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016 Front Wheel Drive

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Turning torque

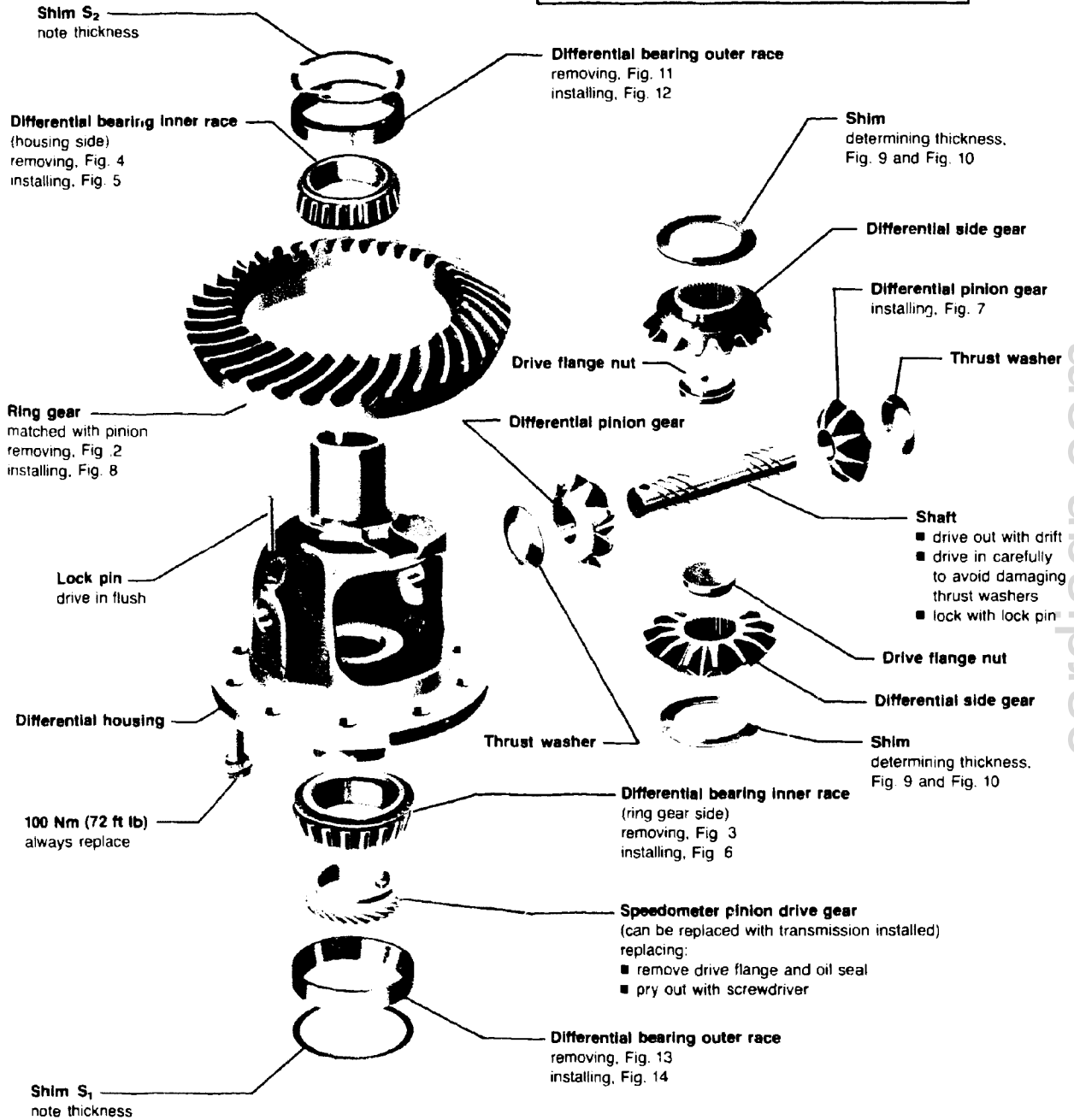
- measuring 39.15

Differential – Manual Transmission

CAUTION

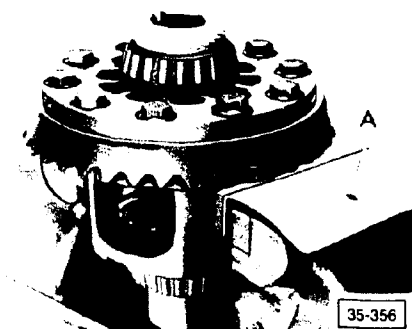
If differential bearings are replaced, readjust pinion and ring gear.

Always replace both differential bearings.



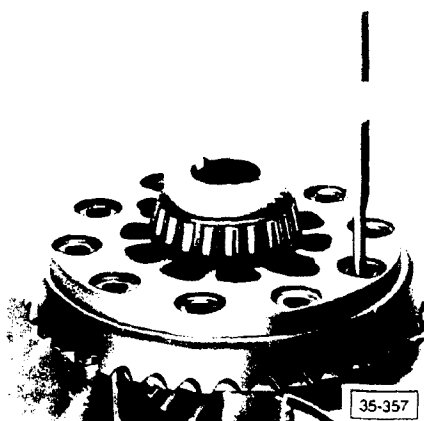
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Differential – Manual Transmission

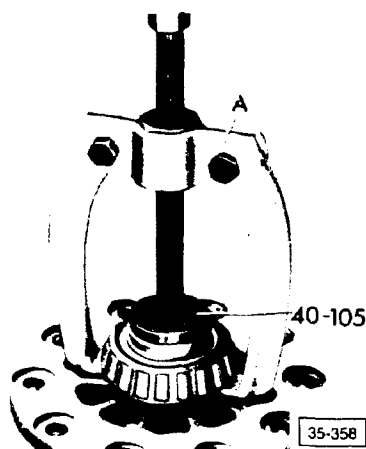


► Fig. 1 Differential housing, disassembling

- use soft jaw covers A

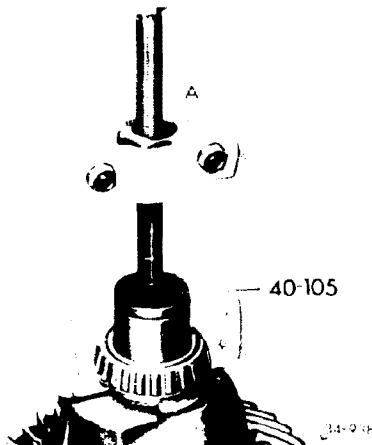


► Fig. 2 Ring gear, removing

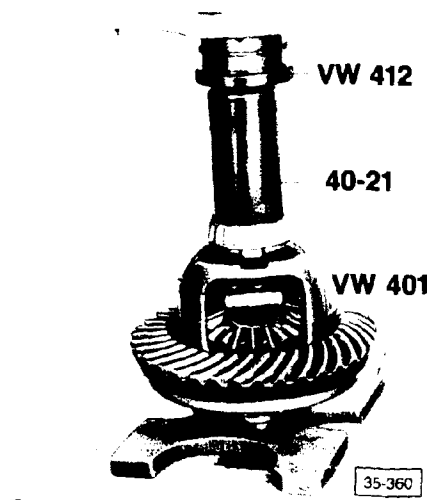


► Fig. 3 Differential bearing inner race (ring gear side), removing

- disassemble puller to insert jaws

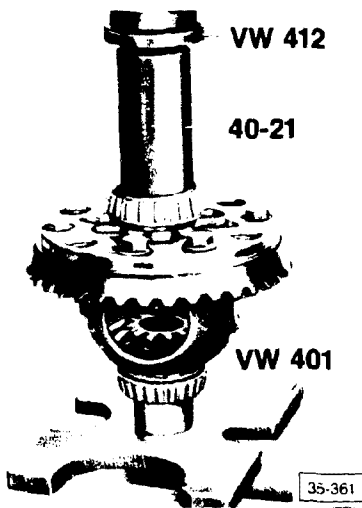


► Fig. 4 Differential bearing inner race (housing side), removing



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

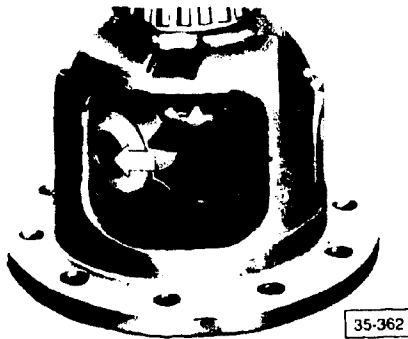
- heat to approximately 100°C (212°F)
- slide on housing and press on



► Fig. 6 Differential bearing inner race (ring gear side), installing

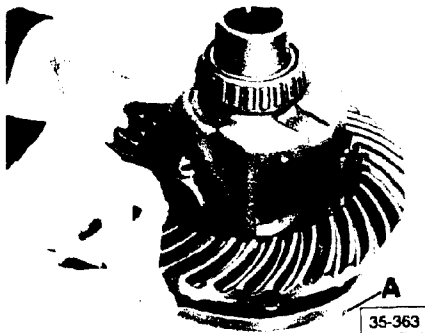
- heat to approximately 100°C (212°F)
- slide on housing and press on until fully seated

Differential – Manual Transmission



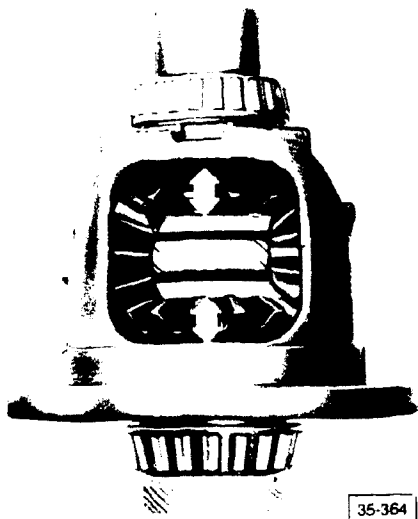
► Fig. 7 Differential pinion/side gears, installing

- lubricate all parts with transmission oil
- install side gears with correct shims (see Fig. 9 and Fig. 10)
- install pinion gears offset 180°
 - stick thrust washers to gears with grease and position by turning
- align thrust washers and gears and insert shaft
- lock shaft with lock pin



► Fig. 8 Ring gear, installing

- heat to approximately 100°C (212°F)
- insert centering pins A (local manufacture)
- install ring gear



► Fig. 9 Differential pinion/side gears, adjusting

- install side gears with thinnest shims (0.5 mm)
- insert pinion gears with thrust washers and position by turning
- install pinion gear shaft

Note

Side gears, pinion gears and thrust washers must not be interchanged.

- press pinion gears outward and check play of side gears (**arrows**)

Note

Adjustment is correct if no play can be felt by hand, but differential gears can be turned easily without binding, see Fig. 10.

Differential – Manual Transmission

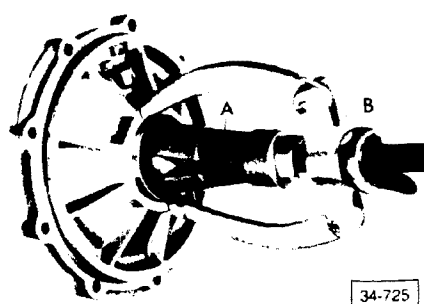
Shims available

Thickness (mm)	Part Number
0.5	011 519 215
0.6	088 409 249
0.7	088 409 249A
0.8	088 049 249B

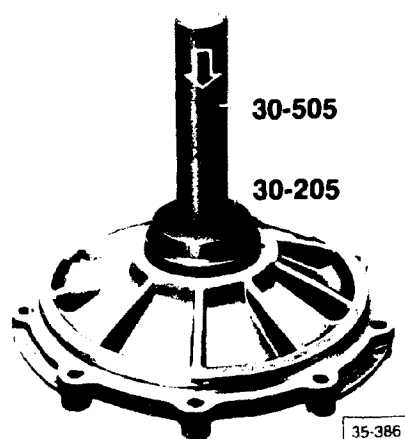


► Fig. 10 Differential pinion/side gears, checking

- turn drive flange in direction of **arrow**.
Flange must turn easily without binding



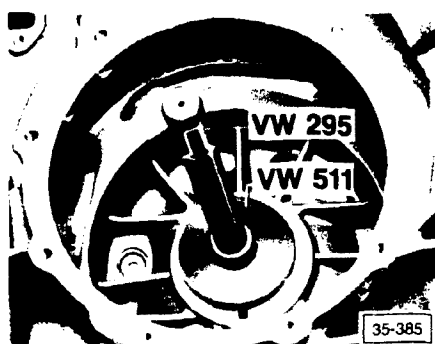
► Fig. 11 Differential bearing outer race in final drive housing cover, removing



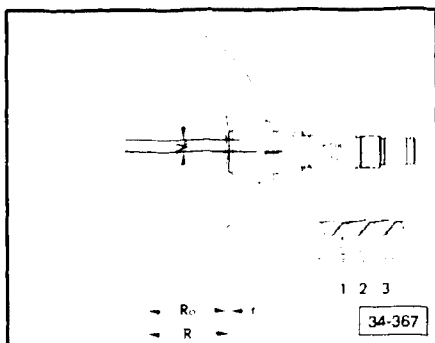
► Fig. 12 Differential bearing outer race in final drive housing cover, installing



► Fig. 13 Differential bearing outer race in final drive housing, removing



► Fig. 14 Differential bearing outer race in final drive housing, installing



Ring gear/pinion, adjustment

Note

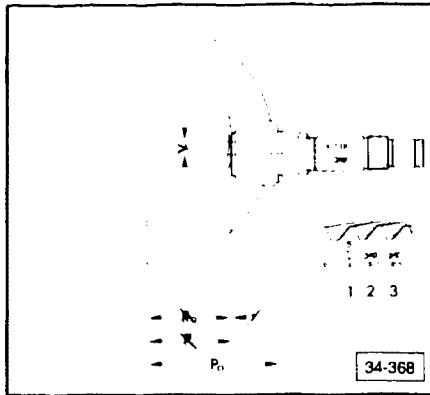
Ring gear/pinion must always be replaced as a matched set, never individually.

Ring gear and pinion markings

Spare parts gears

- 1 — Marking **K7/38** means Klingelnberg gear set with ratio of 7/38 teeth
- 2 — Matching number of gear set (312)
- 3 — Deviation **r** based on master gauge used in special test machine in production. Deviation **r** is always given in 1/100 mm. **25** shown in example means that $r = 0.25$ mm
- Ro** — Length of master gauge in production:
Ro = 59.65 mm
- R** — Actual dimension between ring gear centerline and end face of pinion at quietest running point for this gear set
- Vo** — Hypoid offset = 12 mm

Differential – Manual Transmission



CAUTION

Maximum possible care and cleanliness during all assembly and measuring operations are essential if results are to be satisfactory.

Production gears

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

Po — Setting dimension for production gears

CAUTION

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

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

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Differential – Manual Transmission

Ring gear/pinion, adjustment

When working on final drive it is only necessary to adjust pinion, ring gear, or both if parts which directly influence setting of final drive have been replaced. See table to avoid unnecessary adjustments.

Part replaced	To be adjusted: Ring gear ($S_1 + S_2$) (see page 39.14)	Pinion ($S_3 + S_4$) measured with deviation r (see page 39.10)	Pinion ($S_3 + S_4$) measured with actual dimension (see page 39.9)	Pinion shim S_4 only (see page 39.12)
Final drive housing	X		X	
Gear carrier				X
Differential housing	X			
Pinion bearings			X	
Differential bearings	X			
Ring gear and pinion	X	X		
Final drive cover	X			

Finding position of pinion (actual dimension)

Finding position of pinion is only necessary when deviation r is not marked on ring gear and parts are to be replaced which directly influence position of pinion. These are: **Both pinion bearings and final drive housing.**

- remove differential housing
- assemble measuring bar as described on page 39.11
- place it in final drive housing and measure differential from **Ro**. The measurement corresponds with deviation r . Note reading
- after installing new parts, adjust pinion as described on page 39.86. Deviation r as measured is used to determine thickness of shim S_3



Position of shims

- S_1 — ring gear side
- S_2 — cover side
- S_3 — behind pinion
- S_4 — opposite pinion

Pinion, adjusting

Ring gear pinion needs adjusting if it has been replaced. If other parts which affect position of pinion are to be replaced, setting must be measured before disassembling and pinion set to this dimension when assembling.

Finding total shim thickness ($S_3 + S_4$) (adjusting preload of pinion bearings)

- install bearing outer races in houses and gear carrier **without** shims
- install assembled pinion into final drive housing and fit gear carrier
- tighten bolts to 25 Nm (18 ft lb)
 - **A** = extension, approximately 30 mm
- install dial gauge (3 mm range)
- zero dial gauge with 1 mm preload
- take gauge reading by moving pinion up and down

Example:

1.30 mm

CAUTION

Do not turn pinion, otherwise bearings will settle and make measurement inaccurate.

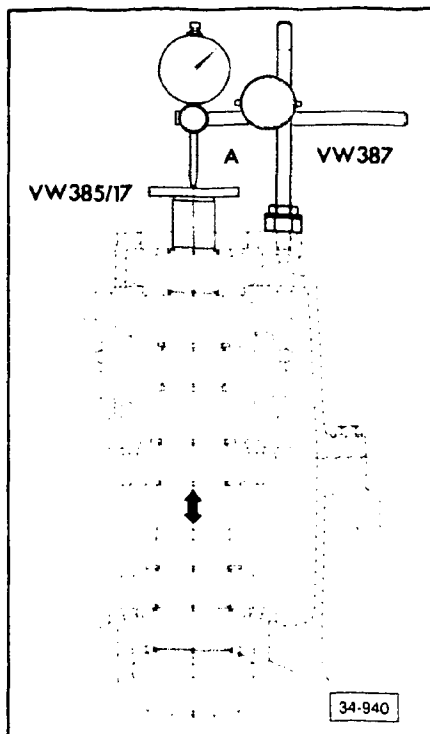
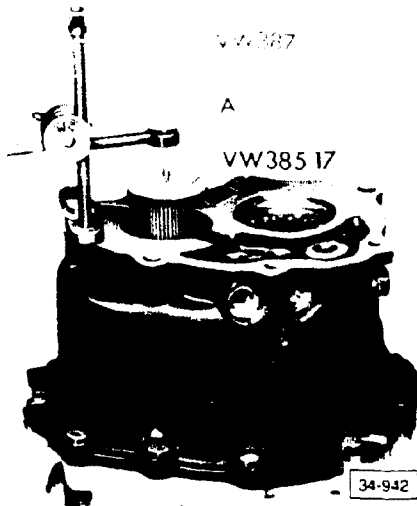
- remove gear carrier

Total shim thickness ($S_3 + S_4$)

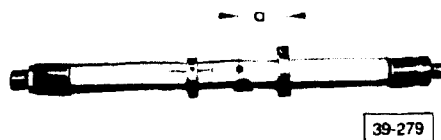
$$S_3 + S_4 = \text{Dial gauge reading} + \text{preload}$$

Example

Preload	0.30 mm
(constant value)	
Measurement	+ 1.30 mm
$S_3 + S_4$	= 1.60 mm



Differential – Manual Transmission

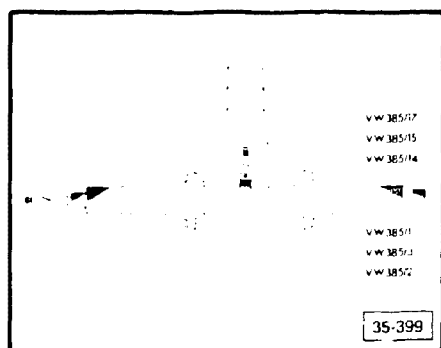
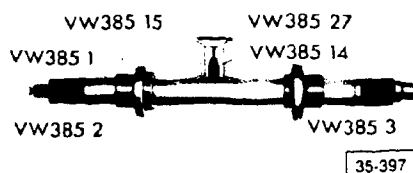


Shim S_3 , determining thickness (distance e)

- place total thickness of shims ($S_3 + S_4$) (example: 1.60 mm) behind bearing outer race in gear carrier (S_4 end)
- install gear carrier again and turn pinion in both directions several times
- adjust setting ring on measuring bar **VW 385/1** to dimension a
 - a = approximately 50 mm



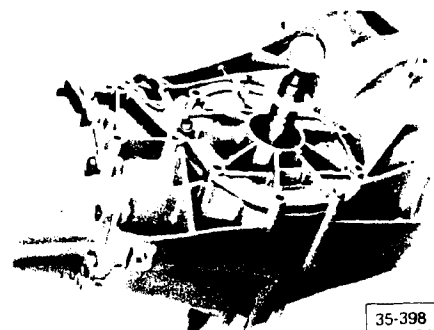
- assemble bar as shown, using extension **VW 385/15 = 9.3 mm** long



- place setting gauge **VW 385/27** ($R_o = 59.65$ mm) on bar and zero dial gauge (3 mm range) with 1 mm preload

Note

Move adjustable setting ring back to stop.



- place measuring plate **VW 385/17** on end of pinion
- remove setting gauge and place bar in differential housing with centering disc **VW 385/2** facing final drive cover
- install final drive cover and secure with 4 bolts

Differential – Manual Transmission

- move 2nd centering ring outwards with adjustable setting ring until bar can just be turned by hand
- turn bar until measuring pin touches plate on pinion and needle shows maximum deflection (return point): reading is dimension **e**

Example:

$$e = 0.46 \text{ mm}$$

Shim S_3 , determining thickness

$$S_3 = e + r$$

e = Measured figure (maximum deflection)

r = Deviation (marked on ring gear in 1:100 mm)

Example

Dial gauge reading for e	0.46 mm
Deviation r	– 0.18 mm
S₃ shim thickness	= 0.64 mm

Shims available

Thickness (mm)	Part Number
0.20	088 311 391
0.25	088 311 391A
0.30	088 311 391B
0.35	088 311 391C
0.40	088 311 391D
0.65	088 311 391E
0.90	088 311 391F
1.15	088 311 391G

Note

Shim thicknesses make it possible to select any required thickness for **S₃**.

Measure shims at several points with micrometer and check for burrs and damage.

Use only shims which are in good condition.

Differential – Manual Transmission

Shim S_4 , determining thickness

$$S_4 = S_{\text{total}} - S_3$$

Example

S_3 total	1.60 mm
S_3 shim thickness	- 0.64 mm
S_4 shim thickness	= 0.96 mm

Shims available

Thickness (mm)	Part Number
0.24	016 311 393
0.27	016 311 393A
0.30	016 311 393B
0.33	016 311 393C
0.36	016 311 393D
0.39	016 311 393E
0.42	016 311 393F
0.45	016 311 393G
0.69	016 311 393H
0.93	016 311 393J
1.17	016 311 393K
1.41	016 311 393L

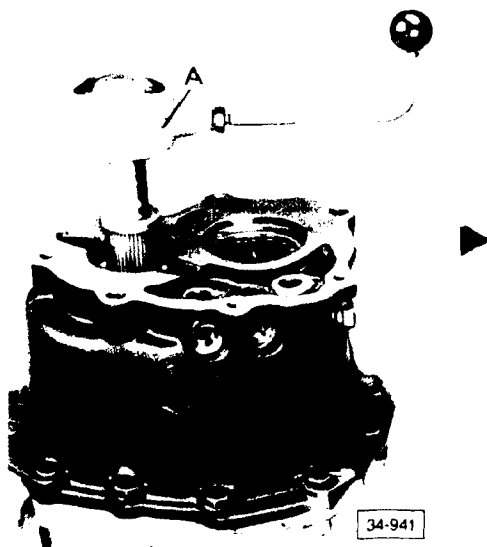
Adjustment, checking

Checking dimension r

- install pinion with measured shims S_3 and S_4 and turn several times in both directions
- place measuring bar in position and check measurements
- if shims have been selected correctly, dial gauge, reading counterclockwise, should show deviation r within tolerance of 0.04 mm

Pinion bearings, checking preload

- A = torque gauge
(range 0-60 cmkg 0-60 in. lb)
- before checking turning torque of pinion bearings lubricate bearings with transmission oil
 - new bearings = 20-40 cmkg (117-34 in. lb)
 - used bearings = 3-6 cmkg (2.6-5.2 in. lb)

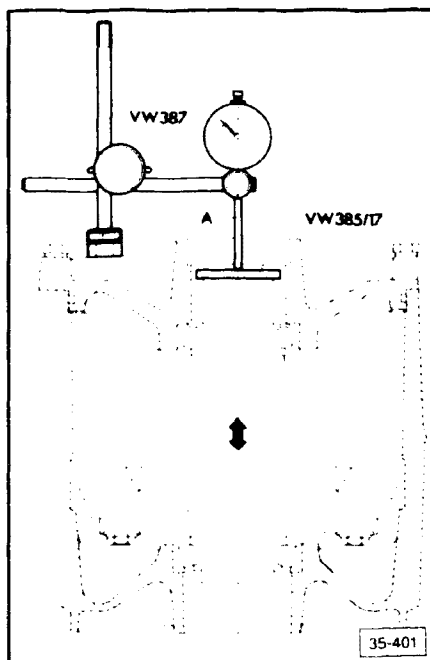
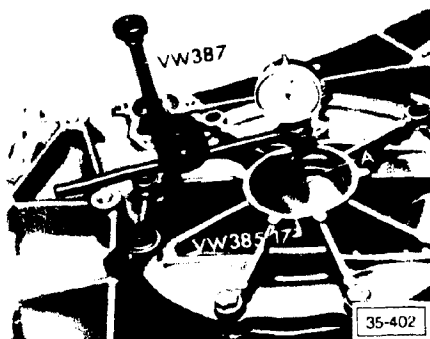


Differential – Manual Transmission

Ring gear, adjusting

Ring gear must be adjusted if transmission housing final drive cover, differential bearings, differential housing or ring gear and pinion have been replaced.

- finding total shim thickness ($S_1 + S_2$) (adjusting preload of differential bearings)
- remove pinion
- remove differential oil seals and bearing outer races and take out shims
- seat bearing outer races without shims
- install differential without speedometer drive gear. Ring gear is opposite side from final drive cover
- fit cover and tighten bolts diagonally to **25 Nm (18 ft lb)**
- install dial gauge
 - extension **A** = approximately **30 mm**
- zero dial gauge (3 mm range) with 1 mm preload



- move differential up and down and note dial gauge reading

Example

1.42 mm

CAUTION

Do not turn differential otherwise bearings will settle and make measurements inaccurate.

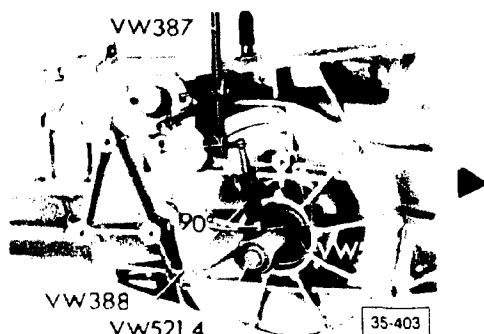
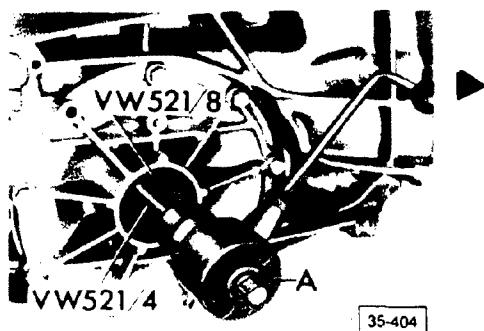
S total = $S_1 + S_2$ measured figure + preload

Example

Preload (constant value)	0.50 mm
Measurement	+ 1.42 mm
S total	= 1.92mm

- install shims $S_1 + S_2$ (1.92 mm for example) behind outer race in final drive cover

Differential – Manual Transmission



Turning torque, measuring

- **A** = Torque gauge
(range 0-60 cmkg/0-60 in. lb)
- before measuring turning torque of differential bearings lubricate bearings with transmission oil
 - new bearings = **250 Ncm**
 - used bearings = **30 Ncm**

Backlash, adjusting

- install pinion with **S₃** and **S₄** shims
- install differential with (**S₁ + S₂**) shims installed on cover side
- turn differential several times to settle bearings
- attach dial indicator
 - distance **a** = **79 mm (3.11 in.)**
- turn ring gear to stop, zero dial indicator, turn ring gear back and take reading. Note backlash
- turn ring gear 90° each time and take three more readings. Add four readings together to find average

Finding average backlash

Example

1st reading	0.84 mm
2nd reading	0.85 mm
3rd reading	0.84 mm
4th reading	0.83 mm
Total	= 3.36 mm
divided by	÷ 4
average backlash	= 0.84 mm

Note

If readings obtained in this check vary by more than **0.06 mm (0.002 in.)** there is something wrong with installation of ring gear or final drive set itself. Check all assembling operation and replace final drive set if necessary.

Differential – Manual Transmission

Shim S_2 , determining thickness
(cover side)

$$\begin{aligned} S_2 &= S \text{ total} \\ &\quad - \text{average backlash} \\ &\quad + \text{lift (constant value)} = 0.15 \text{ mm} \end{aligned}$$

Example

S total	1.92 mm
minus backlash	- 0.84 mm
	= 1.08 mm
plus lift	+ 0.15 mm
S_2	= 1.23 mm

Shims available

Thickness (mm)	Part Number
0.15	113 517 201A
0.20	113 517 202A
0.30	113 517 203A
0.40	113 517 204A
0.50	113 517 205A
0.60	113 517 206A
0.70	113 517 207A
0.80	113 517 208A
0.90	113 517 209A
1.00	113 517 210A
1.20	113 517 211A

Shim thicknesses make it possible to select any required thickness.

Differential – Manual Transmission

Shim S_1 , determining thickness
(ring gear side)

$$S_1 = S_{\text{total}} - S_2$$

Example

S total	1.92 mm
minus S_2	– 1.23 mm
S_1	= 0.69 mm

Shims available

Thickness (mm)	Part Number
0.15	018 409 381
0.20	018 409 383
0.25	018 409 385
0.50	018 409 387
0.80	018 409 389
1.00	018 409 391
1.50	018 409 393

Shim thicknesses make it possible to select any required thickness.

Backlash, checking

Measure backlash at four points. It should be:

- 0.10-0.20 mm (0.004-0.008 in.)

Note

Individual readings must not differ by more than 0.05 mm (0.001 in.).