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DESCRIPTION OF REAR AXLE AND TRANSMISSION - TYPE 911

General

The transmission and differential, contained in one housing, is bolted to the engine and forms a unified power transmission assembly located at the rear of vehicle. The assembly is mounted in rubber on supports attached to the forward part of the transmission and rear of engine. The power transmission unit can be removed or installed only as a whole assembly.

Transmission Housing

The housing -a tunnel type case- is made of die-cast light alloy. A cast iron insert is cast into the center web of the case to support the bearings.

Transmission

The transmission has five forward speeds and one reverse. A servo-lock synchronization is incorporated in all forward speeds. The forward speed gears and Gear II of the reverse gear twin cluster are in constant mesh; silent operation is achieved through the use of helical gears.

The 4th and 5th speed gears on the input shaft are arranged as free-wheeling gears; due to this arrangement, the two gears remain stationary in the neutral gear speed resulting in less gear noise at idling.

Gear Ratios

Due to the 5-speed transmission it was possible to provide close ratios between the gears and thus achieve excellent acceleration and top speed characteristics.

The individual gear ratios are shown in the transmission diagram on page 9. This diagram is a handy reference showing the relative engine rpm, vehicle speed, and gear ratio.

Example:

With engine RPM (left vertical column) at 5000, a third speed gear ratio of 23:28, effective vehicle speed is 69 MPH (bisecting lines of the horizontal 5000 RPM line and the third speed diagonal). Similar readings can be made at any place on the diagram.

Function of Synchronesh in Shifting Gears

Shifting of gears is effected by way of the floor-mounted gearshift lever through a shift rod leading to the transmission through the chassis center tunnel. The reverse gear engages by sliding a gear into reverse speed position. The forward speeds are engaged through the servo-lock Synchronesh units. The servo-thrust force in the Synchronesh units varies according to the prevailing friction, i. e. , the greater the difference in the gears' speed, the more friction is created. The Synchronesh units permit a rapid synchronization of the given gears with the minimal application of force at the gearshift lever.

For better understanding of the function of the Synchronesh units, the following outline will first deal with the mechanical process that takes place when shifts are made with the transmission at standstill.

When a gear is shifted with the transmission at standstill, the selector fork moves the sliding sleeve from its neutral position towards the selected gear and proceeds to engage it with the toothed engagement ring of the selected gear. As this takes place, the synchronizing ring is compressed within the sliding sleeve and, upon completion of the move, snaps to rest within the machined groove on the inner race of the sliding sleeve, locking itself in that position.

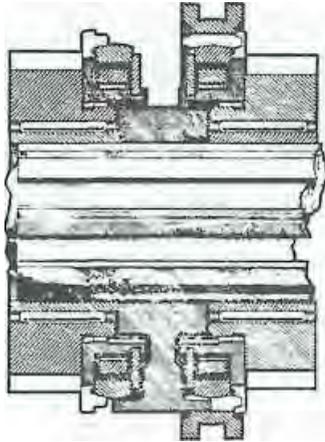


Fig. 1

In the static process it is necessary to overcome only the static resistance created by the spring tension of the synchronizing ring as it is compressed in its diameter by the sliding sleeve.

When gears are shifted while in motion, entirely different conditions prevail. The purpose of the Synchronizing units is to equalize the speeds of the input shaft or pinion shaft and the respective gear on a given shaft; this is possible only by way of a mechanical clutch, i. e. , the Synchronizing unit. This clutch must be able not only to synchronize the gear speeds through friction, but also keep the sliding sleeve from clashing with the toothed ring on the selected gear (clutch carrier) as long as the gears run at unequal speeds.

When shifting gears, the engine clutch must be fully disengaged since the clutch plate is part of the mass to be synchronized and must be accelerated or decelerated, as the case may be.

When a gear is shifted while driving, the selector fork guides the sliding sleeve off the synchronizing ring of the engaged gear, through the neutral position, and on to the point of contact between the internal teeth of the sliding sleeve and the beveled edge of the synchronizing ring of the next gear. As this contact is made, friction created by the unequal gear speeds drags the synchronizing ring to one side, against the brake band energizer. The floating brake band energizer thus slides against a brake band whose other end rests against the brake band stop. Since the brake band stop keeps the brake band from sliding away under the pressure of the band energizer, it is forced outward against the inner race of the synchronizing ring causing it to "grow" within the sliding sleeve. Consequently, there is an instantaneous increase of friction between the synchronizing ring and the inner race of the sliding sleeve which further increases the force exerted upon the brake band and, in turn, upon the synchronizing ring. As may be seen, the synchronizing effect is thus obtained from the self-energized thrust exerted by the brake band upon the synchronizing ring.

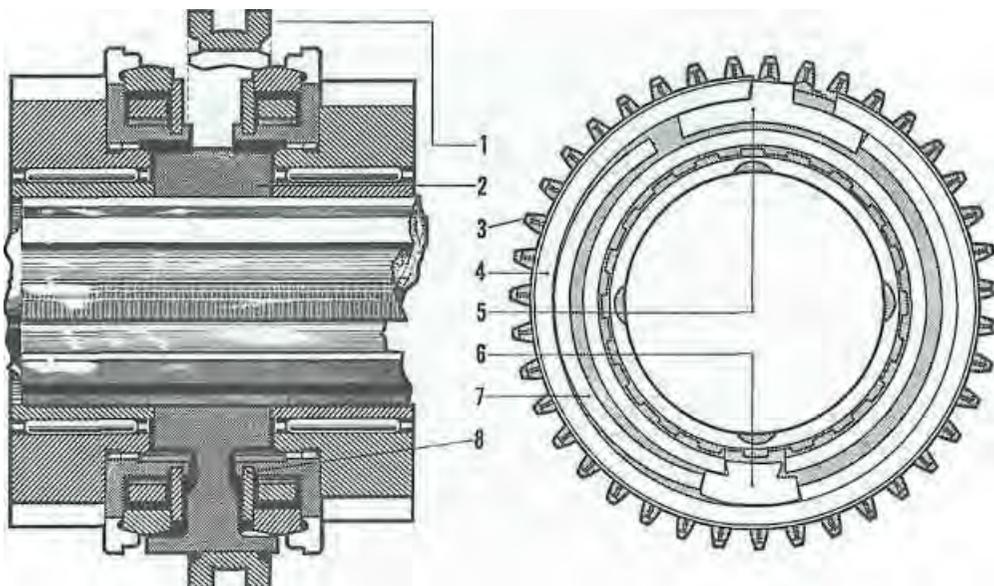


Fig. 2

- | | | | |
|------------------|----------------------|------------------------|----------------|
| 1 Sliding sleeve | 3 Clutch carrier | 5 Brake band energizer | Brake band |
| 2 Spider | 4 Synchronizing ring | 6 Brake band stop | Retaining ring |

The gear about to be engaged is forced to assume the speed of the sliding sleeve. As long as there is a difference in speed between the sliding sleeve and the gear-coupled synchronizing ring, the energized brake band prevents a further compression of the synchronizing ring, preventing the engagement of the sliding sleeve with the teeth in the clutch carrier.

As the difference in speed between the sliding sleeve and the gear decreases, the friction between the synchronizing faces also decreases. When the speeds between the two parts equalize, the servo-thrust components relax and, now, it becomes possible to compress the synchronizing ring in its diameter and move the sliding sleeve fully onto the synchronizing ring. At this point, the synchronizing ring snaps into the groove machined in the inner race of the sliding sleeve and locks itself in that position. For this reason it is no longer necessary to incorporate a locking device in the selector shaft.

All forward speeds of the transmission are equipped with identical Synchromesh components with the exception of the 1st gear which is used for starting. Care was taken to ensure that this starting gear engages with the least possible effort when the car is not in motion.

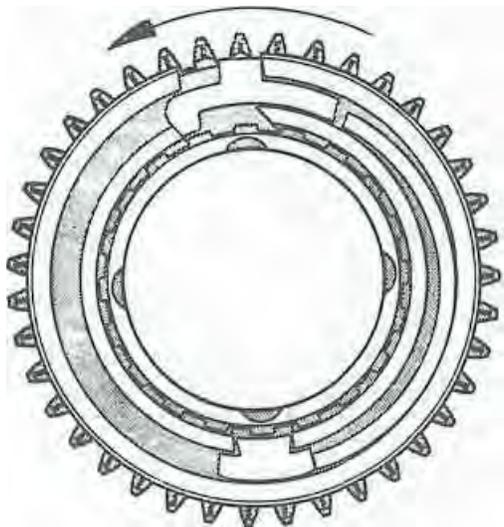


Fig. 3

As shown in Fig. 3, the brake band energizer for 1st gear has been provided with a tab which rests in a recess machined into the clutch carrier; also, only one brake band is utilized. The engine idle speed is very low when compared with revolutions prevailing at operating speeds. When the engine clutch is disengaged prior to shifting into low speed at standstill, the clutch plate stops within a short time following disengagement. To further shorten the engine clutch stopping time and enable the driver to quickly shift into low gear without gear clash, it was necessary to provide a synchronizing device for this purpose; in this case, the Synchromesh unit acts as a brake.

As the gear is slowed down, the force resulting through friction at the synchronizing ring acts directly onto the gear by way of the brake band energizer and its tab. Due to its slanted tab, the brake band energizer exerts a pressure, through its longer end, against the inner face of the synchronizing ring. This small force is sufficient to ensure an easy engagement of the low gear while still preventing a gear clash.

When a shift from 2nd to 1st gear is made while the car is in motion, the 1st gear must be accelerated to match its counterpart. For this purpose, a normal brake band has been provided on the respective Synchromesh side ensuring the same synchronization as on all other gears (see Fig. 4).

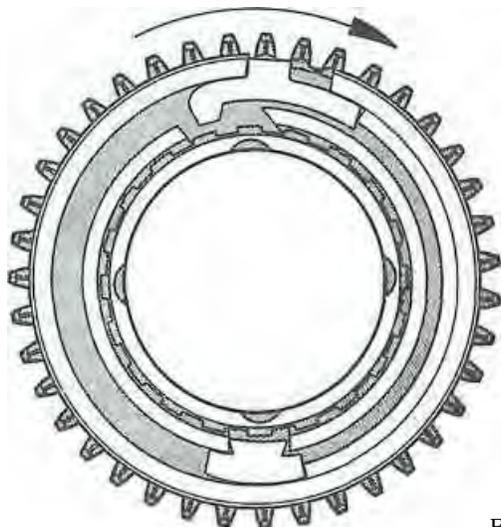


Fig. 4

Rear Axle and Transmission

The power is transmitted to the rear wheels through a spiral bevel gear differential with bevel spider gears, and two double-joint half-axes. Quiet operation and long service of the rear axle is contingent upon the exact adjustment of the ring and pinion gears.

The ring and pinion gear ratio is 1 : 4.428 (7 : 31)

When driving through curves, the outside wheel covers a longer distance than the inside wheel, resulting in differing axle speeds. The purpose of the differential is to make up for the varying axle speeds and ensure that driving torque is evenly distributed between both rear wheels.

Oil Capacity

The transmission oil capacity is approx. 2.5 liters (5 pints). The transmission oil should be changed at intervals indicated in the lubrication schedule using lubricants of prescribed specification. When changing transmission oil, refill with approx. 2.5 liters (5 US pints), as specified.

Synchromesh Components

1. Sliding Sleeve

Friction contact with the synchronizing ring is made on the tapered part of the inner race of the sliding sleeve. In addition, the toothed race engages with corresponding teeth in the gear-coupled clutch carrier of the selected gear providing a firm mechanical connection.

The inside race contour, in addition to the tapered outer edges, includes a machined groove in its center which has the purpose of locking the sliding sleeve onto the synchronizing ring once the respective shift has been completed; for this reason it is no longer necessary to incorporate a locking device in the selector shaft (see Fig. 5).



Fig. 5

2. Spider

The three-pronged spider carries the sliding sleeve and transmits the engine torque; the sliding sleeve is free to move sideways to engage or disengage a given gear (see Fig. 6).



Fig. 6

3. Clutch Carrier

The gear-coupled clutch carrier is the actual gear coupler connecting the gear with the sliding sleeve. The synchronizing ring and the servo-thrust components are contained within the clutch carrier (see Fig. 7). The 1st gear clutch carrier has two slots machined into the body and located opposite one another.

The slanted slot is provided for the brake band energizer. The retaining ring tab must never be positioned within the slanted slot since it belongs into the slot of the brake band stop.



Fig. 7

4. Synchronizing Ring

The synchronizing ring is a split spring ring with two beveled outer edges. One beveled edge represents the synchronizing friction face, the other edge completes the contour to mate with the machined inner groove within the inside race of the sliding sleeve provided for locking the sliding sleeve on the synchronizing ring when the shift has been completed (see Fig. 8).



Fig. 8

5. Brake Band Energizer

One end of the synchronizing ring exerts pressure onto the brake band energizer which, in turn, transmits this pressure to the brake band (see Fig. 9).



Fig. 9

Incorporated into the 1st gear synchronization is a modified brake band energizer, i. e. , one with an actuating tab (see Fig. 10).



Fig. 10

6. Brake Band Stop

The brake band stop is contained within the slot machined into the clutch carrier and is mechanically connected with the respective gear, transmitting the friction forces (moment of friction) from the synchronizing components to the clutch carrier (see Fig. 11).



Fig. 11

7. Brake Band

The brake band receives the synchronizing force, or thrust, exerted by the synchronizing ring against the brake band energizer; consequently, the brake band is forced outward against the inner face of the synchronizing ring (see Fig. 12).



Fig. 12

8. Retaining Ring

The retaining ring has the purpose of containing the synchronizing ring and the Synchromesh components in the clutch carrier (see Fig. 13).



Fig. 13

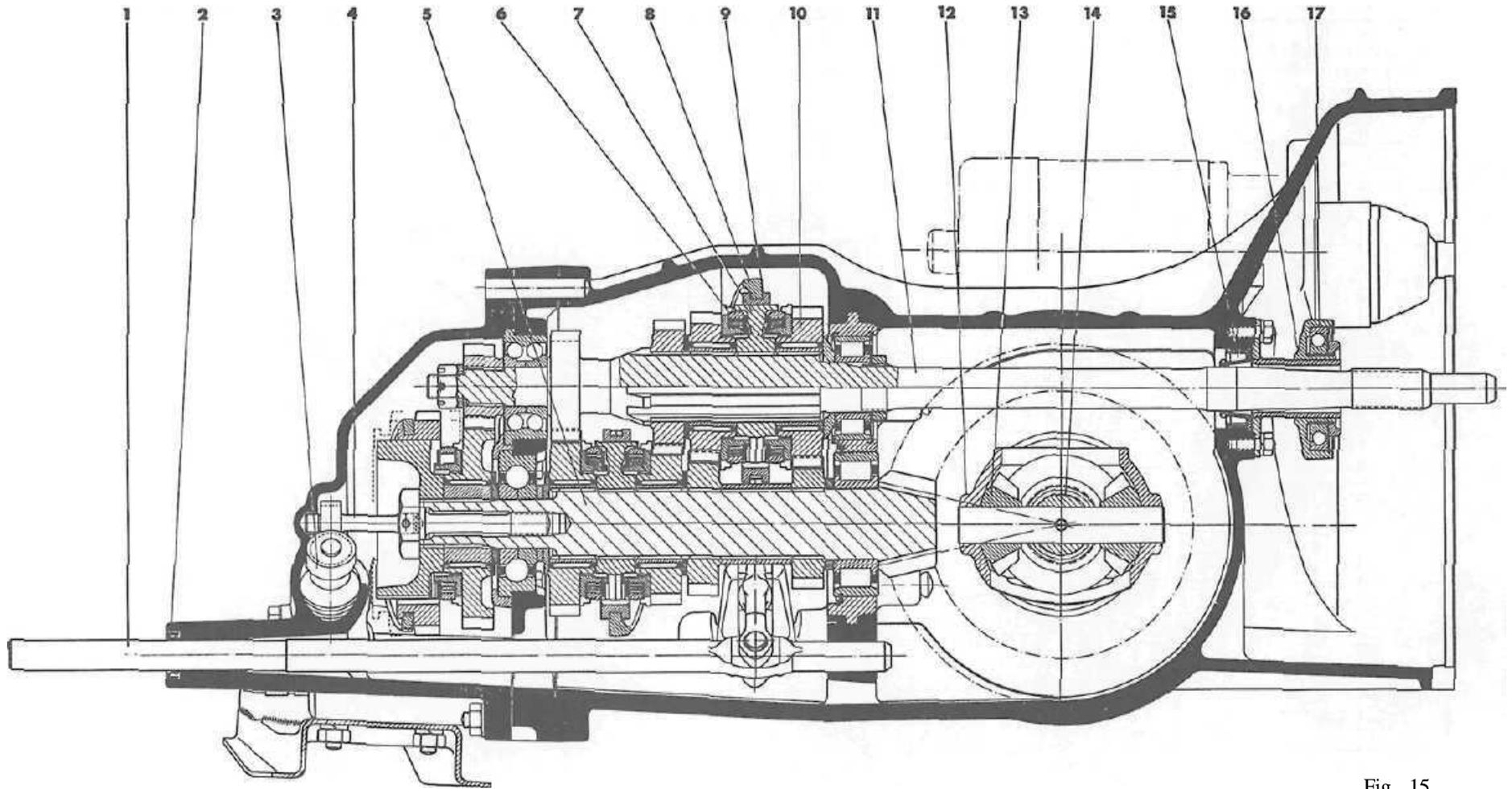


Fig. 15

CROSS-SECTION VIEW OF TRANSMISSION AND DIFFERENTIAL

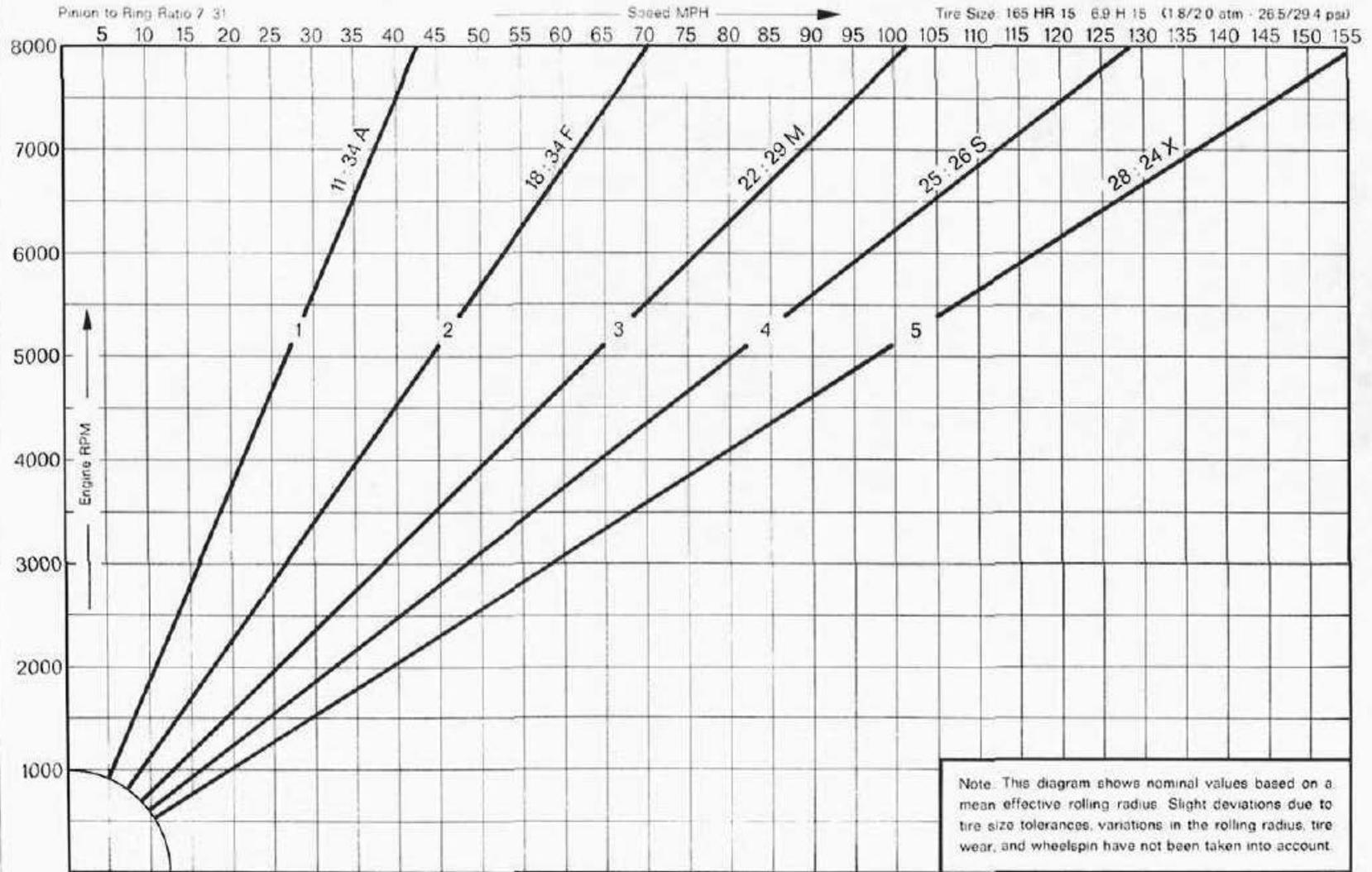
- | | | | |
|--------------------|----------------------|-------------------------|-----------------------------------|
| 1 Shift rod | 5 Pinion shaft | 9 Sliding sleeve | 13 Bevel spider gear |
| 2 Oil seal | 6 Synchronizing ring | 10 Gear 1, 5th speed | 14 Side gear shaft |
| 3 Tachometer drive | 7 Spider | 11 Input shaft | 15 Oil seal |
| 4 Gear shaft | 8 Shift fork | 12 Differential carrier | 16 and 17 Clutch throwout bearing |

R10

PORSCHE

Type 911 (5-speed-transmission)

Transmission Diagram Type 902/1 transmission



Subject to change without notice

Gear ratios from Transmission Nr. 221 722
Revised Page 1 - March 1967

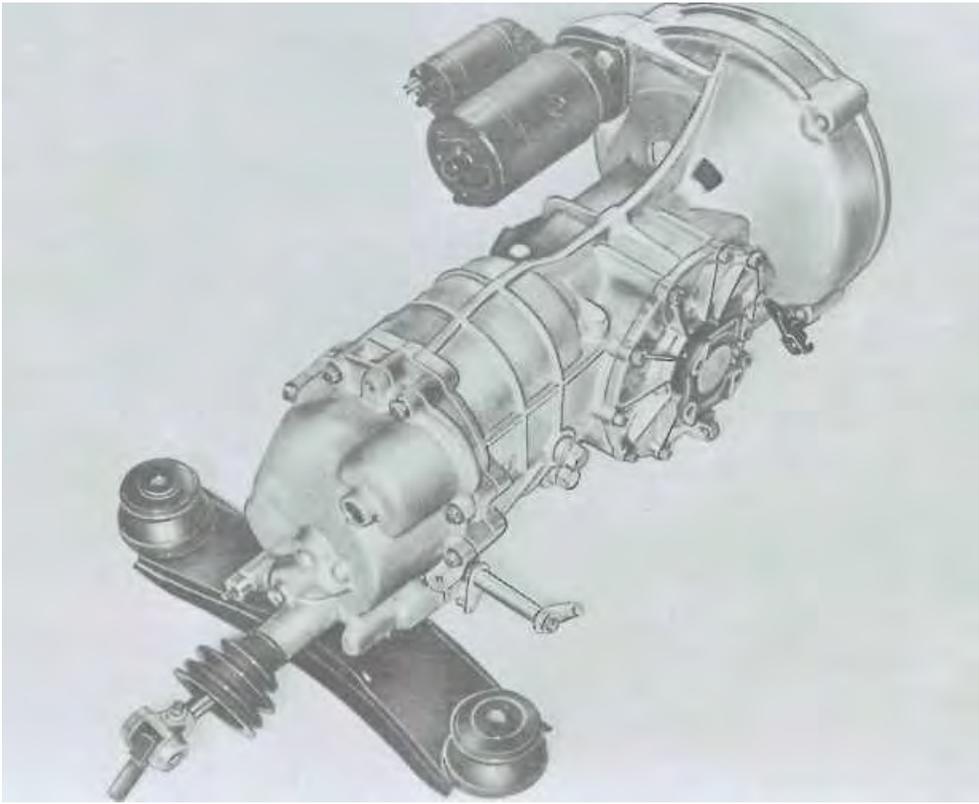


Fig. 16

DISMOUNTED TRANSMISSION AND DIFFERENTIAL ASSEMBLY

For description dealing with removal and installation of the engine and transmission unit refer to the "Engine" group (see 1 EN).

Special Tools

P 37	Holder for input shaft in transmission housing	P 259	Clamp, with gauge holder, for measuring gear backlash
P 66a	Puller for selector shaft detent bushing	P 260	Dummy plate for adjusting selector forks
P 201	Stand for mounting transmission or engine on bench	P 261	Torsiometer, 0-25 cmkp, with drive converter from 1/4 to 1/2 inch
P 251	Socket for pinion shaft stretchbolt	P 262	Driver for installing selector shaft detent bushings
P 252	Socket for input shaft hex nut	P 263	Block for removing differential side bearings
P 253	Press adapter for removing gear shafts from intermediate plate	P 264	Driver for installing differential, side bearing
P 254	Driver for bearing outer races in center web	VW 244b	Driver
P 255	Press adapter for removing roller bearing from pinion shaft	VW 400F	Hydraulic press
P 256	Holder, for input shaft	VW 401	Press adapter, general purpose
P 257/1	Driver for installing retaining pin in spider gear shaft	VW 402	Press adapter, general purpose
P 257/2	Driver for removing retaining pin from spider gear shaft	VW 405	Press adapter, with V-block
P 258	Dummy carrier with dial gauge for measuring pinion shaft adjustment	VW 406	V-blocks
		VW 407	Press adapter, general purpose
		VW 409	Press adapter, general purpose
		VW 412	Press adapter, general purpose

General

The transmission castings are interchangeable and can be individually replaced if damage or wear is confined to individual pieces. Due to perfected machining methods it is no longer necessary to replace serviceable parts by reason of mechanical relation with a defective part.

When replacing the transmission housing it will be necessary to determine the differential side bearing preload (see 10 RA). Also, it will be necessary to readjust the pinion and ring gear (see 11 RA and 12 RA).

When replacing the intermediate plate or the four-point ball bearing of the pinion shaft, check pinion shaft adjustment (see 11 RA and 12 RA).

Disassembly

1. Mount transmission on assembly stand P 201.
2. Remove oil drain plug and drain oil.
3. Remove engine starter.
4. Remove caps from universal joint mounting flanges using two screwdrivers.

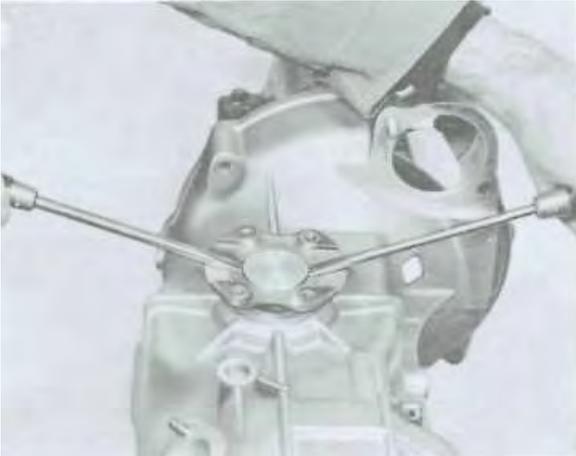


Fig. 17

5. Remove stretchbolts from flanges and withdraw flanges (shift into 5th gear for this operation by turning the inner shift rod clockwise to stop, then pulling it out; block input shaft with special tool P 37).

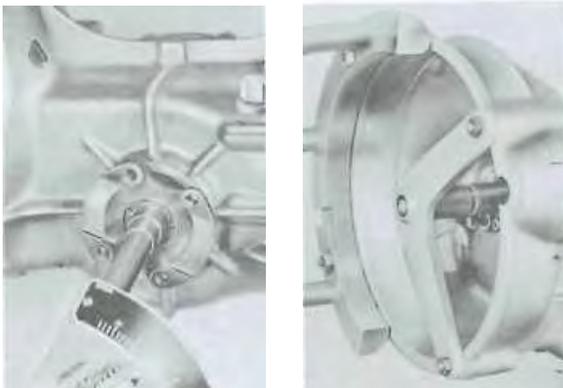


Fig. 18

6. Remove side cover retaining nuts and withdraw differential unit.



Fig. 19

7. Remove transmission support from front cover. Remove front cover retaining nuts and withdraw cover.

Caution!

Reverse gear components can fall out.

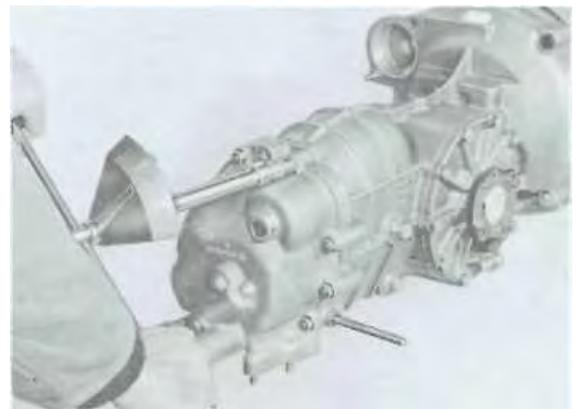


Fig. 20

8. Remove retaining screw of selector fork (1st and reverse gear), remove gear and selector fork.



Fig. 21

9. Remove stretchbolt from pinion shaft using special tool P 251 (transmission engaged in 5th gear and pinion shaft blocked with special tool P 37).



Fig. 22

10. Remove roll pin from castle nut on input shaft using a punch. Remove castle nut and 1st speed gear.



Fig. 23

11. Shift into neutral. Remove retaining nuts from plate of inner shift rod guide fork and withdraw guide fork.

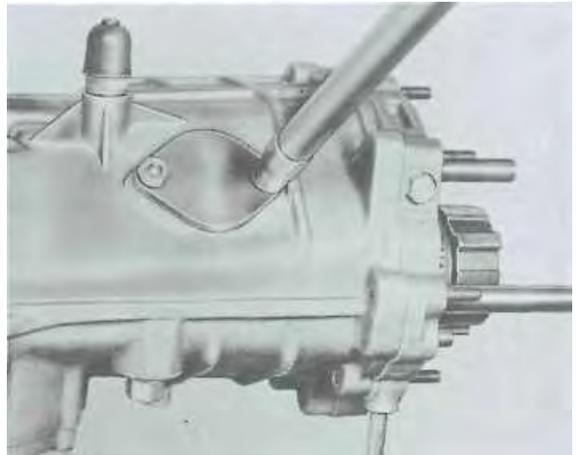


Fig. 24

12. Pull out inner shift rod through the rear access hole. Using a screwdriver inserted into the guide fork orifice, shift into 5th gear and remove intermediate plate with gear clusters (tap plate lightly with a plastic hammer if plate does not come out by hand).

Caution:

The gear clusters can be inserted or removed from the housing only when transmission is in 5th gear position.

Check gasket thickness for reassembly.

13. Mount intermediate plate with gear clusters in a vise equipped with soft, unworn grip liners.
14. Withdraw spider wheel of 1st and reverse speed using two screwdrivers.

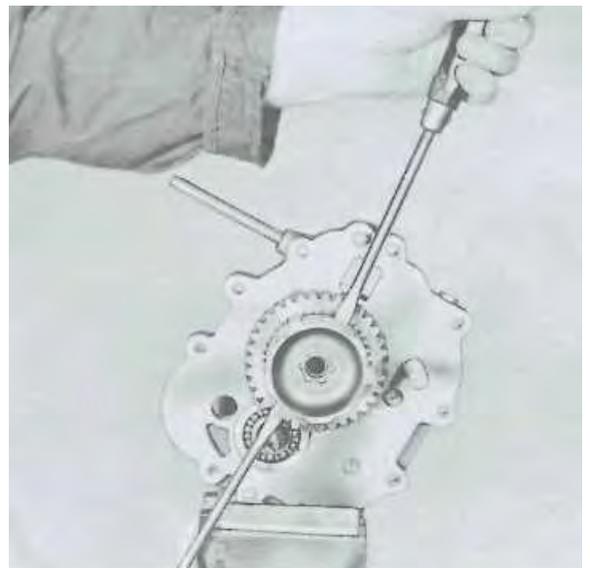


Fig. 25

15. Remove Gear II of 1st speed, remove needle bearing cage.
16. Shift into neutral, unscrew selector shaft detent plug and pull out spring.

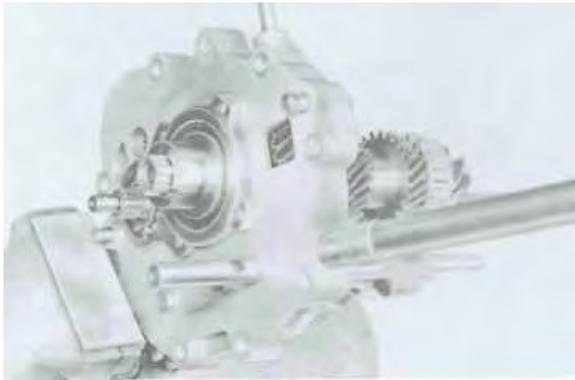


Fig. 26

17. Withdraw selector shaft of 1st and reverse gear, together with detent ball.
18. Remove retaining screw of selector fork for 2nd and 3rd gear, remove selector shaft, selector fork, and detent.

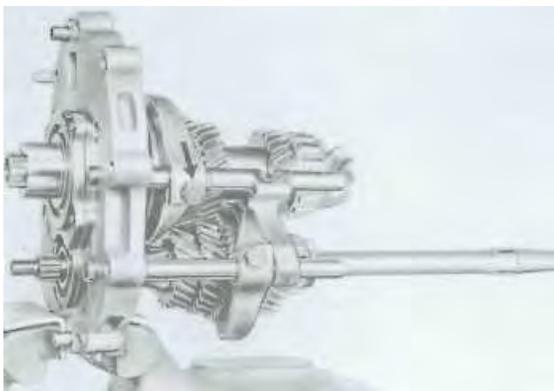


Fig. 27

19. Remove retaining screw of selector fork for 4th and 5th gear, remove selector shaft, selector fork, and detent ball.
- Note:
Mark selector forks for 2nd and 3rd, and 4th and 5th gears to prevent a mixup at reassembly.
20. Remove detent ball, spring, and detent (see Fig. 41 for detent component arrangement).

21. Using press adapter P 253 and VW tool 407, press out input and pinion shafts, together, from the intermediate plate. (Before placing the assembly on the press, drive aligning dowels in plate back and remove throttle linkage to allow plate to rest flat on the press).

Caution:

Bearing balls can possibly fall out of the double-row offset ballbearing.

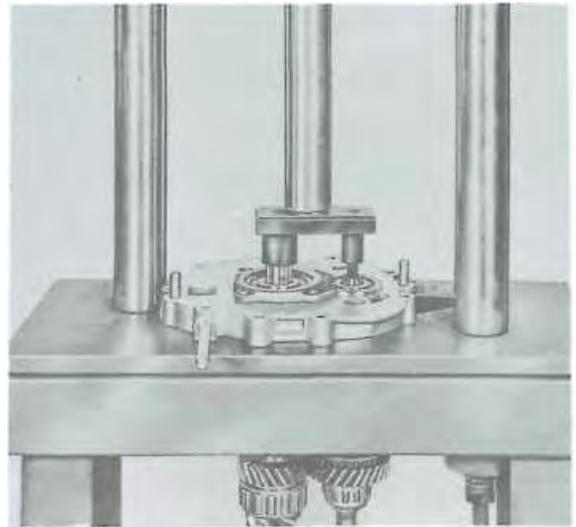


Fig. 28

22. Disassemble intermediate plate (see 7 RA).

Note:

If the intermediate plate is to be replaced, re-adjust the ring and pinion (see 11 RA and 12 RA).

23. Remove from case center web both spring retainers of the input shaft bearing and the front retainer of the pinion shaft using a small screwdriver.



Fig. 29

24. Heat the housing to approx. 120° C (248° F). Using special tool P 254 and a plastic hammer, tap both bearing races out (one at a time).

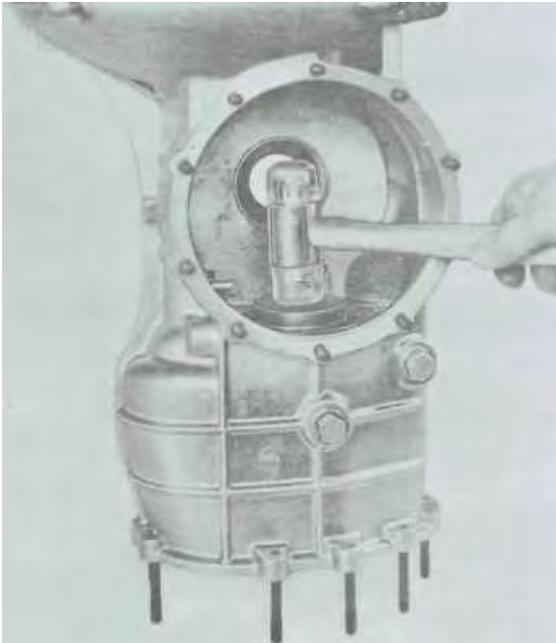


Fig. 30

25. If necessary, remove input shaft oil seal (see 17 RA).

Reassembly

Reassemble transmission in the reverse order of the above noting the following points:

1. Clean the housing and check for wear, external damage, and cracks. If there was a damage inflicted upon the drive pinion or the ring gear (such as breakage), check if the bearing bores in the case center web show any damage; if necessary, replace transmission housing.
2. Check roller bearings of input shaft and pinion shaft for wear or damage, replace if necessary.
3. Check input shaft for run out (see 6 RA).
4. Install appropriate spring retainer into the outer bearing race of the pinion shaft roller bearing.

See Fig. 31 for proper positioning of the spring retainers:

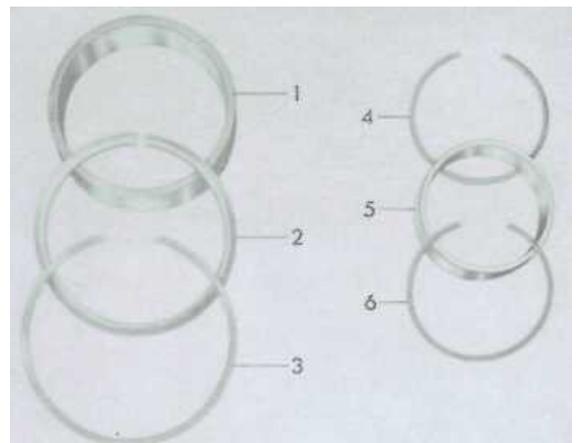


Fig. 31

- 1 Pinion shaft roller bearing outer race
- 2 Spring retainer (mounted onto outer race)
- 3 Spring retainer
- 4 Spring retainer
- 5 Outer race of pinion shaft roller bearing
- 6 Spring retainer

5. Insert the rear spring retainer of input shaft roller bearing into the bearing bore, positioning it at a slant, and guide into its groove with a small screwdriver.

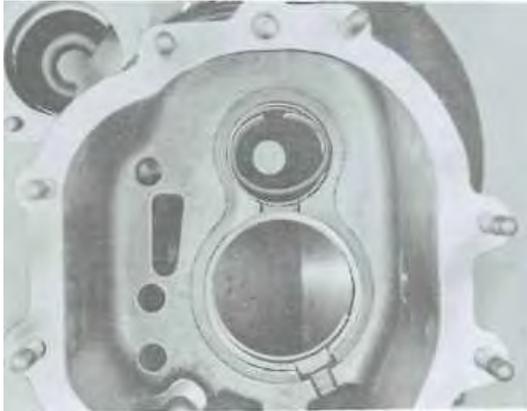


Fig. 32

6. Heat transmission housing to approx. 120° C (248° F), install outer race of input shaft roller bearing in its seat using special tool P 254, and safety with spring retainer.

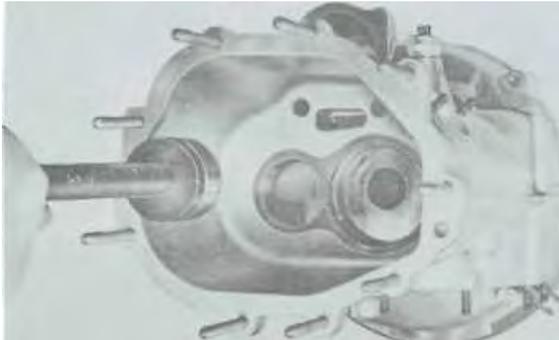


Fig. 33

7. Install outer race of pinion shaft roller bearing, with the spring retainer mounted on the race, in its seat using special tool P 254, and install front spring retainer.

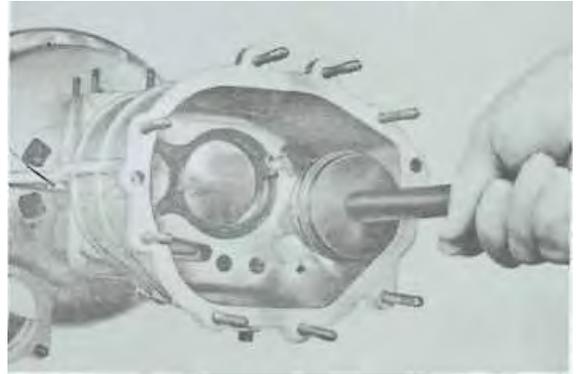


Fig. 34

8. Install input shaft oil seal (see 17 RA).
9. Place the assembled intermediate plate onto the bearing inner race halves of the input and pinion shaft, mount other halves of bearing inner race with an appropriate pipe tool (the inner race half of the pinion shaft bearing, marked X, must be mounted on the outer side of the plate - see Fig. 35). Make certain that the mating numbers match.



Fig. 35

10. Insert the intermediate plate with input and pinion shaft gear clusters, lightly tighten in a cross-sequence at four housing studs by using spacer bushings (5th gear engaged).

11. Install Gear I of 1st speed on the input shaft, insert spacer and tighten castellated nut to a torque of 6.0 to 6.5 mkp (43 to 47 lbs/ft) (use special tool P 37). Secure castellated nut with spiral pin.



Fig. 36

12. Place thrust washer on the pinion shaft with small collar facing the bearing, and guide needle bearing race in place with a suitable pipe tool.



Fig. 37

13. Install needle bearing and Gear II of 1st speed.
14. Install spider wheel of 1st and reverse speed.
15. Oil the pressure seat of pinion shaft stretchbolt (bolt has an extension for tachometer take-off) and tighten to a torque of 11 to 12 mkp (80 to 86 lbs/ft) using special tool P 251 (block input shaft with P 37).



Fig. 38

16. Place intermediate plate, with shafts and gear clusters installed, into a vise (use soft-jaw liners).

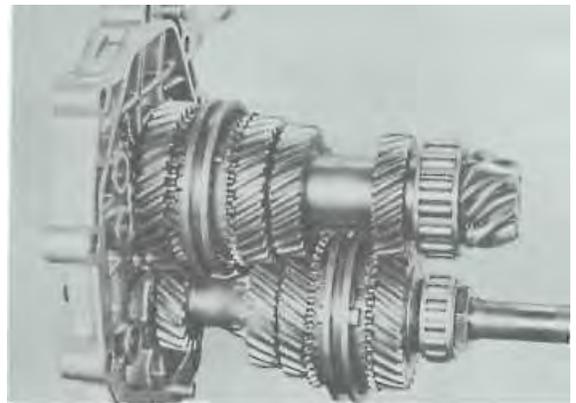


Fig. 39

17. Install selector shafts and forks in the following sequence:
 - a. Place selector fork of 4th and 5th speed onto the respective sliding sleeve and push 4th and 5th speed selector shaft through until it enters its bore in the intermediate plate, then slightly tighten the fork retaining screw (with spring washer); prior to that, secure the shift arm on selector shaft with a roll pin.



Fig. 40

- b. Place into the detent bore (one that connects the selector shaft bores) one ball, detent pin, long spring for detents of speeds 2 thru 5, and then one more ball; it is of advantage to first insert the detent pin into the spring with a little grease, then into its bore.
- c. Place selector fork of 2nd and 3rd speed onto the respective sliding sleeve and push 2nd and 3rd speed selector shaft through until it enters its bore in the intermediate plate; for this operation, the selector shaft of the 4th and 5th speed must be in neutral position and the detent ball of the 2nd and 3rd speed pushed down. Slightly tighten the fork retaining screw (with spring washer).
- d. Move 2nd and 3rd speed selector shaft into neutral, insert detent.
- e. Install selector shaft of 1st and reverse gear, insert detent ball and short spring, tighten cap screw to 2.5 mkp (18 lbs/ft).
- f. Slide selector fork and sliding gear for 1st and reverse speed together onto the spider wheel and selector shaft. Slightly tighten fork retaining screw with washer.
- (See Fig. 41 for proper arrangement of detent components).
- g. Check springs of the detent mechanism, replace when necessary. Free length of the spring for reverse and 1st speed is 29.2 mm, minimum 28.2 mm; spring for 2nd thru 5th speed is 38.5 mm, minimum 37.3 mm.

Note:

If a new intermediate plate is being installed, or the three detent bushings have been removed, follow instructions given in 7 RA (Assembling Intermediate Plate).

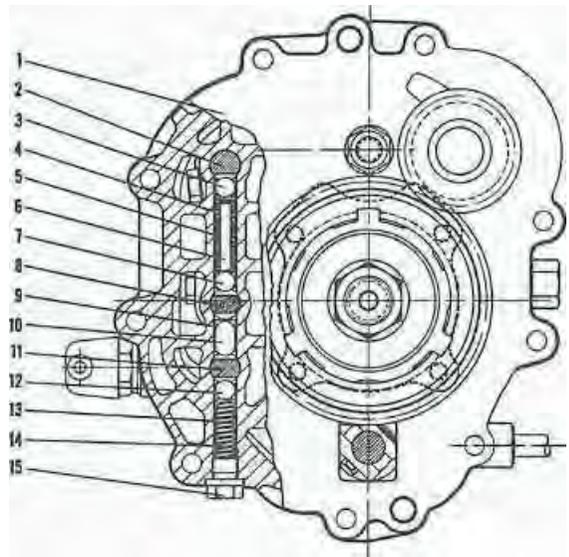


Fig. 41

ARRANGEMENT OF DETENT COMPONENTS

- 1 Intermediate plate
- 2 Selector shaft of 4th and 5th speed
- 3 Ball
- 4 Detent bushing
- 5 Detent spring of 2nd thru 5th speed
- 6 Detent pin
- 7 Ball
- 8 Selector shaft of 2nd and 3rd speed
- 9 Detent bushing
- 10 Detent pin
- 11 Selector shaft of 1st and reverse speed
- 12 Ball
- 13 Detent bushing
- 14 Detent spring (reverse speed)
- 15 Cap screw

18. Adjust selector fork of 1st and reverse speed. Press the assembled reverse twin gear (with bearings and shaft) against the intermediate plate to check that there is a clearance of 1 mm between the reverse gear and the sliding gear when transmission is in neutral; when checking, eliminate the free-play factor that may be between the selector fork and the sliding gear by pushing the sliding gear in the direction of car's travel to ensure that during operation the sliding gear does not strike the reverse gear under remote conditions.

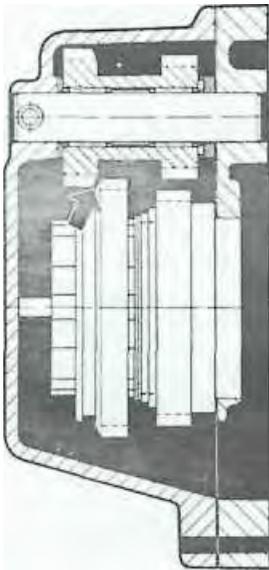


Fig. 42

Tighten selector fork retaining screw to 2.5 mkp (18 lbs/ft) making sure that the selector shaft actuating tabs on 1st and reverse speed shaft have a side clearance of 2 to 3 mm in relation to those of 2nd and 3rd speed.

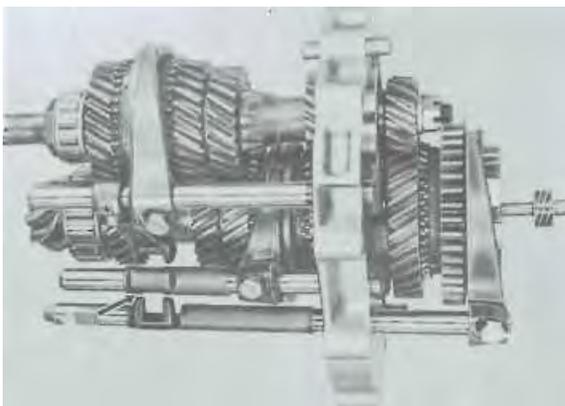


Fig. 43

19. Install special tool P 260 on the selector shafts and adjust selector forks of speeds 4/5 and 2/3.

Note:

The sliding sleeve must be adjusted to a position in the exact center in relation to both synchronizing rings when in neutral. After a shift test, check this adjustment and relocate the sliding sleeve into correct position, if necessary, since smooth and effective gear synchronization will otherwise be not possible.

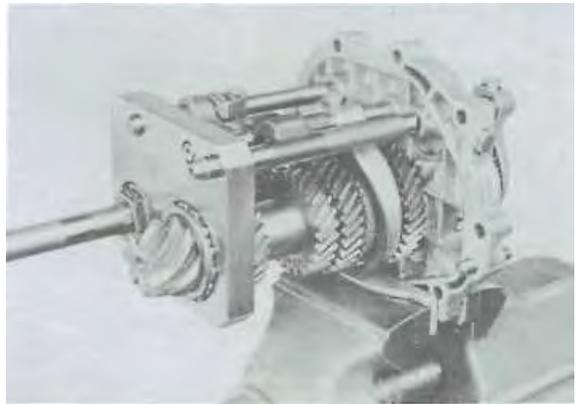


Fig. 44

20. Tighten selector fork retaining screws to 2.5 mkp (18 lbs/ft) making sure that the selector shaft actuating tabs on 4th and 5th speed shaft have a side clearance of 2 to 3 mm in relation to those of 2nd and 3rd speed.

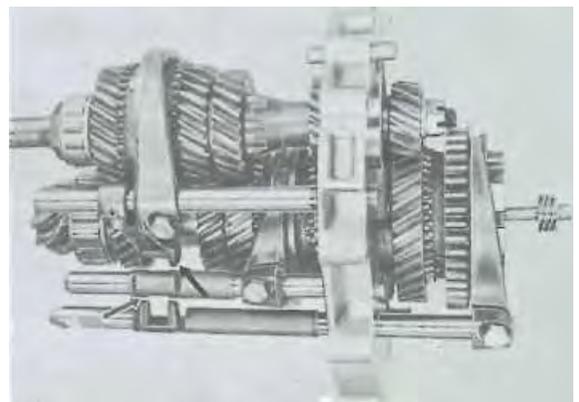


Fig. 45

21. Assemble inner shift rod making sure that the tapered bore in the rod points in the same direction as the inner shift rod. Press retaining pin in and safety with a cotter key.

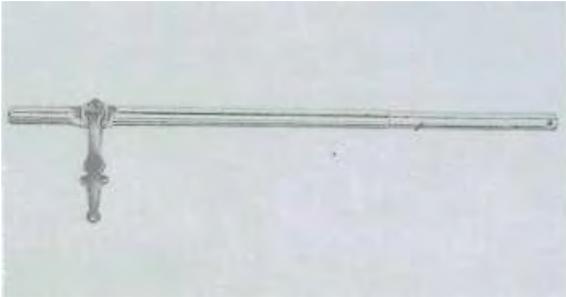


Fig. 46

Note:

The inner shift rod must be installed at the same time as the gear cluster assembly; it is best to insert the shift rod into the housing first (see Fig. 47).

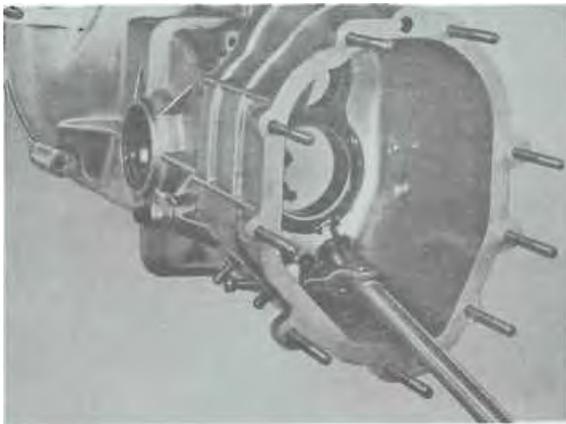


Fig. 47

22. Install intermediate plate with gear clusters and gaskets which have been determined at time of the pinion and ring gear adjustment (shift gears into 5th speed).

Caution:

Exercise care when guiding the gear assembly in so that no damage occurs to the input shaft oil seal.

23. Shift into neutral, guide inner shift rod into proper position at selector shaft tabs and into the rear rod bore.

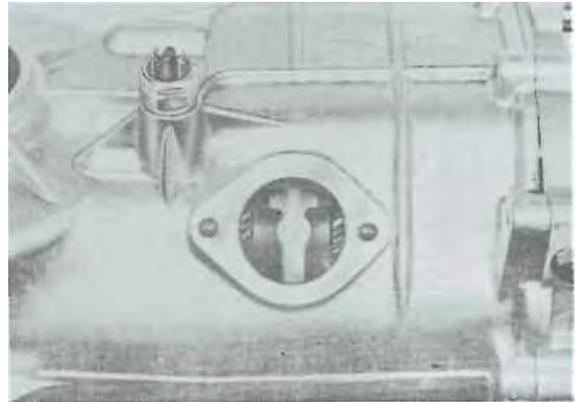


Fig. 48

24. Install guide fork of inner shift rod using a new gasket and making certain that the inner shift rod enters the guide fork.

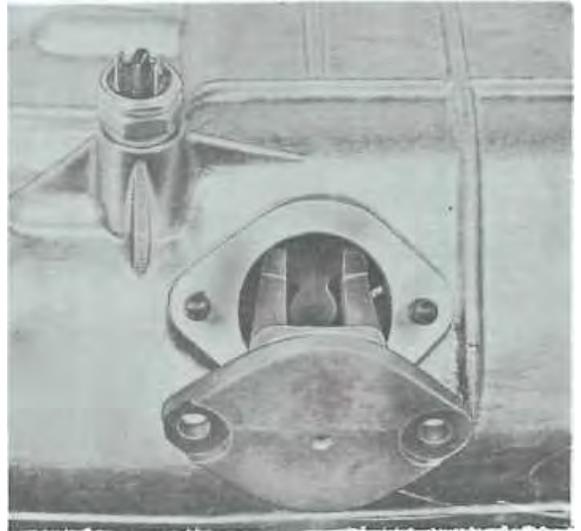


Fig. 48a

25. Assemble front case cover and install (see 15RA).

RECONDITIONING PINION SHAFT

Special Tools

P 255 Press adapter for removing roller bearing from pinion shaft

VW 400F Hydraulic press

VW 401 Press adapter, general purpose

VW 407 Press adapter, general purpose

VW 412 Press adapter, general purpose

2RA

Disassembly

1. Disassemble transmission (see 1 RA).
2. Press out the pinion shaft from the gears using hydraulic press VW 400F and special tools P 255, VW 401, and VW 412.



Fig. 49

3. Remove all pinion shaft components, such as gears etc. In doing so the needle bearing cages have to be marked to avoid any mistake when reinstalling them.

Caution:

Note the number and thickness of spacers (for pinion and ring gear adjustment) between the roller bearing and thick spacer, so that reassembly can be possibly accomplished without the necessity of recomputing the spacer thickness.

Inspection

1. Inspect pinion shaft and, especially, the splines for wear or damage, noting the mating identification numbers.
2. Check roller bearing and four-point ballbearing, replace if necessary. (Note mating numbers.)
3. Check gears for wear or damage, replace when necessary. (Note mating numbers).
4. Check all Synchronesh components for wear.

Determine the adjustment value E from the blueprint value R = 63.50 by adding or subtracting the value of machined deviation r which is marked on the pinion face.

From model 70 on - R = 63.20 + deviation r "N"
(refer to page R 42 and SR 160).

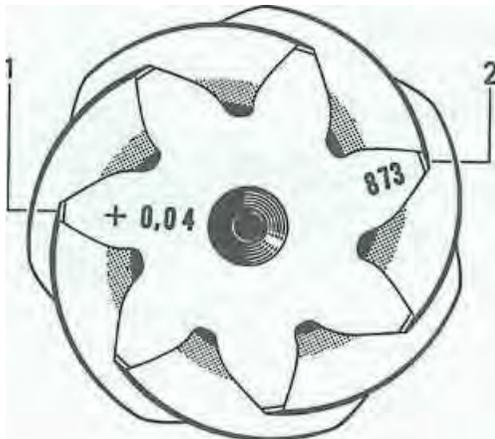


Fig. 50

1 Deviation r + (plus) or - (minus) values: shown as +4 is given in 1/100 mm; +0.04 is given in mm

Deviation r + in 1/100 mm, for example N 34

2 Mating identification number

Example:

If the machined deviation r is shown as +4 or +0.04, proceed as follows:

R (blueprint value) 63.50 mm

r (machined deviation) 0.04 mm

E (adjustment value) 63.54 mm

From model 70 on

When machining deviation r, shown on the pinion face, is N 34

R (Blue print value) 63.20mm

r (machined deviation) + 0.34mm

E (adjusted value) 63.54 mm

A basic approximation value (based on averages) of 64.70 mm makes it possible to predetermine the spacer thickness required. The difference between the adjustment value E and the approximation value (64.70 mm) indicates the spacer thickness needed.

Example:

When the adjustment value E is 63.54 mm, compute as follows:

Approximationvalue 64.70mm

Less E (adjustment value) 63,54 mm

Difference 1.16mm

1.16 mm = required thickness of spacers

The spacers are available in thicknesses of 0.25, 0.30, and 0.40 mm. The 0.10 and 0.15 mm spacers should no longer be used.

The values are always rounded off to the closest 0.05 mm.

The required spacers for the above example are: 3 x 0.30 mm, 1 x 0,25 mm.

4RA

Servicing Synchromesh Components

Disassembly

1. Remove synchronizing ring retainer from clutch carrier using needle nose pliers.
2. Thoroughly clean all parts in cleaning solvent.
3. Inspect parts for wear or damage. If the synchronization was no longer effective, install new synchronizing ring.

2. When assembling 1st speed synchronization, ensure that only one brake band is installed. The band should be placed exactly as shown in Fig. 52.



Fig. 52

Reassembly

1. Place synchronizing ring into clutch carrier and insert brake band energizer, brake band stop, and brake bands.

3. Install synchronizing ring retainer using needle nose pliers.



Fig. 53

4. Check installed synchronizing ring for installed diameter ($76.30 \text{ mm} \pm 0.18 \text{ mm}$).



Fig. 51

Pinion Shaft Cross-section

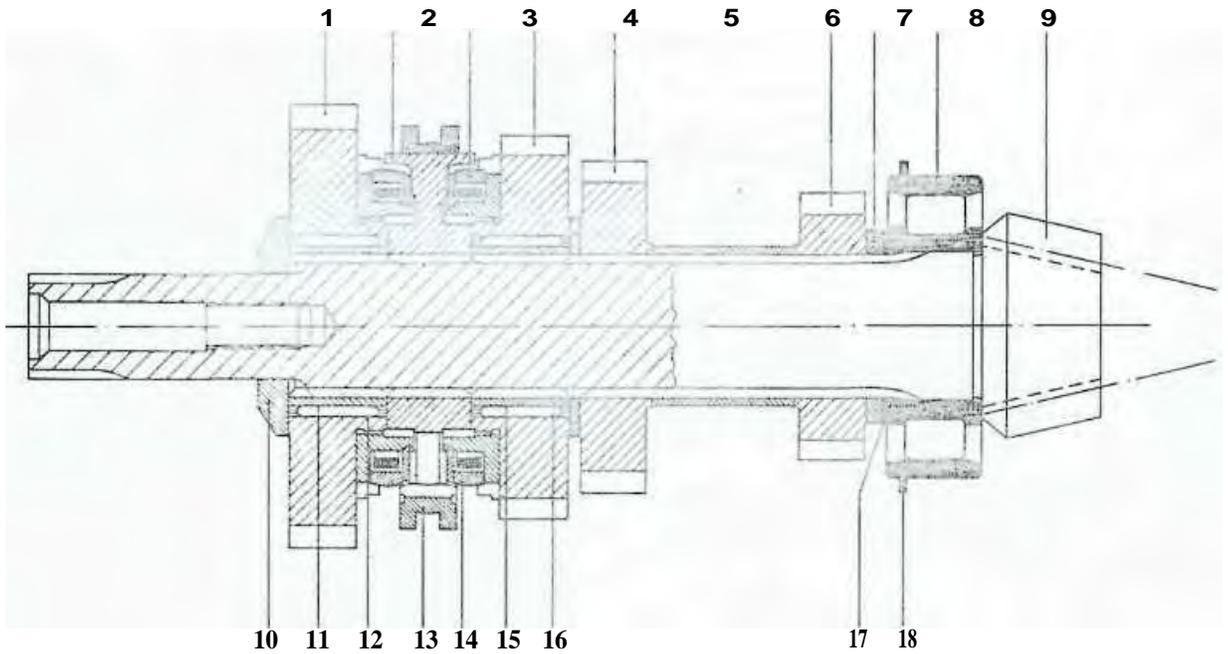


Fig. 54

- | | |
|---|---|
| 1 Gear II for 2nd speed (free-wheeling) | 10 Thrust washer (6.6 mm thickness) |
| 2 Spider | 11 Needle bearing inner race (gear speeds 2 thru 5) |
| 3 Brake band | 12 Needle bearing cage (gear speeds 1 thru 5) |
| 4 Gear II for 3rd speed (free-wheeling) | 13 Sliding sleeve |
| 5 Gear II for 4th speed (fixed) | 14 Synchronizing ring |
| 6 Gear II for 5th speed (fixed) | 15 Needle bearing inner race |
| 7 Spacer | 16 Needle bearing cage |
| 8 Roller bearing | 17 Spacers |
| 9 Pinion shaft | 18 Retaining ring |

Exploded View of Pinion Shaft Components

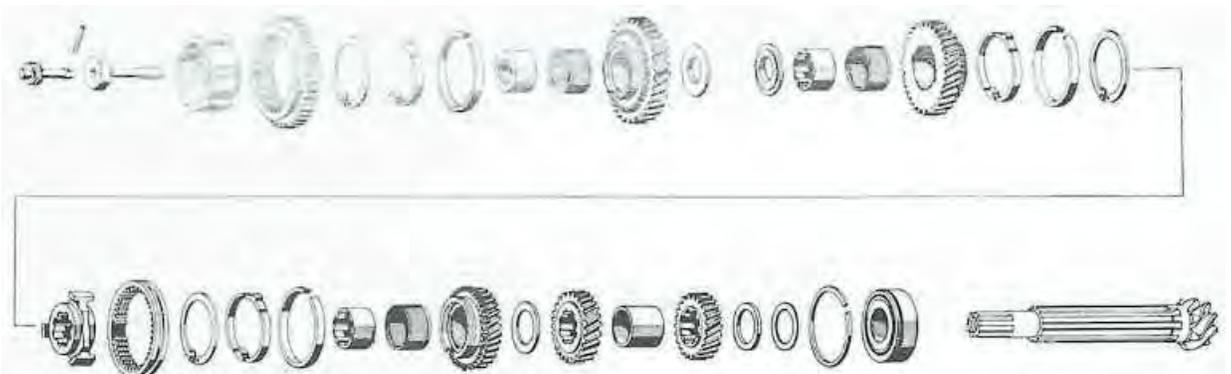


Fig. 55

5RA

General

When assembling the pinion shaft make certain that the roller bearing inner race, together with the cage and rollers, is facing in proper direction, that is, the two-piece roller cage must face with its attached ring towards the transmission gears (see Fig. 56).

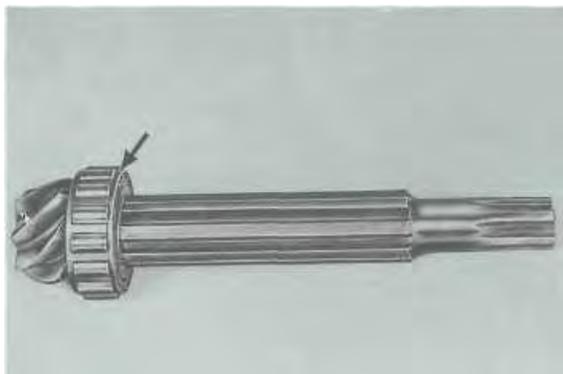


Fig. 56

Note:

All pinion shaft components are to be dry-assembled so that no oil covers the seating surfaces.

The ring gear and pinion are identified with mating numbers (see Fig. 97). It is essential that these numbers match when the parts are assembled.

Reassembly

The pinion shaft components should be assembled in the sequence outlined below and by noting the following points:

1. Install roller bearing using hydraulic press VW 400F, VW 401, and VW 407.

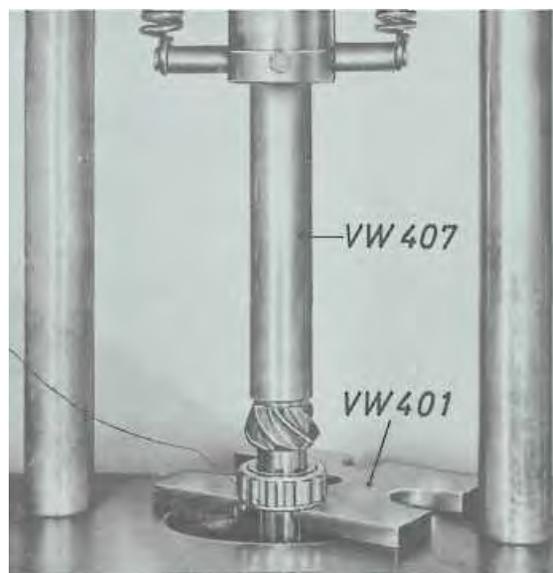


Fig. 57

2. Spacers required in accordance with computations outlined in 3 RA should be installed between the roller bearing and the thick spacer.
3. Insert thick spacer.



Fig. 58

4. Slide Gear II of 5th speed on shaft, small collar facing up.



Fig. 59

7. Install needle bearing cage, Gear II of 3rd speed, and spider.



Fig. 61

5. Slide spacer bushing on shaft and follow with Gear II of 4th speed, small collar facing down against the bushing.
6. Slide thrust washer and roller bearing inner race onto shaft.

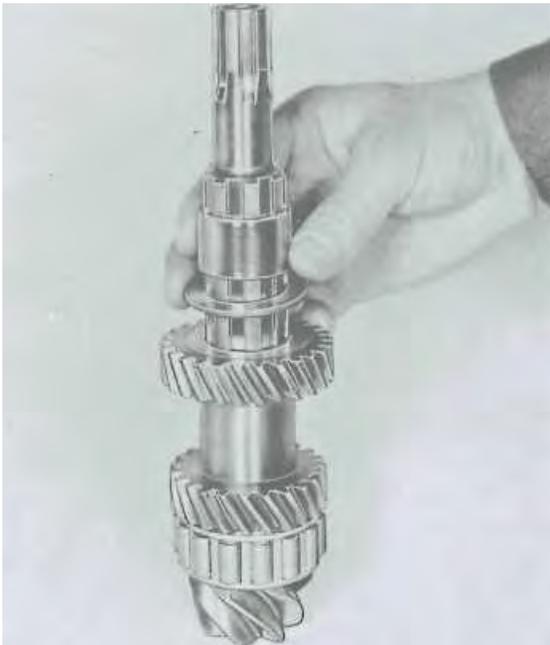


Fig. 60

Caution:
Used needle bearing cages have to be reinstalled with the same gear.

8. Install needle bearing inner race, needle bearing cage, and sliding sleeve.



Fig. 62

9. Install Gear II of 2nd speed.

10. Install beveled thrust washer with plain face towards the needle bearing, follow with small spacer.

Note:

Beginning with Transmission No. 100 407, the thrust washer and the spacer have, been replaced with a single, beveled thrust washer of 6.6 mm thickness.

11. With an appropriate pipe tool, press onto the shaft the bearing inner race half which shows only the mating number (without the letter "X").



Fig. 63

Special Tools

P 37	Holder for input shaft for tightening and loosening castellated nut on the input shaft and the stretchbolt on the pinion shaft	P 256	Holder for input shaft
P 201	Stand for mounting transmission on bench	P 260	Dummy plate for adjusting selector forks
P 251	Socket for pinion shaft stretchbolt	VW 400F	Hydraulic press
P 252	Socket for input shaft hex nut	VW 401	Press adapter, general purpose
P 253	Press adapter for removing gear shafts from intermediate plate	VW 402	Press adapter, general purpose
P 254	Driver for bearing outer races in center web	VW 405	Pressadapter, with V-block
		VW 406	V-blocks
		VW 407	Pressadapter, general purpose
		VW 409	Press adapter, general purpose

Cross-sectional View of Input Shaft

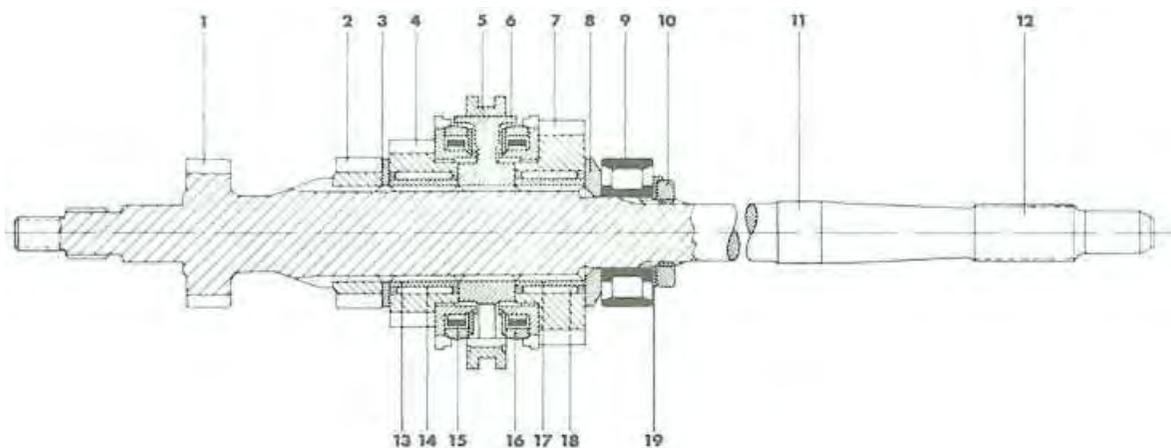


Fig. 64

- | | | | |
|----|---|----|------------------------------|
| 1 | Input shaft (with Gear I for 2nd speed) | 11 | Oil seal race |
| 2 | Gear I of 3rd speed (fixed) | 12 | Splined end for clutch plate |
| 3 | Thrust washer | 13 | Needle bearing inner race |
| 4 | Gear I of 4th speed (free-wheeling) | 14 | Needle bearing cage |
| 5 | Sliding sleeve | 15 | Brake band |
| 6 | Spider | 16 | Synchronizing ring |
| 7 | Gear I of 5th speed (free-wheeling) | 17 | Needle bearing inner race |
| 8 | Thrust washer (5.9 mm thickness) | 18 | Needle bearing cage |
| 9 | Roller bearing | 19 | Nut lock plate |
| 10 | Hex nut | | |

Exploded View of Input Shaft

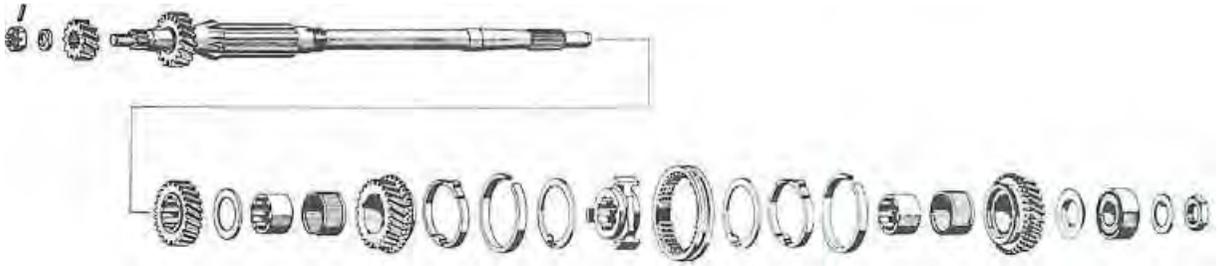


Fig. 65

General

To remove the input shaft, the transmission must be disassembled in part; the differential may remain installed.

Disassembly

1. Drive back the plate lock tabs at hex nut.
2. Place special tool P 256 into vise, insert input shaft into receptacle, and remove retaining nut using special tool P 252.

Removal

1. Remove front cover, pinion and input shaft together with intermediate plate (see 1 RA).

Caution:

Note paper gaskets between transmission housing and intermediate plate.

2. Press pinion and input shaft out of the intermediate plate (see 1 RA, Fig. 28).



Fig. 66

3. Press roller bearing off input shaft using VW 400F with VW 401 and VW 402.



Fig. 67

4. Remove all input shaft components (gears etc.). In doing so, the needle bearing cages have to be marked to avoid any mistake when reinstalling them.
5. Drive the inner half of the ball bearing race somewhat away from its seat (use a drift or similar tool) and pull off with a puller.

Caution:

Do not damage Gear I of 2nd speed.



Fig. 68

6. Clean parts.

Inspection

1. Check input shaft for wear:
 - a. Check stub fitting into flywheel gland bushing for traces of wear.
 - b. Check clutch plate seating splines for wear (radial play).
 - c. Check oil seal race for wear.
 - d. Check seats of bearings and gears for proper condition.
 - e. Check Gear I of 2nd speed for wear or damage. Advanced wear or damage will necessitate replacing the input shaft. (Check mating numbers.)

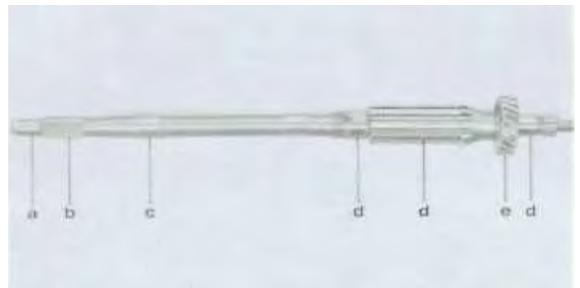


Fig. 69

- a. Pilot stub
 - b. Splines
 - c. Oil seal race
 - d. Seats
 - e. Gear I of 2nd speed
2. Check all Synchronesh parts for wear.

3. Check gears for wear or damage, replace if necessary (note mating numbers).

4. Check double-row ball bearing and the roller bearing for wear or damage, replace if necessary (note mating numbers).

5. Check input shaft for runout.

Note:

Runout should always be checked with the input shaft assembled since tightening the hex nut (M24x1.5) may bring about a certain degree of runout.

To check for runout, remove the double-row ball bearing from the intermediate plate and the outer roller bearing race from the case; the check can also be made with spare bearings.

- a. Place assembled input shaft on V-blocks and check for runout at the flywheel bushing journal. Maximum runout is 0.1 mm.

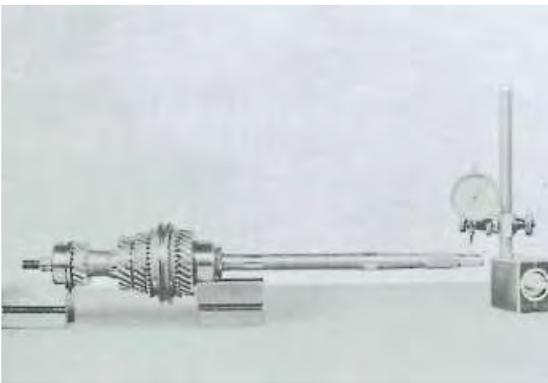


Fig. 70

- b. Excessive runout up to 0.3 mm can be corrected on the press VW 400F in connection with VW 405 and VW 406.

Reassembly

Note:

All input shaft components should be dry-assembled to prevent an oil coating of the contact surfaces.

Reassemble input shaft in reverse order of the preceding by noting the following points:

1. Slide Gear I of 3rd speed onto input shaft with small collar facing the flange on shaft.



Fig. 71

2. Slide thrust washer and needle bearing inner race onto shaft.

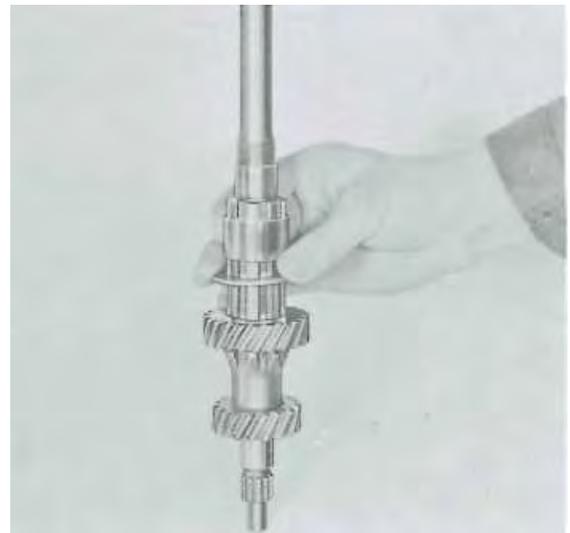


Fig. 72

3. Install needle bearing cage, Gear I of 4th speed, and spider.



Fig. 73

Caution:

Used needle bearing cages have to be reinstalled with the same gear.

4. Install sliding sleeve, needle bearing inner race, needle cage, and Gear I of 5th speed.
5. Install beveled thrust washer (5.9 mm thickness) and the roller bearing (the cage cover ring must face towards the clutch plate splines).

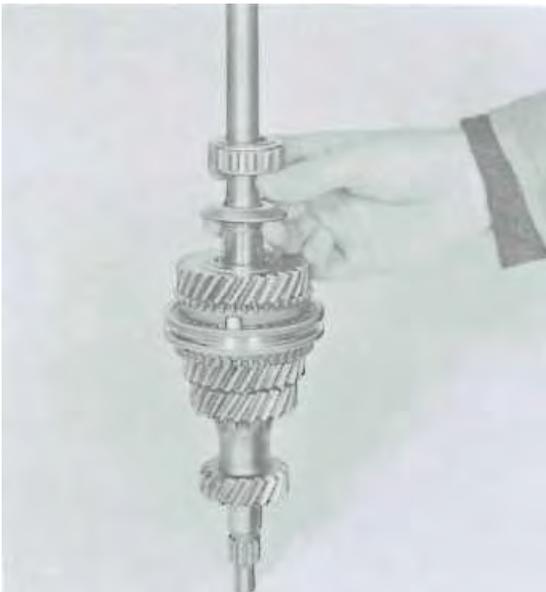


Fig. 74

6. Press roller bearing onto shaft using hydraulic press VW 400F with VW 401, VW 409, and pipe piece 1 (20x3.5 mm, 25 mm long).

Caution:

Take care not to damage the threads on the input shaft.

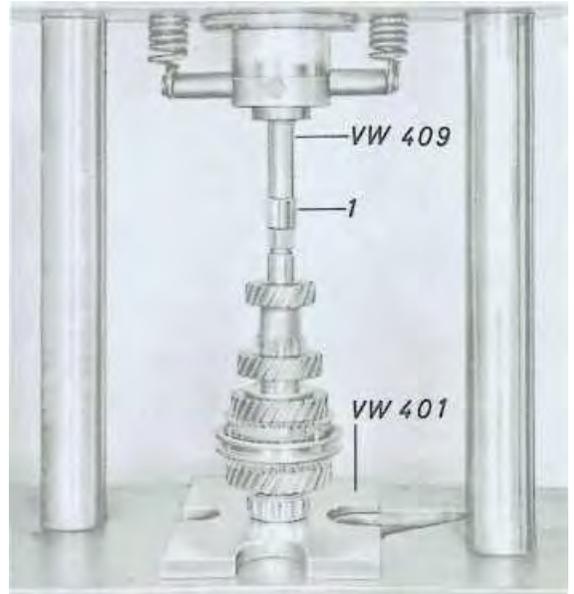


Fig. 75

7. Install new nut lock plate making certain that the guide tab of the plate ring fits into the shaft groove and under the inner race of the roller bearing.

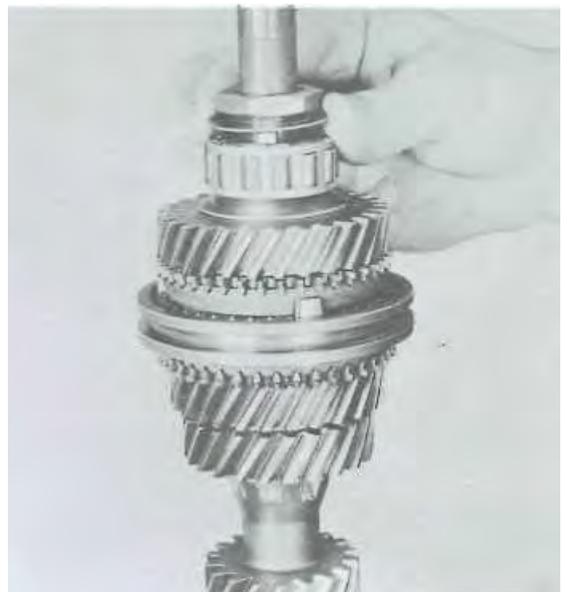


Fig. 76

8. Oil threads and seat of hex nut and install nut with spherical part up.
9. Tighten hex nut to 10 - 12 mkp (72/86 lbs/ft) using special tools P 256 and P 252.

10. Secure hex nut by bending lock plate edge.
11. Press inner race half of ball bearing onto shaft.
Note mating numbers.



Fig. 77

Special Tools

P 66a Puller for selector shaft detent bushing

P 262 Driver for installing selector shaft detent bushings

Note:

If the intermediate plate, the bearing brace plate, or the bearings show signs of wear or damage, replace defective parts as follows:

Disassembly

1. Drive bolt lock tabs back, remove bolts and bearing brace plate.

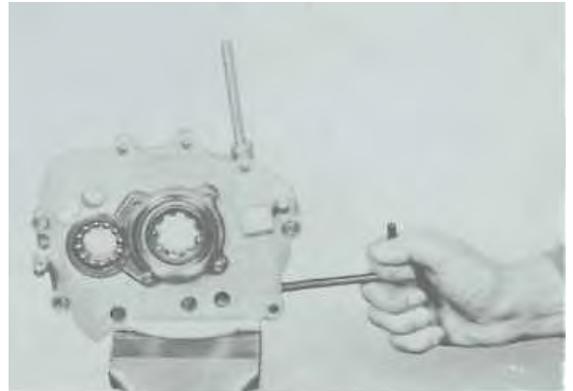


Fig. 79



Fig. 78

Reassembly

1. Clean all parts and check for wear.
2. Heat intermediate plate to approx. 120°C (248° F) and insert the four-point ball bearing and the double-row ball bearing in such way that the race flange seats well on the intermediate plate; grease and insert into bearing any loose bearing balls.

2. Heat intermediate plate to approx. 120° C (248° F) and press out the four-point ball bearing and the double-row ball bearing using appropriate tools.
3. Drive dowel pins out of intermediate plate.
4. If necessary, individually remove detent bushings using special tool P 66a.

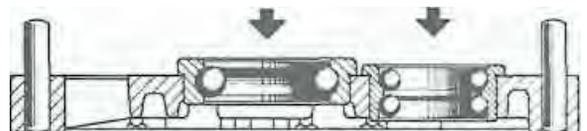


Fig.

3. Position bearing brace plate.



Fig. 81

4. Insert retaining bolts and lock plates, tighten nuts to 2.5 mkp (18 lbs/ft), and secure by bending lock tabs (check for proper lock plate positioning).



Fig. 82

5. Install detent bushings with special tool P 262.

- a. Drive long bushing to collar of driver, P 262.
- b. Drive short bushing to 2nd mark on driver, P 262.
- c. Drive the middle-long bushing to 1st mark on driver, P 262.

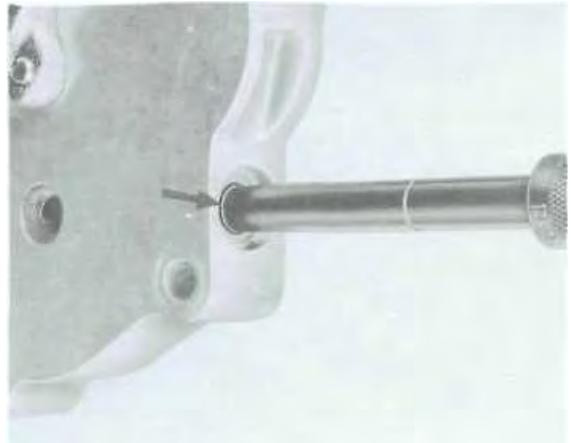


Fig. 83

Caution:

Make sure that none of the 3 bushings protrude into the selector shaft bores.

See 1 RA, Fig. 41, for detent bushing arrangement.

Reconditioning Differential

Special Tools

P 257/1 Driver for installing retaining pin in spider gear shaft

P 257/2 Driver for removing retaining pin from spider gear shaft

P 263 Block for removing differential side bearings

P 264 Driver for installing differential side bearings

General

The differential can be removed without removing the engine/transmission assembly. However, if the work requires adjustments or replacement of parts, it is of advantage to remove the transmission from vehicle.

See 1 EN, Removing Power-transmission Unit.

When performing work on the differential with transmission in vehicle, detach both rear axle half-shafts at differential flanges; also, detach clutch cable and the rear throttle linkage.

See Point 2,4, 5 and 6, 1 RA, for instructions pertaining to removal of the differential.

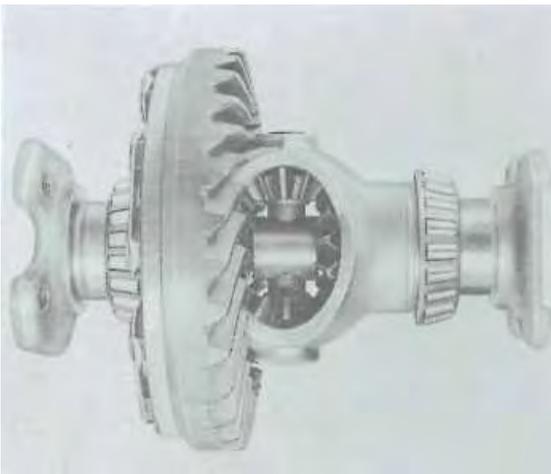


Fig. 84

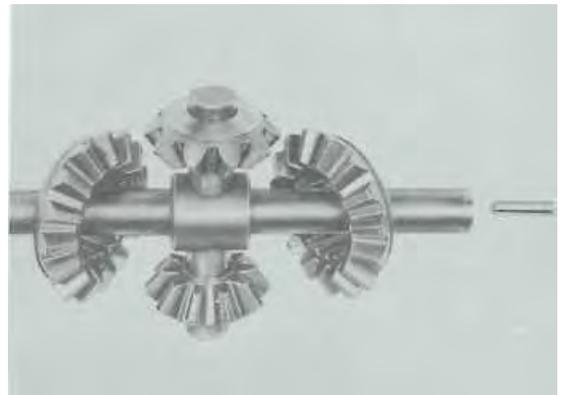


Fig. 85

Disassembly

1. Remove differential side bearings with a puller and special tool P 263.

Note:

Take note of spacer thickness for proper reassembly.



Fig. 86

2. Remove shaft retaining pin with special tool P 257/2.



Fig. 87

3. Remove spider gear shaft using a driver, remove side gear shaft.



Fig. 88

4. Turn spider gears to the side and remove through openings in differential carrier.
5. Remove differential side gears through the larger, oval opening in differential carrier.
6. Drive bolt locking tabs back, unscrew bolts and remove ring gear.

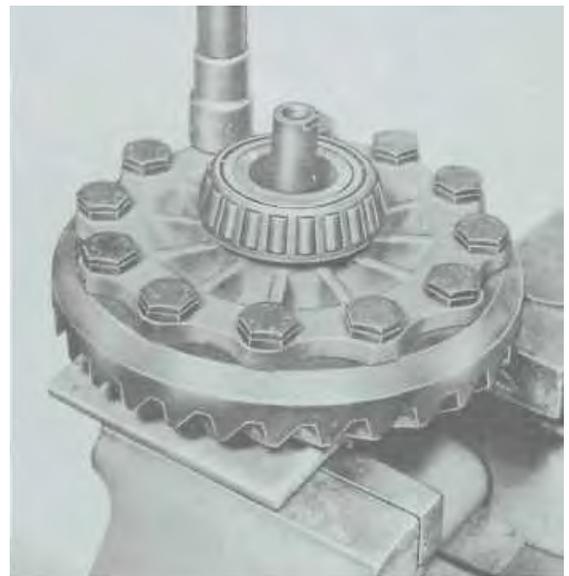


Fig. 89

7. Clean all parts.

Checking Differential

1. Check differential carrier for signs of wear at the seats of side and spider gears, and side bearings; replace carrier if necessary.
2. Inspect side and spider gears for condition of gear teeth and especially signs of wear at the spherical seats; replace if necessary.
3. Check spider gear shaft and side gear splines as well as axle joint flanges for signs of wear; replace if necessary.
4. Check side bearings for wear or damage. If necessary, replace together with bearing outer races in housing or side cover.

Note:

Up to transmission No. 100 268, axial preload for the differential side bearings was determined by diaphragm springs. Gear backlash was, and still is, adjusted by spacer SI located under the side bearing on ring gear side.



Fig. 90

Caution:

To obtain the desired diaphragm spring effect, the inner race of the side bearing must be free to move sideways on the carrier trunnion when the springs are installed.

When replacing a differential carrier designed for use with diaphragm springs with a new part, the springs can no longer be used due to changed design. The new carrier should be installed with spacers SI and S 2 placed beneath the side bearing follow instructions under Reassembly, below.

Differential carriers which still have the required trunnion length for use with diaphragm springs but also have been modified for use with spacers alone have to be assembled with a 5 mm spacer ring under the S 2 spacer.

Reassembly

Reassemble differential in reverse order of the above, noting the following points:

1. Coat seats of side and spider gears inside the differential carrier with an MoS₂ compound. Insert side gears through oval opening in carrier and position with the aid of axle flanges.
2. Insert spider gears through opening in carrier and position opposite from each other so that the shaft will pass through; it may be necessary to reset the gears in teeth to align with shaft.



Fig. 91

3. Rotate spider gears until their bores align with those in carrier. Insert side gear shaft, drive spider gear shaft in, orienting the roll pin bore towards the axles.

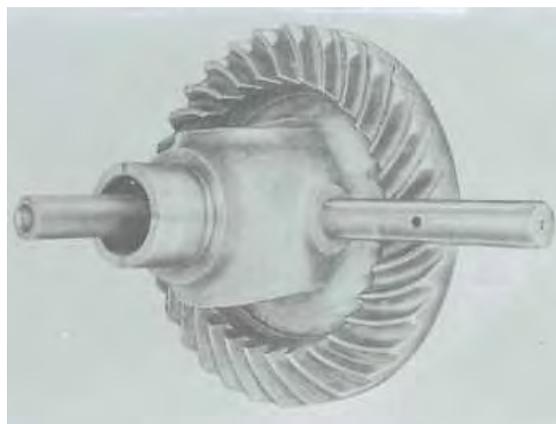


Fig. 92

4. Insert roll pin in special tool P 257/1 and drive into place, in the side and spider gear pins, to stop. (Remove axle flanges prior to assembly.)



Fig. 93

5. Place ring gear onto differential carrier flange and tighten hex bolts to 10 - 12 mkp (72.3 to 86.8 lb ft).



Fig. 94

7. Place appropriate spacers on trunnions and install side bearings with special tool P 264.



Fig. 96

6. Insert bolt locking plates into grooves in bolt heads, tighten open ends with pliers to firmly connect the plates with bolt heads, and secure bolts by bending plates down, over one of the hex bolt flanks.



Fig. 95

8. When replacing outer races of side bearings, heat transmission housing or the cover, to approx. 120° C (248° F) and install outer races with an appropriate tool.

Note:

The ring gear must be readjusted whenever a new differential carrier is installed (see 10 RA and 12 RA).

General

Quiet operation and long service of the rear axle drive depends on proper adjustment of the ring gear and pinion. For this reason the pinion shafts and ring gears are matched during production on special test benches with the object of obtaining the best contact pattern and least possible noise in both directions of rotation. Minimum noise characteristics are achieved by resetting the pinion shaft axially while keeping the ring gear within tolerances of determined gear backlash of 0.12 to 0.18 mm. The deviation r from the designed adjustment position (blueprint value R) is established and etched into the pinion face. Every pinion ring gear set is marked with mating numbers and can be replaced only as a set.

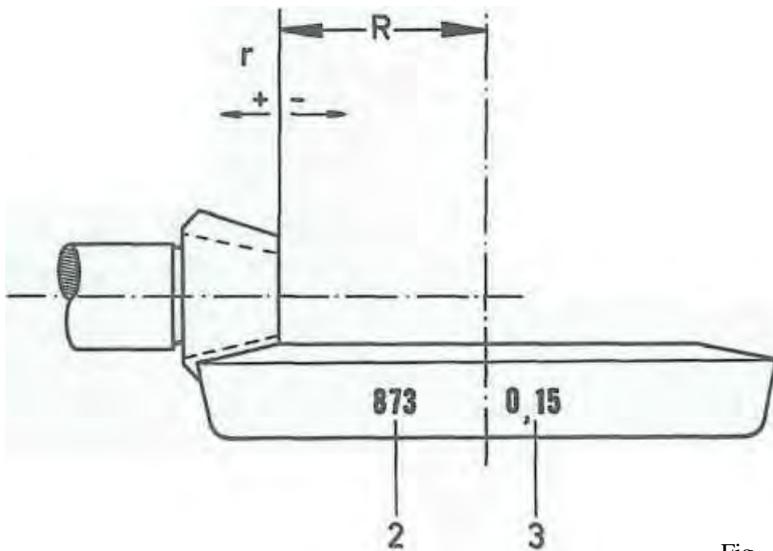
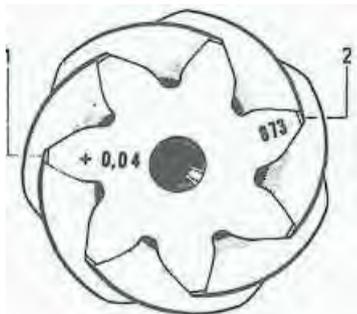


Fig. 97

- R Blueprint value (63.50 mm)
- r Deviation from R+ or - shown in 1/100 mm (+4) or in mm (+0.04)

- 1 Deviation r
- 2 Mating number
- 3 Backlash

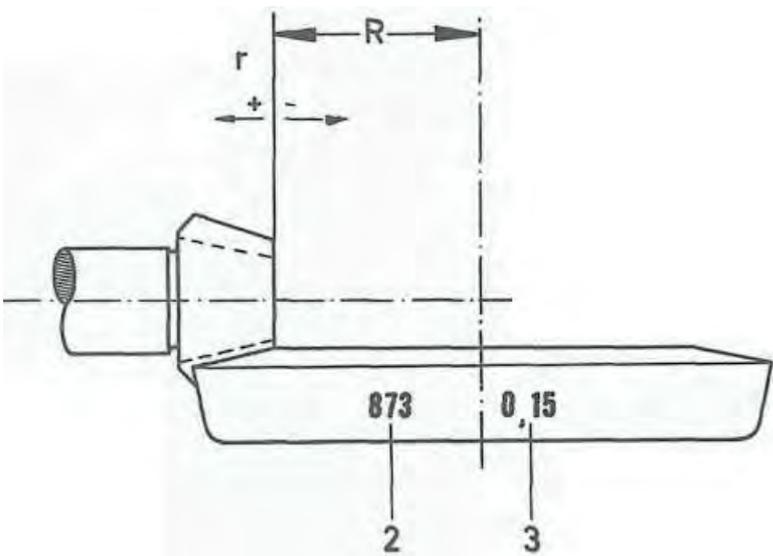


Fig. 97a

- From model 70 on
- R Blueprint value (63.20 mm)
- r Deviation from R+ shown in ;/100 mm (N 18)

- 1 Deviation r
- 2 Mating number
- 3 Backlash

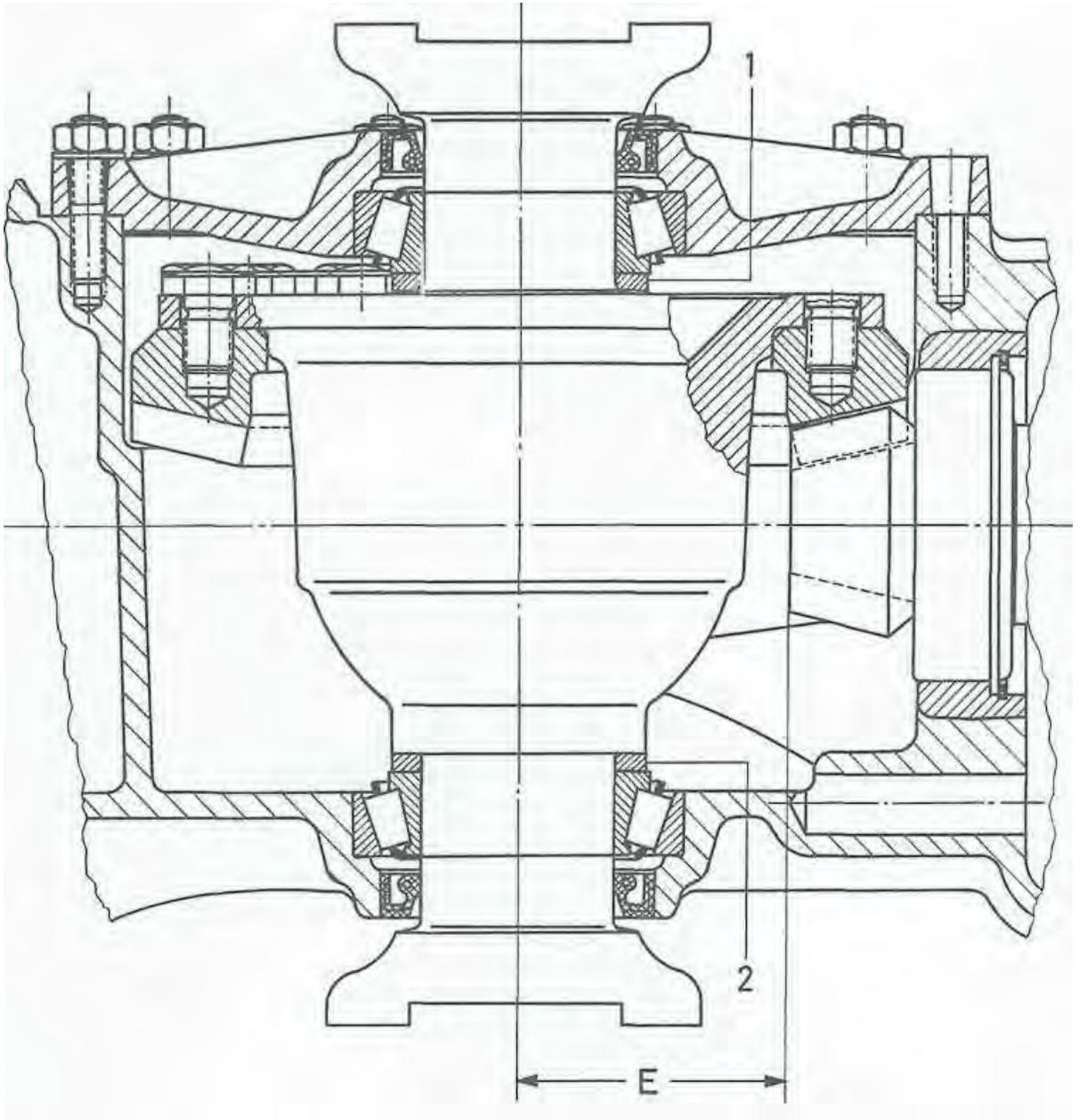


Fig. 98

- 1 Spacer S 1
- 2 Spacer S 2
- E Adjustment value

Meticulous care and cleanliness in all service operations is an essential prerequisite for good results.

Determining Spacer Thickness for Ring Gear Adjustment

Special Tools

P 261 Torsiometer, 0-25 cmkp

P 263 Block - for removing differential side bearings

P 264 Driver - for installing differential side bearings

1. Make sure that the side bearing outer races are well seated in the transmission housing, or cover.
2. Install on the ring gear side of the utilized differential carrier a 3.5 mm thick spacer (S 1), and a 3.0 mm spacer (S 2) on the other side, placing the spacers under the side bearings (install side bearings with special tool P 264).
3. Insert differential with side bearings into transmission housing, place housing cover (without oil seal) together with a 0.20 mm thick gasket onto housing.
4. Slightly tighten with 2 nuts (across) the housing cover against the side bearing and check gap between cover and gasket with a feeler gauge (nominal value for side bearing preload is approx. 0.15 mm) (.006 in.).



Fig. 99

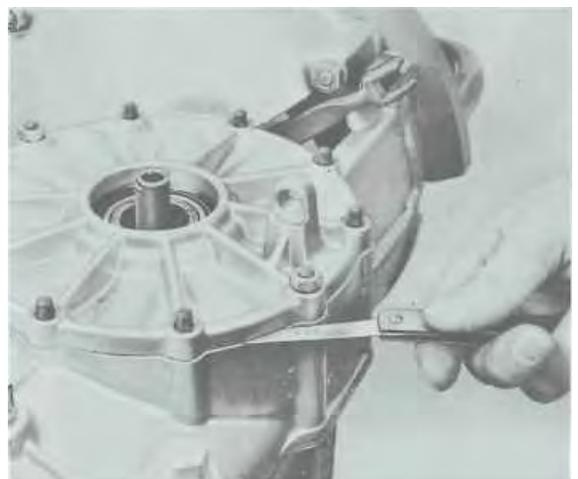


Fig. 100

- Select ring gear side spacer (S 1) of thickness permitting a preload clearance of 0.15 mm (.006 in); mount spacer using special tools P 263 and P 264.

Example:

Clearance determined with feeler gauge 0.40 mm
 Minus desired preload clearance 0.15 mm
 The installed 3.5 mm spacer (S 1) to be replaced with one 0.25 mm thinner, i. e., 3.25 mm

- Tighten housing side cover; use 0.20 mm gasket.

Note:

All nuts must be tightened to 2.5 mkp (18 lbs/ft) to obtain the required effect,

- Insert axle flange, place thrust washer and tighten stretchbolt a little.

- Measure drag of the installed differential with special tool P 261

Note:

When measuring differential drag, the pinion shaft must not be engaged and the axle flange oil seal in housing side cover must be removed to exclude additional drag.



Fig. 101

The differential drag should be between 18 and 24 cmkp (15.6 and 20.8 lbs/in); this will indicate that the side bearing is under proper preload. If the above value has not been obtained, replace the spacer with one of proper thickness.

- Withdraw differential, remove both side bearings, and measure thickness of all spacers using a micrometer and measuring each spacer at four different points. The total thickness of all spacers shows spacer thickness for the ring gear adjustment.

In preparation for the subsequent adjustment of the pinion and ring gear, the spacer S1 should be 0.1 mm thinner than one-half of spacer total, and spacer S 2 should be 0.1 mm thicker,

Example:

Total thickness of spacers S1 + S 2 = 6.25 mm

$$\begin{aligned} \text{Thickness of spacer S 1 } \left(\frac{6.25 \text{ mm}}{2} \right) &= 3.125 \text{ mm} \\ &- 0.100 \text{ mm} \\ &3.025 \text{ mm} \end{aligned}$$

$$\begin{aligned} \text{Thickness of spacer S2 } \left(\frac{6.25 \text{ mm}}{2} \right) &= 3.125 \text{ mm} \\ &+ 0.100 \text{ mm} \\ &3.225 \text{ mm} \end{aligned}$$

The spacers are available in increments of 0.10 mm from 2.5 mm to 3.5 mm.

Due to a 0.25 mm washer, adjustments to nearest 0.05 mm are possible. The calculated thickness of spacers required should be rounded off to match actual (available) spacer thickness, although it should be ascertained that the rounding-off does not alter the value of total spacers required (S 1 + S2)

Example:

Calculated spacer thickness

$$S 1 + S 2 = 3.025 + 3.225 = 6.25 \text{ mm}$$

Rounded-off spacer thickness of

$$S 1 + S 2 = 3.0 + 3.25 = 6.25 \text{ mm}$$

Measure spacer thickness at four points of each spacer using a micrometer. Permissible thickness variation is 0.02 mm. Before measuring, remove any burr that may be on the edges of spacers.

11 RA

Adjusting Pinion Shaft

Special Tool

P 258 Dummy carrier with dial gauge

General

Determine adjustment value E from known blue-print value R (63.50), plus or minus deviation r which is etched onto pinion face (see 3 RA). From model 70 on - $R = 63.20 + \text{deviation } r$ "N". The shaft has been roughly preadjusted at time of reassembly through placement of appropriate spacers (see 3 RA),

Adjustment

1. Insert preassembled intermediate plate, with gears and selector shafts, into transmission housing, omitting the paper gasket; place spacer bushings onto 4 opposing housing studs and tighten nuts in cross-wise fashion.

Note:

The pinion shaft stretchbolt must be tightened to 11 - 12 mkp (79-86 lbs/ft) prior to taking measurements.

2. Place dummy carrier P 258 onto gauge setting plate and fasten dial gauge to a preload of 1 mm (small pointer to 1, large pointer to 0).



Fig. 102

3. Install dummy carrier P 258, with side bearings, into transmission housing. Make sure that the dummy carrier is under an axial preload of approx. 0.1 mm when the side cover has been installed. In no case should the dummy carrier be free to move axially when the measurements are being taken.

The dummy carrier can be installed without axial play with the aid of differential spacers.

4. Carefully turn the dummy carrier until the gauge sensor pin comes to right angle with the face of the pinion. At this point, the gauge pointer will show the highest reading, i.e., the one to be noted.

A notch in the flank of the dummy carrier shows the location of the gauge sensor pin (see Fig. 103).

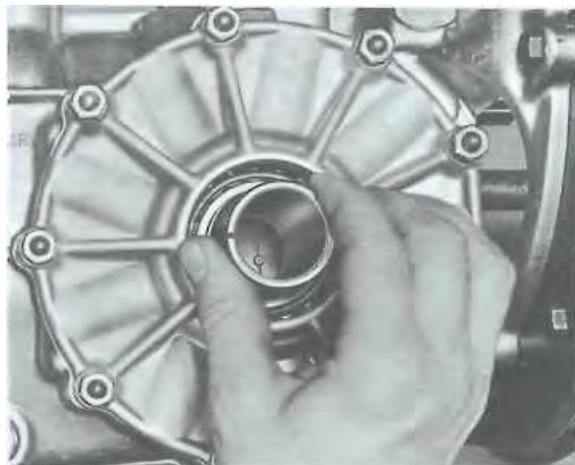


Fig. 103

Note the following when reading the dial gauge:

The distance from the center axis of the dummy carrier to its resting base at the setting plate is indicated on the side of the dummy carrier as actual value, for instance 53.98. The distance from the calibrating surface of the setting plate to the resting base for the dummy carrier is indicated on the side of the gauge setting plate, for instance 9.52.

Both values added together represent the value to which the gauge has been set.

Example: Actual value of dummy carrier 53.98
Actual value of setting plate +9.52
 Actual adjustment value: 63.50

If the gauge reading differs, in clockwise direction, from the adjusted value of, for example, 63.50 mm, then the distance is smaller than 63.50 mm and that shortage must be deducted from the value of 63.50 mm.

Example:

If the small pointer is between 1 and 2, the large one at 0.24 mm:

Gauge adjustment 63.50mm
Minus measured value -0.24 mm
 Distance to face of pinion 63.26 mm

Adjustment value E (as example) 63.54 mm
Minus distance to face of pinion -63.26 mm
 Thickness of paper gaskets 0.28 mm

Thus the pinion shaft must be moved away from the ring gear center by 0.28 mm. This is accomplished by inserting paper gaskets forming a thickness of 0.3 mm; second digit decimal fractions are rounded off as follows: 3 and up = into 5, 7 and up = into 10.

If the gauge reading differs, in counter-clockwise direction, from the adjusted value of 63.50 mm, then the distance is larger than 63.50 and that excess must be added to the value of 63.50 mm.

Example:

If the small pointer is between 1 and 0, the large one at 0.08 mm:

Gauge adjustment 63.50 mm
 Plus measured value +0.08mm
 Distance to face of pinion 63.58 mm

Adjustment value E (as example) 63.68mm
 Minus distance to face of pinion -63.58 mm
 Thickness of paper gaskets 0.10 mm

NOTE:

It is permissible to install paper gaskets in thickness of 0.10 to 0.50 mm between the housing and intermediate plate. Should this be insufficient for obtaining proper adjustment, it will be necessary to disassemble the pinion shaft again and change the adjustment shims appropriately.

Paper gaskets are available in thicknesses of 0.1, 0.15, and 0.2 mm.

Subsequent to the installation of the paper gaskets, the adjustment value E must be checked again; deviations of ± 0.03 mm are permissible. It is not required to check the gear contact pattern again.

Adjusting Ring Gear Backlash

Special Tools

P 259 Clamp and gauge holder for measuring ring gear and pinion backlash

P 263 Block for removing differential side bearings

P 264 Driver for installing differential side bearings

Adjustment

1. Insert into transmission housing the preassembled intermediate plate with gears and selector shafts together with the paper gaskets determined at time of pinion shaft adjustment. Place spacer bushings onto 4 opposing studs in housing and tighten.

Note:

The pinion shaft stretchbolt must be tightened to 11 - 12 mkp (79-86 Ibs/ft) prior to taking measurements.

2. Insert into transmission housing the differential unit together with side bearings and spacers determined in 10 RA (spacers S 1 and S 2).

3. Install side cover with a 0.20 mm paper gasket.

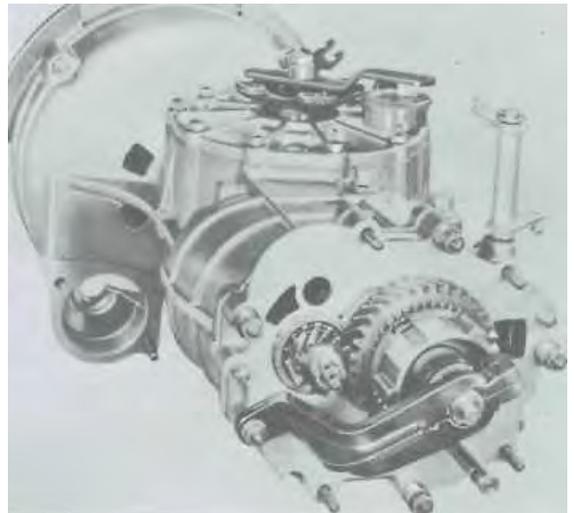
Caution:

When tightening the side cover retaining nuts, continuously check to ensure that a certain side play exists. In no case is it permissible to allow the pinion and ring gear to jam or bind.

4. Tighten all side cover retaining nuts to 2.5 mkp (18 Ibs/ft).

5. Block pinion shaft through stretchbolt and special tool P 259 (see Fig. 104).

6. Insert axle flange into differential, place dial gauge holder P 259 onto axle flange and tighten with an appropriate bolt.



7. Insert dial gauge into holder. Tighten holder look screw and holder retaining bolt (screwed into differential shaft) so that the gauge sensor pin comes into contact with the base of the clutch conduit bracket.

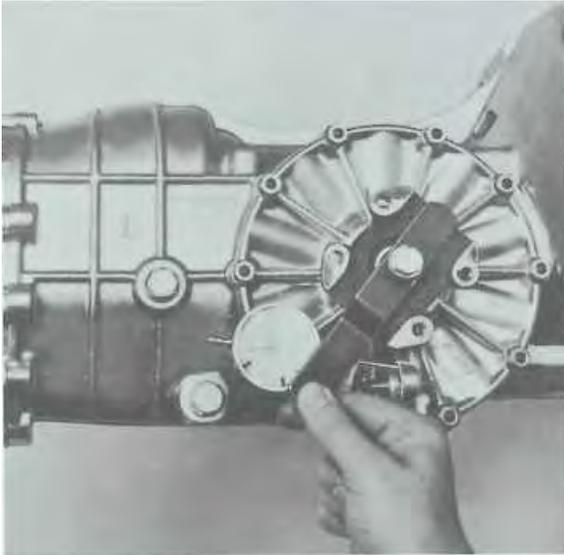


Fig. 105

8. Gently move dial gauge from stop to stop and record amount of gear backlash.

9. Repeat the measurement at every 90° of ring gear rotation. The values must not differ by more than 0.05 mm between each point.

Note:

The exact amount of gear backlash is etched into the ring gear (see Fig. 97). A gear backlash of 0.12 to 0.18 mm is permissible.

10. The spacers S 1 and S 2 can be replaced with special tools P 263 and P 264 until the correct axial (flank) play has been obtained. Particular care must be taken to ensure that the total spacer thickness is not changed.

11. Check axle flange oil seals and replace if necessary.

Note:

Transmission ventilation through a labyrinth in the housing front cover and a small breather pipe has been replaced, beginning with transmission No. 100 100, by a breather screwed into the differential section of the transmission housing.

When replacing front covers in transmission preceding transmission No. 100 100, make sure that the new cover has the venting provision; if not, install a breather into transmission housing.

Removal

The breather can be removed from an assembled or disassembled transmission.

1. Unscrew breather.

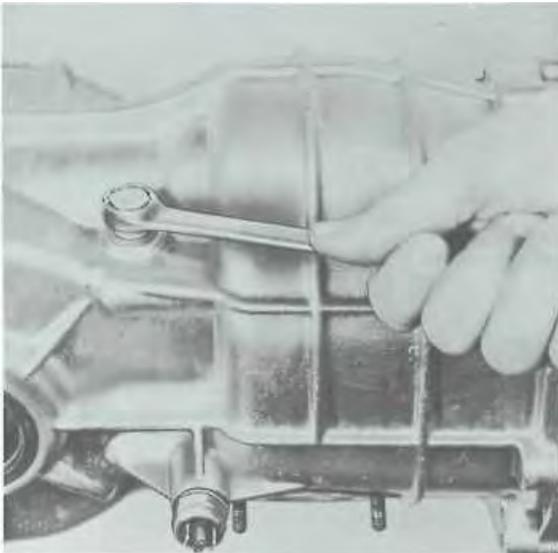


Fig. 106

Installation

1. Clean breather.
2. Screw breather in while noting the proper position of the vent bore (see Fig. 107).

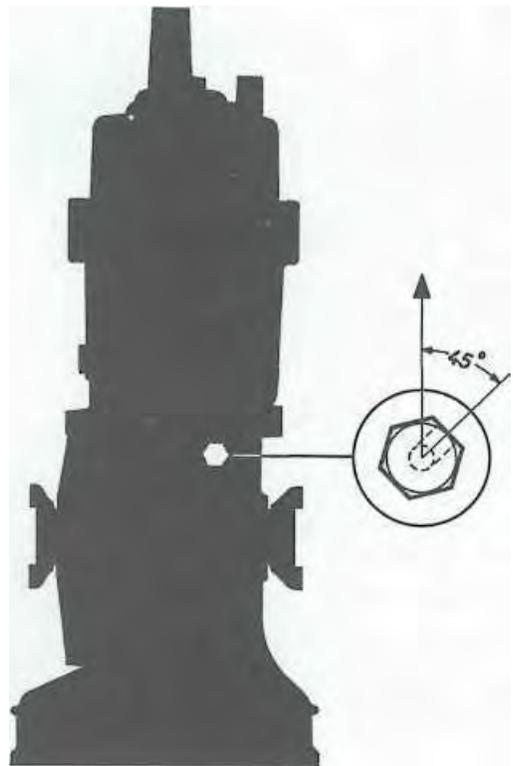


Fig. 107

Note:

When the breather bore points in the wrong direction, oil can spill through it.

General

The backup light switch is actuated by the selector shaft of 1st and reverse gear over an actuating pin. When reverse gear is selected, a slanted tab pushes the actuating pin outward and actuates the switch.

Installation

1. Insert actuating pin, with installed retaining ring, with its longer, rounded end into the guide bore in transmission housing.
2. Screw the switch in and make sure that the gasket is well seated.



Fig. 108

Removal

The switch can be removed when transmission is in the vehicle.

1. Withdraw cover cap from switch and pull connecting wires off terminals.
2. Unscrew switch from housing and withdraw actuating pin.

- 1 Cover cap
- 2 Backup light switch
- 3 Gasket
- 4 Actuating pin with spring retainer

Removal

1. Remove transmission support.
2. Remove cover retaining nuts and withdraw cover.

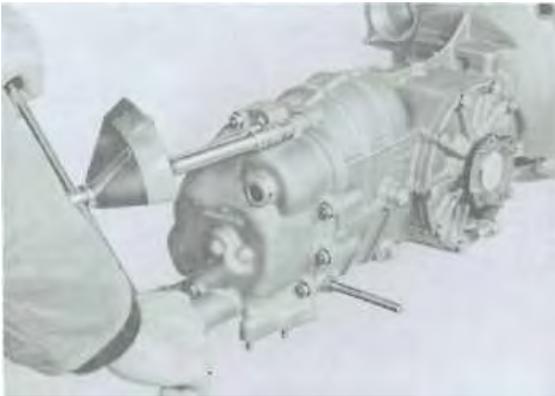


Fig. 109

Disassembly

1. Remove reverse speed gear and loose bearing parts.
2. Remove tachometer drive lock screw and withdraw elbow drive.



Fig. 111

Caution:

Parts of reverse gear can fall out.

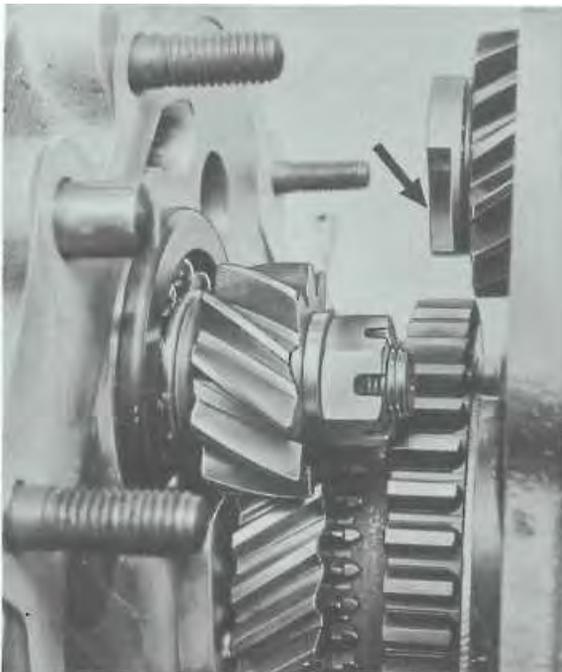


Fig. 110

3. Remove transmission cover gasket.

3. Drive out retaining pin for reverse gear shaft. Heat cover to approx. 120° C (248°F) and drive the shaft inward to remove.
4. Press thrust washer (bronze) off reverse gear shaft.

Reassembly

1. Check oil seal of inner shift rod and replace if necessary.
2. Check reverse gear, shaft, thrust washers, and needle bearings for wear, replace if necessary (note mating numbers).

- Heat cover to approx. 120° C (248° F) and install reverse gear shaft making sure that the oil passage in shaft points down (see Fig. 112).



Fig. 112

- Drive retaining pin in.
- Heat bronze thrust washer to approx. 120° C (248° C) and push onto reverse gear shaft until it firmly sets against the cover. The washer must seat well against the cover in order to prevent a reduction of axial play of the reverse gear.
- Install bearing cages and spacer bushing.



Fig. 113

- Install reverse gear, axial thrust needle bearing, and thrust washer.



Fig. 114

- Insert tachometer elbow drive into cover, make certain that the orifice for the set screw lines up with that in cover (see Fig. 115). Check O-ring, replace if necessary. Install set screw and washer, tighten to 1.6 - 1.8 mkp (11.6 -13, 5 lb/ft)



Fig. 115

9. Place new 0.2 mm thick paper gasket onto the intermediate plate.
10. Install front housing cover; to bring the helical reverse gear past the sliding gear of reverse and 1st speed, pull the reverse gear and its axial thrust needle bearing with thrust washer as far to the end of the shaft as possible (outwards).

Note:

The machined recess in the thrust washer must align with the outer collar of the pinion shaft ball bearing.

11. Tighten cover retaining nuts to 2.1 - 2.3 mkp (15.2 - 16.6 lb/ft)
12. Install transmission support.

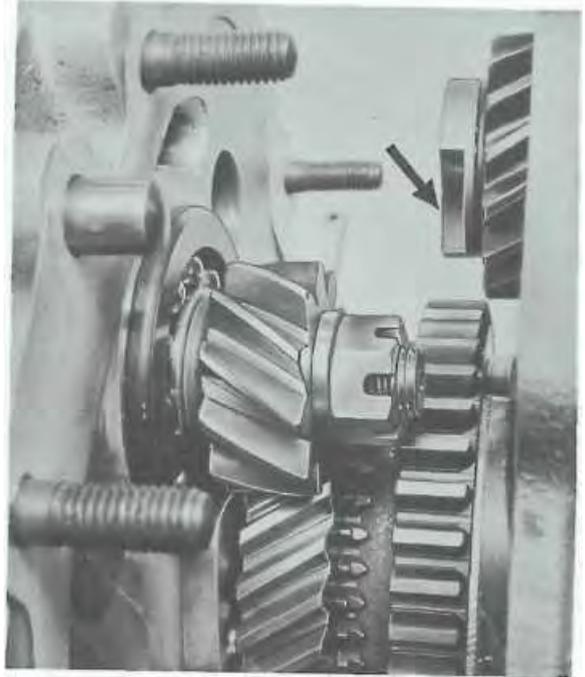


Fig. 116

Special Tools

P 37 Holder for input shaft

P 251 Socket for pinion shaft stretchbolt

General

The tachometer is driven by the transmission pinion shaft over a drive pinion, connecting shaft, and elbow drive, all located in the transmission front cover.

The drive pinion is attached to the pinion shaft stretchbolt by means of a retaining pin.

Tachometer Drive Components



Fig; 117

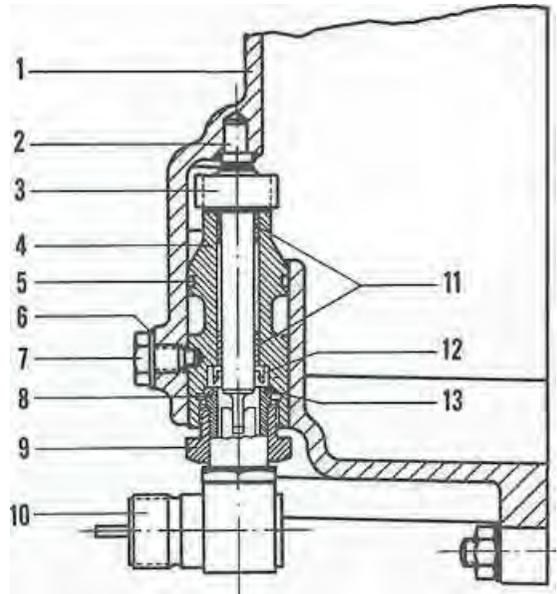


Fig. 118

- | | |
|-------------------------------|----------------------|
| 1 Front cover of transmission | 8 Elbow drive jacket |
| 2 Thrust stud | 9 Coupling nut |
| 3 Connecting shaft | 10 Elbow drive |
| 4 Guide bushing | 11 Support bushings |
| 5 O-ring | 12 Oil seal |
| 6 Spring ring | 13 Centering disc |
| 7 Hex bolt (set screw) | |

Removal

Note:

The entire elbow drive (including connecting shaft) can be removed when the transmission is in the vehicle providing that the transmission is placed on a prop and the transmission support removed from the housing. However, if it becomes necessary to remove the gear shaft, the transmission must be removed from the vehicle and the transmission housing cover withdrawn from the transmission (see 1 EN and 15 RA).

1. Remove transmission support.
2. Remove tachometer drive set screw and pull out elbow drive.



Fig. 119

3. Remove housing front cover (see 15 RA).
4. Remove pinion shaft stretchbolt using special tool P 251 (transmission in gear, input shaft blocked with special tool P 37).
5. Drive out retaining pin from stretchbolt (pin secures tachometer pinion shaft) (steps 3 to 5 apply only to removal of tachometer pinion shaft).

Disassembly

1. Place guide bushing in a vise (use soft-metal jaw covers). Remove coupling nut and pull out elbow drive and centering disc.



Fig. 120

2. Pull out connecting shaft from guide bushing.
3. The support bushings of the connecting shaft and the oil seal can be withdrawn with a suitable tool, if necessary.

Reassembly

Reassembly is accomplished in reverse order of the above by noting the following points:

1. Wash parts, inspect for wear, replace if necessary.
2. Tighten coupling nut connecting elbow with guide bushing; make sure that the two parts are so oriented that the set screw orifice and the connecting end of the tachometer drive point in the same direction (see Fig. 120).
3. Insert complete drive assembly (with connecting shaft) into transmission cover and make sure that the set screw orifice lines up with mat in the cover (see Fig. 121). Check O-ring, replace if necessary. Install set screw and washer, tighten to 1.6-1.8 mkp (11.6-13.5 lb/ft).



Fig. 121

4. Make sure that the gear shaft bushing and the thrust stud of the connecting shaft have been installed in the cover.
5. If the pinion shaft stretchbolt has been loosened it must be tightened with special tools P 251 and P 37 to 11 - 12 mkp (79-86 lbs/ft).
6. Install front transmission cover (see 15 RA).

Special Tool: VW 244b Driver

General

The input shaft oil seal can be replaced without having to disassemble the transmission. The power-transmission assembly must be removed from the vehicle and the transmission detached from the engine (see 1 EN).

Removal

1. Remove the power-transmission assembly and detach engine from transmission (sec 1 EN).
2. Loosen cylinder screw in clutch release lever, detach spring, and remove release lever with throwout bearing.

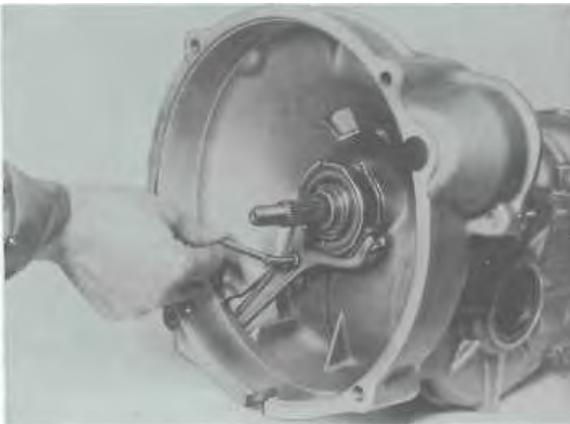


Fig. 122

3. Remove hex nuts from throwout bearing guide and remove guide.

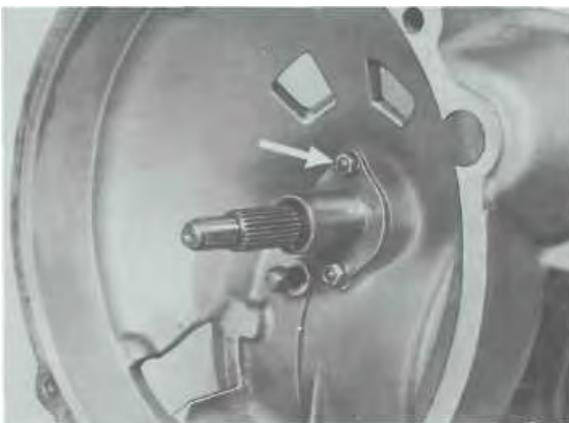


Fig. 123

4. Remove defective oil seal with an appropriate tool, possibly with a medium-size screwdriver.

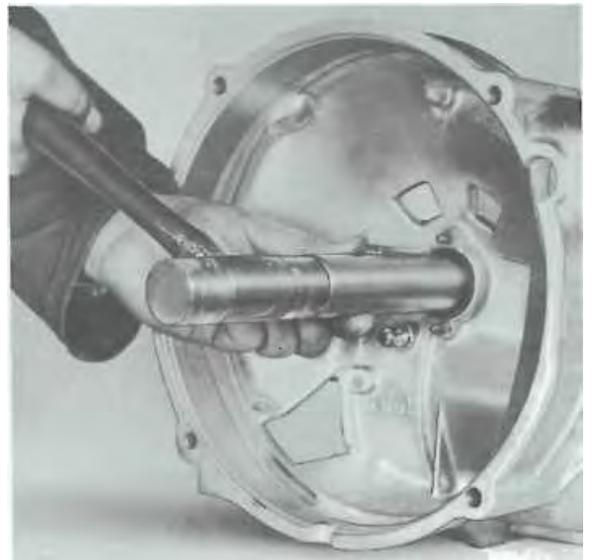
Caution:

Do not damage bore or contact surface.

Reassembly

Note the following points for reassembly:

1. Thinly coat outer circumference of oil seal with gasket compound. Coat with oil the oil seal race on shaft as well as sealing part of seal.
2. Push oil seal onto input shaft and drive into housing with special tool VW 244b.



Caution:

Push the oil seal gently to keep the inner spring from leaving its seat.

Note:

The oil seal is replaced in the same manner when the transmission is disassembled. However, the defective seal can be easier removed by driving it out of the housing with a pipe tool inserted through the empty gear compartment.

Removing

1. Remove engine-transmission unit and remove transmission from flange (see 1 EN).
2. Release dowel pin on clutch withdrawal fork lift out return spring and remove withdrawal fork and thrust bearing.



Fig. 125

Warning:

Do not wash thrust bearing or immerse it in liquid as otherwise the original grease content will be dissipated (see 19 RA).

3. Unscrew ball pin and remove together with sealing washer.

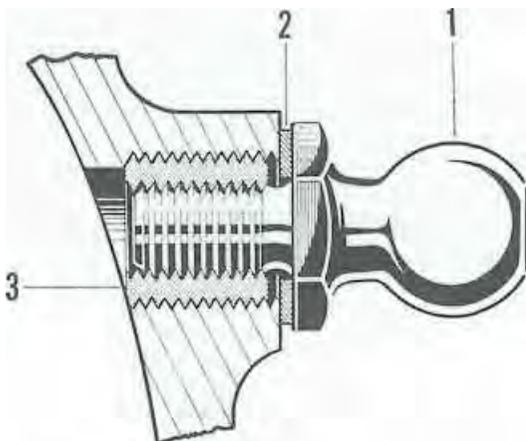


Fig. 126

- 1 Ball pin
- 2 Sealing washer
- 3 Threaded insert

Examining for wear

Examine ball pin and bush for visible wear and if necessary fit new parts.

Note:

Up to Transmission No. 102082 or 222706, the ball pin for the clutch withdrawal fork was secured in the transmission housing with paste. (See fig. 127)



Fig. 127

Refitting

Refitting is a reversal of the removal procedure, particular attention being given, however, to the following points:

1. Tighten ball pin and sealing washer to a torque of 2. 1 to 2. 3 mkp (15. 18 to 16. 63 lb. ft.)
2. Rub some MoS, paste into bushing for ball pin.
3. Smear all sliding surfaces of clutch thrust bearing with MoS2 paste.
4. Tighten dowel pin of the withdrawal fork to a torque of 7. 23 lb. ft. (1. 0 mkp).

Removal

1. Remove power train and detach transmission from engine (see 1 En).
2. Loosen Allen bolt in clutch release fork. Unhook spring and withdraw throwout bearing and release fork.

Inspection

The throwout bearing is service free. It should not be washed with cleaning gasoline or solvents but only wiped with a clean rag. Throwout bearings which are dirty inside or are running loud must be replaced.

NOTE:

The new clutch throwout bearing, Part Nr. 901.116.081.11, is being installed commencing with the below shown dates:

Vehicle Type 911 S	from production beginning
Vehicle Type 911	from 12. Jan. 1967
Vehicle Type 912	from 12. Jan. 1967

The new clutch throwout bearing, Part Nr. 901.116.081.11, replaces the former bearing version and can be subsequently installed without other modifications.

Caution:

The new clutch throwout bearing may be used only in conjunction with both plastic guides, Part Nr. 901.116.825.11. Also, the bearing must be in free suspension in the release fork; if necessary, the plastic guides should be dressed with fine crocus cloth.

Installation

1. Coat all rubbing surfaces of the throwout bearing with MO S2 paste.
2. Torque Allen bolt in release fork to 1.0 mkp (7.23 Ibs/ft).

Caution:

Commencing with the introduction of the modified clutch release with live throwout bearing, the return spring, Part Nr. 901.116.731.01, is no longer in use. The modified clutch release may be spotted through a spring located on the clutch pedal shaft where it pushes the clutch pedal towards the floorboard, that is, the clutch pedal free travel can be checked by pulling the clutch pedal away from the floorboard.

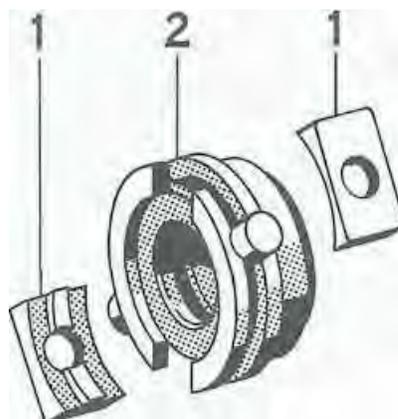
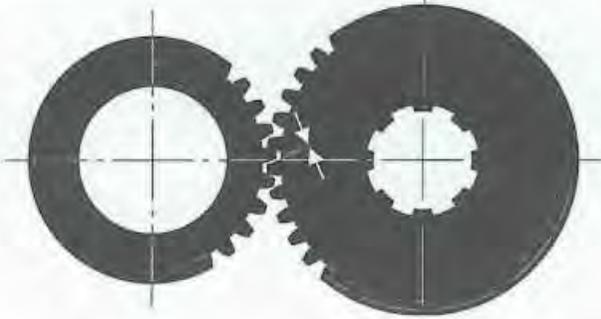
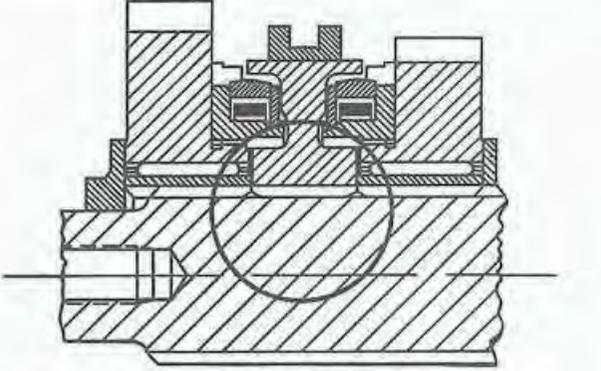
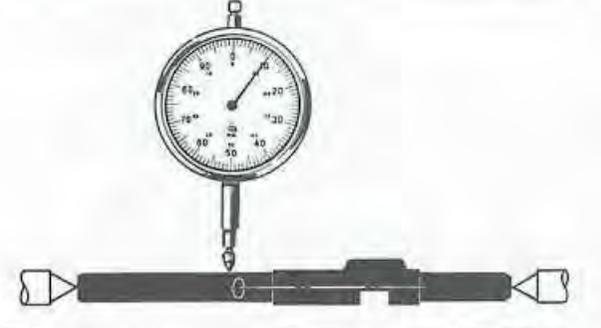


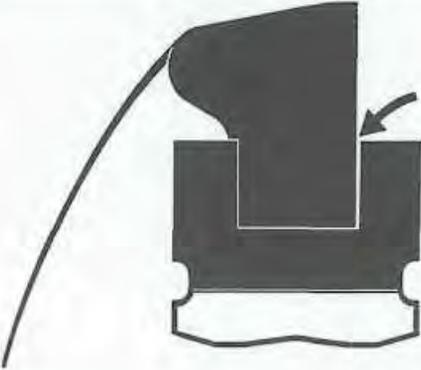
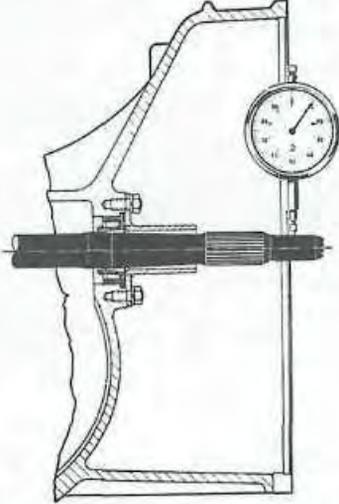
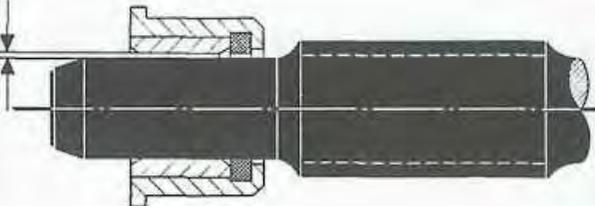
Fig. 127a

- 1 Plastic guide
- 2 Clutch throwout bearing

Revised Page 1 - March 1967

Transmission tolerances

Measuring Point	Fitted tolerances (when new i n mm)	Wear limit in mm	
<p>1. Backlash between gears I and II</p> <p>1st speed 2nd speed 3rd speed 4th speed 5th speed</p>	<p>0.06 - 0.12 (0.0023" - 0.0047")</p>	<p>0.22 (0.0086")</p>	
<p>2. Loose wheels on drive shaft and first motion shaft</p> <p>1st speed 2nd speed 3rd speed end play 4th speed</p>	<p>0.3 - 0.4 (0.011" - 0.015") 0.2 - 0.3 0.2 - 0.3 (0.007" - 0.011")</p>	<p>0.5 (0.019") 0.4 0.4 0.4 (0.015")</p>	
<p>3. Selector shafts</p> <p>a) Radial play in the guides</p>	<p>0.095 - (0.0037") 0.156 (0.0061")</p>	<p>0.4 (0.015")</p>	
<p>b)</p>		<p>0.10 (0.0039")</p>	

Measuring Point	Fitted tolerance (when new) in mm	Wear limit in mm	
<p>4. Selector fork in operating sleeve</p> <p>1st and reverse speed 0.1 - 0.3 2nd and 3rd speed 0.1 - 0.3 4th and 5th speed 0.1 - 0.3 (0.003" - 0.011")</p> <p>End play</p>		<p>0.5 0.5 0.5 (0.019")</p>	
<p>5. Synchronizing rings</p> <p>1st speed 2nd speed 3rd speed 4th speed 5th speed</p> <p>Outer diameter fitted</p>	<p>76.12 - (2.996") 76.48</p>	<p>in accordance with local wear of molybdenum layer a)</p>	
<p>6. First motion shaft</p> <p>a) Run out on guide pin</p>	<p>max. 0.1 (0.003")</p>	<p>max. 0.1 (0.003") (align)</p>	
<p>b) Radial play in bushing of banjo bolt on engine</p>	<p>0.145 - (0.0057") 0.231 (0.0090")</p>	<p>0.3 (0.011")</p>	

Torque tightening figures for screws and nuts on the transmission

M 8 Hexagon nuts on transmission housing:	2,5 mkp (18,1 lb.ft.)
M 6 Hexagon nuts on guide tube:	1,0 mkp (7,2 lb.ft.)
M 6 Socket head screw for withdrawal fork:	1,0 mkp (7,2 lb.ft.)
M 8 Hexagon bolt with pin (angular drive):	2,5 mkp (18,1 lb. ft.)
M 12 drain plug on intermediate plate :	2,5 mkp (18,1 lb. ft.)
M 24 oil filter plug:	2,0-2,5 mkp (14,4 - 18,1 lb. ft.)
M 24 magnetic oil drain plug:	2,0 - 2,5 mkp (14,4 - 18,1 lb. ft.)
Hexagon bolt for clamping plate of intermediate plate:	2,5 mkp (18,1 lb. ft.)
M 24 Hexagon nut on first motion shaft:	10 - 12 mkp (72,3 - 86,8 lb.ft.)
M 12 Crown nut on first motion shaft:	6,0 - 6,5 mkp (43,4 - 47,0 lb. ft.)
M 14 crown nut on first motion shaft (reinforced type):	9,0- 11,0 mkp (65,1 - 79,6 lb. ft.)
M 12 expansion screw or drive shaft:	11-12 mkp (79,6 - 86,8 lb.ft.)
M 8 Hexagon bolt of selector forks:	2,5 mkp (18,1 lb.ft.)
M 12 Hexagon bolts for securing crown wheel:	10 - 12 mkp (72,3 - 86,8 lb.ft.)
M 10 expansion screw for joint flange of differential:	4,5-5,0 mkp (32,6 - 36,2 lb. ft.)
M 8 ball pin for withdrawal fork:	2,1-2,3 mkp (15,2 - 16,6 lb. ft.)

REMOVING AND INSTALLING GEARSHIFT LINKAGE

Removal

1. Remove both front seats.
2. Remove gearshift knob, heater knob, dust boot, and tunnel cover.
3. Remove M 8 and M 6 gearshift base retaining bolts and withdraw base.
5. Remove dust boot from board flange in body and push forward over the gearshift rod.
6. Loosen hex bolt in shift rod clamp and drive shift rod off coupling.



Fig. 128

4. Remove retaining bolts from cover in rear of tunnel and remove cover.



Fig. 129



Fig. 130

7. Withdraw shift rod clamp and dust boot from shift rod.
8. Remove safety wire from square-head tapered screw in shift rod joint, loosen the screw and slide the shift rod joint off its base.



Fig. 131

Note:

The gearshift rod can be removed by pulling it out through the rear but only when the power train is removed from the vehicle.

9. Slide shift rod joint off shift rod.

10. Remove safety wire from square-head tapered screw, loosen screw, and withdraw shift rod coupling.

Installation

Note the following points during installation:

1. Install shift rod by sliding it in from the rear while the power train is out of the vehicle.

5. Tighten M 8 hex bolts of gearshift base to 2.5 mkp (18 Ibs/ft).

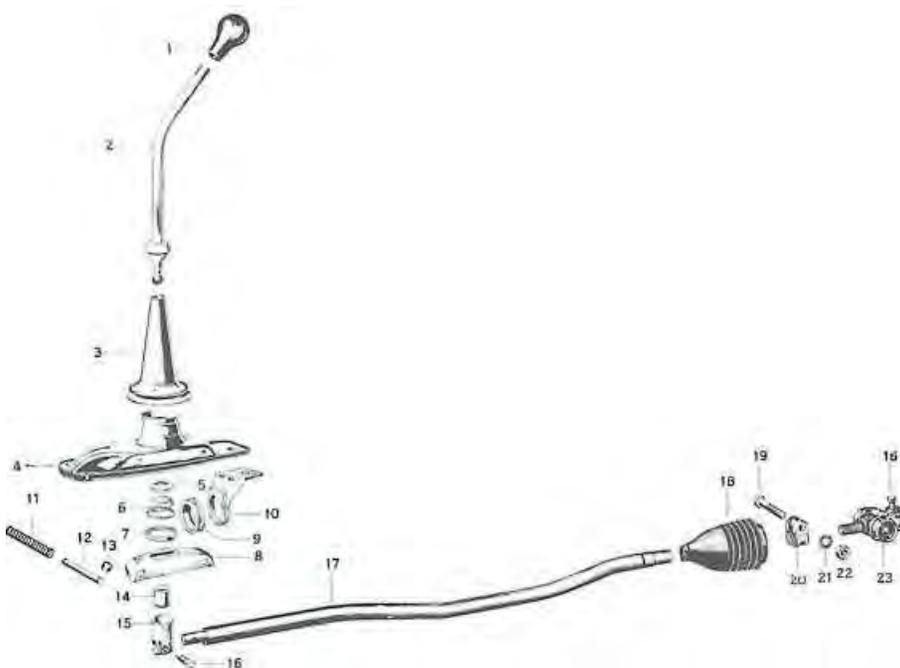
2. Tighten the square-head tapered screw securely, fasten with safety wire. Tightening torque value is 1.5 mkp (11 Ibs/ft).

3. Place shift rod clamp and dust boot onto shift rod before attaching the rod to the shift rod coupling.

6. Tighten M 6 hex bolts which secure the shift rod guide bracket to 1.0 mkp (7.2 Ibs/ft).

4. Coat the inside surface of the shift rod joint as well as the area of the guide bracket with Lithium grease (multipurpose grease).

7. Adjust gearshift linkage as outlined in section 22 RA.



- 1 Gearshift knob
- 2 Gearshift lever
- 3 Dust boot
- 4 Gearshift base
- 5 Spring seat
- 6 Gearshift spring
- 7 Spring seat
- 8 Gearshift stop plate
- 9 Guide bushing
- 10 Guide bracket
- 11 Stop plate thrust spring
- 12 Guide pin
- 13 Retainer
- 14 Ball socket
- 15 Shift rod joint
- 16 Tapered screw
- 17 Shift rod
- 18 Dust boot
- 19 Hex bolt
- 20 Clamp
- 21 Serrated washer
- 22 Hex nut
- 23 Shift rod coupling

Fig. 132

Disassembly

1. Remove plastic ball socket from gearshift lever with the help of a screwdriver.
2. Mount gearshift lever base in a vise and remove both pin retainers.



Fig. 133

3. Push one pin out about half-way.

CAUTION:

The spring now can jump out.

Place the end of a screwdriver behind the unsupported end of the spring, cover the gearshift base with a cloth to catch the spring, and force the spring out of its seat.

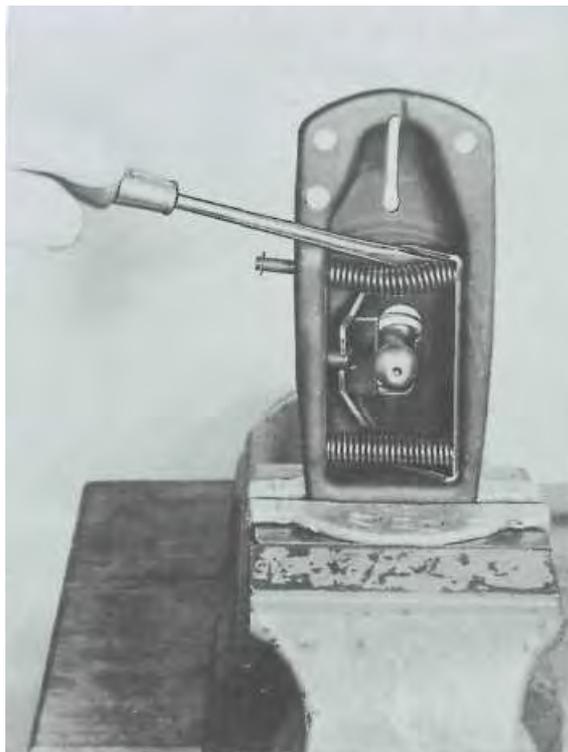


Fig. 134

4. Remove the other spring in the same way.
5. Remove gearshift stop plate.
6. Remove spring seat and spring of the gearshift lever together with the plastic spring seat.
7. Withdraw gearshift lever.
8. Clean all parts.

Inspection

Check all parts for wear or damage, replace when necessary.

Reassembly

Note the following points at reassembly:

1. Place plastic spring seat onto the shift lever spring so that the plastic seat snaps into the spring.
2. Coat the lower part of the gearshift lever well with Lithium grease (multipurpose grease) and insert the lever into the gearshift base.
3. Place 1 pin retainer on each of the two pins which guide the gearshift stop plate.
4. The gearshift thrust springs may be mounted as follows:
 - a. Install gearshift stop plate in gearshift base by installing 1 guide pin.
 - b. Place the second guide pin and retainer in position at an angle and slip the spring on.

- c. Using a modified screwdriver, press the thrust spring into proper position.

CAUTION: The spring can jump out.

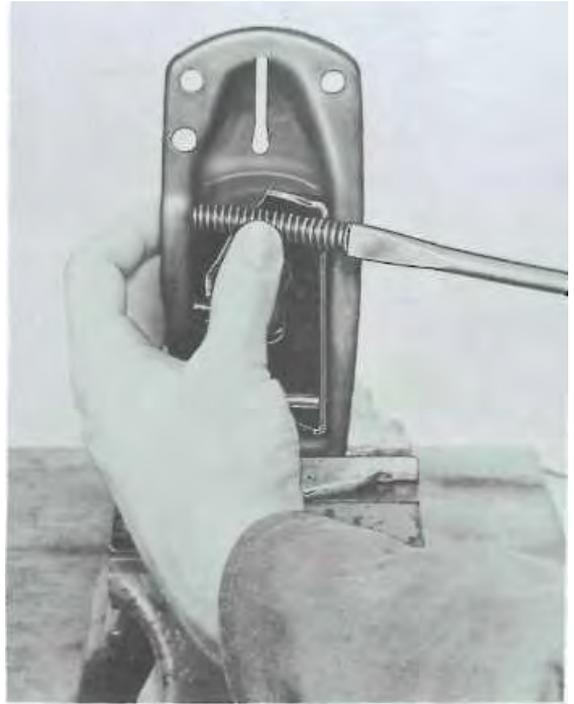


Fig. 135

Modified Screwdriver



a = 12 mm (approx. 1/2 inch)

b = 6 mm (approx. 1/4 inch)

Fig. 136

- d. Push the guide pin through and install the pin retainer.
- e. Install the other thrust spring in same way.

5. Coat the springs as well as the ball end of the shift rod with Lithium grease (multipurpose grease), and install the plastic ball socket with the help of a hammer.

1. Remove retaining screws from cover in rear of center tunnel and withdraw cover.



Fig. 137

2. Loosen hex bolt in shift rod clamp.

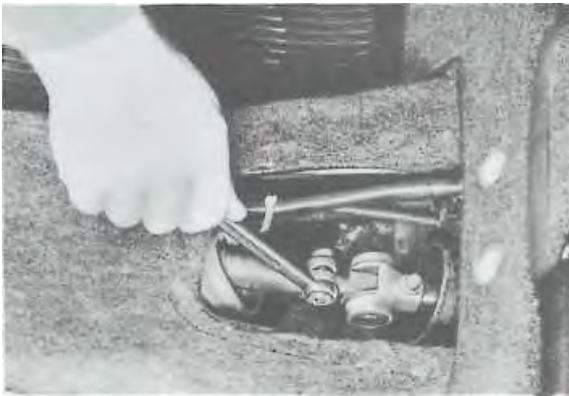


Fig. 138

3. Move selector shaft of internal shift lever in transmission all the way left to stop while in neutral position.
("Right" or "Left" is in direction of travel).

4. With transmission in neutral, move the gearshift lever to the right to stop.



Fig. 139

5. Tighten hex bolt of clamp to 2.5 mkp (18 lbs/ft). (Insert serrated washer under the hex nut).

6. Check adjustment by shifting all gears. Also check play in the gearshift linkage.

(Gearshift lever play should be same in all gears in all directions.)

DESCRIPTION OF REAR AXLE DRIVE

General:

Both rear wheels are guided by triangulated control arms and driven by way of double-joint half shafts.

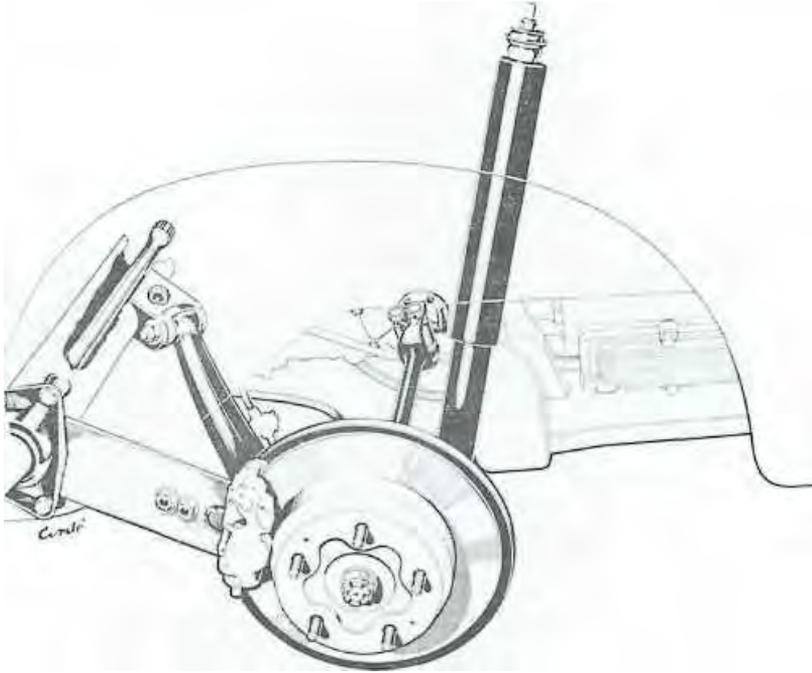
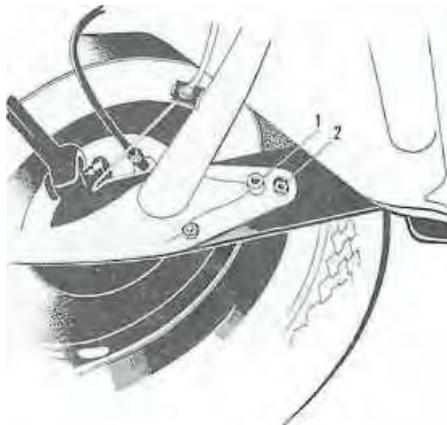


Fig. 140

Each wheel is independently suspended. Springing is by a round transverse torsion bar on each side. A progressively acting rubber buffer is provided within each of the two telescopic Shockabsorbers to supplement springing of each wheel.

Both torsion bars can be adjusted to close specifications since the torsion bar splines are in a vernier arrangement.

One eccentric bolt in the control arm permits a fine adjustment of the camber.
A second eccentric bolt is for adjusting the wheel tracking.
All joints are service free.



- 1 = Camber eccentric
- 2 = Tracking eccentric

Fig. 141

Rear Wheel Cross-section

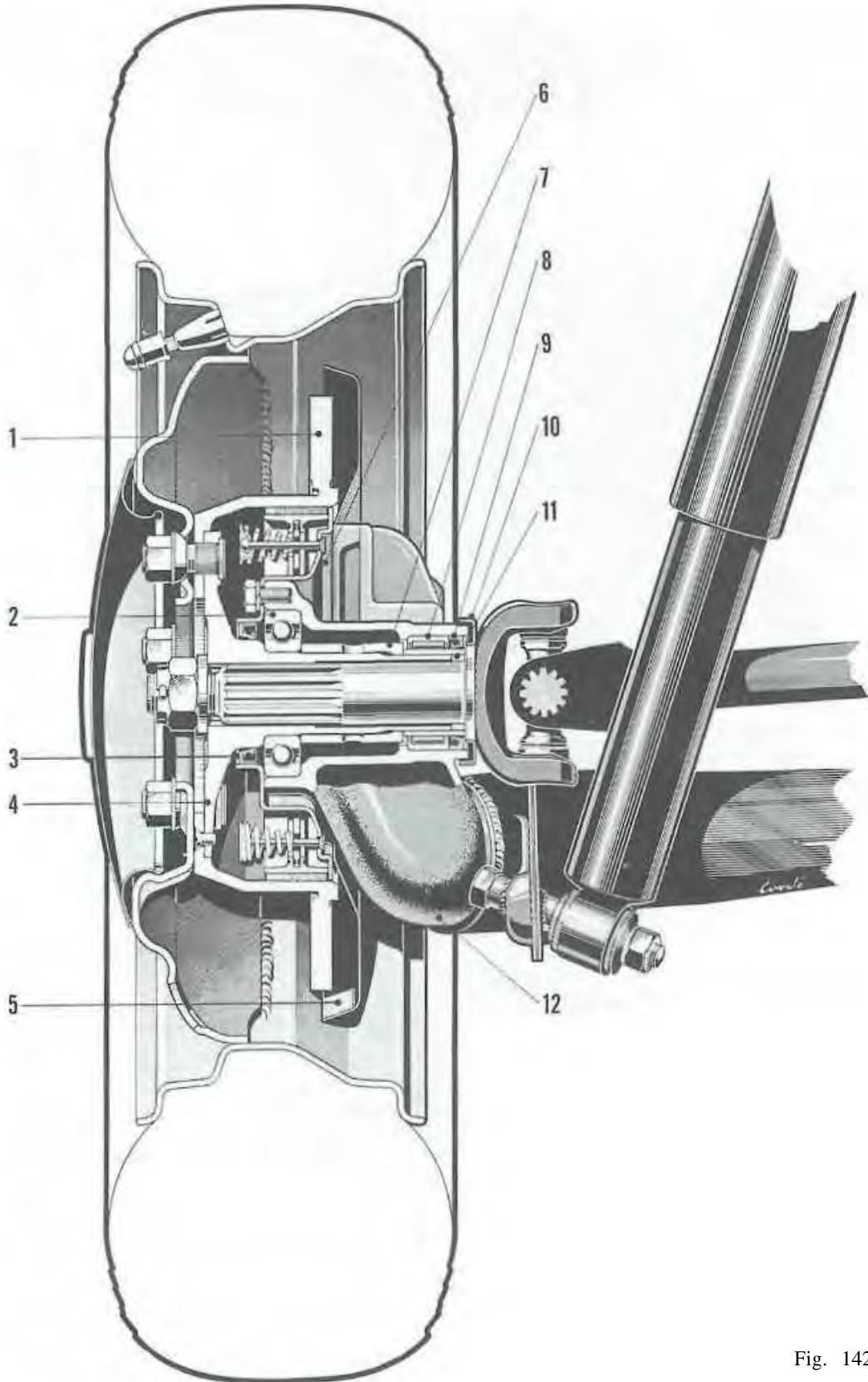


Fig. 142

- 1 Brake disc, rear
- 2 Ballbearing
- 3 Oil seal
- 4 Rear wheel hub

- 5 Disc shroud
- 6 Brake carrier plate
- 7 Spacer tube
- 8 Rollerbearing

- 9 Oil seal
- 10 Dust cap
- 11 Gasket ring
- 12 Control arm, left

DISASSEMBLING AND REASSEMBLING REAR WHEEL SUSPENSION

Special Tools:

P 36b	Hub holder and wrench guide	P 296	Socket for rear axle nut
P 42a	Torque wrench, 75 mkp capacity	P 297	Rear hub mandrel
P 44a	Socket extension	P 298	Rollerbearing press adapter
P 255	Guide sleeve	VW 401	Press adapter for general purpose
P 289	Radius arm tensioner	VW 410	Press mandrel
P 294	Press adapter for brake carrier plate oil seal	VW 261	Clinometer
P 295	Control arm alignment tester		Work press

REMOVING REAR WHEEL CONTROL ARM

23 RA

Special Tools:

Work press	P 289	Radius arm tensioner	
P 36b	Hub holder and wrench guide	P 296	Socket for rear axle nut
P 42a	Torque wrench, 75 mkp capacity	P 297	Rear hub mandrel
P 44a	Socket extension		

Removal

1. Raise car and remove rear wheels.
2. Remove hex bolts which secure the disc shrouds and remove shrouds.
3. Detach brake line from brake caliper (first slightly depress brake pedal with a brake depressor and hold in position to prevent draining of hydraulic brake, fluid in the reservoir).
4. Remove caliper retaining bolts and withdraw caliper.



Fig. 143

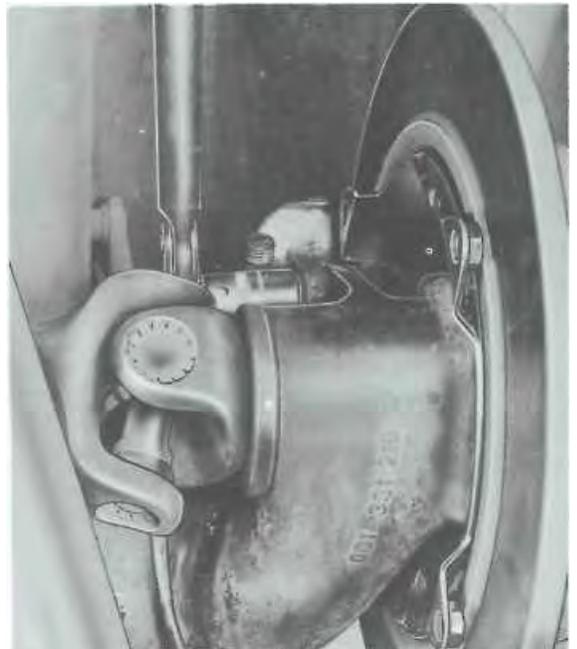


Fig. 144

5. Remove countersunk bolts from brake disc and remove disc.

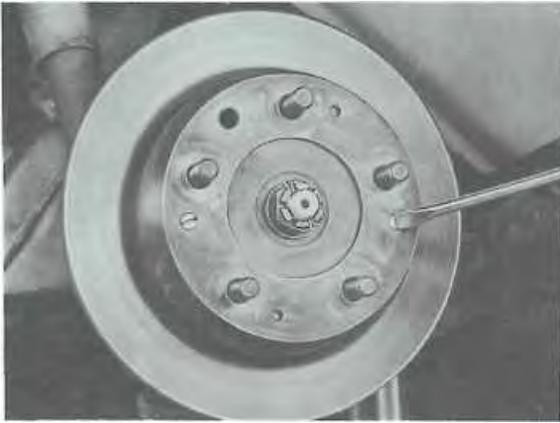


Fig. 145

6. Remove cotter key from castellated nut in half shaft and remove nut with the aid of special tools P42a, P36b, P44a, and P296.

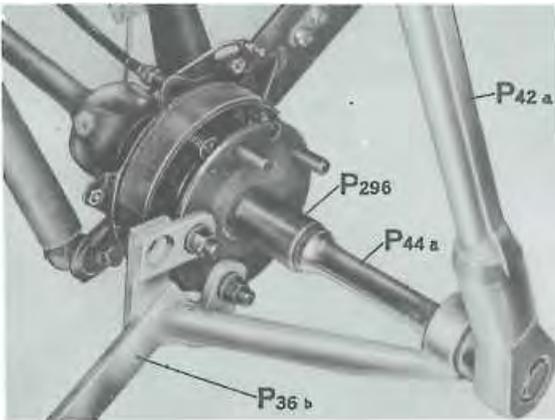


Fig. 146

7. Remove Allen bolts from half shaft flange, knock the half shaft from its seat and remove.

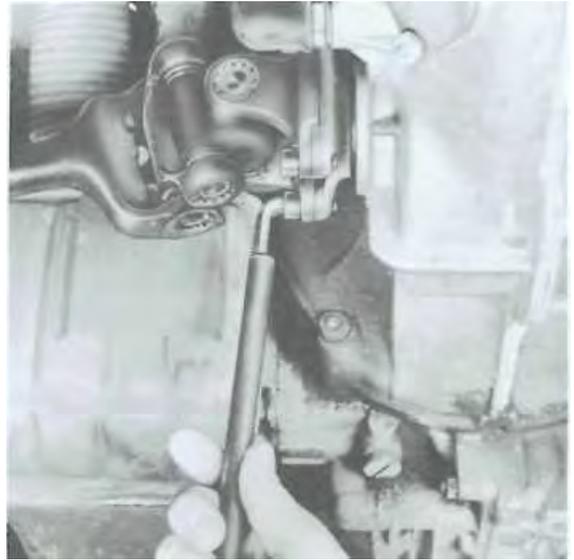


Fig. 147

8. Drive the rear hub out with special tool P 297.



Fig. 148

9. Remove cotter key from castellated nut in brake cable, unscrew nut, and pull the cable out towards center axis of car.

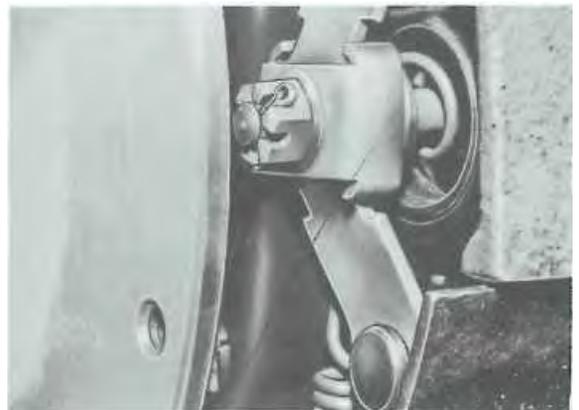


Fig. 149

10. Remove retaining bolts from brake carrier plate and withdraw plate.

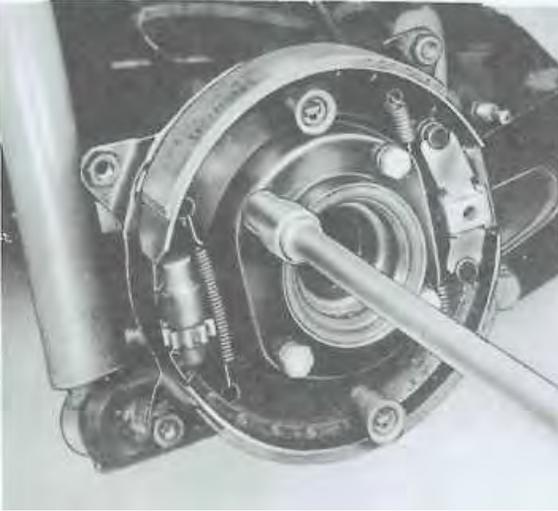


Fig. 150

11. Raise radius arm with the aid of special tool P 289.

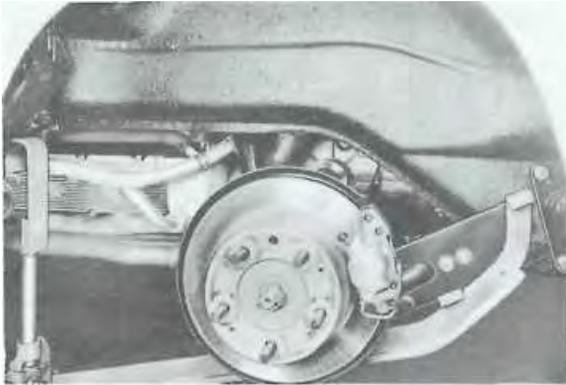


Fig. 151

12. Remove Shockabsorber retaining bolt.



Fig. 152

13. Remove nuts of the control arm retaining bolts and eccentric bolts, withdraw bolts from seats.

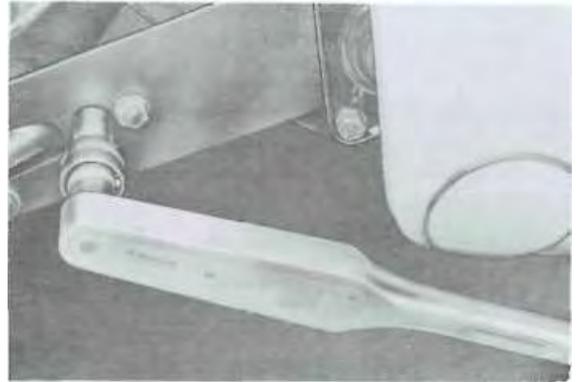


Fig. 153

14. Detach brake hose from control arm.

15. Remove self-locking nut of the control arm mounting bolt and drive the bolt out with the aid of a punch. At that time move the control arm slightly so that the bolt can clear the transmission housing. If necessary, slightly loosen the transmission carrier retaining bolts.



Fig. 154

16. Remove control arm.

24 RA DISASSEMBLING CONTROL ARM AND INSPECTING COMPONENTS

Special Tools:

P 255 Guide sleeve
P 295 Control arm alignment tester
P 298 Rollerbearing press adapter

VW 401 General purpose press adapter
VW 410 Press mandrel

1. Mount control arm in a vise, pull out inner ring for the rollerbearing, move spacer tube out of way, using an appropriate mandril drive the ballbearing out, and remove spacer tube.



Fig. 155

2. Press the rollerbearing out with the aid of special tool VW 410, P 298, P 255 or similar pipe section, and VW 401.

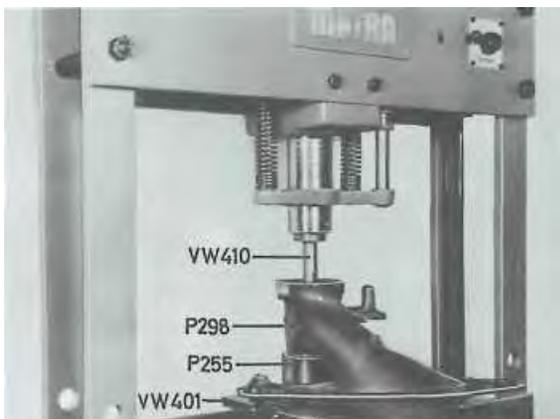


Fig. 156

3. The control arm suspension Flanblocs can be removed only by destroying same.

Inspecting Components

1. Inspect control arm for alignment with the aid of special tool P 295.

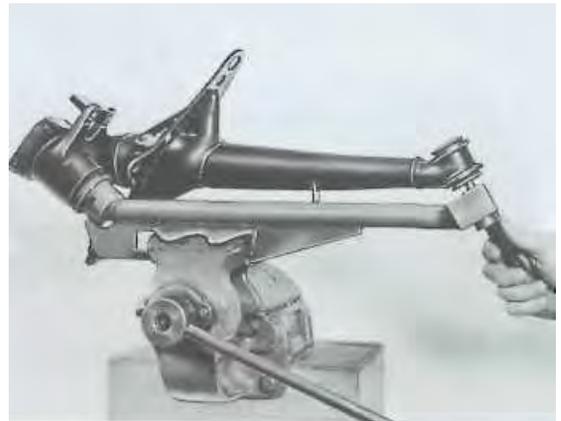


Fig. 157

When testing with installed Flanblocs, the alignment pin must pass into the testing tool. Deformed control arms are to be replaced.

2. Check ballbearing and rollerbearing as well as spacer tube for wear or damage and replace when necessary.

3. Check oil seals and replace when necessary.

Special Tools:

- | | |
|--------------------------------------|--|
| P 36b Hub holder and wrench guide | P 298 Rollerbearing press adapter |
| P 42a Torque wrench, 75 mkp capacity | P 294 Press adapter for brake carrier plate oil seal |
| P 44a Socket extension | |

Reassembly

Note the following points at reassembly:

1. If Flanblocs have been taken out, install new Flanblocs by pressing into place all the way to stop.
4. CAUTION: Install spacer tube so that recess and wide thrust surface faces the roller bearing.

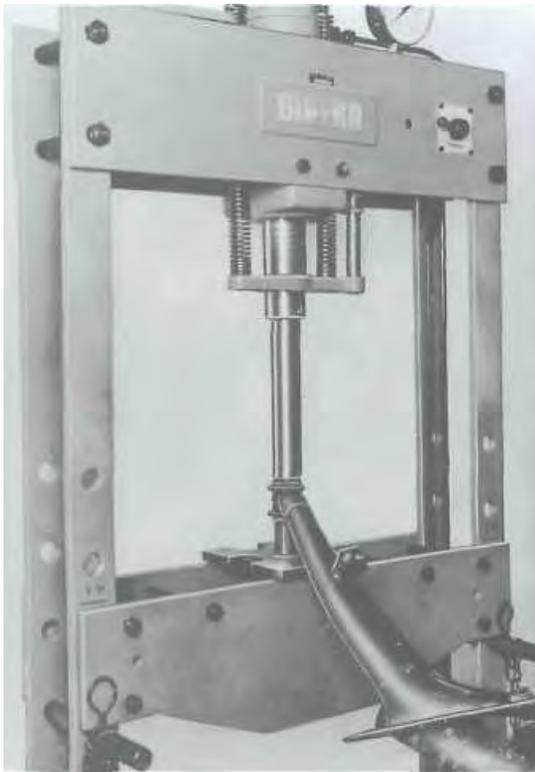


Fig. 158



Fig. 159

2. Press rollerbearing all the way in to stop with the aid of special tool P 298.
3. Using special tool P 298, carefully press oil seal in to stop at the roller bearing.
5. Apply approx. 40 grams (1 1/2 oz) Lithium grease (multipurpose grease) to the rear wheel bearings by thoroughly greasing the bearings and placing the remainder of the grease into the wheel hub.
6. If necessary replace oil seal in brake carrier plate with the aid of special tool P 294.

Installation

Note the following points during installation:

1. Slide hex bolt (M 14 x 1.5) from inside to outside while simultaneously moving the control arm to make the insertion easier. A washer must be placed under the bolt head as well as under the nut.

Caution:

The hex bolt may be tightened only after the vehicle has been placed on its wheels since otherwise the twisting capability of the Flanblocks would be exceeded.

Nominal torque value is 12 mkp (86.8 lb-ft).



Fig. 160

2. Tighten retaining bolts and eccentric bolts to 9 mkp (65 lb-ft).



Fig. 161

3. The camber eccentric should be torqued to 6.0 mkp (36 lb-ft), the tracking eccentric to 5.0 mkp (43 lb-ft).

4. Tighten Shockabsorber retaining bolt to 7.5 mkp (54 lb-ft).
5. Use new O-ring and place into groove with a little grease. Make sure that the O-ring is well seated.

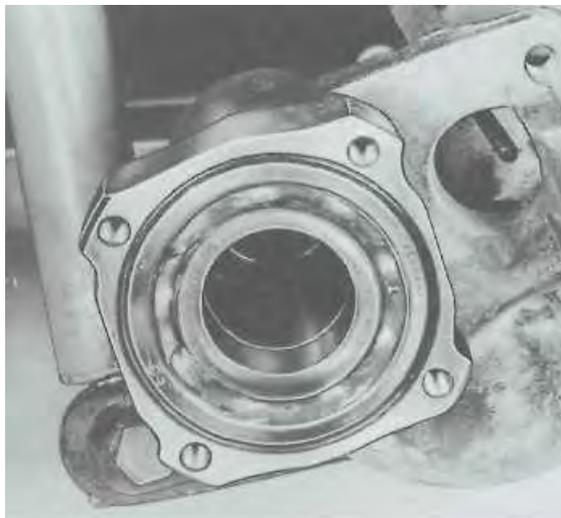


Fig. 1G2

- 5a. Tighten brake carrier plate retaining bolts to 2.5 mkp (18 lb-ft).
6. Screw the castellated nut so far onto the hand brake cable stub until the nut clears the cotter key hole, secure with a new key.

Caution:

Check the mechanical expander for proper seating.

7. Push a new gasket onto the half shaft stub.
3. Using a plastic mallet or similar tool, drive rear wheel hub into place all the way to stop. Supporting the hub flange, drive the inner ring for roller bearing into place.

8. Tighten Allen bolts of half shaft flange to specified torque value. (See 26 RA "Installation", Point 2).
9. Tighten castellated nut of half shaft to 30 - 35 mkp (217 to 253 Ibs/ft).
10. Tighten rear caliper retaining bolts to 6.0 mkp (43 Ibs/ft).
11. Tighten disc shroud retaining bolts to 2.5 mkp (18 Ibs/ft).
12. Bleed brake system (see Group T - Brakes, Section 11 TI and 12 TI).
13. Adjust rear wheel tracking and camber (see Group W, Section 4 WH).

REMOVING AND INSTALLING REAR AXLE HALF SHAFT

26 RA

Special Tools:

- | | |
|--------------------------------------|--------------------------------|
| P 36b Hub holder and wrench guide | P 44a Socket extension |
| P 42a Torque wrench, 75 mkp capacity | P 296 Socket for rear axle nut |

General

Vehicle types 911, 911 S, and 912 are being equipped with NADELLA half shafts (Spare Part Nr. 901.332.025.02) and LOBRO half shafts (Spare Part Nr. 901.332.026.10) on an alternating basis.

CAUTION:

Vehicles equipped with the ZF Multiple Disc Self Locking Differential may be equipped only with NADELLA half shafts (see Fig. 163).

''Nadella'' Half Shaft



Fig. 163

Removal

1. Raise the car and remove rear wheels.
2. Remove cotter key from castellated nut in half shaft and remove nut with the aid of special tools P 42a, P 36b, P 44a, and P 296.

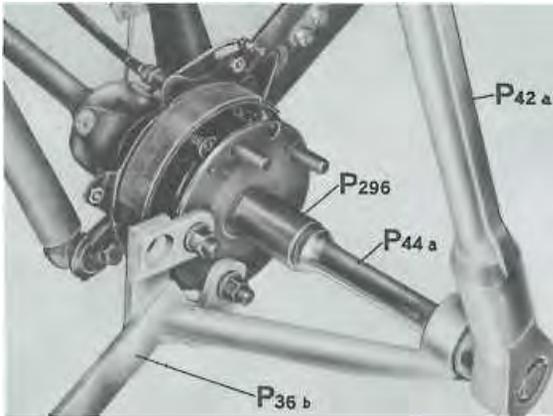


Fig. 164

3. Remove Allen bolts from half shaft flange, knock the half shaft from its seat and remove.

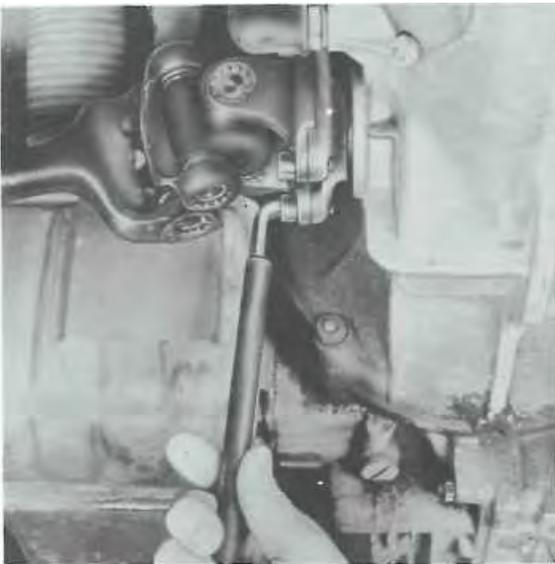


Fig. 164a

Inspection

Check universal joints in half shaft for play. If the universal joints are worn, the entire half shaft will have to be replaced.

NOTE:

NADELLA half shafts can be procured from the Porsche plant on an exchange basis.

Installation

1. Place new gasket ring on the half shaft stub, lightly oil the splines, and insert the stub in the wheel hub.

2. Tighten Allen bolts in half shaft flange to prescribed torque:

- a. NADELLA half shaft - 4.7 mkp (34 Ibs/ft)
- b. LOBRO half shaft - 4.3 mkp (31 Ibs/ft); the Schnorr washer for the Allen bolt must face the base plate with the hollow side.

NOTE:

The LOBRO half shafts may be fastened only with Allen bolts M 8 x 45 DIN 912 - 12 K, Spare Part Nr. 900.067.073.01 (minimum tensile strength of 120 kp/mm²). These bolts bear markings 130 - 140 or 12 K, respectively, on the head of the side.

Also the flange surfaces of the half shaft must be free of grease at time of installation.

3. Tighten the half shaft castellated nut to 30-35 mkp (217 to 253 Ibs/ft) and secure with a new cotter key.

1. Remove hose clamps from dust boot.

2. Remove lock ring and withdraw universal joint and wire retainer from half shaft splines.

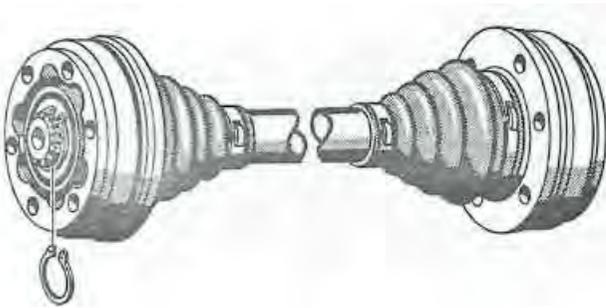


Fig. 164b

3. Remove dust boot.

4. Clean all parts.

5. Insert new dust boot on half shaft.

6. Slide wire retainer and universal joint onto half shaft and secure with lock ring.

7. Fill universal joint with 70 grams (approx. 2 1/2 oz.) of multipurpose MO S2 grease. (Apply as much of that grease to the universal joint and dust boot inside as possible, placing the remainder inside the flange area).

8. Clean the contact surface of the large end of the dust boot and its counterpart flange free of grease and glue the dust boot into place with the aid of gasket compound (EC 750 M - 2 G 51), manufactured by

The Minnesota Mining & Manufacturing Co.
Dusseldorf

9. To make the installation easier, the hose clamp bands may be drilled with two holes of 2 mm dia. each (see illustration).

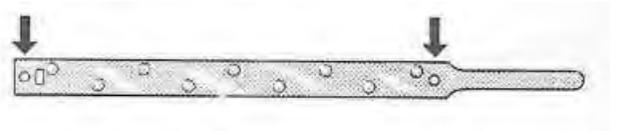


Fig. 164c

5. Insert new dust boot on half shaft.

6. Slide wire retainer and universal joint onto half shaft and secure with lock ring.

10. Tighten hose clamp bands with a round nose plier, bend the end over and tap down with a small hammer. See Fig. 164d.



Fig. 164d

Special Tools:

P 289 Radius Arm Tensioner

Removal

1. Raise car and remove rear wheels.

2. Raise radius arm with the aid of special tool P 289.

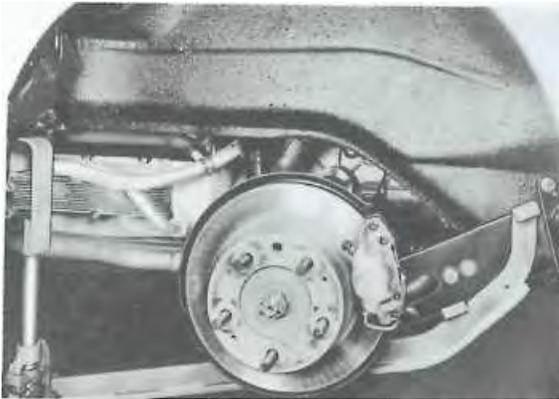


Fig. 165

3. Remove Shockabsorber attaching bolt.



Fig. 166

4. Remove control arm retaining bolts and adjusting eccentric bolts.

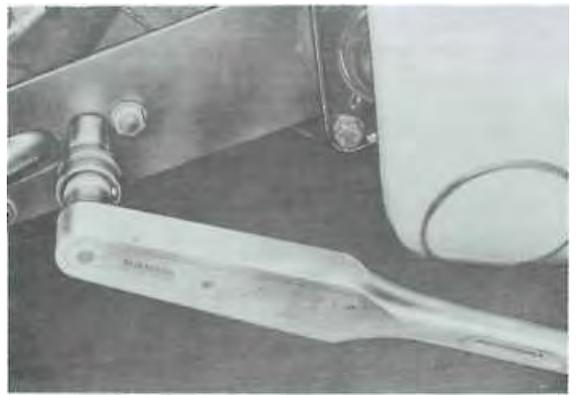


Fig. 167

5. Remove retaining bolts from radius arm cover and withdraw the single spacer.

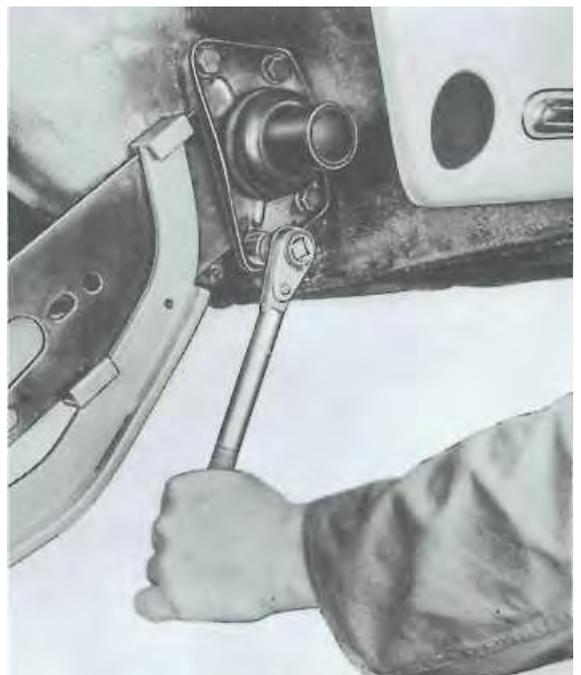


Fig. 168

6. Pry radius arm cover off with the aid of 2 large screwdrivers.

7. Remove radius arm tensioner (P 289).

8. Remove body plug in side of body and remove radius arm.

9. Withdraw torsion bar.

CAUTION: Do not damage torsion bar protective paint since this would allow corrosion to set in and possibly result in the formation of a fatigue crack in the torsion bar.

NOTE:

The inner end of a broken torsion bar may be removed from its seat by removing the opposite torsion bar and pushing through with a suitable steel rod.

Inspection

1. Check the torsion bar for damage in the splines and the protective coating, especially for the evidence of rust formation. Replace the torsion bar if necessary.

2. Check rubber support of torsion bar for wear, replace if necessary.

Installation

Note the following points during installation:

1. Lightly coat the torsion bar with grease (multi-purpose Lithium grease), coating the splines with care.

NOTE:

Torsion bars are prestressed in manufacture and the right and left bars therefore must not be interchanged. As means for identification, the torsion bar ends are stamped with an "L" for left side, and an "R" for right side. (See illustration).



Fig. 169

2. Adjust torsion bar as outlined in section 29 RA.

3. Coat the rubber support of the torsion bar with rubber preserving glycerine paste, such as "Conti-Fix Assembly Paste".

4. Place the radius arm cover in position and start the three accessible bolts in their threads.

5. Raise the radius arm with special tool P 289 until the spacer and the fourth bolt can be installed.

6. Torque the retaining bolts of radius arm cover to 4.7 mkp (34 lb-ft).
7. Torque the attaching bolts of control arm, and adjusting eccentric bolts, to 9 mkp (65 lb-ft).
8. The camber eccentric should be torqued to 6.0 mkp (36 lb-ft), the tracking eccentric to 5.0 mkp (43 lb-ft).
9. Torque the Shockabsorber retaining bolt to 7.5 mkp (54 lb-ft).
10. Adjust rear wheel camber and tracking (see Group W, Section 4 Wh).

29 RA

ADJUSTING TORSION BAR

Special Tools:

VW 261 Clinometer

General

The exact adjustment of the torsion bar is made by measuring the angle of the radius arm in relation to the horizontal plane of the car at which time the radius arm must hang free.

The horizontal plane of the car can be determined with the aid of special tool VW 261 which is placed onto the lower edge of the door cavity in the body.

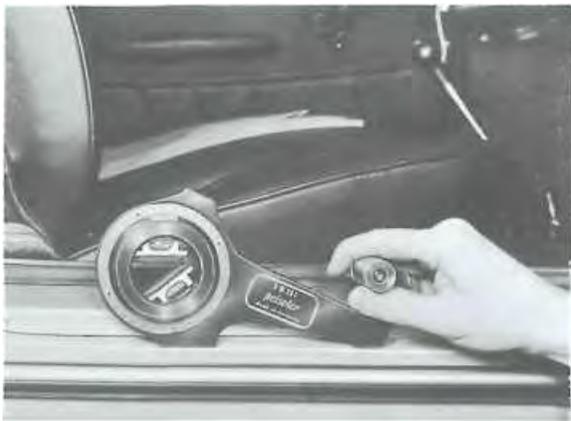


Fig. 170

To achieve the specified values in the rear wheel camber adjustment, it is of importance that the adjusted angle of the radius arm is same on both sides of the car. If the radius arm has been adjusted on one side, the other side should be checked as well and its adjustment corrected when necessary.

The adjusted radius arm angle of a free hanging radius arm is:

Type 911 and 911 S Coupe, Targa	36°
From Model '68 on Type 911 (all)	39° (torsion bar diameter of 22 mm - . 866")
Type 912 Coupe, Targa	33°
From Model '68 on Type 912	36° (torsion bar diameter of 22 mm - . 866")
From Model '69 on Type 911 (all)	36°30' to 37° (torsion bar diameter 23 mm - . 906")
From Model '69 on Type 912	33°30' to 34° (torsion bar diameter 23 mm - . 906")

Accomplish adjustment as follows:

1. Place the torsion bar into the transverse tube with the inner end splines first.
2. Slip radius arm onto the outer end splines.
3. Place special tool VW 261 onto the lower edge of the door cavity in the body.

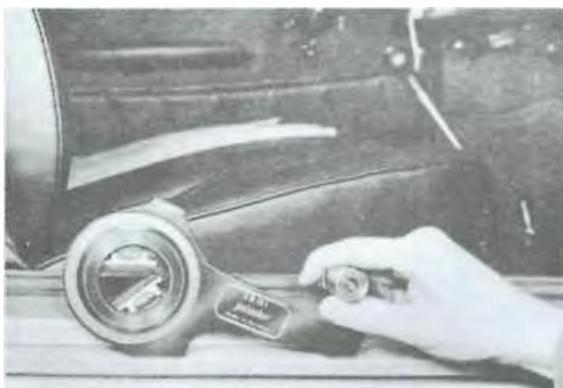


Fig. 171

4. Adjust the clinometer so that the bubble in the glass tube marked "Axle Housing/Angle" is in the center.
5. Reset the glass tube carrier by the value specified for this type vehicle.
6. Place the clinometer onto the free-hanging radius arm and check adjustment of the arm.



Fig. 172

7. If necessary, readjust the radius arm:

An error of one graduation mark on the glass tube shown by the air bubble equals an error in adjustment by $50'$. In this case, the torsion bar and the radius arm must be reset in their splined seats by one spline each, both moving towards each other. It should be noted that the torsion bar must be moved in the same direction in which the glass tube carrier would have to be moved to bring the bubble into center position.

NOTE:

The torsion bar adjustment variations, or those of the radius arm angle, are made possible through a vernier arrangement of splines in both ends of the torsion bar.

Number of splines in torsion bar: Inner end 40 spl.
Outer end 44 spl.

If the torsion bar is reset by one spline at its inner end, a 9° change is effected. If the radius arm is reset by one spline at the outer end of the torsion bar, a change of $8^\circ 10'$ is effected. This results in the smallest change of $50'$ in the radius arm adjustment.

It should be ascertained that the specified adjustment values are reached to the closest possible degree.

8. Adjust rear wheel tracking and camber (see Group W, Section 4 Wh).

Special Tools:

P 289 Radius arm tensioner

General

Travel of the rear wheel springing on the rebound is limited by the Shockabsorber. It is therefore of advantage when changing the rear Shockabsorber that the vehicle stands on its wheels (the car can be raised on a ramp lift or else placed over a pit).

The wheels should be removed when they clear the ground while the car is raised. Furthermore, the radius arm should be tensioned with special tool P 289 so that the Shockabsorber stress is relieved.

Removal

1. Raise car.
2. Shockabsorber stress must be relieved (vehicle should either stand on its wheels or the radius arm should be tensioned with special tool P 289).
3. Remove rubber cap from Shockabsorber top and remove self-locking nut (hold Shockabsorber plunger rod if necessary).



Fig. 173

4. Remove Shockabsorber retaining bolt and remove Shockabsorber.



Fig. 174

Inspection

1. Check exterior of Shockabsorber for deposits of oily dirt. If the whole Shockabsorber is covered with oily dirt, the Shockabsorber will have to be replaced.
2. Mount Shockabsorber vertically in a vise, with the plunger rod up. Push plunger rod repeatedly in and out to bring the fluid into the shock-absorber cylinder and determine free travel of the plunger rod by short counterstrokes. If the free travel is excessive, the Shockabsorber must be replaced.

3. Check the rubber buffer and replace when necessary.

4. Adjust KONI Shockabsorbers (see Group S, Section 9 St).

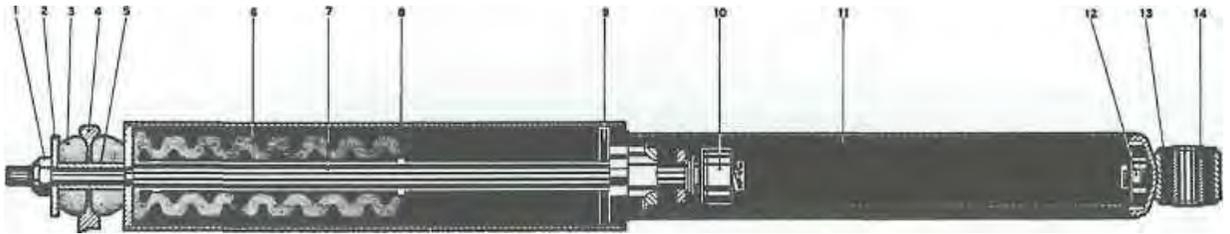


Fig. 175

Rear Shockabsorber

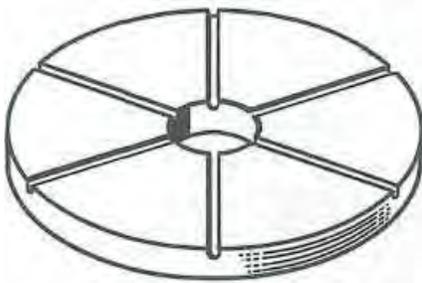
- | | |
|--------------------|--------------------|
| 1 Self-locking nut | 8 Cover tube |
| 2 Washer | 9 Stop disc |
| 3 Grommets | 10 Plunger |
| 4 Seat in vehicle | 11 Cylinder |
| 5 Grommet bushing | 12 Check valve |
| 6 Rubber buffer | 13 Grommet |
| 7 Plunger rod | 14 Grommet bushing |

NOTE: Beginning with 1968 models and in connection with the new rear axle torsion bars of 22 mm (.866") diameter, a longer rubber buffer with 9 rings instead of 8 is being utilized. From 69 model on, rear axle torsion bars 23 mm (.906") in diameter are used together with shock absorbers with different settings and shorter hollow rubber springs with 3 rings only.

Installation

Note the following points during installation:

1. Make sure that the stop disc (Fig. 175, Point 9) grooves face the Shockabsorber plunger since otherwise the hydraulic Shockabsorber fluid will be syphoned out.
2. Install the rubber buffer dry, without the use of any lubricants.



3. Tighten Shockabsorber retaining bolt to 7.5 mkp (54 lbs/ft).

Fig. 176

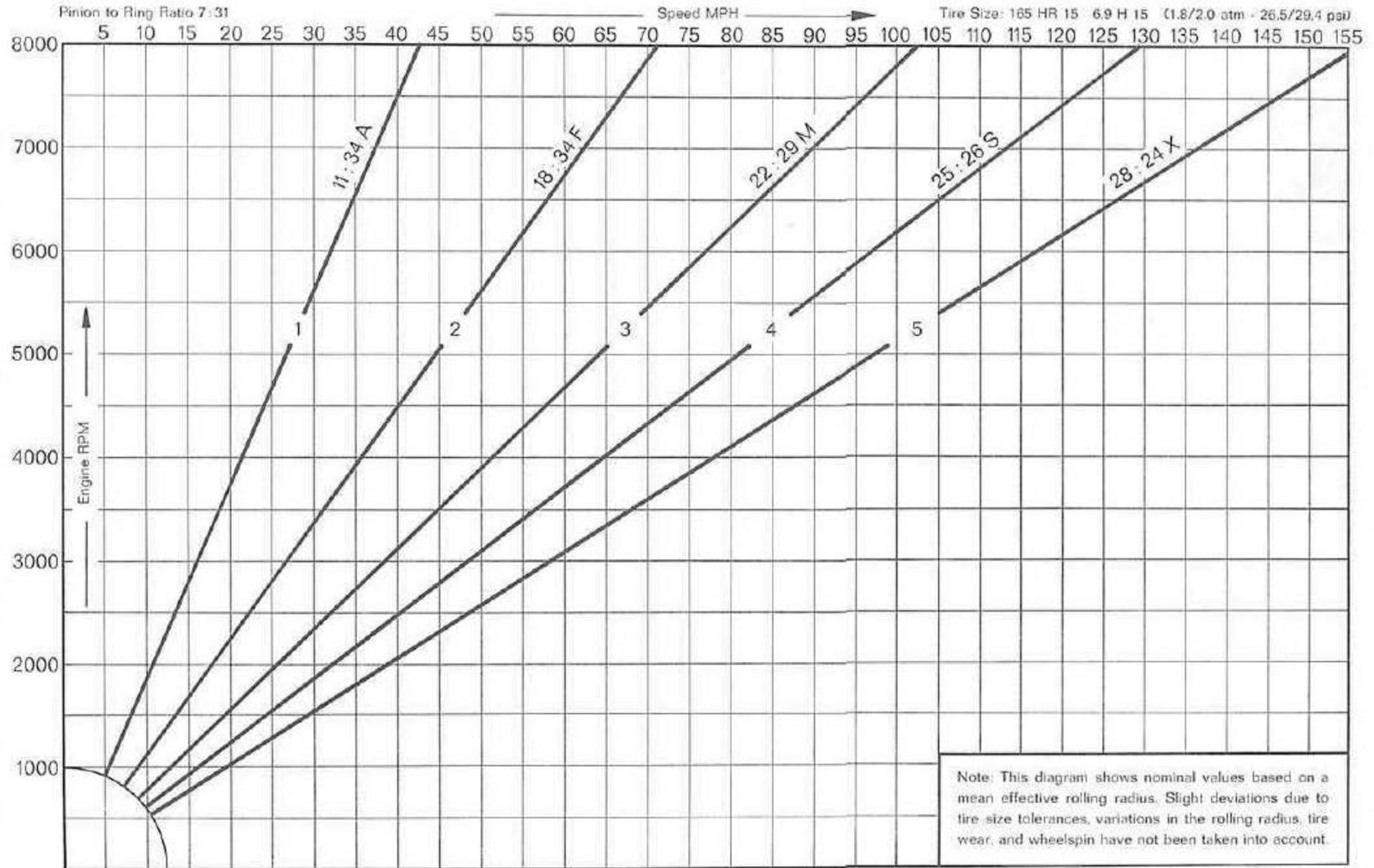
TORQUE VALUES FOR REAR AXLE FASTENERS

Hex bolt for rear axle control arm (M 14 x 1.5 - 10K)	12.0	(86.8)
Hex bolts for radius arm (M 12 x 1.5 - 10K with 8G nut)	9.0	(65.1)
Camber eccentric bolts for radius arm (M 12 x 1.5 - 10K with 8G nut) ..	6.0	(43.4)
Tracking eccentric bolts for radius arm (M 12 x 1.5 - 10K with 8G nut) .	5.0	(36.2)
Hex bolt for Shockabsorber (M 12 x 1.5)	7.5	(54.2)
Castellated nut of rear half shaft	30-35	(217-253)
Allen bolts for NADELLA half shaft flange (M 10 - 8G)	4.7	(34.0)
Allen bolts for LOBRO half shaft flange (M 8 - 12K)	4.3	(31.1)
Allen bolts for LOBRO half shaft flange (M 10 x 55 - 12 K)	8.3	(60.0)
Hex bolts for radius arm bearing cap (M 10)	4.7	(34.0)
Wheel nuts	13.0	(94.0)

PORSCHÉ

Type 912 (5-speed-transmission)

Transmission Diagram Type 902/02 and 902/1 transmission

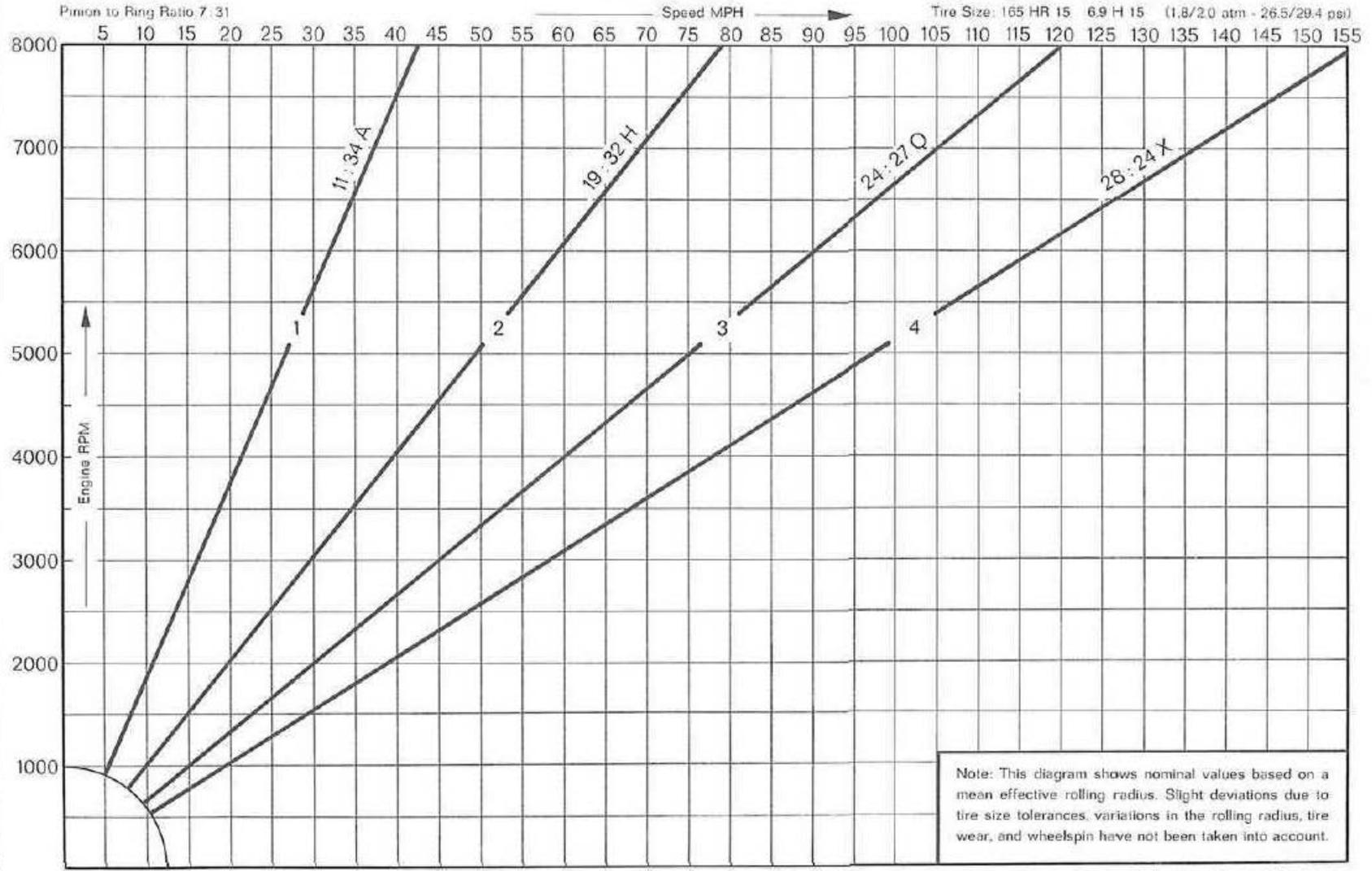


Subject to change without notice

PORSCHE

Type 912
(4-speed-transmission)

Transmission Diagram
Type 902/01 and 902/0 transmission



PORSCHE

Type 912

Transmission Diagram

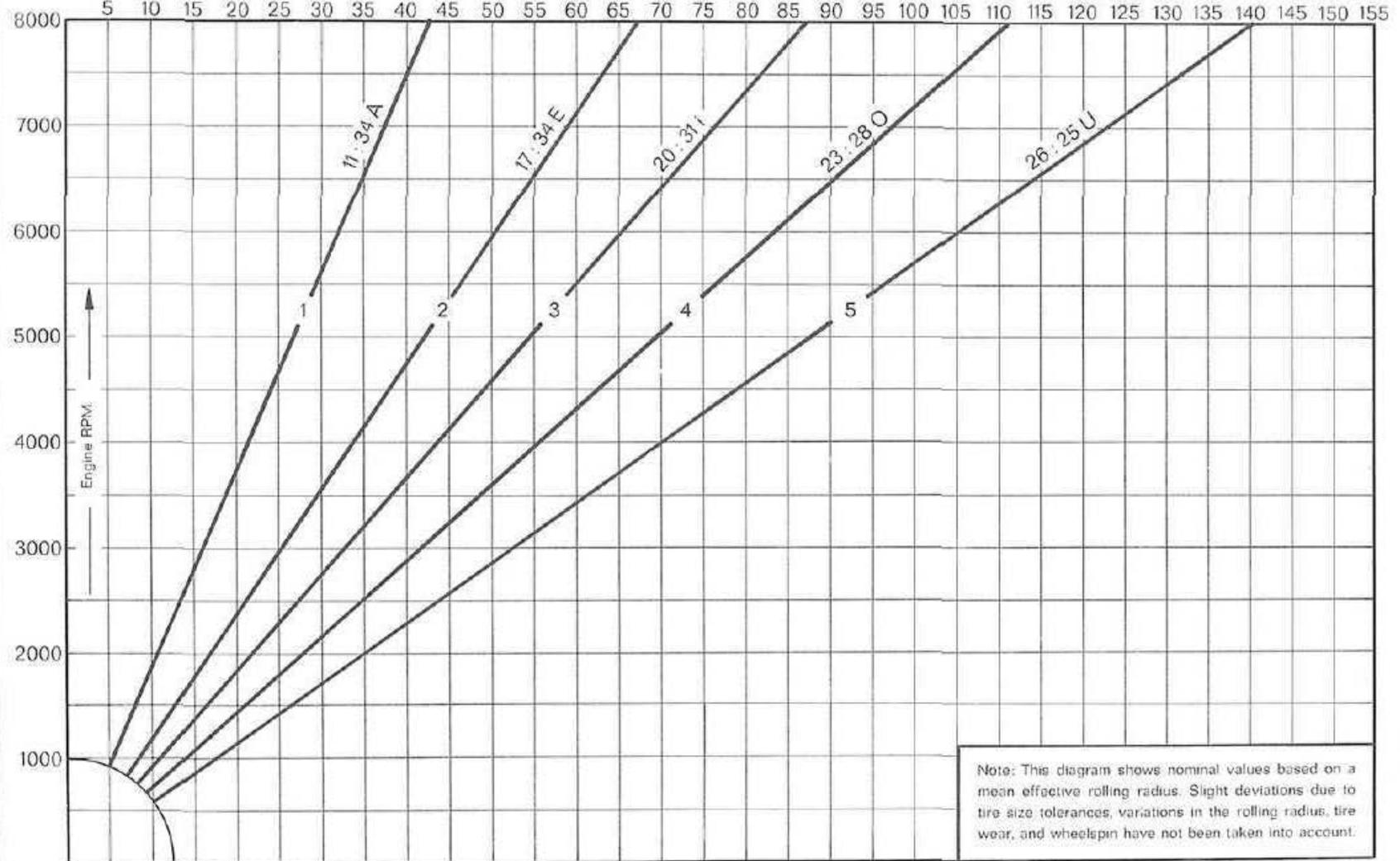
(5-speed-transmission)

Type 902/50 transmission

Pinion to Ring Ratio 7:31

Speed MPH

Tire Size: 165 HR 15 6.9 H 15 (1.8/2.0 atm - 26.5/29.4 psi)



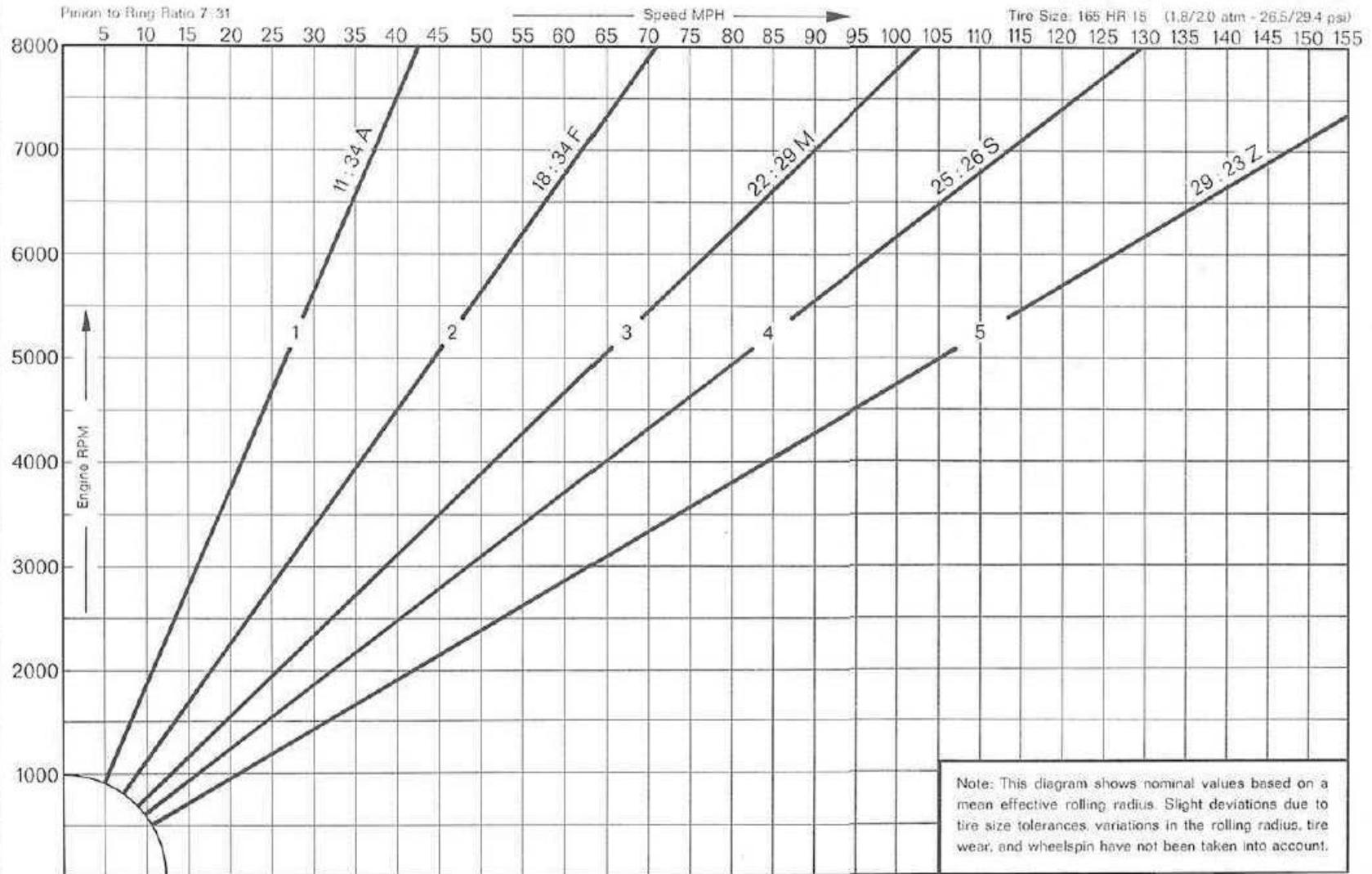
Subject to change without notice

PORSCHE

Type 911 S

Transmission Diagram

Type 901/02 transmission



Subject to change without notice

PORSCHE

Type 911 and 911 S Transmission Diagram

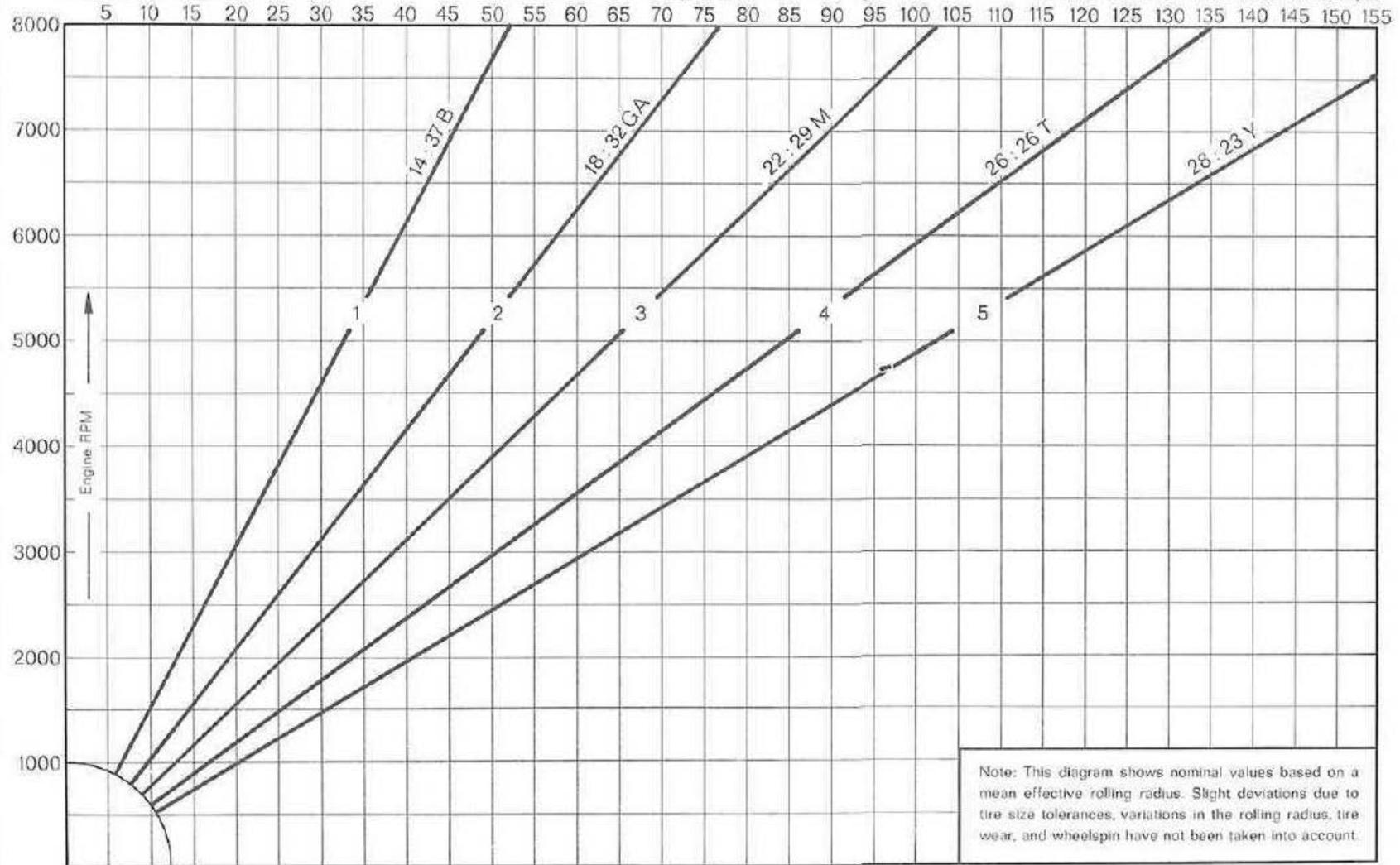
Special Ratio/Standard Ratio

Type 901/50 transmission

Pinion to Ring Ratio 7:31

Speed MPH

Tire Size: 165 HR 15 (1.8/2.0 atm - 26.5/29.4 psi)



Subject to change without notice

PORSCHE

Type 911 and 911 S Transmission Diagram

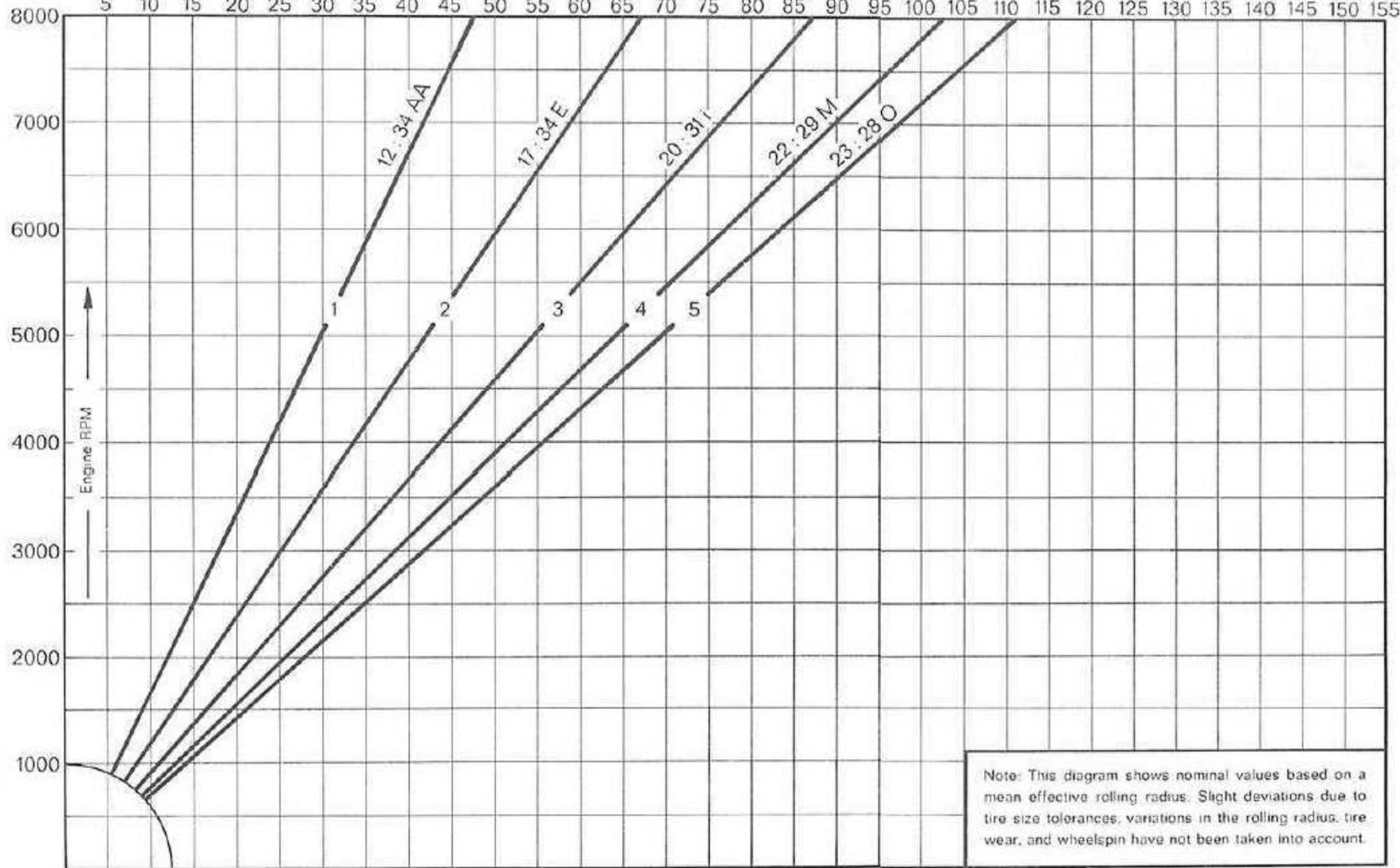
Special Ratio for Hill Climbs

Type 901/51 transmission

Pinion to Ring Ratio 7:31

Speed MPH

Tire Size 165 HR 15 (1.8/2.0 atm - 26.5/29.4 psi)



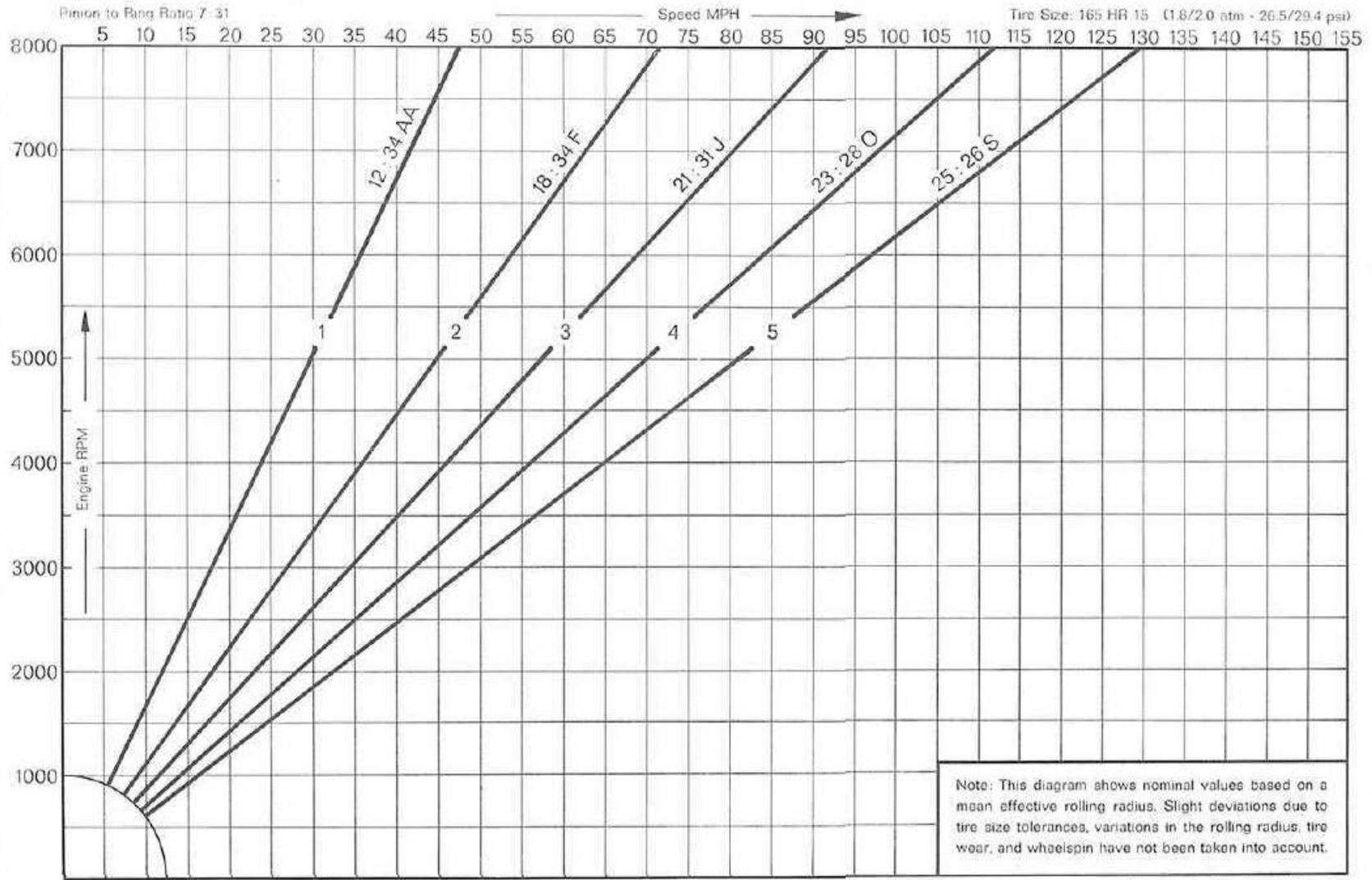
Subject to change without notice

PORSCHE

Type 911 and 911 S Transmission Diagram

Special Ratio for Airport Races

Type 901/52 transmission



Subject to change without notice

PORSCHE

Type 911 and 911 S

Transmission Diagram

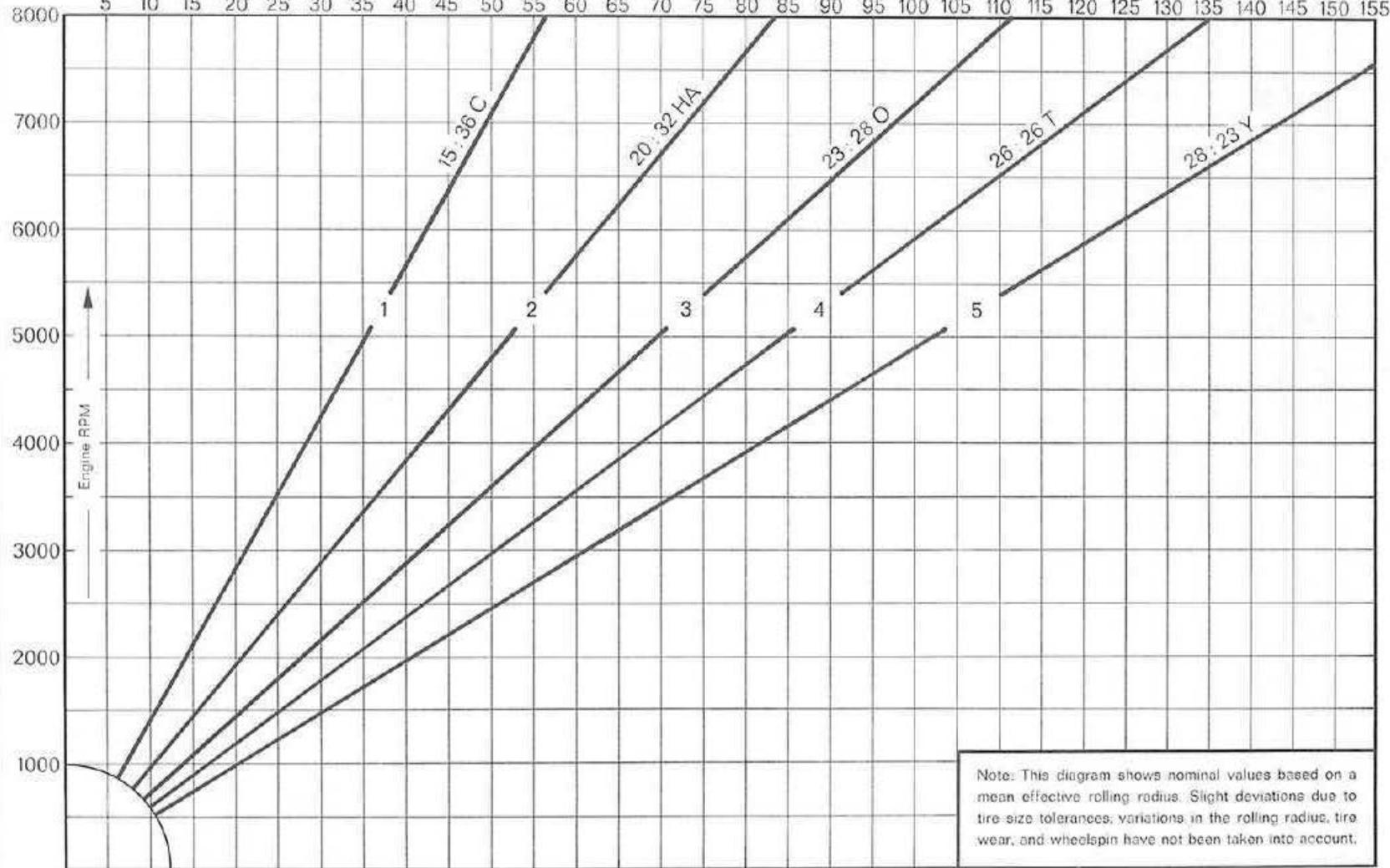
Special Ratios for Speed Circuits

Type 901/53 transmission

Pinion to Ring Ratio 7:31

Speed MPH

Tire Size: 165 HR 15 (1.8/2.0 atm - 26.5/29.4 psi)



Subject to change without notice

PORSCHE

Type 911 and 911 S Transmission Diagram

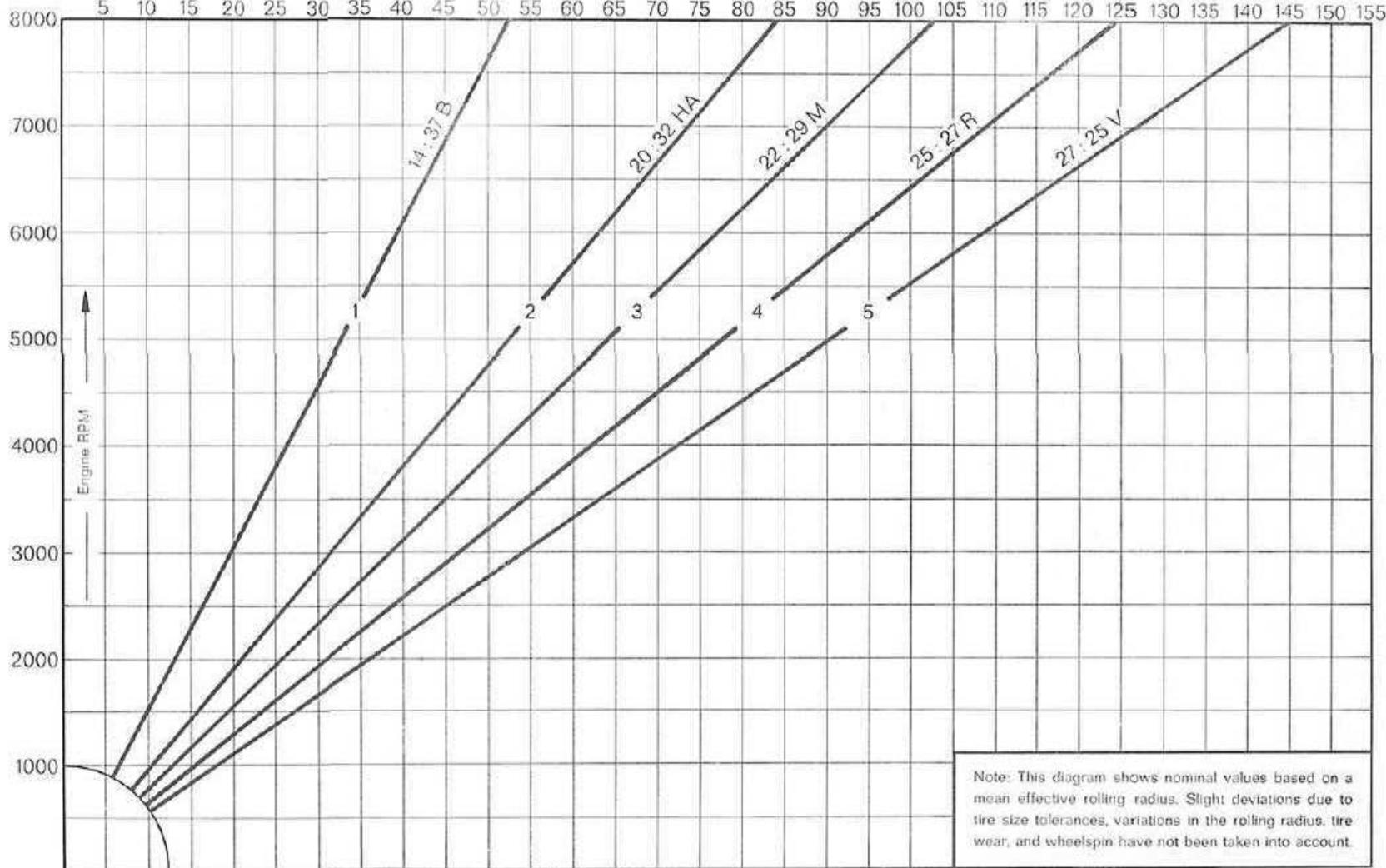
Special Ratios for Nürburgring

Type 901/54 transmission

Pinion to Flyer Ratio 7:31

Speed MPH

Tire Size 165 HR 16 (1.8/2.0 atm - 26.5/29.4 psi)

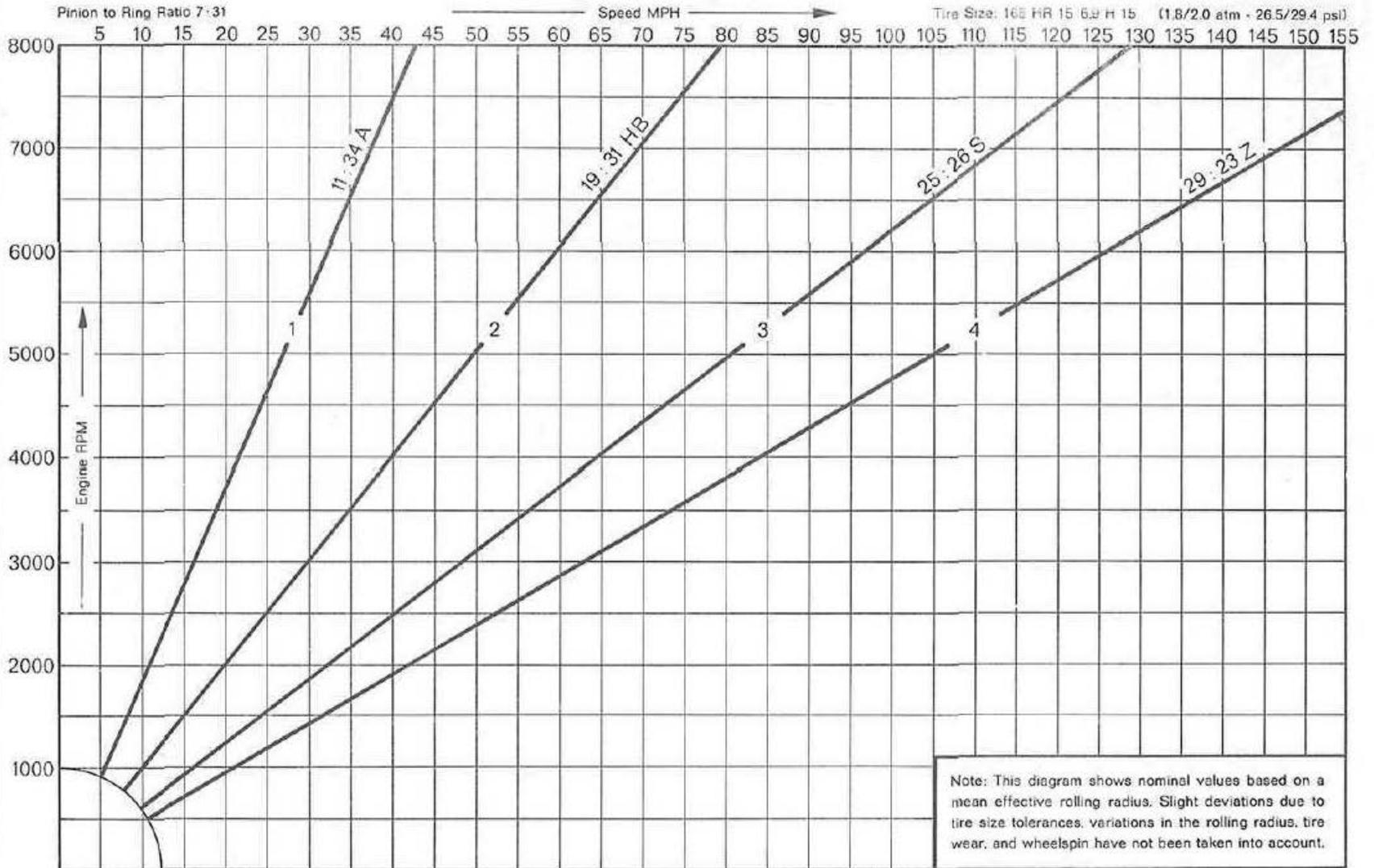


Subject to change without notice

PORSCHÉ

Type 911 T and 911 S
(4-speed-transmission)

Transmission Diagram
Type 901/10 and 901/11 transmission



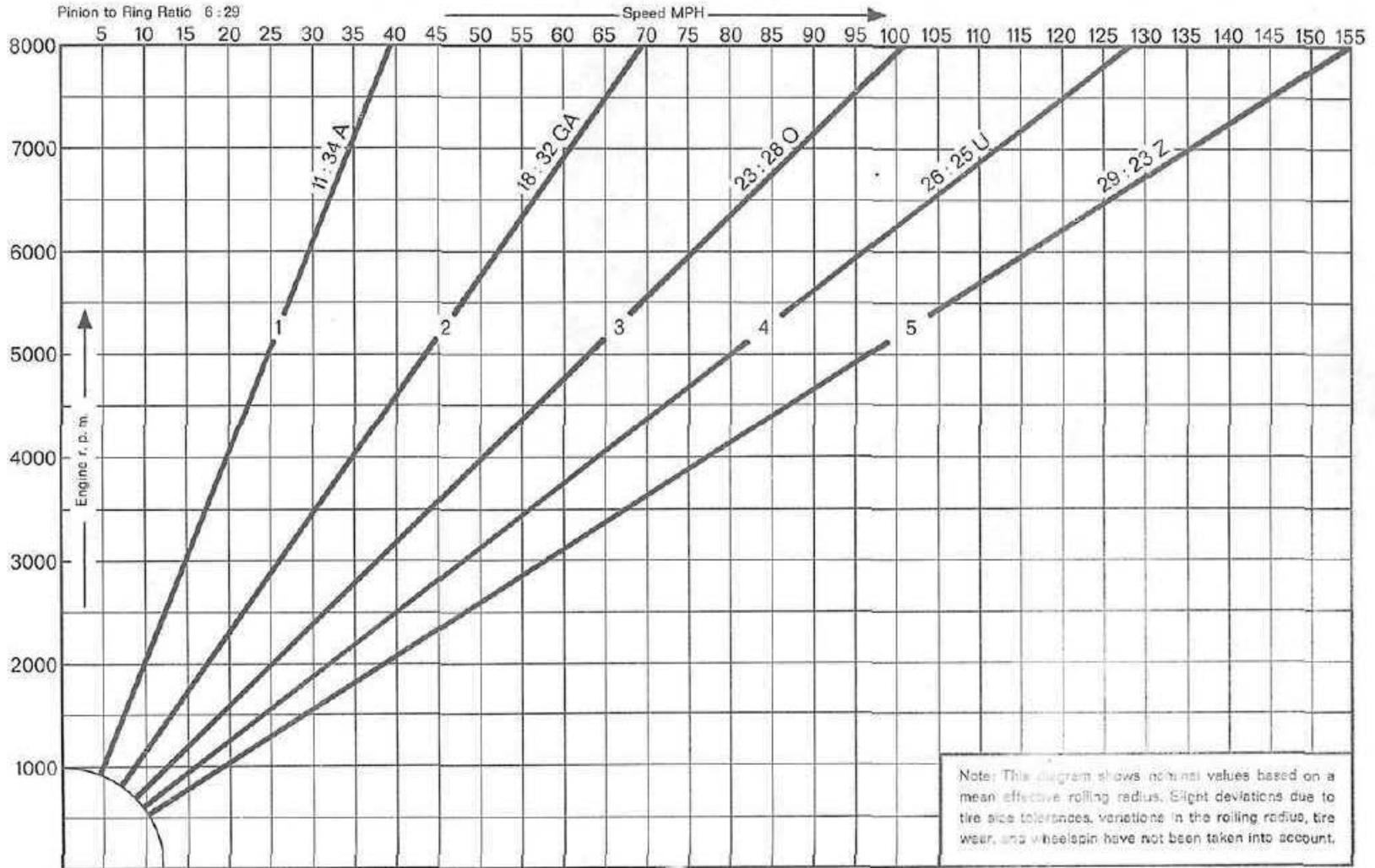
Note: This diagram shows nominal values based on a mean effective rolling radius. Slight deviations due to tire size tolerances, variations in the rolling radius, tire wear, and wheelspin have not been taken into account.

Subject to change without notice

PORSCHE

**Type 912
(5-speed-transmission)**

Transmission Diagram



Subject to change without notice

ASSEMBLY INSTRUCTIONS FOR THE FOUR-SPEED TRANSMISSION

General

When assembling the 4-speed transmission, the usual steps are followed as described in the 5-speed transmission instructions. The arrangement of the forward speeds (1st through 4th speed) on the pinion shaft in the 4-speed transmission is same as gear speeds 2 through 5 in the 5-speed transmission, with

Caution:

Due to the reversed action of the synchronization of the 1st speed in the 4-speed transmission, as compared with the 5-speed transmission, the synchronization components have to be arranged in a directly opposite way. When installing the synchronization components for the 1st speed (in 4-speed transmission), it should be remembered to insert only one brake band. The brake band as well as the brake band energizer should be inserted only in the manner shown in fig. 1 .



Fig. 1

Pinon Shaft Cross-section (4-speed transmission)

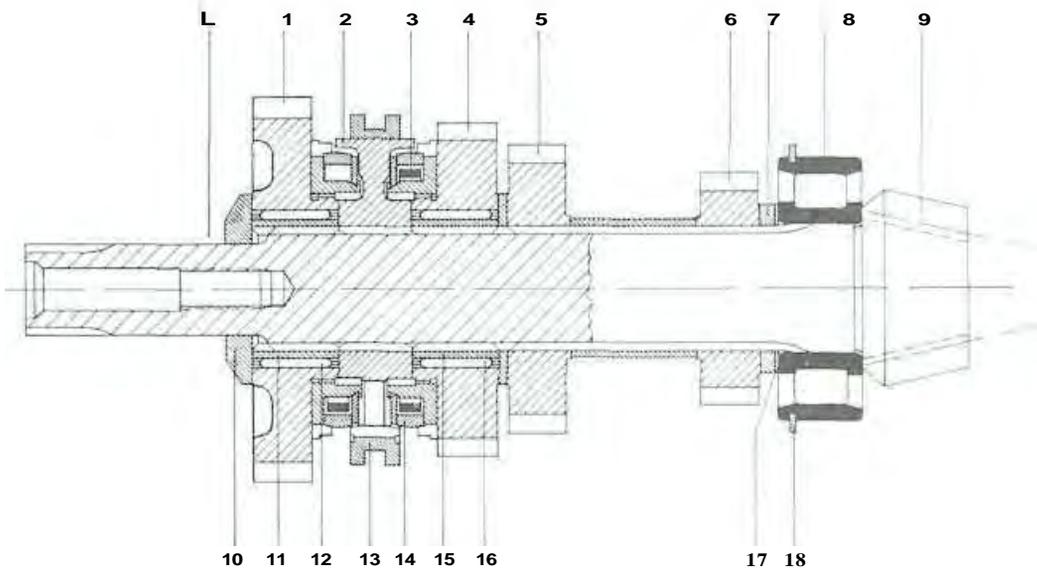


Fig. 2

- | | |
|--|---|
| 1. Four-point ballbearing | 10 Thrust washer (6.6 mm thickness) |
| 1 Gear II for 1st speed (Freewheeling) | 11 Needle bearing inner race (gear speeds 1 thru 4) |
| 2 Spider | 12 Needle bearing cage (gear speeds 1 thru 4) |
| 3 Brake band | 13 Sliding sleeve |
| 4 Gear II for 2nd speed (Freewheeling) | 14 Synchronizing ring |
| 5 Gear II for 3rd speed (Fixed) | 15 Needle bearing inner race |
| 6 Gear II for 4th speed (Fixed) | 16 Needle bearing cage |
| 7 Spacer | 17 Spacers |
| 8 Roller bearing | 18 Retaining ring |
| 9 Pinion shaft | |

ZF MULTIPLE DISC SELF LOCKING DIFFERENTIAL

Function Description

The self locking effect is achieved through internal friction in the differential, created by two multiple disc retarders arranged symmetrically on both sides of the differential. In comparison, the conventional differential will transmit the torque to the wheel which is easiest to turn. When the car is raised off the ground, it is very easy to hold one of the two driving wheels still, in which case the other wheel spins faster. In the self locking differential, this path of least resistance is eliminated to a great degree - and this the more, the greater the driving torque is.

This property is attributable to the fact that the torque transmitted to the differential does not transfer directly onto the spider shafts, as is the case in conventional differentials, but over the two side gear rings which cannot rotate but are free to slide axially in the differential carrier. The contact ramps of the spider shafts, and their counterparts in the side gear rings, are slanted. The driving force resulting from the transfer of torque forces the side gears apart, thus exerting additional pressure to the preloaded friction discs. Since the friction plates are mechanically fixed on the side gears by means of splines, the axle shafts become more or less locked to the differential unit and thus eliminate the possibility of one-sided wheelspin.

Schematic View of the ZF Multiple Disc Self Locking Differential

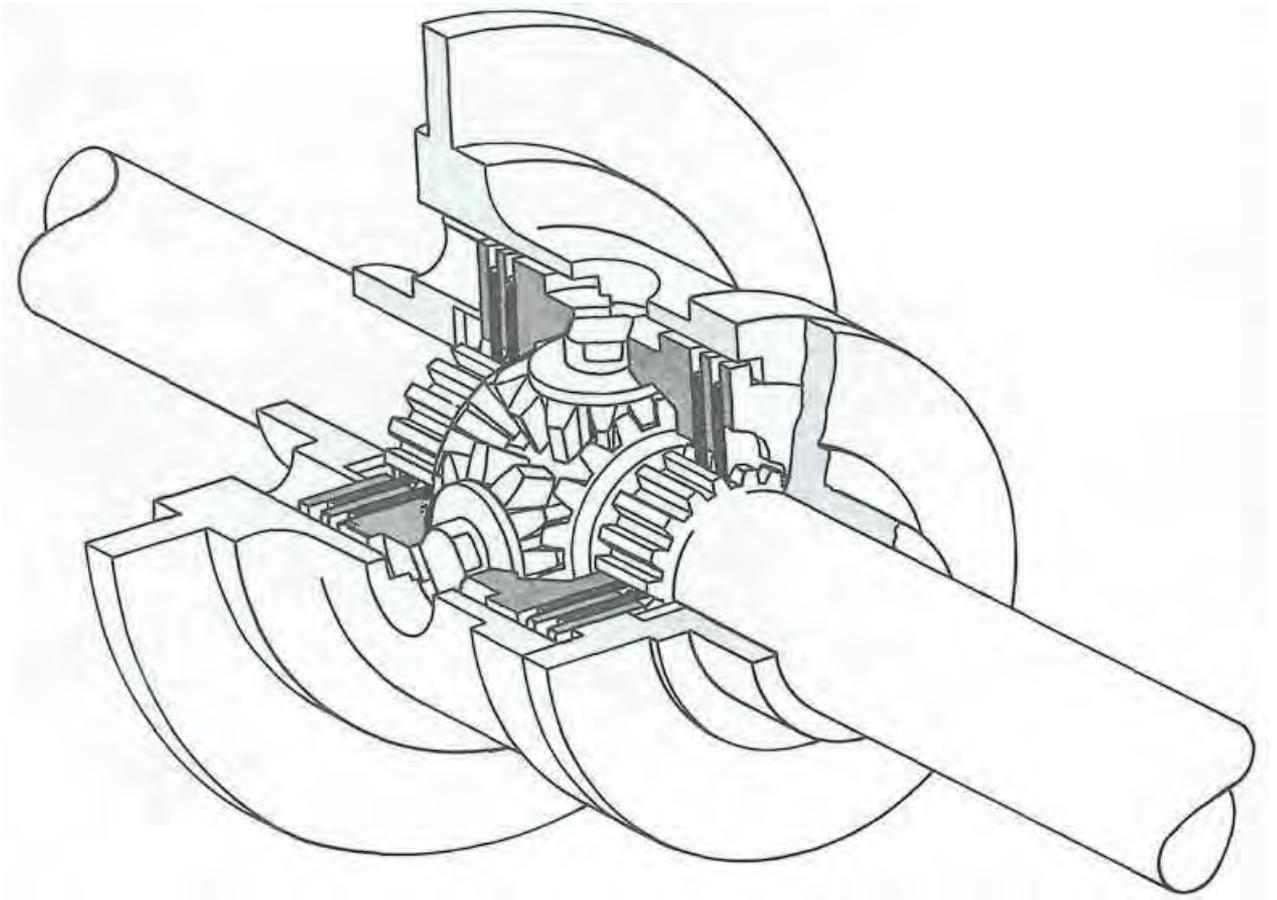


Fig. 1

Two advantages are combined in the ZF self locking differential:

First, a constant locking effect prevails in the differential due to the axially preloaded friction discs. The advantage of this arrangement is that the locking effect imposed upon both axles is present at all times; for instance, when one of the two driving wheels should have little traction in a given moment, one-sided wheelspin can be prevented.

Second, a torque-governed locking effect is obtained through the axial thrust of the slanted spider shafts, which always remains proportionate to the induced torque. Consequently, the locking action varies according to the varying engine torque, including the increased torque in individual gears. This is of special advantage in hard cross-country driving when great torque forces are to be transmitted. Also, this virtue definitely improves the road handling qualities of high-powered passenger cars driven at high speeds.

We define locking effectiveness as follows:

$$S = \frac{M_1 - M_2}{M_1 + M_2} \times 100 \text{ in } \%$$

whereby M_1 is torque at Wheel 1,

and M_2 is torque at Wheel 2.

The ZF self locking differential, Part Nr. 904. 332. 053. 00, is factory preset to an effectiveness of 50 %.

See page SR 23 for arrangement of the friction discs and plates.

Beginning with production date of 6 March 1967, the disc and plate arrangement has been modified (see page SR 28a). Both arrangements can be used at will for the 50 % locking effect.

Compared with conventional units, the ZF self locking differentials offer the following advantages which improve the road handling qualities:

1. Elimination of wheelspin of one wheel when starting or driving over surfaces which provide poor traction on one side.
2. Greatly reduced tendency of one wheel to spin when passing over bumps in road surface.
3. Elimination of skidding dangers at high speed due to uneven traction on both sides, which is especially true in high-performance vehicles.
4. In fast cornering, the wheel on the inside of the curve bears a much smaller load due to the effect of centrifugal forces and would spin if not controlled by a limited-slip differential.
5. When a powerful vehicle travels at high speed on a smooth, rain-wetted surface, traction may become uneven at both wheels as a result of the so-called hydroplaning. In such cases the ZF self locking differential prevents a one-sided wheelspin.

Lubrication:

The only approved lubricant is SHELL Transmission Oil S 1747 A.

NOTE:

This transmission oil is known as indicated in the countries listed:

Australia	SHELL SCL Gear Oil 90
Canada	SHELL HDR Gear Oil 90
USA	SHELL HDR Gear Oil 90 E. P.

Exploded View of the ZF Multiple Disc Self Locking Differential

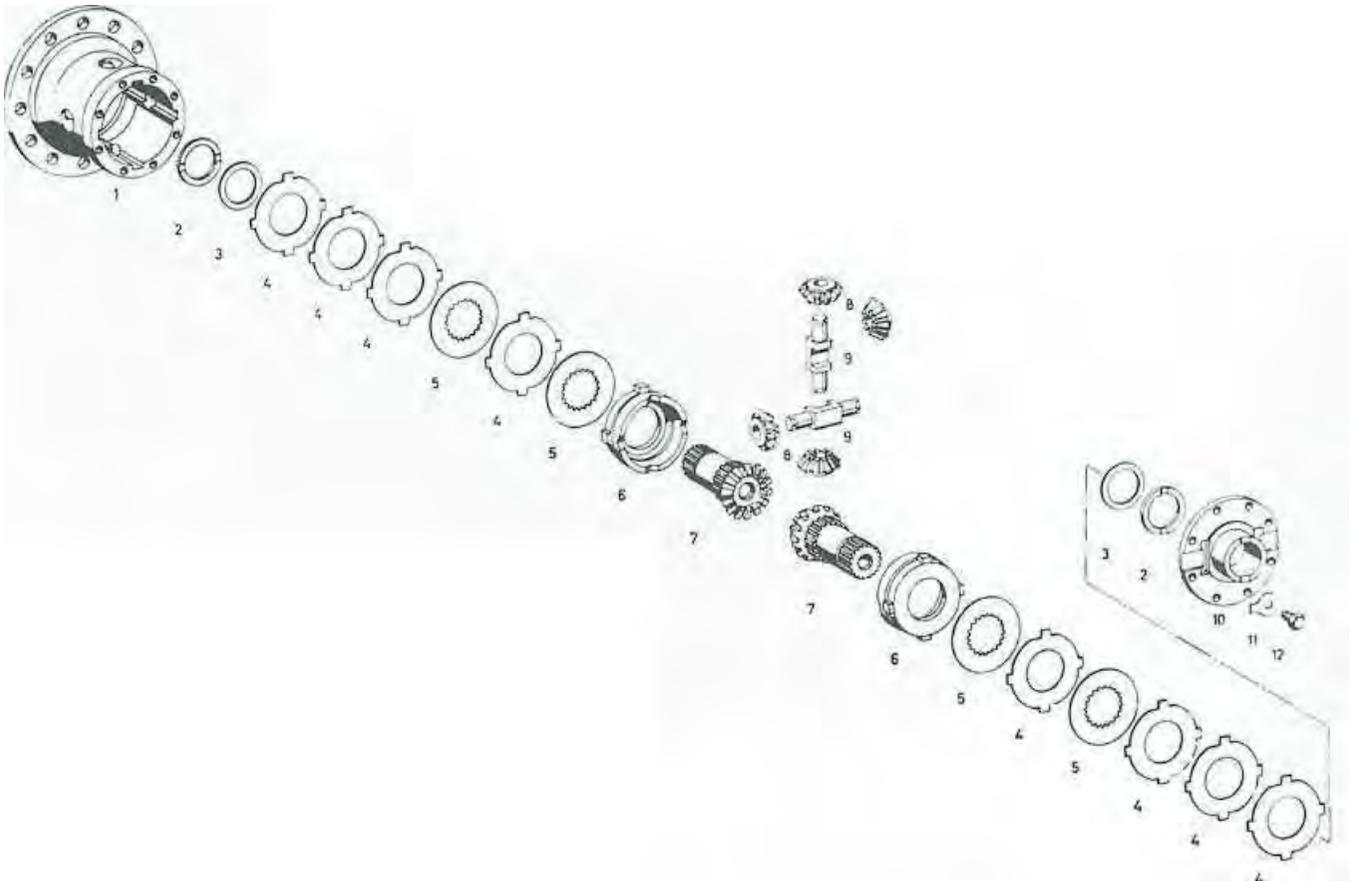


fig. 2

- | | |
|-------------------------------|-----------------------|
| 1 Differential carrier | 7 Side gear |
| 2 Thrust washer (non-ferrous) | 8 Spider gear |
| 3 Thrust washer (ferrous) | 9 Spider shaft |
| 4 Friction plate | 10 Differential cover |
| 5 Friction disc | 11 Lock plate |
| 6 Side gear ring | 12 Hex bolt |

DISASSEMBLING AND REASSEMBLING SELF LOCKING DIFFERENTIAL

Disassembly

1. Unlock safety plate tabs, remove retaining bolts from cover and remove cover.



Fig. 3

2. Remove thrust washers, friction plates and discs, side gear rings and side gear.



Fig. 4

3. Withdraw spider gears and spider shafts from the differential carrier.



Fig. 5

4. Remove the second side gear, side gear ring, multiple disc retarder, and Thrust washer? from the differential carrier.



Fig. 6

NOTE:

Observe the sequential location of the retarder discs and plates; the original sequence must not be disarranged.

Inspecting Components

1. **Differential Carrier:**
Check thrust surface for thrust washers for wear or grooving. Check friction plate locating grooves in the differential carrier for wear.
2. **Differential Cover:**
Check thrust surface for thrust washers for wear or grooving.
3. **Side Gear Ring:**
The locating tabs and thrust surfaces should not be obviously worn or grooved. The side gear rings must move freely in the differential carrier.
4. **Side Gears:**
Thrust surfaces for thrust washers should not be excessively worn. The friction discs must move freely on the side gear splines.
5. **Thrust Washers:**
Check thrust washers for wear.
6. **Friction Discs and Plates:**
Check the plates for wear. The guide tabs of the friction plates and the inner teeth of the friction discs must not be worn or peneed.

Reassembly

1. Coat all contact surfaces of the friction discs and plates, side gear rings, and spider shafts with MOLYKOTEPASTE "G" or LM 348, prior to reassembly.
2. The entire retarder assembly, including the side gear rings and spider shafts, must be checked for installation length under a pressure load of approx. 100 kp (220 lbs) whereby distance "a" must be achieved (max. 82.3 mm to min. 81.6 mm) (max. 3.240" to min. 3.213"). The tolerance between maximum and minimum includes the maximum permissible wear of all parts. The determination of length can be accomplished out of the differential carrier by placing the parts into a shop press. If the values cannot be reached, it will be necessary to determine which parts are worn and replacing these with new.
The wear may have occurred at the following parts:
 - the friction discs or plates
 - the side gear rings
 - the slanted ramps of spider shafts

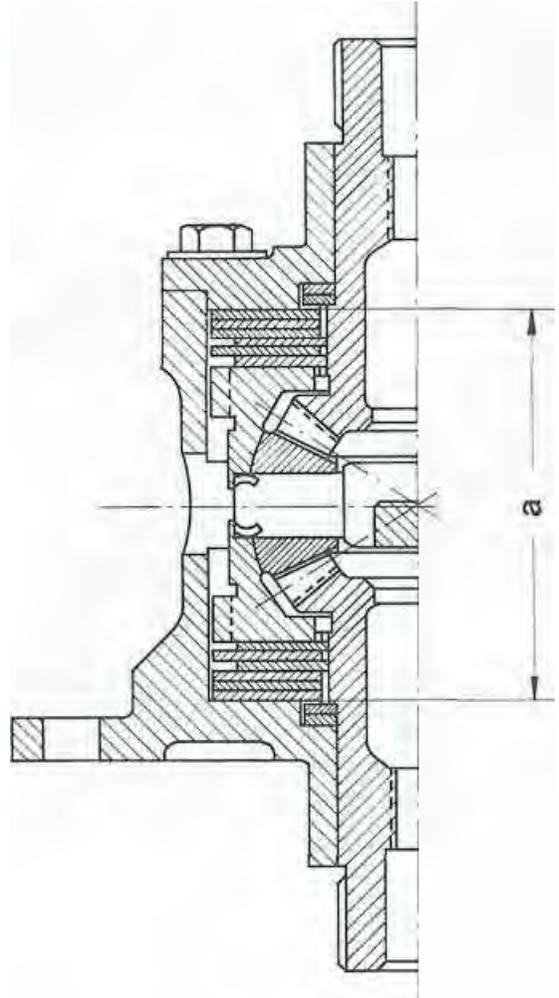


Fig. 7

a = max. 82.3 mm to min. 81.6 mm

3. Place the differential carrier onto a workbench so that the large opening points up. Place non-ferrous thrust washer (Pt. 2, Fig. 2) into the differential carrier with the machined recess facing down. Place ferrous thrust washer (Pt. 3, Fig. 2) on top of(the non-ferrous washer.

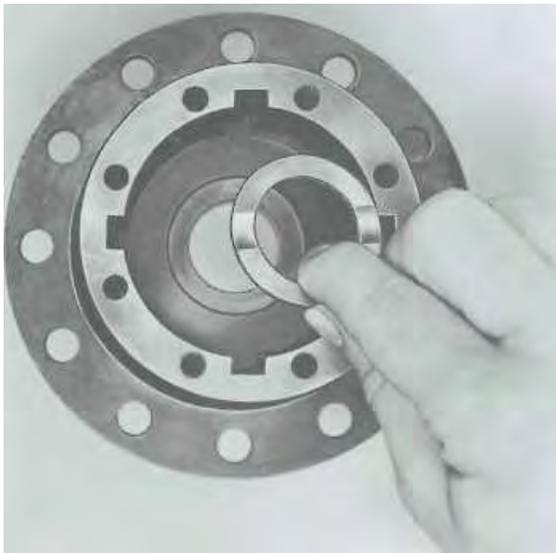


Fig. 8

4. Place the friction discs and plates into the differential carrier in the same sequence as noted during disassembly. (A friction plate is placed at the differential carrier as well as at (the differential cover).



Fig.9

Note:

In differentials equipped with the preloaded friction disc and plate assemblies check the following:

- a. The undulated friction plates (Pt. 4, Fig. 2) should be placed next to the differential carrier and the differential cover.
- b. The plate undulation should be so arranged that a free space exists between the oil groove in the base of the differential carrier or the differential cover, respectively, and the mating friction plate (see Fig. 10).

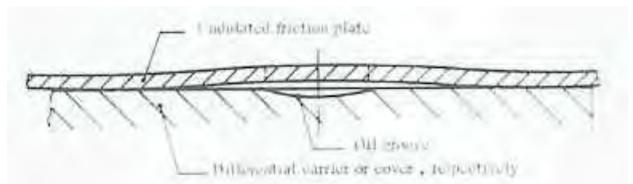


Fig. 10

Special attention must be devoted to the proper positioning of the friction discs and plates since otherwise the self-locking effectiveness may be inadvertently changed. (See cross-sectional view, Fig. 7, in this connection). Place one side gear ring onto the friction discs and plates.



Fig. 11

6. Insert one side gear so that the outer splines of the side gear engage into the inner teeth of the friction discs.

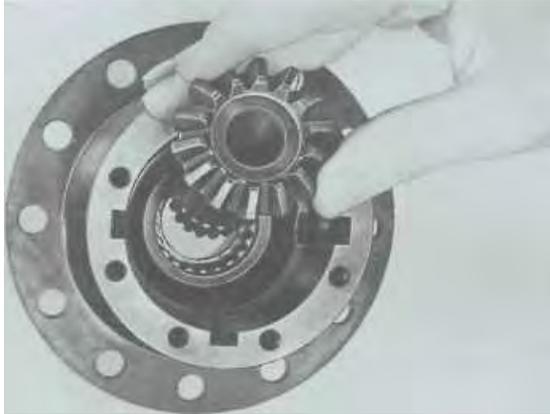


Fig. 12

7. Place two spider gears on each spider shaft. Place the spider shafts across each other and insert into their seats in the differential carrier.



Fig. 13

8. Place the second side gear onto the four spider gears and place the second side gear ring on top.

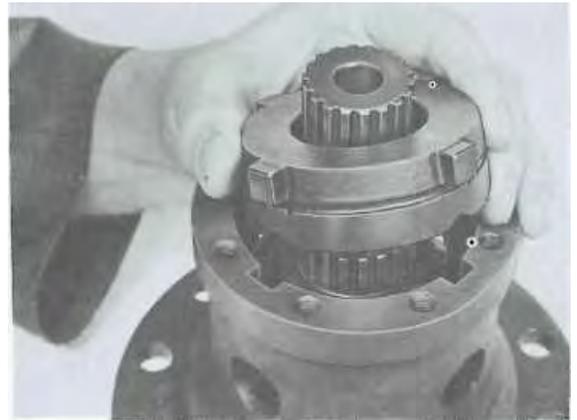


Fig. 14

9. Insert the second set of friction discs and plates. (Also see the note to Pt. 4, above.)

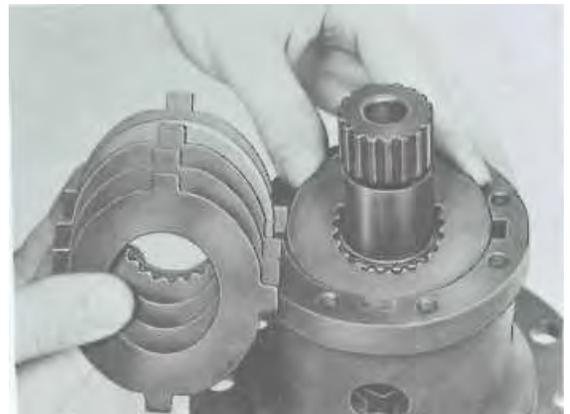


Fig. 15

10. Place the ferrous thrust washer (Pt. 3, Fig. 2), then the non-ferrous thrust washer (Pt. 2, Fig. 2), with machined groove facing up, onto the side gear.



Fig. 16

11. Place differential cover on differential carrier, insert retaining bolts together with safety plates. Torque bolts to 2.5 mkp (18.1 lbs/ft). Secure bolts with safety plates.

FUNCTION TEST OF SELF LOCKING DIFFERENTIAL

The assembled (bolted) differential must turn freely with a torque of 1 to 1.5 mkp (7.2 to 10.8 lbs/ft) without binding at any one point. Moderate noises which may occur, mainly when driving through sharp curves under power, are inherent to the design and will not result in damage to the differential. The noises are caused by mechanical operation of the parts such as friction between the thrust surfaces of the friction discs and plates.

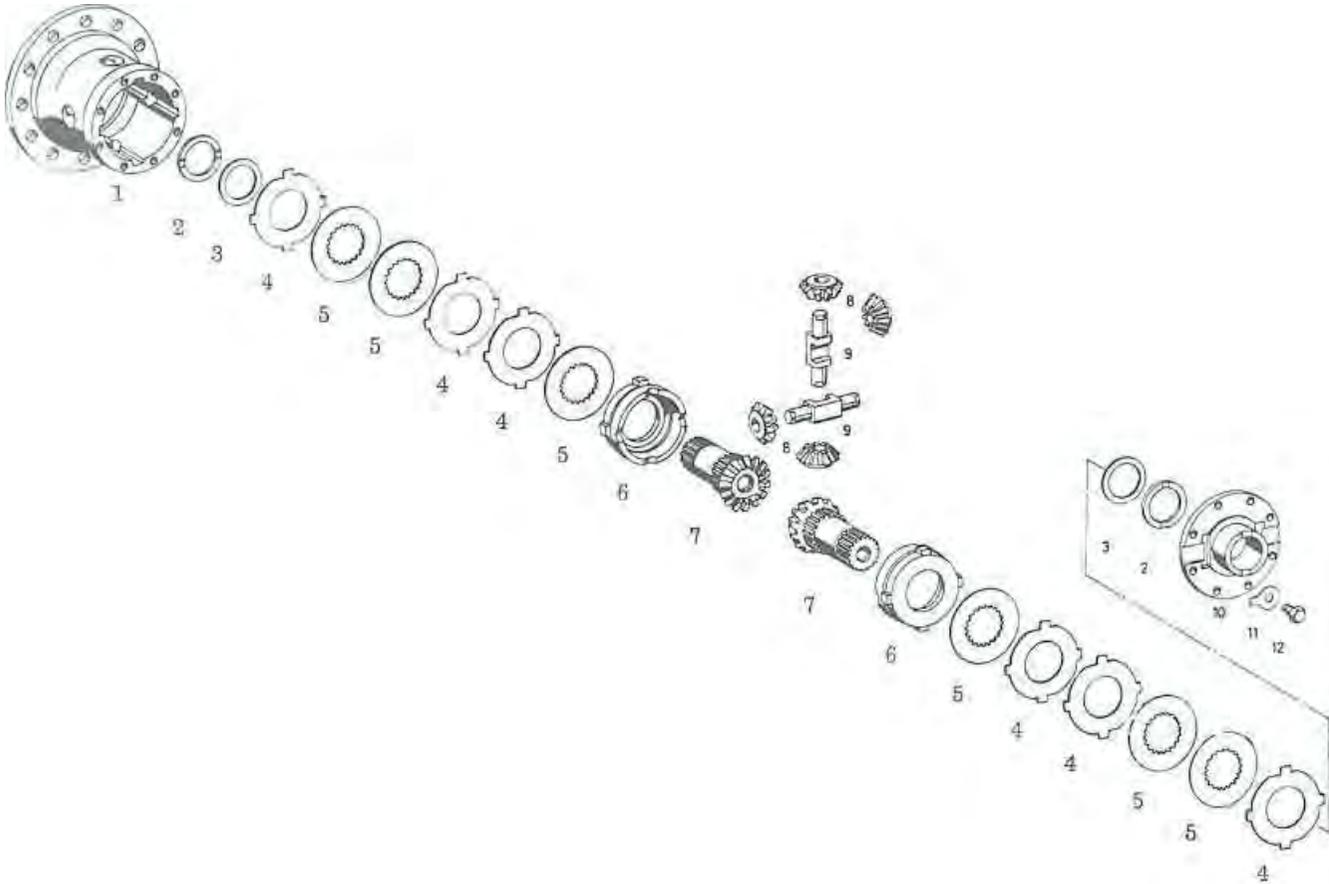
Note:

The ZF multiple disc self locking differential can be installed only in connection with the NADELLA half shafts.

Exploded View of the ZF Multiple Disc Self Locking Differential

From manufacture date of 6 Mar 67

50 % anti-slip effectiveness



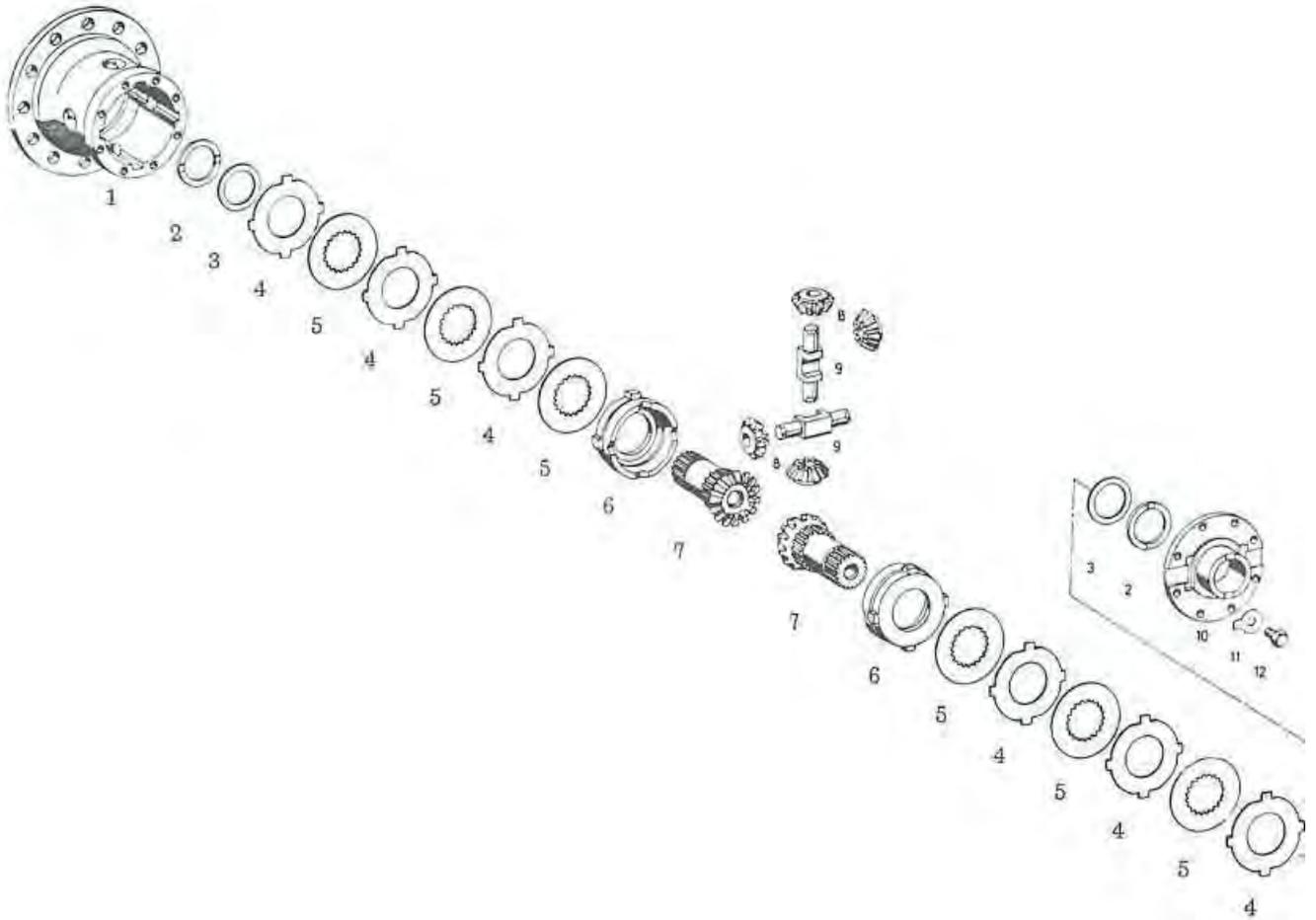
- 1 Differential carrier
- 2 Thrust washer(non-ferrous)
- 3 Thrust washer (ferrous)
- 4 Friction plate
- 5. Friction disc
- 6. Side gear ring

- 7.Side gear
- 8. Spider gear
- 9.Spider shaft
- 10. Differential cover
- 11. Lock plate
- 12.Hex bolt

For use in particular sport events, the self-locking differential can be modified to yield anti-slip effectiveness of 75 % (see page SR 28b).

Exploded View of the ZF Multiple Disc Self Locking Differential

75 % anti-slip effectiveness



- 1 Differential carrier
- 2 Thrust washer (non-ferrous)
- 3 Thrust washer (ferrous)
- 4 Friction plate
- 5 Friction disc
- 6 Side gear ring

- 7 Side gear
- 8 Spider gear
- 9 Spider shaft
- 10 Differential cover
- 11 Lock plate
- 12 Hex bolt

ZF DISC TYPE LIMITED SLIP DIFFERENTIAL - 69 MODEL

General

From 1. April, 1969 on the ZF limited slip differential (strengthened version) has been supplied as a special option. It provides 50 % locking effect. By modifying the sequence of inner and outer discs a locking effect of 75 % can be obtained for special competition purposes. The standard joint flange is now also used on the limited slip differential, but the expansion bolt has been modified.

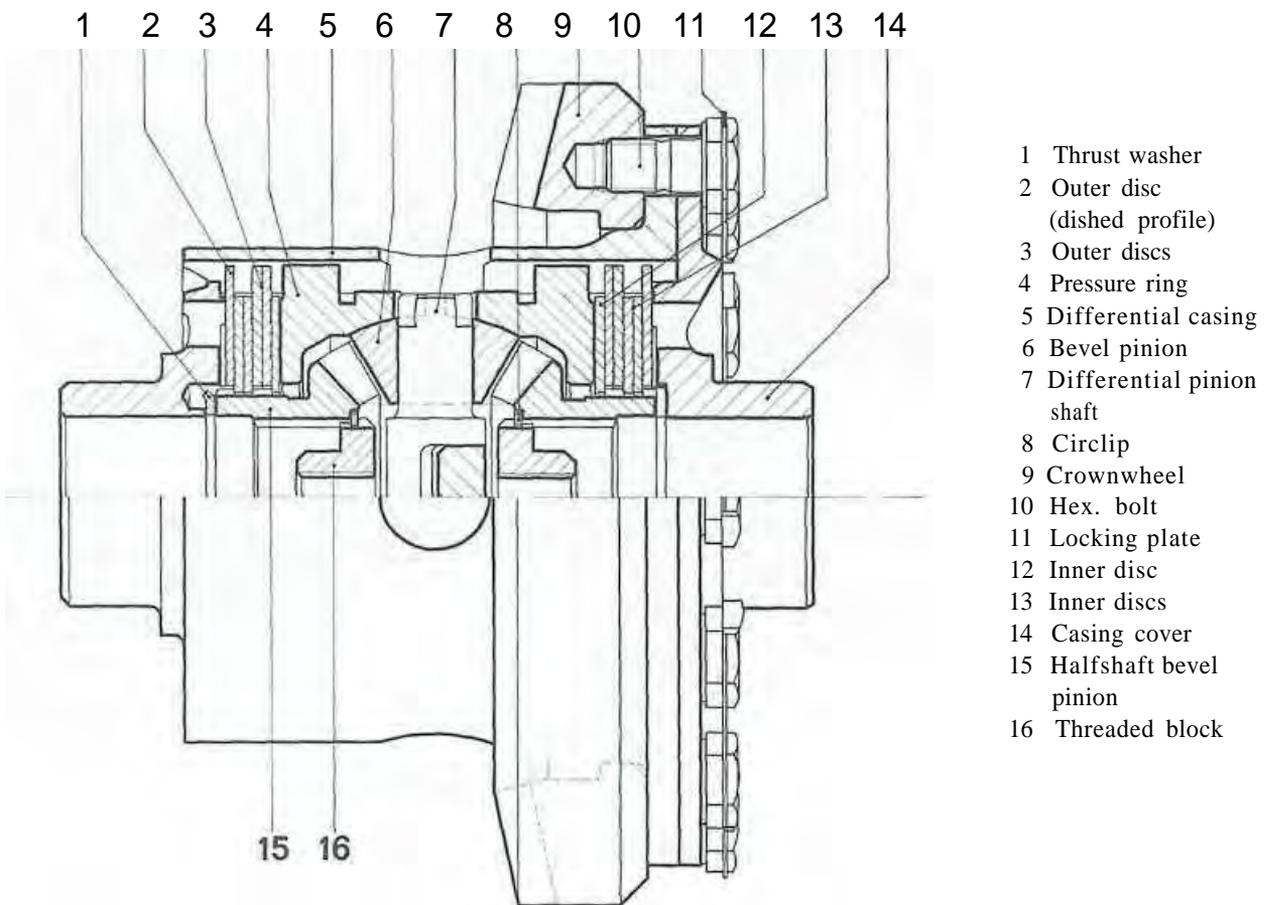


Fig. 1

Lubrication:

Use only Shell S 1747 A gear oil.

Note:

This oil is known in Australia as Shell SCL Gear Oil 90;
in Canada as Shell HDR Gear Oil 90;
in the USA as Shell HDR Gear Oil 90 E. P.

LIMITED SLIP DIFFERENTIAL - DISMANTLING AND RE-ASSEMBLY

Dismantling

1. Take off the crown wheel.
2. Loosen and remove Allen screws on casing flange.



Fig. 2

3. Take out all internal components.
Warning:
Note installed sequence of discs; they must be re-assembled in the same order or the locking effect will not be the same.

2. Pressure ring:
The guide pegs and thrust faces must not be heavily eroded or scored. The pressure rings must move freely in the differential casing.
3. Halfshaft bevel pinions:
The contact faces for the thrust washers must not be worn. The inner discs must move freely on the splines of the halfshaft bevel pinions.
4. Discs:
Check inner and outer discs for wear. The guide pegs on the outer discs and the splines on the inner disc must not have lost their original shape.
5. Thrust washers:
Check for wear.

Re-assembly

Checking condition of components

1. Differential casing:
Check wear at guide slots for outer discs and pressure rings.

For re-assembly note the following points:

1. Before re-assembly starts, apply Molykote 'G' or LM 348 to all sliding surfaces on discs, pressure rings and differential shafts.

2. Insert the thrust washers so that the retaining peg in the hole in the casing or casing cover engages into position. Hold the thrust washers in place with a little grease as used for lubrication.

3. The dished profile outer disc is next to the casing or casing cover.

Warning:

The dished area of these discs must allow an air gap between the oil groove in the base of the casing (or casing cover) and the discs themselves (see drawing).

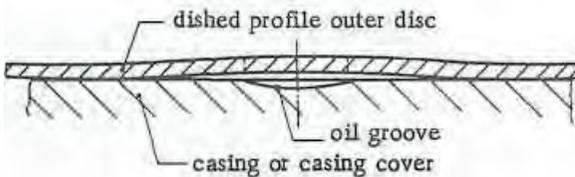


Fig. 3

4. The correct position of the discs is very important, or else the locking effect of the differential will be altered (see sectional and exploded drawings).

5. When re-assembled clamp the flange section of the differential into a vise, using protective jaws. Install the universal joint flange and rotate the differential with a torque wrench.

Disc sequence for 50 % or 40 % locking effect:
torque reading 4-8 mkp (30-57 lb/ft)

Disc sequence for 75 % or 80 % locking effect:
torque reading 6-12 mkp (43-85 lb/ft)

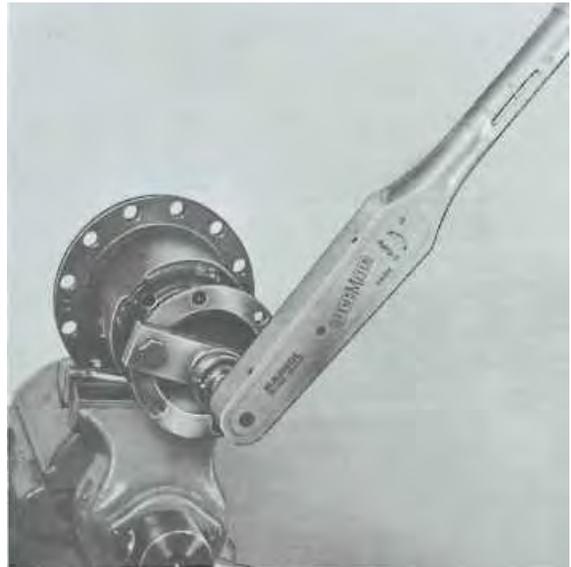


Fig. 4

Note:

By installing suitable inner discs the torque can be adjusted.

Inner discs are available in the thicknesses: 1.9, 2.0 and 2.1 mm.

If the minimum torque readings are not obtained with the thickest inner discs installed, the discs are severely worn and must be replaced.

Note:

The adaptor for the joint flange can be made from 30x15 mm (1.2x0.6") flat steel bar, 120 mm (4.7") long, with a 1/2" square cutout in the center.

6. Tighten the hex bolts for the crown wheel to the specified torque.

EXPLODED VIEW OF ZF DISC TYP LIMITED SLIP DIFFERENTIAL
FROM 69 MODEL ON
50 % LOCKING EFFECT

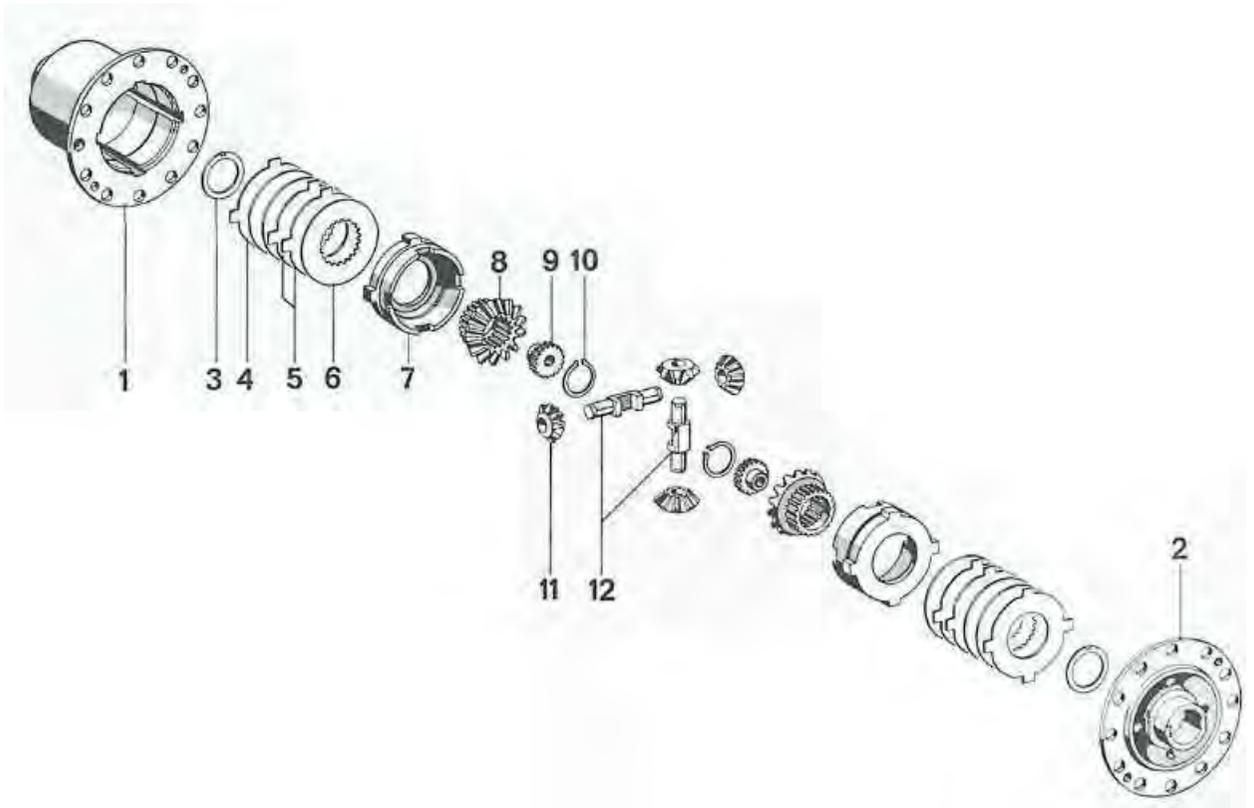


Fig. 5

- | | |
|-------------------------------|------------------------------|
| 1 Differential casing | 7 Pressure ring |
| 2 Casing cover | 8 Halfshaft bevel pinion |
| 3 Thrust washer | 9 Threaded block |
| 4 Outer disc (dished profile) | 10 Circlip |
| 5 Outer disc | 11 Differential bevel pinion |
| 6 Inner disc | 12 Differential pinion shaft |

EXPLODED VIEW OF ZF DISC TYPE LIMITED SLIP DIFFERENTIAL
FROM 69 MODEL ON

75 % LOCKING EFFECT

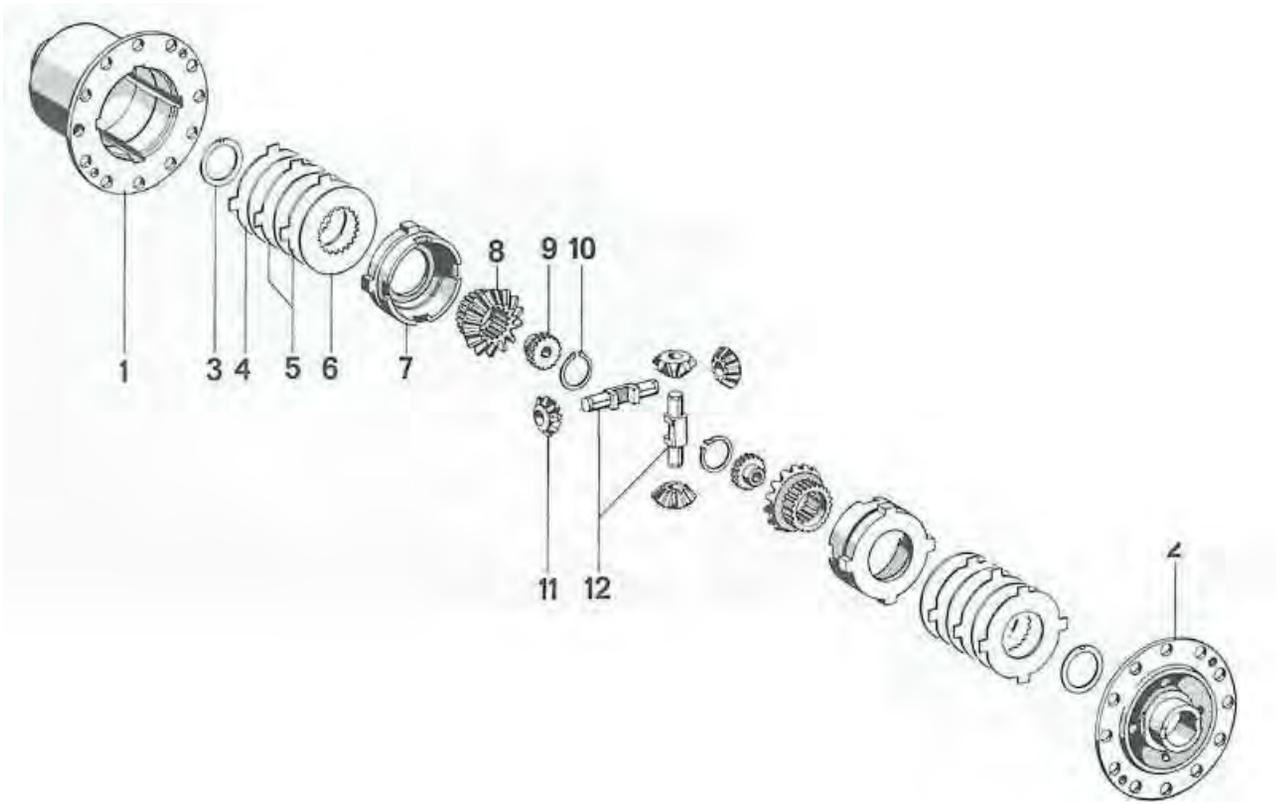


Fig. 6

- | | |
|-------------------------------|------------------------------|
| 1 Differential casing | 7 Pressure ring |
| 2 Casing cover | 8 Halfshaft bevel pinion |
| 3 Thrust washer | 9 Threaded block |
| 4 Outer disc (dished profile) | 10 Circlip |
| 5 Outer disc | 11 Differential bevel pinion |
| 6 Inner disc | 12 Differential pinion shaft |

ZF DISC TYPE LIMITED SLIP DIFFERENTIAL
PRODUCTION DATE AFTER 1 JULY 1969

From 1 July 1969 on the optional ZF limited slip differential uses molybdenum coated inner discs.

When these inner discs are installed, the limited slip differential becomes quieter in operation and the level at which locking effect remains constant is increased.

The normal setting gives 40 % locking effect. By changing the sequence of outer and inner discs, a locking effect of up to 80 % can be obtained for competition purposes.

The molybdenum coated inner discs, part number 901. 332. 551. 21/22/23, replace the plain inner discs, part number 901. 332. 551. 11/12/13, and should be installed in the '69 model' limited slip differential if complaints are received.

Warning:

When subsequently installing molybdenum coated inner plates, the sequence of outer and inner plates changes. See pages SR 28i and SR 28k.

EXPLODED VIEW OF ZF DISC TYPE LIMITED SLIP DIFFERENTIAL, '69 MODEL
PRODUCTION DATE AFTER 1 JULY 1969

LOCKING EFFECT 40 %

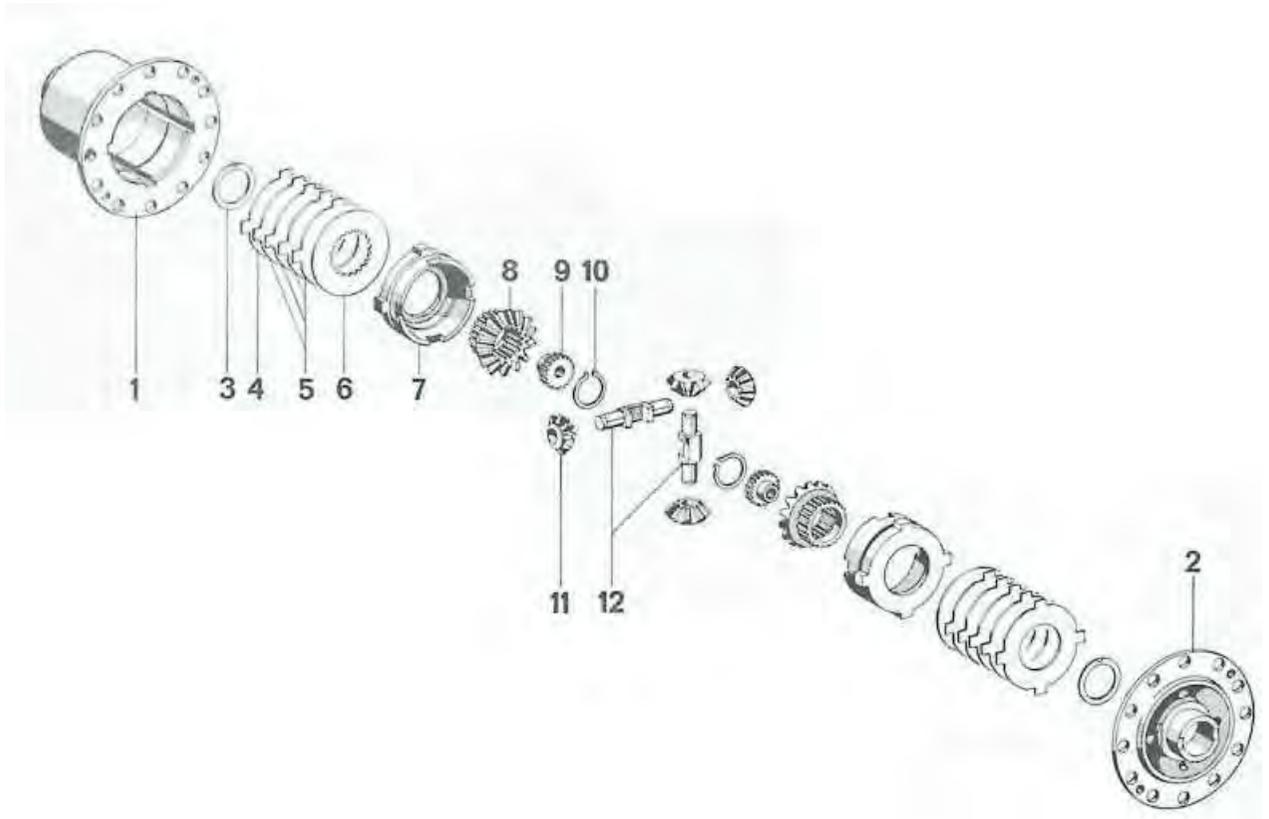


Fig. 7

- | | |
|----------------------------------|------------------------------|
| 1 Differential casing | 7 Pressure ring |
| 2 Casing cover | 8 Halfshaft bevel pinion |
| 3 Thrust washer | 9 Threaded block |
| 4 Outer disc (dished profile) | 10 Circlip |
| 5 Outer disc | 11 Differential bevel pinion |
| 6 Inner disc (molybdenum coated) | 12 Differential pinion shaft |

EXPLODED VIEW OF ZF DISC TYPE LIMITED SLIP DIFFERENTIAL, 69 MODEL
PRODUCTION DATE AFTER 1. JULY 1969

LOCKING EFFECT 80 %

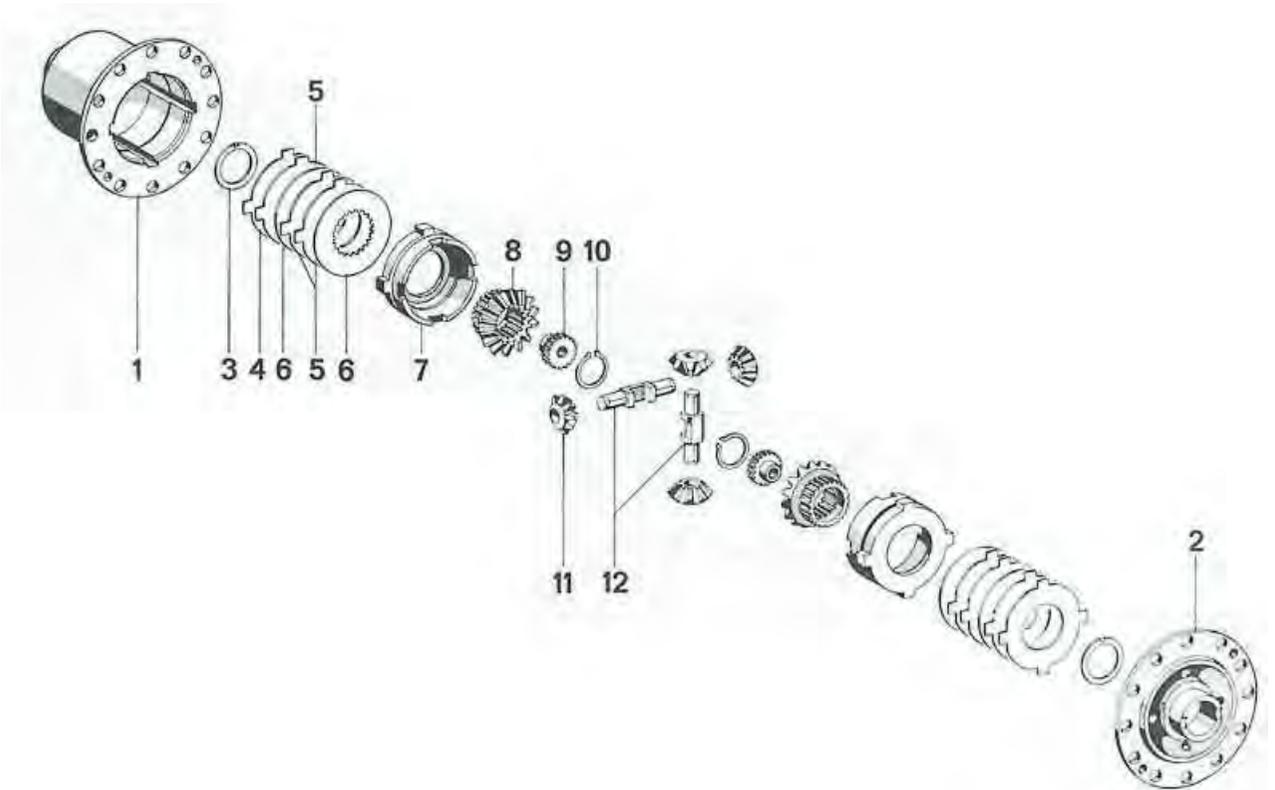


Fig. 8

- | | |
|----------------------------------|------------------------------|
| 1 Differential casing | 7 Pressure ring |
| 2 Casing cover | 8 Halfshaft bevel pinion |
| 3 Thrust washer | 9 Threaded block |
| 4 Outer disc (dished profile) | 10 Circlip |
| 5 Outer disc | 11 Differential bevel pinion |
| 6 Inner disc (molybdenum coated) | 12 Differential pinion shaft |

GEARSHIFT KNOB WITH IMPRINTED SHIFT PATTERN
FOR 4 OR 5 SPEED TRANSMISSIONS

General

Effective 21 March 1967, all Type 911, 911 S, and 912 vehicles are leaving the production line with gearshift knobs which have a gearshift pattern imprint for either the 4 or 5 speed transmission, whichever is installed in the car. The knobs are no longer mounted by means of threads in the shaft. The new knobs are pressed onto the gearshift lever and are held in place by an internal lock ring which secures the knob against turning as well.



Fig. 1

REMOVING AND INSTALLING GEARSHIFT KNOB WITH IMPRINTED SHIFT PATTERN

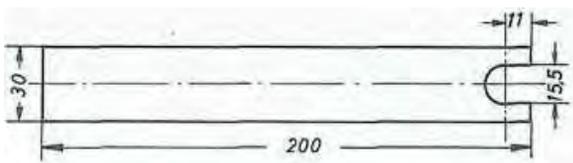
Special Tool:

P 299 Press Adapter for Gearshift Knob

Removal

1. Shift into low gear and drive the knob off the shaft with the aid of self-made remover (see sketch).

Specifications for Local Manufacture of Remover



All edges are beveled
Use 6 mm thick flat steel

Fig. 2



Fig. 3

2. Pull internal locking ring out of the knob with a suitable hook.

Installation

1. Press new internal locking ring into gearshift knob, using a suitable driver, until the ring seats in place.
2. Mark travel depth of knob on the shaft to ensure that the knob will be pushed in all the way.
3. Shift into third gear. Place knob in shaft, positioning the pattern imprint properly, and drive the knob into place with the aid of special tool P 299.

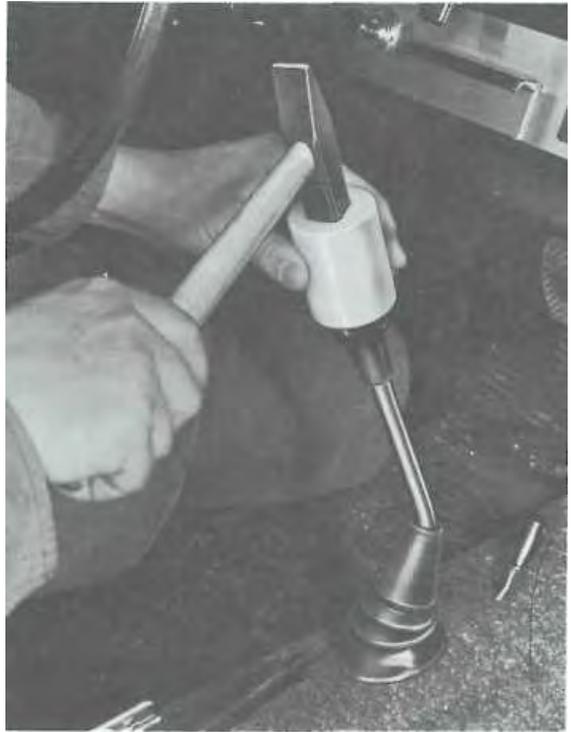


Fig. 4

RADIUS ARMS WITH VULCANIZED RUBBER BUSHINGS

Beginning with the chassis serial numbers listed below, Type 911, 911 S, and 912 vehicles are being equipped with radius arms which have rubber bushings vulcanized into place:

Type 911 S - from Chassis Serial Nr. 305 101 S

Type 911 - from Chassis Serial Nr. 307 325

Type 912 - from Chassis Serial Nr. 354 938



Fig. 1

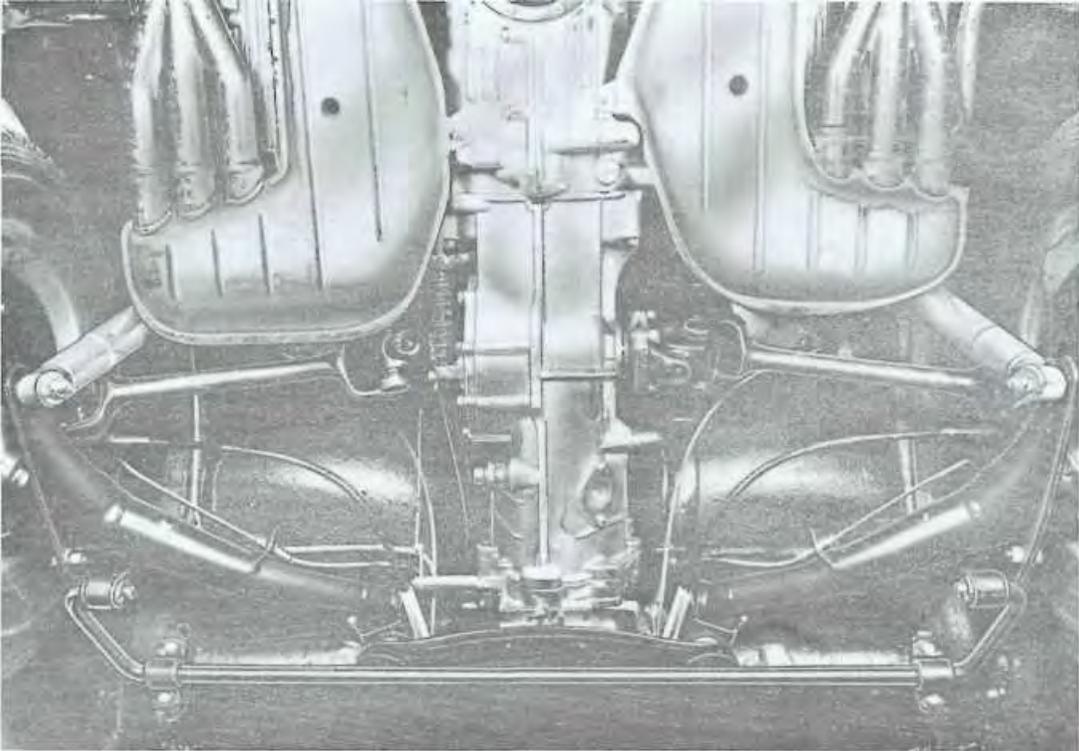
The radius arm seats in the transverse support tubes had to be enlarged to accommodate the new radius arms. Consequently, the new radius arms can be installed only into vehicles built since the above chassis serial numbers.

The installation procedure and adjustment specifications remain unchanged.

REMOVING AND INSTALLING REAR STABILIZER

General

A rear stabilizer of, 63" (16 mm) diameter is installed in Type 911 S vehicles as standard equipment. The stabilizer joints are service free.



Removal

1. Using a large screwdriver, press upper eye of stabilizer shackle off supporting ballstud in transverse control arm.
2. Remove bracket cap retaining bolts and remove stabilizer with bracket caps.

Inspection

Check rubber bushings and mounting grommets for wear, replace when necessary.

Reassembly and Installation

Note the following points at reassembly :

1. Lightly lubricate the shackle mounting grommets and press into the shackles with the help of a vise.
2. Install rubber bushings dry (without lubrication).
3. Position the shackles on the stabilizer so that the grommet openings point inward, as shown in Fig. 2.
4. Lightly lubricate the upper shackle grommets with MoS2 grease and press onto their supporting ballstuds with a large screwdriver.



Fig. 2

NOTE : Beginning with 1968 models, Type 911 S cars receive a rear axle stabilizer of 15 mm (. 591") diameter as standard equipment. Care should be taken during installation that the right size rubber mounts are used.

GEARBOX AND TRANSAXLE WITH PRESSURE CAST HOUSING

Effective from 30. November, 1968, cars of types 912, 911 T, 911 E and 911 S (not Sportomatic) are fitted as standard with a pressure cast gearbox housing.

Introduction of this pressure cast gearbox housing, together with other modifications to the gearbox and transaxle, have led to the establishment of new gearbox type numbers.

Summary of gearbox types:

Gearbox type 902/14 (4-speed)

7:31 (11:34, 19:32, 24:27, 28:24)

For vehicle type: 912

Gearbox type 902/16 (5-speed)

6:29(11:34, 18:32, 23:28, 26:25, 29:23)

For vehicle type: 912 (option)

Gearbox type 902/60 (5-speed)

7:31 (11:34, 17:34, 20:31, 23:28, 26:25)

For vehicle type: 912 (option)

Gearbox type 901/12 (4-speed)

7:31 (11:34, 19:31, 25:26, 29:23)

For vehicle type: 911 T and 911 E-USA
911 E and 911 S (option)

Gearbox type 901/13 (5-speed)

7:31 (11:34, 18:34, 22:29, 25:26, 29:23)

For vehicle type: 911 E and 911 S
911 T (option)

Gearbox type 901/80/81/82/83/84 (5-speed)

7:31 (14:37, 18:32, 22:29, 26:26, 28:23)

(12:34, 17:34, 20:31, 22:29, 23:28)

(12:34, 18:34, 21:31, 23:28, 25:26)

(15:36, 20:32, 23:28, 26:26, 28:23)

(14:37, 20:32, 22:29, 25:27, 27:25)

For vehicle type: 911 T, 911 E and 911 S (option)

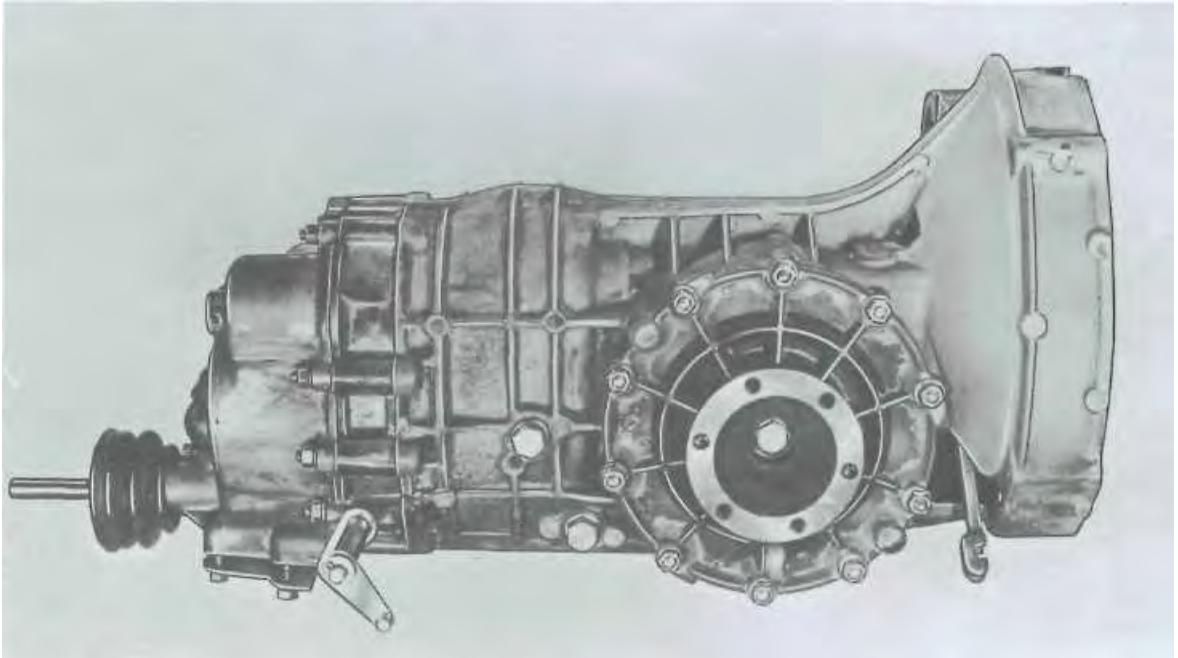


Fig. 1

Gearbox and transaxle with pressure cast housing have been modified as follows:

1. Gearbox housing, intermediate plate, front and side gearbox covers are now pressure castings.
2. To prevent contact corrosion, all studs, washers, etc. are specially corrosion protected.
3. Taper roller bearings for the differential have been enlarged, and this has led to modifications to the differential housing, spacer rings, spacing washers, joint flanges and sealing rings.

Warning:

Pressure-cast parts must not be cleaned with acid, since acids attack magnesium alloys. After any transmission repairs during which the one-season underseal is washed off the gearbox housing, or when the underneath of the vehicle is washed, we recommend that corrosion protection be improved on the pressure-cast gearbox housing by applying a bitumen or wax based one-season underseal, e. g. Tectyl, which should be sprayed or brushed on.

ASSEMBLY INSTRUCTIONS

For repair operations the following additional special tools are needed:

- P 258b Bush (two required)
to be used in conjunction with P 258 for
adjusting the driving shaft
- P 264b Drift
for assembling taper roller bearing in
differential housing

- P 265b Pressure piece
for assembling radial seals in rear axle
joint flanges

Gearbox - dismantline and reassembles

Dismantling

1. Screw special tool P 356b onto joint flange.
Loosen joint flange expansion bolt and take
off joint flange.

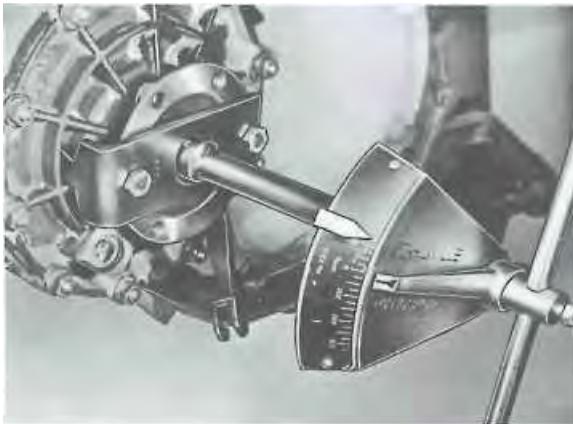


Fig. 2

2. Remove the opposite joint flange in the same
way.
3. Unscrew the self-locking hexagon nuts on the
side gearbox cover and drive off the cover with
alternating blows of a suitable lever.

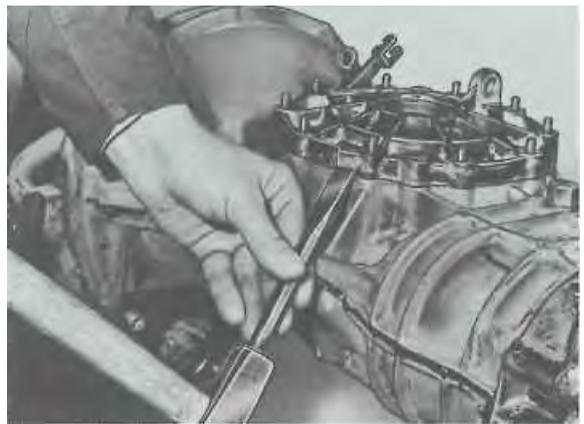


Fig. 3

4. Take out the differential complete with the
crownwheel.
5. Remove the gearbox support on the front gear-
box cover.
6. Unscrew the self-locking hexagon nuts on the
front gearbox cover and remove the cover.
Warning:
Parts of the reverse gear will fall out.

Other assembly procedures are unchanged:
see page R 13, item 1 RA.

Assembly

See page R 16, item 1 RA.

Also note the following points:

1. When the reinforced 4-point ball bearing, spare part number 999.052.016.00 was introduced, the outer half of the bearing inner race was no longer marked with an "x". The assembly instruction therefore no longer applies. The inner race bearing halves from one bearing must not however be combined with another bearing.
2. Tighten the castellated nut on the driving shaft (M 14x1.5) to 9-11 mkp (65 - 80 lb/ft).
3. Drive in the radial seals for the rear axle joint flanges using special tool P 265b, until the special tool makes contact with the gearbox housing or the side gearbox cover.



Fig. 4

4. Pull on a new O-ring for the side gearbox cover, oil lightly and tighten the self-locking hexagon nuts to 2.1 - 2.3 mkp (15.2 - 16.6 lb/ft).



Fig. 5

Warning:

Use only special corrosion-proof steel spacing washers, spare part number 900.031.001.02 under the hexagon nuts.

The self-locking hexagon nuts (spare part number 999.090.101.02) can be used more than once.

5. Assemble the front gearbox cover and install; see page SR 146.

Disassembling and assembling intermediate plates

Disassembling

See page R 35, item 7 RA.
Note also the following procedure:

Fold up the lock plates for the hexagon bolts with internal splines for the clamping plate. Unscrew the bolts with special tool P 292 and remove the plates.

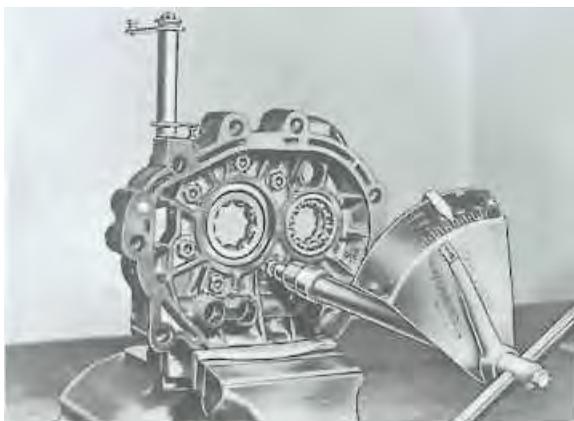


Fig. 6



Fig. 7

2. A spring washer, spare part number 900.028.024.01 must be placed between each keeper plate and the clamping plate. Tighten the hexagon bolt with internal splines using special tool P 292 to 2.1 - 2.3 mkp (15.2 - 16.6 ft/lbs.). Check that the lock plates are correctly installed and lock by bending up.

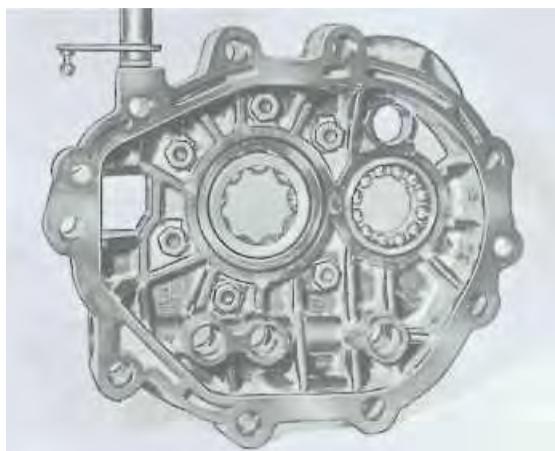


Fig. 8

Assembling

See page R 35, item 7 RA.
Note also the following procedures:

1. Install the clamping plate.

3. The new clamping plates with self-locking heli-coil threaded inserts spare part number 901.301.035.13 require a base plate spare part number 901.301.255.13 between the clamping plate and the intermediate plate. In addition, washers spare part number 900.025.007.02 must be placed under the cheesehead screws. Tightening torque remains unchanged.

Differential - dismantling and reassembling

Dismantling and checking

See page SR 105.

Reassembling

See page SR 106.

Note also the following point:

Force on the taper roller bearing with special tool P 264b.

CROWNWHEEL - FITTING

Determining total thickness of spacing rings for crownwheel fitting.

See page R 44, item 10 RA.

Note also the following procedure:

On the die cast transmission housing the axial interference fit of the tapered roller bearings for the differential has been increased. The following torques must now be developed to produce the correct interference fit for the taper roller bearings.
SKF tapered roller bearings = 25-35 cmkp
FAG tapered roller bearings = 40-65 cmkp

Warning:

Push the disc of special tool P 357 on the joint flange and install the joint flange. Tighten the expansion bolt with washer slightly (prevent the differential from turning).



Fig. 9

Fitting crownwheel

Special tools:

P 258 Gearbox calibrating pin

P 258b Bush (two needed)

See page R 46, item 11 RA.

Fitting procedure is unchanged.

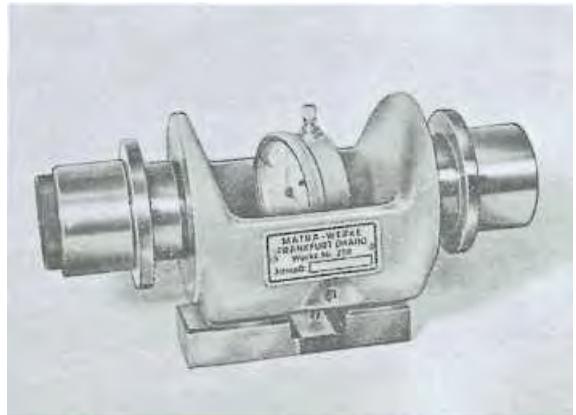


Fig. 10

Adjusting crownwheel tooth backlash

Special tools:

P 259 Retainer and dial gage holder (for measuring crownwheel/pinion tooth backlash)

P 263 Pressure piece (to pull off taper roller bearings from differential housing)

P 264b Drift (for assembling taper roller bearings in differential housing)

P 357 Disc (to prevent differential from turning)

See page R 48, item 12 RA.

Note also the following procedures:

1. Install the side gearbox cover with an O-ring. Oil the O-ring slightly.
2. Tighten all self-locking hexagon nuts on the side gearbox cover to 2.1 - 2.3 mkp (15.2 - 16.6 lb/ft).
3. Push the disc of special tool P 357 onto the joint flange. Mount the joint flange. Place dial gage holder P 259 on the joint flange and secure with a suitable hexagon screw.

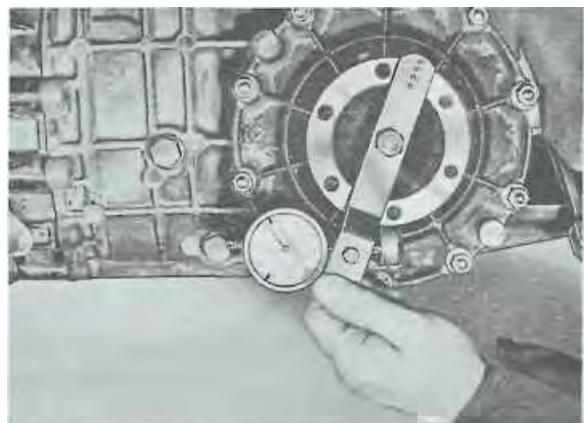


Fig. 11

FRONT GEARBOX COVER

Assembly and installation

See page R 52, item 15 RA.

Note in addition the following points:

1. Install the retaining screw for the angled speedometer drive with a washer, spare part number 900.031.001.02. Tightening torque 1.6 - 1.8 mkp (11.6 - 13 lb/ft).
2. Tighten the self-locking hexagon nuts to 2.1 - 2.3 mkp (15.2 - 16.6 lb/ft).
3. Do not forget to install the aluminum baseplates between the gearbox cover and the gearbox support, and to tighten the self-locking hexagon nuts to 2.1 - 2.3 mkp (15.2 - 16.6 lb/ft).

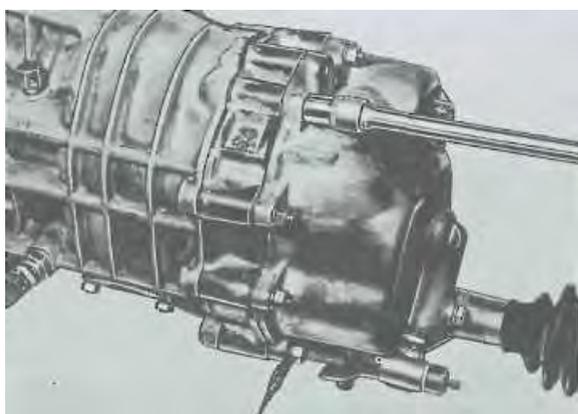
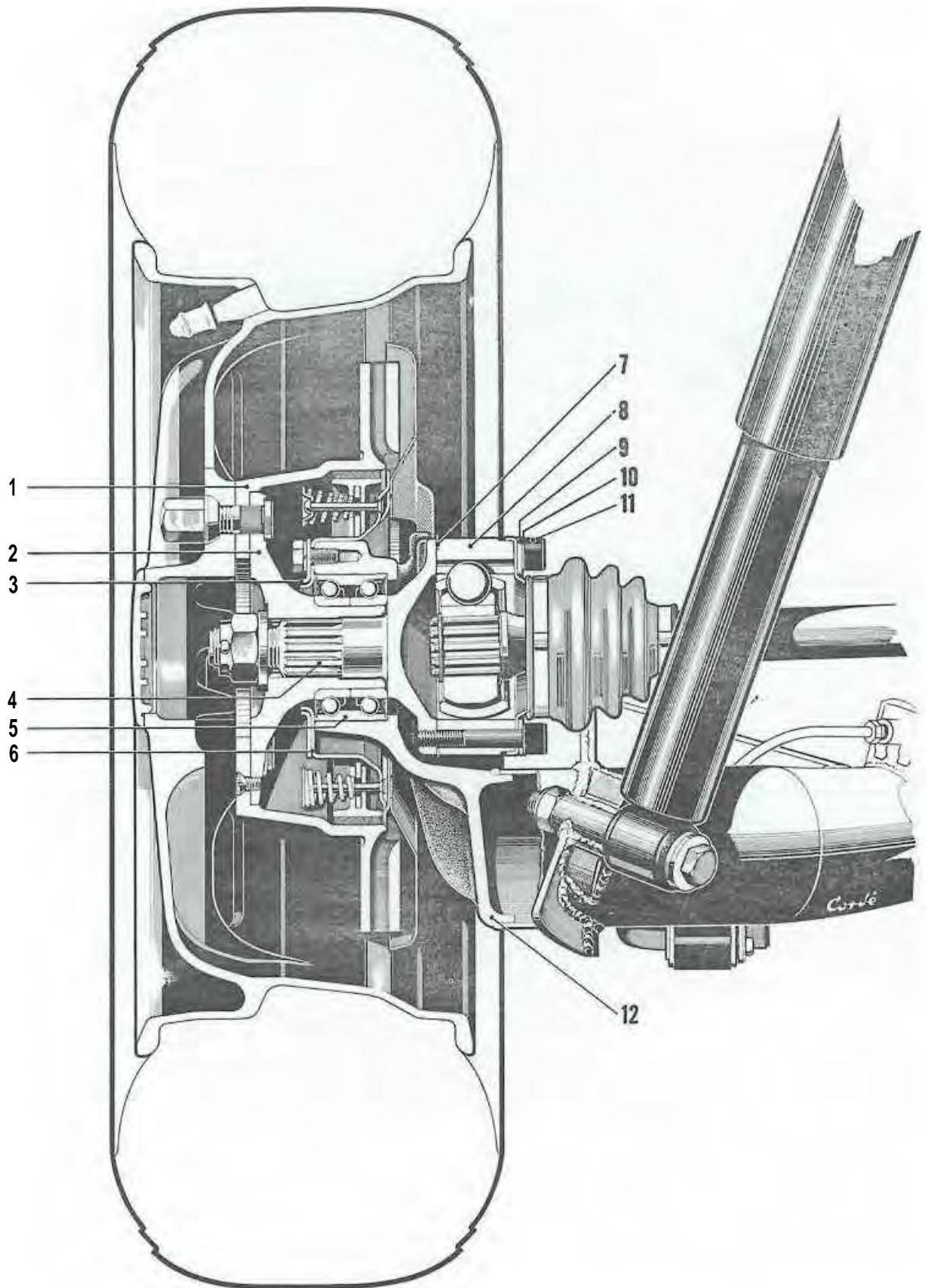


Fig. 12

Warning:

Use only special corrosion-proof steel washers, spare part number 900.031.001.02 under the hexagon nuts. A large washer must be placed between the ground strap and the gearbox cover. The self-locking hexagon nuts, spare part number 999.090.101.02, can be used more than once.

REAR WHEEL CROSS - SECTION



- 1 Brake disc, rear
- 2 Rear wheel hub
- 3 Reinforcing cover
- 4 Stub shaft

- 5 Double-row ballbearing
- 6 Brake carrier plate
- 7 Seal
- 8 LOBRO half-shaft

- 9 Bolt plate
- 10 SCHNORR serrated washer
- 11 Internal wrench bolt
- 12 Rear wheel control arm

REAR AXLE SEMI-TRAILING ARM - REMOVAL AND RE-INSTALLATION

Special tools:

- | | | | |
|-------|---|--------|--|
| P 36b | Guide and retaining device | P 295b | Test gage for semi-trailing arm |
| P 42a | Torque wrench, max. reading 75 mkp
(540 lb/ft) | P 296 | Socket wrench insert for rear axle nut |
| P 44a | Extension | P 297 | Extractor drift for rear wheel hub |
| P 289 | Spring arm clamping device | P 298b | Assembly jig |

Removal

Note:

The rear axle semi-trailing arm can only be removed and installed after the complete engine-gearbox assembly has been removed.

1. Raise the car and take off the rear wheels.
2. Remove the brake line between the fixed caliper and the brake hose (first depress the brake pedal slightly with the pedal retaining clip and hold in position to prevent brake fluid from overflowing in the reservoir).

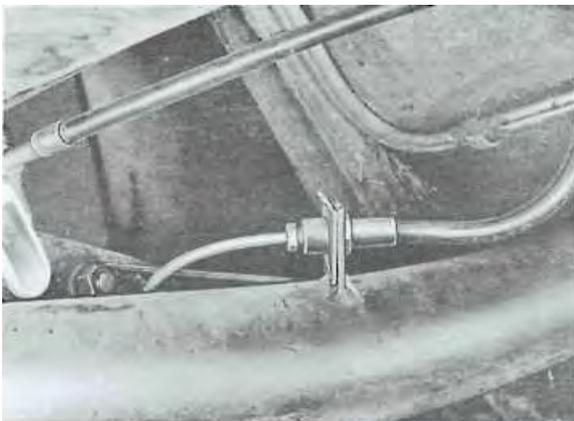


Fig.

3. Drive off the brake hose clip from the rear axle semi-trailing arm, and pull off the brake hose.

4. Loosen the bolts holding the fixed brake caliper, and take off the brake caliper.

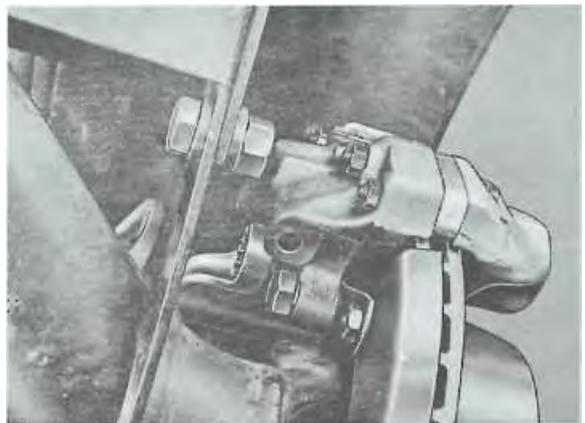


Fig. 2

5. Loosen the countersunk head bolts on the brake disc and remove the brake disc.

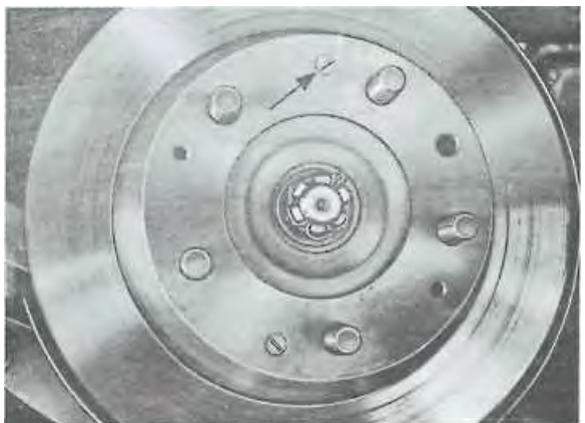


Fig. 3

- Using special tool P 289, lift the rear axle radius arm (spring link) and unscrew the hexagon bolt for the shock absorber.

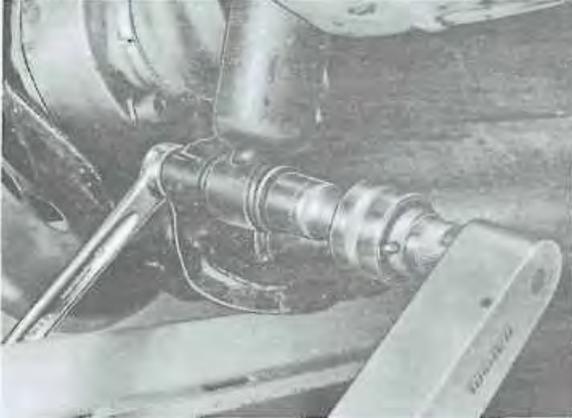


Fig. 4

- Remove the keeper from the castellated nut on the halfshaft and unscrew the nut, using special tools P 42a, P 36b, P 44a and P 296.

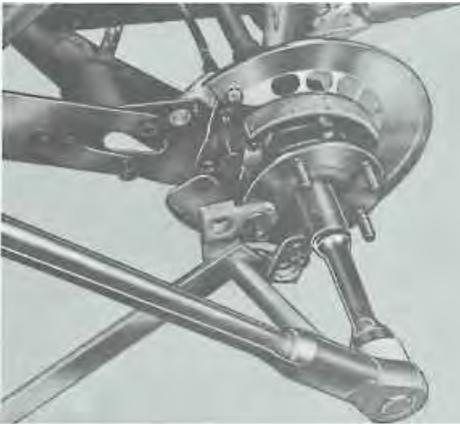


Fig. 5

- Unscrew the cheese-head bolts on the halfshaft at the joint flange. Strike with a flat chisel near the flange gasket to separate the halfshaft from the joint flange, then take off the halfshaft.

Warning :

Do not damage the flange surfaces.

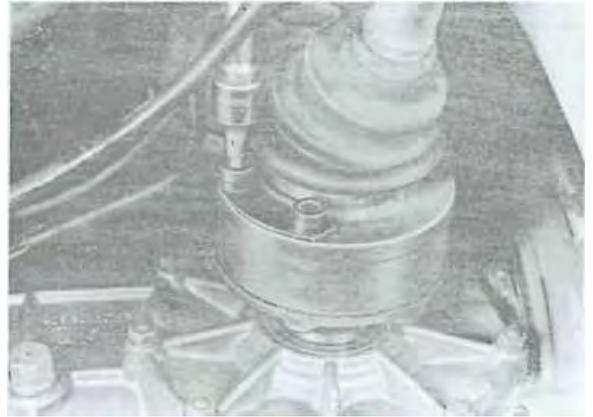
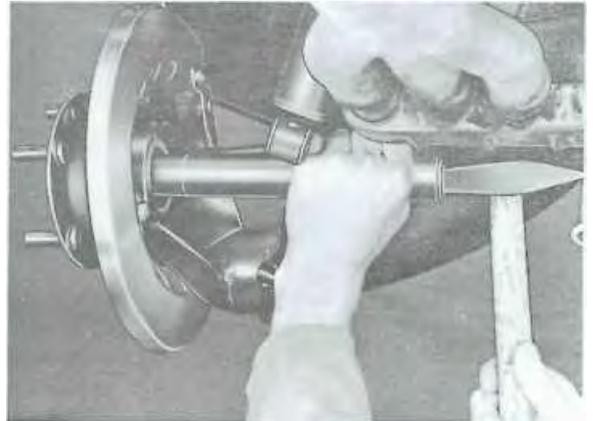


Fig. 6

- Drive out the rear wheel hub with special tool P 297. If necessary remove the bearing inner race from the rear wheel hub.



- Remove the split pin and castellated nut from the brake cable and pull the brake cable out towards the center of the vehicle.



Fig. 8

11. Unscrew the hexagon bolt holding the shield plate.



Fig. 9

12. Unscrew the hexagon bolts on the brake carrier plate and remove the brake carrier plate and shield plate.



Fig. 10

13. Take off the handbrake cable guide.

14. Unscrew the hexagon nuts on the attachment bolts and the eccentric bolts on the rear axle semi-trailing arm flange, and remove the bolts.

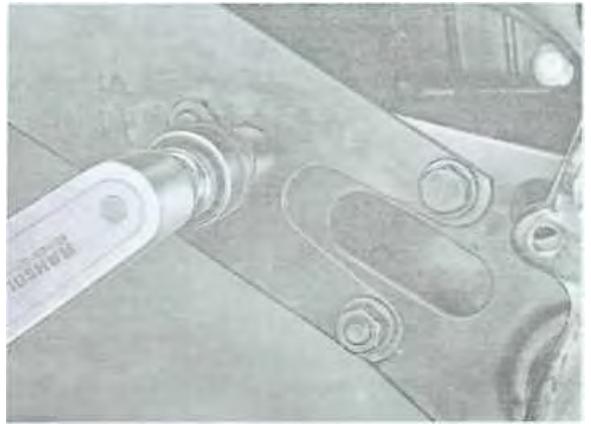


Fig. 11

15. Unscrew the self-locking hexagon nut on the hexagon bolt for the semi-trailing arm pivot bearing, and pull out the bolt.

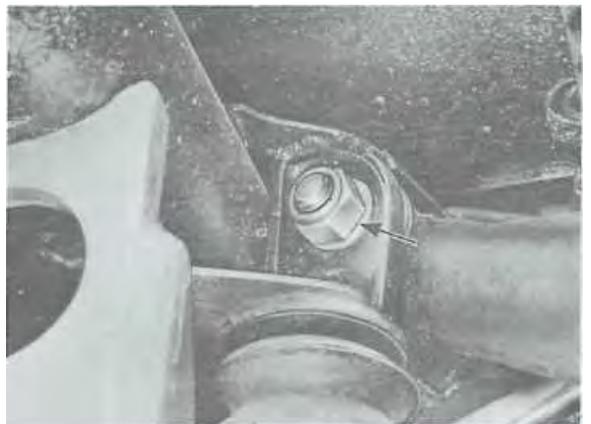


Fig. 12

16. Press out the radial ball thrust bearing.

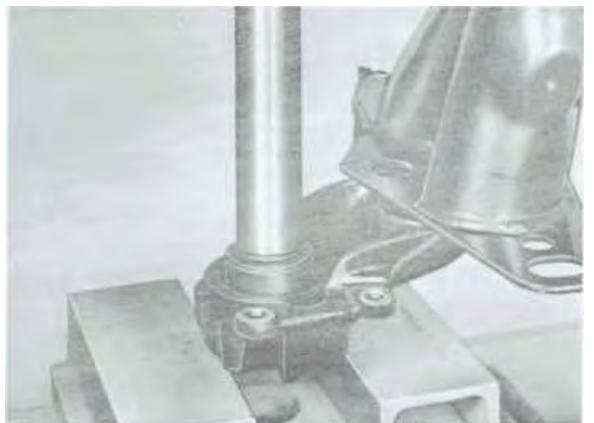


Fig. 13

17. The flanlocs for the semi-trailing arm pivot bearing can only be removed by breaking them up.

Checking condition of parts

1. Check semi-trailing arm for distortion with special tool P 295b.



Fig. 14

When the flamblocs are pressed into the semi-trailing arm, it should be possible to fit the test pin on the gage. Distorted semi-trailing arms must be replaced.

2. Check the flamblocs of the semi-trailing arm pivot bearing for wear and damage, and replace if necessary.

Installation

When installing, note the following procedures:

1. If the flamblocs were removed, press in new flamblocs until they make contact with the end face in the semi-trailing arm.

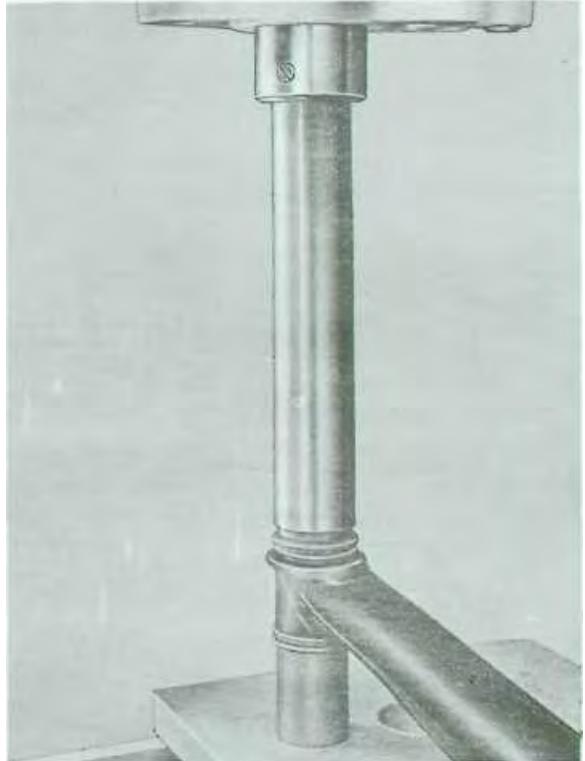


Fig. 15

2. Heat the pivot bearing housing on the semi-trailing arm to approx. 120°C (250°F) and push in a new ball thrust bearing.

Warning:

The radial ball thrust bearing must always be replaced.

3. Use a new self-locking hexagon nut for the hexagon bolt (M14) on the rear axle semi-trailing arm, and tighten to 12 mkp(87 lb/ft). At the same time lift the semi-trailing arm until the lower surface is level with the upper surface of the rear wheel radius arm.

4. Tighten the rear axle radius arm retaining bolts to 9.0 mkp (65 lb/ft).
5. The camber adjustment cam should be tightened to 6.0 mkp (43 lb/ft) and the toe-in adjustment cam to 5.0 mkp (36 lb/ft).
6. Tighten the hexagon bolts for the brake support plate to 2.5 mkp (18 lb/ft).
7. Tighten the hexagon bolt for the shield plate to 2.5 mkp (18 lb/ft).
8. Screw on the castellated nut for the handbrake cable until the hole for the split pin and the slot in the castellated nut are aligned. Then secure, using a new split pin.
Warning:
Check correct position of expander clip.
9. Pull rear wheel hub into radial ball thrust bearing, using special tool P 298b and drive shaft.
Warning:
Do not drive the rear wheel hub into the bearing or the bearing may be damaged.
10. Use a new gasket for the joint shaft flange and check that the flange surfaces are smooth and entirely free from grease.
11. Tighten the cheese-head bolts (M 10x55 - 12 K) for the joint shaft flange to 8.3 mkp (60 lb/ft). The locking washers for the cheese-head bolts must be fitted with the hollow side against the spacing plate.
12. Tighten the castellated nut on the halfshaft to 30-35 mkp (215 - 250 lb/ft) and secure with a new split pin.
13. Tighten the hexagon bolt for the shock absorber to 7.5 mkp (54 lb/ft).
14. Tighten the bolts retaining the brake caliper to 7.0 mkp (50 lb/ft), using new spring washers.
15. Bleed the brake system, and check for leaks (see group "B").
16. Check handbrake setting and adjust if required (see group "B").
17. Adjust rear wheel track and camber (see group "W").

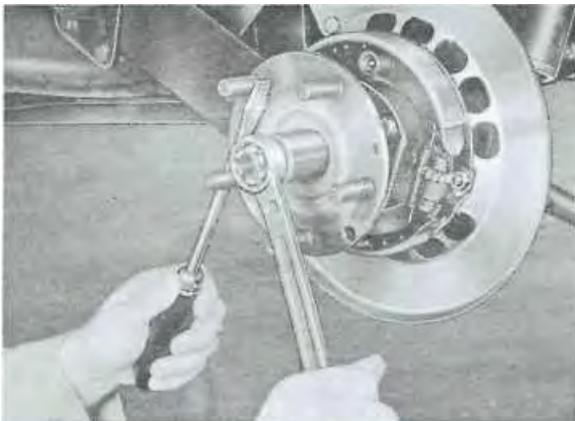


Fig. 16

REPLACING SEALING GAITER ON HALFSHAFT (FROM 69 MODEL ON)

Note:

Remove and re-install halfshaft (see page SR 156). If you wish to replace the outer sealing gaiter, it is best to detach the joint section from the drive shaft and to leave the drive shaft with its castellated nut attached to the car.

1. Clamp the halfshaft into the vise, using protective jaws.
2. Using side cutters, cut up and remove the "ear clips".
3. Separate the larger diameter of the sealing gaiter from the protective cap.
4. Unhook the circlip from the half shaft.

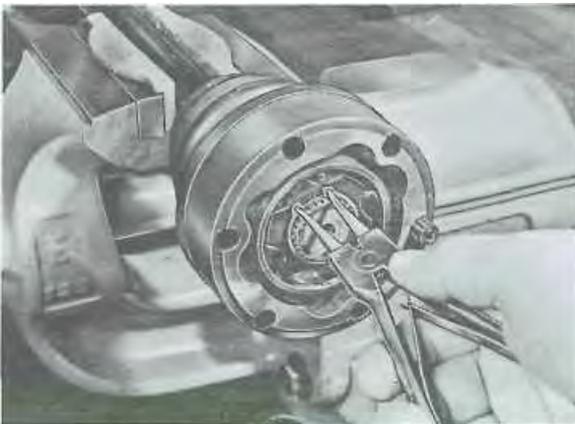


Fig. 17

5. Press of the joint section from the halfshaft.

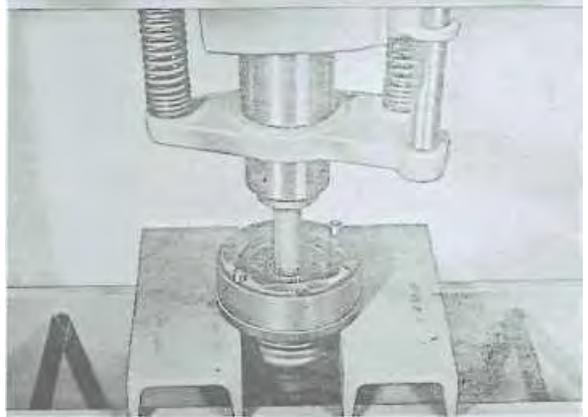


Fig. 18

6. Take off the cup spring and pull of the sealing gaiter.
7. Clean all components.
Warning:
Make sure that the sheet metal protective cap, which is sealed with Curil K, does not become separated from the halfshaft joint section.
8. Attach the cup spring to the joint section with the correct grade of grease, making sure that the hollow side of the spring faces the joint section.
9. Clean all grease from the mating surface for the large diameter of the sealing gaiter, and attach the sealing gaiter with sealing compound (EC 750 M-2G 51). The adhesive is made by;

Minnesota Mining and Manufacturing Co.

10. Tighten the new "ear clip" with blunt-ended pliers, and check that the ears are located at the same height as the spiral pins.

14. Work the remaining 30 g (1.06 oz.) of grease into the joint from the outside and compress the sealing gaiter slightly so that grease also enters the joint from the inside.

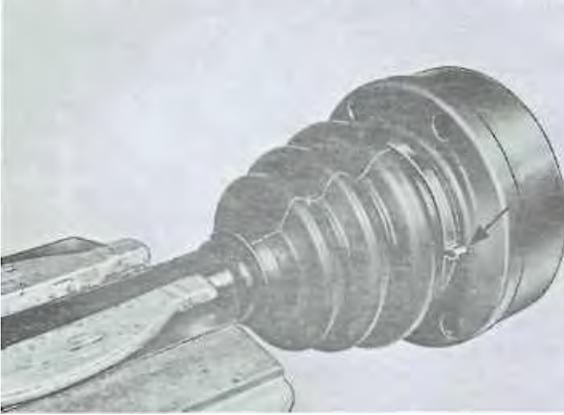


Fig. 19

11. Pack the sealing gaiter with 40 g (1.4 oz.) of grease taken from the total specified quantity per joint, inserting the grease through the smaller diameter of the sealing gaiter.

Warning:

Use only the following grades of grease:

Molykote BR 2 or

Shell Retinax AM

Quantity of grease per joint: 70 g (2.5 oz.)

12. Push the joint section with the sealing gaiter onto the halfshaft. Make sure that the cup spring seats correctly, and push the ball hub onto the half-shaft with a suitable of tube.

13. Fit the circlip, making sure that it locates correctly in the groove on the halfshaft.

REMOVING AND RE-INSTALLING HALFSHAFT

Special tools:

P 36b Guide and retaining device
P 42a Torque wrench, max. reading 75 mkp
(540 lb/ft)

P 44a Extension
P 289 Spring link clamping device
P 296 Socket wrench insert for rear axle nut

Removal

1. Raise the vehicle and take off both rear wheels.
2. Lift the rear radius arm (spring link) with special tool P 289, and unscrew the hexagon bolt for the shockabsorber.
3. Remove the keeper for the castellated nut on the halfshaft and unscrew the nut, using special tools P 42a, P 36b, P 44a and P 296.
4. Unscrew the cheese-head bolts on the halfshaft at the joint flange. Separate the halfshaft from the joint flange using a flat chisel along the flange gasket, and take off the halfshaft.

Warning:

Do not damage the flange surfaces.



Fig. 20

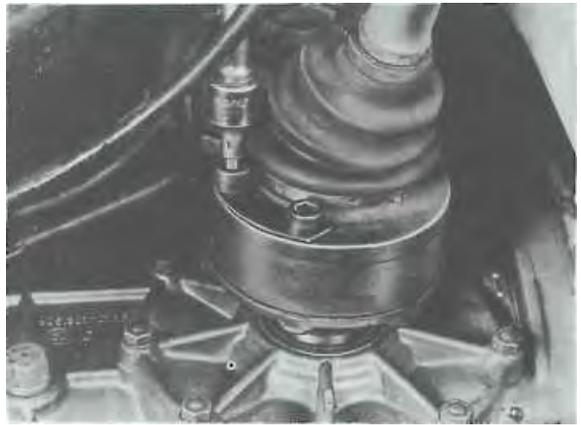


Fig. 22

3. Remove the keeper for the castellated nut on the halfshaft and unscrew the nut, using special tools P 42a, P 36b, P 44a and P 296.



Fig. 21

Checking

Check the halfshaft joints for excessive play. If the joints are defective the halfshaft must be replaced.

Installation

Note the following points during installation:

1. Use new flange gasket. Make sure there are no burrs or grease on the flange surface.

Note !

Repack joints with grease or add fresh grease (see page 155).

2. Torque Allen-head bolts (M 10 x 55 - 12 K) in joint flange to 8.3 mkp (60 ft. Ibs.). Make sure that the hollow side of the Allen-head bolt lock washers face the spacer plate.
3. Torque castellated nut on halfshaft to 30 - 35 mkp (217 - 253 ft. Ibs.) and secure with a new cotter pin.
4. Torque Shockabsorber bolt to 7.5 mkp (54 ft. Ibs.).

REAR WHEEL BEARING - REMOVAL AND INSTALLATION

General

The double-row radial ball thrust bearing is permanently packed with grease provided with a seal on both sides and therefore entirely maintenance-free.

Warning:

When the rear wheel hub is dismantled the radial ball thrust bearing will be destroyed and must always be replaced after this job has been carried out.

Removal:

1. See "Rear axle semi-trailing arm, removal" page SR 149, items 1,2 and 4 to 12.
2. Drive out the radial ball thrust bearing with a suitable length of tube.

Installation:

1. Force in the new radial ball thrust bearing with a length of tube over the outer race.

Warning:

Never strike the inner race of the radial ball thrust bearing or use the inner race of the bearing to drive the complete bearing into position.

2. Items 6 to 16 on page SR 153, "Rear axle semi-trailing arm - installation".

CHANGES ON TRANSMISSION FROM MODEL 70 ON

From Model 70 on the following transmission types are installed as standard equipment.

Transmission Type 911/00 (4-Speed Transmission)

7:31 (11:34, 19:31, 25:26, 29:22)

For Vehicle Model: 911 T

Transmission Type 911/01 (5-Speed Transmission)

7:31 (11:34, 18:32, 23:28, 27:25, 29:22)

For Vehicle Model: 911 E and 911 S

Transmission Type 905/20 (Sportomatic Transmission)

7:27 (15:36, 20:31, 24:27, 28:24)

For Vehicle Model: 911 T and 911 E

Transmission Type 911/80/81/82/83/84 (5-Speed Transmission)

7:31 (14:37, 18:32, 22:29, 26:26, 28:23)

(12:34, 17:34, 20:31, 22:29, 23:28)

(12:34, 18:34, 21:31, 23:28, 25:26)

(15:36, 20:32, 23:28, 26:26, 28:23)

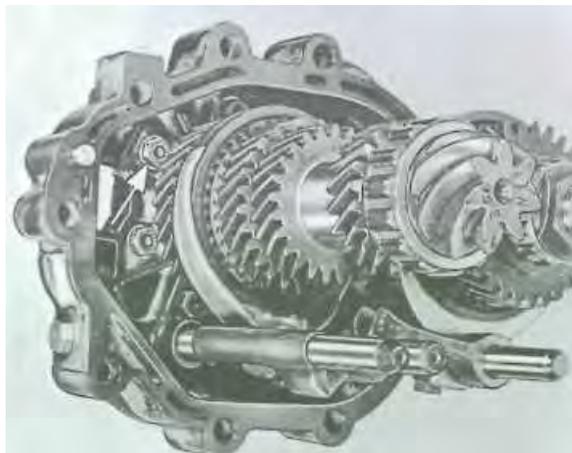
(14:37, 20:32, 22:29, 25:27, 27:25)

For Vehicle Model: 911 T, 911 E and 911 S (optional)

ASSEMBLY INSTRUCTIONS

1. From model 70 on wider gear teeth are installed for 1st and 2nd gear. First gear width of teeth increased by 0.6 mm (0.024 in.); second gear width of teeth increased by 0.8 mm (0.032 in.).

These gears can also be installed in former transmissions. On transmissions with pressure-cast housings prior to Model 70 - transmission type 902/14; 902/60; 902/16; 901/12; 901/13; 901/80; 901/81; 901/82; 901/83 and 901/84 - the wider gears may rub against the clamping plate or the fastening bolts of the clamping plate under load and unfavorable tolerance conditions.



If wider gears are installed in the transmissions named above, the following parts must be included:

Washer	Part number 901.301.255.13
Clamping plate	Part number 901.301.035.13
Discs	Part number 900.025.007.02
Cheesehead screws	Part number 999.509.010.00

2. The blueprint dimensions "R" for pinion shaft and ring gear adjustment for transmissions from Model 70 on were changed as follows:

Blueprint dimension "R" for manual transmission	63.20 mm/2.49 in. (formerly 63.50 mm/2.50 in.)
Blueprint dimension "R" for Sportomatic	54.20 mm/2.13 in. (formerly 54.50 mm/2.15 in.)

The deviation "r" is stated only in 1/100 mm + from now on as before on the pinion face. To prevent confusions, the deviation "r" + is now designated by the letter "N" ("N" means new).

Example:

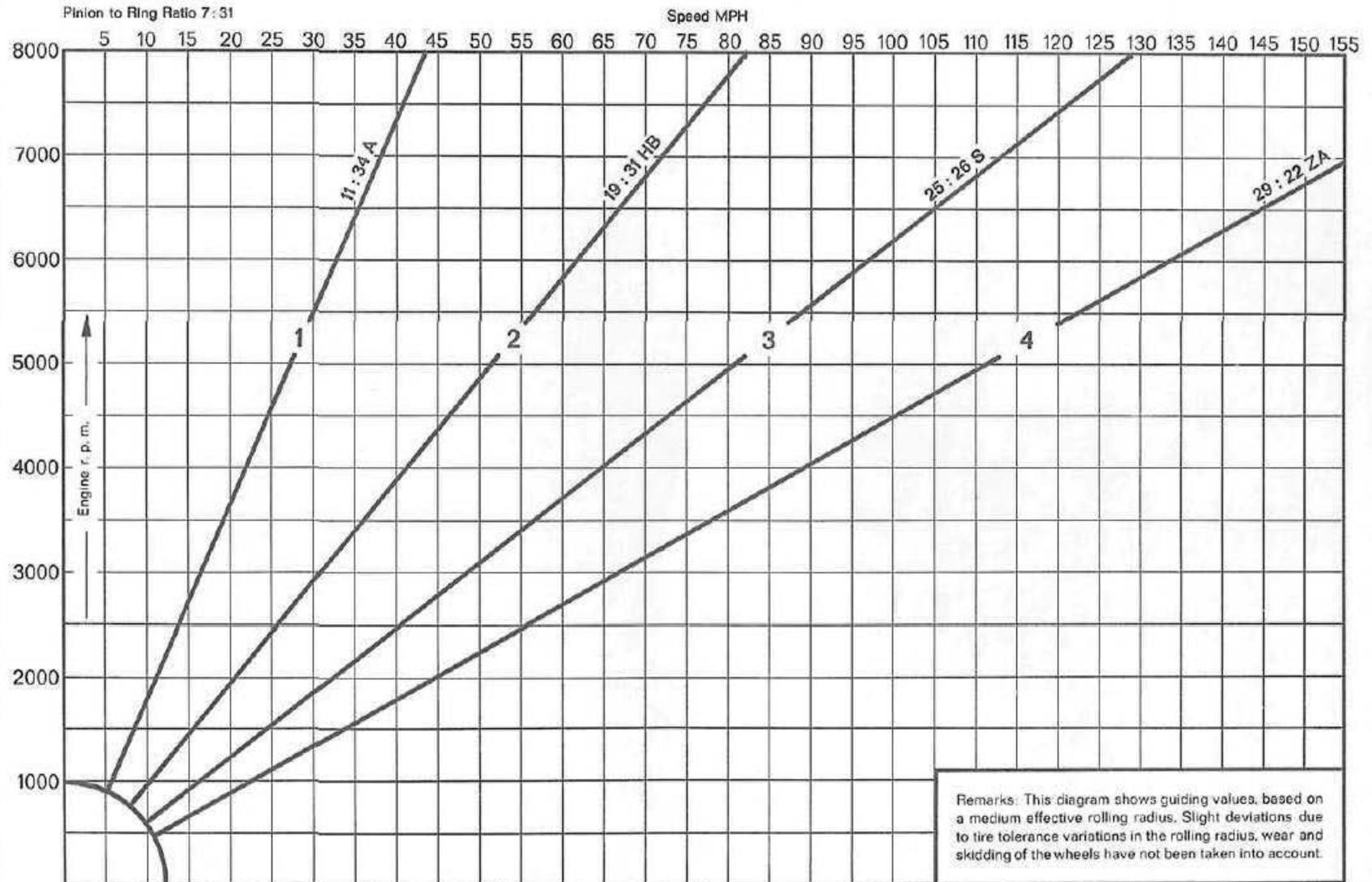
Blueprint dimension "R"	63.20 mm
Deviation "r" = N 18	+ 0.18 mm
Adjusting dimension (E)	63.38 mm

On pinion shaft ring gear sets which are obtained as spare parts and on which the deviation "r" is identified by the letter "N", the new blueprint dimensions "R" also apply and the deviation "r" is shown in 1/100 mm +.

PORSCHE

Transmission Diagram

(4-speed-transmission)

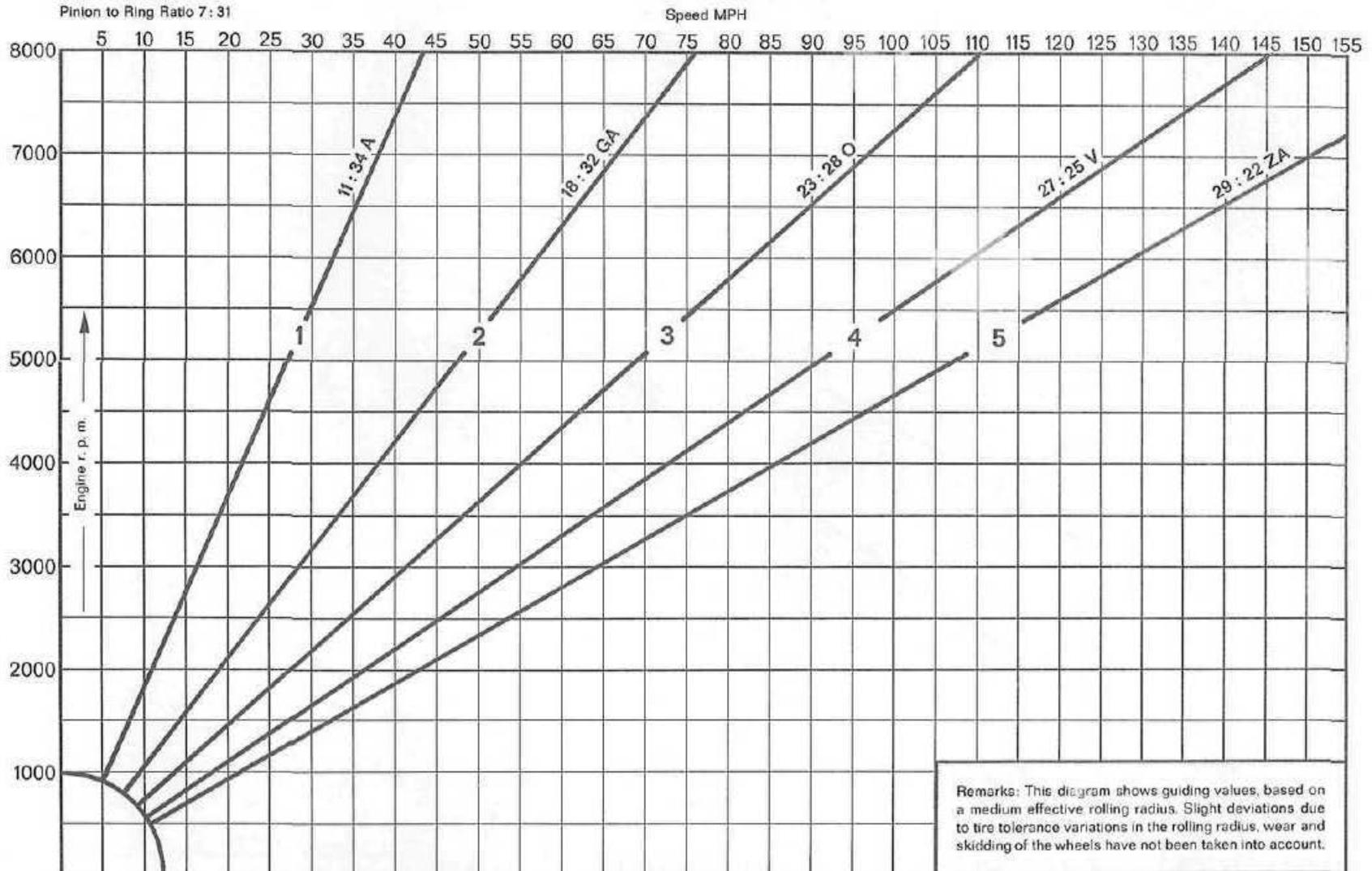


Subject to change without notice

PORSCHE

(5-speed-transmission)

Transmission Diagram



DIFFERENTIAL (WITH ANCHOR PIECE)

General:

All differentials as of December 12, 1970 have been modified. The differential pinion shaft is now retained by an anchor piece which also prevents axial play.

The anchor piece is located on the differential pinion shaft between the small differential pinions and is held in place by a lock pin. As a result of this modification new type expansion bolts are used (without centering points).

When overhauling earlier version differentials, they should be modified by installing the anchor piece and the following points:

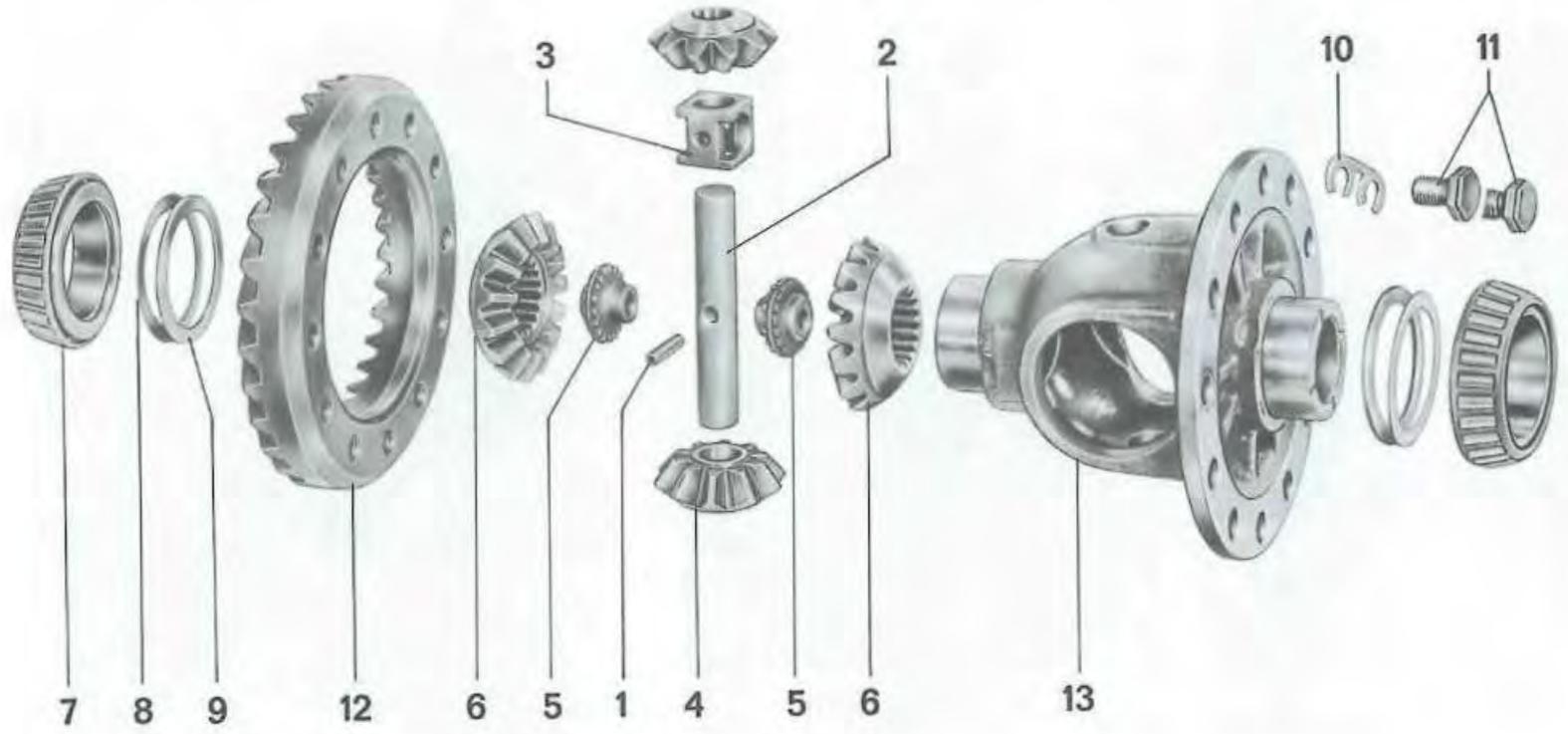
- 2 each threaded lock pieces
- 1 each differential pinion shaft
- 1 each anchor piece
- 1 each lock pin
- 2 each expansion bolts

Special Tools



N°	Description	Special Tool N°	Remarks
1	Puller, claw type	-	Use KUKKO N° 21/5 or similar
2	Thrust piece	P 263	
3	Thrust piece	P 264 b	

Differential with Anchor Piece



N°	Description	Qty.	Note when		Special instructions see
			Removing	Installing	
1	Lock pin	1	Drive out with a punch	Replace	
2	Shaft	1	Drive out with a punch	Note location of the bore	SR 172
3	Anchor piece	1			
4	Small differential pinion	2		Check for wear	
5	Threaded lock piece	2			
6	Large differential pinion (side gear)	2		Check for wear	
7	Tapered roller bearing	2	Remove with KUKKO Puller N° 21/5 and P 263	Install with P 264 b	SR 170
8	Shim	x			
9	Spacer washer	2			
10	Lock plate	6		Replace	
11	Bolt	12		Tighten to correct torque	
12	Ring gear	1		Check for wear	
13	Differential housing	1			

DISASSEMBLING AND ASSEMBLING DIFFERENTIAL (WITH ANCHOR PIECE)

Disassembling

1. Drive lock pin out of differential pinion shaft.

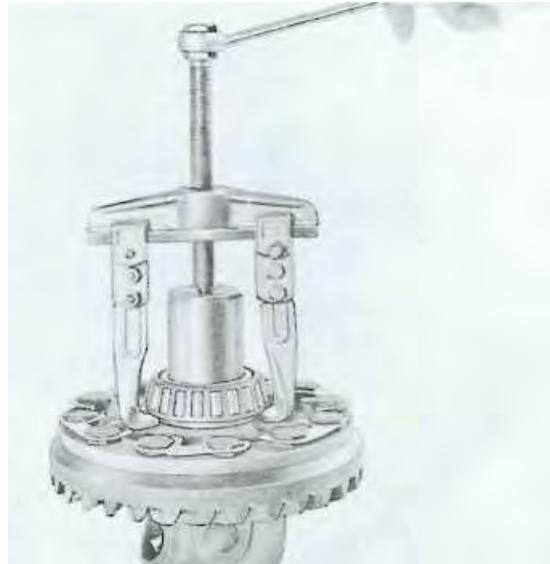


2. Remove the shaft with a punch and take out anchor piece.



3. Turn the pinions so that the small pinions can be taken out through the side openings in the differential housing. Remove the large pinions together with the threaded lock pieces.

4. Remove both tapered roller bearings with the puller and thrust piece P 263.



Caution

Do not interchange the shims or spacers. Attach tags to prevent mixing up right side with left side and vice-versa.

5. Remove lock plates from ring gear retaining bolts. Loosen bolts and remove ring gear.

Assembling

1. Check differential housing, large and small differential pinions, tapered roller bearings, and anchor piece for wear. Replace if necessary.
2. Place ring gear on flange of differential housing and tighten retaining bolts to correct torque.
3. Slide lock plates into grooves of bolt heads and attach lock plates to bolt heads by closing the open ends with pliers. Secure the bolts by bending down on one side of the lock plate against the hex surface of each bolt.
4. Coat thrust surfaces of large and small differential pinions with Molykote or similar paste. Insert the large pinions through the oval opening in the differential housing. Center the large pinions by inserting the flange shafts.



5. Insert the small differential pinions through the opening of the housing. Position them opposite each other so that their bores align with the bores of the housing.

6. Insert the threaded lock pieces with snap rings into the large pinions. Slide the anchor piece between the threaded lock pieces as shown in the illustration.



7. Install the pinion shaft while holding the anchor piece thereby preventing the anchor piece from binding on the shaft during installation.



Caution

In order to install the anchor piece the hole in the pinion shaft must first be aligned.

8. Drive in the lock pin.

9. Place identified or measured shims and spacers for tapered roller bearing on differential housing. Install tapered roller bearing with thrust piece P 264.

10. Re-adjust pinion shaft and ring gear as necessary. (See "Adjusting ring and pinion gears" in this manual).