H. G. WEBSTER.

SWITCHING MECHANISM.

APPLICATION FILED DEC. 26, 1916.

**1,367,338.** **Patented Feb. 1, 1921.**

4 SHEETS—SHEET 1.

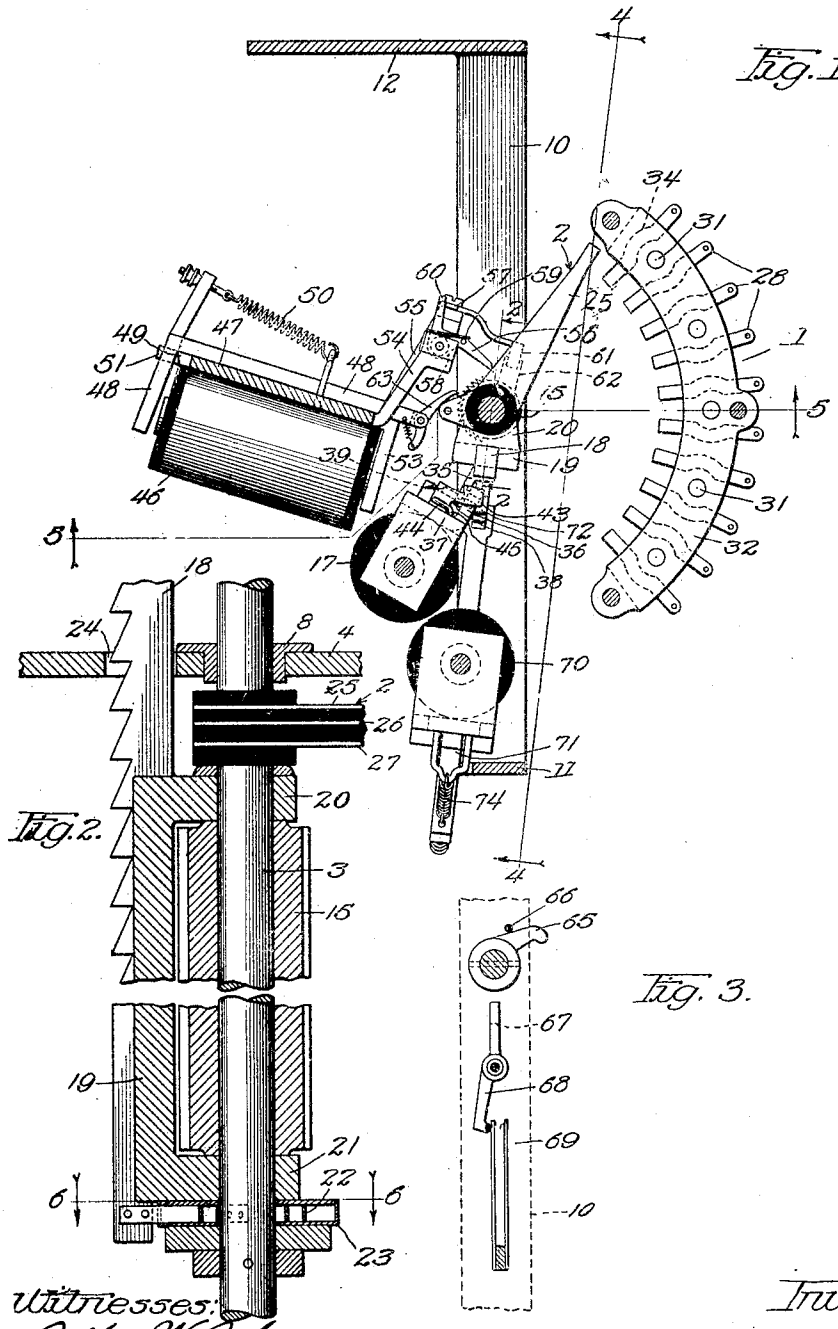

Fig. 1.



Fig. 2.



Fig. 3.

Witnesses:
Arthur W. Cahan
John A. Brenner.

Inventor:
Harry G. Webster

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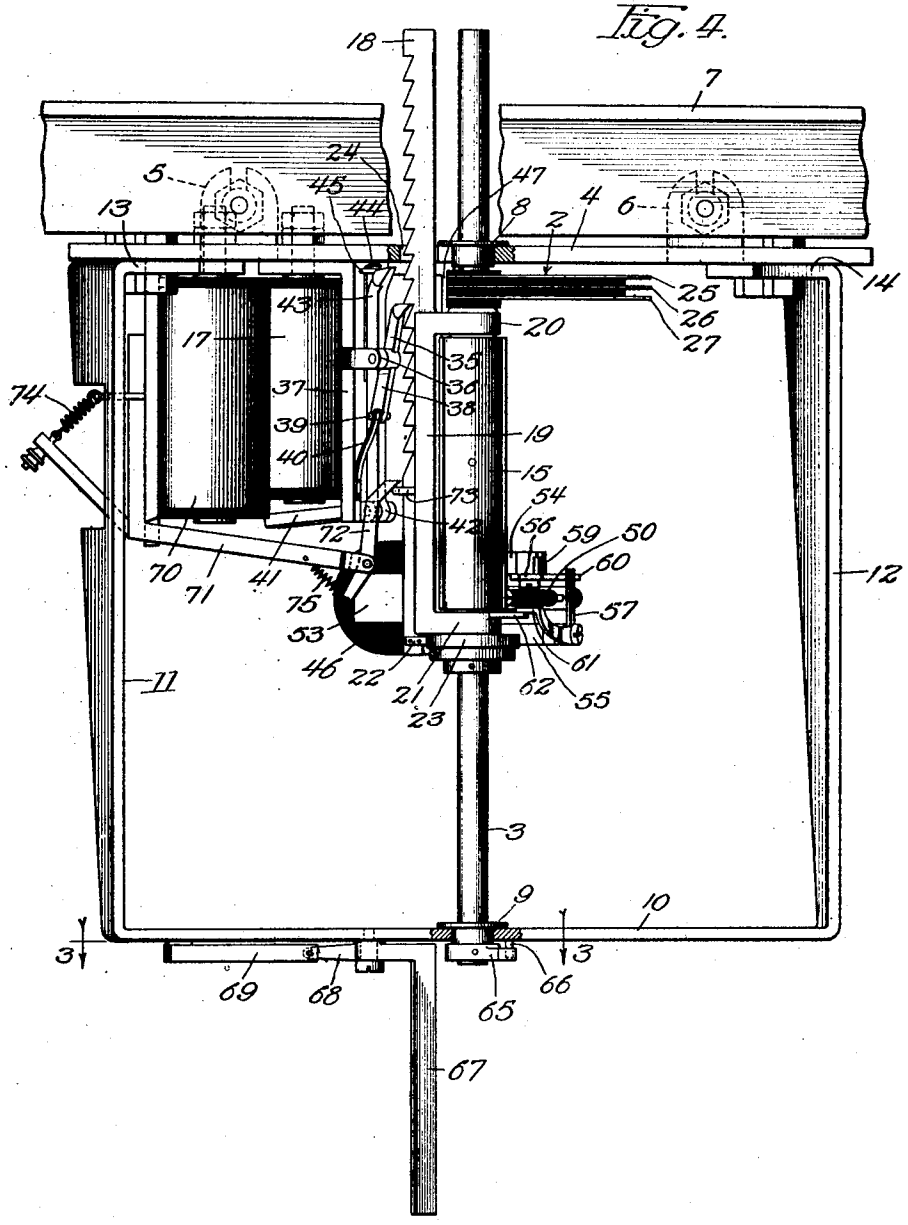
4 SHEETS—SHEET 2.

Fig. 4.

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John A. Dienner.

Inventor:

Harry G. Webster

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4 SHEETS—SHEET 3.

Fig. 5.

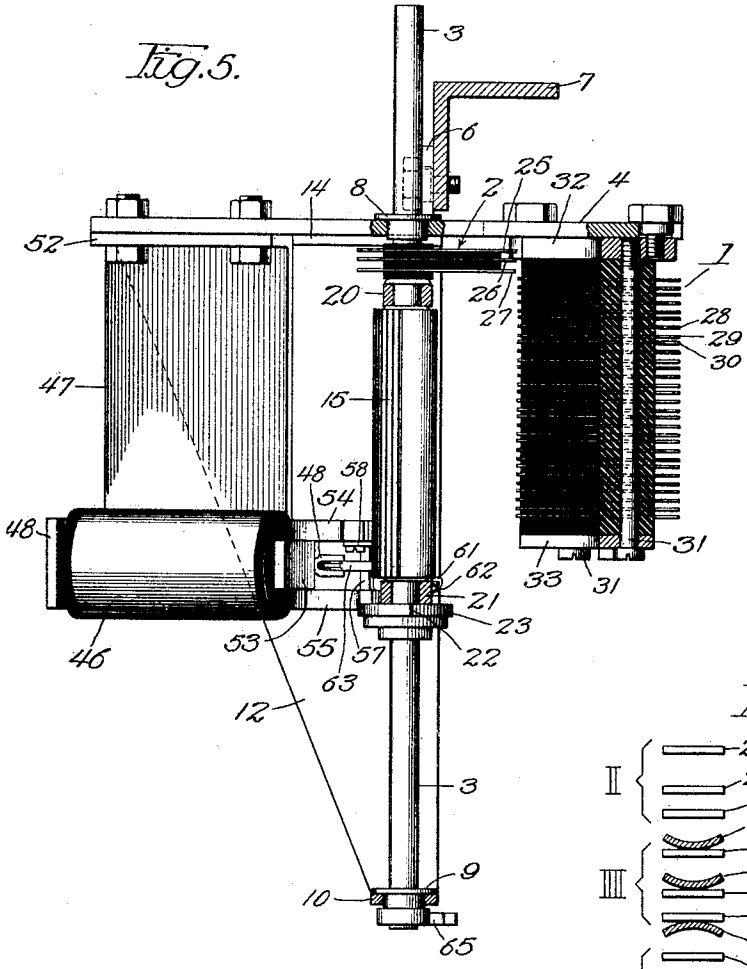



Fig. 7.

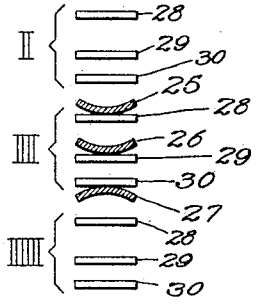
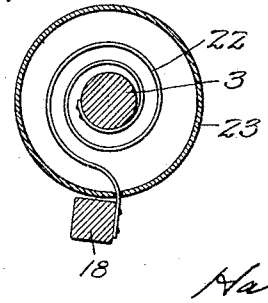



Fig. 6.

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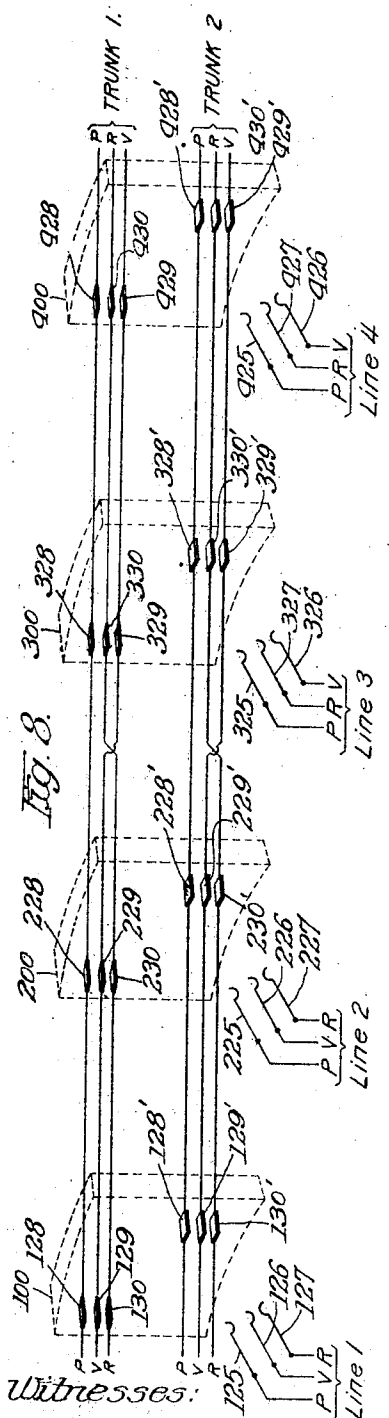


Fig. 8.

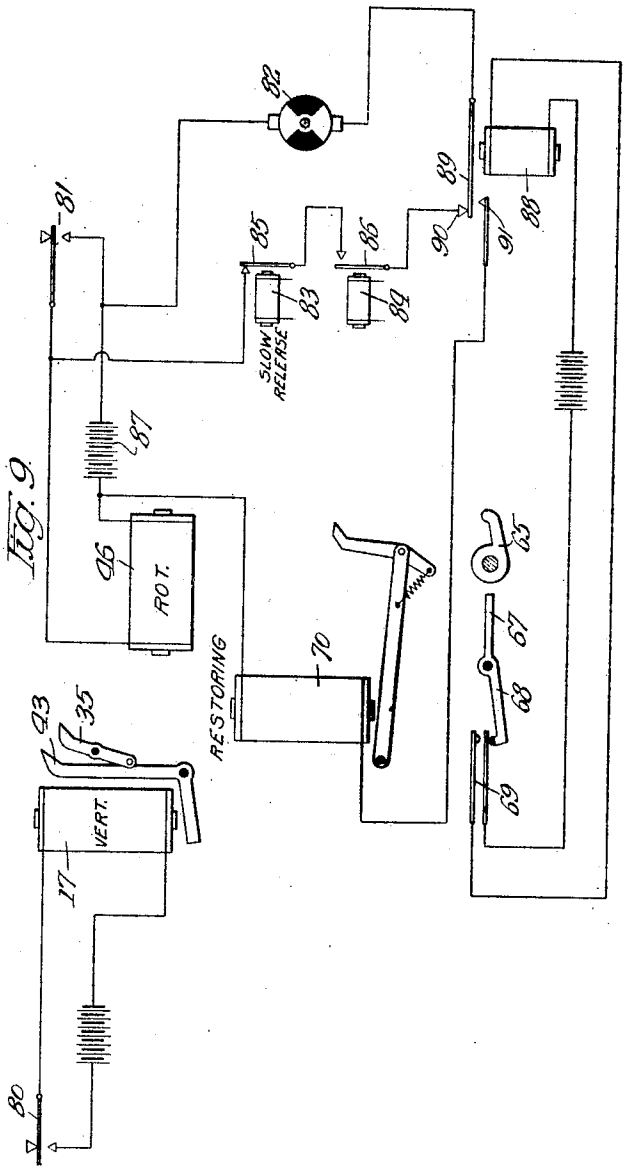


Fig. 9.

Witnesses:
Arthur W. Carlson
John A. Dienner.

Inventor.
Harry G. Webster

# UNITED STATES PATENT OFFICE.

HARRY G. WEBSTER, OF CHICAGO, ILLINOIS, ASSIGNOR TO KELLOGG SWITCHBOARD & SUPPLY COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

## SWITCHING MECHANISM.

1,367,338. Specification of Letters Patent. Patented Feb. 1, 1921.

Application filed December 26, 1916. Serial No. 138,345.

*To all whom it may concern:*

Be it known that I, HARRY G. WEBSTER, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a certain new and useful Improvement in Switching Mechanism, of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

My invention relates to switching mechanism of the general type employed in telephony for automatically extending a line or trunk connection.

The object of the invention is to provide a simple, inexpensive and compact switch structure which is characterized by speedy and accurate operation, uniform wear and ability to withstand long service. The invention further aims to provide an improved scheme of transposition of the connecting wires between switch contact and multiple bank contact so that the contact for the private wire and the contacts for the vertical and rotary sides of the line or trunk may be brought as closely together as desired without unbearable cross talk which has heretofore hindered any attempt at reducing the distance between bank contacts.

The switch of my invention is of the escapement controlled variety. I am aware that escapement controlled switches have heretofore been proposed, but I am unaware of any switch which has a free and unretarded movement of escapement to bring the wipers into a selected position. The particular switch which I shall describe as embodying my invention is of the impulse directed type and comprises a bank of contacts having sets of terminals individual to a line or trunk, arranged in horizontal rows or levels, said rows being arranged vertically one above the other. The wipers which serve said bank are normally free from contact with the terminals of the bank and the initial movement of the switch is a free movement downward by escapement to the desired level in which the particular set of contacts is to be engaged. The horizontal or rotary movement may be directive as in the case of a connector switch, or it may be selective as in the case of a selector switch.

In the switch illustrated, in order to restore the switch to normal, I move the wipers out of engagement with the bank contacts stepping the wipers forward to the eleventh position where a ten point row of contact sets is employed—(in general to the N+1 position where N is the number of contact sets in a row). The wipers are then moved to the zero or normal level as by stepping impulses to raise the movable wiper bearing switch element to its uppermost position. The wipers are then restored to normal by an automatic rotary movement as by a restoring spring. It can be seen that the wipers thus described for each action of making a connection, a complete circuit with even wear upon the terminals and a uniform speed of travel for all analogous parts of the path on each movement. The inertia of the parts is low, the structure is simple, and certainty of operation is assured. The parts are all readily accessible and are arranged to be convenient for inspection or repair.

In the drawings—

Figure 1 is a horizontal section taken below the top plate and showing the rest of the structure in plan;

Fig. 2 is an enlarged detail view on the line 2—2 of Fig. 1 showing the connection of the spindle to the vertical and rotary adjusting element;

Fig. 3 is a fragmentary sectional view taken on the line 3—3 of Fig. 4;

Fig. 4 is a front elevation of the switch with the contact bank cut away as is indicated by the line 4—4 in Fig. 1;

Fig. 5 is a vertical section taken on the broken line 5—5 of Fig. 1;

Fig. 6 is a sectional view of the restoring spring and barrel taken on the line 6—6 of Fig. 2;

Fig. 7 is an enlarged sectional view illustrating the contact between the wipers and a set of bank contacts.

Fig. 8 is a diagrammatic circuit sketch showing the method of wiring the bank contacts of a plurality of switches of the type shown in Figs. 1 to 7, inclusive; and

Fig. 9 shows a circuit arrangement adapted to be used on the switch structure shown in Figs. 1 to 7, inclusive.

The switch comprises the contact bank 1, containing terminal sets individual to lines or trunks and the movable switch wiper 2 having a set of wiper contacts for making connections with any individual set of stationary contacts in the bank. The movable wiper arm 2 is mounted upon a central spin-

dle or shaft 3, which, as will be described later, is provided with means for imparting to it a vertical longitudinal motion of translation, and an angular motion or a motion of rotation, in order to enable the wipers to engage any particular one of the sets of contacts in the bank 1. The switch bank 1 is connected to an upper frame plate 4; this upper frame plate 4 is provided with suitable lugs shown in dotted line in Fig. 4 at 5 and 6 for supporting the switch on a suitable frame or rack, as is indicated by the angle iron bar 7.

The upper end of the spindle 3 is supported in a removable bearing 8 mounted in a frame plate 4 and the lower end of the spindle 3 is mounted in a suitable removable bearing 9 mounted in the lower transverse frame member 10. The lower frame member 10 is connected to the upper frame plate 4 by triangular frame members 11 and 12, the frame members 10, 11 and 12 may be formed integral and to that end are preferably stamped out of a single piece of sheet metal. The upper ends of the frame members 11 and 12 are inturned to form feet 13 and 14 which are clamped to the upper frame member 4 by suitable bolts. The spindle or shaft 3 is provided with a cylindrical ratchet member 15 of a length great enough to permit the rotary magnet 46 to impart the necessary rotary movement to the wipers 2 in any adjusted vertical position. The vertical position of the spindle 3 is determined by the escapement magnet 17 and the vertical rack 18. The vertical rack 18 is connected to the spindle 3 by means of a yoke 19 which has bearings for the spindle 3 at 20 and 21 above and below the ratchet cylinder 15. The shaft 3 however is connected to the rack 18 by means of a spring 22 (see Fig. 6) contained within the cylinder or barrel 23 immediately below the bearing 21. This spiral spring 22 is employed to restore the spindle 3 and wipers 2 to the zero or normal position, as will be described later.

The ratchet 18 is secured to the yoke 19 and passes up through an aperture 24 in the upper frame plate 4. The ratchet 18 thus serves as a guide for holding the yoke 19 in the proper position.

The wiper arm 2 comprises three wiper springs 25, 26 and 27 which are separated by pieces of insulation from each other and from the spindle 3. The wiper 25 is adapted to extend the connection of the private or third wire of a line or trunk, while the wipers 26 and 27 are adapted to be connected in and to extend connection of the two sides of a line or trunk.

The stationary bank contacts, such as are shown at 28, 29 and 30, in Fig. 7, are placed relatively close to each other with the contact 28 which is in the third wire spaced as far away as possible from the contacts which are connected in the talking strands. The bank of contacts comprises preferably ten levels of ten sets each.

As is shown in Fig. 1, the bank of contacts 1 is arranged in the form of a cylinder, but due to the compact arrangement which I am able to employ, only a relatively small arc of a circle is required for the bank. The individual contacts are placed between layers of insulation and the contacts and layers of insulation are firmly clamped together by means of the bolts 31 which connect the upper and lower metallic plates or heads 32 and 33. It can be seen from Fig. 1 that each of the individual contacts such as 28, 29 or 30, is formed with a bent intermediate portion as shown in dotted lines in Fig. 1 at 34. The bowed intermediate portions of adjacent pairs of contacts in a row face each other so that they provide an equal clearance between each other and the bolts 31 which are placed between pairs of contacts in the same row. This permits of sufficient clearance between the clamping bolt 31 and the contacts, and between adjacent contacts from each other, while at the same time allowing the inner ends of the contacts to be spaced equally apart as is shown in Fig. 1.

The wiper arm 2 stands normally as is shown in Figs. 1 and 5, one vertical step away from the first horizontal row of contact sets, and one rotary step away from the first vertical row of contact sets. The rack 18 is held by means of the holding pawl 35 which is pivoted on a lug 36 struck up from the flux-bar 37 of the escapement magnet 17. The pawl 35 is provided with a tail 38 which bears a transverse pin 39 projecting from each side of the tail of the pawl. A leaf spring 40 engages one end of the pin 39 thereby normally holding the pawl 35 in engagement with a tooth of the rack 18. The escapement magnet 17 is provided with an armature 41 pivoted at 42 upon the end of the flux-bar 37 and having an extension substantially at right angles forming a pawl 43 which is adapted to engage the rack 18 at a point above the holding pawl 35. The armature 41 and the pawl 43 are held normally in retracted position by means of a leaf spring 44 which is connected to the pawl 43 and bears against a pin 45 which is connected to the flux bar 37 of the escape magnet 17. The pin 39 in the tail of the pawl 35 projects across the path of the releasing pawl 43 so that when the stepping magnet 17 is energized, the pawl 43 is cast into the adjacent tooth of the rack 18 and at the same time the pawl 43 striking the pin 39 disengages the holding pawl 35 from the rack thereby permitting the rack 18 to drop about half the pitch distance until the adjacent tooth rests upon the end of the pawl 43. Upon de-

energization of the escapement magnet 17, the spring 44 withdraws the releasing pawl 43 and at the same time moves out of engagement with the pin 39, thus permitting the spring 40 to cast the holding pawl 35 into the teeth of the rack 18 so that the rack 18 drops down the rest of the step thereby completing a total downward movement equal to the pitch distance between contact sets or the pitch distance between adjacent teeth on the rack bar 18. In actual operation the attraction and retraction of the armature 41 is so rapid that no appreciable stop between these two movements occurs and is in fact one continuous movement. Thus, for each current impulse through the magnet 17, the wiper arm or switch arm 2 drops one step. This downward movement of escapement is the first motion of the switch and as will be observed from the drawings, is made without any engagement of the wipers with any of the stationary contacts, thus providing a free and unhampered escapement of great rapidity. It is apparent of course that the rapidity of drop may be increased by spring tension but I find that this is not ordinarily of any advantage.

When the wiper arm 2 has dropped to the desired level, the rotary magnet 46, which is supported from the top frame plate 4 by means of an auxiliary frame plate or bracket 47, is energized by stepping impulses and the wiper arm 2 is brought into successive engagement with the sets of bank contacts in the particular level, at which the wiper arm stands.

The rotary stepping magnet 46 is provided with an L-shaped armature 48, pivoted at 49 upon the plate 47 which serves also as a flux bar. A spring 50 normally holds the armature 48 in retracted position. The supporting bracket 47 is of noteworthy construction. It is formed of a plate of sheet metal bent at right angles at its upper end to form a foot 52 which is bolted to the upper frame plate 4. At its lower end it is provided with a tongue 53 which is connected to the core of the magnet 46 and forms a magnetic extension of the same. At the opposite side it is notched or cut away, as shown at 51, to form a recess, the bottom of which has a knife edge, as shown at 49, to form the pivot for the L-shaped armature 48. A pair of short arms 54 and 55 are struck up from above and below the tongue 53 respectively, to form supports for the rotary holding pawl 56 and the pawl releasing arm 57 respectively.

The holding pawl 56 is pivoted in a separate bearing 58 and is provided with a spring 59 tending normally to cast the pawl 56 into the teeth of the ratchet cylinder 15. The pawl 56 is provided with a tail 60 which is adapted to be engaged by the pawl releasing arm 57 which is in the form of a bell crank lever. The pawl releasing lever 57 is pivoted upon the end of the arm 55. The horizontal arm of the pawl releasing bell crank 57 is provided with an inturned portion 61 which lies above a finger 62 which is connected to the yoke 21. When the parts are in normal position, as shown in the drawings, the finger 62 raises the horizontal arm of the releasing bell crank, thereby causing the vertical arm to press against the tail 60 of the pawl 56 to disengage this pawl 56 from the ratchet cylinder 15. Upon the first step downward, however, the finger 62 disengages the contact piece 61 on the bell crank lever 57 permitting the holding pawl 56 to be cast into the teeth of the ratchet cylinder 15. The armature 48 of the rotary magnet 46 is provided with a pawl 63 for rotating the spindle 3. The pawl 63 is normally out of contact with the ratchet cylinder 15 but successive impulses through the rotary magnet 46 cause the pawl 63 to engage the ratchet cylinder 15 to move the wiper arm 2 forward to the desired position for making contact with the desired set of terminals in the contact bank 1.

In this switch, instead of restoring the wiper arm by a retrograde rotary movement over the contacts, the wiper arm is advanced to the eleventh position clear of the contact bank whereupon mechanism about to be described is entrained to raise the spindle and the wiper arm to the zero or uppermost level and impart a free rotary movement to restore the switch to normal. The lower end of the spindle 3 bears a switch controlling arm 65 which normally rests against a pin 66 in the lower frame member 10 to hold the spindle and switch arm 2 in the zero rotary position. When the spindle 3 is rotated so that the switch arm 2 has been advanced to the eleventh rotary position, the arm 65 engages the flange 67 of a lever 68 pivoted on the lower frame member 10. Movement is transmitted through the lever 68 to close the vertical step controlling contacts 69 which are mounted on but insulated from the lower frame member 10. When the contacts 69 are closed, the circuit of the rotary stepping magnet 46 is opened and a circuit is closed for the restoring magnet 70. It is apparent that the contacts 69 and the lever 68 could be mounted on the upper side of the frame member 10 but I prefer to place them below said frame member in order to shield them from settling dust and the like.

The operation of raising the spindle 3 and wiper arm 2 to the normal or zero switch level is accomplished by the magnet 70 which is mounted upon the under side of the top frame member 4. This magnet is provided with an L-shaped armature 71 bearing a pawl 72 normally held out of engagement with the rack 18 by a pin 73. A suitable retractile spring 74 is provided for

the armature and a spring 75 is provided for the pawl.

During the upward movement of the spindle and connected parts, the arm 65 will be held against the flange 67 and thus maintain the contact 69 in closed condition, due to the fact that the rotary holding pawl 56 is in engagement with the eleventh ratchet tooth on the ratchet cylinder 15. Upon the performance of the last upward step the finger 62 which is mounted upon the yoke 19 engages the contact piece 61 on the releasing bell crank 57. The vertical arm of the bell crank 57 engages the tail 60 of the pawl 59 withdrawing it from the ratchet 15 and thereupon the spiral restoring spring 22 moves the spindle and the connected wiper arm 2 by a free unhampered rotary movement back to the starting or normal position. It is apparent that upon the beginning of the rotary restoring movement, the switching arm 65 will disengage the flange 67 of the lever 68 thus opening the contact 69 to break the circuit of the vertical stepping magnet 70.

The operation of the device will be apparent from the above description. Incoming vertical impulses cause the escapement magnet 17 to drop the rack, the spindle and wiper arm 2 one step or level for each impulse. It will be seen that the form of the escapement is such that the inertia or weight of the parts has no tendency to cause slippage or failure of the escapement. When the wiper arm 2 has been dropped to the desired level the rotary magnet 46 is energized to step the wiper arm forward into engagement with the desired set of contacts in the predetermined level. The holding pawl is conditioned for operation upon the occurrence of the first vertical step as has been explained before. After the desired contacts have been established, and the switch is to be restored, the release circuits are controlled to send their current impulses through the rotary magnet until the wiper arm 2 arrives at the eleventh position on that level. Upon the completion of the eleventh step the contacts 69 are closed thereby opening the circuit of the rotary stepping magnet 46 and closing the circuit of the vertical stepping magnet 70 which raises the wiper arm to the zero level. Upon the completion of the last vertical step, the rotary holding pawl is released and the wiper arm is restored to normal position by the rotary spring 22. At the same time the contacts 69 are opened and the vertical stepping magnet 70 is disconnected.

In Fig. 8 I have shown diagrammatically the wiring of the multiple contacts in the various switch banks.

In the switch bank I place the talking contacts near each other and in vertical alinement and place the private contact a short distance above the talking contacts. Thus, between adjacent sets of talking contacts, a private contact is located, and the connecting wires which connect the various switch banks in multiple are similarly arranged. The private wire of one talking set, such for instance as a trunk as is shown in Fig. 8, will be located between the talking strand of adjacent trunks. The position of the private wire is such that it is subjected to the inductive effect from both sides, that is from both trunks, and is generally very productive of cross talk.

I have overcome this tendency by transposing the vertical and rotary contacts in the switch bank and in the switch arms so that for substantially half of the length of the private wire an inductive effect of one character prevails and during substantially the other half an opposite inductive effect prevails. Thus the two inductive effects upon the private wire are neutralized, not only from one trunk, but from both trunks as well. This arrangement effectively cuts out the tendency to cause cross talk. In Fig. 8 it can be seen that the vertical and rotary contacts 329 and 330 in the switch bank 300 have been transposed with respect to the corresponding contact in the switch banks 100 and 200. The contacts in the switch bank 400 are similarly arranged to the contacts in the switch bank 300. It will also be noted that the rotary and vertical wipers for the switches serving these banks have been transposed with respect to the order prevailing in the burden to switches.

The space required to place the contact groups as I have shown demands large vertical steps and for producing such large vertical steps the switch mechanism which I have shown being of the escapement type is particularly efficient and expeditious.

In Fig. 9 I have illustrated diagrammatically the controlling circuit for the switch mechanism. The vertical escapement magnet 17 is energized by closing of the switch 80, each impulse causing the switch stem to drop one step. The switch 80 may be controlled by a suitable key or finger dial, as is well known in the art.

The rotary magnet 46 is energized by impulses created by closing the switch 81. This switch may similarly be operated by a suitable key or finger dial or may, in the case of a trunk selecting switch, be closed intermittently until the corresponding wipers rest upon an idle trunk.

Upon the completion of a conversation the rotary magnet is energized by impulses to bring the switch wipers to the eleventh step, this result being accomplished by connecting the interrupter 82 into the circuit of the rotary magnet 46. The magnets 83 and 84 which are energized during the conversation, have their circuits broken when the conversation is discontinued. The relay 83 is constructed to hold its armature 85 after

current ceases to flow in the winding for a time sufficiently long to permit the switch wipers to be set to the eleventh position. The relay 84 operates to release its armature 86 as soon as the windings are deënergized. The result of this construction is that the circuit through the interrupter 82 and the battery 87 for the rotary relay 46 is closed at the armatures 85 and 86 until the switch arrives at the eleventh position. When the switch arrives at the eleventh position the finger 65 which is attached to the bottom of the switch spindle 3 engages the tail 67 of the pawl 68 and closes the off normal switch contact 69 thereby energizing the relay 88 for opening the circuit of the rotary magnet 46 and for connecting the restoring magnet 70 into circuit with the interrupter 82 and the battery 87. This result is accomplished by means of the armature 89 which, when the switch reaches the eleventh position, is drawn from the back contact 90 against the front contact 91 to close the interrupter circuit through the restoring magnet 70.

The restoring magnet raises the switch to the normal or zero level and when the switch has reached this position, the pawl 56 is disengaged and the switch spindle 3 turns to the normal position because of the spring 22, at the same time opening the contact 69 causing deënergization of the relay 88 and interruption of the restoring magnet circuit.

I have illustrated a single magnet controlling two pawls, but I do not desire to be limited to such a construction as various adaptations of my invention will obviously suggest themselves to those skilled in the art, and its ready applications to varying conditions will be noted; nor am I limited to the escapement movement switches, nor to longitudinal adjustment, nor to interlocking pawls, as these and other details of my invention, as hereinbefore described and illustrated, are matters of preference.

While I have described my invention with reference to details of a particular embodiment, I do not intend to be limited to the details shown and described except as the same appear in the appended claims, as it is apparent that numerous modifications will at once suggest themselves to those skilled in the art.

I claim:

1. In a switch, a bank of contacts, a switch spindle movable in a vertical and in a rotary direction, a wiper on said spindle adapted to engage the contacts in said bank, a longitudinal ratchet connected to said spindle and an escapement magnet having means for permitting said ratchet to drop step by step.

2. In a switch, a bank of contacts arranged in horizontal rows on a plurality of levels, a switch spindle having a wiper movable longitudinally and rotatably to make contact with a given bank contact, a vertical ratchet connected to said spindle and an escapement magnet for causing said spindle to drop step by step free of said contacts and a rotary magnet for rotating said spindle to cause engagement of said wiper with the desired contacts in the particular row or level.

3. In a switch, a bank of contacts, said contacts being arranged upon a plurality of levels, a wiper connected to said spindle, said wiper being movable longitudinally and rotatably to make contact with the desired bank contacts, a ratchet connected to said spindle, said ratchet being parallel with the axis of the spindle, and an escapement magnet for causing said spindle to drop step by step free of said contacts.

4. In a switch, a bank of terminals arranged upon a plurality of levels, a switch spindle having a wiper movable longitudinally and rotatably to make contact with the desired terminal, a ratchet having connection with said spindle and lying parallel to the axis of said spindle, a holding pawl normally engaging said ratchet, a stepping pawl and a stepping magnet for operating said pawls to drop the spindle one tooth of the ratchet for each complete energization and deënergization of the stepping magnet.

5. In a switch, a bank of contact sets arranged in horizontal rows on a plurality of levels, a wiper arm for making connection with any desired row, said arm normally standing one vertical step above the first row or level and one rotary step away from the first contact step in any row, a vertical spindle, an escapement ratchet connected to said spindle, an escapement magnet having a pawl adapted to permit said rack and spindle to drop one step at a time, a rotary magnet for rotating said spindle whereby said wiper may be moved to any desired contact in said row, means for causing said rotary stepping magnet to step the spindle and wiper one step past the last bank contact in a rotary direction, and means operable by bringing said spindle into said last position for restoring the wiper to the normal level.

6. In combination, a bank of contacts arranged in a plurality of rows on horizontal levels, a switch spindle having a wiper arm, said arm standing normally one vertical step and one rotary step from the first contact in the first row, an escapement magnet having means for dropping said wiper in a line one rotary step away from each row, a rotary magnet for rotating said spindle upon any desired level, a restoring magnet for raising said wiper arm to the normal level, switching means operated by movement of the wiper arm one step beyond the last contact in a horizontal row for energizing said restoring magnet, means

operated by return of the wiper arm to the normal level for deënergizing said restoring magnet and spring means for restoring said wiper arm to zero position.

7. In a switch, a plurality of line or trunk terminals arranged in a contact bank having horizontal rows arranged upon a plurality of levels, a wiper arm standing normally one vertical step and one lateral step away from the first contact in the first row, an escapement magnet having means for dropping said wiper arm clear of said contact to any desired level, a magnet having means for moving said wiper arm over successive contacts in any desired row, a restoring magnet for restoring said wiper arm to the zero level, means actuated by movement of the wiper arm to a position beyond the last contact on a given horizontal row for energizing said restoring magnet, means for holding said wiper clear of said contact while said restoring magnet is operated, said means being released when said wiper arm is restored to the zero level, and automatic means for moving said wiper arm laterally back to zero position upon the zero level.

8. In a switch, a top frame plate, a U-shaped frame member, a vertical spindle having bearings in said top frame plate and in the bottom of said U-shaped member, a contact bank secured to said top frame plate member, a wiper arm secured to said spindle, said spindle being movable vertically and rotatably in said bearings, a vertical rack member connected to said spindle, said rack member being relatively non-rotatable with respect to said spindle, and means for moving said rack to adjust the vertical position of said wiper arm.

9. In combination a top frame plate, a U-shaped frame member secured thereto and depending therefrom, a vertical spindle having bearings in said frame plate and in the bottom of said U-shaped member, said spindle being adjustable axially and angularly, a wiper arm secured to said spindle, a magnet for adjusting said spindle vertically, said magnet being secured to and mounted upon said frame plate, a magnet for adjusting the angular position of said spindle, said magnet being supported solely from said frame plate.

10. In combination a bank of contact terminals, a switch spindle having a wiper for making contact with any desired contact terminal in said bank, a step-by-step motor magnet for moving said spindle downward in a vertical direction, a magnet for rotating said spindle, and a motor magnet for raising said spindle.

11. In combination a bank of contact terminals, a spindle having a wiper arm for making contact with any desired one of said terminals, an escapement rack connected to said spindle, an escapement magnet for permitting the downward movement of said spindle, a rotary magnet for rotating said spindle, and a restoring magnet for restoring said spindle.

12. In combination a bank of contact terminals, a switch spindle having a wiper arm, said spindle being movable axially and angularly, a step-by-step magnet for moving said spindle in one direction axially, another step-by-step magnet for moving said spindle in the opposite direction axially, and a magnet for rotating said spindle.

13. In combination, a bank of switch contacts, a switch spindle having a wiper arm for making contact with said contact terminals in said switch bank, said spindle being movable axially and angularly, an escapement rack connected to said spindle, an escapement magnet having step-by-step means coöperating with said rack to permit axial movement of said spindle, a rotary magnet for rotating said spindle, means for coöperation with said rack for raising said spindle and means for rotating said spindle to normal or zero position.

14. In a switch, a plurality of contacts arranged on different successive levels, a vertically movable switch member, a rack connected to said switch member, a holding pawl normally engaging said rack, a magnet having an armature for releasing said holding pawl, a second pawl connected to said armature, said second pawl being adapted to be cast into said ratchet when said holding pawl is released, and means for withdrawing said second pawl and for casting said holding pawl into said ratchet.

15. In a switch, a plurality of contacts arranged on different successive levels, a vertically movable wiper member adapted to make contact with the contacts in said switch bank, a rack member connected to said wiper, an escapement magnet having a holding pawl normally engaging said ratchet and a releasing pawl for releasing said holding pawl upon energization of said magnet, and for restoring said holding pawl upon deënergization of said magnet, and a restoring magnet having an armature provided with a pawl for engaging said ratchet to raise the switch wiper to the normal level.

16. In combination, a switch spindle movable axially and angularly, a wiper arm connected to said spindle, a magnet for causing said switch spindle to move axially downward, a magnet for moving said spindle angularly, means for holding said spindle in an off-normal angular position, a motor magnet for raising said switch spindle axially, and means controlled by movement of said switch spindle to a predetermined axial position for releasing said angular holding means.

17. In combination a switch spindle adapted to move axially and rotatably, a

magnet for moving said spindle to the zero or normal axial position, and means controlled by movement of said spindle to a predetermined angular position for energizing said restoring magnet.

18. In combination, a top or frame plate, a lower frame plate formed independently of said top frame plate, said lower frame plate having suitable members to space the same from said top frame plate, a vertical switch spindle having an operating arm secured thereto, a pair of restoring contacts, a lever for engaging said restoring contacts, said lever having an angular flange adapted to be engaged by the arm secured to said spindle.

19. In a switch, a vertical switch spindle having a ratchet drum, a yoke having bearings above and below said drum, a ratchet secured to said yoke, a rotary holding pawl for engaging said ratchet drum, a lever for disengaging said pawl from said drum and a contact member secured to said yoke for engaging said pawl releasing lever when the switch spindle is raised to a predetermined level.

20. In a switch, an upper frame plate, a depending U-shaped frame member, a switch spindle having bearings in said upper frame plate and in the bottom of said U-shaped frame member, a rotary ratchet secured to said switch spindle, a rotary magnet for said ratchet, a frame plate for mounting said rotary magnet, said frame plate being supported from said top frame member and forming a part of the magnetic circuit of said rotary magnet.

21. In combination, a frame having a top plate member, a switch spindle having bearings in said top plate frame member, a rotary magnet for said spindle, a supporting frame or bracket mounted upon the top plate frame member and depending below the same, said support or bracket comprising a plate having a lug for supporting said rotary magnet, said lug forming a part of the magnetic circuit of said magnet, a second lug on said bracket, a rotary holding pawl mounted on said second lug, a third lug on said bracket and a releasing lever for said holding pawl on said third lug.

22. An automatic switch provided with an endwise movable and rotatable switch shaft, escapement mechanism for controlling the movement of said shaft in one direction, electromagnetic means for rotating said shaft, and step-by-step electromagnetic driving means for returning said shaft to normal.

23. An automatic switch including an endwise movable and rotatable switch shaft, an electromagnetically operable step-by-step escapment device for permitting said shaft to be moved endwise, and a rotary driving magnet for rotating said shaft.

24. An automatic switch including a movable contact maker, movable first in one direction and then in another direction, an escapement device for permitting the said contact maker to be moved in said first direction, a driving magnet for moving said contact maker in the other direction, and electromagnetic and spring means for restoring said contact maker.

25. An automatic switch including an endwise movable and rotatable switch shaft, escapement mechanism for permitting the said switch shaft to operate in an endwise direction, a driving magnet for rotating said switch shaft, and a second driving magnet for returning said switch in an endwise direction to restore the same.

26. An automatic switch including a switch shaft provided with a contact maker adapted to be moved in one direction to elect groups of contacts and in another direction to select contacts in the group, an escapement device for controlling the first movement of said contact maker, and a driving magnet for controlling the second motion of said contact maker.

27. An automatic switch including an endwise movable and rotatable switch shaft, a contact maker for said switch shaft adapted to be moved first to a group of contacts and then to a contact in the group, escapement mechanism for permitting the contact maker to be moved to a group of contacts, a driving magnet for moving said contact maker to a selected contact in the group, said driving magnet also being operable to move said contact maker beyond the last contact in the said group of contacts, and a driving magnet for restoring said contact maker in an endwise direction.

28. An automatic switch including a switch shaft, a contact maker connected to said switch shaft and adapted to be moved in one direction to select a group of contacts and in another direction to select a contact in the selected group of contacts, said switch shaft being operable in said first direction by gravity and in said second direction by electromagnetic means.

29. An automatic switch including a switch shaft, a contact maker connected to said switch shaft and adapted to be moved in one direction to select a group of contacts and in another direction to select a contact in the selected group of contacts, said switch shaft being operable in said direction by gravity and in said second direction by electromagnetic means, and restoring means for said switch including a driving magnet.

30. An automatic switch including a switch shaft operable in two directions, escapement mechanism for controlling the operation of said switch shaft in one direction, electromagnetic means for controlling the operation of said switch shaft in the

other of said directions, electromagnetic driving means for restoring said switch shaft in a direction opposite to the first direction of movement of said switch shaft, and spring means for restoring said switch shaft in a direction opposite to the said second direction of movement.

31. An automatic switch including a switch shaft movable in a lineal and in a rotary direction, a ratchet attached to said switch shaft adapting said shaft to operate in a lineal direction, a rotary ratchet for said switch shaft for rotating said switch shaft, and means for preventing said first ratchet from being rotated when said switch shaft is rotated.

32. An automatic switch of the character described including a switch shaft endwise and rotatably movable, an operating magnet provided with a pair of pawls for operating said switch shaft in an endwise direction, a second magnet for operating said switch shaft in a rotatable direction, and a third electromagnet for moving said switch shaft in an endwise direction opposite to which it was moved by said first electromagnet.

33. An automatic switch provided with a shaft operable to elect a group of contacts by gravity, electromagnetic means operating said shaft to select a contact in the elected group of contacts, and means for restoring said switch shaft.

34. A switch shaft movable by gravity in one direction to elect groups of contacts, and movable in another direction to select a contact in the elected group of contacts, and means for restoring said switch shaft.

35. Selective mechanism including an endwise movable and rotatable switch shaft on which are teeth, and two pawls for working in and out of said teeth when said shaft is being moved endwise, the working in and out of either pawl producing a partial step of said shaft, and contacts for engagement by said mechanism spaced full steps apart.

36. Selective mechanism including a magnet, an armature and a pawl for said magnet, an endwise movable and rotatable switch shaft provided with a ratchet for said pawl to engage, a second pawl, and means for actuating it, said pawls being alternately actuated, and said mechanism progressing on actuation of each pawl.

37. Selective mechanism including a movable member having a vertical ratchet of teeth, a pair of devices for directly and in alternation engaging and disengaging said teeth, each device when actuated producing a fractional adjustment of said member.

38. A selective switch means including a progressing element adapted to be moved in two different directions and two devices, each adapted to engage and free said element in alternation, whereby each device controls every third movement of said element in one direction, and other means for moving said element in the other direction.

39. A selector for automatic systems, including a movable element with teeth having a normal position, and a pair of pawls to engage and disengage said teeth in alternation, whereby one pawl controls adjustment of said element in series one, three, five, etc., and the other in series, two, four, six, etc., and means for returning said element to normal.

40. A selector for automatic exchanges, including a two-dimension adjustable contact maker, and bank contacts for selection by it, teeth mechanically fixed with the contact maker, a pair of pawls to play into and out of said teeth producing alternate steps of said contact maker in the same direction, electromagnet means for moving the pawls, and means for restoring said contact maker.

41. Adjusting mechanism for selective switch means, including a progressively movable switch member, a magnet coil and pair of movable members responsive thereto adapted to engage and disengage said first member, one engaging on energization of said coil and the other on its deënergization, a progressive movement of said first mentioned member accompanying the engagement of either of said other members, a traveling contact controlled by said progressive member and contacts for engagement thereby, said latter contacts spaced apart a distance determined by the progressive movement on energization of said coil plus said movement on deënergization thereof, and electromagnetic step-by-step means for restoring said traveling contact maker to normal.

42. A telephone system of the character described including an automatic switch provided with a switch shaft, rows of bank contacts, a wiper for said switch shaft adapted to be moved adjacent the said rows of bank contacts, an operating magnet for said switch, means controlled by the energization of said magnet to move said switch shaft and wiper substantially one-half the distance between two adjacent rows of bank contacts, means operative upon the deënergization of said magnet to move said switch shaft and wiper the remaining distance, and other means for moving said wiper over the contacts of a selected row of contacts.

43. An automatic switch of the character described including a switch shaft and a contact maker carried thereby, rows of bank contacts, an operating magnet for said switch, mechanism controlled by the energization of said magnet to permit the switch shaft and wipers to move part of the distance between two adjacent rows of contacts and controlled by the deënergization of said magnet to permit the switch shaft and

wiper to move the remaining distance between the said adjacent rows of bank contacts, other means for moving said wiper over the contacts of the selected row of contacts, and restoring means for said switch shaft and wiper.

44. An automatic switch of the character described including an endwise movable switch shaft provided with a contact maker, stationary contacts adapted for coöperation with said contact maker, said switch shaft and contact maker adapted to take two half steps to move from one contact to the other, a magnet for controlling said switch shaft, and mechanism controlled by the energization of said magnet for causing the switch shaft to operate one half step and for causing the switch shaft to operate the other half step necessary to traverse the distance from one bank contact to another when said electromagnet is deënergized.

45. An automatic switch provided with a shaft operable to elect a group of contacts by gravity, means for operating said shaft to select a contact in the elected group of contacts, and electromagnetic step-by-step means for restoring said switch shaft.

46. An automatic switch provided with bank contacts, a switch shaft and a contact maker for said automatic switch for coöperation with said bank contacts, escapement mechanism comprising a pair of pawls for permitting said switch shaft to be moved by gravity to elect one of said bank contacts, and electromagnetic step-by-step means for restoring said switch shaft.

47. An automatic switch of the character described provided with an endwise movable switch shaft, rows of bank contacts, a contact maker for said switch shaft adapted to be moved opposite the different rows of bank contacts, said switch shaft and contact maker adapted to be moved by two successive half steps from one row of bank contacts to another, and a magnet for said switch shaft provided with pawl mechanism for actuating said switch shaft to move it one half step when the magnet is energized and to move the switch shaft the other half step when the magnet is deënergized.

48. An automatic selective switch mechanism having an endwise movable rotatable switch shaft provided with a rack of teeth, two pawls for working in and out of said teeth when the shaft is being moved in an endwise direction, the working in and out of either pawl producing a vertical stepping of said shaft, other mechanism for rotating said shaft, a wiper carried by said shaft, and bank contacts for engagement by said wiper.

49. A selective switch mechanism having an endwise movable and rotatable switch shaft, a rack provided with teeth connected to said shaft, a pair of devices for directly and in alternation engaging and disengaging said teeth, each device when actuated producing a fractional adjustment of said shaft, means for rotating said shaft, and means for restoring the same to normal.

In witness whereof, I hereunto subscribe my name this 23rd day of December, A. D. 1916.

HARRY G. WEBSTER.