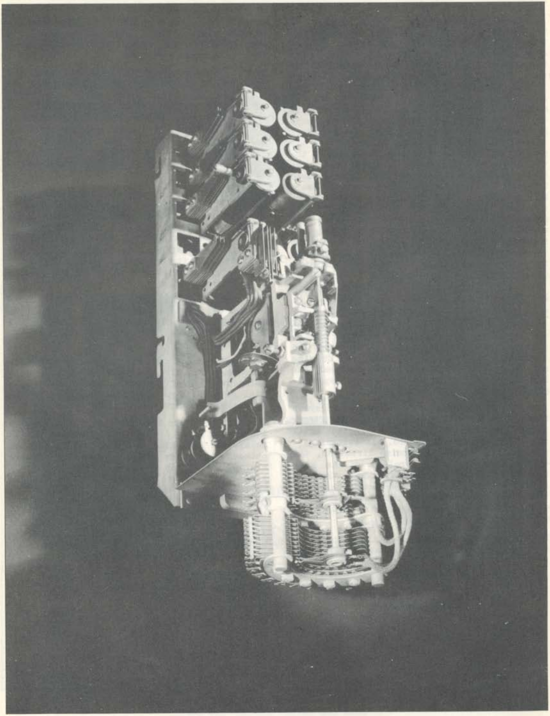

FIG. 17. THE STROWGER TWO-MOTION SWITCH

PART III

STROWGER SWITCH CONSTRUCTION

18. SUMMARY

A switch in telephone parlance is a device for setting up connections usually in response to electrical pulses. One of the most satisfactory of such devices is the Strowger switch. This may be used as a numerical switch, operating in response to dial pulses, or it may be employed as a non-numerical switch, i.e., in such a use that it requires no dial pulses.

A non-numerical use would be linefinding as contrasted against connector or selector operations. In linefinding the switch finds the calling subscriber's line.

A Strowger switch may be considered as consisting of three units:

a. Relays.
b. Switch mechanism including shaft, magnets, and frame.
c. Bank assembly.

19. RELAYS

The electromagnetic relay is one of the most important pieces of equipment used in automatic telephony. Nearly every circuit employs one or often more relays. A large exchange will contain thousands of relays which perform numerous switching operations under varying circumstances. Many of them must operate more than one million times per year. See Fig. 18.

A relay is an electrical device operating in response to an electric current for the purpose of mechanically making, breaking, or changing one or more secondary electrical connections. A relay makes possible the control of a strong current by a feeble current. The principal parts of one are the heel piece, the armature, the coil, and the spring assembly. The parts are labeled in Fig. 19.

19.1 Horizontal Type

The coil is made up of an iron core upon which is wound a number of turns of wire. Fastened tightly near each end of the iron core is an insulating washer called the coil cheek which holds the wire on the core. On the rear coil cheek, the terminals are permanently attached and the wires wound on the core are connected to these terminals. The coil cheeks are fastened to the core by means of a staking opera-

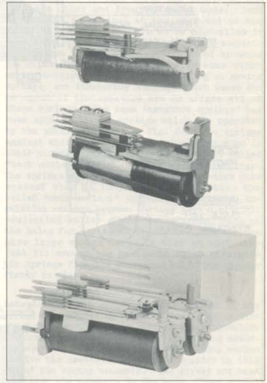

FIG. 18. RELAYS - TOP, STANDARD HORIZONTAL RELAY; CENTER, SLOW TO RELEASE TYPE WITH 1:1 ARMATURE RATIO; BOTTOM, MANUAL TYPE

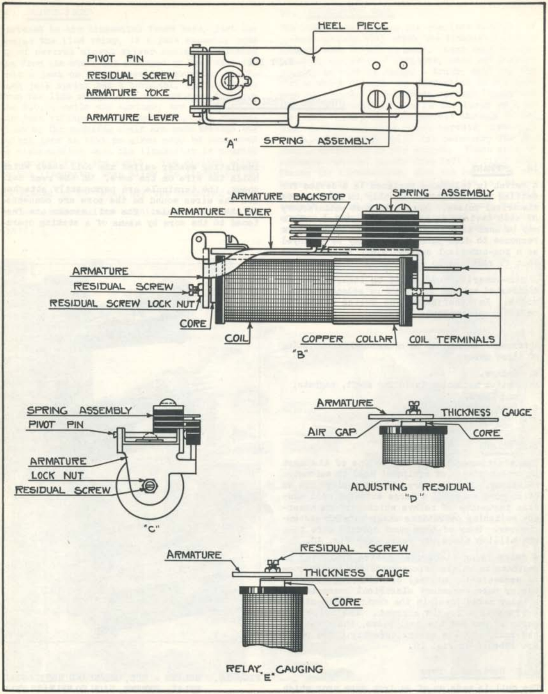

FIG. 19. HORIZONTAL TYPE RELAY

tion which cuts three small triangular grooves in the short projecting ends of the core thus forcing the metal, cut out of the grooves, into the washers to hold them firmly in place. The core, the heel piece, and the armature which compose the magnetic circuit are annealed or softened by being heated and then cooled very slowly. This annealing process is necessary because soft iron forms a better path for magnetism than does hardened iron or steel. The cores are treated by a process called "electro-galvanizing," so that they are practically rust proof. The winding is usually of copper, except where a few turns of German silver or other high resistance wire has been used to add considerably to the resistance of the coil. The wire is covered with a black insulating enamel by means of a special process. This enamel is practically moisture proof and is the only insulation existing between the wires.

Treated insulating washers are placed between the wire and the coil cheeks to serve the double purpose of preventing electrolysis which otherwise might be caused by the presence of acid and moisture in the fibre and to insulate the coil terminals from the coil windings. Around the coil is a layer of heavy empire cloth to give mechanical protection to the outer layer of wire.

19.2 Relay Base

The relay base, i.e., the heel piece, is made so that one or more spring assemblies may be mounted either on the top or on the bottom, or in both places near the rear end of the relay. By means of an iron screw, the coil is fastened to the rear end of the heel piece so that the coil core and the heel piece are in contact. Other threaded holes are provided so that the relay may be fastened to a mounting plate.

19.3 Armature Mounting

The armature which is of soft iron is pivoted to a yoke. The armature yoke is made of brass, for if it were of iron it would become a part of the magnetic circuit and cause the armature to bind when operating. The armature yoke is fastened on to the front end of the relay base by means of a screw and a special metal washer. This washer which is between the screw head and the yoke has a small lug bent so that when in place, the end of the lug fits in a hole in the heel piece and prevents the washer from turning when the screw is tightened. If the washer should turn when the screw is tightened, the armature yoke would probably turn, making it difficult to obtain a correct adjustment of the space between the armature and the heel piece. The inner edge of the washer is concave so as to give greater holding power on the armature yoke.

A brass screw, with a lock nut is used in the center of the armature to adjust the space remaining between the armature and the coil core when the relay armature is in its operated position. This is termed a "residual screw." The armature arm which operates the springs has on its end a hard rubber bushing that insulates the arm from the spring with which it is in direct contact. The armature and the base are plated to prevent them from rusting. The parkerized finish on the armature yoke washer serves the double purpose of making the washer rust proof and of giving it additional holding power. The pivot pin which holds the armature to the yoke is of a non-magnetic material.

19.4 Springs and Spring Assembly

The spring assembly is made up of a number of nickel-silver springs which are insulated one from the other and from the relay base. Each spring has a terminal at the rear end of the relay to which the circuit to be controlled is connected. Each spring has one or more contacts of platinum or some other special metal by means of which a connection is made to some other spring contact. Between the switching or moving springs, are insulating bushings which cause the movement of the armature arm to affect all of these springs. The name "armature springs" has been applied to all springs which are operated by the armature arm. See Fig. 21. The springs against which the armature springs rest when in their normal or inoperative position are called "back contact," i.e., "break contact" springs. The springs with which the armature springs make contact when in their operated position are called "make contact" springs. The micarta insulating washers between springs have a slightly projecting collar of embossing around each of the holes for the assembly screws. The springs have large enough holes in them so that they just fit around the embossing which insulates the springs from the screws and holds the springs firmly in place.

Between the heel piece and first washer of the spring assembly is an armature back stop against which the armature rests when in its inoperative or normal position. On top of the spring assembly over the last washer is placed an iron washer to give the necessary mechanical support to this end of the spring assembly. Two screws are used to fasten the assembly to the base. These screws are tightened as much as possible when the parts are assembled. The relay is mounted with the armature arm and spring assembly at the top, except on double armature relays. Incidentally many relays today have twin contact springs for greater reliability.

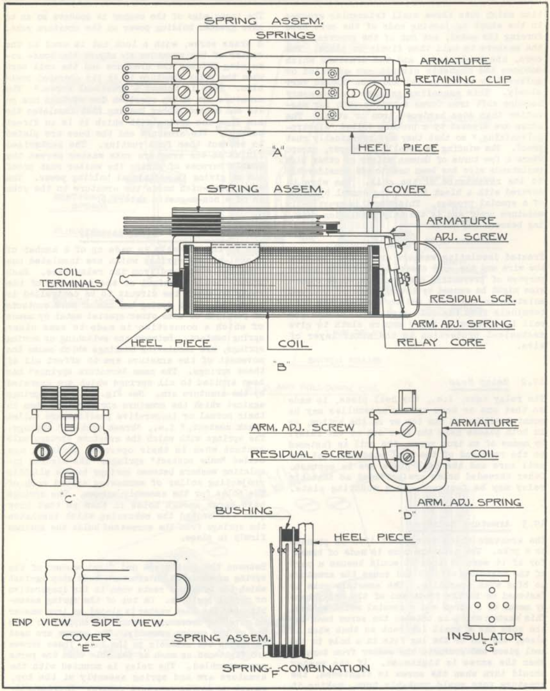

FIG. 20. MANUAL RELAY

19.5 Relay Operation

In order that a relay may perform its function of switching or controlling circuits, its armature must be made to move so as to cause the relay springs to break and make contact. This is accomplished by passing a current through the winding of the coil which causes the core to become saturated with magnetism and the armature to be attracted. When the current ceases to flow, the armature is released.

19.6 Ratios

From Fig. 21, it can be seen that the distance from the residual screw to the armature bearing pin is much shorter than the distance from the bearing pin to the center of the bushing which engages the armature springs. The ratio of these two lever arms is such that for a given movement at the armature, the spring operating bushing moves a greater distance. The bushing engages the spring between the contact and the spring mounting. Considering the spring as a lever, note that operation of the armature will cause the movement of the spring contact to be greater than the movement of the bushing. If an armature spring is adjusted to just touch the make spring while there is yet an air gap between the coil cord and the residual screw, the total deflection of this make spring, when the armature has reached its operated position, will be a distance roughly equal to the above air gap times the overall ratio.

The contact pressure resulting from the deflection of make contact springs varies with the amount of deflection. For a given deflection, contact pressure varies with the thickness of the spring material. Thus it is possible to select a thickness of spring material and a deflection such as to give the desired contact pressure assuming that the relay has the power to operate under the chosen conditions.

19.7 Relay Adjustments

In order that a relay may perform its function in the most satisfactory way possible, certain adjustments of the various parts must be made as follows:

19.71 Residual Screw

In the center of the armature is inserted a brass residual screw and a lock nut. The screw is used to adjust the space between the armature and the coil core when the relay armature is in its operated position. The residual screw is so called, because it prevents residual magnetism from holding the armature in an operated position after the circuit to the coil of the relay is opened. Residual magnetism is that remaining in the coil at this time. The residual gap, as this space is called, must be as small as possible, for air does not form a good path for magnetic lines of force. Therefore, the larger this space, the less power the relay has. Fig. 19O shows the method used to adjust the residual. A second air gap, called the heelpiece gap, separates the armature from the heelpiece. This is located just below the pivot pin and may be adjusted by loosening the armature-bearing-yoke clamp screw and inserting the appropriate gauge between the armature and the heelpiece.

If relay armatures were allowed to strike squarely on the core, this slight amount of residual magnetism might cause the relay armature to remain in its operated position after the relay circuit was opened, especially if the springs did not exert much pressure against the armature arm. The brass screw prevents the armature and the coil core from coming in contact, and the small air gap between them affords such a high resistance path to the few magnetic lines of force from residual magnetism that the armature has no tendency to remain operated after the relay circuit is opened. The air gap between the armature and the core must be as small as is practically possible for the same reason that the air gap between the heel piece and the armature must be small. The longer the air gap the less power the relay has. Therefore, the brass screw is usually set so that there is but 1.5 thousandth of an inch air gap between the armature and the core with the relay operated.

19.72 Spring Gauging

After the armature is properly located, the residual is adjusted, and if necessary, the armature arm is bent into proper alignment with the heel piece. Springs should be straight; that is, free from kinks or bows, both for the sake of appearance and because kinks or sharp bends weaken a spring. Armature springs must be adjusted so that they exert pressure against their associated break contacts or against their associated bushings. This adjustment is called "tensioning" springs. In order that an armature spring will be sure to close a circuit through an associated make contact spring when a relay operates, it is necessary that the two springs be adjusted to make contact before the armature has completed its stroke. Such an adjustment will cause the armature spring to press the make contact spring outward and will result in pressure between the springs which will assure the closing of the circuit. Armature springs must not come in contact with the make contact springs too soon or the relay may not have power enough to operate the armature against the resulting excessive spring pressure. The make contact springs are adjusted to just make contact when the armature is, e.g., .006 of an inch distant from the core (Fig. 22B). This is accomplished by using a thickness gauge as shown in Fig. 19E. With this adjustment, the pressure

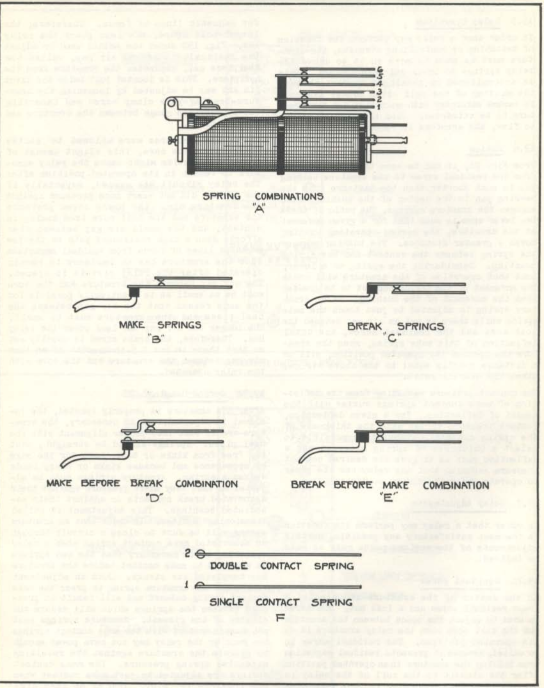

FIG. 21. RELAY SPRINGS

between the springs, with the relay operated, is great enough to assure good contact and yet not great enough to require excessive power for the operation of the springs. The value .010 of inch outside the springs in B is called a stroke value. This stroke value is the normal armature air gap and is met by adjusting the back stop (Fig. 22). These values are necessary only for relays which do not have a break contact as the first spring in the assembly.

In Fig. 22A is a single break assembly; the springs must be adjusted to just break contact with a .006 inch air gap between the residual screw and the coil core.

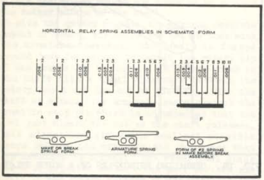

FIG. 22. RELAY SPRING GAUGING

It frequently happens that an armature spring has associated with it both a break contact spring Fig. 22C, and a make contact spring, Fig. 21E. The armature spring when operating must then leave its break contact an instant before it touches the make contact to prevent connecting two separate circuits. To secure this result without making the space between the armature and the core any larger than necessary before the relay is operated, the armature spring is usually adjusted to just leave its break contact with a .010 inch space between the armature and the core. This is shown on adjustment sheets as in Fig. 22C.

The adjustment figures given are approximate for the purpose of giving the reader a general idea of spring gauging. Therefore, to obtain the accurate figures, an adjustment sheet should always be referred to. The assemblies shown in Fig. 22 represent an adjustment sheet.

The same ideas are involved in the adjustments used for a make-before-break spring combination, Fig. 22D and Fig. 21D. The break contact and the stop spring just separate with .004 of an inch gauge between the armature and the core, which gives the minimum clearance that is considered desirable for general use between contacts when the relay is operated. The armature spring and the make contact springs are adjusted to just make contact at .009 of an inch. The make contact spring tension is therefore determined by the above adjustment since it requires just a certain amount of tension to prevent the make contact leaving the stop spring, from the time it makes contact with the armature spring (at .009 of an inch) until the armature is just .004 of an inch from the core. With a make-before-break contact assembly as in Figure 22F, springs 1-4, the armature spring is adjusted to leave its break contact at .013 of an inch where it has an associated break contact. In D of the same figure, the armature spring has no break contact so the stroke of the armature is adjusted by means of the back stop to the .013 value.

Where no break contacts are associated with the armature springs, the armature back stop is adjusted to make the space between the armature and the core equal to whatever the back contact gauging would be, e.g., .010 of an inch. If two or more armature springs are used on a relay and each one has an associated back contact, the outside armature spring (the one farthest from the armature) is adjusted to just leave its break contact at .010 of an inch; the next armature spring is adjusted to just leave its back contact at .011 of an inch, etc. This adjustment allows each armature spring to rest against its associated break contact with its full amount of power pressure or tension.

19.73 Margining

To determine the amount of tension or back-pressure in the armature springs and assure a good back contact, a relay is connected in a circuit with a certain amount of resistance, and the armature spring tension is adjusted so that the relay armature will not operate in series with this resistance ("NO" value). The relay is then tested and adjusted to operate in series with a lower resistance ("O" value) to prevent the possibility of the spring being adjusted too stiff. The resistances used are determined by the winding of the coil, the number of springs, and the functions of the relay. This adjustment is known as margining. A current flow test set is convenient for this purpose.

19.8 Slow Acting Relay (Figure 18)

A relay that prolongs the return of its armature to normal when the relay circuit is opened, or a relay that momentarily delays the attraction of its armature when the relay circuit is closed, is called a slow acting relay. The only difference in construction between a slow acting relay and a standard horizontal type relay is that on the slow acting relay coil there is a round copper slug, which fits tightly over the coil core. The length and the diameter of the copper collar varies in accordance with the requirements. Three different length slugs (11/16", 1", 1-1/2") are commonly used. A circular groove pressed into the copper slug near the coil core (called ring staking) and prong staking on the core similar to that used on the fibre washers hold the slug firmly to the core.

19.9 Rotor Relay

This is a very special relay used largely in rotor relay systems as connectors or finders. A single relay has 35 sets of make contacts which complete connections to "groups" of subscribers' lines. Figs. 23 and 24 show the relay and its operating principle.

In A of Fig. 24, the associated pair of contact springs "a" are resting with predetermined pressure against the insulating stops "b". This is the normal position with cam "c" free of the springs. When the relay magnet "d" is energized, B, the cam shaft, is partially rotated forcing the cam "c" against the contact springs to complete the 35 separate circuits. Note in C the dual contact surfaces on each spring and the wiping action brought about by rotation of the cam. Cams and contactors are silver plated to further reduce contact resistance and to provide protection against microphonic noises on talking circuits.

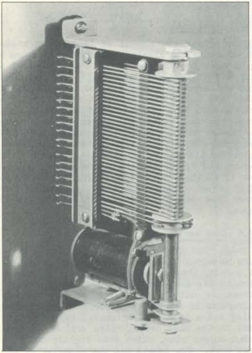

FIG. 23. ROTOR RELAY

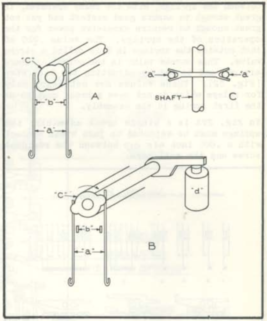

FIG. 24. OPERATING PRINCIPLES OF A ROTOR RELAY

20. BANK ASSEMBLY

The Strowger switch bank assembly as shown in Fig. 25, is made up of two banks (private and line) of brass contacts fastened one above the other on to the bottom of the switch frame by means of supports called bank rods and fasteners called bank rod collars. The top or private bank of contacts consists of 100 contacts, set in 10 horizontal rows of ten contacts each. The contacts are insulated one from the other by micarta insulators placed between the horizontal rows. Each contact on the upper bank has a terminal at the back of the bank by means of which the release trunk wire (C lead) from the switch associated with that contact is connected. The front ends of the contacts are so shaped and arranged that a pair of spring wipers on the shaft may come into contact and make connection with any contact in the 100. By means of the switch shaft, the spring wiper mentioned (called private wiper) may be raised to the horizontal plane of any row of contacts and then rotated over the row of contacts until the contact desired is reached.

The lower or line bank contains 200 brass contacts, set in 10 horizontal levels of 20 contacts each. Each level of 20 contacts is divided into 10 sets of two contacts. The two contacts of any set are placed one above the other with an insulator between them. Each of the contacts in this bank is insulated from the others by means of micarta insulating strips

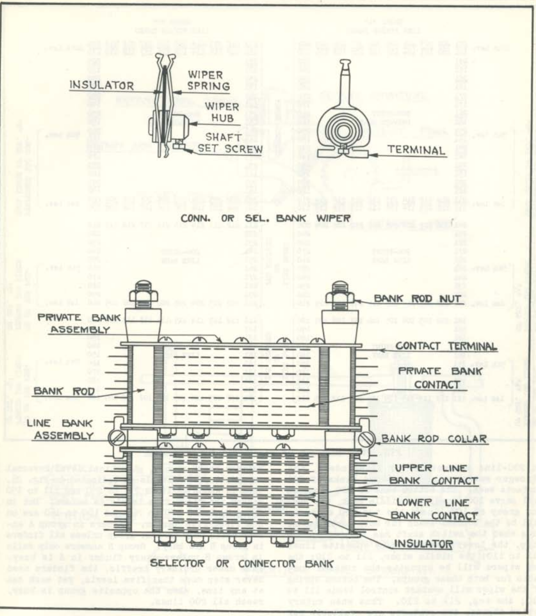

FIG. 25. WIPERS AND BANKS

placed between the horizontal rows of contacts. Each contact has a terminal at the back of the bank by means of which one of the line or trunk wires to the switch associated with the contact is connected. There are 100 pairs of wires connected to the lower bank and 100 single wires connected to the upper bank. A single wire from the upper bank and a pair of wires from the lower bank, connected to corresponding contacts on corresponding levels, are grouped together and are connected to the succeeding switch to form a trunk.

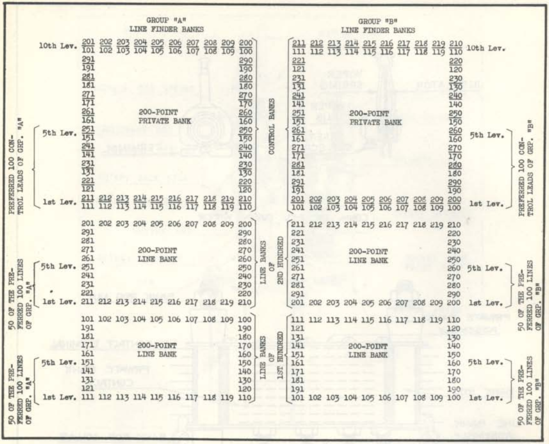

FIG. 26. DIAGRAM OF BANKS FOR A LINEFINDER

On 200-line connectors or linefinders, the Strowger switch will have three banks of 200 contacts each. The bottom bank of 200 contacts will serve 100 lines; the middle bank, the second group of 100 lines; the top 200 contacts will be the control leads for both lower banks. Thus when the switch shaft has stepped up one step, the lower wipers may be opposite lines 111 to 110; the middle wiper, 211 to 210; the top wipers will be opposite the control contacts for both these groups. The bottom spring of the wiper will contact control leads 111 to 110; the top, 211 to 210. Thus when rotary action begins, two contacts are available per step. A choice between the two groups will be automatically made.

The banks of all finder switches are not multipled alike for if they were, subscriber numbers 200 and 100 would always have to wait the maximum hunting time. To avoid this and to reduce hunting time to a minimum, the linefinders are divided into two groups, A and B. Between these groups, a vertical level reversal is made in the multiple as indicated in Fig. 26. Thus in group A, lines 211 to 250 and 111 to 150 occupy the first five levels as before. But in group B, lines 200 to 260 and 100 to 160 are on the first five levels. Finders in group A answer calls only in that group unless all finders in group B are busy. Group B answers only calls in group B unless every finder in A is busy. Thus under ordinary traffic, the finders need never step more than five levels, yet each can at any time, when the opposite group is busy, reach all 200 lines.

Each switch has a flat vertical row of bank contacts to control vertical hunting. The vertical bank is located just to the right of the semicylindrical banks. See Fig. 30. While the shaft is being stepped vertically, the vertical wiper engages the commutator (flat) bank contacts. At the first rotary step this vertical wiper disengages from its bank.

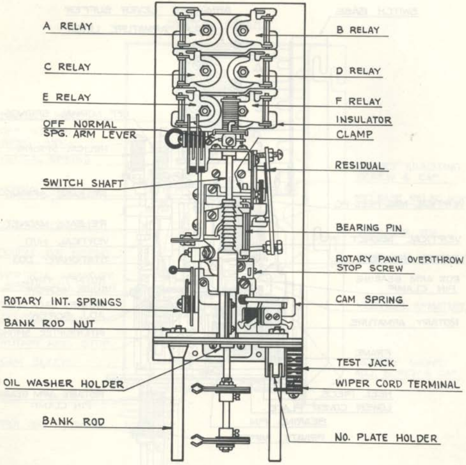

FIG. 27. SELECTOR SWITCH, FRONT VIEW

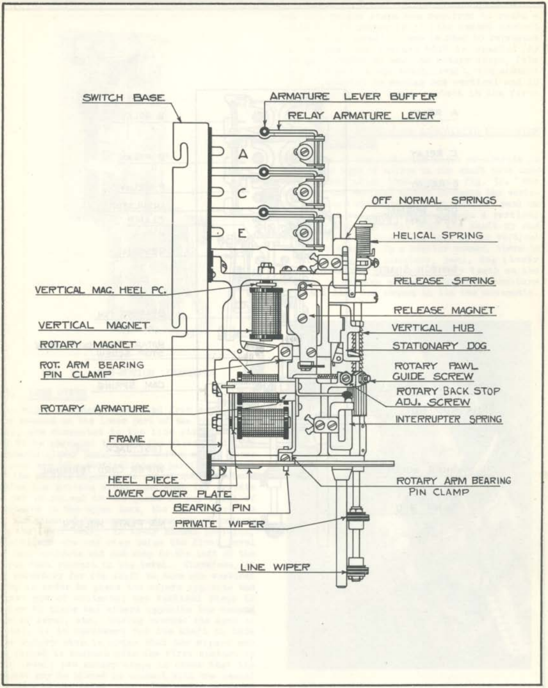

FIG. 28. SELECTOR SWITCH, LEFT VIEW

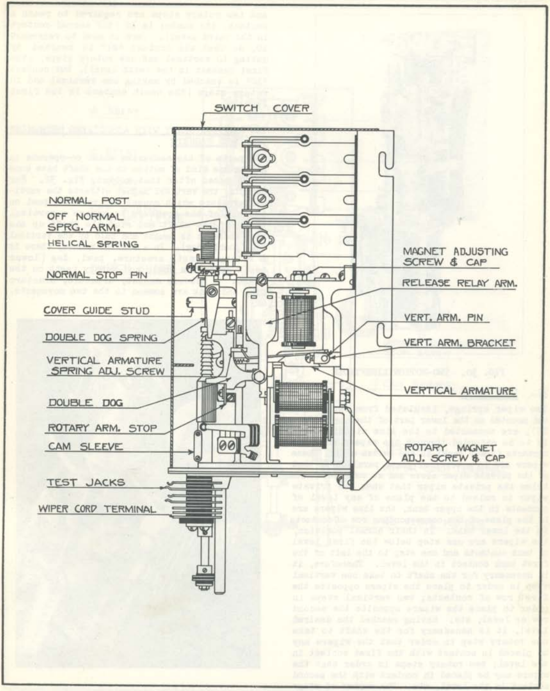

FIG. 29. SELECTOR SWITCH, RIGHT VIEW

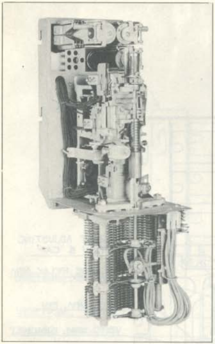

FIG. 30. TWO-MOTION LINEFINDER

21. LINE WIPER

Two wiper springs, insulated from each other and mounted on the lower part of the shaft (Fig. 25), are connected to the line circuit which is to be extended through the wipers and line contacts (lower bank) to the switch ahead. These wipers are in a vertical plane parallel to that of the private wiper above and at such a distance below the private wiper that when the private wiper is raised to the plane of any level of contacts in the upper bank, the line wipers are in the plane of the corresponding row of contacts in the lower bank. In their normal position, the wipers are one step below the first level of bank contacts and one step to the left of the first bank contact in the level. Therefore, it is necessary for the shaft to take one vertical step in order to place the wipers opposite the first row of contacts; two vertical steps in order to place the wipers opposite the second row or level, etc. Having reached the desired level, it is necessary for the shaft to take one rotary step in order that the wipers may be placed in contact with the first contact in the level; two rotary steps in order that the wipers may be placed in contact with the second contact in the level, etc. The number of steps (vertical and rotary) necessary to reach a contact determines its number. If three vertical and two rotary steps are required to reach a contact, its number is 32 (the second contact in the third level). Zero is used to represent 10, so that the contact "01" is reached by making 10 vertical and one rotary steps, (the first contact in the tenth level), but contact "10" is reached by making one vertical and 10 rotary steps (the tenth contact in the first level).

22. SWITCH SHAFT WITH ASSOCIATED MECHANISM AND MAGNETS

The parts of the mechanism which co-operate in giving one kind of motion to the shaft have come to be named after that motion, Fig. 32. For example, the vertical magnet attracts the vertical armature which causes the vertical pawl on the end of the armature to engage a vertical tooth of the shaft and step the shaft up one step where it is caught and held by the vertical dog (double dog). In a similar manner, there is a rotary magnet, armature, pawl, dog (lower tooth of double dog), and rotary teeth on the shaft. A release magnet, armature, armature pin, and link are common to the two movements.

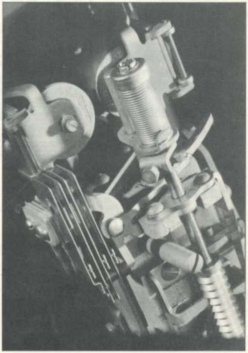

FIG. 31. UPPER END OF SHAFT SHOWING HELICAL SPRING AND NORMAL STOP PIN

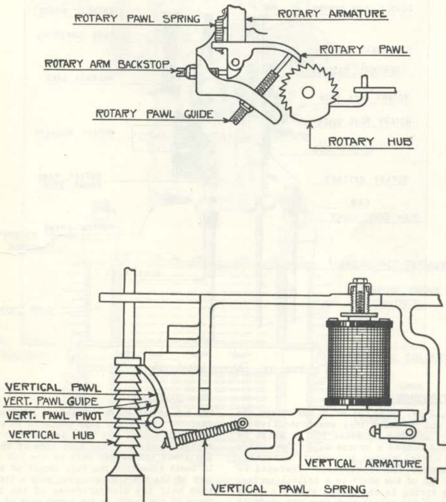

FIG. 32. VERTICAL AND ROTARY MECHANISM

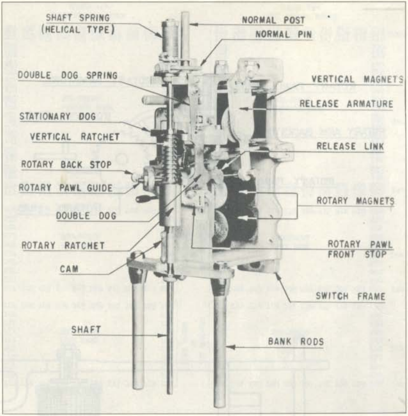

FIG. 33. SWITCH MECHANISM

23. SWITCH SHAFT

The shaft, Figs. 33&31, on which the wipers are fastened and by which they are controlled is made up of a piece of drill rod on which is pressed and pinned a bronze hub. The entire shaft is nickel plated to prevent corrosion and to improve its appearance. Fastened to the upper end of the shaft is a helical spring. Below the spring is the normal stop pin which rests against the normal post when the shaft is at normal, due to the torque exerted on the shaft by the spring. The weight of the shaft rests on the normal stop pin clamp which strikes on the upper shaft bearing when the shaft is at normal. Two bearings, one at the top and one at the bottom of the switch frame, each containing a felt oil washer, guide the shaft. Below the shaft hub is a cam in the shape of a sleeve which clamps tightly on the shaft and serves to operate the cam springs during the rotary operation of the shaft.

24. SHAFT HUB

The hub of the shaft is divided into two parts, Fig. 34. The upper part contains 10 teeth cut entirely around the hub, excepting the small vertical groove in the left side of the shaft. The lower and larger part of the hub contains 18 teeth extending the full length of the lower part of the hub but occupying only a little more than half the circumference of the hub. By means of the teeth in the upper part of the hub, the shaft is lifted step by step to produce the vertical motion of the wipers. The groove in the left side of the vertical teeth allows the shaft to pass by a stationary dog which supports the weight of the shaft during rotary motion. A vertical row of notches pressed into the vertical teeth on the right side of the shaft provides bearing surfaces for the double dog which serves to hold the shaft in place while it is off normal. The notches form a slight "raise" or "bump" on the horizontal plane of each vertical tooth and these bumps are engaged by the vertical tip of the double dog, during vertical stepping. The stationary dog is adjusted so that as the "notches" on the vertical teeth move off the vertical tip of the double dog (on the first rotary step) the edge of that vertical tooth (at the groove) passes on to the stationary dog without raising the shaft or allowing it to drop more than a perceptible amount. Therefore, as soon as the notch on the horizontal base of the vertical tooth has left the vertical tip of the double dog, there is a clearance between the double dog and the vertical tooth, and the stationary dog supports the weight of the shaft. The switch now operates to produce the rotary motion of the shaft.

To give the rotary magnets the maximum possible amount of power, the coils are set so that with the armature operated, the shaft is forced around just far enough to permit the rotary tip of the double dog to drop into a rotary notch in the shaft with a small clearance between the rotary tooth and the top of the dog. With the shaft at normal, the armature rests against the armature stop pin which is adjusted so that the pawl just clears the hub as the shaft releases. This adjustment gives the smallest possible space between the armature and the cores when the armature is normal. The steel pawl guide screw is adjusted so that the pawl strikes exactly in the rotary notches of the shaft as the armature operates. An arm on the armature causes the so-called "interrupter springs" to operate as the armature operates. The flat piece of clock spring steel fastened to the armature and bearing against an adjusting screw in the frame gives the tension necessary to restore the armature to its normal position. Both the vertical and rotary magnet coils have brass caps over the coil core ends, to cause the armatures to release quickly after the coil circuits are opened and thus allow quick positive operation of the armature.

25. RELEASE MECHANISM

The release magnet as shown in Figs. 33 and 29, is made up of a single coil mounted on a base in such a way that a horseshoe magnet is formed by the base and coil core. The annealed iron armature uses the end of the release magnet assembly base as a fulcrum and is held in place by two projections on the base which extends through holes in the armature.

At the top of the armature is a coil spring which tends to hold the armature away from the coil. An adjusting screw at the top of the armature is used to set the armature stroke. In the lower end of the armature is an adjustable pin which strikes the double dog as the release armature operates and forces the double dog into engagement with the release link. A thin strip of brass or a brass core cap between the armature and the coil prevents residual magnetism in the coil core from holding the armature in its operated position after the coil circuit is opened.

26. CAM SPRING ASSEMBLY

On the lower right hand side of the switch frame, Fig. 27, is a spring assembly operated by means of the cam clamped on the lower part of the shaft. This is called the cam spring assembly. The cam springs are generally used on selectors and when used, the shaft cam is usually adjusted to operate the springs on the 11th rotary step i.e. just as the wipers pass off the last contact on a level.

27. OFF-NORMAL SPRINGS

Near the top and front of the switch frame on the left side of the top shaft bearing, Fig. 27, is a spring assembly called the off-normal springs. The off-normal springs are operated by a lever which is engaged by the normal pin as the shaft drops to its normal position. On the first vertical step, the normal pin is lifted clear of the off-normal spring lever, and the moving springs restore against their associated back contact springs. The moving springs are

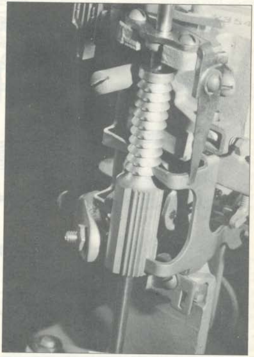

FIG. 34. THE SHAFT HUB AND DOUBLE DOG

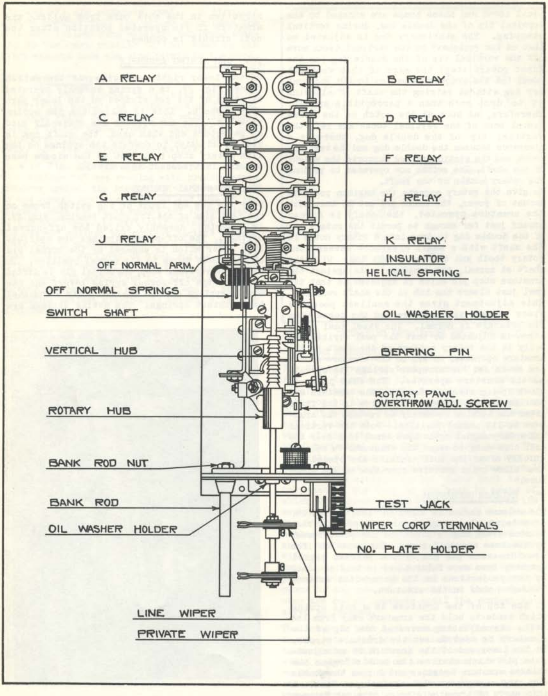

FIG. 35. CONNECTOR SWITCH, FRONT VIEW

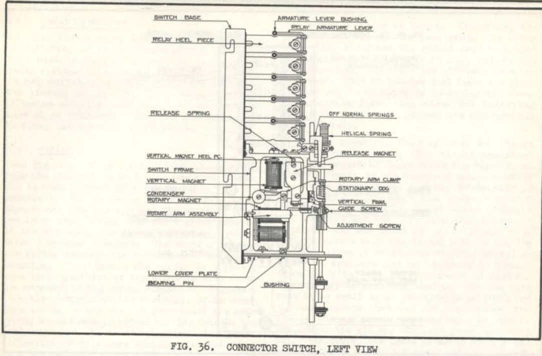

FIG. 36. CONNECTOR SWITCH, LEFT VIEW

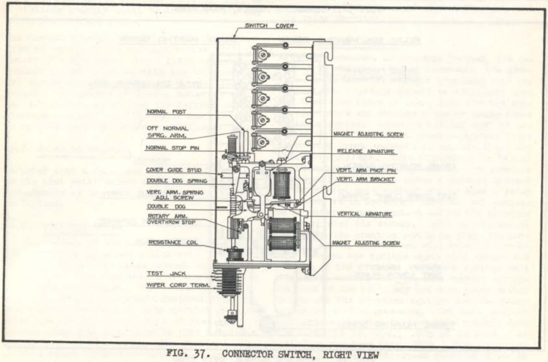

FIG. 37. CONNECTOR SWITCH, RIGHT VIEW

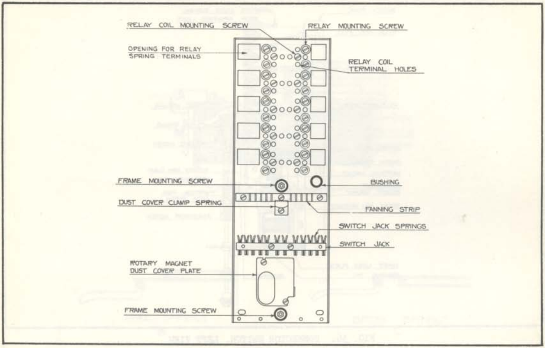

FIG. 38. CONNECTOR SWITCH, REAR VIEW

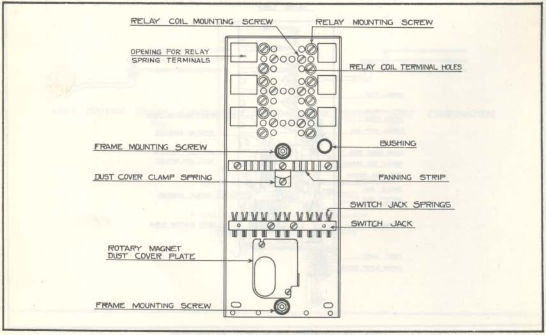

FIG. 39. SELECTOR SWITCH, REAR VIEW

adjusted with enough tension to assure good contact, but must not be made so stiff that they prevent the shaft from restoring to normal.

28. INTERRUPTER SPRINGS

On the lower left hand side of the frame, Fig. 27, is mounted the interrupter spring assembly which usually is made up of only two springs. The moving spring is operated by an arm which is a part of the rotary armature. Selectors have this assembly.

29. SWITCH FRAME

The frame, Fig. 33, to which the shaft mechanism is fastened, is cast iron. Various drilling and milling operations are performed on the frame to provide accurate locations for mounting the various parts. The frame is insulated from the pressed steel base by thick fibre insulators to prevent the passage of current from grounded magnets into the base or from a grounded base into the frame.

30. RELAY MOUNTINGS

The relays are mounted above the mechanism in two vertical rows with their spring assemblies toward the sides of the switch. Each relay is held in place by mounting screws extending through the base from the rear. The relays are insulated from the base by micarta insulators.

The relay coil terminals and spring terminals extend through the openings provided in the base so that the necessary wires are all connected and run in on the rear of the switch base. After the wires are all in place, a sheet iron cover is put over the wiring to protect it and exclude dust from the switch mechanism.

31. FANNING STRIP

A wooden fanning strip as shown in Fig. 39, makes it possible to arrange the wires very neatly before they are attached to the switch jack and serves to hold them permanently in place.

32. SWITCH JACKS

A wooden jack strip, Fig. 39, contains from 16 to 24 nickel silver jack springs insulated one from the other and arranged so that they make contact with jack clips when the switch is mounted. The jack is fastened to the rear of the base below the fanning strip. The wires are connected to these jacks after being fanned out on the wooden fanning strip provided. All circuits leaving or entering this switch pass through the jacks so that it is not necessary to disconnect any wires in removing the switch from its mounting place.

Below the jack strip is an opening in the base through which the rotary magnet adjusting screws are reached when adjustment is necessary. This opening is normally covered by a plate to exclude dust from the switch mechanism.

33. COVER

A large sheet iron cover fits over the entire front of the switch and rests on the lower horizontal part of the switch frame to which the banks are fastened. Guide posts on two relays and on the frame prevent the cover from accidentally striking the relays, springs or switch mechanism when the cover is put on.

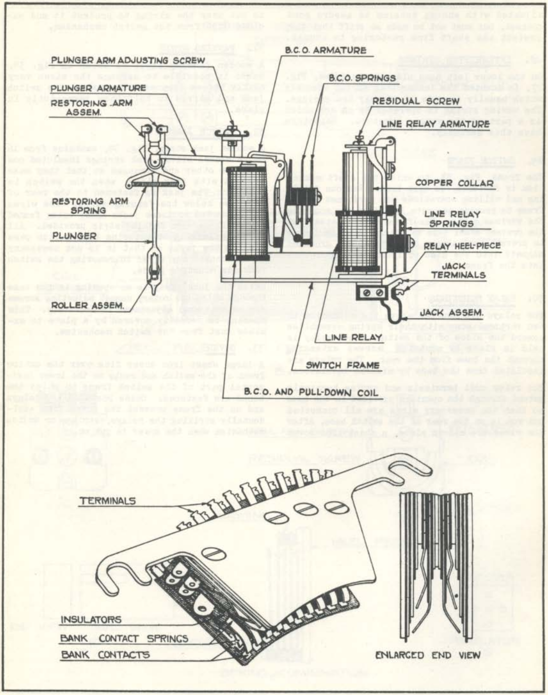

FIG. 40. LINESWITCH AND BANKS (SELF-ALIGNING TYPE PLUNGER)