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01A 5-speed

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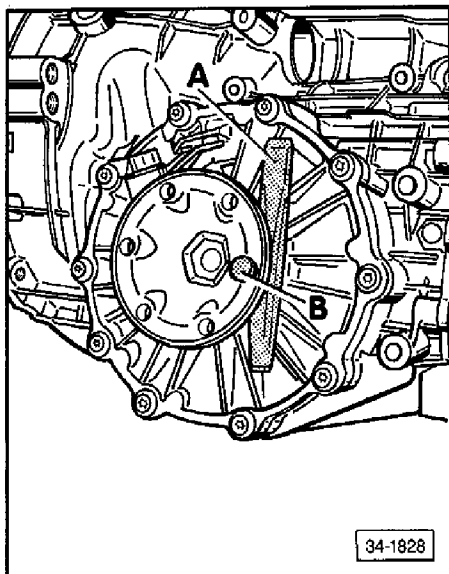
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Technical data, rear final drive

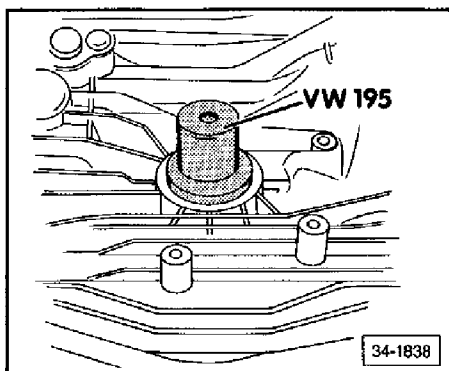
- code letters
- application
- gear ratios

Rear final drive code letters	AAT
Date of manufacture from to	07/84
Application	vehicle
	engine
	manual transmission
Ratio	37:9 = 4.111
Capacity	1.7 liters (1.8 US qt)
Lubricant specification	Gear oil GL-5 SAE 90
Axle shaft flange	108 mm

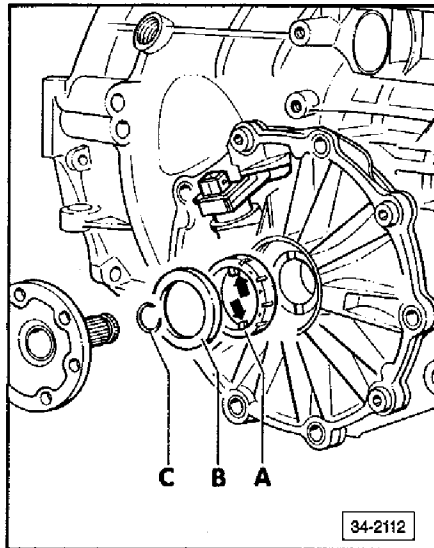


Drive flange oil seals, replacing (transmission installed)

- remove axle shaft from drive flange
- place oil pan under vehicle
- remove flange shaft by placing chisel **A** under flange shaft and pull shaft out by turning bolt **B**
- remove oil seals with **VW 681**
- drive in right side seal 5 mm (0.196 in.) below edge of housing



- drive in left side seal 5 mm below upper edge of final drive cover
- fill space between lips of seal with multi-purpose grease
- drive in flange shaft with **VW 295**
- bolt axle shaft to flange
 - M8 bolts 45 Nm (33 ft lb)
 - M10 bolts 80 Nm (59 ft lb)
- refill transmission oil



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

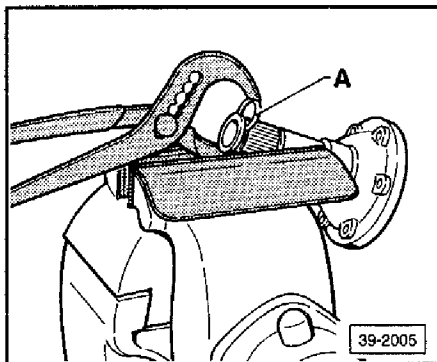
When installing the speedometer gear, the tabs on the gear must point toward the seal. The tabs also lock into grooves in the differential gear housing.

- 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



Differential – Manual Transmission

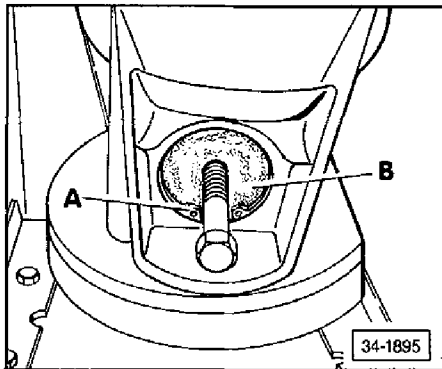
Driveshaft flange oil seal, replacing (transmission installed)

- disconnect driveshaft at transmission

Note

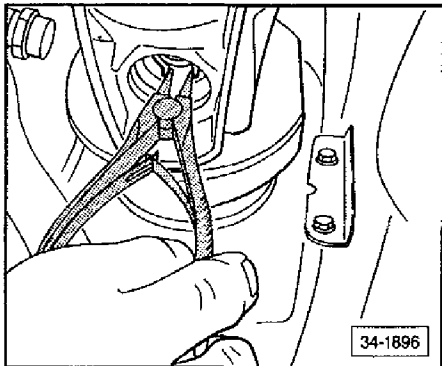
Do not lower driveshaft any more than necessary to remove flange shaft.

- tie driveshaft out of way (to exhaust pipe)
- place oil pan under final drive cover
- remove circlip **A**

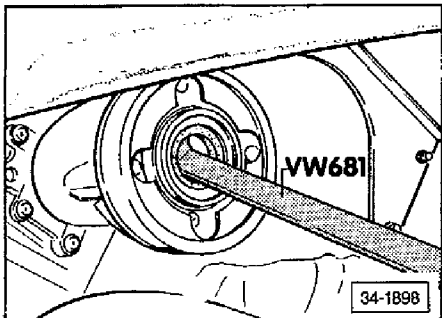


- thread **M8** bolt into cover cap **B** and remove cover cap. Always replace O-ring

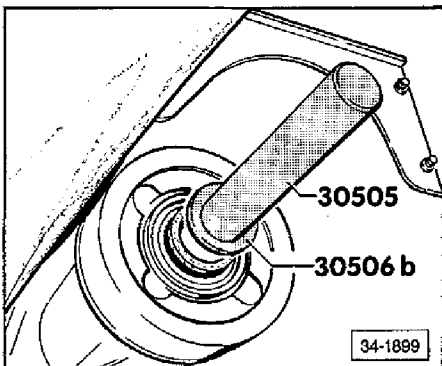
- remove flange shaft by spreading circlip



- remove oil seal with **VW 681**

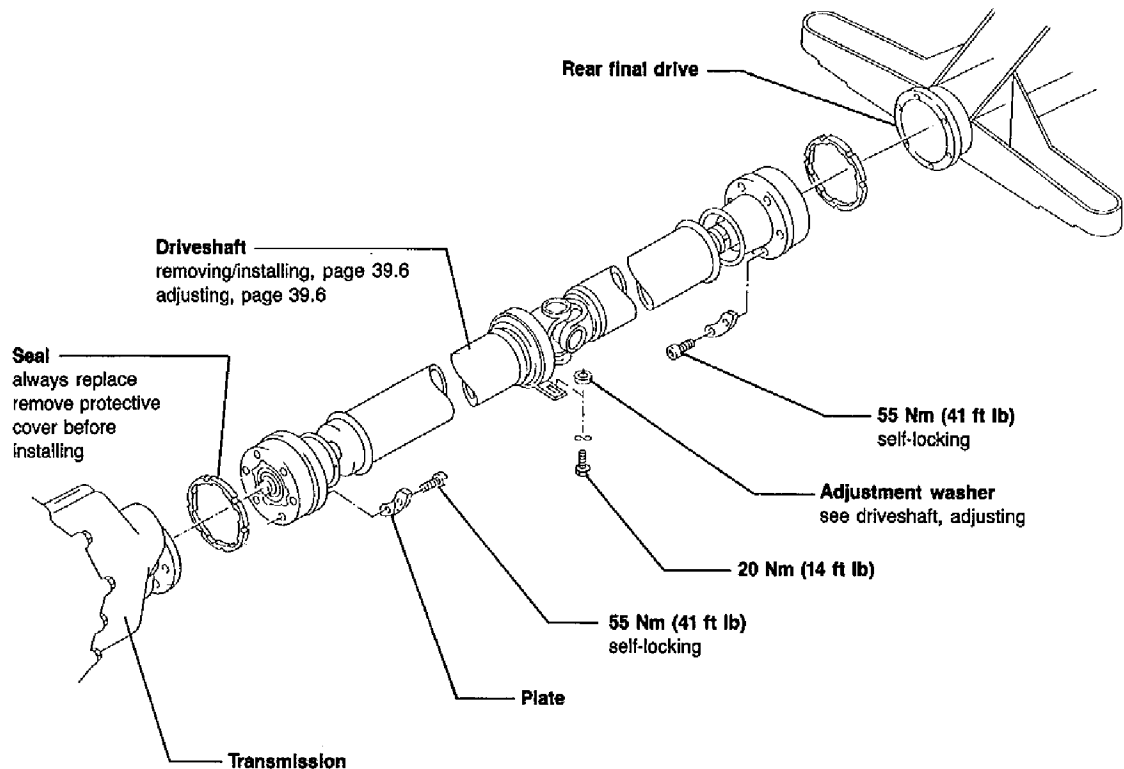


- install oil seal 2 mm below edge of final drive cover
- install flange shaft
- install driveshaft
 - 55 Nm (41 ft lb)
- refill transmission oil if necessary



CAUTION

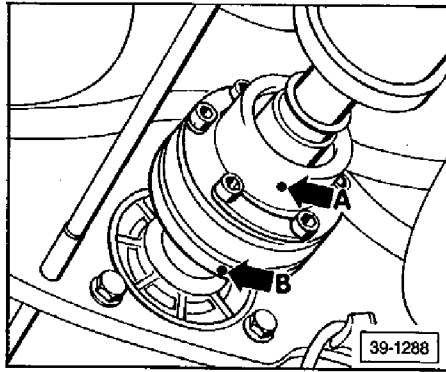
Do not bend driveshaft. Transport and store driveshaft in a straight position.



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Driveshaft, removing/installing**(overview)**

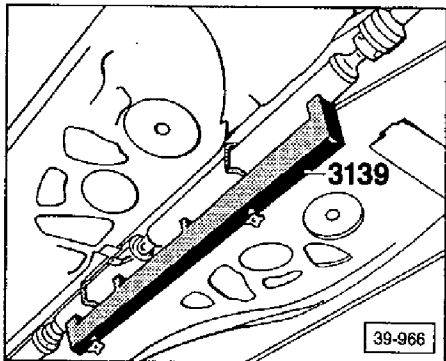
The driveshaft cannot be repaired. For noise and vibration complaints, check the driveshaft alignment. If adjustment does not eliminate the problem, the entire driveshaft must be replaced.



Driveshaft, removing/installing

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

- remove catalytic converter
- tie exhaust pipe toward left side
- loosen driveshaft bolts at transmission, rear final drive and support
- note markings on driveshaft and final drive flange for reassembly. Mark if necessary



- install tool 3139 on driveshaft and tighten plastic nuts
- 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

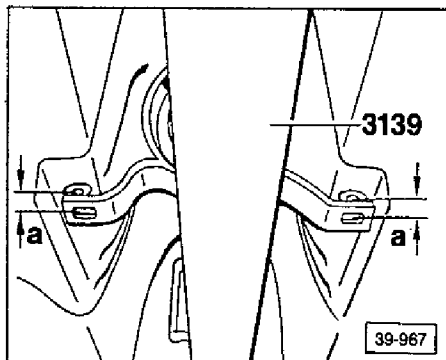
Note

Always check driveshaft alignment after installation.

Driveshaft, adjusting

Precise adjustment is required for quiet, smooth operation.

- remove catalytic converter
- tie exhaust system to left side
- loosen driveshaft center support bolts
- install tool 3139 and tighten plastic nuts
- remove center support bolts and adjustment washers

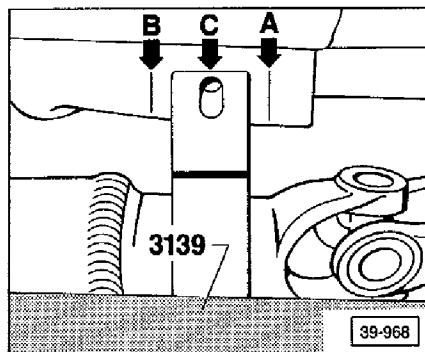


- measure distance a
 - clearance must be equal on both sides

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	867 521 143 B
9.1-11	8	857 521 143 C
11.1-13	10	857 521 143 D

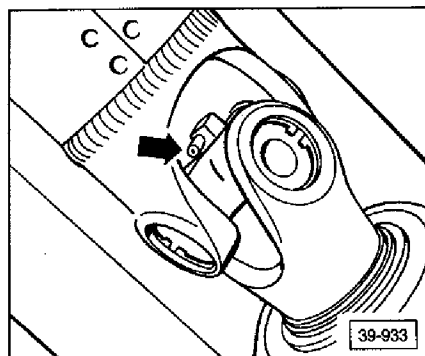
- select adjustment washers from chart



Driveshaft, determining center position

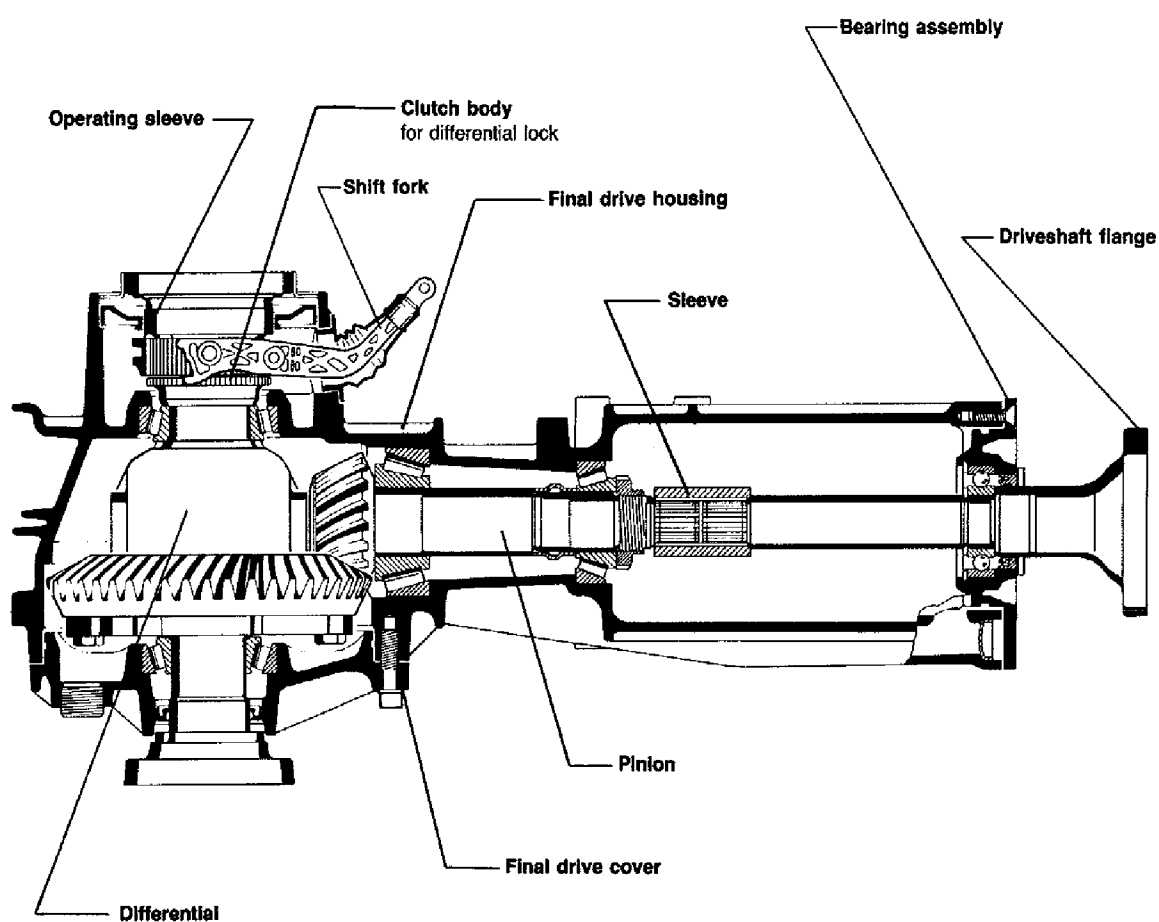
- push driveshaft with tool 3139 rearward to stop
- mark the position of support bracket on body (**arrow A**)
- push driveshaft with tool 3139 toward the front of the car
- mark the position of support bracket on body (**arrow B**)
- center driveshaft support bracket between two marks (**arrow C**)
- 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

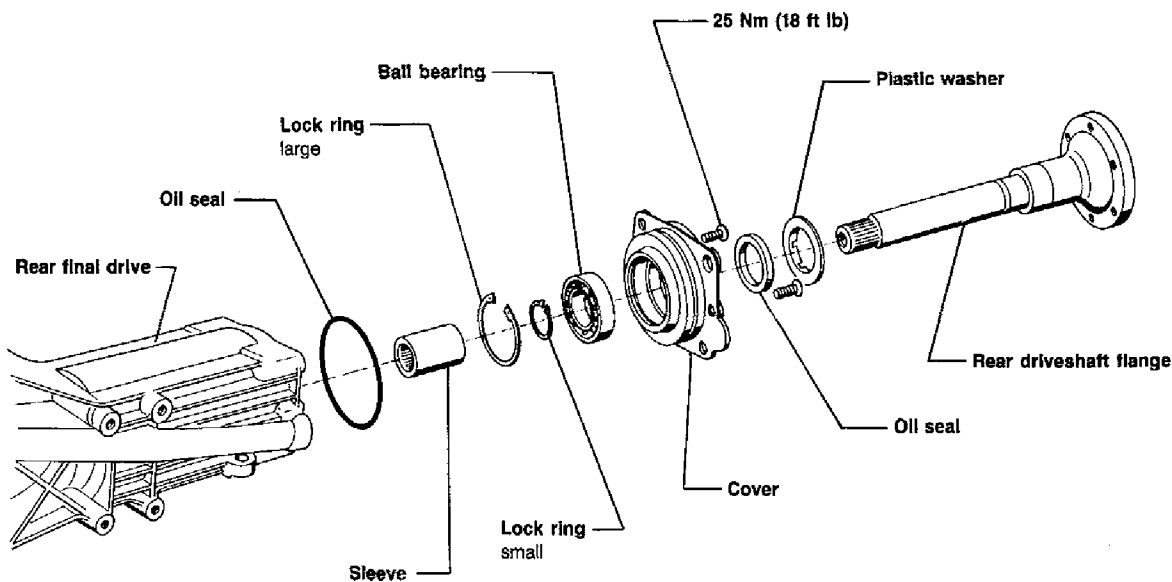


- lubricate center universal joint (**arrow**) with lithium base grease according to maintenance schedule

Differential – Manual Transmission



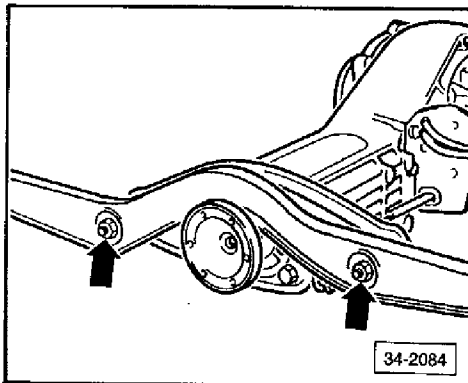
39-909



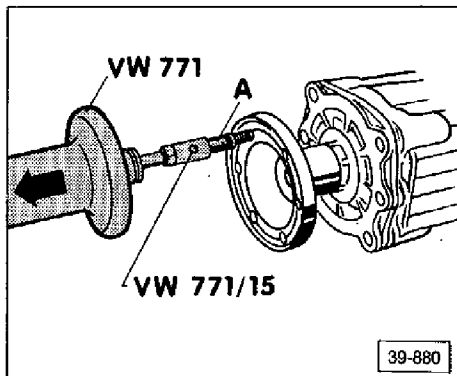
39-915

Differential – Manual Transmission

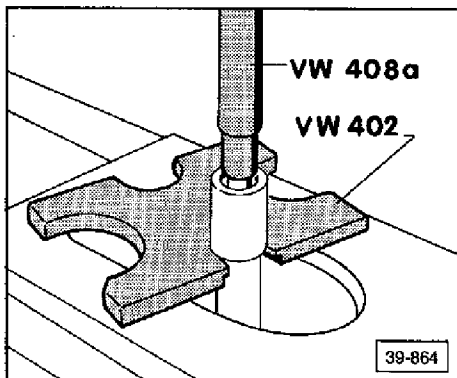
Driveshaft flange bearing/oil seal, replacing



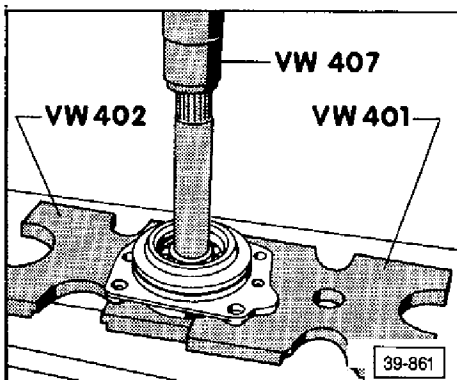
- drain final drive oil
- remove driveshaft from flange and tie out of way
- disengage parking brake cable at front
- remove final drive from crossmember (arrows) and lower carefully
- remove bracket from final drive



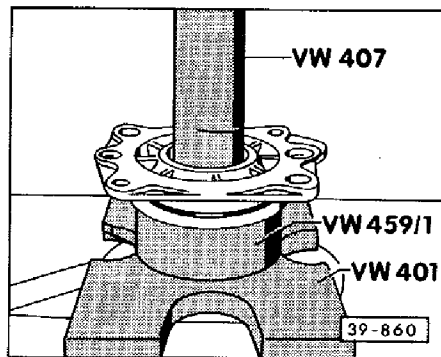
- remove bolts from final drive cover and remove cover
A = bolt M8/M10



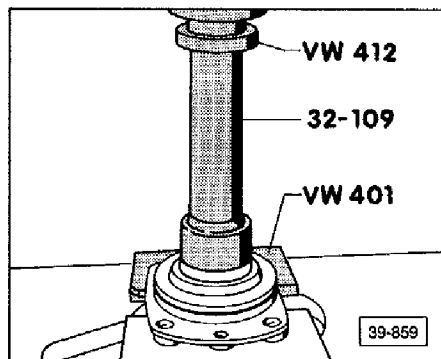
- remove sleeve
- remove small lock ring



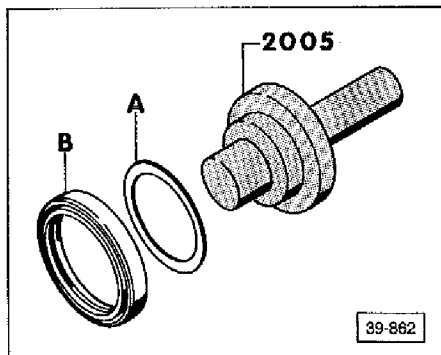
- remove flange
- pry out oil seal with VW 681



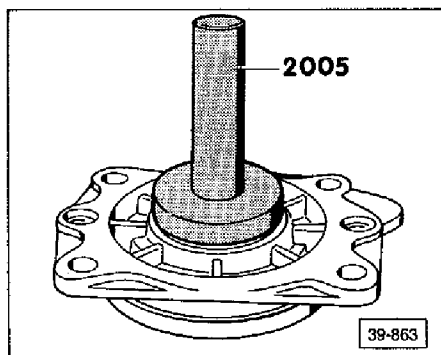
- remove large lock ring
- press out ball bearing



- install ball bearing
- install large lock ring

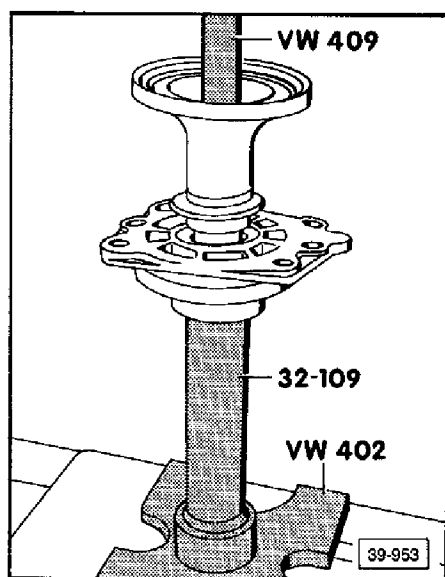


- install new oil seal **B** and washer **A** on 2005



- drive in oil seal to stop
- remove tool and washer

Differential – Manual Transmission



- press in flange
- install small lock ring
- install sleeve and drive on with plastic hammer
- install cover and flange and tighten
- bolt bracket onto final drive
- lift final drive and bolt onto crossmember
- fasten parking brake cable at front and adjust parking brake
- install bolts for final drive cover
- refill final drive oil
- install driveshaft to flange

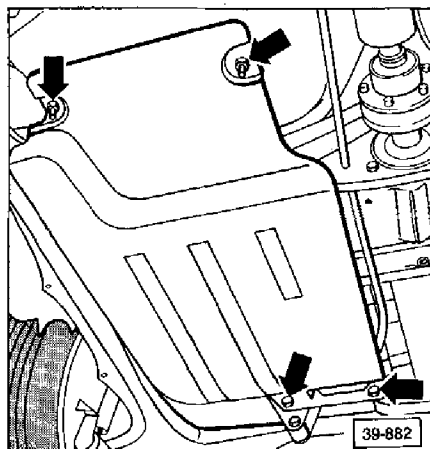
Tightening torques

Driveshaft to flange
55 Nm (41 ft lb)

Final drive to crossmember
45 Nm (33 ft lb)

Bracket to final drive
25 Nm (18 ft lb)

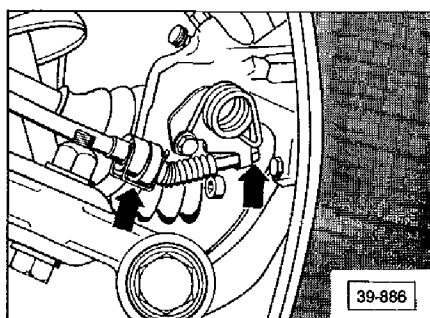
Cover to final drive
25 Nm (18 ft lb)



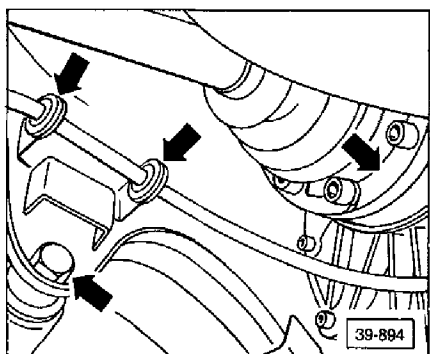
Differential flange oil seal, right side, replacing

(differential installed)

- remove cover (**arrows**)

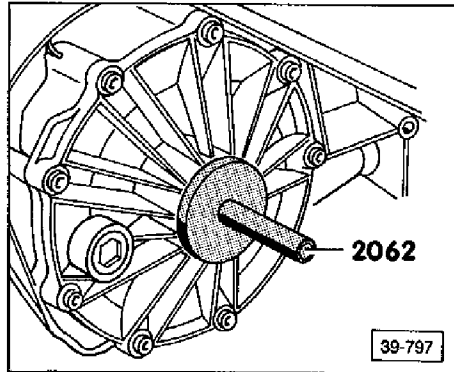


- disengage parking brake cable on right side caliper (**arrows**)



- remove trapezoidal arm from crossmember and lower (**lower arrow**)
- press parking brake cable out of bracket (**upper arrows**)
- remove axle shaft from flange (**right arrow**)
- remove flange shaft bolt
- place oil pan underneath and remove flange
- pry out oil seal

Differential – Manual Transmission



- drive in oil seal to stop
- install flange shaft and axle shaft
- install trapezoidal arm
- press parking brake cable into bracket
- install cover

Tightening torques

Flange shaft to final drive
10 Nm (7 ft lb) plus 1/4 turn (90°)

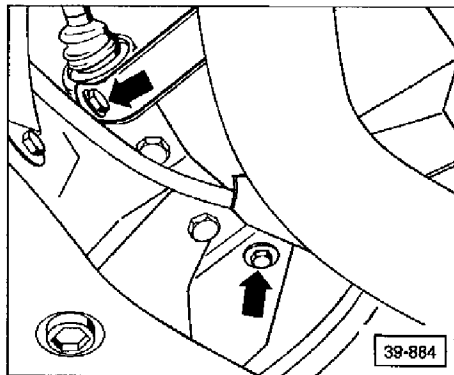
Axle shaft to flange

M8 bolts 45 Nm (33 ft lb)

M10 bolts 80 Nm (59 ft lb)

Trapezoidal arm to crossmember

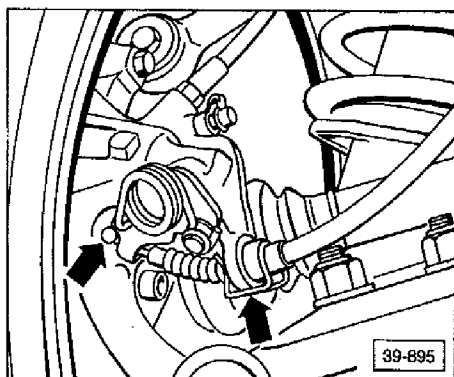
85 Nm (62 ft lb)



Differential flange oil seal, left side, replacing

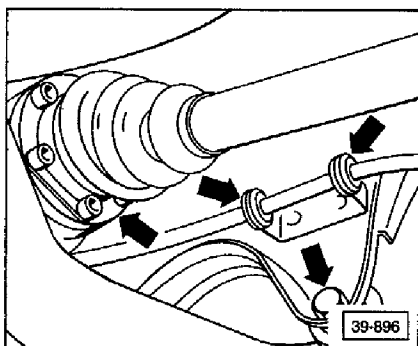
(differential installed)

- remove cover (arrows)

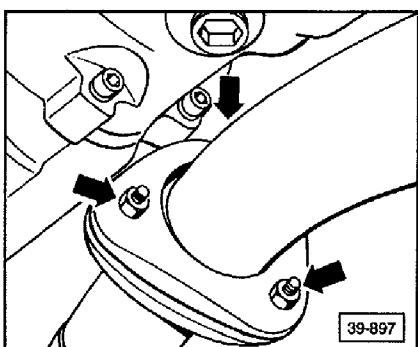


- disengage parking brake cable at caliper (arrows)

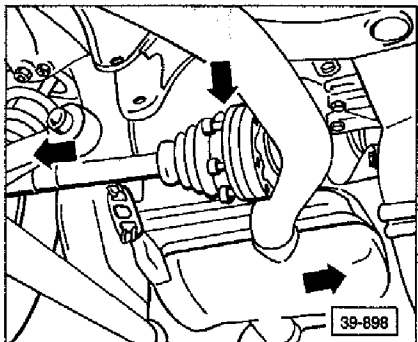
Differential – Manual Transmission



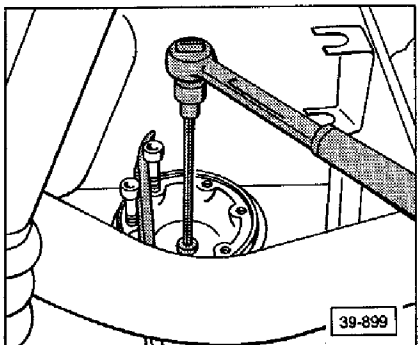
- remove trapezoidal arm from crossmember (**lower arrow**)
- press parking brake cable out of bracket (**upper arrows**)
- remove axle shaft from flange (**left arrow**)



- loosen exhaust pipe (**arrows**)



- move exhaust pipe toward right side, trapezoidal arm to left side and axle shaft downward (**arrows**)
- drain final drive oil

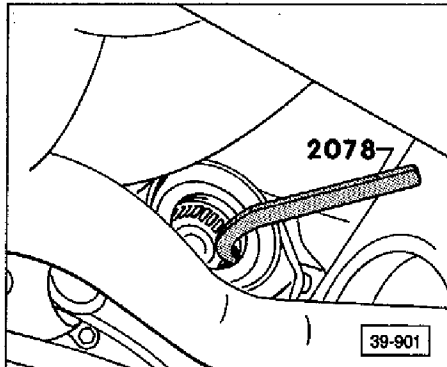


- remove flange shaft bolt
- remove flange

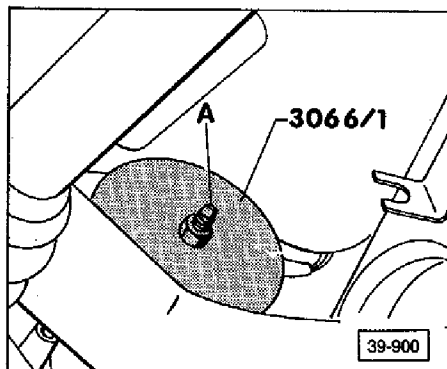
Note

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

Differential – Manual Transmission



- remove seal



- install threaded shaft A of tool 3066 into differential gear
- place oil seal onto tool 3066/1 and tighten to stop with nut
- install flange shaft and axle shaft
- refill oil
- tighten exhaust pipe
- install trapezoidal arm
- install cover
- press parking brake cable into bracket

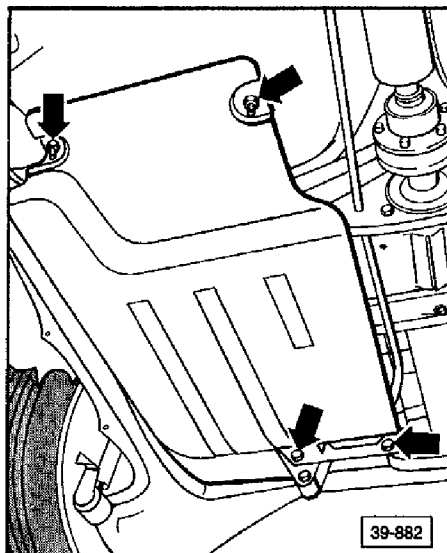
Note

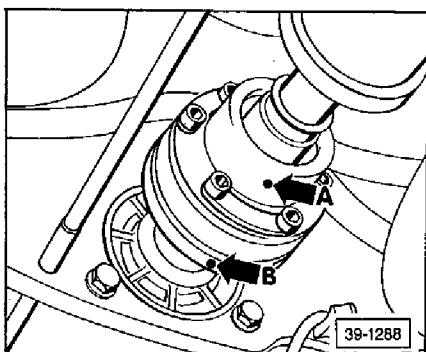
See oil seal, right side, replacing for tightening torques.

Rear final drive, removing/installing

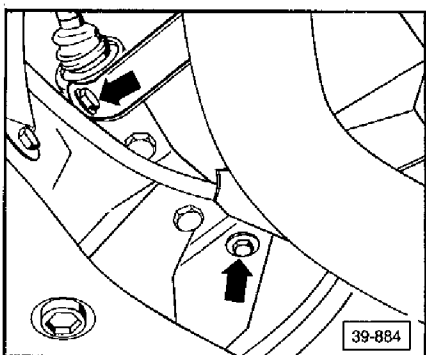
Removing

- remove cover (arrows)
- engage differential lock

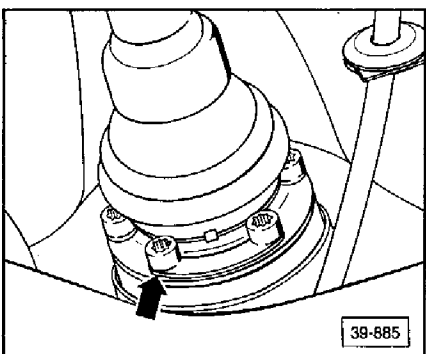




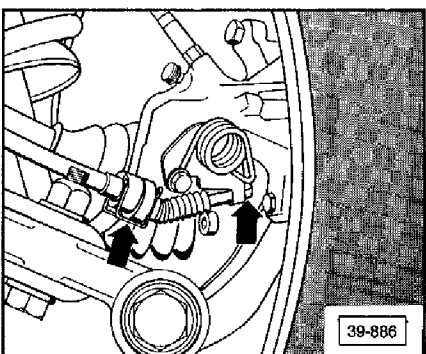
- mark driveshaft and final drive flanges for alignment during reassembly, if not already marked with white and black paint marks (**arrows**)
- unbolt and remove driveshaft from flange
- tie driveshaft out of way



- remove cover for left side axle shaft CV joint (**arrows**)

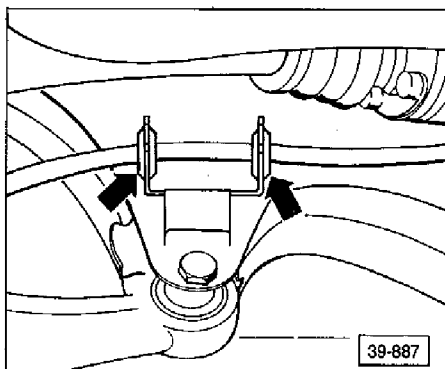


- remove axle shafts from final drive (**arrow**)

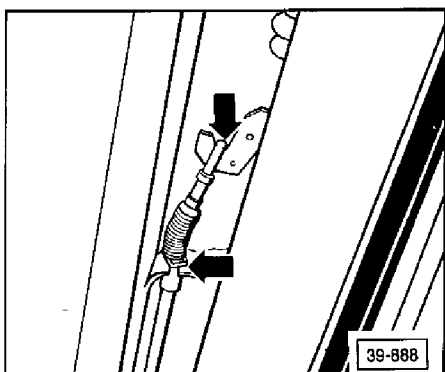


- disengage parking brake cable at calipers (**arrows**)

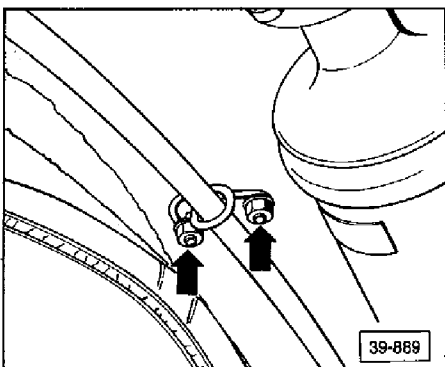
Differential – Manual Transmission



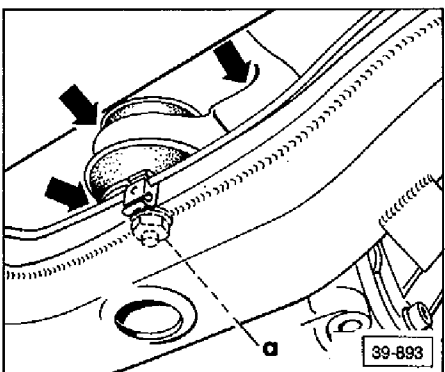
- press parking brake cable out of rubber guides (**arrows**)



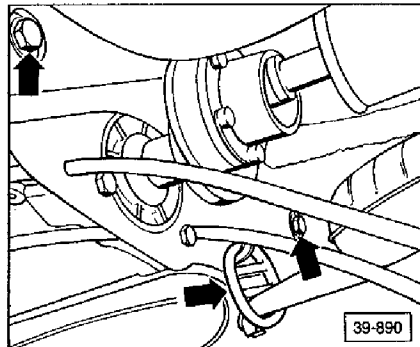
- disengage parking brake cable in front (**arrows**)



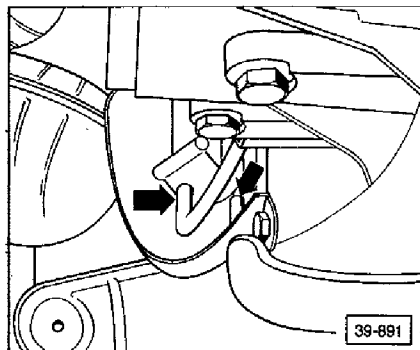
- remove retainer for parking brake cable on left side (**arrows**)
- loosen heat shield
- support final drive using **VW 1383** or equivalent



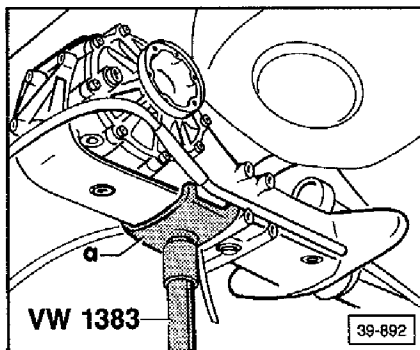
- loosen nut **a**
- remove three bolts (**arrows**)



- remove bolts for crossmember (**left and right arrows**)
- disconnect exhaust pipe (**lower arrow**)
- lower final drive slightly



- remove vacuum hoses (**arrows**) and pull out of bracket with rubber guides
- disconnect wiring for differential lock indicator lamp



- lower final drive
- a = support

Installing

Proceed in reverse order of removal and note the following:

- driveshaft and final drive flanges must be installed so that painted marks or marks made prior to disassembly are aligned as closely as possible

Tightening torques

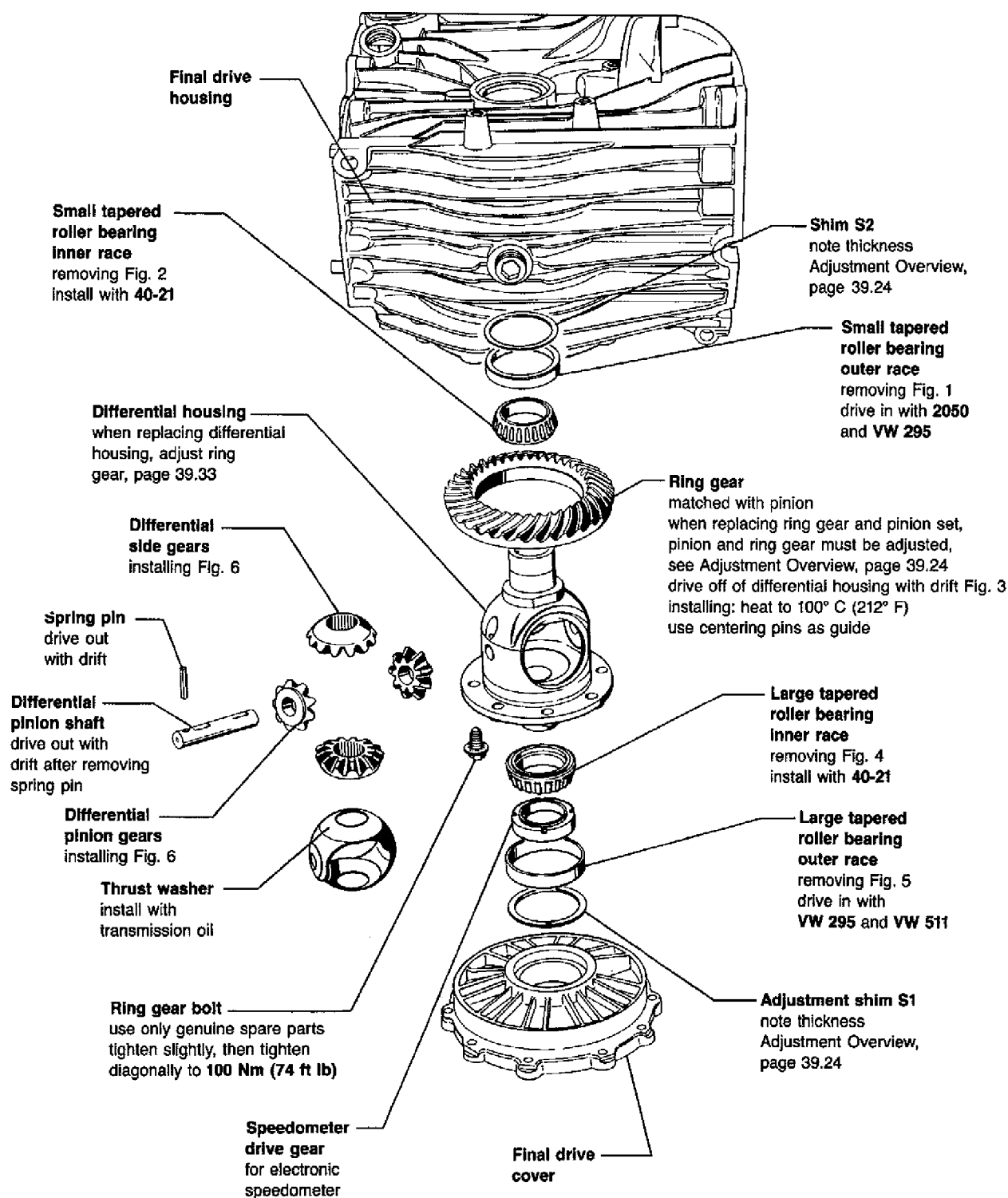
Driveshaft to final drive
55 Nm (41 ft lb)

Axle shafts to final drive
M8 bolts 45 Nm (33 ft lb)
M10 bolts 80 Nm (59 ft lb)

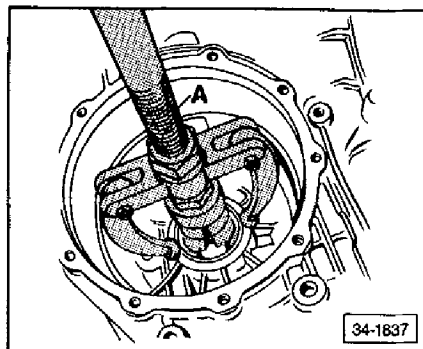
Trapezoidal arm to crossmember
45 Nm (33 ft lb)

Crossmember to body
45 Nm (33 ft lb)

Differential – Manual Transmission

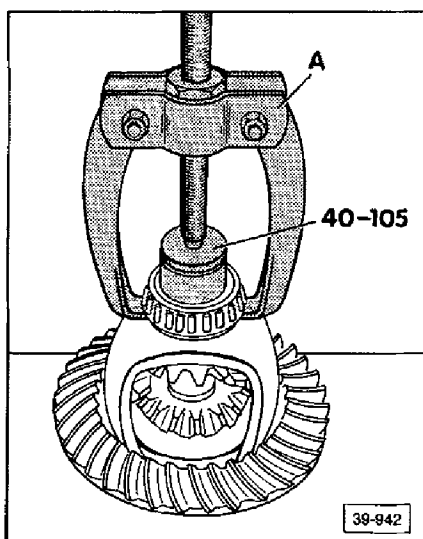


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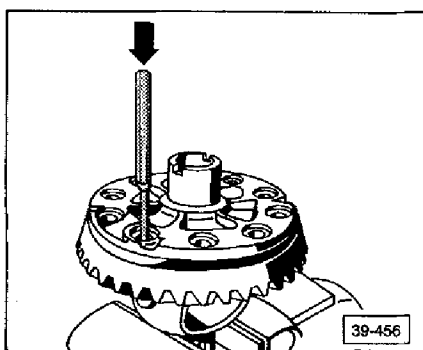
► Fig. 1 Small tapered roller bearing outer race, removing

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

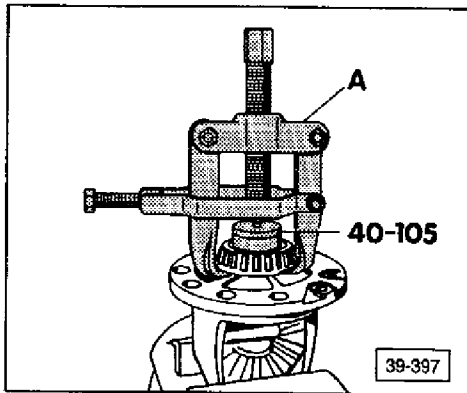


► Fig. 2 Small tapered roller bearing inner race, removing

- A — puller e.g. US 1012 (Kukko 44/2)

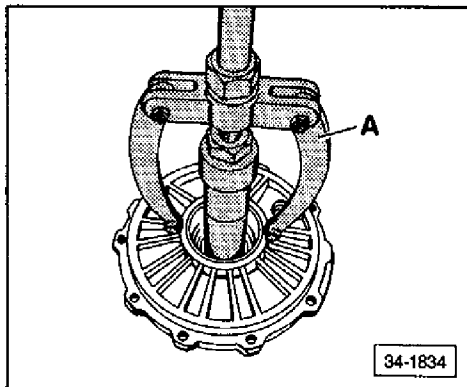


► Fig. 3 Ring gear, driving out of housing



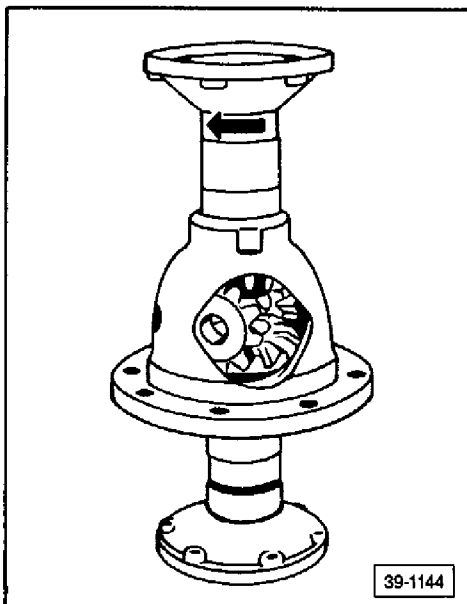
► Fig. 4 Large tapered roller bearing inner race, removing

A — puller e.g. Kukko 204/2



► 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



► 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

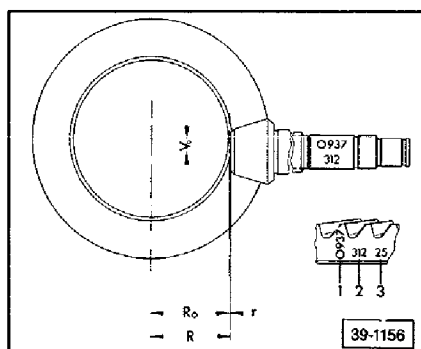
Differential – Manual Transmission

Pinion and ring gear (front differential), 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

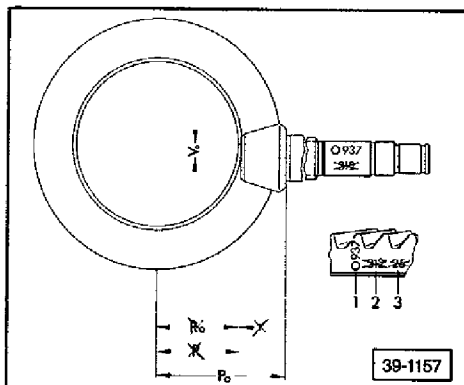
- 1 — Code **0937** means Oerlikon ring gear/pinion set with tooth ratio 37 : 9 (4.11 : 1 overall)
- 2 — Mating number (**312**) of ring gear/pinion set
- 3 — Deviation r related to the master gage of the special test machine used in production. The deviation r is always given in 1/100 mm

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
- V_o** — hypoid offset

Differential – Manual Transmission



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	Pinion	Pinion
	(S1 + S2)	(S3 + S4)	(S3 + S4)	Pinion
Part replaced	see page 39.33	by deviation r see page 39.26	by actual measurement see page 39.25	only shim S4 see page 39.32
Gear carrier housing*	X		X	
End cover				X
Final drive housing	X			
Pinion and hollow shaft tapered roller bearing			X	
Differential tapered roller bearing	X			
Ring gear/pinion set	X	X		
Final drive 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 39.29
- install in final drive housing
- measure difference to **R₀** (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 39.26
 - determined dimension **r** is to be used in determining the **S3** shim

Differential – Manual Transmission

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

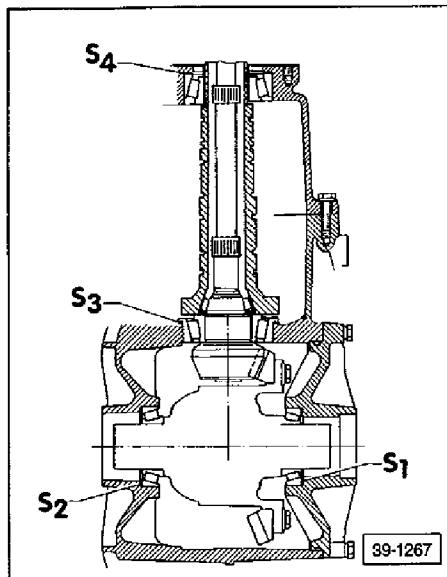
Note

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

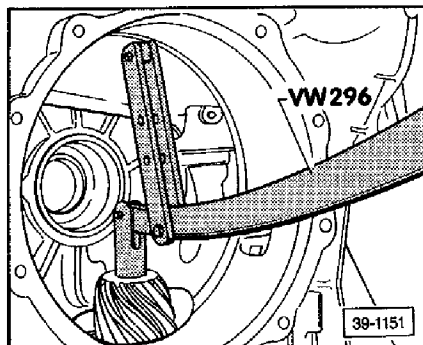
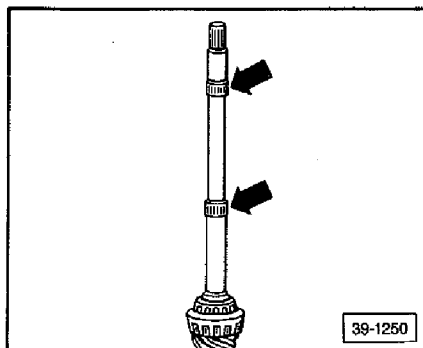
(Pinion and hollow shaft)

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 39.25, also see Adjustment Overview, page 39.24.

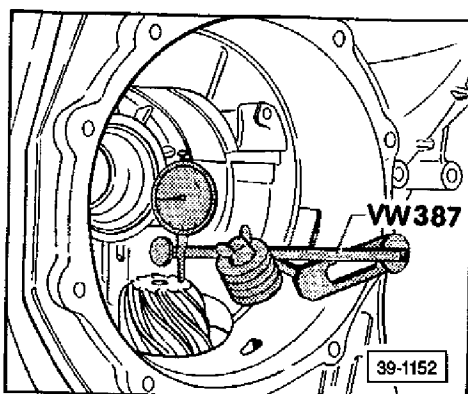
Total shim thickness S total ($S_3 + S_4$), determining

(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 S_4
- 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 with **VW 296** until bearing outer race lies against gear carrier housing (pinion rearward)
- turn pinion and hollow shaft by hand until bearings are seated



Differential – Manual Transmission



- 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

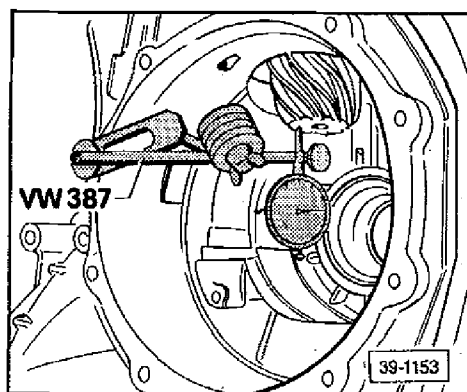
Preload

(constant value) 0.15 mm

Measurement

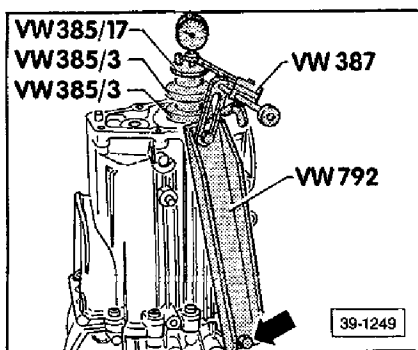
(example) + 1.45 mm

S total = 1.60 mm

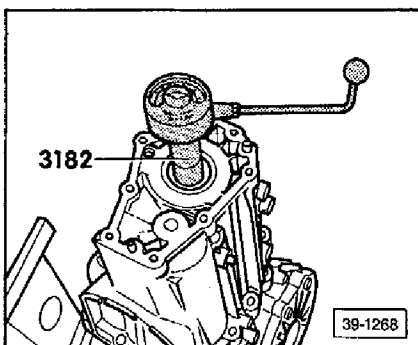


Pinion and hollow shaft bearing preload, checking

- 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

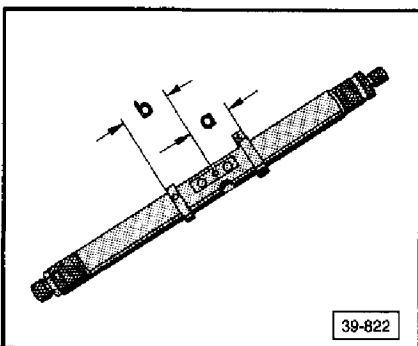


- install measuring tools
- tighten final drive housing bolt (**arrow**)
- zero dial indicator (3 mm measuring range) with 1 mm preload
- loosen gear carrier housing bolts
- if shims were selected properly, the dial indicator should show a reading between 0.08 mm and 0.15 mm



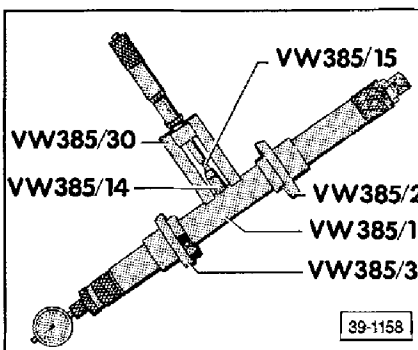
Turning torque, measuring

- 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)

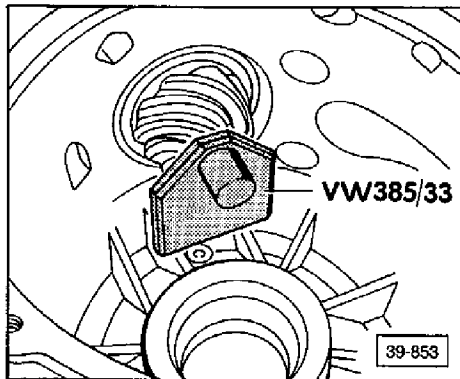


Dimension "e", determining

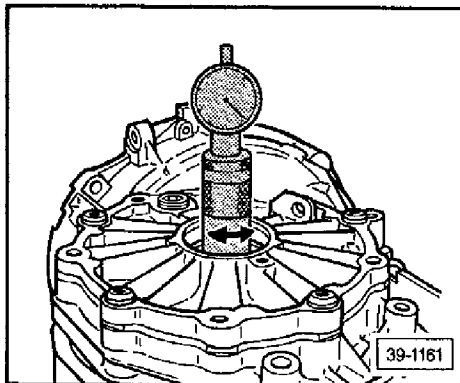
- leave determined total shim thickness behind final drive cover bearing outer race (**S4** side)
- install gear carrier housing
- turn pinion and hollow shaft several times to seat bearings
- adjust setting ring of universal measuring bar **VW 385/1** to dimension **a** = 35 mm
- set movable setting 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



Differential – Manual Transmission



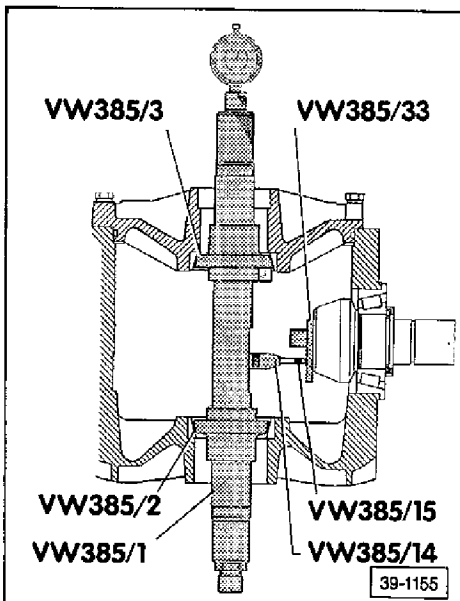
- place end plate **VW 385/33** on pinion head
- remove master gage and install measuring bar in housing
 - centering disc **VW 385/3** faces final drive cover
- install final drive cover and tighten 4 bolts
- pull second centering ring outward until measuring bar can just be turned by hand



- 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

Differential – Manual Transmission

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

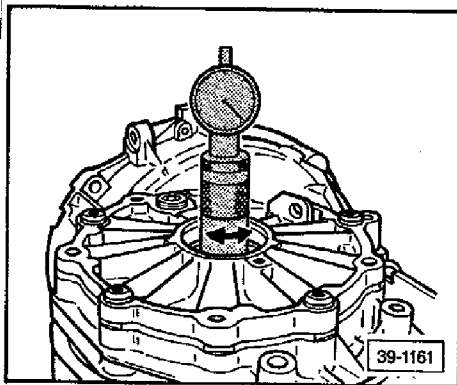
$$S4 = S \text{ total} - S3$$

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

Differential – Manual Transmission

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)

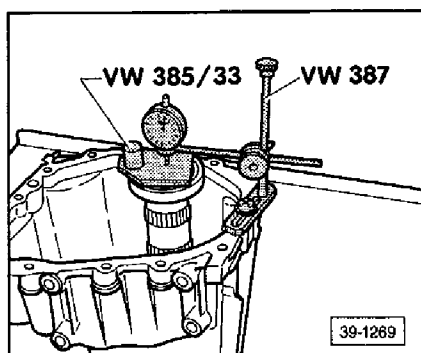
Gear carrier housing, replacing

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 39.27

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 39.24

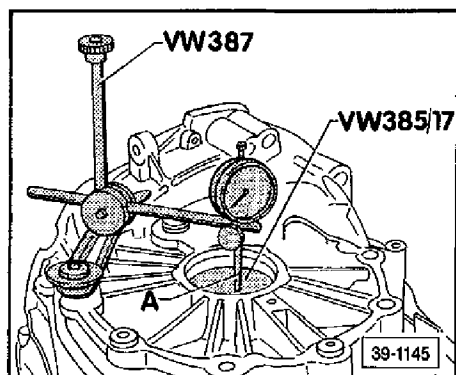
Differential – Manual Transmission

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

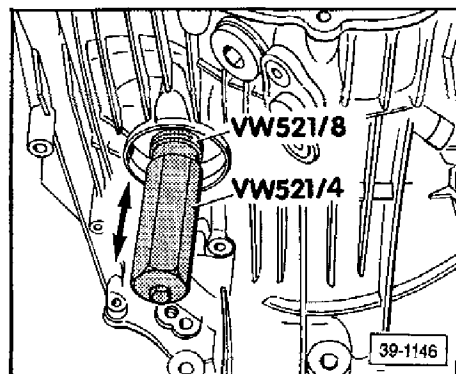
(differential tapered roller bearing preload, adjusting)

Pinion removed

- remove seal and differential bearing outer races
- remove shims (see page 39.5 and page 39.7)
- drive bearing outer races **without** shims in to stop (see page 39.20)
- 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.

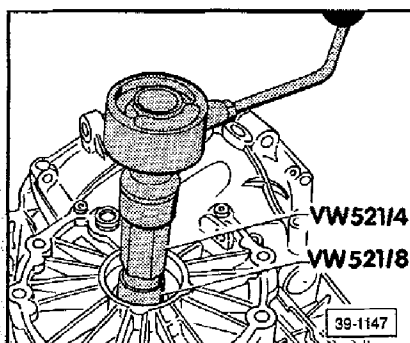
Differential – Manual Transmission

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 39.38



- measure turning torque
 - ▲ — 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

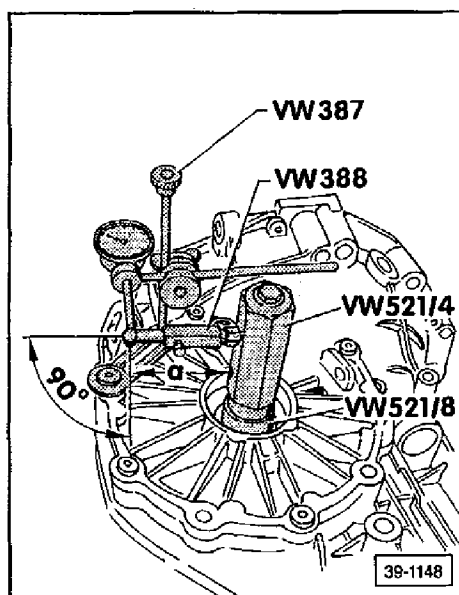
Backlash, adjusting

Note

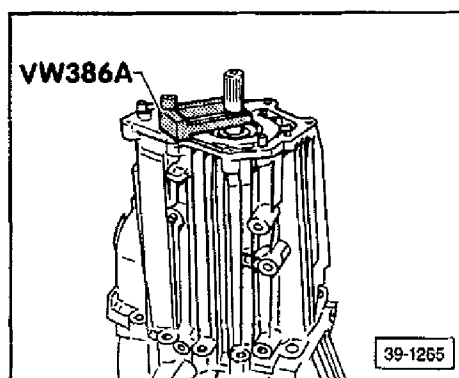
The pinion (with shims **S3** and **S4**) and differential (with **S total = S1 + S2**) are installed in the final drive housing

- turn differential several times in both directions to seat bearings

Differential – Manual Transmission



- 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	= $3.36 \text{ mm} \div 4 = 0.84 \text{ mm}$

Shim S2 thickness, determining

(opposite ring gear)

Example

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

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.

Differential – Manual Transmission

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**

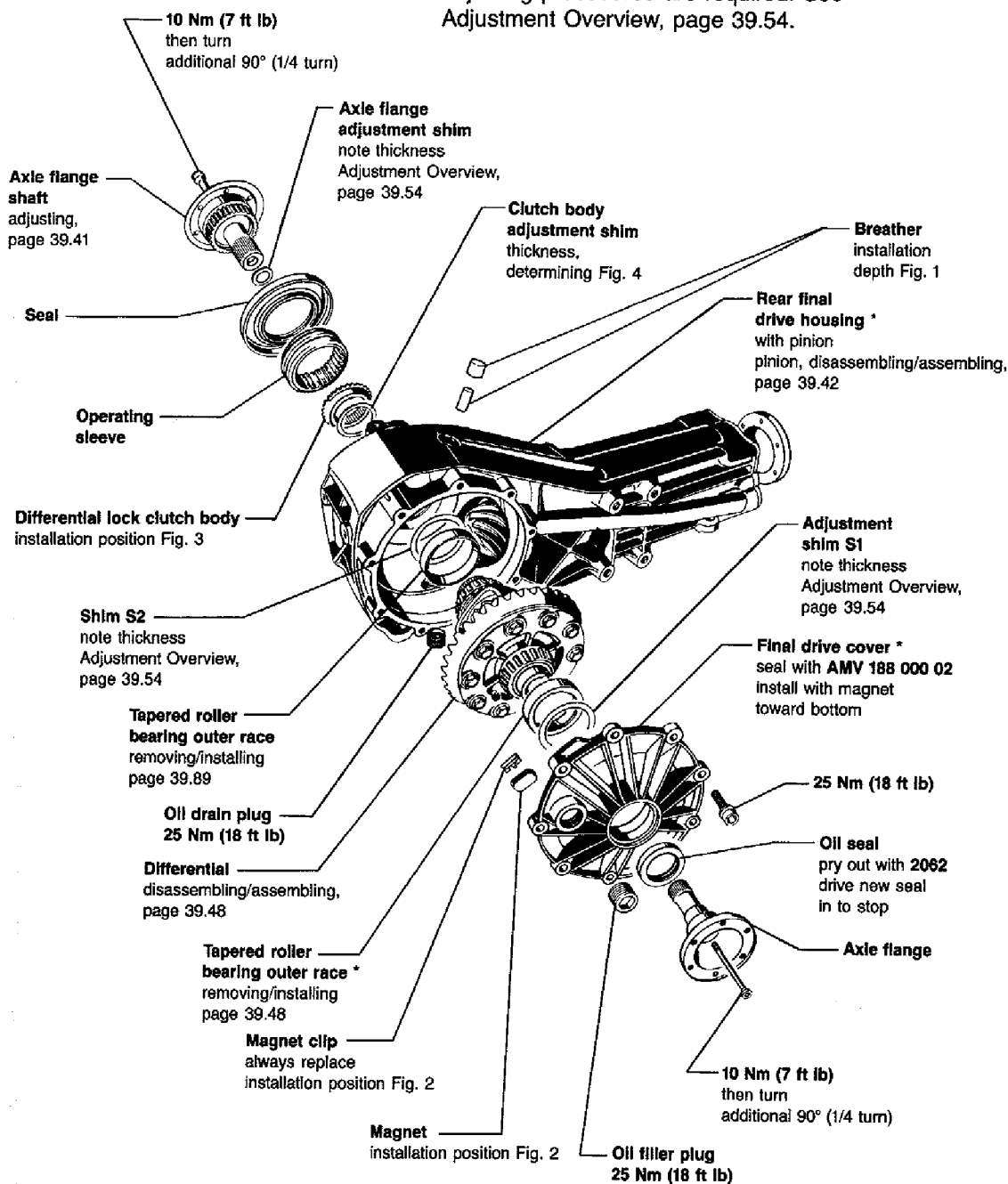
CAUTION

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

Differential – Manual Transmission

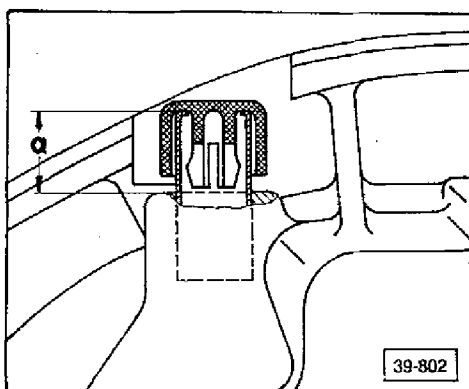
Clamp final drive in assembly stand, page 39.43.

When parts marked with an * are replaced, adjusting procedures are required. See Adjustment Overview, page 39.54.



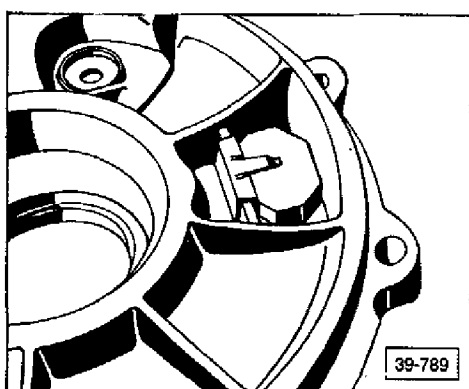
39-1254

Differential – Manual Transmission



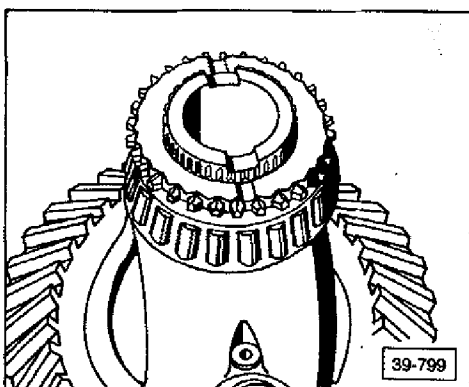
► Fig. 1 Breather, press-in depth

$a = 13 \text{ mm}$



► Fig. 2 Magnet, installing

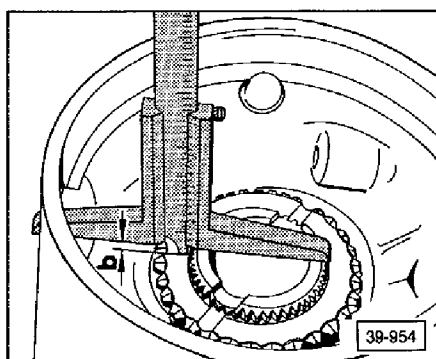
- replace clip if removed



► Fig. 3 Clutch body, installing

(differential removed for purposes of representation)

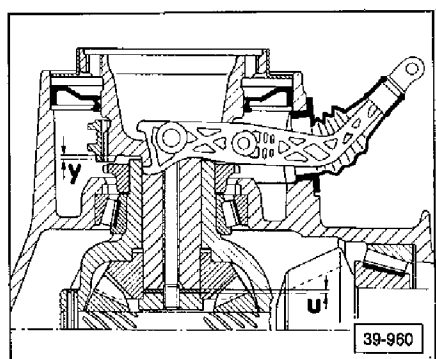
- align oil grooves (arrows) in differential housing and clutch body



► Fig. 4 Clutch body adjustment shim thickness, determining

- measure dimension **b** and determine shim from chart

Dimension b	Thickness (mm)	Part number
- 4.10	—	no washer
4.11 - 4.40	0.3	005 409 737
4.11 - 4.70	0.6	005 409 737 A
4.71 - 4.90	0.9	005 409 737 B

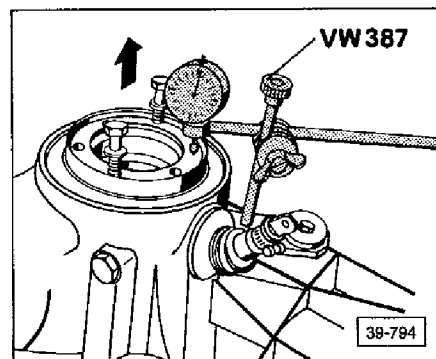


► Axle flange, adjusting

Shim u, determining

- install axle flange with original shims and tighten bolts
- measure gap **y** between axle flange and differential housing
- end play should be 0.2 mm - 0.5 mm
- if there is too little end play, use a thicker adjustment shim
- if there is too much end play, use a thinner adjustment shim

The following adjustment shims are available:

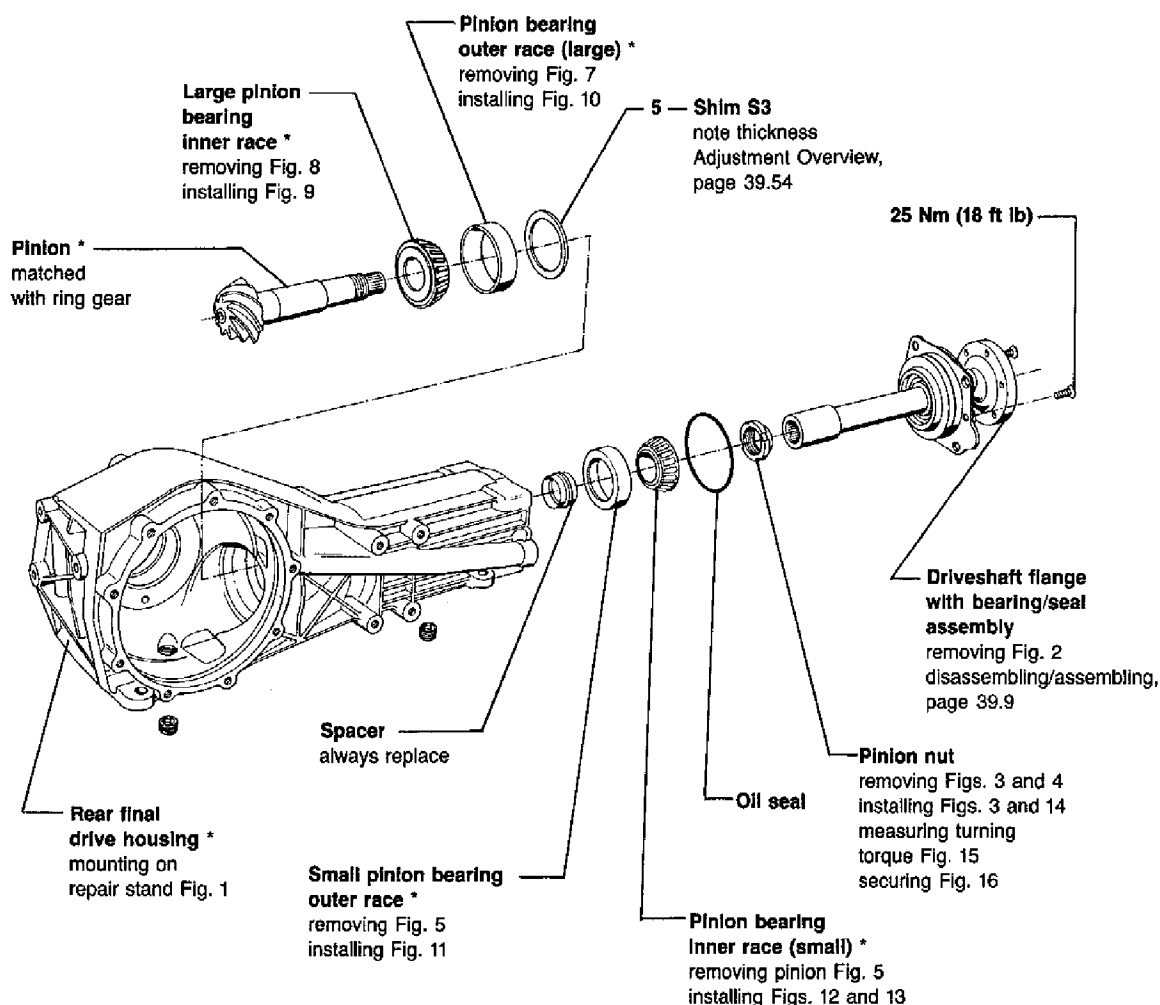


Thickness (mm)	Part number
0.3	183 525 293
0.6	183 525 293 A
0.9	183 525 293 B

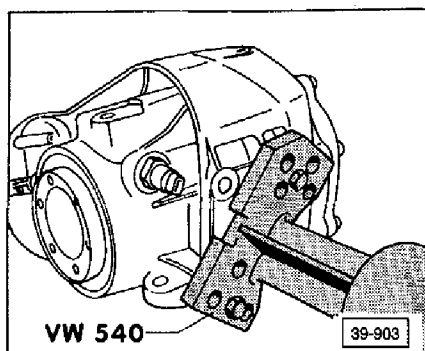
Differential – Manual Transmission

Replace both pinion bearings as a set. Use bearings from the same manufacturer whenever possible.

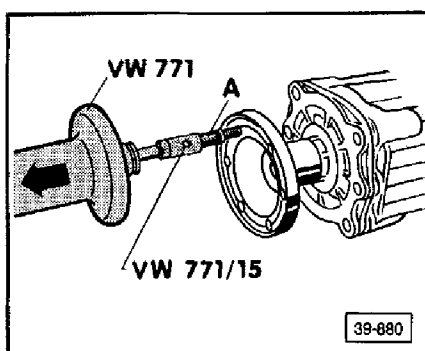
When parts marked with an * are replaced, adjusting procedures are required. See Adjustment Overview, page 39.54.



39-914

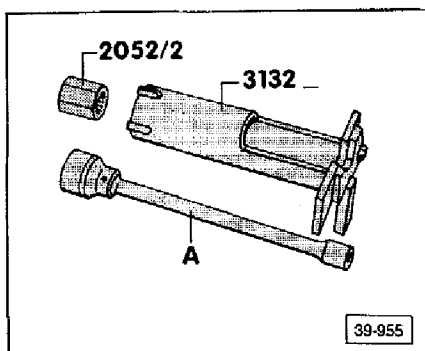


► Fig. 1 Final drive, mounting to repair stand



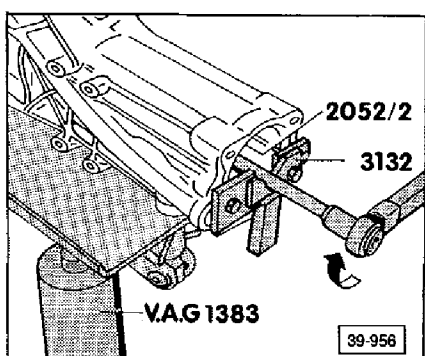
► Fig. 2 Driveshaft flange, removing

A — bolt M 8/M 10



► Fig. 3 Pinion nut, loosening/tightening tool

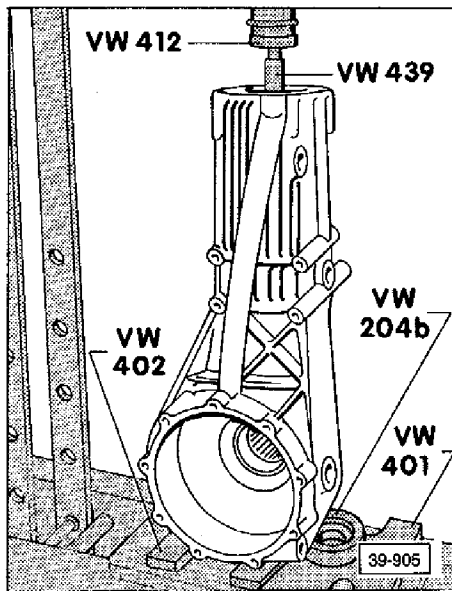
A — extension and socket wrench 32 mm



► Fig. 4 Pinion nut, loosening

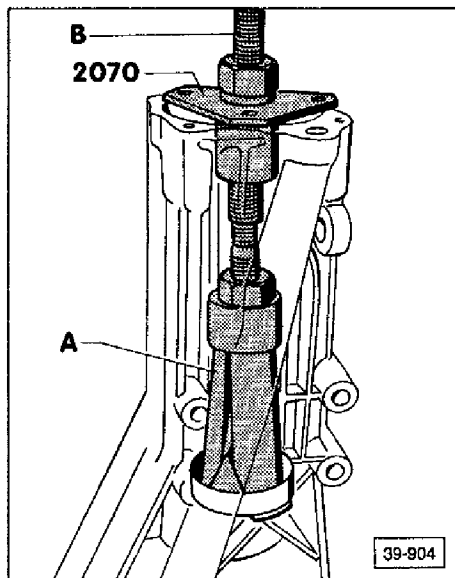
- when loosening the pinion nut, the final drive must be supported with V.A.G. 1383 to prevent housing damage

Differential – Manual Transmission



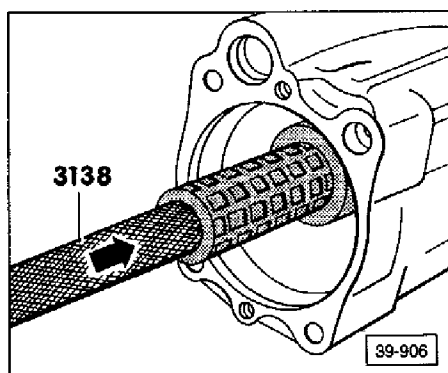
► Fig. 5 Pinion, removing

- press pinion out of bearing

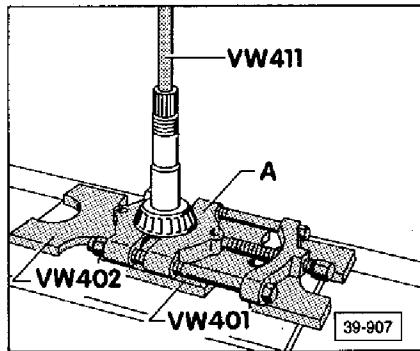


► Fig. 6 Small pinion bearing outer race, removing

- A — commercial puller, e.g. Kukko 21/7 (46 - 56 mm)
- B — spindle of puller Kukko 22/1

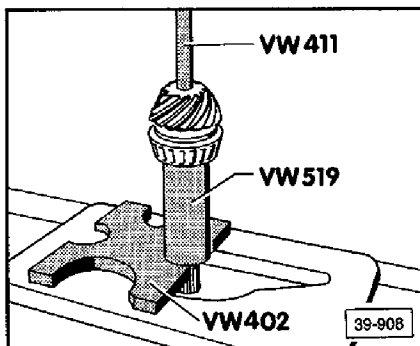


► Fig. 7 Large pinion bearing outer race, removing



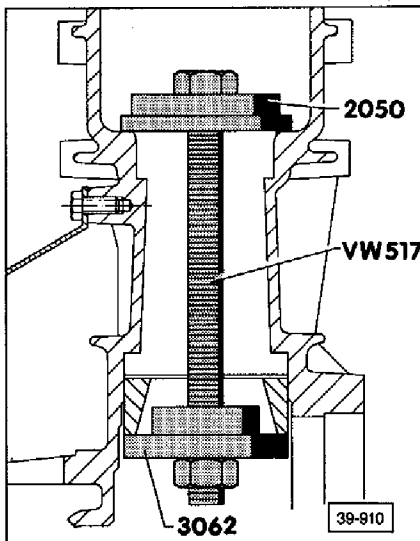
► Fig. 8 Pinion bearing, removing

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



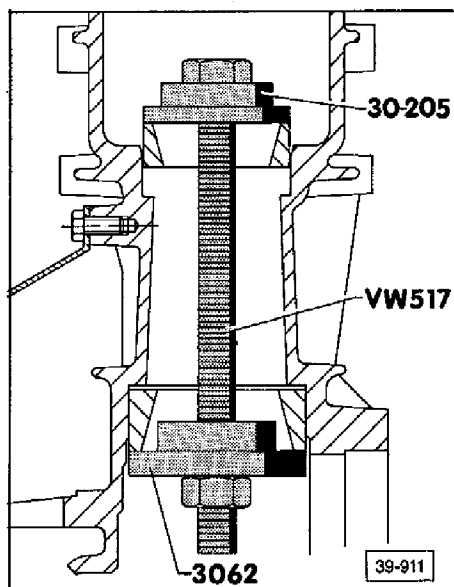
► Fig. 9 Pinion bearing, installing

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

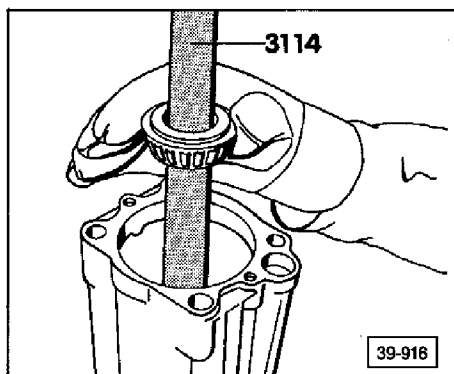


► Fig. 10 Large pinion bearing outer race, installing

■ place required pinion shims behind race before installing

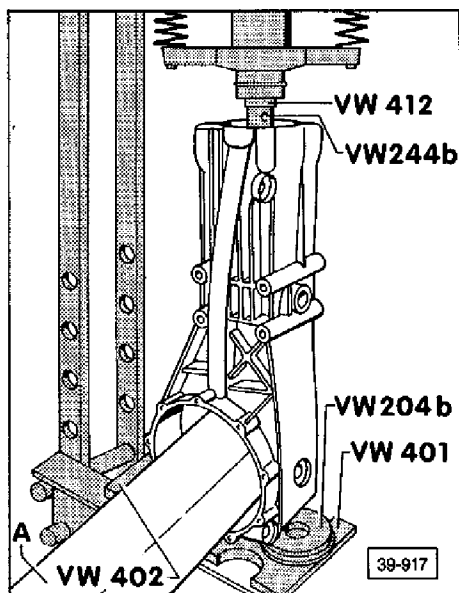


► Fig. 11 Small pinion bearing outer race, installing



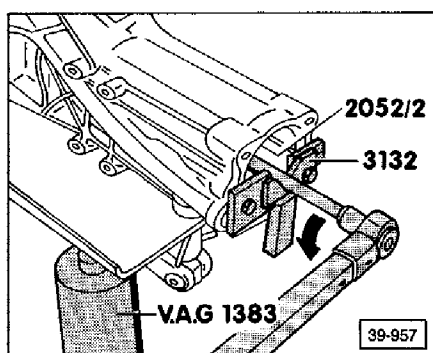
► Fig. 12 Pinion bearing, installing

- heat bearing to approximately 120° C (248° F) and place it on pinion
- insert pinion and **new** spacer first
- press up on pinion and use 3114 to center pinion



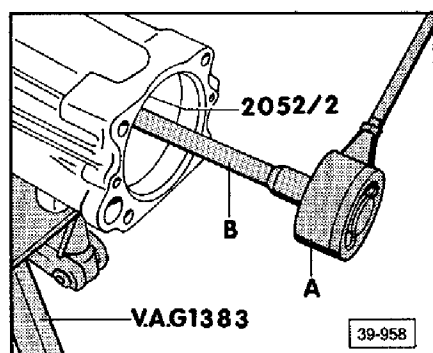
► Fig. 13 Pinion bearing, installing

A — wood support for pinion



► Fig. 14 Pinion nut, tightening

- install and measure turning torque (Fig. 15)
- when tightening the pinion nut, the final drive must be supported with **V.A.G. 1383** to prevent housing damage

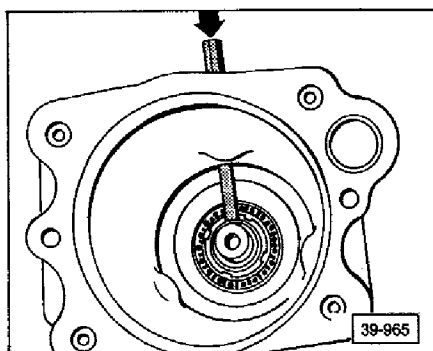


► Fig. 15 Turning torque, measuring

- A — commercial torque gage, 0-600 Ncm (0-54 in. lb)
- B — extension with socket wrench 32 mm
- turning torque range:
 - new bearings: 280-320 Ncm (25-29 in. lb)
 - used bearings: 60 Ncm (3-5 in. lb)
 - *with at least 50 km (31 miles) running time

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 and another adjustment will have to be made. Once the spacer has been compressed it cannot be used again.

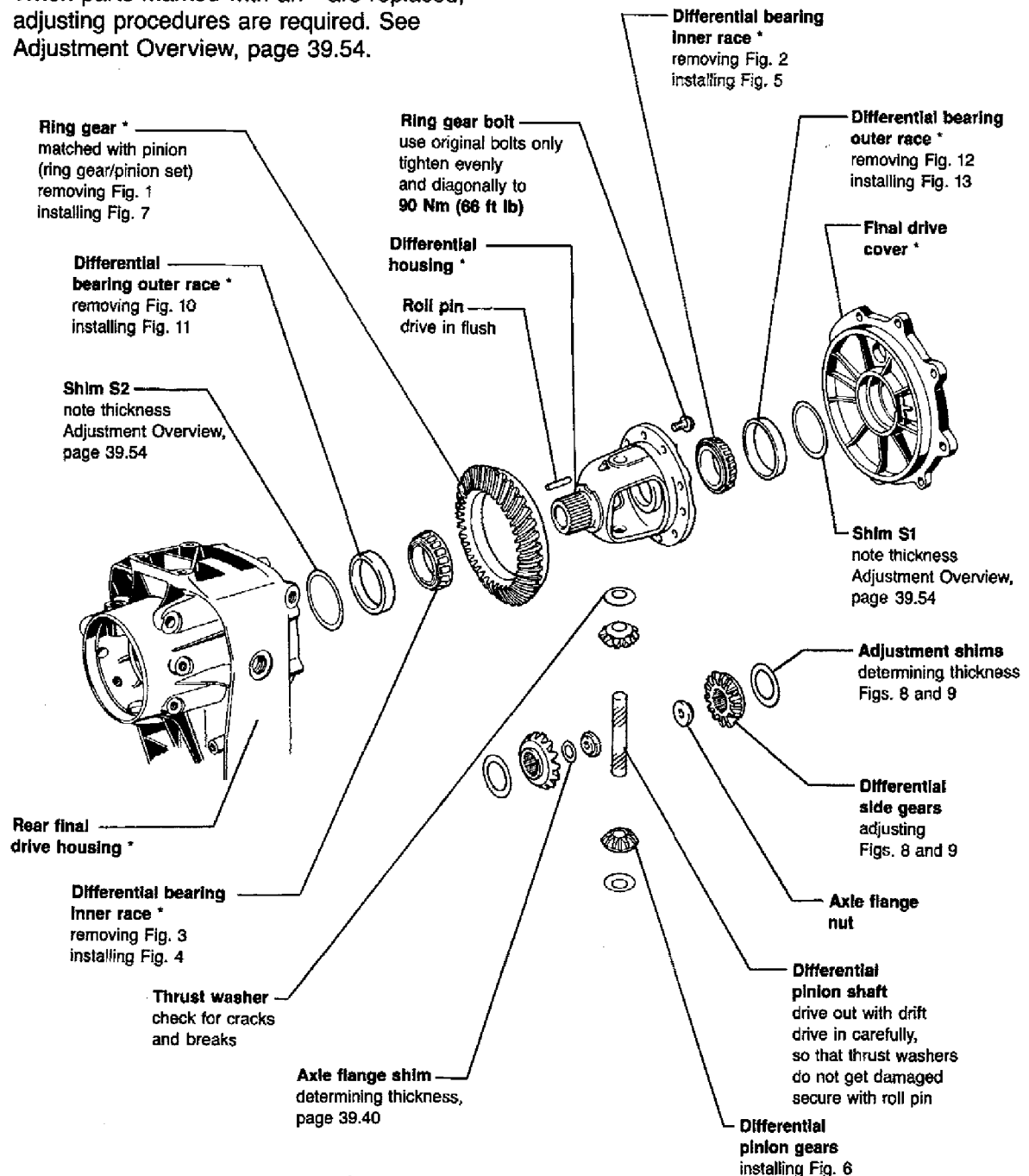


► Fig. 16 Pinion nut, securing

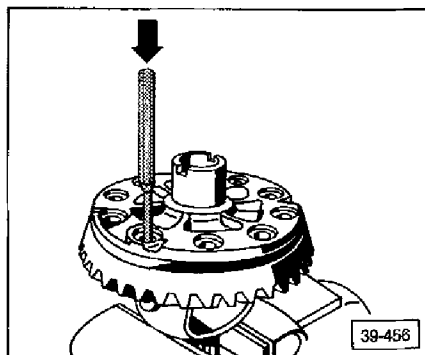
- drift for securing is to be inserted through the oil drain hole

Differential – Manual Transmission

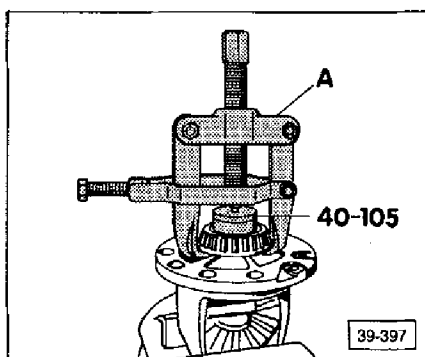
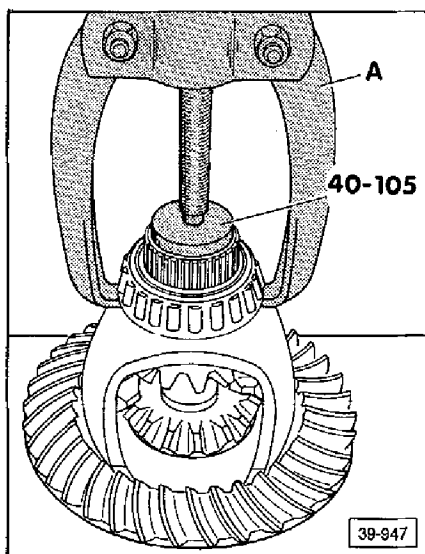
Replace both tapered roller bearings of the differential as a set. Use bearings from the same manufacturer whenever possible. When parts marked with an * are replaced, adjusting procedures are required. See Adjustment Overview, page 39.54.



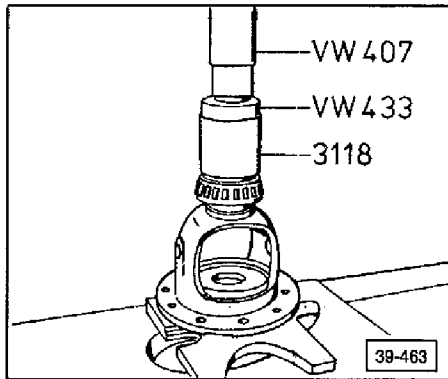
39-804



► Fig. 1 Ring gear, removing

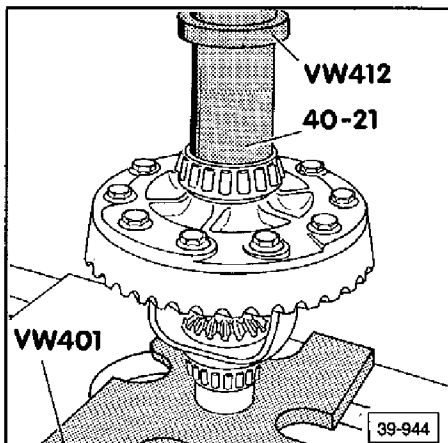
► Fig. 2 Differential bearing inner race, removing
A — commercial puller e.g. Kukko 204/2► Fig. 3 Differential bearing inner race, removing
A — commercial puller e.g. US 1012 (Kukko 44/2)

Differential – Manual Transmission



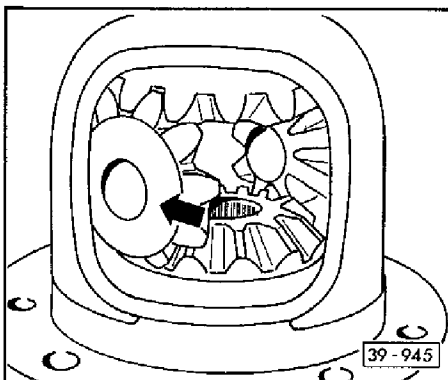
► Fig. 4 Differential bearing inner race, installing

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



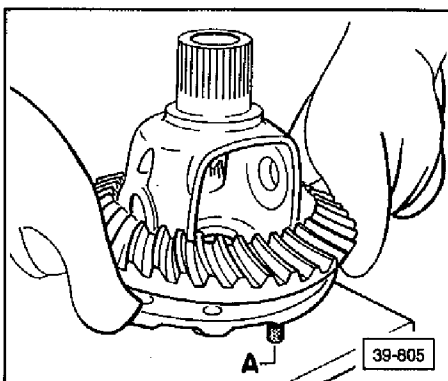
► Fig. 5 Differential bearing inner race, installing

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



► Fig. 6 Differential pinion gears, installing

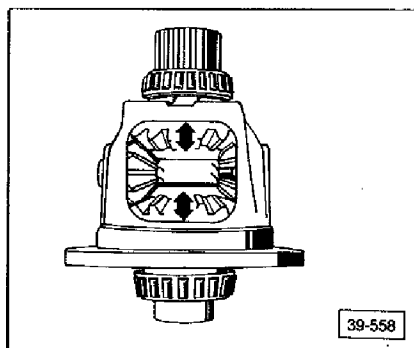
- insert differential side gears with correct adjustment shims, Figs. 8 and 9
- insert differential pinion gears in housing approximately 180° apart
 - coat thrust washers lightly with grease
- rotate gears into position
- insert axle flange nuts
- align thrust washers
- drive in and secure differential pinion shaft



► Fig. 7 Ring gear, installing

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

Differential – Manual Transmission



► Fig. 8 Differential pinion gears, adjusting

- insert differential side gears with the thinnest adjustment shims (0.5 mm)
- insert differential pinion gears with thrust washers
- drive in differential pinion shaft

CAUTION

Do not interchange differential pinion gears and thrust washers.

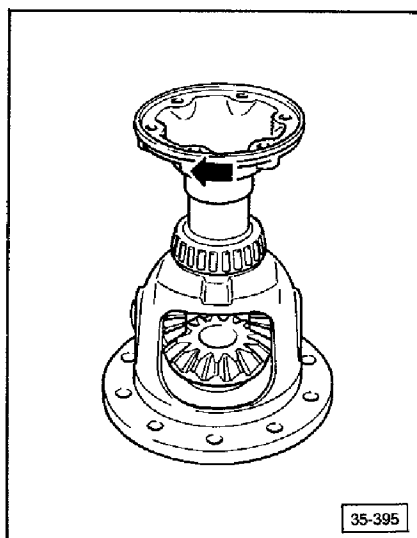
- hold differential pinion gears outward and manually check clearance of side gears (arrow)
- adjust clearance by changing shims
 - maximum clearance 0.10 mm

Note

The clearance is correct if you feel no play and the differential pinion gears can be turned slightly without binding (Fig. 9).

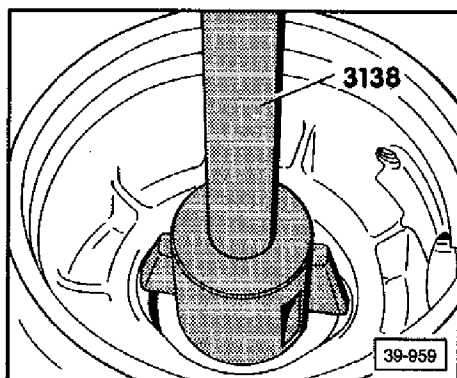
The following adjustment shims are available:

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

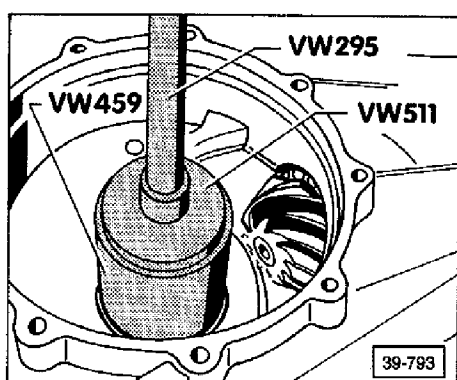


► Fig. 9 Differential pinion gears, turning

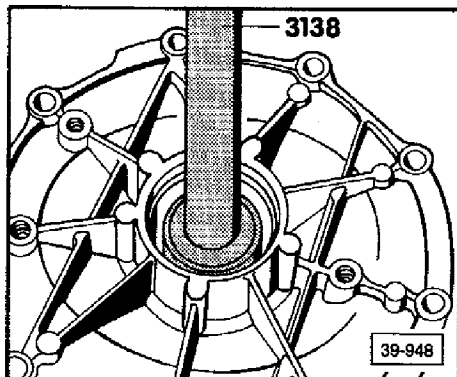
Differential – Manual Transmission



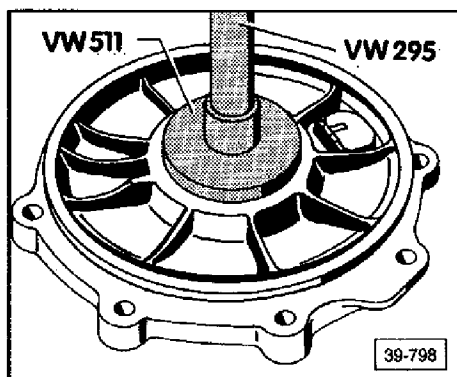
► Fig. 10 Differential bearing outer race, removing



► Fig. 11 Differential bearing outer race, installing
■ drive race into final drive housing



► Fig. 12 Differential bearing outer race, removing



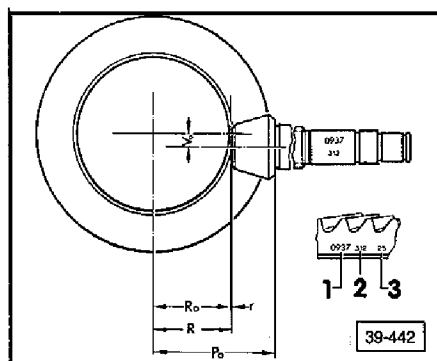
► Fig. 13 Differential bearing outer race, installing

Pinion and ring gear (rear differential), adjusting

General instructions

Careful adjustment of the pinion and ring gear is important to ensure that the final drive has a long service life and runs quietly. The pinion and ring gear are manufactured as a matched set, and are checked with special testing machines for good position of the contact surface and a low noise level. The quietest running position is determined by moving the pinion in an axial direction, whereby the ring gear is far enough removed from the mesh (no play) such that the backlash is within the specified tolerance.

Deviation r (measured against master gage length R_o) is measured for the ring gear/pinion supplied as a replacement part set and is then marked on the outer circumference of the ring gear. Every ring gear/pinion may only be replaced as a matched set.



Ring gear/pinion, identification Service gears

- 1 — 0937 means Oerlikon gear set with a 9:37 tooth ratio (4.11:1 overall)
- 2 — 312 — serial number of matched gear set
- 3 — dimension r is the ring and pinion deviation measured against the master gage of the testing machine used in production. Dimension r is always given in 1/100 mm

Example

25 means $r = 0.25$ mm

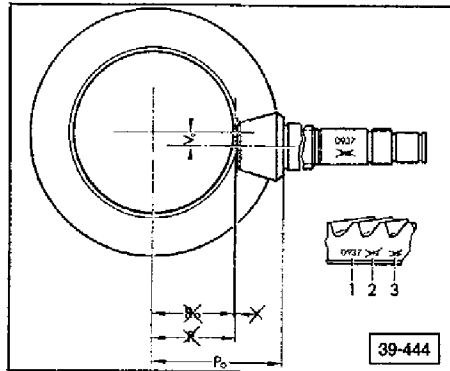
R_o — length of master gage used in factory testing machine

$R_o = 53.15$ mm

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

V_o — hypoid offset = 35 mm

Differential – Manual Transmission



Standard-production gear sets

X — this information is not required in production gears

P₀ — setting dimension for production gears

CAUTION

In production, the position of the pinion is determined by dimension **P₀** (ring gear centerline to back of pinion head). The marking of deviation **r** on the ring gear and the matching number have been eliminated. Because of the missing deviation **r**, it is necessary to measure the position of the pinion before removing it when parts that affect the position of the pinion are to be replaced.

See Adjustment Overview.

Adjustment Overview

When working on the final drive, a new setting of the pinion, ring gear, or ring gear/pinion set and axle flange is only necessary if parts that have a **direct** influence on the adjustment have been replaced. Use the following table to avoid unnecessary adjustments.

Parts replaced	To be adjusted:			
	Ring gear (S1 + S2) page 39.62	Pinion (S3) via dim. r page 39.55	Pinion (S3) via actual measure- ment page 39.55	Axle flange page 39.41
Rear final drive housing	X		X	
Differential housing	X			X
Pinion tapered roller bearing			X	
Differential tapered roller bearing	X			
Ring gear/pinion set	X	X		
Rear final drive cover	X			
Axle flange				X
Differential pinion gears				X

Pinion, determining position

(actual measurement)

This operation is only necessary if deviation **r** is **not** marked on the ring gear and/or the tapered roller bearings or the pinion or final drive housing is being replaced.

Differential, removing

- prepare universal measuring bar as described on page 39.59
- insert bar into final drive housing
- measure the deviation from **R₀** (maximum deflection)
 - note reading in red numeral area
 - the measured value is deviation **r**
- deviation **r** is to be used to determine the thickness of adjustment shim **S3**

Ring gear/pinion, adjusting

- determine total shim thickness **S total (S1 + S2)** for differential tapered roller bearing
- determine shim **S3** thickness so that pinion is installed according to position determined on test machine in production
- distribute **S total** between **S1** and **S2** to obtain specified backlash between ring gear and pinion

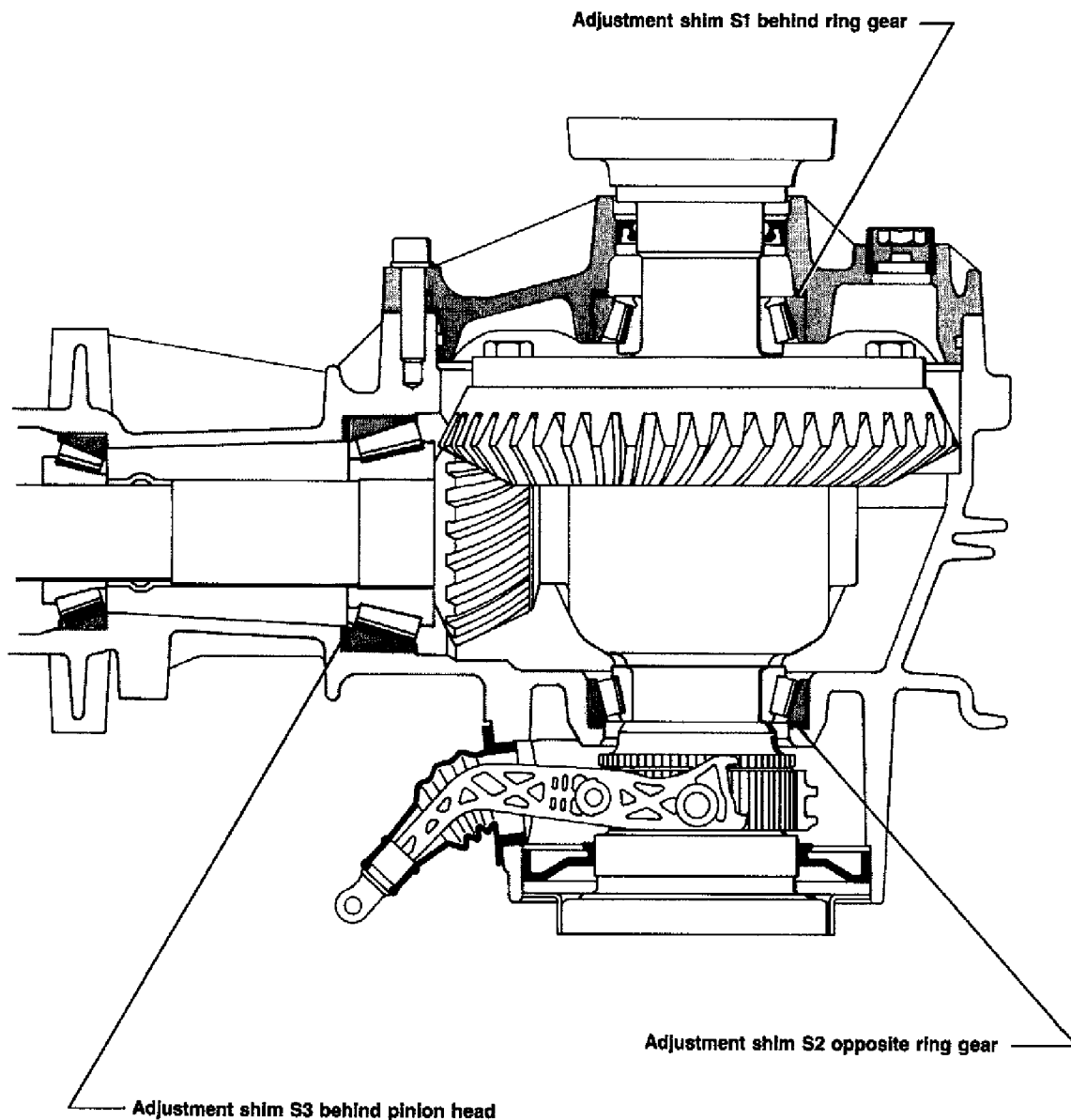
Note

The purpose of this adjustment is to again obtain the quietest operation that was determined on the test machine used in production.

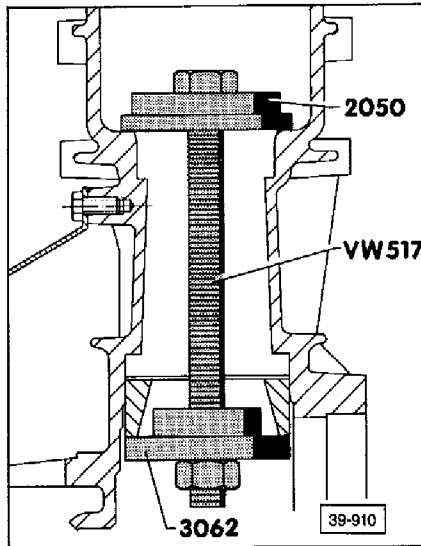
CAUTION

All precautions and cleaning procedures must be followed during assembly and measuring procedures to ensure a satisfactory result.

Differential – Manual Transmission



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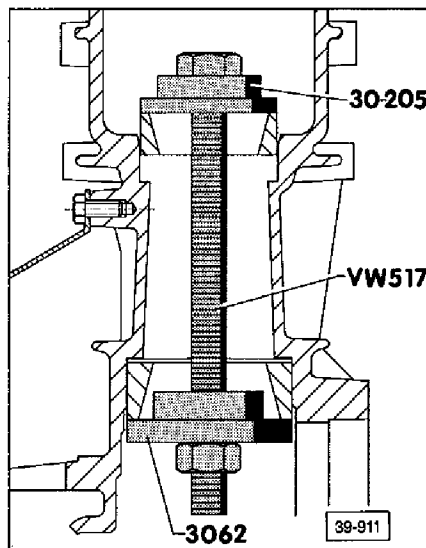


Pinion, adjusting

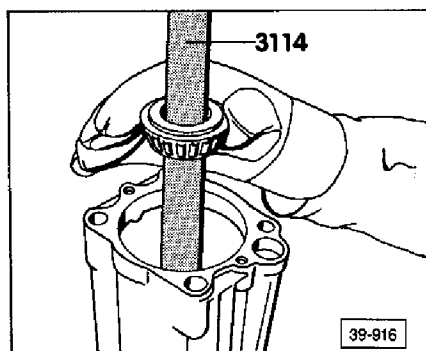
Note

The pinion needs to be adjusted as follows only if the ring gear/pinion set is being replaced. If other parts which affect the position of the pinion are to be replaced, the setting must be measured before disassembly, and the pinion set to this dimension when assembling (actual measurement). See page 39.55 and Adjustment Overview, page 39.54.

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

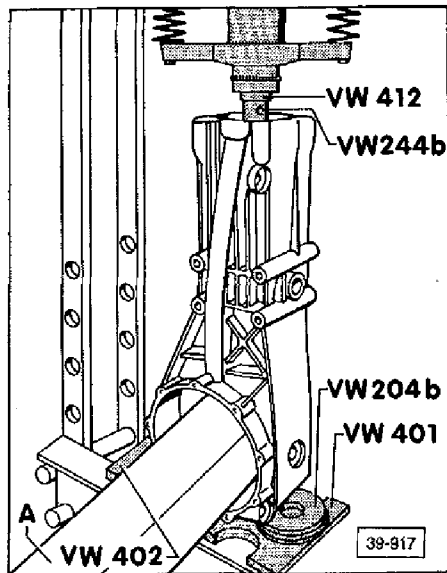


- pull in small pinion bearing outer race
- insert pinion

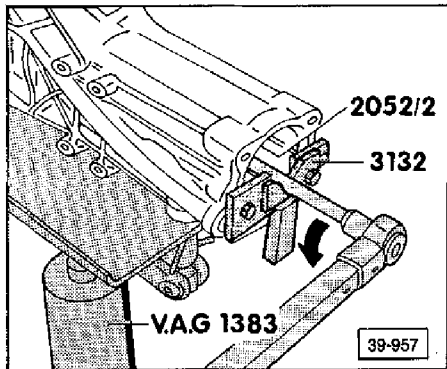


- heat pinion bearing inner race to 120° C (248° F) and install bearing on pinion **without** spacer

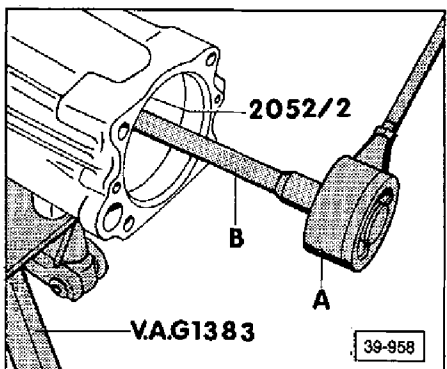
Differential – Manual Transmission



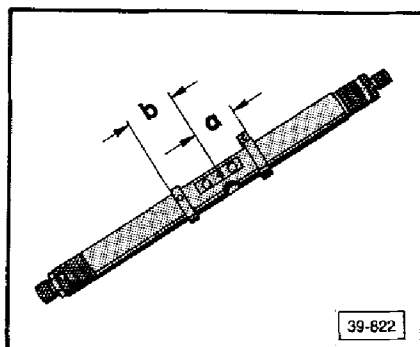
- A — wood support for pinion



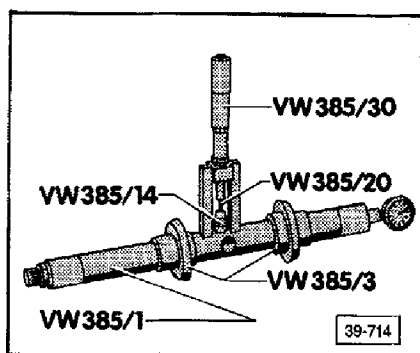
- tighten pinion nut until torque reaches 280-320 Ncm (25-29 in. lb)



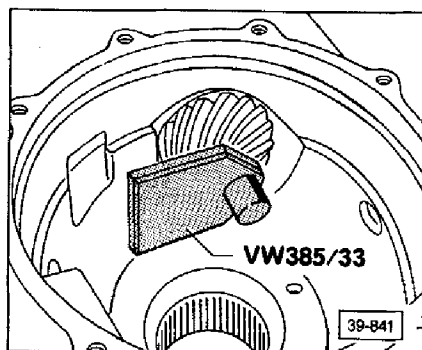
- A — commercial gage 0 - 600 Ncm (0-54 in. lb)
- B — extension with socket wrench 32 mm



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

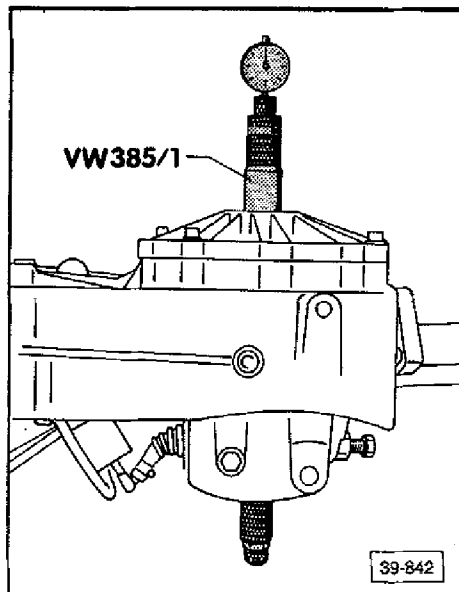


- prepare measuring bar as shown
 - indicator extension VW 385/20 = 3 mm
- set universal master gage VW 385/30 to **Ro** = 53.15 mm
- zero dial indicator with a 3 mm preload



- position end plate on pinion head
- install measuring bar
- install cover for final drive and tighten 4 bolts
- pull 2nd centering ring outward until measuring bar can just be turned by hand

Differential – Manual Transmission



- measure dimension **e** by turning measuring bar until indicator on the end plate of the pinion head shows the maximum deflection
- red numeral area on dial

Example

1.60 mm

CAUTION

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

Shim S3, determining thickness

$$S3 = e - r$$

e = dial indicator reading (maximum deflection)

r = deviation (marked on ring gear in 1/100 mm)

Example

dial indicator reading e	1.60 mm
deviation marked on ring gear r	– 0.42 mm
shim thickness S3	= 1.18 mm

Available shims:

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

Note

Due to the varying tolerances of the adjustment shims, exact shim thickness for **S3** can be obtained by measuring shims.

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

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 and the adjustment repeated. Once the spacer has been compressed it cannot be used again.

- turning torque range:
 - new bearings:
280-320 Ncm (25-29 in. lb)
 - used bearings:*
 - 30-60 Ncm (3-5 in. lb)

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

Measurement, checking

- check dimension r
- turn pinion several times in both directions
- insert measuring bar and check measurement
 - shims are correct if dial indicator (read counterclockwise, red numeral area) shows deviation r within a tolerance of ± 0.04 mm

Ring gear, adjusting

(differential, adjusting)

Note

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

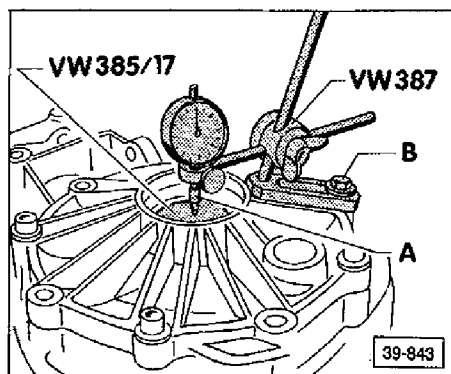
Rear final drive housing
Rear final drive cover
Differential bearings
Differential housing
Ring gear/pinion set
See Adjustment Overview, page 39.54

Total shim thickness S total ($S_1 + S_2$), determining

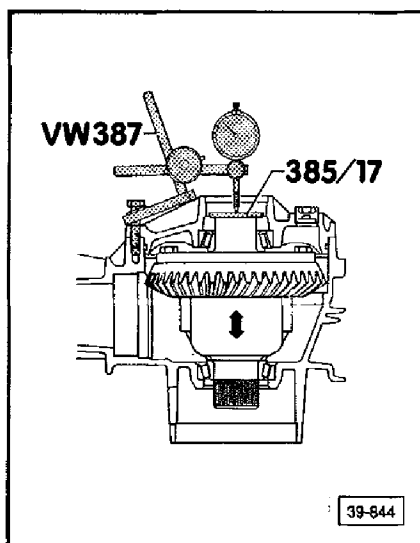
(adjusted preload of differential tapered roller bearing)

Pinion removed

- remove seals and differential bearing outer races (see page 39.48)
- drive in differential bearing outer races to stop **without** shims (see page 39.48)
- install differential in housing
 - ring gear is on the right side (side of final drive cover)
- install cover and tighten bolts to 25 Nm (18 ft lb)
- install measuring device
- zero gage (3 mm measuring range) with 1 mm preload
- A — dial indicator extension approximately 30 mm long
- B — hex head bolt M 8 x 45



Differential – Manual Transmission



- note reading on gage while moving differential up and down

Example

1.60 mm

CAUTION

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

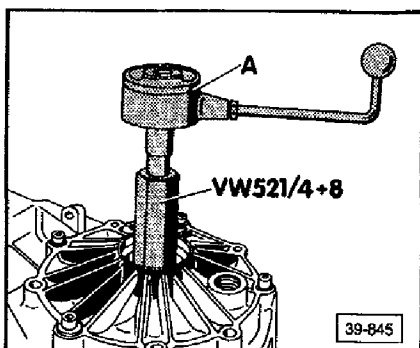
S total (S1 + S2), determining

S total = indicator reading + preload

preload (constant value)	0.40 mm
dial indicator reading	+ 1.60 mm

S total = 2.00 mm

- install **S total** (2.00 mm in example) behind the differential bearing outer race in the final drive housing (S2 side)



Turning torque, measuring

A — commercial torque wrench, 0-600 Ncm (0-54 in. lb)

- turning torque range:
 - new bearings: 280-320 Ncm (25-29 in. lb)
 - used bearings-60 Ncm (3-5 in. lb)

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

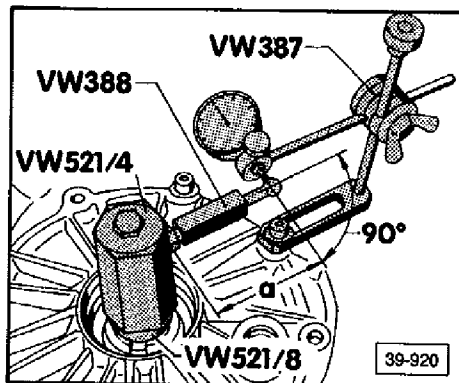
Note

When ring gear and pinion are to be readjusted, start here with pinion adjustment (see page 39.55).

Backlash, adjusting

- pinion installed with shim **S3**
- differential installed with **S total** (S1 + S2) on the housing side
- turn differential several times in both directions to seat bearings

Differential – Manual Transmission



- install measuring devices
- use dial indicator extension **VW 392/10** (6 mm)
- set measuring lever **VW 388** to dimension $a = 79 \text{ mm}$
- turn ring gear to zero dial indicator
- tighten lock bolt
- turn ring gear back and note backlash

- loosen clamping device
- loosen lock bolt
- turn ring gear 90° (1/4 turn)
- tighten lock bolt and clamping device
- turn ring gear back and note backlash
- repeat measuring procedure 2 more times

- add all four readings together and divide by four to find average backlash

CAUTION

If measurements differ more than 0.06 mm from each other, ring gear/pinion installation is not correct. Check ring gear/pinion, replace if necessary.

Average backlash, determining

Example

1st measurement	0.68 mm
2nd measurement	0.70 mm
3rd measurement	0.70 mm
4th measurement	+ 0.68 mm
Total	= 2.76 mm
average backlash: $2.76 \text{ mm} \div 4 = 0.69 \text{ mm}$	

Shim S1 thickness, determining from table
(ring-gear side)

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

Differential – Manual Transmission

Average backlash (mm)	Shim thickness S1 (mm)
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

Example:

average backlash = 0.69

S1 from table = 0.78 mm

The following adjustment shims are available:

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	005 409 385 F

Differential – Manual Transmission

Shim S2 thickness, determining
(opposite ring gear)

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

Example

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

The following adjustment shims are available:

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

- install shim **S1** behind ring gear
- install shim **S2** opposite ring gear

Measurement, checking

- measure backlash at four locations around ring gear
- check that backlash is **0.12 - 0.22 mm**

CAUTION

Backlash must not deviate more than 0.05 mm between readings.