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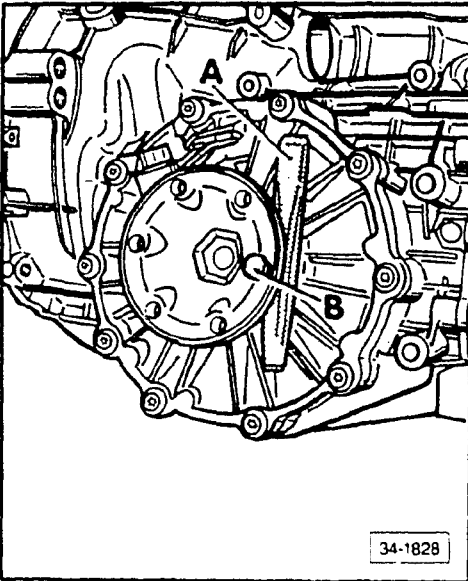
#### Speedometer gear

- replacing 39.3

## Drive flange oil seals, removing/ installing (transmission installed)

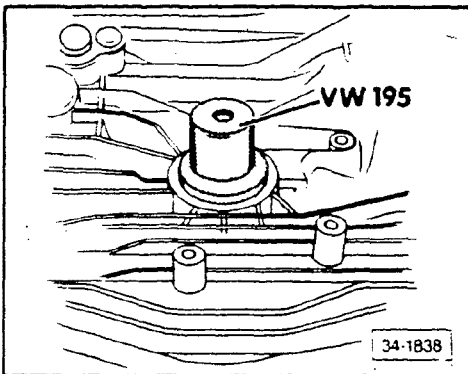
### Removing

- remove axle shaft from drive flange
- place oil pan under vehicle
- remove flange shaft by placing chisel **A** under flange shaft and turning bolt **B** to pull shaft out
- remove oil seals with extractor lever **VW 681**
- replace flange shaft circlip. See page 39.3

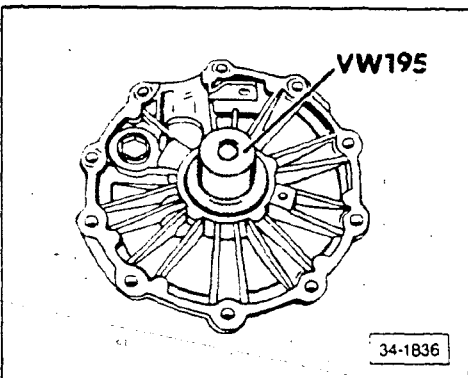


### Installing

- drive in right side seal 5 mm (0.196 in.) below edge of housing



- drive in left side seal 5 mm (0.196 in.) below upper edge of final drive cover

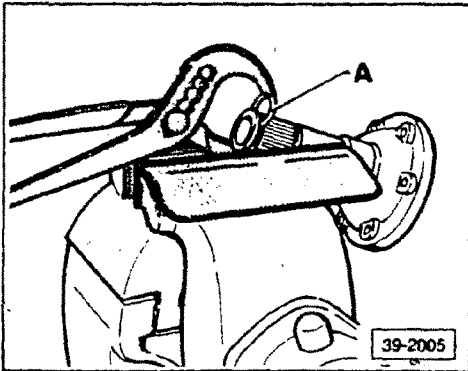


- fill space between lips of seal with multi-purpose grease
- drive in flange shaft with drift **VW 295**
- bolt axle shaft to flange
  - M8 bolts 45 Nm (33 ft lb)
  - M10 bolts 80 Nm (59 ft lb)
- refill transmission oil

## Flange shaft circlip, replacing

Always replace the flange shaft circlip before installing the flange shaft.

- clamp flange shaft in vise
- place opening of new circlip **A** over opening of old circlip in groove
- press circlip into groove with pliers while also pressing old circlip out



## Speedometer gear, replacing

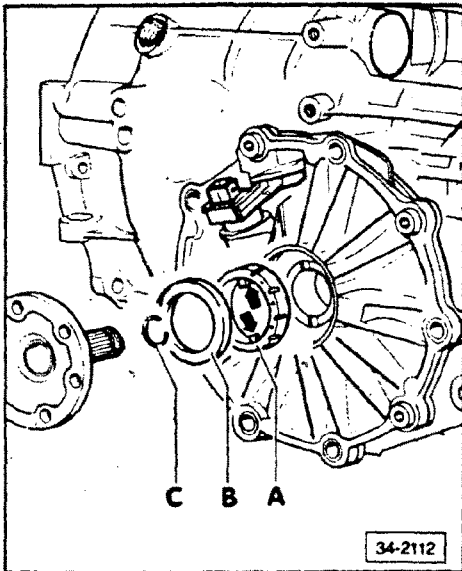
The speedometer gear **A** can be replaced with the transmission installed.

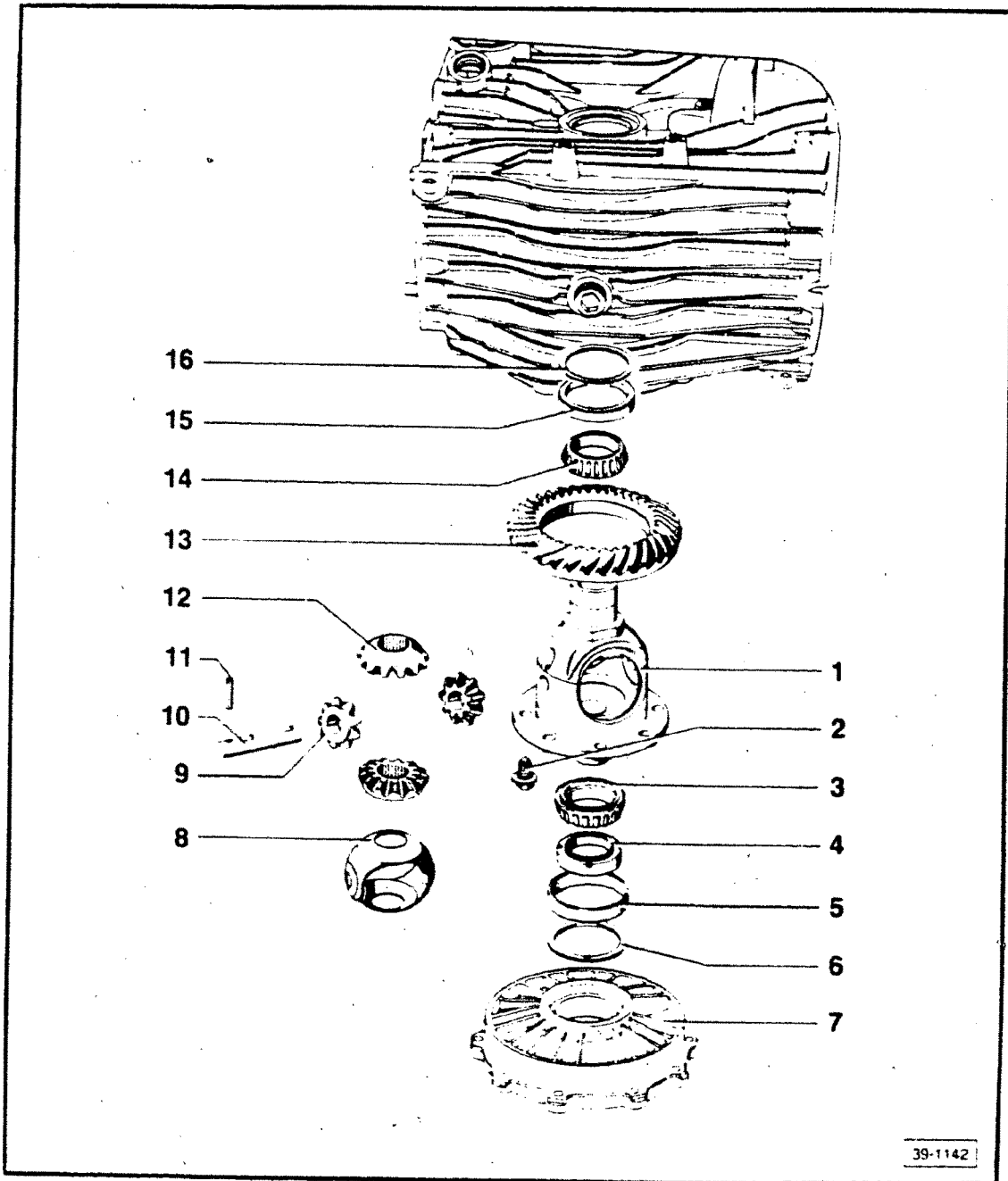
- remove left side axle shaft flange from flange on transmission
- remove flange shaft and seal **B**
- remove speedometer gear **A** by prying alternately on tabs (arrows) with a screwdriver

### Note

When installing the speedometer gear, the tabs on the gear must point toward the seal. The tabs also lock into grooves in the differential gear housing.

- install new seal **B** and circlip **C** for flange shaft
- top up transmission oil if necessary

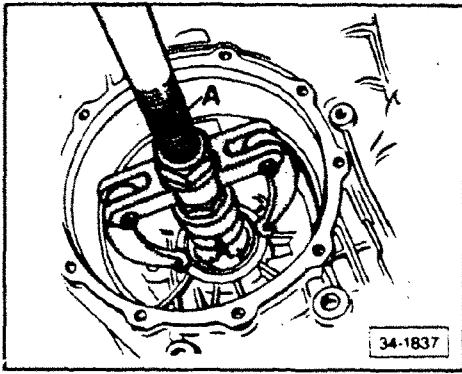




- 1 — **Differential housing**  
adjust ring gear if replacing
- 2 — **Ring gear bolt**
  - use only part number specified
  - tighten evenly in diagonal sequence, to 90 Nm (66 ft lb)
- 3 — **Differential bearing, large — inner race**
  - removing, Fig. 5
  - press in with sleeve 40-21
- 4 — **Speedometer gear**  
can be removed with transmission installed

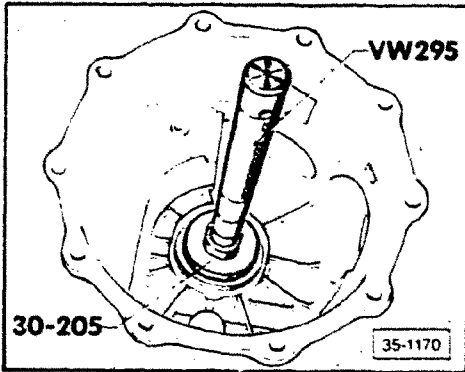
- 5 — **Differential bearing, large — outer race**
  - removing, Fig. 6
  - drive in with VW 295 and VW 551
- 6 — **Shim S1**
  - note thickness
  - Adjustment Overview, page 39.11
- 7 — **Cover**
- 8 — **Thrust washer**  
coat with transmission oil before installing

- 9 — **Differential pinion gears**  
installing, Fig. 7
- 10 — **Differential pinion shaft**  
drive out with drift after removing roll pin
- 11 — **Roll pin**  
drive out with drift
- 12 — **Differential side gears**  
installing, Fig. 7
- 13 — **Ring gear**
  - drive pinion and ring gear are matched set
  - when replacing set, adjust (see Adjustment Overview, page 39.11)
  - removing, Fig. 4
  - installing: heat to 100°C (212°F) and use centering pins to guide part
- 14 — **Differential bearing, small — inner race**
  - removing Fig. 3
  - press in with sleeve 40-21
- 15 — **Differential bearing, small — outer race**
  - removing, Fig. 1
  - installing, Fig. 2
- 16 — **Shim S2**
  - note thickness
  - Adjustment Overview, page 39.11

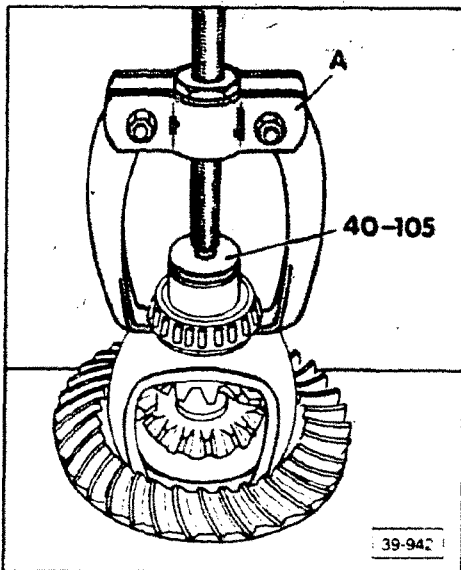


► Fig. 1 Differential bearing, small — outer race, removing

- use 46 mm-56 mm puller. A — e.g. US 1037 (Kukko 21/7) or US 1039 (Kukko 22/2)

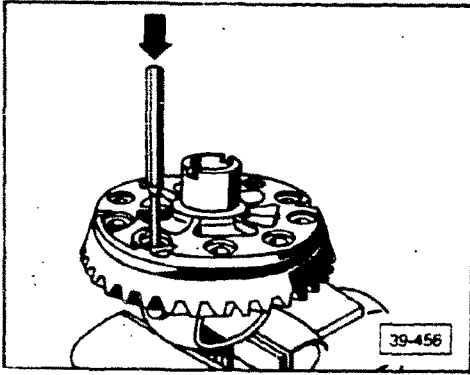


► Fig. 2 Differential bearing, small — outer race, installing

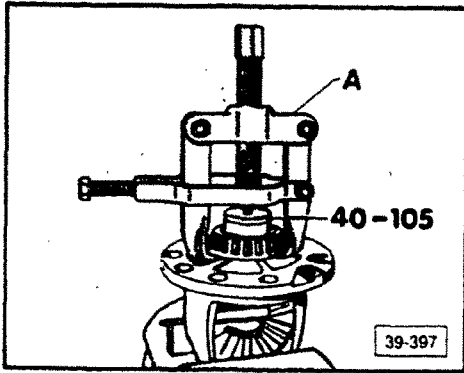


► Fig. 3 Differential bearing, small — inner race, removing

- A — two-arm puller. e.g. Kukko 44/2

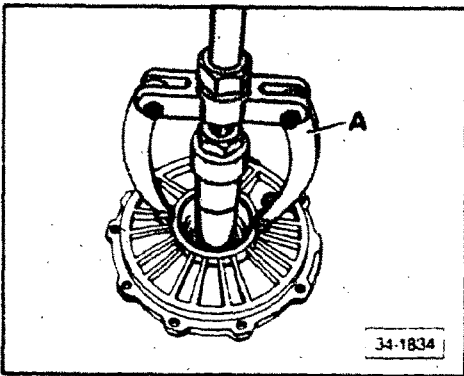


► Fig. 4 Ring gear, removing



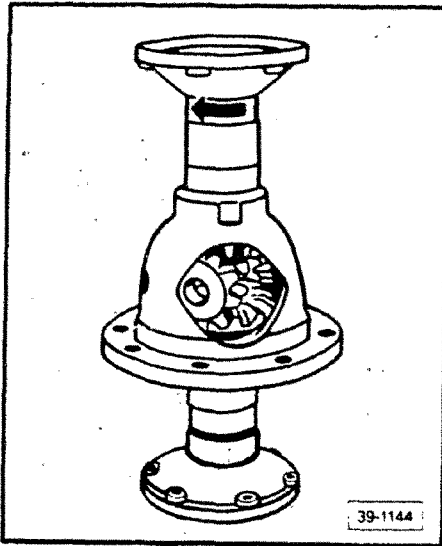
► Fig. 5 Differential bearing, large — inner race, removing

A — two-arm puller, e.g. Kukko 204/2



► Fig. 6 Differential bearing, large — outer race, removing

■ use 46 mm- 56 mm puller. A — e.g. US 1037 (Kukko 21/7) or US 1039 (Kukko 22/2)



► Fig. 7 Differential gears, installing

- install one-piece thrust washer coated with transmission oil
- install differential side gears
- install flange shafts without lock ring
- install differential pinion gears approximately 180° apart and pivot into place by turning flange shaft (**arrow**)
- align thrust washers and pinion gears
- drive in differential pinion shaft and secure with roll pin



## Ring gear/pinion, adjusting

### General notes

Careful adjustment of the ring gear and pinion is important to ensure that the final drive runs quietly and has a long service life. During manufacture, the ring gear and pinion are matched to each other, then inspected on special testing machines to ensure a correct mesh pattern and silent running in both directions. The quietest running position is determined by moving the pinion axially and lifting the ring gear away from the no-play meshing position, maintaining the backlash within specified tolerance.

The deviation  $r$  from the master gage  $R_0$  is measured for the ring gear pinion sets supplied as replacement parts. The value of  $r$  is marked on the outer face of the ring gear. Ring gear and pinion must always be replaced as a matched set.

### Replacement parts, identifying

- 1 — Number **O937** identifies Oerlikon gear sets with 9.37 ratio
- 2 — Matching number (**312**) on ring gear/pinion set
- 3 — Deviation  $r$  (pinion deviation) measured against the master gage of the testing machine used in production. The deviation  $r$  is always given in 1/100 mm

### Example

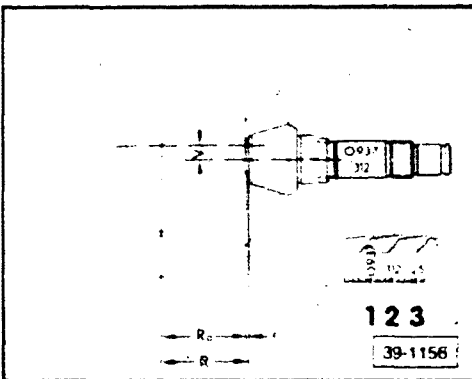
"25" means  $r = 0.25$  mm

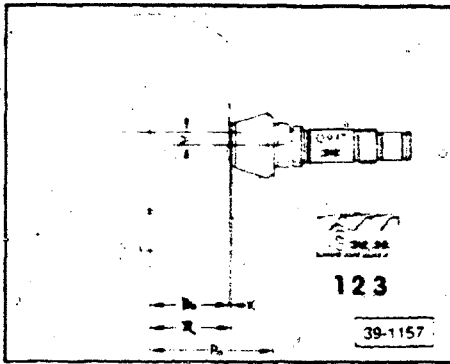
$R_0$  — Length of master gage used in production

$R_0$  = Ring gear diameter 170 mm = 54.95 mm  
 Ring gear diameter 180 mm = 59.65 mm

$R$  — Actual dimension between ring gear center and end face of pinion in position for the quietest running of the particular gear set

$V_0$  — Hypoid offset = 35 mm





## Standard-production gear sets

- X** — Markings X'ed out are not shown on production gears
- P<sub>0</sub>** — The measurement used for setting ring gear/pinion in production

### CAUTION

In production, the position of the pinion is determined by dimension  $P_0$  (ring gear centerline to back of pinion head). The marking of deviation  $r$  on the ring gear and the matching number have been eliminated. It is therefore necessary to measure the position of the pinion before removing it when parts that affect the position of the pinion are to be replaced.

## Adjustment Overview

When assembling the final drive, it is only necessary to adjust the ring gear or pinion or both, if parts have been replaced which **directly** affect the final drive setting. The following table should be used to avoid carrying out unnecessary adjustments.

Replaced part	To be adjusted	Ring gear (S1 + S2)	Pinion (S3) using deviation r	Pinion (S3) using actual measurement	Pinion (shim S4 only)
		page 39.21	page 39.14	page 39.12	page 39.18
Final drive housing <sup>1</sup>		X		X	
Gear carrier housing					X
Differential housing		X			
Pinion bearings				X	
Differential bearings		X			
Ring gear and pinion		X	X		
Cover on final drive housing		X			

<sup>1</sup>When the final drive housing is replaced, adjust the main shaft. See Repair Group 35.

## Pinion, determining position

### (actual dimension)

This operation is only necessary if deviation  $r$  is not marked on the ring gear, and both pinion bearings for the pinion and/or the final drive housing have to be replaced. These parts directly affect the position of the pinion.

## Differential, removing

- set assemble measuring bar.  
(see page 39.15)
- install measuring bar into final drive housing
- measure the deviation from  $R_0$  (maximum deflection in the red range)
  - this reading corresponds with deviation  $r$
  - note reading
- after replacing pinion bearings and or final drive housing, adjust pinion, page 39.14
  - the reading obtained for  $r$  is used to determine the thickness of shim  $S_3$ .

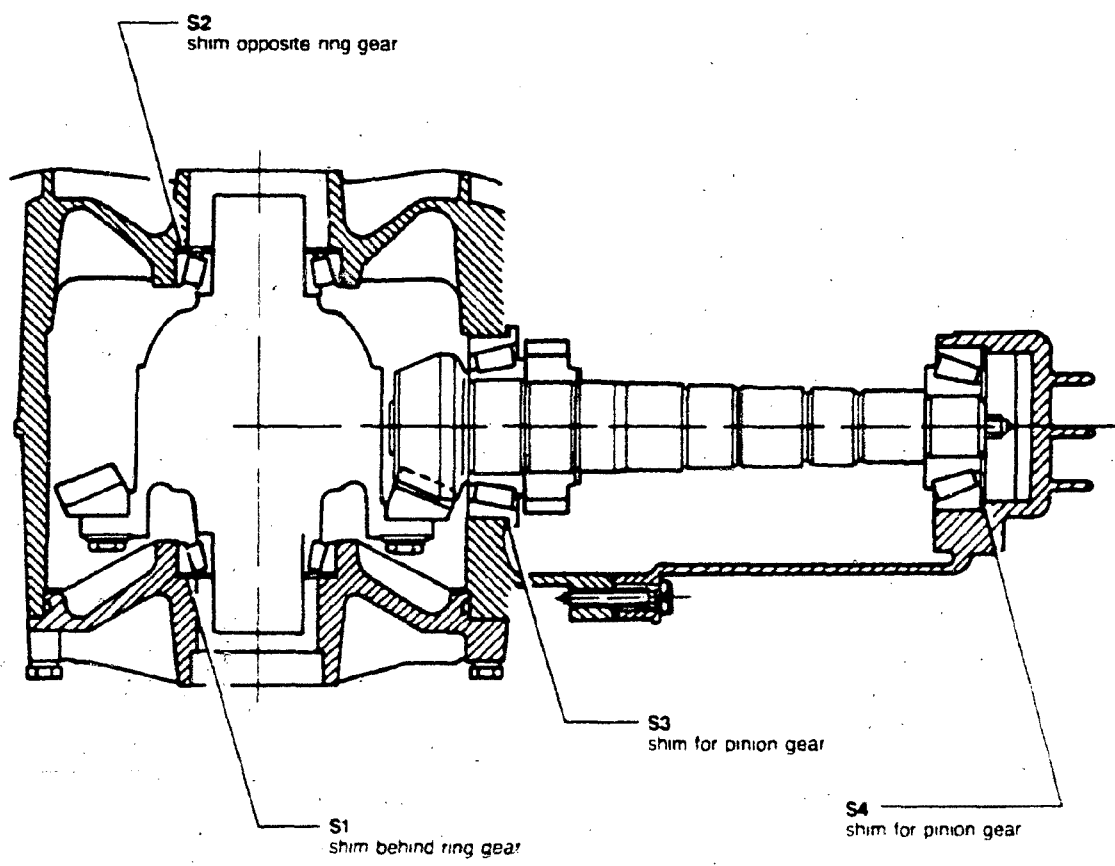
## Ring gear/pinion, adjusting

- determine **S total**, total shim thickness (i.e.,  $S_1 + S_2$ ) to give specified preload of differential bearings
- determine total shim thickness **S total** ( $S_3 + S_4$ ) to give specified preload of differential bearings
- distribute **S total** between **S3** and **S4** so dimension between ring gear centerline and pinion end face corresponds to installation dimension **R** determined in production
- distribute **S total** between **S1** and **S2** to obtain specified backlash between ring gear and pinion

## Note

Always try to adjust the ring gear and pinion to obtain the same quiet running position which was determined on the special test machine used in production.

All assembly operations and measurements require great care and absolute cleanliness to produce accurate results.



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## Pinion, adjusting

Ring gear pinion needs adjusting if it has been replaced. If other parts which affect position of pinion are to be replaced, setting must be measured before disassembly. Pinion must be re-set to this measured value during reassembly.

### Finding total shim thickness i.e., S3 + S4 (adjusting preload of pinion bearings)

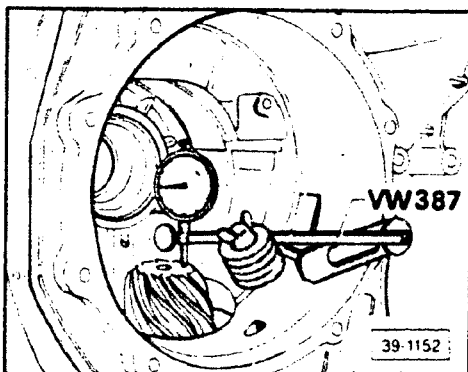
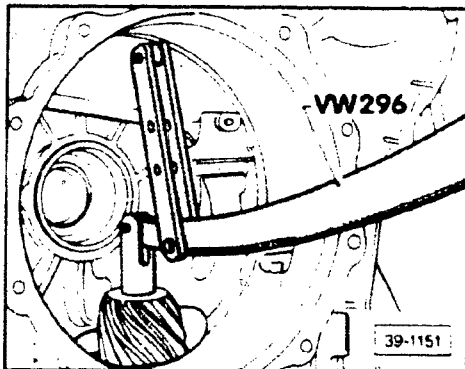
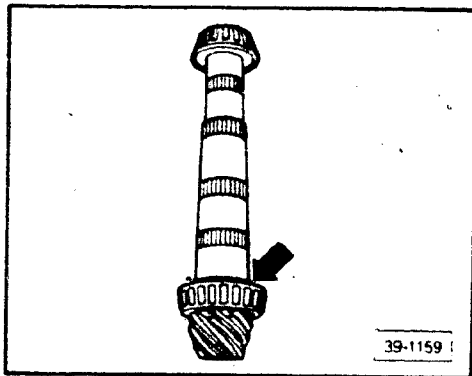
- install bearing outer races in housing and gear carrier **without** shims

#### Note

Always install rubber shim and pressure plate to determine **S4** shim.

Pressure plates of 14.8 mm or 15.3 mm can be installed — see Repair Group 35.

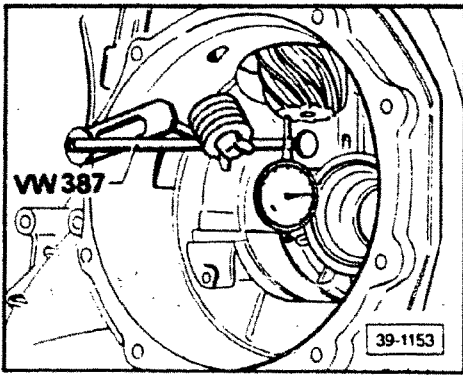
- install pinion bearing inner races
- secure lower bearing (arrow)
- install assembled pinion into final drive housing
- install gear carrier housing and tighten bolts to 25 Nm (18 ft lb)
- turn final drive so gear housing faces down
- press pinion head on with **VW 296** until pinion bearing outer race contacts housing
- turn pinion manually until pinion bearing is seated



- install dial indicator (3 mm range) and set to zero with 1 mm preload
- turn final drive so cover faces up

#### CAUTION

Turn pinion before measuring so pinion bearing seats, or measurement will be inaccurate.



- read measurement
- determine **S total**, total shim thickness (i.e.,  $S_3 + S_4$ ), using the following method:

**S total** (i.e.,  $S_3 + S_4$ ), determining

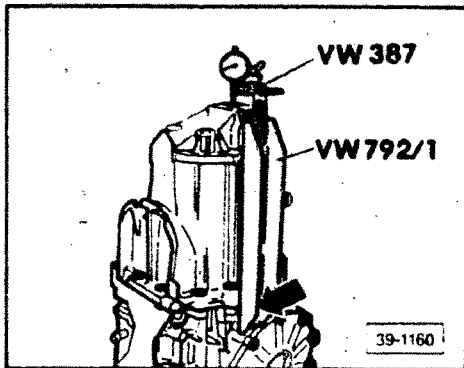
$S \text{ total} = \text{Dial indicator reading} + \text{preload}$
--------------------------------------------------------------------

### Example

Dial indicator reading (example)	1.45 mm
Preload (constant value)	+ 0.15 mm
<b>S total</b>	= 1.60 mm

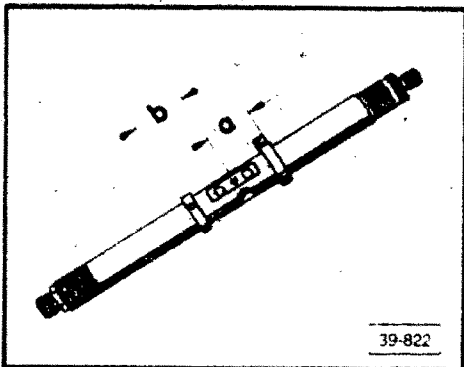
### Pinion bearing preload, checking

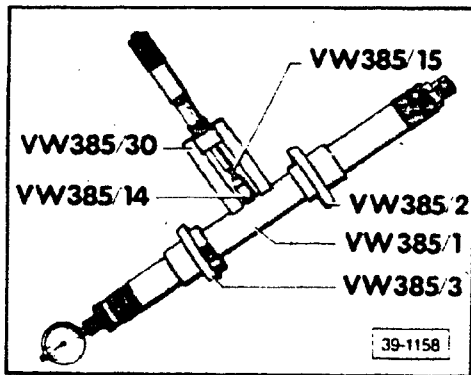
- select shims with combined thickness of **S total** value (e.g. 1.60 mm). Install behind pinion bearing outer race
  - for available shims, see page 39.17
- install gear carrier housing
- turn pinion in both directions several times to seat bearings
- install dial indicator (3 mm range) and zero it with 1 mm preload
  - loosen bolts on gear carrier housing
    - dial indicator will display a value of 0.08 mm to 0.15 mm, with proper selection of adjustment shims



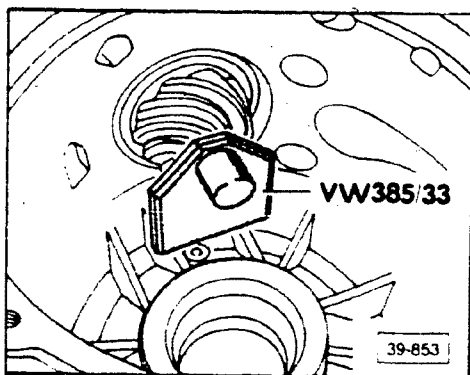
### Dimension "e," determining

- install determined **S total** (e.g. 1.60 mm) behind pinion bearing outer race in gear carrier housing
- install gear carrier housing
- turn pinion in both directions several times to seat bearings
- set universal measuring bar **VW 385:1** centering ring to dimension **a** = 35 mm
- set sliding ring to dimension **b** = 75 mm

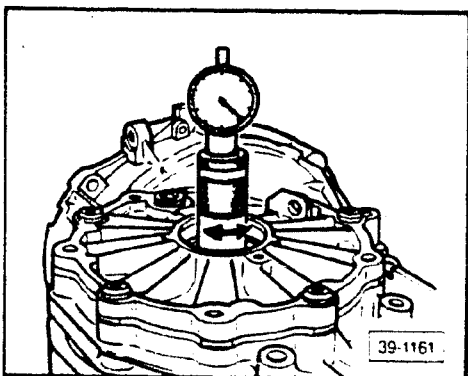




- assemble bar as shown
  - indicator extension **VW 385/15** = 9.3 mm with  $R_o$  = 59.65 mm
  - indicator extension **VW 385/15** = 6.5 mm with  $R_o$  = 54.95 mm
- set universal master gage **VW 385/30** for  $R_o$ :
  - 180 mm diameter ring gear = 59.65 mm
  - 170 mm diameter ring gear = 54.95 mm



- place master gage on measuring bar and set dial indicator (3 mm range) to zero with 1 mm preload
- place end plate **VW 385/33** on pinion end face
- remove master gage and install measuring bar in housing
  - centering disc **VW 385/3** faces final drive cover



- install cover for final drive housing and tighten four bolts
- pull 2nd centering ring outward until measuring bar can just be turned by hand

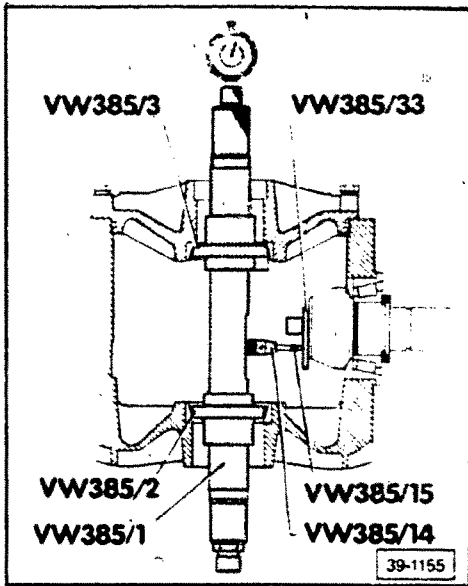
### Dimension "e," measuring

- turn measuring bar slightly until dial indicator contacts end face of pinion and indicates maximum deflection (return point)
  - measured reading = dimension "e"

### Example

$e = 0.46 \text{ mm}$





## Shim S3, determining thickness

$$S3 = e + r$$

e — dial indicator reading (maximum deflection)

r — deviation (marked on ring gear in 1/100 mm or determined by actual measurement)

### Example

Dial indicator reading e	0.46 mm
Deviation r	+ 0.18 mm
<b>Shim thickness S3</b>	<b>= 0.64 mm</b>

The following shims are available:

Thickness (mm)	Part number
0.55	012 311 391 C
0.60	012 311 391 D
0.65	012 311 391 E
0.70	012 311 391 F
0.75	012 311 391 G
0.80	012 311 391 H
0.85	012 311 391 J
0.90	012 311 391 K
0.95	012 311 391 L
1.00	012 311 391 M
1.05	012 311 391 N

## Shim S4, determining thickness

$$S4 = S \text{ total} - S3$$

### Example

Total shim thickness	1.60
<b>S3 shim thickness</b>	<b>- 0.64</b>
<b>S4 shim thickness</b>	<b>= 0.96</b>

The following shims are available:

Thickness (mm)	Part number
0.45	012 311 393
0.49	012 311 393 A
0.53	012 311 383 B
0.57	012 311 393 C
0.61	012 311 393 D
0.65	012 311 393 E
0.69	012 311 393 F
0.73	012 311 393 G
0.77	012 311 393 H
0.81	012 311 393 J
0.85	012 311 393 K
0.89	012 311 393 L
0.93	012 311 393 M
0.97	012 311 393 N
1.01	012 311 393 P
1.05	012 311 393 Q
1.09	012 311 393 R
1.13	012 311 393 S
1.17	012 311 393 T
1.21	012 311 393 AA
1.25	012 311 393 AB
1.29	012 311 393 AC
1.33	012 311 393 AD
1.37	012 311 393 AE
1.41	012 311 393 AF
1.45	012 311 393 AG
1.49	012 311 393 AH

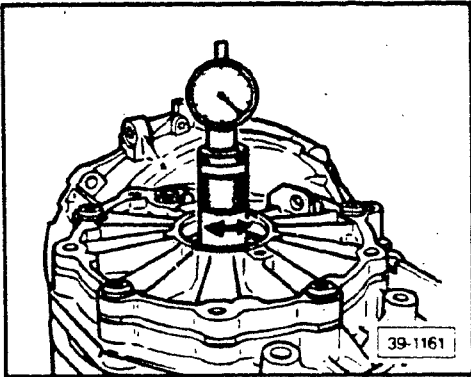
## Note

Pressure plates of 14.8 mm or 15.3 mm can be installed — see Repair Group 35.

Due to varying tolerances, check all shims with a micrometer for correct thickness. Exact shim thickness can be attained by using shims that are thicker or thinner than specifications.

## Dimension r, checking

- install pinion with measured shims **S3** and **S4** and turn several times in both directions
- place measuring bar in position and check measurements
  - adjustment shims are correct if dial indicator, reading counterclockwise (red range), shows deviation **r** within tolerance of 0.04 mm

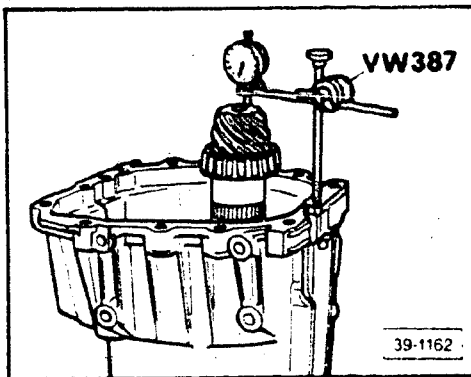


## Gear carrier housing, replacing

### Shim S4, redetermining

If only the gear carrier housing is to be replaced, only the **S4** shim has to be remeasured.

- clean mating surfaces of gear carrier housing and final drive housing
- install pinion in old gear carrier housing
- turn pinion to seat bearing
- place measuring device on housing
- zero dial indicator (3 mm range) with 1 mm preload
- remove **VW 387** complete with dial indicator
- remove pinion and bearing outer race with pressure plate, adjustment shim and washer and install in new housing. See Repair Group 35
- install dial indicator on new housing with **VW 387**
- read value on dial indicator



### Example

preload	1.00 mm
dial indicator reading	- 0.88 mm
<b>x = 0.12 mm</b>	
shim thickness <b>S4</b>	0.77 mm
value <b>x</b>	+ 0.12 mm
= 0.89 mm	

- select shims from table on page 39.18

## Note

If the dial indicator reading is greater than 1.00 mm, the **S4** shim must be reduced by the value **x**.

- install gear carrier housing and check preload of pinion bearing

## Ring gear, adjusting

### Differential, adjusting

- the ring gear must be adjusted if any of the following parts are replaced:

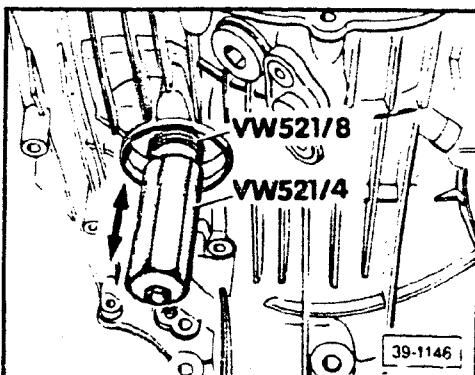
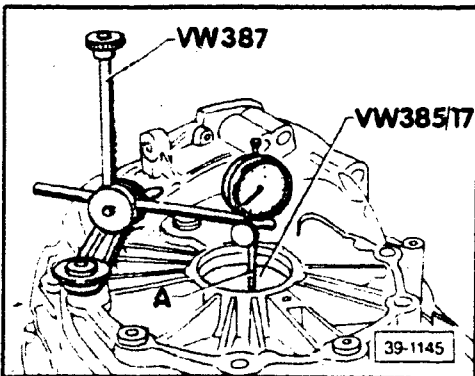
- Final drive housing
- Gear carrier housing
- Differential bearings
- Differential gear housing
- Ring and pinion set

See Adjustment Overview, page 39.11.

### Differential bearings preload, adjusting (pinion removed)

- remove oil seals and outer races of differential bearings
- install bearing outer races **without** shims and drive in to stop
- install differential gear into housing without speedometer gear
  - ring gear on left side (opposite cover side)
- install cover and tighten bolts to 25 Nm (18 ft lb)
- attach measuring equipment
- zero dial indicator (3 mm range) with a 1 mm preload

A — dial indicator extension, 30 mm long



- install **521/4** and **521/8** on final drive housing. Use **521/7** for smaller differential gear housing
- move differential up and down
- read end play from dial indicator and note reading

## Example

Dial indicator reading = 1.42 mm

### CAUTION

While taking measurements, do not turn differential or the bearings will settle, resulting in an incorrect reading.

**S total** (i.e., **S1** + **S2**), determining

**S total** = dial indicator reading + preload

## Example

Dial indicator reading (example)	1.42 mm
Preload (constant value)	+ 0.50 mm
<b>S total</b>	1.92 mm

- install shim of appropriate thickness (1.92 mm in example) behind bearing outer race in final drive housing (**S2** side)

### Note

See table of shims on page 39.24.

### Turning torque, measuring

**A** — commercial torque wrench  
0-600 Ncm (0-60 in. lb or 0-65 cm kg)

**B** — locking sleeve, **VW 521/4**

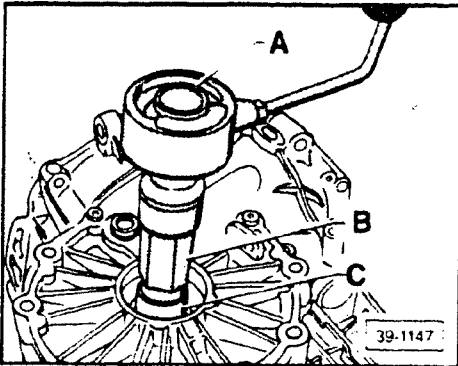
**C** — bushing, **VW 521/8**. For smaller differential gear housings, use **VW 521/7**

- lubricate bearing with transmission oil

- check that turning torque equals:
  - new bearings = 250-350 Ncm (22-31 in. lb or 26-36 cm kg)
  - used bearings = 30-60 Ncm (3-5 in. lb or 3-6 cm kg)

### Note

After these procedures, perform a pinion adjustment inspection, page 39.14.



## Backlash, adjusting

- install pinion with shims **S3** and **S4** installed
- select shims with combined thickness of **S total** (i.e., **S1** + **S2**). Install on housing side of differential
- turn differential several times to seat bearings
- attach measuring equipment

### Note

Use **521/7** for smaller ring gear.

- use dial indicator extension **VW 382/10** (6 mm flat)
- adjust measuring lever **VW 388** to
  - a = 170 mm ring gear = 67 mm
  - a = 180 mm ring gear = 72 mm
- while holding pinion from moving, turn ring gear to stop and set indicator to zero
- turn ring gear back and note backlash

### Note

If pinion turning torque is too low, install bracket **A** (tool **3177**) to measure backlash precisely. The differential must be installed so the opening for installation of gears faces the pinion.

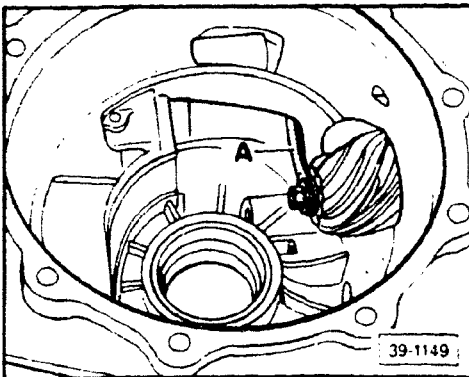
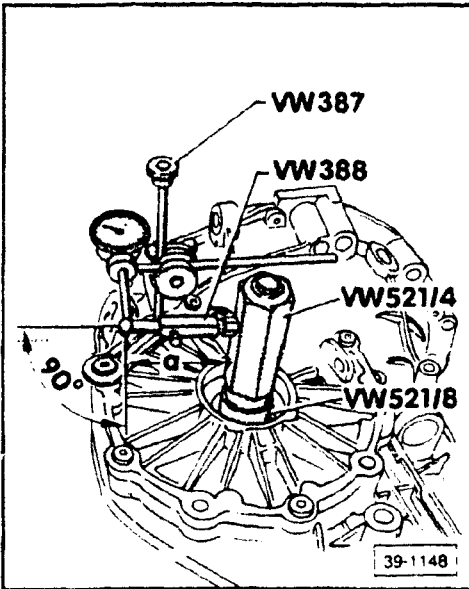
- loosen lock bolt on locking sleeve
- rotate ring gear 90°; tighten lock bolt and measure backlash again
- repeat above procedures at least two more times
- add all four readings together and divide by four to determine average backlash

## Average backlash, calculating

### Example

1st measurement	0.84 mm
2nd measurement	0.85 mm
3rd measurement	0.84 mm
4th measurement	0.83 mm
Total	= 3.36 mm

$$\text{Average backlash} = 3.36 \text{ mm} \div 4 = 0.84 \text{ mm}$$



## Note

If measurements differ by more than 0.06 mm from each other, ring gear/pinion installation is incorrect. Check ring gear and pinion; if necessary, replace.

## Shim S2, determining thickness

(side opposite from ring gear)

<b>S2 = S total</b>
– average backlash
+ lift (constant value of 0.15 mm)

## Example

<b>S total</b>	1.92 mm
minus backlash	– 0.84 mm
	= 1.08 mm
plus lift	+ 0.15 mm
<b>S2</b>	= 1.23 mm

## Shims available

Thickness (mm)	Part number
0.45	012 409 386
0.50	012 409 386 A
0.55	012 409 386 B
0.60	012 409 386 C
0.65	012 409 386 D
0.70	012 409 386 E
0.75	012 409 386 F
0.80	012 409 386 G
0.85	012 409 386 H
0.90	012 409 386 J
0.95	012 409 386 K
1.00	012 409 386 L

Shim thicknesses make it possible to select any required thickness.



## Shim S1, determining thickness (ring gear side)

$$S1 = S \text{ total} - S2$$

### Example

S total	1.92 mm
minus S2	- 1.23 mm
S1	= 0.69 mm

### Shims available

Thickness (mm)	Part number
0.45	012 409 385
0.50	012 409 385 A
0.55	012 409 385 B
0.60	012 409 385 C
0.65	012 409 385 D
0.70	012 409 385 E
0.75	012 409 385 F
0.80	012 409 385 G
0.85	012 409 385 H
0.90	012 409 385 J
0.95	012 409 385 K
1.00	012 409 385 L

Shim thicknesses make it possible to select any required thickness.

### Backlash, checking

- measure backlash four times around circumference of ring gear
  - acceptable values can range from 0.12-0.22 mm
  - no two values can deviate from each other by more than 0.05 mm