

Chapter 6 Transmission

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Specifications

Ratios:	New 500	500 Sport	All later cars
1st gear	3.27	3.27	3.70
2nd gear	2.06	2.06	2.06
3rd gear	1.30	1.30	1.30
4th gear	0.87	0.87	0.87
Reverse	4.13	4.13	5.14
Final drive	5.125	4.88	5.125
1st gear overall	16.8	15.95	18.96
2nd gear overall	10.6	10.1	10.6
3rd gear overall	6.7	6.3	6.7
4th gear overall	4.5	4.3	4.5
Reverse	21.2	20.2	26.33

Oil capacity 1 qt (1.25 US qt) 1.1 litre

Gearbox

Condemnation limits

Input shaft bearing:	Selector-end: Sideways play ... ..	.0018 inch (.045 mm)
	End float ... ..	.0177 inch (.450 mm)
Differential-end:	Sideways play ... ..	.0016 inch (.040 mm)
	End float ... ..	.0156 inch (.400 mm)
Output shaft:	Selector-end: Sideways play ... ..	.0016 inch (.040 mm)
	Differential-end: Sideways play ... ..	.0018 inch (.045 mm)

Backlash between gears : maximum ... ..	.004 inch (.10 mm)
Gear wear (limit on bush ... ..	.008 inch (.20 mm)
Dog-clutch sliding sleeves on hubs ... ..	.006 inch (.15 mm)

Final drive

Differential side bevel gear thrust ring:	Standard ... ..	.039 inch (1 mm)
	Oversizes various up to ... ..	.051 inch (1.3 mm)

Crownwheel and pinion distance "B"

Which is differential centre line to seat of pinion shoulder on inner

race of output shaft bearing	75 mm
Shims available in thicknesses: ... ..	.10 and .15 mm
Crownwheel to pinion backlash ... ..	.08 - .12 mm (.0031 inch - .0047 inch)
Differential bearing preload: Torque to rotate ... ..	.130 - .150 kgm (.94 - 1.08 lbf.ft)

Shaft wear limits:

Drive shaft cross head slip joint in differential	
bevel side gears ... ..	.20 mm (.0079 inch)
Shaft in sleeve at hub end ... ..	.15 mm (.0059 inch)

Tightening torques

Input shaft end nut	18½ - 25 lbf.ft	(2.5 - 3.5 kg.m)
Output shaft end nut	29 - 36 lbf.ft	(4 - 5 kg.m)
Bolts through crownwheel in differential casing	23½ lbf.ft	(3.2 kg.m)
Flywheel housing to gearbox casing	27½ lbf.ft	(3.8 kg.m)
Transmission to engine nuts	18 - 22 lbf.ft	(2.5 - 3.0 kg.m)
Drive shaft sleeve to hub	20 lbf.ft	(2.8 kg.m)

1 General description

1 The gearbox and final drive with differential are built as one transmission unit. The drive from the clutch passes forward by a long shaft over the differential into the gearbox. On this shaft in the top of the gearbox is a gear cluster with a series of gearwheels, one for each gear, and all permanently locked to their shaft, the input shaft. Below is the output shaft. On this lower shaft again there is a gearwheel for each gear speed, but these being in constant mesh with those on the top, input shaft, are normally free, and just one locked to the output shaft when needed. The output shaft brings the drive back again to the final drive, where it is turned across the car and given another gear reduction.

2 The gears are engaged by locking them to the output shaft with dog-clutch sleeves sliding on splined hubs on the output shaft. There is not any synchromesh to get the gearwheel going at the correct speed before the dog-clutch engages. This makes work on the gearbox much simpler. The gearwheels are very light on such a small gearbox, so if gear changes are made without much skill the teeth of the dog-clutches do not complain loudly, but changes should be made employing double-declutching.

3 The price of a reconditioned transmission at first looks rather high but for this you get a guaranteed factory overhaul. If the transmission has one isolated and obvious defect, like running very rough in one gear indicating the gear teeth have failed, it could readily be stripped and that one defect rectified. The problem comes if work is undertaken involving changing the crownwheel and pinion, the double ball thrust bearing at the front, or selector-end, of the output shaft. Unless the official workshop setting gauges are available it is difficult to set up the position of the pinion, which is also the output shaft, or mesh the crownwheel properly, and adjust the preload of its bearings. If just general noise is the problem a partial overhaul may give disappointed results. Yet if every component is to be renewed then the bill will be expensive, and there could well be difficulty in getting all the parts. But if silence is not the problem, then everything is fairly straightforward.

4 When you strip the transmission it is important to lay out the components in order as they come out or off, so that they can go back in the same order, and in the same relative position, and not get muddled up.

2 Removal of the transmission from the car (engine in place)

1 It is normally expected that if the transmission is needing repair, some other components of the car will be as well, and therefore the transmission will be removed with the engine. This makes work a lot easier, as there is less to do under the car, and the car has not got to be lifted to a height to clear the transmission as it comes out (if there is no pit for working under the car). The removal with the engine is described in Chapter 1.

2 If it is necessary to remove the transmission with the engine still in place, proceed as follows.

3 Place the car over the pit, or jack it up well clear of the ground, and mount it very securely, with the wheels clear, so that they can be turned over.

4 Drain the oil from the transmission.

5 Remove the three bolts securing each drive shaft sleeve to the hubs. Reach inside the joint and remove the small spring between the hub and the drive shaft.

6 Disconnect the starter motor, and all controls on the transmission and the speedometer cable, as described in Chapter 1.5.

7 Remove the starter motor.

8 Support the engine by a jack, putting wooden blocks between the jack head and the sump. Undo the ring of bolts securing the flywheel housing to the crankcase. Put a second jack under the transmission.

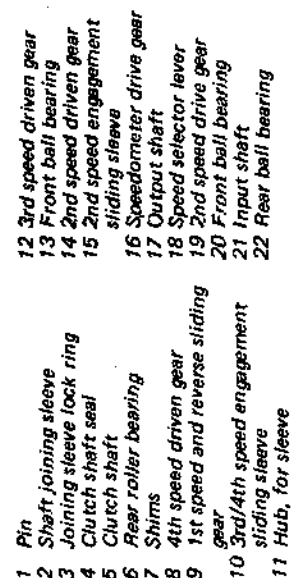
9 Undo the two bolts holding the front crossmember and transmission mounting to the car body.

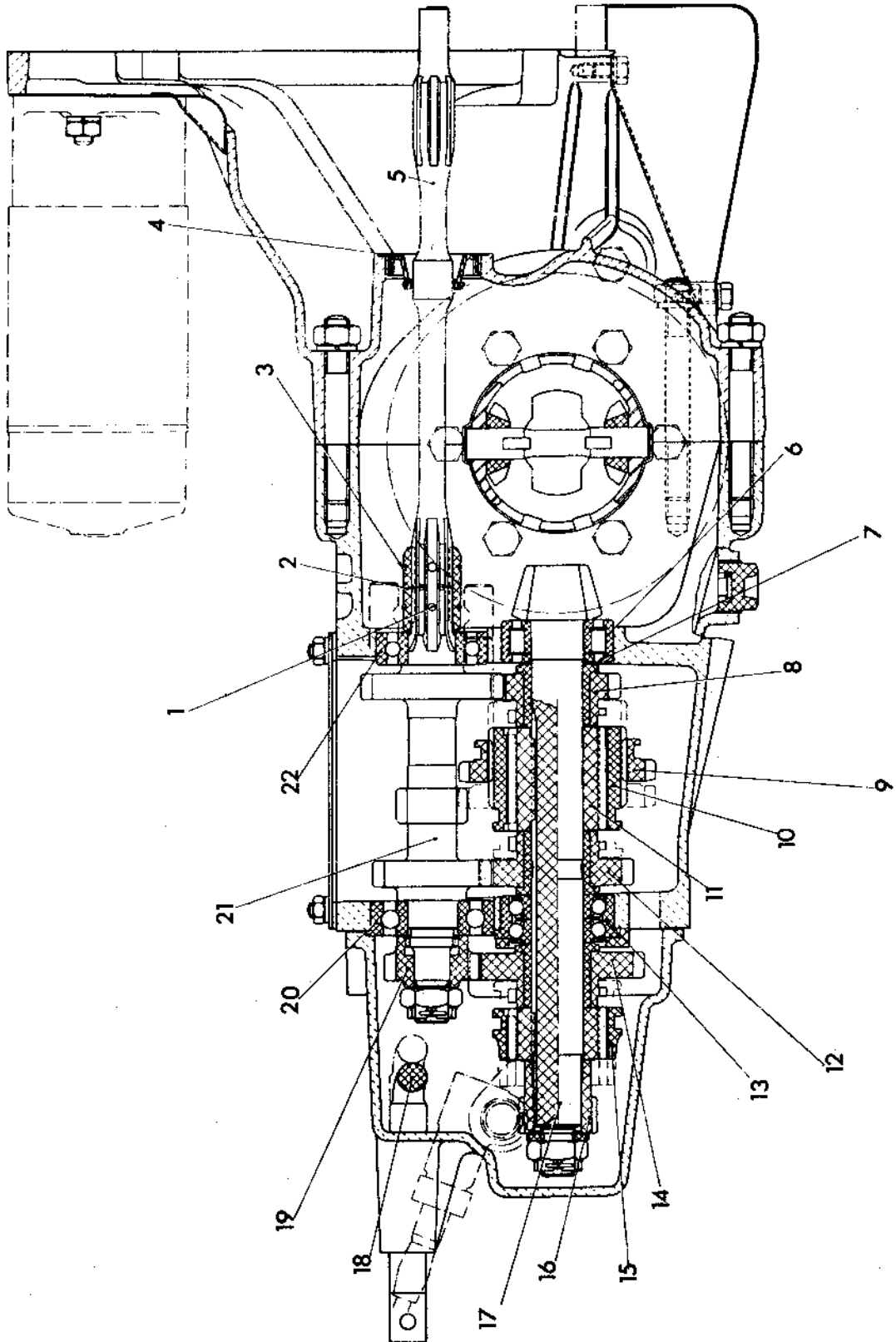
10 Lower the jacks very slightly, and then slide the transmission forward so the shaft comes out of the clutch driven plate. Then lower the transmission clear of the car. In doing this there might be some trouble in getting the drive shafts clear of the axle. If you are working alone these might need wedging clear of the suspension arms whilst the transmission is manoeuvred out.

11 Clean the exterior of the transmission.

12 Remove the transmission mounting support bracket and rubber mountings from the casing.

Fig. 6.1. The transmission showing the gearbox and final drive parts





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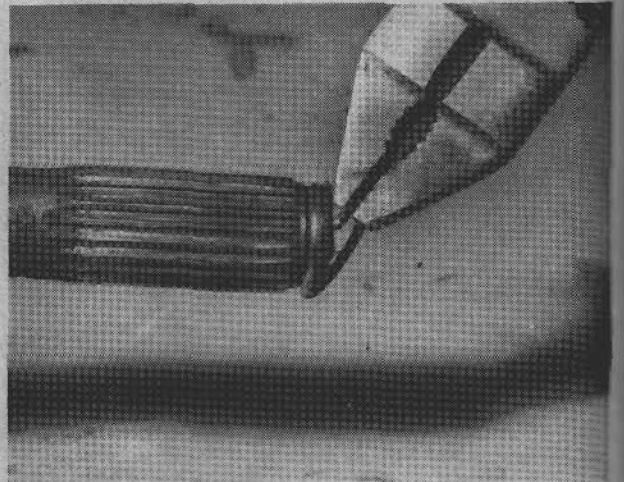


3 Removal of drive shafts and differential

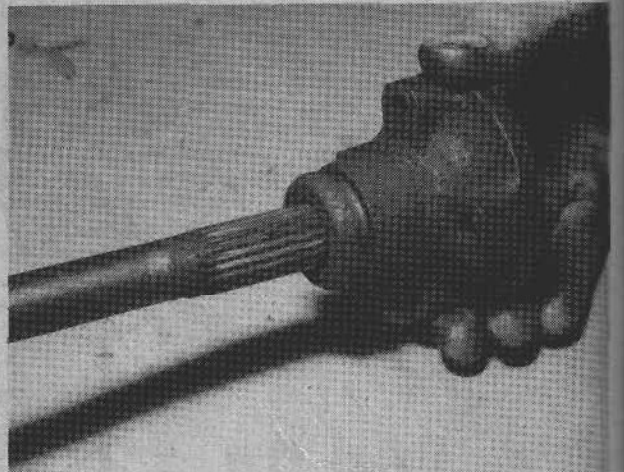
- 1 To remove these the transmission must be removed from the car and the differential dismantled.
- 2 Remove the driving sleeves from the outer ends of the drive shaft. To do this prise back the rubber dirt excluder, and push that to the middle of the shaft. Clean any dirt that might have got under the excluder onto the splines, and then push the drive sleeve along the shaft so that the circlip at the end is exposed. Remove the circlip, and then slide the sleeve off, with its dirt excluder, (photos).
- 3 Remove the four bolts holding the ring on the rubber oil retaining boots where the driveshafts fit into the transmission casing, (photo).
- 4 Take off the boots noting that inside is a locking tab that holds the adjustment for the output bearing race, (photo).
- 5 Undo the four nuts holding the star shaped outer race housing for the output bearing to the transmission casing, and take off the race housing, (photo).
- 6 Repeat for the other side.
- 7 Mark the position in which the race housings were fitted on the studs, so that they are replaced in the same way.
- 8 Note that in the housing is the castellated ring that sets the bearing preload for the differential. This adjusts the meshing and preload of the differential, and it is important that it is not disturbed. Mark the position of the castellated ring in the bearing housing with paint if it appears free to move.
- 9 As the star shaped bearing housings have been removed, the differential section of the housing can now be split.
- 10 Remove the nuts from the studs in the flywheel housing either side of the clutch withdrawal mechanism, which hold the two halves of the differential section of the transmission casing together, (photo).
- 11 Remove the flywheel housing from the rest of the transmission casing, (photo).
- 12 Holding the two drive shafts lift the differential clear of the casing, (photo).
- 13 Now strip the differential as described in section 4 following, when at last the drive shafts will be free.

4 Stripping the differential

- 1 In order to remove the drive shafts from the differential, the latter must be dismantled.
- 2 Undo the bolts holding the crownwheel to the differential case. Hold the differential whilst this is being done either in a vice with soft jaws, or by passing a bar through the hole in the casing.
- 3 The crownwheel is now free from the casing, and the two halves of the differential casing can be split. Mark every item as you take it apart so that you can refit it in the same position as it was before. The two halves of the differential casing are likely to be a tight fit and will require careful prising apart to keep them straight as they are withdrawn, (photo).
- 4 The drive shaft with the driving cross heads of the slip joint can now be taken apart, (photo).
- 5 Note the bronze thrust ring that takes the outward thrust of the differential bevel side gears against the end of the casing. These are of varying thickness to give correct meshing of the bevel gears, (photo).
- 6 The right hand bevel side gear and drive shaft cannot come out until the two idler pinions on their shaft are removed. To release these bend back the lugs holding the shaft retaining cup to the differential casing, and prise it off carefully, so that it can be reused.
- 7 Leave the roller bearings in place on each half of the differential casing, and their outer races in the housings unless they are to be renewed.



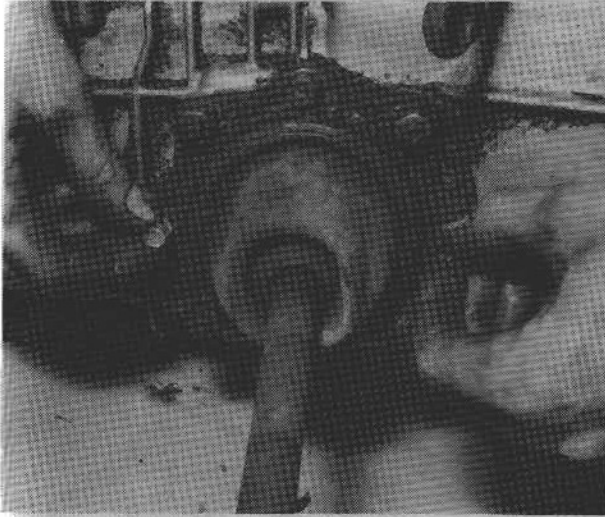
3.2a. Take off the circlip,



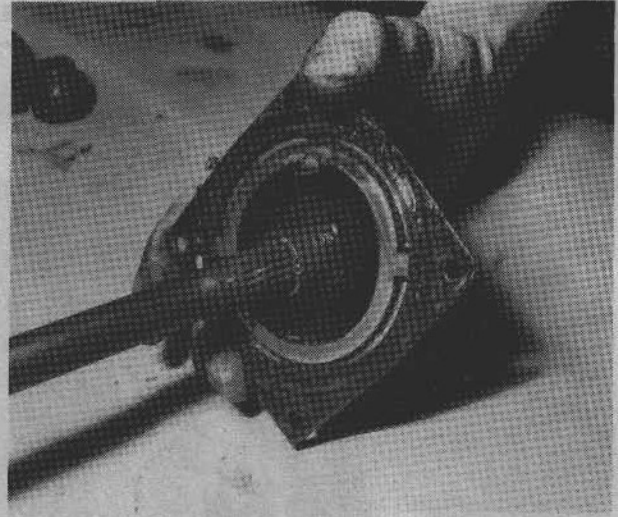
3.2b. the coupling sleeve,



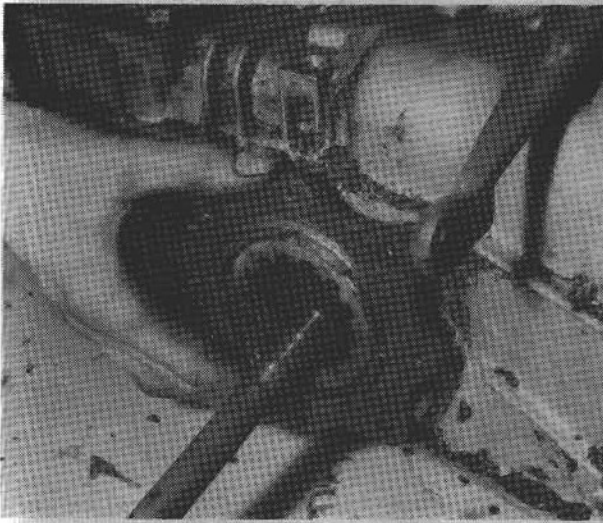
3.2c. and the dirt excluder from the outer ends of the driveshafts



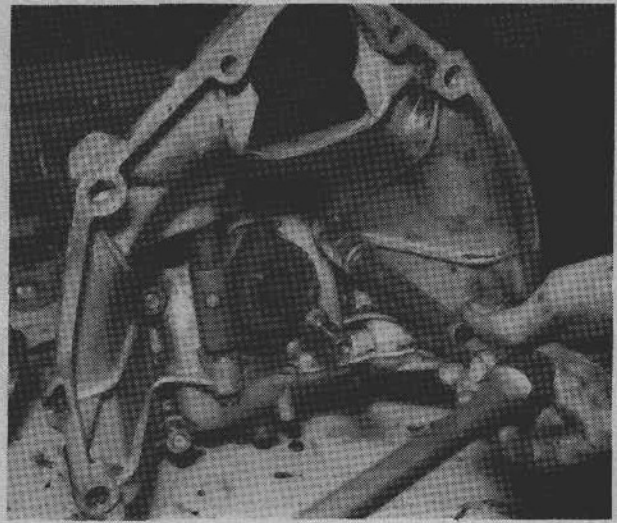
3.3. Take off the bolts for the oil-boot retainer,



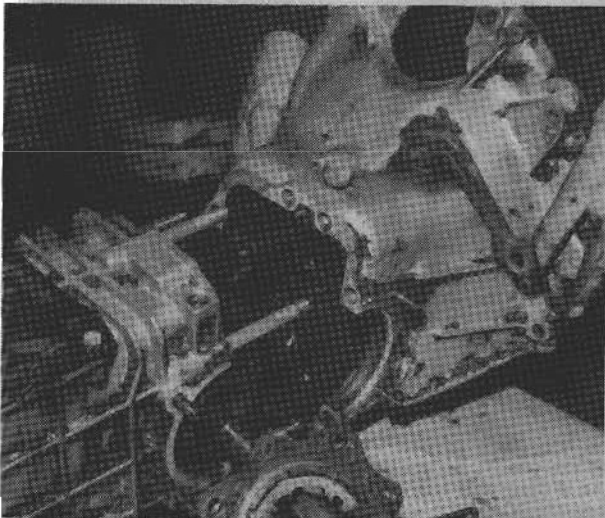
3.4. which also holds the locking-tab ring



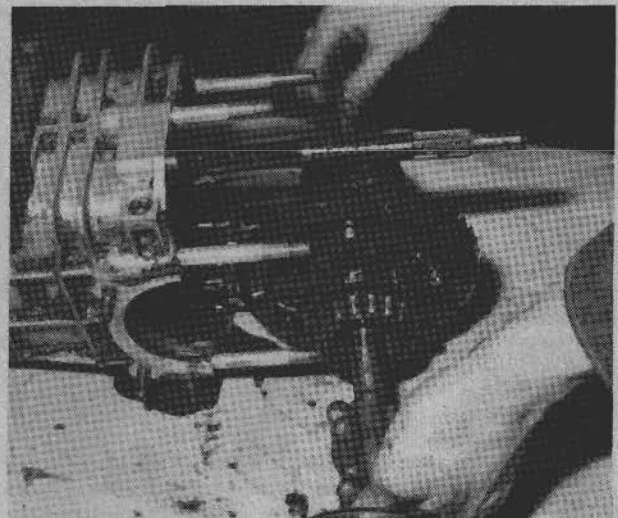
3.5. Carefully prise off the bearing housing



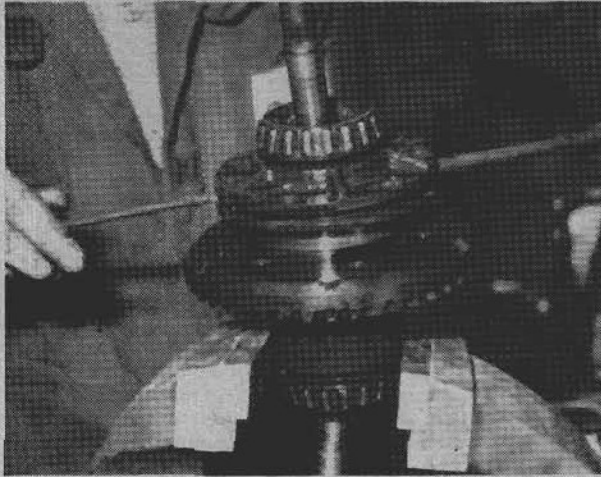
3.10. Remove the six nuts and washers,



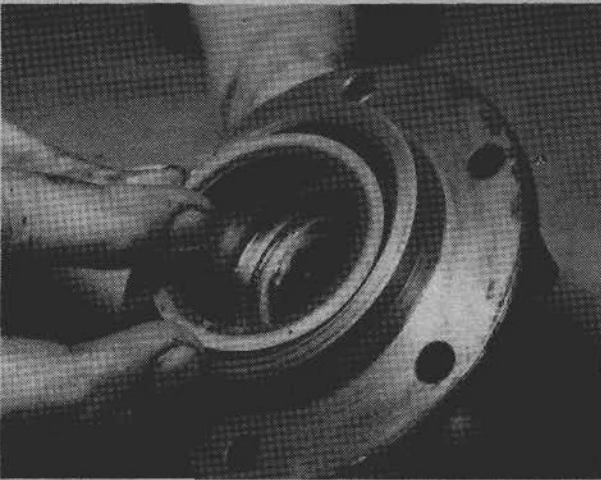
3.11. and pull the flywheel housing off the gearbox



3.12. Lift out the differential by the drive shafts



4.3. Undo the bolts, then prise the differential apart



4.5. The thrust rings in the differential case for the side gears also adjust end-float

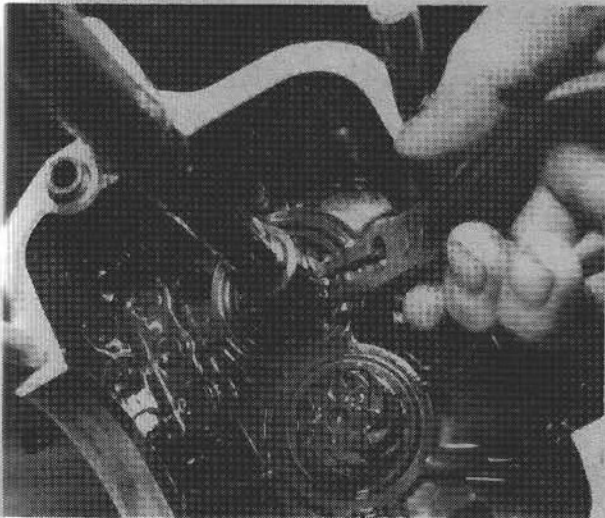
5 Stripping the gearbox

- 1 The front half of the casing with the differential having been removed as described in the previous section, proceed as follows:
- 2 Pinch together the ears of the circlip on the sleeve locking the clutch shaft onto the gearbox input shaft. Slide the circlip out of its groove and let it rest on the sleeve. Now push out the pin that is through the sleeve and through the input shaft. (This is the furthest of the two pins). Pull the clutch shaft and sleeve off the gearbox input shaft, (photo).
- 3 Remove the four set screws holding the gearbox top cover, and take off this cover from the gearbox, (photo).
- 4 Turn the gearbox on end.
- 5 Remove the nut from the stud holding the speedometer drive, and withdraw the drive, (photo).
- 6 Undo all the nuts holding the gearbox selector rod end cover to the main casing.
- 7 Pull the end cover upwards.
- 8 Lift the end casing off, sliding it along the gear selector rod. If there is difficulty in getting the selector rod to move down into the housing, it may be necessary to file off any burrs on the end of the selector rod shaft. If it gets stuck it is possible to lift off the end cover with the selector rod still in place, unhooking it from the gear shift rods, (photo).

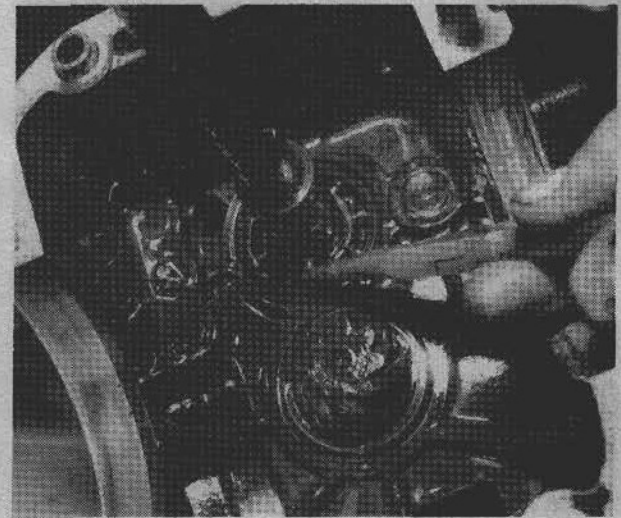


4.4. The cross-heads on the drive shaft are now free to slide out of the bevel side gear. The grooves in the working surface assist lubrication

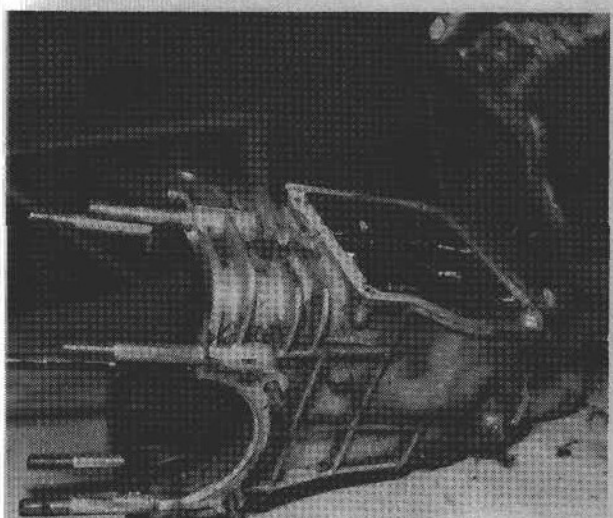
- 9 Remove the two nuts holding the cover for the springs for the gear selector detents.
- 10 Remove the three springs from their holes. Tip up the gearbox so that the three detent balls roll out of their passages, (photos).
- 11 Remove the bolt holding the reverse selector fork to its rod, slide the rod out of the gearbox casing, and lift out the fork, (photo).
- 12 In the same way remove the bolt holding the 3rd/4th gear selector fork. Pull the rod out a bit, and get from the gearbox casing one interlock ball and one thin plunger from between the housings for the far end of the gear selector rods. Take out that selector rod and its fork, (photos).
- 13 From the outside of the casing remove the bolt locking the reverse gear shaft, and then from the differential end of the casing push the shaft out towards the selector-end. Lift out the reverse gear pinion, (photos).
- 14 Slide two gears into mesh at the same time, so that the gearbox is locked.
- 15 Remove the split pin from the end of the output shaft, and undo the nut. Do the same for the input shaft, (photos).
- 16 From the lower, the output shaft, remove the washer and then holding a hand underneath it, to catch the ball that is its locating member instead of a key, slide the speedometer drive pinion off the output shaft, (photo).
- 17 Take the second gear pinion off the end of the input shaft.
- 18 Undo the bolt holding the first gear selector fork to the lowest gear engaging rod. Slide out the rod, pulling it by the second gear fork at the end, and bringing off the end of the output shaft the second gear engaging sleeve which is within the arms of the fork. Look for and catch the last ball from the interlock mechanism in the differential-end housing for the rod, (photos).
- 19 Take off the output shaft the remaining parts: The hub for the engaging sleeve, the second gear wheel and its bush. (photo)
- 20 Undo the two screws countersunk into the selector-end bearing housing for the output shaft. These may need tapping with a punch to start them out of the housing. Take off the bearing housing, (photo).
- 21 The selector-end bearing for the input shaft is now free. If it will come easily, just take it out: Note the flange with the flat cut on it to clear the other bearing, (photo).
- 22 Slide the input shaft towards the selector end; out of the end of the casing. It may need carefully driving out with a drift. If the selector-end bearing could not be got out before, it will be driven out now. When the shaft is free pull that selector end bearing off the end of the shaft. It does not matter if the differential-end bearing is still on the end of the input shaft, or left in the casing.



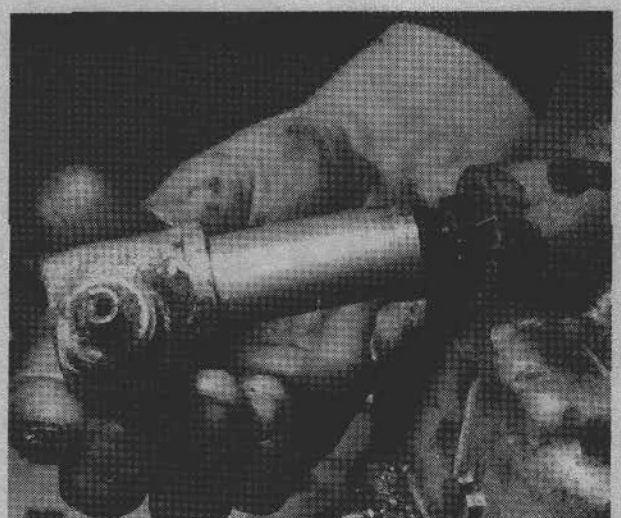
5.2a. Spring aside the far circlip,



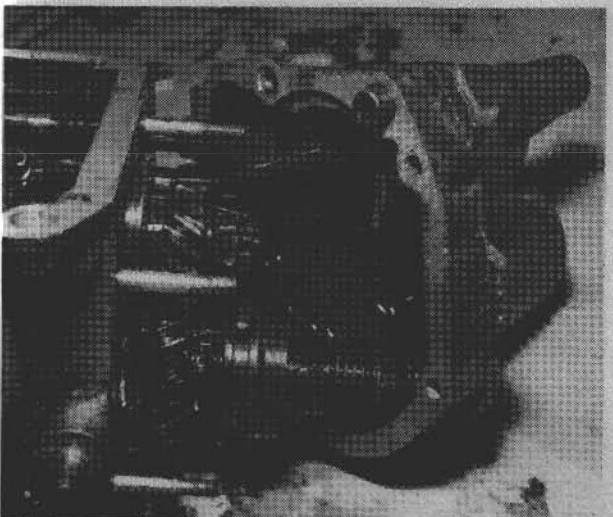
5.2b. and take out the far pin, so the clutch shaft will come off bringing the sleeve



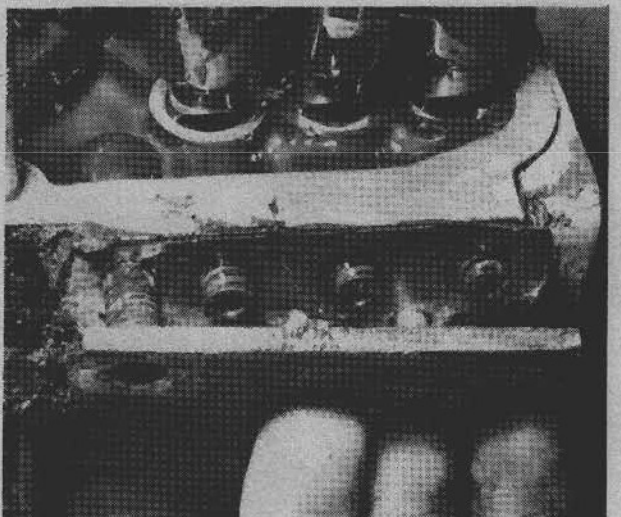
5.3. Take off the cover



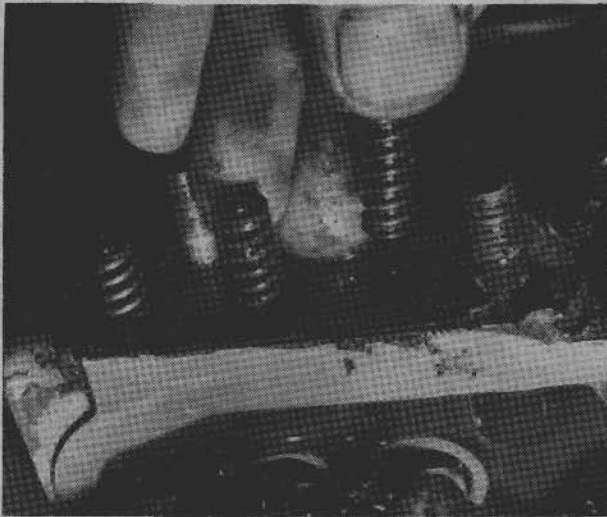
5.5. Remove the speedometer drive



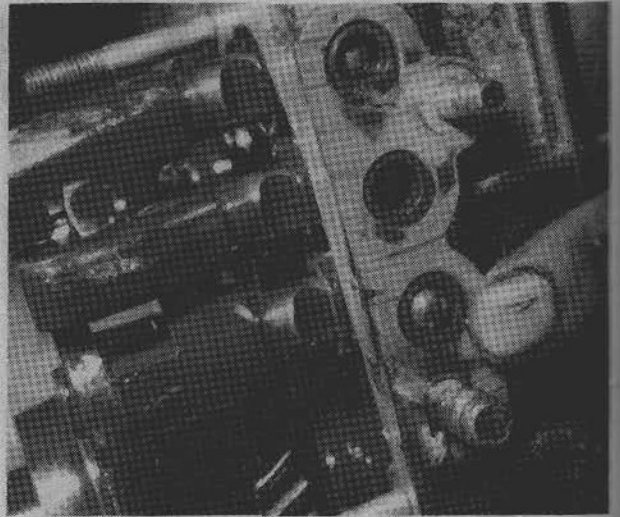
5.8. and the end cover. Our gear selector wouldn't slide out, so we unhooked it from the rod ends



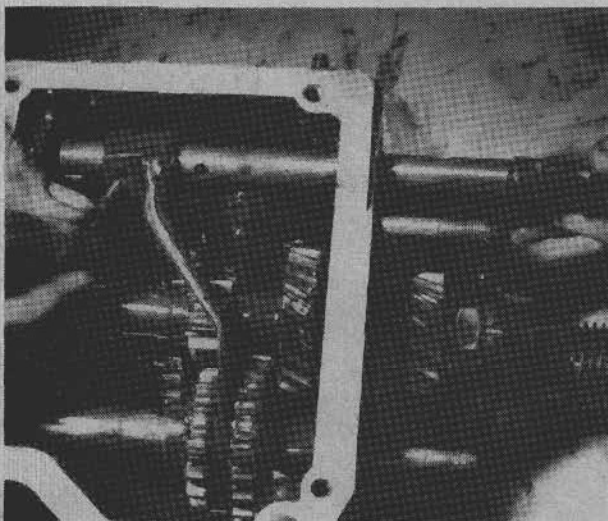
5.9. Take off the detent spring cover



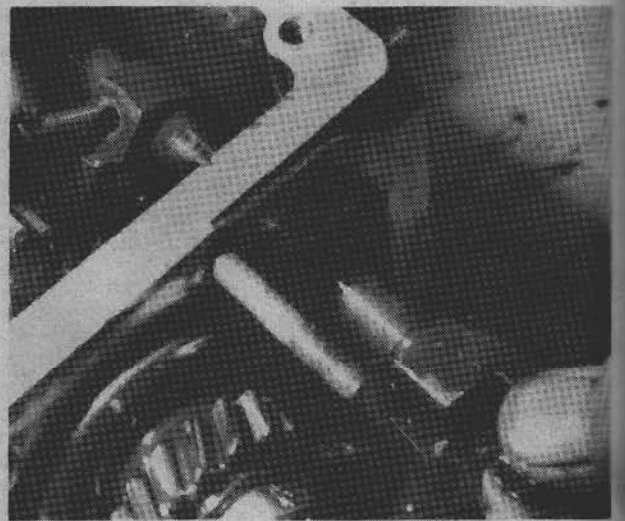
5.10a. Take out the springs



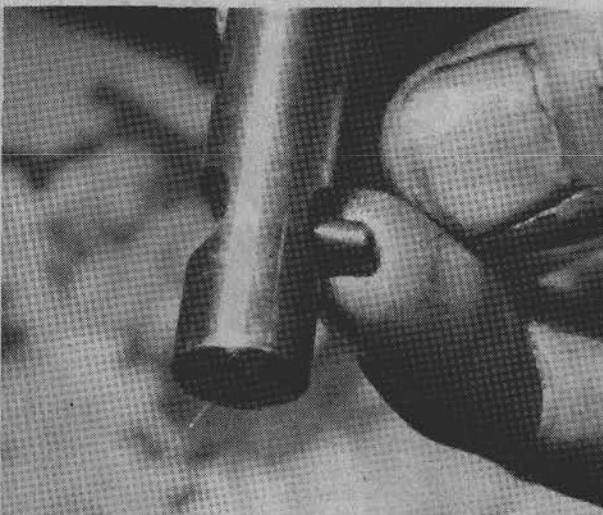
5.10b. Tip out the three balls. Remember the way the selector rods face the detents for reassembly



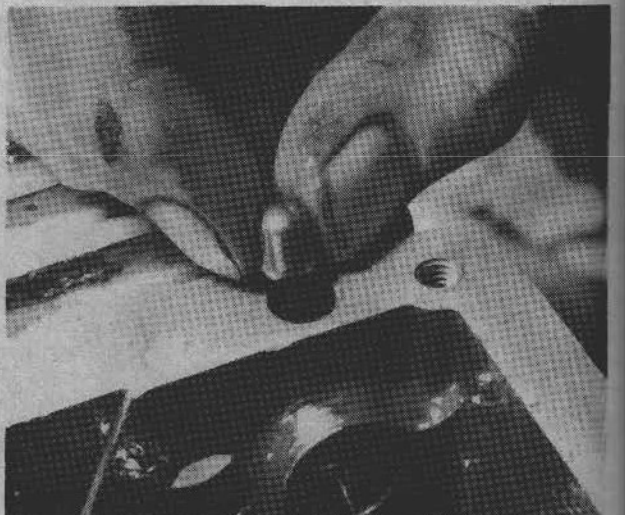
5.11. Unbolt the reverse fork and pull out the rod



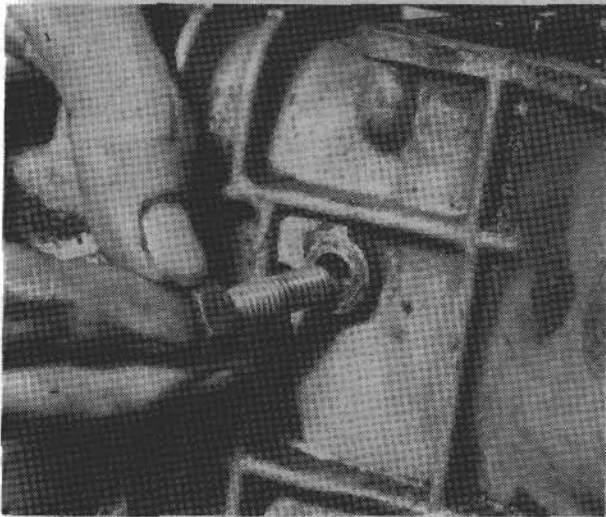
5.12a. With the next rod,



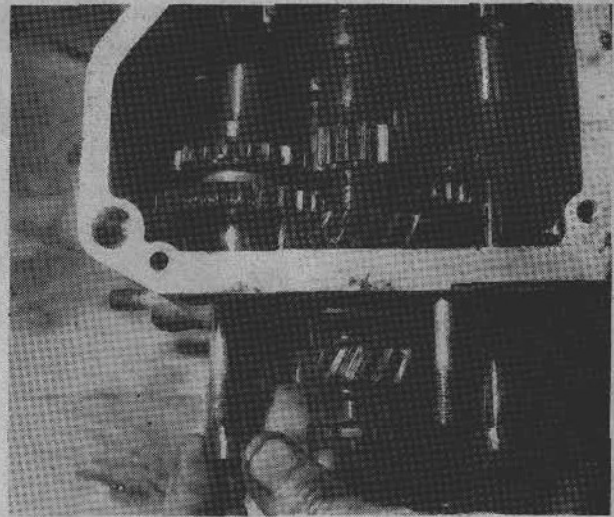
5.12b. comes the interlock plunger,



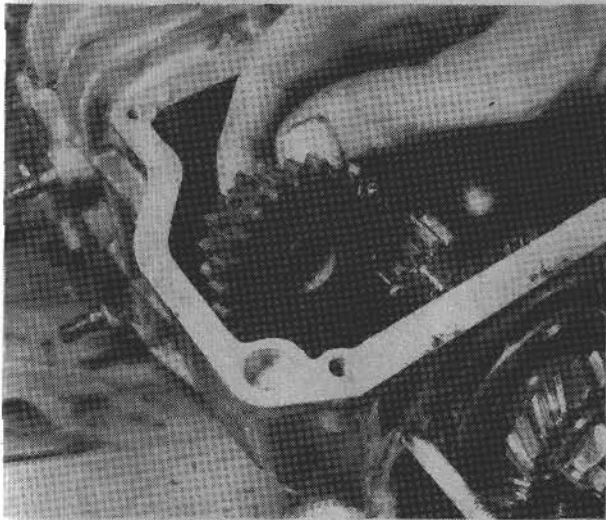
5.12c. and the first of the two elongated balls



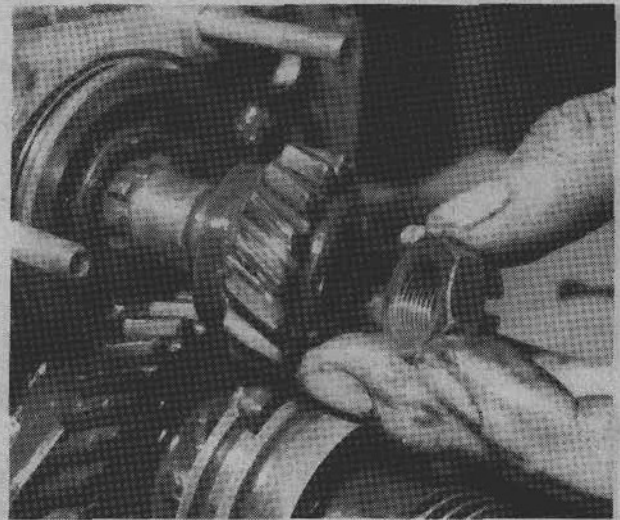
5.13a. The reverse shaft lock-bolt comes out of the casing side



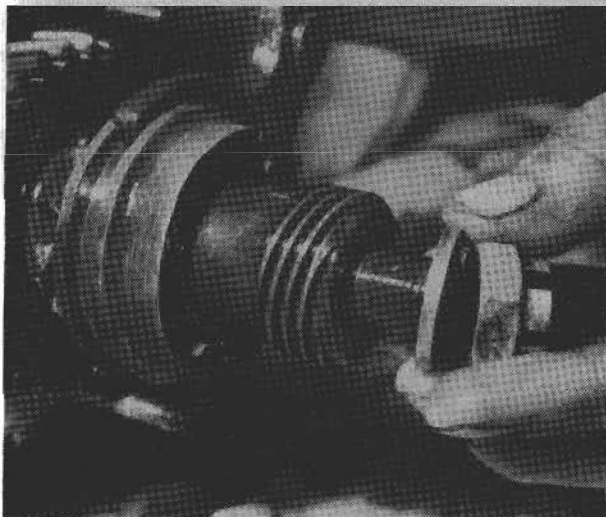
5.13b. Then the shaft can be driven out. It will NOT go the other way



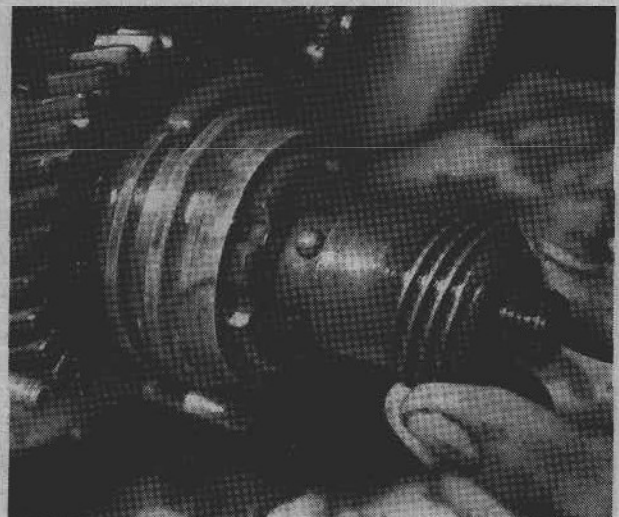
5.13c. The reverse gear is free



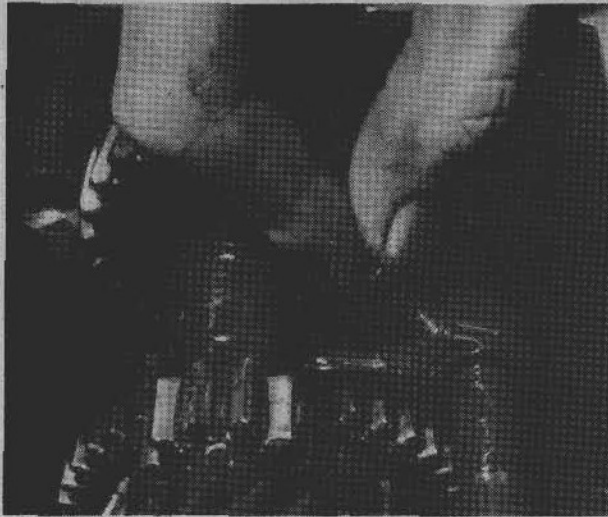
5.15a. The nut, without washer, and the 2nd gear pinnion on the input shaft



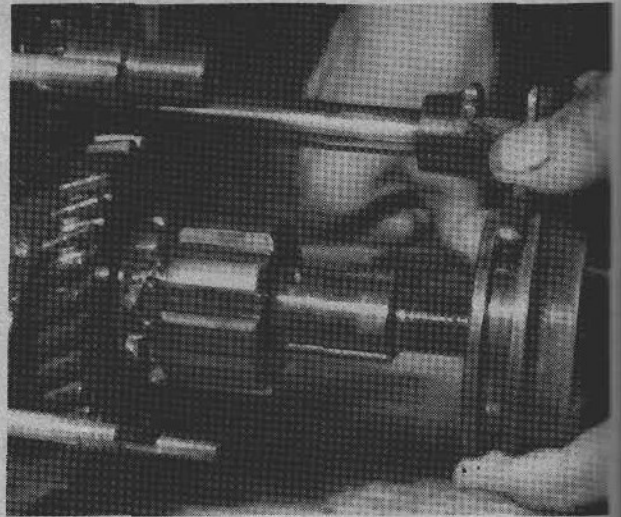
5.15b. The nut and washer on the output shaft



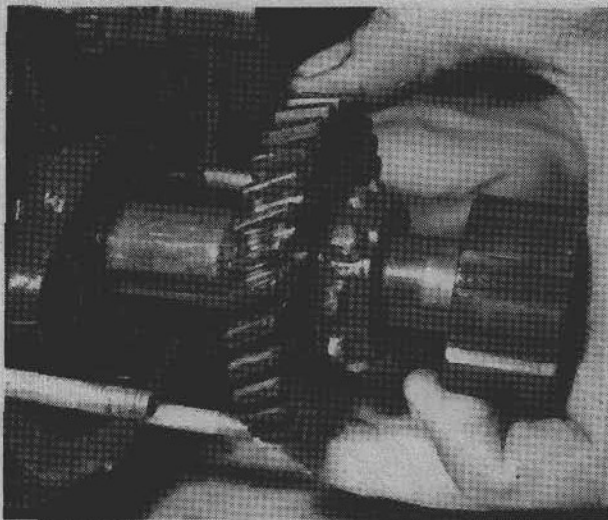
5.16. Don't loose the ball for the speedometer drive



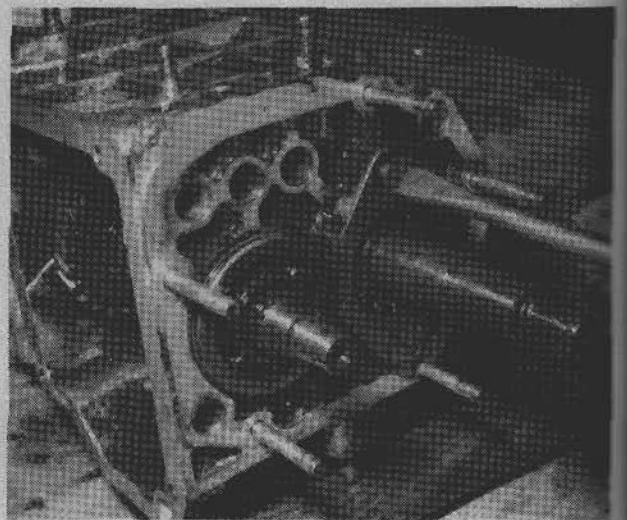
5.18a. Unbolt the 1st gear fork



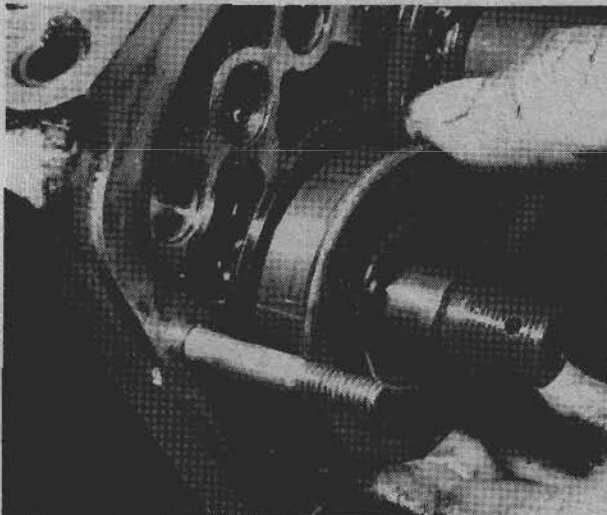
5.18b. The rod brings off the 2nd gear fork: there will also be the last interlock ball at the other end



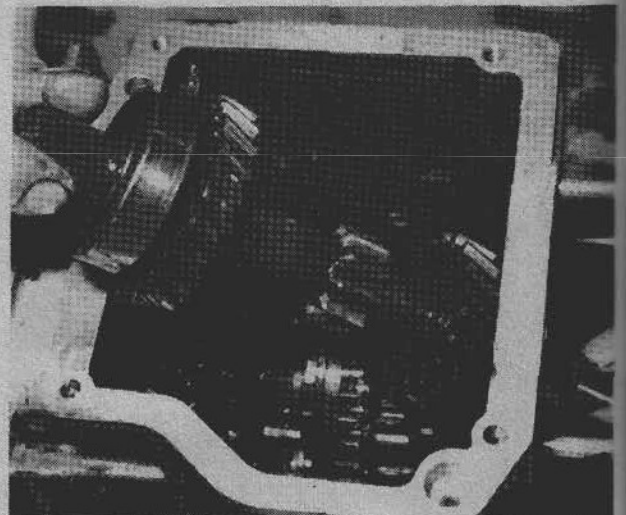
5.19. The gear-engaging dog-cluster hub and the 2nd gear wheel



5.20. Take off the output shaft bearing housing



5.21. Then the input shaft bearing: If it is stiff drive it out with the shaft from the other end



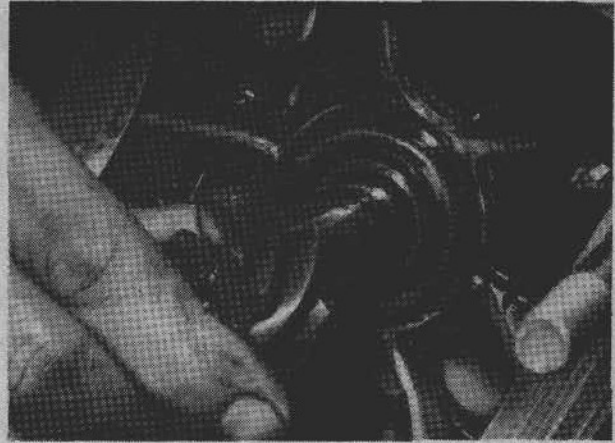
5.23. The input shaft being threaded out with the differential-end bearing on it

23 Lift the input shaft out of the casing. If the bearing is on its differential-end, it can just be threaded out through an area in the opening where the side has been machined to allow this. Leave the bearing where it is for now. It need only be moved to replace it if it is worn out, (photo).

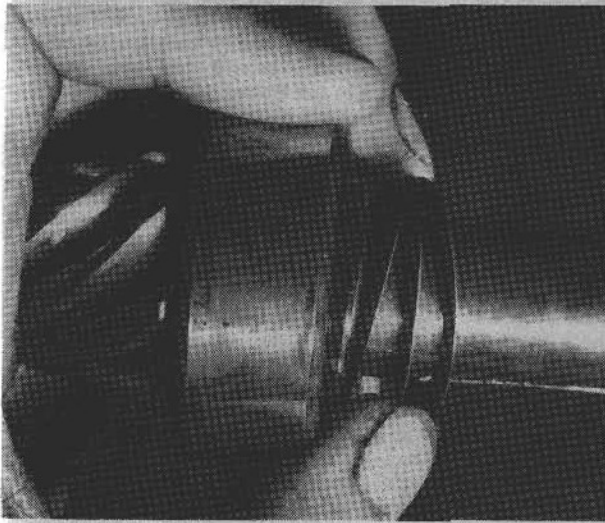
24 Now take out the output shaft. Pull it slowly by the pinion out of the differential-end of the casing. As it moves each gear-wheel and engaging sleeve is going to drop off the shaft. And last there will be the shims next to the bearing. Take all these parts out and lay them out in order and the same way round so that they will not get muddled. The shims are very important. The differential-end bearing should come out on the shaft. (photos)

25 Take out of the selector-end of the casing the other bearing. But if it proves stubborn leave it there lest it be damaged, and it need only come out if to be replaced, (photo).

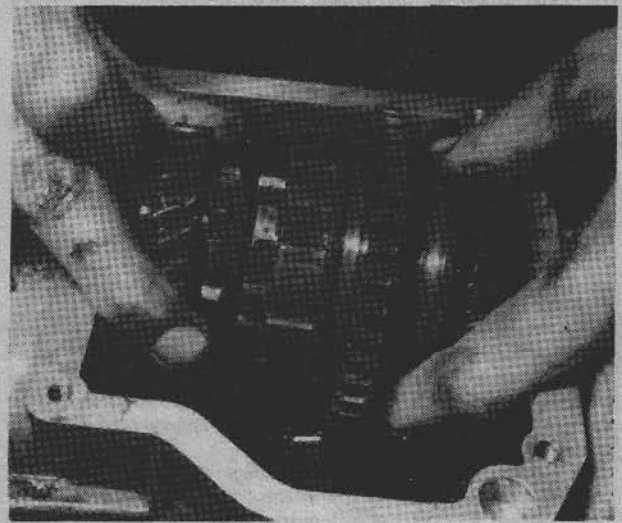
26 If the parts cannot be left out in neat order due to lack of space it is suggested they are all put back on the shafts to store them in correct order and the right way round, (photo).



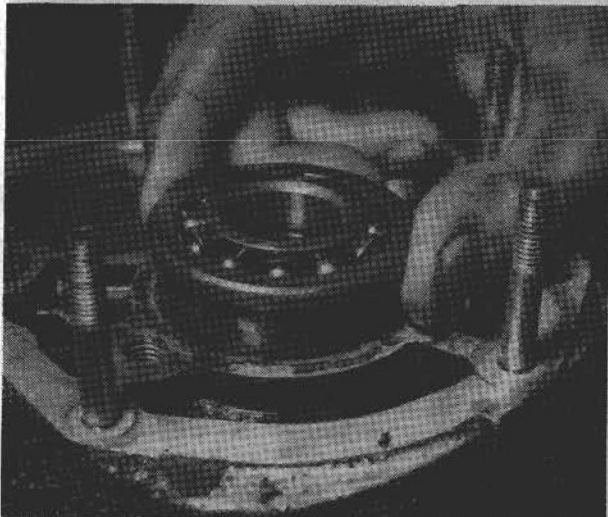
5.24a. Draw out the output shaft



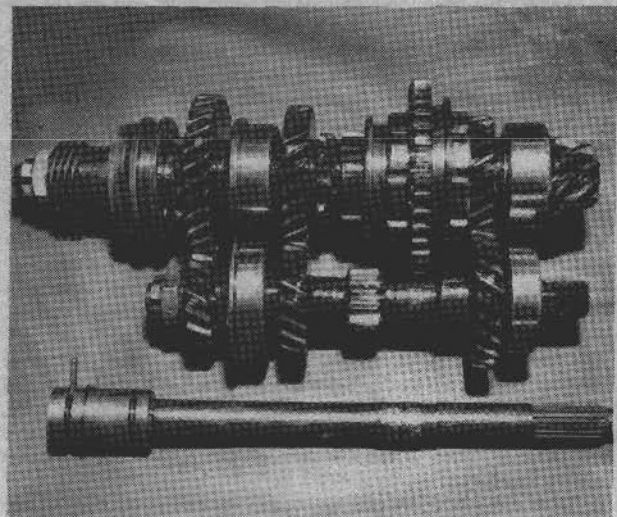
5.24b. with bearing and shims still on it. Or else they will be in the box with the gears



5.24c. The other parts come off inside the casing and can be lifted out



5.25. The selector-end bearing of the output shaft locates the pinion in relation to the crown wheel



5.26. This is what came off the two shafts. It goes back in the reverse sequence

6 Renovation of the gearbox

- 1 Clean all parts, examining them for signs of damage; scuffing, scoring, cracks or chips out of gear teeth. Check all ball and roller bearings for smooth rotation, and any visible defects: These last must be very carefully washed quite clean in clean paraffin.
- 2 Put each gear wheel on its own hub and check the pair for wear. Check the ball and roller bearings' free play against the specifications, by judging it, by "feel". If your dealer is co-operative, compare them with new ones.
- 3 Temporarily reassemble the components that go on the input and output shafts into the gearbox, and check the gear pairs for excessive backlash.
- 4 If the double ball bearing at the selector end of the output shaft is replaced this is going to upset the position of the pinion in relation to the crown wheel, as it is this bearing that takes the end thrust. See Section 8.
- 5 Also if the bushes supporting either 3rd or 4th gear wheels on the output shaft are changed there is the same risk. In this case compare the lengths of the old and new bushes by standing them on end on a flat surface, such as a sheet of glass, and putting a steel ruler across the top so that the difference can be measured with feeler gauges. It can be reckoned that each bush will shrink about $\frac{1}{2}$ a thousandth of an inch (.0005 in) when first fitted. So they can afford to be a little larger. If there is greater variation alter the shims at the pinion accordingly.
- 6 Pay particular attention to the 4th gear wheels as these are used for such a longer distance than the others.
- 7 You will need new gaskets for the cover, end part of the casing, speedometer drive, and plate retaining the gear detent springs and balls. You will need new oil seals for the input shaft from the clutch, and new boots and dirt excluders for both ends of the drive shafts.

7 Renovation of the final drive

- 1 Your diagnosis from the noises made when the car was in use should have led you to suspect what major components in the final drive seemed at fault. In particular a loud whine might demand the crown wheel and pinion be changed even though they look all nice and smooth.
- 2 Examine all parts for signs of damage: Scoring, cracks etc. In particular look at the races and the rollers for the taper roller bearings that support the differential in the casing. These should be smooth and shiny. There is a strong possibility they will appear pitted, almost as if rusting has taken place. If so they will need replacing. They can be a loud source of noise.
- 3 If there has been loud whining for some time, and the car has done a high mileage, then the crown wheel and pinion will need replacement. But if the mileage is low, and the onset of whine recent, then it could be possible to silence it by resetting the meshing. The two have to be replaced as a pair.
- 4 If the crown wheel and pinion are not being replaced it is vital that the adjuster rings in the star shaped bearing houses are not disturbed, or the meshing adjustment and bearing preload will be changed.
- 5 Measure the thickness of the bronze thrust rings in the differential casing for the bevel side gears. If these are worn more than 0.001 inch replace them. Do so with the oversize ones.
- 6 Check the clearance of the crossheads on the drive shafts in the bevel gears. If slightly excessive new crossheads may suffice. Otherwise the gears must be replaced too.
- 7 Check the slop of the sleeve on the hub end of the drive shaft. If it is an old car, and the splines have got rusty new shafts may be needed. These will give new splines at the outer ends, and also new pivots at the inner end for the crossheads. All this will remove snatch in the transmission due to all the lost motion adding together.
- 8 New dirt excluders will be needed for the outer ends of the drive shafts. New oil retaining boots will be necessary at the inner ends, and a new oil seal for the clutch input shaft through the flywheel housing.

8 Meshing the crown wheel and pinion

- 1 If a new crown wheel and pinion have been fitted their meshing will need setting. The same should be done if the position of the existing pinion has been altered by new gearbox parts that affect this.
- 2 If the meshing is altered care must be taken not to change the bearing preload. If the differential taper roller bearings are replaced the preload must be reset.
- 3 FIAT do the meshing using dummy shafts and a special gauge. If possible get a dealer to do the setting for you. Assuming this is not possible, it can be done, with difficulty and risk of ending up inaccurately set, by the method that follows.
- 4 On the end of the gearbox output shaft, which is also the pinion, will be found two figures. One is a mating code for the crown wheel. The other will have a + or - sign before it. This figure is, for that particular pinion, the variation it must have for correct meshing from the nominal 75 mm distance from differential centre line to shoulder at the back of the pinion.
- 5 If you are only replacing the crown wheel and pinion, then the new pinion can be positioned by changing the thickness of the shims behind the bearing next to the pinion the same amount as the difference between the two figures stamped on the old and new pinions. Then all that need be done is to move the crown wheel across to get the correct backlash, whilst not upsetting the bearing preload. This will then have properly positioned the new pinion, as the altered thickness of shims will have accounted for the variation in the pinions. It can be done on the basis that the remaining parts in the gearbox will have maintained their position.
- 6 If some of the parts that govern the position of the pinion have been changed then it ought to be repositioned by reference to the centre line of the differential. Without either FIAT's special gauges, or a surface table and proper measuring instruments this cannot be done by measurement. It could be done from first principles using blue marking dye and shifting the two mating gears about till the correct tooth contact is obtained. This needs a lot of practice and is outside the scope of this book to teach. Therefore, in default of the gauges it is recommended that the new pinion/output shaft is fitted, with the shims corrected as already described for both the different number on the pinion, and for any variation in the 3rd or 4th gear bushes' length. It must be assumed that if a new bearing has been fitted, it is the same dimensions as the old.
- 7 Assemble the gearbox as described in section 9. But at this stage only do the output shaft, just in case it has to come apart again: Leave out the input shaft, but fit the output shaft bearing housing, and tighten the two countersunk screws. Fit the second gear wheel bush, the hub for its sleeve, and the speedometer drive gear, not bothering for now with its locating ball, or the second gear wheel, as these will have to come off again when the time comes to fit the input shaft. Fit the washer and nut on the end of the shaft.
- 8 Assemble the differential. This might as well be done now in full, putting in the drive shafts. See section 10.
- 9 Put the differential in position in the casing, with the taper roller bearings, and bolt on the flywheel cover part of the casing, and fit the nuts and tighten these to the correct torque.
- 10 Fit the star shaped bearing housings to each side of the differential. If new bearings have been fitted leave the adjusters so that the bearings are slack whilst the housings are tightened. If the old bearings are still being used leave the adjusters, but as they are tightened check that the crown wheel is not being forced down on the pinion, and that there is some backlash between them. If there is no backlash due to differences between the old crown wheel and the new then the bearings must be temporarily shifted to allow their fitting. Screw both serrated rings in the same direction the same number of serrations, so that the same preload is kept on the bearings. As the bearing housings are tightened into place turn the differential over so that its bearings may roll into place.
- 11 Once all is tightened the sideways position of the crown

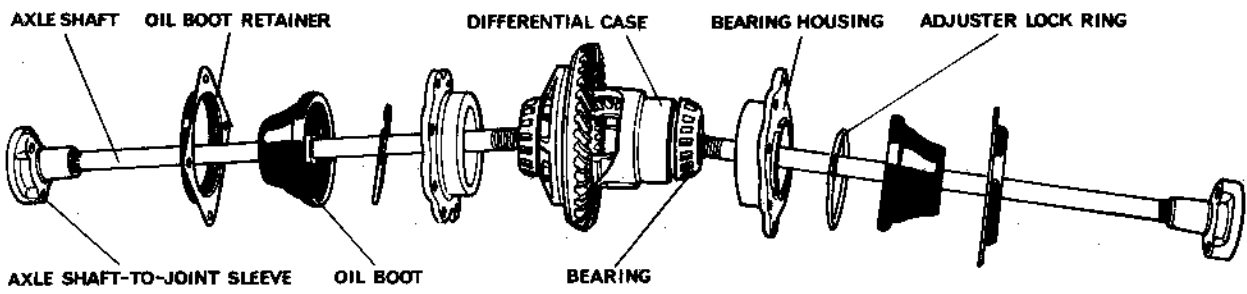


Fig. 6.2. The differential and drive-shaft parts

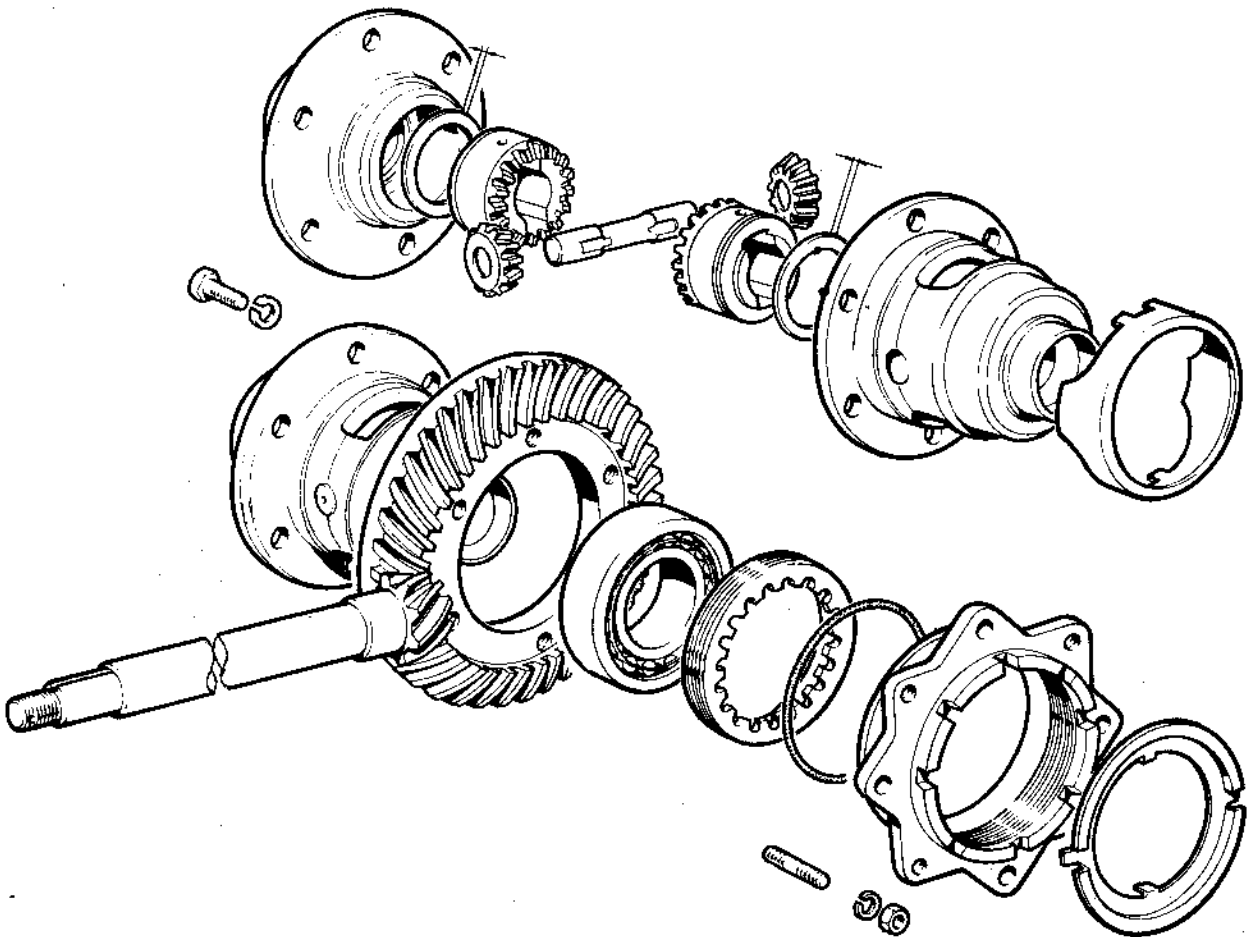


Fig. 6.3. Differential components analysed further

wheel must be adjusted to get the backlash correct. This is difficult to judge as there is access only through the hole for the clutch shaft to the input, admittedly still without the oil seal at this stage.

12 If new bearings have been fitted, or the adjustment for the old ones disturbed, the preload of the bearings must be set.

13 Rotate the differential, by putting the drive sleeves on the splines at the drive shaft ends. Check that there is some backlash between the gears. Continue to turn over the shaft, so that the rollers in the bearings can roll up their races into position, tighten the right sides adjustment serrated ring; this is the one that pushes the crown wheel away from the pinion. Tighten, turning the drive shaft all the time to feel for resistance to the bearings getting tight.

When this happens tighten the adjuster ring firmly to make sure the outer races of the bearings are nicely seated against the adjusters. Slacken the adjuster ring again gradually to find where the preload comes off, and the gears are turned more easily. Bring in the adjuster again only this time to give the correct preload.

14 Fortunately the preload is such as to give a resistance to rotating the differential in its bearing of 1 lb. ft. Make a little "balance" on the driving sleeve at the end of the shaft. Support the shaft so that it sticks out straight. Tie or bolt a stick or metal strip about 3 ft long across the drive sleeve. Half of it must stick out either side. Hang something weighing 1 lb on the cross bar a distance 1 ft from the centre. The bearings should be adjusted so

that if they are one serration looser the weight is enough to rotate the differential.

15 Now adjust the backlash between crown wheel and pinion teeth. Slacken the right serrated bearing adjuster and tighten the left an equal amount to move the crown wheel closer to the pinion. The remaining backlash can be most easily felt at the pinion, by turning the end of the gearbox input shaft. It is easily moved but the crown wheel not, because of the bearing preload. Bring the crown wheel right in until all backlash disappears.

16 Now back the crownwheel away again, continuing to move both bearing adjusters an equal amount. Try the size of the backlash after moving each serration.

17 To help judge the backlash, set one of the tappets on the engine to the backlash; 0.004 in compared with the tappet setting of 0.006 in. Compare the feel of these clearances. Try a tighter one.

18 Now get the backlash to this. It is better to be say 0.001 too tight rather than too loose, but no more.

19 All this movement of the bearings may have upset their preload. Check this again. This also should not be on the loose side or noise will develop when under load and the casing is hot. Check that the locking plates that fit under the oil retainers will fit into their slots.

20 All should now be set. So take off again from the gearbox casing the flywheel housing. Lift out the differential, and complete the reassembly of the gearbox.

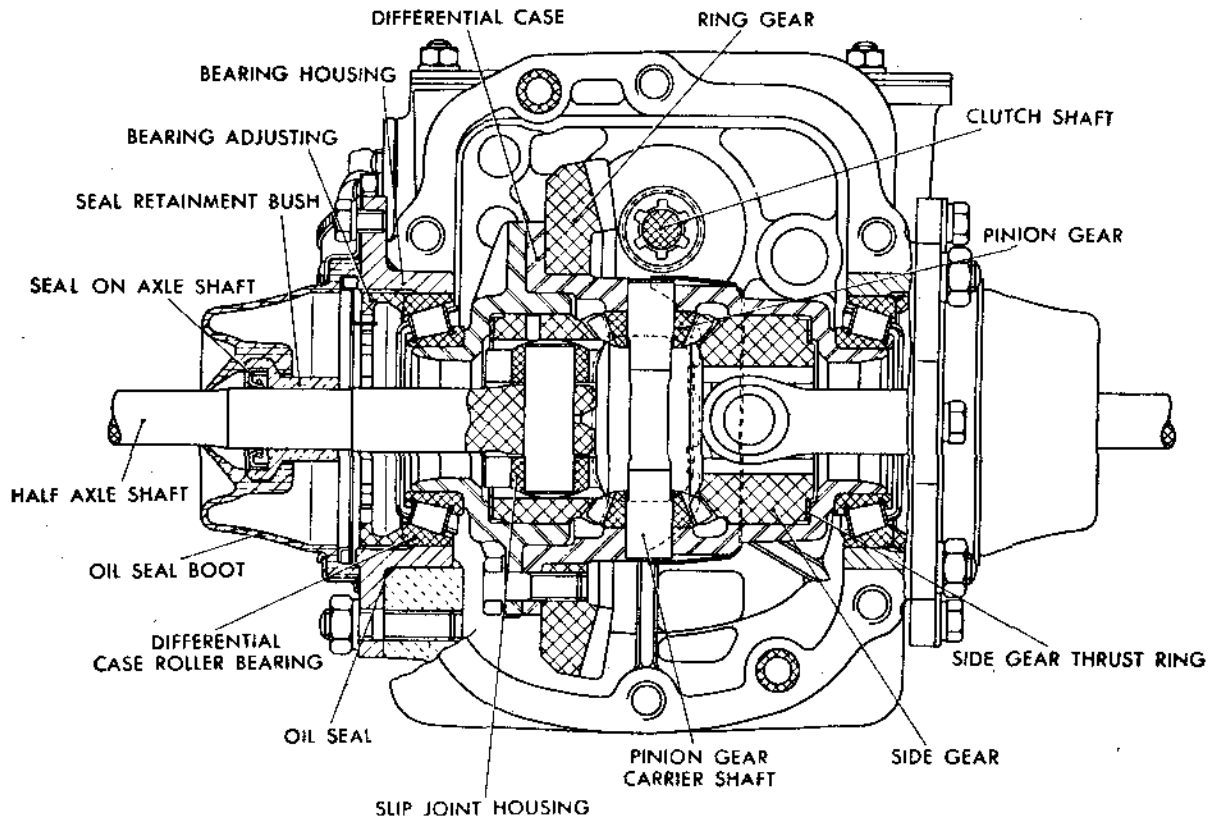


Fig. 6.4. A section through the differential looking forwards

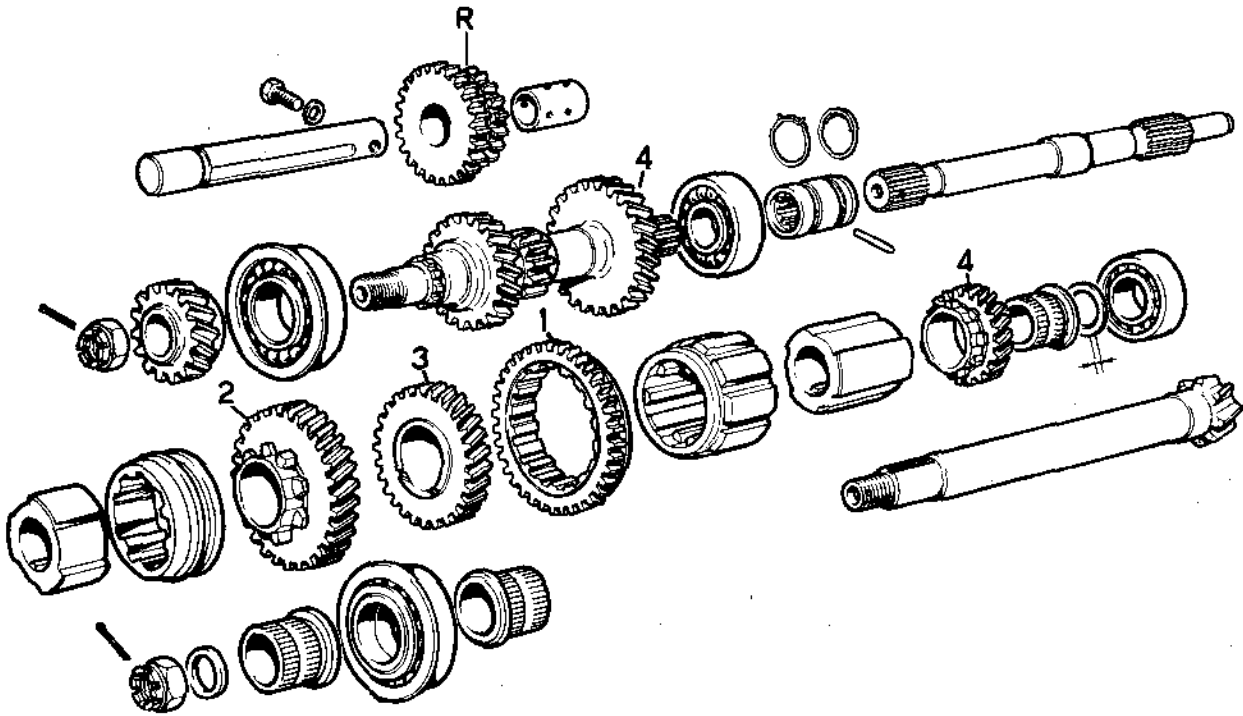


Fig. 6.5. Gear clusters and shafts with actual gear numbering

9 Reassembling the gearbox

1 Gather together all the parts. Make sure they and the casing are thoroughly clean. Have an oil can handy, filled with gearbox oil, 90EP. Assembly makes many oil drips, so put out some clean newspaper on the work surface.

2 All the parts want to be laid out in order. If they have been disturbed from the pattern in which they were laid out on stripping, have a trial assembly of everything onto the shafts, but not in the gearbox. Then you can compare everything with the pictures to check it is correct. Every part has some clue showing which way round it goes. At the worst you might have to take something out again to turn it round if it is wrong. Then lubricate all the parts.

3 Put the roller bearing on the output shaft, and slide it right the way along to the shoulder of the pinion. It may need driving along by a hammer. If so, support the inner race on something firm, such as the vice jaws opened enough not to touch the shaft, but to give good support, and cleaned, and hit the pinion.

4 Put the shims, if no parts changed the same as before, otherwise as calculated in sections 6/5 and 8/4, onto the shaft and close up to the bearing. Lubricate the shaft again.

5 Enter the threaded end of the shaft into its hole (the bottom one) in the casing from the differential end, so that it is just in far enough to start loading onto it all the bushes and gear wheels that must be fitted.

6 Fit the 4th gear bush, shouldered end first, and then the 4th gear wheel, its engaging-teeth-end last.

7 Put onto the output shaft the assembly of the first gear wheel, the 3rd/4th sliding dog-clutch sleeve, and the inner hub, engaging its keyway in the slot cut in the shaft. The groove for the 1st gear selector fork should be towards the differential end, but that on the sleeve for the 3rd/4th fork the other (selector end).

8 Last of this batch comes the 3rd gear bush, its shoulder last, with already on it the gear wheel, engaging dog-clutch teeth towards the differential.

9 All the parts that go on that output shaft within the main section of the casing should now be on the shaft.

10 Push the shaft on through the hole in the casing at the selector end, lining up the bearing by the pinion with its hole in the casing.

11 Fit the other bearing onto the shaft at the selector end, flange outermost, and slide it along the shaft to the casing. Now get both bearings entered into their holes in the casing. Once both are started, each work together to hold everything straight, so that the bearings can be pushed home.

12 Fit the ball bearing to the differential end of the input shaft, unless it stayed in the casing when stripped, and is still there. It seems easier to fit the bearing to the shaft outside, though it makes it a tight fit inserting the shaft with bearing into the casing. But if it came out on the shaft, then it will go back that way. Casings may differ.

13 Insert the input shaft into the casing, selector-end first, sliding it down so that the far end with the bearing on it comes down above the seat for it in the casing, where part of the casing has been machined away to allow just this. Manoeuvre it round

and down, and then forward again to enter the bearing in the differential-end of the casing.

14 Put the other bearing on the selector end of the input shaft, flange outermost, and the flat ground in that flange nearest the bearing on the output shaft, and slide it into its position in the casing.

15 Getting the shaft into its position lined up to fit these bearings will need some turning of the gear wheels down below on the output shaft to allow the gear teeth to engage.

16 With both shafts in position and their bearings fitted, put into place the housing for the output shaft bearing on the selector-end of the casing and fit the two countersunk screws, with conical lockwashers on cars after 1967, and tighten them.

17 Fit the bush for the 2nd gear to the output shaft, flange first, followed by its gear wheel, engaging dog-clutch teeth last.

18 Follow with the hub for the engaging sleeve, getting its key engaged in the groove on the shaft. (The sleeve will be fitted later).

19 Make sure all the parts on the end of the shaft are close up to the bearing housing, and give the shaft a push to make sure it is as far in as it will go. Then turn the shaft over by the pinion so that the seat, a little cup machined in the shaft, for the speedometer ball, is uppermost.

20 Fit the speedometer gear's driving ball in place in the cup, and then slide the speedometer gear wheel along the shaft, slot for the ball cut in the inside first, and get it into place.

21 Fit the washer and nut on the end of the shaft, tightening it finger tight for now.

22 To the input shaft fit the 2nd gear wheel, splined end first, followed by the nut (no washer). Again leave it finger tight for now. (Just in case something is wrong and it has to be taken apart again!)

23 Put the reverse gear shaft through its hole in the casing at the selector-end, its small end first, and then fit onto it inside the gearbox the reverse gear wheel, the smaller of its rings of teeth being towards the differential end.

24 Slide the reverse shaft on towards its location in the differential end of the casing, turning it so that the threaded hole in the end of the shaft is lined up for the bolt hole in the casing. Push it into place and insert the bolt.

25 Now check that nothing is wrong that will mean taking it apart again. Have you got the correct shims in for the pinion? The only gearbox parts left over should be the second gear sleeve, the selector forks and rods, and their detent and interlock balls. Engage each gear in turn, seeing that the hubs and wheels slide easily, and that the shafts turn easily.

26 Now tighten the retaining bolt for the reverse gear shaft.

27 Engage two gears to lock the gearbox, and then tighten the nuts on the ends of the two shafts, and fit their split pins. Unlock the gears, and check the shafts still turn easily.

28 Next the selector rods are fitted. Each can be recognised by the grooves cut at the "selector end" for the detents to hold the rods in the various positions, and the grooves, or hole in the middle (3/4th gears) one, for the interlock balls/plungers that prevent two gears being engaged simultaneously. See Fig. 6.5.

29 Enter the bottom, the 1st/2nd selector rod in the casing, this being the one with the second gear fork on its end combined with the actuating hook. As the rod is pushed into place, in the 2nd gear fork put the 2nd gear engaging sleeve and guide it onto the splined of its hub and within the fingers of the fork. Inside the gear box engage the first gear fork with its groove on the 1st gear wheel, and push the selector rod through it. The first gear fork is the stubby one. Line up the threaded hole in the rod with that in the fork, and insert its retaining bolt. (These are the special ones with long fat shanks). Tighten the bolt.

30 Insert a ball into the hole in the differential-end of the casing for the middle selector rod, and guide it down into the passage leading down to the lower rod. These "balls" are elongated, so must be fiddled around with a pair of screwdrivers till they stand on end to line up with the hole. Some grease makes them more amenable, as they will not fall over.

31 Get the middle rod ready. This is the one with a hole through its differential end. Into this hole put the thin plunger rod,

coating it with grease so that it is less likely to fall out.

32 Insert the middle rod in the casing, and slide it along till selector fork, the 3rd/4th can be put on. The correct way round for the rod is to have the three detents at the selector end outwards, for the ball retainers to seat. Put the fork on the rod, slide the rod along into the differential end of the casing, and twist to line up the thread for the little retaining bolt for the fork. Fit this and tighten it. With the fingers on the fork different spans apart, the forks cannot be muddled, and they go with their retaining bolts uppermost.

33 Insert the next "ball" into the hole in the casing at the differential end for the top rod, and again guide it into the downwards passage. Push and pull the middle and bottom rods so that they are in the neutral positions, and so that the balls and the plunger in the middle rod can sink to their bottom position and not be in the way when the top rod is inserted.

34 Now fit the top, reverse, selector rod, with the long thin fork guiding it in to line up the threads, fitting and tightening the bolt in the fork as for the others. Again the correct way round is shown by the detents at the selector end, and that at the other for the interlock, which must be downward.

35 Using the rods, select each gear in turn. Try to select two simultaneously to check the interlock.

36 Fit the selector-end cover. Grease its shaft, and put the gear selector lever a short way into its hole in the cover. Put the new gasket into place on the studs. Pick up the end cover and hook the end of the gear selector lever into position in the hooks on the end of the selector rods. Line up the holes in the cover with the studs on the end of the gear box casing. Push the cover onto the studs, maybe having to do so quite hard, to push the gear selector into the cover. Fit the spring washers and nuts, and tighten them evenly and diagonally.

37 Refit the speedometer drive, using a new paper gasket, and maybe giving it a twist to line up the gear teeth as it goes in. Fit the spring washer and nut.

38 Fit the top cover to the gearbox, using a new gasket, and tightening the screws evenly.

39 Fit the three balls and their springs into the side of the gearbox casing for the detents, and fit the cover, with new gasket.

10 Reassembly of the differential and drive shafts

1 In this section the reassembly is described assuming all parts are the old ones, or if new the meshing of crownwheel and pinion and the bearing preload has been reset.

2 Prepare the working area with layers of clean newspaper so that drops of oil will do no harm, and the parts stay clean. The oil can filled with 90 EP oil will be needed.

3 Oil all parts.

4 Fit the bronze thrust rings into each half of the casing ready for the side bevel gears.

5 Fit the cross heads to each drive shaft.

6 Put the right drive shaft into its bevel gear, getting the cross heads into the slot so that the bearing surface, the shiny one with the cuts for lubricant to move, taking the load.

7 Put that drive shaft and bevel gear into its half, the bigger one, of the differential case. Fit to the case the idler gears on their shaft, and lock them into place with the retaining cup.

8 Assemble the other drive shaft into its half of the casing with the other gear.

9 Fit the two halves of the casing together, lining up the bolt holes in the same position as before it was stripped.

10 Thread the crown wheel along the drive shaft and into place on the differential casing. Fit all the bolts with their lock washers, and then tighten them evenly and gradually.

11 Check that the gears inside the differential can be turned over by the drive shafts.

12 Fit the inner races of the roller bearings to both ends of the differential. Put the outer races into the bearing housings, and the new oil ring.

13 Fit the clutch shaft in its sleeve onto the gearbox input shaft.

Put in the pin, and lock that with its spring ring.

14 Fit the new oil seal for the clutch shaft to its hole in the flywheel housing. Tap it carefully in from the clutch side, with its lips towards the differential.

15 Lift the differential into place in the casing. If possible get an assistant to hold the gearbox upright so that the differential will sit in the bearing openings.

16 Fit the flywheel housing to the gearbox casing. Take care to slide it down the clutch shaft so that the oil seal is not strained. Make certain there is no dirt on the faces of the two halves of the casing, as there is no gasket, and they must seat in well.

17 Fit the star shaped bearing housings on either side, supporting the differential by the drive shafts to help the races get into place on the bearing rollers. Ensure that the housings are put back in their original places.

18 Fit the nuts to the studs holding the flywheel housing onto the gearbox casing, with their washers, and tighten them. Then fit and tighten the nuts for the bearing housings.

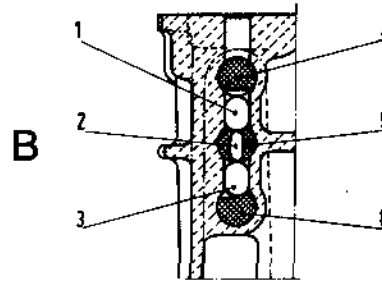
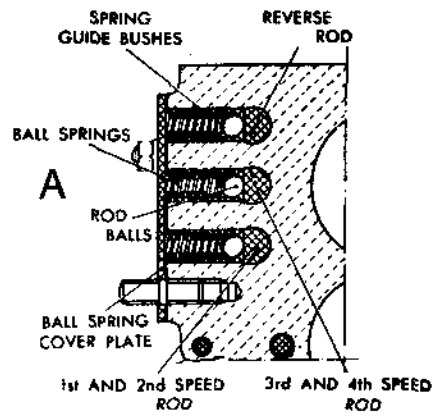
19 Check that everything can be turned over. First the clutch shaft, then one drive shaft alone: the other should turn backwards under differential action. Then turn both together. They will be stiff due to the bearing preload, but should turn smoothly.

20 Fit the locking rings to the serrated bearing adjusters, then the oil retaining boots, and their retaining rings, and bolt them into place.

21 Fit the dirt excluders to the outer ends of the drive shafts.

22 Smear their splines liberally with molybdenum-disulphide grease, and fit the driving sleeves.

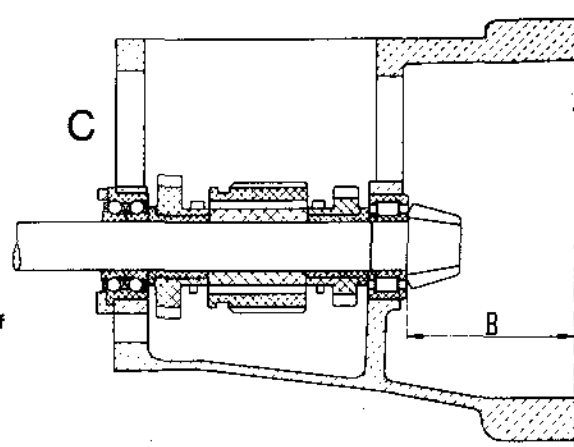
23 Push on their circlips to the end of the drive shafts.



A Fig. 6.6. Spring loaded detent balls to hold gears in mesh or out

B Fig. 6.7. Inter-lock elongated balls (1 and 3) and plunger (2) to prevent simultaneous engagement of two gears. The top rod (4) engages reverse, the centre (5) third and fourth, and the bottom (6) first and second gears.

C Fig. 6.8. The dimension 'B' is the distance from the centre line of the differential to the rear face of the pinion. It is nominally 75 mm. The variation + or - of this that an individual pinion needs for correct meshing is stamped on the threaded end of the shaft



11 Refitting the transmission to the car

1 Normally the transmission would be refitted with the engine, and this is described in Chapter 1. This section deals with those few cases when it has been removed on its own, the vehicle being over a pit.

2 Fit the new mounting rubbers to the casing, and to them the crossmember.

3 It is assumed the engine is still sitting on a jack in the car, and that the clutch has not been disturbed, so its driven plate is still centralised.

4 Wipe any oil or grease off the splines on the clutch shaft. Smear a little grease on the very end of the shaft, where it goes in the spigot bearing in the crankshaft.

5 Get a jack or an assistant ready to hold the transmission in place whilst it is bolted up.

6 Lift the transmission into line with the engine. Make sure it is straight so that the clutch shaft can slide into the driven clutch plate without straining the clutch, or fouling the release mechanism.

7 Push it onto the engine. It may need a twist to get the splines on the shaft into the clutch plate.

8 Fit all the nuts holding the engine and transmission together, with their washers. Tighten them all evenly, supporting the transmission all the while.

9 Still supporting the transmission, fit the bolts holding the crossmember to the floor.

10 Remove the support under the transmission and the engine.

11 Refit the starter motor.

12 Reconnect all the controls, the starter motor, and the speedometer cable.

13 Connect up the drive shafts to the hubs, fitting in between the little springs.

14 Fill the transmission with oil.

15 Recheck all is refitted correctly.

16 Road test the car, and then check all bolts for tightness, and the transmission for leaks.

17 After 500 miles change the transmission oil to wash out any dirt that might inadvertently have got in during the work, and the metal rubbed off new parts.

12 Gear lever adjustment

- 1 If difficulty is found in engaging odd pairs or even pairs of gears the lever may need adjustment.
- 2 The gear lever mounting is fixed to the right side of the spine (or tunnel) down the centre of the floor by two bolts; with elongated holes to allow adjustment.
- 3 If 1st and 3rd gears are difficult to engage push the lever assembly forwards. Move it back if 2nd and 4th will not engage.

13 Smooth silent gear changing

- 1 If the gears are not engaged smoothly and correctly synchronised their engagement dog clutches will wear. Chips broken off them will grind away other components. After long abuse a gear may not work at all. (It usually happens to third gear first).
- 2 The double declutch method of gear change should be used. 500 gear box is very forgiving, and the gears will engage quietly with the speed mismatched to quite a wide extent.
- 3 If the mismatch of gear speeds is too wide, yet enough to cause actual gear grating, the transmission may produce a usual, and loud, clonk.
- 4 If there is difficulty engaging a gear silently from neutral, when moving off, even after waiting for a few moments after disengaging the clutch for the gear wheels to come to rest, then refer to clutch defects (drag) in Chapter 5.

14 Fault finding

- 1 Faults can be sharply divided into two main groups: Some definite failure with the transmission not working: Noises implying some component worn, damaged, or out of place.
- 2 The failures can usually be tracked down by commonsense and remembering the circumstances in which they appeared.

Thus if the car will not go at all a mechanical failure will occur in different circumstances to a broken linkage from the gear lever!

- 3 If there is a definite fault within the transmission then it has got to be removed and dismantled to repair it, so further diagnosis can wait till the parts can be examined.
- 4 But if the problem is a strange noise the decision must be taken whether in the first place it is abnormal, and if so whether it warrants action.
- 5 Noises can be traced to a certain extent by doing the test sequence as follows:
- 6 Find the speed and type of driving that makes the noise. If the noise occurs with engine running, car stationary, clutch disengaged, gear engaged: The noise is not in the transmission. If it goes after the clutch is engaged in neutral, halted, it is the clutch.
- 7 If the noise can be heard faintly in neutral, clutch engaged, it is in the gearbox. It will presumably get worse on the move, especially in some particular gear.
- 8 Final drive noises are only heard on the move. They will only vary with speed and load, whatever gear is engaged.
- 9 Noise when pulling is likely to be either the adjustment of preload of the differential bearings, or the crown wheel and pinion backlash.
- 10 Gear noise when free-wheeling is likely to be the relative positions of crownwheel and pinion.
- 11 Noise on corners implies excessive tightness or excessive play of the bevel side gears or idler pinions in the differential.
- 12 In general, whining is gear teeth at the incorrect distance apart. Roaring or rushing or moaning is bearings. Thumping or grating noises suggest a link out of a gear tooth.
- 13 If subdued whining comes on gradually, there is a good chance the transmission will last a long time to come.
- 14 Whining or moaning appearing suddenly, or becoming loud, should be examined quickly.
- 15 If thumping, or grating noises appear stop at once. If bits of metal are loose inside, the whole transmission, including the casing, could quickly be wrecked.

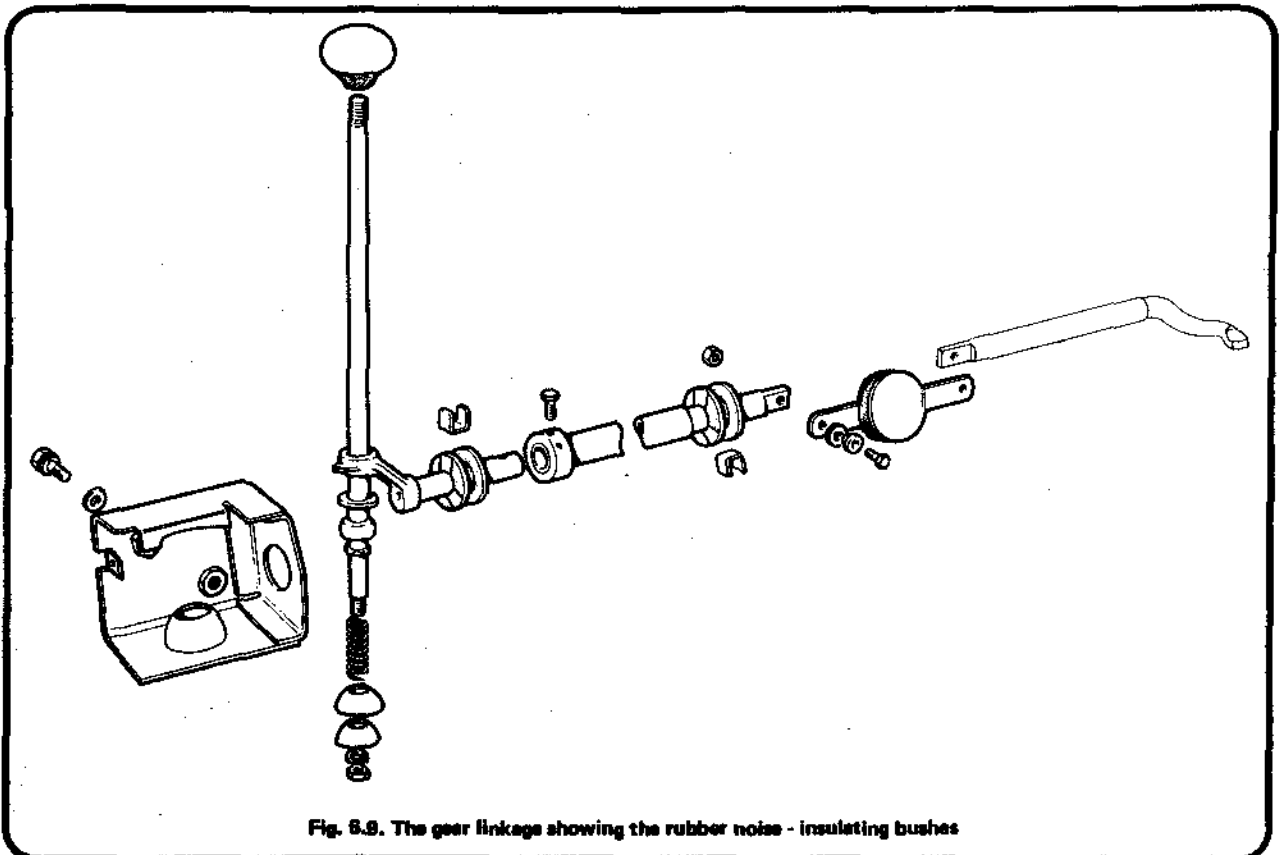


Fig. 8.8. The gear linkage showing the rubber noise - insulating bushes