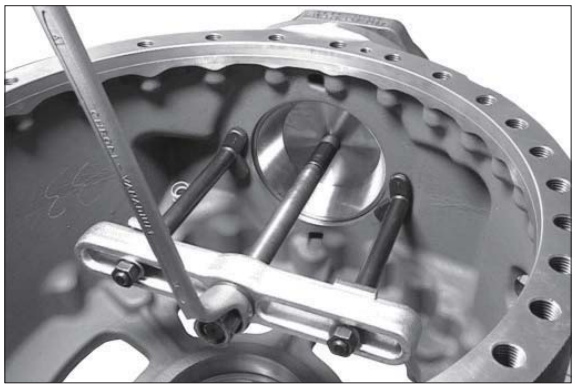
7809AX86

⑬ Loosen the threaded connection and remove the releasing oil tube.

7809AX87

⑭ If necessary pull the internal bearing outer ring out of the axle drive housing and remove the shim behind.

Assembly device	AA00 696 770
Counter support	5870 300 020



7809AX88

⑮ If necessary pull the external bearing ring out of the axle drive housing.

Assembly device	AA00 696 770
Counter support	5870 300 020

7809AX89

(4) Disassembly differentials

Disassembly multi-disk differential lock

① Remove axial roller cage (arrow).

7809AX90

② Pull both tapered roller bearings from the differential.

Crown wheel side

Rapid grip	AA00 303 274
Basic tool	5873 004 001
Pressure piece	AA00 694 360

Opposite side

Grab sleeve	5873 004 026
Basic tool	5873 004 001
Clamping cylinder	5873 003 016
Pump	5870 287 010

7809AX91

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

Pressure piece	AA00 694 360

7809AX92

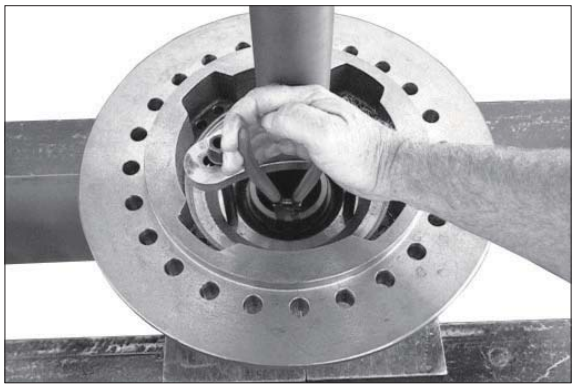
④ Lift the differential cover from the differential housing by means of the lifting device.

Inner extractor	5870 300 008
Eye nut	AA00 680 376

7809AX93

⑤ Preload the compression spring by means of the press and disengage the retaining ring.

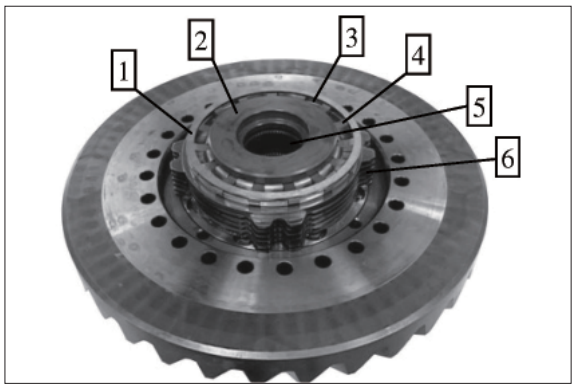
Then pull the sliding sleeve out of the differential cover and remove the releasing compression springs.



7809AX94

⑥ Remove single parts.

1 = Disk
2 = Pressure piece
3 = Cage
4 = Lever (15EA)
5 = Disk carrier
6 = Disk package



7809AX95

⑦ Loosen hexagon screws and remove the releasing disk.

7809AX96

⑧ Remove thrust washer and axle bevel gear from the differential housing.

7809AX97

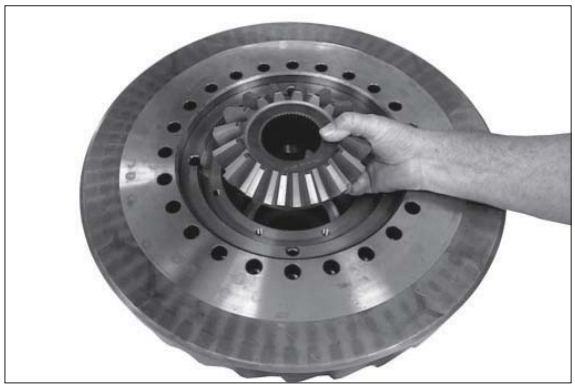
⑨ Force out slotted pins (4EA).

7809AX98

⑩ Pull spider shafts (4EA) and remove the releasing spider gears with the thrust washers from the differential housing.

7809AX99

⑪ Remove the axle bevel gears and the shims behind.



7809AX100

⑫ Support the crown wheel and force out the differential housing.

7809AX101

2) ASSEHBY

(1) Assembly differentials

Assembly multi-disk differential lock

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

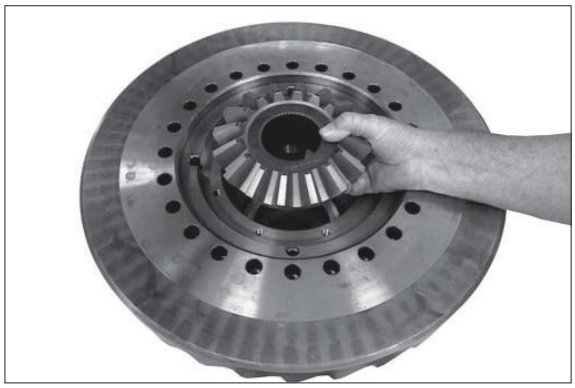
Adjusting screws 5871 204 040

7809AX102

② Insert disk and thrust washer into the differential housing

7809AX103

③ Insert axle bevel gear.

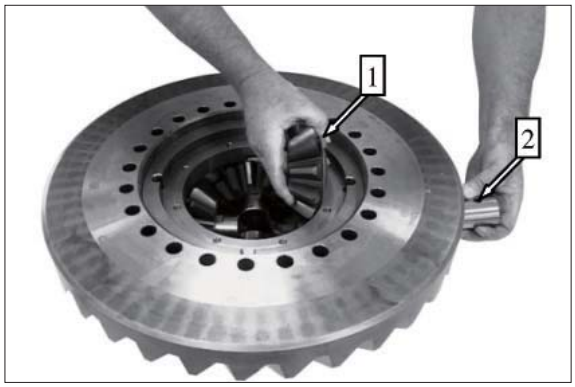


7809AX104

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

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

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



7809AX105

⑤ Fix spider shafts with slotted pins (2 pieces / hole).

※ Press the slotted pins with 180° offset openings into flush position.

7809AX106

⑥ Mount second axle bevel gear and thrust washer.

7809AX107

⑦ Mount disk and fix it with hexagon screws.

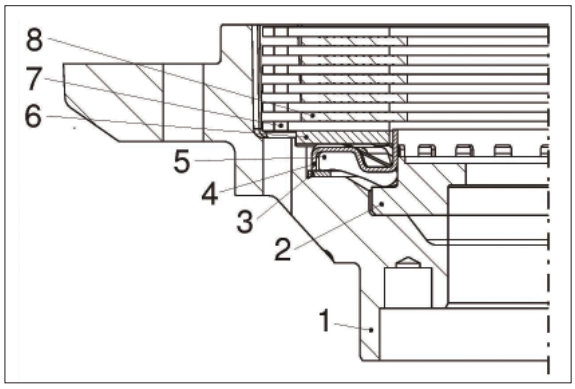
· Tightening torque (M10/10.9) :
5.1 kgf · m (36.9 lbf · ft)

7809AX108

Setting of disk package

⑧ Premount single parts according to the adjacent sketch.

1 = Differential cover
2 = Pressure piece
3 = Disk
4 = Cage
5 = Lever (15EA)
6 = End plate
7 = Outer disks (optional)
8 = Inner disks



7809AX109

⑨ Preload disk package with an axial force of F = 7 ton.

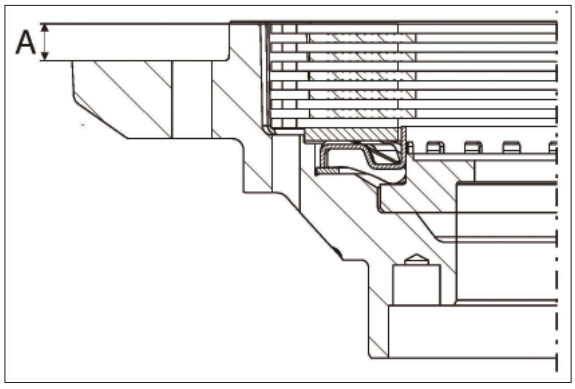
Then check the **setting dimension A = 15.5 $_{-0.2}$ mm** from the mounting face of the differential cover to the plane face of the outer disk (see also below sketch).

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


7809AX110

Legend to sketch:

A = Setting dimension = 15.5 $_{-0.2}$ mm



7809AX111

⑩ Engage the snap ring (see arrow) into the annular groove of the disk carrier.


7809AX112

⑪ Insert the premounted disk carrier onto the axle bevel gear.

7809AX113

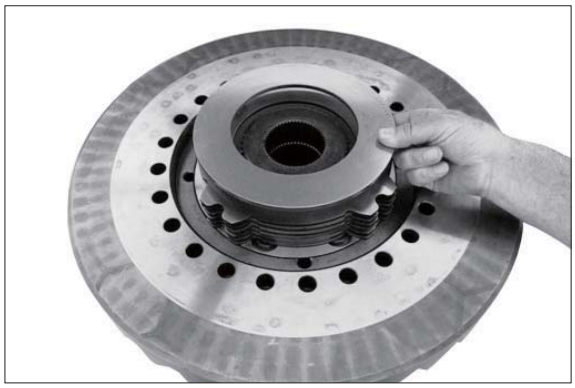
⑫ Mount outer and inner disks.

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

※ Pay attention to the radial installation position of the disk package, as shown on the adjacent figure.

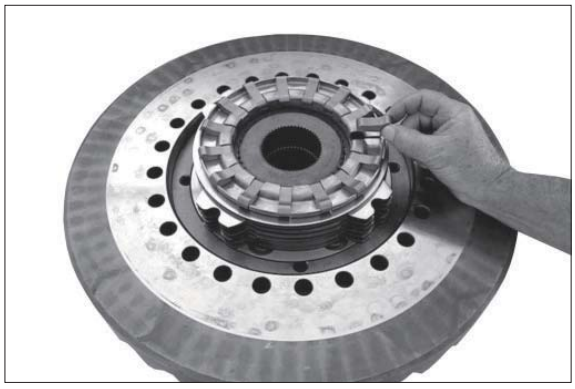
7809AX114

⑬ Insert end plate.



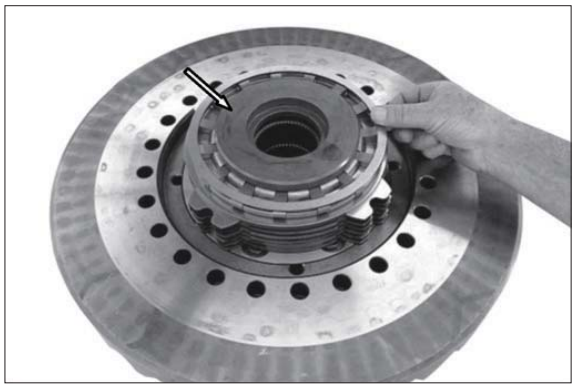
7809AX115

⑭ Mount cage and lever (15EA).



7809AX116

⑮ Insert pressure piece (see arrow) and install disk.



7809AX117

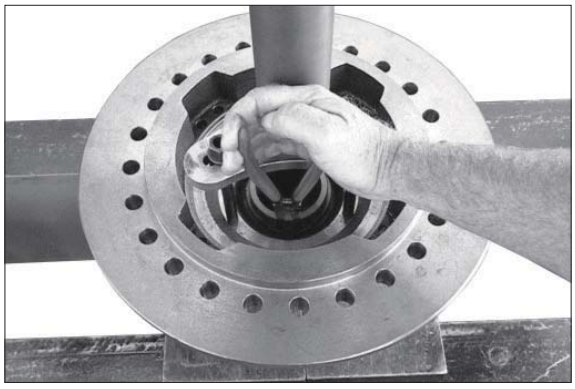
⑯ Insert compression springs (6EA) into the differential cover.

7809AX118

⑰ Insert sliding sleeve.

7809AX119

⑱ Preload the compression springs by means of the press and engage the retaining ring into the annular groove of the sliding sleeve.



7809AX120

⑲ Mount two adjusting screws and insert the differential cover by means of the lifting device.

Adjusting screws	5870 204 040
Inner extractor	5870 300 008
Eye nut	AA00 680 376

7809AX121

⑳ Preload the differential by means of the press and bolt with **new** locking screws.

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

Pressure piece	AA00 694 360

7809AX122

㉑ Heat both tapered roller bearings and insert until contact is obtained.

※ Adjust tapered roller bearing after cooling down.

7809AX123

㉒ Insert axial roller cage (see arrow).

7809AX124

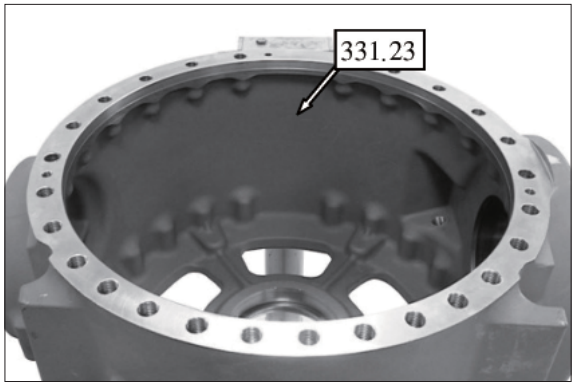
(2) Assembly axle drive housing

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

Determination of shim thickness to obtain a correct contact pattern

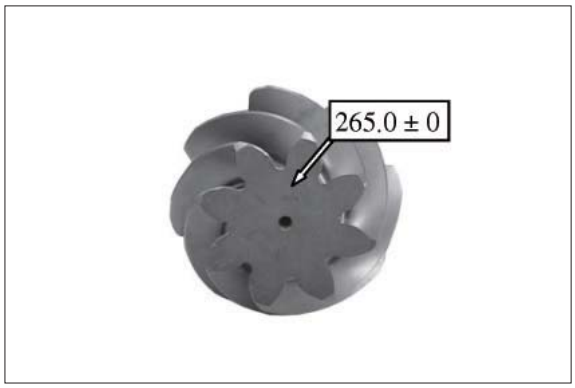
※ The following measuring procedures must be carried out with utmost accuracy.
Inaccurate measurements lead to an incorrect contact pattern requiring an additional disassembly and reassembly of input pinion and differential.

① Read dimension I from the axle drive housing.
Dimension I e.g ..... 331.25 ㎜



7809AX125

② Read dimension II (pinion dimension).
Dimension II e.g ..... 265.00 ㎜



7809AX126

③ Determine dimension III (bearing width).

Dimension III e.g. . . . . 63.60 mm

Calculation example A :

Dimension I . . . . . 331.25 mm
Dimension II . . . . . - 265.00 mm
Dimension III . . . . . - 63.60 mm
Difference = shim s = 2.60 mm

7809AX127

Reassembly of input pinion

① Undercool the external bearing outer ring and insert it into the axle drive housing until contact is obtained.

Driver tool	5870 050 007
Handle	5870 260 004

7809AX128

② Insert the determined shim e.g. s = 2.60 mm into the housing hole.

7809AX129

③ Undercool the internal bearing outer ring and bring it into contact position in the housing hole by using the assembly fixture.

Assembly fixture	AA00 623 955

7809AX130

④ Heat the tapered roller bearing and insert it into the input pinion until contact is obtained.

7809AX131

Setting of rolling torque of input pinion bearing 0.1~0.5 kgf·m (without shaft seal ring)

⑤ Insert spacer (e.g. s = 7.13 ㎜).

※ According to our experience the necessary rolling torque is obtained when reusing the spacer which has been removed during disassembly (e.g. s = 7.13 ㎜).
A later check of the rolling torque, however, is absolutely necessary.

7809AX132

⑥ Insert the preassembled input pinion into the axle drive housing and insert the heated tapered roller bearing until contact is obtained.

7809AX133

⑦ Press the protection plate onto the input flange (see arrow) until contact is obtained.

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

7809AX134

⑧ Insert input flange and fix it by means of disk and slotted nut.

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

Wrench	5870 401 093
Fixing device	AA00 695 905
Clamping device	870 240 002

※ Preliminarily mount slotted nut without Loctite.

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


7809AX135

⑨ Check rolling torque (0.15~0.51 kgf·m without shaft seal ring).

※ When installing new bearings try to achieve the upper value of the rolling torque.

※ In case of deviations from the necessary rolling torque correct with a corresponding spacer (figure AX132, page 3-245) as specified below.
Insufficient rolling torque - install thinner spacer ring.
Excessive rolling torque - install thicker spacer ring.


7809AX136

⑩ Mount threaded connection.

・Tightening torque :
10.2 kgf · m (73.8 lbf · ft)


7809AX137

⑪ Mount oil tube.

・Tightening torque :
10.2 kgf · m (73.8 lbf · ft)

7809AX138

⑫ Grease O-rings (see arrows) and insert them into the annular grooves of the piston.

7809AX139

⑬ Insert piston (see arrow) into the bearing housing until contact is obtained.

7809AX140

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

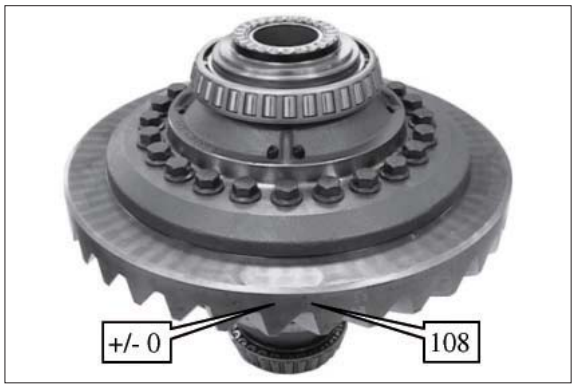
※ Determine the required shims on the basis of the read value (deviation/test dimension) and the corresponding specifications of the table below: (KRS – SET – RIGHT) (KRS = bevel gear set):

① Deviation see crown wheel rear side.

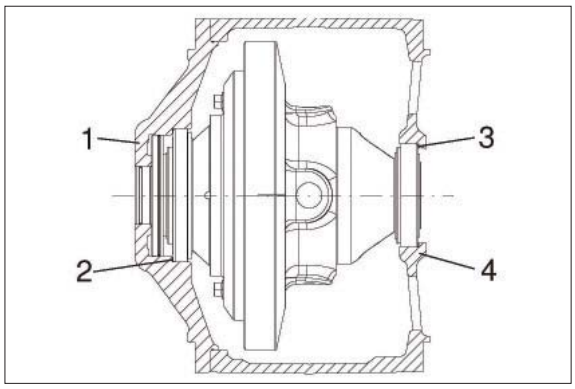
The test dimension 108 is stamped into the crown wheel rear side. If no + or – deviation is indicated, this value corresponds to the actual value 0 in the table below. According to this value, the required shims are allocated in the table below.

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

Legend to sketch:
1 = Bearing housing
2 = Shim (crown wheel side)
3 = Shim (differential carrier side)
4 = Axle drive housing



7809AX141



7809AX142

Shims for differential						
Crow wheel marking	- 30	- 20	- 10	0	10	20
Deviation	- 0.3	- 0.2	- 0.1	0	0.1	0.2
Shim diff cage side shim thickness	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**
Shim P/No.	ZGAQ-03681	ZGAQ-03676	ZGAQ-03677	ZGAQ-03678	ZGAQ-03679	ZGAQ-03680
Shim crown wheel side shim thickness	**1.7**	**1.6**	**1.5**	**1.4**	**1.3**	**1.2**
Shim P/No.	ZGAQ-03687	ZGAQ-03686	ZGAQ-03685	ZGAQ-03684	ZGAQ-03683	ZGAQ-03682

② Insert the determined shim (e.g. s = 1.4 mm) into the hole of the axle drive housing and reset until contact with the bearing outer ring is obtained.

7809AX143

③ Cover some drive and coast flanks of the crown wheel with marking ink.
Then insert the premounted differential into the axle drive housing.

Inner extractor	5870 300 008
Eye nut	AA00 680 376

7809AX144

④ Insert the determined shim (e.g. s = 1.4 mm) into the bearing housing and reset the bearing outer ring until contact is obtained.

7809AX145

⑤ Place the premounted bearing housing onto the axle drive housing by means of the lifting device.

Inner extractor	5870 300 008
Eye nut	AA00 680 376

※ Preliminarily mount the bearing housing without O-ring.

7809AX146

⑥ Fix the bearing housing by means of cylindrical screws (3EA).

・Tightening torque (M12/10.9) :
5.1 kgf · m (36.9 lbf · ft)

7809AX147

Leakage test of lock

⑦ Pressurize the lock (p = 1 bar), close shut-off valve and remove air line.

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

7809AX148

⑧ By rotating the input flange, roll crown wheel over the input pinion in both directions several times.
Then remove the bearing housing again and lift the differential out of the axle drive housing.
Compare the obtained contact pattern with contact pattern.

※ In case of any contact pattern deviation, a measuring error was made when determining the shim (Figure AX129, page 3-244), which must be corrected by all means.

7809AX149

⑨ After the contact pattern check insert the differential again into the axle drive housing.

7809AX150

Reassembly of shaft seal ring (figure AX151~153)

⑩ Loosen slotted nut and pull the input flange from the input pinion.

Wrench	5870 401 093
Fixing device	AA00 695 905
Clamping device	5870 240 002

7809AX151

⑪ Mount the shaft seal ring with the seal lip showing to the oil chamber.

Driver tool	AA00 623 986

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

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

7809AX152

⑫ Insert input flange and finally tighten by means of disk and slotted nut.

· Tightening torque :
122 kgf · m (12.5 lbf · ft)

Wrench	5870 401 093
Fixing device	AA00 695 905
Clamping device	5870 240 002

※ Cover the thread of the slotted nut with loctite #262.

7809AX153

⑬ Grease O-ring (see arrow) and insert it into the annular groove of the bearing housing.

7809AX154

⑭ Insert the bearing housing by means of the lifting device and finally tighten it with cylindrical screws.

· Tightening torque (M12/10.9) :
5.1 kgf · m (36.9 lbf · ft)

7809AX155

⑮ Grease O-rings (see arrows) and insert them on both sides of the axle drive housing.

7809AX156

⑯ Mount two adjusting screws and bring axle drive housing in contact position with the axle housing by using the lifting device.
Then fix the axle drive housing with hexagon screws.

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

Adjusting screws (M20)	5870 204 024
Eye bolt (M20)	5870 204 086
Thread insert	AA00 677 715

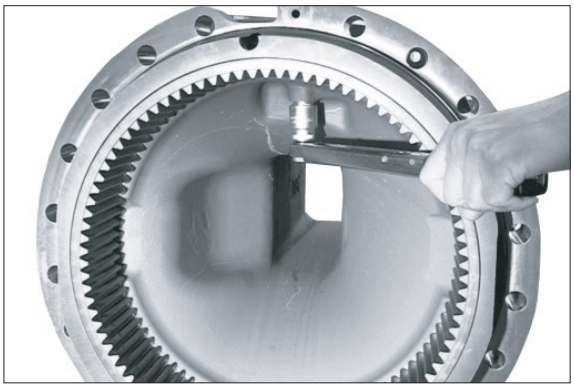
※ After mounting the axle drive housing unbolt the support until contact is obtained.

7809AX157

(3) Assembly axle housing

① Mount both fittings.

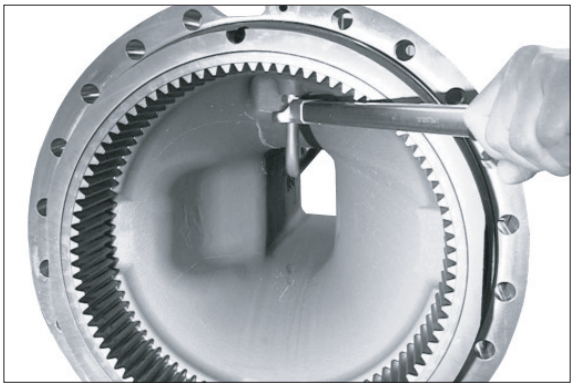
· Tightening torque : 3.67 kgf · m
(26.6 lbf · ft)



7809AX158

② Mount brake tube.

· Tightening torque : 10.2 kgf · m
(73.8 lbf · ft)



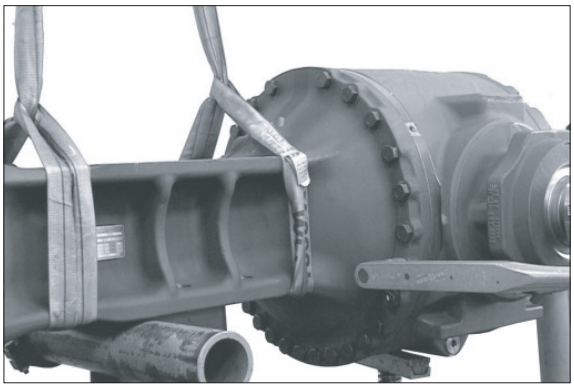
7809AX159

③ Mount two adjusting screws and bring the axle housing into contact position with the axle drive housing by using the lifting device.
Then fix the axle housing by means of hexagon screws.

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

Adjusting screws (M20) 5870 204 024

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



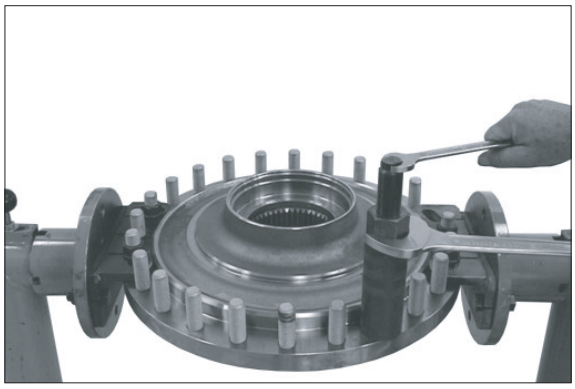
7809AX160

(4) Aeassembly output and brake

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

Wheel stud puller - basic tool
5870 610 001
Insert (M22x1.5) 5870 610 002

※ Special tool may only be used for repair solution when exchanging individual wheel studs with mounted output shaft. When using a new output shaft, mount the wheel studs with the press.


7809AX28

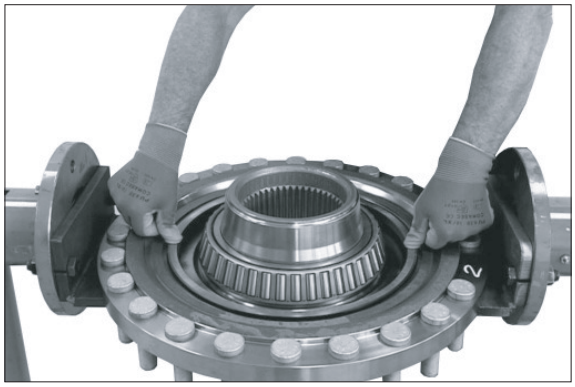
② Heat tapered roller bearing and insert it into the output shaft until contact is obtained.

7809AX29

② Wet O-ring of the slide ring seal and locating hole with spirit.
Snap **new** slide ring seal (1) into the output shaft.
Then mount **new** slide ring seal (part 2) accordingly into the brake housing.

※ For the installation position of the seal please also refer to sketch AX34, page 3-256.

※ The surface of the slide ring seal may not have any grooves, scratches or other types of damage. Take care that the sealing surface is parallel to the housing face.
The O-rings must be mounted evenly into the locating hole and must not bulge out of the hole. Risk of injury - Metal rings have extremely sharp edges. Wear protective gloves.

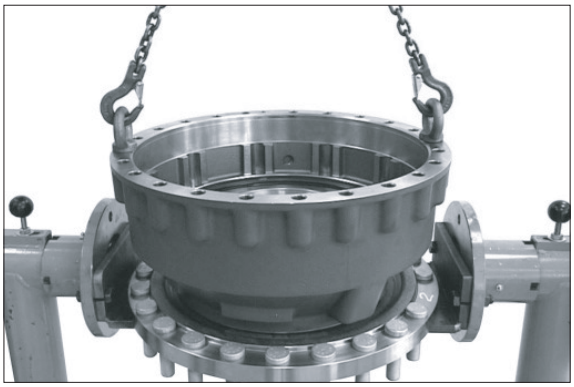


7809AX30


7809AX31

③ Insert the premounted brake housing by means of the lifting device over the output shaft until contact is obtained.

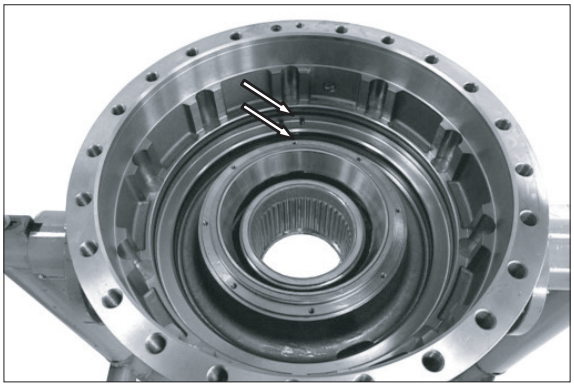
※ Before clamping the seal rings to installation dimension, clean the sliding surfaces and apply an oil film. We recommend to use a leather cloth soaked with oil.



7809AX31

④ Insert back-up rings and grooved rings into the annular grooves of the brake housing (see arrows).

※ Pay attention to the installation position; please also refer to sketch AX34, page 3-256.

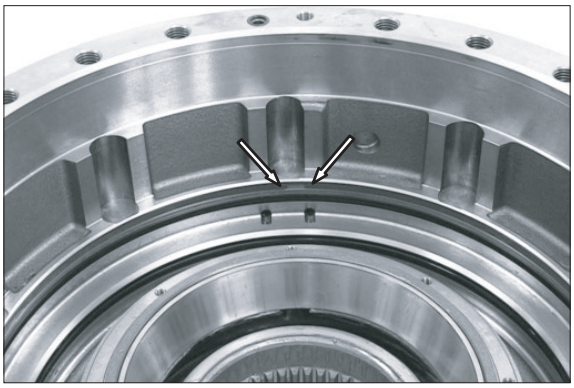


7809AX32

⑤ Clean the annular groove of the brake housing with spirit.
Then insert the guide ring into the annular groove (see also the following sketch) and fix it with loctite #415 at its extremities (see arrows).

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

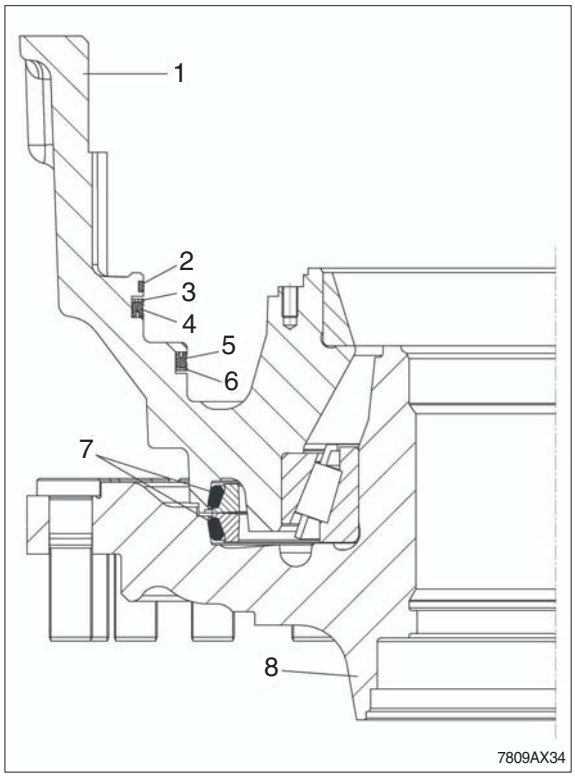
※ Upon installation the orifice of the guide ring must show upwards (12 o'clock).



7809AX33

Legend to sketch:

1 = Brake housing
2 = Guide ring
3 = Back-up ring
4 = Grooved ring
5 = Grooved ring
6 = Back-up ring
7 = Slide ring seal
8 = Output shaft

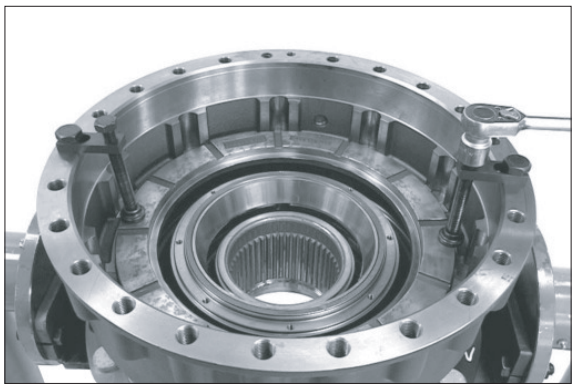


7809AX34

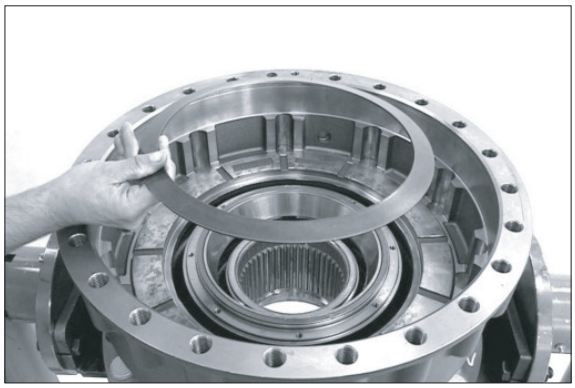
⑥ Insert the piston into the brake housing and carefully install with the fixing device until contact is obtained.

Fixing device AA00 680 530

※ Sufficiently oil seal surface of piston/ back-up rings, grooved rings and guide ring (W-10 oils to be used).

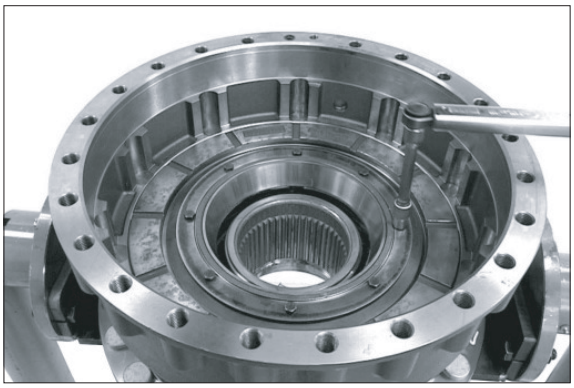

7809AX35

⑦ Insert cup spring into the piston with the convex side showing upwards.


7809AX36

⑧ Insert disk and fix it by means of hexagon screws.

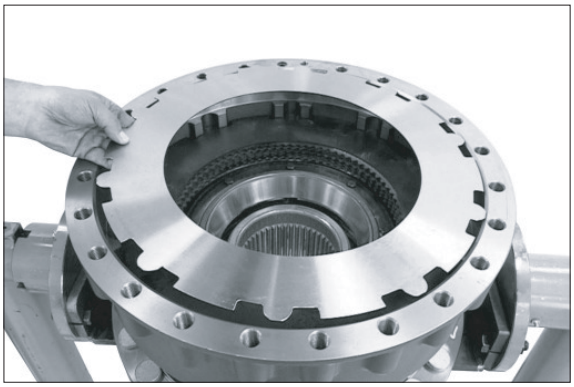
· Tightening torque (M8/10.9) :
3.47 kgf · m (25.1 lbf · ft)



7809AX37

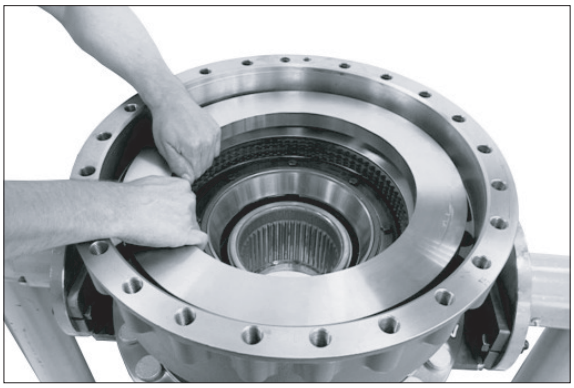
⑨ Mount outer and inner disks.

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



7809AX38

⑩ Insert end plate.



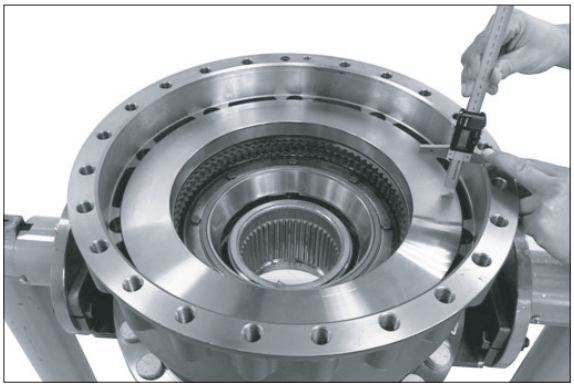
7809AX39

Setting of installation dimension 57.25~ 57.79 mm

⑪ Measure installation dimension from the mounting face of the brake housing to the front face of the end plate.

Installation dimension e.g . . . . . 57.50 mm

※ Any deviation from the necessary installation dimension must be corrected with an appropriate outer disk (see spare parts manual).

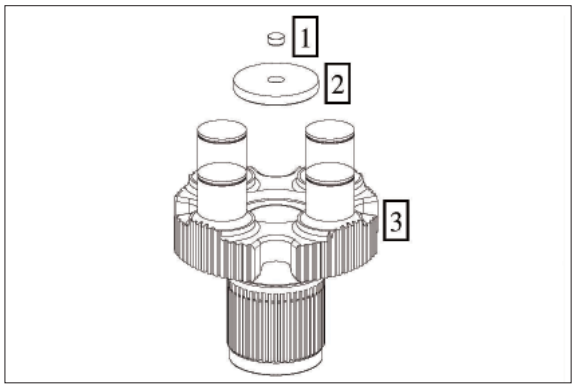


7809AX40

⑫ Press stop bolt into the cover until contact is obtained.

Then insert the premounted cover into the planetary carrier until contact is obtained.

Legend to sketch:
1 = Stop bolt
2 = Cover
3 = Planetary carrier

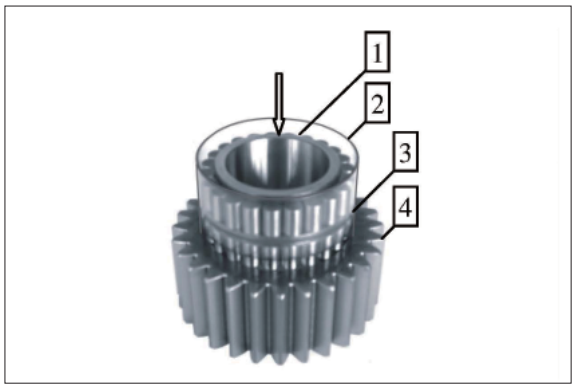


7809AX161

⑬ Insert the cylindrical roller bearing into the planetary gear – for this purpose press the cylindrical roller bearing through the packaging sleeve until the snap ring engages into the annular groove of the planetary gear.

※ Use packaging sleeve to facilitate assembly.

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



7809AX162

⑭ Heat bearing inner rings and insert the premounted planetary gears with large radius facing the planetary carrier (downwards) until contact is obtained.

※ Adjust bearing inner rings after cooling down.

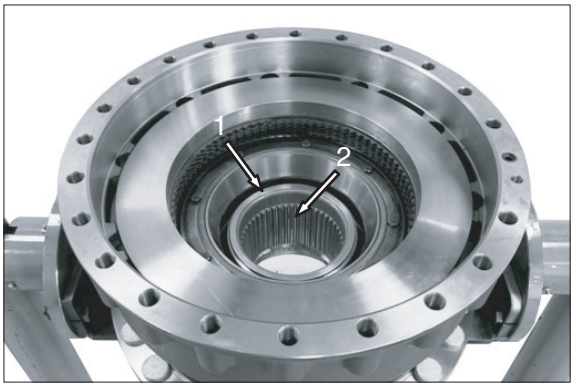
Then fix planetary gears by means of retaining rings.


7809AX163

⑮ Heat tapered roller bearing and install it to the planetary carrier until contact is obtained.


7809AX164

⑯ Wet front face (contact face bearing inner ring, arrow 1) and profile (teeth, arrow 1) in the output shaft with anti-corrosive agent.



7809AX41

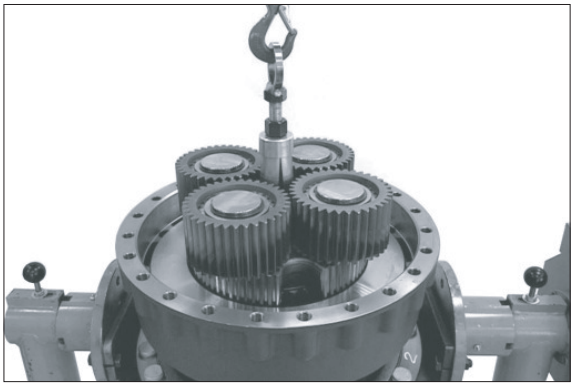
⑰ Align disk package centrally and radially. Then insert the planetary carrier by means of the lifting device into the teeth of the output shaft until contact is obtained.

- Rear axle (planetary carrier with 3 planetary gears)

Inner extractor	5870 300 019
Eye bolt	5870 204 073

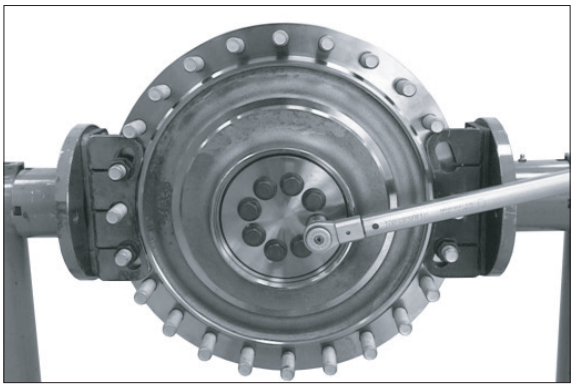
- Front axle (planetary carrier with 4 planetary gears)

Inner extractor	5870 300 008
Eye nut	AA00 680 376


7809AX42

⑱ Pivot output 90°.
Insert disk and fix planetary carrier with **new** locking screws.

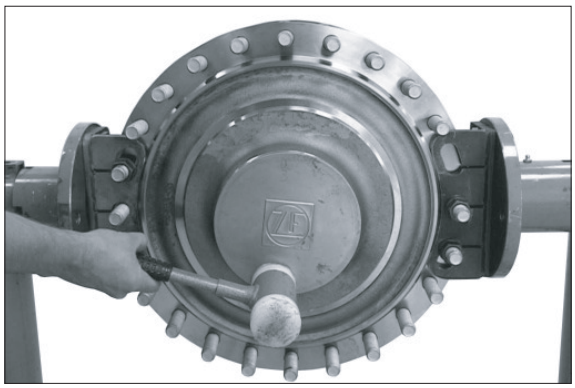
※ Tighten locking screws successively with a tightening torque of 20.4 kgf · m (147.5 lbf · ft).
Then retighten the locking screws successively with a tightening torque of 51 kgf · m (369 lbf · ft).


7809AX43

⑲ Install O-ring (see arrow) to the cover.

7809AX44

⑳ Insert the cover into the output shaft until contact is obtained.



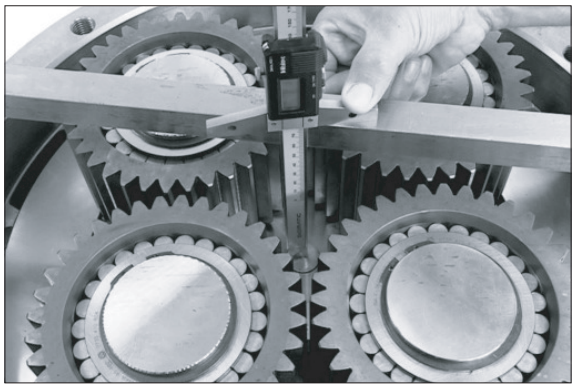
7809AX45

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

⑳ Determine dimension I, from the mounting face of the brake housing to the front face of the stop bolt.

Dimension I e.g. . . . . 58.60 mm

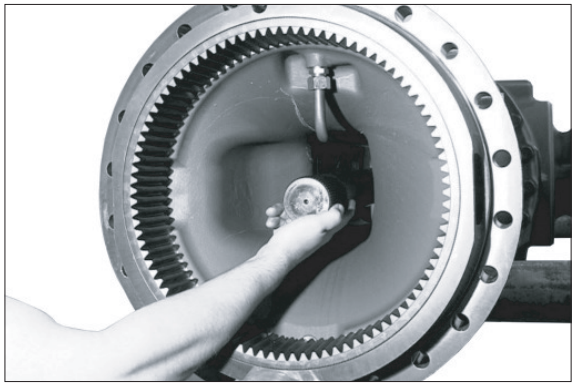
Gauge blocks	5870 200 066
Straightedge	5870 200 022



7809AX46

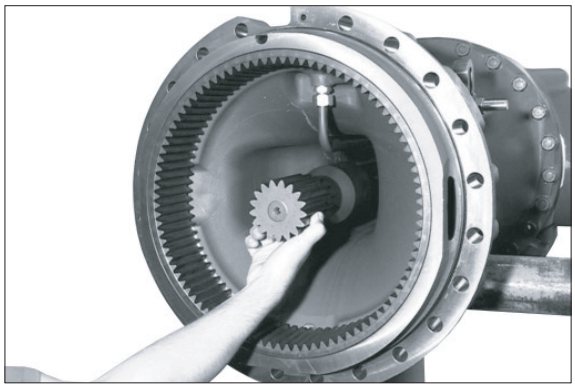
㉑ Insert stub shaft into the teeth of the axle bevel gear until contact is obtained.

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



7809AX47

㉒ Insert the sun gear shaft until contact is obtained.



7809AX48

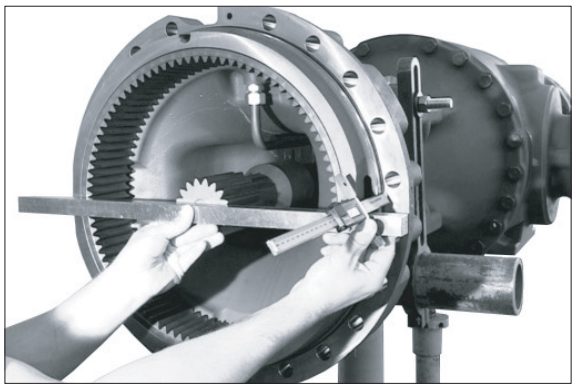
㉓ Measure dimension II, from the front face of the sun gear shaft to the mounting surface of the axle housing.

Dimension II e.g. . . . . 56.60 mm

Straightedge 5870 200 022

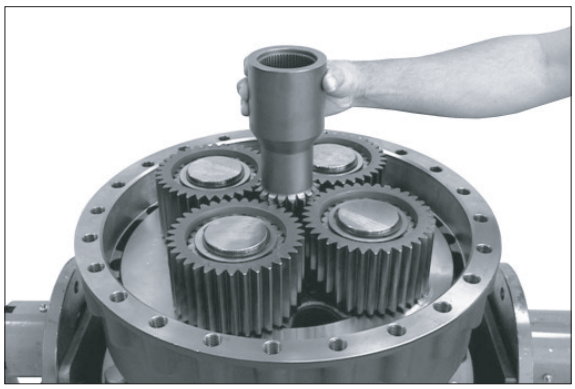
Calculation example :

Dimension I . . . . . 58.60 mm
Dimension II . . .. - 56.60 mm
Difference . . . . . 2.00 mm
Required axial play e.g. . . . . - 1.00 mm
Difference = shim e.g. s = 1.00 mm



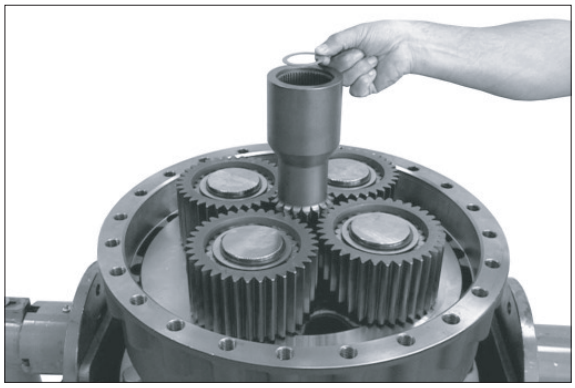
7809AX49

㉔ Insert sun gear shaft into the planetary carrier.



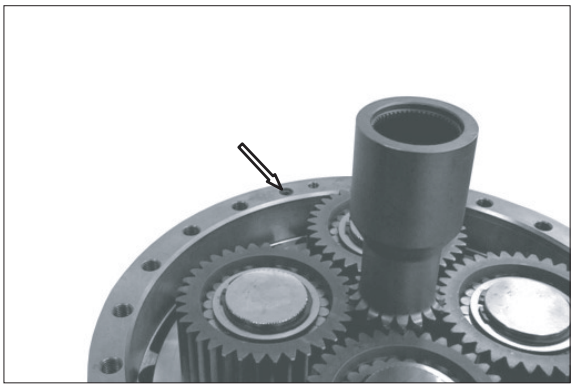
7809AX50

㉕ Fix determined shim e.g. s = 1.00 mm with grease into the sun gear shaft.



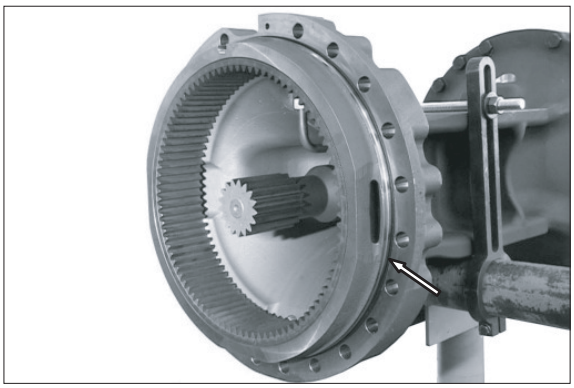
7809AX51

㉖ Fix O-ring (see arrow) with grease into the countersink of the brake housing.



7809AX52

㉗ Grease O-ring (see arrow) and install it to the axle housing.



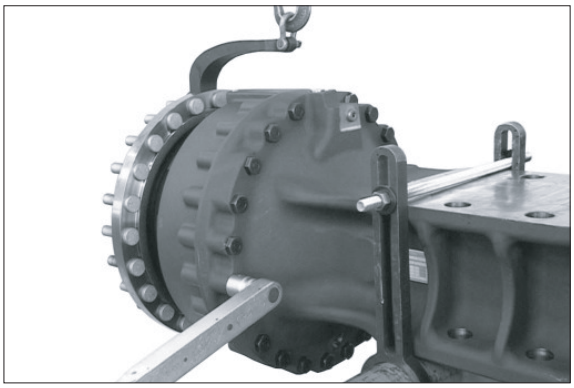
7809AX53

㉘ Mount two adjusting screws and use the lifting device to bring the output into contact position with the axle housing. Then fix the output by means of hexagon screws.

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

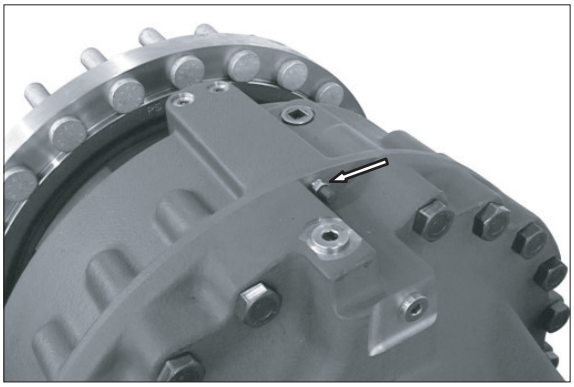
Adjusting screws (M20)	5870 204 024
Load-carrying device	AA00 685 875

※ Fix load carrying device with wheel stud.



7809AX54

㉙ Mount breather (see arrow).



7809AX55

㉚ Check brake hydraulics for leakages.

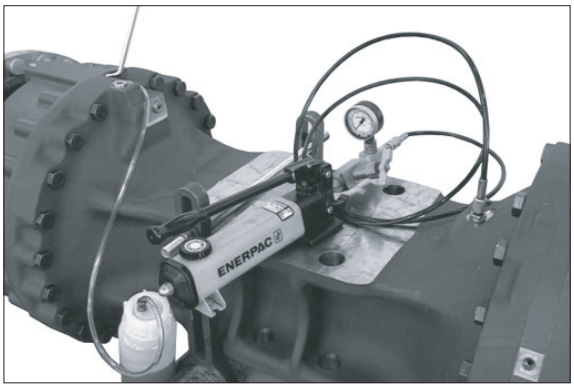
※ Before starting the test, completely breathe the brake hydraulics.
Then pressurize the brake temporarily (5EA) with p = 100 bar max.

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

Low-pressure test :
Reduce test pressure p = 5 bar and close shut-off valve.
No pressure drop is allowed during a 5 minute testing time.

Test media :
Engine oils SAE 10-W

HP pump	5870 287 007
Clutch	0501 207 939
Reduction (M18x1.5)	5870 950 161
Oil collector bottle	5870 286 072



7809AX56

㉛ Check operability of differential hydraulic lock

Build up pressure p = 20 bar max. and close connection to HP pump via shut-off valve.

Lock on:
When rotating the input flange, both outputs must have the same direction of rotation.

Lock off:
When rotating the input flange one side holds or has the opposite direction of rotation.

※ Prior to putting the axle into operation, fill it with oil according to the related lubrication and maintenance instructions.


7809AX165