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## I. DESCRIPTION

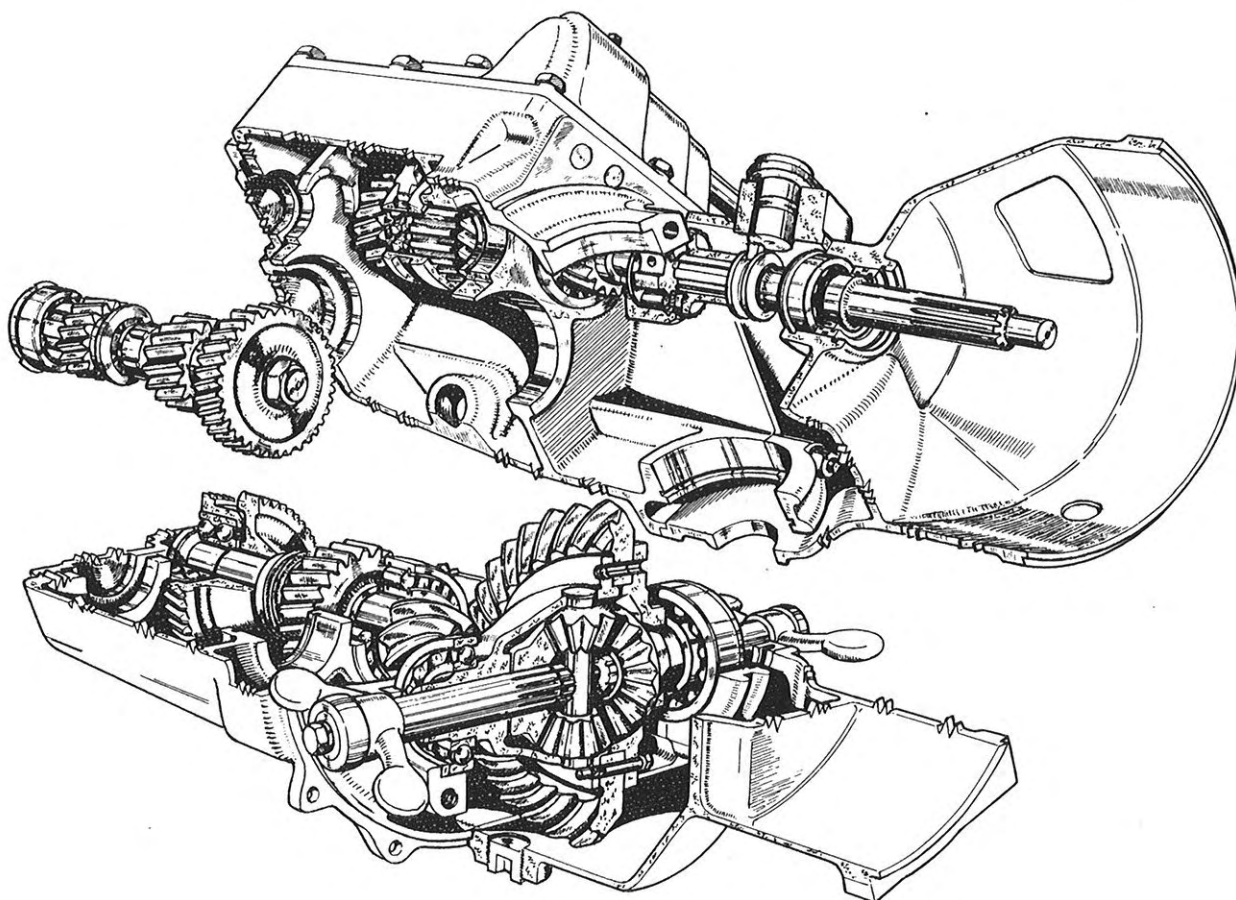


Fig. 1. Transmission

### I.1. General

The Saab 93 has front-wheel drive. The drive shafts run to each front wheel from the differential, which is built in between clutch and gear box. The transmission case, which encloses not only the gear box but also the differential and clutch, consists of one cast iron housing and one light metal housing and its front end is bolted to the flywheel end of the engine. The entire transmission with the exception of the drive shafts and outer universal joints thus forms an integral unit, see Fig. 1.

All forward speeds are obtained by means of constant-mesh helical gears with dog clutch engagement. The reverse is a sliding gear with helical teeth and it also serves as coupling sleeve for the 1st speed gear. The shafts and gears are all carried in ball or roller bearings with the exception of the 2nd speed drive gear, which is carried by a plain bearing on the main shaft.

The transmission also includes a freewheel device which can be engaged or disengaged from inside the car.

### I.2. Clutch

The clutch is a single dry disk type composed of three units, disk, spring assembly and release bearing.

The disk consists of a steel disk with damper springs fixed to a hub which can slide on the clutch shaft, to which it is splined. Clutch facings are riveted to both sides of the disk.

The spring assembly is attached to the flywheel by six bolts and consists of a steel disk with a cast pressure plate loaded by six coil springs. The springs are mounted in cups which fit into holes in the steel disk. Three clutch release levers are carried on gussets which are riveted to the disk. The spring assembly is held together by three adjusting screws with lock nuts which are connected

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to the pressure plate and rest against the clutch release levers. On the inner ends of the clutch release levers there rests a spring-retained steel plate, against which the release bearing is pressed when the clutch is disengaged.

The release bearing consists of a ball bearing mounted in a bearing shell which is held onto the clutch fork by spring clips. The ball bearing is provided with a graphite ring which is pressed against the steel plate when the clutch is disengaged. Power is transmitted from the flywheel via the steel disk and pressure plate to the disk and thence to the clutch shaft. One end of the clutch shaft is carried in a self-lubricating bearing in the crankshaft, the other end in a needle bearing in the main shaft. On the middle of the clutch shaft there is a ball bearing, the outer race of which has radial play but is fixed axially and thus preventing end float of the shaft.

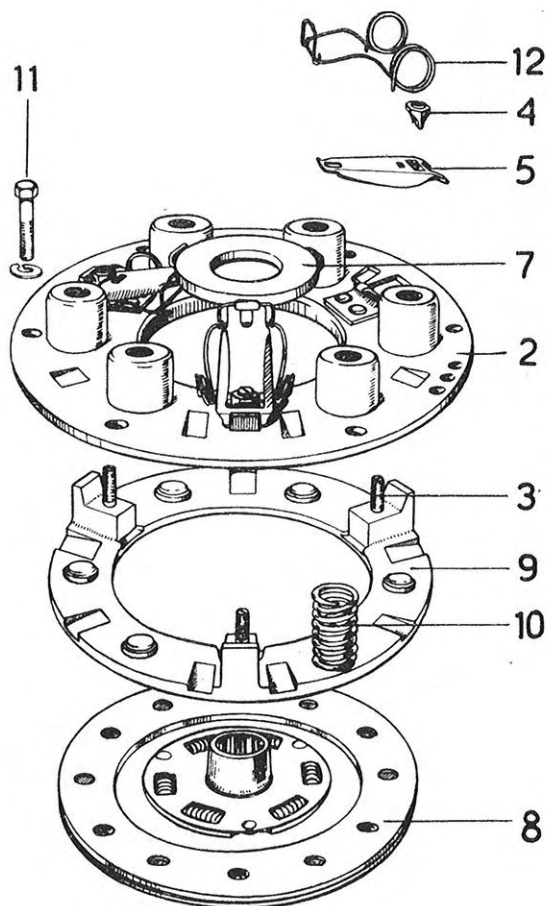
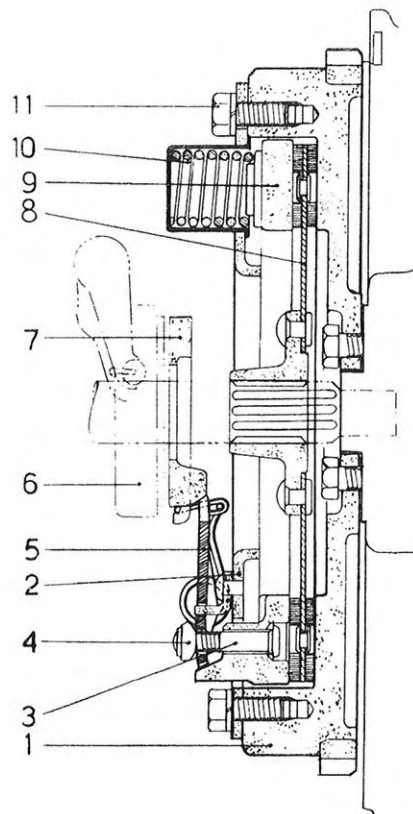


Fig. 2. Clutch with disk, dismantled



- |                    |                      |
|--------------------|----------------------|
| 1. Flywheel        | 7. Release plate     |
| 2. Spring assembly | 8. Disk              |
| 3. Stud            | 9. Pressure plate    |
| 4. Lock nut        | 10. Spring           |
| 5. Clutch lever    | 11. Screw            |
| 6. Release bearing | 12. Retaining spring |

Fig. 3. Clutch, sectioned

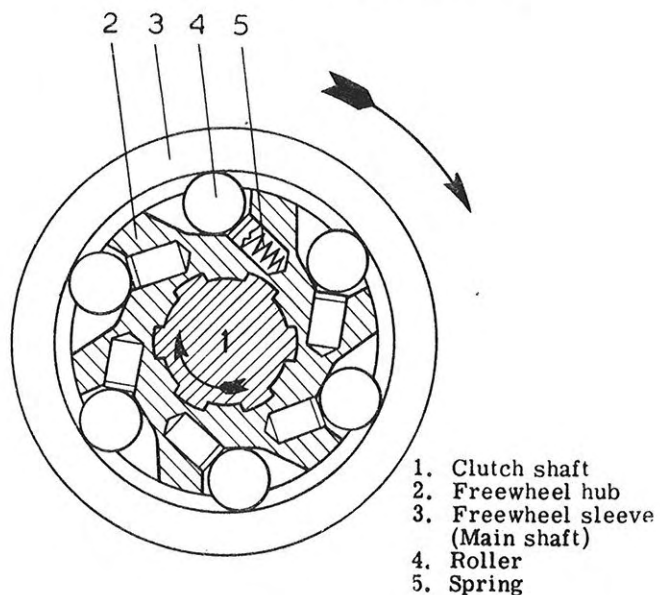


Fig. 4. Freewheel, principle drawing

The pressure plate is forced against the disk by six coil springs. When the clutch is disengaged, the three release levers force the pressure plate away from the flywheel. The release bearing is supported by the clutch fork, which is attached to the vertical release shaft, which is carried in the transmission case. The clutch lever is attached to the lower end of the shaft by an expanding pin. The movement of the clutch pedal is transmitted to the lever by the clutch cable. This consists of a steel wire in a steel sheath, one end of which is connected to an adjusting screw on the underside of the transmission, the other end to a screw connection in the firewall. A push rod runs from the adjusting screw to the clutch lever. The pedal play is adjusted by means of the adjusting screw at the front end of the clutch cable. The clutch is shown in Figs. 2 and 3. See also Chapter 10, "Pedals and controls".

### 1.3. Freewheel

The freewheel is combined with the clutch shaft and the main shaft. The clutch shaft is splined to the freewheel hub, which is provided with six roller recess, each one containing one roller, which is independently spring-loaded by a coil spring forcing the roller up on the roller way. Around the hub there is a cylindrical sleeve which is integral with the main shaft, see Fig. 4.

When the engine drives the car, the freewheel engages because the freewheel hub, which by the clutch shaft is connected to the engine, tends to rotate more rapidly than the main shaft. As the rollers are forced up on the roller ways, they are jammed against the main shaft sleeve and the main shaft is forced to rotate at the same speed as the clutch shaft. Thus the main shaft will become rigidly connected to the clutch shaft.

If on the other hand the main shaft tends to rotate more rapidly than the clutch shaft, as when the car is coasting downhill, then the rollers are released, that is, the sleeve forces them back into the recesses. Thus the main shaft can rotate independently of the clutch shaft.

The freewheel is provided with a control by means of which it can be locked from inside the car.

### 1.4. Gearbox

The gear box used in the Saab 93 is of rather unconventional type. It is combined with the freewheel, differential and inner drive joints which form the transmission unit.

In 1st gear, power is transmitted from the main shaft to the countershaft by a pair of gears in constant mesh located immediately behind the freewheel. The 1st speed gear on the countershaft is in constant mesh with the 3rd speed gear on the main shaft, the latter gear acting as an idler. Thus when the 1st speed gear is locked to the countershaft by means of a dog clutch, power is transmitted from this shaft through the pair of 3rd speed gears to the pinion shaft.

In 2nd gear, power is transmitted from the main shaft to the pinion shaft by locking the 2nd speed gear to the main shaft by means of a coupling sleeve.

In 3rd gear, power is transmitted to the pinion shaft in the same way as in 2nd gear, though in this case it is the 3rd speed gear that is locked to the main shaft by the sleeve.

2nd and 3rd gears are synchronized. The synchronization operates as follows: When the coupling sleeve is to be engaged with the 3rd speed gear, the sleeve pushes in front of it a bronze ring with an internal cone. The exterior of this ring is provided with teeth corresponding to the teeth on the gear and the ring can rotate half a tooth pitch in relation to the internal teeth in the sleeve. The sleeve and bronze ring rotate at the same speed as the main shaft. If the 3rd speed gear has a different speed at the instant when it is to be engaged, then the motion of the sleeve is blocked by the teeth on the bronze ring, the internal cone of which is forced against the external cone on the 3rd speed gear. Friction between the two cones brings the gear and sleeve to the same speed and then the way is clear for the sleeve to engage with the teeth on the 3rd speed gear.

The same thing happens when shifting to 2nd gear. The synchronizing device is shown in Fig. 6.

In reverse, power is transmitted from the main shaft to the countershaft by the previously mentioned pair of gears behind the freewheel. The reverse can slide on the countershaft to which it is splined, and when it is brought into mesh with the 2nd speed gear on the pinion shaft, the power is transmitted to this shaft. This reverses the direction of rotation of both pinion shaft and gear. The reverse idler also serves as a clutch sleeve for the 1st speed gear.

Movements of the gear lever are transmitted to the two gear shift forks in the transmission case, one

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for 1st and reverse, one for 2nd and 3rd. These gear shift forks can slide on their bars and are held in the engaged positions by spring-loaded balls which engage with notches in the rails. The gear shift forks are also locked, so that it is impossible to engage two gears at the same time.

The speedometer is driven by a worm gear on the pinion shaft. Drive is transmitted from the worm gear to a drive shaft through the gear box case. The drive shaft end has an internal square socket into which the end of the flexible shaft to the speedometer is inserted. This shaft is enclosed in a sheath which is screwed to the bearing sleeve in which the speedometer drive shaft is carried. As the speedometer is driven by the pinion shaft, it will register the true speed and mileage since the pinion shaft always rotates together with the front wheels.

## 1.5. Differential

The differential in the Saab 93 consists of two differential pinions and two axle pinions enclosed in a housing, see Figs. 5 and 7. All four pinions are straight-toothed bevel gears. The axle pinions are splined to the outgoing shafts by means of which they are rigidly connected to the two inner universal joints. The universal joints are in turn splined to the inner drive shafts.

The ring gear, to which power is transmitted from the gear box by means of the pinion shaft, is bolted to the differential housing. As soon as the car moves, the differential housing starts to rotate. If the car is driven straight forward or back, the two front wheels rotate at the same speed, and the differential pinions remain stationary. Of course, they do move in the sense that they follow the motion of the differential housing in which they are carried, but they do not rotate around their own

axis. In this case the differential pinions serve only as drivers for the axle pinions, causing the front axles to follow the rotation of the differential housing.

In order to get a clearer idea of how the differential operates, refer to Fig. 7. Imagine that the axle pinion A in the figure is locked. When the ring gear B rotates, it carries with it the differential housing C and thus the differential pinions D. These two pinions, which are in engagement with the axle pinions, cannot now as in the previous case carry round these two pinions, since one of them, A, is locked. The differential pinions, D, is instead forced to roll around the locked pinion and thus they rotate around their own axis. This rotation is transmitted to the other axle pinion E which, in addition to the motion it receives owing to the rotation of the differential housing, has its speed doubled because of the rotation of the differential pinions.

When the car is driven in a curve the situation will be somewhat different. If the two axle pinions rotate at the same speed as the differential housing (driving straight ahead), the differential pinions do not rotate. If the speed of one front wheel is reduced so that it is less than that of the differential housing, then the differential pinions must start to rotate as when one axle pinion is locked. But in this case the rotational speed of the differential pinions will be less, since the wheel itself has a certain, though reduced, speed. The rotation of the differential pinions will then affect the other axle pinion and increase its original speed, that is, its speed when both front wheels had equal rate of rotation. The increase in speed of one axle pinion will thus be equal to the reduction in speed of the other one.

## 2. TECHNICAL DATA

### General:

Oil capacity,	approx. litres	2
	(gall.)	1/2)
Gear ratios, overall:		
1st		17.19:1
2nd		8.53:1
3rd		5.23:1
Reverse		21.01:1

### Clutch:

Type	single dry-disk
Size, facing	mm 180 x 125 x 3.5 (in. 7.1 x 4.9 x 1.4)
Clutch pedal play measured at pedal tip	mm 20 - 25 (in. 0.8 - 1)

### Differential:

Reduction ratio, pinion/ ring gear	5.43:1
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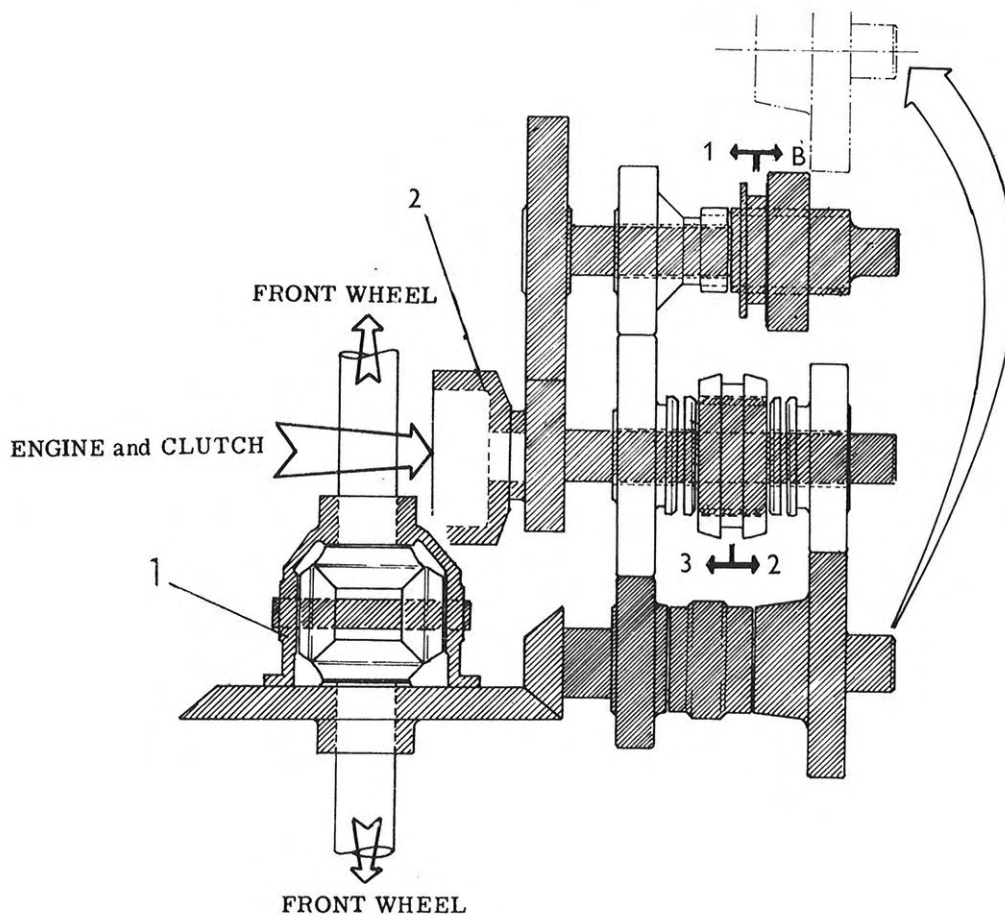


Fig. 5. Transmission, principle drawing

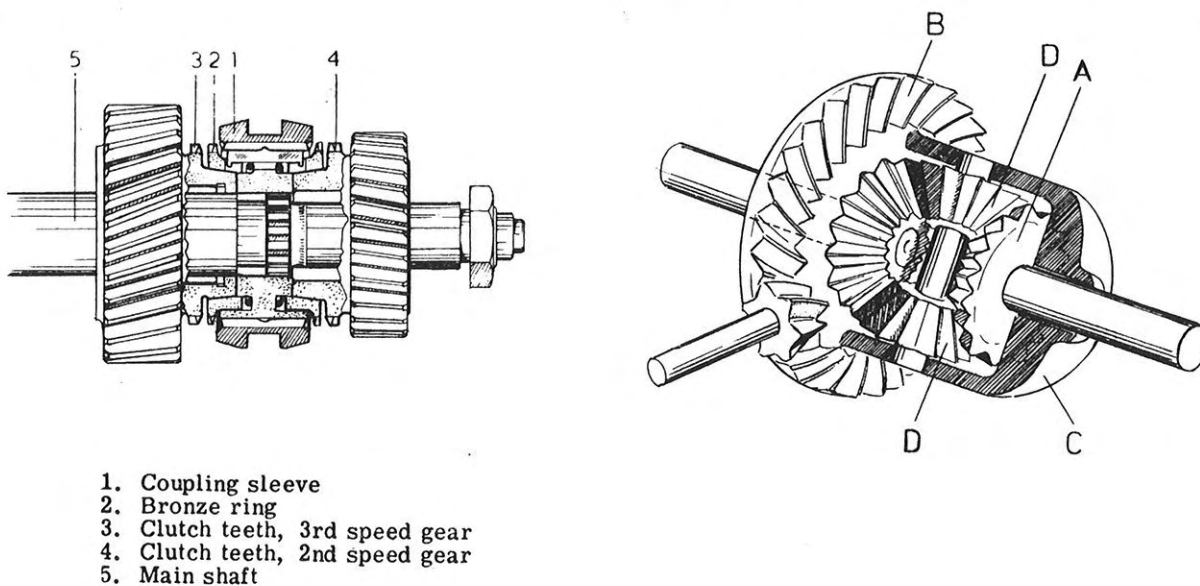


Fig. 6. Synchronizing device

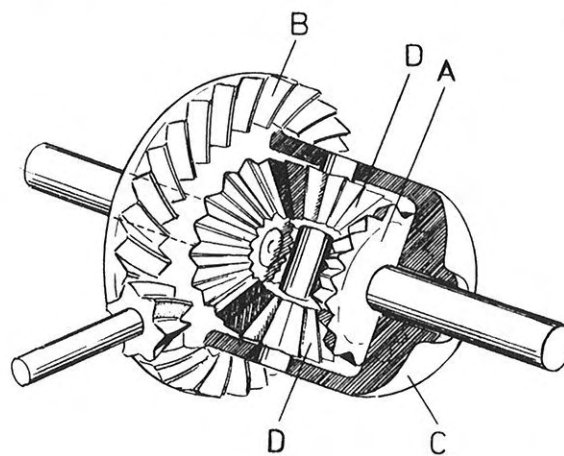
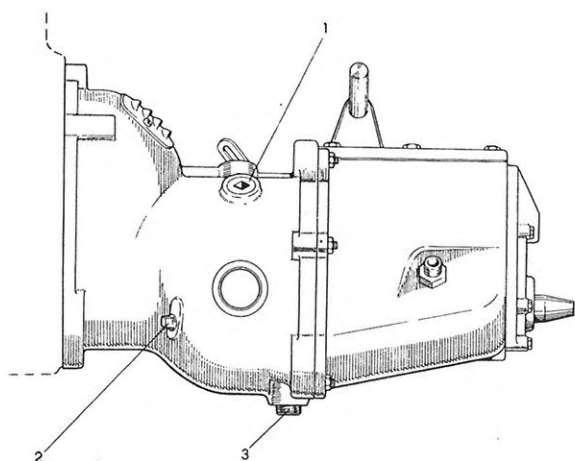


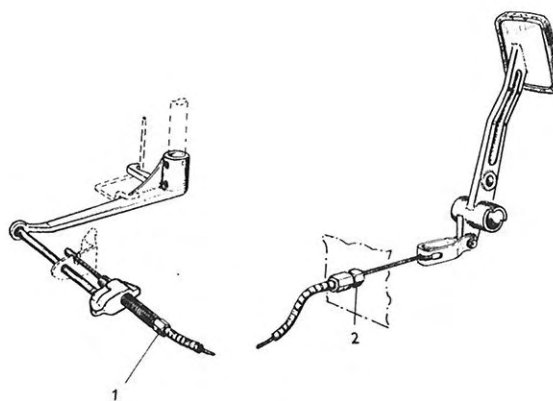
Fig. 7. Differential, principle drawing

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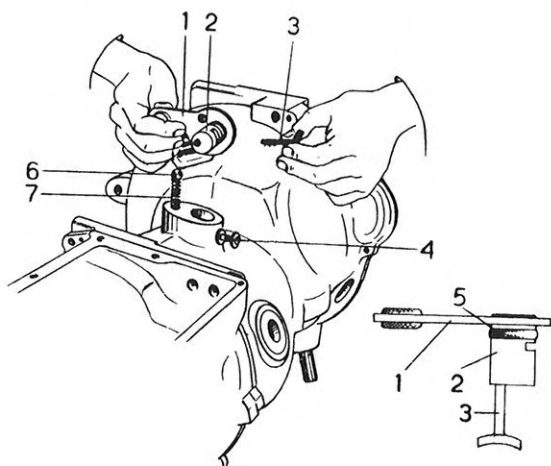
1. Filler plug
2. Level plug
3. Drain plug

Fig. 8. Plugs for filling and draining transmission oil



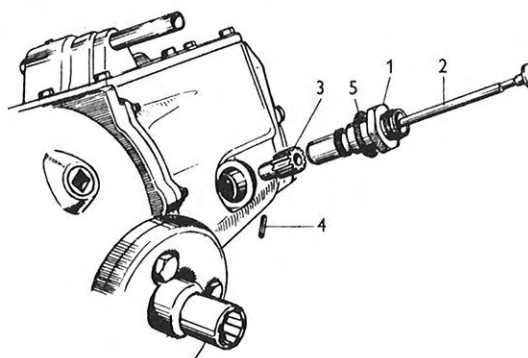
1. Adjusting nut
2. Cable attachment at firewall

Fig. 9. Adjustment of clutch pedal play



1. Lever
2. Shaft
3. T-pin
4. Lock screw
5. Seal ring
6. Ball catch
7. Spring

Fig. 10. Freewheel control



1. Bearing sleeve
2. Shaft
3. Gear
4. Expanding pin
5. Seal ring

Fig. 11. Speedometer drive

### 3. WORK ON CAR

#### 3.1. Work with both engine and transmission in car

##### 3.1.1. Oil changing

1. Drain off the old oil.
2. Insert the drain plug when all oil has run, and fill with suitable flushing oil.
3. Drive car carefully a short distance, then drain off flushing oil.
4. Screw in drain plug tightly and fill with approx. 2 litres (1/2 gall.) of the oil recommended in the lubricating instructions, Chapter 15.

The oil level in the transmission case can be checked by leaving the level plug on the transmission open when pouring in oil, see Fig. 8.

##### 3.1.2. Adjustment of gear shift device

See Chapter 11, "Steering".

##### 3.1.3. Adjustment of clutch

When the clutch is correctly adjusted, the clutch pedal play measured at the tip of the pedal should be 20 - 25 mm (0.8 - 1 in.). As the clutch wears, this play decreases, but it must not be less than 10 mm (0.4 in.).

The movement of the clutch pedal is transmitted to the clutch lever by the clutch cable, the front end of which is connected to an adjusting screw from which a push rod runs to the clutch lever. The clutch pedal play can be increased by tightening this adjusting screw. The opposite effect will of course be obtained by unscrewing it, see Fig. 9.

##### 3.1.4. Removal and installation of freewheel control

1. Disconnect control rod from lever on transmission by removing cotter pin and washer.
2. Loosen screw 4, Fig. 10, and lift out control device. Be careful that the ball catch under the operating lever is not thrown out and into the transmission case.
3. Collect pin 3, which remains in the hole.
4. Shaft 2 and lever 1 can now be separated from each other.

After replacing worn or damaged parts, install in reverse order. Make sure that pin 3 is fitted in the appropriate groove of the coupling sleeve. Check this by engaging and disengaging the freewheel a few times.

##### 3.1.5. Removal and installation of speedometer drive

1. Disconnect the flexible shaft from transmission case.
2. Screw out and remove bearing sleeve 1, Fig. 11, with drive shaft 2, pinion and gasket 5.
3. Drive out the expanding pin 4 which locks the gear to the shaft. The gear, drive shaft and bearing sleeve can then be separated.

After replacing worn or damaged parts, install in reverse order.

##### 3.1.6. Removal and installation of inner universal joint

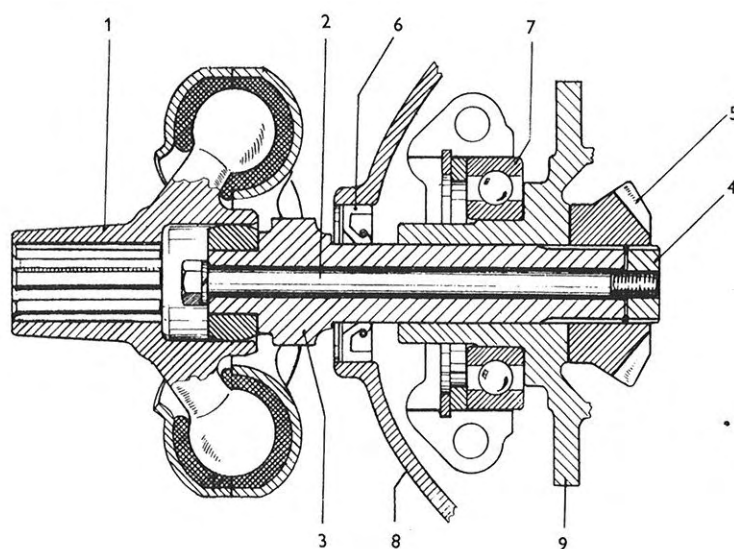
1. Jack up car and remove front wheel on the side where the universal joint is to be removed.
2. Disconnect upper pivot from steering knuckle housing. This is best done by removing the two bolts or nuts which hold the pivot and steering arm to the steering knuckle housing. See Chapter 7, "Axles and suspension".
3. Pull the inner drive shaft out of the universal joint.
4. Remove the screw which holds the universal joint and its shaft to transmission, see Fig. 12.
5. Pull out and remove joint and shaft, see Fig. 13.
6. Dismantle universal joint and remove rubber rings.

After replacing defective parts, install in reverse order.

##### 3.1.7. Removal and installation of seal ring inside inner universal joint

1. Remove inner universal joint as described in 3.1.6., points 1 - 5 above.
2. Lever the seal ring out of the transmission case with a screwdriver or the like, see Fig. 14.

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- |                          |                |                         |
|--------------------------|----------------|-------------------------|
| 1. Inner universal joint | 4. Nut         | 7. Ball bearing         |
| 2. Screw                 | 5. Axle pinion | 8. Differential case    |
| 3. Shaft                 | 6. Seal ring   | 9. Differential housing |

Fig. 12. Shaft with inner universal joint

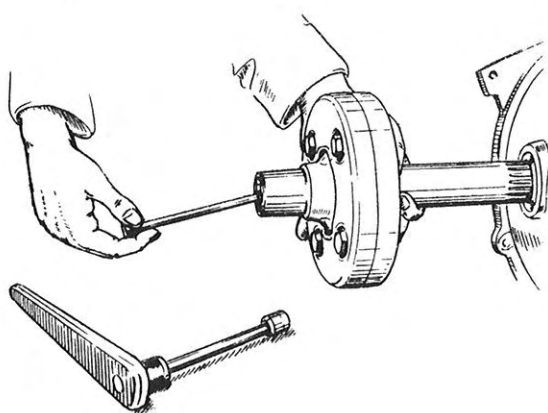


Fig. 13. Removal of shaft and inner universal joint

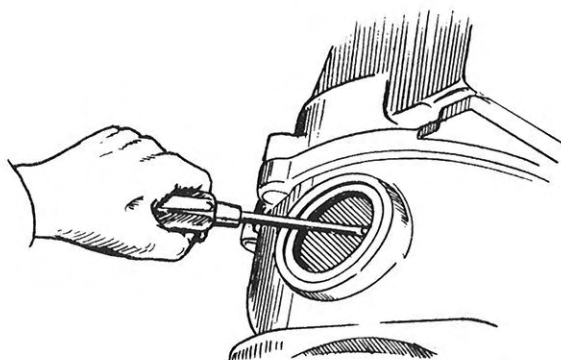


Fig. 14. Removal of seal ring, drive shafts.

3. Press in a new seal ring using tool Saab 92-34, see Fig. 15.

4. Install inner universal joint with shaft and tighten the screw. Be careful not to damage the seal ring.

5. Insert drive shaft into universal joint and connect pivot to steering knuckle housing.

6. Fit wheel and lower car.

## 3.2. Work for which engine must be removed from car

### 3.2.1. Removal and installation of clutch release bearing

1. Remove engine as described in Chapter 2,

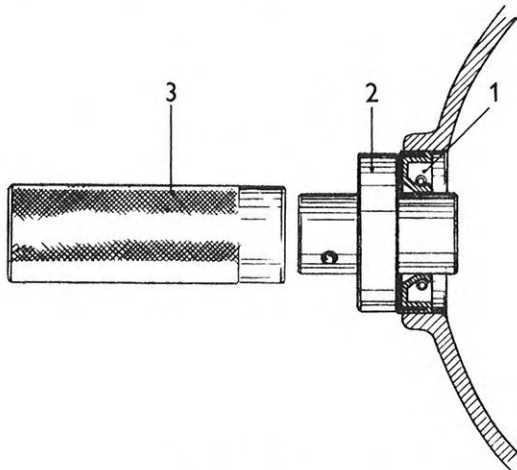
"Engine".

2. Turn clutch lever forward and remove the two spring clips which hold the release bearing to the fork, see Fig. 16.

3. Remove release bearing.

Replace release bearing in reverse order. Mount engine and adjust clutch pedal play.

The graphite ring of the release bearing must not be so badly worn that it is flush with the holder.



1. Seal ring
2. Tool, Saab 92-34
3. Handle, Saab 92-31

Fig. 15. Pressing in seal ring

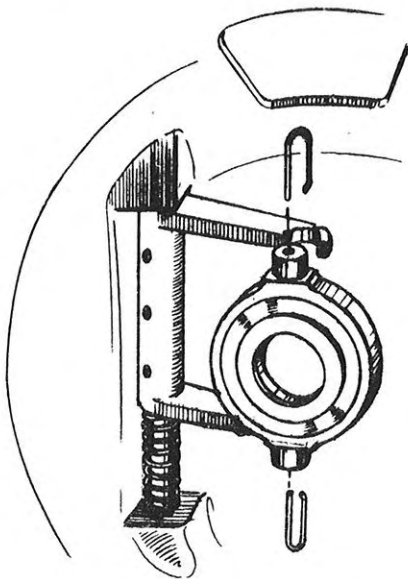


Fig. 16. Release bearing and spring clips

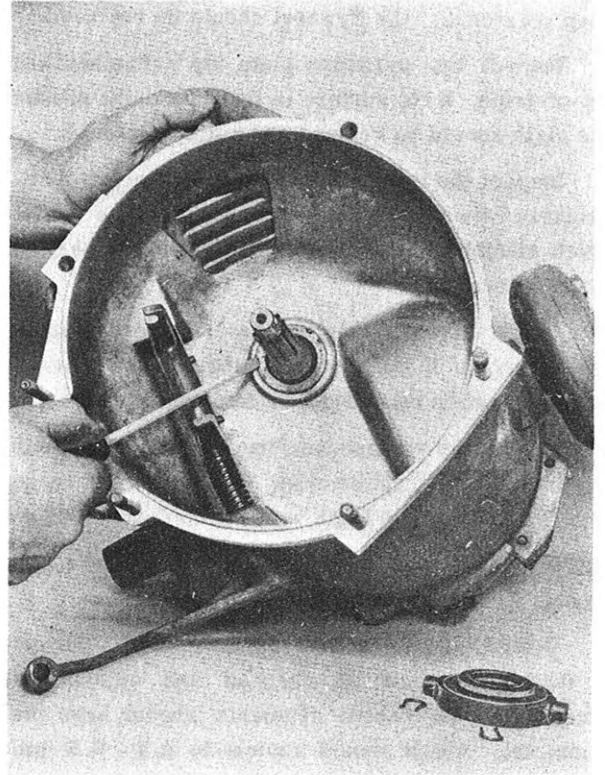


Fig. 17. Removal of seal ring, clutch shaft

### 3.2.2. Replacement of clutch shaft seal ring

1. Remove release bearing as described in 3.2.1. above.
2. Using a screwdriver or the like, lever out the seal ring located in the casing around the clutch shaft, see Fig. 17.
3. Fit a new seal ring.
4. Install the release bearing.
5. Install engine in car as described in Chapter 2, "Engine".

### 3.2.3. Removal of clutch

1. Lift engine out of car, see Chapter 2, "Engine".
2. Loosen the six screws which hold the spring assembly to the flywheel. Loosen the screws in stages, placing the three spacers, tool 93-122, under the clutch arms, see Fig. 18.
3. Remove spring assembly and disk.

#### 3.2.3.1. Inspection and replacement of facing

1. Inspect disk contact surface in flywheel. It is

not of great importance if the surface is blued and has a number of small cracks, but if there are deep scratches, the flywheel should be replaced.

2. Inspect the pressure plate for scratches and out-of-truth. If its surface is irregular, the pressure plate should be replaced or surface-ground.

3. Inspect the three clutch levers for wear, particularly where they bear on the release plate, which should therefore be removed for inspection of the levers.

4. Check that the release plate is not damaged, as it may be if the graphite ring for the release bearing is worn right down or damaged.

5. Inspect the release bearing, paying particular attention to the graphite ring. This must not be so badly worn that it is flush with the holder.

6. Inspect the disk for wear and replace the facings if necessary.

7. Before the new facings are riveted on, the set of the disk should be checked and adjusted if necessary. All twelve segments should have the same set, which should amount to 0.4 - 0.6 mm (0.016 - 0.024 in.), see Fig. 19.

8. After fitting new facings, check the disk for out-of-truth. The side throw must not exceed the normal set with more than 0.5 mm (0.02 in.), see Fig. 20.

### 3.2.3.2. Dismantling

Before dismantling the spring assembly all parts should be marked so that they can be replaced in the same positions when the unit is assembled. This is important with regard to the balance of the clutch.

1. Remove the locking of the nuts on the clutch arm adjusting screws, see Fig. 21.

2. Screw out the adjusting screws in stages and the spring assembly can then be completely dismantled, see Fig. 22.

3. Inspect and check all parts as detailed in 3.2.3.1. if this has not already been done. The springs should also be checked and they should have the following data:

Springs:

Length, free	mm	49.5
	(in.)	1.96
Length, compressed	mm	29.4
	(in.)	1.16

Pressure	kg	49 - 52
	(lbs)	108 - 115
Minimum allowed pressure	kg	45
	(lbs)	100

### 3.2.3.3. Assembly

1. Lubricate the friction surfaces of the clutch arms with graphite grease. Apply the grease very sparingly.

2. Insert the clutch springs into the cups and insert the latter into the spring plate.

3. Place the pressure plate in position and screw on the clutch arms with the adjusting screws. Use new nuts with undamaged locking flanges. The screws should also be replaced if they have been damaged during the dismantling.

4. Attach the release plate with the retaining springs and place the spacers 93-122 under the clutch arms, see Fig. 18.

5. Insert the spring assembly into the flywheel on an undamaged clutch disk, tighten the six retaining screws in stages and remove the spacers.

6. Place a steel rule over the release plate. The distance from the rule to the flywheel surface should be 26 mm all the way round, see Fig. 22. It is important that this distance is the same at all points, otherwise the release plate will warp. The plate can be adjusted by means of the clutch arm screws.

7. Depress and release the release plate a few times and measure again.

8. Detach the spring assembly from the flywheel. Don't forget to insert the spacers and lock the adjusting screws by folding the nut locking flanges into the screw slots, see Fig. 23.

### 3.2.4. Installation

1. Insert the disk and mount the spring unit on the flywheel.

2. Centre the disk with tool 93-121 which fits in the crankshaft.

3. Tighten the six clutch retaining screws in stages.

4. Install the engine as described in Chapter 2, "Engine".

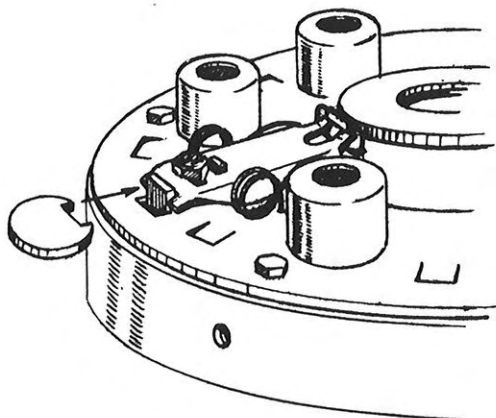


Fig. 18. Location of the spacers, tool 93-122, during removal or installation of the spring assembly

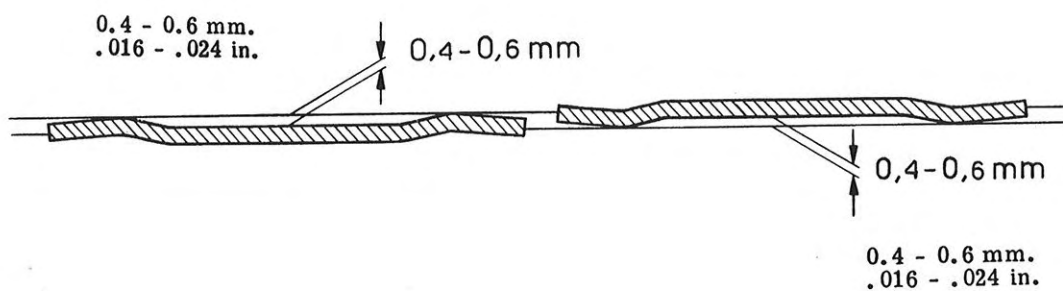


Fig. 19. Checking set of disk

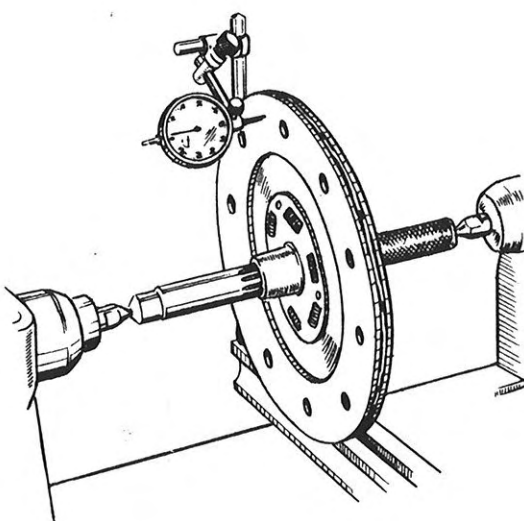


Fig. 20. Checking side throw of disk

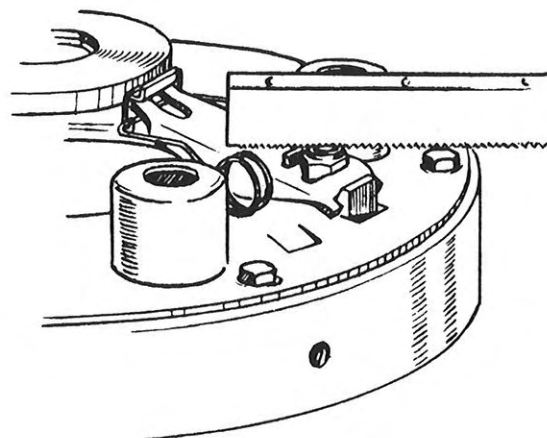


Fig. 21. Removal of locking from adjusting screw

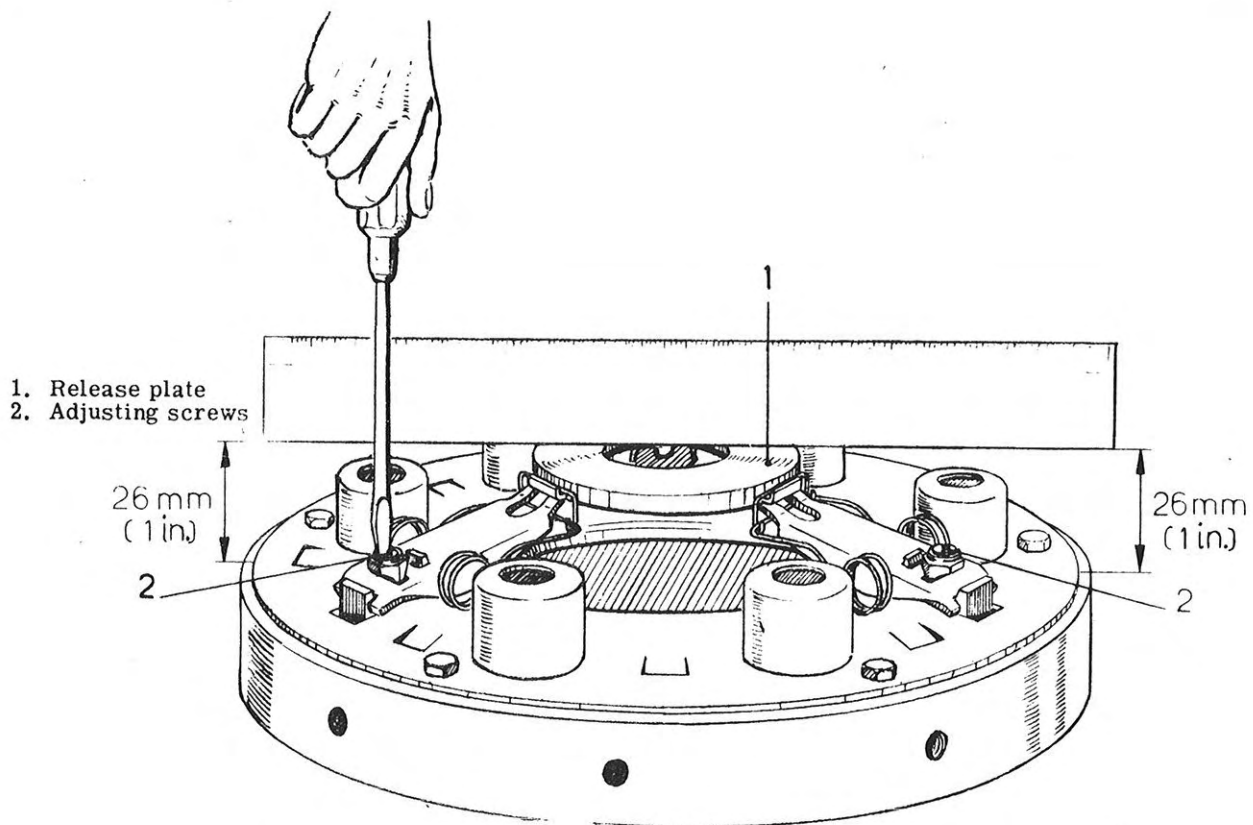


Fig. 22. Checking and adjustment during assembly of spring unit

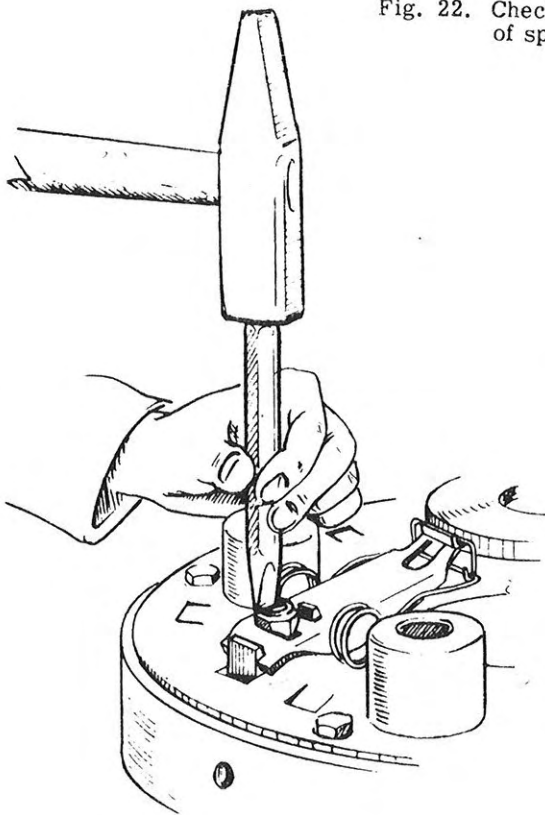


Fig. 23. Locking the nuts of adjusting screws

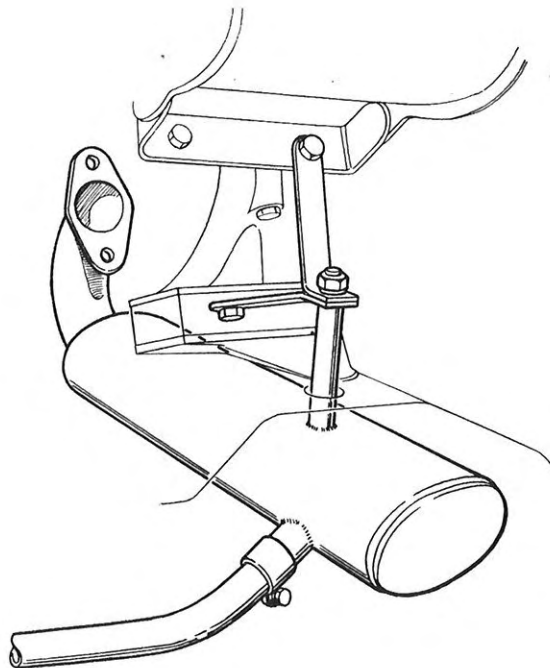


Fig. 24. Front muffler suspension

## 4. INSPECTION WORK

### 4.1. Removal of power unit from car

If the transmission is to be removed from the car, the entire power unit must be lifted out at the same time.

1. Disconnect ground cable from battery and engine.
2. Remove engine hood as follows:
  - a. Disconnect electric cables.
  - b. Disconnect hood straps.
  - c. Move the hood backwards and upwards until it slides off the hinge pins.
3. Disconnect the generator cables and the distributor primary cable.
4. Remove carburetor intake muffler with filter and preheater.
5. Disconnect fuel line, throttle control and cold-start control from carburetor.
6. Disconnect starter control and cables.
7. Loosen muffler suspension, see Fig. 24.
8. Disconnect muffler from exhaust manifold.
9. Disconnect the two front engine brackets from the body.
10. Disconnect the clutch wire by releasing its tension and freeing it from the attachment under the engine.
11. Disconnect the engine side stay.
12. Disconnect the speedometer cable and free-wheel control from the transmission.
13. Drain off the coolant.
14. Disconnect the thermometer bulb.
15. Disconnect the upper radiator hose at the thermostat.
16. Disconnect the lower radiator hose at the pump.
17. Remove the right-hand pedal board and disconnect the rear power unit attachment.
18. Jack up and trestle the front end of the car and remove the right-hand front wheel.
19. Free the upper pivot on the right-hand side by removing the two bolts or nuts which hold the

steering arm and pivot to the steering knuckle housing.

20. Pull out the steering knuckle housing to release the drive shaft from the inner universal joint.
21. Disconnect the gear shift rod from the universal coupling in the engine compartment by removing the tapered pin, see Fig. 25.
23. Fit lifting hook 93-110 and lift out the power unit, see Fig. 26.

### 4.2. Instructions for subsequent removal and installation

After removing the power unit from the car, clean it, then separate engine and transmission and drain off transmission oil.

#### 4.2.1. *Clutch fork with shaft and lever*

##### 4.2.1.1. Removal

1. Remove the clutch lever return spring.
2. Remove the release bearing.
3. Drive out the expanding pins, pull out the shaft with clutch lever attached, and remove clutch fork and coil spring.
4. Drive out expanding pins and separate shaft and lever.

##### 4.2.1.2. Installation

1. Fit clutch lever to shaft, ream the holes and drive in expanding pins.
2. Insert shaft into casing and slide on coil spring and clutch fork. Lock with expanding pins after reaming the holes.
3. Fit release bearing.
4. Fit return spring to clutch lever.

#### 4.2.2. *Freewheel*

When dismantling the freewheel for repair, it is usually sufficient to extract the hub with the six rollers, but if the freewheel sleeve should be damaged, the main shaft must be replaced. See point 4.2.9.

## 4.2.2.1. Removal

1. Remove inner universal joints with shafts. They are attached to the pinions inside the differential with bolts through the centres of the shafts, see Fig. 13.

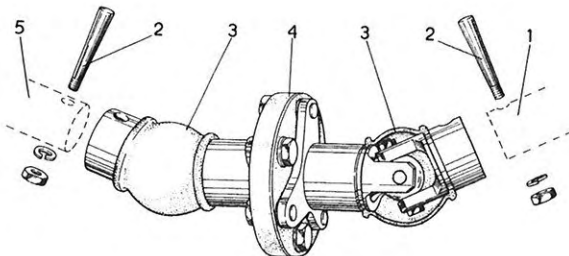
2. Separate the transmission at the joint between differential case and gear box case. When all bolts have been removed, the clutch shaft must be turned to a certain position to permit separation of the cases. Rotate the clutch shaft and locate this position when the differential case is removed.

NOTE. Be careful not to damage the needle bearing in freewheel sleeve which may occur if the differential case is removed in too great an angle in relation to the gear box case.

3. Remove the hub with the six rollers from the freewheel sleeve. Note that this must be done carefully, otherwise the spring-loaded rollers may be thrown out, see Fig. 27.

4. Remove the needle bearing in which the clutch shaft is carried in the freewheel sleeve.

If the clutch shaft and freewheel sleeve (main shaft) have to be removed, see 4.2.5. and 4.2.9. respectively.



- |                            |                            |
|----------------------------|----------------------------|
| 4. Rubber disk             | 1. Gear shift rod          |
| 5. Shift rod, transmission | 2. Taper pin with lock nut |
|                            | 3. Rubber bellows          |

Fig. 25. Universal coupling, gear shift rod

## 4.2.2.2. Assembly

1. After replacing worn or damaged parts, insert the hub with the six rollers and springs into the freewheel sleeve. When installing the hub, fit a hose clamp or the like around it to keep the rollers in place. Note that the hub must be inserted in such a way that the freewheel engages when the hub is

turned to the right, see Fig. 4. The hub is marked on the front.

2. Insert the needle bearing into the freewheel sleeve.

3. Fit the differential case to the gear box case.

NOTE. Turn the clutch shaft so that it clears the differential.

4. Install the inner universal joints with shafts. Insert the shafts carefully so as not to damage or displace the seal rings.

## 4.2.3. Differential side bearings

The pinion shaft need not be removed for replacement of the differential side bearings. However, it is important that the ring gear should be correctly adjusted axially in relation to the pinion shaft. Therefore lay aside the shims removed from outside the side bearings.

## 4.2.3.1. Removal

1. Remove the inner universal joints with shafts. They are attached to the pinions inside the differential with bolts through the centres of the shafts. See Fig. 13.

2. Separate the transmission at the joint between differential case and gear box case. When all bolts have been removed, the clutch shaft must be turned to a certain position to permit separation of the cases. Rotate the shaft and locate this position when the differential case is removed.

3. Mount the gear box in fixture 93-120, see Fig. 28.

4. Remove the two differential bearing caps and lift out differential and ring gear. Note and lay aside the shims outside the bearings. Don't forget the location of the shims. See Fig. 29.

5. Pull off the side bearings.

## 4.2.3.2. Assembly

1. Press in the side bearings.

2. Place differential in bearing seats and shims as they were positioned before removal. It may be necessary to increase or decrease the total thickness of the shims in order to compensate any difference in thickness between the new and the old bearings. Check that the outer bearing race has no axial play. For adjustment, see 4.2.11 and 4.2.11.2. and Fig. 44.

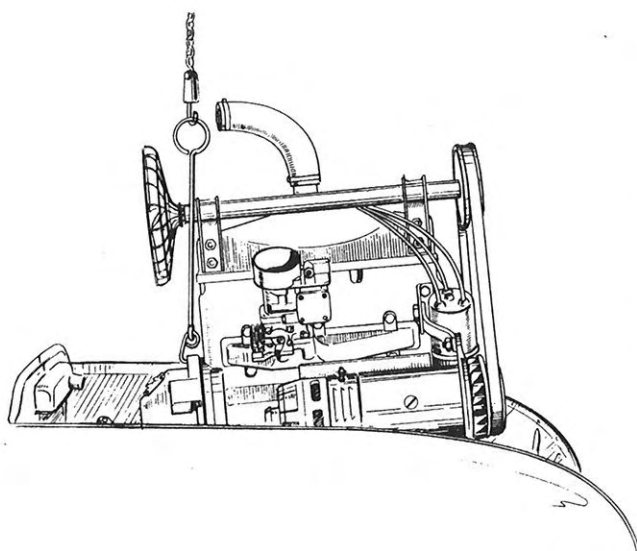


Fig. 26. Lifting out power unit

3. Fit the caps, which are provided with guides.

NOTE. Tighten the nuts with a wrench torque of 3.5 - 4.5 kgm (25 - 33 lb.-ft.).

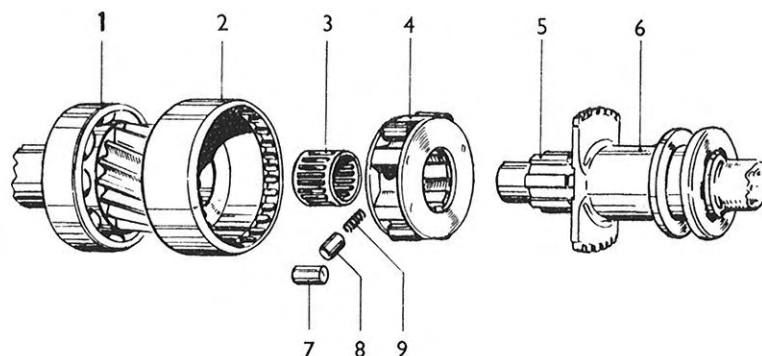
4. Check the back lash of the ring gear, see 4.2.11.2.

5. Remove the gear box from the fixture.

6. Fit the differential case to the gear box case.

NOTE. Turn the clutch shaft so that it clears the differential.

7. Install the inner universal joints with shafts. Insert the shafts carefully so as not to damage or displace the seal rings.



- 1. Ball bearing
- 2. Freewheel sleeve (main shaft)
- 3. Needle bearing
- 4. Freewheel hub
- 5. Clutch shaft

- 6. Coupling sleeve
- 7. Roller
- 8. Plunger
- 9. Spring

Fig. 27. Freewheel device

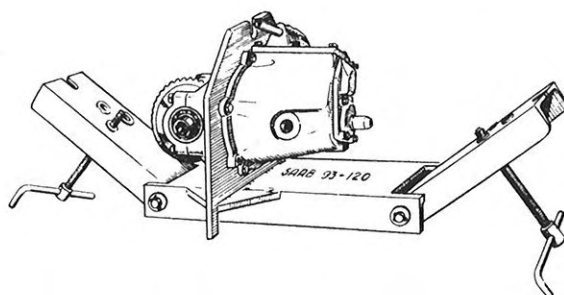
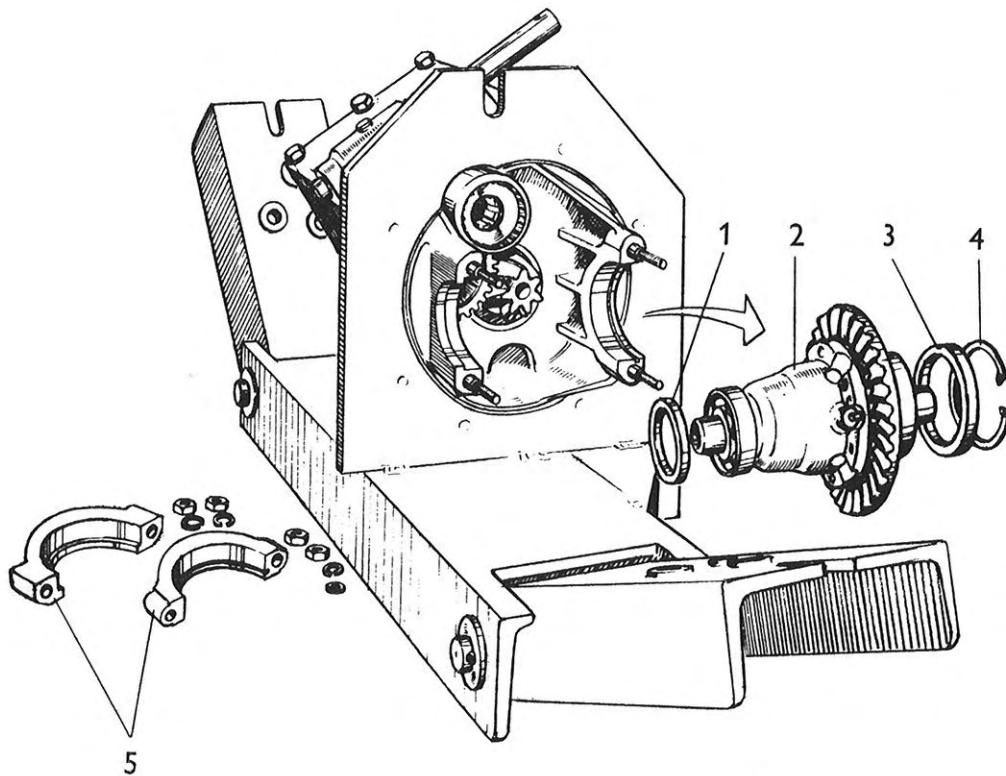


Fig. 28. Gear box mounted in fixture



- 1 & 3. Shims
- 2. Differential housing
- 4. Retainer
- 5. Caps

Fig. 29. Removal of differential

## 4.2.4. Differential

### 4.2.4.1. Removal and dismantling

1. Separate differential case and gear box case. Note position of clutch shaft. Remove differential as described in 4.2.3.1., points 1 - 4.
2. Unlock and loosen the ring gear screws, which hold the differential housing together.
3. Take the differential housing apart and remove the ring gear.
4. Drive out the differential pinion shaft and remove the pinions.
5. Remove the axle pinions and the two splined nuts for axial locking of the universal joints. Note the snap rings inside the axle pinions.
6. If necessary, pull off the two differential side bearings.

### 4.2.4.2. Assembling and installation

1. After replacing worn or damaged parts, place the splined nuts in the axle pinions. Don't forget the snap rings. Insert one pinion into the differential housing.
2. Insert the differential pinions and press in their shaft.
3. Place the ring gear on the assembled differential housing.
4. Insert the other pinion with the splined nut in place.
5. Fit the end of the differential housing and tighten the screws with a torque wrench, see Chapter 1, "General". Note that the two long screws are intended for locking the differential pinion shaft, see Fig. 48.
6. Lock the screw with wire.

7. Press on the side bearings if they have been removed.

8. Place differential in bearing seats and shims as they were positioned before removal. It may be necessary to increase or decrease the total thickness of the shims if any part which affects the differential width has been replaced. Check that the bearing has no axial play. For adjustment, see 4.2.11. and 4.2.11.2. and Fig. 44.

9. Screw on the bearing caps.

NOTE. The nuts must be tightened with a torque wrench.

10. Check the back lash of ring gear, see 4.2.11.2.

11. Remove the gear box from the fixture.

12. Fit the differential case to the gear box case.

NOTE. Turn the clutch shaft so that it clears the differential.

13. Install the inner universal joints with shafts. Insert the shafts carefully so as not to damage or displace the seal rings.

#### 4.2.5. Clutch shaft

##### 4.2.5.1. Removal

1. Remove the inner universal joints with shafts. They are attached to the pinions inside the differential by bolts through the centres of the shafts, see Fig. 13.

2. Separate the transmission at the joint between differential case and gear box case. When all bolts have been removed, the shaft must be turned to a certain position to permit separation of the cases. Rotate the shaft and locate this position when the differential case is removed.

3. Remove the outer snap ring on the shaft and pull off the freewheel coupling sleeve.

4. Loosen the lock screw for the freewheel control and remove shaft and pin, see Fig. 10. Collect the ball catch.

5. Remove the snap ring in the casing and pull out the shaft and ball bearing.

6. Remove the two remaining snap rings from the shaft and pull off the ball bearing.

7. Remove the needle bearing from inside the freewheel sleeve. If the needle bearing is damaged, check that all the needles are removed and also the freewheel hub should then be extracted.

8. Remove the seal ring from the casing if necessary.

##### 4.2.5.2. Installation

1. After replacing worn or damaged parts, press the ball bearing onto the clutch shaft.

2. Fit the two inner snap rings to the shaft and replace the seal ring if removed.

3. Push the shaft with bearing into the casing and fit snap ring.

NOTE. The shaft must be inserted carefully so as not to damage the seal ring.

4. Push the freewheel coupling sleeve onto the shaft and fit the outer snap ring.

5. Replace the freewheel control and make sure that the pin and the ball catch are properly fitted. Tighten the lock screw.

6. Insert the needle bearing and, if removed, the freewheel hub into the freewheel sleeve.

7. Fit the differential case to the gear box case.

NOTE. Turn the disk shaft so that it clears the differential.

8. Install the inner universal joints with shafts. Insert the shafts carefully so as not to damage or displace the seal rings.

#### 4.2.6. Gear shift mechanism

1. Remove the top cover from the gear box case.

2. Remove the end cover.

3. Remove the gear shift bars by pushing them out through the end wall of the transmission case with a screwdriver. Make sure that ball catches are not thrown out of the forks when the bars are removed, see Fig. 30. Collect the spring which is located in the end of the gear shift bars for 2nd and 3rd speeds.

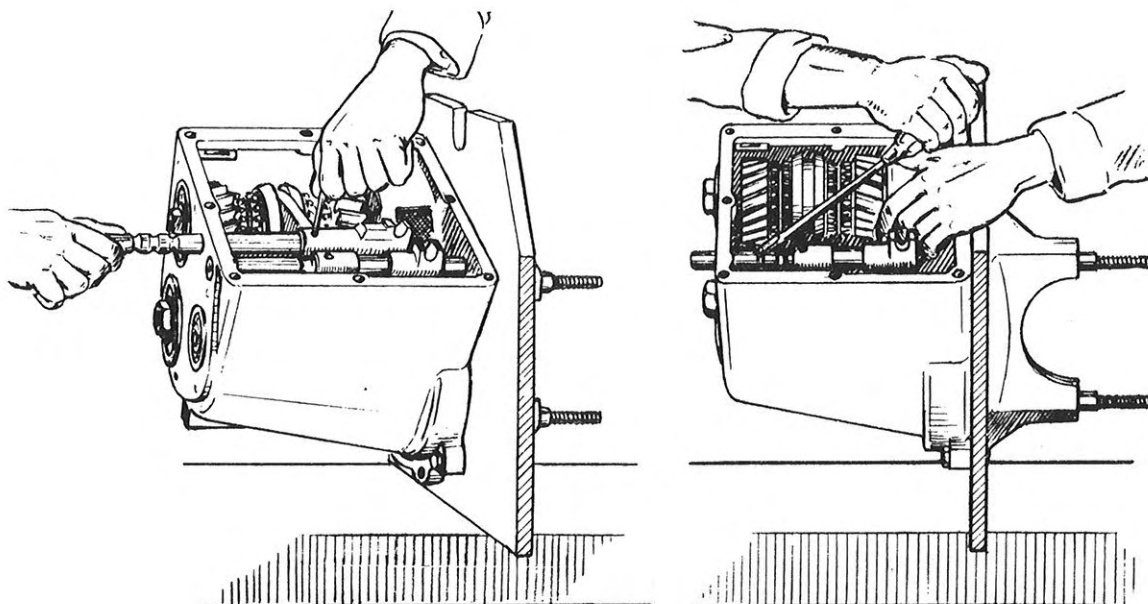
4. Lift out the gear shift forks.

5. Drive out the tapered pin and remove the universal coupling from the shift rod.

6. Remove the catch pivot 7 and catch 4, Fig. 31, from the top cover.

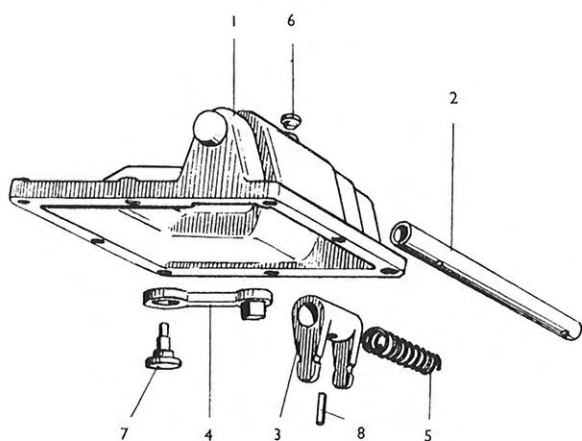
7. Remove plug 6 or drill up a hole and drive out expanding pin 8.

8. Pull out shift rod 2, then remove the yoke 3 and spring 5.



3rd and 2nd gear shift fork  
1st and reverse gear shift fork

Fig. 30. Removal of gear shift forks



- |              |                  |
|--------------|------------------|
| 1. Top cover | 5. Spring        |
| 2. Shift rod | 6. Plug          |
| 3. Yoke      | 7. Catch pivot   |
| 4. Catch     | 8. Expanding pin |

Fig. 31. Top cover of transmission case with gear shift mechanism

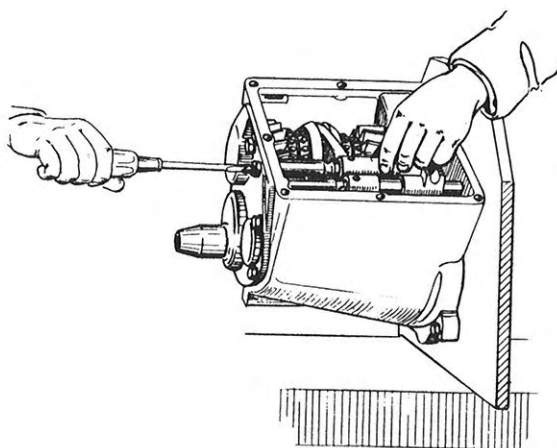


Fig. 32. Adjustment of gear shift bar for 2nd and 3rd speeds

## 4.2.6.2. Installation

1. After inspecting all parts, especially the gear shift forks, and replacing worn or damaged parts, insert the forks into the gear box.
2. Place springs and ball catches in the forks and push in the bars while the balls are kept in place with a suitable tool. Don't forget the spring in the front end of the bar for 2nd and 3rd speeds.
3. Fit the end cover. Inspect the gasket and tighten the screws with a torque wrench.
4. If necessary, loosen the adjusting screw in the end cover, see Fig. 32, and adjust the position of the fork for 2nd and 3rd speeds. The fork should be adjusted so that its movement is divided equally for engagement of 2nd and 3rd speed.
5. Insert the shift rod, spring and yoke into the top cover. Lock the yoke with an expanding pin.
6. Fit a new rubber plug into the hole in top cover.
7. Fit catch 4 and catch pivot 7, Fig. 31.
8. Fit the universal coupling to shift rod.
9. Fit the top cover to the case.

## 4.2.7. Pinion shaft rear bearing, thrust bearing

### 4.2.7.1. Removal

1. Remove the inner universal joints with shafts. They are attached to the pinions inside the differential with bolts through the centre of the shafts, see Fig. 13.
2. Separate the transmission at the joint between differential case and gear box case. When all bolts are removed, the clutch shaft must be turned to a certain position to permit separation of the cases. Rotate the shaft and locate this position while the differential case is removed.
3. Mount the gear box in fixture 93-120. See Fig. 28.
4. Remove the caps from the two differential journal bearings and lift out differential and ring gear.

NOTE. Collect the shims outside the two bearings and note their location, see Fig. 29.

5. Before dismantling further, check the setting of the pinion, see 4.2.11.
6. Make a note of the indicator readings and remove the measuring jig carefully so as not to disturb the attachment of the dial indicator.

7. Remove the top and end covers from the gear box.

8. Engage two gears, 1st and 2nd, at the same time and loosen the pinion shaft nut. Note that this nut has a left-hand thread.

9. Screw puller 93-120/1 onto the pinion shaft bearing sleeve and pull out sleeve and bearing, see Fig. 33. Collect the shim(s) inside the bearing.

10. Press the bearing out of the sleeve.

### 4.2.7.2. Installation

1. Press the bearing into the bearing sleeve. Note That the marking on the inner bearing race must face inwards, see Fig. 34.

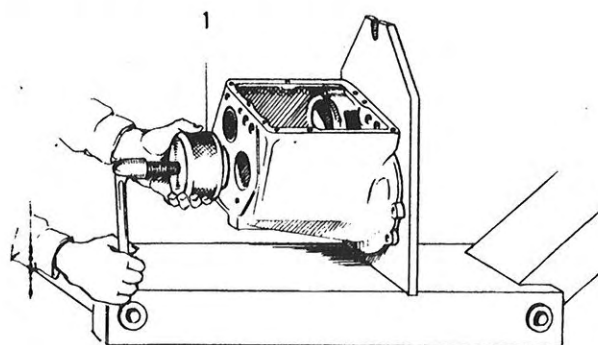
2. Insert the shim(s). Raise the rear end of the fixture and press in the sleeve and bearing with tool 93-120/2, supporting the pinion shaft at the other end with the front press screw, see Fig. 35.

3. Tighten the pinion shaft nut with a torque wrench, but do not secure it with the lock washer.

NOTE. The nut has a left-hand thread.

4. Inspect the end cover of the case. Inspect the gasket and tighten the screws with a torque wrench.

5. Check and, if necessary, adjust the setting of the pinion as described in 4.2.11.



1. Puller 92-120/1

Fig. 33. Removal of pinion shaft bearing

6. When the pinion shaft is correctly adjusted, lock the shaft nut, then fit the end cover and tighten the screws with a torque wrench.

7. Return the coupling sleeves to the neutral position and fit the top cover.

8. Place the differential in the bearing seats and the shims as they were positioned before removal.

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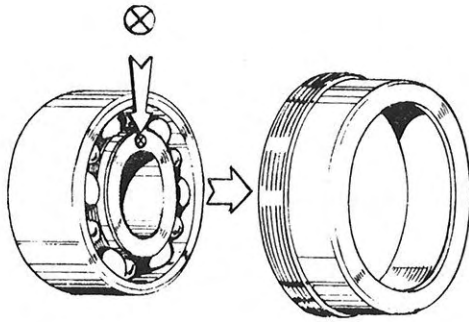


Fig. 34. Location of pinion shaft bearing in bearing sleeve

case to the gear box case.

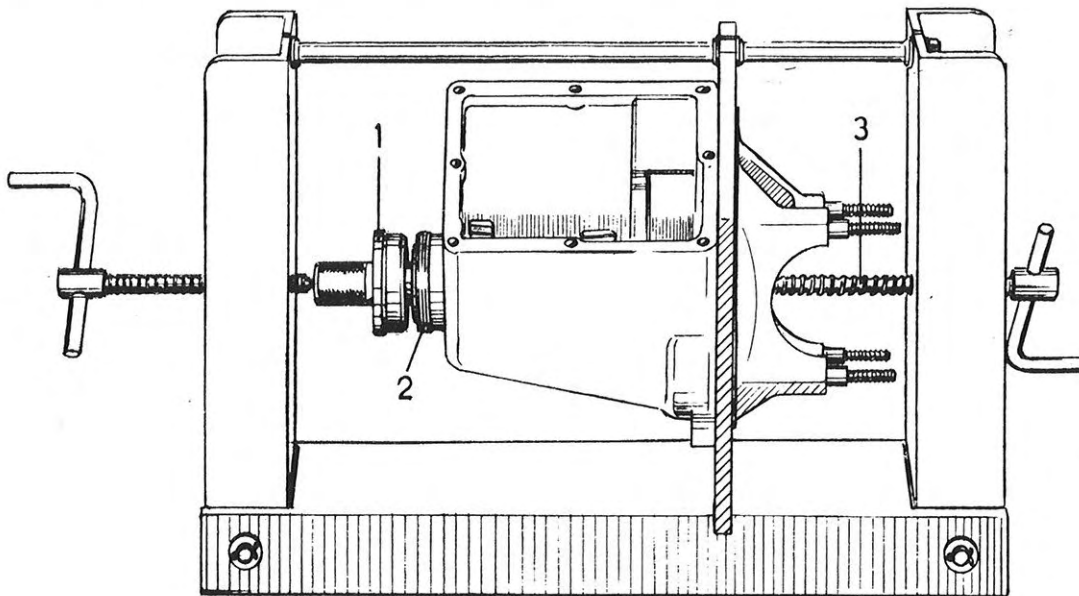
NOTE. Turn the clutch shaft so that it clears the differential.

12. Install the inner universal joints with shafts. Insert the shafts carefully so as not to damage or displace the seal rings.

## 4.2.8. Countershaft with gears and bearings

### 4.2.8.1. Removal

1. Remove the inner universal joints with shafts. They are attached to the pinions inside the differential by bolts through the centre of the shafts. See Fig. 13.



1. Tool 93-120/2
2. Bearing sleeve with bearing
3. Press screw

Fig. 35. Pressing in pinion shaft bearing

NOTE. Marking of ring gear and pinion shaft, see Fig. 44.

If any part in the differential has been replaced or if the pinion shaft setting has been altered, then the ring gear must be adjusted as described in 4.2.11.

9. Fit the caps to the side bearings and tighten the screws with a torque wrench.

10. Remove the gear box from the fixture.

11. Check that the needle bearing is inserted into the freewheel sleeve and fit the differential

2. Separate the transmission at the joint between differential case and gear box case. When all bolts have been removed, the clutch shaft must be turned to a certain position to permit separation of the cases. Rotate the shaft and locate this position while the differential case is removed.

3. Mount the gear box in fixture 93-120. See Fig. 28.

4. Remove the caps from the two differential side bearings and lift out the differential.

NOTE. Collect the shims outside the two bear-

ings and note their location, see Fig. 29.

5. Remove the top and end covers from the gear box case. Note gasket under end cover.

6. Remove the gear shift bars by pushing them through the end of the gear box case with a screwdriver. Make sure that the ball catches are not thrown out of the gear shift forks when the bars are removed, see Fig. 30. Collect the spring which is located in the end of the bar for 2nd and 3rd speeds.

7. Move the coupling sleeves so as to engage two gears at the same time.

8. Open the lock washer and loosen the nut at the front end of the countershaft. If the main and pinion shafts are also to be removed, loosen their end nuts as well.

NOTE. The nut on the pinion shaft has a left-hand thread.

9. Return the coupling sleeves to neutral position.

10. Raise the rear end of the fixture and lock it in position.

11. Remove the countershaft using pusher 93-120/10, see Fig. 36. Press out the shaft until the bearings and countershaft gear come free. Remove the tool and the countershaft gear.

12. Lift up the front end of the countershaft and grasp the gears with one hand. Pull out the shaft through the rear bearing seat, and lift out the gears.

Note the washer which is located between the 1st speed gear and the ball bearing, and lay aside the two needle bearings from inside the 1st speed gear.

If necessary:

13. Remove the snap ring and press the ball bearing off the shaft.

14. Remove the snap ring in the gear box case and press out the front bearing forwards with the fixture press screw and tool 93-120/8. See Fig. 37.

#### 4.2.8.2. Installation

1. After replacing worn or damaged parts, press the front ball bearing into its seat from inside the gear box. Use the fixture press screw and tool 93-120/8 after raising and locking the rear end of the fixture. Fit the snap ring inside the bearing.

2. Place the countershaft gear on the outside

against the bearing and keep it in position with the front press screw and tool 93-120/8, see Fig. 38.

3. Put together the reverse gear, 1st speed gear with the two needle bearings inserted and the washer. Insert these parts as one unit at the same time as the countershaft is inserted through the rear bearing seat. Make sure that the splines on the shaft enter those in the countershaft gear.

If the ball bearing has not been removed from the shaft, it can be installed together with the shaft if the snap ring is removed.

4. Press in the shaft with the fixture rear press screw and tool 93-120/4.

If the shaft is pressed in together with the ball bearing, use tool 93-120/9 instead. This tool should also be used for pressing in the ball bearing if the shaft is already fitted. Don't forget to lock the bearing with the snap ring.

5. Move the coupling sleeves so as to engage two gears at the same time. Fit a new lock washer and tighten the nut of the countershaft, then lock it with the lock washer.

6. Return the coupling sleeves to neutral position and insert the gear shift forks.

7. Place the springs and ball catches in the forks and insert the bars while the balls are kept in place with a suitable tool. Don't forget the spring in the front end of the bar for 2nd and 3rd speeds.

8. Check that the oil collector in the wall is correctly fitted with the key in the groove.

9. Check the gasket and fit the end cover.

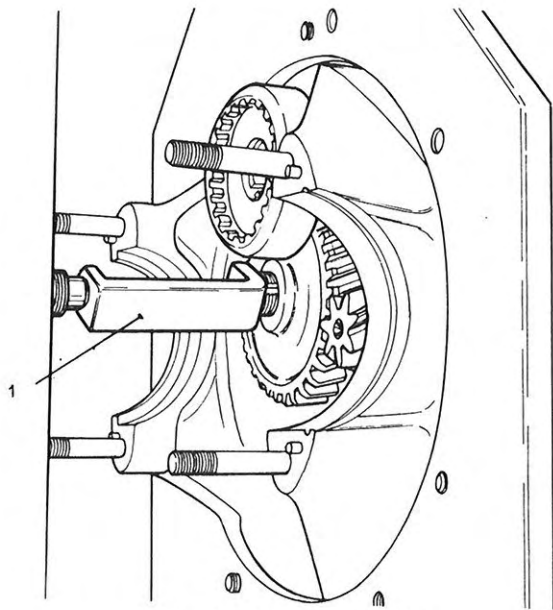
10. If necessary, loosen the lock nut and adjust the 2nd and 3rd speed gear shift bar, see Fig. 32, so that the fork is not subjected to axial thrust when 2nd or 3rd speed is engaged. In both cases there should be noticeable clearance between the coupling sleeve and the appropriate gear.

11. Move the forks to neutral position and fit the top cover.

12. Place the differential in the bearing seats and the shims as they were positioned before removal.

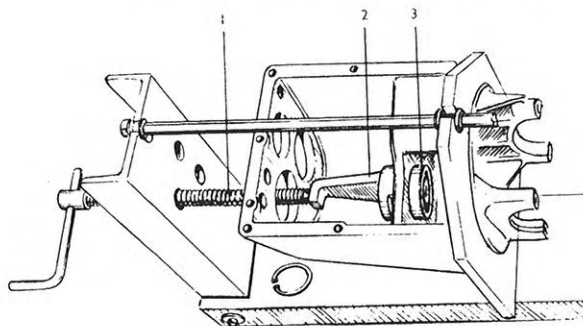
NOTE. Marking of ring gear and pinion shaft. See Fig. 44.

If a bearing or any other part of the differential has been replaced, the ring gear must be adjusted as described in 4.2.11. and 4.2.11.2.



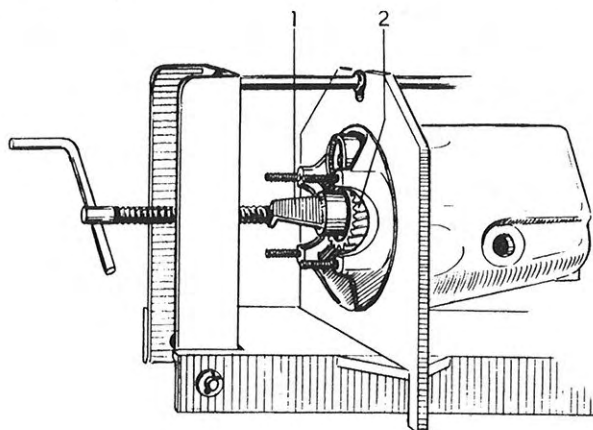
1. Pusher 93-120/10

Fig. 36. Removal of countershaft



1. Press screw
2. Tool 93-120/8
3. Ball bearing

Fig. 37. Removal of countershaft front bearing



1. Tool 93-120/8
2. Countershaft gear

Fig. 38. Location of gear during installation of countershaft

13. Fit caps to side bearings and tighten screws with a torque wrench.

14. Remove gear box from fixture.

15. Check that the needle bearing is inserted into the freewheel sleeve.

16. Fit the differential case to the gear box case.

NOTE. Turn the clutch shaft so that it clears the differential.

17. Install the inner universal joints with shafts. Insert the shafts carefully so as not to damage or displace the seal rings.

#### 4.2.9. Main shaft with synchronizing device, gears and bearings

If the 2nd and 3rd speed gears on the main shaft are to be replaced, it should be noted that they are paired with counter-rotating gears on the pinion shaft. Thus the above mentioned gears are available as spare parts only in pairs with the mating gears. At present the 1st speed gear is also paired with the 3rd speed gear.

##### 4.2.9.1. Removal

1. Remove the countershaft as described in 4.2.8.1.

2. Place the rear press screw of the fixture against the main shaft and fit tool 93-120/4 between screw and shaft.

3. Press out the shaft forwards, see Fig. 39, until the bearings come free from their seats.

4. Unscrew the press screw and remove the tool.

5. Remove the shaft forwards.

6. Grasp the synchronizing device and the gears and let the washer between 2nd speed gear and ball bearing drop down into the gear box, then lift out the gears and synchronizing device as one unit.

7. Remove the double needle bearing from the 3rd speed gear if it did not come out with the shaft.

8. Remove the bushing from the 2nd speed gear.

9. Take the synchronizing device apart.

If necessary:

10. Press the rear main shaft bearing out of its seat with the front press screw and tools 93-120/6 and 93-120/9.

11. Remove the spacer and lock pin from the shaft.

12. Remove the snap ring and press the ball bearing off the shaft.

13. Remove the freewheel hub and needle bearing from the freewheel sleeve. If the needle bearing is damaged, all the needles must be found and removed. Collect rollers, plungers and springs of freewheel hub.

#### 4.2.9.2. Installation

1. After replacing worn or damaged parts, press the ball bearing into the main shaft and secure it with the snap ring. Use tool 93-120/7.

2. Insert the freewheel hub with rollers into the freewheel sleeve. Note that the hub should engage when it is turned to the right. The hub is marked on the front.

3. Insert the lock pin into the shaft and place the spacer against the snap ring so that the pin drops into the notch in the washer and prevents it from rotating.

4. Put together the 3rd speed gear with double needle bearings inserted, synchronizing device with rings and 2nd speed gear without bushing. Insert this unit into the gear box and place the guide tool 93-120/3 through the rear wall against the 2nd speed gear.

5. Insert the main shaft from the front, turning it slightly back and forth so that its splines enter the hub of the synchronizing device.

6. Insert tool 93-120/4 into freewheel sleeve. Note that the needle bearing must be removed from inside the freewheel sleeve, otherwise it will be damaged.

7. Lift up and lock the two ends of the fixture and support the guide tool inserted into the 2nd speed gear with the rear press screw.

8. Press in the main shaft carefully with the front press screw against the tool in the freewheel sleeve, see Fig. 40. Check that the synchronizing hub slides easily on the shaft.

9. Loosen the rear press screw and remove the guide tool from the 2nd speed gear.

10. Insert the bushing into the 2nd speed gear with the tool 93-120/3, and place the washer on the shaft.

11. Press in the main shaft rear bearing with the press screw and tool 93-120/9. Note that the press screw at the freewheel sleeve is used for holding-

on.

12. Loosen the press screws and remove the tools.

13. Fit the lock washer and end nut on the shaft.

NOTE. Tighten with a torque wrench, but not before the countershaft is installed.

14. Install the countershaft as described in 4.2.8.2.

#### 4.2.10. Pinion shaft with gears and bearings

##### 4.2.10.1. Removal

1. Remove inner joints, differential case and differential as described in 4.2.8.1., points 1 - 4.

2. Before proceeding with removal, measure pinion setting, See 4.2.11. and 4.2.11.1.

3. Proceed with removal as described in 4.2.8.1.

4. Remove main shaft as described in 4.2.9.1.

5. Apply puller 92-120/1 to pinion shaft rear bearing and pull out sleeve and bearing, see Fig. 33. Collect shim(s) inside bearing.

6. Remove speedometer drive.

7. Place rear press screw against pinion shaft and press out the shaft forward. When the shaft comes free, remove the shaft and lift out the gears.

8. Press off the pinion shaft roller bearing if necessary.

##### 4.2.10.2. Installation

1. After inspecting all parts and replacing those that are worn or damaged ones, press the roller bearing into the pinion shaft and insert the two Woodruff keys into their slots.

NOTE. The keys are of different sizes and the small key is intended for the 2nd speed gear.

2. Place the 3rd and 2nd speed gears and the speedometer worm gear in the gear box.

NOTE. Place the worm gear with its bevelled end forward.

3. Insert the pinion shaft from the front.

4. Fix the 3rd speed gear in relation to the keyway. Make sure that the worm gear engages and fix the 2nd speed gear in relation to the keyway. This is best done by aligning the keyway in the gear with the notch in the lock washer, which is in line with the shaft keyway.

5. Place the front press screw against the pinion

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shaft and press in the shaft carefully, supporting the 2nd speed gear against the rear wall of the gear box. Make sure that the 2nd speed gear is at right angles to the shaft and press in the shaft until it enters the gear.

6. Loosen the press screw a few turns, supporting the gears at the same time, and place guide tool 93-120/2 in the rear bearing seat. Make sure that the shaft end enters into the tool.

7. Press in the tool with the fixture press screw, until its flange makes contact with the gear box wall. Leave the press screw in this position.

8. Press in the pinion shaft with the opposite press screw until the roller bearing makes contact with the 3rd speed gear. See Fig. 41.

9. Loosen the press screws and remove the tool from the rear bearing seat.

10. Select two shims to a total thickness of 3.5 mm on the shaft end. If neither the pinion shaft nor any part on it has been replaced, then the previously used shim(s) should be refitted.

11. Press the double ball bearing into the bearing sleeve if these parts have been separated. The marking on the bearing, see Fig. 34, should face inwards.

12. Press in the bearing and sleeve with the rear press screw and tool 93-120/2, the pinion shaft being supported by the opposite press screw.

13. Place a new lock washer and nut, note: left-hand thread, on the pinion shaft. Tighten the nut with a torque wrench, but not until the main shaft and countershaft have been installed.

14. Install the speedometer drive.

15. Install the main shaft as described in 4.2.9.2., points 1 - 13.

16. Install the countershaft as described in 4.2.8.2., points 1 - 11.

17. Check the pinion setting as described in 4.2.11. and 4.2.11.1.

NOTE. Before measurements of the pinion shaft setting the shaft nut and all the end cover screws must be tightened with a torque wrench.

18. Place the differential with ring gear in the bearing seats and adjust the pinion shaft and ring gear back lash as described in 4.2.11. and 4.2.11.2.

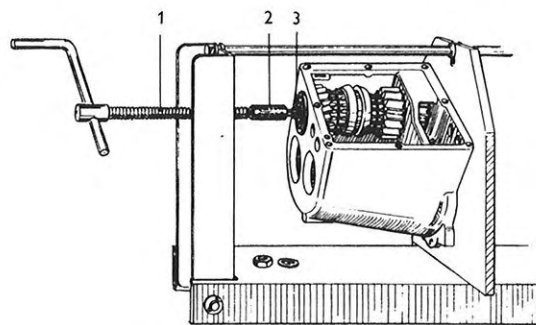
19. Remove the gear box from the fixture.

20. Insert the needle bearing into the freewheel sleeve.

21. Attach the differential case to the gear box.

NOTE. Turn the clutch shaft so that it clears the differential.

22. Install the inner universal joints with shafts. Insert the shafts carefully so as not to damage or displace the seal rings.



1. Press screw
2. Tool 93-120/4
3. Main shaft

Fig. 39. Pressing out main shaft

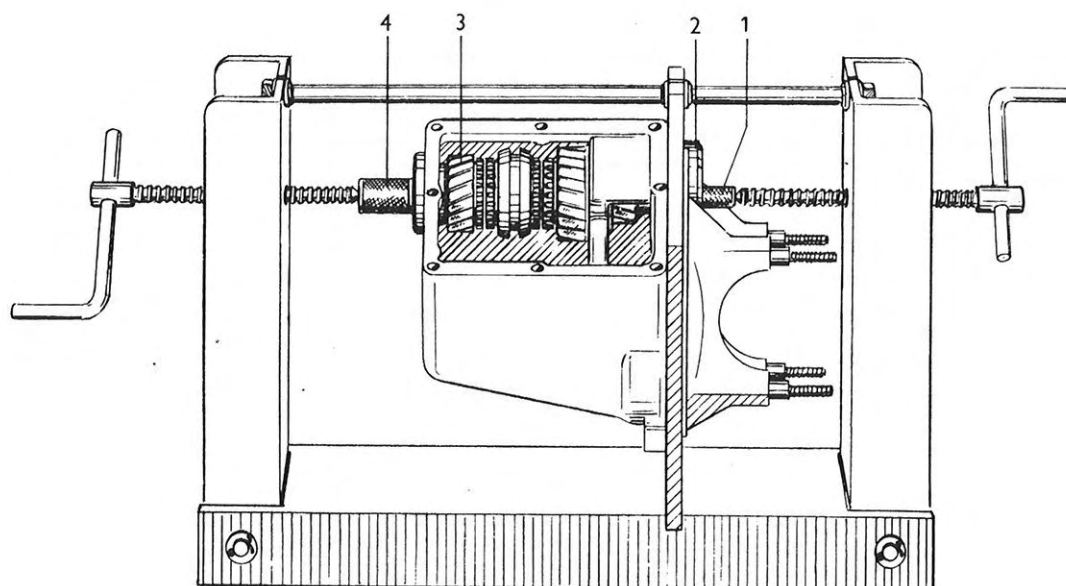
## 4.2.11. Adjustment of ring gear and pinion shaft

The adjustment of pinion shaft and ring gear in relation to one another is of great importance for quiet operation and long life of the gears.

The pinions and ring gears are manufactured in pairs, and they are adjusted for ideal operation while they rotate in a test machine by moving the two gears in relation to each other. The position of the pinion in relation to the ring gear is read off on a dial indicator and the correct distance  $a$ , Fig. 42, is etched on the end face of the pinion, see Fig. 42. When adjusting the pinion shaft this value should be aimed at, but a variation of  $\pm 0.05$  mm is allowed.

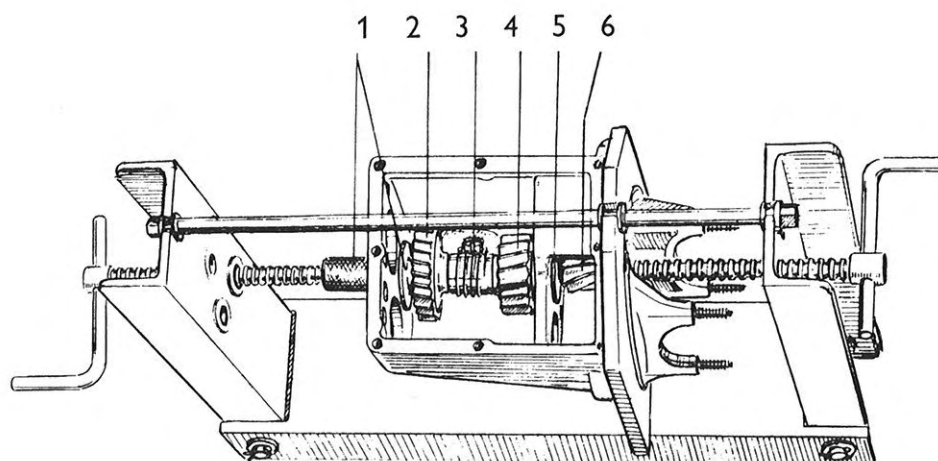
The back lash of ring gear is also measured in the test machine and etched on the ring gear, see Fig. 43. The teeth which should be in engagement when fitting ring gear to pinion is also marked and the gears should be assembled in this position when they have been separated, see Fig. 44.

In addition to the above markings, the pinion shaft and ring gear have a pair number, see Fig. 42 and 43. Gears with different numbers must never be used together.



- |                     |                        |
|---------------------|------------------------|
| 1. Tool 93-120/4    | 3. 2nd speed gear      |
| 2. Freewheel sleeve | 4. Guide tool 93-120/3 |

Fig. 40. Pressing in main shaft



- |                          |                   |
|--------------------------|-------------------|
| 1. Guide tool 93-120/2   | 4. 3rd speed gear |
| 2. 2nd speed gear        | 5. Roller bearing |
| 3. Speedometer worm gear | 6. Pinion shaft   |

Fig. 41. Pressing in pinion shaft



60.90 = distance a  
 605 = pair number  
 Ø see Fig. 44

Fig. 42. Marking of pinion shaft

#### 4.2.11.1. Adjustment of pinion

Before measurements of the pinion setting, the pinion shaft nut and all end cover screws must be tightened with a torque wrench.

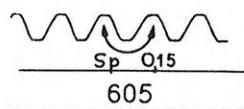
The setting of the pinion shaft, distance a, Fig. 42, is adjusted by means of shims inside the pinion shaft rear bearing, see Fig. 45. Adjustments are

# 3 TRANSMISSION

carried out by removing the bearing as described in 4.2.7. and altering the combination of shims.

A tool 93-123 combined with a dial indicator is used for correct measurement of the pinion setting. This tool consists of a measuring jig 1, in which a dial indicator 3 is fixed, and a V-block 2, see Fig. 46. A value A, Fig. 46, which is individual for each tool, is stamped on the V-block.

If the ring gear and pinion shaft or any of the gears or bearings on the pinion shaft have been replaced, then the setting of the pinion must be checked and adjusted as follows:



0.15 = back lash  
605 = pair number  
↪ see Fig. 44

Fig. 43. Marking of ring gear

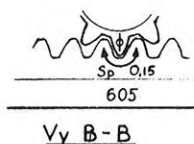
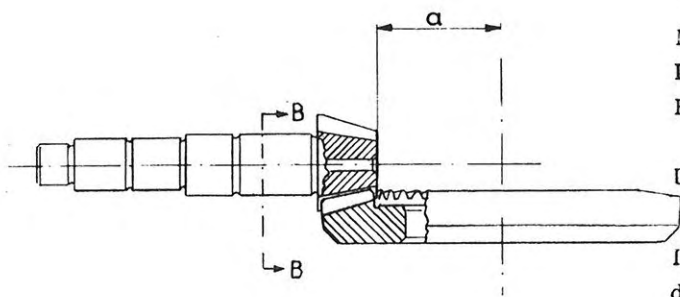


Fig. 44. Location of ring gear in relation to pinion shaft

1. Read and note down the marking of the pinion, that is, distance a, Fig. 42.
2. Read and note down the value A of the V-block, Fig. 42.
3. Set the dial indicator to zero in the V-block so that the big hand is at zero while the small hand is in the middle of the measuring range, say at 5 if an indicator with a range of 10 mm is used, see Fig. 46. The distance from the centre axis of the measuring jig to the point of the indicator stem is thus equal to the distance A when the indicator reading is 5.00 mm.

If this distance is reduced, the indicator reading increases, but if the distance is increased, the reading decreases.

4. Place the measuring jig in the differential bearing seats with the indicator stem against the surface-ground end of the pinion shaft, see Fig. 47. Note down the indicator reading. The true distance V can then be calculated as follows:

A = marking on V-block

T = indicator setting in V-block

P = reading during measurement against pinion shaft

S = difference between indicator readings

V = true pinion distance

$V = A + \text{or} - S$

## Example 1

Marking of V-block,  $A = 61.05$ .

Indicator setting in V-block,  $T = 5.00$ .

Reading during measurement against pinion shaft,  
 $P = 5.08$ .

Difference between readings,  
 $S = 5.08 - 5.00 = 0.08$ .

In this example the indicator reading increases during measurement against the pinion and therefore the difference  $S = 0.08$  must be subtracted from the marking on the V-block,  $A = 61.05$ , in order to give the true pinion distance.

Thus the true pinion distance is  $61.05 - 0.08 = 60.97$ .

## Example 2

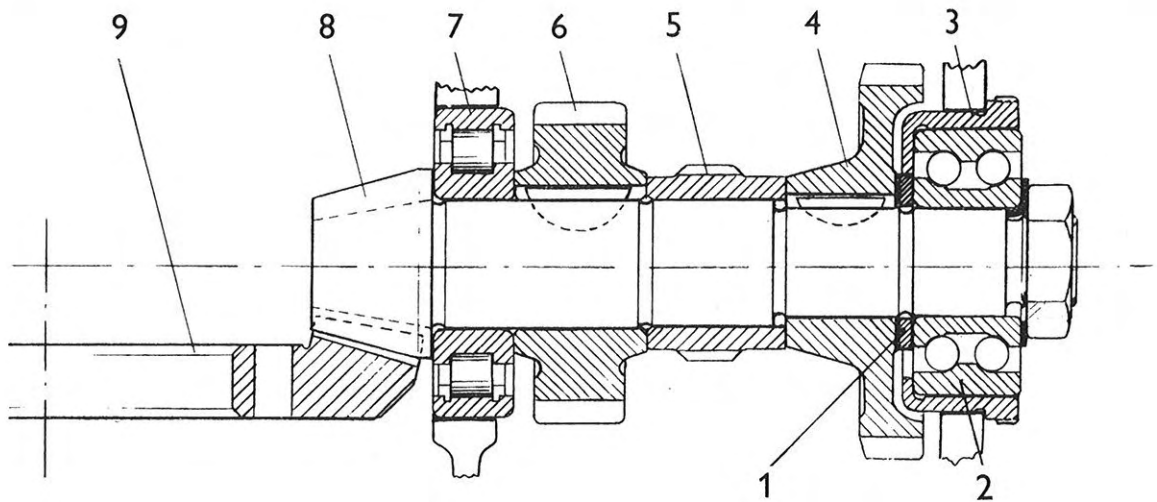
Marking of V-block,  $A = 61.05$ .

Indicator setting in V-block,  $T = 5.00$ .

Reading against pinion,  $P = 4.95$ .

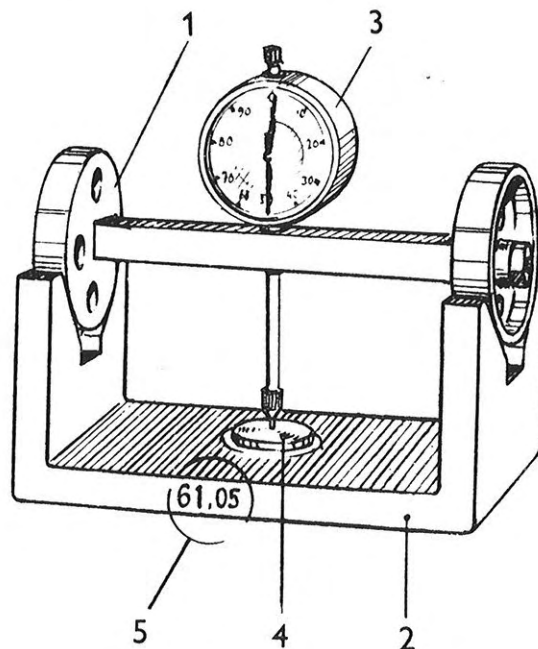
Difference between readings,  
 $S = 5.00 - 4.95 = 0.05$ .

In this case the indicator reading decreases during



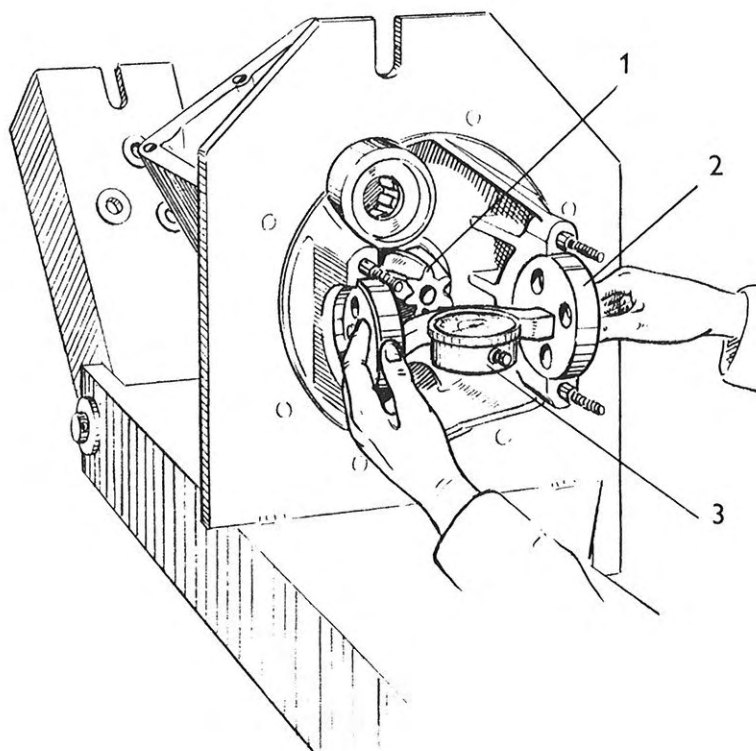
- |                   |                          |
|-------------------|--------------------------|
| 1. Shim           | 5. Speedometer worm gear |
| 2. Ball bearing   | 6. 3rd speed gear        |
| 3. Bearing sleeve | 7. Roller bearing        |
| 4. 2nd speed gear | 8. Pinion shaft          |
|                   | 9. Ring gear             |

Fig. 45. Adjustment of pinion shaft by means of shims



- |                   |                          |
|-------------------|--------------------------|
| 1. Measuring jig  | 4. Measuring shoulder    |
| 2. V-block        | 5. Distance A = 61.05 mm |
| 3. Dial indicator |                          |

Fig. 46. Measuring tool Saab 93-123 for adjustment of pinion distance



- 1. Pinion shaft
- 2. Measuring jig
- 3. Dial indicator

Fig. 47. Location of jig for measuring of pinion distance

measurement against the pinion and therefore the difference,  $S = 0.05$ , must be added to the marking on the V-block,  $A = 61.05$ .

Thus the true pinion distance is  
 $61.05 + 0.05 = 61.10$ .

5. When the true pinion distance is determined, compare it with the value,  $a$ , etched on the pinion end surface.

#### Example 3

Pinion marking,  $a = 60.75$ .

Measured true pinion distance,  $V = 60.97$ .

The true distance is thus  $0.22$  mm too large and the pinion setting must be altered by moving the pinion  $0.22$  mm forward, that is, towards the differential. Insert  $0.2$  mm thicker shim combination.

#### Example 4

Pinion marking,  $a = 61.08$ .

Measured true pinion distance,  $V = 60.97$ .

Difference,  $r = 61.08 - 60.97 = 0.11$ .

In this example the true distance is  $0.11$  mm too small and the pinion setting must therefore be adjusted by moving the pinion  $0.11$  mm backwards. Insert  $0.1$  mm thinner shim combination.

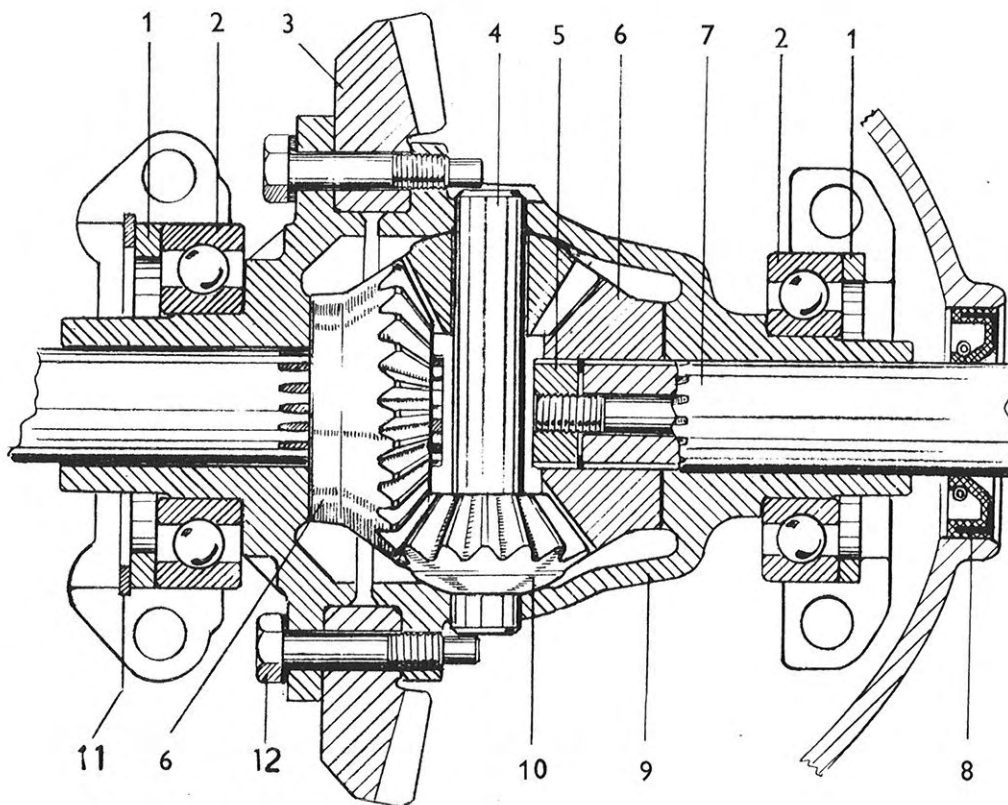
NOTE. The true pinion distance must not differ by more than  $0.05$  mm from the value etched on the pinion.

6. Remove the end cover from the gear box.

7. Extract pinion shaft rear bearing with sleeve, see 4.2.7.1. point 9, and remove the shims inside the bearing.

8. Select a new combination of shims to increase or decrease the pinion distance, depending on the result of the measurements. If the total thickness of the shims is increased, the pinion shaft is moved forward.

The shims are marked with their thicknesses, which are  $1.6$ ,  $1.7$ ,  $1.9$ ,  $2.0$  and  $2.1$  mm. They are intended to be used in pairs forming various combinations.



- |                              |                         |
|------------------------------|-------------------------|
| 1. Shims                     | 7. Drive shaft          |
| 2. Ball bearings             | 8. Seal ring            |
| 3. Ring gear                 | 9. Differential housing |
| 4. Differential pinion shaft | 10. Differential pinion |
| 5. Splined nut               | 11. Retainer            |
| 6. Axle pinion               | 12. Stop screw          |

Fig. 48. Differential housing, sectioned

#### 4.2.11.2. Adjustment of ring gear

As mentioned in 4.2.11., each ring gear is marked with its back lash, see Fig. 43.

When the differential with ring gear is correctly adjusted, the back lash must not differ by more than 0.02 mm from the value etched on the ring gear.

The back lash is adjusted by means of shims which are placed outside the two side bearings of the differential, see Fig. 48. These shims are available in two different series, one for each bearing, owing to their difference in diameters. The larger shims are available in thicknesses of 2.8, 2.9, 3.1, 3.2 and 3.3 mm, and the smaller shims in thicknesses of 2.1, 2.2, 2.4, 2.5 and 2.6 mm.

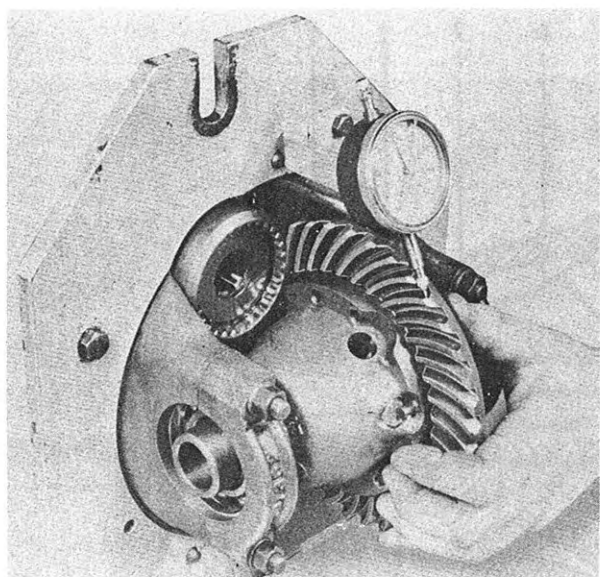
1. Place differential with ring gear into bearing seats. Note that the marked teeth should be fitted together, see Fig. 44.

2. Insert shims outside the larger side bearing and adjust the ring gear position to give the correct back lash. Check with the dial indicator placed in the loop on the fixture, see Fig. 49.

3. Insert shims at the other bearings until there is no axial play at the outer races of the bearings.

4. Fit the side bearing caps and tighten the screws with a torque wrench. Note the guide pins.

5. Measure the back lash with the dial indicator and check that it is kept within the prescribed limits. If the clearance should be incorrect, the bearing caps must be removed and another shim combination selected.



1. Dial indicator

Fig. 49. Measurement of ring gear back lash

Increasing the thickness of shims 0.1 mm at one bearing and decreasing it the same amount at the other one will change the back lash about 0.03 mm.

## 4.3. Installation of power unit in car

1. After screwing engine, transmission and starter together, lift the power unit into the car, while inserting the left-hand drive shaft into the inner universal joint. Use lifting hook 93-110.
2. Push right-hand drive shaft into inner universal joint.
3. Attach steering arm and pivot to steering knuckle housing.
4. Disconnect lifting hook.
5. Fit right-hand front wheel and lower the car.
6. Tighten the rear power unit attachment.
7. Attach the front engine brackets.
8. Connect the freewheel control to the lever on the transmission.
9. Connect the speedometer cable to the transmission case.
10. Install the gear shift rod universal coupling and lock the pins.
11. Fit the engine side stay.
12. Connect the ground cable to the engine.

13. Fit the throttle control rubber bellows at the carburetor.
14. Connect the starter cables and control.
15. Connect the generator cables and the primary cable to the distributor.
16. Connect the fuel hose to the carburetor.
17. Connect the ignition cable to the distributor.
18. Connect the lower radiator hose to the water pump.
19. Install the thermometer bulb.
20. Connect the clutch cable with nut and push rod and fit the wire to the attachment under the engine. Adjust clutch pedal play. See description 3.1.3.
21. Install muffler and connect it to exhaust manifold and exhaust pipe before tightening suspension nut. Attach rubber buffer for exhaust pipe.
22. Connect upper radiator hose.
23. Install intake muffler with air filter and preheater.
24. Fasten pedal board.
25. Connect ground cable to battery.
26. Mount engine hood.
27. Fill cooling system and fill transmission with oil.
28. Road-test the car.

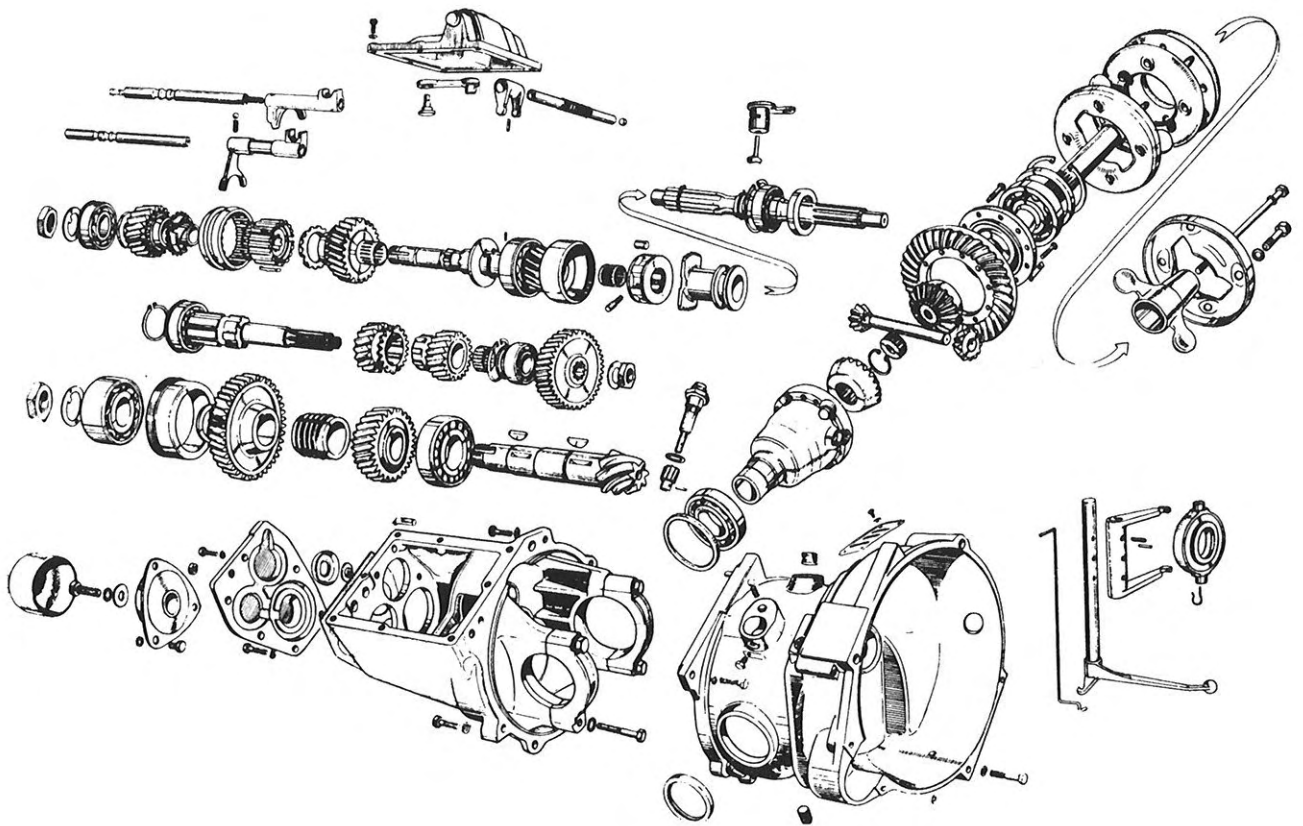


Fig. 50. Transmission