

Workshop Manual

928

DR. ING. h. c. F. PORSCHE Aktiengesellschaft

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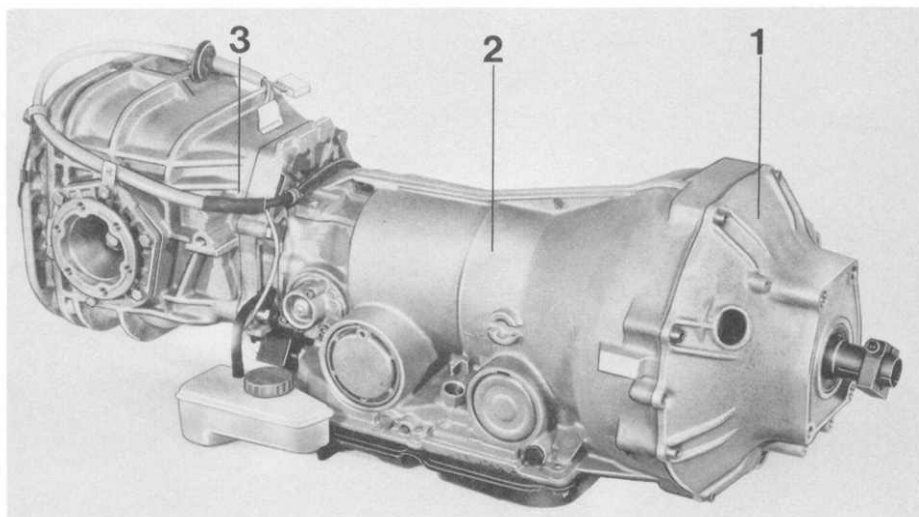
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4 - SPEED AUTOMATIC TRANSMISSION (UP TO '86 MODELS)



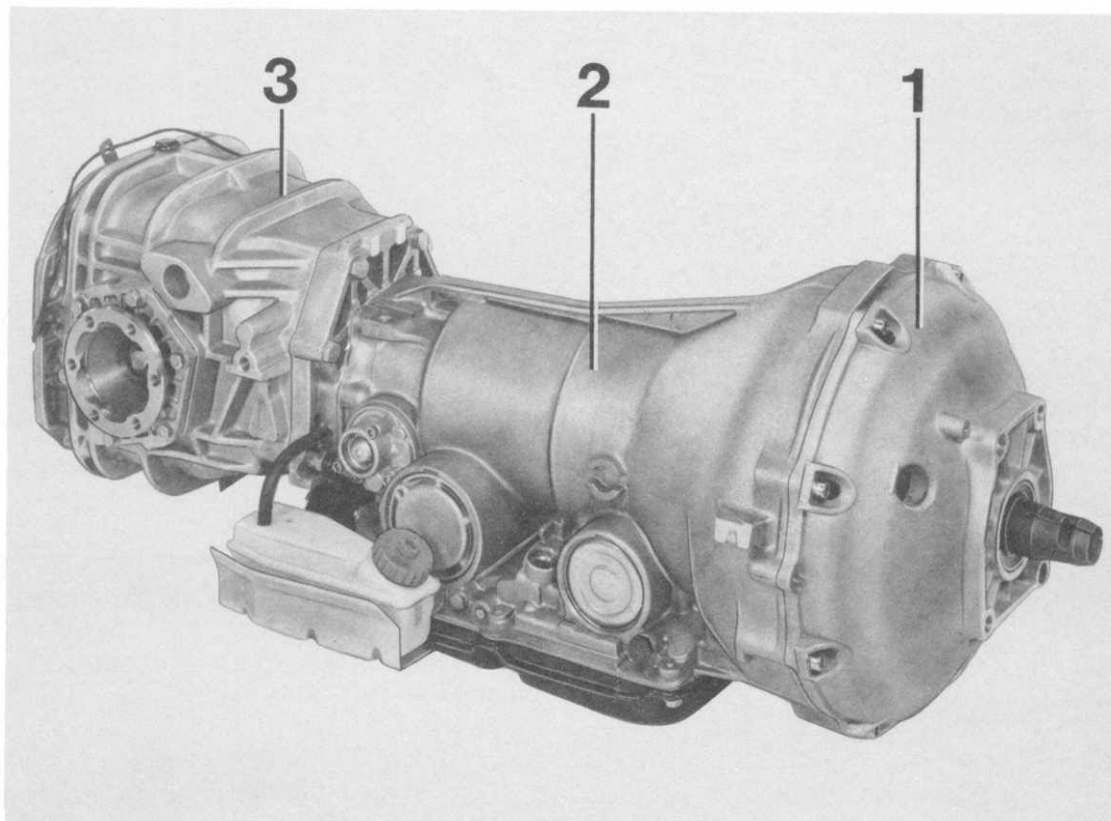
1 - Front converter casing
3 - Final drive

2 - Automatic transmission

Transmission Type	installed in
A 28.01	928 S, USA series / '83 and '84 models for Japan
A 28.02	928 S, Special option for Europe / rest of the world, '84 models
A 28.03	928 S, Special option (M 251) Europe / rest of the world 3/84 onward (as 28.02, but rear axle transmission ratio 13 : 33)
A 28.04	928 S, USA series / '85 models for Japan
A 28.05	928 S, Special option Europe / '85 models rest of the world
A 28.06	928 S, Special option (M 251) Europe / '85 models rest of the world (as A 28.05, but with rear axle transmission ratio 13 : 33)
A 28.07	928 S, USA series / '86 models for Japan
A 28.08	928 S, Special option Europe / '86 models rest of the world
A 28.09	928 S, Special option (M 251) Europe / '86 models rest of the world (as A 28/08, but with rear axle transmission ratio (13 : 33)
A 28.11	928 S, Australia series, special option (M 299) for FGR, Switzerland, Austria, Sweden ('86 models)

Technical Data

4-speed automatic transmission ('87 models onward)



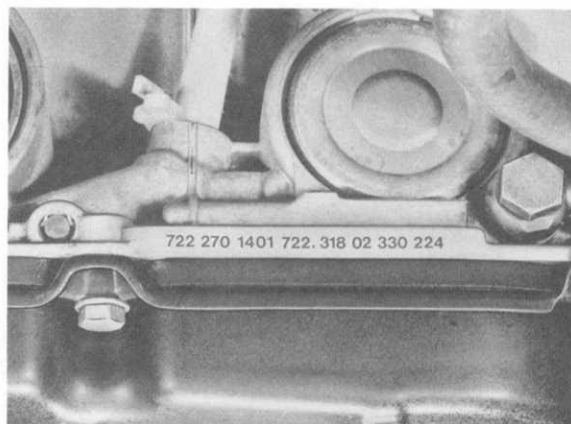
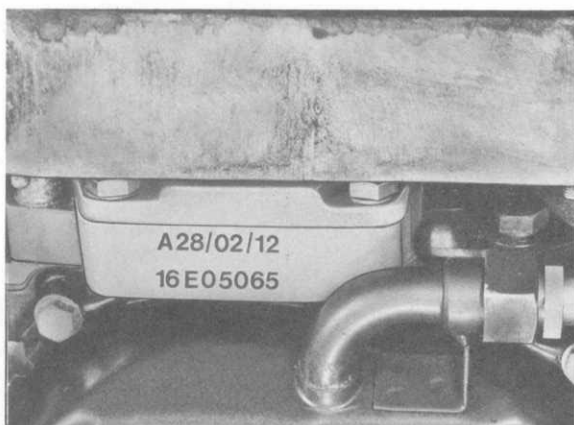
1 - Front converter casing
3 - Final drive

2 - Automatic transmission

Type	Key-number	Equipment	installed in	model
A28.12	—	4 speed	928 S 4 USA/Jap.	87/88
A28.14	—	4 speed	928 S 4 R.d.W.	87/88
A28.16	—	4 speed	928 S 4 worldwide	89/90/91
A28.18	—	4 speed	928 GTS worldwide	92/93

Technical Data

Transmission Designation



A 28 02 12 1 6 E 05065

Serial number	E 05065
year of manufacture	E
D = 1983 E = 1984 F = 1985 G = 1986 H = 1987	E
Type	6
1 = 5 - speed transmission 6 = Automatic	6
Transmission for 8 cylinder vehicles	1
Limited-slip differential 40 %	12
Country code	02
Transmission type	28
A 28 = four speed automatic A 22 = three-speed automatic G 28 = five-speed manual transmission	A 28

Product Number Combinations:

722 270 12 01 722 316 02...= A 28.01
 722 270 14 01 722 318 02...= A 28.02/03
 722 270 17 01 722 316 02...= A 28.04
 722 270 18 01 722 318 02...= A 28.05/06
 722 270 21 01 722 318 02...= A 28.08/09

722 270 25 01 722 316 02...= A 28.07
 722 270 26 01 722 316 02...= A 28.11
 722 270 21 01 722 326 02...= A 28.12/14
 722 270 32 01 722 360 03...= A 28.16
 722 270 34 01 722 360 03...= A 28.18

Technical Data

Transmission numbers (12 digits)

A2814	1	J	00903
Transmission type	Index for variants within the assembly number	Model year	Serial number e.g. 00903
	0 = no differential 1 = normal differential 2 = ZF limited slip differential 3 = proportional slip differential	J = 1988 K = 1989 L = 1990 M = 1991	

Note:

As from model '88, the gear box number will be readable from below, stamped on the rear stiffening rib of the rear-axle housing

* As of MY '92, the model letter is omitted.

General data	A28.01/04/07/12	A28.02/03/05/06/08/09/11/14/16/18
Design	Fully automatic 4-speed sun-and-planet transmission	
Ratios		A 28/16
1st gear	3,68	3,87
2nd gear	2,41	2,25
3rd gear	1,44	1,44
4th gear	1,00	1,00
Rückwärtsgang	5,14	5,59
Final drive	Drive pinion without hypoid displacement	
Final drive ratio	15 : 33 i = 2,200	14 : 33 i = 2,357 (A 28.02/05/08) 13 : 33 i = 2,538 (A 28.03/06/09/ 11/14/16/18)
(Stall speed)	A 28.01 = 2200...2600rpm	A 28.02/03/05/06/08/09/11 = 2200...2600rpm
	A 28.04/07 = 1650...2050rpm	A 28.14/16/18 = 1750...2150rpm
	A28.12 = 1750...2150rpm	
Capacity, rear axle final drive	up to MY '86 = approx. 2.7 l from MY '87 to '90 = approx. 3.0 l MY '91 = 2.3 l* as of MY '92 = 1.9 l	
Oil grade	Multigrade transmission oil 75 W 90 to MIL - L 2105 B or API classification GL5	
Capacity, auto. unit with converter	Total capacity = approx. 8.01 ('87 models onward, approx. 9.31). Capacity for fluid change with converter = approx. 6.01 ('87 models onward, approx. 7.31) ATF Dexron II D.	

* refer to Technical Information No. 1/91 of 08.3.91

TIGHTENING TORQUE FOR AUTOMATIC TRANSMISSION

Location	Description	Threads	Material	Torque Nm (ftlb)
Primary pump to front cover	Bolt	M 8	8.8	20 (14)
Plug (converter)	Bolt	M 10 x 1	10.9	14 (10)
Front cover to transmission case	Bolt	M 8	8.8	13 (9)
Support flange to transmission case	Bolt	M 6	10.9	11 (8)
Plug (brake band B 1 mount)	Plug	M 27 x 1.5	—	70 (51)
Catch plate on range selector shaft	Bolt	M 6	8.8	8 (6)
Leaf spring to transmission case	Bolt	M 6	8.8	8 (6)
Starter interlock and backup light switch to transmission case	Bolt	M 6	8.8	8 (6)
Range selector lever to shaft	Bolt	M 6	8.8	8 (6)
Secondary pump to transmission case	Bolt	M 6	8.8	8 (6)
Governor axial hold on shaft	Nut	M 6	8	6 (4.3)

TIGHTENING TORQUE FOR AUTOMATIC TRANSMISSION

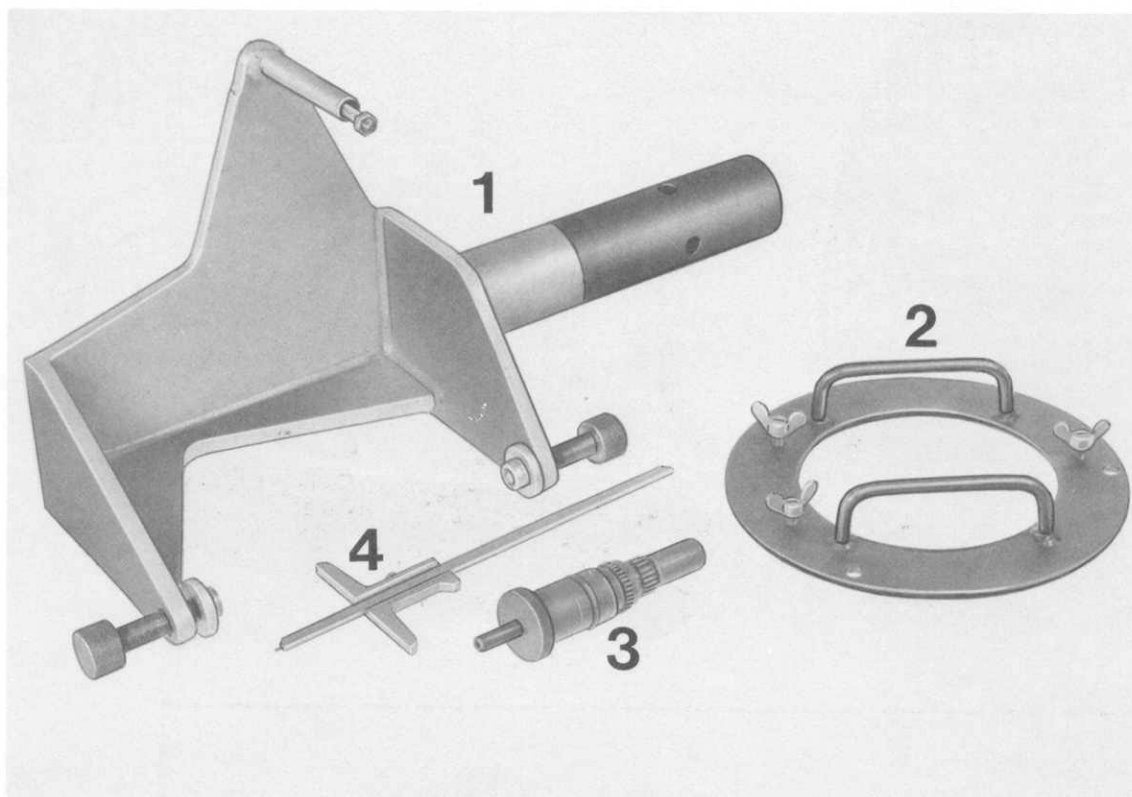
Location	Description	Threads	Material	Torque Nm (ftlb)
Lower cover with reinforcement plate	Bolt	M 5	5.8	4 (3)
Lower cover assy. to transmission case	Bolt	M 6	8.8	8 (6)
Plug (test connection for modulating, governor and operating pressure)	Plug	M 8 x 1	—	13 (9)
Vacuum unit bracket	Bolt	M 6	8.8	8 (6)
Kickdown solenoid valve	Solenoid	M 14 x 1.5	—	20 (14)
End plate on valve body housing	Bolt	M 4	8.8	3.3 (2.3)
End plate on drive housing	Bolt	M 4	8.8	3.3 (2.3)
Drive housing to valve body housing	Bolt	M 5	4.8	0.15 (0.11)
Valve body housing to transmission	Bolt	M 6	8.8	8 (6)
ATF filter to lower cover	Bolt	M 5	8.8	4 (3)

Tightening torques (automatic transmission)

Location	Thread	Tightening Torque Nm (ftlb)
Threaded plug (ATF pan)	M 10 x 1	22 (12)
ATF pan to transmission case	M 8	8 (5.9)
Front converter casing to transmission case	M 8	23 (17)
Carrier plate to converter	M 8	46 (34)
Rear transmission cas to transmission case	M 10	42 (31)
Bearing assembly to rear transmission case	M 8	33 (24)
Final drive to transmission case	M 10	46 (34)
Collar nut (drive pinion)	M 26 x 1.5	380* (280)
ATF filler tube to ATF pan	M 24	78 (58)
ATF reservoir to ATF pan	M 6	6 (4.4)

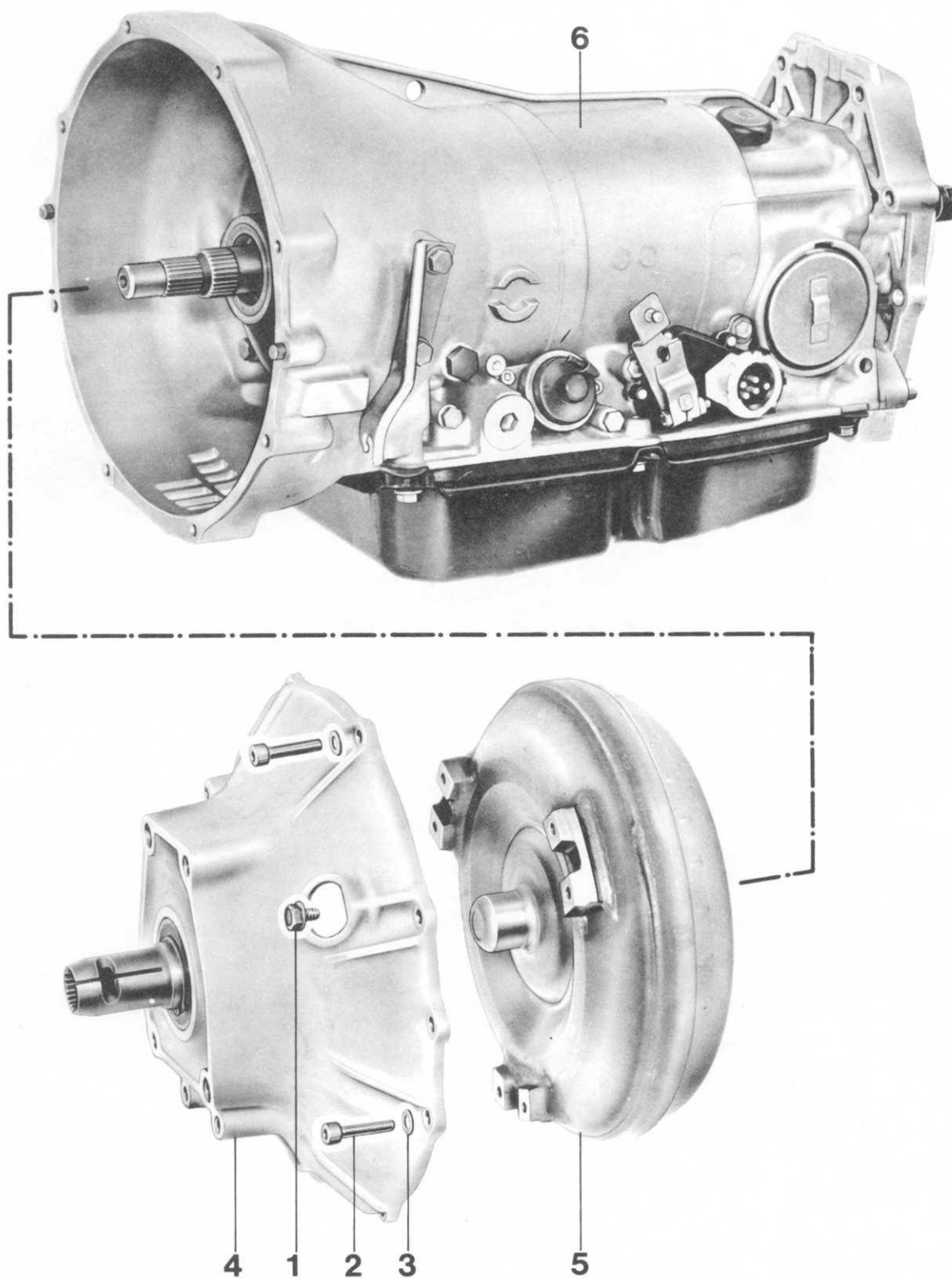
* As of MY '92 (transmission type A28.18) = 450 Nm (332 ftlb).

TOOLS



No.	Description	Special Tool	Remarks
1	Transmission holder	9216	Standard tool
2	Grip plate	9301	
3	Mandrel	9310	
4	Depth gauge	—	

REMOVING AND INSTALLING TORQUE CONVERTER

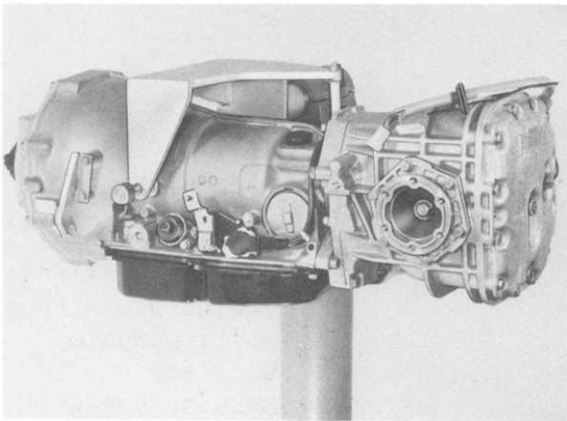


No.	Description	Qty.	Note When:	
			Removing	Installing
1	Mounting bolt	6		Tightening torque: 46 Nm (34 ftlb)
2	Panhead bolt	8		Tightening torque: 23 Nm (17 ftlb)
3	Washer	8		
4	Front converter casing	1		
5	Torque converter	1		Renew if badly worn or if particles are found in ATF. Lubricate drive flange and bearing pin with MoS ₂ multi-purpose grease. Place transmission upright and insert carefully using Special Tool 9301. Note installation depth.
6	Automatic transmission	1		

NOTES ON REMOVING AND INSTALLING

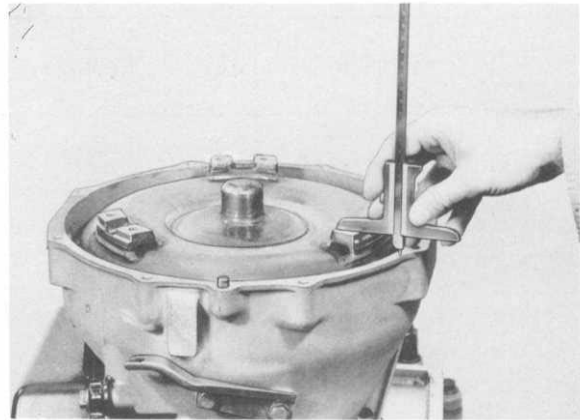
Removing

1. Remove transmission.
2. Using Special Tool 9216, attach transmission to assembly support.

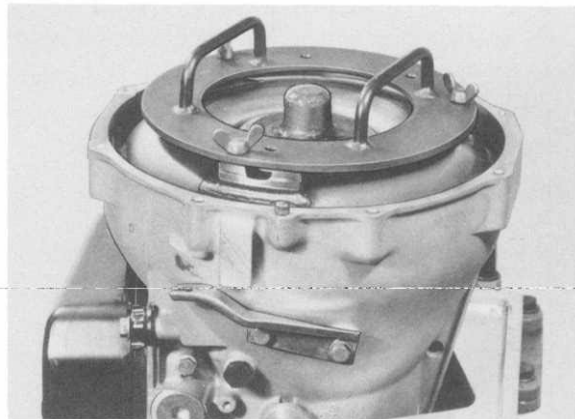


3. Place transmission upright and working through the openings in the converter casing, remove converter mounting bolts.
4. Remove mounting bolts for converter casing and remove casing.
5. Measure installation depth of converter and make a note for reassembly.

Up to '86 models = approx. 16 mm
'87 models onward = approx. 28 mm



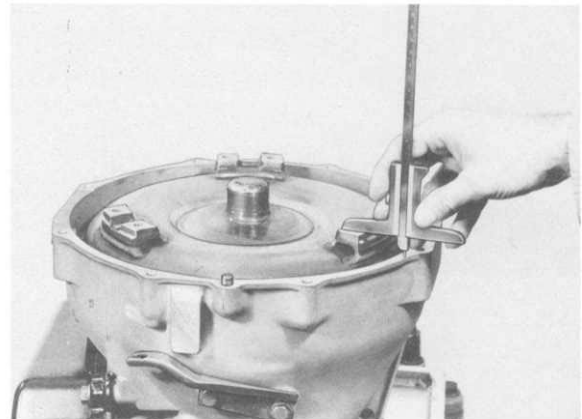
6. Attach Special Tool 9301 to torque converter and carefully lift out converter.

InstallingNote:

If the ATF smells burnt or if the fluid contains particles of pad material, torque converter and ATF cooler must be rinsed.

If particles of metal are found in the ATF pan, the torque converter must be replaced. Rinsing will not remove all metal particles and damage to the transmission may result.

1. Rinse torque converter with Special Tool 9310. To rinse, fill converter with approx. 1l of kerosine, insert the rinsing pin and use a hand drill to turn the pin at low speed. Then drain kerosine off through drain plug. Repeat rinsing 2 - 4 times until the kerosine drained from the converter is clean.



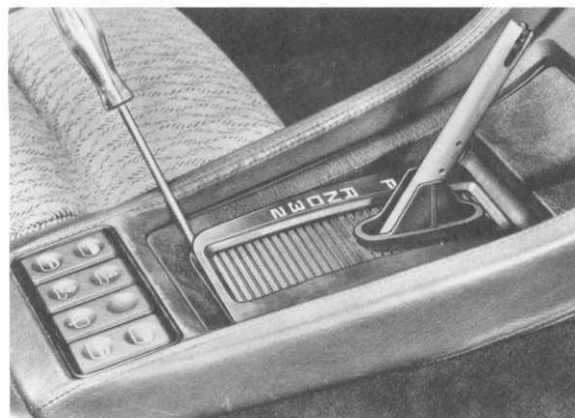
2. Attach Special Tool 9301 to torque converter.
3. Coat drive flange and bearing pin of converter with MoS_2 multi-purpose grease.
4. Place transmission upright and carefully insert converter, turning unit in both directions to engage the teeth.
5. Check installation depth of converter.

Up to '86 models = approx. 16 mm
'87 models onward = approx. 28 mm

REMOVING AND INSTALLING SELECTOR LEVER COVER FRAME

Removing

1. Remove selector lever grip and take off rubber boot.
2. Move selector lever to position "2" and push rear locking bar forward against stop with a suitable tool (e. g. scribe).

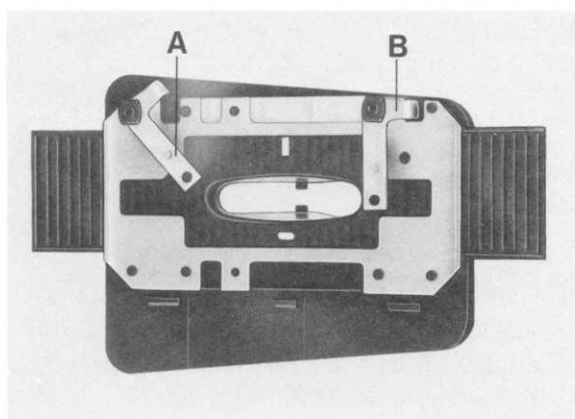
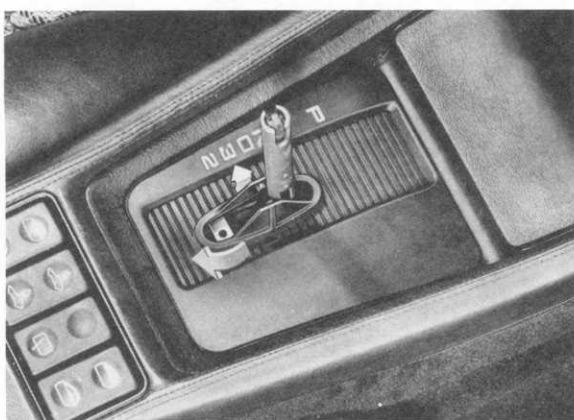


6. Move selector lever to position "N" and remove frame inclined toward rear.

Installing

3. Move selector lever to position "R", disconnect gate and push forward as far as possible.
4. Push front locking bar forward against stop with a suitable tool (e. g. scribe).
5. Move selector lever to position "P" and press out cover frame carefully with a suitable screwdriver applied at the left rear corner.
6. Move selector lever to position "N" and remove frame inclined toward rear.
1. Move selector lever to position "3".
2. Push gate in frame forward all the way.
3. Install cover frame in correct position and move selector lever to position "P".
4. Push cover frame forward and move right side to correct installed position (this is done by lifting left rear corner slightly and pushing down on right side).
5. Push down on left rear corner until frame fits in center console correctly.

6. Position selector lever between "R" and "P", disconnect gate on selector lever and push forward.
7. Push front locking bar toward rear until it engages.
8. Move selector lever to position "3" and push rear locking bar toward rear until it engages.
9. Attach gate in selector lever, install rubber boot in correct position and install selector lever grip.
10. Move selector lever in and out of all positions and make sure that cover frame fits properly.



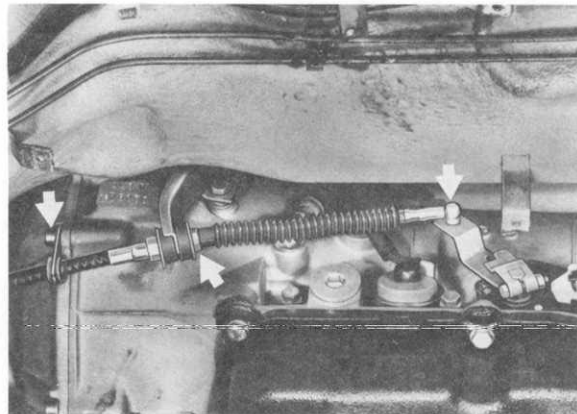
A — Locked

B — Unlocked

REMOVING AND INSTALLING SELECTOR LEVER CABLE

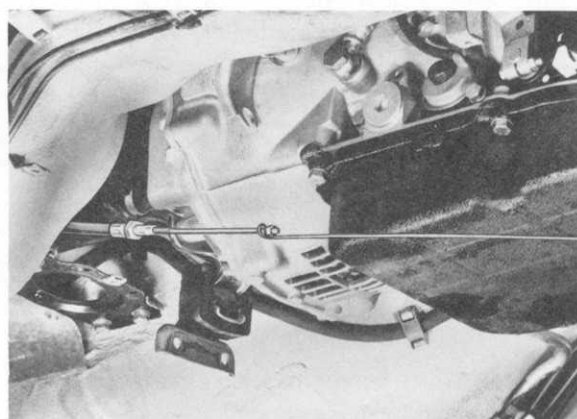
Removing

1. Unscrew ground strap of battery on body.
2. Remove selector lever grip and take off rubber boot.
3. Remove cover frame (see page 37 - 101).
4. Pull bulb holder carrier out of retaining clips.
5. Mark location of selector lever base for reinstallation and remove mounting screws.
7. Disconnect selector lever cable on transmission lever and detach cable sleeve on brackets.

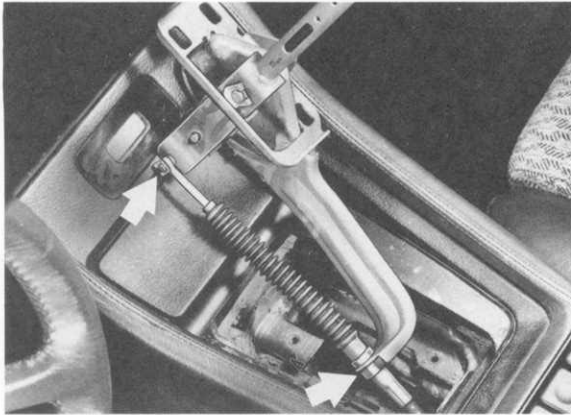


6. Loosen intermediate muffler shield and push aside as far as possible.

8. Take off ball head, hexagon nut and mounting parts.
9. Attach tailing wire on cable and pull out selector lever base with cable by pulling forward at an angle.



10. Remove cable circlip on selector lever and detach cable sleeve on selector lever base.



Installing

1. Attach cable sleeve on selector lever base, tightening the hexagon nut carefully.
2. Push cable on to selector lever pin and install circlip.
3. Attach tailing wire, pulled forward during removal, on cable and pull cable toward rear, whereby one person should guide in the selector lever base and a second person must pull wire and cable.
4. Install selector lever base in correct position (watching mark) and tighten mounting screws with 15 Nm/11 ftlb.
5. Install cover frame and selector lever grip. Place selector lever at "N".

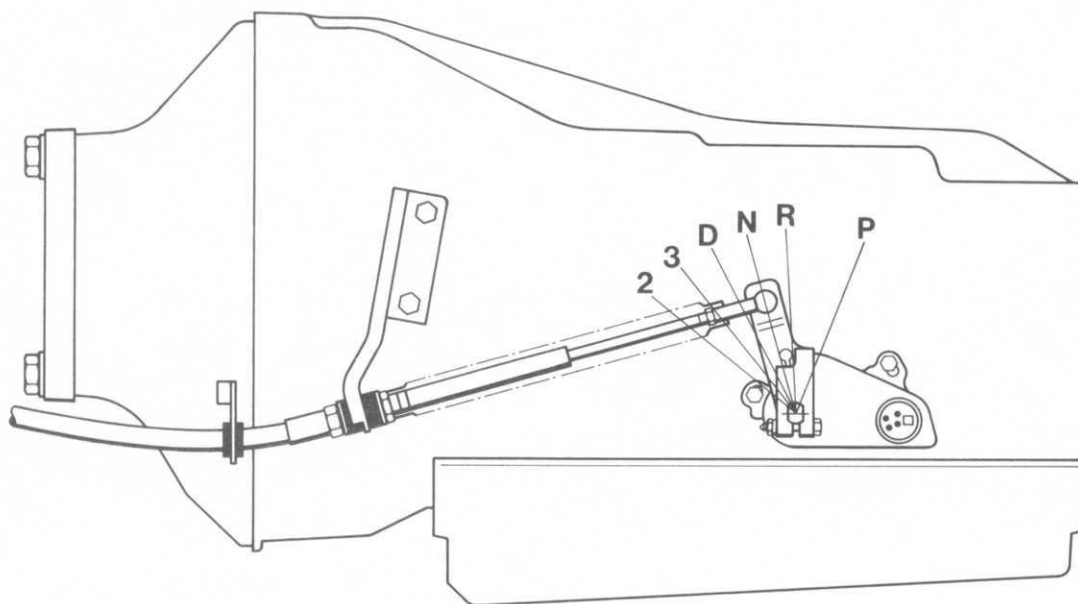
Note:

If light opening of gate and letter "N" are not exactly opposite each other in cover frame, remove cover frame again and reposition selector lever base in slots.

6. Mount selector lever cable on transmission as specified.

7. Adjust selector lever cable (see page 37 - 105).

ADJUSTING SELECTOR LEVER CABLE



1. Move selector lever to position "N".
2. Place range selector lever on transmission in "N".
3. Adjust ball end on cable that attachment is possible without tension.

Note :

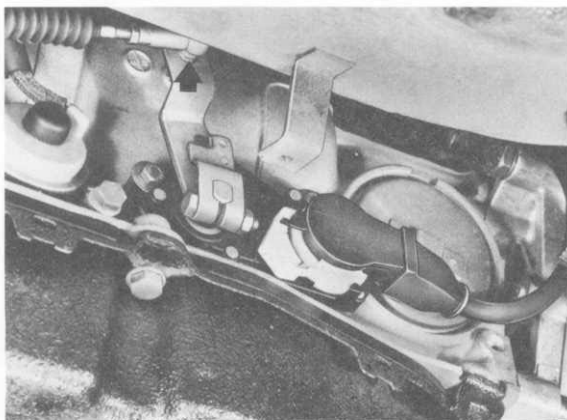
Bolt for range selector lever must be tightened for adjustments.



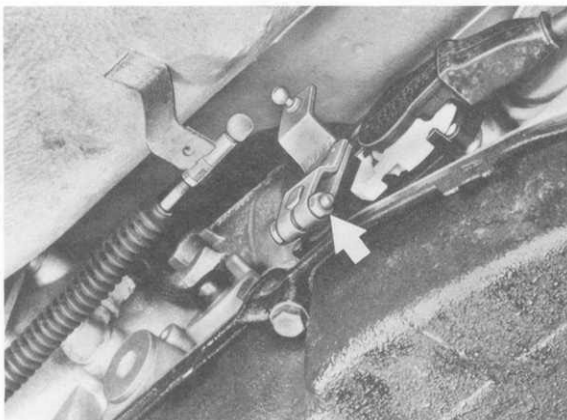
REMOVING AND INSTALLING STARTER LOCKING AND BACKUP LIGHT SWITCH

Removing

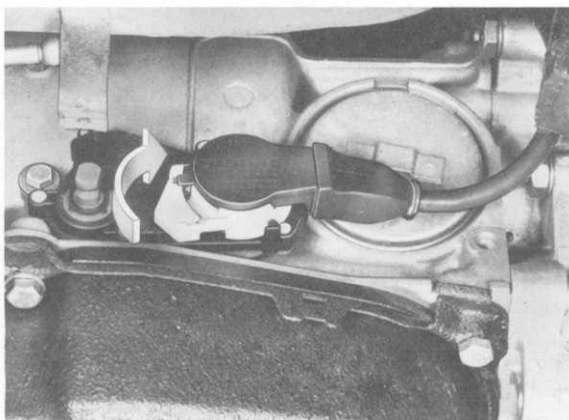
1. Disconnect selector lever cable.



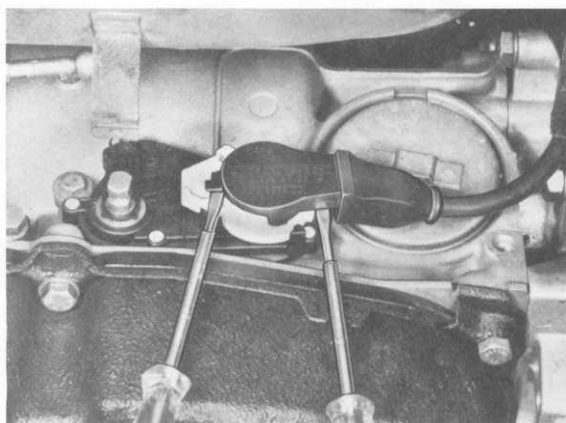
2. Remove bolt for range selector lever and pull off lever.



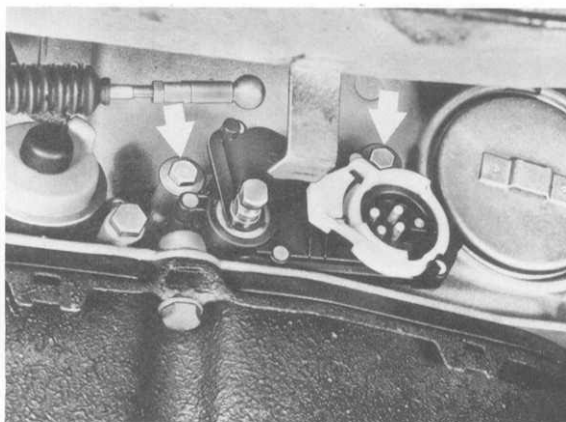
3. Unlock plug by turning white plastic ring (arrow) upwards in direction of arrow.



4. Pry off plug carefully with two screwdrivers applied on cable outlet and bar.



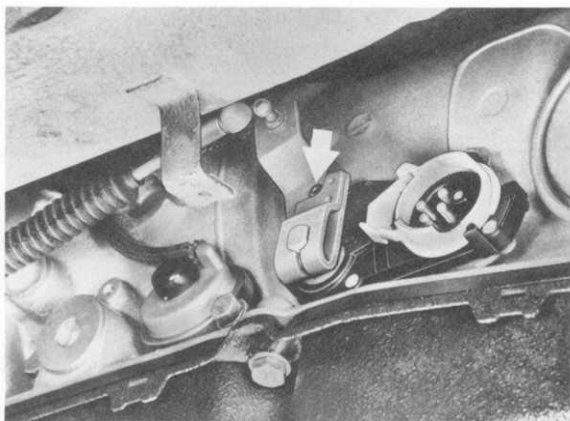
5. Remove switch mounting screws and take off switch.



Installing

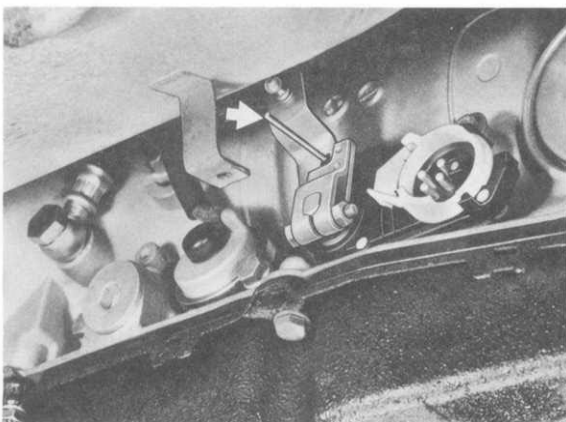
1. Install switch with both mounting screws, but do not tighten.

2. Install range selector lever that lug on switch engages. Move range selector lever to position "N".



ADJUSTING STARTER LOCKING AND BACKUP LIGHT SWITCH

1. Insert locating pin made of 4 mm dia. welding wire (or 4 mm dia. drill) through lug into locating bore in switch housing.



2. Tighten switch mounting screws with 10 Nm (7 ftlb) and pull out locating pin.
3. Press on plug and turn white plastic ring down.



CHECKING ADJUSTMENT OF SELECTOR LEVER CABLE AND STARTER LOCKING/BACKUP LIGHT SWITCH

Move selector lever to position "N". Run engine at fast idle speed.
Pull up parking brake lever and press down on brake pedal for following tests.

6. Starting engine should only be possible in "P" or "N".

7. Backup lights must be on in position "R".

1. Move selector lever to position "R". Engine speed must drop as gear engages.

2. Move selector lever to position "P". Engine speed should increase as reverse gear disengages.

3. Repeat test in point 1.

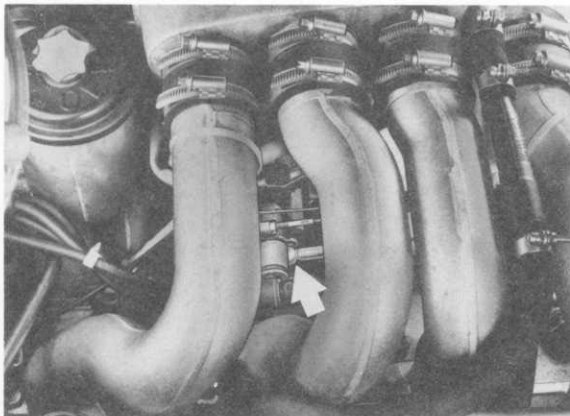
4. Move selector lever to position "N". Engine speed should increase as reverse gear disengages.

5. Move selector lever to position "D". Engine speed should drop as gear engages.

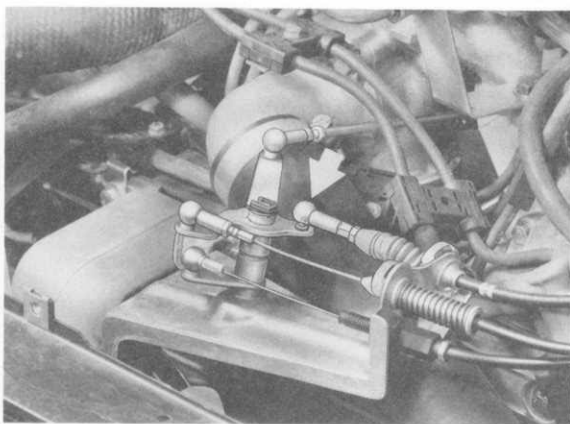
NOTES ON REMOVING AND INSTALLING

Removing

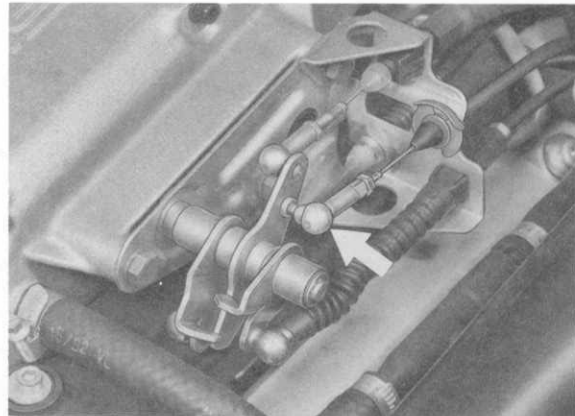
1. Remove top and bottom halves of air filter (16-valve engines only)
2. Disconnect control cable at engine.



16-valve engines



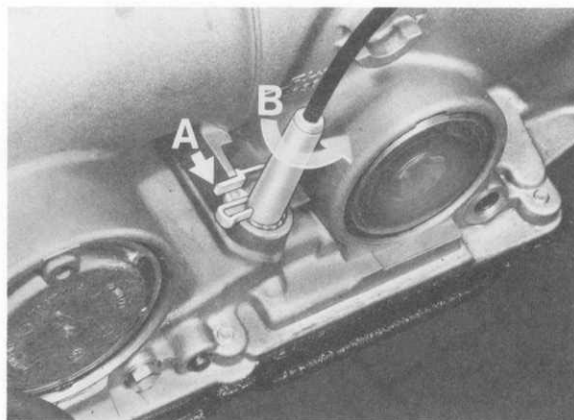
32-valve engines (up to '86 models)



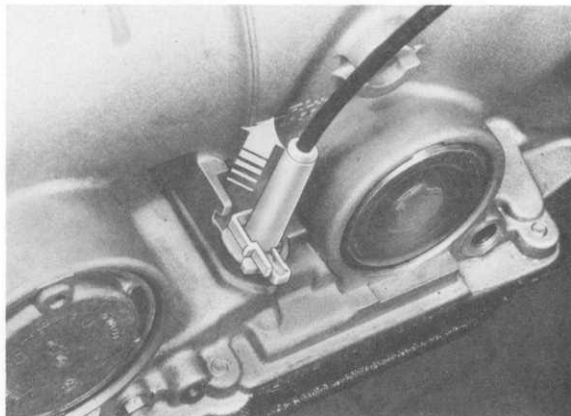
32-valve engines ('87 models onward)

3. Sever bowden cable behind threaded connector.

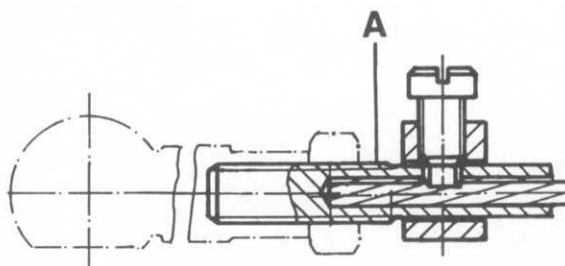
4. Disengage control cable from transmission by pressing locking tab of guide as arrowed (arrow A) and turning guide anti-clockwise (arrow B).



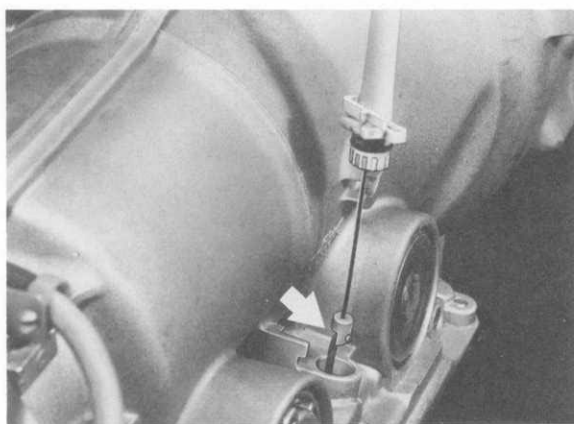
5. Carefully lift out guide.



2. Install clamp correctly and attach spherical head with hex nut.



6. Detach control cable from actuating rod and pull out toward rear.



A = Clamp

3. Attach Bowden cable to transmission

4. Adjust cable for control pressure (see page 37 - 115).

—

Installing:

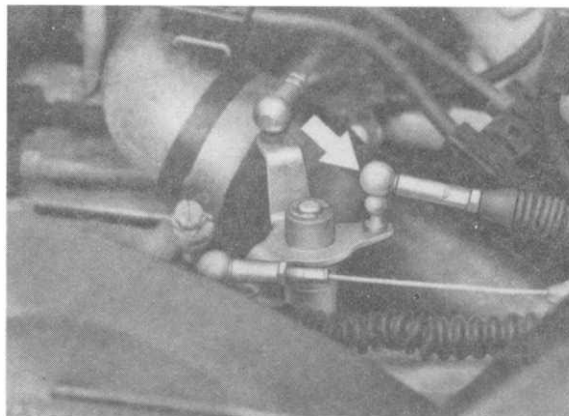
1. Carefully feed control cable through sleeve from rear.

CONTROL PRESSURE CABLE, ADJUSTING

Note:

Correct adjustment of the Bowden cable for control pressure is vitally important for faultless operation of the transmission.

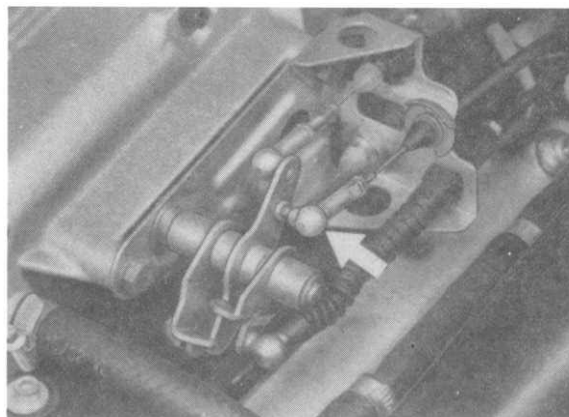
1. Set idle speed.
2. Take up play in throttle cable.
3. Adjust spherical head of control cable until cable can be installed without strain.



32-valve engines (up to '86 models)

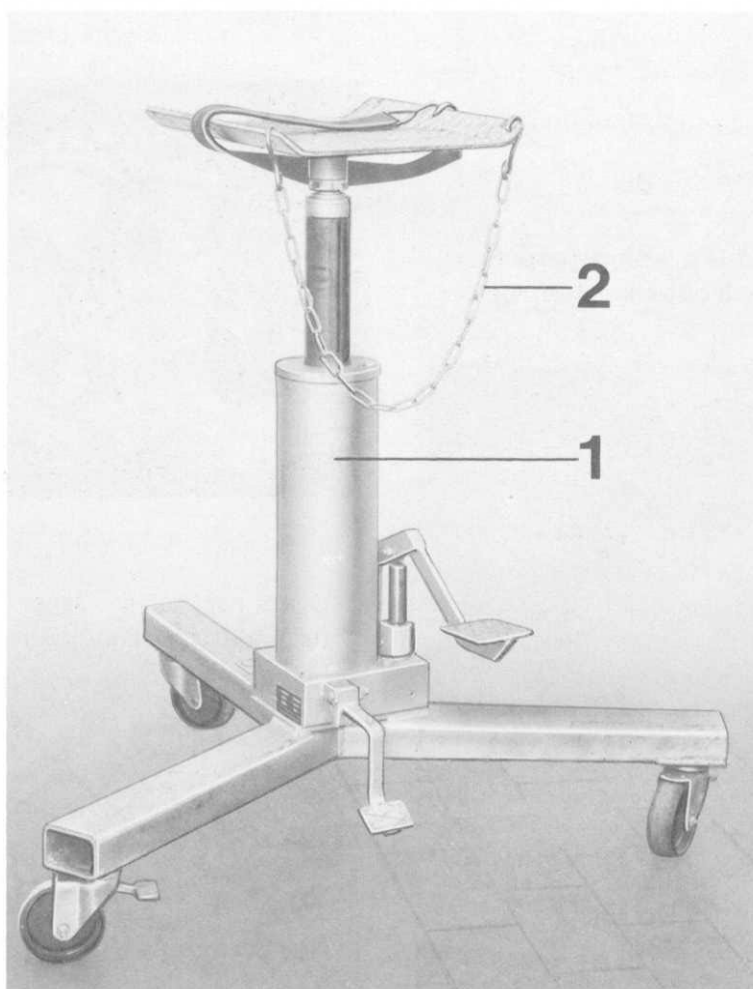


16-valve engines



32-valve engines ('87 models onward)

TOOLS

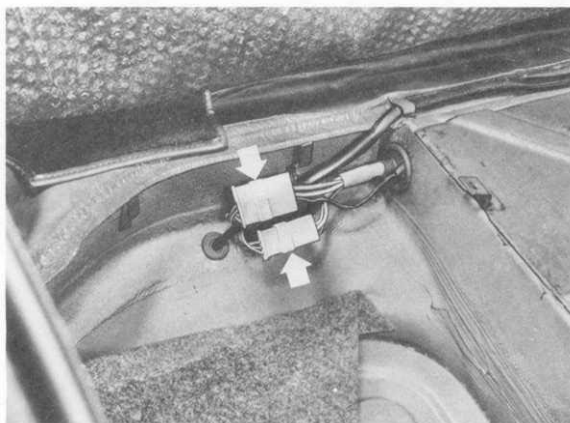


No.	Description	Special Tool	Remarks
1	Universal transmission jack	—	Standard, e. g. from Hahn, Metallbau GmbH 7012 Fellbach
2	Holding chain	9164	

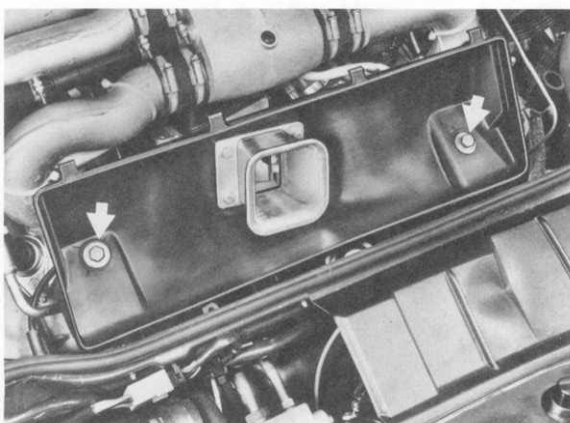
REMOVING AND INSTALLING TRANSMISSION

Removing

1. Unscrew battery ground strap on body.
2. Disconnect multiple pin plugs in spare wheel well and pull out wires from below.

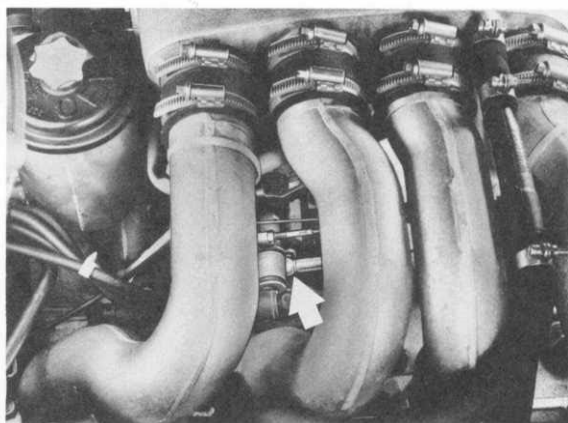


3. Remove upper and lower air cleaner housings.



4. Remove upper air guide section.

5. Disconnect control cable on throttle housing.



6. Disconnect oxygen sensor wire on central fuse/relay panel and pull out from below (USA cars).

7. Remove engine air guide.

8. Remove complete exhaust assembly with shields.

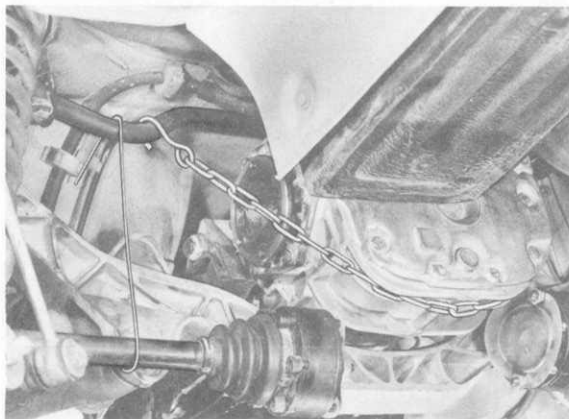
9. Remove starter and suspend in suitable position.

10. Drain ATF and remove reservoir.

11. Disconnect drive shafts on transmission end and suspend on wire in horizontal position.

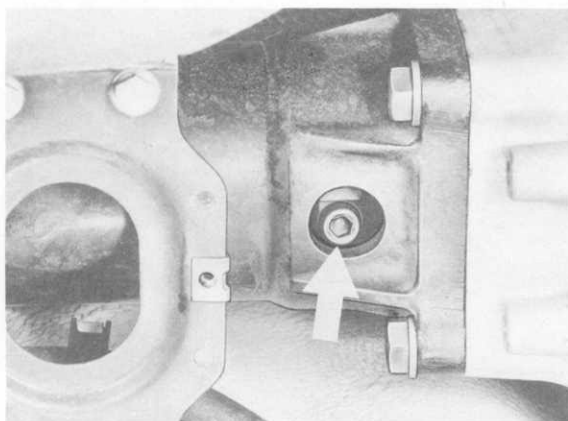
12. Remove rear axle cross member/transmission suspension mounting bolts.

13. Support transmission on stabilizer with Special Tool 9164 (if necessary, lift transmission on transmission support slightly).

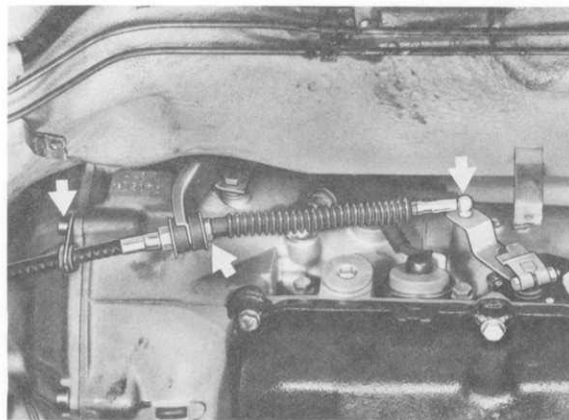


14. Mark position of toe eccentric and rear axle cross member for reinstallation and remove entire rear axle.

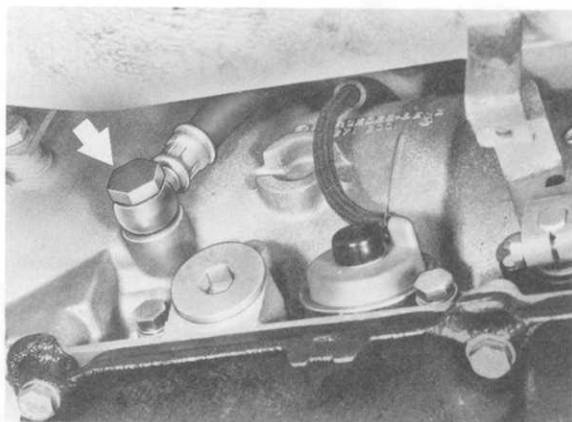
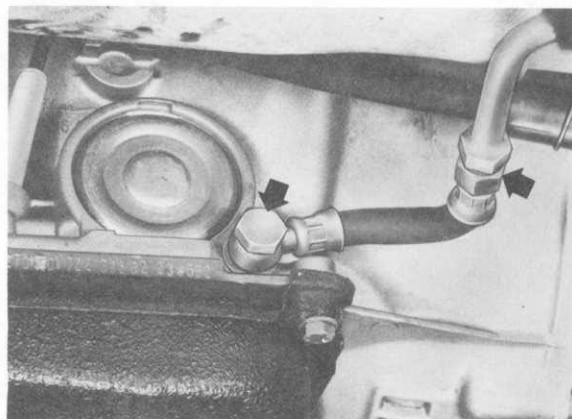
15. Remove clamp bolt.



16. Disconnect selector lever cable on transmission lever and unscrew cable sleeve on holder and case.

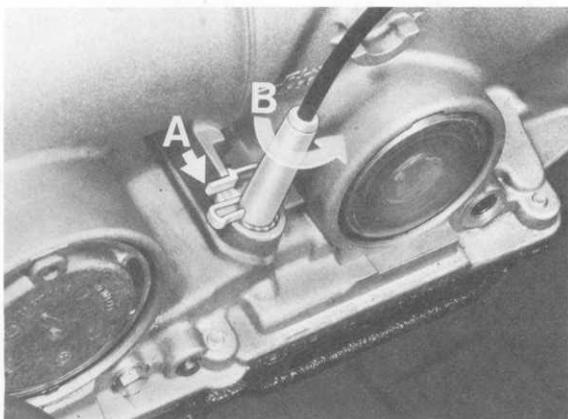


17. Remove feed and return lines for ATF cooler. Plug open bores in case.

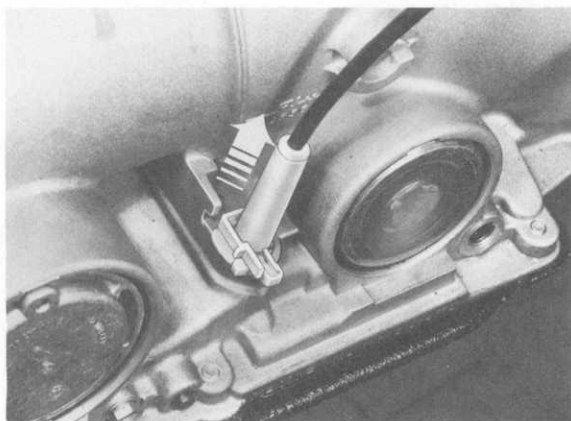


18. Pull off vacuum hose on modulating pressure box.

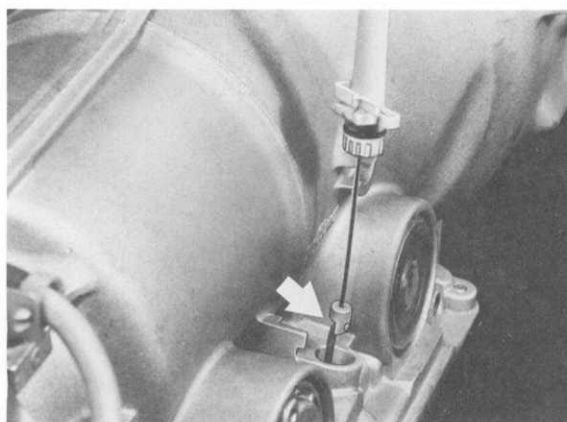
19. Disconnect control pressure cable on transmission. This is done by pushing locking bar of guide in direction of arrow (arrow A) and turning guide counter-clockwise (arrow B).



Pull out guide from above carefully.

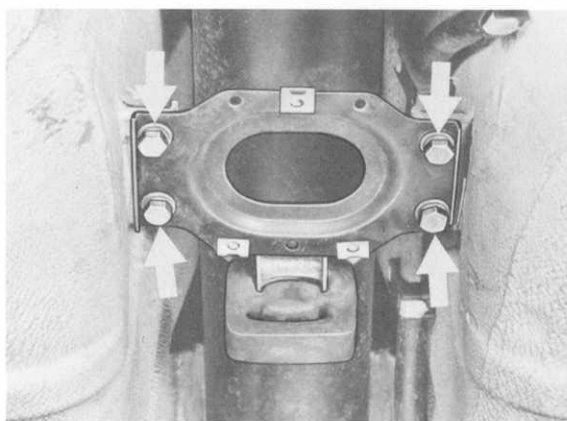
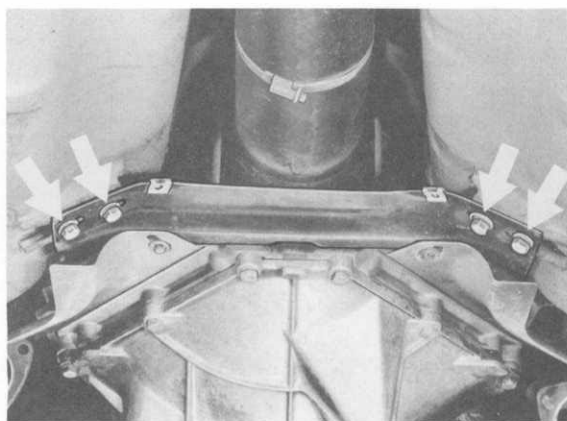


Disconnect control cable on operating rod.



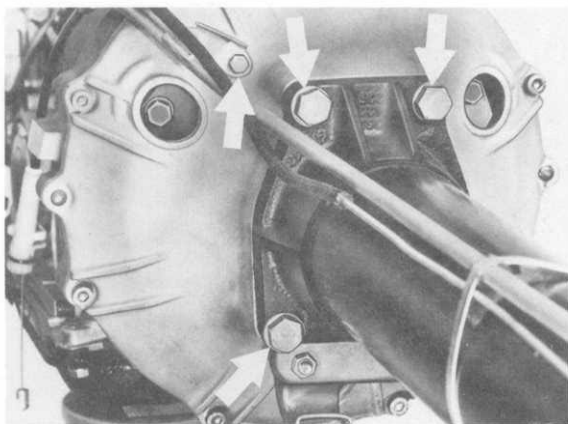
20. Place universal transmission jack underneath transmission and tighten rubber strap.

21. Remove front and rear reinforcement plates.



22. Lift transmission slightly and disconnect holding chain.

23. Lower transmission only far enough that central tube/transmission mounting bolts and control cable mounting bolt can be removed.



24. Move central tube to installed position, mount rear brace with two bolts and place a suitably thick block of wood between central tube and brace.

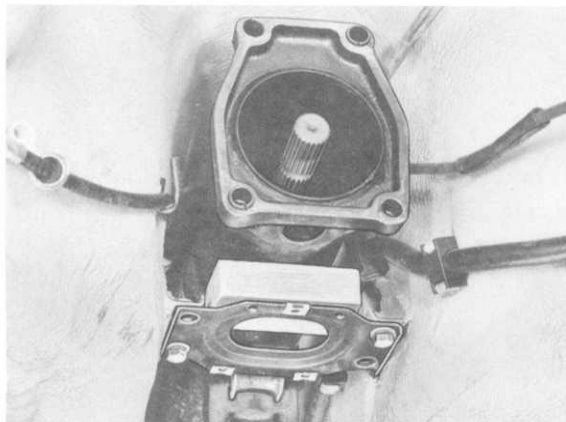
25. Pull back transmission and lower carefully.

Installing

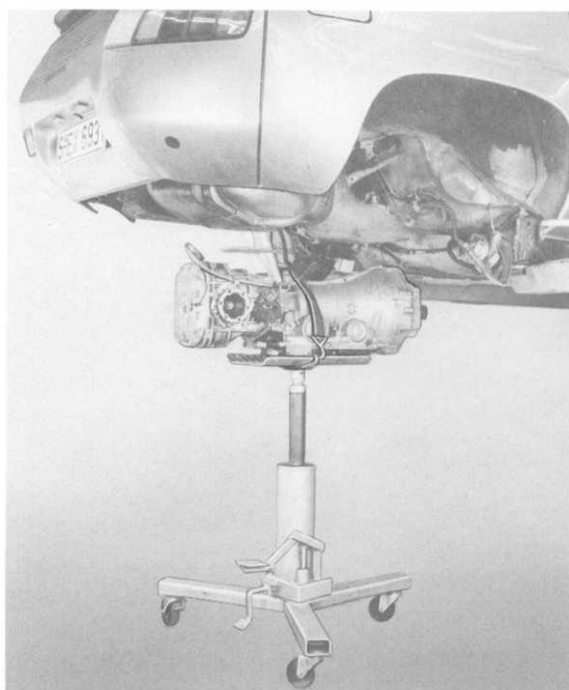
Note:

Installation is in reverse order of removal procedures, but also conform with following points.

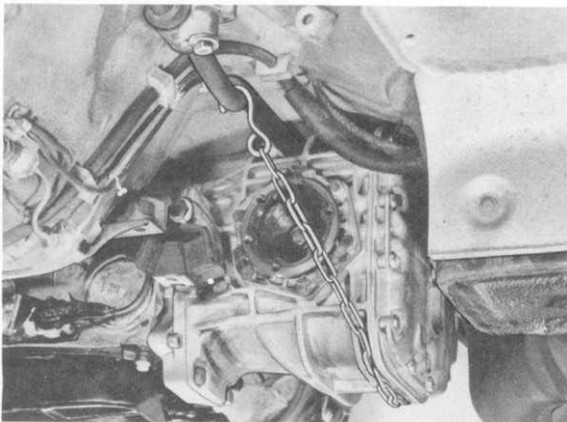
1. Place central tube in installed position with a suitably thick block of wood and coat splines on central shaft with Optimoly HT.



2. Lift transmission with universal transmission jack and push on to central shaft.



3. Install and slightly tighten accessible bolts on central tube flange.
4. Lift transmission, remove block of wood and take out brace again.
5. Lower transmission only far enough that remaining bolts can be screwed in central tube flange (tightening torque: 120 Nm/ 87 ftlb).
6. Mount guide tube for control cable on converter housing (tightening torque: 8 Nm/6 ftlb).
7. Push wire harness upwards through opening in spare wheel well.
8. Lift transmission and hold in installed position with Special Tool 9164.
9. Lower universal transmission jack.
10. Install rear axle and tighten all bolts except for two transmission mount bolts.
11. Lift transmission and disconnect Special Tool 9164.
12. Adjust transmission suspension (see page 37 - 123).
13. Mount transmission on cross member (tightening torque: 85 Nm/61 ftlb).
14. Check adjustment of selector lever and control pressure cables, correcting if necessary.



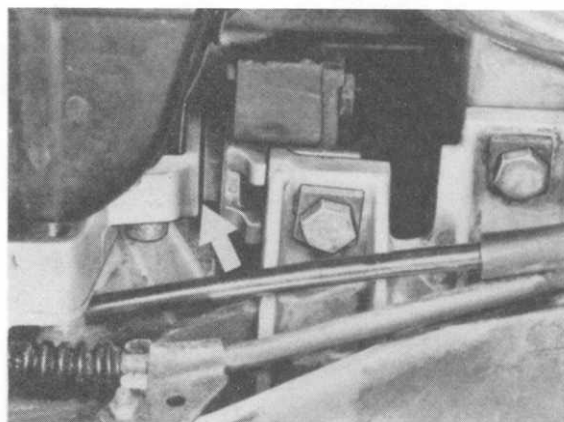
ADJUSTING TRANSMISSION SUSPENSION

The transmission mounts have to be adjusted to avoid tension in the transmission suspension and to also guarantee good insulation.

Note :

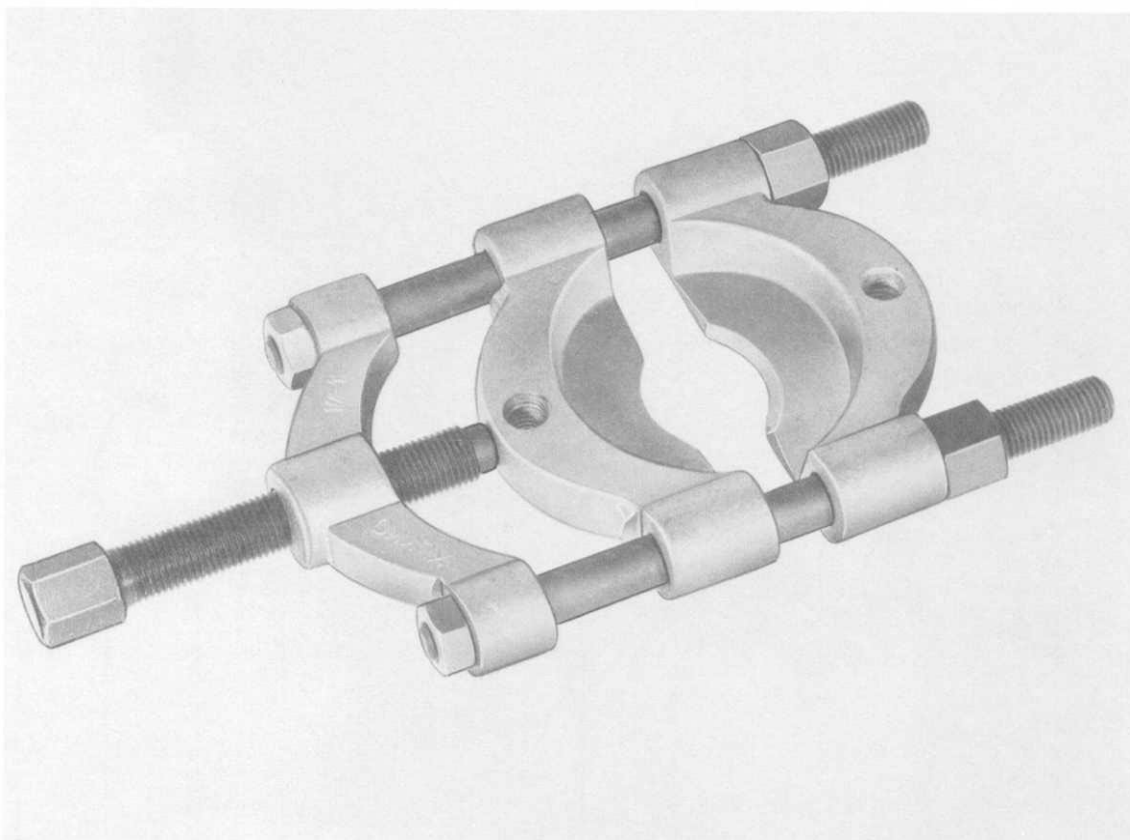
After tightening the mounting bolts there must be at least 1 mm clearance between the transmission case and stop on side of transmission mount.

1. Install transmission and rear axle. Tighten transmission mount/transmission case mounting bolts with 85 Nm/61 ftlb.
2. Screw in cross member/transmission mount bolts several turns.
3. Lift transmission in middle of case far enough that there is a gap between both transmission mounts and the cross member. Measure this gap on both sides and take up difference with shims.



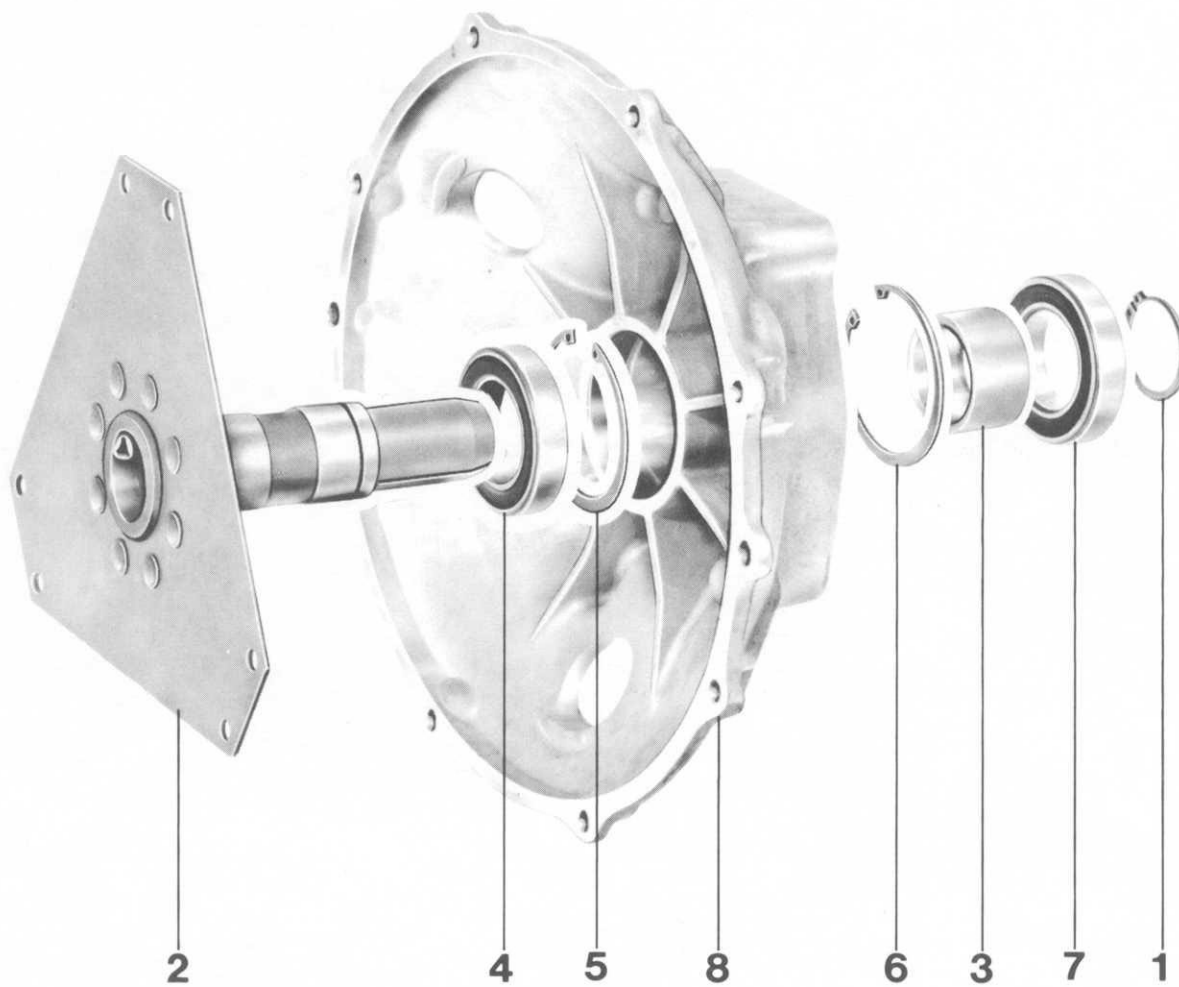
4. Place shims of pertinent thickness between transmission mounts and cross member, lower transmission and tighten transmission mounts/cross member bolts with 85 Nm/61 ftlb.

TOOLS



No.	Description	Special Tool	Remarks
	Support rail	—	Standard (e. g. Kukko, Size 1)

DISASSEMBLING AND ASSEMBLING FRONT CONVERTER HOUSING

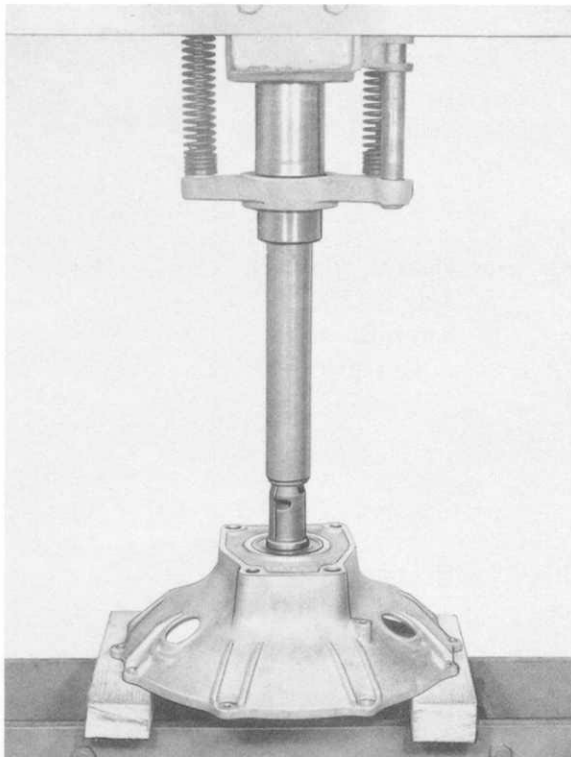


No.	Description	Qty.	Note When:		Special Instructions
			Removing	Installing	
1	Circlip	1			
2	Drive flange	1	Press out	Press into case with grooved ball bearing (no. 4)	
3	Spacer	1			
4	Grooved ball bearing	1	Press off with support rail, e. g. Kukko, size 1	Heat to approx. 120 °C/250 °F and push on to drive flange	
5	Circlip	1			
6	Circlip	1			
7	Grooved ball bearing	1	Press out with suitable piece of pipe	Heat case to approx. 120 °C/250 °F and press in with suitable piece of pipe, supporting with drive flange	
8	Housing	1			

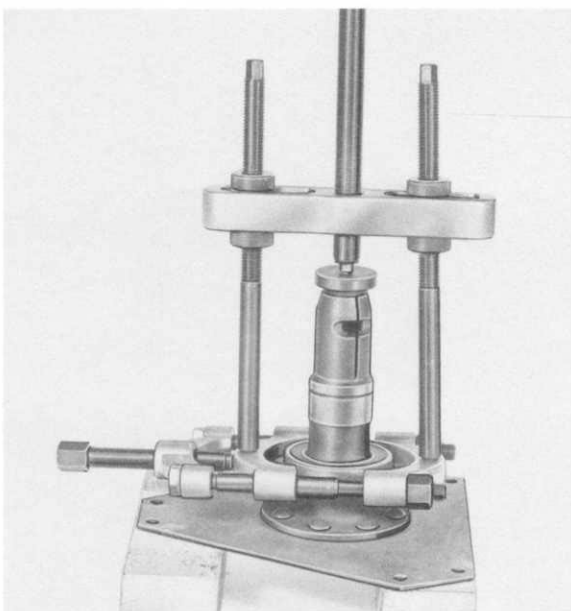
DISASSEMBLING AND ASSEMBLING FRONT CONVERTER HOUSING

Disassembling

1. Remove circlip and press out drive flange.

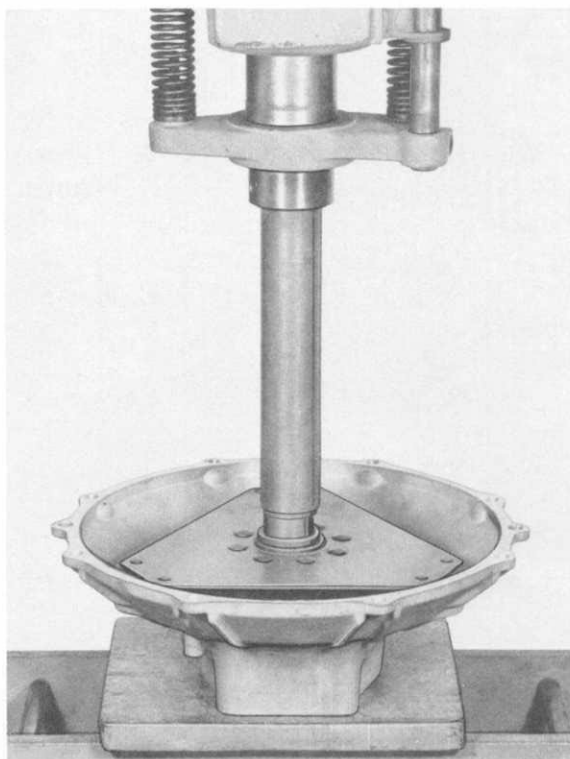


2. Press grooved ball bearing off of drive flange with a support rail (e. g. Kukko, size 1).

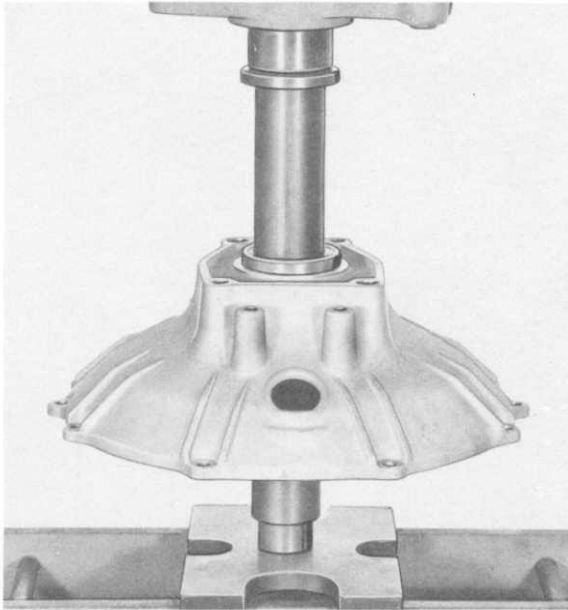


Assembling

1. Install both circlips in converter housing.
2. Heat grooved ball bearing to about 120 °C/250 °F and press bearing on drive flange against shoulder with a suitable piece of pipe applied on bearing inner race.
3. Heat converter housing to about 120 °C/250 °F and press in drive flange with grooved ball bearing against circlip.



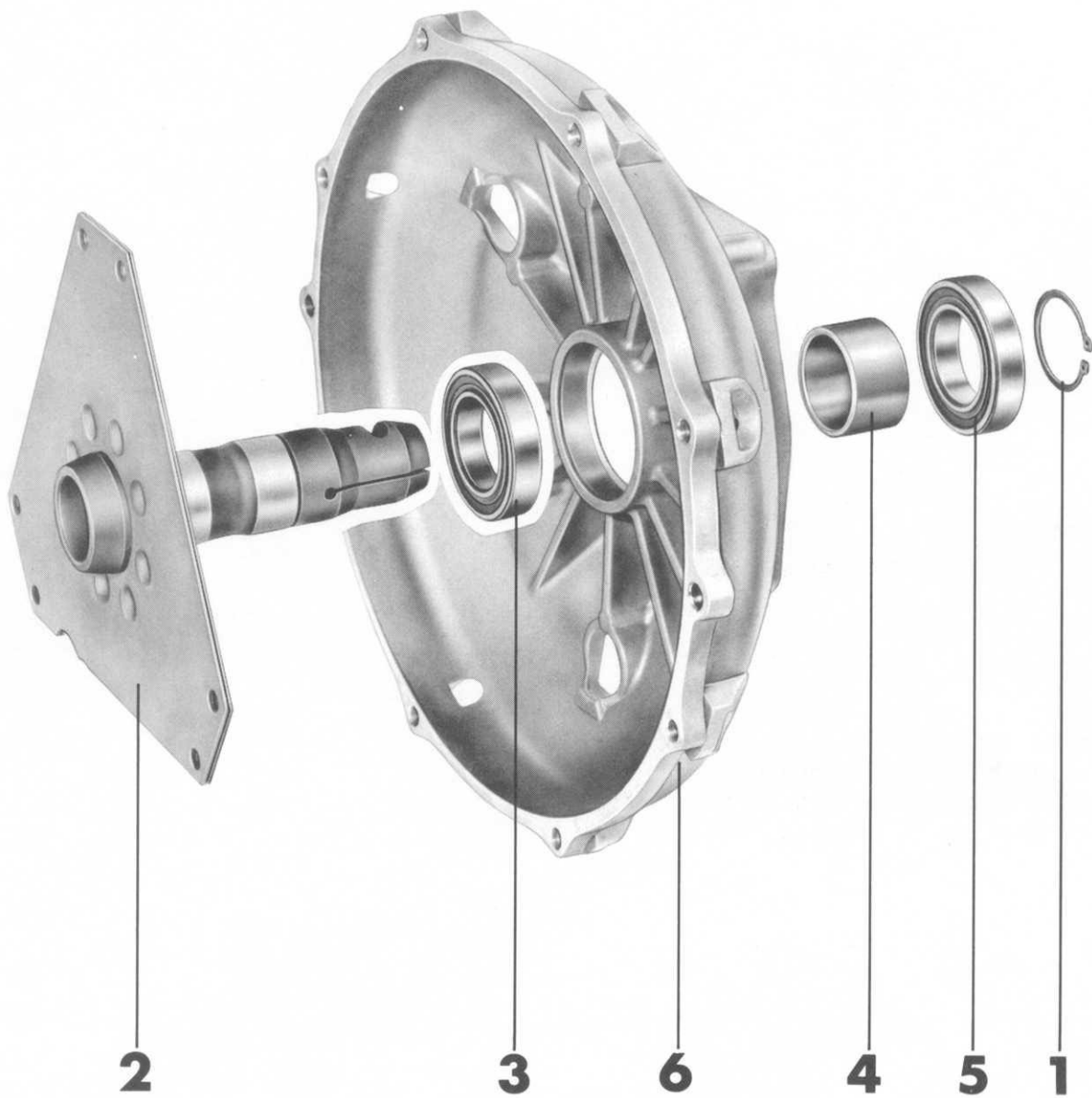
4. Insert spacer sleeve and using a suitable piece of pipe, press front deep-groove ball bearing over inner race until bearing contacts circlip.



Note:

Place a suitable pressure piece beneath the drive-flange bearing to keep it from moving out as the front bearing is pressed in.

DISASSEMBLING AND ASSEMBLING FRONT CONVERTER CASING ('87 MODELS ONWARD)

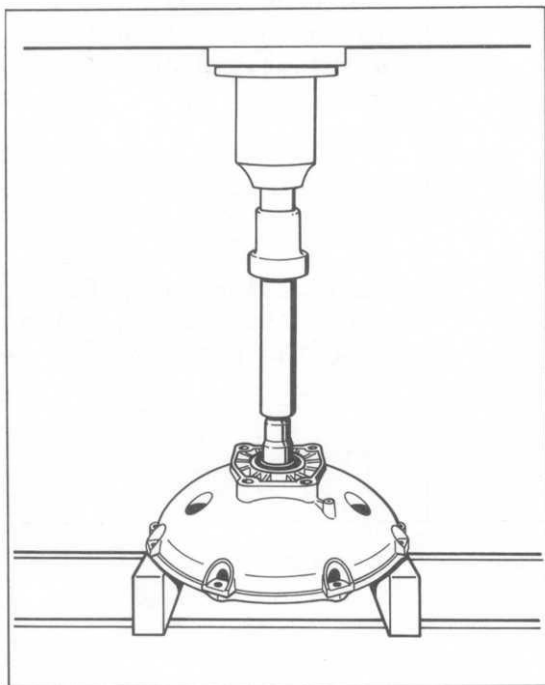


No.	Designation	Qty.	Note when:	
			Removing	Installing
1	Circlip	1		
2	Drive flange	1	Press out	Press in, after inserting deep-groove ball bearing (No. 5)
3	Deep-groove ball bearing	1	Pull off with puller (e.g. Kukko, size 1)	Heat casing to approx. 120°C and press in as far as possible with a suitable piece of pipe.
4	Spacer sleeve	1		
5	Deep-groove ball bearing	1		Heat casing to approx. 120°C and press in with a suitable piece of pipe
6	Case	1		

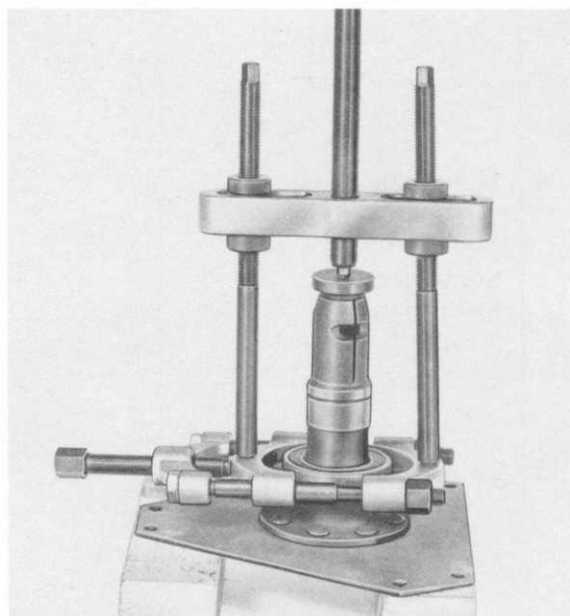
NOTES FOR ASSEMBLY AND DISASSEMBLY

Disassembling

1. Remove circlip and press out drive flange.

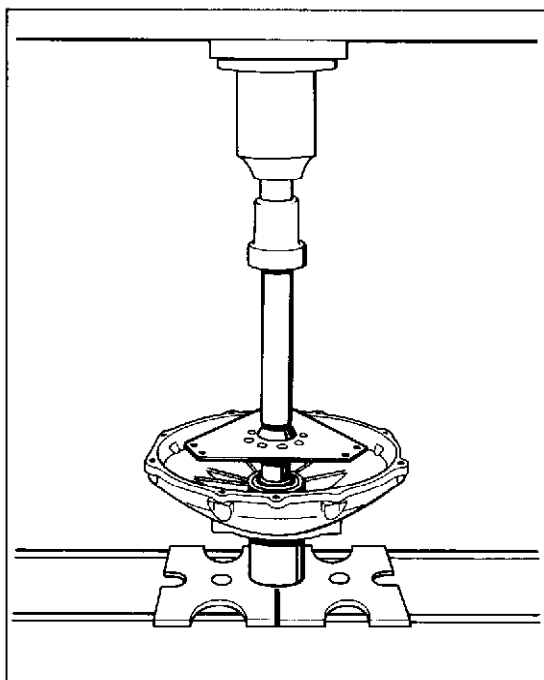


2. Using puller (e.g. Kukko, size 1) pull deep-groove ball bearing off drive flange.

Assembling

1. Heat converter casing to approx. 120°C and install both deep-groove ball bearings with spacer sleeve.

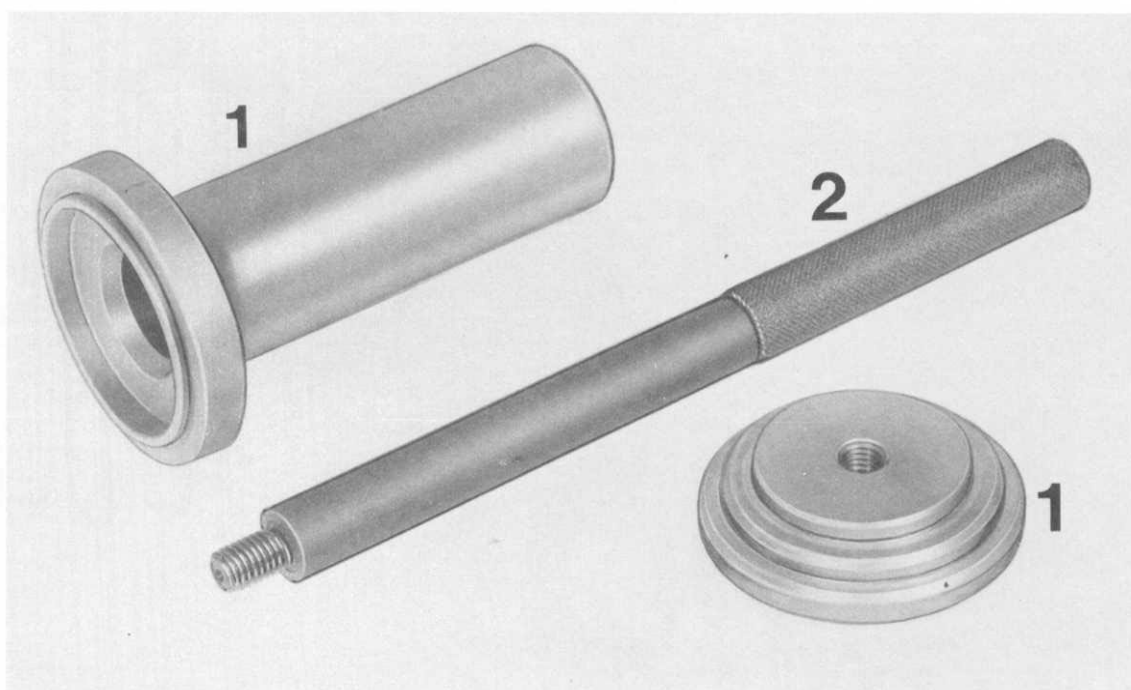
2. Press drive flange in as far as it will go.



Note:

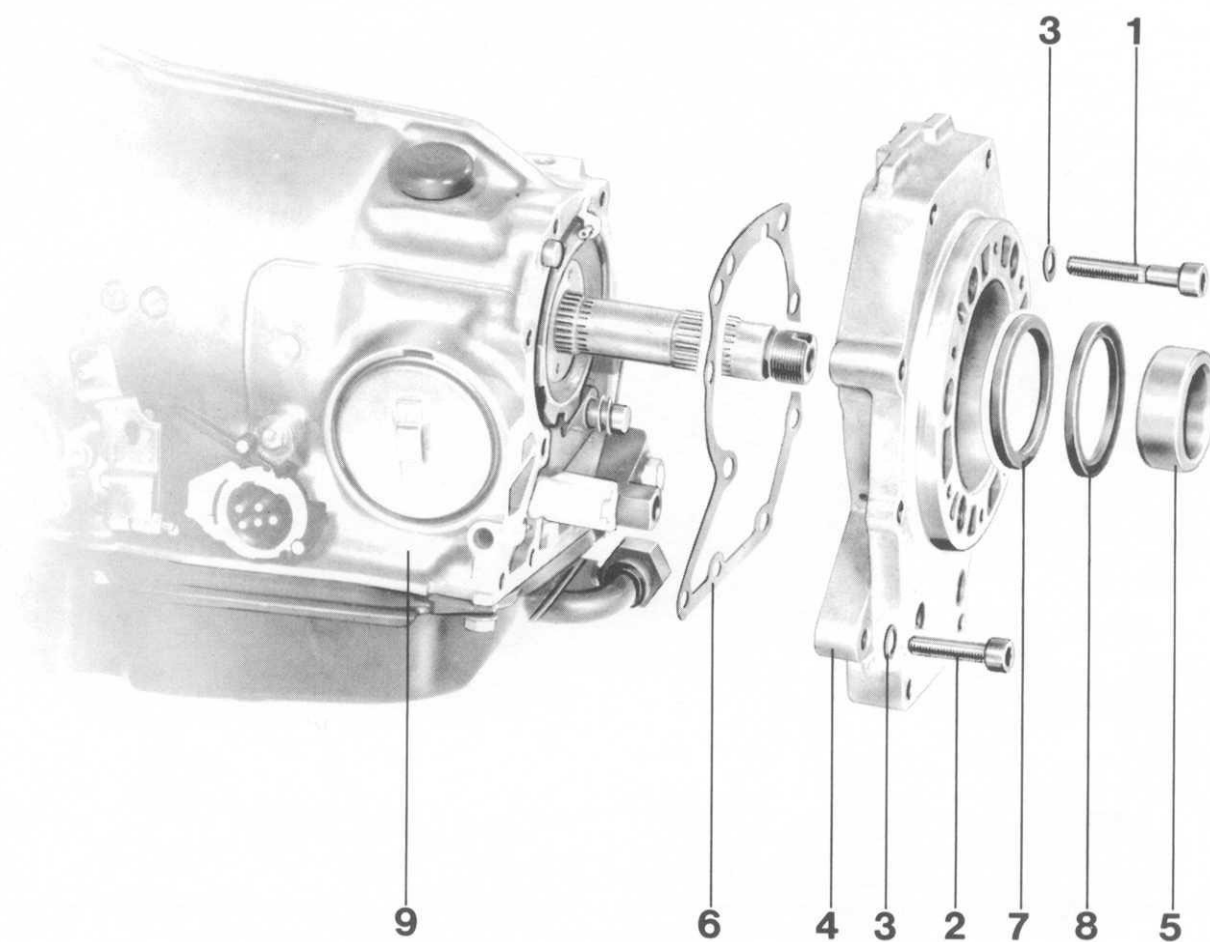
To prevent the deep-groove ball bearing (No.5) moving out as the flange is pressed, position a suitable piece of pipe against the bearing outer race as a support.

TOOLS



No.	Description	Special Tool	Remarks
1	Pressure pad	9180/1	
2	Mandrel	P 254	

REMOVING AND INSTALLING REAR TRANSMISSION CASE



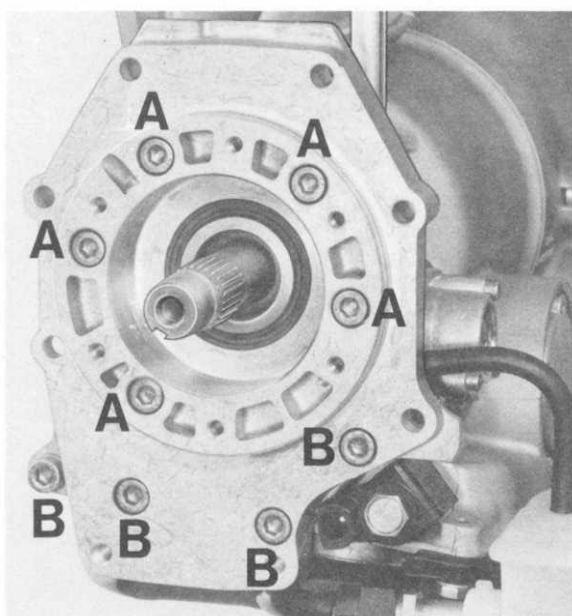
No.	Description	Qty.	Note When:		Special Instructions
			Removing	Installing	
1	Bolt M 10 x 55	5		Torque: 42 Nm/30 ftlb	
2	Bolt M 10 x 40	4		Torque: 42 Nm/30 ftlb	
3	Washer	9			
4	Rear transmission case	1			
5	Race	1		Insert after installing case	
6	Gasket	1		Replace	
7	Seal	1	Drive out with suitable screw-driver	Replace, drive in to correct position with Special Tool 9180/1 and coat sealing lip with ATF	
8	Seal	1	Drive out with suitable screw-driver	Replace, drive in to correct position with Special Tool 9180/1 and coat sealing lip with ATF	
9	Automatic transmission	1			

REMOVING AND INSTALLING REAR TRANSMISSION CASE

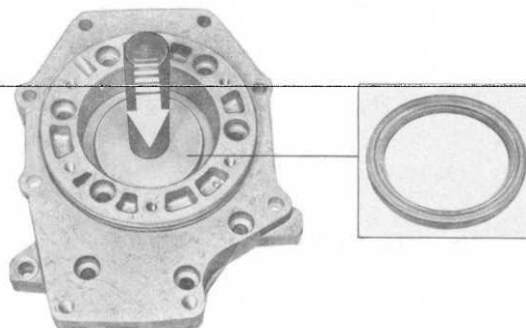
Removing

1. Remove final drive and bearing assembly (see page 39 - 101).

2. Remove case mounting bolts.



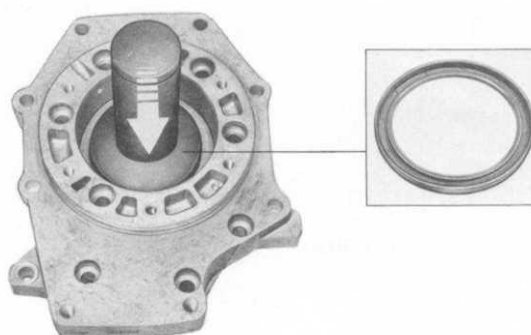
A = Five M 10 x 55 bolts
B = Four M 10 x 40 bolts



Note:

Hold seal on special tool with a small amount of grease and drive in seal that sealing lip faces automatic transmission.

2. Drive in outer seal to correct position with Special Tool 9180/1.



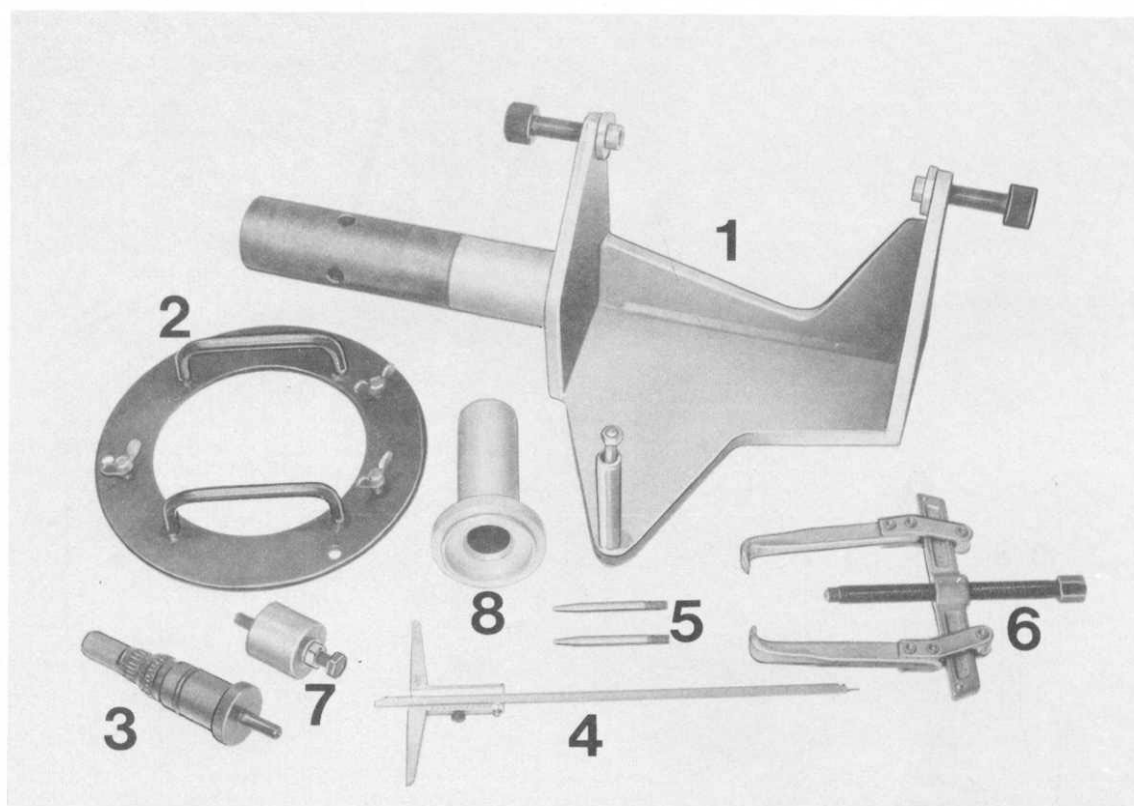
Installing

1. Drive in inner seal to correct position with Special Tool 9180/1.

Note:

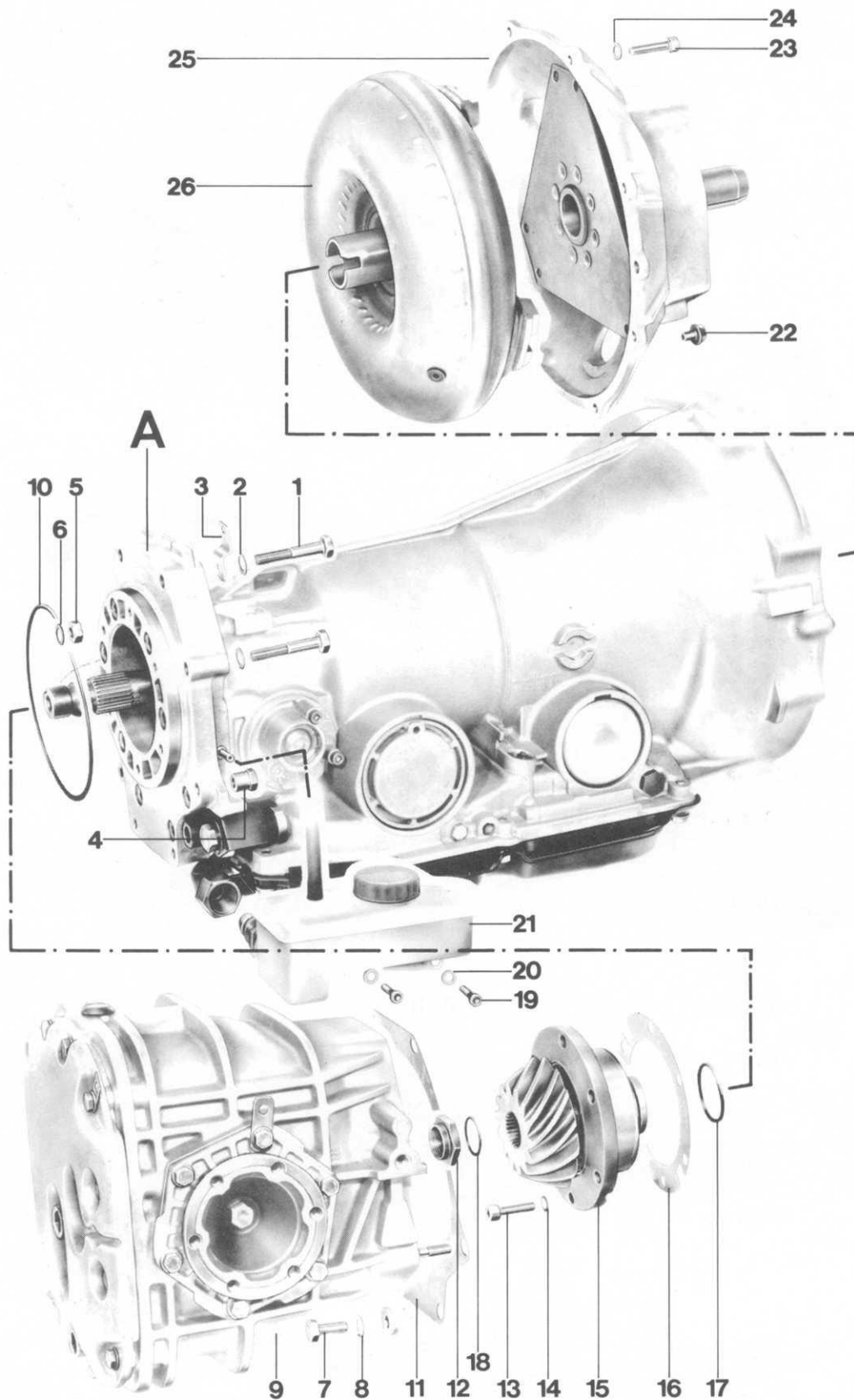
Seal must be installed that its sealing lip faces final drive.

TOOLS



No.	Description	Special Tool	Remarks
1	Holder	9216	
2	Grip	9301	
3	Mandrel	9310	
4	Depth gauge	—	Standard tool
5	Centering pins	9321	
6	Puller	—	Standard tool
7	Pressing in tool	—	Made locally (steel pipe 45 x 5 x 40 mm with welded cover and 11 mm dia. bore)
8	Pressure pad	9180/1	

REMOVING AND INSTALLING REAR TRANSMISSION



No.	Designation	Qty.	Note:	
			Removal	Installation
1	Bolt	4		Torque: 46 Nm / 33 ftlb
2	Washer	4		
3	Holder	1		
4	Collar nut	1		Torque: 46 Nm / 33 ftlb
5	Nut	1		Torque: 46 Nm / 33 ftlb
6	Washer	1		
7	Bolt	1		Torque: 46 Nm / 33 ftlb
8	Washer	2		
9	Final drive	1		
10	O-ring	1		Replace, coat with ATF
11	Shim "S3"	X		Determine thickness
12	Collar nut	1	Engage parking lock and unscrew	Torque: 380 Nm / 275 ftlb (as of mod. '92 = 450 Nm, 367 ftlb), and lock
13	Bolt	6		Torque: 33 Nm / 24 ftlb
14	Lock washer	6		Hollow side faces flange
15	Bearing assembly with drive pinion	1	If necessary, pull out with a suitable puller	If necessary, press in with locally made tool

No.	Description	Qty.	Note When:	
			Removing	Installing
16	Shim	X	Note number and thickness for reinstallation	Recalculate, if necessary
17	O-ring	1		Replace, coat with ATF
18	O-ring	1		Replace, coat with ATF
19	Panhead bolt	2		Tightening torque: 6 Nm (4.4 ftlb)
20	Washer	2		
21	ATF reservoir	1		
22	Mounting bolt	6		Tightening torque: 46 Nm (34 ftlb)
23	Panhead bolt	8		
24	Washer	8		Tightening torque: 23 Nm (17 ftlb)
25	Converter casing	1		
26	Torque converter*	1	Lift out carefully with Special Tool 9301	
				Rinse with Special Tool 9310. Install with Special Tool 9301.
A	Mid-mounted transmission	1		

* Note installation depth:

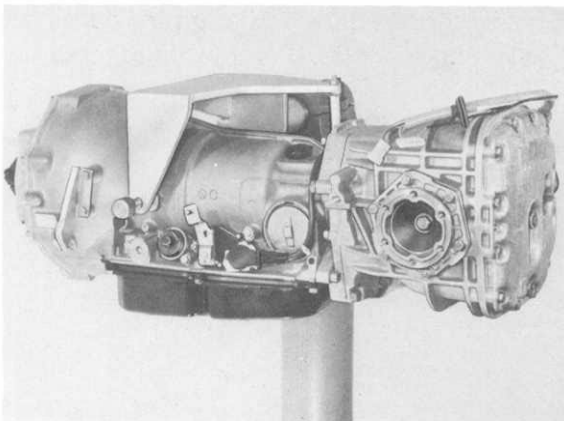
Up to '86 models = approx. 16 mm

'87 models onward = approx. 28 mm

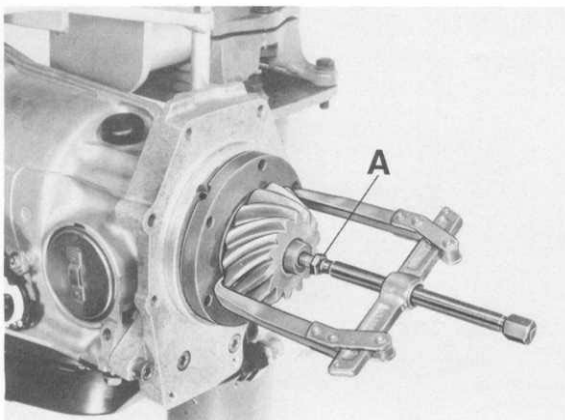
REMOVING AND INSTALLING REAR TRANSMISSION

Removing

1. Remove transmission.
2. Mount transmission in assembly stand with Special Tool 9216 and drain final drive oil.

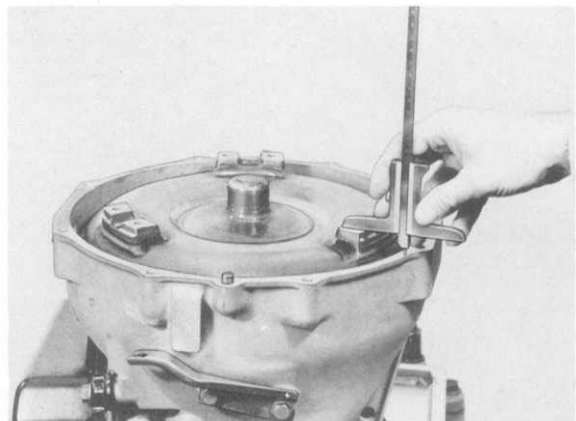


3. Engage parking lock and remove collar nut for drive pinion.
4. Remove bearing assembly mounting bolts and pull off bearing assembly (use a suitable puller, if necessary).

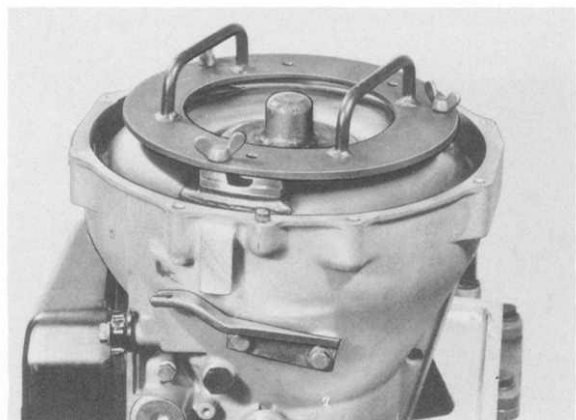


A = Bolt 10 x 30 with centering bore

5. Position transmission upright and remove converter mounting bolts through openings in housing.
6. Remove converter housing mounting bolts and take off housing.
7. Measure installed depth of converter (about 16 mm) and note value for reinstallation.



8. Mount Special Tool 9301 on torque converter and lift out converter carefully.

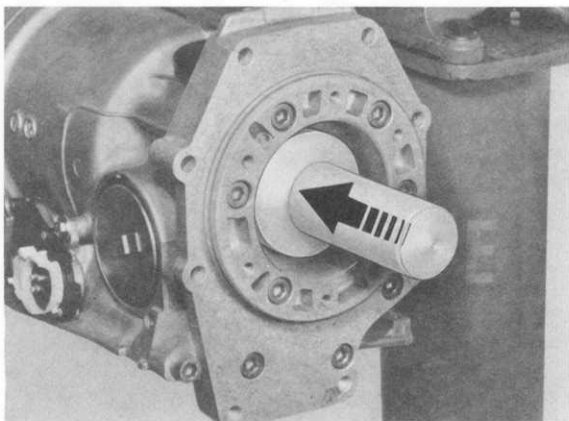


Installing

Note:

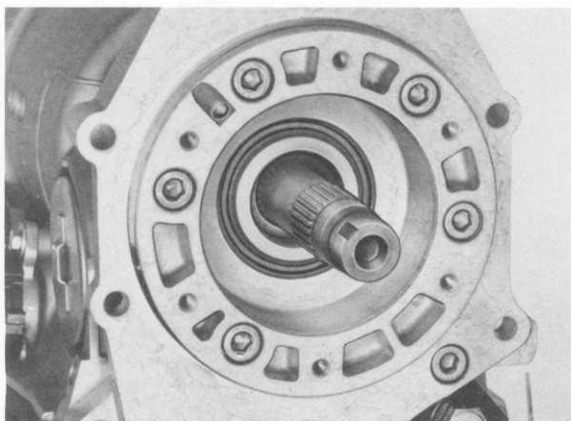
The outer seal on the rear transmission between the transmission case and final drive could be missing due to manufacturing conditions.

1. Drive in outer seal (if not already installed) to correct position with Special Tool 9180/1.



Note:

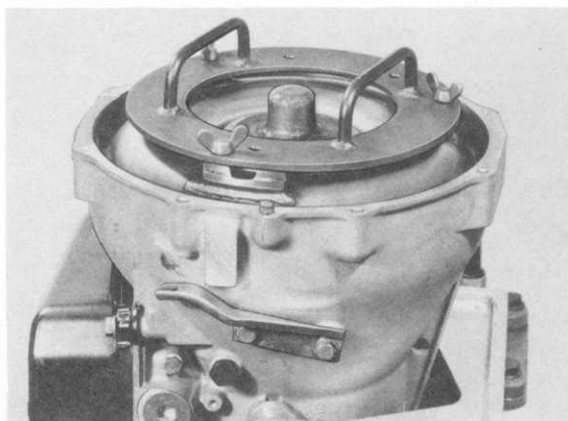
Outer seal must be installed that sealing lip and spring supporting the sealing lip face final drive.



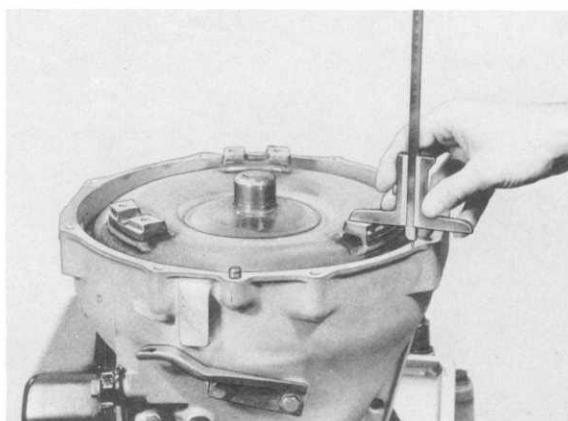
2. Mount Special Tool 9301 on torque converter.

3. Coat drive flange and bearing journal of converter with a multi-purpose grease containing MoS₂ additives.

4. Position transmission upright and install converter carefully, while turning converter back and forth until splines mesh.



5. Check installed depth of converter (about 16 mm).

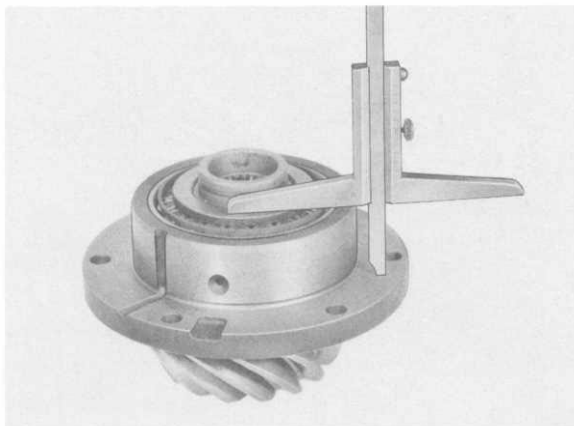


Note :

If ATF smells burnt or contains metal particles, torque converter and ATF cooler must be flushed.

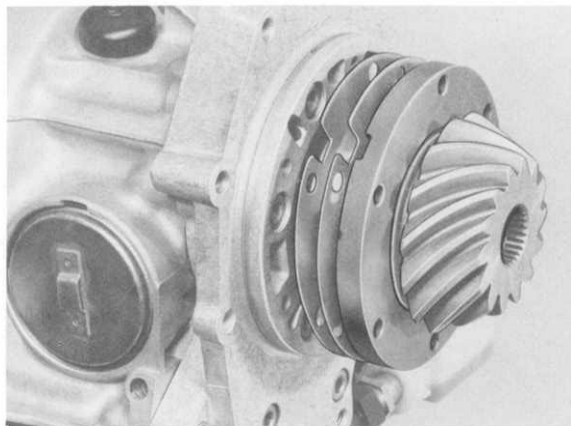
If ATF sump contains metal particles, torque converter has to be replaced. Metal particles could not be completely removed by flushing and would lead to transmission damage.

6. Determine thickness of shims for bearing assembly. Measure distance from tapered roller bearing surface to bearing flange surface with a depth gauge (for example: 34.55 mm). Since the distance specified by design is only 34 ± 0.05 mm, shims having a thickness of 0.55 mm must be installed.

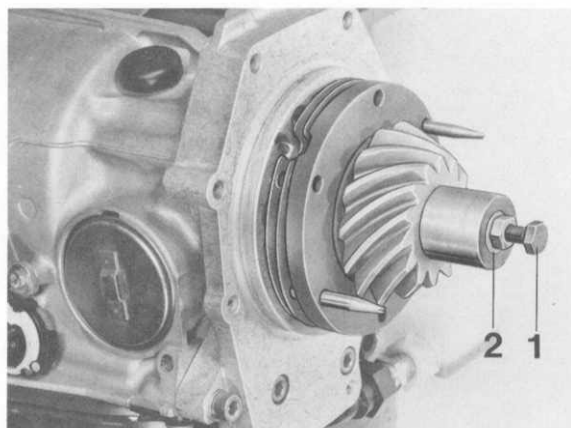
**Example:**

34.55 mm Actual distance (measured)
34.00 mm Nominal distance (specified)
 0.55 mm Thickness of shims

7. Install shims of determined thickness and bearing assembly on output shaft.

**Note :**

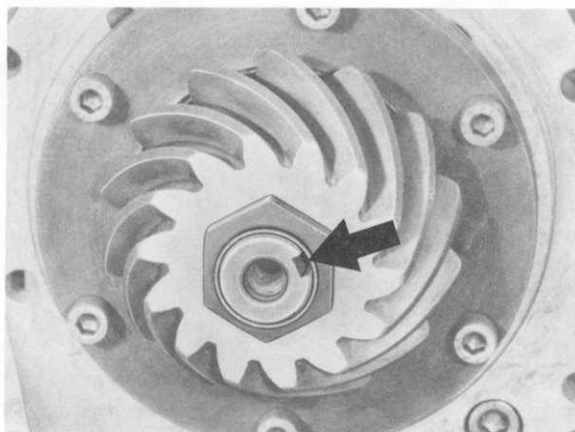
Use Special Tools 9321 and a locally made pressing in tool to make installation easier.



1 = Bolt from Special Tool 9148

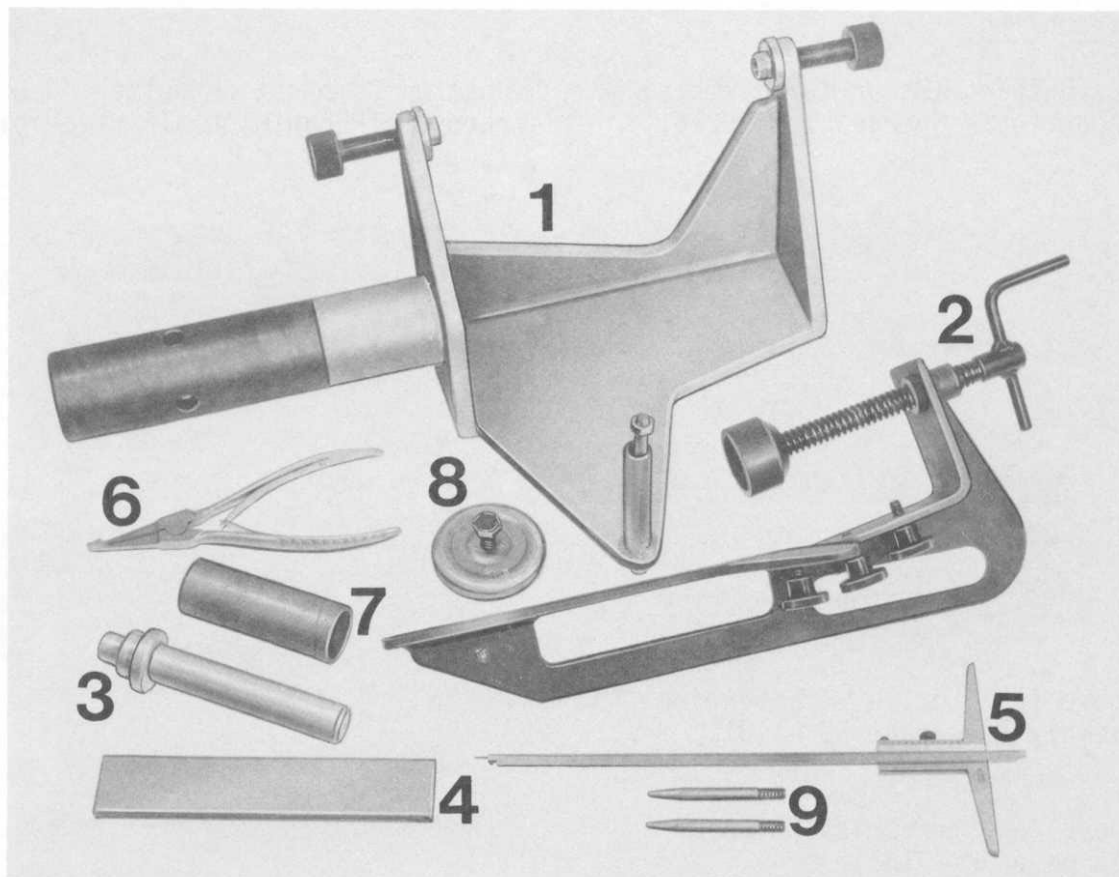
2 = Washer

8. Tighten flange nut for drive pinion to specified torque and lock by upsetting the flange.



9. Adjust drive pinion and ring gear (see page 39 - 125).
10. Install transmission and check adjustment of selector lever and control pressure cables.

TOOLS

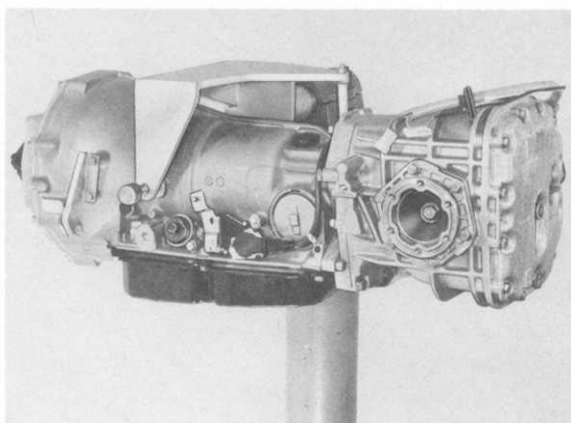


No.	Designation	Special Tool	Remarks
1	Holder	9216	Commercially available Commercially available (e.g. Hazet 1847 - 2)
2	Assembly support	9316	
3	Mandrel	9119	
4	Measuring bridge	9313	
5	Depth gage	-	
6	Circlip pliers	-	
7	Spacer sleeve	9312	
8	Measuring device	9320	
9	Centering pins	9321	

DISASSEMBLING AND ASSEMBLING TRANSMISSION

Disassembling

1. Attach transmission to assembly support with Special Tool 9216.

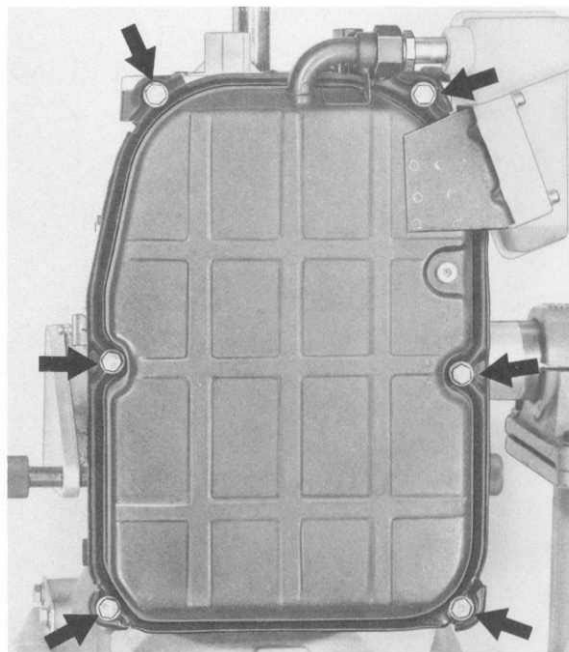


2. Remove final drive with bearing assembly (see page 39 - 101).

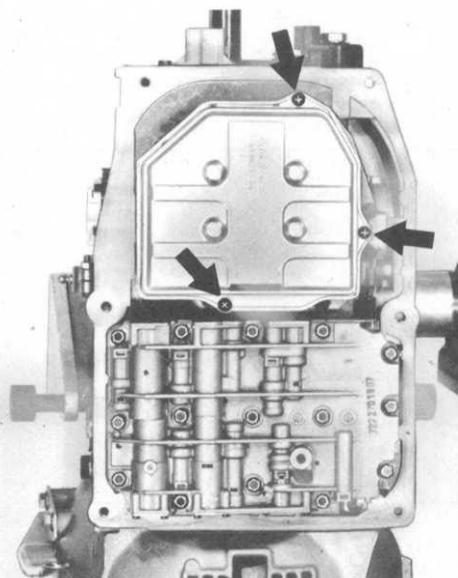
3. Remove rear transmission case (see page 37 - 131).

4. Remove front converter casing and converter (see page 32 - 101).

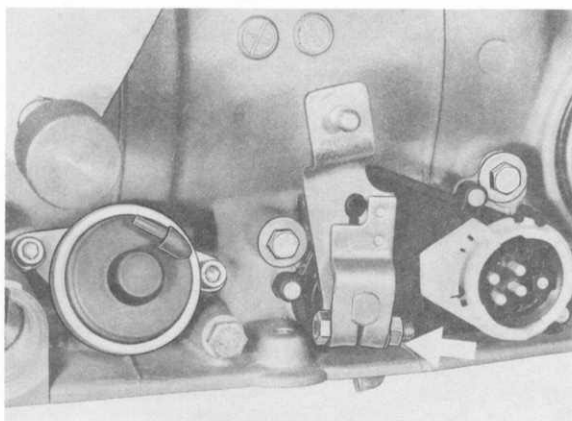
5. Unscrew combination bolts and remove ATF pan with ATF reservoir.



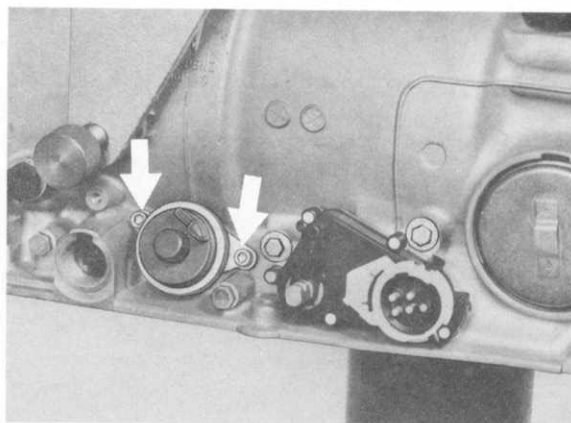
6. Unscrew cross-recess screws and remove filter.



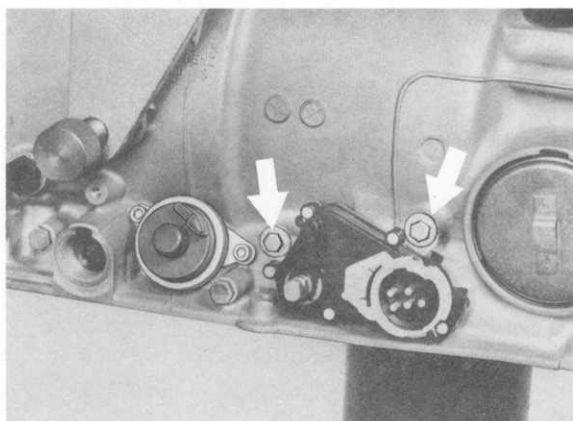
19. Unscrew hex bolt and remove drive-range selector lever.



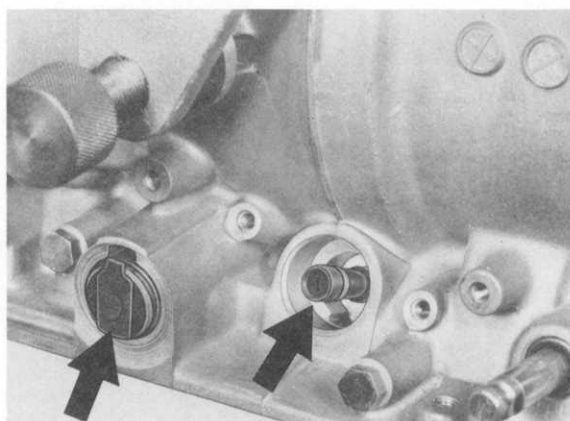
21. Remove vacuum-control unit after unscrewing socket-head bolts.



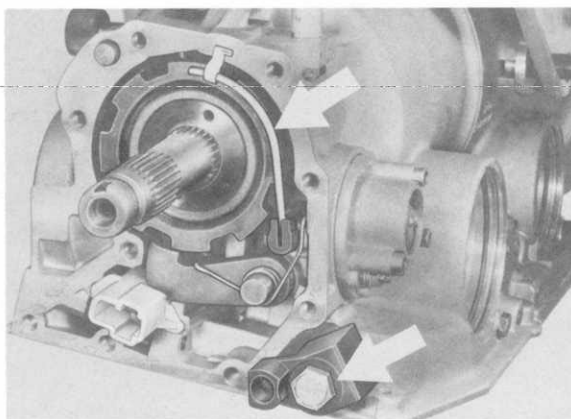
20. Remove starter-interlock switch after unscrewing mounting bolts.



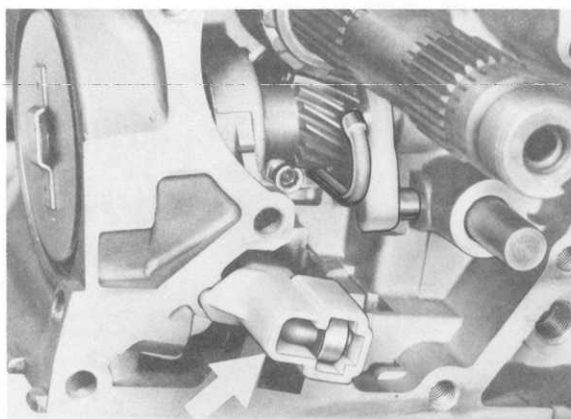
22. Remove pressure unit B 1 and modulating pressure control valve.



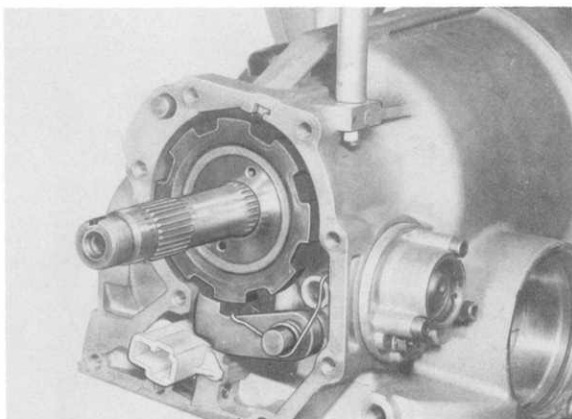
23. Remove kickdown solenoid valve and injector tube.



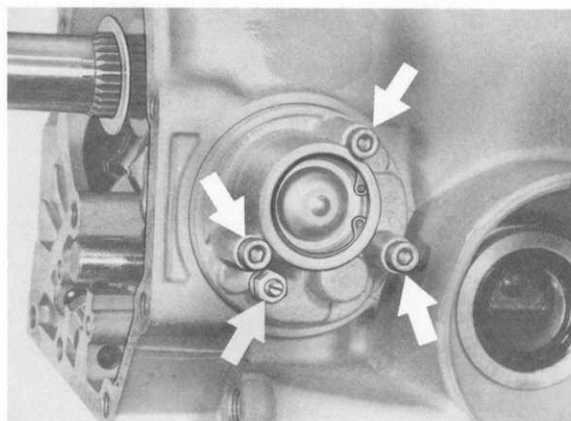
25. Remove plastic guide and roller.



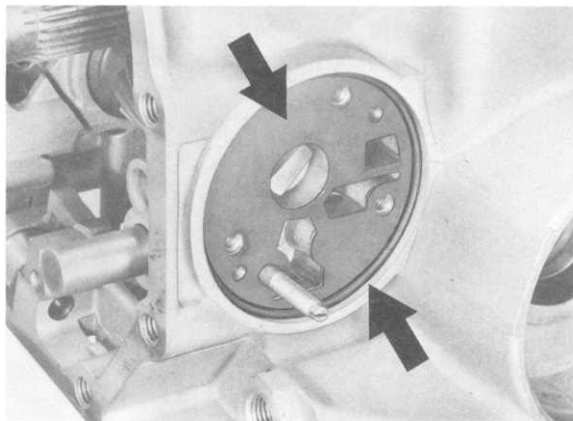
24. Remove parking lock with pawl and expander spring.



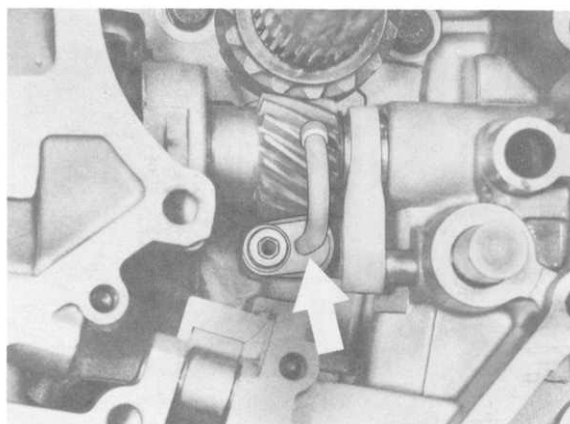
26. Remove secondary pump by unscrewing hex nut from axial holder and removing socket-head bolts.



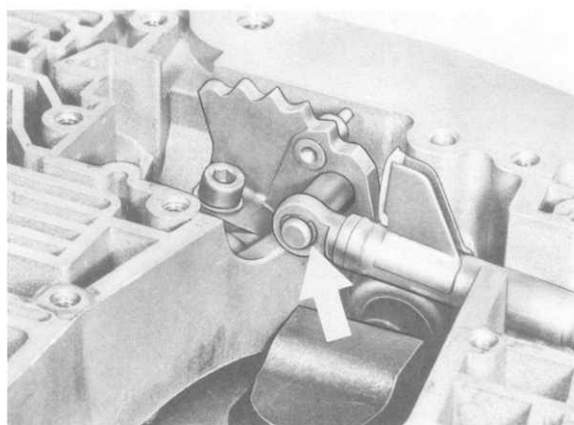
27. Remove O-ring and backer.



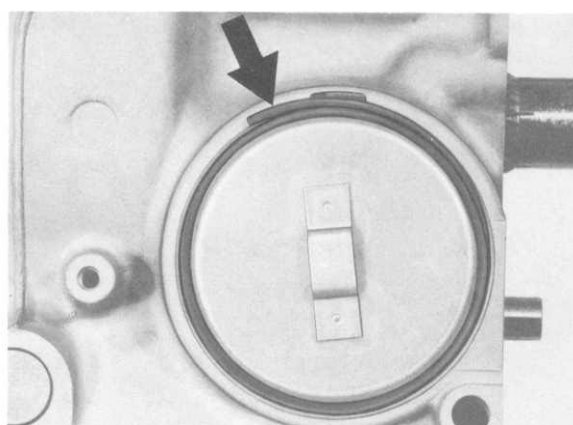
29. Unscrew socket-head bolt and remove with oil tube. The oil tube has been discontinued as of model year '87.



28. Remove circlip and sprung linkage. The circlip has been discontinued as of model year '87. Linkage is staked to detente plate.

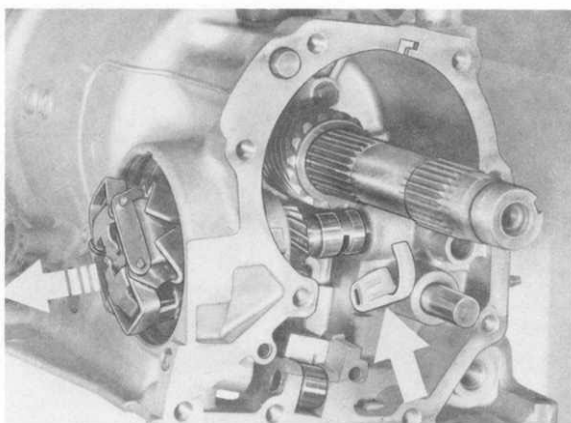


30. Press in cover and remove circlip.



31. Withdraw cover.

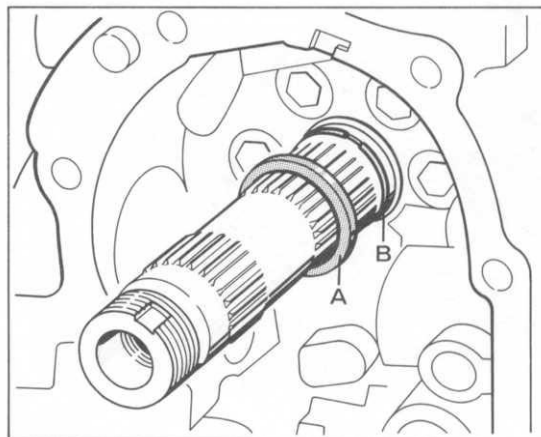
32. Withdraw centrifugal-force controller after swinging back axial holder.



33. Remove axial holder.

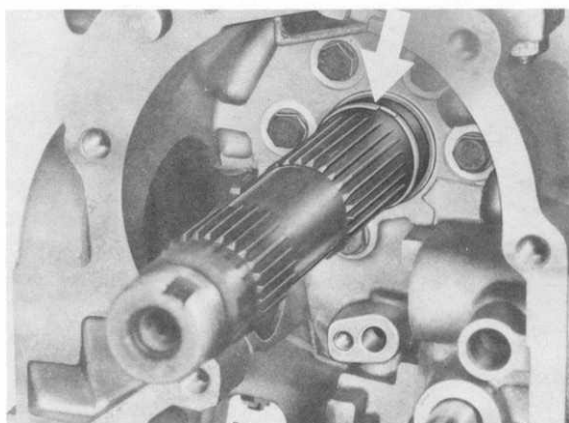
34. Remove helical gear with shims. Note thickness of shims for reinstallation.

35. A modified controller drive gear was fitted as of approx. December 1986. With this design, remove spacer.

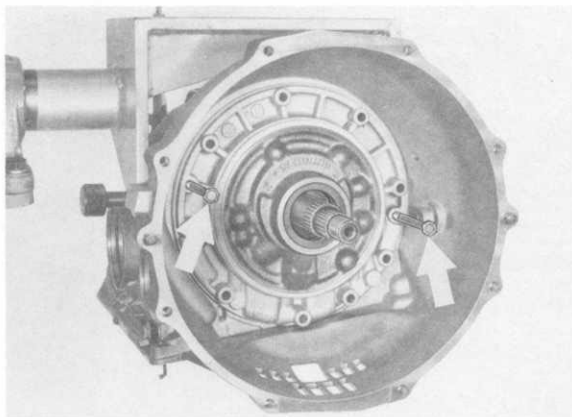


A = Spacer
B = Circlip

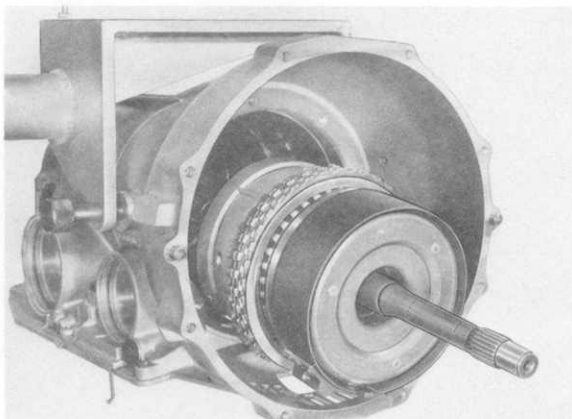
36. With a suitable pair of pliers (e.g. Hazet 1847 - 2) disengage circlip from input shaft.



37. Remove front cover by unscrewing combination bolts, screwing two bolts into the threaded holes and using these to pull off cover.



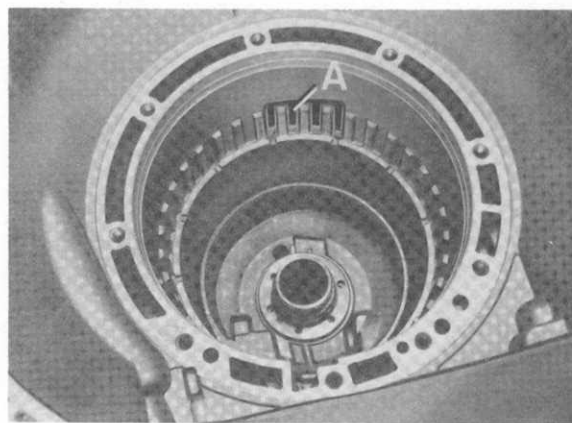
38. Grasp gearset at input shaft and carefully pull forward and out.



39. Pull clutch K 1 with brake band B 1 from gearset.

40. Remove plates B 3.

41. As of transmission No. 379 225 remove damping spring for plates B 3.



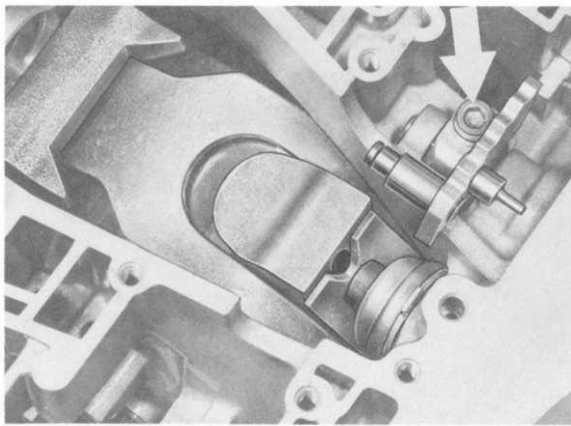
A = Damping spring

42. Remove clutch K 2.

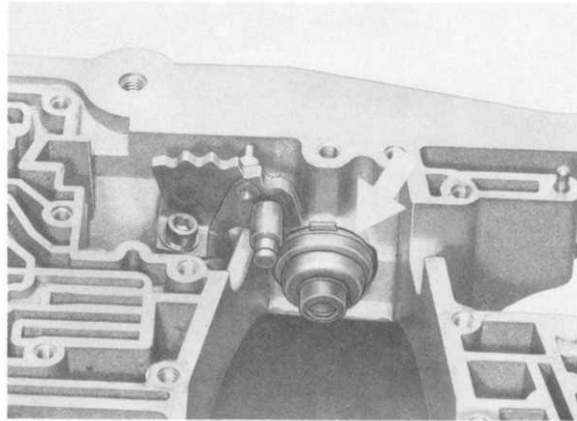
43. Remove pressure pin.

44. Tilt brake band B 2 and remove.

45. Unscrew socket-head bolt, withdraw shaft and remove detente plate.

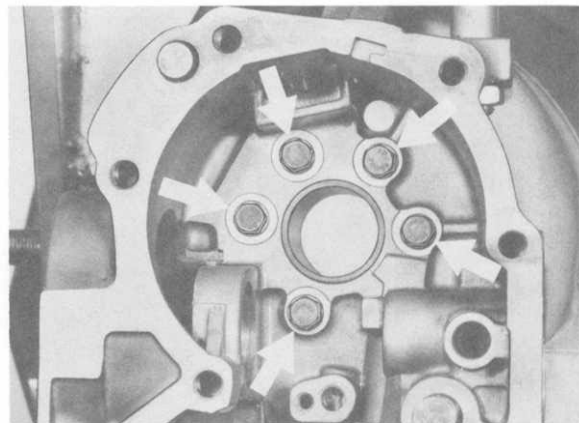
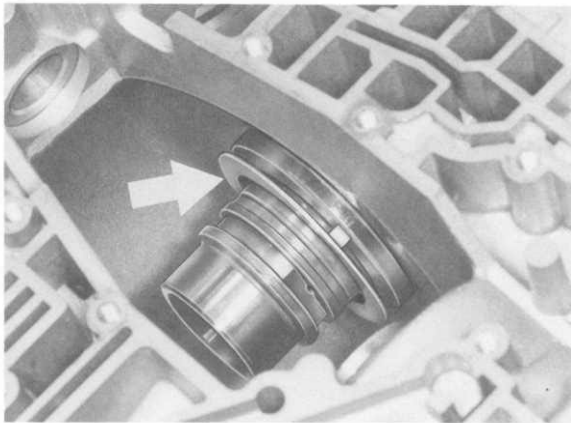


47. Withdraw pressure unit B 2.



48. Unscrew hex bolts. Screw two approx. 80 mm long bolts into two opposite holes and release flange from casing by tapping the two bolts with a hammer.

46. Remove thrust washer



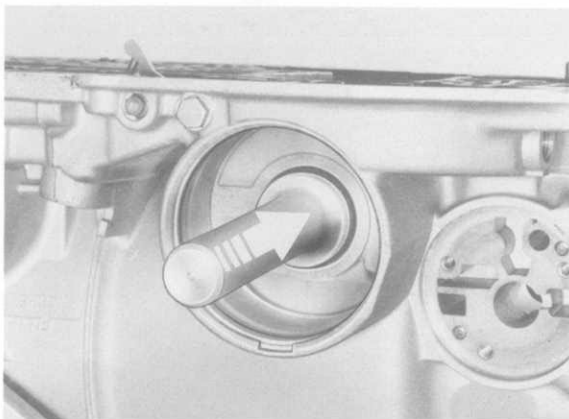
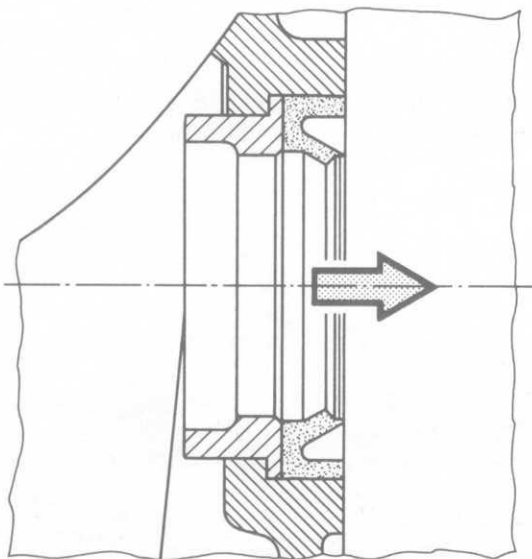
49. Remove any remaining sealing rings, measuring-connection plugs etc. from case.

Assembling

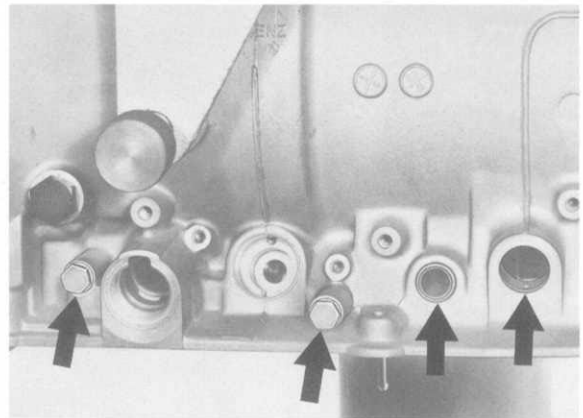
Note:

When assembling, coat all bearings and friction surfaces with ATF. Soak new brake bands and coated plates in ATF for approx. 1 hour before installation.

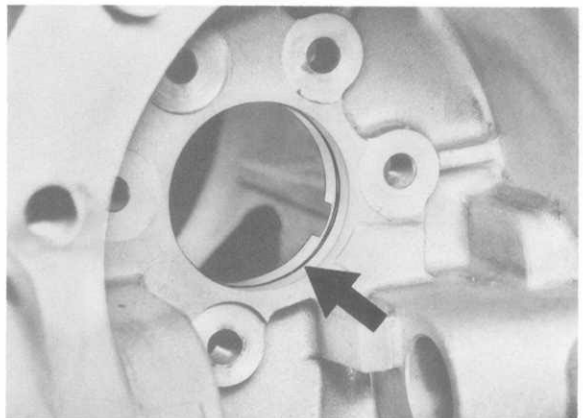
1. Insert guide ring and with Special Tool 9119, drive in sealing ring right way round, sealing lip (arrowed) facing outward toward brake-band piston cover.



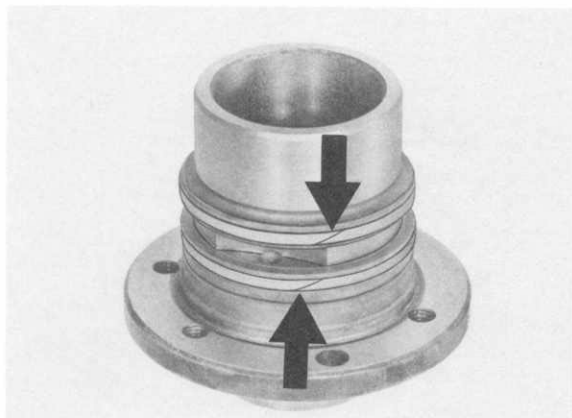
2. Insert O-ring and sealing ring. Screw in threaded plug with new sealing ring and tighten. Tightening torque 10 Nm (7 ftlb).



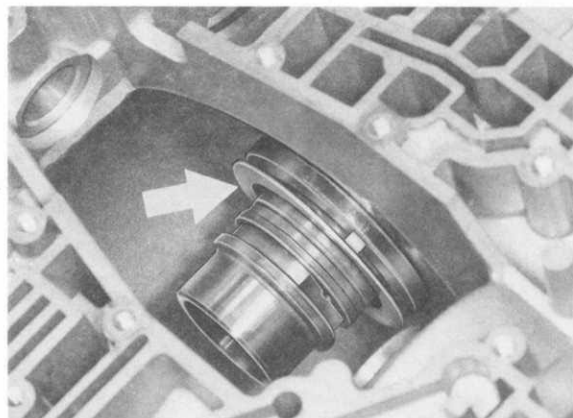
3. Place O-ring (arrowed) in groove.



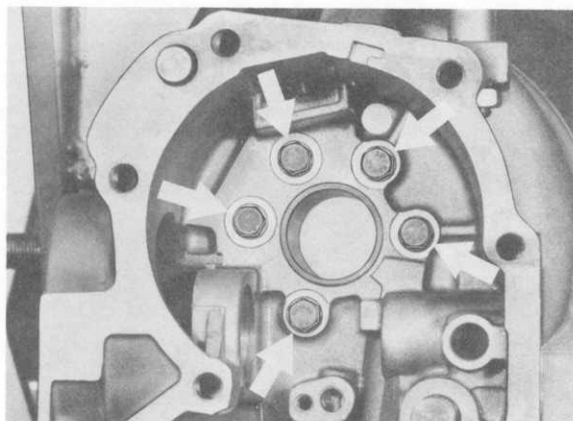
4. Grease grooves in support flange K 2. Insert teflon rings and press into grooves until joints (arrowed) are closed.



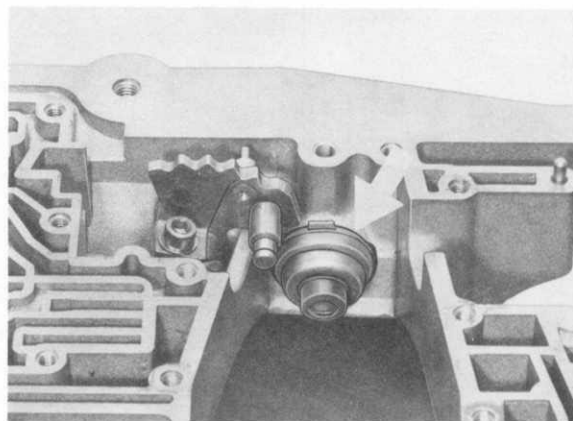
6. Position thrust washer right way round (positioning lug engages support flange).



5. Position support flange so that holes are aligned. Tighten mounting bolts. Tightening torque: 11 Nm (8 ftlb).



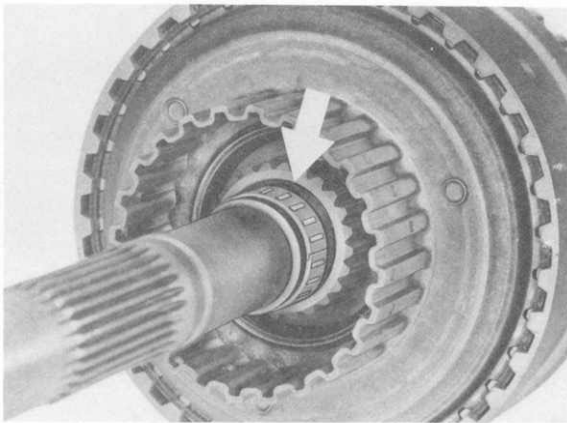
7. Insert pressure unit B 2 with projection (arrowed) upward.



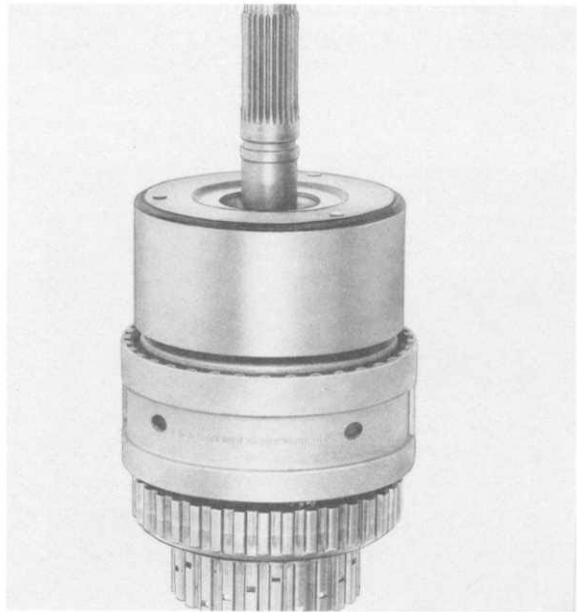
8. Recheck to ensure that teflon rings are correctly seated on support flange.

9. Press brake band B 2 as close together as possible at the support lugs and insert right way round in case.

10. Place greased split radial bearing on output shaft.



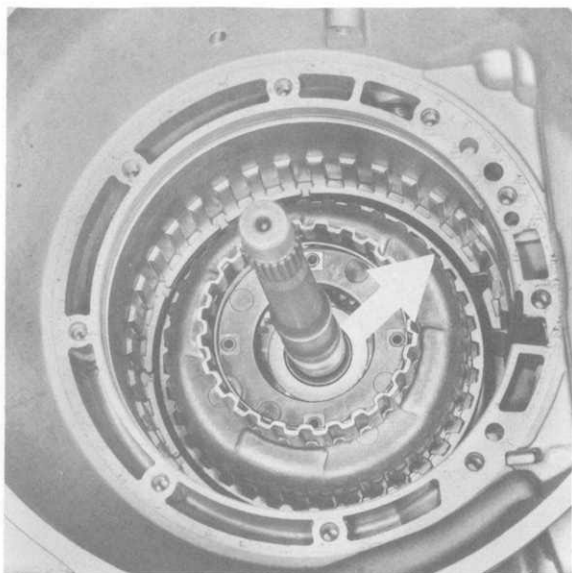
11. Push clutch K 2 onto gearset.



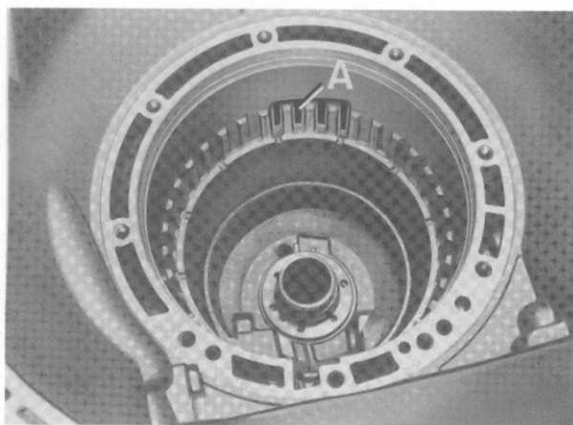
12. Carefully place gearset without clutch K 1 in transmission case while turning input shaft.

13. Set transmission upright with input shaft at top.

14. Check installation position of gearset. The gearset position is correct when the upper edge of the connector element (arrowed) is lower than the contact surface of the outer plate LB 3.

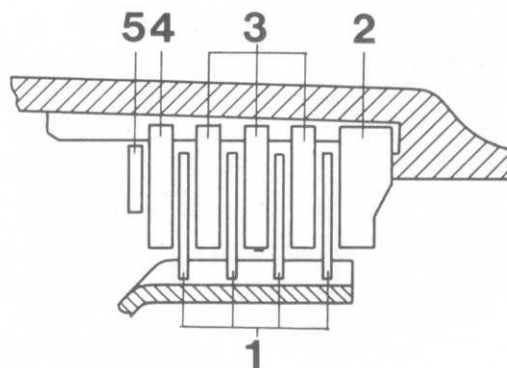


15. As of transmission No. 379225, install damping spring.



A - Damping spring

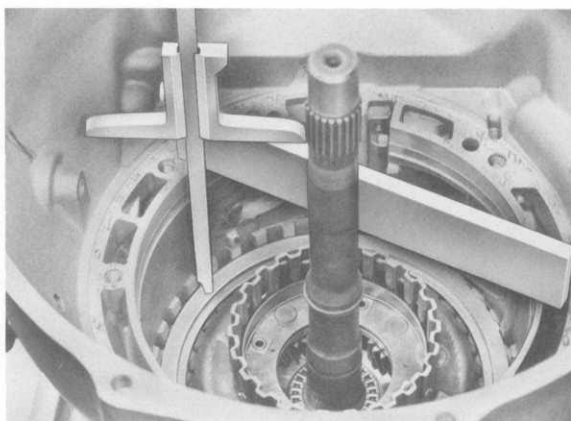
16. Insert plates for plate brake B 3 right way round.



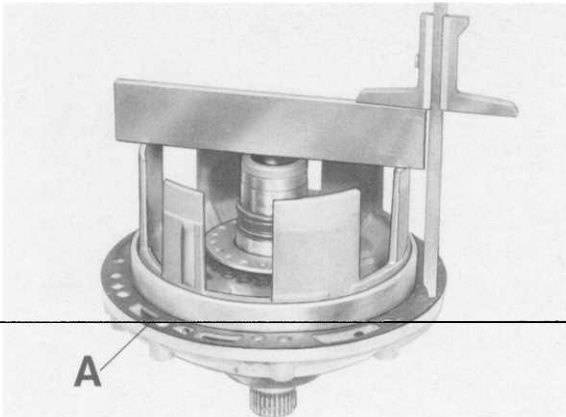
- 1 = Inner plate 2.1 mm thick
2 = Outer plate 7.7 mm thick
3 = Outer plate 2.3 or 2.8 mm thick*
4 = Outer plate 2.8 mm thick
5 = Shim 2.5-3.0-3.5 mm thick*

* as required to correct play

17. Measure play "L" of B 3 and correct.
Measure distance "d":
Place measuring bridge 9313 on prepared face and measure with depth gage to shim.

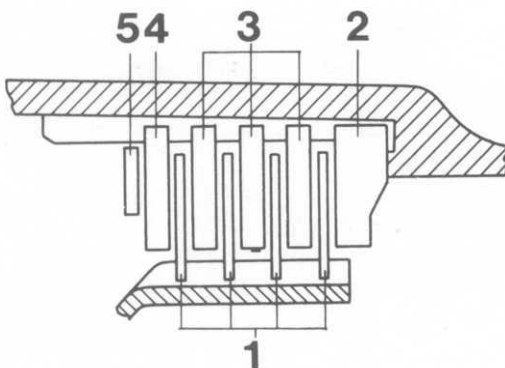


Measure distance "e":
Place measuring bridge 9313 on
piston of plate brake and measure
with depth gage to seal.



A = seal

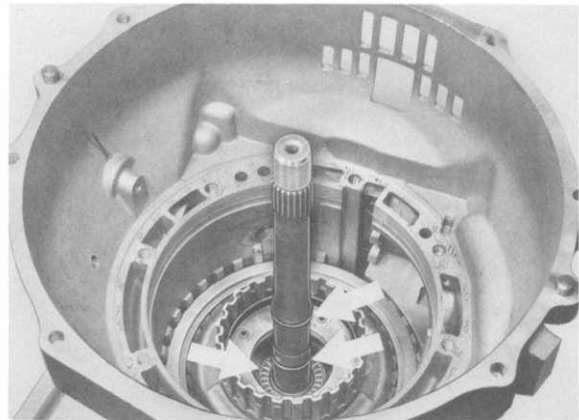
The difference between the two
distances is the play "L". Correct
play to specified value
1.5...2.0 mm. Correct by inserting
outer plates and shims of
appropriate thicknesses.



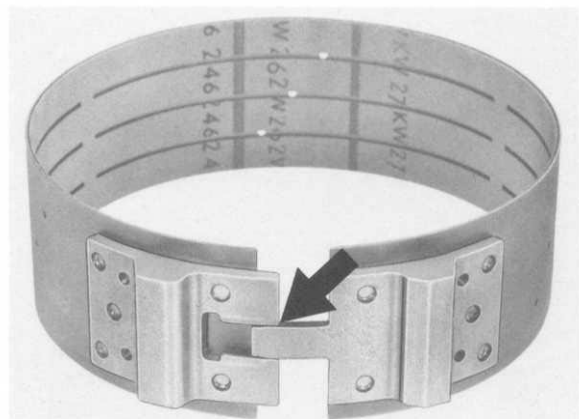
- 1 = Inner plate 2.1 mm thick
- 2 = Outer plate 7.7 mm thick
- 3 = Outer plate 2.3 or 2.8 mm thick*
- 4 = Outer plate 2.8 mm thick
- 5 = Shim 2.5-3.0-3.5 mm thick*

* as required to correct play.

18. Place axial bearing in planet carrier. Check that lubricating pressure rings are correctly seated (insert with grease).



19. Engage brake band B 1 in assembly lock (arrowed).

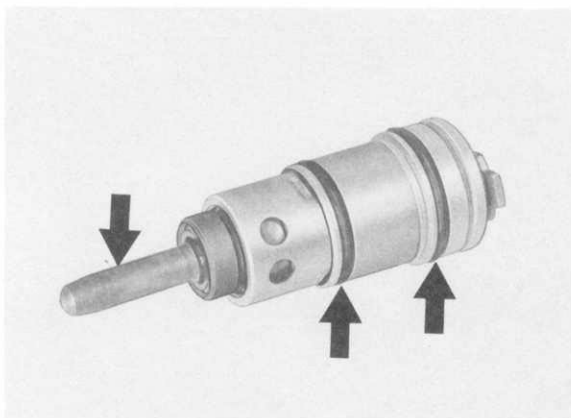


20. Insert clutch K 1 while turning until teeth engage.

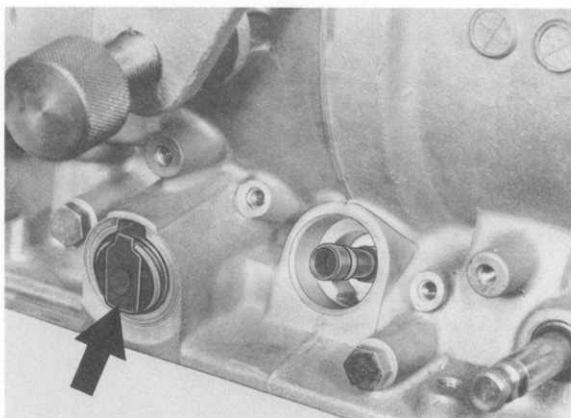
21. Insert brake band such that pin is facing from assembly lock to pressure unit B 1 (see Step 19).

22. Do not insert axial bearing and shims until axial play of clutch K 1 has been measured.

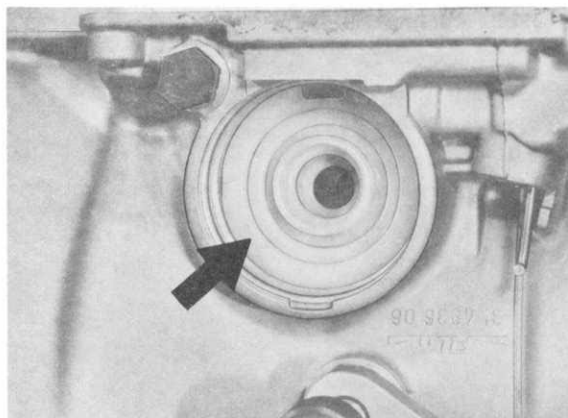
23. Push pressure pin into pressure unit B 1 (replace O-rings).



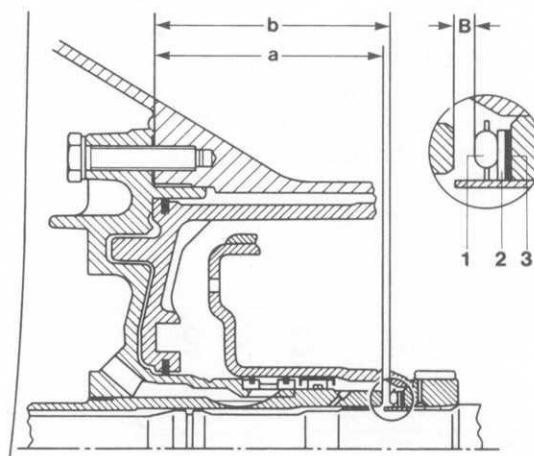
24. Insert pressure unit, screw in threaded plug or transmission protection switch in '87 models onward and tighten. Tightening torque 70 Nm (52 ftlb).



25. Insert brake-band guide. The locating pins must engage the holes in the case.



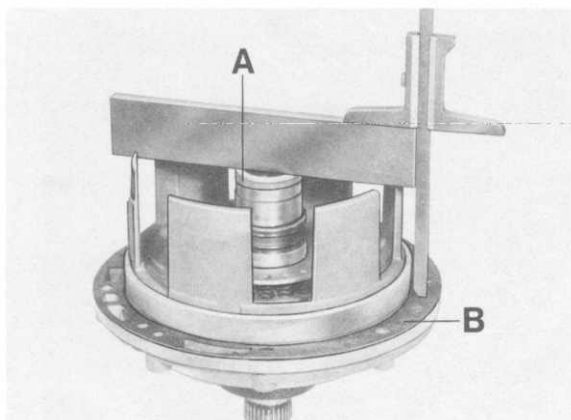
26. Check axial play "B" for clutch K 1 and correct.



- 1 = Axial bearing
- 2 = Rotation washer
- 3 = Shim
- B = Axial play

Measure distance "a":

Place seal on front cover. Place Special Tool 9313 on flange and with depth gage, measure to seal. (e.g. 119.0 mm).

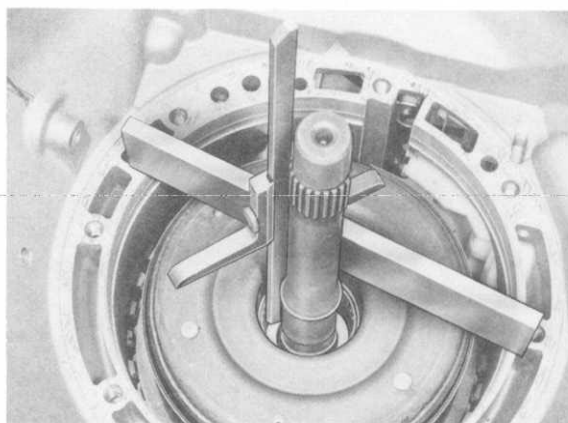


A = Spacer (discontinued as of transmission No. 472 213)

B = Seal

Measure distance "b":

Place measuring bridge 9113 on prepared face and, with depth gage, measure to clutch K 1 (e.g. 123.6 mm)



The difference between the two measurements is the axial play "B" (without axial bearing, rotation washer or shim).

Example

"b" =	123.6 mm	
"a" = -	119.0 mm	

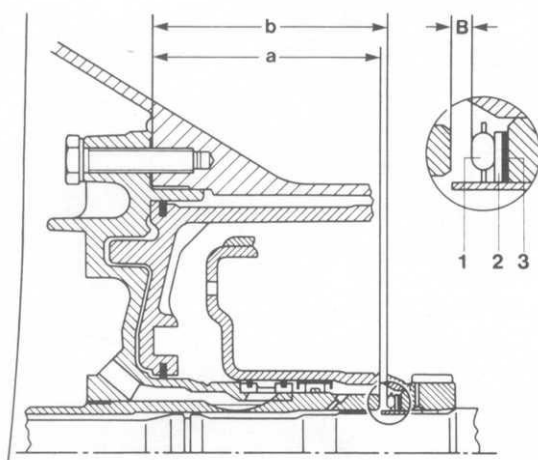
	4.6 mm	
-	0.8 mm	
	-----	specified axial
		play.
	3.8 mm	Play without axial
	-----	bearing and
		shims.

Note:

Correct play to 0.8 mm by installing axial bearing, rotation washer and the appropriate shims.

Select axial bearing, rotation washer and shims such that the overall thickness is 3.8 mm.

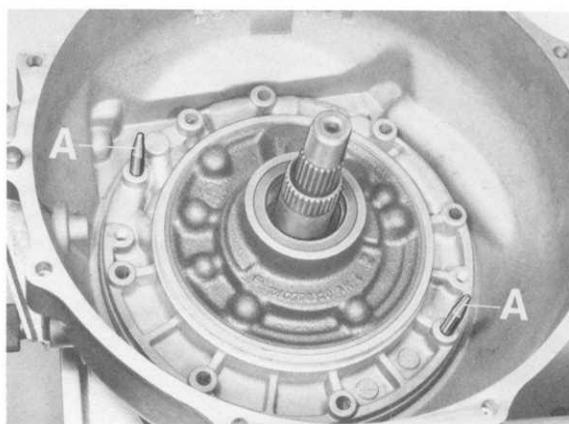
Insert these spacers as calculated (thickness in example, 3.8 mm)



- 1 = Axial bearing
- 2 = Rotation washer
- 3 = Shim

27. Check that teflon rings in front cover and on input shaft are correctly seated.

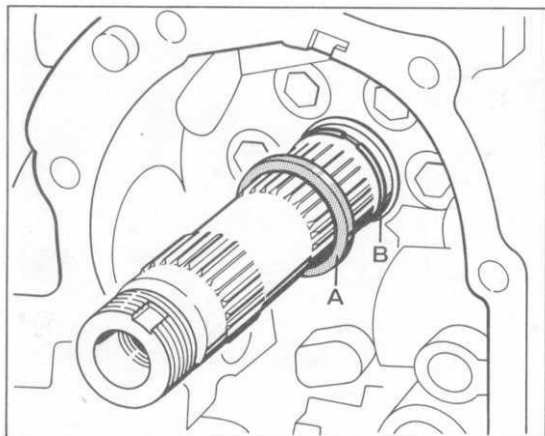
28. With a blob of grease, attach spacer to support and place front cover with seal in position. Tighten mounting bolts. Tightening torque: 13 Nm (10 ftlb).



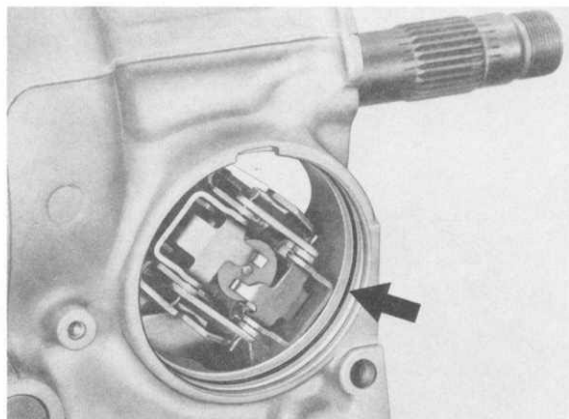
A - Centering pins 9321

29. Turn assembly support so that output shaft is facing upward.

30. Insert circlip and position spacer right way round.



32. Insert O-ring and install centrifugal-force controller

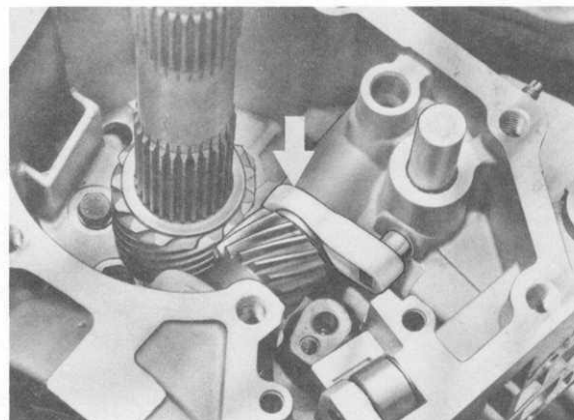
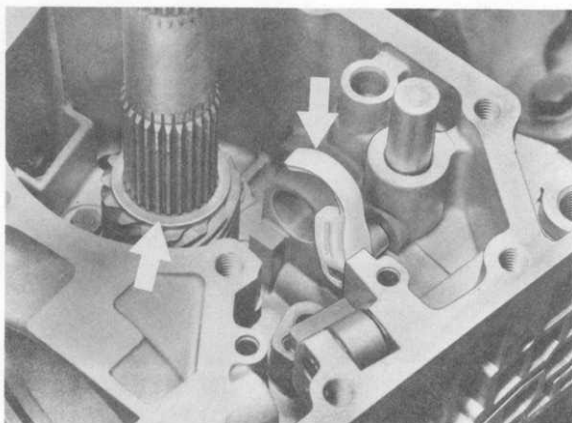


33. Swing axial holder over to centrifugal-force controller so that holder engages groove of controller shaft.

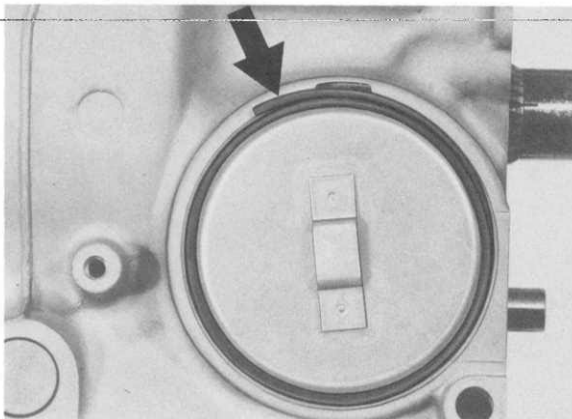
Note:

The spacer has been in use since approx. December, 1986.

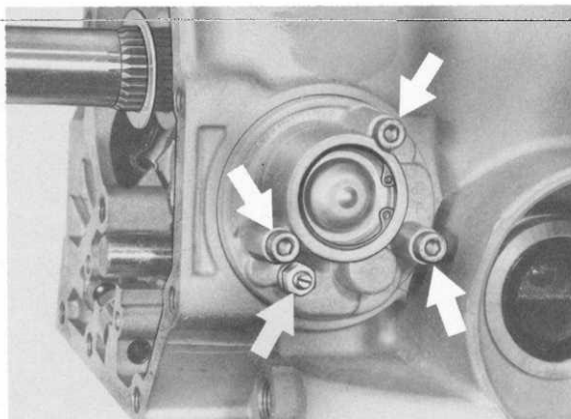
31. Install helical gear and axial holder.



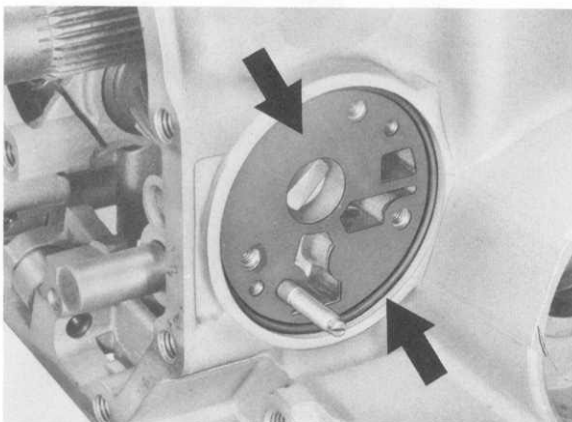
34. Insert cover and install circlip. Then pull cover out so that it makes contact with circlip around entire circumference.



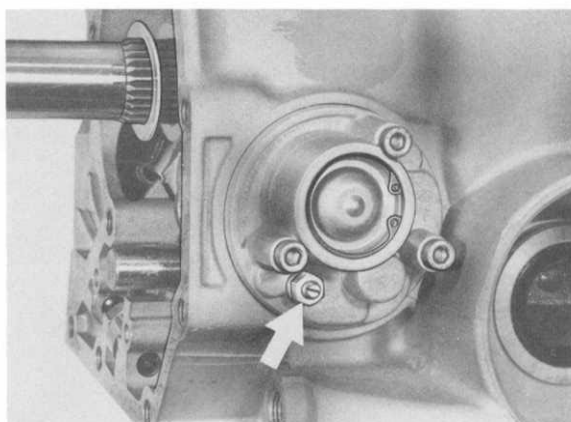
36. Place secondary pump in position and tighten hex bolts. Tightening torque: 8 Nm (5.9 ftlb).



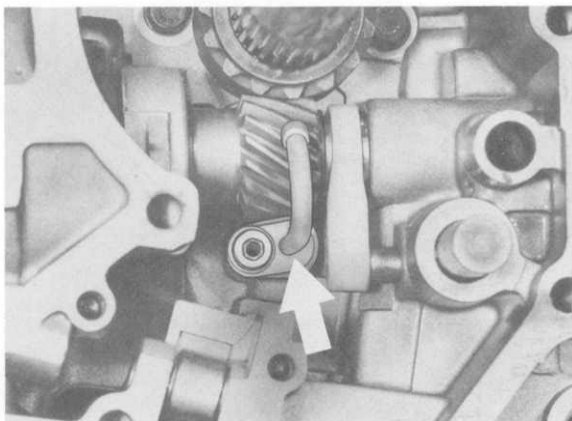
35. Install backer and insert O-ring.



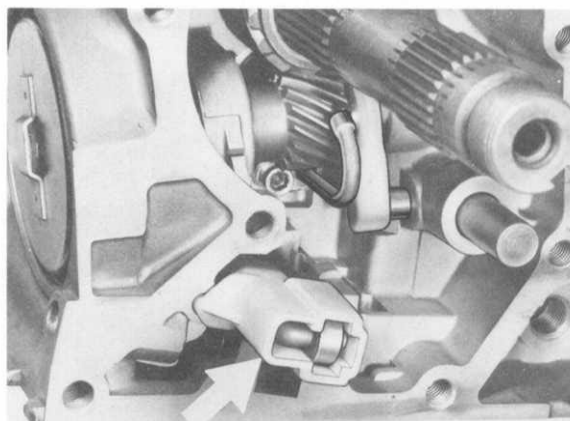
37. Recheck seating of axial holder and tighten new nut. Tightening torque: 6 Nm (4.4 ftlb).



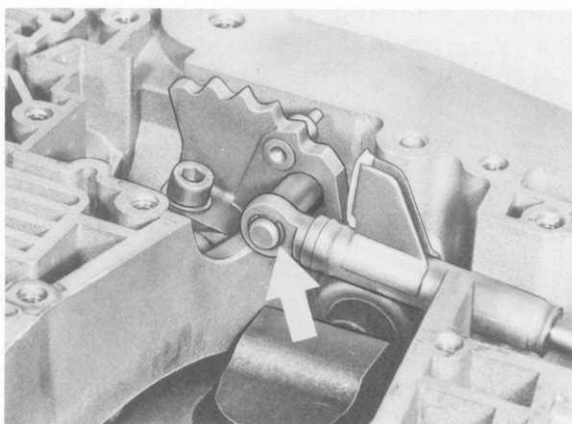
38. Insert oil tube (arrowed) and tighten socket-head bolt. Tightening torque: 8 Nm (5.9 ftlb). The oil tube is discontinued as of '87 models.



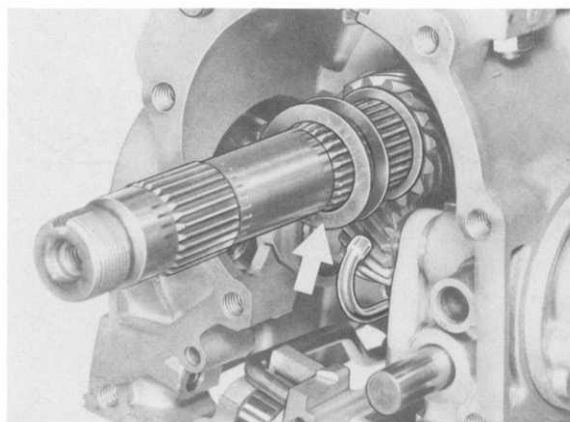
40. Push roller onto sprung linkage, place plastic guide in position and push into positioning holes.



39. Insert detente plate with shaft, screw in socket-head bolt and tighten. Tightening torque: 8 Nm (5.9 ftlb). Push sprung linkage onto detente plate and install circlip (arrowed). The circlip is discontinued as of '87 models. Linkage is staked to detente plate.

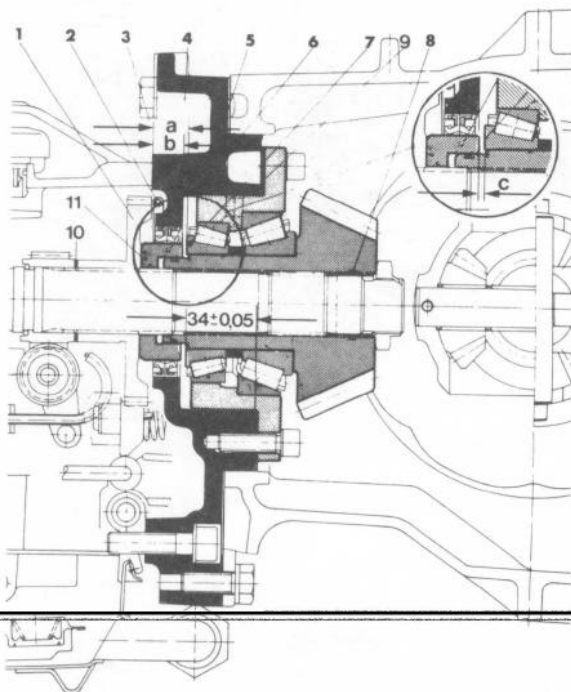


41. Place correct number of shims on helical gear.



42. Install parking lock pawl, expander spring and parking lock gear.

43. Measure axial play "C" of output shaft (clutch K 2) and correct.



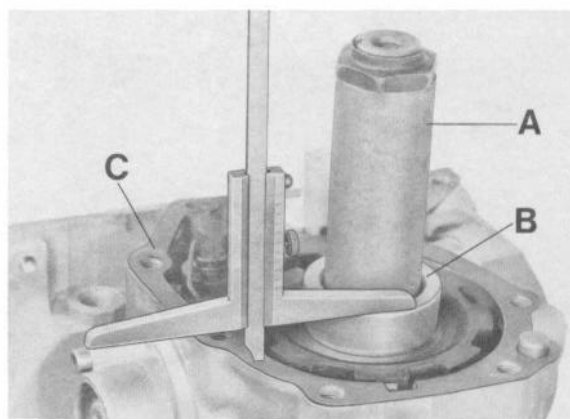
- 7 = Taper roller bearing - inner race
- 9 = Shim for bearing assembly
- 10 = Shim for axial play "C"
- 11 = Rotation ring
- C = Axial play

Measure distance "b":

Push Special Tool 9312 onto output shaft and tighten collar nut. Tightening torque 380 Nm (280 ftlb). To do so, engage parking lock pawl.

Place seal in position.

Use a depth gage to measure from rotation ring to seal (e.g. 15.3 mm).

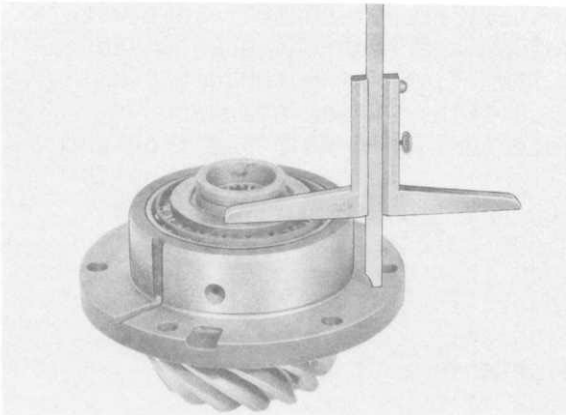


- A = Special Tool 9312
- B = Rotation ring
- C = Seal

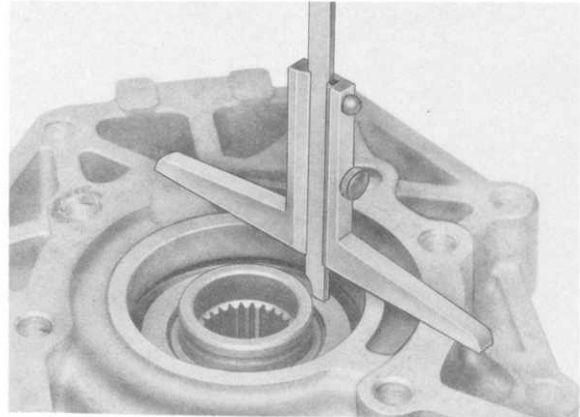
Measure distance "a":

Calculate thickness of shims for bearing assembly:

Use a depth gage to measure from bearing surface of taper roller bearing to bearing face of bearing assembly (e.g. 34.55 mm). However, because the specified distance may not exceed 34 ± 0.05 mm, 0.55 mm must be made up in shims.



Use a depth gage to measure from case bearing face to inner race of cylindrical roller bearing (e.g 15.9 mm).

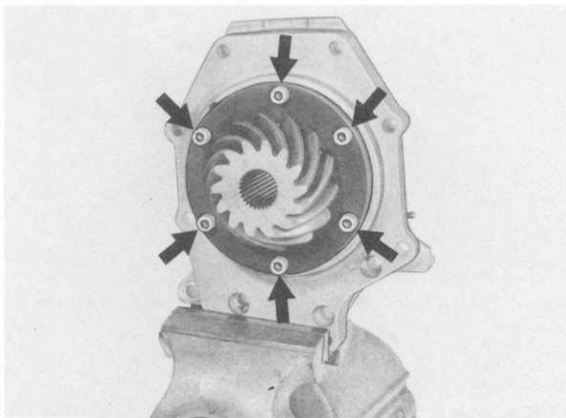


Example:

34.55 mm	As-is (measured on bearing assembly)
- 34.00 mm	Specified (design distance)

0.55 mm	Thickness of shims

Install bearing assembly with shims as calculated in case and tighten all mounting bolts. Tightening torque: 33 Nm (24 ftlb).



Distance "b" minus distance "a" equals distance "C".

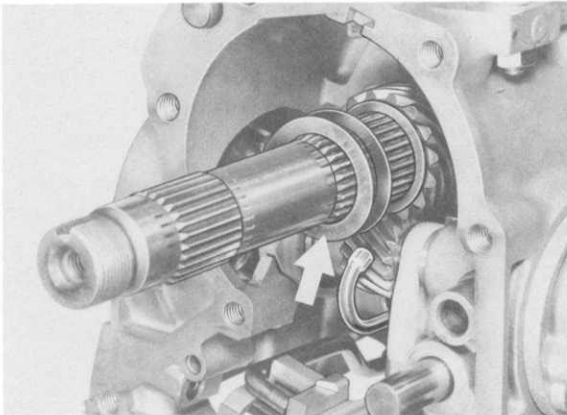
Example:

Distance "a"	15.9 mm
Distance "b"	- 15.3 mm
	=====
Distance "C"	0.6 mm
	=====

Correct axial play "C" to 0.4 + 0.1 mm by inserting or removing shims beneath parking lock gear.

Note:

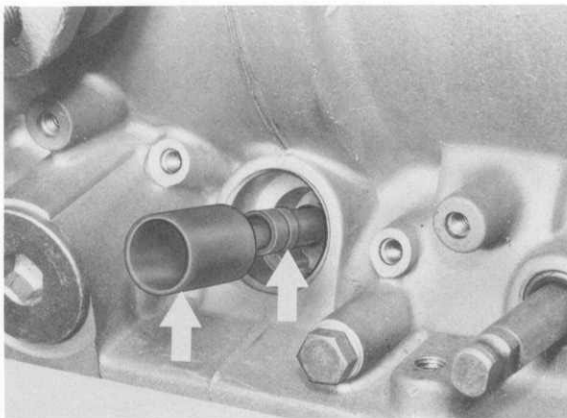
Remove bearing assembly from case and do not reinstall finally until case is fully assembled (see page 37 - 131).



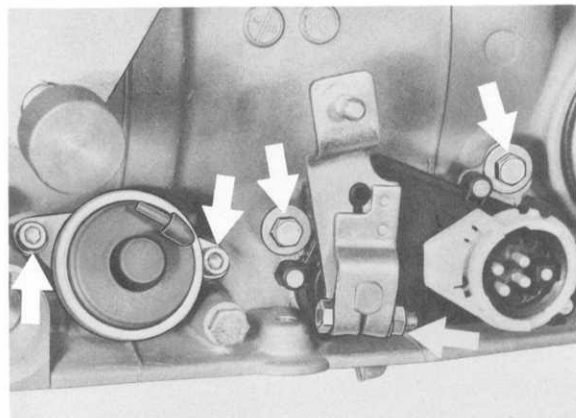
44. Insert injector tube.
Discontinued as of '87 models.

45. Screw in kickdown solenoid valve and tighten. Tightening torque: 20 Nm (15 ftlb).

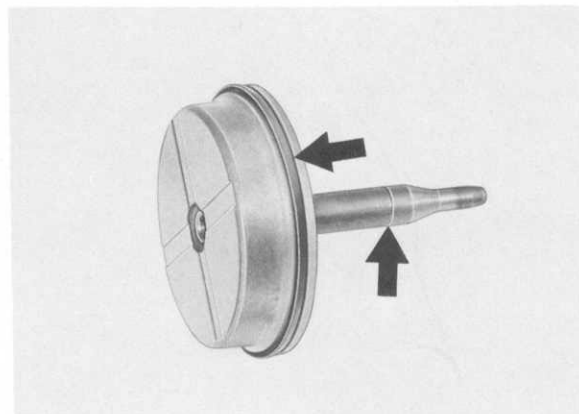
46. Insert modulating pressure control valve and pressure pin.



47. Install vacuum-control unit with holder and tighten socket-head bolts. Tightening torque: 8 Nm (5.9 ftlb). Place starter interlock switch in position and slightly tighten mounting bolts (do not tighten fully). Place range selector lever in position such that carrier is fixed in lever. Insert hex bolt and tighten. Tightening torque: 8 Nm (5.9 ftlb).



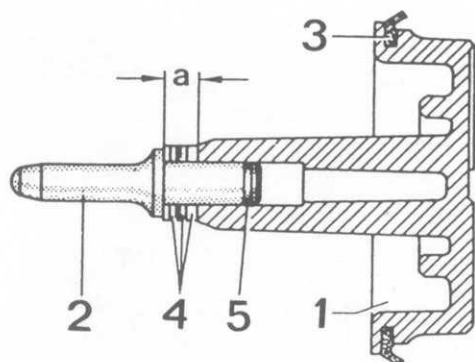
48. Insert sealing ring with lip in brake band piston B 1 such that sealing lip is pointing in the direction arrowed.



Note:

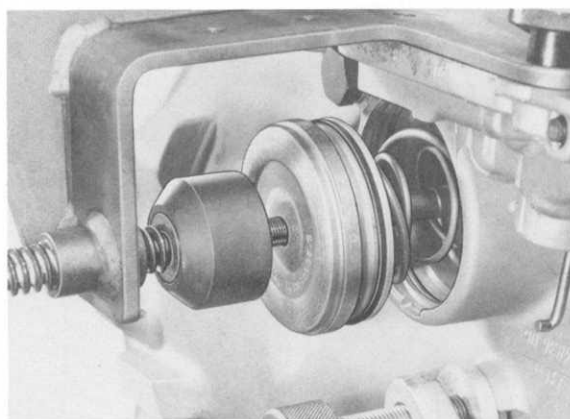
Brake-band pistons with five different pressure pins marked with grooves (arrowed) are available to correct play at brake band B 1. The brake band piston with the shortest pressure pin has no identification groove, the brake band piston with the longest pressure pin has four identification grooves.

Brake band pistons with removable pressure pins were installed as of transmission No. 788 606. To correct play, use shims available in three thicknesses 0.5 mm, 1.0 mm and 1.5 mm.



- 1 = Brake band piston B 1
- 2 = Pressure pin
- 3 = Sealing ring with lip
- 4 = Shims
- 5 = O-ring
- d = Max. 6.5 mm

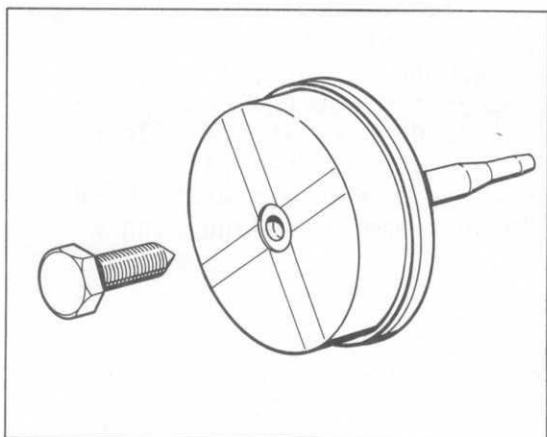
49. Bolt Special Tool 9316 to transmission case and insert brake band piston B 1 with compression springs and Special Tool 9320. Screw spindle down while ensuring that piston pressure pin enters brake band (do not damage sealing ring with lip).

Note:

Play is set with either a flat or pointed adjuster screw for Special Tool 9320, depending on the design of brake band piston.

Piston with rivetted pressure pin = hex screw with point

Piston with removable pressure pin = flat hex screw M 10 x 1



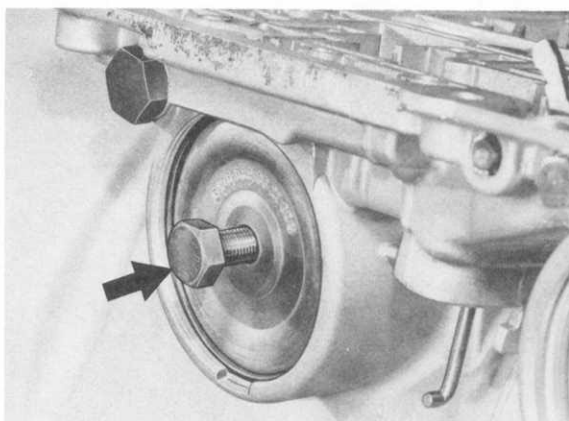
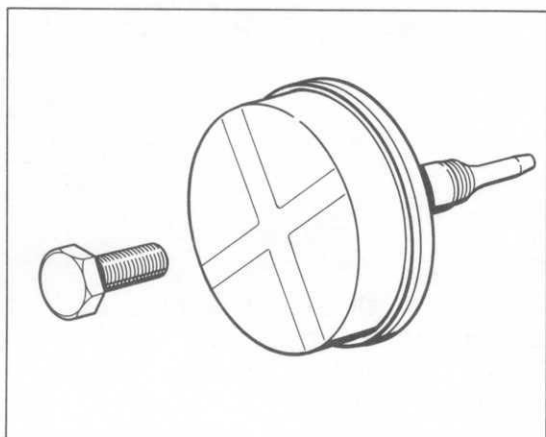
50. Insert circlip, relieve Special Tool 9316 and remove.

51. Measure and adjust play "L" of brake band.

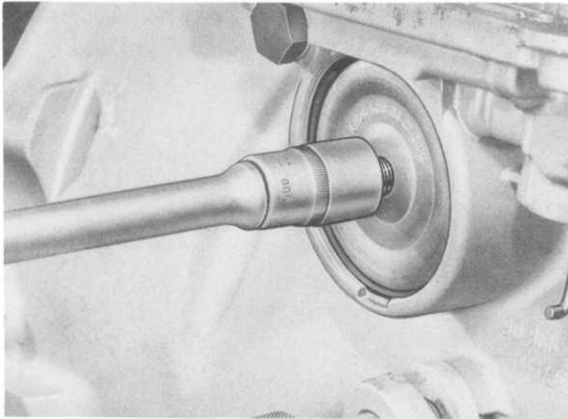
Note:

The thread of Special Tool 9320 has a 1 mm lead, which means that one full turn equals 1 mm travel.

Turn screw of Special Tool by hand until resistance is felt.



Tighten screw further with torque wrench, counting turns and tightening to 5 Nm (2.3 ftlb).

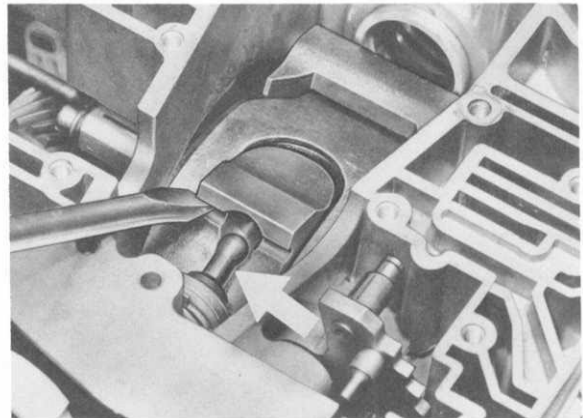


Travel at brake band must be 3...4 mm, in other words, the 5 Nm (2.3 ftlb) torque must be reached after 3...4 turns.

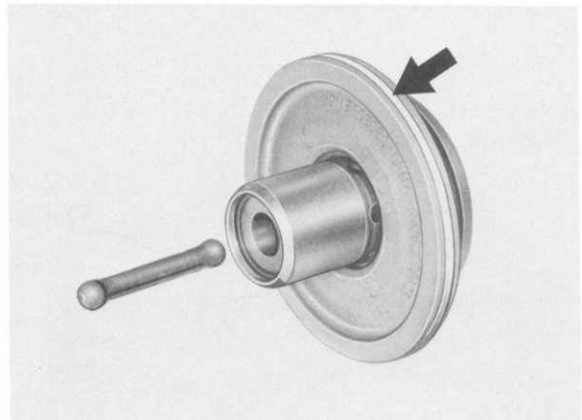
52.If travel is excessive, fit a brake band piston with a longer pressure pin; if travel is too short, fit a brake band piston with shorter pressure pin. As of transmission No. 788 606, use appropriate shims to correct travel.

53.Place Special Tool 9316 in position and bolt down. Remove brake band piston B 1 and install brake band piston cover instead of Special Tool 9320.

54.Install pressure pin with larger diameter toward brake band B 2.



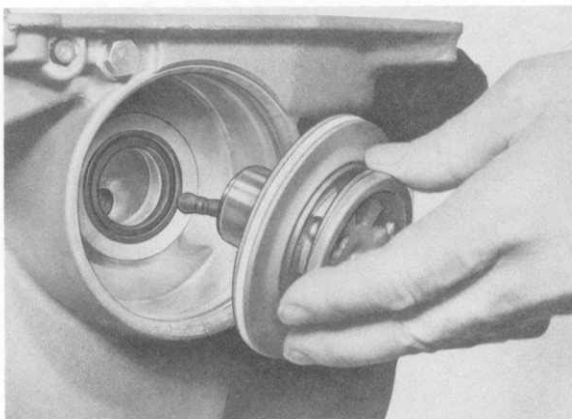
55.Insert teflon ring with grease in groove and insert pressure pin.



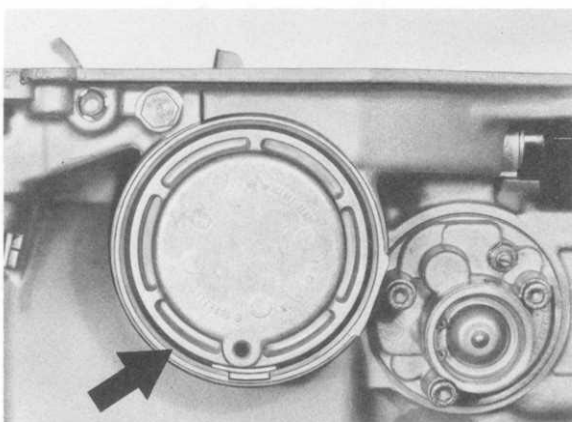
Note:

Pressure pins are available in 4 lengths for correcting travel at brake band B 2.

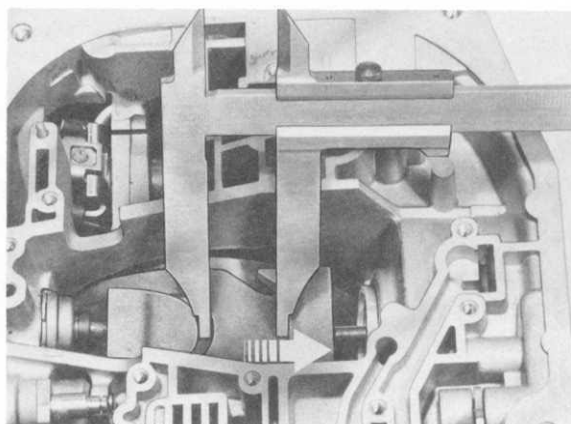
56. Insert brake band piston B 2, ensuring that pressure pin engages brake band.



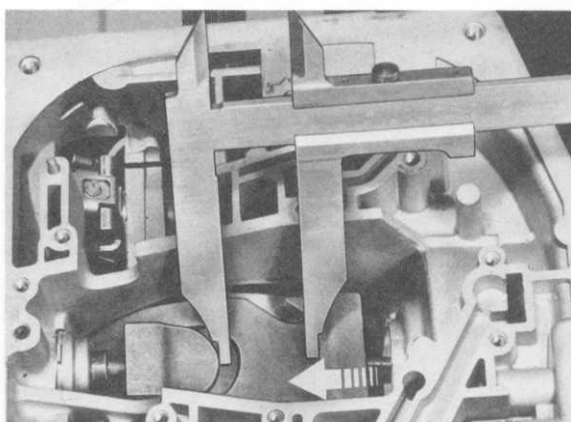
57. Press in brake band piston cover B 2 and insert circlip.



58. Measure play "L" at brake band B 2 and adjust:
press brake band B 2 toward brake band piston at support lug (as arrowed) so that brake band piston contacts brake band piston cover. Use a feeler gage to measure distance "a" at brake band.

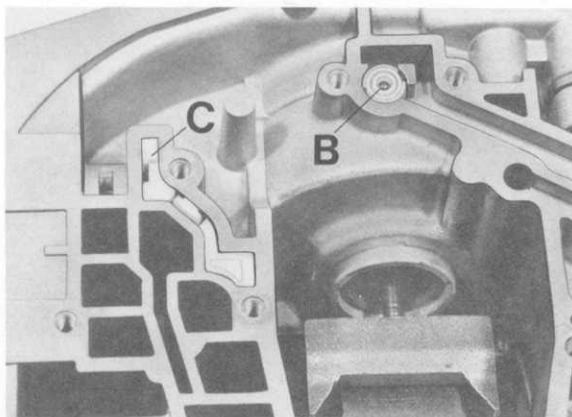


- Again, press brake band B 2 toward pressure unit at support lug (as arrowed) and measure distance "a" again.

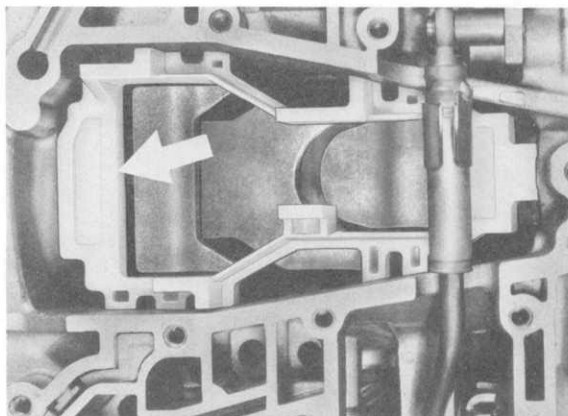


The difference between the two measurements is the play "L". Adjust play "L" to 6...7 mm by changing pressure pin in brake band piston B2.

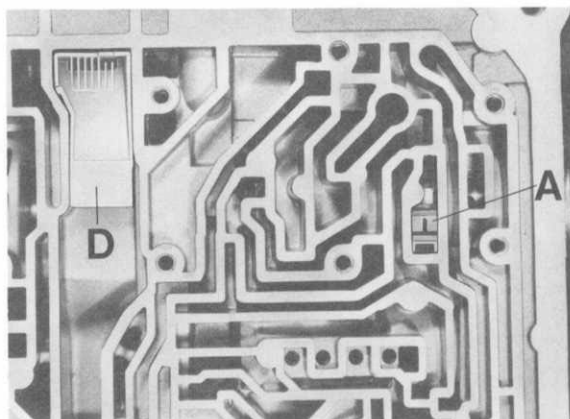
59. Insert one-way valve and filler.



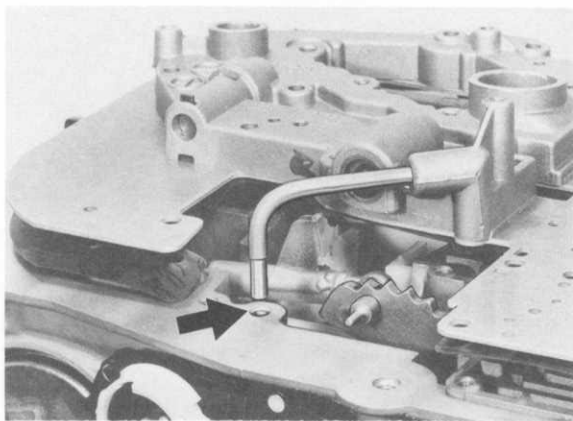
60. Insert brake band guide.



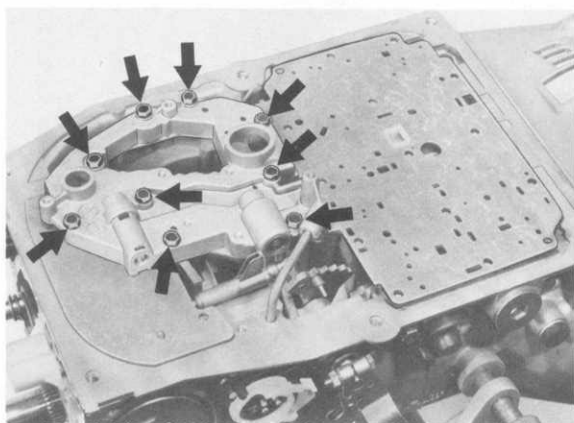
61. Insert temperature throttle and push into oil duct until throttle is flush with casing. Insert oil wiper.



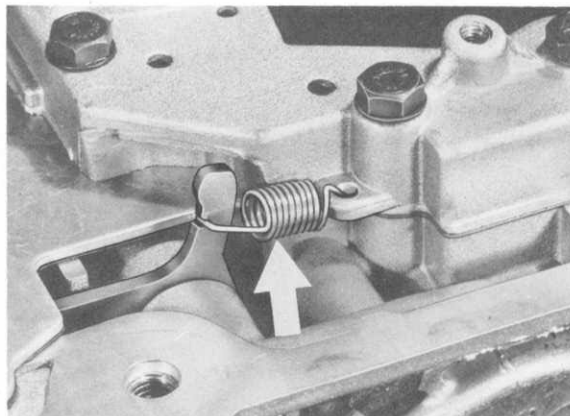
62. Install lower cover with back plate, in so doing, insert oil tube in casing bore.



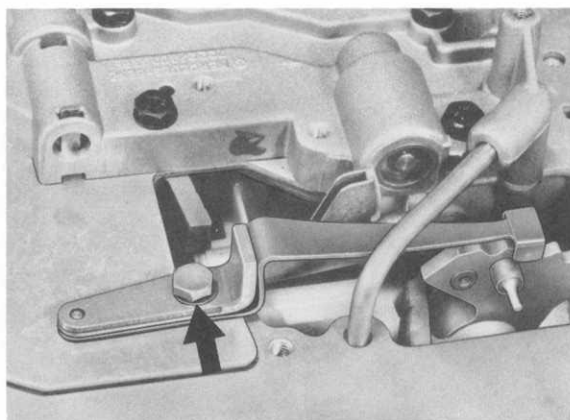
63. Insert combination bolts and tighten nuts slightly (do not tighten fully).



64. Engage return spring.

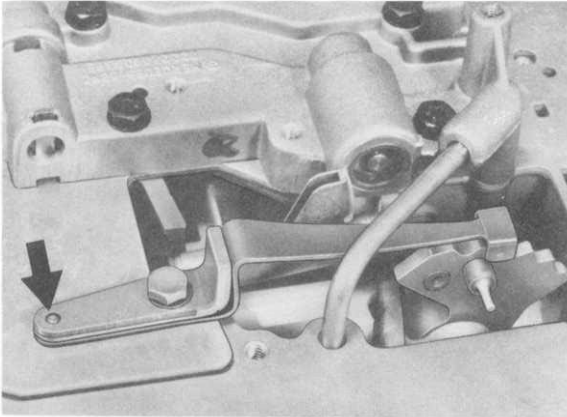


65. Place leaf spring with holder in position and tighten mounting bolts slightly (do not tighten fully).

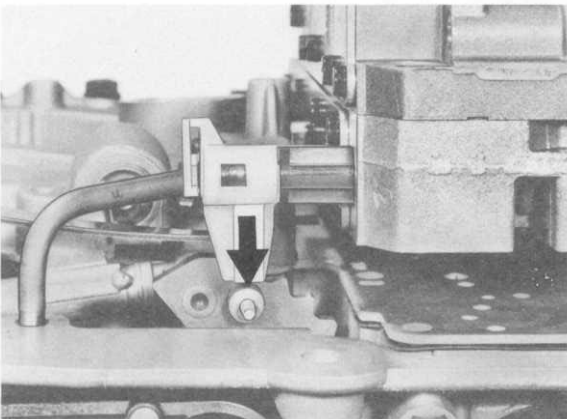


Note:

Holder must be properly pinned in place.



66. Install shift valve casing, range selector must engage carrier on detente plate (arrowed).

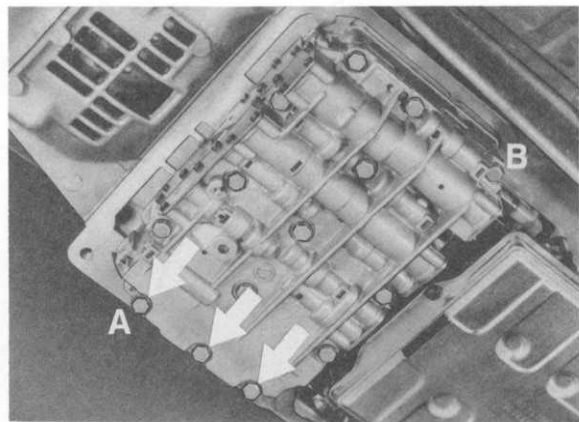


67. Insert combination bolts and tighten to 8 Nm (5.9 ftlb).

Note:

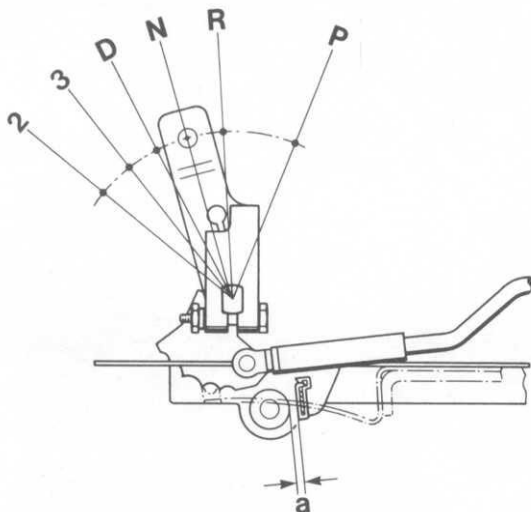
Note length of bolts. The three arrowed bolts are only 50 mm long, the remaining 12 bolts are 55 mm long.

Begin by tightening the two bolts A/B slightly to center the shift valve casing.

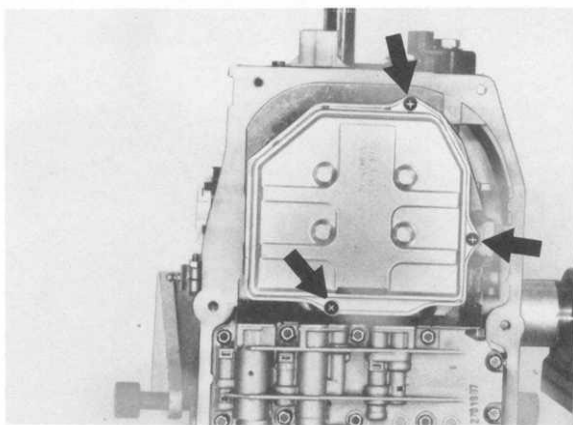


68. Tighten combination bolts for back plate and leaf spring holder to 8 Nm (5.9 ftlb)

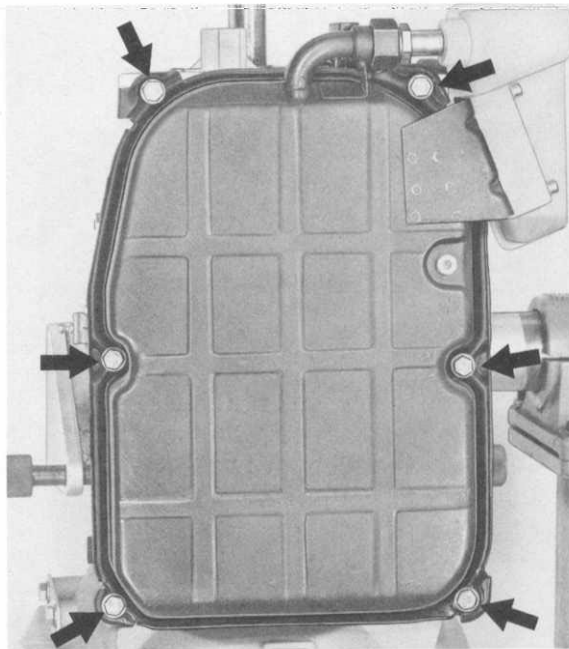
69. Check clearance "a" between locking piston and stop on sprung linkage, adjust if necessary. Use plastic clips to adjust play to 0.4...1.0 mm with selector in "N" position. Plastic clips are available in three thicknesses.



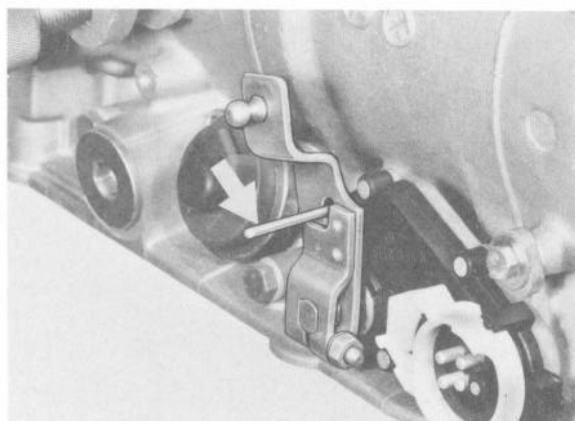
70. Place ATF filter in position, insert cross-recess head screws and tighten to 4 Nm (2.95 ftlb).



71. Install oil pan with gasket, screw down mounting bolts and tighten to 8 Nm (5.9 ftlb).



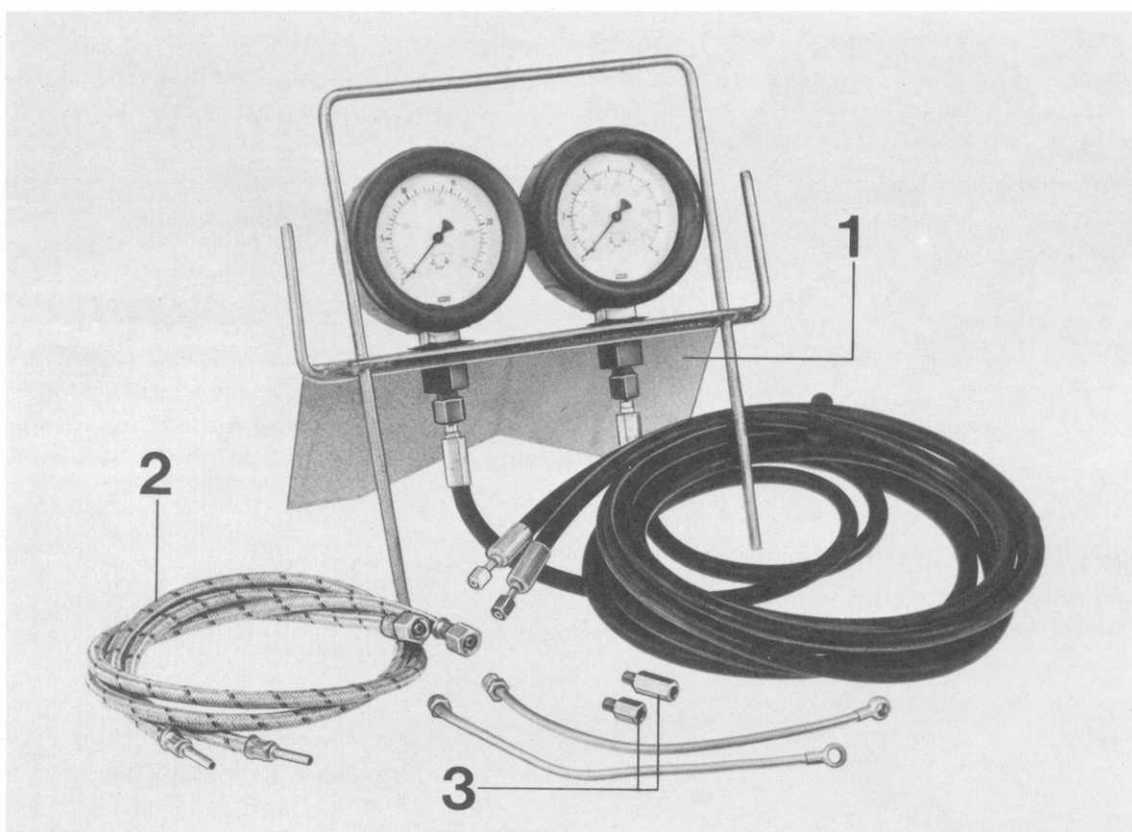
72. Set range selector to "N" position, insert a holding pin made of 4 mm welding wire (or 4 mm twist drill) through selector into hole in shift valve casing and tighten mounting bolts to 8 Nm (5.9 ftlb). Remove holding pin.



Note:

Once the transmission has been installed, check settings of cables for selector lever and control pressure and check modulating pressure, reset if necessary.

TOOLS



No.	Description	Special Tool	Remarks
1	Pressure tester	V 90	
2	Hoses	9170	
3	Adapters	9300/1	

CHECKING TRANSMISSION OPERATION

Prior to making repairs on an automatic transmission, troubleshoot transmission as instructed below and with help from the following tests.

A – General Checks

B – Transmission Fluid Level

C – Stall Speed

D – Test Drive

E – Pressure Test

Caution!

All jobs, which require that engine runs, should only be carried out with selector lever in "N" or "P" and parking brake applied.

Exceptions are tests, which require briefly a different selector lever position.

A – General Checks

Following jobs must be performed prior to any testing of transmission, and if defects are found, they must be eliminated before continuing with other work on transmission.

1. Check engine tuning (ignition timing, idle and transition).
2. Check for external damage, e. g. leaks on transmission (ATF) or final drive (hypoid oil) and missing or loose mounting bolts.

B – Transmission Fluid Level

The specified fluid level is extremely important for proper operation of an automatic transmission, so that following test must be carried out with great care.

Check ATF Level

Also check appearance and odor of ATF. Burnt friction linings cause a burnt odor. Contaminated oil could cause failure in valve body.

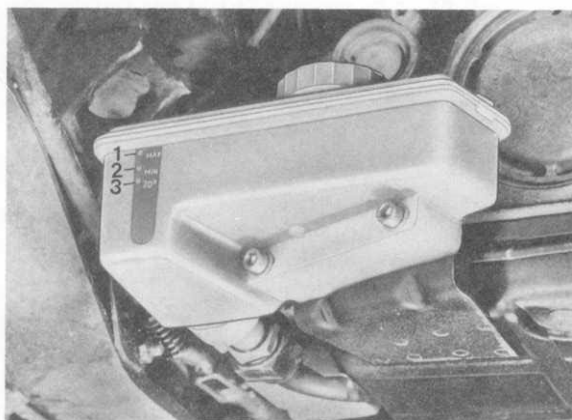
In this case transmission must be removed and repaired or replaced. ATF lines and cooler must also be flushed.

ATF level check is carried out at engine idle speed, parking brake applied and selector lever at "N". Car must be on level surface.

Let engine run at idle speed 1 to 2 minutes before checking fluid level, so that torque converter will be full.

ATF level can be checked on a cold or warm transmission. However, the level will be more accurate on a cold transmission (20 to 30°C/68 to 86°F ATF temperature) than on a warm transmission (80°C/176°F ATF temperature). ATF temperature of 80°C/176°F can only be estimated.

ATF level in transmission will change with fluid temperature. Max. and min. marks on transparent tank are in reference to an ATF temperature of 80 °C. When ATF temperature is 20 to 30 °C, the maximum ATF level will be below the minimum mark (see figure). The amount of ATF between min. and max. marks is 0.2 liters.



- 1 = max. at 80 °C ATF temperature
- 2 = min. at 80 °C ATF temperature
- 3 = max. at 20 to 30 °C ATF temperature

Add ATF to correct level. Cleanliness is essential!

If ATF level is too low, oil pump will draw in air, which can be heard. ATF will foam and cause incorrect readings when checking ATF level. Stop engine until ATF foam disappears (approx. 2 minutes). Add ATF and recheck ATF level.

Excessive ATF must be drained or drawn off, since otherwise transmission components would splash excessively and raise the temperature too much, until finally foamed oil is forced out through vent. This condition could damage transmission on a longterm basis.

After correcting ATF level to specifications, operate brake pedal, leave selector lever in each position (R—N—D—N—R) several seconds and then return it to "N", so that working pistons of power parts are filled with ATF. Recheck and, if necessary, correct ATF level.

C — Stall Speed Test

This check provides information on operation of engine, converter and transmission. It is applied, when top speed cannot be reached or acceleration is insufficient.

Note :

During this check all the engine power is converted into heat in the converter, which is why this test must not last longer than 5 seconds.

Rear wheels must not be permitted to turn for this check.

Also engine must be at operating temperature and develop its full power.

Extra equipment, e. g. compressor for air conditioner, must be turned off.

Check must not be made with car's tachometer.

1. Connect tachometer that it can be read from driver's seat.
2. Run engine at about 2,000 rpm approx. 2 minutes prior to testing.
3. Apply parking brake fully and depress brake pedal with left foot.

4. Set selector lever to "D", fully depress gas pedal, transmission must reach the specified stall speed (see Technical Data, page 30 - 0103).

Note :

If the stall speed drops some 400 to 700 rpm below the specified value, the torque converter freewheel is slipping.

If the measured stall speed exceeds the specification by more than 300 rpm, transmission slip is the cause of trouble.

If the engine does not reach its top speed despite a correct stall speed setting, the freewheel is blocking in both directions or is frozen. On the motorway, this fault usually shows itself as a leakage of ATF from the air bleeder.

The drop in engine power with every 1000 m of altitude above sea level reduces the stall speed by approx. 125 rpm.

The stall speed may also drop slightly beneath the lower value if outside temperatures are very high.

D - Test Drive

Take the vehicle for a test drive (only if transmission not obviously damaged). During test driving, it is important to pass through all the automatic transmission ranges and make careful note of transmission response. It is particularly important to note speed and shift characteristics of the shifting points for upshift and downshifts as well as the kickdown shifting points.

The transmission must shift gear quickly and without loss of pulling force. A careful check should be made to see whether the engine accelerates suddenly as the gears shift. Such acceleration indicates that a brake or clutch is slipping.

Experience in working with automatic transmissions is essential if the unit's method of operation is to be assessed and any faults identified. If this experience is not available, it is advisable to compare the transmission with a second unit of the same rating and in verifiably sound condition.

After the test drive, check the transmission for leaks.

Checking Operation

Shifting points in km/h

	Transmission Type A 28.01/04/07/12		Transmission Type A 28.02/05/08	
Gas pedal position	km/h	km/h	km/h	km/h
Selector lever position	↑	↓	↑	↓
Idle "D" 1-2-1	58...64	28...24	54...59	26...22
Idle "D" 2-3-2	109...125	54...47	102...117	50...44
Idle "D" 3-4-3	190...211	131...115	177...197	122...107
Idle "2" 1-2	58...64	—	env. 63	—
Kick-down "D" 1-2-1	62...68	45...39	58...63	42...36
Kick-down "D" 2-3-2	126...143	122...106	118...133	144...99
Kick-down "D" 3-4-3	207...216	203...183	193...213	189...171
Kick-down "2" 1-2	69...75	—	env. 68	—

	Transmission Type A 28.03/06/09/11/14		Transmission Type A 28/16		Transmission Type A 28.18	
Gas pedal position	km/h	km/h	km/h	km/h	km/h	km/h
Selector lever position	↑	↓	↑	↓	↑	↓
Idle "D" 1-2-1	50...55	24...21	41...50	30...23	41...50	30...24
Idle "D" 2-3-2	95...109	47...41	102...117	49...43	102...117	49...43
Idle "D" 3-4-3	165...183	114...100	169...188	144...128	169...188	144...128
Idle "2" 1-2	50...55	—	53...58	—	53...58	—
Kick-down "D" 1-2-1	54...59	39...34	59...61	48...43	57...58	47...42
Kick-down "D" 2-3-2	109...112	106...92	123...125	120...105	119...121	115...99
Kick-down "D" 3-4-3	180...188	176...159	192...195	186...167	180...189	180...162
Kick-down "2" 1-2	60...65	—	59...61	—	56...75	—

Note: All speeds stated are approximations

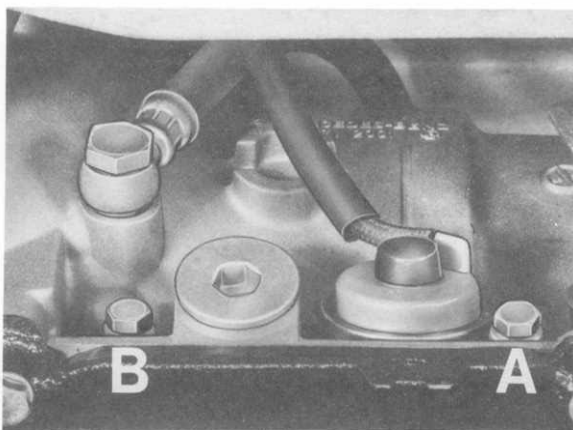
Key to symbols: ↑ Upshift
 ↓ Downshift

E – Pressure Test

This pressure test will indicate any defects in the hydraulic control system.

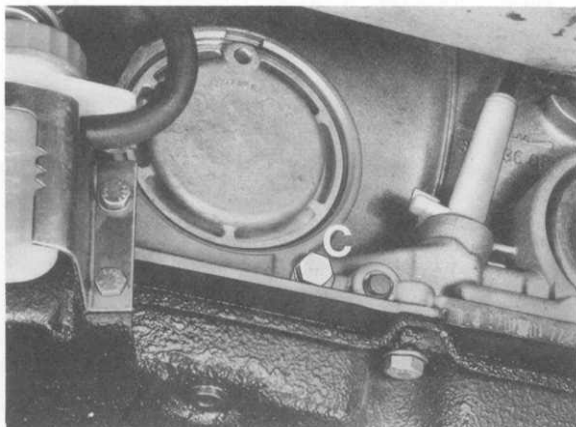
MEASURING NOMINAL PRESSURES

Automatic transmission is fitted with three measuring connections, so that the three most important pressures (modulating pressure, operating pressure, governor pressure) can be measured with help of a tester.



A – Modulating pressure

B – Governor pressure



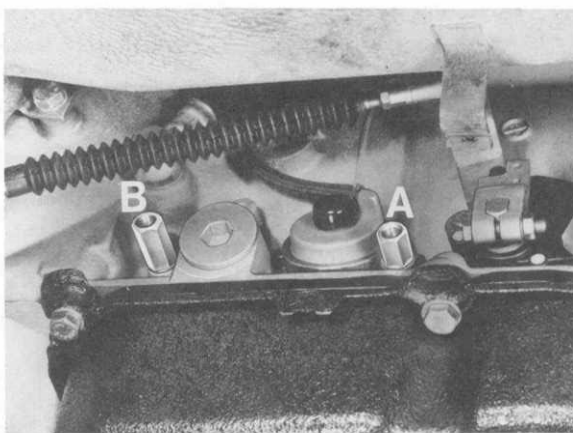
C – Operating pressure

A pressure tester with up to 25 bar pressure range is required for measuring the operating pressure. The 10 bar pressure tester is applied for modulating and governor pressure tests.

Pressure gauges are best connected, that they can be read by driver during a test drive (if a dynamometer is not available).

Tester is set up in footwell in front of front passenger's seat. Pressure gauges are connected to their measuring points by way of hoses, which are guided through window of right door. This requires disconnecting and pushing shield for rear muffler aside.

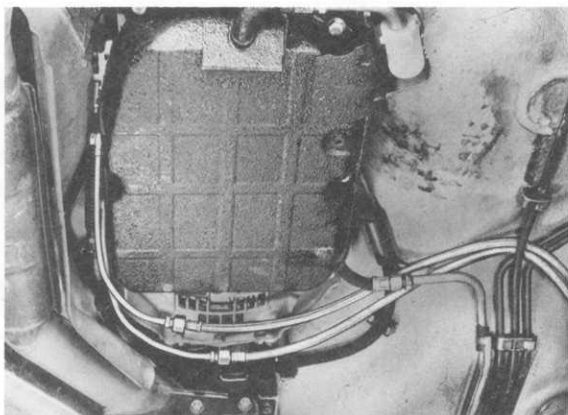
Screw in adapters for modulating pressure and governor pressure connections.



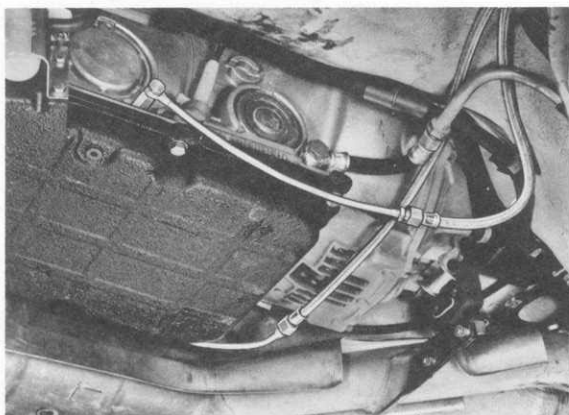
A – Short adapter for modulating pressure

B – Long adapter for governor pressure

Connections for modulating and governor pressures.



Connection for operating pressure.



Note:

Do not let hoses hang through too much or rest on the exhaust system.

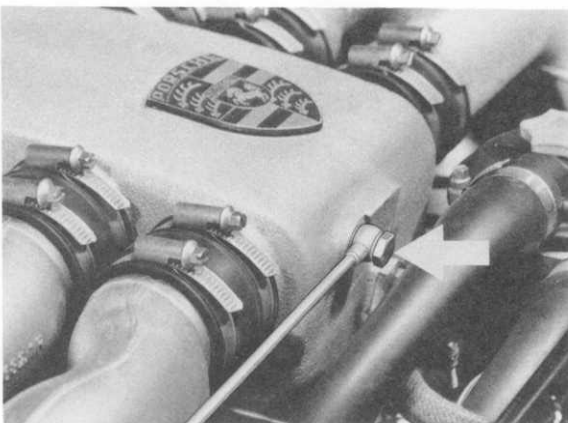
Modulating pressure, measuringNote:

It is essential to measure the modulating pressure and reset if necessary, before testing any other pressures. When the modulating pressure is correctly set, the working pressure is produced of its own accord.

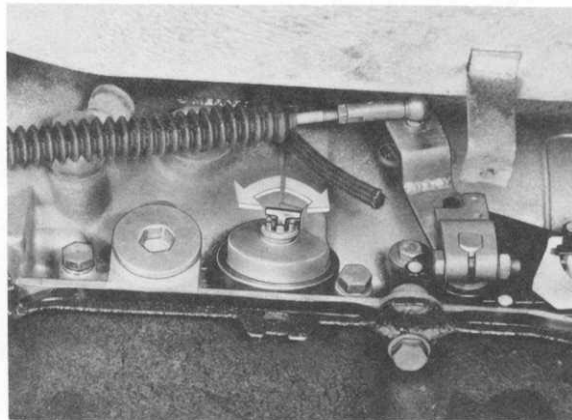
On the dynamometer or on the road, accelerate to approx. 140 km/h with the selector lever at "D" and check the reading on the pressure gauge (with vacuum line interrupted).

Note:

When working on K-Jetronic engines, disconnect the vacuum line from the intake manifold and plug socket with a suitable bolt (e.g. plug for test connection on transmission).

Modulating pressure, adjusting

1. Remove rubber cover from vacuum-control unit.
2. Pull the retainer out slightly and adjust the setting screw in the vacuum-control unit with the retainer.

Note:

One full turn of the setting screw changes the pressure by approx. 0.4 bar.

Clockwise:

Pressure is increased

Anti-clockwise:

Pressure is reduced

3. Lockplate must be pressed into nearest locking slot again after finishing adjustment.

Measuring Governor Pressure

4. Recheck after finishing adjustment.

Since governor pressure is derived from operating pressure, operating pressure must be checked simultaneously or previously.

Reference Information for Adjustments:

One turn of adjusting screw changes pressure by 0.4 bar.

Drive car on dynamometer or road and compare governor pressure with values specified in table.

If no or deviating governor pressure is measured, the governor must be disassembled, cleaned and repaired.

Checking Operating Pressure

Not adjustable; modulating pressure automatically affects operating pressure.

Control Pressure

Control pressure is part of modulating pressure. It is regulated mechanically depending on position of accelerator pedal.

Checking Governor Pressure

If modulating pressure is adjusted correctly, the control pressure will automatically be correct.

Note:

Always disconnect vacuum line to check governor pressure.

Governor pressure is part of operating pressure and is brought to the necessary value by the centrifugal governor.

SPECIFIED PRESSURES IN BAR UP TO '86 MODELS

Test pressure	Transmission type A 28.01/04/07	Transmission type A 28.02/03/ 05/06/08/09/11	Testing Conditions	
Modulating pressure*	4.4 ± 0.05	4.0 ± 0.05	ATF temperature approx. 80°C, selector lever at "D", speed approx. 140 km/h vacuum line disconnected from modulating pressure sensor	
Working pressure	16.9 ± 1	15.3 ± 1	ATF temperature approx. 80°C, selector lever at "D", engine idling, vacuum line disconnected from modulating pressure sensor	
Controller pressure	approx. 0.2 approx. 1.1 approx. 2.0 approx. 2.7	approx. 0.2 approx. 1.1 approx. 2.0 approx. 1.7	at 20 km/h at 50 km/h at 100 km/h at 150 km/h,	Selector lever at "D" car moving in partial-load range vacuum line disconnected from modulating pressure sensor

*Note.

If local conditions do not permit a test at approx. 140 km/h, measurements may also be taken at approx. 50 km/h.

Checking functioning

Nominal pressures in bar as from Model '87

Test pressure	Gearbox type			Measuring conditions
	A 28.12/14/16	A 28.18		
Modulation pressure*	4.2 ± 0.05		4.4 ± 0.05	ATF temperature approx. 80°C, Selector lever in position D, driving speed approx. 140 km/h, Vacuum line disconnected at the modulating pressure cell
Working pressure	16.0 ± 1		15.8 ± 1	ATF temperature approx. 80 ° C, selector lever in position D, engine speed 1400 rpm, hand brake applied and servicebrake actuated, Test no longer than 5 seconds. Vacuum line dis- connected at the modulating pressure cell
Controller pressure	A 28.14/16	A 28.12	A 28.18	Selector level in position D Vehicle moving in partial-load range Vacuum line disconnected at the modulating prssure cell
	approx. 0.2	0.17	0.45 at 20 km/h	
	approx. 1.1	0.96	1.40 at 50 km/h	
	approx. 2.0	1.74	2.15 at 100 km/h	
	approx. 2.7	2.35	3.10 at 150 km/h,	

* Note

If the local conditions do not permit testing at approx. 140 km/h, measurements are still possible at approx. 50 km/h.

TROUBLESHOOTING AUTOMATIC TRANSMISSION

Note : If transmission oil is black and smells burnt or there is an unusual large amount of metal particles in oil pan, either repair or replace transmission.

Condition:

Transmission slips in all selector lever positions.

Cause/Correction:

1. Check modulating pressure, adjusting if necessary.
If not adjustable, check movement of modulating pressure control valve.
2. Check whether vacuum line from intake branch to vacuum box is plugged. If yes, replace.
3. Check operating pressure. If too low or not available:
 - a) Disassemble and clean shift valve housing and service valve. Replace shift valve housing if necessary.
 - b) Remove and inspect primary pump, replacing if necessary.

Condition:

2nd gear slips or transmission shifts from 1st to 3rd gear.

Cause/Correction:

1. Check movement of control valve B 1, replacing shift valve housing if necessary.
2. Remove and install brake band B 1 piston and check seal, replacing if necessary.
3. Replace brake band B 1 and pressure element for B 1.

Condition:

Transmission slips when moving off in 1st and 2nd gear, or moving off not possible in forward gear. Reverse gear is still good.

Cause/Correction:

1. Service shift valve B 2, replacing shift valve housing if necessary.
 2. Replace brake band B 2 piston.
 3. Adjust brake band B 2 by installing a longer thrust pin.
Replace brake band in case of excessive wear or broken brake band.
-

Condition:

Transmission slips during 2nd/3rd shift, or slips at first and then grabs hard.

Cause/Correction:

1. Check modulating pressure, adjusting if necessary.
 2. Check whether temperature orifice is installed (see removing and installing lower cover on page 38 - 131).
 3. Replace shift valve housing.
 4. Replace inner plates of clutch K 1. Repair clutch depending on findings.
-

Condition:

Transmission slips during 3rd/4th shift.

Cause/Correction:

1. Check modulating pressure, adjusting if necessary.
 2. Replace shift valve housing.
 3. Replace inner plates of clutch K 2. Repair clutch depending on findings.
-

Condition:

After installation, transmission has no power flow or fails after a brief time of operation.

Cause/Correction:

Torque converter not installed according to instructions.
Drive dogs do not engage accurately in drive gear of primary pump.

Follow-up damage: Torque converter drive dogs and primary pump will be destroyed.

Replace primary pump and, if necessary, torque converter.

Condition:

No power flow in all selector lever positions for a brief period immediately after starting engine (especially when car had not been used for a while).

Cause/Correction:

Torque converter drains partially via leaky or defective lubricating ring on drive shaft or via leaky lubricating valve in shift valve housing.

1. Check lubricating ring on drive shaft, replacing if necessary.
 2. Check and clean lubricating valve in shift valve housing.
-

Condition:

No power flow in reverse gear.

Cause/Correction:

1. Check lined plates and seals on piston of brake band 3, replacing if necessary.
 2. Replace one-way clutch in gear set.
-

Condition:

Strong jolt when engaging selector lever in "D" and "R".

Cause/Correction:

1. Adjust idle speed and CO level to specifications.
 2. Check modulating pressure, correcting if necessary.
 3. Check whether spring is installed underneath valve ball (5) in shift valve housing (see page 38 - 126).
 4. Check vacuum line and connections for leaks.
 5. Check whether pressure acceptance piston in shift valve housing moves easily and is in correct installed position, replacing shift valve housing if necessary.
-

Note : If there is a hard engagement jolt when quickly shifting back and forth between "N" and "D" several times, there is no fault. The pressure pick-up requires a running time of approx. 2 seconds. If this time is given, the engagement jolt will also be correct.

Condition:

Strong jolts when changing gears.

Cause/Correction:

1. Check modulating pressure, adjusting if necessary.
2. Check vacuum line and connections for leaks.

Condition:

Strong jolt in downshift from 4th to 3rd gear.

Cause/Correction:

1. Replace seal on release end of B 2.
 2. Replace brake band piston B 2.
 3. Pressure element of B 2 has turned; replace pressure element.
-

Condition:

Jolts when shifting in partial load range.

Cause/Correction:

1. Check adjustment of control pressure cable.
 2. Check modulating pressure, adjusting if necessary.
 3. Check vacuum line and connections for leaks.
-

Condition:

Shaking during upshifts.

Cause/Correction:

Check whether screen restrictor with spring is installed (see page 38 - 126).

Condition:

No upshifts.

Cause/Correction:

1. Check governor pressure. If there is no governor pressure reading, continue with point 2. If governor pressure is correct, continue with point 3.
 2. Clean and service centrifugal governor.
 3. Disassemble and clean shift valve housing, replacing if necessary.
-

Condition:

Upshifts only in upper speed range of gears.

Cause/Correction:

1. Check and adjust control pressure cable.
 2. Check governor pressure and replace centrifugal governor, if governor pressure is too low.
 3. Service control pressure valve.
-

Condition:

Upshifts only in lower speed range of gears.

Cause/Correction:

1. Check whether control pressure cable is disconnected or torn, and then adjust accurately.
 2. Check full throttle stop. Move accelerator pedal from full throttle and check whether throttle is against full throttle stop, adjusting if necessary.
 3. Check governor pressure and replace centrifugal governor, if governor pressure is too high.
-

Fault:

No kickdown from 3rd to 2nd
shifting points in partial load range too low

Cause/remedy

check gas and control pressure cable settings

Fault:

No kickdown downshifts

Cause/remedy:

1. Check fuse for power supply to solenoid valve.
 2. Remove solenoid valve. With valve removed, connect to power supply and check operation. Fit replacement if necessary.
 3. Check that control pressure cable is not disconnected, broken or maladjusted.
 4. Check that kickdown control slide moves freely in housing, install replacement housing if necessary.
-

Fault:

No brake shifts (4-3 and 3-2)

Cause/remedy:

1. Adjust control pressure cable.
2. Check vacuum lines and connections for leaks.
3. Release brake shift plunger, if necessary separate shift slider housing.

Condition:

Automatic, unwanted downshifts outside of partial throttle downshift range, without operation of kickdown switch.

Cause/Correction:

1. Remove kickdown solenoid valve.
Check O-ring on solenoid valve for damage.
 2. Check whether kickdown switch sticks in pressed position, replacing if necessary.
 3. Check whether solenoid valve sticks in open position, replacing if necessary.
-

Condition:

Poor acceleration when moving off.

Cause/Correction:

1. Check stall speed.
2. If stall speed drops below specified value by approx. 400 to 700 rpm, one-way clutch in converter is slipping. Replace torque converter.

Condition:

Selector lever cannot be engaged in "R" and "P".

Cause/Correction:

- a) With engine running
- b) With engine stopped

1. a) Clean and service centrifugal governor.
 2. b) Service blocking piston in lower cover.
-

Condition:

Engine cannot be started with selector lever in "P" and "N".

Cause/Correction:

1. Adjust selector lever cable and starter interlock switch.
2. Replace starter interlock switch.

Condition:

1st and reverse gears too loud.

Cause/Correction:

1. Replace front gear set depending on findings.

Note:

First and reverse gears are louder than the other gears because of the ratio. A different car should be used for comparison.

Condition:

3rd gear too loud.

Cause/Correction:

1. Replace rear planet gear set.
-

Condition:

Whining noise only when changing gears with full load.

Cause/Correction:

1. Replace oil filter.
-

Condition:

Whining noise, which increases in loudness as engine speed rises.

Cause/Correction:

1. Check primary pump, replacing if necessary.
-

Condition:

Invisible oil loss (leak cannot be seen on outside) in conjunction with smoke in exhaust.

Cause/Correction:

Diaphragm in vacuum box is defective. ATF drawn in by engine via vacuum line.

1. Replace vacuum box.
-

Condition:

Oil lost between torque converter and primary pump (oil escaping through vent grid).

Cause/Correction:

1. Install oil drain plug on torque converter with a new seal as well as Hylomar on threads, and tighten. If still leaking, continue with point 2.
2. Replace radial oil seal and O-ring of primary pump, inspecting O-ring groove in primary pump for porous spots. Replace primary pump, if necessary.

Condition:

Rattling noise at engine speed of 1500 rpm in all selector lever positions, except "R".

Cause/Correction:

Plates of reverse gear brake swinging in transmission case.

1. Replace inner plates of reverse gear brake B 3;
adjust play to smallest value.
-

Condition:

Light grinding noise in selector lever positions "P" and "N".

Cause/Correction:

This noise concerns a normal rolling noise from the front gear set, which cannot be eliminated.

Condition:

Chattering noise when driving in reverse gear.

Cause/Correction:

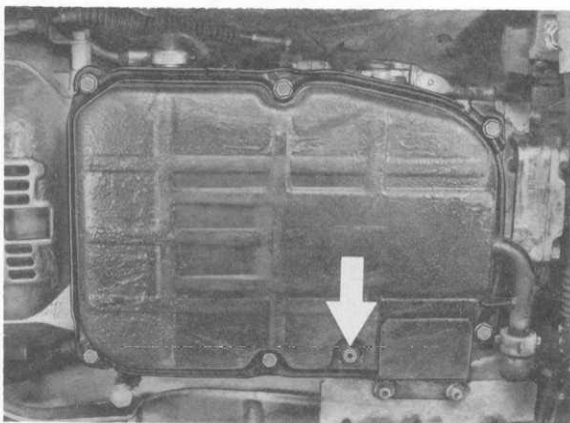
Play of plate brake B 2 excessive. Outer plate carrier of K 1 scraping on piston of B 3.

1. Adjust play to specified value (1.5 to 2 mm).
-

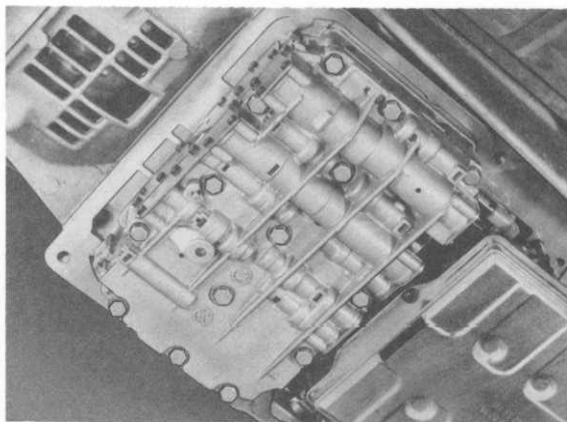
REMOVING AND INSTALLING SHIFT VALVE CASING

Removing

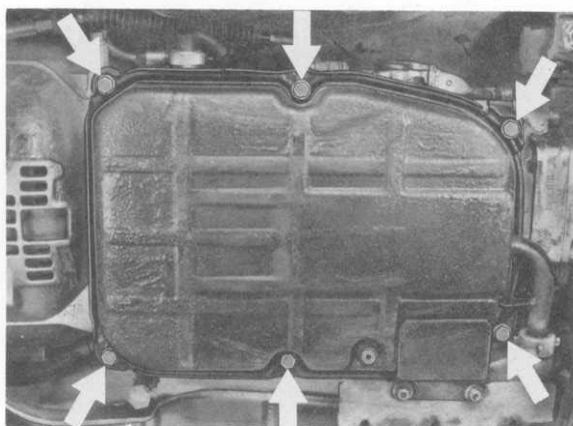
1. Remove drain plug and drain ATF.



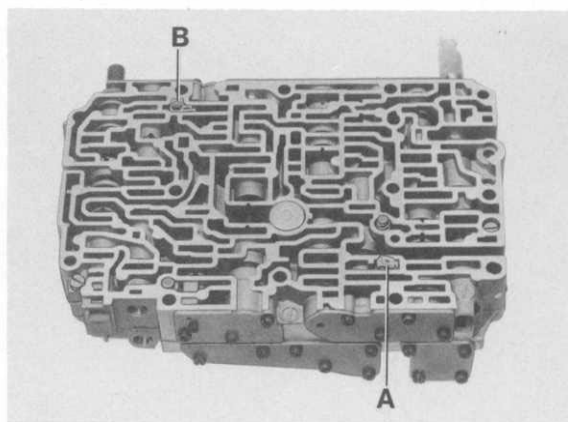
3. Unscrew mounting bolts and remove shift valve casing.



2. Remove ATF pan by disconnecting breather holes for ATF reservoir and removing mounting bolts.

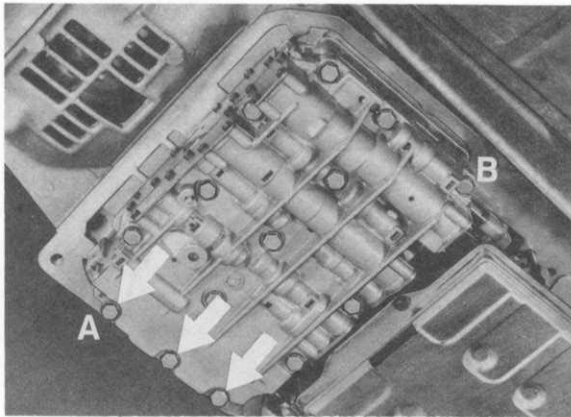
Installing

1. Ensure that plastic poppet valve and chip screen for shift valve B 2 are correctly seated.



A - Plastic valve
B - Chip screen (use in series production as of Nov. '85, transmission No. 729 001)

2. Place shift valve casing in position, range selector valve must engage carrier.
3. Insert mounting bolts and tighten. Tightening torque: 8 Nm (5.9 ftlb).



Note:

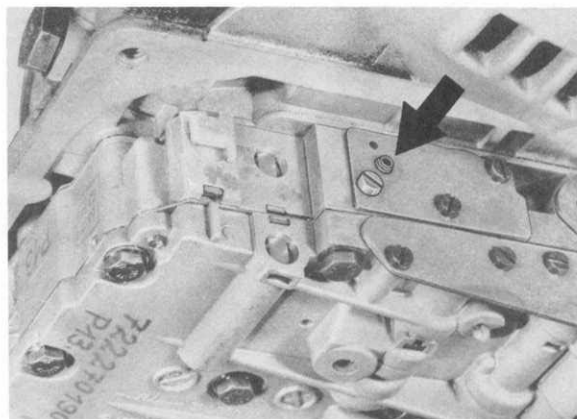
Center shift valve casing by first tightening the two bolts A/B slightly.

The three bolts marked with arrows are 50 mm in length, the remainder are 55 mm long.

4. Install ATF pan with gasket and tighten mounting bolts. Tightening torque: 8 Nm (5.9 ftlb).
5. Screw in drain plug with new sealing ring and tighten. Tightening torque 14 Nm (8 ftlb)
6. Top up ATF.

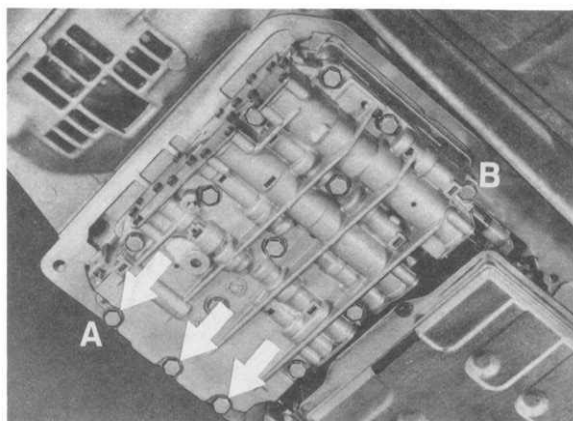
Note:

The full-throttle control pressure can be changed by turning the socket-head bolt (arrowed). Turning the bolt clockwise makes the full load or kick-down upshifts earlier. Turning the bolt anticlockwise makes the upshifts later.



7. Check setting of control-pressure cable and readjust if necessary.

2. Place shift valve casing in position, range selector valve must engage carrier.
3. Insert mounting bolts and tighten. Tightening torque: 8 Nm (5.9 ftlb).



Note:

Center shift valve casing by first tightening the two bolts A/B slightly.

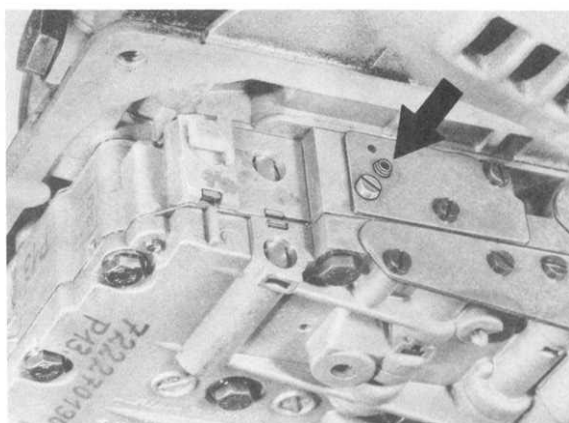
The three bolts marked with arrows are 50 mm in length, the remainder are 55 mm long.

4. Install ATF pan with gasket and tighten mounting bolts. Tightening torque: 8 Nm (5.9 ftlb).
5. Screw in drain plug with new sealing ring and tighten. Tightening torque 14 Nm (8 ftlb)

6. Top up ATF.

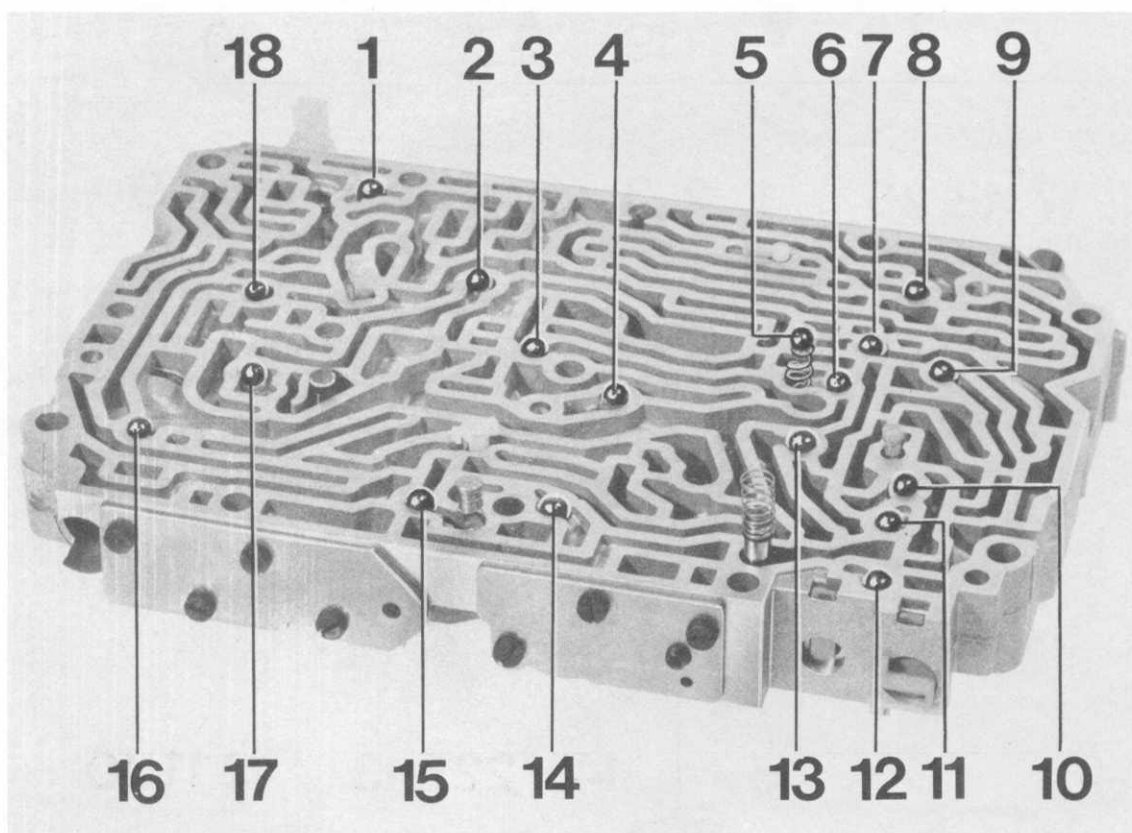
Note:

The full-throttle control pressure can be changed by turning the socket-head bolt (arrowed). Turning the bolt clockwise makes the full load or kick-down upshifts earlier. Turning the bolt anticlockwise makes the upshifts later.

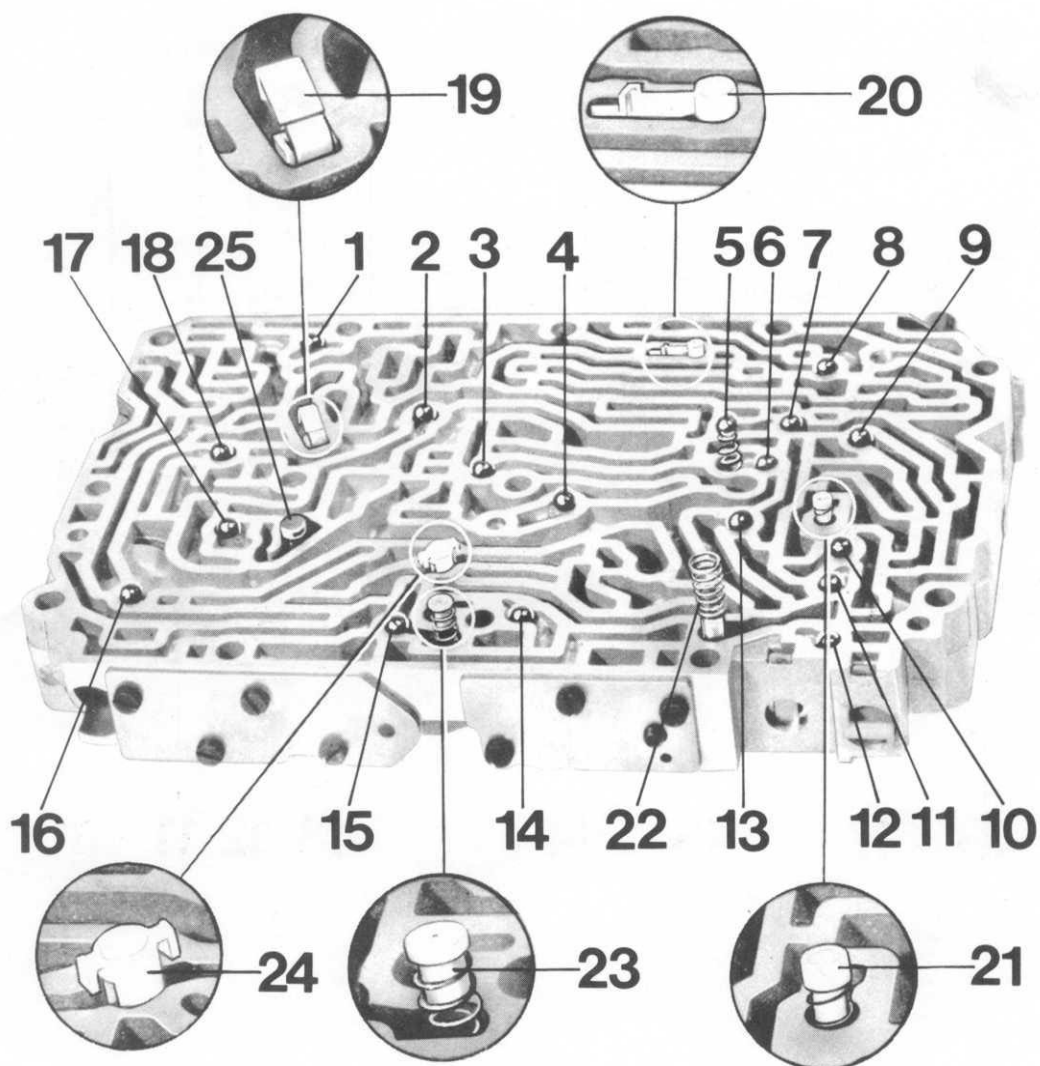


7. Check setting of control-pressure cable and readjust if necessary.

DISASSEMBLING AND ASSEMBLING SHIFT VALVE HOUSING



DISASSEMBLING AND ASSEMBLING SHIFT VALVE HOUSING



No.	Description	Qty.	Note When:		Special Instructions
			Removing	Installing	
1— 18	Valve ball (5.5 mm dia.)	18		Install conical spring with large diameter end facing down underneath ball no. 5	
19	Plastic valve (light without bore)	1		Install in correct position, do not mix up with valve without bore	
20	Throttle check valve	1			
21	Check valve	1		Install with spring	
22	Lubricating pressure operating pin	1		Install with spring	
23	Orifice	1		Install with spring	
24	Valve	1			
25	Operating pin	1	Unlosable		

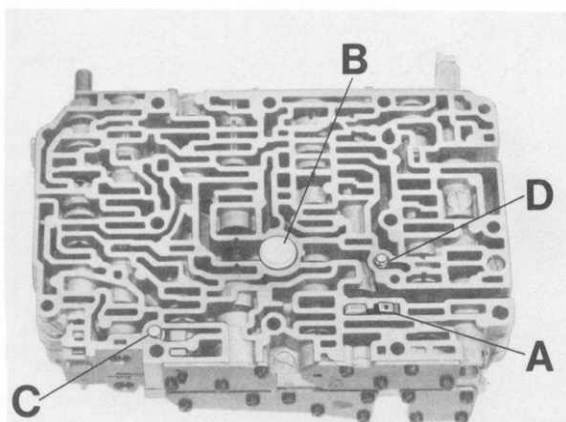
DISASSEMBLING AND ASSEMBLING SHIFT VALVE HOUSING

Disassembling

Note:

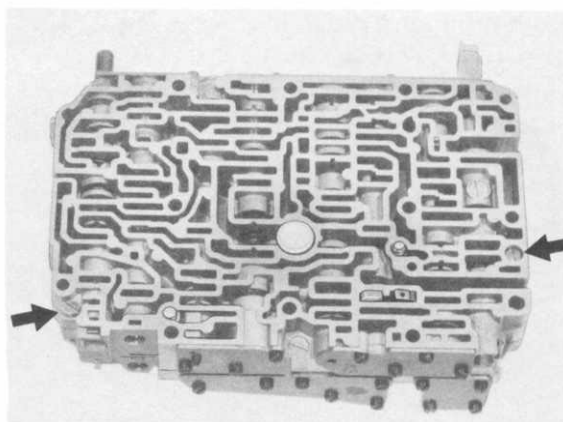
Absolute cleanliness is essential for any work on the shift valve housing. If at all possible work should be done on a plastic lined work-bench (leather sheets would be especially suitable). After disassembling all parts must be washed and dried with compressed air.

1. Remove plastic valve.



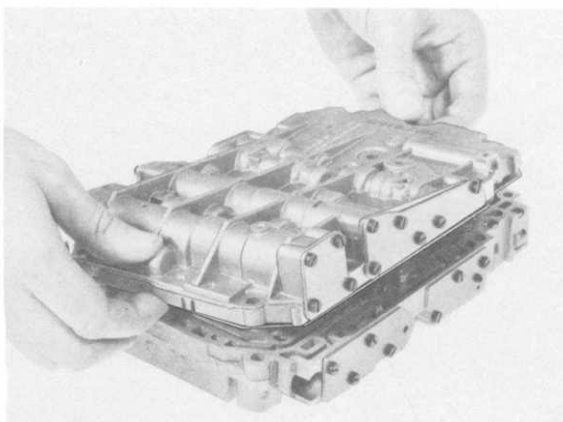
- A = Plastic valve
 B = Check valve
 C = Operating pin
 D = Blocking valve K 1

2. Remove both mounting bolts (arrow).



3. Hold and turn shift valve housing and pick-up housing around.

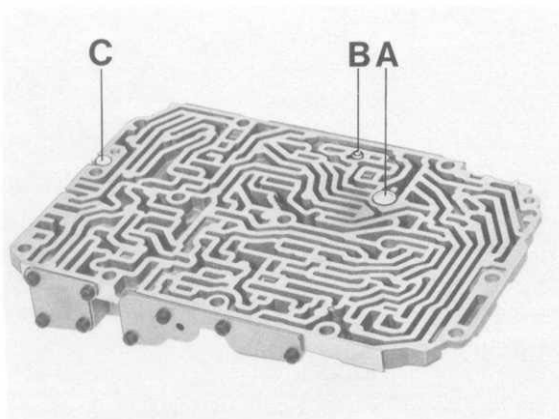
4. Lift off pick-up housing with transfer plate carefully.



5. Take out all valves and balls.

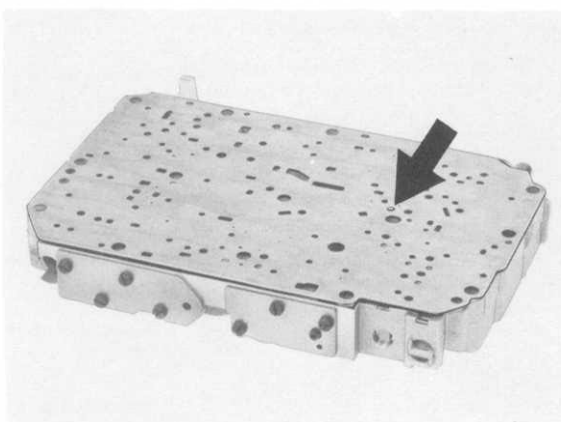
Assembling

1. Place all balls and valves in shift valve housing (see layout drawing).
2. Install lubricating valve, modulating pressure valve and vent valve K 1 in pick-up housing.

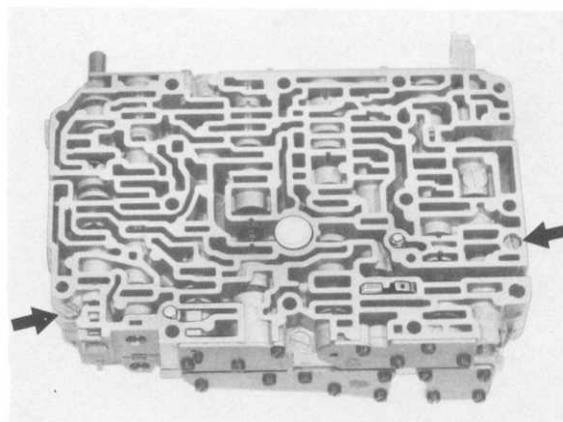


- A = Lubricating valve (unlosable)
 B = Modulating pressure valve (unlosable)
 C = Vent valve (unlosable)

3. Place transfer plate on shift valve housing carefully and check whether valve ball (arrow) is in correct installed position.



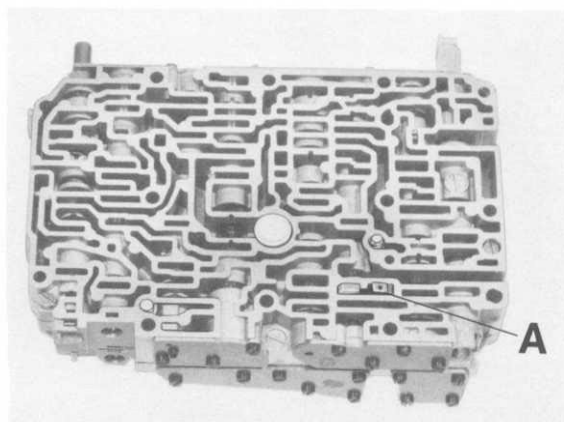
4. Place pick-up housing on shift valve housing.
5. Hold shift valve housing and pick-up housing together and turn both around.
6. Screw in both bolts, but do not tighten.



Note:

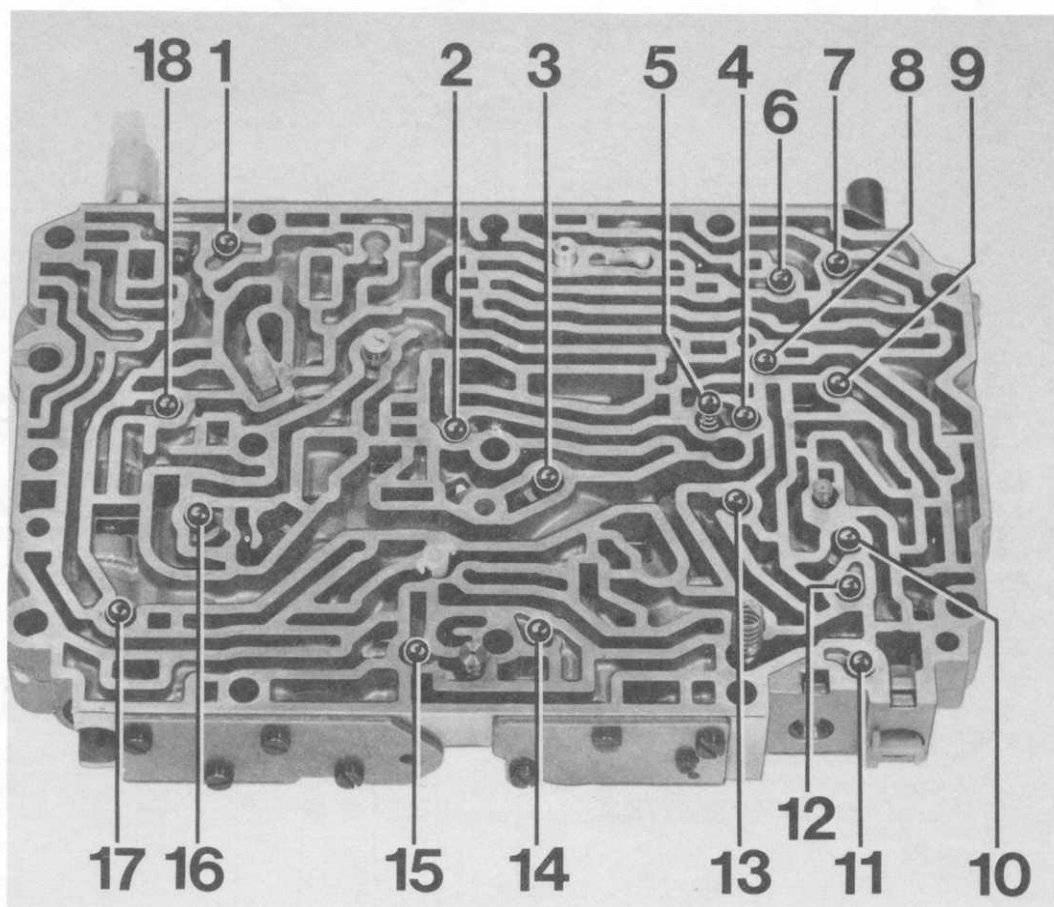
Tighten bolts only enough that both housings can still be moved to align them.

7. Install plastic valve (green) in housing that bore is in correct position.

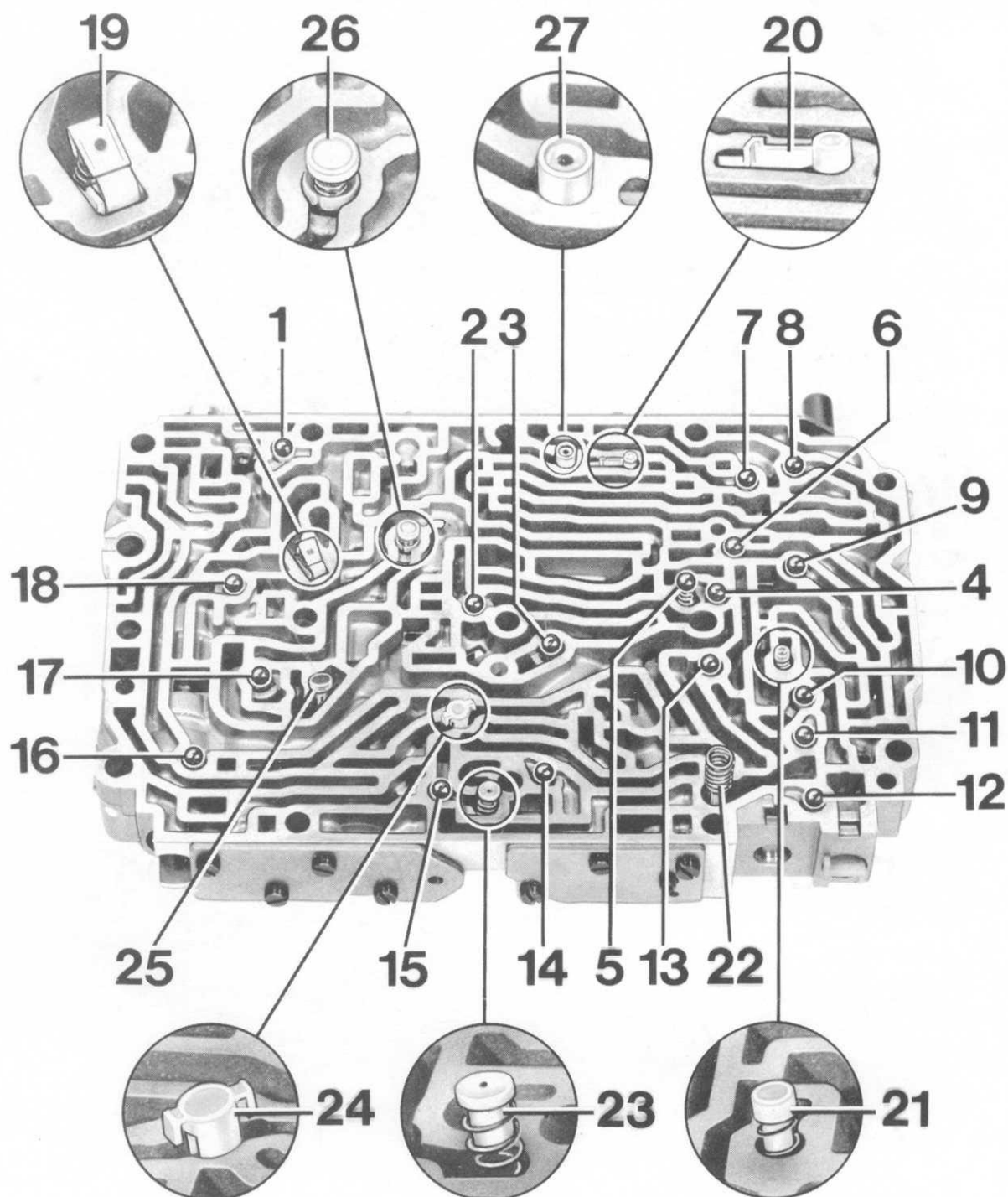


A = Plastic valve

DISASSEMBLING AND ASSEMBLING SHIFT VALVE CASING ('87 MODELS ONWARD)



DISASSEMBLING AND ASSEMBLING SHIFT VALVE CASING ('87 MODELS ONWARD)



No.	Designation	Qty.	Note When:	
			Removing	Installing
1... 18	Valve ball (dia. 5.5 mm)	18		Insert taper spring with large diameter downward beneath ball No. 5.
19	Plastic valve (light, without bore)	1		Insert right way round, do not mix up with valve with bore
20	Throttle check valve	1		
21	Check valve	1		Install with spring
22	Shift pin, lubricating pressure	1		Install with spring
23	Throttle	1		Install with spring
24	Valve	1		
25	Shift pin	1	Captive	
26	Valve	1		
27	Throttle* (with spring)	1		Install with spring

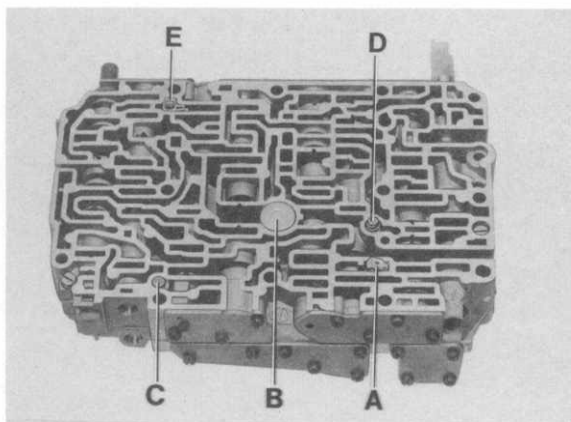
* At the start of series production the throttle was installed in some cases and was later discontinued without replacement.

NOTES FOR DISASSEMBLY AND ASSEMBLY

DisassemblingNote:

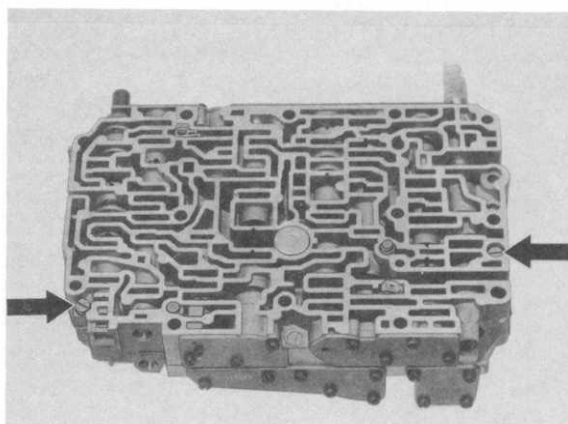
It is essential to maintain absolute cleanliness during all work on the shift valve casing. If possible, spread a plastic sheet on the workbench beneath the parts (moleskin cloths are particularly suitable). After disassembly, wash all parts and blow through with compressed air.

1. Remove plastic valve and chip screen.



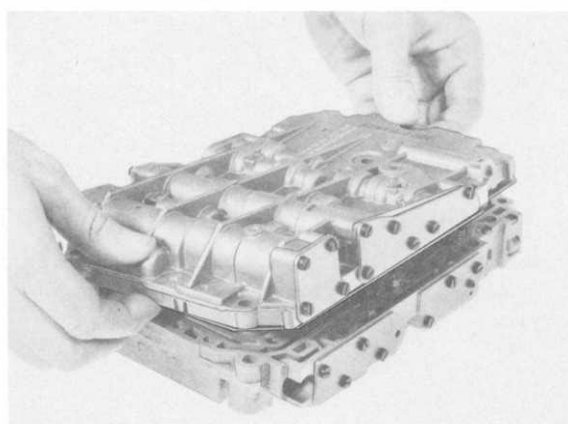
- A - Plastic valve
- B - Check valve
- C - Shift pin
- D - Lock valve K 1
- E - Chip screen

2. Remove both mounting screws (arrowed).



3. Hold shift valve casing and sensor housing together and turn over.

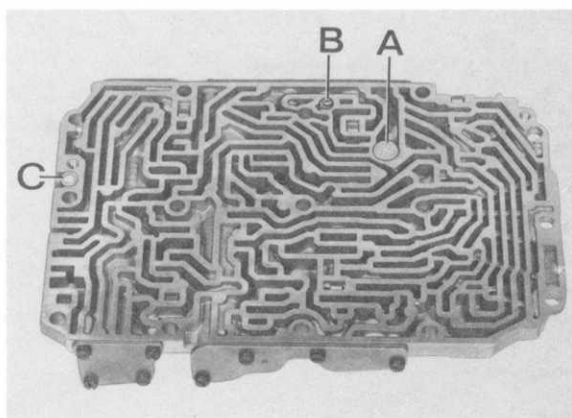
4. Carefully lift off sensor housing with back plate



5. Remove all valves and balls.

Assembling

1. Place all valve balls and valves in shift valve casing (see exploded drawing).
2. Install lubricating-pressure valve, overpressure modulating valve and bleed valve K1 in sensor housing.

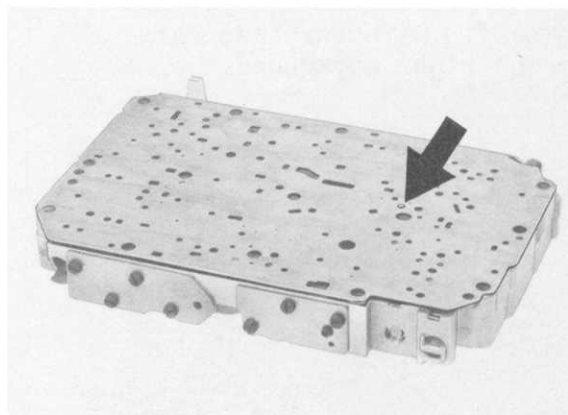


A = Lubricating pressure valve (captive)

B = Overpressure modulating valve (captive)

C = Bleed valve (captive)

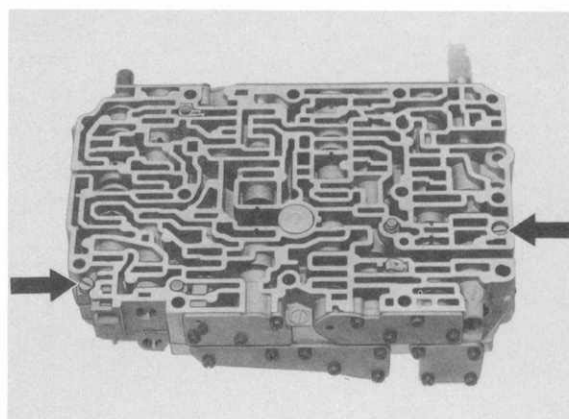
3. Carefully place back plate on shift valve casing and check that valve ball (arrowed) is in its installation position.



4. Place sensor housing on shift valve casing.

5. Hold shift valve casing and sensor housing together and turn over.

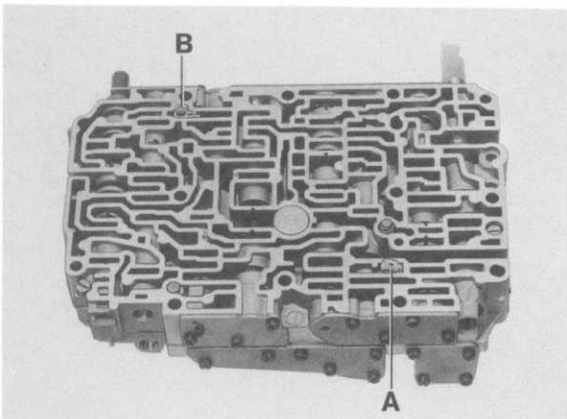
6. Insert both screws (do not tighten).



Note:

Tighten screws so that housing and casing can still be moved against each other.

7. Insert plastic valve (yellow) in casing with bore and chip screen right way round.

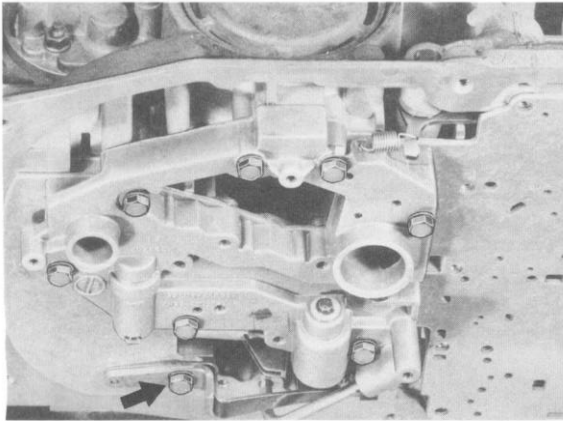


A = Plastic valve
B = Chip screen

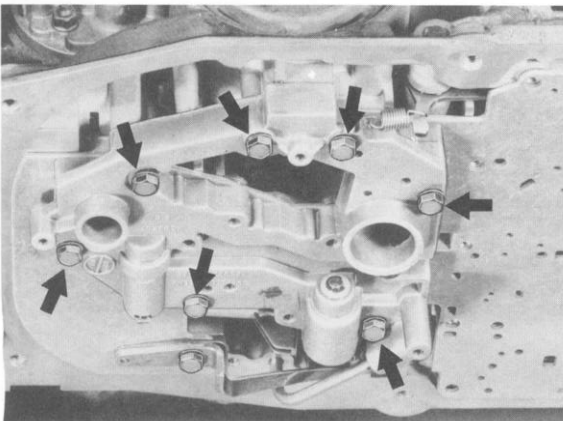
REMOVING AND INSTALLING LOWER COVER

Removing

1. Remove shift valve housing.
2. Remove ATF filter.
3. Remove holder and leaf spring.

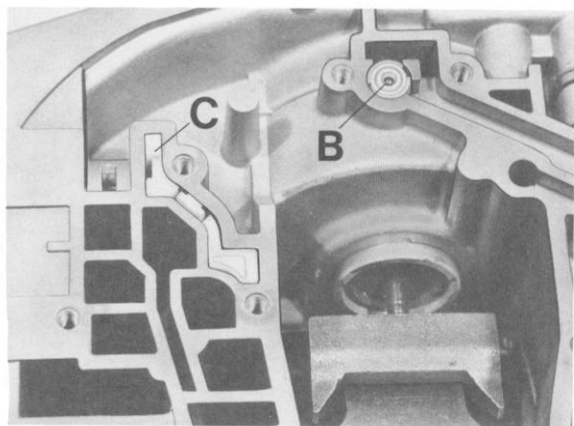
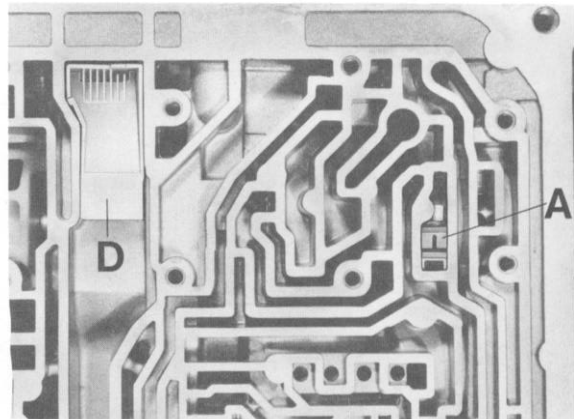


4. Remove combination bolts and take off cover with oil tube.



Installing

1. Check for proper seating of temperature orifice, plastic valve, filler and oil deflector.



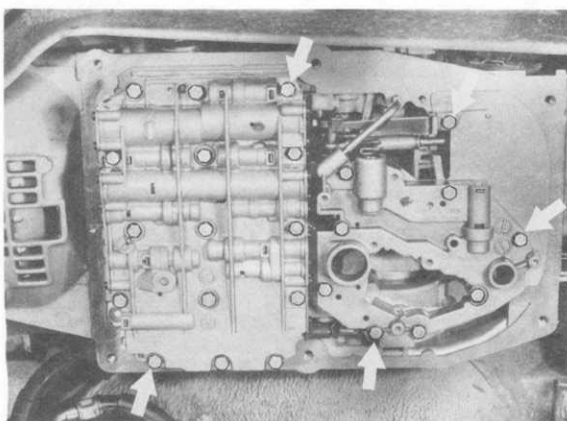
A = Temperature orifice

B = Plastic valve

C = Filler

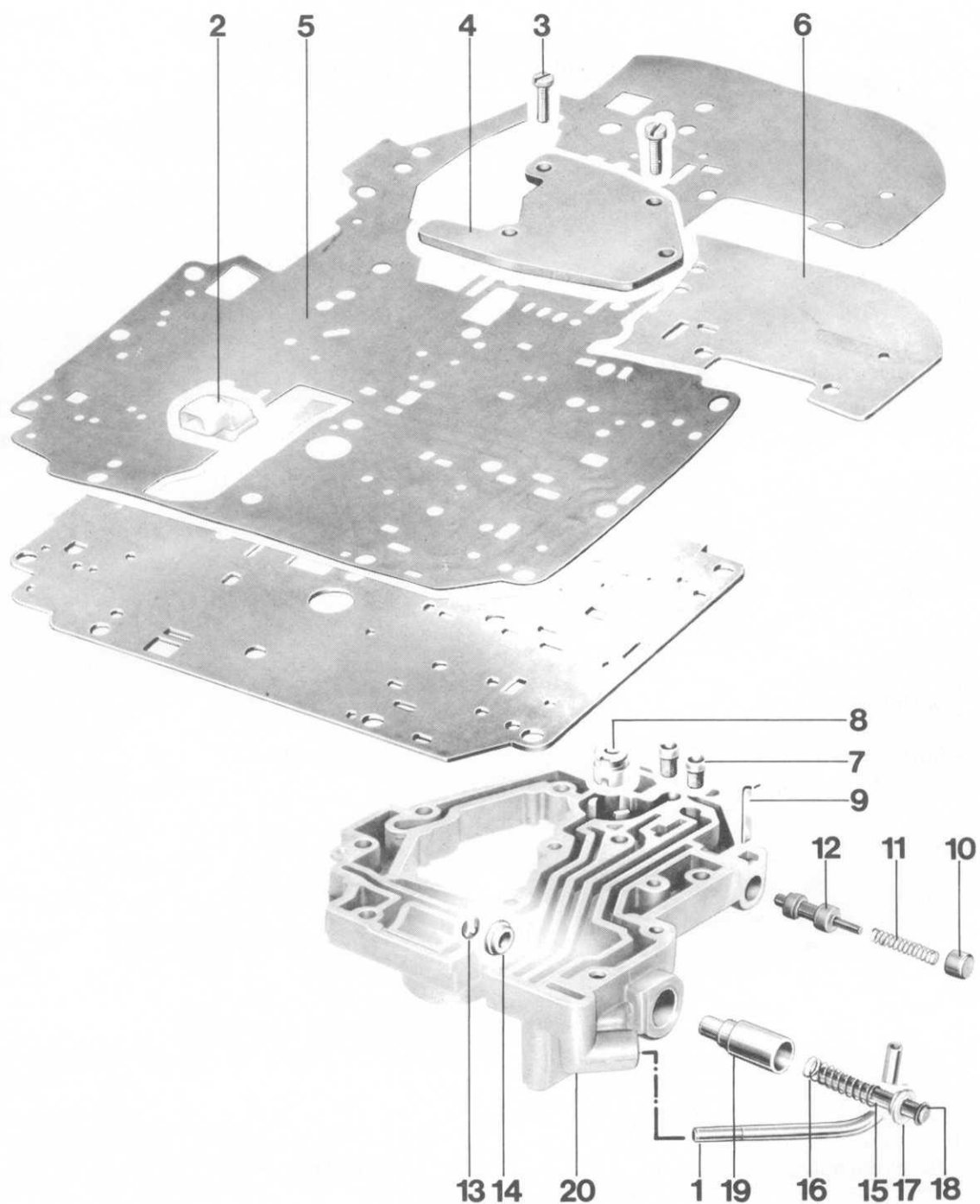
D = Oil deflector

2. Mount lower cover, guiding oil tube into bore.
3. Install combination bolts, but do not tighten (tighten bolts with 8 Nm/6 ftlb only after installing the shift valve housing).
4. Mount leaf spring with holder and install bolt but do not tighten (tighten bolt with 8 Nm/6 ftlb only after installing the shift valve housing).
5. Install shift valve housing and tighten combination bolts with 8 Nm/6 ftlb (including bolts on lower cover).



6. Install ATF filter and tighten phillips screws with 4 Nm/3 ftlb.

DISASSEMBLING AND ASSEMBLING LOWER COVER



No.	Description	Qty.	Note When:		Special Instructions
			Removing	Installing	
1	Oil tube	1			
2	Injector	1	Squeeze tabs together and remove	Install in correct position	
3	Bolt	4		Torque: 8 Nm/6 ftlb	
4	Cover	1			
5	Gasket	1		Replace, if necessary	
6	Transfer plate	1			
7	Filter screen	2			
8	Valve	1		Position correctly, check for tight fit	
9	Holder	1		Position correctly	
10	Plug	1			
11	Spring	1			
12	Shift valve secondary pump	1		Install with ATF	
13	Circlip	1			
14	Sleeve	1			
15	Shaft	1			
16	Spring	1			
17	Sleeve	1			
18	Circlip	1			
19	Blocking valve	1		Coat with ATF	
20	Housing	1			

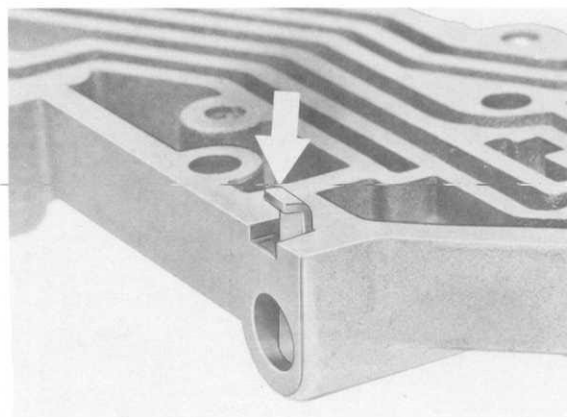
DISASSEMBLING AND ASSEMBLING LOWER COVER

Note:

Absolute cleanliness is essential for any work on shift valve housing and lower cover. Work should be performed with a plastic liner on the workbench whenever possible. Never use cloths losing lint.

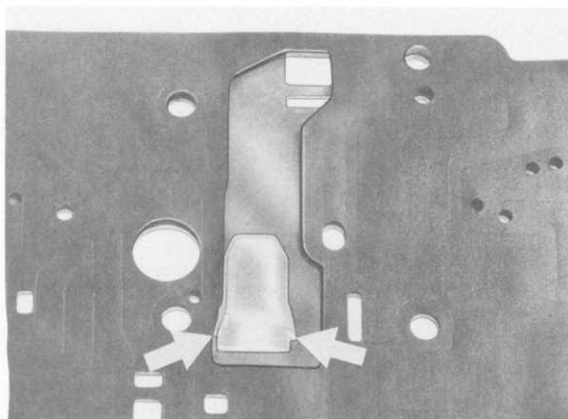
Assembling

1. Install shift valve secondary pump with spring and plug, and secure with holder.

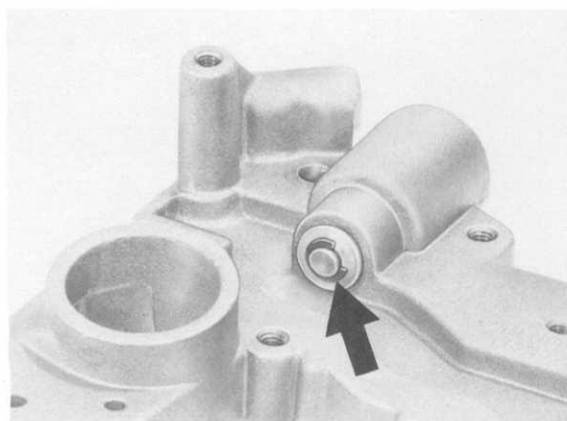


Disassembling

1. Squeeze both tabs together and remove injector.



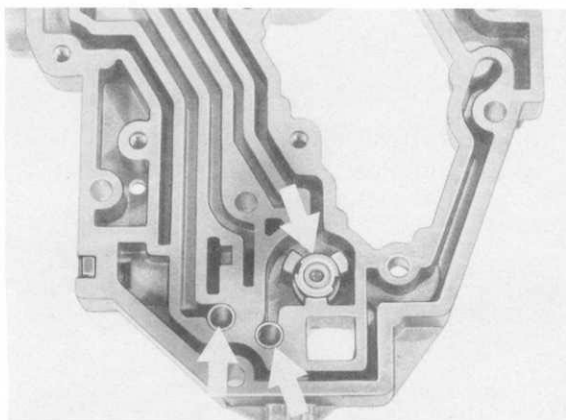
2. Insert blocking valve with spring and shaft, and install circlip.



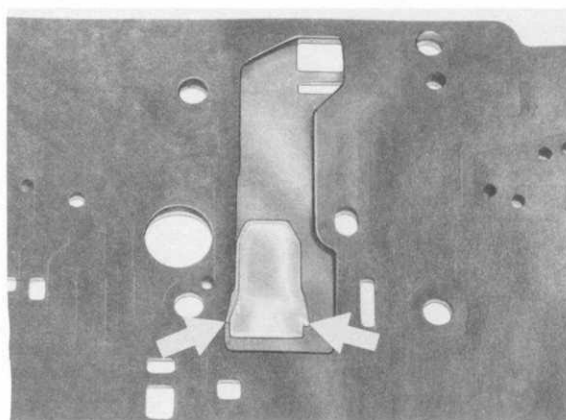
2. Remove filter screens and valve.

3. Take off circlip. Remove blocking valve with spring and shaft.

3. Install valve and filter screens in correct position.



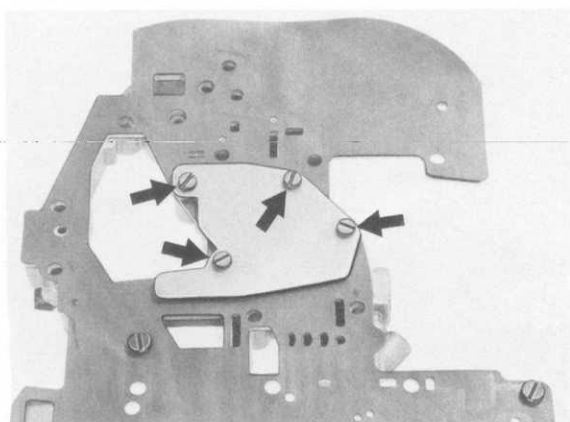
7. Insert injector in correct position until both tabs (arrows) engage.



4. Place transfer plate and gasket on lower cover.

5. Align gasket with transfer plate by inserting two bolts.

6. Mount cover and tighten mounting bolts with 8 Nm/6 ftlb.



TOOLS



No.	Description	Special Tool	Remarks
—	Filler	—	Commercially available, e. g. Dresser-Wayne Model 3009

AFT AND FILTER, CHANGING

Filling Capacities

After drainage approx. 8.0 l

After oil change approx. 6.0 l

Types of oil:

ATF Dexron B - sperm-oil free

The ATF and the filter must be changed every 40,000 kilometers.

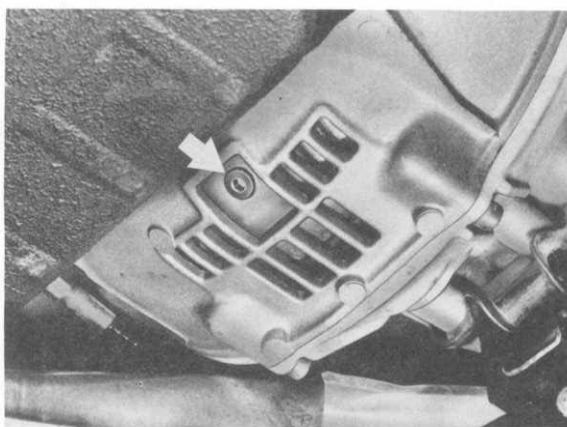
Note

If a vehicle is subjected to particularly severe wear and tear (e.g. used for towing) the ATF should be changed every 20,000 km (without replacement filter)

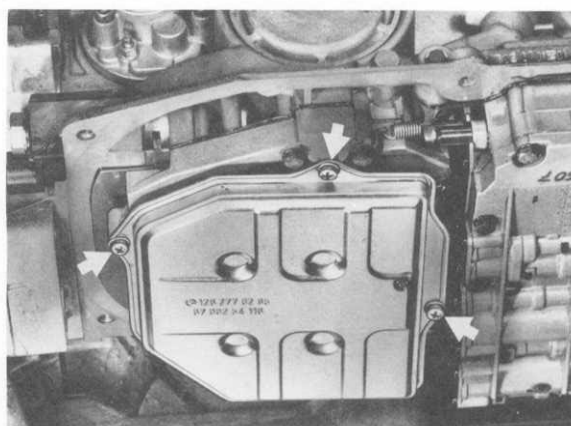
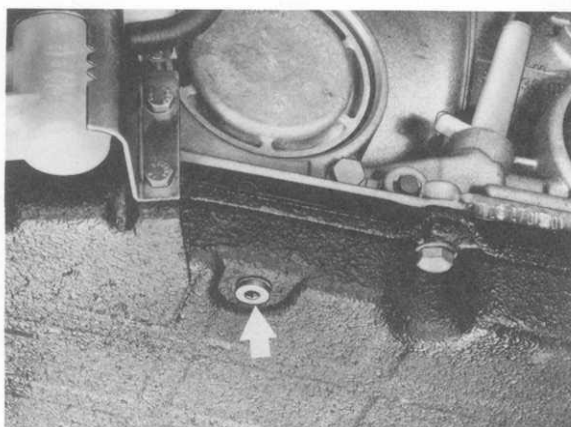
If the ATF is to be changed, the vehicle must be standing on level ground, the transmission must be hot and the engine switched off.

Unscrew drain plug from oil pan and drain the ATF into a suitable container.

Turn crankshaft until the converter drain plug is visible and can be removed.



When ATF ceases to drain from the oil pan and torque converter, remove transmission oil pan and install replacement ATF filter.

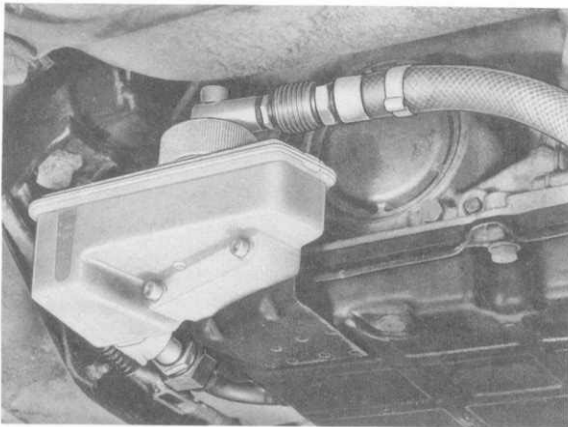


Install oil pan with gasket and torque retaining bolts with 8 Nm (8.7 ftlb).

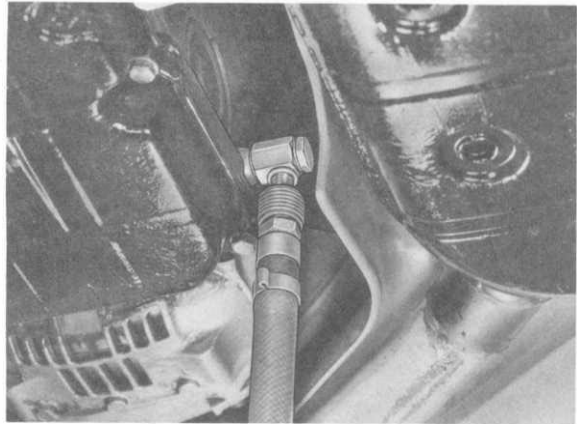
Screw in plugs with new seals and tighten with 14 Nm (10.2 ftlb).

R e f i l l i n g w i t h A T F

Before starting the engine, use a filler to pump most of the ATF (approx. 5 l) into the oil pan. With the selector lever at "P" start the engine and allow to idle. Observe the ATF level in the reservoir and top up with the rest of the ATF without delay.



Up to 85 models

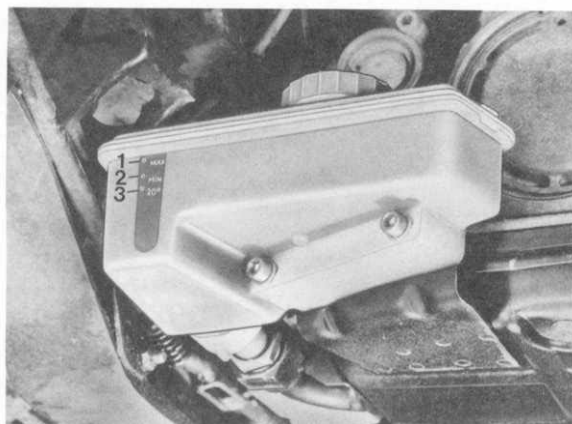


86 models onward

Operate service brake and set the selector lever to each position for a few seconds. Recheck ATF level.

N o t e

The level of ATF in the transmission varies with the temperature of the fluid. The marks (max. and min.) on the reservoir are indexed for an ATF temperature of 80° C. However, at temperatures between 20 and 30° C, the maximum ATF level is below the minimum mark (see fig.). This fact is of importance, as the ATF is usually changed at these temperatures.



Up to 85 models



86 models onward

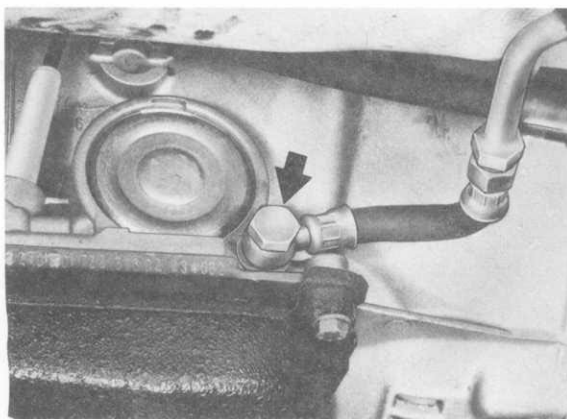
- 1 = max. at 80°C ATF temperature
- 2 = min. at 80°C ATF temperature
- 3 = max. at 20-30°C ATF temperature

FLUSHING ATF COOLER AND LINES

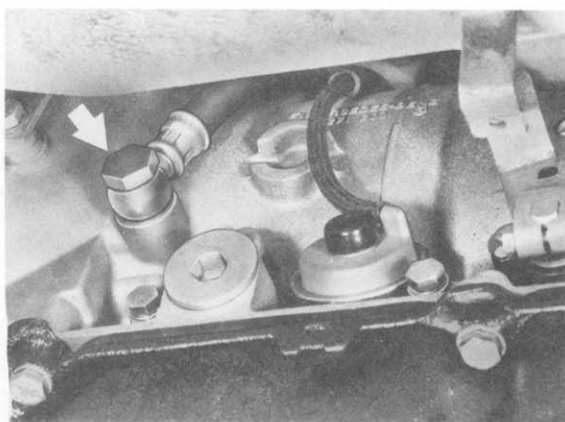
Note:

If ATF smells burnt and there are metal particles, sludge or liner abrasion in oil pan, it is not sufficient to only replace the valve body or transmission. The ATF cooler and lines will also have to be flushed with ATF.

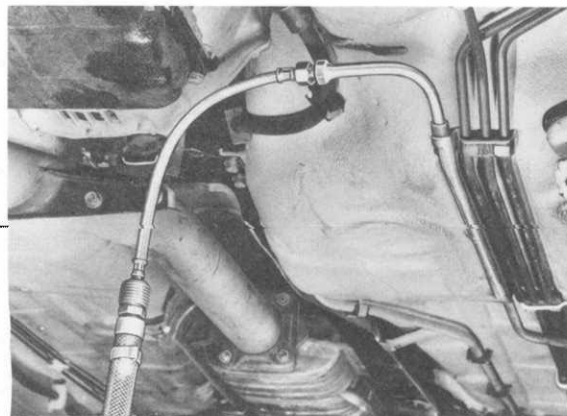
1. Disconnect return line on transmission case and take off short hose on return line.



2. Disconnect feed line on transmission case.



3. Attach extra hose from ATF charger (see Workshop Equipment Group of Special Tool Catalog) on return line and flush cooler as well as lines with the charger.

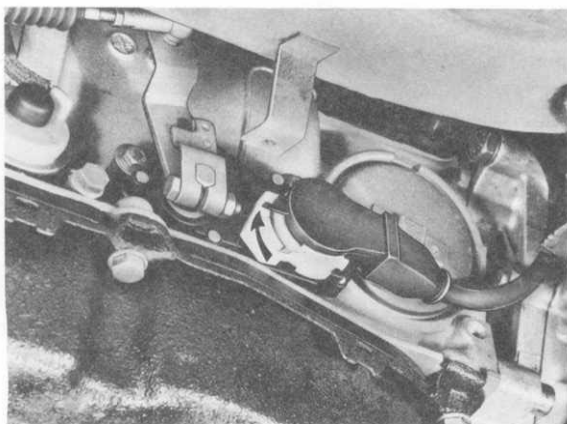


4. Catch ATF running out of feed line.

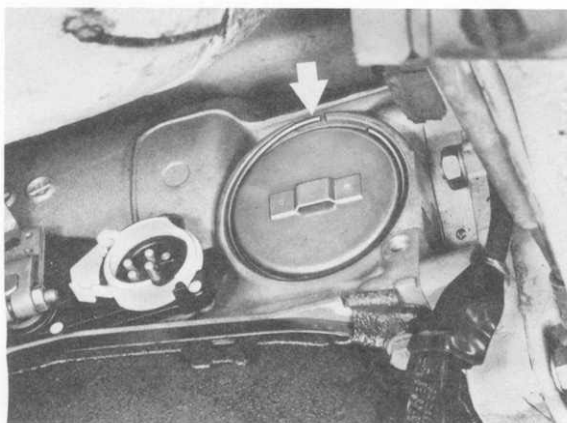
REMOVING AND INSTALLING GOVERNOR

Removing

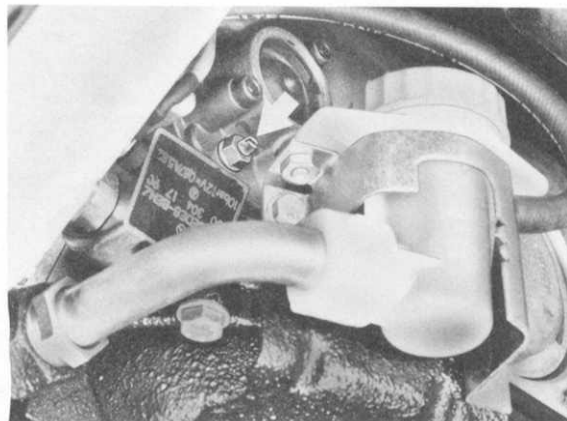
1. Loosen intermediate muffler shield and push aside as far as possible.
2. Unlock plug for starter locking and backup light switch by turning up white plastic ring in direction of arrow. Pry off plug carefully with two screw-drivers applied on both sides.



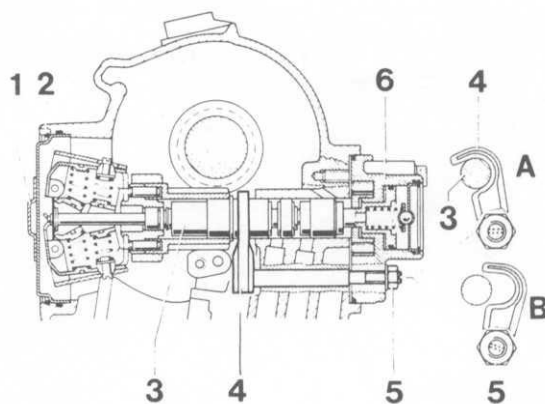
3. Press in cover and remove snap ring with cover.



4. Loosen nut for axial holder.



5. Turn axial holder counterclockwise with a screwdriver inserted in slot (corresponding with position "B" in sectional view).



- 1 = Cover
- 2 = Snap ring
- 3 = Governor
- 4 = Axial holder
- 5 = Axial holder nut
- 6 = Secondary pump

6. Pull out governor.

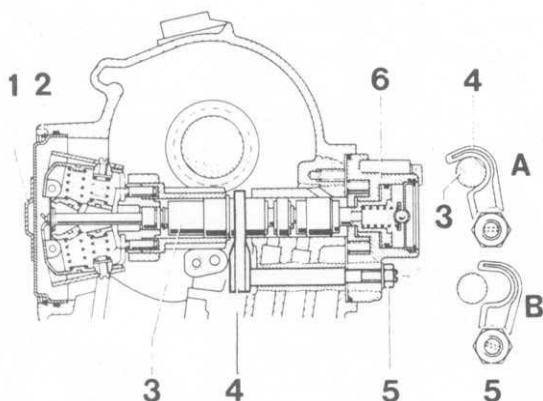
Installing

1. Guide in governor.

Note:

Absolute cleanliness is necessary for installation of governor. If necessary, cover area of governor installation with lint free cloths.

2. Move centrifugal governor lightly in and out while turning axial holder clockwise until governor engages firmly (position "A" in section drawing).



- 1 = Cover
- 2 = Snap ring
- 3 = Governor
- 4 = Axial holder
- 5 = Axial holder nut
- 6 = Secondary pump



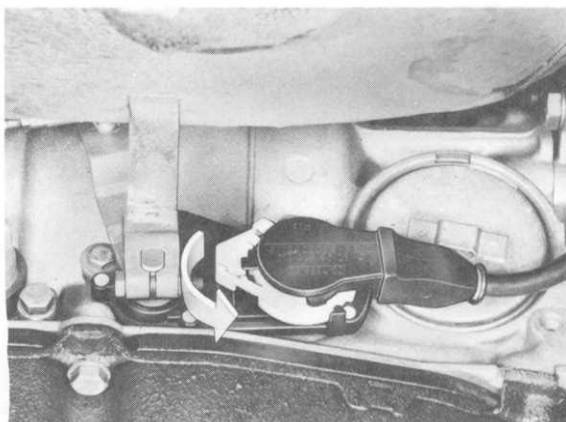
Note:

Axial holder has been installed correctly when slot is horizontal (position "A" in section drawing).

4. Press in cover and insert snap ring.

5. Press out cover again until it rests on snap ring.

6. Press on plug for starter locking and backup light switch. Lock by turning white plastic ring down.

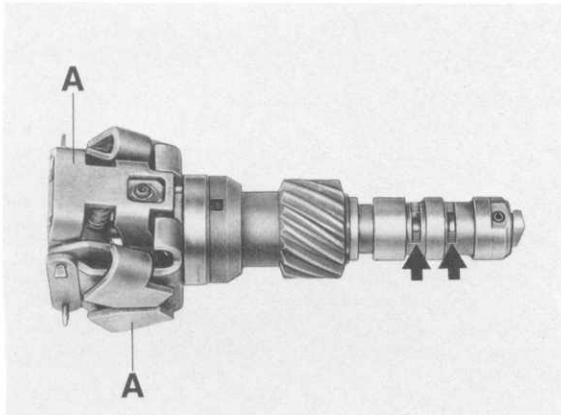


3. Tighten axial bearing nut to 8 Nm/6 ftlb.

7. Bolt shield.

Checking Governor

Move centrifugal weight "A" and at same time check movement of governor valve in openings (arrows).



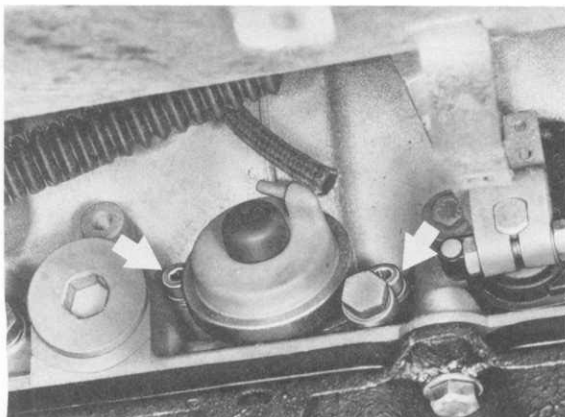
Note:

It should be possible to move governor valve easily. If necessary, wash governor and dry thoroughly with compressed air.

REMOVING AND INSTALLING VACUUM MODULATOR

Removing

1. Loosen intermediate muffler shield and push aside as far as possible.
2. Adjust modulating pressure (see page 38 - 108).
2. Pull off vacuum hose on vacuum modulator.
3. Remove socket head screws and remove with holder.

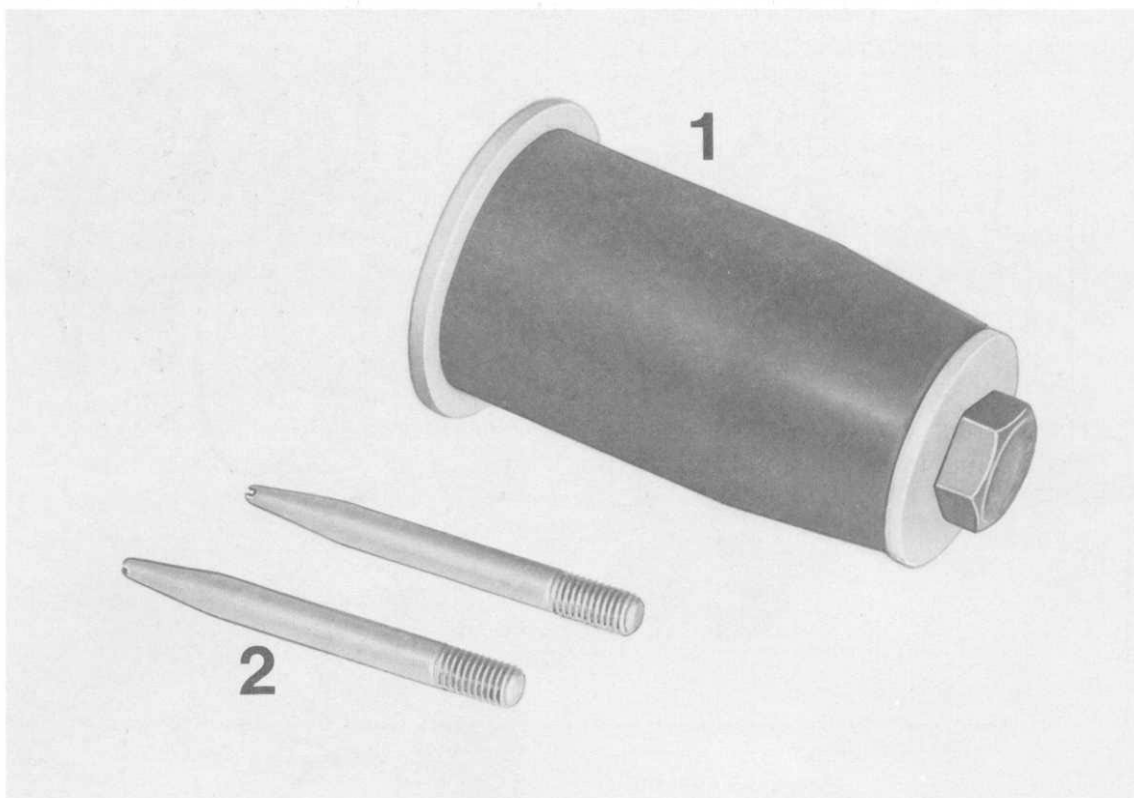


4. Pull out vacuum modulator.

Installing

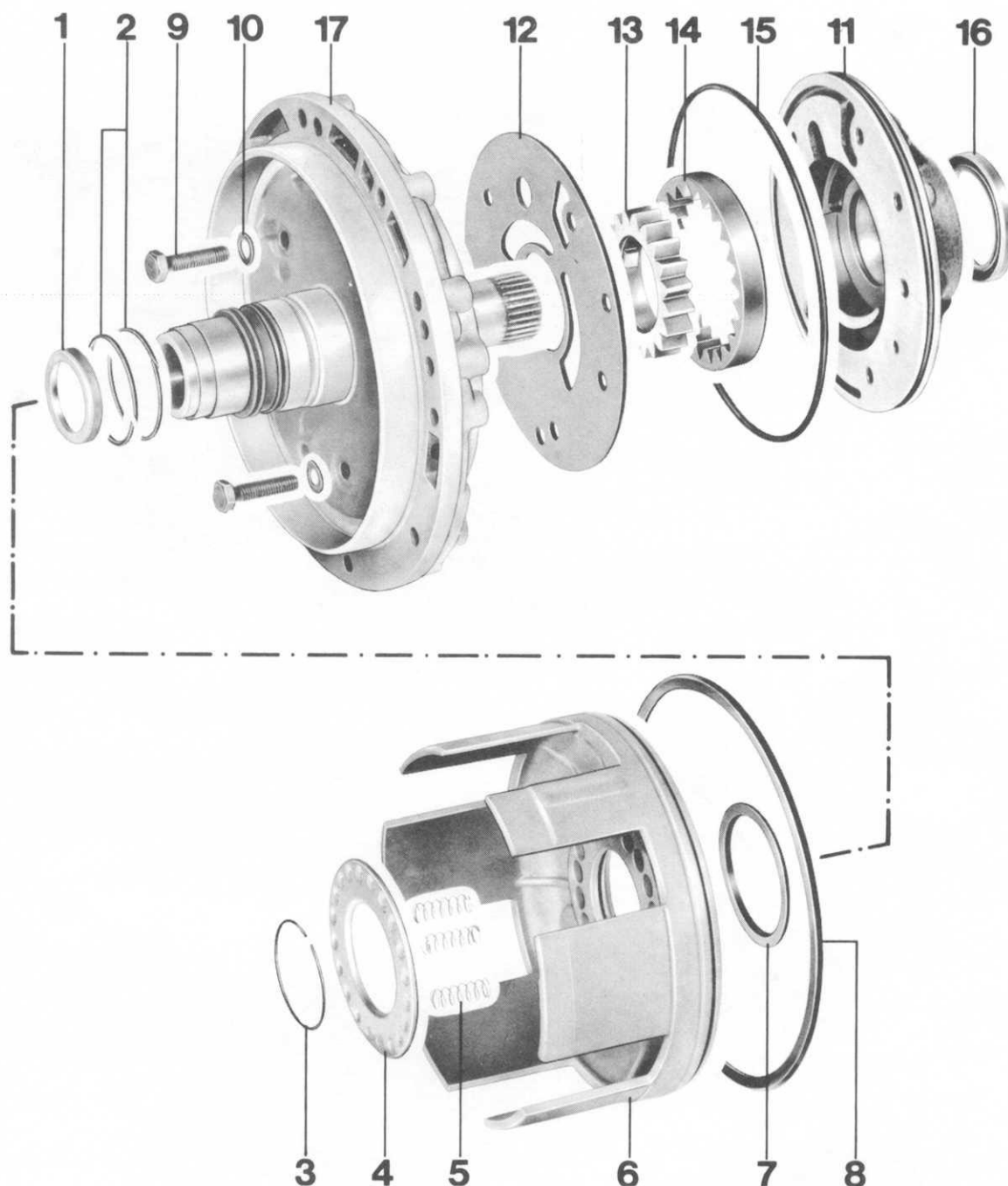
1. Mount vacuum modulator with holder and tighten socket head screws to 8 Nm/6 ftlb.

TOOLS



No.	Description	Special Tool	Remarks
1	Guiding sleeve	9319	
2	Centering pins	9321	

REMOVING AND INSTALLING PRIMARY PUMP



No.	Description	Qty.	Note When:	
			Removing	Installing
1	Thrust washer	1		
2	Teflon ring	2		Replace, install with grease.
3	Circlip	1		
4	Spring plate	1		Insert right way round
5	Compression spring	20		
6	Piston	1		Insert right way round
7	Sealing ring with lip	1		Sealing lip must face toward cover
8	Sealing ring with lip	1		
9	Hex bolt	1		Tightening torque: 20 Nm (15 ftlb)
10	Spring washer	6		
11	Pump casing	1		Check bearing sleeve for damage
12	Backer	1		Install right way round
13	Pump gear (driving)	1		
14	Pump gear (driven gear)	1		Bevel faces toward bearing sleeve
15	O-ring	1		Replace, coat with ATF
16	Sealing ring	1		Drive in with suitable pressure piece
17	Cover	1		

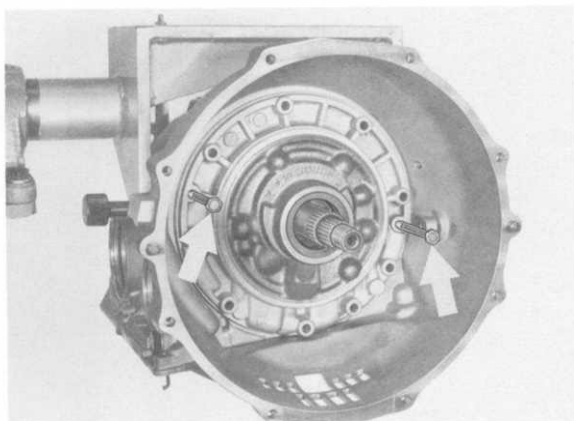
* As of transmission No. 472 213, the pin on the cover (No. 17) has been extended. The thrust washer is no longer installed.

NOTES FOR REMOVING AND INSTALLING

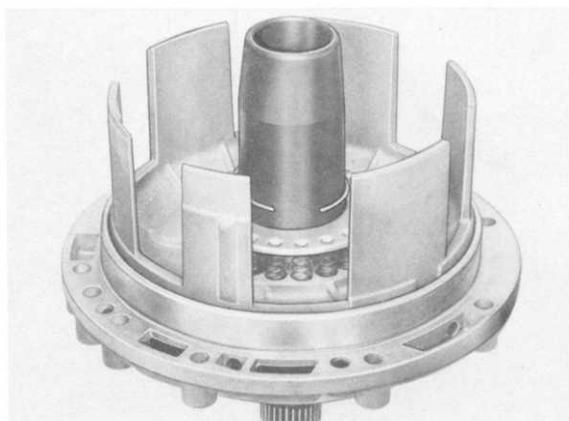
RemovingNote:

It is not necessary to disassemble the transmission to remove or install the primary pump.

1. Remove transmission.
2. Remove front converter casing and converter.
3. Unscrew mounting bolts for front transmission cover.
4. Screw two bolts in threaded holes and pull bolts to withdraw cover.



5. Press spring plate down and remove circlip.



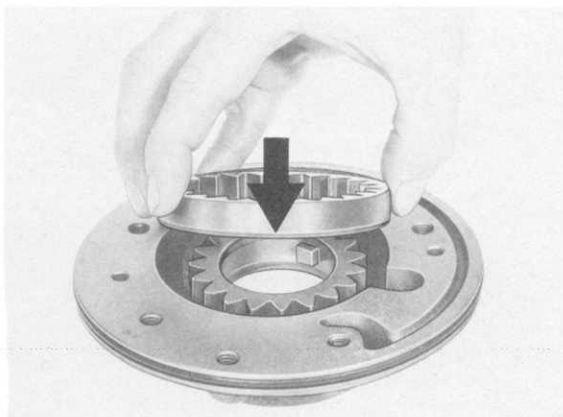
6. Unscrew mounting bolts and remove pump; screw two bolts in threaded holes and carefully drive out primary pump with light taps of a nylon-headed hammer.

Installing

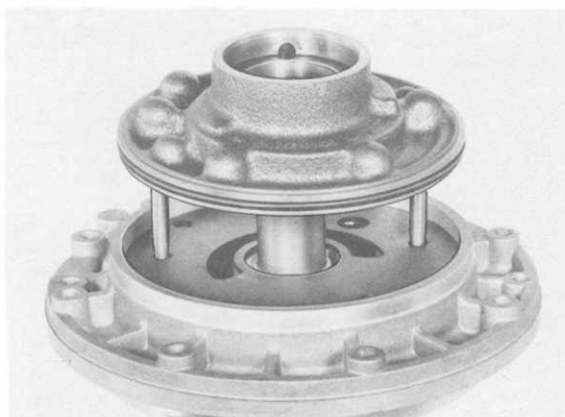
1. Check bearing sleeve for grooves or signs of damage. If damage is discovered, the primary pump must be replaced.



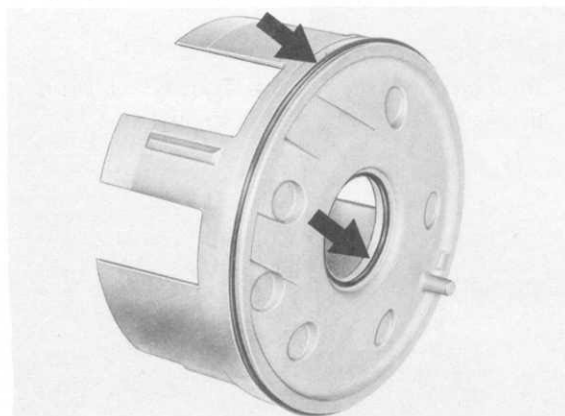
2. Lubricate both pump gears with ATF and install in pump body, whereby the large gear must be installed that the chamfer (arrow) faces bearing sleeve.



3. Screw Special Tools 9321 in pump body. Place transfer plate in correct position and install pump in front cover. Bearing sleeve must not be damaged by the stator shaft during this step. Tighten mounting bolts to 20 Nm/14 ftlb.



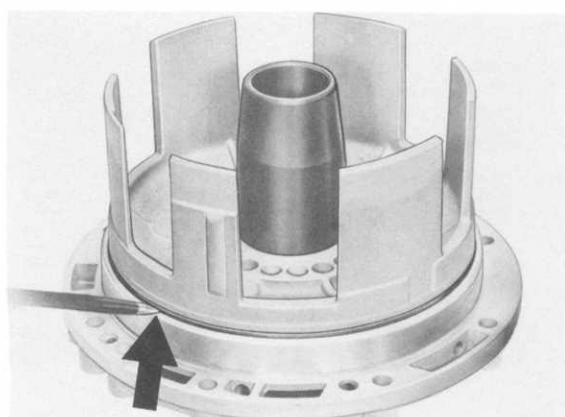
4. Install seals on piston that sealing lips face down (direction of arrow).



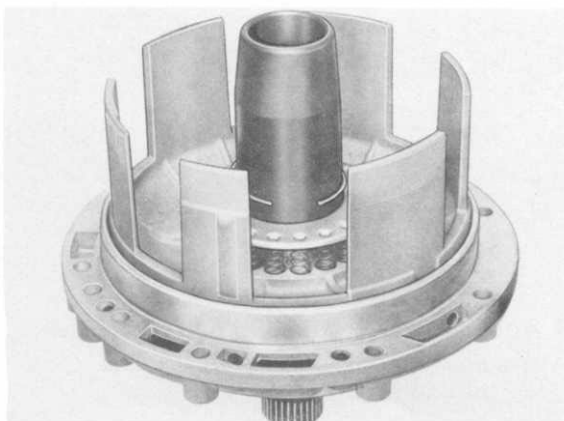
5. Apply Special Tool 9319 on front cover and coat sliding surfaces with ATF.

6. Coat seals on piston with ATF and install piston that journal (on piston) and bore in front cover are aligned.

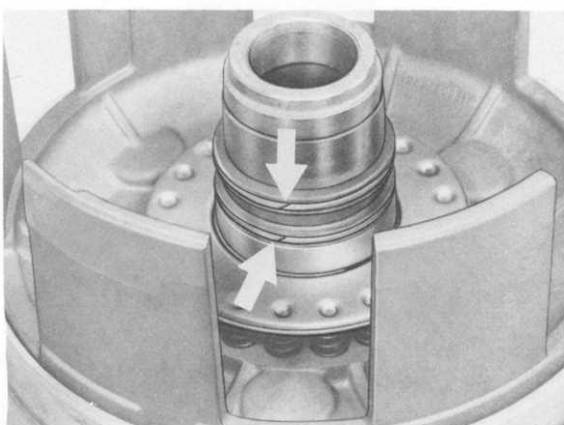
7. Press in piston carefully and without canting, driving in with a suitable pin applied on outer seal (arrow) if necessary.



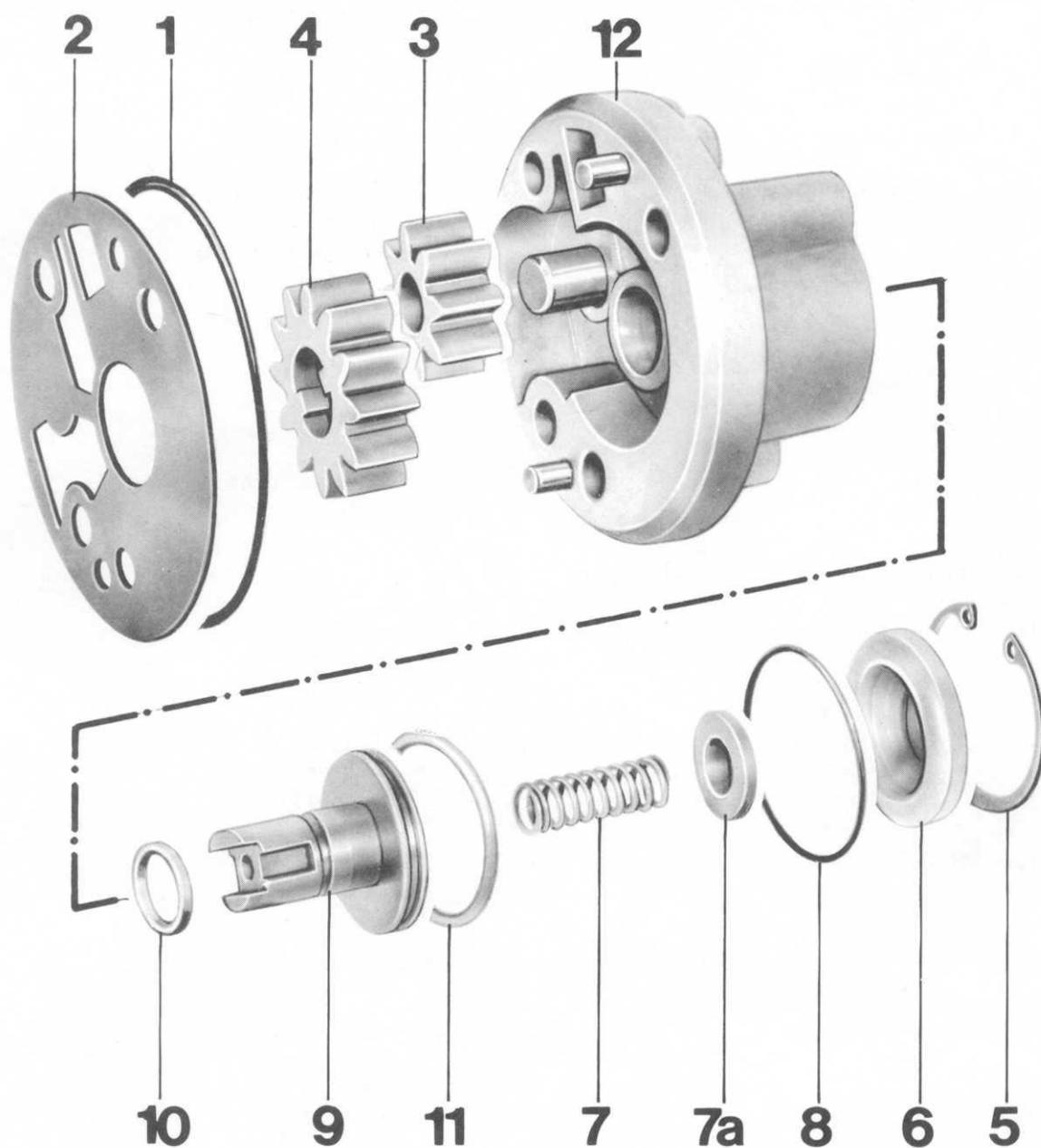
8. Install return springs and diaphragm spring.
9. Slide circlip over Special Tool 9319, hold circlip down and pull off special tool.



10. Push down on diaphragm spring with circlip until circlip engages in its groove.
11. Install teflon rings with grease, making sure gap of rings (arrow) remain together. If necessary, take off rings again and shape them carefully to a smaller diameter.

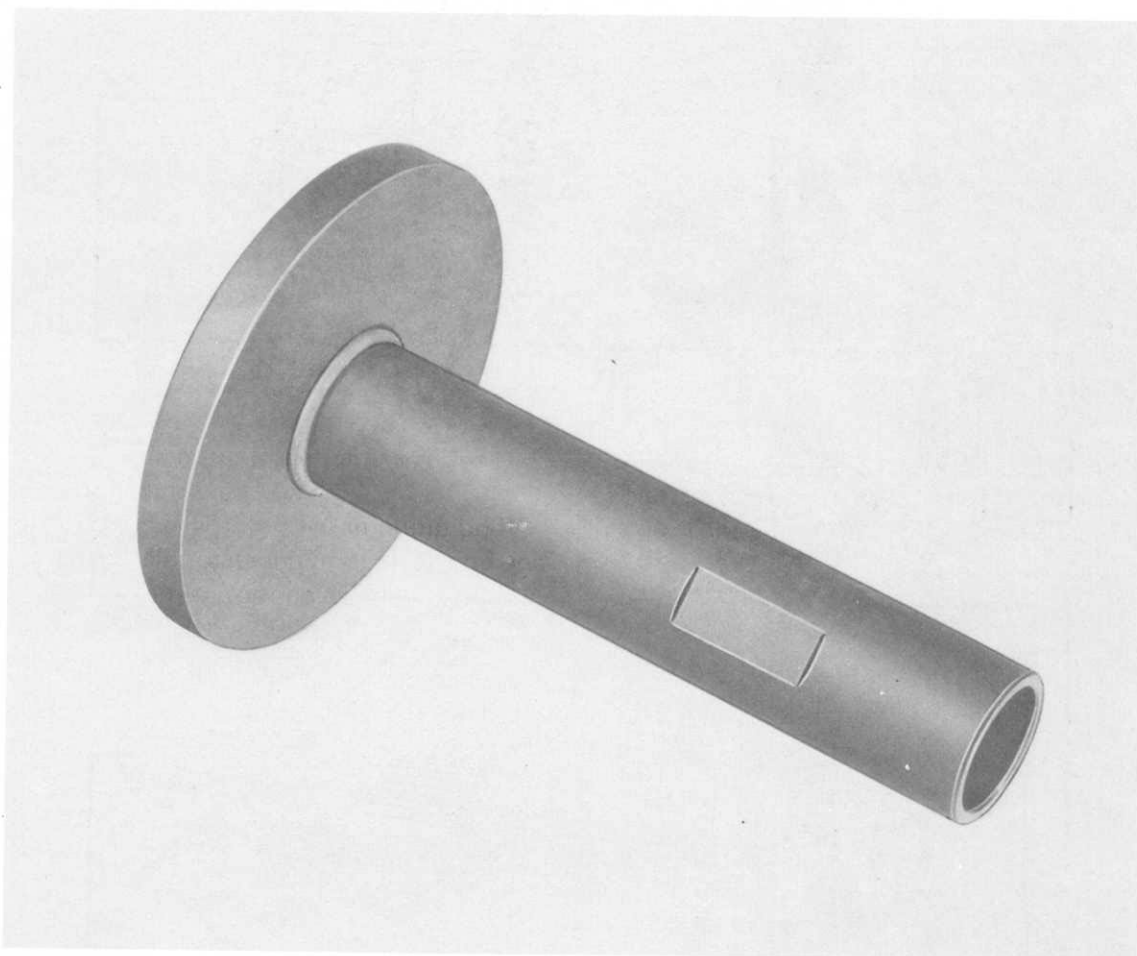


DISASSEMBLING AND ASSEMBLING SECONDARY PUMP



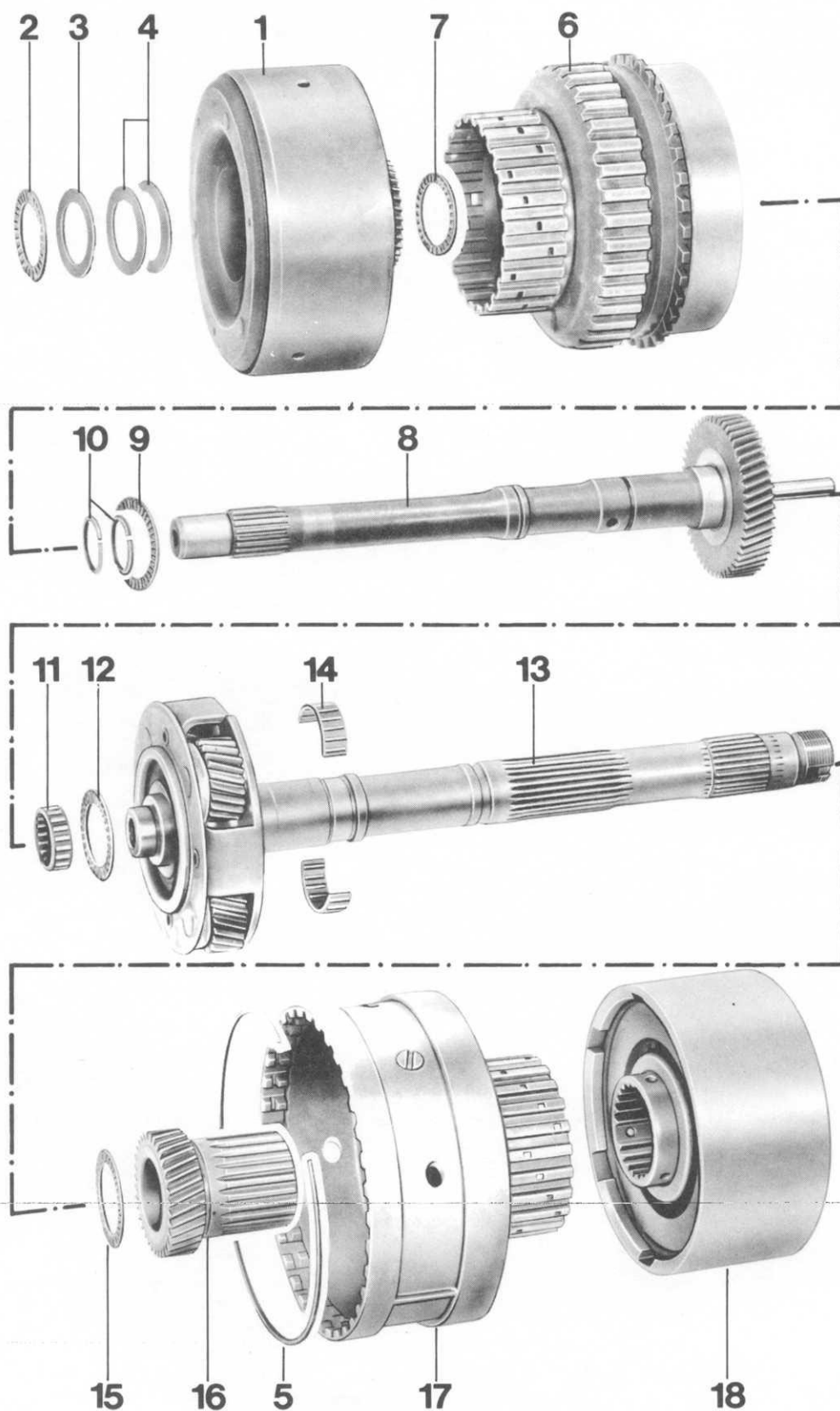
No.	Description	Qty.	Note When:		Special Instructions
			Removing	Installing	
1	O-ring	1		Replace if necessary. Coat with ATF	
2	Transfer plate	1			
3	Gear (driven)	1		Coat with ATF	
4	Gear (driving)	1		Coat with ATF; drive dog must engage in groove	
5	Circlip	1			
6	Cover	1			
7	Spring	1			
8	O-ring	1		Replace, coat with ATF	
9	Piston	1			
10	Teflon ring	1		Replace, install in groove with grease	
11	Teflon ring	1		Replace, install in groove with ATF	
12	Body	1			

TOOLS



No.	Description	Special Tool	Remarks
	Assembly stand	9314	

DISASSEMBLING AND ASSEMBLING GEAR ASSEMBLY

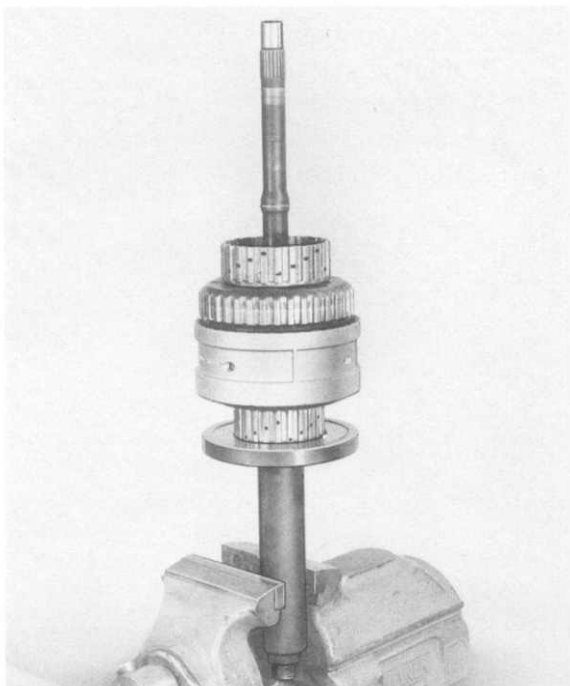


No.	Description	Qty.	Note When:		Special Instructions
			Removing	Installing	
1	Clutch K 1	1		Install only after gear assembly is in case	
2	Axial bearing	1			
3	Thrust washer	1			
4	Shim	X	Note thickness for reinstallation	Redetermine thickness if necessary	
5	Snap ring	1	Remove with a suitable screw-driver	Check for correct fit	
6	Front gear set	1			
7	Axial bearing	1			
8	Drive shaft	1			
9	Axial bearing	1			
10	Lubricating ring	2		Replace, install with grease	
11	Radial bearing	1			
12	Axial bearing	1			
13	Drive shaft	1			
14	Radial bearing (split)	1		Install with grease	
15	Axial bearing	1			
16	Sun gear	1			
17	Inner plate carrier with one-way clutch	1			
18	Clutch K 2	1			

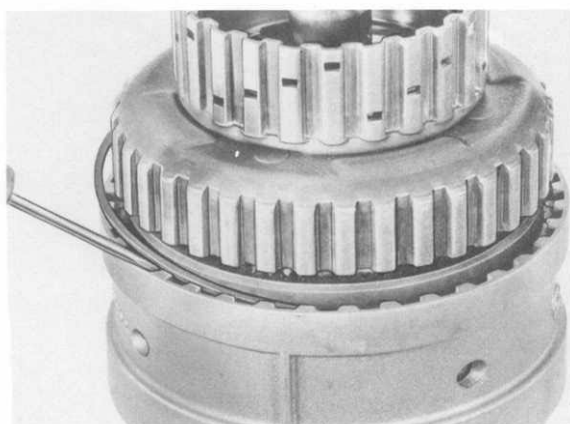
DISASSEMBLING AND ASSEMBLING GEAR ASSEMBLY

Disassembling

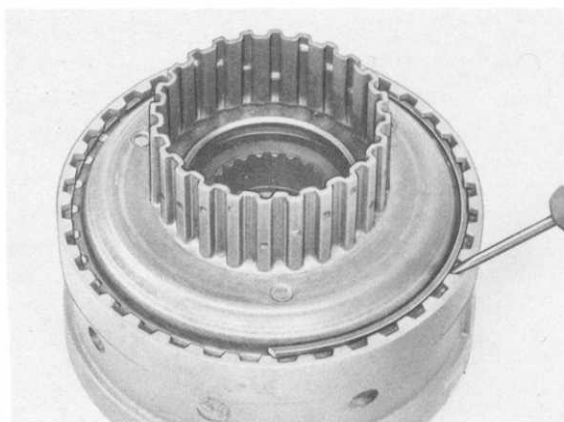
1. Clamp Special Tool 9314 in a vise on both surfaces with plate facing up and mount gear assembly with drive shaft facing up.



2. Remove snap ring.



3. Take off parts separately.
4. Remove snap ring and take inner plate carrier with one-way clutch out of connecting carrier



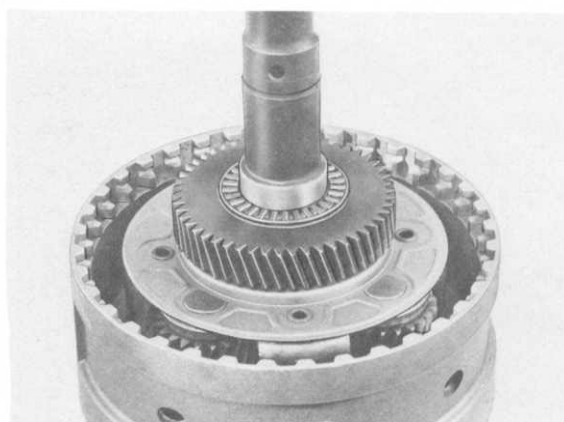
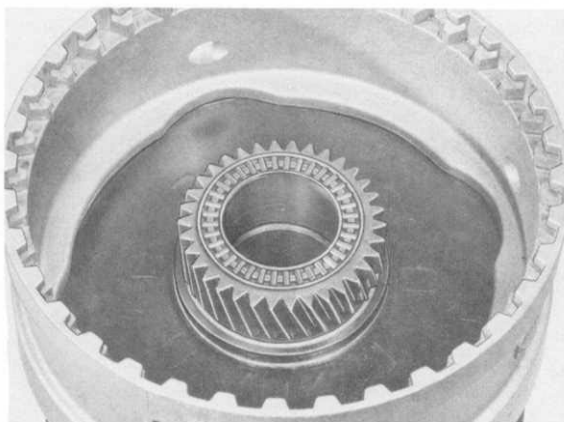
Assembling

Note:

Coat all bearing surfaces and sliding surfaces with ATF when assembling.

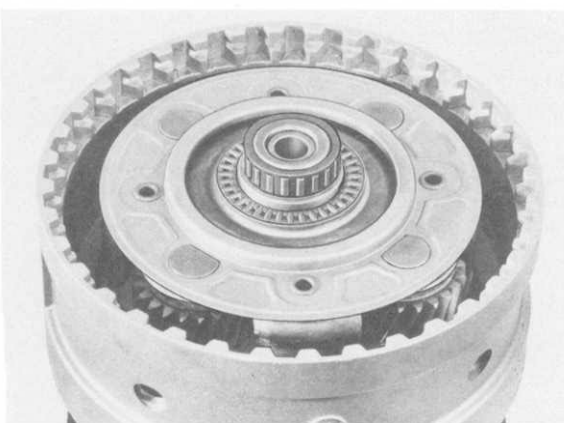
1. Place one-way clutch with connecting carrier on Special Tool 9314.

2. Mount sun gear and install axial bearing.

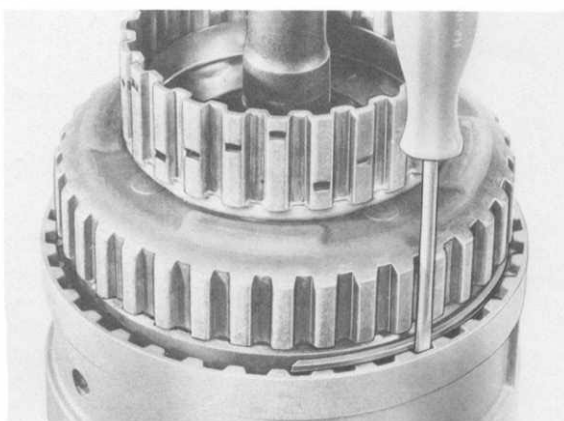


3. Install output shaft.

4. Install axial and radial bearings on output shaft.



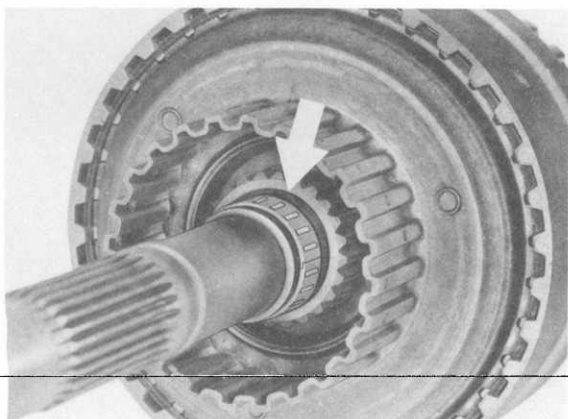
6. Install front gear set and secure with snap ring. Press snap ring into groove with a screwdriver.



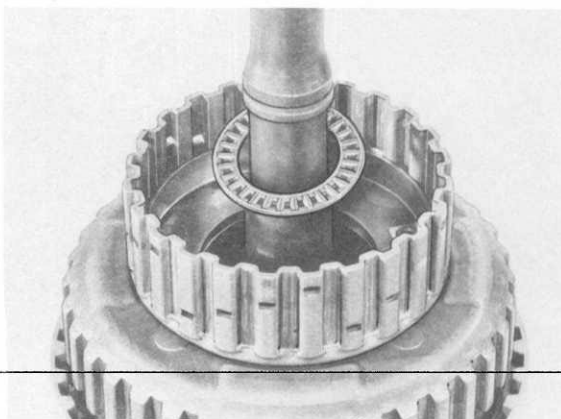
5. Install drive shaft and axial bearing.

7. Lift gear assembly off of Special Tool 9314 and install again with drive shaft facing up.

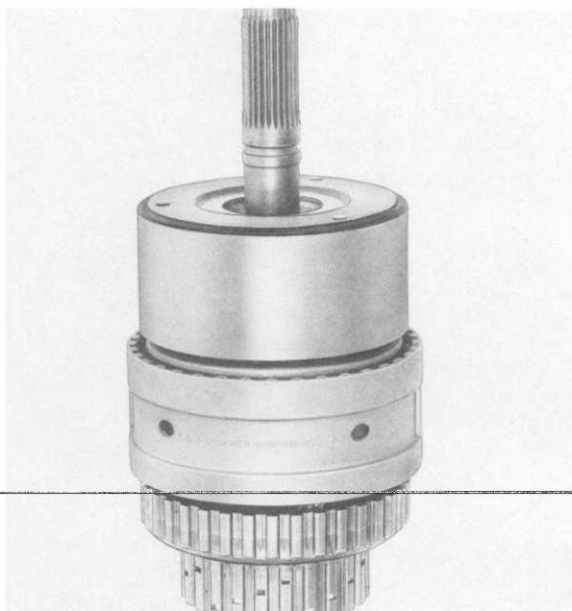
8. Install split radial bearing on output shaft with a small amount of grease.



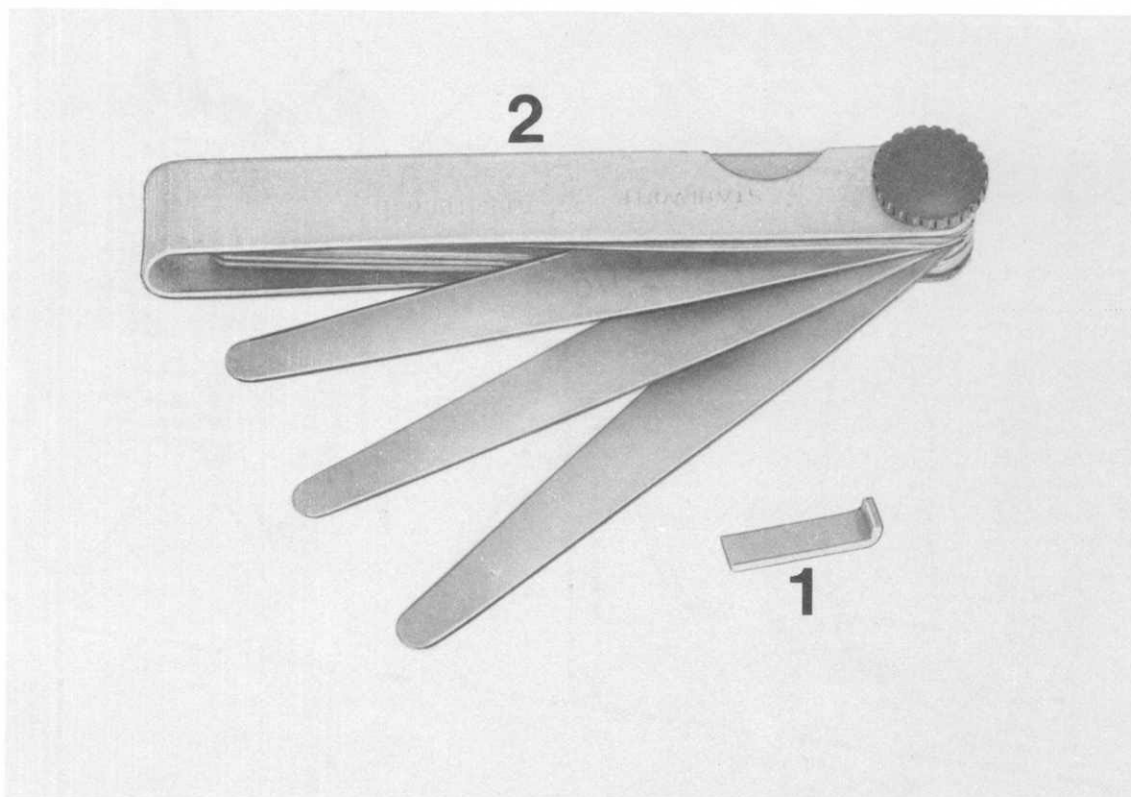
10. Take gear assembly off of Special Tool 9314 and install axial bearing on drive shaft with a small amount of grease.



9. Install clutch K 2.

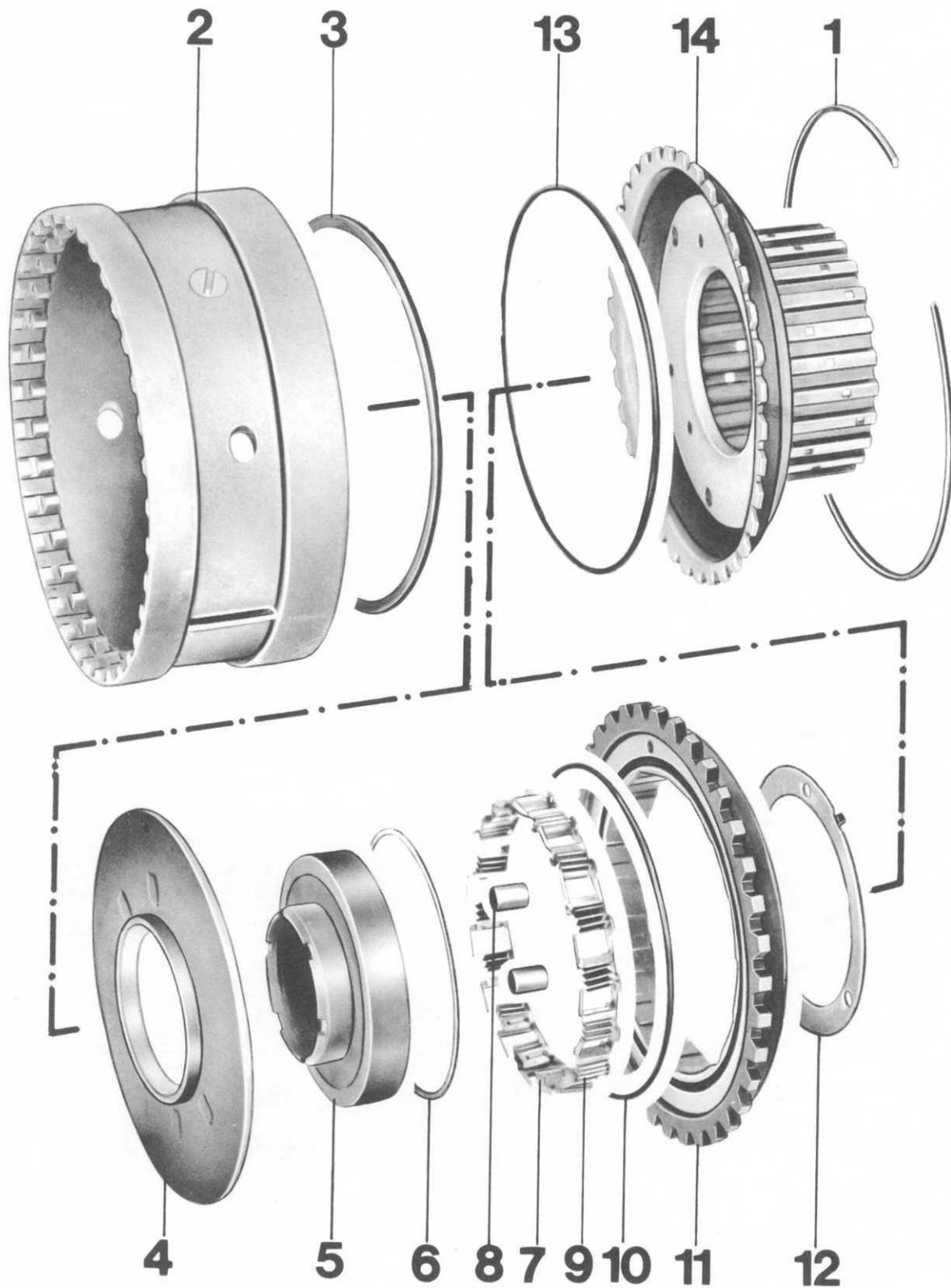


TOOLS



No.	Description	Special Tool	Remarks
1	Lockplate	9322	Sixteen (16)
2	Feeler blade gauge	—	Standard tool

DISASSEMBLING AND ASSEMBLING ONE-WAY CLUTCH

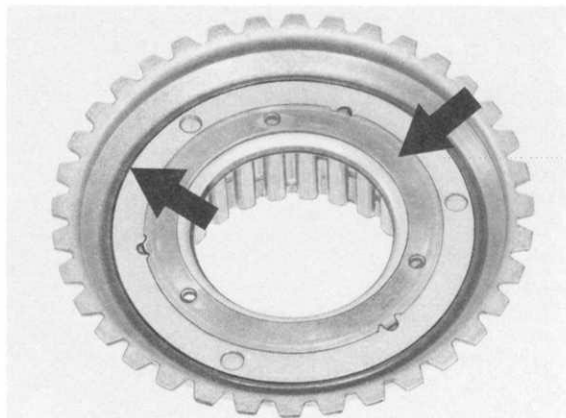
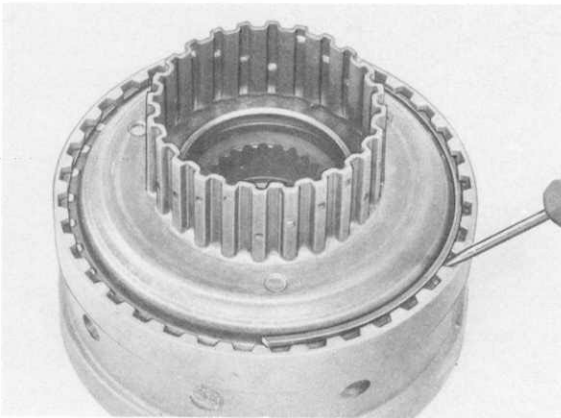


No.	Description	Qty.	Note When:		Special Instructions
			Removing	Installing	
1	Snap ring	1		Check for correct fit	
2	Connecting carrier	1			
3	Shim	X		Redetermine thickness, if necessary	
4	Support	1		Position correctly	
5	One-way clutch inner race	1		Use Special Tool 9322	
6	Shim	1			
7	Roller cage	1			
8	Cyl. roller	16			
9	Spring	16			
10	O-ring	1		Replace, install after checking axial play	
11	One-way clutch outer race	1		Check for wear	
12	Thrust washer	1		Tabs engage in plate carrier	
13	O-ring	1		Replace	
14	Plate carrier	1			

DISASSEMBLING AND ASSEMBLING ONE-WAY CLUTCH

Disassembling

1. Remove snap ring and lift inner plate carrier K 2 with one-way clutch out of connecting carrier.
1. Place thrust washer and O-ring on inner plate carrier.



2. Turn inner race of one-way clutch counter-clockwise and pull out.
2. Install cylindrical rollers in roller cage.

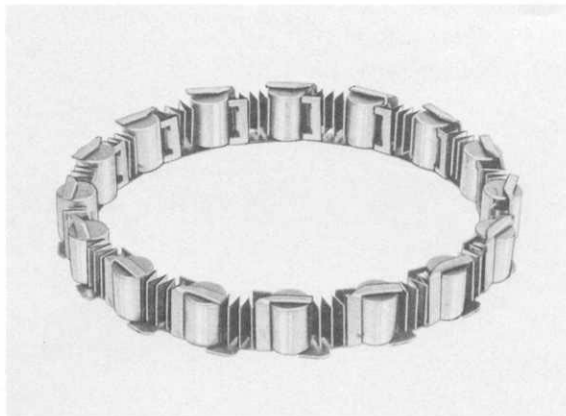
Assembling

Note:

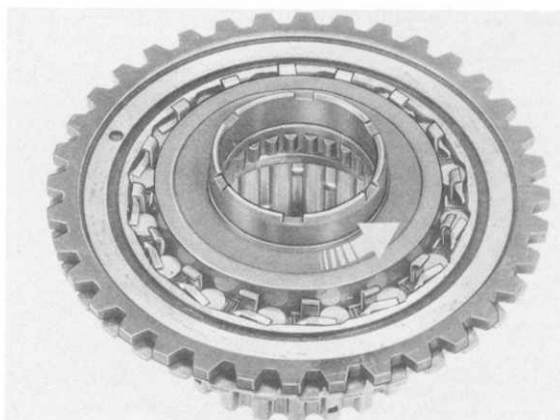
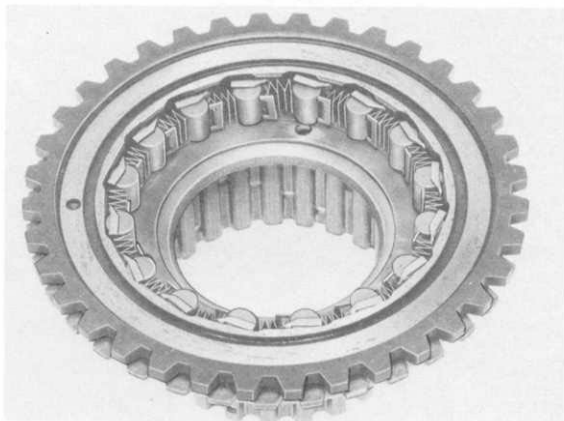
Check bearing surfaces and inner race of one-way clutch for wear.

If bearing surface of cylindrical rollers on inner race of one-way clutch shows strong scoring or notching, replace the entire one-way clutch.

Coat bearing surfaces and sliding surfaces with ATF.



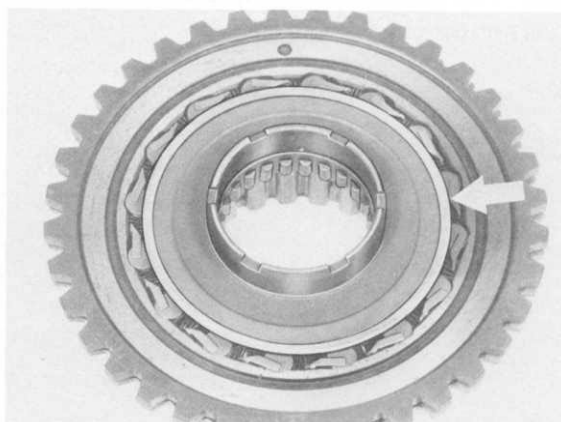
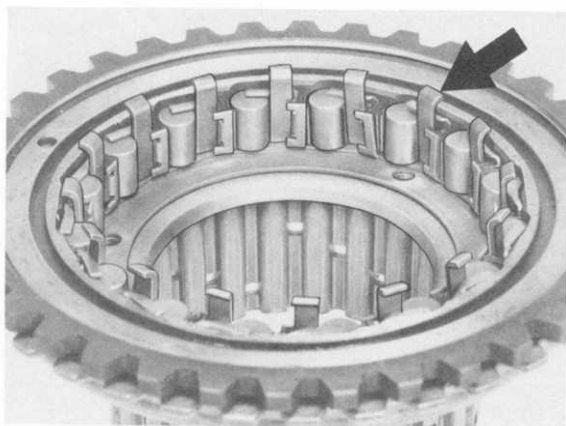
3. Place outer race of one-way clutch on inner plate carrier and install roller cage in correct position.



6. Remove Special Tool 9322.

7. Install shim.

4. Push cylindrical rollers against springs and apply Special Tool 9322 with bend facing out.

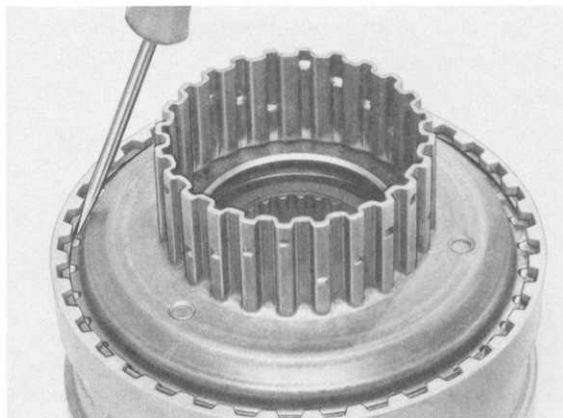
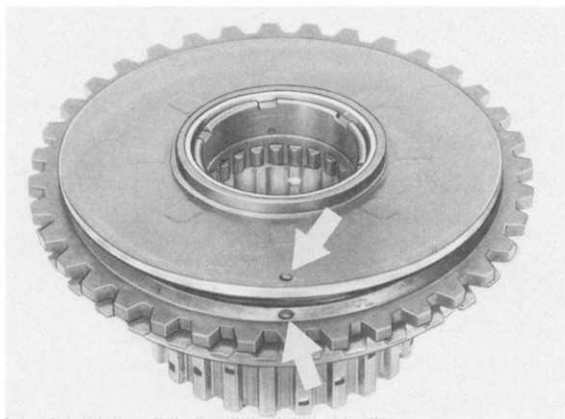


5. Install one-way clutch inner race while turning in direction of arrow.

Note:

Install O-ring only after checking axial play of one-way clutch.

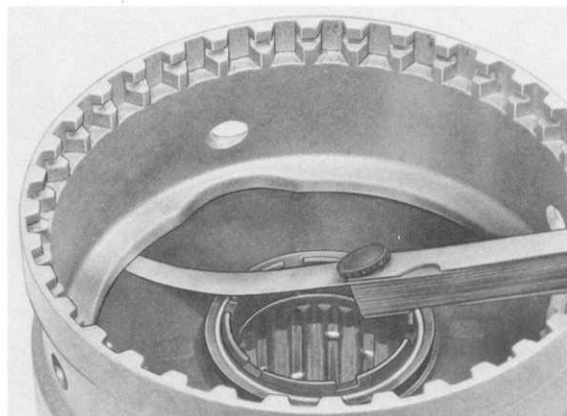
8. Install support that pin engages in bore (arrow) of one-way clutch outer race.



Checking and Adjusting One-way Clutch Axial Play:

9. Place shims (if available) on outer race of one-way clutch and install connecting carrier on one-way clutch.

1. Check play between one-way clutch and connecting carrier with a feeler gauge.

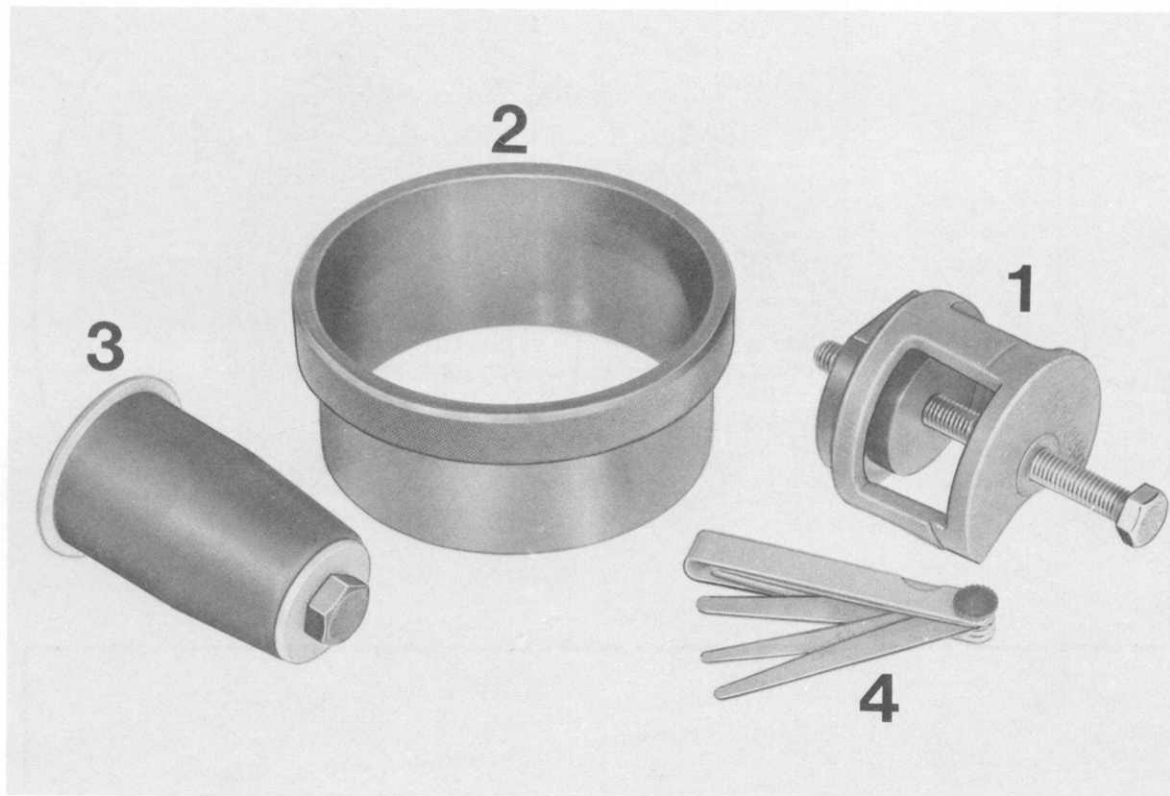


10. Install snap ring and press into groove with a screwdriver.

2. Adjust play to 0.05 . . . 0.2 mm with shims.

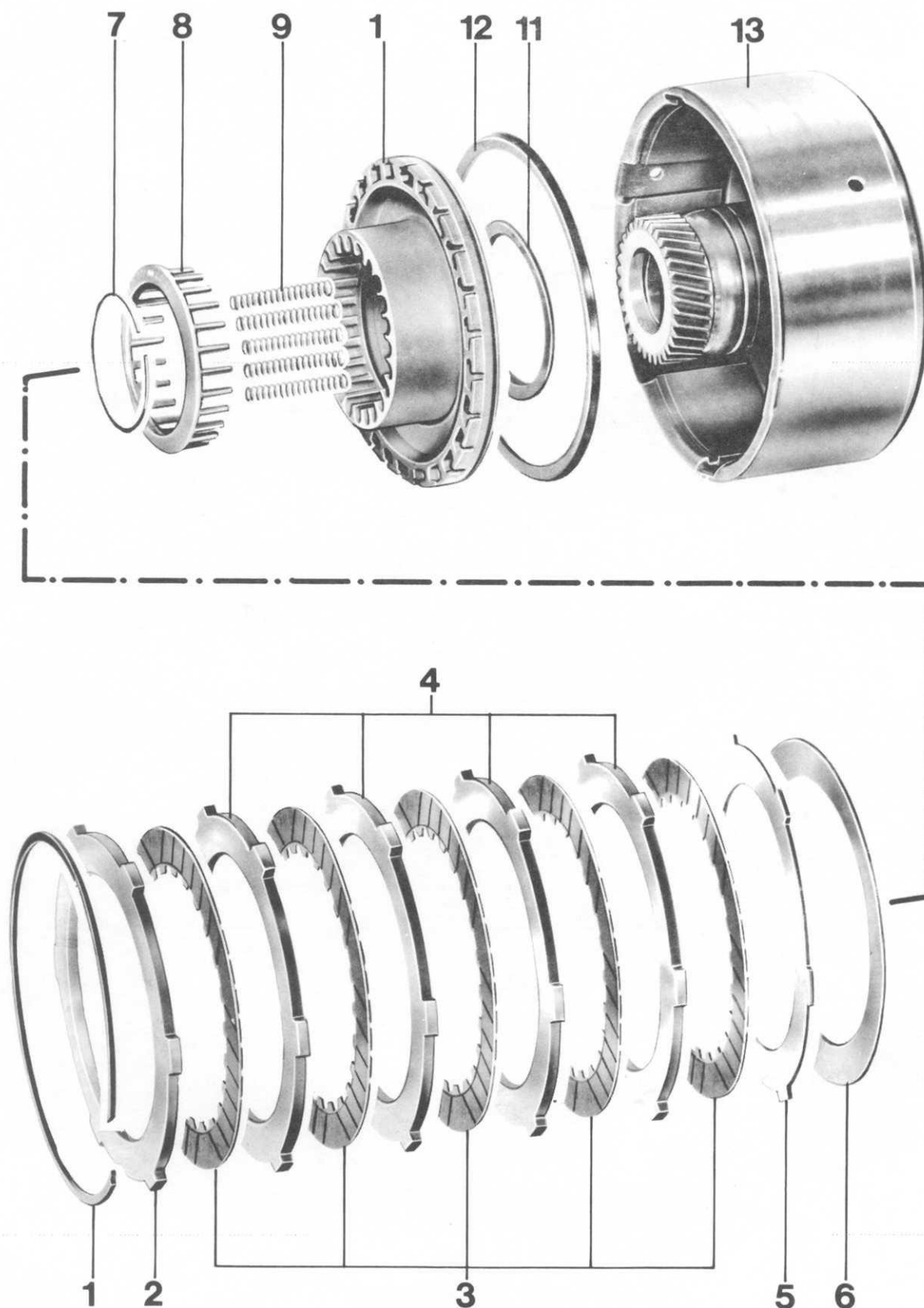
3. Install O-ring.

TOOLS



No.	Description	Special Tool	Remarks
1	Assembly tool	9315	Standard tool
2	Assembly sleeve	9317	
3	Assembly sleeve	9318	
4	Feeler blade gauge	—	

DISASSEMBLING AND ASSEMBLING CLUTCH K 1



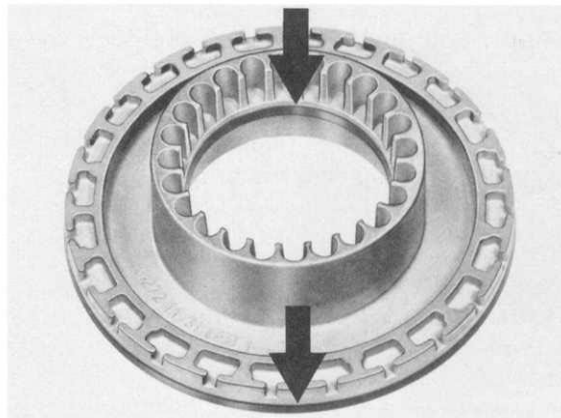
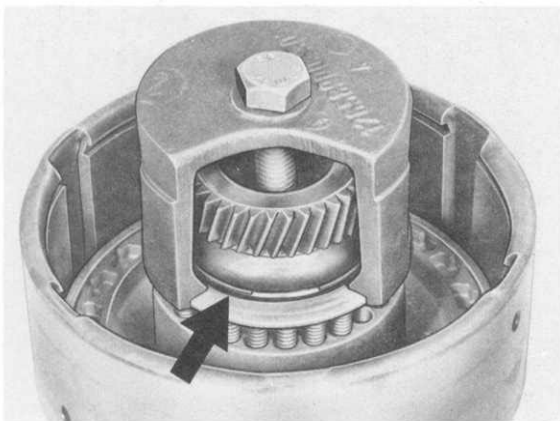
No.	Description	Qty.	Note When:		Special Instructions
			Removing	Installing	
1	Snap ring	X		Redetermine thickness, if necessary	4.5 or 5.0 mm thick (optional to adjust play)
2	Outer plate	1		Check for burnt spots and bending	
3	Inner plate (2.1 mm thick)	5		Check for burnt spots and wear. If less than 2 mm thick, replace. Place in ATF about 1 hour before installing	
4	Outer plate	4		Check for burnt spots and bending	3.0 or 3.5 mm thick (optional to adjust play)
5	Outer plate (2.0 mm thick)	1		Check for burnt spots and bending	
6	Diaphragm spring	1		Position correctly that curved surface faces piston	
7	Snap ring	1	Remove with Special Tool 9315	Install with Special Tool 9315, checking for correct fit	
8	Diaphragm spring	1			
9	Spring	X	Note quantity for reinstallation		

No.	Description	Qty.	Note When:		Special Instructions
			Removing	Installing	
10	Piston	1		Install with Special Tools 9317 and 9318	
11	Seal	1		Position correctly, coat with ATF	
12	Seal	1		Position correctly, coat with ATF	
13	Plate carrier	1			

DISASSEMBLING AND ASSEMBLING CLUTCH K 1

Disassembling

1. Apply Special Tool 9315 on diaphragm spring and tighten until snap ring can be removed.



2. Apply Special Tools 9318 and 9317 in outer plate carrier.
3. Install piston carefully and press into outer plate carrier without canting.

2. Remove diaphragm spring and springs.

Note:

The quantity of springs for clutch piston will vary. If new springs are required, the same quantity of springs must be installed.



Assembling

1. Install seals in piston that sealing lips face down (direction of arrow).

Note:

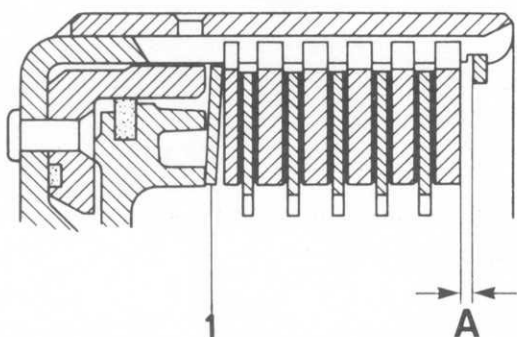
Coat seals and sliding surfaces on Special Tools 9318 and 9317 with ATF.

4. Install springs in piston and place on diaphragm spring, whereby each spring must be centered by a guide pin.

5. Apply and tighten Special Tool 9315.

6. Install snap ring and release special tool. Check that snap ring fits properly.

7. Install diaphragm spring with curved surface on piston as shown in figure.



1 = Diaphragm spring

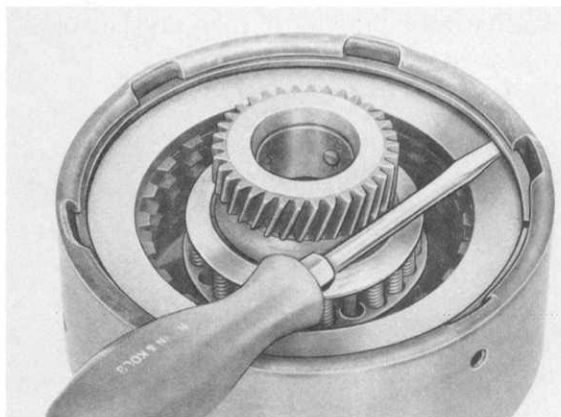
8. Assemble set of plates as shown in layout drawing and install in plate carrier.

Note:

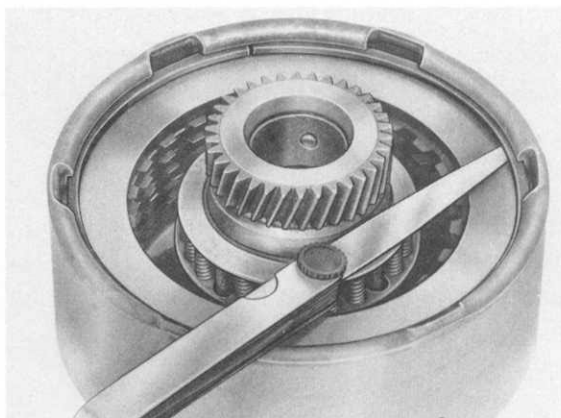
New inner plates must be placed in ATF about 1 hour before installing.

Checking Play (0.7 to 1.2 mm) of Clutch:

1. Push up snap ring around entire periphery with a suitable screwdriver.

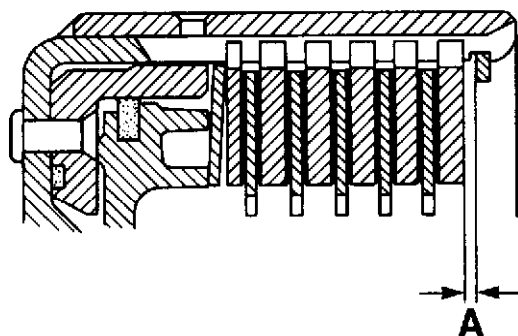


2. Check play "A" with a feeler gauge blade.

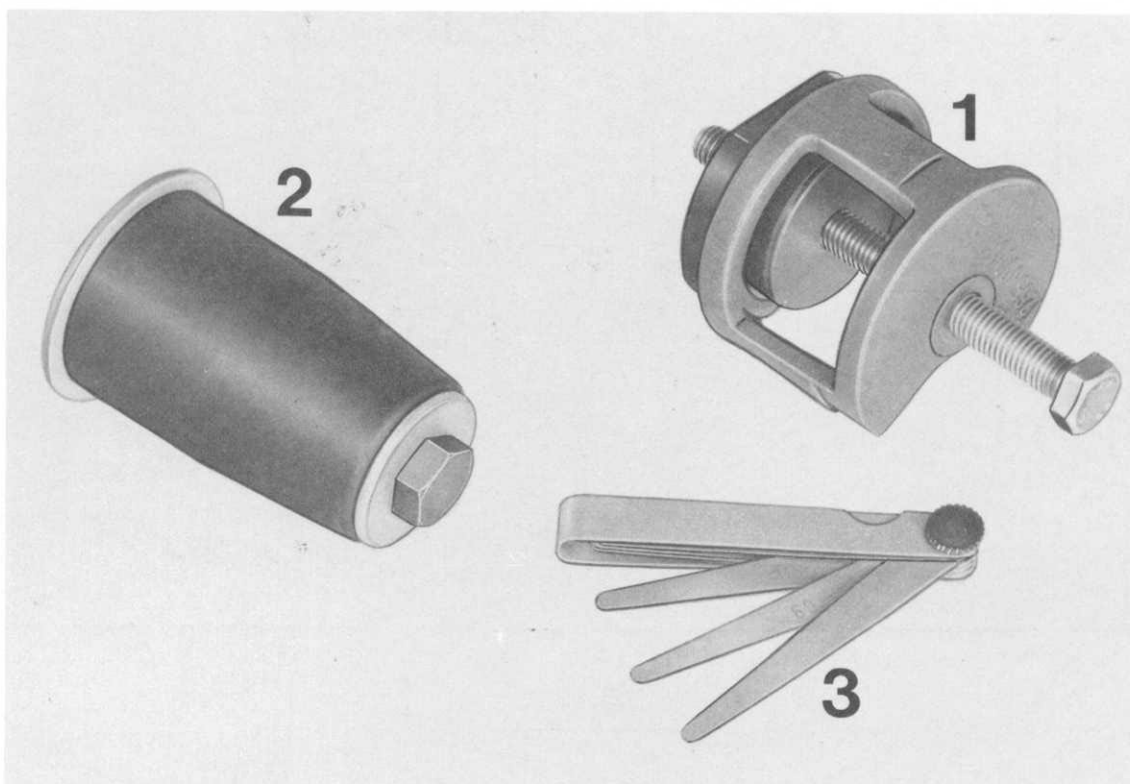


Note:

Play "A" can be adjusted with a snap ring which is available in 3 thicknesses (2.0 / 2.5 / 3.0 mm). However, if the specified play cannot be reached with snap rings, the center outer plates must also be used for adjusting.

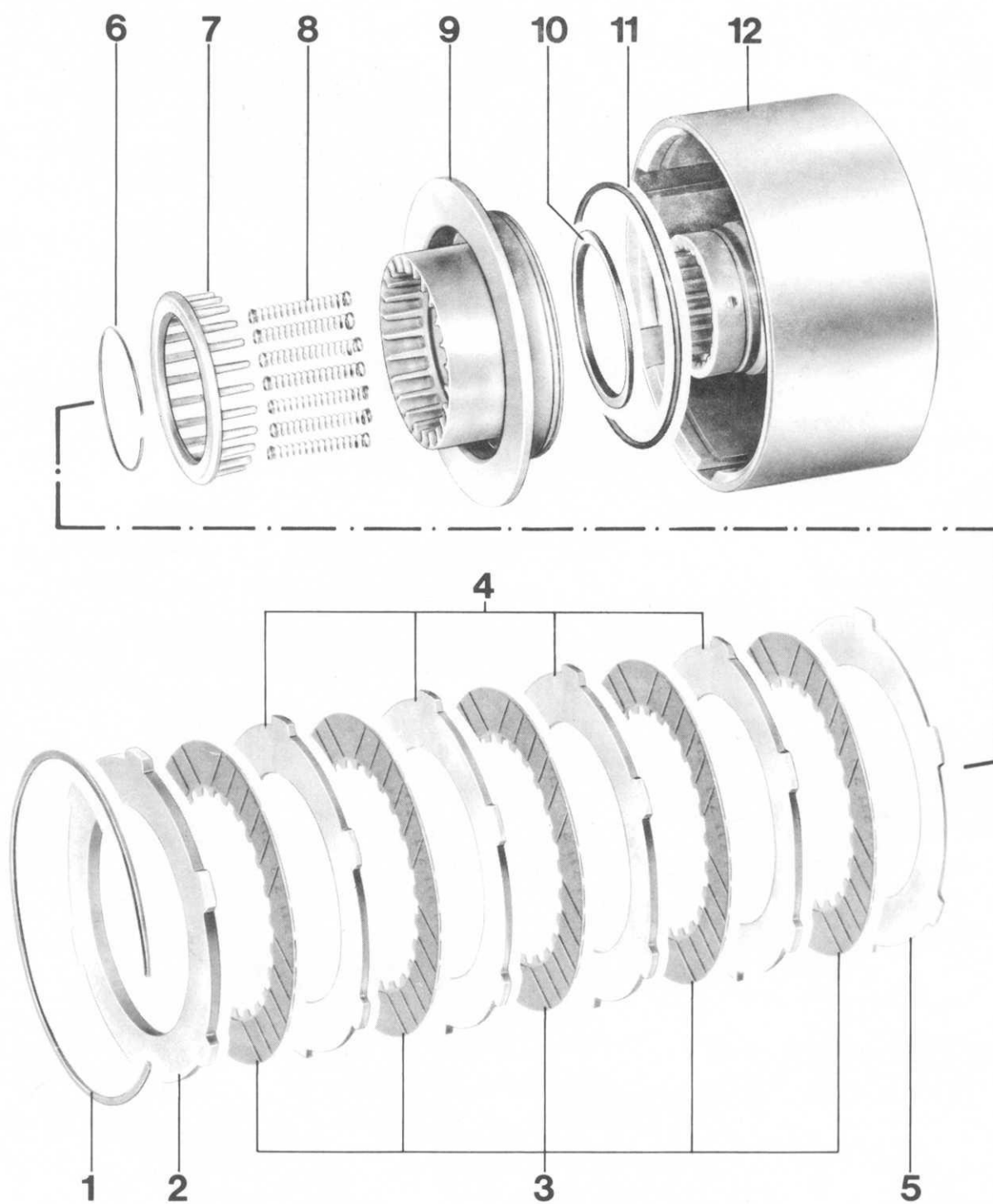


TOOLS



No.	Description	Special Tool	Remarks
1	Assembly tool	9315	Standard tool
2	Assembly sleeve	9317	
3	Feeler blade gauge	—	

DISASSEMBLING AND ASSEMBLING CLUTCH K 2



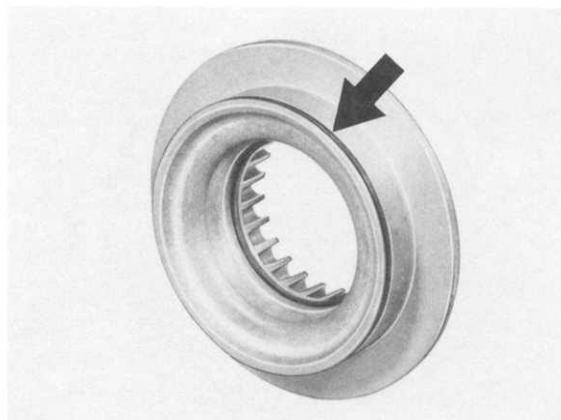
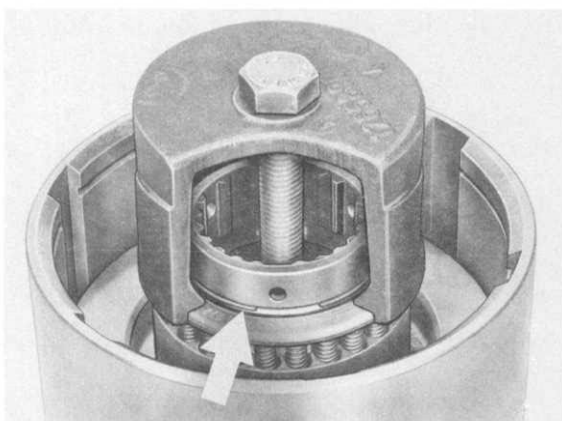
No.	Description	Qty.	Note When:		Special Instructions
			Removing	Installing	
1	Snap ring	1		Redetermine thickness if necessary	
2	Outer plate	1		Check for burnt spots and bending	4.5 or 5.0 mm thick (optional to adjust play)
3	Inner plate (2.1 mm thick)	5		Check for burnt spots and wear. Replace if thickness is less than 2 mm. Place in ATF about 1 hour before installing.	
4	Outer plate	4		Check for burnt spots and bending	
5	Outer plate (2 mm thick)	1		Check for burnt spots and bending	3.0 or 3.5 mm thick (optional to adjust play)
6	Snap ring	1	Remove with Special Tool 9315	Install with Special Tool 9315. Check for correct fit	
7	Diaphragm spring	1			
8	Spring	X	Note quantity for reinstallation		
9	Piston	1		Install with Special Tool 9317	

No.	Description	Qty.	Note When:		Special Instructions
			Removing	Installing	
10	Seal	1		Position correctly, coat with ATF	
11	Seal	1		Coat with ATF, must not turn on its own	
12	Plate carrier	1			

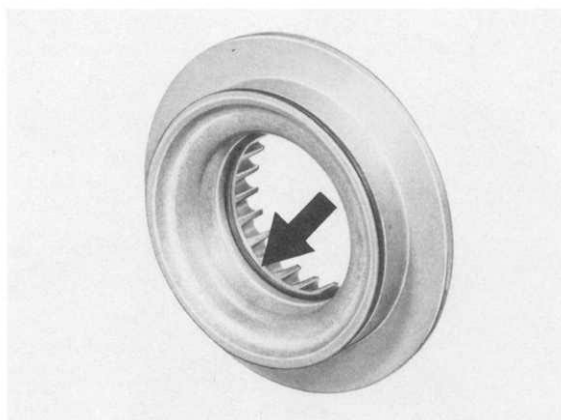
DISASSEMBLING AND ASSEMBLING CLUTCH K 2

Disassembling

1. Apply Special Tool 9315 on diaphragm spring and tighten until snap ring can be removed.



2. Install seal in piston that sealing lip faces down (direction of arrow).



2. Remove diaphragm spring and springs.

Note:

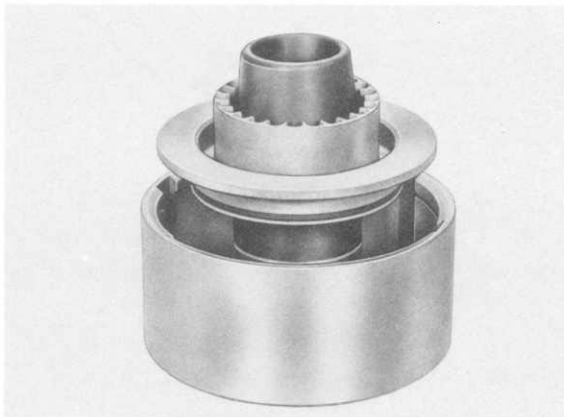
The quantity of springs for clutch piston will vary. If new springs are required, the quantity must not be changed.

3. Apply Special Tool 9317 on plate carrier.

Assembling

1. Install seal and make sure that seal does not turn on its own.

4. Install piston in plate carrier by turning slightly. Do not cant the piston.



6. Apply and tighten Special Tool 9315.

7. Install snap ring.

8. Assemble set of plates as shown in layout drawing and install in plate carrier.

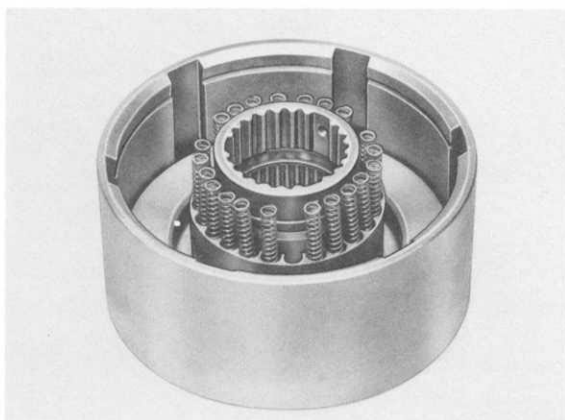
Note :

Place new inner plates in ATF about 1 hour before installing.

Note :

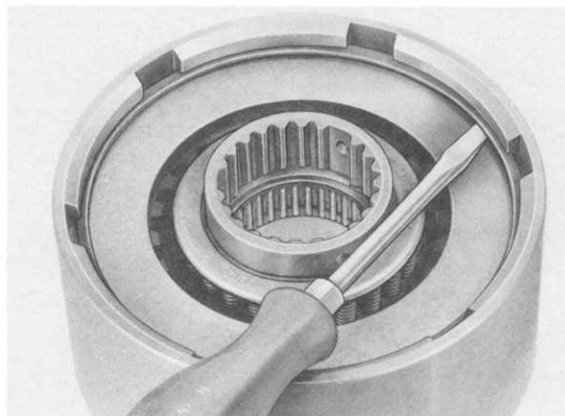
Coat seals and sliding surfaces on special tool with ATF.

5. Install springs in piston and mount diaphragm spring that each spring is centered by a guide pin.

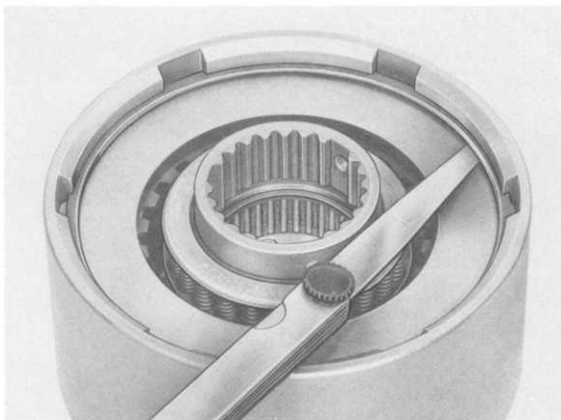


Checking Play (0.7 to 1.2 mm) of Clutch:

1. Push up snap ring around entire periphery with a suitable screwdriver.

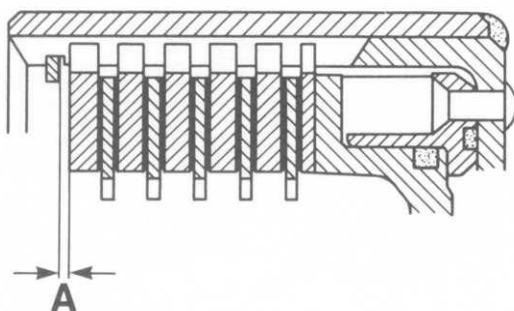


2. Check play "A" with a feeler gauge blade.

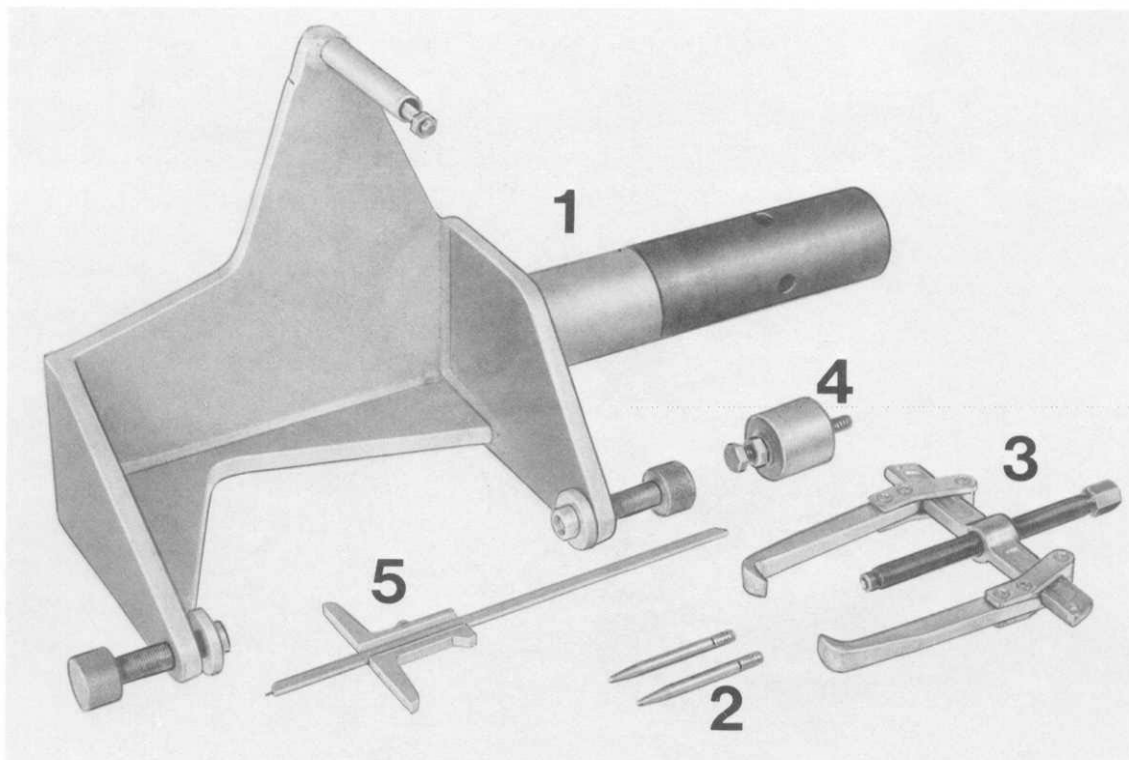


Note:

Play "A" can be adjusted with a snap ring which is available in 3 thicknesses (2.0 / 2.5 / 3.0 mm). However, if specified play cannot be reached with snap rings, the center outer plates must also be used for adjusting.

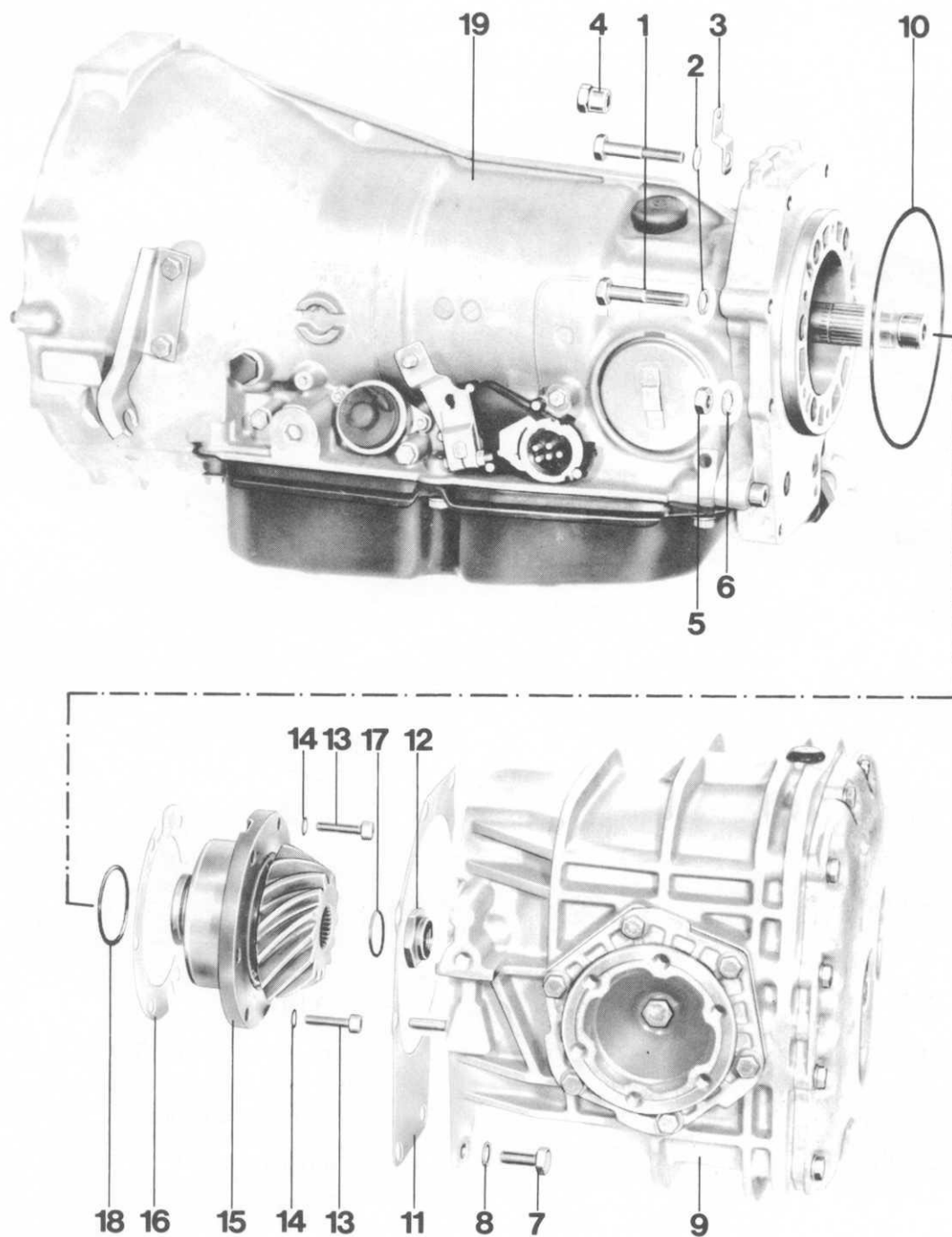


TOOLS



No.	Description	Special Tool	Remarks
1	Holder	9216	
2	Centering pin	9321	
3	Puller	—	Standard tool
4	Pressing in tool	—	Made locally (45 x 5 x 40 mm steel pipe with welded cover and 11 mm dia. bore)
5	Depth gauge	—	Standard tool

REMOVING AND INSTALLING FINAL DRIVE



No.	Description	Qty.	Note when	
			Removing	Installing
1	Bolt	4		Torque: 49 Nm / 33 ftlb
2	Washer	4		
3	Holder	1		
4	Collar nut	1		Torque: 46 Nm / 33 ftlb
5	Nut	1		Torque: 46 Nm / 33 ftlb
6	Washer	1		
7	Bolt	2		Torque: 46 Nm / 33 ftlb
8	Washer	2		
9	Final drive	1		
10	O-Ring	1		Replace, coat with ATF, check for correct fit
11	Shim S ₃	X	Note quantity and thickness for reinstallation	Redetermine, if necessary
12	Flange nut*	1	Engage parking lock and unscrew	Tighten to 380 Nm / 275 ftlb and lock
13	Bolt	6		Torque: 33 Nm / 24 ftlb
14	Lock washer	6		Hollow side faces flange

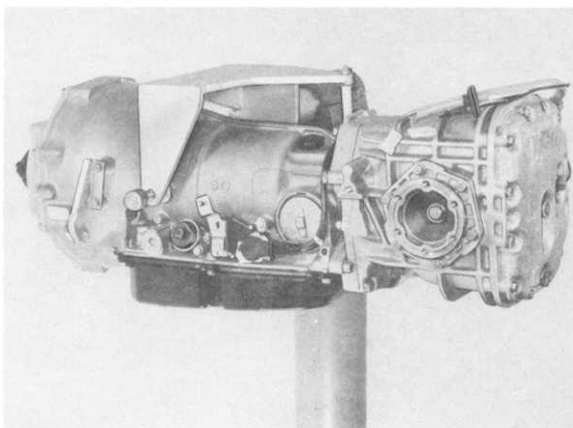
* As of MY '92 (Transmission type A 28.18) = 450 Nm (332 ftlb.)

No.	Description	Qty.	Note When:		Special Instructions
			Removing	Installing	
15	Bearing assembly with drive pinion	1	If necessary, pull out with suitable puller	If necessary, press in with locally made tool	
16	Shim	X	Note quantity and thickness for reinstallation	Redetermine, if necessary	
17	O-ring	1		Replace, coat with ATF	
18	O-ring	1		Replace, coat with ATF	
19	Automatic transmission	1			

REMOVING AND INSTALLING FINAL DRIVE

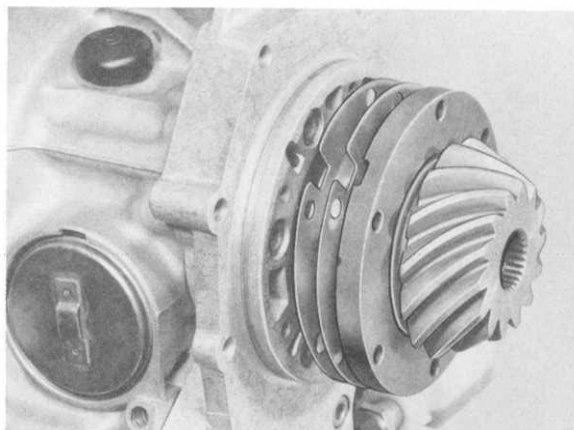
Removing

1. Remove transmission.
2. Mount transmission on assembly stand with Special Tool 9216 and drain final drive oil.



Installing

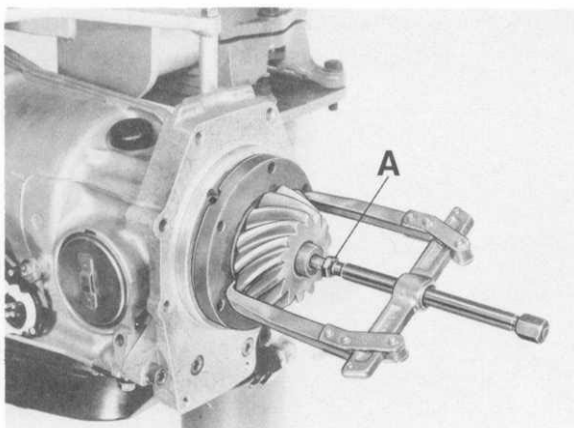
1. Install quantity of shims noted during removal or shims of redetermined thickness and bearing assembly on drive pinion.



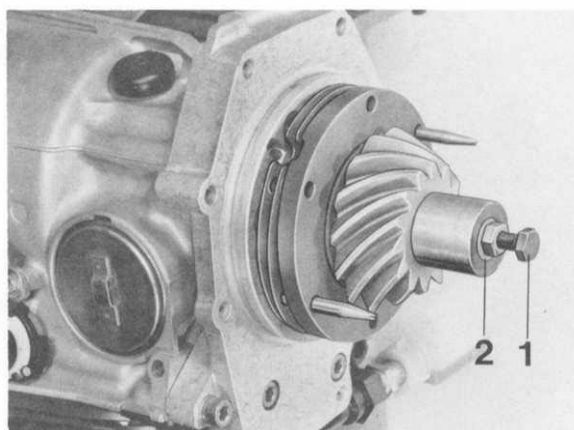
3. Engage parking lock and remove collar nut for drive pinion.
4. Remove mounting bolts for bearing assembly and pull off bearing assembly (if necessary, use a suitable puller).

Note:

Use centering pins, Special Tool 9321, and a locally made pressing in tool to make installation easier.

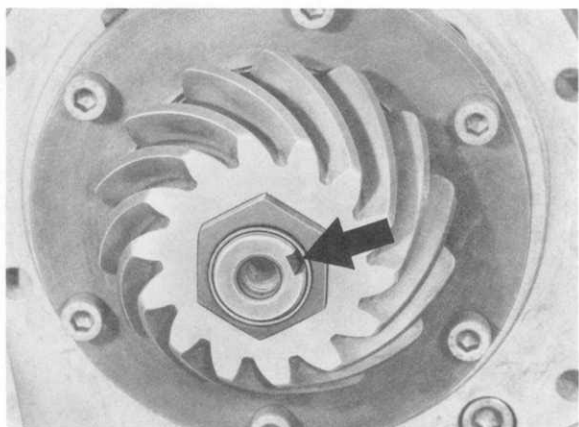


A = M 10 x 30 bolt with centering bore

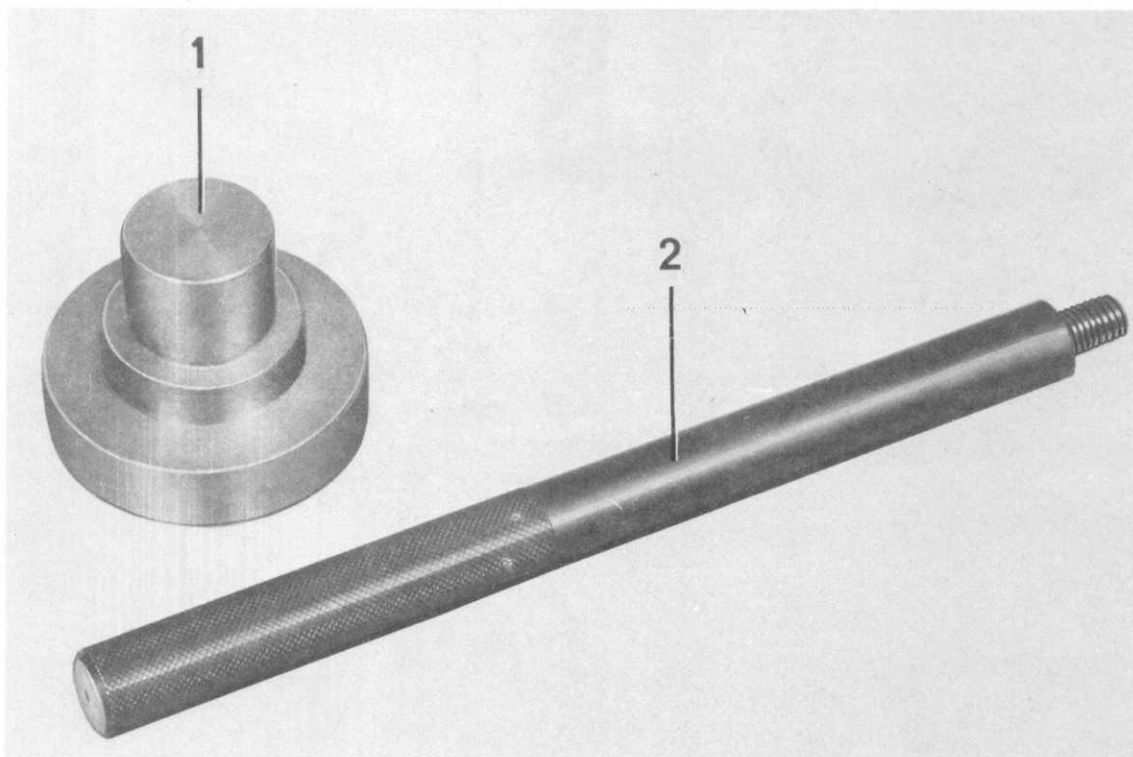


1 = Bolt from Special Tool 9148
2 = Washer

2. Tighten flange nut for drive pinion to specified torque and lock by upsetting the flange.

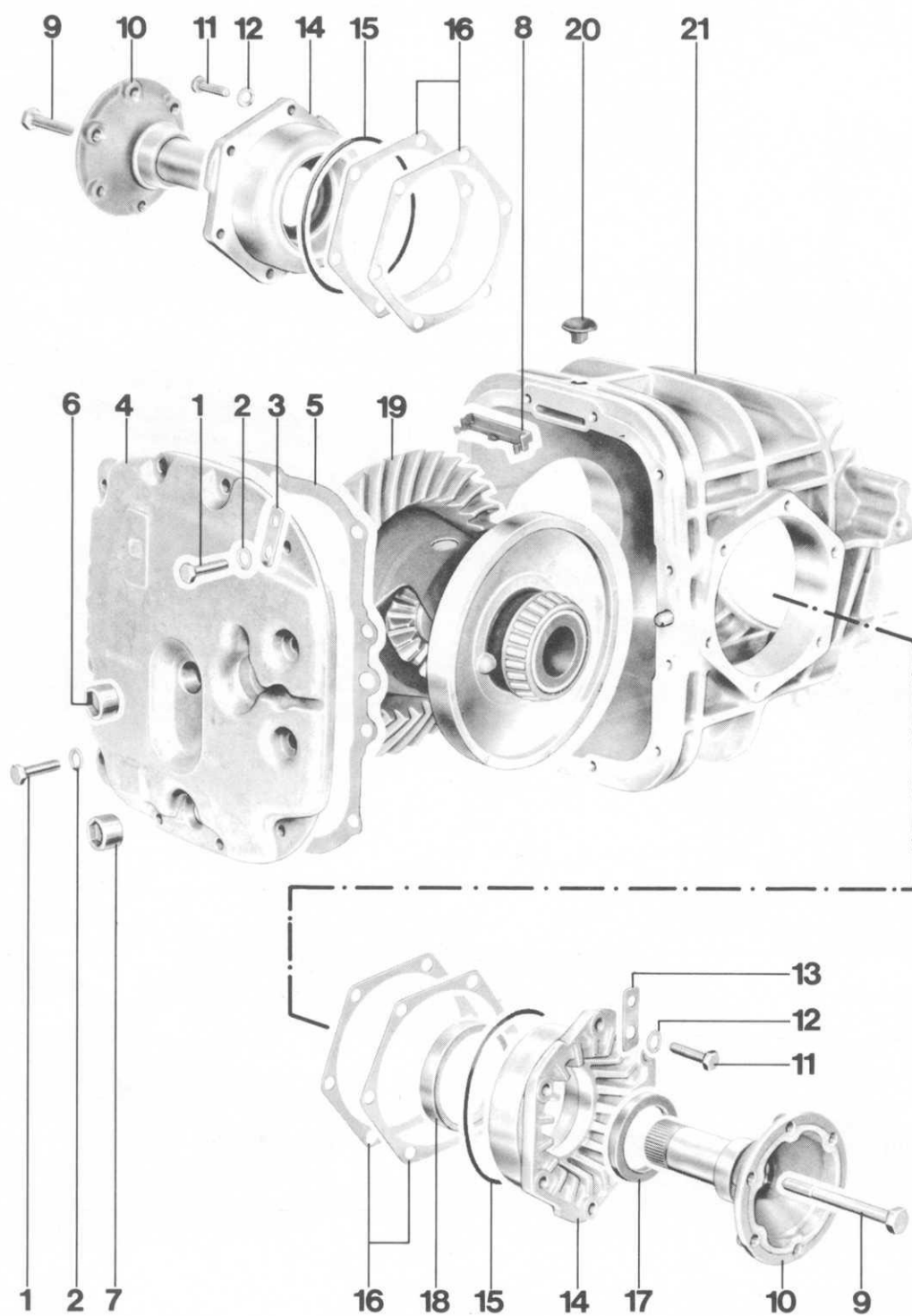


TOOLS



No.	Description	Special Tool	Remarks
1	Pressure pad	9147	From P 254
2	Pin	—	

DISASSEMBLING AND ASSEMBLING FINAL DRIVE



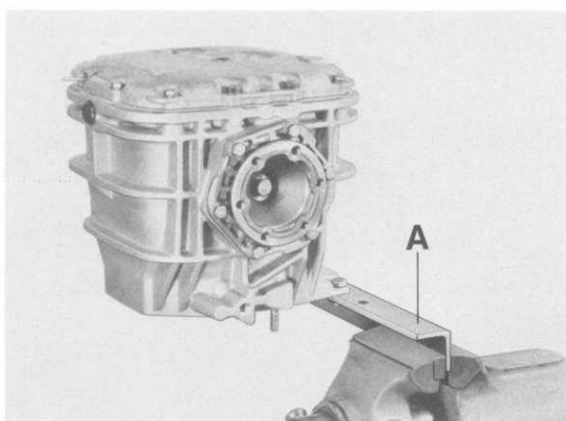
No.	Description	Qty.	Note When:		Special Instructions
			Removing	Installing	
1	Bolt	12		Torque: 23 Nm/17 ftlb	
2	Washer	12			
3	Holder	1			
4	Cover	1			
5	Gasket	1		Replace	
6	Plug	1		Torque: 22 Nm/17 ftlb	
7	Plug (with magnet)	1		Torque: 22 Nm/17 ftlb	
8	Shield	1			
9	Bolt	2		Torque: 46 Nm/33 ftlb	
10	Joint flange	2			
11	Bolt	12		Torque: 23 Nm/17 ftlb	
12	Washer	12			
13	Holder	1			
14	Bearing cap	2	Mark for reinstallation	Must be installed same side	
15	O-ring	2		Replace, coat with final drive oil	

No.	Description	Qty.	Note When:		Special Instructions
			Removing	Installing	
16	Shim	X	Note quantity and thickness on each side for reinstallation	Redetermine, if necessary	
17	Seal	2	Drive out with a suitable screw-driver	Drive in with Special Tool 9147	
18	Tapered roller bearing outer race	2	Mark for reinstallation	Install in same bearing cap. Heat bearing cap to 100 °C/212 °F and drive in with a suitable pressure pad	
19	Differential	1		Adjust, if necessary	
20	Vent	1			
21	Case	1			

DISASSEMBLING AND ASSEMBLING FINAL DRIVE

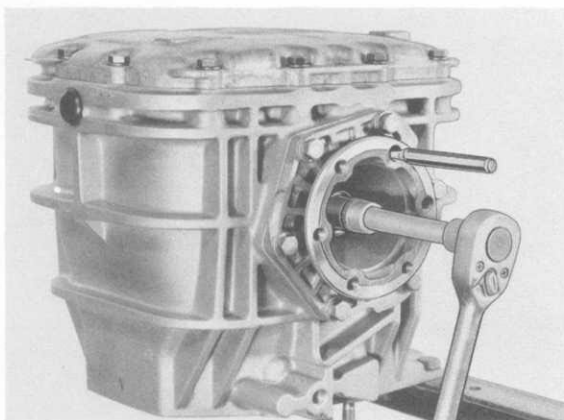
Disassembling

1. Clamp final drive in a vise with a suitable fixture.



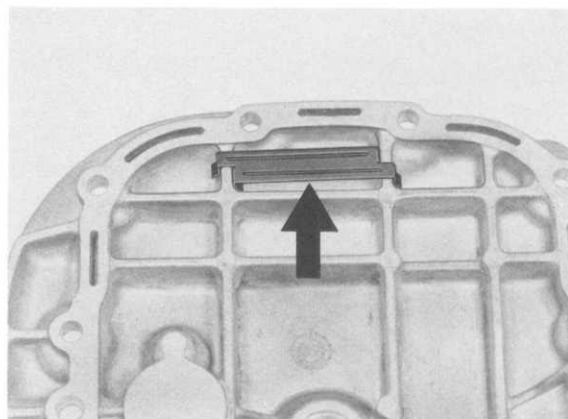
A = Iron angle

2. Remove bolt for joint flange and take off flange.

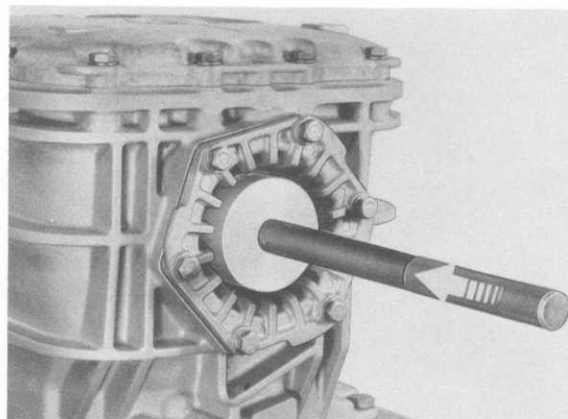


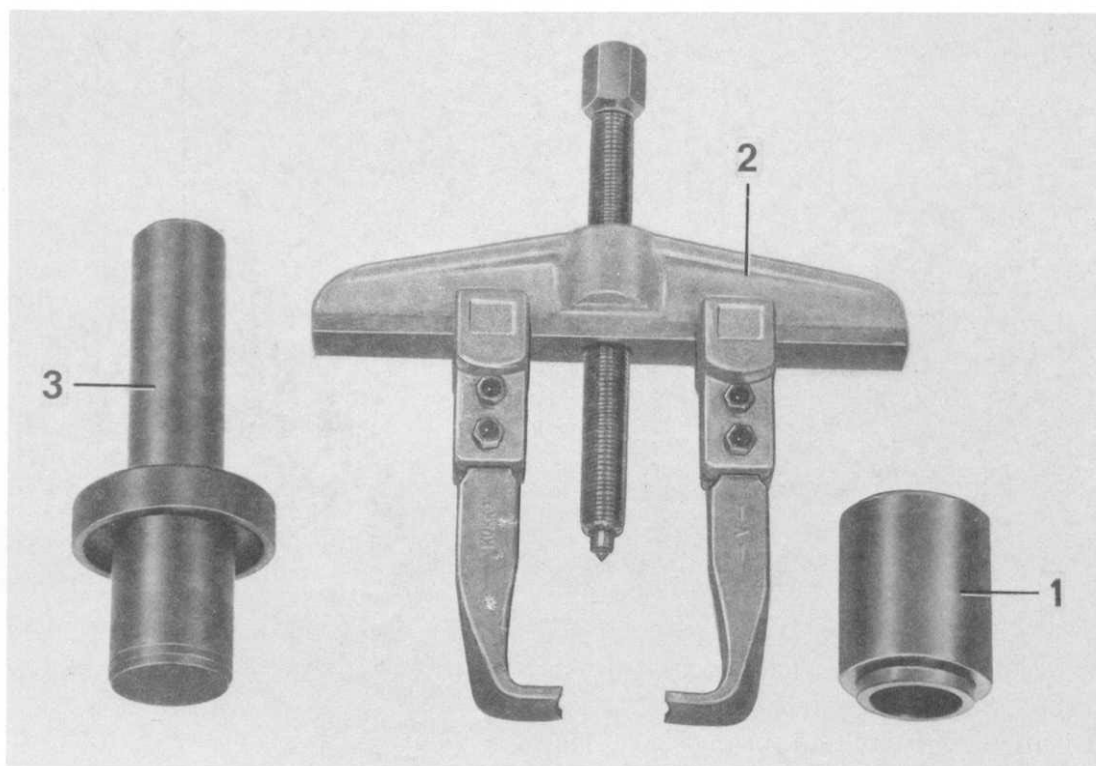
Assembling

1. Install shield.



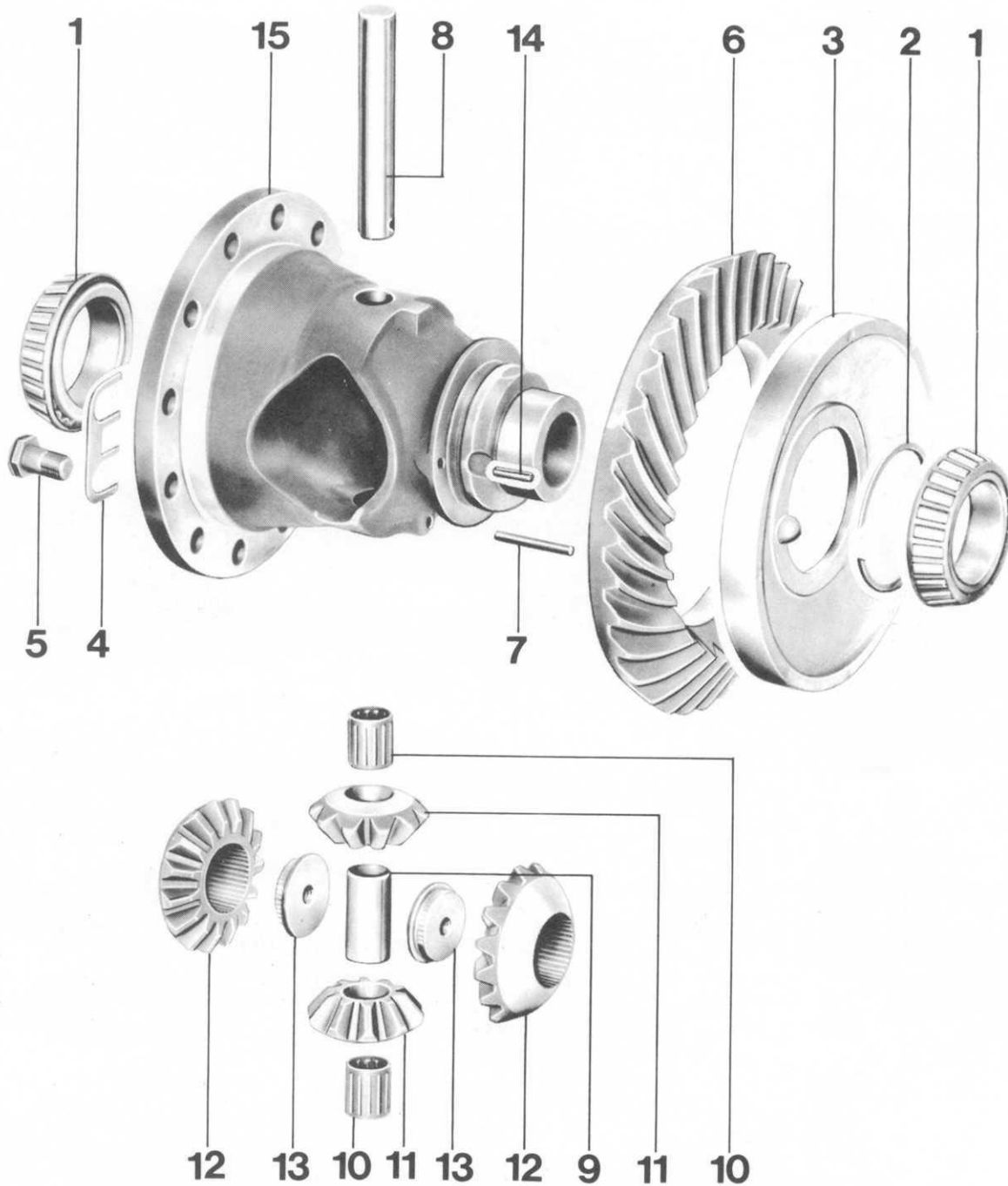
2. Drive in seal for joint flange with Special Tool 9147.





No.	Description	Special Tool	Remarks
1	Pressure pad	P 263	Standard tool
2	Puller	—	
3	Pressure pad	P 264 b	

DISASSEMBLING AND ASSEMBLING DIFFERENTIAL



No.	Description	Qty.	Note When:		Special Instructions
			Removing	Installing	
1	Tapered roller bearing inner race	2	Pull off with a suitable puller and Special Tool P 263	Drive on with Special Tool P 264 b	
2	Circlip	1			
3	Magnet carrier plate	1			
4	Lockplate	6		Replace	
5	Bolt	12		Threads must be dry and greaseless. Torque: 150 Nm/ 108 ftlb	
6	Ring gear	1		Tapped holes for ring gear bolts must be dry and greaseless. Note pair number. Adjust if necessary	
7	Pin	1			
8	Differential pin	1			
9	Spacer *	1			
10	Needle cage *	2			
11	Small differential gear	2		Coat oval surface with MoS ₂ paste. Replace only in pairs	

No.	Description	Qty.	Note When:		Special Instructions
			Removing	Installing	
12	Large differential gear	2		Coat oval surface with MoS ₂ paste. Replace only in pairs	
13	Threaded piece	2			
14	Key	1			
15	Differential case	1			

* Modified needle-bearing mount as from Model '86. The spacer sleeve is no longer required thanks to the new needle-roller assembly.

DISASSEMBLING AND ASSEMBLING DIFFERENTIAL

Disassembling

1. Pull off tapered roller bearing inner race with a suitable puller and Special Tool P 263.



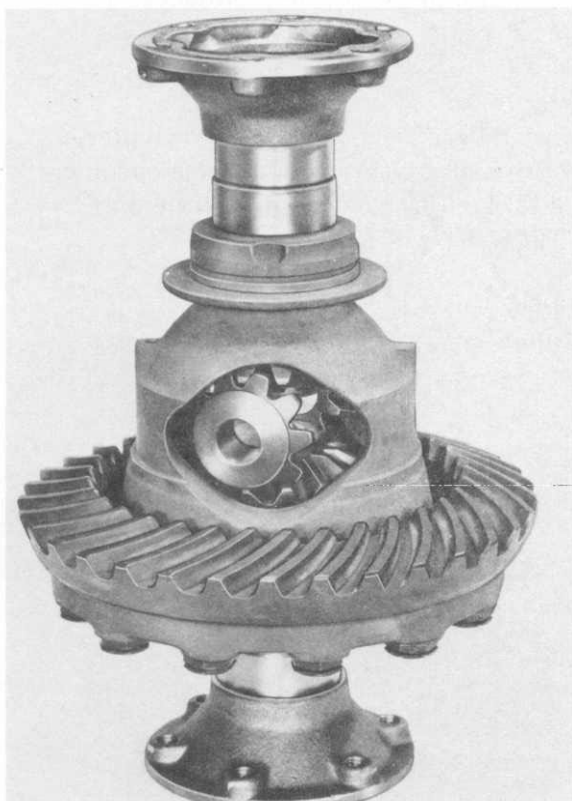
2. Coat oval surface of differential gears with MoS_2 paste.
3. Install large differential gears with press-fit threaded plates through large opening in differential case and hold with joint flanges.



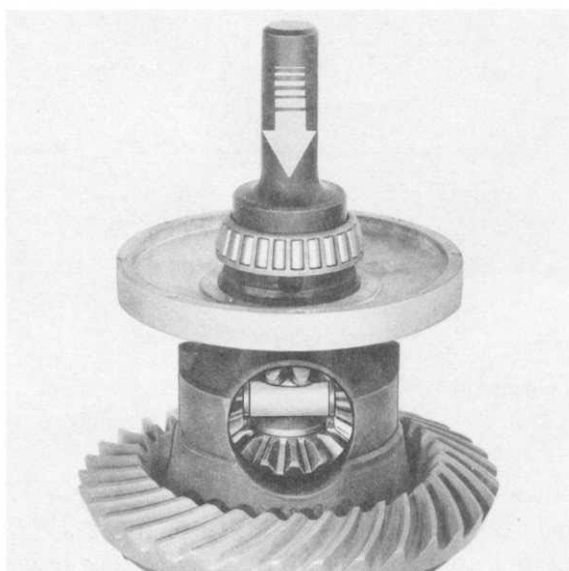
Assembling

1. Install ring gear on case and tighten ring gear bolts to 150 Nm/108 ftlb. Slide lockplate into groove of bolts, squeeze together at front with a pliers (to unite lockplate with bolt) and bend down over a hexagon surface to lock.

4. Install small differential gears between large differential gears and turn, until bores of gears are aligned with bores in case.
6. Drive in differential pins to correct position and lock with key.

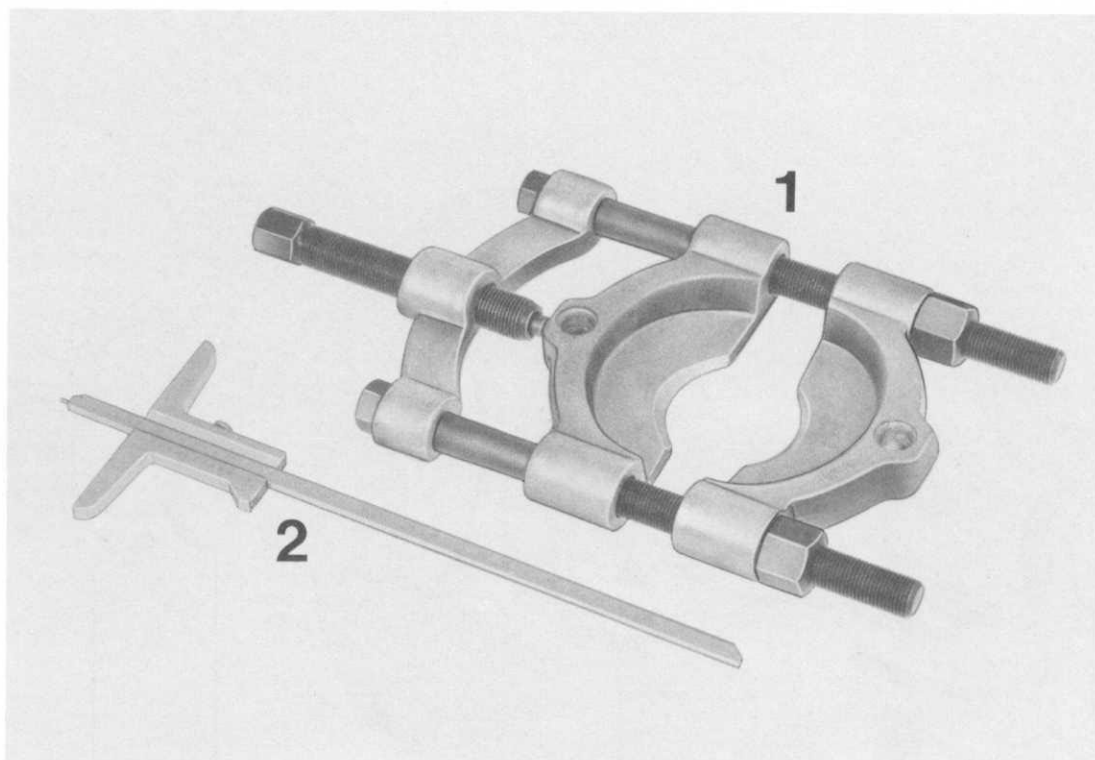


5. Install needle cages and spacer.



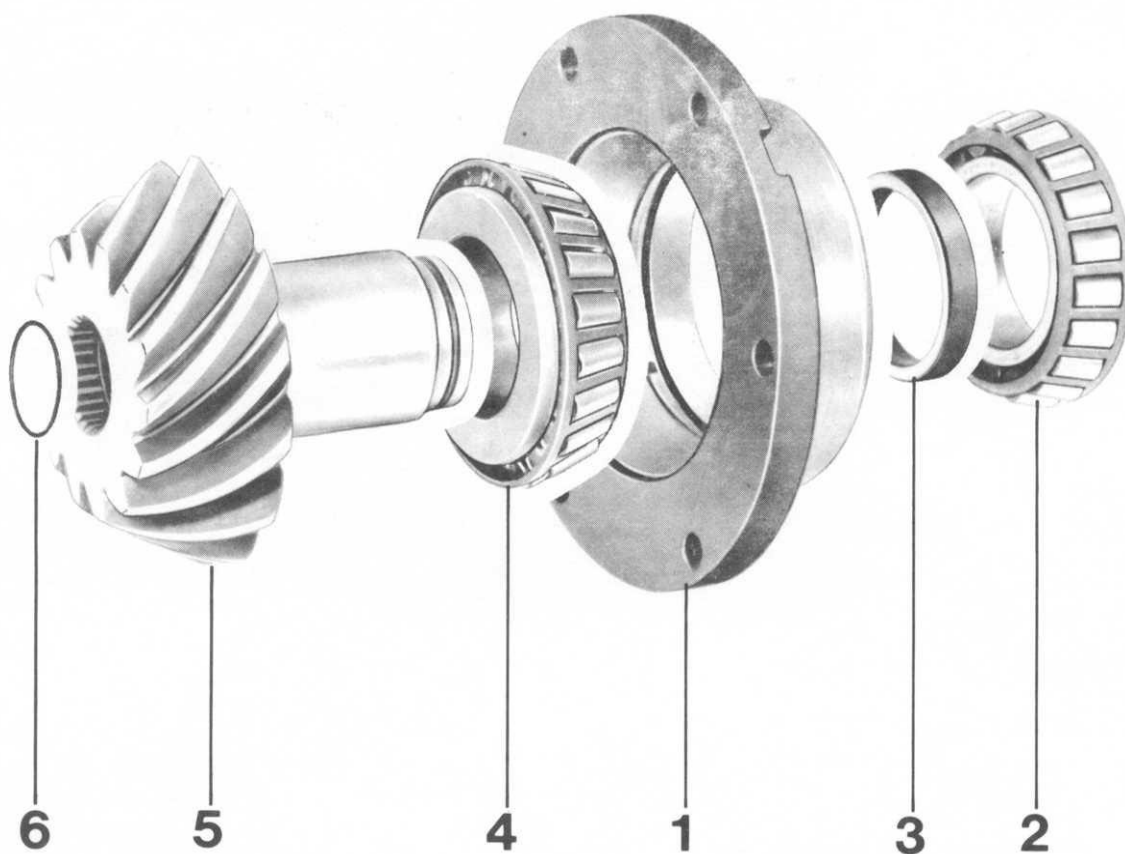
7. Drive on tapered roller bearing inner race with Special Tool P 2546.

TOOLS



No.	Description	Special Tool	Remarks
1	Puller	—	e. g. Kukko, size 2
2	Depth gauge	—	Standard tool

DISASSEMBLING AND ASSEMBLING BEARING ASSEMBLY

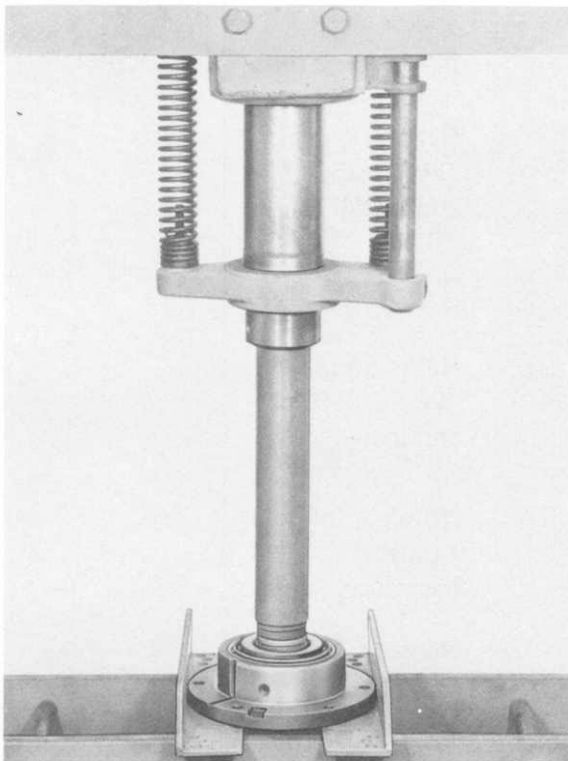


No.	Description	Qty.	Note When:		Special Instructions
			Removing	Installing	
1	Bearing flange	1		For replacements only available as complete part (positions 1 to 4)	
2	Tapered roller bearing inner race	1		Heat to approx. 120 °C/250 °F and install	
3	Adjusting ring	X			
4	Tapered roller bearing inner race	1		Heat to approx. 120 °C/250 °F and install	
5	Pinion	1	Press out with a piece of suitable pipe	Note pair number. Adjust if necessary	
6	O-ring	1		Replace, coat with ATF	

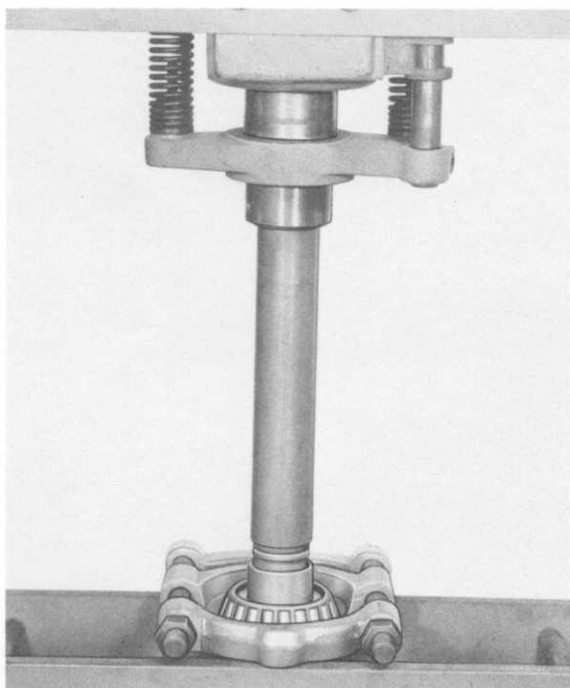
DISASSEMBLING AND ASSEMBLING BEARING ASSEMBLY

Disassembling

1. Press out pinion with a piece of suitable pipe.



2. Press off tapered roller bearing inner race with a special tool (e. g. Kukko, size 2).

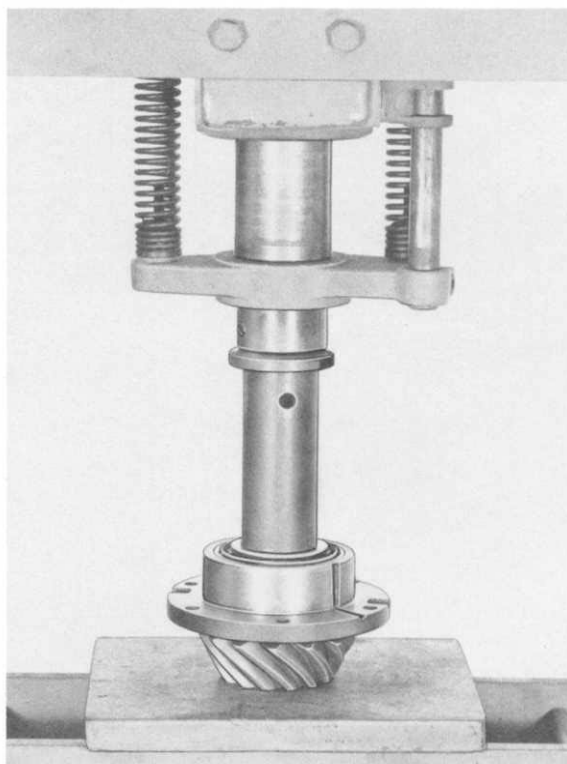


Assembling

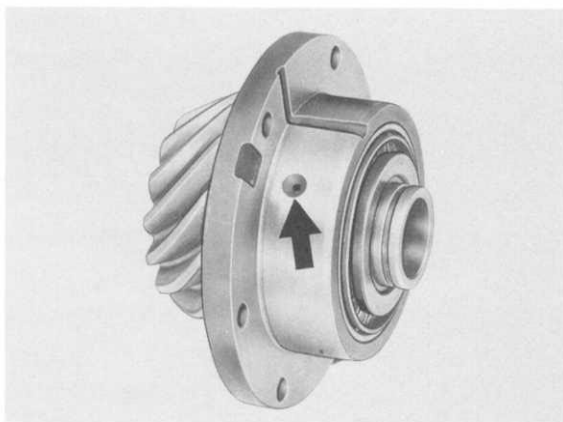
Note:

Bearing flange is only available as a complete unit (with tapered roller bearings and adjusting ring) for replacements.

1. Heat tapered roller bearing inner races to approx. 120 °C/250 °F and install.
2. Press on assembled bearing with a piece of suitable pipe (approx. 5 tons force).

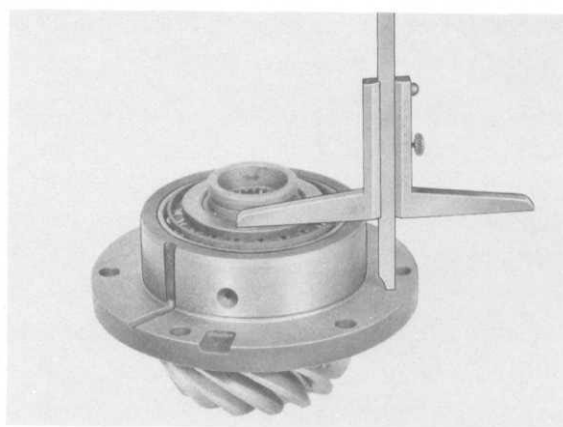


3. Lubricate both tapered roller bearings with final drive oil through oil feed bore after installation.



Use a depth gauge to measure distance from tapered roller bearing surface to bearing flange surface (for example: 34.55 mm).

Since the design calls for a distance of only 34 ± 0.05 mm, a shim 0.55 mm thick has to be used.



4. If necessary, determine thickness of shims for bearing assembly.

Determining Thickness of Shims for Bearing Assembly

Example :

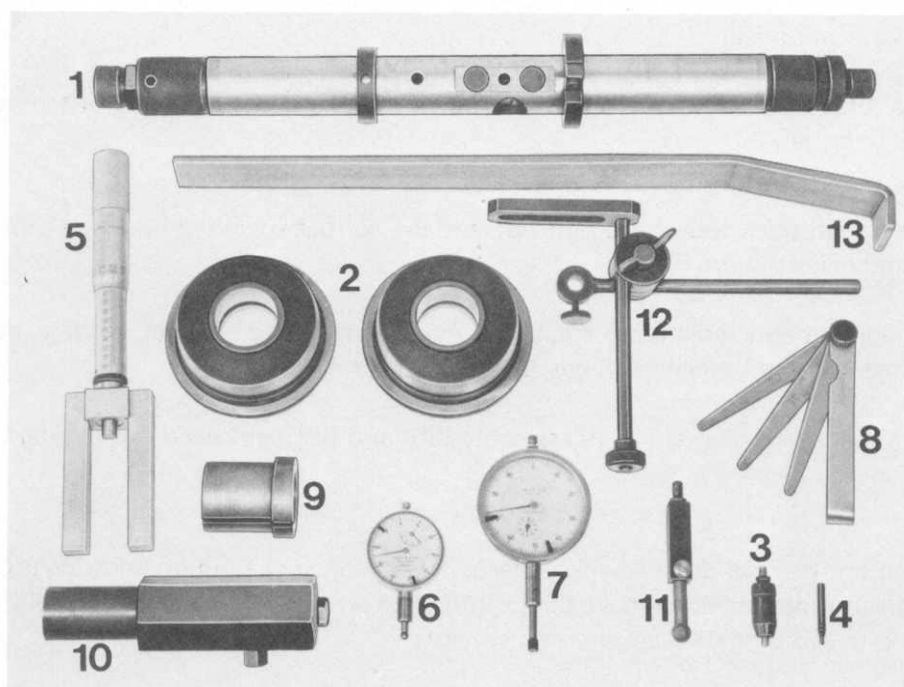
34.55 mm	actual distance (measured)
– 34.00 mm	nominal distance (specified)
<hr/>	
0.55 mm	thickness of shims

Note :

The adjustment of bearing assembly is important for axial play of automatic transmission.

Consequently the thickness of shims has to be determined again after repairing or replacing a bearing assembly.

TOOLS



No.	Description	Special Tool	Remarks
1	Master gauge	VW 385/1	Standard, 3 mm range Standard, 10 mm range Standard, 0.05 to 1.0 mm Made locally
2	Centering plates	VW 385/4	
3	Master plunger	VW 385/14	
4	Dial gauge extension (30 mm)	9323	
5	Adjusting gauge	VW 385/30	
6	Dial gauge	—	
7	Dial gauge	—	
8	Feeler gauge	—	
9	Clamping sleeve	9145	
10	Adjusting fixture	VW 521/4	
11	Master lever	VW 388	
12	Dial gauge holder	VW 387	
13	Lever	—	

Recommended Sequence for Adjustment of Pinion/Ring Gear

If drive pinion and ring gear have to be adjusted, the following sequence of procedures would be most economical.

1. Determine total shim thickness "Sges" (S_1 plus S_2) for specified preload of tapered roller bearing/differential.
2. Determine shim thickness " S_3 ".
3. Divide total shim thickness "Sges" into S_1 and S_2 , so that specified backlash is between ring gear and drive pinion.

Objective of adjustments must be to regain the maximum degree of quiet running, as had been determined by the special testing machine in manufacturing.

Absolute cleanliness is essential for all assembly jobs and testing procedures to guarantee perfect results.

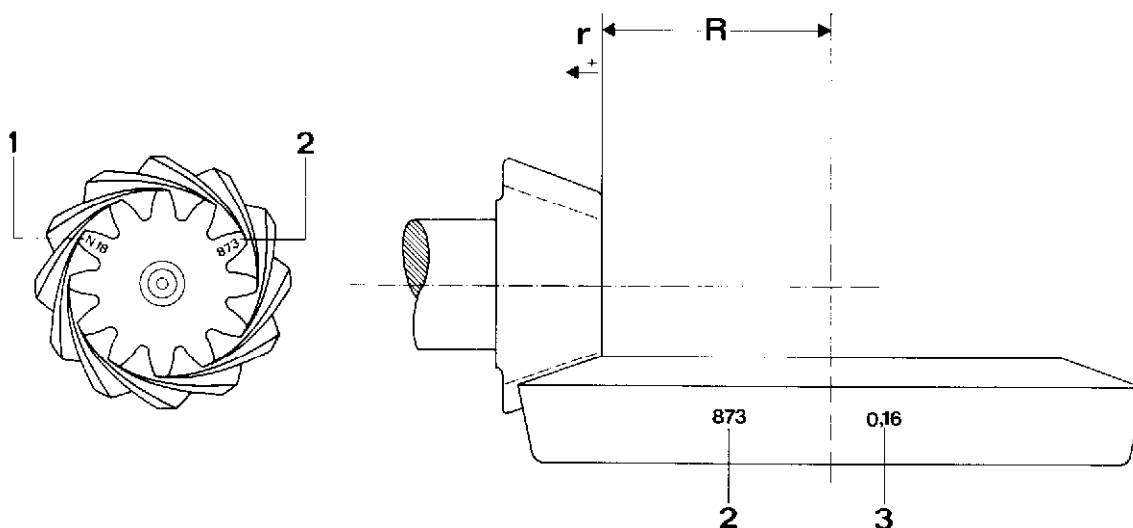
After working on the final drive it will be necessary to adjust the pinion and ring gear, if parts had been replaced which have direct influence on said adjustment. The following chart will help in avoiding unnecessary adjustments!

Part Replaced \ Adjust:	Ring Gear ($S_1 + S_2$)	Drive Pinion Deviation " r " (S_3)
Transm. case (automatic) or rear transmission case	X	X
Bearing assembly for pinion	X	X
Final drive case	X	X
Side transmission cover	X	X
Pinion/ring gear	X	X
Differential case	X	
Tapered roller bearing for differential	X	

ADJUSTING DRIVE PINION AND RING GEAR

General Information

Accurate adjustments of the pinion and ring gear are immensely important for the service life and smooth running of the final drive. This is why pinions and ring gears are paired during manufacture and checked in special machines for tooth pattern and quietness in both directions of rotation. The position of smoothest running is determined by moving the pinion in an axial direction, whereby the ring gear is lifted out of the no-play meshing position far enough so that the backlash will be kept with specified tolerances. Deviation " r " from the adjusting distance called for by design (design distance " R_0 ") is measured and recorded on face of drive pinion. Ring gears and pinions are designed so that deviation " r " is always added to " R ", i. e. is preceded by a + sign.

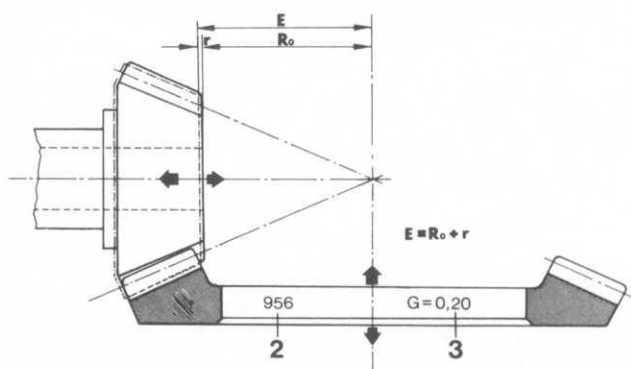
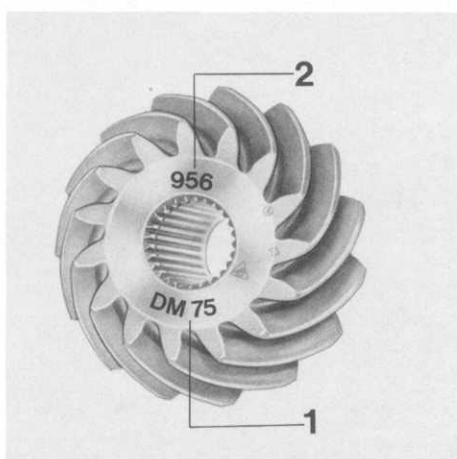


- R_0 = Design distance 74.70 mm
- r = Deviation from R in 1/100 mm
- 1 = Deviation r
- 2 = Pair number
- 3 = Backlash

Changes on Drive Pinion/Ring Gear

Since about January of 1984 manufacturing uses optionally drive pinions/ring gears, on which a DM value (e. g. DM 75) is recorded instead of deviation "r" (N).

Since this DM value is equal to adjusting distance E ($R_O + r$), the adjusting distance does not have to be figured out for these drive pinions/ring gears.



R_O = Design distance 74.70 mm

E = Adjusting distance

r = Deviation

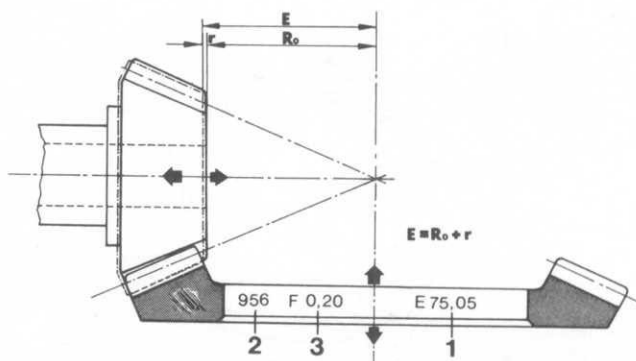
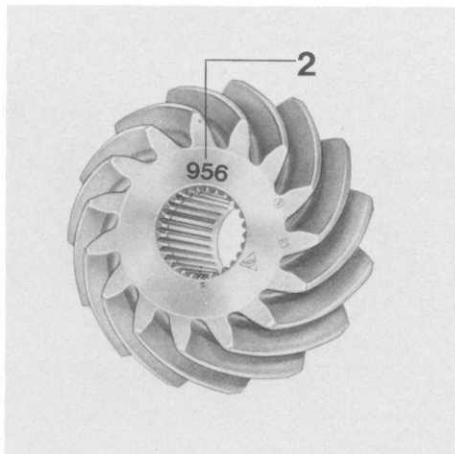
1 = Adjusting distance ($R_O + r$)

2 = Pair number

3 = Backlash

Changes on Drive Pinions/Ring Gears

In the near future there will be drive pinions/ring gears with the following adjusting information.



- R_O = Design distance 74.70 mm
- E = Adjusting distance
- r = Deviation
- 1 = Adjusting distance ($R_O + r$), e. g. 75.05 mm
- 2 = Pair number (three digits: 001 . . . 999)
- 3 = Backlash

Note:

The missing 5 mm thick gauge plate VW 385/17 must also be considered for adjustments with these drive pinions/ring gears.

Example:

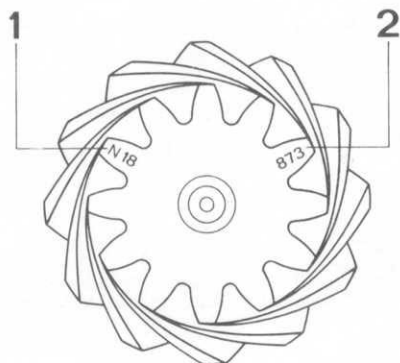
Recorded on ring gear — adjusting distance $E = 75.05$

Adjusting distance E	75.05 mm
Missing gauge plate	+ 5.00 mm
Adjustment of adjusting gauge	80.05 mm

ADJUSTING PINION

Pinion/Ring Gear Marked "N"

On these drive pinion/ring gear sets adjusting distance "E" is calculated from known design distance " R_O " = 74.70 mm + deviation "r", which is located on face of drive pinion.



1 = Deviation "r" in 1/100 mm
2 = Pair number

Note:

The design of the drive pinion will not allow use of the 5 mm thick Special Tool 385/17, normally applied for adjustments.

Since Special Tool VW 385/30 includes this 5 mm distance, it is important to add 5 mm to adjusting distance "E".

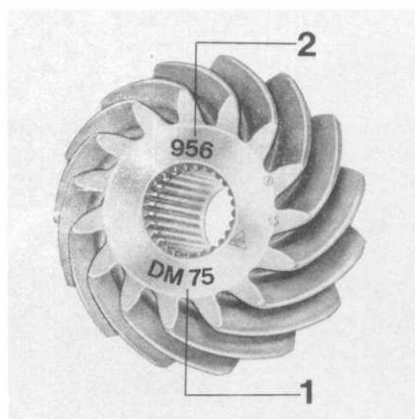
Example:

N 18 is the deviation "r" on face of pinion.

R_O = design distance	74.70 mm
r = deviation	+ 0.18 mm
E = adjusting distance	74.88 mm
Missing special tool	+ 5.00 mm
Adjustment of master gauge	79.88 mm

Pinion/Ring Gear Marked "DM"

On these drive pinion/ring gear sets "DM" is adjusting distance "E"



1 = Adjusting distance (75.00 mm in example)
2 = Pair number

Note:

The design of the drive pinion will not allow use of the 5 mm thick Special Tool 385/17, normally applied for adjustments.

Since Special Tool VW 385/30 includes this 5 mm distance, it is important to add 5 mm to adjusting distance "E".

Example:

DM 75 is adjusting distance on face of pinion.

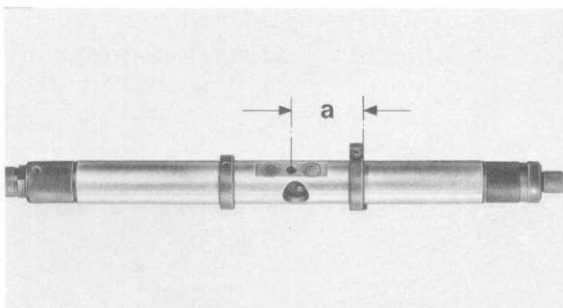
DM = adjusting distance	75.00 mm
Missing special tool	+ 5.00 mm
Adjustment of master gauge	80.00 mm

1. Install bearing assembly with shims and tighten collared nut to 380 Nm/275 ftlb.

2. Install final drive case (without shims) and tighten all bolts or nuts to 46 Nm/33 ftlb.

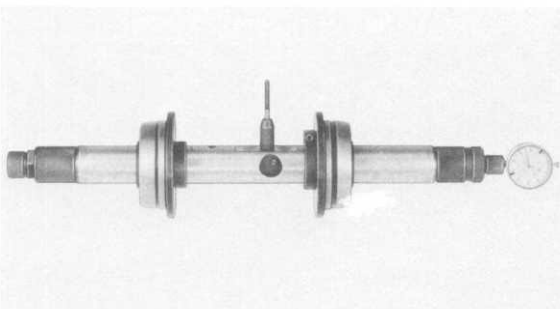
3. Install one side bearing cover without O-ring and secure with two bolts.

4. Adjust setting of Special Tool VW 385/1 to distance "a".



$a = 39 \text{ mm}$

5. Slide Special Tools VW 385/4 on to 385/1. Install Special Tool VW 385/14 with dial gauge extension 9323.

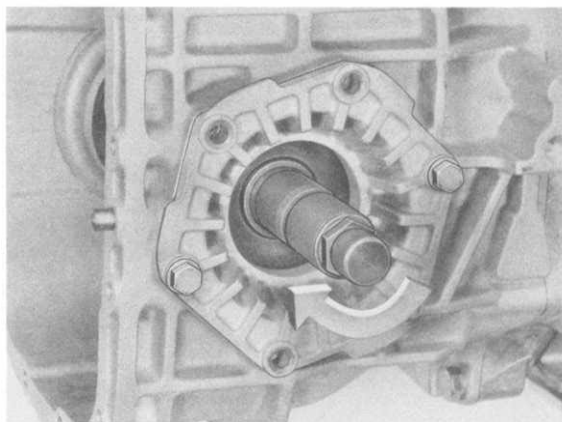


6. Turn pinion that surface of collared nut is vertical.

7. Insert master gauge into case.

8. Install second side bearing cover without O-ring and secure with two bolts.

9. Pull out centering plate of master gauge with the spindle that master gauge can still just be turned by hand.



10. Set Special Tool VW 385/30 to adjusting distance "E" + 5 mm (for missing Special Tool VW 385/17).

Example:

$R_O =$	74.70 mm	
$r =$	$+ 0.18 \text{ mm}$	
$E =$	74.88 mm	
	$+ 5.00 \text{ mm}$	
	79.88 mm	adjustment of master gauge

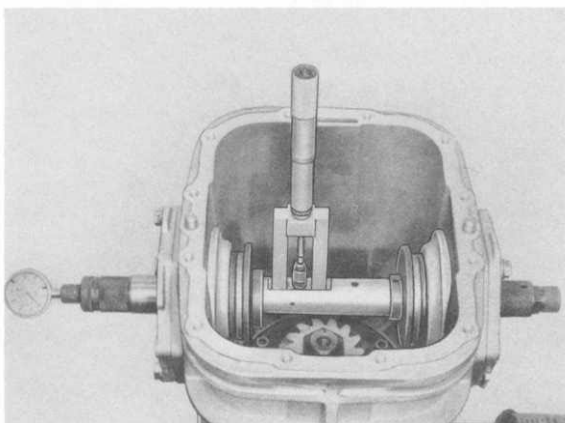
Example:

$$\begin{array}{rcl}
 \text{DM} = \text{E} & 75.00 \text{ mm} & \\
 + & 5.00 \text{ mm} & \\
 \hline
 & 80.00 \text{ mm} & \text{adjustment of} \\
 & & \text{master gauge}
 \end{array}$$

Note:

The measured value will always deviate from the set distance in clockwise direction (small needle of dial gauge will be between 1 and 2), i. e. when adjusting the dial gauge with 1 mm preload the value deviating from 1 is added as shim thickness S_3 .

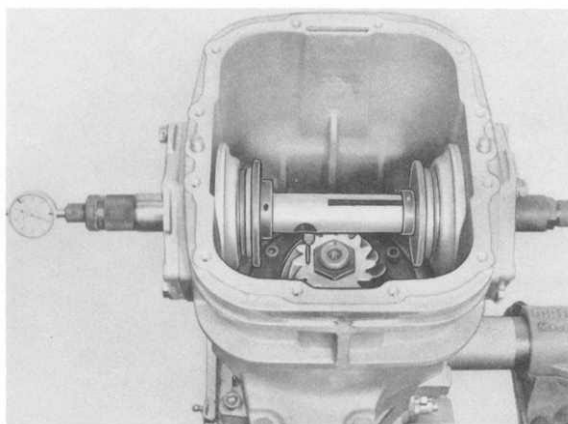
11. Install master gauge and set (3 mm range) dial gauge at zero with 1 mm preload.



13. Install the determined shim thickness S_3 between transmission case and final drive case.

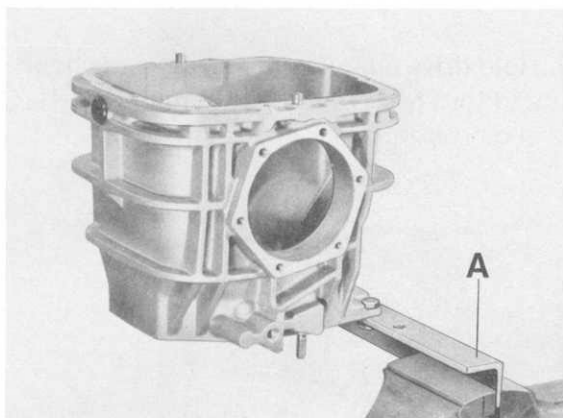
14. Recheck distance after installation of shims with determined thickness. A deviation of $\pm 0.03 \text{ mm}$ is permissible.

12. Turn master gauge carefully until dial gauge extension is vertical to face of drive pinion head. At this moment dial gauge needle will reach its point of reverse direction, at which dial gauge must be read.



ADJUSTING RING GEAR (S_{ges})

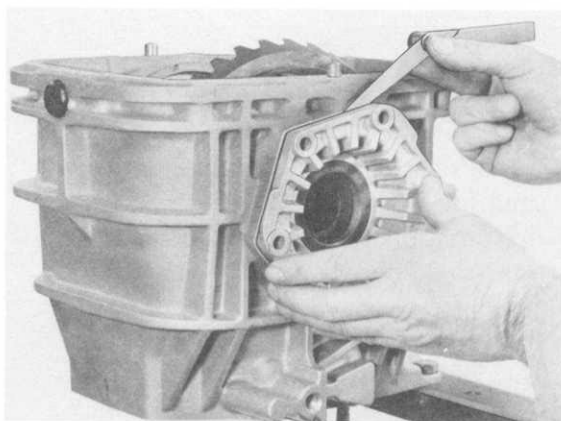
1. Clamp final drive case in a vise, using a suitable fixture.



A = L-iron bar

2. Install differential with ring gear in case.
3. Install side transmission cover (ring gear end) without shims and tighten all hexagon head bolts to 23 Nm/17 ftlb.
4. Guide in second side transmission cover without shims carefully.

5. Check gap between transmission case and side transmission cover with a feeler gauge.



6. Calculate shim thickness S_{ges} .

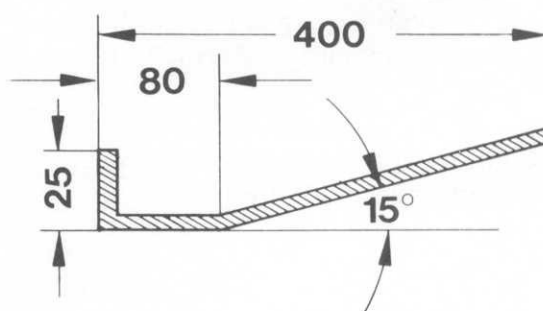
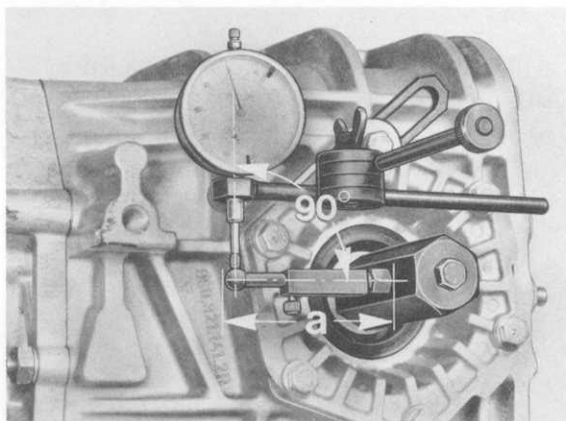
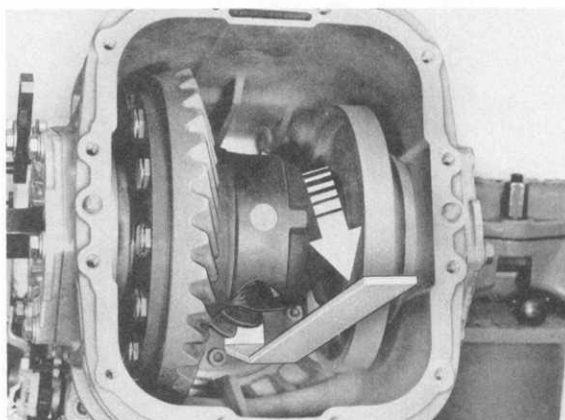
$$S_{ges} = \text{gap} - 0.30 \text{ mm (bearing preload)}$$

Example:

Gap	1.25 mm
Bearing preload	<u>- 0.30 mm</u>
S_{ges}	0.95 mm

ADJUSTING BACKLASH

1. Place shims determined for pinion adjustment between transmission case and final drive case. Install final drive case and tighten all mounting bolts to specified torque of 46 Nm/33 ftlb.
2. Install differential in case.
3. Install side transmission cover, using total shim thickness "Sges" as determined on ring gear end and tighten all hexagon bolts to 23 Nm/17 ftlb.
4. Turn differential in both directions several times, to settle tapered roller bearings.
5. Install measuring tools. Set Special Tool VW 388 to distance "a" = 80 mm.
6. Engage parking lock.
7. Turn ring gear carefully by hand against stop and set dial gauge to zero.
8. Hold drive pinion with locally made hook and turn back ring gear carefully. Read and note amount of backlash.



Hook made locally from flat iron 30 x 5 mm

DETERMINATION OF SHIMS S_1 AND S_2

Measured backlash must be brought to value specified by manufacturer of pinion/ring gear by splitting total shim thickness S_{ges} .

Determining Shim
Thickness S_2
(Opposite Ring Gear)

Backlash required is stamped on ring gear. Adjusted backlash value could be less by 0.05 mm, but must never be greater than the stamped value.

$$S_2 = S_{ges} - S_1$$

Example:

S_{ges}	0.95 mm
S_1	<u>- 0.27 mm</u>
	<u>0.68 mm</u>

Determining Shim
Thickness S_1
(Ring Gear End)

$$S_1 = S_{ges} \text{ (total shim thickness)} \\ - \text{measured backlash} \\ + \text{backlash inscribed on ring gear}$$

Note:

On the basis of experience with these pinions/ring gears the shims S_2 (opposite ring gear) can be selected approx. 10 to 15 % thinner in favor of shims S_1 (ring gear end).

Example:

S_{ges}	0.95 mm
- measured backlash	<u>0.88 mm</u>
	0.07 mm
+ inscribed backlash (by way of example)	<u>0.20 mm</u>
S_1	<u>0.27 mm</u>

1. Remove side transmission cover and split total shim thickness S_{ges} , that it gives the determined shim thicknesses S_1 and S_2 .

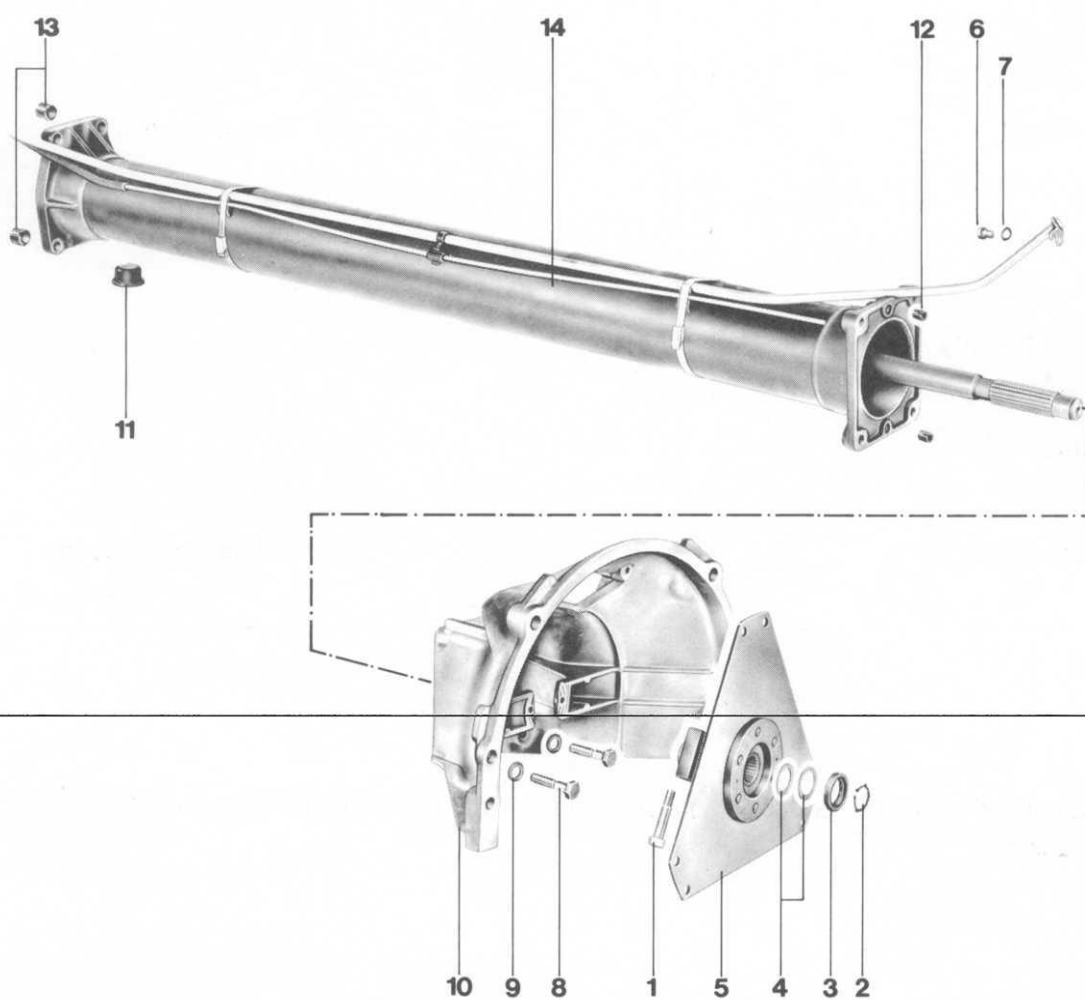
Note:

When tightening nuts for side transmission covers, always remember that there is a certain amount of backlash. Never let the drive pinion and ring gear clamp.

2. Measure backlash and, if necessary, change shims S_1 and S_2 again until specified play is reached.

 3. Check backlash at four places on periphery, turning ring gear by 90° each time. Measurements must not deviate from each other by more than 0.05 mm.
-

DISASSEMBLING AND ASSEMBLING CENTRAL TUBE



No.	Designation	Qty.	Note when:	
			Removing	Replacing
1	Pan-head screw	1		Tighten only after driver plate (5) has been fitted to flywheel. Tightening torque: 80 Nm
2	Circlip*	1		
3	Sleeve*	1		
4	Shim*	X		
5	Driver plate	1		
6	Pan-head	1		Torque: 20 Nm
7	Spring washer	1		
8	Hex bolt	4		Torque: 45 Nm
9	Spring washer	4		
10	Clutch housing	1		
11	Cover	1		
12	Sleeve	2		
13	Sleeve	2		
14	Central pipe	1		prüfen ggf. erneuern

* Parts are deleted as of MY '85. Adjustment of the driver plate (including pre-1985 models) is no longer required.

Checking Central Tube

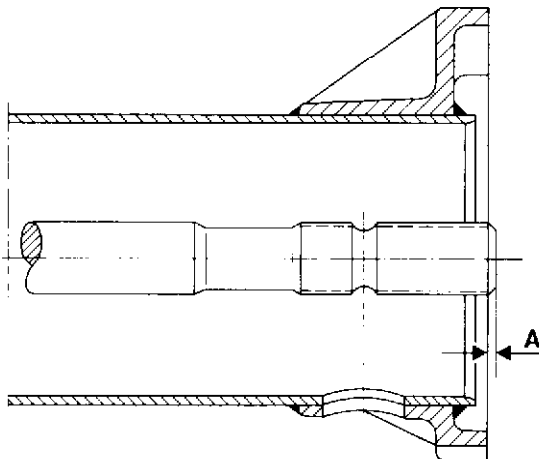
Note :

Replace entire central tube with shaft and bearings, if bearings and/or shaft are damaged.

There are no replacement parts available.

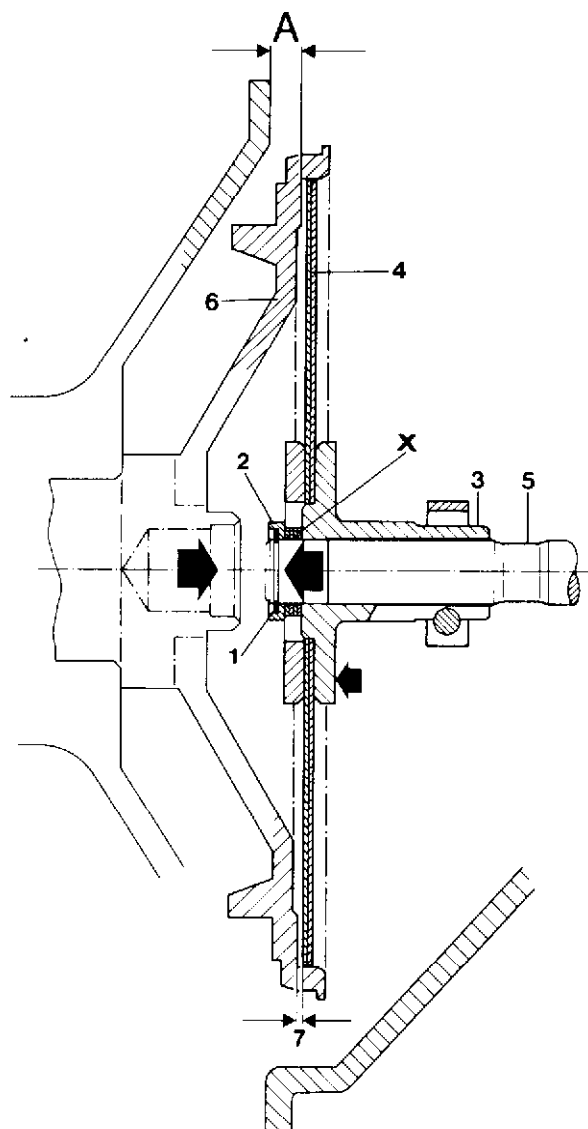
3. Small corrections can be made by tapping face of central shaft with plastic hammer.

1. Check easy movement of central shaft bearings by turning shaft by hand. Shaft must turn easily and without restriction at any point.
2. Position of central shaft and rear flange shaft is important to guarantee proper function.
Distance between central shaft and rear flange must be $A = 2 \pm 0.5$ mm.



Adjusting Drive Plate

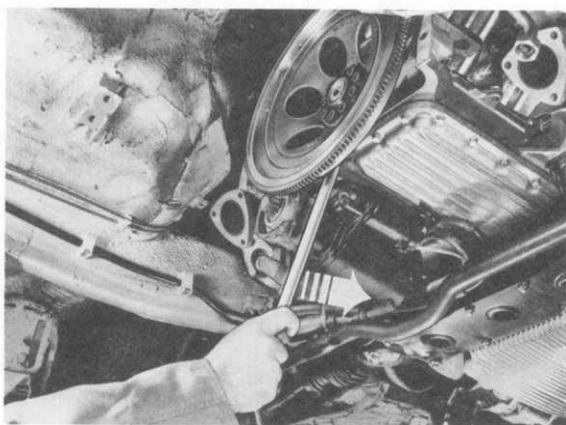
To avoid axial pressure on crankshaft and crankshaft thrust bearings, the connections between flywheel and drive plate (distance X) must be checked and adjusted after replacement of engine, flywheel or central tube. This adjustment is not necessary after replacement of transmission or transmission parts.



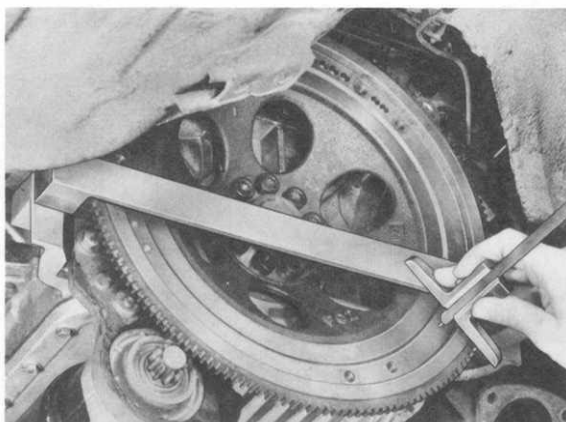
- 1 – Circlip
- 2 – Bushing
- 3 – Holding flange
- 4 – Drive plate
- 5 – Central shaft
- 6 – Engine flywheel
- 7 – Preload $0.3 + 0.2$ mm
- A – Distance A, engine flange/flywheel mating surface
- X – Shim thickness (must be determined again)

Determining Distance "X"

1. Crankshaft must contact thrust bearing toward the rear. Use a lever to press flywheel in direction of transmission, until axial play of crankshaft is eliminated.



2. Determine distance "A", by using 9211 and measuring distance from engine flange to flywheel mating surface.



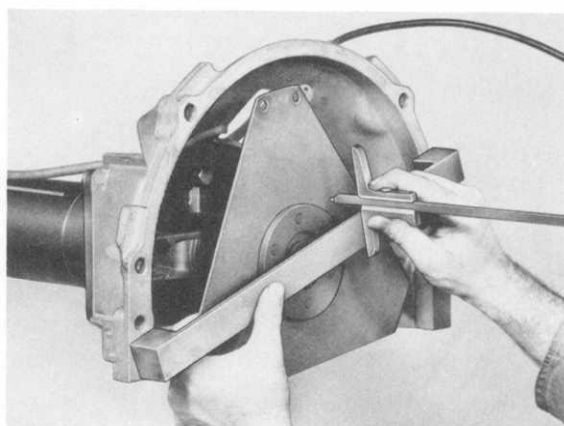
Note:

Mark thickness of gauge when measuring.

Example:

Measured value	52.5 mm
Gauge thickness	<u>40.0 mm</u>
Distance "A"	12.5 mm

3. Mount transmission on central tube to specified torque. Screw in clamping sleeve mounting bolt by hand (do not tighten).
4. Push drive flange with bushing, but without shims, on to central shaft and install circlip.
5. Use a suitable lever and push central shaft on drive flange far enough forward, that central shaft rests on rear clamping screw in shaft groove.
6. Tighten rear mounting bolt for clamping sleeve to 75 . . . 85 Nm/54 . . . 61 ftlb.
7. Push drive flange forward against stop on circlip and tighten bolt.
8. Determine distance "B". Use 9211 and measure distance from clutch housing to drive plate bearing surface (as far in as possible).



Note:

Mark thickness of gauge used for measuring.

Example:

Measured value	45.4 mm
Gauge thickness	<u>— 40.0 mm</u>
Distance B	5.4 mm

Determine distance "X"

$$X = A - B + 0.3 \text{ mm preload}$$

A =	12.5 mm
B =	<u>— 5.4 mm</u>
	7.1 mm
Preload	<u>+ 0.3 mm</u>
X =	7.4 mm

Install shim having thickness X
(in example 7.4 mm).

Shims are available in thicknesses of 0.2 mm,
0.5 mm and 1.0 mm.

Tighten mounting bolt for front drive flange
only after central tube has been installed.

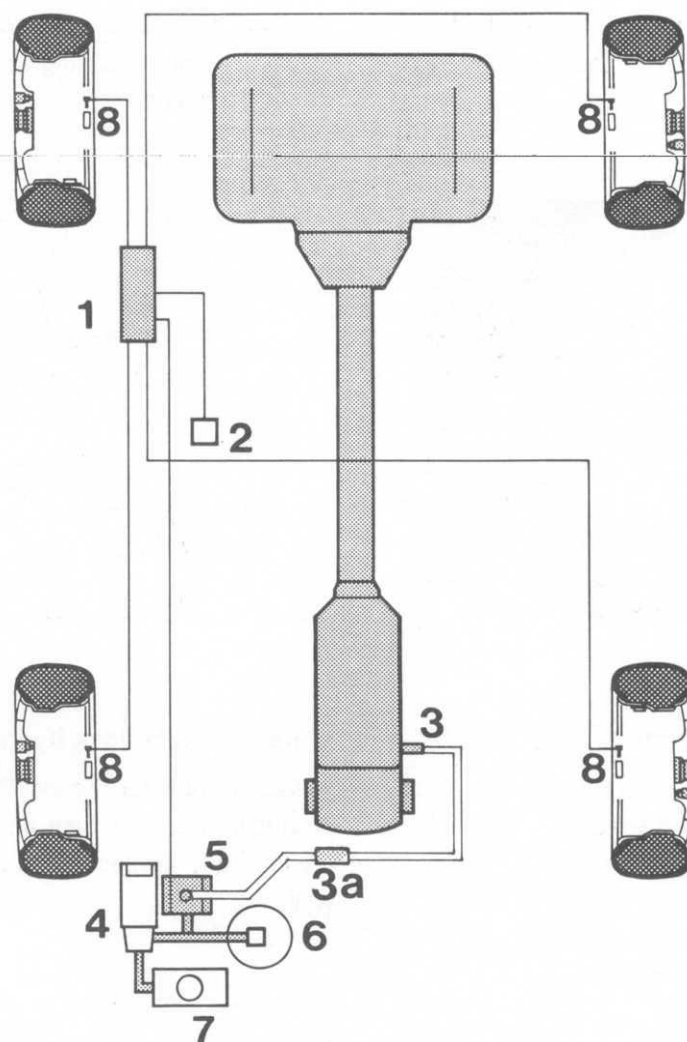
PSD diagnosis / Troubleshooting

PSD = Electronically controlled Porsche limited-slip differential

Contents

Test point	Title	Page
	PSD layout.....	D39-202a
	Component layout.....	D39-202b
	PSD - fault display / troubleshooting procedure.....	D39-202c
1	Bleeding condition of lock control..... (Re-bleeding lock operating hydraulics / point 2 on P. D39-202d)	D39-202d
2	Measuring plate wear of controlled limited-slip differential	D39-202e
3	Checking locking torque (friction coefficient) of transverse lock.....	D39-203
4	Checking pilot pressure valve in the lock hydraulics (lock operation)	D39-215
5	Lateral acceleration sensor (mounting/testing).....	D39-219
6	PSD - Diagnosis with system tester 9288.....	D39-223
7	Checking lock hydraulics	D39-247
	Pressure test on lock hydraulics.....	D39-251
–	Replacing the pressure warning switch.....	D39-257
–	Replacing the pressure reservoir.....	D39-259

PSD layout



2394-D39

- 1 - ABS / PSD control unit
- 2 - Lateral acceleration sensor
- 3 - Slave cylinder, transverse lock
- 3a- Pilot pressure valve in lock hydraulics
- 4 - Pressure pump with pressure warning switch*

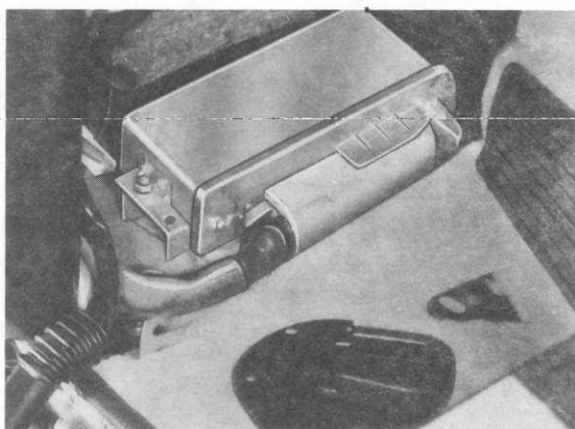
- 5 - Lock solenoid valve*
- 6 - Pressure reservoir*
- 7 - Supply tank*
- 8 - Wheel speed sensor

* The lock hydraulics (No. 4 to No. 7) is located on a joint bracket in the left-hand wheel well. Brake fluid is used as the operating medium.
Further information on P. D39-247.

Component layout

ABS / PSD control unit

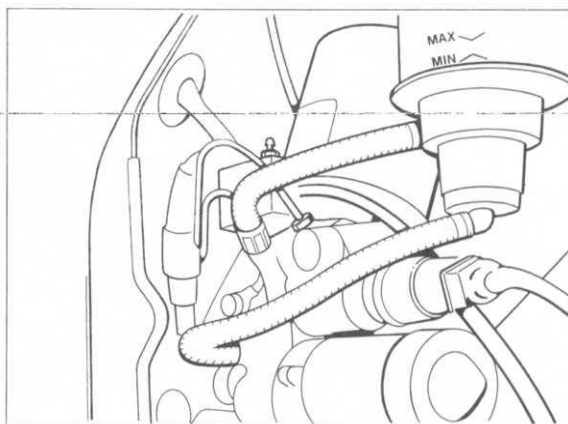
The control unit is located in the driver's footwell - near the A-pillar - above the front cover opening handle.



9537

Lock hydraulics

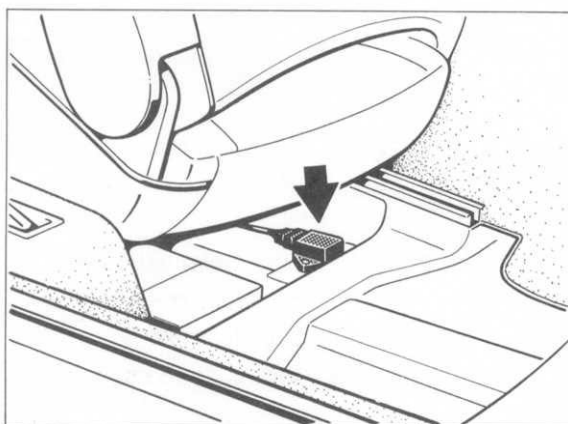
The lock hydraulics is accessible in the left-hand rear wheel housing after removal of the wheel housing cover.



992 - D39

Lateral acceleration sensor

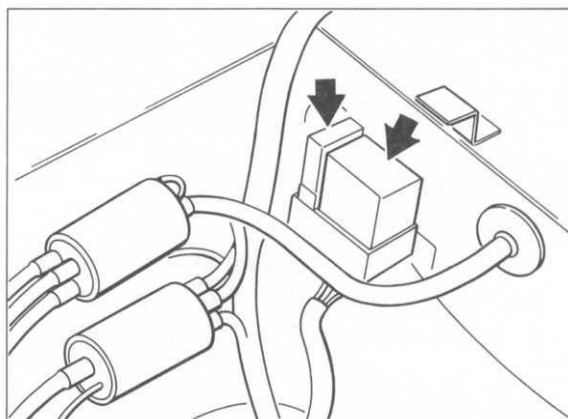
The sensor is mounted on a welded-on bracket below the left-hand seat.



2038 - 39

Voltage supply, lock hydraulics

Voltage supply for the lock hydraulics (energy production) is via a fuse and a relay. The relay and fuse are located in the spare-wheel well.



2395/1 - D39

PSD - Fault display / Troubleshooting procedure

Fault display

If the ABS/PSD control unit detects a fault in the electronically controlled limited-slip differential (PSD), the PSD is switched off for safety reasons and the following fault display appears in the display fields of the information system:

PSD

OFF

The PSD is always switched off when the ABS (antilock braking system) is switched off.

Note

The **PSD indicator lamp** (green lamp) in the instrument cluster lights up while the lock is active.

Troubleshooting procedure

Read out the DTC memory with system tester 9288 and remedy the fault if necessary. This is described on Page D39-223 ff.

If only the PSD is switched off (ABS OK) and **no** fault is stored in the ABS/PSD DTC memory, the fault lies in the lock hydraulics (energy production).

Bleeding hydraulics of Porsche controlled limited-slip differential (PSD)

Preparatory work:

- Remove rear left inner fender.
- Connect bleeding device to PSD hydraulic reservoir.
- Disconnect vent line (if present).
- Build up bleed pressure (approx. 1.5 - 2.0 bar).

1. Bleeding the pressure reservoir.

To charge the pressure reservoir, **the ignition must be switched on.**

When the pressure reservoir has been charged, the pump cuts out; reservoir pressure is then approx. 180 bar.

- Connect the bleed cylinder.
- Switch off the ignition.
- Carefully open the bleed valve and allow the pressure level to drop gradually.
While this is being done, the **ignition must remain switched off** to ensure that the pressure is completely reduced and the air is expelled from the reservoir.
- Repeat this procedure several times, making sure that the **ignition is switched on/off at the appropriate stages in the procedure.**

2. Bleeding the valve block and the locking line to the lock slave cylinder

- Connect the 9288 system tester.
- Switch the ignition "ON".
- Connect the bleed cylinder to the bleed screw on the slave cylinder.
- Open the bleed screw on the slave cylinder.
- Select "Start PSD Bleeding" and actuate repeatedly until no further air emerges.
- The bleeding device must remain switched on, because the reservoir volume is used up rapidly.
- After this, close the bleed screw on the slave cylinder.
- Select "Stop Bleeding" and "Start Pressure Reduction" on the system tester.
- Switch off the bleeding device and disconnect it.
- Screw on the reservoir cover.
- Open the vent line at the reservoir again (if present).

- Check level in the reservoir. The fluid must be approx. 1 cm above the step in the reservoir body or between the markings (with the pressure reservoir charged).

Measuring the plate wear on the controlled-slip differential

Note

The wear dimension can be determined only by means of the measuring cylinder - special tool 9514.

1. Remove slave cylinder.

Note

In order to avoid venting of the lock system, the pressure line at the slave cylinder must not be disconnected when the transmission is installed. In this case, unflange the slave cylinder with pressure line from the housing.

2. Back off the adjusting screw of the measuring cylinder as far as possible (this facilitates assembly of the cylinder).

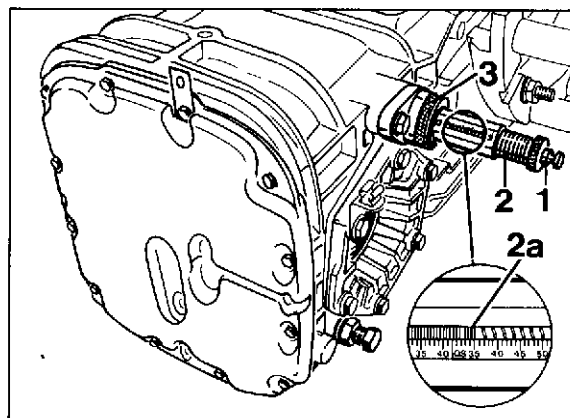
3. Mount the measuring cylinder on the transmission and tighten the knurled nut.

Note

If the transmission is installed, it is recommended to use two studs M8 x 45 with continuous thread to secure the measuring cylinder.

4. Screw in the adjusting screw on the measuring cylinder until there is no longer any axial play at the spacer tappet. Read off the wear dimension in this position.

New dimension = 34.5 mm
Wear dimension = 45.0 mm



357-39

LS = Measuring range for longitudinal lock
911 Carrera 4

QS = Measuring range for transverse lock
928 S 4,
928 GT, 928 GTS and 911 Carrera 4

1 - Spacer tappet

2 - Adjusting screw

2a - Measuring groove on adjusting screw

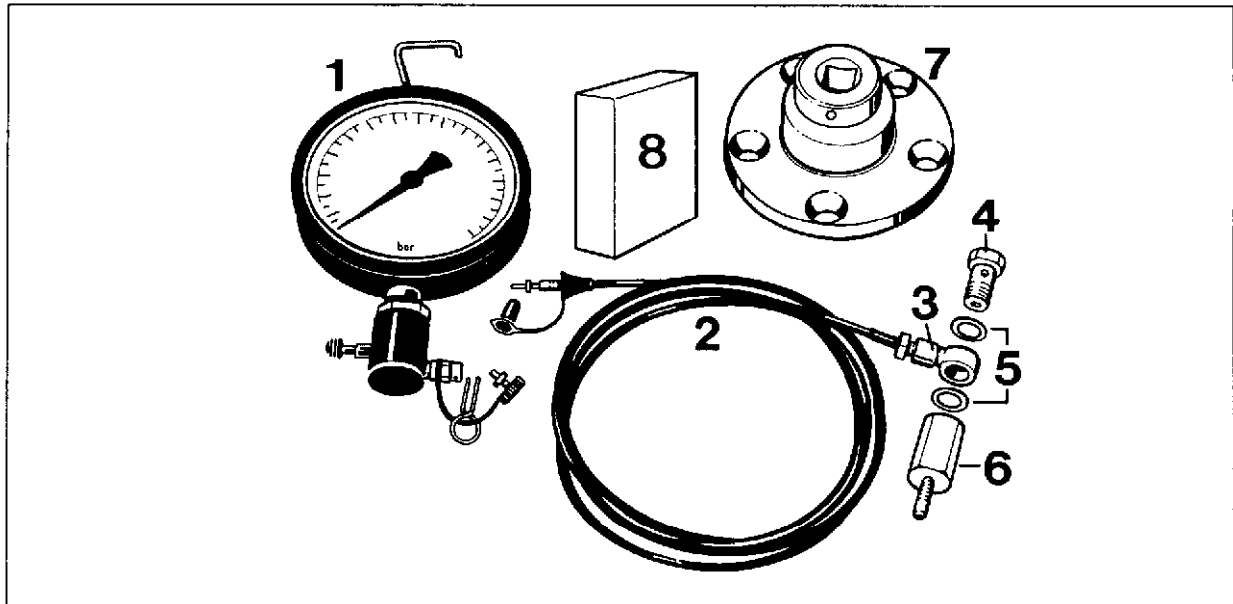
3 - Knurled nut

Note

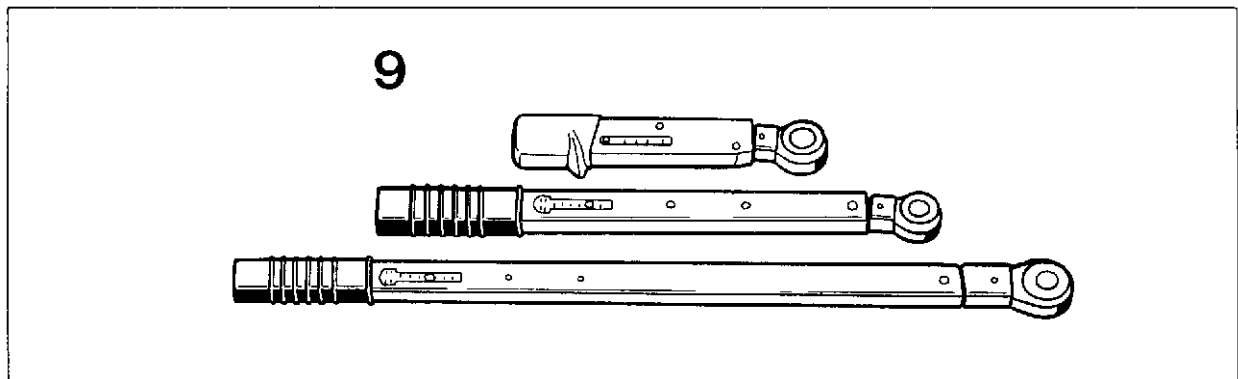
When the wear dimension has been reached, the plates of the lock must be replaced. Do not correct the wear dimension at the thrust bearing under any circumstances.

Checking locking torque (friction coefficient) of transverse lock

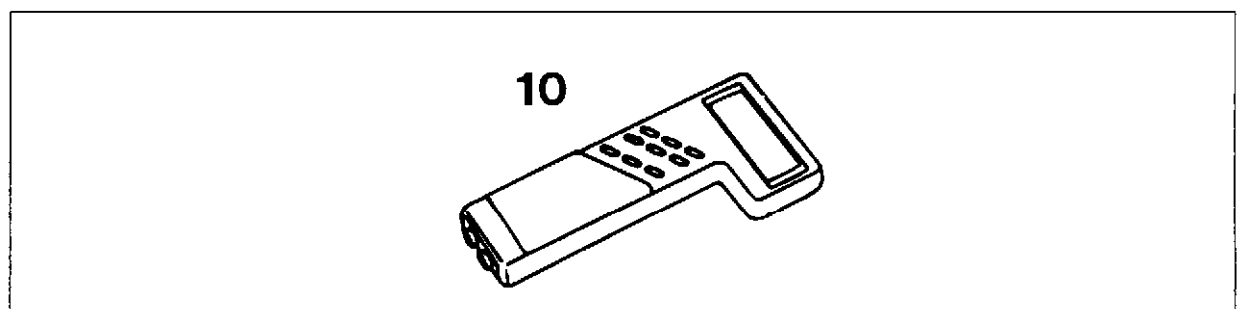
Tools



345-D39/45



483-D39/45



No.	Designation	Special tool	Order number	Explanation
1	Pressure gauge	9509	000.721.950.90	
2	High-pressure measuring line	9509/1	000.721.950.91	
3	Ring flange	-	999.215.027.02	
4	Banjo bolt	-	930.110.547.00	shorten threads by approx. 4 mm
5	Seal	-	N 013 811 2	2 pc.
6	Union	9509/3	000.721.950.93	
7	Torque adapter plate	9510/1	000.721.951.01	
8	Support block	9509/4	000.721.950.94	1 pc.
9	Self-disengaging torque wrench (click wrench) covering a range of 5 Nm (4 ftlb) to 500 Nm (369 ftlb)	-		commercially available (refer to shop manual). Depending on the type of torque wrench used, corresponding reduction pieces or adapters are required for connection to the adapter plate (No. 7).
10	System Tester 9288 with connecting hose and corresponding program module (acc. to language used)	9288	000.721.928.80	
		9288/1	000.721.928.81	
		928DV	000.721.928.DV.008	German
		928GV	000.721.928.GV.008	English
		928FV	000.721.928.FV.008	French
		928IV	000.721.928.IV.008	Italian
		928EV	000.721.928.EV.008	Spanish
		928SV	000.721.928.SV.008	Swedish
		928JV	000.721.928.JV.008	Japanese

Checking locking torque (friction coefficient) of transverse lock

Important notes

Check with cold transmission. Parking brake released, no gear engaged.

When checking the locking torque, it is not the rotating torque (starting torque) but rather the breakaway torque that is measured. For this reason, self-disengaging torque wrenches must be used.

Checking

Procedure	Execution / Notes
1. Carry out general preparations according to right-hand column	<ul style="list-style-type: none">– Remove rear wheels– Fit torque adapter plate (Special Tool 9510/1) with original wheel bolts to left-hand rear wheel hub.– Remove rear left-hand inner wheel arch panel– Prepare self-disengaging torque wrenches (click wrenches) covering a range of approx. 5 Nm (4 ftlb) to 500 Nm (369 ftlb). To fit them to the torque adapter plate, suitable reduction pieces or adapters are required.

Procedure

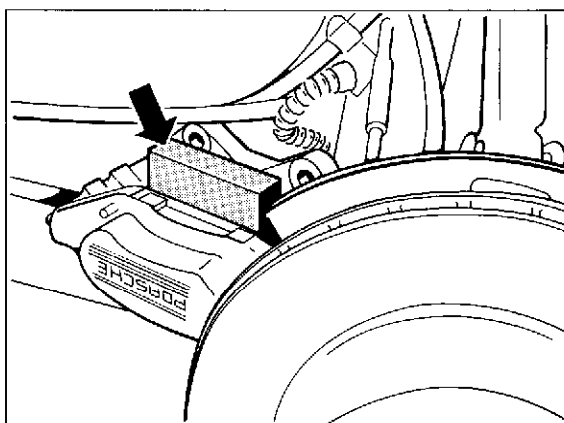
Execution / Notes

2. Prepare vehicle for transverse lock measurement.

Proceed as follows:

- Remove rear left-hand brake caliper (do not open hydraulic brake system) and place support block - Special Tool 9509/4 - into the brake caliper, replacing the brake disc.
- Connect pressure gauge to transverse lock cylinder.
- Connect System Tester 9288 to diagnosis socket.
- Bleed pressure gauge. To keep the reservoir level from dropping too far (low volume), connect a bleeder unit to the reservoir. Bleeding pressure approx. 1.5 to 2.0 bar. The venting line remains clamped.

- Remove rear left-hand brake caliper.
Place the support block (arrow) into the brake caliper, replacing the brake disc. Place brake caliper on rear axle trailing arm or suspend in a suitable place.



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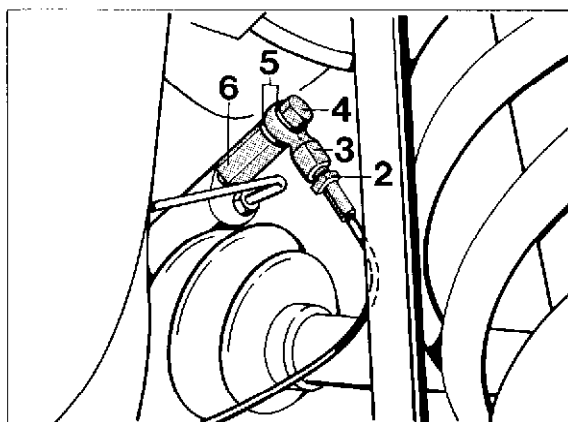
Procedure

Execution / Notes

- Connect ring flange (No. 3) to measuring line (No. 2). Proceed by fitting this assembly, complete with banjo bolt, seals and fitting (Nos. 4, 5 and 6), **to the transverse lock slave cylinder, replacing the bleeder valve.**

Important note

Tighten Nos. 4 and 6 carefully and use a second wrench to lock when tightening, making sure the parts do not bind. If this is not observed, the fitting (No. 6) may shear off. Pilot pressure is normally present at the bleeding valve (No. 6). Open valve slowly before removing it (to allow the pressure level to be dumped slowly).

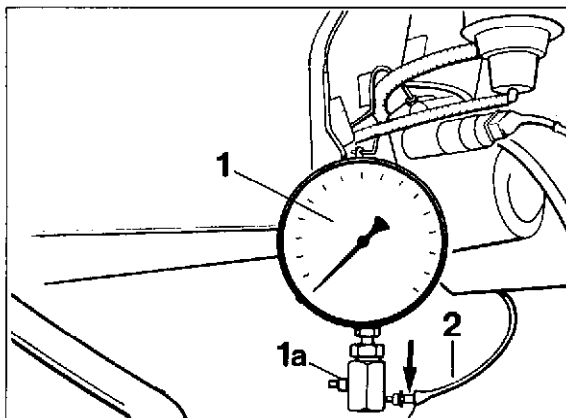


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Procedure

Execution / Notes

- Connect high-pressure measuring line (No. 2) to pressure gauge (cf. arrow) and suspend pressure gauge (No. 1) in rear left-hand wheel housing area so that it may be read off easily.
Bleed pressure gauge by connecting the bleeding device to the PSD reservoir. Clamp venting line. Build up bleeding pressure (approx. 1.5 to 2.0 bar). Connect System Tester 9288 along with adapter line 9288/1 to diagnosis socket (located next to the passenger's seat under the booster cover). Clock lock solenoid valve complete with System Tester 9288 in "Drive links / Bleed position" menu and allow brake fluid to escape at the bleeder valve (No. 1 a) until it is free from air bubbles. (Use collector bottle).
Close bleeder valve and press stop button. Select pressure reduction position.
Switch off bleeding device.



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Procedure	Execution / Notes
<p>3. Perf. transverse lock measurement (locking torque to pressure ratio)</p> <p>Testing cond. / important information</p> <ul style="list-style-type: none"> – Transmission cold / parking brake released, no gear (driving position) selected – Before starting measurements, close lock once for a short time (activate full pressure) – To measure the locking torque, rotate only in forward direction! Always measure across adapter plate at left-hand rear hub – Lock right-hand rear wheel fully using the service brake – Measure breakaway torque / locking torque at the specified test pressures using the torque wrench. Do not jerk when rotating. Advance carefully from bottom (low value) to top until the breakaway torque / locking torque is reached. – Establish test pressures using System Tester 9288, clocking the transverse lock solenoid valve. (Drive links / Check transv. lock menu) 	<ul style="list-style-type: none"> – Observe testing conditions indicated in opposite column – Switch on System Tester. Select "Check transv. lock" – Fully close transverse lock by applying approx. 20 pulses (gauge pressure $\approx 140...180$ bar). Pressing operating button at tester once = 1 pulse – Switch to pressure release position and start with measurement no. 1 – Measurement 1 = gauge pressure 0...5 bar Set torque wrench to approx. 5 Nm and use adapter plate to connect to left-hand rear wheel hub (No. 7). Observe clicking direction of torque wrench. While performing measurements, actuate service brake to ensure that the right-hand rear wheel is fully locked. Turn torque wrench carefully (i.e. avoiding jerks) in forward direction. If the wheel hub does not yet rotate when the torque wrench clicks the actual locking torque has not yet been reached. Adjust torque wrench to higher value and repeat operation. The actual locking torque (actual value) is achieved when the wheel hub turns and the moment when the torque wrench starts to click is just about reached. If the wheel hub turns but the wrench does not yet click, the torque set at the wrench is too high (actual locking torque is lower).
<p>Test pressures / measuring process</p> <p>Measurem. 1 = press. between 0...5 bar Measurem. 2 = " " 10...20 bar Measurem. 3 = " " 20...40 bar Measurem. 4 = breakaway torque 500 Nm (369 ftlb) minimum, with pressure held at 60 bar or above Measurem. 5 = check pilot pressure transverse lock. Specified value approx. 3.0...4.5 bar</p>	

Procedure	Execution / Notes
<p>Refer to page D39-213 for a listing of the actual values (admissible locking values) vs. the corresponding pressures.</p>	<p>When measuring the breakaway torque, measure at several locations (angular positions) within one wheel revolution.</p>
<p>Possible causes for deviation from specification</p> <ul style="list-style-type: none"> - Test requirements not met. Example: RH rear wheel not fully locked, pressure gauge and lock hydraulics not properly bled. - Faulty discs - Hydraulic pressure does not become effective to the degree indicated at the discs, e.g. due to faulty setting of the mating bearing screw of the engaging lever (engaging lever rides). 	<p>After the actual locking torque has been reached, immediately read off the pressure at the pressure gauge. Record both actual values (torque + pressure).</p> <ul style="list-style-type: none"> - Measurement 2 = Gauge pressure 10...20 bar Use the System Tester to build up test pressure, applying a corresponding number of pulses. Set torque wrench to bottommost value (depending on pressure) according to boundary value window (p. D39-213). Repeat process as described for measurement. no. 1. - Measurement 3 = Gauge pressure 20...40 bar. Repeat process as described for measurements 1 and 2, respectively. - Compare actual values obtained in measurements 1/2/3 with values specified on p. D39-213.

Procedure	Execution / Notes
	<p>Example:</p> <p>Measurement 2 = Gauge pressure 10...20 bar</p> <p>Actual values: Gauge pressure = 13 bar, locking torque measured = 240 Nm (177 ftlb)</p> <p>Specified value according to table at 13 bar: 120...300 Nm (88...221 ftlb)</p> <p>Measurement 2 o.k. since results are within the tolerance band (boundary value window)</p> <p>– Measurement 4 = Minimum locking torque of 500 Nm (369 ftlb) must be ensured. Equivalent pressure 60 bar or higher</p> <p>– Measurement 5 = pilot pressure valve Proceed to pressure release position and read off pressure at gauge. Specified value: approx. 3.0...4.5 bar. If measurements are out of limits, repeat process, starting from low pressure - max. 20 bar. In this case, release pressure by switching off ignition.</p>

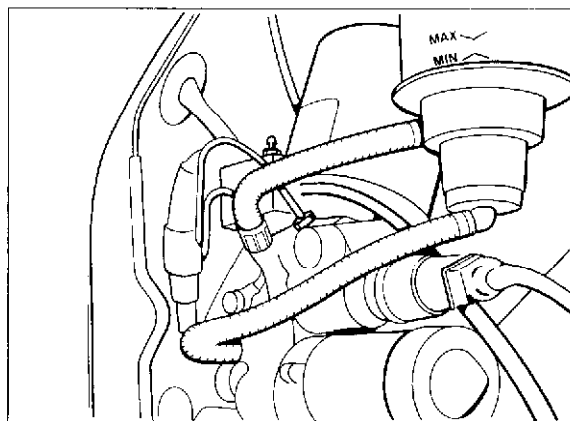
Procedure

4. With the System Tester switched off (to ensure that only pilot pressure is present at the measuring line), remove pressure gauge complete with connecting lines.
Install bleeder valve and bleed transverse lock.
Correct reservoir fluid level.

5. Check lock hydraulics for leaks.
Disconnect System Tester.
Install rear brake caliper.
6. Fit rear left-hand wheel housing inner panel. Fit rear wheels.
Take vehicle for a short test drive (to check lock and brake operation).

Execution / Notes

- Open measuring line and transverse lock cylinder carefully (observing pilot pressure). Remove measuring line and fit bleeder valve.
- Bleed transverse lock using System Tester 9288, with bleeding device connected to reservoir and switched on (vent line clamped off).
Follow by correcting reservoir level (to a level between MIN and MAX mark) with accumulator fully charged.
Screw on reservoir lid, open vent line at reservoir again.

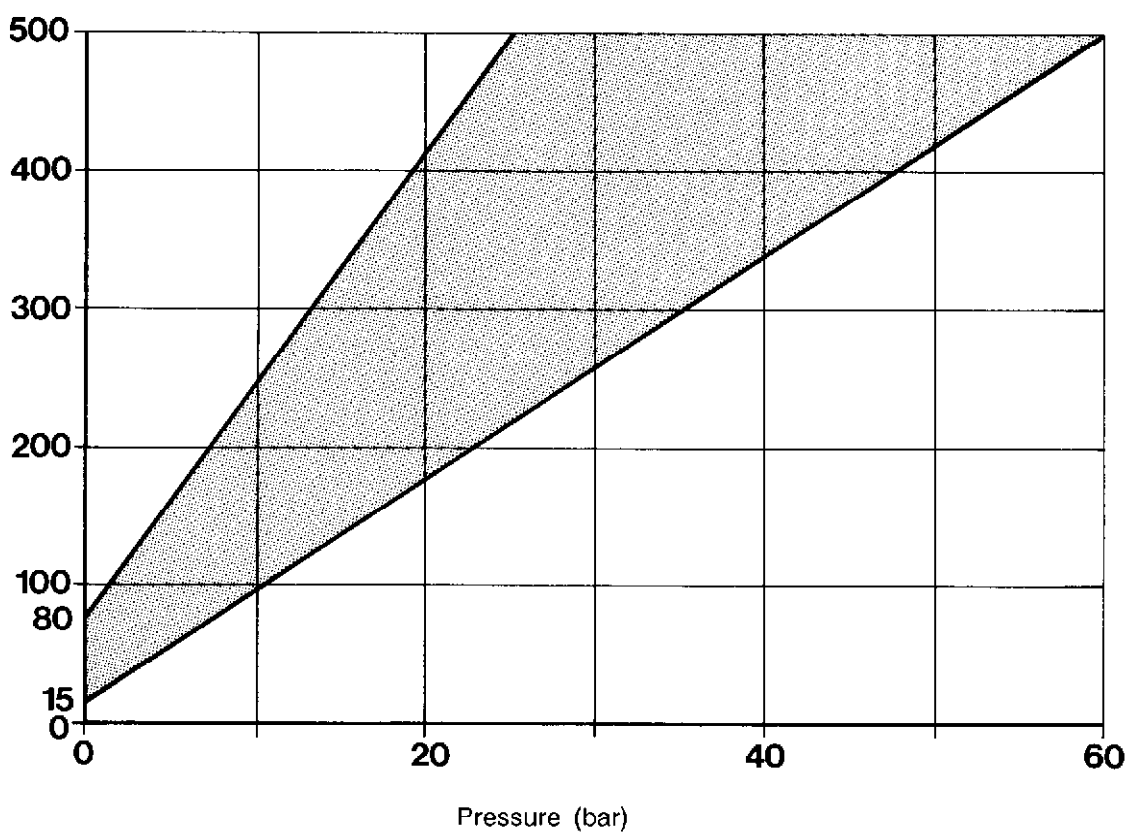


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- Check hydraulic lines for outside leaks, controlling full system pressure at lock cylinder using System Tester 9288.
- Then disconnect System Tester.
- Tighten brake caliper mounting bolts to 85 Nm (63 ftlb).

Locking torque-to-pressure limits

Locking torque (Nm) (ftlb)



618-D39

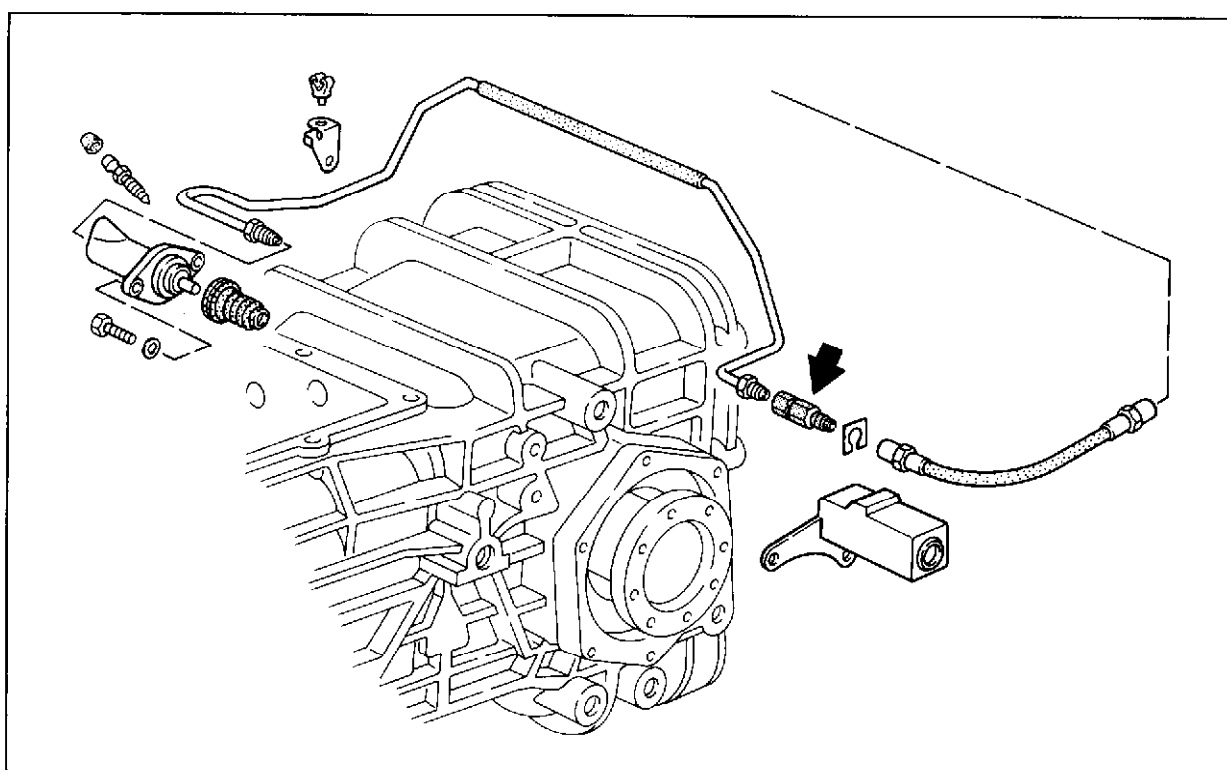
Checking pilot pressure valve of lock hydraulics (lock operation)

General

Normally the pilot pressure valve is checked within the scope of measuring the friction coefficient of the transverse lock (test item 3).

A pilot pressure valve (arrow) is located ahead of the transverse lock slave cylinder on the left-hand transmission side.

If pilot pressure is too high, squeal noises may result. Due to wear and vehicle dynamics constraints, zero pilot pressure is also to be avoided. **When replacing components, do not confuse with the PDAS pilot pressure valves designed for the 911 Carrera 4.**



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Specifications / identification of the pilot pressure valves

Type	Specification	Identification
911 Carrera 4	approx. 2.0 to 3.5 bar	2 - 3 stamped on valve
928 with PSD	approx. 3.0 to 4.5 bar	3 - 4 stamped on valve

Checking pilot pressure valves

Procedure

1. Prepare vehicle for pilot pressure valve check.

Operations:

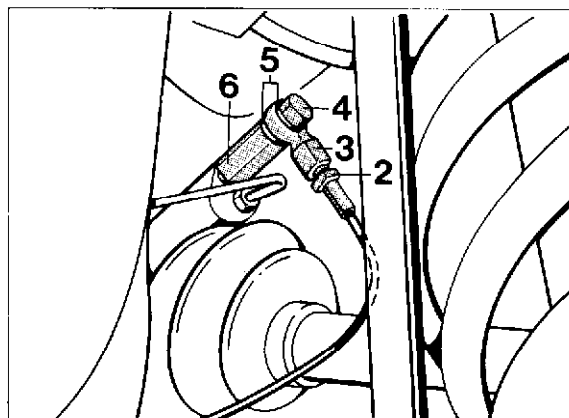
- Connect pressure gauge to lock slave cylinder.
- Connect System Tester 9288 to diagnosis socket.
- Bleed pressure gauge.

Execution / Notes

- Connect ring flange (No. 3) to measuring line (No. 2). Proceed by fitting this assembly complete with banjo bolt, seals and fitting (Nos. 4, 5 and 6), **to the lock cylinder, replacing the bleeding valve.** Connect high-pressure measuring line (No. 2) to pressure gauge.

Important note

Tighten Nos. 4 and 6 carefully and lock when tightening, making sure the parts do not bind. If this is not observed, the fitting (No. 6) may shear off.



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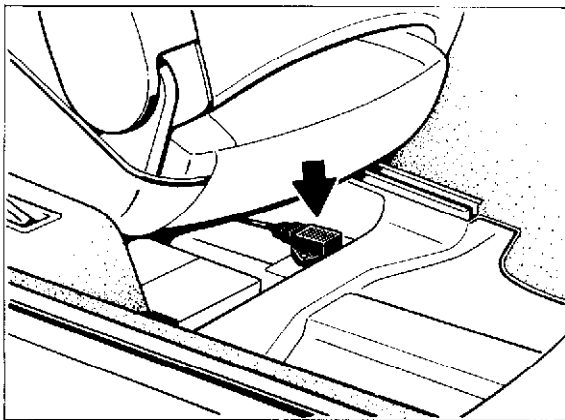
Procedure	Execution / Notes
<p>2. Check pilot pressure valve operation as described below: Use System Tester 9288 to activate transverse lock solenoid (Drive links / Check transv. lock menu) with 1 - 2 pulses. Then switch to pressure reduction position and read off gauge pressure after a short interval (to allow for gauge damping). For specifications, refer to p. D39-215.</p> <p>3. Follow check by bleeding the transverse lock and correcting the reservoir level.</p>	<p>– Connect System Tester 9288 along with adapter line 9288/1 to diagnosis socket (located next to the passenger's seat under the booster cover). Bleed pressure gauge by clocking lock solenoid valve complete with System Tester in "Drive links / Bleed position" menu and allow brake fluid to escape from the pressure gauge at the bleeder valve until it is free from air bubbles. (Use collector bottle). For this purpose, leave bleeding device connected to reservoir and leave bleeding line clamped. Bleeding pressure approx. 1.5 - 2.0 bar. Close bleeding valve and press stop button. Select pressure reduction position. Switch off bleeding device.</p> <p>Important note</p> <p>If pilot pressure is too high (before replacing a valve), build up a lower pressure and reduce pressure by switching off the ignition, thus deviating from the previous testing procedure. Pilot pressure may drop by max. 0.2 bar within 5 minutes.</p> <p>– After disconnecting the pressure gauge, use the System Tester (Drive links - Select bleeding menu) and allow brake fluid to escape at bleeder valve of the transverse lock slave cylinder until fluid is free from air bubbles.</p> <p>– Correct reservoir level with accumulator fully charged (after pump unit has switched off automatically). Do not fill above "max. mark". Screw on reservoir lid. Open venting line at reservoir again. Disconnect System Tester.</p>

Lateral acceleration sensor

Installation position

The lateral acceleration sensor has been installed on a support welded in under the LH seat.

The sensor is required for the electronically controlled limited slip differential.



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Important notes

The sensor must not be exposed to extreme accelerations which may, for example, be caused by throwing, falling down or shocks.

After an accident, the sensor must always be checked. If the sensor is out of specifications, it has to be replaced.

Installation

The sensor is fastened onto a welded-in support (2 bolts). The correct installation position (sensor in horizontal position) will be obtained automatically, if the welded-in support has not been deformed.

If the support has been deformed (due to an accident), it has to be readjusted using a bubble level:

For this purpose, park the vehicle on level ground.

After installation, check the sensor for proper functioning.

Checking

Notes on checking

Checking relates to the following aspects:

- correct installation position of the sensor
- sensor function

The **55-pin ABS 2 LED adapter lead** (see item 1), a multimeter, a shop trolley jack and a measuring tape are required for this test. The **55-pin** adapter lead required to run an ABS test on the Carrera 4 (964) and the 928 with PSD (instead of the **35-pin** adapter lead) has 3 outputs incorporated for testing the longitudinal and lateral acceleration sensors. The longitudinal acceleration sensor is only fitted to the Carrera 4 (964).

Manufacturer of the adapter lead:

Robert Bosch GmbH
Dept.: KH/VKD 2
Postfach 41 09 50
D-76225 Karlsruhe
Phone: 0721/942-0
Fax: 0721/9422187

Supplier of the adapter lead:

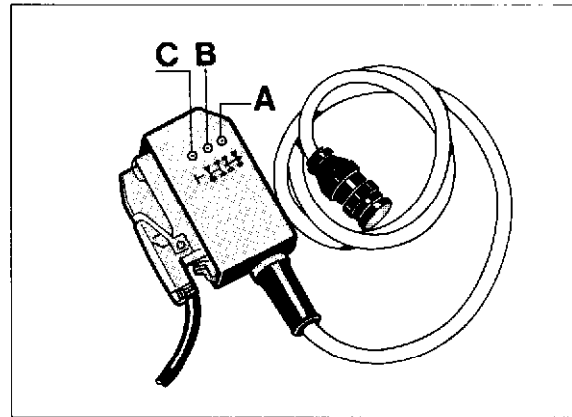
Authorized dealer
Part No. KDAS 0003/7

1. With the ignition switched off, take off the ABS/PSD control unit connector and connect it to the 55-pin ABS 2 LED adapter lead.

Note

The following tests can be carried out with or without the ABS 2 LED tester being connected. The 3 outputs are identified by special symbols

- A = Signal of longitudinal acceleration sensor
- B = Signal of lateral acceleration sensor
- C = Ground contact for both sensors



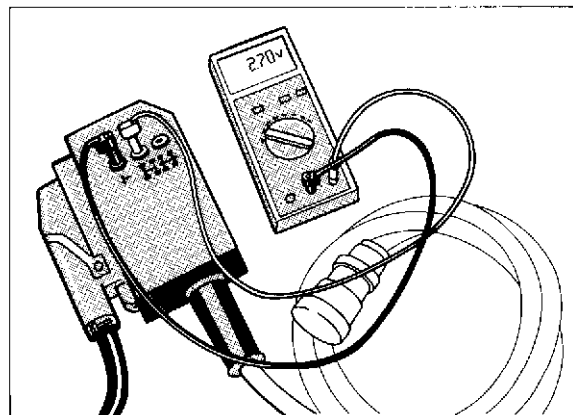
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2. With the vehicle in normal position, check and record the voltage reading at the **lateral acceleration sensor** (with the ignition switched on).

Specification: 2.7 ± 0.14 volts.

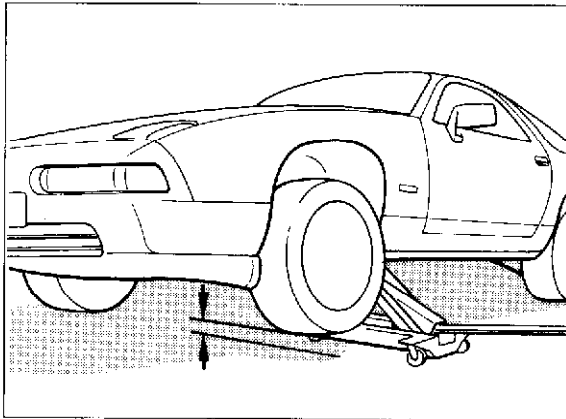
Normal position means: Vehicle must be on a level surface. If the vehicle was off the ground before the test, slacken the suspension if required (move vehicle a few yards and jounce front and rear ends of vehicle several times).

If the reading deviates from the specification, continue with the assessment table at the end.



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3. Establish a ground clearance of approx. 150 mm at the left front wheel by lifting the vehicle at the left front jacking point. Read off and record sensor voltage value.



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4. Lower left front side of vehicle. Then raise vehicle at the front right end in the same manner by approx. 150 mm. Read off and record sensor voltage value.
5. Assess readings according to the below table. Correct any faults that may be present.

Assessment table for sensor tests

Test item / Notes	Requirements Fault / Troubleshooting						
<p>Sensor installation position via output voltage</p> <p>The sensor is supplied with an input voltage of 5 volts across the ABS /PSD control unit. The output voltage is 2.7 volts, provided that the sensor is in a horizontal position and fully operative.</p>	<p>- Specified reading: 2.7 ± 0.14 volts when the vehicle is on a level surface (ignition is switched on).</p> <p>If the reading exceeds or falls below the specification, this means that the sensor bracket is bent or that the sensor is faulty.</p> <p>If no voltage is displayed, the wiring has gone open circuit, the sensor is faulty or an incorrect socket was used at the test lead. Check wiring routing according to wiring diagram if required. Some faults (open circuit / short circuit, sensor fault) are stored in the fault memory of the ABS/PSD control unit. The fault memory (in PSD system) must therefore be read out with System Tester 9288 and erased after the fault has been eliminated.</p>						
<p>Sensor operation</p> <p>To test, raise vehicle once at front right and once at front left by approx. 150 mm in each case.</p> <p>This must result in an exactly predefined change of the voltage.</p> <p>Use the above measurement (initial reading obtained with vehicle on level surface) as a reference.</p>	<p>- Specified display: Based on the initial reading, the voltage must be higher when the left side is raised and lower when the right side is raised.</p> <p>Example:</p> <table> <tr> <td>Initial reading</td><td>2.65 V</td></tr> <tr> <td>Raised at front left</td><td>2.85 V</td></tr> <tr> <td>Raised at front right</td><td>2.46 V</td></tr> </table> <p>If the voltage does not change when the vehicle is raised (by the same amount on left and right), this means that the sensor is faulty.</p> <p>Read out fault memory (in PSD system) with System Tester 9288 after eliminating the fault and erase the fault memory as required.</p>	Initial reading	2.65 V	Raised at front left	2.85 V	Raised at front right	2.46 V
Initial reading	2.65 V						
Raised at front left	2.85 V						
Raised at front right	2.46 V						

PSD - Diagnosis with system tester 9288

General information

The PSD/ABS control unit is suitable for self-diagnosis. This means that the control unit can detect, store and output certain faults of the PSD and the ABS.

Diagnosis is performed with system tester 9288 in combination with the adapter lead 9288/1 and the corresponding module (depending on the language in question).

The diagnosis socket is located next to the passenger's seat underneath the booster cover. Positive potential is permanently connected to the PSD/ABS control unit in order to prevent detected and stored faults from being deleted when the ignition is switched off.

PSD diagnosis is **not** possible with the engine running.

Overview of available PSD menus

1 = DTC memory

2 = Drive links

1 = DTC memory see Page D39 - 226

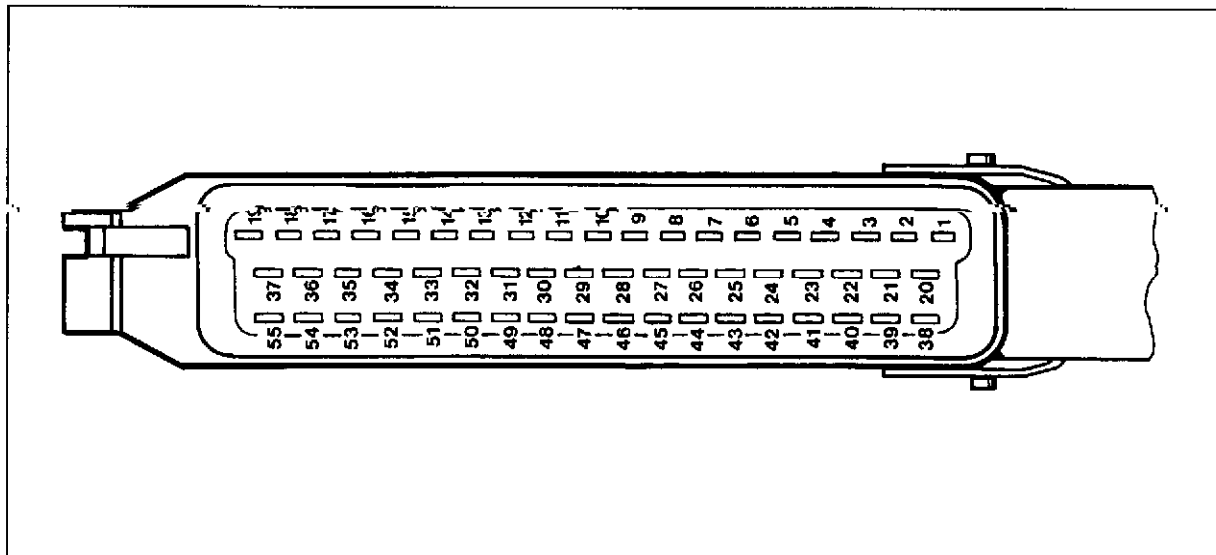
2 = Drive links

Submenu:

Bleeding see Page D39 - 202d

Checking the transverse lock
see Page D39 - 203

Connector pin assignment for control unit (PSD/ABS)



Z397-D39

- | | |
|---|---|
| 1 - Voltage, terminal 15 | 10 - Speed sensor output at rear right for RDK (tire pressure monitoring system) control unit |
| 2 - Operation of ABS rear-axle solenoid valve | 11 - Voltage, terminal 30 |
| 3 - Ground, ABS solenoid valve, front right | 12*- Speed sensor output at rear left for RDK control unit* |
| 4 - K wire from diagnosis | 13 - Free |
| 5 - Operation of pump motor relay on hydraulic unit | 14 - Free |
| 6 - Free | 15 - Voltage supply (+5V) for acceleration sensor |
| 7 - Operation of valve relay on hydraulic unit | 16*- Speed sensor output at front right for RDK control unit* |
| 8 - Free | |
| 9 - Ground of acceleration sensor | |

* additionally for vehicle speed. PIN 16 (front left) on mod. 1991/ 1992. PIN 12 (rear left) as of mod. 1993.

- | | |
|---|--|
| 17 - Monitoring, voltage supply for ABS solenoid valves | 37 - Ground, ABS solenoid valves, front left + rear axle |
| 18 - Free | 38 - Free |
| 19 - Operation of ABS solenoid valve, front left | 39 - Free |
| 20 - Voltage for valve and motor relays on hydraulic unit | 40 - Indicator lamp (green) for PSD function |
| 21 - Operation of transverse lock solenoid valve | 41 - Free |
| 22 - Operation of ABS solenoid valve, front right | 42 - Ground, shield, speed sensor at rear right |
| 23 - Monitoring of voltage supply for lock solenoid valve | 43 - Signal, speed sensor at rear right |
| 24 - Operation of ABS warning lamp | 44 - Ground, shield, speed sensor at rear left |
| 25 - Free | 45 - Signal, speed sensor at rear left |
| 26 - Free | 46 - Ground, shield, speed sensor at front right |
| 27 - D + (Terminal 61 / charge) | 47 - Signal, speed sensor at front right |
| 28 - Free | 48 - Ground, shield, speed sensor at front left |
| 29 - Brake light switch | 49 - Free |
| 30 - L wire from diagnosis | 50 - Signal, speed sensor at front left |
| 31 - Pump motor monitoring (hydraulic unit) | 51 - Free |
| 32 - Free | 52 - Electronics ground |
| 33 - Free | 53 - Speed sensor output at front right for RDK control unit |
| 34 - Signal from lateral acceleration sensor | 54 - Free |
| 35 - Operation of instrument cluster: PSD off | 55 - Free |
| 36 - Free | |

DTC memory

Overview of the possible fault displays

\$\$: Transverse lock valve \$	DTC 11	\$\$: Speed sensor, rear right \$	DTC 23
\$\$: Lateral acceleration sensor, short circuit/discont. \$	12	\$\$: Speed sensor, rear left \$	24
\$\$: Lateral acceleration sensor, signal implausible \$	13	\$\$: ABS valve, front left \$	31
\$\$: Transverse lock, deviation \$	14	\$\$: ABS valve, front right \$	32
\$\$: Control unit defective \$	15	\$\$: ABS valve, rear axle \$	33
\$\$: Speed sensor, front left \$	21	\$\$: Valve relay \$	34
\$\$: Speed sensor, front right \$	22	\$\$: Return pump \$	35

Fault overview/Troubleshooting (diagnosis/test plan)

Test point	DTC	Fault display (short fault text)	Page
1	11	Transverse lock valve	D39 - 230
2	12	Lateral acceleration sensor, short circuit/discontinuity	D39 - 232
3	13	Lateral acceleration sensor, signal implausible	D39 - 233
4	14	Transverse lock, deviation	D39 - 234
5	15	Control unit defective	D39 - 235
6	21	Speed sensor, front left	D39 - 236
7	22	Speed sensor, front right	D39 - 238
8	23	Speed sensor, rear right	D39 - 238
9	24	Speed sensor, rear left	D39 - 238
10	31	ABS valve, front left	D39 - 238
11	32	ABS valve, front right	D39 - 240
12	33	ABS valve, rear axle	D39 - 240
13	34	Valve relay	D39 - 241
14	35	Return pump	D39 - 245

DTC memory / Troubleshooting

Important notes

If warning displays light up and/or faults are shown in the DTC memory of the PSD/ABS, they may also have been triggered by the following problems:

- Control unit supply voltage less than 9.5 Volt (undervoltage)
- Control unit plug disconnected.
- Contact resistance caused by poor ground connections, leading to differences in potential or inadequate shielding of speed sensors. The poor ground connection may not only occur at the affected components, but also at other important grounding points.
- **Important:** The warning "PSD off" may appear in the display fields of the instrument cluster, even though no fault is stored in the DTC memory. Check the lock hydraulics (lock operation) in this case (as of Page D39-247).

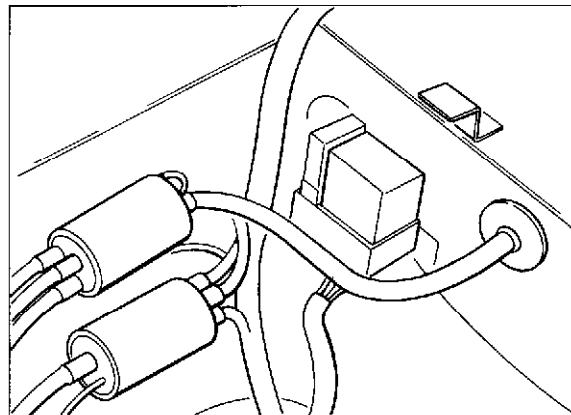
Troubleshooting aids

When measuring with the multimeter at the control-unit plug, make up 1 or 2 auxiliary leads in your own workshop, each with 2 flat pin plugs No. 17.457.2, to avoid damaging the plug contacts in the control-unit plug during the test.

Combined plug connections - distinguishing between wires

In the brake pad wear, speed sensor and HF sending unit wiring there are several combined plug connections of similar pattern. In this area, the wires can be distinguished as follows:

- Shielded wires for the speed sensors and HF sending units.
- 2 wires with a protective tube for brake pad wear.
- One pin and one socket exist on the HF sending unit plug connections. The speed sensor plug connections possess 2 pins as well as 2 sockets on the opposite side.
- Two combination connectors are located one above the other in the spare tire area. The wires are identified there with L = rear left and R = rear right.



Replacing the hydraulic unit

After installing/bleeding the ABS hydraulic unit, carry out a complete ABS test with the ABS 2-LED tester.

Test-drive after eliminating the fault.

Clear the DTC memory after eliminating the fault. Perform a test drive and then read out the DTC memory again.

If necessary (e.g. in the case of a fault in the speed sensors), also clear the DTC memory of the RDK control unit.

Fault, DTC

Possible causes, remedy, notes

Test point 1

Transverse lock valve

DTC 11

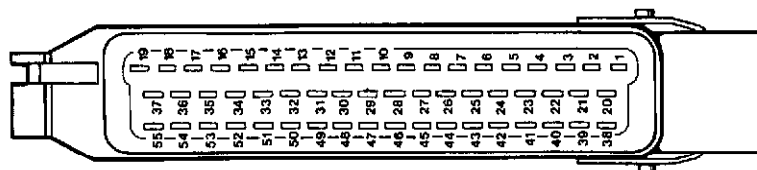
No feedback signal from valve to control unit.

1. Switch off the ignition. Pull the plug off the control unit.
Check that circuits at plug are not interrupted.

PIN 21 to PIN 23

PIN 21 to PIN 17

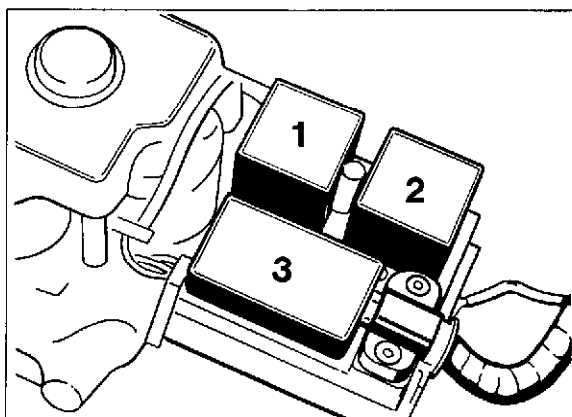
If necessary, interrupt the wiring path (plug on transverse lock solenoid valve) and localize the discontinuity by reference to the wiring diagram.



2. Pull off valve relay (No. 1) on the hydraulic unit. (Remove wheel housing cover at the front-left side).

Check for a short circuit to plus or ground in the wiring path, as described in point 1, by measuring at PIN 21.

If there is a fault in the wiring path, separate it as described in point 1 so that the unwanted connection to the positive or negative side can be located.



2391-039

Fault, DTC

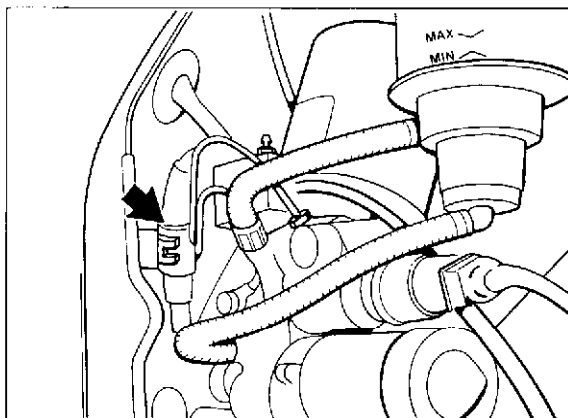
Possible causes, remedy, notes

3. Measure the internal resistance of the transverse lock valve

For this purpose, disconnect the plug connection on the transverse lock solenoid valve (arrow). The transverse lock solenoid valve is located beneath the rear left wheel housing cover.

Nominal value 2...4 Ω between the PINs on the valve block.

Nominal value not OK: Replace the transverse lock solenoid valve.



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4. Check that the valve relay is energized (voltage present at solenoid valves of ABS and PSD).

Connect all plugs and the relay for this purpose. Push back the protective tube on the transverse lock valve plug (in the wheel housing on the rear left).

Switch off the ignition, then switch it on again.

Battery voltage must be present at the black wire.

If **no** battery voltage is present: Continue with test point 13/DTC 34 (valve relay). Note testing instructions (see below).

If voltage is present, try replacing the PSD/ABS control unit (output stage defective).

Notes on testing

If a plug for the power supply to the solenoid valves (ABS or differential lock) is detached while the ignition is switched on, the valve relay is de-energized. Even if the plug is then reconnected, the relay will not be re-energized until the ignition has been switched off and on again.

Fault, DTC**Possible causes, remedy, notes****Test point 2**

Lateral acceleration sensor, short-circuit/discontinuity

DTC 12

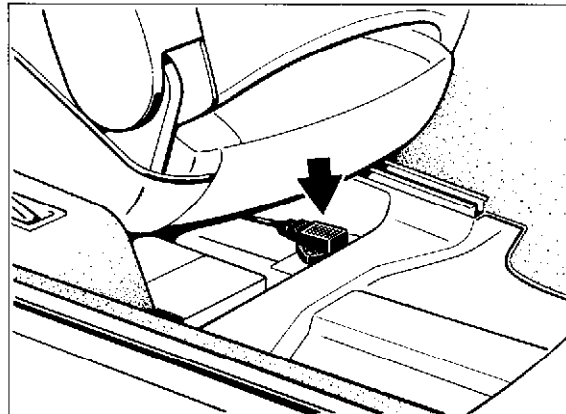
Wiring between control unit and lateral acceleration sensor not in working order (discontinuity, short circuit to plus or short circuit to ground), or the lateral acceleration sensor itself is damaged.
The following wiring is installed:

- Power supply to sensor (5 Volt) =
PIN 15 at control unit - PIN 3 at sensor
- Ground for sensor =
PIN 9 at control unit - PIN 1 at sensor
- Signal from sensor to control unit
(2.7 ± 0.14 Volt with car in normal-load position) =
PIN 34 at control unit - PIN 2 at sensor

1. Check power supply (approx. 5 Volt) at the sensor plug after detaching it, with the ignition switched on. PIN 1 (-) and PIN 3 (+).

Note

The sensor is located under the left-hand seat.

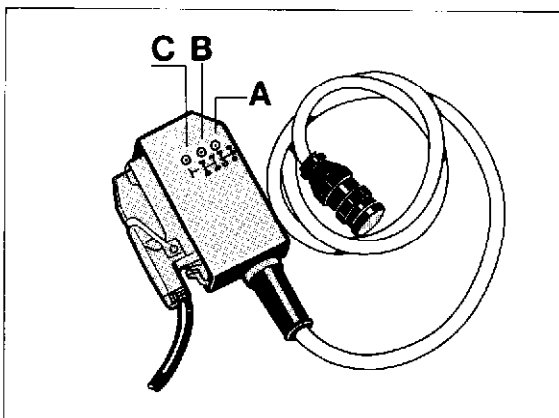


2038-38

2. Check for discontinuity or short circuit to ground at the wire between PIN 2 at the sensor plug and PIN 34 at the control unit plug after this has been detached.
3. Connect the plug to the sensor. Check the installation position of the sensor and its function by testing the output signal. To make this check, connect the 55-pin ABS 2-LED adapter lead to the control unit plug. Connect the multimeter to sockets B and C. For the measuring procedure and nominal values, see Pages D39-219...D39-222.

Fault, DTC

Possible causes, remedy, notes



2039-39

Test point 3

Lateral acceleration
sensor, signal implausible
DTC 13

Signals from lateral acceleration sensor to control unit are incorrect. The sensor has a mechanical defect or its installation position is incorrect.

1. Check lateral acceleration sensor,
Pages D39-219 ... D39-222.
2. Replace the sensor if necessary. No repair work on the sensor is permitted.
3. After eliminating the fault, repeat the test.

Fault, DTC	Possible causes, remedy, notes
Test point 4 Transverse lock, deviation DTC 14	<p data-bbox="500 378 1324 471">During the transverse lock regulating phase, the monitoring circuit in the PSD/ABS control unit has identified excessive variations between the nominal and actual values.</p> <p data-bbox="500 499 694 530">Possible faults</p> <ul data-bbox="500 553 1324 995" style="list-style-type: none"><li data-bbox="500 553 1223 583">– Lock control circuit poorly bled (lock operation hydraulics)<li data-bbox="500 606 812 637">– Lock hydraulics leaking<li data-bbox="500 659 1072 690">– Lock solenoid valve has a mechanical defect<li data-bbox="500 712 1324 774">– Lock cylinder does not retain preset pressure (leaking through relief bore)<li data-bbox="500 796 1139 827">– Inadequate signal from a rear wheel speed sensor<li data-bbox="500 849 893 880">– Fault in transverse lock plates<li data-bbox="500 902 1324 995">– Insufficient hydraulic pressure builds up at plates, e.g. because thrust-bearing bolt of engaging lever is wrongly adjusted (engaging lever makes contact). <p data-bbox="500 1024 636 1055">Procedure</p> <ol data-bbox="500 1077 1324 1592" style="list-style-type: none"><li data-bbox="500 1077 1324 1139">1. Check lock hydraulics for external leaks. Replace defective parts if necessary.<li data-bbox="500 1190 1324 1282">2. Repeat bleeding procedure for lock control circuit (lock hydraulics). If new parts have been installed, the lock must be bled as appropriate (Page D39-202d).<li data-bbox="500 1333 1227 1364">3. Check speed sensor signals (Pages D39-236 ...D39-238).<li data-bbox="500 1415 1324 1477">4. Measure thickness of plates with lock measuring cylinder (special tool 9514). Page D39-202e.<li data-bbox="500 1528 1244 1592">5. Check pressure at locking torque (friction value of the lock) (Pages D39-203...D39-213).

Fault, DTC**Possible causes, remedy, notes****Test point 5**

Control unit defective

DTC 15

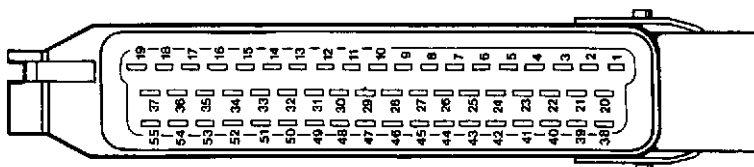
Before replacing the control unit, check whether:

- there is any electrical interference from the ignition voltage (for example, if the spark plug caps are not correctly attached)
- there are any differences in potential caused by contact resistance (missing or poor ground connections).

Important:

A poor ground connection may occur not only at the affected components but also at other important grounding points.

- ground contact is present at control unit plug PINs 3, 52 and 37. These wires are connected to ground point IV or V (at the steering console in the case of left-hand drive vehicles / over the central electrical system in the case of right-hand drive vehicles).

**Important**

When replacing the PSD/ABS control unit, make sure that it is not confused with the PDAS/ABS control unit from the 911 Carrera 4 (964).

Distinguishing feature on P. D39-236.

Fault, DTC

Possible causes, remedy, notes

Test point 6

Front left
wheel sensor
DTC 21

No signal from speed sensor reaches control unit, or signal is incorrect / unrealistic.

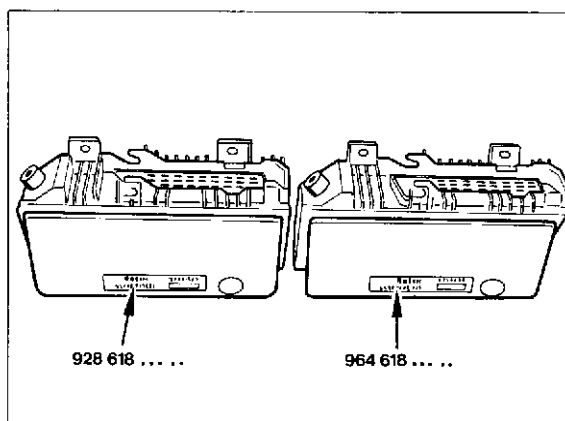
Important: This fault is also indicated if the PDAS/ABS control unit for the 911 Carrera 4 (964) is installed.

If assembly work has already taken place, check that the correct control unit has been installed.

Distinguishing feature: part number.

928 control unit with PSD = 928 618

911 Carrera 4 control unit = 964 618



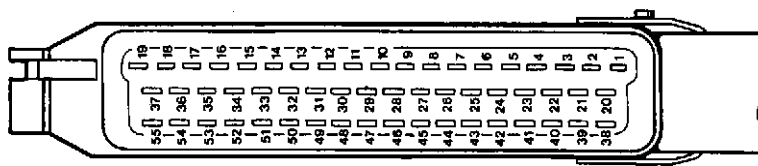
1. Pull off the control unit plug. Measure the internal resistance / check continuity between PIN 50 and PIN 48 on the plug.

Nominal value 600...1600 Ω .

If the nominal value is not attained, check the wires and plug connections in the circuit from the front left speed sensor.

If the nominal value (600...1600 Ω) is not attained although the wires / plug connections are in working order, replace the speed sensor.

Important: Perform measurement directly on the speed sensor before replacing the sensor.



Fault, DTC

Possible causes, remedy, notes

2. Checking the speed sensor signal.

For this check, use the ABS 2-LED tester or an oscilloscope.

Connect the ABS 2-LED tester to the control unit plug with the 55-pole adapter lead.

If an oscilloscope is used, separate the speed sensor plug connection at the wheel suspension or on the spring strut dome in the engine compartment (see Page D39-228 for distinguishing features for wires).

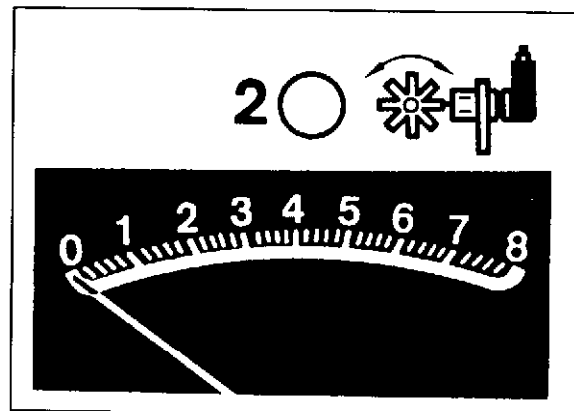
Connect the oscilloscope to the plug at the speed sensor side.

Depending on the tester, select special input or secondary screen.

Check by turning the left front wheel by hand.

ABS tester in program switch position 6 / rotary switch for wheel selection to front-left wheel. Turn the wheel until the LED (No. 2) lights up without flickering.

If an oscilloscope is used, turn approx. 1 revolution per second.



D39/45-20a

Nominal values / nominal display

ABS 2-LED tester = > 2.0

Oscilloscope = sine wave > 2 Volt
(measured value: peak to peak)

Possible causes of deviations:

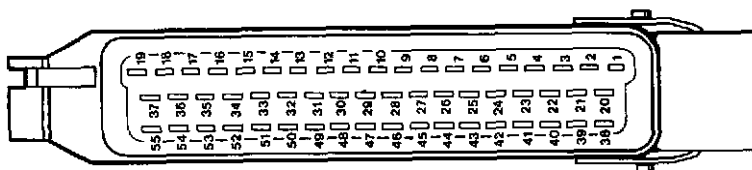
- Air gap at speed sensor too large / too small
(check installation).
- Pulse wheel damaged or corroded
- Wheel bearing play too large

Fault, DTC	Possible causes, remedy, notes
Test point 7 Front right speed sensor DTC 22	General procedure as for DTC 21 (test point 6) 1. Internal resistance / continuity between PIN 47 and PIN 46 at control unit plug. 2. Speed sensor signal: If the ABS tester is used, turn the wheel selector switch to the front right wheel.
Test point 8 Rear right speed sensor Rear left	General procedure as for DTC 21 (test point 6) 1. Internal resistance / continuity between PIN 42 and PIN 43 at control unit plug. 2. Speed sensor signal: If the ABS tester is used, turn the wheel selector switch to the rear right wheel.
Test point 9 Rear left speed sensor DTC 24	General procedure as for DTC 21 (test point 6) 1. Internal resistance / continuity between PIN 44 and PIN 45 at control unit plug. 2. Speed sensor signal: If the ABS tester is used, turn the wheel selector switch to the rear left wheel.
Test point 10 Front left ABS valve DTC 31	Certain faults in the ABS valve area (short circuit to plus or short circuit to ground in a control wire) can also be shown as a valve relay fault by the 9288 system tester. A fault in the ABS valve circuits is normally stored as an ABS valve fault in the DTC memory of the control unit. When the DTC memory is read out, it is possible in the above situation for two faults to be displayed (ABS valve and valve relay) .

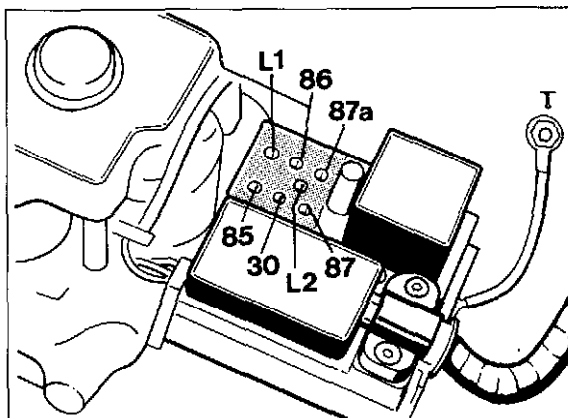
Fault, DTC

Possible causes, remedy, notes

1. Switch off the ignition and pull the plug off the control unit. Check PIN 19 of plug to PIN 17 and to PIN 23 for continuity. If necessary, interrupt the circuit (plug at hydraulic unit) and localize the discontinuity by reference to the wiring diagram.



2. Pull off the valve relay (7-pole) at the hydraulic unit. Check for a short circuit to plus or to ground in the circuit as described in point 1 by measuring at PIN 19. If a fault is detected, interrupt the circuit as described in point 1 in order to localize the incorrect short-circuit to plus or to minus.
3. Check resistance between PIN 19 of the plug and terminal 30 at the valve relay.



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If nominal value is obtained: proceed with point 4.

If nominal value is not obtained:

Pull off the 12-pole plug at the hydraulic unit.

Check internal resistance of the ABS solenoid valve. Measure between PIN 1 and PIN 4 (at the hydraulic unit).

Nominal value 0.7...1.7 Ω .

If nominal value is incorrect: replace the hydraulic unit.

Fault, DTC**Possible causes, remedy, notes**

4. Check whether the valve relay is energized (voltage is present at the solenoid valves).

To make this check, connect all plugs and the relay. Push back the protective tube on the transverse lock valve plug (in the wheel housing at the rear left).

Switch the ignition off, then on again.

Battery voltage must be present at the black wire.

If no voltage is present: continue with DTC 34 (valve relay). Comply with the testing notes.

If voltage is present, try replacing the PSD/ABS control unit (output stage defective).

Testing notes

If a voltage supply plug to the solenoid valves (ABS valves or differential lock) is pulled off while the ignition is switched on, the valve relay will be de-energized. It is not re-energized when the plug is re-connected until the ignition has been switched off and on again.

Test point 11

Front right

ABS valve DTC 32

Comply with note under test point 10: Front left ABS valve (DTC 31).

When troubleshooting, proceed as for DTC 31, but use PIN 22 instead of PIN 19 on the control unit plug.

To check the internal resistance of the ABS valve (after pulling off the 12-pin plug at the hydraulic unit), measure between PIN 3 and PIN 4 (instead of PIN 1 and PIN 4).

Test point 12

Rear axle

ABS valve

DTC 33

Comply with note under test point 10: Front left ABS valve (DTC 31).

For troubleshooting, proceed as for DTC 31, but use PIN 2 instead of PIN 19 of the control unit plug.

To check the internal resistance of the ABS valve (after pulling off the 12-pin plug at the hydraulic unit), measure between PIN 5 and PIN 4 (instead of PIN 1 and PIN 4).

Fault, DTC

Possible causes, remedy, notes

Test point 13

Valve relay

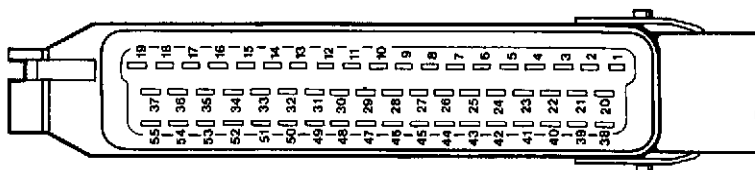
DTC 34

Certain faults in the ABS valve area (short circuit to plus or short circuit to ground in a control wire) may also be shown as **valve relay faults** by the 9288 system tester.

A fault in the ABS valve circuit is normally stored as an **ABS valve fault** in the DTC memory of the control unit.

In the case described above, when the DTC memory is read out the display of **two faults is possible (ABS valve and valve relay)**.

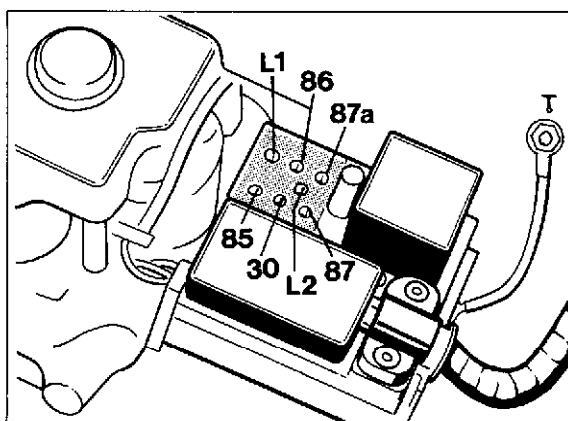
1. Switch off the ignition. Pull off the control unit plug.
Check the control circuit (wire with relay) - from PIN 20 to PIN 7 - for any discontinuity, short circuit to ground and short circuit to plus.



If no fault is found, proceed with 2.

If there is a discontinuity, short circuit to plus or short circuit to ground, pull off the valve relay. Check the wires between terminal 85 on the relay base and PIN 7 on the control unit plug and between terminal 86 and PIN 20.

If the wires are in working order, replace the valve relay.



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Fault, DTC	Possible causes, remedy, notes
	<p>2. Measure resistance between the following PINs at the control unit plug:</p> <p>PIN 19 to PIN 17 PIN 22 to PIN 17 PIN 2 to PIN 17 Nominal value approx. 1...2 Ω</p> <p>PIN 21 to PIN 23 Nominal value approx. 2...4 Ω</p> <p>If the nominal value is correct, proceed with 3.</p> <p>If incorrect values are obtained, localize the fault as appropriate. From PINs 19, 22, 2 to PIN 17 = ABS valves + wiring. From PIN 21 to PIN 23 = Lock valve + wiring.</p> <p>Re ABS valves + wires</p> <p>Pull off the 12-pole plug at the hydraulic unit. Measure the internal resistance of the solenoid valves. PIN 1 to PIN 4 PIN 3 to PIN 4 PIN 5 to PIN 4 Nominal value approx. 0.7...1.7 Ω</p> <p>Nominal value not obtained: replace hydraulic unit.</p>

Fault, DTC

Possible causes, remedy, notes

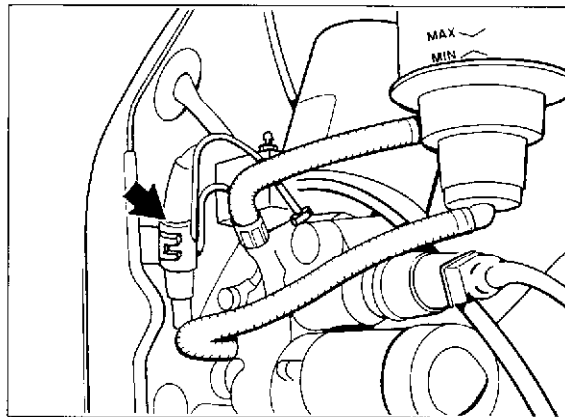
Re transverse lock valve + wiring:

Separate plug connection at the transverse lock valve (arrow).

Measure internal resistance of the solenoid valve.

Nominal value 2...4 Ω

If an incorrect value is obtained: Replace transverse lock valve.

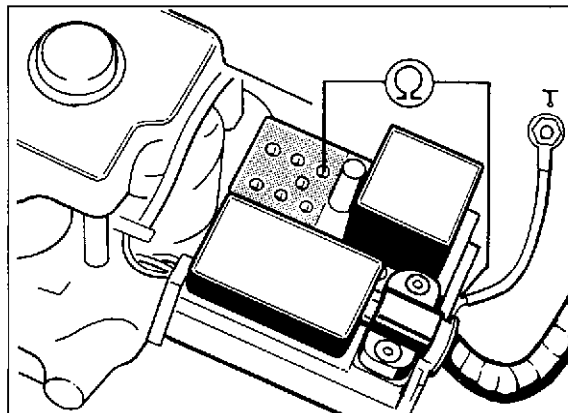


3. Pull off valve relay (7-pole) at hydraulic unit. Measure at control unit plug PIN 17 in order to determine whether there is a short circuit to plus or to ground.

If necessary, interrupt the circuit at the hydraulic unit plug (12-pole) and localize the fault by reference to the wiring diagram.

4. Check whether voltage is present at terminal 87 of the relay base when the valve relay is pulled off. Required display: approx. 12 Volt (battery voltage).

5. Measure resistance between terminal 87 a on the relay base and the ground wire at the pump motor.
Nominal value \approx 2...4 Ω . The prerequisite is here is that the ground wire and the ground point are in working order.
If necessary, replace the hydraulic unit (resistance in relay base has increased in value).



Fault, DTC

Possible causes, remedy, notes

6. Check wires from terminal L1 on the relay base to PIN 24 on the control unit plug and from L2 to PIN 35 for discontinuity.

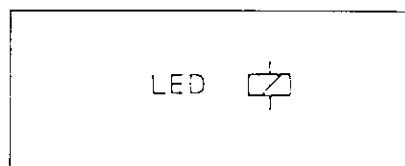
Important: The test from L2 to Pin 35 can be performed only if the warning contact of the pressure warning switch is closed (see wiring diagram).

This means that the pump for the lock hydraulics must have operated beforehand (system pressure greater than 140 bar).

7. Check that the valve relay is energized (voltage present at the solenoid valves).
Connect all plugs and the relay.
Push back protective tube on the transverse lock valve plug (at the rear left in the wheel housing).
Switch the ignition off, then switch it on again.
Battery voltage must be present at the black wire.

If no voltage is present, try replacing the valve relay, or test the relay with the ABS 2-LED tester in order to determine whether it is actually defective.

If the LED of the ABS tester fails to light up steadily in program switch position 5 with the ignition switched on, the relay is defective.



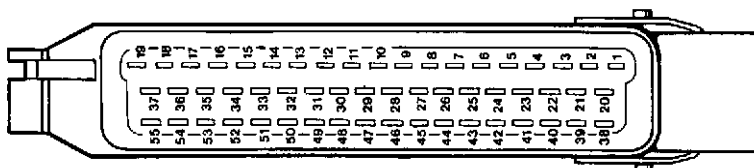
8. If the valve relay is in working order, try replacing the PSD/ABS control unit (output stage defective).

Fault, DTC

Possible causes, remedy, notes

Test point 14Return pump,
DTC 35

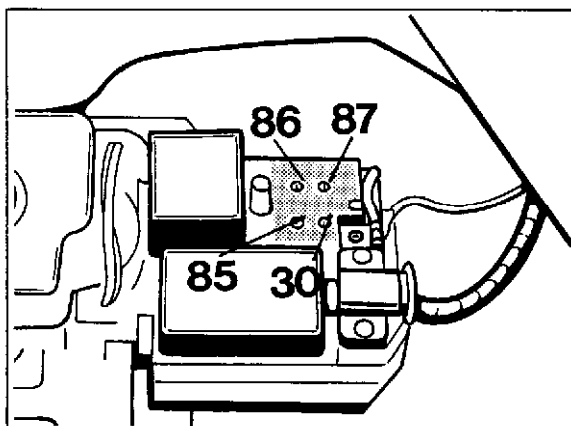
1. Switch off the ignition. Pull off the plug at the control unit. Check control circuit (wire with relay) - PIN 20 to PIN 5 - for discontinuity and short circuit to ground/to plus.



If no fault is found, proceed with 2.

If there is a discontinuity, short circuit to plus or to ground, pull off the motor relay. Check wiring between terminal 85 at the relay base and PIN 5 on the control unit plug, and between terminal 86 and PIN 20.

If the wiring is in working order: Replace the motor relay.



2. Pull off the motor relay. Battery voltage (approx. 12 Volt) must be present at terminal 87 of the relay base.

3. Bridge terminals 30 and 87 at the relay base.
If the return pump does not run, continue with 4.

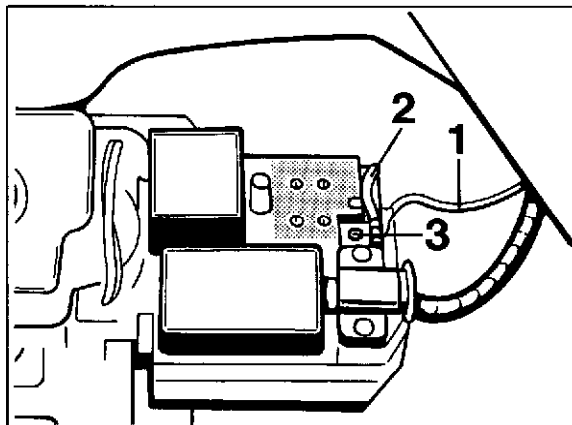
If the return pump runs:

Check wire from terminal 30 on the relay base to PIN 31 at the control unit plug. If the wire is in working order: Replace the motor relay.

Fault, DTC

Possible causes, remedy, notes

4. Check connections at ground wire (1) and plus wire (2) (contact resistance).
Bridge terminals 30 and 87 at the relay base and check whether voltage is present at the connection point (3).
If voltage is present (but the return pump is not running): Replace the hydraulic unit (defective return pump).



Check lock hydraulics (energy production)

General information

The hydraulics comprises the high-pressure pump, solenoid valve, pressure reservoir and supply tank. The components are located on a joint bracket in the rear-left wheel housing.

The brake fluid for operating the transverse lock is obtained from the piston reservoir mounted on the high pressure pump. The operating pressure is between 140 and 180 bar. The pump is activated via a pressure warning switch.

The solenoid valve familiar from the ABS system controls the functions pressure increase, pressure maintenance and pressure reduction, and applies pressure to the slave cylinder of the transverse lock.



Important note

Check hydraulics of the lock (energy production) if "PSD off" appears in the display fields of the instrument cluster even though no fault is stored (following pages).

Check hydraulics of the lock

This comprises: check of the lock hydraulics without pressure gauge (special tool 9509).

Precondition

Read out DTC memory with system tester 9288. No fault stored.

1. Jack up the vehicle on one side until a rear wheel can be turned freely.
2. Switch on system tester 9288. Select lock test (system PSD/ Drive Links menu).
3. Pulse transverse lock (pressing function key 1 on tester once = 1 pulse) and simultaneously turn the rear wheel.
4. The wheel must be completely fixed (locked) after several pulses.
Caution: If the vehicle is fully raised, hold the opposite rear to keep it from turning.
5. If the wheel does not lock, continue with troubleshooting "System depressurized". If the wheel does lock, continue with troubleshooting: System pressure present.

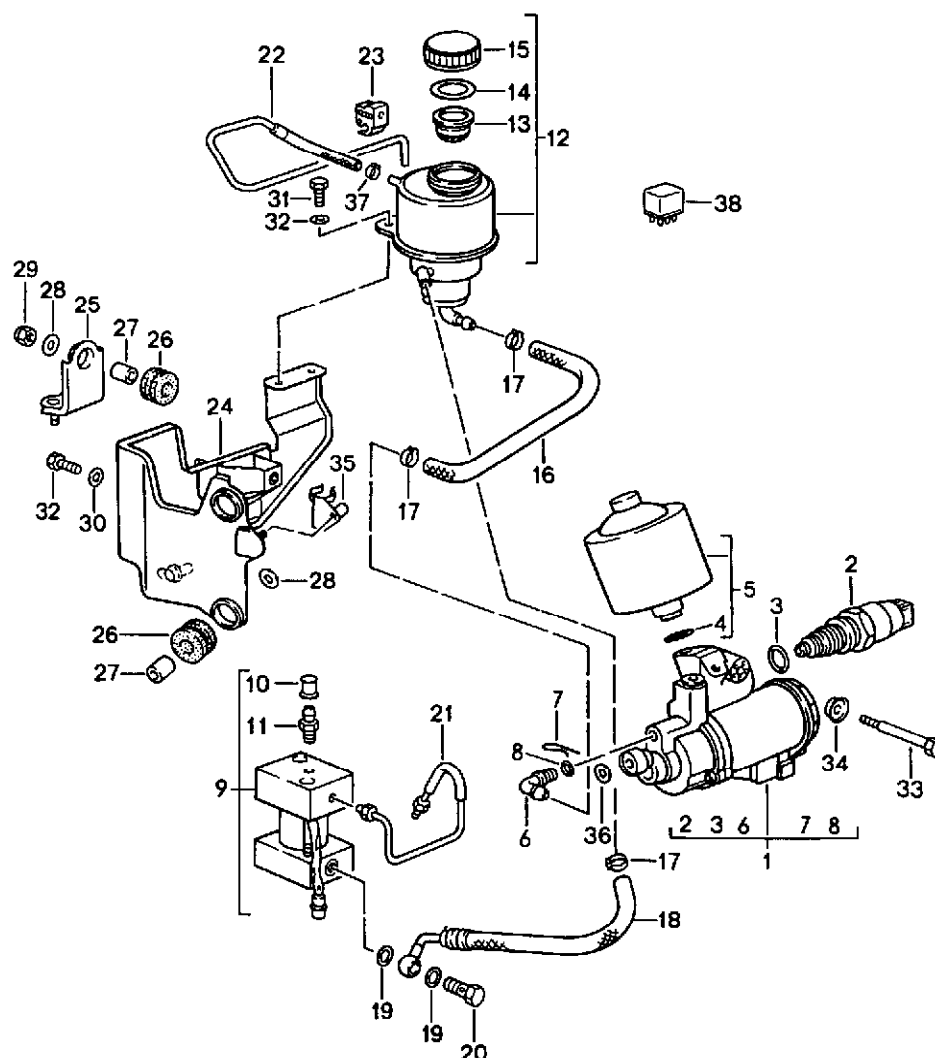
Troubleshooting

If the system is depressurized, the following faults are possible:

- Brake fluid reservoir (No. 12) empty (system leaks).
- Voltage supply for high-pressure pump (No. 1) not OK (check pump relay No. 38 and fuse in the luggage compartment).
- Pressure warning switch (No. 2) not OK.
Test on Page D39-251 ff.
- High-pressure pump (No. 1) defective.
Check pump operation by bridging terminals 30 and 87 on the pump relay (in the luggage compartment).
Important: Pump operating time when bridging the terminals max. 3 seconds. (Perform test only once.)
- Mechanical defect of lock solenoid valve (No. 9).

The following faults are possible if system pressure is present:

- Pressure warning switch (No. 2) not OK.
- Electrical wire for activating the fault display "PSD off" not OK (check in combination with the wiring diagram).
- High-pressure pump no longer operates (defect, or voltage supply not OK), but there is still a residual pressure of less than 107 bar in the system. This pressure is reduced each time the pump is operated.



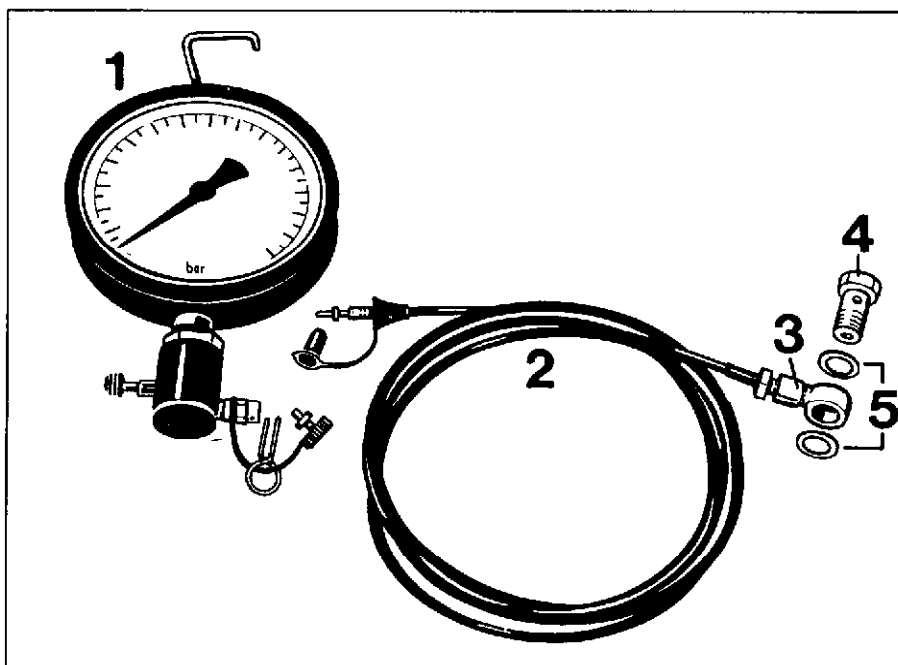
3/07/82

Important note

If the pressure warning switch (No. 2) and / or the pressure reservoir (No. 5) is detached with the high-pressure pump (No. 1) **removed**, **do not set down the pump upside down** (with the pressure reservoir connection facing down). **If this is not observed**, the pump might not function after installation (air in the pump). Fast turning or shaking motions from the normal position might make the pump operational again.

Checking locking torque (friction coefficient) of transverse lock

Tools



345/1-D39/45

No.	Designation	Special tool	Order number	Explanation
1	Pressure gauge	9509	000.721.950.90	
2	High-pressure measuring line	9509/1	000.721.950.91	
3	Ring flange	-	999.215.027.02	
4	Banjo bolt	-	930.110.547.00	shorten threads by approx. 4mm
5	Seal	-	N 013 811 2	2 pc.

Pressure tests on the lock hydraulics (energy production)

Overview

1. General
2. Pressure gauge connection
3. Tests
4. Nominal values/Notes

1. General

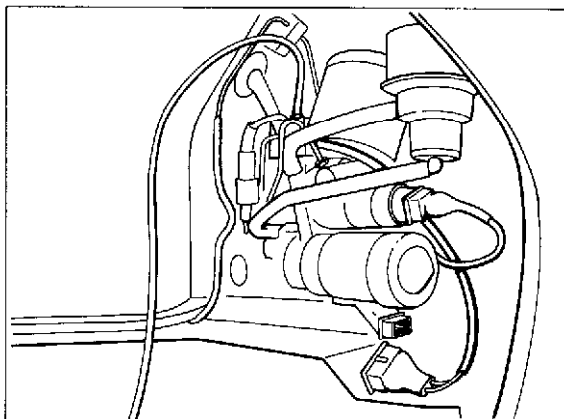
The following points can be checked by means of the pressure test on the differential lock hydraulics (lock control):

- Freedom from leaks of the lock hydraulics (any internal leak can thus be localized)
- Gas filling pressure of the pressure reservoir
- Switching points for the lock hydraulics (display "PSD off" and operating pressure). This is controlled by the pressure warning switch of the pump assembly.

2. Pressure gauge connection

- Depressurize the lock hydraulics. To do this, disconnect the electrical plug at the pressure pump (pump assembly) and then relieve the pressure at the pressure relief valve of the lock solenoid valve (use a collection bottle).

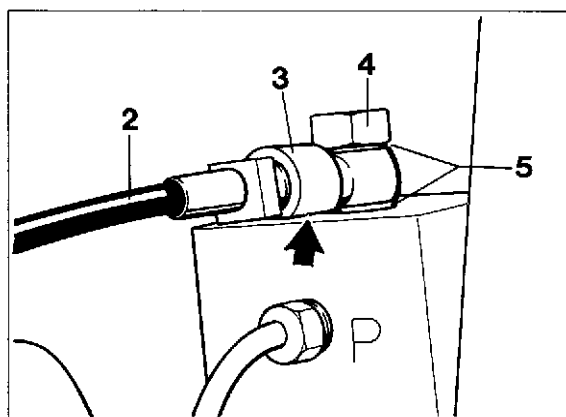
Important: Wear goggles and protective gloves, as the pressure may be as high as 180 bar.



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- Connect pressure gauge 9509 - in combination with the high-pressure measuring line 9509/1 (No.2), ring connection (No. 3), banjo bolt (No. 4) and two seal rings (No. 5) - at the lock solenoid valve instead of the bleeder valve.

Important: Machine ring connection (No. 3) beforehand (apply face/arrow).



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- **Bleed pressure gauge (No. 1).** To do this, connect a collection bottle to the pressure gauge bleeder valve (No. 1a) and open the valve.

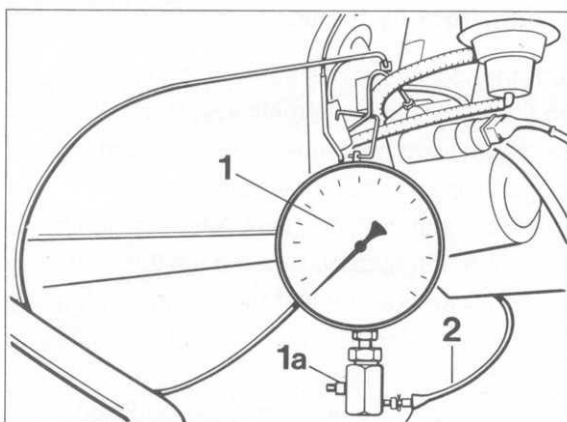
Turn ignition key to position 2 (necessary for pump operation).

Plug the electrical plug onto the pump. **Disconnect the electrical plug and close the bleeder valve** as soon as no air bubbles are visible anymore in the transparent bleeder line of the collection bottle.

Make sure that the brake fluid reservoir is not sucked empty. Fill in brake fluid from time to time if necessary.

Note

Depressurize the lock hydraulics before removing the pressure gauge after the test.



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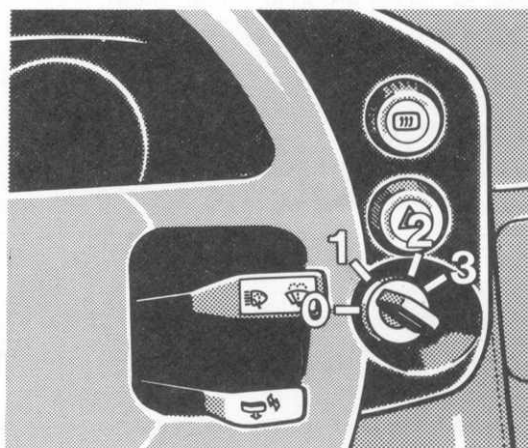
3. Tests

Note

Operation of the pump is regulated by means of the ignition key for testing purposes.

Position 0 = Pump **off**

Position 2 = Pump **on** until switched off by the pressure warning switch.



BA-928/30

- In ignition key position 0, plug the electrical plug onto the pump. Locate the pressure gauge in a position where it can be seen.

For the tests, it is expedient to observe the following sequence:

- a. Pressure reservoir - gas filling pressure
 - b. Switching points for the warning display "PSD off"
 - c. Cut-in and cut-out points of the pump
 - d. Leak test
- Turn the ignition key to position 2 (pump starts up).

a. Gas filling pressure of the pressure reservoir.

Turn the ignition key to position 0 at approx. 100 bar. Briefly open the bleeder valve on the pressure gauge (use collection bottle) and close it again immediately. The pressure drop on the pressure gauge should be approx. 5 bar. Continue this process in intervals. The pressure reservoir gas filling pressure has been reached at the instant the pointer of the pressure gauge abruptly falls to 0 bar. Refer to Page D39-255 for nominal values.

Important: Always wear goggles and protective gloves when decreasing the pressure via the bleeder valve.

b. Checking the switching points for the warning display in the instrument cluster.**During pressure increase:**

Start the engine and observe the warning display. Immediately turn the ignition key to 0 position at the instant the warning display (PSD off) goes out. Read off the pressure on the pressure gauge.

During pressure reduction

Produce a system pressure of approx. 140 bar.

Disconnect the plug at the pressure pump.

Start the engine.

Reduce the pressure - in a similar manner to the procedure described in Gas filling pressure of the pressure reservoir - until the warning display (PSD off) lights up. Read off the pressure on the pressure gauge. Refer to Page D39-255 for nominal values.

c. Checking the switching points of the pressure pump

Cut-out pressure: Turn the ignition key to position 2. The electrical plug must be plugged onto the pressure pump for this.

Read off the pressure on the pressure gauge **immediately** after the pump cuts out automatically.

Cut-in pressure: Turn ignition key to position 2. Wait until the pump cuts out automatically if necessary. Carefully reduce the system pressure at the pressure gauge bleeder valve (use collection bottle) until the pump cuts in again. Read off the pressure on the pressure gauge at this moment. Refer to Page D39-255 for nominal values.

d. Checking the tightness (pressure loss) of the lock hydraulics.

Turn the ignition key to position 2. Wait until the pump cuts out automatically. Carefully lower the system pressure at the pressure gauge bleeder valve (use collection bottle) until the pump cuts in again. After the pump cuts out automatically, turn the ignition key to position 0 and disconnect the electrical plug at the pump. Measure the pressure decrease over time.

The permissible values are given on Page D39-255.

Note

Depressurize the lock hydraulics before removing the pressure gauge.

4. Nominal values/Notes

Nominal values

Notes

Pressure reservoir - Gas filling pressure

new	80 ± 5 bar
wear limit	40 bar

Replace pressure reservoir if the gas filling pressure has reached or fallen below the wear limit

Switching points of the pressure warning switch

PSD off	Warning point
<u>for pressure increase</u>	up to approx. 115 bar max. up to 133 bar
<u>for pressure reduction</u>	as of $105 + 2 / - 5$ bar

If the actual values deviate from the nominal values, replace the pressure warning switch.

Cut-out point of the pump
at the latest at approx. 180 bar
at the earliest at approx. 160 bar
Cut-in point of the pump
(after pressure reduction) $140 + 5 / - 6$ bar

Read off the pressure immediately after the pump cuts out automatically.

Freedom from leaks of the lock hydraulics

Pressure reduction, starting from the cut-out point of the pump (precondition: the nominal value has been achieved)

not below 140 bar in 30 minutes
not below 100 bar in 3 hours

Fill the pressure reservoir completely 2x previously (start the pump running again after the 1st cut-out operation by opening the bleeder valve on the pressure gauge). Use a collection bottle. Then turn the ignition key to position 0 and disconnect the electrical plug at the pump.
External leak: Retighten lines or replace the corresponding parts.

Possible internal leaks:
Refer to Page D39-256

Nominal values

Notes

Possible internal leaks:

- Lock solenoid valve
- Pump assembly

First check the lock solenoid valve. Then remove the pressure line from the pump assembly (with the system depressurized).

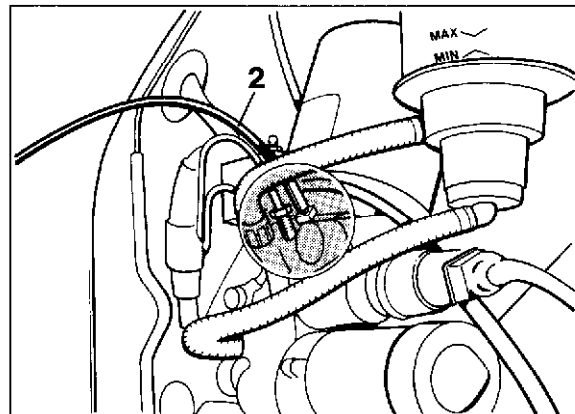
Connect high-pressure measuring line 9509/1 (No. 2) – **without ring connector** – to the pump assembly.

Repeat the test. If the nominal values are now achieved, replace the lock solenoid valve.

If the nominal values are not achieved, the fault lies in the pump assembly.

Replace faulty parts and bleed the system.

Caution: Wear goggles and protective gloves when reducing pressure via the bleeder valve.



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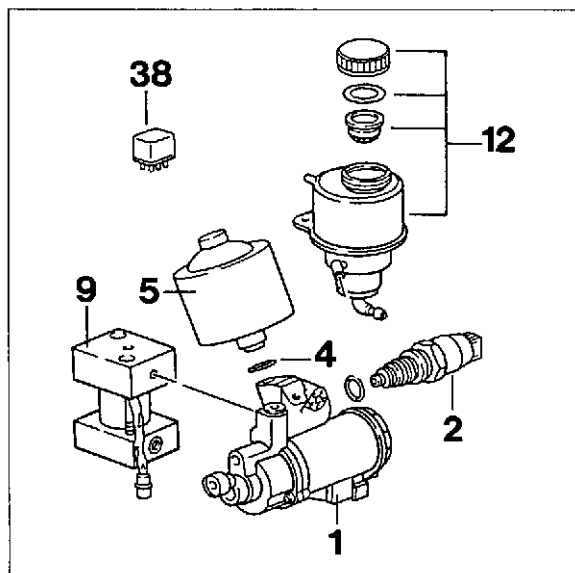
Removing and installing pressure warning switch of lock hydraulics

Removal

1. With the ignition key in position 0, pull off both plugs at the pump assembly.
2. Completely depressurize the system. To do this, slowly open the bleeder valve on the lock solenoid valve and drain the brake fluid into a collection bottle.
Important: The system is under a pressure of up to 180 bar. Wear goggles and protective gloves.

3. Remove pressure warning switch (No. 2) with special tool 9524. Prevent the pump assembly from turning while loosening the switch.

Important: First clean the area around the pressure warning switch and cover it with lint-free cleaning cloths to trap the small amount of residual brake fluid that emerges.



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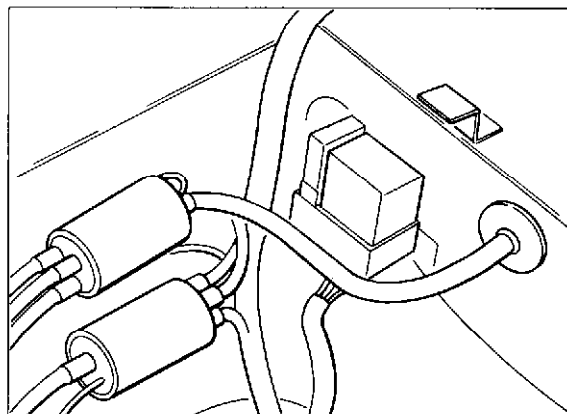
Installing

1. Screw in the pressure warning switch (No. 2) and tighten to a torque of 26 Nm (19 ft-lb). Replace the O-ring if necessary. Prevent the pump assembly from turning while tightening the pressure warning switch.

Note

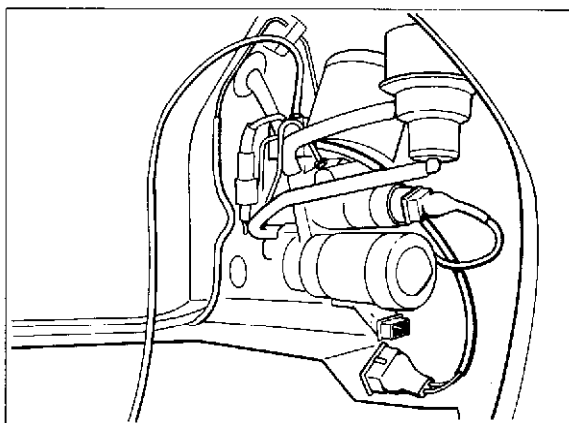
Wet the sealing ring with brake fluid only. Never use brake cylinder paste. Absolute cleanliness is essential. Use only lint-free cleaning cloths.

2. If there is an electrical fault at the pressure warning switch, always replace the hydraulic pump relay (in the luggage compartment) as well.



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3. Attach plug to pressure warning switch (plug on the pump side remains disconnected at this point).



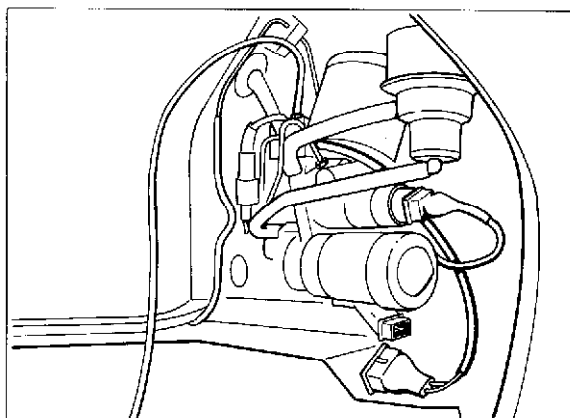
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4. Partially bleed the lock hydraulics as follows:
With the ignition switched on, open the bleeder valve on the lock solenoid valve. Attach the electrical plug to the pump. As soon as brake fluid emerges free from air bubbles, pull off the electrical plug and close the bleeder valve.
Next, charge the pressure reservoir completely. To do this, attach the electrical plug. As soon as the pump is heard to switch off, **pull off the electrical plug** and reduce the pressure at the bleeder valve of the lock solenoid valve. Slowly open the bleeder valve and hold the bleed hose firmly.
Important: A pressure of up to 180 bar is present in the system. Wear goggles and protective gloves.
 5. If necessary, connect pressure gauge - special tool 9509 - to the pressure reservoir and check the switching points of the pressure warning switch and also for leakage in the differential lock hydraulics.
The exact work procedures and nominal values are stated on Pages D39-251 - D39-256.
- Note**
- If necessary, top up the brake fluid level at intervals so that the brake fluid reservoir is not drained completely. The lock hydraulics must be at zero pressure when connecting and removing the pressure gauge.
6. After the testing and assembly work has been completed, correct the brake-fluid level when the pressure reservoir is fully charged.

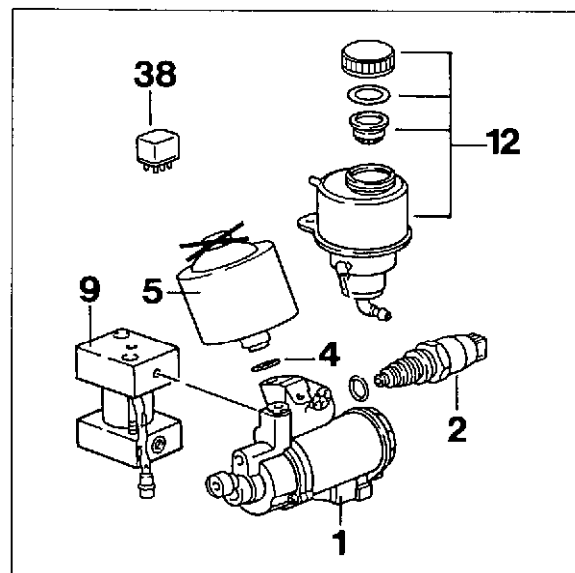
Removing and installing the pressure reservoir

Removal

1. Pull off plug on the pump motor with the ignition key in position 0.
2. Completely depressurize the system. For this purpose, slowly open the bleeder valve on the lock solenoid valve and drain the brake fluid into a collection bottle.
Important: The system is under a pressure of up to 180 bar. Wear goggles and protective gloves.



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Installation

1. Screw in the pressure reservoir (No. 5) with new O-Ring (No. 4) and carefully tighten it using a universal filter wrench (tightening torque 40 ... 46 Nm; damage is possible above a torque of approx. 70 Nm).
Never turn the filler screw when installing the pressure reservoir.
Hold the pump assembly in position when tightening the pressure reservoir.

Note

Wet the seal ring with brake fluid only. Never use brake-cylinder paste. Absolute cleanliness is essential. Use only lint-free cleaning cloths.

3. Undo the pressure reservoir (No. 5). Use a universal filter wrench – e.g. Hazet 2171-2 – for this purpose.
Important: Never loosen at the filler screw X, as the gas pressure will escape abruptly in this case.

2. Bleed the pressure reservoir and lock solenoid valve as follows:

Open the bleeder valve on the lock solenoid valve. Push the electrical plug onto the pump with the ignition switched on. Pull off the electrical plug and close the bleeder valve as soon as the brake fluid emerges without air bubbles (use a collection bottle). **Now fully charge the pressure reservoir.** Push on the electrical plug. As soon as the pump is heard to switch off, **pull off the electrical plug** and reduce the pressure at the bleeder valve of the lock solenoid valve to zero (slowly open the bleeder valve / use a collection bottle).

Important: The system is under a pressure of up to 180 bar. Wear goggles and protective gloves.

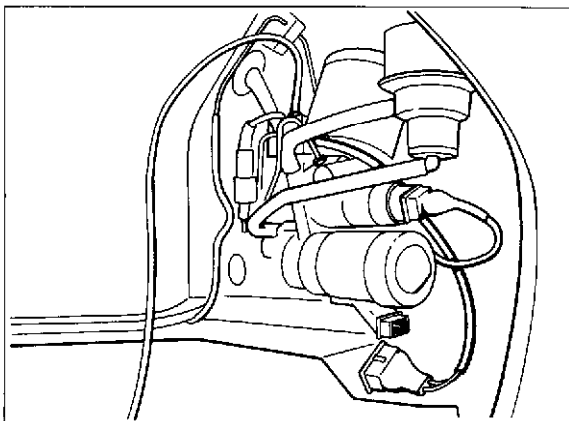
Note

If a filling and bleeding unit is not connected, always check the level in the fluid reservoir between bleeding processes and top up with brake fluid if necessary.

3. Repeat the last process (fully charging the pressure reservoir and then reducing the reservoir pressure to zero) approx. 1-2 times (brake fluid must be free from air bubbles).

4. Bleed lock cylinder and pressure lines. For this purpose, the lock solenoid valve is pulsed with system tester 9288. The high pressure present at the solenoid valve thereby enters the pressure lines in pulses and reaches the lock cylinder via the non-return valve.
Drain off brake fluid at the bleeder valve of the lock cylinder until no more air bubbles appear.

5. After completing the assembly and bleeding work, correct the brake fluid level – with the pressure reservoir fully charged.



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