GEARBOX / DIFFERENTIAL

TRACTION AVANT FOUR CYLINDER

FIG. 2: SECTION OF SECOND-SPEED IDLER.

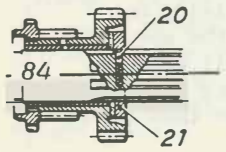


FIG. 3: LOCKED THRUST WASHER IN POSITION.

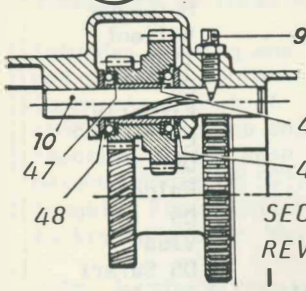
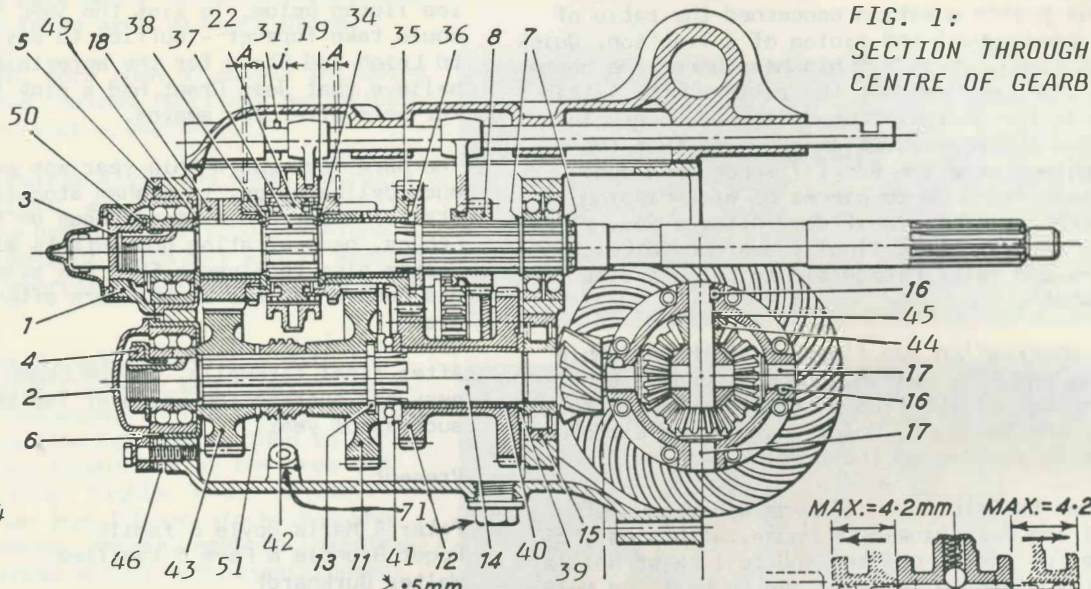


FIG. 4: SECTION OF REVERSE IDLER.



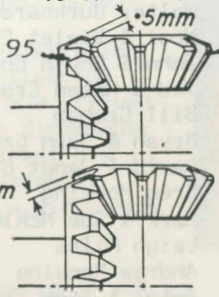


FIG. 5: SUN & PLANET WHEELS SHOULD BE FLUSH

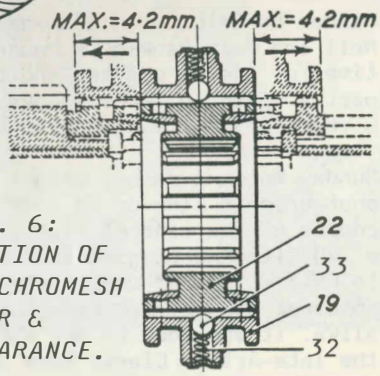


FIG. 6: SECTION OF SYNCHROMESH GEAR & CLEARANCE.

IDENTIFYING AND NAMING THE PARTS

Names given to gearbox and differential parts vary considerably, depending on local and national practices. The problem is compounded when, as in the Traction, some parts have multiple oles. The names proposed here are intended to be reasonably descriptive, unambiguous(?), and acceptable to local users.

Bill Graham/Jack Weaver.

1. Mainshaft front-bearing cover
2. Layshaft front-bearing cover
3. Mainshaft end-cap & crank dog
4. Pinion (layshaft) nut
5. Mainshaft front-bearing housing
6. Layshaft front-bearing housing
7. Mainshaft circlips
8. First/reverse sliding gear
9. Reverse shaft setscrew & locknut
10. Reverse-gear shaft
11. Layshaft second-speed pinion
12. First/reverse cluster gear
13. Split collars
14. Layshaft/pinionshaft
15. Layshaft/pinion rear-bearing
16. Planet gear spindle retaining pin
17. Planet gear spindle
18. Third gear (upper)
19. Synchromesh ring
20. Mainshaft plunger & spring
21. Second-speed pinion retaining washer (locked thrust washer)
22. Synchromesh gear hub
23. Lockbolt for selector fork
24. Selector shaft (1/R)
25. Selector shaft (2/3)
26. Retaining cup & circlip
27. Lockshaft spring (1938-)
28. Gearshift lockshaft (1938-)
29. Threaded plug for locking slug (RHS)
30. Locking slug/piece
31. Selector shaft washers
32. Synchromesh gear springs
33. Synchromesh gear balls
34. Keyway washer (similar to 38)
35. Second-speed idler (cluster) gear
36. Celoron washer
37. Synchromesh locking key
38. Two-groove washer (non-rotating thrust washer)
39. Layshaft Celoron washer
40. Layshaft loose bush
41. Ball thrust-race
42. Speedometer drive-worm
43. Lower top-speed pinion
44. Satellite (planet) gear
45. Planet washer
46. Front-bearing shims
47. Reverse-gear pinion inner thrust washers
48. Reverse-gear pinion outer thrust washers
49. Top-gear thrust washer
50. Mainshaft bearing washer
51. Layshaft adjusting washer
52. Selector shaft welsh plug
53. Oil deflectors (2/3) (-1935)
55. Selector fork (2/3)
57. Selector fork (1/R)
60. Generator pivot bolt
61. Clutch dust cover (metal)
62. Gearbox cover studs & nuts
63. Extended studs & sleeves to mount horns
64. Gearbox cover (lid)
65. Cover gasket
66. Upper bearing cover bolts
67. Lower bearing cover bolts
68. Selector shaft plug
68a. Seal
69. Speedo drive bush & cable sheath retainer
70. Alternative to pinchbolt of 69
71. Gearbox drainplug & gasket (same as filler on RHS)
72. Gearbox casing
73. Clutch (bell) housing
74. Gearbox/bellhousing studs
75. Clutch cross-shaft bush & housing
76. Gasket/surface seal
77. Bellhousing lower cover
78. Cover fixing bolt
79. Auxillary drive oil return ring (1954-)
80. Speedo drive shaft
81. Speedo drive lower bush
82. Auxillary drive greaser
83. Mainshaft front-bearing
84. Primary (main) shaft
85. Third-gear (upper) bush
86. Second-speed cluster bush (2)
87. Mainshaft rear bearings (2)
88. Alternative to 87 (-1935)
89. Layshaft front-bearing
90. Reverse idler thrust balls
91. Reverse idler bush
92. Reverse idler gear
93. Output-shaft bush
94. Differential pinion carrier (spool, cage)
95. Output shaft & sun wheel
96. Celoron thrust washer
97. Planet-shaft centre
98. Crown wheel
99. Crown wheel/ diff. carrier bolt
100. Lock plate
101. Differential side bearing cone
102. Differential side bearing cup
103. Crown wheel adjusting ring nut
104. Differential side oil seal
105. Drive flange
106. Flange circlip
107. Flange retaining washer
108. Output shaft nut
109. Drive flange bolt, nut & lock plate
110. Differential side bearing cap, stud & nut (modified late 1940s)
111. Gearshift lockball (2)
112. Crankhandle-dog cover & seal
113. Mainshaft rear bearing spacer
114. Crankhandle-dog tab washer
115. Pinion nut tab washer
116. Crankhandle drive pin

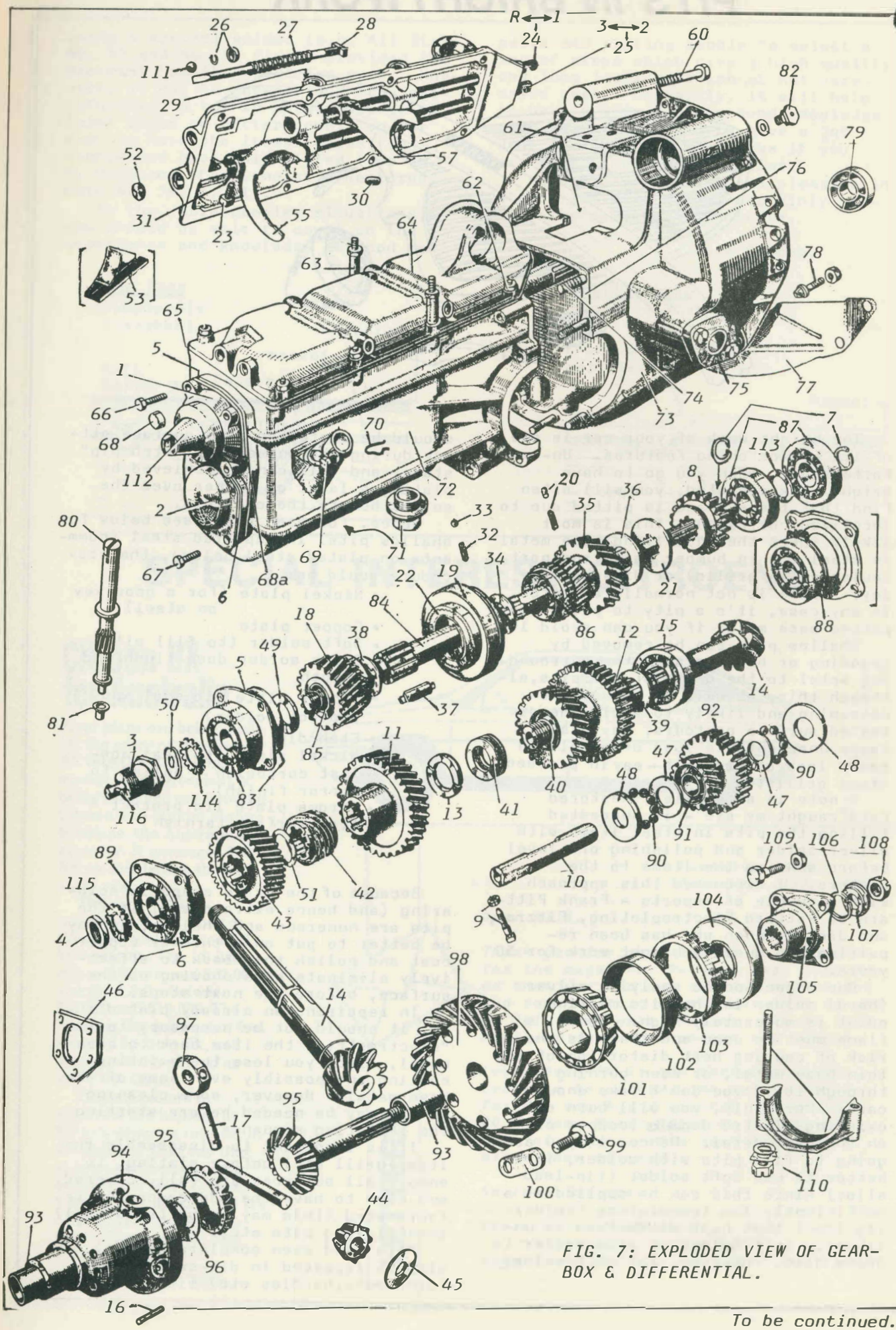
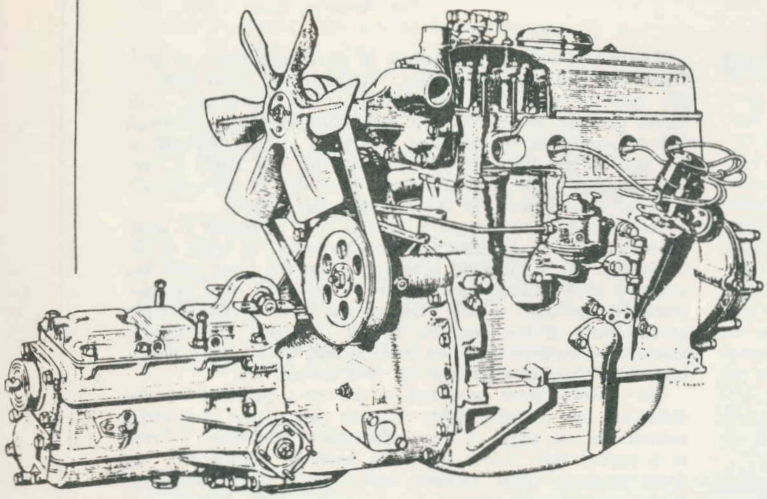


FIG. 7: EXPLODED VIEW OF GEAR-BOX & DIFFERENTIAL.

To be continued.

GEARBOX REPAIRS

TRACTION AVANT FOUR CYLINDER



The three-gear gearbox on the Citroen is mounted ahead of the front wheel centre as clearly shown in this drawing, the drive being taken over the crown wheel and pinion by an extension shaft.

Anyone who owns a Traction Avant (T.A.) will be well aware that there is always an abundance of mechanical work to be done on them. I feel many people may be put off doing much of this work themselves, for when turning to the workshop manual they find instructions which refer to the use of one special tool after another.

Well, one should not be daunted! I had the same experience myself some seventeen years ago, and to this day have only the barest collection of special tools. Many repairs can be done with no more than the average hobbyist mechanic's tool kit.

Frequently, the gearbox is in need of repair, a job which can indeed be done by you. In the event that you do not possess a manual, I will lead you through the procedure in this article, using virtually no special tools. For diagrammatic details and identification of parts, dig out your copy of Front Drive Volume 9 No. 2, and turn to Pages 12 and 13.

Having drained the gearbox (72) (hitherto "the box"), detach it from the bell housing (73) and remove box from vehicle. Remove the cover (64). Generally, there is little wear on its components. The thrust points on the selector forks (55 &57) may need to be built up with bronze and refaced if a substitute component is not available.

The gearshift lockshaft (28) wears in the ball contact area. Before removing it, take note of the position of the circlip and cup (26) for there are two grooves into which they may be placed. As a result, a worn lockshaft may still be used if the clip was in the first groove, simply by putting it in the second groove.

Drive flanges (105) are more readily removed with the differential assembly still in situ. Spacing of the bolts on these flanges is not equidistant. Select two bolts on a narrow edge of each flange and refit their nuts (109). In doing so, you create a means of anchorage for a large screwdriver which you lay diagonally between these two bolts. This provides something to pull against when undoing the output shaft nut (108). Repeat on the other output shaft. If you utilize the two bolts on the broad side of the flange to anchor your screwdriver, you will obstruct the fitting of a socket onto nut 108.

Remove mainshaft and layshaft front bearing covers (1 & 2), also differential bearing caps (110) and diffential assembly (94/98 etc). Engage synchromesh ring (19) with second speed idler gear (35), also first/reverse sliding gear (8) with reverse idler gear (92). This will lock up the box, enabling removal of the crank dog (3) and the pinion nut (4).

The configuration of the crankdog prevents the use of a socket for its removal. A tube or ring spanner of 36 mm or 13/16 whitworth will therefore be required.

The next step will require the use of a drift. I recommend a 30 cm length of approximately seven mm diameter mild steel rod. This is soft enough to yield against the hardened steel of the bearings, yet harder than bronze and less likely to chip and deposit unwanted metal debris within the bearings.

Having removed the rearmost of the mainshaft circlips (7), rear bearing(s) (87) [or(88)] and front bearing (83) complete with housing (5) may now be drifted out, thereby allowing removal of the mainshaft. Normally, bearing 87 comprises two bearing separated by a washer (113). Therefore, if when drifting the bearings out, they suddenly come to a halt, it will be due to the washer having dropped into the rear circlip groove.

On occasion I have found boxes fitted with a single rear bearing (88) instead the double set (87).

Undo setscrew (9) and knock out the reverse gear shaft (10) toward the front of the box, carrying with it plug 68. When extracting the reverse idler gear (92), take care not to lose the thrust balls (90) - these total 26 in all.

Insert a screwdriver between second speed pinion (11) and the first/reverse cluster (12). This provides access to a pair of collets or collars (13) which can be flicked out using a narrow-bladed screwdriver. You may have to rotate the pinion shaft (14) to gain access to the gap between the two collets. This done, the pinion shaft can be pushed out toward the rear of the box.

To remove the roller bearing (15), a support plate and a press will be great help. The Timken bearings (101) on the differential assembly will likewise require the use of a press. Both items can usually be found at your local garage, and if you do the work yourself, there is no charge as a rule.

If the bearings are not going back into the box, one can remove them with a little leverage and impact. The Timken bearing on the crown wheel side of the differential can be readily prised off using two stout screwdrivers - preferably of equal length - with some form of packing to provide a fulcrum between each screwdriver and the back of the crown wheel. The other Timken and the roller bearing can be tapped off by working around their circumference with each tap.

All bearings in a T.A. box stand up very well to the many miles which they accrue. They can usually be refitted, but always check the races for tracking and replace if need be. If fitting a new crown wheel and pinion, the three aforementioned bearings (15, 101/102 x2) should be replaced, regardless of their condition.

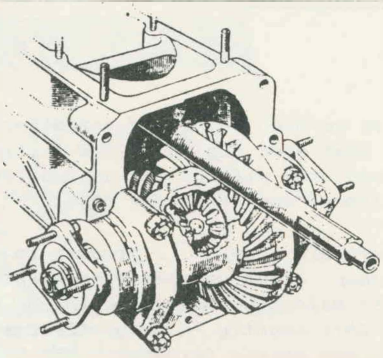
In order to remove the second speed idler (35) from the main shaft, a very small fine-bladed screwdriver will be needed to depress the plunger and spring (20). While the spring is fully depressed, the retaining washer (21) must be rotated until its spline aligns with that of the main shaft. Now ease the second speed idler gear (35) outward until you can fit a screwdriver between the gear and the washer to prise it off. Do not attempt to carry the washer completely off with the gear, as the plunger will foul in the oil groove formed internally in the bronze bush (86) inside the gear. At the least, the fouling would damage the bush. Sometimes two half-length bushes will be found.

In most cases, it will be necessary to replace this bush as it is very prone to wear. The journal on which the bush runs also wears. An under-sized bush cannot be fitted directly to offset this wear since an under-sized bush would not then clear the unworn splined section of shaft to the rear where it carries the first/reverse sliding gear (8) and runs in the mainshaft rear bearings (87).

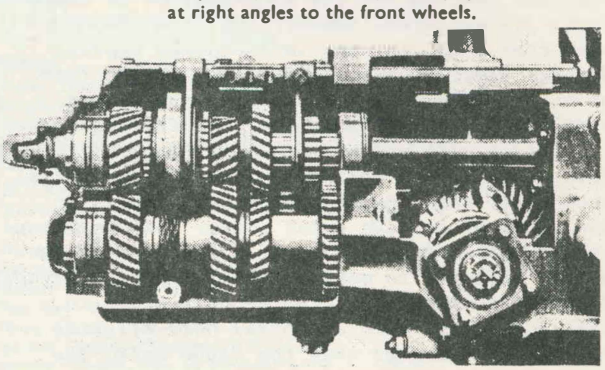
Many people opt for fitting a standard sized bush which will indeed reduce the free play. However, this will not prevent the gear from canting over longitudinally to some extent if the journal area of the shaft is worn. Some hold the view that this matters little, as the excess movement only makes the box a little noisier.

What they may not have considered though is why it is noisier! Simply, the noise is due to the gear canting. This creates point contact at the gear teeth, rather than full surface contact. Point contact creates very high local pressures on the teeth, which surely must explain the comparative scarcity of good second speed idler gears (!).

If your T.A. only hits the road for club outings, I dare say that you will opt for fitting a standard bush and leaving it at that. Those like me



The crown-wheel, bevel pinion and differential are compact and in unit with the gearbox, the bevel pinion being integral with the gearbox layshaft. Short transmission shafts run at right angles to the front wheels.



Section through the gearbox and spiral-bevel differential.

who are everyday T.A. addicts must look to doing a top job. The most turned-to method of rectification is that of having the journal area of the shaft built up by welding and then grinding it back to size - a specialist job (!).

Other means of rectification are being looked into at present and will be advised on later if this is warranted.

(To be continued).

Kenn Gilbert.

GEARBOX REPAIRS

TRACTION AVANT FOUR CYLINDER

Continued from Front Drive 9 (2), 9 (6).

When removing the mainshaft (84), other components - the synchro assembly (19, 22), third gear (18), thrust washer (38) and locking key (37) - may well have been displaced. Do not be disturbed by this as their sequence of assembly is readily seen in Figure 7 on page 13 of Front Drive 9 (2). Washer 38 is identical to the one located before the second speed idler pinion (35), i.e. item (34). In most cases, these washers can be re-used.

The locking key (37) is partly relieved at each end. This is done so that the key engages the inner notches of washers 34 & 38 and prevents them rotating relative to the shaft and synchro hub when assembled. If the locking key is damaged, it is probable that at least one of the washers need to be replaced along with the key. This can be readily discerned upon inspection of the thrust surfaces of the washers - both sides of each must be free of any circular score marks.

You will notice that one face of each of these washers has four vee-shaped oil grooves cut into it. Often a crack may be found at the base of one of these grooves. Cracks may also occur at the corners of the locking key rebate. These cracks are not always readily visible. Therefore insert the jaws of a pair of long-nozed pliers into the bore of the washer, ensuring that they align with one of pair of grooves. Now attempt to open the jaws, so tending to ovalize the washer and expose any latent cracks. Repeat this test with the jaws aligned with the other pair of grooves.

The locking key is made of mild steel. If a replacement is not available, a 100 mm (four inch) nail of suitable gauge will do quite well if cut to length and suitably filed to shape at the ends.

Having taken the necessary steps (new bush etc - see F.D. 9 (6)) to obtain a minimum diametric clearance of 0.04 mm (0.0016 inch) between the bush (86) of the second speed idler pinion and the mainshaft, the pinion (35) may now be refitted to the mainshaft. If clearance is less than about 0.04 mm, the bush may "pick up"(gall) on the shaft. If the clearance is much more than 0.04 mm (i.e. more than a just perceptible "wiggle" on the shaft), it is excessive e.g. 0.25 mm is "bad" - see earlier comments.

Firstly offer up the washer (34) from the rear (unthreaded) end of the shaft, ensuring that the oil grooves face towards the second speed idler pinion which is fitted next, followed by a Celeron washer (36). Now fit the retaining (locked thrust) washer (21) and rotate it in the mainshaft groove so that it cannot slide back. This done, check the lateral play of the gear (35) by inserting feeler gauges between the washer (34) and the end of the splined section of the mainshaft where it accomodates the synchro hub (22). The clearance should be between 0.05 mm and 0.10 mm (0.002 - 0.004 in.). If. as is likely, the clearance is in excess of these values, a thicker Celeron washer will have to be fitted. The spring and plunger (20) have not yet been fitted as it will be necessary to try several thicknesses of Celerons unless you have access to a vernier caliper or a micrometer to help you sort through your stock. In the event that you do not have a stock of washers to choose from, a washer of suitable thickness may be produced in phosphor bronze. This material is available in a suitable extrusion form from Geo. White & Co., 527 Church St, Richmond, Vic. Tel. (03) 428 1462.

When the correct clearance has been obtained, remove the retaining washer and fit the spring and plunger. To refit the retaining washer, the spring and plunger must first be depressed and kept down until the washer encroaches on it. This operation can be a little tedious, and is perhaps most effectively achieved through the use of a feeler gauge blade of 0.15 mm - see Figure 8. With the feeler gauge now removed, the retaining washer having been slid fully home, the washer then needs to be rotated until the plunger enters one of the splined rebates. An audible click will be emitted when this happens, indicating the end of this sequence.

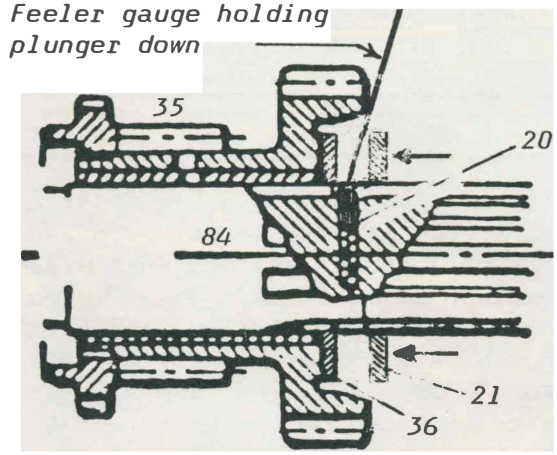


FIG. 8: FITTING LOCKED THRUST WASHER

The synchromesh assembly (19 & 22) should be dismantled by pushing the hub (22) out of the ring (19) by hand. To avoid loss of the locating balls and springs (33, 32 - six of each), place the assembly in a plastic bag or a cloth first. Any broken springs must be replaced.

Inspect the synchro hub. Check the bronze bands, the tapered surface of which are segmented by series of flutes which must be more than just shadow deep. If wear is excessive, try to obtain another hub. The crests of the six spline sectors on which the balls run are subject to tracking. This represents no real problem, since on assembly it can be arranged that the balls run on previously unworn crests.

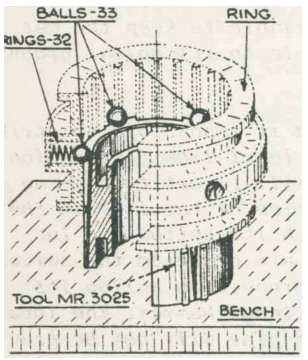
Reassembly of the synchro assembly can be done with a modified synchro hub if you have one which is only fit for sacrifice. The modified hub cannot be reused for its original purpose.

— FITTING SYNCHROMESH GEAR —

TOOL MR.3025 IS MADE OF A CITROEN FRONT WHEEL DRIVE "11" (LIGHT 15 OR BIG 15) SYNCHROMESH CENTRE SLIDE MODIFIED AS FOLLOWS. AFTER MODIFICATION THIS PART CANNOT BE USED IN A GEARBOX.

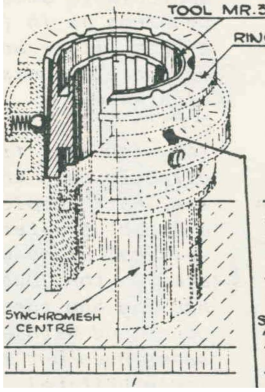
1. Anneal part
2. Make 6 tapered grooves to receive balls as shown below.
3. Ease off all splines to get free movement of synchromesh ring.

— Fig 9 —



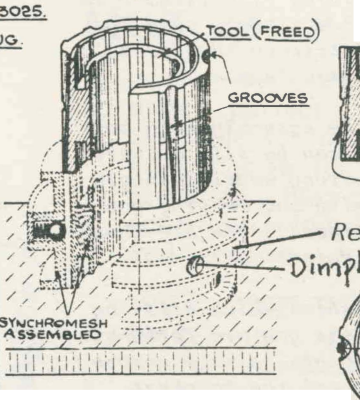
PLACE SYNCHROMESH RING ON TOOL. PLACE 6 SPRINGS IN THEIR HOUSINGS. PLACE 6 BALLS IN GROOVES. PUSH SYNCHROMESH RING DOWN ON TOOL.

— Fig 10 —



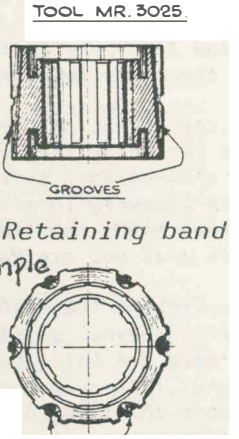
PLACE ASSEMBLY OF SYNCHROMESH RING ON TOOL PUSH DOWN THE SYNCHROMESH RING TO RETURN THE BALLS.

— Fig 11 —



CONTINUE TO PUSH DOWN RING TO FREE TOOL.

— Fig 12 —



Each groove to be cut out from the middle spline of a group of 3 splines.

Mark location of hole if replacing balls & springs by removing band.

Details of the modification are shown in Figures 9 - 12. An alternative method which I have used requires that the steel retaining band on the outer circumference of the synchro ring be removed. To do this, stand the synchro ring on a solid surface, place a pin punch into one of the holes which accomodate the detent springs (32) and strike the punch so as to push out the retaining dimple in the retaining band. Repeat this operation for for all six holes. Once all six indentations have been relieved, the retaining band can be tapped off.

The hub can now be placed in the ring with ease. This done, first the balls then the springs are fitted into the holes. So as to ensure that the balls and springs stay put, first pack the holes with grease. A fabricated band must be placed around the ring to enable compression of the springs.

The compression band can be fabricated from an empty 825 g food can, cutting a narrow strip of tinplate about 5 mm wide and of sufficient length to enclose the uncompressed springs with enough length left that the two ends can be gripped by narrow-nozed pliers. The pliers are then used as a key to wind up the surplus strip, thereby compressing the springs and enabling the fitting of the retaining band by carefully sliding it into place.

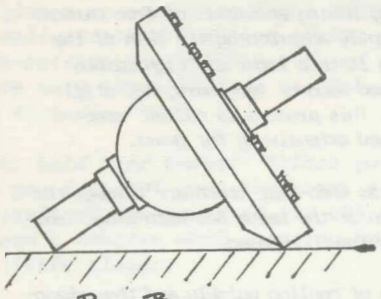
Once in place, the retaining band must again be secured. Place the synchro assembly on a stout piece of wood supported on a solid surface. The pin punch is used again to reform the depressions in the retaining band by tapping down over the detent spring holes. Before the springs are refitted, it will facilitate the subsequent punching of the depressions in the band if the location of at least one of the spring holes is marked with paint ot a felt pen on the vertical face of the selector fork groove adjacent to the hole (see Figure 10). It is important to cushion the underside of the synchro ring when reforming the indentations in the retaining band since repeated striking on a hard surface would "stretch" the band to the point where it would no longer stay in place.

(To be continued)

Kenn Gilbert.

GEARBOX / DIFFERENTIAL

TRACTION AVANT FOUR CYLINDER



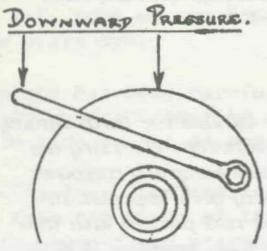
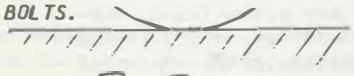


FIG. 14: REMOVING THE CROWN WHEEL/DIFF. CAGE BOLTS.



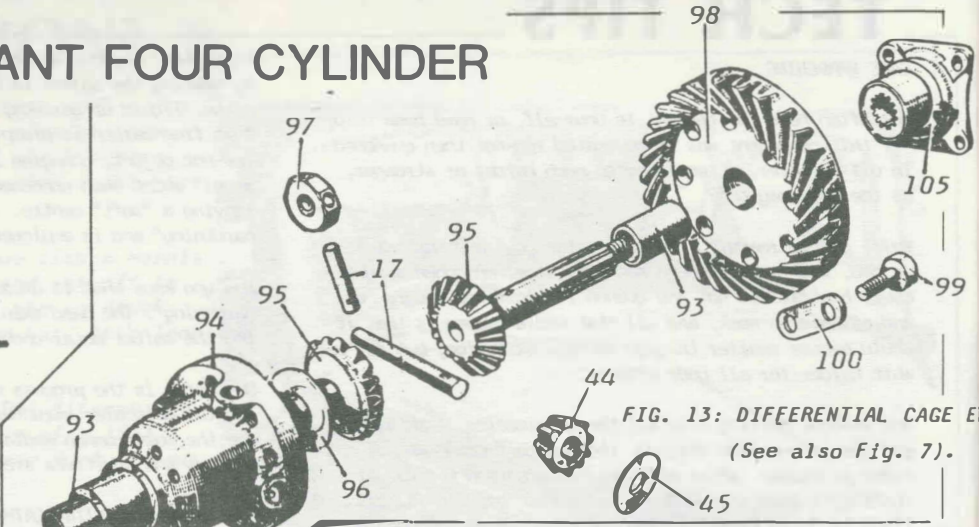


FIG. 13: DIFFERENTIAL CAGE E
(See also Fig. 7).

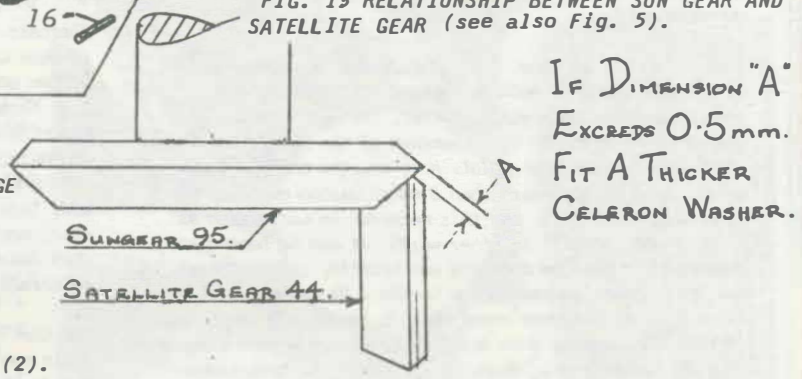


FIG. 15 RELATIONSHIP BETWEEN SUN GEAR AND SATELLITE GEAR (see also Fig. 5).

Continued from Front Drive 9 (2), 9 (6), 10 (2).

You may remember that we started working our way through the Traction gearbox some 18 months ago? Well, no more suspense - the saga is continuing.

The next step is to rebuild the differential assembly if necessary (and that's most likely). The differential assembly is essentially item 94, the pinion carrier, bolted up to item 98, the crown wheel - see Fig. 7 in FD 9 (2), reproduced in part here as Fig.13.

Take the differential assembly and place it in a vice with the crown wheel uppermost. Remove the eight bolts (99) securing the crown wheel (98) to the differential cage or pinion carrier (94) and lift the crown wheel off, taking care not to drop the sun wheel and output shaft (95) which pass through it.

If a suitable vice is not available, a piece of timber can be employed instead. An offcut of 25 mm pine, 150 mm wide and 300 mm long would be best. Place the differential on the offcut so that the differential is resting on the outer circumference of the crown wheel and the protruding end of the output shaft. By fitting a spanner "across the crown wheel" as in Fig. 14 to the retaining bolts (99) in turn, the bolts usually give before the crown wheel turns on the board. In exceptional circumstances, it may be necessary to have a second person assist in holding the differential on the board.

At this point, remove the sun wheel (95) from the crown wheel and inspect its teeth. Any degeneration here will be indicative of the other gears. If wear is appreciable, you had best chase up another set.

Looking at the open side of the differential cage, you can now see the surface which mates with the crown wheel. Within that surface are the ends of three planet gear spindle retaining pins (16). All three pins are tapered and to remove them, they must be drifted toward you as now viewed. Once the pins are removed, the planet gear spindles (17) of which there are two short and one long, can now be pushed out - these are a sliding fit. You can now remove all the remaining components, preferably one at a time so that you can re-assemble more easily.

In each of the differential cage and the crown wheel, there is an output shaft bush (93). Both of these bushes will need to be replaced as each carries the weight of both the output shaft and the inner end of the drive shaft. Wear on the corresponding rubbing area of the output shafts (95) will generally be negligible. A standard bush can be fitted to each side if you can get one. There is nothing available through bush manufacturers which comes even remotely close to what is needed. In all probability, you will have to have a pair turned up by someone with a lathe.

The bushes can usually be removed by selecting a socket which is slightly smaller than the outside diameter of the bush, and using the socket as a "drift" to enable the bush to be tapped out of the bore containing it.

Refitting the bushes is best done with a press but it is usually alright to use an output shaft as a mandrel passing through the bush and guiding it into the bore of the crown wheel or cage. In tapping the output shaft to drive

the bush in, it is necessary to protect the gear teeth cut on its end by placing a suitable sized socket in the centre of the sun wheel and striking it with the hammer. The bushes are driven in until flush.

Once the bushes have been fitted, and the components have been cleaned up, re-assembly will permit examination of the mesh of the differential gears (see Fig. 5, page 12 of FD 9 (2). Re-assembly is simple enough. First place the celeron washer (96) onto the output shaft, ensuring that the oil grooves are towards the back of the gear, then slide the shaft into the differential cage (94). Take the longest of the planet gear spindles (17), and insert the end without the machined rebate into the second bore which has provision for the sun gear spindle retaining pin. The count may be taken clockwise or anti-clockwise as there are three such bores. The fourth bore is without provision for a retaining pin, and it will be found that this fourth bore is directly opposite the one we seek.

Now fit in sequence a dome washer (45), planet gear (44), planet shaft centre (97), planet gear (44) and dome washer (45). Then slide the spindle (17) home and fit the retaining pin (16) to secure the assembly thus far. Next, offer up a short spindle (17), fit a dome washer (45) and planet gear (44), push the spindle home and again fit a retaining pin. Repeat for the remaining short spindle section.

There are two factors which control the proper meshing between the sun wheels (95) and the satellite (planet) gears (44) - see Figures 5 and 15. These factors are the dome washers (45) fitted behind the satellite gears, and the celeron washers (96) fitted behind the sun gears. Wear in the celeron washers is normally negligible, so that free play in the differential is taken as due to wear in the dome washers.

To check the meshing of these gears, pack out the four planet gears away from the cage so that they are fully meshed with the sun wheel. Now place the second sun wheel, complete with its celeron washer, into full mesh with the assembly of planet gears. A straight-edge placed across the open face of the cage should almost touch the outer exposed face of the second celeron washer. If the celeron washer is "too low" and the sun wheel protrudes beyond the planet gears by more than 0.5 mm, a thicker celeron washer will have to be fitted so as to bring this overlap into the range of +0.5 to -0.5 mm. As in Fig. 5, the ideal is for the gears to be flush at their outer mating circumferences. As mentioned earlier, the celerons usually wear very little, and the main wear occurs at the dome washers.

To determine the amount of wear which must be adjusted out at the dome washers, insert feeler gauge blades between the planet gear and the dome washer - check the one opposite at the same time. Repeat the operation for the other pair of gears. The wear is usually much the same for all the dome washers, so it is possible to make four spacing washers of a common thickness in most cases. These spacers should be turned up from 60 ton steel and then rubbed down with fine emery on a piece of plate glass to ensure the flat surfaces are parallel. If there is appreciable difference, then allowance should be made from gear to gear so that each spacing washer brings its gear within the acceptable meshing tolerance.

It can be seen that this tolerance is quite broad, but it is desirable that variations of controlled meshing between gears be kept to a minimum. Too great a variation would put most of the load onto one or two gears, and not spread it evenly over the four gears as is intended.

Having had the spacing washers made up, they will need to be trial fitted. Lightly oil all the components and assemble as before, only now fitting a spacer washer between each of the planet gears and the dome washers. Place the sun gear in situ and check the mesh once again, using the straight edge as directed earlier.

If the mesh checks out properly, remove the loose sun gear. Take hold of the differential assembly and turn the output shaft - it should move freely though it might be a little "notchy". Next, fit and secure the crown wheel complete with the remaining sun wheel and celereon washer. Torque up the retaining bolts (99) to 44-50 foot-pounds. Secure the bolt heads by bending up the lock tab against a flat and/or put a drop of Lock Nut on the clean threads before fitting each bolt (at final fitting - see below).

If the earlier checks have been satisfactory, this one is likely to be also. However, to fully verify that the differential cage assembly is acceptable, make the further checks as below.

Fit and secure an output (drive) flange (105) to either of the output shafts, hold the differential assembly, and rotate the flange. Rotation should be smooth and free. Depending on the gears used, you may find that the flange turns freely but not smoothly. This is no cause for alarm. The fact that it can be turned by hand without great force is what counts. As a comparison, the force should be no more than is needed to turn the chuck of your 10 mm dual-speed drill when it is in low-range. If more torque than this is needed, it is likely that there is insufficient longitudinal clearance on the output shaft and sun wheel (95). This clearance should be between 0.025 and 0.15 mm (0.001 - 0.006 inch).

The most probably remedy will be to reduce the thickness of the celeron washer. The only time that this remedy would not work is if the sun gear is excessively proud of the satellite gear i.e. as it is depicted in Figure 15. In such a case, one would have to reduce ever-so-slightly the thickness of the new flat washers.

Reducing the washers at fault can be achieved by sanding them on a piece of fine wet-and-dry paper. Place the paper on a flat surface such as a piece of glass sheet. Work the washers on the wetted paper in a circular motion, applying as even a pressure as possible in order that the washers will retain a uniform thickness. A vernier caliper or micrometer is desireable for gauging this uniformity, but a sensitive touch, a dose of patience and ordinary fitter's calipers can see an adequate job done.

Continued on page 5.

Gearbox repairs from page 7.

There is room here for error, though the smaller the better. You will have noticed that I have not written of replacing the three spindles (17) which carry the satellite gears. New ones are not available and there is no cost-efficient alternative. You will find that there is annular wear on both the spindles and in the bore of the satellite gears. Hence, there is room for the satellite gears to displace with any high spots on the washers.
Reassemble the unit and again check the clearance and freedom of rotation of the output shafts. This procedure may have to be repeated a few times to reach the desired standard.

(To be continued).

Kenn Gilbert.