

## SECTION 3 POWER TRAIN SYSTEM

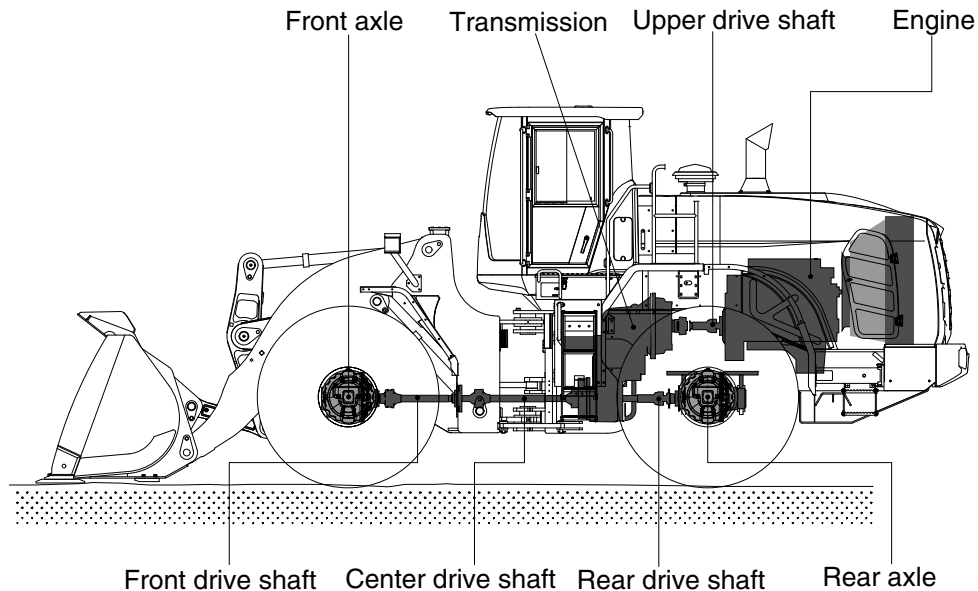
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# SECTION 3 POWER TRAIN SYSTEM

## GROUP 1 STRUCTURE AND FUNCTION

### 1. POWER TRAIN COMPONENT OVERVIEW



980A3PT01

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 four 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.

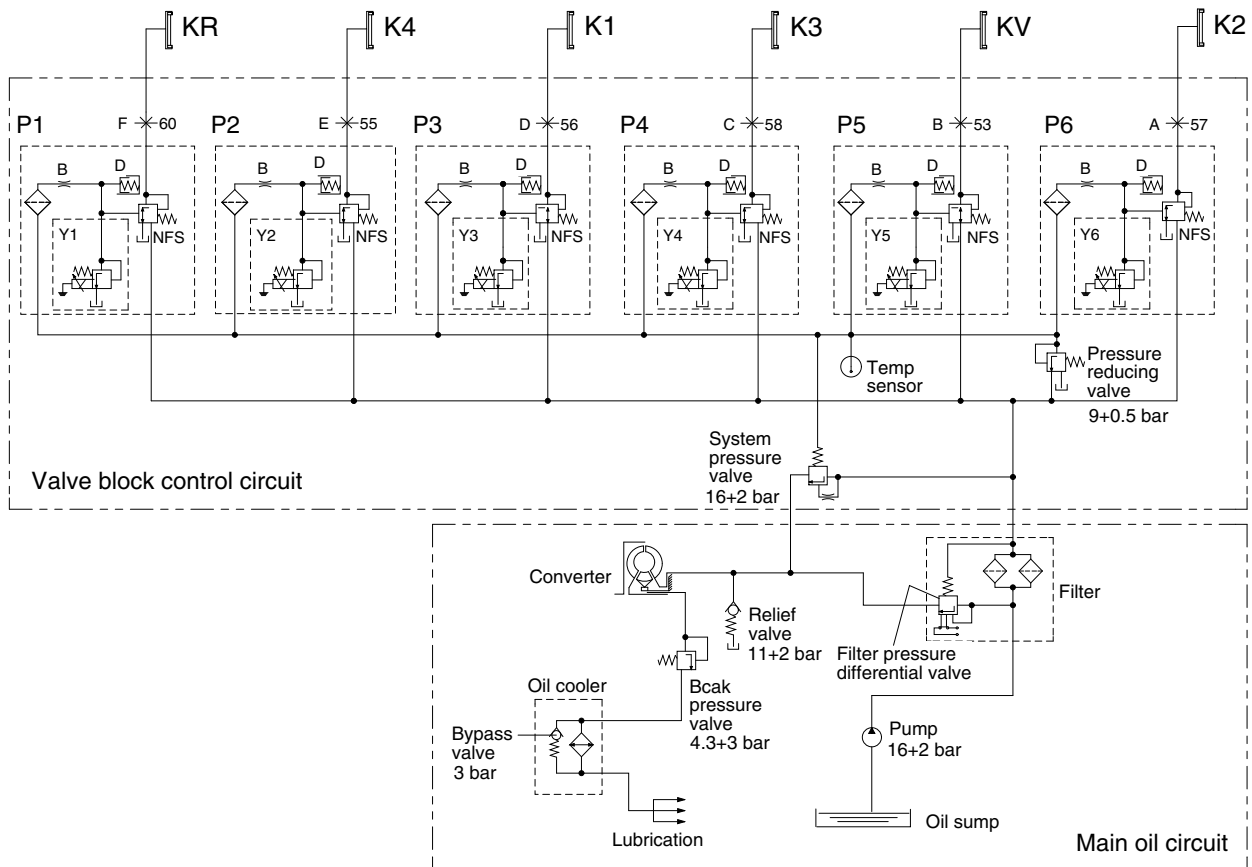
The rear axle is equipped with conventional differential as standard.

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



7707APT09

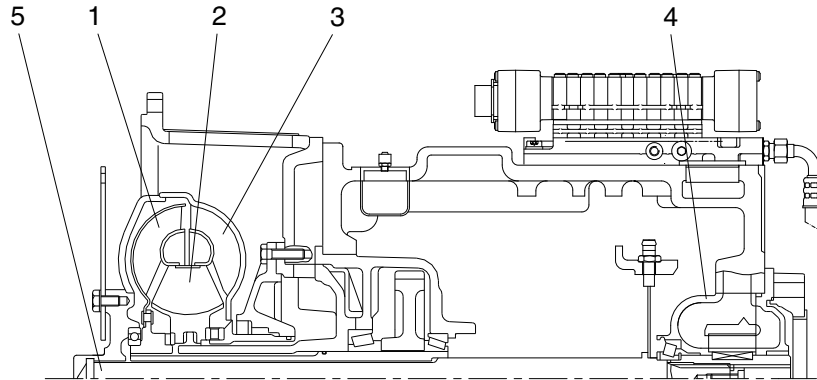
- |     |                              |       |                                      |
|-----|------------------------------|-------|--------------------------------------|
| NFS | Follow-on slide              | P3    | Proportional valve clutch K1         |
| D   | Oscillation damper           | P4    | 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

## 2. TORQUE CONVERTER

### 1) FUNCTION



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- |   |         |   |                   |   |             |
|---|---------|---|-------------------|---|-------------|
| 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 inverted 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.

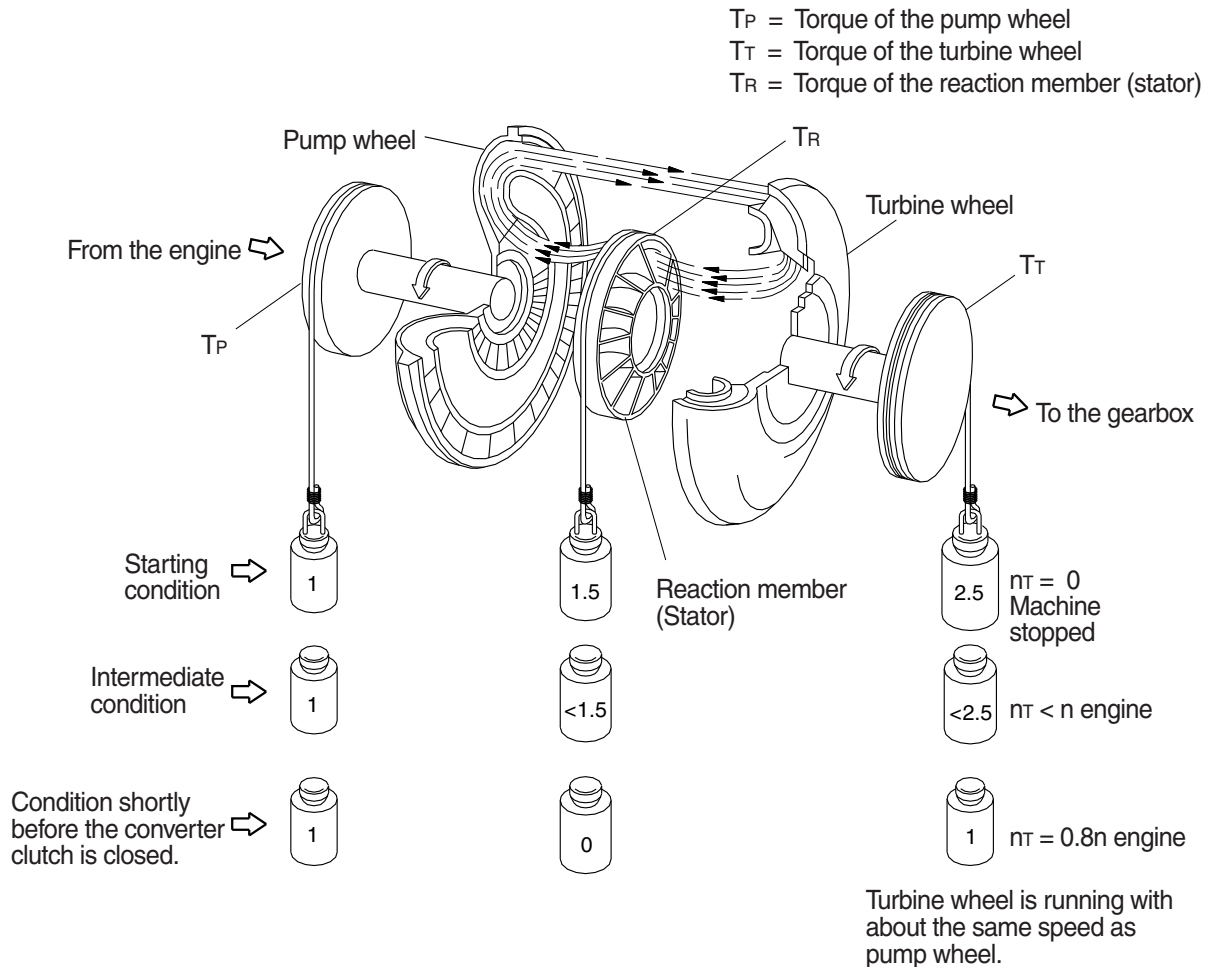
If the turbine speed is reaching about 80% of the pump speed, the conversion becomes 1.0 i.e. the turbine moment becomes equal to that of the pump moment.

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.

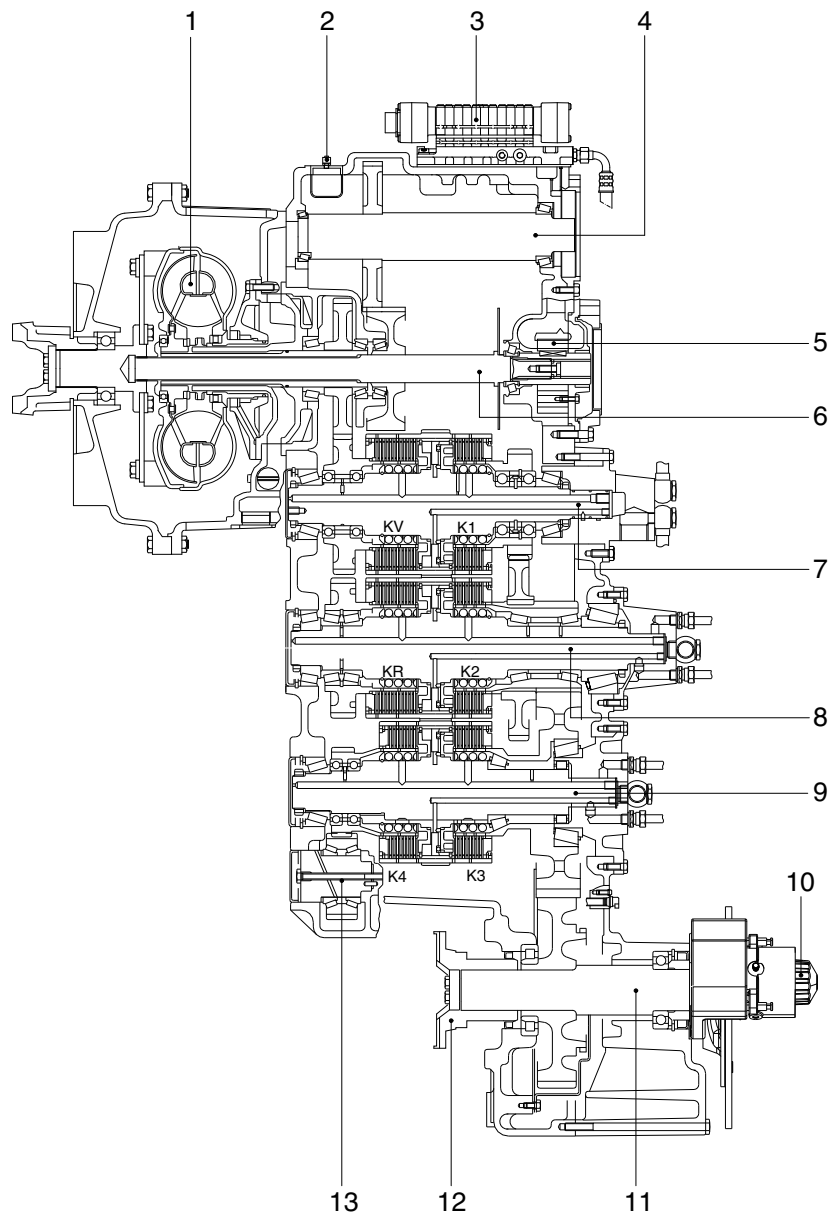
### Function of a hydrodynamic torque converter (schematic view)



3-4(770-3)

### 3. TRANSMISSION

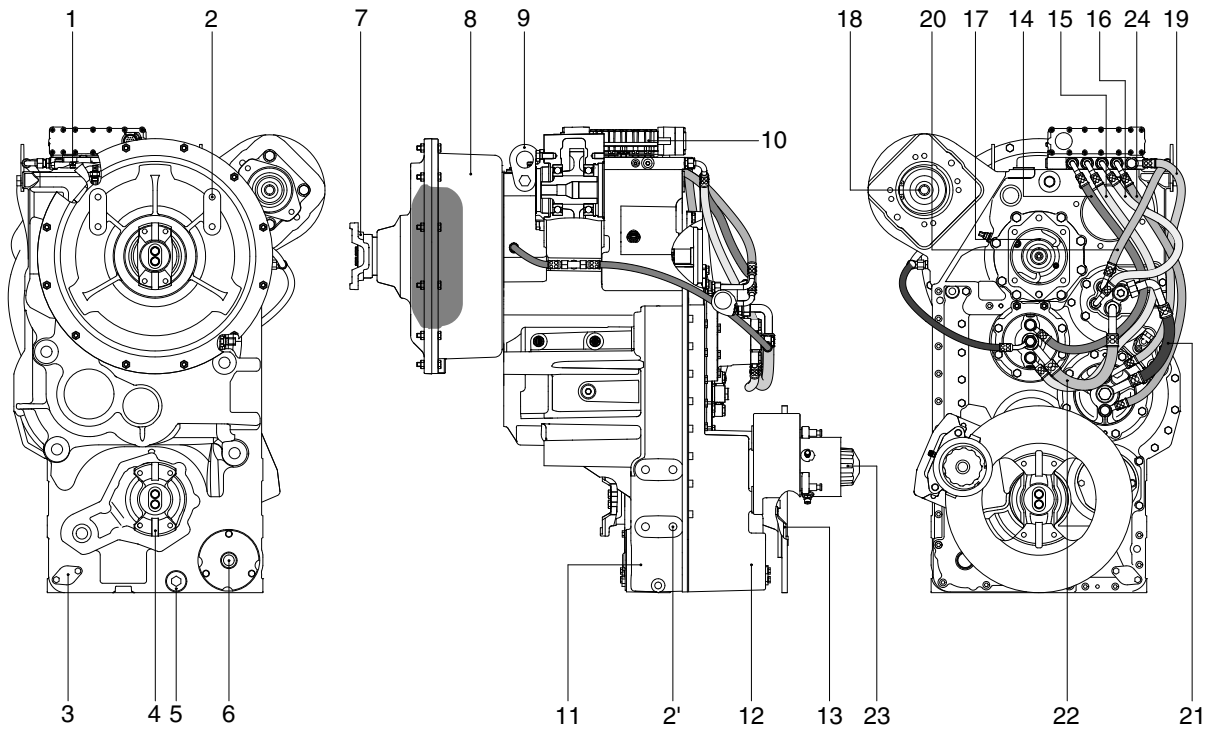
#### 1) LAYOUT



- |   |                                 |    |                                |
|---|---------------------------------|----|--------------------------------|
| 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               |    |                                |

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## 2) INSTALLATION VIEW



980T33PT05

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

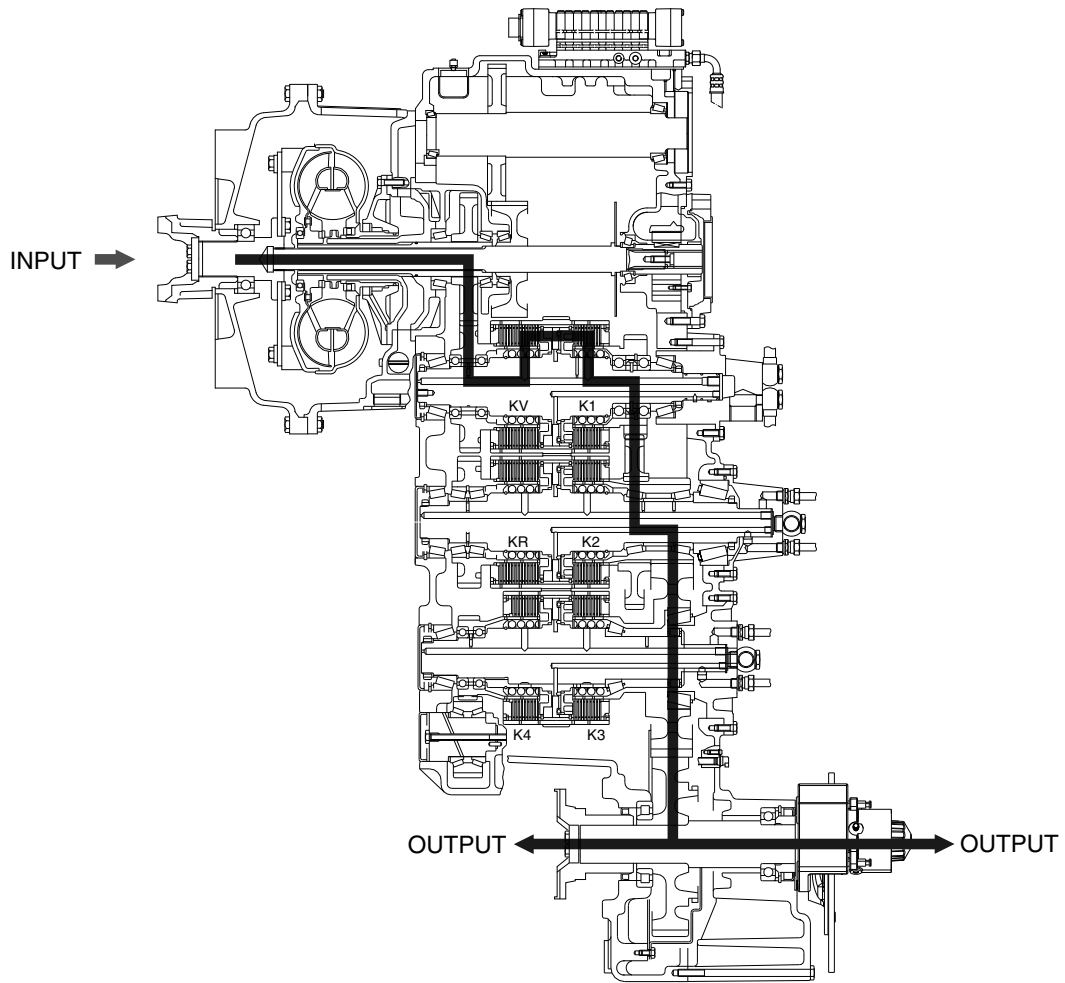
### 3) OPERATION OF TRANSMISSION

#### (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.



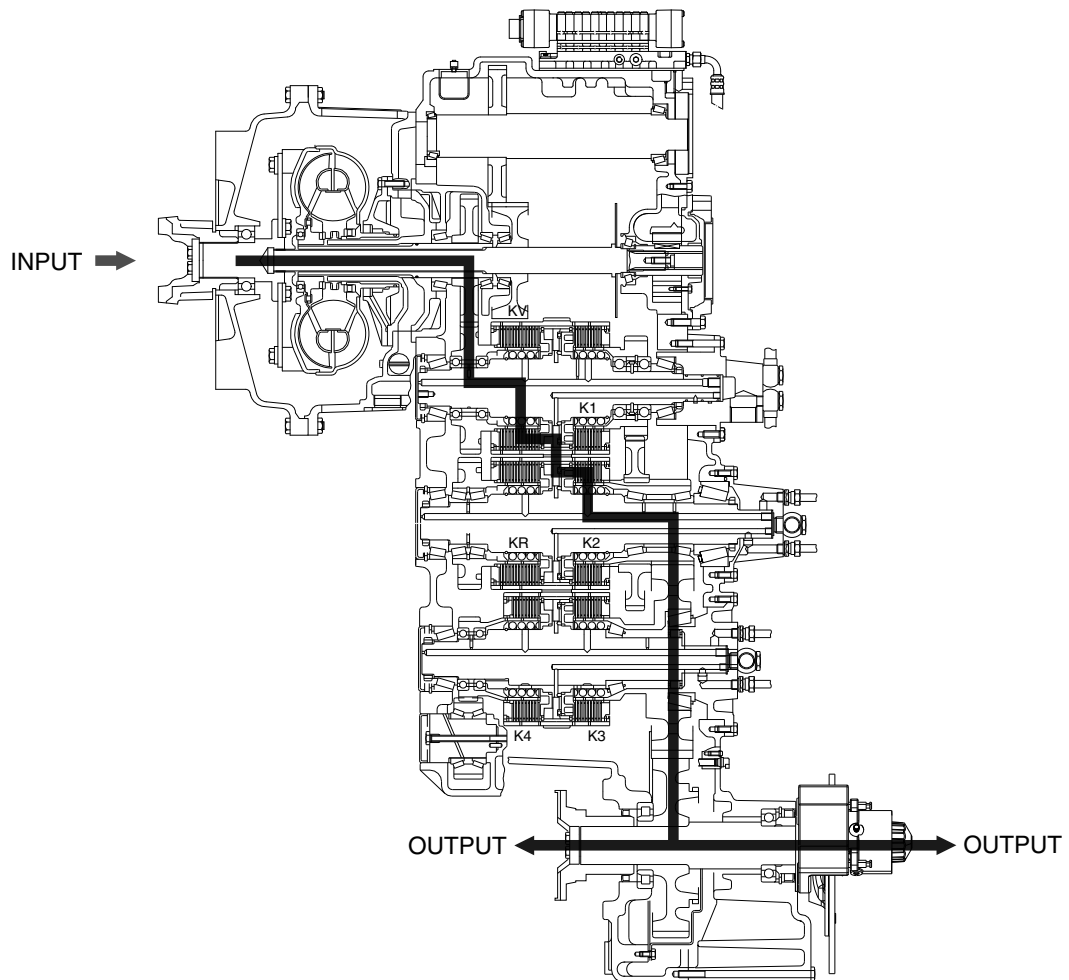
78093PT07



## 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.

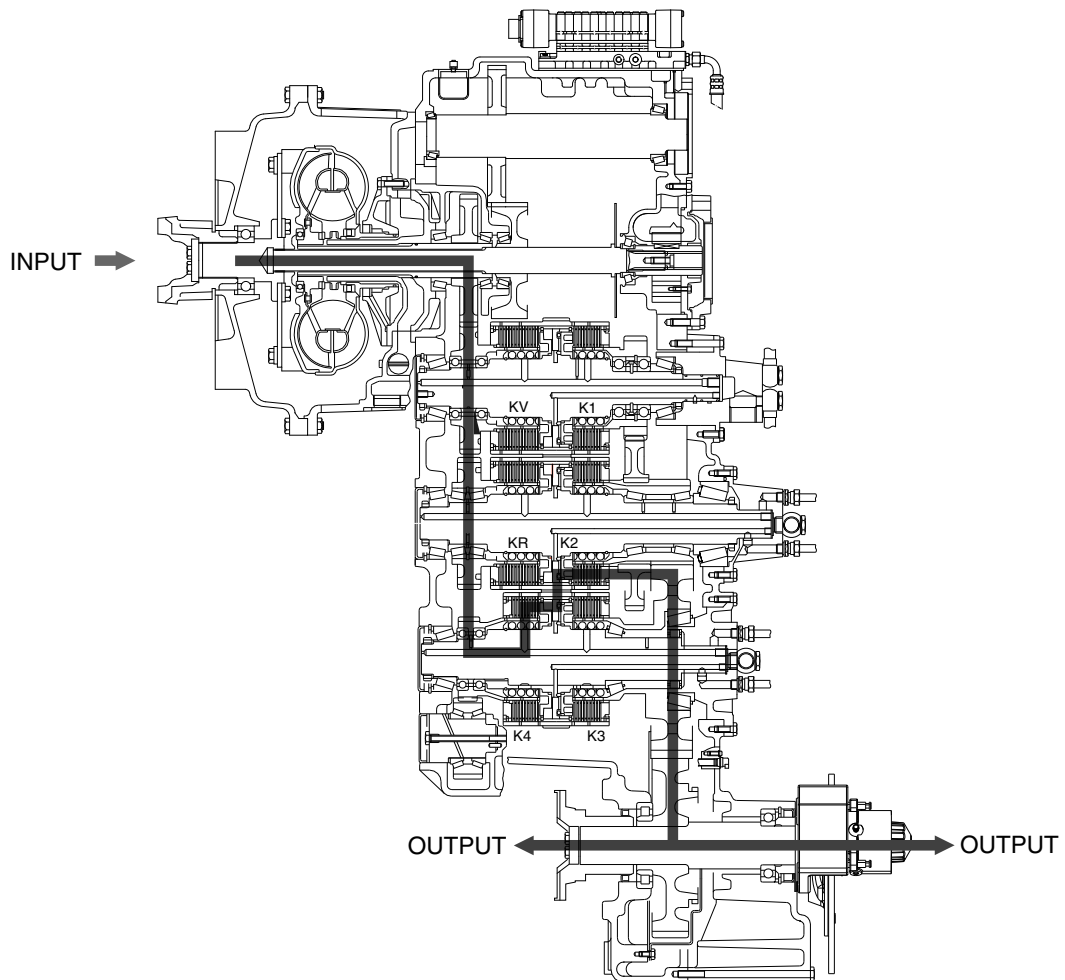


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### ③ Forward 3rd

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.

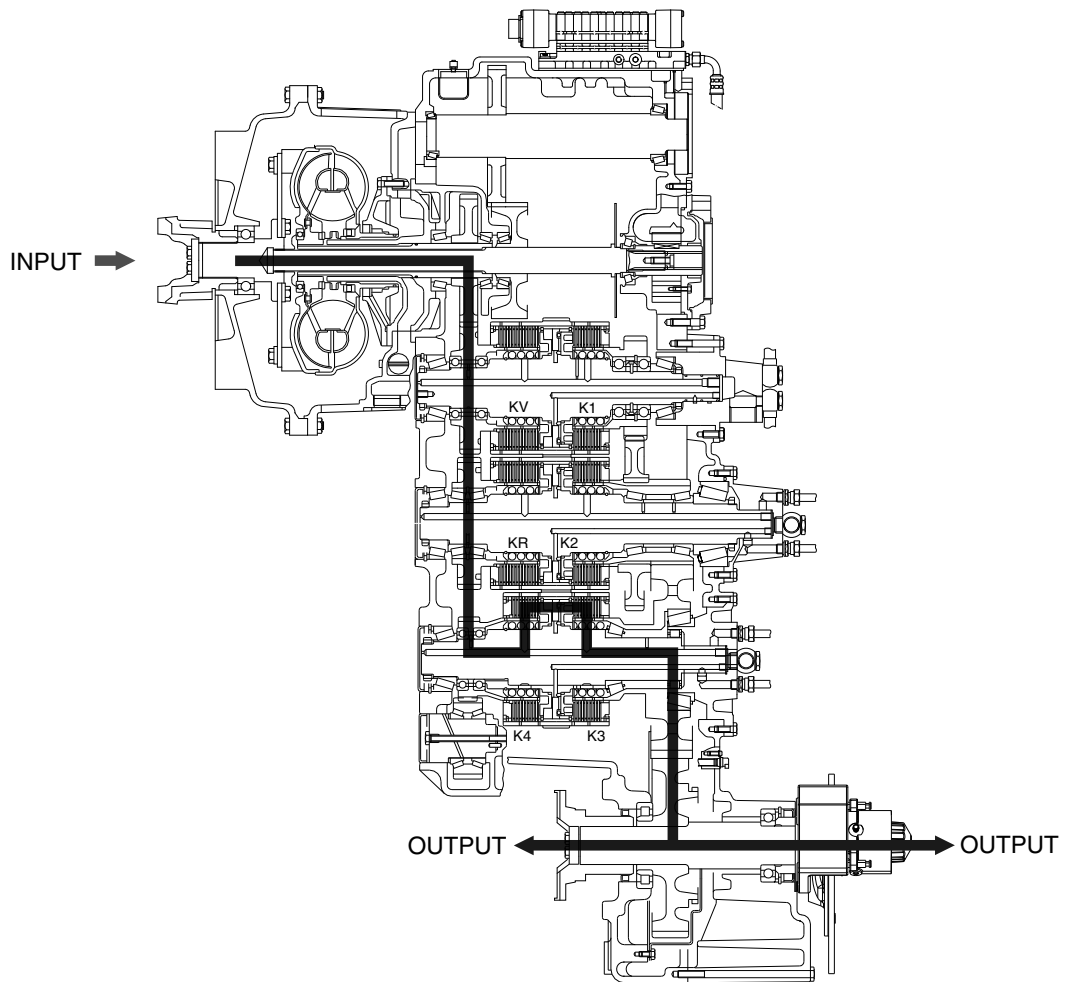


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#### ④ Forward 4th

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.



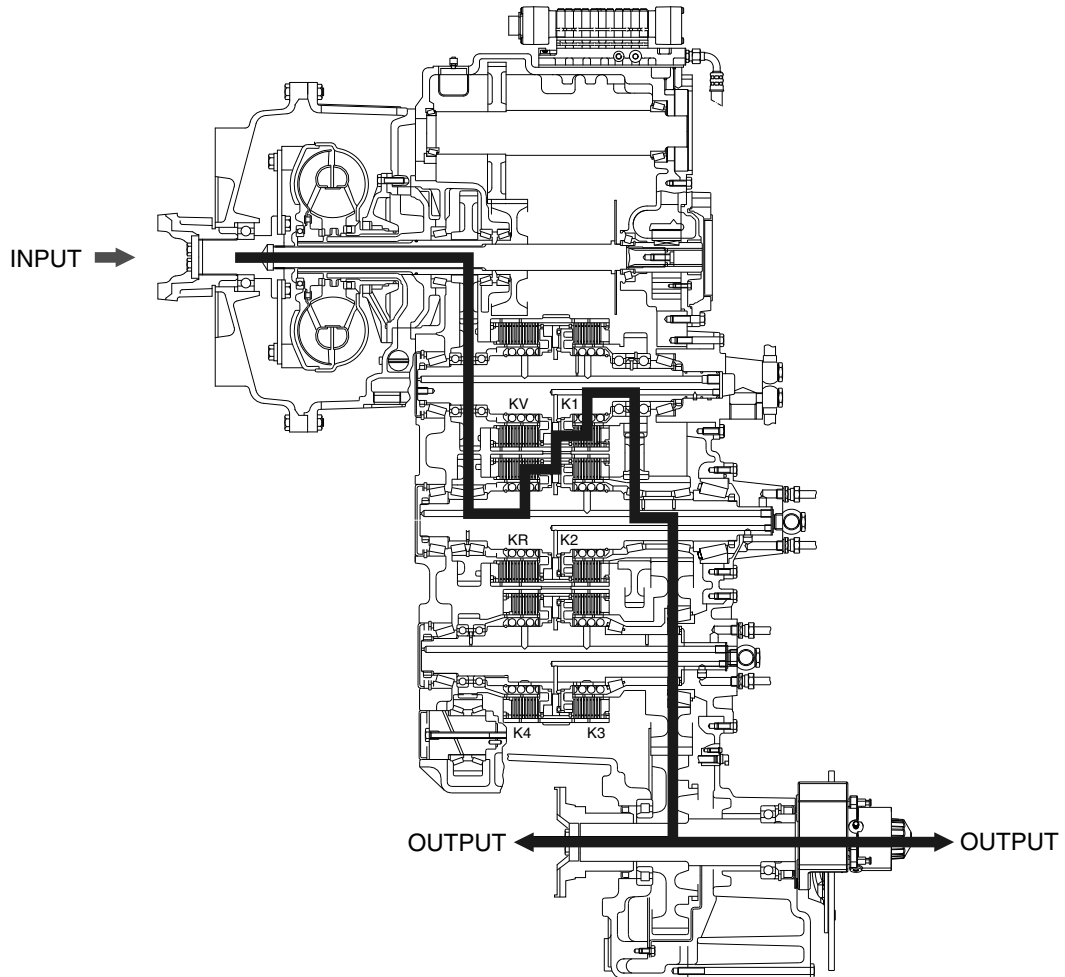
78093PT10

**(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.

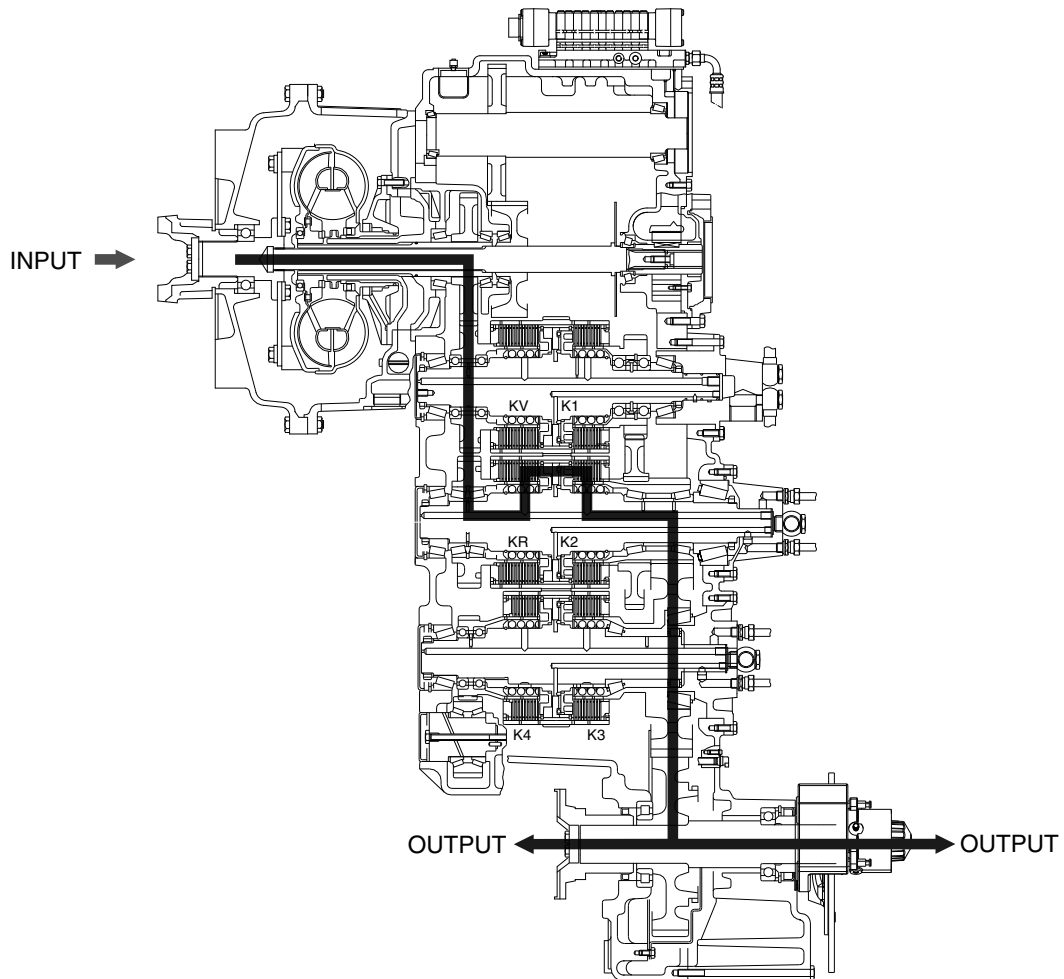


78093PT11

## 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.

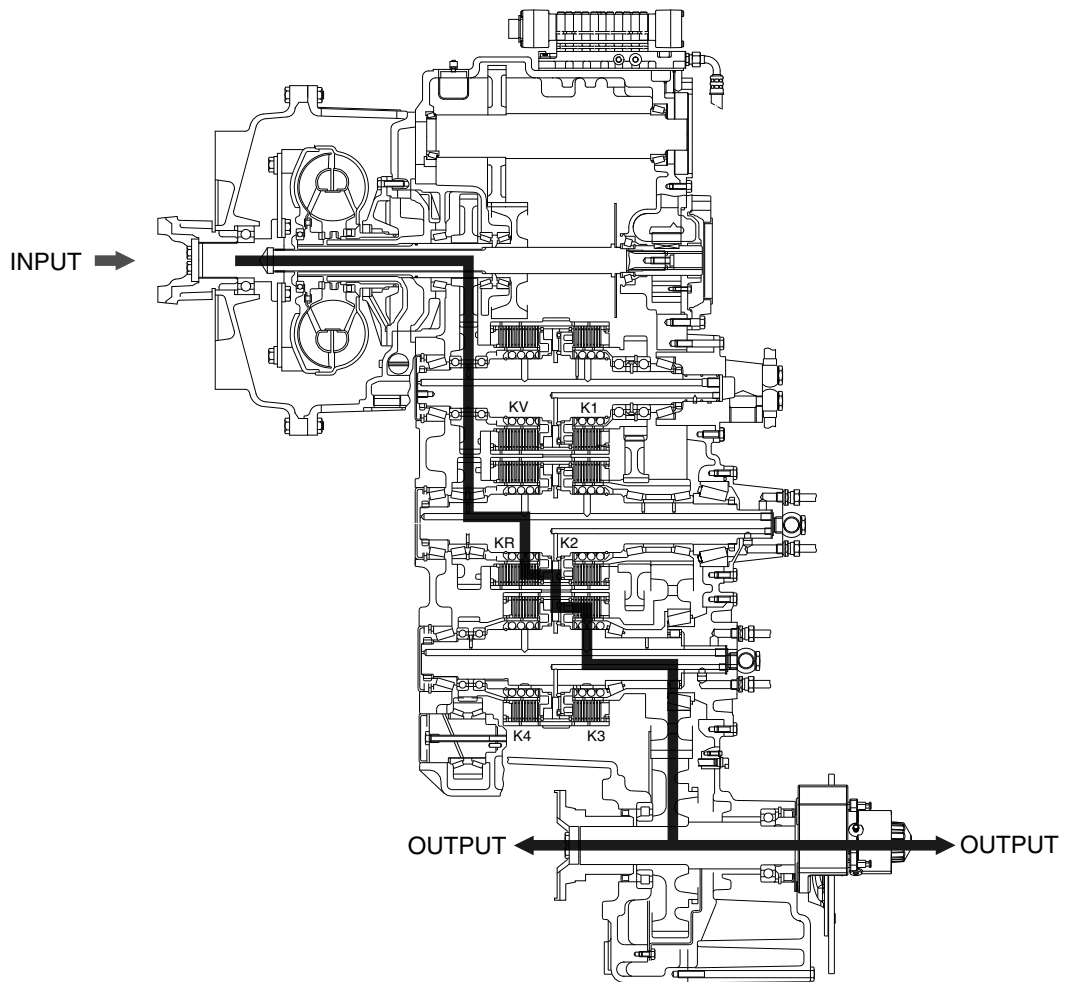


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### ③ Reverse 3rd

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

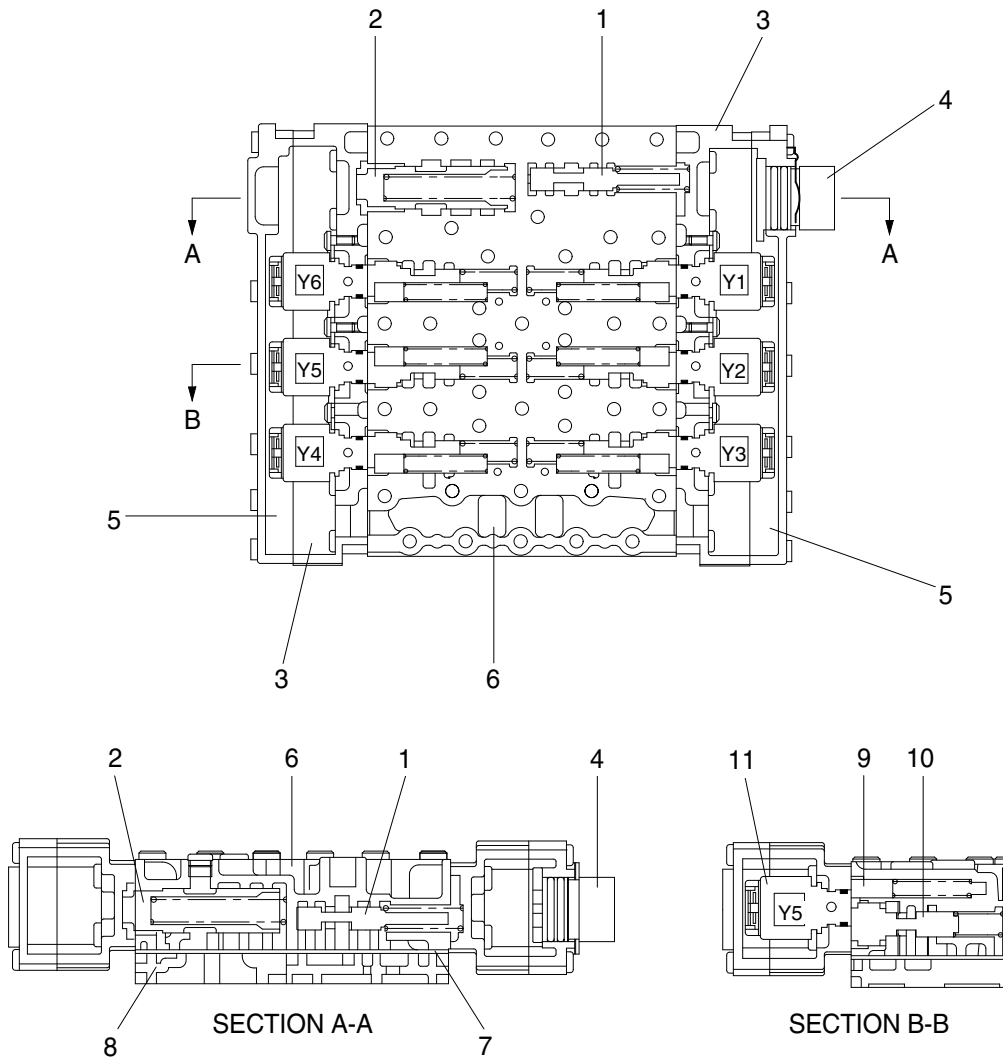
reverse clutch and 3rd clutch are actuated by the hydraulic pressure applied to the clutch piston.



78093PT13

#### 4) ELECTRO-HYDRAULIC SHIFT CONTROL WITH PROPORTIONAL VALVE

##### (1) 4-speed transmission



73033CV01

- |   |                                     |    |                    |
|---|-------------------------------------|----|--------------------|
| 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                         |    |                    |

Transmission control, see schedule of hydraulic circuit, electro-hydraulic control unit and measuring points at page 3-2, 3-17 and 3-93.

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)

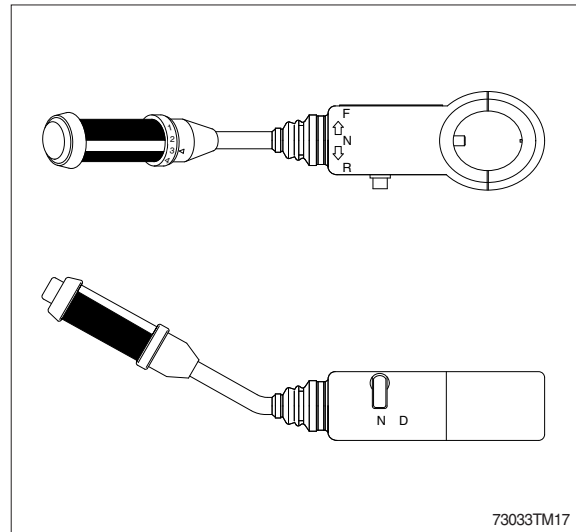
The gear selector is designed for the mounting on the left side of the steering column. The positions (speeds) 1 to 4 are selected by a rotary motion, the driving direction Forward (F)-Neutral (N)-Reverse (R) by tilting the gear selector lever.

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.

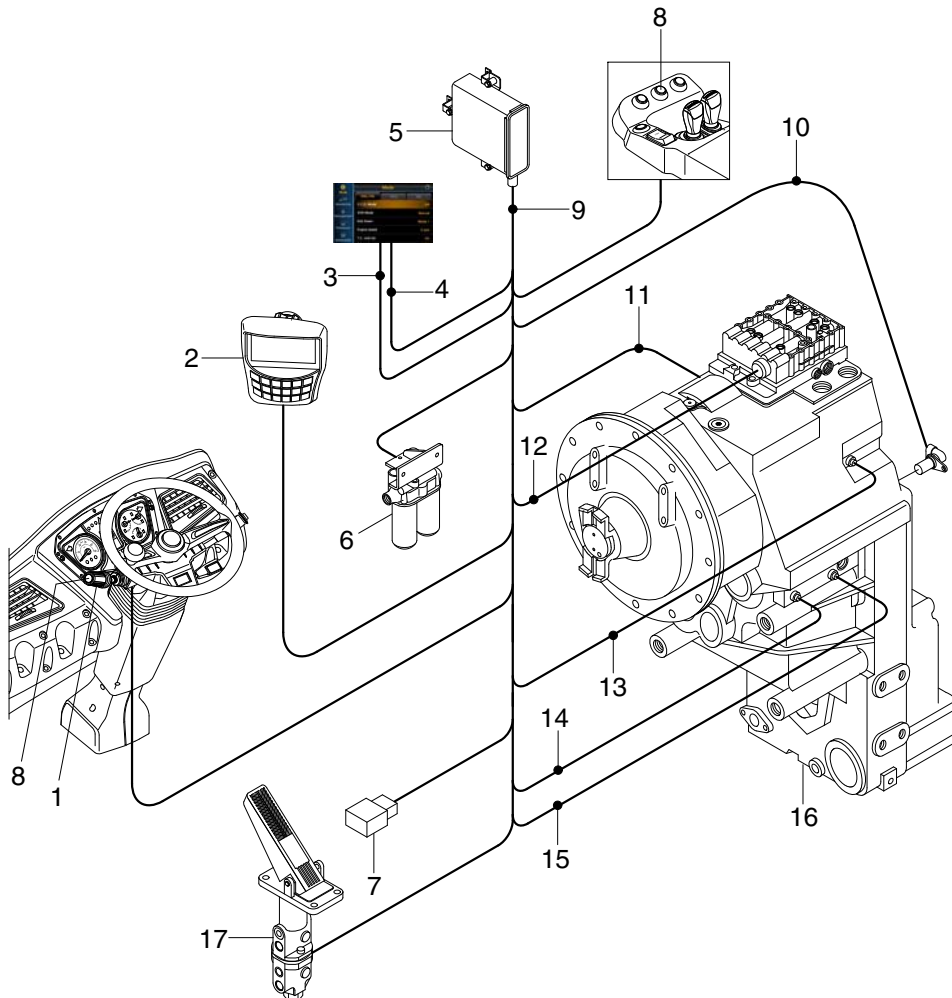
Position D - Driving.



73033TM17

## 6) ELECTRIC CONTROL UNIT

### (1) Complete system



980T33PT23

- 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

### (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-cycle 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 - forward 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 joystick 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 joystick 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 joystick 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	EHCUC sensor power voltage high
2328	1	EHCUC sensor power voltage low
2328	3	EHCUC sensor power voltage above normal or shorted to high source

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

### 1-3) AAVM FAULT CODE

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

## 2) ENGINE FAULT CODE

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

※ Some fault codes are not applied to this machine.

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

※ Some fault codes are not applied to this machine.

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

※ Some fault codes are not applied to this machine.

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

※ Some fault codes are not applied to this machine.



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

※ Some fault codes are not applied to this machine.

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

※ Some fault codes are not applied to this machine.

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

※ Some fault codes are not applied to this machine.

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

※ Some fault codes are not applied to this machine.

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

※ Some fault codes are not applied to this machine.

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

※ Some fault codes are not applied to this machine.

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

※ Some fault codes are not applied to this machine.

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

※ Some fault codes are not applied to this machine.



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

※ Some fault codes are not applied to this machine.

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

※ Some fault codes are not applied to this machine.

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

※ Some fault codes are not applied to this machine.

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

※ Some fault codes are not applied to this machine.

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

※ Some fault codes are not applied to this machine.

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

※ Some fault codes are not applied to this machine.

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

※ Some fault codes are not applied to this machine.

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

※ Some fault codes are not applied to this machine.



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

※ Some fault codes are not applied to this machine.

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

※ Some fault codes are not applied to this machine.

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

※ Some fault codes are not applied to this machine.

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

※ Some fault codes are not applied to this machine.

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

※ Some fault codes are not applied to this machine.

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

※ Some fault codes are not applied to this machine.

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

※ Some fault codes are not applied to this machine.

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

※ Some fault codes are not applied to this machine.



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

※ Some fault codes are not applied to this machine.

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

※ Some fault codes are not applied to this machine.

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

※ Some fault codes are not applied to this machine.

### 3) DEFINITION OF OPERATING MODES

#### (1) Normal

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

#### (2) Substitute clutch control

TCU can't change the gears or the direction under the control of the normal clutch modulation. TCU uses the substitute strategy for clutch control. All modulations are only time controlled. (Comparable with EST 25)

#### (3) Limp-home

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

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

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

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

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

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

#### (4) Transmission-shutdown

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

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

Transmission shifts to neutral.

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

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

#### (5) TCU-shutdown

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

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

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

The transmission will stay in neutral.

#### ※ Abbreviations

OC : Open circuit

SC : Short circuit

OP mode : Operating mode

TCU : Transmission control unit

EEC : Electronic engine controller

PTO : Power take off

#### 4) TRANSMISSION FAULT CODES

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 selector 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 <ul style="list-style-type: none"> <li>· Cable is defective and is contacted to battery voltage</li> <li>· Customer specific function No. 1 device has an internal defect</li> <li>· Connector pin is contacted to battery voltage</li> </ul>	Customer specific	<ul style="list-style-type: none"> <li>· Check the cable from TCU to customer specific function No. 1 device</li> <li>· Check the connectors from customer specific function No. 1 to TCU</li> <li>· Check the resistance of customer specific function No. 1 device</li> </ul>
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 <ul style="list-style-type: none"> <li>· Cable is defective and has no connection to TCU</li> <li>· Customer specific function No. 1 device has an internal defect</li> <li>· Connector has no connection to TCU</li> </ul>	Customer specific	<ul style="list-style-type: none"> <li>· Check the cable from TCU to customer specific function No. 1 device</li> <li>· Check the connectors from customer specific function No. 1 device to TCU</li> <li>· Check the resistance of customer specific function No. 1 device</li> </ul>
21	S.C. to battery voltage at clutch cut off input The measured voltage is too high: <ul style="list-style-type: none"> <li>· Cable is defective and is contacted to battery voltage</li> <li>· Clutch cut off sensor has an internal defect</li> <li>· Connector pin is contacted to battery voltage</li> </ul>	Clutch cut off function is disabled OP mode : Normal	<ul style="list-style-type: none"> <li>· Check the cable from TCU to the sensor</li> <li>· Check the connectors</li> <li>· Check the clutch cut off sensor</li> </ul>
22	S.C. to ground or O.C. at clutch cut off input The measured voltage is too low: <ul style="list-style-type: none"> <li>· Cable is defective and is contacted to vehicle ground</li> <li>· Cable has no connection to TCU</li> <li>· Clutch cut off sensor has an internal defect</li> <li>· Connector pin is contacted to vehicle ground or is broken</li> </ul>	Clutch cut off function is disabled OP mode : Normal	<ul style="list-style-type: none"> <li>· Check the cable from TCU to the sensor</li> <li>· Check the connectors</li> <li>· Check the clutch cut off sensor</li> </ul>
25	S.C. to battery voltage or O.C. at transmission sump temperature sensor input The measured voltage is too high: <ul style="list-style-type: none"> <li>· Cable is defective and is contacted to battery voltage</li> <li>· Cable has no connection to TCU</li> <li>· Temperature sensor has an internal defect</li> <li>· Connector pin is contacted to battery voltage or is broken</li> </ul>	No reaction, TCU use default temperature OP mode : Normal	<ul style="list-style-type: none"> <li>· Check the cable from TCU to the sensor</li> <li>· Check the connectors</li> <li>· Check the temperature sensor</li> </ul>

※ 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	Starting 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 <ul style="list-style-type: none"> <li>· Interference on CAN-Bus</li> <li>· CAN wire/connector is broken</li> <li>· CAN wire/connector is defective and has contact to vehicle ground or battery voltage</li> </ul>	No reaction, TCU uses default signal accelerator pedal in idle position OP mode : Normal	<ul style="list-style-type: none"> <li>· Check EEC controller</li> <li>· Check wire of CAN-Bus</li> <li>· Check cable to EEC controller</li> </ul>
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 <ul style="list-style-type: none"> <li>· Cable/connector is defective and has contact to battery voltage</li> <li>· Cable/connector is defective and has contact to another regulator output of the TCU</li> <li>· Regulator has an internal defect</li> </ul>	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	<ul style="list-style-type: none"> <li>· Check the cable from TCU to the gearbox</li> <li>· Check the connectors from TCU to the gearbox</li> <li>· Check the regulator resistance*</li> <li>· Check internal wire harness of the gearbox</li> </ul> <p>* See page 3-77</p>
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 <ul style="list-style-type: none"> <li>· Cable/connector is defective and has contact to vehicle ground</li> <li>· Regulator has an internal defect</li> </ul>	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	<ul style="list-style-type: none"> <li>· Check the cable from TCU to the gearbox</li> <li>· Check the connectors from gearbox to TCU</li> <li>· Check the regulator resistance*</li> <li>· Check internal wire harness of the gearbox</li> </ul> <p>* See page 3-77</p>
73	O.C. at clutch K1 The measured resistance value of the valve is out of limit <ul style="list-style-type: none"> <li>· Cable/connector is defective and has no contact to TCU</li> <li>· Regulator has an internal defect</li> </ul>	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	<ul style="list-style-type: none"> <li>· Check the cable from TCU to the gearbox</li> <li>· Check the connectors from gearbox to TCU</li> <li>· Check the regulator resistance*</li> <li>· Check internal wire harness of the gearbox</li> </ul> <p>* See page 3-77</p>
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 <ul style="list-style-type: none"> <li>· Cable/connector is defective and has contact to battery voltage</li> <li>· Cable/connector is defective and has contact to another regulator output of the TCU</li> <li>· Regulator has an internal defect</li> </ul>	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	<ul style="list-style-type: none"> <li>· Check the cable from TCU to the gearbox</li> <li>· Check the connectors from gearbox to TCU</li> <li>· Check the regulator resistance*</li> <li>· Check internal wire harness of the gearbox</li> </ul> <p>* See page 3-77</p>
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 <ul style="list-style-type: none"> <li>· Cable/connector is defective and has contact to vehicle ground</li> <li>· Regulator has an internal defect</li> </ul>	TCU shifts to neutral OP mode : Limp home If failure at another clutch is pending TCU shifts to neutral OP mode : TCU shutdown	<ul style="list-style-type: none"> <li>· Check the cable from TCU to the gearbox</li> <li>· Check the connectors from gearbox to TCU</li> <li>· Check the regulator resistance*</li> <li>· Check internal wire harness of the gearbox</li> </ul> <p>* See page 3-77</p>

※ 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 3-77
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 3-77
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 3-77
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 3-77
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 3-77
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 3-77

※ 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 3-77
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 3-77
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 3-77
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 3-77
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 3-77
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 3-77

※ 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 3-77
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 3-77
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 3-77
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 3-77
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 3-77
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 3-77

※ 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 3-77
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 3-77
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 3-77
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 3-77
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 3-77

※ 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 3-77
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 3-77
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 3-77
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 3-77
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 3-77

※ 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 3-77
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 3-77
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 3-77
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 <ul style="list-style-type: none"> <li>· Low pressure at converter lockup clutch</li> <li>· Low main pressure</li> <li>· Wrong signal at engine speed sensor</li> <li>· Wrong signal at turbine speed sensor</li> <li>· Wrong size of the sensor gap</li> <li>· Clutch is defective</li> </ul>	No reaction OP mode : Normal	<ul style="list-style-type: none"> <li>· Check pressure at converter lockup clutch</li> <li>· Check main pressure in the system</li> <li>· Check sensor gap at engine speed sensor</li> <li>· Check sensor gap at turbine speed sensor</li> <li>· Check signal at engine speed sensor</li> <li>· Check signal at turbine speed sensor</li> <li>· Replace clutch</li> </ul>
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	<ul style="list-style-type: none"> <li>· Cool down machine</li> <li>· Check oil level</li> <li>· Check temperature sensor</li> </ul>
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 <ul style="list-style-type: none"> <li>· Cable is defective and is contacted to vehicle ground</li> <li>· Joystick status indicator has an internal defect</li> <li>· Connector pin is contacted to vehicle ground</li> </ul>	No reaction OP mode : Normal	<ul style="list-style-type: none"> <li>· Check the cable from TCU to joystick status indicator</li> <li>· Check the connectors from joystick status indicator to TCU</li> <li>· Check the resistance* of joystick status indicator</li> </ul> <p>* See page 3-77</p>
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 <ul style="list-style-type: none"> <li>· Cable is defective and is contacted to battery voltage</li> <li>· Joystick status indicator has an internal defect</li> <li>· Connector pin is contacted to battery voltage</li> </ul>	No reaction OP mode : Normal	<ul style="list-style-type: none"> <li>· Check the cable from TCU to joystick status indicator</li> <li>· Check the connectors from joystick status indicator to TCU</li> <li>· Check the resistance* of joystick status indicator</li> </ul> <p>* See page 3-77</p>

※ 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

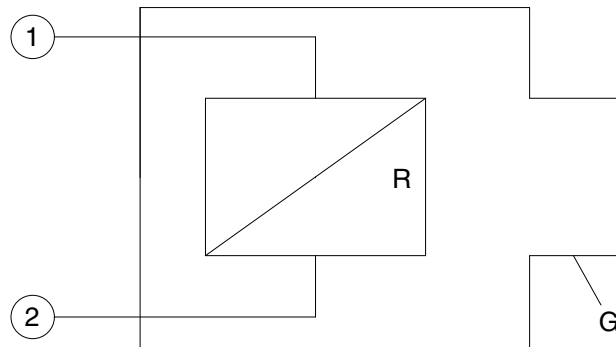
※ Some fault codes are not applied to this machine.

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

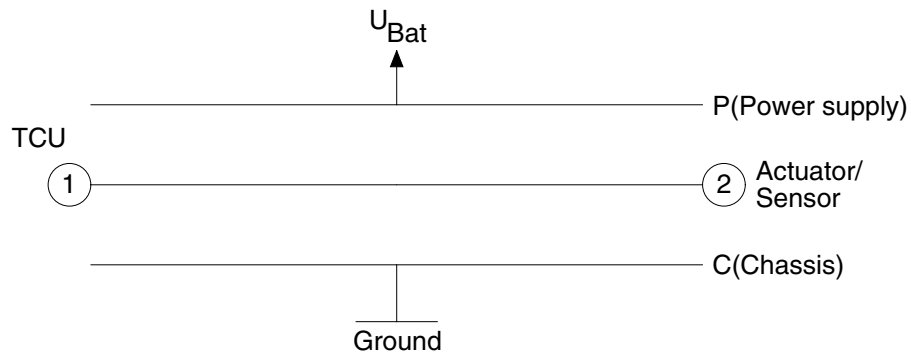
### (1) Actuator



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

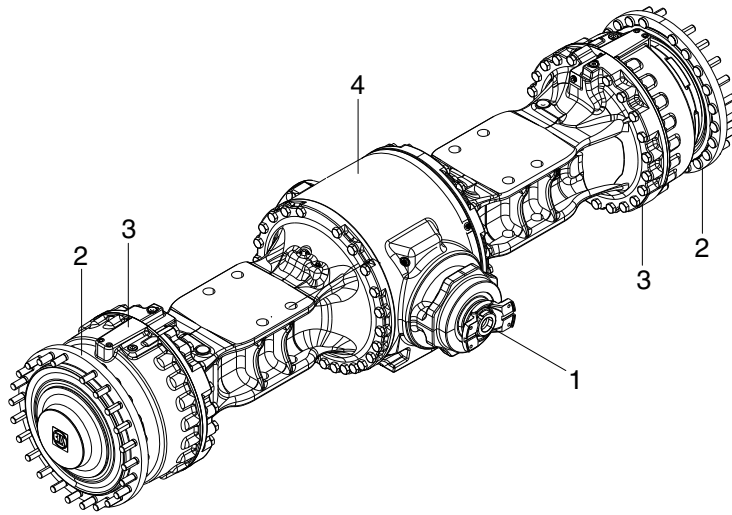
- Open circuit  $R_{12} = R_{1P} = R_{1C} = R_{2P} = R_{2C} = \infty$   
 Short cut to ground  $R_{12} = 0$ ;  $R_{1C} = R_{2C} = 0$ ,  $R_{1P} = R_{2P} = \infty$   
 Short cut to battery  $R_{12} = 0$ ;  $R_{1C} = R_{2C} = 0$ ,  $R_{1P} = R_{2P} = 0$

## 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



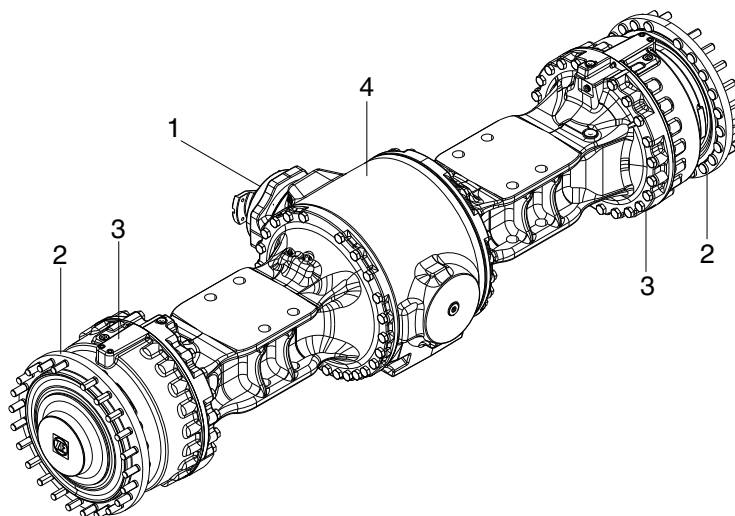
78093PT14

1 Input  
4 Axle housing

2 Output

3 Brake

#### (2) Rear axle



78093PT15

1 Input  
4 Axle housing

2 Output

3 Brake

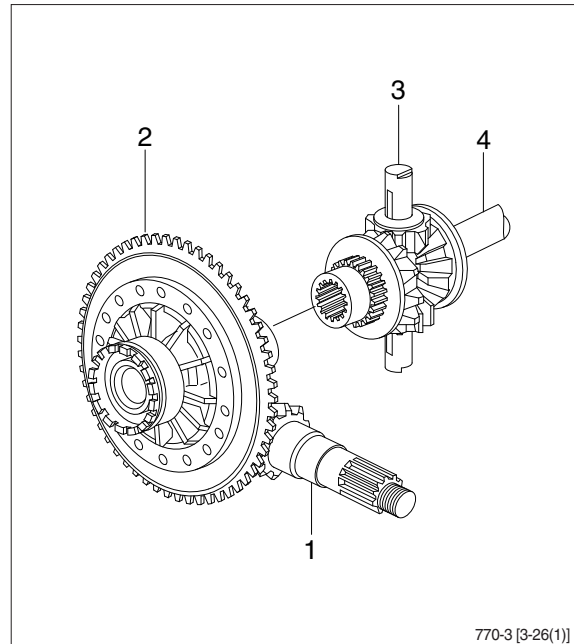
## 2) DIFFERENTIAL

### (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 at different speeds, during a turn.

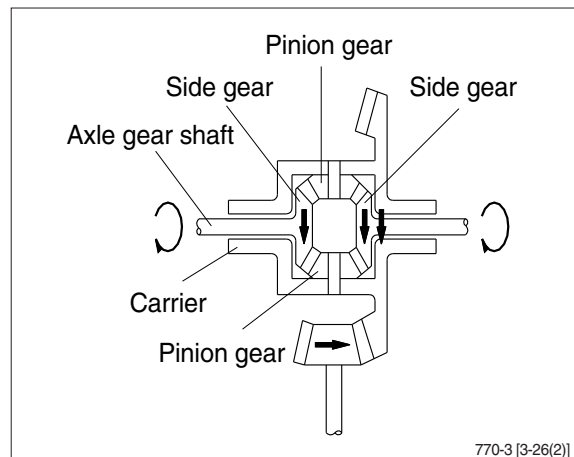
The power from the drive shaft passes through bevel pinion (1) and is transmitted to the bevel gear (2). The bevel gear changes the direction of the motive force by 90 degree, and at the same time reduces the speed.

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



### (2) When driving straight forward

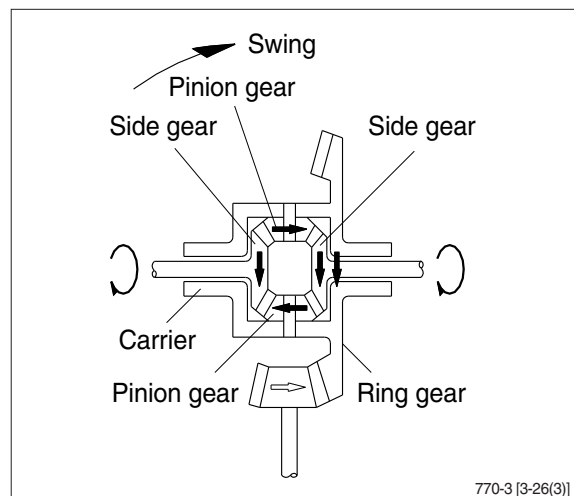
When the machine is being driven straight forward and the right and left wheels are rotating at the same speed, so the pinion gear inside the differential assembly do not rotate. The motive force of the carrier is sent through the pinion gear and the side gear, therefore the power is equally transmitted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



### (3) When turning

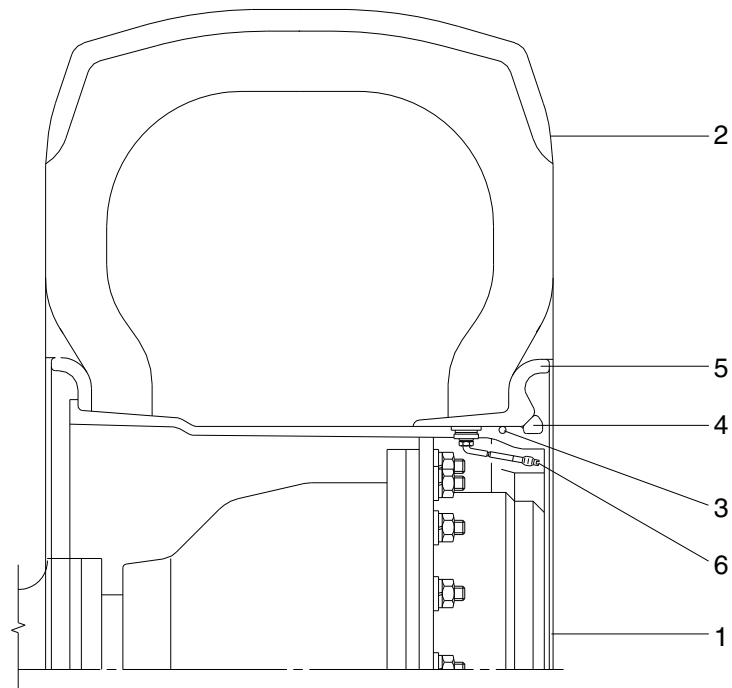
When turning, the rotating speed of the left and right wheels is different, so the pinion gear and side gear inside the differential assembly rotate in accordance with the difference between the rotating speed of the left and right wheels.

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





## 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.



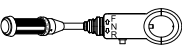

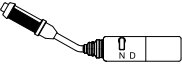



At the end of each check, if no problem is found(OK), that check is complete or an additional check is needed. If problem is indicated(NOT OK), you will be given repair required and group location.

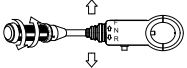
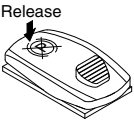



If verification is needed, you will be given next best source of information :

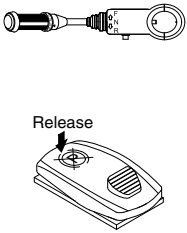
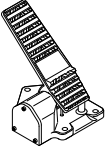
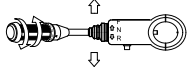
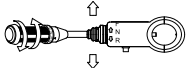
Chapter 2 : Troubleshooting

Group 3 : Tests and adjustments

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

Item	Description	Service action
<b>Transmission oil warm-up procedure</b>	 <p>Start engine. Apply service brakes and release parking brake.</p> <p>Select T/M shift mode to MANUAL mode.</p> <p>Move gear selector lever to 3rd speed.</p> <p>Move gear selector lever to forward "F" position.</p>  <p>Increase engine speed to high idle for 30 seconds.</p>  <p>Move gear selector lever to neutral "N" position and run for 15 seconds.</p> <p>Repeat procedure until transmission temperature gauge arrow points to bar above dial.</p>	<p><b>OK</b> Check completed.</p>
<b>Gear selector lever and neutral lock latch checks</b> Engine OFF.	 <p>Move gear selector lever to each position.</p> <p><b>NOTE</b> : Gear selector lever position changes slightly as steering column is tilted.</p> <p><b>FEEL</b> : Lever must move freely through all positions.</p>  <p>Engage neutral lock.</p> <p>Apply slight effort to move lever into forward (F) and reverse (R).</p> <p><b>LOOK</b> : Neutral lock must stay engaged.</p>	<p><b>OK</b> Check completed.</p> <p><b>NOT OK</b> Repair lock or replace switch.</p>
<b>Automatic shifting check</b>	 <p>Start engine.</p> <p>Move gear selector lever to 4th speed.</p> <p>Select T/M shift mode to AL (auto light) mode.</p>  <p><b>LOOK</b> : Automatic sign on cluster.</p> <p>Move gear selector lever to forward or reverse position.</p>  <p>Increase engine rpm.</p> <p><b>LOOK</b> : Speed on cluster must vary with machine speed.</p>	<p><b>OK</b> Check completed.</p> <p><b>NOT OK</b> Go to transmission fault code group at page 3-60~3-76. Repair or replace the monitor or harness.</p>

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

Item	Description	Service action
<p><b>Forward, reverse and 4th speed clutch pack drag check</b>            ※ <b>Transmission must be warmed up for this check.</b>            Engine running.</p>	  <p>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.  <b>LOOK</b> : Unit must not move in either direction.  <b>NOTE</b> : If unit moves forward, either the forward pack or the 4th speed pack is dragging.</p>	<p><b>OK</b>            Check completed.  <b>NOT OK</b>            If unit moves, repair transmission.</p>
<p><b>Transmission shift modulation check</b>            Engine running.</p>	 <p>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.  <b>LOOK</b> : Unit must slow down and change direction smoothly.</p>	<p><b>OK</b>            Check completed.  <b>NOT OK</b>            Go to unit shifts too fast, chapter 2 in this group.</p>
<p><b>Torque converter check</b></p>	 <p>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.  <b>LOOK</b> : Torque converter stall rpm must be within the following range.            Stall rpm : <math>2050 \pm 70</math> rpm            Move gear selector control lever to neutral "N" position and run for 15 seconds.</p>	<p><b>OK</b>            Check completed.  <b>NOT OK</b>            If stall rpm are too low or too high, problem may be engine power or torque converter.  <b>IF OK</b>            Replace transmission torque converter.</p>

## 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	<p>Low oil level.</p> <p>Wrong oil grade.</p> <p>Restricted transmission pump suction screen.</p> <p>Leak in transmission control valve or gasket.</p> <p>Low transmission pump flow due to worn pump.</p> <p>Weak or broken pressure regulating valve spring.</p>	<p>Add oil.</p> <p>Change oil.</p> <p>Remove and clean screen.</p> <p>Remove valve and inspect gaskets.</p> <p>Do transmission pump flow test.</p> <p>Do transmission system pressure test.</p>
Error code on display	Something wrong in transmission.	Go to transmission fault code group at page 3-60~3-76.

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

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



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

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

Problem	Cause	Remedy
Torque converter stall RPM too low	Low engine power. Mechanical malfunction.	Do engine power test. Remove and inspect torque converter.
Transmission pressure light comes ON when shifting from forward to reverse (all other gears OK)	Low oil level. Cold oil. Leak in reverse pack.	Add oil. Warm oil to specification. Do transmission pressure, pump flow, and leakage check.
Transmission pressure light comes ON for each shift	Cold oil. No time delay in monitor. Restriction in modulation orifice. Stuck PPC valve. Low transmission pressure circuit. Leak in transmission pressure circuit. Failed transmission pump. Clogged filter.	Warm oil to specification. Do monitor check. Remove orifice and inspect for restriction and/or plugging. Remove and inspect. Do transmission system pressure test. Do converter out pressure test. Do transmission pump flow test. 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. Incorrect type of oil. Dragging brakes. Failed pinion bearing. Incorrect gear mesh pattern between ring and pinion gear. Failed differential pinion gears and/or cross shafts. Failed axle bearing. Mechanical failure in axle planetary.	Check oil. Remove drain plug and inspect for metal particles in differential case. Disassemble and determine cause. Change oil Do brake check. Remove and inspect pinion. Check to ensure pinion housing was indexed. Remove pinion gear housing and inspect ring and pinion gear. Remove differential housing drain plug and inspect for metal particles. Disassemble and inspect. Do axle bearing adjustment check. Remove differential. Inspect, repair.
Oil seeping from outer axle seal	Excessive end play in axle. Worn outer bearing and/or cup. Overfilled differential.	Do axle bearing adjustment check. Disassemble and inspect outer axle bearing, cup, spacer, and seal. Replace, if necessary. Check differential oil return system for excessive internal restriction.
Axle overheats	Low differential oil. Overfilled differential. Brake drag.	Add oil. See differential overfills with oil in this group. See brakes drag in this group.

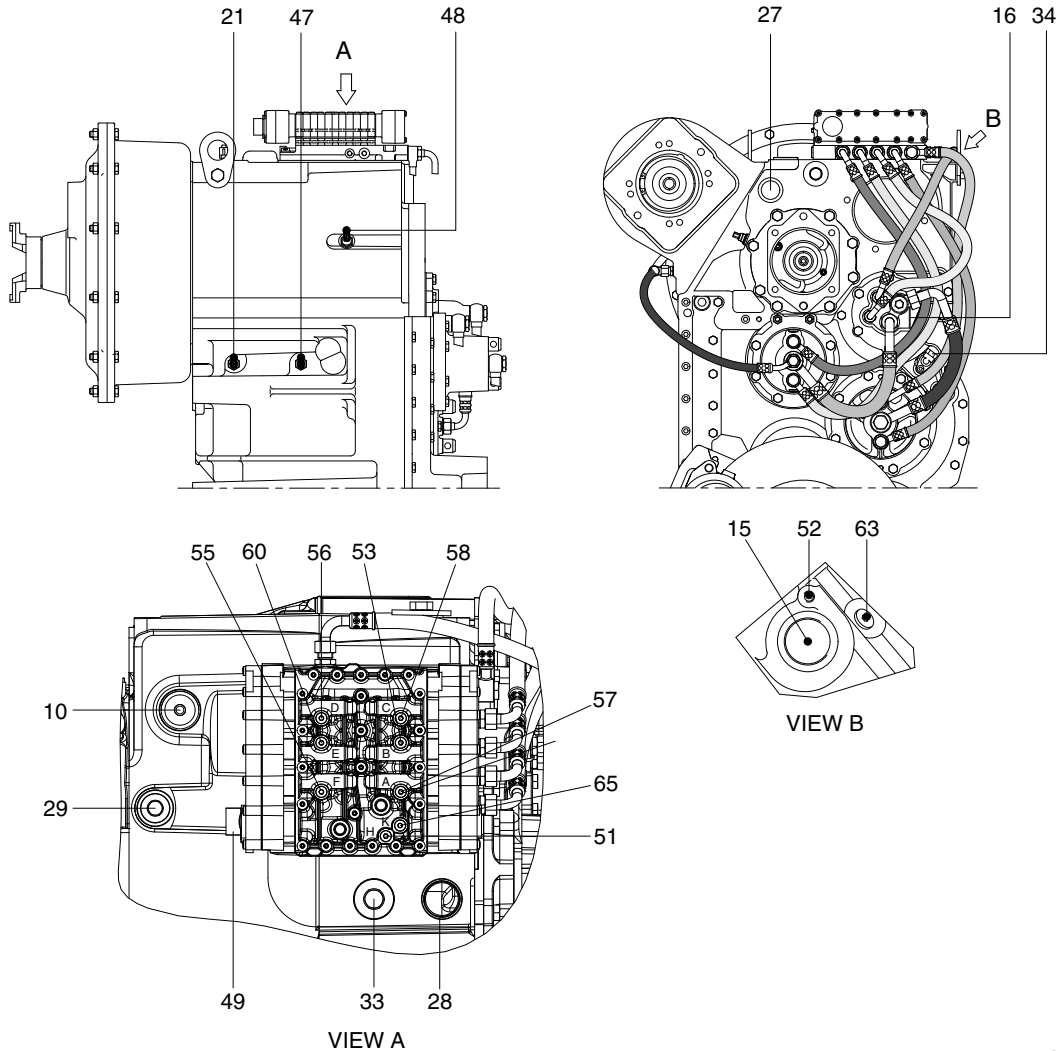
### 3) DRIVE LINE

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).



980T33PT17

#### 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

## 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

## GROUP 4 DISASSEMBLY AND ASSEMBLY

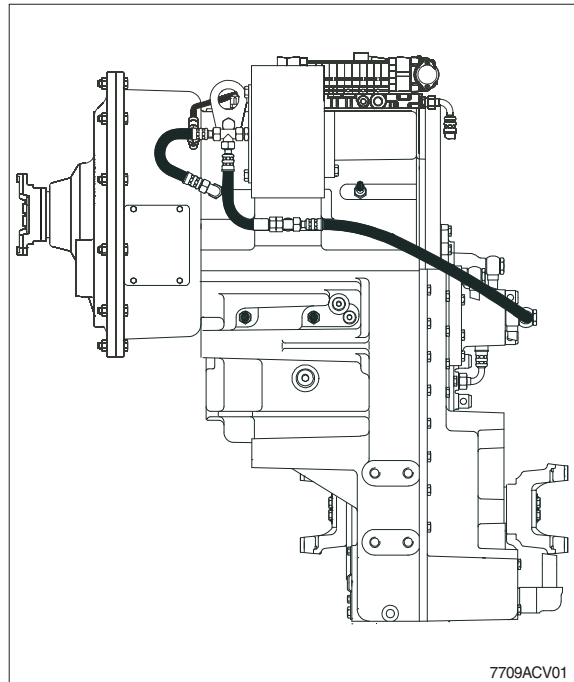
### 1. CONTROL VALVE

#### 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.

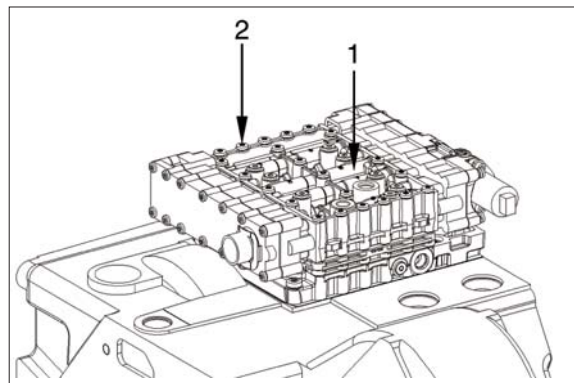


7709ACV01

#### Removal of electric gear-shift control

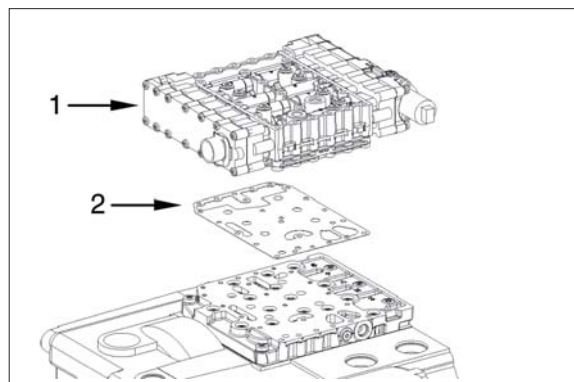
(2) Remove all oil pipes.  
Remove gear-shift control (1).  
Loosen torx screws (2).

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



7709ACV02

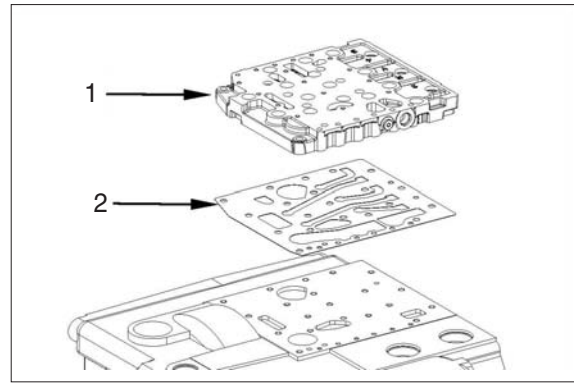
(3) Remove gear-shift control assy (1) and gasket (2).



7709ACV03

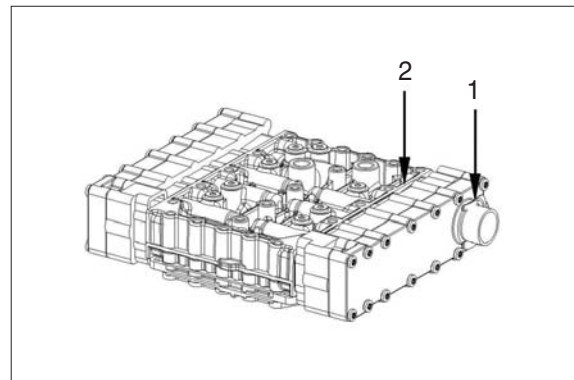


- (4) Loosen torx screws and separate duct plate (1) and gasket (2) from gearbox housing.



7709ACV04

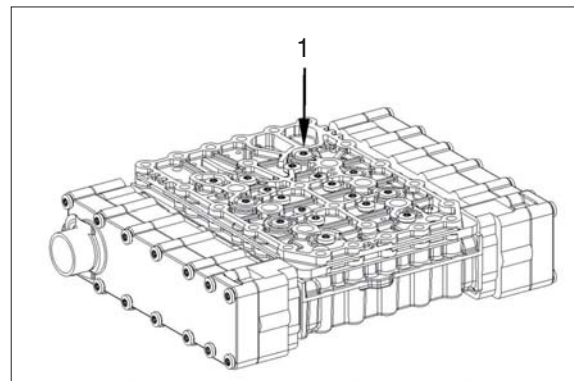
- (5) Mark installation position of wiring harness (1) towards valve block (2).



7709ACV05

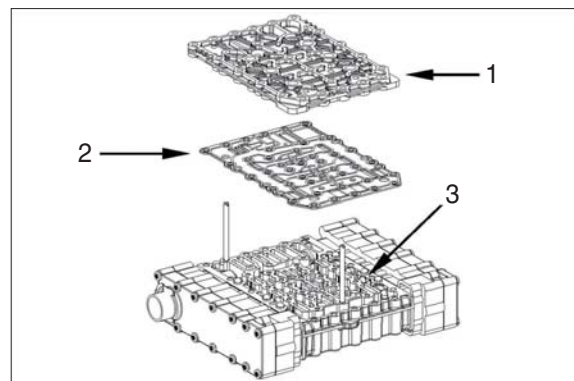
- (6) Loosen torx screws (1).

Socket wrench TX-27      5873 042 002



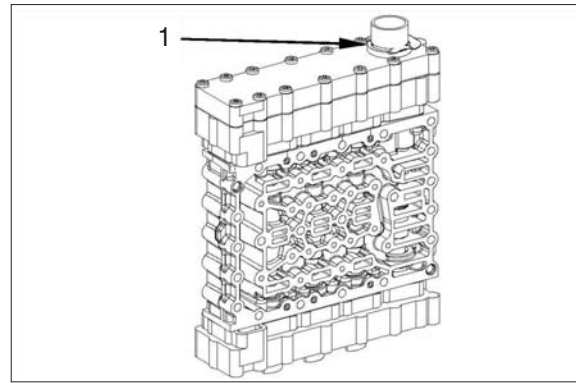
7709ACV06

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



7709ACV07

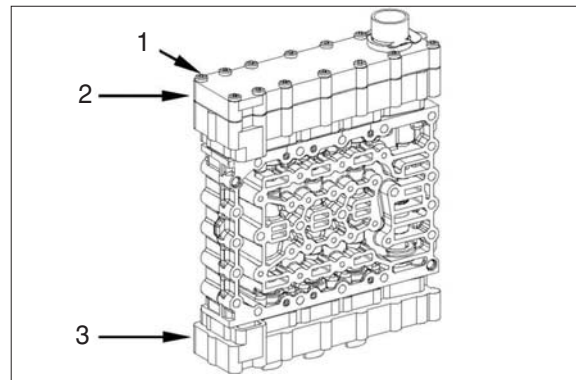
(8) Remove retaining clamp (1).



7709ACV08

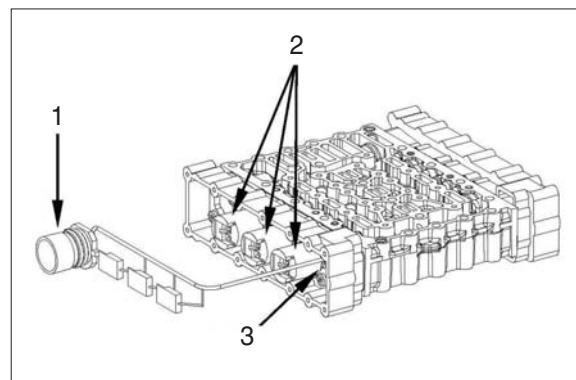
(9) Loosen torx screws (2) and remove cover (2). Remove opposite cover (3) in the same way.

Socket wrench TX-27      5873 042 002



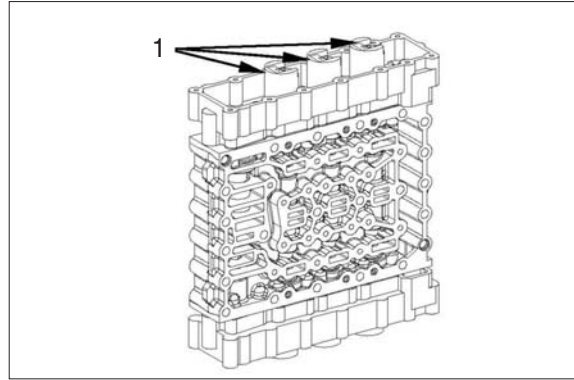
7709ACV09

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



7709ACV10

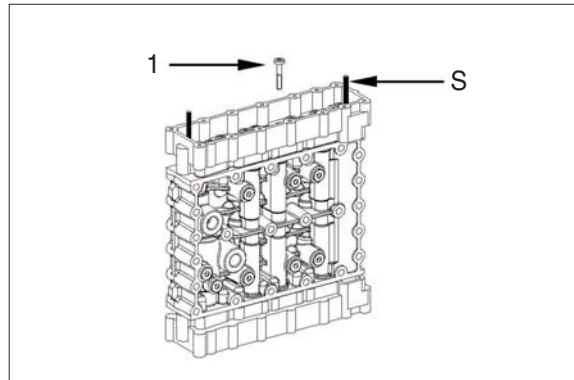
(11) Loosen cylindrical screws, remove fixing plates and remove pressure controllers (1) on opposite side.



7709ACV12

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

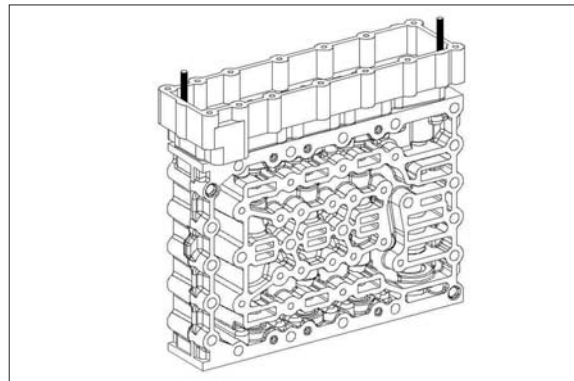
Adjusting screws                      5870 204 036



7709ACV13

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

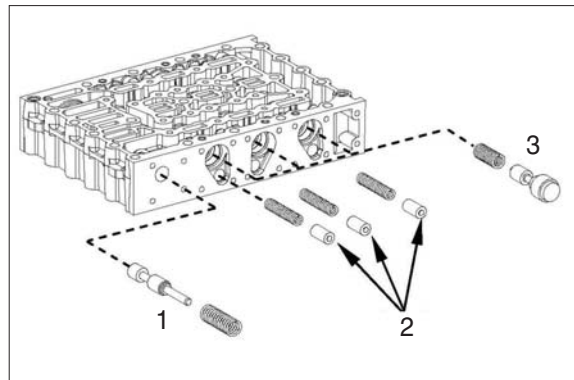
Adjusting screws                      5870 204 036



7709ACV14

(14) Remove individual parts :

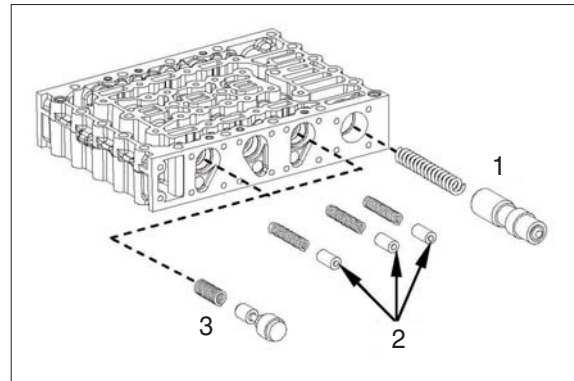
- 1 Pressure reducing valve
- 2 Vibration dampers
- 3 Follow-on silde



7709ACV15

(15) Remove individual parts of opposite side analogously :

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

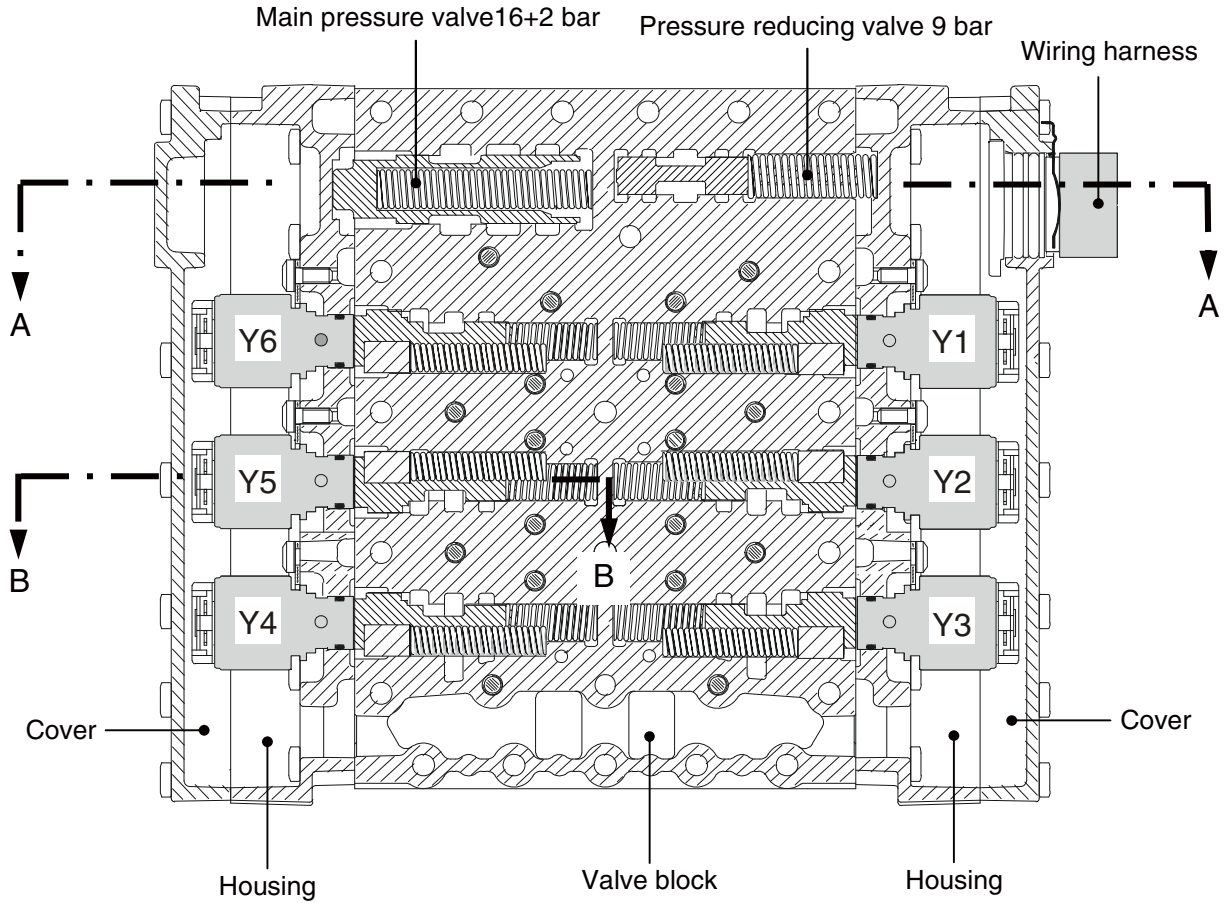


7709ACV16

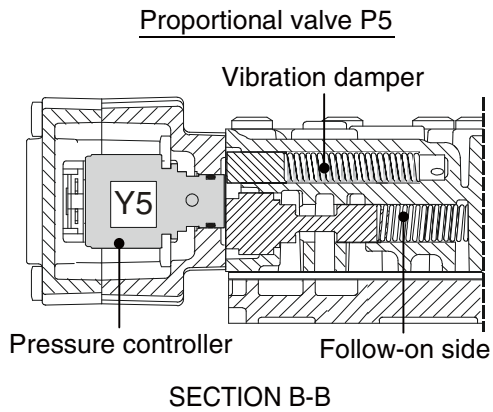
## 2) REASSEMBLY

### Electro-hydraulic control with proportional valves :

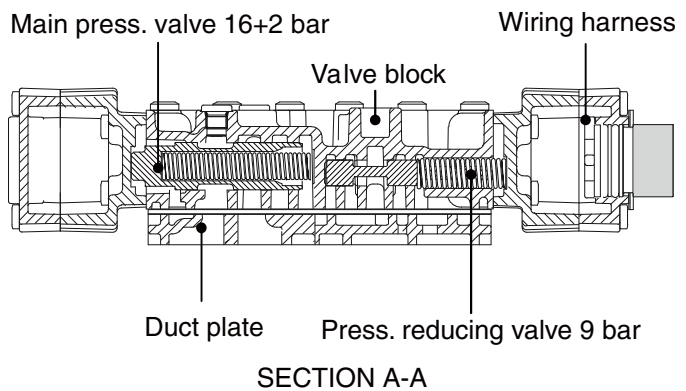
※ The following sketches show the sectional views of the electro-hydraulic control.



7709ACV17



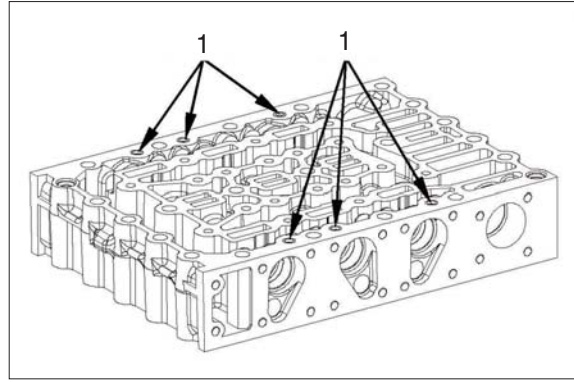
7709ACV18



7709ACV19

**(1) Fitting of electric control**

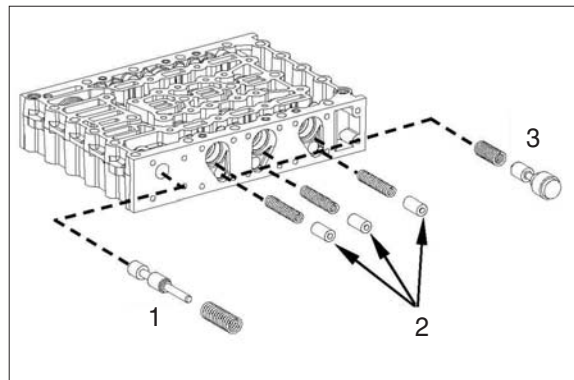
- ※ All single parts are to be checked for damage and replaced, if required. Ensure free travel of the moving parts in the valve block prior to installation. Pistons can be exchanged individually. Prior to the installation, oil single part.
- ① With the concave side showing upwards, insert orifice (1) until contact is obtained.
- ※ See arrows for installation position.



7709ACV20

- ② The opposite figure shows the following single parts :

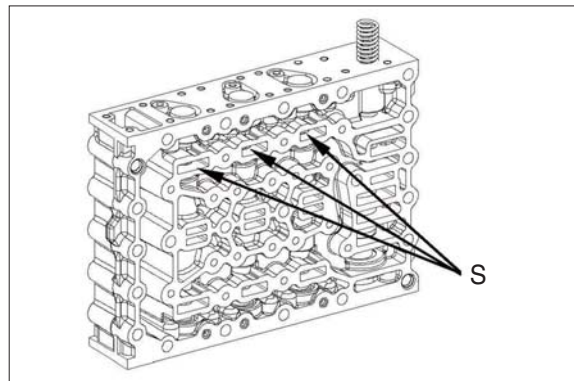
- 1 Pressure reducing valve (1EA, piston and compression spring)
- 2 Vibration damper (3EA, piston and compression spring)
- 3 Follow-on slide (3EA, piston and compression spring)



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  $\varnothing 5.0$  mm (assembly aid), see arrows (S).

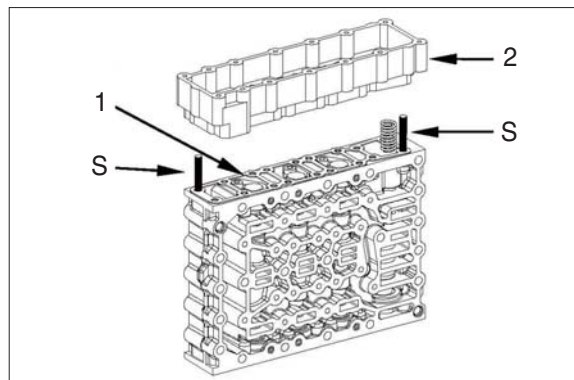


7709ACV22

- ④ Fit two adjusting screws.

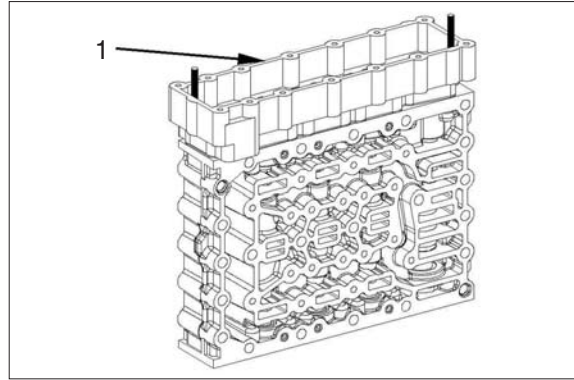
Mount seal (1) and housing (2). Then position housing equally by means of adjusting screws until contact is obtained.

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).

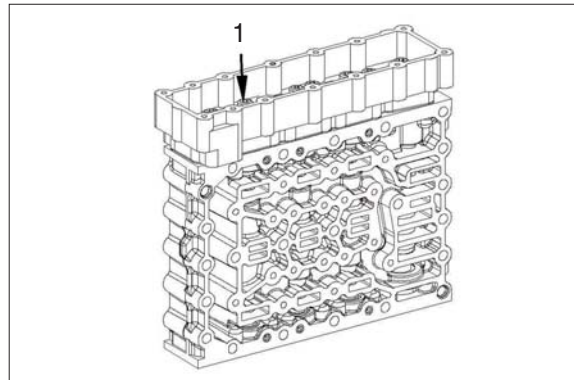


7709ACV24

- 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



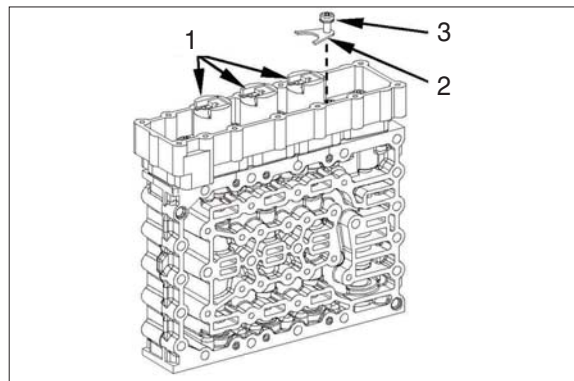
7709ACV25

- ⑦ Mount 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

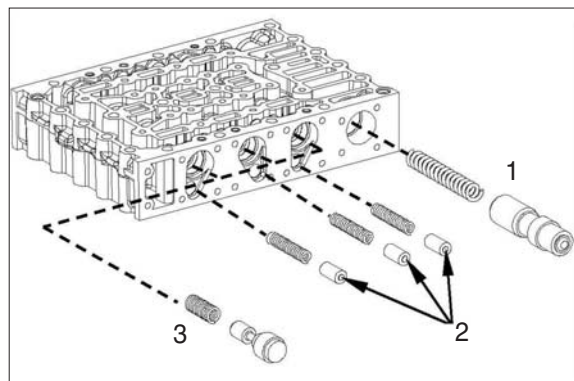


7709ACV26

### 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

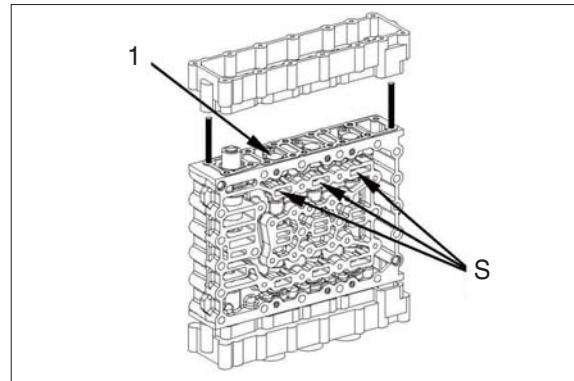
⑨ Install the single parts according to figure CV27.

※ Preload the compression springs of the follow-on slides and fasten the pistons preliminarily by means of cylindrical pins (S)  $\varnothing 5.0$  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.

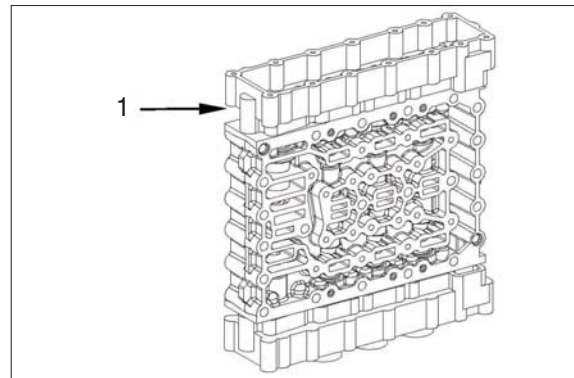
Then fasten the housing cover by means of torx screws (1).

· Tightening torque (M5/10.9 $\times$ 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



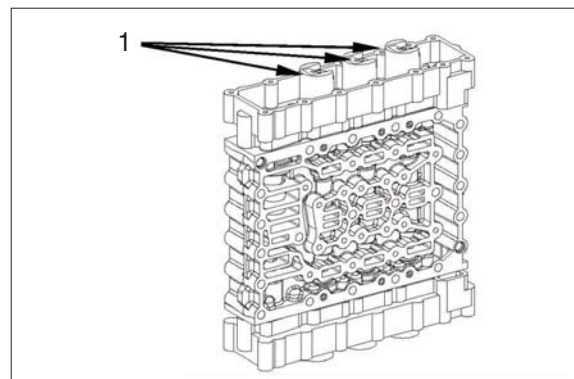
7709ACV29

⑪ Mount the pressure regulators with O-ring 13.5 $\times$ 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 $\times$ 12) :  
0.56 kgf · m (4.06 lbf · ft)

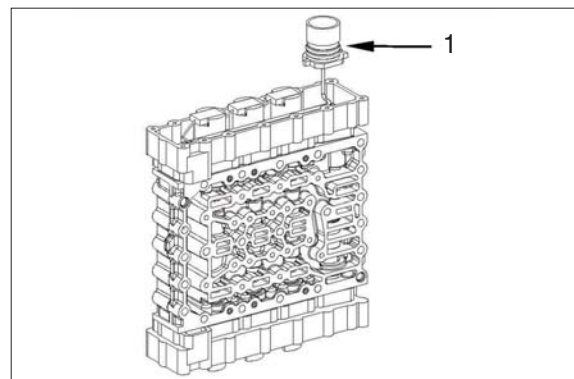


7709ACV30

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).

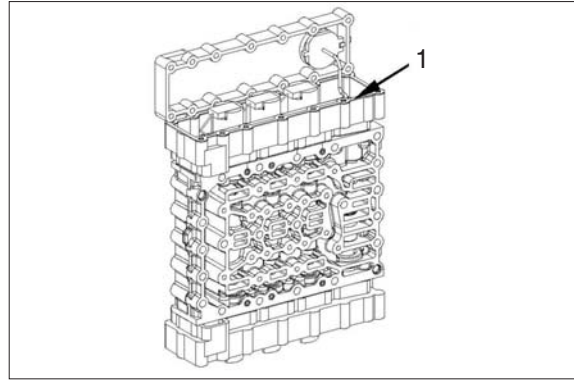
Assemble the plug socket with the slot showing to the lug of the cover until contact.

Fasten the cover by means of cap screws.

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

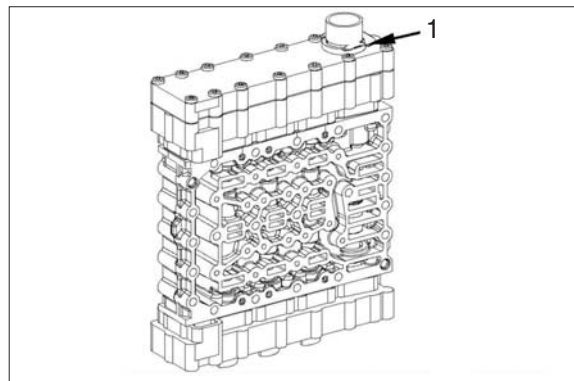
Reducer 5870 656 056

Socket spanner TX-27 5873 042 002



7709ACV32

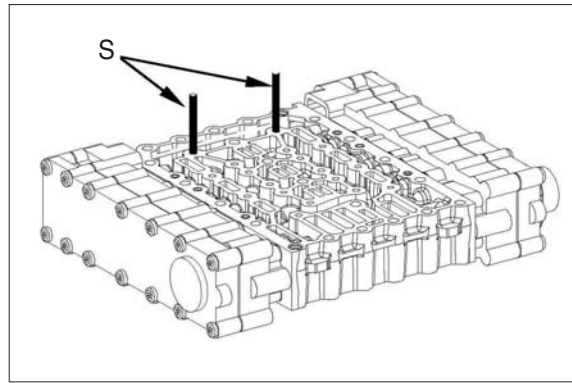
- ⑭ Fix the wiring harness by means of retaining clamp (1).



7709ACV33

⑮ Install two adjusting screws (S).

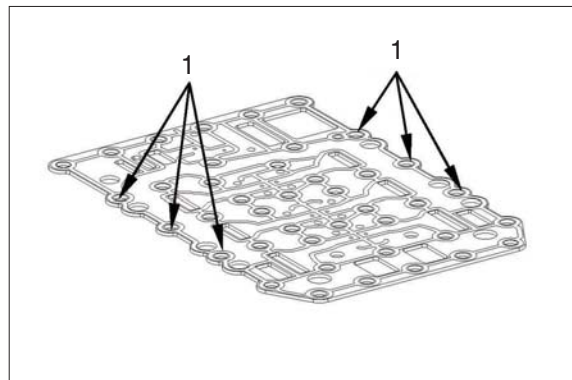
Adjusting screws 5870 204 063



7709ACV36

⑯ 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).

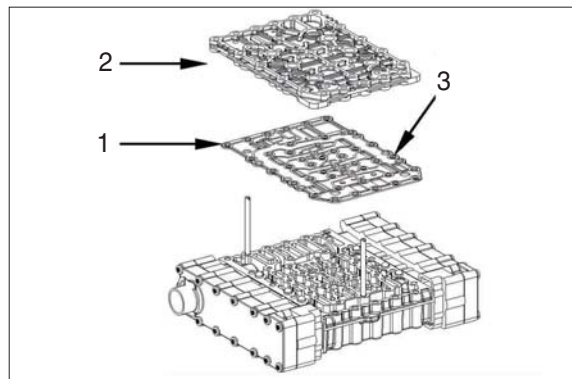


7709ACV37

⑰ 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.

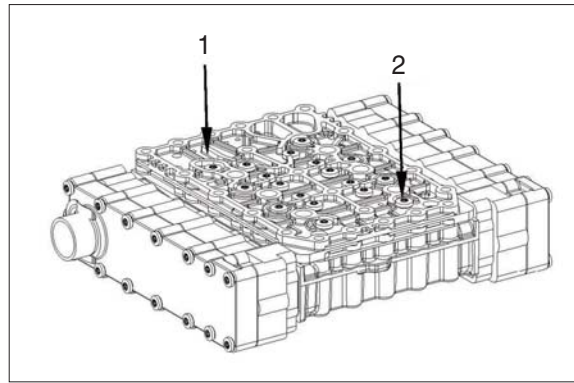


7709ACV38

- ⑱ 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)

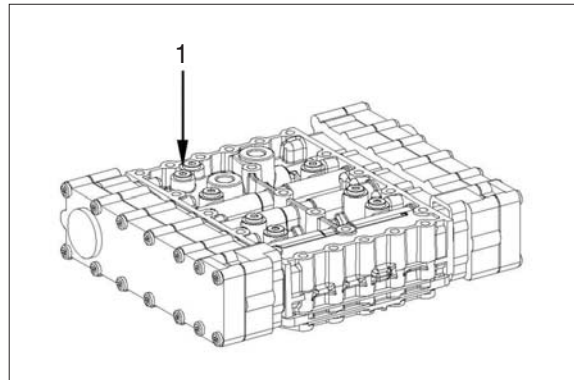
Socket wrench TX-27      5873 042 002



7709ACV39

- ⑲ 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)

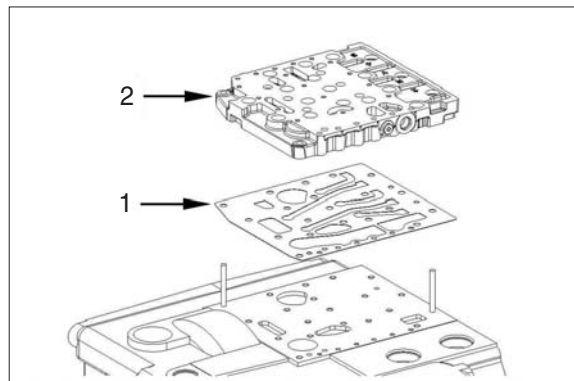


7709ACV40

- ⑳ 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

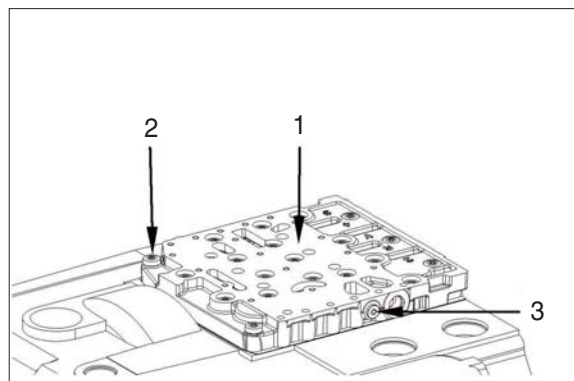
- ㉑ Fix duct plate (1) by means of torx screws (2).

· 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



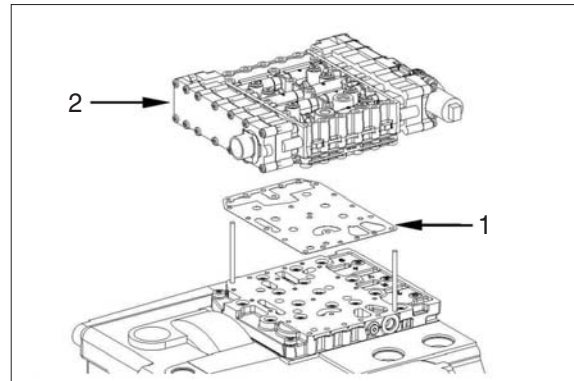
7709ACV42

② 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.



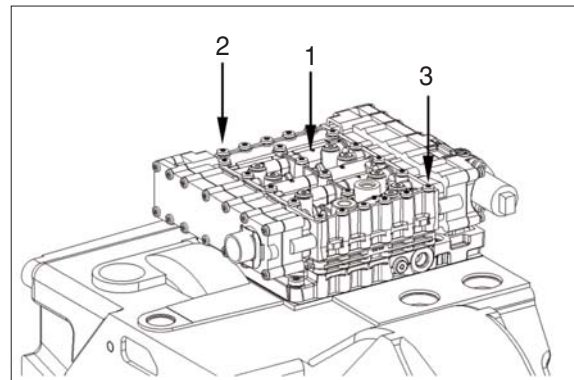
7709ACV43

③ 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)

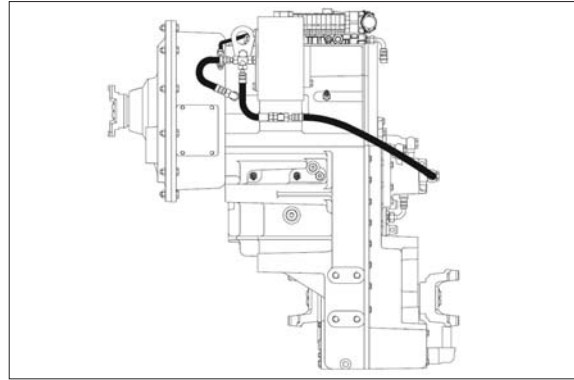
Socket wrench TX-27        5873 042 002

Reducing adapter            5870 656 056



7709ACV44

※ 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.

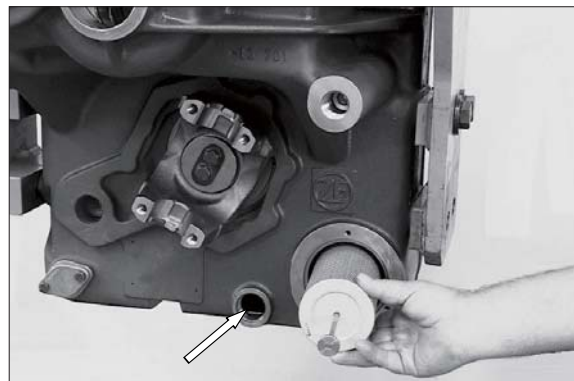


Figure 2

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

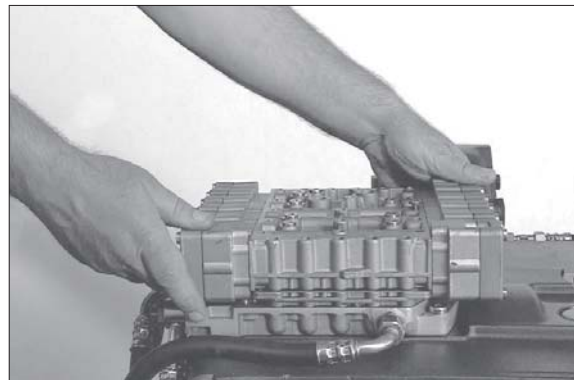


Figure 3

### 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 converter 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.



Figure 10

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



Figure 11

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



Figure 12



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

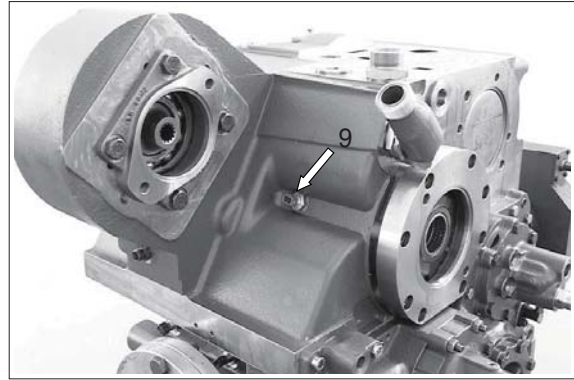


Figure 13

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

- (1) Loosen the cap screw.

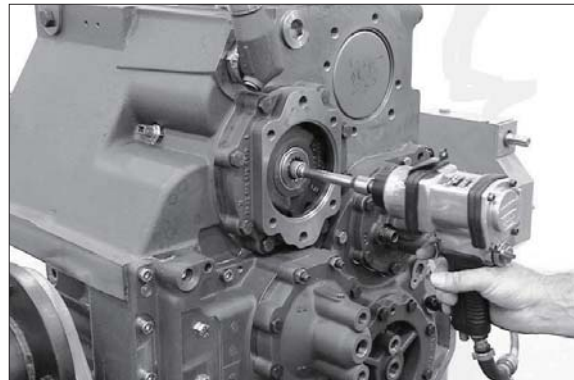


Figure 21

- (2) Remove the cap screw and clamping plate.

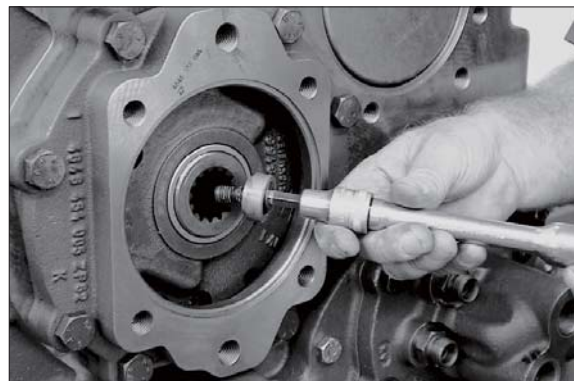


Figure 22

- (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).

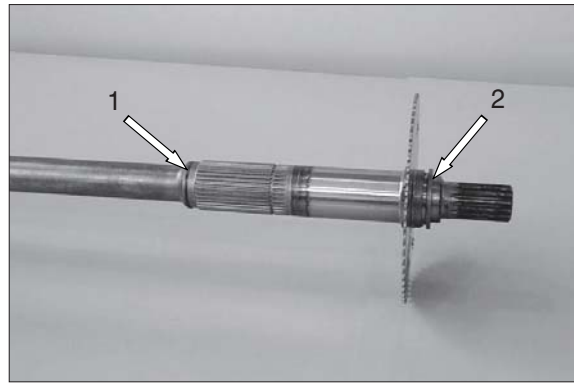


Figure 24

### Transmission pump

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

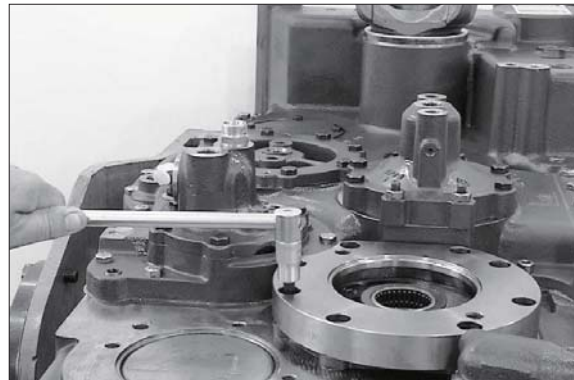


Figure 25

- (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

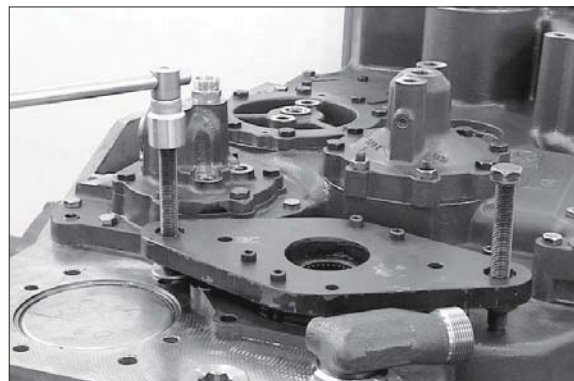


Figure 26

### 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.

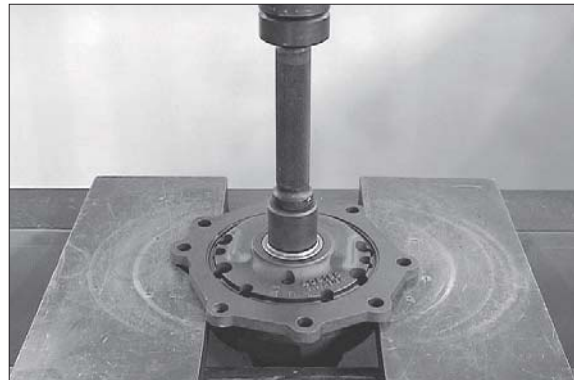


Figure 29

(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).

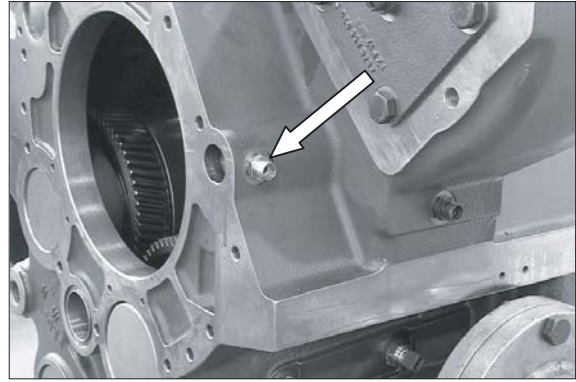


Figure 31

(8) Sealing cap is to be drilled centrally 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

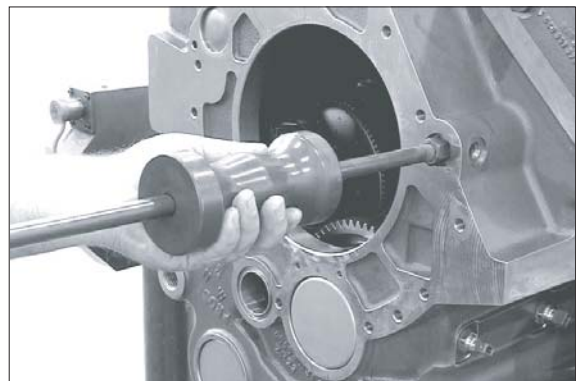


Figure 33

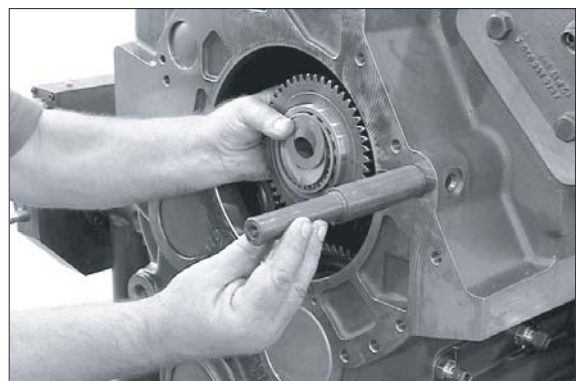


Figure 34

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

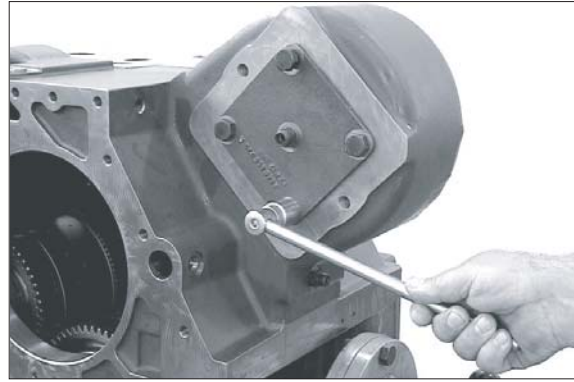


Figure 35

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

Clamping pliers                      5870 900 021

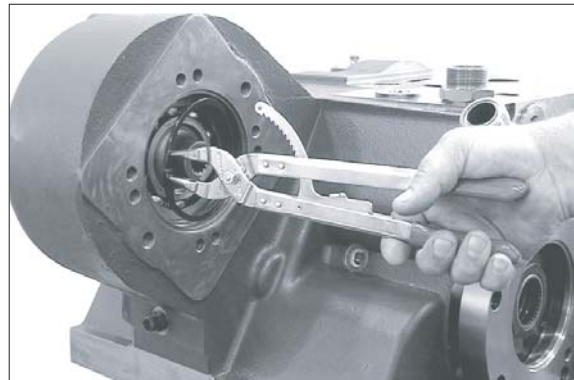


Figure 36

(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

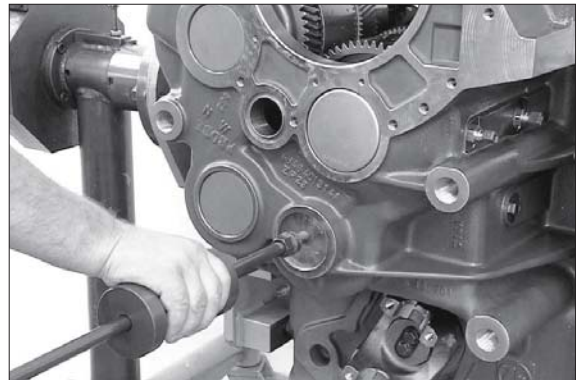


Figure 39

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

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

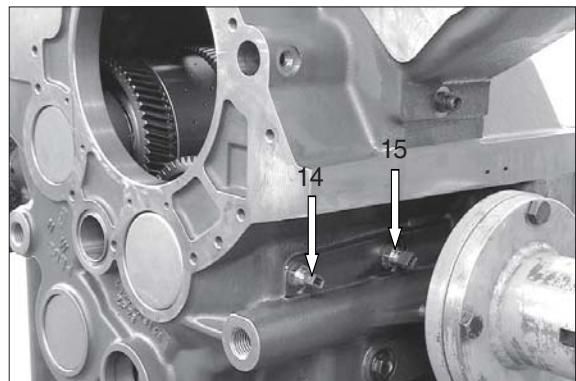


Figure 40

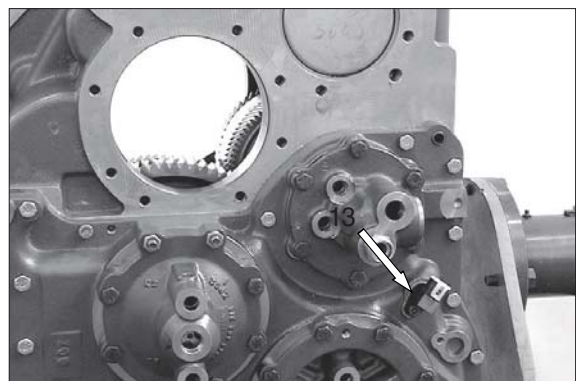


Figure 41

## 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 rear side.



Figure 42

## Transmission rear side

**▲** 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.

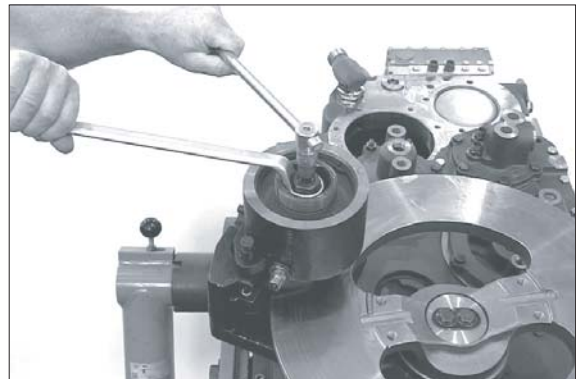


Figure 44

(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

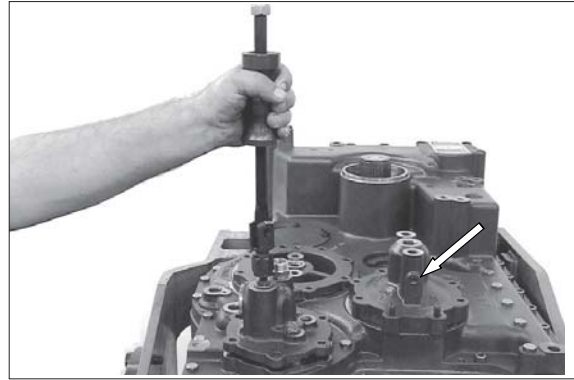


Figure 46

- (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

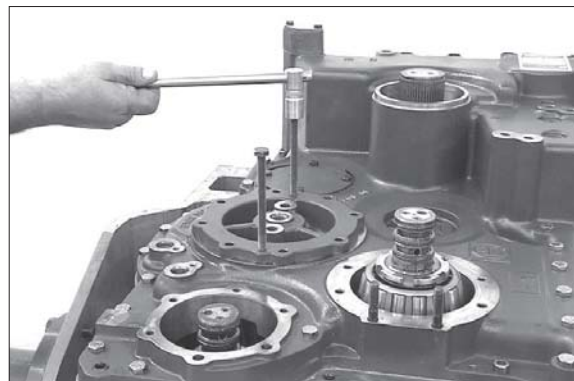


Figure 47

- (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

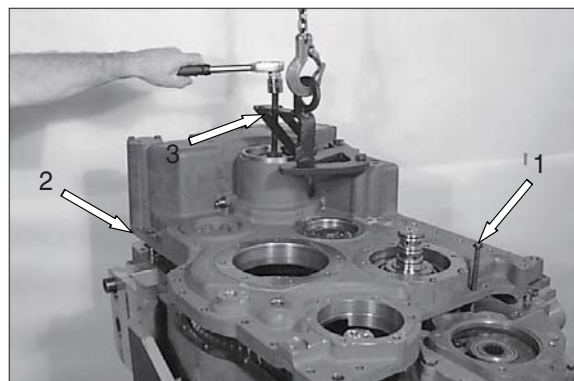


Figure 49



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

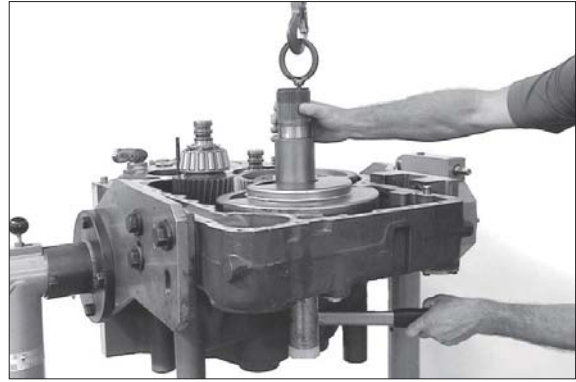


Figure 50

- (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

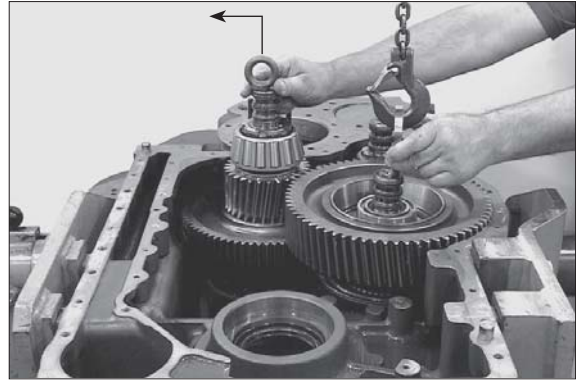


Figure 54

(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

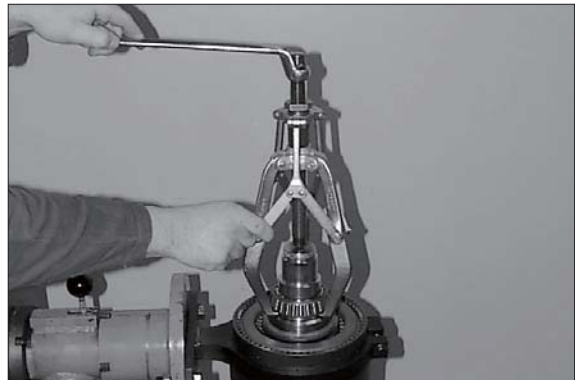


Figure 71

(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.

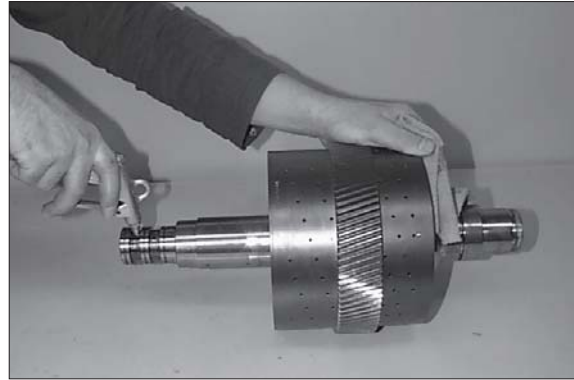


Figure 74

### 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

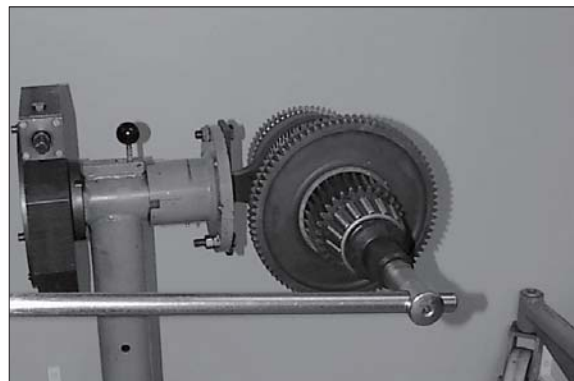


Figure 76

- (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.

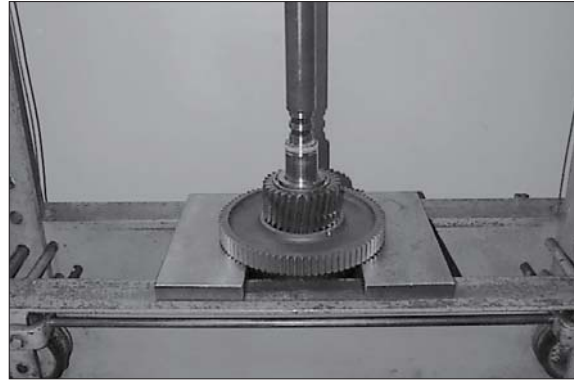


Figure 78

(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.

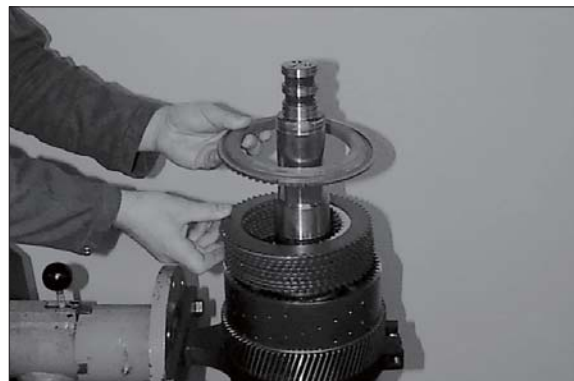


Figure 80

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

※ Special tool

Slotted nut wrench 5870 401 099

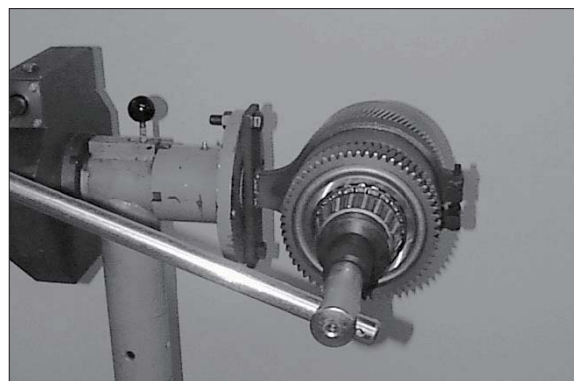


Figure 81

(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

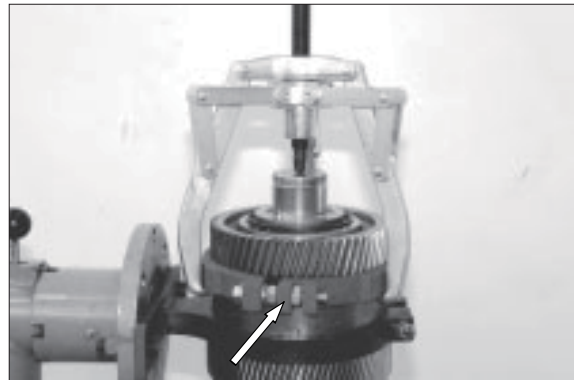


Figure 83

(10) Remove the ring.

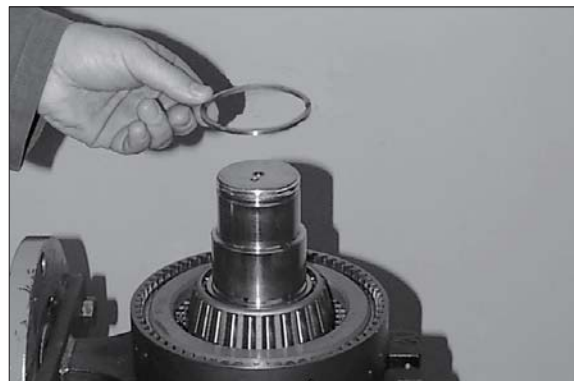


Figure 84

(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

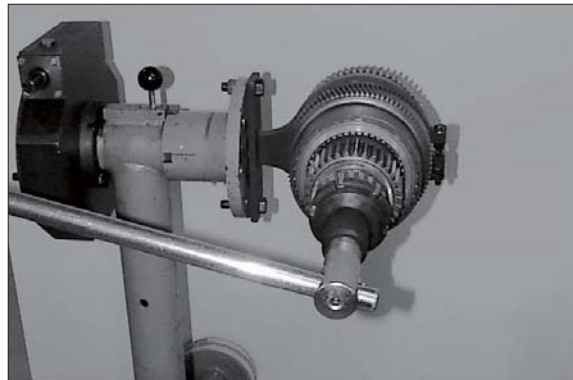


Figure 87

(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.

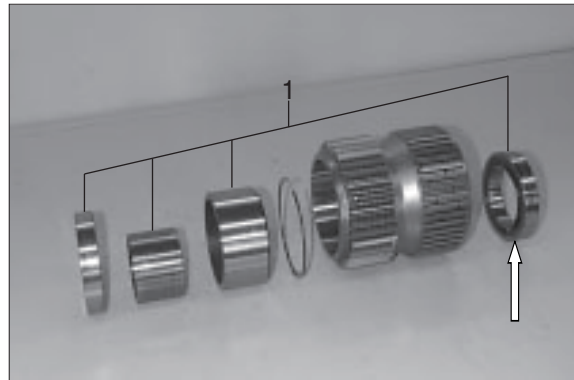


Figure 91

(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

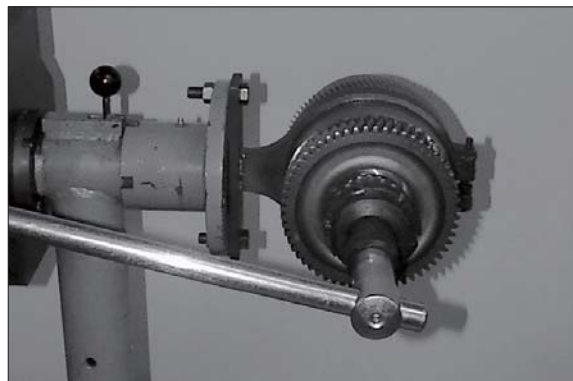


Figure 96

- (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

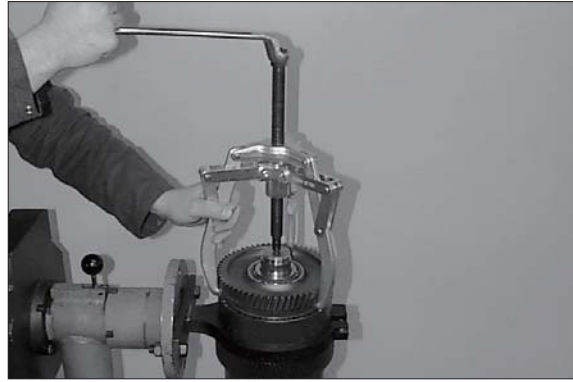


Figure 98

(12) Remove the ring.

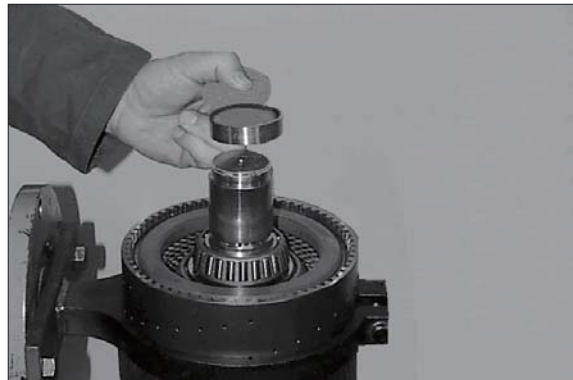


Figure 99

(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

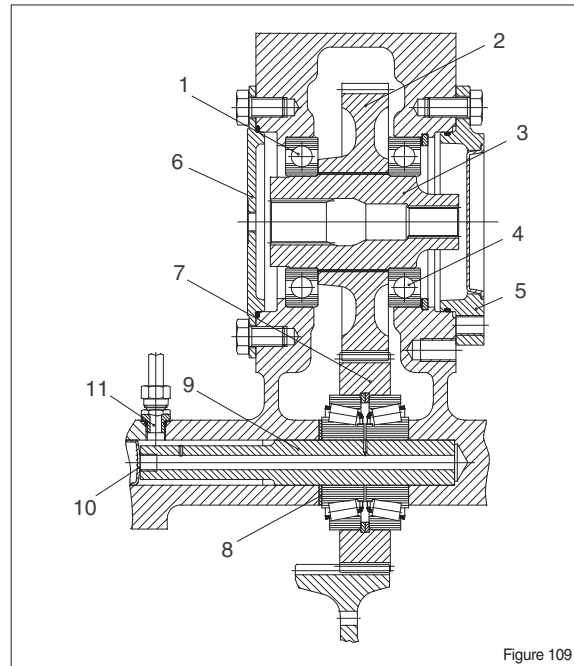


Figure 100

## 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



- (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).

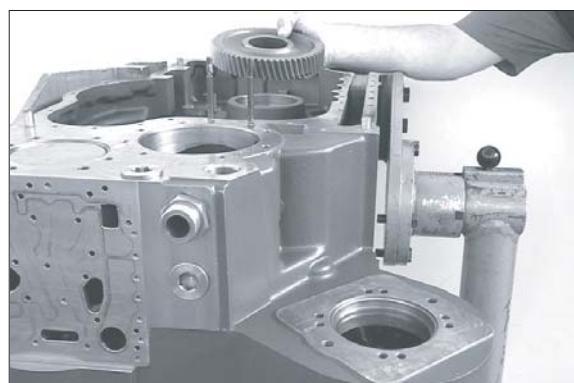


Figure 111

(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 contact.

※ 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

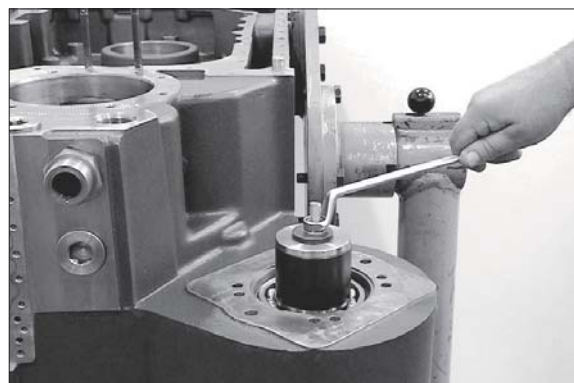


Figure 114

**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 to be corrected with the corresponding shim.

Feeler gauge                      5870 200 112

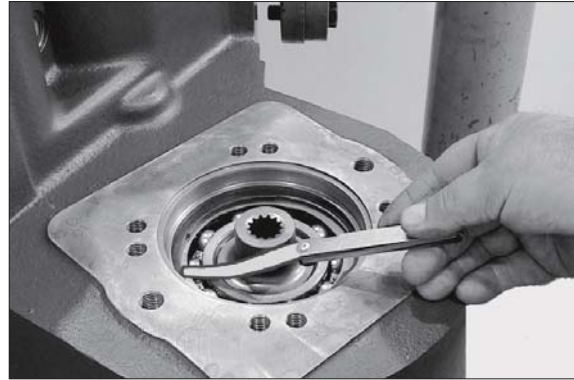


Figure 116

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

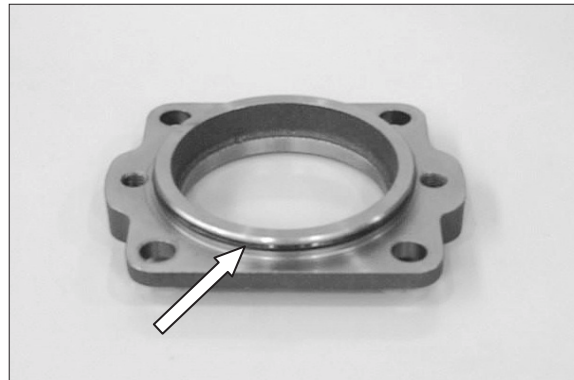


Figure 117

(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 of the housing bore.

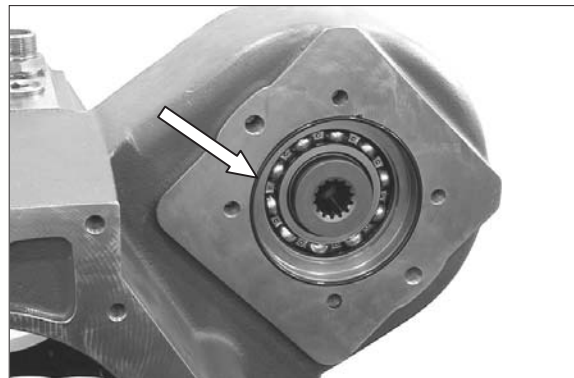


Figure 119

(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) and install it.

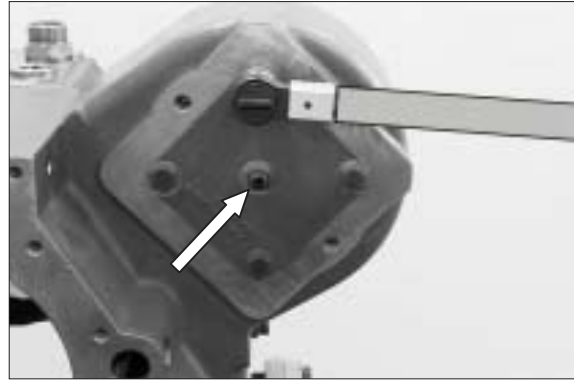


Figure 120

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

※ Exact locating of the single components to be ensured by pressing



Figure 121

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

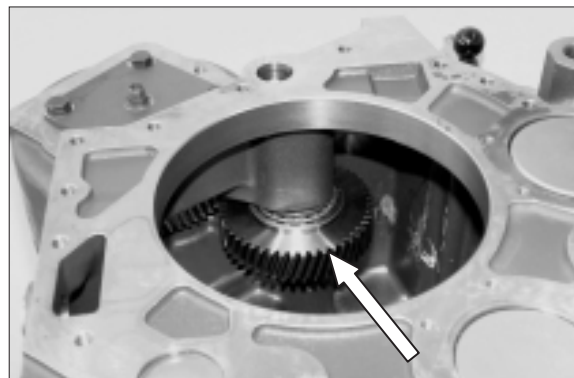


Figure 122

(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**

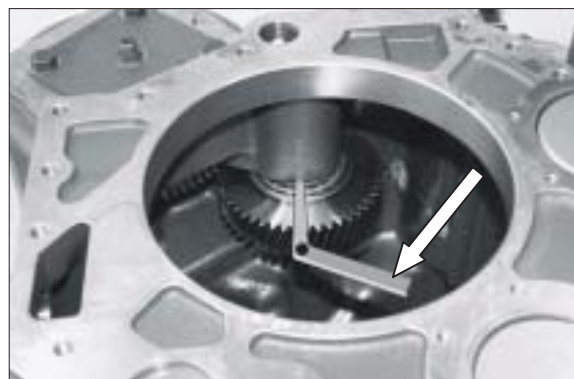


Figure 123

Feeler gauge 5870 200 112



(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 centrally. Undercool the pin (9) and install it until contact.

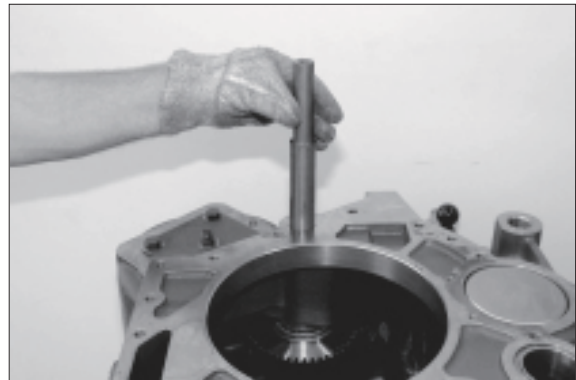


Figure 125

(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).

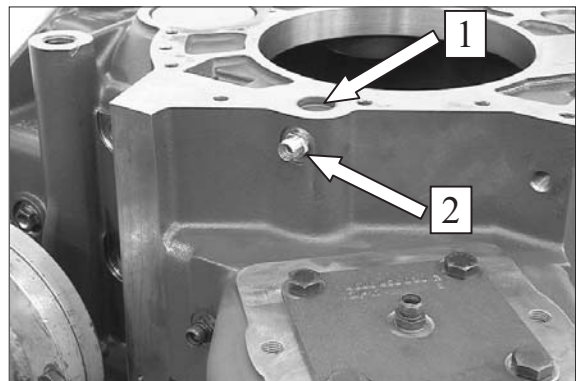


Figure 126

### Assembly of the multi-disc clutch K4/K3

The following sketch shows the clutch sectioning

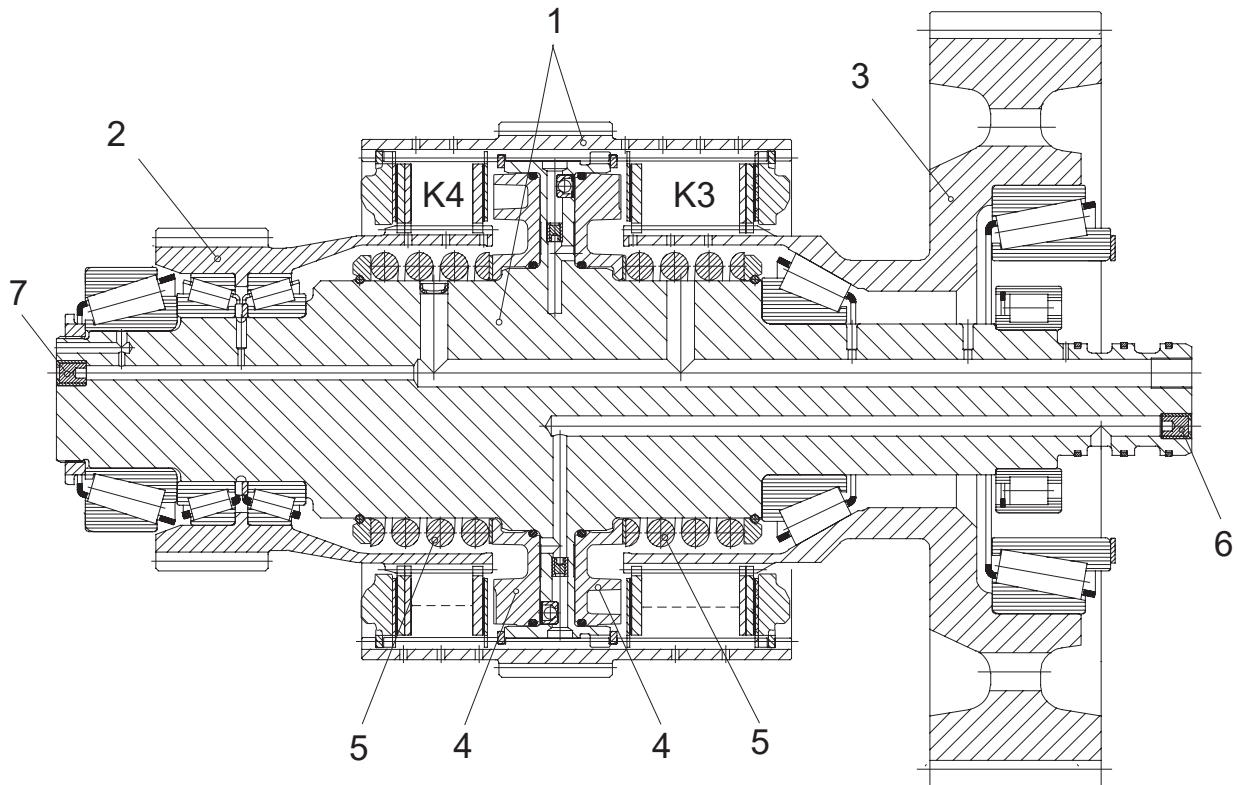


Figure 127

- |   |                    |    |                      |   |                    |
|---|--------------------|----|----------------------|---|--------------------|
| 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, figure 128 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

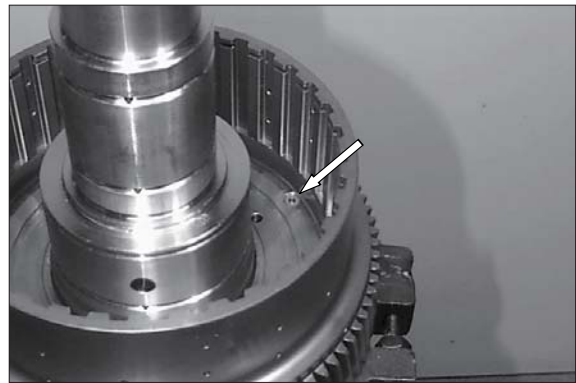


Figure 130

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

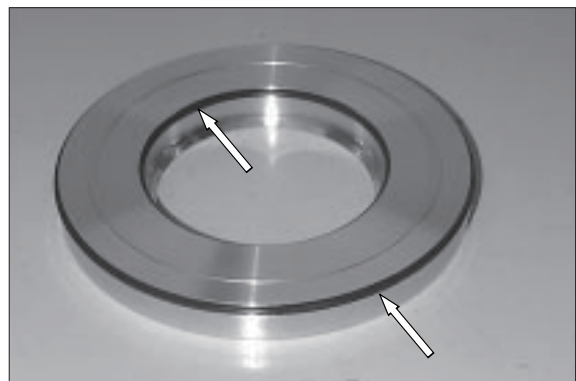


Figure 131

- (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.

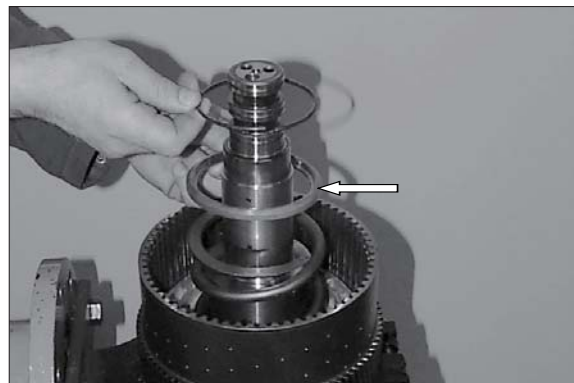


Figure 134

- (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.

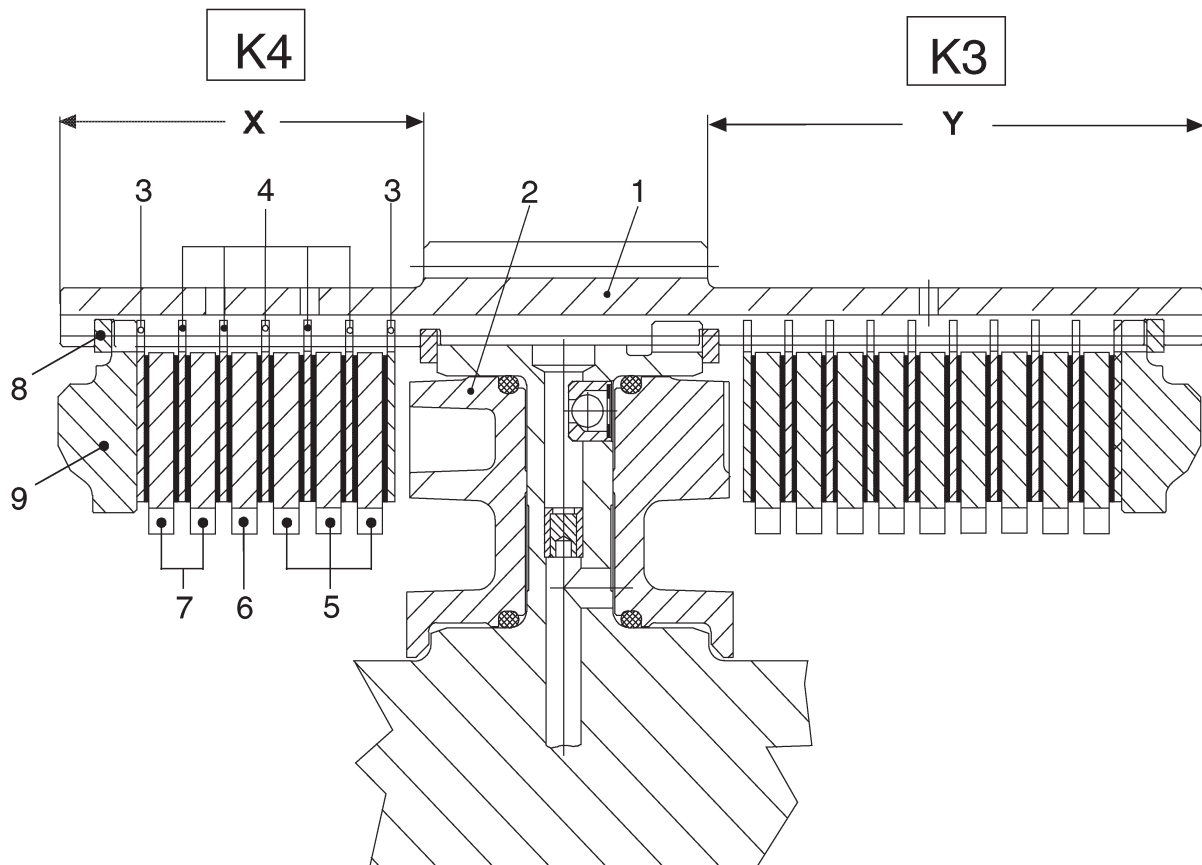


Figure 136

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  $K_4=2.2\sim 2.4$  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.

※ Special tool

Magnetic stand                      5870 200 055

Dial indicator                        5870 200 057

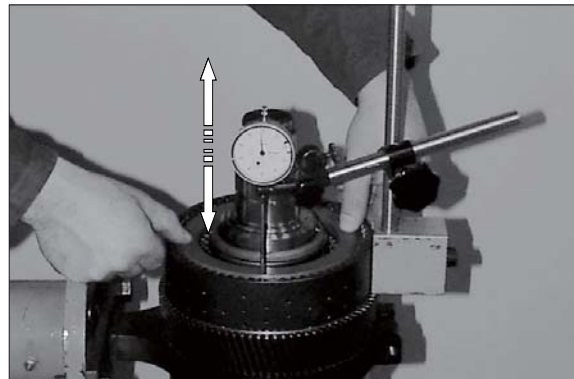


Figure139

**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.

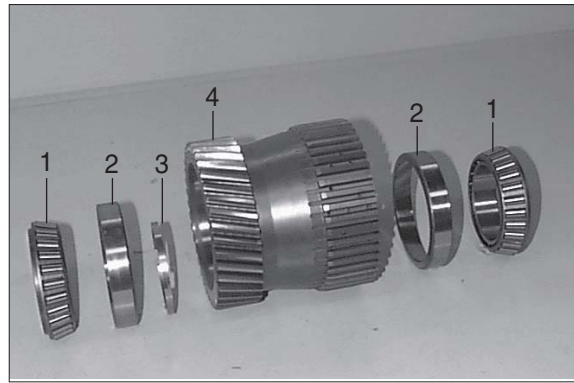


Figure140

(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.

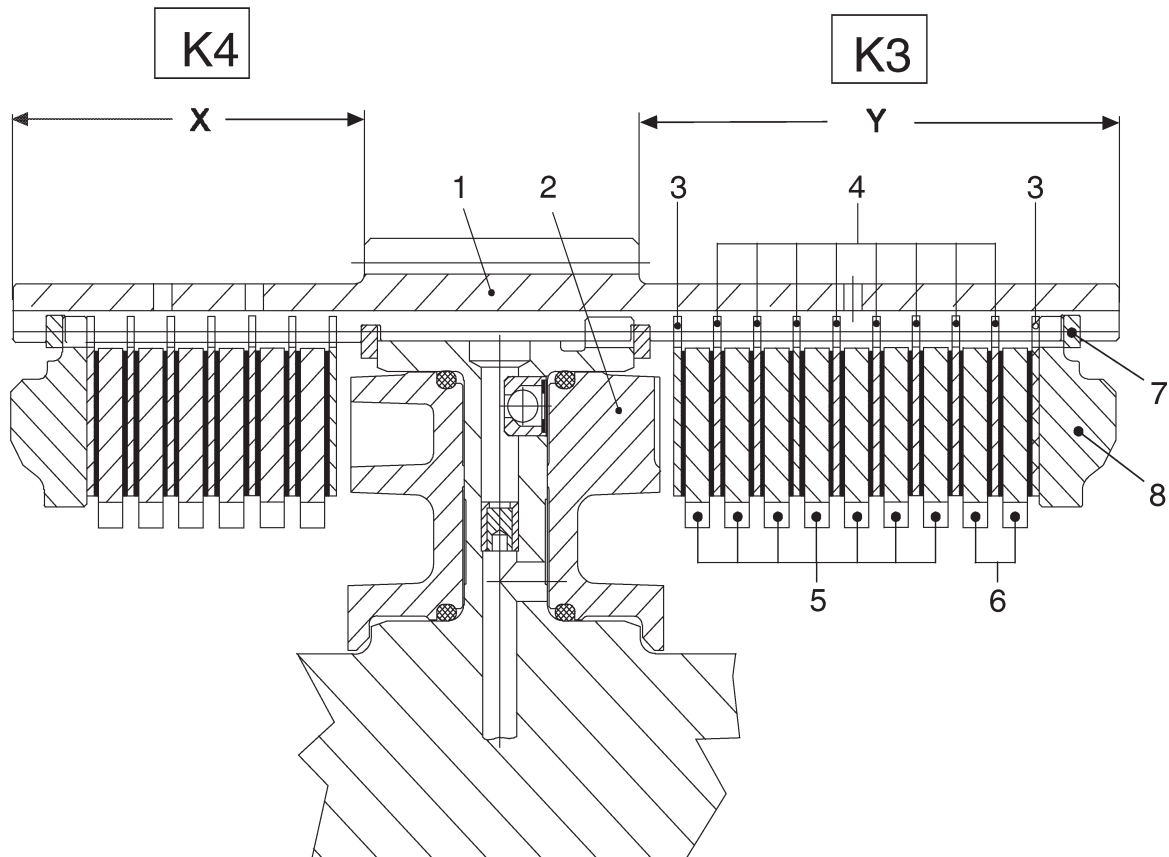


Figure146

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  $K3=2.6\sim 2.8$  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.

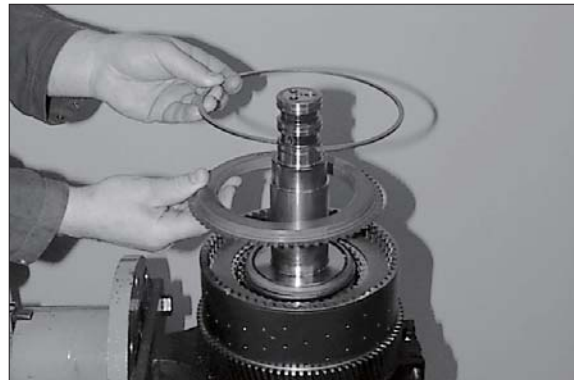


Figure 148

(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.

※ Special tool

※ Magnetic stand                      5870 200 055

Dial indicator                            5870 200 057

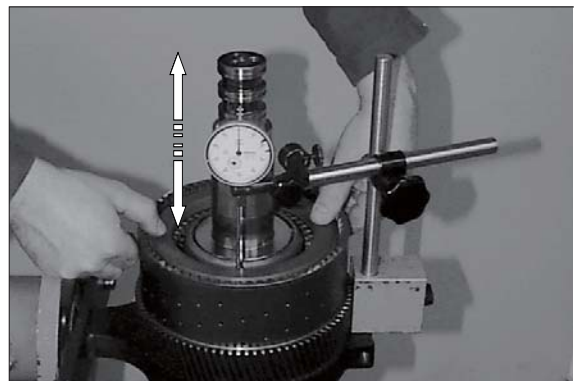


Figure 149

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

▲ Use safety gloves.

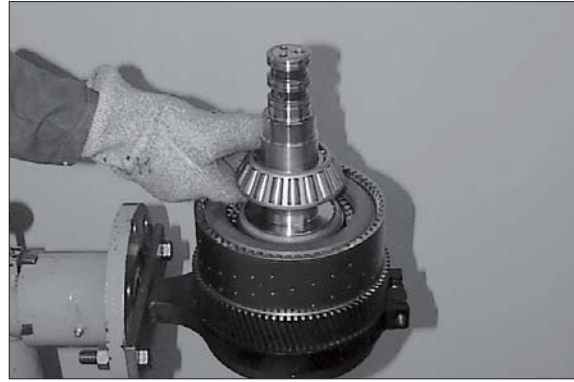


Figure 150

(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 ( $\varnothing 60$  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.

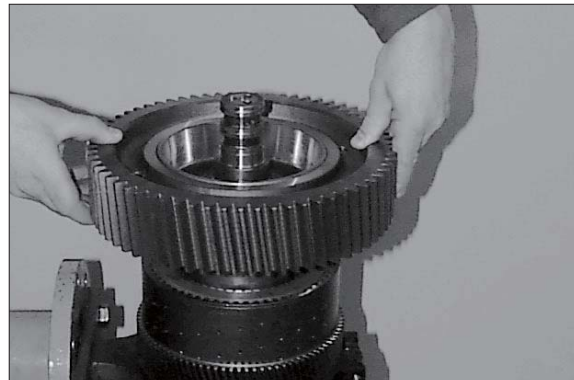


Figure 154

- (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.

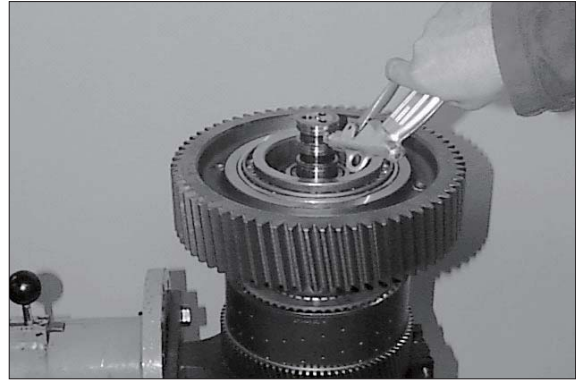


Figure 157

(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.

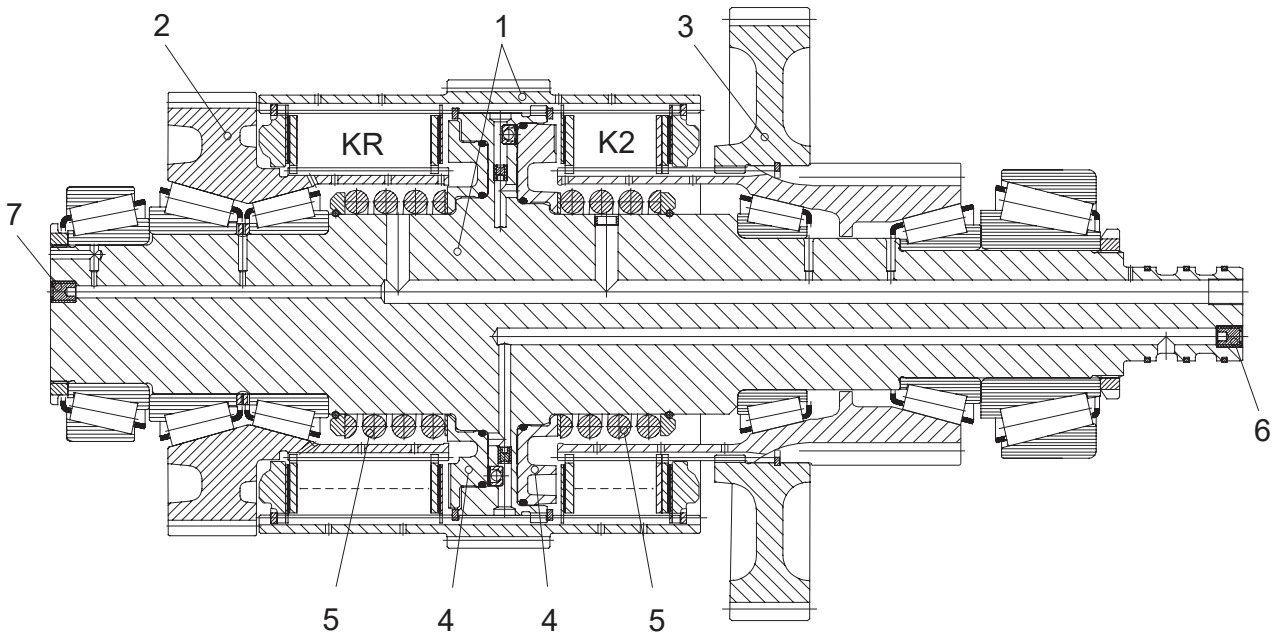


Figure159

- |   |              |    |                      |   |                    |
|---|--------------|----|----------------------|---|--------------------|
| 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

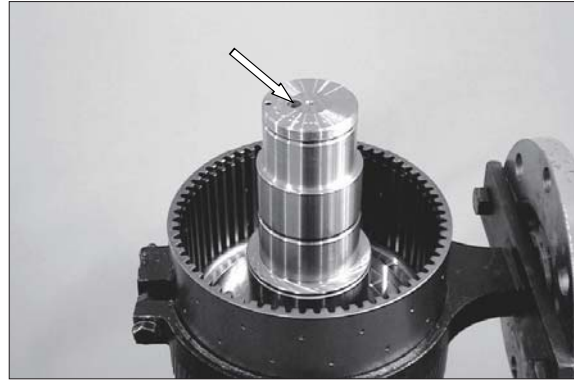


Figure 160



Figure 161

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

※ Special tool	
Inserting tool	5870 320 019

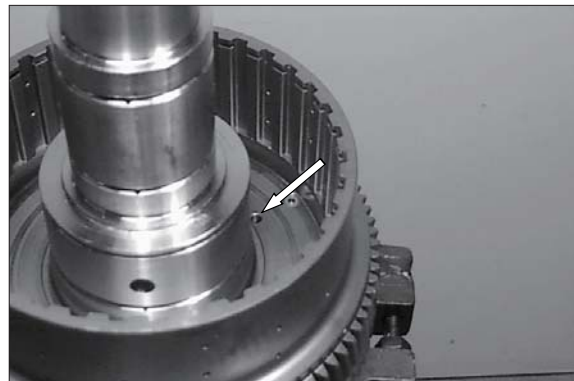


Figure 162

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

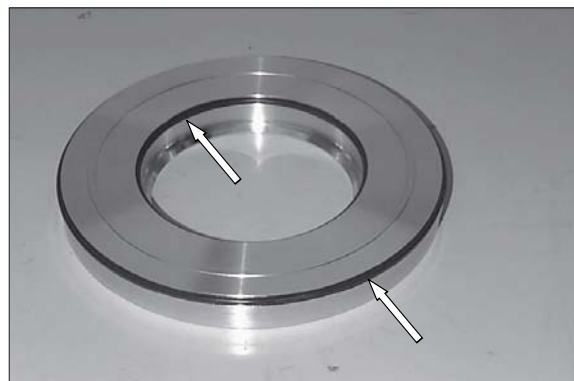


Figure 163

- (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°.



Figure 167

- ※ Special tool
- |                  |              |
|------------------|--------------|
| Pressure piece   | 5870 345 072 |
| Clamping fixture | 5870 654 036 |



## 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.

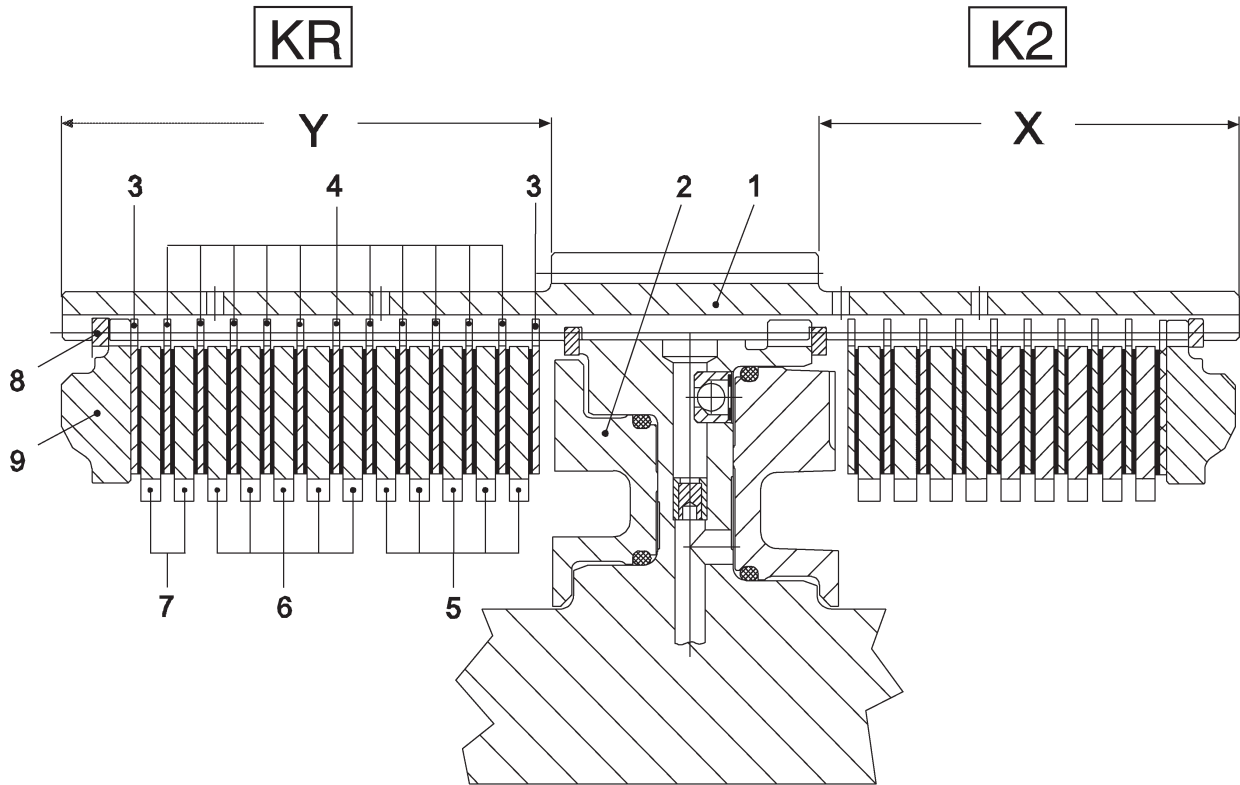


Figure 168

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.

※ Special tool

Magnetic stand                      5870 200 055

Dial indicator                        5870 200 057

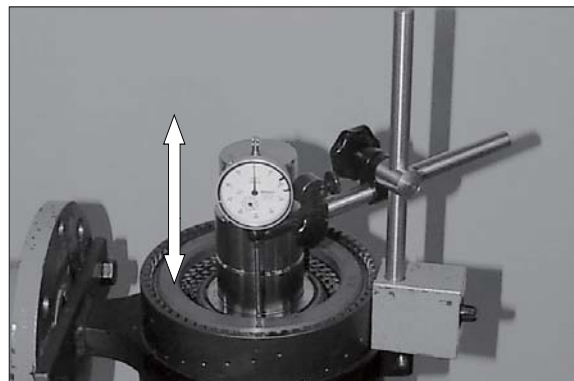


Figure 171

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)

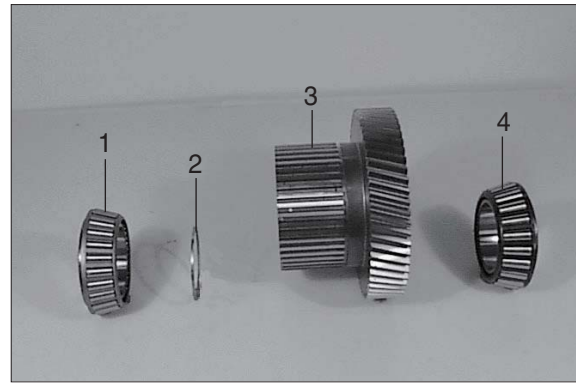


Figure 172

(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.

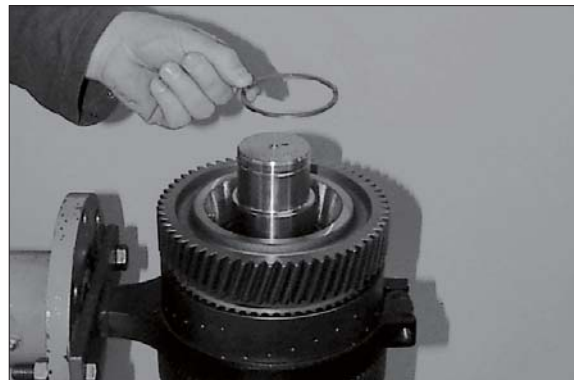


Figure 175

(5) Heat the bearing inner ring (75×41 mm) 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.

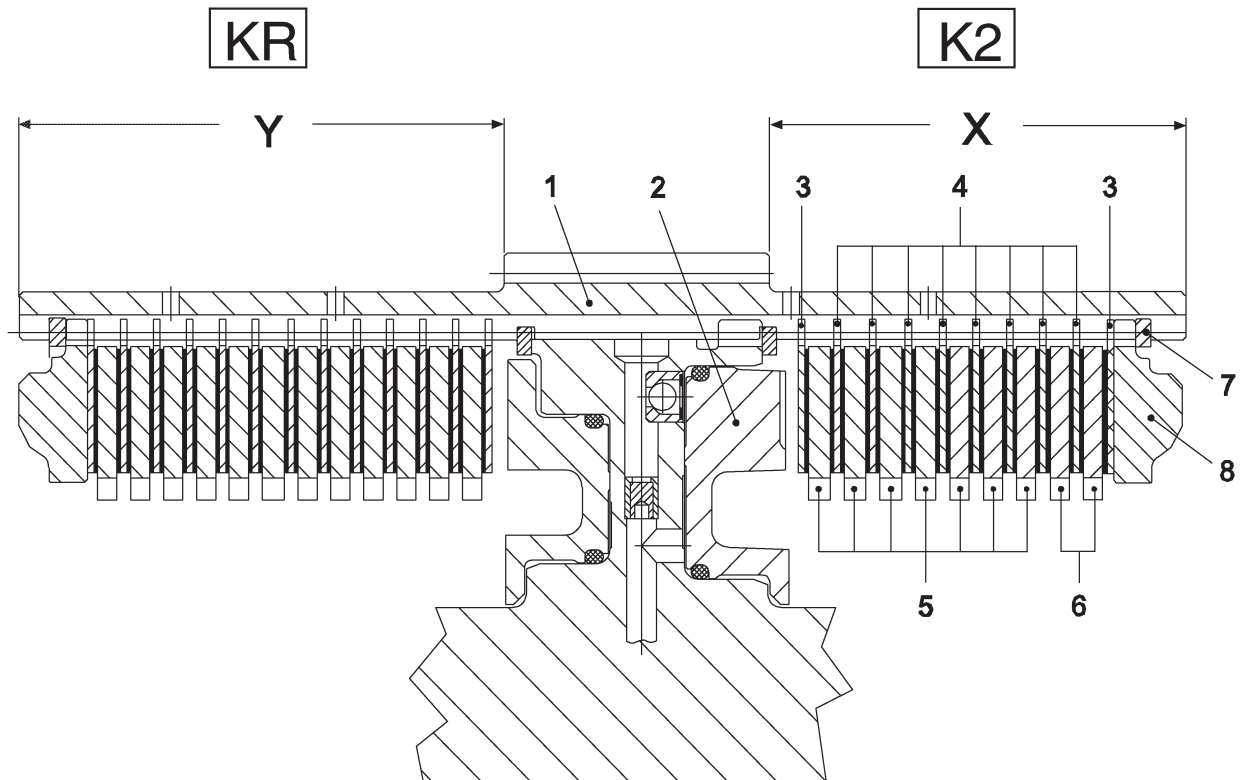


Figure 178

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  $K_2=2.6\sim 2.8$  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.

※ Special tool

Magnetic stand                      5870 200 055

Dial indicator                        5870 200 057

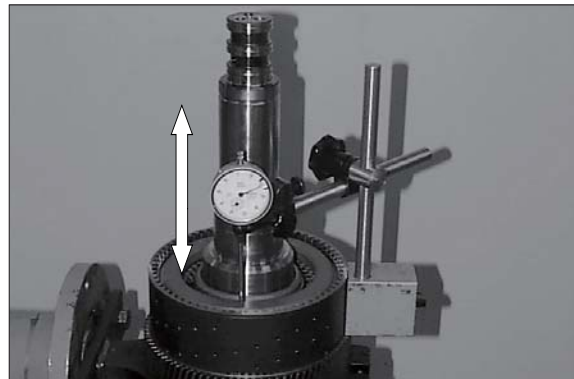


Figure 181

**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.

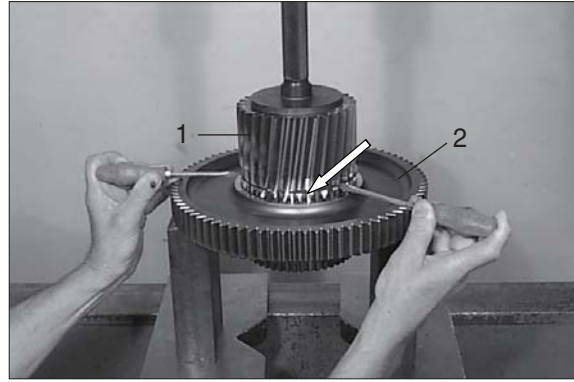


Figure 182

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

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

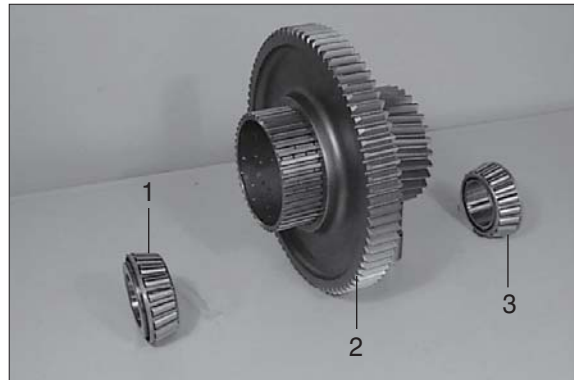


Figure 183

- (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.

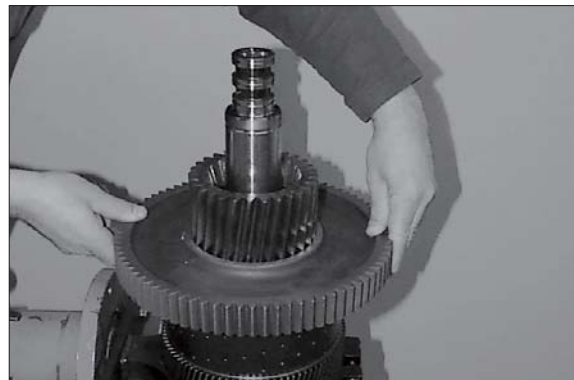


Figure 185

(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

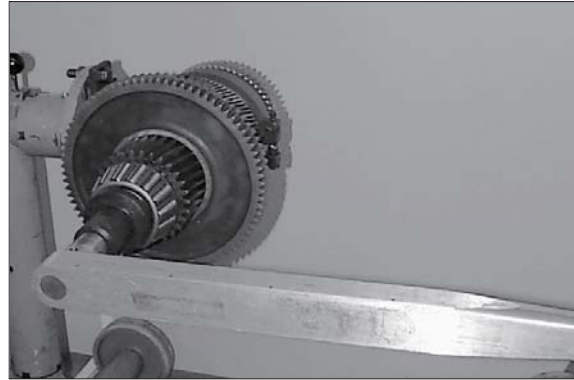


Figure 189

**KR-side :**

Install the slotted nut.

- ※ Observe installation position of the slotted nut. Collar ( $\varnothing 76$  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).

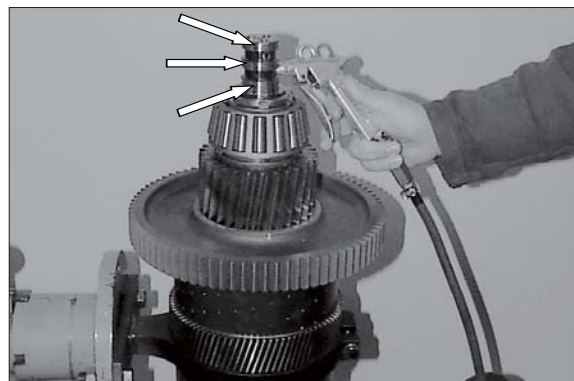


Figure 191

### Assembly of the multi-disc clutch KV/K1

The following sketch shows the clutch sectioning

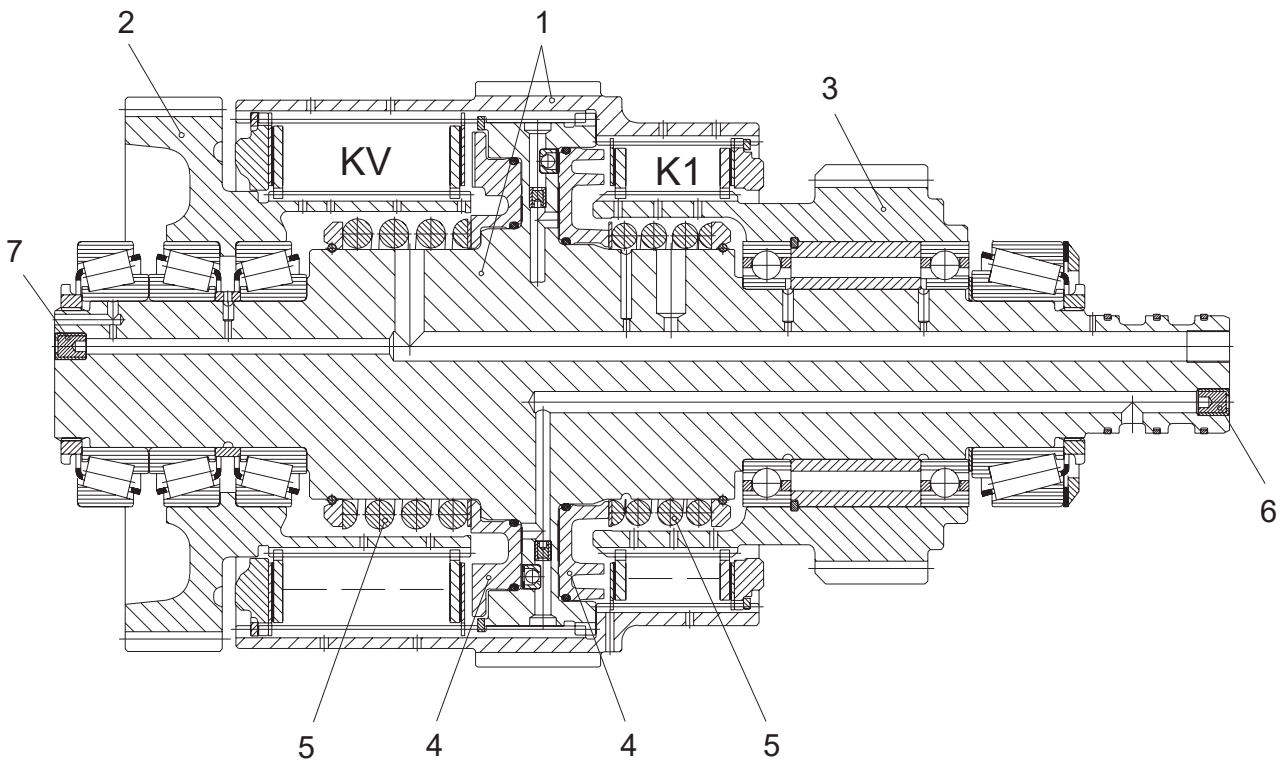


Figure 192

- |   |              |    |                      |   |                    |
|---|--------------|----|----------------------|---|--------------------|
| 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.

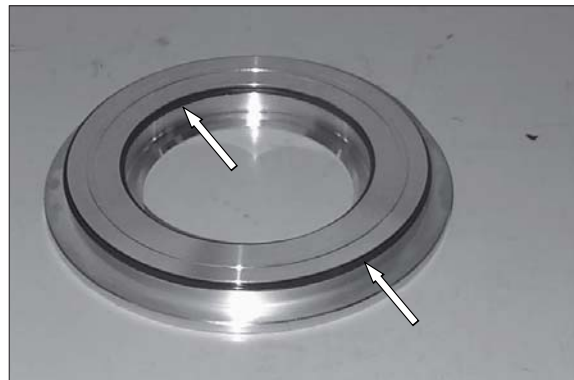


Figure 196

(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.

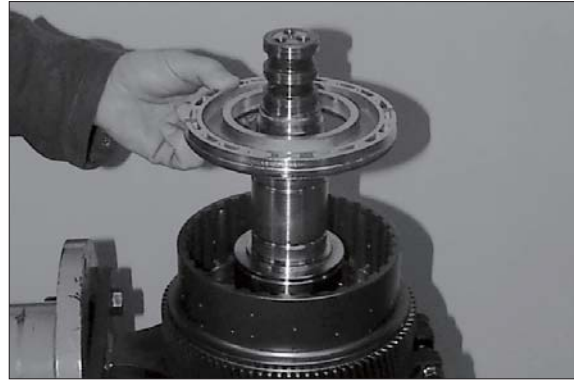


Figure 197

(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.

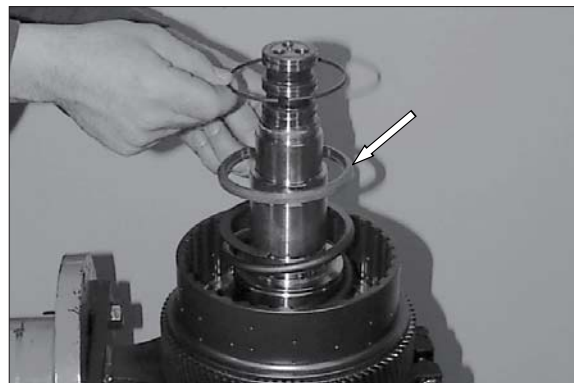


Figure 199

(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°.



Figure 200

※ Special tool

Pressure piece 5870 345 072

Clamping fixture 5870 654 036

## 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.

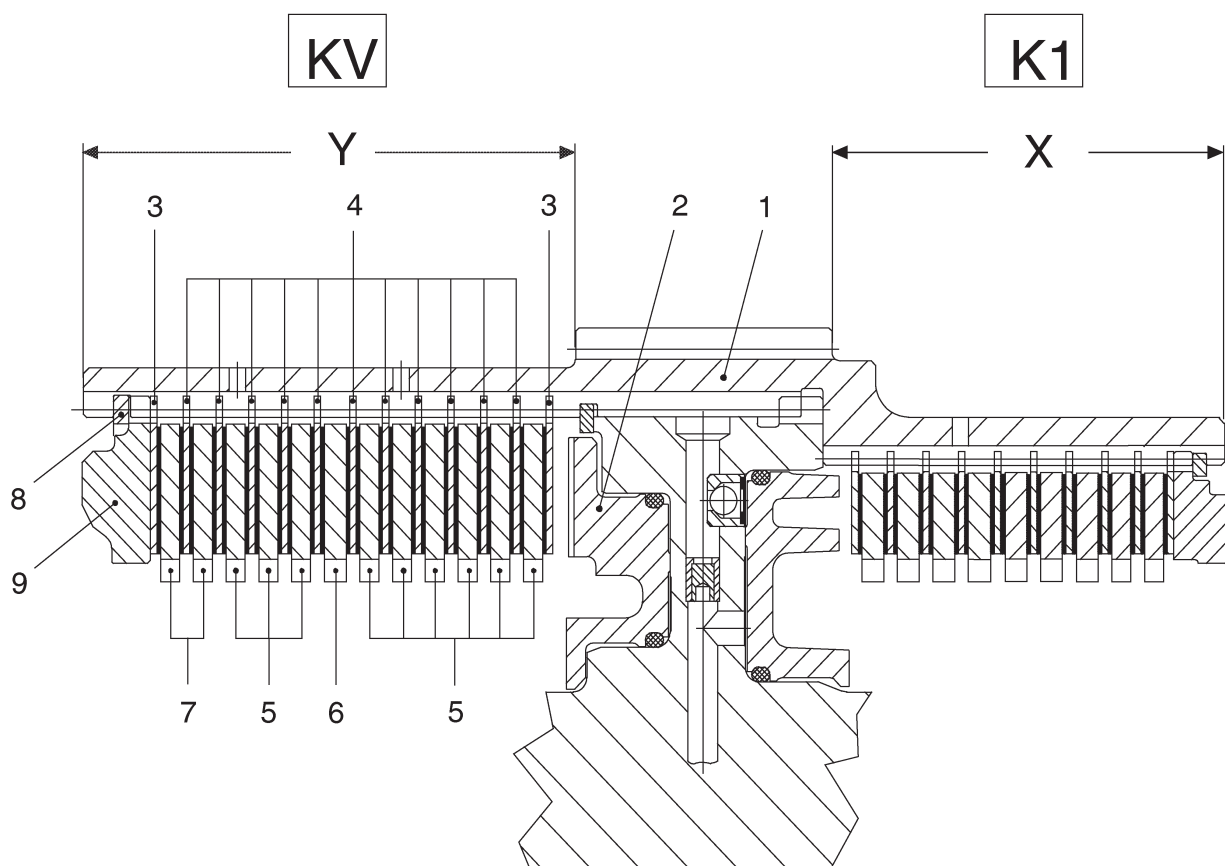


Figure 201

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  $\varnothing$  of the disc carrier respectively, see sketch.

KV Dimension Y (long disc carrier side and large  $\varnothing$  respectively)

K1 Dimension X (short disc carrier side and small  $\varnothing$  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).

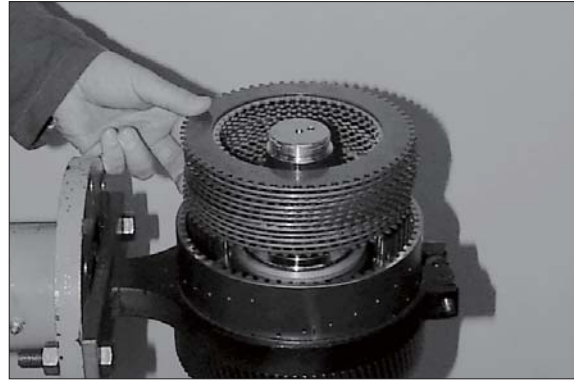


Figure 202

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

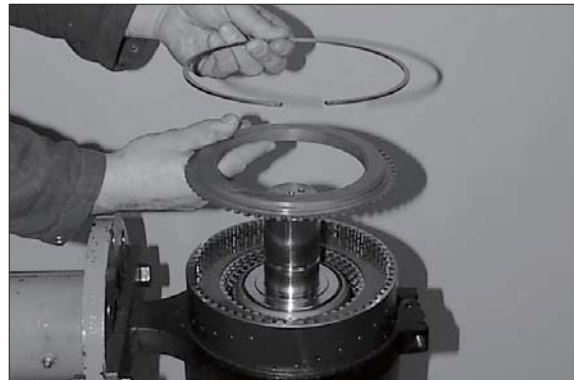


Figure 203

(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.

※ Special tool

Magnetic stand                      5870 200 055

Dial indicator                        5870 200 057

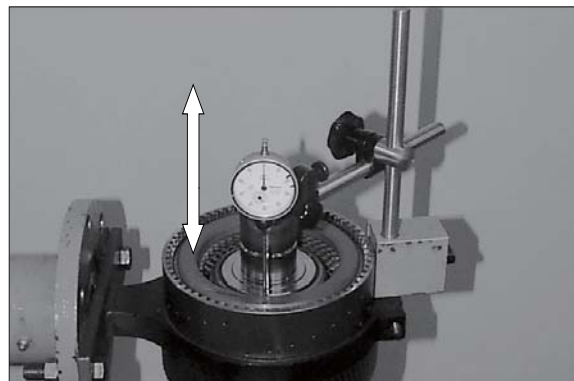


Figure 204

**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.

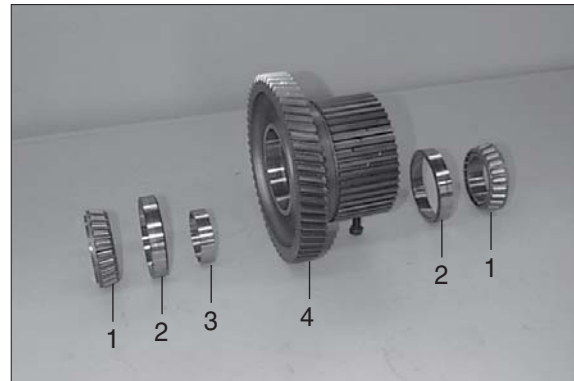


Figure 205

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

**▲ Use safety gloves.**



Figure 206

(3) Install the ring.

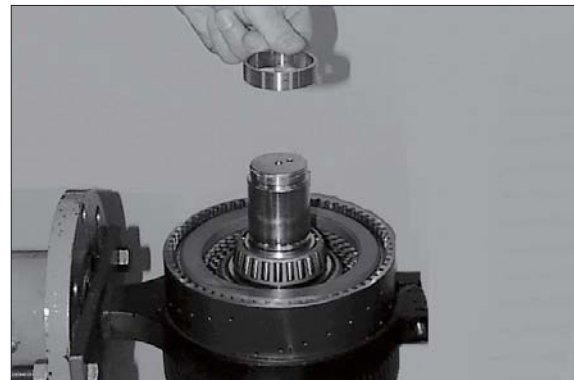


Figure 207

(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.

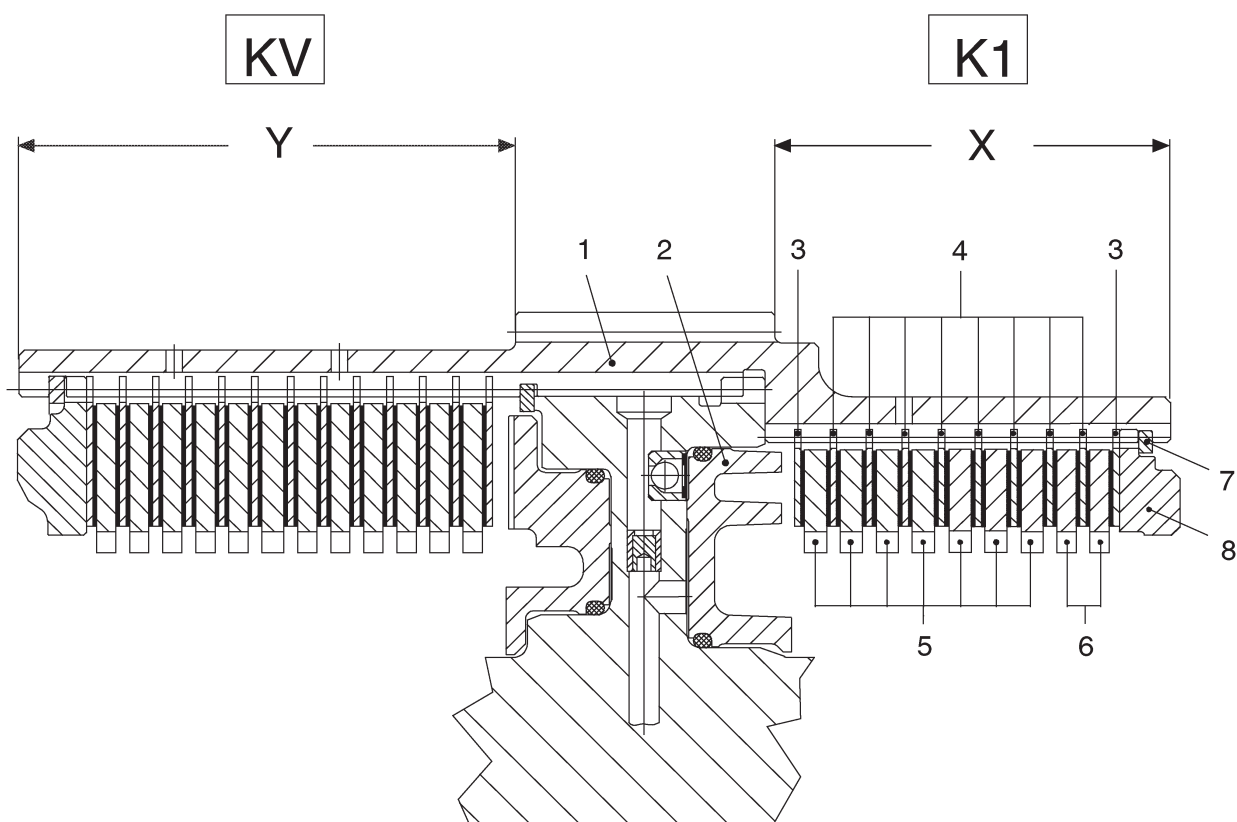


Figure 211

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  $\varnothing$  of the disc carrier respectively, see sketch.

K1 Dimension X (short disc carrier side and small  $\varnothing$  respectively)

KV Dimension Y (long disc carrier side and large  $\varnothing$  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.

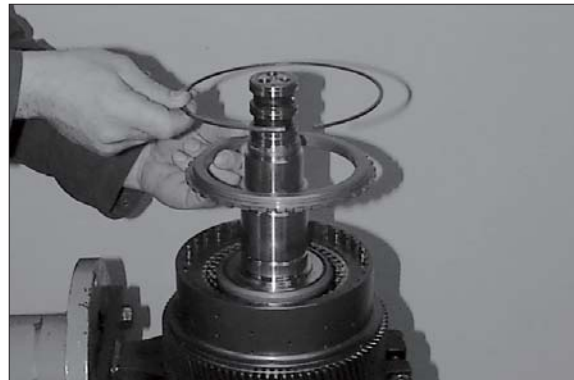


Figure 213

(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.

※ Special tool

Magnetic stand                      5870 200 055

Dial indicator                        5870 200 057

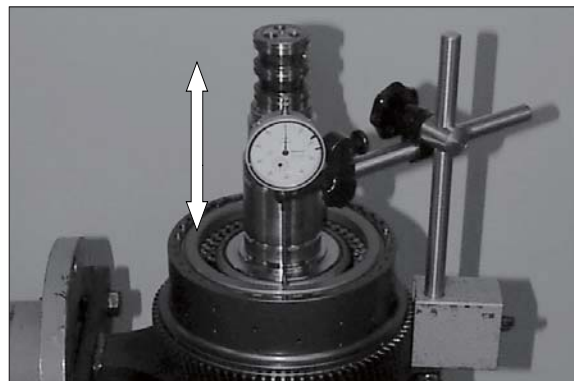


Figure 214

**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.

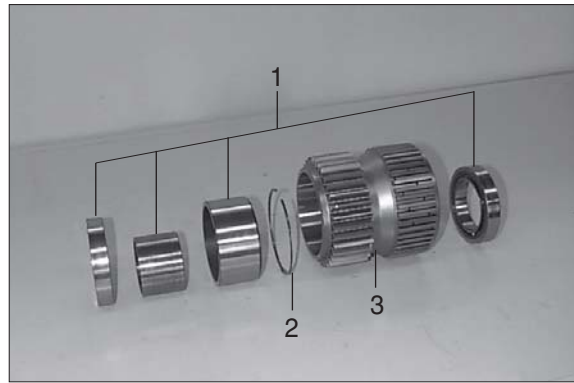


Figure 215



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 the bearing outer ring.

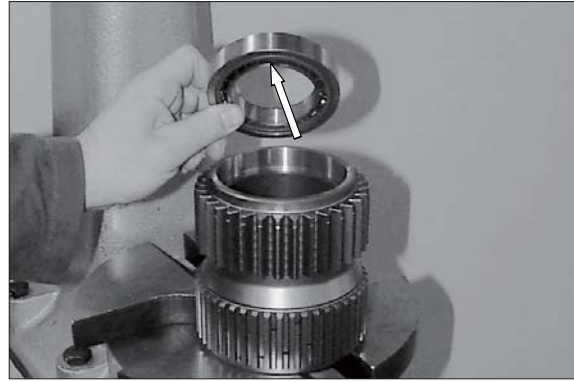


Figure 219

(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  $s = 1.20 \text{ mm}$



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 (Ø60 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

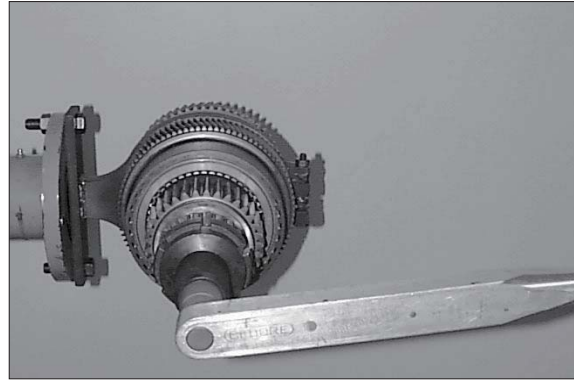


Figure 226

(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

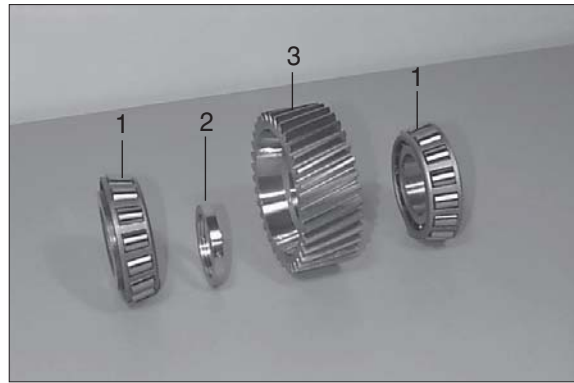


Figure 229

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

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

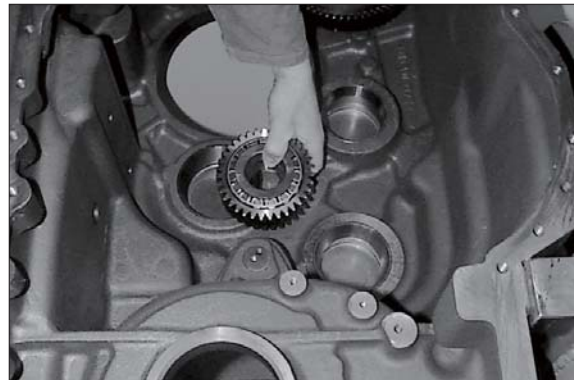


Figure 230

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

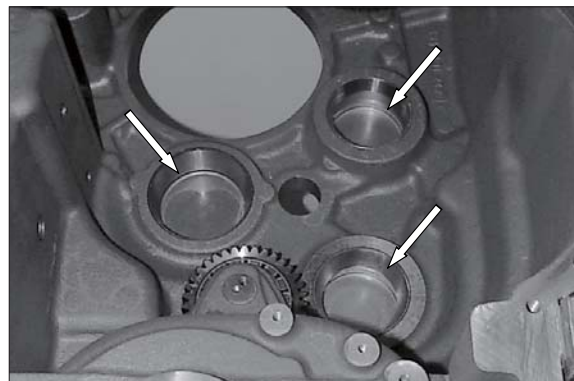


Figure 231

(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.

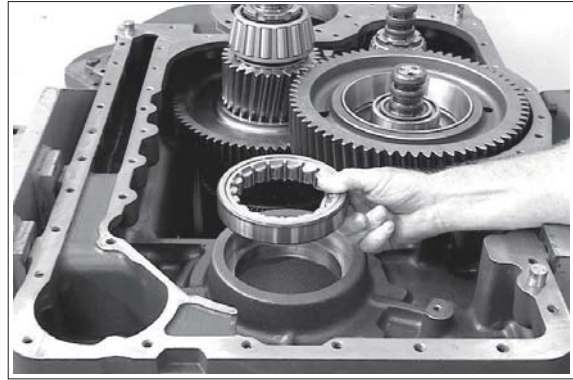


Figure 237

(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

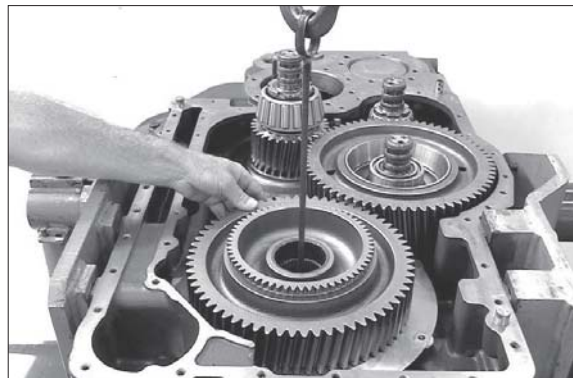


Figure 240

(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).

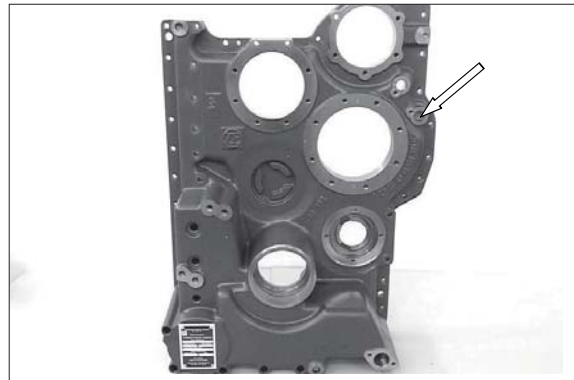


Figure 242

(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)

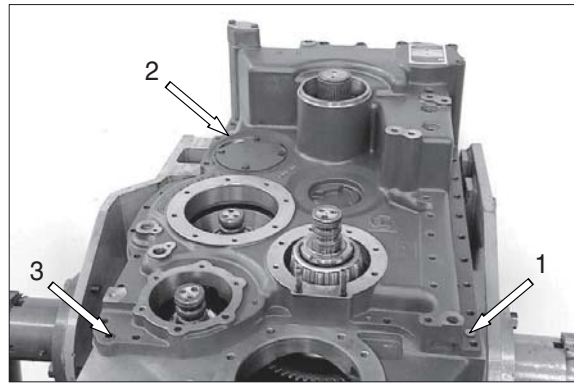


Figure 245

**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

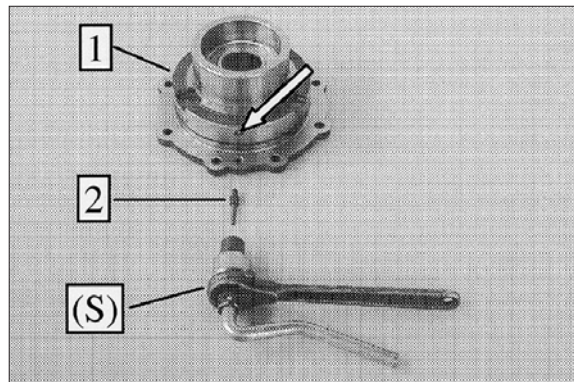


Figure 246

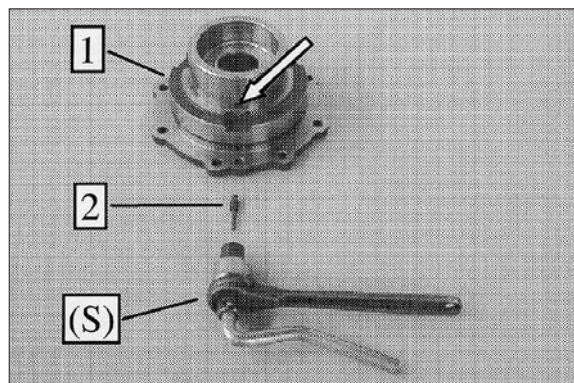


Figure 247

**Housing dimension :**

- (1) Press on equally the bearing inner ring and determine 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

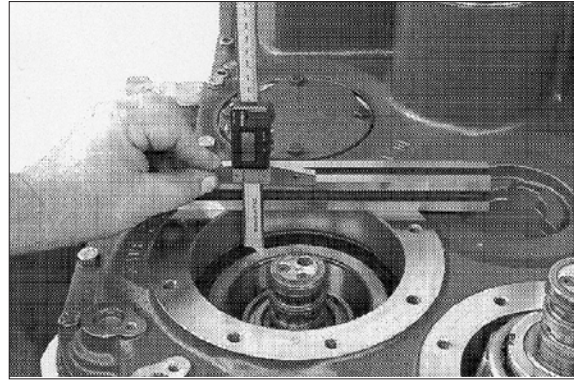


Figure 248

**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

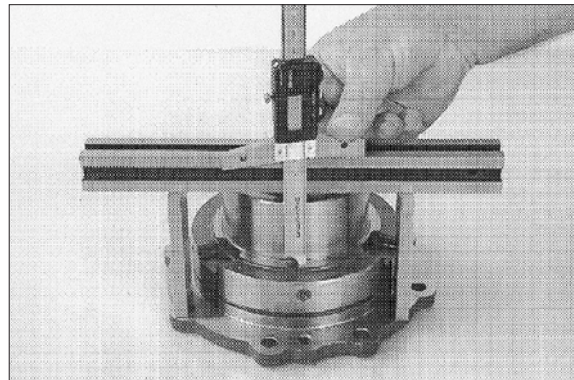


Figure 249

**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

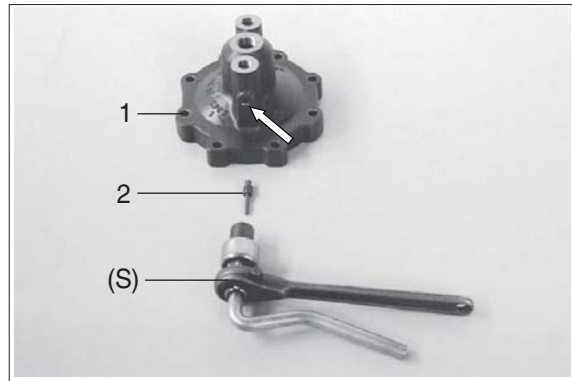


Figure 256

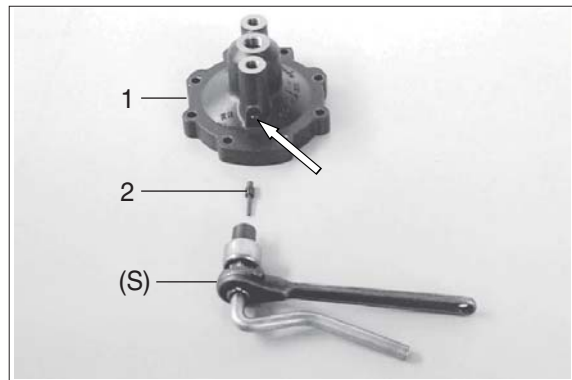


Figure 257

(1) Install both studs (arrows).

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

- Torque limit (M10) :  
1.33 kgf · m (9.59 lbf · ft)

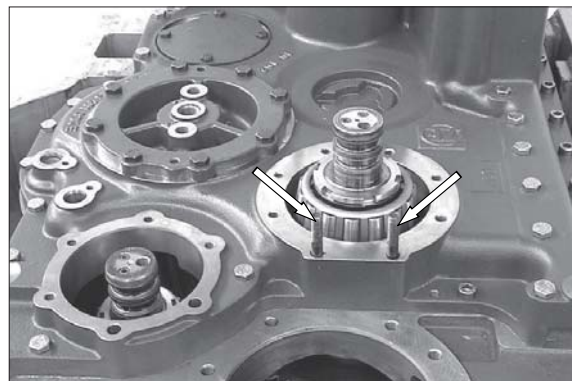


Figure 258

(2) Install the bearing outer ring until contact.

※ Pay attention to exact contact.

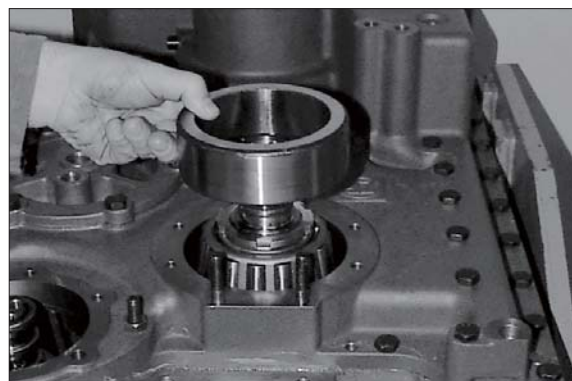


Figure 259

**Housing dimension :**

- (3) Determine Dimension I, from the bearing outer ring to the mounting face.

Dimension I e.g ..... 16.13 mm

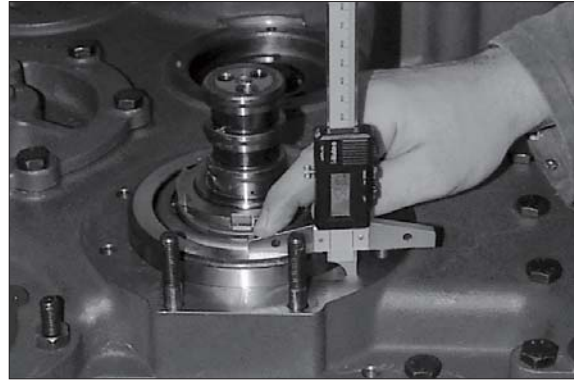


Figure 260

**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

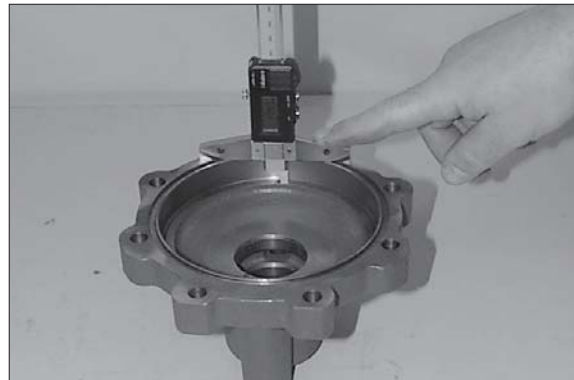


Figure 261

**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.

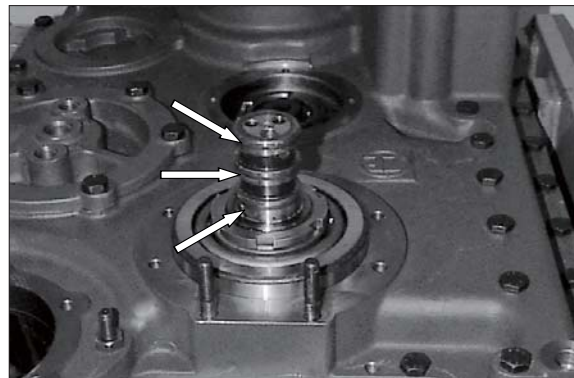


Figure 263

(7) Pull the bearing cover equally until contact.

· Torque limit (M10/8.8) :

4.69 kgf · m (33.9 lbf · ft)

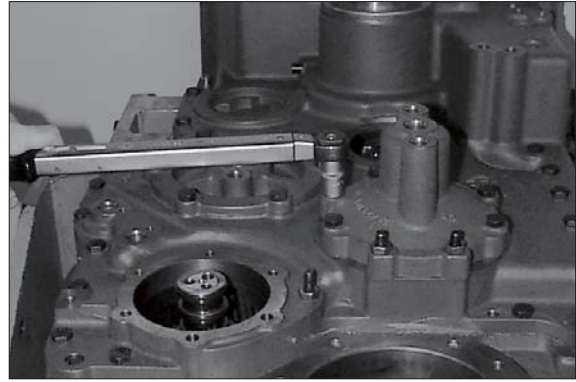


Figure 264

(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

※ Special tool

- Hand mounting tool            5870 320 014
- Ratchet spanner                5870 320 018

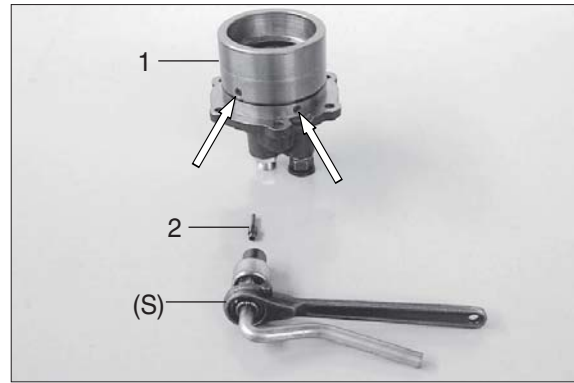


Figure 266

- (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.

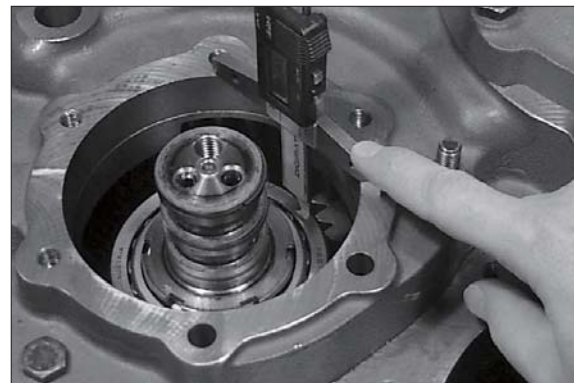


Figure 267

- (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.

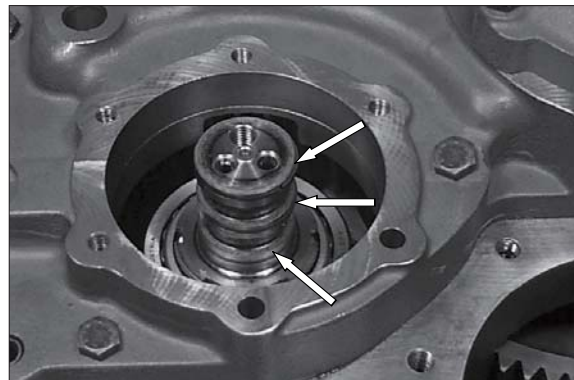


Figure 272

(7) Heat the bearing bore.

※ Special tool

Hot-air blower 230V            5870 221 500

Hot-air blower 115V         5870 221 501

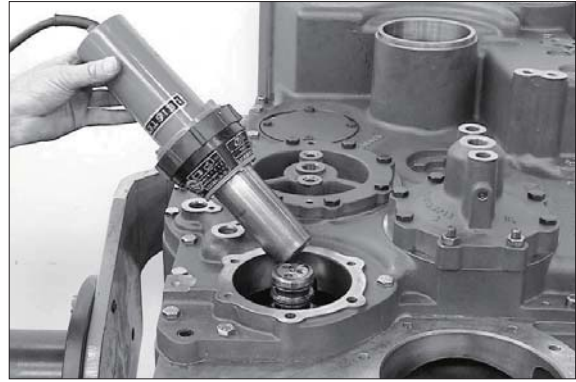


Figure 273

(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

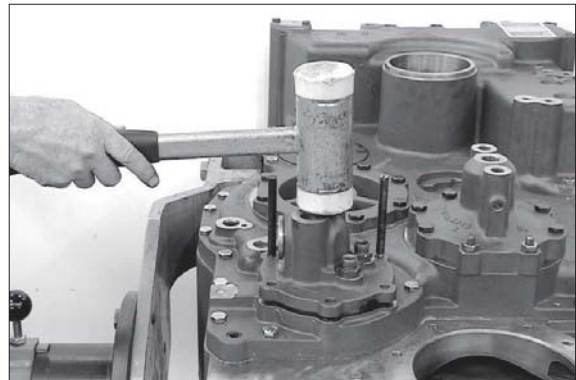


Figure 274

(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.

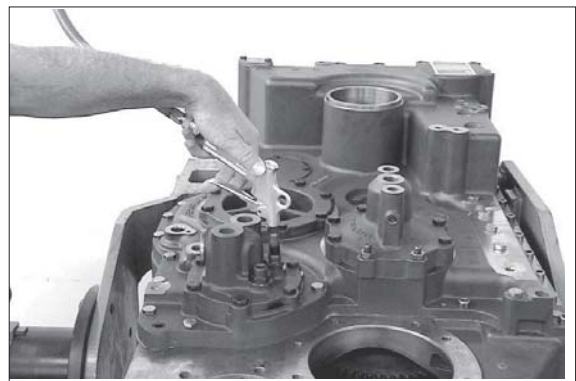


Figure 275

## 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

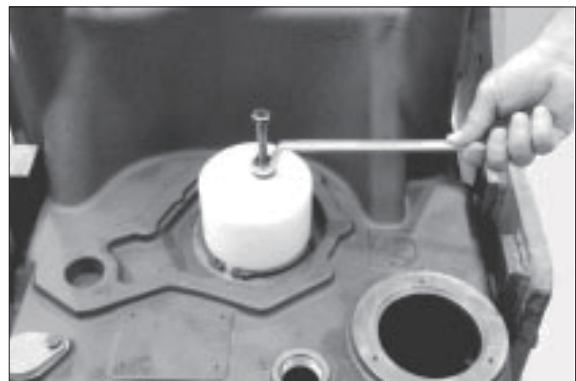


Figure 279

**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.

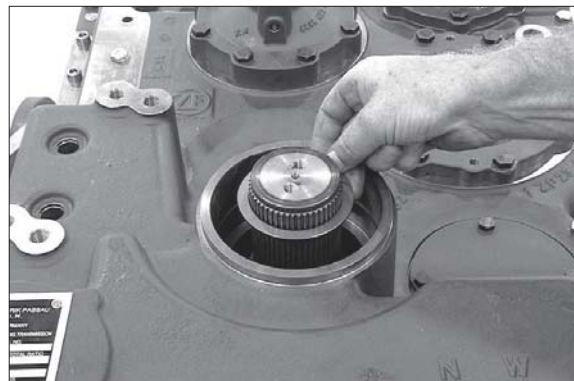


Figure 282

- (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  $X = 0.3\sim 0.8$  mm  
(figure 289~292) :

- X    Gap size
- 1    Shim
- 2    O-ring.

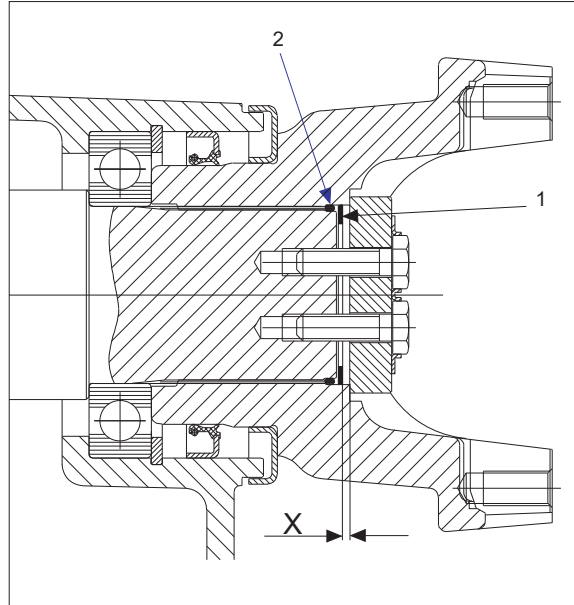


Figure 289

(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

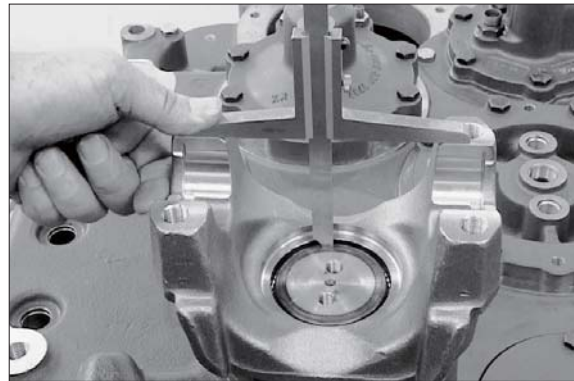


Figure 290

(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

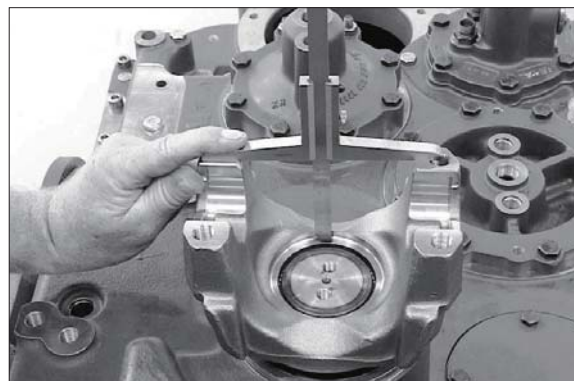


Figure 291

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

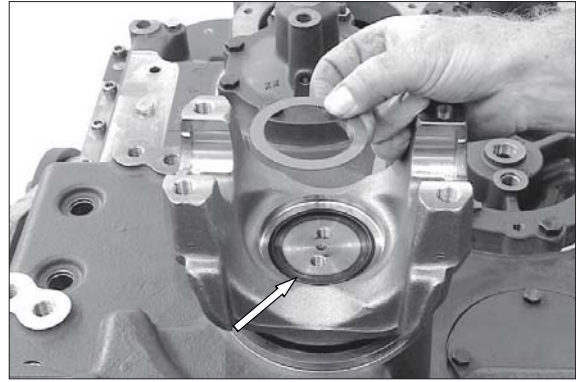


Figure 292

- (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)

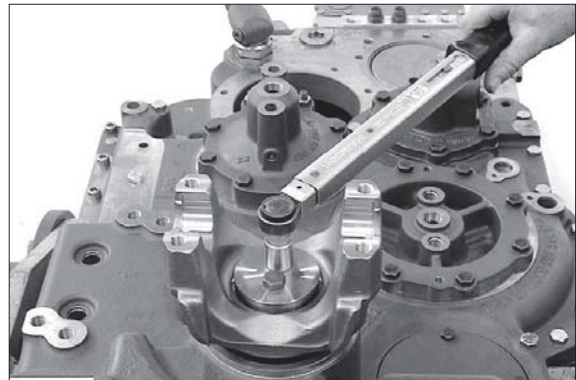


Figure 293

- (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

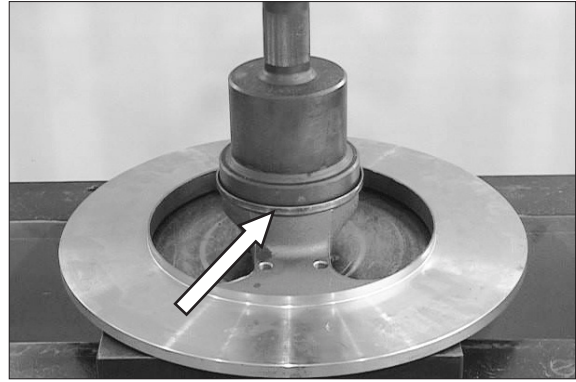


Figure 295

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

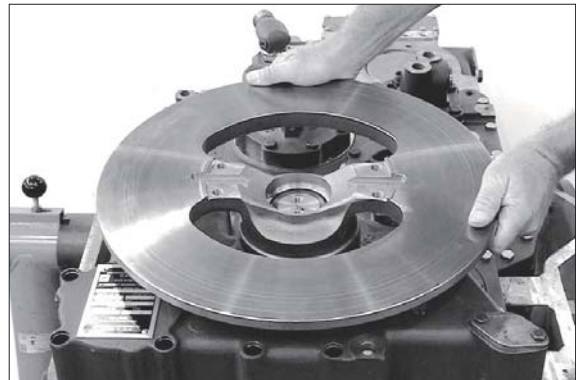


Figure 296

### 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 dimension  $> 13.0$  mm (brake disc shim) results (figure 297).

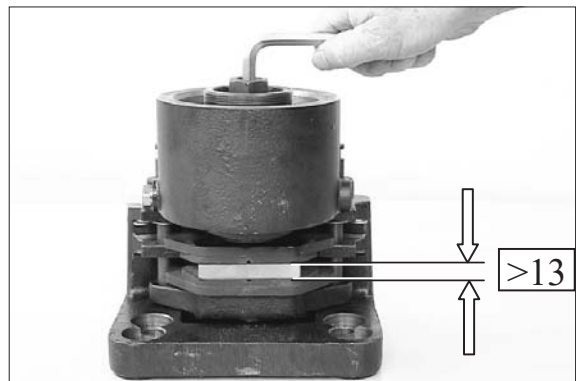


Figure 297

(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

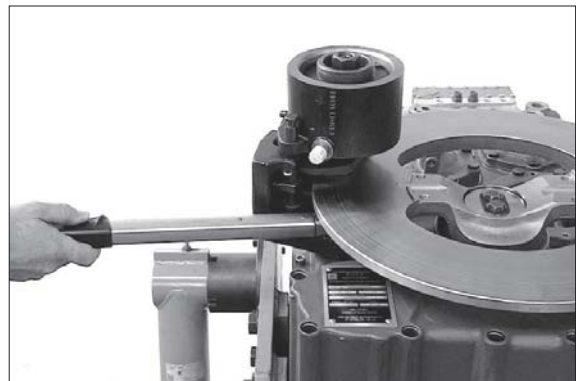


Figure 298

**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.

- (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

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

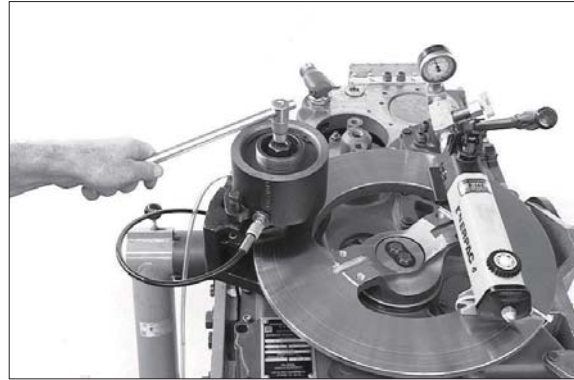


Figure 299

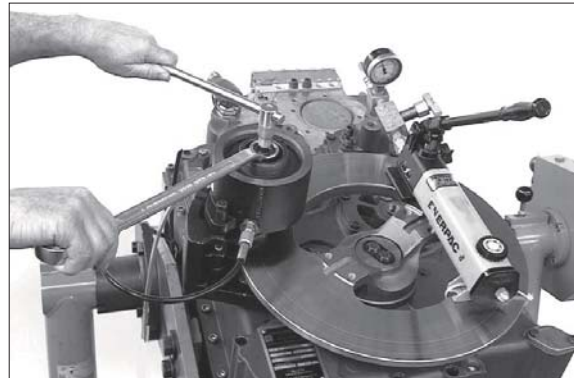


Figure 300

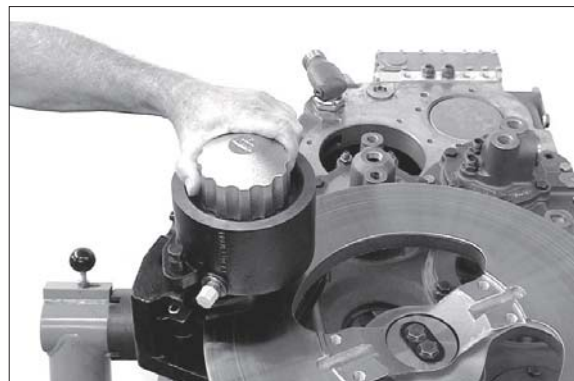


Figure 301

### 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).

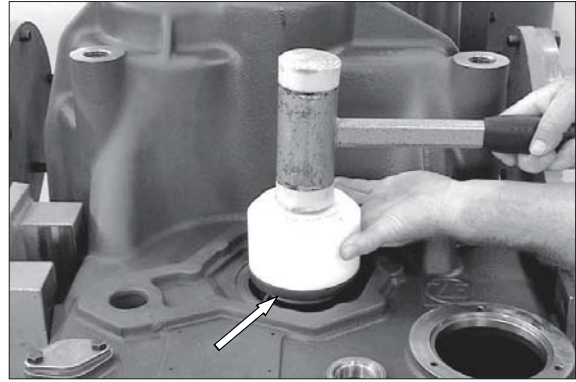


Figure 302

(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

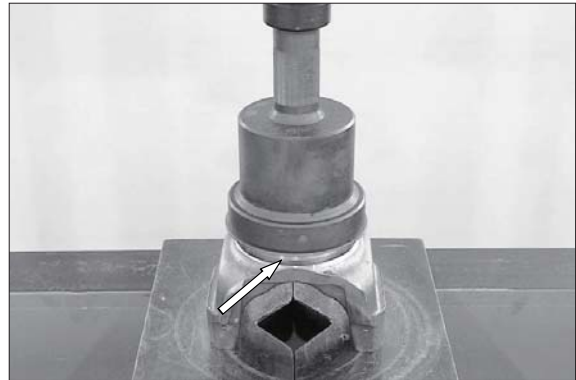


Figure 303

- 1 Screen sheet
- 2 Output flange

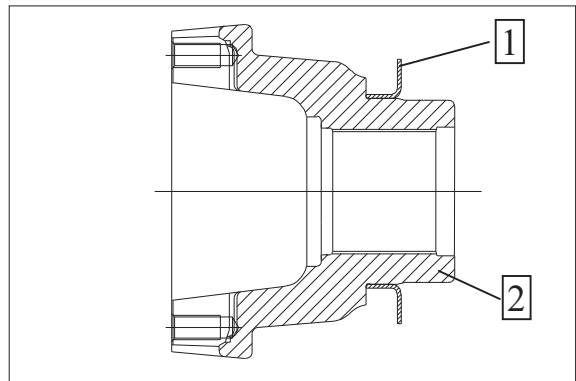


Figure 304

(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 centrally.  
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)

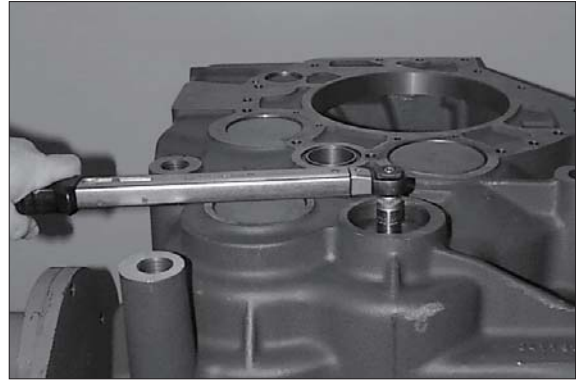


Figure 309

(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

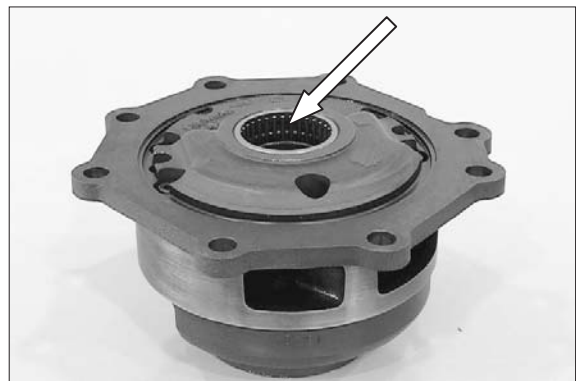


Figure 311

(2) Locate the bearing outer ring until contact.



Figure 312

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

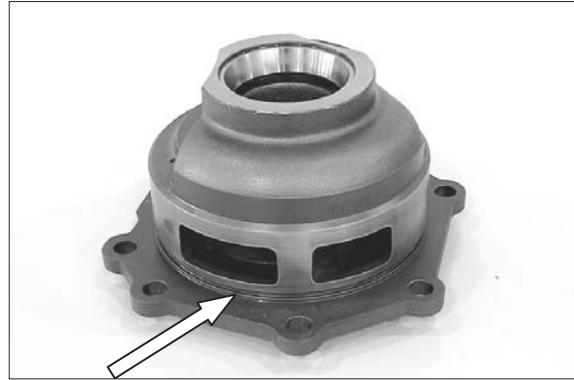


Figure 313

(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.

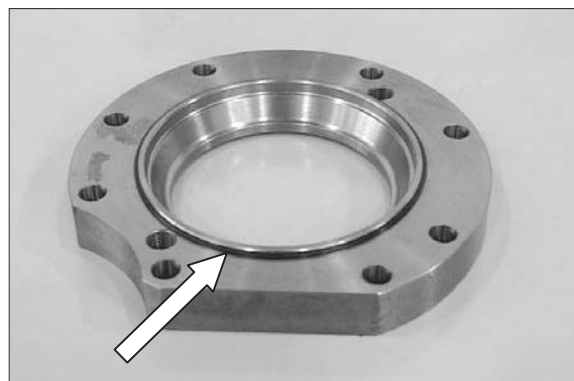


Figure 316

(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)

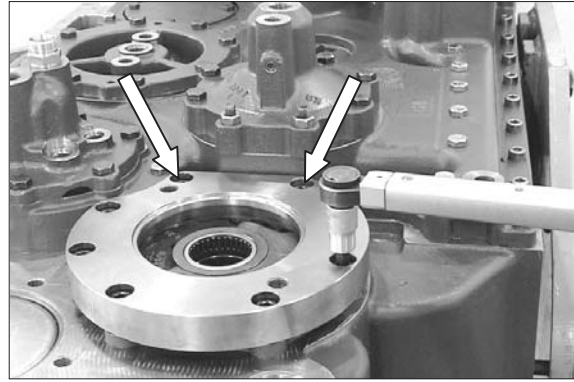


Figure 317

(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

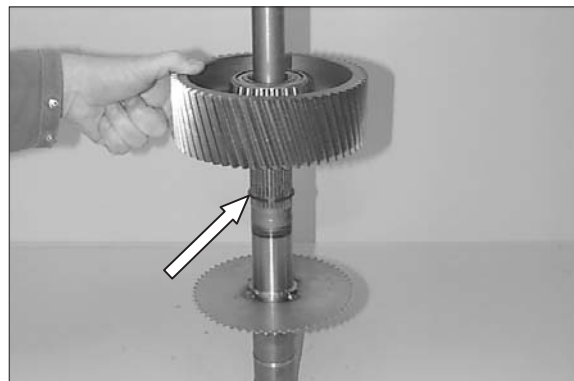


Figure 323

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

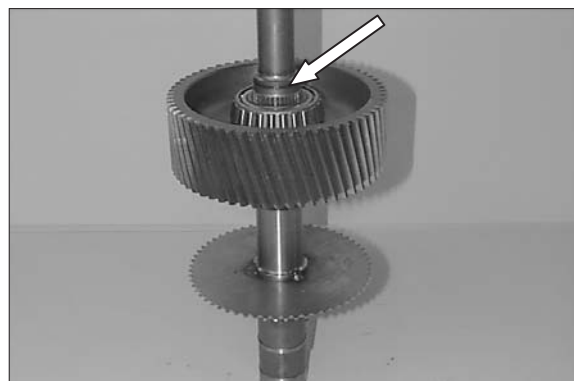


Figure 324



(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.

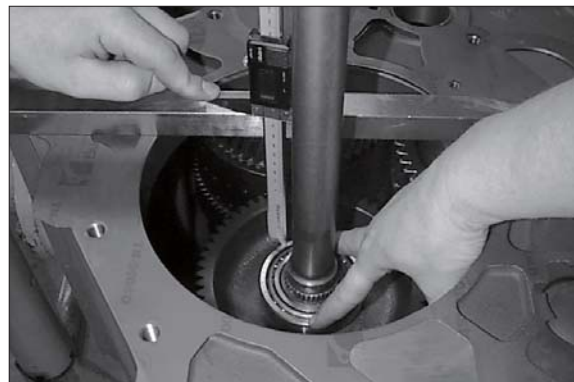


Figure 326

(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

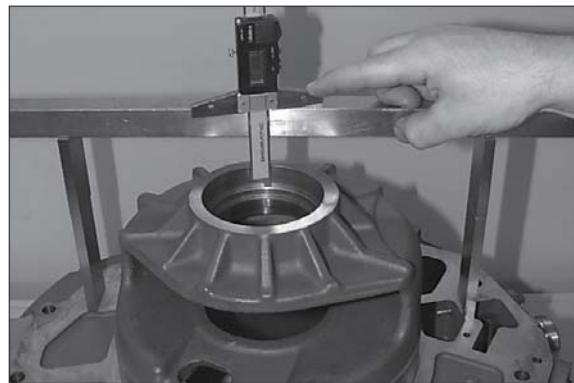


Figure 327

**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

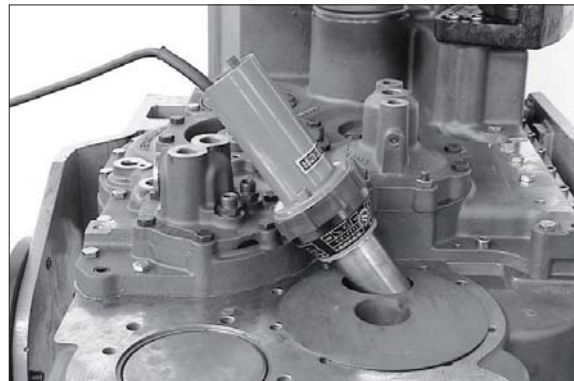


Figure 335

(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°.

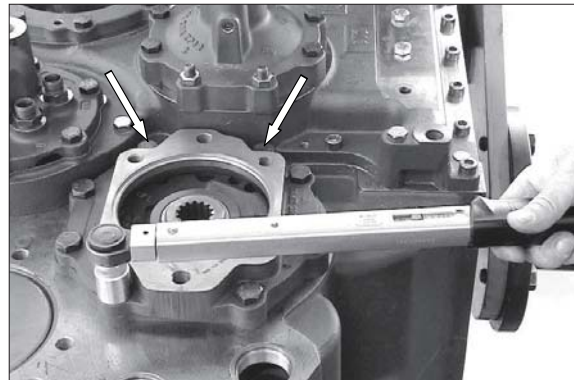


Figure 338

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

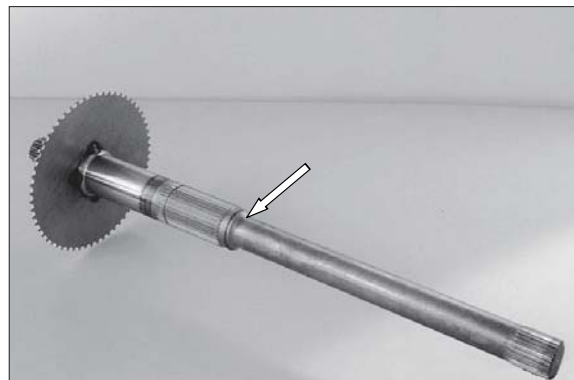


Figure 339

(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

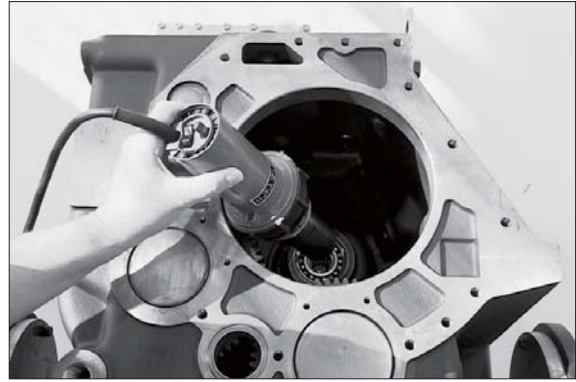


Figure 341

(14) Install the input shaft until contact.

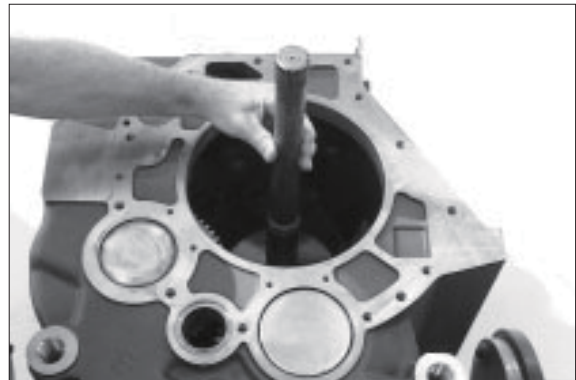


Figure 342

(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

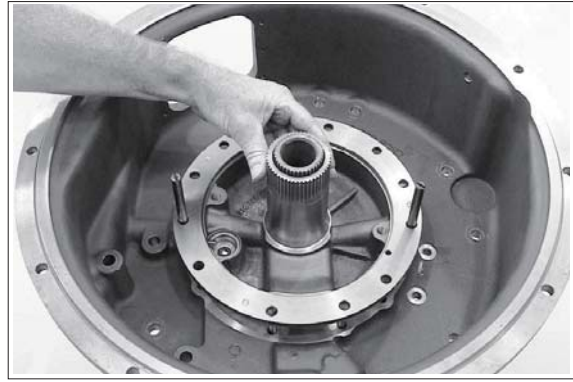


Figure 356

(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

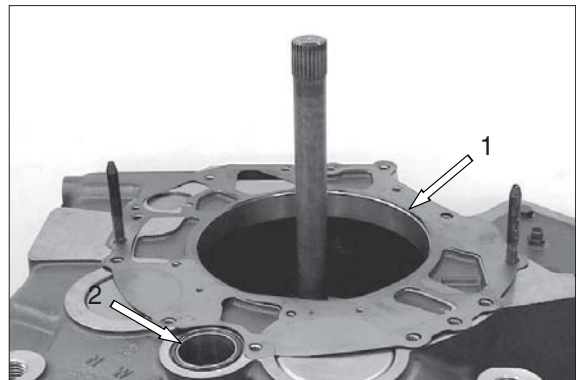


Figure 363

(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)

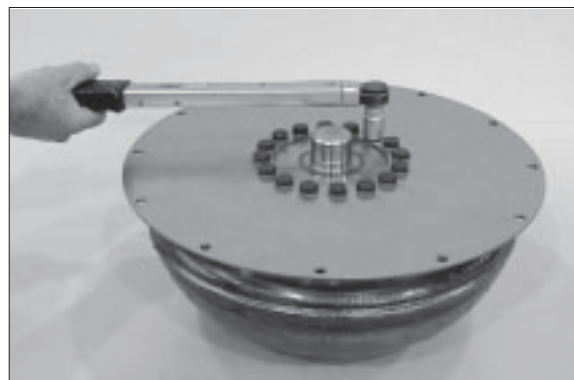


Figure 366

(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

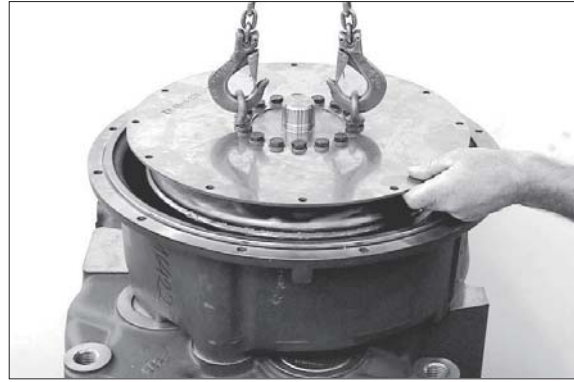


Figure 368



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).

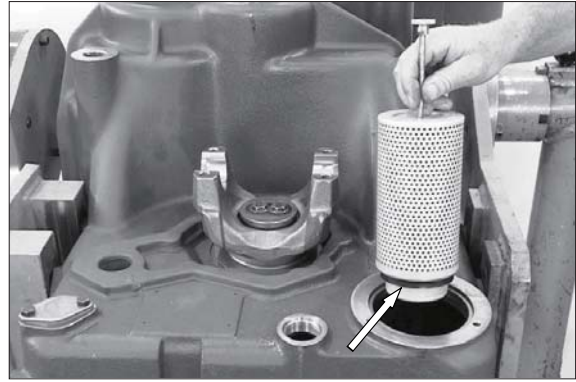


Figure 371

(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-Internal speed input
13	Speed transmitter	n-Output

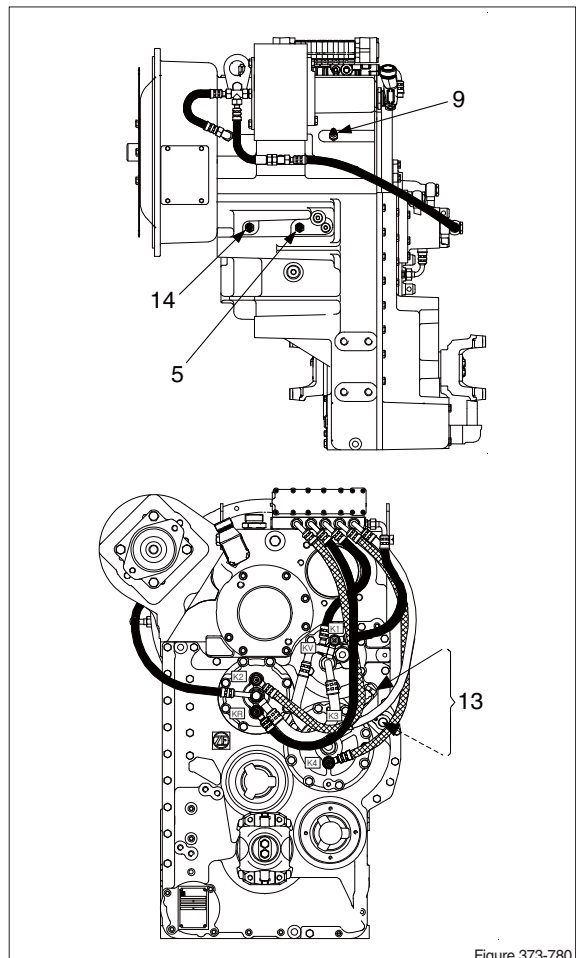


Figure 373-780

※ 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<sup>+0.3</sup> mm**

**Inductive transmitter n-Turbine (14)**

**X = 0.5<sup>+0.3</sup> mm**

**Induct. transmitter n-int. speed input (5)**

**X = 0.3<sup>±0.1</sup> mm**

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

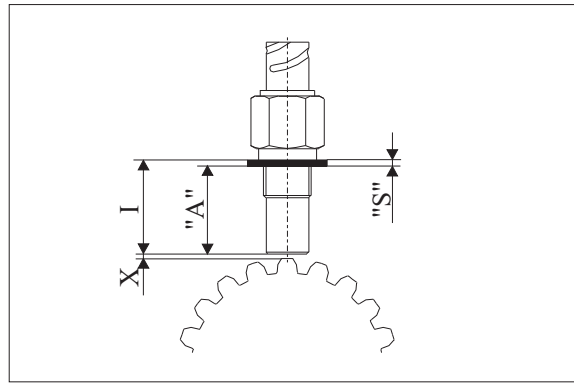


Figure 375



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

※ Special tool  
Plug gauge 5870 200 104

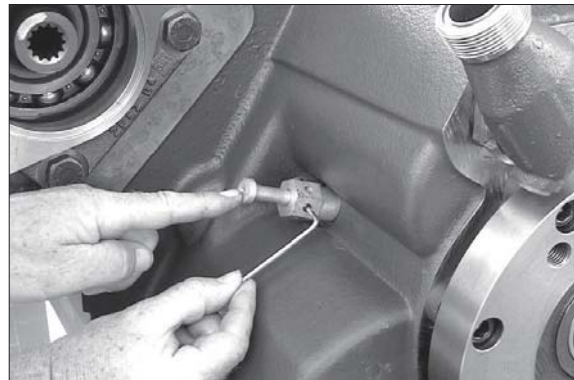


Figure 377

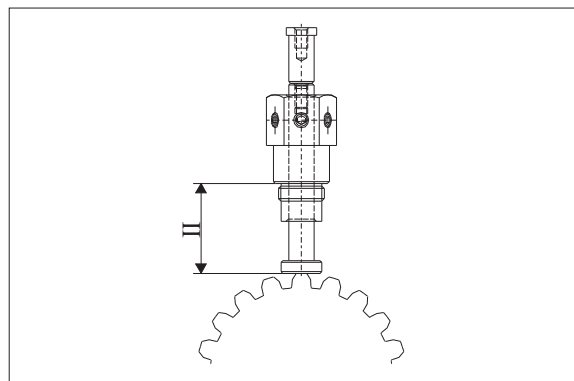


Figure 378

- (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<sub>1</sub>" :

$$\begin{array}{r}
 \text{Dimension II} \quad \quad \quad \underline{30.10 \text{ mm}} \\
 \text{Dimension X (0.5}^{+0.3} \text{ mm)} \quad - \underline{0.60 \text{ mm}} \\
 \text{Results in installation dimension A} \\
 \quad \quad \quad \quad \quad \quad \quad \quad = \underline{29.50 \text{ mm}}
 \end{array}$$

Example "A<sub>2</sub>" :

$$\begin{array}{r}
 \text{Dimension I} \quad \quad \quad \underline{30.00 \text{ mm}} \\
 \text{Installation dimension A} \quad - \underline{29.50 \text{ mm}} \\
 \text{Results in shim ring (s)} \quad s = \underline{0.50 \text{ mm}}
 \end{array}$$

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

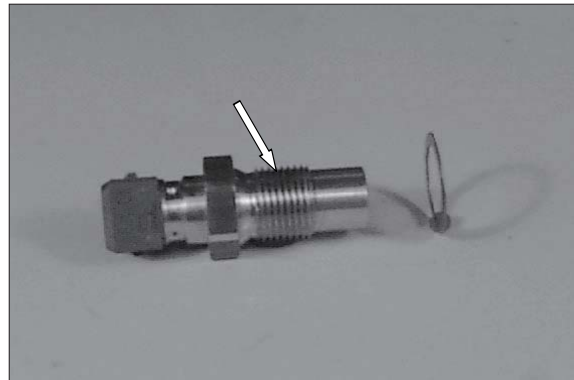


Figure 380

- (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

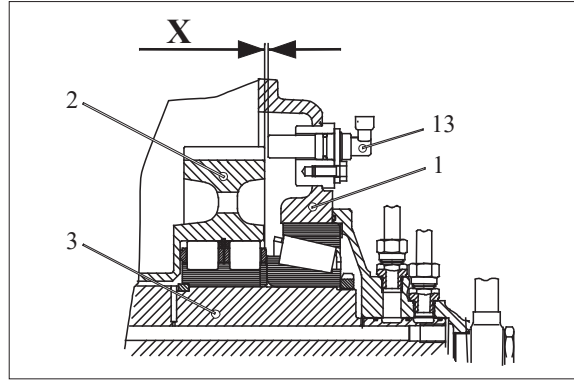


Figure 382

(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

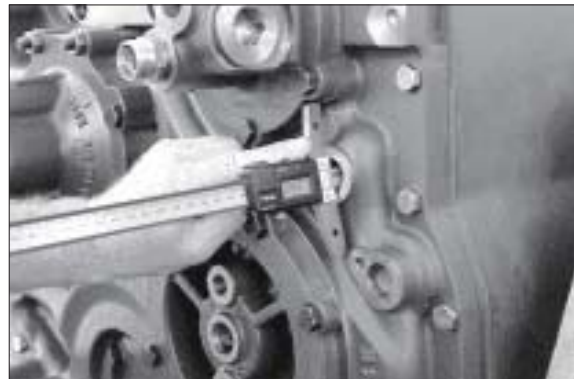


Figure 384

(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<sub>1</sub>" :

$$\begin{array}{r} \text{Dimension I} \qquad \qquad \qquad \underline{39.70 \text{ mm}} \\ \text{Dimension X}(1.0+0.5\text{mm}) \quad - \underline{1.20 \text{ mm}} \\ \text{Results in installation dimension} \\ \hline \qquad \qquad \qquad \qquad \qquad \qquad = \underline{38.50 \text{ mm}} \end{array}$$

Example "B<sub>2</sub>" :

$$\begin{array}{r} \text{Dimension II} \qquad \qquad \qquad \underline{40.00 \text{ mm}} \\ \text{Installation dimension A} \quad - \underline{38.50 \text{ mm}} \\ \text{Results in shim(s)} \qquad \qquad \quad s = \underline{1.50 \text{ mm}} \end{array}$$

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

(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.

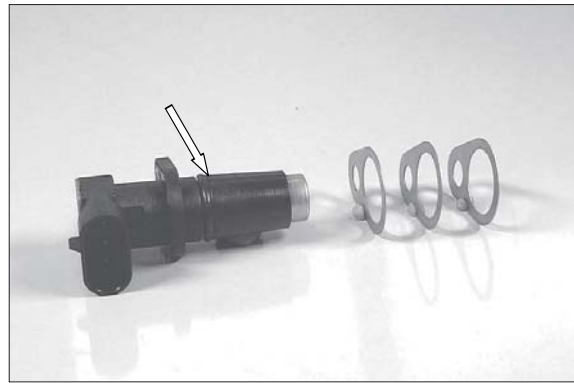


Figure 386

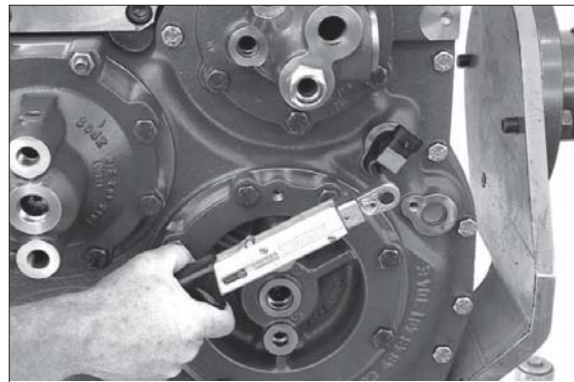


Figure 387

### 3. AXLE

#### 1) DISASSEMBLY

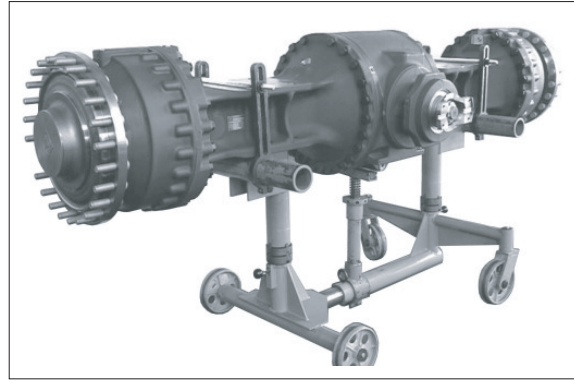
##### (1) Disassembly output and brake

① Fix axle to assembly truck.

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

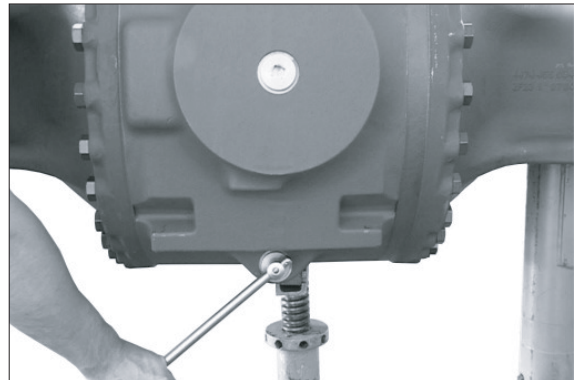
※ Before clamping the axle fully turn in the support.

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

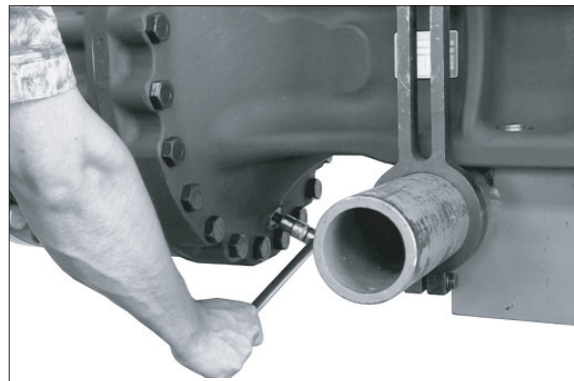


7809AX01

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



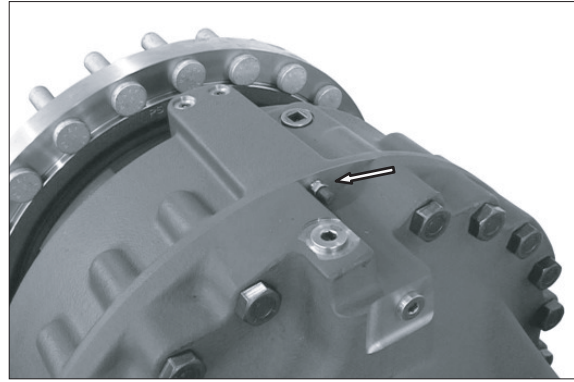
7809AX02



7809AX03

③ Remove the breather valve (see arrow).

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

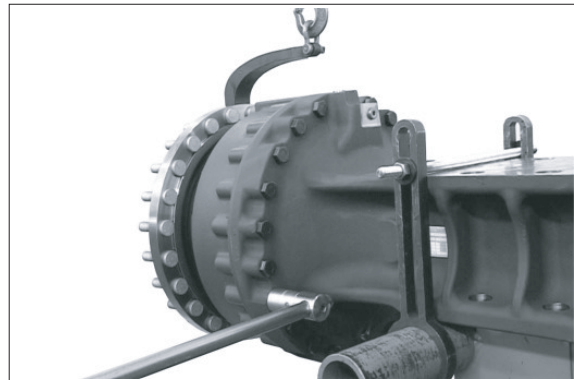


7809AX04

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

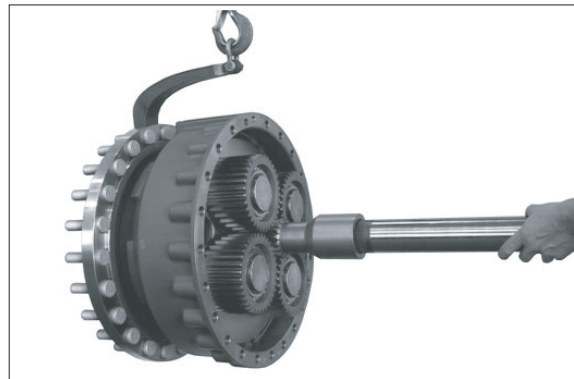
※ Fix the load carrying device with wheel nuts.



7809AX05

⑤ Pull stub shaft and sun gear shaft.

※ Pay attention to potentially releasing shim(s).

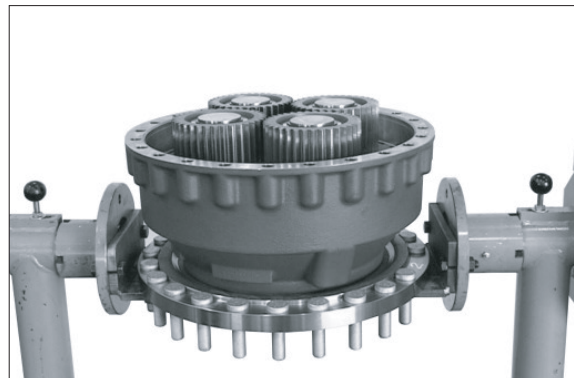


7809AX06

⑥ Fix output to assembly truck.

Assembly truck                      5870 350 000

Fixtures (2EA)                      5870 350 113



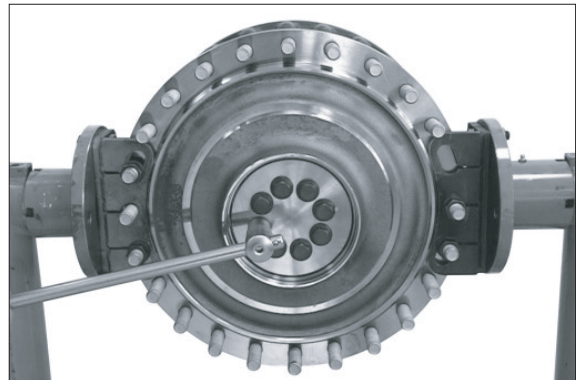
7809AX07

- 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.



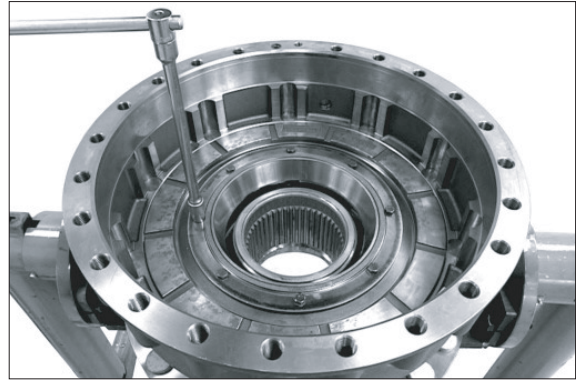
7809AX73

⑭ Lift the disk package out of the brake housing.



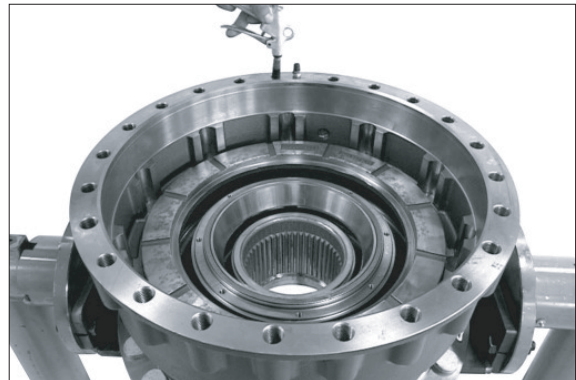
7809AX12

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



7809AX13

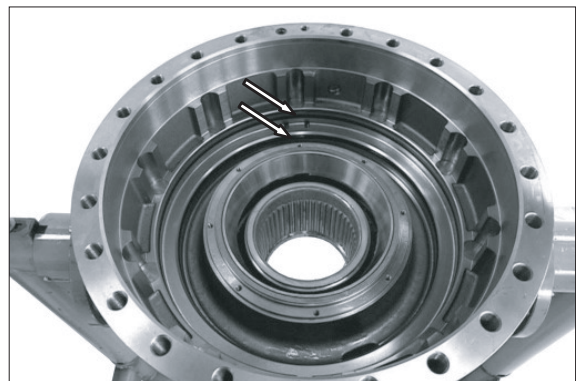
- ⑯ Mount breather valve and press piston out of the brake housing by means of compressed air.



7809AX14

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

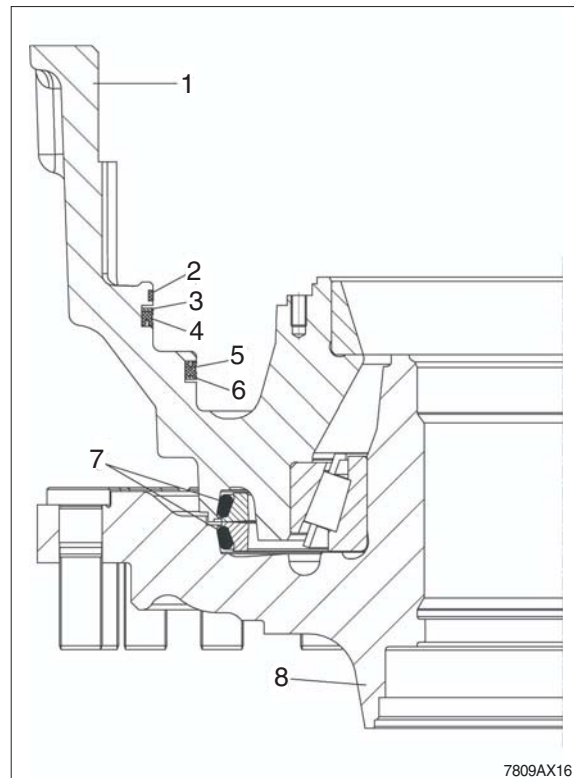
- ※ For the installation position of the single parts please also refer to the following sketch.



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



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



- 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



- 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

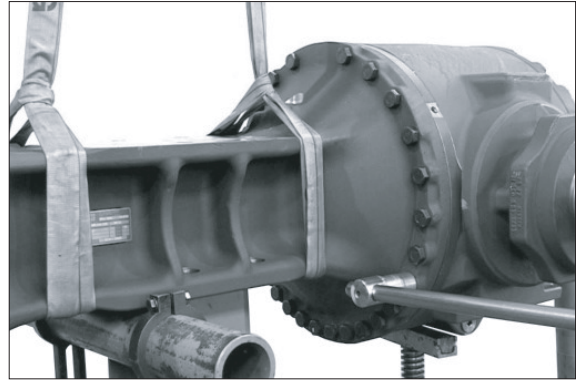


7809AX75



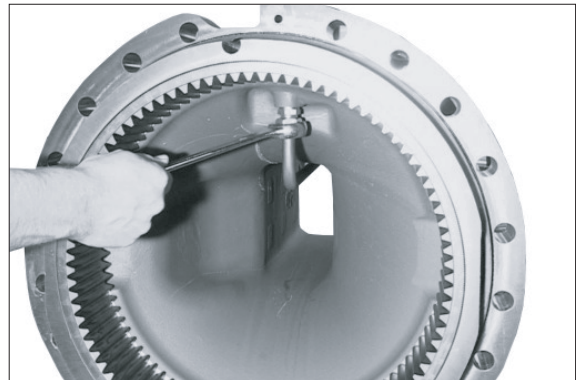
## (2) Disassembly axle housing

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



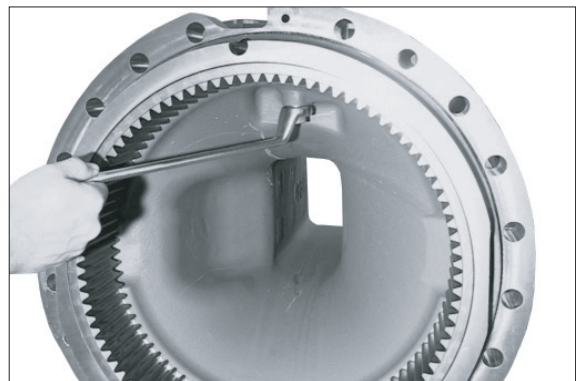
7809AX19

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



7809AX20

- ③ Loosen both screw necks.



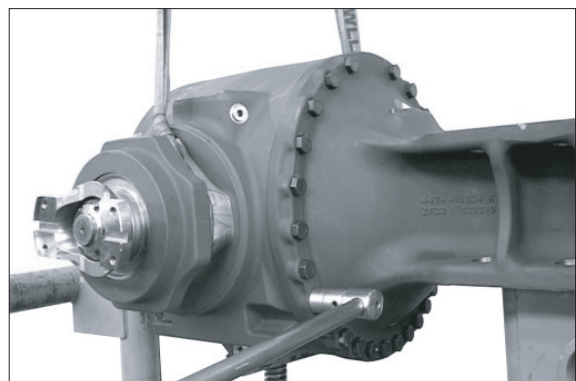
7809AX21

## (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)  
Thread insert

5870 204 086  
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 3-229.



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

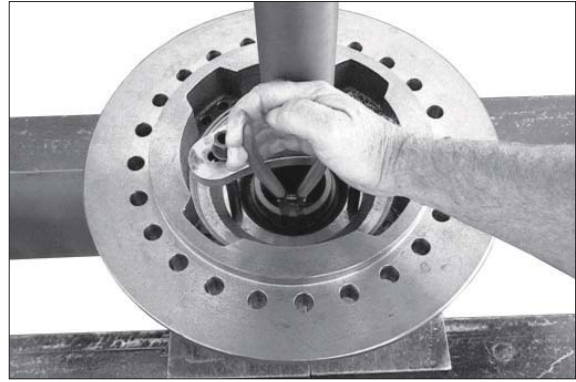
Eye nut AA00 680 376



7809AX93

- ⑤ Preload the compression spring by means of the press and disengage the retaining ring.

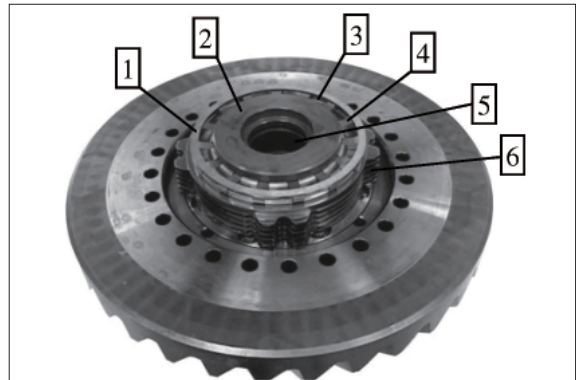
Then pull the sliding sleeve out of the differential cover and remove the releasing compression springs.



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



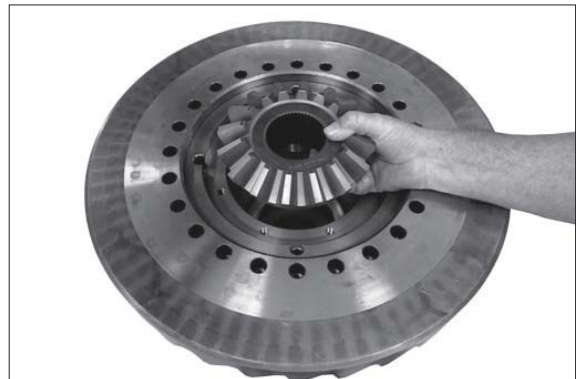
7809AX102

- ② Insert disk and thrust washer into the differential housing



7809AX103

- ③ Insert axle bevel gear.

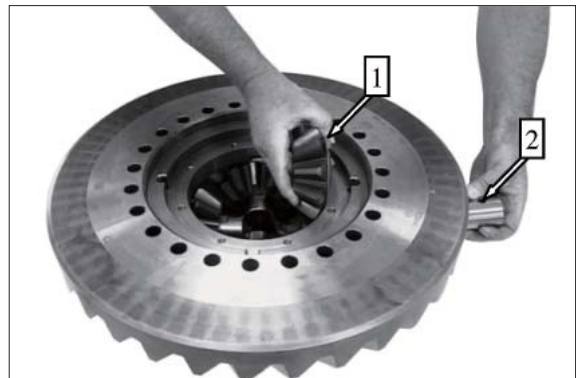


7809AX104

- 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)

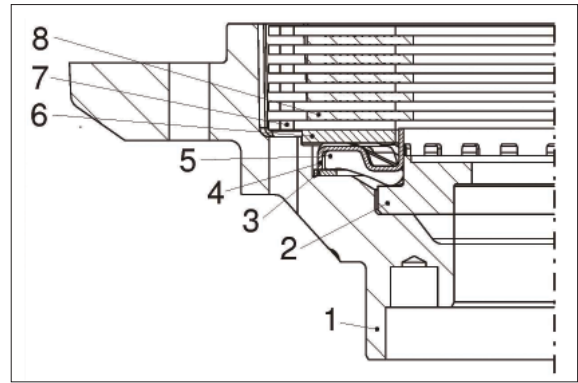


7809AX108

### 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).

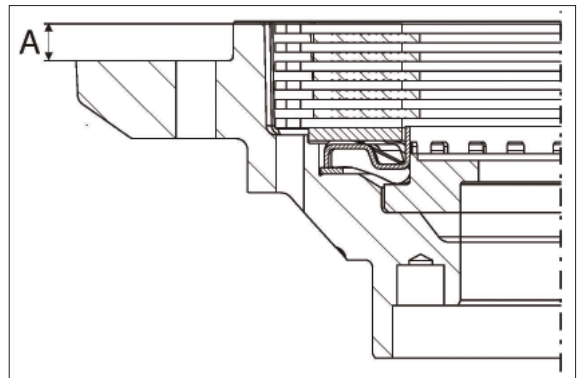
- ※ Any deviation from the specified setting dimension must be corrected with a corresponding outer disk.



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.



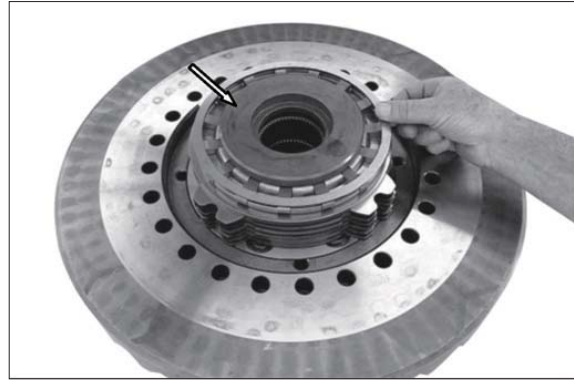
7809AX115

- 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.



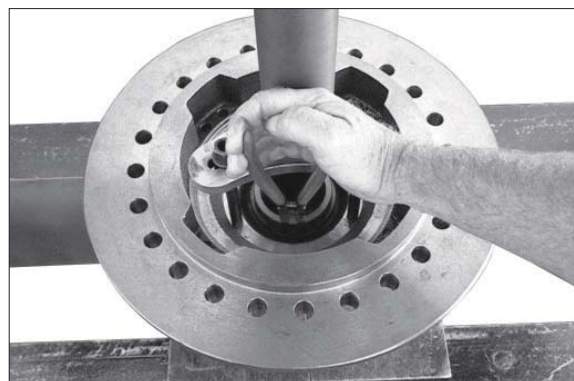
7809AX118

- 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

- ① 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

- ② 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

- ③ Heat both tapered roller bearings and insert until contact is obtained.

※ Adjust tapered roller bearing after cooling down.



7809AX123

- ④ Insert axial roller cage (see arrow).



7809AX124

## (2) Assembly axle drive housing

※ If crown wheel or input pinion are damaged, both parts must be jointly replaced.

In case of a new installation of a complete bevel gear set pay attention to an identical mating number of input pinion and crown wheel.

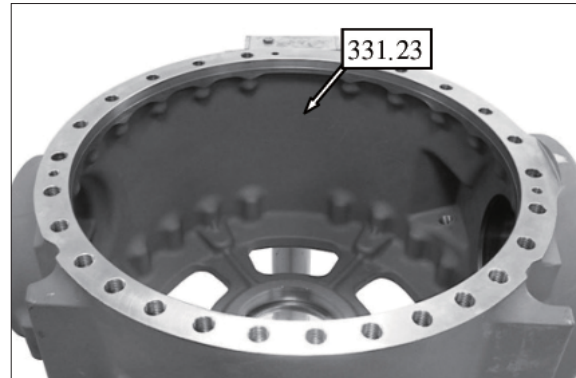
### Determination of shim thickness to obtain a correct contact pattern

※ The following measuring procedures must be carried out with utmost accuracy.

Inaccurate measurements lead to an incorrect contact pattern requiring an additional disassembly and reassembly of input pinion and differential.

① Read dimension I from the axle drive housing.

Dimension I e.g ..... 331.25 mm



7809AX125

② Read dimension II (pinion dimension).

Dimension II e.g ..... 265.00 mm



7809AX126

- ③ Determine dimension III (bearing width).

Dimension III e.g. .... 63.60 mm

Calculation example A :

Dimension I ..... 331.25 mm

Dimension II ..... - 265.00 mm

Dimension III ..... - 63.60 mm

Difference = shim                      s = 2.60 mm



7809AX127

### Reassembly of input pinion

- ① Undercool the external bearing outer ring and insert it into the axle drive housing until contact is obtained.

Driver tool                      5870 050 007

Handle                              5870 260 004



7809AX128

- ② Insert the determined shim e.g.  $s = 2.60$  mm into the housing hole.



7809AX129

- ③ Undercool the internal bearing outer ring and bring it into contact position in the housing hole by using the assembly fixture.

Assembly fixture                      AA00 623 955



7809AX130



- ④ Heat the tapered roller bearing and insert it into the input pinion until contact is obtained.



7809AX131

**Setting of rolling torque of input pinion bearing 0.1~0.5 kgf·m (without shaft seal ring)**

- ⑤ Insert spacer (e.g.  $s = 7.13$  mm).
- ※ According to our experience the necessary rolling torque is obtained when reusing the spacer which has been removed during disassembly (e.g.  $s = 7.13$  mm).  
A later check of the rolling torque, however, is absolutely necessary.



7809AX132

- ⑥ Insert the preassembled input pinion into the axle drive housing and insert the heated tapered roller bearing until contact is obtained.



7809AX133

- ⑦ Press the protection plate onto the input flange (see arrow) until contact is obtained.
- ※ Do not fit the shaft seal ring until the contact pattern has been checked.



7809AX134

- ⑧ Insert input flange and fix it by means of disk and slotted nut.

· Tightening torque :

122 kgf · m (885 lbf · ft)

Wrench 5870 401 093

Fixing device AA00 695 905

Clamping device 870 240 002

- ※ Preliminarily mount slotted nut without Loctite.

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



7809AX135

- ⑨ Check rolling torque (0.15~0.51 kgf·m without shaft seal ring).

- ※ When installing new bearings try to achieve the upper value of the rolling torque.

- ※ In case of deviations from the necessary rolling torque correct with a corresponding spacer (figure AX132, page 3-240) 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.

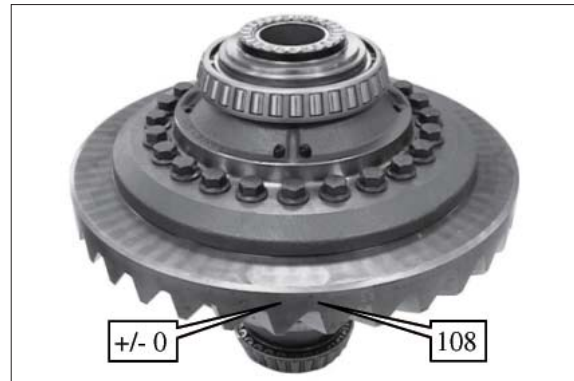
The test dimension 108 is stamped into the crown wheel rear side. If no + or – deviation is indicated, this value corresponds to the actual value 0 in the table below. According to this value, the required shims are allocated in the table below.

※ 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) .

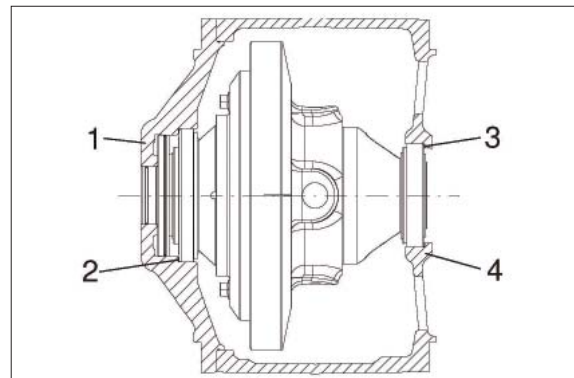
In accordance with this deviation, the required shims are allocated in the table below.

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						
Crown wheel marking	- 30	- 20	- 10	0	10	20
Deviation	- 0.3	- 0.2	- 0.1	0	0.1	0.2
<b>Shim diff cage side shim thickness</b>	<b>1.1</b>	<b>1.2</b>	<b>1.3</b>	<b>1.4</b>	<b>1.5</b>	<b>1.6</b>
Shim P/No.	ZGAQ-03681	ZGAQ-03676	ZGAQ-03677	ZGAQ-03678	ZGAQ-03679	ZGAQ-03680
<b>Shim crown wheel side shim thickness</b>	<b>1.7</b>	<b>1.6</b>	<b>1.5</b>	<b>1.4</b>	<b>1.3</b>	<b>1.2</b>
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 3-239), which must be corrected by all means.



7809AX149

- ⑨ After the contact pattern check insert the differential again into the axle drive housing.



7809AX150

### Reassembly of shaft seal ring (figure AX151~153)

- ⑩ Loosen slotted nut and pull the input flange from the input pinion.

Wrench	5870 401 093
Fixing device	AA00 695 905
Clamping device	5870 240 002



7809AX151

- ⑪ Mount the shaft seal ring with the seal lip showing to the oil chamber.

Driver tool	AA00 623 986
-------------	--------------

- ※ The exact installation position of the shaft seal ring is obtained when using the specified driver tool.
- ※ Wet the outer diameter of the shaft seal ring with spirit directly before installation and fill the space between seal and dust lip with grease.



7809AX152

- ⑫ Insert input flange and finally tighten by means of disk and slotted nut.

· Tightening torque :  
122 kgf · m (12.5 lbf · ft)

Wrench	5870 401 093
Fixing device	AA00 695 905
Clamping device	5870 240 002

- ※ Cover the thread of the slotted nut with loctite #262.



7809AX153

- ⑬ Grease O-ring (see arrow) and insert it into the annular groove of the bearing housing.



7809AX154

- ⑭ Insert the bearing housing by means of the lifting device and finally tighten it with cylindrical screws.

· Tightening torque (M12/10.9) :  
5.1 kgf · m (36.9 lbf · ft)



7809AX155

- ⑮ Grease O-rings (see arrows) and insert them on both sides of the axle drive housing.



7809AX156

- ⑯ Mount two adjusting screws and bring axle drive housing in contact position with the axle housing by using the lifting device.

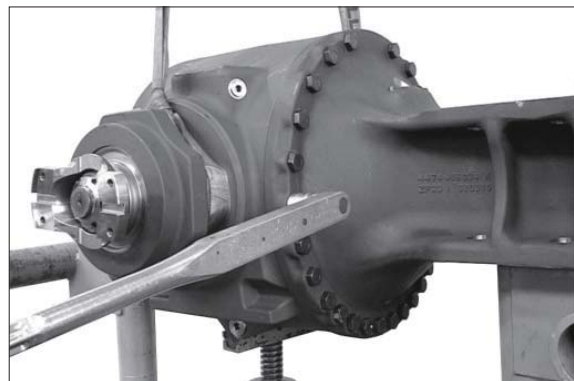
Then fix the axle drive housing with hexagon screws.

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

Adjusting screws (M20) 5870 204 024

Eye bolt (M20) 5870 204 086

Thread insert AA00 677 715



7809AX157

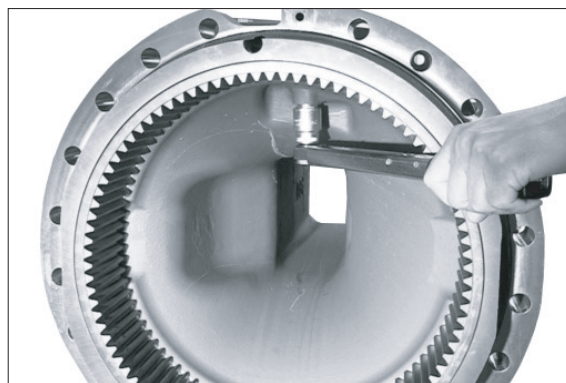
- ※ After mounting the axle drive housing unbolt the support until contact is obtained.



### (3) Assembly axle housing

① Mount both fittings.

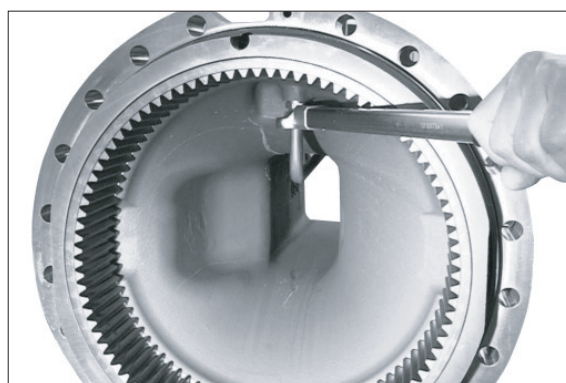
- Tightening torque : 3.67 kgf · m  
(26.6 lbf · ft)



7809AX158

② Mount brake tube.

- Tightening torque : 10.2 kgf · m  
(73.8 lbf · ft)



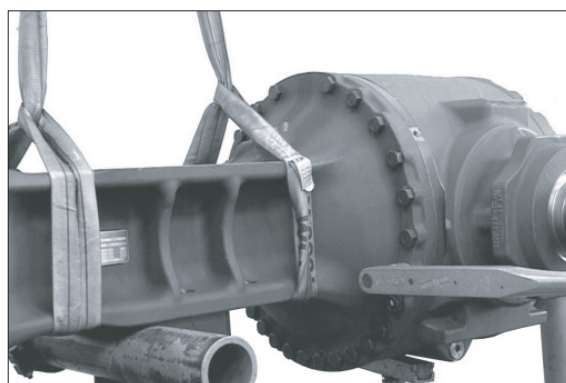
7809AX159

③ Mount two adjusting screws and bring the axle housing into contact position with the axle drive housing by using the lifting device.

Then fix the axle housing by means of hexagon screws.

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

Adjusting screws (M20) 5870 204 024



7809AX160

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

#### (4) Assembly output and brake

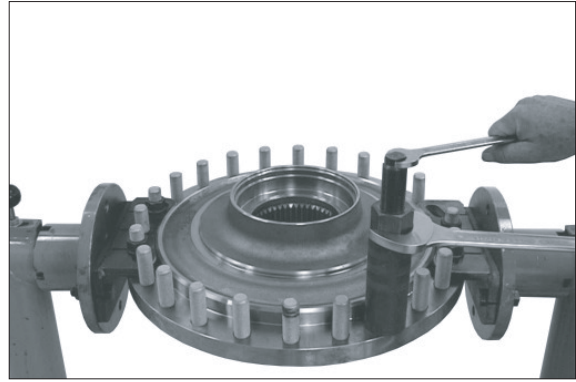
- ① Pull in wheel stud into the output shaft until contact is obtained.

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.



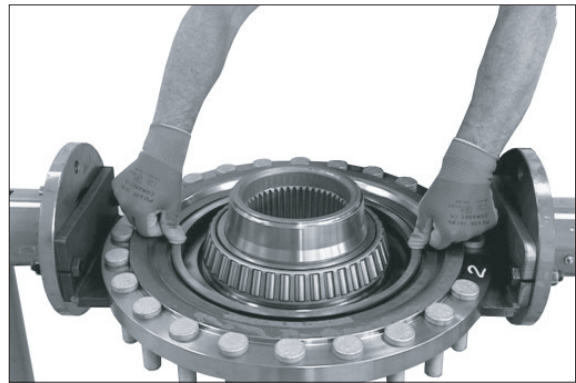
7809AX29

- 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 3-251.



7809AX30

- ※ 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.

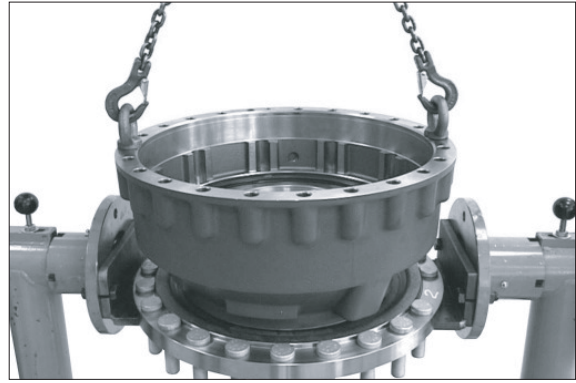
The O-rings must be mounted evenly into the locating hole and must not bulge out of the hole. Risk of injury - Metal rings have extremely sharp edges. Wear protective gloves.



7809AX31

③ Insert the premounted brake housing by means of the lifting device over the output shaft until contact is obtained.

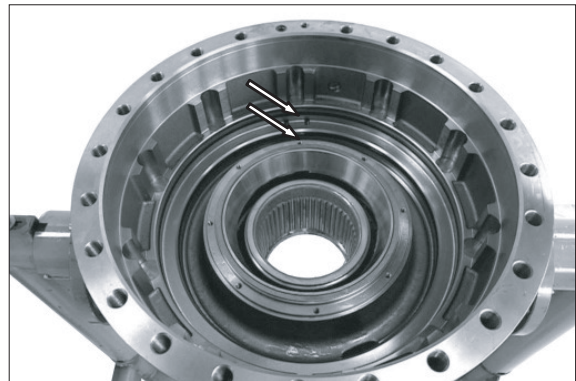
※ Before clamping the seal rings to installation dimension, clean the sliding surfaces and apply an oil film. We recommend to use a leather cloth soaked with oil.



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 3-251.



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.

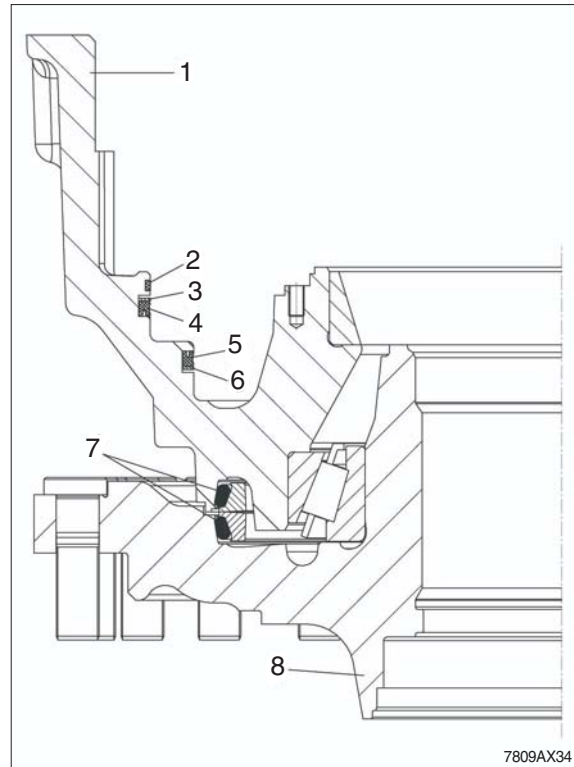
※ Upon installation the orifice of the guide ring must show upwards (12 o'clock).



7809AX33

**Legend to sketch:**

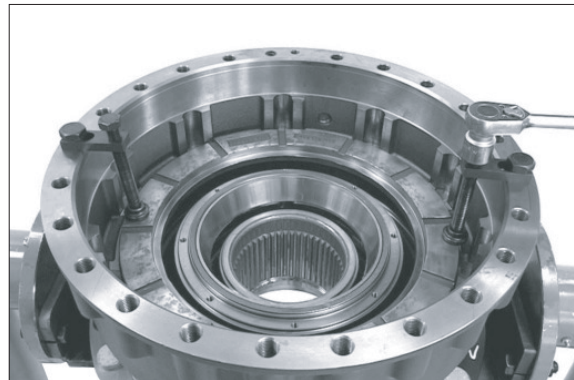
- 1 = Brake housing
- 2 = Guide ring
- 3 = Back-up ring
- 4 = Grooved ring
- 5 = Grooved ring
- 6 = Back-up ring
- 7 = Slide ring seal
- 8 = Output shaft



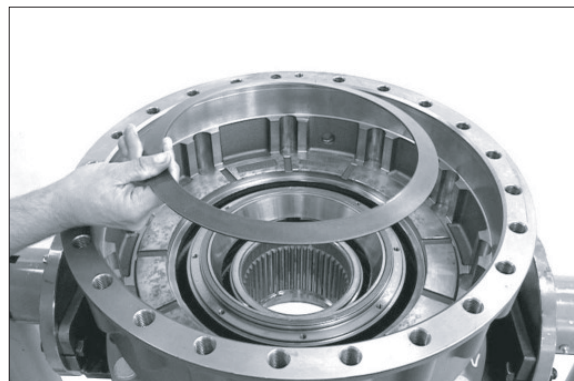
- ⑥ Insert the piston into the brake housing and carefully install with the fixing device until contact is obtained.

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).

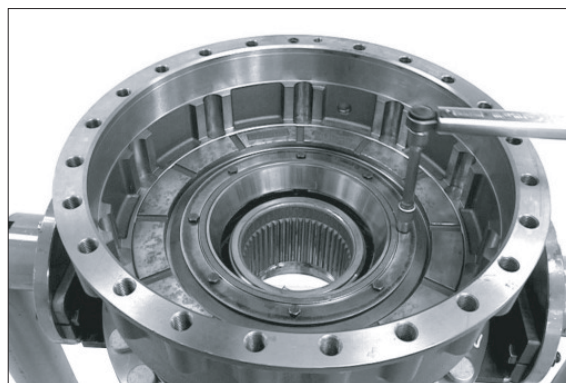


- ⑦ Insert cup spring into the piston with the convex side showing upwards.



- ⑧ Insert disk and fix it by means of hexagon screws.

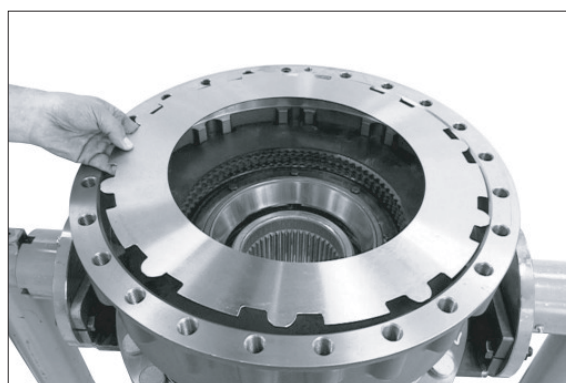
· Tightening torque (M8/10.9) :  
3.47 kgf · m (25.1 lbf · ft)



7809AX37

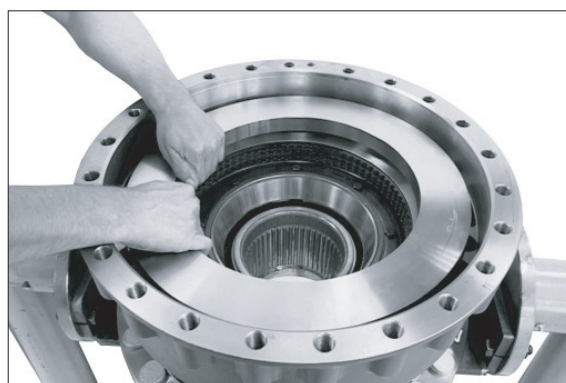
- ⑨ Mount outer and inner disks.

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



7809AX38

- ⑩ Insert end plate.



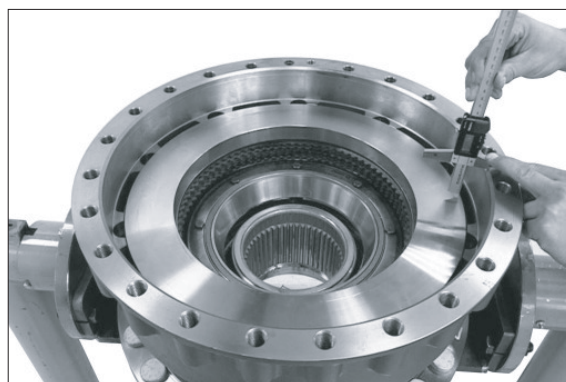
7809AX39

**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).



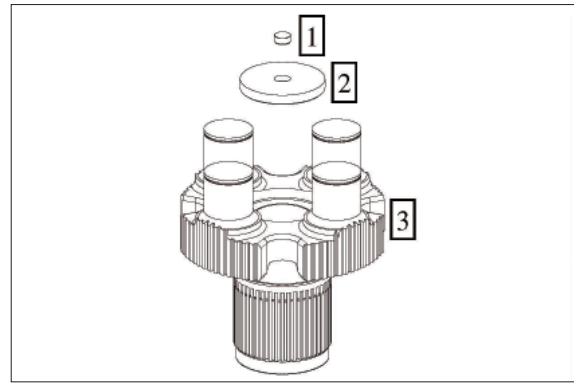
7809AX40

- 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

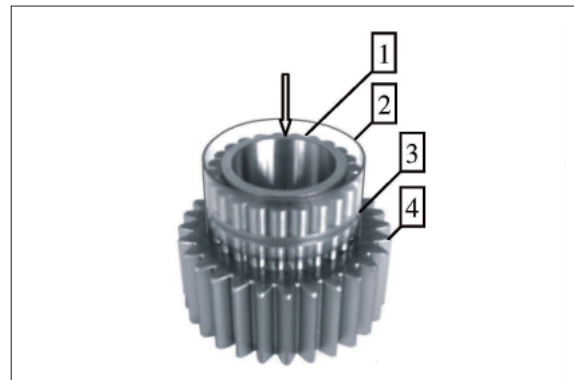


7809AX161

- 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.



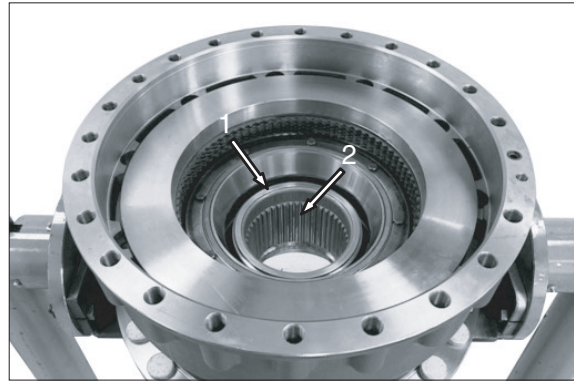
7809AX163

- ⑮ Heat tapered roller bearing and install it to the planetary carrier until contact is obtained.



7809AX164

- ⑩ Wet front face (contact face bearing inner ring, arrow 1) and profile (teeth, arrow 2) in the output shaft with anti-corrosive agent.



7809AX41

- ⑪ 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)

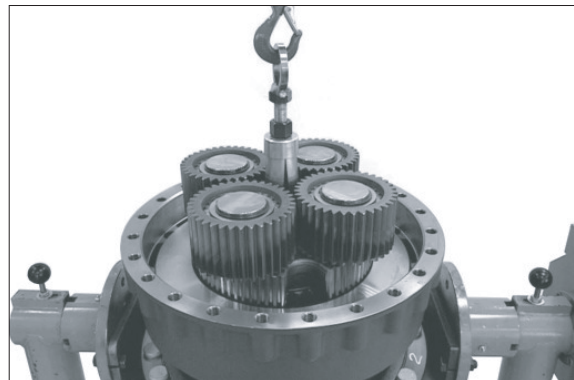
Inner extractor                    5870 300 019

Eye bolt                            5870 204 073

- Front axle (planetary carrier with 4 planetary gears)

Inner extractor                    5870 300 008

Eye nut                              AA00 680 376

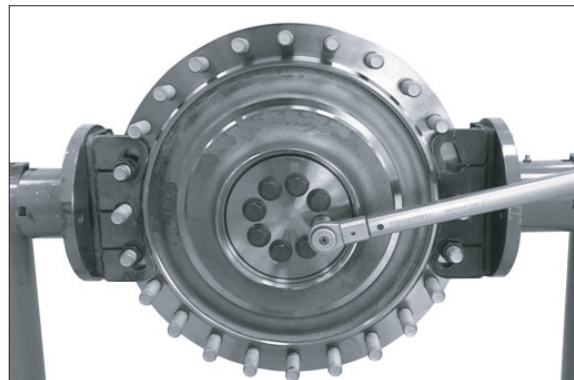


7809AX42

- ⑫ 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

⑱ 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**

㉑ 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

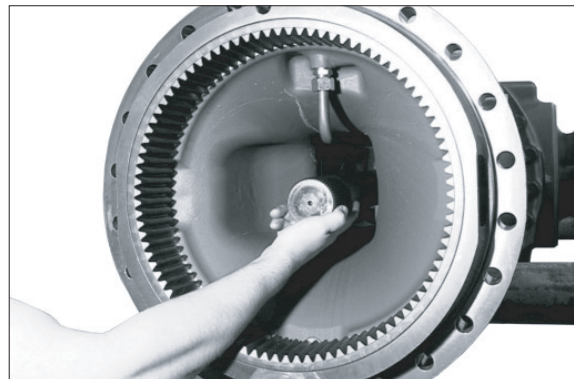
Straightedge 5870 200 022



7809AX46

㉒ Insert stub shaft into the teeth of the axle bevel gear until contact is obtained.

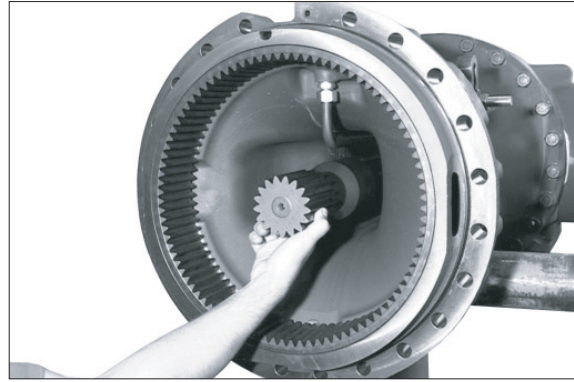
※ Pay attention to the installation position;  
mount the stub shaft with the long teeth  
showing to the differential.



7809AX47



- ② Insert the sun gear shaft until contact is obtained.



7809AX48

- ③ 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 :**

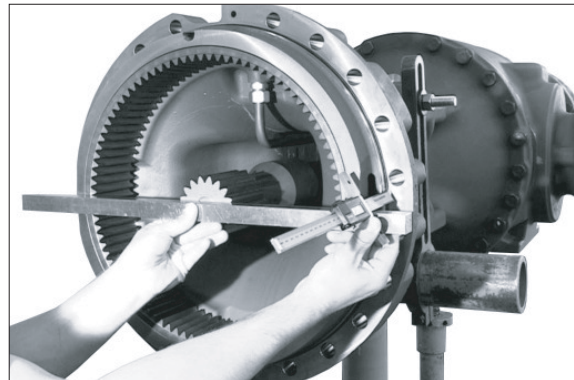
Dimension I ..... 58.60 mm

Dimension II ..... - 56.60 mm

Difference ..... 2.00 mm

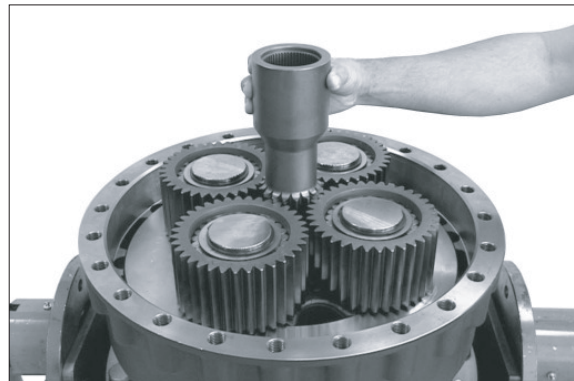
Required axial play e.g. .... - 1.00 mm

**Difference = shim e.g. s = 1.00 mm**



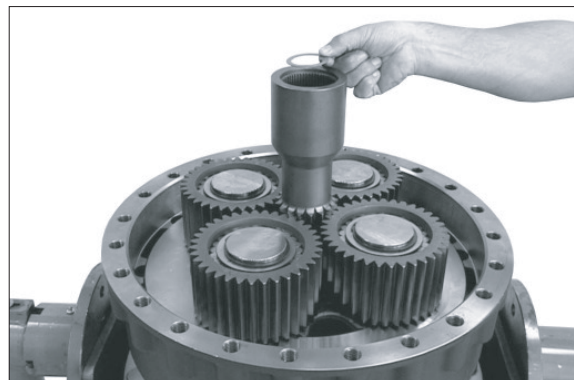
7809AX49

- ④ Insert sun gear shaft into the planetary carrier.



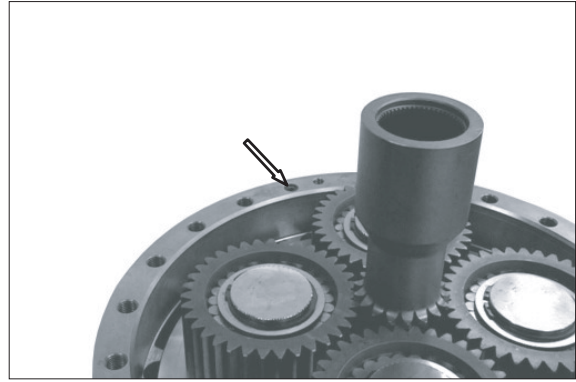
7809AX50

- ⑤ Fix determined shim e.g. s = 1.00 mm with grease into the sun gear shaft.



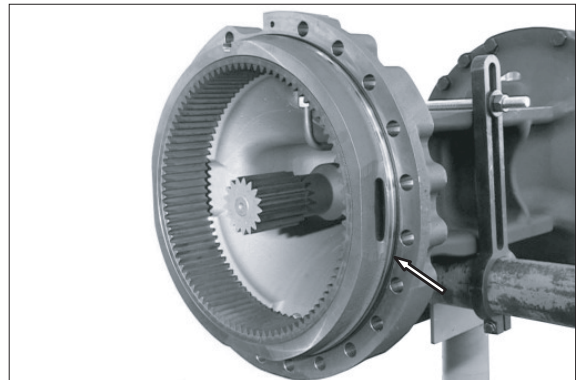
7809AX51

- 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.



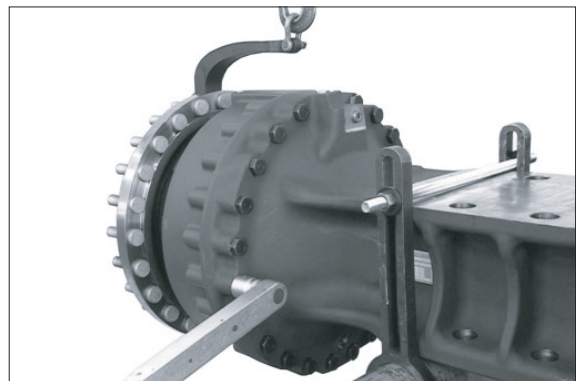
7809AX53

- 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)

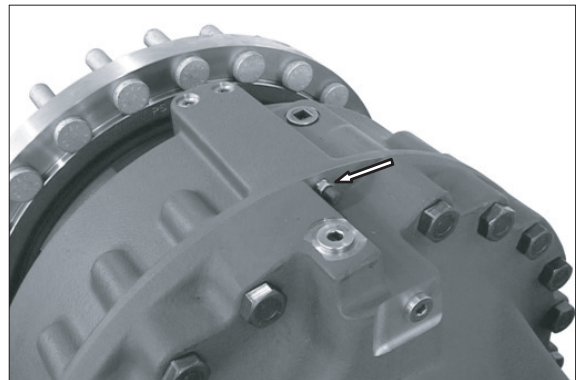
Adjusting screws (M20) 5870 204 024  
Load-carrying device AA00 685 875

- ※ Fix load carrying device with wheel stud.



7809AX54

- ②⑨ Mount breather (see arrow).



7809AX55

③ 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 :**

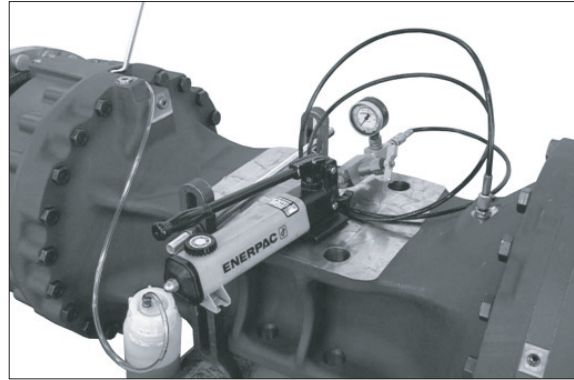
Reduce test pressure  $p = 5$  bar and close shut-off valve.

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

③ 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