C. H. NORTH.

AUTOMATIC SWITCH FOR TELEPHONE SYSTEMS.

APPLICATION FILED DEC. 8, 1908.

977,536. Patented Dec. 6, 1910.

4 SHEETS—SHEET 1.

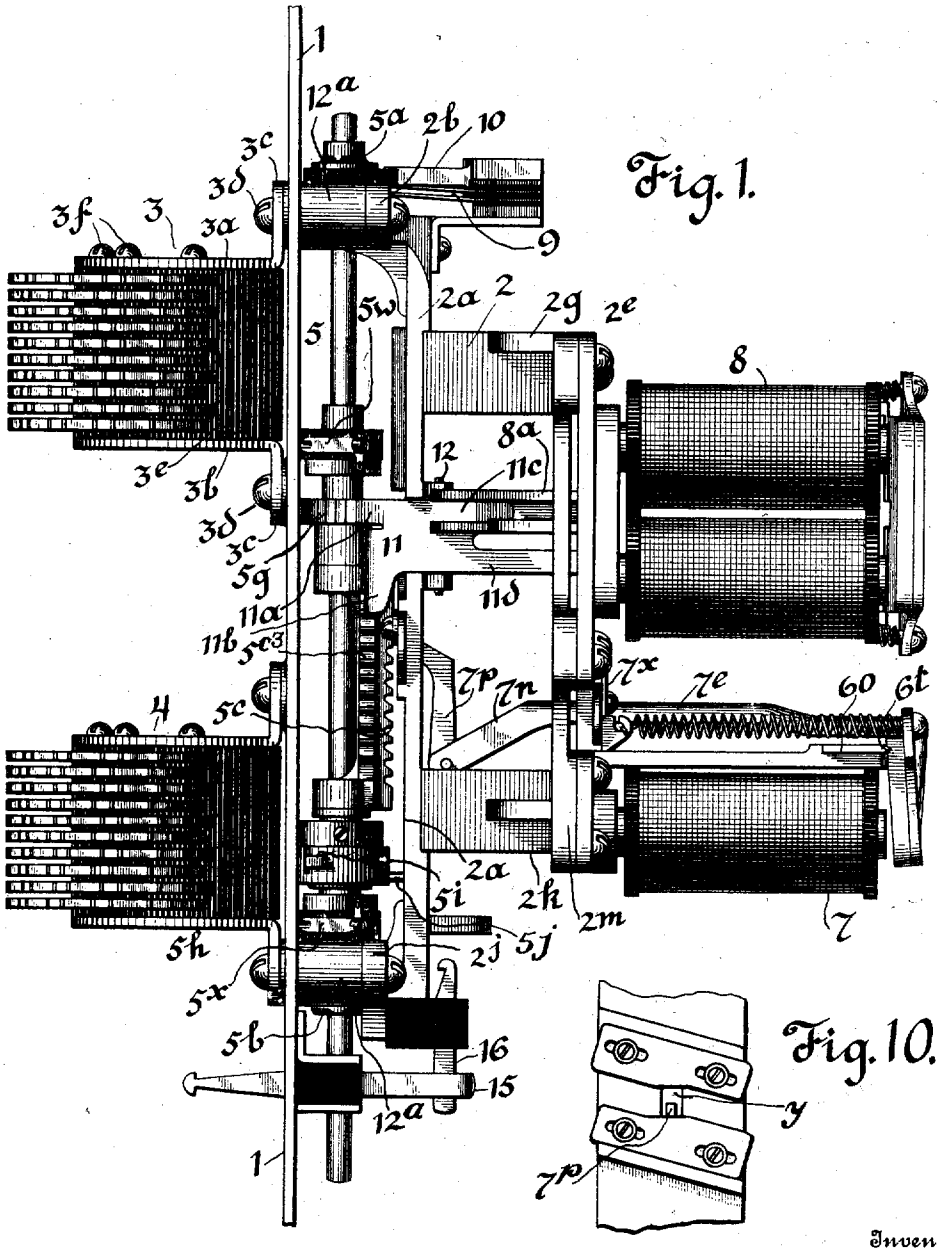

Fig. 1.

Fig. 10.

Witnesses
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H. B. Löwenstein.

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4 SHEETS—SHEET 2.

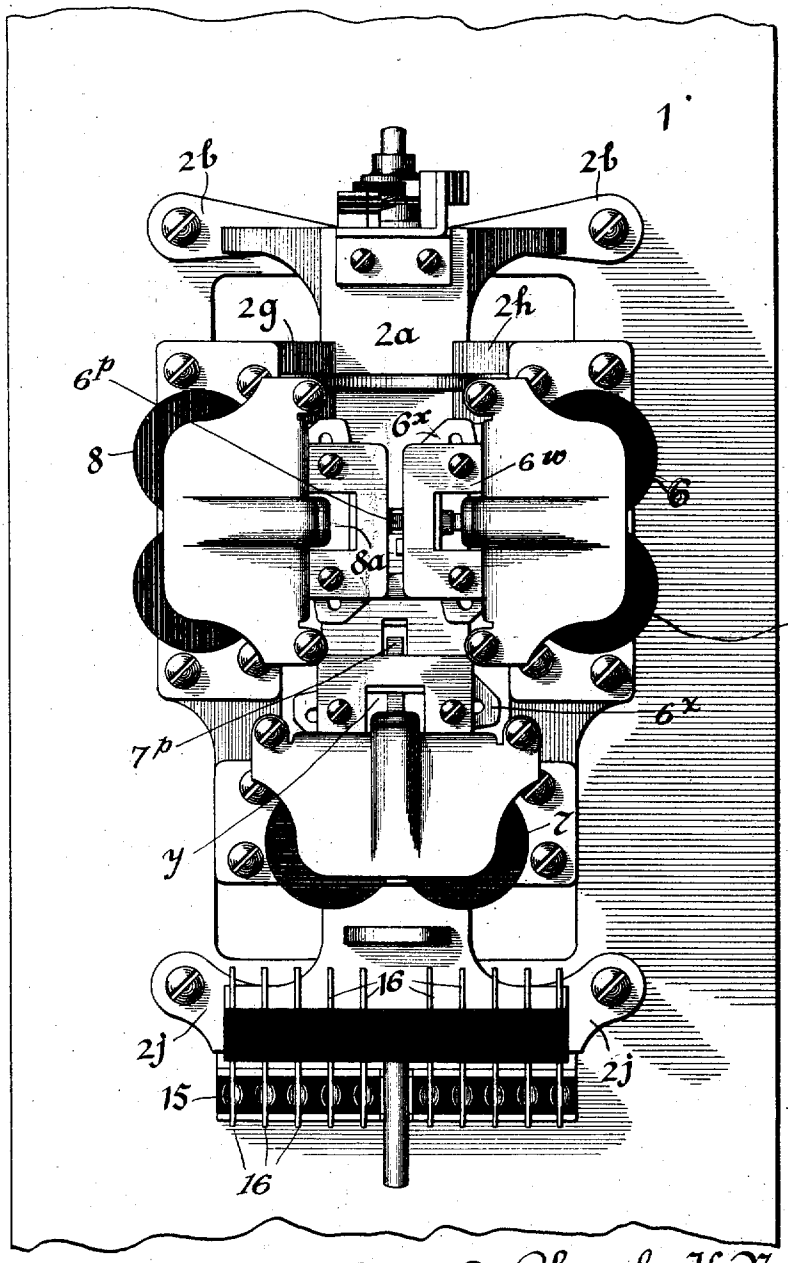

Fig. 2.

Witnesses

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4 SHEETS—SHEET 3.

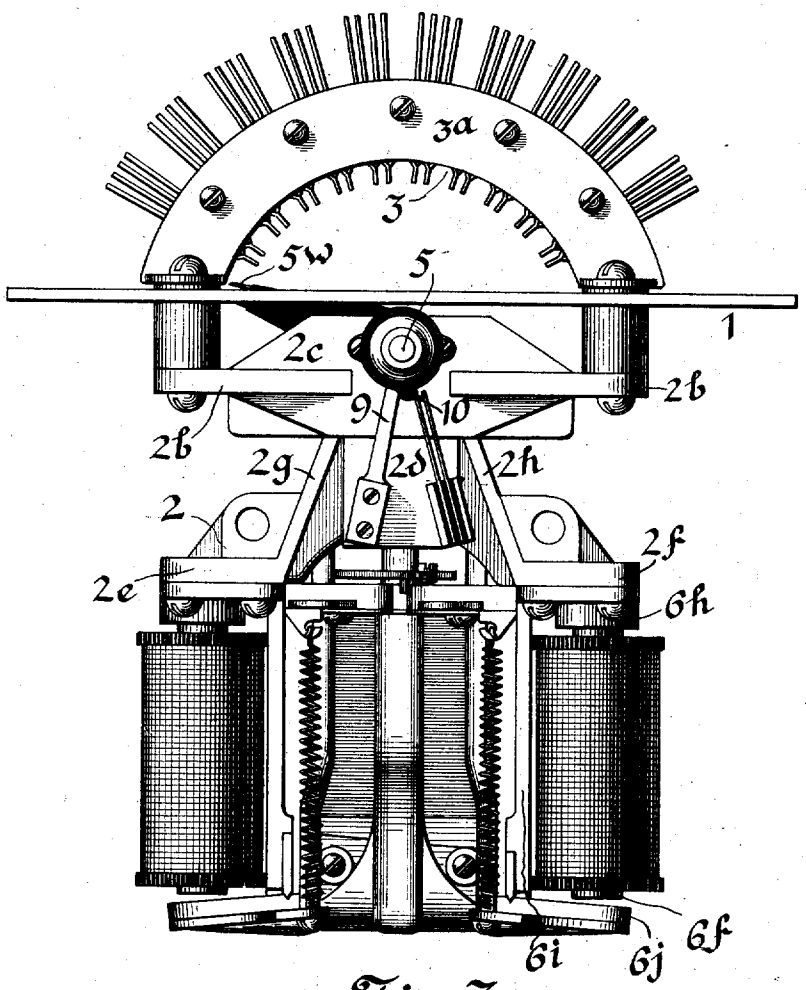

Fig. 3.

Witnesses

[illegible] Whiting

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4 SHEETS—SHEET 4.

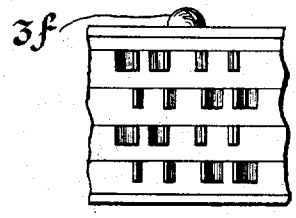


Fig. 9.

Fig. 6.

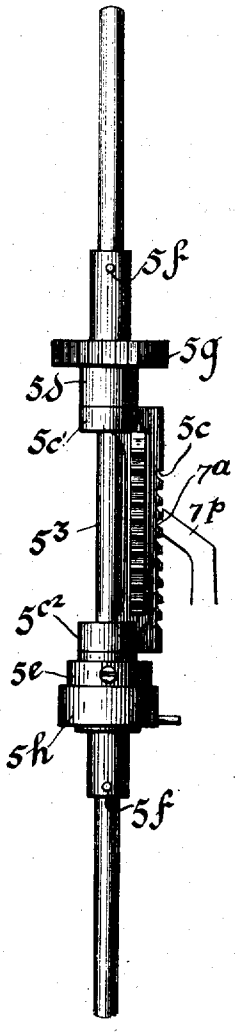
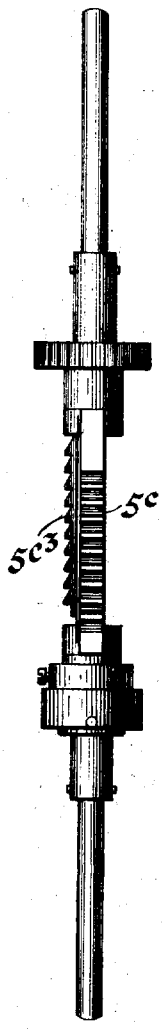


Fig. 7.



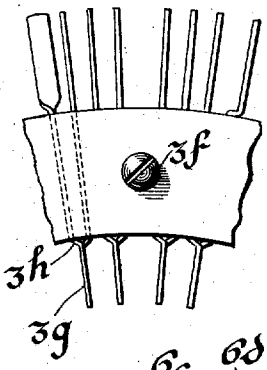


Fig. 8.

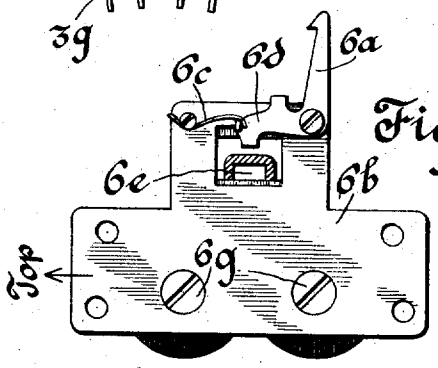


Fig. 5.

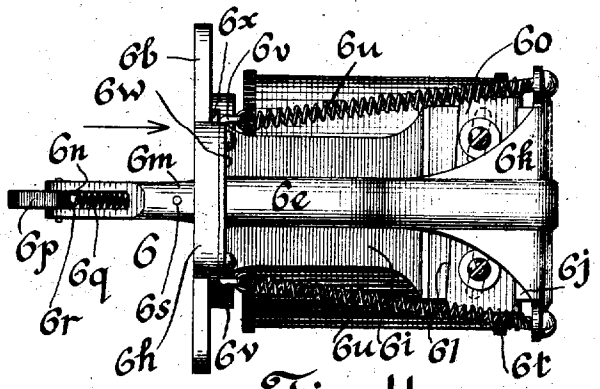


Fig. 4.

Witnesses
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H. L. Bowenstein.

Inventor
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By Edward E. Clemens
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UNITED STATES PATENT OFFICE.

CHARLES HOWARD NORTH, OF CLEVELAND, OHIO, ASSIGNOR TO THE NORTH ELECTRIC COMPANY, OF CLEVELAND, OHIO, A CORPORATION OF OHIO.

AUTOMATIC SWITCH FOR TELEPHONE SYSTEMS.

977,536. Specification of Letters Patent. Patented Dec. 6, 1910.

Application filed December 8, 1908. Serial No. 466,572.

To all whom it may concern:

Be it known that I, CHARLES H. NORTH, a citizen of the United States, residing at Cleveland, in the county of Cuyahoga and State of Ohio, have invented certain new and useful Improvements in Automatic Switches for Telephone Systems, of which the following is a specification, reference being had therein to the accompanying drawing.

My invention relates to so-called automatic switches for telephone systems, that is to say switches employed to effect connection between different lines or circuits, by mechanical means electrically controlled.

It has particular reference to such switches as are used in telephone systems for selectively connecting a given circuit with any one of a number of other circuits. The switches heretofore employed for this purpose are well exemplified in Patents Nos. 815,176 and 815,321, granted to Keith and Erickson March 13, 1906.

The object of my invention is to produce a switch which shall be at once simpler and more efficient than those heretofore available, quickness and certainty of movement being points particularly in mind.

In order to attain my object I provide one or more banks containing the contacts from which selection is to be effected, mount the same upon a suitable support, and associate therewith a frame carrying a spindle and wipers, together with operating magnets therefor. In order to secure quickness and certainty of operation, I mount the magnet armatures upon knife-edges, and in order to increase the ease of maintenance and repair, as well as decrease the cost of manufacture, I make these magnet structures interchangeable units.

Various other points of improvement will sufficiently appear from the detailed description hereinafter and the appended claims.

My invention is illustrated in the accompanying drawings wherein;

Figure 1 is a side view of a switch embodying my invention; Fig. 2 is a rear view thereof; Fig. 3 is a plan view of the same; Fig. 4 is a plan view of one electromagnet unit removed from the frame; Fig. 5 is an end view thereof looking in the direction of the arrow in Fig. 4, and showing a latch for the release movement, this particular unit being the rotary magnet; Figs. 6 and 7 are detail figures of the spindle and its ratchets removed from the frame; Fig. 8 and Fig. 9 are plan and face views of a portion of a contact bank, showing the method of inserting and securing the springs therein. Fig. 10 is a detail view of a modification for the adjustable pawl stop.

Referring to the drawings, 1 represents a plate upon which the different parts of the switch are mounted. Upon the back of this plate are secured the banks 3 and 4, and upon the front of it a frame 2 carrying the spindle 5 with its wipers, the operating magnets 6 and 7, and the release magnet 8. The banks 3 and 4 are alike in their construction and a brief description of one will suffice for both. The bank 3, therefore, consists of ten straight vertical rows of ten pairs of contacts each, held in a body of insulating material, and clamped between side plates 3^a and 3^b, each of which is provided with ears 3^c, through which screws 3^d are inserted to secure it upon the plate 1. The body of insulation 3^e, is preferably built up of layers or curved strips of a suitable insulating composition, but it may be molded solid, the contacts in that case being set in the die and the composition molded around them. Where the strips are employed, they are slotted or grooved to receive the contacts, which are placed therein as indicated in Figs. 8 and 9, and then the successive strips piled up from the bank. Where the slots are made exactly the same width as the contacts, however, there is a tendency for the latter to work loose, and I remedy this by having the strips molded with the slots from .003 to .008 of an inch shallower than the width of the springs. The contacts being insulated and the strips piled up, the top and bottom plates 3^a and 3^b are put in position, the screws 3^f are inserted, passing from the top to the bottom plate and tapped into the latter, the bank is placed in an oven and heated sufficiently to soften the composition a little, and then by tightening the screws or otherwise forcing the plates 3^a and 3^b together, the contacts will be forced into the substance of each strip, both above and below, until the surfaces of the strips meet, thus insuring an absolutely tight grip. In Fig. 8 I have shown each contact 3^g with a small return bend in it at 3^h, but with a straight tail on the outside of the bank. The bend 3^h is for the purpose of preventing

longitudinal displacement outwardly and to prevent the same inwardly. I may adopt either of the two expedients shown in Fig. 8, one on the left hand side, where the contact is given a quarter turn outside the bank, the other on the right hand, where it is given a straight offset or bend on the outside. These two methods may be combined if desired, and it will be observed in Fig. 9 that the offset at 3^h affords an opportunity to increase the insulation between the respective contacts by setting the offset in opposite directions in alternate rows and by setting it oppositely for each pair if desired. The contacts are all placed with their surfaces vertical and the wipers are slipped around beneath the rows of contacts until the desired row is reached, and then pass up that row. This it will be observed is a reversal of the method employed in the Keith and Erickson switches hereinbefore referred to. In those and in all of the Strowger switches the movement is up to the row and then around the row, the contacts being arranged with their flat surfaces horizontal. The vertical arrangement, however, I consider to be better, because it makes the contacts self-cleaning, which is an important point in apparatus of this character.

The frame 2 consists of a finished white metal or similar casting having a vertical straight-faced member or body 2^a, with upper and lower attaching arms 2^b and 2^j respectively. Carried upon suitable forward extensions 2^g, 2^h and 2^k, are front mounting plates 2^e, 2^f and 2^m. These are of course connected by suitable webs or flanges in casting so that the whole frame is properly braced without superfluous metal. The arms 2^b have an intermediate horizontal web 2^c carrying the upper bearing for the spindle 5, and an extension 2^d of this web carries the vertical and rotary cutoff contact springs 9 and 10 which are actuated by the spindle as it returns to its zero or normal position. A similar web at the bottom of the frame carries the lower bearing for the spindle, these bearings being formed in separate collars or bushings inserted through openings molded in the webs of the frame.

The spindle 5 slides vertically and also rotates in the bearings 5^a and 5^b. This vertical or sliding movement is produced by means of a rack 5^c, best shown in Figs. 1, 6 and 7. This rack does not turn with the spindle, but has upper and lower collars $5^{c'}$ and 5^{c2} through which the spindle passes and through which it turns, these collars lying between fixed collars or sleeves 5^d and 5^e secured upon the spindle in any suitable way as by means of the pins 5^f. The upper collar 5^d carries the rotary ratchet 5^g, and the lower collar 5^e carries the casing 5^h within which the coiled spring is carried for restoring the switch to its zero position. This coiled spring is secured at its inner end upon the spindle and its outer end to the casing 5^h as indicated at 5^i in Fig. 1. The casing carries the pin 5^j which slides along the edge of the frame 2^a and thereby keeps the tension of the spring constant for all vertical positions. The rack 5^c has its teeth formed in a peculiar way. Instead of each having one long inclined face and one short face, as usual with ratchet teeth, they are formed by merely milling out or casting in the rack a succession of approximately semicircular openings. The pawl 7^p coöperating with these teeth, and which is shown in engagement therewith in Fig. 6, has not the usual sharp nose, but instead has a squared end, with a slight projection 7^a adapted to fit into the curved indentations in the ratchet. By this construction I minimize the wear on the parts, and secure a strong grip or engagement between them. The retaining pawl for the vertical ratchet, and the teeth which coöperate with it are on the side thereof as shown at 5^{c3} in Figs. 6 and 7, and are of the ordinary conformation.

Coöperating with both the rotary and vertical ratchets is a double detent dog 11, pivoted at 12 and having an upper straight member 11^a engaging the rotary ratchet, a lower hooked pawl 11^b engaging the side ratchet 5^{c3} on the vertical rack, and two tails 11^c and 11^d, the former engaged by the end of the armature lever 8^a of the release magnet 8, and the latter adapted to engage and to be held by a latch 6^a pivoted on the frame 6^b of the rotary magnet 6 (see Fig. 5).

In operation, when the release magnet is energized, the lever 8^a is thrown over (to the right in Fig. 2), the tail 11^d of the dog 11 is thrown with it and engages the latch 6^a, being held thereby so that in case the release magnet is deënergized before the release switch is fully restored, the dog will not be released, and the complete restoration of the switch will not be interfered with. The latch 6^a is a bell crank pivoted at its angle and normally held in latching position by a spring 6^c bearing upon its tail 6^d. The armature lever 6^e of the rotary magnet is the first to move when the switch is actuated, and its first movement, lifting the tail of the latch, releases the dog 11, and permits the pawls 11^a and 11^b to engage their respective ratchets and thereby properly perform every function of holding the spindle in a position to which it may be stopped and until it is again released.

The three magnets 6, 7 and 8 are made as identical and interchangeable units. I believe that I am the first to succeed in accomplishing this important end, which not only greatly reduces the expense of initial production, but insures accuracy and uniformity in the adjustment and working of the several magnets, as well as ease and effi-

ciency in maintenance, since the removal of a magnet and the substitution of a new one therefor is but the affair of a moment. The only difference then between the rotary and vertical units, and the release unit, lies in the provision of a differently shaped pawl, and in the case of the release unit of no pawl at all.

It will be observed in Fig. 1 that the bifurcated end of the lever 8^a is open, serving to strike against the inclined tail 11^e of the detent dog. In Fig. 4 I have shown one unit detached, its armature lever being fitted with a pawl. A description of this unit will suffice for all the units, and as Fig. 4 is a plan view only, reference may be had to any of the units in the other figures to supplement this illustration. For the purposes of this description we will assume that Fig. 4 represents the rotary unit 6. This is mounted on a frame plate 6^b, which may be of iron or other suitable metal.

The two magnet cores 6^f are secured to the plate by screws 6^g (see Fig. 5), and are provided with an iron yoke 6^h, if the frame plate is of non-magnetic metal. Along one side of the electromagnets lies an extension member of the frame, 6^i, constituting a support for the armature. This armature is formed of a plate of soft iron 6^j, with an aluminum bell-crank lever 6^k riveted to it. A long arm 6^m of this lever constitutes the continuation of a rib formed up in the aluminum body, and as the lever is beveled off at its end, a bifurcation results, as indicated at 6^n, the two sides of the lever forming cheek pieces for the reception of the pawl 6^p normally held with its point out by the spring 6^q, extending from the tail of the pawl at 6^r to a fixed stud 6^s. Where the unit is to be used for release, as indicated at 8 in Fig. 1, the pawl, spring, and stud are omitted.

The armature plate 6^j is scored across near the top, so as to take over the knife-edge 6^t, formed on a tapered plate 6^o, secured upon the top of the frame bar 6^l by screws extending through washers and slots in the taper plate. The inclined edge of this plate rests against a shoulder 6^l formed on the frame plate, and adjustment of the armature to and from the cores is readily accomplished by loosening the screws and sliding the plate laterally, this motion being permitted by the slots, and the plate 6^o resting against the shoulder 6^l in all positions, so that all strain and wear is taken up by the frame plate. The arrangement of this shoulder and the strip are well shown in Fig. 1, where the magnet 7 is presented in side elevation. It should be noted that Fig. 5 shows the unit turned upon its side, with the top to the left, as indicated by the arrow in that figure.

The armature, and the bell-crank lever 6^k are held against the top of the frame plate 6^l, by means of helical tension springs 6^u, hooked at one end into eyes 6^v attached to a transverse plate 6^w carried on the frame plate, and formed with an opening through which the lever arm 6^e passes. A transverse sliding plate similar in its movement to that carrying the knife-edge 6^t is provided under this plate 6^w, to adjust the throw up and down of the lever, as indicated at 6^x in Figs. 2 and 4, and at 7^x in Fig. 1. I limit the throw of the pawls 6^p and 7^p, of the rotary and vertical magnets respectively, by fitting slides to the frame member 2^a, as indicated in Figs. 1 and 2. It is particularly important that the motion of the actuating pawls be positively limited, in order to avoid any over-throw, and to positively with-draw each pawl from its ratchet when its armature retracts, so that it may fall into the succeeding tooth. Fig. 2 shows the adjustable limiting plate or slide for the vertical pawl, which is marked 6^x in that figure and 7^x in Fig. 1. By loosening the holding screws, and sliding the plate slightly from side to side, the edges of the opening y in the plate may be raised or lowered as required.

In operation, when the pawl is thrown up by the action of the magnet, its nose 7^a is forced into one of the indentations in the vertical ratchet, so that it carries the spindle with it. As the upper edge of the pawl comes against the upper end of the opening y in the limiting plate, its own motion stops, and because of the peculiar shape of the nose and of the indentations, the vertical motion of the spindle also ceases instantly, thus obviating any possible liability to "over-throwing," or moving more than the single step intended. As the pawl drops, its lower edge strikes the lower edge of the opening y, and it slides out, tensioning its spring 6^q, ready to engage the next tooth if the magnet is again energized. This transverse plate may be made in two parts, or rather two separate plates for upper and lower stops of the pawl 7^p may be provided, the upper one presenting its lower edge to the pawl, and the lower one its upper edge, as shown in Fig. 10. These adjusting plates are all of steel, may be case-hardened, and afford a means for very accurate adjustment of the parts and of their movements. I consider that the broad principle involved in the use of these plates is original with me, and that they form important elements of the switch structure, hence I shall claim the same accordingly.

In assembling this switch, the frame 2 is secured to the plate 1 through the medium of short posts 12^a, by screws passing through the ends of the arms 2^b and 2^j. The length of these posts is such that when the screws are set up, the spindle 5 is centered with regard to the curvature of the banks, so

that its wipers 5^w and 5^x (see Figs. 1 and 3) will engage the contacts in the banks when the spindle is rotated by the magnet 6 and raised by the magnet 7. In operation the magnet 6 works first, turning the spindle until the wipers *w* and *x* come under the desired row of contacts, the spindle being held in position by the nose 11^a on the dog 11, engaging the rotary ratchet 5^g. The spindle and its wipers are then raised step by step through the agency of the magnet 7, until the wipers rest upon the desired contacts in the row selected. The switch is adapted to be used for any purpose, and in any circuit, either as a selector or connector. To restore it to zero, the magnet 8 is energized, attracting its armature and causing the end of its lever 8^a to force over the tail 11^c of the dog 11 until the tail 11^d engages and is held by the latch 6^a on the rotary mounting plate. The detents 11^a and 11^b are then disengaged from the respective ratchets 5^g and 5^{c3}, and the spindle drops of its own weight until the wipers have cleared the row with which they were engaged, after which the spring in casing 5^h turns the spindle back to the zero position in the drawings.

For convenience in making connections, I provide a set of jacks on the lower portion of the plate 1, as indicated at 15, coöperating blades 16 being carried on the lower part of the frame 2. The jack springs 15 are mounted in an insulating strip and extend through to the back of the plate for ready access in wiring, and the upper ends of the blades 16 are notched for connection to the terminal wires of the magnets and the wipers.

I am aware that some changes may be made in matters of detail in this structure, without affecting the design or the essential features of my invention. I wish it thoroughly understood that all such non-essential changes or modifications are contemplated by me, if within the scope of the appended claims.

Having thus described my invention, what I claim and desire to secure by Letters Patent of the United States, is:

1. An automatic switch comprising relatively fixed contacts, a relatively movable selective contact, and a plurality of electromagnets having mechanical connection with and control of said movable contact, all of said electromagnet structures being identical and interchangeable units.

2. In an electrical switch, a contact bank, a coöperating wiper, and a plurality of electromagnets controlling the wiper, each of said magnets comprising a pair of spools, a frame, an armature and armature lever, and means at the end of the lever for attaching a pawl, and all of said magnets being made as identical and interchangeable self-contained units.

3. In an electrical switch, relatively fixed contacts, a relatively movable coöperating contact, and a plurality of electromagnets to control said movable contact, all of said magnets being identical and interchangeable self-contained units, and each comprising a frame, a pair of cores carrying spools thereon, a knife-edge on the frame adjacent to the ends of the cores, an armature fulcrumed on the knife-edge and extending across and in juxtaposition to the cores, and an armature lever extending forwardly parallel to the cores and beyond the frame with retracting springs secured to the frame.

4. In an electrical switch bank contacts and a coöperating movable wiper contact, with a plurality of controlling magnets therefor all formed as self-contained identical and interchangeable units, and each comprising a frame or return bar with an end plate for attachment to the switch frame, a pair of cores and magnet spools mounted on the end plate with a suitable connecting yoke, the cores extending parallel to the frame, a knife-edge on the frame adjacent to the free ends of the cores, an armature fulcrumed upon said knife-edge, a lever extending from the upper end of the armature along the return bar and having its end fitted with actuating or controlling means for the movable contact, and spring means extending between the armature and frame serving to keep the lever down against the frame bar, and at the same time to keep the armature seated on its fulcrum.

5. An electric switch comprising fixed and movable contacts, a spindle for the latter, ratchet devices for the spindle, and a plurality of identical and interchangeable self-contained actuating and controlling elements for said ratchets, each comprising the following instrumentalities: a separate frame, a pair of magnet cores and spools thereon, an adjustable knife-edge, an armature fulcrumed on the knife-edge, an armature lever extending from above the knife-edge to beyond the end of the frame, means for attaching an actuating pawl to said lever and retracting springs for the armature serving also to hold the same in position upon its fulcrum.

6. In an electrical switch, relatively fixed and relatively movable contacts, and a plurality of electromagnets for producing variable coördination between said contacts, said electromagnets being identical and interchangeable self-contained units, each comprising the following instrumentalities: a frame having a right angle end piece, a pair of magnet cores and spools with a suitable magnetic yoke mounted upon the end piece and extending parallel with the frame, an

adjustable knife-edge on the forward end of the frame, an armature fulcrumed on said knife-edge and extending across and in juxtaposition with the ends of the magnet cores, an armature lever of greater length than the frame extending over the top thereof and bifurcated at its end to receive an actuating pawl, and a pair of helical springs secured at one end to the frame and at the other end to the armature above the knife-edge, whereby the lever is normally maintained in a depressed position, and the armature is kept upon its fulcrum.

7. In an electrical switch, relatively fixed and relatively movable contacts, and a plurality of actuating electromagnets therefor constituting identical and interchangeable units, each comprising a core and spool, a frame, and an armature and retracting springs therefor, and a knife-edge fulcrumed for the armature consisting of a tapered strip of hardened steel with a straight knife-edge and an inclined back, together with slots extending parallel to the back, and screws in the same securing the strip on the frame, with its inclined back resting against a complementary inclined shoulder or flange formed on the frame, whereby lateral movement of the strip will result in longitudinal adjustment of the armature to and from the magnet cores, and when set the parts may be locked on the frame, with the back of the strip against a solid abutment to take up all shocks of pounding.

In testimony whereof I affix my signature in presence of two witnesses.

CHARLES HOWARD NORTH.

Witnesses:

GEO. H. FISTER,

EDWARD E. CLEMENT.