

### III. Assembly of Transmission

#### Transmission Cover:

33. Insert locking plate in correct position into the transmission cover and tighten lightly (Fig. G 3/33). The longitudinal slots in the locking plate must be parallel with the shifting rails. To achieve this, install fixing device 191 589 02 31 in the transmission cover, before you tighten the locking plate.

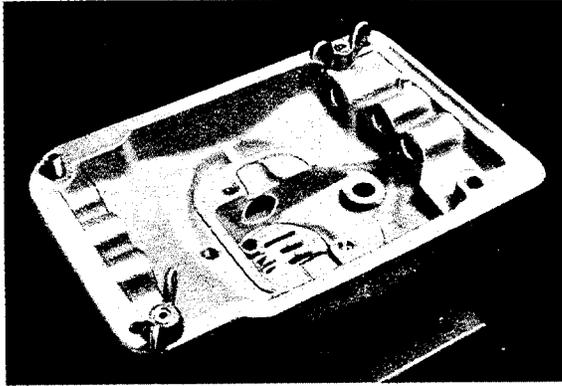


Fig. G 3/33

34. Insert shifter shaft with splined end first so into the transmission cover that the splined end projects out of the left side of the transmission cover (as seen into direction of travel).

When inserting the shifter shaft, push on washer (4) and shift finger (2); see Fig. G 3/34. It must be easily possible to move the shift finger on the shifter shaft.

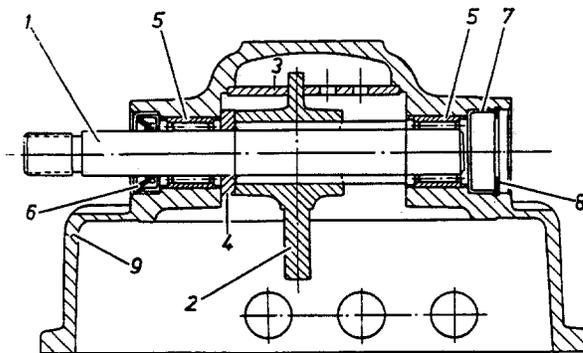


Fig. G 3/34

- |                  |                   |
|------------------|-------------------|
| 1 Shifter shaft  | 5 Needle bearing  |
| 2 Shifter finger | 6 Grease retainer |
| 3 Locking plate  | 7 Cover plate     |
| 4 Washer         | 8 Lock ring       |

35. Push the two needle bearings on the shaft and press lightly into the cover by means of pin 187 589 02 39.
36. To push the grease retainer on the shifter shaft, use sleeve 187 589 05 61, as otherwise the lip of the grease retainer will be damaged by the splines. When pressing the retainer into the cover use pin 187 589 03 39.
37. Press cover plate into opposite bore in transmission cover by means of pin 187 589 01 39 and install lock ring in front of cover plate.

Check whether it is possible to move the shift finger on the shaft and make sure that shaft can be rotated easily.

38. Install selector finger so in the transmission cover that it projects into the recess of the shift finger (Fig. G 3/38).

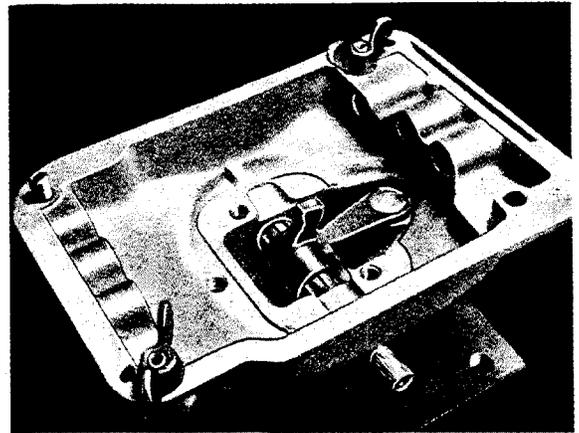


Fig. G 3/38

39. Push out selector lever on selector finger shaft and clamp in place. Observe the mark made during disassembly.

In Type 220 attach pointer to selector lever.

The selector lever must be at right angles to the selector finger and in Type 220 also to the pointer (Fig. G 3/39).

40. Push outer gear shift lever on shifter shaft and clamp in place. In neutral position the gear shift lever should point slightly towards the front (see Fig. G 3/39).

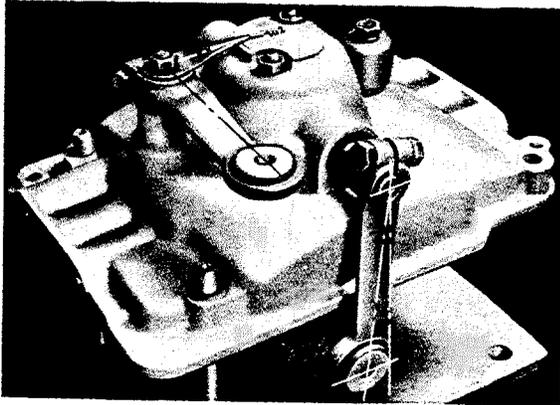


Fig. G 3/39

41. Install guide plate. It must be possible to move the plate easily, but without play. Use new nuts and washers. Secure the nuts by clamping them together.
42. Install shifting forks and shifting rails. To facilitate installation of the springs and locking balls in the shifting forks, use pin 136 589 09 61.
- Note that the spring for the reverse speed shifting fork has to take a greater load (see spring test table on page G 3/13).

**Note:** When the gear is engaged, the shifting fork must be positively locked in the shifting rail; no lateral thrust must be exerted on the shifting fork.

For this reason the distance between spacer tube or adjusting ring and transmission cover must be 0.1 to 0.15 mm (0.004 to 0.006") in shift position.

For correcting the distance the adjusting rings are available in the following thicknesses:

0.30 mm (0.012"), 0.50 mm (0.02") and 1.0 mm (0.04").

**Type 220a only**

43. Install latch with adjusting washer for reverse speed stop. Select adjusting washer (2) so that stop (A) of guide plate abuts against the latch when the first or second gear is selected with the selector lever (Fig. G 3/43).

It must then be possible to move the shift finger in slot (B) of guide plate without difficulty; make sure that the finger does not contact the rounded corners of the slots.

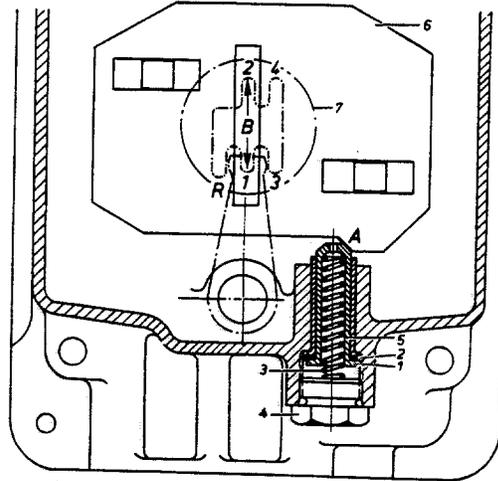


Fig. G 3/43

- |                    |                 |
|--------------------|-----------------|
| 1 Latch            | 5 Bushing       |
| 2 Adjusting washer | 6 Guide plate   |
| 3 Pressure spring  | 7 Locking plate |
| 4 Screw plug       |                 |

**In the case of right-hand steering systems** the following deviations regarding cf. 34 to 37 must be considered.

34-37a. The shifter shaft is so positioned in the cover that its splined end projects beyond the right side of cover (as seen in direction of travel).

Hence the grease retainer must be pressed into the right side of the bore. In front of the retainer the lock ring is positioned. The cover plate is pressed into the bore on the left side (Fig. G 3/34a).

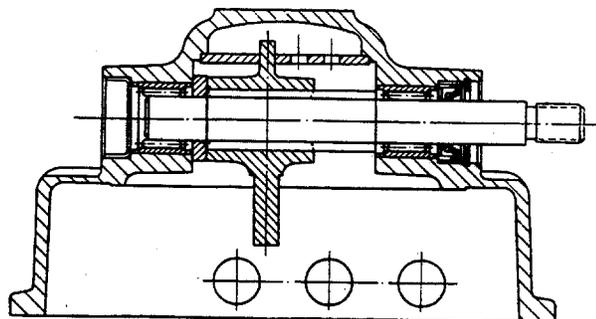


Fig. G 3/34a

**Synchronizer Units:**

44. Insert followers and springs into the synchronizer unit and insert the unit into the gear sleeve (Fig. G 3/44).

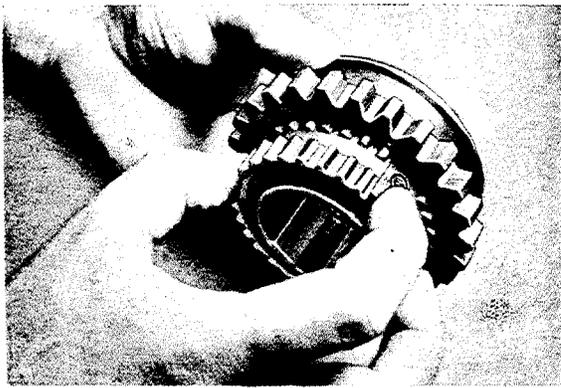


Fig. G 3/44

45. Press one follower at a time towards the front, install a ball and push follower back again (Figs. G 3/45 and 45a).

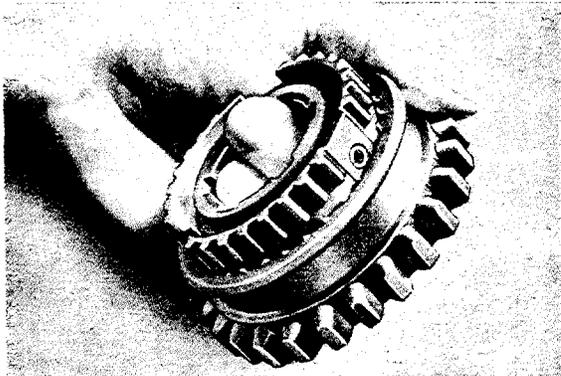


Fig. G 3/45

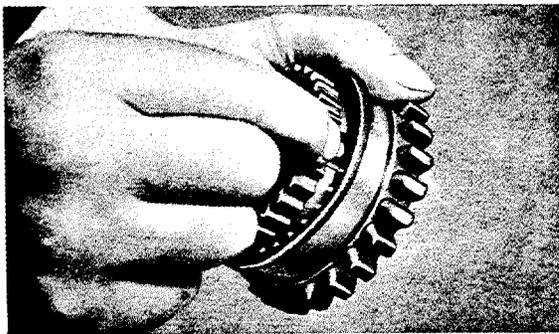
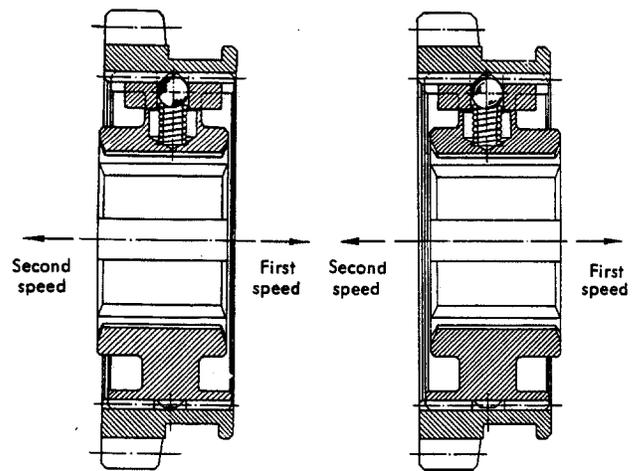


Fig. G 3/45a

Install first and second speed synchronizer unit so that **in Type 220 the short hub side of the synchronizer unit is on the side of the guide groove** (in the gear sleeve); **in Type 220a the short hub side must be on the side where the teeth are** (Fig. G 3/45b). In the case of the third and fourth speed syn-



Type 220a

Type 220

Fig. G 3/45b

chronizer unit the wide hub side of the synchronizer unit and the grooved side of the gear sleeve are on the same side (Fig. G 3/45c).

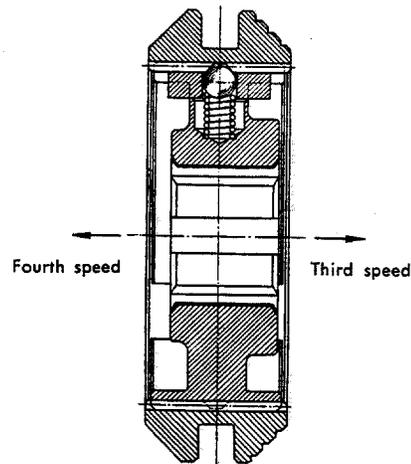


Fig. G 3/45c

After the assembly has been effected, check whether gear sleeve disengages at an axial thrust of 7–11 kg (15.5–24 lb.).

#### Mainshaft Type 220

46. Clamp mainshaft vertically (centering journal at top) into a vise using lead jaws. Put on first contact washer with keyway downward, install second contact washer, push on first speed gear (cone downward) and place large contact washer (recessed face towards the rear) on collar of shaft.
47. Check overall play between first speed gear and the two contact washers with a tolerance tape (Fig. G 3/47). The specified play (0.1–0.18 mm = 0.004–0.007") can be

achieved by using a contact washer of the required thickness. Exchange only the washer **provided with a keyway!**

The contact washers are available in thicknesses from 3.9–4.1 mm (0.15–0.16"), the sizes varying from 0.05 mm (0.002") to 0.05 mm (0.002").

48. Remove contact washer and first speed gear again. Insert roller assembly into bore of gear, then install gear and contact washer again.
49. Push sleeve 136 589 07 61 or a short length of pipe ( $31 \times 40 \times 93$  mm =  $1.22 \times 1.57 \times 3.66$ ") and three-arm flange on the shaft and screw in place with slotted nut in order to arrest the gear on the mainshaft.

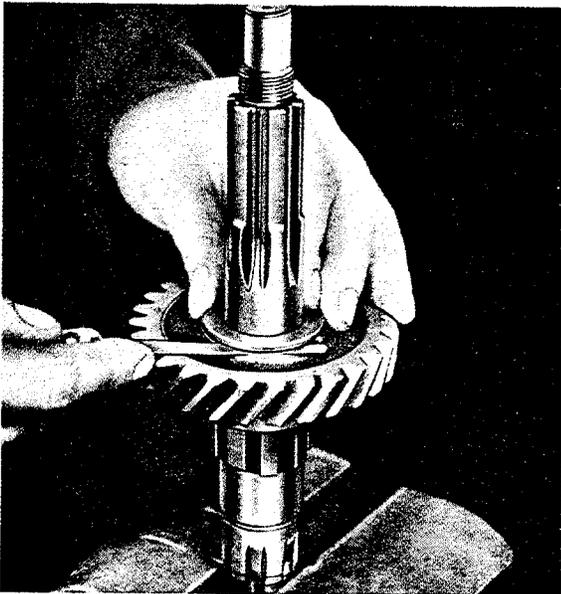


Fig. G 3/47

50. Invert mainshaft and clamp again in the vise; turn contact washer so that the keyway is on key bed of mainshaft. Install synchronizer ring for the first speed gear.
51. Place key on key bed of mainshaft and into keyway of contact washer. Push contact washer on shaft flush with the grooves and check end play of key (min. play 0.1 mm = 0.004") with a tolerance tape (Fig. G 3/51). When making the check take play between first speed gear and the two contact washers into consideration. The contact washers with keyway for the first and second speed gear are identical.



Fig. G 3/51

52. Take contact washer off again. Push synchronizer unit (with guide groove for shifting fork downward) over the installed key. Install contact washer and synchronizer ring for second speed gear. Be careful that keyway of contact washer and key coincide.
53. Push second speed gear and bearing bushing on shaft, then check play (0.1–0.18 mm = 0.004–0.007") in the same way as indicated in connection with the first speed gear (Fig. G 3/53).

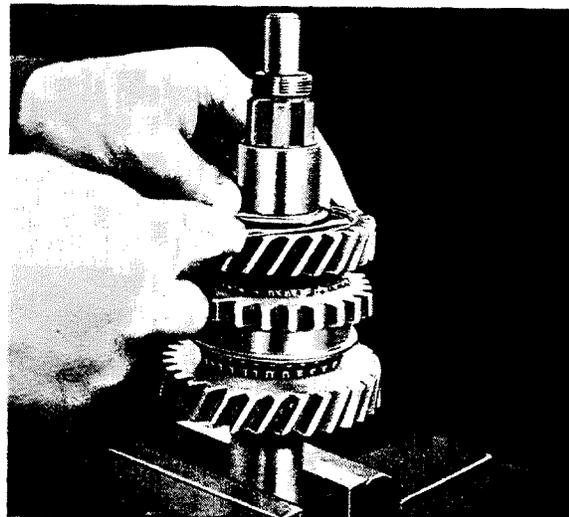


Fig. G 3/53

54. Remove bearing bushing and gear again. Grease mainshaft, install 47 needles each with intermediate ring on the shaft and push the gear carefully over the needles.

55. Push third speed gear on bushing and check end play as indicated in Fig. G 3/55. The specified play will be achieved when the bushing is 0.1–0.18 mm (0.004–0.007") wider than the gear.

The end play can be corrected by selecting a suitable steel bushing. If the end play is insufficient the third speed gear may be re-ground if necessary. Make sure that the gear is perfectly finished, as otherwise it might seize.

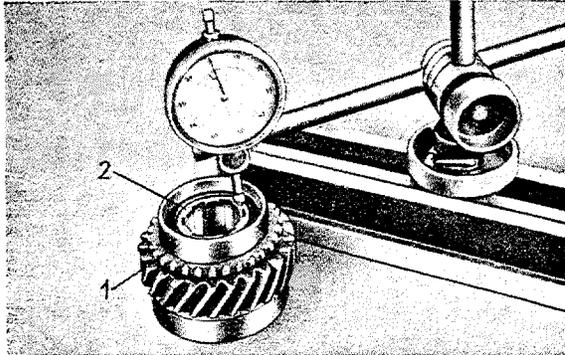


Fig. G 3/55

1 Third speed gear      2 Bearing bushing with collar

56. Install bearing bushing and third speed gear with synchronizer ring and put on contact washer.
57. Push synchronizer unit (with grooved side downward) on shaft. Screw on slotted nut with lock plate and tighten with wrench 120 589 04 07.  
Rotate second and third speed gear. Tighten slotted nut so that the two gears can be rotated by hand as easily as before.  
Bend lock plate slotted nut **on all four ends**.

### Mainshaft Type 220a

- 46a. Clamp mainshaft vertically (with centering journal at top) into a vise using lead jaws.
- 47a. Install split roller assembly on shaft, push second speed gear over the rollers and install contact ring in front.
- 48a. Check end play between second speed gear and collar of shaft (see Fig. G 3/53).

The play should be 0.1–0.18 mm (0.004–0.007") and can be corrected by means of the contact ring. The contact rings are available with thicknesses from 7.90 to 8.10 mm (0.31 to 0.32"), the thickness varying from 0.05 mm (0.002") to 0.05 mm (0.002").

- 49a. Turn contact ring so that keyway and key bed on mainshaft register. Place key on key bed, install contact washer on the shaft flush with the keyways and check end play of the key (min. play 0.1 mm = 0.004") with a tolerance tape (see Fig. G 3/51).

When making the check take play between second speed gear and contact ring into consideration.

- 50a. Take contact washer off again and place synchronizer ring on cone of second speed gear. Push synchronizer unit over installed key with guide groove for shifting fork at top. Install contact washer; make sure that keyway and key coincide.

- 51a. Push first speed gear on shaft, place contact washer (recessed face towards the rear) on collar of shaft and check play between the two contact washers and the first speed gear. The specified play can be achieved by using a contact washer having the required thickness. Exchange only the contact washer with keyway.

The contact washers are available with thicknesses of from 4.40 to 4.60 mm (0.17 to 0.18"), their thickness varying from 0.5 mm (0.002") to 0.05 mm (0.002").

- 52a. Remove contact washer and first speed gear again. Place roller assembly into bore of gear, then install gear with synchronizer ring and contact washer again.

- 53a. Push sleeve 198 589 02 61 or a short length of pipe ( $31 \times 40 \times 62$  mm =  $1.22 \times 1.57 \times 2.44$ ") and three-arm flange on shaft and screw in place with slotted nut in order to arrest the first speed gear on the mainshaft.

- 54a. Invert mainshaft and clamp again in the vise.

Push third speed gear on shaft and install contact washer.

Check play between third speed gear and contact washer.

The play is 0.1–0.18 mm (0.004–0.007").

55a. Place synchronizer ring on third gear and push synchronizer unit (with grooved side downward) on shaft.

56a. Install slotted nut with lock plate and tighten lightly with wrench 120 589 04 07. Rotate second and third speed gear. Tighten slotted nut so that the two gears can be rotated as easily as before.

Bend lock plate of slotted nut **on all four ends.**

58. If a suitable test device is available, check the shifting play of the various gears before assembling the transmission (Fig. G 3/58).

The travel of the synchronizer unit to the counter cone of the pertaining gear is as follows:

First, second and third speed gear:  
= 0.8–1.3 mm (0.03–0.05")

Fourth speed gear  
= 0.5–1.0 mm (0.02–0.04")

Deviations can be corrected by means of the large contact washer between first speed gear and ball bearing. The contact washers are available with thicknesses ranging from 3.80 to 4.50 mm (0.15 to 0.18"), the thickness varying from 0.1 mm (0.004") to 0.1 mm (0.004").

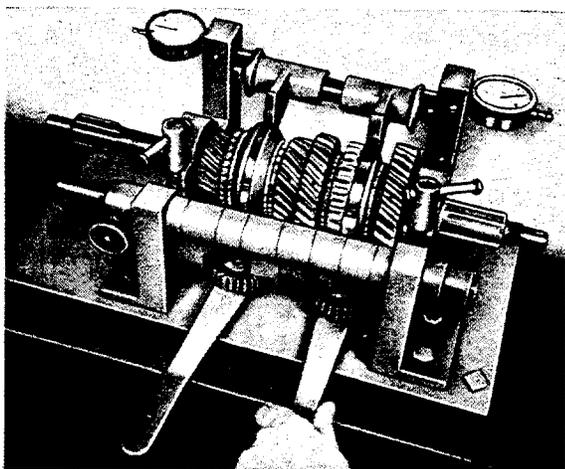


Fig. G 3/58

#### Installation of Gear Set:

59. Insert intermediate arm for reverse speed with shift dog into the transmission case.

60. Insert reverse shaft into the transmission case, pushing on reverse gear with guide groove towards the rear in such a way that the shift dog of the intermediate arm projects into the guide groove of the reverse gear (Fig. G 3/60).

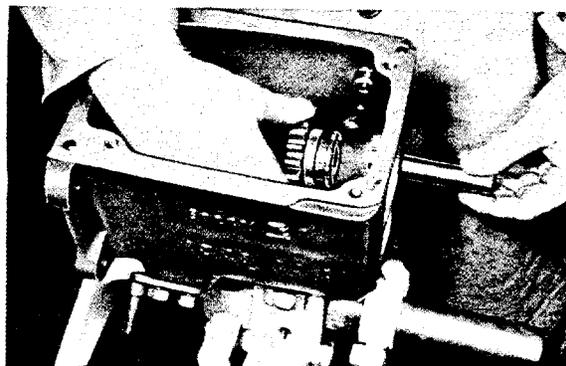


Fig. G 3/60

61. Secure reverse shaft by means of retaining screw and tighten check nut.

62. Insert countershaft from above.

63. Insert mainshaft from top and push Kling roller bearing into bore of driveshaft. Place synchronizer ring on driveshaft and insert shaft from front (Fig. G 3/63).

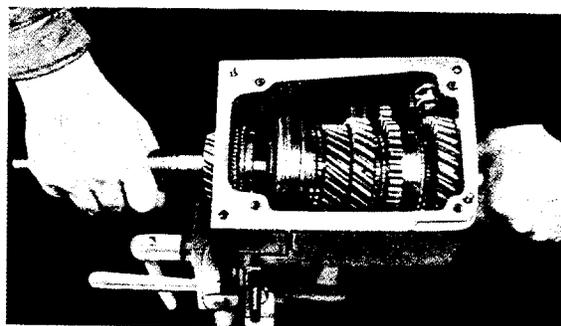


Fig. G 3/63

64. Push guard washer on rear end of countershaft. Force rear ball bearing on countershaft and drive into the transmission case together with countershaft by means of drift 136 589 06 39, lifting the driveshaft and mainshaft somewhat (Fig. G 3/64). Install front ball bearing before installing the countershaft.

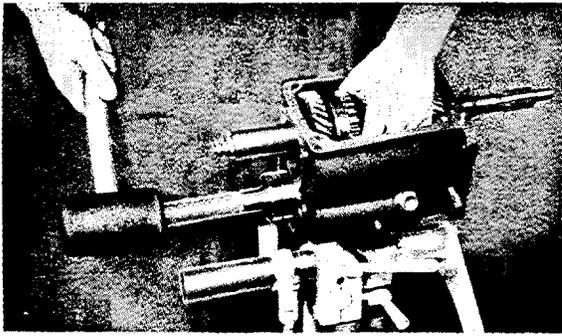


Fig. G 3/64

65. To rule out any possible damage, support first and second speed gear with tool 135 589 38 61. Remove sleeve 136 589 07 61 or 198 589 02 61 resp., push on rear ball bearing (marked X) and drive it into the transmission case with snap ring towards the rear.
66. Push oil thrower on driveshaft and force front ball bearing (snap ring towards the front) with spacer ring on the driveshaft and force into the transmission case with arbor 136 589 07 39.
67. Push sleeve 136 589 07 61 or a length of pipe  $31 \times 40 \times 75 \text{ mm} = 1.22 \times 1.57 \times 2.95''$  (in Type 220a length of pipe  $31 \times 40 \times 41 \text{ mm} = 1.22 \times 1.57 \times 1.61''$ ) on the projecting end of the mainshaft and pull mainshaft to the rear by tightening the slotted nut until the contact washer abuts against the rear ball bearing.
68. Check whether the snap rings of the front and rear ball bearing abut snugly against the transmission case.  
In Type 220 push spacer sleeve on drive shaft and install snap ring in front. Before this is done, check gap clearance of sealing ring (max. gap  $0.1 \text{ mm} = 0.004''$ ) by inserting the sealing ring into the cover.  
Insert sealing ring with gap at top into the driveshaft groove. Before installing the ring, fill groove with grease.  
In Type 220a the snap ring is located immediately in front of the ball bearing without a spacer sleeve being provided.
69. Check play between front ball bearing and recess on front cover of transmission case. Correct the play, which should not be more than  $0.05 \text{ mm} (0.002'' )$ , by means of shims (Figs. G 3/69 and 69a). Coat cover with a

sealing compound and bolt to transmission case.

In Type 220 the sealing ring must be centered before the front cover is installed. Slip the cover carefully over the shaft (see Fig. G 3/07).

In Type 220a a rubber grease retainer is provided in the bore on the cover in the place of the grease retainer on the driveshaft. When installing the cover, be careful not to damage the grease retainer (see Fig. G 3/08).

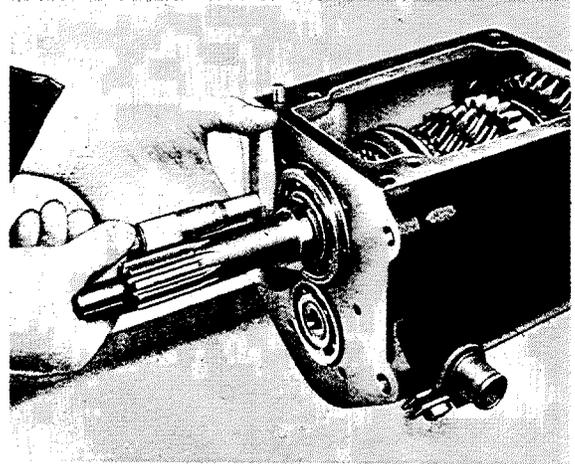


Fig. G 3/69

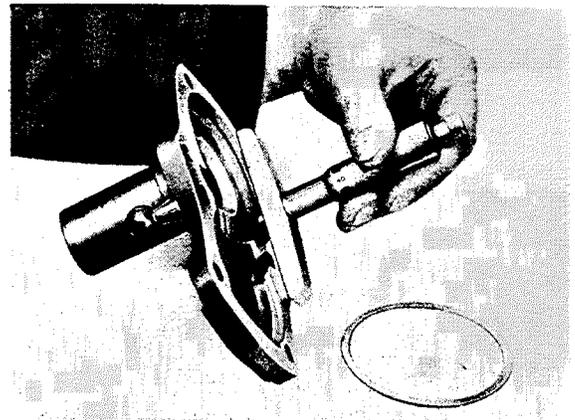


Fig. G 3/69a

70. Drive countershaft carefully towards the front until front ball bearing abuts against cover. Measure rear overhang of ball bearing as well as recess on rear cover of transmission case. The play between rear bearing on countershaft and rear cover of transmission case should be  $0.1 \text{ to } 0.15 \text{ mm} (0.004 \text{ to } 0.006'' )$ , and the play between rear bear-

ing on mainshaft and rear cover should be 0.0–0.05 mm (0.000–0.002"). If the play is excessive, correct it by means of shims (Figs. G 3/70, 70a and 70b). When checking the play, take thickness of paper gasket into consideration.

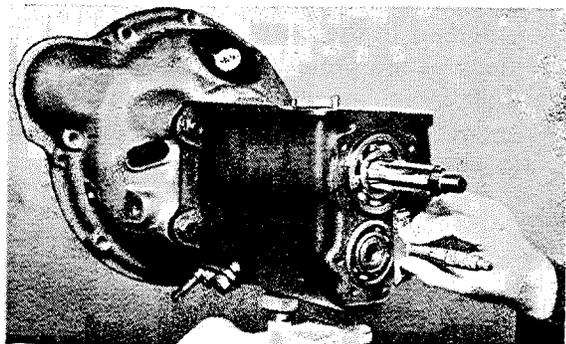


Fig. G 3/70

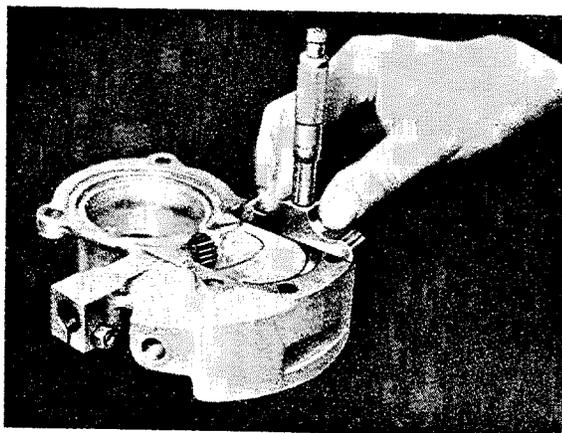


Fig. G 3/70a



Fig. G 3/70b

71. Remove the length of pipe. Push spacer ring and helical gear for speedometer on mainshaft.

**Note:** In Type 220 a the helical gear and spacer ring are made of one piece.

72. Provide rear cover with a paper gasket and bolt to transmission case.

73. Grease sliding surface for grease retainer on three-arm flange liberally and push flange on shaft. Install lock plate, screw the slotted nut on and tighten forcefully with the pin wrench (see Operation No. G 3, cf. 4). Before securing the nut, check three-arm flange for lateral out of true (Fig. G 3/73). When checking at the outer radius, the out of true must not exceed 0.03 mm (0.0012"), otherwise the flange must be displaced or even ground or replaced, if necessary.

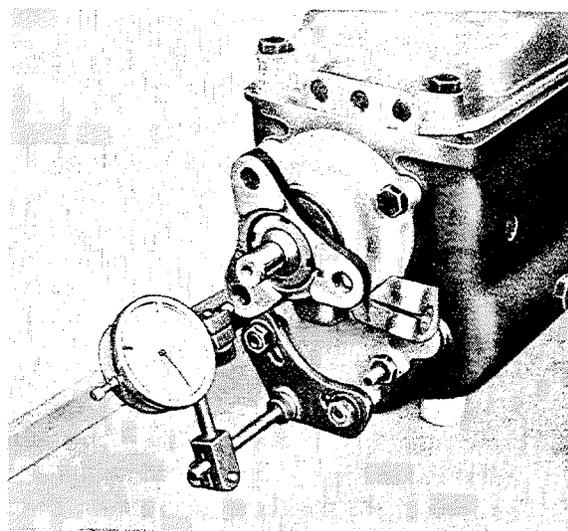


Fig. G 3/73

74. Attach clutch housing.

75. Place throwout fork on ball pin and push on throwout collar.  
In Type 220 push on pressure spring and spring retainer, then install snap ring.

In Type 220a install two wire clips into the throwout collar, turn towards the rear and attach the bent ends to the throwout fork.

76. Bring both synchronizer units into middle position (neutral), put on transmission cover in neutral position (after providing with a paper gasket) and tighten.

77. Fill in 1.4 liters (2.96 U.S. pints; 2.46 Imp. pints) of transmission oil.