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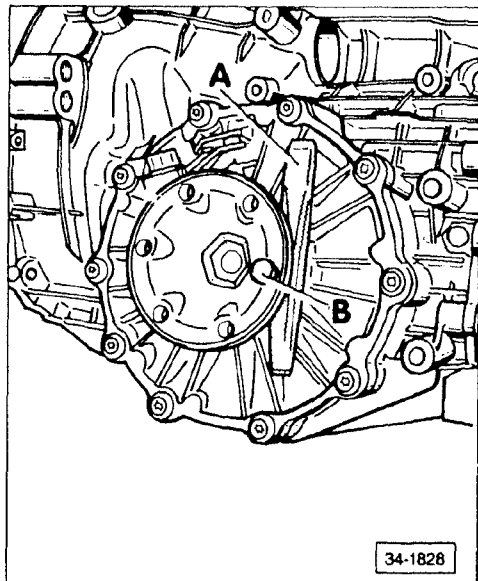
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Code, component specification, ratio, filler amounts

Rear differential

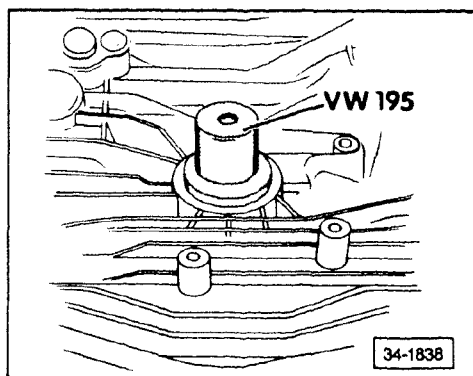
Code		AEX	AEC	ARS
Production	from:	06/86	06/86	
Arrangement	Type	Audi 80 Quattro	Audi 90/Coupe Quattro	
	Engine	2.0 liter 83 kW (108 hp)	2.3 liter 101 kW 2.3 liter 125 kW (20V)	
	Standard Transmission	AKT	AKU/AXL ASZ/AXM	
Ratio	Differential	41:9 = 4.556	37:9 = 4.111	
Filler amount		0.75 liter (0.79 qt)		
Specification		Transmission oil GL 5 (MIL-L 2105 B) SAE 90		
Drive shaft flange		90 mm	100 mm	90 mm



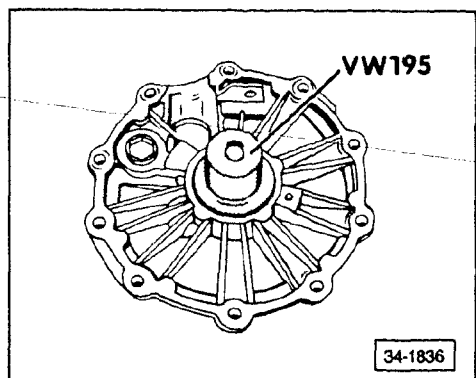
Front differential drive flange oil seals, replacing

(with transmission installed)

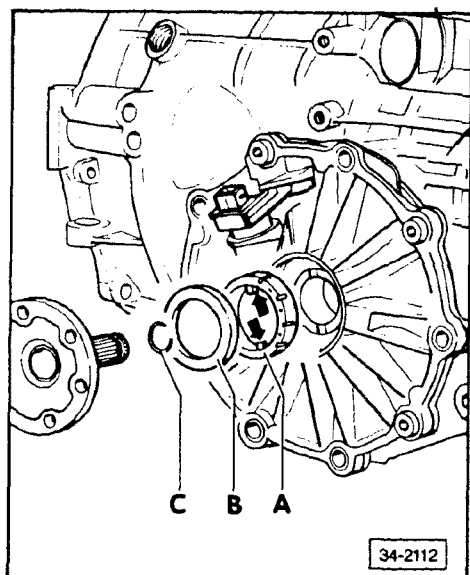
- remove axle shaft
- place oil pan under vehicle
- remove axle flange shaft by threading bolt B into flange against a punch or chisel A
 - always replace circlip
- remove seals with VW 681



- drive right oil seal in to 5 mm (3/16 in.) below transmission housing surface



- drive left oil seal in to 5 mm (3/16 in.) below cover edge
- coat seal lips with multi-purpose grease
- drive in flange shaft with rubber hammer
- install axle shaft
- tighten shaft bolts to 45 Nm (33 ft lb)
- check transmission oil, refill if necessary



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

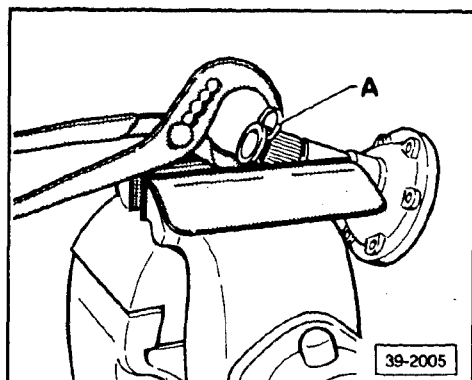
Note

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.

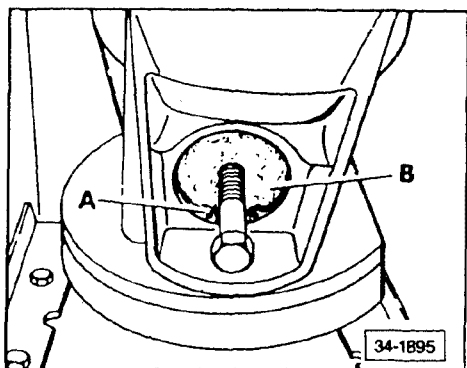
- install new seal **B** and circlip **C** for flange shaft (see flange shaft circlip, replacing, below)
- top up transmission oil if necessary

Flange shaft circlip, replacing

Replace the flange shaft circlip before installing the flange shaft.



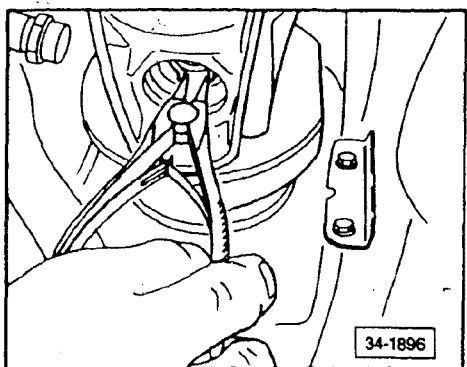
- clamp flange shaft in vice
- place opening of new circlip **A** over opening of old circlip in groove
- press circlip into groove with pliers while also pressing old circlip out



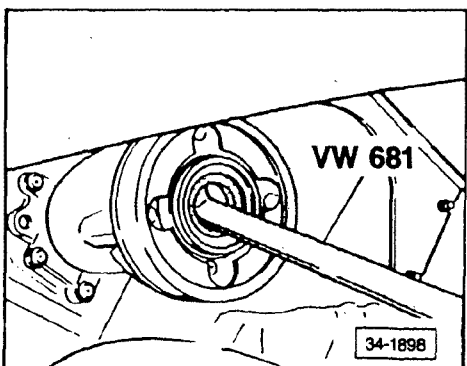
Driveshaft flange oil seal, replacing

(with transmission installed)

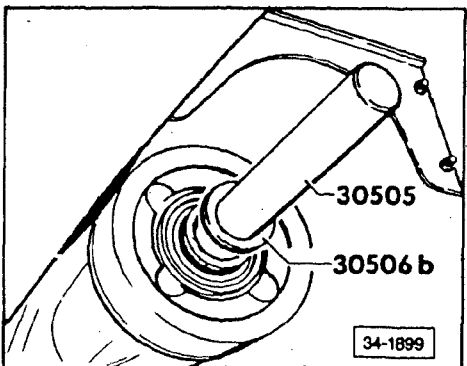
- remove drive shaft — see page 39.5
- place oil pan under vehicle
- remove snap ring **A**
- thread M8 bolt into cover cap **B** and remove cover cap. Do not damage rubber seal



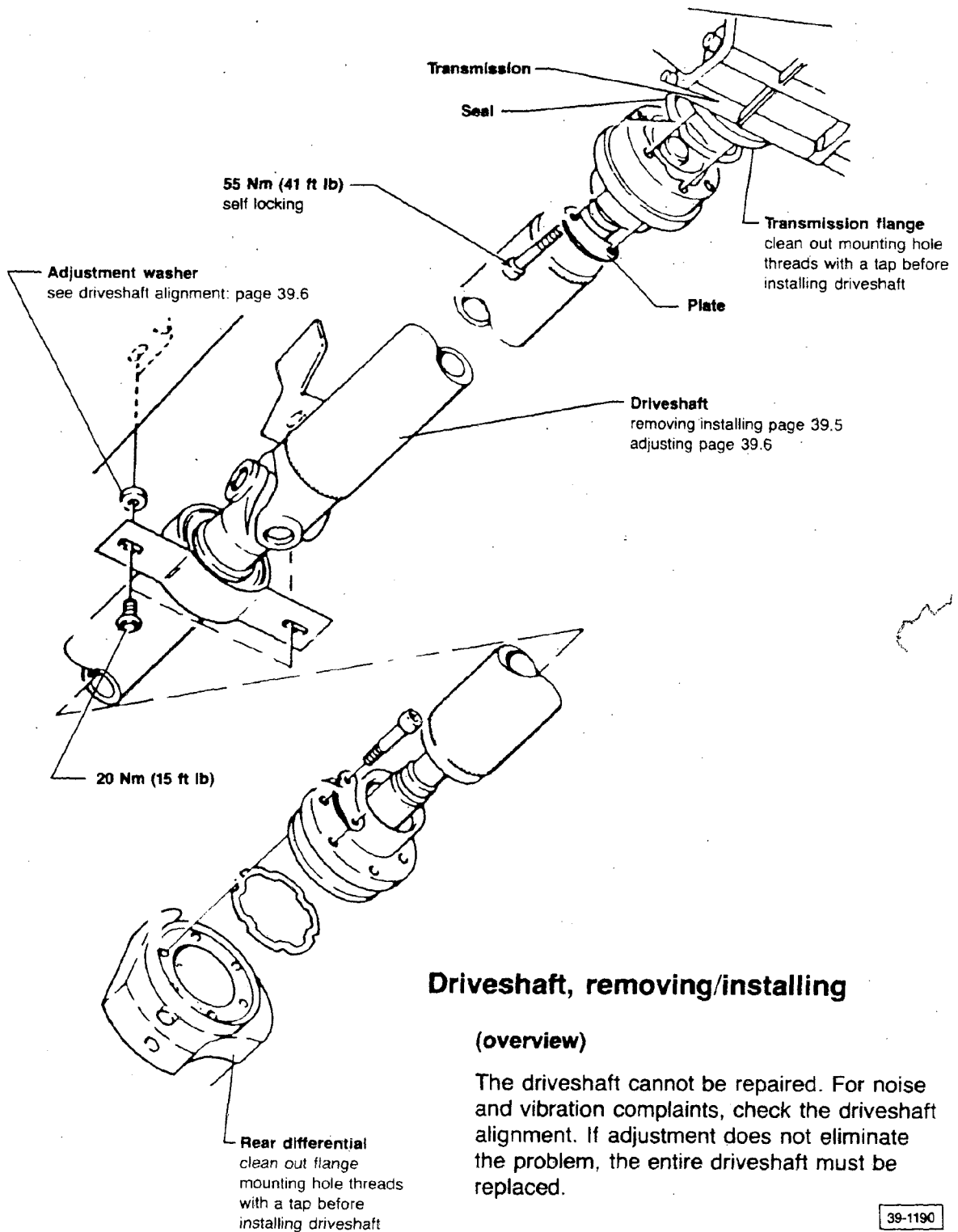
- remove flange shaft snap ring and flange shaft



- remove oil seal with **VW 681**



- install oil seal with **30-506b** and **30-505**
- install flange shaft
- check transmission oil, refill if necessary
- install drive shaft



Driveshaft, removing/installing

(overview)

The driveshaft cannot be repaired. For noise and vibration complaints, check the driveshaft alignment. If adjustment does not eliminate the problem, the entire driveshaft must be replaced.

39-1190

Removing/Installing Driveshaft (Vehicles With Airbag)

Vehicles equipped with an airbag system have a front driveshaft section made of carbon fiber.

The new driveshaft has variations in diameter which makes the installation and adjustment procedure different from that of the previous Quattro driveshaft.

Use the following procedure when removing/installing driveshafts with a carbon fiber front section.

Driveshaft, removing/installing

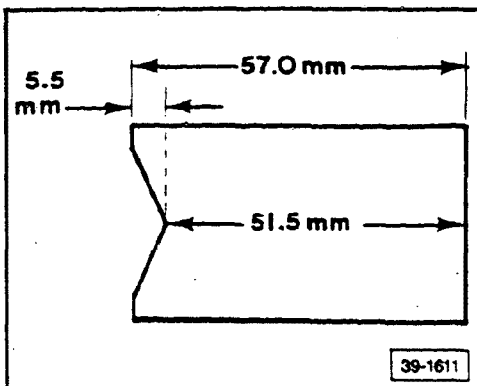
- raise vehicle on a hoist with sufficient clearance for driveshaft work
- remove catalytic converter and exhaust pipe
- tie exhaust system over to right side
- loosen driveshaft bolts at transmission, rear differential and center support

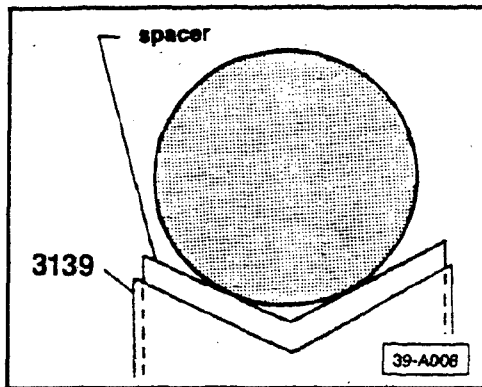
Note

The driveshaft must be spaced away from the driveshaft alignment tool **3139**. Choose one of the following two methods to accomplish the required spacing.

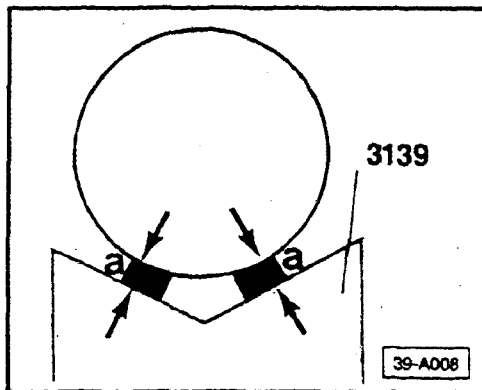
Square tubing spacer (Method No. 1)

- fabricate a spacer from 34 x 34 mm square steel tubing (1-11/32 in.)





- insert fabricated spacer in rear V-block of driveshaft alignment tool 3139 (end opposite arrow embossed on tool)
 - spacer inserted in alignment tool will raise alignment surface 11.5 mm,
- install alignment tool 3139 to driveshaft
 - tool must be installed with embossed arrow facing rear of vehicle



Shim spacer (Method No. 2)

- mount alignment tool 3139 to driveshaft using 11.5 mm shim stock installed between front of driveshaft and rear V-block of tool
 - $a = 11.5$ mm
 - tool must be installed with embossed arrow facing rear of vehicle

CAUTION

White dot on rear driveshaft flange must be aligned with black dot on rear differential flange when installing driveshaft. If paint dots are not visible, mark driveshaft and differential flange before disassembly.

- remove driveshaft attaching bolts at rear differential and transmission
- support driveshaft and tool and remove center support bolts
- remove driveshaft and tool together
- install in reverse order

CAUTION

Do not bend driveshaft. Store and transport driveshaft and tool together.

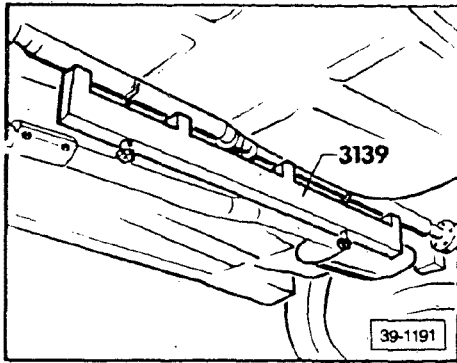
Note

Always check driveshaft alignment after installation.

Driveshaft, removing/installing

Driveshaft work must be performed with the vehicle on a dual support hoist.

- remove catalytic converter and exhaust pipe
- tie exhaust system to right side
- loosen driveshaft bolts at transmission, rear differential and center support
- install tool **3139** on driveshaft and tighten plastic nuts



CAUTION

White dot on rear driveshaft flange must be aligned with black dot on rear differential flange when installing driveshaft. If paint dots are not visible, mark driveshaft and differential flange **before** disassembly.

- remove driveshaft attaching bolts at rear differential and transmission
- support driveshaft and tool and remove center support bolts
- remove driveshaft and tool together

Install in reverse order.

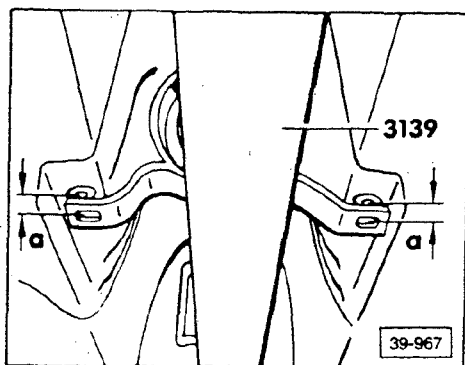
Note

Do not bend driveshaft. Store and transport driveshaft only in parallel position.

Tightening torques

Driveshaft to transmission	55 Nm (40 ft lb)
Driveshaft to differential	55 Nm (40 ft lb)
Center support to body	20 Nm (14 ft lb)

- always check driveshaft alignment after installation



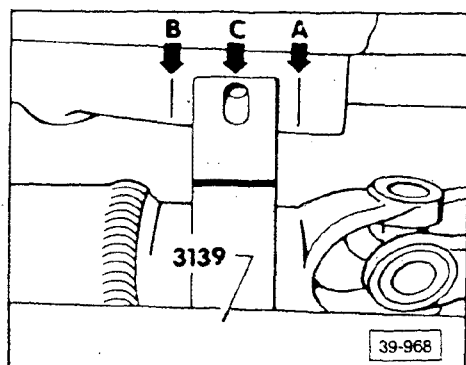
Driveshaft, adjusting

Precise adjustment is required for smooth, quiet operation.

- remove exhaust pipe and catalytic converter: page 34.3
- tie exhaust system to right side
- loosen driveshaft center support bolts
- install tool **3139** and tighten plastic nuts
- remove center support mounting bolts and adjustment washers
- measure distance **a**, clearance must be equal on both sides. Select adjustment washers from following chart

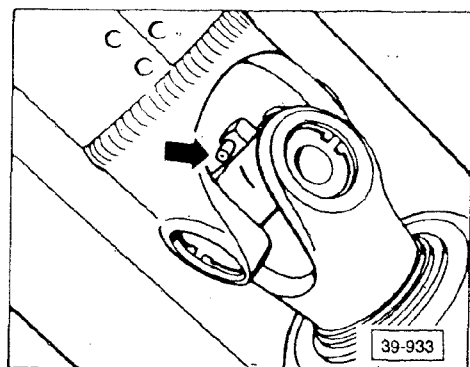
Washers

Distance a mm	Thick- ness mm	Part Number
0-3	—	—
3.1-5	2	857 521 143
5.1-7	4	857 521 143 A
7.1-9	6	857 521 143 B
9.1-11	8	857 521 143 C
11.1-13	10	857 521 143 D



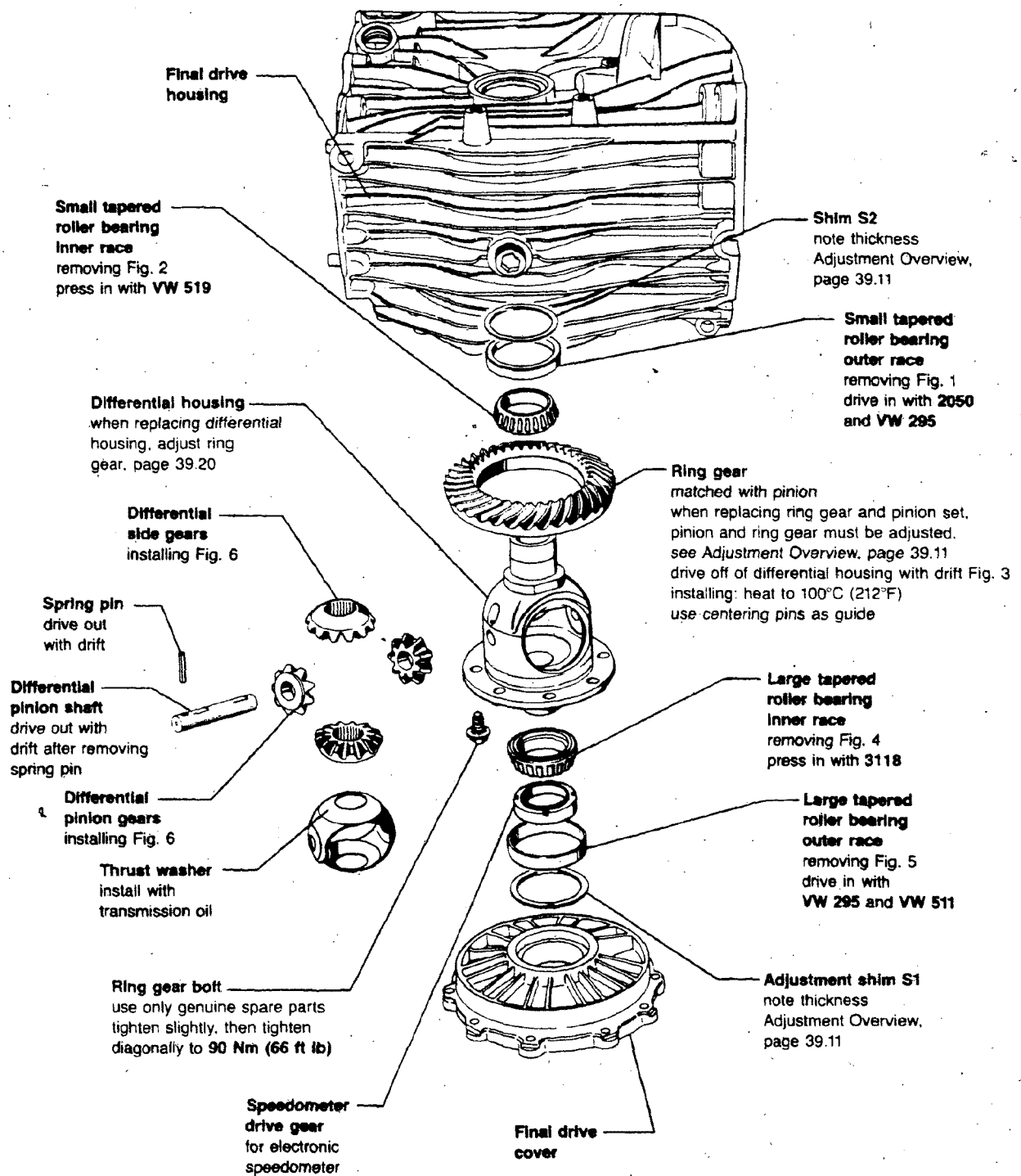
Driveshaft, determining center position

- push driveshaft with tool **3139** rearward to stop
- mark the position of support bracket on body (**arrow A**)
- push driveshaft with tool **3139** toward the front of the car
- mark the position of support bracket on body (**arrow B**)
- center driveshaft support bracket between two marks (**arrow C**)
- install bolts and previously determined washers, tighten to 20 Nm (14 ft lb)
- remove tool **3139**
- install exhaust pipe and catalytic converter

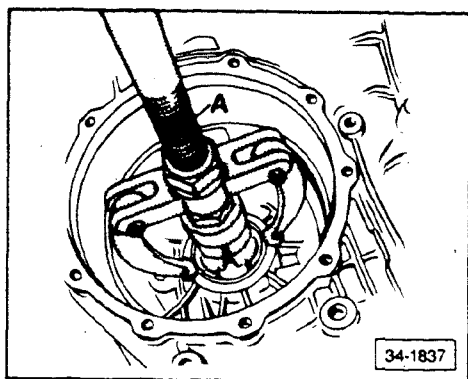


Driveshaft center universal joints, lubricating

- lubricate center universal joint (**arrow**) with lithium base grease

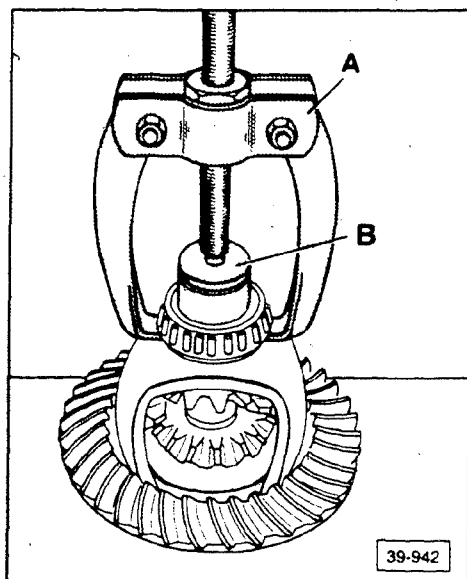


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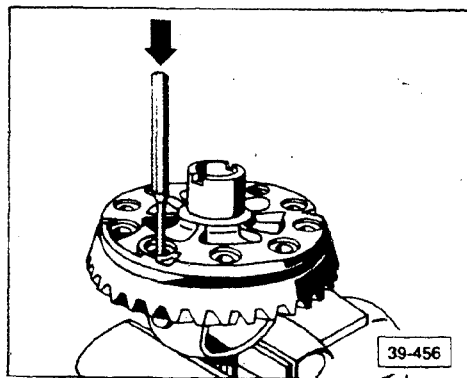
► Fig. 1 Small tapered roller bearing outer race, removing

- remove with puller and holder A, e.g. Kukko 21/7 = 46 mm-56 mm and Kukko 22/2 or drive out with 3138

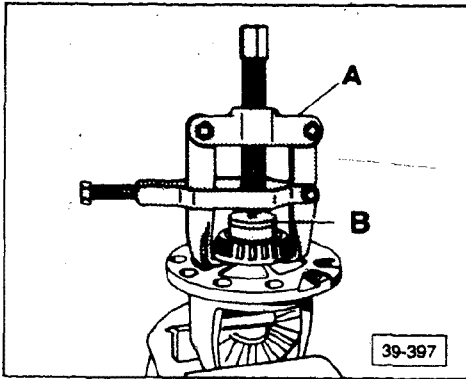


► Fig. 2 Small tapered roller bearing inner race, removing

- A — puller (Kukko 204/2) with VW 447H or use Kukko 20/10 with VW 295a

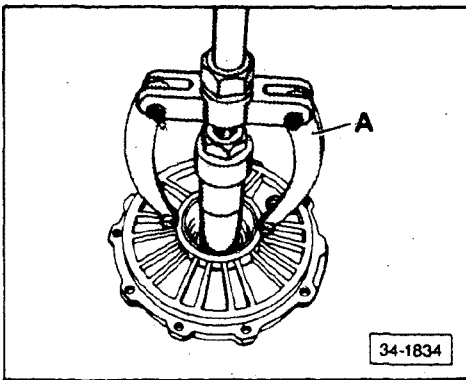


► Fig. 3 Ring gear, driving out of housing



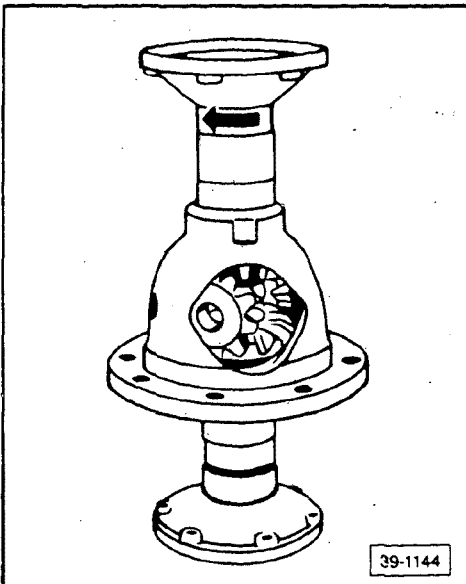
► Fig. 4 Large tapered roller bearing inner race, removing

A — puller e.g. Kukko 204/2 with VW 447H or use Kukko 20/10 with VW 295a



► Fig. 5 Large tapered roller bearing outer race, removing

- remove with puller and holder A, e.g. Kukko 21/7 = 46 mm-56 mm and Kukko 22/2 or press out with 3138



► Fig. 6 Differential pinion/side gears, installing

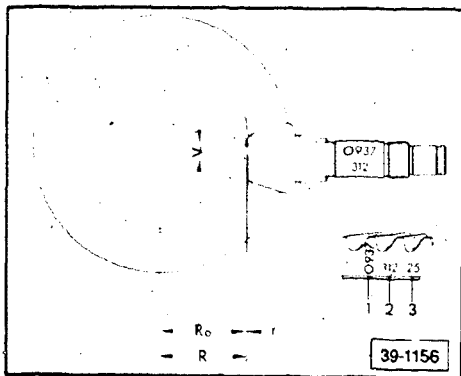
- install thrust washer with transmission oil
- install side gears
- install drive flanges without circlip
- install pinion gears turned 180° (1/2 turn) and position by turning drive flange
- align thrust washer and pinion gears
- drive in pinion shaft spring pin

Pinion and ring gear, adjusting

General instructions

For long service life and quiet operation of the final drive, careful adjustment of the pinion with hollow shaft and ring gear is essential. Pinions and ring gears are paired during manufacture and inspected with special test machines for best positioning of the contact surface and quiet operation in both turning directions. The position for maximum quiet operation is determined by sliding the pinion in an axial direction, whereby the ring gear is constantly lifted far enough out of engagement (free of play) so that the backlash comes within the specified tolerance.

Deviation r related to master gage R_o is measured on the outer circumference of the ring gear with ring gear and pinion sets supplied as replacement parts. Every ring gear and pinion set must only be replaced as a set.



Ring gear/pinion set identification

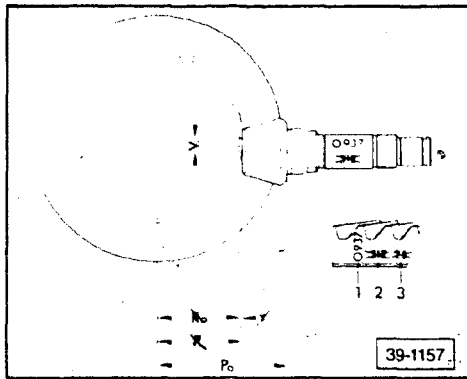
Service parts, ring gear/pinion sets

- 1 — Code **0937** means Oerlikon ring gear/pinion set with tooth ratio 37 : 9 (4.11 : 1 overall)
- 2 — Mating number (**312**) of ring gear/pinion set
- 3 — Deviation r related to the master gage of the special test machine used in production. The deviation r is always given in 1/100 mm

Example

"25" means $r = 0.25$ mm

- R_o** — length of master gage used on the special test machine **R_o** = 54.95 mm
- R** — actual measurement between ring gear axis and face side of pinion at the point of quietest operation for this one ring gear/pinion set
- Vo** — hypoid offset



Production ring gear/pinion sets

X — this data is not needed in production

Po — adjusting dimension for production

CAUTION

In production, the position of the pinion is determined using the dimension **Po** (center of ring gear to rear side of pinion head). The identification of the deviation **r** on the ring gear and the mating number is eliminated. Because of the missing data on deviation **r** it is necessary to carry out an actual measurement before removing the pinion, when parts are to be replaced which directly affect the installation position of the pinion.

Adjustment Overview

During transmission installation jobs, re-adjustment of the pinion with hollow shaft, ring gear or ring gear/pinion set is only required if parts are replaced that **directly** affect the adjustment of the final drive. In order to avoid unnecessary adjustment jobs, note the following table.

To be adjusted	Ring gear	Pinion (S3 + S4) by deviation r	Pinion (S3 + S4) by actual measurement	Pinion only shim S4
Part replaced	(S1 + S2) see page 39.20	see page 39.13	see page 39.12	see page 39.19
Transmission/gear carrier housing*	X		X	
Transmission cover housing				X
Differential housing	X			
Pinion and hollow shaft tapered roller bearing			X	
Differential tapered roller bearing	X			
Ring gear/pinion set	X	X		
Differential cover	X			

*If gear carrier housing is replaced, the main shaft must also be adjusted, see Repair Group 35 — Main shaft, adjusting

Pinion Installation position, determining

(actual measurement)

This procedure is only to be carried out if dimension **r** is not given on the ring gear and/or parts have to be replaced which directly influence the position of the pinion. These parts are:

Pinion double tapered roller bearing
Hollow shaft tapered roller bearing
Hollow shaft
Gear carrier housing

Differential, removing

- assemble universal measuring bar as described on page 39.16
- install in final drive housing
- measure differential to **Ro** (maximum reading, read from red number range) and note reading
 - the value obtained corresponds to the dimension **r**
- after replacing parts, adjust pinion as described on page 39.13
 - determined dimension **r** is to be used in determining the **S3** shim

Ring gear/pinion set new adjustment sequence

If the pinion and ring gear have to be adjusted, the following sequence is to be used:

- determine total shim thickness **S total (S1 + S2)** for preload according to specification of tapered roller bearing/differential gear
- determine total shim thickness **S total (S3 + S4)** for preload according to specification of tapered roller bearing/pinion with hollow shaft
- distribute total shim thickness **S total** between **S3** and **S4** so that dimension from the center of the ring gear to face side of pinion corresponds to installation dimension **R** determined during production
- distribute total shim thickness **S total** between **S1** and **S2** so that specified backlash is present between ring gear and pinion

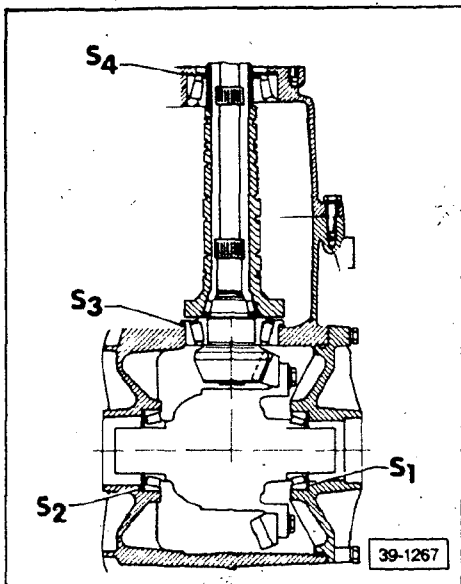
Note

The goal of the adjustment is to reach the point of quietest operation that was determined on the test machine in production.

The greatest possible care and cleanliness are of the utmost importance in all assembly jobs and measurement procedures for a satisfactory result.

Shim position

- S1** — final drive housing cover ring gear shim
- S2** — final drive housing ring gear shim
- S3** — final drive housing pinion shim
- S4** — gear carrier housing pinion shim



Pinion, adjusting

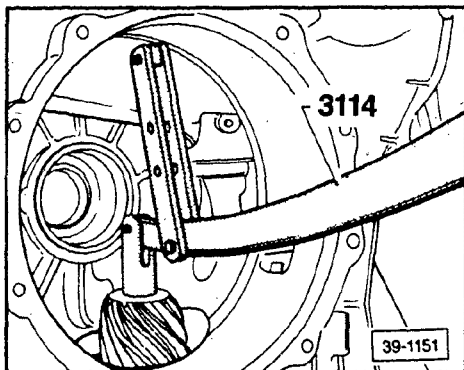
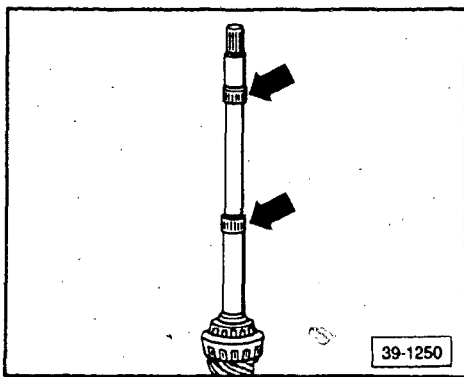
(Pinion and hollow shaft)

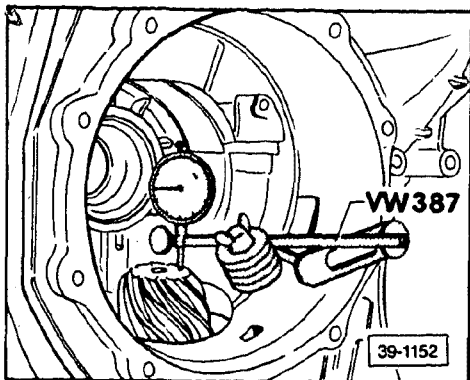
Readjustment of the pinion, according to the following instructions, is only required if the ring gear/pinion set is replaced. If other parts, which also influence the position of the pinion, are replaced, they must be adjusted to the previously determined installation position. For actual measurement, see page 39.12, also see Adjustment Overview, page 39.11.

Total shim thickness S_{total} ($S_3 + S_4$), determining

(Preload of tapered roller bearing/pinion with hollow shaft, adjusting)

- install bearing outer races into final drive housing and gear carrier housing **without** shims
 - always insert washer (rubber) and pressure plate for measuring the shim thickness as well as determining shim **S4**
- press double tapered roller bearing inner race on pinion and secure — see Repair Group 35 — Pinion and hollow shaft, disassembling/assembling
- place tapered roller bearing circlip on hollow shaft and press on tapered roller bearing — see Repair Group 35 — Pinion and hollow shaft, disassembling/assembling
- place needle bearing (**arrows**) on pinion shaft and install hollow shaft
- place pinion with hollow shaft in final drive housing
- put gear carrier housing on and tighten bolts to 25 Nm (18 ft lb)
- press on pinion head until bearing outer race lies against gear carrier housing (pinion rearward)
- turn pinion and hollow shaft by hand until bearings are seated

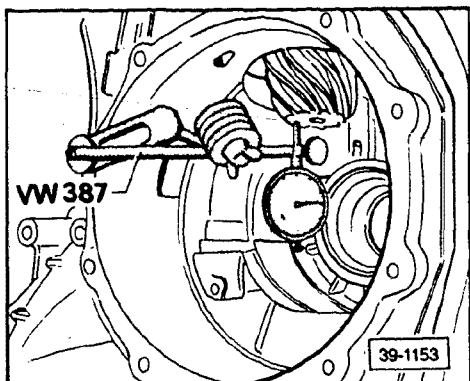




- install measuring tool and zero dial indicator with 1 mm preload
- turn final drive 180° (1/2 turn) so that gear carrier housing points upward
- turn pinion by hand, so that the tapered roller bearing settles

CAUTION

Before measuring, turn the pinion and hollow shaft so that the bearings are seated. Otherwise the measurements will be incorrect.



- read measurement on dial indicator

Example

$$S_{\text{total}} = \text{measurement} + \text{preload}$$

Example reading = 1.45

Preload

(constant value)

0.15 mm

Measurement

(example)

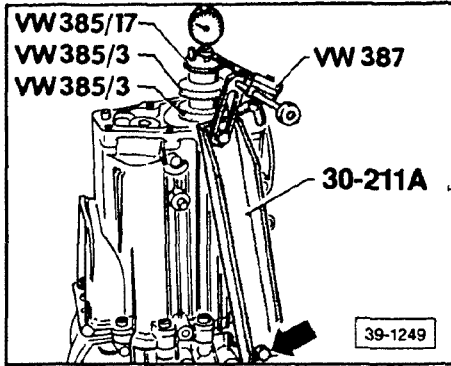
+ 1.45 mm

S total

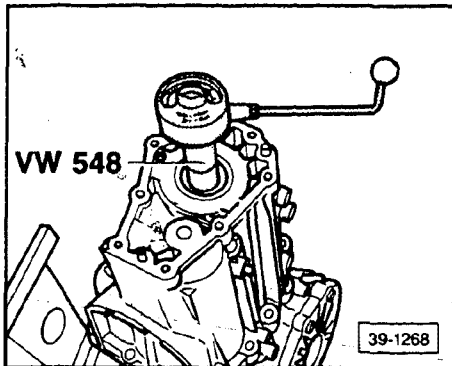
= 1.60 mm

Pinion and hollow shaft bearing preload, checking

- use determined total shim thickness to select shim from table on page 39.31
- install shim behind gear carrier housing bearing outer race (**S4** side)
- install gear carrier housing
- turn pinion and hollow shaft to seat bearings

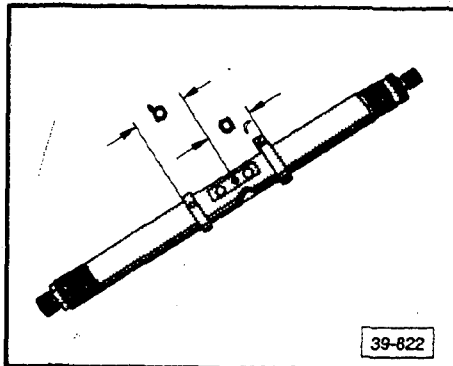


- install measuring tools
- tighten final drive housing bolt (**arrow**)
- zero dial indicator (3 mm measuring range) with 1 mm preload
- loosen gear carrier housing bolts
- if shims were selected properly, the dial indicator should show a reading between 0.08 mm and 0.15 mm



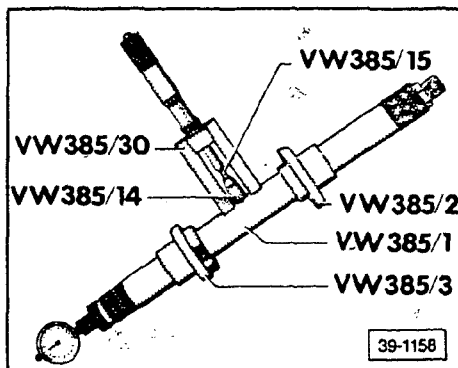
Turning torque, measuring

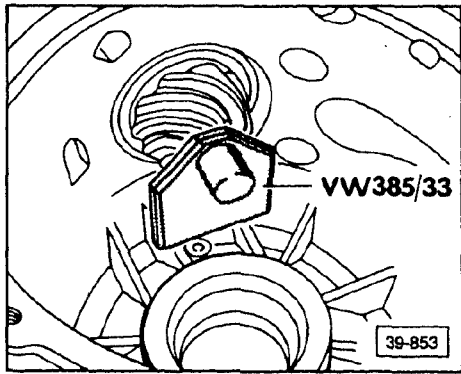
- leave determined total shim thickness behind the gear carrier housing bearing outer race (**S4** side)
- lubricate bearing with oil
- install gear carrier housing
- measure turning torque of pinion/hollow shaft bearing
 - turning torque range:
 - new bearings: 150-300 Ncm (14-28 in. lb)
 - used bearings: 30-60 Ncm (3-5 in. lb)



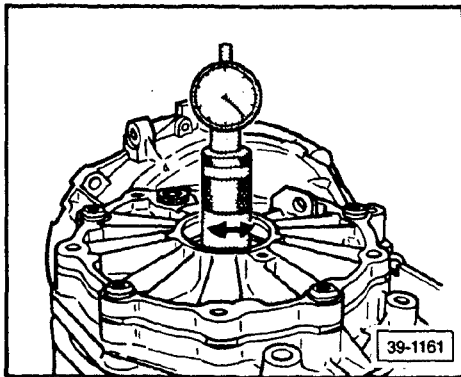
Dimension "e", determining

- leave determined total shim thickness behind final drive cover bearing outer race (**S4** side)
- install gear carrier housing
- turn pinion and hollow shaft several times to seat bearings
- adjust setting ring of universal measuring bar **VW 385/1** to dimension **a** = 35 mm
- set movable setting ring to dimension **b** = 75 mm
- complete universal measuring bar according to illustration
 - measuring gage extension = 6.5 mm long at **Ro** = 54.95 mm
- adjust master gage **VW 385/30** to **Ro** = 54.95 mm
- place master gage on measuring bar
- zero dial indicator (3 mm measuring range) with 1 mm preload





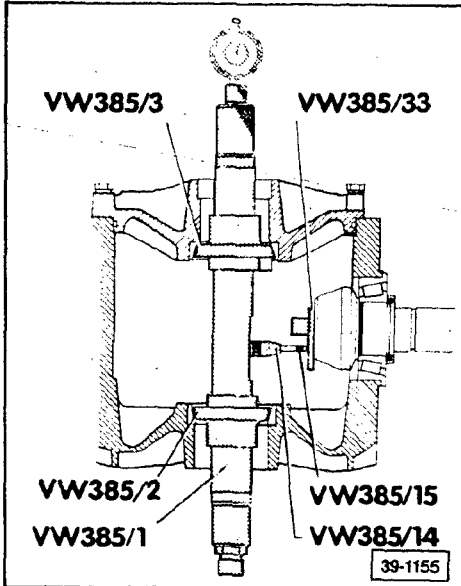
- place end plate **VW 385/33** on pinion head
- remove master gage and install measuring bar in housing
 - centering disc **VW 385/3** faces final drive cover
- install final drive cover and tighten 4 bolts
- pull second centering ring outward until measuring bar can just be turned by hand



- measure dimension **e** by turning measuring bar until dial gage tip touches end plate on pinion head and shows maximum reading
 - measured value (dimension **e**) is in the black number range

Example

0.46 mm



Measuring tools, installation position

- install measuring tools as shown when determining dimension **e**

Shim S3 thickness, determining

$$S3 = e + r$$

e = determined value (maximum reading)

r = deviation (given on the ring gear in 1/100 mm or determined during actual measurement)

Example

value e read from dial indicator	0.46 mm
deviation r printed on ring gear	+ 0.18 mm
shim thickness S3	= 0.64 mm

Note

Because of the shim tolerances, any thickness can be obtained for **S3**.

Available shims for **S3**:

Thickness (mm)	Part number
0.40	012 311 391
0.45	012 311 391 A
0.50	012 311 391 B
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
1.10	012 311 391 P
1.15	012 311 391 Q
1.20	012 311 391 R
1.25	012 311 391 S

Shim S4 thickness, determining

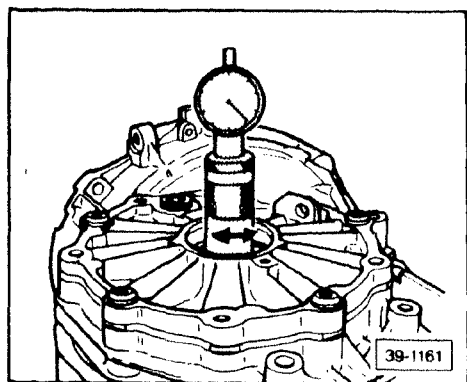
Example

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

total shim thickness	1.60 mm
shim thickness S3	– 0.64 mm
shim thickness S4	= 0.96 mm

Available shims for **S4**

Thickness (mm)	Part number
0.45	01A 311 393
0.50	01A 311 393 A
0.55	01A 311 393 B
0.60	01A 311 393 C
0.65	01A 311 393 D
0.70	01A 311 393 E
0.75	01A 311 393 F
0.80	01A 311 393 G
0.85	01A 311 393 H
0.90	01A 311 393 J



Note

If the measured shim thickness **S3** or **S4** is greater than those listed in the tables, two shims that total the measured value can be installed.

Dimension r, checking

- install pinion with hollow shaft and shims **S3** and **S4**
- turn in both directions several times
- install universal measuring bar and do measurement check
- if the correct shims have been selected, measuring gage will show the value of the specified deviation **r** with a tolerance of ± 0.04 mm
 - read measuring gage in counter clockwise direction (red number range)

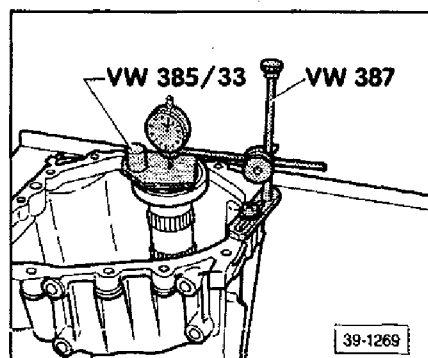
Gear carrier housing, replacing

Shim **S4** thickness, determining

Note

If only the gear carrier housing is being replaced, only shim **S4** needs to be measured.

- clean housing mating surfaces
- place hollow shaft in transmission cover and turn until bearing is seated



- install measuring tools
- zero dial indicator (3 mm measuring range) with 1 mm preload
- remove holder **VW 387** complete with dial indicator
- remove hollow shaft and bearing outer race with pressure plate, shim, and washer and install in the new transmission cover — see Repair Group 35 — Pinion and hollow shaft, disassembling/reassembling
- place dial indicator with holder **VW 387** on new transmission cover
- read value on dial indicator

Example

preload	1.00 mm
value read	– 0.88 mm
	= 0.12 mm
shim S4	0.77 mm
value x	+ 0.12 mm
	= 0.89 mm

- select shim according to table on page 39.32
- if value shown on the dial indicator is greater than 1.00 mm, shim **S4** must be reduced by value of **x**
- install gear carrier housing and check preload of pinion and hollow shaft bearing, see page 39.14

Ring gear, adjusting

(differential, adjusting)

Note

Adjustment of the ring gear is required if any of the following parts are replaced:

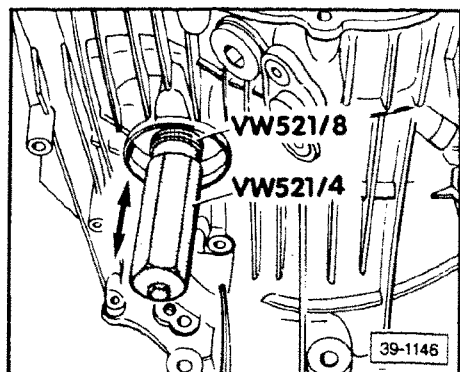
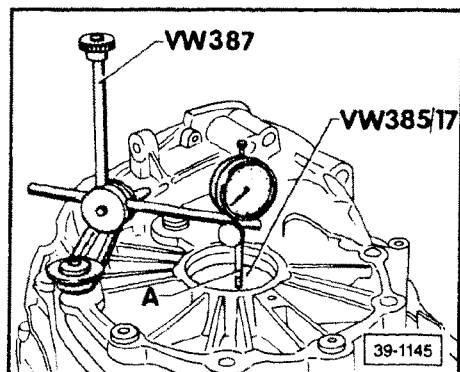
Final drive housing
 Final drive cover
 Gear carrier housing
 Differential tapered roller bearing
 Differential housing
 Ring gear/pinion set
 See Adjustment Overview, page 39.11

Total shim thickness "S total" (S1 + S2), determining

(differential tapered roller bearing preload, adjusting)

Pinion removed

- remove seal and differential bearing outer races
- remove shims (see page 39.7)
- drive bearing outer races **without** shims in to stop (see page 39.7)
- install differential without speedometer drive gear in housing
 - ring gear is on left side (final drive cover side)
- install cover and tighten bolts to 25 Nm (18 ft lb)
- install special tool **VW 521/4** and sleeve **VW 521/8** on final drive housing side of differential housing
 - on smaller differential housing use sleeve **VW 521/7**



- install measuring tools
- zero dial indicator (3 mm measuring range) with 1 mm preload
 - A — dial indicator extension approximately 30 mm long

- move differential up and down, read play on dial indicator and write it down

Example

1.42 mm

CAUTION

Do not turn differential during measurement, the bearings will settle and make measurements inaccurate.

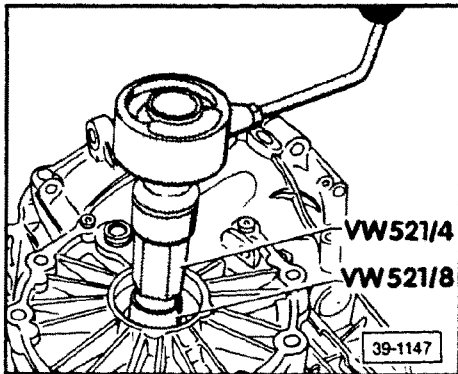
(continued)

S total (S1 + S2), determining

S total = measurement result + preload

preload (constant value)	0.50 mm
measurement result (example)	+ 1.42 mm
S total	= 1.92 mm

- install determined shim thickness (1.92 mm in the example) behind bearing outer race in the final drive housing (**S2** side)
- select shims according to table, page 39.25



- measure turning torque
 - A — torque gage, commercial, 0-600 Ncm (0-54 in. lb)
 - use sleeve **VW 521/7** with smaller differential housing
- lubricate bearings with transmission oil
 - turning torque range:
 - new bearings: 250-350 Ncm (22-31 in. lb)
 - used bearings: 60 Ncm (3-5 in. lb)

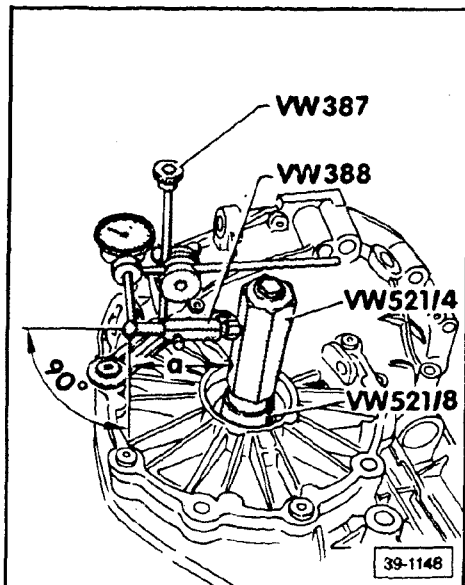
*with at least 50 km (31 miles) running time

Backlash, adjusting

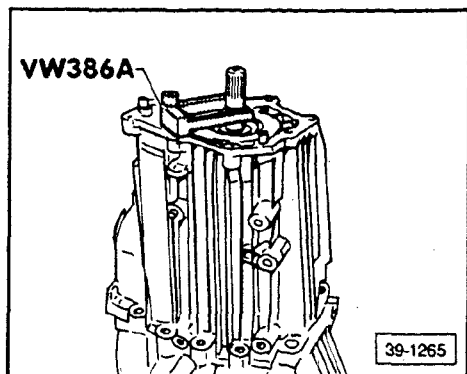
Note

The pinion (with shims **S3** and **S4**) and differential (with **S total** = **S1** + **S2**) are installed in the final drive housing

- turn differential several times in both directions to seat bearings



- install measuring tools
- use dial indicator extension **VW 382/10** (6 mm flat)
 - on smaller differential housings use sleeve **521/7**
- set measuring lever **VW 388** to dimension **a**
 - **a = 67 mm**



- install clamping device and clamp pinion tightly
- turn ring gear to stop, zero dial indicator
- tighten lock bolt
- turn ring gear back and note backlash value
- loosen clamping device
- loosen lock bolt
- turn the ring gear 90° (1/4 turn)
- tighten lock bolt and clamping device
- turn ring gear back and note backlash value
- repeat measuring procedure 2 more times
- add the four measurements and calculate the average backlash

CAUTION

If the determined individual values vary from each other by more than 0.06 mm, the installation of the ring gear or ring gear/pinion set is not correct. Check installation, if necessary replace ring gear/pinion set.

Determination of the average backlash

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
average backlash	= 3.36 mm ÷ 4 = 0.84 mm

Shim S2 thickness, determining

(opposite ring gear)

Example

$$S2 = S \text{ total} - \text{average backlash} + \text{constant value}$$

constant value = 0.15 mm

S total	1.92 mm
average backlash	- 0.84 mm
	= 1.08 mm
constant value	+ 0.15 mm
S2	= 1.23 mm

- the following shims are available for S2 in the transmission housing:

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

Various tolerances make it possible to pick the exact shim thickness required.

Shim thickness S1, determining

(ring gear side)

Example

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

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

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

Note

Various tolerances make it possible to pick the exact shim thickness required.

- install the shims determined, if necessary use 2 shims
 - S1 on the ring gear side
 - S2 opposite the ring gear

Measurement, checking

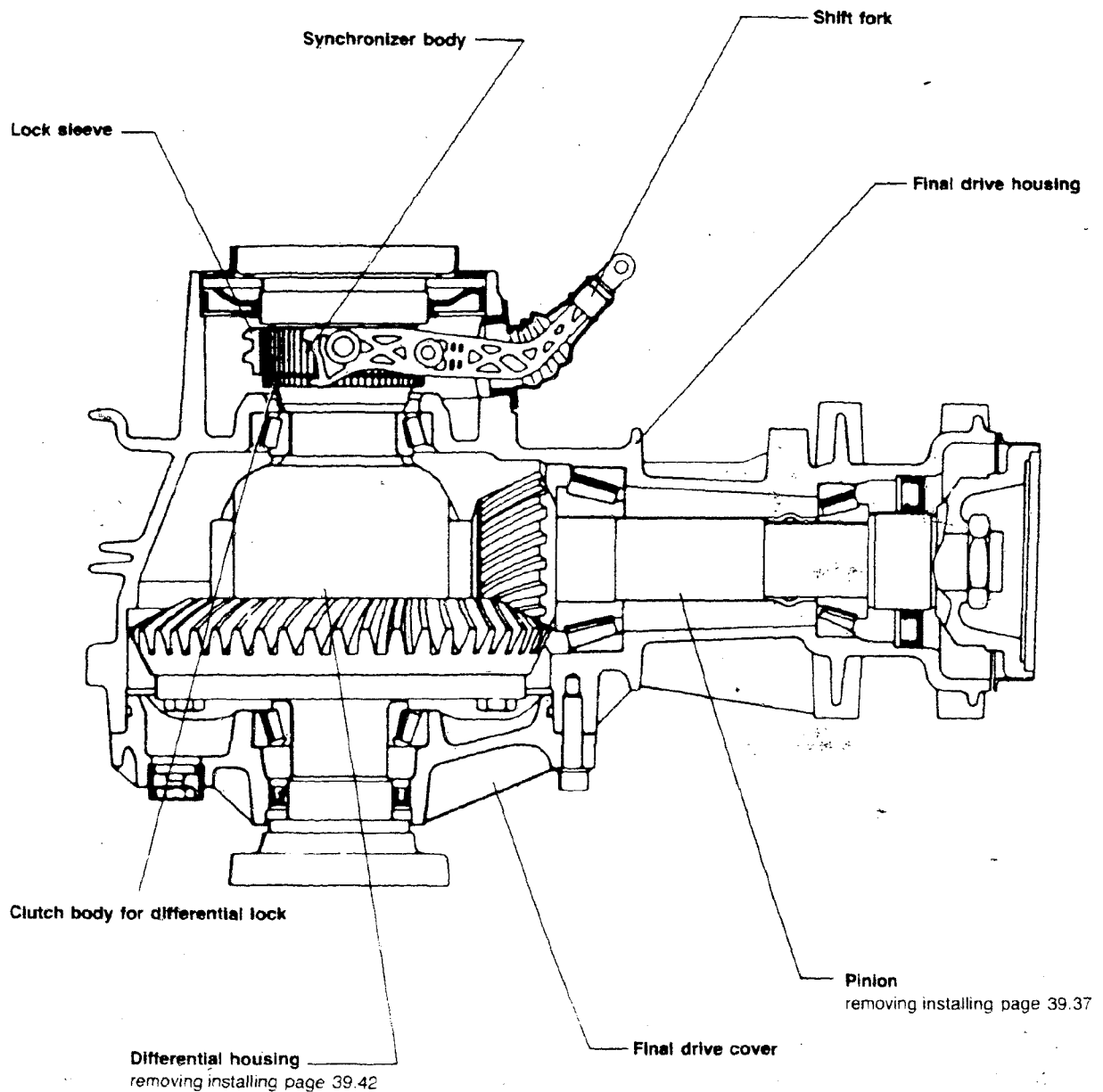
- measure backlash again four times on the circumference
 - backlash must be 0.12 - 0.22 mm

CAUTION

The individual measurements may vary a maximum of 0.05 mm from each other.

THIS FRAME INTENTIONALLY LEFT

BLANK



39-801

Differential flange oil seal, right side, replacing

(with differential installed)

- remove axle shaft
- remove drive flange bolt. Support flange with drift punch
- place oil pan underneath and remove flange
- pry out oil seal with **VW 681**
- drive in new oil seal to stop
- install flange and axle shaft

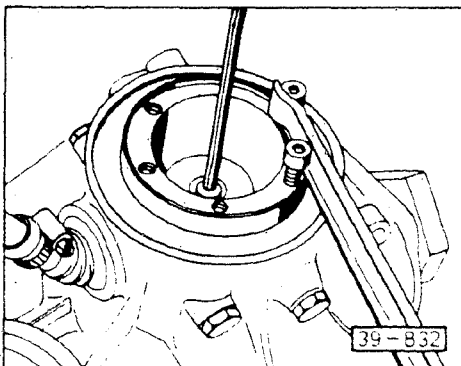
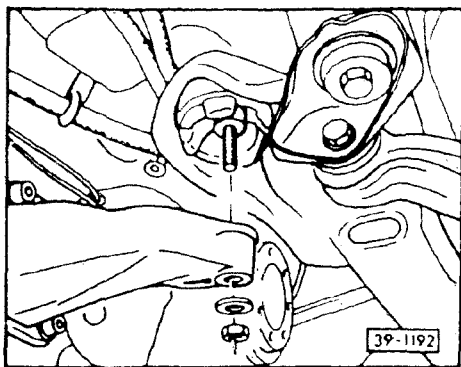
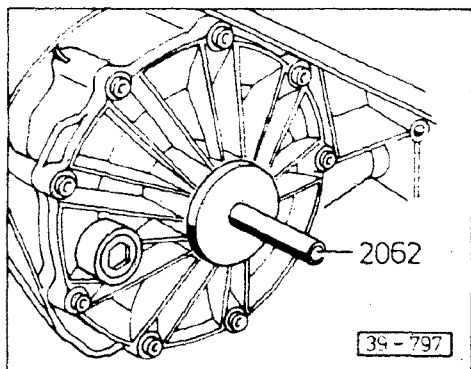
Tightening torques

Flange to differential	25 Nm (18 ft lb)
Axle shaft to flange	45 Nm (33 ft lb)

Differential flange oil seal, left side, replacing

(with differential installed)

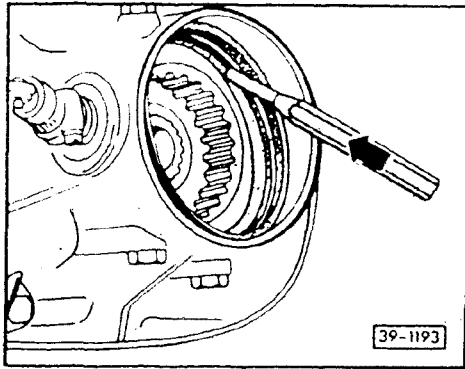
- disconnect axle shaft from axle flange and push upward
- unbolt left differential support, lower differential until flange is accessible
- support differential with **VW 1383**



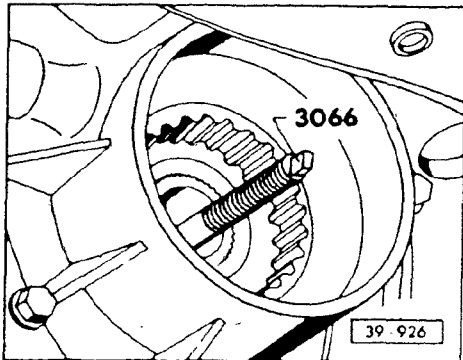
- install two bolts into flange and hold flange with bar. Remove flange bolt
- remove flange

Note

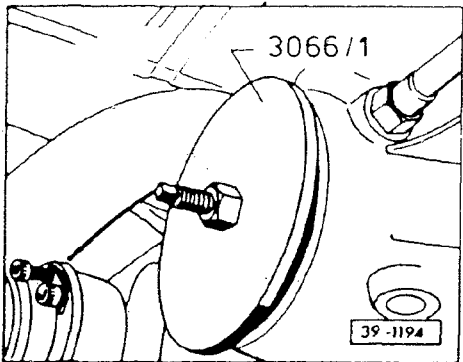
Do not lose adjustment shim between flange shaft and differential gear.



- pry out seal



- screw in threaded rod of tool **3066**

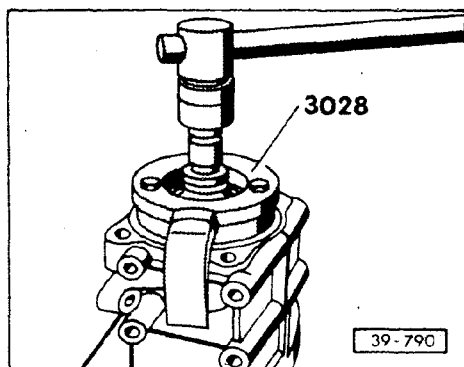


- install new oil seal onto tool **3066/1**
- draw in new oil seal and tighten hex nut up to stop
- be sure lever for differential lock does not interfere with seal during installation
- install flange and shim (lubricate with grease)
- install axle shaft
- reinstall differential support
- check transmission oil level and refill as necessary

- oil capacity: 2.75 liters (5.8 US pints)
- type: Hypoid oil, SAE 90 API/GL5 (MIL-L-2105 B)

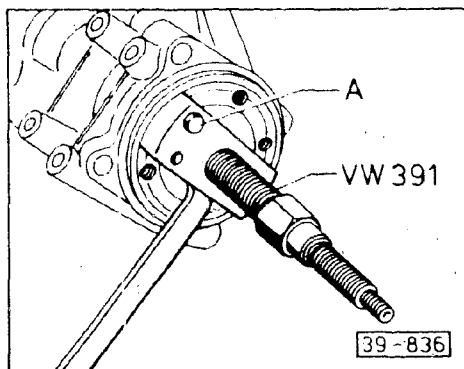
Tightening torques

Flange to differential	25 Nm (18 ft lb)
Axle shaft to flange	45 Nm (33 ft lb)
Suspension to subframe	45 Nm (33 ft lb)

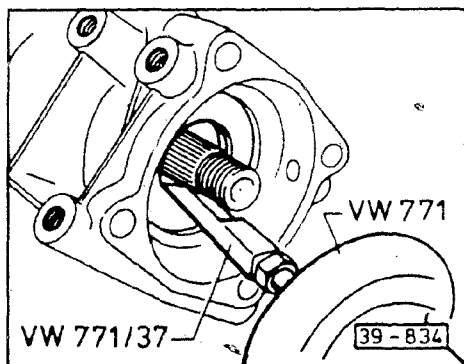


Differential oil seal for driveshaft flange, replacing

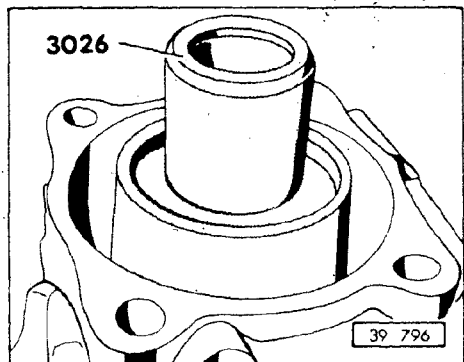
- disconnect driveshaft at differential
- mark position of pinion nut to pinion
- install holder 3028 and remove pinion nut



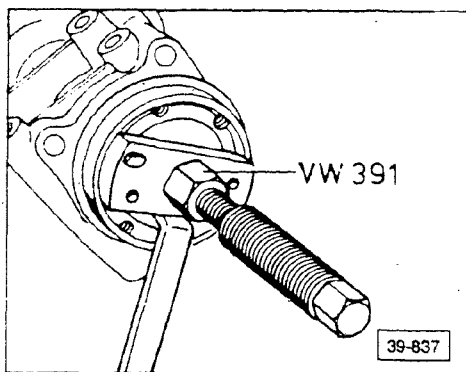
- remove puller flange with puller **VW 391**
A = Hex head bolt M 8 x 30



- remove differential oil seal



- drive in new oil seal up to stop with tool **3026**
(continued)



- reinstall pinion flange. Be sure pinion nut and threads are free of oil and grease. Coat threads of nut lightly with locking compound **D 000 600**
- tighten pinion nut exactly to previously marked position
- peen pinion nut collar

Note

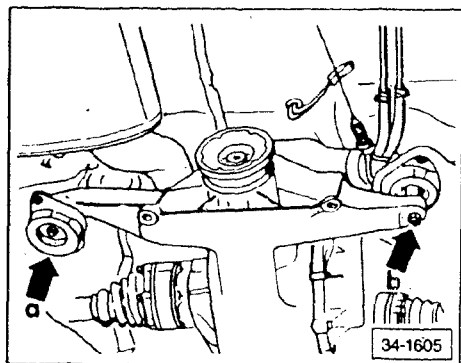
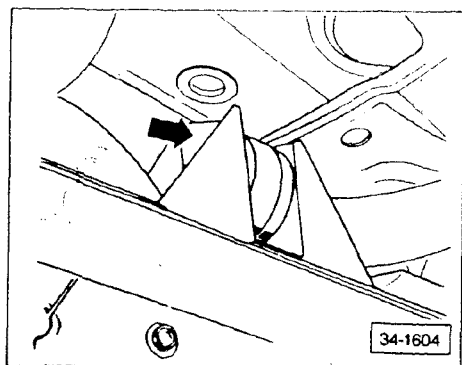
Always use the same nut to assure the original installed position is attained.

- install driveshaft and tighten bolts to 55 Nm (40 ft lb)

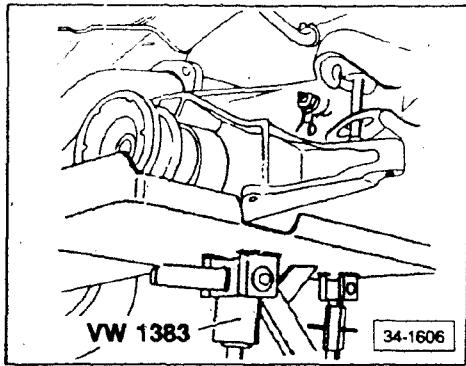
Rear differential, removing/installing

Removing

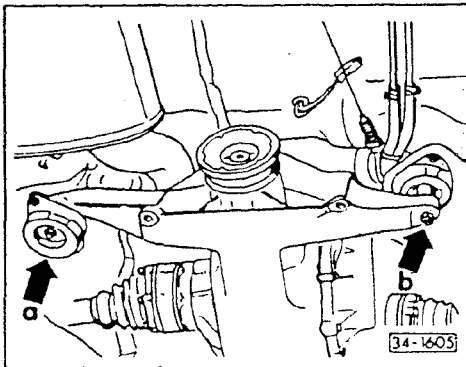
- remove differential flange driveshaft bolts and tie driveshaft out of way
- remove and tie up axle shafts
- remove differential lock servo and bracket. See page 34.10
- remove wires for differential lock indicator switch
- remove nut from differential rear mounting bushing (arrow)



- remove nut **a** and loosen nut **b**



- slightly lift differential with **VW 1383**
- remove rubber bonded bushing on right side



- remove nut **b** and mounting bolt from rear bushing
- push differential forward, then lower carefully

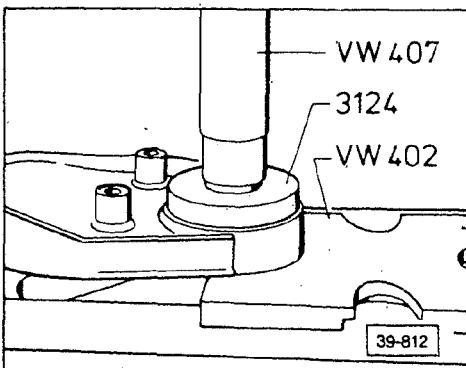
Installing

Installation is in reverse order. Be sure differential is installed without stress.

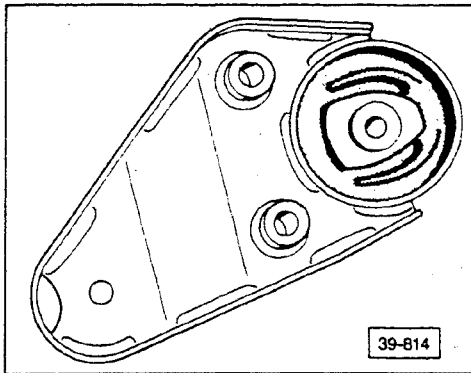
Tightening torques

Rubber bonded bushing to subframe	25 Nm (18 ft lb)
Differential to bearing/subframe	45 Nm (33 ft lb)
Driveshaft to differential	55 Nm (40 ft lb)
Axle shaft to differential	45 Nm (33 ft lb)

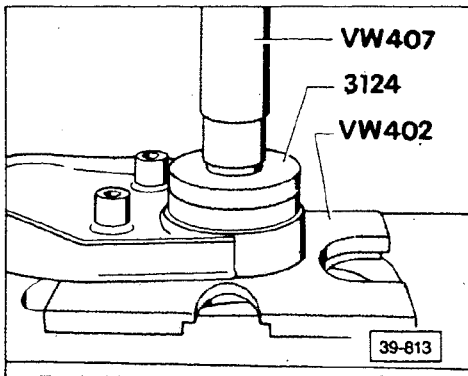
Rubber bonded bushing for rear differential, removing/installing



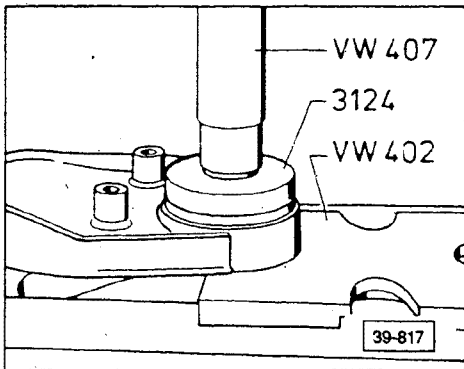
- support differential with **VW 1383**
- remove bolts for rear mounting bracket support
- unbolt bracket from rear differential
- with bracket and support out of car, unbolt from rubber bonded bushing
- press out rubber bonded bushing



- installed position



- install bushing exactly as shown
- when installing bushing, position bracket in the center of **VW 402** and press bushing in halfway. Recheck bushing installed position

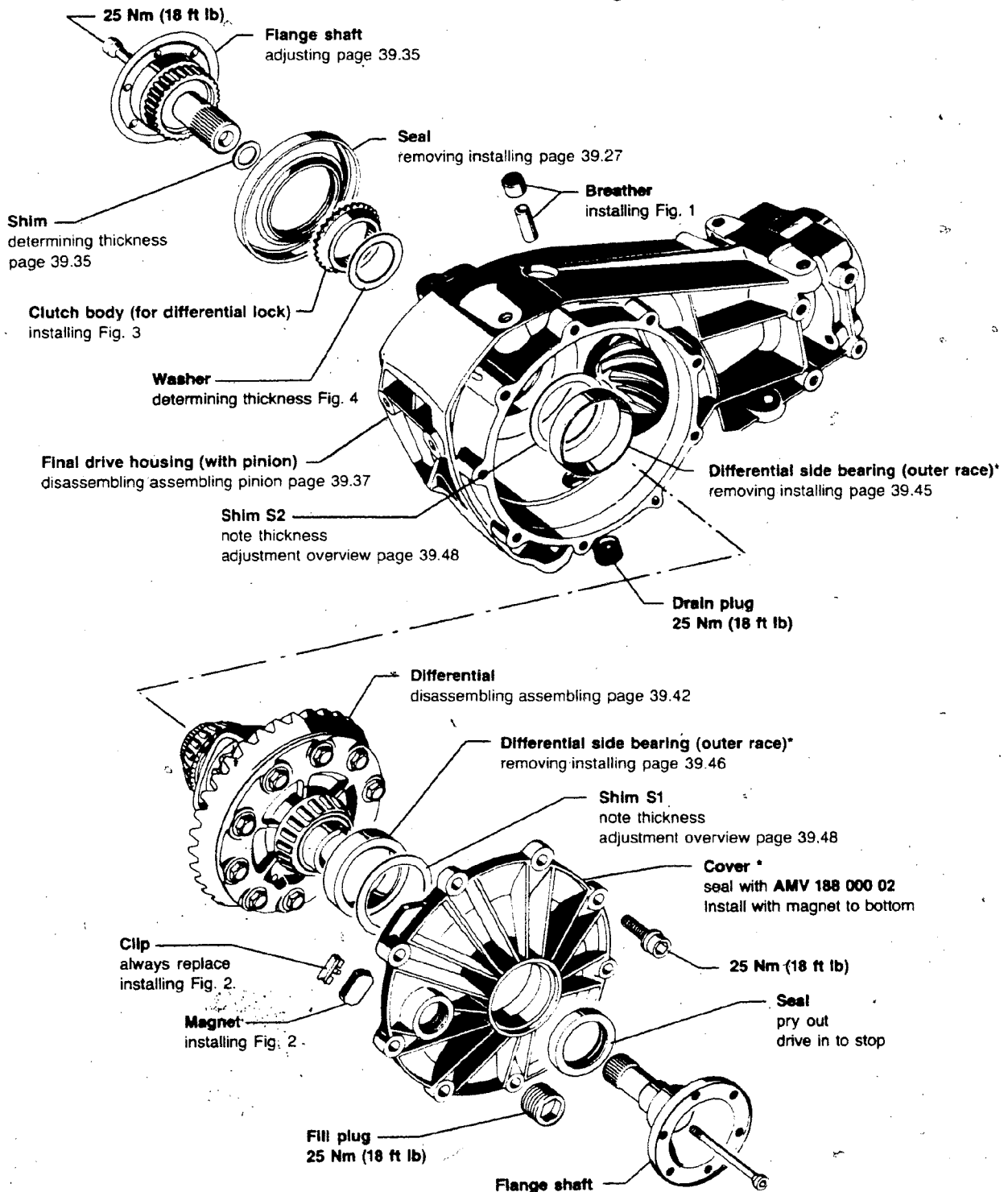


- position bracket with rubber bushing over the largest opening of **VW 402** and press bushing in flush
- bolt bracket and support together and install into vehicle

Tightening torques

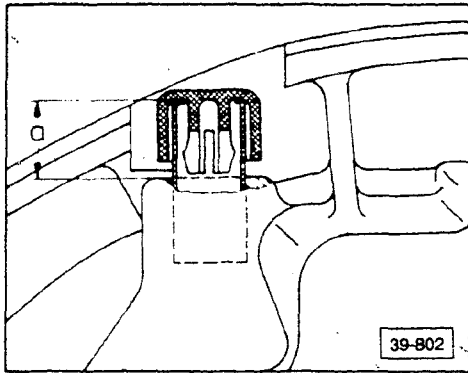
Bracket to differential	45 Nm (33 ft lb)
Support to body	80 Nm (59 ft lb)
Bolt for bonded rubber bushing	65 Nm (48 ft lb)

Mounting differential to repair stand page 39.37



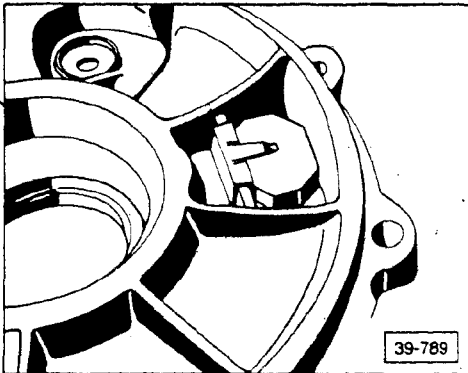
*Adjustments required when replacing these parts. See Adjustment overview page 39.48.

39-1195



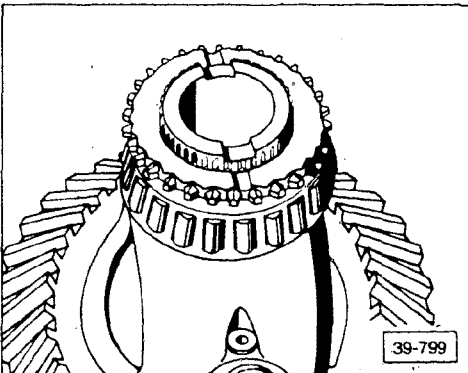
► Fig. 1 Breather, installing

- $a = 13 \text{ mm (1/2 inch)}$



► Fig. 2 Magnet, installing

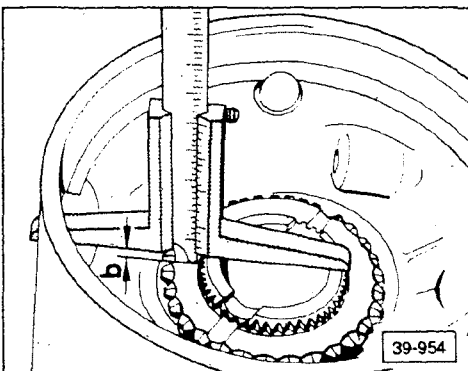
- replace clip if removed



► Fig. 3 Clutch body

(differential shown removed)

- align oil grooves in clutch body and differential



► Fig. 4 Adjustment washer, determining thickness

- measure dimension b and determine shim from chart

Dimension b	Thickness mm	Part Number
under 4.10	—	no washer
4.11 - 4.40	0.3	005 409 737
4.41 - 4.70	0.6	005 409 737 A
4.71 - 4.90	0.9	005 409 737 B

Flange shaft, adjusting

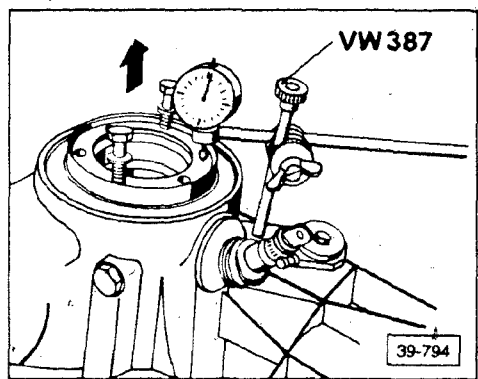
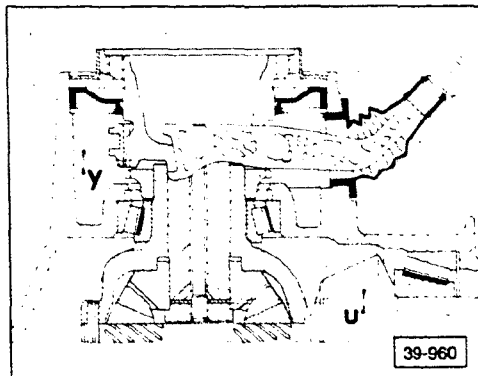
The flange shaft must be adjusted if any of the following parts are replaced:

- flange shaft
- differential housing
- differential pinion gears

Note

This adjustment is important to insure smooth shifts and low wear.

- $y = 0.2-0.5 \text{ mm } (.008-.019 \text{ inch})$



Determining shim "u"

- install flange shaft with original shim and tighten bolt

- end play should be 0.2-0.5 mm (.008-.019 inch)

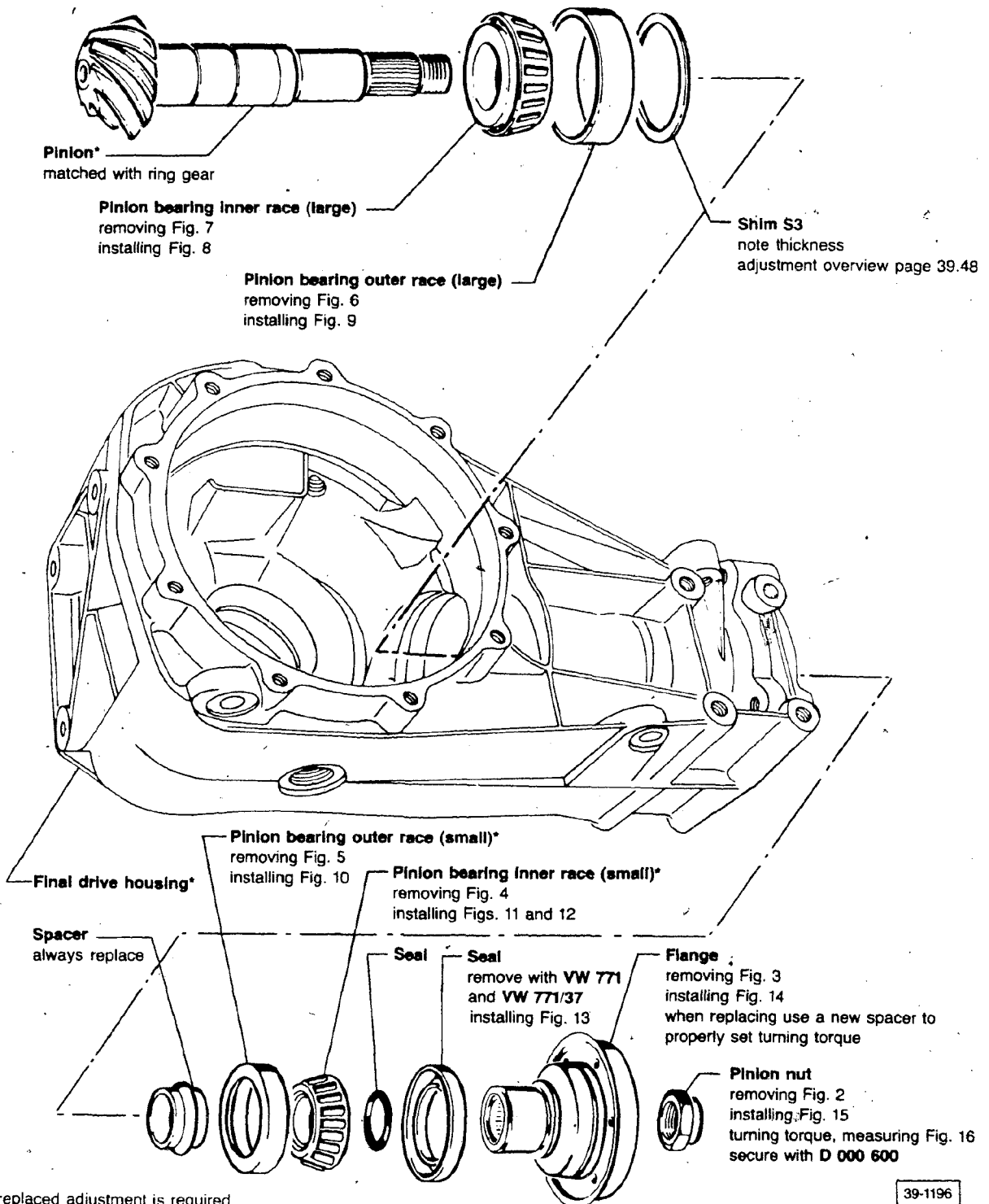
- if too much end play, use thicker shim
- if too little end play, use thinner shim

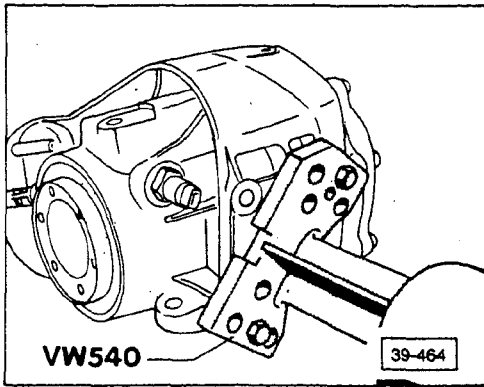
- available shims

Thickness mm	Part Number
0.3	183 525 293
0.6	183 525 293 A
0.9	183 525 293 B

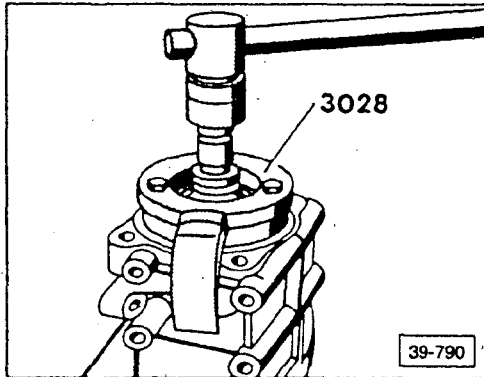
Note

If a new pinion bearing is required, replace both bearings at the same time.

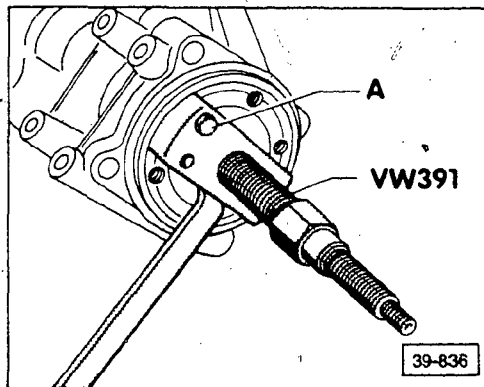




► Fig. 1 Final drive, mounting to repair stand

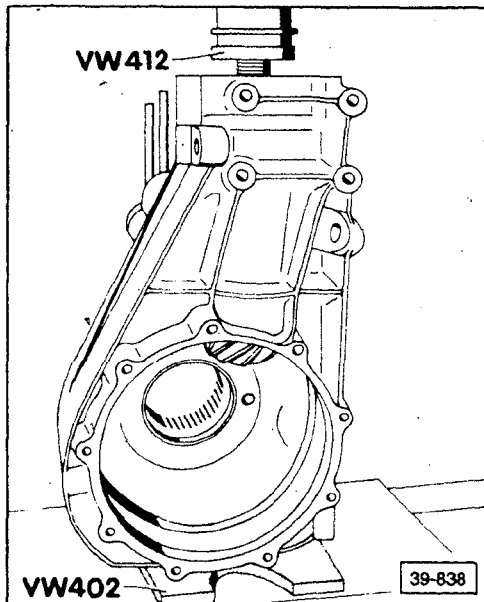


► Fig. 2 Pinion nut, removing



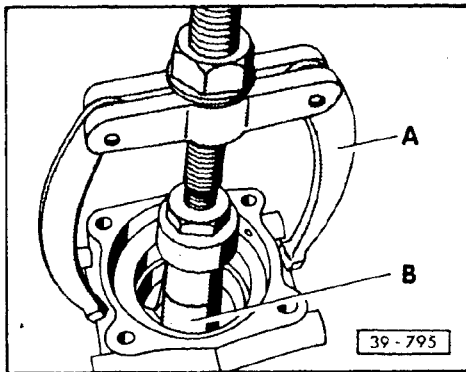
► Fig. 3 Flange, removing

• A = bolt M 8 x 30



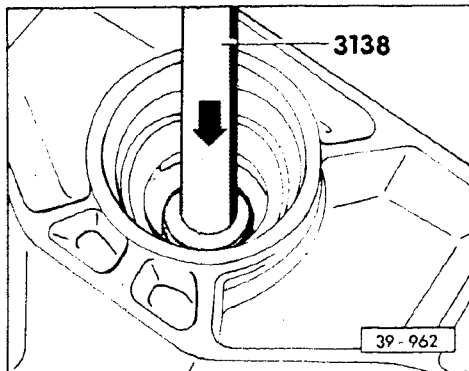
► Fig. 4 Pinion, removing

■ press out of bearing

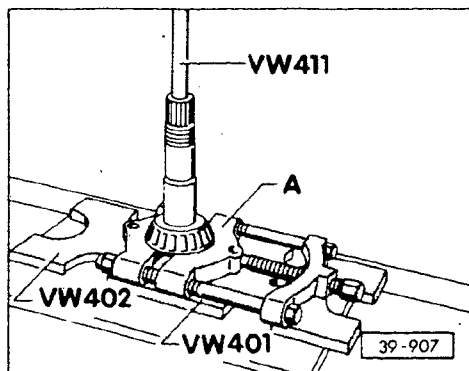


► Fig. 5 Pinion bearing outer race (small), removing

- A = puller e.g. Kukko 22/1
- B = extractor 46-56 mm e.g. Kukko 21/7

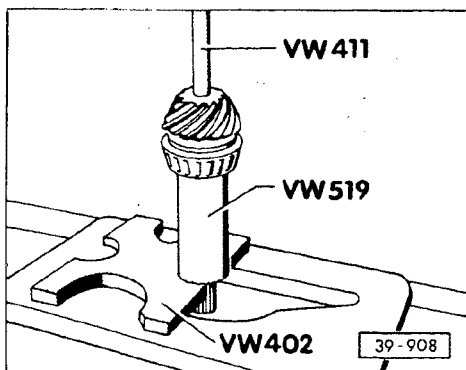


► Fig. 6 Pinion bearing outer race (large), removing



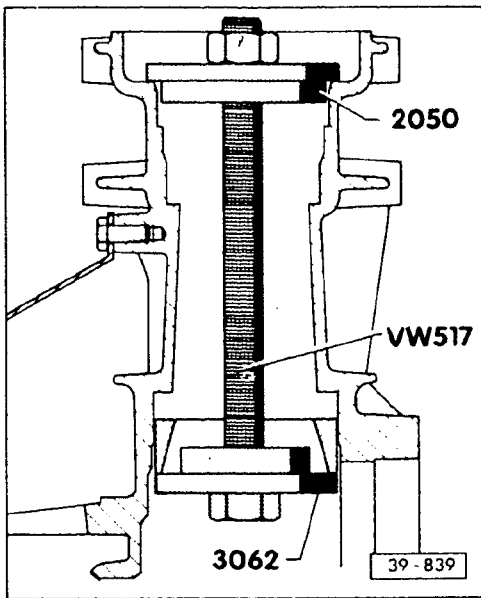
► Fig. 7 Pinion bearing inner race (large), removing

- A = separator 22-115 mm e.g. Kukko 17/2



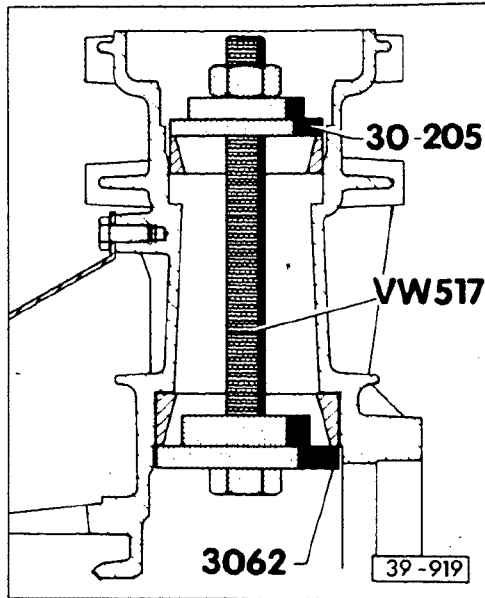
► Fig. 8 Pinion bearing inner race (large), installing

- heat bearing to approximately 120°C (248°F)

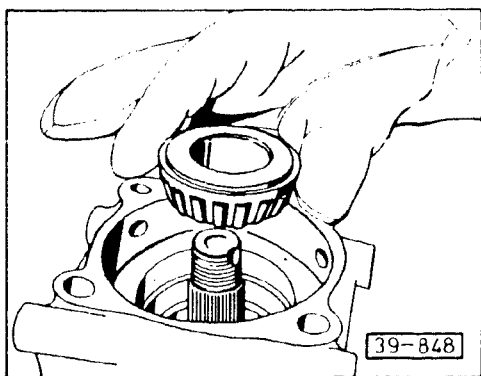


► Fig. 9 Pinion bearing outer race (large), installing

- place required pinion shims behind race before installing

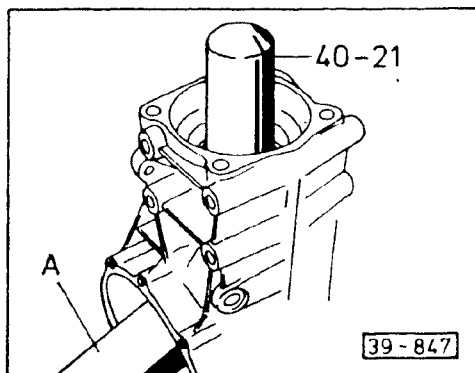


► Fig. 10 Pinion bearing outer race (small), installing



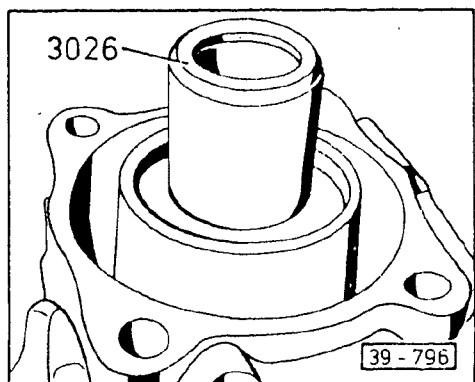
► Fig. 11 Pinion bearing inner race (small), installing

- insert pinion and new spacer
- heat bearing to 120°C (248°F) and install on pinion



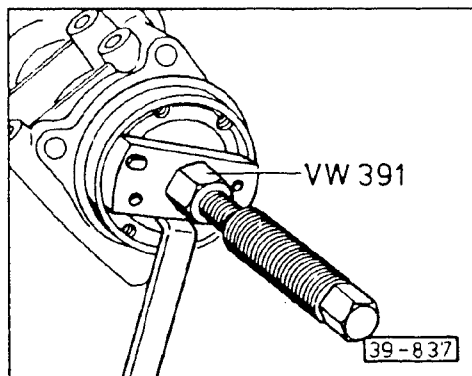
► Fig. 12 Pinion bearing, seating

- A = wood to support pinion

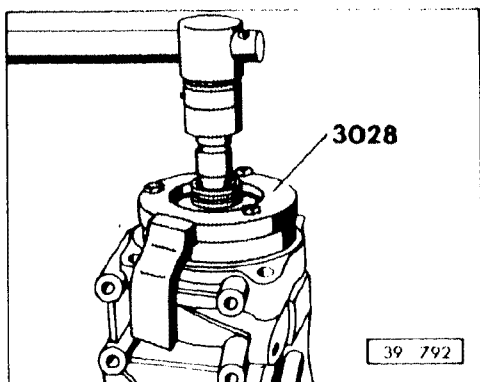


► Fig. 13 Seal, installing

- drive in to stop

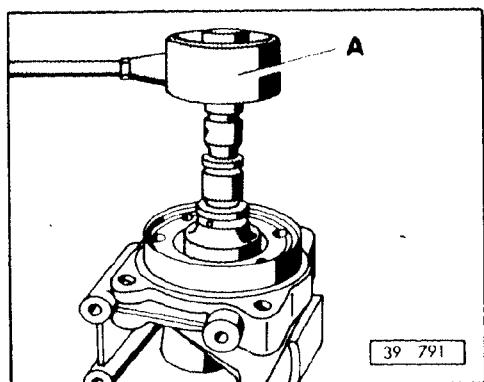


► Fig. 14 Flange, installing



► Fig. 15 Pinion nut, installing

- measure turning torque, Fig. 16



► Fig. 16 Turning torque, measuring

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

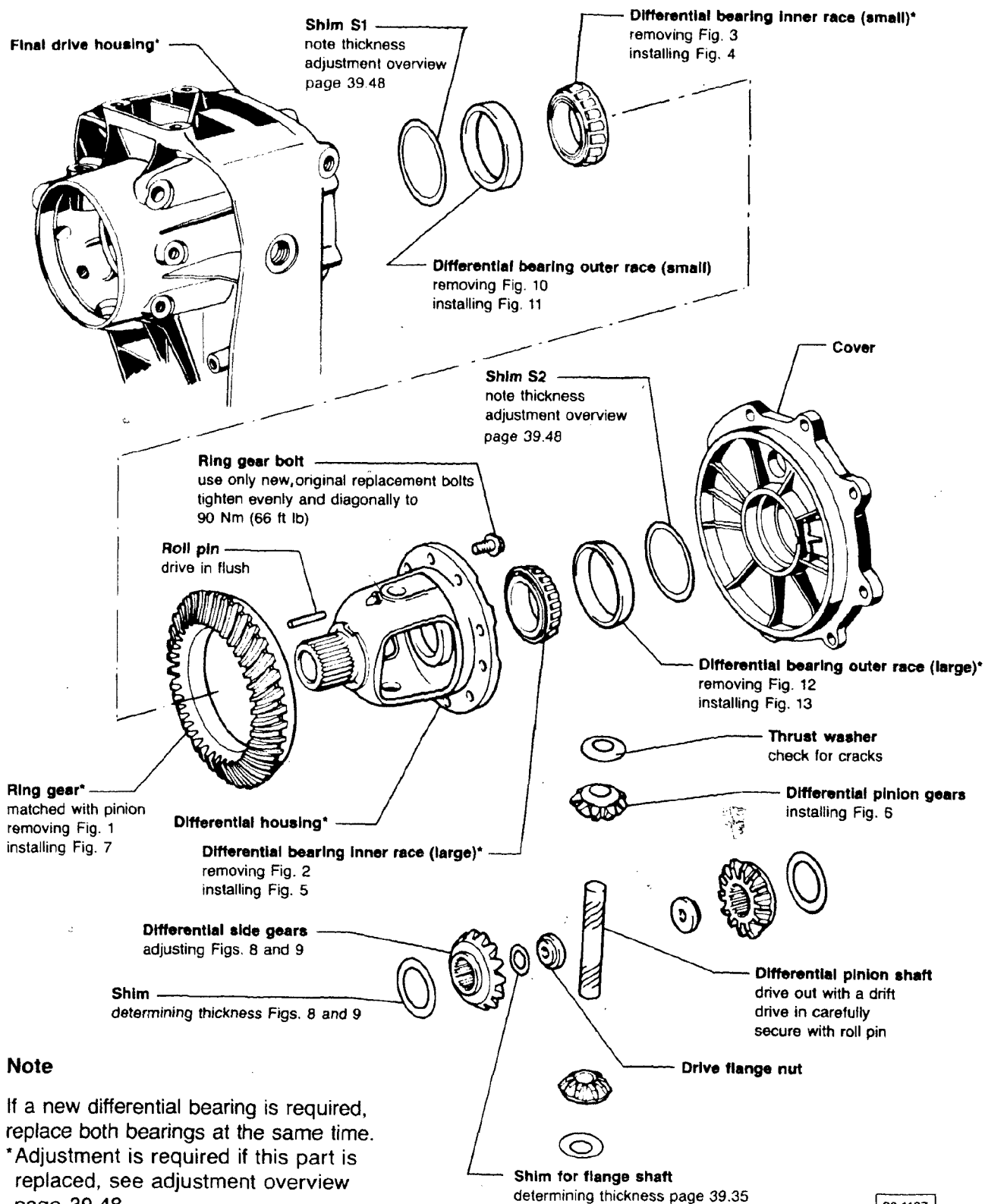
CAUTION

Tighten pinion nut a little at a time and read turning torque frequently. If turning torque exceeds specifications the spacer will have to be replaced. Once the spacer has been compressed it cannot be used again.

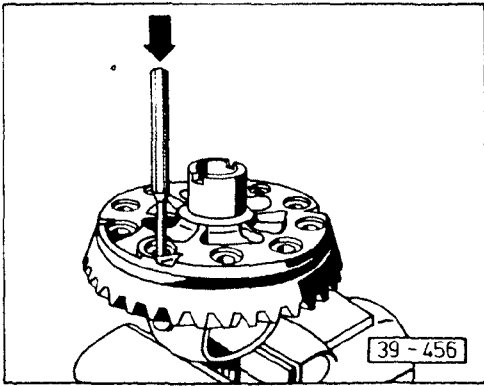
Turning torque, specifications

- new bearings = 280-320 Ncm
(25-28 in. lb. or 29-33 cm kg)
- used bearings* = 30-60 Ncm
(3-5 in. lb. or 3-6 cm kg)

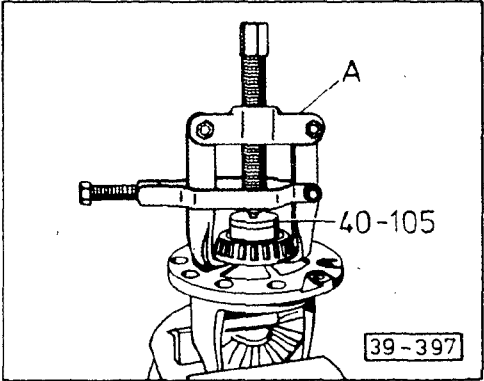
*with at least 50 km (30 miles) running time



39-1197

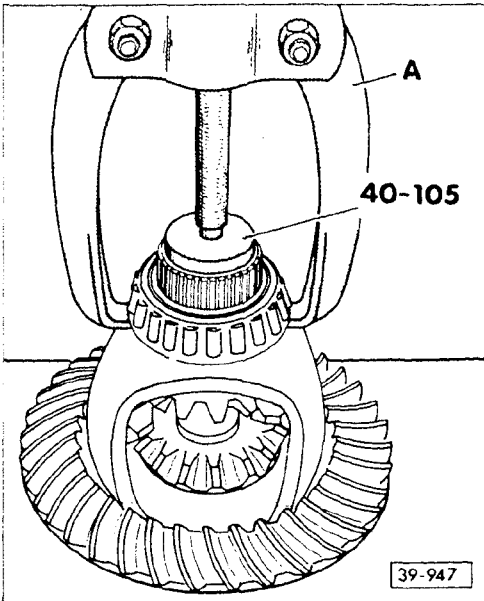


► Fig. 1 Ring gear, removing



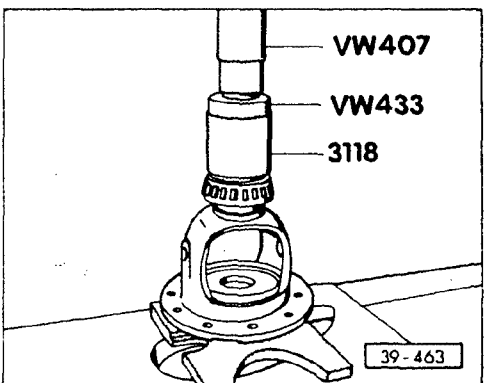
► Fig. 2 Differential bearing inner race (large), removing

- A = puller e.g. Kukko 204/2



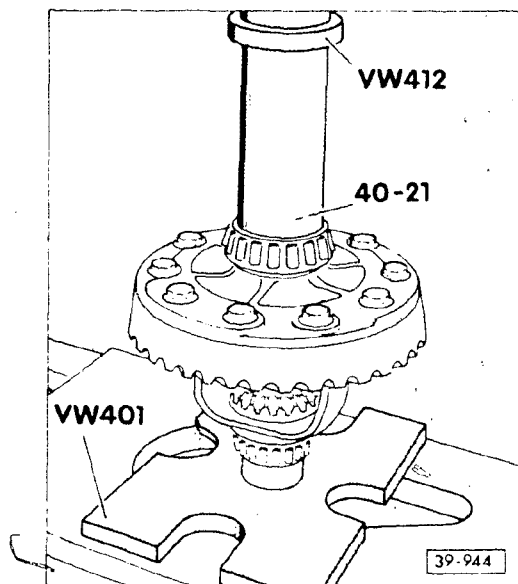
► Fig. 3 Differential bearing inner race (small), removing

- A = puller e.g. Kukko 44/2



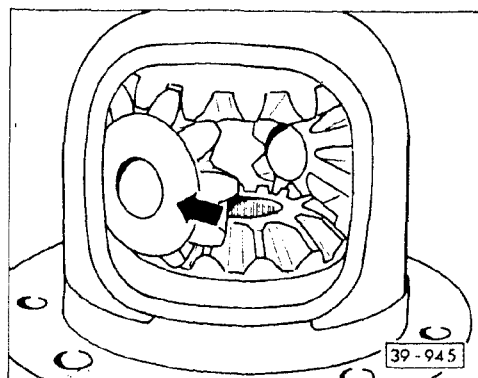
► Fig. 4 Differential bearing inner race (small), installing

- heat bearing to approximately 100°C (212°F) and press on



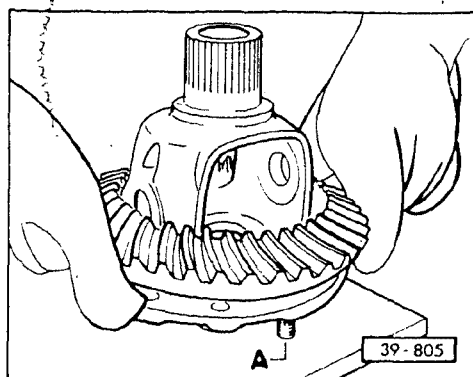
► Fig. 5 Differential bearing inner race (large), installing

- heat bearing to approximately 100°C (212°F) and press on



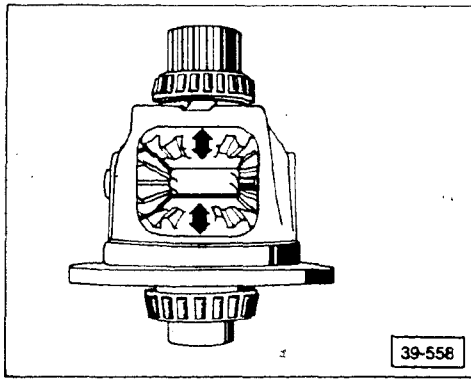
► Fig. 6 Differential pinion gears, installing

- insert differential side gears with correct adjustment shims (Figs. 8 and 9)
- insert differential pinions in housing approx. 180° apart (coat thrust washers lightly with grease)
- rotate gears into position
- insert drive flange nuts
- align thrust washers
- drive in differential pinion shaft
- secure with roll pin



► Fig. 7 Ring gear installing

- heat to approximately 100°C (212°F) and install
 - A = alignment pins



► Fig. 8 Differential pinion gears, installing

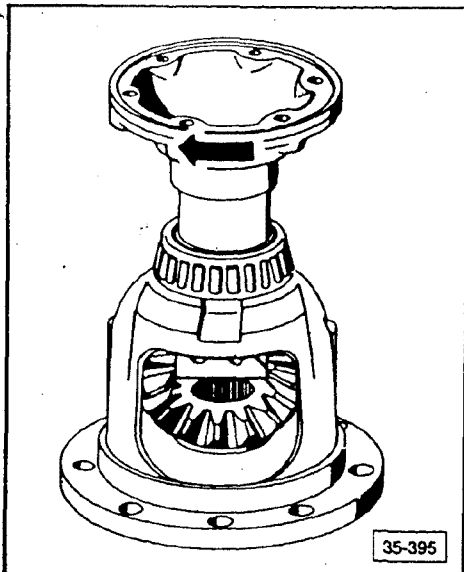
- insert differential side gears with 0.5 mm (0.019 inch) shims
- insert differential pinion gears with thrust washers
- drive in differential pinion shaft
- hold differential pinion gears outward and check the clearance of the side gears (**arrows**)
- adjust clearance by changing shims
 - maximum clearance 0.10 mm (0.004 inch)

Note

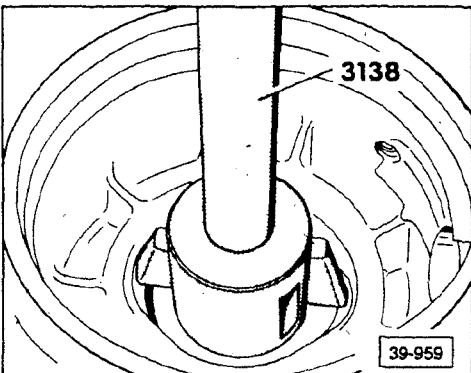
The clearance is **OK** when you feel no play and the differential pinion gears can be turned slightly without catching (Fig. 9).

- available shims

Thickness mm	Part Number
0.5	011 519 215
0.6	088 409 249
0.7	088 409 249 A
0.8	088 409 249 B
0.9	088 409 249 C
1.0	088 409 249 D

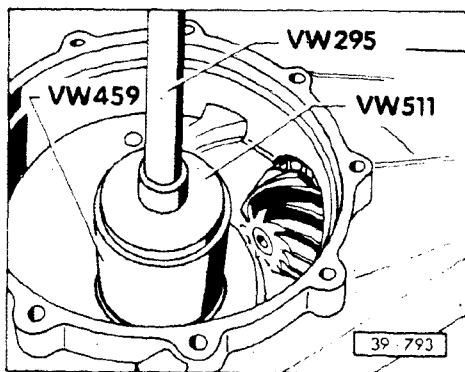


► Fig. 9 Differential pinion gears, turning

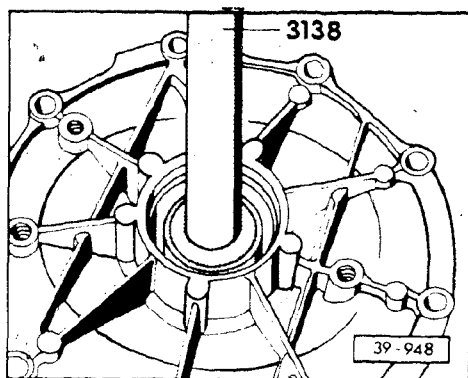


► Fig. 10 Differential bearing outer race (small), removing

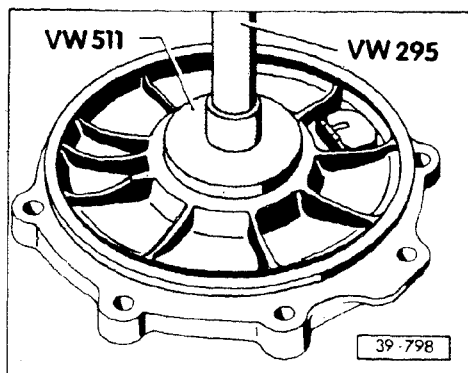
- drive race out of final drive housing



► Fig. 11 Differential bearing outer race (small), installing



► Fig. 12 Differential bearing outer race (large), removing



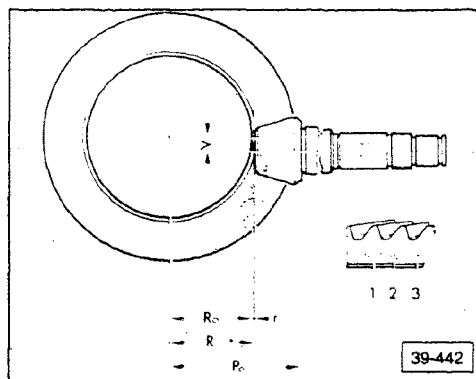
► Fig. 13 Differential bearing outer race (large), installing

- press in with VW 511 and VW 295

Ring gear/pinion, adjusting

Careful adjustment of the ring gear and pinion is important to ensure that the final drive gives long service and runs quietly. The ring gear and pinion may only be replaced as a matched set.

Ring gear/pinion, adjustment



Service gears

- 1 — **0937** = Oerlikon gear set, 9:37 ratio
- 2 — **312** = Serial number of matched gear set
- 3 — **25** = Dimension r is the ring and pinion deviation measured against the master gauge used in production. Dimension r is always given in 0.01 mm. For example: 25 means $r = 0.25$ mm

R_o — Length of master gauge used in factory testing machine.
R_o = 53.15 mm

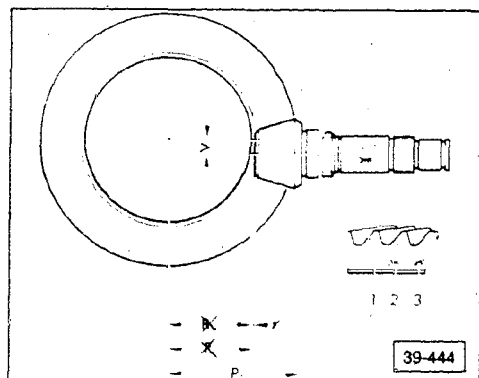
R — Actual dimension between ring gear centerline and end face of pinion at quietest running point for this gear set

V_o — Hypoid offset = 35 mm

Production gears

X — Markings x'ed out are not shown on production gears

P_o — Setting dimension for production gears



CAUTION

In production position of pinion is determined by dimension **P_o** (ring gear centerline to back of pinion head).

Marking of deviation r on ring gear and matching number have been discontinued. It is therefore necessary to measure position of pinion **before** removing it when parts which affect position of pinion are to be replaced. See adjustment overview, page 39.48.

Ring gear/pinion, adjusting

Adjustment overview

to be adjusted				
Part replaced	Ring gear (S1 & S2) page 39.53	Pinion (S3) Via dim. "r" page 39.47	Pinion (S3) Via actual measurement page 39.48	Flange shaft page 39.35
Housing for final drive	X		X	
Differential gear housing	X			X
Taper roller bearing for pinion			X	
Taper roller bearing for differential	X			
Ring for pinion set	X	X		
Cover for final drive	X			X
Flange shaft				X
Differential pinion gear				

Pinion, determining position

(actual dimension)

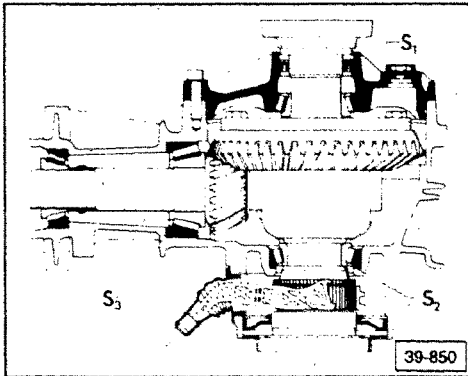
This operation is only necessary if the deviation r is not marked on the ring gear and if any parts which directly affect the pinion position are to be replaced. These parts are:

- pinion bearings
- final drive housing
- remove differential from final drive housing
- insert universal measuring bar in final drive housing as described on page 39.51
- measure the deviation from R_0 (maximum deflection)
- note reading, this is dimension r
 - after replacement of parts this dimension is used to determine the thickness of shim $S3$

Ring gear/pinion, replacement

If a new ring and pinion gear set is to be installed, the following work sequence should be followed.

- 1 — Determine the total shim thickness **S total (S1 plus S2)** for differential turning torque.
- 2 — Determine shim **S3** for new pinion.
- 3 — Distribute **S total** between **S1** and **S2** to obtain the specified backlash for the ring and pinion gear set.



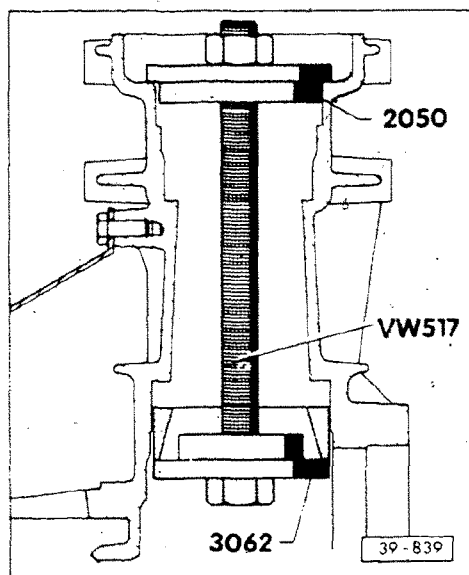
Note

All cautions and procedures must be followed carefully to insure quiet, reliable operation of the final drive assembly.

Position of shims

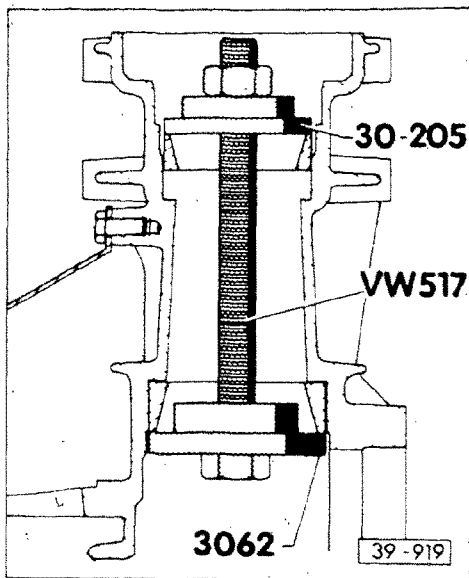
- **S1** = shim behind ring gear
- **S2** = shim opposite ring gear
- **S3** = shim behind the pinion bearing outer race

Pinion, adjusting

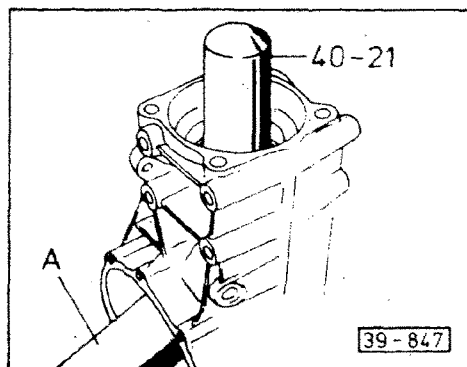


Ring gear/pinion need adjusting if gear set has been replaced. If other parts which affect position of the pinion are to be replaced, setting must be measured **before** disassembly, and pinion set to this dimension when assembling (see adjustment overview, page 39.48).

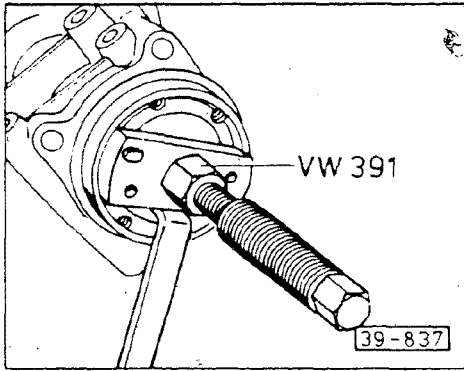
- mount final drive to holding fixture
- pull in large pinion bearing outer race **without** shim S3



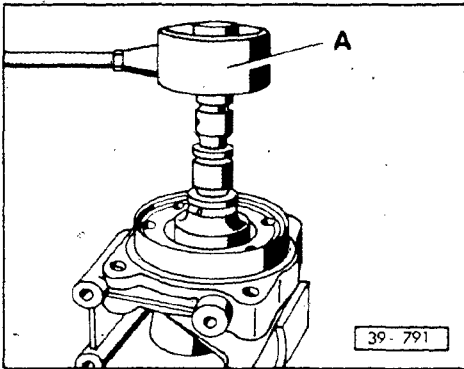
- pull in small pinion bearing outer race



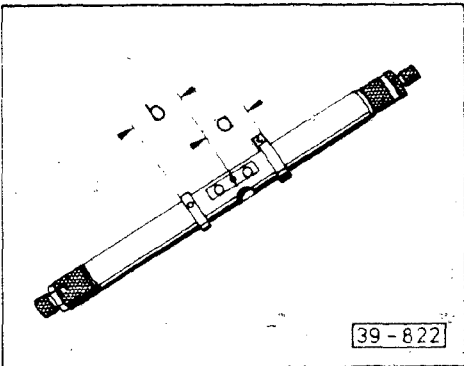
- insert pinion
- heat pinion bearing inner race to 120°C (248°F) and install bearing on pinion **without** spacer
- A = wood support



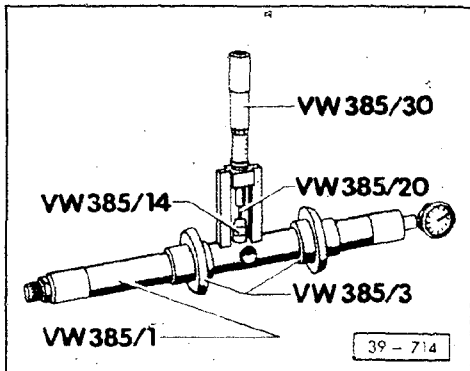
- install flange onto pinion



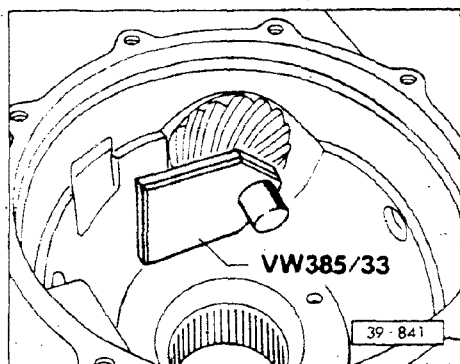
- tighten flange nut until pinion turning torque reaches 280-320 Ncm (25-28 in. lb. or 29-33 cm kg)
 - A = wrench gauge 0-600 Ncm (0-60 in. lb or 0-65 cm kg)



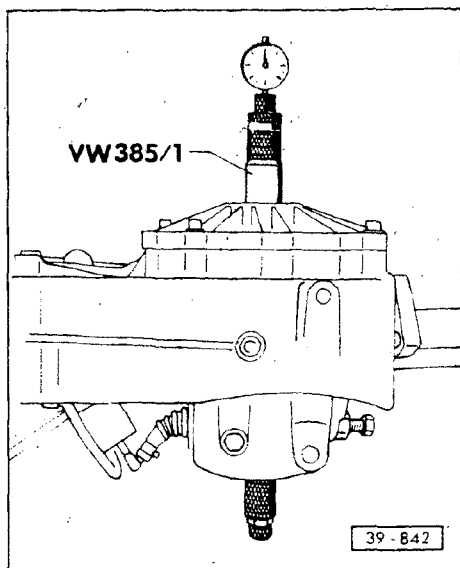
- slide centering ring on measuring bar **VW 385/1** and set **a** to 60 mm
- slide opposite ring on bar to set **b** to 50 mm



- prepare measuring bar as shown (use dial indicator with 3 mm range)
 - indicator extension **VW 385/20** = 3 mm long
- set universal master gauge **VW 385/30** to **Ro** = 53.15 mm
- zero dial indicator with a 3 mm preload



- position end plate **VW 385/33** to pinion
- install measuring bar in housing
- install cover for final drive housing and tighten 4 bolts
- pull 2nd centering ring outward until measuring bar can just be turned by hand



- turn measuring bar slightly until dial indicator indicates maximum reading **e**
 - example: **e** = 1.60 mm

CAUTION

When measuring bar has been removed check to be sure that it zeros with 3 mm preload when master gauge **VW 385/30** is mounted.

Shim S3, determining thickness

$$S3 = e - r$$

e = dial indicator reading (maximum deflection)
r = deviation (marked on ring gear in 1/100 mm)

Example

e dial indicator reading	1.60 mm
r deviation	– 0.42 mm
S3	= 1.18 mm

Thickness (mm)	Part Number
0.95	183 525 231
1.00	183 525 231 A
1.05	183 525 231 B
1.10	183 525 231 C
1.15	183 525 231 D
1.20	183 525 231 E
1.25	183 525 231 F
1.30	183 525 231 G
1.35	183 525 231 H
1.40	183 525 231 J
1.45	183 525 231 K
1.50	183 525 231 L
1.55	183 525 231 M

CAUTION

Tighten pinion nut a little at a time and read turning torque frequently. If turning torque exceeds specifications the spacer will have to be replaced. Once the spacer has been compressed it cannot be used again.

S3 shims available

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.

- remove measuring bar
- remove pinion and install it with the determined shim, spacer and seal
- install flange and flange nut
- tighten flange nut until specified turning torque is reached

- check that turning torque is:
 - new bearings = 280-320 Ncm (25-28 in. lb or 29-33 cm kg)
 - used bearings* = 30-60 Ncm (3-5 in. lb or 3-6 cm kg)
- *with at least 50 km (30 miles) running time

Checking measurement

- turn pinion several times in both directions
- insert measuring bar and check measurement
 - Shim **S3** is correct if dial indicator shows ring gear deviation r within tolerance of ± 0.04 mm

Ring gear, adjusting

Note

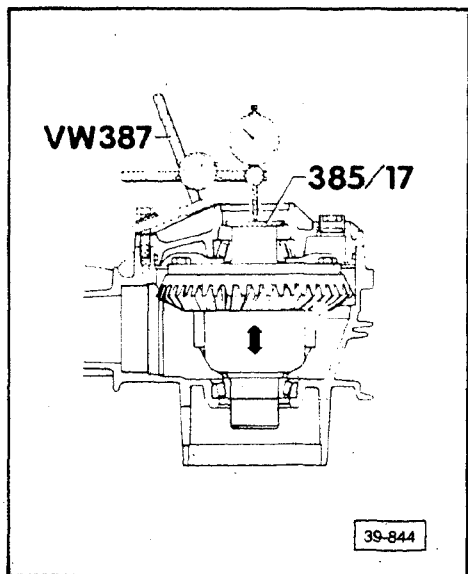
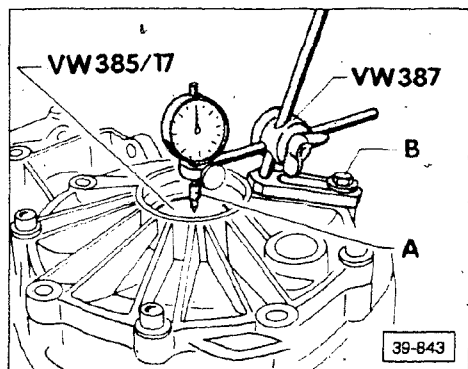
The ring gear must be adjusted if any of the following parts are replaced:

- final drive housing
- final drive cover
- differential bearings
- differential gear housing
- ring and pinion set

See adjustment overview page 39.48.

S total, determining (pinion removed)

- remove differential bearing outer races from final drive housing and cover (see pages 39.45 and 39.46)
- remove shims **S1** and **S2**
- install bearing outer races **without** shims (see page 39.46)
- insert differential gear into housing (ring gear toward cover)
- install cover and tighten bolts evenly to 25 Nm (18 ft lb)
- position final drive housing in holding fixture with the cover up
- attach dial indicator as shown with 1 mm preload, zero gauge
 - **A** = 30 mm extension
 - **B** = bolt M8 x 45



- note reading on gauge while moving differential gear up and down
 - example: 1.60 mm

CAUTION

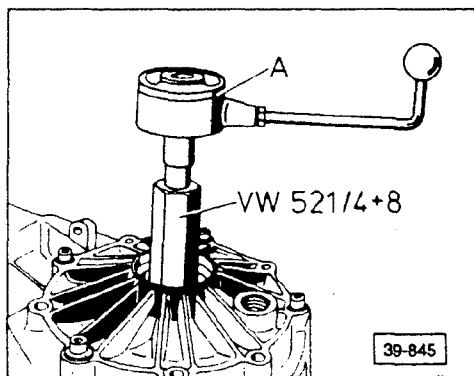
Do not turn differential while taking reading or a false reading will result.

S total (S1 + S2), determining

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

Example

preload (constant value)	0.40 mm
dial indicator reading	+ 1.60 mm
S total	= 2.00 mm



Turning torque, measuring

- lubricate bearings with hypoid oil before installing
- check that turning torque is:
 - 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)
- A = torque wrench 0-600 Ncm (0-60 in. lb or 0-65 cm kg)

Note

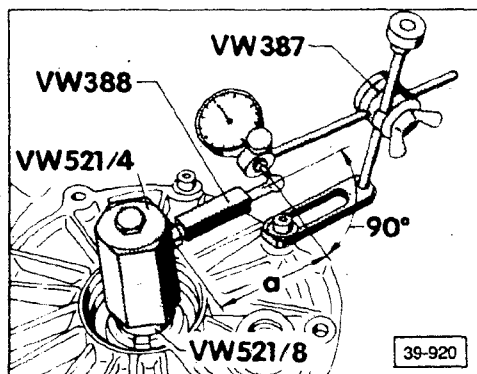
When ring gear and pinion are to be readjusted; start now with pinion adjustment (page 39-50).

Backlash, adjusting

- install pinion with shim **S3** installed
- install **S** total (**S1** + **S2**) on housing side of differential
- turn differential several times in both directions to seat bearings
- install dial indicator as shown
- use dial indicator extension **VW 382/10**
 - a = 79 mm
- while holding pinion from moving, turn ring gear to stop and zero dial indicator
- turn ring gear back and note backlash
- loosen lock bolt on locking sleeve
- rotate ring gear 90° tighten lock bolt and again measure backlash
- repeat above procedures at least two more times
- add all four readings together and divide by four to find average backlash

Note

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



Example

1st reading	0.68 mm
2nd reading	+ 0.70 mm
3rd reading	+ 0.70 mm
4th reading	+ 0.68 mm
Total	= 2.76 mm
divided by 4	÷ 4
Average backlash	= 0.69 mm

Average backlash (mm)	Shim thickness S1 (mm)
0.62	0.67
0.63	0.69
0.64	0.70
0.65	0.72
0.66	0.73
0.67	0.75
0.68	0.76
0.69	0.78
0.70	0.80
0.71	0.81
0.72	0.83
0.73	0.84
0.74	0.86
0.75	0.87
0.76	0.89
0.77	0.91
0.78	0.92
0.79	0.94
0.80	0.96
0.81	0.97
0.82	0.99
0.83	1.00
0.84	1.01
0.85	1.03
0.86	1.04
0.87	1.06
0.88	1.07
0.89	1.09
0.90	1.10
0.91	1.12
0.92	1.13
0.93	1.15
0.94	1.16
0.95	1.18
0.96	1.19
0.97	1.21
0.98	1.23
0.99	1.24
1.00	1.25
1.01	1.27
1.02	1.28
1.03	1.30
1.04	1.32
1.05	1.33
1.06	1.35
1.07	1.36
1.08	1.38
1.09	1.39
1.10	1.41
1.11	1.42
1.12	1.43
1.13	1.45
1.14	1.46
1.15	1.48

Shim S1, determining thickness
(behind ring gear)

■ select shim **S1** from chart

Thickness (mm)	Part Number
0.15	005 409 385
0.20	005 409 385 A
0.25	005 409 385 B
0.50	005 409 385 C
0.80	005 409 385 D
1.00	005 409 385 E
1.50	055 409 385 F

Thickness (mm)	Part Number
0.15	005 409 381
0.20	005 409 381 A
0.25	005 409 381 B
0.55	005 409 381 C
0.60	005 409 381 D
0.65	005 409 381 E
0.80	005 409 381 F
1.35	005 409 381 G
1.50	005 409 381 H
1.65	005 409 381 J

Example

average backlash = 0.69 mm

S1 from table = 0.78 mm

- S1 shims available

Shim S2, determining thickness

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

Example

S total	2.00 mm
S1	– 0.78 mm
S2	= 1.22 mm

- S2 shims available
- install shim **S1** behind ring gear
- install shim **S2** opposite ring gear
- measure backlash at four locations around ring gear
- check that backlash is 0.12-0.22 mm
 - backlash must not deviate more than 0.05 mm between readings