GEARBOX

51. The gearbox is of unit construction with the transfer box (Fig 20) and provides five speeds which, through the medium of the transfer box, may be used in either a forward or a reverse direction. Early type gearboxes, i.e., those fitted in early production Mk 1 vehicles, give higher "indirect" gear ratios than those given by the late type (see page 11). Except for this difference in ratios, altered to improve the performance of the vehicle, both types of gearbox are basically similar in principle and construction.

> **Note:** *The gears are commonly spoken of as "Emergency low, 1st, 2nd, 3rd and top" but herein they are referred to as "1st, 2nd, 3rd, 4th and top" (or "5th") in conformity with the gear positions as engraved on the selector gate and the designations given in the vehicle Parts List.*

RUNNING GEAR

52. The gearbox casing is integral with that of the transfer box. The running gear is of conventional design and comprises an epicyclic gear train which gives four reduction gear ratios, a plate clutch which provides direct drive (for 5th gear) and a gear type oil pump which ensures adequate lubrication of revolving parts.

Driving shaft

53. The gearbox input or driving shaft (Fig 21(4)) is driven by the fluid flywheel and is supported on a ball bearing (55) at the flywheel end. The outer race of the bearing is held in a housing (66) and the inner race is backed by an adjusting washer (54). A locking nut (62) screws on to the outer end of the shaft and is secured with a lockring. This nut bears against a distance piece (60) carrying the oil pump driving gear which is sandwiched between the nut and the inner race of the ball bearing. On earlier types of gearbox (see para 94) no distance piece is fitted and the nut simply abuts the driving gear. Security of the ball bearing outer race is obtained by attaching an oil pump body (56) to a gearbox front cover (69) by long screws which first pass through an oil pump body cover (58). The oil seal, held in the latter cover, fits around the driving shaft nut and serves to prevent oil escape from the pump.

Clutch

54. The top gear clutch sliding member (51) rides by means of a bush (67) on the driving shaft. Superimposed between the sliding member and an actuating ring (68) is an angular-contact ball thrust bearing (52) and a thrust ring (53). It should be noted that this bearing should have its outer race fitted with the deepest flange towards the direction from which the thrust will occur, in this instance where the thrust ring bears firmly upon it.

55. There are four outer clutch plates (8) and five inner plates (7) held apart by six return springs (6) and plungers (5). This multi-plate clutch provides a straight-through drive for 5th (or top) gear and is operated in the same manner as the brake bands which engage the other four gears.

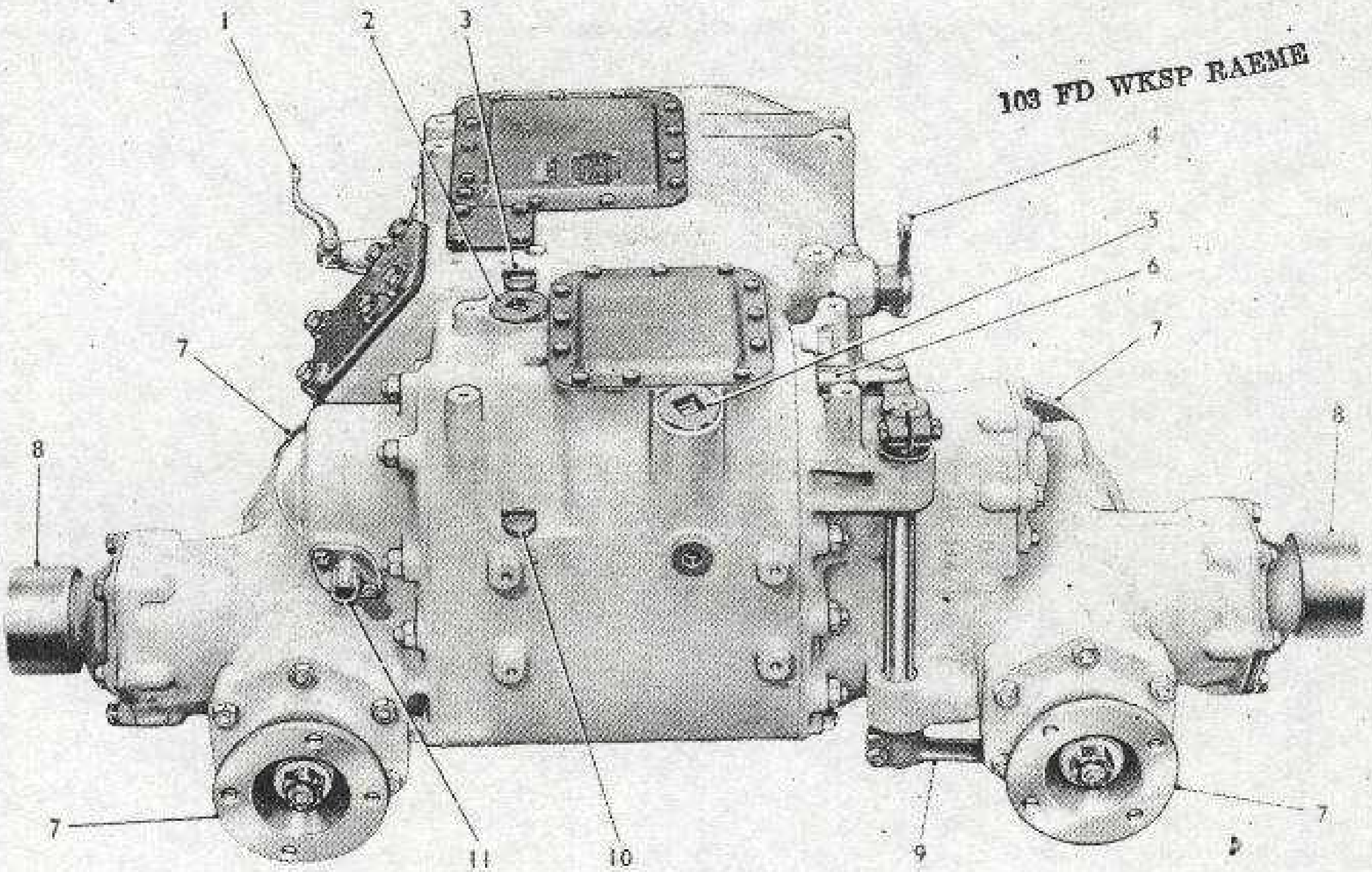
Gear trains

56. The 1st speed brake drum (17) is held within a ball bearing (20) which fits between the drum and an oil seal housing (34). The input gear bearing housing (31) is slightly recessed to receive the bearing. Between the oil seal housing and the outer race a running gear adjusting washer (35) is inserted. This washer is supplied in three thicknesses to permit adjustment of the running gear end float.

57. The following floating bushes are fitted: 1st speed sun wheel bush (37); 1st speed carrier bush (39); 2nd speed brake drum bush (41); 4th speed carrier bush (45); 3rd speed brake drum bush (48); 4th speed sun wheel bushes (46) and (50).

58. A support washer (44) is fitted between the 2nd and 3rd speed carrier plates and a thrust washer (42) is fitted between the driving and driven shafts. The planet gears run on roller bearings.

59. The 1st speed sun wheel (38) and the 2nd speed planets and carrier assembly (15) are splined to the driven shaft (23). A double sun wheel (43) splined to the driving shaft drives both the 2nd speed planets and carrier assembly (15) and the 3rd speed planets and carrier assembly (12). As indicated in para 57 the 4th speed sun wheel runs on two flanged bushes.



1 Gearbox selector lever
2 Gearbox oil filler plug
3 Gearbox oil dipstick
4 Busbar outer operating lever
5 Transfer box oil filler plug
6 Forward/reverse selector shaft
7 Coupling flange
8 Cover and mounting bracket
9 Bottom selector lever
10 Transfer box oil dipstick
11 Speedometer drive bracket

Fig 20 Gearbox and transfer box - front view

Driven shaft and transfer box input bevel pinion

60. The driven shaft rotates on bushes (18) and (19) fitted between it and the driving shaft. At its outer end the driven shaft is externally-splined to receive the shaft portion of the transfer box input bevel pinion (28) which is supported by opposed taper roller bearings (27). Between the inner races are fitted a spacer (30) and shims (26) selected to give a bearing pre-load of 0.000 to 0.002 in. A nut (24) threaded on to the pinion shaft and locked with a tabwasher secures the whole assembly together. The two outer races of the roller bearings are separated by shoulders formed on the input gear bearing housing (31) the outer race at the inner end being held by an oil seal housing (34); this housing is pegged to the bearing housing.

Key to Fig 21 (opposite)

1 Timing pointer
2 Front cover guard
3 Top gear outer member
4 Driving shaft
5 Return spring plunger
6 Return spring
7 Inner clutch plate
8 Outer clutch plate
9 Gearbox top cover
10 4th speed brake band
11 3rd speed brake drum (part of 4th speed planets assembly)
12 4th speed annulus (part of 3rd speed planets assembly)
13 3rd speed brake band
14 2nd speed brake band
15 2nd speed planet carrier (part of 2nd speed planets assembly)
16 1st speed brake band
17 1st speed brake drum (part of 1st speed planets assembly)
18 Driven shaft front bush
19 Driven shaft rear bush
20 1st speed brake drum bearing
21 Circlip
22 Oil seals
23 Driven shaft
24 Input pinion locknut
25 Input pinion lockwasher
26 Input bevel pinion shims
27 Taper roller bearing
28 Transfer box input bevel pinion
29 Input pinion insert
30 Input bearing spacer
31 Input gear bearing housing
32 "O" packing - 4.750 in. x 0.210 in.
33 "O" packing - 3.850 in. x 0.210 in.
34 Oil seal housing
35 Running gear adjusting washer
36 Input gear bearing housing shims
37 1st speed sun wheel bush
38 1st speed sun wheel
39 1st speed carrier bush
40 2nd speed brake drum
41 2nd speed drum bush
42 Sun wheel thrust washer
43 2nd and 3rd speed sun wheel
44 3rd speed carrier plate washer
45 4th speed carrier bush
46 Sun wheel rear bush
47 4th speed sun wheel
48 3rd speed brake drum bush
49 4th speed brake drum
50 Sun wheel front bush
51 Top gear sliding member
52 Thrust bearing
53 Top gear thrust ring
54 Driving shaft adjusting washer
55 Driving shaft bearing
56 Oil pump body
57 Oil pump driven gear
58 Oil pump body cover
59 No.3 Woodruff key
60 Distance piece
61 Driving shaft nut lockring
62 Driving shaft nut
63 Oil seal
64 No.5 Woodruff key
65 Oil pump driving gear
66 Driving shaft bearing housing
67 Top gear sliding member bush
68 Top gear actuating ring
69 Gearbox front cover
70 Oil pump driving gear

(a) Sectional arrangement showing late type oil pump

(b) Part section showing early type oil pump driving gear

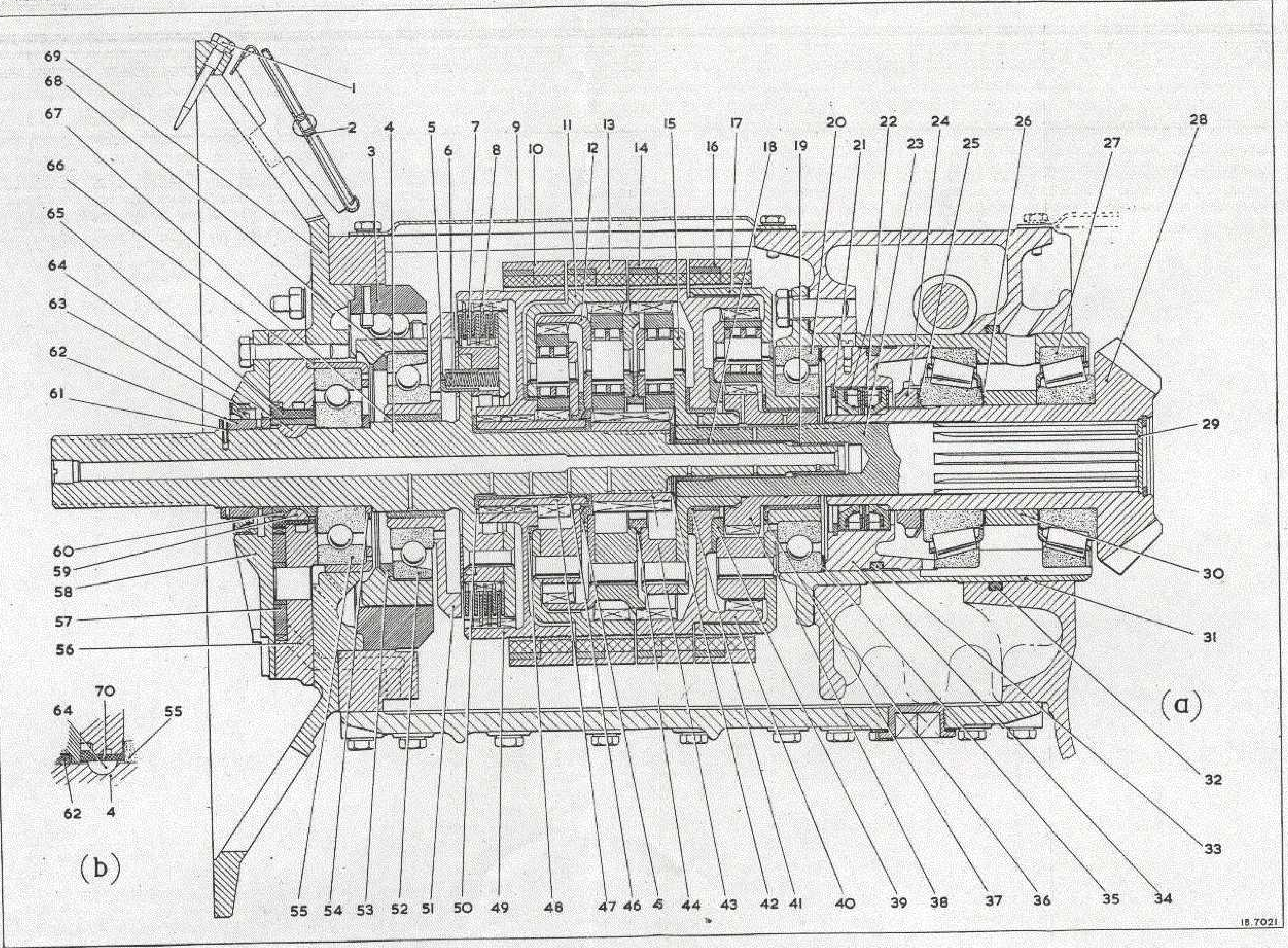


Fig 21 Gearbox running gear and tansfer box input bevel pinion

61. Two oil seals (22) are fitted face to face around the input bevel pinion shaft and "O" packings (32) and (33) are inserted respectively in annular grooves in the gearbox casing and the oil seal housing. Between the gearbox casing and the input gear bearing housing, shims (36) are fitted. These shims are supplied in various thicknesses to enable the bevel pinion to be correctly meshed.

Operation

62. With this arrangement of compound epicyclic gearing torque conversion only takes place when a member of any one train is locked by holding the corresponding brake drum with a brake band anchored to the gearbox casing, thus providing a reaction point or fulcrum. At the output end is a single epicyclic train which determines the reduction for 1st speed. Intermediate speeds are obtained by driving the epicyclic trains at various rates, thus reducing the reduction until, for top gear, a clutch prevents relative rotation of parts and the whole assembly revolves together.

63. The compound gear train, as shown in Fig 21(a) consists of four simple trains. The 2nd speed train is the basic train, the purpose of the others being to govern the speed and direction of rotation of the 2nd speed annulus which also forms the 2nd speed brake drum.

64. The 2nd speed drum (40) is connected to the 3rd speed planet carrier plate which is integral with the 4th speed annulus (12) whilst integral with the drum is the 1st speed annulus. The second speed drum, except when held by the brake band (14) must rotate at the speed and in the direction which result when one of three other brake bands (16) (13) or (10) is applied.

65. The gearbox output is transmitted to the transfer box input bevel pinion through the driven shaft (23) which splines into the bore of the 2nd speed planet carrier (15) and also into the bore of the 1st speed sun wheel (38).

66. With 1st gear engaged the 1st speed brake drum (17) (and hence the planet carrier) is held by the brake band (16). As the driving shaft rotates, it turns the 2nd and 3rd speed sun wheel (43) which in turn drives the 2nd speed planets. These planets turn their carrier and, therefore, the gearbox driven shaft in the same direction as the driving shaft but at a much reduced speed, owing to the action of the 1st speed train which causes the 2nd speed annulus (integral with the 1st speed annulus) to turn in the direction opposite to that of the driving shaft. The reduction ratio in this gear is 6.046 : 1 (earlier type 5.66 : 1).

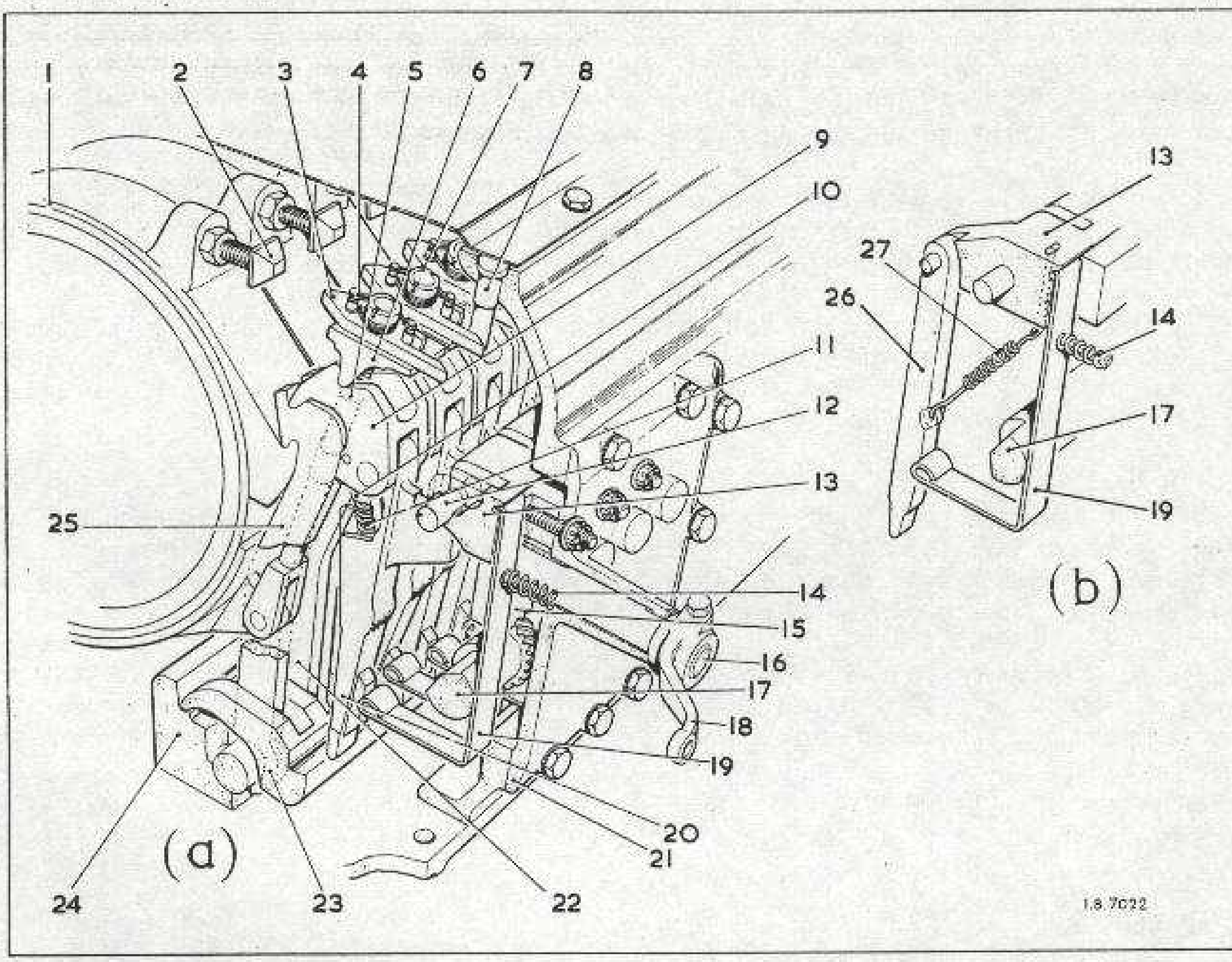
67. For 2nd gear, the 2nd speed brake band (14) is applied and this holds the 2nd gear brake drum (40) stationary. The driving shaft drives the 2nd and 3rd speed sun wheel (43) which rotates the 2nd speed planets and, because the 2nd speed annulus is locked by the brake drum, the 2nd speed planet carrier turns at a higher speed than in 1st gear and hence the gearbox driven shaft also. The reduction ratio in 2nd gear is 4.381 : 1 (earlier type 4.17 : 1).

68. In 3rd gear, the 3rd speed brake drum (11) (and hence the 3rd speed annulus) is held stationary by the brake band (13). The driving shaft rotates the 2nd and 3rd speed sun wheel and therefore the 3rd speed planets. As the 3rd speed planet carrier revolves, it rotates the 2nd speed annulus and the 2nd speed planet carrier is turned at a higher speed than in 2nd gear and hence the gearbox driven shaft also. The reduction ratio in 3rd gear is 2.437 : 1 (earlier type 2.375 : 1).

69. The 4th gear is obtained by applying the brake band (10) thus holding stationary the drum (49) and hence the 4th speed sun wheel (47). Because of the intermeshing

between the 3rd and 4th gear train, the 3rd speed carrier revolves faster than when 3rd gear is engaged and therefore the speed of 2nd speed planet carrier is increased and also that of the gearbox driven shaft. The reduction ratio in this gear is 1.569 : 1 (earlier type 1.527 : 1).

70. Top gear is obtained by engaging the plate clutch, all the brake bands being disengaged. This locks the driving shaft to the 4th speed brake drum and causes all the members of the compound gear train to rotate as a whole and so give direct drive to the gearbox driven shaft.



1 Brake band
2 Adjuster screw
3 Adjuster ring
4 Adjuster spring
5 Pull-rod
6 Adjuster table
7 Pull-rod nut
8 Adjuster tail pin
9 Thrust pad
10 Operating strut plunger
11 Operating strut spring
12 Locking bar plunger
13 Selector locking bar
14 Spring
15 Quadrant (integral with shaft (16))
16 Selector quadrant shaft
17 Selector camshaft
18 Selector lever
19 Cam following plate
20 Operating strut
21 Selector cover
22 Rear hook
23 Busbar
24 Busbar fulcrum bracket
25 Front hook
26 Neutral strut
27 Neutral strut spring

(a) General arrangement
(b) Part-view showing neutral strut

Fig 22 Selector gear and brake band operating gear

BRAKE BANDS AND OPERATING GEAR

71. The gearbox components are controlled through the medium of a pre-selector mechanism operated by a lever mounted near the driver's seat. When the lever is moved it operates a camshaft in the gearbox, the position of the camshaft determining which gear will be engaged when the gear change pedal is depressed. The gear is not changed until the pedal is depressed and then released.

72. The downward pedal movement releases the gear in operation whilst on the spring-actuated return stroke a locking bar engages the mechanism brought into position by the selector lever and permits it to apply the necessary pressure to contract the brake band of that gear. The brake bands each comprising an external and an internal band are of conventional design as shown in Fig 21 and 22 and each brake band is applied in a similar manner to any other in the gearbox.

73. Each brake band is applied when a strut (Fig 22(20)) having a thrust pad (9) pinned to its upper end is lifted by a busbar (23) which is controlled by a powerful spring (para 78) and is connected by linkage to the gear change pedal (para 105).

74. Fig 23(a) shows the position of the busbar after depressing the gear change pedal. This allows the lower end of the strut corresponding to the selected gear to engage in the groove in the busbar. Fig 23(b) shows the position of the busbar after releasing the gear change pedal, the brake band now being applied.

75. Each brake band has an auto-adjuster to maintain the correct clearance between the brake band and the drum. When the strut is lifted to apply the brake band the adjuster moves towards the adjuster screw (Fig 22(2)). As the brake band wears slightly the movement of the strut increases causing the adjuster ring (3) to strike the adjuster screw and be deflected in a counter-clockwise direction. In this direction the spring (4) slips round the pull-rod nut (7). When the gear change pedal is next depressed, the adjuster moves away from the brake band and the other end of the adjuster ring strikes the tail pin (8) which deflects the ring in a clockwise direction. The spring now tightens on the nut which screws down on the pull-rod (5) a small amount.

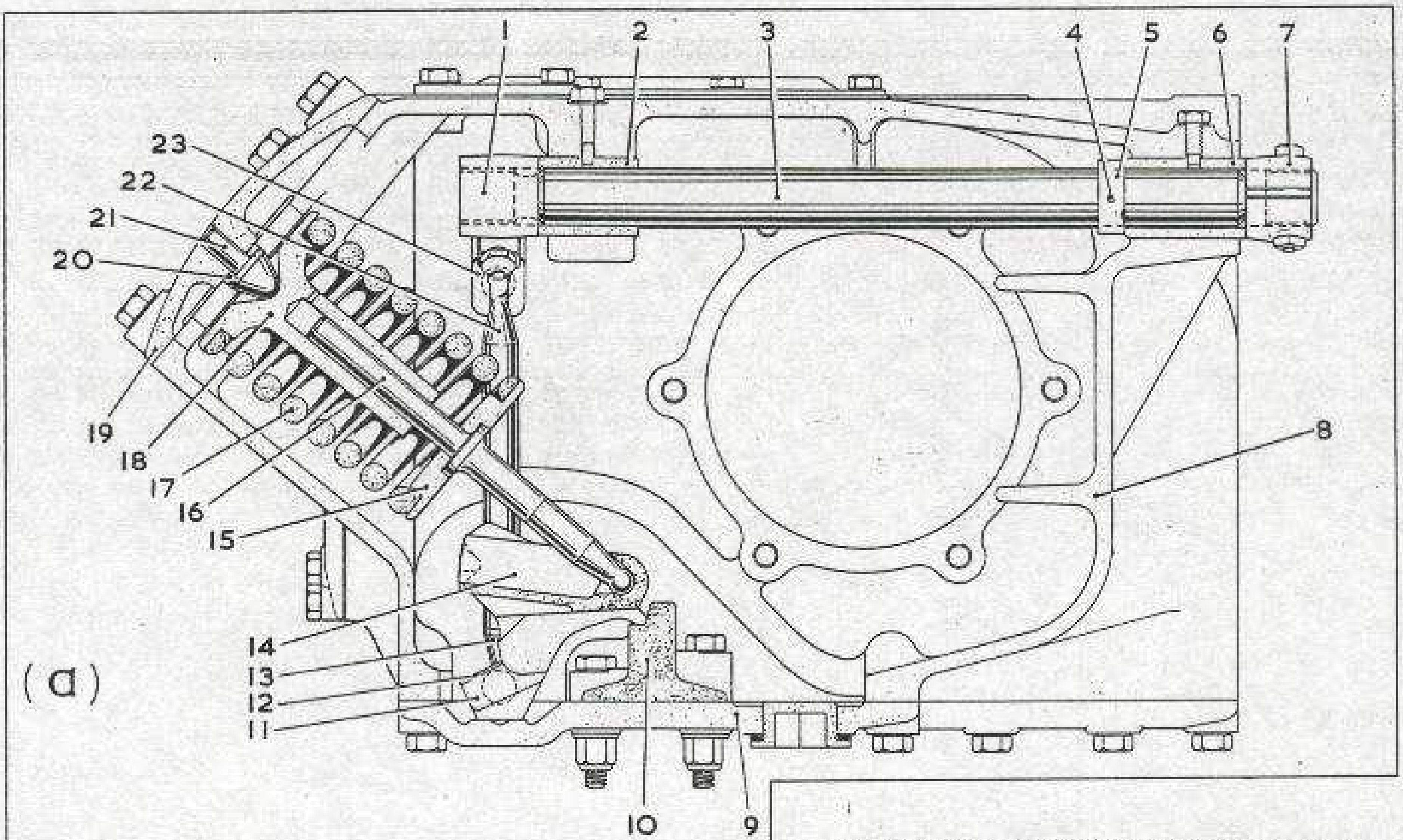
76. The adjuster will continue to operate as described until the brake band clearance is correct; the adjuster ring then just touches the adjuster screw and the action ceases.

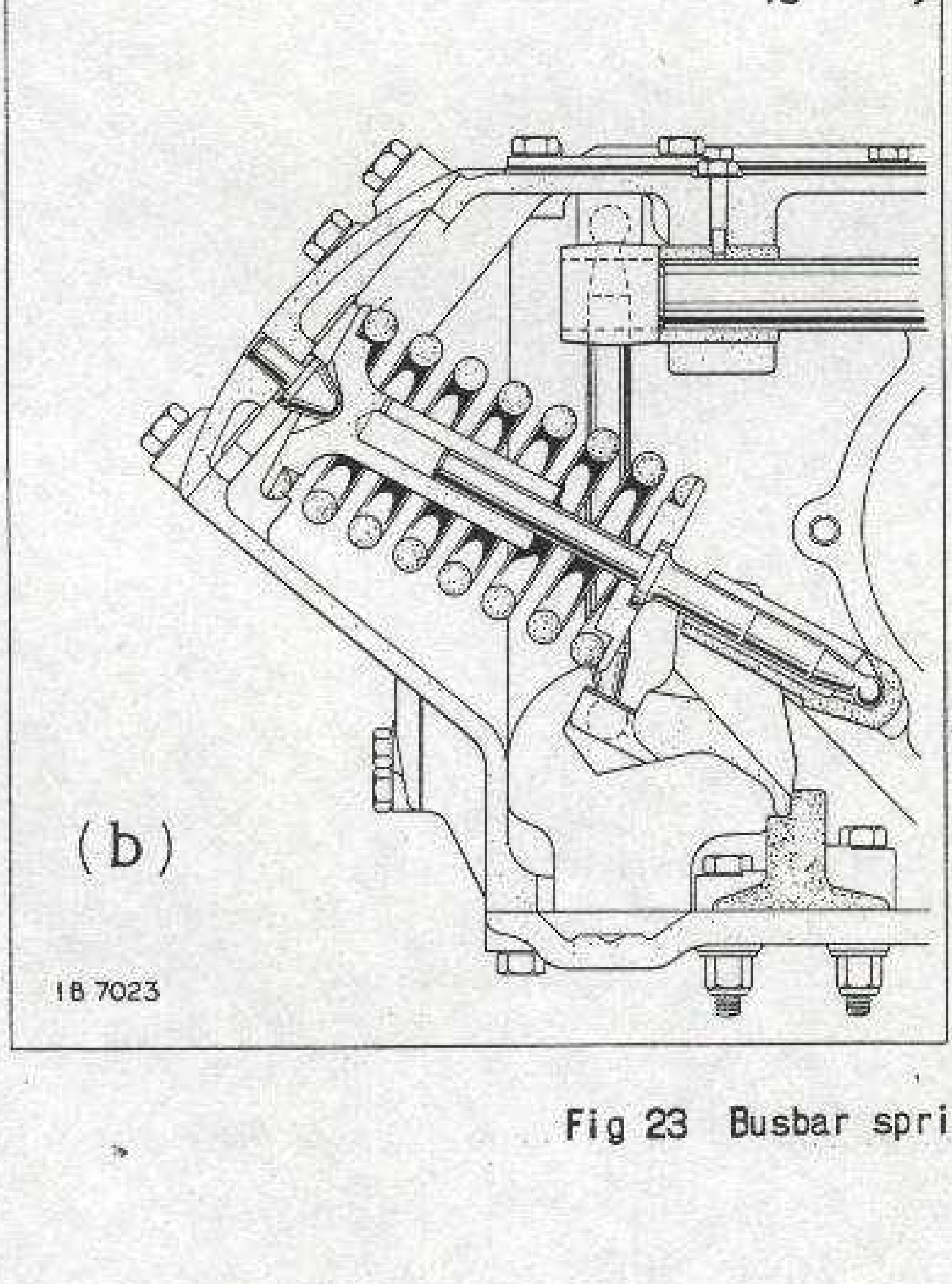
TOP GEAR CLUTCH

77. Top gear (5th) is engaged by the busbar lifting a strut in exactly the same manner as described for the other gears but, instead of tightening a brake band, the strut lifts a pin which is attached to the clutch actuating ring (Fig 28(68)). The ring has spiral grooves. There are corresponding grooves in the outer member (3) and steel balls working in the grooves cause the rotary motion given to the actuating ring to be converted to endwise movement. This is transmitted to the sliding member (51) which presses the clutch plates together. The clutch has an automatic adjuster similar to that described for each brake band.

BUSBAR SPRING GEAR

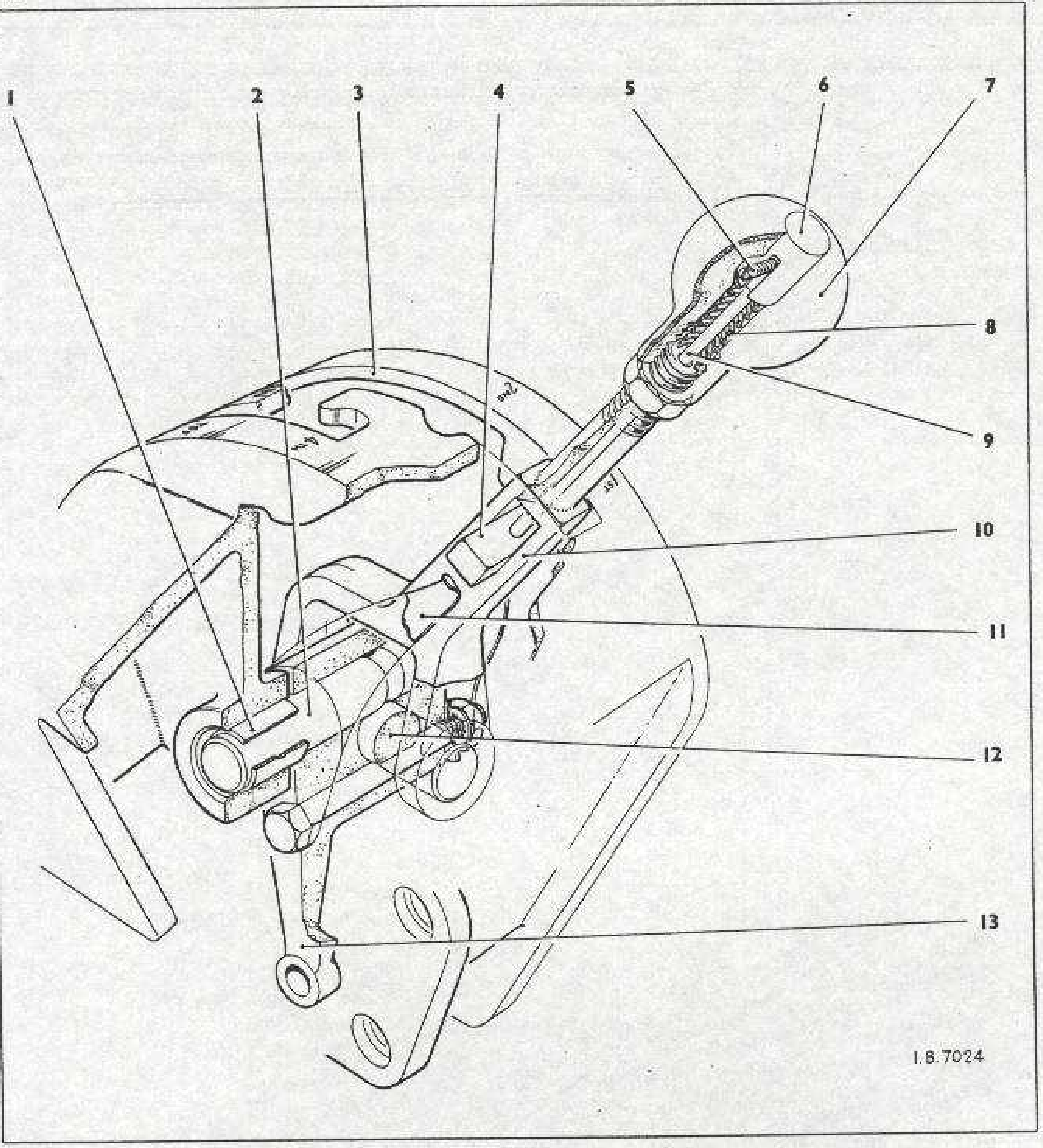
78. The arrangement of the spring gear is shown in Fig 23, the gear change pedal being connected by linkage to the busbar outer operating lever (7) serrated and clamped to the cross-shaft (3). The cross-shaft is support in two bushes located in the casing by dowel-end screws. A collar secured by a Mills pin prevents endwise movement. At its inner end, an inner lever (1) is serrated and clamped to the shaft; the ball ends of a





1 Busbar inner operating lever
2 Cross-shaft inner bush
3 Busbar operating cross-shaft
4 Mills pin
5 Collar
6 Cross-shaft outer bush
7 Busbar outer operating lever
8 Gearbox and transfer box casing
9 Gearbox bottom cover
10 Busbar fulcrum bracket
11 Busbar
12 Rod retaining plate
13 Busbar operating rod
14 Busbar bucket
15 Spring guide collar
16 Spring inner guide
17 Busbar spring
18 Spring outer guide
19 Spring cover
20 Ball pin adjusting washer
21 Ball pin
22 Busbar operating sleeve
23 Sleeve retaining plate
(a) Gear change pedal depressed
(b) Gear change pedal released

Fig 23 Busbar spring gear



1 Oil retaining bronze bush	8 1st speed stop spring
2 Selector lever spring pivot pin	9 1st speed stop rod
3 Selector gear gate	10 Selector gear lever
4 1st speed stop	11 Selector lever R.H. control spring
5 1st speed stop grubscrew	12 Selector lever pivot pin
6 1st speed stop button	13 Selector operating lever
7 Selector lever knob	

Fig 24 Selector gear lever and gate assembly - three-quarter front view

busbar operating sleeve (22) and rod (13) fit into hollows formed respectively at the end of this lever and at an outer position on the busbar.

79. When the pedal is fully depressed, the busbar (11) is held down against a stop on the gearbox bottom cover (9) the pedal pressure being opposed by the force of the spring (17). Although the spring is fully compressed and exerting maximum force, the effective arm of the spring force about the busbar pivot is very short, owing to the busbar bucket (14) having swung into abutment at its lower end with the busbar. As a result the pedal pressure necessary to balance the force is not excessive.

80. When the pedal is released, the spring force acting through the bucket causes the busbar to rise to the position shown in Fig 23(b). Although the spring force decreases as the busbar rises, owing to the spring extending, this decrease is more than compensated for by the increase in the effective arm of the spring force, except for a brief period just before the lower end of the bucket swings away from the busbar. Thus, the moment of the spring force causing the busbar to rise increases and with it the force applied to the strut.

SELECTOR GEAR

81. The selector gear (as illustrated in Fig 22) is of modified design, incorporating a neutral strut (see para 90 to 92) and comprising a toothed quadrant (15) which is meshed with a spiral gear integral with the selector camshaft (17) which carries one cam for each gear and an additional cam for neutral.

82. The selector camshaft is mounted in a bearing at each end. For each cam there is a cam following plate (19) which has a coil spring (14) behind it. An interlocking device for preventing two gears being engaged at the same time is formed by a locking bar (13) having five slots and housing a row of four plungers (12) through which projections on the five operating struts (20) have to pass. Sufficient end movement is provided to allow only one strut to pass at a time.

83. The quadrant is integral with the shaft (16) which is mounted in two bushes pressed into the cover (21) and has a lever (18) keyed and clamped to its outer end.

84. When the selector gear lever of the selector gear control is placed opposite any gear marked on the gate, that gear will be engaged when the gear change pedal is fully depressed and then released. In operation, the camshaft is turned so that the affected cam following plate is pushed towards the strut (20) by its spring. This pushes the strut against the busbar (23) but as the busbar is already held up by the busbar spring no action takes place.

85. As soon as the gear change pedal is depressed the busbar is depressed and the cam following plate is then able to push the strut so that it rests over the groove in the busbar. When the gear change pedal is released the busbar rises and lifts the strut with it. This applies the brake by lifting the thrust pad (9) which is connected to the lower end of the brake band by means of a pull-rod (5). The top end of the brake band is held by two hooks (22) and (25).

86. When the gear change pedal is depressed for the next change of gear the disengaging spring-loaded plunger which is fitted inside the strut forces the strut away from the busbar. The cam following plate is, at this period, held out of the way by the camshaft.

87. Let it be assumed that 1st gear is engaged and the selector gear lever is moved to the 2nd gear position. This causes the camshaft to be rotated until the lower point

of the 2nd gear cam is opposite the cam following plate, which pushes the 2nd gear strut against the busbar. At the same time, the 1st gear cam following plate is forced away from the 1st gear strut.

88. When the gear actuating pedal is fully depressed the 2nd gear strut enters the groove in the busbar while the 1st gear strut is flicked clear of the busbar by the spring-loaded plunger incorporated in the strut. On releasing the pedal the busbar spring lifts the busbar and the 2nd gear strut so tightening the brake band and engaging 2nd gear.

89. From the foregoing it should be fully understood why it is so essential to depress the gear actuating pedal FULLY when changing gear. The selection and engagement of top gear is carried out in exactly the same manner, except that a clutch is engaged instead of a brake band being applied.

90. With the modified design of selector gear neutral is obtained by the busbar being held right down by the neutral strut (26). This ensures a greater clearance between the 4th gear brake band and drum and in the top gear clutch and so reduces the drag in neutral.

91. Early type gearboxes were fitted with a selector gear of conventional design and therefore did not incorporate the neutral strut, while the camshaft had five cams in all, one for each gear. These gearboxes were so timed that, when neutral was selected, two struts (i.e., 4th and 5th) were pushed into the busbar when it was depressed to its lowest position by the gear actuating pedal. The plungers on the locking bar are of such a length that only one slot at a time can be filled by the projection on the back of a strut. Consequently, when the gear change pedal was released, the two struts were prevented from passing through the correspoinding slots and rising high enough to tighten the 4th gear band or compress the top gear clutch. As neither the brake band nor the top clutch was applied, the gearbox was left in neutral.

92. In all early type gearboxes the selector gear of conventional design will be replaced by the modified design on vehicle overhaul, in accordance with Wheeled Vehicles V 627 Mod. Inst. No.15.

LUBRICATION SYSTEM

93. The gearbox has an oil capacity of 10 pints. It is fitted with a combined dip-stick and breather and a filler plug, both of which are accessible after opening a hinged cover under the gunner's seat.

94. The lubrication system is pressure fed by a gear type oil pump. In earlier types the driving gear is keyed directly to the shaft but in the later types of gearbox a different arrangement is adopted. A distance piece is fitted between the driving gear and the shaft; this distance piece is keyed to the shaft and the driving gear is in turn keyed to the distance piece. Woodruff keys are used in both cases and, during assembly, the driving gear must be a good sliding fit on the shaft. The front shaft nut in this instance clamps the distance piece between itself and the inner race of the driving shaft and thus does not bear directly upon the oil pump driving gear.

95. The pump draws oil from the gearbox casing and discharges it into an axial hole in the driving shaft whence it is distributed through radially drilled holes to the various bushes and gears. The oil then finds its own level in the gearbox casing to be recirculated by the pump. Two oil pressure relief valves, each loaded by a spring, are housed in the oil pump body behind a cover.

Warning: *Should the vehicle be towed with the engine stationary, the gearbox in neutral and the transfer box engaged, some parts of the gearbox will be running at high speed although the oil pump will not be working. Under these conditions there is a definite risk of gearbox overheating and seizure. To avoid this, the transfer box must also be placed in neutral when the vehicle is being towed; it is not sufficient to place the gearbox in neutral.*

SELECTOR GEAR CONTROL

DESCRIPTION

96. The selector gear lever (Fig 24(10)) operates in a gate (3). This gate is secured by studs welded to the hull at the right of the driver's seat. The lever pivots on two pins; one, the selector lever spring pivot pin (2) and the other the selector lever pivot pin (12). By means of the first of these two pins the lever can be moved in a forward or rearward direction or, by use of the second, tilted sideways into either slot of the gate.

97. The spring pin is mounted in two oil-retaining bronze bushes pressed into bosses formed on the flanks of the gate and supports, in addition to the selector gear lever, a selector operating lever (13) together with a R.H. control spring (11) at one side and a similar L.H. spring at the other. Both springs are secured by a bolt which passes through the selector operating lever (13). This lever operates the linkage. When a gear in either slot of the gate is selected, one control spring bears firmly upon the selector gear lever thereby jamming it against the side of the slot. In neutral gear the lever is clasped firmly between the two control springs.

98. The 1st speed stop (4) fits into a slot in the selector gear lever and is screwed on to one end of a rod (9) which is free to slide in the centre of the lever shaft. At its top end the rod screws into a button (6) loaded by a small coil spring (8). A deep projection cast on the gate prevents the lever being moved to the 1st gear position unless the thumb button is first depressed.

99. The gate is engraved with the following gear positions: 1st, 2nd, 3rd, 4th, T and N (T = top, N = neutral).

100. An adjustable control rod is pin-jointed to the selector operating lever at one end and to an idler lever (Fig 25(3)) at the other end. The idler lever pivots by means of an oil-retaining bronze bush on a pin welded at one end to a bracket and fitted at the other end with a collar, secured by a Mills pin, for retaining the lever.

101. From the second eye end of the idler lever another adjustable control rod is connected to the outer arm of a bell-crank lever (4) which pivots by means of two oil-retaining bronze bushes on a pin welded to the hull structure. This lever also is retained on its pin by a collar secured by a Mills pin. The inner arm of the bell-crank lever is pin-jointed to a short adjustable control rod which is attached to the gearbox selector lever (5).

Notes:

1. *The arrangement at the rear end of the selector gear control as shown in Fig 25 is that applicable to the modified gearbox selector gear incorporating a neutral strut. In this arrangement the gearbox selector lever and the inner arm of the bell-crank lever (Pt. No. FV51866) project rearwards when in neutral. When 1st gear is selected the gearbox selector lever is moved to its highest position.*

2. With the conventional selector gear as fitted in early gearboxes (see para 90), the gearbox selector lever and the inner arm of the bell-crank lever (Pt. No. FV50266) project forwards when in neutral. When 1st gear is selected, the gearbox selector lever is moved to its lowest position.

OPERATION

102. The selector gear lever does not engage the gear and the position of the lever is no indication that the gear is engaged in the gearbox. When the lever is moved it operates the gearbox camshaft upon the position of which depends which gear will be engaged when the gear change pedal is depressed.

103. It is most important that, before the engine is started, the selector lever is moved to the neutral position and the pedal operated. The pedal should be operated even if the lever is in the neutral position.

104. When any gear is being engaged the lever should be moved to the required position before the change is made. The lever may be left in position for the next change for any length of time.

GEAR CHANGE PEDAL AND LINKAGE

DESCRIPTION

105. The pedal (Fig 25(14)) is welded to a tubular shaft which also carries at its left-hand end an integral linkage operating lever. This pedal assembly is free to pivot on a solid shaft which is held in brackets (13) bolted to the hull, the shaft being secured to the bracket at one end with a Mills pin. Two oil retaining bronze bushes, pressed into the ends of the tube, support the pedal assembly.

106. A short adjustable rod is connected to the pedal lever and an idler lever (12) respectively. The idler lever is free to move by means of an oil-retaining bronze bush on a shaft held in a bracket bolted to the left-hand bevel box; the shaft is secured with a Mills pin.

107. From the second eye connection on the idler lever a longer rod, also having forked ends, is linked to a bell-crank lever. The bell-crank comprises a tubular member with levers integral at each end. It pivots by means of two oil retaining bronze bushes on a short shaft which is held in a bracket (7). The bracket is bolted to the floor of the hull and a Mills pin secures the shaft rigidly to it. From the bell-crank lever another adjustable rod is linked to the gearbox busbar outer operating lever (6) (see also Fig 23(7)).

108. Split-pinned joint pins and fork-ends with locknuts provide means of attachment for all the control rods. The pedal and bell-crank lever are set to angular dimensions measured through the centre of the busbar outer operating lever (i.e., 5° below the horizontal when the pedal is down and 47° above it when the pedal is up) the rods being adjusted to give an equal swing of the idler lever about a vertical centre line.

OPERATION

109. This is as described in para 78.

TRANSFER BOX

DESCRIPTION

110. The transfer box is of unit construction with the gearbox (Fig 20). The main body of the transfer box is cast integral with the gearbox casing (Fig 26(60)) and is provided with studs to receive the right-hand and left-hand output gear casings (59) and (24). In the upper half of the box, two directional spiral bevel gears supported in taper roller bearings are in constant mesh with the input bevel pinion (7). A mainshaft (8) passing through the hollow centres of the directional gears carries a sliding dog free to move on that portion of the shaft between the gears. This sliding dog is controlled by the forward/reverse lever in the driver's compartment and can be actuated at will to engage either one or other of the directional gears.

111. When the dog engages a gear the motion of that gear is imparted to the mainshaft which in turn drives (through the medium of a double-helical gear train at the right-hand end of the shaft) a bevel differential assembly which divides the drive and directs it at each side to an output spiral bevel pinion that is in constant mesh with two output bevel gears.

112. Both output gear casings are machined metal castings, the left-hand casing (24) being the longer of the two. Each is secured to the studs on the main body by plain nuts and shakeproof washers. The bevel pinion cover at the end of each output casing incorporates a bracket (trunnion) which serves to mount the complete transmission assembly.

113. The right-hand end of the mainshaft drives the speedometer. In the main body an oil filler and dipstick are provided. A breather is incorporated in the dipstick assembly; air pressure developed in the transfer box through operation of the gears is equalized through connecting passages and then vented through the breather to atmosphere. Lubrication is by the oil bath method, the oil reaching the various gears, ball and roller bearings, by splash and oil mist. An oil drain plug is fitted to the base of the box and is accessible through a hole in the underside of the hull after a drain plug coverplate (Fig 79(4)) has been removed.

114. One directional bevel gear is mounted in the right-hand side of the main body. This gear is supported by opposed taper roller bearings (Fig 26(3)) carried in a flanged bearing housing (6) the flange being drilled and counterbored for eight socket-headed screws which secure the housing in the main body.

115. Between the bearing housing flange and the face of the casing where it abuts, shims (5) are fitted to ensure correct meshing of the gear with the input pinion. These shims are supplied in four thicknesses ranging from 0.002 in. to 0.025 in. The cups of the bearings fit against abutments machined in the housing, while a spacer and shims (12) as required separate the cones. A locknut (13) fits on the shaft of the bevel gear which is externally threaded to receive it; when tightened this nut bears against a lockwasher which bears on the inner cone of the outer bearing thereby securing the gear against axial movement, the shims (12) having been selected to give a bearing pre-load of 0.000 in. to 0.002 in.

116. Identical otherwise in method of assembly, the other directional bevel gear is mounted in the output gear casing (24) at the left-hand side.

117. The mainshaft passes through the hollow shafts of the directional bevel gears and is supported at the left-hand end by a roller bearing (16) and a ball bearing (17) which are held apart by an inner and an outer spacer. Being shouldered, the mainshaft is

positively held in these bearings, its abutment being clamped against the inner race of the roller bearing by the tightening of a slotted nut (20) which bears upon a washer (21) against the inner race of the ball bearing. The nut is locked by split-pinning. This double bearing can adjust itself to deflections of the shaft and, having to carry a radial load without much thrust, the inner races are clamped as described to prevent them jarring loose.

118. The splined centre portion of the mainshaft carries a sliding dog (9) which is toothed at each end. Engaging in a groove cut round the centre of the dog is a fork (11) which is part of the forward/reverse mechanism. The teeth of the dog engage with corresponding teeth in either of the bevel gears, the dog being slid along to engage it with the right-hand gear if FORWARD is selected or the left-hand gear if REVERSE is chosen. Selection of neutral on the forward/reverse lever places the dog in the midway position with neither gear in engagement. The end teeth of the sliding dog are cut with 6° reverse lead in order to prevent disengagement.

119. The right-hand end of the mainshaft is splined to carry a staggered double-helical gear (58) which meshes with a driven gear (39) of similar pattern on the differential assembly. The mainshaft helical gear is held in position at one end by a sleeve (57) which abuts the dog-splines on the mainshaft and, at the other end, by the inner race of a roller bearing (56). This roller bearing which has a single-lip outer race is mounted in the right-hand output gear casing and supports the right-hand end of the shaft. Keyed to that portion of the mainshaft beyond the roller bearing is the speedometer gear (55). This gear (a worm driving a worm wheel) bears against the inner race of the mainshaft right-hand bearing and is held there by a thick washer, slotted nut and split pin. The speedometer pinion, i.e., the worm wheel, abuts a thrust pad and runs in a shouldered bush pressed into a bracket (40) which is secured by a pair of nuts screwed down on studs, the bracket being positioned to bring the oil hole at the inner end uppermost.

120. The differential casing (32) and (36) is supported in roller bearings (31) and (48) one in each output gear casing. The outer races of these bearings have single lips. The differential casing is stepped down at both ends to mount the inner races of these bearings, the reduced diameters thereby affording positive location of the casing between bearings spaced at opposite ends. At the right-hand end, the double-helical gear driven by the mainshaft gear is splined to the casing.

121. The differential casing is made up in two parts, a long portion (36) (mounting the helical gear) and a much shorter part (32). Four holes arranged radially around the casing joint in the same plane as the joint, accommodate the differential cross-pin or spider (33) which is clamped into position when the casing is assembled. Eight bolts, nuts and split pins are used for holding together the two parts of the casing.

122. Each arm of the cross-pin carries a bush. On the bush rides a bevel pinion (35). A dished thrust washer (34) is fitted between the head of the pinion and the casing to prevent "picking up". Both long and short casings receive in floating bushes the differential bevel gears. These gears are driven by the four pinions.

123. Each output bevel pinion (49) is supported in an identical manner by opposed taper roller bearings (50) which are a press-fit within a flanged housing (54) which fits inside the output gear casing. The cups are separated by a shoulder machined in the housing and the cones by a spacer. Shims (53) are available in three thicknesses for insertion at the outer ends of the spacers to give a bearing pre-load of 0.000 in. to 0.002 in. The shaft of the output bevel pinion projects through the bearings and its end is externally-threaded to take a nut (52) which when tightened bears upon its lockwasher which bears against the cone of the outer bearing.

124. The housing accommodating these bearings is secured to the casing by nuts and hexagon-headed screws which also secure a cover (23) over the end of the casing. This cover incorporates a bracket or trunnion for mounting the transfer box and, indeed, the whole front end of the combined transmission and power unit installation. Caps fit over the mounting trunnions at both sides. The trunnions are held in a Metalastic rubber bush. Shims (41) are provided for fitment between the bearing housing and the casing to permit adjustment of the backlash between the output bevel gear and the output pinion.

125. Each output bevel pinion drives two output bevel gears (44) positioned respectively forward and aft and at right angles to the output shaft (differential halfshaft). These bevel gears are supported by opposed taper roller bearings (43) and (47) carried in a housing (46) and fitted with spacer and shims in a like manner to that used in the case of the output bevel pinion. The end of each output bevel gear shaft is splined to receive a coupling flange (25) which is secured with a slotted nut and split pin. Within a housing (42) retained by nuts and shakeproof washers on studs, an oil seal is fitted.

Key to Fig 26 (opposite)

1 Gearbox oil dipstick
2 Gearbox oil filler plug
3 Taper roller bearing - 65 mm x 120 mm x 1.142 in.
4 Transfer box top cover
5 Forward/reverse bearing housing shims
6 Forward/reverse bearing housing
7 Input bevel pinion (gearbox output pinion)
8 Mainshaft
9 Sliding dog
10 Forward/reverse bevel gear
11 Selector fork
12 Forward/reverse bevel gear shims
13 Forward/reverse gear locknut
14 Circlip
15 Selector shaft
16 Roller bearing - 40 mm x 90 mm x 23 mm
17 Ball bearing - 40 mm x 90 mm x 23 mm
18 Mainshaft cover
19 Top selector lever
20 Slotted nut - 5/8 in. UNF
21 Mainshaft washer
22 Transfer box oil filler plug
23 Cover and mounting bracket
24 L.H. output gear casing
25 Coupling flange
26 Selector spring plug
27 Detent ball
28 Selector spring
29 Bottom selector lever
30 Selector lever shaft
31 Roller bearing - 55 mm x 100 mm x 21 mm
32 Short differential casing
33 Differential cross-pin
34 Differential pinion thrust washer
35 Differential pinion
36 Long differential casing
37 Differential gear
38 Differential gear thrust washer
39 Differential casing helical gear
40 Speedometer drive bracket
41 Output bearing housing shims
42 Oil seal housing
43 Taper roller bearing - 1.5 in. x 3.75 in.
44 Output bevel gear
45 Output bevel gear shims
46 Output gear bearing housing
47 Taper roller bearing - 1.625 in. x 3.75 in.
48 Roller bearing - 2.1/4 in. x 4.1/2 in. x 7/8 in.
49 Output bevel pinion
50 Taper roller bearing - 1.8125 in. x 3.750 in. x 1.094 in.
51 Output shaft (differential half shaft)
52 Output pinion locknut
53 Output bevel pinion shims
54 Output pinion bearing housing
55 Speedometer gear
56 Roller bearing - 30 mm x 90 mm x 23 mm
57 Sleeve
58 Mainshaft helical gear
59 R.H. output gear casing
60 Gearbox and transfer box casing

(a) Three-quarter front broken perspective view
(b) Part-view showing selector shaft detent ball

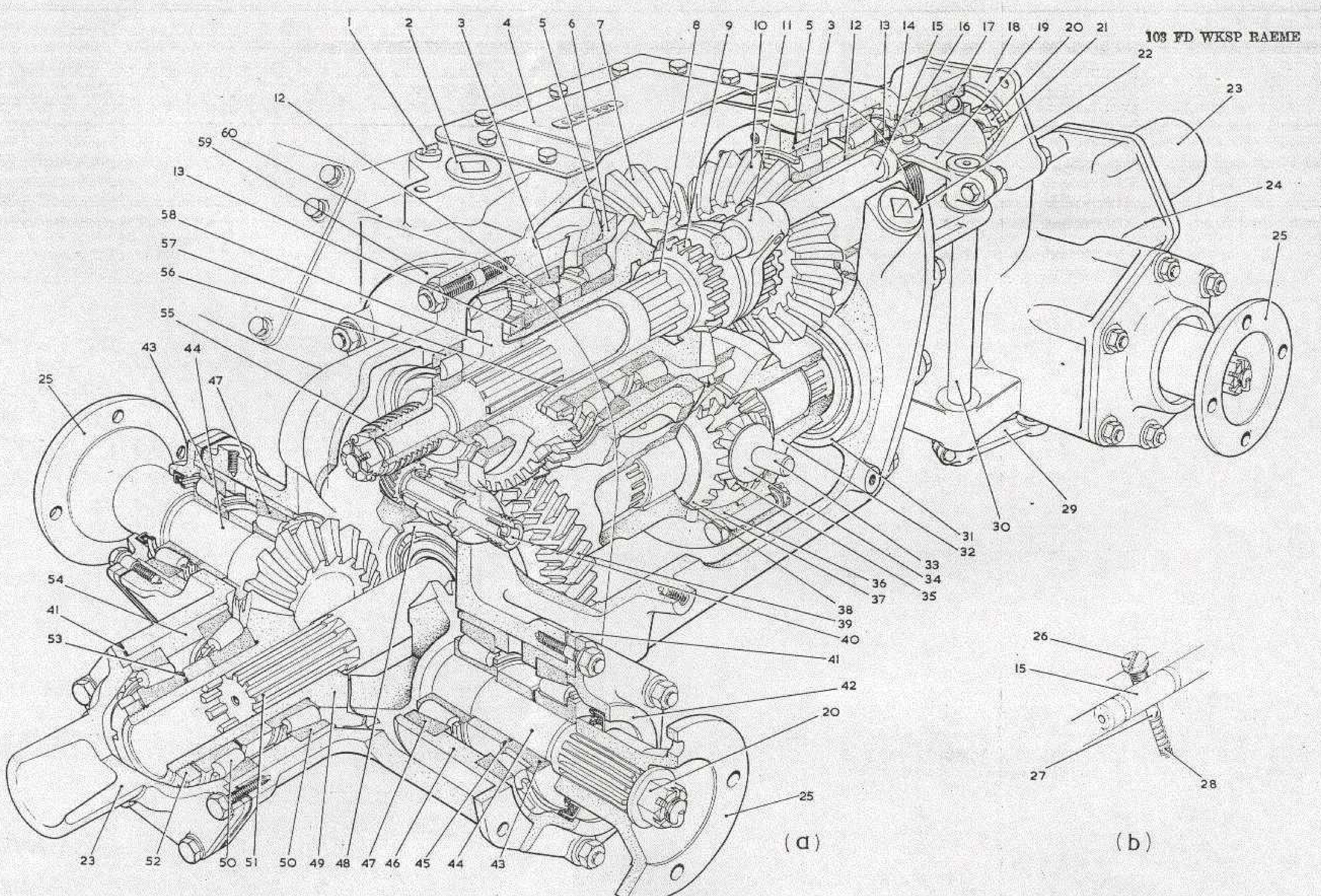
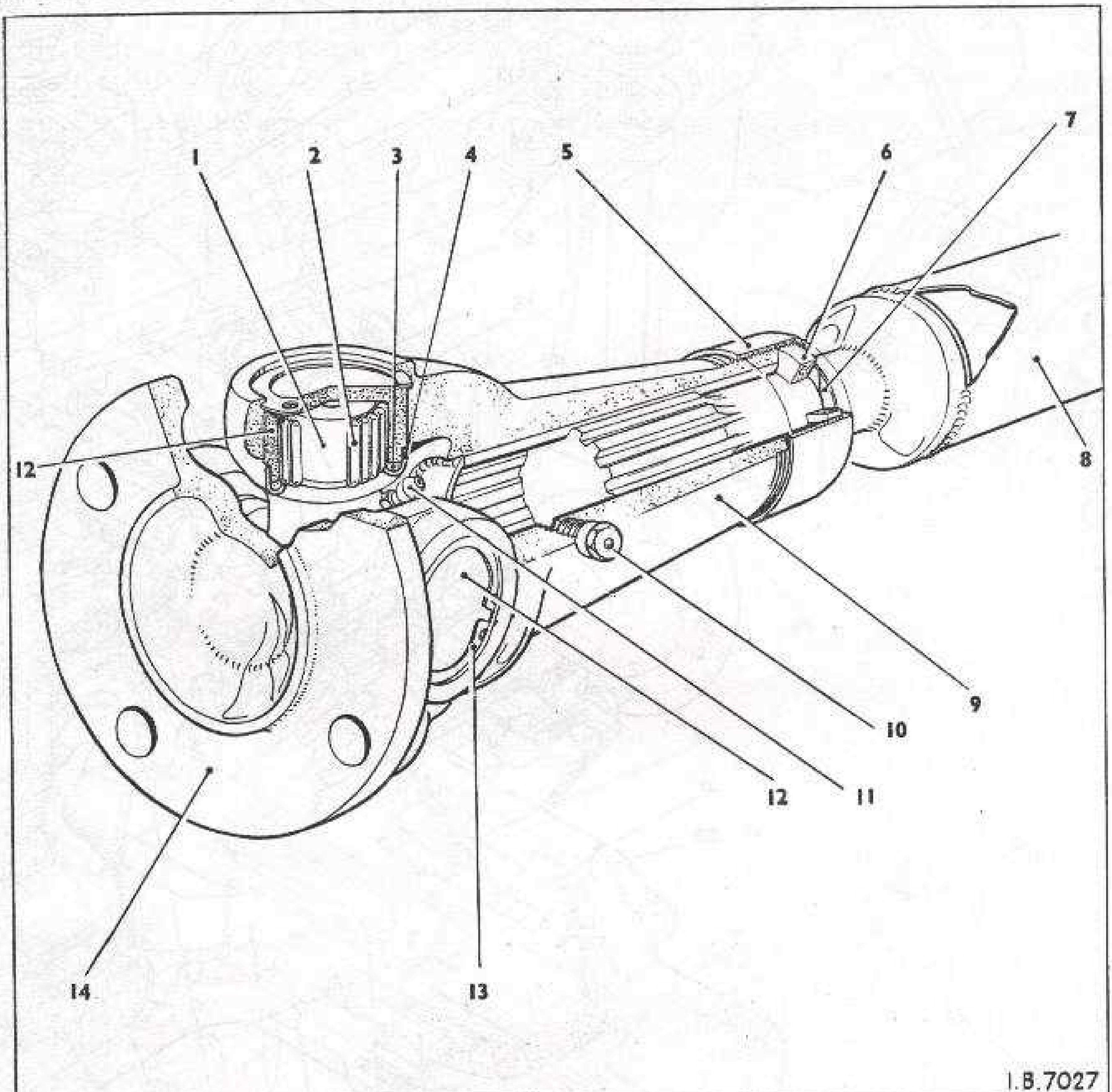


Fig 28 Transfer box

126. The selector fork (11) of the forward/reverse mechanism is bolted to a shaft (15) which slides in bushes fitted to the main casing. Two grooves are cut into the right-hand end of this selector shaft and a spring-loaded ball (Fig 26(b)) engages in one of the grooves when either FORWARD or REVERSE is selected. This ensures positive location of the selector dog and, together with the reverse lead on the dog splines, prevents displacement due to vibration. At the left-hand end of the shaft its fork-end is connected by means of a joint pin to a lever (19). The other end of the lever



1	Journal	8	Tubular shaft
2	Needle rollers	9	Sleeve yoke
3	Cork gasket	10	Hook-on type lubricating nipple
4	Gasket retainer	11	Press-on type lubricating nipple
5	Dust cap	12	Needle bearing race
6	Cork washer	13	Snap ring
7	Steel washer	14	Flange yoke

Fig 27 Propeller shaft sliding spline joint

is attached to the serrated upper end of a shaft (30) which runs vertically through brackets cast on the left-hand output gear casing. At the bottom of this shaft a second lever (29) is fitted to serrations and (as is the top one) bolted at the correct angle; suitable linkage then leads off to the forward and reverse lever mounted in a quadrant to the left of the driver's seat.

> **Important:** *Should the vehicle have to be towed, the transfer box must be placed in neutral. It is not sufficient to place only the gearbox in neutral - see Warning, para 95.*

OPERATION

127. The drive is taken to either directional bevel gear as desired. The double-helical gear splined to the right-hand end of the mainshaft is meshed with a mating gear on the differential assembly in the lower half of the box. This gear causes the small differential pinions to revolve, with the differential casing thereby driving the differential gears and, at the same time, making provision for the vehicle cornering. Halfshafts connect the differential gears with the output pinions which in turn transmit the drive to the four bevel gears and thence to the propeller shafts through tracta joints. The transfer box speed ratio is 1.347 : 1, both FORWARD and REVERSE.

FORWARD AND REVERSE CONTROLS

128. The forward and reverse control consists of a hand lever (Fig 25(10)) a quadrant and appropriate linkage. The quadrant is secured to the hull at the left-hand side of the driver's seat and the linkage leads directly to the transfer box. When the lever is placed in the forward position, "forward" gear is engaged; the central position engages "neutral" and the rear "reverse".

129. The quadrant is constructed from two plates separated by two distance pieces. One plate (11) is secured to all of four studs projecting from the hull while the other fastens to only two of the studs with the distance pieces in between. This latter and narrower plate retains the hand lever, the quadrant assembly being finally secured with nuts and shakeproof washers.

130. The hand lever pivots on a pin integral with the hull plate (11). A spring washer, plain washer and split pin serve to secure the lever to the pin and it is mounted at this fulcrum point by means of an oil-retaining bronze bush. At its lower end, the lever is pin-jointed to the forked end of an adjustable control rod that is attached at its other end to the bottom lever (9) of the transfer box vertical control shaft (see para 126).

PROPELLER SHAFTS

131. The drive from the transfer box is transmitted through two long and two short propeller shafts at front and rear respectively. These shafts are of the conventional tubular type with a needle bearing universal joint at each end, one joint being fixed to the shaft, whilst the other is a sliding or slip spline joint. Except for the difference in length of their tubular shaft portions, the front and rear propeller shafts are identical.

132.* The sliding spline joint (Fig 27) which accommodates any alteration in length between the ends of the shaft, and is coupled to the transfer box, comprises a cruciform journal (1) four needle bearings, a flange yoke (14) and a sleeve yoke (9); the fixed joint is of similar construction except that the sleeve yoke is replaced by a stub yoke, which is integral with the tubular shaft (8). Each bearing race (12) is retained in the yoke by a snap ring (13) and is sealed against loss of lubricant by a cork gasket (3) held in a retainer (4) pressed on to the journal. A dust cap (5) housing a cork washer (6) backed by a steel washer (7) is screwed on the sleeve yoke to protect the splines from the ingress of dirt and water. A "press-on" type lubricating nipple (11) is fitted to the journal of each joint, whilst a "hook-on" type nipple (10) is fitted to the sleeve yoke of the sliding joint. Alignment arrows are stamped on the sleeve yoke and the splined end of the shaft.

BEVEL BOXES AND WHEEL HUBS

133. The propeller shafts transmit the drive to the bevel boxes, one of which is provided for each road wheel. All four bevel boxes are rigidly bolted to the hull of the vehicle, the front bevel boxes being located in the driver's compartment and the rear ones in the engine compartment.

134. A spiral bevel pinion in the bevel box is driven by the propeller shaft and this, in turn, drives a spiral bevel wheel. This bevel wheel imparts the motion to the bevel box tracta fork which is coupled by the inner tracta joint to the inner tracta fork. A coupling sleeve is used to connect the inner tracta fork to the outer tracta fork which in turn drives, through the outer tracta joint (identical to the inner tracta joint), the hub tracta fork. Final drive to the road wheels is through a hub reduction gear driven by this hub tracta fork.

135. It should be noted that the inner tracta joint and fork are part of the bevel box assembly and that the outer tracta fork and joint are part of the hub assembly.

BEVEL BOX ASSEMBLY

136. The four bevel boxes are all similar in principle and are interchangeable in pairs, i.e., the front right and the rear left boxes (Fig 28) are exactly similar while the front left and the rear right are also identical. Before the rear bevel boxes can be removed the engine must be taken out.

137. Each bevel box casing (17) is a one-piece L-shaped casting, housing the bevel pinion and bevel wheel assembly and containing the inner tracta joint within the same casing. A relief valve is incorporated with a large hexagon plug to vent excess air pressure to atmosphere and a filler plug fitted with a joint washer is embodied for topping up the oil; the filler plugs are located in the inner tracta joint housing ends of the bevel box casings at the outer side of the hull. At the bottom of the inner tracta joint housing end of each casing a drain plug (18) is fitted; for convenience of illustration this plug is shown 45° out of position. The hexagon-socket plug (14) is fitted only to late type casings. These casings are of malleable cast-iron and the plug is used for manufacturing purposes; early type casings were of cast steel.

138. The drive from the propeller shaft is taken to a coupling flange (1) which is secured to the integral splined shaft of the bevel pinion (6) with a large washer, slotted nut (2) and split pin. The slotted nut also serves to secure the cones of the two taper roller bearings (8) (separated by a spacer and shims) which support the bevel pinion shaft, the cups of the bearing being contained in a shouldered housing (7). This housing is flanged and between the flange and the casing, shims (4) varying from 0.002 in. to 0.020 in. in thickness, are fitted to ensure correct meshing of the bevel pinion. The pinion bearings should be preloaded 0.000 in. to 0.002 in. A housing (3) for an oil seal (5) fits against the flange of the bearing housing and both housings are bolted to the outer casing with bolts locked by shakeproof washers.

1 Coupling flange
2 Slotted nut, UFN310/A
3 Bevel pinion oil seal housing
4 Bevel pinion bearing housing shims
5 Oil seal
6 Bevel pinion
7 Bevel pinion bearing housing
8 Taper roller bearing, 1.375 in. x 3.00 in. x 0.938 in.
9 Dowel
10 Screw, UFS104/3R
11 Bevel box tracta fork
12 Bevel wheel hub
13 Rivet
14 Plug
15 Bevel wheel
16 Slotted tracta joint
17 Front right and rear left bevel box casing
18 Drain plug (shown 45° out of position)
19 Bearing housing dowel (shown 45° out of position)
20 Bearing housing screw (shown 45° out of position)
21 Inner tracta housing sliding seat
22 Bearing housing shims
23 Tracta housing seat oil seal
24 Locking ring
25 Tracta joint housing shims
26 Spigoted tracta joint
27 Gaiter retaining ring
28 Inner gaiter
29 Ball bearing 1.1/4 in. x 2.3/4 in. x 11/16 in.
30 Coupling sleeve retaining pin
31 Tracta fork coupling sleeve
32 Inner tracta fork
33 Inner tracta fork housing
34 Hose clip
35 Hose clip
36 Oil seal
37 Inner tracta oil seal housing
38 Sealing ring
39 Outer bearing housing
40 Socket-headed screw

(a) Bevel box assembly showing late type bevel wheel and hub with riveted attachment
(b) Part-view showing early type bevel wheel and hub and the attachment by means of screws and nuts

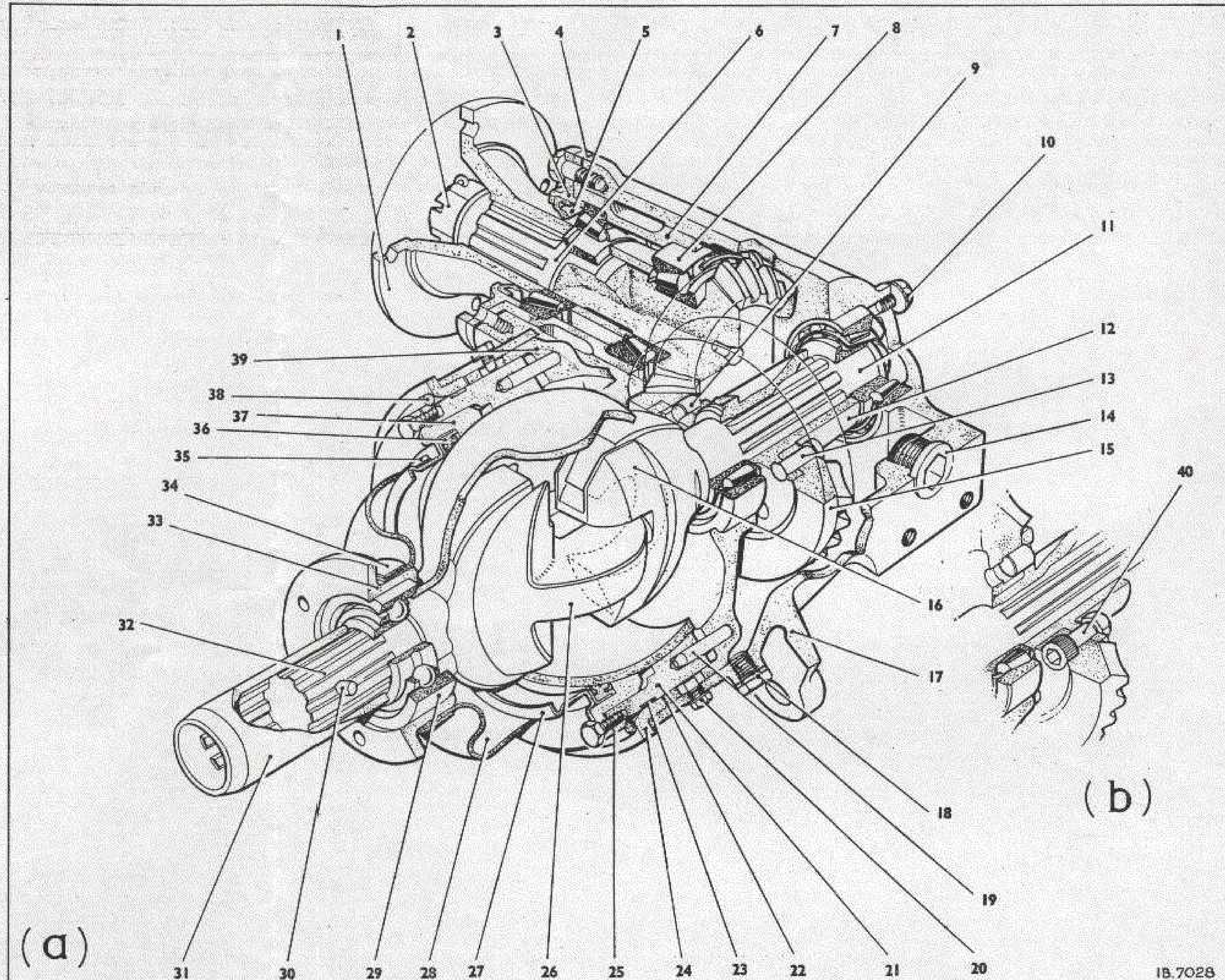


Fig 28 Front R.H. and rear L.H. bevel box assembly

139. A bevel wheel driven by the pinion gives a ratio of 1.923 : 1. The bevel wheel (15) is of the late type, being dowelled and secured by rivets (13) to a flanged and splined hub (12). The early type bevel wheel and the corresponding hub are shown in Fig 28(b); this wheel is also dowelled but is secured to the hub by socket-headed screws (40) and plain nuts, the ends of the screws being peened over. The bevel wheel hub mates with the externally-splined shaft of the bevel box tracta fork (11). It is secured between the cones of two opposed taper roller bearings which are situated one at each end of the hub. A shoulder on the tracta fork shaft bears against the outer end of the cone of the outer bearing and a bolt at the opposite end of the shaft, when tightened, draws down a large washer upon the cone of the inner bearing, thereby holding the assembly securely in position. The bolt is locked with a shakeproof washer. The cup of the inner bearing is housed within the bevel box casing. Two screws (10) permit the roller cup and shims to be tapped out when the bevel box is being dismantled. These shims are used in the adjustment of the bevel wheel. The cup of the outer bearing is held in its own housing (39).

140. The sliding seat (21) of the inner tracta fork housing is free to slide a small amount on the dowels (19) sunk into the outer bearing housing. A seal (23) fits between it and an externally-threaded flanged locking ring (24) which screws into the bevel box casing. The threads of the locking ring are treated with "Wellseal" and a locking plate ensures that the preloading (0.000 in. to 0.002 in.) of the inner and outer taper roller bearings, which is effected by means of shims (22) between the locking ring and the outer bearing housing, is not disturbed. Two dowel-ended screws (20) bolted through from the outside of the bevel box casing prevent rotary movement of the outer bearing housing. Outside the flange of the locking ring an O-section ring (38) sealing the inner tracta housing is fitted.

141. A flanged housing (37) for an oil seal (36) is fitted between the sliding seat and the spherical portion of the inner tracta fork housing (33) shims (25) being fitted between the sliding seat and oil seal housing flanges to obtain proper adjustment. This seal prevents oil escaping from the tracta joint. Adjacent to the flange of the oil seal housing is a gaiter retaining ring (27); the sliding seat, the shims, the oil seal housing and the gaiter retaining ring are secured together in one combined sliding seat and tracta fork housing assembly by screws locked with shakeproof washers. Bostik is applied to contacting faces of the retaining ring and the oil seal housing. The spherical joint must move freely after the housing assembly screws haye been tightened.

142. The spherical portion of the inner tracta fork housing is protected by a rubber gaiter (28). Bostik must be applied to the faces between the gaiter and its retaining ring and the gaiter and the inner tracta fork housing, prior to assembly. At both ends, the gaiter is secured with hose clips ((34) and (35) respectively). All gaiter clips have inserts fitted under them.

143. The inner tracta fork housing is free to slide (see para 140) to accommodate variations due to suspension movement. This end movement is taken up in the rotating parts of the tracta joint itself. In addition, at each side of the spherical part of the housing is a drilled hole into which a dowel fits; these dowels prevent rotation of the housing but allow it to rise and fall with suspension movement. V-shaped oil deflectors are welded inside the spherical portion with their apices facing each other. On the periphery of the housing flange is stamped the word TOP to ensure that the housing is fitted with the deflectors uppermost.

144. The tracta forks with their integral shafts are made from steel stampings hardened all over and, after machining, radiused and chamfered on their working faces. A tracta joint is fitted between each pair of forks. Each joint consists of two

separate parts, one spigoted and the other slotted. In each part a groove is cut at right angles to the spigot or slot to receive the fork. The inner side of the claw of the fork clasps round a bearing surface, or journal, within the groove. Individual parts of the joint are free to turn about axes at right angles to the flanks of the forks while the spigot and slot allow relative movement between the two parts of the joint in a plane at right angles to that allowed by the journals. The drive is taken through the flanks of the forks and the sides of the grooves, and the flanks of the spigot and the sides of the slot.

145. The shaft of the inner tracta fork (Fig 28(32)) runs on a single-row rigid type ball bearing (29). On the inner side the inner race of the bearing bears against the stepped-up fork end of the shaft; at the outer end the inner race abuts the splined coupling sleeve (31) which couples together the inner tracta fork shaft and the outer one. The outer race of the ball bearing is held between a flange at the inner tracta fork housing (33) and the projecting lip of the housing (Fig 29(12)) for the outer tracta fork. The flanges of the two tracta fork housings are bolted together by hexagon-headed bolts fitted with shakeproof washers.

146. As already mentioned, a coupling sleeve is used to join the inner tracta fork to the outer tracta fork. A pin (30) secures the sleeve to the inner tracta fork. New pins must always be used when the splined sleeve component is reassembled and they must be rolled over at the ends.

HUB ASSEMBLY

147. The following description and Fig 29 are applicable to the front wheel hub assemblies and, if "hub carrier" be substituted for "hub swivel", are equally applicable to the rear wheel hub assemblies. The sole difference between front and rear wheel hub assemblies is that the hub swivel (7) which is fitted with trunnions for the attachment of the link pins of the suspension assembly, is replaced in each rear wheel hub assembly by a hub carrier; this hub carrier incorporates attachment points for the top and bottom suspension links (see under SUSPENSION AND ROAD WHEELS). Each front and each rear wheel hub assembly incorporates a hub (47) fitted with eight wheel studs (1); the studs at the left-hand side of the vehicle have left-hand threads while those at the opposite side have right-hand threads.

Tracta forks and outer tracta joint

148. The outer tracta joint is enclosed, in a similar manner to the inner tracta joint, in a spherical housing which is part of the outer tracta fork housing (Fig 29(12)). This outer tracta fork housing is bolted to the inner tracta fork housing (Fig 28(33)) the two housings together with their tracta forks forming the axle between the bevel box and the wheel hub. A needle bearing (Fig 29(15)) in the housing (12) supports the outer tracta fork (14). An oil seal (13) in the housing rides on the coupling sleeve (Fig 28(31)).

149. The spherical housing is held in the hub swivel by a seat (Fig 29(18)) and an oil seal housing (8) the seat and housing providing a ball joint for the axle. A machined recess in the oil seal housing accommodates an oil seal, the lip of which bears on the spherical housing and prevents escape of oil. A gaiter (10) is positioned externally over the outer tracta fork housing and is secured at the inner end by a hose clip (11). At the outer end, screws pass through a gaiter cup (19) the gaiter (10) the flange of the oil seal housing (8) and shims (9) and screw into the hub swivel; copper wire is used to lock the hexagon-headed screws.

1 Wheel stud
2 Brake lining
3 Brake drum
4 Brake shoe
5 Brake backplate
6 Late type oil filler plug
7 Front wheel hub swivel or rear wheel hub carrier
8 Outer tracta oil seal housing
9 Tracta joint housing shims
10 Outer gaiter
11 Hose clip
12 Outer tracta fork housing
13 Oil seal
14 Outer tracta fork
15 Outer tracta fork needle bearing
16 Slotted tracta joint
17 Spigoted tracta joint
18 Hub tracta housing seat
19 Gaiter cup
20 Hub tracta fork
21 Circlip
22 Hub bearing distance piece
23 Hub oil seal
24 Hub tracta fork needle bearing
25 Taper roller bearing, 3.1875 in. x 5.375 in. x 1.188 in.
26 Hub swivel and hub carrier dowel
27 Needle rollers, 3 mm x 19.8 mm
28 Socket-headed screws
29 Late type planet gear pin
30 Sun wheel
31 Bolt, UFB105/10R
32 Hub nut lockwasher
33 Hub locknut
34 Ball bearing, 1 in. x 2.1/2 in. x 3/4 in.
35 Hub sun wheel shims
36 Hub sun wheel spacer
37 Bolt, UFB106/12R
38 Circlip
39 Hub bearing housing
40 Hub reduction gear planet cage
41 Hub bearing shims
42 Planet gear cover
43 Planet gear
44 Hub reduction gear cover
45 Hub reduction gear annulus
46 Dowel
47 Hub
48 Wheel nut
49 Early type planet gear pin
(a) Hub assembly, including late type planet gear assembly
(b) Part-view of early type planet gear assembly

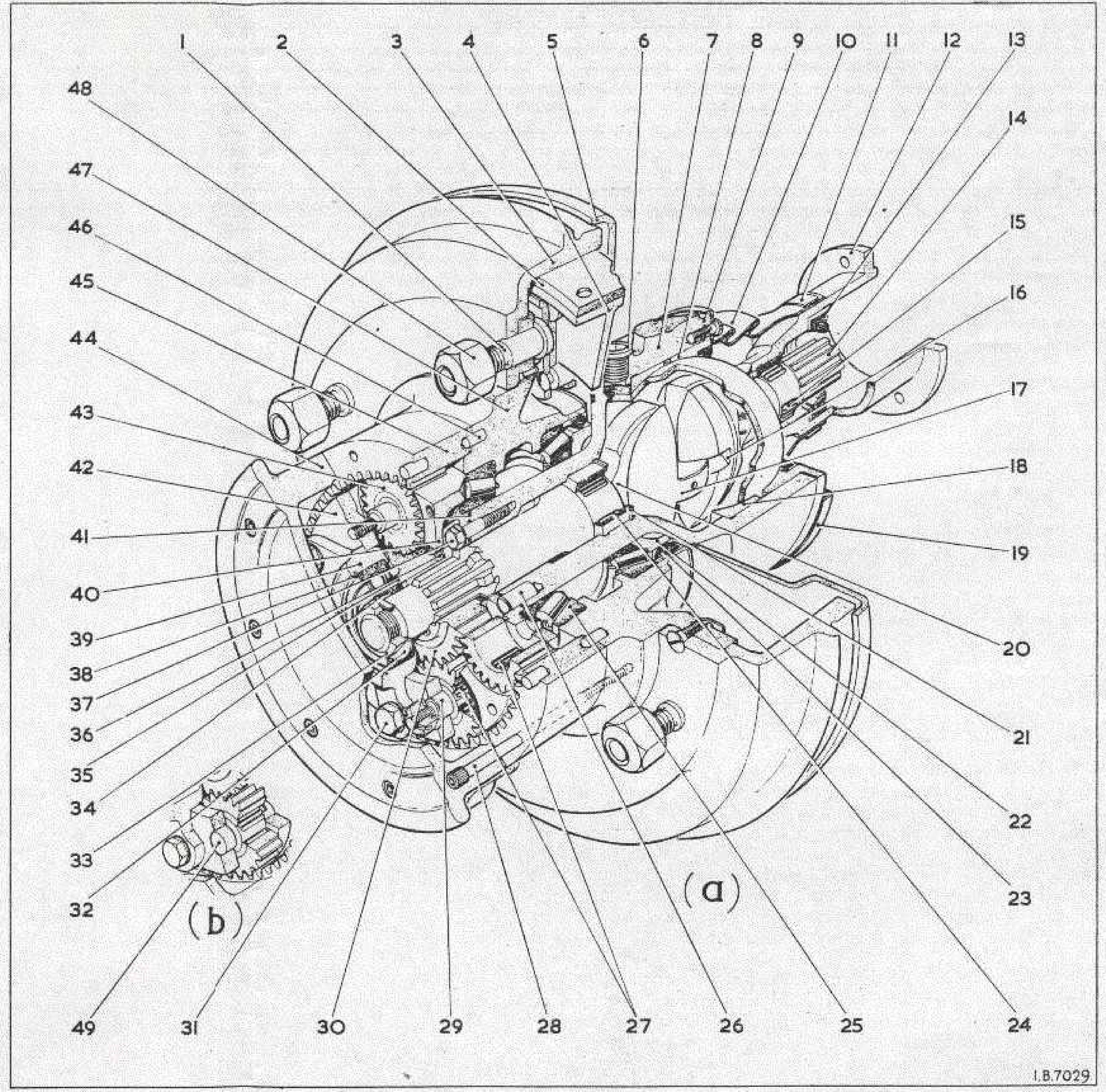


Fig 28 Hub assembly

150. The hub tracta fork is supported at its inner (forked) end in a needle bearing (24) lodged in a recess machined in the hub swivel. This bearing is retained by a circlip (21).

151. The outer end of the hub tracta fork is carried in a single-row rigid type ball bearing (34). The outer race of this ball bearing is secured in a bearing housing (39) which in turn is secured by hexagon-headed bolts (31) locked with shakeproof washers to the planet gear cover (42) and the hub reduction gear planet cage (40). This cage is bolted (37) and dowelled (26) to the hub swivel the hexagon-headed bolts being locked by tabwashers. At the outer end the outer race is held in the housing by a circlip (38). The inner race of the ball bearing is drawn on to the shaft by a nut (33) secured with a lockwasher (32). This nut screws on to the end of the shaft and clamps tight the inner race, shims (35) the sun wheel of the hub reduction gear (30) and a spacer (36) to the shaft. The spacer is pressed against a shoulder formed by a raised portion of the splines upon which the sun wheel is mounted thus ensuring positive location and, when important measurements have been taken and a spacer of correct dimensions inserted, exact adjustment of the shaft.

152. Opposed taper roller bearings (25) pressed on to the hub swivel support the hub. These well-spaced externally-mounted bearings carry the weight of the vehicle and resist lateral forces due to centrifugal action when cornering. The cone of the inner bearing abuts a distance piece (22) while the cone of the outer bearing is located against the hub reduction gear cage (40) of the epicyclic gears. Landing on the distance piece holding the inner race at the inner end are two oil seals (23) with the sealing lips facing each other. The cups of both bearings fit against shoulders formed in the hub. Shims (41) are fitted between the hub swivel and the projecting lip of the hub reduction gear cage. These shims are supplied in three thicknesses to enable the taper roller bearings to be adjusted.

Final drive

153. The final drive to the hub is taken through epicyclic gears which give a large reduction in a small compass. In operation, the sun wheel of this gear train is driven by the hub tracta fork to which it is splined. Meshing with it are six planet gears (Fig 29(43)) free to rotate on pins fixed to the hub reduction gear planet cage and cover; the cage and cover are not free to rotate. Outside the planets is the annulus (45) of the hub reduction gear with teeth on its inner surface enabling it to mesh with the planets. This annulus when driven by the planet gears is made to revolve around the shaft of the sun wheel and consequently causes the hub to turn. The hub reduction gear ratio is 2.400 : 1.

154. The planet gear pins (29) are of the late type. These pins have stepped-down diameters at both ends, while one end, which is longer than the other, is also threaded. The short ends of the pins are fixed in the planet cage (40) by rolling over the protruding portions and grinding them flush. After assembling the planet gears the planet gear cover (42) is secured on the long ends of the pins by slotted nuts, each fitted with a plain washer and locked by a split pin. The planet gears ride on needle rollers (27) fitted between the pin and the gear; at both ends of the needle rollers, thrust washers are fitted. It should be noted that the planet cage and cover, and the bearing housing (39) also, are of the late type introduced with the late type planet pin. The cage is secured to the hub swivel by hexagon-headed bolts, each locked by a tabwasher, as described in para 151.

155. In the early type of planet gear arrangement (see Fig 29(b)) planet gear pins (49) with similar stepped ends are used. One end, slightly shorter than the other, is fixed in the planet cage by rolling, while the other is fixed in the same manner in

the planet gear cover, after the planet gears have been fitted. The early type planet cage is secured to the hub swivel by socket-headed screws, each locked by peening a slug into the serrations on the head. These slugs were originally of copper and later of soft iron.

156. The annulus (45) of the hub reduction gear is located by four dowels (46) on the hub (47) and secured by two, short, socket-headed screws. The reduction gear cover is, in turn, located by a second set of four dowels on the annulus and is secured by eight, long, socket-headed screws (28) which, after passing through the cover and the annulus, screw into the hub.

Relief valve and filler plugs

157. A relief valve is fitted to the outer tracta joint housing to vent to atmosphere air pressures set up by the churning action of the joints. To top up the outer tracta joint housings or road wheel hubs, the filler plug (6) must first be removed along with one of the oil level plugs fitted to the sides of the housing. No provision is made for draining the outer tracta joint housings or road wheel hubs. On later versions of drive the hub filler plugs of male type have been replaced by female type plugs as illustrated.

STEERING

GENERAL DESCRIPTION

158. Steering is effected by means of the front wheels as shown in Fig 30. The steering wheel (1) is fitted to a shaft which is mounted in an upper bevel box (2) attached to the hull front sloping plate. A recirculating ball race (4) which is housed in a lower bevel box is coupled through bevel gears to the upper box by a shaft (3) that is enclosed in a steering column attached to the upper and lower bevel box housings. The recirculating ball race converts the rotary movement of the steering wheel into transverse movement of a shaft (5) the outer ends of which are connected through links (6) to the inner steering levers (7) which are fitted on shafts mounted in casings bolted on opposite sides of the hull. Also fitted on the shafts are outer steering levers (8) which are connected to the adjacent front wheel steering arms (10) by adjustable steering rods (9) incorporating ball socket joints at both ends.

UPPER BEVEL BOX AND STEERING COLUMN

159. A three-spoke steering wheel (Fig 31(13)) is used, the inside rim of which is ridged to afford a positive grip to the hands of the driver. From lock to lock, approximately $3\frac{5}{8}$ turns of the steering wheel are required. The steering wheel (13) is keyed to the tapered portion of the steering wheel shaft (22) which is integral with a bevel gear fitted in the upper bevel box (2). The end of the shaft is threaded for a cap-nut (14) which tightens down onto the hub of the steering wheel.

160. The steering wheel shaft (22) is mounted in two ball bearings (16) and (21) the larger one of which has its inner race fitted on a journal formed on the shaft with a ring nut (18) and similar locknut clamping the race against the bevel wheel shoulder. The outer race fits into a flanged bearing housing (20) which in turn is fitted into a register in the bevel box (2). The outer race of the smaller ball bearing (16) is fitted into the steering wheel shaft housing (12) and the inner race onto a reduced portion of the shaft. A spigot formed on the steering wheel shaft housing fits into the flanged housing (20) and clamps the outer race of the larger ball bearing, and the whole bearing assembly is secured to the bevel box by four setscrews (17) which are locked by shakeproof washers. An oil seal (6) is fitted in the shaft housing adja-