PART IV

SELF-ALIGNING PLUNGER LINESWITCH

34. CONSTRUCTION

The plunger type lineswitch, Fig. 40, is made up of two relay assemblies mounted on a cold rolled steel frame. One of the relay assemblies is called the line relay, and the other assembly is called the bridge cut-off or the plunger coil assembly.

35. LINE RELAY

The line relay is similar to the horizontal type relay in construction except that the relay springs differ somewhat in shape. Because of the close proximity of the jack assembly, the springs are made "U" shaped to keep the terminals from interfering with the jack assembly and to give the springs flexibility. The coil used is similar in construction to the other coils described and has a copper slug on its armature end so as to make the line relay slow acting. The coil, the armature, and the spring assembly are fastened to a soft iron heel piece just large enough to hold these three parts properly. This heel piece is in turn fastened to the cold rolled steel lineswitch frame.

36. B.C.O. RELAY

The bridge cut-off relay (B.C.O.) or plunger coil assembly consists of a coil with two windings, a spring assembly with its associated armature, and a second armature which controls the plunger. A slot is cut in the plunger armature through which the end of the B.C.O. armature extends. The B.C.O. armature, which operates the spring assembly, and the plunger armature are supported on the same bearing pin. The B.C.O. armature, mounted in a position above the plunger armature, extends only to the center of the coil core, and when attracted it strikes the center coil core without interfering with the plunger armature. The plunger armature extends across the entire coil end and when attracted does not touch the B.C.O. armature.

The B.C.O. relay spring assembly is similar to the line relay spring assembly in construction except that there is a spring called the plunger restoring spring used to restore the plunger armature to normal.

The two windings of the coil are of such strength that when the pulldown, or plunger coil is energized, both the B.C.O. and the plunger armatures are attracted, but when the B.C.O. coil alone is energized, only the B.C.O. armature is attracted. The former condition exists when a call is being made, while the latter condition exists when the line is being called.

The double wound coil, the two armatures, and the spring assembly are mounted on a heel piece which is a part of the lineswitch frame.

37. PLUNGER ASSEMBLY

The plunger armature is normally held against an adjustable steel back stop screw due to the pressure exerted against it by the plunger armature restoring spring. Supported at the extreme end of the plunger armature is a hub upon which is affixed a plunger and the plunger restoring arms. The restoring arms are held in their normal position by a coiled spring. Attached to the outer end of the restoring arms are hard rubber rollers between which the plunger guide shaft engages the plunger assembly. The plunger assembly is engaged with the plunger guide shaft at all times. When the lineswitch is connected to a trunk and the plunger guide shaft has moved all the idle lineswitches opposite the next idle trunk, tension is placed on the coil spring due to the movement of the restoring arm. When the lineswitch is released from the bank by disconnection, it is brought into alignment with the other idle lineswitches. This is caused by the tension placed on the coiled spring through the movement of the plunger guide shaft and the restoring arm.

38. SWITCH JACKS

Fastened to the lineswitch frame base, just opposite the line relay, is a jack assembly made up of several nickel silver springs insulated one from the other and arranged so they will fit into a jack on the lineswitch mounting shelf. Each jack spring has a terminal, and the wires from the line relay coils and springs, and from the B.C.O. coils and springs, are connected to the jack springs at the terminals. All connections to the mounting shelf are made through the switch jack so that no wires need be connected or disconnected when the lineswitch is mounted or removed from the shelf. The slotted holes in the lineswitch base allow the lineswitch to be placed on or taken off the mounting shelf without removing the mounting screws from the shelf.

39. LINESWITCH BANK

The lineswitch bank is the complete assembly of contact springs with which the lineswitch plunger engages when a call is made. Each bank is composed of ten sets of contacts, each set corresponding to what is called a trunk; that is, the wiring which extends the connection to the succeeding switch. The contact springs (there are two in the upper and two in the lower part of the bank) close the line circuit through to the next switch and also close certain local and auxiliary circuits which are necessary for the proper operation of the switch. These sets of contacts (trunks) number from left to right when facing the lineswitches, thus the set to the extreme left is trunk No. 1 and the set to the extreme right is trunk No. 10. The thin movable contact springs are usually termed "bank contact springs," and the heavy stationary contacts are usually called "bank contacts." See Fig. 40.

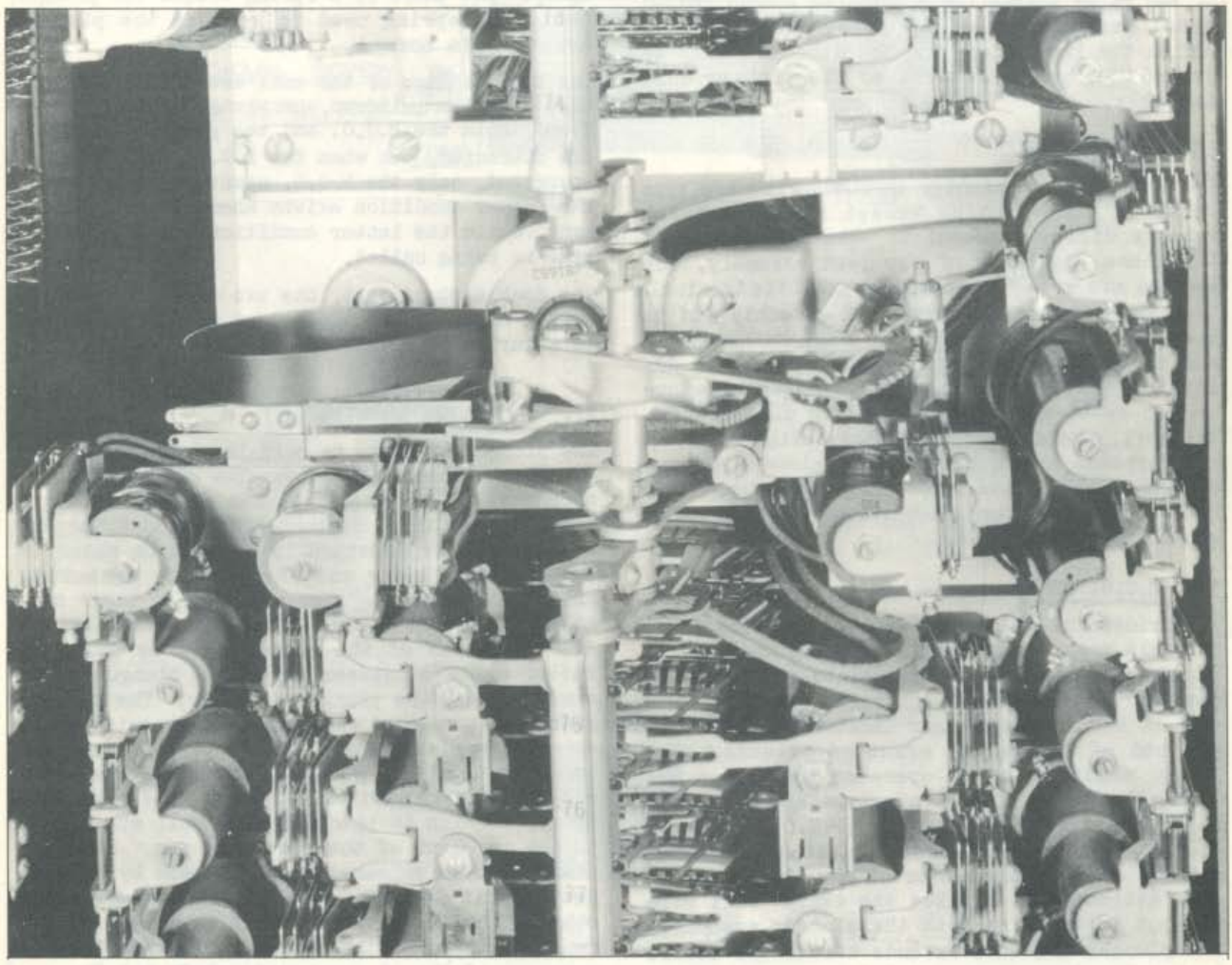

FIG. 41. MASTER SWITCH AND ASSOCIATED LINE SWITCHES

PART V

MASTER SWITCH

40. FUNCTION AND MECHANISM

The function of the master switch, as previously stated, is to hold the plungers of idle line-switches opposite an unoccupied trunk at all times. The structure of the master switch is shown in Fig. 42. That part of the mechanism which holds the plungers in position and transmits to them an oscillatory motion is called the plunger guide shaft. Rigidly fixed to this shaft are the locking segment and the governor driving segment with No. 1 trunk arm and No. 10 trunk arm. The solenoid plunger, through its arm, is firmly fixed to the governor driving segment. The "U" spring is held between two "U" spring posts, one of which is a part of the frame and is stationary, while the other is part of the governor driving segment and is movable. These parts, viz., solenoid plunger, "U" spring, plunger guide shaft, locking segment, governor driving segment with No. 1 trunk arm and No. 10 trunk arm, are definitely fixed mechanically and their motions are correlated.

41. MASTER SWITCH CONSTRUCTION

The armature of the locking magnet carries a locking arm which is normally engaged with one of the notches of the locking segment, but when the magnet is energized, the locking arm is lifted and the segment is free to move in either direction. The notches of the locking segment correspond in number with the bank contacts or the trunk to the next succeeding switch, so that the locking arm in a given notch means that the trunk corresponding to that notch is unoccupied and all the plungers of the idle lineswitches are in front of it, ready to plunge in should a subscriber make a call. When this trunk, for instance, No. 5 is seized, the locking arm is lifted and the locking segment moves counter-clockwise until the next idle trunk is found and the locking arm re-engages the locking segment. When the last notch is reached, No. 1 trunk arm closes two springs called the arm springs, preparing the circuit to the trip relay. The trip relay energizes on the next call and closes the circuit to the solenoid. The solenoid plunger is now pulled in and the locking segment, as well as the plunger guide shaft, moves in a clockwise direction. The spring contacts of the trip relay are held closed by its own locking spring until the solenoid plunger has been pulled in far enough so that the tenth notch of the locking segment has just passed the locking arm, when No. 10 trunk arm comes against the locking spring and allows the trip relay springs to return to normal and re-energize the solenoid. The return motion of the locking segment takes place under the force of the "U" spring. The speed is controlled by the governor.

The governor driving segment, Fig. 43, transmits the motion of the plunger guide shaft to a lantern pinion which in turn, engaging with the governor worm, causes the governor shaft to rotate on its own axis. On the governor shaft are fastened two strips of thin phosphor bronze called the governor wings, and to the end of each governor wing is riveted a small metal cup into which a fibre shoe called a friction shoe is fitted. The complete assembly is called the governor. A cylindrical metal housing called the governor cup encases the friction shoes. As the governor shaft rotates on its own axis, the governor wings, due to centrifugal force, spread away from the shaft causing the governor friction shoes to rub against the inner surface of the governor cup. The faster the shaft rotates, the farther apart will the wings spread, and the friction between the friction shoes and the cup is increased proportionately. This friction offers resistance to the driving force of both the "U" spring and the solenoid and regulates the speed of the plunger guide shaft.

The idle trunk is pre-selected since non-busy plungers are always standing opposite free trunks and hence without any testing or hunting, the plunger of the calling lineswitch enters its own bank contacts immediately after the receiver of the calling telephone is lifted from the hook.

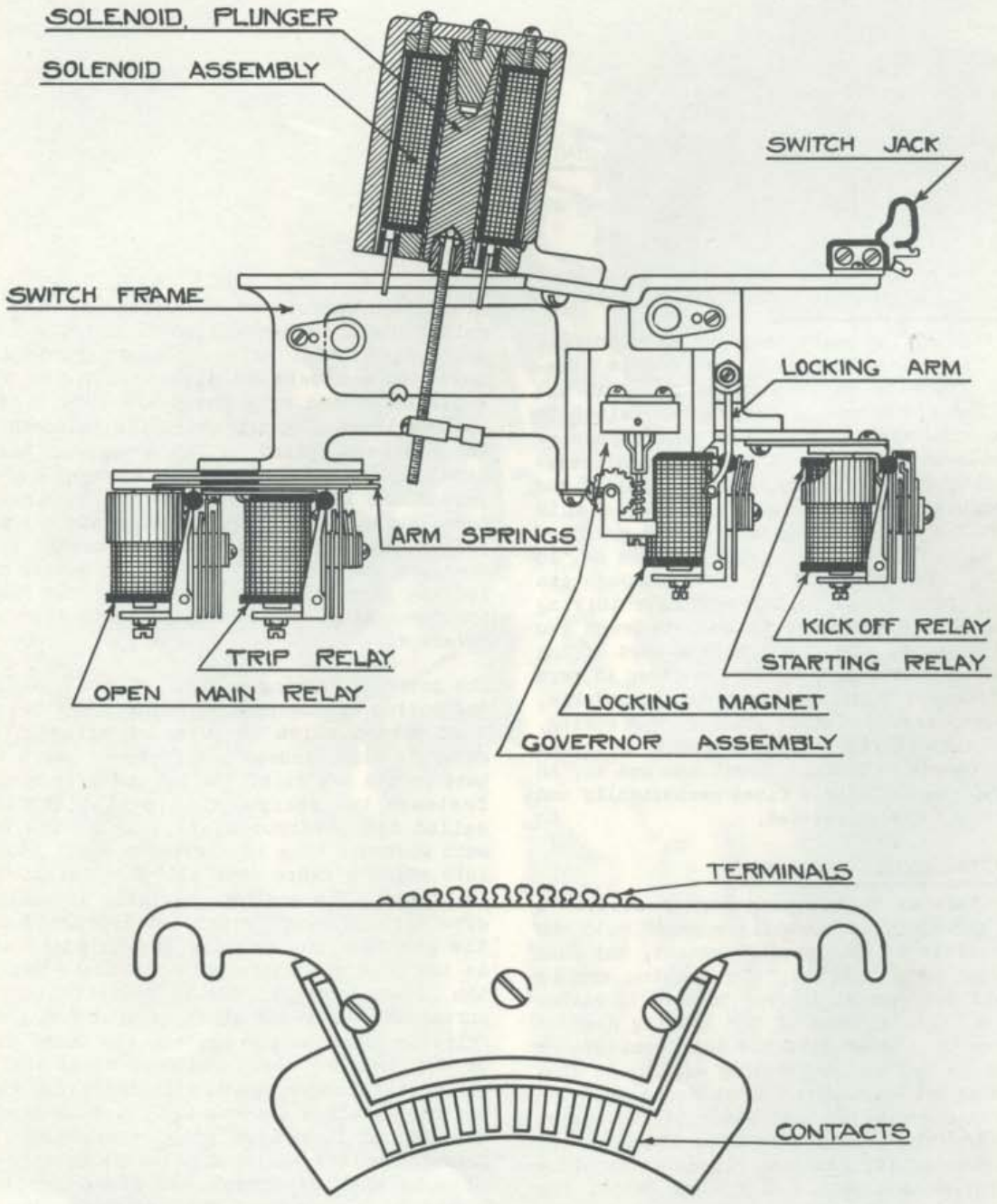

FIG. 42. MASTER SWITCH AND BANK

42. MASTER SWITCH BANK

The master switch bank, Fig. 42, is an auxiliary bank, composed of two rows of stationary contacts (10 in each) corresponding to the ten trunks in the lineswitch banks. These banks are located at the top or the bottom of each group of lineswitch banks. The master switch wiper (which is always engaged with a set of contactors on the master switch bank) has the same relative position on this bank that the lineswitch plungers (which are engaged with the guide shaft) have with respect to the lineswitch bank. Where more than one master switch is used, one master switch wiper and one master switch bank are used with each master switch.

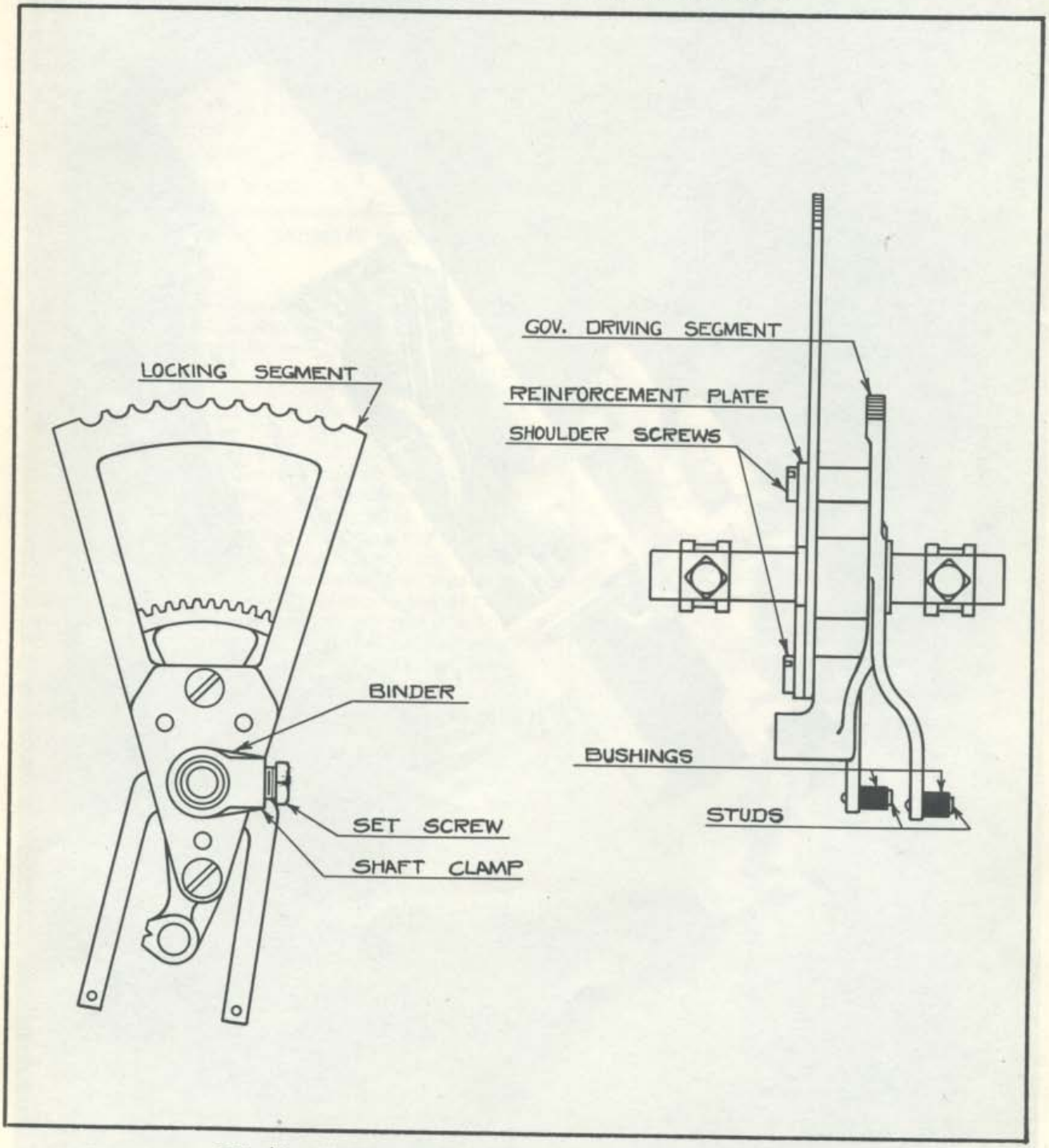

FIG. 43. MASTER SWITCH GOVERNOR DRIVING SEGMENT ASSEMBLY

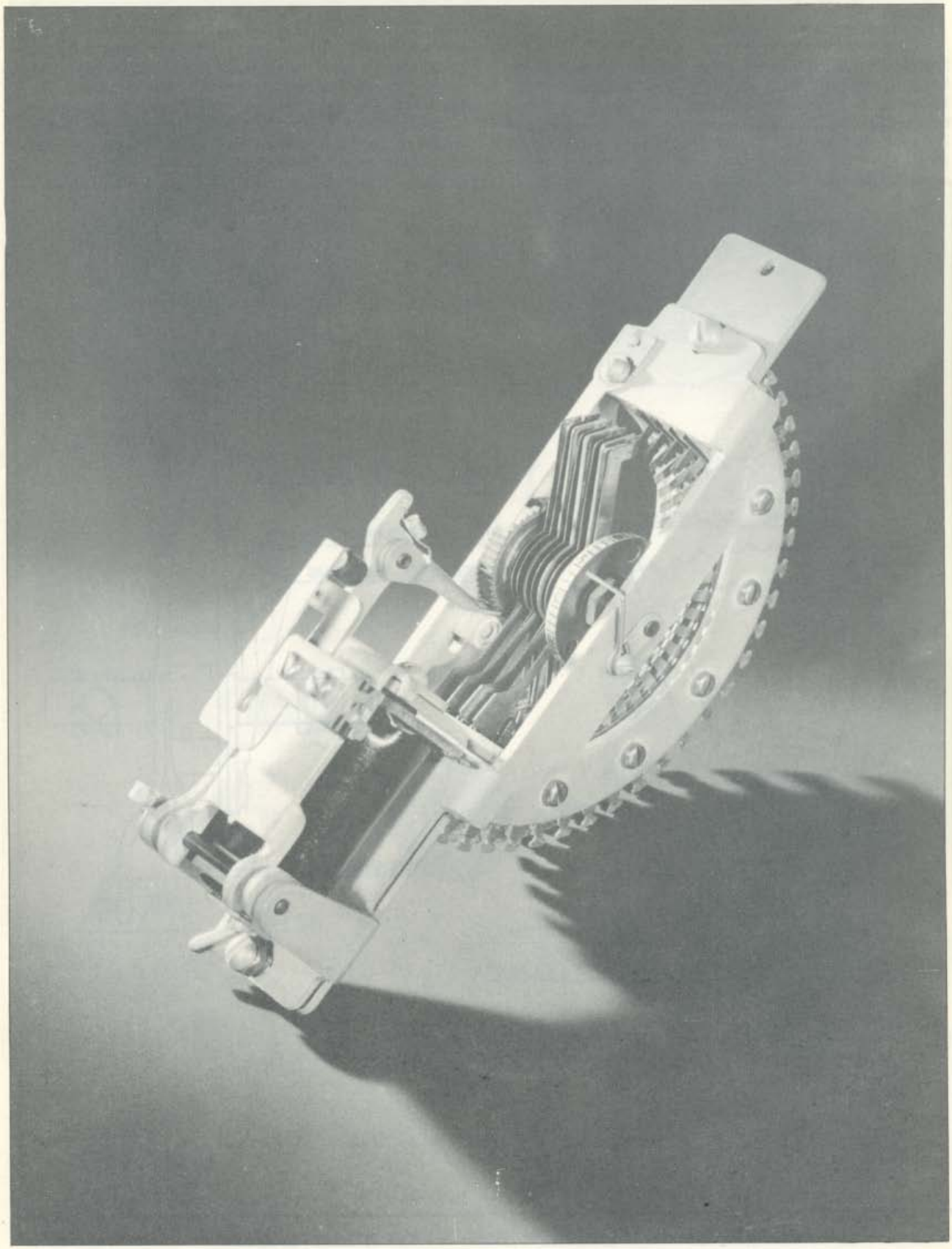

FIG. 44 ROTARY SWITCH, 25-POINT

PART VI

ROTARY SWITCH

43. COMPONENTS AND USE

The rotary switch consists of a bank assembly and a mechanism. The latter is composed of a relay assembly, rotary mechanism, and a wiper assembly.

The rotary switch may be used either as a line-switch or as a linefinder. In small systems, it is frequently employed as a connector. Thus it is used as both a numerical and as a non-numerical switch.

44. RELAY ASSEMBLY

The relay assembly, Fig. 45, is made up of a line relay and a cut-off relay. They are mounted together as a unit on a frame with armature springs of both relays placed side by side on the top. Between the two relays lies a two-pronged spring. One prong extends forward toward a finger on the armature of the cut-off relay preventing the armature from pulling completely up should this relay be energized first. Should the line relay (relay with copper slug) operate first, a finger on its armature will engage an inclined plane (cam-like bend) on the other prong of the interlocking spring. As the finger moves toward the cam, the straight prong of the spring will be lifted from the cut-off relay permitting that relay to operate. Thus on an incoming call, the cut-off relay may operate only far enough to open its break contacts but not far enough to close its make contacts. On an outgoing call, the line relay operates first releasing the lock and permitting the cut-off relay to pull completely up switching the calling line through to the following switches and opening the circuit to the line relay.

45. ROTARY MECHANISM

The rotary mechanism, Fig. 46, consists chiefly of motor magnet with spring assembly, rotary pawl, ratchet wheel, and wiper assembly. When the motor magnet is energized its armature pulls up opening the break contacts of its own interrupter spring and thereby breaking the circuit to the motor magnet. The magnet de-energizes and its armature falls back stepping the wiper assembly around one contact, thereby allowing the interrupter spring to again make contact, and if further rotation is required, again closing the circuit to the magnet. The rotary pawl is attached to the armature. It is drawn away from the pawl stop when the armature pulls up and, due to the tension of a small spring attached to it, falls into the next tooth of the ratchet wheel. When the armature falls back, the rotary pawl is pushed in toward the armature stop by the force of the tension spring, and thus the ratchet wheel to which the wipers are attached, is caused to turn on its axis. The arrangement of the armature pawl and the ratchet pawl spring prevents the ratchet wheel from making any movement except under the control of the rotary armature. The wipers are double ended, making contact with either end, and are of special design to give flexibility and good contact. The construction of the bank, Fig. 49, is such that one end or the other of the wipers will at all times be in engagement with a set of bank contacts, the second set of wipers coming into action when the first one leaves the last contact of the bank. There are three pairs of wipers, sometimes more, depending on the circuit employed. They are the private, positive,

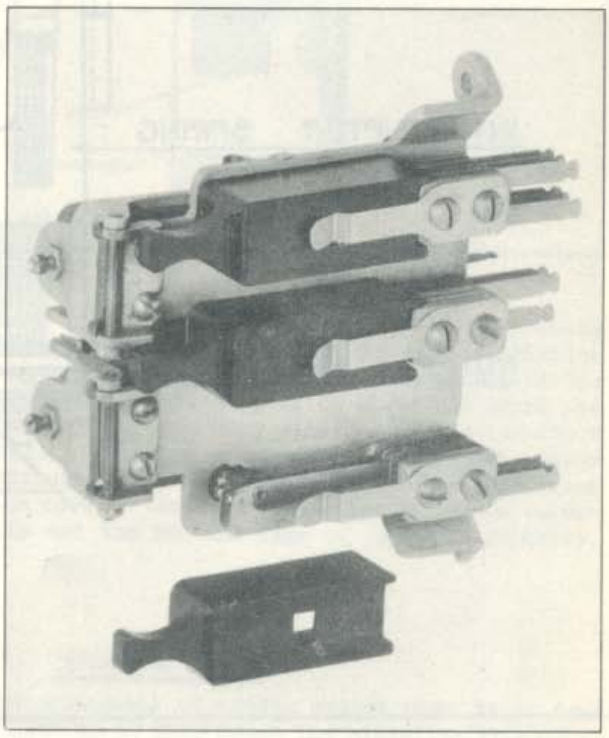

FIG. 45. A ROTARY LINESWITCH RELAY ASSEMBLY

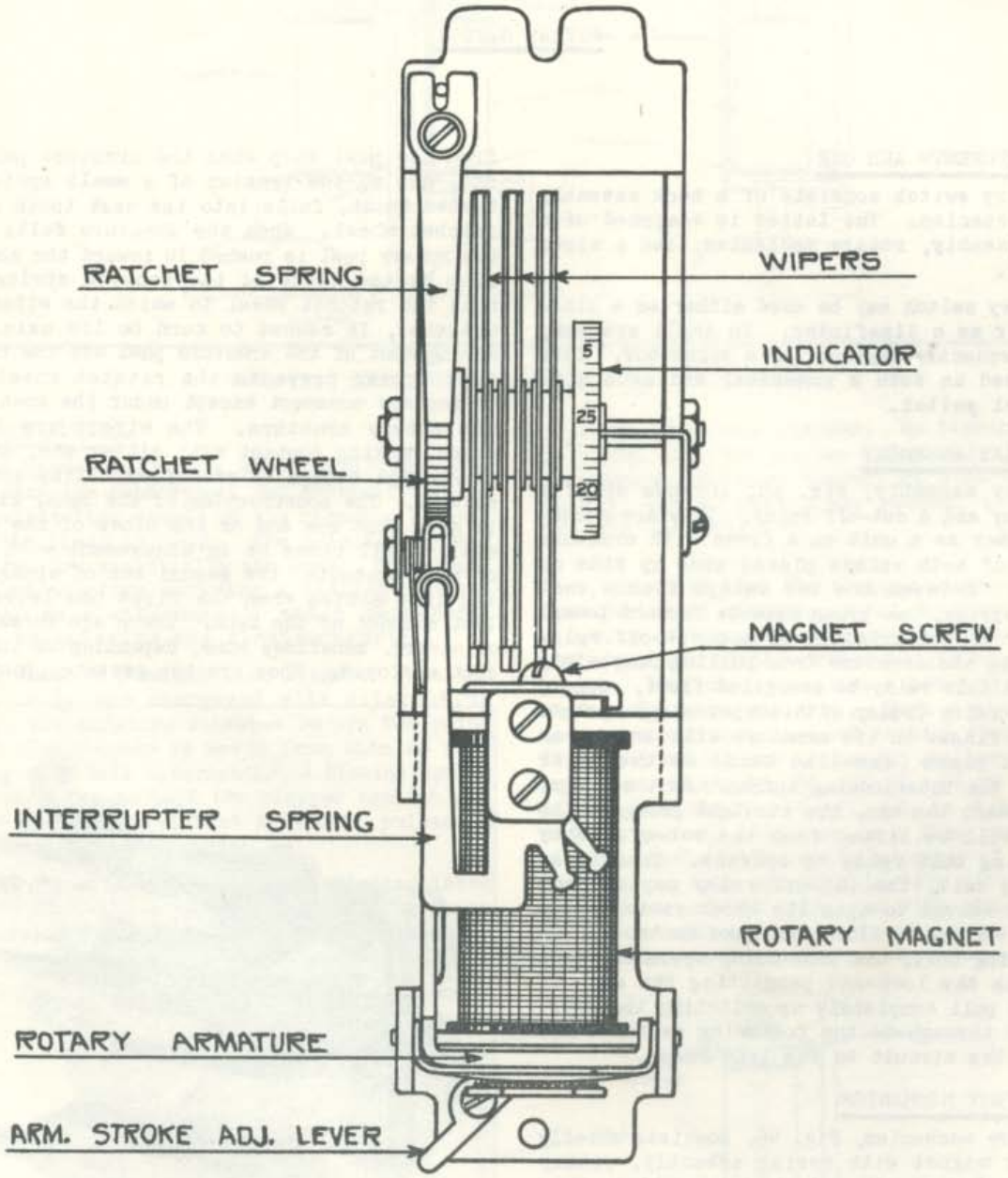

FIG. 46. ROTARY SWITCH, FRONT VIEW

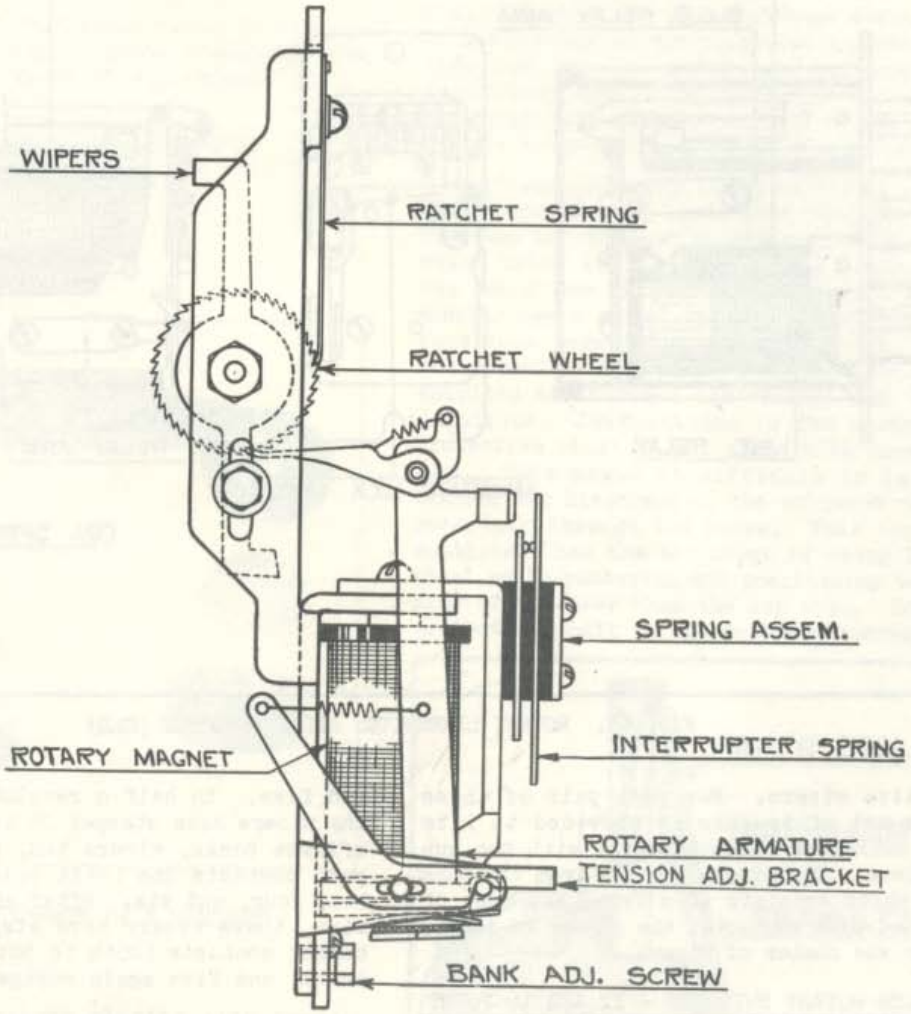

FIG. 47. ROTARY SWITCH, SIDE VIEW

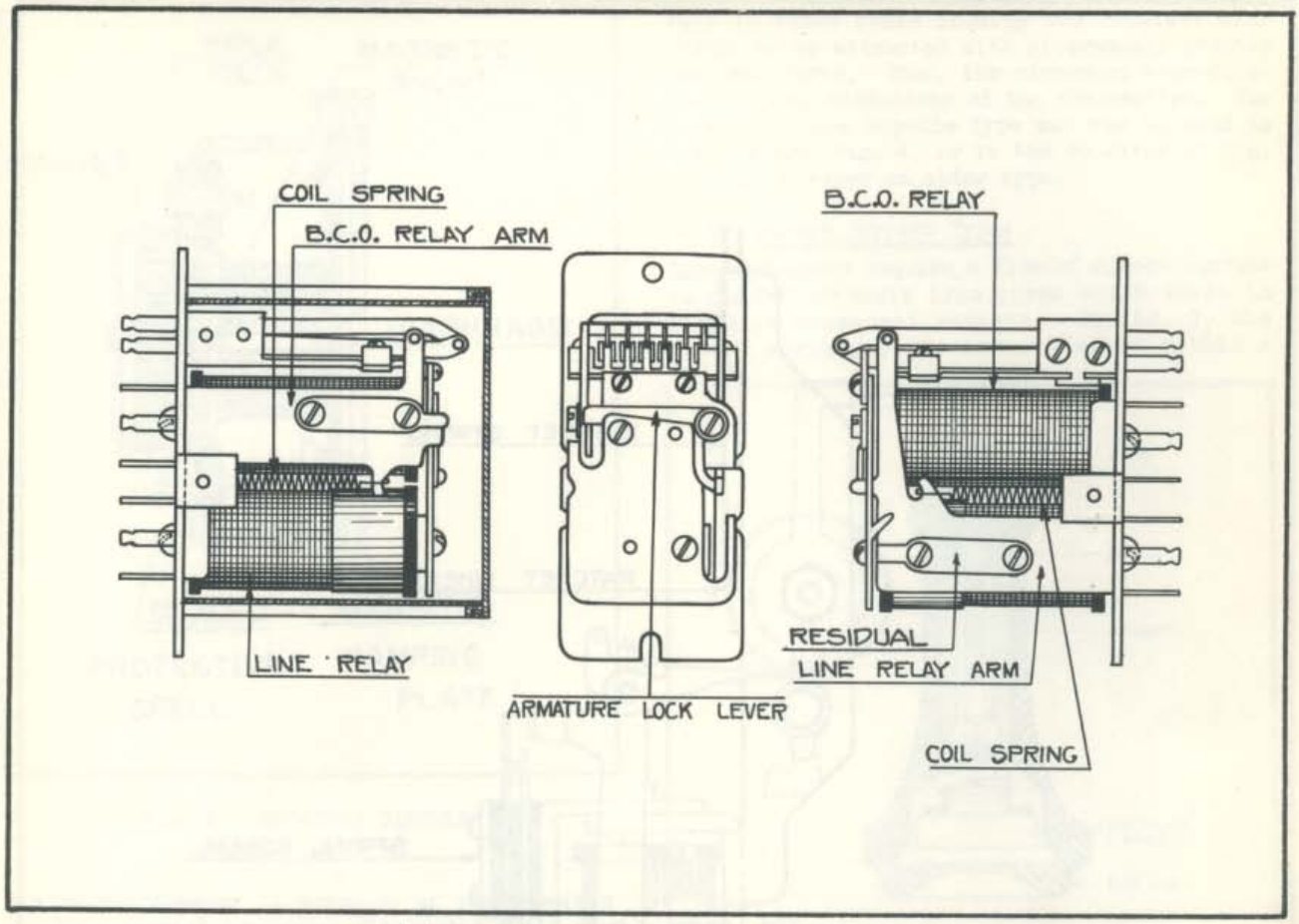

FIG. 48. ROTARY LINESWITCH RELAY ASSEMBLY (OLD)

and negative wipers. For each pair of these wipers, a set of brushes is provided to ride upon the collector rings integral with the hub of the wipers. The wipers project from the bank assembly which consists of a frame and rows of 25 insulated bank contacts; the number of levels depends on the number of wipers.

46. SMALLER ROTARY SWITCHES - 11 AND 16 POINT

Rotary lineswitches are made in sizes other than 25 point. The 16-point switch is similar to the larger size except that it is usually employed as a homing-type switch. It returns to its home position by continuing rotation in the forward direction. A cam and off-normal springs open the motor circuit when the home position is reached. The 11-point lineswitch is similar to the 16-point.

47. A 50-POINT ROTARY SWITCH

By adding banks and cutting off one end of all wipers, a 25-point rotary lineswitch can be converted into a 50-point switch. Thus on a three-conductor circuit, wipers one, three, and five start on contact one of banks one, three, and five. In half a revolution of the shaft, the wipers have stepped 25 times. As they step off the banks, wipers two, four, and six step onto contacts one (26th point) of bank levels two, four, and six. After another half revolution, these wipers have stepped over 25 additional contacts (26th to 50th) and wipers one, three, and five again engage the bank.

48. FUNCTION OF ROTARY SWITCH

Unlike the plunger type lineswitch, the rotary lineswitch searches for an idle trunk after the receiver has been removed from its telephone. If its wipers happen to be standing upon an idle trunk, the cut-off relay operates and cuts the lines through to the next switch ahead, but if its wipers happen to be standing upon a busy trunk, the motor magnet first operates and moves the wipers to an idle trunk, following which the cut-off relay operates.

Sometimes the rotary switch is used as a line-finder. In such an instance, the rotary switch is associated with a trunk to the next switch instead of with a subscriber's line.

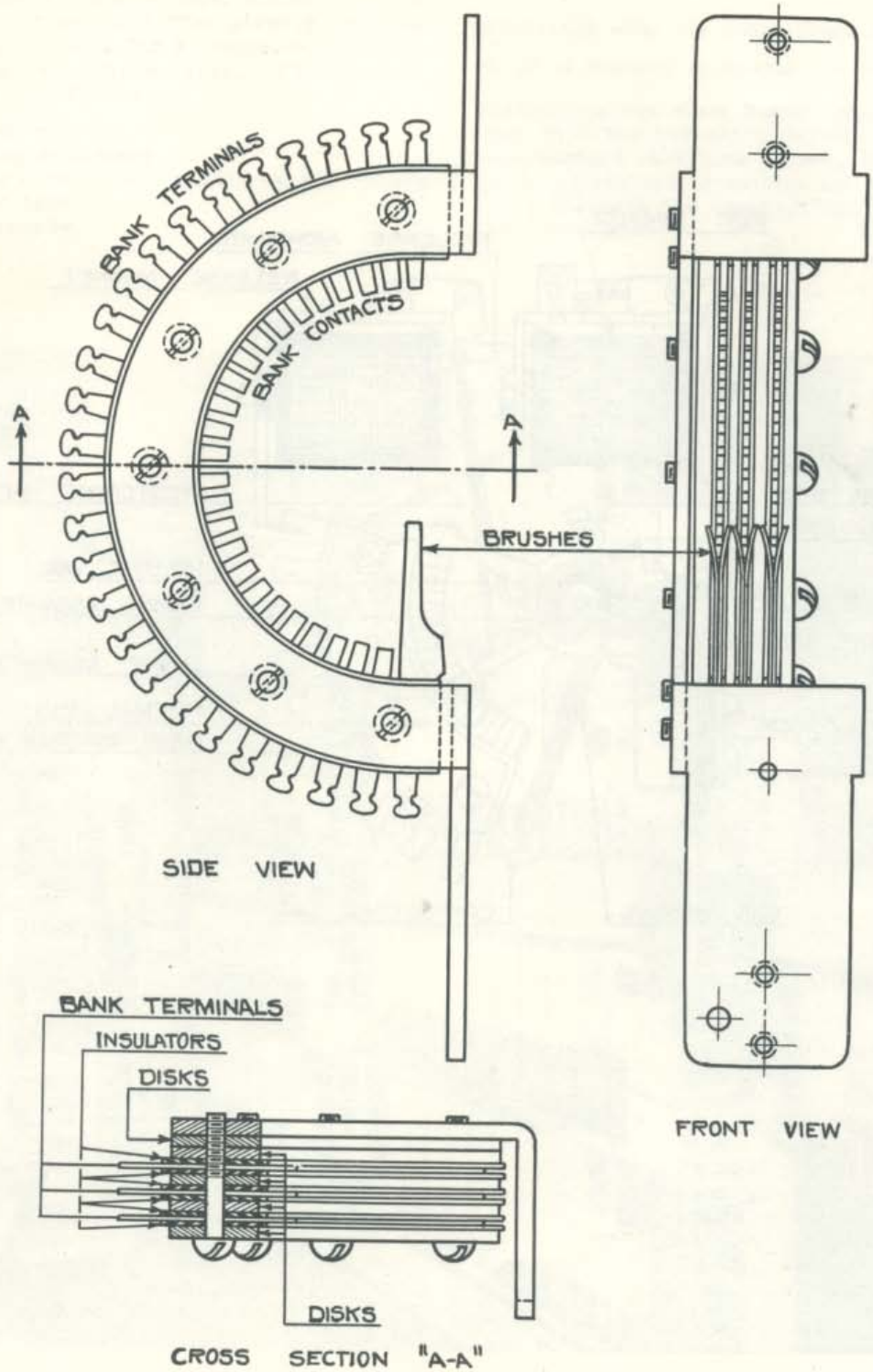

FIG. 49. ROTARY SWITCH BANK ASSEMBLY

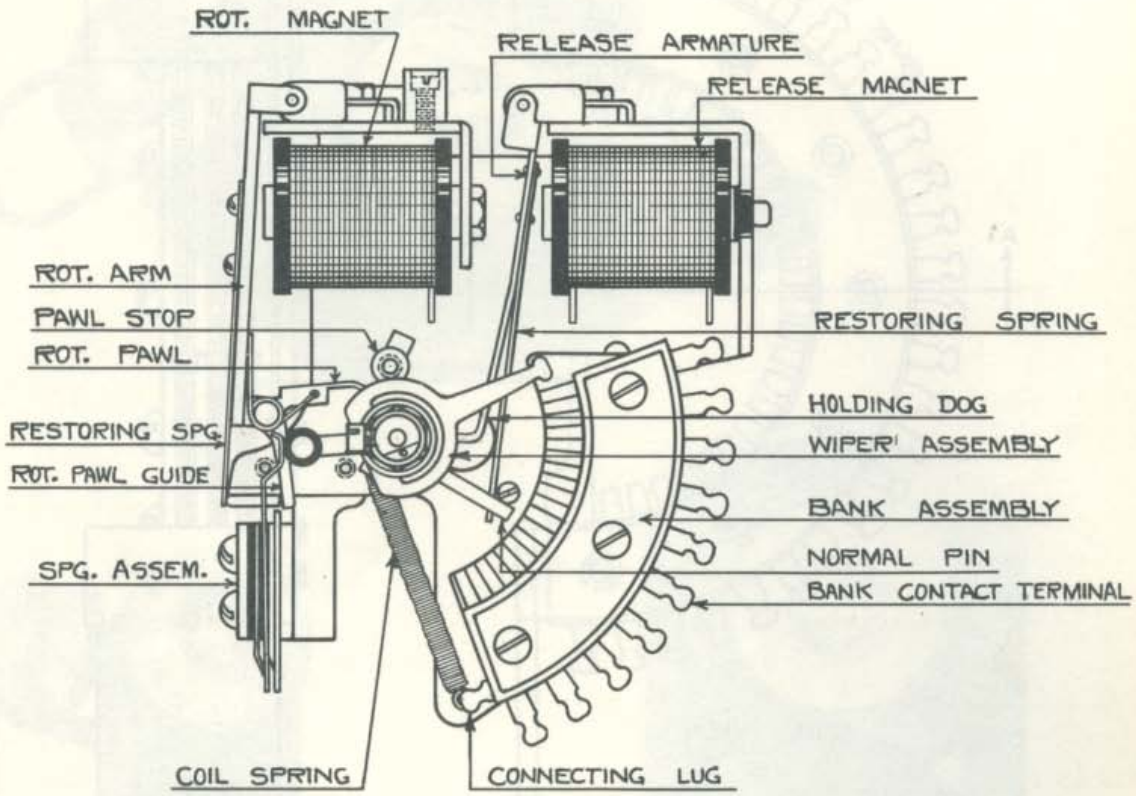

FIG. 50. MINOR SWITCH

PART VII

MINOR SWITCH

49. COMPONENTS

The minor switch, Fig. 50, is a type of switch with a ten-point bank assembly. It is so called because of the minor purpose for which it is used; viz., frequency or code selecting, sequence control, and digit storing. It consists chiefly of a frame, two electro-magnets, rotary and release mechanisms, and bank assembly with associated wipers. This is a returnable switch whose wipers return to normal under spring tension.

50. MINOR SWITCH CONSTRUCTION

The frame is of one piece construction. It is so shaped that a part of it becomes the heel piece of the two electro-magnets. The two magnets are called the rotary and the release magnets respectively.

The armature of the rotary magnet carries a rotary pawl which operates the rotary mechanism. When the dial impulses energize the magnet, its armature is attracted, and the rotary pawl engages one of the ratchet wheel teeth, causing the ratchet to turn on its axis which is a bearing pin riveted to the frame. The wiper pairs are rigidly assembled to this ratchet in correct relationship. The stroke of the rotary armature is determined by the back stop lever at the heel piece and the rotary pawl stop, while the pawl is guided into the ratchet by the guide lever which is a part of the pawl. Thus the step-by-step movement of the wipers is produced. A flat steel spring attached to the rotary armature provides restoring tension for the armature.

The holding dog, which is complete in one piece with the release magnet armature, is controlled by the restoring spring and the magnet. It engages the ratchet wheel and retains the wipers on any contacts. As the wipers step, a spiral spring attached to the wiper assembly increases its tension. This increased tension is utilized to restore the wipers to their normal position as soon as the release magnet operates and disengages the holding dog from the ratchet wheel.

51. SWITCH BANK

A minor switch may have as many as three bank levels. A level consists of two sets of bank contacts - one set for the top wiper of the wiper pair, one for the lower wiper. The upper contacts of each set are made up of ten individual contact points. The bottom contacts of each set are often combined in a solid segment. The wiper pair serves to complete a circuit from the solid (commoning) segment to the individual contacts. The commoning segment is sometimes replaced by individual contacts.

PART VIII

IMPULSE REPEATER

52. GENERAL

The impulse repeater should not be confused with the voice repeater whose function it is to amplify a feeble voice current so that the voice may be heard over very long circuits. The impulse repeater, in contrast to the above, has for its purpose the repetition of dial pulses from one exchange to another in such a manner that two-wire trunks may be employed between the exchanges thus eliminating the control conductor (third) required within the exchange to hold up the connection. Incidentally, the impulse repeater permits talking battery to be supplied from the subscriber's local exchange.

The impulse repeater, Fig. 51, differs in general construction from the selector and connector in that switch banks and mechanism are unnecessary. However, the relays are mounted on a steel switch base in the same manner as those on the selector. The various functions performed by the repeater are completed by relays without aid from any mechanism.

A second type of impulse repeater sometimes called an impulse regenerator is occasionally employed. This is a mechanical type in which the impulses are received and stored on one side while being mechanically recreated and sent forth on the other. It corrects feeble and distorted pulses.

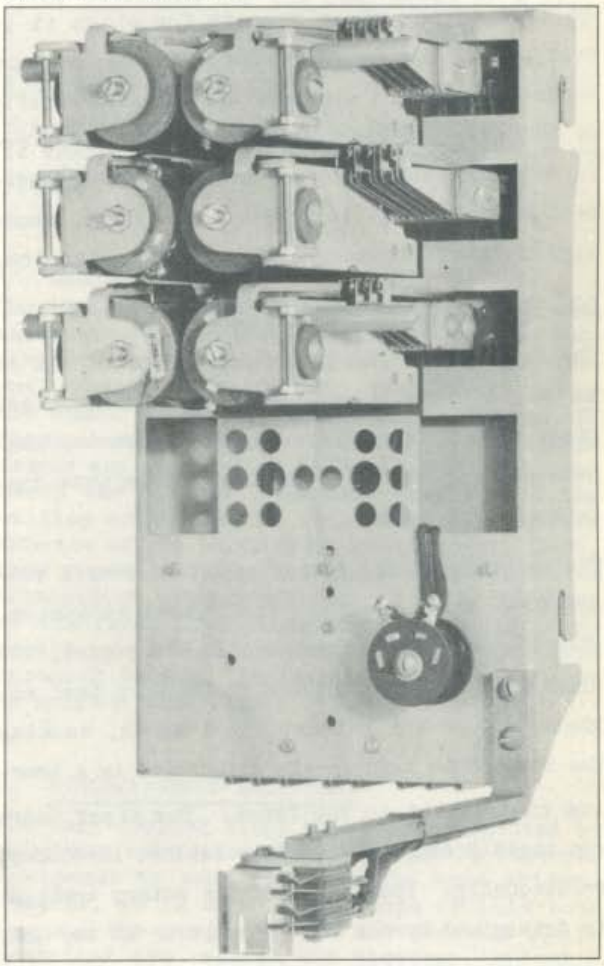

FIG. 51. IMPULSE REPEATER

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