

**Getriebe**  
**Transmission**  
**Boîte de Vitesses**  
**Cambio**

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**PORSCHE**

**Workshop-Manual**

**914  
914/6**

**DR.-ING. h. c. F. PORSCHE KG STUTTGART-ZUFFENHAUSEN**

This publication contains the essential removal, installation and adjustment procedures for the Porsche 914-914/6 vehicles sold in the USA and Canada,

Components and procedures described in this manual are identical for both types unless differences are pointed out in the text.

It is assumed that the reader is familiar with basic automotive repair procedures. Special tools required in performing certain service operations are identified in the manual and recommended for use. Use of tools or procedures other than those recommended in this repair manual may be detrimental to the vehicle's safe operation as well as the safety of the person servicing the vehicle.

The Porsche 914 - 914/6 Workshop Manual is divided into 8 volumes. The volumes are subdivided into 10 Main Groups as follows:

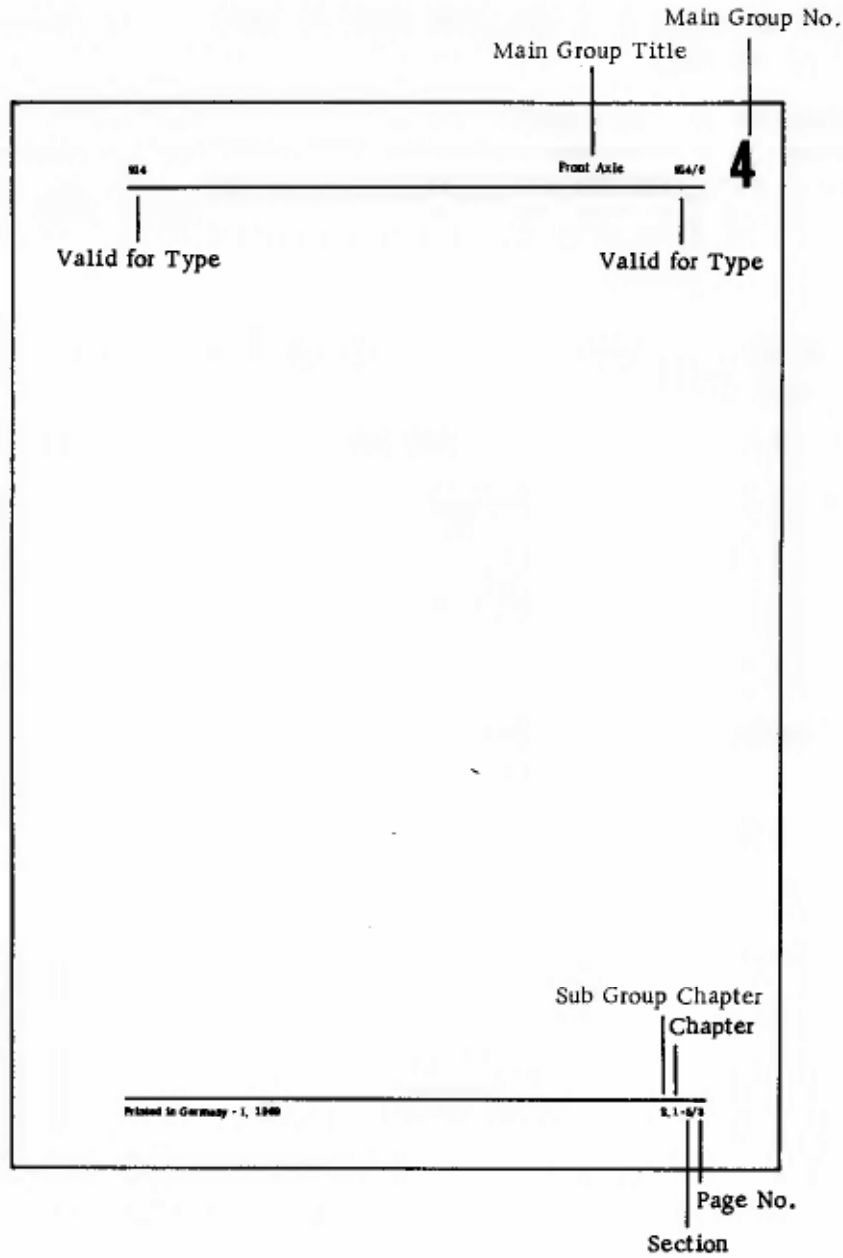
1st Volume	Engine and Clutch - 914	Main Group No. 1
2nd Volume	Fuel System - 914	Main Group No. 2
3rd Volume	Engine and Clutch - 914/6 Fuel System - 914/6	Main Group No. 1 Main Group No. 2
4th Volume	Transmission	Main Group No. 3
5th Volume	Front Axle Rear Axle	Main Group No. 4 Main Group No. 5
6th Volume	Brakes, Wheels, Tires Pedal System and Levers Maintenance, Specifications	Main Group No. 6 Main Group No. 7 Main Group No. 0
7th Volume	Body	Main Group No. 8
8th Volume	Electrical System	Main Group No. 9

The binders have a transparent plastic pocket on the spine into which the appropriate volume title can be inserted.

To find the individual repair operations, each main group is subdivided into "Chapters" and "Sections". Every main group is provided with a very detailed table of contents. Refer to example on next page.

The repair operations described in this Workshop Manual are based on the Type 914 vehicle. Repair operations which apply to Type 914/6 vehicles are described separately. The type vehicle to which the repair operation applies is given on the top left or right of the page.

When certain repair operations are similar for both type vehicles, the procedures are described together and the minor differences for the 914/6 emphasized by notes and remarks.



Technical Information

The "Technical Information" pages which are published from time to time should be filed in chronological order at the beginning of the respective Main Groups of the Workshop Manuals.



## CONTENTS

0 - GENERAL INFORMATION, DESCRIPTION, TECHNICAL DATA	
0 0 General Information	
5-Speed Transmission	
Sportomatic	
0 1 Description	
5-Speed Transmission - Operation	0 1 - 1/1
5-Speed Transmission - Design and Function	0 1 - 1/2
5-Speed Transmission - Power Flow	0 1 - 1/9
5-Speed Transmission with Side-Shift- General	0 1 - 1/11
Sportomatic - Operation	0 1 - 2/1
Sportomatic - Design and Function	0 1 - 2/4
Sportomatic - Power Flow	0 1 - 2/21
0 2 Technical Data Tolerances, and Wear Limits	
Technical Data - Applicable to 914 and 914/6	0 2 - 1/1
Tolerances and Wear Limits for Sportomatic and Manual Transmissions	0 2 - 2/1
0 3 Maintenance, Torque Values, and Special Tools	
Maintenance - Sportomatic and Manual Transmissions	0 3 - 1/1
Torque Values - Sportomatic	0 3 - 2/1
"      " <i>Manual</i>	<del>0 3 - 2/3</del>
Special Tools - Sportomatic	0 3 - 3/1
1 - REMOVING AND INSTALLING TRANSMISSION	
1.1 Transmission (914 and 914/6), remove and install	
Power Train Assembly - remove and install (see Group M)	
1 2 Sportomatic Transmission (914 and 914/6), remove and install (see Group M)	
2 - CONTROL VALVE, OIL AND VACUUM RESERVOIRS, TORQUE CONVERTER	
2 1 Control Valves	
Control Valve (914) - remove and install	
Control Valve (914/6) - remove and install	2 1 - 2/1
Control Valve (914) - adjust	
Control Valve (914/6) - adjust	2 1 - 4/1
Control Valve (914) - disassemble and reassemble	2 1 - 5/1

2.2	Oil and Vacuum Reservoirs	
	ATF-Reservoir (914) - remove and install	
	Oil Reservoir (914/6) - remove and install	2 2 - 2/1
	Vacuum Reservoir (914 and 914/6) remove and install	2 2 - 3/1
2 3	Torque Converter	
	Torque Converter - clean converter	2 3 - 1/1
	Torque Converter - replace bushing	2 3 - 2/1
3 -	MANUAL TRANSMISSION - 5-SPEED TRANSMISSION (914 and 914/6)	
3.1	Manual Transmission - disassemble and reassemble	
	Manual Transmission - disassemble and reassemble	3 1 - 1/1
	Shift Forks - adjust	3 1 - 2/1
	Rear cover - disassemble and reassemble	3.1 - 3/1
	Intermediate Plate - disassemble and reassemble	3 1 - 4/1
	Transmission Housing - disassemble and reassemble	3 1 - 5/1
	Input Shaft - disassemble and reassemble	3 1 - 6/1
	Pimon Shaft - disassemble and reassemble	3.1 - 7/1
	Synchronization - disassemble and reassemble	3 1 - 8/1
3.2	Manual Transmission with Side Shift - disassemble and reassemble	
	Gear Assembly - remove and install	3.2 - 1/1
	Shift Forks - adjust	3.2 - 2/1
	Shift Support - disassemble and reassemble	3 2 - 3/1
4 -	SPORTOMATIC TRANSMISSION (914/6)	
4.1	Sportomatic Transmission - disassemble and reassemble	
	Function Check	4 1 - 1/1
	Trouble Chart	4.1 - 1/3
	Converter Housing and Servo Motor - remove and install	4 1 - 2/1
	Converter Housing - disassemble and reassemble	4 1 - 3/1
	Clutch - remove and install	4 1 - 3/5
	Clutch Carrier Plate - remove and install	4.1 - 3/9
	Gear Assembly - remove and install	4 1 - 4/1
	Rear Cover - disassemble and reassemble	4.1 - 5/1
	Intermediate Plate - disassemble and reassemble	4 1 - 6/1
	Transmission Housing - disassemble and reassemble	4 1 - 7/1

Input Shaft - disassemble and reassemble	4.1 - 8/1
Pinion Shaft - disassemble and reassemble	4.1 - 9/1
Synchronization - disassemble and reassemble	4.1 - 10/1

## 5 - DIFFERENTIALS

### 5.1 Differential - Manual Transmission

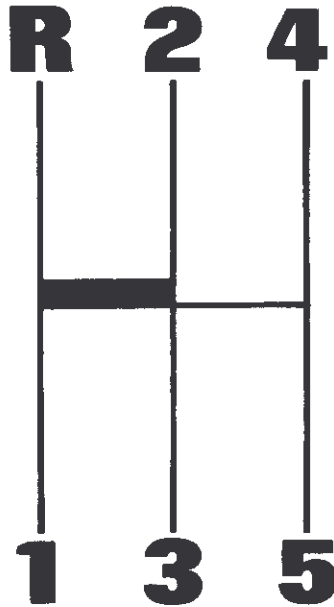
Differential - remove and install	5.1 - 1/1
Differential - disassemble and reassemble (without anchor piece)	5.1 - 2/1
Differential - disassemble and reassemble (with anchor piece)	5.1 - 2/7
Limited Slip Differential - disassemble and reassemble	5.1 - 3/1
Ring Gear and Pinion - adjust, general	5.1 - 4/1
Ring Gear and Pinion - adjust	5.1 - 5/1

### 5.2 Differential - Sportomatic Transmission

Differential - remove and install	5.2 - 1/1
Differential - disassemble and reassemble	5.2 - 2/1
Ring Gear and Pinion - adjust, general	5.2 - 3/1
Ring Gear and Pinion - adjust	5.2 - 4/1

## OPERATION

The transmission gears are shifted by a gear shift lever positioned in the center of the vehicle and a shift rod in the center tunnel.



The 5 forward gears and reverse are selected as follows:

- 1st gear - Push gear shift lever to left, over spring guide, then pull straight back
- 2nd gear - Push straight forward, off the spring guide
- 3rd gear - Pull straight back
- 4th gear - Push forward to the right
- 5th gear - Pull straight back to the right.
- Reverse - Push gear shift lever to left over spring guide then push straight forward

When shifting gears make sure that the clutch pedal is fully depressed and the gear shift lever moved according to the shift pattern (see diagram above) Do not try to move the gear shift lever diagonally since this may cause the linkage to jam.

## DESIGN AND FUNCTION

### General

The transaxle consisting of the transmission, differential, and final drive, is unitized with the engine to form the power train assembly in the rear of the vehicle. The engine is located in front of the transaxle. This is referred to as "mid-engine" design.

The die-cast, tunnel-type transmission housing is closed at the rear by the intermediate plate and rear cover, and at the front by the clutch housing.

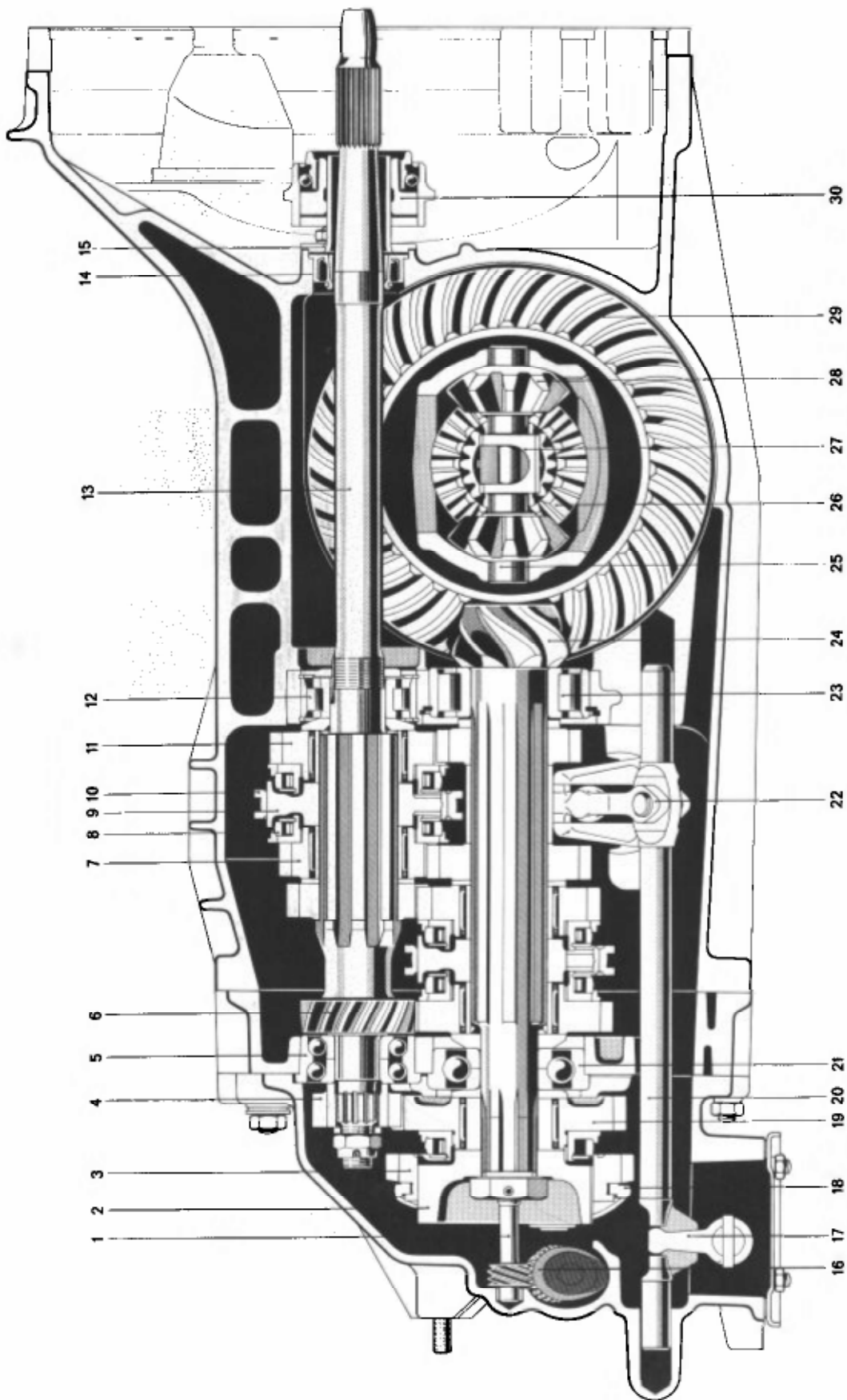
A finned partition in the center of the transaxle divides the transmission from the differential. The partition has several openings which ensure an even oil level in both parts of the housing.

## TRANSMISSION

The gear train is in the center section of the transaxle assembly.

The transmission has forward gears and a reverse. A servo-lock synchronization is used in all forward gears. The forward drive gears and gear II of the reverse gear cluster are in constant mesh. The use of helical gears ensures silent operation. The 4th and 5th gears ride on needle bearings on the input shaft, thereby reducing idle speed noise.

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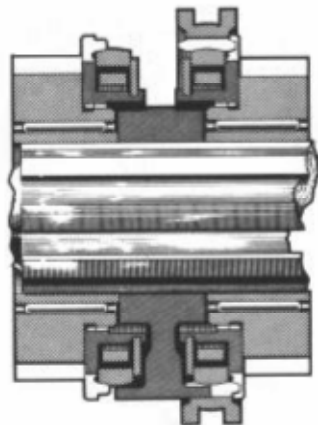
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|------------------------------------|--|
| 1 - Speedometer drive pinion       | 16 - Speedometer drive take off            |
| 2 - Guide sleeve, 1st and reverse  | 17 - Shift lever                           |
| 3 - Shift gear for 1st and reverse | 18 - Shift fork for 1st and reverse        |
| 4 - 1st gear                       | 19 - Gear II for 1st gear                  |
| 5 - Double-row ball bearing        | 20 - Shift rod                             |
| 6 - 2nd gear                       | 21 - Ball bearing                          |
| 7 - 4th gear                       | 22 - Selector shaft                        |
| 8 - Synchronizing ring             | 23 - Roller bearing                        |
| 9 - Synchro hub                    | 24 - Pinion                                |
| 10 - Shift sleeve                  | 25 - Shaft for small pinion (spider) gears |
| 11 - 5th gear                      | 26 - Side gear (large pinion)              |
| 12 - Roller bearing                | 27 - Anchor piece                          |
| 13 - Drive (input) shaft           | 28 - Spider gear (small pinion)            |
| 14 - Seal                          | 29 - Ring gear                             |
| 15 - Guide tube                    | 30 - Throw-out bearing                     |

## SYNCHROMESH - MANUAL TRANSMISSION

The Porsche synchromesh system uses servo-thrust forces to synchronize the transmission gears. Friction created between synchronizing ring is increased by the servo-lock component contained within the synchronizing ring.

### Operation (from neutral - vehicle stationary)

When a gear is selected from the neutral position (car stationary) the shift sleeve moves from its neutral position toward the toothed engaging ring of the selected gear. At the same time, the synchronizing ring is compressed inside the shift sleeve. When the shift is completed (teeth of shift sleeve machined groove on the inner surface of the shift sleeve).



### Note

When selecting a gear while the vehicle is stationary, only the spring tension created when the synchronizing ring is being compressed between shift has to be overcome.

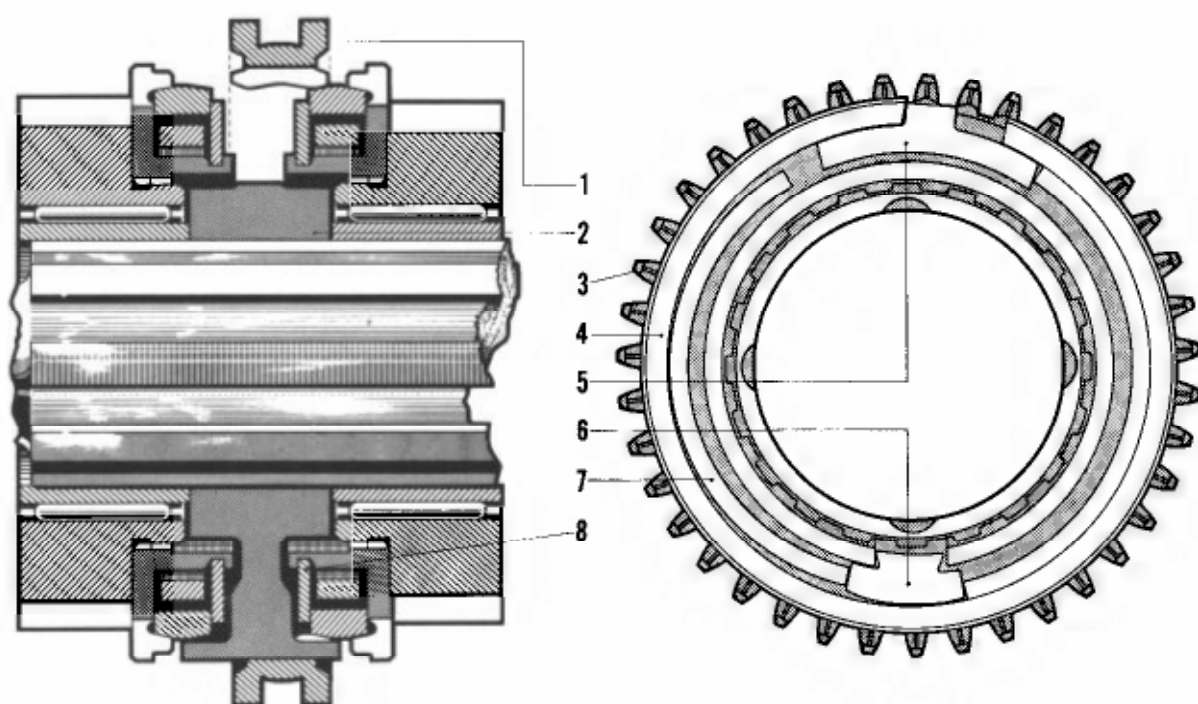
### Operation (changing gears - vehicle in motion)

When the gears are shifted while the car is in motion, different conditions exist. The purpose of synchromesh component is to synchronize the speed of the input shaft and pinion shaft, respectively, and that of the given gear on a given shaft, before the actual engagement is made. The synchronizing unit must be able to only synchronize the gear speeds by friction, but also prevent contact between the shift sleeve and the teeth of the engaging ring of the selected gear until the shift speeds are fully synchronized.

When shifting gears, the engine clutch must be fully disengaged since the clutch disc is part of the mass to be synchronized; that is, to be either accelerated or decelerated (up shift or down shift).



When a shift is made while driving, the shift fork guides the shift sleeve off the synchronizing ring of the engaged gear, through the neutral position to the point of contact between the internal teeth of the shift sleeve and the beveled edge of the synchronizing ring of the next gear. As this contact is made, the friction created by the unequal gear speeds rotate the synchronizing ring to one side against the thrust block. The moveable thrust block then slides against a brake band. Since the other end of the brake band rests against the anchor block, the brake band is forced out against the inner race of the synchronizing ring. As a result, there is an immediate increase of friction between the synchronizing ring and the shift sleeve. This increase is the force applied on the brake band which in turn increases the force on the synchronizing ring. The gear is therefore forced to rotate at the same speed as the shift sleeve.



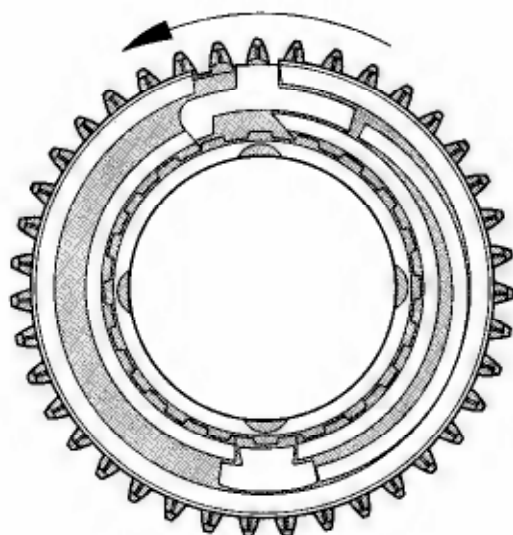
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|----------------|----------------------|----------------|--------------|
| 1 Shift sleeve | 3 Gear               | 5 Thrust block | 7 Brake band |
| 2 Synchro-hub  | 4 Synchronizing ring | 6 Anchor block | 8 Circlip    |

As long as there is a difference in speed between the shift sleeve and the gear-connected synchronizing ring, the energized brake band prevents the synchronizing ring from compressing - therefore the shift sleeve cannot engage with the teeth on the selected gear.

As the difference in speed between the sliding sleeve and the gear decreases, the friction between the synchronizing faces also decreases. When the speeds between the two parts equalize, the servo-thrust components relax. The synchronizing ring can now be compressed in its seat. This allows the shift sleeve to move completely onto the synchronizing ring. At this point, the synchronizing ring snaps into the groove machined in the inner race of the shift sleeve and locks itself in that position. For this reason, a locking device in the selector shaft is no longer necessary.

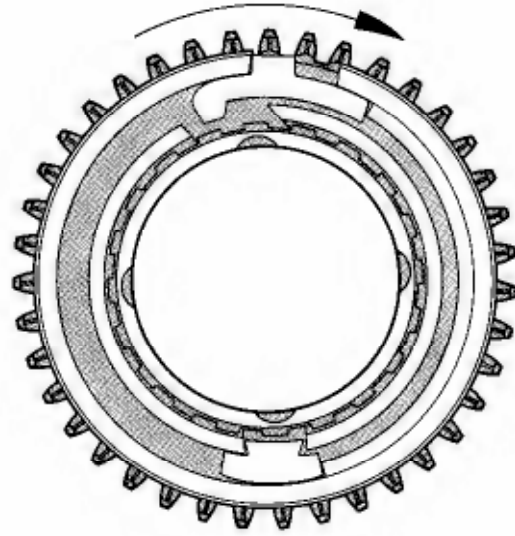
All forward speeds of the transmission with identical synchromesh components with the exception of the 1st gear which is used for starting. Care was taken to ensure that this starting gear engages with the least amount of effort when the car is not in motion.

As shown in the illustration, the thrust block for 1st gear has been provided with a tab which rests in a recess machined into the gear. Note that only one brake band is used. The engine idle speed is very low when compared with rpm's at operating speeds. When the engine clutch is disengaged prior to shifting into low speed at standstill, the clutch plate stops within a short time following disengagement. To further shorten the engine clutch stopping time and allow the driver to quickly shift into low gear without gear clash, it was necessary to provide a synchronizing device for this purpose; in this case, the synchro-mesh unit acts as a brake.



As 1st gear is slowed down, the force resulting through friction at the synchronizing ring acts directly onto the gear by way of the thrust block and its tab. Due to its slanted tab, the thrust block exerts a pressure, through its longer end, against the inner face of the synchronizing ring. This small force is enough to ensure easy engagement of 1st gear while still preventing gear clash.

When a shift from 2nd to 1st gear is made while the car is in motion, the 1st gear must be accelerated to match its counterpart. For this purpose, a brake band has been provided on the respective synchromesh side ensuring the same synchronization as on the other gears (see illustration).

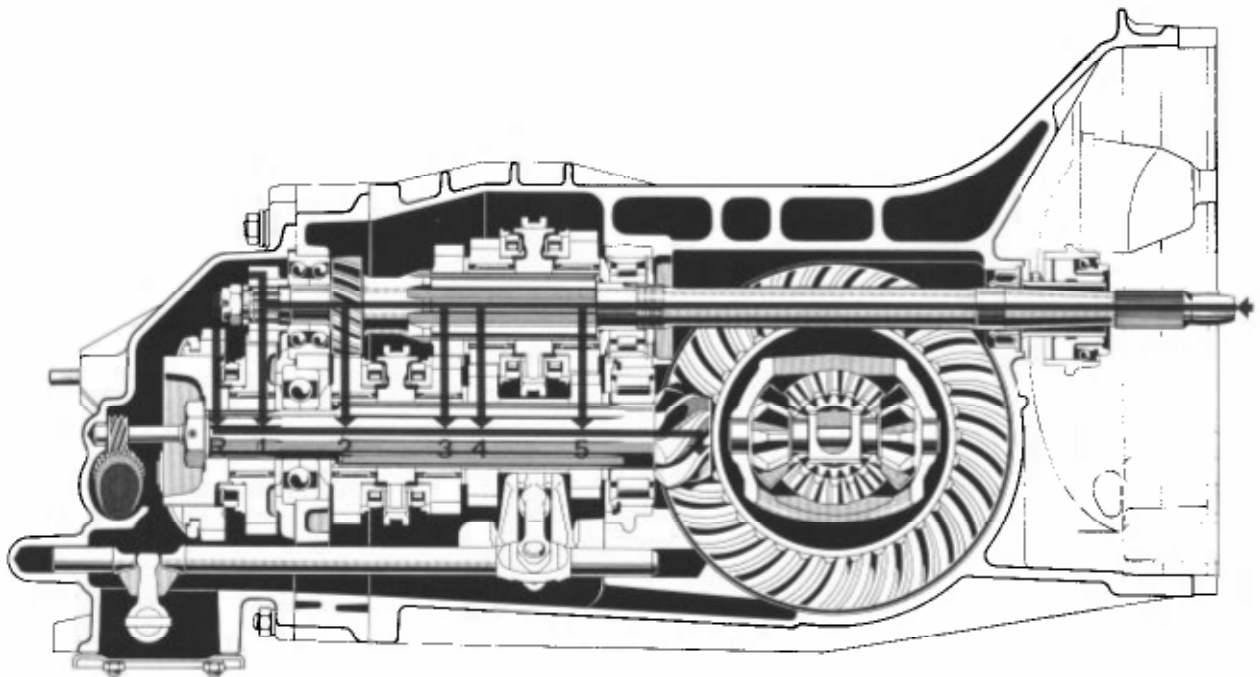


### POWER FLOW

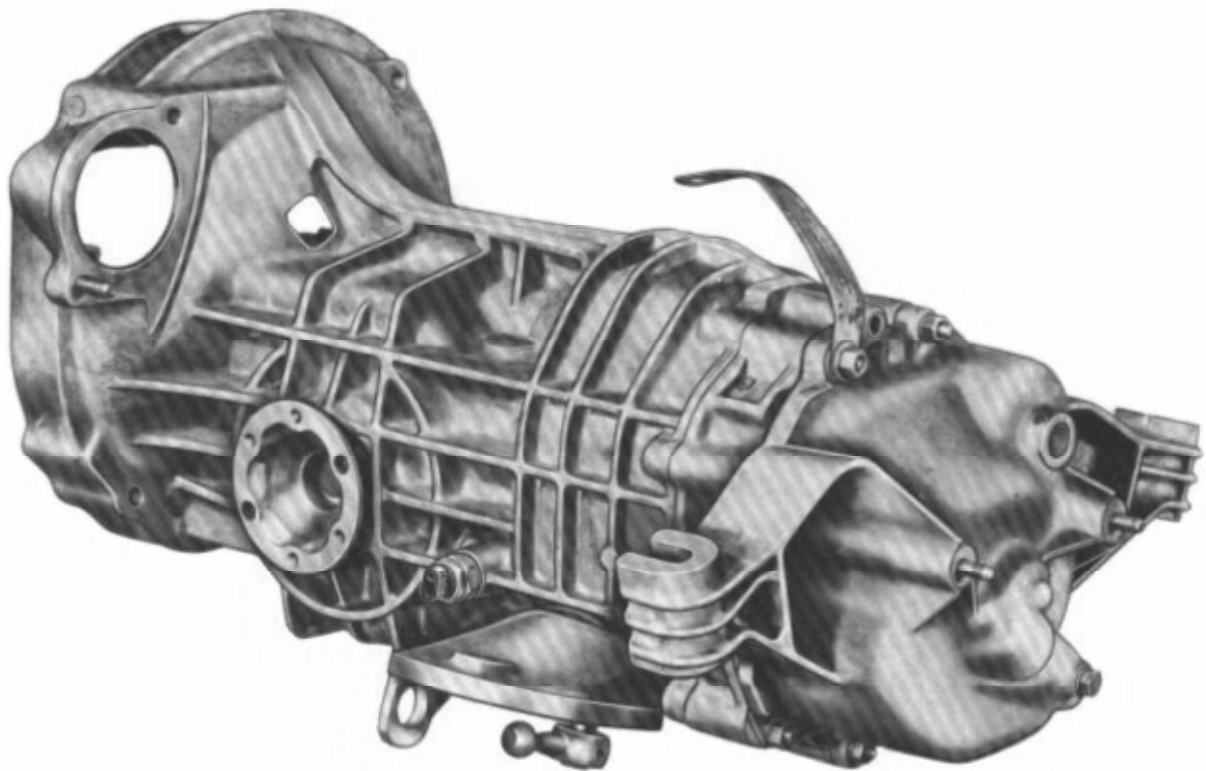
Power flow in all gears is through the input shaft and the respectively engaged gear pair to the pinion shaft. The shifting and synchronizer components for gears 1 thru 3 are located on the pinion shaft side, while the components for gears 4 and 5 are situated on the input shaft.

Torque transfer is effected only thru the respective gear pair. The mechanical gear engagement in gears 1 thru 3 is effected by moving the shift sleeve on the pinion shaft, with gears 4 and 5 engaged by moving the shift sleeve on the input shaft.

Reverse gear power flow is from the input shaft thru the reverse shaft and its sliding gear to the pinion shaft.

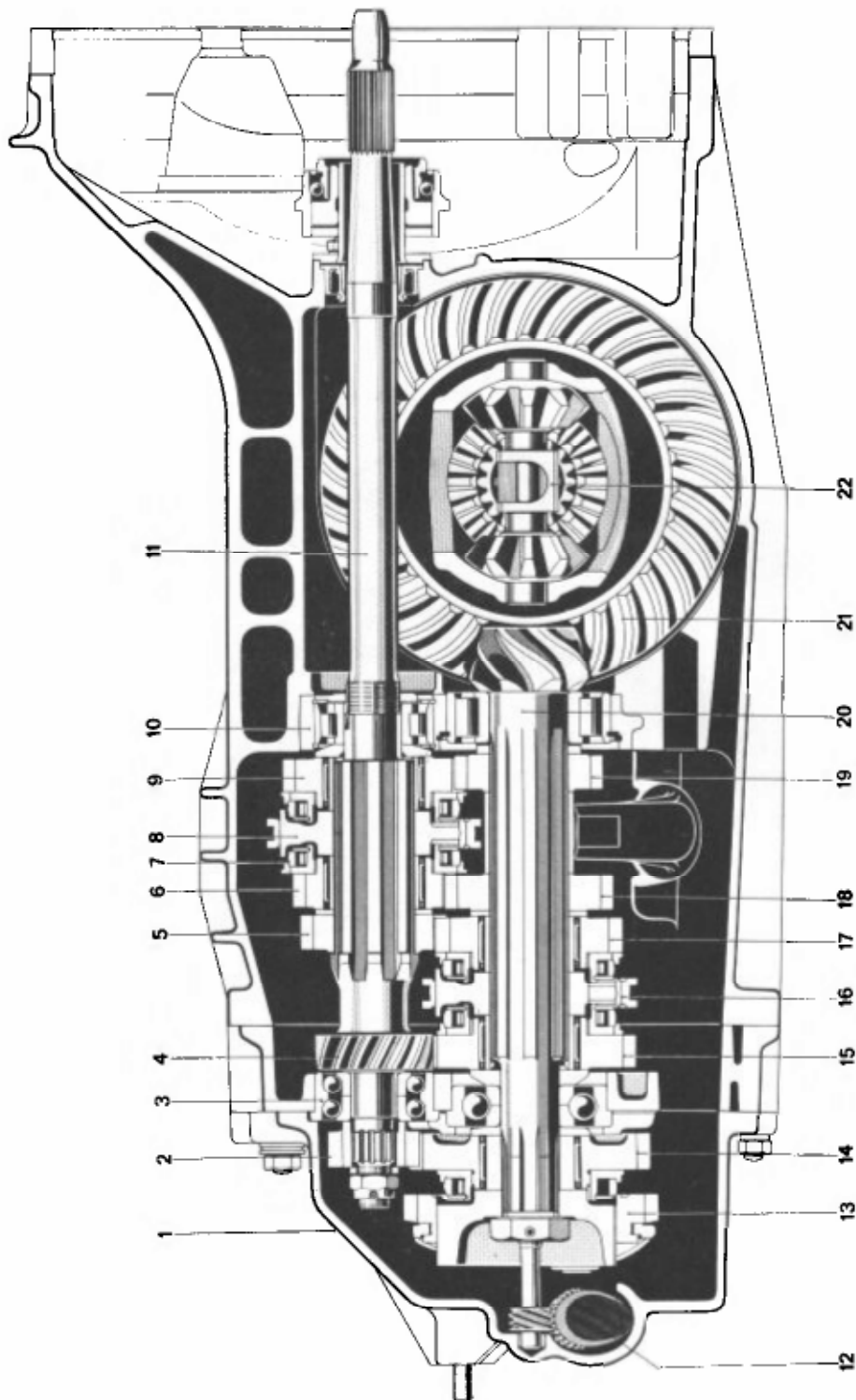


## TRANSMISSION



Beginning with 1973 models, Type 914/1.7 and 914/2.0 vehicles are equipped with a modified transmission which has been designated 914/12.

This transmission has a side-mounted shifting mechanism.



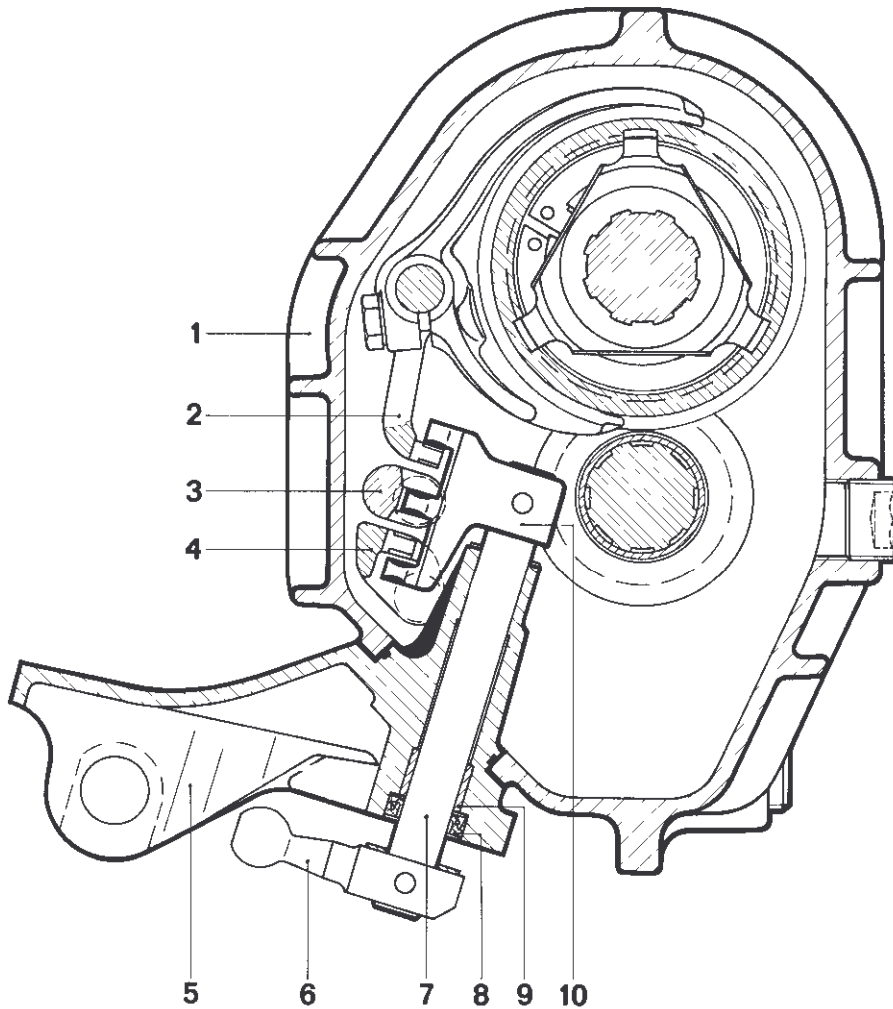
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- |      |                         |      |                                |
|------|-------------------------|------|--------------------------------|
| 1 -  | Transmission rear cover | 12 - | Speedometer drive take-off     |
| 2 -  | Gear I for 1st speed    | 13 - | Shift gear for 1st and reverse |
| 3 -  | Double-row ball bearing | 14 - | Gear II for 1st speed          |
| 4 -  | Gear I for 2nd speed    | 15 - | Gear II for 2nd speed          |
| 5 -  | Gear I for 3rd speed    | 16 - | Shift sleeve                   |
| 6 -  | Gear I for 4th speed    | 17 - | Gear II for 3rd speed          |
| 7 -  | Synchronizing ring      | 18 - | Gear II for 4th speed          |
| 8 -  | Synchro hub             | 19 - | Gear II for 5th speed          |
| 9 -  | Gear I for 5th speed    | 20 - | Pinion shaft                   |
| 10 - | Roller bearing          | 21 - | Ring gear                      |
| 11 - | Input shaft             | 22 - | Anchor piece                   |

## DESCRIPTION

The 914/12 side shift transmission is basically the same as the previous versions. The only change is in the side-mounted support with shift linkage, modified shift rods, and modified rear cover. This change eliminates the shift rod with inner selector shaft and fork piece, as well as the shift lever shaft in the rear cover.

The gears are shifted by a rake-like shift finger which engages the individual shift rods.

The gearshift pattern remains the same since no change occurred in the arrangement of gears and shift rods.



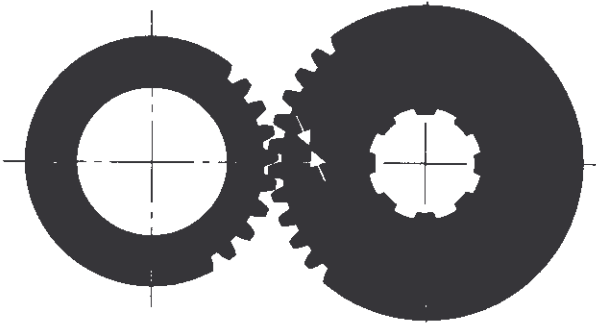
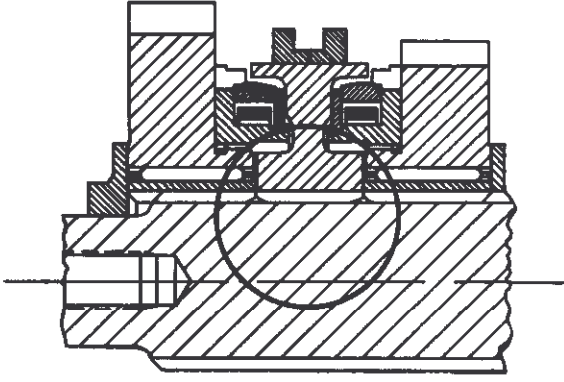

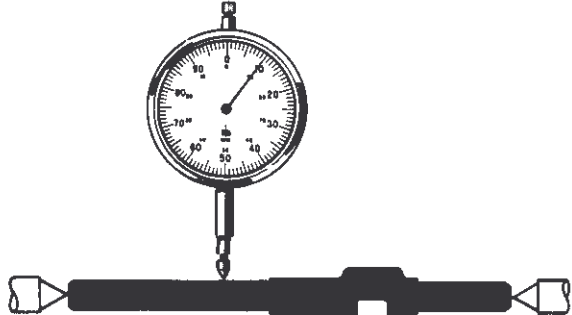
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| 1 - Transmission housing               | 6 - Ball-joint lever  |
| 2 - Shift piece for 4th and 5th gear   | 7 - Shift lever shaft |
| 3 - Shift rod for 2nd and 3rd gear     | 8 - Oil seal          |
| 4 - Shift rod for 1st and reverse gear | 9 - Bushing           |
| 5 - Shift support                      | 10 - Shift finger     |



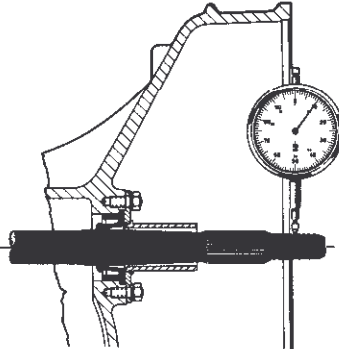
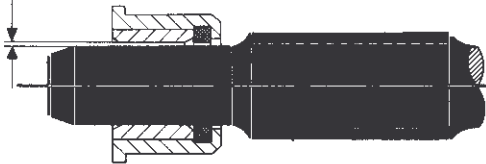


## Specifications

General Data	914	914/6
<b>Driving performance</b>		
Horsepower rating	85 SAE HP at 5000 rpm (80 DIN HP at 4900 rpm)	125 SAE HP at 5800 rpm (110 DIN HP at 5800 rpm)
Engine torque	99.6 ft lbs at 3500 rpm (13.5 mkg at 2700 rpm)	131 ft lbs at 4200 rpm (16.0 mkg at 4200 rpm)
Max speed	105 mph	121 mph
<b>Dimensions</b>		
Wheel base	96.5 in. (2450 mm)	96.5 in. (2450 mm)
Track, front	with 5 1/2 J x 15 rims 52.40 in. (1331 mm)    52.87 in. (1343 mm)	with 5 1/2 J x 14 rims 53.3 in. (1354 mm)    53.4 in. (1356 mm)
rear	53.98 in. (1371 mm)    54.45 in. (1383 mm)	54.3 in. (1379 mm)    54.4 in. (1381 mm)
<b>Gear ratios</b>		
<b>Manual transmission</b>		
1st Gear	3.09 (34 : 11)	3.09 (34 : 11)
2nd Gear	1.89 (34 : 18)	1.78 (32 : 18)
3rd Gear	1.26 (29 : 23)	1.22 (28 : 23)
4th Gear	0.93 (25 : 27)	0.93 (25 : 27)
5th Gear	0.71 (22 : 31)	0.76 (22 : 29)
Reverse Gear	3.13 (16:11 x 43:20)	3.13 (16:11 x 43:20)
Drive ratio	4.429 (7 : 31)	
<b>Filling Capacity</b>		
Transmission and final drive	2.6 qts. (2.5 lits Hypoid oil SAE 90)	

## Tolerances and Wear Limits

Measuring point	Installation tolerance (new)mm	Wear limit mm	
1. Backlash between gear I and II 1st Gear 2nd Gear 3rd Gear 4th Gear	0,06-0,12	0,22	
2. Loose gears on pinion shaft and main drive shaft 1st Gear 2nd Gear 3rd Gear axial play 4th Gear 5th Gear	0,3-0,4 0,2-0,3 0,2-0,3 0,2-0,3 0,2-0,3	0,5 0,4 0,4 0,4 0,4	
3 Shift rods a) in guides radial play	0,195- 0,256	0,4	
b) out-of-true		1,10	

Measuring point	Installation tolerance (new) mm	Wear limit mm	
4. Shift fork in shifting sleeve  1st and reverse gear 2nd and 3rd gear 4th and 5th gear  Axial play	0.1-0.3 0.1-0.3 0.1-0.3	0.5 0.5 0.5	
5. Synchronizing rings  1st Gear 2nd Gear 3rd Gear 4th Gear 5th Gear  OD installed	76.12-76.48	After wear of molybdenum layer (a)	
6 Drive shaft a) on guide pin out-of-true	max. 0.1	max. 0.1 (straighten)	
b) in bushing of hollow screw on engine  Radial play	0.145-0.231	0.3	

### Maintenance and lubrication

The following maintenance and lubrication work should be performed in accordance with the current maintenance instructions

1 - Transmission and final drive:

Check oil level. If necessary add hypoid transmission oil. Check for leaks.

3 - Check constant velocity joint bolts for proper torque.

2 - Transmission and final drive:

Change oil, clean magnetic oil drain plugs.  
Check for leaks

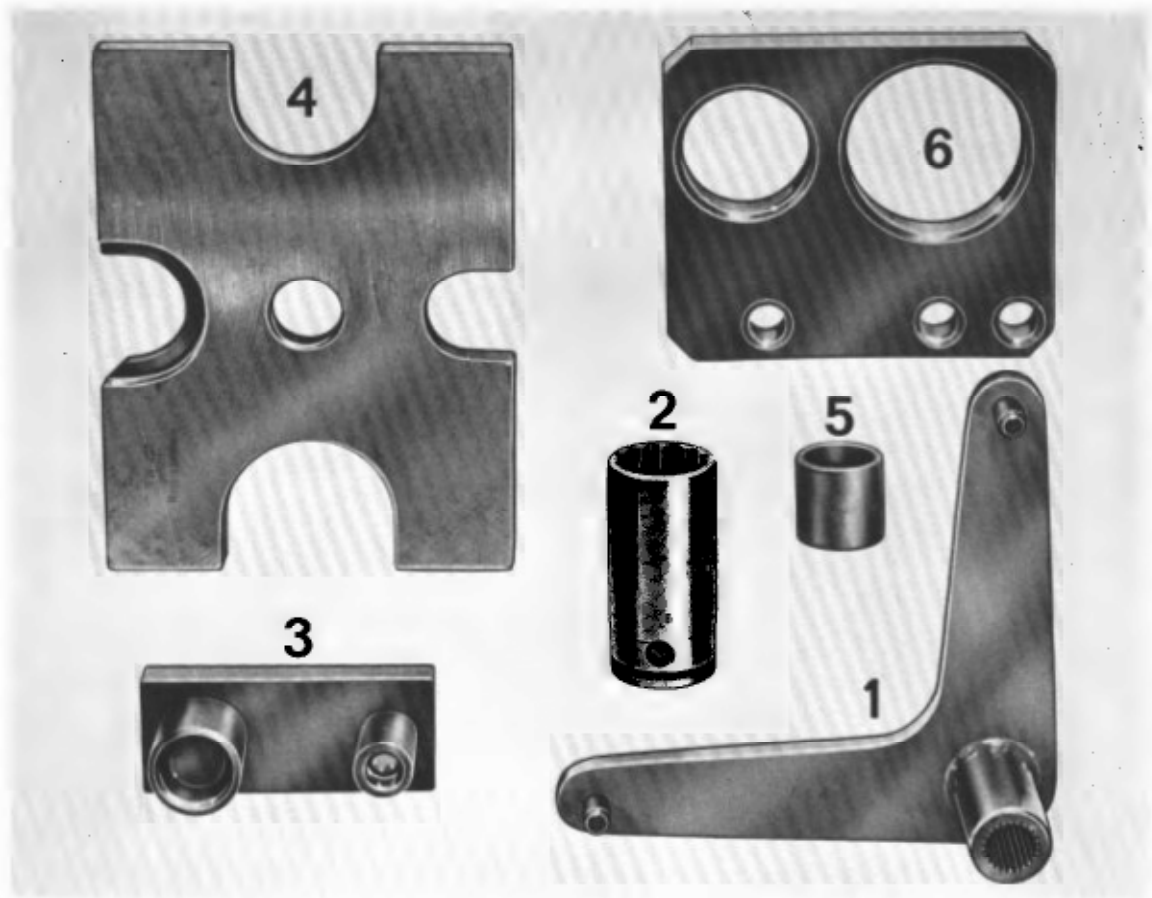
4 - Check constant velocity joint boots for leakage and damage. Check tightness of securing clamps.

	mkp	ft/lb
Hex. nuts on transmission housing M8	2.5	18.0
Hex. screw with trunnion (angle drive) M8	1.5	10.8
Closing screw on intermediate plate M12	3.0	21.7
Closing screw oil inlet M 24	2.5	18.0
Magnetic plug oil drain M 24	2.5	18.0
Hex. screws for intermediate plate clamping plate	2.5	18.0
Hex. nut on input shaft M 24	11	80
Crown nut on input shaft M 14	10.0	72
Expanding screw of pinion shaft M 12	12	87
Hex. screws of shift forks M 8	2.5	18.0
Hex. screws for ring gear attachment M 12	10.0	72
Expanding screws for universal flange of differential M 10	3.5 - 4.0	25.3 - 18.9
Hex. nuts on converter housing and servo motor M 8	2.5	18.0
Hex. nuts on converter housing and starter M 10	4.5	32.5
Closing screw on front gearbox cover for parking lock M 12 x 1.5	4.7	34.0
Double hex. socket screws for clutch pressure plate M 6	1.5	10.8
Double hex. socket screws for freewheel support M 6	1.5	10.8
Double hex. screw for converter-drive plate M 8	2.4 - 2.6	17.4 - 18.8
Bridging switch M 18 x 1.5	3.5 - 4.0	25.3 - 28.9
Backup light switch M 18 x 1.5	3.5 - 4.0	25.3 - 28.9
Hollow screw of angle drive in guide bushing M 24 x 1.5	2.2 - 2.4	15.9 - 17.4

## TIGHTENING TORQUES FOR MANUAL TRANSMISSION

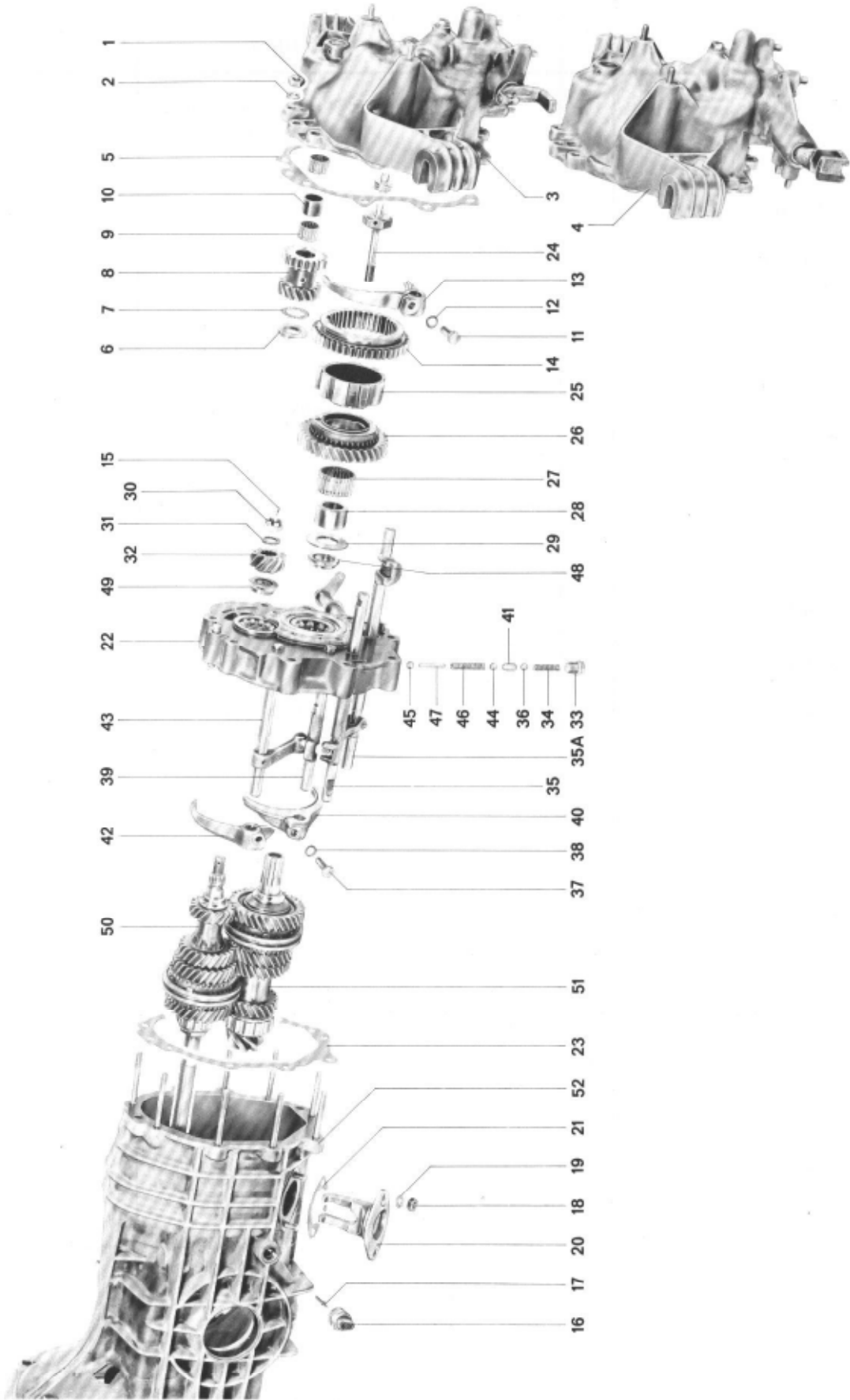
Location	Description	Thread	Grade	Tightening torque	
				ft. lbs.	mkp
Side and rear cover on transmission housing (studs)	Self-locking hex. nut	M 8x1.25	X 12 Cr Ni 18.8	16-18	2.2-2.5
Fork piece on housing	Nut	M 8x1.25	6.8	15-17	2.1-2.3
Guide tube for throwout bearing on housing	Nut	M 6x1.0	6.8	7	0.8-0.9
Transmission housing (oil filler hole)	Closing plug	M 24x1.5 (taper 1:16)	St 37	15-18	2.0-2.5
Transmission housing (oil drain hole)	Closing plug	M 24x1.5 (taper 1:16)	St 37	15-18	2.0-2.5
Transmission housing (bearing throwout fork)	Ball pin	M 8x1.25	8.8 45 S 20 K	15-17	2.1-2.3
Transmission housing (breathing)	Breather	M 14x1.5 (taper 1:16)	9S 20 K	15-22	2.0-3.0
Backup light switch on housing	Backup light switch	M 18x1.5	Ms	25-29	3.5-4.0
Holding plate on throwout fork	Fillister head screw	M 6x1.0	8.8	6-7	0.8-0.9
Starter on transmission housing	Hex. nut	M 10x1.5	8.8	33-35	4.6-4.8
Clamping plate on intermediate plate	Fillister head screw	M 8x1.25	10.9	15-17	2.1-2.3
Bolt for guide lever on intermediate plate	Bolt	M 8x1.25	9S 20 K	15-17	2.1-2.3
Lock on intermediate plate (gear shift lock)	Closing screw	M 14x1.5	4.6	16-18	2.2-2.5
Speedometer drive on rear housing cover	Bolt	M 8x1.25	8.8	12-13	1.6-1.8
Miter drive in guide bushing	Hollow screw	M 24x1.5	6.8	16-18	2.2-2.4
Drive shaft	Nut	M 24x1.5	6.9	72-86	10-12
Drive shaft	Castle nut	M 24x1.5	8.8	65-80	9-11

Location	Description	Thread	Grade	Tightening torque	
				ft. lbs.	mkp
Pinion shaft	Expansion bolt	M 12x1.5	10.9	80-87	11-12
Shift forks on shift rods	Hex. screws (m 8 x 25)	M 8x1.25	8.8	18-19	2.4-2.6
Ring gear on differential housing	Bolt	M 12x1.5	10.9	72-86	10-12
Constant velocity flange on differential	Expansion bolt	M 10x1.5	8.8	25-29	3.5-4.0
Shift rod bearings on rear transmission cover (914 only)	Nut	M 8x1.5	6.8	15-17	2.1-2.3
Cover plate on rear transmission cover	Nut	M 6x1.0	6.8	6-7	0.8-0.9



No.	Description	Special Tools	Remarks
1	Holding plate	P 37	
2	Deep socket 36 mm		
3	Thrust piece	P 253	
4	Thrust plate	VW 401	
5	Tubing	VW 472/2	
6	Holding plate	P 260	





No	Description	Qty.	Note when		Special Instructions see
			Removing	Installing	
1	Self-locking nut	10		Replace, if necessary Torque to specifica- tion	
2	Washer	10			3.1-3/1
3	Transmission cover 914/6	1			
4	Transmission cover 914	1			3.1-3/1
5	Gasket	1		Replace	
6	Thrust washer	1			3.1-1/15
7	Axial needle cage	1		Check for wear	
8	Reversing double gear	1		Check for wear	
9	Needle cage	2		Check for wear	
10	Sleeve	1			
11	Bolt	1		Torque to specification	
12	Spring washer	1		Replace, if necessary	
13	Shift fork	1		Check for wear	
14	Shift gear	1		Check for wear	
15	Spiral pin	1		Replace	
16	Switch for backup light	1		Torque to specification	
17	Contact tappet	1		Position correctly	
18	Nut	2		Torque to specification	
19	Spring washer	2		Replace, if necessary	
20	Fork piece	1			
21	Gasket	1		Replace	

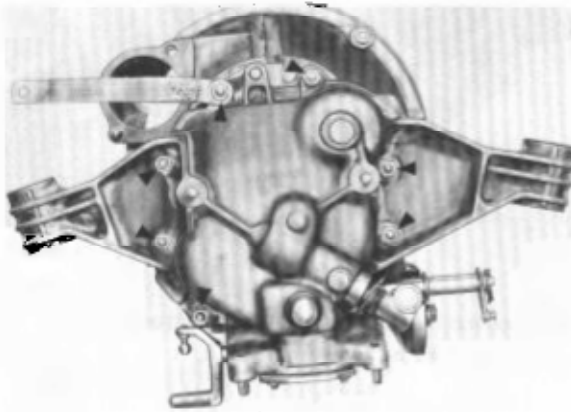
No.	Description	Qty.	Note when		Special Instructions see
			Removing	Installing	
22	Intermediate plate	1	Disassemble, if necessary, and reassemble		3.1-4/5
23	Gasket	x	Note quantity and thickness of gaskets	Check thickness	3.1-5/1
24	Expansion bolt	1		Lightly lubricate and tighten to correct torque	
25	Guide sleeve	1	Remove, using 2 screw drivers	Check for wear	
26	Gear II for 1st gear	1		Replace only in pairs, check synchronization	
27	Needle cage	1		Check for wear	
28	Bushing	1			
29	Thrust washer	1		With flat, machined surface toward needle bearing	
30	Castle nut	1		Torque to specification	
31	Washer	1			
32	Gear I for 1st gear	1		Replace only in pairs	
33	Closing screw	1		Torque to specification	
34	Spring	1		Check	
35	Shift rod for 1st and reverse gear	1			
35A	Shift rod	1		Make sure selector lever is correctly installed on shift rod	3.1-1/14
36	Ball	1			
37	Bolt	2			

No.	Description	Qty.	Note when		Special Instructions see
			Removing	Installing	
38	Spring washer	2		Replace, if necessary	
39	Shift rod (2nd + 3rd gear)	1			3.1-2/1
40	Shift fork	1		Do not mix up shift forks. Adjust	
41	Locking piece	1			
42	Shift fork	1		Do not mix up shift forks. Adjust	
43	Shift rod for 4th and 5th gear	1			3.1-2/1
44	Ball	1			
45	Ball	1			
46	Spring	1		Check	
47	Pin for gear interlock	1		Apply light coat of grease and insert with spring	
48	Bearing inner race	1		Press on	
49	Bearing inner race	1		Press on	
50	Drive shaft	1	remove with P 253		3.1-1/11
51	Pinion shaft	1	remove with P 253		
52	Transmission housing	1	Disassemble, if necessary and reassemble		3.1-5/11

## REMOVING AND INSTALLING TRANSMISSION

## Removing

1. Attach transmission to stand P 201.
2. Drain transmission oil.
3. Loosen nuts on rear transmission cover.

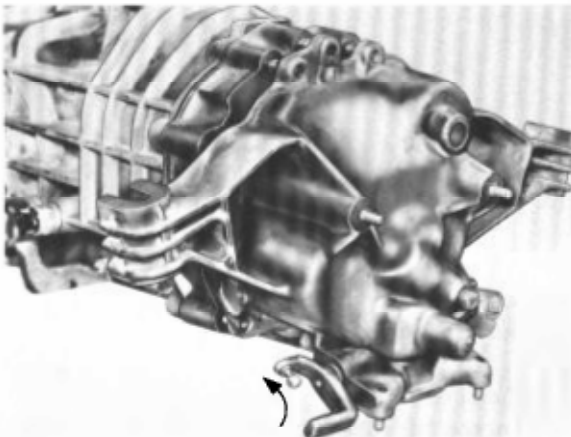


4. Remove the four nuts and take off the shift lever cover plate on the bottom of the transmission cover.

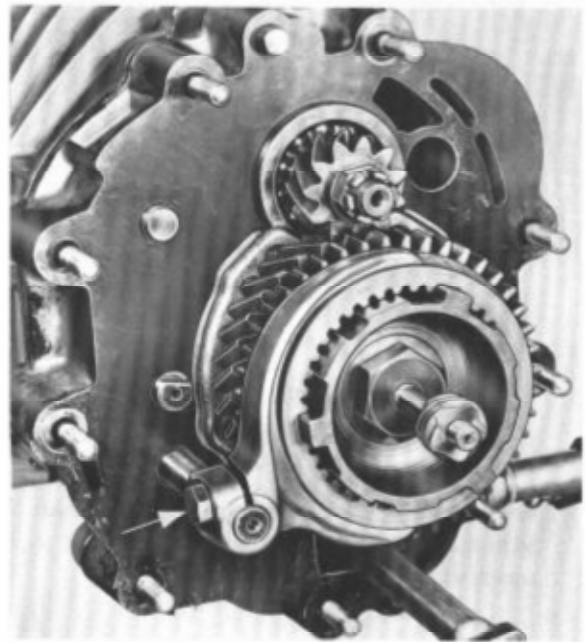
**Caution**

When removing the transmission cover, components on the idler shift may fall out.

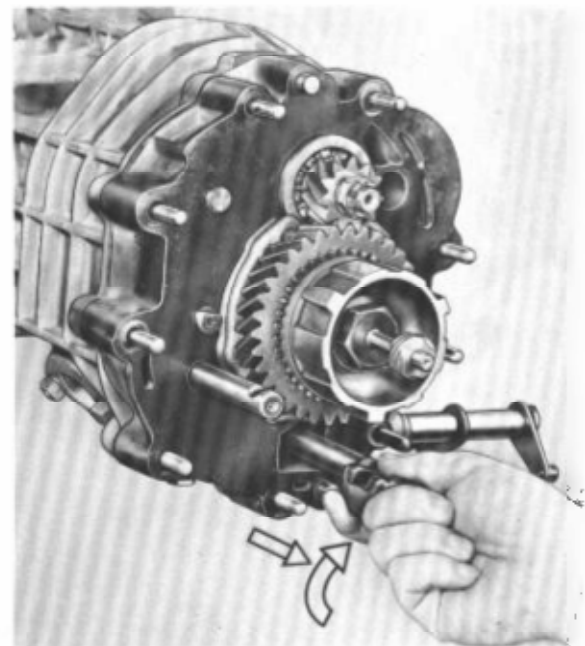
5. Remove rear transmission cover while turning shift lever shaft slightly counterclockwise. This disengages the shift lever from the shift rod.



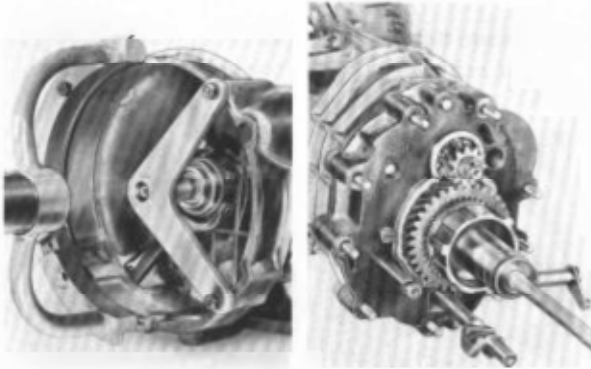
6. Loosen bolt on shift fork for 1st and reverse gear and remove shift gear together with shift fork.



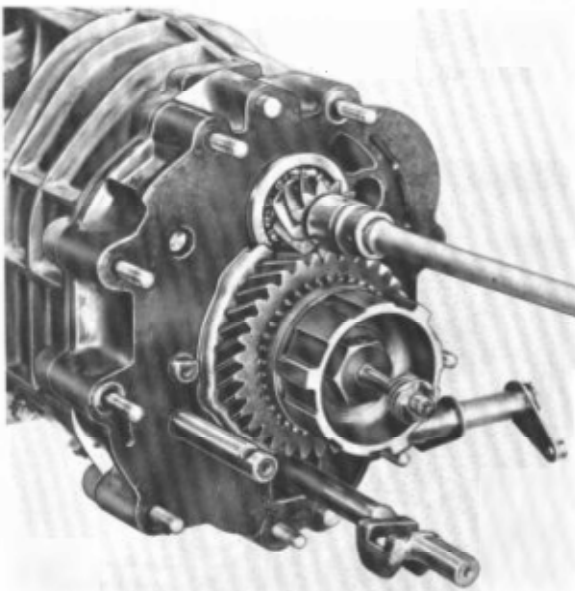
7. Engage 5th gear (turn shift rod to the right and pull out).



8. Lock drive shaft with holding plate P 37. Loosen expansion bolt of pinion shaft with insert (do not remove).

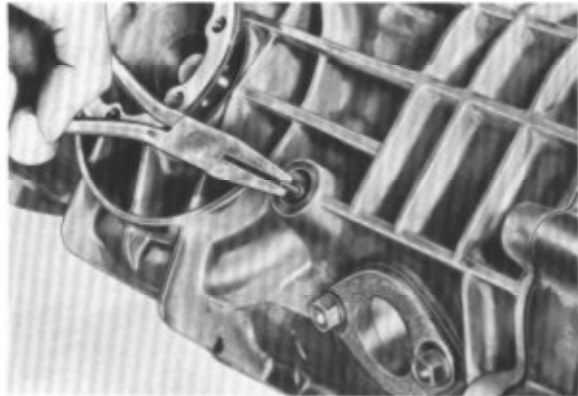


9. Remove spiral pin of castle nut on drive shaft with mandrel and loosen castle nut (do not unscrew).

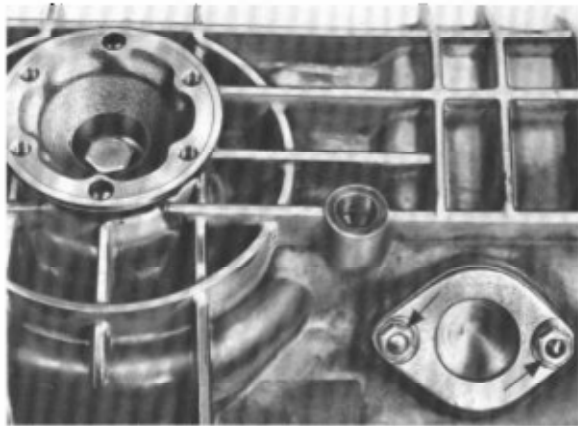


10. Engage neutral.

11. Unscrew backup light switch and pull out contact pin.



12. Loosen nuts on fork piece for internal shift lever and pull out fork piece.



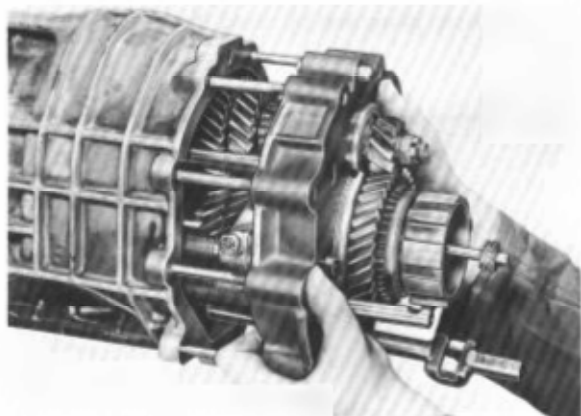
13. Pull internal shift rod out of its guide.

14. Engage 5th gear. Use a screw driver through hole of fork piece.

**Caution**

Engage 5th gear when removing and installing and intermediate plate with gear assembly.

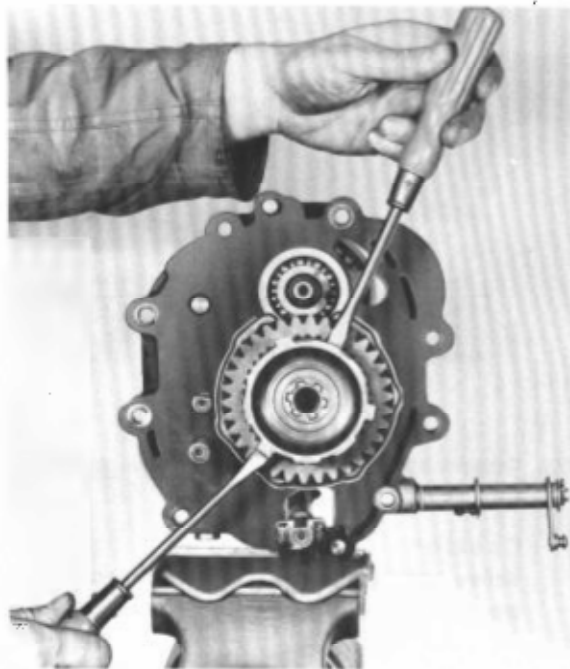
15. Withdraw intermediate plate with gear assembly from transmission housing until it clears the studs. Then turn intermediate plate assembly slightly to the right and remove. (If necessary, tap intermediate plate lightly with a soft mallet.)



16. Note the quantity and thickness of the gaskets between the transmission housing and intermediate plate.

17. Place intermediate plate with gear assembly into vise equipped with aluminum jaw caps.

18. Remove pinion shaft expansion bolt. Remove guide sleeve and 1st and reverse gear using 2 screw drivers.

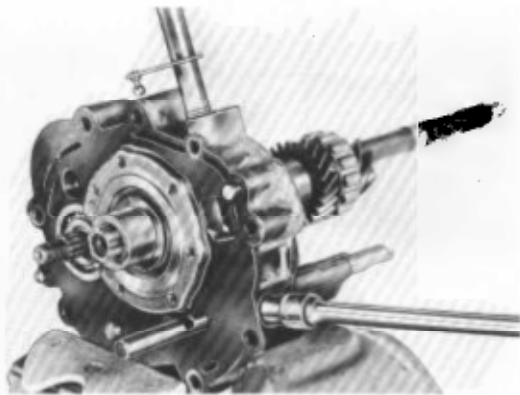


19. Remove gear II for first gear, race, needle bearing cage, and thrust washer.

20. Remove castle nut and gear I for first gear from the drive shaft.

21. Engage neutral.

22. Loosen gear interlock retaining bolt and remove spring.

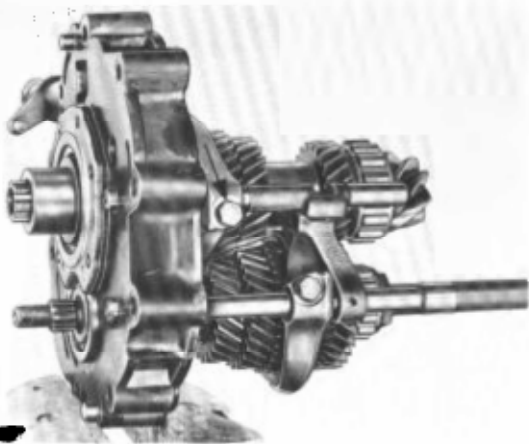


23. Remove shift rod for 1st and reverse gear as well as ball for gear interlock.

**Caution**

Before removing, put on identifying marks to ensure proper re-installation. (Attach tags.)

24. Loosen retaining bolt of 2nd and 3rd gear shift fork. Remove shift rod, shift fork and locking piece.



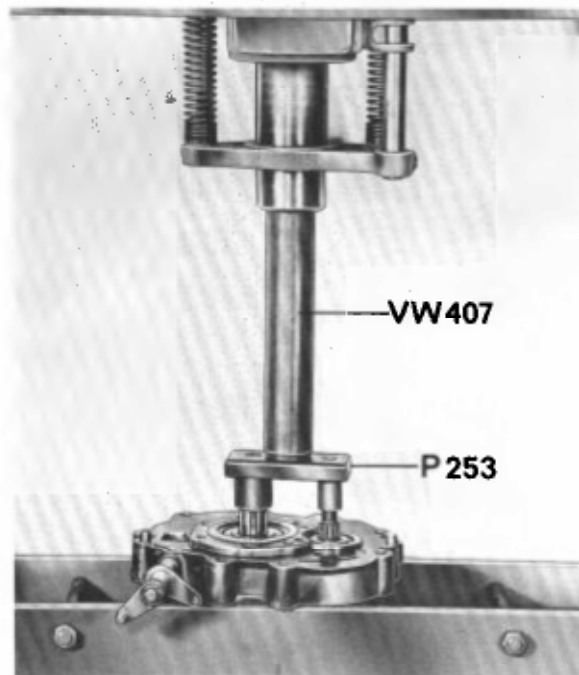
25. Loosen retaining bolt of 4th and 5th gear shift fork. Remove shift rod, and ball for gear interlock.

26. Remove gear interlock, ball, spring and locking pin.

**Caution**

When pressing out pinion and drive shaft ball bearings may fall out.

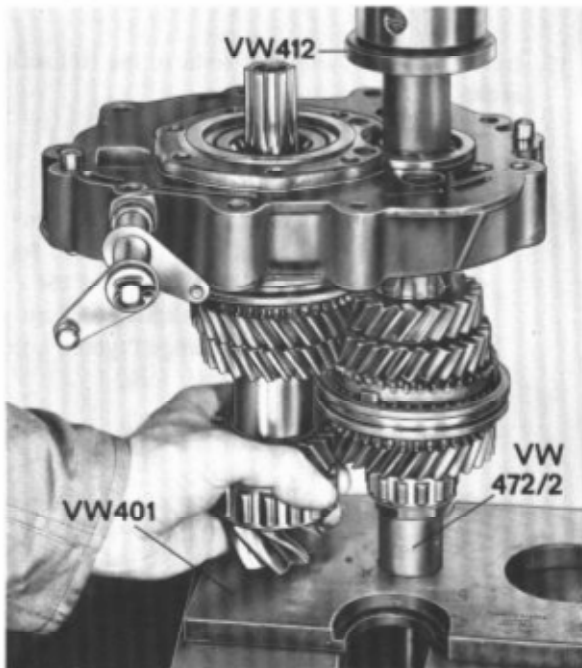
27. Press out pinion and drive shafts from intermediate plate and by using thrust piece P 253.



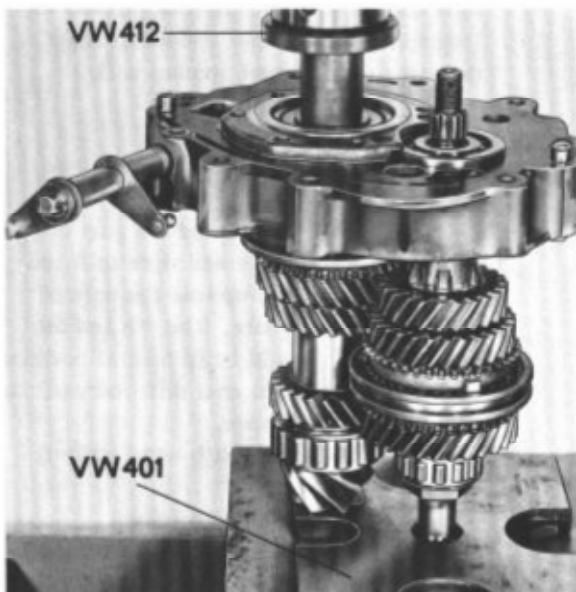


### Installing

1. Position intermediate plate on inner race halves of pinion and drive shaft bearings. Slide tubing VW 472/2 on drive shaft. Position the shaft on thrust plate VW 401. Press on inner bearing race using suitable tubing. Hold pinion shaft in position.



Remove VW 472/2 from drive shaft. Position pinion shaft on VW 401. Press on inner half of bearing race.

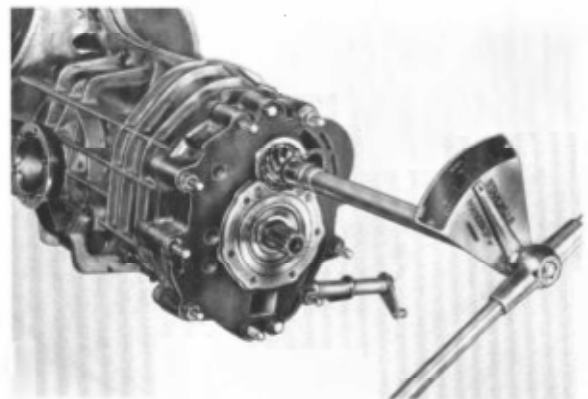


### Caution

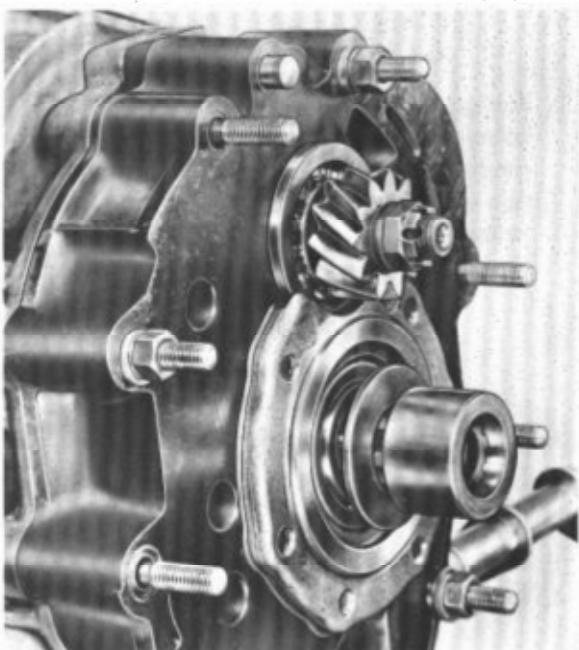
To prevent damage to gears, make sure gears are properly in mesh before pressing on inner half of pinion bearing race.

2. Engage 5th gear. Install intermediate plate assembly into transmission. Temporarily fasten intermediate plate to four of the housing studs (use spacer bushings). Hand tighten in crisscross pattern.
3. Lock drive shaft with holding plate P 37.
4. Place gear I for 1st gear on drive shaft.
5. Install castle nut with washer and tighten to specified torque.

- a. Secure castle nut with lock pin.



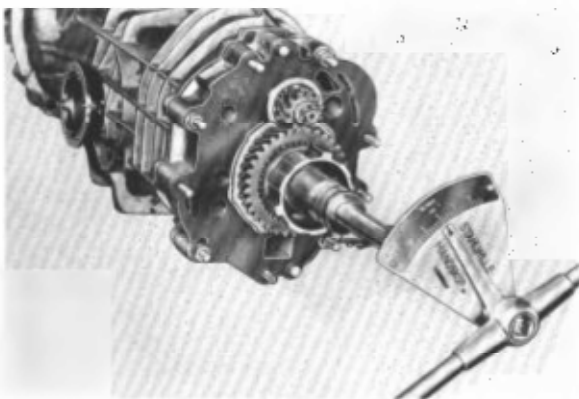
6. Slide thrust washer with small collar toward bearing on pinion shaft together with race for needle bearing.



7. Install needle bearing and gear II of 1st gear.

8. Install guide sleeve for 1st and reverse gear.

9. Lubricate thrust surface of pinion shaft bolt (with speedometer drive). Torque to specification.

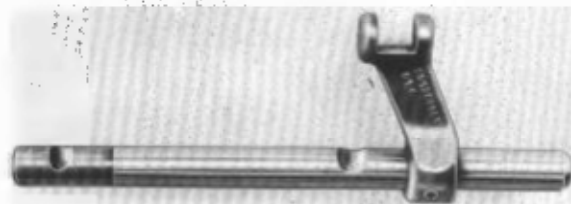


10. Remove intermediate plate with pinion and drive shafts. Clamp intermediate plate with gear assembly into vise quipped with aluminum jaw caps.

11. Engage neutral.

12. Install shift rods and shift forks in the following order:

- a. Place shift fork for 4th and 5th gear on respective shifting sleeve. Slide shift rod for 4th and 5th gear up into the hole of the intermediate plate. Attach shift piece on the shift rod with a lock pin. (Tighten bolt (with wave washer) for shift fork.

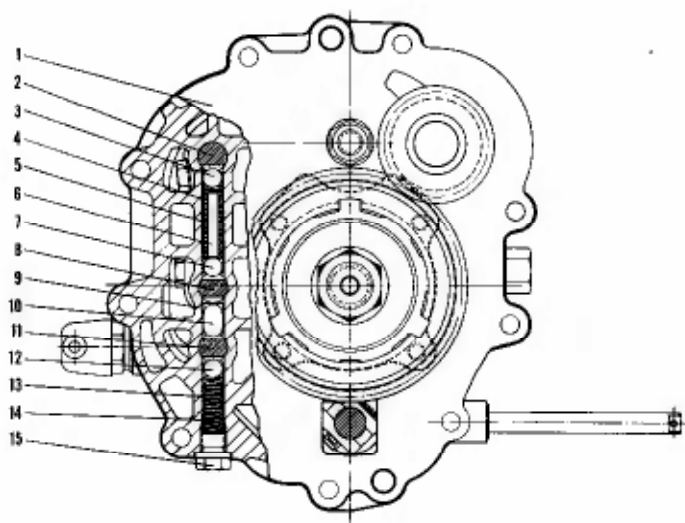


- b. Insert a ball into the connecting duct of the shift rod bores. Coat the lock pin and the long spring with grease and insert them at the same time. Insert another ball.

- c. Place shift fork for 2nd and 3rd gear on respective shift sleeve and slide shift rod for 2nd and 3rd gear up into the hole of the intermediate plate. The 4th and 5th gear shift rod should be in neutral position. Push the 2nd and 3rd gear shift rod until the ball seats in the groove. Slightly tighten bolt (with wave washer) for shift fork.

- d. Insert detent for gear interlock. Make sure 2nd and 3rd gear shift rod is in the neutral position.

- e. Insert shift rod for 1st and reverse gear.



- f. Insert a ball and a short spring. Tighten retaining bolt to correct torque.

- g. Slide shift fork and shift gear for 1st and reverse gear together on guide sleeve and shift fork. Slightly tighten bolt (with wave washer) for shift fork. Adjust shift forks. Refer to page 3.1-2/1.

- 1 Intermediate plate
- 2 Shift rod for 4th and 5th gear
- 3 Ball
- 4 Bushing for gear lock
- 5 Spring (large) for gear interlock pin
- 6 Interlock pin
- 7 Ball
- 8 Shift rod for 2nd and 3rd gear
- 9 Bushing for gear lock
- 10 Detent
- 11 Shift rod for 1st and reverse gear
- 12 Ball
- 13 Bushing for gear lock
- 14 Spring (small) for gear interlock
- 15 Retaining bolt

- h. Check interlock springs and replace if necessary.

1st and reverse gear spring length, unloaded:

29,2 mm (1.15 in.)

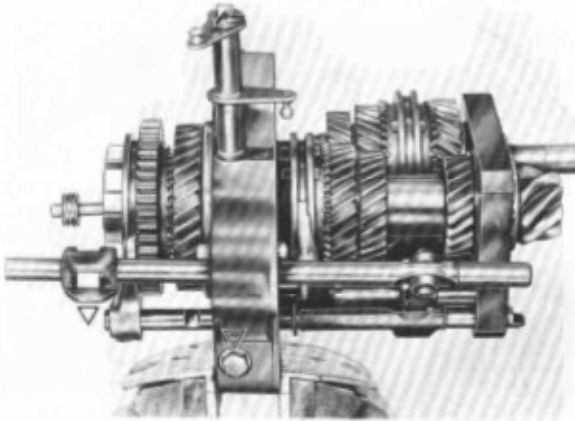
minimum length: 28,2 mm (1.11 in.)

2nd to 5th gear spring length, unloaded:

38,5 mm (1.5 in.)

minimum length: 37,3 mm (1.47 in.)

13. Attach selector lever to inner shift rod with clevis pin. Make sure the lever is properly positioned and fastened with a cotter pin.



14. Place the correct number of gaskets on the transmission housing.

**Caution**

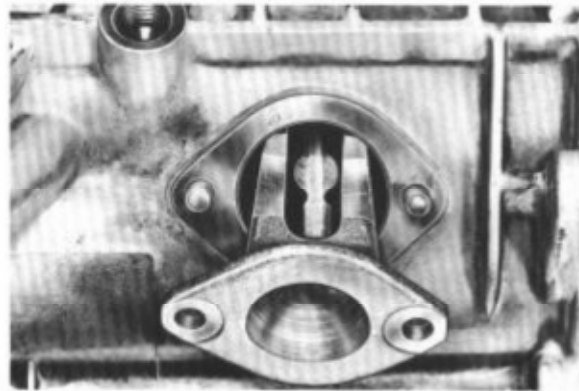
When inserting the gear assembly be careful not to damage the drive shaft seal. Replace seal if necessary.

15. Engage 5th gear. Insert intermediate plate with gear assembly into housing.

16. Engage neutral.

17. Insert inner shift rod into its bushing. Make sure selector lever engages correctly in shift rod gates.

18. Install fork piece with new gasket. Be sure that the inner shift lever is guided in the fork piece.

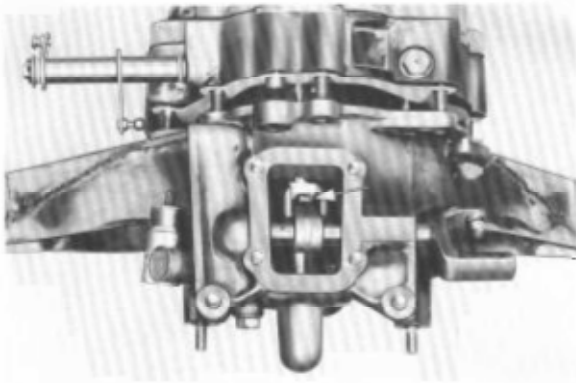


19. Tighten nuts to specified torque.

20. Place needle cages and spacer sleeve on first and reverse idler gear shaft (in rear transmission cover).

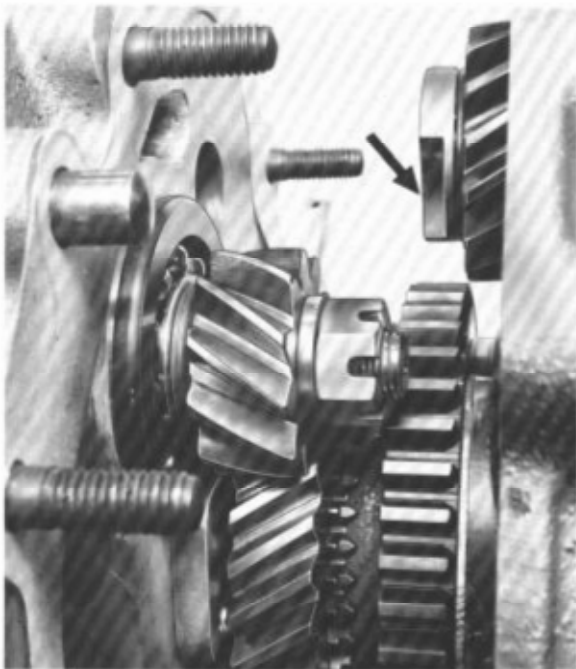
21. Place new paper gasket on intermediate plate.

22. Insert bearing cages and spacer bushing on reverse idler shaft. Install reverse idler gear axial bearing and thrust washer.
23. With the cover ready for installation pull the thrust washer, axial bearing and idler gear as far to the front of the idler shaft as possible. This enables the idler gear to be guided across the first and reverse shifting gear.
24. Start pushing rear transmission cover toward intermediate plate. Engage shift lever with shift rod before positioning rear transmission cover in plate.
25. Tighten nuts for rear transmission cover and the cover inspection plate to specified torque.
26. Position contact pin for backup light switch. The longer end should point toward shift rod. Tighten switch to specified torque.



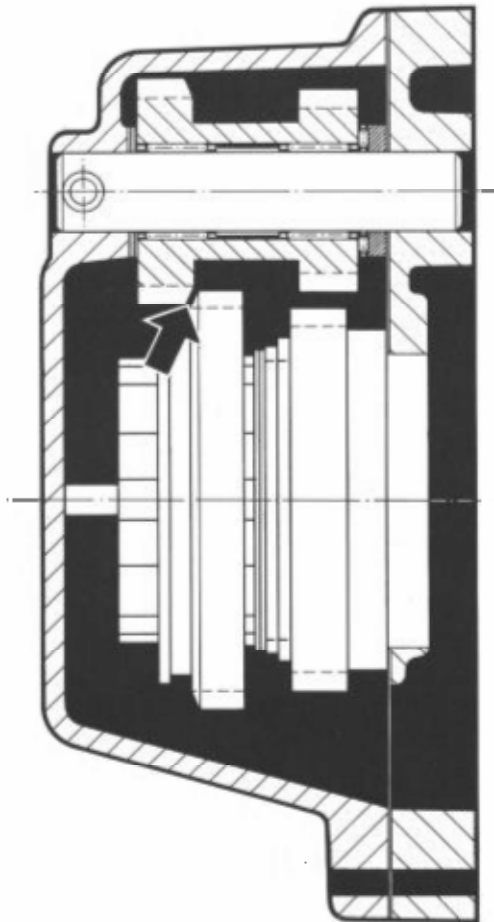
#### Caution

Make sure that the thrust washer is aligned in such a way that the outer collar of the pinion shaft ball bearing fits into the indentation of the thrust washer.

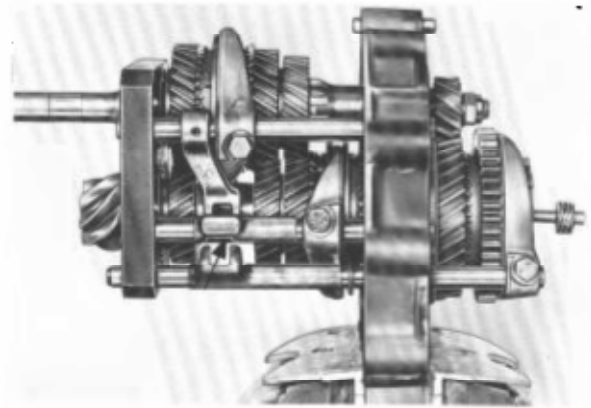


## ADJUSTING SHIFT FORKS

- Slide holding plate P 260 on shift rods.
- Adjust shift fork:  
Put Transmission in neutral. Press the assembled reverse idler gear with axial bearings and thrust washer in the direction of the intermediate plate. The clearance between the shift gear and the idler shaft should be 1 mm (arrow). Eliminate any play between shift fork and shift gear by pushing the shift gear forward (in driving direction) and repositioning the shift fork on shift rod.



- Tighten shift fork retaining bolt to 18 ft. lbs. (2.5 mkg). Make sure that the 1st and reverse shift piece has 2 - 3 mm side play between 2nd and 3rd gear shift piece.

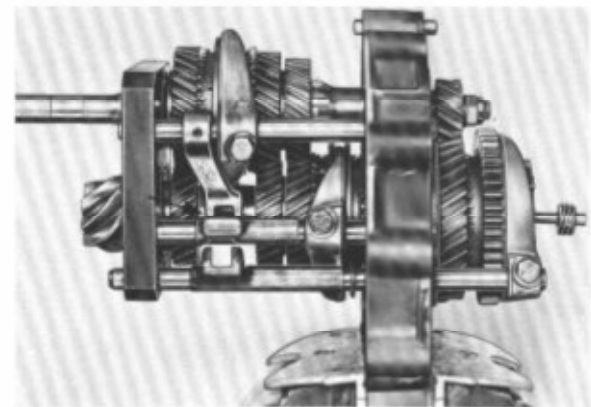


- Adjust 4th and 5th gear shift forks as well as 2nd and 3rd gear shift forks.

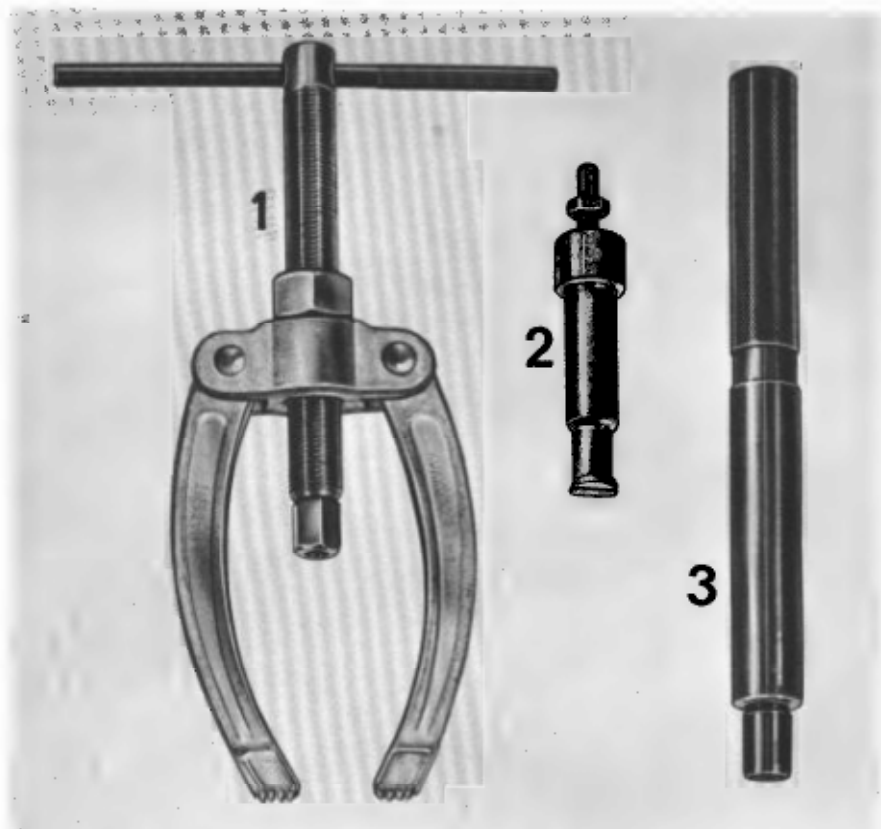
## Note

Make sure the shift sleeve is positioned in the center between the synchronizing rings when the transmission is in neutral.

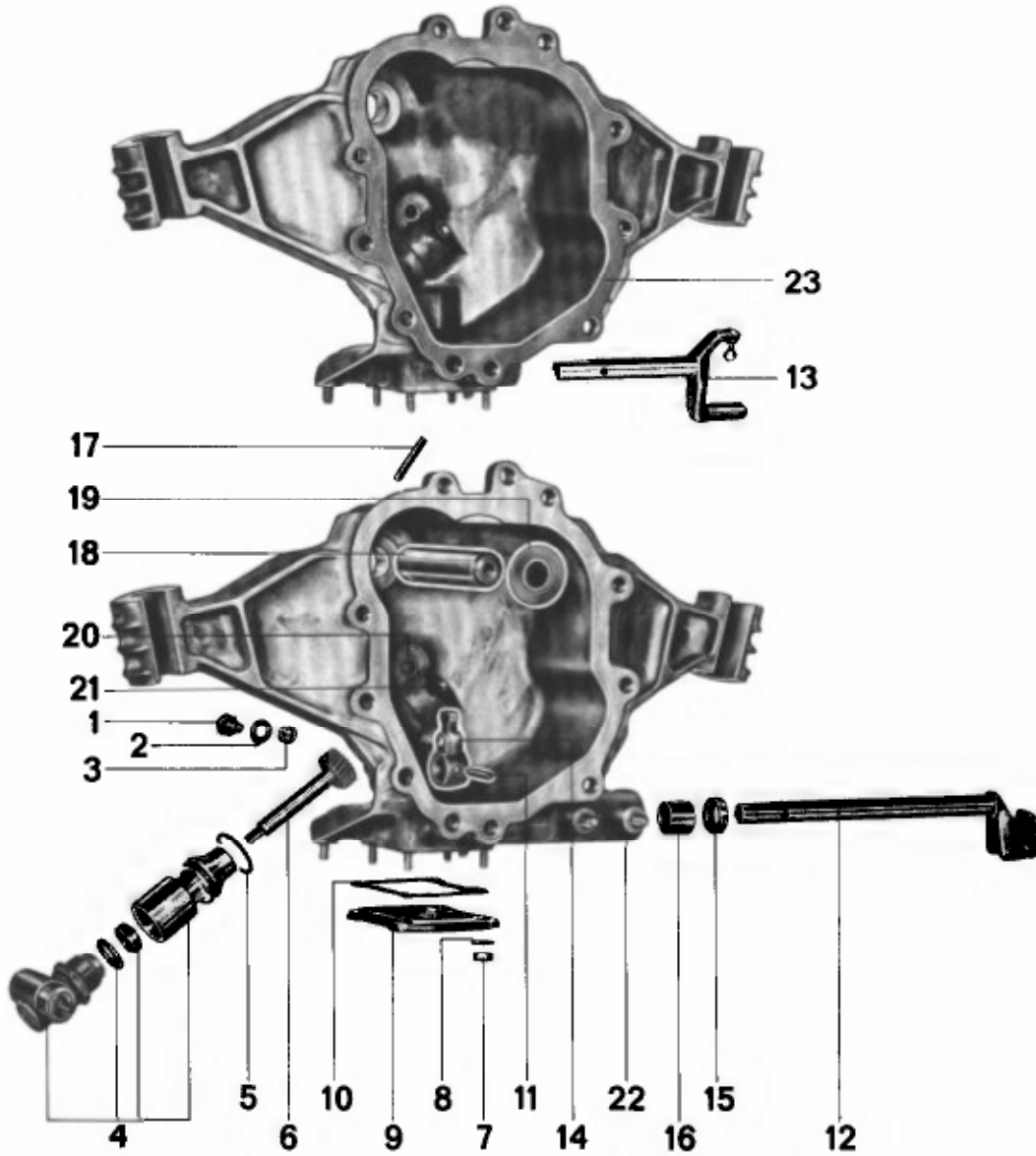
- Tighten shift fork retaining bolts to 18 ft. lbs. (2.5 mkg). Make sure 4th and 5th shift piece has 2-3 mm side play between 2nd and 3rd gear shift piece.



- Put transmission in neutral. Check that the shift sleeve is centered between the synchro rings. Adjust shift sleeve by re-positioning the shift fork. Check operation; readjust if necessary.



No.	Description	Special Tool	Remarks
1	Counter support	-	Kukko No. 22/1
2	Internal puller	-	14,5 - 18,5 mm Kukko No. 21/2
3	Mandrel	VW 207	





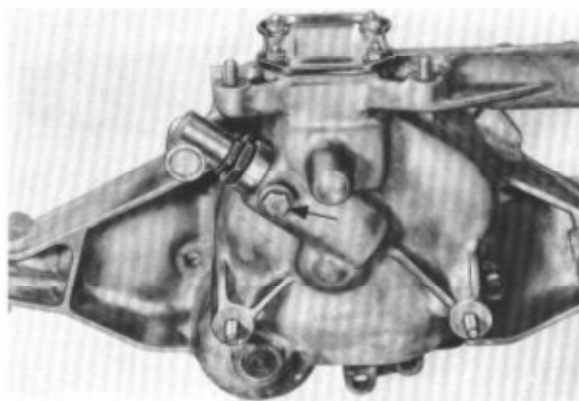
No.	Description	Qty.	Note when		Special Instructions See
			Removing	Installing	
1	Bolt	1		Tighten to spec. torque	
2	Washer	1			
3	Helicoil	1			
4	Speedometer drive	1			
5	O-ring	1		Replace	
6	Drive shaft	1		Check pinion for wear	
7	Self-locking nut	4		Replace, if necessary and torque to specification	
8	Washer	4			
9	Cover plate	1			
10	Seal	1		Replace	
11	Lock pin	1		Replace	
12	Shift lever shaft 914	1			
13	Shift lever shaft 914/6	1			
14	Shift lever	1		Observe position shift lever shaft - shift lever	3.1-3/9
15	Seal	1		Replace	
16	Bushing	1	Use puller	Install using VW 206	3.1-3/7
17	Lock pin	1		Replace	
18	Idler shaft	1	Heat transmission cover to approx. 120° C (250° F) and force out in inward direction	Heat transmission cover to approx. 120° C (250° F) and insert shaft in correct position	

No	Description	Qty.	Note when		Special instructions see
			Removing	Installing	
19	Thrust washer	1	Force out with bolt	Heat to approx. 120° C (250° F) and slide on shaft up to stop	3.1-3/9
20	Bushing for speedometer drive pinion	1		Check for wear	
21	Thrust piece	1		Check for wear	
22	Transmission cover 914	1			
23	Transmission cover 914/6	1			

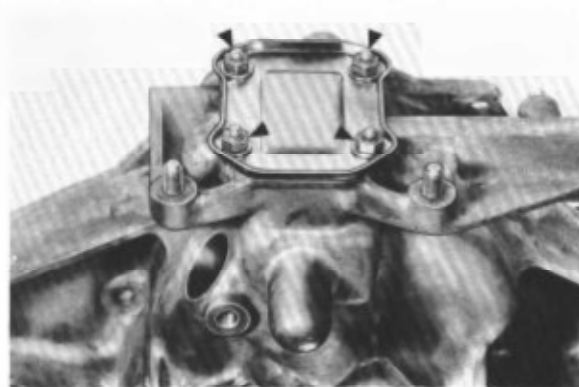
## DISASSEMBLING AND ASSEMBLING REAR TRANSMISSION COVER

## Disassembling

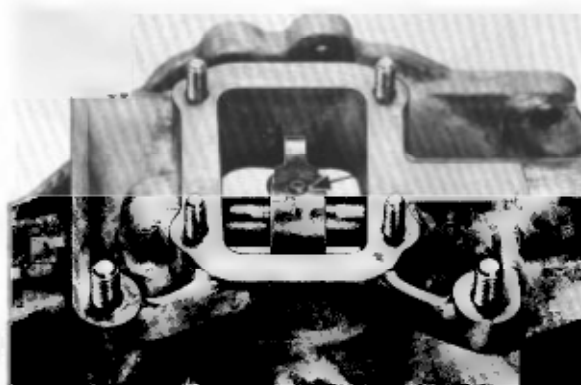
1. Loosen bolt for speedometer drive and pull out miter drive.



2. Remove cover plate from bottom of transmission cover.

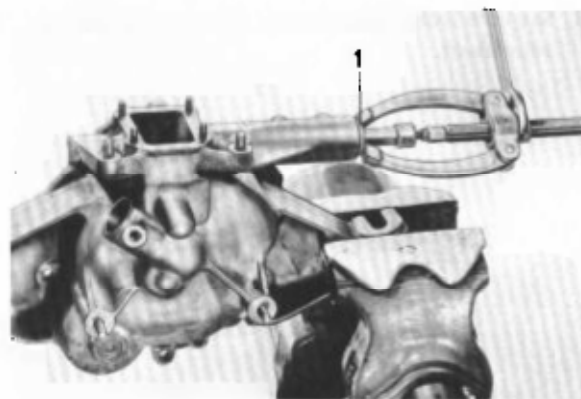


3. Knock lock pin out of shift lever shaft.



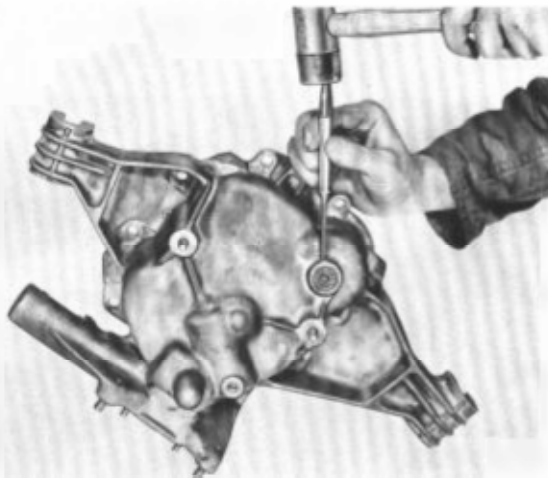
4. Pull out shift lever shaft, while removing shift lever from shaft.

5. Pull out seal and bushing with a puller/washer combination.



1 = Washer

6. Knock out lock pin for reverse idler shaft.



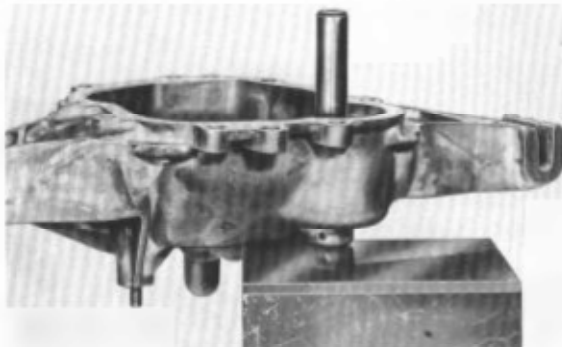
7. Heat transmission cover to approx. 120° C (250° F) and knock out idler shaft in inward direction. Then remove thrust piece and bushing for speedometer drive.

8. Remove inner thrust washer (bronze washer) from idler shaft.

9. Check parts for wear and damage and replace, if necessary.

#### Assembling

1. Heat transmission cover to approx. 120° C (250° F). Install reverse idler shaft. Make sure that the oil hole points downward at an angle.



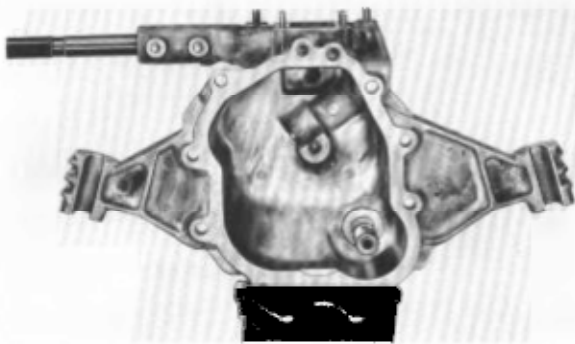
#### Caution

Be sure that the hole for the lock pin in the housing and in the shaft align.

2. Install lock pin.

3. Insert bushing for speedometer drive pinion and thrust piece for speedometer drive.

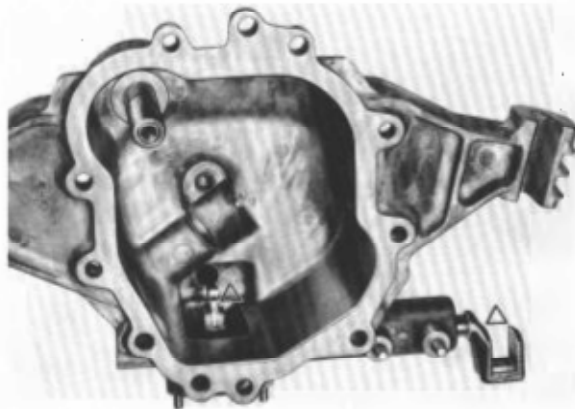
4. Install bushing for shift lever shaft with VW 207 and insert seal.



5. Insert shift lever shaft while simultaneously sliding shift lever onto shaft.

#### Note

The opening of the shift lever shaft and the shift lever on Type 914 should point upward.  
The ball pivot of the shift lever shaft on Type 914/6 should point upward.



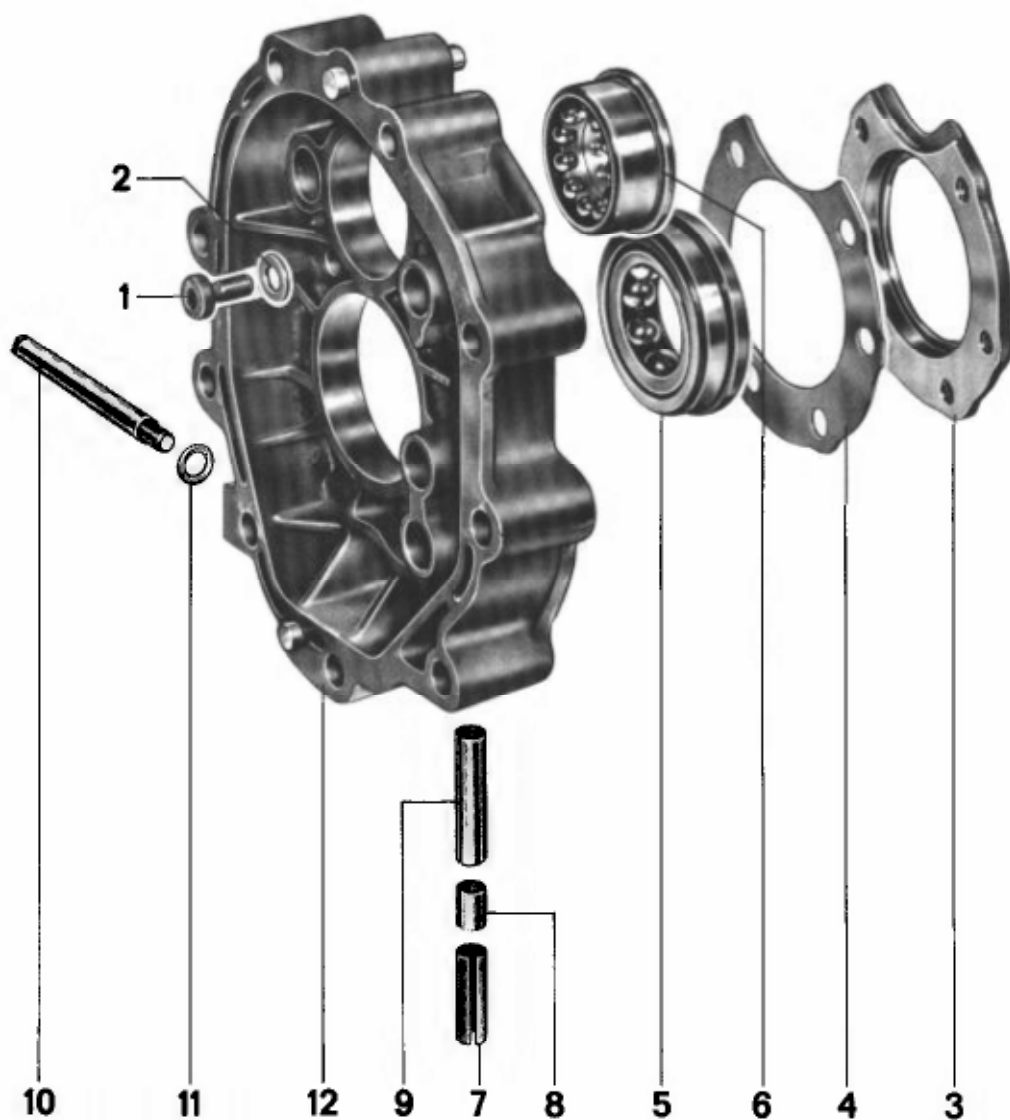
6. Heat bronze thrust washer to approx. 120° C (250° F) and slide on reverse idler shaft. Make sure the thrust washer is flush against the cover, so as not to reduce the end play of the reverse idler gear.

7. Insert miter drive for speedometer.

8. Align blind hole in guide piece with hole in housing. Install bolt with spring washer and tighten to specified torque.



No.	Description	Special Tool	Explanation
1	Extractor hook	-	Local manufacture
2	Mandrel	P 262	



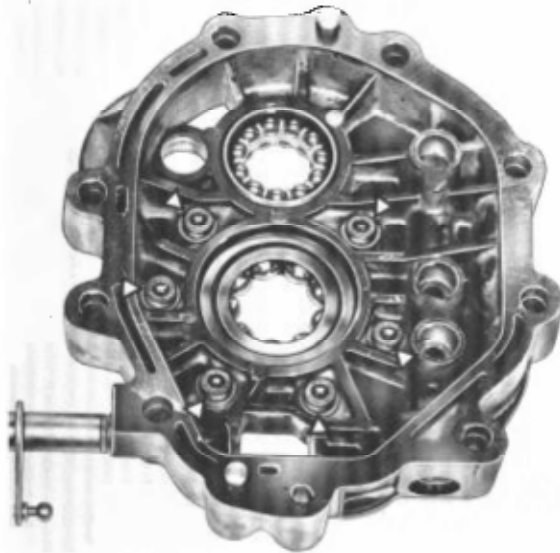
No.	Description	Qty.	Note when		Special Instructions See
			Removing	Installing	
1	Socket head screw (12 point)	6		Tighten to correct torque	
2	Washer	6			
3	Clamping plate	1			
4	Supporting plate	1			
5	Drive shaft ball bearing	1	Heat intermediate plate to approx. 120° C (250° F) and press out with suitable tool	Check for wear. Heat intermediate plate to approx. 120° C (250° F) and install in correct position	3.1-4/5
6	Pinion shaft ball bearing	1	Heat intermediate plate to approx. 120° C (250° F) and press out with suitable tool	Check for wear. Heat intermediate plate to approx. 120° C (250° F) and install in correct position	3.1-4/5
7	Bushing	1	Pull out with hook	Install with P 262	
8	Bushing	1	Pull out with hook	Install with P 262	
9	Bushing	1	Pull out with hook	Install with P 262	
10	Shaft	1			
11	Washer	1			
12	Intermediate plate	1			



## DISASSEMBLING AND REASSEMBLING INTERMEDIATE PLATE

## Disassembling

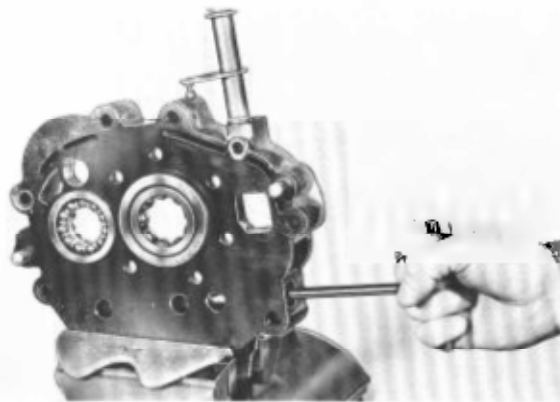
1. Loosen screws for clamping plate and remove clamping plate with supporting plate. (See arrows).



2. Heat intermediate plate to 120° C (250° F). Push out 4-point ball bearing and double-row angular contact ball bearing with suitable tool.

3. Knock lock pin out of intermediate plate.

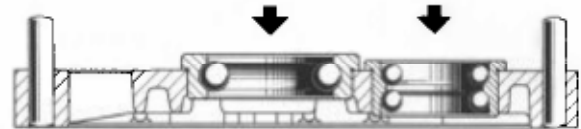
4. Pull out bushings for securing gear lock in sequence using a hook.



## Assembling

1. Check parts for wear or damage and replace if necessary.

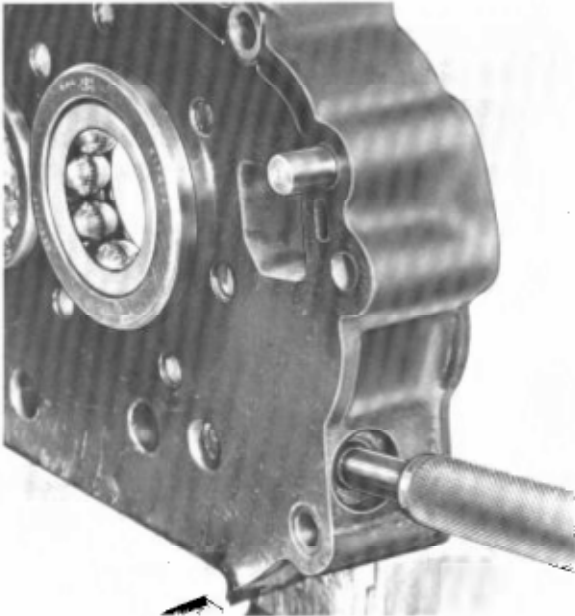
2. Heat intermediate plate to 120° C (250° F). Make sure that all the balls are in the bearing. Install the two bearings in the intermediate plate. Ensure bearing flanges are flush with intermediate plate.



3. Position clamping plate together with supporting plate.



4. Install retaining bolts with washers. Tighten to correct torque.
5. Install bushings for securing gear lock with mandrel P 262.



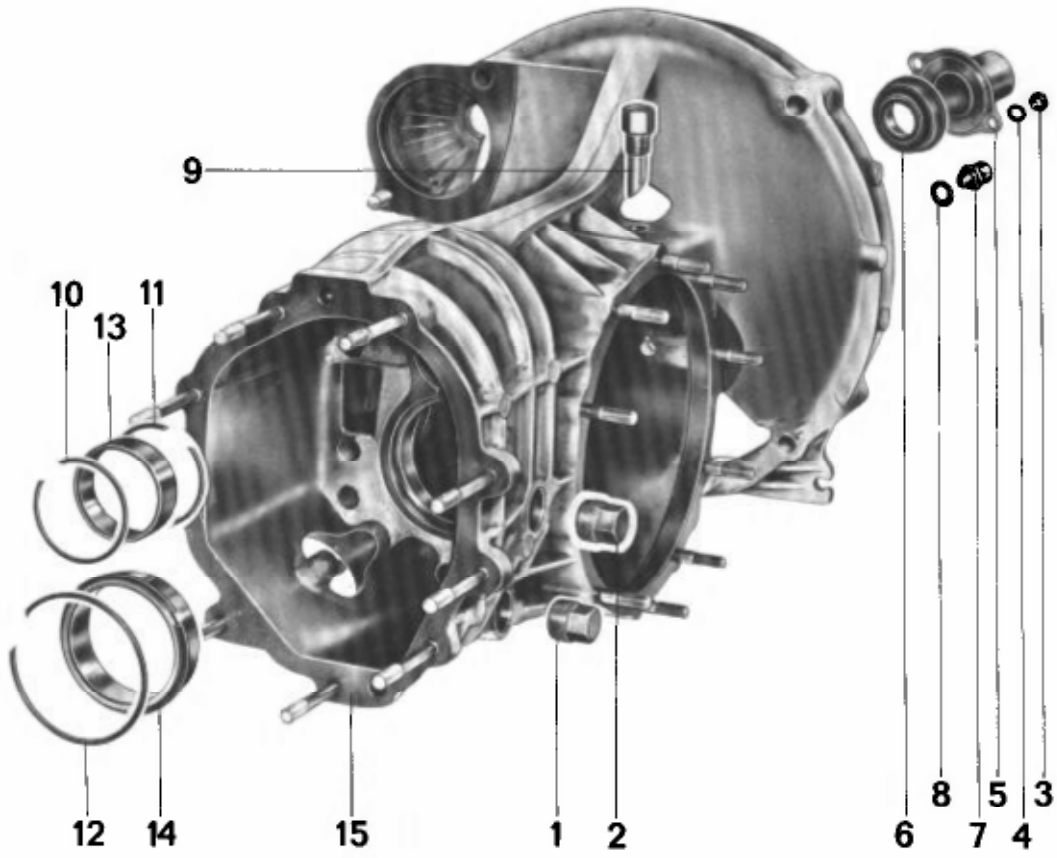
**Caution**

When installing the bushings, make sure they do not project into the shift bores.

- a. Install long bushing up to stop of mandrel.
- b. Install short bushing up to second mark of mandrel.
- c. Install center bushing up to first mark of mandrel.



No.	Description	Special Tool	Remarks
1	Driver/extractor thrust pieces	P 254	3 Parts
2	Installing sleeve	VW 244b	



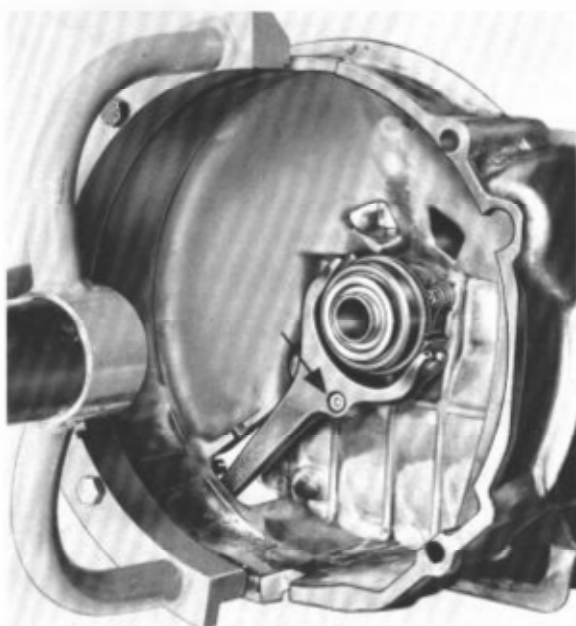
No.	Description	Qty.	Note when		Special Instructions See
			Removing	Installing	
1	Magnetic drain plug	1		Tighten to correct torque	
2	Filler plug	1		Tighten to correct torque	
3	Nut	2		Tighten to correct torque	
4	Lock washer	2		Replace, if necessary	
5	Guide tube	1			
6	Seal	1		Install with VW 244 b	
7	Ball pin	1		Tighten to correct torque	
8	Washer	1			
9	Breather	1		Observe installation position	3.1-5/7
10	Snap ring	1	Remove with small screw driver	Insert into groove of drive shaft bearing	3.1-5/5
11	Snap ring	1	Remove with small screw driver		3.1-5/5
12	Snap ring	1	Remove with small screw driver		3.1-5/5
13	Bearing outer race	1	Heat transmission housing to approx. 120° C (250° F) and knock out with P 254	Check for wear Install with P 254	3.1-5/6
14	Bearing outer race	1	Heat transmission housing to approx. 120° C (250° F) and knock out with P 254	Check for wear Install with P 254	3.1-5/6
15	Transmission housing	1			3.1-5/6

## DISASSEMBLING AND REASSEMBLING OF TRANSMISSION HOUSING

## Disassembling

1. Remove transmission cover, manual gear shift and differential.

2. Loosen fillister head screw on clutch throwout fork and remove throwout fork with throwout bearing.

**Caution**

Do not wash throwout bearing.

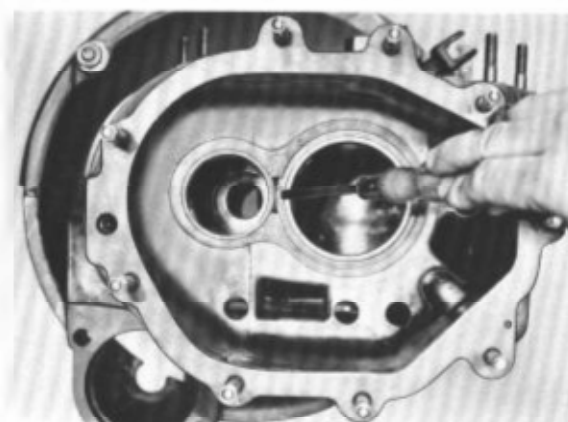
3. Loosen nuts on guide tube for throwout bearing and remove guide tube.

4. Knock out seal for drive shaft from inside of transmission with a suitable piece of tubing. With the drive shaft assembly installed, remove seal with suitable tool, do not damage bore or seat.

5. Loosen ball pin for clutch throwout fork. Remove ball pin with sealing washer.

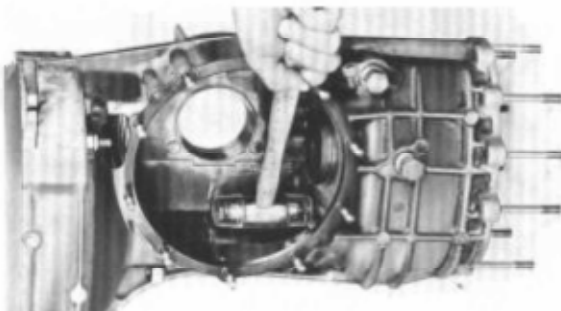
6. Remove breather.

7. Remove both snap rings from drive shaft bearing and rear snap ring of drive shaft bearing in housing with a small screw driver.

**Note**

The snap ring in front of the bearing race of the drive shaft is pressed against the housing by the bearing race. Loosen the bearing race first from the snap ring with a punch.

8. Heat transmission housing to 120° C (250° F) and remove both bearing outer races one after the other by means of special tool P 254 and a plastic mallet.

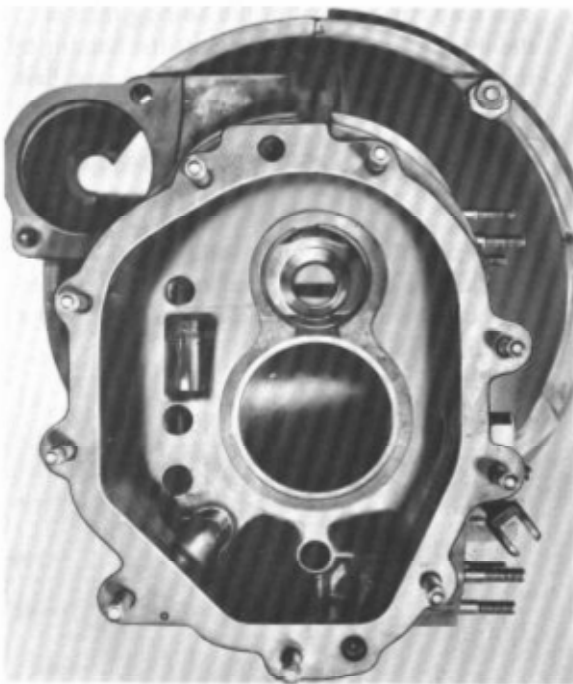


### Assembling

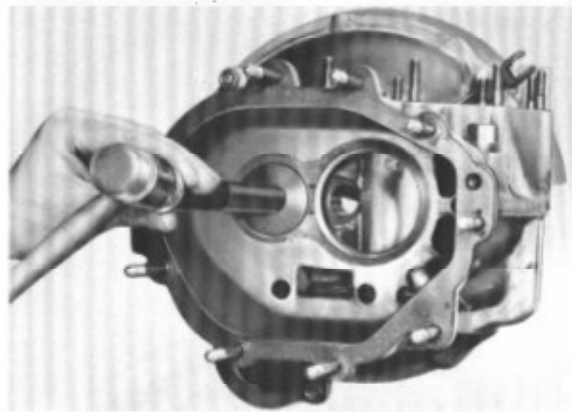
#### Caution

When cleaning the transmission housing, do not use corrosive cleaning materials as they will damage the magnesium alloy.

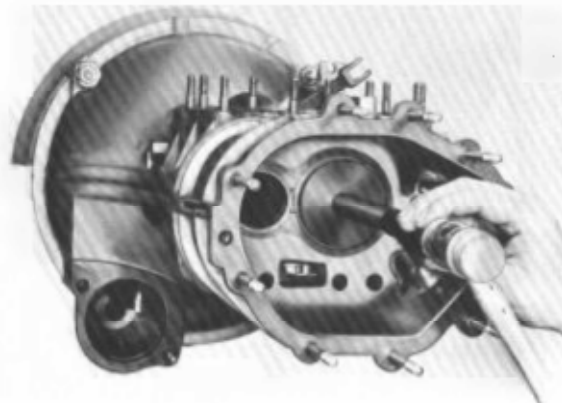
1. Clean transmission housing and check for cracks, wear, and external damage. In the event of damage to pinion shaft or ring gear (for example fracture) check to see that the bearing bores in the center housing wall are not damaged. Replace the housing if necessary.
2. Check all other components for damage and replace as necessary.
3. Insert front snap ring into groove of drive shaft bearing outer race.



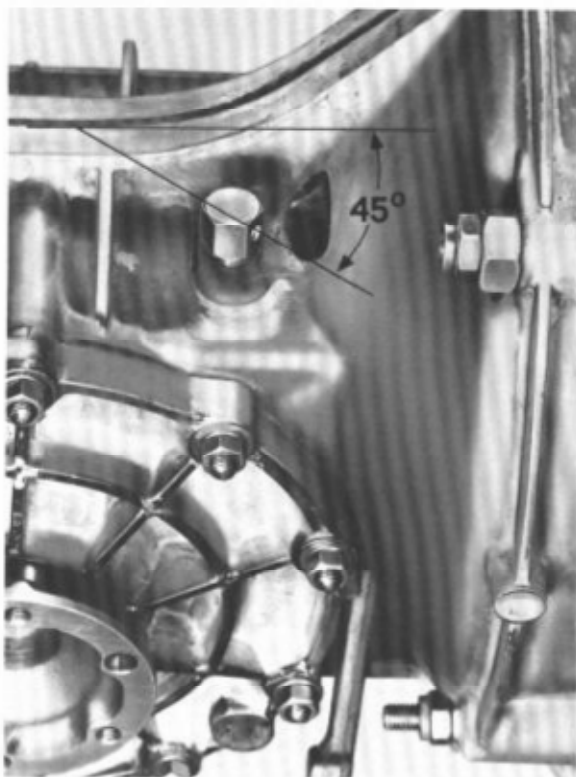
4. Heat transmission housing to 120° (250° F) and install drive shaft bearing outer race into bearing bore. Use thrust piece P 254. Install rear snap ring.



5. Install pinion shaft bearing outer race (with snap ring installed) into bearing bore. Use thrust piece P 254. Insert rear circlip.



6. Install breather. Tighten to correct torque. Make sure the drilling in the head of the breather is at a  $45^{\circ}$  angle toward the front when viewed from the top.



**Caution**

The bore in the hexagon of the breather should be at an angle of  $45^{\circ}$  in forward direction toward longitudinal axis of transmission.

7. Insert ball pin with sealing washer and tighten to correct torque.

**Caution**

Install intermediate plate with gear assembly before installing drive shaft seal. This prevents damage to seal lip.

8. Install drive shaft seal with VW 244 b. Make sure seal is fully seated.

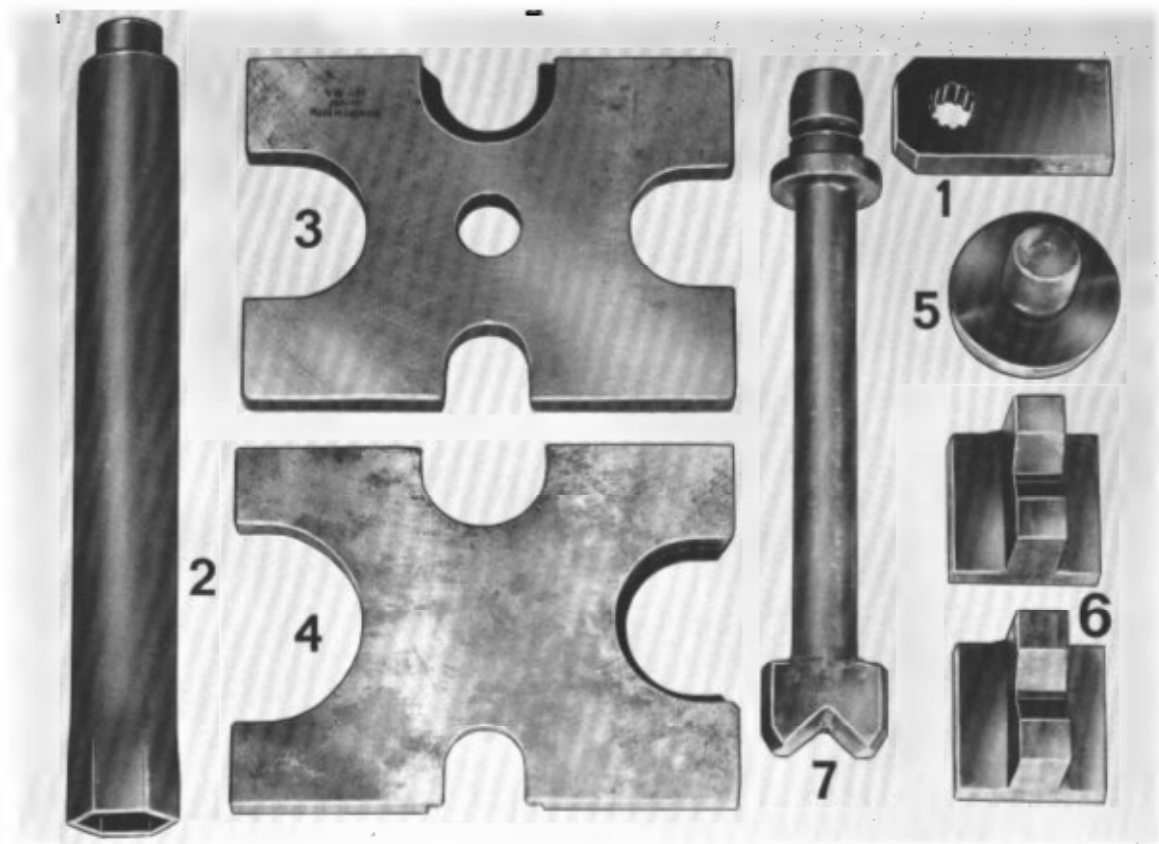


9. Install remaining components (refer to individual chapters).

**Important**

10. After making repairs to transmission, apply new protective undercoating to the entire outside of the housing.





No.	Description	Special Tool	Remarks
1	Holding plate	P 256	
2	Socket insert 32 mm	P 252	
3	Thrust plate	VW 401	
4	Thrust plate	VW 402	
5	Thrust piece	VW 412	
6	V-blocks	VW 406	2 parts
7	V-blocks punch	VW 405	



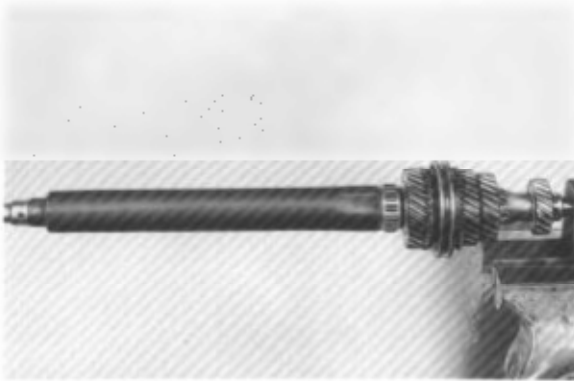
No.	Description	Qty.	Note when		Special Instructions see
			Removing	Installing	
1	Lock pin	1		Replace	
2	Castle nut	1		Tighten to correct torque	
3	Washer	1			
4	1st gear	1		Replace only in pairs	3.1-1/11
5	Bearing inner race	1		Check for wear, replace only as pair with respective bearing	3.1-1/11
6	Bearing inner race	1		Check for wear, replace only as pair with respective bearing	3.1-6/7
7	Nut	1	Unlock and loosen with P 252	Tighten to correct torque and secure	
8	Lock plate washer	1		Replace	
9	Roller bearing	1	Remove with VW 401, 402 and 412	Install in correct position with VW 401 and 412	3.1-6/8
10	Thrust washer	1		Flat surface toward needle bearing	
11	5th gear	1		Check synchronization, replace only in pairs	3.1-8/1
12	Needle bearing	1	Fasten to respective gear and race with mechanic's wire	Make sure bearings have not been interchanged	
13	Needle bearing race	1	Fasten to respective gear and bearing with mechanic's wire	Make sure races have not been interchanged	
14	Shift sleeve	1		Check for wear	3.1-8/7
15	Synchro hub	1			
16	4th gear	1		Check synchronization, replace only in pairs	3.1-8/1

No.	Description	Qty.	Note when		Special instructions see
			Removing	Installing	
17	Needle bearing	1	Fasten to respective gear and race with mechanic's wire.	Make sure bearings have not been interchanged	
18	Needle bearing race	1	Fasten to respective gear and bearing with mechanic's wire	Make sure races have not been interchanged	
19	Thrust washer	1			
20	3rd gear	1		Replace in pairs only, with narrow flange toward splined shoulder	
21	Drive shaft	1		Check for out-of-true	3.1-6/10

## DISASSEMBLING AND ASSEMBLING DRIVE SHAFT

## Disassembling

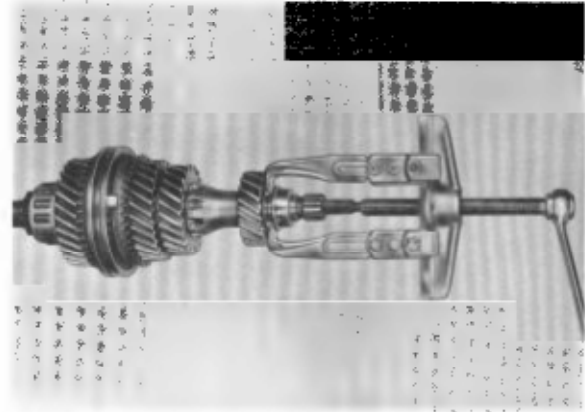
1. Clamp holding plate P 256 into vise. Secure drive shaft. Bend back lock plate for nut. Loosen nut with special tool P 252.
4. Using a brass drift, slightly separate inner half of ball bearing race from contact surface (use care so as not to damage race or seat). Remove race with claw puller.



2. Press roller bearing from drive shaft. Use thrust plate VW 401 and 402 and thrust piece VW 412.



3. Pull remaining parts from drive shaft. Wire needle bearings, races and respective gears together to ensure correct reinstallation.



## Assembling

## Caution

Install all parts of drive shaft dry. Make sure oil does not enter between the contact surfaces.

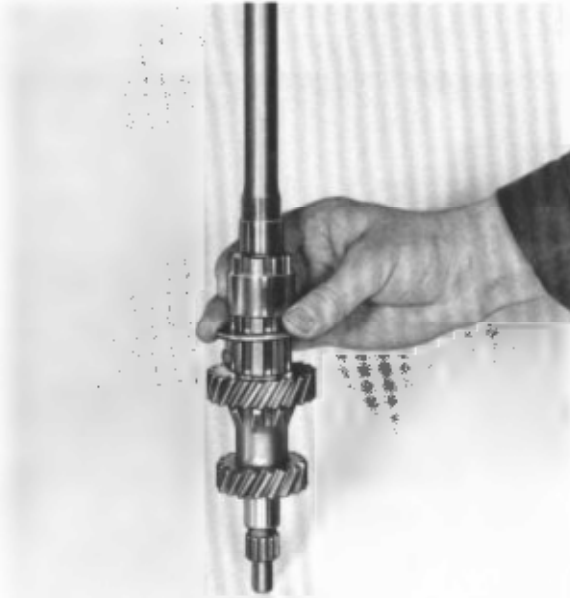
1. Slide gear I from 3rd gear on drive shaft (narrow flange toward splined shoulder).



**Caution**

When reinstalling needle bearings and races, make sure they are not interchanged with those of another gear.

2. Install thrust washer and needle bearing race.



3. Install needle bearing.

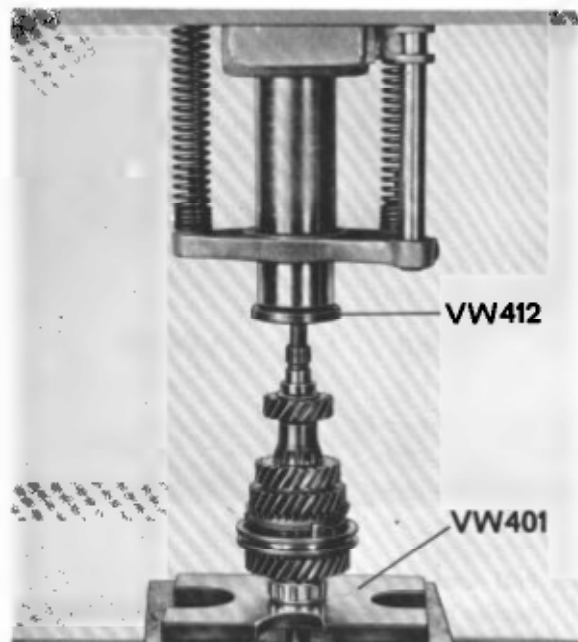


4. Install gear I for 4th gear. Then install guide sleeve.

5. Position shift sleeve, needle bearing race, needle bearing, and gear I for 5th gear.



6. Mount tapered thrust washer (5.9 mm thick). Install the roller bearing with the ring of the bearing cage toward the splines of the pilot stub.



7. Install roller bearing with thrust plate VW 401 and thrust piece VW 412.



10. Tighten nut to correct torque using special tool P 256 and P 252.

11. Secure nut by bending tab of lock plate.

12. Heat inner half of ball bearing race in oil to approx. 100° C (210° F). Press inner half of race on shaft.

8. Install new lock plate. Make sure that the locking tab is located in the groove on the drive shaft so that it fits under the inner race of the roller bearing.

9. Lubricate threads and thrust surface of nut. Install with curved face of nut in outward direction.

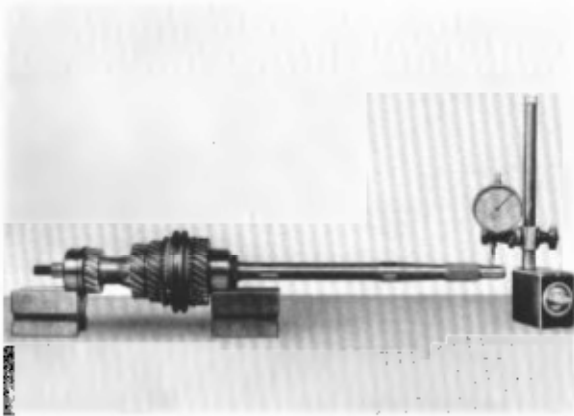


### CHECKING DRIVE SHAFT RUN-OUT

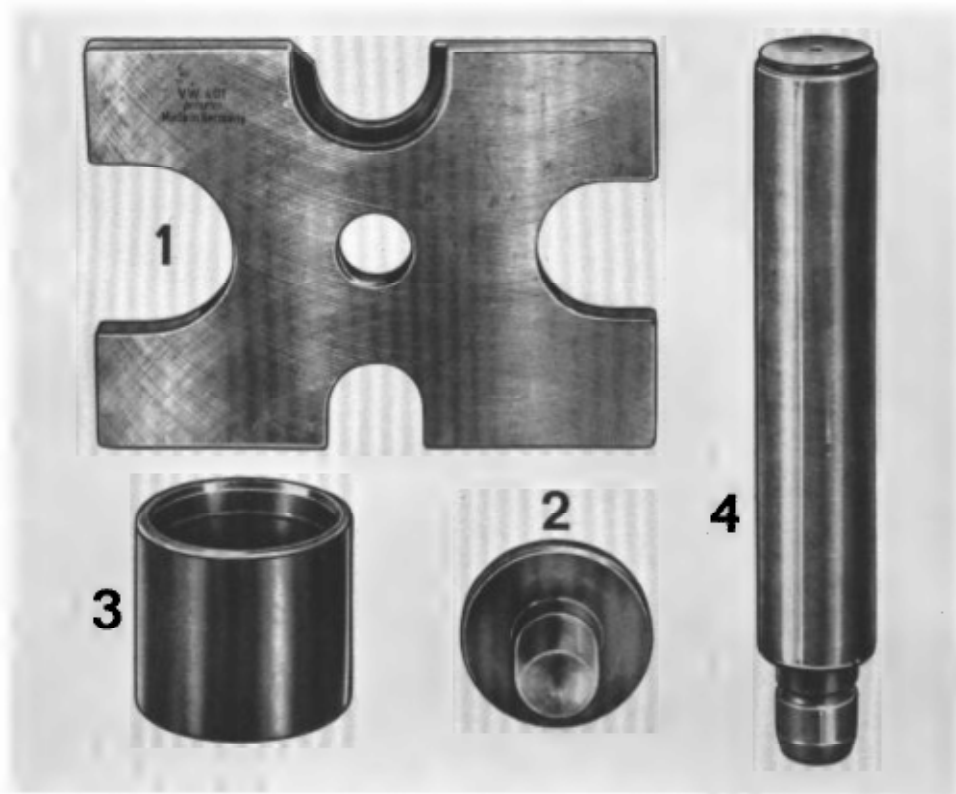
Always check assembled drive shaft for run-out. The tightening of the nut (M 24 x 1.5) may result in some shaft run-out.

Remove the double row ball bearing from the intermediate plate and the roller bearing race from the transmission housing.

1. Place assembled drive shaft with mounted bearings on V-blocks and check for run-out at pilot. Maximum run-out 0.1 mm (0.004 in.).
2. The drive shaft can be straightened (cold) if run-out does not exceed 0.3 mm (0.012 in.). Use press with V-blocks VW 406 and V-block punch VW 405.

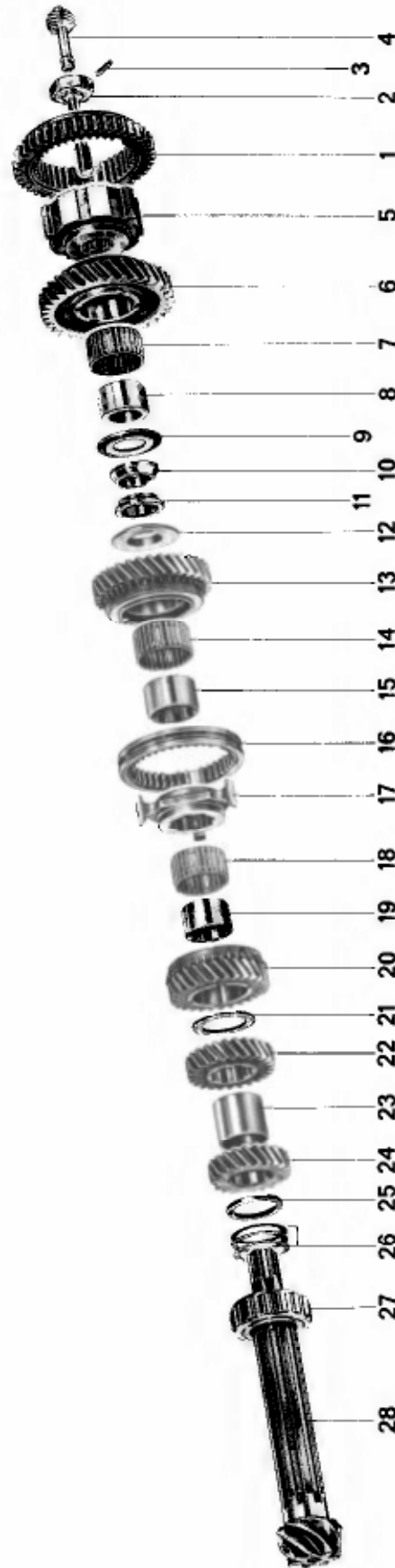






No.	Description	Special Tool	Remarks
1	Thrust plate	VW 401	
2	Thrust piece	VW 412	
3	Guide sleeve	P 255	
4	Thrust piece	VW 407	

H 37



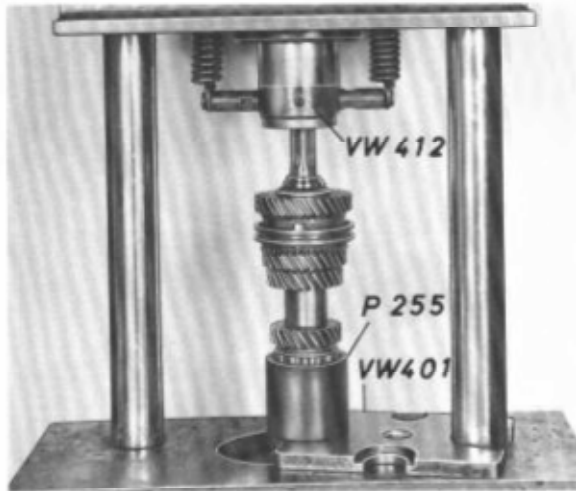
No.	Description	Qty.	Note when		Special instructions see
			Removing	Installing	
1	Shift gear for 1st and reverse gear	1		Check for wear	
2	Expansion bolt	1		Lubricate on thrust surface and tighten to correct torque.	
3	Lock pin	1		Replace	
4	Pinion shaft for Speedometer drive	1		Check for wear	
5	Guide sleeve	1	Remove with two screwdrivers	Check for wear	
6	1st gear	1		Check synchronization, replace in pairs only	3.1-8/1
7	Needle bearing	1	Fasten to respective gear and race with mechanic's wire	Make sure bearings have not been interchanged	
8	Needle bearing race	1	Fasten to respective gear and bearing with mechanic's wire	Make sure races have not been interchanged	
9	Thrust washer	1		Flat surface toward needle bearing	
10	Bearing inner race	1		Check for wear, mount only with respective bearing	3.1-1/11
11	Bearing inner race	1		Check for wear, mount only with respective bearing	3.1-7/7
12	Thrust washer	1		Flat surface toward needle bearing	
13	2nd gear	1		Check synchronization, replace only in pairs	3.1-8/1
14	Needle bearing	1	Fasten to respective gear and race with mechanic's wire	Make sure bearings have not been interchanged	

No.	Description	Qty.	Note when		Special instructions see
			Removing	Installing	
15	Needle bearing race	1	Fasten to respective gear and bearing with mechanic's wire	Make sure races have not been interchanged	
16	Shift sleeve	1		Check for wear	
17	Synchro hub	1		Check for wear	
18	Needle bearing	1	Fasten to respective gear and race with mechanic's wire	Make sure bearings have not been interchanged	
19	Needle bearing race	1	Fasten to respective gear and bearing with mechanic's wire	Make sure races have not been interchanged	
20	3rd gear	1		Check synchronization, replace only in pairs	3.1-8/1
21	Thrust washer	1			
22	4th gear	1		With narrow flange toward spacer bushing, replace in pairs only	
23	Spacer bushing	1			
24	5th gear	1		With narrow flange toward spacer bushing, replace in pairs only	
25	Spacer washer	1			
26	Shims	x	Note quantity and thickness of shims	When installing certain new parts, determine new quantity and thickness of shims	3.1-7/7
27	Roller bearing	1	Remove with VW 401, 412 and P 255	Install with VW 401 and 407	3.1-7/7
28	Pinion shaft	1		Readjust when replacing pinion and ring gear	5.1-5/1

## DISASSEMBLING AND ASSEMBLING PINION SHAFT

## Disassembling

1. Press ball bearing inner race and roller bearing inner race from pinion shaft. Use thrust plate VW 401, thrust piece 412 and tubing P 255.



2. Remove components from pinion shaft. Wire needle bearings and races to respective gears to prevent interchanging of parts during reinstallation.

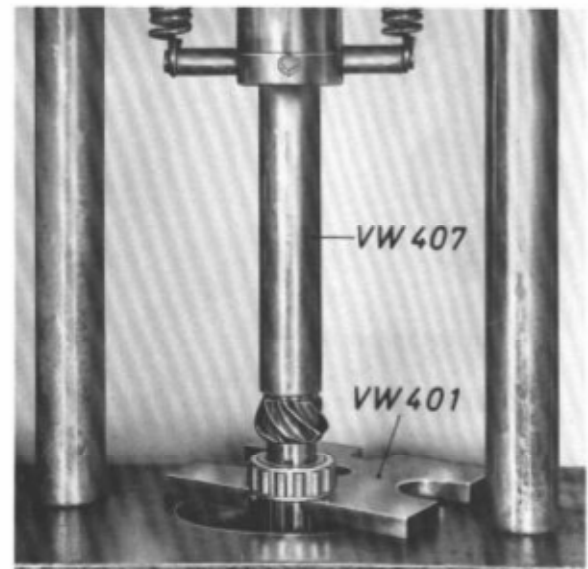
## Note

To simplify reinstallation procedure, note the quantity and thickness of pinion shaft/ring gear adjusting shims (between roller bearing and spacer washer).

## Assembling

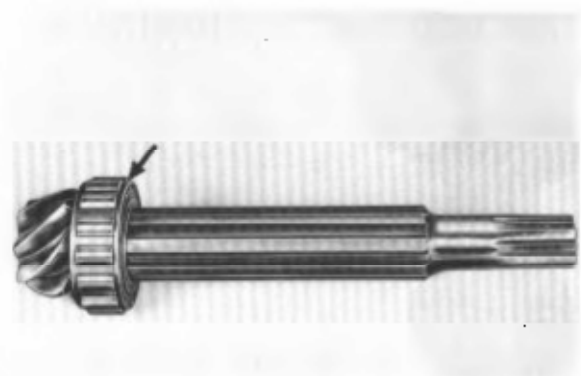
Assemble the pinion shaft dry. Make sure that no oil enters between the contact surfaces. The pinion shaft and the ring gear are provided with paired numbers. These numbers must match during installation.

1. Mount pinion shaft bearing with VW 401 and thrust piece VW 407.



## Caution

Install bearings so that the ring of the two-part roller cage faces the gears (arrow).



2. Install the adjusting shims. When replacing the pinion assembly, measure the required new thickness and use new shims.



5. Install spacer bushing and gear II for 4th gear with narrow flange in downward direction against spacer bushing.
6. Position thrust washer and bushing for needle bearing.



3. Insert the spacer washer.

4. Install gear II for 5th gear with narrow flange up.



7. Mount needle bearing, gear II for 3rd gear and synchro hub.

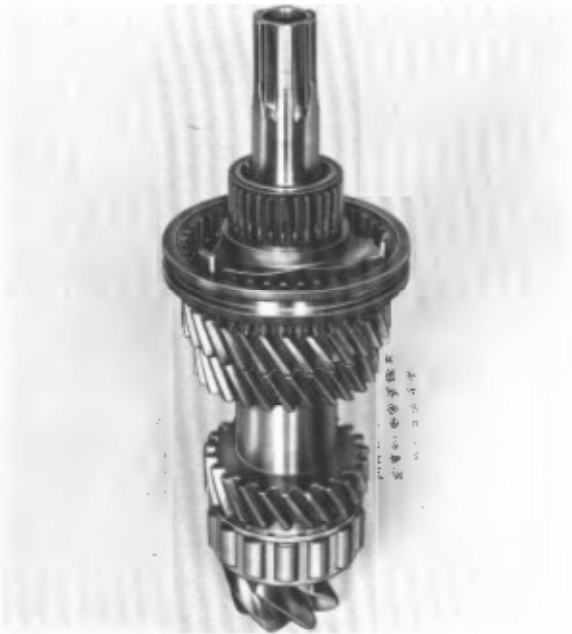


**Caution**

Make sure needle bearings and needle bearing races are not interchanged.

11. Press half of inner bearing race on shaft with suitable piece of tubing or heat in oil to approx. 100° C (210° F) and install.

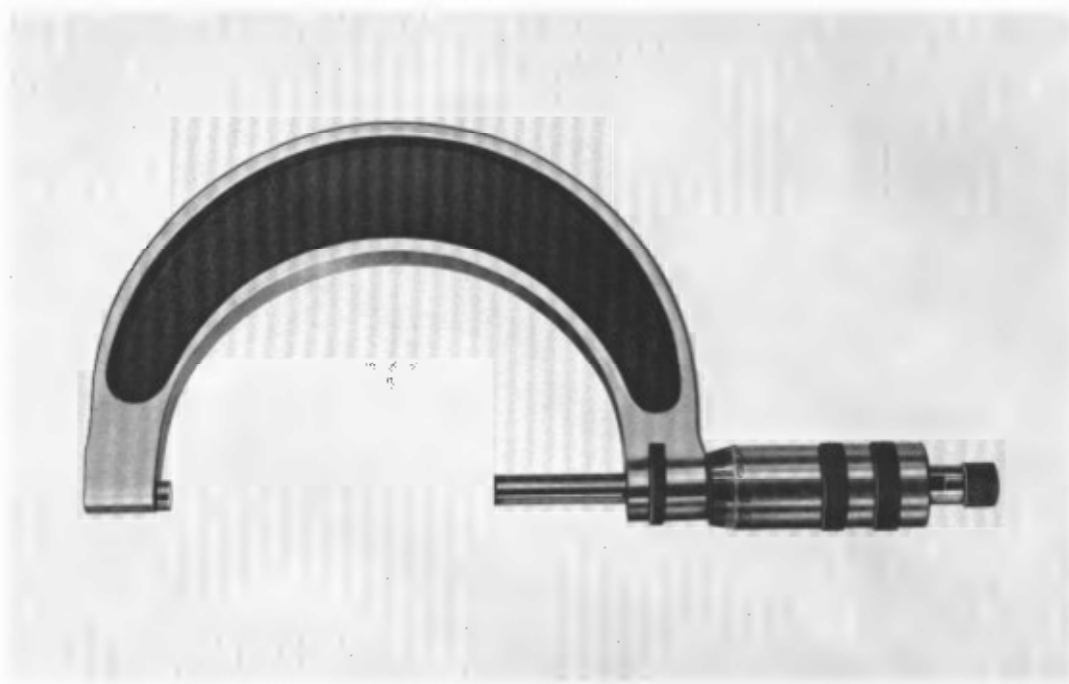
8. Install needle bearing race, needle bearing and shift sleeve.



9. Mount gear I for 2nd gear.

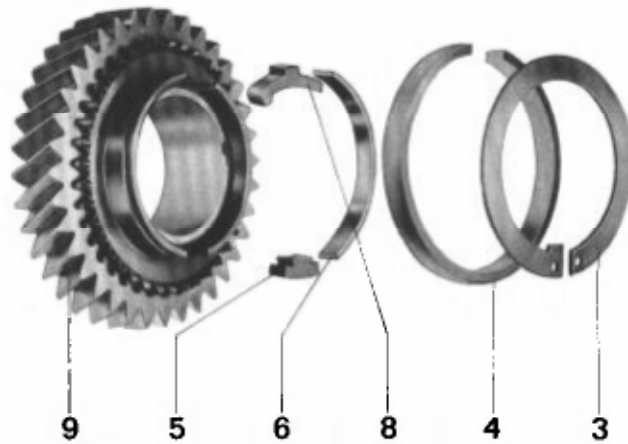
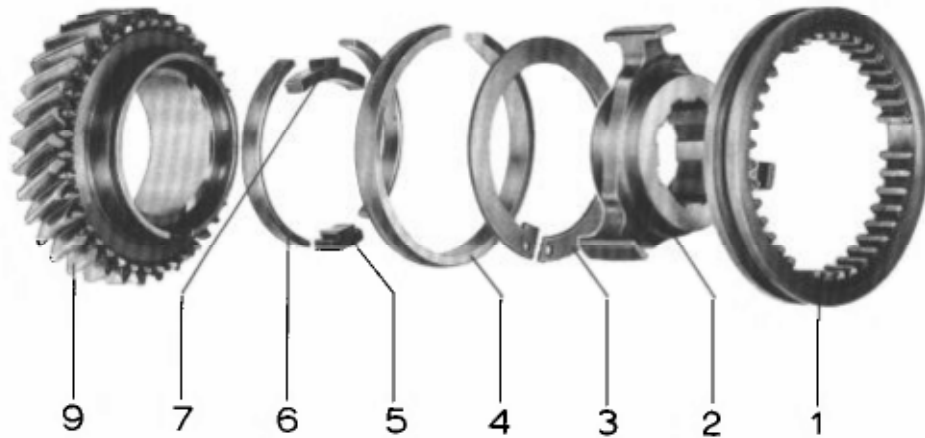
10. Install beveled thrust washer with flat surface against needle bearing.





No.	Description	Special Tool	Remarks
	Micrometer	-	commercial Size 4 (75-100 mm)



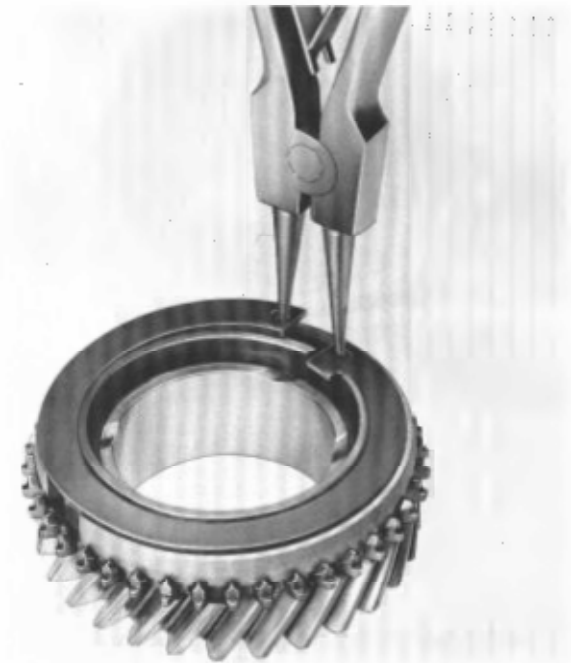


No.	Description	Qty.	Note when		Special instructions see
			Removing	Installing	
1	Shift sleeve	1		Check dimension of gap between shifting sleeve and shifting fork	3.1-8/7
2	Synchro hub	1			3.1-8/5
3	Circlip	1			
4	Synchronizing ring	1		Check for wear	
5	Anchor block	1			
6	Brake band one only, for 1st gear	2		For 1st gear, place on correct side	
7	Thrust block, 2nd to 5th	1			
8	Thrust block, 1st gear	1			
9	Gear	1			

## DISASSEMBLING AND ASSEMBLING SYNCHRONIZER

### Disassembling

1. Remove circlip.



2. Check all parts for wear and damage. Replace as necessary.

### Assembling

#### Caution

Make sure synchronizing ring, anchor block, thrust block and brake band are installed according to the illustration.

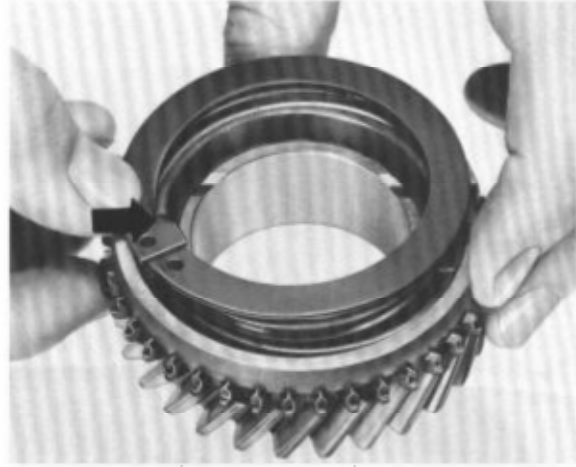
1. Position synchronizing ring so that the rough surface faces the shift sleeve. Insert thrust block and anchor block together with brake bands.



2. When assembling the first gear synchronizer be sure that only one brake band is inserted. Insert brake band only as shown in illustration.



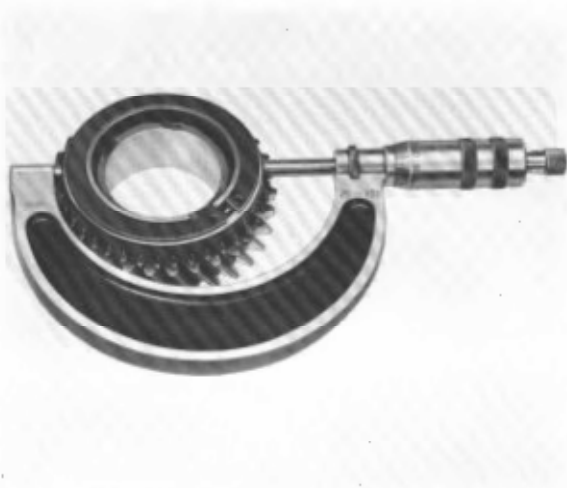
3. Place tong of circlip into the anchor block cut-out. Push circlip into groove, while pushing synchronizer ring on its seat, if necessary.



4. Spread circlip pliers and seat circlip.

### Checking

1. Check diameter of synchronizer ring installed with a micrometer. Position micrometer at highest point of synchronizing ring.



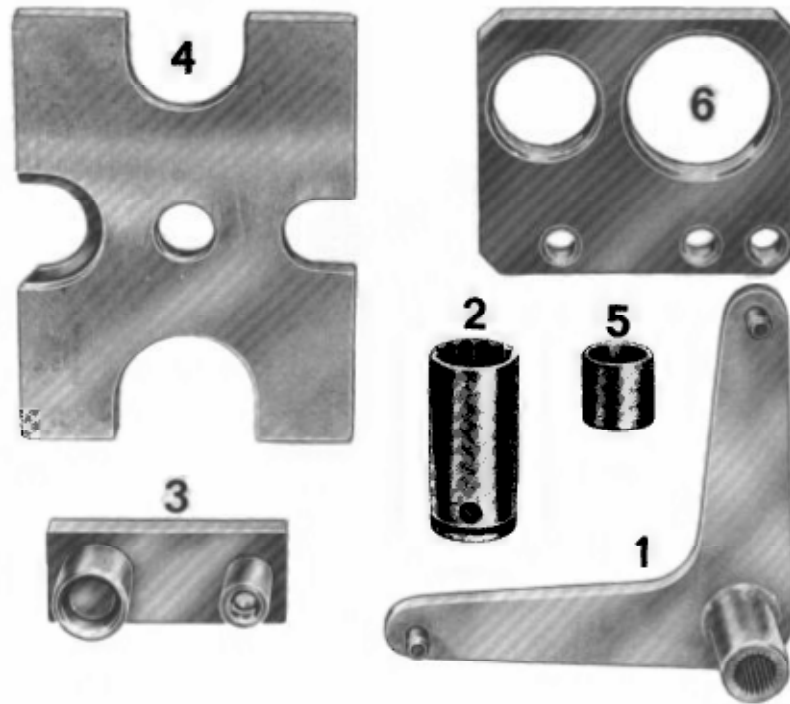
Dia.: 76,30 mm  $\pm$  0,18 mm

2. Maximum play between shift fork and shift sleeve 1st to 5th gear: 0,5 mm (0,02 in.).



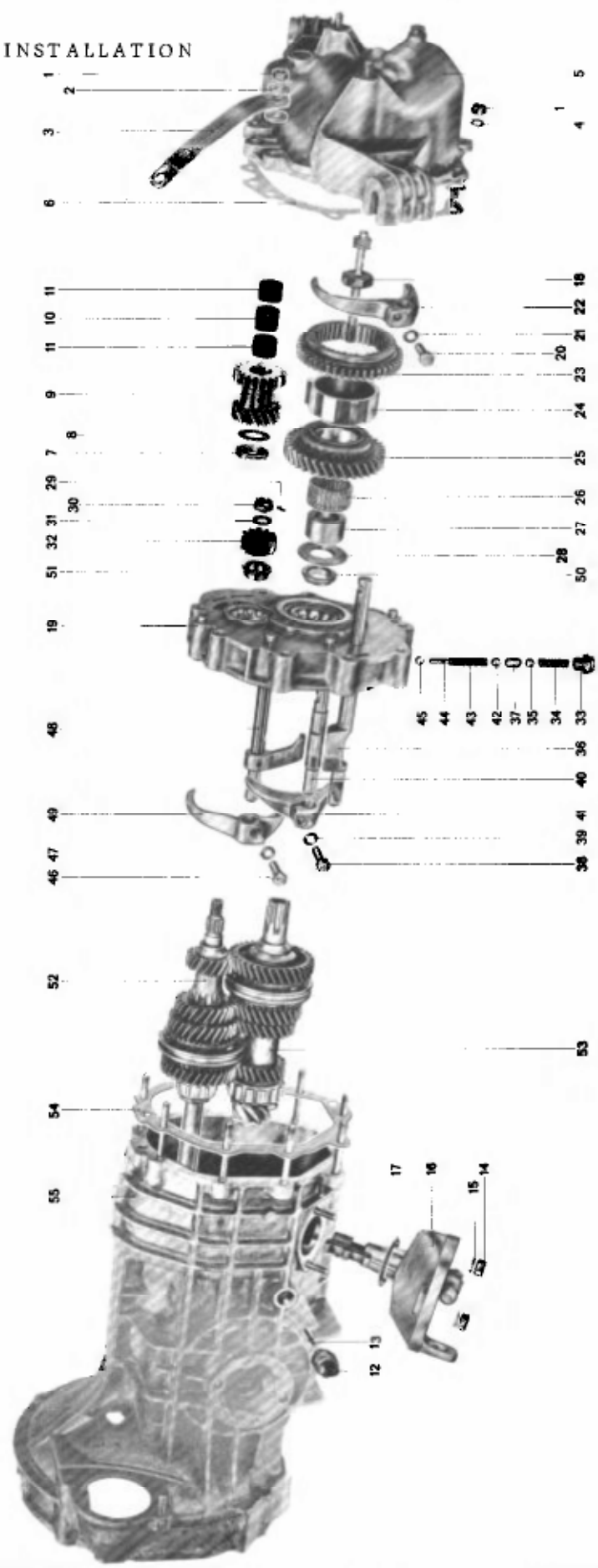
## TRANSMISSION

## TOOLS



No.	Description	Special Tools	Remarks
1	Input shaft holder	P 37	
2	Deep socket, 36 mm	--	
3	Thrust piece	P 253	
4	Thrust plate	VW 401	
5	Spacer sleeve	VW 472/2	
6	Shift rod holder	P 260	

### REMOVAL AND INSTALLATION



No.	Description	Qty.	removal	Note during installation	Remarks
1	Self-locking nut	9		Replace if necessary. Torque to specification.	
2	Washer	2		Place one on each side of the ground strap.	
3	Ground strap	1		Position properly during installation	
4	Washer	8			
5	Rear cover	1			
6	Oil seal	1		Replace.	
7	Thrust washer	1	Can fall out during removal of rear cover	Groove must face the outer race of input shaft ball bearing	3.1 - 1/15
8	Axial needle bearing cage	1	Can fall out during removal of rear cover.	Check for wear.	
9	Reverse (twin) gear	1	Can fall out during removal of rear cover		
10	Sleeve	1	Can fall out during removal of rear cover		
11	Needle bearing cage	2	Can fall out during removal of rear cover.	Check for wear.	
12	Backup light switch			Torque to specification	
13	Contact plunger	1	Remove with needle nose pliers	Long side must face selector shaft.	3.1 - 1/8

No	Description	Qty.	removal	Note during installation	Remarks
14	Self-locking nut	2		Replace if necessary Torque to specification	
15	Washer	2			
16	Support	1		Shift rake and ball-joint lever must point upward	
17	O-ring	1	Remove with small screwdriver	Install new O-ring lightly coat with oil	
18	Stretch bearing bolt	1	Shift into 5th gear block input shaft with P37 holder and loosen stretch bolt (do not unscrew)	Replace if necessary. Coat contact surfaces with oil, Torque to specification,	3 1 - 1/8
19	Intermediate plate	1	Shift into 5th gear, remove from studs together with items 20 thru 53		3 1 - 1/9
20	Bolt	1		Torque to specification	
21	Spring washer	1		Replace if necessary.	
22	Shift fork	1		Check for wear and readjust.	3 2 - 2/1
23	Shift gear	1		Check for wear.	
24	Guide sleeve	1	Use 2 screwdrivers to remove		3 1 - 1/9
25	Gear II for 1st speed	1		Replace only in pairs. Check synchronization.	3 1 - 8/3
26	Needle bearing cage	1		Check for wear.	
27	Bushing	1			

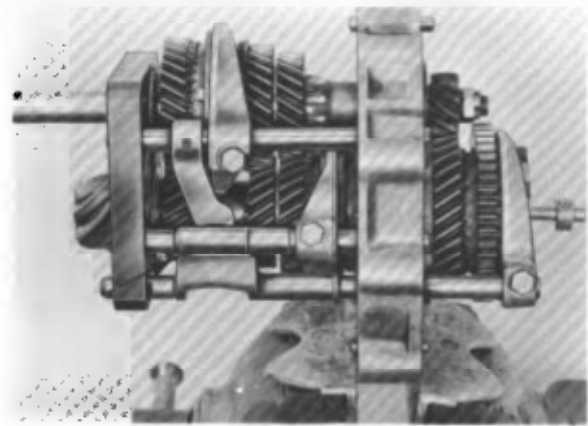
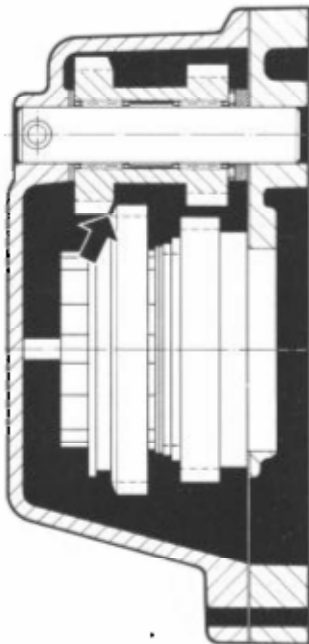


No.	Description	Qty	removal	Note during installation	Remarks
28	Thrust washer	1		Machined side must face needle bearing	
29	Lock pin	1		Replace	
30	Castellated nut	1	Engage 2 gears when loosening.	Torque to specification. Secure with lockpin.	
31	Washer	1			
32	Gear I for 1st speed	1		Replace only in pairs.	
33	Plug	1		Torque to specification	3 1 - 1/13
34	Spring	1		Check free length.	3 1 - 1/13
35	Ball	1			
36	Shift rod for 1st and reverse gears	1			
37	Detent	1			
38	Nut	1		Torque to specification	
39	Spring washer	1		Replace if necessary.	
40	Shift rod for 2nd and 3rd gears	1			
41	Shift fork	1	Mark for reassembly.	Check for wear and readjust	3.2 - 2/1
42	Ball	1			
43	Spring	1		Check free length.	3 1 - 1/13

No.	Description	Qty	removal	Note during installation	Remarks
44	Pin for detent	1		Grease and install together with spring	
45	Ball	1			
46	Bolt	1		Torque to specification	
47	Spring washer	1		Replace if necessary	
48	Shift rod for 4th and 5th gears	1			
49	Shift fork	1	Mark for reassembly	Check for wear and readjust.	
50	Bearing inner race	1		Press on	3 1 - 1/11
51	Bearing inner race	1		Press on.	3 1 - 1/11
52	Input shaft	1	Remove with P 253	Check for runout	3.1 - 1/10
53	Pinion shaft	1	Remove with P 253		3 1 - 1/10
54	Gasket	x	Note number and thickness of gaskets	Recompute thickness if necessary.	5 1 - 5/5
55	Transmission housing	1			

## ADJUSTING SHIFT FORKS - Side Shift Transmission

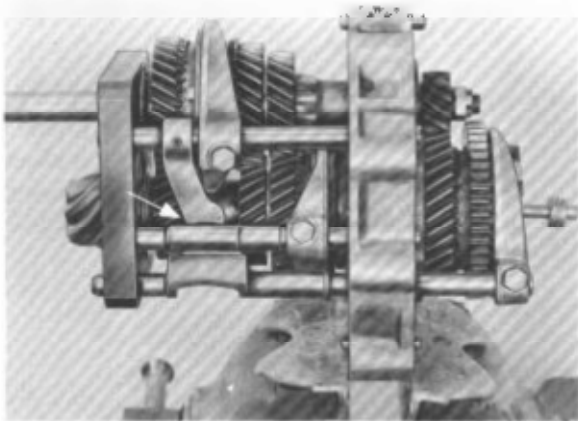
- 1 - Slide holder P 260 onto shift rods.
- 2 - Bring shift rod of 1st and reverse gear into center position by turning it left and right. Adjust shift fork so that 1 mm clearance is provided between reverse (twin) gear and shift gear when in neutral; when checking, push the reverse (twin) gear with axial needle bearing cage, thrust washer, needle bearings, and appropriate pin or shaft against the intermediate plate.
- 3 - Tighten shift fork retaining bolt to specified torque.
- 4 - Bring shift rod of 2nd and 3rd gear into center position. Adjust shift fork and tighten retaining bolt to specified torque. A clearance of about 2 mm must exist between the shift components of 1st and reverse gears, and 2nd and 3rd gears.



## Note:

Eliminate clearance between the shift gear and fork by pressing the shift gear against the driving direction when making the adjustment. (The shift gear can strike the reverse (twin) gear under unfavorable conditions).

- 5 - Adjust shift fork of 4th and 5th gears and tighten retaining bolt to specified torque. Make sure that a side clearance of about 3 mm is provided between the shift component of 4th and 5th gears, and 2nd and 3rd gears.

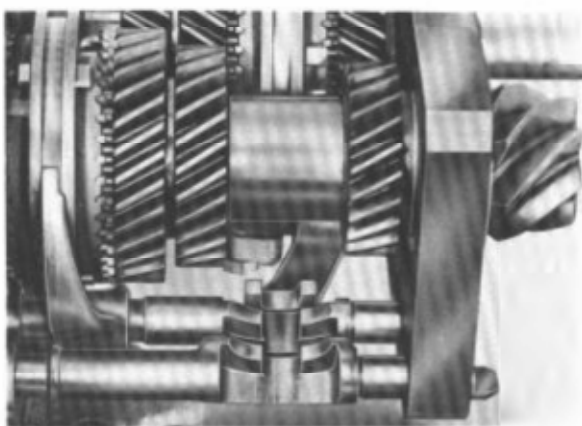


Note:

The shift sleeves should be centered between the synchro rings. Deviations should be corrected by readjusting the shift forks.

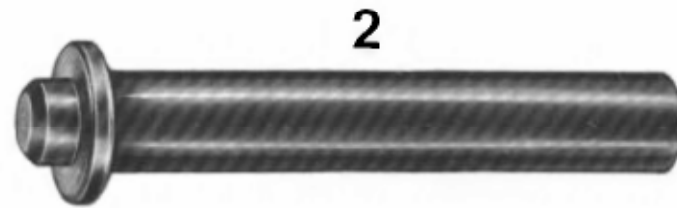
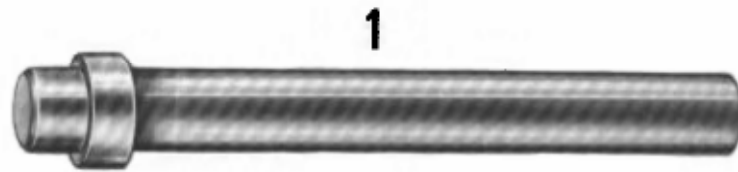
Note:

All shift rods must be so adjusted that they don't touch one another and the shift finger can travel freely through the shift components.



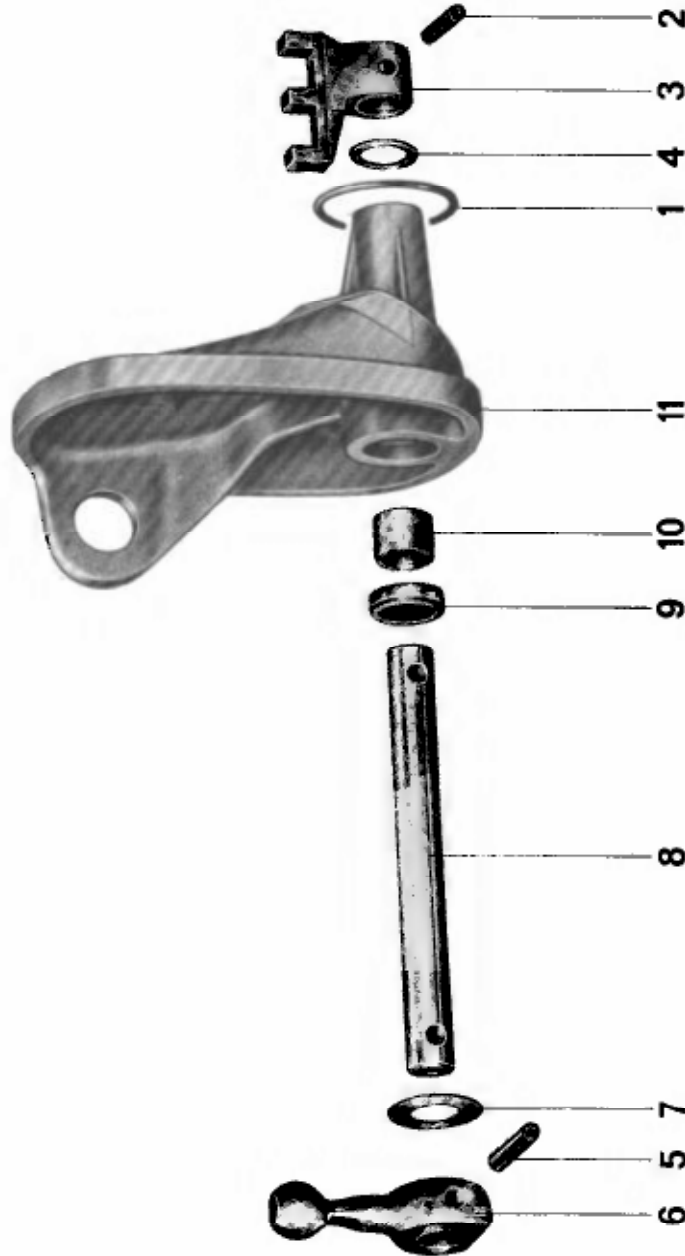
## SHIFT SUPPORT

## TOOLS



No.	Description	Special Tool	Remarks
1	Mandrel	P 379	
2	Mandrel	P 369	

Disassembly and Reassembly

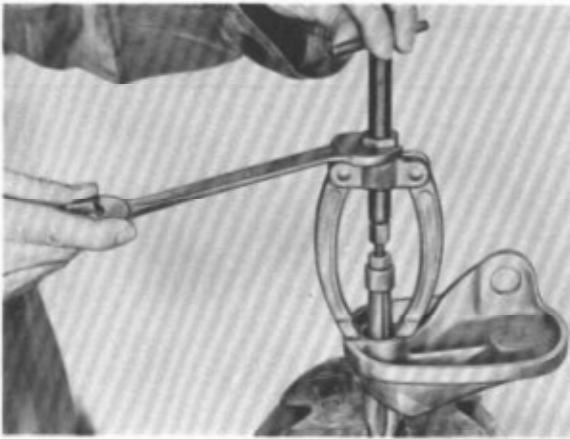


No.	Description	Qty	Note during		Remarks
			removal	installation	
1	O-ring	1		Replace Oil lightly during installation.	
2	Lock pin	1			
3	Shift finger	1		Position properly	
4	Washer (top)	1			
5	Lock pin	1			
6	Ball-joint lever	1		Beveled side faces outward.	
7	Washer (bottom)	1			
8	Shift lever shaft	1		Check or free movement	
9	Oil seal	1	Press out with large screwdriver	Install with P 369.	
10	Bushing	1	Pull out with KUKKO internal puller	Drive in fully with P 379	
11	Shift support	1			

## DISASSEMBLING AND REASSEMBLING SUPPORT

## Disassembly

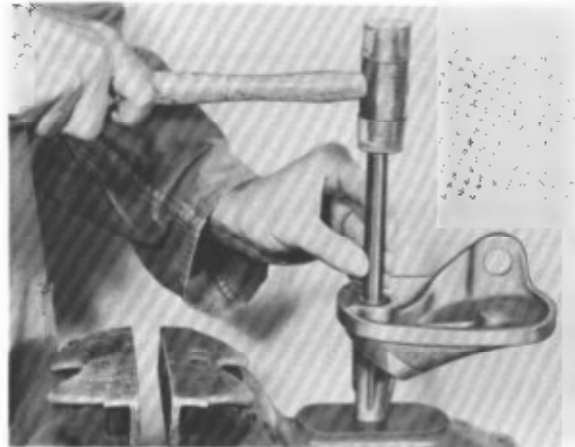
- 1 - Remove O-ring with a small screwdriver.
- 2 - Using an appropriate punch, drive lock pin out of the shift finger and remove shift finger.
- 3 - Pull shift lever shaft and ball-joint lever out. Remove plastic washers.
- 4 - Press oil seal of shift lever shaft out with the aid of a large screwdriver.
- 5 - Remove bushing with a KUKKO internal puller.



- 6 - Drive lock pin out of ball-joint lever and remove it.

## Reassembly

- 1 - Push ball-joint lever onto shift lever shaft with the beveled side facing outward. Drive lock pin into the aligned holes.
- 2 - Drive bushing in with the aid of P 379.





- 3 - Drive oil seal for shift lever shaft fully in with the aid of P 369.



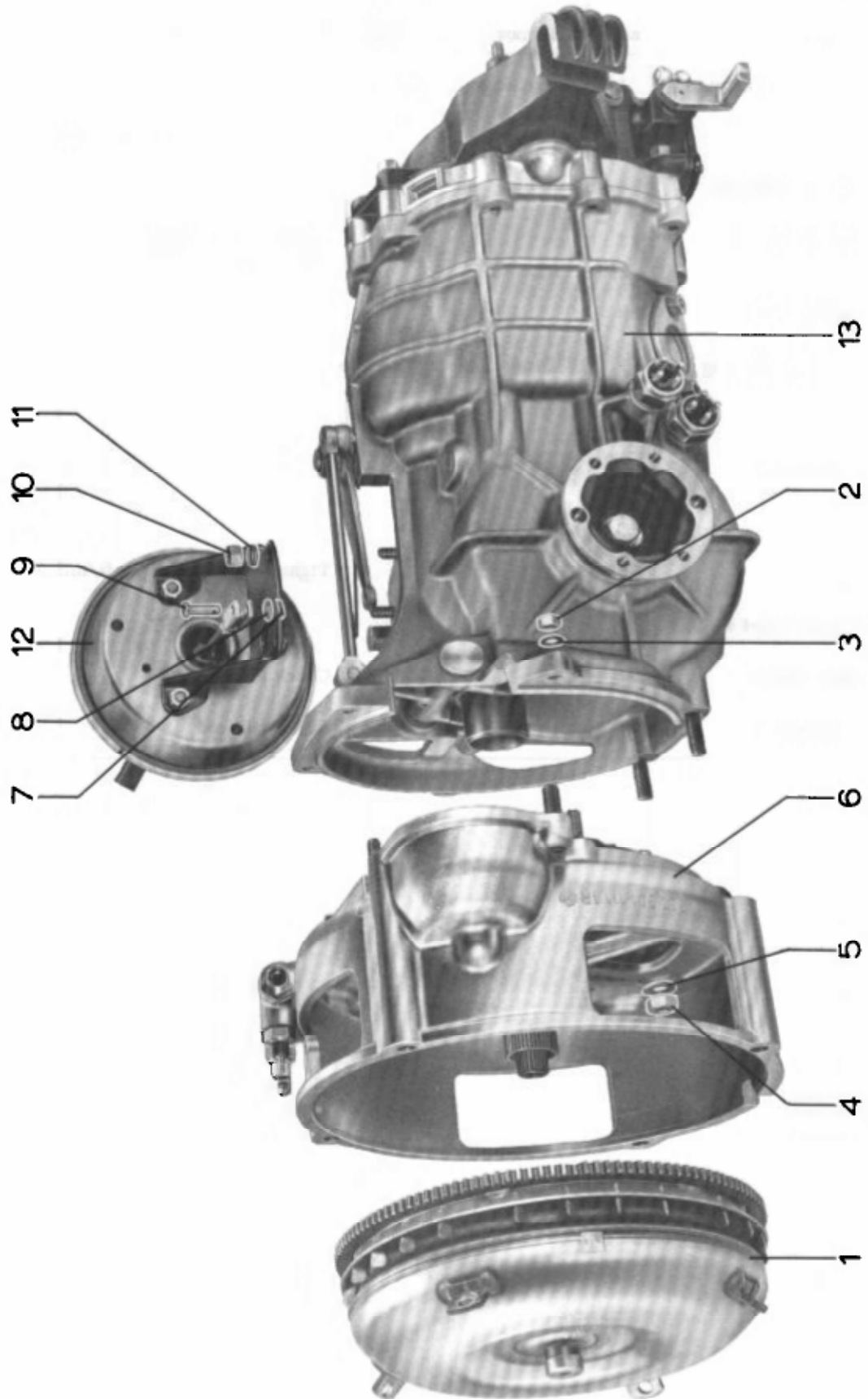
- 4 - Lightly oil the shift lever shaft, install large plastic washer, and insert shaft into shift support.

- 5 - Install small plastic washer and shift finger. Drive lock pin into the aligned holes. (See exploded view for installed position of the shift finger).

**Note:**

Shift finger and ball-joint lever must face in the same direction.

- 6 - Lightly oil the O-ring and insert in the groove in shift support.



No.	Designation	Each	Observe during		Refs.
			Removal/Disassembly	Installation/Assembly	
1	Torque converter	1	Exchange if damaged		
2	Nut M 8	4		Tighten to 2.5 mkp (18 ft/lb)	
3	Spring washer B8	4			
4	Nut M 10	2		Tighten to 4.5 mkp (32.5 ft/lb)	
5	Spring washer B10	2			
6	Converter housing	1	Disassemble and assemble, if required		4.1-3/1
7	Cotter pin	1			
8	Washer B 6	1			
9	Bolt	1			
10	Nut M 8	3		Tighten to 2.5 mkp (18 ft/lb)	
11	Spring washer B 8	3			
12	Servo motor	1		Check for function	
13	Transmission	1		Adjust pull rod	

## REMOVAL AND INSTALLATION OF CONVERTER HOUSING.

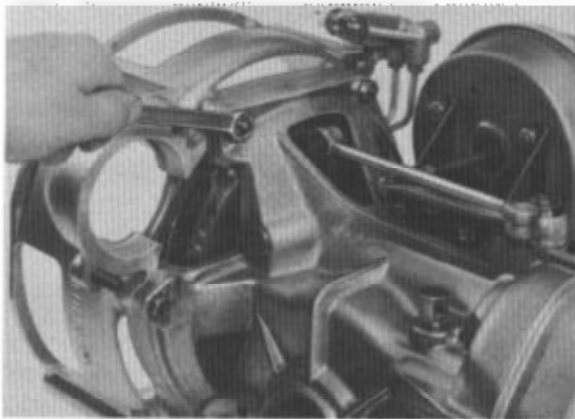
## Removal

- 1 - Place transmission on bench and pull torque converter from freewheeling unit (2) and remove. Cover hub opening, so that no foreign bodies will enter converter.

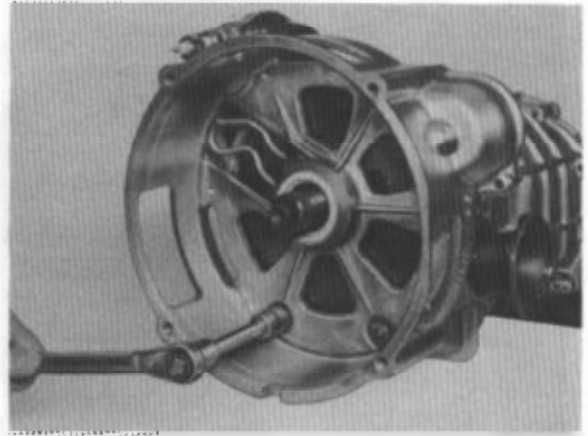
## Caution!

In the event of leaks within range of freewheeling unit first repair leaks of freewheeling unit even when converter is heavily oiled up. Do not exchange torque converter, since practical experience has shown that converters hardly ever leak. Exchange only when converter hub shows deep scoring marks of sealing rings, which will generally occur after very long periods of operation. Also, of course, when other faults occur, for example on bearing bushing or on ring gear.

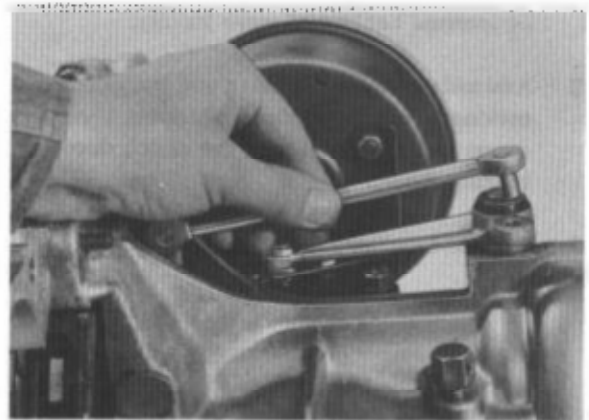
- 2 - Unscrew hex. nuts for outside attachment of converter housing.



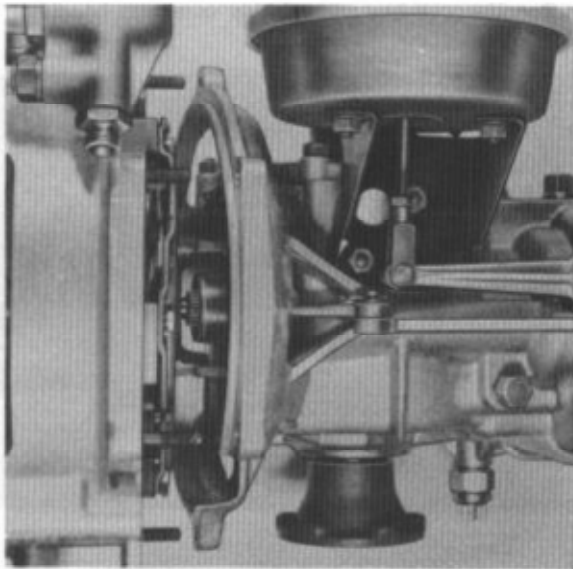
- 3 - Unscrew hex. nuts inside converter housing.



- 4 - Remove cotterpin of push rod on intermediate lever and disconnect push rod.



- 5 - Remove converter housing from transmission housing while simultaneously removing clutch throwout bearing from throwout lever.

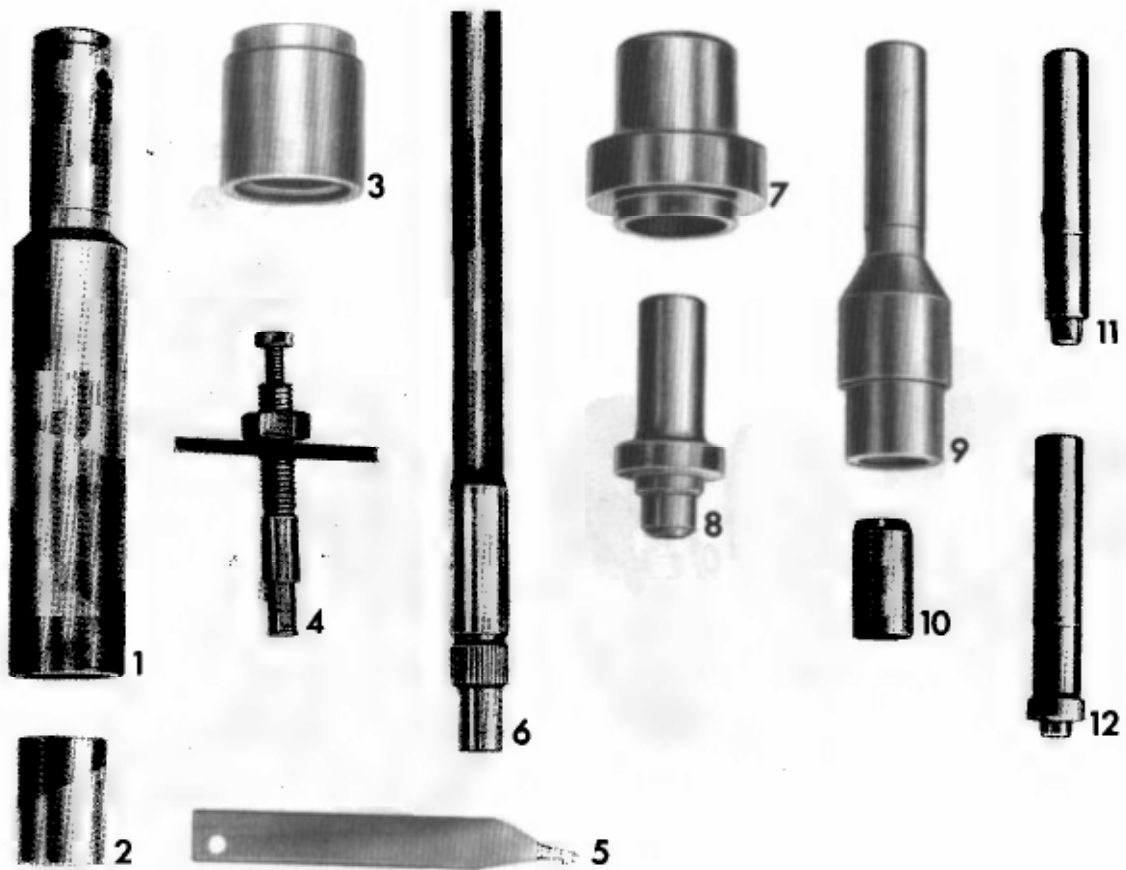


- 4 - Insert push rod on intermediate lever and secure with new cotter pin. Complete basic adjustment of clutch. Refer to "Adjustment of Clutch" on page

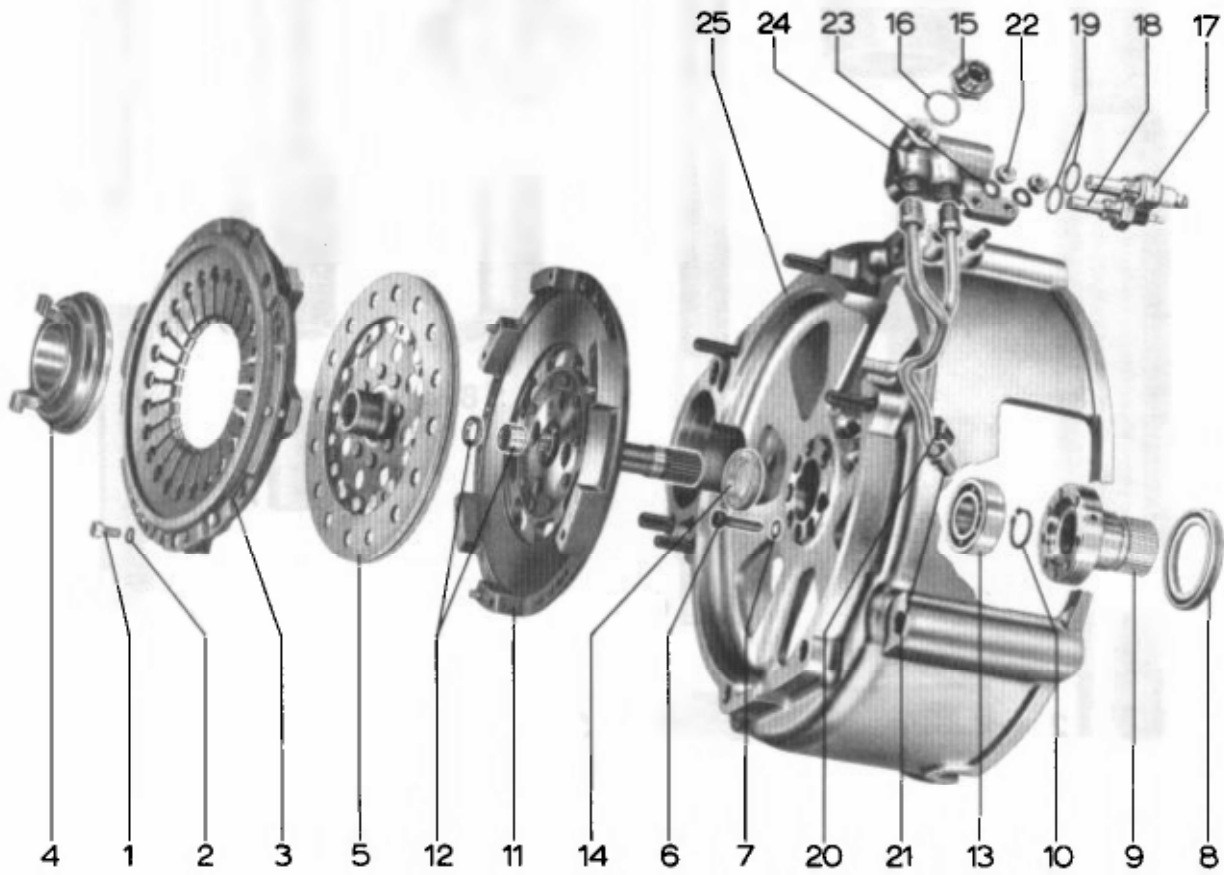
- 5 - Place torque converter on freewheeling unit and keep turning for insertion into turbine shaft.

#### Installation

- 1 - Insert lefthand engine fastening screw into converter housing (hex. screw can no longer be inserted because of servo motor).
- 2 - Assemble converter housing and transmission, making sure that the clutch throwout lever enters into the two lugs of the clutch throwout bearing.
- 3 - Tighten hex. nuts uniformly and to specified torque.



No.	Designation	Special Tools	Explanations
1	Fitting sleeve	VW 244b	-
2	Tube section	VW 426	-
3	Thrust piece	VW 455	-
4	Puller	VW 228b	-
5	Hook	-	Self-made
6	Centering mandrel	-	Self-made, cutoff input shaft
7	Thrust piece	P 358	-
8	Thrust piece	P 359	-
9	Thrust piece	P 360	-
10	Sleeve	P 364	-
11	Thrust piece	P 361	-
12	Thrust piece	P 362	-



No.	Designation	Each	Observe during		Refs.
			Removal/Disassembly	Installation/Assembly	
1	Internal multi-tooth screw	6	Unscrew uniformly	Tighten to 1.5 mkp (10.8 ft/lb)	
2	Spring ring	6			
3	Plate spring clutch with pressure plate	1		Check clutch friction surface and tongues of diaphragm spring for wear	
4	Throwout bearing	1		Do not wash, wipe off dry only	4.1-3/5
5	Clutch plate	1		Check for wear, total thickness min. 5.5 mm, lateral wobble max. 0.5 mm, check teeth of clutch plate/drive shaft for easy operation	
6	Internal multi-tooth screw	8		Tighten uniformly to 1.5 mkp (10.8 ft/lb)	
7	Sealing washer	8		Replace	
8	Sealing ring	1	Knock out together with freewheeling unit	Moisten with oil outside	
9	Freewheeling unit	1		Check teeth and bushing of turbine shaft for wear	
10	Locking ring	1		Replace	
11	Carrier plate	1	Force out	Check clutch friction surface for scoring and profile for receiving turbine hub as well as oil flow hole, knock in together with bearing with VW 455 and VW 244b	4.1-3/9
12	Sealing ring and needle bearing	1	Pull out with VW 228b	Check bearing for wear, replace sealing ring, force in needle bearing with P 361, sealing ring with P 362	4.1-3/9
13	Grooved ball bearing	1	Force out w. mandrel	Check for wear	
14	Sealing ring	1	Force out w. mandrel	Moisten with oil outside	
15	Double connection	1			
16	Sealing ring	1		Replace	
17	Tele-thermometer transmitter	1			
18	Temperature switch	1			
19	Sealing ring	2		Replace	

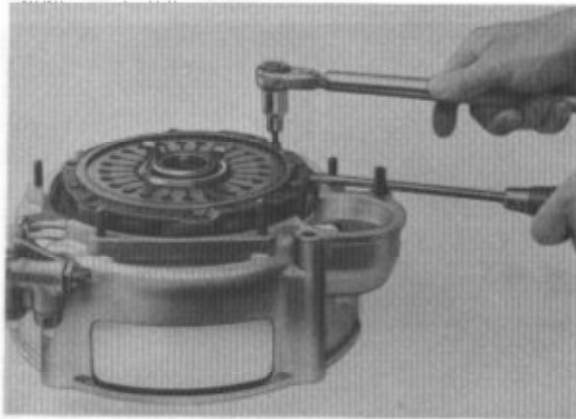


No.	Designation	Each	Observe during		Refs.
			Removal/Disassembly	Installation/Assembly	
20	Pressure pipe	1			
21	Return flow pipe	1			
22	Nut M 6	2			
23	Spring plate B 6	2			
24	Switch housing	1			
25	Converter housing	1			

## REMOVAL AND INSTALLATION OF TRANSMISSION CLUTCH

## Removal

- 1 - Unscrew internal multi-tooth screw of clutch pressure plate with socket spanner insert (double hex.), loosen screws uniformly so that pressure plate is not distorted.



- 2 - Remove clutch pressure plate and clutch plate.

**Caution!**

Clutch throwout bearing may fall out of pressure plate.

- 3 - Slide clutch throwout bearing out of pressure plate at an angle toward the rear.

**Caution!**

Do not wash throwout bearing!  
Wipe off dry only.

## Installation

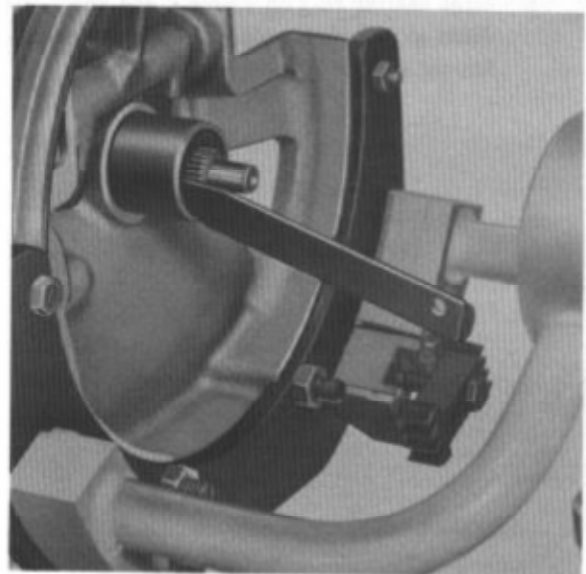
- 1 - Check clutch plate, pressure plate, throwout bearing for wear or damage and replace, if required. Check clutch carrying plate, as well as needle bearings and sealing ring in clutch carrier plate for wear and replace, if required (refer to Removal and Installation of Clutch Carrier Plate ...).

- 2 - With oiled up clutch

If the clutch has been oiled up by ATF or engine oil, replace sealing ring of clutch carrier plate (seal to converter). Refer to Removal and Installation of Clutch Carrier Plate, page ...

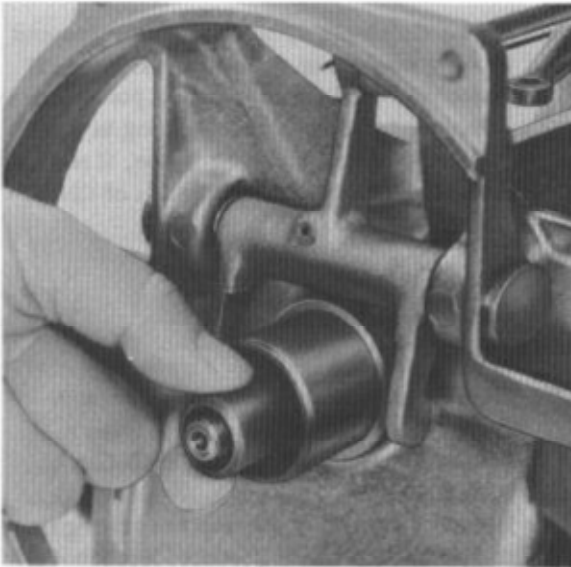
If there is emerging oil, replace sealing ring in transmission housing (seal of input shaft) as follows:

- 3 - Pull out sealing ring with self-made hook.

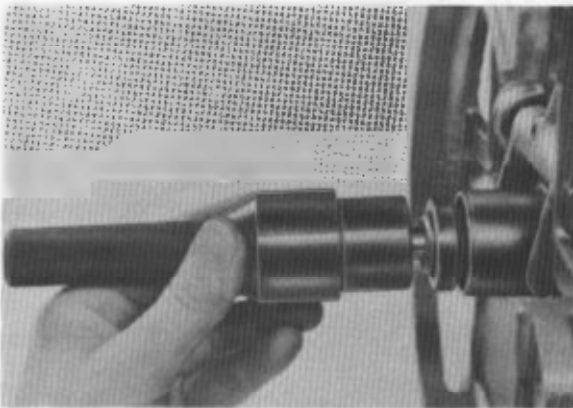


4 - Fit new sealing ring for input shaft as follows:

a - Slide sleeve P 364 on input shaft.



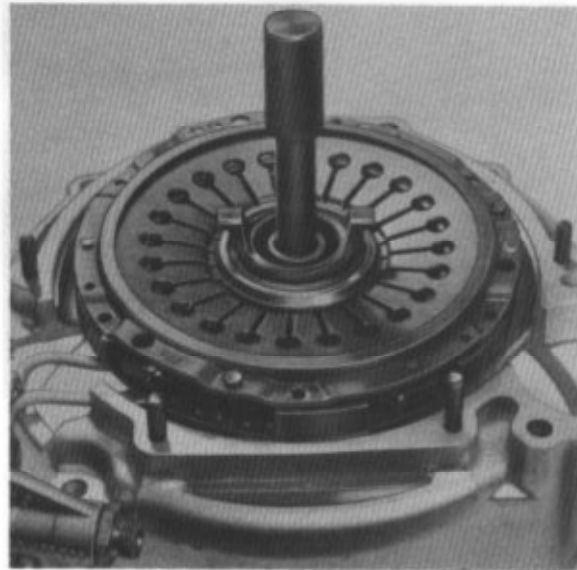
b - Slide sealing ring on sleeve P 364 and force in with thrust piece P 360 until tool knocks against bearing tube.



5 - Lubricate needle bearing in carrier plate with some lithium grease and MOS 2 additive and position driven plate on carrier plate. This requires centering the plate with a clutch mandrel (cutoff driven shaft).

**Caution!**

Use grease sparingly to keep clutch plate clean.



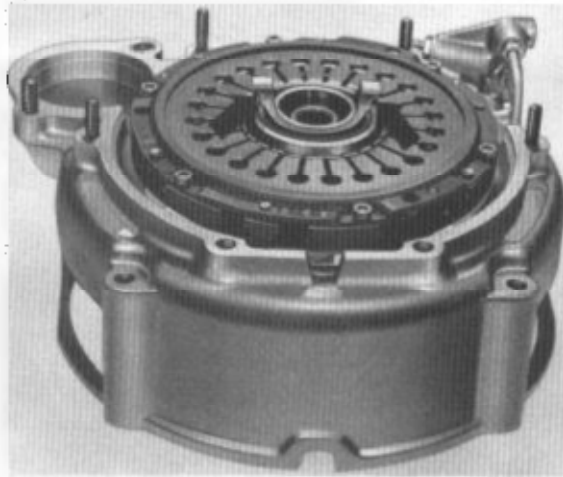
6 - Grease tongues of diaphragm spring for clutch pressure plate on both sides with some lithium grease and MOS 2 additive and insert clutch throwout bearing at an angle into the clutch pressure plate from inside in outward direction.

7 - Screw down clutch pressure plate with internal multi-tooth screws uniformly and then tighten.

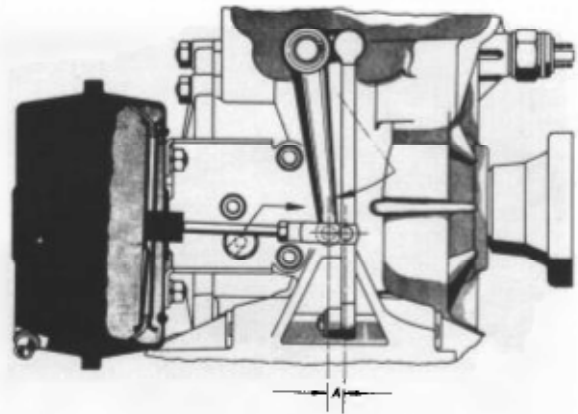
**Caution!**

Be sure that the throwout bearing does not jam in plate spring and that the clutch pressure plate engages with centering pin.

- 8 - Grease guides of throwout bearing on transmission housing neck as well as the two claws (arrows) lightly with lithium grease and MOS 2 additive.



manner that the bore of the fork head extends 10 to 12 mm (dimension A) beyond the bore of the intermediate lever.



#### Basic Adjustment with New Clutch Plate

- 1 - Remove cotter pin on bolt for pull rod and intermediate lever and pull out bolt.
- 2 - Pull rod attached to servo engine out up to stop while simultaneously pushing the intermediate lever in the direction of the servo motor against stop. In this position the fork head of the pull rod should be set in such a

#### Checking the Clutch Play

In a new clutch the play has been properly set during basic adjustment. The normal wear of the clutch linings will reduce this play in the course of time.

However, there should always be a minimum play, so that the clutch can be fully engaged. If not, the clutch will slip and excessive heating and increased wear will follow.

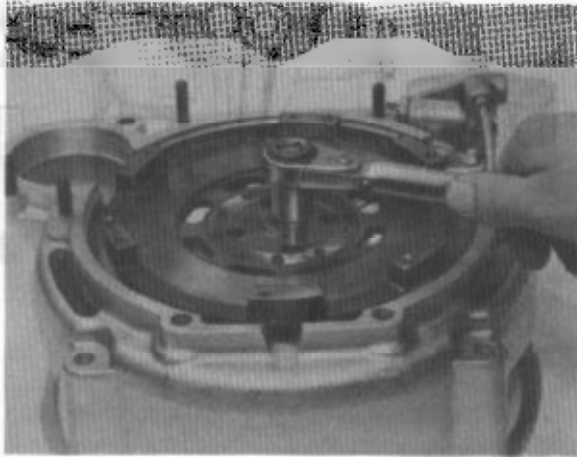
For these reasons, the clutch play must be checked at the specified intervals and, if required, adjusted as follows:

Pull vacuum hose from servo motor and push intermediate lever with left hand away from servo motor. The intermediate lever should move for a distance of at least 5 mm. If it is less, the clutch play must be newly adjusted. Refer to previous section.

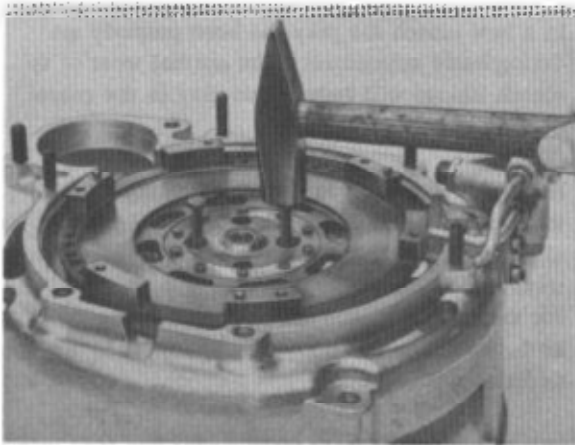
## REMOVAL AND INSTALLATION OF CLUTCH CARRIER PLATE (CLUTCH REMOVED)

## Removal

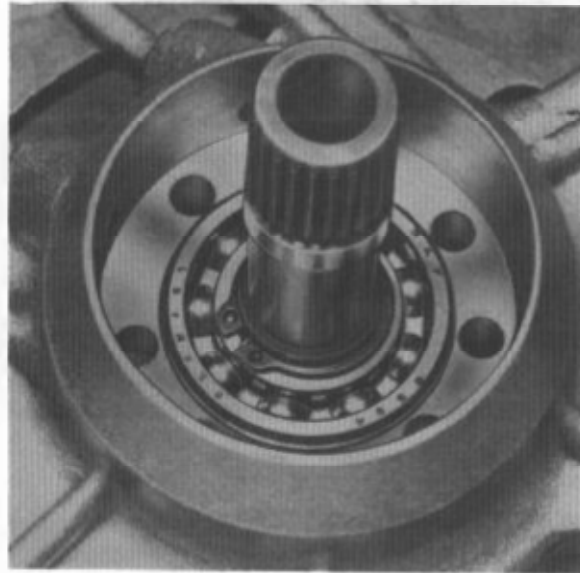
1 - Unscrew internal multi-tooth screw (6 mm) through holes in clutch carrier plate.



2 - Screw two hex. screws (M 6 x 60) in opposite position down for approx. 8 mm and carefully knock out freewheeling unit together with radial sealing ring by means of light blows against screw



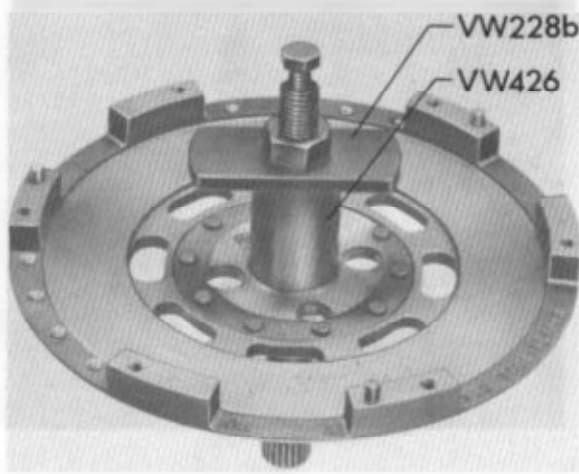
3 - Remove locking ring on turbine shaft.



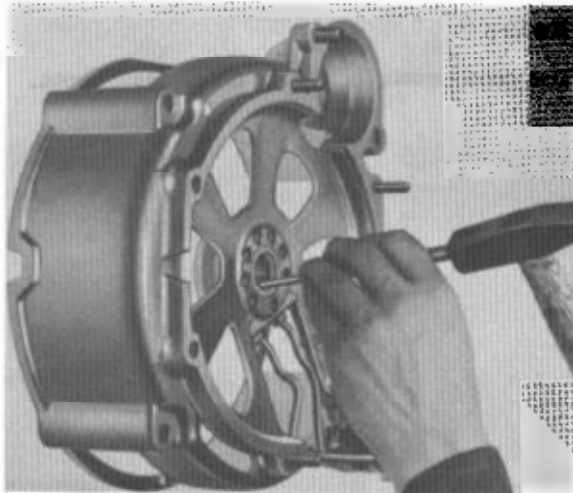
4 - Knock carrier plate out of bearing by blowing against turbine shaft with a rubber hammer. Wash out for good support of converter housing.



- 5 - Pull sealing ring and needle bearing in carrier plate by means of puller VW 228b and tube VW 426.

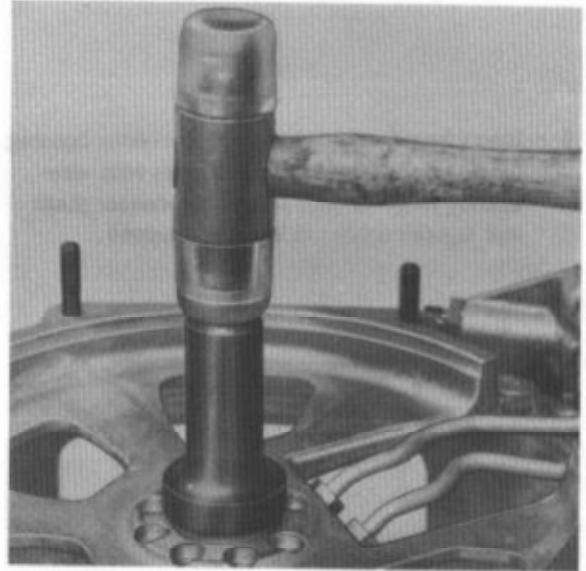


- 6 - Force out grooved ball bearing and sealing ring for carrier plate one after the other with a punch.

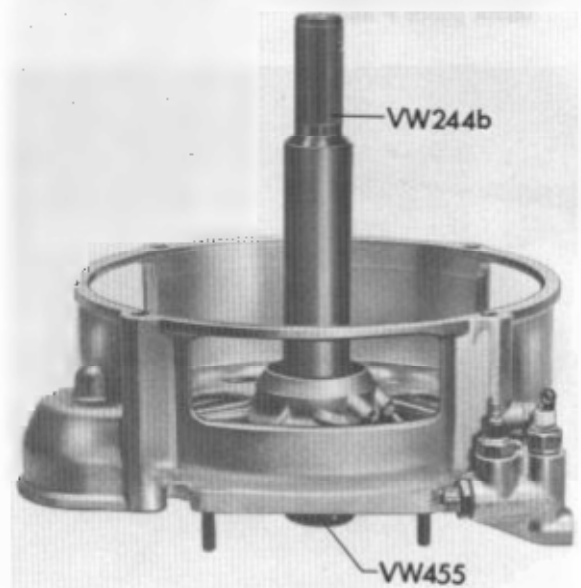


### Installation

- 1 - Lubricate new sealing ring (silicon ring) on seat for converter housing well and force in by means of thrust piece P 359, with sealing lip pointing toward converter.



- 2 - Insert clutch carrier plate into converter housing and position with thrust piece VW 455. Then force grooved ball bearing into converter housing against stop by means of thrust piece P 359 or fitting sleeve VW 244b.



### Caution !

Replace bearings which are damaged or too loud.

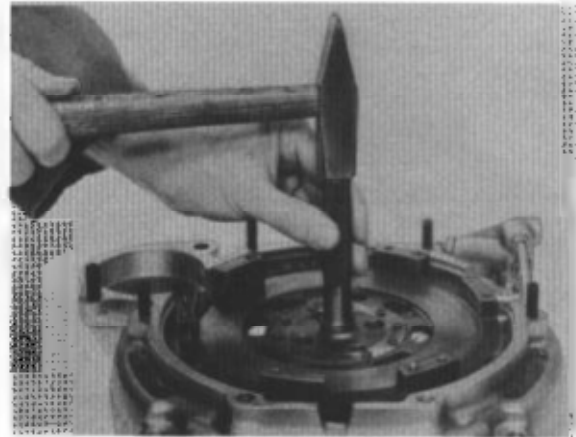
3 - Place locking ring on turbine shaft.

4 - Insert freewheeling unit into converter housing. Insert internal multi-tooth screws with new sealing rings through holes into carrier plate and tighten screws to specified torque.

5 - Lubricate new sealing ring for torque converter (silicon ring) well on seat for converter housing and force in with thrust piece P 358.

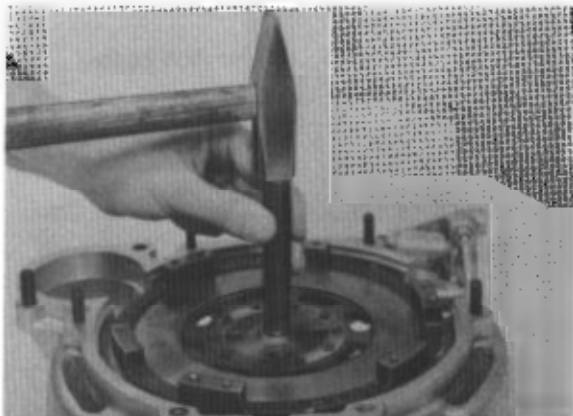
6 - Force in needle bearings for input shaft with thrust piece P 361.

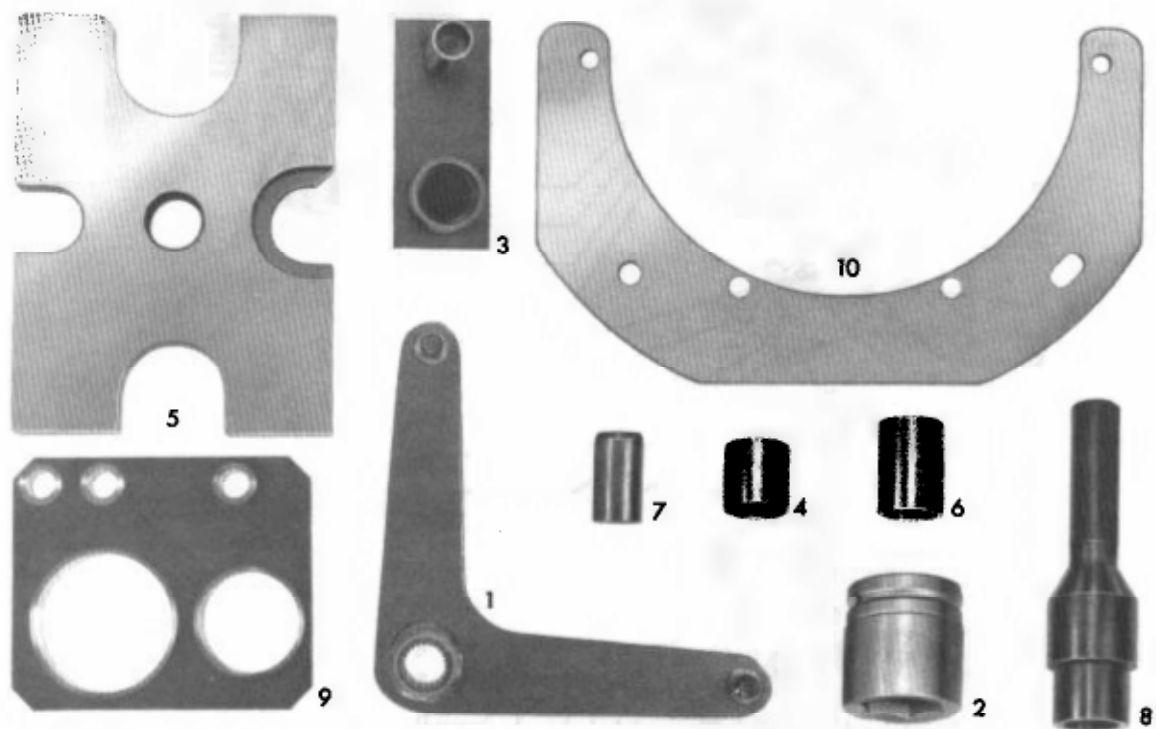
7 - Force in sealing ring for input shaft with thrust piece P 362. Grease needle bearing for input shaft with some lithium grease MOS 2 additive.



**Note:**

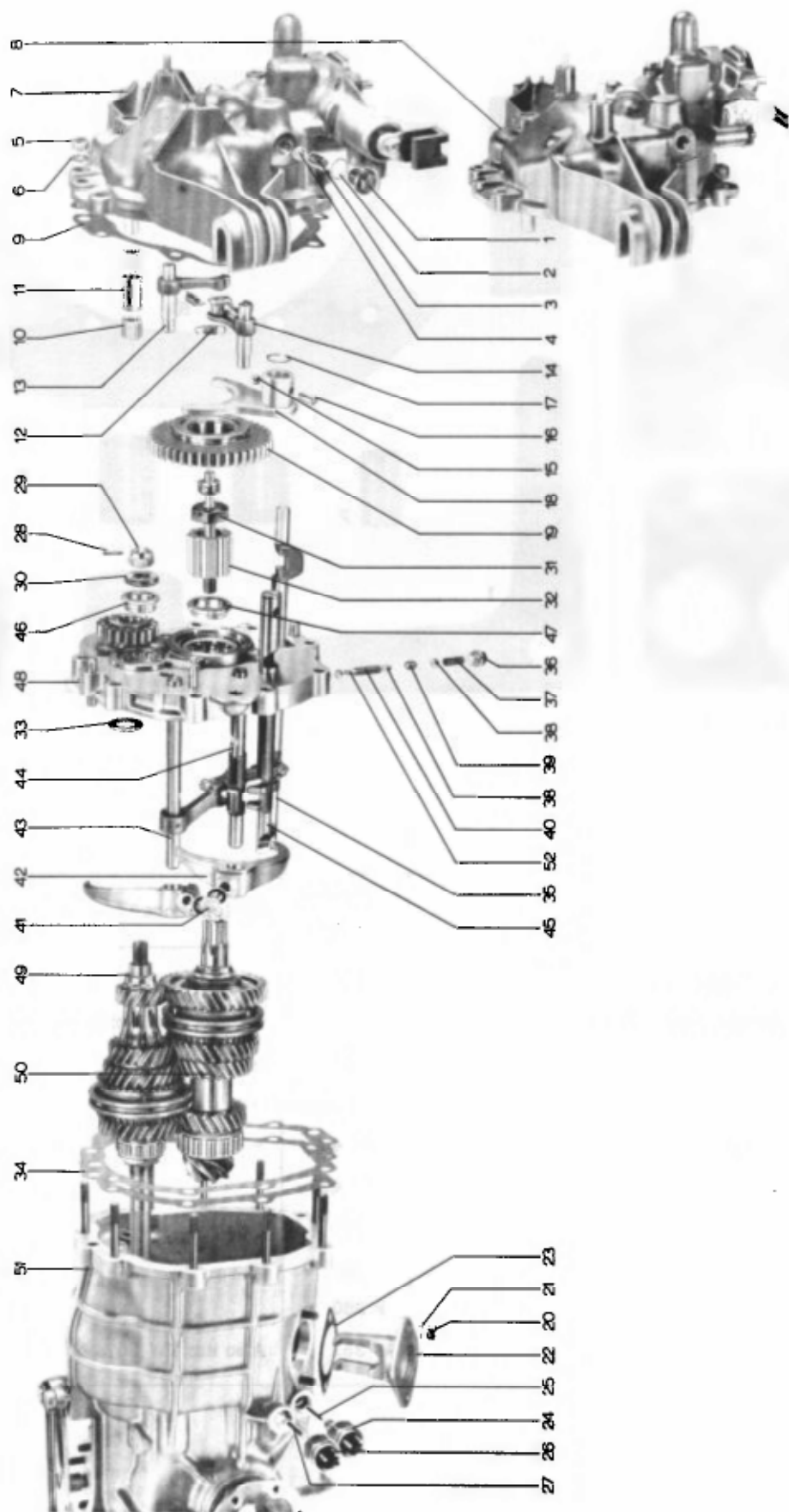
Use grease sparingly to keep clutch plate clean.





No.	Designation	Special Tools	Explanations
1	Supporting angle piece	P 37	-
2	Socket spanner insert SW 36	-	Commercial, excess length
3	Thrust piece	P 353	-
4	Tube	VW 472/2	-
5	Pressure plate	VW 401	-
6	Tube	VW 426	-
7	Sleeve	P 364	-
8	Thrust piece	P 360	-
9	Holding plate	P 360	-
10	Holding plate	P 351	Also use VW 307a or P 201





No.	Designation	Each	Observe during		Refs.
			Removal/Disassembly	Installation/Assembly	
1	Closing screw	1		Tighten to 4.5 mkp (32.5 ft/lb)	
2	Sealing ring	1		Replace	
3	Spring for parking lock	1			
4	Ball 9 mm	1			
5	Self-locking screw	9		Tighten to 2.5 mkp (18.0 ft/lb)	
6	Washer	9			
7	Gearbox cover 914	1	Disassemble and reassemble, if required		4.1-5/1
8	Gearbox cover 914/6	1	Disassemble and reassemble, if required		4.1-5/1
9	Seal	1		Replace	
10	Needle bearing	2		Check for wear	
11	Spacer bushing	1			
12	Draw spring	2			
13	Pawl for parking lock	1			
14	Lever for parking lock	1			
15	Ball 7 mm	1			
16	Bolt	1			
17	Locking ring	1		Replace	
18	Shift fork for reverse gear	1		Check for wear	
19	Gear wheel rev. gear	1		Check for wear	
20	Nut M 8	2		Tighten to 2.5 mkp (18.0 ft/lb)	
21	Spring ring B 8	2			
22	Fork piece	1		Insert only when no gear is engaged	
23	Seal	1		Replace	
24	Bridging switch	1		Tighten to 4.0 mkp (28.9 ft/lb)	
25	Plunger	1			
26	Switch backup lights	1		Tighten to 4.0 mkp (28.0 ft/lb)	

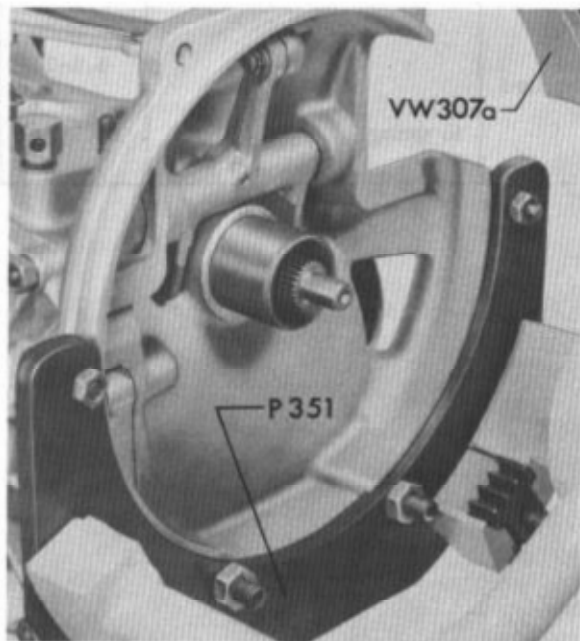
No.	Designation	Each	Observe during		Refs.
			Removal/Disassembly	Installation/Assembly	
27	Plunger				
28	Clamping sleeve	1		Replace	
29	Castle nut	1		Tighten to 10 mkp (72 ft/lb)	
30	Washer	1		with bevel toward nut	
31	Expanding screw	1		Tighten to 12 mkp	
32	Spline shaft sleeve	1		with internal teeth to hexagon of expanding screw	
33	Axial needle bearing	1		Needles pointing toward thrust washer in transmission housing	4.1-4/11
34	Seal	X	Note number and thickness	Determine new size, if required	5.2-4/1
35	Shift rod	1		Insert prior to installing intermediate plate	
36	Closing screw	1		Tighten to 3.0 mkp (21.7 ft/lb)	
37	Spring	1			
38	Ball 9 mm dia.	3			
39	Locking piece	1			
40	Spring with pin for gear lock	1			
41	Screw with spring washer	2		Tighten to 2.5 mkp (18.0 ft/lb)	
42	Shift forks	2	Mark for reinstallation	Do not mix up, adjust	4.1-4/13
43	Shift rod 3rd and 4th gear	1		Adjust	4.1-4/13
44	Shift rod 1st and 2nd gear	1			
45	Shift rod for parking lock and rev. gear	1			
46	Bearing inner race	1	Force off with P 353	Check for wear, force on with VW 401, 426, 472/2	4.1-4/9
47	Bearing inner race	1		Check for wear, force on with VW 401, 426, 472/2	4.1-4/9

No.	Designation	Each	Observe during		Refs.
			Removal/Disassembly	Installation/Assembly	
48	Intermediate plate	1	Disassemble and re-assemble, if required		4.1-6/1
49	Driving shaft	1	with P 353 from intermediate plate		4.1-4/8
50	Driven shaft	1	Press out, disassemble and assemble, if required		
51	Transmission housing	1	Disassemble and assemble, if required		4.1-7/1
52	Pin, gear lock	1		in spring	4.1-7/1

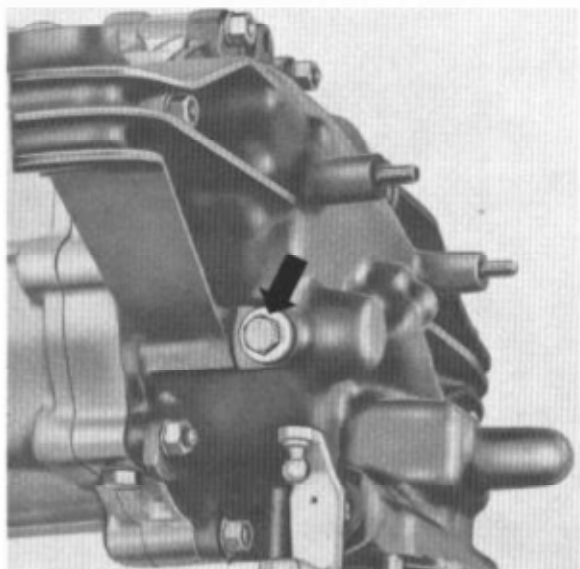
## REMOVAL AND INSTALLATION OF TRANSMISSION

## Removal

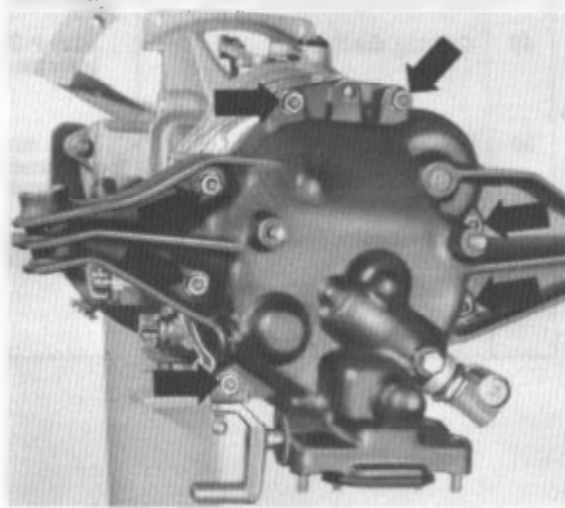
- 1 - Attach transmission in combination with holding plate P 351 to holder P 201 or holder VW 307a (screw transmission down at all four points).



- 2 - Unscrew closing screw for parking lock, remove spring and ball.



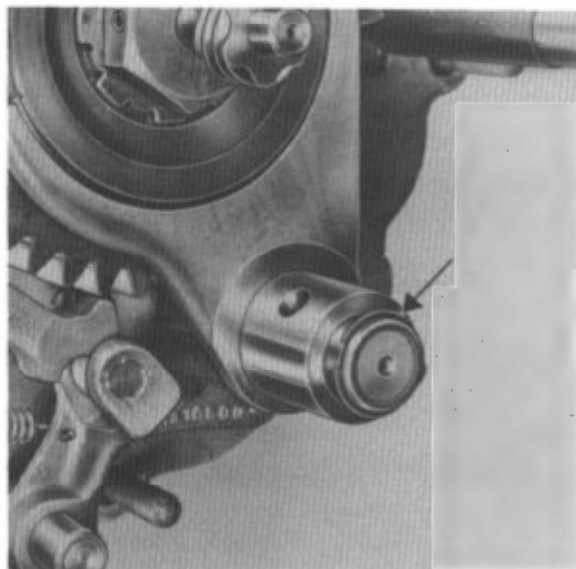
- 3 - Loosen hex. nuts on front gearbox cover.



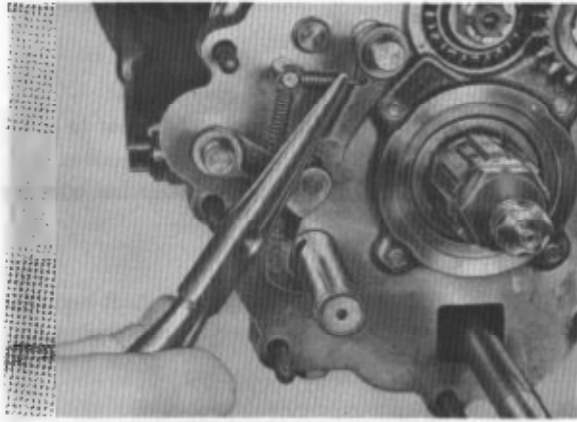
- 4 - Remove gearbox cover.

- 5 - Remove bolt and 7 mm ball for parking lock from shift lever for reverse gear.

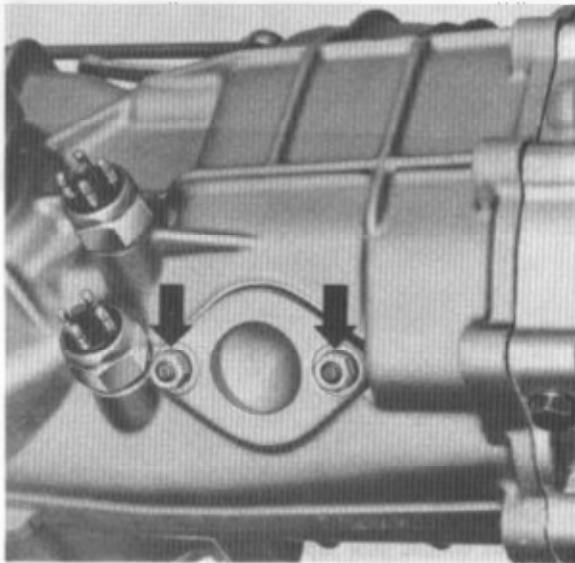
- 6 - Remove circlip from shift rod for reverse gear and parking lock and remove shift fork together with slide wheel.



- 7 - Disconnect draw springs for parking lock and remove pawl as well as lever for parking lock.

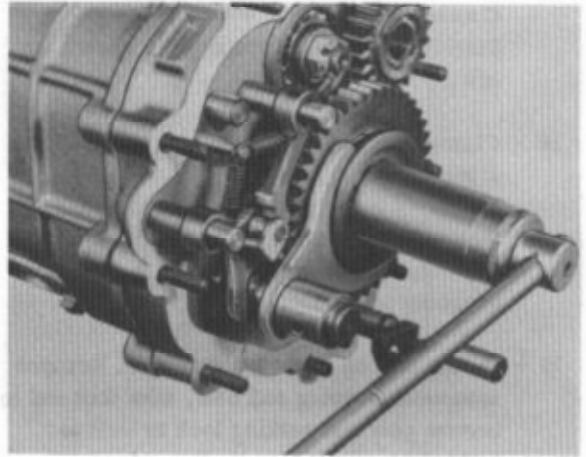


- 8 - Loosen hex. nut on fork piece for internal shift lever. Remove fork piece and pull internal shift lever out of rear guide bore.



- 9 - Engage 4th gear.

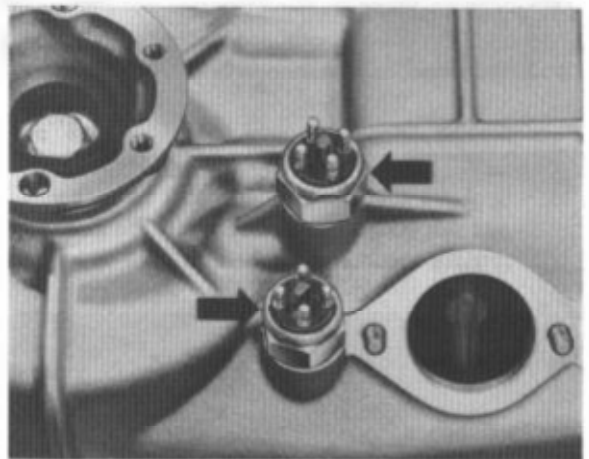
- 10 - Block input shaft with supporting angle piece P 37 and loosen expanding screw on pinion with insert.



- 11 - Pull off spline shaft sleeve.

- 12 - Knock out clamping sleeve of castle nut for input shaft with mandrel. Loosen castle nut and remove washer.

- 13 - Unscrew bridging switch and switch for backup lights and pull out plunger for both switches.



- 14 - Pull shift rod for reverse gear and parking lock up to stop on intermediate plate.

- 15 - Pull gear set with intermediate plate out of transmission housing.

**Caution !**

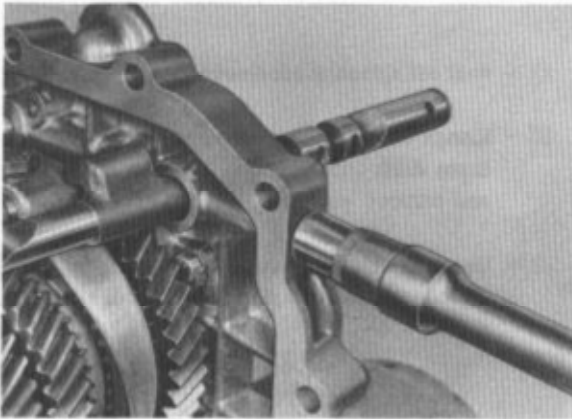
Turn intermediate plate slightly toward the left.

- 16 - Clamp intermediate plate with gear set into vise, using soft jaws.

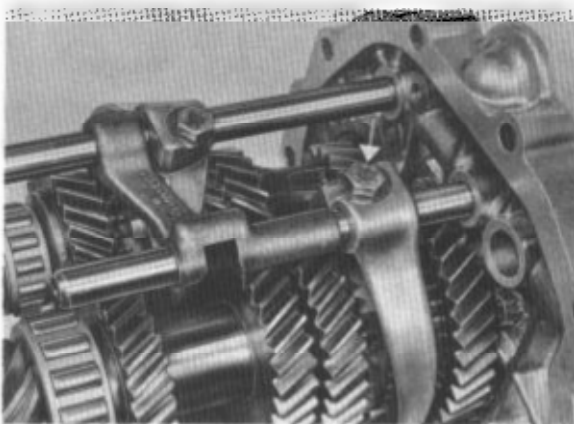
**Note**

Write down number and thickness of adjusting seals.

- 17 - Loosen closing screw for gear lock. Remove compression spring and ball, take shift rod for reverse gear and parking lock as well as parking bit out of intermediate plate.



- 18 - Loosen hex. screw for shift fork from first and second gear, force out shift rod and remove together with shift fork.

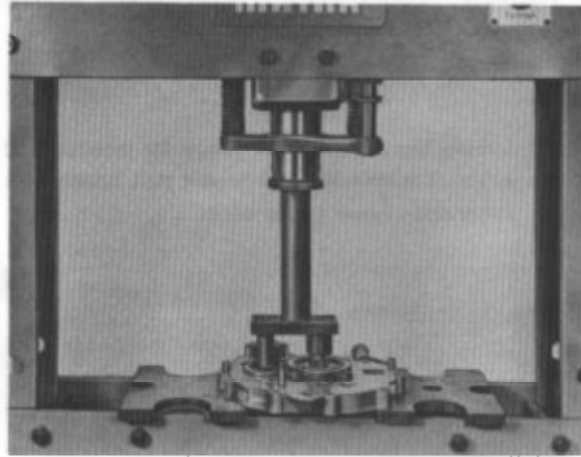


**Caution !**

Balls, pin and compression spring for gear lock will fall out.

- 19 - Mark shift fork for 3rd and 4th gear to prevent confusion during reinstallation. Loosen hex. screw and remove shift rod together with shift fork.

- 20 - Press drive pinion and driving shaft together out of intermediate plate using thrust piece P 353.

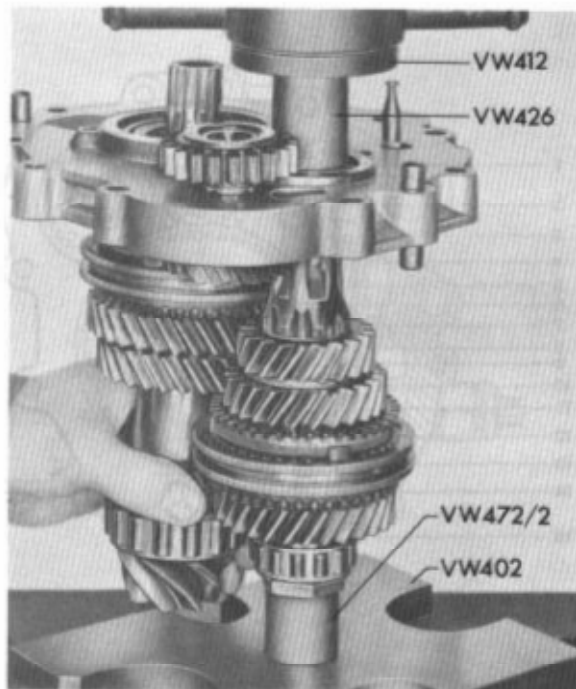


**Caution !**

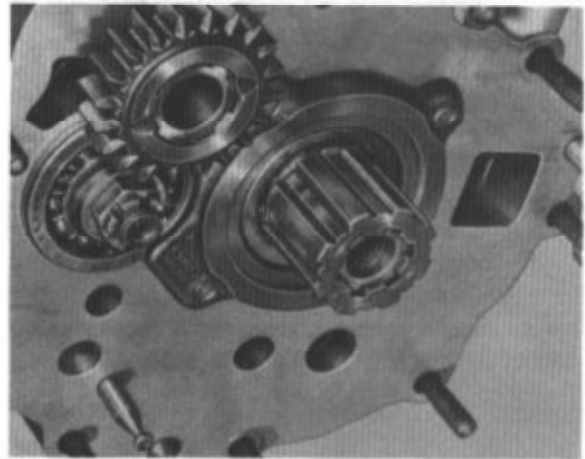
Balls of double-row tapered ball bearing may fall out.

### Installation

- 1 - Place intermediate plate on bearing inner race halves of pinion and driving shaft and fit other halves of bearing inner races. First slide tube VW 472/2 on input shaft and place against pressure plate VW 401. Fit bearing inner race with tube VW 426, while holding pinion in position. Then pull VW 472/2 from input shaft, placing pinion on VW 401 and also fit bearing inner race.



- 5 - Secure castle nut with clamping sleeve.
- 6 - Slide splining sleeve on pinion with internal profile pointing outwards.

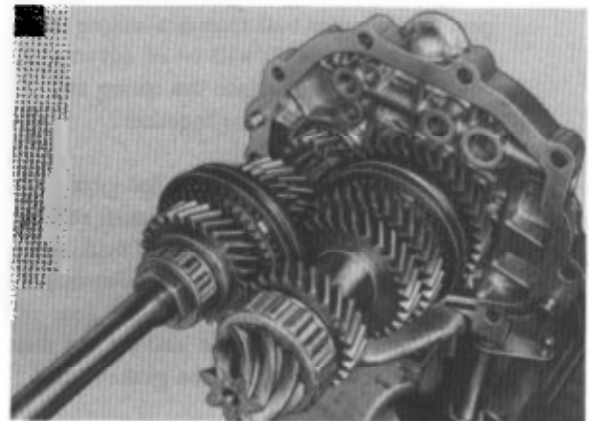


- 7 - Lubricate expanding screw for pinion (with speedometer pinion) on pressure surface and tighten to specified torque with insert.
- 8 - Remove intermediate plate with pinion and input shaft again for adjusting shift forks and clamp into vise (use soft jaws).

### Caution!

Guide input shaft and pinion carefully to prevent any damage to tothing.

- 2 - Engage 4th gear and slide intermediate plate with pinion and input shaft into transmission housing. Attach intermediate plate crosswise to 4 studs of housing with nuts, placing several washers under nuts.
- 3 - Block input shaft with supporting angle piece P 37.
- 4 - Place washer (with chamfer outwards) to input shaft, screw on castle nut and tighten to specified torque.

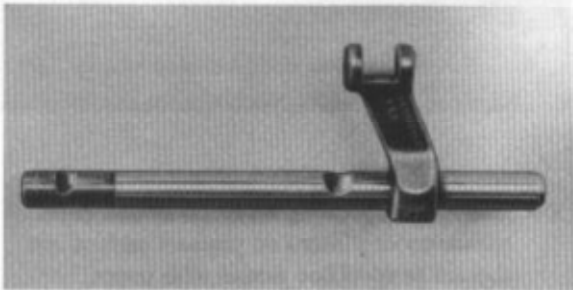




9 - Assemble shift rods and shift forks in the sequence described;

a - Check springs for securing shift rods, replace if required. Relax length of springs for 1st to 4th gear 38.5 mm, minimum length 37.3 mm. Relax length of spring for reverse gear and parking lock 29.3 mm, minimum length 28.2 mm.

b - Place shift rod for 3rd and 4th gear on pertinent shifting sleeve and slide shift rod for 3rd and 4th gear through bore of shift fork into intermediate plate. Tighten hex. screws with spring washer for shift fork slightly. (First attach shift piece with clamping sleeve on shift rod).



c - Insert one ball, pin for shift lock, long compression spring for gear lock 1st to 4th gear and another ball into connecting duct of shift rod bores. It will be of advantage, to insert the pin first into the spring and then assemble both parts together.

d - Replace shift fork for 1st and 2nd gear on pertinent shift sleeve and slide shift rod for 1st and 2nd gear through bore of shift fork into bore of intermediate plate. For this purpose the shift rod of 3rd and 4th gear should be at idling and the ball for the shift rod 1st and 2nd gear must be pushed into the duct.

Tighten hex. screw with spring washer for shift fork slightly. Adjustment of shift forks refer to page ...

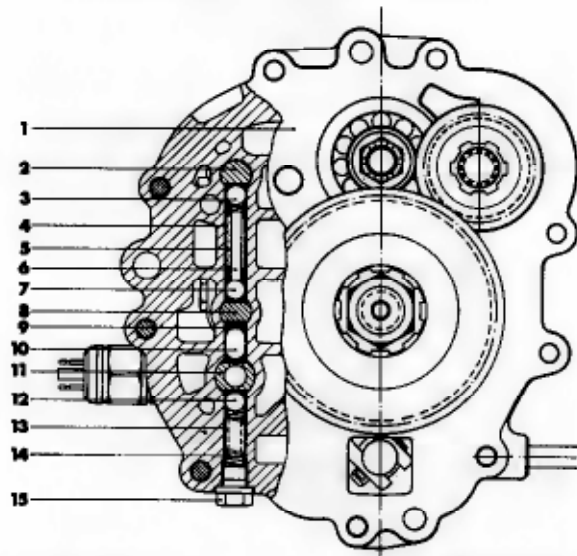
#### Note

If a new intermediate plate is installed, refer to page 4.1-6/1 Disassembly and Assembly of Intermediate Plate.

10 - Insert locking piece for gear lock (set shift rod 1st and 2nd gear to idling).

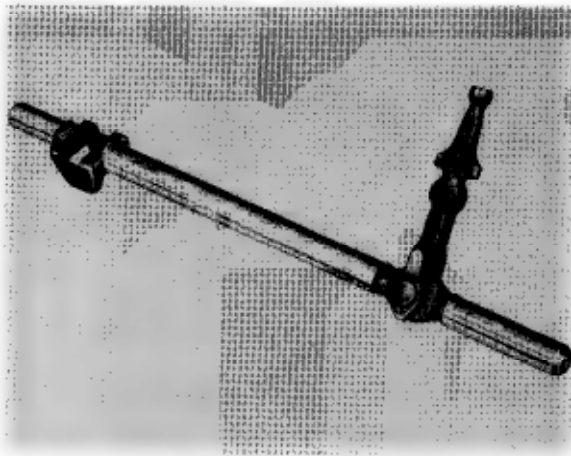
11 - Insert shift rod for reverse gear and parking lock.

12 - Insert ball and spring for gear lock (reverse gear and parking lock) screw down closing screw and tighten.



- 1 Intermediate plate
- 2 Shift rod for 3rd and 4th gear
- 3 Ball
- 4 Bushing for gear lock
- 5 Spring for gear lock 1st to 4th gear
- 6 Pin for gear lock
- 7 Ball
- 8 Shift rod for 1st and 2nd gear
- 9 Bushing for gear lock
- 10 Locking piece for gear lock
- 11 Shift rod for reverse gear and parking lock
- 12 Ball
- 13 Bushing for gear lock
- 14 Spring for gear lock (reverse gear and parking lock)
- 15 Closing screw

- 13 - Assemble internal shift lever. Watch out for correct position of lever.

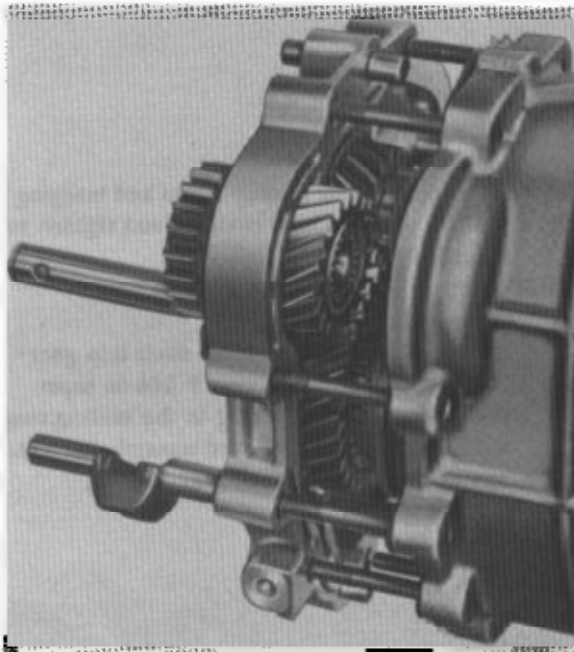


- 14 - Slide internal shift lever through cutout in intermediate plate.

**Note:**

When unfavorable tolerances add up, the assembled internal shift lever may not pass through the cutout in the intermediate plate. In such cases, the cutout must be pertinently enlarged with a file.

- 15 - Coat axial needle bearings with some grease and insert with needles pointing toward thrust washer in transmission.



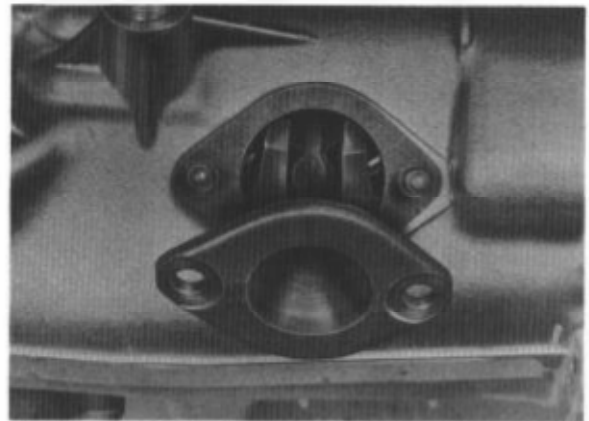
- 16 - Slide number of seals written down during removal or number of seals computed when adjusting the driving assembly in proper size on studs of gearbox housing.

- 17 - Insert intermediate plate with input shaft and pinion into housing.

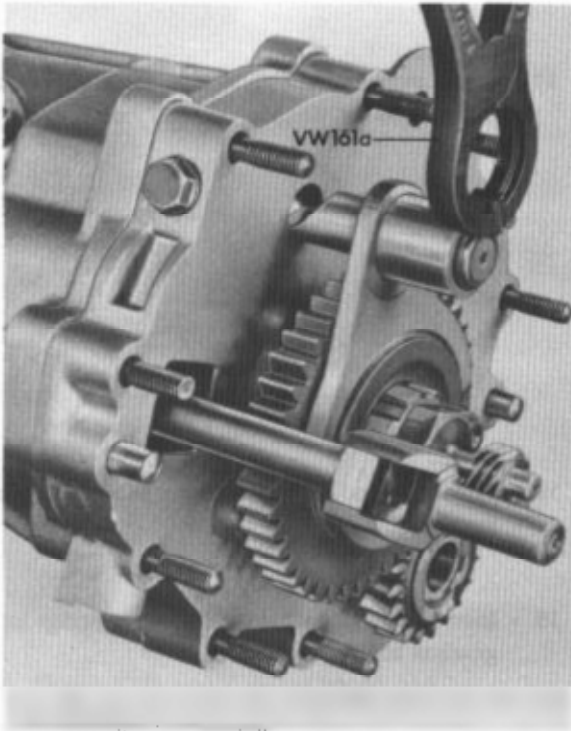
- 18 - Slide shift rod for reverse gear and parking lock into housing.

- 19 - Insert internal shift lever into its bearings in gearbox housing.

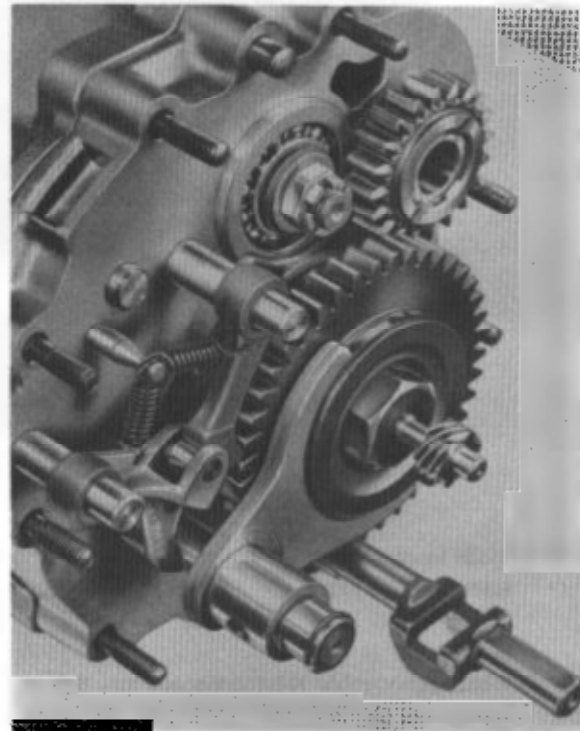
- 20 - Mount fork piece with a new seal, making sure that the internal shift lever is guided in the fork piece. Insert only when no gear is engaged. Tighten both hex. nuts, to specified torque.



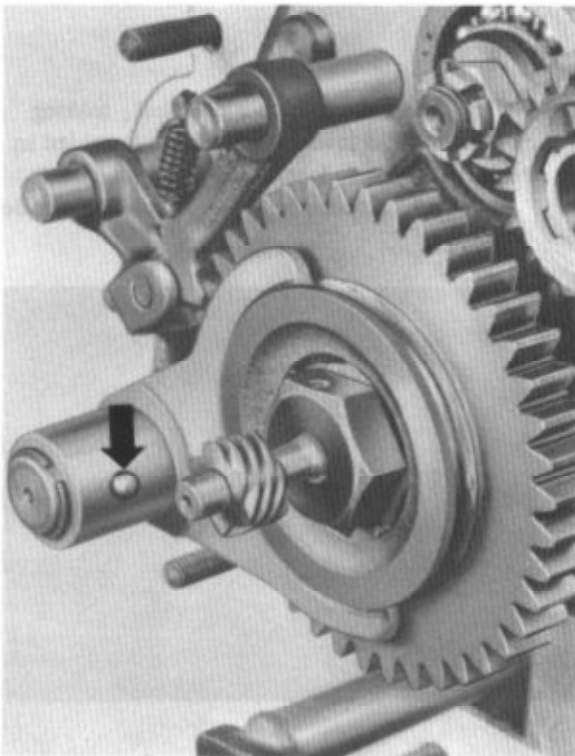
- 21 - Slide shift fork and slide gear for reverse gear on shift rod or splining shaft sleeve and position locking ring with VW 161a.



- 23 - Place pawl and lever for park lock on intermediate plate and connect both draw springs.



- 22 - Coat bolts and 7 mm ball for parking lock with some grease and insert into bore of shift fork and shift rod.



- 24 - Place needle bearing and spacer bushing on shaft for reversing gear.

- 25 - Mount gearbox cover and tighten nuts to specified torque.

**Caution!**

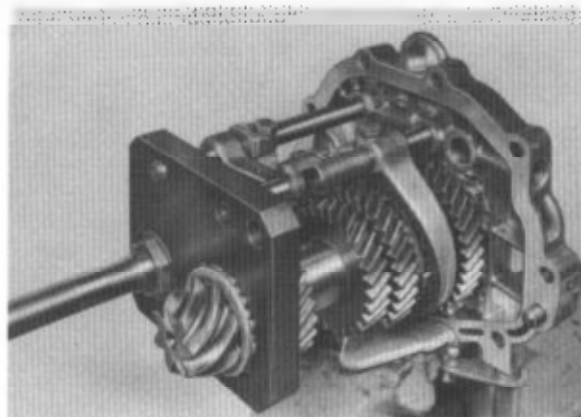
Do not forget new seal.

- 26 - Insert plunger for backup lights and bridging switch, screw in both switches and tighten to specified torque.

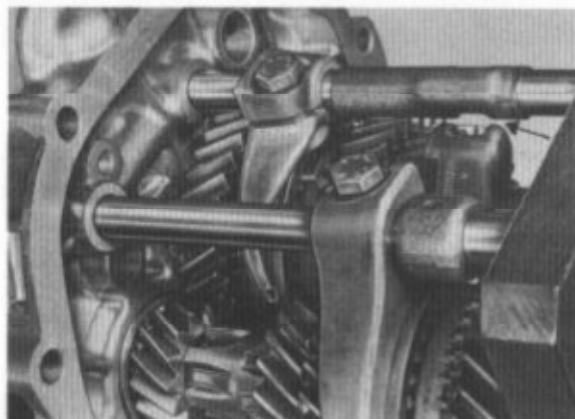
- 27 - Install sealing ring for input shaft into gearbox housing, sliding sleeve P 364 on input shaft first and then forcing in the sealing ring with its lip pointing toward transmission well against tool, using thrust piece P 360.

### Adjusting the Shift Fork

- 1 - Slide holding plate P 260 on shift rods and adjust shift forks for 1st and 2nd, as well as 3rd and 4th gear.



- 2 - Tighten hex. screws of shift forks to specified torques, making sure that the shifting piece of 3rd and 4th gear has a play of approx. 2 mm in lateral relation to shift rod of 1st and 2nd gear.

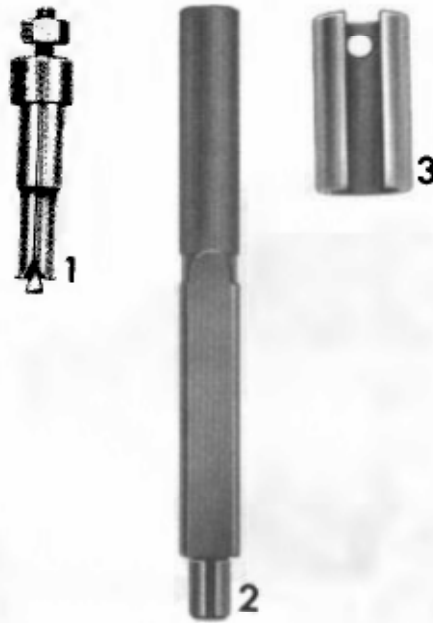


#### Caution!

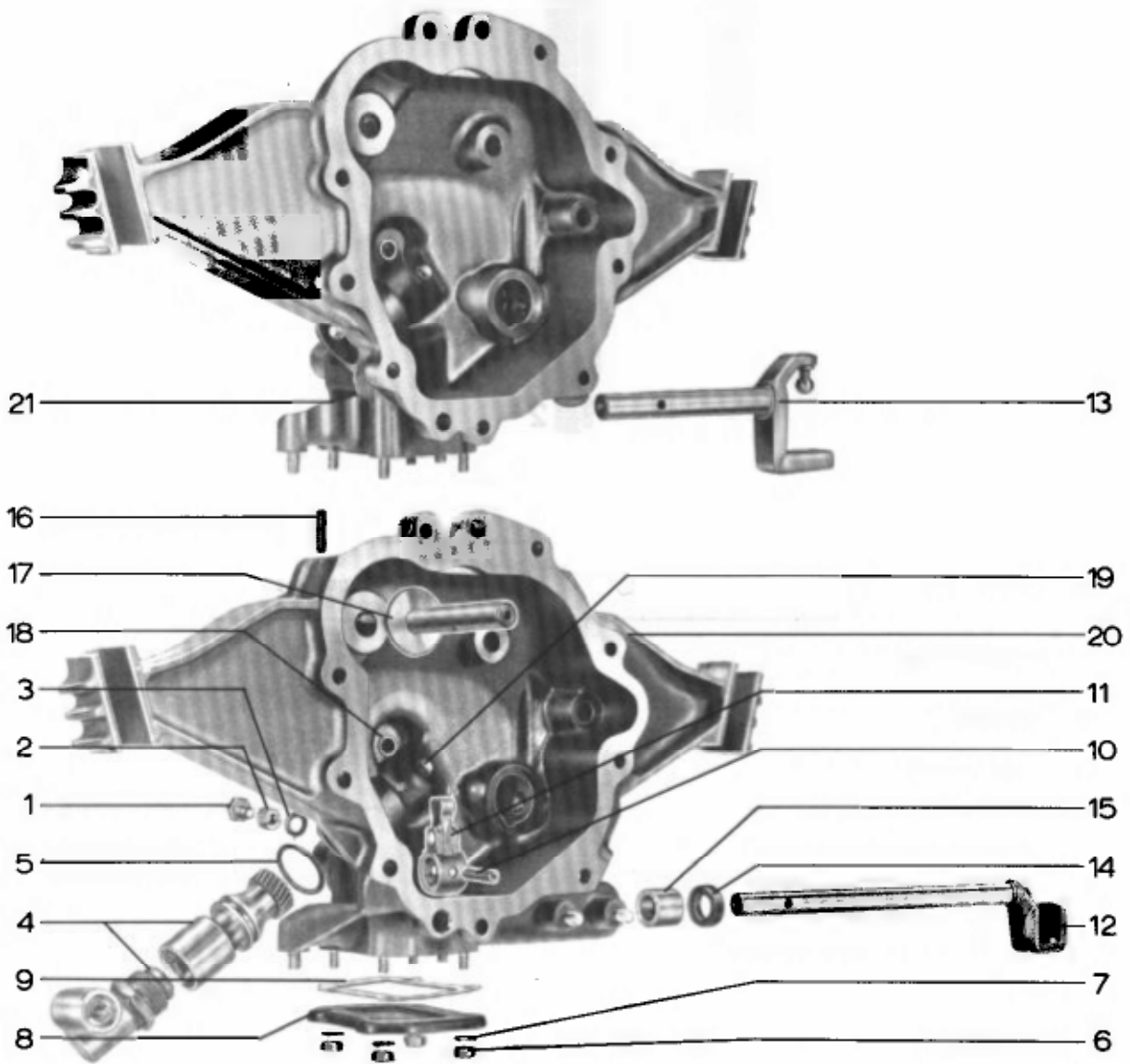
Adjust shifting sleeve via shifting fork in such a manner that it will be accurately in the center between the synchronizing rings in idling position. Compensations for any deviations must be made very accurately to guarantee perfect function of synchronization.

- 3 - Remove holding plate and pull shift rod for reverse gear and parking lock as far as possible in outward direction toward intermediate plate.

## TOOLS



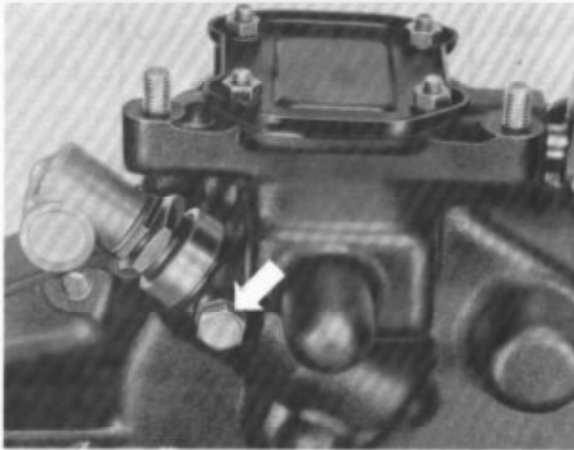
No.	Designation	Special Tools	Explanations
1	Internal puller	No. 21/2	14.5 - 18.5 mm Kukko
2	Mandrel	VW 207	-
3	Tube (slotted)	VW 422	-



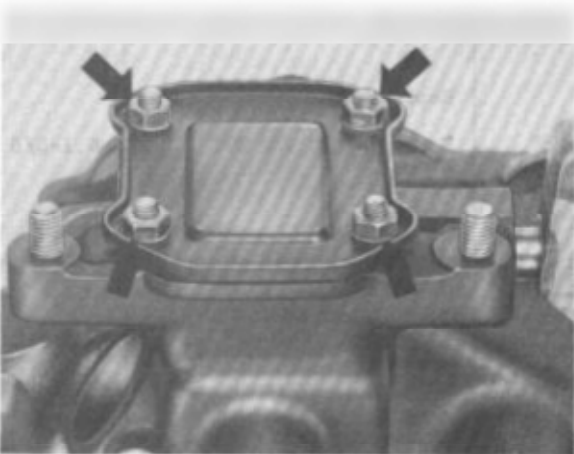
No.	Designation	Each	Observe during		Refs.
			Removal/Disassembly	Installation/Assembly	
1	Screw	1		Tighten to 1.5 mkp (10.8 ft/lb)	
2	Helicoil	1			
3	Spring plate	1			
4	Speedometer driver	1		Check pinion for fit	
5	O-ring	1		Replace	
6	Nuts	4			
7	Spring Ring	4			
8	Cover	1			
9	Seal	1		Replace	
10	Clamping sleeve	1		Replace	
11	Shift finger	1		Note position shifting finger/ shifting shaft	4.1-5/5
12	Shifting shaft 914	1			
13	Shifting shaft 914/6	1			
14	Sealing ring	1		Replace	
15	Bushing	1	Pull with VW 422 and Kukko puller	Force in with VW 207	4.1-5/5
16	Clamping sleeve	1		Replace	
17	Shaft for reversing gear w. thrust washer	1	Force out with mandrel	After knocking in clamping sleeve slide thrust washer up to transmission	
18	Bushing for speedo- meter drive pinion	1		Replace	
19	Thrust piece	1		Check for wear	
20	Gearbox cover 914	1			
21	Gearbox cover 914/6	1			

## Disassembly

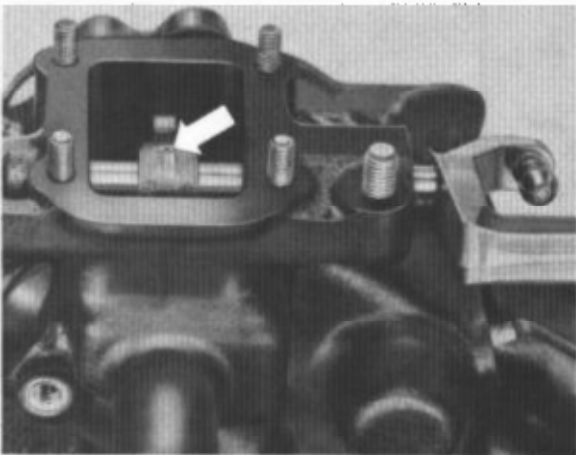
1 - Loosen hex. screw for speedometer drive and pull out angle drive.



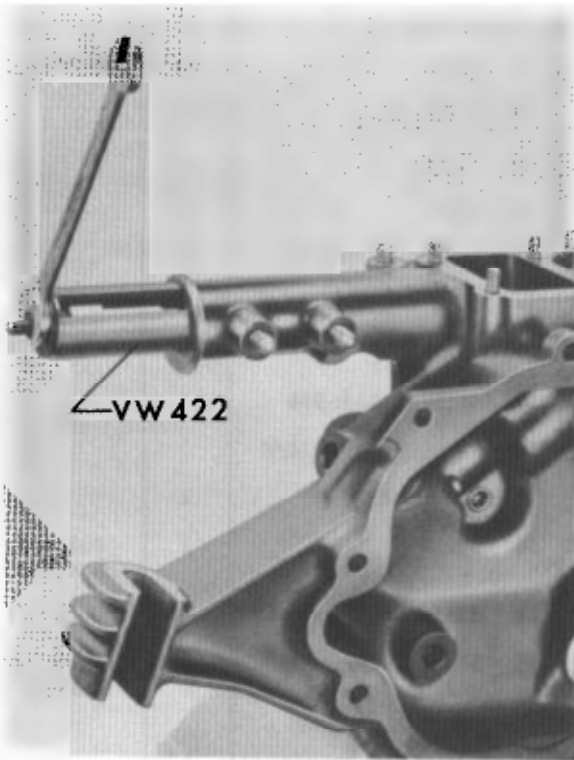
2 - Unscrew cover for shift actuation.



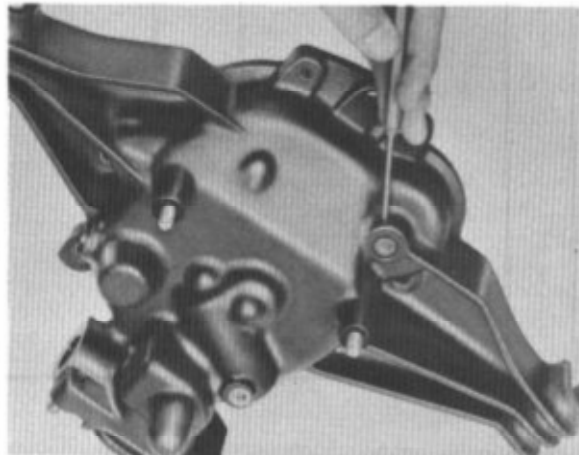
3 - Knock clamping sleeve out of shifting shaft.



4 - Pull out shifting shaft, removing shifting fingers from shaft.



6 - Knock out clamping sleeve for shaft of reversing gear.

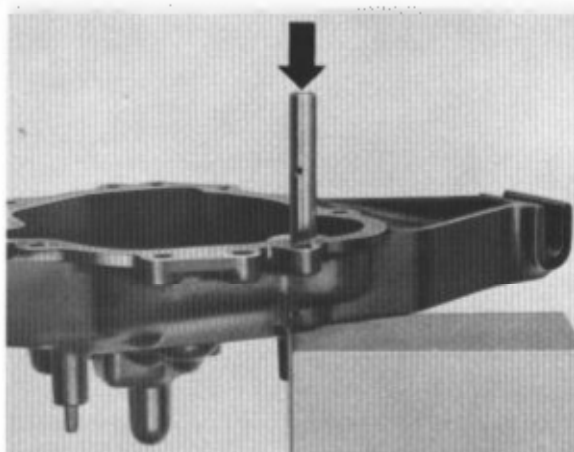




- 7 - Heat gearbox cover to approx. 120°C (348°F) and force out shaft in inward direction. Then remove thrustpiece and bearing bushing for speedometer drive.
- 8 - Press thrust washer (bronze washer) from shaft for reversing gear.
- 9 - Check parts for wear and damage and replace, if required.

#### Assembly

- 1 - Heat gearbox cover to approx. 120°C (348°F) and force in shaft for reversing gear.

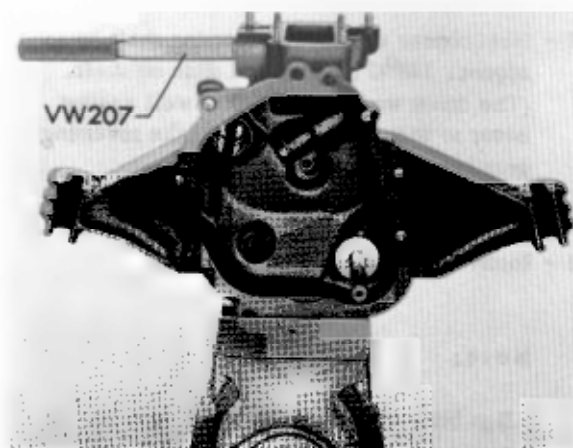


#### Caution!

Be sure that the bore in the housing and in the shaft are in alignment, so that the clamping sleeve can be forced in later.

- 2 - Insert bushing for pinion and thrust piece for speedometer drive.

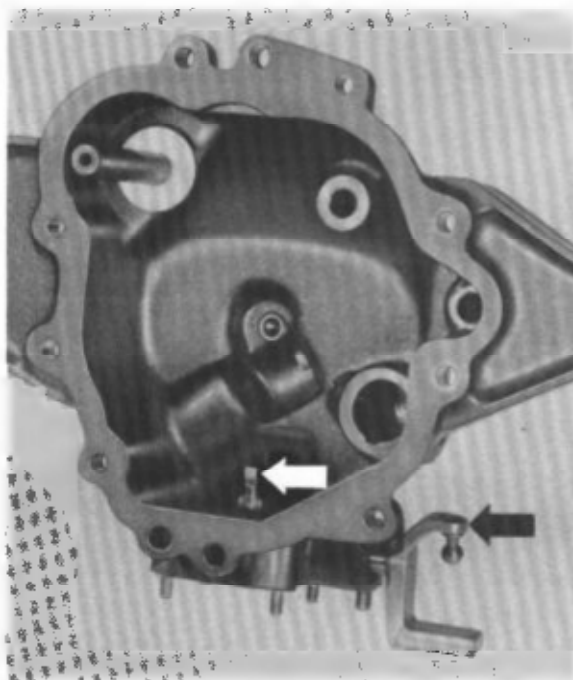
- 3 - Force in bushing for shifting shaft with mandrel VW 207 and insert sealing ring.



- 4 - Insert shifting shaft while simultaneously sliding shifting fingers on shaft.

#### Note:

The ball head of the shifting shaft and the shifting fingers is pointing upwards.



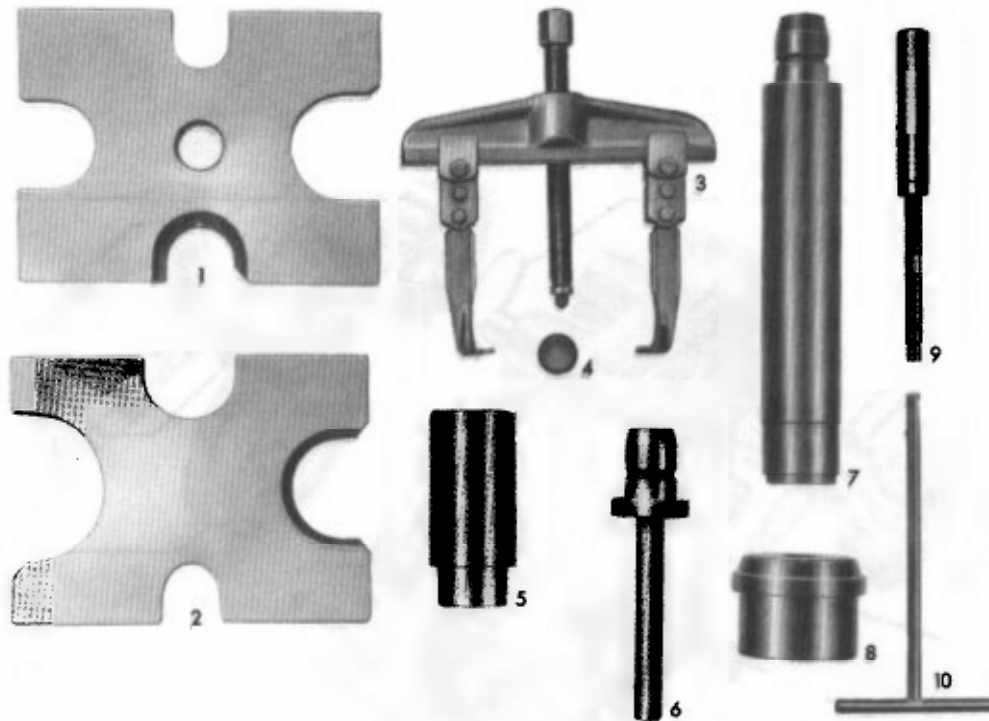
- 5 - Turn shaft slightly and force in clamping sleeve.

- 6 - Insert clamping sleeve for shaft of reversing wheel.
  
- 7 - Heat bronze washer for reversing shaft to approx. 120°C (348°F) and slide on shaft. (The thrust washer should seat well against cover so that the axial play of the reversing gear is not reduced.)
  
- 8 - Insert angle drive for speedometer.

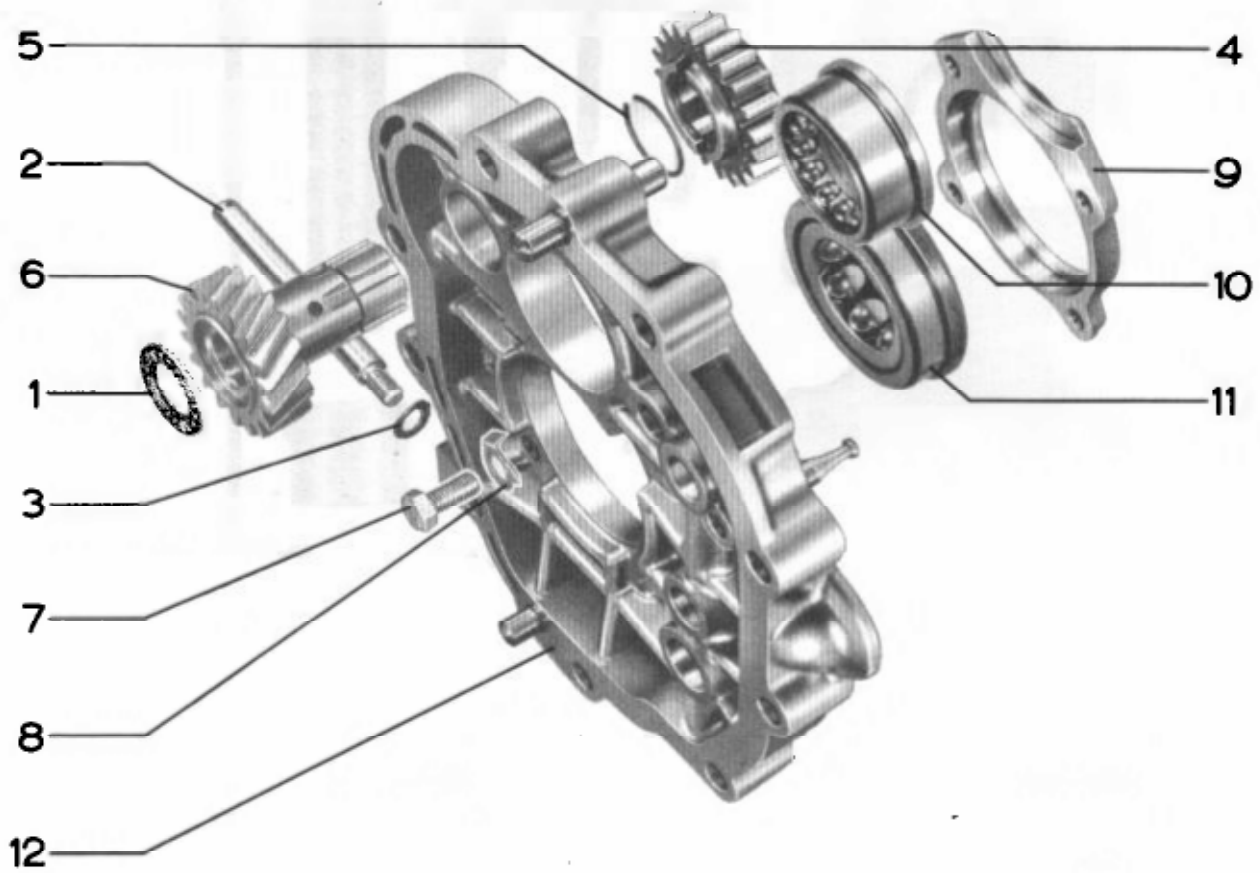
Note:

Align blind hole in guide piece with bore in housing. Screw in hex. screw with spring washer and tighten to specified torque.

## TOOLS



No.	Designation	Special Tools	Explanations
1	Pressure plate	VW 401	-
2	Pressure plate	VW 402	-
3	Puller Kukko		Commercial, 100 mm clamping width
4	Thrust piece	P 854	-
5	Thrust piece	VW 432	-
6	Thrust pin	VW 411	-
7	Thrust pin	VW 407	-
8	Thrust piece	VW 472/1	-
9	Mandrel	P 292	-
10	Pulling hook	P 86 a	-

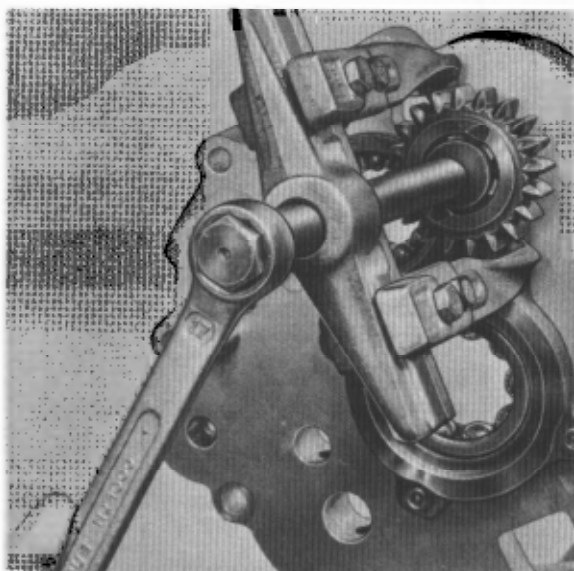


No.	Designation	Each	Observe during		Refs.
			Removal/Disassembly	Installation/Assembly	
1	Axial needle bearing	1		Needles toward thrust washer in transmission housing	4.1-4/11
2	Shaft for accelerator lever 914/6	1			
3	Spring washer B 8	1			
4	Gear wheel/rev. gear	1	Pull with Kukko puller and P 354	Check for wear	4.1-6/4
5	Locking ring	1	will be destroyed during disassembly	Compress with pliers	4.1-6/6
6	Gear wheel/rev. gear	1		Check for wear	
7	Screw M 8	4		Tighten to 2.5 mkp (18.0 ft/lb)	
8	Lock washer	4		Replace, watch out for correct position	
9	Clamping plate	1			
10	Double tapered ball bearing	1	Press out with VW 401, 402, 432	Check for wear, press in with VW 402, 411, 432	4.1-6/5
11	Four-point bearing	1	Press out with VW 402, 407, 472/1	Check for wear, press in with VW 402, 407, 472/1	4.1-6/5
12	Intermediate plate	1			

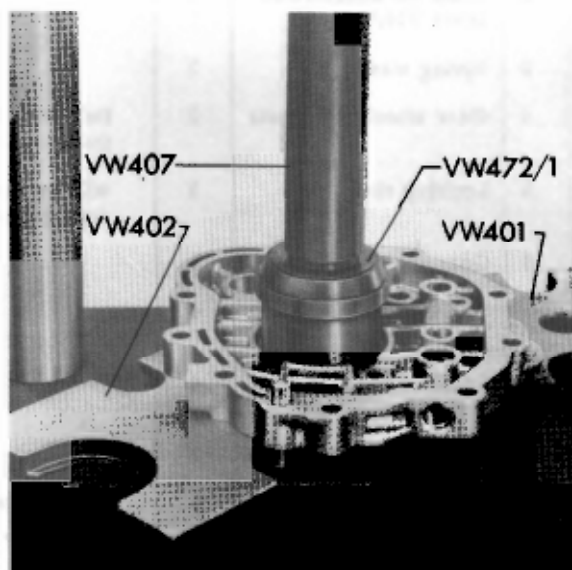
## DISASSEMBLY AND ASSEMBLY OF INTERMEDIATE PLATE

## Disassembly

- 1 - Pull wheel 3 for reverse gear with a puller and thrust piece P 354.



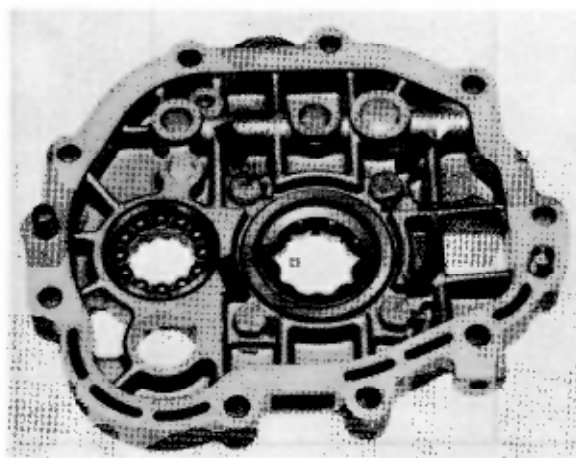
- 4 - Heat intermediate plate to approx. 120°C and press out four-point ball bearing with pressure plate VW 402 and pressure pin 407 and pressure piece 472/1.



## Caution!

This will destroy the circlip.

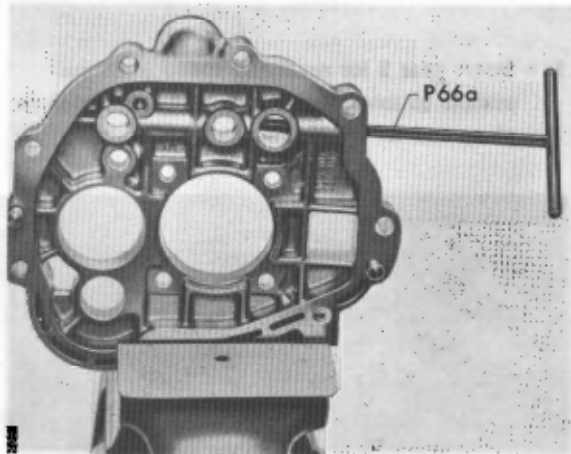
- 2 - Carefully remove all parts of destroyed circlip so that no remnants will enter transmission.
- 3 - Unbend lock washers of fastening screws for clamping plate, loosen screws and remove clamping plate.



- 5 - Then pressout double tapered ball bearing with pressure plate VW 401 and 402, pressure pin 411 and pressure piece 432.

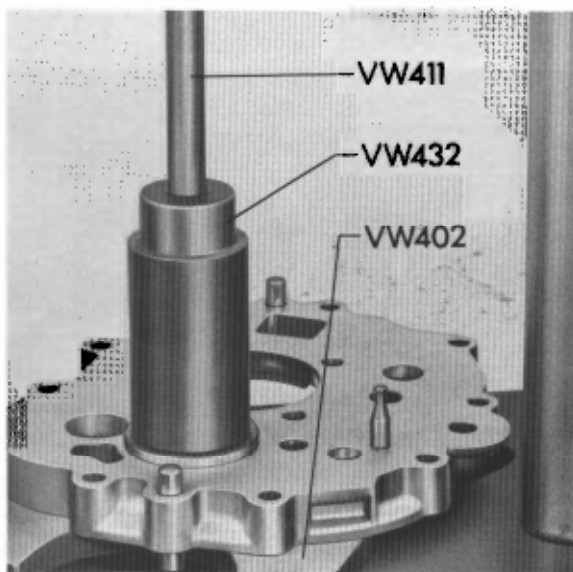


- 6 - Knock fitted pins out of intermediate plate.
- 7 - Pull out bushings securing gear locks by means of pulling hook P 66 a one after the other.

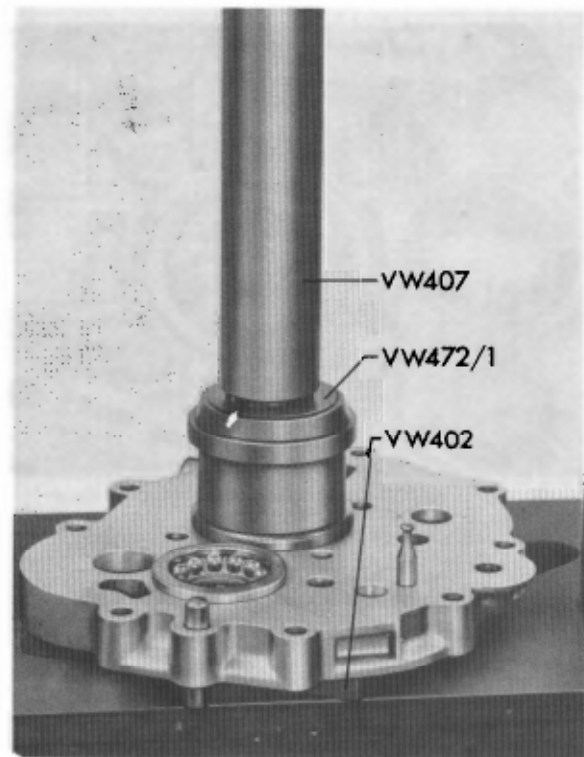


#### Assembly

- 1 - Check parts for wear or damage and replace, if required.
- 2 - Heat intermediate plate to approx. 120°C and press in double tapered ball bearing with pressure plate VW 402, pressure pin 411 and pressure piece 432. (Illustration points toward face end of intermediate plate.)



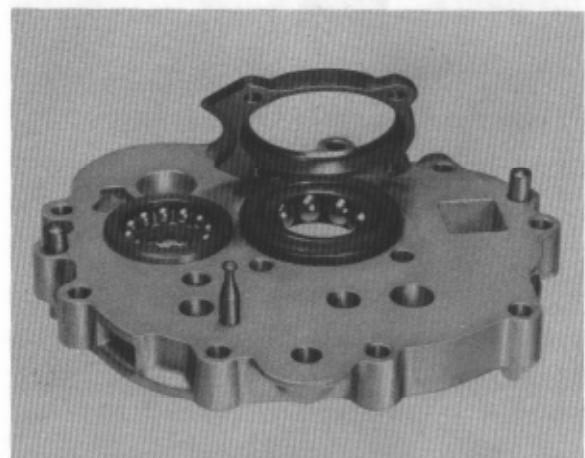
- 3 - Press in four-point ball bearing with pressure plate VW 402, pressure pin 407 and pressure piece 472/1, from same side.



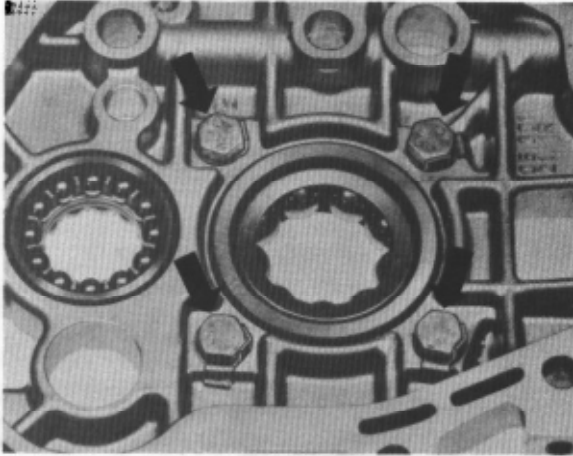
#### Caution!

Insert any loose balls of double-row tapered ball bearing with grease.

- 4 - Position clamping plate.

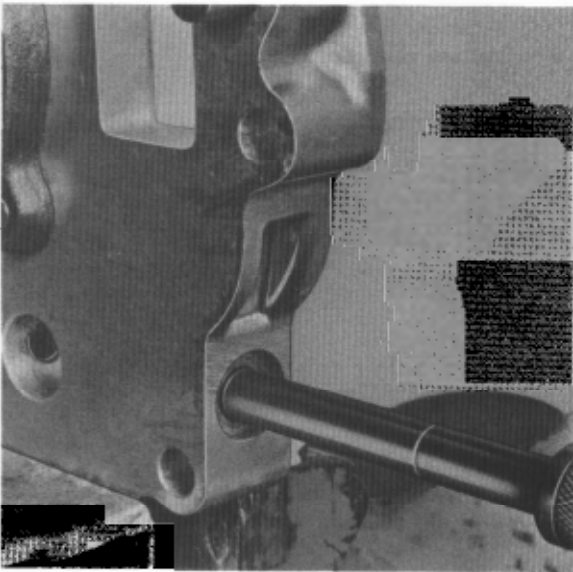


- 5 - Mount fastening screws with new lock washers and tighten screws to specified torque. Bend lock washers (watching correct position of lock washers).



- 6 - Force in bushings securing gear lock with mandrel P 262 one after the other.

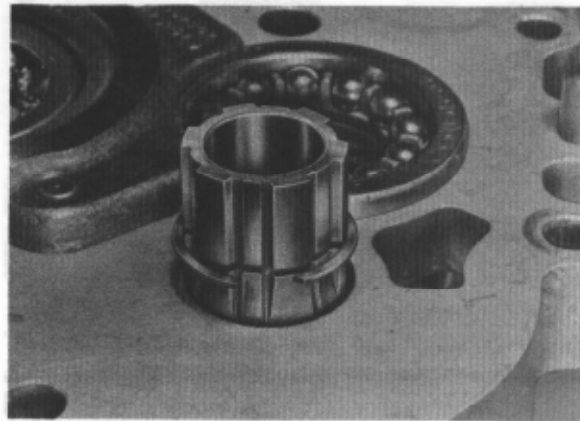
- a - Force in long bushing against stop of mandrel.
- b - Force in short bushing until the guide bores of the shift rods are exposed.
- c - Force in medium-long bushing up to first mark of mandrel.



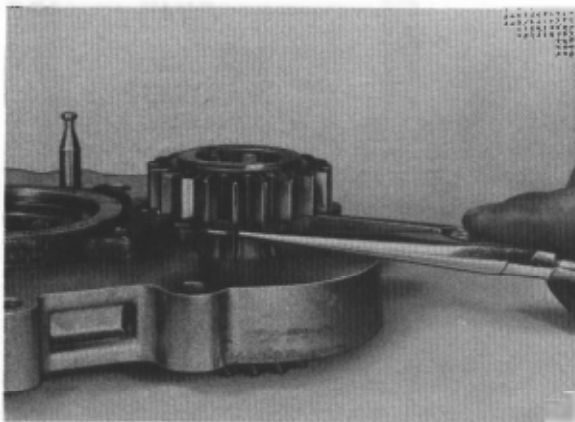
#### Caution!

Watch out that none of the bushings extend into the guide holes of the shift rods.

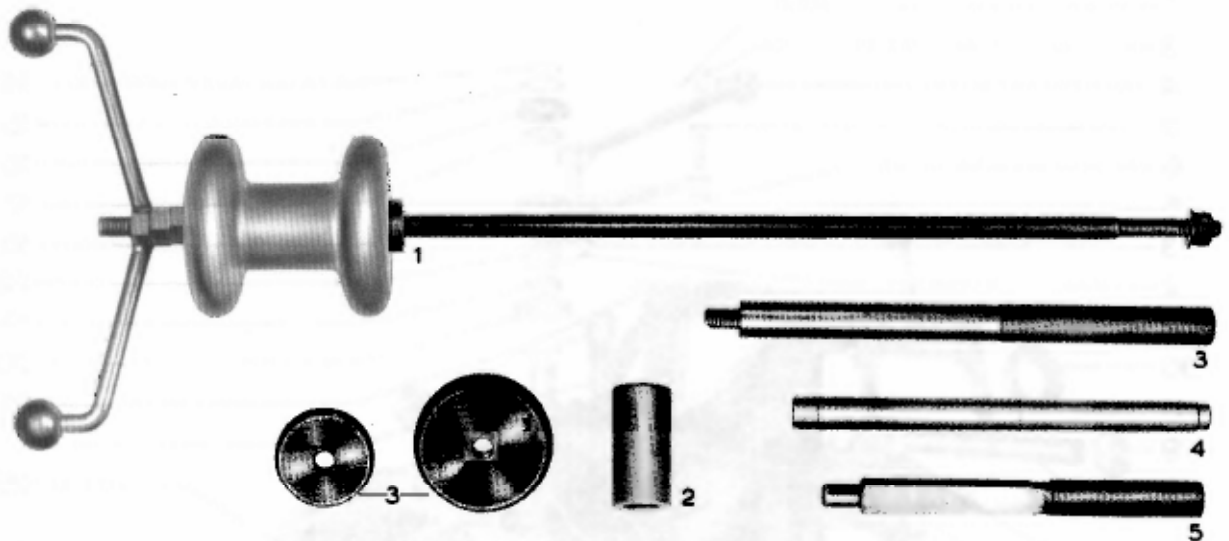
- 7 - Insert gear 2 for reversing speed from the outside in inward direction into intermediate plate and fit circlip into groove of gear.



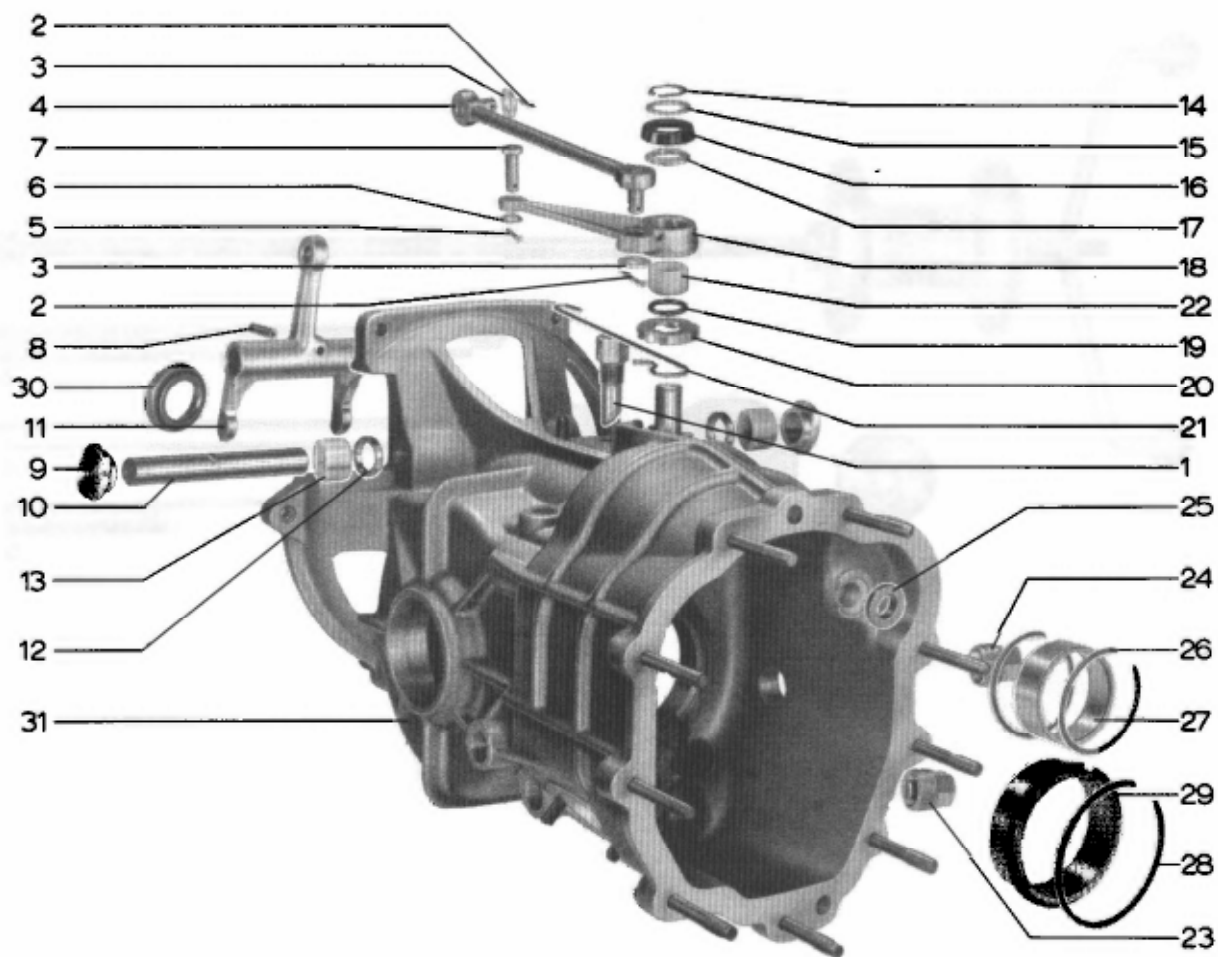
- 8 - Slide gear 3 on teeth of gear 2 and compress circlip with pliers until gear 3 engages the circlip while applying light blows with a plastic hammer.







No.	Designation	Special Tools	Explanations
1	Multi-purpose tool	VW 771	(Local manufacturer)
2	Tube	VW 418a	-
3	Mandrel w. thrust pieces	P 254	3 Parts
4	Guide piece (offset)	VW 439	-
5	Mandrel	VW 207	-



No.	Designation	Each	Observe during		Refs.
			Removal/Disassembly	Installation/Assembly	
1	Breather	1	Unscrew prior to removing differential	Observe install. pos.	5.2-1/5
2	Cotter pin	2			
3	Washer B 6	2			
4	Push rod	1			
5	Cotter pin	1			
6	Washer B 5	1			
7	Bolt	1			
8	Clamping sleeve	1	Kock out	Replace	
9	Closing cap	2			
10	Clutch shaft	1		Grease with lithium grease and MOS 2 additive	
11	Throwout lever	1			
12	Spacer ring	2			
13	Bushing	2	Force out with VW 207	Force in with VW 207	
14	Locking ring	1		Replace	
15	Washer	1			
16	Sleeve	1			
17	Spacer sleeve	1			
18	Intermediate lever	1		Check bushing for wear and renew, if required. Grease shaft with lithium grease and MOS 2 additive	
19	O-ring	1		Replace	
20	Washer	1			
21	Torsion spring	1			
22	Bushing f. interm. lever	1	Force out of intermediate lever with VW 439	Replace, if required, force in with VW 439	4.1-7/10
23	Closing screw with magnet	1		Tighten to 2.5 mkp (18.0 ft/lb)	
24	Closing screw	1		Tighten to 2.5 mkp (18.0 ft/lb)	
25	Thrust ring	1	Force out w. mandrel	Check surface	

No.	Designation	Each	Observe during		Refs.
			Removal/Disassembly	Installation/Assembly	
26	Circlip	2	Remove w. small screw driver		4.1-7/8
27	Bearing outer race	1	Pull out with P 254 and VW 771	Check for wear	4.1-7/9
28	Circlip	1	Remove w. small screw driver		
29	Bearing outer race	1	Pull out w. P 254 and VW 771	Check for wear Force in with P 254	4.1-7/9
30	Sealing ring	1	Force out with VW 418 a in inward direction	Force in with P 360 and P 364	
31	Housing	1			

## DISASSEMBLY AND ASSEMBLY OF TRANSMISSION HOUSING

## Disassembly

1 - Remove torque converter and converter housing.

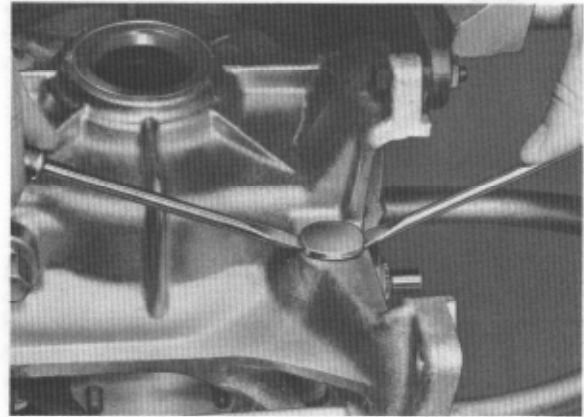
2 - Remove transmission cover, gearbox assembly and differential.

3 - Remove cotter pin on bolt for pull rod, pull out bolt and pull fork head from intermediate lever.

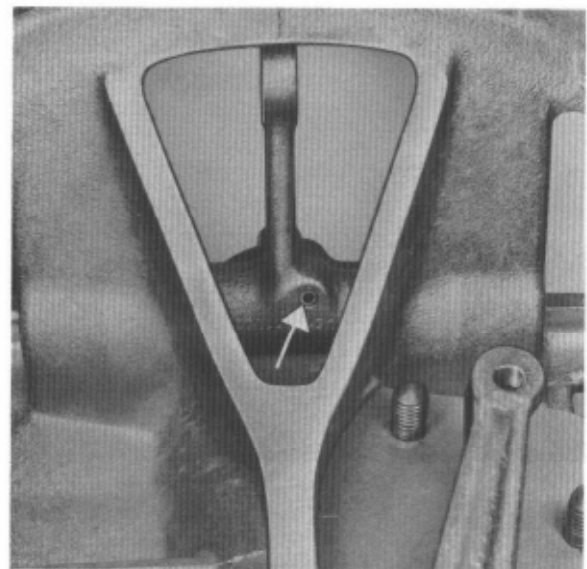
4 - Remove cotter pin for push rod on intermediate lever and disconnect pull rod.

5 - Disconnect push rod on throwout lever.

6 - Remove both covers above shaft of throwout lever.



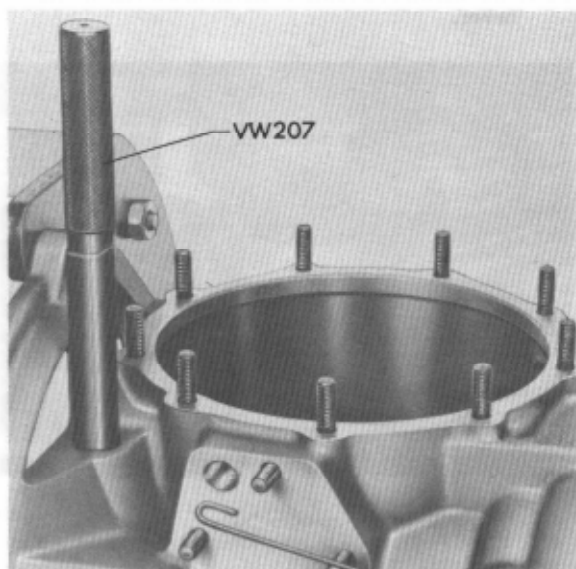
7 - Knock clamping sleeve out of throwout lever and force shaft out toward one side.



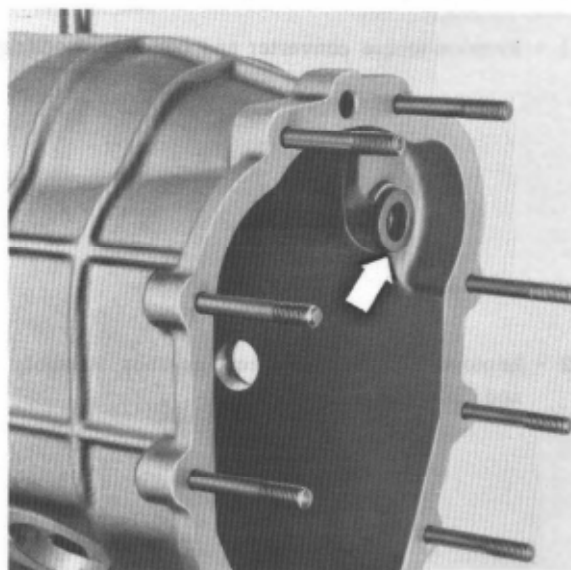
Caution!

Spacers may drop out.

- 8 - Force out both bushings one after the other using mandrel VW 207.



- 12 - Carefully force out thrust washer for needle bearing by means of mandrel.

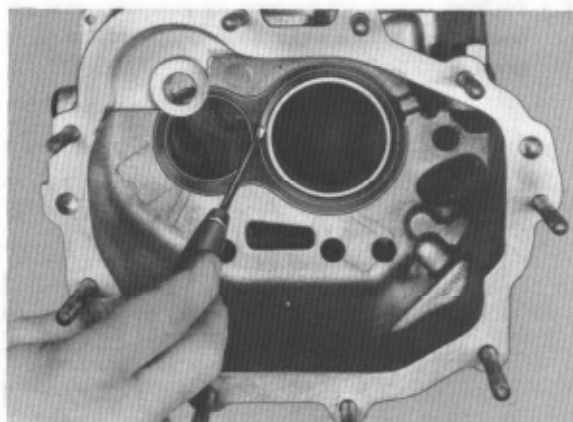


- 9 - Remove intermediate lever.

- 10 - Force bushing out of intermediate lever with offset guide piece VW 439.



- 13 - Remove both circlips of input shaft bearing in housing web and front circlip of pinion bearing with small screw driver.



#### Note

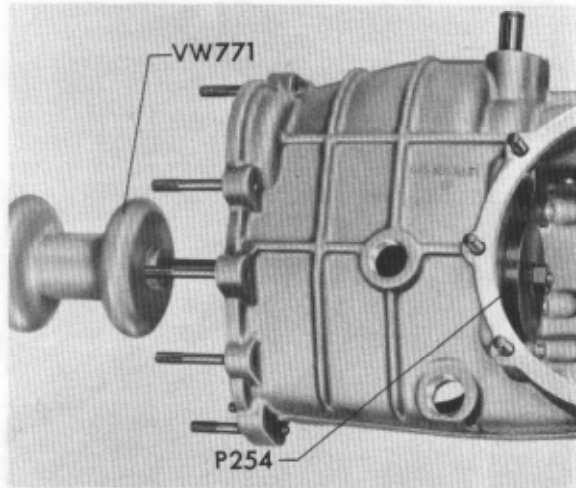
The shaft for the intermediate lever can be removed by heating the gearbox housing to 120°C and then pulling out shaft. Similar to pulling clamping sleeve.

#### Note

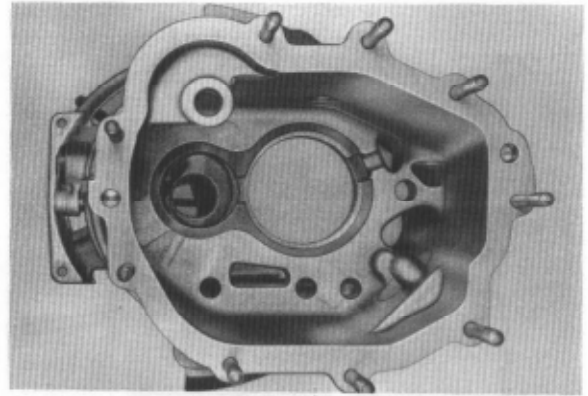
The circlip behind the bearing ring for the driving shaft is pressed by the bearing ring against the housing. It will therefore be of advantage to loosen the bearing ring first slightly from circlip by means of a punch.

- 11 - Unscrew oil filler plug and oil drain plug.

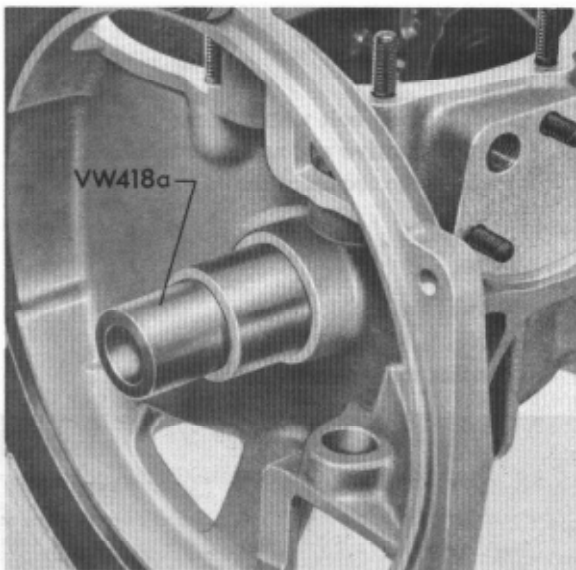
- 14 - Heat gearbox housing to approx. 120°C and pull both bearing outer races one after the other by means of thrust pieces off tool P 254 in combination with multi-purpose tool VW 771.



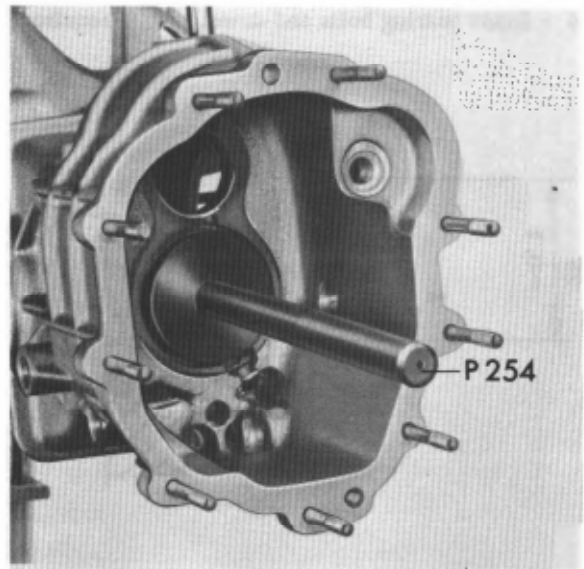
- 2 - Insert rear circlip for bearing outer race of input shaft bearing into groove.



- 15 - Force sealing ring for input shaft out in inward direction with VW 418 a.



- 3 - Heat gearbox housing to approx. 120°C and force bearing outer race for input shaft into bearing bore by means of thrust piece P 254 and secure with front circlip.

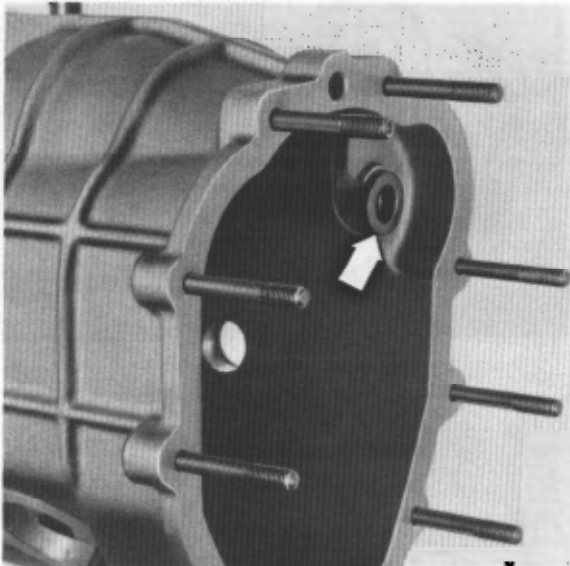


#### Assembly

- 1 - Clean gearbox housing and check for wear, external damage and cracks. If the pinion or ring gear are damaged (for example fracture) check whether the bearing holes in the central housing web are also involved. If required, replace gearbox housing.

- 4 - Force bearing outer race for pinion with assembled circlip into bearing bore by means of thrust piece P 254 and fit front circlip.

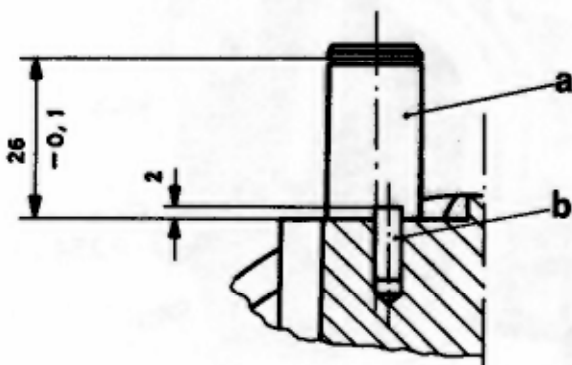
5 - Insert thrust washer for axial needle bearing of reversing gear.



7 - Force in bearing bushing in intermediate lever for clutch actuation with offset guide piece VW 439 to the extent that bushing is flush on top.



6 - Insert bearing bolts and dowel pin, if required.



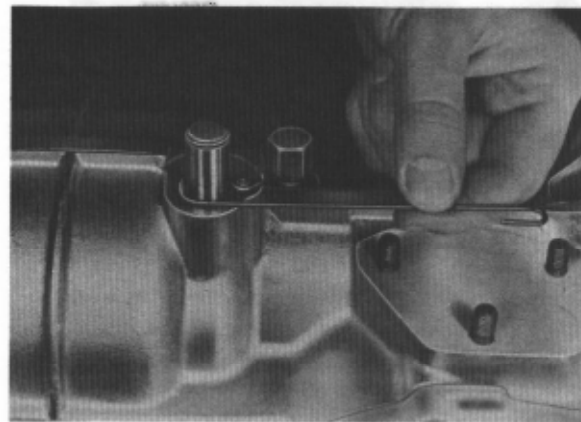
Installation dimensions in mm

a Bearing bolt  
b Spiral pin

8 - Coat bearing bolt with lithium grease and MOS 2 additive and assemble intermediate lever in the sequence shown.

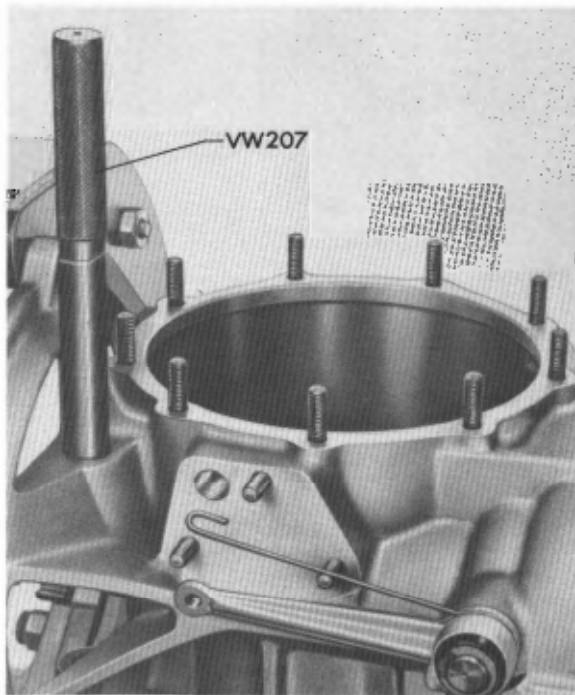
Caution!

Position torsion spring correctly.





- 9 - Insert push rod on throwout lever and secure with new cotterpin.
- 10 - Force bushings for shaft of throwout lever with mandrel VW 207 one after the other into the housing to the extent that the cover can later still be fitted.

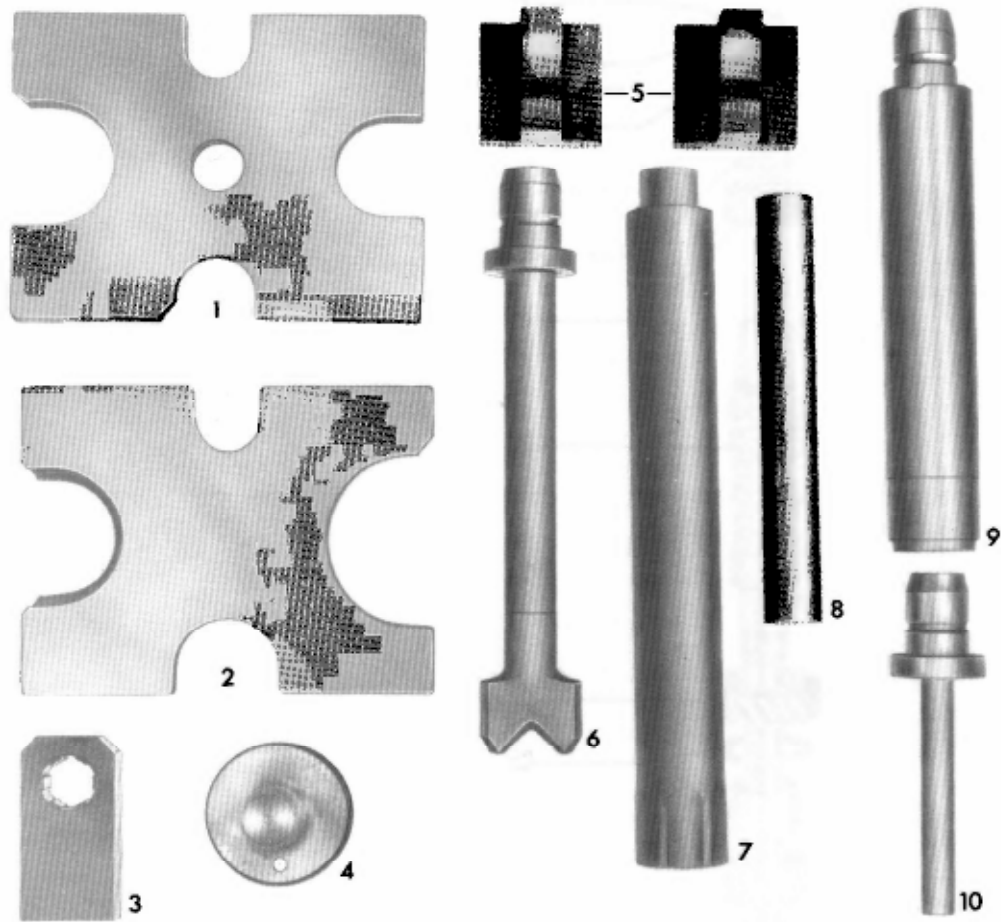


- 11 - Coat shaft lightly with lithium grease and  $\text{MOS}_2$  additive and insert together with throwout lever and the two spacing washers.

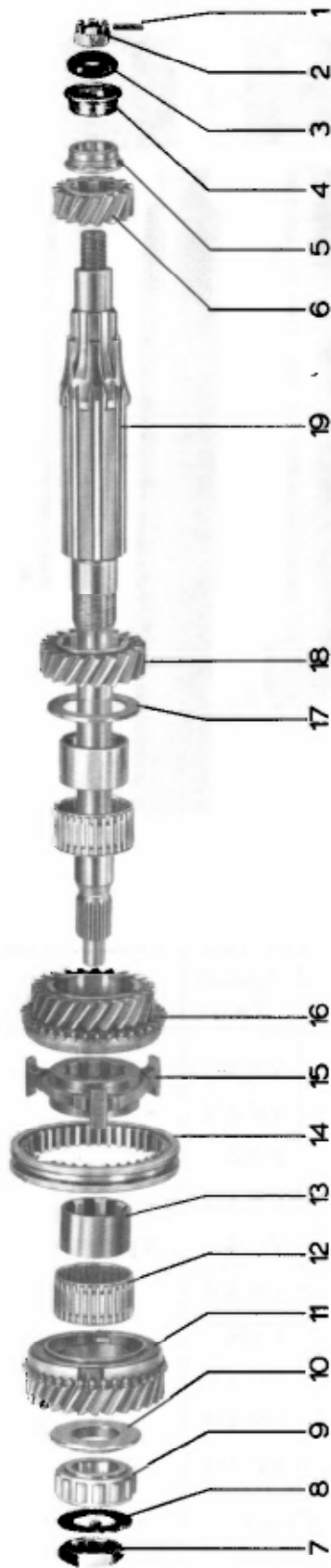
**Caution!**

The notch in the shaft is off-center. Insert shaft in such a manner that the notch on the shaft and the bore on the throwout lever are in alignment.

- 12 - Clamping sleeve must be inserted into throwout lever and fit both closing caps.
- 13 - Install remaining parts. Refer to individual chapters.



No.	Designation	Special Tools	Explanations
1	Pressure plate	VW 401	-
2	Pressure plate	VW 402	-
3	Holding plate	P 355	-
4	Pressure pin	VW 412	-
5	V-Pieces	VW 405	2 parts
6	Pressure pin	VW 406	
7	Spanner	P 252	
8	Tube	VW 420	
9	Pressure pin	VW 407	
10	Pressure pin	VW 411	

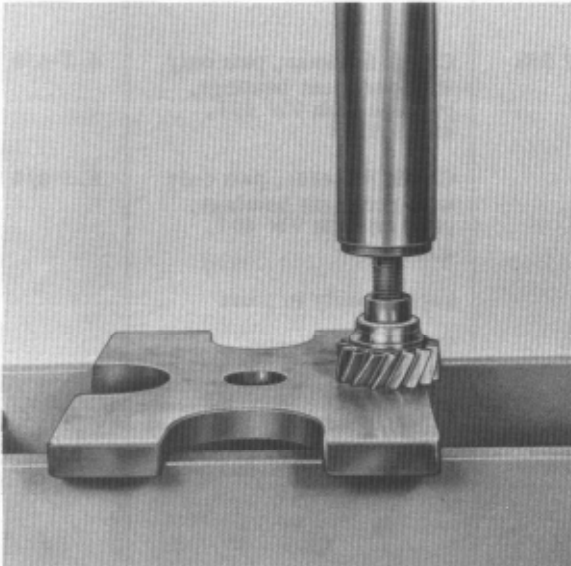


No.	Designation	Each	Observe during		Refs.
			Removal/Disassembly	Installation/Assembly	
1	Clamping sleeve	1		Replace	
2	Castle nut	1		Tighten to 10 mkp (72 ft/lb)	
3	Washer	1			
4	Bearing inner race	1	Press off with P 353	Check for wear, pair only with pertinent bearings, press on with VW 401, 426, 472/2	4.1-4/9
5	Bearing inner race	1	Press off with VW 401, 407	Check for wear, pair only with pertinent bearings, press on with VW 401, 420	4.1-8/4
6	Gear wheel 1st gear	1		Replace only in pairs	
7	Nut	1		Tighten to 11 mkp (80 ft/lb)	
8	Locking plate	1		Replace	
9	Cyl. roller bearing	1	Press off with VW 402, 412	Press on with VW 401, 402	4.1-8/5
10	Spacing washer	1			
11	Gear wheel 4th gear	1		Check synchronization, replace only in pairs	4.1-10/1
12	Needle bearing	2	Mark	Do not confuse	
13	Spacing bushing	2	Mark	Do not confuse	
14	Shifting sleeve	1		Check for wear	4.1-10/4
15	Guide sleeve	1			
16	Gear wheel 3rd gear	1		Check synchronization, replace only in pairs	4.1-10/1
17	Thrust washer	1			
18	Gear wheel 2nd gear	1		Replace only in pairs, with narrow flange against collar	
19	Driving shaft	1		Check for out-of-true	4.1-8/7

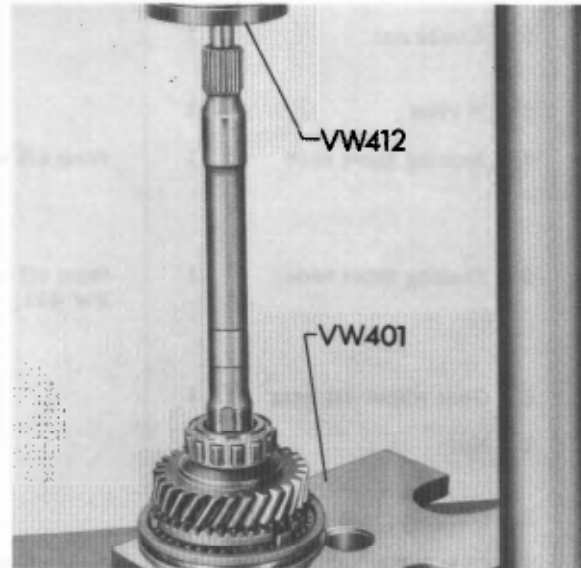
## DISASSEMBLY AND ASSEMBLY OF INPUT SHAFT

### Disassembly

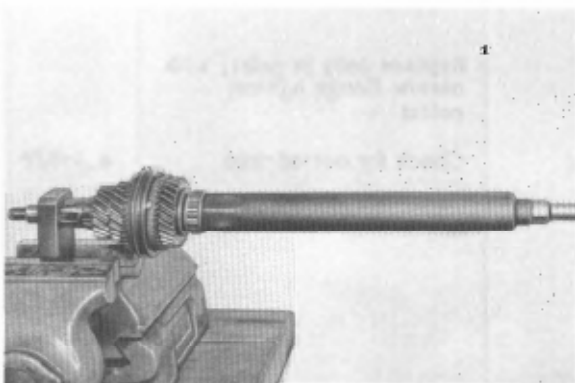
- 1 - Press off gear wheel of 1st gear with inside race half of tapered ball bearing by means of pressure plate VW 401 and thrust piece VW 407.



- 3 - Press cylindrical roller bearing from input shaft with pressure plate VW 401 and pressure pin 412.



- 2 - Clamp holding plate P 355 into vise, mount input shaft and knock back lock for hex. nut. Then loosen hex. nut with spanner P 252.



- 4 - Pull remaining parts from input shaft.

Be sure to mark needle cages to eliminate any confusion during reinstallation.

### Reassembly

#### Note

All parts of the input shaft must be mounted dry, so that no oil enters in between mating surfaces.

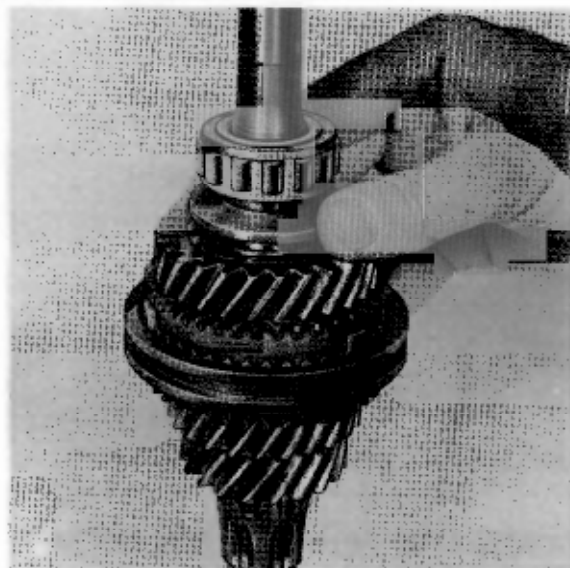
- 1 - Slide gear of second gear with narrow flange against stop on input shaft.

2 - Fit thrust washer and bushing for needle bearing.

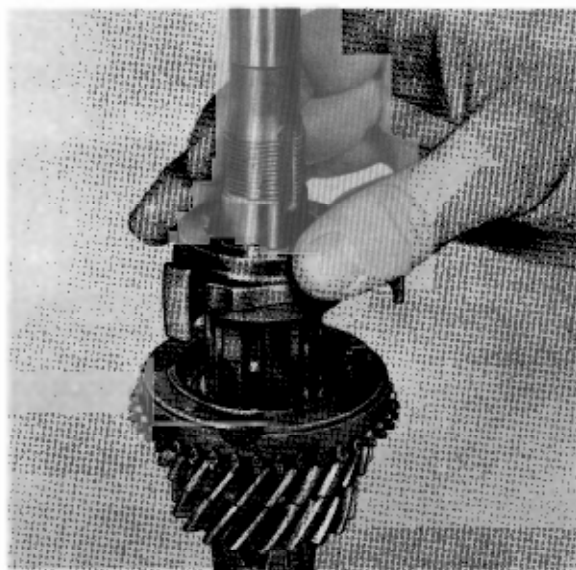


4 - Mount shifting sleeve, bushing for needle bearing, needle cage and gear wheel for 4th gear.

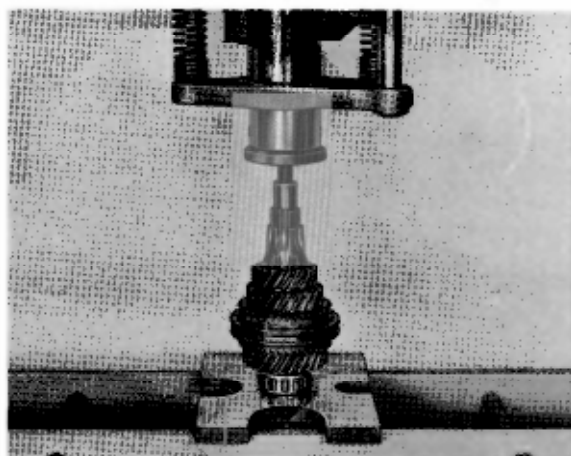
5 - Position tapered thrust washer and cylindrical roller bearing in correct lateral position (the mounted ring of roller cage should face splining of clutch plate).



3 - Mount needle cage, gear wheel for 3rd gear and guide sleeve.



6 - Press on cylindrical roller bearing using pressure plate VW 401 and pressure pin VW 412.



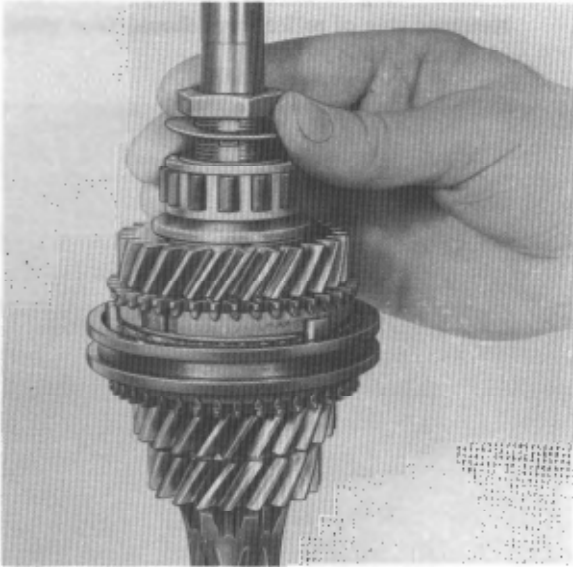
**Caution!**

If reinstalled, used needle cages must be fitted with the same gear wheel.

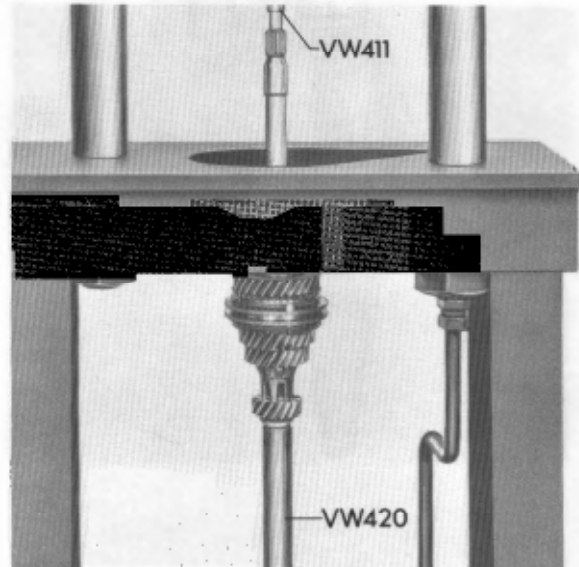
**Caution!**

Do not chafe and damage threads on driving shaft.

- 7 - Position new lock washer, making sure that the tab of the washer rests in the groove on the shaft and under the inner race of the cylindrical roller bearing.

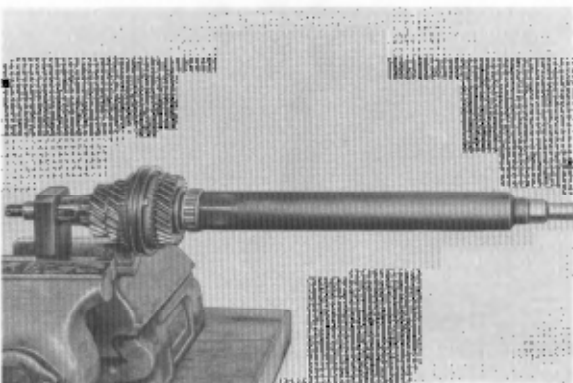


- 10 - Fit gear wheel for .1st gear with narrow flange outwards and press on inside half of race of tapered ball bearing by means of pressure pin VW 411 and tube VW 420.



- 8 - Lubricate threads and pressure surface of hex. nut. Fit spherical end of nut outwards.

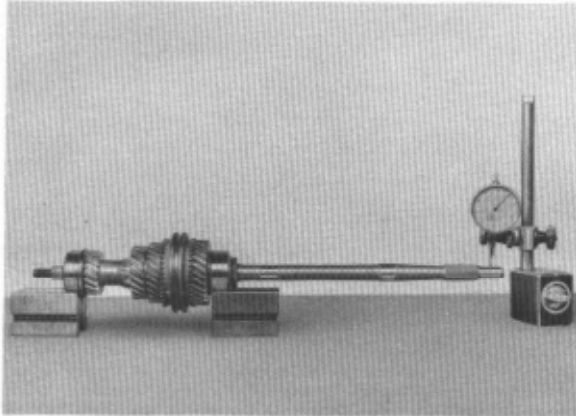
- 9 - Tighten hex. nut to specified torque with spanner P 252 and secure with lock washer.



#### Checking Input Shaft for Out-of-true

The shaft should always be checked for out-of-true in assembled condition, since the tightening of the hex. nut (M 24 x 1.5) may cause some wobble on shaft. For checking, press double-row tapered ball bearing out of intermediate plate and outer race of roller bearing out of gearbox housing. The check can also be made by means of auxiliary bearings.

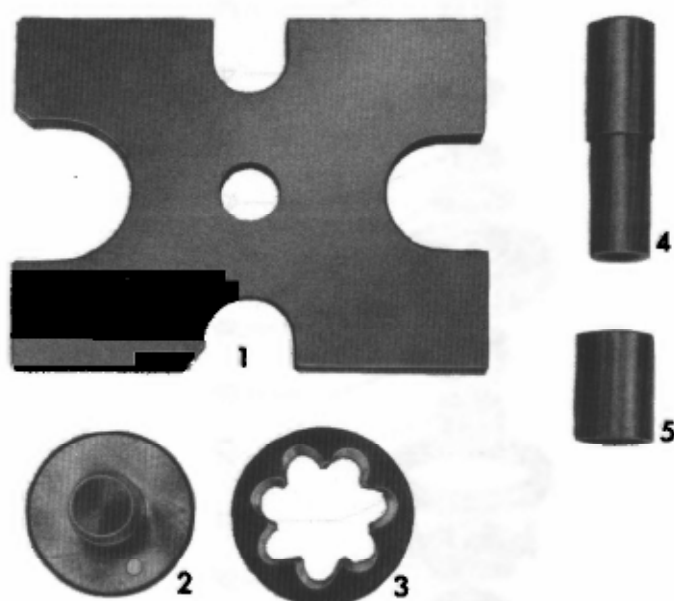
- a - Place assembled input shaft with bearings attached on V-blocks and check on trunnion for needle sleeve. Max. out-of-true: 0.1 mm (0.4").



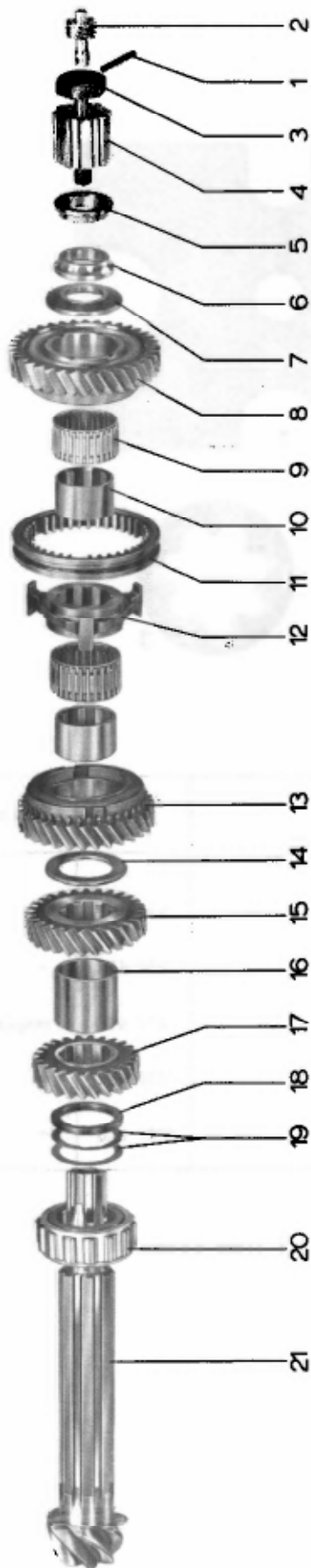
- b - Any unpermissible out-of-true up to 0.3 mm (0.12") the input shaft can be straightened in cold condition on the repair press, using V-pieces VW 405 and the pressure pin VW 406.



## TOOLS



No.	Designation	Special Tools	Explanations
1	Pressure plate	VW 401	-
2	Pressure pin	VW 412	-
3	Thrust piece	VW 449c	requires some reconditioning
4	Tube	VW 421	-
5	Tube	VW 426	-

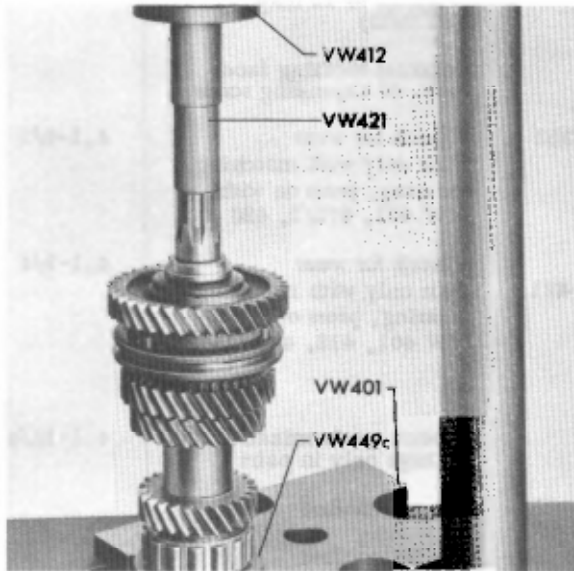


No.	Designation	Each	Observe during		Refs.
			Removal/Disassembly	Installation/Assembly	
1	Clamping sleeve	1		Renew	
2	Pinion shaft for speedometer drive	1		Check for wear	
3	Expanding screw	1		Tighten to 12 mkp (87 ft/lb)	
4	Splined shaft bushing	1		Internal toothing faces hex. of expanding screw	
5	Bearing inner race	1	Press out w. P 353	Check for wear Pair only with matching bearing, press on with VW 401, 472/2, 426	4.1-4/9
6	Bearing inner race	1	Press off with VW 401, 412, 421, 449c	Check for wear Pair only with matching bearing, press on with VW 401, 412, 426	4.1-9/4
7	Thrust washer				
8	Gear wheel 1st gear	1		Check synchronization change only in pairs	4.1-10/4
9	Needle bearing	2	Mark	Do not confuse	
10	Spacer bushing	2	Mark	Do not confuse	
11	Shifting sleeve	1		Check for wear	4.1-10/4
12	Guide sleeve	1			
13	Gear wheel 2nd gear	1		Check synchronization change only in pairs	4.1-10/4
14	Thrust washer				
15	Gear wheel 3rd gear	1		with narrow flange facing spacer bushing, replace only in pairs	
16	Spacer bushing	1			
17	Gear wheel 4th gear	1		with narrow flange facing spacer bushing, replace only in pairs	
18	Spacing washer	1			
19	Adjusting washers	X	Note thickness and number	Determine new dimensions when installing certain new parts	4.1-9/4
20	Cyl. roller bearing	1	Press of w. VW 401, 412, 421, 449 c	Check for wear, press on warm with VW 401, 407	4.1-9/4
21	Pinion shaft	1		Readjust upon replacement	5.2-4/1

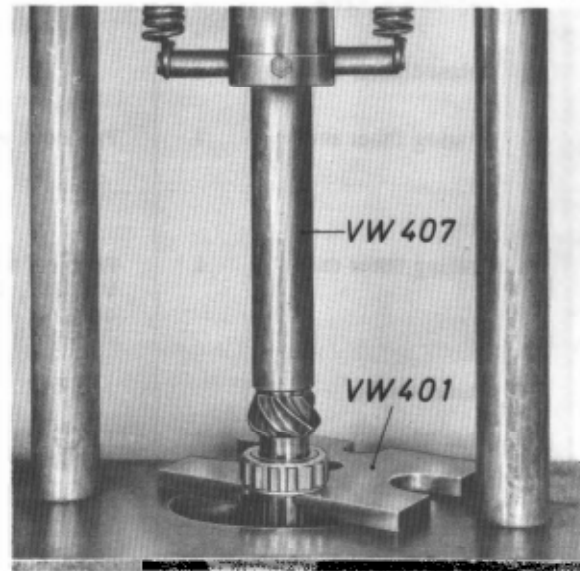
## DISASSEMBLY AND ASSEMBLY OF PINION SHAFT

## Disassembly

- 1 - Press bearing inner race of four-point ball bearing and cylindrical roller bearing from pinion shaft using pressure plate VW 401, pressure pin VW 412, tube VW 421 and thrust piece VW 449c.



- 1 - Fit pinion shaft bearing with pressure plate VW 401 and pressure pin VW 407.



## Note

For this purpose, machine thrust piece 449c with milling cutter for sliding fit on pinion shaft end.

- 2 - Remove all parts from pinion shaft. Identify needle cages to prevent confusion during reinstallation.

## Note:

Note number and thickness of washers (for pinion shaft/ring gear adjustment) between roller bearing and thick spacer washer, so that the adjusting washers need not necessarily be newly determined during reassembly.

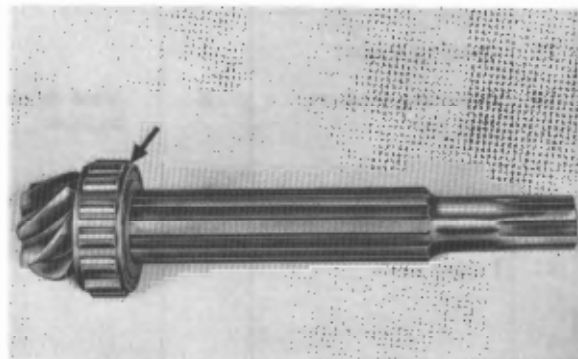
## Assembly

## Note 1

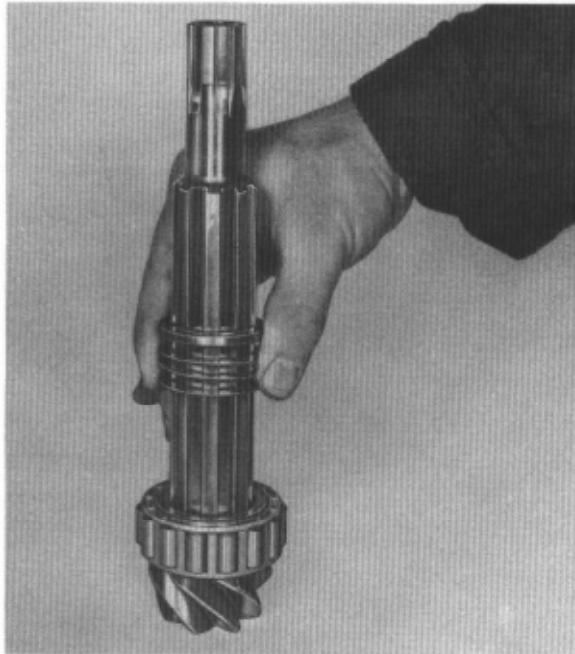
All parts of pinion shaft must be assembled in dry condition, so that no oil enters between mating surfaces. Pinion and ring gear must be provided with a pairing number. Be sure that these numbers match during installation.

## Note 1

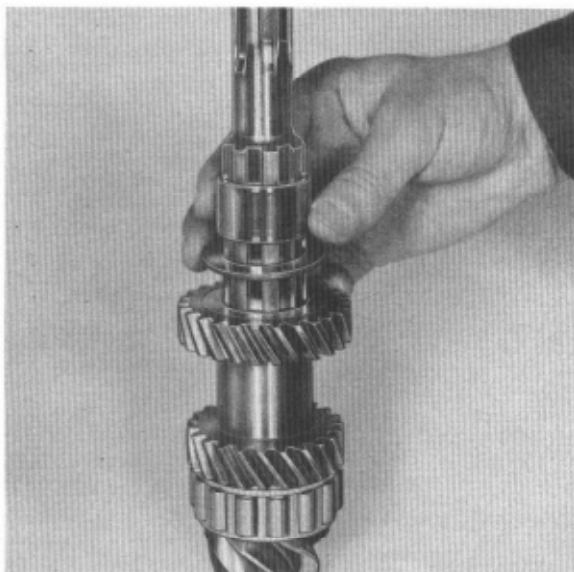
Mount bearing in such a manner that the washer on the temporary roller cage faces the gear set (arrow).



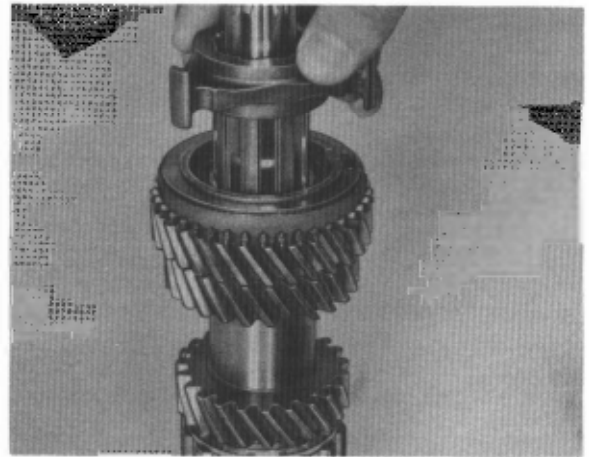
- 2 - Position removed adjusting washers or newly determined adjusting washers for replaced pinion shaft assembly. Then fit thick spacer washer.



- 3 - Fit gear wheel for 4th gear with narrow collar facing upwards.
- 4 - Fit spacer bushing and gear wheel for 3rd gear against spacer bushing with narrow collar facing downwards.
- 5 - Fit thrust washer and bushing for needle bearings.



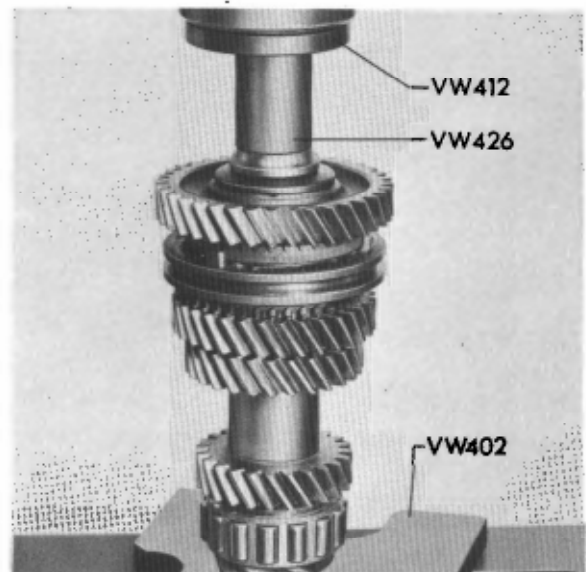
- 6 - Fit needle cage, gear wheel for 2nd gear and guide sleeve.



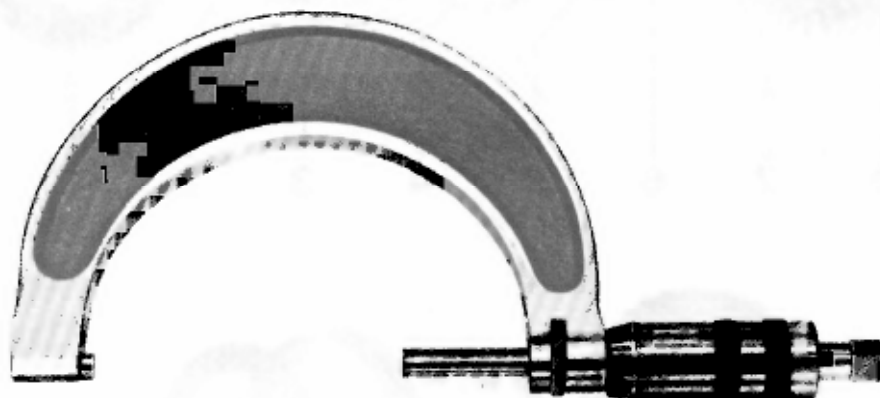
**Note!**

Used needle cages must be installed with the same gear wheel as before.

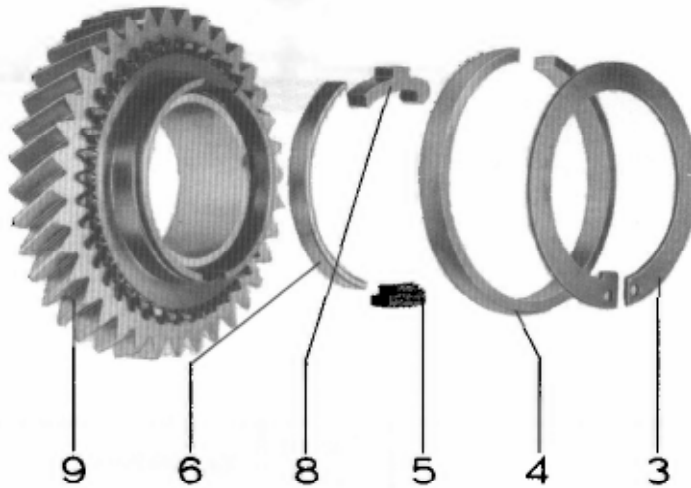
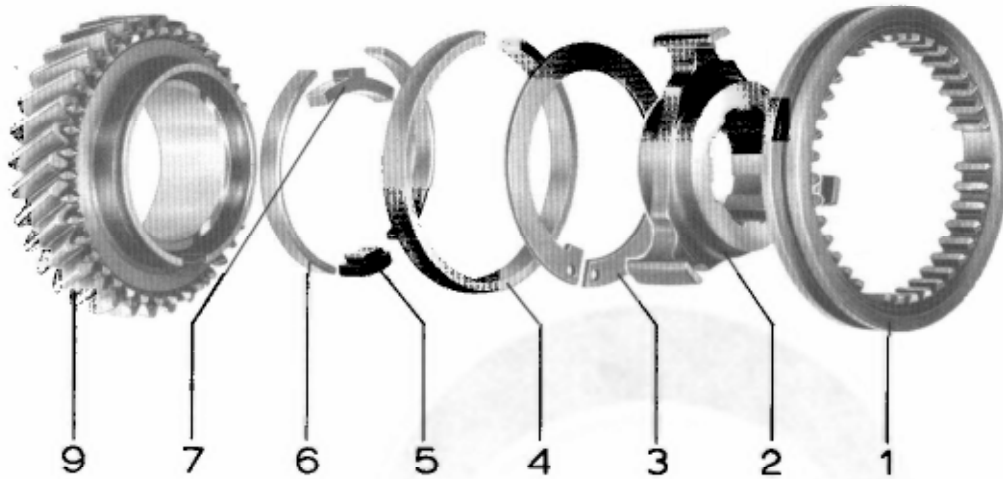
- 7 - Slide bushing for needle bearing, needle cage and shift sleeve on shaft.
- 8 - Install gear wheel for 1st gear.
- 9 - Install tapered thrust washer.
- 10 - Press bearing inner race half on shaft, using pressure plate VW 402, pressure pin VW 412 and pipe tool 426.



## TOOLS



No.	Designation	Special Tool	Explanations
	Micrometer	-	conventional, Size 4 (75-100 mm)

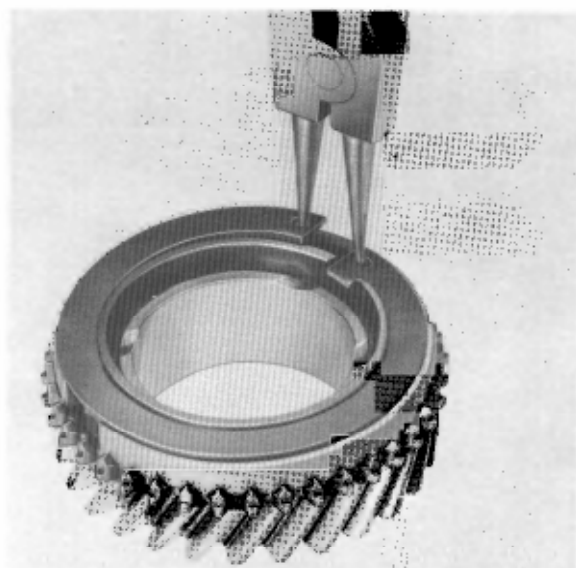


No.	Designation	Each	Observe during		Refs.
			Removal/Disassembly	Installation/Assembly	
1	Shifting sleeve	1		Check dimension of gap between shifting sleeve and shifting fork	4.1-10/4
2	Guide sleeve	1			
3	Retaining ring	1	Remove with pliers	Insert with pliers	4.1-10/3
4	Synchronizing ring	1		Check for wear	
5	Stop	1			
6	Break band (only one for 1st gear)	2		Install on correct end for first gear	
7	Energizer 2nd to 4th gear	1			
8	Energizer 1st gear	1			
9	Gear wheel	1			

## DISASSEMBLY AND ASSEMBLY OF SYNCHROMESH ASSY

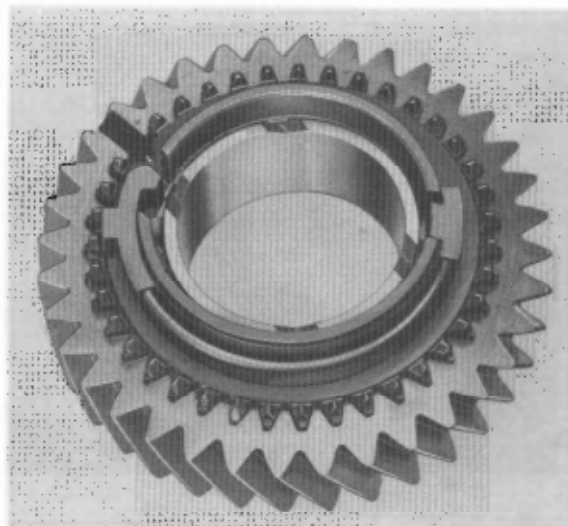
## Disassembly

Remove retaining ring for synchronizing ring from clutch body. For this purpose, insert retaining pliers (outside) and spread. Simultaneously, tilt pliers in such a manner that the noseless end of the retaining ring is raised out of groove in upward direction. Keep spreading pliers and force ring out of groove by twisting in lateral direction.



## Note !

The mating surfaces of the synchronizing body and the energizer are matched and should be installed accordingly (arrow).



- 3 - Place nose of retaining ring into cutout for energizer and push retaining ring into groove at this end, pushing the synchronizing ring against its seat, if required.

## Assembly

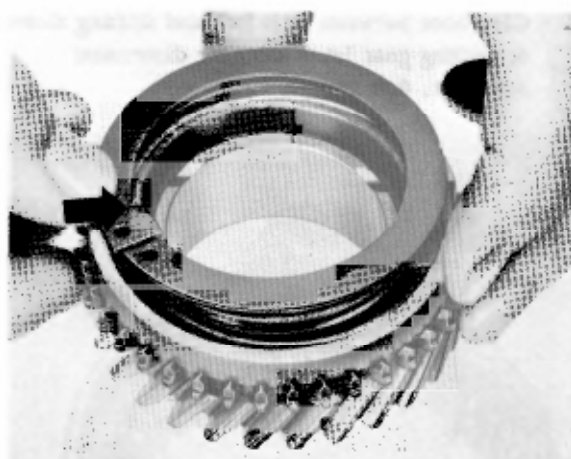
- 1 - Position synchronizing ring on clutch body, insert energizer and stop together with braking band.

## Note

The rough surface of the synchronizing ring has a molybdenum coating. During the shifting operation, the two sides of the synchronizing ring are subject to different stresses.

In the event of repairs, the synchronizing ring should therefore be turned, so that the coarse surface faces the sliding sleeve.

- 2 - When assembling the synchronizing components for 1st gear note that only one break band is inserted. Refer to illustration.



Apply pliers once again, if required, to secure ring completely.

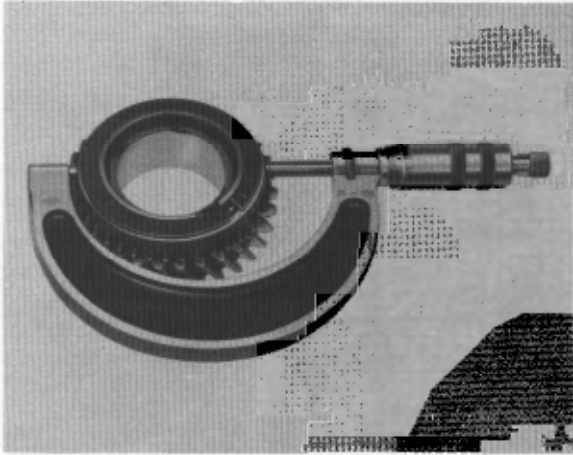
Apply retaining pliers, spread ring while simultaneously twisting pliers laterally in such a manner that the ring can be pushed into the groove in the direction of the arrow using the thumb of the other hand.



### Inspection

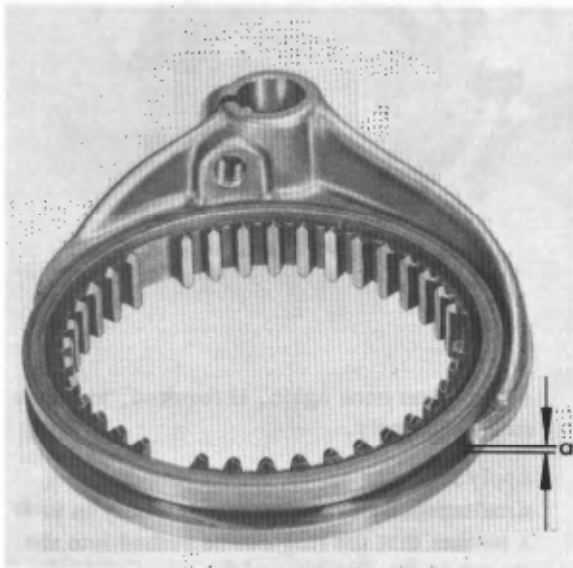
To guarantee perfect synchronization check the following two items:

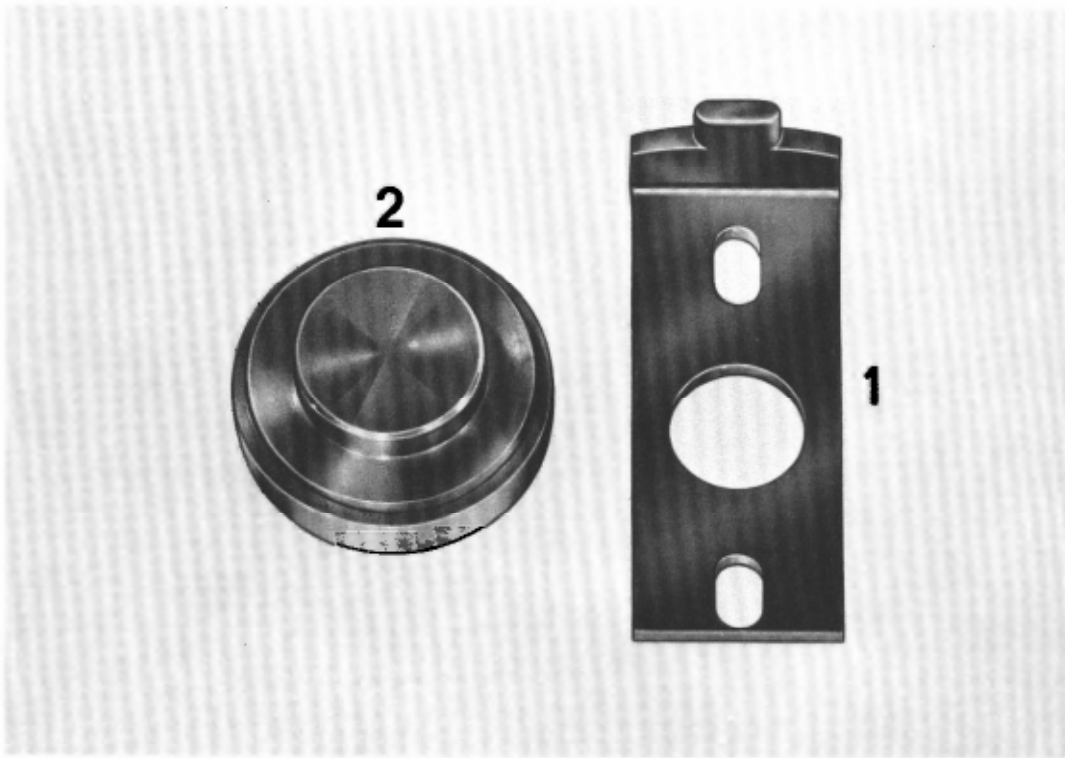
- 1 - Measure built-in synchronizing ring with micrometer for installation diameter. Position micrometer at highest point of synchronizing ring.



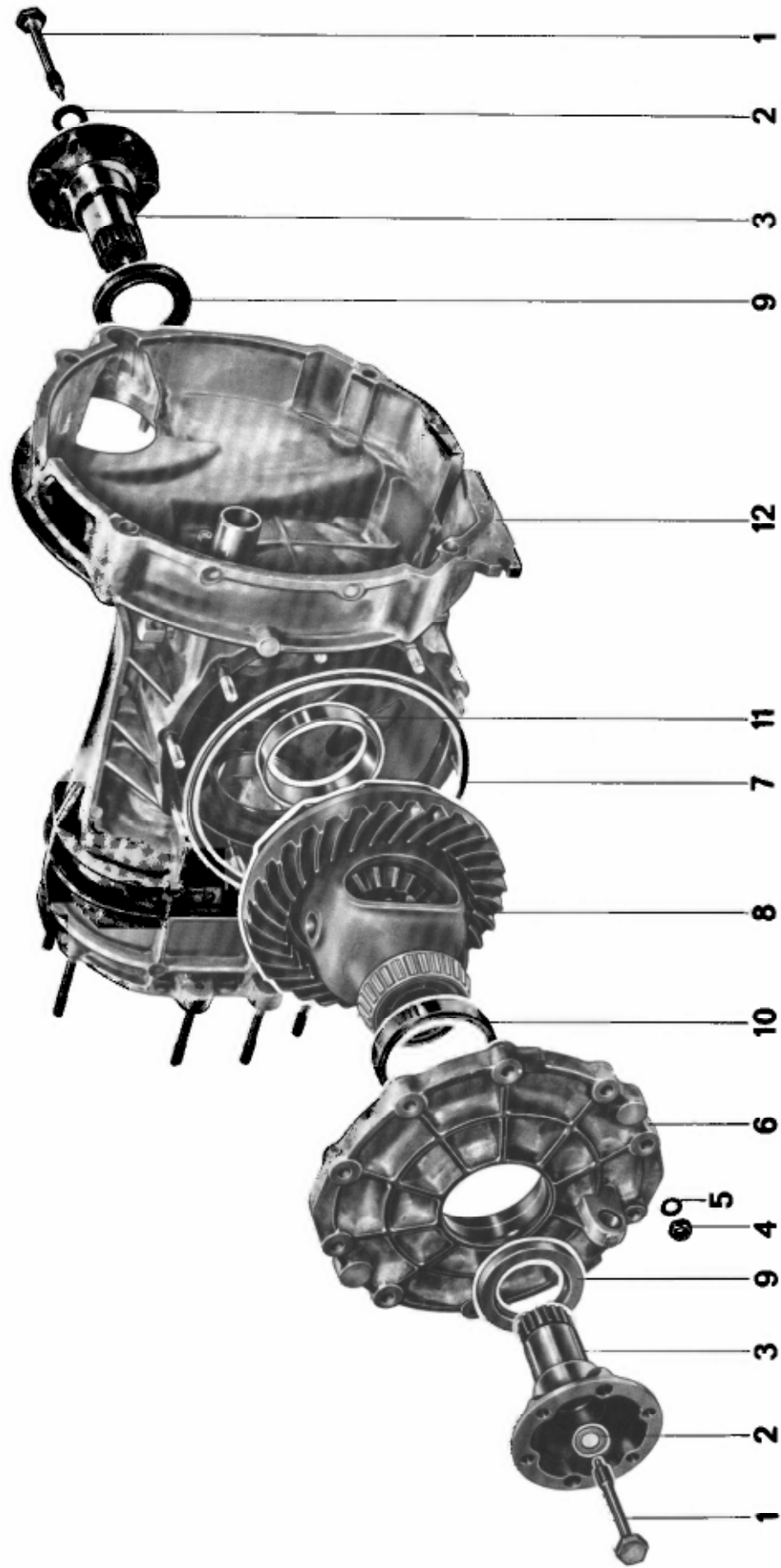
Diameter: 76.10 to 76.50 mm.

- 2 - Clearance between shift fork and shifting sleeve or shifting gear 1st to 4th gear dimension  
 $a = \text{max. } 0.5 \text{ mm (0.2")}$ .





No.	Description	Special Tool	Remarks
1	Holding fixture	P 356 b	must be refinished
2	Thrust piece	P 285 b	



No.	Description	Qty.	Note when		Special instructions see
			Removing	Installing	
1	Expansion bolt	2		Tighten to correct torque	
2	Washer	2			
3	Flange shaft	2	Prevent from rotating. Use 356 b	Check for wear	5.1-1/5
4	Lock nut	10		Tighten to specified torque	
5	Washer	10			
6	Final drive cover	1			
7	O-ring	1		Replace. Lubricate lightly	
8	Differential	1		Readjust, if necessary	5.1-5/1
9	Seal	2	Knock out with drift	Install with P 256 b	
10	Bearing outer race	1	Knock out with drift	Heat transmission cover to approx. 120° C (250° F) and install with appropriate tubing	
11	Bearing outer race	1	Knock out with drift	Heat housing to approx. 120° C (250° F) and install with appropriate tubing	
12	Final drive housing	1			

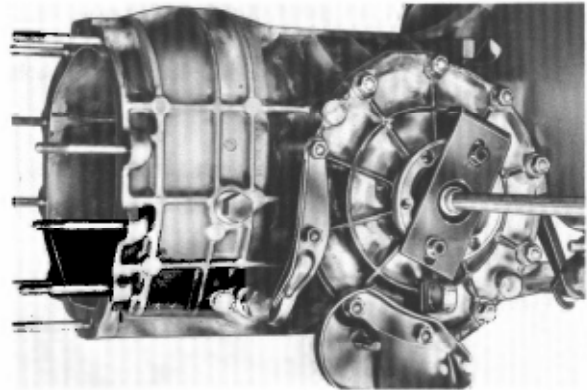
## REMOVING AND INSTALLING DIFFERENTIAL

**Caution**

Before removing the differential, the transmission gears must be removed.

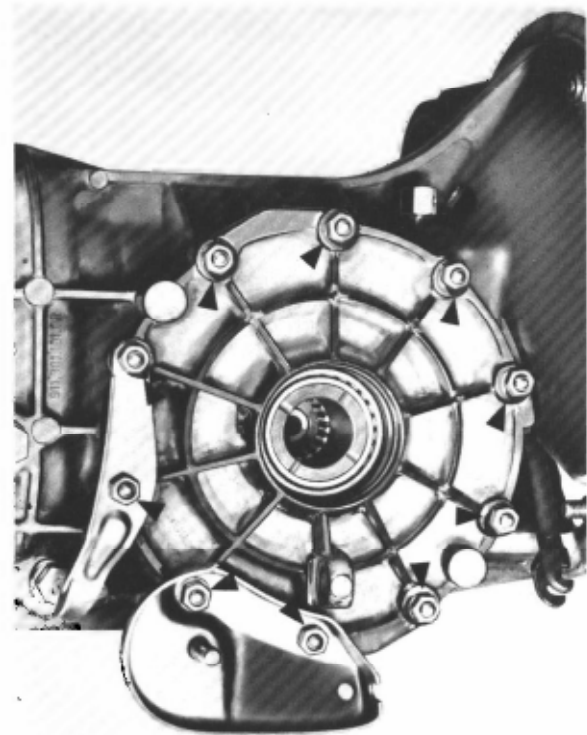
**Removing**

1. Block universal flange with special tool P 356 b and loosen expansion bolts.



2. Remove opposite universal flange.

3. Loosen lock nuts on final drive cover. Remove cover. Tap cover lightly with plastic mallet if necessary.



4. Remove differential from housing.

5. Knock seal and bearing outer races from cover and housing with a drift.

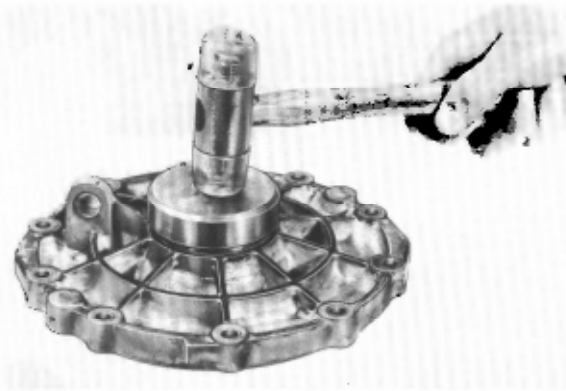
## Installing

1. Check tapered roller bearings and differential for excessive wear or damage. Replace if necessary.

**Caution**

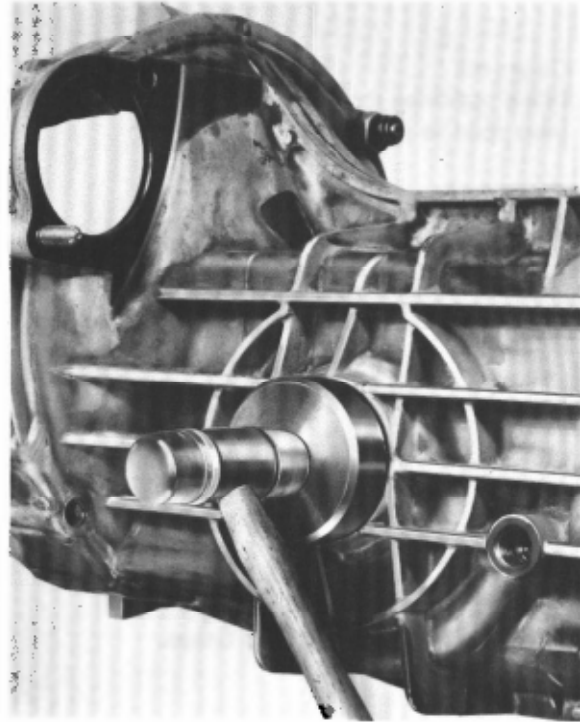
When heating transmission components, do not use open flame.

2. Heat final drive cover to 120° C (250° F) using either electric hot plate or hot oil. A drop of water on the heated surface will sizzle at the correct temperature. Press or drive in the bearing outer race with appropriate tubing.
3. Install seal in cover. Use thrust piece P 256 b.



4. Heat housing to 120° C (250° F) by placing bearing side of housing on electric hot plate and install bearing outer race. Use press or drive in with hammer and appropriate adaptor.

5. Install seal in housing. Use thrust piece P 256 b. Make sure seal is fully seated.

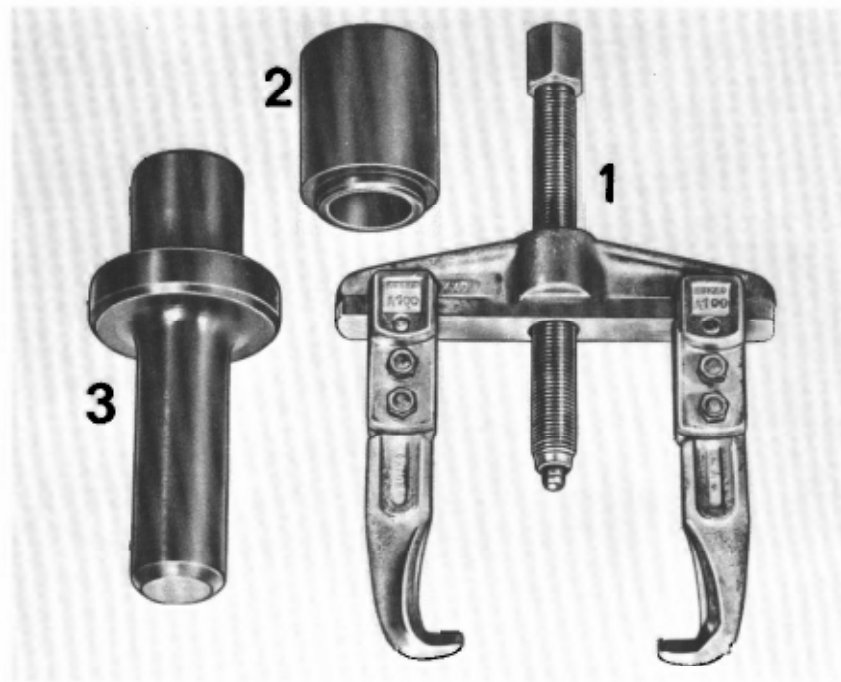


6. Insert differential.

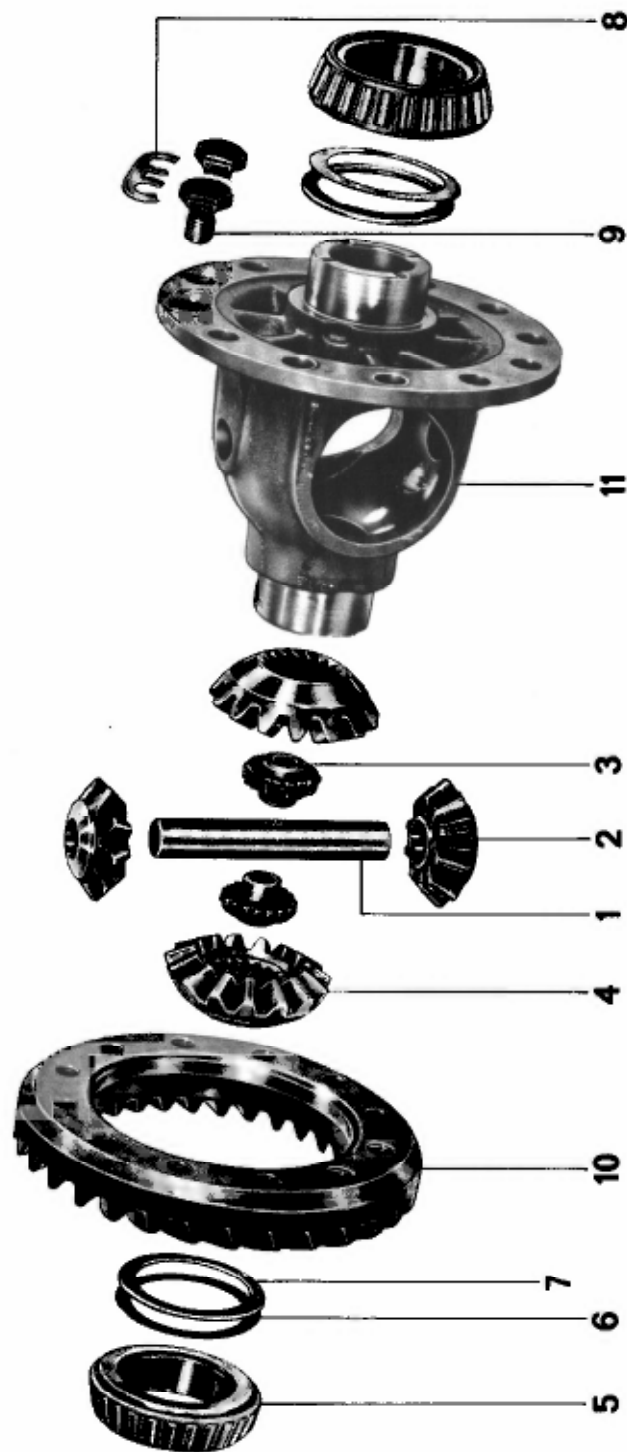
7. Lightly lubricate new O-ring for cover and install.

8. Install cover. Position washers and tighten self-locking hex. nuts to specified torque.

9. Insert universal flanges, block with special tool P 356 b. Tighten expansion bolts to correct torque.



No.	Description	Special Tool	Remarks
1	Puller	-	Kukko No. 21/5
2	Thrust piece	P 263	
3	Thrust piece	P 264 b	





No.	Description	Qty.	Note when		Special instructions see
			Removing	Installing	
1	Shaft	1	Remove with mandrel	Observe position of hole	5. 1-2/6
2	Small differential pinion	2		Check for wear	
3	Threaded lock piece	2			
4	Large differential	2		Check for wear	
5	Tapered roller bearing	2	Use puller P 263	Install with P 264 b	5. 1-2/5
6	Shim	x			
7	Spacer washer	2			
8	Lock plate	6		Replace	
9	Bolt	12		Tighten to correct torque	
10	Ring gear	1		Check for wear	
11	Differential housing				

## DISASSEMBLING AND ASSEMBLING DIFFERENTIAL (without anchor piece)

## Disassembling

1. Knock out differential shaft with mandrel.



2. Turn pinions in so that the small pinions can be removed through the openings in the differential housing. Remove the large pinions together with threaded lock pieces.

3. Remove both tapered roller bearings with a puller and thrust piece P 263.



## Caution

Do not interchange the shims or spacer washers. Attach tags to prevent mixing up right side with left or vice versa.

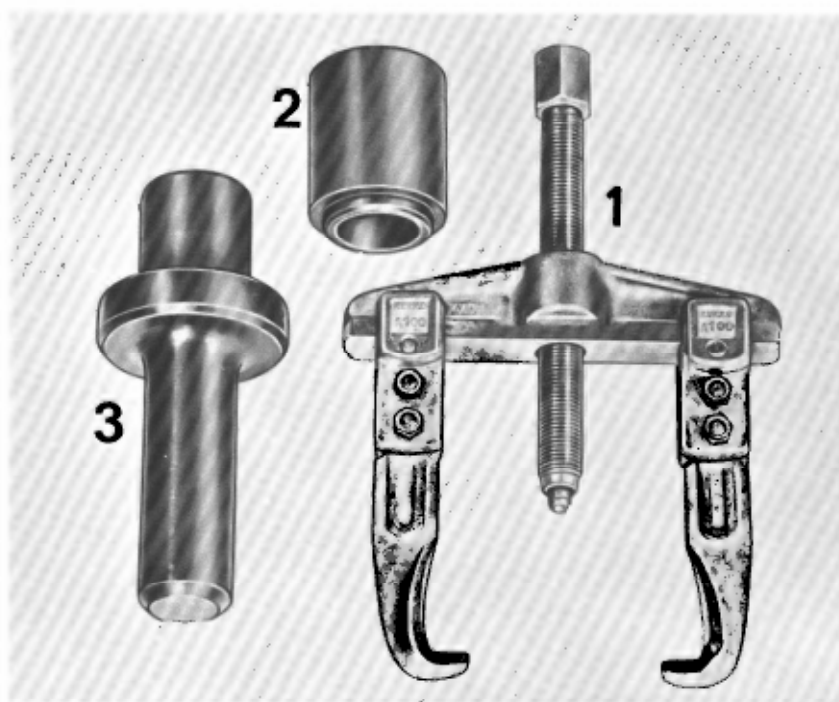
4. Remove lock washers on bolts of ring gear. Loosen bolts and remove ring gear.

## Assembling

1. Check differential housing, small and large differential pinions, and tapered roller bearings for wear or damage. Replace as necessary.

2. Replace ring gear on flange of differential housing and tighten bolts to correct torque.

## TOOLS



Nr.	Description	Special Tool Nr.	Remarks
1	Puller	-	Kukko Nr. 21/5 or similar
2	Thrust piece	P 263	
3	Thrust piece	P 264b	

3. Slide lock plates into grooves of bolt heads. Bend together at front with pliers. Knock down one side of lock plate against hex surface.

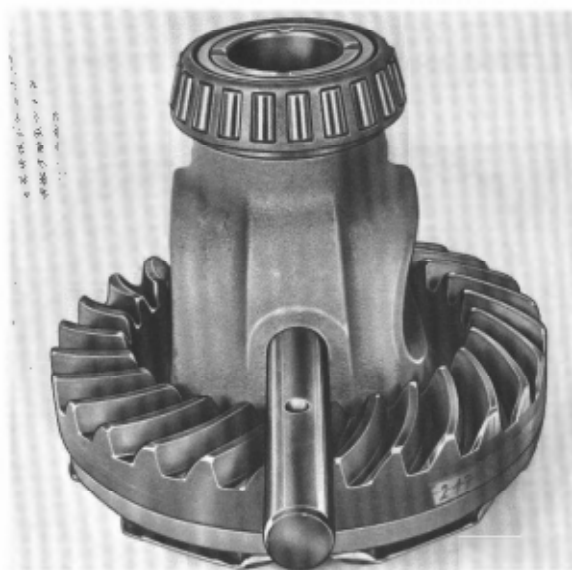


4. Coat thrust surfaces of differential pinions in differential housing with moly paste. Insert differential pinions through the oval opening on differential housing. Center pinions by inserting flange shafts.



5. Insert small differential pinions between the large differential pinions and turn until the bores of the gears are in alignment with bores of the housing.

6. Insert threaded lock piece with snap rings into the large differential pinion. Install differential shaft.



#### Caution

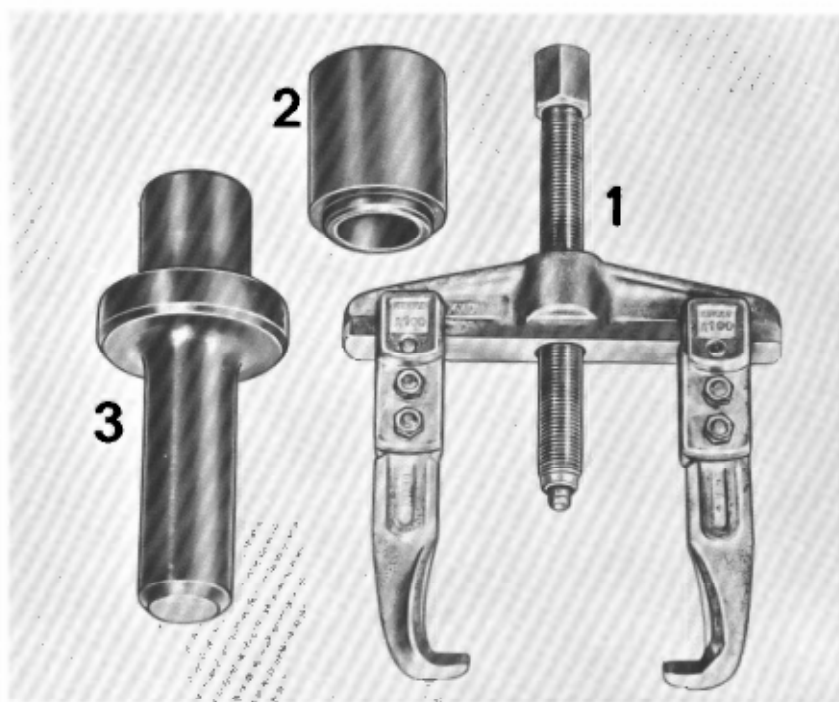
The locating hole in the differential shaft must be concentric with differential in axial direction. The tips of the expansion bolts extend into the locating holes and thereby retain the shaft.

7. Place identified or measured shims and spacer washer for tapered roller bearing on differential housing. Install tapered roller bearing. Use thrust piece P 264 b.

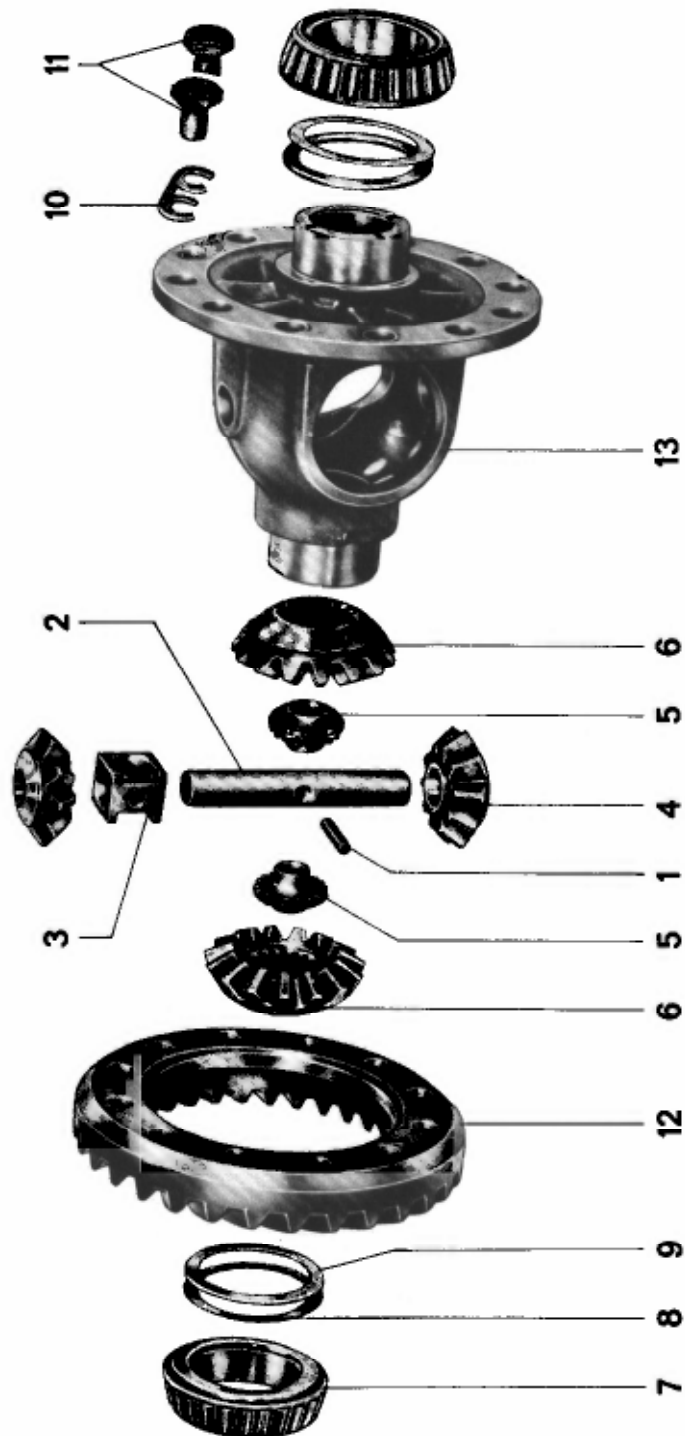


8. Readjust pinion shaft and ring gear if necessary. Refer to "Adjusting Ring Gear and Pinion", page 5.1-4/1.

## TOOLS



Nr.	Description	Special Tool Nr.	Remarks
1	Puller	-	Kukko Nr. 21/5 or similar
2	Thrust piece	P 263	
3	Thrust piece	P 264b	



Nr.	Description	Qty	Note when		Special Instructions see
			Removing	Installing	
1	Roll pin	1	Drive out with a punch	Replace	
2	Shaft	1	Drive out with a mandrel	Note the location of the bore	5 1-2/15
3	Anchor piece	1			
4	Small differential pinion (spider gear)	2		Check for wear	
5	Threaded lock piece	2			
6	Large differential pinion (side gear)	2			
7	Tapered roller bearing	2	Use puller with P 263	Install with P 264b	5 1-2/11
8	Shim	X			
9	Spacer washer	2			
10	Lock plate	6		Replace	
11	Bolt	12		Torque to correct value	
12	Ring gear	1		Check for wear	
13	Differential housing	1			

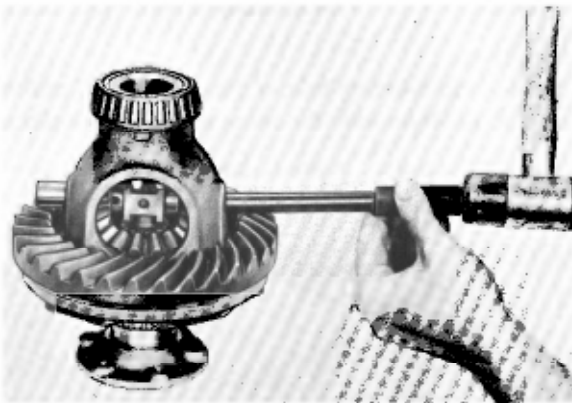
## DISASSEMBLING AND ASSEMBLING DIFFERENTIAL (with anchor piece)

## Disassembling

1. Drive out pinion shaft roll pin.

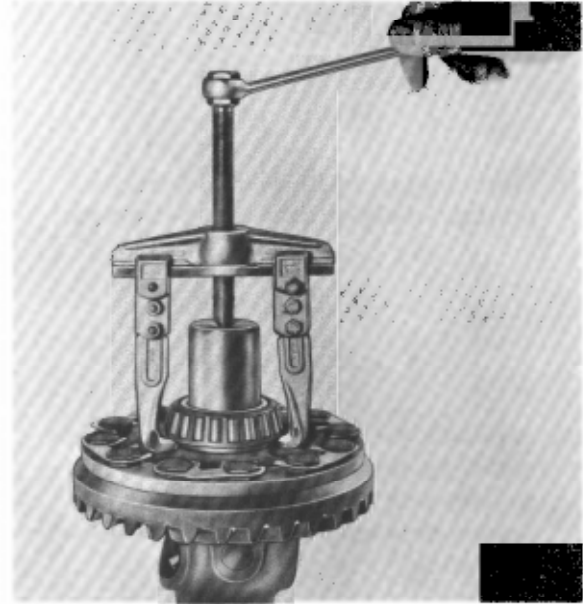


2. Knock out differential shaft with mandrel and remove anchor piece.



3. Turn the differential gears so that the small pinions can be taken out through the side openings. Take out the large pinions and threaded lock pieces.

4. Remove both tapered roller bearings with a puller and thrust piece P 263.



## Caution

Do not inter-change shims or spacer washers. Attach tags to prevent mixing up right side with left or vice versa.

5. Remove lock plates from ring gear retaining bolts. Remove bolts and take off ring gear.



### Assembling

1. Check differential housing, small and large differential pinions, tapered roller bearings, and anchor piece for wear and damage. Replace if necessary.
2. Place ring gear on flange of differential housing and tighten bolts to correct torque.
3. Slide lock plates into grooves of bolts heads. Attach the plates to the bolt heads by closing the open ends with pliers. Secure bolts by bending the plates down on one side of the hex surface.
4. Coat thrust surface of the differential pinions in the differential housing with Molykote or similar lubricant. Insert large pinions (side gears) through the oval opening in the housing. Center the pinions by inserting the flange shafts.



5. Insert small differential pinions (spiders) between the large differential pinions. Turn the small pinions until the bores align with those of the housing.
6. Insert threaded lock pieces with snap rings into the large differential pinions. Slide the anchor piece between the threaded lock pieces (see illustration).



#### Caution

Position the locating hole of the differential pinion shaft so it aligns with the holes of the anchor piece.

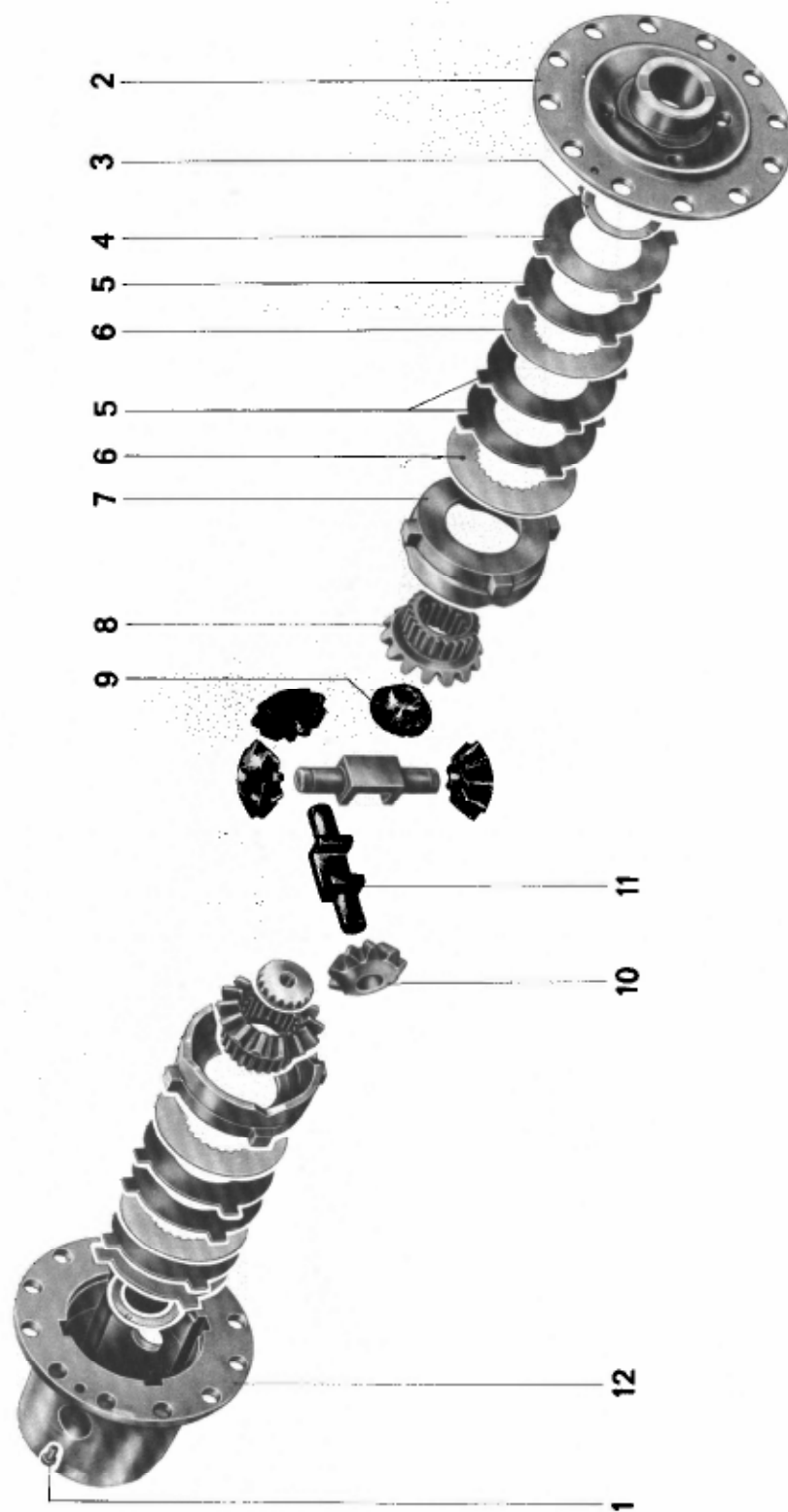
7. Hold the anchor piece in place (to prevent binding) and drive in the differential pinion shaft.



8. Make sure the bore of the shaft and anchor piece is aligned, then drive the roll pin in place.

- 
- 9 Place marked or measured bearing shims and spacer washers on the differential housing. Install tapered roller bearing using thrust piece P 264
  
  - 10 Re-adjust ring and pinion gears if necessary. See "Adjusting Ring Gear and Pinion".

Limited Slip Differential

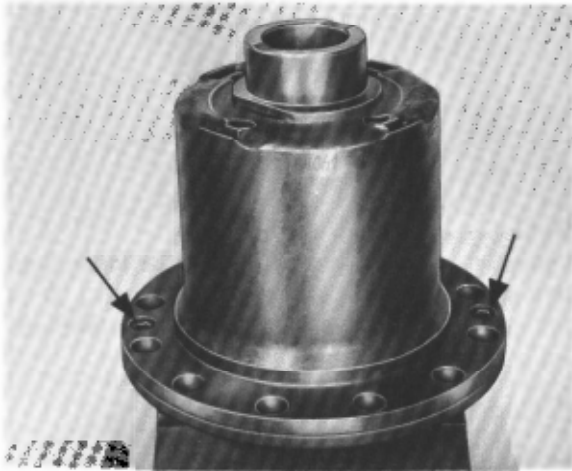


Nr.	Description	Qty.	Note when		Special instructions see
			Removing	Installing	
1	Fillister head bolt	2			
2	Differential housing cover	1			
3	Thrust washer	2		Position in proper location. Apply light coat of grease before installing	
4	Friction plate (waved)	2		Position in proper location	5.1-3/4
5	Friction plate	6		Check for wear	
6	Friction disc (molybdenum coated)	4		Check for wear	5 1-3/4
7	Thrust ring	2		Check for wear	5.1-3/4
8	Side gear (large pinions)	2		Check for wear	
9	Threaded lock piece with snap ring	2			
10	Spider gear (small pinions)	4		Check for wear	
11	Differential pinion shaft	2		Check for wear	
12	Differential housing	1			

## DISASSEMBLING AND ASSEMBLING LIMITED SLIP DIFFERENTIAL (80% lock)

## Disassembling

1. Remove ring gear.
2. Remove Allen-head bolts from differential housing flange and remove cover.

**Caution**

Note the installation sequence of friction discs and plates by attaching tags. This way the same locking effect is maintained after assembly.

## Assembly

1. Check all parts for wear and replace as necessary.
  - a. Differential housing:  
Check friction plate and thrust ring locating grooves in housing for wear.

## b. Thrust rings:

The locating tabs and thrust faces should not be excessively worn or scored. Also, they should move freely within the differential housing.

## c. Side gears:

The contact surfaces for the thrust washers should not be worn. The friction discs must move freely on the side gear splines.

## d. Friction plates and discs:

Check friction plates and discs for wear. The locating tabs of friction plates, and the teeth of the friction discs should not show wear.

2. Coat all thrust surfaces of the plates, discs, thrust rings, and spider shafts with SAE-90 Hypoid gear oil before assembling.

3. Install the thrust washers in such way that the locating tab comes to rest in the corresponding bore in the differential housing or cover respectively. Coat the washers with a light coat of grease before installing so that they will not fall during assembly.

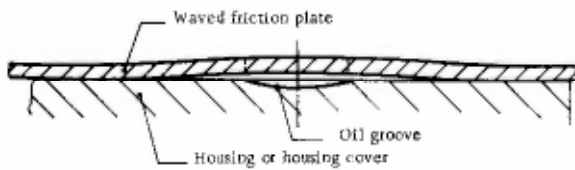
**Caution**

Install the friction plates and discs in the same order they were removed. Refer to the tags which were attached during removal.

4. Install remaining parts. Refer to the exploded view (see page 5.1-3/1).

**Caution**

The waved friction plates must be placed next to the housing or cover, respectively.  
When installing, make sure that the wave of the friction plate faces away from the oil groove in the seat of housing (or cover). This provides an air gap between the oil groove in the seat of the housing (or cover) and the discs themselves.

**Note**

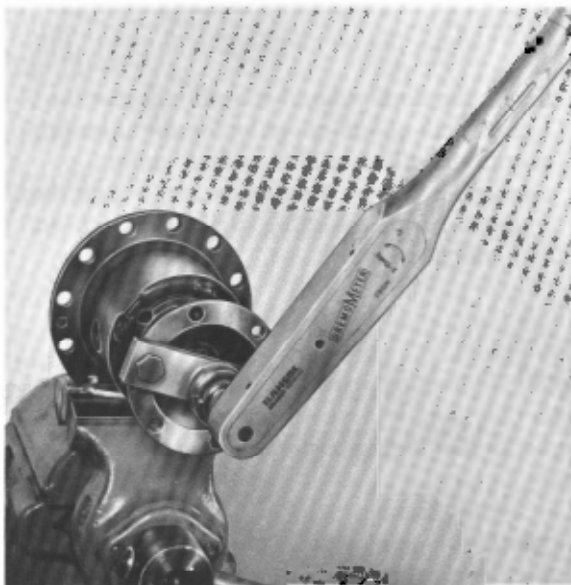
The specified torque cannot be obtained, the friction discs may have to be changed. Friction discs are available in the following thicknesses: 1.9 mm, 2.0 mm, and 2.1 mm.

If the thickest friction discs are installed, and the specified torque is still not obtained, the friction discs and plates are worn out and must be replaced.

**Note**

The adaptor for the joint flange can be made from 30 x 15 mm (1.2 x 0.6 in.) flat steel stock, 120 mm (4.7 in.) long, with a 1/2 in. square cut-out in the center.

5. Clamp the flange of the assembled differential in a vice equipped with jaw caps. Install the axle flange, then rotate the differential using the adaptor (described below) and a torque wrench. Torque should be 4 - 8 mkp (29 - 58 ft. lbs.).

**Lubrication**

Only shell S 1747 A gear oil may be used for lubrication.

In the USA: Shell HDR gear oil 90 E. P. (or lubricants of identical composition)

In Canada: Shell HDR gear oil 90 (or lubricants of identical composition)

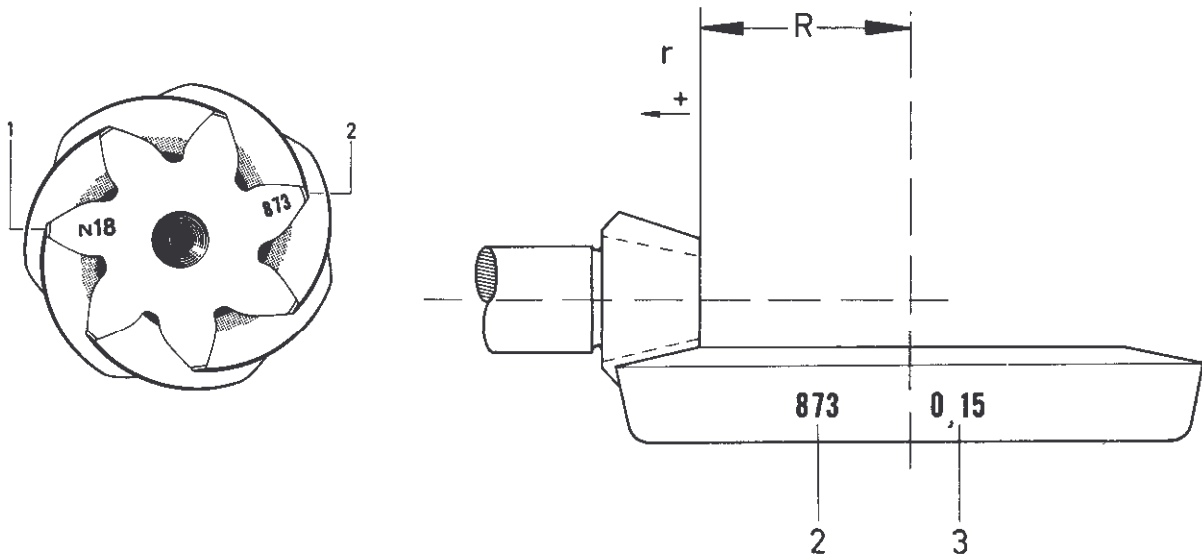
## ADJUSTING RING GEAR AND PINION

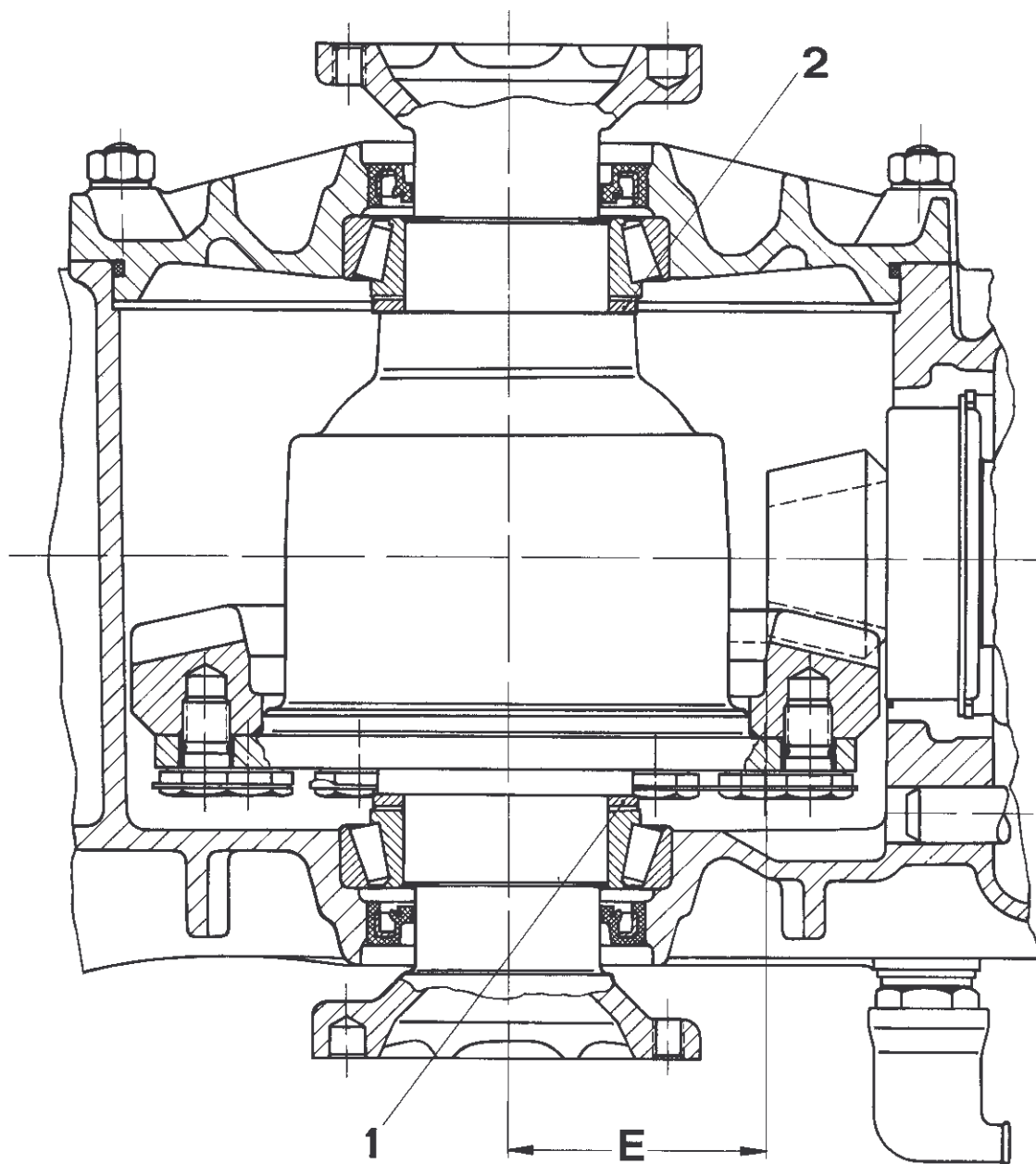
## General

Adjustment of the ring gear and pinion is important for quiet operation of the rear axle assembly. For this reason the pinion shaft and ring gear is already matched as a pair during production. They are checked on testing machines for correct contact pattern and low noise level in both directions of rotation. When the ring gear and pinion is tested it is set according to the design dimension "R". Dimension "R" is the distance from the face of the pinion to the ring gear center line. The pinion is then moved in or out of mesh until the quietest operation is determined. The deviation from the design dimension (the in or out movement of the pinion) is called "r" and is etched on the face of the pinion. While making this test, the ring gear backlash is kept within a tolerance of 0.12 - 0.18 mm. The ring gear and pinion shaft is designed in such a way that the deviation "r" must always be added to the design dimension "R".

Earlier pinion assemblies had either a plus (+) or a minus (-) etched in front of the deviation "r" whereas on the newer pinion assemblies, the letter "N" preceding the deviation "r" on the pinion shaft.

Ring gear and pinion sets are also stamped with a matching set number and should always be replaced as a complete set.





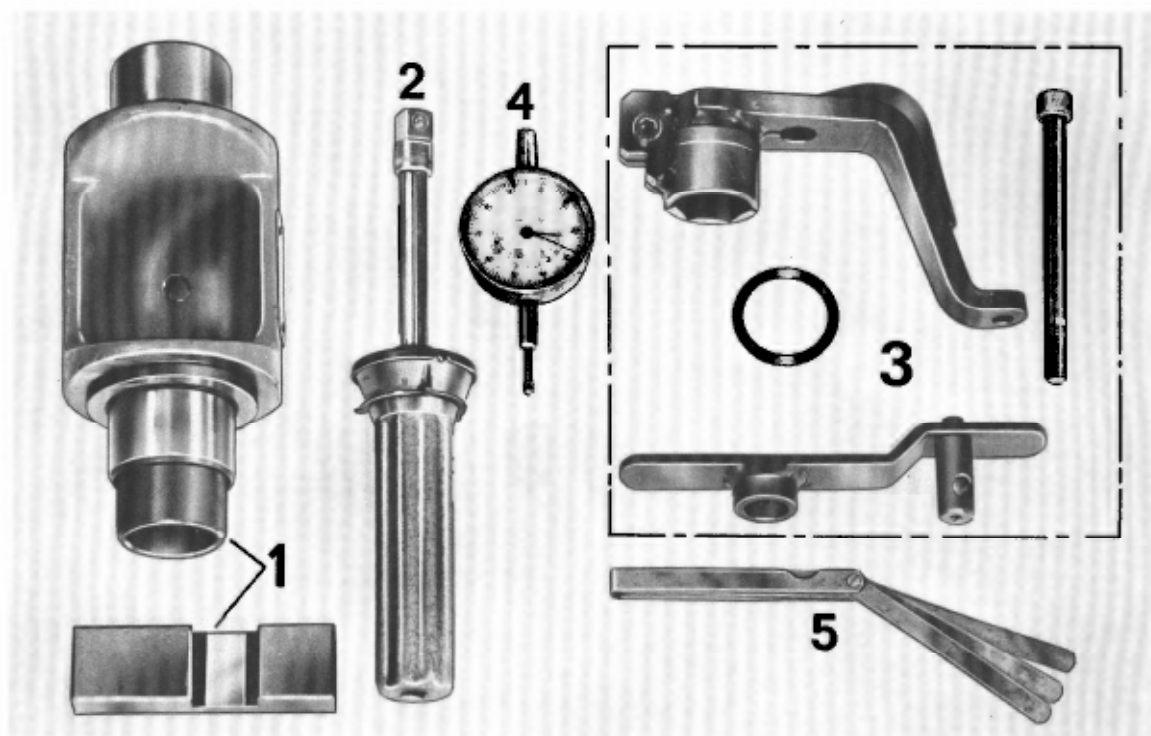
- 1 Spacer S 1
- 2 Spacer S 2
- E Adjusting dimension



Replaced Part	To be adjusted:	
	Pinion	Ring Gear
Transmission housing	X	X
Transmission side housing cover		X
Tapered roller bearing for differential		X
Ring gear and pinion	X	X
Intermediate plate	X	
Four-point ball bearing	X	
Thrust washer 6, 6 mm thick	X	
Races for needle bearing 2nd and 3rd gear	X	
Guide sleeve	X	
Thrust washer	X	
Fixed wheel 4th gear	X	
Fixed wheel 5th gear	X	
Spacer bushing	X	
Spacer washer	X	
Cyl roller bearing	X	

Suitable sequence for readjusting pinion assembly

- A - Determine total thickness of spacers for ring gear adjustment
- B - Adjust pinion shaft
- C - Adjust ring gear (backlash) and check

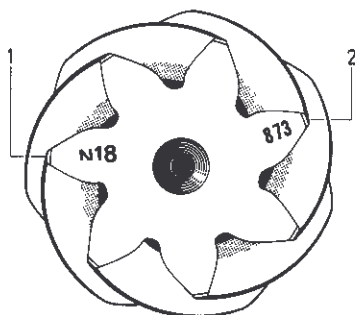


No.	Description	Special Tool	Remarks
1	Mandrel	P 258	with adjusting piece and bushings
2	Torque wrench	-	Commercial type Measuring range 0-35 cmkp
3	Measuring device	P 259	4-part (with disc from special tool P 357)
4	Dial/indicator	-	Commercial type Measuring range 0-10 mm
5	Feeler gauge	-	Commercial type 0,05-1,0 mm

### DETERMINING THICKNESS OF SHIMS FOR PINION SHAFT

By adding the design dimension "R" and the deviation "r" you get the adjusting dimension "E". Dimension "E" is the distance from the ring gear center line to the face of the pinion at which the ring and pinion set has been found to operate best.

If the pinion shaft were installed without shims you would find a "basic distance" from the face of the pinion to the ring gear center line of 64.70 mm. To find the shim thickness, subtract the adjusting dimension "E" from the "basic distance".



- 1 Dimension "r" in 1/100 mm  
2 Mating number

#### Example

Adjusting dimension E = 63.38 mm

Basic distance	64.70 mm
- Adjusting dimension E	- 63.38 mm
Shim thickness	<u>1.32 mm</u>

The shims are available in 0.25 mm, 0.30 mm and 0.40 mm thicknesses. Therefore the correct adjustment for this example requires the following shims: 2 each 0.40 mm, 1 each 0.30, 1 each 0.25 mm.

#### Example

The pinion shaft face end shows the deviation "r" to be N 0.18

R (Design dimension)	63.20 mm
+ r (Deviation)	+ 0.18 mm
E (Adjusting dimension)	<u>63.38 mm</u>

#### Note

The values are always rounded off to the next 0.05 mm.

## ADJUSTING PINION SHAFT

1. Insert the assembled intermediate plate with gear assembly and shift rods into housing. Do not use gasket between intermediate plate and housing. Install four spacer bushings and nuts and tighten in a crisscross pattern.

**Caution**

Tighten expansion bolt of differential pinion shaft to correct torque before making measurements.

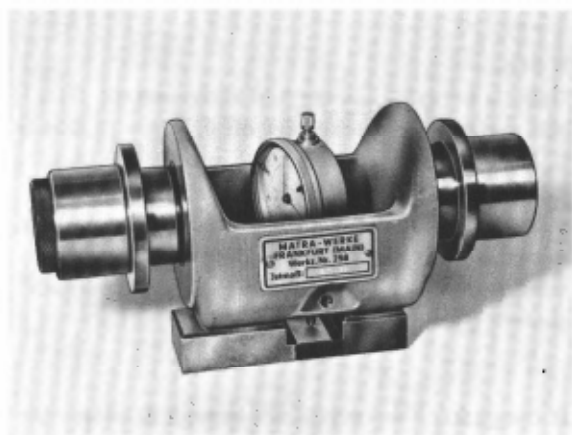
2. Place mandrel P 258 on the adjusting piece. Insert dial indicator and adjust to 1 mm preload.

3. Determine the dimension of the mandrel and the adjusting piece. These dimensions are marked on the sides of the tools. By adding these two dimensions the "actual adjusting dimension" is obtained.

**Example**

Mandrel dimension	54,015
+ <u>Adjusting piece dimension</u>	+ <u>9,52</u>
Actual adjusting dimension	<u><u>63,53</u></u>

4. Install mandrel P 258 with side bearings in the transaxle housing. Make sure the mandrel is under approx. 0.1 mm (.004 in.) axial preload. The mandrel must not have axial play when making measurements. Any axial play can be eliminated by inserting shims.



5. Watch dial indicator through the hole in the mandrel. Bring the sensor of the dial indicator into contact with the end face of the pinion. (A notch on the end of the mandrel shows the location of the dial indicator sensor). Turn slowly until the dial indicator shows the highest reading.

a. If the pointer reads to the right (clockwise), the distance is smaller than the "actual adjusting dimension" (63,53 mm). Therefore subtract the dial indicator reading from the "actual adjusting dimension" to determine the distance from ring gear center to face of pinion

Example

Actual adjusting dimension	63,53 mm
- Dial indicator reading	- 0,26 mm
Distance from ring gear center to face of pinion	<u>63,27 mm</u>

To determine the thickness of the paper gasket between the intermediate plate and the housing:

subtract the distance from face of pinion to ring gear center (63,27 mm) from the adjusting dimension "E" (63,38 mm - obtained by adding "R" + "r").

Example

Adjusting dimension "E" (example from page 5.1 - 5/3)	63,38 mm
- Distance from face of pinion to ring gear center	+ 63,27 mm
Gasket thickness	<u>0,11 mm</u>

b. If the pointer reads to the left (counterclockwise), the distance from the ring gear center to the face of the pinion is larger than the "actual adjusting dimension" (63,53 mm). Therefore, add the dial indicator reading to the "actual adjusting dimension" to determine the distance from the face of pinion to ring gear center.

Example

(the dimensions used in this example are different from those in the preceding examples)

Actual adjusting dimension (mandrel dim + adj. piece dim)	63,50 mm
+ Dial indicator reading	+ 0,08 mm
Distance from ring gear center to face of pinion	<u>63,58 mm</u>
Adjusting dimension "E"	63,68 mm
- Distance from ring gear center to face of pinion	- 63,58 mm
Gasket thickness	<u>0,10 mm</u>

Note

Gaskets between housing and intermediate plate are available in thicknesses of: 0,1 mm (0,004 in.), 0,15 mm (0,006 in.) and 0,2 mm (0,008 in.). The total thickness of gaskets must not exceed 0,50 mm (0,019 in.). After inserting the gaskets, check adjusting dimension "E" once again. The tolerance is  $\pm 0,03$  mm (0,001 in.). No contact pattern check is required

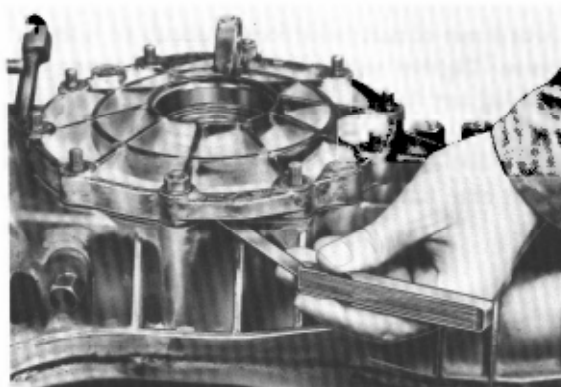
If the gasket thickness is not enough to obtain the correct adjusting dimension, the pinion shaft must be disassembled and the pinion shaft adjusting shims changed accordingly.

#### DETERMINING THICKNESS OF SPACERS FOR RING GEAR ADJUSTMENT

1. Make sure that the tapered roller bearing outer races are fully seated in the housing and side cover.

2. Install a 3.5 mm (0.138 in.) spacer (S 1) on the ring gear side beneath the side bearing. Install a 3.0 mm (0.118 in.) spacer (S 2) on the opposite side beneath the other side bearing.

4. Lightly tighten the side cover using two nuts opposite each other. This preloads the roller bearings. Check the gap between the cover and gasket with a feeler gauge. The nominal value for side bearing preload is approx. 0.15 mm (0.006 in.).



#### Caution

The differential can be removed or installed only with the transmission gears removed.

5. If the nominal value of 0.15 mm (0.006 in.) is not attained, replace the S 1 spacer (ring gear side) with an appropriate spacer.

3. Insert differential with tapered roller bearings into housing. Install gasket and side cover (without oil seal).

**Example**

Feeler gauge measurement	0.40 mm
- Nominal value for side bearing preload	- 0.15 mm
	<u>0.25 mm</u>

The installed 3.5 mm spacer must therefore be replaced by a 3.25 mm spacer. That is, one which is 0.25 mm thinner.

- Install rest of nuts (with lock washers) on side cover. Tighten nuts to correct torque before making any further measurements.
- Place disc of special tool P 357 on axle flange. Insert axle flange. Slightly tighten expansion bolt.

**Caution**

When measuring differential drag, the pinion shaft must be disengaged and the axle flange oil seal must be removed from the side cover to prevent additional drag.

- Measure drag of assembled differential with a torque wrench. The following values must be obtained to ensure proper side bearing preload:  
25-35 cmkp (22-30 in. lbs.) with SKF side bearings  
40-65 cmkp (35-57 in. lbs.) with FAG side bearings

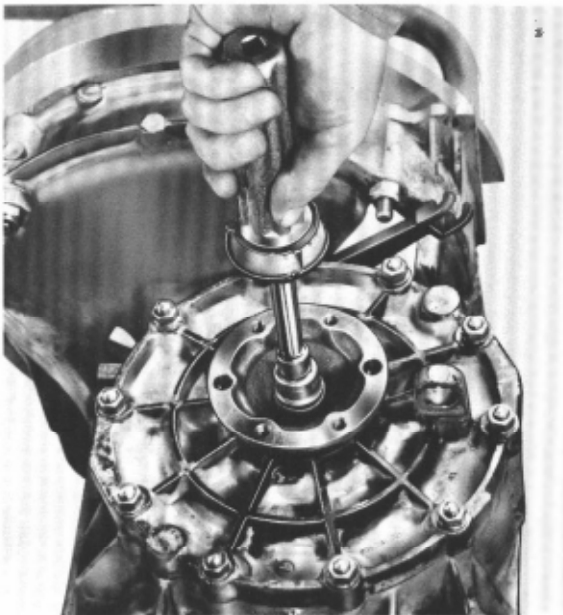
If the differential drag is not within tolerance, replace the spacer washer.

- Remove differential.

**Caution**

Do not interchange spacer washers after removal.

- Remove both tapered roller bearings and spacers. Measure the thickness of the two spacers with a micrometer. Add these measurements to obtain the total thickness of the spacers for ring gear adjustment.



### Note

In order to check backlash correctly (a subsequent procedure), the spacer S1 should be 0.1 mm (0.004 in.) thinner than one half of the sum of spacers S1 and S2. The spacer S2 should be 0.1 mm (0.004 in.) thicker than one half of the sum of spacers S1 and S2.

### Example

Total thickness of spacers (S1 + S2) .. 6.25 mm

$$\begin{array}{r} \frac{6.25 \text{ mm}}{2} = 3.125 \text{ mm} \\ - 0.10 \text{ mm} \\ \hline \text{Thickness of spacer S 1} = \underline{\underline{3.025 \text{ mm}}} \end{array}$$

$$\begin{array}{r} \frac{6.25 \text{ mm}}{2} = 3.125 \text{ mm} \\ + 0.10 \text{ mm} \\ \hline \text{Thickness of spacer S2} = \underline{\underline{3.225 \text{ mm}}} \end{array}$$

Spacers are available in increments of 0.10 mm (0.004 in.) from 2.5 to 3.7 mm (0.098 in. - 0.146 in.)

A shim, 0.25 mm (0.01 in.) thick, permits adjustments to the nearest 0.05 mm (0.002 in.). The rounded off spacer thickness should not differ from the calculated spacer thickness.

### Example

Calculated spacer thickness

$$S1 + S2 = 3.025 + 3.225 = 6.25 \text{ mm}$$

Rounded off spacer thickness

$$S1 + S2 = 3.0 + 3.25 = 6.25 \text{ mm}$$

Before measuring, remove any burr that may be on the edges of the spacers. Measure the thickness of the two spacers with a micrometer at four different points; the thickness tolerance is 0.02 mm (0.008 in.)



### ADJUSTING RING GEAR BACKLASH

#### Caution

The accurate backlash is marked on the ring gear.  
Backlash tolerance: 0.12 to 0.18 mm  
(0.005 - 0.007 in.)

1. Insert differential with tapered roller bearings and correct spacers (S1 and S2) into housing.
2. Install the assembled transmission intermediate plate with gears, shift rods and predetermined gaskets. Place spacer bushings on four opposing studs. Tighten down intermediate plate in a crisscross pattern.
3. Install side cover with O-ring. Apply light coat of oil to O-ring.

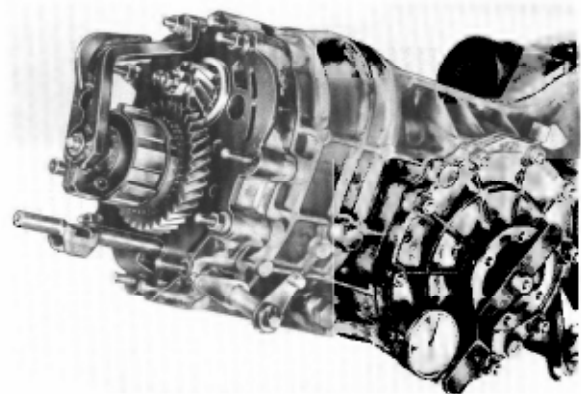
#### Caution

Tighten differential pinion shaft expansion bolt before tightening side cover to correct torque.

When tightening the side cover, make sure ring and pinion does not bind. There should always be some backlash.

4. Tighten side cover to correct torque.

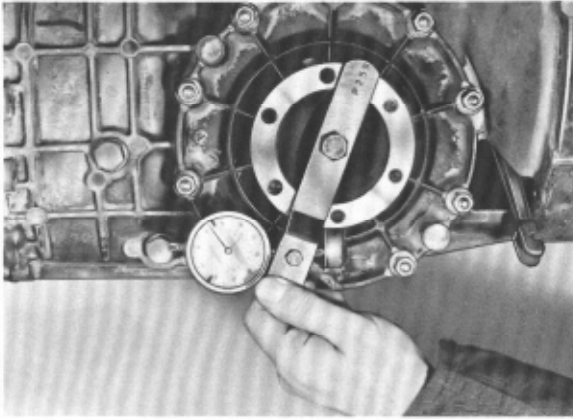
5. Block differential pinion shaft with holding fixture P 259 at expansion bolt (refer to illustration).



6. Place disc of special tool P 357 on axle flange. Insert axle flange. Attach dial indicator to bracket P 259. Fasten bracket to flange surface using a M 10 x 130 bolt.

7. Attach sensor to dial indicator. Set dial indicator so that it contacts the bracket for the clutch cable with slight preload.

8. Move dial indicator bracket back and forth.  
Read backlash on dial indicator.

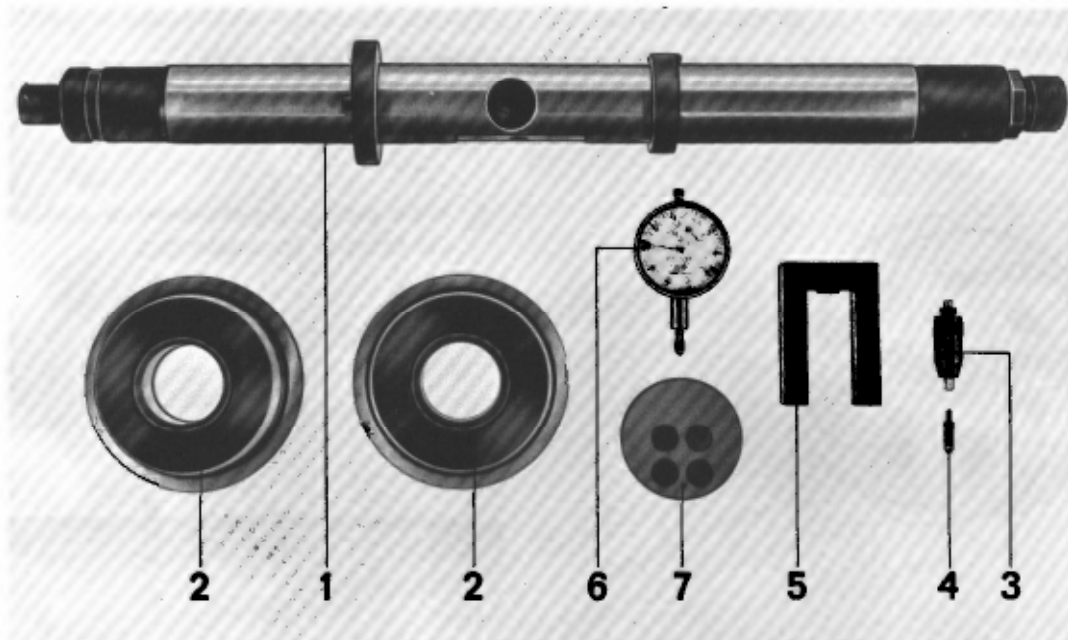


9. Turn ring gear approximately  $90^{\circ}$  and measure backlash again. The readings should not vary by more than 0,05 mm (0,002 in.).

10. The spacers S1 and S2 can be exchanged by using special tools P 263 and 264 b to obtain the permissible backlash. Be sure that the total thickness of the spacers is not changed.

11. Check axle shaft oil seals for damage. Replace if necessary.

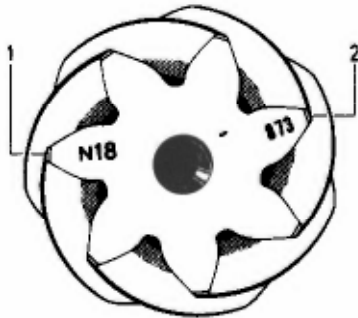
## TOOLS



No.	Description	Special Tool	Remarks
1	Measuring mandrel	VW 385/1	
2	Centering disc	VW 385/4	
3	Measuring pin	VW 385/14	
4	Dial indicator extension	VW 385/16	12,3 mm
5	Setting gauge	VW 385/12	R = 63,50 mm
6	Dial indicator	-	conventional, measuring range 3 mm
7	Measuring plate	VW 385/17	

### ADJUSTING PINION SHAFT WITH UNIVERSAL MEASURING GAUGE VW 385

The adjustment value "E" is computed from the fixed blueprint value  $R = 63,20 \text{ mm} + \text{deviation "r"}$  on face of pinion.



1 = Deviation "r" in 1/100 mm  
2 = Mating number

#### Example :

Face of pinion shows deviation "r" N 18

R = Blueprint value	63,20 mm
r = Deviation	+ 0,18 mm
E = Adjustment value	<u>63,38 mm</u>

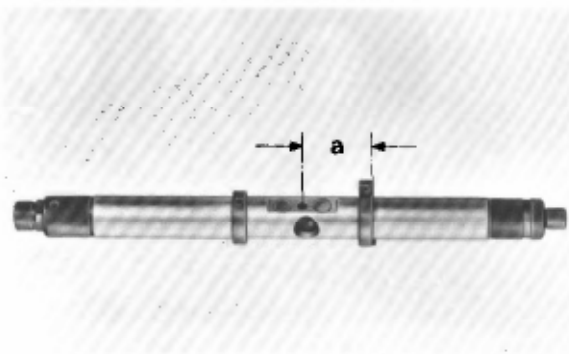
Pinion is already roughly adjusted during assembly by adding shims (refer to page 5,1-5/3).

1. Insert preassembled intermediate plate with gear set, but each without paper gaskets, into transmission housing. Install four spacers and tighten in a crisscross pattern.

#### Note

Tighten expanding bolt of pinion to specified torque prior to measuring.

2. Adjust setting ring of measuring mandrel VW 385/1 to dimension "a".



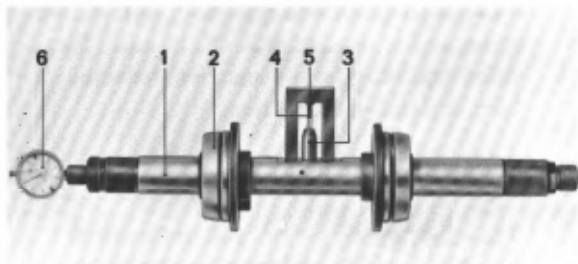
a = approx. 50 mm

3. Slide centering discs VW 385/4 on measuring mandrel and screw in measuring pin VW 385/14 with dial indicator extension VW 385/16 (12,3 mm).

#### Note

Screw adjustable setting ring back against stop spindle.

4. Position setting gauge VW 385/12 (R = 63,50 mm) and set dial indicator (3 mm measuring range) with 1 mm preload to 0 (small needle at 1, large needle at 0),

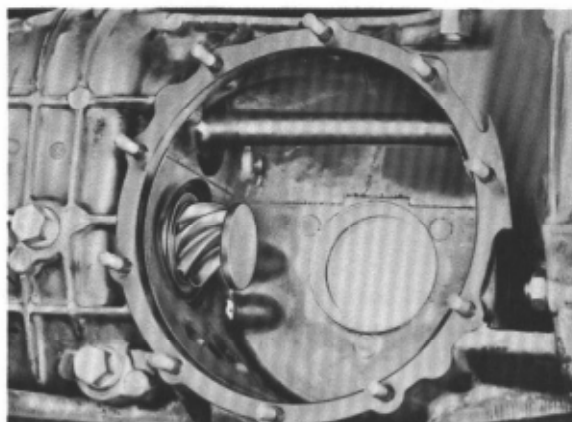


- |               |                          |
|---------------|--------------------------|
| 1 = VW 385/1  | Measuring mandrel        |
| 2 = VW 385/4  | Centering disc           |
| 3 = VW 385/14 | Measuring pin            |
| 4 = VW 385/16 | Dial indicator extension |
| 5 = VW 385/12 | Setting gauge            |
| 6 =           | Dial indicator           |

#### Note

To keep costs of supplementary parts for measuring mandrel low, the 914 transmission types (R = 63,20 mm) can be adjusted by means of the setting gauge (R = 63,50) which is 0,30 mm larger. When checking dimensions, this 0,30 mm must be taken into consideration.

5. Place measuring plate VW 385/17 on head of pinion.



6. Remove setting gauge and insert measuring mandrel into transmission housing. Dial indicator extension should be in range of measuring plate.

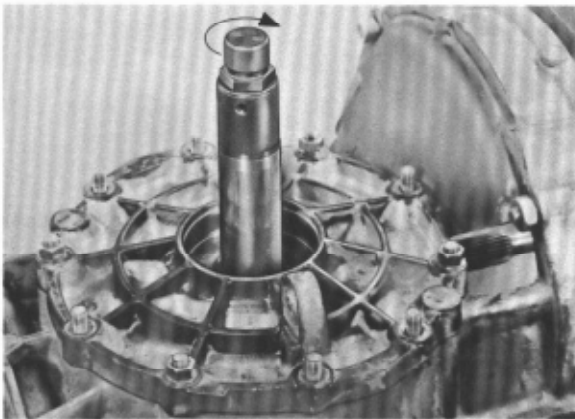


7. Place side (transmission housing) cover in position without O-ring and tighten nuts to specified torque.

**Note:**

Do not use hammer when positioning transmission side cover. The measuring plate is held by magnets and may slip from pinion head. Move transmission side cover into its installation position by uniform tightening of nuts.

8. Turn second centering disc with spindle outward until the measuring mandrel can just be rotated manually.



9. Rotate measuring mandrel carefully until dial indicator extension is in vertical position in relation to face end of pinion head. The needle of the dial indicator will then be at its reversing point, at which point the dial indicator should be read.

When reading the dial indicator, observe the following:

Adjusting value of measuring mandrel is 63,50 mm.

If the value measured by the dial indicator deviates from adjusting value of measuring mandrel in clockwise direction, that is, the dimension is smaller than 63,50 mm, the value deviating from 0 must be deducted from dimension 63,50 mm.

**Example:**

The small needle of the dial indicator is between 1 and 2, the large needle indicates 0,40 mm.

Adjusted dimension =	63,50 mm
- measured value	<u>./.</u> 0,40 mm
Dimension toward face of pinion	63,10 mm

Adjusting dimension "E" for example =	63,38 mm
- dimension toward face end of pinion	<u>./.</u> 63,10 mm
Thickness of paper gaskets	0,28 mm

The pinion should therefore be moved away from ring gear center by an additional 0,28 mm. This is obtained by adding a paper gasket 0,20 mm thick and another gasket 0,10 mm thick. (Measurements above 2 are rounded off to 5, and above 7, to 10.)

Paper gaskets are available 0,10, 0,15 and 0,20 mm thick.

Check adjustment value E , in example 63.38 mm, once again after adding paper gasket.

#### Checkup

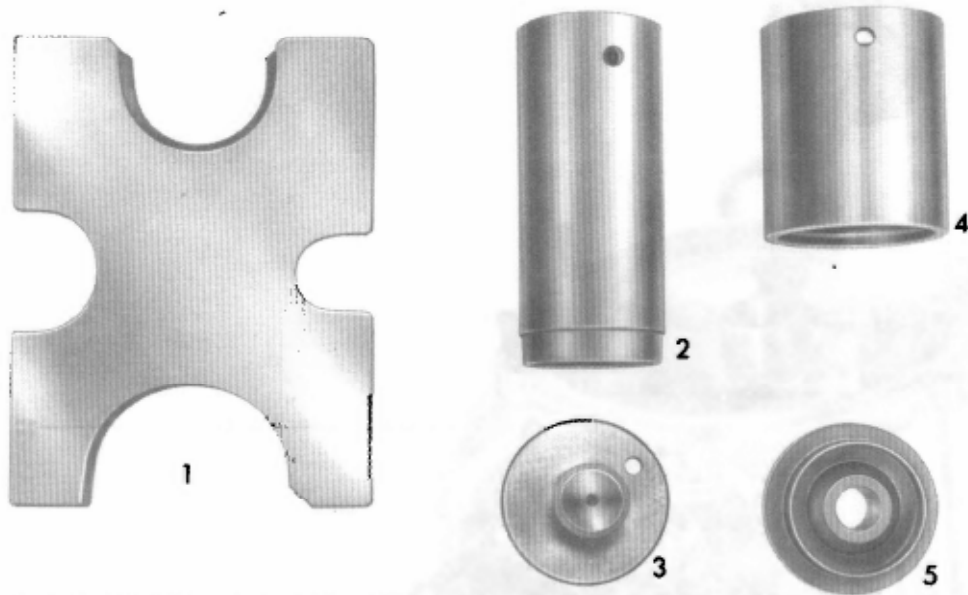
With correctly selected paper gaskets, using indicator gauge VW 385/12 (R = 63.50 mm), the dial setting should indicate the difference between the indicator gauge and the adjustment value "E" at a tolerance of  $\pm 0.03$  mm.

#### Example

Dimension of indicator gauge	63.50 mm
- adjustment value "E"	<u>63.38 mm</u>
Dial setting should indicate	0.12 mm
	$\pm 0.03$

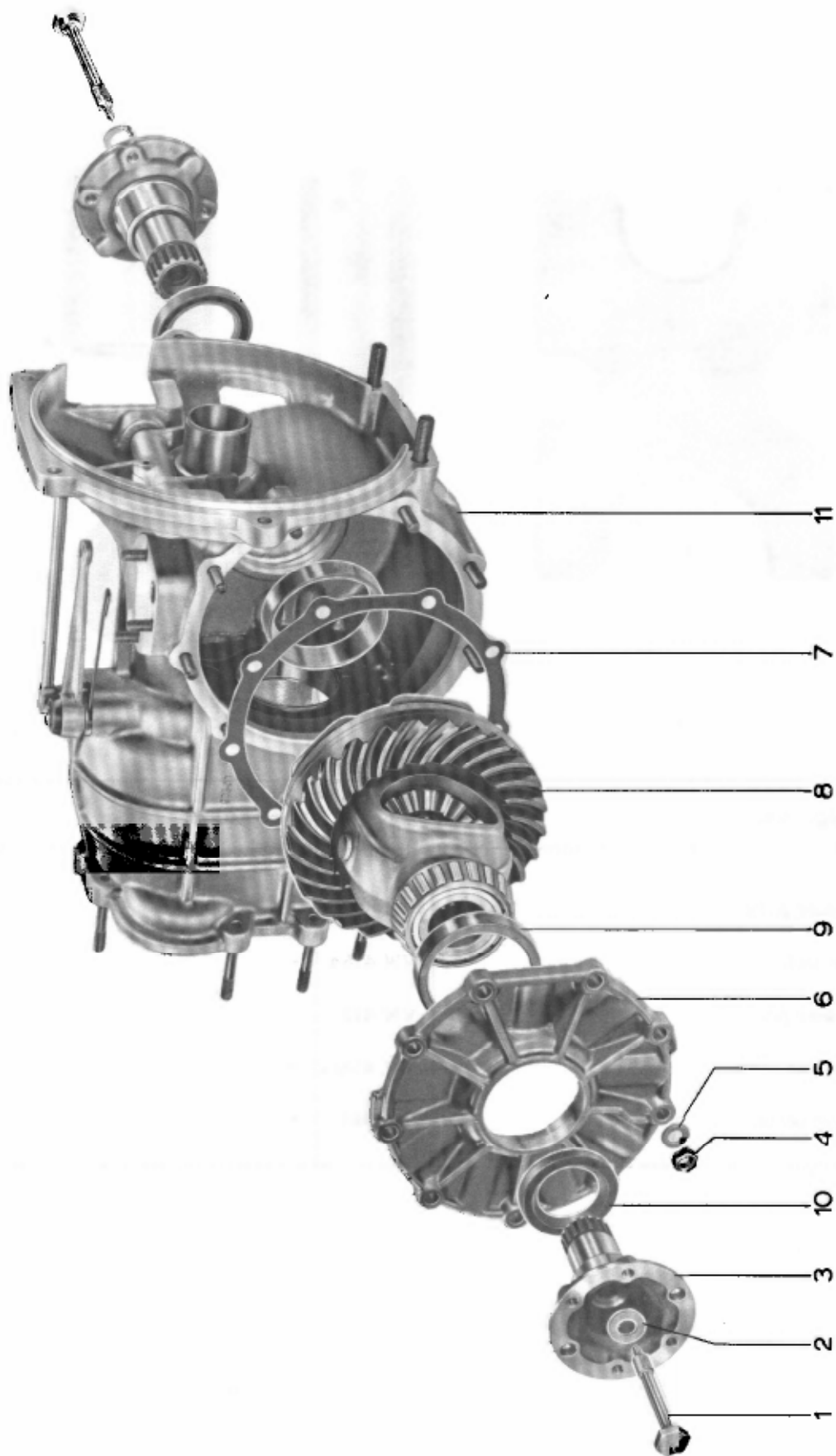
The small needle of the dial setting will then be between 1 and 2, the large needle will indicate 0.12 mm.

## TOOLS



No.	Designation	Special Tools	Explanations
1	Pressure plate	VW 402	-
2	Pipe tool	VW 415 a	-
3	Pressure pin	VW 412	-
4	Pipe tool	VW 459/2	-
5	Thrust piece	VW 442	-



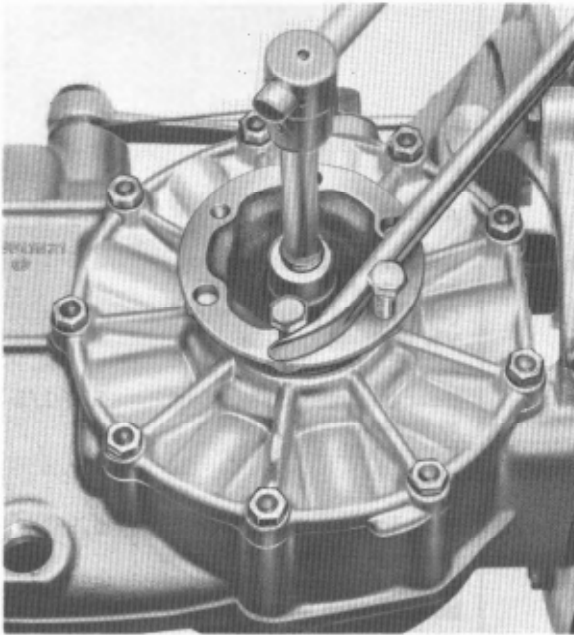


No.	Designation	Each	Observe during		Refs.
			Removal/Disassembly	Installation/Assembly	
1	Stretch bolt for flange shaft	2		Tighten to 3.5-4.0 mkp (25.3 - 28.9 ft/lb)	
2	Washer	2			
3	Flange shaft	2	Secure against rotation	Check for wear	5.2-1/4
4	Hex. nut M 8	9		Tighten to 2.0-2.5 mkp (14.5-18.0 ft/lb)	
5	Spring washer B 8	9			
6	Transmission housing cover	1			
7	Seal	1		Replace	
8	Differential	1		Adjust	5.2-4/1
9	Tapered roller bearing outer race	2	Knock out with punch	Heat transmission housing cover to approx. 120°C (248°F) and press in with VW 402, 412, 415a, 442 and 459/2	5.2-1/4
				Heat transmission housing to approx. 120°C and install with VW 442, 459/2	5.2-1/5
10	Sealing ring	2	Knock out with punch	Press into bearing cover with VW 408a and 472/1, Install in transmission housing with VW 442	5.2-1/4 5.2-1/5
11	Transmission housing	1			

## REMOVAL AND INSTALLATION OF DIFFERENTIAL

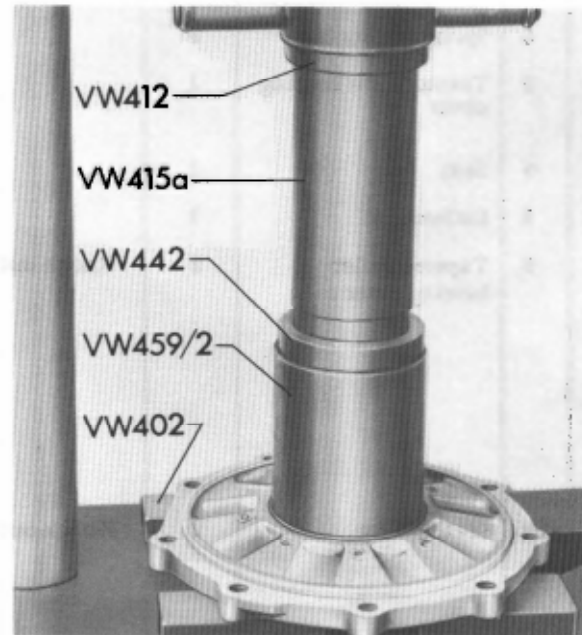
## Removal

- 1 - Remove servo motor.
- 2 - Unscrew breather screw for transmission housing.
- 3 - Unscrew stretch bolt for flange shaft and remove flange.



## Installation

- 1 - Check tapered roller bearing and differential and replace, if required.
- 2 - Heat transmission cover to approx. 120°C (248°F) and press bearing outer ring into cover using pressure plate VW 402, pressure pin 412, pipe tool 415 a, 459/2 and thrust piece 442.

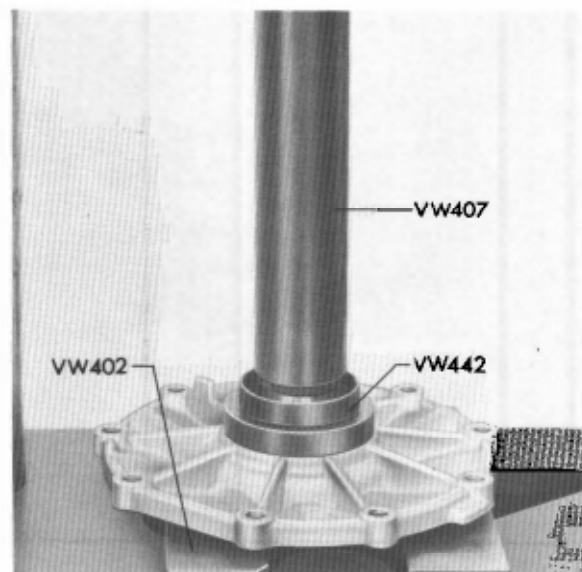


- 4 - Remove universal flange on opposite end.

- 5 - Loosen hex. nuts on lateral transmission cover and remove cover.

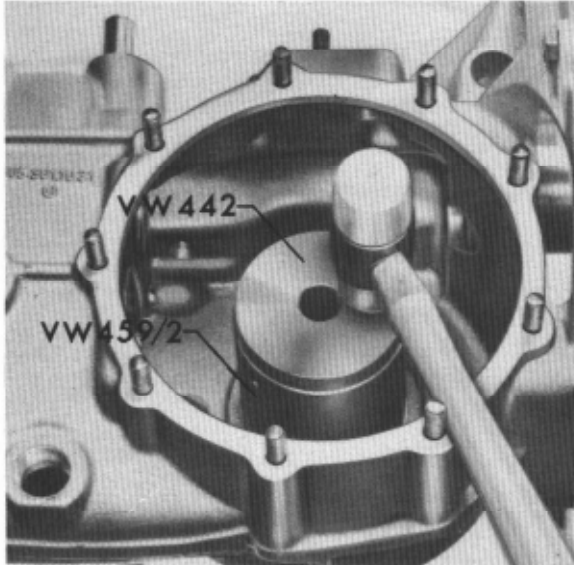
- 6 - Remove differential from transmission housing.

- 7 - Knock sealing ring and bearing outer race out of transmission cover and transmission housing by means of punch.

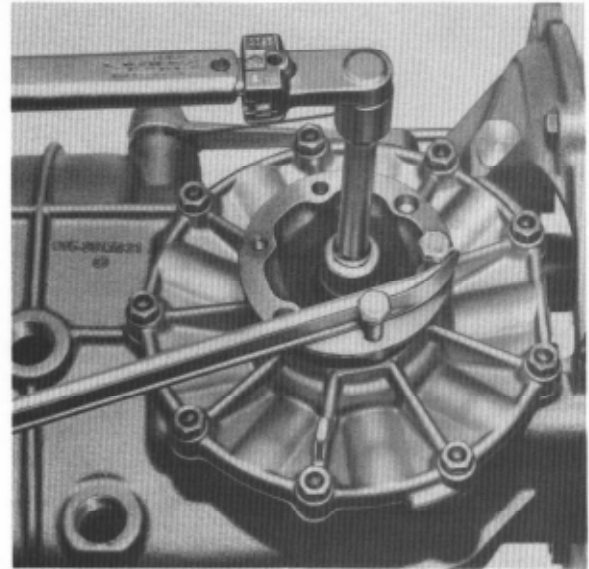


- 3 - Press in sealing ring with pressure plate VW 402, pressure pin 407 and thrust piece 442.

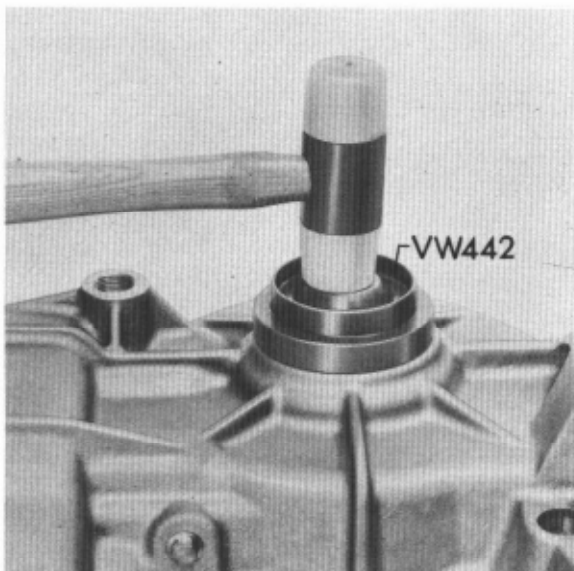
- 4 - Heat transmission housing to approx. 120°C (248°F) and force bearing outer race into transmission housing using thrust piece VW 442 and pipe tool 459/2.



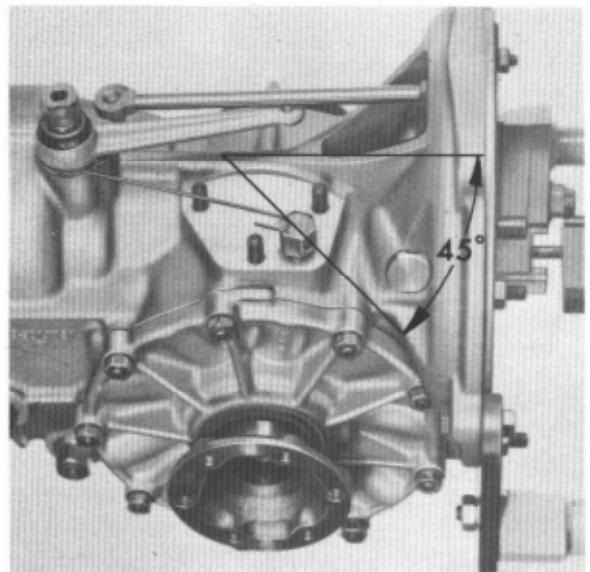
- 7 - Insert flange shafts and tighten stretch bolts to specified torque.



- 5 - Force sealing ring against stop in transmission housing using thrust piece VW 442.



- 8 - Screw breather screw into transmission housing.



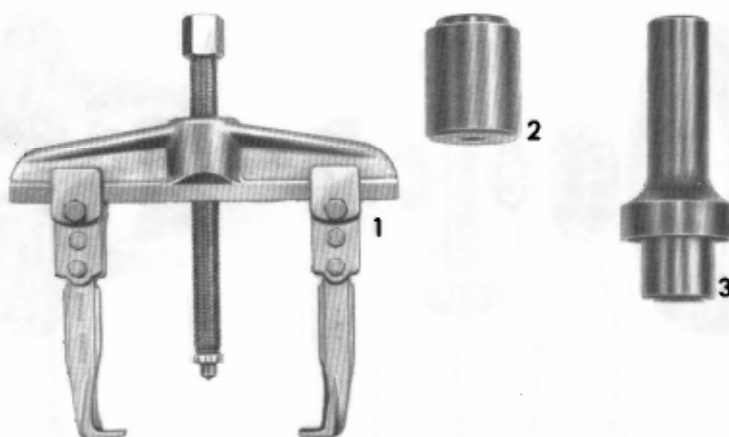
- 6 - Install differential in transmission housing, insert new paper seal for lateral transmission cover, position transmission cover, screw on hex. nut with spring washers and tighten to specified torque.

#### Caution!

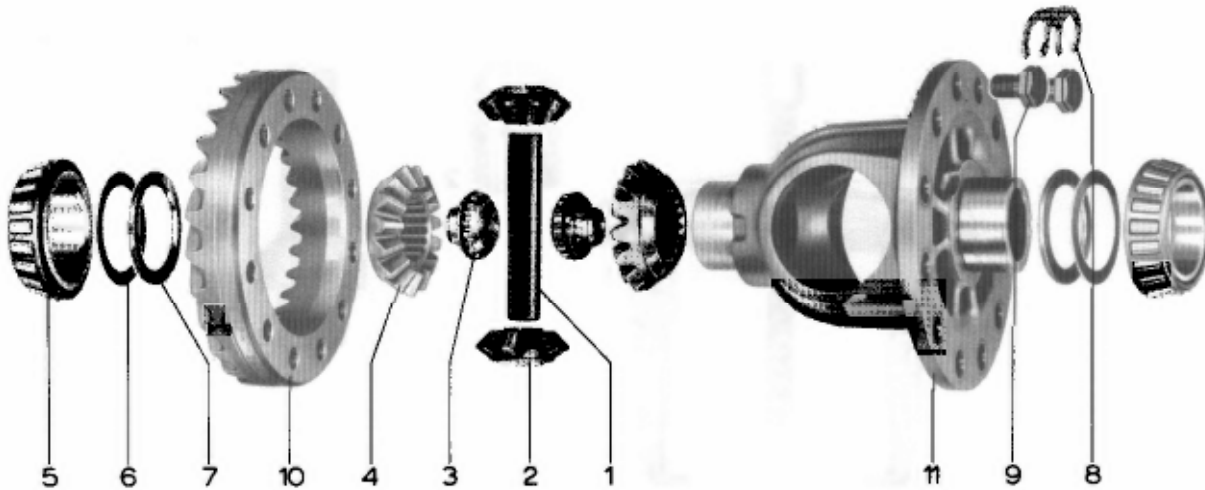
The bore in the hex. head should be at an angle of 45° in forward direction in relation to longitudinal axis of transmission.

- 9 - Attach servo motor.

## TOOLS



No.	Designation	Special Tools	Explanations
1	Puller	-	Kukko No. 21/5
2	Thrust piece	P 263	-
3	Thrust piece	P 264	-



No.	Designation	Each	Observe during		Refs.
			Removal/Disassembly	Installation/Assembly	
1	Bolt/small differential pinion	1	Knock out w. mandrel	Observe location of bore	5.2-2/4
2	Small differential pinion	2		Check for wear	
3	Nut with circlip for stretch bolt	2			
4	Large differential pinion	2		Check for wear	
5	Tapered roller bearing inner race	2	Pull with Kukko No. 21/5 and P 263	Heat to approx. 120°C (248°F) for fitting and press in	5.2-2/3
6	Adjusting washer	X			
7	Spacer washer	2			
8	Lock washer	6		Replace	
9	Hex. screw	12		Tighten to 10.0 mkp (72 ft/lb)	
10	Ring gear	1			
11	Differential housing	1			

## DISASSEMBLY AND ASSEMBLY OF DIFFERENTIAL

## Disassembly

- 1 - Knock out differential bolt with mandrel.



- 2 - Twist pinions in such a manner that the small pinion can be removed through the lateral holes in the differential housing and remove large pinions with threaded components.
- 3 - Pull both tapered roller bearings with puller and thrust piece P 263.



## Note:

For this purpose, the claws of the two arms must be slightly ground off laterally.

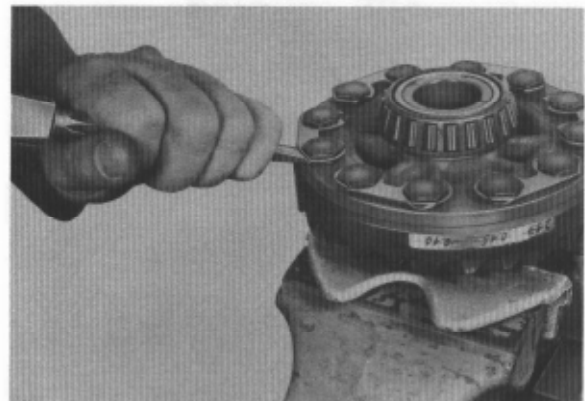
## Caution!

Do not confuse the adjusting washers and spacer rings on both sides.

- 4 - Remove lock washers on hex. bolts of ring gear, loosen hex. bolts and remove ring gear.

## Assembly

- 1 - Check differential housing, small and large differential pinions, bolts for small differential pinions and tapered roller bearing for wear or damage and replace, if required.
- 2 - Place ring gear on flange of differential housing and tighten hex. bolts to specified torque.
- 3 - Slide lock washer into groove of hex. bolts, tighten at front with pliers so that the lock washer is tightly connected with hex. bolt and secure in downward direction against hex. surface.

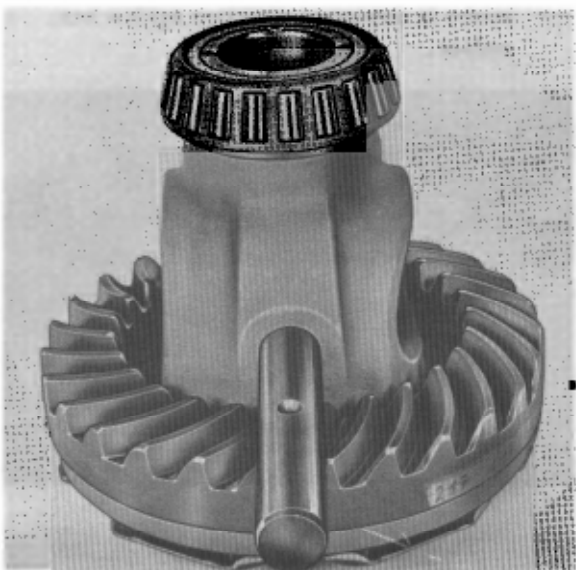




- 4 - Coat thrust surfaces of differential pinions in differential housing with  $MOS_2$  paste, insert large differential pinions through oval hole in differential housing and locate in relation to universal flanges.



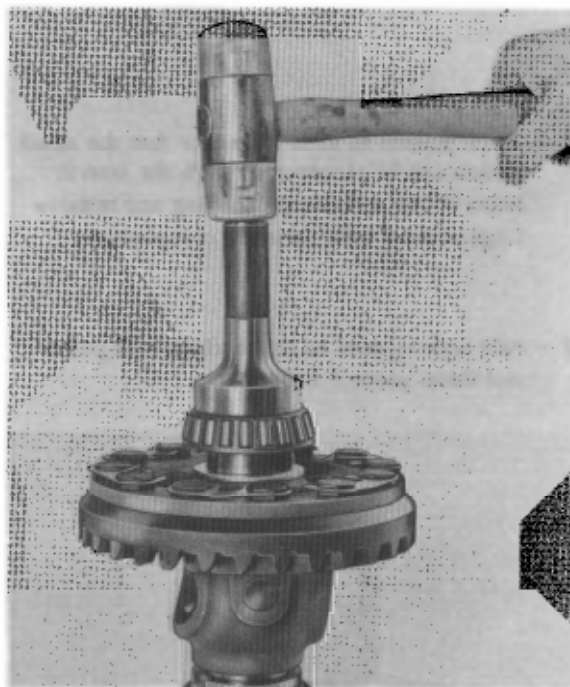
- 5 - Insert small differential pinions through opposite holes in housing in between the large differential pinions and turn until the bores of the gears are in alignment with the bores of the housing.
- 6 - Insert threaded components with circlip into large differential pinion and force in bolt for differential.



#### Caution!

The fixing hole in the differential bolt should be centrally in axial direction of the differential, since the tips of the stretch bolts extend into the hole and thereby secure the bolt in axial direction.

- 7 - Place marked or measured adjusting washer and spacer ring for tapered roller bearing on differential housing and fit tapered roller bearing with thrust piece P 264.

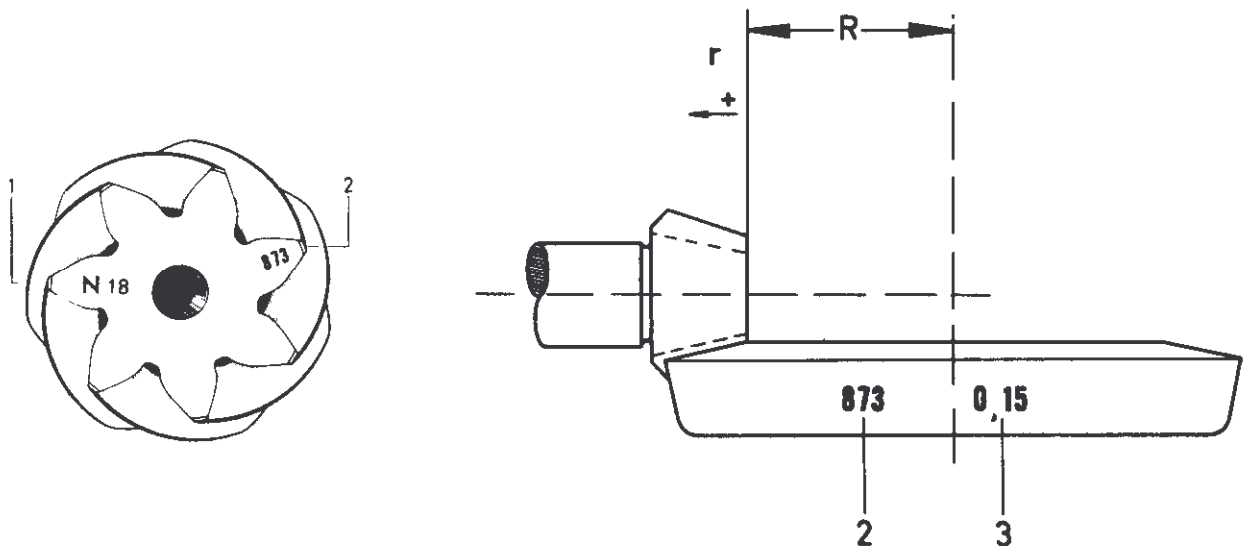


- 8 - If required, adjust pinion and ring gear again. Refer to "Adjustment of Pinion and Ring Gear", page ...

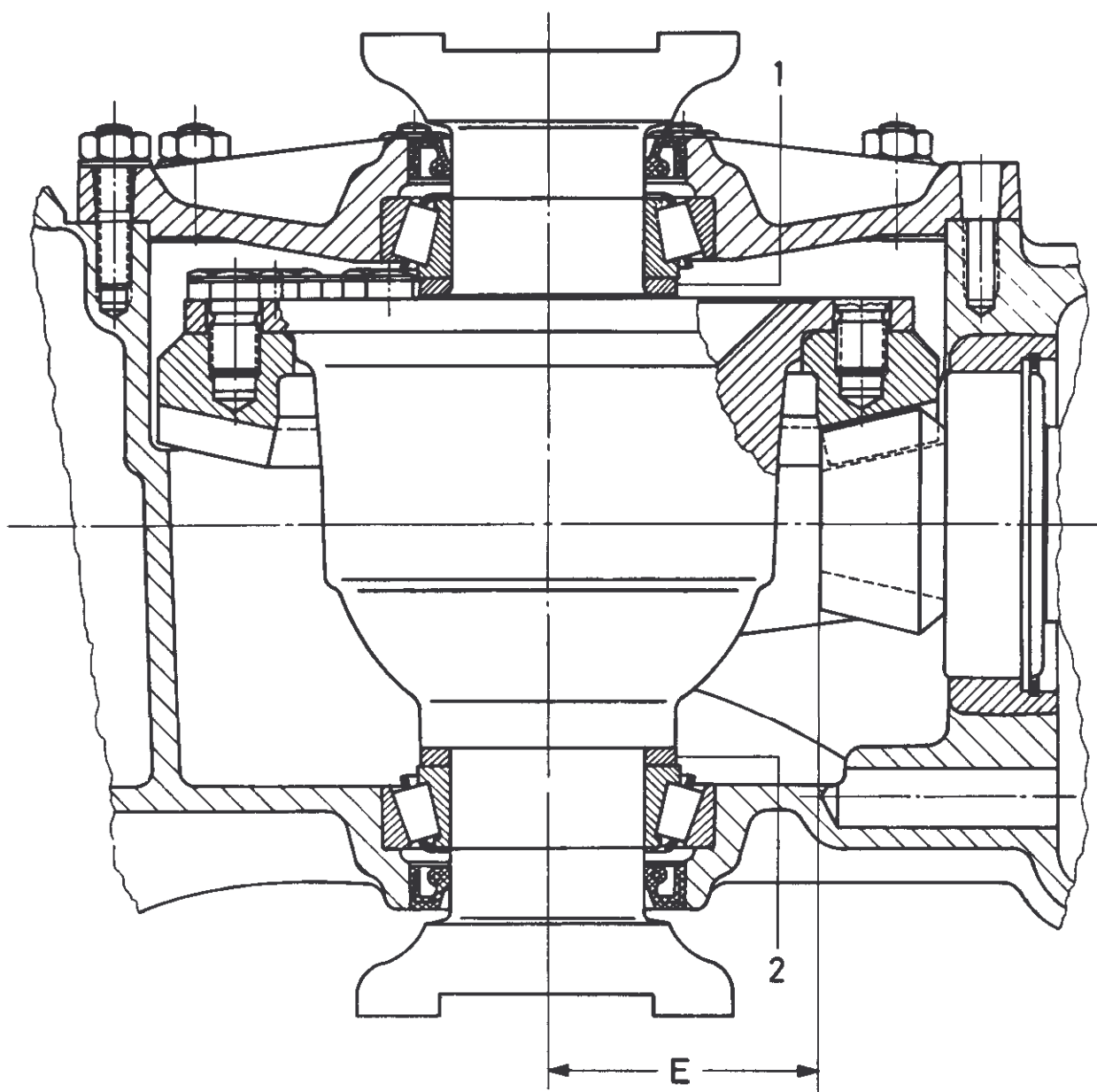


**General:**

Quiet operation and long service of the rear axle depend on proper adjustment of the pinion shaft and ring gear. For this reason, pinion shafts and ring gears are mated already in the course of production and are checked on special test devices for best contact patterns and minimum noise in both directions of rotation. The position for minimum noise is determined by moving the pinion shaft axially while keeping the ring gear within tolerances of prescribed gear backlash of 0,12 and 0,18 mm. The deviation "r" from the designed adjustment position (blue print dimensions "R") is determined and etched into the pinion shaft face. The ring gear and the pinion shaft are designed in such a manner that the dimension "r" is always additive in relation to the designed dimension "R", and therefore carries the prefix +. To differentiate from earlier pinion shaft sets, in which the deviation "r" could be + or -, this pinion shaft assembly carries a large "N" in front of the value "r" on face of pinion shaft. Each pinion-shaft-ring-gear set is provided with a mating number and should be exchanged only together.



- R Blue print value (54,20 mm for Sportomatic transmission)  
 r Deviation from R indicated in mm (N 18)  
 1 Deviation r  
 2 Mating number  
 3 Backlash



- 1 Spacer S1
- 2 Spacer S2
- E Adjustment value

Meticulous care and cleanliness in all service and measuring operations is an essential prerequisite for good results.

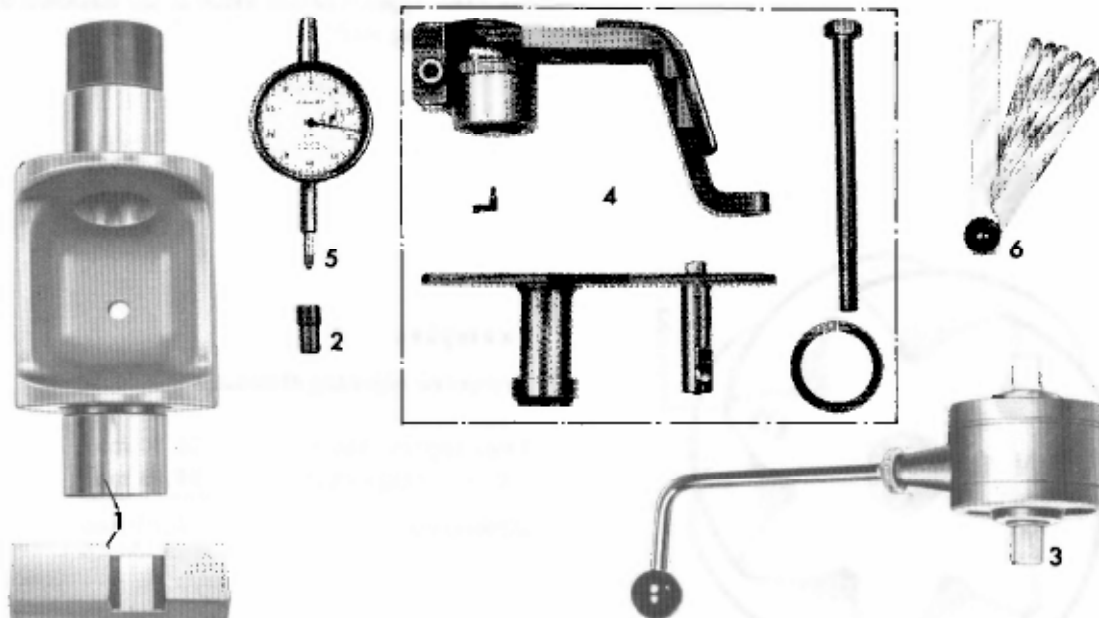
To eliminate unnecessary adjusting jobs, the following table should be observed:

Replaced part	Adjust:	
	Pinion	Ring gear
Transmission housing	X	X
Lateral transmission cover		X
Tapered roller bearing f. differential		X
Ring gear and pinion	X	X
Intermediate plate	X	
Four-point ball bearing	X	
Thrust washer 6.6 mm thick	X	
Bushings for needle bearings 1st and 2nd Gear	X	
Guide sleeve	X	
Thrust washer	X	
Fixed wheel 3rd gear	X	
Fixed wheel 4th gear	X	
Spacer bushing	X	
Spacer washer	X	
Cyl. roller bearing	X	

Suitable sequence when newly adjusting pinion shaft assy.

- A - Determine total thickness of spacer rings for ring gear adjustment
- B - Adjust pinion shaft
- C - Adjust ring gear (backlash) and inspect

## TOOLS

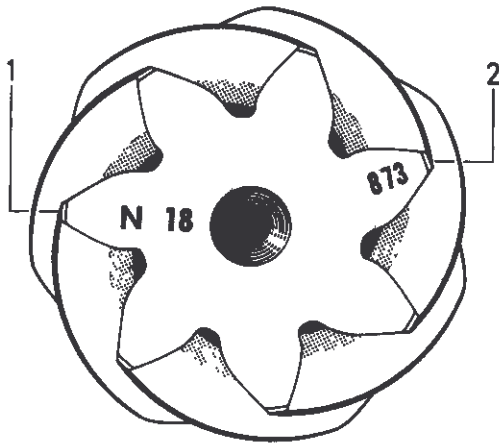


No.	Designation	Special Tools	Explanations
1	Gear measuring gauge	P 258	with adjusting piece
2	Bushing	P 365	
3	Torque gauge	-	conventional, measuring range 0-35 cmkg
4	Measuring device	P 357	in 5 parts
5	Dial gauge	-	conventional, measuring range 0-10 mm
6	Feeler gauge, assortment	-	conventional, 0.05-1.0 mm

**DETERMINATION OF ADJUSTING WASHERS FOR PINION SHAFT**

The fixed designed dimension  $R = 54.20$  mm of the deviation  $r$  on pinion shaft face is used to determine the adjusting dimension  $E$ .

A so-called basic approximation value (empirical value) of 55.70 mm permits determining the thickness of the adjusting washers in advance. The difference between the adjusting dimension  $E$  and the basic approximation value is the thickness of the adjusting washer.



Example:

Computed adjusting dimension  $E = 54.38$  mm

Basic approx. value	55.70 mm
- $E$ (adjusting dim.)	<u>54.38 mm</u>
Difference	<u><u>1.32 mm</u></u>

Thickness of adjusting washers = 1.32 mm.

- 1 Deviation  $r$  in mm (N 0.18)
- 2 Mating number

Adjusting washers are available 0.25 mm, 0.30 mm and 0.40 mm thick.

Example:

The pinion shaft face shows the deviation  $r$  N 0.18

$R$ (design dimensions)	54.20 mm
	+ 0.18 mm
	<u>54.38 mm</u>
$E$ (adjusting dimension)	<u><u>54.38 mm</u></u>

Required adjusting washers:

- 2 each 0.40 mm,
- 1 each 0.30 mm,
- 1 each 0.25 mm.

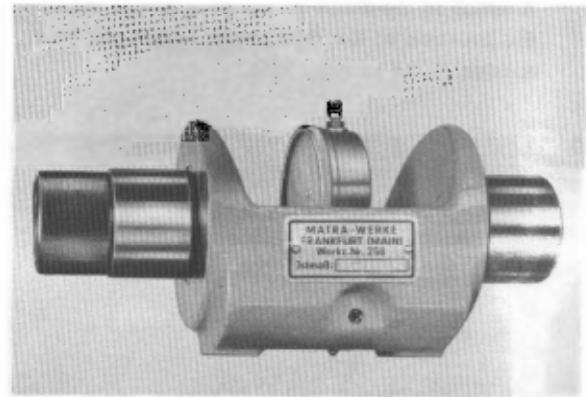
Values are always rounded off to the next higher or lower 0.05 mm number.

## B - ADJUSTMENT OF PINION SHAFT

### General:

Determine adjustment value E from known blue print value  $R = 54,20 \text{ mm} + \text{deviation } r$  shown on pinion face (refer to page 5.2 - 4/2).

the like) and attach dial gauge at 1.5 mm preload to transmission plug gauge - small pointer between 1 and 2, large pointer to 0.



### Adjustment:

- 1 - Insert preassembled intermediate plate, with gears and selector shaft, into transmission housing, omitting the paper gasket, place spacer bushings onto 4 opposing housing studs and tighten nuts in crosswise fashion.

The pinion shaft is already roughly adjusted during assembly by inserting adjusting washers.

### Caution!

The pinion shaft stretch bolt must be tightened to the specified torque prior to taking measurements.

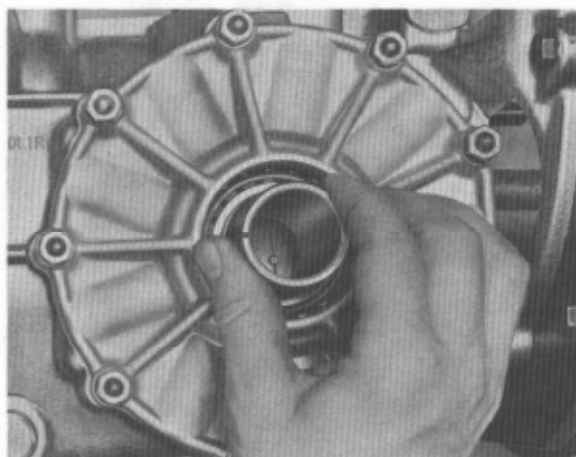
- 3 - Install transmission plug gauge P 258 with tapered roller bearings into transmission housing in such a manner that the plug gauge is under an axial pressure of approx. 0.1 mm with the lateral transmission cover mounted. The plug gauge should never have any axial play while measuring.

- 2 - Insert dial gauge into transmission plug gauge P 258, using bushing P 365. Place transmission plug gauge on a plane surface (surface plate or

(The plug gauge can be adjusted free of play in axial direction by means of the differential spacer rings).

- 4 - Carefully turn plug gauge until the feeler pin of the dial gauge comes to right angle with the face of the pinion. At this point, the gauge pointer will show the highest reading, i.e., the one to be noted.

A notch in the flank of the plug gauge shows the location of the dial gauge feeler pin from outside (refer to Fig. 182).



Note the following when reading the dial gauge:

The distance from the center axis of the plug gauge to its resting base at the setting plate is indicated on the side of the plug gauge as actual value, for instance actual value = 54.015. This value is then the one actually set on the dial gauge.

If the gauge reading differs in clockwise direction from the originally adjusted value (for example 54.015 mm), then the distance is smaller than 54.015 mm, that is, the value differing from zero must be deducted from the dimension 54.015.

Example:

If the large pointer of the dial gauge is between 1 and 2, the large pointer is at 0.02 mm.

Dial gauge adjustment	54.015 mm
- measured value	0.020 mm
<hr/>	
Distance to face of pinion	<u>53.995 mm</u>
<hr/>	
Adjustment value E (as example)	54.42 mm
- distance to face of pinion	53.99 mm
<hr/>	
Thickness of paper gaskets	<u>0.43 mm</u>

The pinion shaft should therefore be moved away from the ring gear center by 0.43 mm. This is accomplished by inserting paper gaskets 0.45 mm thick. (Decimal fractions are rounded off as follows: 3 and up = into 5, 7 and up = into 10).

If the dial gauge reading differs in counter-clockwise direction from the originally adjusted value (54.015 mm) then the distance is larger than 54.015, that is, the excess in relation to zero must be added to the value of 54.015 mm.

Example:

If the small pointer is slightly beyond 1, the large one at 0.24 mm.

Dial gauge adjustment	54.015 mm
+ measured value	+ 0.24 mm
<hr/>	
Distance to face of pinion	<u>54.25 mm</u>
<hr/>	
Adjustment value E (as example)	54.54 mm
- distance to face of pinion	- 54.25 mm
<hr/>	
Thickness of paper gaskets	<u>0.29 mm</u>

Note:

It is permissible to install paper gaskets in thicknesses of 0.10 to 0.50 mm between the housing and intermediate plate. If this is insufficient for obtaining proper adjustment, it will be necessary to disassemble the pinion shaft again and to change the adjustment shims accordingly.

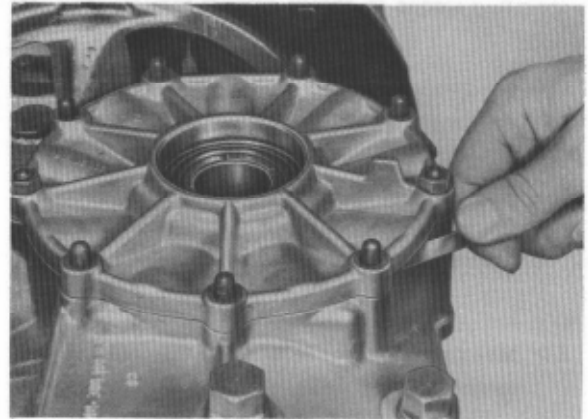
Paper gaskets are available in thickness of 0.1, 0.15, and 0.2 mm.

Subsequent to the installation of the paper gaskets, the adjustment value E must be checked again. Deviations of + 0.03 mm are permissible. It is not required to check the gear contact pattern again.

#### A - DETERMINATION OF TOTAL THICKNESS OF SPACER RINGS FOR RING GEAR ADJUSTMENT

- 1 - Be sure that the bearing outer races of the tapered roller bearings in the transmission housing or lateral transmission cover are seated well.
- 4 - Slightly press lateral transmission cover by means of two opposite nuts against tapered roller bearing and determine distance between cover and gasket with feeler gauge (approx. value for pressure against tapered roller bearing 0.15 mm).

- 2 - Fit a spacer ring (S1) 3.5 mm thick, and at the opposite end a spacer ring (S2) 3.0 mm thick under tapered roller bearings at the ring gear end of the differential housing to be used.



- 5 - If the approx. value of 0.15 mm is not attained, replace spacer ring (S1).

- 3 - Insert differential with tapered roller bearings into transmission housing and position lateral transmission cover (without sealing ring) with gasket (0.20 mm thick).

#### Example:

Value measured with feeler gauge = 0.40 mm  
 - approx. value for axial pressure = 0.15 mm  
 The installed spacer ring S1 of 3.5 mm thickness must be replaced by ring thinner by 0.25 mm = 3.25 mm thick.



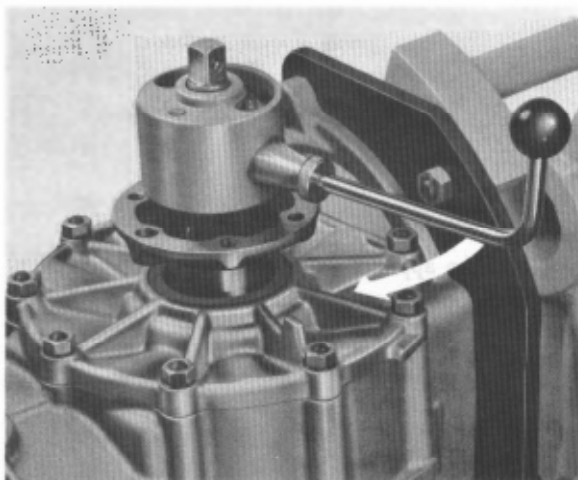
- 6 - Tighten lateral transmission cover well (with gasket 0,20 mm thick).

**Caution!**

All nuts must be inserted and tightened to the specified torque to obtain correct results.

- 7 - Slide disk of special tool P 357 on universal flange and place flange in position. Tighten stretch bolt with washer slightly.

- 8 - Measure torque of assembled differential with torque gauge P 261.



**Caution!**

While measuring the torque, the pinion shaft should not be in mesh and the gasket on the lateral transmission cover should be removed, so that no additional friction will occur.

The attained torque should be 18 to 24 cmkp to provide the correct axial pressure against tapered roller bearings. If required, replace spacer ring once again to obtain correct value.

- 9 - Remove differential, pull off both tapered roller bearings and measure thickness of spacer rings with a micrometer at 4 points of the ring circumference. When added, the values of the two spacer rings provide the total thickness of the spacer rings for ring gear adjustment.

The starting point for the subsequent adjustment of the backlash (ring gear - pinion shaft) the spacer ring S1 is selected 0,1 mm thinner than the spacer ring S2 (refer to Fig. ).

**Example:**

Total thickness of spacer rings

$$S1 + S2 = 6,25 \text{ mm}$$

Thickness of spacer ring S1

$$\begin{array}{r} \underline{6,25 \text{ mm}} \\ 2 \\ \hline = 3,125 \\ - 0,10 \\ \hline \underline{\underline{3,025}} \end{array}$$

Thickness of spacer ring S2

$$\begin{array}{r} \underline{6,25 \text{ mm}} \\ 2 \\ \hline = 3,125 \\ + 0,10 \\ \hline \underline{\underline{3,225}} \end{array}$$

**Note:**

Spacer rings are available in thickness of 2,5 - 3,7 mm in steps of 0,10 mm.

A washer 0,25 mm thick permits ring steps spaced 0,05 mm apart. The computed ring dimensions are thereby rounded off to applicable dimensions so that the total thickness of rings S1 and S2 is not changed.

**Example:**

Computed ring thicknesses

$$S1 + S2 = 3,025 + 3,225 = 6,25 \text{ mm}$$

Rounded off ring thicknesses

$$S1 + S2 = 3,0 + 3,25 = 6,25 \text{ mm}$$

Measure ring thickness with micrometer at four points of ring circumference. Permissible deviation: 0,02 mm.

Remove burr, if any, on edges of rings prior to measuring.

## C - ADJUSTMENT OF RING GEAR BACKLASH

- 1 - Slide preassembled intermediate plate with gear set and shift rods into transmission housing using the paper gaskets determined when adjusting the pinion shaft and screw crosswise to transmission housing by means of 4 spacer bushings and studs.

**Caution!**

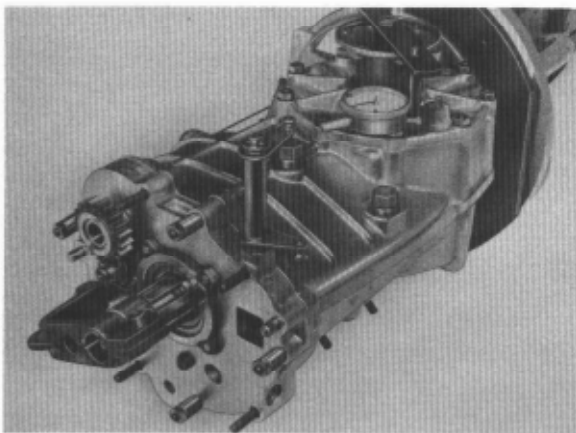
The stretch bolt of the pinion shaft should be tightened to the specified torque prior to measuring.

- 2 - Insert differential with tapered roller bearings and determined spacer rings (S1 and S2) into transmission housing.
- 3 - Mount lateral transmission cover with paper gasket (0.20 mm thick).

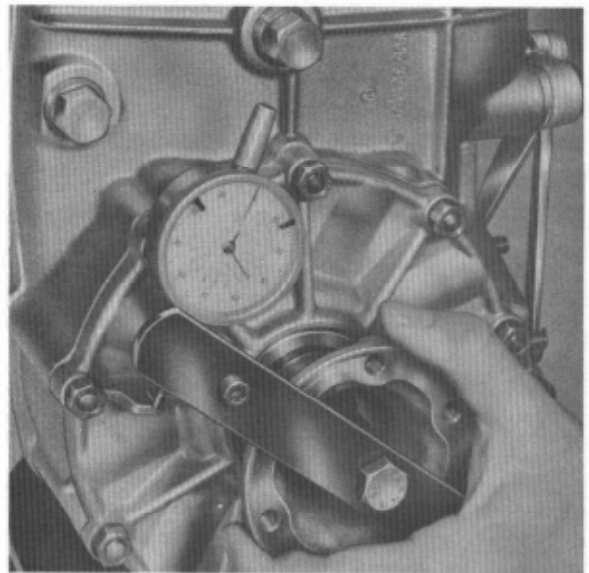
**Caution!**

When tightening the nuts for the lateral transmission cover check to ensure that a certain side play exists. In no case is it permissible to allow the pinion and ring gear to jam or bind.

- 4 - Tighten all hex. nuts of lateral transmission cover to specified torque.
- 5 - Block pinion shaft at stretch bolt with holding fixture P 357 (refer to illustration).



- 6 - Slide disk of special tool P 357 on flange shaft and mount flange shaft. Attach dial gauge to dial gauge holder P 357 and screw dial gauge holder lightly down by means of hex. bolt (M 10 x 130) and universal shaft.
- 7 - Screw offset feeler point on dial gauge and adjust dial gauge to a slight preload, with the feeler tip in center position in relation to the measuring rib on transmission cover. Tighten hex. bolt and cheesehead screw on dial gauge holder.
- 8 - Move dial gauge holder lightly against stop at both ends and read backlash on dial gauge.



- 9 - After turning ring gear by 90°, repeat measurements. The measured values should not deviate by more than 0.05 mm in relation to each other.

A backlash of 0.12 to 0.18 mm is permitted.

**Caution!**

The accurate backlash is shown on ring gear.

- 10 - Special tools P 263 and P 264 are used to exchange spacer rings (S1 and S2), until the permissible backlash has been obtained. Be sure that the total thickness of the spacer rings is not changed.
- 11 - Check radial sealing rings for universal flange and replace, if required.