

Index

097 4-speed Automatic

Axle flange oil seal

- removing/installing
(transmission installed) **39.33**
- installing
(transmission removed) **39.38**

Differential

- assembly **39.35**

Output gear

- assembly **39.39**
- removing/installing **39.41**

Differential

- assembly **39.49**
- disassembling/assembling **39.53**

Final drive

- adjustment overview **39.55**
- shim/bearing positions **39.53**
- shim positions **39.62**

Output gear

- adjusting **39.56**
- bearing turning torque **39.59**

Pinion

- assembly **39.43**
- removing/installing **39.45**

Ring gear/pinion

- adjusting **39.60**
- indentifying **39.60**

Pinion shaft

- adjusting **39.63**
- drive gear bearing
turning torque **39.66**

Ring gear

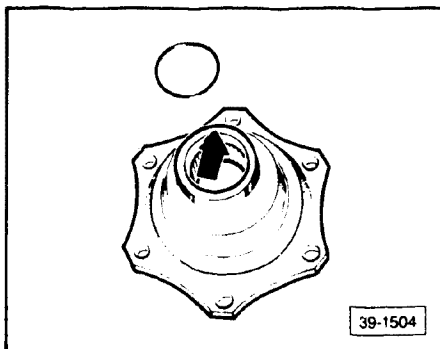
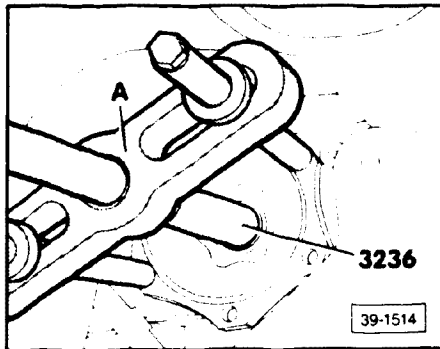
- adjusting **39.72**
- backlash, determining **39.75**
- backlash, checking **39.78**

Axle flange oil seal, removing/ installing (transmission installed)

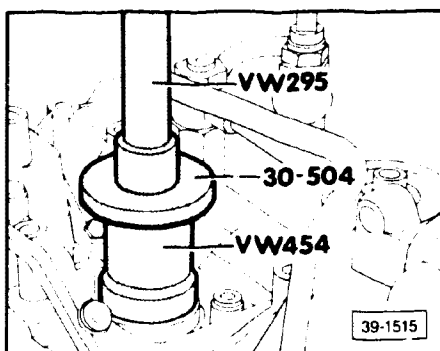
Removing (right side)

- remove axle shaft from axle flange
- remove axle flange lock ring
- position drain pan under vehicle
- remove axle flange using puller **A**,
Kukko 18/1

- remove oil seal, using extractor lever
VW 681



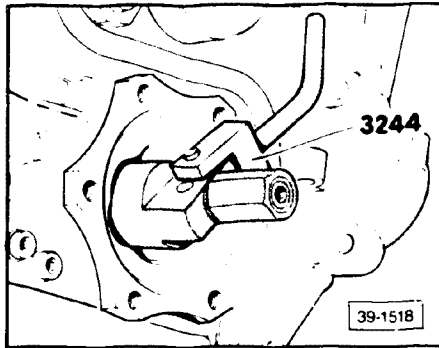
- remove O-ring from axle flange (**arrow**)



Installing (right side)

- drive new oil seal in, up to stop
 - fill space between seal and lip with multi-purpose grease
- install new O-ring

Differential – Automatic Transmission



- install axle flange to differential shaft
- install axle flange lock ring
- install axle shaft to axle flange
- refill transmission oil, to specifications

Tightening torque (right side)

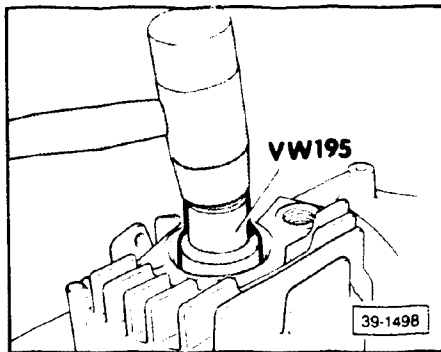
Axle shaft to axle flange 80 Nm (59 ft lb)

Removing (left side)

- remove axle shaft from axle flange
- remove axle flange bolt
- position oil pan under vehicle
- remove axle flange
- remove oil seal, using extractor lever **VW 681**

Installing (left side)

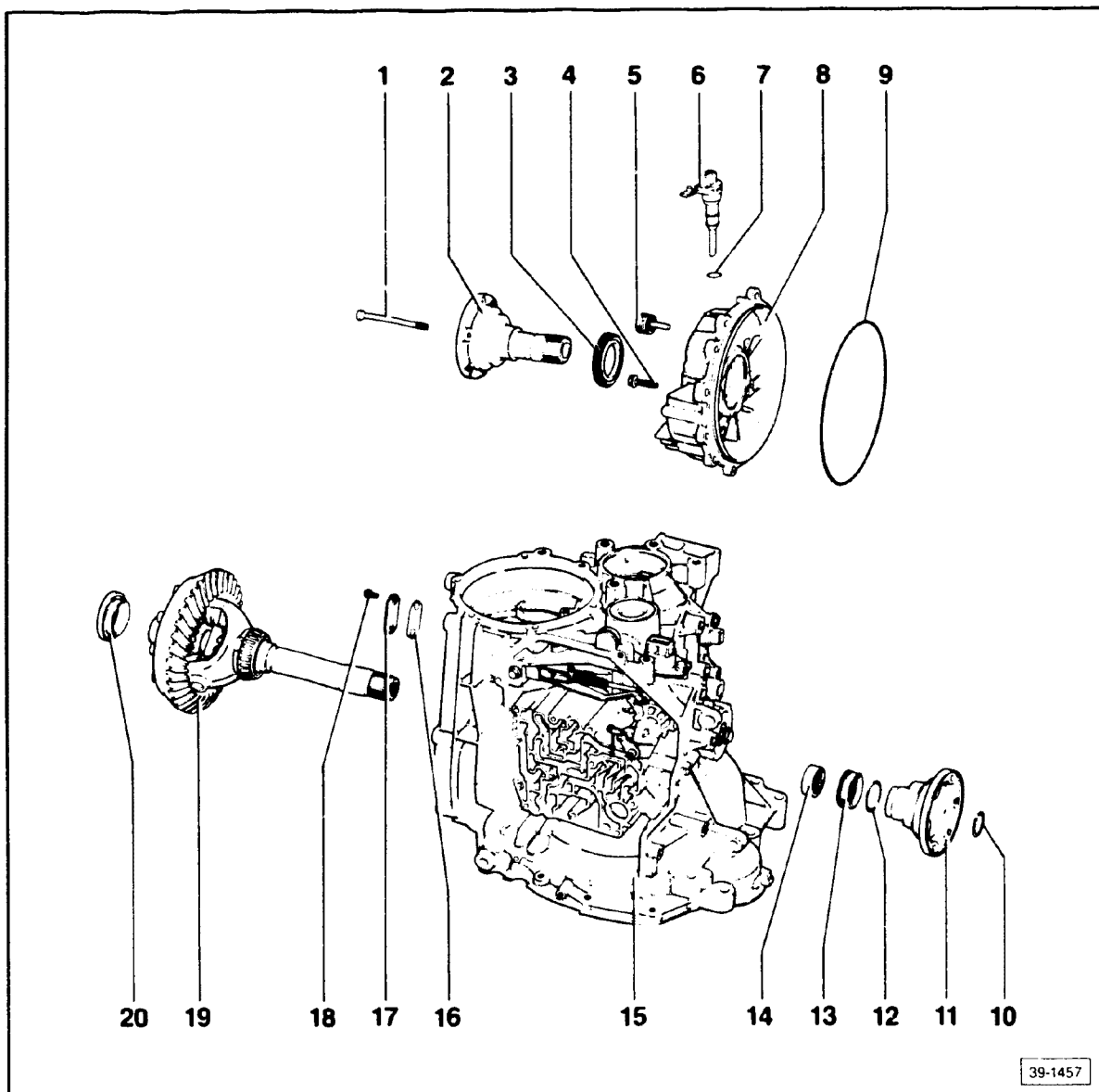
- drive new oil seal in, up to stop, with arbor **VW 195**
 - fill space between seal and lips with multi-purpose grease
- install axle flange
- install axle flange bolt
- install axle shaft to axle flange
- refill transmission oil to specifications



Tightening torques (left side)

Axle flange to transmission 25 Nm (18 ft lb)
Axle shaft to axle flange 80 Nm (59 ft lb)

Differential – Automatic Transmission



Note

If ring gear pinion and bearings are being reused, it is necessary to measure backlash (page 39.75) and pinion turning torque (page 39.66) **before** disassembling final drive. Note these measurements and adjust during reassembly, to obtain same settings.

CAUTION

If speedometer drive is dropped during assembly, damage could affect accuracy.

- 1 — 25 Nm (18 ft lb)
- 2 — Axle flange (left side)
- 3 — Axle flange oil seal
removing installing, page 39.33
- 4 — 25 Nm (18 ft lb)
- 5 — ATF filler plug
- 6 — Speedometer drive
- 7 — O-ring
always replace
- 8 — Final drive cover
when replacing cover, readjust ring gear

Differential – Automatic Transmission

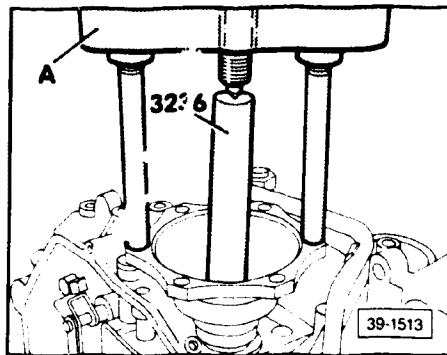
- 9 — **Seal**
 - always replace
- 10 — **Lock ring for axle flange**
- 11 — **Axle flange**
 - removing installing, page 39.37
- 12 — **O-ring**
 - always replace
 - installing, page 39.37
- 13 — **Oil seal**
 - remove with extractor lever **VW 681**
 - installing, page 39.38
- 14 — **Needle bearing**
 - removing installing, page 39.38
- 15 — **Transmission housing**
- 16 — **Gasket**
- 17 — **Cover for axle vent**
- 18 — **10 Nm (7 ft lb)**
- 19 — **Differential**
 - disassembling assembling, page 39.51
 - adjusting ring gear, page 39.72
- 20 — **Impulse wheel**
 - for electronic speedometer

Differential – Automatic Transmission

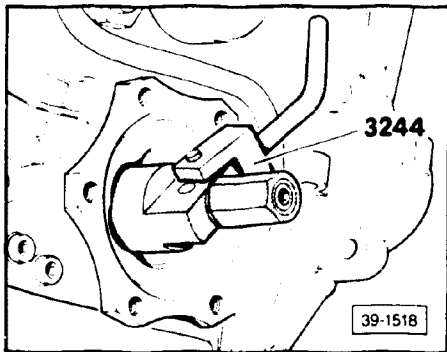
Differential assembly, removing/ installing

Axle flange (right side), removing

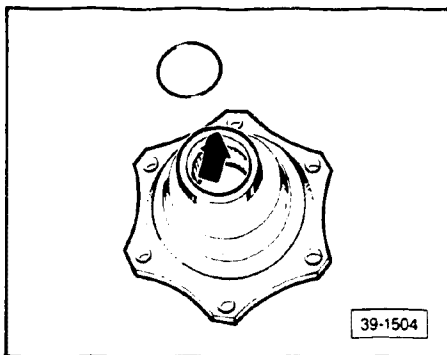
A — Kukko 18/1



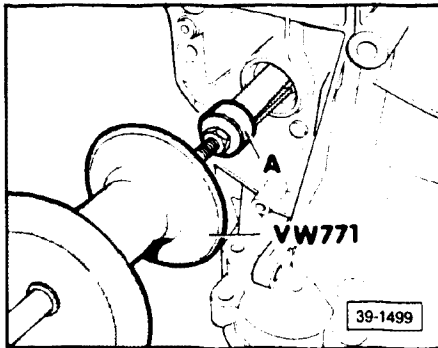
Axle flange (right side), installing



O-ring for axle flange (right side),
replacing

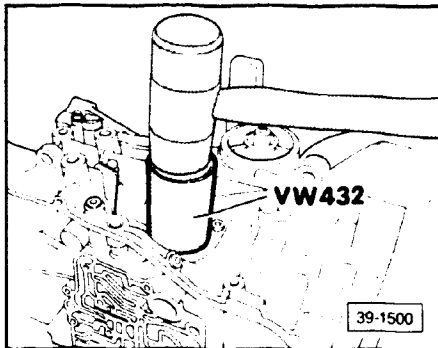


Differential – Automatic Transmission

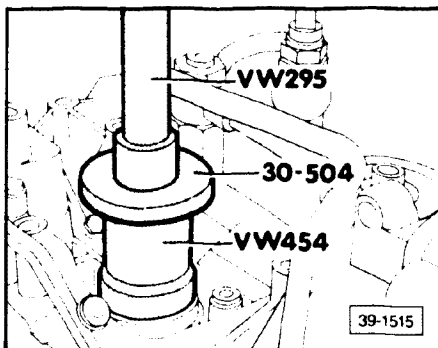


Needle bearing for axle flange (right side),
removing

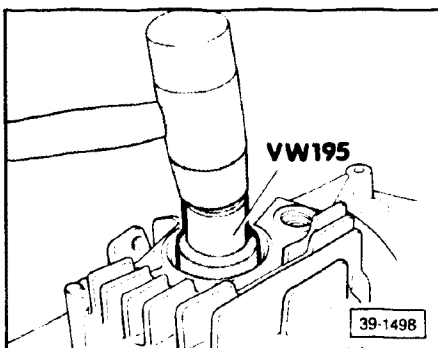
A — Kukko 21/5



Needle bearing for axle flange (right side),
installing

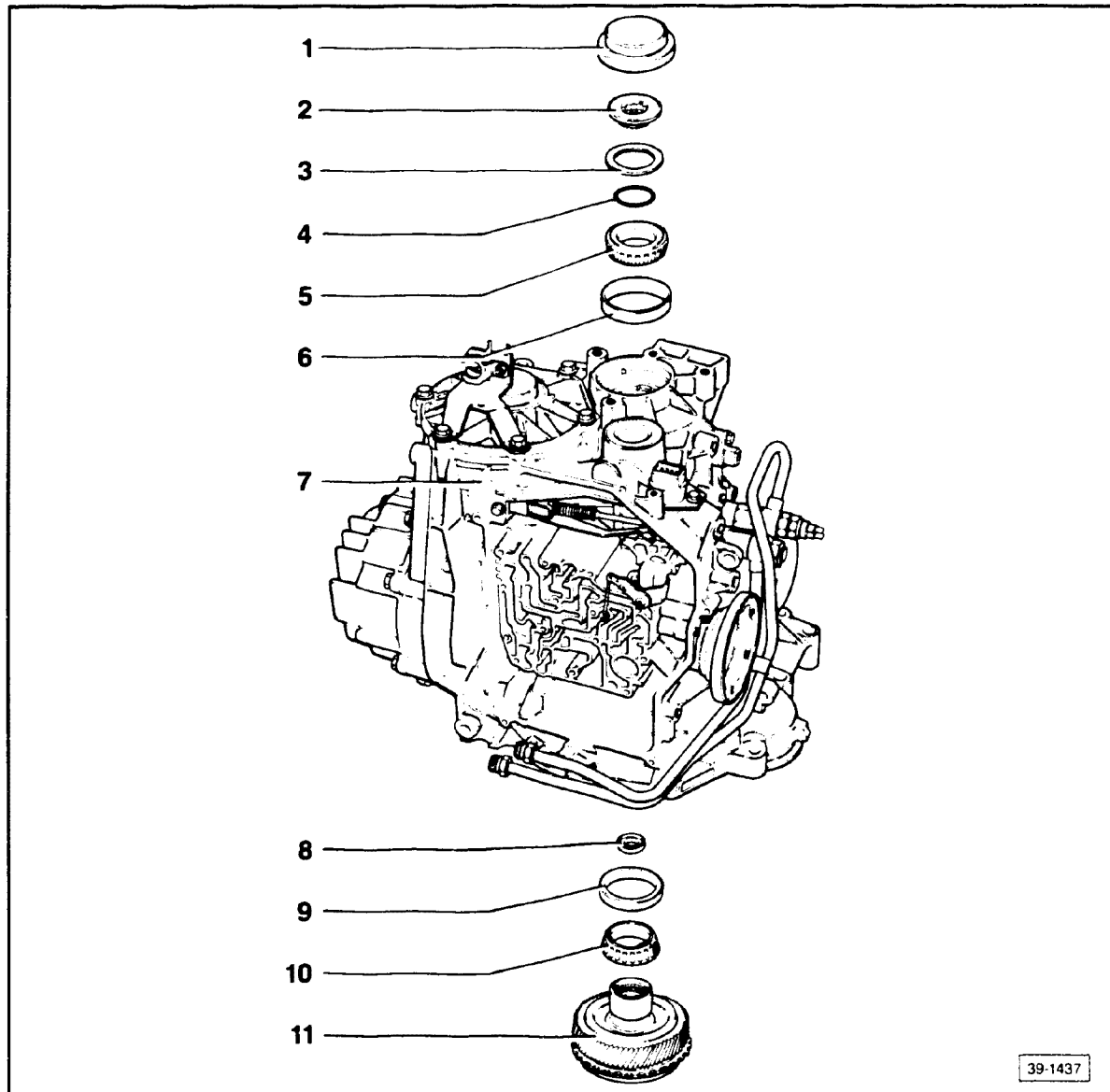


Oil seal for axle flange (right side),
installing



Oil seal for axle flange (left side), installing

Differential – Automatic Transmission



Note

Pinion and differential can remain installed during this procedure.

1 — Rubber cap

- pry out with screwdriver
- drive in with sleeve 40-20

2 — Tensioning bolt — 250 Nm (184 ft lb)

- engage parking pawl when removing/installing
- removing/installing, page 39.42

3 — Dished washer

- curved side faces tensioning bolt

4 — Shim

- determining thickness, page 39.56

5 — Inner race, tapered roller bearing

- install so that lugs engage in groove of other tapered roller bearing inner race (item 10)
- after determining adjustment shim measurement, install race on pinion using locking compound, Part No. **AMV 185 100 01**

6 — Outer race, tapered roller bearing

- drive out with suitable mandrel
- drive in using thrust pad 30-205
- install using locking compound, Part No. **AMV 185 100 01**

Differential – Automatic Transmission

7 — Transmission housing

8 — Axial bearing

- flat side faces drive shaft
- before installing, place tensioning bolt in output gear

9 — Outer race, tapered roller bearing

- drive out with suitable mandrel
- drive in using thrust pad **30-205**
- install using locking compound.
Part No. **AMV 185 100 01**

10 — Inner race, tapered roller bearing

removing installing, page 39.41

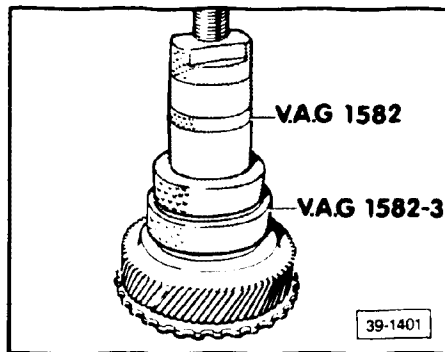
11 — Output gear

- number of teeth, see Technical data.
Repair Group 37
- adjusting, page 39.56
- when replacing output gear, adjust planet carrier.
Repair Group 38

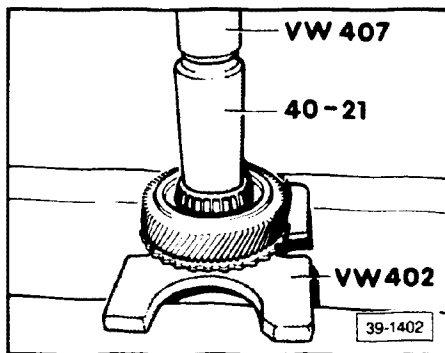
Differential – Automatic Transmission

Output gear assembly, removing/ installing

Inner race — tapered roller bearing
(item 10, illustration 39-1437), removing

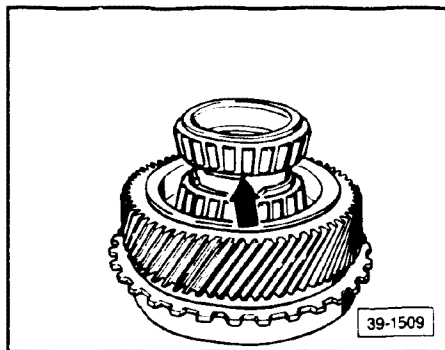


Inner race — tapered roller bearing
(item 10, illustration 39-1437), pressing on

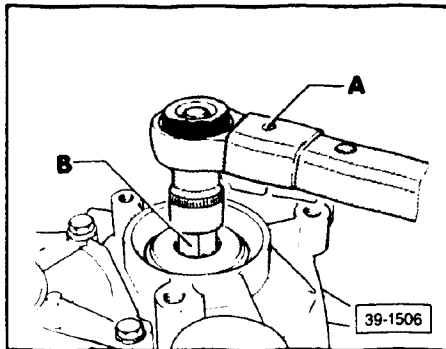


Inner race — tapered roller bearing
(item 5, illustration 39-1437), installing

- install inner race using locking compound,
Part No. **AMV 185 100 01**
- position so that lugs on inner race
engage grooves in opposite inner race
(arrow)



Differential – Automatic Transmission



Tensioning bolt, replacing

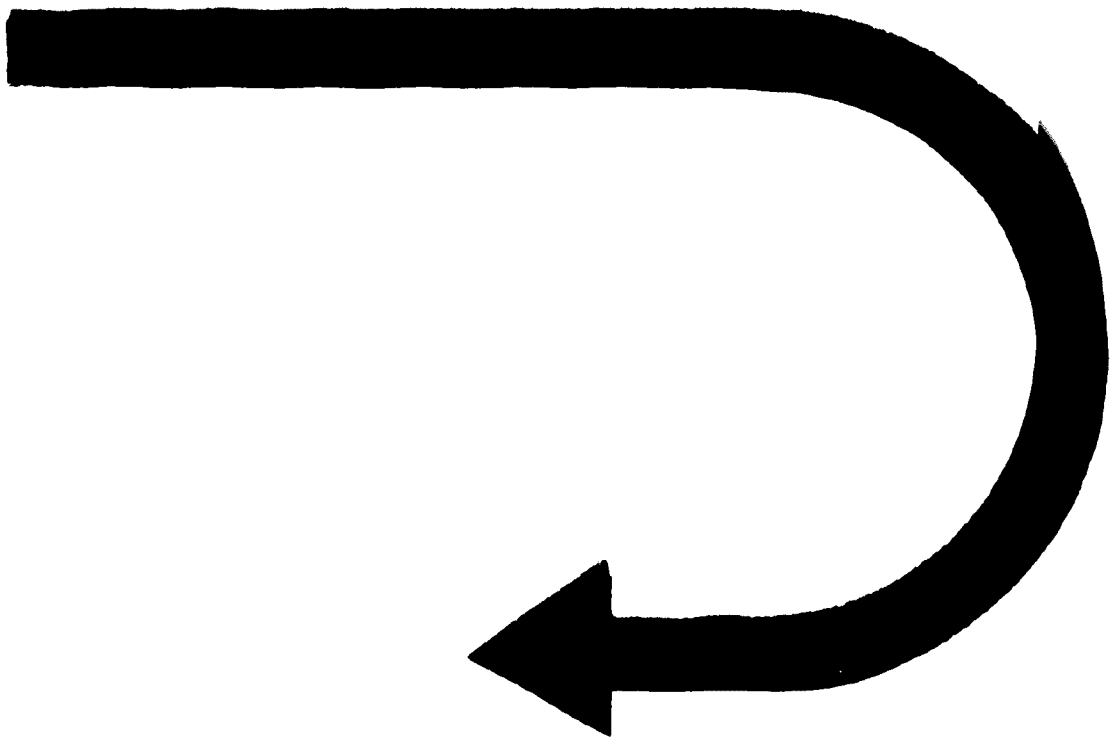
A — torque wrench

B — two pin spanner wrench, **VW 524**

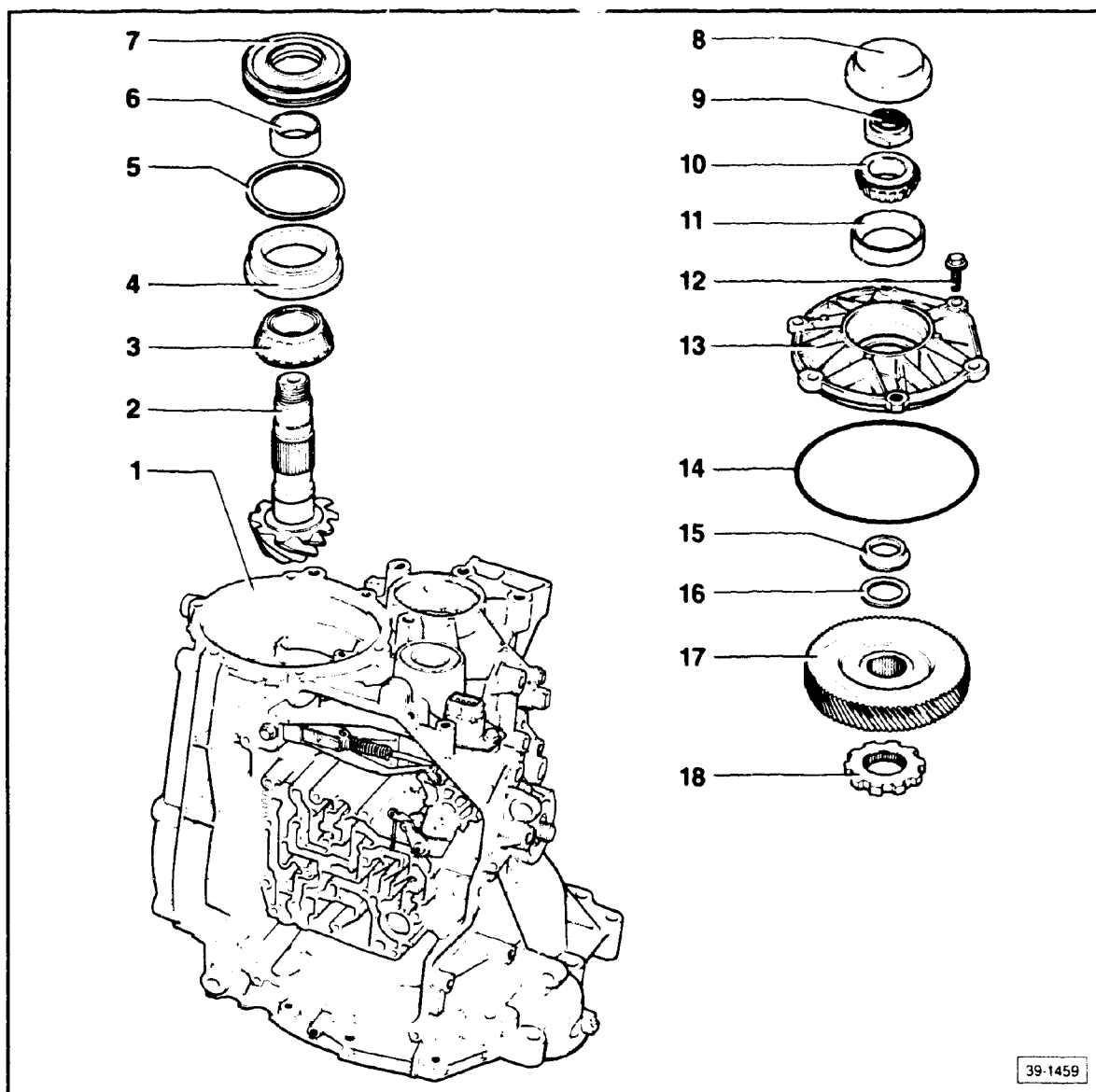
Note

Tightening torque = 250 Nm

CONTINUED IN THE
BEGINNING OF NEXT ROW



Differential – Automatic Transmission



1 — Transmission housing

2 — Pinion

- number of teeth, see Technical data.
- Repair Group 37
- paired with ring gear and replaced as matched set
- installing, page 39.47
- adjusting, page 39.63

3 — Inner race, tapered roller bearing
removing/installing, page 39.45

4 — Outer race, tapered roller bearing
• drive out with mandrel
• installing, page 39.45

5 — Shim — S3

determining, see Pinion adjusting, page 39.63

6 — Bushing for pinion shaft

- remove with inner race of tapered roller bearing, page 39.45
- installing, page 39.45

7 — Oil seal for pinion shaft

- always replace
- drive out with screwdriver
- installing, page 39.46

8 — Rubber cap

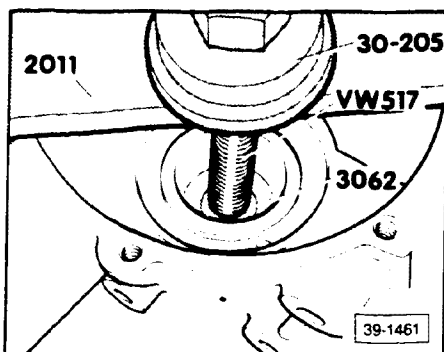
- drive out with screwdriver
- installing, page 39.46

Differential – Automatic Transmission

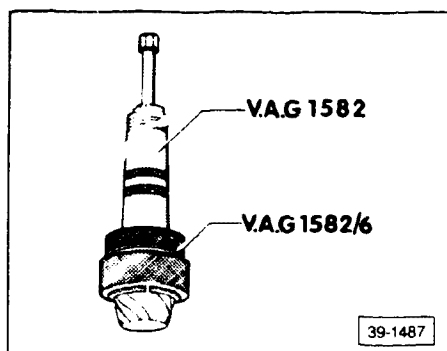
- 9 — **Hex nut**
secure after setting torque, page 39.46
- 10 — **Inner race, tapered roller bearing**
- 11 — **Outer race, tapered roller bearing**
 - drive in with mandrel
 - pressing in, page 39.46
- 12 — **25 Nm (18 ft lb)**
- 13 — **Pinion cover**
removing, page 39.47
- 14 — **O-ring**
always replace
- 15 — **Spacer**
wider contact surface faces drive gear
- 16 — **Shim — S4**
determining, see Pinion adjusting, page 39.63
- 17 — **Pinion drive gear**
 - number of teeth, see Technical data, Repair Group 37
 - raised collar faces parking pawl
 - removing, page 39.47
- 18 — **Parking lock gear**
rounded side faces drive gear

Differential – Automatic Transmission

Pinion assembly, removing/installing

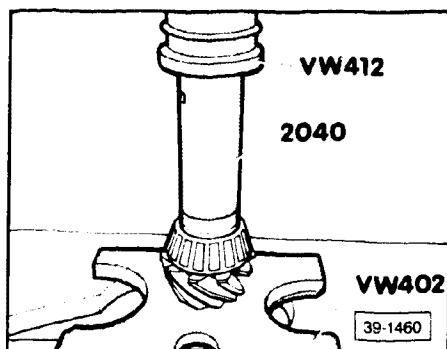


Outer race — tapered roller bearing
(item 4, illustration 39-1459), installing in
transmission housing



Inner race — tapered roller bearing
(item 3, illustration 39-1459), removing

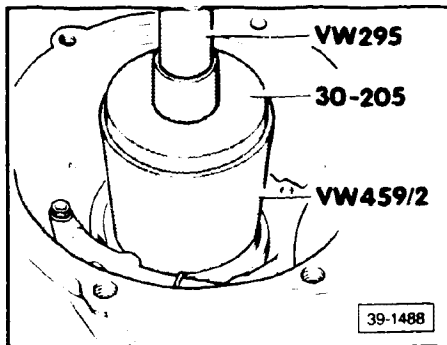
- remove along with pinion shaft bushing



Inner race — tapered roller bearing
(item 3, illustration 39-1459), installing

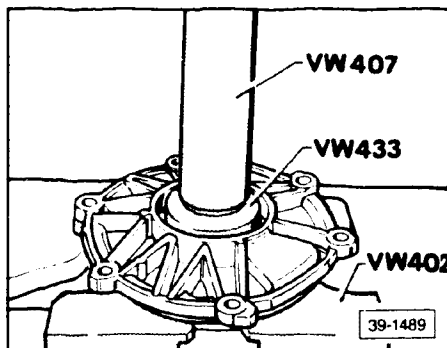
- press on, along with pinion shaft bushing

Differential – Automatic Transmission

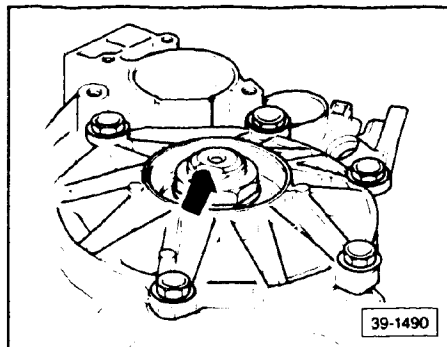


Oil seal for pinion shaft, installing

- drive seal in, up to stop
 - raised collar (inner) faces parking pawl

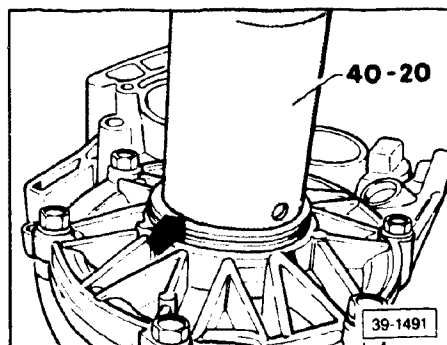


Outer race — tapered roller bearing (item 11, illustration 39-1459), pressing on



Hex nut, securing

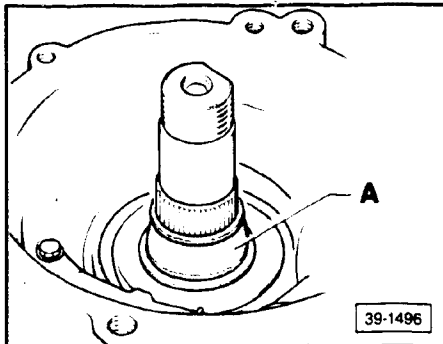
- peen collar of hex nut against flat edge of pinion (**arrow**)



Rubber cap, installing

- drive cap (**arrow**) in, up to stop

Differential – Automatic Transmission

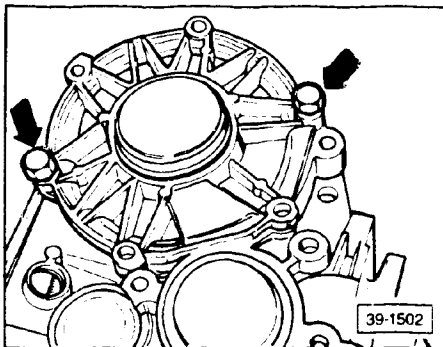


Pinion, installing

A = 3187

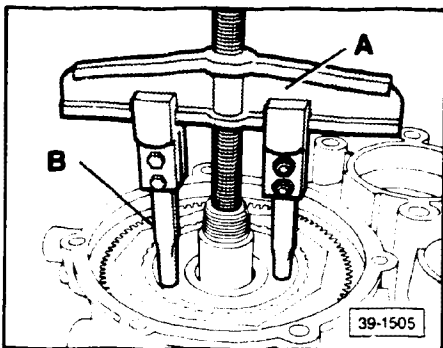
CAUTION

To avoid damage to the lip-type seal during pinion installation, use sleeve 3187.



Pinion cover, removing (for pinion cover designs with threaded holes)

- remove rubber cap
- remove pinion hex nut
- thread two bolts (**arrows**) into pinion cover
- turn bolts, alternately and evenly, to press cover off

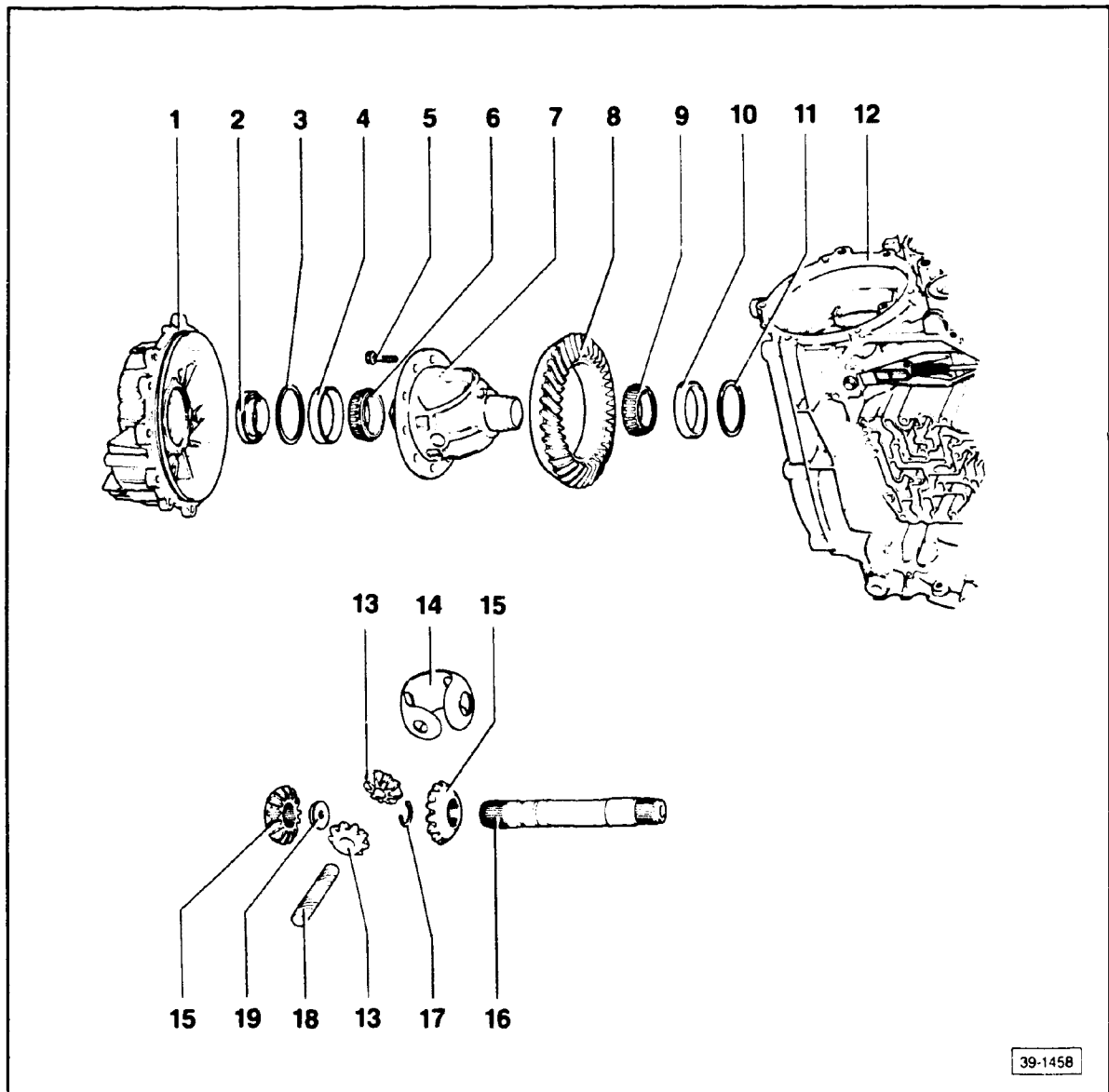


Pinion drive gear, removing

A — two arm puller **US 1078** (or **Kukko 20-10**)

B — puller hooks **Matra V172**

Differential – Automatic Transmission



39-1458

Note

Heat inner race of tapered roller bearings to 100 C (212 F) before pressing on.

- 1 — **Cover for differential gear**
removing installing, page 39.36
- 2 — **Impulse wheel**
removing installing, page 39.36
- 3 — **Shim — S1**
determining, page 39.72
- 4 — **Outer race, tapered roller bearing**
 - drive out with mandrel
 - pressing in, page 39.51

5 — 90 Nm (66 ft lb)

6 — **Inner race, tapered roller bearing**
removing installing, page 39.51

7 — **Differential housing**
re-adjust when replacing ring gear, page 39.72

8 — **Ring gear**

- number of teeth, see Technical data, Repair Group 37
- paired with pinion and replaced as matched set
- adjust pinion ring gear set after replacing. See Adjustment Overview, page 39.55
- to remove, drive out of differential housing using mandrel
- before installing, heat to 100 C (212 F) and fabricate centering pin guide, page 39.52

Differential – Automatic Transmission

- 9 — **Inner race, tapered roller bearing**
removing/installing, page 39.51
- 10 — **Outer race, tapered roller bearing**
 - drive out with mandrel
 - driving in, page 39.52
- 11 — **Shim — S2**
determining, page 39.72
- 12 — **Transmission housing**
- 13 — **Differential pinion gears**
installing, page 39.52
- 14 — **Thrust washer**
place in differential housing before installing gears
- 15 — **Differential side gears**
installing, page 39.52
- 16 — **Output shaft**
install output shaft first, before differential pinion shaft
- 17 — **Lock ring**
- 18 — **Differential pinion shaft**
 - drive out with mandrel
 - inspect for wear; replace if necessary

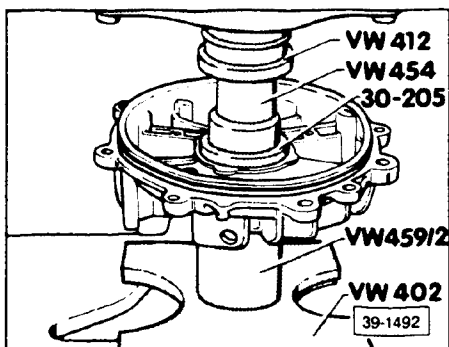
CAUTION

When driving shaft in, do not damage thrust washer.

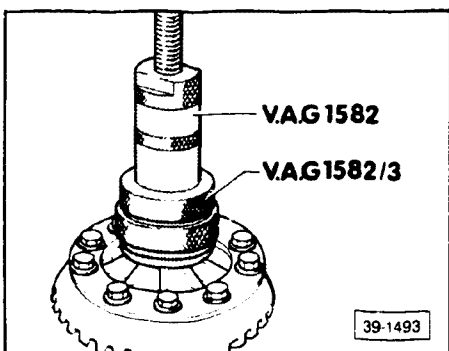
- 19 — **Axle flange nut**

Differential – Automatic Transmission

Differential, disassembling/ assembling



Outer race — tapered roller bearing
(item 4, illustration 39-1458), pressing on

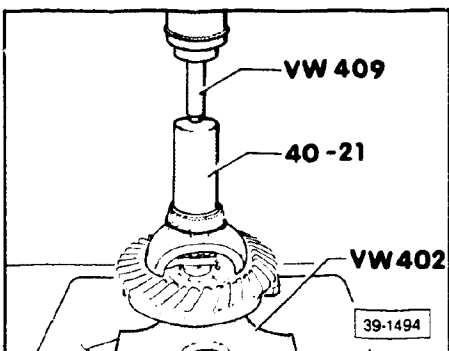


Inner race — tapered roller bearing
(item 6, illustration 39-1458), removing

■ thrust piece 40-105 (not shown) is
positioned on differential housing

Note

When removing inner race (item 9, illustration 39-1458), follow this same procedure.

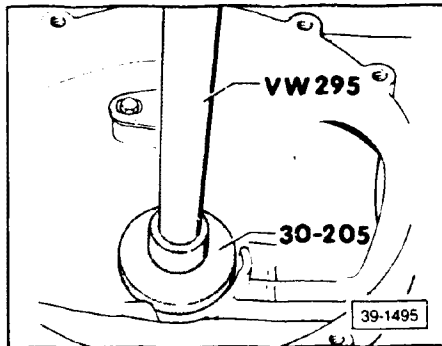


Inner race — tapered roller bearing
(item 6, illustration 39-1458), installing

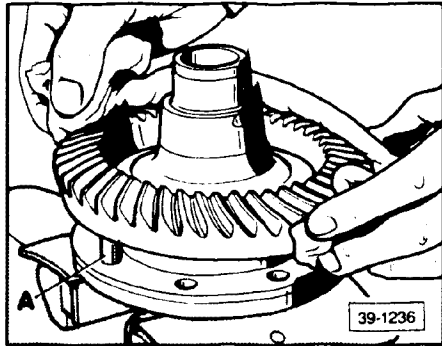
Note

When installing inner race (item 9, illustration 39-1458), follow this same procedure.

Differential – Automatic Transmission



Outer race — tapered roller bearing
(item 10, illustration 39-1458), driving in

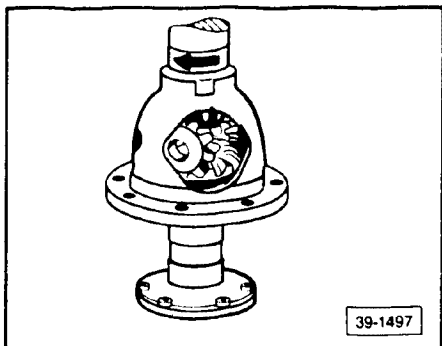


Ring gear, installing

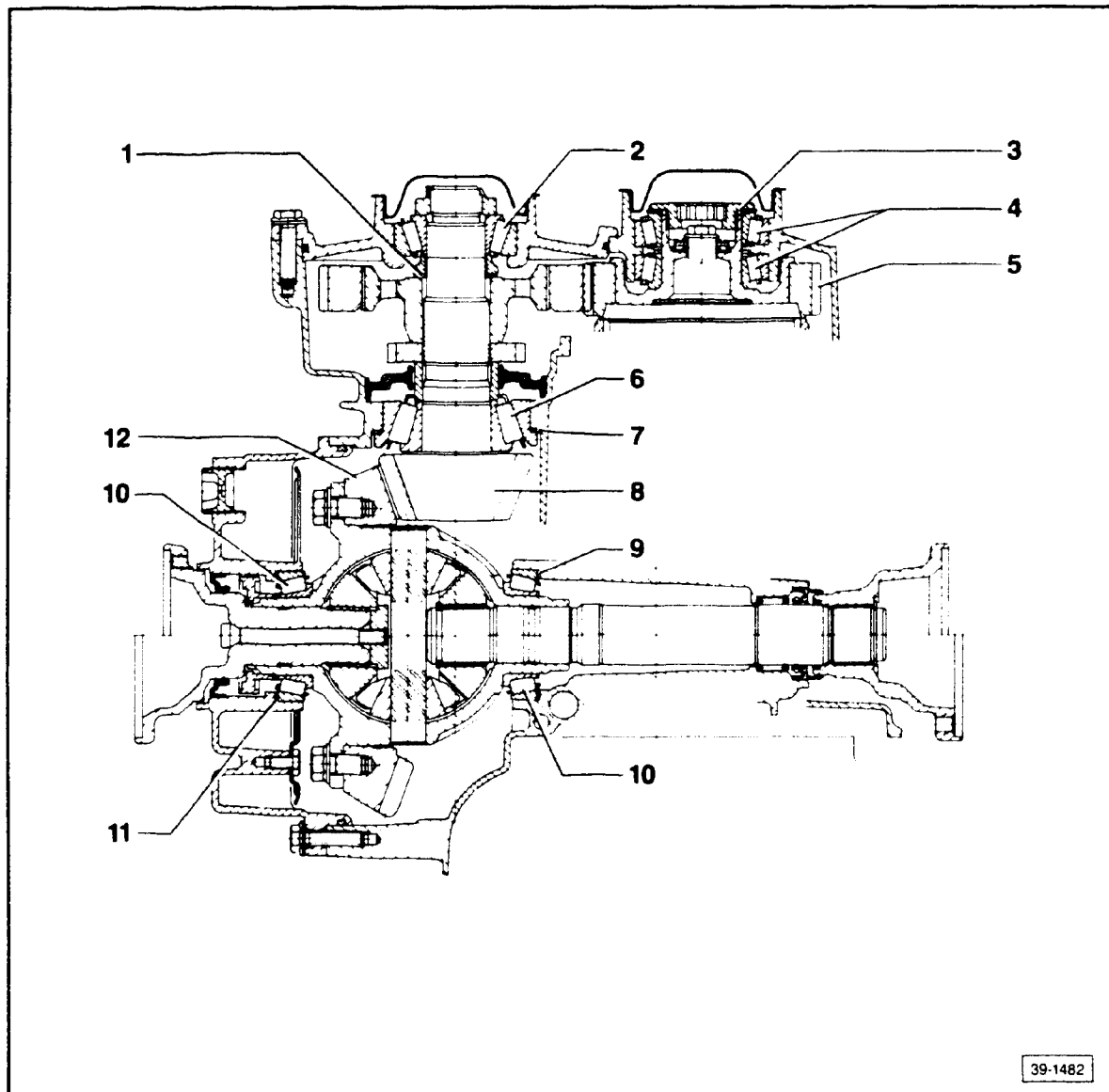
- install ring gear, as follows:
 - heat gear to approximately 100°C (212°F)
 - center, using suitable-sized pins **A**

Differential gears, assembling

- position thrust washer in differential housing
 - before inserting, lubricate washer with gear oil
- install differential side gears
 - center gears by inserting left axle flange and axle shaft
- install differential pinion gears
 - pivot into position (at 180° angle to side gears) by turning drive shaft in direction of **arrow**
- align pinion gears with thrust washer
- drive in pinion shaft, to secure pinion gears



Differential – Automatic Transmission



Note

See also Adjustment Overview chart (page 39.55), when replacing individual transmission components

1 — S4 shim

- for pinion
- determine thickness from chart, page 39.69

2 — Tapered roller bearing (small)

- for pinion
- when replacing bearing, also replace large tapered roller bearing for pinion
- for new bearing, turning torque must be 135-265 Ncm (11.9-23.5 in. lb or 13.7-27.0 cm kg)
- when replacing bearing, install new **S3**, **S4** shims

3 — Shim

- for output gear
- determine thickness from chart, page 39.58

4 — Tapered roller bearings

- for output gear
- when replacing bearings, replace as a set
- measure turning torque via pinion shaft. For new bearings, torque must be 165-245 Ncm (14.6-21.7 in. lb or 16.8-25.0 cm kg) **above** turning torque for pinion shaft
- when replacing bearing, install new shim (see page 39.58)

5 — Output gear

- adjusting, page 39.56

Differential – Automatic Transmission

- 6 — **Tapered roller bearing (large)**
 - for pinion
 - when replacing bearing, also replace small tapered roller bearing for pinion
 - for new bearing, turning torque must be 135-265 Ncm (11.9-23.5 in. lb or 13.7-27.0 cm kg)
 - when replacing bearing, install new **S3, S4** shims
- 7 — **S3 shim**
 - for pinion
 - determine thickness from chart, page 39.71
- 8 — **Pinion**
 - when replacing pinion, also replace ring gear
 - adjusting, page 39.63
- 9 — **S2 shim**
 - for ring gear
 - determine thickness from chart, page 39.77
- 10 — **Tapered roller bearings**
 - for differential
 - when replacing bearings, replace as a set
 - measure turning torque via pinion shaft. For new bearings, torque must be 50-70 Ncm (4.4-6.2 in. lb or 5.1-7.1 cm kg) **above** turning torque for pinion shaft
 - when replacing bearings, install new **S3, S4** shims
- 11 — **S1 shim**
 - for ring gear
 - determine thickness from chart, page 39.77
- 12 — **Ring gear**
 - when replacing ring gear, also replace pinion
 - adjusting, page 39.61

Differential – Automatic Transmission

Adjustment overview

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

Replaced part	To be adjusted	Ring gear (S1 + S2) page 39.72	Pinion (S3 + S4) using deviation r page 39.63	Output gear page 39.56	Pinion (S4) via turning torque page 39.66
Transmission housing		X	X	X	
Output gear bearing				X	
Output gear				X	
Differential housing		X			
Pinion bearing			X		
Differential bearing		X			
Pinion cover					X
Pinion bushing, parking pawl gear and pinion drive gear					X

Output gear, adjusting

Note

Adjust output gear by shimming it to a specified thickness. Determine the specified thickness using the chart at the end of this section. In order to read the chart, the specified bearing preload must be calculated, using the equation:

$$\text{specified bearing preload} = c + d - e$$

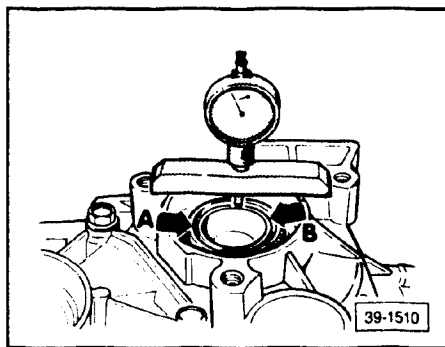
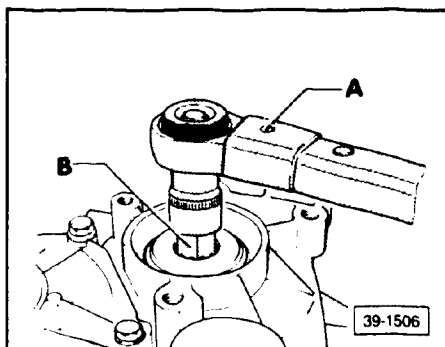
Values for **c**, **d**, and **e** are given or determined, as follows:

Dimension c, constant

A — torque wrench

B — two pin spanner wrench **VW 524**

- tighten tensioning bolt to 100 Nm (74 ft lb)
 - **do not** install dished washer (1.50 mm thickness **c**), or shim, at this time
 - parking pawl must be engaged
- remove tensioning bolt



Dimension d, determining

- install dial indicator along with measuring bar **VW 382/7**
 - zero dial indicator with 3 mm preload
- measure **d** = distance between output gear **B** and inner race of tapered roller bearing **A**
- record dial indicator reading

Example

d = 1.00 mm

Dimension e, bearing preload (constant)

e = 0.18 mm

Differential – Automatic Transmission

Specified bearing preload, calculating

Note

Using values for **c**, **d** and **e** determined previously, calculate the following:

Specified bearing preload = c + d - e

Example

Thickness of dished washer c	1.50 mm
Dial indicator reading d	+ 1.00 mm
Bearing preload e	- 0.18 mm
Specified bearing preload =	2.32 mm

Specified shim value, determining

Note

Using the specified bearing preload just calculated, find the correct adjustment shim value in the chart on page 39.58.

Adjustment shim, installing

- install adjustment shim on output shaft
- install axial needle bearing and dished washer
- install tensioning bolt
 - tighten to 250 Nm (184 ft lb)

Differential – Automatic Transmission

Specified bearing preload (mm)	Shim size needed	Part number
1.55 – 1.59	1.60	095 323 839
1.60 – 1.64	1.65	095 323 839 A
1.65 – 1.69	1.70	095 323 839 B
1.70 – 1.74	1.75	095 323 839 C
1.75 – 1.79	1.80	095 323 839 D
1.80 – 1.84	1.85	095 323 839 E
1.85 – 1.89	1.90	095 323 839 F
1.90 – 1.94	1.95	095 323 839 G
1.95 – 1.99	2.00	095 323 839 H
2.00 – 2.04	2.05	095 323 839 J
2.05 – 2.09	2.10	095 323 839 K
2.10 – 2.14	2.15	095 323 839 L
2.15 – 2.19	2.20	095 323 839 M
2.20 – 2.24	2.25	095 323 839 N
2.25 – 2.29	2.30	095 323 839 P
2.30 – 2.34	2.35	095 323 839 Q
2.35 – 2.39	2.40	095 323 839 R
2.40 – 2.44	2.45	095 323 839 S
2.45 – 2.49	2.50	095 323 839 T
2.50 – 2.54	2.55	095 323 839 AA

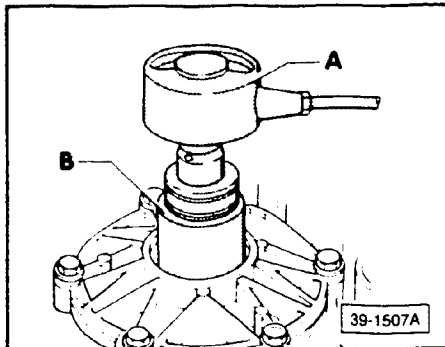
CAUTION

Part numbers are for reference only.
Always check with your Parts
Department for latest information.

Note

Verify shim thickness at several sites around circumference, using a micrometer. Inspect shim(s) for burrs or irregularities.

Differential – Automatic Transmission



Output gear bearings, checking turning torque

A — torque wrench, with range of 0-600 Ncm
(0-55 in. lb or 0-65 cm kg)

B — socket (41 mm)

- lubricate bearing with ATF before checking

Note

Measure output gear turning torque by turning pinion.

For **new** tapered roller bearings, the turning torque must be 220-260 Ncm (19.5-23.0 in. lb or 22.4-26.5 cm kg) **higher** than the turning torque for the pinion shaft differential alone.

Example

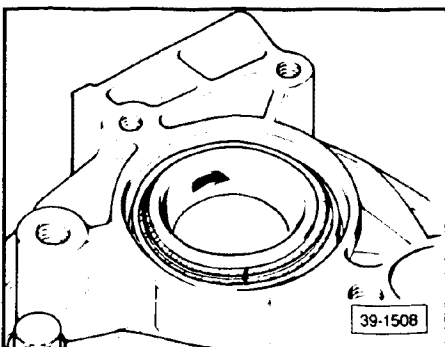
Pinion shaft differential	260 Ncm (23.0 in. lb or 26.5 cm kg)
Drive gear	+ 240 Ncm (21.2 in. lb or 24.4 cm kg)
	500 Ncm (44.3 in. lb or 51.0 cm kg)

Inner race of tapered roller bearing, securing

Note

After checking turning torque of output gear bearings:

- secure inner race of tapered roller bearing (**arrow**) with sealant **AMV 185 100 01**
- install axial bearing and dished washer
- install tensioning bolt
 - tighten to 250 Nm (184 ft lb)



Ring gear/pinion, adjusting

General notes

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

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

Replacement parts, identifying

- 1 — Number **1141** (arrow) identifies Oerlikon gear sets with **41:11** ratio
- 2 — Matching number (**312**) on ring gear/pinion set
- 3 — Deviation r (pinion deviation) measured against the master gauge of the testing machine used in production. The deviation r is always given in 1/100 mm

Example

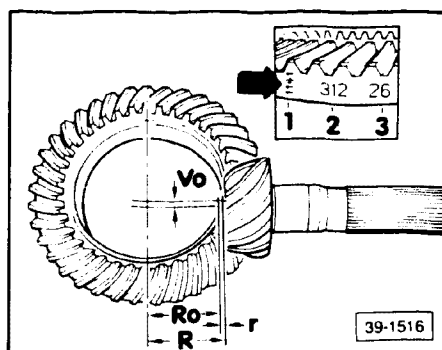
"26" means $r = 0.26$ mm

R_o — Length of master gauge used in production

$R_o = 5.92$ mm

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

V_o — Hypoid offset



Differential – Automatic Transmission

Ring gear/pinion, adjusting

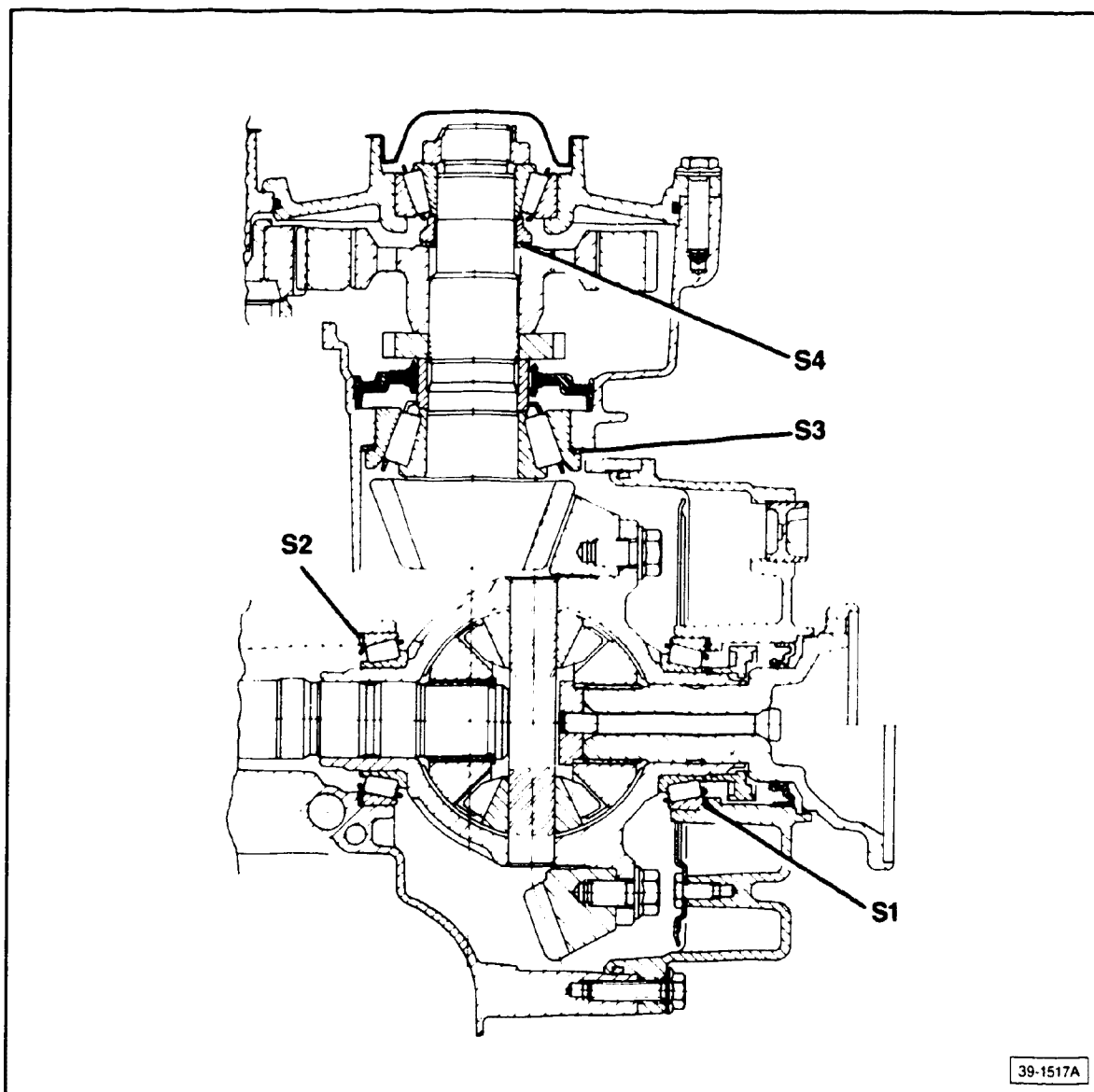
- determine **S total**, total shim thickness (i.e., **S1** + **S2**) to give specified preload of differential bearings
- determine total shim thickness **S total** (**S3** + **S4**) to give specified preload of pinion bearings
- distribute **S total** between **S3** and **S4** so dimension between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

Note

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

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

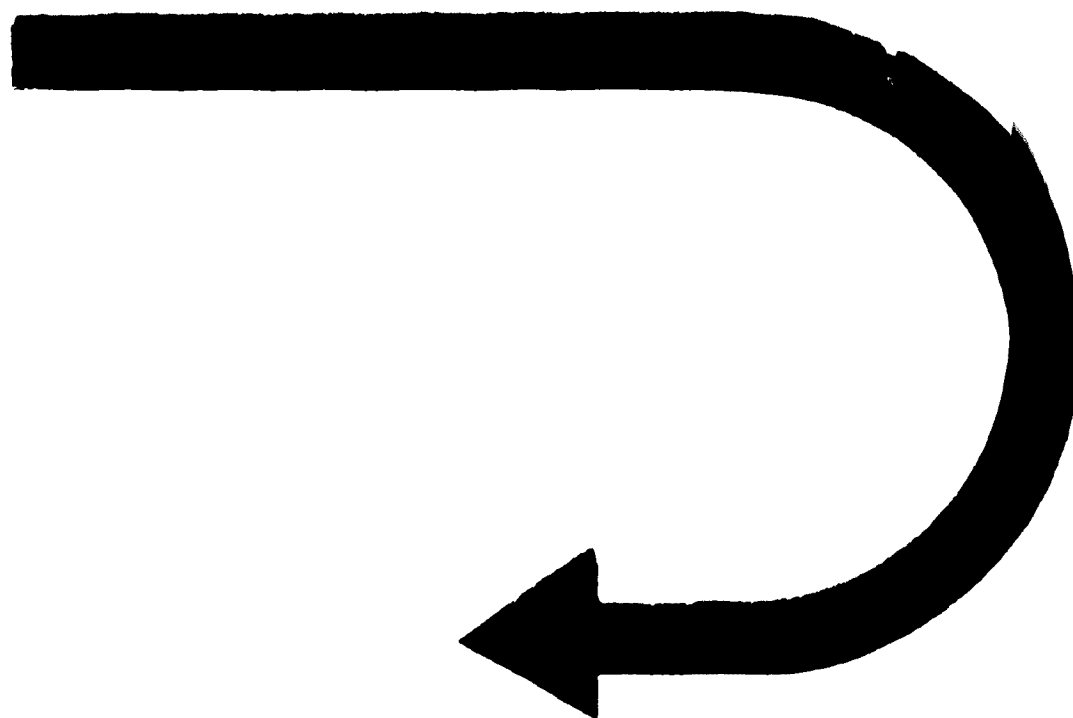
Differential – Automatic Transmission



- S1 — Shim for ring gear, in final drive housing cover
- S2 — Shim for ring gear, in final drive housing
- S3 — Shim for pinion in final drive housing

- S4 — Shim for pinion, between pinion drive gear and spacer

CONTINUED IN THE
BEGINNING OF NEXT ROW



Pinion shaft, adjusting

Note

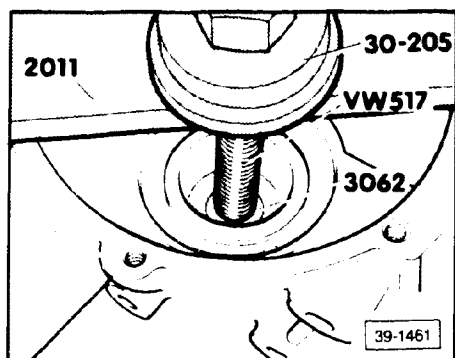
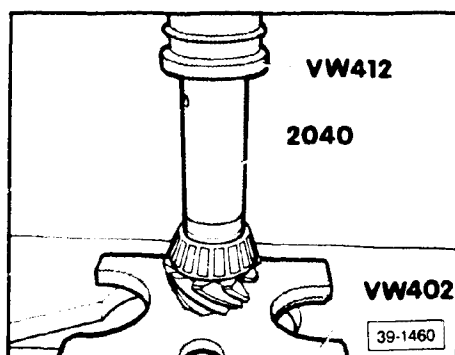
If the pinion shaft bushing, spacer, pinion cover or small pinion bearing are replaced, only the **S4** shim thickness should be redetermined. Begin with "Pinion drive gear bearing, checking turning torque," page 39.66.

If the ring and pinion set, or the large pinion bearing are replaced, proceed with the pinion shaft adjustment which follows.

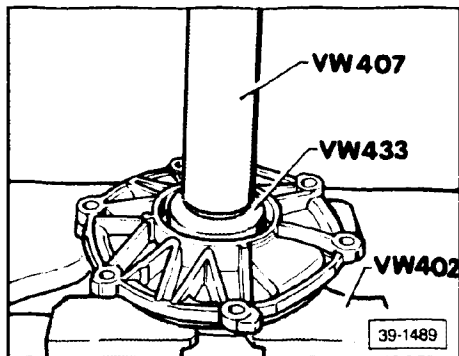
Adjust preload of pinion bearings by finding total shim thickness (i.e. **S3** + **S4**). When selecting shims for test use or actual use, inspect for burrs or irregularities. Verify shim thickness at several sites around the circumference, using a micrometer.

S3/S4 test shims, installing

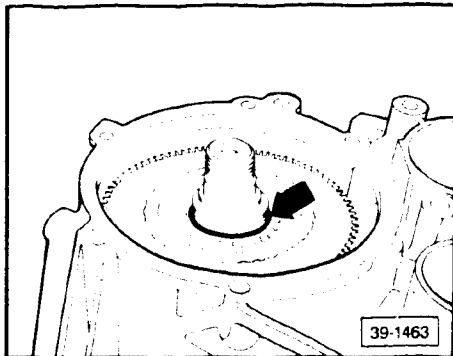
- install inner race of tapered roller bearing, along with pinion shaft bushing
- install outer race of tapered roller bearing, along with **S3** test shim (1.5 mm), into final drive housing



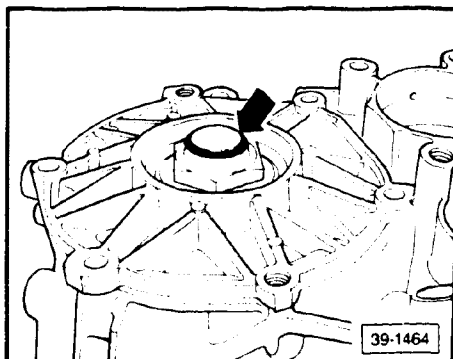
Differential – Automatic Transmission



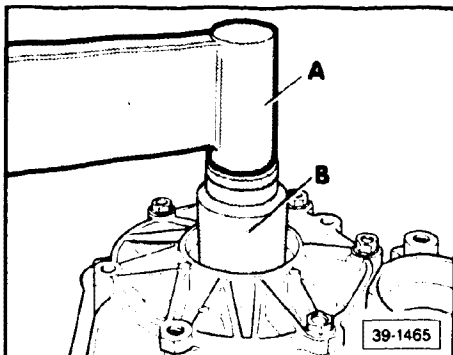
- install outer race of tapered roller bearing in pinion cover



- install, in the following sequence:
 - pinion
 - parking lock gear
 - drive gear
 - S4 test shims (arrow) = 2.4 mm total thickness
 - spacer



- continue installing:
 - pinion cover
(do not tighten to specifications at this time — see below)
 - inner race of tapered roller bearing
 - pinion hex nut (arrow)
(do not tighten nut to specifications, at this time — see below)
- tighten pinion cover bolts (four)
 - torque specification = 25 Nm (18 ft lb)



- A — torque wrench
- B — socket (41 mm)
- engage parking pawl
- tighten pinion hex nut
 - torque specification = 240 Nm (177 ft lb)

Differential – Automatic Transmission

S4 test shim correction, determining

Note

S4 corrected value must be calculated in the following equation:

$$S4_c = x - y - z$$

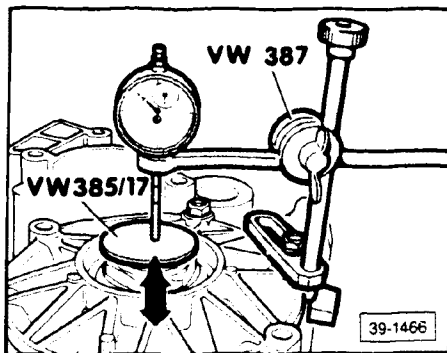
Values for **x**, **y**, and **z** are given or measured, as follows:

Dimension **x**, constant

x = 2.40 mm (value of **S4** test shims before correction)

Dimension **y**, measuring

- attach dial indicator holder **VW 387** to pinion cover
- position **VW 387** (50 mm diameter magnetic plate) on pinion end
- insert dial indicator in holder and set to zero
- move pinion in direction of **arrow** to limits of travel, and note reading



CAUTION

Do not allow pinion to turn during procedure or bearings will settle and reading will be incorrect.

Example

Dimension **y** = 0.95 mm

Dimension **z**, constant

z = 0.25 mm (bearing preload and settling allowance)

Differential – Automatic Transmission

S4 test shim correction, calculating

Note

Using values for **x**, **y** and **z** determined previously, calculate the following:

$$S4_c = x - y - z$$

Example

S4 test shims x	2.40 mm
Dial indicator measurement y	– 0.95 mm
Bearing preload/settling z	– 0.25 mm
S4 test shim, corrected value =	1.20 mm

- remove pinion cover
- install 1.20 mm shim
- install pinion cover
- tighten pinion hex nut to 340 Nm (251 ft lb)
- loosen hex nut and retighten to 240 Nm (177 ft lb)

Pinion drive gear bearing, checking turning torque

Note

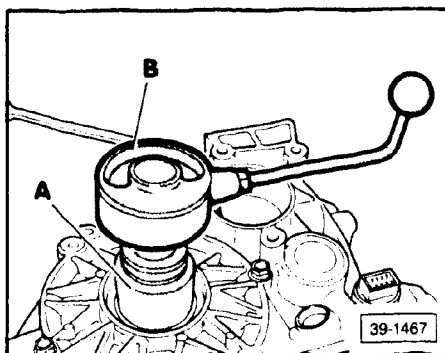
If only the **S4** shim thickness is to be redetermined, begin by checking turning torque.

- A** — torque wrench with range of 0-600 Ncm
(0-60 in. lb or 0-70 cm kg)
- B** — socket (41 mm)

Note

For **new** tapered roller bearings, the turning torque must be between 135-265 Ncm (11.9-23.4 in. lb or 13.7-27.0 cm kg)

For bearings with normal wear, measure turning torque before disassembly.



Differential – Automatic Transmission

S3 shim (actual), determining

Note

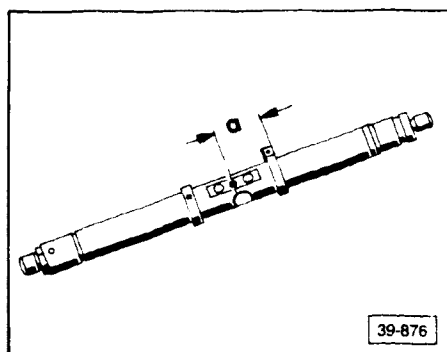
The **S3** shim thickness must be calculated using the equation:

$$S3 = +/ - e + k - r$$

Values for **e**, **k**, and **r** are given or measured, as follows:

Dimension e, measuring

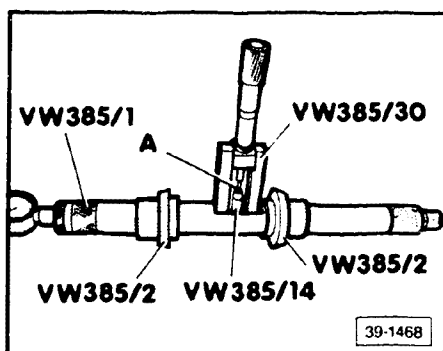
- set centering ring on universal measuring bar **VW 385/1** to distance **a** = 70 mm



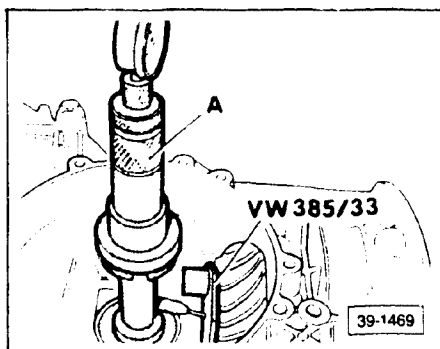
Note

If $R_o = 59.2$ mm:

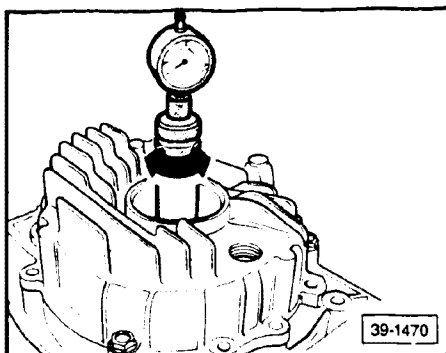
- assemble bar as shown
 - dial indicator extension **A** = 12 mm
 - **VW 385/30** = 59.2 mm
- set dial indicator to zero with 1 mm preload



- place end plate **VW 385/33** on pinion end face
- remove master gauge and install measuring bar **A** in housing
- install cover for final drive housing and tighten four bolts
- pull 2nd centering ring outward until measuring bar can just be turned by hand



Differential – Automatic Transmission



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

Example

e = 0.32 mm (red figures)

Dimension **k**, constant

k = 1.5 mm (**S3** test shim thickness)

Dimension **r**, determining

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

S3 shim (actual), calculating thickness

Note

Using values for **e**, **k** and **r** determined previously, calculate the following:

$$\mathbf{S3} = + / - \mathbf{e} + \mathbf{k} - \mathbf{r}$$

e is added within the equation if it was measured in the red range.

e is subtracted within the equation if it was measured in the black range.

Example

Dial indicator reading e	0.32 mm
S3 test shim k	1.50 mm
Deviation r	– 0.26 mm
S3 shim (actual) =	1.56 mm

Differential – Automatic Transmission

Note

Select shims from the following chart:

S3 shim thickness (mm)	Part number
1.05	097 409 141 AG
1.10	097 409 141 AJ
1.15	097 409 141 AL
1.20	097 409 141 AN
1.25	097 409 141 AQ
1.30	097 409 141 AS
1.35	097 409 141 BA
1.40	097 409 141 BC
1.45	097 409 141 BE
1.50	097 409 141 BG
1.55	097 409 141 BJ
1.60	097 409 141 BL
1.65	097 409 141 BN
1.70	097 409 141 BQ
1.75	097 409 141 BS
1.80	097 409 141 CA
1.85	097 409 141 CC

CAUTION

Part numbers are for reference only.
Always check with your Parts
Department for latest information.

S4 shim (actual), determining

Note

Calculate **S4** shim thickness, using the equation:

$$\mathbf{S4} = + / - \mathbf{e} + \mathbf{k} - \mathbf{r}$$

Values for **e**, **k** and **r** are given or determined, as follows:

Dimension **e**, measuring

e — dial indicator reading, i.e., maximum deflection (determined previously)

Differential – Automatic Transmission

Dimension k, determining

k — **S4** test shim, corrected value
(determined previously)

CAUTION

If only the **S4** shim is being redetermined, **k** = thickness of existing **S4** shim.

Dimension r, determining

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

S4 shim (actual), calculating

Note

Using values for **e**, **k** and **r** determined previously, calculate the following:

$$\text{S4} = +/- e + k - r$$

Note

e is added within the equation if it was measured in the red range.

e is subtracted within the equation if it was measured in the black range.

Example

Dial indicator reading e	0.32 mm
S4 test shim, corrected value k	1.20 mm
Deviation r	– 0.26 mm
S4 shim (actual) =	1.26 mm

Note

Select **S4** shim from the following chart. It may be necessary to install two **S4** shims, to arrive at specified thickness.

If a thicker **S3** shim is needed, a thicker **S4** shim must also be installed. A thinner **S3** shim will require a thinner **S4** shim.

Differential – Automatic Transmission

S4 shim thickness (mm)	Part number	S4 shim thickness (mm)	Part number
1.000	082 519 141 AA	1.525	082 519 141 BD
1.025	082 519 141 AB	1.550	082 519 141 BE
1.050	082 519 141 AC	1.575	082 519 141 BF
1.075	082 519 141 AD	1.600	082 519 141 BG
1.100	082 519 141 AE	1.625	082 519 141 BH
1.125	082 519 141 AF	1.650	082 519 141 BJ
1.150	082 519 141 AG	1.675	082 519 141 BK
1.175	082 519 141 AH	1.700	082 519 141 BL
1.200	082 519 141 AJ	1.725	082 519 141 BM
1.225	082 519 141 AK	1.750	082 519 141 BN
1.250	082 519 141 AL	1.775	082 519 141 BP
1.275	082 519 141 AM	1.800	082 519 141 BQ
1.300	082 519 141 AN	1.825	082 519 141 BR
1.325	082 519 141 AP	1.850	082 519 141 BS
1.350	082 519 141 AQ	1.875	082 519 141 BT
1.375	082 519 141 AR	1.900	082 519 141 CA
1.400	082 519 141 AS	1.925	082 519 141 CB
1.425	082 519 141 AT	1.950	082 519 141 CC
1.450	082 519 141 BA	1.975	082 519 141 CD
1.475	082 519 141 BB	2.000	082 519 141 CE
1.500	082 519 141 BC	2.025	082 519 141 CF
		2.400	082 519 141 DC

CAUTION

Part numbers are for reference only.
Always check with your Parts
Department for latest information.

Ring gear, adjusting

Note

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

- transmission housing
- differential cover
- differential bearing
- differential gear housing
- ring and pinion set

See Adjustment Overview, page 39.55.

With the **pinion removed**, adjust preload of the differential bearings by finding total shim thickness (i.e., **S1** + **S2**).

When selecting shims for test use or actual use, inspect shims for burrs or irregularities. Verify shim thickness at several sites around the circumference, using a micrometer.

S2 test shim, installing

- remove oil seals, outer races of differential bearings, and shims
 - install bearing outer race into transmission housing, along with 1.5 mm test shim (**S2**)
 - drive in to stop
- install differential into housing without speedometer gear
 - ring gear on left side (opposite cover side)

Differential – Automatic Transmission

Test shim total (i.e., $S1 + S2$), determining

Note

Total test shim thickness is calculated as follows:

$$S \text{ test total} = a + b + c$$

Values for **a**, **b** and **c** are given or determined as follows:

Dimension a, constant

$$a = 1.5 \text{ mm (S2 test shim thickness)}$$

Dimension b, measuring

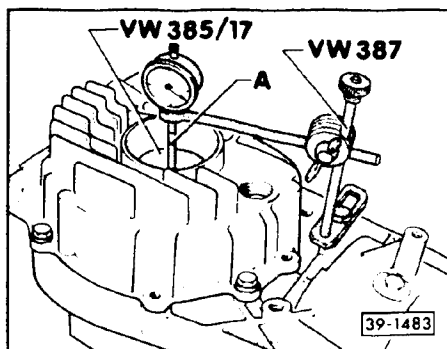
- attach measuring equipment, as shown
- zero dial indicator (3 mm range) with a 1 mm preload

A — dial indicator extension, 30 mm long

- move differential up and down to limits of travel, and note reading

Example

$$b = 0.60 \text{ mm}$$



CAUTION

Do not turn the differential when measuring, otherwise the bearings will settle and the gauge reading will be inaccurate.

Dimension c, constant

$$c = 0.40 \text{ mm (bearing preload)}$$

Differential – Automatic Transmission

Test shim total (i.e., S1 + S2), calculating

Note

Using values for **a**, **b** and **c** determined previously, calculate the following:

$$\text{S test total} = a + b + c$$

Example

S2 test shim a	1.50 mm
Dial indicator reading b	0.60 mm
Bearing preload c	+ 0.40 mm
S test total =	2.50 mm

S1 test shim, calculating

Note

Using values determined previously, calculate the following:

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

Example

S test total	2.50 mm
S2 test shim (constant)	- 1.50 mm
S1 test shim =	1.00 mm

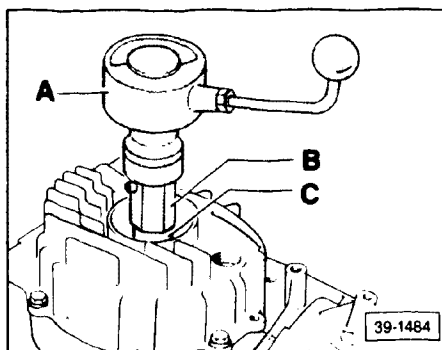
Differential bearings, measuring turning torque

- A** — commercial torque wrench 0-600 Ncm (0-55 in. lb or 0-65 cm kg)
- B** — locking sleeve, **VW 521/4**
- C** — bushing, **VW 521/8**

- lubricate bearing with transmission oil
- check that turning torque equals:
 - new bearings = 70-150 Ncm (6.2-13.3 in. lb or 7.1-15.3 cm kg)
 - used bearings = 20-40 Ncm (1.8-3.5 in. lb or 2.1-4.0 cm kg)

Note

Whenever the gear set is adjusted, adjust inspect the pinion, also. See page 39.63.



Differential – Automatic Transmission

Backlash, determining

- install pinion with adjustment shims **S3** and **S4** installed (thicknesses determined previously)
- install differential
- turn differential several times in both directions to seat bearings
- attach measuring equipment
- adjust measuring lever **VW 388** to $a = 70 \text{ mm}$
- while holding pinion from moving, turn ring gear to stop and set indicator to zero
- turn ring gear back and note backlash

Note

If pinion turning torque is too low, install separation device **Kukko 17/1**.

Average backlash b , calculating

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

CAUTION

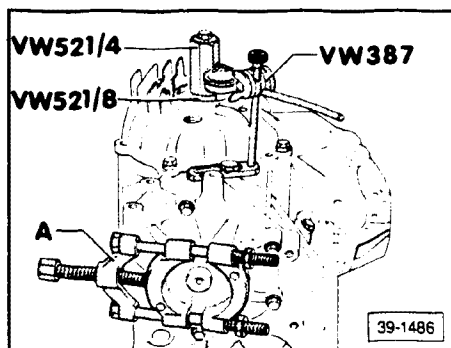
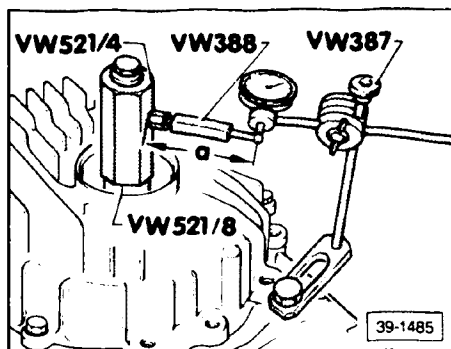
If the measured readings differ from one another by more than 0.06 mm, there is incorrect fitting of the ring gear or the gear set itself. Recheck installation procedures. If necessary, replace gear set.

Example

1st measurement	0.49 mm
2nd measurement	0.48 mm
3rd measurement	0.50 mm
4th measurement	0.49 mm

Total 1.96 mm

Average backlash $b = 1.96 \text{ mm} : 4 = 0.49 \text{ mm}$



Differential – Automatic Transmission

S2 shim (actual), determining

Note

Calculate thickness of **S2** shim, in the equation:

$$\mathbf{S2} = \mathbf{a} - (\mathbf{b} \times \mathbf{c}) + \mathbf{d}$$

Values for **a**, **b**, **c** and **d** are given or measured, as follows:

Dimension a, constant

$$\mathbf{a} = 1.5 \text{ mm (S2 test shim)}$$

Dimension b, measuring

Note

b — value of average backlash calculated previously

Dimension c, constant

$$\mathbf{c} = 1.17 \text{ mm}$$

Dimension d, constant

$$\mathbf{d} = 0.20 \text{ mm (the lift)}$$

S2 shim (actual), calculating

Note

Using values for **a**, **b**, **c** and **d** determined previously, calculate the following:

$\mathbf{S2} = \mathbf{a} - (\mathbf{b} \times \mathbf{c}) + \mathbf{d}$
--

Example

S2 test shim a	1.50 mm
Average backlash b x constant c (0.49 mm x 1.17 mm)	– 0.57 mm
Lift value d	+ 0.20 mm
S2 shim (actual) =	1.13 mm

Note

Select shim(s) from chart on page 39.77.

Differential – Automatic Transmission

S1 shim (actual), calculating

Note

Using values determined previously, calculate the following:

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

Example

S test total	2.50 mm
S2 shim (actual)	– 1.13 mm
S1 shim (actual) =	1.37 mm

Note

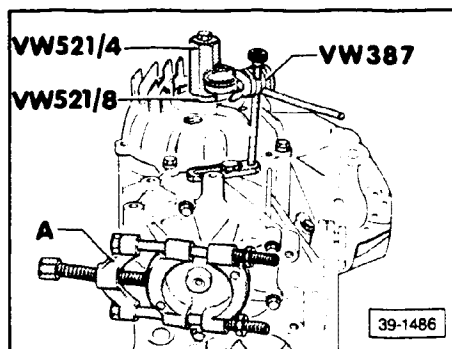
Select **S1** and **S2** shims from the following chart. (It may be necessary to install two shims each, to arrive at the specified thickness.)

S1 and S2 shim thickness	Part number
0.55	097 409 298 AE
0.60	097 409 298 AG
0.65	097 409 298 AJ
0.70	097 409 298 AL
0.75	097 409 298 AN
0.80	097 409 298 AQ
0.85	097 409 298 AS
0.90	097 409 298 BA
0.95	097 409 298 BC
1.00	097 409 298 BE

CAUTION

Part numbers are for reference only.
Always check with your Parts
Department for latest information.

Differential – Automatic Transmission



Backlash, checking

- measure backlash four times around circumference of ring gear, after installing shim **S1** and **S2**
 - acceptable values can range from 0.15-0.25 mm
 - no two values can deviate **from each other** by more than 0.05 mm