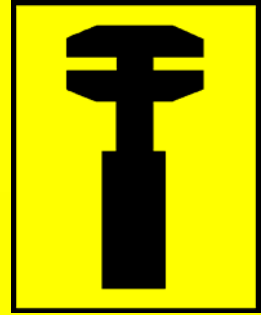
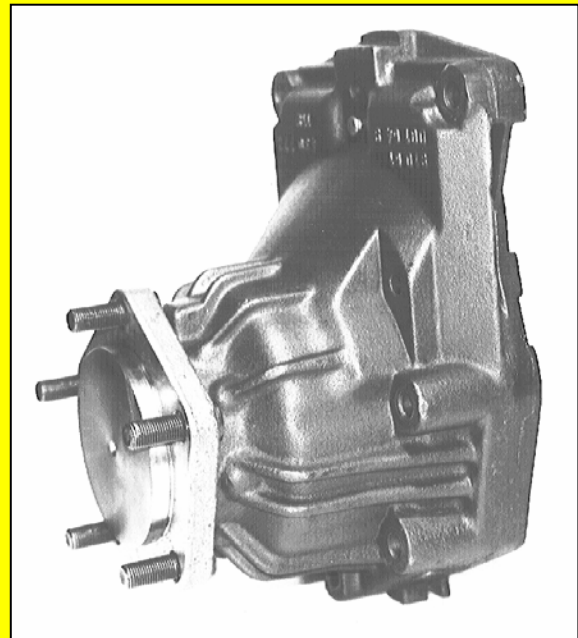


ZF-Ergomat HFS 507, GP 18, GP 20 & GP 21 Repair Manual



Edition: 26.07.2004

For all publications we reserve us the right of modifications due to technical reasons in production, processing and appearance.



ZF GOTHA GMBH
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Introduction

This repair manual describes the disassembly and reassembly as well as the elimination of failures for HFS 507, GP 18, GP 20 and GP 21 transmissions. The herein described work is only allowed to be made by specialists who were trained by ZF GOTH A for maintenance and repair work on ZF units. It is absolutely required that design and function of the mentioned transmission types are known.

Prior to start work read this manual carefully. Carry out the single working steps as described and do not change them without permission. Observe the safety instructions. If you do not understand a procedure or cannot follow it doubtlessly, do not act on your own without permission, but consult the After-Sales Service at ZF GOTH A*.

For the work described in this manual only original spare parts from ZF GOTH A or spare parts approved by ZF GOTH A are allowed to be used. If no original parts are used the optimum function of the transmission can be negatively affected and the warranty claim will lapse.

ZF GOTH A does not accept any liability for damages and failures caused by

- faulty installation
- modifications on the transmission or the drive unit without permission
- inadequate use of the transmission or the drive unit
- insufficient maintenance
- improperly and incompetently performed work and the resulting consequential damages
- faulty operation
- disregard of the repair manual
- work on the transmission which was not made by ZF GOTH A.

ZF GOTH A reserves further technical development of their products. It is possible that procedures can become necessary which differ from those described in the original version of this manual. In this case the customers are informed by ZF GOTH A and the changed pages of this manual will be made available to them.

The customer is responsible to replace the changed pages and thus to keep this repair manual updated. The respective version is indicated on the bottom of every page for information. If you are not sure, whether you have the current version of your manual, please consult the Technical Service of the ZF Gotha GmbH and request the respective current version.

Keep this manual in such a way that it can always be found by persons concerned with the product. A separate operating manual is available for the installation and operation.

Since further technical development of the product might require setting and test data for repair and maintenance we recommend not to make the repair and maintenance work not on your own.

ZF GOTH A offers to persons interested the illustrated special and adapter tools, for the use of which the customer is responsible on his own.

It is a requirement that adequate presses and corresponding bolting/connection technology are available. ZF GOTH A also offers the planning and delivery of a complete assembly unit which is to be inquired at our company separately.

For an optimum maintenance and repair of the product we recommend to have made the repair and maintenance work by our service technicians.

Maintenance and repair work made by us are also covered by a ZF warranty within the applicable terms of contract.

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Date: June 2004

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1. Product Description

1.1 Components and Accessories of a HFS 507 or GP – Transmission

Transmissions of the HFS 507 & GP Product Range consists essentially of the following components:

Item 01	Transmission housing
Item 02	Transmission cover
Item 03	Wheel shaft
Item 04	Model Identification Plate
Item 05	Motor *

Not illustrated are for instance:

- Helical gear set, consisting of helical gear and drive pinion
- Planetary gear stage
- Oil filler and oil level plug
- Brake lever

* optional component

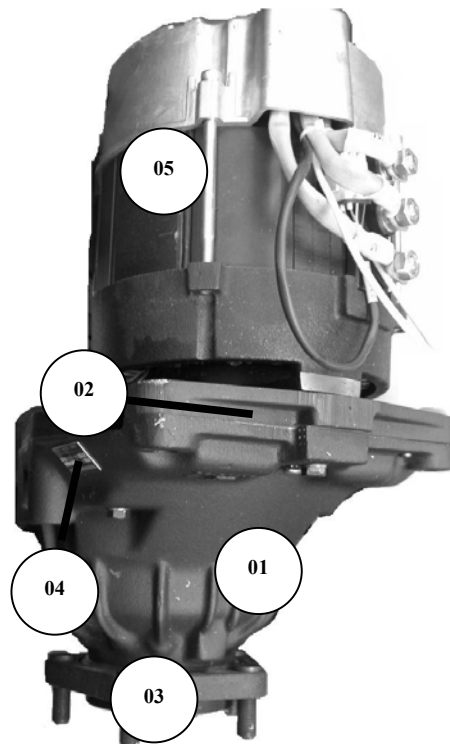


Figure 01

1.2 Transmission Identification

The model identification plate is fixed to the transmission housing side.

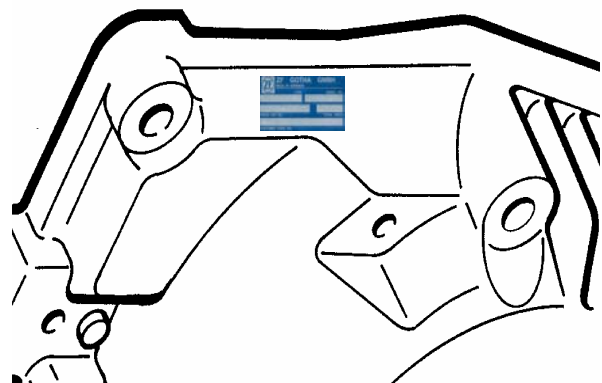


Figure 02

Data indicated there are as follows:

- 01 Transmission Type
- 02 Serial No.
- 03 Total Ratio
- 04 ZF Parts List No.

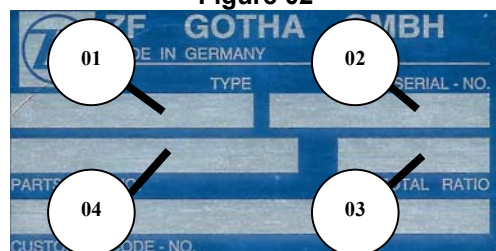


Figure 03

2. Safety Instructions

2.1 Applied Terms and Warning Symbols

If the below described work is hazardous, you will be warned by means of safety instructions. Please observe and follow these instructions.

The following terms and symbols are used:

"WARNING" refers to a possibly threatening danger which can cause serious injuries or even be fatal.

"CAUTION" refers to possibly dangerous situations which can cause minor injuries.

"ATTENTION" refers to situations which can cause damage to the product or material.



This symbol refers to moving parts, for example gears, which can cause injuries.



This symbol refers to danger of burns for example by hot transmission oil.



This symbol refers to dangers by substances which are harmful to health.



This symbol refers to important instructions. If these are not followed by you, the transmission or add-on parts can be damaged.



This symbol refers to additional information.

3. Product Safety and Danger Zones

This product was made with utmost care and corresponds to the state of technology and the recognized safety rules. But nevertheless, this product might cause dangers which can be of

- mechanical nature (transmission mechanism, drive)
- thermal nature (hot transmission oil)
- chemical nature (cleaning agents, adhesives).

Please read the safety instructions and the procedures of this manual carefully prior to start the work and observe all safety rules and instructions. If there is anything you do not understand or you are not sure, please consult your superior or ZF GOTHÄ's After-Sales Service.

Please observe the accepted rules of industrial safety and the regulations for the prevention of accidents.

Modifications or changes on the transmission without the proper permission are not allowed and can cause hazards or damages.

3.1 Immediate Actions at Contact with Cleaning Agents



In case of skin contact rinse immediately with a lot of water! If swallowed, call medical aid immediately!

4. General Data for Disassembly and Reassembly

4.1 Safety Instructions



During work on movable transmission parts in the installed transmission, these could start unexpectedly and cause injuries to you. Prior to all work on the installed transmission (e.g. oil change) or its add-on parts disconnect the power source feeding the motor.



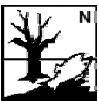
During work on the installed or mounted transmission the vehicle might suddenly move and cause injuries to you. Block the wheels prior to start the work. The vehicle must be standing on even and not on steep ground.



You might get injured by aggressive cleaning agents and adhesives at contact with the skin and the eyes or when inhaled or swallowed. Always wear safety gloves and goggles working with cleaning agents and observe the manufacturer instructions. Do not eat, drink and smoke.



You can get burned by transmission oil when the transmission was in operation before and the oil is still hot. Have the transmission cooled down prior to start work.



Cleaning agents and transmission oil can cause environmental damages, when these get into the sewerage system or the environment. Never drain cleaning agents and oil into the sewerage system or into the soil. Collect it and take care of an adequate disposal in compliance with the disposal regulations of your company.

4.2 General Instructions for Correct Disassembly and Reassembly

- Pay attention to cleanliness and expert like manner for all work to be carried out. Transmissions removed from the vehicle have therefore to be cleaned prior to opening. Both utmost care and cleanliness are essential conditions for a correct disassembly and reassembly of the unit as well as for the installation of each spare part. A fault during installation can result in an early wear and chips as well as foreign particles in the transmission can cause fatal damages.
- Prior to assembly all parts must be cleaned and inspected for wear and other defects.
- If it is found that removed parts are damaged or worn, do not reinstall but replace them by new ones.
- If not separately indicated, the housing and cover faces forming an oiltight connection are to be provided with the corresponding sealing compound during assembly.
- Special devices and special tools are necessary besides the standard tools. Their use is unavoidable for a technically adequate dis- and reassembly! The application of devices, special tools and other fixtures are to be adapted to circumstances of the respective users.
- All screws and threads in this transmission have metric dimensions. Only spanners and socket spanners with metric sizes are allowed to be used.
- For reassembly all of the indicated setting values, test data and tightening torques must be observed.
- The ZF units have to be filled with oil after repair work. Procedure and admissible oil types are indicated in the manual "ZF-Ergomat HFS 507, GP 18, GP 20, GP 21 Operating Instructions" or in the Internet under www.zf.com / Products for / Tech.Information / List of Lubricants.
- Observe the described sequence of the working steps.

4.3 Torque Limits in Nm for Screws to ZF Standard 148

Torque limits, if not especially indicated, can be taken from the following list:

Metric ISO-Standard thread DIN 13, Sheet 13				Metric ISO-Fine thread DIN 13, Sheet 13			
Size	8.8	10.9	12.9	Size	8.8	10.9	12.9
M 4	2.8	4.1	4.8	M 8x1	24	36	43
M 5	5.5	8.1	9.5	M 9x1	36	53	62
M 6	9.5	14	16.5	M 10x1	52	76	89
M 7	15	23	28	M 10x1.25	49	72	84
M 8	23	34	40	M 12x1.25	87	125	150
M 10	46	68	79	M 12x1.5	83	120	145
M 12	79	115	135	M 14x1.5	135	200	235
M 14	125	185	215	M 16x1.5	205	300	360
M 16	195	280	330	M 18x1.5	310	440	520
M 18	280	390	460	M 18x2	290	420	490
M 20	390	560	650	M 20x1.5	430	620	720
M 22	530	750	880	M 22x1.5	580	820	960
M 24	670	960	1100	M 24x1.5	760	1100	1250
M 27	1000	1400	1650	M 24x2	730	1050	1200
M 30	1350	1900	2250	M 27x1.5	1100	1600	1850
M 33	1850	2600	3000	M 27x2	1050	1500	1800
M 36	2350	3300	3900	M 30x1.5	1550	2200	2550
M 39	3000	4300	5100	M 30x2	1500	2100	2500
				M 33x1.5	2050	2900	3400
				M 33x2	2000	2800	3300
				M 36x1.5	2700	3800	4450
				M 36x3	2500	3500	4100
				M 39x1.5	3450	4900	5700
				M 39x3	3200	4600	5300

Friction value: μ tot. **0.12** for screws and nuts **without** after-treatment, as well as phosphatized nuts.

Tightening by hand

4.4 Consumables

4.4.1 For Cleaning

Suitable cold cleaners, e.g. LOCTITE.



"WARNING"

Only use suitable cleaners which are non-toxic, non-combustible and permissible on the market. Never use benzene, solvents or other combustible cleaning agents.

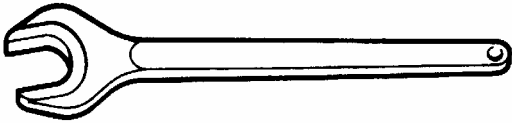
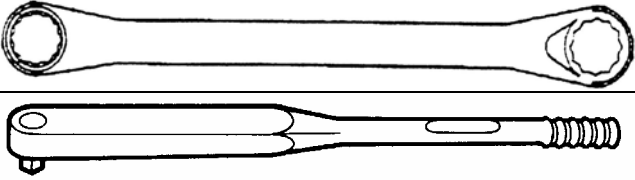
4.4.2 For Assembly

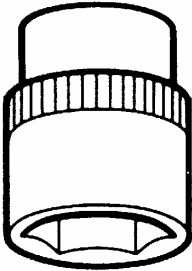
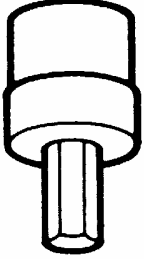
Description	To be used for
LOCTITE No. 243	Screw lock up to Size M10 and bigger
LOCTITE No. 270	Screw lock for studs
LOCTITE No. 574	to glue the shaft seal into the housing
LOCTITE No. 5910	Surface sealing for transmission cover on the housing
Grease "Shell Alvania R3"	for greasing or wetting of the sealing lip on the shaft seal
Silicone grease	for greasing or wetting of the O-Rings
Transmission oil	acc. to the Manual "ZF-Ergomat HFS 507, GP 18, GP 20 GP 21 Operating Instructions" Section: "Transmission Oil Data"

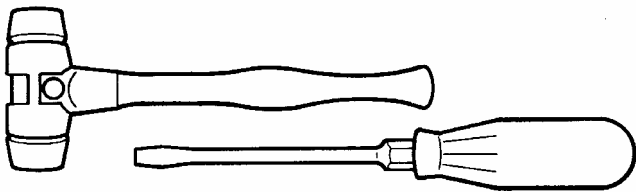
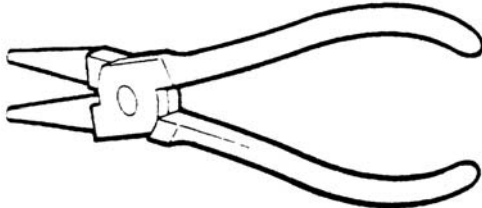
4.5 Additional Literature

1. Manual "ZF-Ergomat HFS 507, GP 18, GP 20, GP 21 Operating Instructions"
2. Manual "Spare Parts Lists HFS 507"
3. Manual "Spare Parts Lists GP 18"
4. Manual "Spare Parts Lists GP 20"
5. Manual "Spare Parts Lists GP 21"



4.6 Standard Tools

Open jaw spanner/Ring spanner	10 mm	
	13 mm	
	17 mm	
	19 mm	
Torque wrench Adjustable up to 550 Nm		
Torx socket spanner	15 mm	
	20 mm	
	25 mm	
	27 mm	

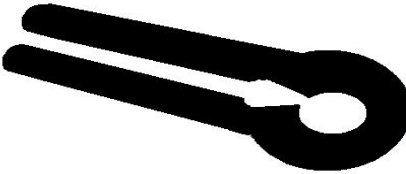

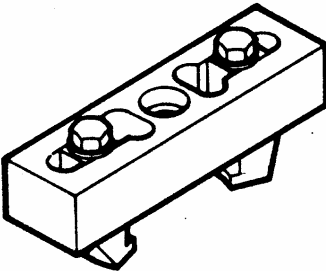
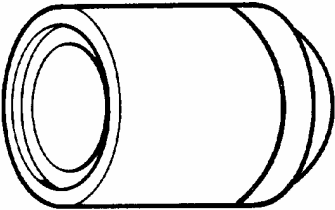


Hexagon socket spanner	13	mm		
	17	mm		
	19	mm		
	24	mm		
	30	mm		
			5	mm
			8	mm
			10	mm

Plastic tip hammer	1000 g	
Impact resistant screwdriver		
Flat round nosed pliers		

4.7 Measuring Tools

Description	Use	Ident No.	Illustration
Measuring fixture „I“	Housing dimension to be measured for bearing load of the wheel shaft bearing	4699 295 001	
Measuring fixture „II“	Planet carrier and wheel shaft to be measured for bearing preload of the wheel shaft bearing	4699 295 002	

4.8 Transmission – Special Tools & Fixtures

Description	Use	Ident No.	Illustration
Strap wrench „A“	To lock the drive pinion	53930	
Slotted nut wrench „B“	To remove the slotted nut	618 846	
Extractor „C“	To pull off the drive pinion	662 244	
Impact mandrel „D“	To install the planetary gears	610 390	
Peening mandrel „E“	To peen the planetary gears	450 971	
Extractor „F“	To pull off the planetary gears from the planet carrier	4699 395 001	

Description & Description in the text	Use	Fixture Number	Illustration
Assembly drift „G“	Installation of the radial shaft seal in the wheel shaft area	610 060	
Sleeve „H“	Bearing inner ring is pressed onto the wheel shaft and planet carrier	618 845	
Pressing fixture „I“	Preassembly of wheel bolts	4699 395 002	
Assembly drift „J“	Install the bearing outer rings into the housing seat	4699 395 004	
Locating plate „K“	Transmission fixture when installing the planet carrier-wheel shaft connection	63265	

**Description &
Description in the
text****Use****Fixture Number****Illustration**

Three-point
plunger
„L“

To press the planet
carrier onto the wheel
shaft

60734-0



Socket spanner
„M“

Tightening of the slotted
nut

618 846-02



Beading punch
„N“

Full peening of the
slotted nut

62842-01



Spanner
„O“

Bolting together of the
connection planet carrier
and wheel shaft

5966148



**Description &
Description in the
text****Use****Fixture Number****Illustration**

Plate

„P“

To measure the bearing
drag torque of the wheel
shaft after assemblyFor 5 wheel
bolts
61007For 6 wheel
bolts
62631For 7 wheel
bolts
62771Locating fixture
„Q“Swivelling locating
fixture for the
transmission

362 907



5. Disassembly

5.1 Safety Instructions



During work on movable transmission parts in the installed transmission, these could start unexpectedly and cause injuries to you. Prior to all work on the installed transmission (e.g. oil change) or its add-on parts disconnect the power source feeding the motor.



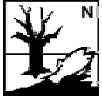
During work on the installed or mounted transmission the vehicle might suddenly move and cause injuries to you. Block the wheels prior to start the work. The vehicle must be standing on even and not on steep ground.



For removal of the transmission observe the instructions of the vehicle manufacturer.

5.2 Removal of the Drive Unit from the Vehicle

Prior to removal of the drive unit drain oil from the transmission.



Transmission oil can cause environmental damages, when it gets into the sewerage system or the environment. Never drain oil into the sewerage system or into the soil. Collect it and take care of an adequate disposal in compliance with the disposal regulations of your company.

Unscrew and remove the wheel nuts as well as the drive wheel. Further information or possible working steps are indicated in the manual "ZF-Ergomat HFS 507, GP 18, GP 20, GP 21 Operating Instructions" and in the vehicle manual.

- E-motor and accessories mounted to the E-motor have to be disconnected electrically.
- Remove the brake lever connections.
- Loosen the fixing bolts (Item 1) on the vehicle frame and remove the drive unit cautiously.



"ATTENTION"

Do not damage the drive unit at removal from the vehicle frame! Damages can cause a limited function of the unit.

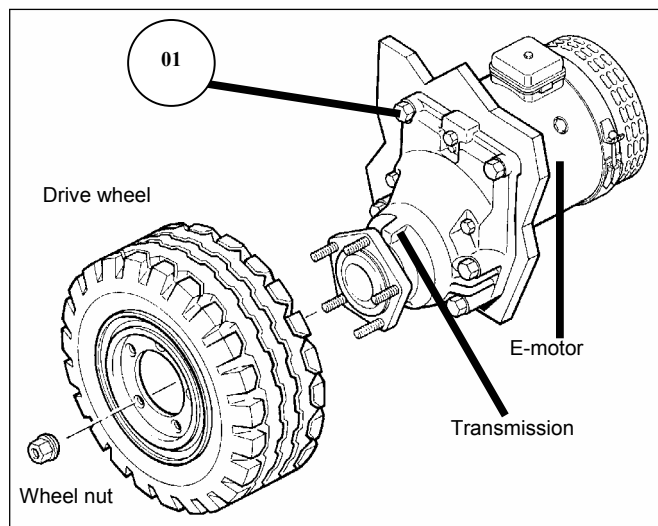


Figure 04

5.3 General Instructions

- Prior to dismantling clean the transmission thoroughly.
- Parts which can only be obtained as assembly will not be dismantled any further.
- For transmission disassembly and reassembly we recommend using a locating fixture as shown in Figure 05.

5.4 Disassembly of the Drive Unit

"ATTENTION"



Place the drive unit into an adequate fixture. It is recommendable to install a locating fixture at the working place. Secure the drive unit from turning over, falling down and other movements.

- It serves for attachment and swivelling of the drive unit and easier working at the disassembly and reassembly.

Locating fixture „Q“ & „K“:

01 362 907

02 63 265

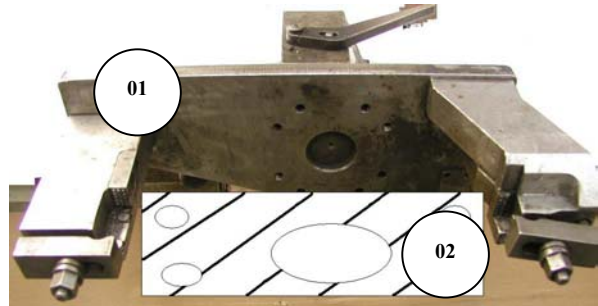


Figure 05

5.4.1 Removal of the E-Motor

- Loosen and remove the screws (Item 01).
- Take away the E-motor from the transmission cautiously.

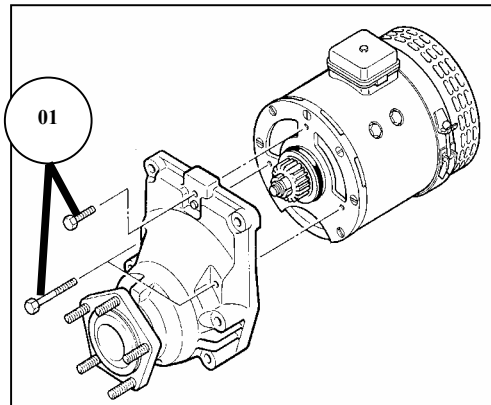


Figure 06

"ATTENTION"



Do not damage the teeth of the motor pinion and the helical gear! Damage can cause louder running noises. In case of an inadequate removal of the E-motor from the transmission there is the danger to damage the sealing surface for the O-ring in the transmission housing!

"ATTENTION"



If only the E-motor is removed, the released transmission opening is to be sealed in order to avoid that dirt can get inside the transmission.

5.4.2 Disassembly of the Drive Pinion

- Hold the drive pinion (Item 01) with special tool "A" and remove the slotted nut (Item 02) with special tool "B".
- Pull off the drive pinion by means of special tool "C".
- Remove the O-ring (Item 03) from the centering seat of the motor cautiously.

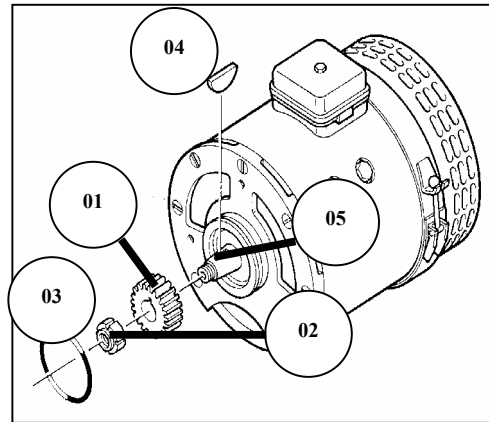


Figure 07



"ATTENTION"

Remove the fitting key (Item 04) from the motor shaft (Item 05) only when replacing the motor.

5.5 Disassembly of the Transmission

5.5.1 Introduction

Prior to disassembly clean the transmission carefully.

5.5.2 Disassembly

- Loosen and remove the two retaining rings (Item 01).
- Beat out the cylindrical pin (Item 02) and remove the brake lever (Item 03) from the cover.

For HFS 507, GP 18, GP 20 and GP 21 with cap screws is applicable:

- Loosen the 8 cap screws M6x16 (Item 04) and press off the cover (Item 05) from the basic transmission cautiously.

For GP 21 with self-drilling Torx screws is applicable:

- Loosen the 8 self-drilling Torx screws M6x16 (Item 04) and press off the cover (Item 05) from the basic transmission cautiously.

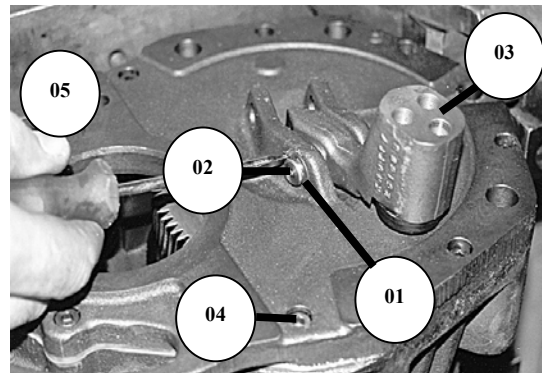


Figure 08



"ATTENTION"

Before unscrewing the cap screws beat onto the same slightly to loosen the LOCTITE connection!

- Remove the housing cover and keep it on a clean place. Further details on disassembly of the housing cover are indicated in the Section "Disassembly of the Housing Cover".

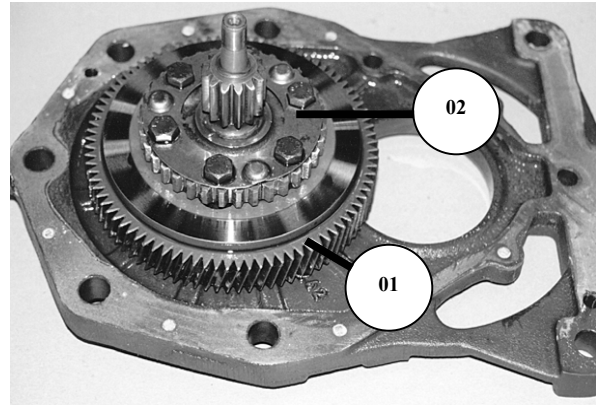


Figure 09

**"ATTENTION"**

At removal of the housing cover, the helical gear (Item 01) will remain connected with the inner disc carrier (Item 02) as one unit! (see Figure 07)

- Pull out the disc set – consisting of 4x outer discs and 3x inner discs as well as the thrust washer – from the ring gear and keep it on a clean place.

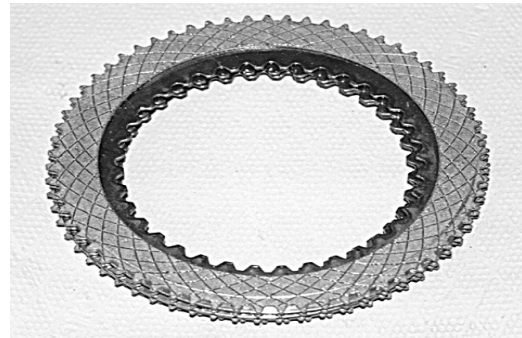


Figure 10

- The special tool "F" consists of two pieces. The first piece (Item 01), which is connected with the screw has with the opening to be put around the planetary gear. Following the second piece (Item 02) is to be put around the planetary gear opposed to the first piece.
- Now a round face is obtained.
- Turn in the screw of the first piece slowly in direction of the planetary gear thus detaching the gear from the planet carrier.
- This procedure is to be repeated with all of the three planetary gears.

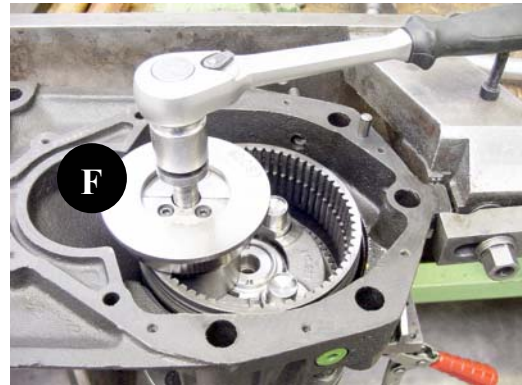


Figure 11

**"ATTENTION"**

The planetary gears will be pulled off with the bearing completely.

For HFS 507 & GP 18 is applicable:

- Loosen the four screws (Item 01).
- Remove the screws together with the washer (Item 02) and scrap them.

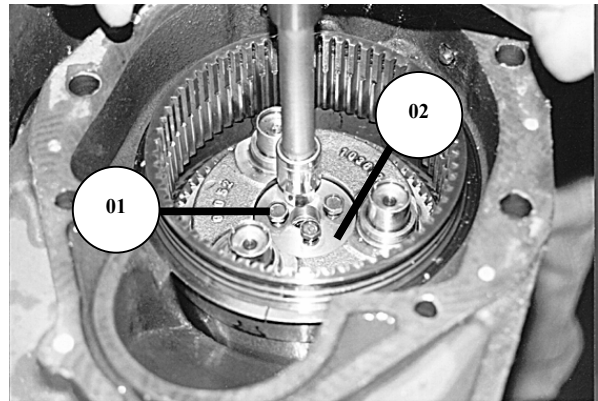


Figure 12

For GP 20 and GP 21 is applicable:

- Secure the wheel shaft against distortion by means of special tool "K".
- By means of a drill (Item 01) –Ø size approx. 9mm – bore the slotted nut (Item 02) on two sides.

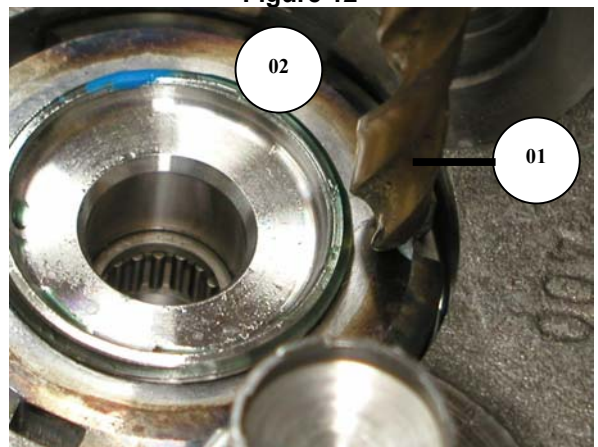


Figure 13

- Loosen and remove the slotted nut for the wheel shaft bearing. Use special tool "B".
- Scrap the slotted nut

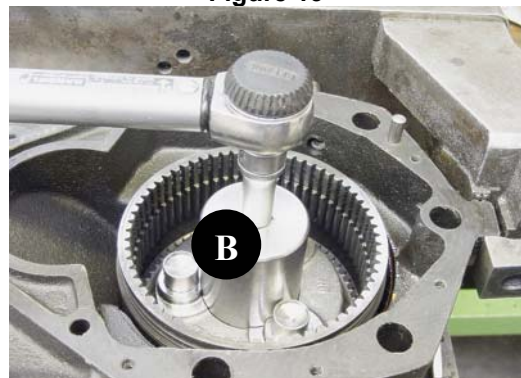


Figure 14

- Drive out and remove the wheel shaft (with taper roller bearing inner ring) by means of a copper mandrel and a hammer.

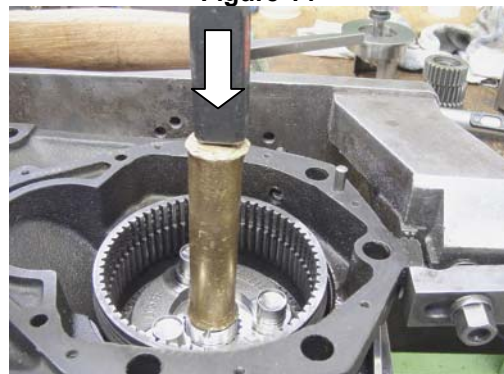


Figure 15

- Remove the planet carrier (with taper roller bearing inner ring) from the bearing seat of the housing.
- Scrap the planet carrier and the wheel shaft.

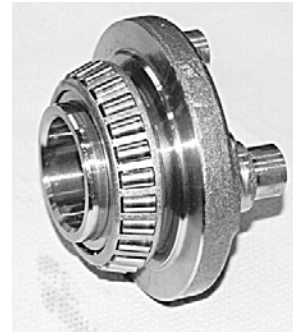


Figure 16

- Loosen the 10 internal Torx screws M 10x35 (Item 01) and take the ring gear out of the housing. The Feyring will remain mounted to the ring gear.

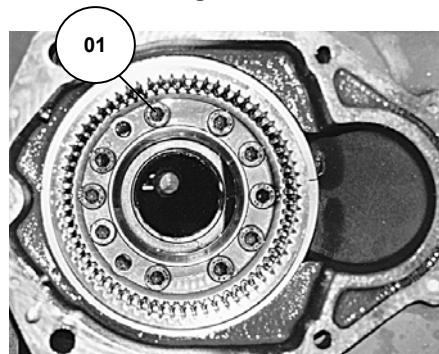


Figure 17

- On both sides the bearing outer rings for supporting of the wheel shaft and the planet carrier have to be driven out cautiously by means of a copper mandrel and a hammer.
- When the outer ring is driven out on the gear side, the radial shaft seal is removed together with the bearing!

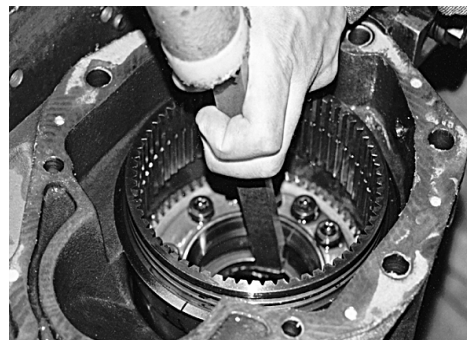


Figure 18

**"ATTENTION"**

When the bearing outer ring is driven out on the gear side, pay attention not to damage the shims.

**"ATTENTION"**

The radial shaft seal is not reusable and has to be replaced by a new part for reassembly!

5.5.3 Disassembly of the Housing Cover

- Put the housing cover of the transmission on a level support.
- Unscrew and remove the six hexagon screws M8x35 (Item 01).

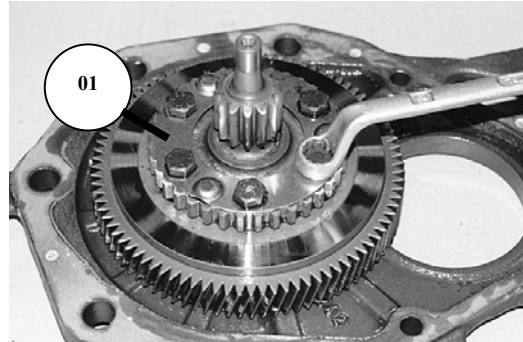


Figure 19

- Remove the fixing plate (Item 01) with the compression springs (Item 02) underneath and keep the same in a suitable bin for reuse.
- Remove the inner disc carrier (Item 03) with the thrust washer (Item 04) from the helical gear.

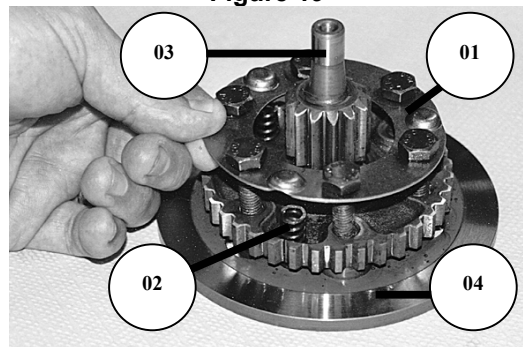


Figure 20

- By means of flat round nosed pliers remove the retaining ring 30x1.5 (Item 1) on the bearing seat of the cover.

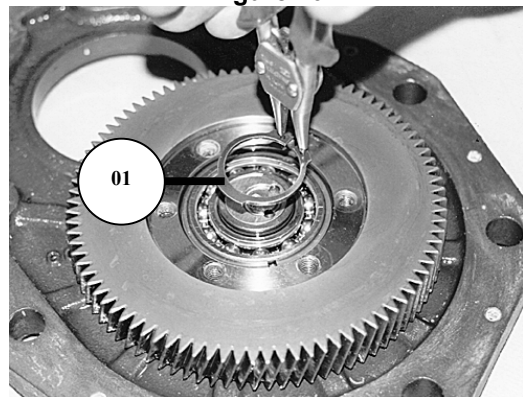


Figure 21

- Press off the helical gear (with the bearing) from the bearing seat of the cover.
- Use the threads M8 (6 pcs.) (Item 01) on the helical gear to fasten the inner disc carrier.
- Turn in the six screws equally and at distances of 3 mm press off the helical gear from the housing cover!

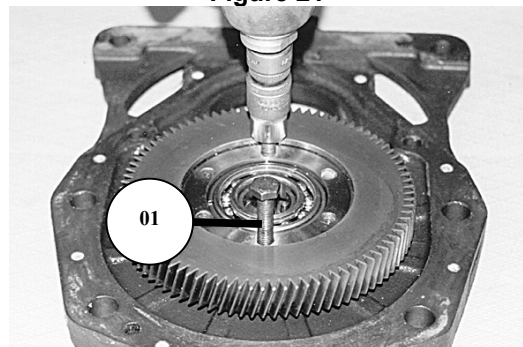
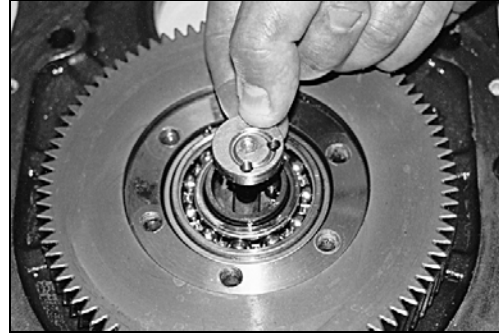


Figure 22

- By means of pliers remove the axial slide bearing from the bore seat of the cover.

**Figure 23****"ATTENTION"**

Do not damage the surface of the axial slide bearing. Pay attention to the installation position of the axial slide bearing and write it down if necessary!

6. Reassembly

6.1 Safety Instructions



"WARNING"

During work at the vehicle, the drive system could start unexpectedly and cause injuries to you. Prior to start the reassembly, disconnect the power source feeding the motor.



"WARNING"

The vehicle might suddenly move and cause injuries to you. Block the wheels prior to start the work. The vehicle must be standing on even and not on steep ground.

"WARNING"



You might get injured by aggressive cleaning agents and adhesives at contact with the skin and the eyes or when inhaled or swallowed. Always wear safety gloves and goggles working with cleaning agents and observe the manufacturer instructions. Do not eat, drink and smoke at work.



Never use benzene, solvents or other combustible substances for cleaning, but exclusively the cold cleaners indicated in Section 4.4 "Consumables" Page 07. Observe the manufacturer instructions and the regulations for the prevention of accidents.

In case of skin contact rinse immediately with a lot of water! If swallowed, call medical aid immediately!



"WARNING"

Cleaning agents and transmission oil can cause environmental damages, when these get into the sewerage system or the environment. Never drain cleaning agents and oil into the sewerage system or into the soil. Collect it and take care of an adequate disposal in compliance with the disposal regulations of your company!

6.2 General Instructions for Reassembly

- If needed, clean the parts with a cleaning agent and remove the LOCTITE residues.
- Check all parts for wear, damage and cracks, replace the parts if necessary.

6.3 Assembly of the Transmission

6.3.1 Preassembly of Wheel Shaft and Planet Carrier

- Place the wheel bolts with the flat side on the bolt collar (Item 01) towards the wheel shaft center.



Figure 24

- By means of a press and the special tool "I" press in the wheel bolts (Item 01) into the wheel shaft until contact is obtained.

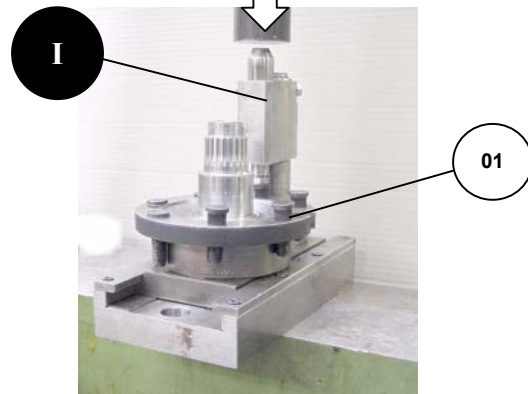


Figure 25



"ATTENTION"

Do not jam the wheel bolts at pressing-in!

- Push the NILOS-ring (Item 01) onto the wheel shaft until contact is obtained and apply a grease acc. to TE ML 17.

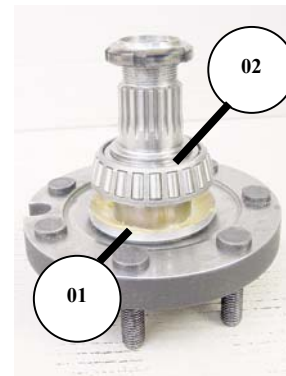


Figure 26

- Press a new taper roller bearing inner ring (Item 01) by means of special tool "H" onto the wheel shaft until contact with the NILOS-ring.

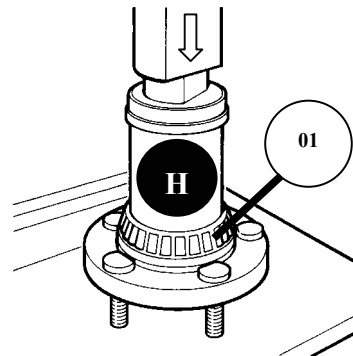


Figure 27

- Press the taper roller bearing inner ring (Item 01) by means of special tool "H" onto the planet carrier until contact with the NILOS-ring.

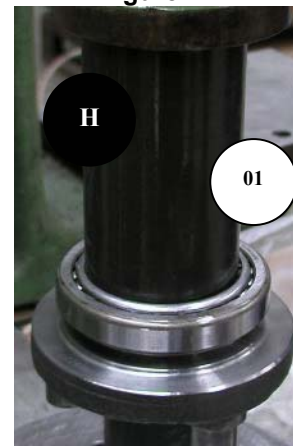


Figure 28

6.3.2 Install the Ring Gear into the Housing

- Hole pattern of the ring gear must align with the transmission hole pattern.
- Apply one drop of LOCTITE 270 each onto the thread of the 10 inner Torx screws M10x35 (Item 01).
- Tighten the 10 inner Torx screws crosswise with **50 Nm**.
- Tighten the 10 inner Torx screws crosswise with **68 Nm**.

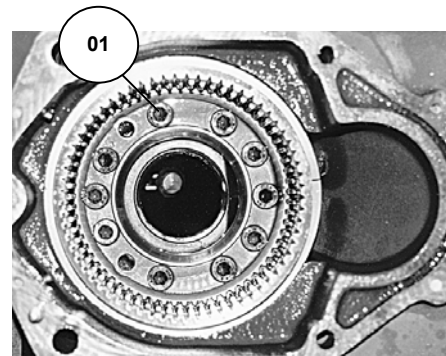


Figure 29

6.3.3 Install the Radial Shaft Seal into the Housing

- Apply a thin layer of LOCTITE 574 onto the outer diameter of the radial shaft seal (Item 01).
- By means of special tool "G" install the radial shaft seal into the housing seat until contact is obtained with the drift.

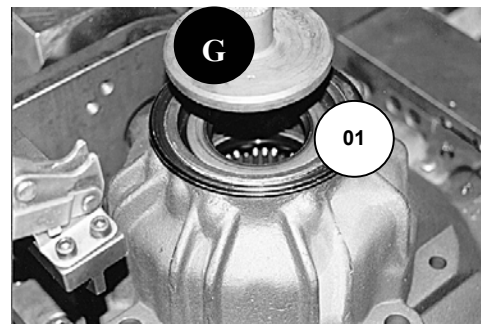


Figure 30

Ident Number Radial Shaft Seal:
Type-dependent / See spare parts list

**"ATTENTION"**

Do not damage the sealing lip of the radial shaft seal. Damages might cause later leakages on the wheel shaft.

6.3.4 Install the Connection Wheel Shaft & Planet Carrier**Measure the housing dimension (without bearing outer rings)**

Measure the housing dimension as follows:

- Bring fixture part "I" with dial gauge to zero position.
- Zero position of the dial gauge = Dim. A = 29.0mm

Ident Number Measuring fixture „I“:
4699 295 001

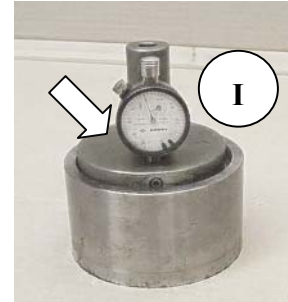
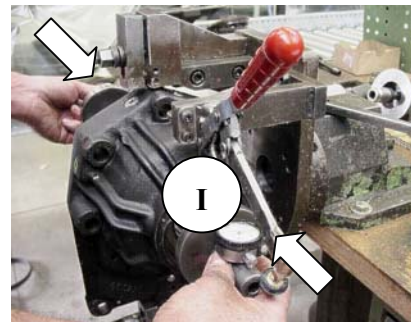
- Insert the complete fixture "I" into the housing until contact is obtained.
- Fasten it hand-tight.
- Determine Dim. B and add it to Dim. A 29 mm.

Example:

Dim. A 29.00 mm

Dim. B + 0.36 mm

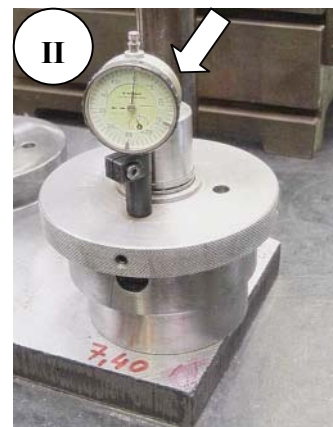
Total = Housing dimension 29.36 mm

**Figure 31****Figure 32****Measure the planet carrier (with taper roller bearing)**

Measure the planet carrier as follows:

- Bring fixture part "II" with dial gauge to zero position.
- Zero position of the dial gauge = Dim. C = 7.40mm

Ident Number Measuring fixture "II":
4699 295 002

**Figure 33**

- Put the planet carrier (Item 01) onto the fixture until contact.



Figure 34

- Put on the fixture part "II" and by turning motions roll in the taper roller bearing on the planet carrier (Item 01).
- Fasten it hand-tight at the same time and determine Dim. D.
- Add Dim. D to Dim. C = 7.40 mm.

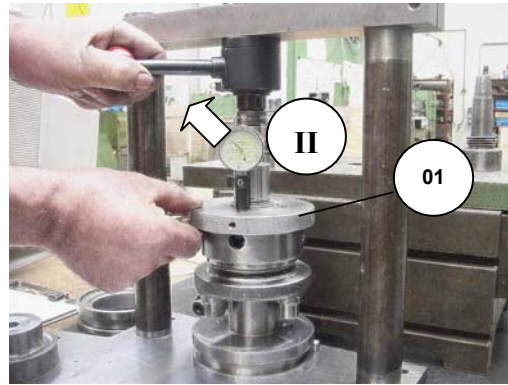


Figure 35

Example:

Dim. A 7.40 mm

Dim. B + 0.43 mm

Total = Dim. Planet carrier 7.83 mm

Measure the wheel shaft (with taper roller bearing)

The wheel shaft is measured as follows:

- Bring fixture part "II" with dial gauge to zero position.
- Zero position of the dial gauge = Dim. E = 21.56mm
- Put the wheel shaft (Item 01) onto the fixture until contact.
- Put on the fixture part "II" and by turning motions roll in the taper roller bearing on the wheel shaft.
- Determine Dim. F and add it to Dim. E = 21.56 mm.

Example:

Dim. A 21.56 mm

Dim. B + 0.46 mm

Total = Dim. Wheel shaft 22.02 mm



Figure 36

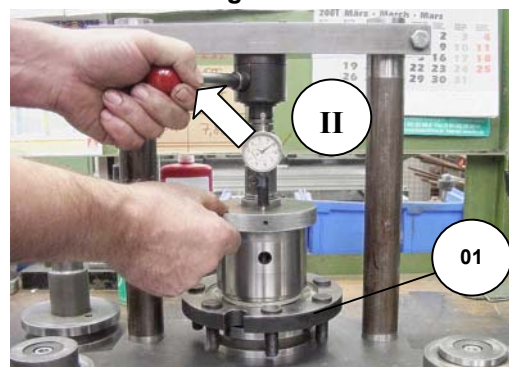


Figure 37

Determine the shims to be added

The following method can be applied to determine the thickness of the shim (Item 01).

Dim. A, Housing dimension =
Distance from contact plane face bearing outer ring to contact plane face bearing outer ring.

Dim. B, Dim. Planet carrier =
Distance from plane face bearing outer ring to plane face planet carrier.

Dim. C, Dim. Wheel shaft =
Distance from plane face bearing outer ring to plane face wheel shaft.

Calculate the shim thickness (Item 01) by means of the equation

$$Z = B + C - A$$

Add shim according to Thickness Z.

Example:

A = 29.36 measured on the housing
B = 7.83 measured on the planet carrier
C = 22.02 measured on the wheel shaft

$$Z = 7.83 + 22.02 - 29.36 = 0.49 \text{ mm}$$

As per experience 0.1 mm will be deducted from Dim. Z, so that a more favourable bearing preload adjustment is obtained for the operating conditions.

$$Z = 0.49 - 0.1 = 0.39 \text{ mm}$$

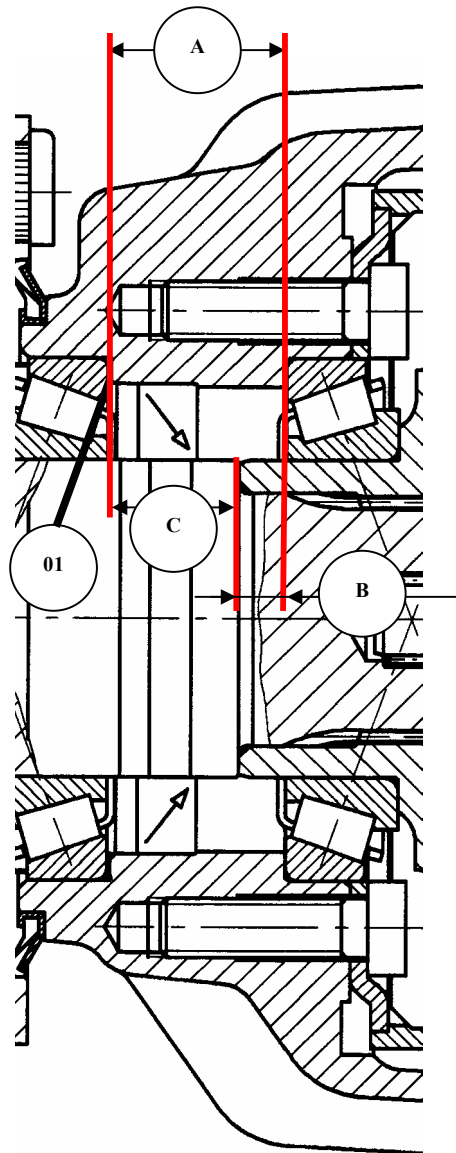


Figure 38

- The shim thickness determined is to be obtained by combining of differently thick shims.
- Put the shim (Item 01) and the bearing outer ring (Item 02) into the bearing seat.

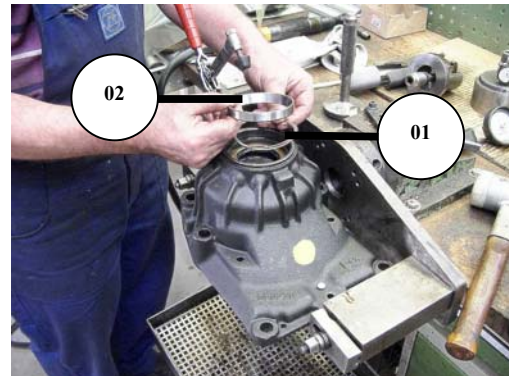


Figure 39

- By means of special tool "J" and a plastic tip hammer install the bearing outer ring (Item 01) with the shim into the bearing seat of the housing until contact is obtained.
- Also install the bearing outer ring on the opposite side.

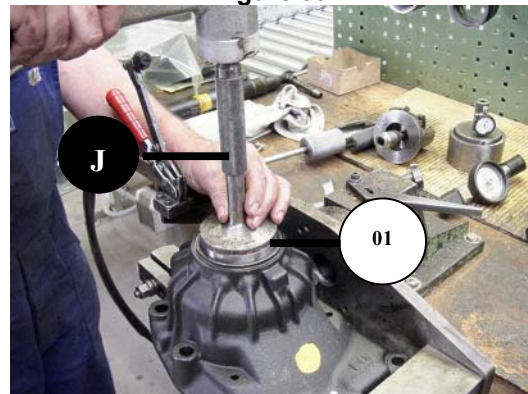


Figure 40

- Apply grease acc. to TE ML 17 onto the taper roller bearing inner ring and into the roller gap on the preassembled wheel hub.



Figure 41

- Join the preassembled wheel shaft (Item 01) to the taper roller bearing outer ring of the housing.
- Lock the wheel shaft against slipping and distortion.



Figure 42

Assembly of the wheel shaft connection

The assembly unit for transmissions of the product range GP 20 and GP 21 essentially consists of the following components:

Item 01	Locating for the transmission
Item 02	Hydraulic cylinder of the press with tool location
Item 03	Electric control for rotation angle- and torque-monitored bolting of the connection
Item 04	Spanner

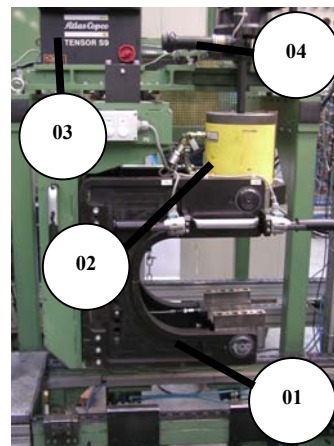


Figure 43

- The transmission is clamped into the locating of the assembly unit.
- The wheel shaft is put onto special tool "K" and clamped as counter holder for the wheel shaft.

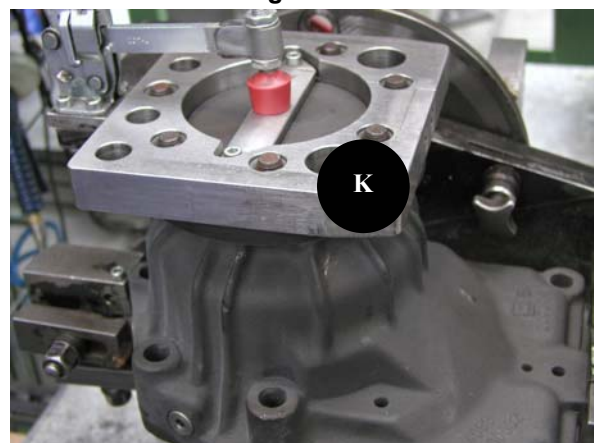


Figure 44

- Heat the planet carrier to 60°C.
- Together with the wheel shaft the transmission is rotated downwards by 180°.
- Apply a thin layer of LOCTITE 270 on the internal gearing of the planet carrier (Item 01).
- Install the planet carrier gearing cautiously into the wheel shaft teeth.

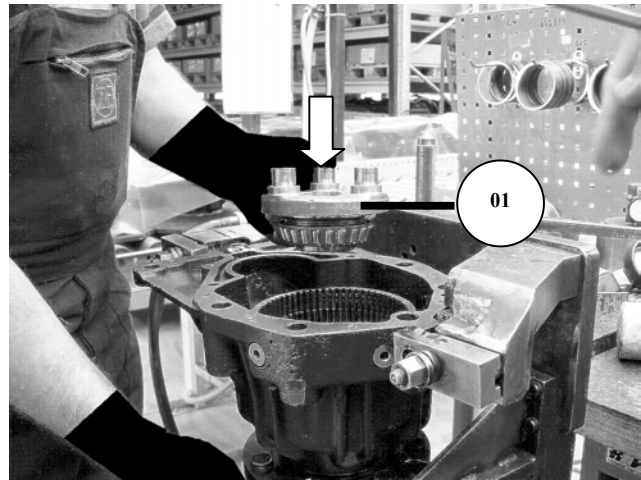


Figure 45

**"CAUTION"**

Touch the heated planet carrier only with gloves or pliers. The temperature required for the planet carrier can cause skin burns!

- Special tool "L" is put onto the 3 axle end bores of the planet carrier.



Figure 46

- The transmission with the installed special tool "L" is moved underneath the hydraulic cylinder.
- The piston of the hydraulic press moves with a pressing force of 8.0 t towards the special tool "L" until contact is obtained and presses the planet carrier into the wheel shaft.



Figure 47

- Wet the thread of the slotted nut slightly and equally with LOCTITE 270.
- Put the slotted nut by hand onto the wheel shaft and adjust it slightly towards the tool head of the special tool “M”.
- Then, like in Figure 46, the piston of the hydraulic press moves with the same pressing force towards the connection and remains there.
- Then the special tool “M” retracts from the hydraulic cylinder.
- Now the slotted nut is tightened with a torque being programmed in the electric control and a monitored rotation angle to 535 Nm.
- After tightening of the slotted nut the transmission under the hydraulic cylinder will be pulled out and the special tool “L” removed.



Figure 48

- Rotate the transmission with the wheel shaft upwards by 180°.
- Rotate the wheel shaft several times to have aligned the taper rollers in the bearing rings.
- No bearing play must be measurable during the check! However the wheel shaft must be rotatable by hand.
- The bearing preload is correctly adjusted, when a bearing friction torque of 1.5 ... 5.0 Nm is obtained.
- Use an electronic torque spanner (Item 01) and the special tool “P” (Item 02) to check the bearing friction torque.

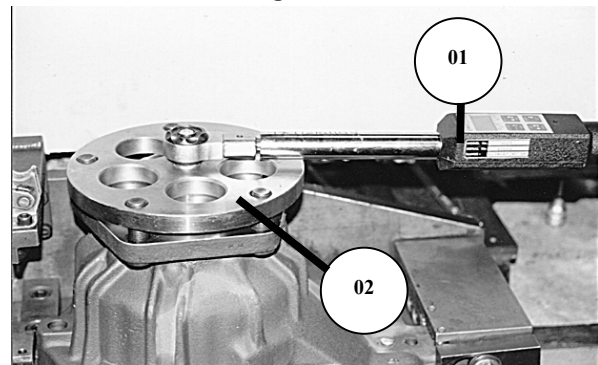


Figure 49

**“ATTENTION“**

If the bearing friction torque is beyond the requested value a new adjustment is required. The final value has to be obtained by adding or removing of shims (see Fig. 37/38).

- Move the transmission by means of the special tool "N" under the hydraulic cylinder.
- Now the piston of the hydraulic press widens the collar of the wheel shaft towards the slotted nut.
- Thus the slotted nut is secured by full peening.
- After the full peening the transmission under the hydraulic cylinder will be pulled out and the special tool "N" removed.



Figure 50

- Rotate the transmission with the wheel shaft upwards by 180°.
- Rotate the wheel shaft several times to have aligned the taper rollers in the bearing rings.
- No bearing play must be measurable during the check! However the wheel shaft must be rotatable by hand.
- The bearing preload is correctly adjusted, when a bearing friction torque of 1.5 ... 5.0 Nm is obtained.
- Use an electronic torque spanner (Item 01) and the special tool "P" (Item 02) to check the bearing friction torque.

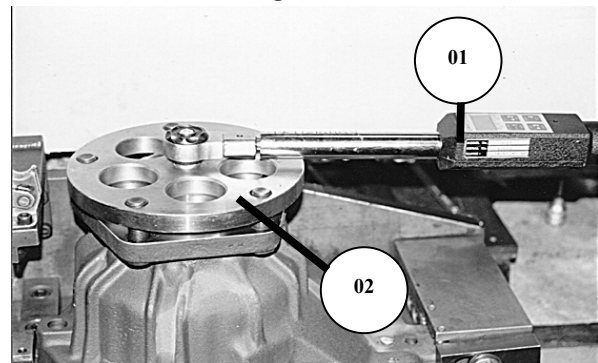


Figure 51

**“ATTENTION“**

If the bearing friction torque is beyond the requested value a new adjustment is required. The final value has to be obtained by adding or removing of shims (see Fig. 37/38).

6.3.5 Assembly of the Planetary Gears with the Planet Carrier

- Put the planetary gear (Item 1) onto the axle end (Item 02) of the planet carrier.
- By means of the special tool “D” press it on until stop.
- Repeat this procedure for the two remaining planetary gears.

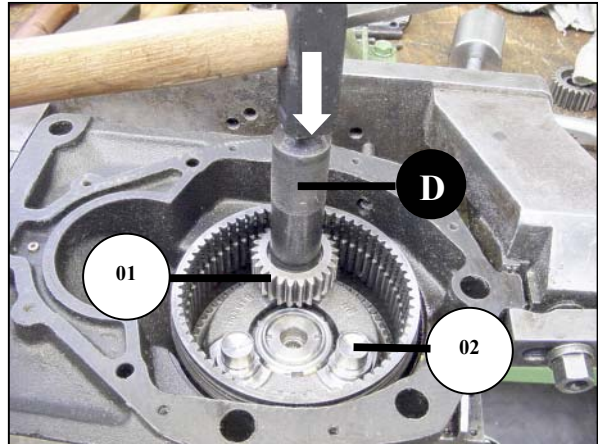


Figure 52



“ATTENTION”

Pay attention that when placing the planetary gear it does not get jammed on the axle end. Later consequences can be a rough running behaviour and transmission noises.



“ATTENTION”

Pay attention to the installation position of the planetary gear! The radius of the inner ring must always be on the stop of the axle end.

- Lock the three planetary gears (Item 01) against axial displacement by means of peening mandrel “E”.
- Widen the edge of the blind hole to such an extent that the bearing inner ring of the planetary gears cannot be displaced any more.

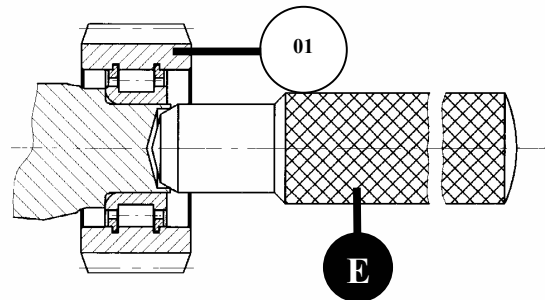


Figure 53

6.3.6 Assembly of the Transmission Disc Set

Two possibilities have to be observed for the disc set assembly:

Possibility 1:

- If for wearing reasons only the disc set (Item 01) is replaced, the previous thrust washer (Item 02) can be reused.
- Insert the thrust washer
- For insertion of the disc set the following sequence applies:

Outer disc/inner disc/outer disc /
inner disc/outer disc/inner disc /
outer disc

(Outer disc = Outer gearing;

Inner disc = Inner gearing)

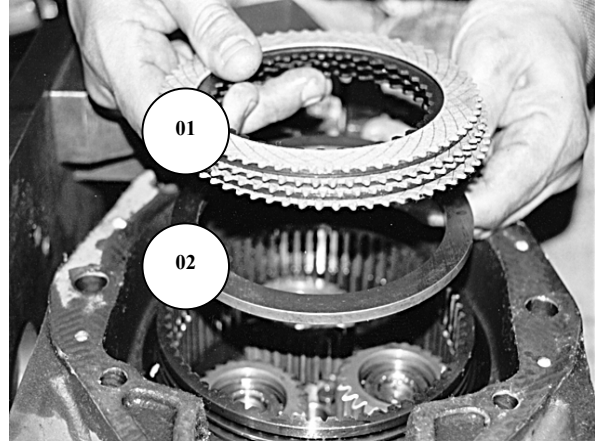


Figure 54

- The sine inner discs have to be aligned equally to the undulations.

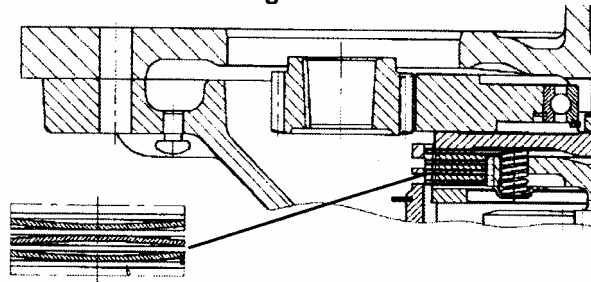


Figure 55

- A rapid and exact method is the alignment and centering respectively with an additional inner disc carrier which is not used for assembly of the transmission.
- The inner disc carrier (Item 01) is put into the installation position.
- By slightly rotating and moving respectively of the inner disc carrier the position of the discs is fixed clearly now.
- Following to this the inner disc carrier is to be removed cautiously from the installation position, so that the position of the discs will not be changed any more.

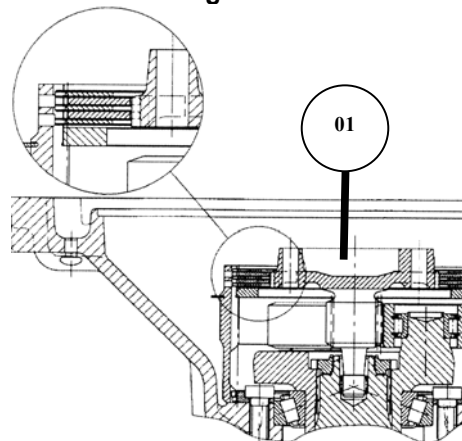


Figure 56

“ATTENTION“



When replacing the disc set in a transmission, the disc set of the transmission on the other vehicle side has also to be replaced!

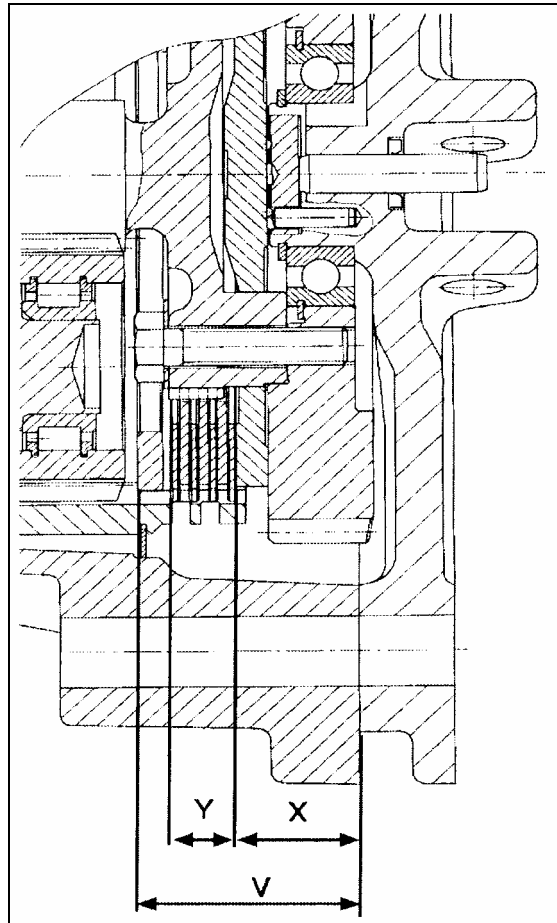
In case of non-observance there might be a strongly varying braking effect between the left and the right transmission resulting in an excessive wear of the disc set just replaced. Additionally a longer braking distance has to be expected.

Possibility 2:

- If several parts of the transmission (e.g. cover or thrust washer) are changed or replaced, the required thickness of the thrust washer has to be determined as follows.
- Dim. X is the distance from the plane face Cover to the plane face Thrust washer.
- Dim. Y is the thickness of the disc set in compressed condition.
- Dim. W is an auxiliary dimension obtained by the addition of Dim. X and Y.
- Dim. V is the distance from the plane face Housing until contact of the thrust washer in the ring gear.
- Dim. Z is an auxiliary dimension obtained by the subtraction of Dim. V and W. It serves to determine the thrust washer thickness as per Table 01.

$$W = X + Y$$

$$Z = V - W$$

Example:

Dim. X 23.23 mm

Dim. Y 12.60 mm

Dim. W 35.83 mm

Dim. V 41.93 mm

Dim. Z 6.10 mm**Figure 57**

Dim. Z (in mm)	Thrust washer
5.58 to 6.10	4.8 mm thick
6.11 to 6.70	5.3 mm thick
6.71 to 7.22	5.8 mm thick

Table 01

6.3.7 Assembly of the Housing Cover

The housing cover will in principle be assembled in reversed order of the disassembly.
For assembling, however, it has to be observed as follows:

- Dim. A is the thickness of the axial slide bearing (Item 01).
- Dim. B is the distance from the plane face of the axial slide bearing to the bottom side of the pin (Item 02)

$$Z = A - B$$

- Dim. Z must not be more than 2.0 mm and not less than 1.0 mm.
- If the dimension is higher or lower another length of the pin has to be selected.

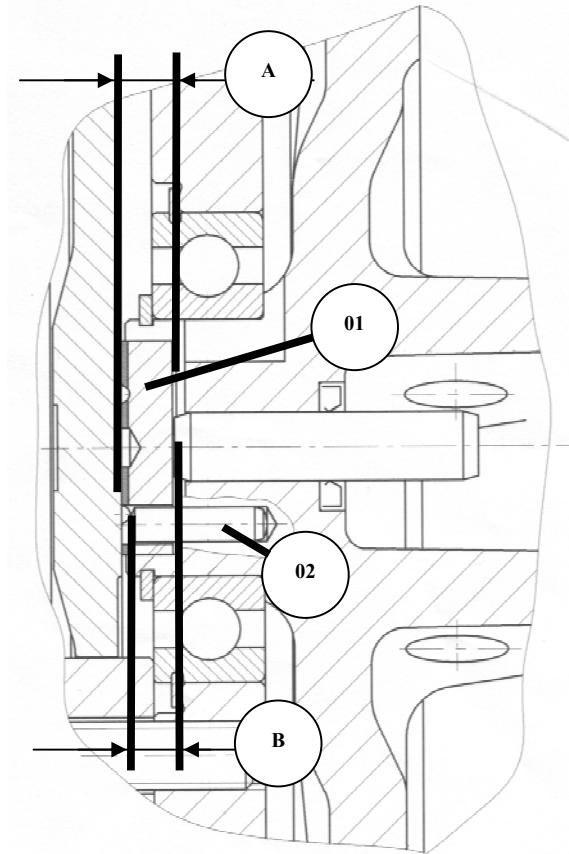


Figure 58

- Insert the axial slide bearing into the bore seat of the cover.

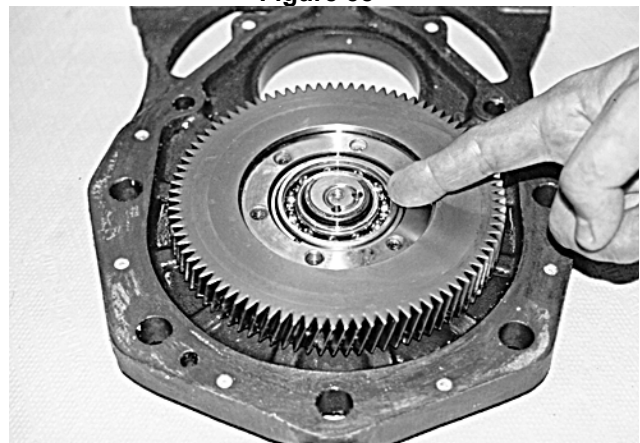


Figure 59



“ATTENTION”

Observe the installation position for mounting of the axial slide bearing!

- Put the helical gear (Item 01, with the preassembled bearing) onto the bearing seat of the cover and install it until contact is obtained.
- Install the retaining ring (Item 02) with aid of flat round nosed pliers and lock the helical gear.

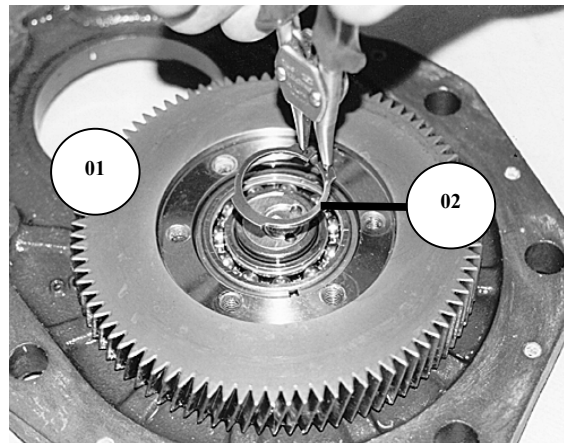


Figure 60

- Put the thrust washer (Item 01) and the inner disc carrier (Item 02) onto the helical gear.
- Put the three compression springs (Item 3) into the bore of the inner disc carrier as well as the fixing plate (Item 4) with the recesses onto the compression springs.

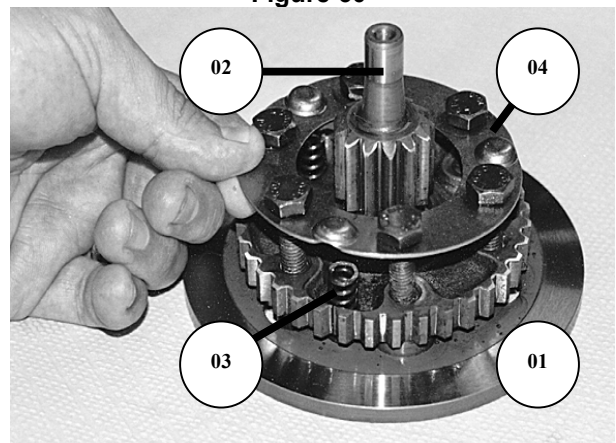


Figure 61

**“ATTENTION“**

Align the fixing plate on the inner disc carrier to the gearing, so that assembly of the cover is not hindered.

- Apply one drop each of LOCTITE 243 to the thread of the six hexagon screws M8x35 (Item 01).
- Insert the hexagon screws into the holes.
- By means of the hexagon screws connect the inner disc carrier with the helical gear.
- Tighten the hexagon screws with **34 Nm**.

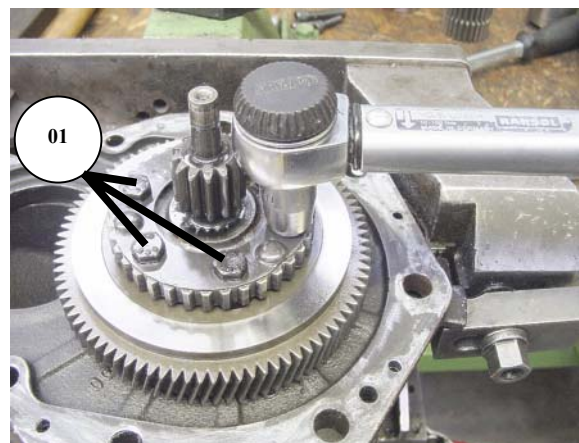


Figure 62

- Clean the sealing face of the cover from LOCTITE residues carefully.
- Additional cleaning with abrasive paper is required.
- The sealing face of the cover is to be provided with LOCTITE 574.

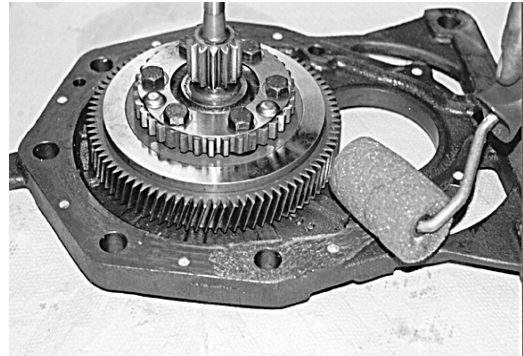


Figure 63

- Insert the cover cautiously and install it until contact is obtained by beating slightly with a plastic hammer.

For HFS 507, GP 18, GP 20 and GP 21 with cap screws is applicable:

- Put one drop each of LOCTITE 234 onto the thread of the eight cap screws M6x16 (Item 01).
- With the cap screws fasten the cover to the basic transmission with a tightening torque of **9.6 Nm**.

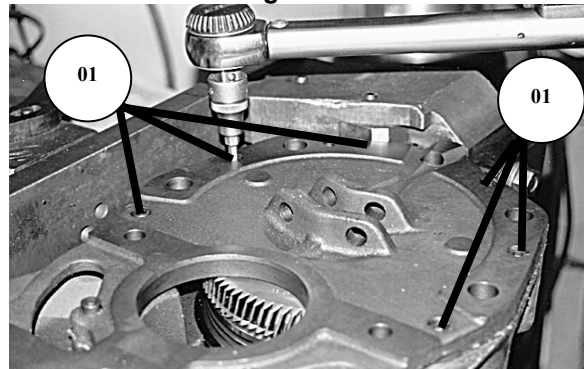


Figure 64

For GP 21 with Torx screws is applicable:

- By means of the Torx screws fasten the cover to the basic transmission with a tightening torque of **12.0 Nm**.

6.3.8 Assembly and Adjustment of the Brake Lever

- Slightly wet the sealing lip of the sealing ring with grease!
- Put the sealing ring (Item 01) into the bore. (See Figure 66)
- Install the pressure pin (Item 02) into the bore provided. (See Figure 66)



“ATTENTION“

Do not damage the radial shaft seal (Item 03) when installing the pressure pin.

- Put the brake lever (Item 01) into the bracket (02) of the cover and pay attention to the installation position!
- By means of a drift install the cylindrical pin (Item 03) into the bracket of the brake lever at the same time.
- With the two retaining rings (Item 05) lock the cylindrical pin against loosening from the bracket.

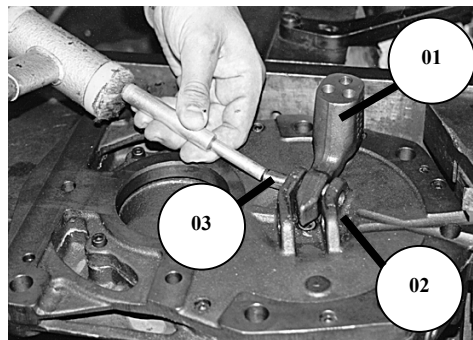


Figure 65

- With the two retaining rings (Item 03) lock the cylindrical pin against loosening from the bracket.

Following the brake lever is installed and the adjusting dimension "A" has to be checked and set.

- The adjusting dimension has to be checked with a dial gauge.
- For this purpose position the feeler of the dial gauge on the brake lever in the specified measuring point range. (See Figure 66)
- Press the brake lever against the cover and read the deflection on the dial gauge. (See Figure 68)
- If the adjusting dimension $0.4^{+0.6}$ mm should not be within the specified range, it has to be set by alternative pressure pins (Item 02). Pressure pins of different lengths are available for this purpose.
- If the pressure pin is replaced, the brake lever has to be removed and installed again.

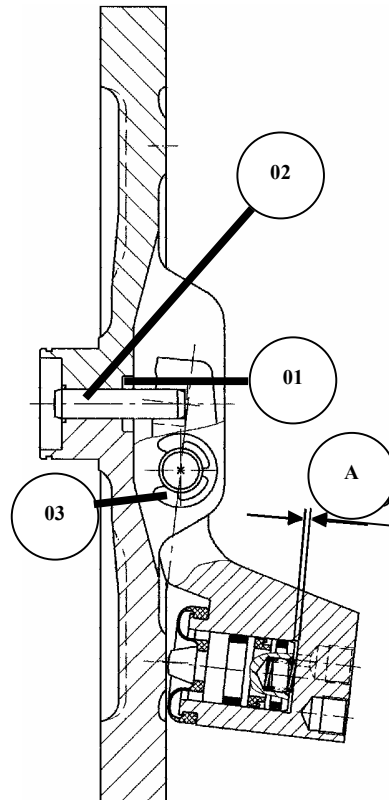


Figure 66



“ATTENTION”

Do not damage the sealing ring (Item 03) when installing the pressure pin!

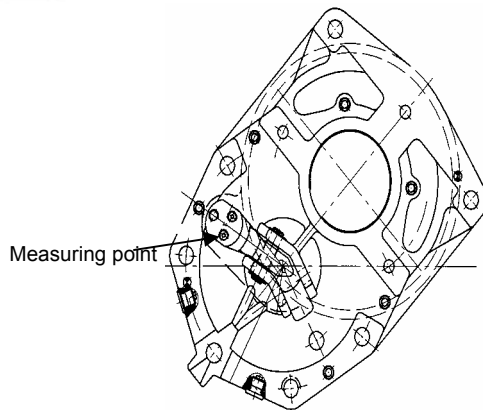


Figure 67

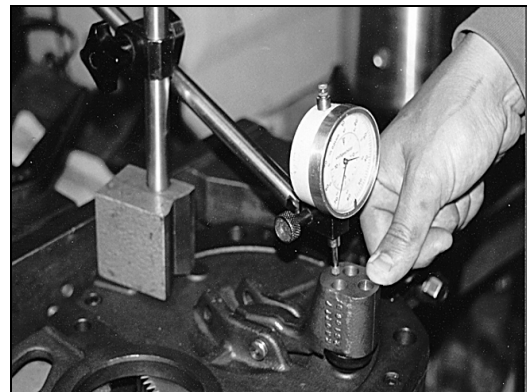


Figure 68

6.4 Assembly of the Drive Unit

The following sections are not dealt in detail, the illustrations, the description and the tightening torques are indicated in the Manual "Installation and Maintenance".

6.4.1 Assembly of the Drive Pinion with the E-Motor

See Manual „ZF-Ergomat HFS 507, GP 18, GP 20, GP 21 Operating Instructions“.

6.4.2 Assembly of the E-Motor with the Transmission

See Manual „ZF-Ergomat HFS 507, GP 18, GP 20, GP 21 Operating Instructions“.

6.4.3 Assembly of the Drive Unit to the Vehicle Frame

See Manual „ZF-Ergomat HFS 507, GP 18, GP 20, GP 21 Operating Instructions“.

6.4.4 Assembly of the Drive Wheel to the Transmission

See Manual „ZF-Ergomat HFS 507, GP 18, GP 20, GP 21 Operating Instructions“.

6.5 General Instructions after the Assembly

For storage of the transmission, e.g. for replacement purposes after assembly the following has to be observed:

- The transmission opening (motor locating) is to be sealed on transmissions without E-Motor.
- The transmission always requires conservation.

Conservation is possible e.g. by filling the transmission with oil.

Rotate the output shaft several times and then drain off the oil again.

The corresponding oil quantity and oil type are indicated in the Manual "Installation and Maintenance".