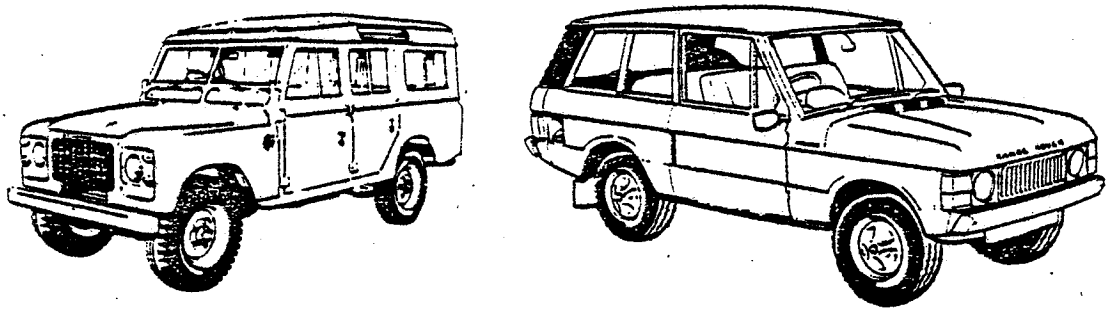
LAND ROVER

SERVICE PRODUCT TRAINING



Land Rover

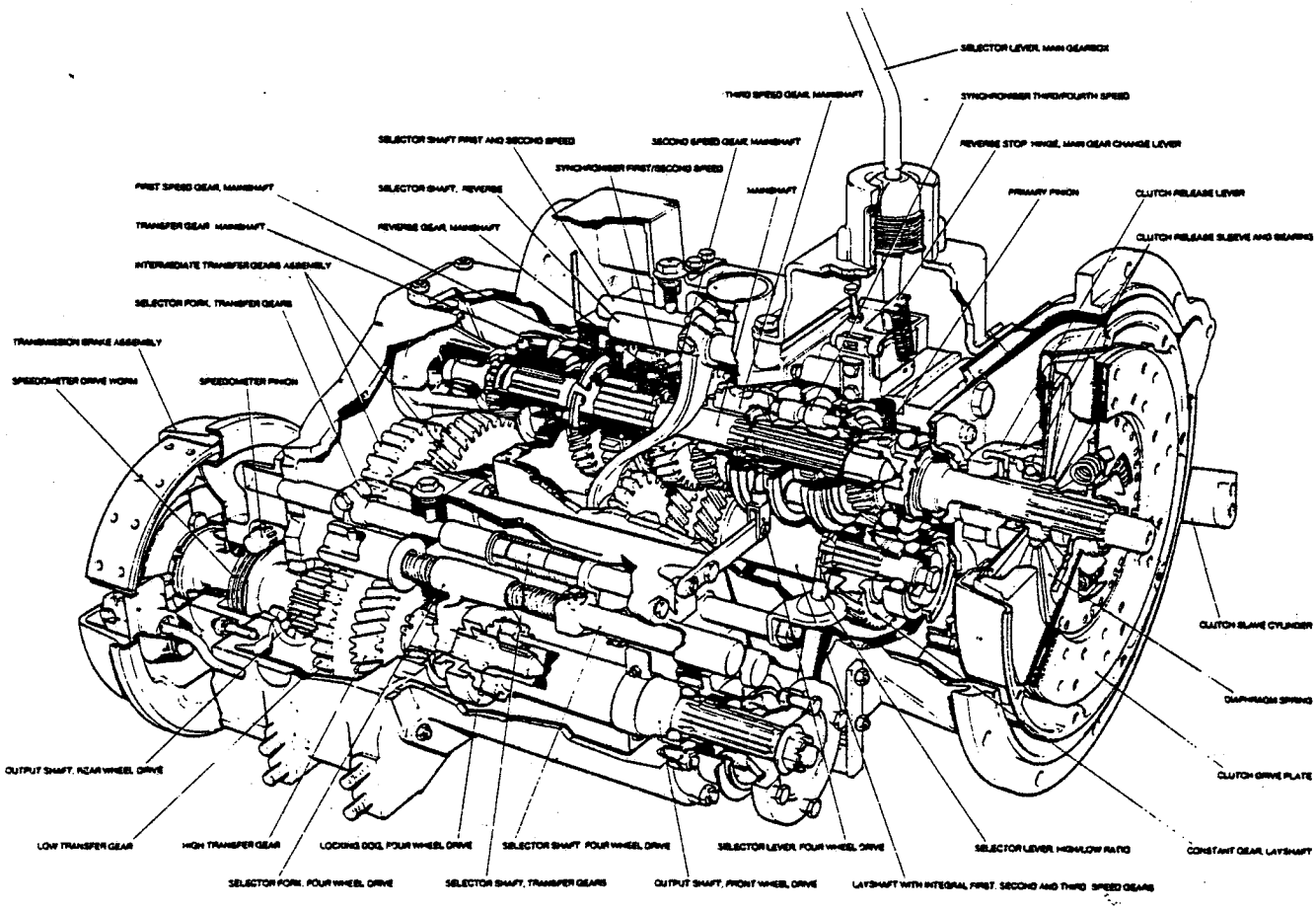
LT66 4 CYL

TRANSMISSION

LAND ROVER Land Rover Limited

Transfer Box — 4 cyl

Land-Rover Series III



Synchromesh Gearbox with Two Speed Transfer Box and Four Wheel Drive

Fig. 1

The Land Rover was introduced in 1948 and the original design concept of the transmission is retained without major change in its production today.

The overall reliability of the robust unit has played a prominent part in making the Land Rover one of the most popular vehicles for road or cross-country use.

The transmission design and location ensures easy access for maintenance and allows a large proportion of repair operations without removal from the chassis.

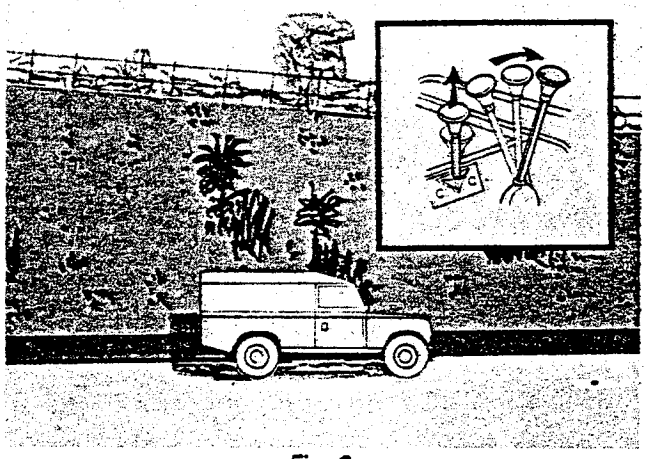


Fig. 2

The complete transmission consists of two basic units — the transfer box and the main box which, when bolted together, provide eight forward and two reverse ratios with the options of high ratio rear wheel drive for normal road use *(Fig. 2)*, high

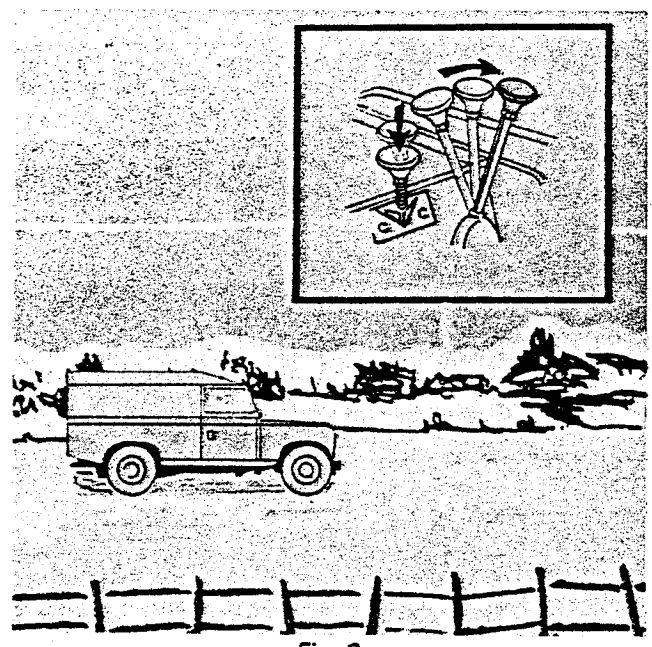


Fig. 3

ratio four-wheel drive for doubtful surface conditions such as icy or muddy roads *(Fig. 3)*, or low ratio four-wheel drive for conditions requiring maximum traction with maximum torque *(Fig. 4)*.

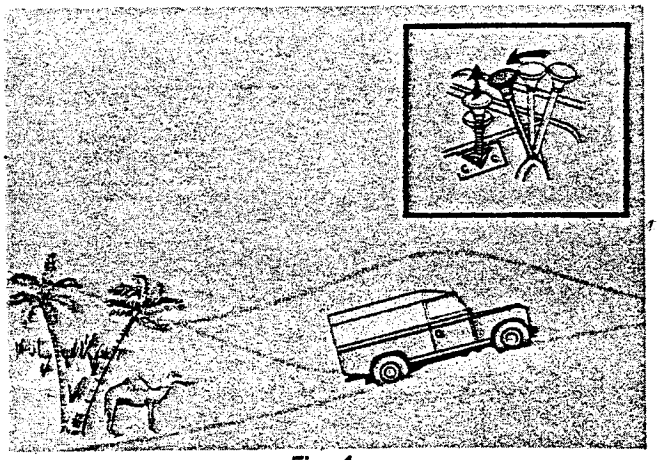


Fig. 4.

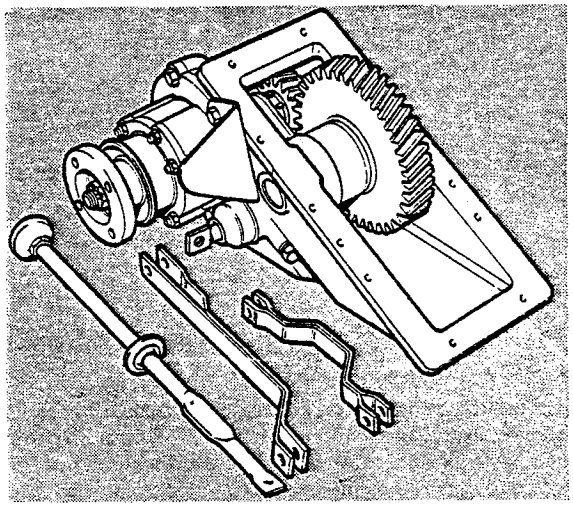


Fig. 5

The transfer gearbox can also be fitted with top and/or bottom power take off units as shown in *(Fig. 5)*. To provide efficient lubrication, main and transfer boxes have separate oil reservoirs and independent ventilation systems. *(Fig. 6)* shows the relationship of the two boxes and the location of the oil seals in each.

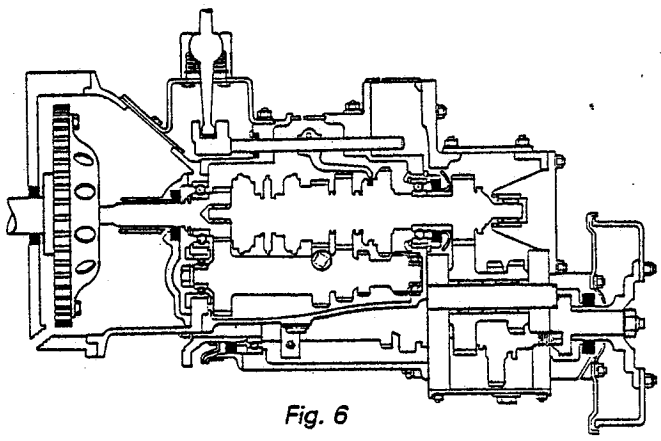


Fig. 6

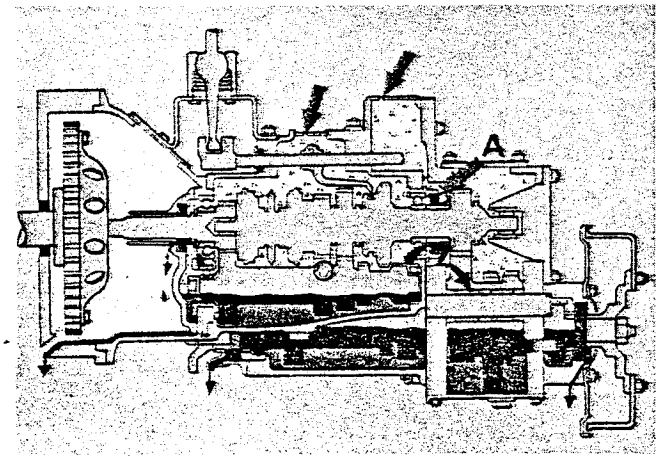


Fig. 7

If one oil level is found to be high and the other low, both vent holes arrowed in *(Fig. 7)* should be checked and, if necessary, cleared of any blockage and the level of oil corrected in each unit. The oil levels should be checked regularly for the next 500 km and any reoccurrence of oil transfer indicates a need to renew seal 'A' *(Fig. 7)*.

Blockage of the breathers may also cause external leakage as shown in *(Fig. 7)*. The nature and viscosity of any oil leaking from the flywheel housing will determine whether it is gearbox oil passing through the primary shaft seal or engine oil escaping through the crankshaft rear seal.

Should the transfer box vent and/or the drain hole adjacent to the rear transfer box seal be blocked (as shown in *Figs. 8 and 9)* any seepage of oil through the seal will eventually contaminate the hand brake linings. Therefore, this drain hole and the ventilators should be checked regularly, especially when operating in adverse conditions. The front output shaft seal should also be checked for leakage.

Remember! Blocked breathers 'spell' oil leaks.

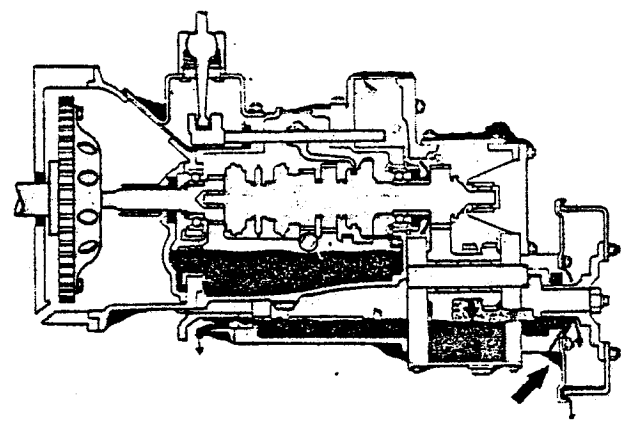


Fig. 8

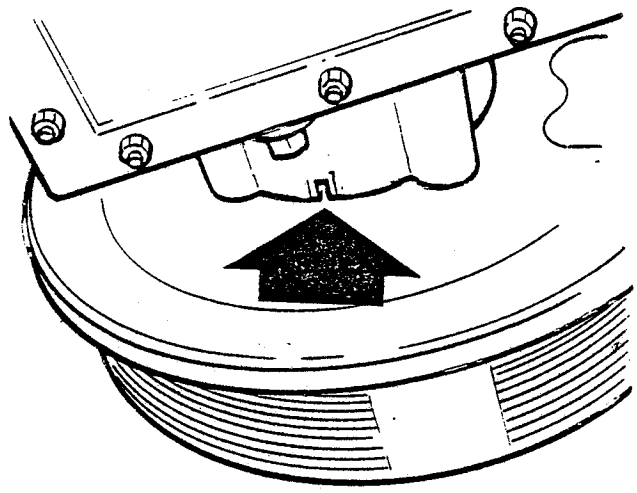


Fig. 9

The flywheel housing plug indicated in *(Fig. 10)* must be fitted before operating in mud or water and returned to its parking bracket as soon as conditions allow.

Failure to fit the plug into the vent hole when operating in adverse conditions may cause serious damage to the clutch.

Now let's look at the operations which can be carried out with the gearbox *in situ* with the vehicle on a ramp or over a pit.

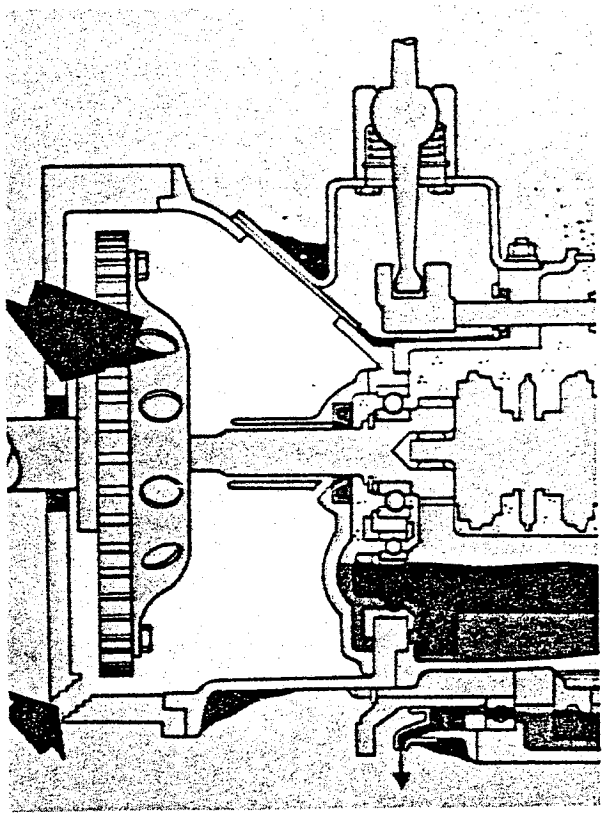


Fig. 10

PARKING BRAKE

Dismantling begins with the transmission-mounted parking brake which is a particular feature of the Land Rover.

When applied with four-wheel drive engaged this brake allows safe parking of the vehicle on steep inclines *(Fig. 11).*

The high location of the units and their short hand brake linkage minimise the risk of damage and the effect of the elements.

The condition of the parking brake linings should be checked regularly and this is easily done by removing the brake drum from the gearbox output flange and sliding it out of the way along the propeller shaft.

Incidentally, the quickest way to ruin the hand brake linings is to use the brake to stop the vehicle.

Many delivery drivers have a very bad habit of pulling on the hand brake before the vehicle has stopped, which not only wears the linings but can also account for loose or sheared brake backplate bolts or even a broken axle shaft.

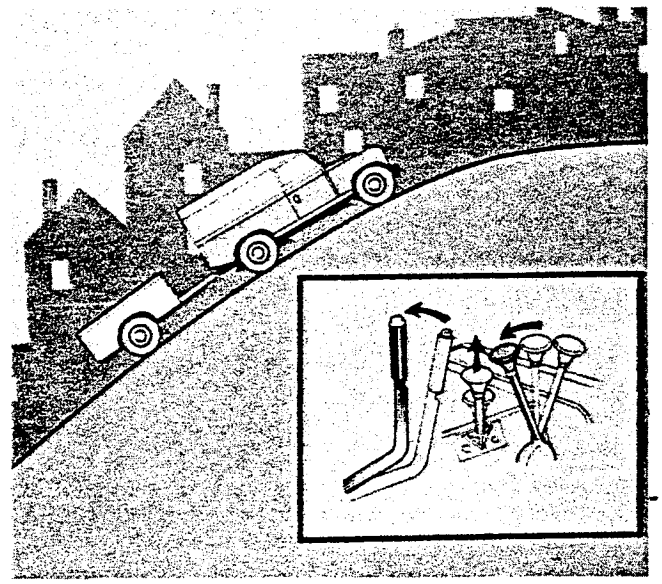


Fig. 11

Over adjustment of the hand brake linkage, so that it has only a short travel can cause the brake to apply over rough ground. In such conditions the movement of the body relative to the chassis causes the brake to self-apply. The hand brake lever should travel about five clicks to the fully applied position. Note this only applies to 'rod linkage'.

If replacement is indicated, the shoes can be levered off using the tool, part number Girling T4-64947019, shown in *(Fig. 12).*

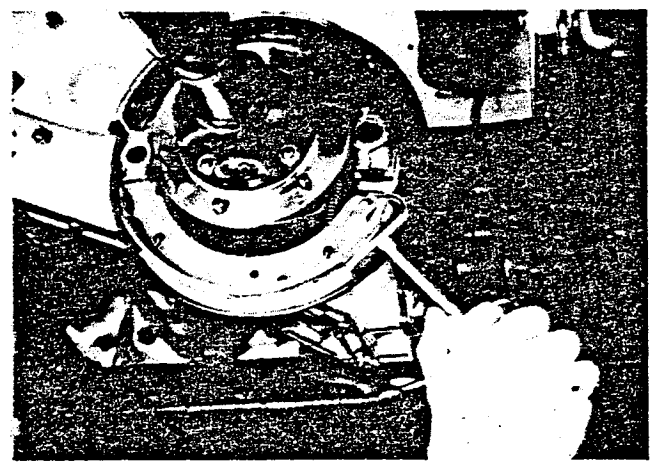


Fig. 12

TRANSFER BOX—
dismantling in the chassis
Before dismantling the transfer box further, drain the oil from the unit, disconnect the propeller shaft and secure it safely away from the immediate working area.

Extract the split pin, release the castellated nut and draw off the output shaft drive flange. Note the felt seal for the splines as shown in *(Fig. 13–A).*

Brake backplate
To remove the brake backplate it is easier to remove it complete with relay lever and linkage as shown in *(Fig. 14)* by releasing the locking nuts 'B'.

There are two reasons for removing the complete linkage as follows:

1. The clevis pin 'A' is usually tight and is rather inaccessible.
2. The relay and linkage will probably need lubrication anyway and what better method than merely to submerge the complete linkage in a container of oil where it may be left to soak while we continue dismantling.

With the brake backplate and oil catcher removed the output shaft seal (indicated by an arrow in *Fig. 15)* is accessible and may be renewed at this stage.

Next, disconnect the speedometer cable, the rear support plate for the main shaft and the sump plate.

Intermediate shaft
The intermediate shaft gear cluster runs on two easy-fitting roller bearings and is a heavy component, requiring strong hand support as the shaft is removed. Care should also be taken to ensure that the bearings do not fall out of the gear.

After removal of the nut securing the intermediate shaft retainer, the shaft should be carefully extracted using the special tool (part number 605862) *(Fig. 15).*

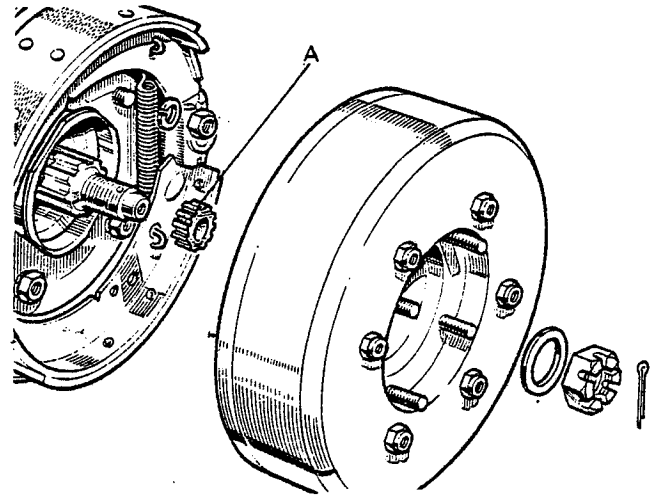


Fig. 13

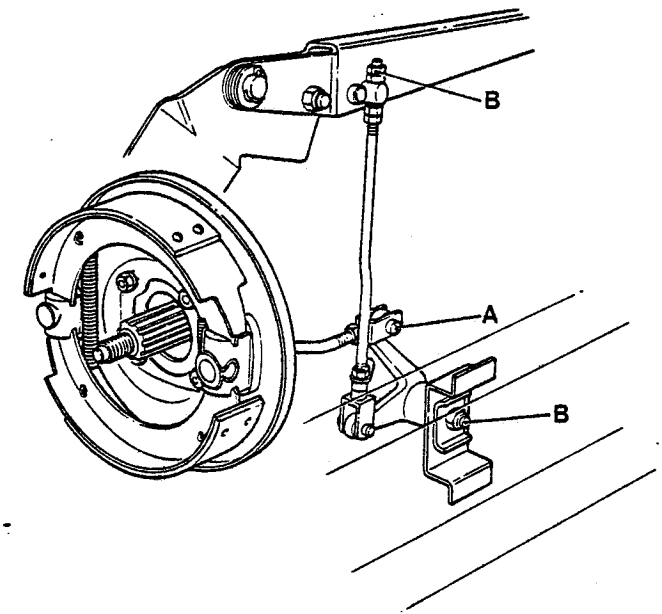


Fig. 14

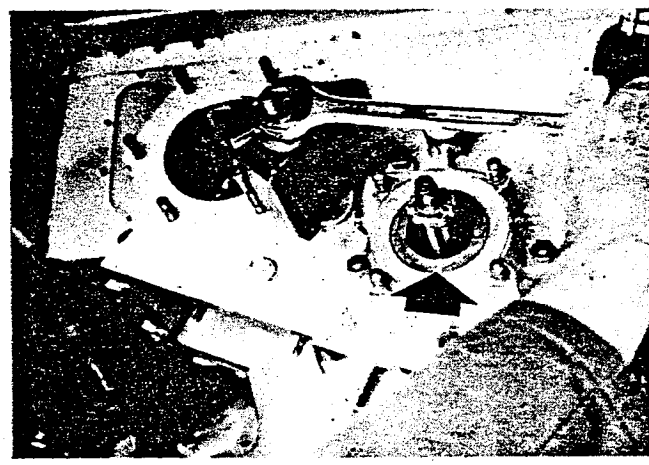


Fig. 15

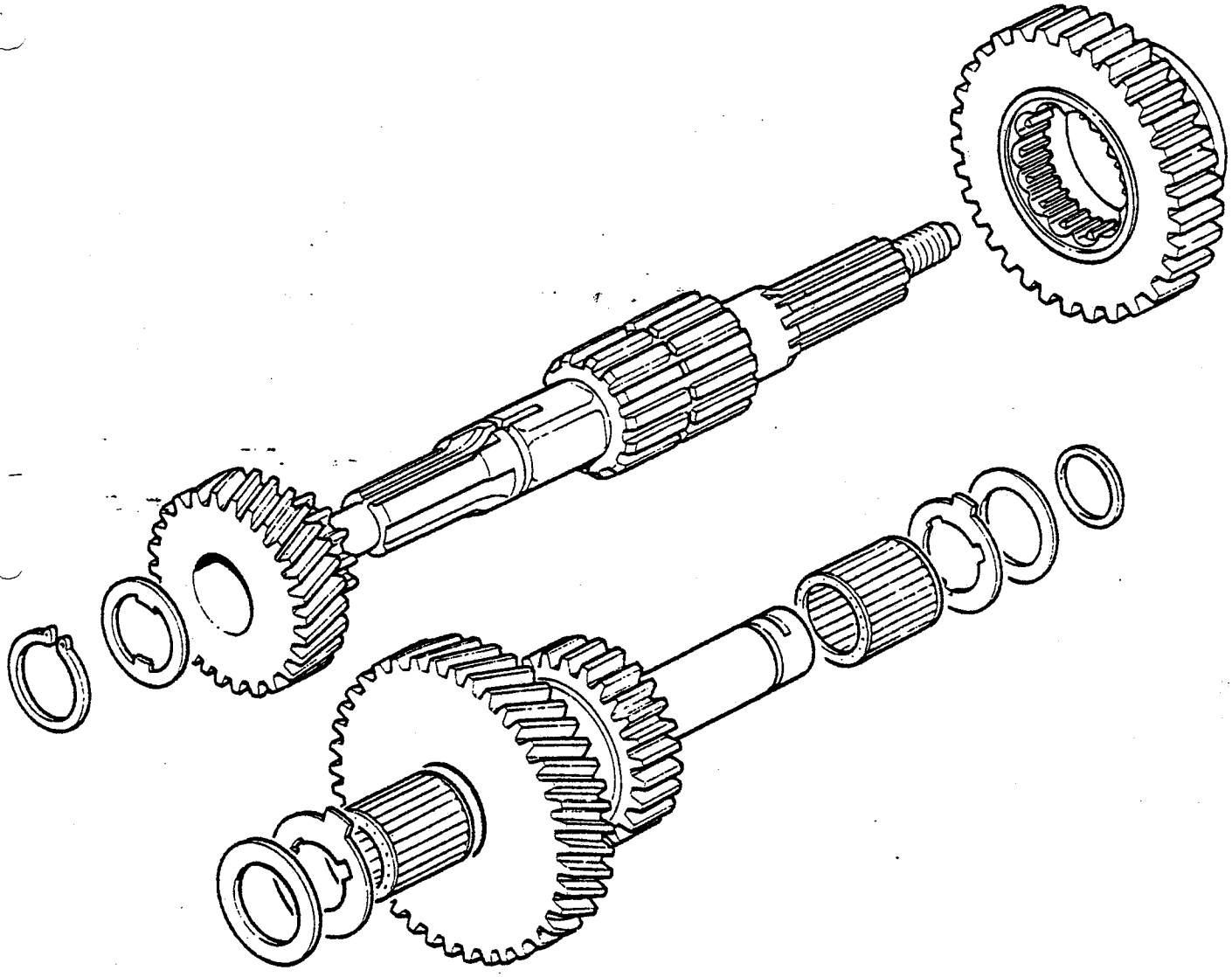


Fig. 16

Note the bronze-faced thrust washers (they may have shims behind them) which are used for end-float adjustment of the gear *(Fig. 16)*.

Two other items can be inspected and renewed if necessary at this stage.

One is the front wheel drive output shaft seal for which renewal details will be given later.

The other item is the oil seal which separates the main and transfer box oil systems referred to in *(Fig. 7-A)*. This is located behind the special nut and gear on the end of the main shaft indicated in *(Fig. 17)*.

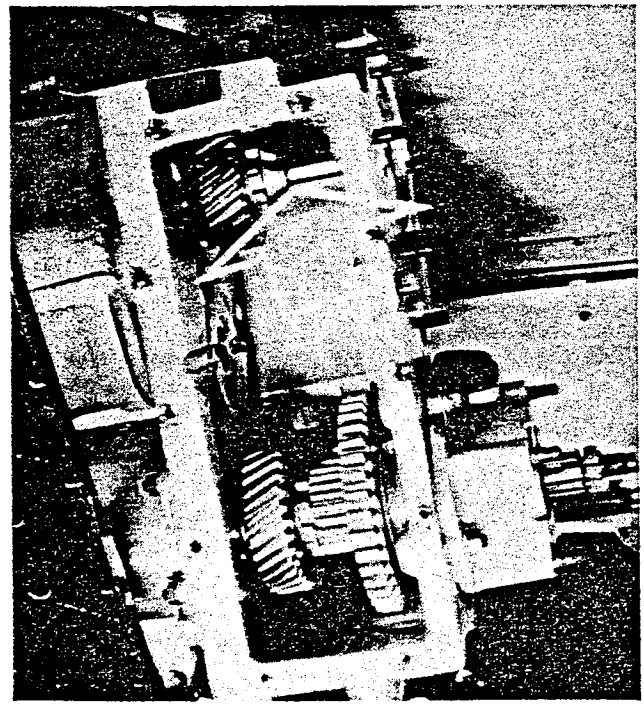


Fig. 17

Renewal of seals
To gain access to this seal, engage top gear to prevent the shaft from turning, bend back the lockplate and remove the castellated nut using the special spanner (part number 600300). Remove the components and slide off the gear as shown in *(Fig. 18)*.

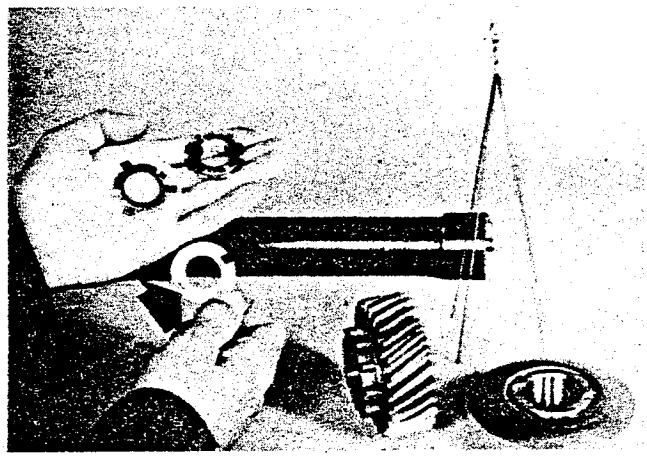


Fig. 18

If any difficulty is experienced in removing the oil thrower and collar, equi-spaced wire hooks used as shown in *(Fig. 19)* will be found useful.

The seal may now be levered out and a new one fitted. When refitting the components it is very important to ensure that the hardened steel washer arrowed in *(Fig. 18)* is fitted behind the lockplate, otherwise the lockplate will not be effective.

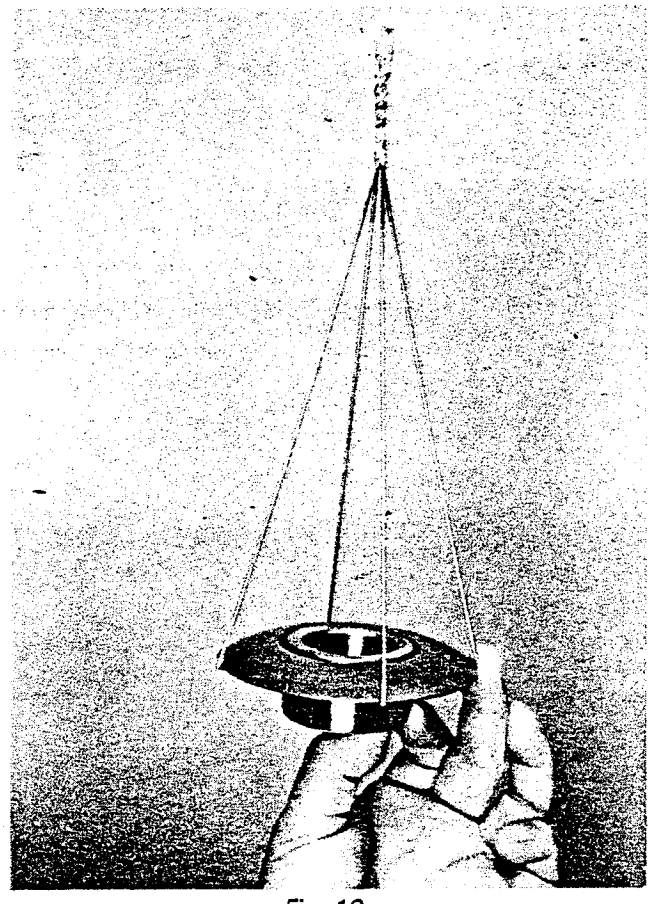


Fig. 19

TRANSFER BOX—
removal from chassis
Further work on the transfer box necessitates its removal from the chassis, so support the main box and disconnect the front propeller shaft. Disconnect the two control levers. Disconnect the rear gearbox mountings before releasing the five external nuts and three internal self-locking nuts securing the transfer box *(Fig. 20)*.

Lower the box to the floor ready for dismantling on the workbench.

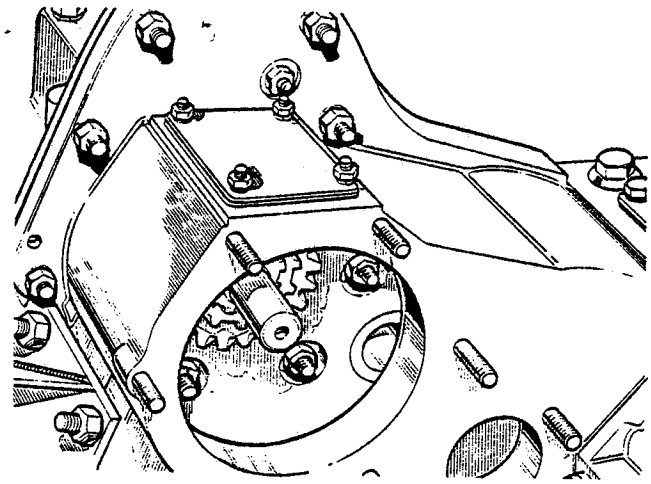


Fig. 20

Dismantling on the Workbench
To continue the dismantling of the transfer box, remove both mounting brackets and the four-wheel drive control rod and lever for ease of handling.

Remove the top cover and release the selector pinch bolt *(Fig. 21–arrowed)* which is positioned with its head toward the right-hand side of the gearbox.

Steady the selector fork ensuring that the bolt remains central to the selector groove, otherwise the bolt threads may be stripped as the bolt is unscrewed.

Remove the plug, spring and detent plunger also seen in *(Fig. 21)*. Release the nuts securing the selector housing and separate the selector housing from the transfer casing, putting it aside for overhaul later.

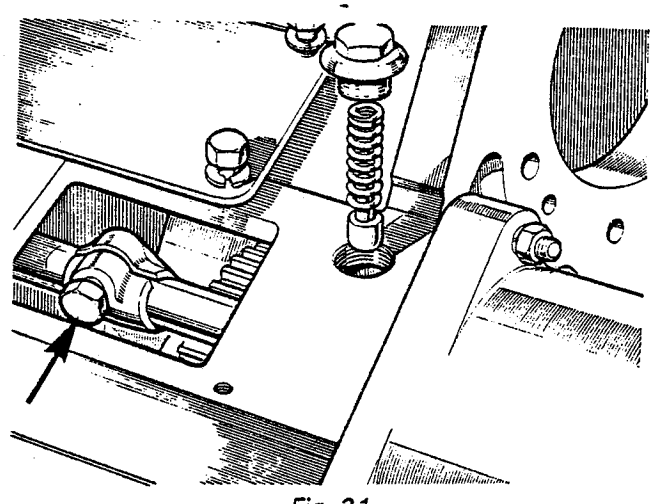


Fig. 21

With the speedometer housing removed, slide the speedometer gear off the shaft and remove the shim pack *(Fig. 22)*.

Turn the transfer casing over and, using a plastic or hide-faced hammer, tap the output shaft toward the rear of the box to dislodge the rear bearing track.

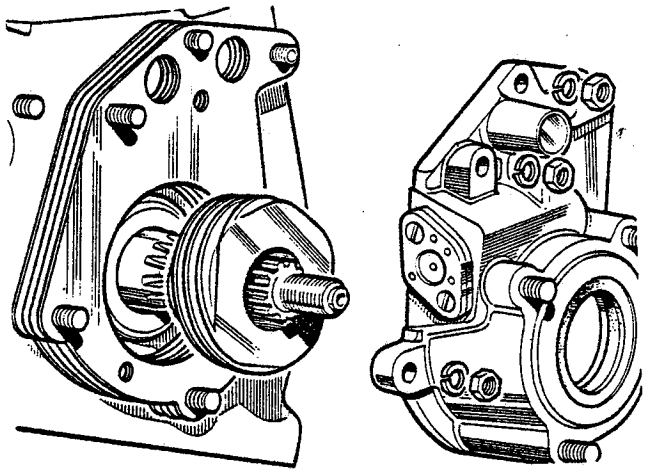


Fig. 22

Then, with the shaft supported clear of its bearings as shown in *(Fig. 23)* use a blunt-ended mild steel chisel or drift to force the front taper roller bearing away from the circlip, thrust washer and high-speed gear so that the circlip can be removed from its groove by suitable pliers.

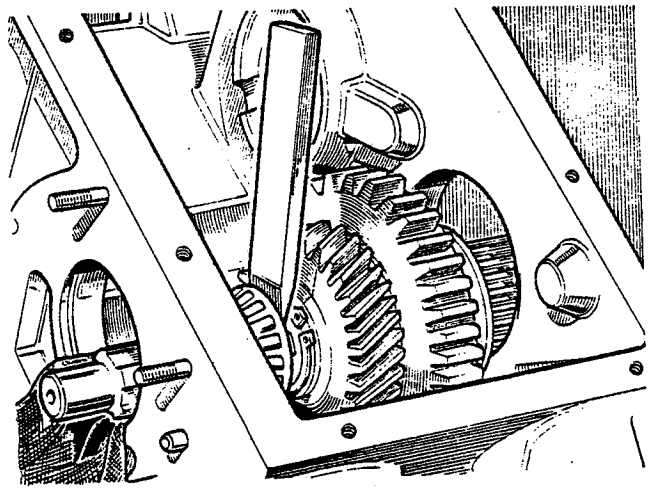


Fig. 23

With the circlip clear of its groove, support the gears and bearings by hand and pull the shaft toward the rear of the box. Lift out the gears, selective thrust washers, circlip and the bearing *(Fig. 24)*.

Remove the large clip retaining the front roller bearing track and, using a soft punch, drift the track out of the casing.

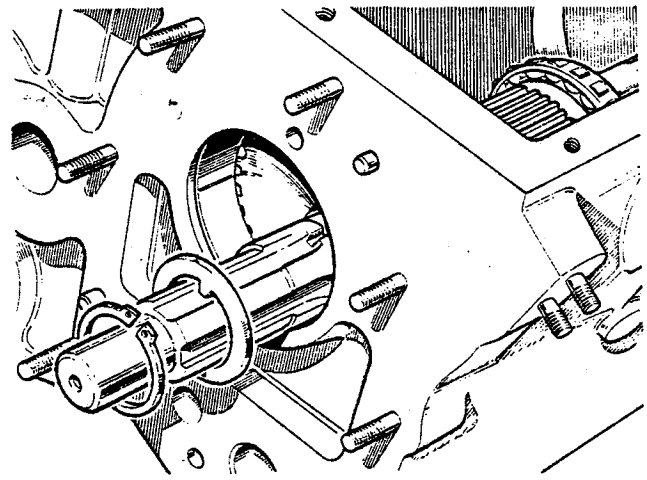


Fig. 24

Using the special thread protection tool (part number 243241) and the large low speed gear as a press block shown in *(Fig. 25)* remove the rear roller bearing from the shaft.

This completes the dismantling of the transfer box.

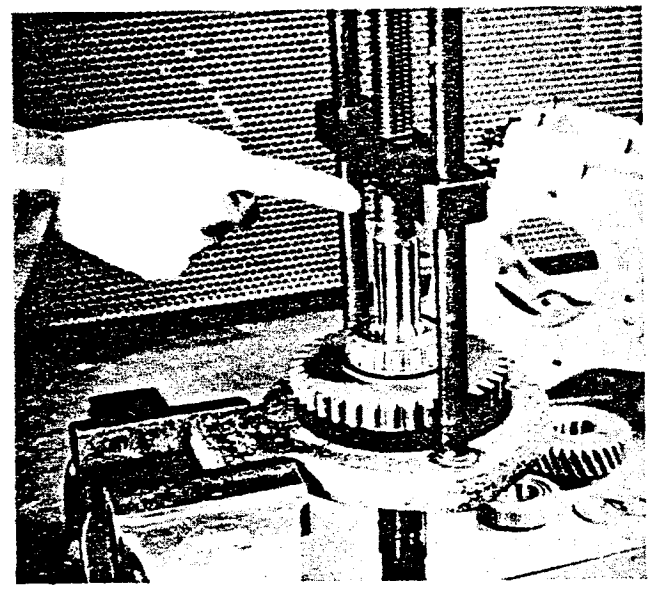


Fig. 25

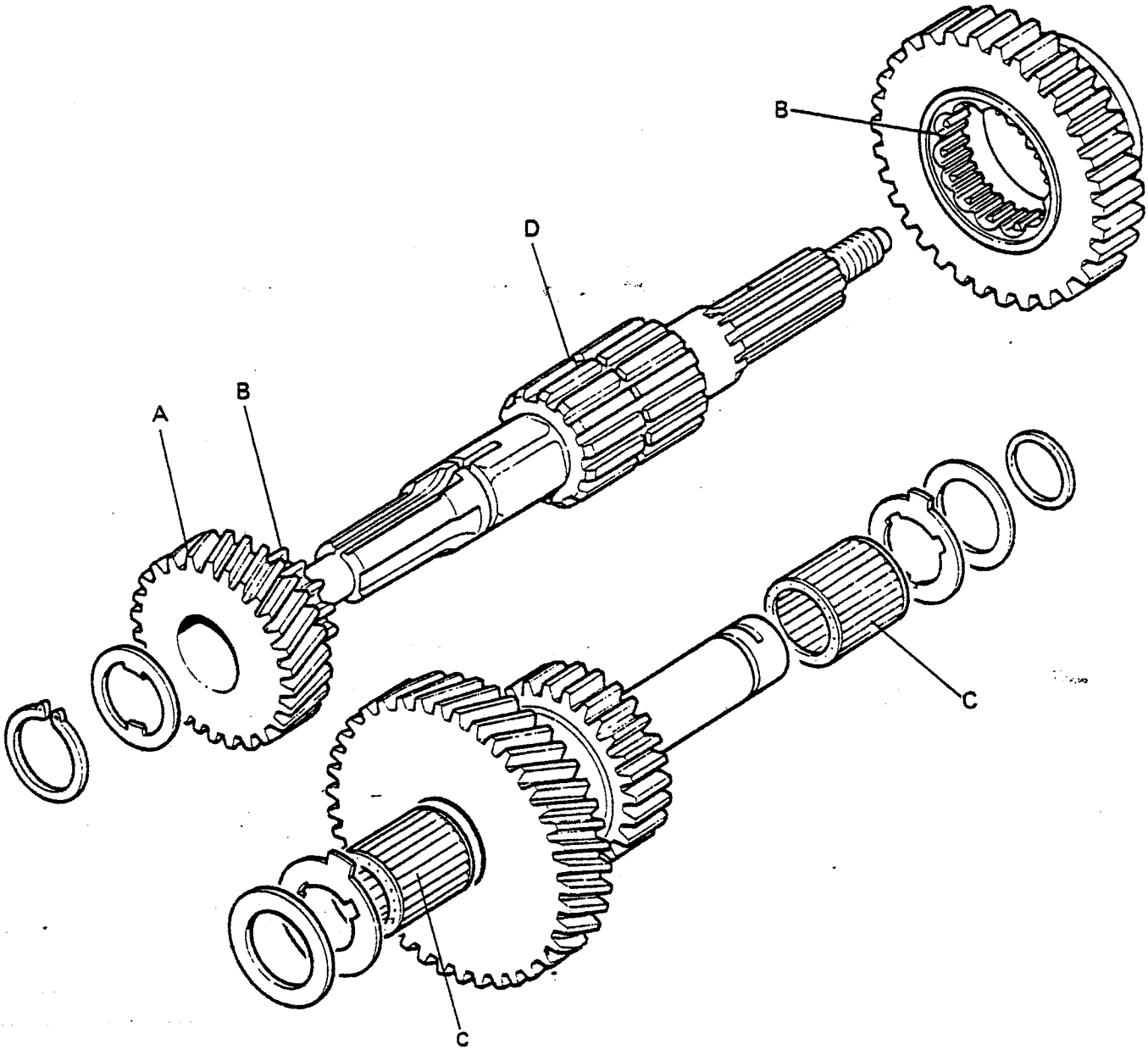


Fig. 26

All the parts must now be inspected for damage or wear and renewed as necessary *(Fig. 26)*.

Inspection of Gearing
Inspect the intermediate and low-speed gears and check the condition of the gear teeth.

Inspect the high-speed gear 'A' and dog teeth 'B' for damage or wear and examine the intermediate gear roller bearings 'C', shaft and thrust washers shown in *(Fig. 26)*.

The large low-speed gear is a loose fit on its splines to provide locking of the gear in low transfer.

Closer examination of the output shaft will reveal that the short splines are thick and that the long splines are thin to provide a method of locking low ratio.

The step formed by the different thickness of the splines provides an effective method of preventing gear 'jump out'.

Closely examine the corner of the spline at 'D' on the shaft which forms the step and the internal spline of the low gear which abuts the step. Wear or rounding of the corners at these points can be the cause of gear 'jump out'.

Having determined and obtained the necessary replacement parts, pre-assembly of the gearing for the transfer box can commence.

Pre-assembly of the Gearing

INTERMEDIATE GEAR

Using a little petroleum jelly, secure the intermediate thrust washers in position in the casing with the bronze surfaces toward the gear.

Install the intermediate gear complete with roller bearings and insert the shaft.

Check the end-float which should be 0,1 to 0,2 mm (0.004 to 0.008 in) *(Fig. 27)* and adjust by fitting suitable shims behind the thrust washers. When the end-float is correct, remove the gear and shaft complete and place aside until required.

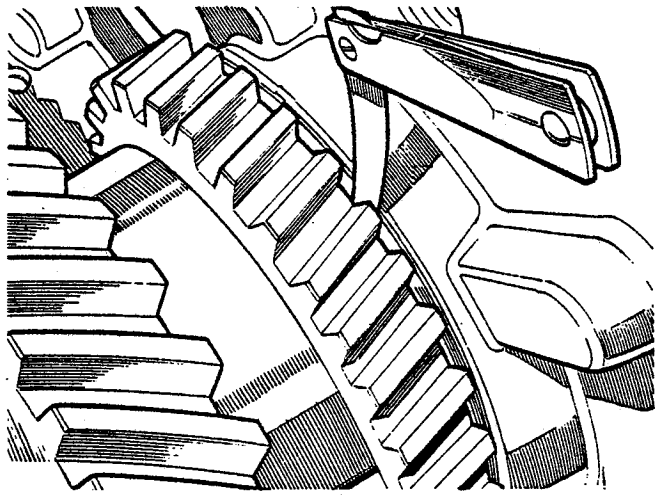


Fig. 27

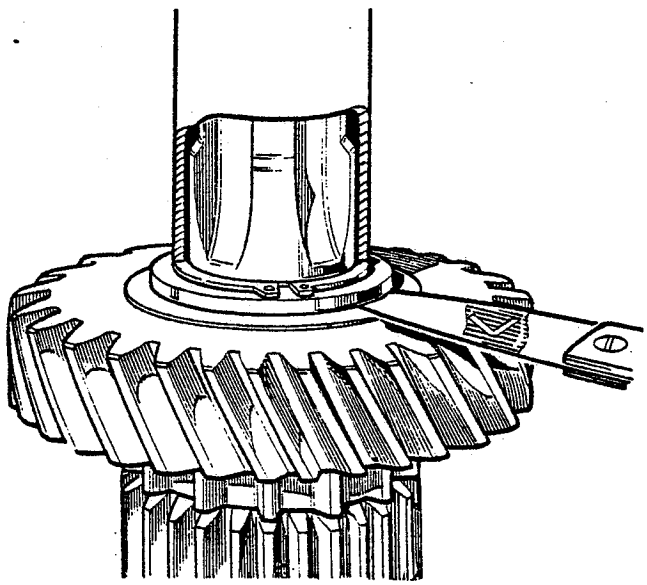


Fig. 28

HIGH-SPEED GEAR ADJUSTMENT

Steady the output shaft in the rear drive flange to provide a working platform while carrying out the adjustment. Now fit the high-speed gear, thrust washer and circlip to the output shaft.

Using a suitable piece of metal tubing pressed hard down by hand to eliminate circlip to groove clearance *(Fig. 28)* check the end-float with a feeler gauge between the gear and the thrust washer. Final end-float must be between 0.15 and 0.2 mm (between 0.006 and 0.008 in). At this stage it must be adjusted to the maximum. On rare occasions it may be necessary to reduce the thickness of the thrust washer by rubbing down with emery cloth on a flat surface in order to obtain the required end-float.

With the end-float set, remove the components from the shaft prior to assembly into the casing.

Press the new output shaft rear roller bearing into position on the shaft, again using a suitable tube.

Excessive force is not required, therefore, the high-speed gear can be used to support the shaft.

Assembly into the casing

Mesh the high- and low-speed gears and install them into the casing, locating them on the output shaft as it is slid into position as shown in *(Fig. 29)*.

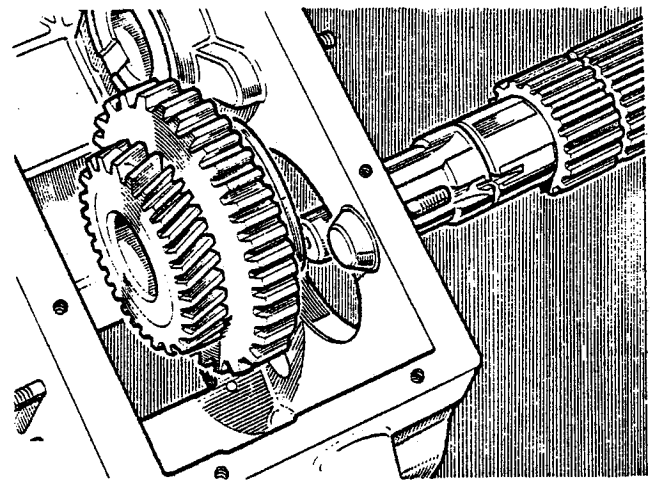


Fig. 29

Fit the selected thrust washer and circlip.

Fit the thread protector to the rear of the shaft and drift the front roller bearing onto the shaft using the metal tube *(Fig. 30)*.

Fit the front outer bearing track and circlip and fit the rear bearing outer track to the housing.

Apply a little sealing compound to the inside of the speedometer casing and fit a new seal squarely into it.

It should be noted that although the recess is deeper than the seal width the seal must be pressed in only enough to ensure that it is flush with the face of the casing.

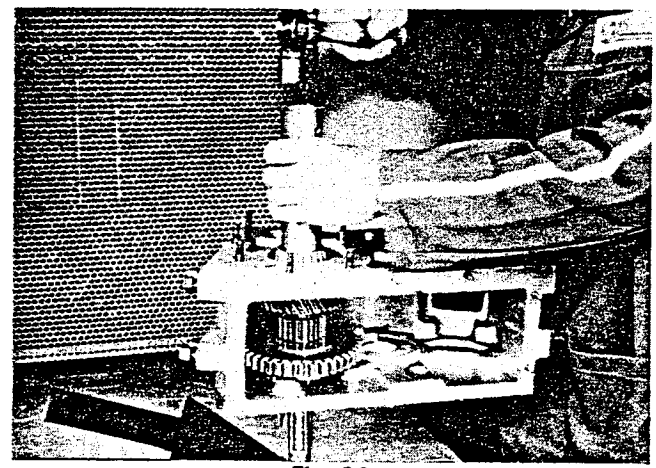


Fig. 30

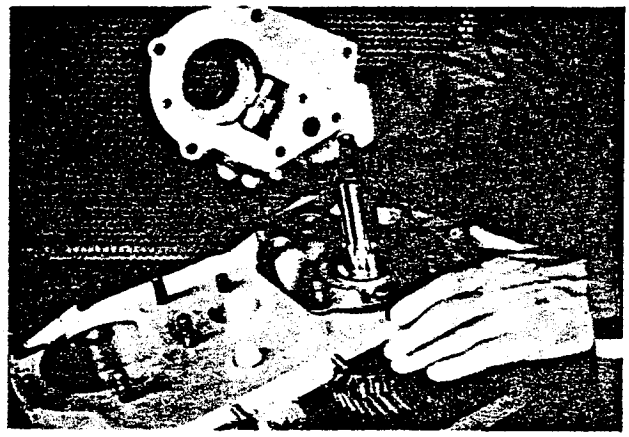


Fig. 31

Fit the speedometer drive and housing using the original pack of shims *(Fig. 31)*.

Ensure that the nuts are tightened to the correct torque of 4 to 5 kgf m (30 to 35 lbf ft).

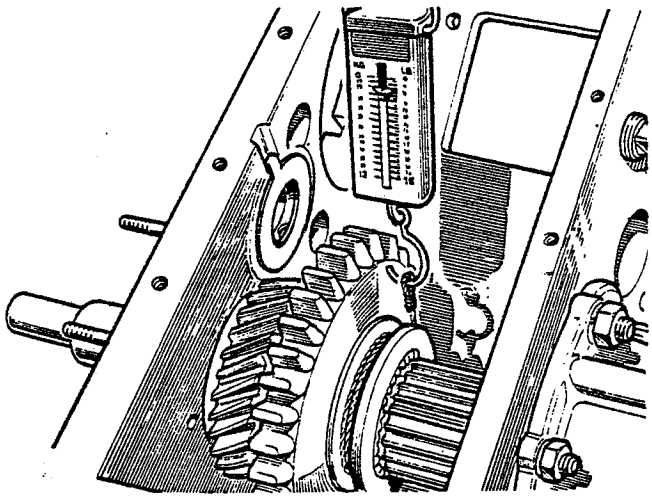


Fig. 32

To measure the rolling resistance of the output shaft, wind a length of string around the low gear selector groove and attach to a spring balance *(Fig. 32)*.

The resistance should be between 0.9 and 1.8 kg (2 and 4 lb) and can be adjusted by variation of the shims behind the speedometer housing.

Fig. 33

The accuracy of the spring balance may be periodically checked *(Fig. 33)* by simple comparison with a known weight, such as a hammer or using the low-speed gear. The weight of the low-speed gear is 1.8 kg or 4 lb so if your spring balance shows a different weight then the spring balance is faulty.

This completes the overhaul of the transfer gearing. Now we turn to the transfer box selector housing.

Dismantling the Selector Housing

Remove the high/low and four-wheel drive selector shafts complete with spring, distance tube, four-wheel engagement dog and pivot shaft/toggle assembly.

Remove the dust cover and the large and small rubber rings.

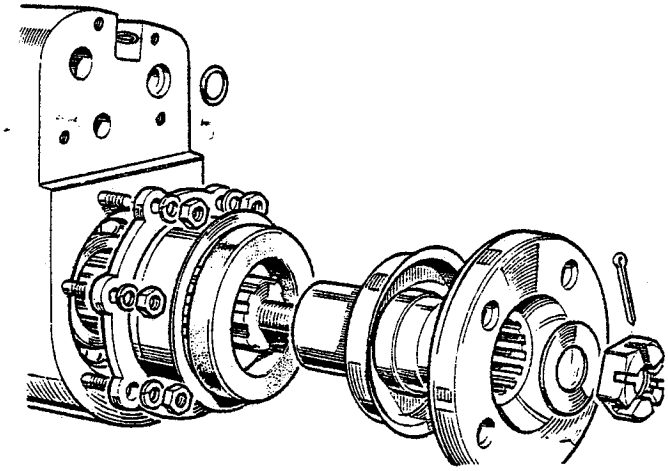


Fig. 34

Remove the front output shaft drive flange nut, flange and shaft *(Fig. 34)*. If the shaft is tight in the bearing, use the thread protector to cover the threads of the shaft whilst driving it out.

Remove the six nuts retaining the front output shaft oil seal and tap the bearing from its recess.

This completes the dismantling of the selector housing.

Now we commence inspection of the components before re-assembly.

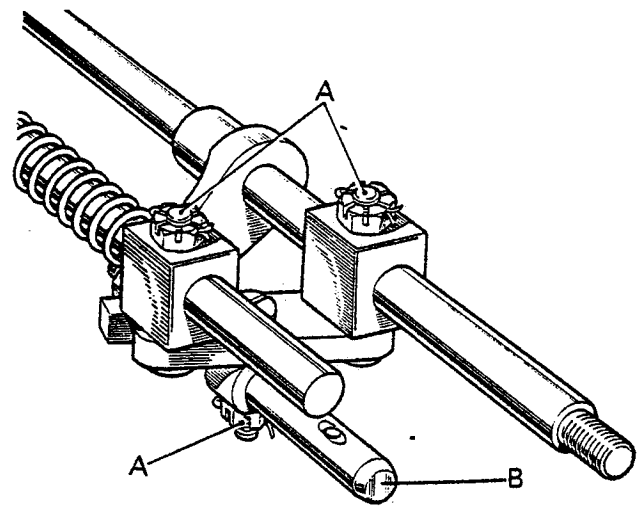


Fig. 35

Inspection of Selectors

Release the pivot bolts 'A' one at a time and examine each bolt and hole in the selector for wear. Each bolt should be examined and replaced individually to ensure correct refitting *(Fig. 35)*. Particular note should be taken when dismantling the pivot shaft 'B' as this component resembles a Chinese puzzle and may be reassembled incorrectly.

Study *(Fig. 35)* to ensure correct assembly.

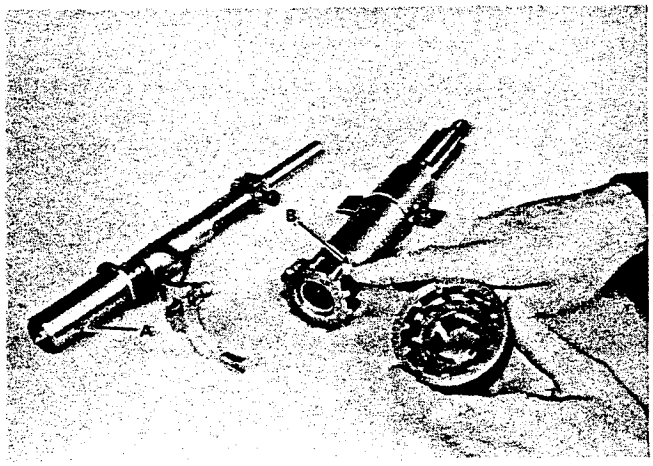


Fig. 36

Examine the bronze selector fork *(Fig. 36)* and dog for wear and renew the springs if showing signs of weakness.

Check that the plunger 'A' *(Fig. 36)* is secure on the four-wheel drive selector shaft and also check that there is no misalignment, particularly if a new securing pin 'B' *(Fig. 36)* has been fitted.

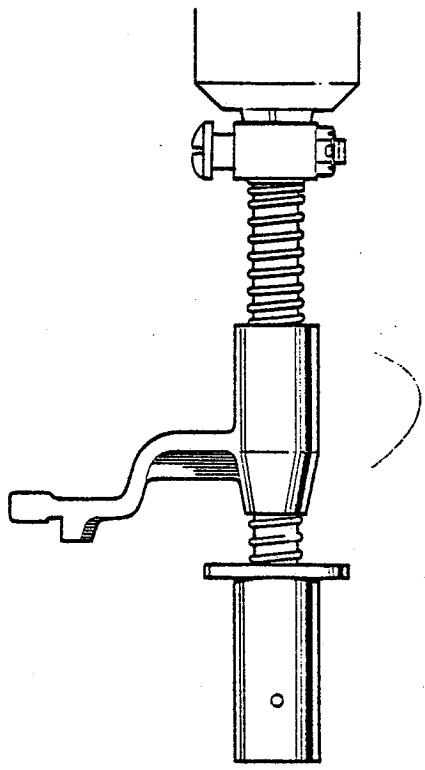


Fig. 37

Alignment is best checked as shown in *(Fig. 37)*. Mount the selector in a drill chuck, rotate slowly and check for concentricity. The plunger on early transfer casing was supported by bronze bushing which may be renewed. Later plungers fit directly into the aluminium casing. Any misalignment can cause the selector to stick, preventing four-wheel drive high being engaged by operation of the yellow knob. This problem should not be confused with failure to engage four-wheel drive high due to incorrect adjustment of the yellow knob control rod which is explained later.

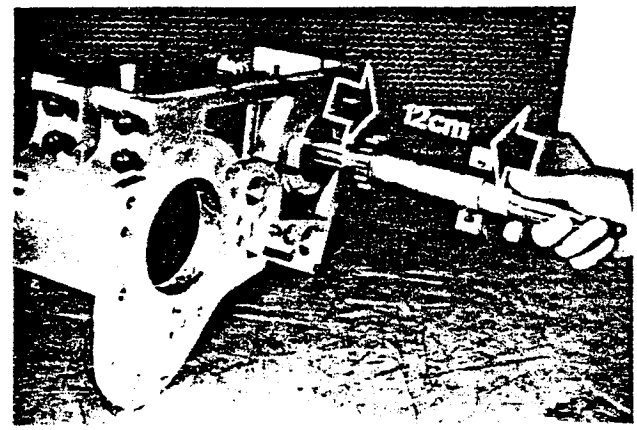


Fig. 38

Check that the oil thrower is secured approximately 12 centimetres (4¾ inches) from the gear end face and that the bronze bush is a sliding fit on the output shaft *(Fig. 36)*.

Having renewed, if necessary, the front output shaft bearing, apply sealing compound (Hylomar) to the bore of the seal housing and press in the seal so that it is approximately 2 mm (0.08 in) below the aluminium rim.

Fit the seal housing with a new gasket, install the front output shaft and drive flange and, using the special tool (part number 530105) tighten the castellated nut to 11.75 kgf m (85 lbf ft).

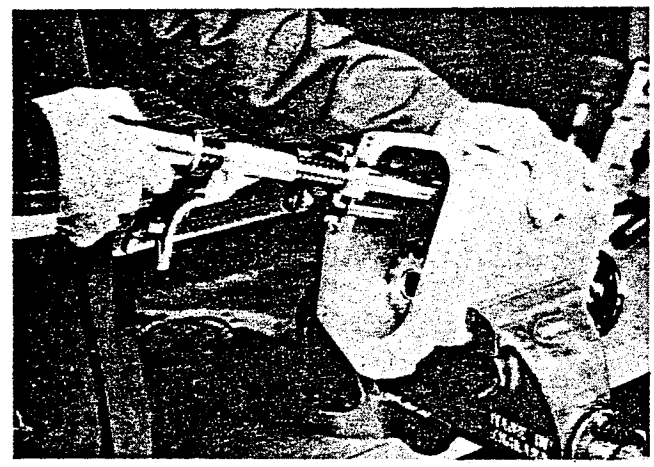


Fig. 39

Assemble the four-wheel drive high/low selector as shown in *(Fig. 35)* and partially install it in the housing as shown in *(Fig. 39)*. Fit the four-wheel drive selector dog.

Fit the spring, guide and distance piece before pushing the assembled selectors completely into the housing.

This completes the assembly of the selector housing, we will now assemble it to the transfer casing.

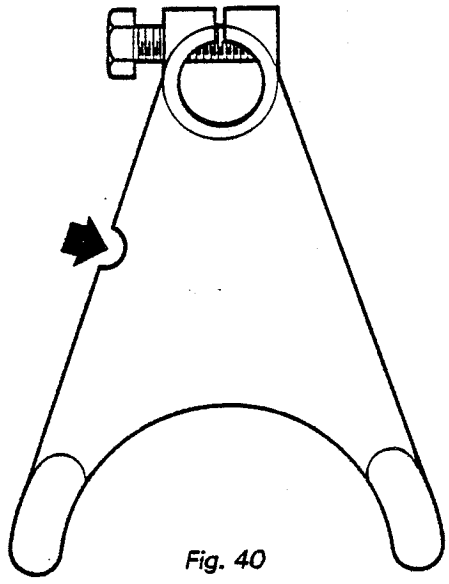


Fig. 40

Fit a new gasket and install the high/low selector fork into the transfer casing so that it locates on the low-speed gear with the cutaway edge of the fork (as shown in *Fig. 40)* toward the outside of the casing (right-hand side of gearbox).

Fit the selector housing ensuring that the fork is located correctly on the selector shaft, and secure the housing with two nuts only at this stage.

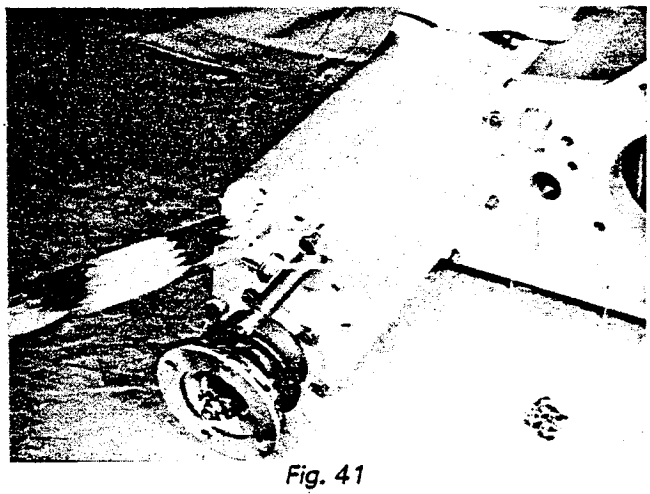


Fig. 41

Note the protrusion of the pivot shaft arrowed in *(Fig. 41)* as the next operation is to check the function of the selectors before finally securing all the fixings.

The selector operation should be checked by alternately pushing the four-wheel and high/low selector shafts inward. If the mechanism is assembled correctly, this should cause inward and outward movement of the pivot shaft.

If the pivot shaft does not move as described, the housing must be removed and the selector assembly rechecked. Secure the selector housing with the remaining fixings tightened to 2.7 kgf m (20 lbf ft). Fit the selector pinch bolt to the high/low selector fork *(Fig. 42)* and secure it with the fork midway in its slot, taking care that the bolt threads are not damaged as the bolt is tightened.

Fit the selector plunger, spring and plug. The yellow-striped spring is identical with that used on the reverse selector of the main box. Note that the brass plug has a flat top. It requires no sealing washer and must not be confused with that fitted in the main gearbox top cover. Refit the cover plate using a new gasket.

Fit the two selector '0' rings, the dust cover and the selector yoke.

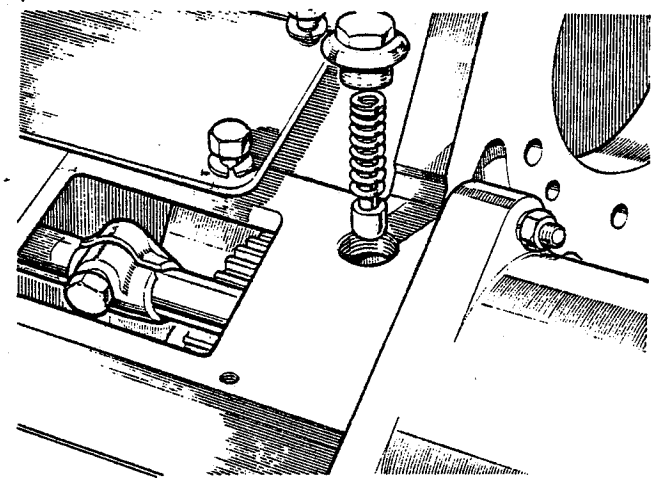


Fig. 42

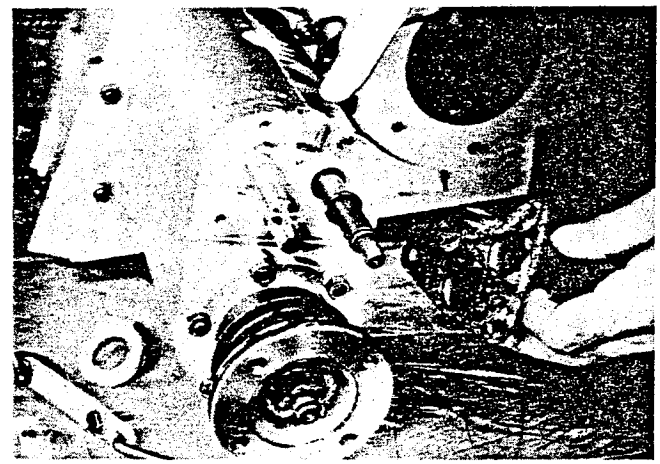


Fig. 43

Sealing compound should be used between the face of the dust cover and the casing as shown in *(Fig. 43).*

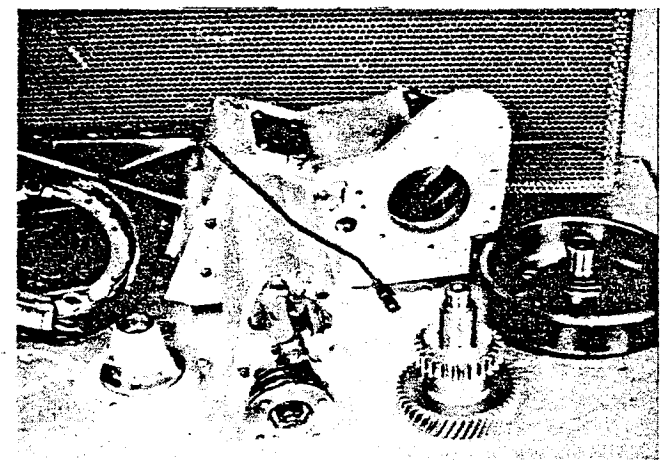


Fig. 44

Fit the four-wheel drive control lever and pivot bolt and lay all the components out ready for the next stage *(Fig. 44).*

This completes the overhaul and assembly of the transfer box.

Details of refitting the transfer box to the main box will be given after the overhaul details of the main gearbox.

LAND ROVER TRANSFER GEARBOX

A. You have been warned twice about the possibility of damaging the threads of a particular component in the Land Rover transfer box. In which of the following illustrations can this component be clearly seen?
   1. Figure 34 and Figure 24.
   2. Figure 21 and Figure 42.
   3. Figure 23, Figure 33 and Figure 29.
   4. Figure 32, Figure 14 and Figure 6.
   5. Figure 17.

B. Which of the following five options describes the power-flow through the gearbox relative to the gear position shown in Figure 2?
   1. The engine clutch drives the primary shaft in the main gearbox which causes the layshaft constant mesh gear to be driven. The layshaft is driving the smallest of the mainshaft gears which delivers the drive to the mainshaft via the synchromesh. The output shaft gear on the end of the mainshaft is meshed with the helical-cut teeth of the intermediate gear. The straight cut spur teeth of the intermediate gear is driving the straight cut spur gear on the output shaft to the rear wheels. The front output shaft is not being driven.
   2. The main gearbox primary shaft is driving the largest diameter helical gear on the mainshaft and its synchromesh via the layshaft gears. The mainshaft output gear is driving the intermediate gear which, in turn, drives the high-speed gear on the output shaft to both axles.
   3. The main gearbox primary shaft, which is driven by the engine and clutch, is connected directly to the mainshaft via the synchromesh and thus the drive is delivered to the output shaft gear on the rear of the mainshaft. This gear will engage by the controls with the straight cut helical gear on the intermediate shaft delivering the drive to the high-speed gear on the output shaft to the rear axle. The front output shaft is not turning since it is not engaged with the four-wheel drive selector dog.
   4. Power is delivered to the mainshaft and output gear via the 3rd/4th synchromesh. The output gear drives the helical intermediate gear which is meshed with the small diameter gear on the transfer output shaft. The helical gear on the transfer output shaft is engaged with the low transfer gear, which is splined to the output shaft and drives the rear wheels of the vehicle. The front road wheels and axle will be driving the front output shaft at the same speed as the rear output shaft is being driven.
   5. Figure 2 shows the vehicle travelling at high speed down a straight road. In this condition power is delivered to the layshaft via the primary shaft in the same direction as engine rotation, when viewed from the front of the vehicle. Assuming the main gearbox to be in gear, the layshaft will be driving the mainshaft in an anti-clockwise direction again when viewed from the front of the vehicle. The output shaft gear on the rear of the mainshaft will be driving the intermediate shaft high-speed gear clockwise. Since Figure 2 shows the controls in the four-wheel drive high ratio position, both axles will be driven at the same speed.

C. With which statement do you disagree?
   1. The principal advantages of a transmission handbrake over brakes which operate on both rear wheels are as follows:
      Short linkage and high mounted which makes it much less vulnerable to damage over rough terrain and less likely to freeze in cold climates.
   2. 18G 1336 is a fairly recently introduced Churchill tool for expanding the circlip on the end of the Land Rover mainshaft. Even when using this tool the circlip must be renewed when re-assembling the mainshaft component.
   3. The yellow knob should spring to the 'up' position as the red lever is pulled to the rear position but only if the gearbox was previously in four-wheel drive high ratio.
   4. When operating a Land Rover fitted with free wheeling front hubs, set in the free position, the vehicle must be brought to a halt and the free wheeling hubs locked before engaging four-wheel drive.
   5. The gears in the transfer box are locked in the low transfer position only by a spring loaded detent plunger which is retained by a brass plug.

D. Which statement is correct?
   1. The springs which hold the four-wheel drive selector fork in the central position are of different tension and must be fitted in such a way as to ensure that the fork is central on the shaft.
   2. The transfer box is vented to atmosphere via a slot, machined in the speedometer drive housing, adjacent to the hand brake backplate.
   3. The felt seal visible in Figures 13 and 15 is similar to the felt seal used in the Land Rover axle shaft drive flange.
   4. To rectify speedometer fluctuation, the cable must first be renewed.
   5. All the nut and bolt threads used on the Land Rover gearbox are UNF.

E. The following are complaints made by Land Rover owners claiming that the transfer box is suffering a malfunction. Which of the five complaints is valid and rectifiable by simple adjustment?
   1. 'So you're the Land Rover expert. Just come and look at this! It says in my book to pull the red lever back "so" and to press the yellow knob down "so", but it keeps springing up.'
   2. 'When I'm towing my horse box up a hill and pull the red lever back to get low gear, the gears make an awful noise, even if I push the clutch pedal down.'
   3. 'I bought this Land Rover to pull my caravan and when I came back complaining of heavy fuel consumption, you talked me into buying those gadgets on the front axle which do improve the fuel consumption as you said they would, but now I can't get through the mud with my caravan, because the gearbox is faulty. I can't engage four-wheel drive.'
   4. 'I know I've got different size tyres fitted but I don't see why that should make any difference to the gearbox. When I've driven round the track at the race meetings the gearbox and the steering seem to go all peculiar and I can't get the red lever out of four-wheel drive low ratio.'
   5. 'This is my first Land Rover and I think it's a wonderful vehicle but with the red knob pushed fully forward I just can't get four-wheel drive ratio. The yellow knob keeps springing up, no matter how hard I press it, it won't stay down. As I say, it's a great vehicle but I wish you'd change the colour of the red

and yellow knobs to black, because the kids keep playing with them and pulling the red lever into neutral. It's a big joke to them but not to me.'

F. Which statement is correct?
1. The three leaf springs fitted to the 3rd/top synchromesh unit are not renewable.
2. The front and rear output seals in the Land Rover transfer box are not inter-changeable.
3. The shims fitted behind a speedometer drive housing are available in fifteen different thicknesses.
4. The threads used on the various nuts and bolts in the Land Rover gearbox were changed to metric at suffix 'C'.
5. The overdrive which is an optional fitting on the Land Rover uses engine oil and has its own independent reservoir.

G. Which statement is incorrect?
1. A Land Rover being operated in four-wheel drive high ratio will have the red lever in the fully forward position and the yellow knob depressed. To revert to rear wheel drive only, the vehicle must be brought to rest and, with the clutch depressed, the red lever pulled fully rearwards and then pushed fully forwards. As the red lever is pushed forwards, the yellow knob will spring upwards.
2. A Land Rover being operated in four-wheel drive low ratio will have the red lever fully rearwards, the yellow knob if depressed will not remain in the down position but will continually spring up.
3. Four-wheel drive high ratio may be engaged at any speed in any gear providing all wheels are travelling at approximately the same speed and that free wheeling hubs, if fitted, are in the locked position.
4. The rear output shaft oil seal fitted in the speedometer housing was originally a single lipped seal which may be modified to the latest double lipped seal on any of the earlier gearboxes.
5. When operated in normal two-wheel drive, the large coil spring fitted on to the red lever selector shaft is held in tension by the yellow knob mechanism and is ready for instant release to engage the front wheel drive selector dog, by depressing the yellow knob. This can only be done if the proviso in option (3) is satisfied.

H. With which statement do you disagree?
1. When operating a power take-off with the vehicle stationary, the red knob lever should be in neutral position.
2. The intermediate gear thrust washer should be fitted with the steel face towards the gear.
3. Self locking nuts are used inside the transfer casing to secure the transfer box to the main gearbox.
4. A change from four-wheel drive low to two-wheel drive high may be carried out with the vehicle in motion.
5. The transfer gearbox fitted to one ton Land Rover is not the same as the type described in this Bulletin.

J. A measurement of 58 mm (2.312 in) refers to which of the following?
1. Free length of the two springs which are located each side of the four-wheel drive selector fork.
2. Compressed length of the spring fitted to the red knob selector shaft.
3. The position of the low gear selector fork on the selector shaft, prior to tightening the clamp bolt.
4. An adjustment to the hand brake linkage to ensure correct travel of the linkage before the brake shoes are applied.
5. An adjustment related to the four-wheel drive high ratio control.

K. With which statement do you disagree?
1. The oil capacity of the main gearbox is 1.5 litres and transfer capacity is 2.5 litres.
2. Option (3) of question (C) agrees with the movement of the gear levers shown in illustrations Figures 3 and 4 of this Bulletin.
3. When parking a Land Rover facing down a steep hill, the main gearbox should be engaged in reverse gear and the transfer gearbox in four-wheel drive low, with the hand brake applied.
4. GLR 120 is the part number of the overdrive kit which may be fitted to the rear of the main gearbox.
5. Land Rover gearbox fitted to diesel models has a higher transfer box ratio to compensate for the lower r.p.m. of the diesel engine.

PREPARATION

Apart from renewal of the rear main-shaft seal by access through the transfer box casing as described previously, the majority of work on the main box necessitates removal of the complete transmission from the chassis as detailed in the Repair Operation Manual.

With the gearbox mounted on a suitable workstand *(Fig. 45)*, detach the transfer box as described previously in readiness to start dismantling the main gearbox.

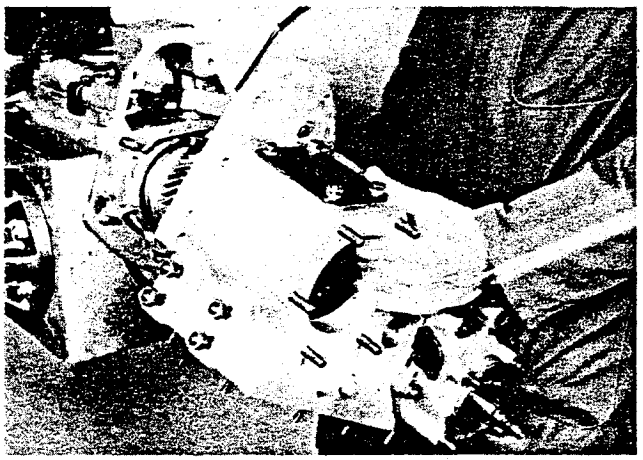


Fig. 45

DISMANTLING THE BOX

Dismantling of the main box begins with the release of the selector spring tension by removal of the retainer plates at each side of the top cover and the brass plug from the centre *(Fig. 46)*.

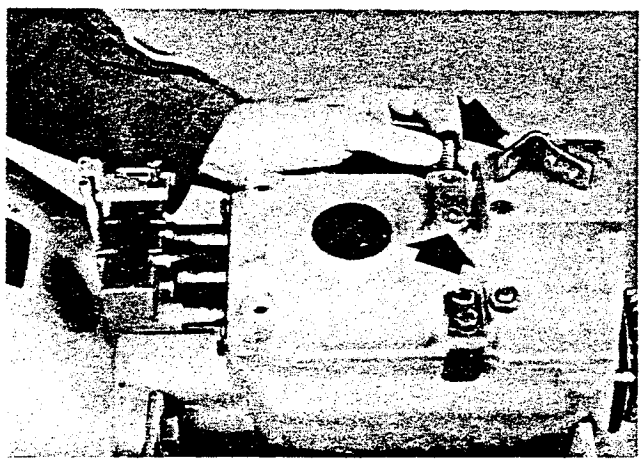


Fig. 46

This brass plug has a pip on its top surface and should not be confused with the flat-topped plug on the transfer box.

The spring location bore in each plug is a different depth.

Note also that the reverse selector spring on the right of the box is marked with a yellow stripe, it is the same spring which is used on the transfer selector and is stronger than those used on first/second and third/fourth selectors.

Remove the top cover *(Fig. 47)* and ensure that its face and the mating face of the casing are protected. The cover and casing are supplied as a matched pair and any damage to either will necessitate complete replacement.

Remove the three detent balls and interlocking rollers.

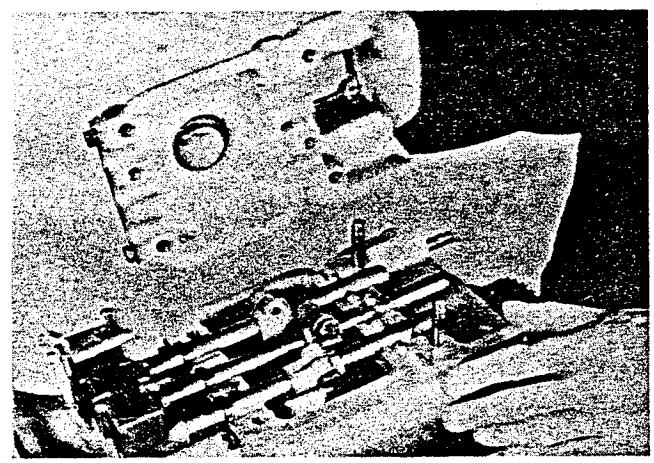


Fig. 47

Selector removal *(Fig. 48)*

Engage third gear, lift the reverse and second selector as high as possible and remove the third/fourth selector.

Lift out first/second selector and remove the reverse selector by turning it anti-clockwise through 90° as it is lifted out.

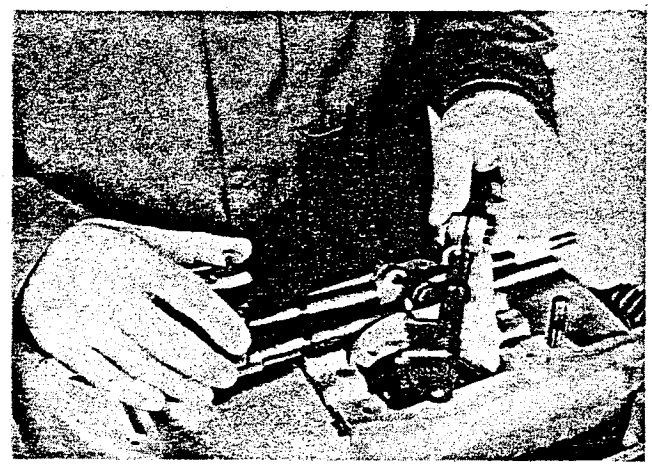


Fig. 48

Access to primary shaft seal

Detach the clutch lever by releasing the retainer from the pivot bolt, remove the plastic staple which attaches the lever to the bearing and remove the components *(Fig. 49)*.

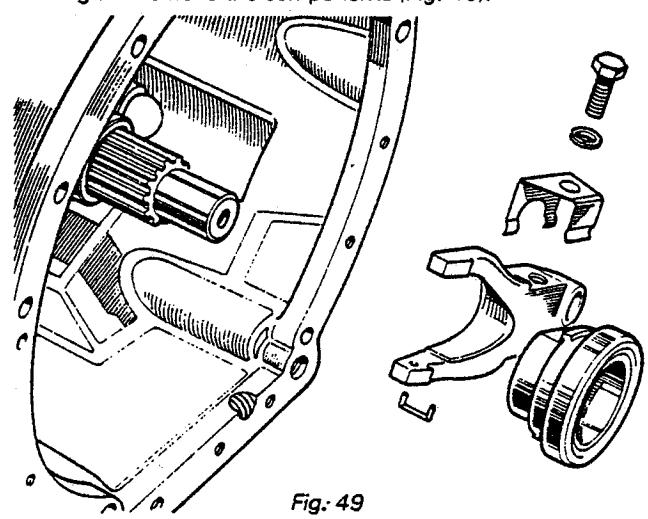


Fig. 49

Release the fixings and remove the clutch withdrawal extension sleeve to gain access to the primary shaft seal *(Fig. 50)*.

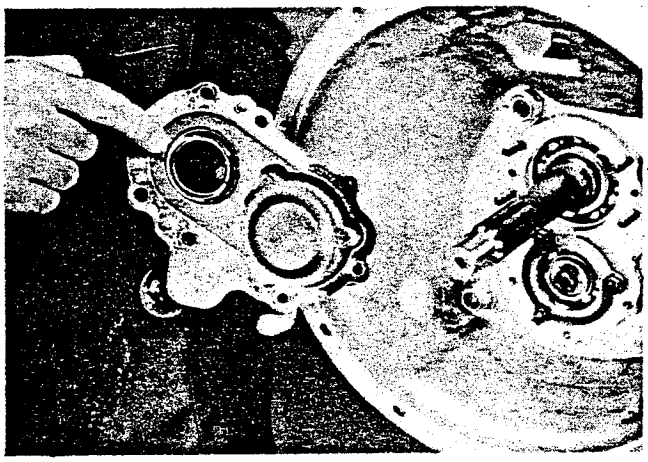


Fig. 50

To lock the mainshaft

Now select any two gears to prevent the shafts turning and release the layshaft retaining bolt.

At the rear of the box, bend back the lock washer tabs and remove the castellated nut using the special tool (part number RO 600300) shown in Fig. 51.

Remove the components to gain access to the oil seal. This seal may also be renewed with the gearbox in the chassis as previously described.

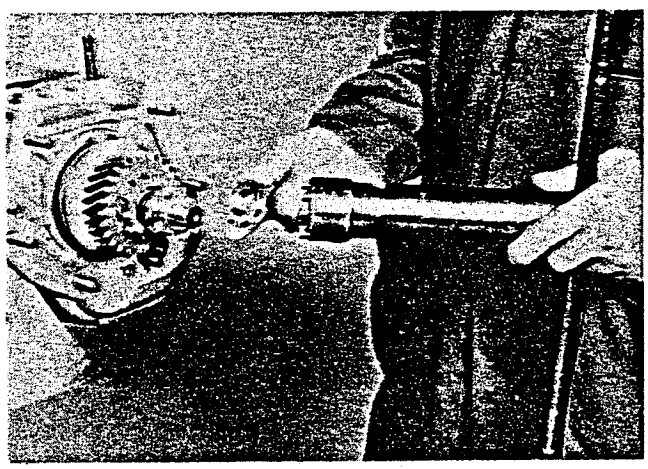


Fig. 51

Removal of gearing

Release the four bell housing self-locking nuts and holding the layshaft back inside the casing with a suitable piece of metal, dislodge the housing from the main casing.

The metal bar shown in Fig. 52 is screwed into the end of the layshaft.

Note that the primary gear, conical distance piece and spigot roller bearing will be detached by removal of the housing and should be restrained from falling.

Fig. 52

Remove the third/fourth synchromesh unit and layshaft *(Fig. 53)*.

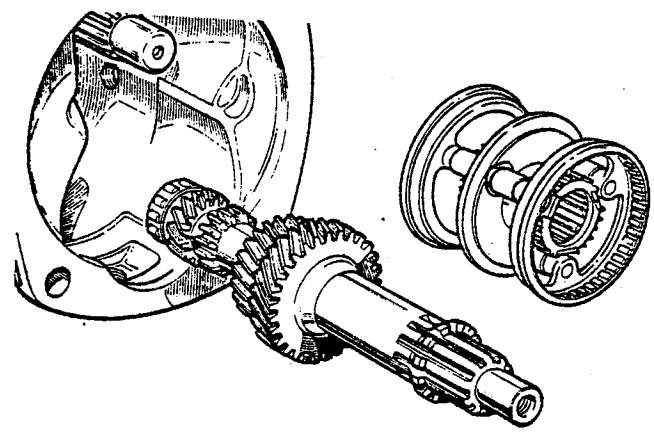


Fig. 53

Drive or press out the mainshaft from the rear bearing and casing and lift it clear *(Fig. 54)*.

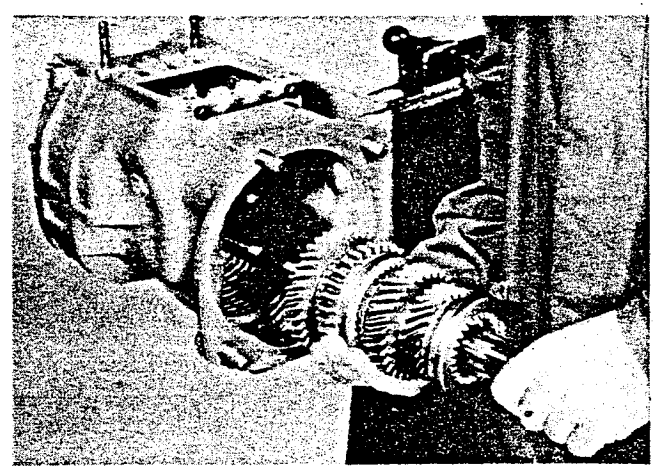


Fig. 54

Take care that the loose first gear components at the rear of the shaft are prevented from falling.

Remove the reverse shaft either by drifting or with the aid of the metric extraction thread provided *(Fig. 55)*.

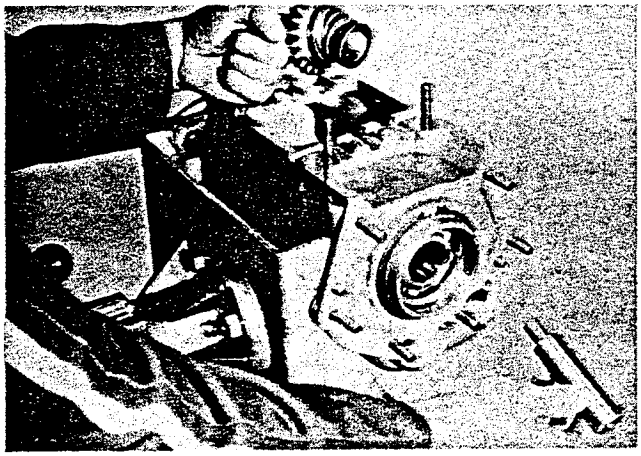


Fig. 55

Bearing renewal

If necessary, the rear layshaft bearing track can be removed by the use of a suitable drift.

The large circlip on the outside of the box retains the mainshaft bearing/seal housing and should not be disturbed as the housing is secured with Loctite during manufacture.

The mainshaft rear bearing is retained by a circlip accessible from inside the box. When the circlip is removed, the bearing may be driven or pressed out and a new bearing fitted *(Fig. 56)*.

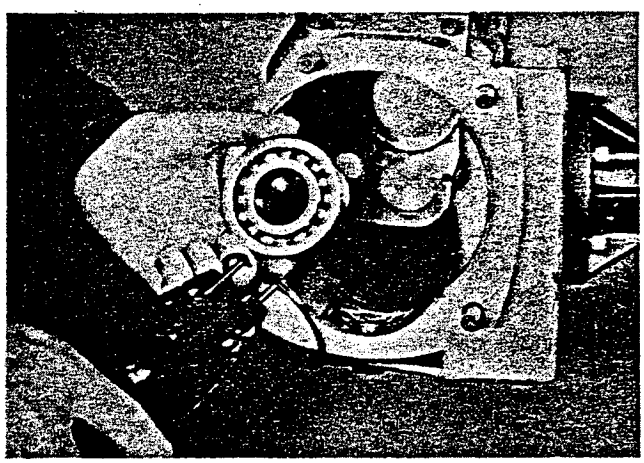


Fig. 56

Before continuing to dismantle the mainshaft we would like to remind you that in the previous course dealing with Land Rover 2¼ engines, it was suggested that you colour some of the diagrams to make the components easier to identify.

The colour code shown below is normally used for identification of electrical resistors and is therefore very useful for its own sake.

0 — Black
1 — Brown
2 — Red
3 — Orange
4 — Yellow
5 — Green
6 — Blue
7 — Violet
8 — Grey
9 — White

The selected items on the full page exploded view of the gear train *(Fig. 57)* should be coloured in accordance with the code which will help you to understand the construction and answer some of the questions later.

When the gear train colouring is completed continue:

Dismantling the mainshaft

Now we turn our attention to the dismantling of the mainshaft gearing.

Slide off the loose gears and washers from the rear of the shaft, taking care that the inner and outer members of the synchromesh unit do not separate *(Fig. 58)*.

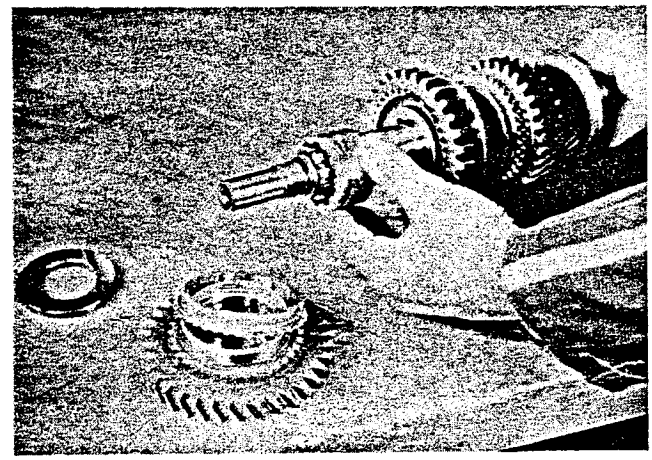


Fig. 58

The third and second gears are retained in position on the mainshaft by a snap ring which may be cut by a chisel at several points around its circumference so that it can be dislodged or can be removed using special tool 18G 1336 *(Fig. 59)*.

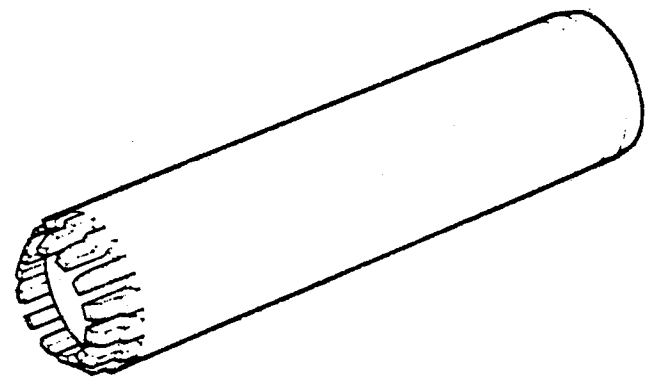


Fig. 59

Remove the third gear thrust washer, third gear bronze bush and the second gear.

Note that the second gear thrust washer is retained on the shaft by two pins and does not normally require replacement.

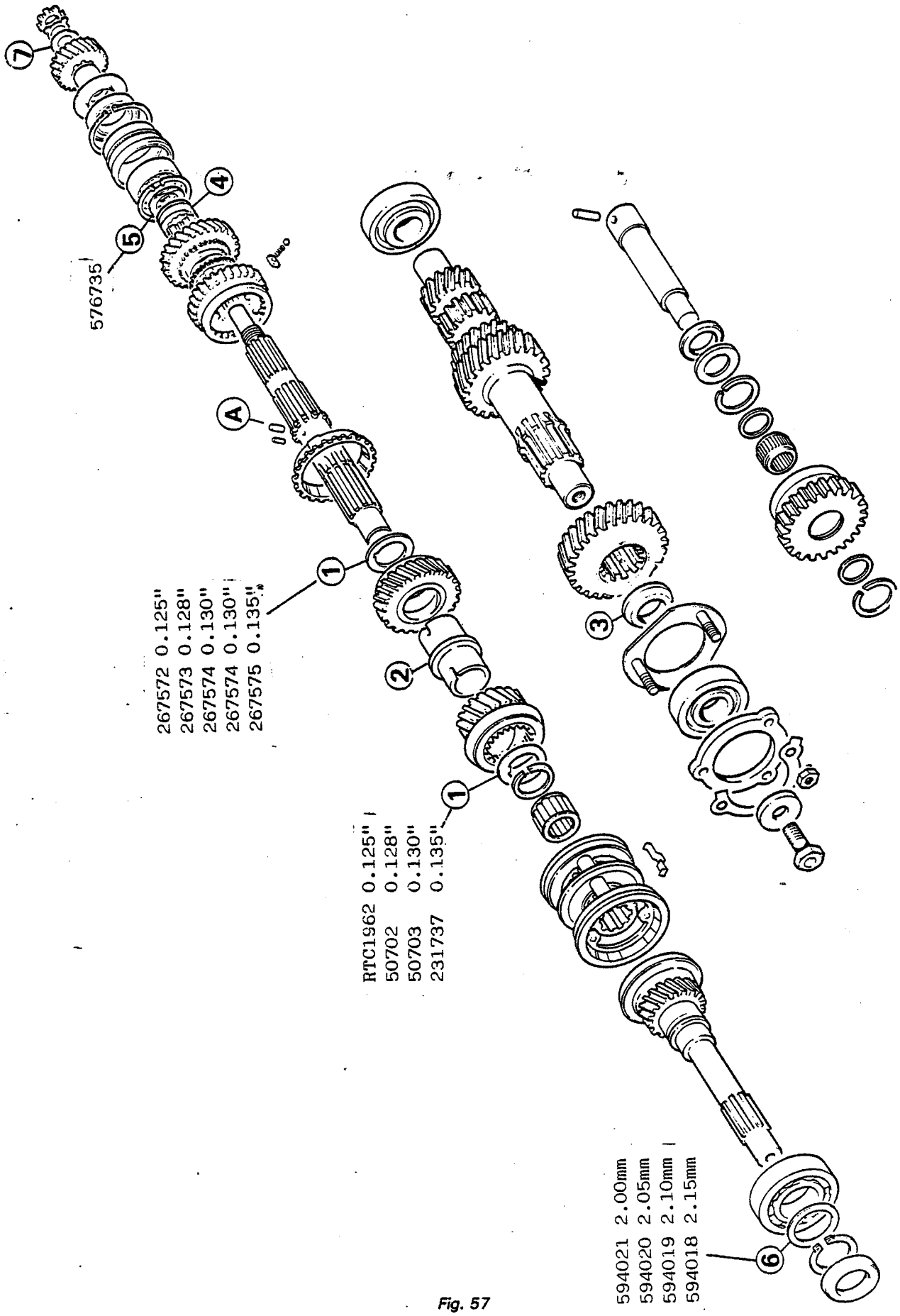

576735
267572 0.125"
267573 0.128"
267574 0.130"
267574 0.130"
267575 0.135"
RTC1962 0.125"
50702 0.128"
50703 0.130"
231737 0.135"
594021 2.00mm
594020 2.05mm
594019 2.10mm
594018 2.15mm

Fig. 57

Inspection of gearing

Carefully inspect the first and second gears for wear, paying particular attention to the four thick dog teeth on each gear which provide effective locking *(Fig. 60)*. The remaining teeth are thin.

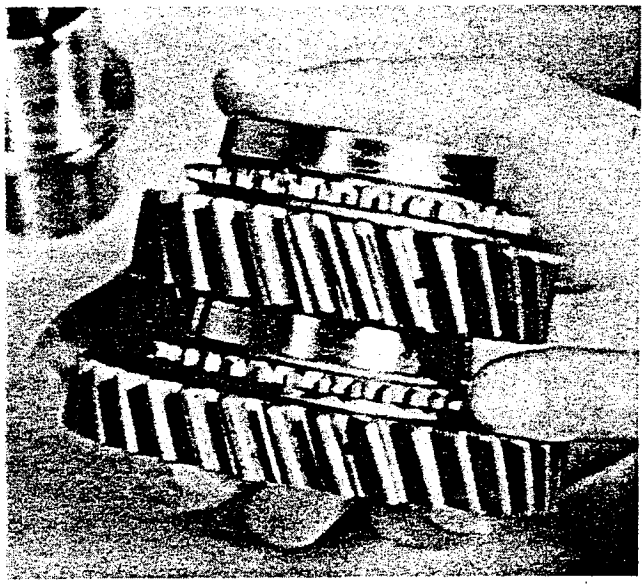


Fig. 60

Examine the bronze third/fourth synchromesh cones for wear. Carefully inspect the fourteen thin teeth and four thicker teeth on each side of the synchromesh inner member. This tooth arrangement, like that on first and second gears, ensures retention of the selected gear and particular attention must be given to the condition of the teeth.

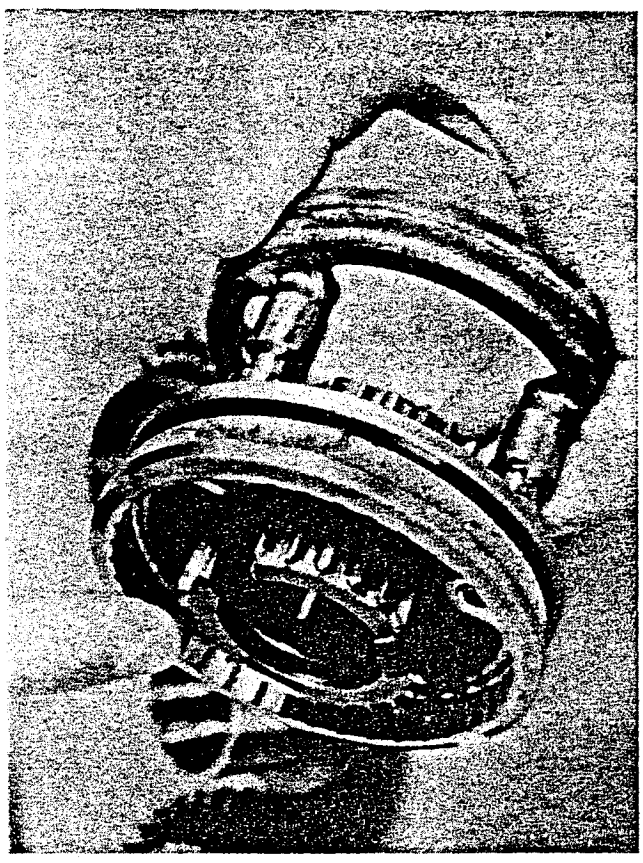


Fig. 61

Note also that there is a recess on the side of the synchromesh facing the third gear. The recess ensures clearance of the circlip on the end of the mainshaft *(Fig. 61)*.

Inspection of the splines on the first/second synchromesh necessitates dismantling the unit. First note that there are scribe lines on members which ensure correct relationship for reassembly *(Fig. 62)*.

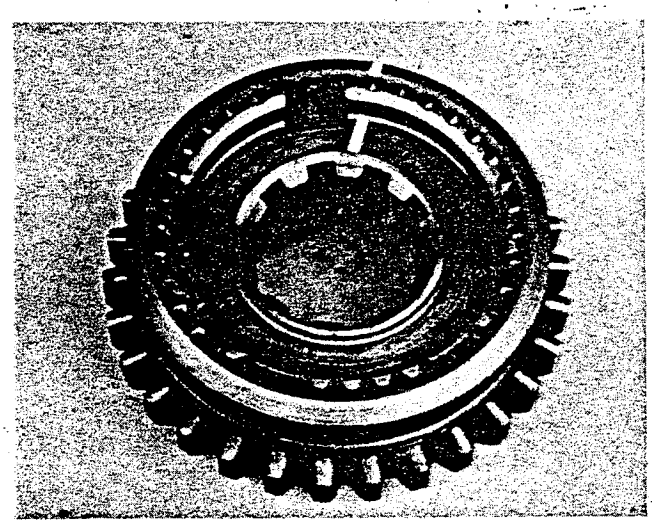


Fig. 62

Dismantling is best done by placing the unit and a bronze baulk ring into a bag or box so that when the baulk ring is used to press the centre out of the outer member, the ejected ball bearings and springs are contained *(Fig. 63)*.

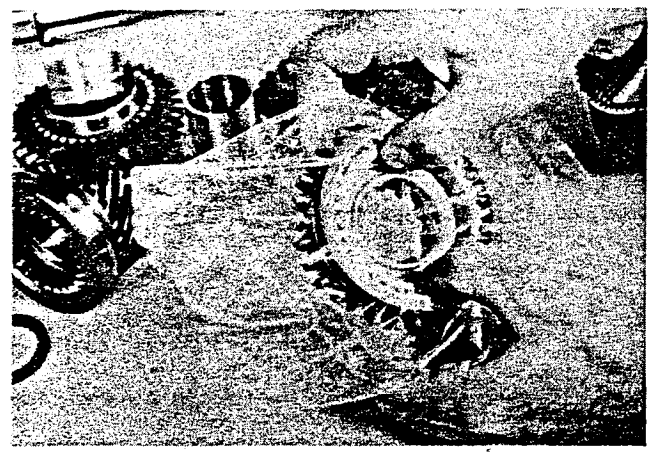


Fig. 63

Examine the inner and outer members for damage or wear. Particular attention should be given to the condition of the splines around the annular groove on the inner member. Any wear or damage in this area will necessitate replacement of the synchromesh unit.

Gear locking

The splines on the inner member of the first/second synchromesh unit are grouped in fours, four short splines and four long splines, as shown in Fig. 64. Closer examination will reveal that the short splines are slightly thicker than the long ones, shown again diagramatically in Figs. 65 and 66.

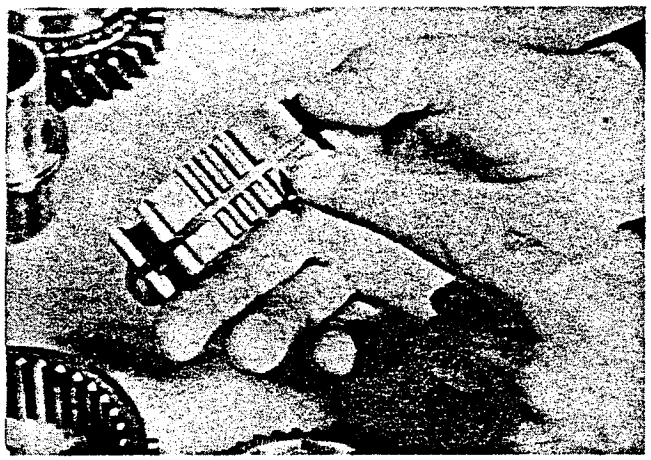


Fig. 64

Both of these diagrams should be coloured in accordance with the colour code given earlier, before proceeding with the following 'Explanation of operation.'

Explanation of operation

The side 'B' of the splines are aligned with one another whilst side 'A' are misaligned. Thus a step is formed at 'C' by the thick spline.

This step, as you will see, prevents disengagement of the gear when decelerating, on the overrun, down hill for example.

Figure 66 shows the splines of the synchromesh outer member (3) engaged with second gear dog teeth (2). The arrows show the path of the driving force.

It is obvious from this diagram that for second gear to become disengaged, the synchromesh outer member must ride 'up and over' the step 'C' formed by the thick spline.

The condition of the step is of primary importance when deciding if the component should be renewed during overhaul.

There is nothing you can do but change the worn components, but it is satisfying to be able to pinpoint the wear causing the trouble, which is after all what we call 'diagnosis'.

The thick and thin spline arrangement is also used, by the way, on the transfer box output shaft to lock the low gear ratio. Have a second look at the output shaft splines to confirm this.

The dog teeth on the right in Fig. 66 are those of 1st gear which employs a different type of locking system and is described in the following paragraph.

This other method is not only employed for locking 1st, 3rd and 4th gears but is also used on 2nd gear in addition to the system already described.

Examine 1st and 2nd gear dog teeth and the splines on the 3rd 4th synchromesh shown in Figs. 60 and 61. First and second gears have four thick dog teeth among a majority of thin ones. The 3rd 4th synchro has three groups of six splines, one group of which has four thick splines all the remainder are thin.

The spacing of the thick dog teeth on 1st/2nd and the thick splines on 3rd/4th synchro are so arranged that the drive load, during acceleration, is equally spread to all the teeth and splines. However, on deceleration the four thick teeth or splines take the initial overrun loads, this causes a force eccentric to the mainshaft axis to be applied to the synchromesh which in turn locks the synchromesh in the selected gear position.

The latest gearboxes have thick and thin splines on both ends of the 3rd/4th synchromesh, whereas early sychromesh had the four thick splines only on 3rd gear end. The latest synchromesh can be used in place of any of the earlier units.

I am sure that armed with this kind of information and there is more to come, you will look a little closer at any gearbox overhauls you carry out in future.

Since the introduction of the all synchromesh gearbox on the Land Rover a number of modifications have taken place to the reverse and first gears which also affect the layshaft.

The summary on page 24 with Figure 70 and the paragraph headed 'Interchangeability of Parts' on page 23 should help to clarify the situation. This does not, however, explain what a 'Z' shaft is and does, for example, so let us take a closer look at it.

The 'Z' reverse shaft so named because of its shape, is designed to ensure that the gear remains engaged once selected.

Many different methods of locking a gear in the engaged position are open to the designer and many new ideas have yet to be invented. One of the original methods was to load the selector shaft with spring and ball detents to prevent gear disengagement. Although this method works quite well, in some gearboxes the forces trying to disengage the gear are so powerful that you would need two hands to move the lever against the spring loading in order to change gear.

With more powerful engines and the demand for more compact transmission design, the engineers have been compelled to look for better methods of 'in gear locking' as we explained previously, using first, second, third and top as an example.

The 'Z' shaft works on quite a simple principle, which is best understood by reference to Fig. 67 showing suffix 'A' reverse gear arrangement when looking from the top of the gearbox, i.e. in plain view.

Colour Key to Fig. 67

2 = 'Z' shaft
3 = Reverse gear
5 = Reverse gear bush
6 = Layshaft/mainshaft gears

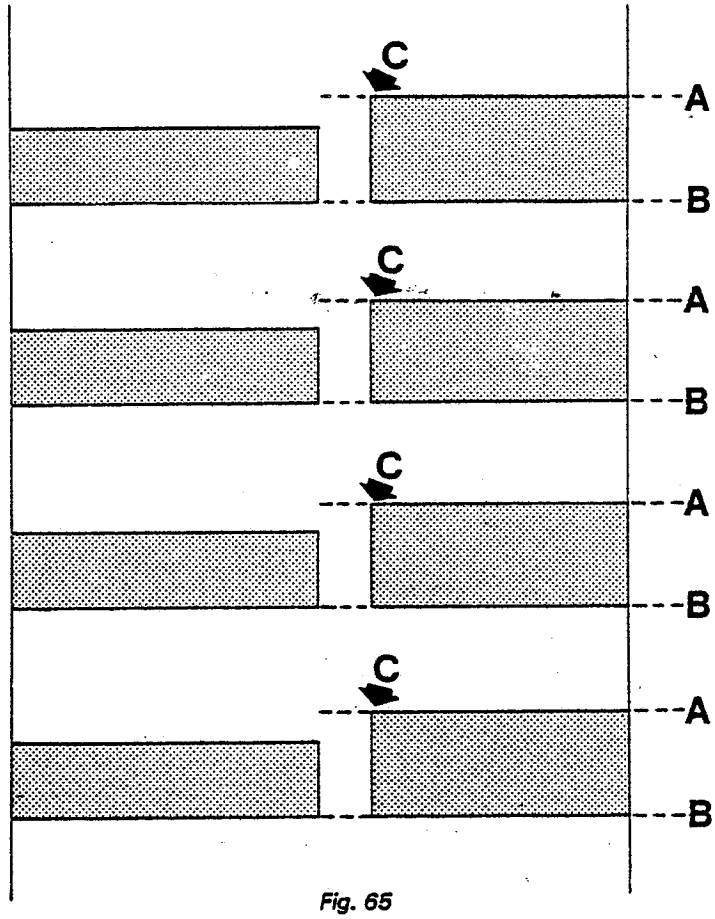


Fig. 65

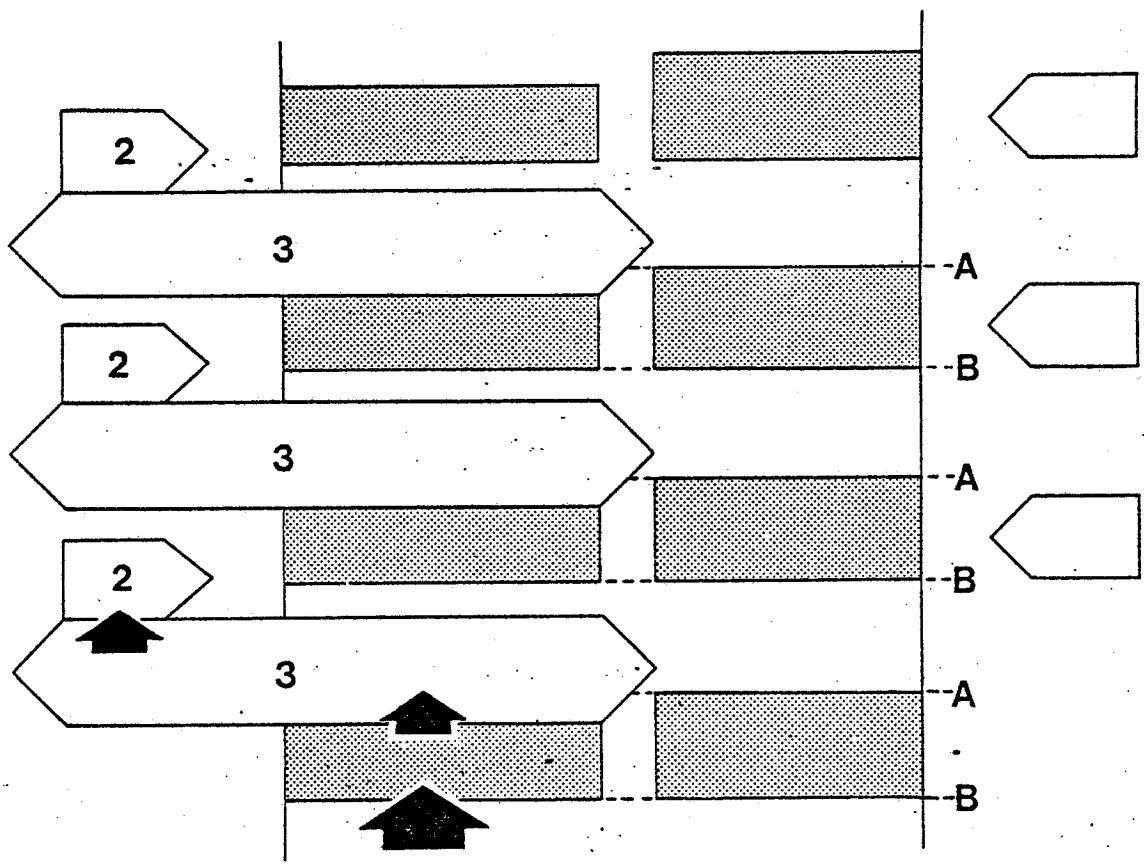


Fig. 66

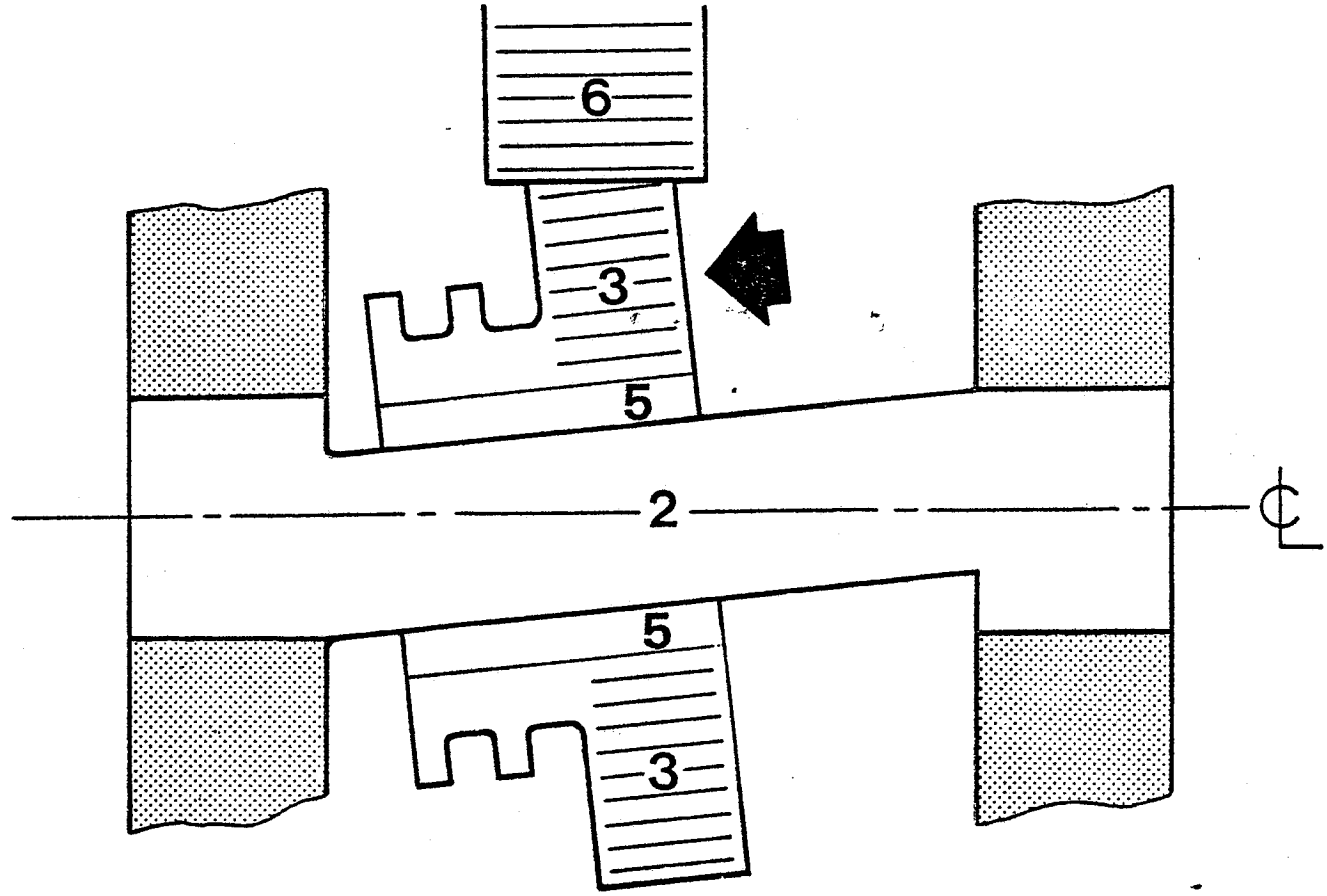


Fig. 67

Here we see that the reverse shaft is not machined parallel but is roughly 'Z' shaped when viewed from the top of the gearbox.

The reverse gear, when driven by the layshaft or the mainshaft gear, has a natural tendency to move out of mesh (in the direction of the arrow) but is prevented by the limited selector shaft travel (not the ball detent). Obviously it is important that the reverse shaft is not allowed to turn. If the latter happened the natural tendency of the gear would be to move in the other direction and disengagement would occur.

This system is quite clever and works well but the shaft is a comparatively costly item to machine. An even neater idea has been taken from the Range Rover box and was introduced on suffix 'B' gearboxes.

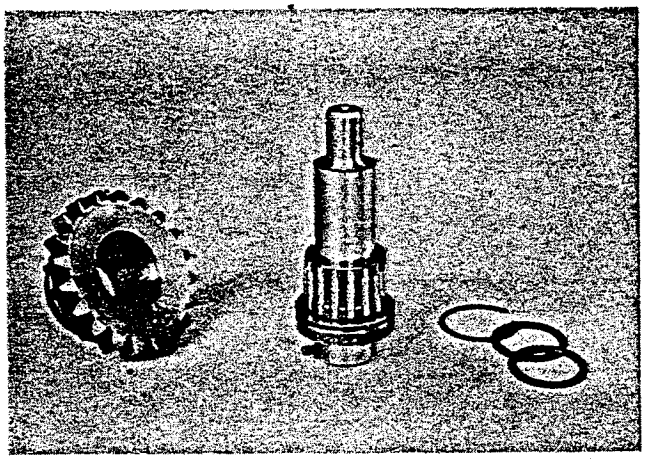


Fig. 68

If you examine the parts shown in Fig. 68, I doubt if you will spot what keeps this gear engaged.

The shaft is larger in diameter than the 'Z' shaft (which has no bearing on how it locks) and is machined parallel (roll it on a flat surface and see). The gear has no odd thickness and the roller bearing looks like any other, but in fact the bearing is not quite the same as an ordinary needle roller—it is twisted.

The needle bearing cage is twisted during manufacture. This twist causes the gear to tilt on the shaft, the result being exactly the same as the 'Z' shaft.

The twist causes the gear to thrust towards the rear of the gearbox *(Fig. 69)*, where it contacts one steel and one bronze thrust washer. As the washers are stopped by the casing the gear must stay engaged.

If the bearings are worn and loose their twist, the gear may disengage.

Colour Key to Figure 69

1 = Steel washer
2 = Reverse shaft
3 = Reverse gear
4 = Bronze washer
5 = Twisted bearing
6 = Layshaft/mainshaft gears

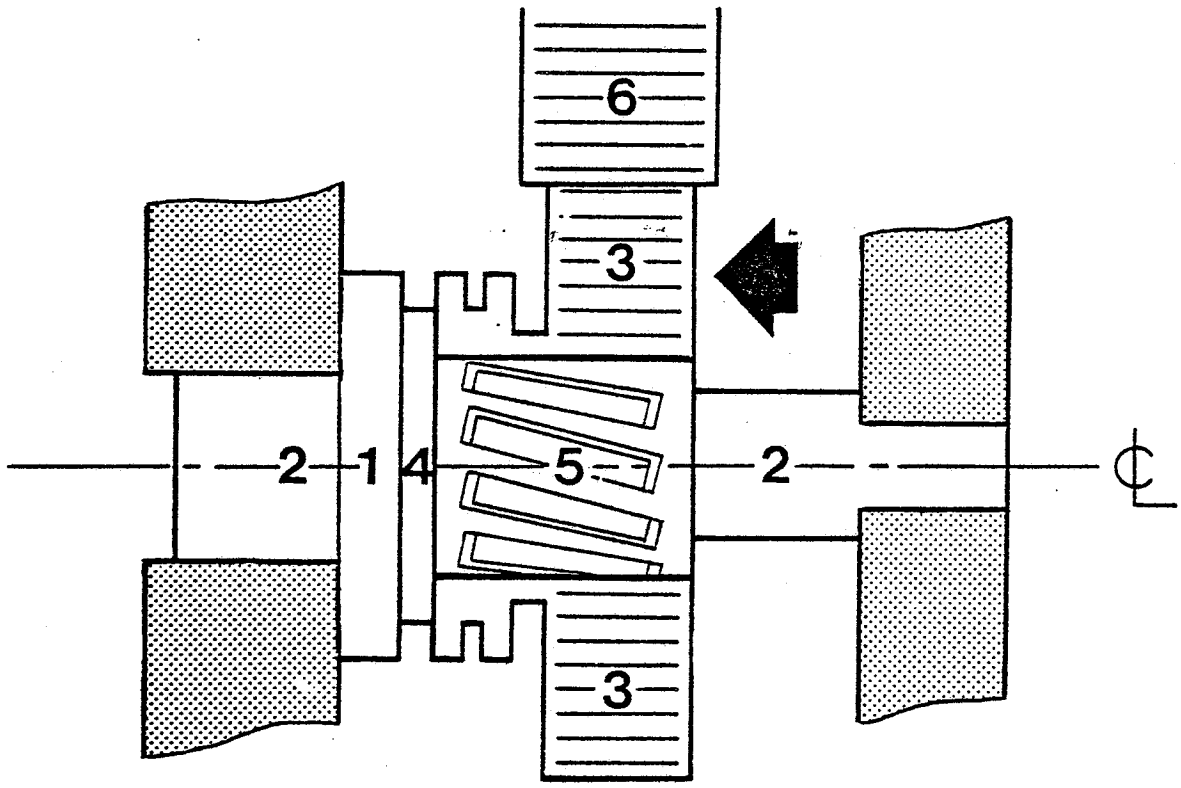


Fig. 69

Interchangeability of Parts

To update a suffix 'A' gearbox the following suffix 'B' parts should be fitted:

1st/2nd synchromesh unit RTC 2195—30 thick teeth.

Layshaft FRC 1691—which has thicker reverse teeth to suit the new 1st/2nd sychromesh and is identified by letter 'D'.

The suffix 'B' reverse shaft and gear cannot be fitted into the suffix 'A' gear casing because of the difference in the reverse shaft diameter. To overcome this a special 'reverse gear' FRC 1893 is available. This gear has 20 thick teeth and a small bore bush so that it will fit the original 'Z' shaft.

Suffix 'A' gearbox may also be updated to suffix 'C' specification by fitting the following parts:

1st gear FRC 2056 is identified by the letter 'C' with 31 teeth and ratio of 3.729:1.

Layshaft FRC 2084 is identified by the letter 'C' and 14 teeth first gear.

Special reverse gear FRC 1893 using original 'Z' type shaft.

Suffix 'B' gearboxes may be updated by using suffix 'C' parts as listed against Fig. 70.

None of the early gearbox parts must be fitted into later suffix models.

SUMMARY OF GEARBOX COMPONENT APPLICATION & IDENTIFICATION

Colour the component parts in Figs. 70-A, B, C) also the text reference numbers, using the colour code recommended on page 17:

Suffix 'A'

First/second synchromesh unit (2). 31 thin teeth. Part No. 608283.
First gear. 35 teeth (5). 3.684 : 1 ratio. Part No. 591362.
Bushed reverse gear (6). 21 thin teeth. 4.061 : 1 ratio. Part No. 576707.
'Z' type reverse shaft (3). Bearing diameter 0.8 in. (bore in casing to suit). Part No. 591527.
Reverse gear on layshaft (4). 13 thin teeth:
First gear on layshaft (1). 16 teeth.
Layshaft. Part No 576686.

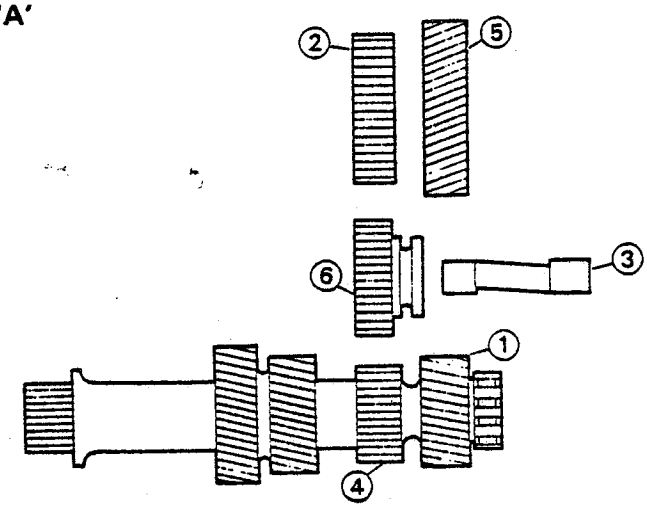


Fig. 70 A

Suffix 'B'

Casing thicker with ribs and large bore for reverse shaft.
First/second synchromesh unit (2). 30 thick teeth. Part No. RTC 2195.
First gear (5). As suffix 'A'.
Angled needle roller bearing reverse gear (6). 20 thick teeth. Part No. FRC 1810.
Parallel reverse shaft—large diameter (3). Part No. FRC 1813.
Thrust washers for reverse gear (Fig. 69—1 & 4).
Reverse gear on layshaft (4). 13 thick teeth. Shaft identified by letter 'D' stamped on shaft.
First gear on layshaft (1). 16 teeth.
Layshaft. Part No. FRC 1691.

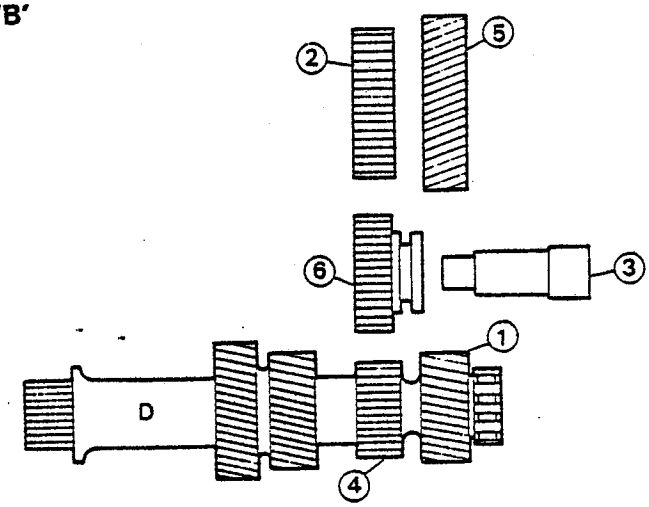


Fig. 70 B

Suffix 'C'

Casing as suffix 'B'.
First/second synchromesh unit same as suffix 'B' (2).
First gear (5). 31 teeth. 3.729 : 1. Identified by letter 'C' stamped on gear. Part No. FRC 2056.
Reverse gear as suffix 'B' (6).
Reverse shaft as suffix 'B' (3).
Reverse gear on layshaft (4). 13 thick teeth but first gear on layshaft (1) has 14 teeth.
Layshaft identified by a letter 'C' stamped on the shaft. Part No. FRC 2084.

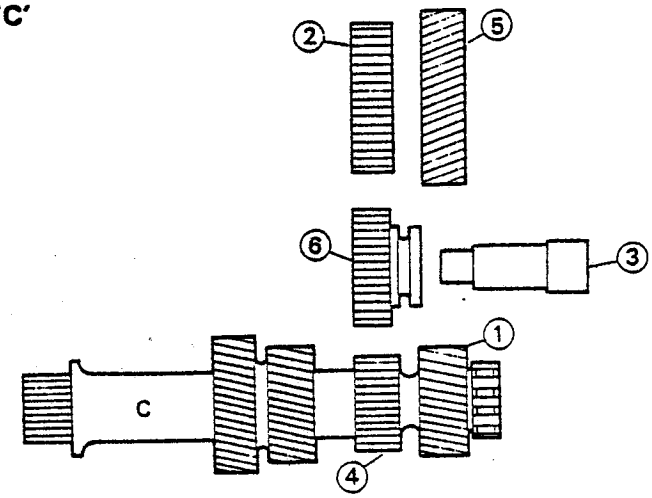


Fig. 70 C

Now back to the practical aspect of the gearbox.

Clearance and end float

Check the condition of the baulk ring by placing it on its gear and ensuring a clearance of not less than 0,64 mm (0.025 inch) exists between the shoulder of the gear and the baulk ring face.

Check the end float of the second gear by assembling it onto the appropriate end of the bronze bush with a thrust washer held against the face of the bush as shown in Fig. 71. A clearance of 0,10 to 0,18 mm (0.004 to 0.007 inch) should be detected between the face of the gear and the shoulder of the bush.

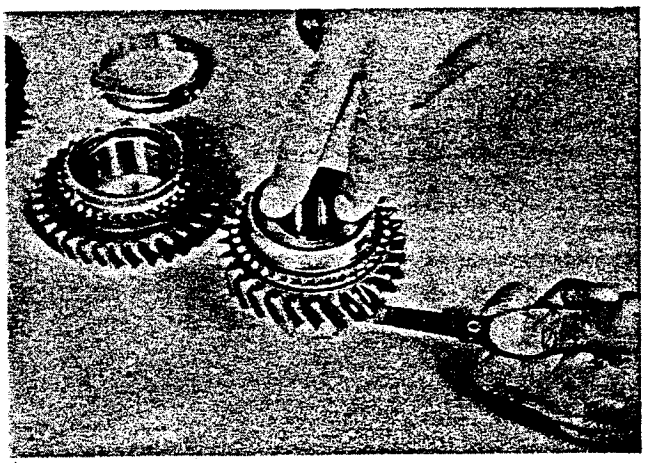


Fig. 71

Clearance can be decreased by rubbing down the end face of the bush on a piece of fine grade emery paper over a flat surface but special care must be taken that the correct end of the bush is rectified *(Fig. 72.)* If the bush is too short for the appropriate gear, a new bush must be fitted and assembly re-checked.

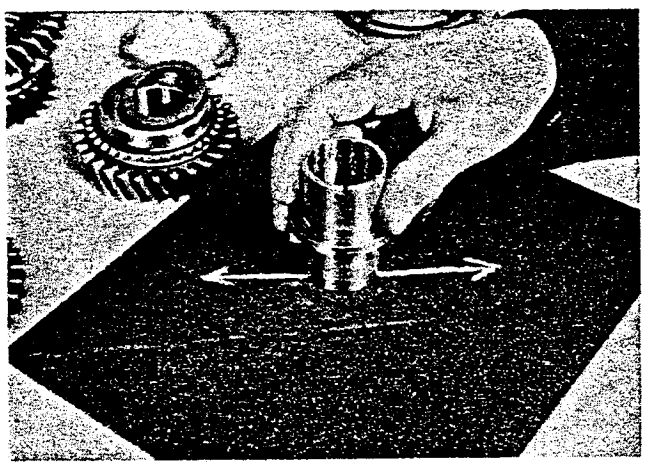


Fig. 72

When the second gear end float is correct, check third gear in exactly the same manner.

With gear end float correct, place the mainshaft in the end plate for support and assemble the bush, selective washer and snap ring onto the shaft to check the bush end float as shown in Fig. 73. This should be between 0,025 and 0,2 mm (0.001 and 0.008 inch).

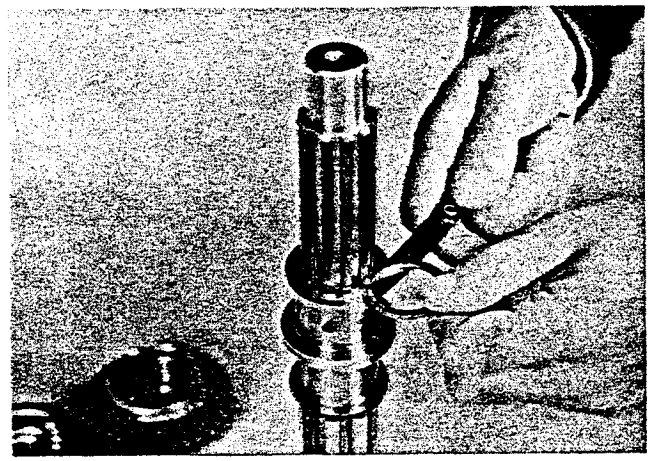


Fig. 73

The bush must not be rubbed down to produce this end float which is controlled by the selection of a suitable thrust washer from a range of four different thicknesses.

MAINSHAFT ASSEMBLY

When the bush end float is correct, assemble the bush and the gears onto the shaft using a little lubricating oil. Fit the selected thrust washer, retain with a new clip and put aside.

Now we see how to assemble the first/second synchromesh and this view illustrates the components of the inner member *(Fig. 74).*

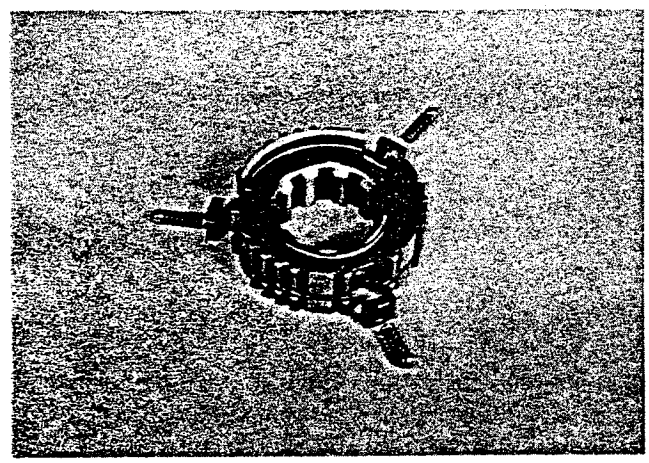


Fig. 74

Particular care should be taken that the square sliding guide blocks are fitted correctly with the slightly convex faces to the outside.

Here we show the relationship of the members, correctly aligned for reassembly using short lengths of 3 mm rod. Realignment of the assembly marks will ensure that the ball bearings locate in the deepest location grooves in the outer member.

Assemble the synchromesh unit with the aid of pieces of 3 mm rod as shown in Fig. 75. Locate the three springs and the guide blocks on the ends of the rod and insert these into the inner member. Then remove one rod, retaining the sliding block by hand, and insert a ball bearing. Repeat this operation to install the other ball bearings and complete the assembly. Force should not be necessary in this operation and can only result in spring damage.

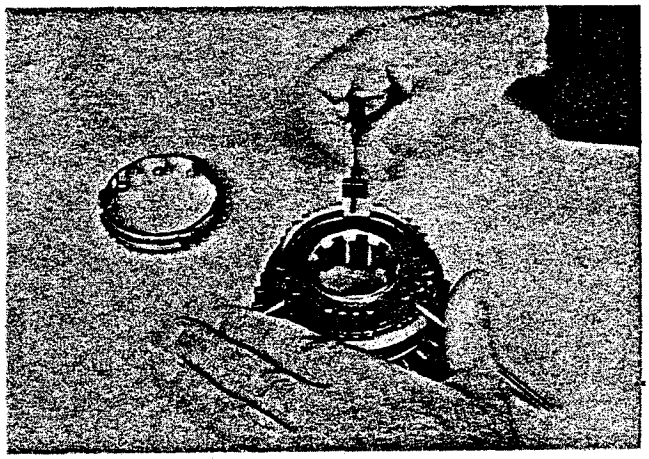


Fig. 75

Fit the first/second synchromesh unit complete with baulk rings to the partly-assembled mainshaft, followed by the first gear bush with its annular lubrication groove to the rear of the shaft as shown in Fig. 76.

Fit the first gear and thrust washer with its grooved face towards the gear on the shaft.

Put the mainshaft assembly aside until required for installation into the casing.

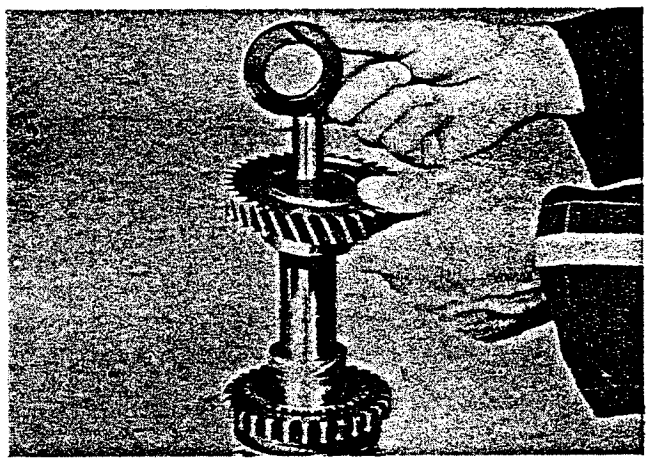


Fig. 76

REVERSE GEAR ASSEMBLY

Ensure that the latest reverse gear is fitted with the bronze washer next to the gear and the steel washer next to the casing *(Fig. 77)*.

Locate the Mills pin in its groove in the casing.

INSTALLATION OF GEARING

With the rear mainshaft bearing in position, install the mainshaft ensuring that the washers fitted behind the first/second synchromesh are correctly located on the shaft, and press or drift the shaft into the rear bearing.

Inspect the layshaft for wear or damage and replace as necessary.

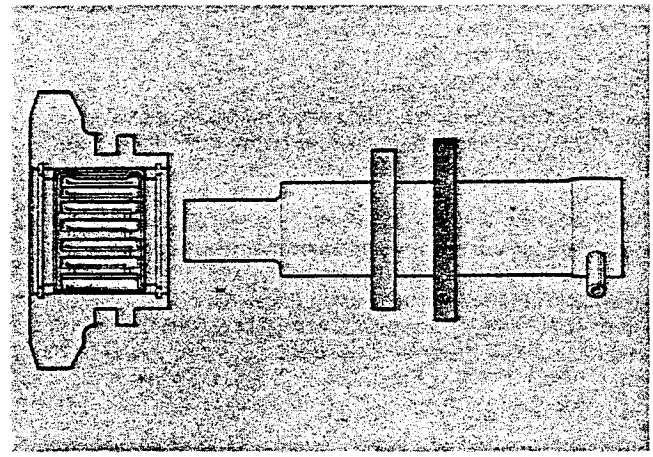


Fig. 77

With the layshaft bearing fitted and lubricated, locate the shaft into the rear bearing in the casing.

Fit the third/fourth synchromesh ensuring that the recessed side of the inner member faces third gear *(Fig. 78)*. This completes the installation of the main gear train.

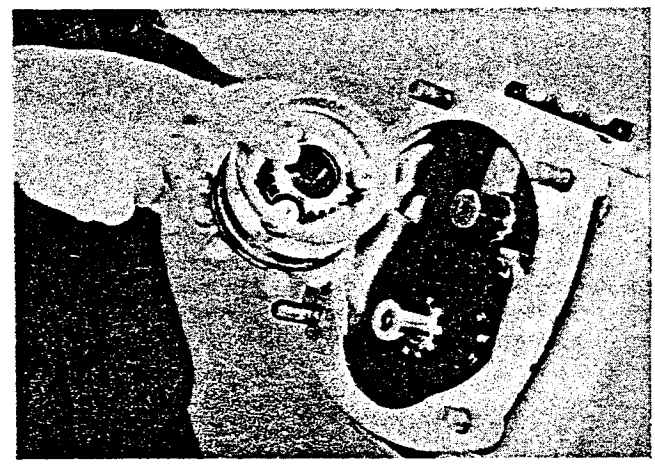


Fig. 78

Primary shaft, gear and bearing

Now we turn to the primary gear assembly located in the bell housing.

Using a hide-faced hammer, drive the primary shaft, complete with ball race, out of the housing.

Bend back the lockplate and remove the three nuts and retainer plates to release the layshaft bearing.

If necessary, remove the circlip and selective washer to allow removal of the primary shaft bearing.

The primary shaft and its mating layshaft gear are supplied only as a matched pair.

Press the new bearing onto the primary shaft and fit the distance washer and circlip. When the circlip is in position, the washer selected must be free to rotate with minimum end play *(Fig. 79)*. Four thicknesses of washer are available.

Refit the layshaft front bearing and secure the nuts with a new lockplate.

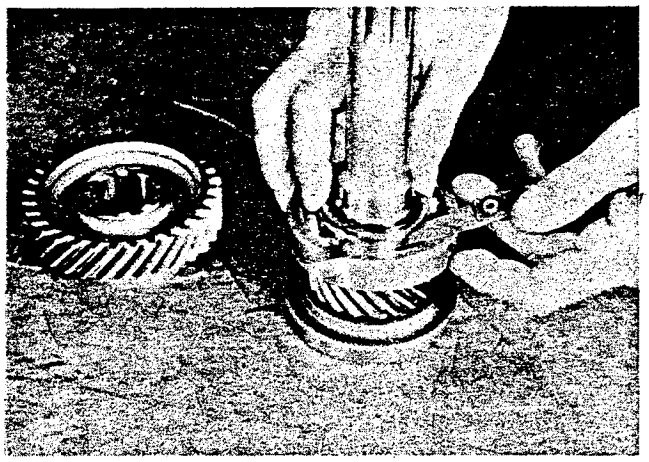


Fig. 79

Refitting the bell housing

When reassembling the primary shaft into the bell housing, ensure that the retainer plates are correctly fitted as shown in Fig. 80. These plates are handed and it is therefore possible to fit them incorrectly so that they foul the gear teeth.

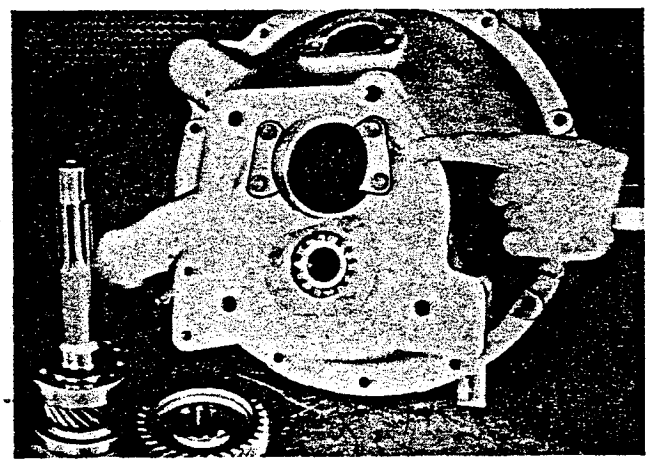


Fig. 80

Next, check that the primary gear will slide on to every spline of the layshaft, this will prevent difficulty when fitting the bell housing.

Assemble the conical distance piece and the primary gear to the primary shaft and bell housing, ensuring that the tapered face of the distance piece is toward the front.

Lubricate and fit the spigot bearing into the primary shaft.

Fit a new gasket lightly smeared with grease to the casing and, using a suitable pilot fitted to the end of the layshaft, assemble the bell housing to the main casing.

Difficulty at this stage is usually because the primary gear is not a 'sliding' fit on the layshaft splines.

Secure the assembly by applying the four retaining nuts firmly but not tightly and check that the layshaft bearing end clearance is not less than 0,12 mm (0.005 inch) by pushing and pulling the shaft *(Fig. 81)*.

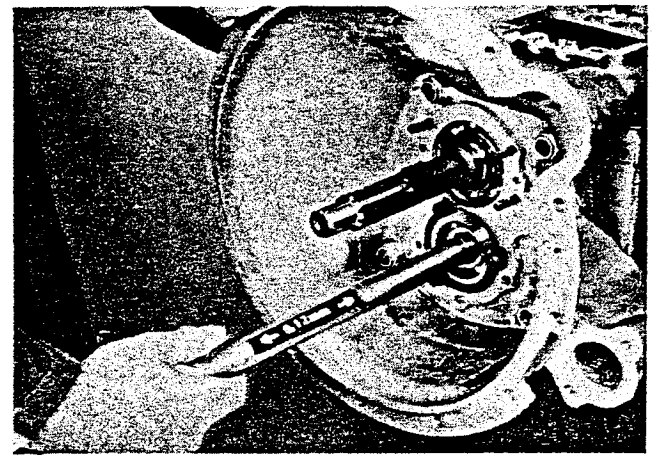


Fig. 81

The layshaft bearing end clearance (arrowed—*Fig. 82)* is determined by the thickness of the selective conical distance piece shown here, behind the bearing on the front of the layshaft.

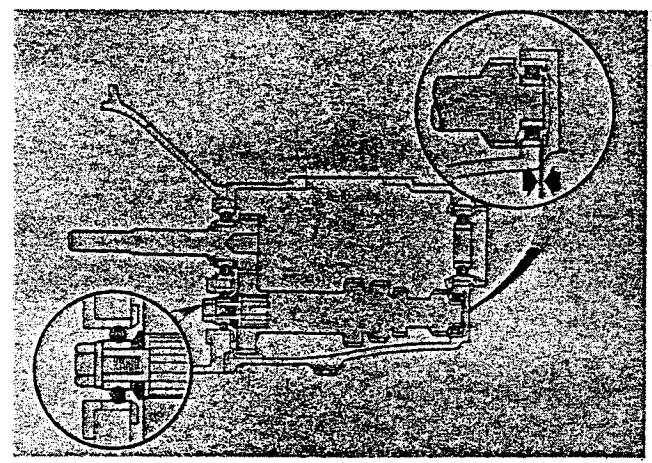


Fig. 82

Layshaft bearing clearance may be checked without the mainshaft in position as shown in Fig. 82.

Selection of an incorrect distance piece will cause excessive load on both bearings and subsequent failure. When the clearance is correct, tighten the bell housing retaining nuts to a torque of 8,5 kgf m (60 lbf ft) and recheck the clearance.

Select two gears to prevent the mainshaft and layshaft from turning. Apply Loctite to the front layshaft bolt and tighten it to a torque of 8,5 kgf m (60 lbf ft) as shown in Fig. 83.

Fit a new rear seal and refit the oil thrower and seal track.

Refit the rear output gear with a new lockplate and protective washer as shown in Fig. 84. It is very important that this washer is fitted. Without it the lockplate is ineffective (a self-locking nut will not stay secure).

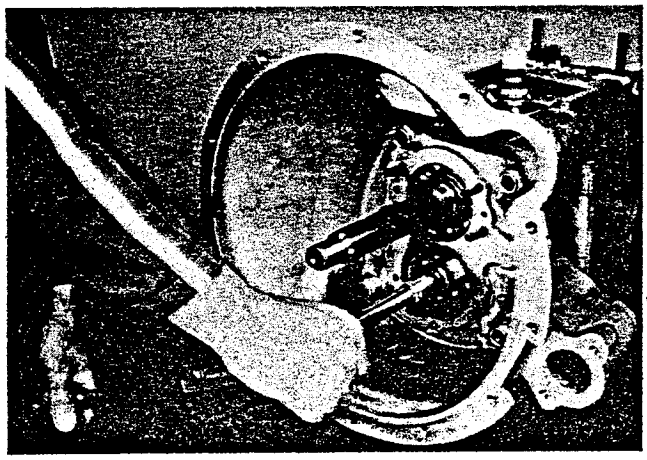


Fig. 83

Refit and tighten the serrated nut to a torque of 11,7 kgf m (85 lbf ft) using the special tool (Part No. 600300) and the torque spanner adaptor (Part No. RO 1013), then bend the tab of the lock plate to secure the setting.

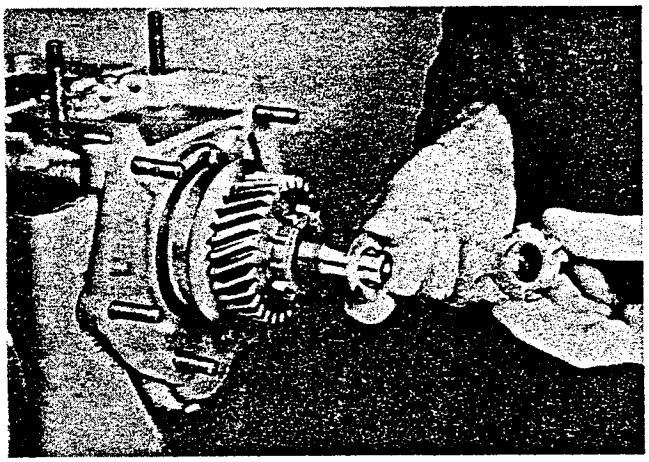


Fig. 84

Installation of selectors

Before commencing reassembly of the gear selection mechanism, check the selector shafts and forks for wear or damage and, if in order, fit three new selector shaft seals ensuring that the thinner edge of each seal is toward the front of the shaft as shown in Fig. 85.

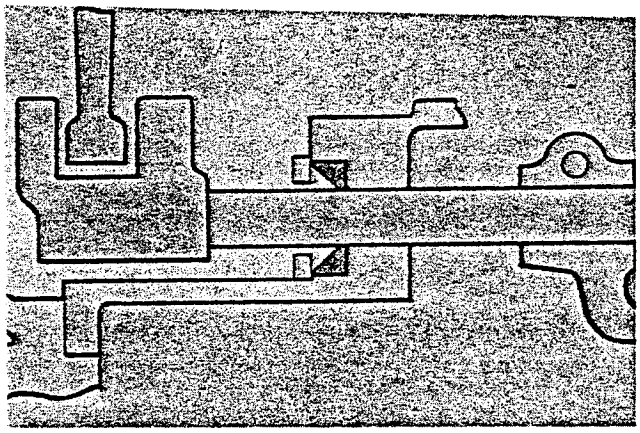


Fig. 85

Engage third and second gears, install the third/fourth and first/second selectors and install the reverse selector by inserting the fork with the shaft at 90 degrees to the axis of the box before rotating the selector clockwise into position *(Fig. 86)*. Ensure that each fork locates on the appropriate gear.

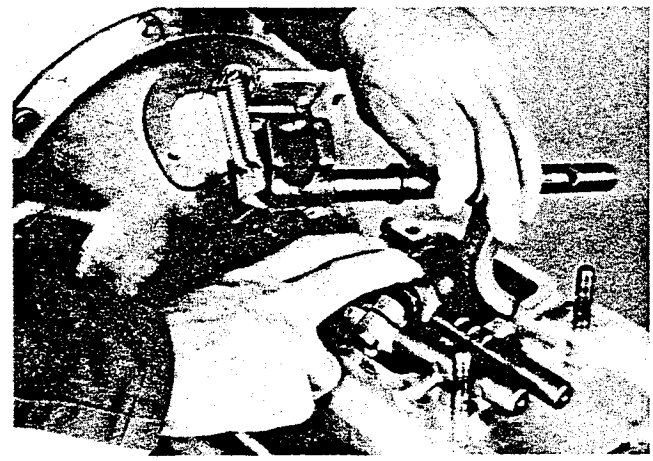


Fig. 86

Lubricate with grease and fit the two interlocking rollers and the two ball bearings to the selectors. Ensure that the top cover and gearbox faces are clean and undamaged and that the selector seals are correctly located in their grooves. Then fit the top cover, which requires neither a gasket nor jointing compound.

Fit the ball, spring and brass plug to first/second selector.

Fit the spring, seal and retainer plate to the third/fourth selector on the left side of the gearbox.

Note that the retainer plates are relative to each side of the box *(Fig. 87)* and must be correctly positioned to ensure an oil tight seal.

Fit the yellow-striped reverse selector spring, which is the strongest of the three, and fit the seal and retainer plate.

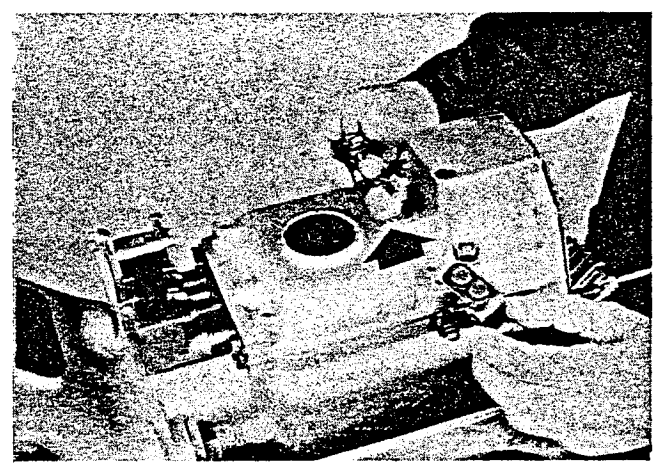


Fig. 87

CLUTCH WITHDRAWAL ASSEMBLY

Examine the clutch withdrawal bearing and fork assembly for damage or wear and replace as necessary. A new plastic staple must always be fitted.

Inspect the clutch withdrawal sleeve for damage or wear. Ensure that the vent below the primary shaft is clear and renew the primary shaft seal.

Tape over the splines of the primary shaft as shown in Fig. 88 to prevent damaging the seal. Fit the clutch withdrawal housing using a new gasket and secure it in position. Tighten the nuts to 2,7 kgf m (20 lbf ft) and the bolts to 2 kgf m (15 lbf ft).

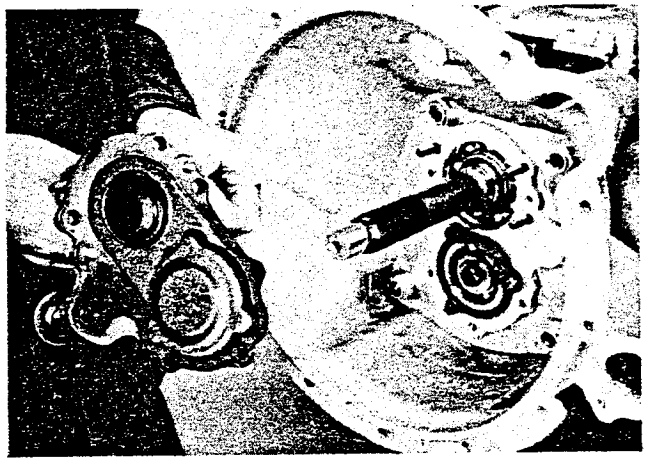


Fig. 88

The Land Rover clutch release bearing 'A' can be identified by the radius on the thrust face. This must not be confused with the Range Rover type, 'B' *(Fig. 89).*

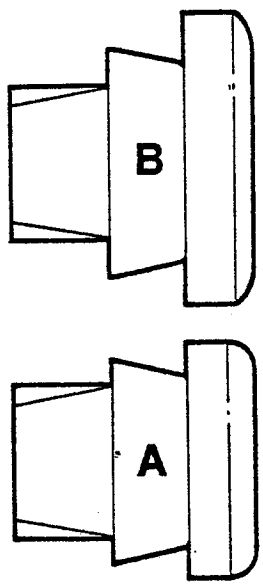


Fig. 89

Lightly lubricate the clutch withdrawal sleeve and fit the bearing, withdrawal lever and the new plastic staple with its ridged leg a tight fit in the lever.

Temporarily fit the main gear change and check the operation of the gears. This concludes the assembly of the main gearbox.

REFITTING TRANSFER BOX

The transfer box can be fitted with the main gearbox in the chassis, or with the main box mounted on the work stand as we see in Fig. 90.

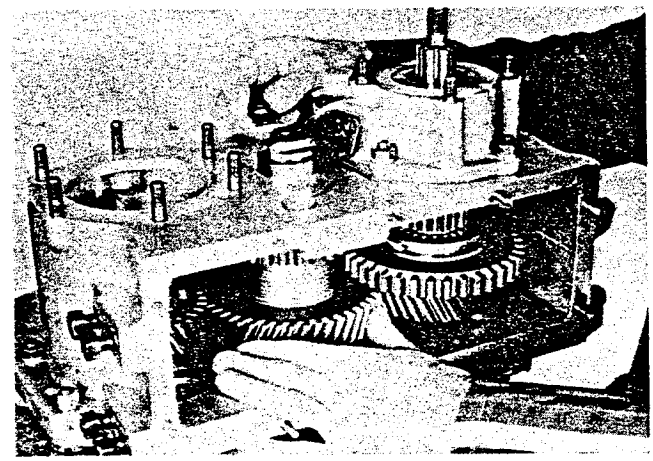


Fig. 90

Fit a new gasket to the rear of the main gearbox, retaining it in position with a light smear of grease and affix the transfer box casing using the appropriate nuts and bolts including the three self-locking nuts inside the casing.

Position the previously selected intermediate gear thrust washers, lightly smeared with grease, in the transfer box casing. Lubricate the roller bearings and fit the intermediate gear into the casing.

With a new 'O' ring fitted, lubricate and install the shaft. Secure the assembly with the retainer plate.

Refit the brake anchor plate and dust shield using a new gasket and suitable sealing compound. Tighten the four securing nuts to 4 to 5 kgf m (28 to 36 lbf ft).

Ensure that the slot at the bottom of the dust shield is not blocked by excessive sealing compound.

Check the condition of the output shaft oil seal track on the drive flange *(Fig. 91)* and fit the flange.

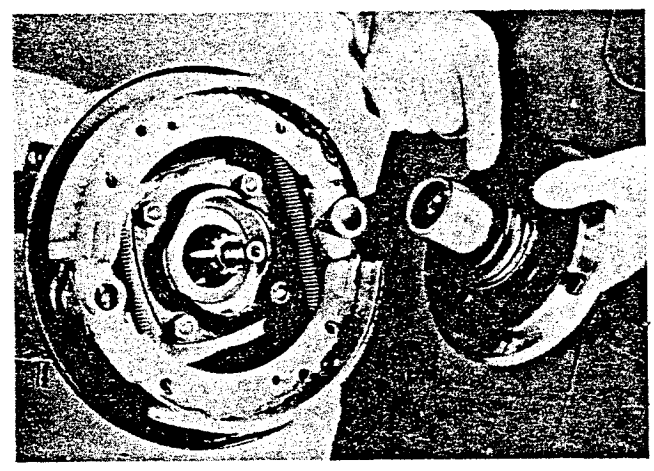


Fig. 91

Fit the felt seal onto the drive flange splines. Fit the plain washer, fit the castellated nut and tighten it to the correct torque of 11,7 kgf m (85 lbf ft) *(Fig. 92)*.

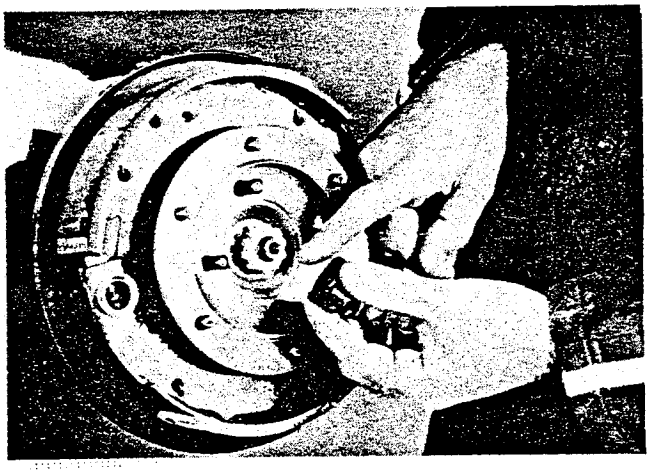


Fig. 92

Fit the split pin and bend it over to secure the nut.

Slacken the brake adjuster completely, fit the brake drum and tighten the nuts securely.

Adjust the handbrake by first screwing in the adjuster until the brake drum cannot be turned and then unscrewing it sufficiently to allow free rotation of the drum.

Refit the red-knobbed high/low selection lever using a new anti-rattle spring *(Fig. 93)*.

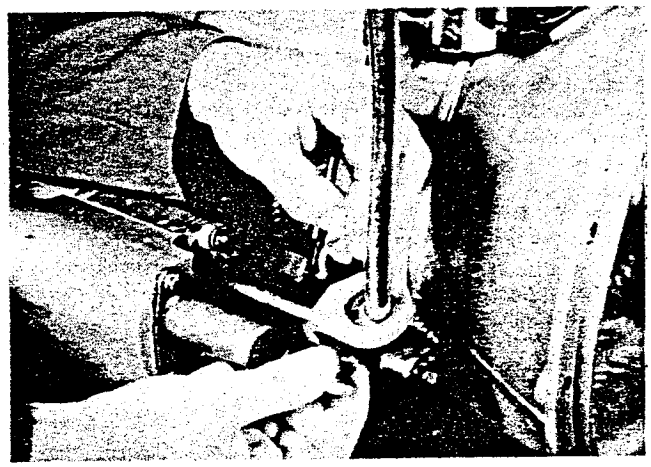


Fig. 93

Finally, fit the mainshaft rear bearing end plate and bottom cover using a new gasket. This concludes the assembly of the Land Rover gearbox.

Details for reinstallation will be found in the Repair Operation Manual.

Questions

LAND ROVER MAIN GEARBOX

N.B. Participants please note there are only 10 questions on this paper.

A. Land Rover gearboxes, suffix 'D', introduced in October 1981, incorporate which of the following modifications?
1. Introduction of ECM gears on 3rd and top gear only, together with a modified 3rd/4th selector shaft and fork.
2. Introduction of ECM gears resulting in a new primary shaft and constant mesh gear, a new 3rd/4th synchromesh, a new 3rd speed mainshaft gear and a modified layshaft.
3. A new 1st speed mainshaft gear, a new 2nd speed mainshaft gear, a new 1st/2nd speed synchromesh inner/outer members, a new 1st/2nd selector shaft plus all that which is mentioned in answer 2.
4. Introduction of electro-chemical machining of top gear including an ECM reverse gear pinion.
5. Introduction of a new 1st gear FRC 3201 with ECM machining, a new layshaft FRC 2084 which incorporates a 1.07 mm (0.042 in) reduction in the width of the 1st gear teeth, and a new mainshaft complete with needle roller bearings to replace the bush previously used.

B. With which statement do you disagree?
1. The layshaft when correctly fitted should have not less than a 0.12 mm (0.005 in) end float before the front location bolt is Loctited and secured.
2. The 3rd/4th and reverse selector spring detent retaining plates are interchangeable.
3. When carrying out the 3rd and 2nd mainshaft gear and bush adjustment, the gear end float adjustments must be made before the bush to shaft end float is adjusted.
4. All the main gearbox gears are Helical cut except those which are used when reverse gear is selected.
5. Before replacing any leaking gearbox oil seals the ventilation systems should be checked for blockage.

C. A broken reverse shaft location pin is most likely to cause gear jump out on which of the following gearboxes?
1. Suffix 'E'.
2. Suffix 'C'.
3. Suffix 'D'.
4. A broken reverse shaft location pin will not cause reverse gear to jump out on any of these gearboxes.
5. Suffix 'A'.

D. With which statement do you disagree?
1. The mainshaft bearing/seal housing which is Loctited to the casing during manufacture, was on early boxes merely located by a loose dowel and retained with the circlip.
2. The 1st/2nd selector spring detent plug is not fitted with a gasket.
3. 1st gear bush on the mainshaft may be fitted either way round and is clamped firmly to prevent it from rotating on the shaft by tightening the nut to 11.7 kgf m (60 lbs ft).
4. The range of various thickness washers available for adjustment of the mainshaft bush end float are as follows:
   3.18 mm (0.125 in). 3.25 mm (0.128 in).
   3.30 mm (0.130 in). 3.43 mm (0.135 in).
5. The springs used in the 1st/2nd synchromesh shown in Fig. 74 are identical to those used in the 1st/2nd and 3rd/4th synchromesh units on the Range Rover box.

E. Which of the main gearbox selected positions is described in option 2 of question B in Bulletin Number 1?
1. 4th gear.
2. 3rd gear.
3. 1st gear.
4. Reverse gear.
5. 2nd gear.

F. With which statement do you agree?
1. When renewing the mainshaft bush location pin (A) seen in Fig. 57, it is important that the pin is a tight fit in the shaft and must not protrude above the bearing surface for 2nd gear.
2. Suffix 'D' gearboxes retain the sixteen teeth on 1st gear on the layshaft.
3. The baulk ring used for 1st gear synchromesh is different to the one which is used for 2nd gear.
4. The washers used for eliminating clearance between the primary shaft and its ball race are in the same range as those given in the optional answers to question D.
5. Option 1 of question B in Bulletin No. 1 describes the power flow through the main gearbox with 2nd gear engaged.

G. Let us assume that you are the chief 'trouble-shooter' located in the Head Office of a large Land Rover distributor and have received a telephone call from one of your smaller garages requesting diagnostic advice regarding a noisy Land Rover gearbox. Assume that you already have the chassis number, gearbox number, mileage, owner's name and address and all the documentary evidence. In what order of priority would you question the mechanic when you next speak to him? (Which is the best sequence of questioning?)
1. (a) Is there noise in 1st gear?
   (b) Does the owner pull a trailer?
   (c) Is the oil level correct?
   (d) Is it noisy on the overrun?
2. (a) Are the main and transfer box oil levels correct?
   (b) Is there any evidence of metal particles in the oil?
   (c) Is the viscosity of the oil correct?
   (d) Are the ventilation systems clear of blockage?
   (e) Have you carried out any static running tests including those which may be performed with the transfer box in neutral?
3. (a) Is the gearbox noisy in all the gears?
   (b) Is the noise worse with heavy loads?
   (c) Have you checked the oil level?
   (d) Are any of the seals leaking?
4. (a) Have you checked for noise with the engine running and the main gearbox in neutral? Does the noise alter when the clutch is pressed?
   (b) With the transfer box in neutral and the engine running have you listened to the noise in 1st, 2nd, 3rd, 4th and reverse gears?
5. (a) Does the main gearbox jump out of engagement?
   (b) Are all the tyres on the vehicle the same size?
   (c) Does the vehicle have free-wheeling hubs fitted?
   (d) Have you checked the oil level?
   (e) Have you tried it in four-wheel drive, low ratio?
   (f) Is it more noisy in rear wheel drive only, with the yellow knob depressed?
   (g) Do you think it might be the clutch withdrawal bearing?

H. Which statement is incorrect?
1. Before fully tightening the bell housing it is essential to ensure that the layshaft has sufficient end clearance. If it has no clearance and the bell housing bolts are tightened the rear roller bearing will be damaged by the extreme pressure applied.
2. The hardened steel washer on the end of the mainshaft is essential in preventing the locknut from damaging the lockplate and making it ineffective.
3. The clutch withdrawal lever is fully interchangeable between 2¼ petrol and diesel Land Rover, V-8 Land Rover and Range Rover gearboxes.
4. In very early Land Rover gearboxes with a synchromesh on 3rd and top only, it is necessary to adjust the reverse and 2nd gear selector stop bolts which are accessible through the main gearbox top cover inspection plate.
5. A broken reverse shaft location pin on suffix 'B', 'C' and 'D' gearboxes is liable to be the cause of reverse gear jump out.

J. This question should be answered in the same context as question G, again assuming that you are the chief 'trouble-shooter', only this time the complaint is of clutch drag. (Choose the correct sequence of questioning).
1. (a) Have you checked the clutch fluid reservoir?
   (b) Have you checked the adjustment of the clutch slave cylinder?
   (c) Is the clutch master cylinder leaking?
   (d) Does this problem occur when the vehicle is hot or when it is cold?
2. (a) Are there any extra layers of carpet, or accumulation of dirt preventing the clutch pedal from being fully depressed?
   (b) Is the clutch pedal height and master cylinder adjustment correctly adjusted?
   (c) Is there any sign of fluid leaks and is the reservoir topped up to the correct level with the specified fluid?
   (d) Has the system been bled and are you sure it is free of all air contamination?
3. (a) Is the vehicle under warranty?
   (b) Does the general condition of the vehicle reflect its age and mileage?
   (c) Is there any evidence of oil leakage from the flywheel housing via the wading plug hole?
4. (a) Does the clutch slip under heavy load conditions?
   (b) Any signs of judder?
   (c) Have you checked the clutch adjustment?
   (d) Is the vehicle fitted with any auxilliary equipment such as compressors or winches?
5. (a) Is there anything obstructing the clutch pedal travel?
   (b) Has the system been bled?
   (c) Is there any sign of fluid leakage from the master cylinder or slave cylinder?
   (d) Is the fluid reservoir topped up to the correct level with the correct grade of fluid?
   (e) Have you tried freeing the centre plate on the primary shaft splines by spraying WD40 into the bell housing?
   (f) Is the clutch linkage adjusted correctly?
   (g) Is there any sign of clutch master cylinder or slave cylinder seizure?

K. What prevents two gears being engaged at the same time?
1. When any single gear is selected in the gear box the selector jaw moves out of line with the remaining selector jaws, thereby preventing simultaneous engagement of two gears.
2. As there are three selector shafts in the top of the gearbox and each of these is held in the selected position by the spring loaded ball bearings, it is impossible to engage two gears at the same time.
3. By reference to Fig. 47 and close examination of the 3rd/4th gear selector shaft, it will be seen that the neutral position of the selectors is retained by the three ⅜" diameter ball bearings and the spring tension applied to each. Interlocking of the selectors is achieved by the movement of any one selector, causing the adjacent ⅜" rollers to be moved into engagement with the other two selectors, thereby preventing the engagement of two gears simultaneously. If one of the side selectors is moved, interlocking action is transmitted via the pin in the centre selector to the selector shaft on the opposite side of the gearbox. When the centre selector is moved, both rollers are pushed outwards to engage in the selectors on each side of the box.
4. Interlock, or the method by which two gears are prevented being engaged simultaneously, is achieved as follows. When any one selector is moved to engage a particular gear, the roller in contact with that selector shaft is forced to ride up out of the neutral detent position and engage with the adjacent selector, whilst the other selector is prevented from moving by the tension of the spring and ball fitted in the top cover of the box, as well as the spring tension applied to the outer member of the synchromesh, thus preventing two gears being engaged simultaneously.
5. Engagement of two gears simultaneously is impossible on the Land Rover gearbox because of the gated gear change plate, fitted below the main gear lever. The spring-loading of the synchromesh outer members in the neutral position only and the ball and spring detents fitted to the top cover are a further precaution to prevent simultaneous auto-engagement of the gears.

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