

COMMONWEALTH OF AUSTRALIA
POSTMASTER-GENERAL'S DEPARTMENT



MAINTENANCE CIRCULAR No. 21

Automatic Exchanges—Adjustment of
Uniselectors and Bi-Motional Switches

PART 7

BI-MOTIONAL SWITCHES—TYPE 2000

Distribution List C (Modified)—Serial No. 108

SECTIONS 1 to 4
(Reprint—Includes Amendment No. 1)

Chief Engineer's Branch,
Postmaster-General's Department,
Treasury Gardens,
MELBOURNE, C.2

Approved—

R. V. McKAY,
for Chief Engineer

4/6/40

COMMONWEALTH OF AUSTRALIA.

POSTMASTER-GENERAL'S DEPARTMENT.

MAINTENANCE CIRCULAR NO. 21.

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UNISELECTORS AND BIMOTIONAL SWITCHES.

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APPROVED

W. Mackay
for Chief Engineer.
4/6/1940.

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A M E N D M E N T S .

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COMMONWEALTH OF AUSTRALIA.POSTMASTER-GENERAL'S DEPARTMENT.MAINTENANCE CIRCULAR NO. 21.AUTOMATIC EXCHANGES - ADJUSTMENT OF
UNISELECTORS AND BIMOTIONAL SWITCHES.PART 7.BIMOTIONAL SWITCHES - TYPE 2000.SECTION 1.GENERAL.1. CONTENTS.

1.1 The Circular is subdivided as follows :-

- | | | |
|-----------|---|--|
| Section 1 | - | General. |
| Section 2 | - | Mechanism Adjustments. |
| Section 3 | - | Mechanically Operated Spring Assembly Adjustments,
Shelf Jacks, Wipers and Wiper Cords. |
| Section 4 | - | Lubrication, Dismantling and Assembly, Tools. |

2. THE OBJECT OF THE CIRCULAR.

2.1 The purpose of this circular is to provide in readily accessible form details of adjustments, the maintenance of which is necessary to ensure satisfactory performance of type 2000 bimotional switches.

3. STANDARD ADJUSTMENTS.

3.1 The adjustments detailed herein are the Standard Adjustments for type 2000 Bimotional Switches, and shall be applied in Exchanges where this type of equipment is installed.

4. Alterations to the Standard Adjustments.

4.1 No alterations to the Standard Adjustments specified herein shall be made without first submitting the matter for approval to Central Office. It is realised that it may be necessary to try out in practice slight modifications to the Standard Adjustments before furnishing a report to this office setting out the conclusions thereon. All such local experiments, however, shall be limited to three months' duration, and shall be approved by the Superintending Engineer before trial. No permanent alterations shall be made without the approval of the Chief Engineer.

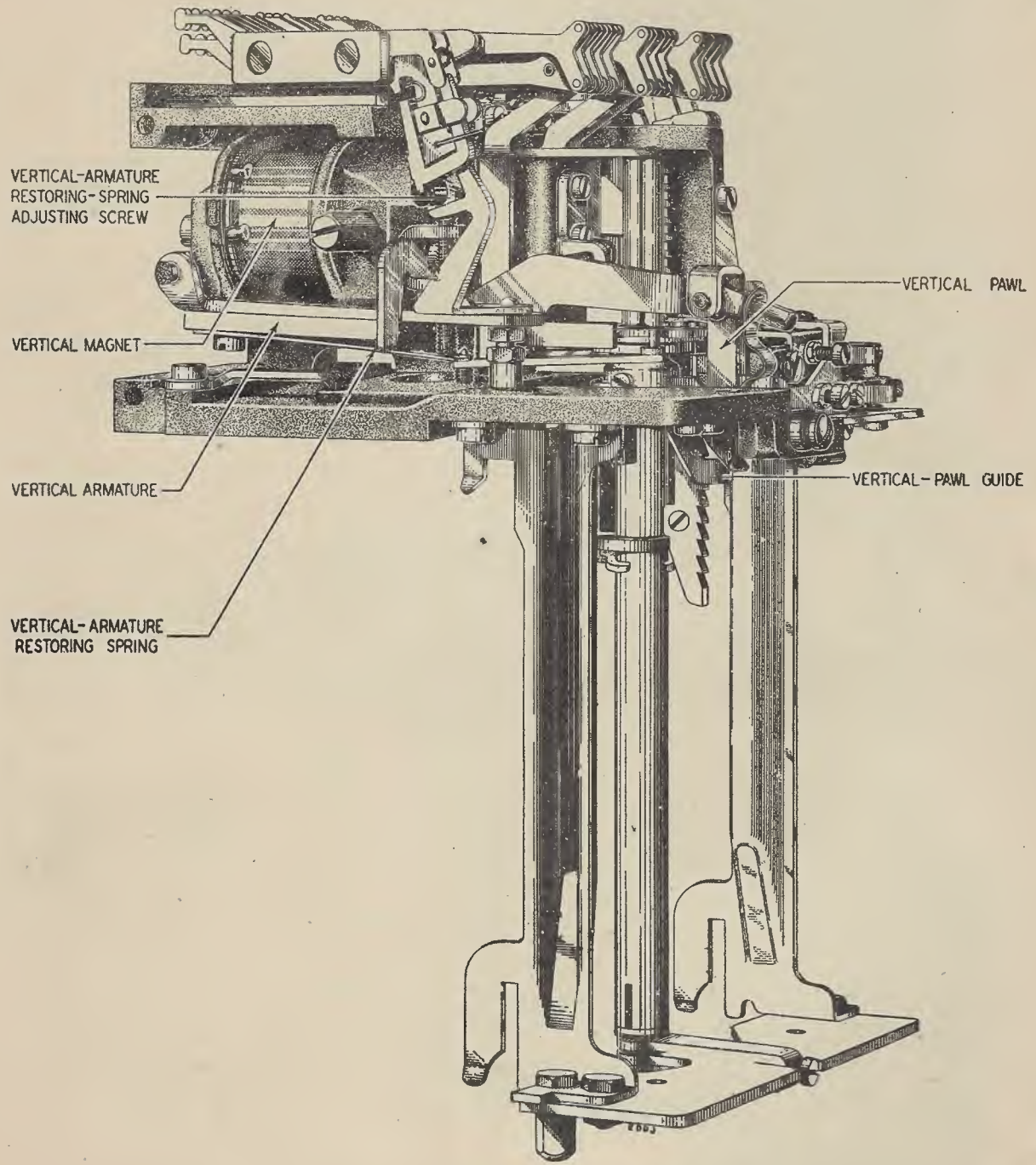


FIG. 2

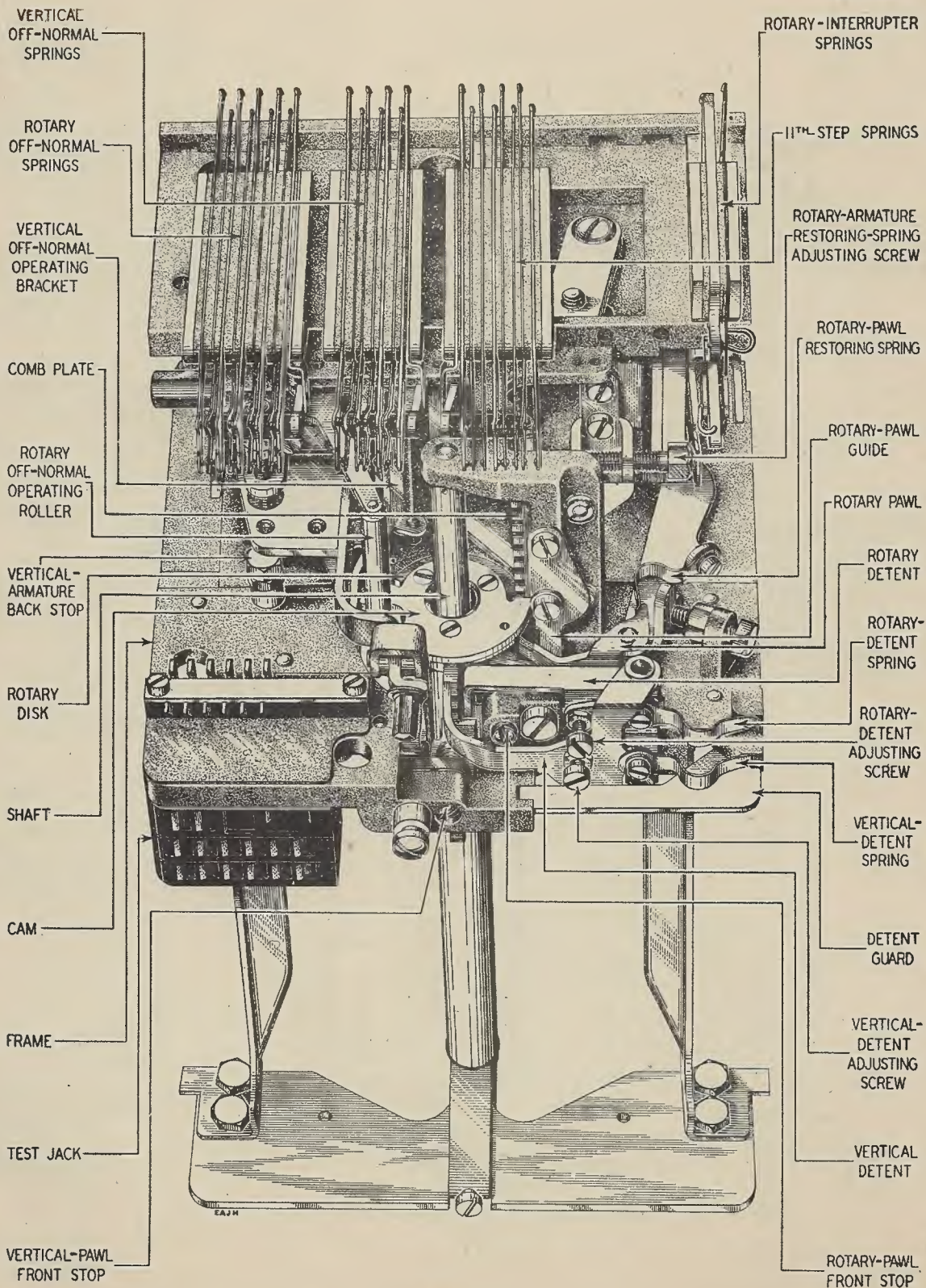


FIG. 1

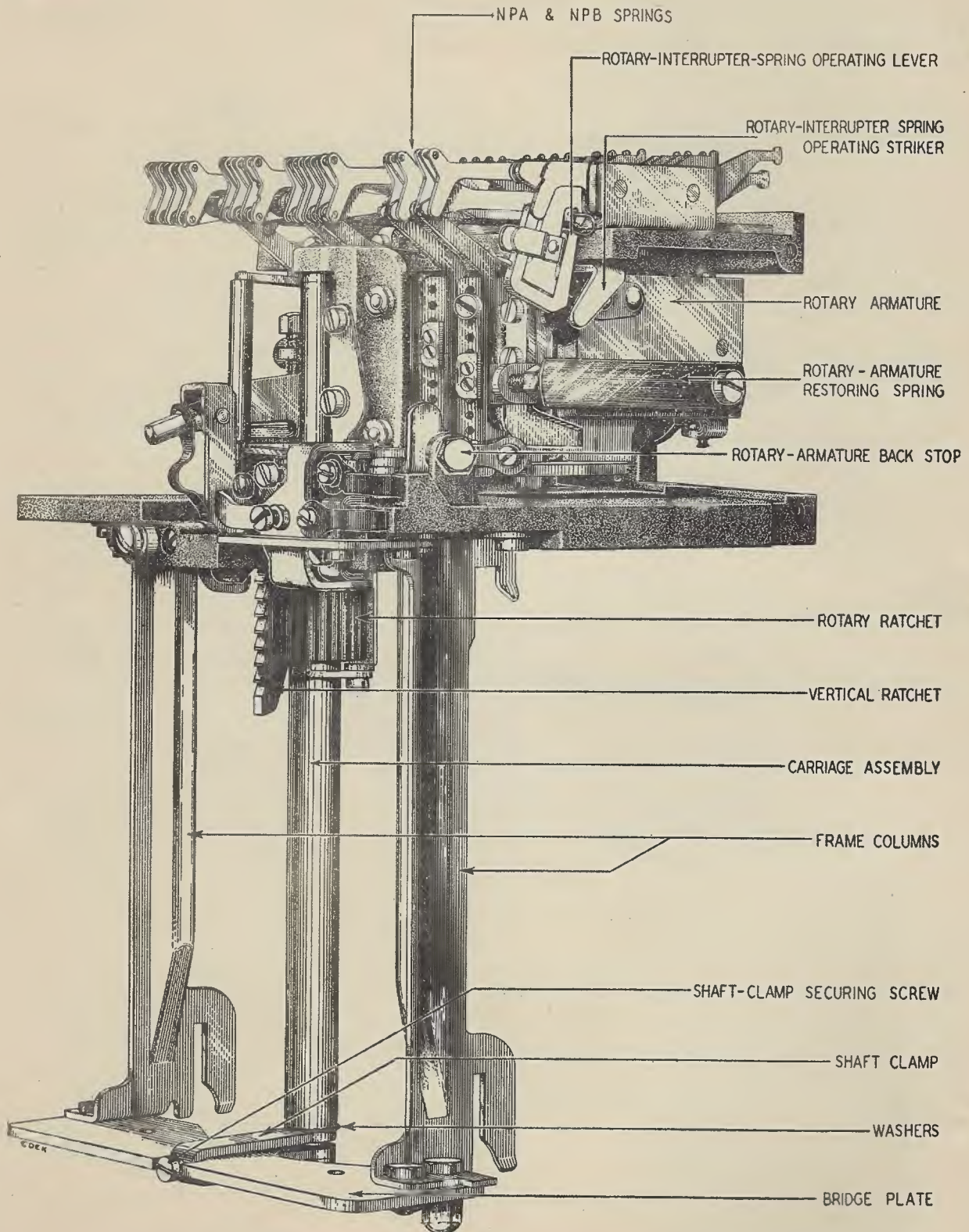


FIG. 3.

SECTION 2.MECHANISM ADJUSTMENTS.1. NAMES OF THE VARIOUS PARTS.

1.1 The names of the various parts of the bimotional switch mechanism may be ascertained from Figures 1, 2 and 3.

2. MAJOR ADJUSTMENTS AND REPLACEMENTS.

2.1 When it is necessary to make major adjustments or replacements the switch shall be removed from the shelf and the adjustments carried out on the bench or test stand.

2.2 In handling switches care must be taken not to place undue strain on the bottom bridge plate and, in particular, switches must not be lifted or carried solely by the bridge plate.

3. TO REMOVE A SWITCH FROM THE SHELF.

3.1 Check that the wiper carriage assembly is in the normal position to ensure that wipers are clear of bank contacts.

3.2 Busy the switch by moving the red marker from Test Jacks 13-14 to Test Jacks 7-8 and remove the green marker from Test Jacks 11-12 to disconnect the rotary circuit and so obviate the possibility of wipers rotating during the removal of the switch. The numbering of Test Jacks is shown in Fig. 4. In certain cases switches are fitted with an 8-point Test Jack. In these cases reference should be made to the circuit drawing. See also Fig. 4.

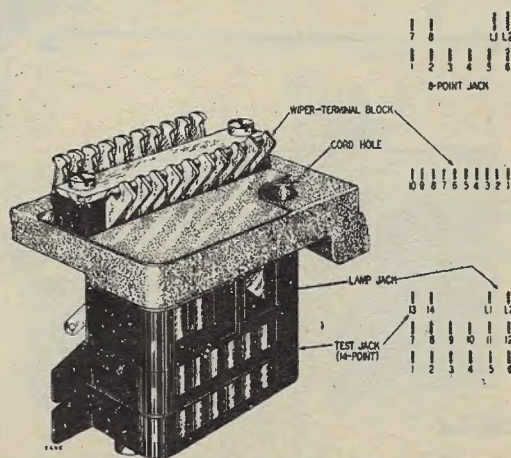


FIG. 4.
TEST JACK NUMBERING

- 3.3 Before removing a switch fitted with a vertical marking wiper, the vertical marking bank shall be swung clear of the wiper, Fig. 98, page 60, and locked by the ball engaging the rear hole in the mounting bracket.
- 3.4 To remove a switch from the rack, grip it firmly alongside the shaft clamp at the bottom of the carriage and by the top cover guide and push it upwards using steady pressure only until the locating screws in the relay mounting plate strike the top of the slots in the shelf cradle. Fig. 5 refers. The switch shall then be lifted forward until it is just clear of the slots, then upwards until clear of the bank. Care shall be taken not to swing the switch too far forward, otherwise damage to the bank engaging fork at the bottom of the frame will result.

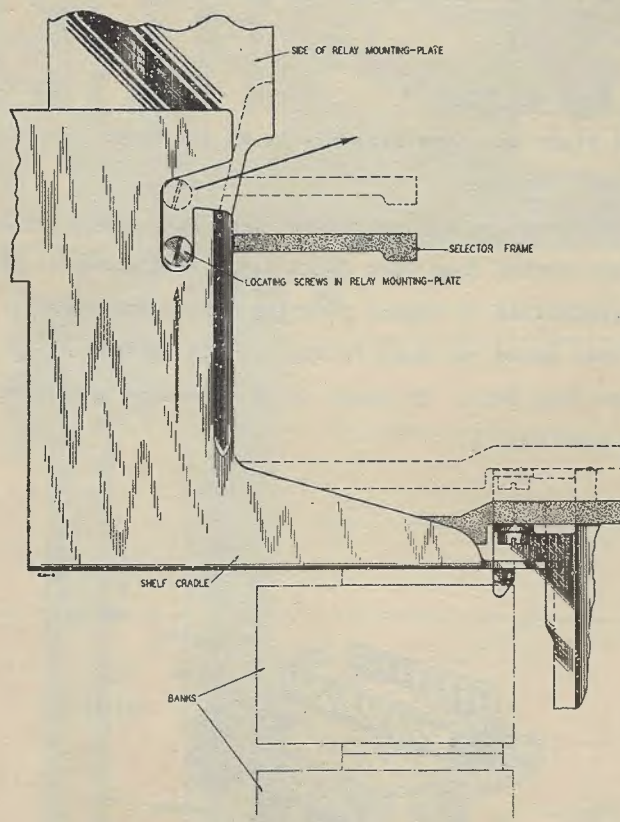


FIG. 5.
REMOVAL OF SELECTOR FROM CRADLE.

4. TO FIT A SWITCH ON THE SHELF.

- 4.1 Before attempting to fit a switch see that the red marker is in Test Jacks 7-8, the wiper carriage is normal and the vertical marking wiper, if fitted, is swung and held to the front of the carriage so as to avoid the possibility of fouling the Line and Private Banks.

- 4.2 Place the slots in the frame columns over the tongues on the bottom bank plate, Fig. 6. Hinge the switch towards the shelf so that the locating screws in the relay mounting plate engage the slots in the shelf cradle. Then lower the switch into the shelf jack. The switch should slide down easily into position without straining the frame columns over the bottom bank plate guides.

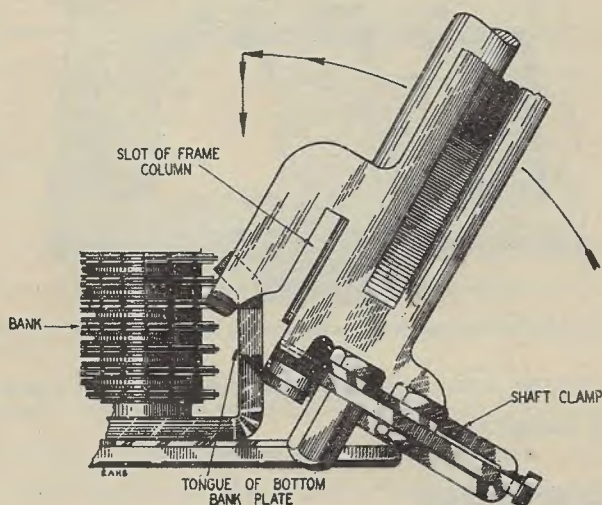


FIG. 6.
REPLACEMENT OF SELECTOR.

- 4.3 The position of the switch shall be such that it is located by the stop blocks on the underside of the frame resting right down on the cradle. See Figs. 7 and 8.

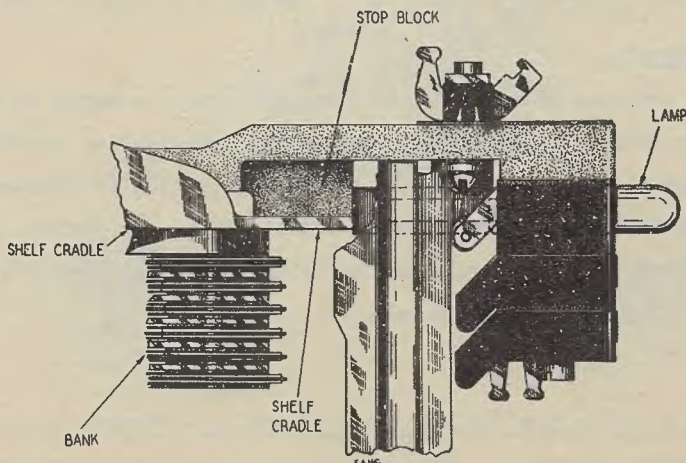


FIG. 7.
LOCATION OF SELECTOR ON CRADLE

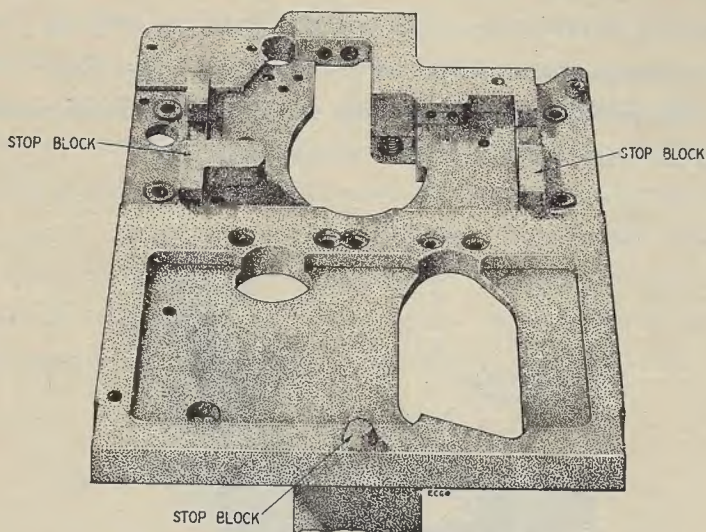


FIG. 8.—UNDERSIDE OF FRAME, SHOWING STOP BLOCKS

4.4 To restore the switch into service the markers shall be returned to their normal positions. See paragraph 3.2.

5. MINOR ADJUSTMENTS AND REPLACEMENTS.

5.1 When it is necessary to make minor adjustments or replacements with the switch mounted in position, the switch must be busied throughout the period that it is withdrawn from service, and, if necessary, the green marker must also be withdrawn to prevent rotary movement. When the mechanism has been operated by hand, care shall be taken to ensure that the armatures are resting on their back stops and that the interrupters are resting at normal before the switch is restored to service.

6. CARE AGAINST INTERFERENCE.

6.1 When adjusting switches mounted in position, care must be taken to ensure that no interference is caused to subscribers engaged in conversation on outlets from the banks or to disengaged subscribers due to the application of ringing currents to line via the bank multiple. To prevent these conditions an appropriate circuit contact shall be insulated with the insulator for relay contact points, Tool No. 171, so that the wiper switching relay will not operate.

7. TOLERANCES.

7.1 The tolerances shown in the following paragraphs are extreme values and are only to be allowed for checking purposes. When re-adjustments are being made mean values shall be aimed at and the tolerances reduced to a minimum.

8. FIXING SCREWS, NUTS AND RESIDUAL PLATES.

8.1 All fixing screws and nuts must be tight. *It is necessary, however, that care shall be exercised when turning screws which are tapped into the switch frame. This is due to the fact that the frame is produced by die-casting, which imposes certain limitations on the mechanical characteristic of the metal. Care is most necessary when re-inserting screws which have been withdrawn completely (e.g. replacing the fixing screws after changing a springset), to ensure that they are not cross threaded, as this will cause the thread in the frame to be badly damaged. The residual plate on the vertical and rotary magnets must lie flat on the core face.*

9. FRICITION LOCKED ADJUSTING SCREWS.

9.1 The vertical and rotary pawl front stops, the adjusting screws for the vertical and rotary armature restoring springs are friction locked and are only intended to be held by friction, tight enough not to move in use or when an attempt is made to turn them by hand. They shall, however, be free enough to be turned with a screwdriver or spanner.

9.2 The frictional locking of the vertical and rotary pawl front stops is obtained by a clamp plate and locking screw as shown in Fig. 9. In these cases the locking screw shall be tightened sufficiently to ensure that the front stops comply with the conditions indicated previously.

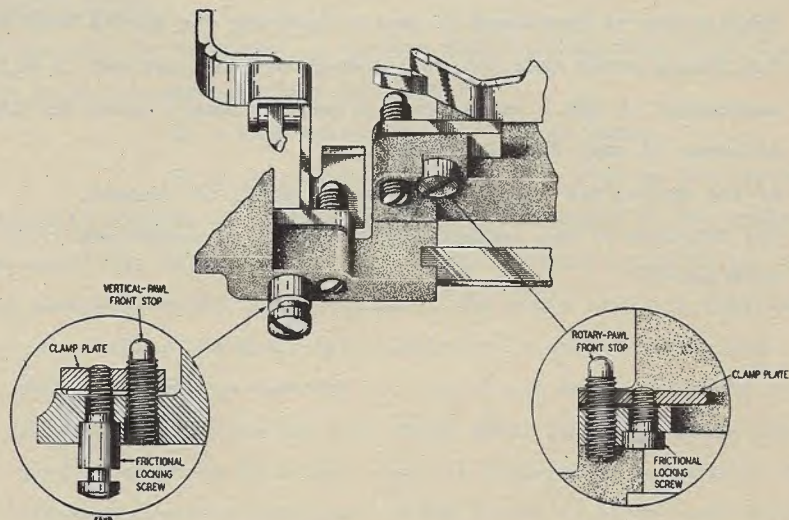


FIG. 9.—FRICITIONAL LOCKING OF VERTICAL- AND ROTARY-PAWL FRONT STOPS

- 9.3 In the case of the armature restoring spring adjusting screws, the brackets are initially set outwards so that the threads are thrown out of pitch. When the adjusting screw is inserted the bracket is sprung inwards until the threads are in pitch and the screw is held friction tight by the outward tension of the bracket. In cases where this condition is not met the screw shall be removed and the bracket re-set until the screw is held friction-tight.
- 9.4 On early switches of the 2000 type the vertical and rotary detent adjusting screws are also retained by friction, and it has been found in practice that there is some tendency for these screws to become loose. When such screws are discovered, lock nuts shall be fitted. It may be necessary to fit longer screws in some cases also to accommodate the lock nuts and allow the correct adjustment to be obtained.
(No. 6-BA. screws and nuts are suitable)

10. METHOD OF TENSIONING PAWL AND DETENT SPRINGS.

- 10.1 The tension of the pawl and detent springs can be varied as follows :-
- 10.11 To increase the tension of one of these springs the fixing screw shall be loosened just sufficiently to enable the spring to be turned away from its stop to a position where it can be levered free from obstruction. The spring can then be given a set at its root by gently levering in the direction in which it normally exerts its tension. The spring shall then be restored to its stop and the fixing screw re-tightened.
- 10.12 Tension can be decreased by gently levering the spring away from its stop. The fixing screw need not be loosened in this case and it will be found convenient to use a small screw-driver to insert under the tip of the spring to lever it away from the stop.
- 10.13 If the spring has become distorted it shall be changed.
- 10.14 The tensions of the springs are specified in paragraphs 17.1, 19.1 and 25.1 of this section.

SHAFT AND WIPER CARRIAGE ASSEMBLY.11. SHAFT.

- 11.1 The shaft must be located in its conical seating so that there is no side play. If this condition is not met reference should be made to paragraph 13 of this section. Fig. 10 indicates the location of the shaft in its conical seating.

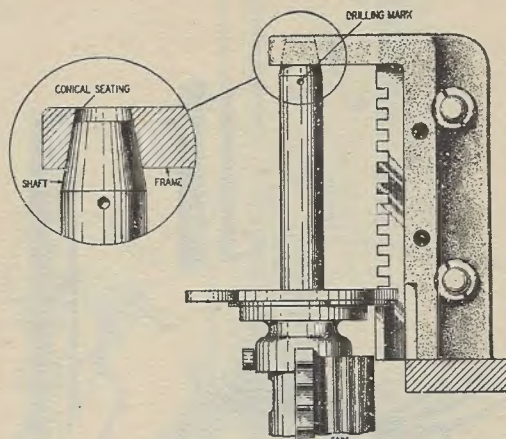


FIG. 10.—LOCATION OF SHAFT IN CONICAL SEATING

12. CARRIAGE ASSEMBLY.

- 12.1 This assembly must be free on the shaft when raised or lowered in the twelfth rotary position. The side play, if any, shall be only just perceptible.

13. CARRIAGE RESTORING SPRING.

- 13.1 This spring must be tensioned to conform with the following when the carriage assembly is in the normal rotary position :-

On 2 bank selectors - three turns.

On 3 or 4 bank selectors - four to five turns.

- 13.2 The tension is applied by lifting the carriage assembly to the eighth or ninth vertical position, loosening the shaft clamp securing screw at the base of the carriage assembly, gripping the bottom of the shaft with the right-hand thumb and finger, and rotating the shaft anti-clockwise (viewed from the top).

Note: When the carriage assembly is free of all friction and no tension exists in the restoring spring, the shaft shall be turned until the drilling mark immediately below the cone tip thereof is in front of the mechanism before commencing the count of the number of shaft revolutions to tension the spring. See Fig. 10.

- 13.3 The shaft must then be pushed firmly upwards from the bottom of the shaft with the first finger of the left hand, at the same time pressing the shaft clamp down with the thumb. The clamp securing screw must then be re-tightened. Fig. 11 refers.

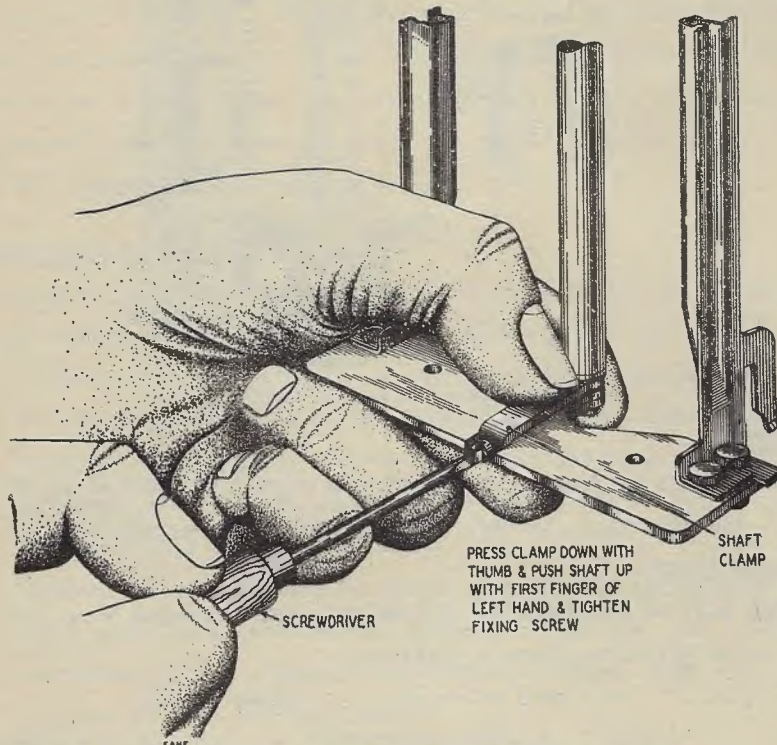


FIG. 11.--CLAMPING OF SHAFT

14. SHAFT CLAMP ADJUSTING SCREW.

- 14.1 This screw, which is at the bottom of the shaft clamp, must then be adjusted so that the clamp and not the extended lug at the bottom of the comb takes the weight of the carriage when at normal. See Fig. 12.

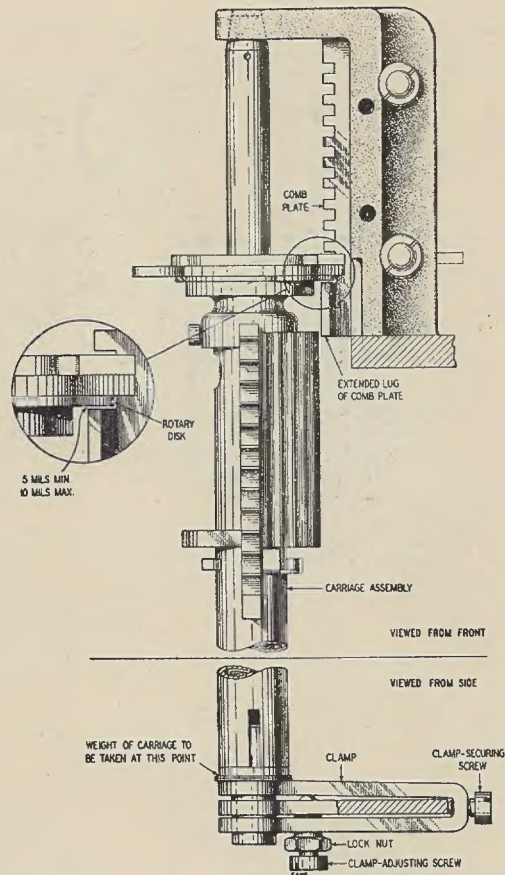


FIG. 12.—ADJUSTMENT OF SHAFT CLAMP

14.2 The adjustment must be made as follows :-

14.21 Loosen the clamp securing and clamp adjusting screws and withdraw the clamp adjusting screw so that it is possible to push the clamp down to its lowest position, taking care not to disturb the adjustment specified in paragraph 13. Tighten the clamp securing screw.

14.22 Screw in the clamp adjusting screw so that the carriage is raised until the clearance between the extended lug on the comb plate and the rotary disk is 5 mils min. 10 mils max. Check with special thickness gauge Tool No. 138. Lock the clamp adjusting screw by means of the lock nut.

- 14.23 Check that the rotary disk does not foul the top face of the bottom comb slot when the carriage is returning on the normal level. See Fig. 13.

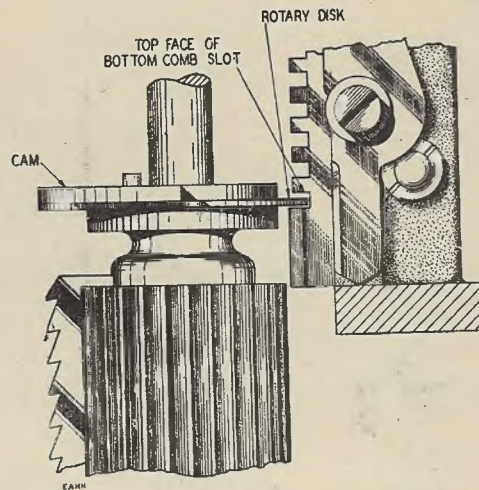


FIG. 13.—CHECK FOR CLEARANCE BETWEEN TOP FACE OF
BOTTOM COMB SLOT AND ROTARY DISK, CARRIAGE RETURN-
ING ON NORMAL LEVEL

DETENT ADJUSTMENTS.15. VERTICAL AND ROTARY DETENT BEARINGS.

15.1 The vertical and rotary detents must be free on their bearings without any vertical play. The side play, if any, shall be only just perceptible.

15.2 The vertical play in the bearings can be taken up by loosening the bracket clamp screw and pushing the pin downwards and tightening the screw. See Fig. 14.

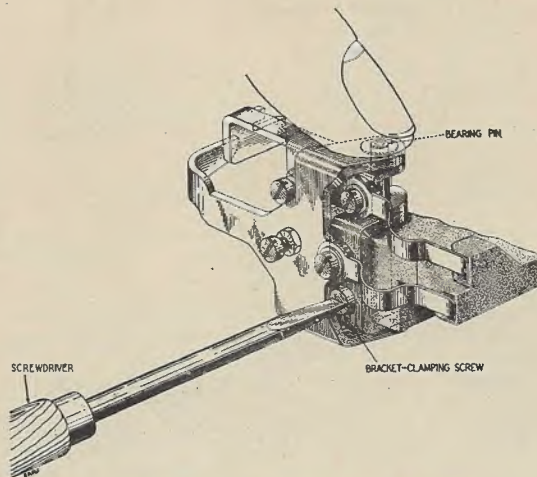


FIG. 14.—TAKING UP VERTICAL PLAY IN DETENTS

16. VERTICAL DETENT.

16.1 The vertical detent adjustments, consisting of two bending adjustments and one screw adjustment, shall be made as detailed hereunder in either (a), (b) and (d) or (a), (c) and (d), according to the type of rotary disk fitted on the switch. The weight of the carriage is taken by the vertical detent during vertical motion only. When the carriage is rotated, the rotary disk enters the comb slot and the vertical ratchet leaves the vertical detent; the weight of the carriage is thus transferred from the vertical detent to the comb plate. On early switches the entering edge of the rotary disk is cut square (see Fig. 16) and, to prevent the comb plate obstructing the rotary disk on entry, the detent shall be adjusted as outlined in (b). On later switches the entering edge of the rotary disk has been chamfered (see Fig. 17) and presents a leading edge to the comb plate. The adjustment for this condition is outlined in (c)

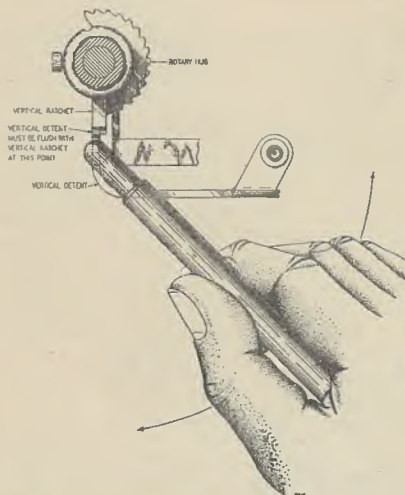


FIG. 15.—LATERAL ADJUSTMENT OF VERTICAL DETENT

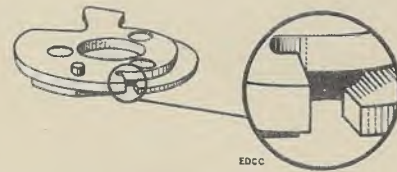


FIG. 16.—ROTARY DISK WITH SQUARE-CUT ENTERING EDGE

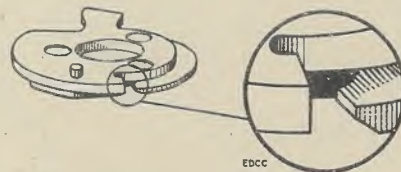


FIG. 17.—ROTARY DISK WITH CHAMFERED ENTERING EDGE

- (a) *Both types of rotary disk:* The carriage assembly shall be raised to the fifth level, and the tip of the detent bent sideways so that it engages flush with the left-hand side of the vertical ratchet (see Fig. 15).
- (b) *Square-cut rotary disk:* The detent shall be set, by raising the tip up or down (twist at the straight portion of the detent as near as possible to the point where it commences to curve in towards the vertical ratchet (see Fig. 18)), so that, when the carriage assembly is rotated, the rotary disk enters the slot in the comb with a drop of approximately 5 mils as shown in Fig. 19. Particular care shall be taken over this adjustment. The amount of drop shall be estimated by observing the rotary disk as it enters the comb slot, and shall be checked on the first, fifth, and tenth levels.
- (c) *Chamfered rotary disk:* The detent shall be set, by raising the tip up and down, so that, when the carriage assembly is rotated, the rotary disk enters the comb slot without rise or fall (see Fig. 20). This adjustment shall be checked on the first, fifth and tenth levels, and if variation exists, a mean adjustment shall be obtained.
- (d) *Screw adjustment:* The locking nut on the vertical detent adjusting screw shall next be loosened. With the carriage assembly raised to the fifth level, the detent adjusting screw shall be set by turning it in or out, until the tip of the detent just touches the bottom of the vertical tooth (see Fig. 21). The locking nut shall then be re-tightened.

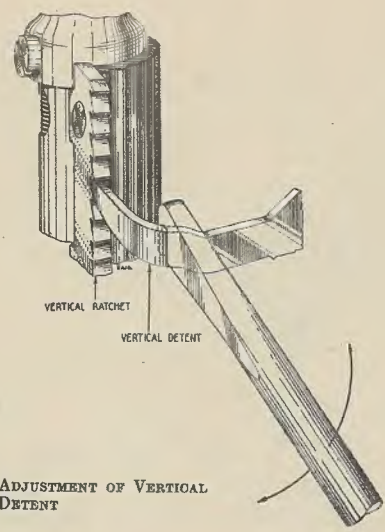


FIG. 18.—VERTICAL ADJUSTMENT OF VERTICAL DETENT

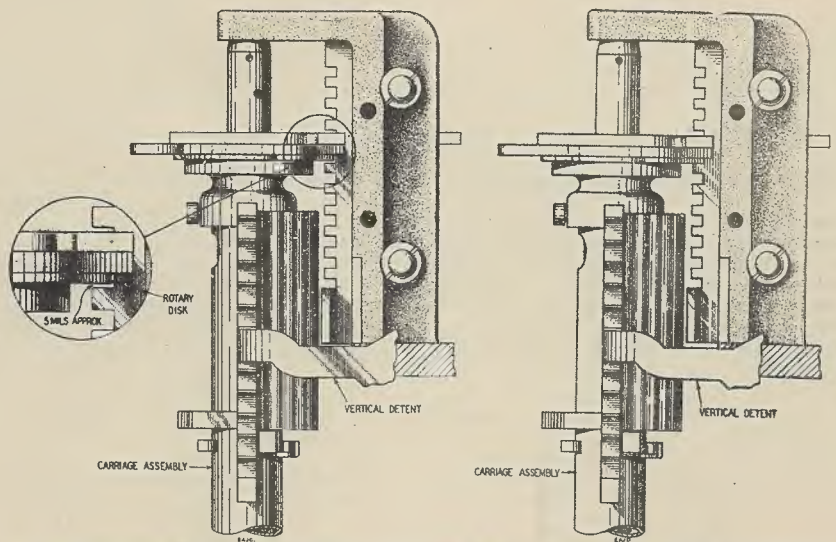


FIG. 19.—CHECKING VERTICAL ADJUSTMENT OF VERTICAL DETENT
(Selectors with square-cut rotary disk)

FIG. 20.—CHECKING VERTICAL ADJUSTMENT OF VERTICAL DETENT
(Selectors with chamfered rotary disk)

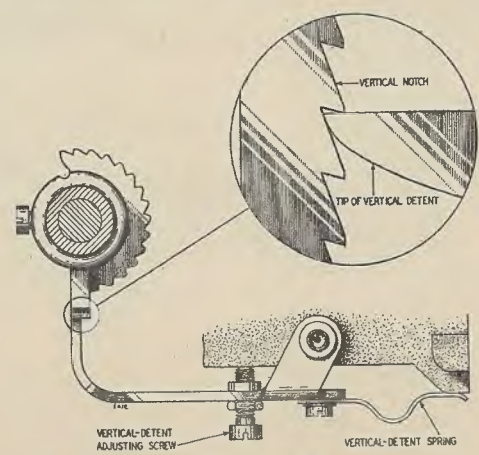


FIG. 21.—ADJUSTING DEPTH OF ENGAGEMENT OF VERTICAL DETENT

17. VERTICAL DETENT SPRING.

17.1 This spring must be tensioned to give 110 grammes \pm 30 grammes measured at the tip of the detent with the carriage assembly rotated on level 0. Fig. 22.

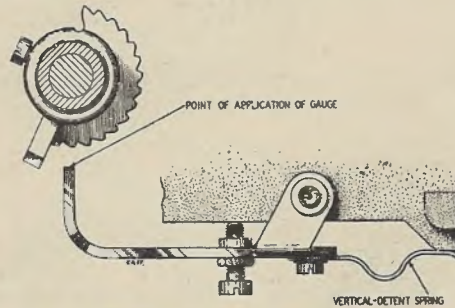


FIG. 22.—CHECKING TENSION OF VERTICAL-DETENT SPRING

18. ROTARY DETENT.

18.1 Before proceeding with adjustment of this detent see that the rotary pawl front stop locking screw is tight. The rotary detent adjustments, consisting of two bending adjustments and one screw adjustment, shall be made as detailed in (a), (b) and (c).

- (a) The detent shall be adjusted by bending it up or down, so that the upper projection is flush with the upper surface of the rotary disk (see Fig. 23) and will just clear the underside of the cam when the carriage assembly is returning, on the normal level. This will ensure that the upper detent projection will latch freely and securely behind the rotary disk with the carriage assembly at normal (see Fig. 24). The lower detent projection shall just clear the top face of the rotary hub (see Fig. 25).

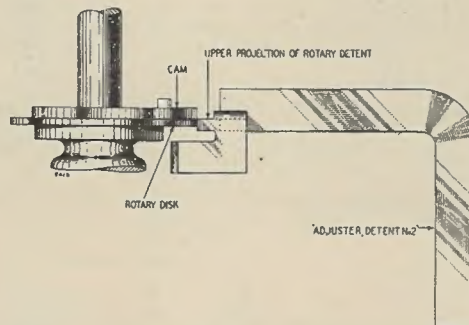


FIG. 23.—ALIGNMENT OF ROTARY-DETENT PROJECTION WITH ROTARY DISK

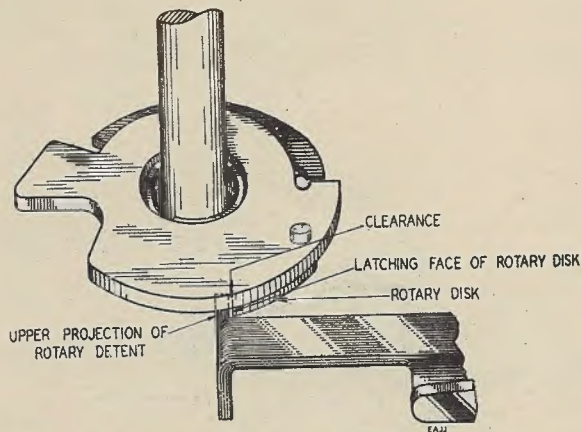


FIG. 24.—LATCHING OF ROTARY-DETENT PROJECTION WITH ROTARY DISK

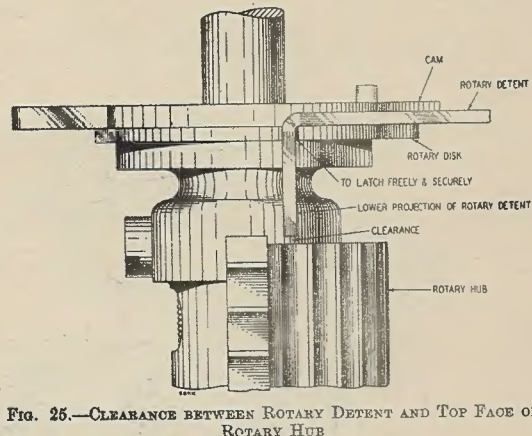


FIG. 25.—CLEARANCE BETWEEN ROTARY DETENT AND TOP FACE OF ROTARY HUB

- (b) When the carriage assembly is stepped vertically from the normal position a small clearance is necessary between the tip of the rotary detent and the short face of the first rotary notch, to prevent the detent obstructing the vertical stepping of the carriage assembly (see Fig. 26). This clearance, however, shall be as *small* as possible without interfering with the vertical stepping of the carriage assembly. It shall not be large enough to permit of the insertion of a 5 mil gauge between the tip of the rotary detent and the short face of the first rotary notch when the carriage is raised to the fifth vertical step. This adjustment shall be made by bending the tip of the rotary detent to the left or right as required, using the rotary detent bender (Tool No. 58), as indicated in Fig. 27.
- (c) The detent locking nut shall next be loosened. The detent adjusting screw shall then be set, by turning it in or out, so that the detent just clears the long face of the rotary notch and it is possible to raise the carriage assembly from normal with the rotary detent riding clear in the first rotary notch on the hub (see Fig. 28). The detent locking nut shall then be tightened. A check shall be made to ensure that, when the carriage assembly is returning to normal from the twelfth rotary position on the normal level, the upper detent projection latches freely and securely behind the rotary disk in the normal position.

18.2 The setting of the vertical and rotary detents shall result in the vertical detent just clearing the vertical ratchet when the carriage is rotated one step by operating the rotary armature (see Fig. 29). This shall be checked on levels 1 and 0.

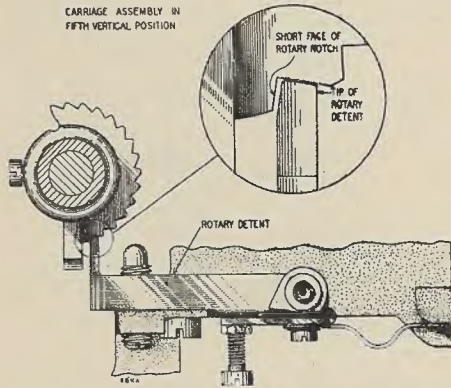


FIG. 26.—LATERAL ADJUSTMENT OF ROTARY-DETENT TIP

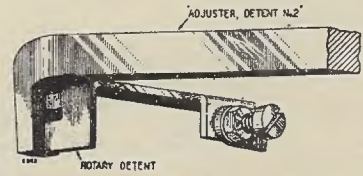


FIG. 27.—ADJUSTING ROTARY-DETENT TIP

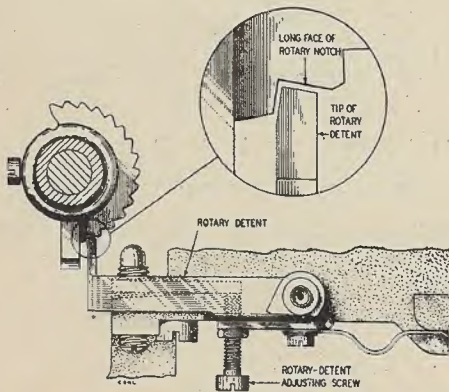


FIG. 28.—DEPTH OF ENGAGEMENT OF ROTARY DETENT

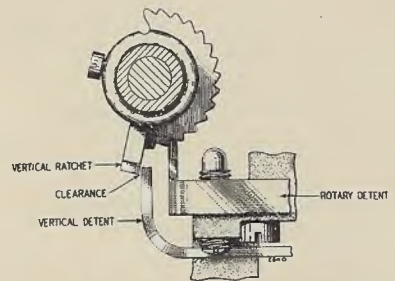
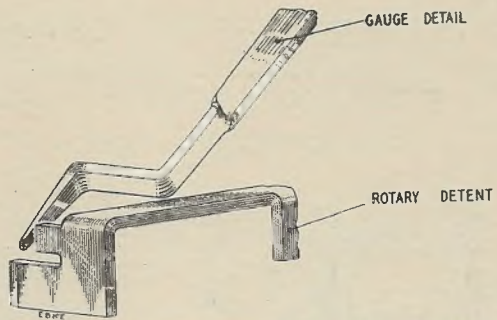


FIG. 29.—CLEARANCE BETWEEN VERTICAL DETENT AND VERTICAL RATCHET WITH CARRIAGE ROTATED ONE STEP

19. ROTARY DETENT SPRING.

19.1 This spring must be tensioned to give 130 grammes \pm 30 grammes pressure measured at the bend in the detent with the carriage assembly raised. See Fig. 30.



★ FIG. 30.—CHECKING TENSION OF ROTARY-DETENT SPRING

VERTICAL ADJUSTMENTS.

20. ARMATURE AND PAWL BEARINGS.

20.1 The vertical armature and the pawl must be free on their bearings with a minimum amount of lateral play.

21. ARMATURE BEARING CLAMP PLATE.

21.1 This plate is initially set so that when the magnet is energised the armature strikes squarely on both faces of the magnet core. See Fig. 31.

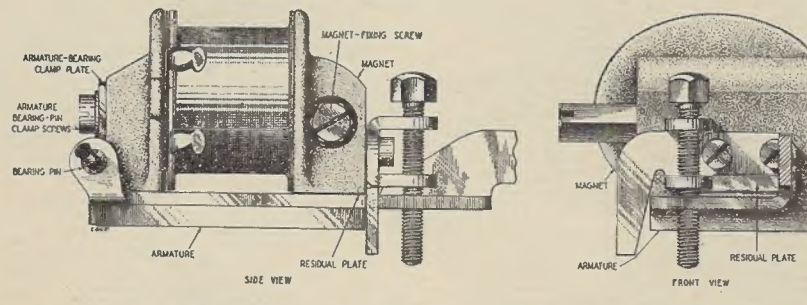


FIG. 31.—ADJUSTMENT OF VERTICAL-ARMATURE BEARING-PIN CLAMP

21.2 If it is necessary to reset the armature clamp plate, slacken off the armature bearing pin clamp screws and the magnet fixing screw. Operate the armature electrically and push the bearing pin well home; re-tighten the magnet fixing screw and then tighten the armature bearing pin clamp screws.

22. PAWL, PAWL GUIDE AND ARMATURE STROKE.

22.1 To facilitate the adjustment of the pawl, pawl guide and armature stroke, the magnet assembly fixing screw shall be loosened (care shall be taken not to withdraw the magnet fixing screw completely from its clamping plate as difficulty may be experienced in replacing the screw) and the assembly pushed upwards as far as possible, so that the armature has a maximum travel. The magnet assembly fixing screw shall then be re-tightened and the vertical pawl front stop withdrawn clear of the pawl in its operated position.

22.2 Pawl. The vertical pawl must engage the vertical teeth so that its left-hand edge is flush with the left side of the vertical ratchet (see Fig. 32). If this condition is not met, the armature shall be bent as shown in Fig. 33, at the same time ensuring that the pawl strikes the teeth squarely. This adjustment in conjunction with the setting of the rotary detent (see paragraph 18) should result in the pawl just clearing the ratchet teeth when the carriage assembly is rotated one step and the armature operated by hand. (Check on Levels 1 and 0.) See Fig. 34. If this condition is found to be incorrect, the rotary detent adjustment detailed in paragraph 18 shall be re-checked. The side portion must clear the pawl front stop. See Fig. 35.

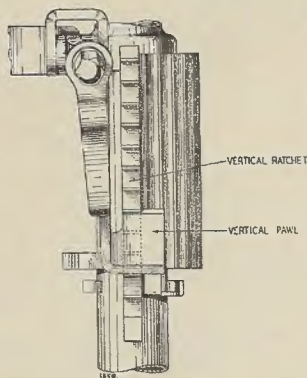


FIG. 32.—ALIGNMENT OF VERTICAL PAWL WITH VERTICAL RATCHET

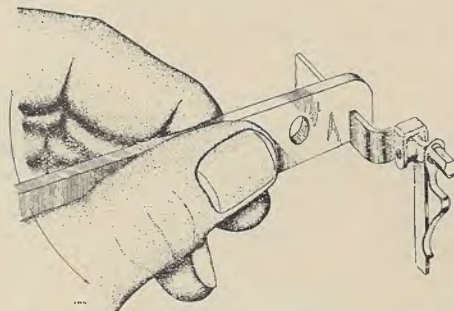


FIG. 33.—ADJUSTMENT OF VERTICAL ARMATURE FOR ALIGNMENT OF VERTICAL PAWL

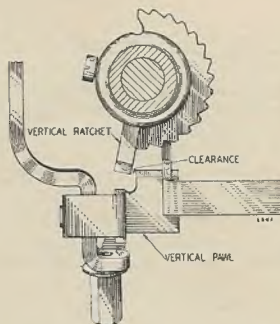


FIG. 34.—CLEARANCE BETWEEN VERTICAL PAWL AND VERTICAL RATCHET TEETH, SHAFT ROTATED ONE STEP

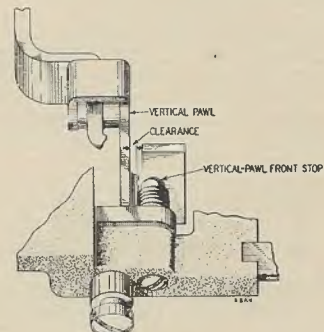


FIG. 35.—CLEARANCE BETWEEN SIDE OF VERTICAL PAWL AND PAWL FRONT STOP

- 22.3 Pawl Guide. Raise the carriage assembly to the first level and adjust the pawl guide by bending towards or away from the carriage, so that the tip of the pawl strikes into the root of the fourth vertical notch, without sliding along either face when the armature is operated by hand (see Fig. 36). The carriage assembly shall then be restored to normal. Check that the pawl clears the third vertical notch when the switch is restoring on the normal level.

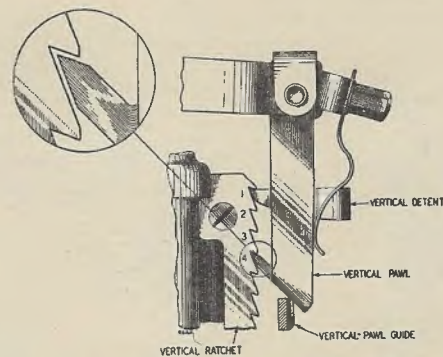


FIG. 36.—ADJUSTMENT OF VERTICAL-PAWL GUIDE

- 22.4 Armature Stroke. To adjust the stroke of the vertical armature proceed as follows :-

- (a) Unscrew the vertical armature back stop so that it lifts the armature and the carriage assembly until the vertical detent drops over the first vertical tooth, and leaves a gap of 5 mils minimum, 10 mils maximum, between the short face of the vertical tooth and the top surface of the vertical detent (see Fig. 37). Alternatively, the armature may be lifted by inserting a metal wedge between the armature and the back stop.
- (b) Without disturbing the position of the vertical armature back stop or wedge, loosen the magnet fixing screw and with the aid of a small screwdriver gently lever the magnet assembly towards the armature until its pole face is just in contact with the armature (see Fig. 38). Tighten the magnet fixing screw.
- (c) Screw in the armature back stop or remove the wedge so that the armature is lowered, operate the armature electrically, and check that the clearance between the horizontal surface of the tooth and the top surface of the vertical detent still exists.

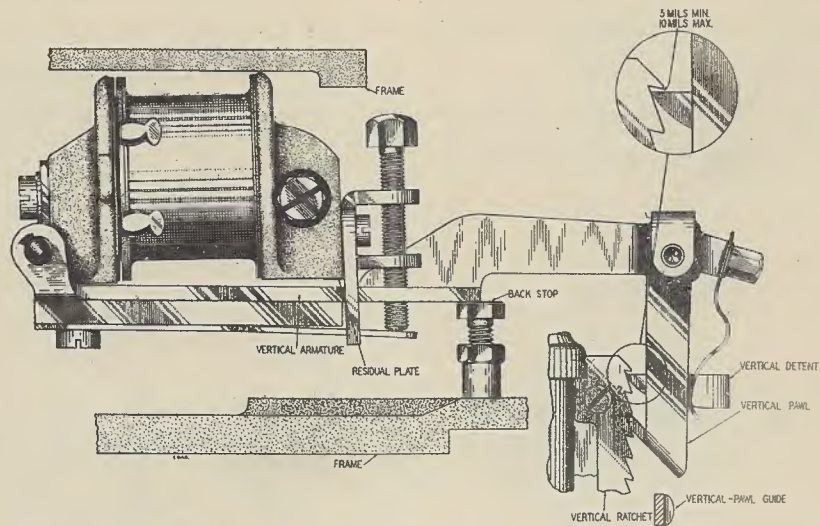


FIG. 37.—LOCATING VERTICAL ARMATURE IN OPERATED POSITION

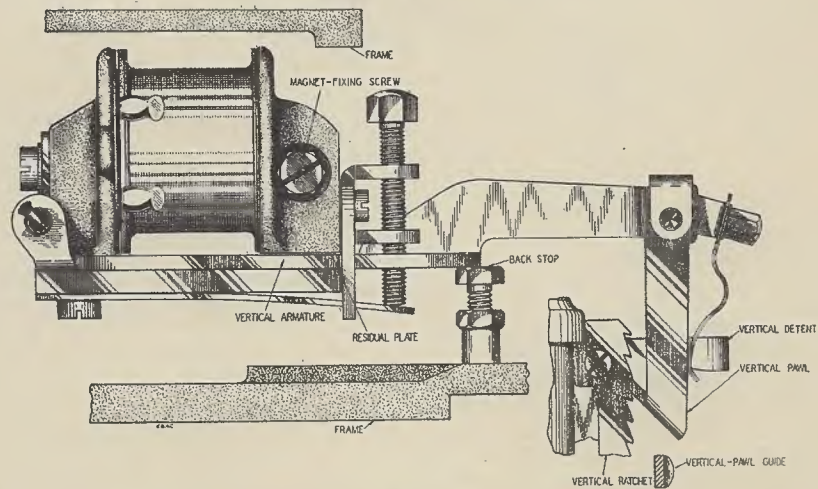


FIG. 38.—ADJUSTING POSITION OF VERTICAL MAGNET

23. ARMATURE BACK STOP.

- 23.1 Adjust the position of this stop so that, when the armature returns to normal against it, the vertical pawl just trips over the teeth without causing the carriage to rise. This must be checked on all vertical steps. Tighten the back stop locking nut.
- 23.2 To ensure that the carriage assembly can release if the vertical detent fails to drop in (the weight of the carriage then being taken by the vertical pawl) the vertical detent shall be withdrawn and the carriage assembly held by the vertical pawl on Level 2. The rotary armature shall then be operated by hand and the adjustments detailed in (a) and (b) of this paragraph checked. This check shall be repeated on Level 9.

- (a) On switches having rotary disks with a square-cut entering edge, check that the rotary disk enters the comb slot without rise when the carriage is rotated (see Fig. 39).
- (b) On switches having chamfered rotary disks, check that the disk enters the comb slot freely. The disk may rise slightly along its chamfered edge as it cuts in (see Fig. 40) but the disk should never strike the comb plate on that portion of the disk above the chamfer (see Fig. 41). It shall also be checked that the position of the vertical pawl is such that it does not prevent the carriage assembly from returning to normal on the normal level.

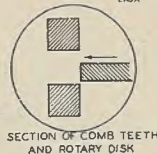
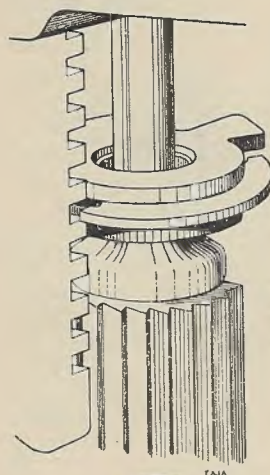


FIG. 39.—CHECK OF CORRECT ADJUSTMENT OF VERTICAL-ARMATURE BACK STOP (ROTARY DISK ENTERING COMB SLOT WITHOUT RISE)

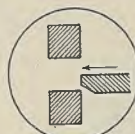
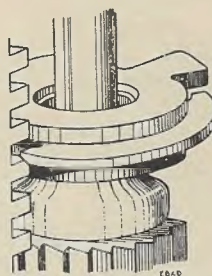


FIG. 40.—CHECK OF ADJUSTMENT OF VERTICAL-ARMATURE BACK STOP (CORRECT, ROTARY DISK ENTERING COMB SLOT WITH SLIGHT RISE)

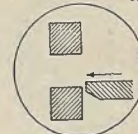
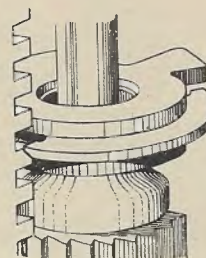


FIG. 41.—CHECK OF ADJUSTMENT OF VERTICAL-ARMATURE BACK STOP (INCORRECT, VERTICAL PORTION OF ROTARY DISK STRIKING COMB TEETH)

24. PAWL FRONT STOP.

- 24.1 The vertical pawl front stop shall be adjusted by screwing the stop in until the vertical detent *just drops in* the root of the next tooth when the armature is operated by *hand* on any vertical step (see Fig. 42). This setting will ensure that when the vertical armature is operated electrically the vertical pawl strikes its front stop slightly in advance of the vertical armature striking the magnet core face. The vertical pawl front stop shall then be secured by means of the locking screw.
- 24.2 Check that with the armature operated electrically, there is *no vertical play* in the carriage assembly. Also that the carriage does not drop when the armature commences to restore. To allow for slight variation of the ratchet due to manufacture, however, a slight drop in the carriage is permissible on some

teeth but not on all. The maximum permissible drop on any step is 5 mils. The amount of drop shall be checked by inserting a feeler gauge between the vertical detent and the short face of the vertical tooth when the armature is operated electrically.

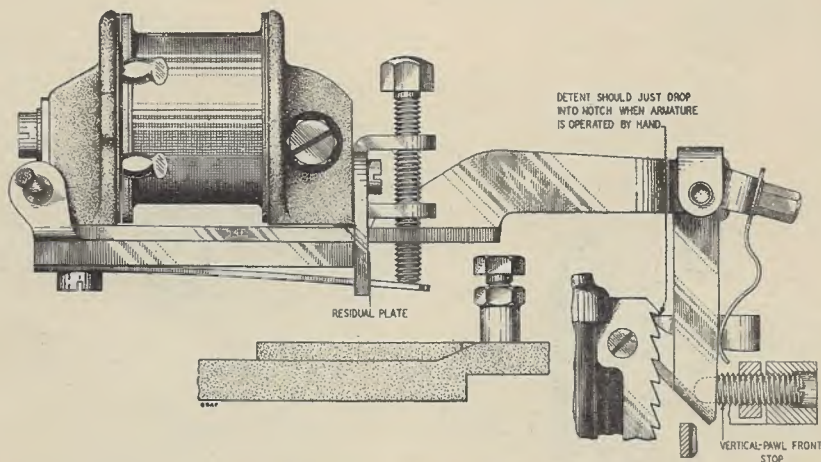


FIG. 42.—ADJUSTMENT OF VERTICAL-PAWL FRONT STOP

25. PAWL SPRING.

25.1 The vertical pawl spring must be tensioned to give a pressure of 80 grammes \pm 30 grammes, measured at the tip of the spring when the vertical armature is operated. See Fig. 43.

25.2 Check that the curved tip of the spring clears the vertical pawl front stop clamping plate, and that the side of the spring clears the vertical pawl front stop.

26. ARMATURE RESTORING SPRING.

26.1 The vertical armature restoring spring must be adjusted by means of its adjusting screw, so that it exerts a pressure of 350 grammes \pm 50 grammes, measured at the spring tip (see Fig. 44). A reasonable margin of adjustment in both directions shall be left on the restoring spring adjusting screw.

27. SUBSIDIARY VERTICAL PAWL GUIDE.

27.1 This guide is fitted to prevent the vertical pawl fouling the rotary teeth if the vertical armature is operated with the carriage in any rotary position. With the carriage assembly normal, check that the guide rests approximately central in the space between the bottom of the vertical teeth and the rotary hub (see Fig. 45). It must clear the vertical ratchet when the carriage assembly is at normal.

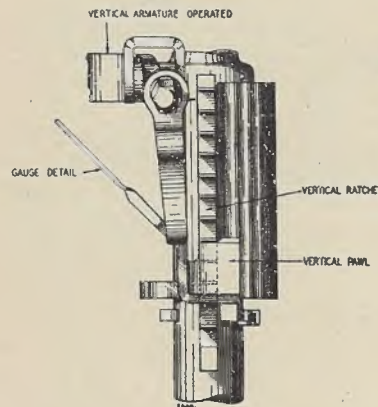


FIG. 43.—CHECKING THE TENSION OF THE VERTICAL-PAWL SPRING

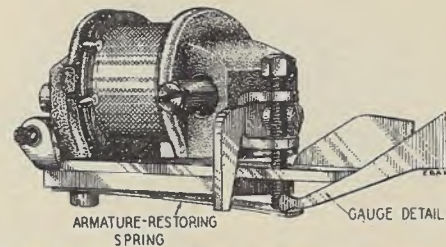


FIG. 44.—CHECKING VERTICAL ARMATURE-RESTORING SPRING TENSION

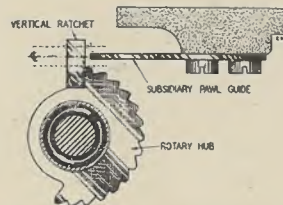


FIG. 45.—POSITION OF SUBSIDIARY VERTICAL-PAWL GUIDE, VIEWED FROM UNDERSIDE

ROTARY ADJUSTMENTS.28. ARMATURE AND PAWL BEARINGS.

28.1 The rotary armature and pawl must be free on their bearings with a minimum amount of lateral play.

29. ARMATURE BEARING CLAMP PLATE.

29.1 This plate is initially set so that when the magnet is energised, the armature strikes squarely on both faces of the magnet core. (See Fig. 46.) If it is necessary to reset the clamp plate, the armature bearing pin clamp screws and the magnet fixing screw shall be loosened; next the armature shall be operated electrically and the bearing pin pushed into the casting as far as possible. The magnet fixing screw and the armature bearing clamp screws shall then be re-tightened.

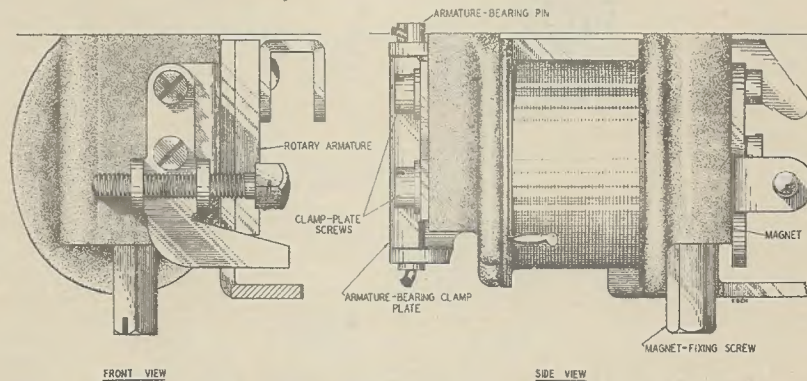


FIG 46.—ADJUSTMENT OF ROTARY-ARMATURE BEARING-PIN CLAMPS

30. PAWL, PAWL GUIDE AND ARMATURE STROKE.

30.1 To facilitate the adjustment of the pawl, pawl guide and armature stroke, the armature back stop shall be replaced by the special armature stroke adjusting screw, Tool No. 29; the pawl front stop shall be withdrawn clear of the pawl in its operated position; the magnet assembly fixing screw shall be loosened, and the magnet assembly positioned to the left as far as possible so that the armature travel is a maximum. (The magnet fixing screw should not be withdrawn completely, as difficulty may be experienced in replacing it.) The magnet assembly fixing screw shall then be re-tightened. The armature restoring spring fixing screw shall next be loosened so that no tension is exerted by the spring on its stop when the armature is operated.

30.2 Pawl. The pawl locking projection must not project above the extended lug on the comb plate. This can be checked with the carriage in the twelfth rotary position, and the rotary armature operated (see Fig. 47). The pawl must clear the rotary hub when the carriage is returning on the normal level with the rotary armature operated (see Fig. 48). The tip of the pawl must strike squarely into the teeth when the rotary armature operates. If these conditions are not met, the armature shall be adjusted by bending as shown in Fig. 49.

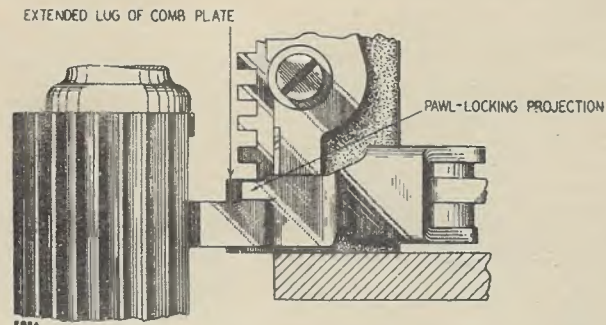


FIG. 47.—CHECKING ALIGNMENT OF ROTARY-PAWL LOCKING PROJECTION WITH COMB-PLATE LUG (CARRIAGE ASSEMBLY IN 12TH ROTARY POSITION WITH ARMATURE OPERATED)

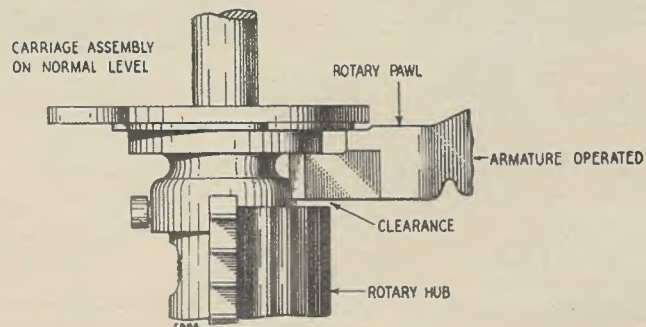


FIG. 48.—CLEARANCE BETWEEN ROTARY PAWL AND TOP OF ROTARY HUB

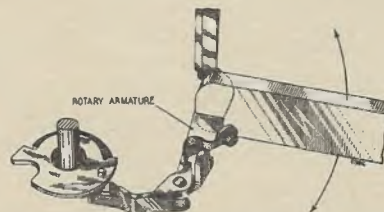


FIG. 49.—ADJUSTMENT OF ROTARY ARMATURE FOR ALIGNMENT OF ROTARY PAWL

30.3 Pawl Guide. With the carriage raised and rotated one step, set the pawl guide by loosening the fixing screws, and swinging the guide to the right or left, pivoting on the upper screw, so that the pawl strikes into the fourth rotary notch on the hub with approximately one-third slide on the long face of the tooth (see Fig. 50). The fixing screws must then be re-tightened. A check shall be made to ensure that:-

- (a) With the carriage assembly held by hand against the rotary detent, in the twelfth rotary position, and the armature operated, the locking projection of the pawl locks securely behind the extended lug at the bottom of the comb plate and that the pawl tip is quite clear of the hub on all levels (see Fig. 51).
- (b) During the operation of the rotary armature on any step, the pawl locking projection clears the extended lug on the comb plate.

If condition (a) is not complied with, the slide of the pawl on the long face of the rotary tooth may be extended to a maximum of two-thirds.

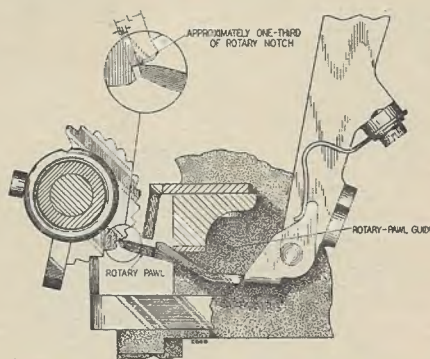


FIG. 50.—ADJUSTMENT OF ROTARY-PAWL GUIDE

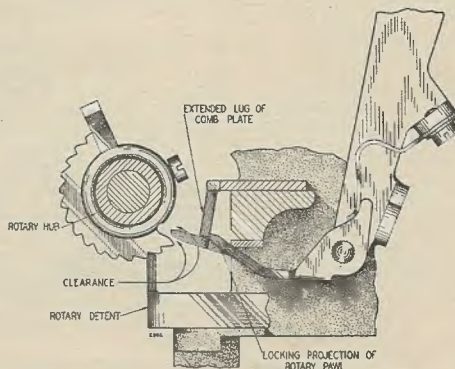


FIG. 51.—LOCKING OF ROTARY PAWL WITH COMB-PLATE LUG (CARRIAGE ON 12TH STEP)

30.4 Armature Stroke. The stroke of the rotary armature shall be adjusted as detailed in (a), (b) and (c).

- (a) With the carriage stepped to the fifth vertical step, screw in the special adjusting screw so that the rotary pawl rotates the carriage until the rotary detent drops over the next rotary tooth and leaves a clearance of 5 mils minimum, 10 mils maximum, between the detent and the short face of the tooth (see Fig. 52). Care shall be taken to ensure that the operating strikers do not foul the operating lever of the rotary interrupter springs during this operation.
- (b) Without disturbing the position of the special adjusting screw loosen the magnet fixing screw and with the aid of a small screw-driver gently lever the magnet assembly over to the right until its pole face is just in contact with the armature (see Fig. 53). The magnet fixing screw shall then be tightened.
- (c) Slacken off the special armature adjusting screw, operate the rotary armature electrically, and check that the clearance between the detent and the short face of the rotary tooth still exists. Replace the armature back stop and tighten the armature restoring spring fixing screw.

Note: To avoid the necessity of using the special adjusting screw, the back stop screw may be used for the above adjustments by placing a metal plate approximately 1/16" thick between the armature and the end of the back stop screw.

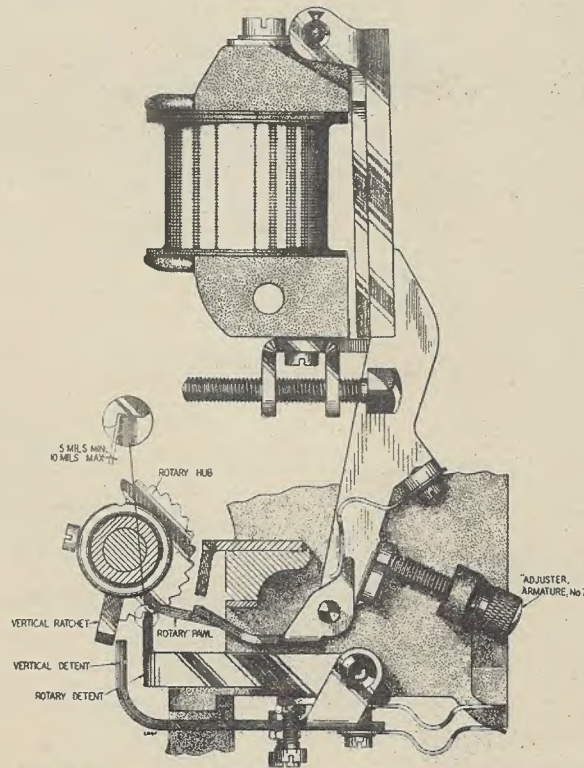


FIG. 52.—LOCATING ROTARY ARMATURE IN OPERATED POSITION

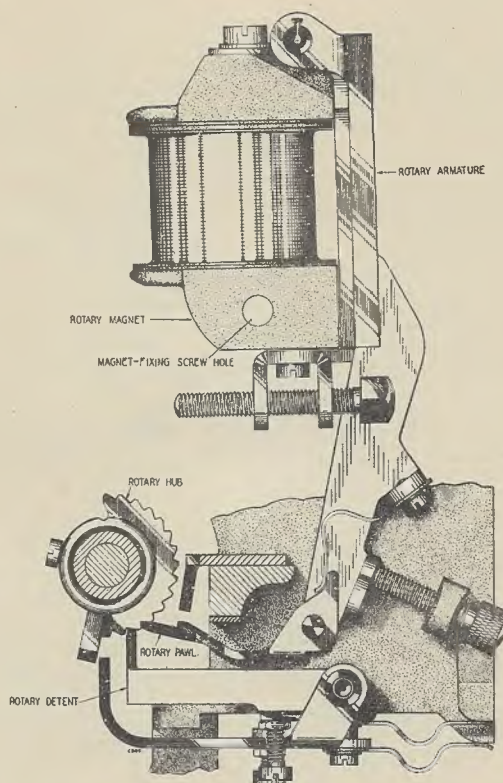


FIG. 53.—ADJUSTING POSITION OF ROTARY MAGNET

31. ARMATURE BACK STOP.

- 31.1 The rotary armature back stop shall be adjusted so that, when the armature is normal, the tip of the pawl clears the long face of the third rotary notch just sufficiently to allow the carriage to be raised from normal to the first level (see Fig. 54). Tighten the back stop screw locking nut.
- 31.2 The maximum clearance between the tip of the pawl and the rotary notch must be such that when a 10 mil gauge is inserted between the armature and the back stop, the tip of the rotary pawl fouls the rotary notch when the shaft is raised from the normal to the first level. With a 5 mil gauge inserted the pawl shall clear the rotary notch.

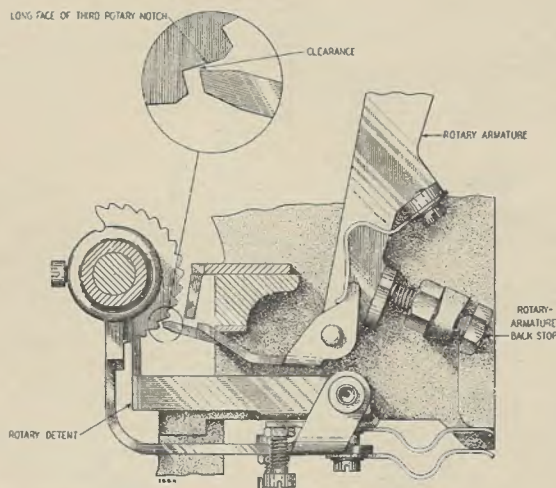


FIG. 54.—ADJUSTING NORMAL POSITION OF ROTARY ARMATURE

32. PAWL FRONT STOP.

32.1 To adjust the rotary pawl front stop, the locking screw shall first be loosened; the carriage shall then be raised to the fifth vertical step and the pawl front stop screwed in until the rotary detent *just drops into* the rotary notch when the rotary armature is operated by hand (see Fig. 55). This must be checked on each rotary step on levels 1 and 0. This setting will ensure that the pawl strikes its front stop slightly in advance of the armature striking the magnet core face. Tighten the pawl front stop locking screw.

32.2 Check that with the armature operated electrically there is *no rotary play* in the carriage assembly, also that there is no back-lash in the carriage when the armature commences to restore. To allow for slight variation of the ratchet due to manufacture, slight back-lash is allowable on some teeth but not on all. The maximum back-lash allowable is such that a 2 mils gauge binds when inserted between the rotary detent and the short face of the rotary notch when the armature is operated electrically. Check also that the adjustment of the pawl front stop has not disturbed the depth of the engagement of the rotary detent (see paragraph 18.1(c)).

33. PAWL SPRING.

33.1 The rotary pawl spring must be tensioned to exert a pressure of 150 grammes \pm 30 grammes measured at the tip of the pawl with the armature normal and the carriage assembly raised to level 0 (see Fig. 56).

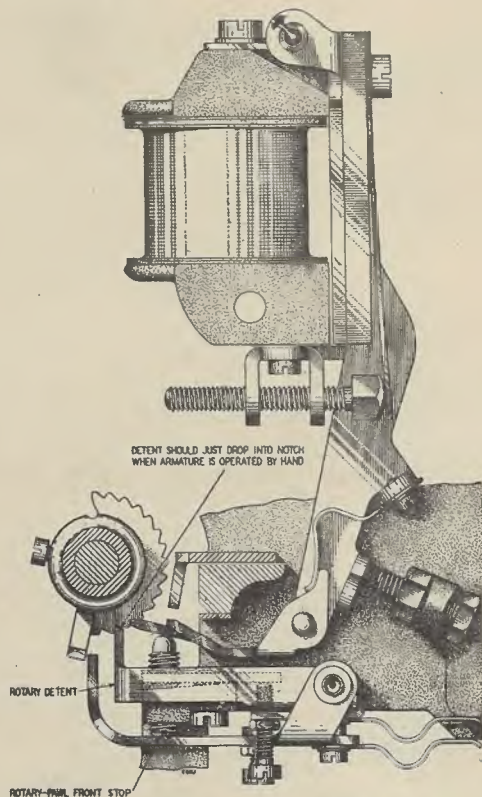


FIG. 55.—ADJUSTMENT OF ROTARY-PAWL FRONT STOP

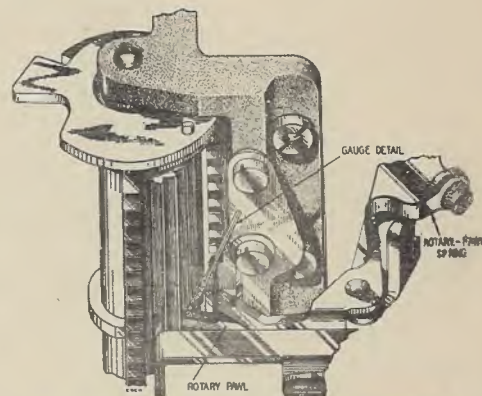


FIG. 56.—CHECKING TENSION OF ROTARY-PAWL SPRING

34. ARMATURE RESTORING SPRING.

- 34.1 This spring must be adjusted by means of its adjusting screw to exert a pressure of 350 grammes \pm 50 grammes on the screw head, measured at the spring tip.
- 34.2 A reasonable margin of adjustment in both directions shall be left on the restoring spring adjusting screw.
- 34.3 With the carriage in the twelfth rotary position, check that the rotary armature will restore fully on to its back stop when it is released gently by hand. When checking this condition, the interrupter spring operating lever must be restored by hand.

SECTION 3.

MECHANICALLY OPERATED SPRING ASSEMBLIES,
SHELF JACKS, WIPERS AND WIPER CORDS.

1. OPERATING LEVERS AND ROLLERS.

- 1.1 The levers must strike approximately in line with and flat on the buffers (see Fig. 57). They must be free on their bearings with a minimum amount of vertical or side play. Vertical play can be taken up by the adjustment of the bottom bearing screws (use Tool No. 235).
- 1.2 Rollers must be free to revolve on their bearings with a minimum amount of vertical or side play. Vertical play in the rollers can be adjusted by bending the roller brackets. If the roller bearings have become worn, the roller or bracket, whichever is at fault, shall be changed.

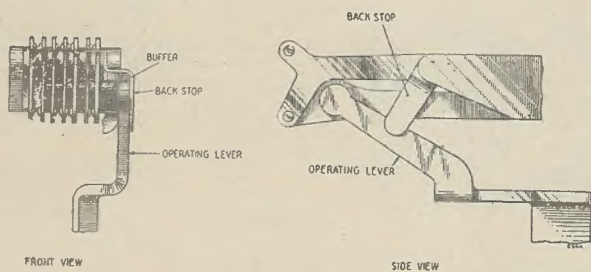


FIG. 57.—ALIGNMENT OF OPERATING LEVER WITH BUFFER

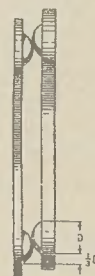


FIG. 58.—SHOWING
MAXIMUM OVERLAP

2. STRAIGHTNESS OF SPRINGS.

- 2.1 All springs must be straight between their clamped portion and the contacts. The parallel condition of contact springs is controlled by the thickness of the insulators and spring buffers. In cases where the first spring in an assembly is a "break" spring, the adjustment of this spring to lie straight throughout its length will ensure that the remaining contact springs after being adjusted as outlined below, will be reasonably parallel and straight throughout their length. In cases where an assembly has all "make" contacts, the first "make" spring shall be adjusted to lie straight throughout its length.
- 2.2 A spring adjuster (Tool No. 18A) is provided for carrying out spring adjustment, and Duck-Bill Pliers can be used if preferred on assemblies where the springs are accessible.
- 2.3 The principles involved in the method of tensioning springs are the same as those applying to relay springs.

3. ALIGNMENT OF CONTACTS.

3.1 Pairs of contacts, which make electrical contact, must not overlap each other by more than one-third of the diameter of a contact (see Fig. 58). Twin contacts must make or break approximately simultaneously. The extended tip of the spring adjuster shall be used for adjusting twin contacts.

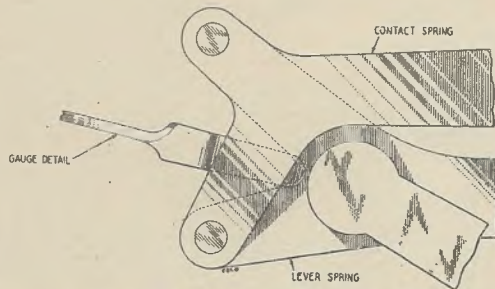
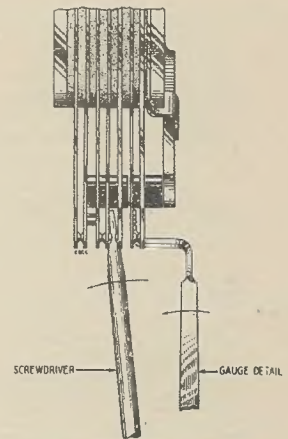


FIG. 59.—SHOWING POINT OF APPLICATION OF GAUGE

FIG. 60.—SHOWING TENSION OF
OUTER LEVER SPRING BEING
RELIEVED4. CONTACT PRESSURES AND CLEARANCES.

- 4.1 The contact pressure of all "make" or "break" contacts must be 30 ± 10 grammes. When measuring such pressures the tip of the tension gauge detail shall be applied to the bottom of the V portion of the spring (see Fig. 59).
- 4.2 When measuring the contact pressure of "break" contacts, the inward tension of the outer springs shall be relieved (see Fig. 60); also when the first combination of springs in an assembly is a "change-over" the tension of the other lever springs shall be relieved while the contact pressure of the "break" portion of the "change-over" is being measured.
- 4.3 Contact openings are normally controlled by the thickness of the separating insulators and buffers also contact pressures, except in cases where the assembly has a complement of one "make" contact or one or more "break" contacts. The contact opening must then be 20 ± 10 mils.
- 4.4 "Change-over" contacts must have a minimum contact clearance of 5 mils between "break" contacts before the "make" contacts close.

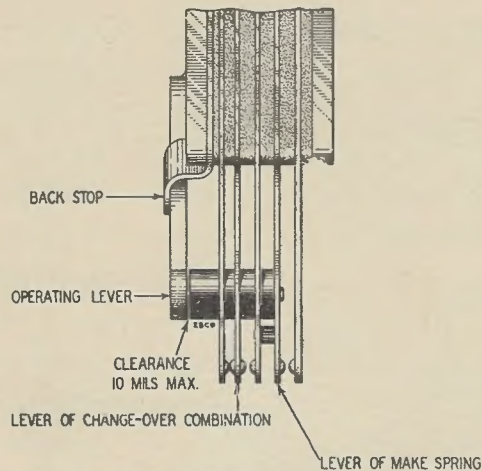


FIG. 61.—ADJUSTMENT OF BACK STOP

5. OPERATING LEVER BACK STOPS.

5.1 When the first set of springs in an assembly constitutes a "break" or "change-over" contact the operating lever back stop must be adjusted to allow the lever to have perceptible play between the buffer of No. 2 spring and the back stop (see Fig. 61). This clearance must not exceed 10 mils, measured between the lever and the buffer of spring No. 2. The extended tip of the spring adjuster shall be used for adjusting the back stops.

6. METHOD OF ADJUSTING SPRING-SETS.

6.1 General.

- 6.11 In order to ensure against spring vibration during the operation of the mechanism, intermediate "make" springs are buffered against the following "break" or "lever" springs.
- 6.12 When a "make" spring is buffered against a "break" spring, the former must remain in contact with the buffer of the latter throughout its travel. When there is a sequence of "break" contacts in an assembly these "break" contacts must break simultaneously or in sequence, commencing from the first "break" contact.
- 6.13 When a "make" spring is buffered against a "lever" spring the tension of the former must not be such that it lifts the buffer of the latter away from its preceding "lever" spring (see Fig. 62).
- 6.14 In certain cases, buffer pressures are specified for "lever" springs. These buffer pressures shall be measured with the gauge detail applied to the bottom of the V portion of the spring (see Fig. 59). This pressure shall

be measured when the spring is free of its associated "break" spring and/or outer "lever" spring.

- 6.15 For the purpose of this instruction, and in order that all aspects of the adjustment of springs may be considered, the adjustment of typical spring-sets only are described. The adjustments are described in the order in which they shall be carried out, and the letters shown in the following illustrations against the springs concerned also indicate the order in which the adjustment shall be carried out.

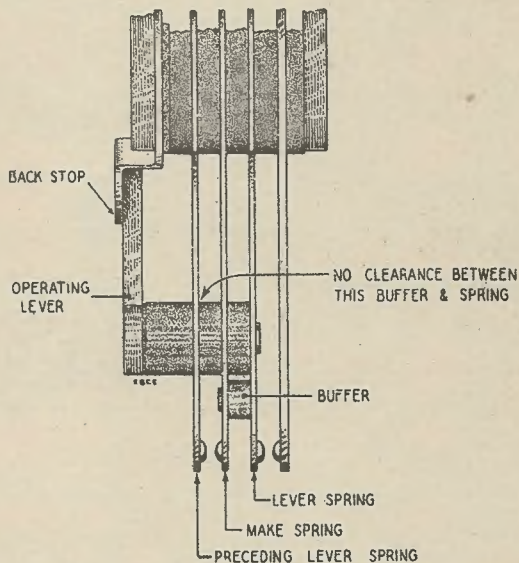


FIG. 62.—'MAKE' SPRING BUFFERED AGAINST A LEVER SPRING

6.2 Single "Make" Contact - Fig. 63.

6.21 The spring-set shall be adjusted as follows :-

- (a) Adjust Spring No. 2 so that it is straight throughout its length.
- (b) The operating lever back stop shall be adjusted so that there is a contact clearance of 20 ± 10 mils. This must be checked with the operating lever normal and the lever spring buffer resting against the operating lever.
- (c) Tension Spring No. 1 so that its buffer rests against the operating lever with a pressure of 20 ± 10 grammes.
- (d) The operating lever shall be adjusted by bending, so that when the springs are operated the travel is such that the contact pressure of the "make" contact is 30 ± 10 grammes.

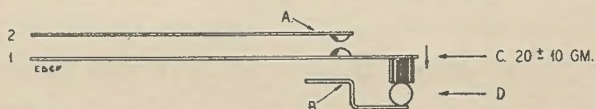


FIG. 63.—SINGLE 'MAKE' CONTACT

6.3 Two "Break" Contacts - Fig. 64.

6.31 The spring-set shall be adjusted as follows :-

- (a) Check that a clearance exists between the operating lever and the buffer of Spring No. 2. If necessary adjust the operating lever back stop to obtain this clearance.
- (b) Adjust Spring No. 1 so that it is straight throughout its length.
- (c) Tension Spring No. 2 to exert a contact pressure of 30 ± 10 grammes on Spring No. 1. Hold springs 3 and 4 clear when gauging.
- (d) Tension Spring No. 4 to exert a contact pressure of 30 ± 10 grammes on Spring No. 3; at the same time Springs Nos. 3 and 4 must be adjusted to break at the same time or in sequence with Springs Nos. 1 and 2.
- (e) Adjust the operating lever by bending so that when the springs are operated the travel is such that the contact opening of the break contacts is 20 ± 10 mils.
- (f) Adjust the operating lever back stop so that there is a clearance of 10 mils maximum between the operating lever and the buffer of Spring No. 2.

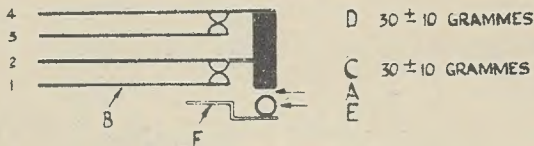


FIG.64. TWO BREAK CONTACTS

6.4 Three "Change-over" Contacts - Fig. 65.

6.41 The spring-set shall be adjusted as follows :-

- (a) Check that a clearance exists between the operating lever and the buffer of Spring No. 2. If necessary adjust the operating lever back stop to obtain the clearance.
- (b) Adjust Spring No. 1 so that it is straight throughout its length.
- (c) Tension Spring No. 2 to exert a contact pressure of 30 ± 10 grammes on No. 1. Hold springs 3 to 9 clear when gauging.
- (d) Tension Spring No. 5 so that its buffer rests on Spring No. 2 with a pressure of 40 ± 10 grammes. When gauging on Spring No. 5 hold Springs Nos. 3, 4 and 8 clear.
- (e) Tension Spring No. 8 so that its buffer rests on Spring No. 5 with a pressure of 40 ± 10 grammes. Hold Springs Nos. 6 and 7 clear when gauging.
- (f) Tension Springs Nos. 3 and 4 towards Spring No. 5 so that the contact pressure between Springs Nos. 4 and 5 is 30 ± 10 grammes. Gauge on Spring No. 4. Check that the pressure is not such that it lifts the buffer of Spring No. 5 away from Spring No. 2.
- (g) Tension Springs Nos. 6 and 7 towards Spring No. 8 so that the contact pressure between Springs Nos. 7 and 8 is 30 ± 10 grammes. Gauge on Spring No. 7. Check that the pressure is not such that it lifts the buffer of Spring No. 8 away from Spring No. 5.
- (h) Adjust the operating lever by bending so that when the springs are operated the travel is such that the contact pressure of Springs Nos. 3 and 6 is 30 ± 10 grammes. Adjust Spring No. 9 so that when operated its contact pressure is 30 ± 10 grammes.
- (j) Adjust the operating lever back stop so that there is a clearance of 10 mils maximum between the operating lever and the buffer of Spring No. 2.

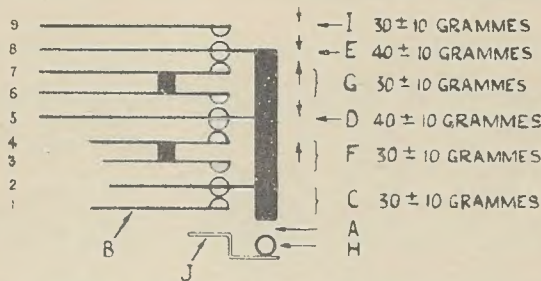


FIG.65. THREE CHANGE-OVER CONTACTS

6.5 One "Break," one "Change-over" and two "Make" Contacts - Fig. 66.

6.51 The spring-set shall be adjusted as follows :-

- (a) Check that a clearance exists between the operating lever and the buffer of Spring No. 2. If necessary adjust the operating lever back stop to obtain this clearance.
- (b) Adjust Spring No. 1 so that it is straight throughout its length.
- (c) Tension Spring No. 2 to exert a contact pressure of 30 ± 10 grammes on Spring No. 1. Hold Springs 3 to 9 clear when gauging.
- (d) Tension Spring No. 4 to exert a contact pressure of 30 ± 10 grammes on Spring No. 3; at the same time Springs Nos. 3 and 4 must be adjusted to break at the same time or in sequence with Springs Nos. 1 and 2. Hold Springs 5 to 9 clear when gauging.
- (e) Tension Spring No. 6 so that its buffer rests on Spring No. 4 with a pressure of 30 ± 10 grammes. Hold springs 5 and 7 to 9 clear when gauging.
- (f) Tension Spring No. 8 so that its buffer rests on Spring No. 6 with a pressure of 30 ± 10 grammes. Hold Spring No. 7 clear when gauging.
- (g) Tension Springs Nos. 5 and 7 so that their buffers rest against Springs Nos. 6 and 8 respectively. Check that the tension of Springs Nos. 5 and 7 is not such that it lifts the buffers of Springs Nos. 6 and 8 away from Springs Nos. 4 and 6 respectively.
- (h) Adjust the operating lever by bending so that when the springs are operated the travel is such that the contact pressure of Springs Nos. 5 and 7 is 30 ± 10 grammes. Adjust Spring No. 9 so that when operated its contact pressure is 30 ± 10 grammes.
- (j) Adjust the operating lever back stop so that there is a clearance of 10 mils maximum between the operating lever and the buffer of Spring No. 2.

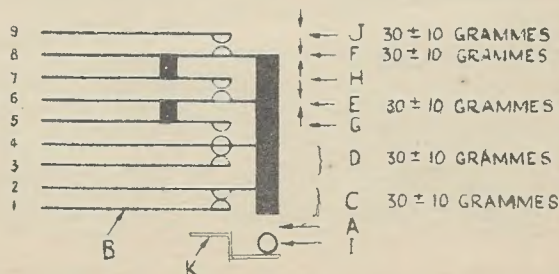


FIG 66 ONE BREAK ONE CHANGE-OVER AND TWO MAKE CONTACTS

6.6 Two "Change-over" and one "Make" Contact. (Primary Line Finder N.R. Springset.)
Fig. 66A.

6.61 The spring-set shall be adjusted as follows :-

- (a) Check that a clearance exists between the operating lever and the buffer of Spring No. 2. If necessary adjust the operating lever back stop to obtain this clearance.
- (b) Adjust Spring No. 1 so that it is straight throughout its length.
- (c) Tension Spring No. 2 to exert a contact pressure of 30 ± 10 grammes on Spring No. 1. Hold Springs 3 to 8 clear when gauging.
- (d) Tension Spring No. 5 so that its buffer rests on Spring No. 2 with a pressure of 40 ± 10 grammes. When gauging on Spring No. 5 hold Springs 3, 4 and 7 clear.
- (e) Tension Spring No. 7 so that its buffer rests on Spring No. 5 with a pressure of 30 ± 10 grammes. Hold Spring No. 6 clear when gauging.
- (f) Tension Springs Nos. 3 and 4 towards Spring No. 5 so that the contact pressure between Springs Nos. 4 and 5 is 30 ± 10 grammes. Gauge on Spring No. 4. Check that the pressure is not such that it lifts the buffer of Spring No. 5 away from Spring No. 2.
- (g) Tension Spring No. 6 so that its buffer rests against Spring No. 7. Check that the pressure is not such that it lifts the buffer of Spring No. 7 away from Spring No. 5.
- (h) With the spring-set operated (up 1 in 1 for finder N.R. spring-sets) adjust the operating lever by bending so that when the springs are operated the travel is such that the contact pressure of Springs Nos. 3 and 6 is 30 ± 10 grammes. Tension Spring No. 8 so that when operated its contact pressure is 30 ± 10 grammes.
- (j) Adjust the operating lever back stop so that there is a clearance of 10 mils maximum between the operating lever and the buffer of Spring No. 2

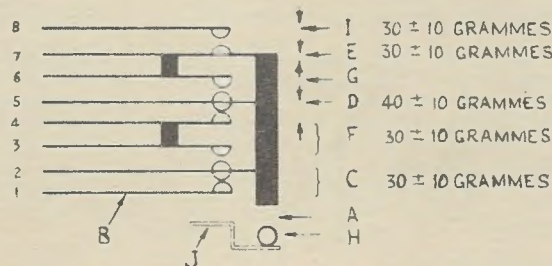


FIG 66A. TWO CHANGE-OVER AND ONE MAKE CONTACT

7. VERTICAL OFF NORMAL SPRINGS (N)

- 7.1 While carrying out the following adjustments it will be found convenient to hold the rotary detent latch away from its lock so that the "N" springs can be operated by rotating direct into the normal level. It may also be necessary to set the lever back stop away from the operating lever.
- 7.2 The operating lever shall then be adjusted in conjunction with the spring assembly so that on the return of the carriage to the normal position the lever has sufficient movement to give the required travel to the lever spring. Adjustments to the

operating lever must be carried out by bending the lever just above its shoulder.
(See Fig. 67.)

- 7.3 It will be found that when the correct travel of the operating lever has been obtained the tongue of the cam commences its engagement with the lever operating arm just past the cranked portion of the arm (see Fig. 68).

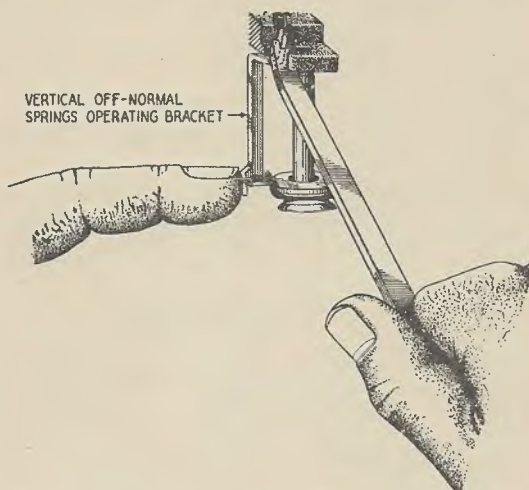


FIG 67.- ADJUSTING THE VERTICAL OFF-NORMAL SPRING-OPERATING LEVER

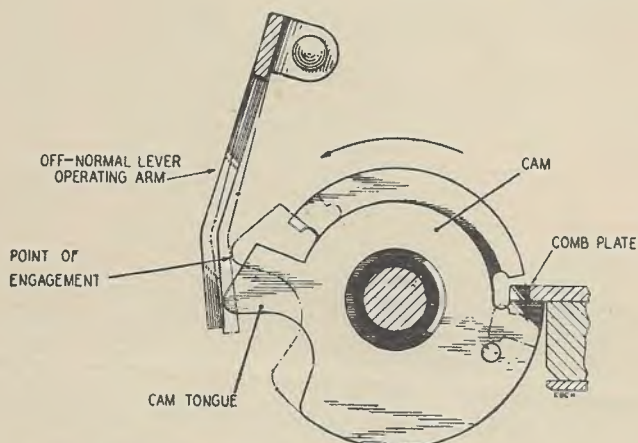


FIG. 68.—SHOWING POINT OF ENGAGEMENT OF CAM WITH VERTICAL OFF-NORMAL LEVER OPERATING ARM

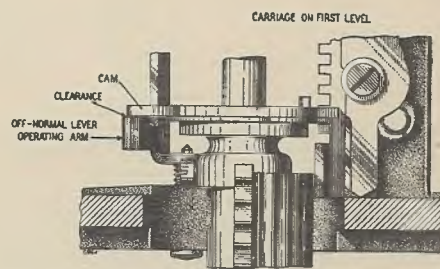


FIG. 69.—SHOWING CLEARANCE BETWEEN VERTICAL OFF-NORMAL LEVER OPERATING ARM AND CAM

- 7.4 The lever operating arm shall be set by bending up or down so that there is just perceptible clearance between its top surface and the under side of the cam when the carriage assembly is raised to the first level. (See Fig. 69.) Care must be taken when carrying out this adjustment to ensure that previous adjustments are not disturbed.

7.5 With the carriage assembly raised to level 1 and the vertical detent and pawl held out of engagement with the vertical ratchet, the foregoing adjustments should ensure that when the carriage assembly is held by the cam resting on the operating arm, the rotary disk enters the comb slot without rise when the carriage is rotated by operating the rotary armature. On switches fitted with chamfered rotary disks the carriage may rise slightly as it cuts in, but on switches fitted with a square-cut entering edge the carriage must enter the comb slot without rise.

8. ELEVENTH STEP SPRINGS (S).

8.1 The operating lever shall be adjusted so that when the carriage is stepped to the eleventh step on level 0, the lever has a sufficient movement to give the required travel to the lever springs. Adjustments to the operating lever are carried out as shown in Fig. 70.

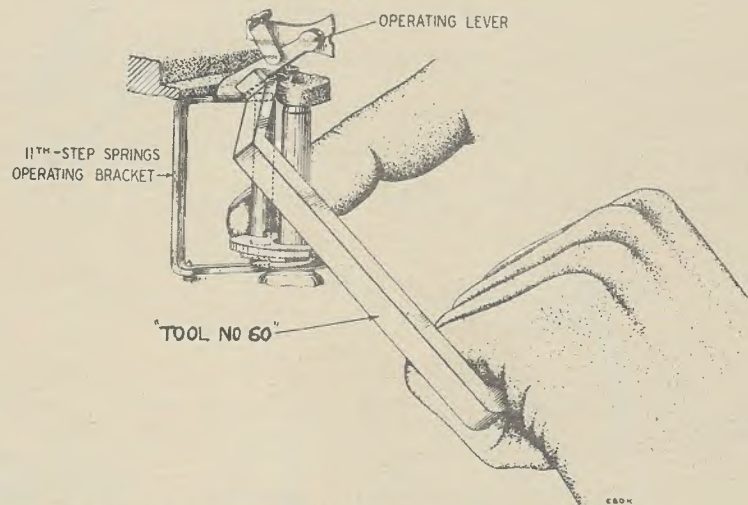


FIG. 70.—ADJUSTING 11TH-STEP SPRINGS OPERATING LEVER

8.2 Check that the vertical alignment of the operating roller is such that the movement of the lever springs is approximately the same on levels 1 and 0. This can be done by checking the contact pressure of a "make" contact when the carriage is standing on the eleventh contact of level 1 and comparing the contact pressure of the same contact when the carriage is standing on the eleventh contact of level 0. If no "make" contact is fitted, the contact opening of a "break" contact shall be checked. If variation outside the permitted tolerances exists the roller brackets shall be re-set by positioning the carriage on the eleventh contact of level 1 or 0, whichever is concerned, and gently levering inwards the roller bracket remote from the cam. Only slight adjustment to the brackets will, however, be found necessary. A small screwdriver may be used for this adjustment by applying its tip to the bracket and gently pressing inwards (see Fig. 71).

- 8.3 When measuring contact pressures of "make" contacts care must be taken to ensure that the carriage is definitely on the eleventh step with the rotary detent resting against the short face of the rotary notch.
- 8.4 Check that the cam clears the roller on the step preceding and succeeding the eleventh step and that it is clear of the full reduced diameter of the roller during the release of the carriage from the twelfth rotary step on level 0. (See Fig. 72.)

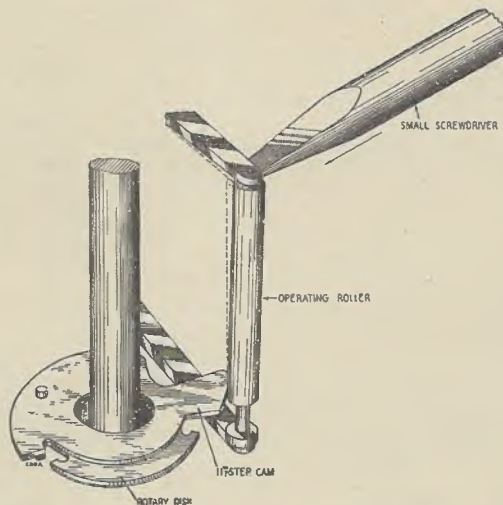


FIG. 71.—ADJUSTING 11TH-STEP OPERATING BRACKET TO CORRECT THE VERTICAL ALIGNMENT OF THE ROLLER

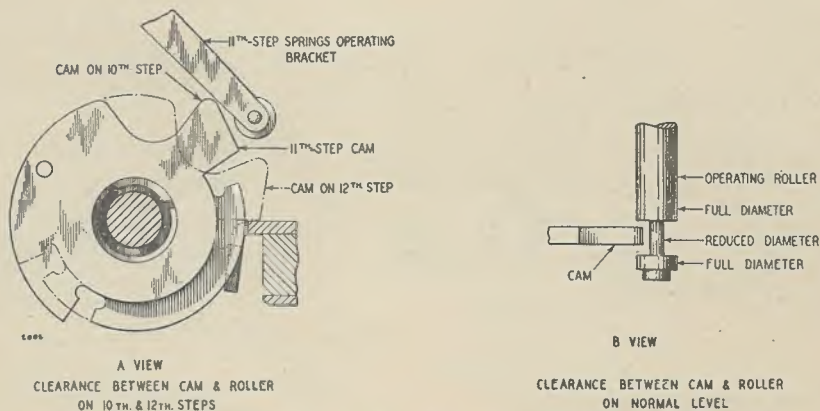


FIG. 72.—CHECKING POSITION OF OPERATING BRACKET OF 11TH-STEP SPRINGS

9. ROTARY OFF NORMAL SPRINGS (NR).

- 9.1 The operating lever must be adjusted in conjunction with the spring assembly so that when the carriage is rotated one step on level 0, the lever has sufficient movement to give the required travel to the lever springs. Adjustments to the operating lever are carried out as indicated for the lever of the "S" springs.
- 9.2 Check that the vertical alignment of the operating roller is such that the movement of the lever springs is approximately the same when the carriage is rotated to the first rotary step on levels 1 and 0. This can be done by checking the contact pressure of a "make" contact when the carriage is standing on contact 11 and comparing the contact pressure of the same contact when the carriage is standing on contact 01. If no "make" contact is fitted, the contact opening of a "break" contact shall be checked. If variation outside the permitted tolerance exists, the roller brackets shall be reset by positioning the carriage on contact 11 or 01, whichever is concerned, and gently levering inwards the roller bracket remote from the cam. Only slight adjustment to the brackets will, however, be found necessary. The method of carrying out this adjustment is described in paragraph 8.2 of this section and illustrated in Fig. 71.
- 9.3 The concentricity of the spring-set operating cam shall also be checked to ensure that there is no appreciable variation in contact pressure or contact opening when the carriage is rotating over any level. This shall be checked with the carriage in the first, second and tenth rotary positions. If variation exists such that the contact pressures or opening cannot be kept within their specified tolerances the operating cam shall be changed.
- 9.4 The cam must clear the operating roller during vertical stepping. It must also clear the full and reduced diameter of the roller during the complete return of the carriage to normal from the twelfth rotary position on level 0 (see Fig. 73).

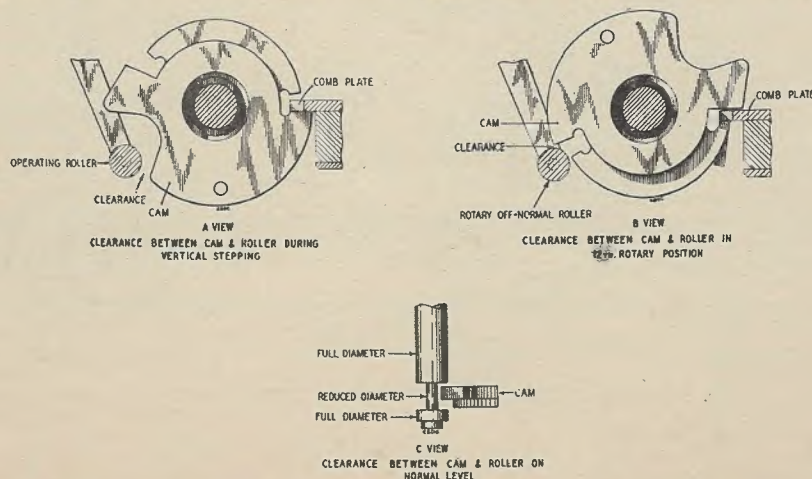


FIG. 73.—CHECKING POSITION OF OPERATING BRACKET OF ROTARY OFF-NORMAL SPRINGS

10. LEVEL SPRINGS (NP).

10.1 On circuit diagram, level springs are designated as NP when only one spring set is fitted or NPA and NPB when two spring sets are fitted. For adjustment purposes, the level springs are considered as NPA and NPB only, the former occupying the inner position and the latter the outer position. The spring sets are operated by two steps on a tongue of an auxiliary cam at the carriage head, the inner step operates the NPA spring set and the outer step operates the NPB spring set (see Fig. 74).

10.2 A tongue adjuster is provided for the adjustment of the tongue. The end of the tool marked "A" must be used for adjustment to the NPA operating step and that marked "B" for adjustment of the NPB operating step (see Fig. 75). If the same level spring set is required to operate on two or more adjacent levels, cam plates are fitted (see Fig. 76).

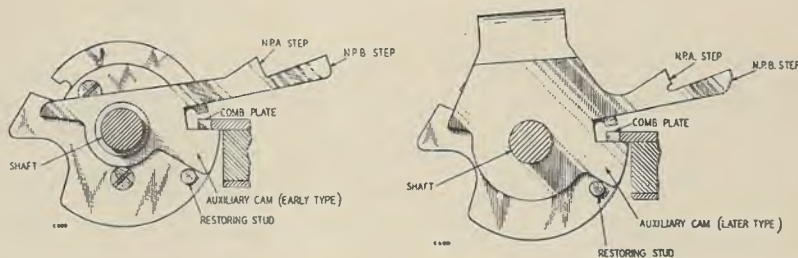


FIG. 74.—LEVEL-SPRING AUXILIARY CAM

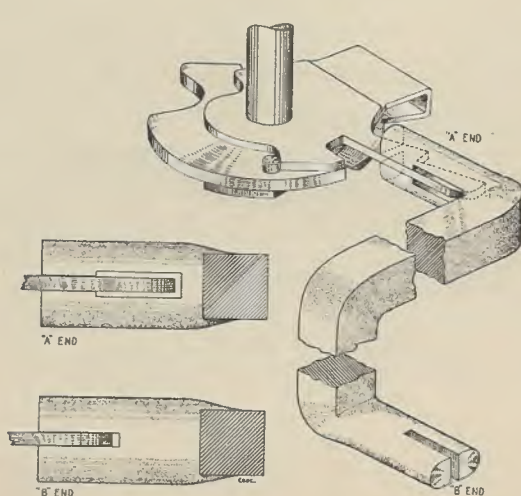


FIG. 75.—ADJUSTING THE N.P.A. AND N.P.B. OPERATING STEPS

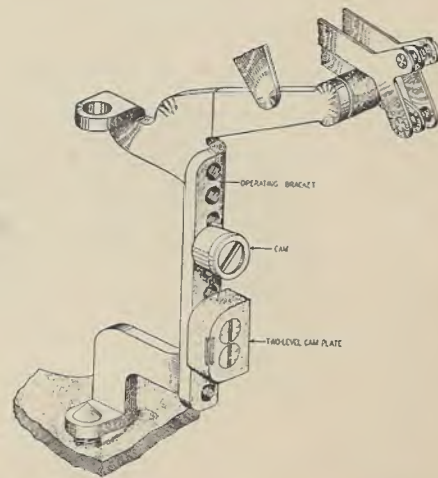


FIG. 76.—SHOWING TWO-LEVEL CAM PLATE FITTED TO OPERATING BRACKET

10.3 The auxiliary cam shall be free on the carriage, with a minimum amount of vertical play, and shall lie flat on the top of the carriage. The vertical play can be taken up by adjustment of the upturned tongue at its lower bearing (see Fig. 77). Side play in the lower bearing shall also be at a minimum. This can be adjusted by rotating the tongue bracket about its clamping screw.

Note 1. On early switches, the auxiliary cam is located by a bush on the carriage head (see Fig. 74). If vertical or side play develops in this type of cam, the cam shall be changed for one of the later type, also shown in Fig. 74.

Note 2. On some early supplies of switches fitted with the later type of auxiliary cam, two thin washers were fitted between the underside of the cam and the top of the carriage. These washers have been found unnecessary and shall be removed and scrapped, if or when occasion arises to dismantle the carriage assembly. The excess vertical play resulting from the removal of the washers shall be taken up by adjustment as detailed in this paragraph.

10.4 The operating tongue shall be adjusted by bending up or down, so that its step engages centrally with the cam when the carriage is standing on the level on which the springs are to operate (see Fig. 78). When this adjustment is being made the carriage shall be held in the twelfth rotary position, and the auxiliary cam supported by being clamped firmly against the rotary off normal cam using pliers (Tool No. 213) inserted from the front of the switch between the shaft and the comb plate; the upper jaw of the pliers shall bear directly on the top of the auxiliary cam, and the lower jaw shall bear against the flange at the top of the rotary hub. This method of supporting the auxiliary cam is necessary to prevent distortion, which would result in the cam not lying flat on the carriage. If cam plates are fitted, the operating steps shall line up with the centre of either of the cam plate fixing screws. It should be noted that if the "NPA" step is adjusted, the "NPB" step will be affected. The "NPB" step shall be corrected by setting the tongue, up or down as required, from a point immediately in front of the "NPA" step. The operating tongue shall clear the cam or cam plate when the carriage is standing on the vertical steps preceding and succeeding that on which the springs are intended to operate (see Fig. 79).

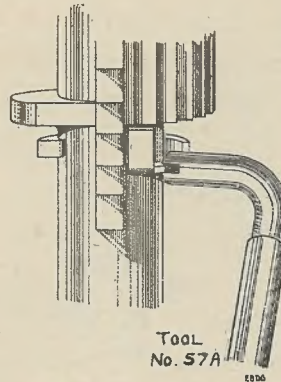


FIG. 77.—ADJUSTMENT OF
AUXILIARY CAM

- 10.5 The operating tongue shall hold the level springs operated during rotation, until released by the restoring stud on the cam of the carriage assembly, when the latter is stepped from the eleventh to the twelfth rotary position.
- 10.6 The operating lever shall be adjusted in conjunction with the spring assembly, so that, when the level springs are operated by the carriage standing on the required level, the lever has sufficient movement to give the required travel to the lever springs. Check that, when the carriage is lifted gently upwards by hand so that the step on the operating tongue is just over the inclined face of the operating cam or cam plate, the carriage returns fully on to the vertical detent when the hand is removed. Adjustments to the operating lever shall be made as indicated for the lever of the "S" springs.
- 10.7 There shall be a minimum clearance of 10 mils between the steps of the operating tongue and the cams on the operating bracket when the carriage is returning to normal from the twelfth rotary position on level 0 (see Fig. 80).

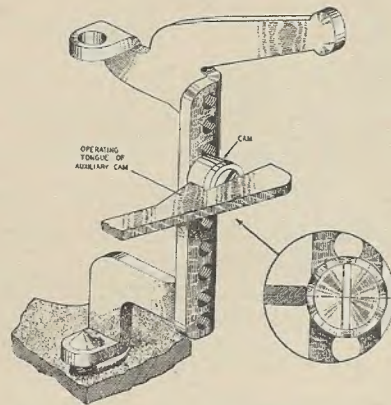


FIG. 78.—ALIGNMENT OF OPERATING TONGUE WITH CAM

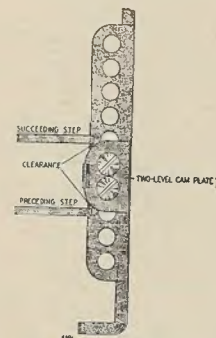


FIG. 79.—CLEARANCE ON PRECEDING AND SUCCEEDING STEPS

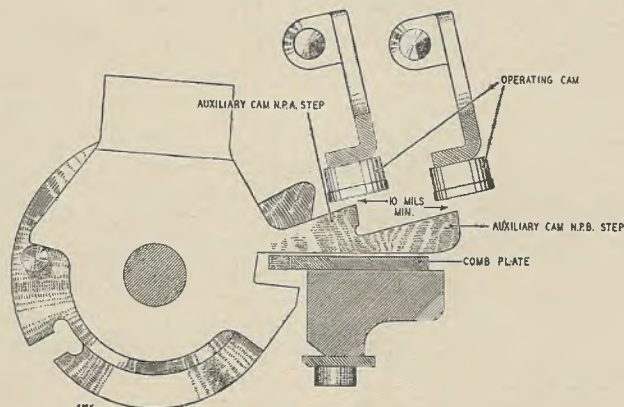


FIG. 80.—CLEARANCE BETWEEN OPERATING TONGUES AND CAMS DURING RELEASE

INTERRUPTER SPRINGS, VERTICAL AND ROTARY.

11. GENERAL.

- 11.1 The interrupter spring operating lever is designed so that after being carried beyond its centre line by the operating striker it continues its movement under the control of the loop spring until it reaches the stop. During this movement of travel it operates contacts, the type of which is determined by the circuit requirements.
- 11.2 The same spring set assembly is used for change-over and make before break contacts, the function being determined by adjustment. Before adjustments to the interrupter

spring assembly are carried out the adjustments of the vertical or rotary movements, whichever apply, must be in accordance with those detailed in this circular. It will be found to be of assistance if, before making the adjustments, the armature is wedged midway on its travel so that the operating lever can be moved in either direction without being obstructed by the striker. To obtain this condition a suitable wedge may be inserted between the armature and its back stop.

12. INTERRUPTER SPRING OPERATING LEVER.

- 12.1 The operating lever must be absolutely free on its bearings with a minimum amount of play.
- 12.2 The travel of the operating lever is determined by the location of the lever stops which are set in manufacture and should not be disturbed. This travel ensures that, in the case of the "break" contact performing the magnet interrupter function, this contact does not break until the lever has passed its centre of balance.

13. CONTACT PRESSURES AND CLEARANCES.

- 13.1 The contact pressure of both "break" and "make" springs must be 40 ± 10 grammes. Contact pressure is measured at a point immediately in front of the contact (see Fig. 81).
- 13.2 The contact pressure of the make spring must be measured with the operating lever in the operated position. Adjust the tip of the break contact on all types of spring sets so that when the operating lever is operated and resting fully against its stop there is a contact clearance between the "break" contacts of 12 mils minimum 18 mils maximum (see Fig. 82).
- 13.3 The interrupter springs shall be tensioned by drawing or setting tension into the springs throughout their full length. Bent duck-bill pliers shall be used to tension the springs. The method used for tensioning side armature type relay springs by setting the springs at the back or fixed end shall on no account be used for interrupter springs on 2000 type switches, as the short light gauge springs will not retain the desired tension over long periods when this method of tensioning is used.

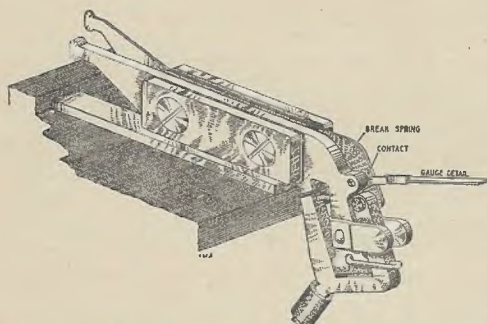


FIG. 81.—POINT OF APPLICATION OF GAUGE WHEN MEASURING CONTACT PRESSURE

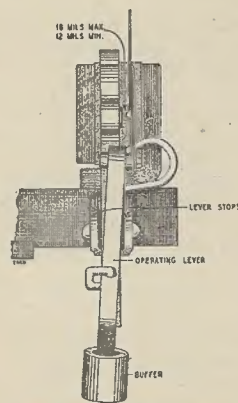


FIG. 82.—BREAK-CONTACT ADJUSTMENT, LEVER OPERATED

14. THE FOLLOWING ADJUSTMENT APPLIES SPECIFICALLY TO "CHANGE-OVER" CONTACTS.

14.1 To ensure that the "break" contact breaks before the "make" contact makes, there must be a clearance of 10 mils maximum between the tip of the make spring and the stud of the operating lever when the operating lever is fully operated. (See Fig. 83.) Adjustment may be effected by bending the tip of the "make" spring.

15. THE FOLLOWING ADJUSTMENT APPLIES SPECIFICALLY TO "MAKE BEFORE BREAK" CONTACTS.

15.1 The clearance between the tip of the make spring and the stud of the operating lever when the lever is operated, must be such that during operation of the lever the "make" contact makes before the "break" contact breaks. Also when the operating lever is normal, there must be a clearance between the "make" contacts of 10 mils minimum. (See Fig. 84.) Adjustment is effected by bending the tip of the make spring.

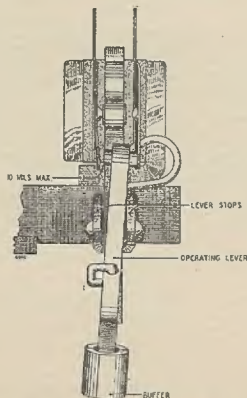


FIG. 83.—'CHANGE-OVER' CONTACT ADJUSTMENT, LEVER OPERATED

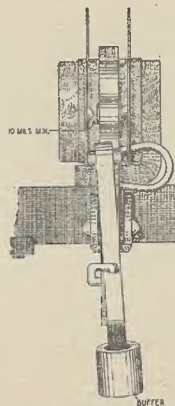


FIG. 84.—'MAKE-BEFORE-BREAK' CONTACT ADJUSTMENT, LEVER NORMAL

16. LOOP SPRINGS.

- 16.1 The loop spring must have sufficient tension to carry and hold the operating lever reliably over to its back stop against the tension of the "make" and "break" springs. The tension of the loop spring can be increased by placing one of the tips of a pair of pliers (half round) through the middle of the loop (see Fig. 85). Light pressure with the pliers will tend to straighten out the loop and therefore increase the tension.
- 16.2 On early switches the loop springs were set at right angles to the operating lever, but in order to provide greater clearance for the cover those in later switches are slightly off-set from the right-angled position towards the front of the switch. Where this is the case the tension can be more easily increased by inserting the tip of a pair of pliers through the loop from the back and not from the front as illustrated in Fig. 85.
- 16.3 The tension can be decreased by placing the tips of the pliers over the loop (see Fig. 86). Light pressure with the pliers will decrease its tension.

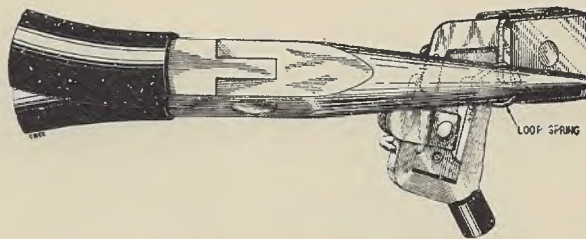


FIG. 85.—INCREASING TENSION OF LOOP SPRING

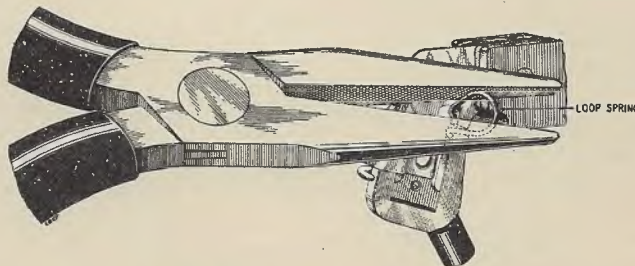


FIG. 86.—REDUCING TENSION OF LOOP SPRING

- 16.4 It is essential that the resultant tension of the loop and contact springs be such that the operating lever will not move from its stop with a pressure of 150 grammes applied immediately in front of the spring operating stud on the lever (see Fig. 87) and that it trips over to the other stop with a pressure of 220 grammes. This test shall be applied with the operating lever in both the operated and unoperated positions.

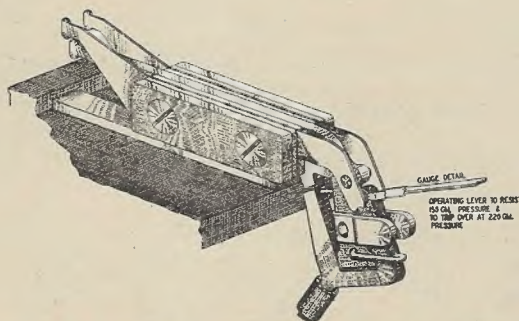


FIG. 87.—CHECKING TENSION OF LOOP AND CONTACT SPRINGS

- 16.5 If it is found that the tension is unbalanced to the extent that it is outside the limits in one direction only, it may be corrected by :-
- (a) Varying the tension of the loop spring;
 - (b) Varying the contact pressure within the specified limits.
- 16.6 If adjustment within the limits of 150 to 220 grammes cannot be obtained by these methods, it indicates that the rear arm of the operating lever requires resetting. For example, if it is found that by raising the tension on one side to just above the minimum of 150 grammes, the tension of the other side is raised above the maximum of 220 grammes, the rear arm of the lever shall be bent towards the side having the lowest tension. This can be done by holding the operating lever by placing the forked end of Tool No. 60A over the horizontal limb of the lever, and using Tool No. 59 to bend the rear arm of the lever in the desired direction. This method is illustrated in Fig. 88 for rotary interrupter springs, and in Fig. 89 for vertical interrupter springs.

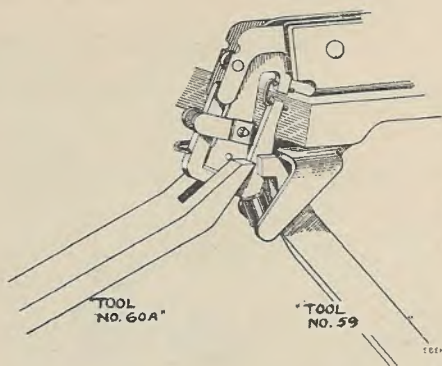


FIG. 88.—ADJUSTMENT OF OPERATING LEVER FOR
ROTARY-INTERRUPTER SPRINGS

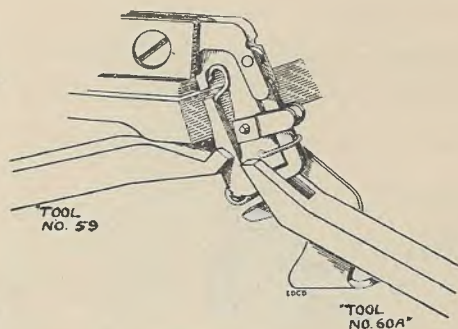


FIG. 89.—ADJUSTMENT OF OPERATING LEVER FOR
VERTICAL-INTERRUPTER SPRINGS

17. OPERATING STRIKERS.

- 17.1 The following adjustments must be carried out with the wedge removed from between the armature and back stop so that the armature is free to operate and release fully.
- 17.2 With the armature operated electrically and the interrupter springs broken so that the operating lever is fully operated, there must be a clearance between the operating striker and the buffer. (See Fig. 90.) This clearance must not exceed 5 mils.
- 17.3 With the armature fully restored and seated against its back stop so that the spring operated lever is normal, there must be a clearance between the restoring striker and the buffer (see Fig. 91). This clearance must not exceed 5 mils.
- 17.4 If re-adjustment of the strikers is necessary, they shall be bent by means of Tool No. 60A in the case of vertical interrupter spring sets or Tool No. 58A or 66 in the case of rotary interrupter spring sets (see Figs. 92 and 93).
- 17.5 *The following check applies specifically to the rotary interrupter springs:* With the spring operating lever normal and the rotary armature operated electrically in the twelfth rotary position so that the upper projection of the rotary pawl is locked against the extended lug at the bottom of the comb plate, there must be a clearance between the operating striker and the lever buffer so that the break contacts do not break.

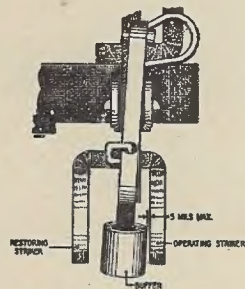


FIG. 90.—SHOWING 5 MILS MAX. CLEARANCE BETWEEN OPERATING STRIKER AND BUFFER, ARMATURE OPERATED

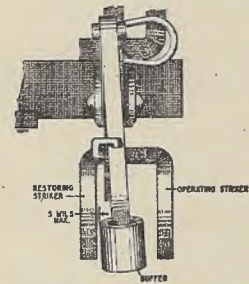


FIG. 91.—SHOWING 5 MILS MAX. CLEARANCE BETWEEN RESTORING STRIKER AND BUFFER, ARMATURE NORMAL

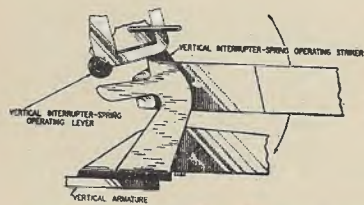


FIG. 92.—ADJUSTMENT OF VERTICAL STRIKERS

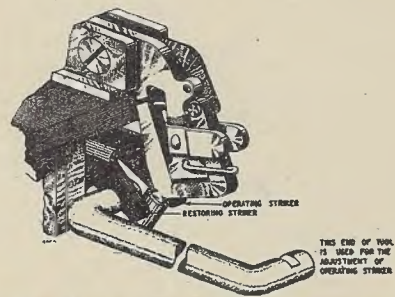


FIG. 93.—ADJUSTMENT OF ROTARY STRIKERS

WIPERS - LINE AND PRIVATE.18. GENERAL.

18.1 Care shall be taken to ensure that the wipers are secure on the carriage before adjustments are carried out.

19. METHOD OF ADJUSTING WIPER SPRINGS.

19.1 During manufacture each wiper spring is set outwards from the base (approximately $\frac{3}{8}$ " across the tips), so that when the fibre collar is fitted the springs are tensioned outwards against the collar. This can be checked without removing the collar by noting that when either spring is pressed against the separating insulator at a point behind the collar, the other spring has an outward tension. Check that the collar does not bind on either spring.

19.2 When off the bank the springs must be approximately straight from the spring fixing to the collar and each spring must be clear of the separating insulator. (See Fig. 94.)

20. WIPER TIPS.

20.1 All wipers must have a gap of 12 mils minimum, 20 mils maximum, between the contact tips of the wiper springs when off the bank (see Fig. 94). Any adjustment necessary to obtain this gap must be made at the straight portion of the spring in front of the collar.

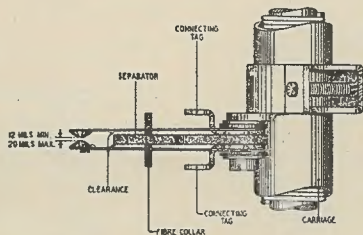


FIG. 94.—ADJUSTMENT OF WIPERS WHEN OFF THE BANK

21. WIPER ASSEMBLY. POSITION ON CARRIAGE.

- 21.1 With the wiper clamp fixing screws lightly tightened, wipers must be set to rest within the limits of $1/3$ to $1/2$ way on contact 6 of level 1 or 0 (see Fig. 95). If there is any appreciable difference in their positions when resting on contacts 1 and 0 a mean adjustment shall be obtained.
- 21.2 The vertical position of the wipers on the carriage must also be such that each wiper spring rests clear of its separating insulator when the wiper tips are resting on any bank contact on any level (see Fig. 96).
- 21.3 Wiper tips must be clear of the bank insulation when the carriage assembly is raised from the normal position to level 0 and lowered from the twelfth rotary position; the wiper tips shall also be clear of the bank contacts when returning on the normal level.
- 21.4 When these adjustments have been made, the wiper fixing screws shall be tightened until it is not possible to rotate the wiper assembly on the carriage when reasonable pressure is applied by hand.

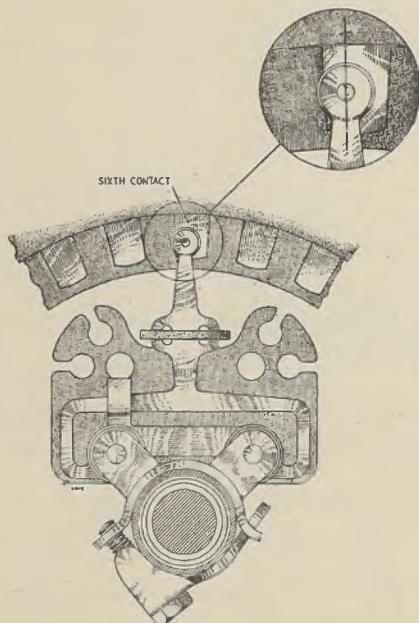


FIG. 95.—LATERAL ADJUSTMENT OF WIPER ON CONTACT

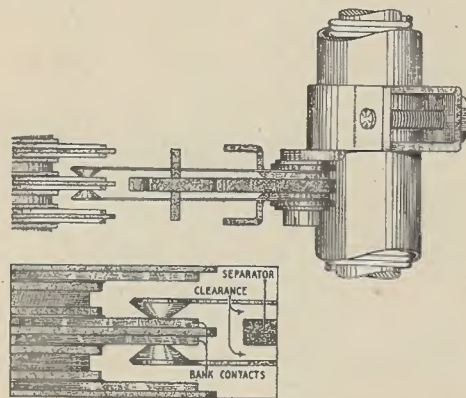


FIG. 96.—SHOWING WIPER RESTING ON BANK CONTACTS

VERTICAL MARKING BANK AND WIPERS.22. BANK.

22.1 The vertical marking bank must be located so that it is approximately parallel with the selector frame column. Its position must also be such that the wiper tips rest on any bank contact at a point which is not less than $1/4$ of the way along the length of the contact (see Fig. 97).

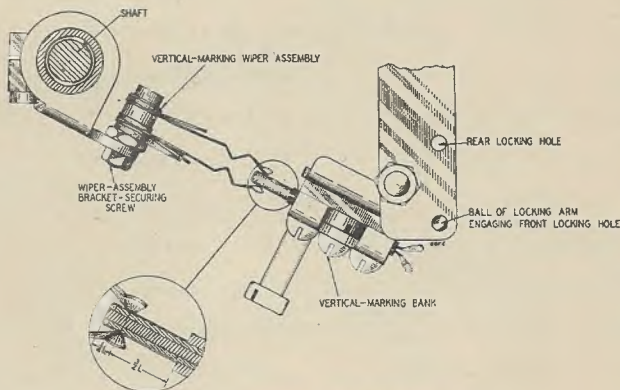


FIG. 97.—POSITION OF WIPERS ON CONTACTS

- 22.2 This condition is mainly covered in manufacture, but, if necessary, slight adjustments to the bank may be obtained by loosening the two bank fixing screws and moving the bank about the play in the screw fixing holes.
- 22.3 The bank must be held firmly in position by the ball of the locking arm engaging correctly in the hole in the mounting bracket. The tension of the spiral spring on the bank supporting pillar should be sufficient to ensure this, and if any play between the ball and the hole exists, the ball arm should be bent upwards.
- 22.4 As mentioned in paragraph 3.3, Section 2, before the selector is removed from its position on the shelf, the vertical marking bank shall be swung clear of the wiper and locked by the ball engaging the rear hole in the mounting bracket (see Fig. 98).
- 22.5 Care shall be taken when restoring the bank to its correct position, that the wipers engage the bank without their tips fouling the front edge of the bank insulation (see Fig. 99).

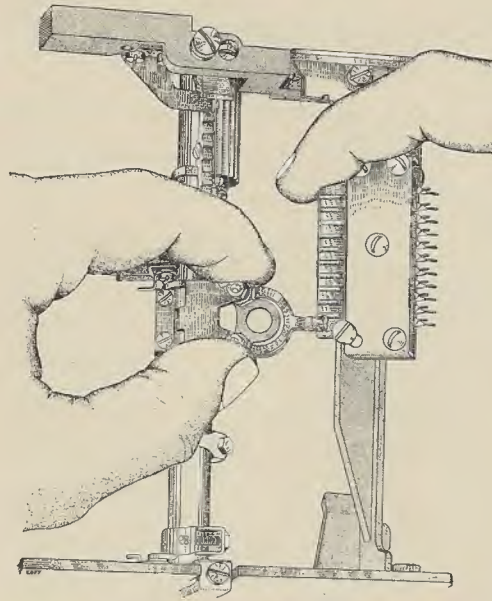


FIG. 98.—DISENGAGING VERTICAL-MARKING BANK FROM WIPER

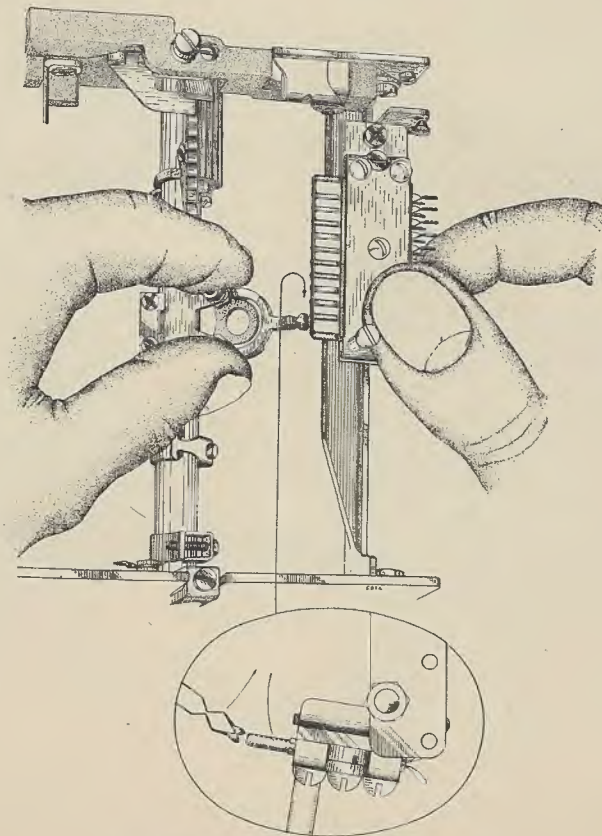


FIG. 99.—RE-ENGAGING BANK WITH WIPER

23. WIPER ASSEMBLY BRACKET.

23.1 The wiper assembly bracket must rotate freely on the carriage with no more than just perceptible vertical play. If vertical play exists it must not allow the wiper tips to move more than one-third of the width of a bank contact.

24. WIPERS.

24.1 The wiper springs and insulators are assembled as a complete unit which for replacement purposes is detachable from the wiper assembly bracket by removing the two securing nuts.

24.2 The ball tips of the wipers shall be in the same horizontal plane. The position of the wipers shall be such that the ball tips rest slightly below the centre of the bank contact. Adjustment to the position of the wipers shall be made with the carriage standing on the fifth vertical step and the wipers resting on the sixth bank contact; on this contact the wipers shall be adjusted by means of the locating collar (see also paragraph 25), so that the ball tips take up a position between the limits of one-third to half-way on the contact (see Fig. 100). Care shall be taken to ensure that, when the carriage is rotated to any position on any level, the ball tip of the wiper is quite clear of the raised portion of the bank insulation.

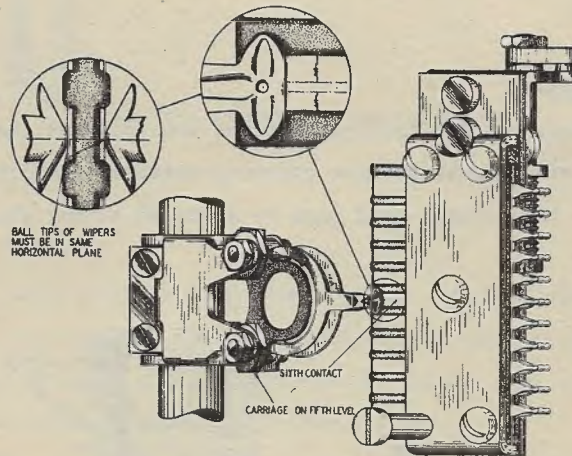


FIG. 100.—POSITION OF VERTICAL WIPER ON VERTICAL-MARKING BANK

25. WIPER ASSEMBLY LOCATING COLLAR.

25.1 With the carriage in the normal position, the wiper assembly locating collar must be set with the screw heads towards the front so as to leave a clearance of not less than $1/16$ inch between the end of the slot on the collar and the tongue of the wiper assembly bracket (see Fig. 101). This clearance shall not be such that the collar touches the wiper assembly when the carriage is in the twelfth rotary position.

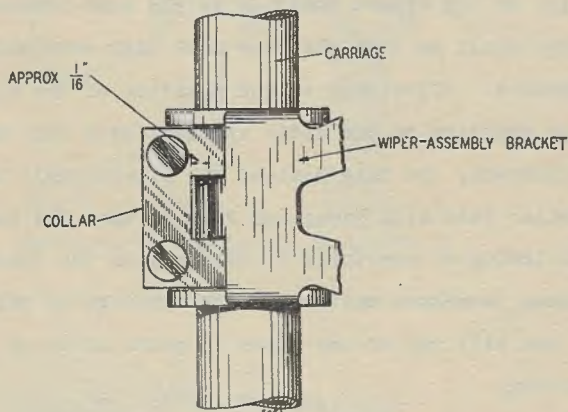


FIG. 101.—SETTING OF WIPER-ASSEMBLY LOCATING COLLAR

26. WIPER CONTACT PRESSURE.

26.1 The wiper springs must be tensioned at the base so that the wiper contact pressure is 25 grammes minimum, 40 grammes maximum, measured immediately behind the ball tip of the wiper. The tension need only be measured on one wiper spring (see Fig. 102).

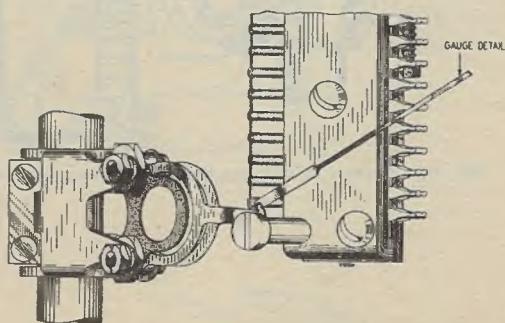


FIG. 102.—SHOWING POINT OF APPLICATION OF GAUGE
DETAIL BEHIND VERTICAL-WIPER TIP

27. SHELF JACKS.

27.1 Shelf jack springs shall be adjusted so that there is a space of approximately 18 mils between either jack spring and the other of a pair, except when the "P" wire and earth circuits are connected to a pair; these latter springs shall be adjusted to make a good contact when the switch plug is removed. All shelf jack springs shall be curled outwards at the tips, but care shall be taken to ensure that, when the switch is replaced, the switch plug enters the shelf jack freely without causing adjacent springs to be forced into contact (see Fig. 103).

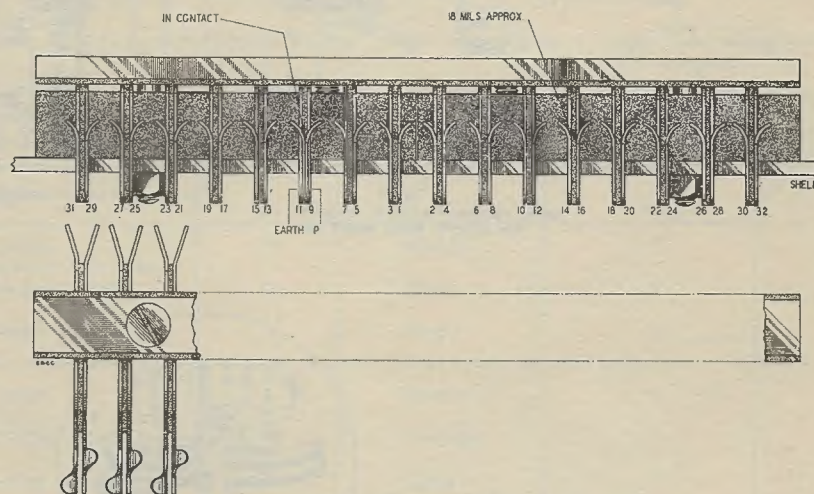
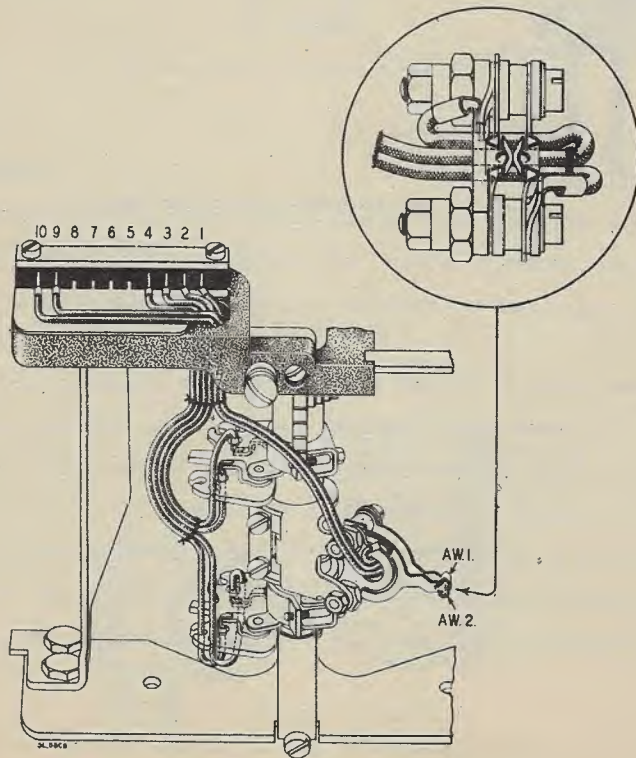
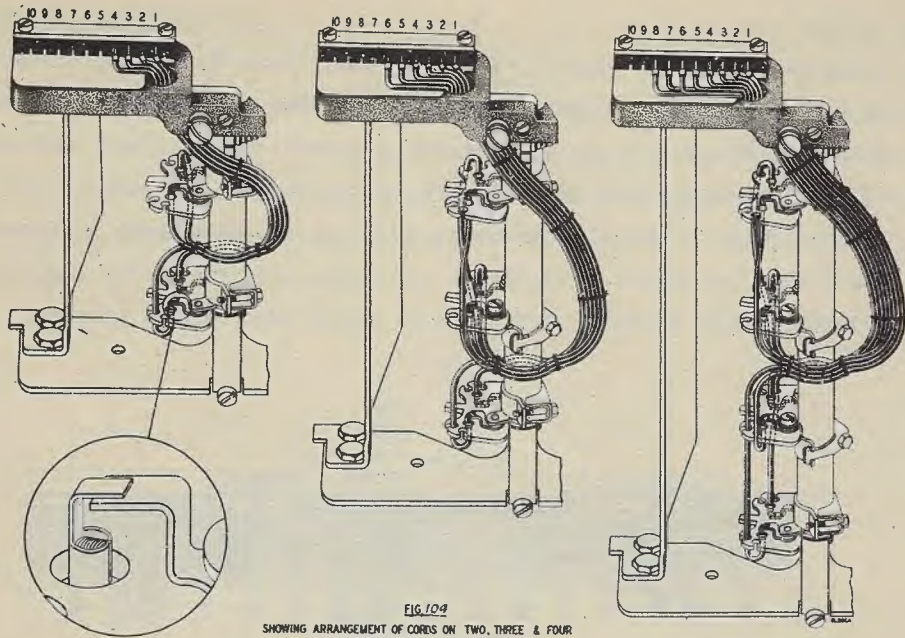


FIG. 103.—ADJUSTMENT OF SHELF-JACK SPRINGS

28. WIPER CORDS.

28.1 Faulty wiper cords shall not be repaired, the complete cord assembly must be changed. The wiper cords shall be brought as a complete assembly to the right hand side of the wiper carriage and turning to the left divided to form a loop around the carriage as indicated in Fig. 104.

28.2 In the case of a two-bank selector fitted with a vertical marking wiper, the cords cannot be looped around the carriage. In this case, the vertical marking wiper and the line wiper cords shall be run as shown in Fig. 105.



- 28.3 On three and four bank switches fitted with vertical marking wipers, the cords to these wipers shall be run also as shown in Fig. 105. The line and private wiper cords are unaffected in these cases and shall be run as shown in Fig. 104.
- 28.4 In all cases the cords will pass through the slots provided in the side of the wiper insulation. The cord tag must then be bent to an L shape and soldered to the wiper tag. Check that the cord tag does not foul the wiper spring.
- 28.5 Line and private wipers are numbered from the bottom upwards and the wiper cords shall be connected to their corresponding tag number on the wiper cord terminal block (see Fig. 104). The vertical marking wipers are numbered AW 1 and AW 2, AW 2 wiper being at the front. The cords of these wipers shall be connected to wiper cord terminal block tags Nos. 9 and 10 respectively.
- 28.6 Further details concerning wiper cords are given in the following table.

<i>Bank Arrangement.</i>	<i>Wiper No.</i>	<i>Identifying Colour of End Bindings.</i>	<i>Wiper Cord Terminal Block Tag No.</i>	<i>Standard Stock List Description Cord Instrument.</i>
1 Bank				
2 Bank, Without Vertical Marking Wiper (3-way cord)	3	White	3	3007
	2	Blue	2	
	1	Red	1	
2 Bank, Without Vertical Marking Wiper (4-way cord)	4	White	4	4007
	3	Orange	3	
	2	Blue	2	
	1	Red	1	
2 Bank, With Vertical Marking Wiper (5-way cord)	AW 2	Slate	10	5007 $\frac{1}{8}$
	AW 1	Brown	9	
	3	White	3	
	2	Blue	2	
	1	Red	1	
2 Bank, With Vertical Marking Wiper (6-way cord)	AW 2	Slate	10	6007 $\frac{1}{8}$
	AW 1	Brown	9	
	4	White	4	
	3	Orange	3	
	2	Blue	2	
	1	Red	1	

Bank Arrangement	Wiper No.	Identifying Colour of End Bindings.	Wiper Cord Terminal Block Tag No.	Standard Stock List Description Cord Instrument.
3 Bank, Without Vertical Marking Wiper. (5-way cord)	5	White	5	5009 $\frac{3}{4}$
	4	Blue	4	
	3	Red	3	
	2	Black	2	
	1	Green	1	
3 Bank, Without Vertical Marking Wiper. (6-way cord)	6	White	6	6010 $\frac{1}{2}$
	5	Orange	5	
	4	Blue	4	
	3	Red	3	
	2	Black	2	
3 Bank, With Vertical Marking Wiper. (7-way cord)	AW 2	Slate	10	7009 $\frac{3}{4}$
	AW 1	Brown	9	
	5	White	5	
	4	Blue	4	
	3	Red	3	
	2	Black	2	
	1	Green	1	
3 Bank, With Vertical Marking Wiper. (8-way cord)	AW 2	Slate	10	8010 $\frac{1}{2}$
	AW 1	Brown	9	
	6	White	6	
	5	Orange	5	
	4	Blue	4	
	3	Red	3	
	2	Black	2	
4 Bank, Without Vertical Marking Wiper. (7-way cord)	7	Slate	7	7010 $\frac{3}{8}$
	6	White	6	
	5	Orange	5	
	4	Blue	4	
	3	Red	3	
	2	Black	2	
	1	Green	1	

Bank Arrangement	Wiper No.	Identifying Colour of End Bindings.	Wiper Cord Terminal Block Tag No.	Standard Stock List Description Cord Instrument.
4 Bank, Without Vertical Marking Wiper. (8-way cord)	8	Slate	8	8011
	7	Brown	7	
	6	White	6	
	5	Orange	5	
	4	Blue	4	
	3	Red	3	
	2	Black	2	
	1	Green	1	
4 Bank, With Vertical Marking Wiper. (9-way cord)	AW 2	Slate	10	9010 $\frac{3}{8}$
	AW 1	Brown	9	
	7	Slate	7	
	6	White	6	
	5	Orange	5	
	4	Blue	4	
	3	Red	3	
	2	Blue	2	
	1	Green	1	
4 Bank, With Vertical Marking Wiper. (10-way cord)	AW 2	Slate	10	10011
	AW 1	Brown	9	
	8	Slate	8	
	7	Brown	7	
	6	White	6	
	5	Orange	5	
	4	Blue	4	
	3	Red	3	
	2	Blue	2	
	1	Green	1	

SECTION 4.

LUBRICATION,

DISMANTLING AND ASSEMBLY, TOOLS.

1. GENERAL.

1.1 In order to obtain the maximum efficiency from the lubrication of the mechanical parts of the apparatus, it is essential that consideration be given to the following matters :-

- (a) Lubrication shall be carried out conjointly with the routine examination of the mechanism, unless otherwise stated.
- (b) The lubricant appropriate to the various parts shall be applied as indicated in paragraph 6 of this Section.
- (c) An excess of lubricant is liable to be projected on to other parts. It shall therefore be applied in moderate quantity and any excess found after the subsequent operation of the mechanism shall be carefully removed.
- (d) The lubricant shall be kept free from grit and other foreign matter.

2. LUBRICANTS.

2.1 The only lubricants which shall be used are as follow :-

- (a) Oil, Commonwealth No. 2.
- (b) Oildag, Concentrated.

3. OILDAG.

3.1 Where a surface is exposed to the atmosphere or excessive friction, a light oil would quickly evaporate and leave the bearing surface dry. In these cases oildag has been specified, vide paragraph 6 of this Section.

4. SUPPLY OF LUBRICANTS AND CONTAINERS.

4.1 In order to keep the lubricants clean and to enable them to be easily transported and stored, they shall be contained in small bottles, approximately one oz., fitted into a wooden stand. This shall be arranged for locally. The stand shall be marked showing the type of lubricant to be placed in the bottle in each of the three holes provided. Commencing from the left, the bottles shall contain :-

- 1st, Clean oil, Commonwealth No. 2, for lubrication of bearings.
- 2nd, Used oil, for use in conjunction with the Oildag for lubrication of ratchets.
- 3rd, Oildag, for use on ratchets when required.

4.2 The corks when not in the bottles shall be placed in small holes provided in the stand.

5. NOTES ON THE LUBRICATION OF SWITCHES.

5.1 The method of applying lubricants to the more common parts is given below :-

- 5.11 *Ratchets:* When making an initial application of Oildag to a ratchet or hub, first clean the dust from the bearing parts, using a stiff bristle brush, moistened with oil, Commonwealth No. 2. The oil used for this purpose shall be taken from the centre bottle, the brush being cleaned after each operation by wiping on a piece of clean Selvyt. Oildag shall then be applied sparingly to all teeth as required by means of a No. 1 sable brush. (Similar to a small water colour brush). When making a subsequent application of Oildag, it is often found that sufficient graphite from previous applications remains to provide a satisfactory lubricant with the application of a small quantity of oil taken from the centre bottle. A stiff bristle brush shall be used for this purpose, and it will be necessary to work this well down into the notches, to bring the Oildag to a suitable consistency and re-distribute it over the bearing surfaces. Where insufficient graphite from a previous lubrication remains, or where the existing lubricant is dirty, it shall be cleaned from the notches by means of a stiff bristle brush moistened with oil taken from the centre bottle. The brush must be worked well down into the notches, to remove as much as possible of the original lubricant, and then cleaned by rubbing on a piece of clean Selvyt. When the notches have been cleaned, concentrated Oildag shall be applied sparingly to the notches using a No. 1 sable brush.
- 5.12 *Pawl Stops and other Exposed Surfaces:* Oildag shall be applied to these surfaces by means of a No. 1 sable brush, surplus lubricant being removed by means of a piece of clean Selvyt.
- 5.13 *Bearings:* Oil, Commonwealth No. 2, from No. 1 bottle, shall be applied as required, using a No. 1 sable brush which shall be specially reserved for this purpose. When not in use, this brush shall be kept absolutely clean. Before the application of the lubricant, the surplus oil shall be wiped from the brush with a piece of clean Selvyt.
- 5.14 *Wiper Carriage:* Before lubrication, the wiper carriage shaft shall be thoroughly cleaned with a piece of clean linen tape, and after lubrication the wiper carriage shall be raised to the 0 level a few times and any surplus oil removed.

5.2 Interrupter Springs. Owing to the possibility of oil creeping to the spring contacts, oil shall be applied sparingly to the operating lever bearing pin and the loop springs, and after application all surplus oil shall be carefully wiped from the assembly.

5.3 All brushes shall be kept in a clean condition and replaced when showing signs of wear.

6. LUBRICATION SCHEDULE.

Switch Part or Bearing Surface	Lubricant	Where Lubricant shall be Applied
<u>VERTICAL MECHANISM:</u>		
Armature	Oil	To the exposed portion of the lubricating wick and the outer bearing.
Pawl	Oil	Between the pawl and the bearing collars.
Pawl Spring	Oildag	To the tip of the spring at point of contact with the pawl.
Armature restoring Spring.	Oildag	At the point where the spring engages its adjusting screw.
Pawl Guide	Oildag	At point of contact with pawl.
Pawl Front Stop	Oildag	At point of contact with pawl.
<u>ROTARY MECHANISM:</u>		
Armature	Oil	To the exposed portion of the lubricating wick and the lower bearing.
Pawl	Oil	Between the pawl and the bearing collars.
Pawl Spring	Oildag	To the tip of the spring at point of contact with the pawl.
Armature restoring Spring.	Oildag	At the point where the spring engages its adjusting screw.
Pawl Guide	Oildag	At the point of contact with pawl.
Pawl Front Stop	Oildag	At point of contact with pawl.
<u>SHAFT AND WIPER CARRIAGE ASSEMBLY:</u>		
Shaft and Carriage Restoring Spring.	Oil	After the shaft has been cleaned, three or four applications of the oil shall be applied to the exposed portion of the shaft using a No. 1 sable brush. One similar application of the oil shall be applied to the lower exposed portion of the shaft when the carriage is lifted to the 0 level.
Vertical Ratchet	Oildag	To all vertical teeth.
Rotary Ratchet	Oildag	To all rotary teeth.

Switch Part or Bearing Surface	Lubricant	Where Lubricant shall be Applied
<u>DETENTS:</u>		
Vertical and Rotary Detent Bearings	Oil	At point of bearing on spindle.
Rotary Detent Upper Projection	Oildag	At point of engagement with rotary disk.
Vertical and Rotary Detent Springs	Oildag	At tip of springs where they engage the frame.
<u>MECHANICALLY OPERATED SPRING LEVERS AND ROLLERS:</u>		
Bearings	Oil	Upper and lower bearings. Oil holes are provided in frame for upper bearings.
Rollers	{ Oil	Upper and lower bearings.
	{ Oildag	Outer roller surfaces.
Operating cam	Oildag	At periphery of cam.
Off Normal Spring Operating Cam	Oildag	At point of contact with cam.
Level Spring Roller	{ Oil	Roller bearing.
	{ Oildag	To outer roller surface.
Level Spring Cam Plates (when fitted)	Oildag	To bearing surface of cam plate.
Level Spring Auxiliary Cam	Oildag	To under surface of cam.
<u>INTERRUPTER SPRINGS:</u>		
Operating Lever Bearing Pin	Oil	To both ends of bearings.
Loop Spring	Oil	To both bearings.
<u>VERTICAL MARKING WIPER:</u>		
Bearing	Oil	Between bearing and wiper carriage and sides of tongues on vertical wiper bracket.

Note: Where "Oil" is specified, this means clean "Oil Commonwealth No. 2" from No. 1 bottle of the stand.

7. DISMANTLING AND ASSEMBLY.

7.1 Dismantling. The following list indicates the order in which the parts of the

2000 type mechanism shall be dismantled :-

- (a) Remove the Relay Mounting Plate.
- (b) Remove the Mechanically Operated Spring-sets.
- (c) Remove the Wipers.
- (d) Remove the Spring-set Operating Brackets. (To facilitate this operation the carriage assembly shall be raised to level O.)
- (e) Remove the Detent Guard.
- (f) Remove the Vertical and Rotary Detent Springs.
- (g) Remove the Vertical and Rotary Detents.
- (h) Remove the Subsidiary Pawl Guide.
- (j) Remove the Vertical Pawl Guide.
- (k) Remove the Vertical Pawl Spring.
- (l) Remove the Vertical Pawl Front Stop.
- (m) Remove the Vertical Magnet Assembly.
- (n) Remove the Vertical Armature, Vertical Armature Restoring Spring, Restoring Spring Adjusting Screw and Bracket, and Residual Plate, from the magnet.
- (o) Remove the Vertical Armature Back Stop.
- (p) Remove the Rotary Armature Back Stop.
- (q) Remove the Rotary Pawl Front Stop.
- (r) Remove the Rotary Pawl Spring.
- (s) Remove the Rotary Magnet Assembly.
- (t) Remove the Rotary Magnet Locating Plate.
- (u) Remove the Vertical Magnet Locating Plate.
- (v) Remove the Rotary Armature, Rotary Armature Restoring Spring, Restoring Spring Adjusting Screw and Bracket, and Residual Plate, from the magnet.
- (w) Remove the Rotary Pawl Guide.
Loosen the Shaft Clamp Screw and release the tension of the Carriage Restoring Spring.
- (x) Remove the Comb Plate.
- (y) Remove the Shaft Clamp Plate.
- (z) Remove the Complete Shaft and Carriage Assembly.
- (ab) Remove the Shaft Clamp, Shaft Clamp Adjusting and Securing Screws.
- (ac) Remove the Shaft and Level Spring Auxiliary Cam from the Carriage.

- 7.2 Assembling. The following list indicates the order in which the parts of the 2000 type mechanism shall be assembled and adjusted :-
- (a) Replace the Level Springs Auxiliary Cam and the Shaft to the Carriage.
 - (b) Replace the Shaft Clamp and the Shaft Clamp Adjusting and Securing Screws to the Bridge Plate.
 - (c) Replace the Shaft Clamp Plate.
 - (d) Replace the Shaft and Carriage Assembly.
 - (e) Replace the Comb Plate.
Adjust as indicated in paragraphs 11 to 14 of Section 2 of the Circular.
 - (f) Replace the Rotary Pawl Front Stop (set the front stop well back in the frame).
 - (g) Replace the Vertical and Rotary Detents.
 - (h) Replace the Vertical and Rotary Detent Springs.
As a preliminary adjustment, the rotary detent shall be adjusted by means of its adjusting screw so that the detent tip is just clear of the long face of the first rotary tooth.
 - (j) Replace the Detent Guard.
Adjust as indicated in paragraphs 15 to 19 of Section 2 of the Circular.
 - (k) Replace the Vertical Armature, Vertical Armature Restoring Spring, Restoring Spring Adjusting Screw and Bracket, and Residual Plate to the magnet.
 - (l) Replace the Vertical Armature Back Stop (set the stop well down in the frame).
 - (m) Replace the Vertical Magnet Locating Plate.
 - (n) Replace the Vertical Magnet Assembly.
 - (o) Replace the Vertical Pawl Guide.
 - (p) Replace the Vertical Pawl Spring.
 - (q) Replace the Vertical Pawl Front Stop.
 - (r) Replace the Subsidiary Pawl Guide.
Adjust as indicated in paragraphs 20 to 27 of Section 2 of the Circular.
 - (s) Replace the Rotary Armature, Rotary Armature Restoring Spring, Restoring Spring Adjusting Screw and Bracket, and Residual Plate to the magnet.
 - (t) Replace the Rotary Magnet Locating Plate.
 - (u) Replace the Rotary Magnet Assembly.
 - (v) Replace the Rotary Pawl Spring.
Adjust as indicated in paragraphs 28 to 34 of Section 2 of the Circular.
 - (w) Replace the Spring-set Operating Brackets. (It will be found convenient if the operating bracket for the eleventh step spring is replaced first.)
 - (x) Replace the Mechanically Operated Spring-sets.
Adjust as indicated in paragraphs 1 to 17 of Section 3 of the Circular.
 - (y) Replace the Wipers.
Adjust as indicated in paragraphs 18 to 25 of Section 3 of the Circular.
 - (z) Replace the Relay Mounting Plate.

8. TOOLS.

8.1 The following list indicates the tools necessary for the adjustment of the 2000 type bimotional switch mechanism described in this Circular.

Tool Number	General Description	Use
14A	Adjuster, Spring.	Mechanically operated spring-sets. light springs.
18A	Adjuster, Spring.	Mechanically operated spring-sets, heavy springs.
29	Adjuster, Screw.	Rotary Armature Stroke.
48A	Bender, Armature.	Vertical and Rotary Armatures.
55A	Bender, Roller Bracket.	Roller Brackets of mechanically operated spring-sets.
56A	Bender, Off-Normal Lever.	Off-Normal Lever.
57A	Bender, Vertical Detent.	Vertical Detent and Pawl Guide.
58	Bender, Rotary Detent.	Rotary Detent and Subsidiary Pawl Guide.
58A	Bender, Rotary Interrupter Striker (alternative to Tool No. 66).	Rotary Interrupter Strikers.
59	Bender, Rotary Interrupter Lever.	Vertical and Rotary Interrupter Rear Arm.
59A	Bender, Cam.	Auxiliary Cam which operates Level Springs.
60	Bender, Operating Lever.	Operating Levers of mechanically operated spring-sets.
60A	Bender, Interrupter Lever.	Vertical Interrupter Strikers and Vertical and Rotary Interrupter Levers.
66	Bender, Rotary Interrupter Striker (alternative to Tool No. 58A).	Rotary Interrupter Strikers.
88	Cleaner, Contact.	Spring-sets.
138	Gauge, Feeler, Mechanism and Wipers (set in case).	General Use. Includes :- 5-10 mils - flat for mechanism. 12-18 mils - " " " 12-20 mils - wire for wipers. 10-30 mils - wire for mechanically operated spring-sets.
151	Gauge, Tension 10 to 80 grammes.	General Use.
152	" " 50 to 250 "	" "
153	" " 100 to 500 "	" "
201	Mirror, Magnifying No. 2 (Dental Type).	" "
209	Pliers, Diagonal Cutting.	Loop Springs and General Use.
211	Pliers, Bent, Duckbill.	Interrupter Springs and General Use.
213	Pliers, Half Round, Stripping.	Loop Springs and General Use.
219	Pliers, Fine Taper Nosed, 5".	Wipers and General Use.
235	Ring Driver.	Comb Plate Nuts and Mechanically Operated Spring-set Bearings.

Tool Number	General Description	U s e
257	Screwdriver, Pocket.	General Use.
258	Screwdriver, Spindle, 5 $\frac{1}{2}$ " x 3/16".	" "
286	Spanner, Box, Wiper and Pawl Screws.	Wipers and Vertical Pawl Screws.
299	Spanner, Box, Magnet.	Vertical and Rotary Magnet Adjusting Screws.
312	Spanner, Cranked, $\frac{1}{4}$ " x $\frac{3}{8}$ "	General Use (2 spanners to be provided in kit).
327	Spanner, Flat, 5/32" x 3/16".	Locking Nuts on Vertical and Rotary Detent Adjusting Screws.